UNGIWG United Nations Geographic Information Working Group

United Nations Spatial Data Infrastructure

UNSDI COMPENDIUM

A UNSDI Vision, Implementation Strategy and Reference Architecture

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Preface

Geographic information, known variously as geospatial data, geodata, or geo-information is vital for the execution of many United Nations activities. These range from peacekeeping and humanitarian assistance in which knowledge of the locality and terrain are indispensable, to development, environment and health programmes in which geographically referenced data are equally critical for sound planning and coordination.

Historically, the production and use of geospatial data have been accomplished within the United Nations by its component organizations, in accordance with their individual needs and expertise. But concordant with the recent, rapid increase in the use of geospatial data for UN activities is the need for greater coherence in its management system-wide.

The United Nations Geographic Information Working Group (UNGIWG) established in March 2000, currently coordinates activities and formulates policies concerning geographic information that affect the work of UN Organizations and Member States. UNGIWG comprises a voluntary network of professionals working in the fields of cartography and geographic information science that seeks to address common geospatial issues - maps, boundaries, data exchange, standards, naming conventions, and location. It also works directly with non-governmental organizations, research institutions and industry to develop and maintain common geographic databases and geospatial technologies to enhance guidance and operational capabilities.

In November 2005, at its 6th Plenary Meeting in Addis Ababa, UNGIWG endorsed the concept of establishing a Spatial Data Infrastructure (SDI) to add coherence to geospatial data management in the UN context, to assist sustainable development and support achievement of the UN Millennium Development Goals.

Spatial data infrastructures provide an institutional and technical foundation of policies, interoperable standards and procedures that enable organizations and technologies to interact in a way that facilitates spatial data discovery, evaluation and applications. Such data infrastructures have been established by national governments, UN partners and others to foster more efficient and effective use of spatial information thereby strengthening economic development, improving management of natural resources, and assisting protection of the environment.

Scope and methodology of this report

Compilation of this 'UNSDI Compendium' represents a major step in the ongoing process of development and refinement of a UNSDI. It is both a reference and a guide to assist that process: A borrow-pit of concepts, experiences, references, requirements and proposals regarding SDIs in general, as well as a subject matter 'Yellow Pages' and assemblage of recommended UNSDI building blocks.

The draft content of the Compendium was presented at the 7th UNGIWG Plenary Meeting in Santiago, Chile in November 2006 in the form of a 'UNSDI Discussion Paper' commissioned earlier in 2006 by UNGIWG. Updates and feedback from, and subsequent to the 7th Plenary were also utilized in compilation of the UNSDI Compendium.

The vision, implementation strategy and reference architecture outlined in the 'UNSDI Compendium' are built upon the findings of the original 'Geographic Information Strategic Plan for the United Nations[1]' prepared in 2001-2002, upon ensuing global research regarding spatial data infrastructures, and upon user requirements and experiences concerning geographic information obtained from U.N system operatives and from its external partners. In this regard, individual consultations and interviews conducted in 2006 included a range of UNGIWG members in Rome, Geneva and New York, and the GSDI, GIST and other groups relevant to this undertaking, as well as representatives of regional SDI initiatives and select Member States.

This process enabled views on a possible UNSDI and the issues associated with its development to be assessed directly from a wide variety of UN and external stakeholders and strategic partners. It also provided an understanding of current GIS-related activities within and outside the UN system that are of relevance to the development of a UNSDI. A review of documentation related to the ongoing and planned SDI initiatives of UNGIWG members and other national and international institutions that may eventually link to the UNSDI was also undertaken, as was an investigation into the possibilities for forming strategic partnerships, capacity building and mechanisms for long-term sustainability of the initiative. The outcome of these reviews and investigations is contained in the UNSDI Compendium that follows.

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[1] A report of the UN Cartographic Section

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[2] Rob Atkinson (Social Change Online), Jody Garnett (Refractions Research), Joshua Liebermann (Traverse Technologies), Pier Giorgio Marchetti (ESA) Ludwig Moeller (ESA), Doug O'Brien (IDON Technologies), Raj Singh (OGC), Jeremy Tandy (UK Met Office), Jeroen Ticheler (FAO), Suha Ulgen (UN-OCHA), Mick Wilson (UNEP)

Table of Contents

Part II: Building for the Future

Part III: Implementing the UNSDI

Part IV: An Architecture for the UN Spatial Data Infrastructure

List of Tables

List of Figures

List of Boxes

List of Appendices

Executive Summary

Background and justification

Whether in the quest for peace, advancing the health, education or well being of children, women and the afflicted, or reducing poverty, improving food security, responding to natural disasters, safeguarding the environment or advancing sustainable development, the United Nations' increasingly requires spatially representative information to realize its goals for the benefit of all.

These 'geospatial' data contain embedded information about the location, shape and relationships among and between geographic features. Typically, they include topographic and cadastral surveys, satellite imagery and aerial photographs, censuses and household surveys, biological inventories and the like.

Historically, the production and use of geospatial data has been accomplished within the United Nations by its component organizations and in accordance with their individual needs and expertise. The result has been a proliferation of approaches concerning the management and use of these information resources by UN organizations. But to maximize the potential benefits of geospatial data for UN operations and business processes, greater coherence in their system-wide management is essential.

This was acknowledged at an operational level in March 2000 with the establishment of the United Nations Geographic Information Working Group (UNGIWG). UNGIWG comprises a voluntary network of professionals working in the fields of cartography and geographic information science that seeks to address common geospatial issues - maps, boundaries, data exchange, standards, naming conventions, and location. It works directly with non-governmental organizations, research institutions and industry to develop and maintain common geographic databases and geospatial technologies that enhance guidance and operational capabilities.

UNGIWG also coordinates activities and formulates policies concerning geographic information that affect the work of UN Organizations and Member States. As a result, the working group identified the need for an enterprise-wide solution that ensures the coherent use and management of geospatial data for UN activities. The concept of developing a Spatial Data Infrastructure (SDI) to service these data management needs was duly approved by UNGIWG members in 2005[3], in the context of a UN-specific SDI, or UNSDI.

UNSDI Vision

At its core, the UNSDI should contribute substantively to the Mission of the United Nations and realization of the UN Millennium Development Goals. By facilitating efficient global and local access, exchange and utilization of geospatial information, a UNSDI can enhance decision-making on a global basis and at all levels of societies, for the benefit of human-kind and the environment.

Decision-making is enhanced globally and at all levels of societies by the UNSDI, benefiting humanitarian assistance, sustainable economic development and environmental protection.

[3] At the 6th UNGIWG Plenary Meeting held in Addis Ababa, in October 2005

UNSDI Mission

Spatial data infrastructures provide the institutional and technical foundation of policies, interoperable standards and procedures that enable organizations and technologies to interact in a way that facilitates spatial data discovery, evaluation and applications. Thus, the development of a UNSDI is considered essential for increasing system coherence for the use and exchange of geospatial data and information for UN activities.

UNSDI is a mechanism for adding system coherence for the applications and exchange of geospatial data for UN activities

Structure and content of the report

The UNSDI Compendium comprises four main sections:

- Part I: Responding to a Changing World
- Part II: Building for the Future
- Part III: Delivering the UNSDI Strategy
- Part IV: An Architecture for the UN Spatial Data Infrastructure

Each is reviewed below, with a summary of the main findings and recommendations contained in the Compendium.

Part I: Responding to a Changing World

The opening chapters of the report examine the driving forces and benefits of establishing a UNSDI in the current UN context and progress toward achieving this objective.

Current UN context

The principal UN activity clusters to be served by a UNSDI include:

1. The ongoing UN Reform Agenda, 'investing in change' to:
    - Raise UN efficiency and effectiveness
    - Undertake comprehensive management reform in 2007
    - Increase UN System-wide Coherence for 'Development, Humanitarian Assistance and the Environment'
2. Achieving UN Millennium Development Goals by 2015, with focus on:
    - Eradication of extreme poverty & hunger
    - Ensuring environmental sustainability
    - Developing a global partnership for development (including information and communications technologies)
3. Accommodating the demands of growing 'Global Governance':
    - Countries increasingly work in the context of multi-lateral agreements
    - The UN is a repository for the non-commercial, human knowledge base – including the commons of data

- The UN Secretary General's vision that all UN activities should be rights-based, including access to information.

Together, these activity clusters define the strategic context for geospatial data in the United Nations and the attendant requirement for increasing system coherence in the application and exchange of such data for UN activities.

Building the case for a UNSDI

In Chapter 2 of the report, the case is built for establishment of a UNSDI. The broad justification for spatial data infrastructures is captured in the 1994 statement of US President Clinton concerning the coordination of geographic data acquisition and access in the United States Federal Government.

> ***".. to promote economic development, improve our stewardship of natural resources, and to protect the environment." (US President Clinton 1994)***

The message is a universal one, however, being equally applicable to all nations and the international organizations that serve them in seeking these laudable outcomes. Increasingly, decision-makers in national governments are recognizing the value of spatial information for economic and social development and the associated need for implementing SDIs to cost effectively harvest this potential. SDI programs have blossomed on a national scale since the original NSDI initiatives were implemented in countries such as Australia, Canada and the United States in the 1990s, and now span the full gamut of national economic development conditions prevailing in the countries concerned, from highly developed to developing economies.

Spatial data infrastructures are formally defined and discussed in Chapter 2, but in brief they comprise: '..*an umbrella of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management and production of geo-spatial data*[4]'.

Through use of interoperable data standards, descriptions and standards-based networking tools, SDIs lend order and predictability to the discovery, evaluation, and relative accessibility of geospatial data.

They are also about stakeholders working smarter not harder and about re-use, sharing and learning from others:

1. Re-use:
   - re-use of geospatial data and information
   - re-use of technical capabilities
   - re-use of skills developed
   - re-use of intellectual effort and capital
2. Sharing:
   - 'sharing-not-wearing' the costs of people, technology and other shared infrastructure assets by stakeholders, helping to realize more rapid returns on investment

[4] After Ottichilo, 2005

3. Learning from others:
    - Avoiding the pitfalls experienced by others

Key stakeholders

The unique functions of the United Nations mean that the key stakeholders of a future UNSDI span the full spectrum of spatial data users and producers. This includes users and generators of global scale datasets all the way down to users and producers of local and even village level spatial data. Key UN stakeholders will be drawn from United Nations ranks in the Secretariat and its numerous Programmes, Funds and Agencies that currently utilize or plan to utilize spatial data in fulfilling their mandates. Additionally, individual Member States, regional organizations, and United Nations partners in business, academia, the not for profit sector and foundations, and concerned citizens around the globe will form an integral part of a future UNSDI.

Trends in the development of SDIs

The Compendium delves in some detail in Chapter 3 into the experiences of others who have established SDIs to highlight the lessons learned. National, sub-national, regional, global, thematic, academic and other types of SDIs are reviewed. Strong parallels appear to exist between the generation and management of geospatial data and information in federal systems of government and those of the United Nations, making their experiences all the more relevant too a UNSDI. Issues such as governance, leadership, communications, data standards, legal issues, data access, coordination and interoperability feature commonly among the SDIs reviewed as needing to be addressed for success.

An important trend is noted toward employment of geospatial enterprise architectures by several national SDIs that has encouraged greater interoperability across government agencies in these countries. And the need for a business and management approach in the development of a UNSDI is also increasingly affirmed by the experiences of others. In the context of the United Nations, an international, geospatial enterprise architecture would similarly encourage interoperability, but across international jurisdictions and with all UN Member States.

Assembling the essential components of a UNSDI – lessons learned

Taking into account the experiences of organizations, agencies and nations that have successfully implemented SDIs, the key components for success include data quality and interoperability standards, inclusion of digital base and thematic framework maps and their attribute data, metadata (data documentation and catalogues), and interoperable services that typically support data discovery, access, processing and integration via the Web. But the influence of intangible factors such as the people, procedures and the work cultures involved will likely wield 80% of the responsibility for the success or otherwise of a UNSDI. As a result, the technical features of a UNSDI will need to be integrated with appropriate governance mechanisms and human and financial resources to forge a robust and efficient spatial data infrastructure.

A future UNSDI should thus encompass the technologies, policies, criteria, standards and people necessary to promote geospatial data sharing throughout the United Nations and its Agencies, Funds and Programmes and, to the maximum extent possible, those of its Member States and partners. It should also encourage the best practices and relationships among producers and users of geospatial data to facilitate its sharing and

use for more precise and informed decision making in support of the UN Millennium Development Goals and UN Charter.

UN business cases driving development of a UNSDI

The evolution of a spatial data user community in the UN is discussed in Chapter 4 of the report. Very different rates of adoption and achievement exist across the system with respect to geospatial information and supporting technologies. As a result, a distinctly bi-modal UN user community now exists regarding competence with, and dependence upon, geospatial data and information.

Among this user community, four primary business cases drive the need for a UNSDI, one that can increase system coherence in the management of geospatial data across the UN system:

1. Provision of spatial data and information including:
   - Cartographic data, satellite imagery and GIS services system-wide
   - Thematic data to supporting the three pillars of sustainability
   - Data from, and for, global and regional environmental observation and assessment
   - Data to support emergency response and disaster preparedness
2. Development of common data services to:
   - Increase sharing and potential reuse of data internally and for immediate partners such as member states
   - Adopt/develop data standards, metadata and the provision of technical infrastructure
3. Capacity building
   - Internal, UN capacity building to increase efficiency and effectiveness
   - External capacity building in spatial information related subjects, primarily with member states and regions to strengthen abilities to share and utilize spatial data
4. Promotion of partnerships and cooperation
   - Strategic partnerships promoted to leverage spatial data access and support capacity building

Recent SDI proposals and inter-agency cooperation

UN bodies dependent upon geospatial data for normative activities have steadily grown to accept the need to structure information management more effectively within their own agencies - and with their partners - to improve data reliability, exchange, and utilization.

Significant initiatives have accordingly been initiated by individual agencies or groups of UN partners to address common data sharing issues. OCHA for example, proposed the development of modular, service-oriented, and standards-compliant web-based information architectures and UNEP has scoped out a notional SDI. FAO and other agencies steered the development of GeoNetwork opensource, a software tool that facilitates interoperability and single point of entry access to geospatial data and systems. UNOSAT and UNOOSA also facilitated operational access to satellite data coverage to assist in responding effectively to natural and manmade disasters.

These and other examples of inter-agency cooperation supporting the evolution of a UNSDI are reviewed in Chapter 4.

The role of UNGIWG in development of a UNSDI

The inter-agency structure, aims, and functions of the United Nations Geographic Information Working Group (UNGWG) and the activities of its six Task Groups are reviewed in Chapter 5 of the Compendium, where UNGIWG is recognized as the single most important development to date in the evolution of a UN spatial data infrastructure. Since its creation in March 2000, UNGIWG Task Groups have, in effect, been laying the foundations for a UNSDI.

The "Geographic Information Strategic Plan for the United Nations" (UNGISP), prepared by the OGC during the period 2001-2002, is also briefly discussed in Chapter 5 and identified as a valuable departure point from which to develop an updated and more user-driven UN spatial data and information management system. A system that is more in line with current agency attitudes and consensus-based practices is recommended. One that strikes a balance between a centralized and decentralized approach to the management and exchange of spatial information in an integrated, matrix-like manner, particularly across organizations.

Subject to resources availability, the development of a UNSDI will likely continue in an evolutionary and stepwise manner during the formulation of a more comprehensive, multi-year master plan for the initiative.

Consultation with UNSDI stakeholders

Consultations undertaken in February 2006 in Rome, Geneva and New York with members and partners of UNGIWG, provided feedback on stakeholders' views of a UNSDI and an understanding of current GIS-related activities within the UN system. Feedback was realized through interviews, meetings and teleconferences. A review of SDI-related documents prepared and/or being considered by UNGIWG members or other national and international institutions that are, or may eventually be linked to the UNSDI was also undertaken. Coordination with relevant EU officials in Brussels and Ispra was initiated in March 2006 as well, on SDI-related technical and institutional developments in the context of the EU Programmes GMES and INSPIRE.

Stakeholder feedback regarding a UNSDI is presented and analyzed in Chapter 6 of the Compendium with tabular comparisons of the original UNGISP findings and those of the 2006 interviews with UN agency staff.

Issues identified

The UNSDI-related issues identified in 2006 by stakeholders cluster into four broad categories similar to those identified in the UNGISP:

- Policy and organization
- People and resources
- Data and information
- Technology

Results from the 2006 survey proved remarkably similar to those identified in 2001-2002, suggesting change in 'big-ticket items' has been slow. For example, the current ineffectiveness or absence of polices, leadership, clear communications and governance

related to data access and dissemination in the UN are high on the list of stakeholder concerns. There is also a universal belief among practitioners in the UN that currently available levels of resources limit advancement of geospatial technologies system-wide. A related problem concerns the inability to recruit appropriately skilled staff and a lack of technical training for existing staff. Agencies place particular importance on addressing data standards, best practices, and the introduction of a metadata policy as priorities. Beyond an overwhelming preference for an open standards and web-based approach to the information architecture and technical infrastructure for a UNSDI, the technical proponents of geospatial data systems in UN agencies expressed preference for modular, smarter and more cost-effective ways of working. The importance of focusing on interoperable solutions that create bridges between the previously identified 'islands of success' in the UN is widely accepted as fundamental.

Engaging with Member States and regional bodies

The 2006 agency consultations while significant are an incomplete picture of the issues that must be addressed for a UNSDI to succeed. To round out the process, in March 2006 UNGIWG initiated a corresponding dialogue with national and regional bodies regarding SDI developments underway at these two levels. A number of countries including The Netherlands, the Czech Republic and Hungary have agreed to act as pilot countries and strategic partners in this process, whereas 13 other countries and three regional organizations in Asia, Africa, Europe and central and South America have committed their general support to the UNSDI process and are participating in the ongoing dialogue.

Focus of the ongoing regional and national dialogue is on making geospatial data available internationally for a number of selected applications fields, such as integrated water resources management, forest resources management, transport and logistics, cartography, agricultural extension, biodiversity, tourism and others.

A workshop planned for early March 2007 will be a crucial mechanism for obtaining national and regional feedback from potential stakeholders in the UNSDI process who are based outside of UN organizations but work in partnerships with them.

Strategic partnerships

Chapter 6 also focuses on strategic partnerships that have been influential in shaping the approaches taken by UNGIWG members and Task Groups in developing or adopting open data and metadata standards, and tools that encourage interoperability across the UN system and beyond, to link with partners around the globe. UNGIWG must remain alert to new developments in geospatial data and information management to ensure that the design and implementation of a UNSDI remains current and tuned to the needs of users. It is here that UNGIWG's strategic partners have much to offer UNSDI development, as their memberships operate at the cutting edge of geospatial data and information management and analysis.

In this regard, opportunities exist for UNGIWG to take leadership in evaluating and promoting promising concepts such as the "Public Commons of Geographic Data". Open approaches of this kind for sharing data, labor and skills in networked environments, offer considerable potential for the effectiveness and efficiency of a future UNSDI and serve well the Secretary General's call for all UN activities to be rights-based and the demands of increasing global governance.

The role of strategic partnerships between the UN and business is additionally touched upon in Chapter 6. Geospatial sector support from business is already helping to resolve humanitarian, health and development issues and offers promise for converging the purpose and greater future interoperability of local information infrastructures in times of need. Given the considerable potential for developing such initiatives in concert with a future UNSDI, details concerning possible strategies in this regard are provided in Part II of the Compendium.

Part II: Building for the Future

Future vision and role of a UNSDI

Chapter 7 of the Compendium outlines the vision and mission of a UNSDI, and the strategy by which these might be brought about in the context of assisting UN reform, delivering UN MDGs and supporting the needs of increased global governance.

In a nutshell, the UNSDI vision is to enhance decision-making globally and at all levels of societies, to benefit humanitarian assistance, sustainable economic development and environmental protection. This requires a mechanism for ensuring that access, retrieval, and dissemination of geospatial data and information are enabled globally in an easy and secure way, avoiding duplication in data collection and management within the United Nations, and with and between its Member States and partners.

A UNSDI will undoubtedly provide the most appropriate mechanism for adding system coherence for the applications and exchange of geospatial data for UN activities. This it can do by providing the relevant base collection of technologies, standards, fundamental datasets, human resources, policies, institutional arrangements, and partnerships that increase availability and access to geospatial information across international jurisdictions.

Since the UN's unique, added business value is that its mandate and obligations require it to work across such jurisdictional boundaries, a valid UNSDI should use and extend other SDI's by enabling them to better operate collaboratively to support cross-organizational projects. Where SDI's do not yet exist - within or beyond the bounds of the UN - it is in the UN's interest to foster their development as a means of encouraging improved ease of access and re-use of spatial data to support UN activities. The UNSDI thus aspires to enabling interoperability between SDI's operating within UN agencies, among groups of UN agencies sharing common interests, and between the UN, Member States and their regional and thematic groupings, and partners sharing their data and technical advances in overlapping interests – humanitarian assistance, sustainable development, and protection of the environment among others.

Strategy and goals

UNGIWG recognizes that to succeed in its mission it must engage vigorously with its members, Member States, regional organizations and partners in a participatory process to design the UNSDI. The UNSDI should be built upon consensus, good governance, and best enterprise management and information sharing practices that maximize the benefits of geospatial information worldwide.

Given the nature and range of UN vocation, a distinct version of a SDI should be developed for the UN context and reflected in the name "UNSDI". It should also build

upon what already exists and provide a conceptual framework that better guides all of the activities of UNGIWG, including those of its Task Groups.

To achieve this, UNGIWG must stimulate the understanding and wherewithal of the United Nations, its partners and UN Member States to:

- Identify issues of importance for the establishment, successful operation and sustainability of a UNSDI, and define goals and actions to address them;
- Develop a partnership strategy to guide internal and external linkages, capacity building and technical transfer with member states, regional bodies and other partners;
- Investigate options for funding of essential activities to underpin the future sustainability of the UNSDI.

The outcome of UNGIWG consultations with stakeholders is particularly important for developing a strategy to address the issues of concern for the development of a future UNSDI. Issues identified by stakeholders are addressed in the proposed UNSDI strategy in accordance with the four broad categories of issues identified in Part I of the report[5].

With these and other considerations in mind a series of 11 goals, and the related objectives and specific actions recommended to achieve them, are developed throughout Chapter 7 for consideration, discussion and possible adoption by UNGWG. Schematic representations of the overlapping sequence of outcomes associated with the delivery of each 'Goal' are shown in a series of Figures in this section of the report. A summary table including all goals and proposed actions is contained in Annex 2, in reference to UNSDI implementation (see Part III for details).

Monitoring and evaluation

UNSDI accountability is a cross-cutting issue that has potential to impact on stakeholder confidence in an enterprise-based UNSDI. Establishing credible levels of monitoring and evaluation is important therefore, to maintain stakeholder and donor confidence in the UNSDI. Existing UN systems and services that deal with internal efficiencies, program evaluation and audit can be called upon to assist in fulfilling this role. Other IT-related industry tools and methodologies should also be adapted to complement the monitoring and evaluation required.

There are additionally contingencies and risks that cannot be fully predicted but may impact on the schedule, cost, quality, or overall scope of the UNSDI. Potential contingencies and risks are identified in Chapter 7 as part of overall UNSDI planning and should be evaluated before implementation and closely monitored throughout.

Part III: Delivering the UNSDI Strategy

Implementation strategy

This section of the report outlines the process by which the target elements of a UNSDI defined earlier in the document can be built over time. To ensure a successful and sustainable UNSDI, the implementation strategy proposed builds upon existing UNGIWG geospatial data development efforts, provides for highly visible results in the

[5] Policy and organization; People and resources, Data and information; & Technology

near-term, and sets an appropriate framework for medium and long-term UNSDI development and maintenance.

The ever increasing convergence of geospatial and web technologies in particular has opened up exciting new prospects for the Organization to revolutionize its global business integration while at the same time strengthening its decision support, planning and operational capacities. By more effectively integrating, managing and utilizing these technologies to serve its geographic information needs, the UN enterprise stands to reap substantial political, social and economic returns on investment in these sectors.

The information infrastructure envisaged in Part II of this report also has the potential to transform 'business as usual' in the UN by integrating geospatially enabled data, technologies and applications into the globally distributed nuclei of the enterprise, raising management efficiencies, and the timeliness and effectiveness of decision making while at the same time moderating costs.

The UNSDI business model

UNGIWG plans to implement an international, geospatial enterprise architecture that encourages interoperability not only within the Organization, but across international jurisdictions and with and between all UN Member States. Critical in this regard will be successfully addressing outstanding organizational and technical issues, the leveraging of investment in capacity building for developing nations and the forging of strategic partnerships to complement the knowledge base of best practices for the development of the UNSDI.

The need for a business and management approach in the development of the UNSDI is affirmed by stakeholder feedback and the experiences of parties that have successfully travelled parallel journeys in developing enterprise based frameworks for local, national, or regional SDIs.

In particular, a UNSDI designed along business lines will improve the usefulness and integration of geospatial investments and assets by identifying opportunities to collaborate and coordinate. Thus, 'sharing not wearing' the costs for multiple partners through the pooling of infrastructure and other assets. Increases in efficiency will come from avoidance of duplication both with respect to data and infrastructure, and by formalizing data access arrangements. Improved ease of access to new data and the diminution of barriers to existing data will also contribute to greater effectiveness of the spatial data assets and related investments in technology and people that are hosted by involved stakeholders.

These and other benefits of an enterprise approach to implementation of the UNSDI are outlined in Chapter 8, including a brief discussion on the possible return on investment that suggests benefits in financial, efficiency and social and humanitarian terms could be substantial.

Implementation options and stages

History has demonstrated that implementing the UNSDI through a 'revolutionary' process requiring the establishment of an instituted authority and purpose-built organization –a UN Geographic Information Office (GISO) - appears untenable for the UN up to this time. An evolutionary, user-driven approach to the establishment of the UNSDI, one based primarily on consensus and cooperation facilitated by UNGIWG, is a more realistic option and the stated preference of the majority of stakeholders as well.

Details regarding the pros and cons of these approaches are discussed in Chapter 8 of the Compendium which provides insight into the proposed four overlapping implementation stages of the first, indicative five-year Implementation Plan for the UNSDI:

1. Stage 1: Building UNSDI foundations - short-term (0-12 months)
2. Stage 2: Building the Infrastructure - medium-term (12-24 months)
3. Stage 3: Institutionalizing the Infrastructure - long-term (>24 months)
4. Stage 4: Continuous Improvement of UNSDI Processes.

Stage 4covers the continuous improvement of the UNSDI beyond the completion of Stage 3 where the UNSDI is assumed to have reached full functionality for the presently available levels of technology and resources.

Each of these implementation stages has outcomes defined by the strategic 'Goals' and the 'Specific Actions' outlined in Part II. Related tasks need to be implemented in a coordinated, integrated manner within each Stage and according to the program components that address UNSDI issues, linkages and partnerships, and sustainable funding (see Annex 2).

Indicative implementation plan

An indicative UNSDI implementation plan is set out in Chapter 9 according to the key Program Components that frame the UNSDI strategy as follows:

1. Addressing Issues:
   - Policy and Organization
   - People and Resources
   - Geospatial Data and Information
   - Technology
2. Linkages and Partnerships
   - Communications and advocacy
   - Capacity building
   - Strategic partnerships
3. Sustainable Funding
   - UNSDI core funds
   - Donor funds for external capacity building
   - Building UN system-wide capacities
   - Franchising the logo
   - Corporate Social Responsibility programmes

Associated with each of the Program Components are the 'Specific Actions' identified in Part II of the UNSDI strategy. When combined into a series of 'Tasks' and successfully executed, these activities deliver Milestones or 'Outcomes' that collectively satisfy the Goals of each Program Component. Details and timelines are shown in Annex 2 of the report.

Priority activities

Early stages of UNSDI implementation provide an opportunity to promote priority activities associated with the establishment and operation of the information and

applications architectures that are built upon the existing achievements of UNGIWG Task Groups. Wisely chosen, priority activities will encourage confidence in the UNSDI process by providing stakeholders with the early and highly visible results.

A number of critical, consensus-endorsed UNSDI priorities have in effect already been identified by UNGIWG through the deliberations of its various Task Groups. Here, specialists from the UN family and partner organizations knowledgeable in the business needs of the UN and the potential for geospatial data utilization have pooled their collective best judgments to select ongoing and planned activities for each Task Group. As these activities support the UN business cases identified, their selection as priorities for implementation has been chosen with this in mind.

Establishing governance mechanisms, policies, coordination, advocacy, assessing organizational readiness, capacity building, and accountability and management of risk are high among the implementation priorities identified for a successful UNSDI.

Each priority task from within Stage 1 is expanded upon for each Program Component of the strategy. These are illustrated throughout Chapter 9 as timelines of the multitude of tasks concerned. An example of all priority tasks and timelines associated with the Programme Component 'Policy and Organization' is shown in Annex 3.

National coordination committees

Development of the UNSDI, in addition to promising improved efficiencies and effectiveness for UN business processes, opens up unique opportunities for global participation in design of the UNSDI through a consultative process between UNGIWG and UN member states. This promises increased utility and benefit of the UNSDI to national stakeholders, but also opens up a conduit for leveraging the support required to strengthen SDI capacities in developing nations. The spin-off for the UN is the potential to strengthen future system-wide operations and expanded support for achievement in the medium-term of the MDGs. Proposals concerning pilot countries as models for extending the value of the UNSDI are included in Chapter 9 and will be a center-point of UNSDI development in the future.

Monitoring and evaluation needs

At the completion of the first five-year planning period a thorough program evaluation needs to be undertaken in addition to the annual performance evaluations embedded in the plan itself. A new five-year plan will then need to be developed since establishing a truly effective UNSDI may take upwards of 15 years, if the experience of other substantive SDI initiatives is considered.

Throughout all stages of implementation in fact, it will be important to periodically review the recommendations concerning each Program Component and to reconcile them with actual progress toward achievement of UNSDI goals. The implementation strategy may need to be revised in accordance with these findings, but maintaining flexibility in this regard is important.

Next Steps

UNSDI strategies and implementation plans will remain meaningless unless translated into concrete actions at the national, regional and global levels. In this regard, the next steps involve turning theory into practice and plans into actions. Selecting the highest priorities for action from among the many priority actions identified elsewhere in this

report. This will require the convening of relevant UNGIWG Special Interest Groups during the remainder of 2006 and early 2007, to focus on implementation of critical path components of the UNSDI and the generation of visible outcomes. Guidance is provided in this regard in Chapter 9.

Part IV: Architecture for the UN Spatial Data Infrastructure

The UNSDI Architecture section provides a first draft outline of requirements and implementation strategies that enable the building of a UN Spatial Data Infrastructure as outlined in the previous sections of the Compendium. The principal guideline followed while developing this architecture can be summarized as "re-use what is existing and identify opportunities where relevant".

The UNSDI architecture proposed does not provide a one-size fits all solution for Spatial Data Infrastructures. Rather, it attempts to establish a coherent umbrella architecture in which essential components become interoperable and can be reused by the individual agencies and their partners for different purposes, and at different scales and times.

A common set of requirements and solutions for implementing SDI's able to contribute to a shared SDI are progressively outlined in Part IV. These requirements are considered from a number of viewpoints- enterprise, information and computation - and are consistent with the current global best practices and reference models described earlier[6].

The common "Information Architecture" identifies and defines the key information elements that need to be shared between SDI's before business benefits can be realized. This section of the document is far too brief to aspire to being a comprehensive definition of the architecture. Rather, it is notional in form and identifies key characteristics and principles for *any* architecture finally adopted for a UNSDI.

Based on the current design and implementation strategies taken by most, if not all of the significant SDI initiatives, the UNSDI architecture must be built using the Reference Model of Open Distributed Processing (RM-ODP) standard as the conceptual framework. The RM-ODP standards constitute among others the conceptual basis for the ISO 19100 series of geographic information standards as well as the OpenGIS Reference Model (OGC 2003). Following of the RM-ODP process is also in line with the existing efforts within the UN that work towards providing geospatial services.

6 Such as the Open Geospatial Consortium (OGC) Reference Model (ORM), the GSDI cookbook, W3C Web Services and 'grid' architectures

Part 1: Responding to a Changing World

1. A new United Nations for a new millennium

Today's world moves at a frenetic pace, paradoxically rendering change a constant. It is also a globalized world, a world in which the United Nations must step up to the challenge and growing demands of its member states, its Secretariat, Agencies, Funds and Programmes. More services need to be delivered in more places than ever before to those people most in need. But these escalating demands and expectations have strained the Organization's existing structures and systems in the face of mounting budgetary constraints.

1.1 Investing in change

While the United Nations believes the principles of its Charter are as relevant today as they were in 1946, it is also aware that the manner in which it delivers on these aims and objectives has to *"move with the times"*. In line with these sentiments, UN Secretary-General Kofi Annan recently called for a major overhaul of UN management structures and practices. He warned that "*years of skimping on investment in staff and operating systems"* and "*outmoded management policies"* had taken their toll, leaving the UN *"barely able to conduct its work effectively and efficiently."*

Following a request from the 2005 World Summit, the Secretary General reported on the conditions and measures necessary for him to carry out his managerial responsibilities more effectively. And, among others, this included an assessment and recommendations to help ensure that the United Nations can respond to current needs and enable the efficient and effective conduct of its work into the future.

The report, *Investing in the UN: for a Stronger Organization Worldwide* (UN, 2006), deals specifically with the management of the Secretariat and confirms the need for significant investment to match its overall pursuit of efficiency and results. Proposals focus on seven areas of expertise, of which "*information and communications technology"* and "*cost reduction and increase of efficiency"* are of particular relevance in defining the future role and management of geographic information in the Organization and the related need to establish a United Nations Spatial Data Infrastructure (UNSDI).

In addition, a high level panel on system-wide coherence, set up in early 2006, is the prime venue and vehicle for reforming the operational activities of the UN as part of the broader and ongoing UN reform process[7].

Collectively, these recent initiatives focus on interrelated areas of reform that are strongly endorsed by major donor nations as follows:

- Raising UN efficiency & effectiveness
- UN System-wide Coherence (Development, Humanitarian Assistance & Environment')

[7] United Nations, 2006.

- Comprehensive management reform in 2007

1.2 Advancing United Nations goals

The eight goals embraced by the United Nations, IMF, OECD and World Bank in the United Nations Millennium Declaration address issues of extreme poverty and hunger, access to primary education, gender equality, the systemic health risks to children, mothers-to-be and victims of pandemics, and the broader problems associated with environmental sustainability and development

UN Secretary General Kofi Annan noted: *"We will have time to reach the Millennium Development Goals – worldwide and in most, or even all, individual countries – but only if we break with business as usual. We cannot win overnight. Success will require sustained action across the entire decade between now and the deadline."*

1.2.1 Harnessing spatial data to support the MDGs

Whether in the quest for peace, advancing the health, education or well being of children, women and the afflicted, or for reducing poverty, improving food security, responding to natural disasters, safeguarding the environment or in search of sustainable development, the United Nations and its member states increasingly require spatially representative information to guide decision makers toward achieving the Millennium Development Goals (MDGs).

Spatial data are referred to variously as *geographic information, geospatial data, geodata,* or *geo-information* and contain embedded data about the location, shape and relationships among and between geographic features such as a the site of village, street address, latitude and longitude, or location within a census block or administrative boundary. These rapidly evolving technologies include remote sensing, geographic information systems (GIS), global positioning systems (GPS), and an array of environmental monitoring platforms in space that have in common digital data recording, time series data acquisition and data geo-referencing capabilities. Sources of spatial data include topographic and cadastral surveys, satellite imagery and aerial photographs, censuses and household surveys, biological inventories, and sensors.

Spatial data is the fuel upon which the analytical power of GIS depends.

The unique characteristics associated with geo-information technologies facilitate the integration of scientific, social and economic data through space and time, opening up exciting possibilities for monitoring, assessment and change detection, thus enabling better informed interventions in human and natural systems.

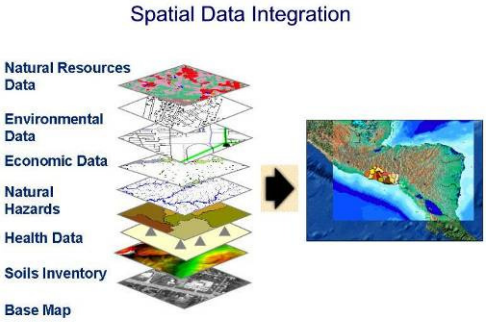


Figure 1: Geo-information technologies facilitate the integration of scientific, social and economic data through space and time.

For example, spatial representations of the state of natural resources, sensitive environments, disease vectors, agricultural activities, and socio-economic and demographic phenomena are today most often achieved by integrating layers of relevant spatial data in a GIS (see

Figure 1). Outputs in the form of maps, tables and graphs provide the spatial component so often used to explain and visualize the cause-effect relationships analysed. Integrating spatial information is this manner is critical for the long-term sustainable use of resources and the future well-being of humankind. It is also of paramount importance in the design, targeting and implementation of short-term interventions when situations such as pandemics, food security crises or natural disasters arise unexpectedly.

1.2.2 Priority issues to resolve

The technology to acquire, process, analyze, display and manage massive amounts of geographic data has increased exponentially in recent decades, but this wealth of spatial information has not been matched by the opportunity or ability of stakeholders and users in general to discover, access, evaluate, dependably utilize and share it. The challenge for the United Nations and its partners is thus clear: to make this plethora of spatial data more accessible and usable for the managers, technicians, decision-makers and scholars who seek to achieve the tenets of the Millennium Development Goals.

Despite the proven value of spatial information, it is an expensive resource and needs to be fully utilized to maximize the return on investment required for its generation, management and use. Reuse of pooled spatial information for multiple purposes is an important approach applied in countries where investment in the collection and appropriate management of spatial data has advanced on the basis of its known asset value. And very substantial economic benefits have been estimated by countries that have moved in the direction of optimizing data reuse. But it is still relatively easy to find examples of projects and other development activities from around the globe that required expensive recapture of essential spatial data because it was originally captured in unique or non-standard file formats, or perhaps discarded after initial use. Recapture of data has also been undertaken in many cases simply because its prior existence was known only to its originators.

The United Nations has not been immune to this problem, both within and between the multitude of entities that make up the Secretariat and its agencies, funds and programmes. Historically, UN entities acquired or developed a variety of unique software tools and GIS systems in a bid to solve specific problems that benefited from an infusion of geospatial data and information. Although created at considerable expense, the resultant systems often turned out to be unique, lacked interoperable standards and contained poorly documented data of unspecified quality.

These early, agency-specific actions resulted in a legacy of limited opportunities for sharing the tools and data for uses beyond their originally intended purposes, and reduced the possibilities for 'growing' these applications further in the future. A culture of working in isolation was largely responsible for these missed opportunities, perhaps spawned by the ready availability of funds in days when accountability was less of an issue with member states and donors than it is today. With the onset of tighter budgets, the Secretary General's desire to increase efficiency and accountability, and a growing awareness throughout the United Nations of the benefits of sharing data and systems, the culture has changed considerably in recent years to one of greater cooperation.

Information management systems of some national governments also evolved in similar ways in the past allowing only limited interoperability and data sharing between internal authorities, and even less with external bodies such as the UN. Consequently, the sharing of spatial information both within and between United Nations authorities and

within and between many of its member states has also been hampered historically by the lack of information infrastructures that promote data access, sharing and interoperability through agreed policies and standards.

"Only through common conventions and technical agreements will it be easily possible for local communities, nations and regional decision-makers to discover, acquire, exploit and share geographic information vital to the decision process." (Developing Spatial Data Infrastructures: The SDI Cookbook, GSDI 2004)

1.3 Global governance

The basis for major reform and restructuring of the expansive UN system into a mechanism for global governance was elaborated in 1997 by the UN-funded Commission on Global Governance. An associated report, entitled 'Renewing the United Nations: A Programme for Reform', proposed a step-by-step program to implement many of the recommendations advanced by the UN-funded Commission on Global Governance. Significantly, this report notes that: "Reform is not intrinsically an exercise in cutting costs or reducing staff. It is an exercise to assure the Organizations' relevance in a changing world....".

The service area for the United Nations henceforth began shifting away from sovereign nations to focus directly on the citizens of those nations, including the provision of "security for the people" within those nations. However, the reformation subsequent to 1997 has not only been of the United Nations, but of global societies. This continues to occur and grow daily, being actively promoted through a variety of UN Conventions[8] and other UN policy instruments that increasingly depend upon geospatial data for assessments and compliance monitoring. These policies are *de facto* global governance by the United Nations Countries as they increasingly work in the context of multi-lateral agreements to fulfill the principles laid down in the UN Charter.

Global governance is thus not an event; but a process with a clear requirement for responsiveness from the UN Secretariat and its many Programmes, Agencies and Funds in the service of its Member States and their citizens. As the requirement for UN responsiveness grows with the evolution of this process, so the availability of reliable geospatial data and its competent and objective management grows.

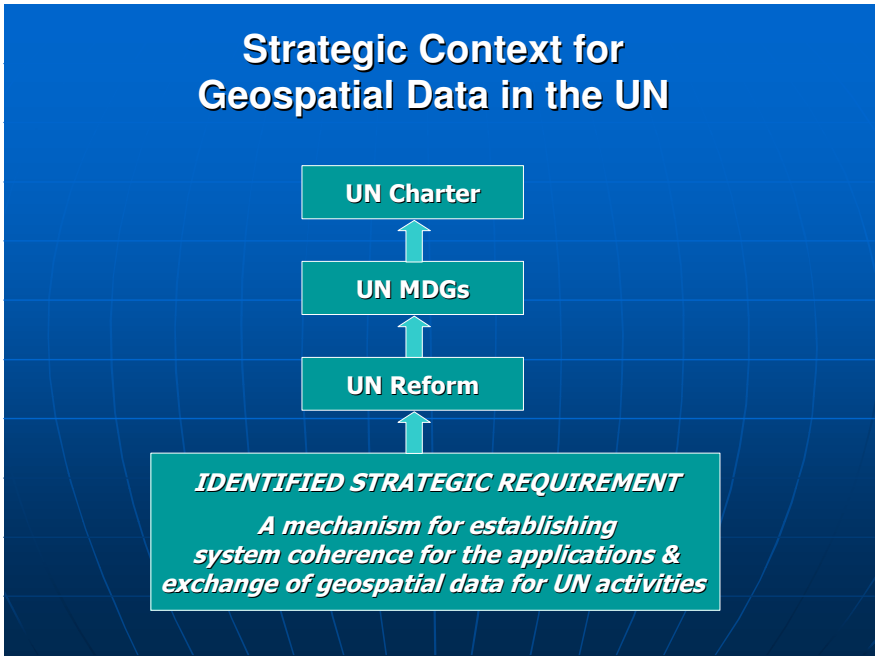
1.4 Strategic context for geospatial data in the UN

Taking due account of the demands of the aforementioned UN Reform agenda, the demands of the UN MDGs and trends toward global governance, there is clear potential for improving UN efficiency, effectiveness and responsiveness to deal with these issues through increased system-wide coherence for the application of geospatial data for UN activities.

[8] UN Conventions relate to: Climate Change; Biological Diversity; the Rights of the Child; the Law of the Sea; Chemical Weapons; the International Criminal Court; Elimination of all forms of Discrimination Against Women; World Heritage Sites; the UN World Wide Biosphere Reserve Network; RAMSAR Convention on Wetlands; International Trade in Endangered Species; the Ecosystem Management Policy; the American Heritage Rivers Initiative; the Sustainable Communities Initiative and a host of other UN policies in place or under development.

The strategic context for geospatial data, including the pressing requirement for a mechanism that establishes coherence in this regard across the full range of UN activities is illustrated in Figure 2 below.

Figure 2: Strategic context for geospatial data in the UN and an identified requirement for system coherence.



2. Building the case for a UNSDI

2.1 Background

The concept of spatial data infrastructure development took root by the early 1990s to support development of geographic information exchange standards and establishment of nation-wide spatial information networks in countries such as the U.S.A, United Kingdom, Canada, the European Community, Australia and New Zealand. An Executive Order concerning the coordination of geographic data acquisition and access in the United States Federal Government was signed in 1994 for example, elevating the issue of SDI from a technical subject to one being essential for the social and economic development of the country (see Box 1).

> ***"… to promote economic development, improve our stewardship of natural resources, and to protect the environment." (US President Clinton 1994)***

Box 1: The drivers of Spatial Data Infrastructure development

The emergence of National SDIs in countries such as the U.S.A., Australia and others in the 1990s sparked interest in the SDI concept around the globe. And with the growing availability of SDI documentation, particularly that generated by the Federal Geographic Data Committee (FGDC) in the U.S.A., development of related initiatives was stimulated elsewhere in the world. SDI development initiatives now range in scale of purpose from local, national, regional up to global levels and span many sectors and thematic areas of interest.

The early national initiatives confirmed that the discovery, ready access to, evaluation and dependable utilization of spatial data is greatly facilitated by establishing an underlying infrastructure of policies, technologies, data, common standards, standard practices, protocols and specifications that collectively contribute to a 'Spatial Data Infrastructure' or SDI (see Box 2). The technical features of a SDI need to be integrated with appropriate governance mechanisms and human and financial resources to forge a robust and efficient spatial data infrastructure. The term infrastructure, for its part, usefully encapsulates the sense of a reliable foundation for exchange of geographic information to support national development, somewhat analogous to a conventional 'infrastructure' of rail, road, communications and port links that move goods to support economic activity.

Spatial data infrastructures are, by and large, about working smarter, not harder and also about re-use:

2. Re-use:
    - re-use of geo-spatial data and information
    - re-use of technical capabilities

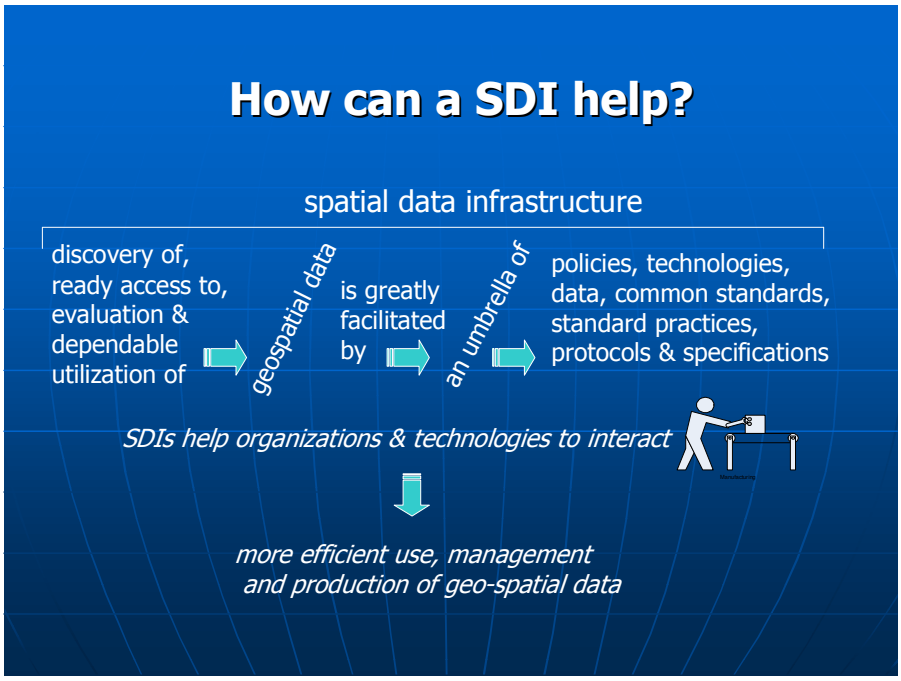
- re-use of skills developed
- re-use of intellectual effort and capital

4. Sharing:
   - 'sharing-not-wearing' the costs of people, technology and other shared infrastructure assets, helping to realize more rapid returns on investment
5. Learning from others:
   - Avoiding the pitfalls experienced by others

2.2 Spatial Data Infrastructure defined

In brief, *'SDI can be defined as an "umbrella" of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management and production of geo-spatial data.'* (Ottichilo 2005). See Figure 3 below.

Figure 3: SDIs complement interaction of organizations and technologies, fostering more efficient use, management and production of geo-spatial data.



2.2.1 Global Spatial Data Infrastructure Association (GSDI)

The Global Spatial Data Infrastructure Association (GSDI), an inclusive organization of organizations, agencies, firms, and individuals from around the world, promotes international cooperation and collaboration in support of local, national and international spatial data infrastructure developments. A more comprehensive definition provided by the GDSI includes details of the major functions of a SDI, the environment in which it functions and its beneficiaries (see Box 2).

"The term "Spatial Data Infrastructure (SDI)" is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.

... an SDI hosts geographic data and attributes, sufficient documentation (metadata,) a means to discover, visualize, and evaluate (catalogues and Web mapping), and some method to provide access to geographic data. Beyond this are additional services or software to support applications of the data. To make an SDI functional it must also include the organizational elements needed to coordinate and administer it on a local, regional national, and or trans-national scale. Although the core SDI concept includes within its scope neither base data collection activities or myriad applications built upon it, the infrastructure provides the ideal environment to connect applications to data- influencing both data collection and applications construction through minimal appropriate standards and policies."

Box 2: Spatial Data Infrastructures defined in detail (**Developing Spatial Data Infrastructures: The SDI Cookbook, GSDI 2004**)

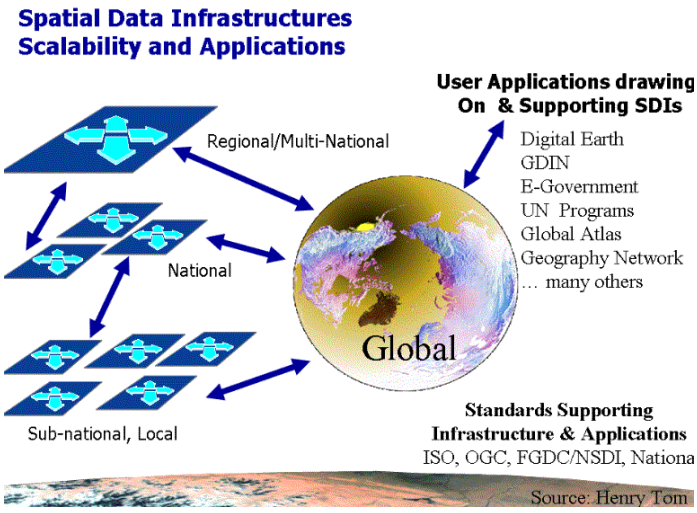
Establishment of an information infrastructure of the type outlined in Box 2, the GSDI believes, will allow nations to better address social, economic, and environmental issues of pressing importance.

A spatial data infrastructure that incorporates the principles outlined, if established within the United Nations, can contribute to more coordinated and better informed decision making by the Organization in collaboration with its Member States. It would also result in significant financial benefits for the Organization and its partners through increased efficiencies and effectiveness. However, the unique character and functions of the United Nations require an imaginative and flexible solution if a UNSDI development is to succeed, a subject explored in more detail throughout this report.

2.3 Key stakeholders

The unique functions of the United Nations mean that the key stakeholders in the development of a future UNSDI span the full spectrum of spatial data users and producers. This includes users and generators of global scale datasets all the way down to users and producers of local and even village level spatial data (see Figure 4). Key UN stakeholders will be drawn from United Nations ranks in the Secretariat and its numerous Programmes, Funds and Agencies that currently utilize or plan to utilize spatial data in fulfilling their mandates. Additionally, individual Member States, regional organizations, and United Nations partners in business, academia, the not for profit sector and foundations, and concerned citizens around the globe will form an integral part of a future UNSDI.

Figure 4: Stakeholder relationships between multi-level and multi-purpose SDIs (based on Ottichilo and Tom, 2005)



Typically, at a national level, government departments concerned with mapping and surveying, cadastre, census and statistics, transport and utilities have been at the forefront of SDI development. Other national agencies characteristically involved include those connected with agriculture, mining, watershed management and the environment, expanding the realm of SDI initiatives to include sectoral and thematic interests. But the involvement of national governments at various levels in the evolution of SDIs has inevitably led to more of a 'top-down' approach than is commonly acknowledged.

Sub-national organizations in many countries also require access to, or generation of, spatial data for carrying out their functions effectively. In a number of developed countries, sub-national organizations at state and municipal levels are beginning to lead the way in the innovative development of SDI characteristics to better support local requirements. SDI has thus evolved to become a bricolage of many different efforts, particularly local efforts.

2.4 Broad SDI requirements, influences and outcomes

The complexity of the issues involved in creating SDIs that function at all scales and for multiple purposes, such as would be the requirement for a UNSDI, is captured in the following description from "*GIS Worlds Creating Spatial Data Infrastructures,*" (Masser, 2005.) Here, emphasis is placed on the requirement of an SDI to support ready access to geographic information. "*This is achieved through the co-ordinated actions of nations and organizations*" in promoting awareness "*and the implementation of complimentary policies, standards, and effective mechanisms for the development and availability of interoperable*" spatial data "*and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national and regional scale are not impeded in meeting their objectives.*"

This description complements the four key concepts identified by Masser as underpinning all SDIs (see Box 3). Although derived in relation to experience with national and regional SDIs, these concepts provide useful supplementary guidance for the future development of a UNSDI.

1. ***The overriding objective of an SDI is to maximize the use of geographic information;***
2. ***SDIs cannot be realized without the coordinated actions of governments;***
3. ***SDIs must be user driven;***
4. ***SDI implementation involves a wide range of activities, both technical and institutional/organizational.***

Box 3: Four key concepts underpinning all SDIs (paraphrased after Masser 2005)

2.4.1 Potential impact of a SDI on data access

The use of interoperable data standards, descriptions and standards-based networking tools of a SDI lend order and predictability to the discovery, evaluation, and relative accessibility of geospatial data. A SDI also greatly facilitates the use and potential for reuse of geospatial data subject to prevailing data policies. The conceptual impact of enabling a SDI and its associated data standards on access to an otherwise disconnected selection of spatial data at various management and applications levels is illustrated schematically in Figure 5.

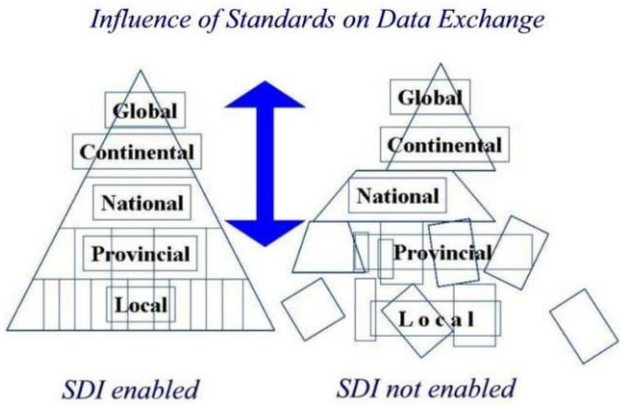


Figure 5: Schematic of the potential impact of SDI implementation and associated data standards on spatial data access at multiple levels and scales (Adapted from Yola Georgiadou, ITC 2005).

To achieve the implied levels of concordance between spatial data assets from such widely differing scales and sources, the actions of the numerous stakeholders must be fully coordinated and the technical and organizational aspects of the SDI predictable. If both conditions are successfully met, ready access to and exchange of spatial data over the entire scale from global to local levels is possible. In practice however, such a hierarchical view of standards development is not the case, with 'global not dictating local' and with efforts often being sectoral. Note also that the term 'Continental' in the schematic incorporates the concept of 'Regional' with regard to development, operation and management of SDIs.

2.4.2 Tangibles versus intangibles

Two main classes of factors drive the successful implementation and operation of a SDI, the so called tangible and the intangible factors. However, the technology encompassing the tangible components of a SDI is just the tip of the SDI iceberg. Technical specialists do not always perceive the relationship this way, but there are many other elements of a SDI that if not properly addressed or budgeted for prior to its implementation will guarantee failure. Data for example, are often collected to serve

specific missions and business processes. The result is inefficient use of resources, potential duplication, inconsistency, incompatibility, and an inability to maximize the value of data resources.

Experience with operational SDIs indicates that the influence of intangible factors such as the people, procedures and the work cultures involved wield 80% of the responsibility for the success or otherwise of the SDI. In contrast, the technological factors, including the hardware and software necessary for an SDI's operation, share only 20% of the total influence over its operational effectiveness.

This overwhelming influence of the intangibles over the tangible factors associated with SDI implementation is illustrated by the "SDI Iceberg" in Figure 6. The implication is clear; institutions must be willing to work together for a common vision if an effective spatial data infrastructure is to be realized. This is an important reality to keep in mind during the future development of a UNSDI, given the sheer size, diversity and complexity of the Organization's distributed global structure, its mandates, and its multi-cultural origins and management systems.

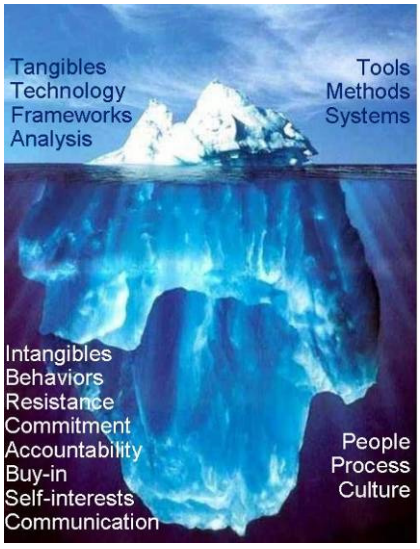


Figure 6: The relative influence of the people and procedures to that of the technology in the creation and operation of a successful SDI. (Source: Knodel, 2004. Journal of Change Management 4(1): 53)

2.4.3 The technical infrastructure stack

The relationships between the broad technical clusters that make up a SDI are illustrated in Figure 7. Geographic data and their attributes make up the bulk of the primary 'infrastructure' toward the base of the technical infrastructure stack. Core, or framework data, comprising commonly required, reusable subject matter such as basic cartographic and topographic data are common components of an SDI at the very base of the technology stack, and upon which other thematic layers of geographic information are built for applications purposes. The metadata (data documentation) and data catalogues and the means to discover and access them sit above the geographic data in the stack.

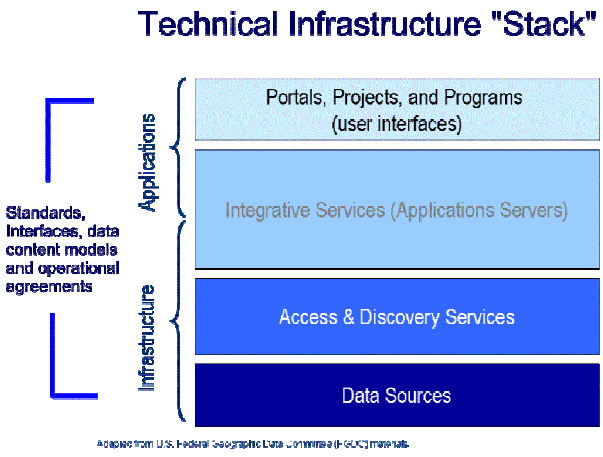


Figure 7: Schematic relations between the broad technical clusters that make up a SDI (Adapted from Doug Nebert, US FGDC, 2003)

Projects and portals that provide online services (applications) rest on top of the foundation of data sources and data discovery mechanisms. *"Spatial portals are Web sites that either*

assemble many online resources and links into single locations to form easy to use products… or provide search tools that help users find information on the Web." (Tang & Selwood, 2005). Also increasingly important in this regard is the growing base of geospatial data services coming on line in the spatial data community. These assets, once enabled with open standards, are a policy decision away from being accessible for reuse by other interests.

Atop the technology infrastructure stack are additional services and software to support applications that require spatial data. These applications are typically GIS or web mapping services that increasingly enable integration of data from distributed databases over the Web and that ultimately lead to the creation of information and knowledge. But it is worth noting that applications will always be limited by the quality and availability of the geospatial data accessed, as they rely upon the standards, interfaces, data content models, and operational agreements supporting the data "sub-structure". Without a reliable data "sub-structure", user applications will be constrained. And for all of these components to function as desired, there must be strong inter-institutional leadership and partnerships.

The technical details and recommendations associated with the various elements of the 'technology stack' are discussed in more detail in Part IV of this report and also in Part II in relation to a geographic information strategy prepared by the Open Geospatial Consortium (OGC) in 2001/2 for the United Nations (UNGISP, 2002).

2.4.4 Assembling the essential components of a SDI

Taking into account the experiences of those organizations, agencies and nations that have successfully implemented SDIs, the key components for success include adoption of data quality and interoperability standards, inclusion of digital base and thematic framework maps and their attribute data, metadata (data documentation and catalogues), and interoperable services that typically support data discovery, access, processing and integration via the Web.

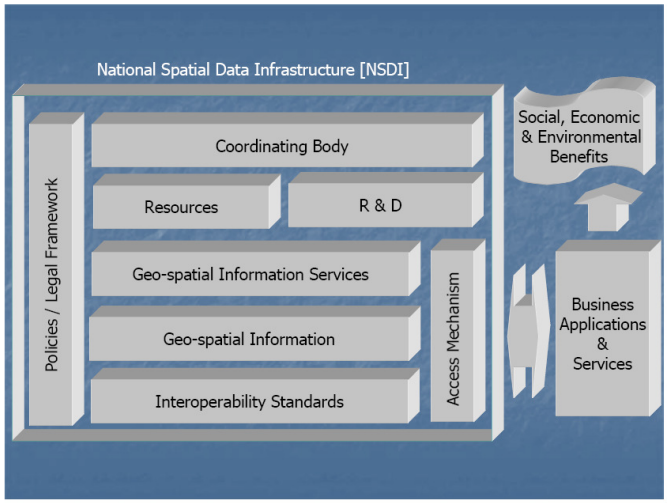


Figure 8: Schematic of the essential components of a NSDI (Robin McLaren, 2006)

These factors need to be coupled with an adequate communications network, an appropriate information policy and the legal and institutional framework to provide the necessary levels of governance and coordination between the involved institutions and partners. The relationship between these fundamental components is illustrated schematically in Figure 8.

2.4.5 Additional considerations for a UNSDI

Beyond the given of establishing a sound, interoperable technical framework for a UNSDI, is the overriding requirement to define a clear UNSDI strategy and business plan that moderates the influence of intangible factors that stem from the people, processes and cultures involved in its operation. This includes establishing stakeholder consensus regarding the governance mechanisms, policies, coordination, organizational readiness, accountability and management of risk in relation to future investment in geospatial technologies, data and systems, and business processes. While these aspects have not always been adequately incorporated into national, regional or global efforts to build SDIs, accumulated evidence from around the world indicates that there is a pressing need to ensure these requirements are addressed in a future UNSDI.

A future UNSDI should thus encompass the technologies, policies, criteria, standards and people necessary to promote geospatial data sharing throughout the United Nations and its Agencies, Funds and Programmes and, to the maximum extent possible, those of its Member States and partners. It should encourage the best practices and relationships among producers and users of geospatial data to facilitate its sharing and use for more precise and informed decision making in support of the UN Millennium Development Goals and UN Charter.

3. Trends in the development of SDIs

3.1 National initiatives

Increasingly decision-makers in national governments are recognizing the value of spatial information for economic and social development and the associated need for implementing SDIs to cost effectively harvest this potential. As a consequence, formal SDI programs have begun to blossom on a national scale since the original NSDI initiatives were implemented in countries such as Australia, Canada and the United States in the 1990s, and now span the full gamut of national economic development conditions prevailing in the countries concerned, from highly developed to developing economies.

Most national government initiatives have been stimulated into action by the potential benefits known to be associated with successful SDIs, such as the promotion of sustainable economic and social development, better government and environmental well-being. Additionally, the successful move by many countries toward implementation of system-wide e-government business processes has been responsible for creating a mindset that is more conducive to investment in spatial data infrastructures by decision-makers.

SDIs have most often been initiated at central or federal government levels, although multi-national initiatives such as the European INSPIRE scheme (see details of regional initiatives below) and private sector initiatives including the NGDF in the United Kingdom have also come into existence in recent years. Evolution of many national SDIs has been described as user-driven, although the degree to which this is true is the subject of debate. Others are unequivocally centralized, command and control systems. But the extent of success resulting from either implementation model is challenged in some quarters – *'I cannot think of a market segment well served by SDI efforts to date'* (Paul Ramsey, in 'Why SDIs Fail' 2006).

Regardless, an increasingly vigorous infusion of the SDI concept and related applications into sub-national business processes has been taking place recently in developed economies, enriching the SDI 'landscape' in terms of data scalability and service levels required by clients.

In developing countries, the initiation of select national SDIs has been stimulated by project or programme support from organizations such as the World Bank and bilateral donors although the sustainability of such initiatives has been criticized for lack of mature governance in the countries concerned and the inadequacy of the seed funding to create a critical mass of capability. Despite growing awareness of the measurable economic and social benefits that SDIs can bring, government funds in developing nations are most often stretched beyond reasonable limits and investing in what is poorly understood by local politicians and senior decision-makers is unlikely to receive priority attention without initial encouragement from trusted bodies like the United Nations or major donors.

But the poor availability or lack of interoperability of framework data on populations, vital infrastructure and environment for much of the developing world remains a major

restriction in the expeditious management of humanitarian crises stemming from natural disasters and other causes. Long-term, sustainable development initiatives similarly lack the framework data in many instances sufficient to support the levels of planning required at a country or sub-country level.

The wider implementation of operational SDIs in developing nations could substantially offset many of these constraints if realized.

There is obviously an opportunity here to be seized, by both the countries concerned and the United Nations. By incorporation of responsible business plans in project proposals and establishment of two-way data sharing agreements brokered between recipient nations and the UN bodies that encourage the implementation of SDI initiatives, there would be greater motivation from both sides to support and implement these measures.

3.2 Learning from others, examples of national SDIs

The following section includes a number examples from both developed and developing countries where SDIs have been implemented with varying degrees of success in recent years, as the approaches and results are instructive for the development of a UNSDI. The intent is to provide feedback on lessons learned and to further distil the essential ingredients of what constitutes a successful SDI for both the United Nations and the member states with, and upon which, it depends and cooperates.

At first glance it may not appear the case, but there are in fact strong parallels between the generation and management of data and information in federal systems of government and those of the United Nations. For example, in addition to the many federal ministries, departments and authorities with responsibility for spatial data generation and management in federal systems, considerable devolution of this responsibility is given to states, regional bodies and to municipalities. The specialized Agencies, Funds and Programmes of the United Nations have similarly devolved responsibilities akin to those of states in a federal system of government and answer in the first instance to their own governing bodies which are generally comprised of subsets of United Nations Member States. The Secretariat of the United Nations is correspondingly made up of numerous departments and units many of which exercise largely independent responsibilities for generating and managing the spatial data and information required for achieving the goals of the Organization. Implementing unifying standards and procedures associated with spatial data within and across all UN bodies is, therefore, going to be a complex task and the governance and administrative requirements of a system-wide UNSDI will be strongly influenced by this complexity.

3.2.1 The NSDI and the Geospatial Enterprise Architecture Initiative

The NSDI

The goal of the National Spatial Data Infrastructure (NSDI) managed by the Federal Geographic Data Committee (FGDC) in the United States is to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, and to make geographic data more accessible to the public. Through achievement of these goals the benefits of using available data are expected to increase. And, by establishing key partnerships with states, counties, cities, tribal nations, academia and the private sector the NSDI initiative endeavors to increase data

availability. The value of establishing key partnerships should be seen as a fundamental requirement of a future UNSDI as well.

The NSDI has been described as *"a set of actions and new ways of accessing, sharing and using geographic data that enables far more comprehensive analysis of data to help decision-makers choose the best course(s) of action."* There are parallels and mileage in this statement that extend to a UNSDI and these are revisited later in this report.

It is also encouraging to others establishing or refining an SDI elsewhere in the world that the FGDC, commenting on NSDI achievements in 2005, indicated that: *"Much has been accomplished in recent years to further the implementation of the NSDI, but there is still much to be done to achieve the vision of current and accurate geographic data being readily available across the country"*. The character of the NSDI, developed under the umbrella of a large federal system of government therefore appears to be very much an evolutionary one. Change then will be ongoing if the goals set by the FGDC for the NSDI are to be fully achieved. Thus, while the accomplishments of the NSDI are impressive, in the eyes of its creators it still remains a work in progress.

Geospatial Enterprise Architecture Initiative

Revolution also appears to be an important aspect of the further development of the NSDI in the United States. The FGDC, in partnership with other areas of the federal government, is developing a Geospatial Profile guidance document for the incorporation of common geospatial capabilities in the business processes of government as developed through agency Enterprise Architectures (see Box 4). This initiative stems from a proposal by the USGS to develop a national, geospatial enterprise architecture to encourage interoperability across all jurisdictions of government. The effort involves federal, state, local government representatives as well as academic and commercial contributors interested in facilitating the exchange of geographic information over common services.

Enterprise Architecture (EA) is: "the explicit description and documentation of the current and desired relationships among business and management processes and information technology" (IT). It defines a framework in which one describes all the work activities and justifies the investments of personnel, data, and applications within an enterprise. Enterprise Architecture is a practice used in business process re-engineering and is widely adopted in electronic government (e-Gov) initiatives.

US Office of Management and Budget (OMB)

Box 4: Enterprise Architecture defined

The identification of geospatial capabilities in governmental business and IT planning is believed justified by the FGDC for a variety of reasons:

- *"Geographic information is used in a majority of business settings in and outside of government*
- *Geographic information and services are not addressed consistently within and between organizations*

- *Interoperability among providers and consumers of geographic data and services requires a common understanding of semantics and functional capabilities*
- *Development of common multi-jurisdictional approaches to the use of geographic information and services requires inclusion in Enterprise Architecture approaches."*

By pursuing this initiative, the FGDC believes it will:

- *"increase awareness of geospatial capabilities within mainstream IT and business planning and promote awareness of current EA practices within the geospatial community*
- *leverage existing EA work within agencies will advance the development of a common geospatial Profile*
- *validate the Geospatial Profile through active prototyping and*
- *identify opportunities to leverage investments in geospatial capabilities across government."*

There are very important lessons here for the development of the UNSDI.

Selected sub-national and institutional trends in information management

Important information management and SDI developments have been taking place in a number of countries in recent years at a sub-national and institutional level. Many advanced examples can be found, but for the purposes of this report only a small selection are examined here to garner possible lessons for the development of a UNSDI.

New York State GIS Coordination Program

At a state level in the United States many agencies are using GIS for such things as emergency response planning, business development, property tax administration and analysis, transportation planning and analysis, wildlife and natural resource analysis, health care (disease studies), and school aid distribution and political boundary mapping. Local governments are using GIS for similar tasks. The private sector, in including utility companies and marketing firms, are also active users of GIS technologies.

The Office of Cyber Security & Critical Infrastructure Coordination is responsible for implementing New York's State-wide GIS Coordination Program. This office coordinates, promotes and facilitates the development, effective use, and sharing of geographic information. It also removes barriers to implementing geographic information technology to improve the delivery of public services, protect the public and the environment, and enhance the business climate for the benefit of the State, its municipalities, businesses and citizens.

Major Issues addressed state-wide to make GIS development and implementation simpler, less costly and more effective throughout New York State include:

Data Access: *"Much of the data used state-wide is created at the local level either because of local need or State mandate. Eighty percent of the costs associated with GIS are attributable to gathering and maintaining the data. Unfortunately, this valuable data is not often shared among agencies at the State or Local Government levels."*

Leadership: *"The need for leadership in New York State in the GIS forum has been evident to many over the past years. Guidance concerning standards, data*

coordination, legal issues and training has been often requested by government agencies wishing to initiate GIS programs. With the millions of dollars being spent on GIS around the State, the opportunities for government savings through proper guidance and planning are numerous."

Legal Issues: *"Legal issues surrounding GIS involve Freedom of Information Law (FOIL), liability, licensing, and privacy. The lack of resolution of these issues is leading to reluctance to develop GIS by some local communities."*

Data Coordination: *"Lack of data coordination requires government agencies to develop their own versions of data that already may exist in other places, resulting in unneeded costs being incurred for many."*

A State-wide 'Technical Policy on Geographic Information Systems' established the framework for the development of a permanent 'State-wide GIS Program' and charged the Coordinating Body with developing a state-wide policy that allows the transfer of digital data between State and Local Governments easily at little or no cost.

Work groups are being used by the Coordinating Body to address specific issues as they arise. Local and State Government and Private Sector Advisory Groups have been formed to provide input to the Coordinating Body on issues specifically affecting their sectors. Establishment of a clearinghouse, adoption of standards, drafting of legislation to eliminate GIS inhibitors and pursuit of financial and marketing possibilities for GIS in New York State complete the picture.

Wisconsin Enterprise Geographic Information System (WEGIS) services

The State Of Wisconsin has recently developed the office of the Geographic Information Officer (GIO) as the statewide coordinating body for Wisconsin Enterprise Geographic Information System (WEGIS) services. *'Delivering GIS services in an enterprise fashion will improve critical services to state agencies and citizens at an overall lower cost. The State of Wisconsin will benefit from an enterprise GIS through sharing infrastructure (hardware and software), resources (people), and processes across state agencies. In establishing the office of the GIO, it is important to recognize Enterprise GIS as an asset for the public, and the need for integration of spatial data with tabular data for better decision making.'*

The Wisconsin business plan links the transformation to GIS enterprise systems with that for its IT infrastructure. By agencies sharing resources, the State notes that the cost of data administration and supporting infrastructure will be reduced. Building *'common GIS service offerings'*, developing *'data distribution and management policies and standards, and collaboratively working with local and federal entities to more effectively manage GIS information within the State of Wisconsin'* is furthermore considered mutually beneficial to the agencies involved.

'Creation of an enterprise GIS program provides a model for sharing. The GIO will facilitate the coordination of previously disconnected efforts at the state and local levels to provide data sharing, standardization, and collaboration to improve the overall GIS landscape in the State Of Wisconsin. This coordination will better situate Wisconsin for emergency preparedness, economic competitiveness, public health delivery, environmental management, educational opportunities, and efficient delivery of services to the public'.

Communication and consultation are again important components of this business plan.

In detail, current initiatives include the following:

- GIS Communications Program
- Wisconsin Enterprise GIS (WEGIS) Strategic Plan
- Enterprise GIS Data Repository
- WEGIS Web Mapping Infrastructure and Services
- Enterprise Addressing Tool

Other instructive examples of geospatial data initiatives

Initiatives such as the US Department of Interior's Geospatial Modernization Blueprint, provide additional lessons regarding best practices in the design of a spatial information system that creates long term savings and business efficiencies, improves the ease, usability and reuse of location-based information and services, and improves the effectiveness of the Department's investments.

The Capability Assessment Toolkit for Sharing Justice Information, although not centered on geospatial data sharing, still offers useful lessons in the creation of an information system that promotes information sharing capability across jurisdictions. It was developed by The Center for Technology in Government (CTG) at the University at Albany. The multi-year project reflects a broad consensus that integrating justice information will have the potential to save lives, time, and dollars.

The Toolkit asks two key questions: What is our current capability for sharing and integrating information among the organizations involved? And: How can these organizations build higher levels of sharing and integration capability? The Toolkit defines sixteen basic capability dimensions and provides a detailed survey for those involved in the initiative to assess organizational, technical, and policy-related aspects of capability. The results of the assessment help determine how to fill gaps in capability both within and across organizations.

Implications for development of a UNSDI

The need for a business and management approach in the development of a UNSDI is increasingly affirmed as details of the planning and experiences of entities like the FGDC accumulate. In the context of the United Nations, the vision would be to develop an international, geospatial enterprise architecture that would similarly encourage interoperability, but across international jurisdictions and with all UN member states.

To date, geospatial capabilities within the UN have not been linked strongly with mainstream ICT funding. Significant areas of the geospatial data user community within the UN have had to allocate funds from within existing budgets that target applications to advance their in-house data infrastructures as a result and have not benefited from mainstream allocations for ICT funding. By taking an enterprise architecture approach to its development strategy, a UNSDI could conceivably draw, in part at least, on the significant ICT funding allocated under UN budgets.

3.2.2 GeoConnections

GeoConnections is a national partnership program that was set up in Canada in 1999 to advance the development of a Canadian Geospatial Data Infrastructure (CGDI) and comprises system-wide government participation in concert with the private sector and academia: *'..to support the protection and betterment of Canada's health, social,*

cultural, economic, and natural resources heritage and future.' The CGDI provides Canadians with on-demand access to geographic information such as maps, satellite images and related services and applications in support of sound decision making.

The CGDI is composed of four key components:

- *"**National framework data,** integrated from federal, provincial and territorial sources, provide the 'base' layers that many users can access to initiate analysis. These layers include positional survey data, international and provincial/territorial boundaries, place names, a primary and secondary road network, satellite imagery, and terrain relief;*
- ***Common data policies,** agreed to by federal, provincial, and territorial agencies, remove barriers to information sharing and encourage consistent approaches that reduce duplication;*
- ***Technical standards** govern the sharing of location-based information to ensure it is interoperable (that it can be mixed and matched). These standards are developed through federal/provincial/territorial and international negotiations;*
- ***Enabling technologies** based on open standards and specifications can be used to develop Internet mapping applications. These applications use the CGDI to integrate information from distributed sources in real time to address a full range of policy issues, from disease surveillance to protected areas reporting and Aboriginal land-use planning. This CGDI "toolbox" provides standardized building blocks that any organization may use to build applications to serve their own needs while 'plugging in' to the national infrastructure."*

The CGDI as a national resource

GeoConnections has developed the CGDI in partnership with other government agencies and the private sector. By so doing, the CGDI supports the shared decision making necessary for resolving many horizontal and inter-jurisdictional challenges. With its four key components, the CGDI serves as a common foundation for key government information systems, as well as for third-party service delivery.

Under this scheme, the significance of government policies to accelerate private sector commercialization of geospatial information is important as is the consideration of e-commerce and SDI in the same context.

Implications for development of a UNSDI

The strong business development element apparent in the GeoConnections SDI development strategy possibly points the way to the future regarding the value of geospatial products in market economies. A UNSDI may well have to look at elements of cost recovery for critical future datasets to encourage investment in their generation in the first instance. Revenue sharing with data generators and custodians where circumstances dictate may also become an issue to resolve in a future UNSDI.

3.2.3 The Australian Spatial Data Infrastructure (ASDI)

The ASDI is a national framework for linking users with providers of spatial information. It comprises the people, policies and technologies necessary to enable the

use of spatially referenced data through all levels of government, the private sector, non-profit organisations and academia.

The Standing Committee acknowledges that the ASDI should be seen as more than an aggregation of individual jurisdictional SDI initiatives and that it is important to identify and engage all stakeholders in the evolution of the ASDI as a national initiative. Implementation needs to be value-driven and cooperative.

With a vision to ensure *"Australia's spatially referenced data, products and services are available and accessible to all users", The Australian and New Zealand Land Information Council ANZLIC, through its Spatial Data Infrastructure Standing Committee (SDI SC) is facilitating solutions to the various barriers facing the ASDI and monitoring those factors driving implementation."*

Key components of the ASDI are the:

- Australian Spatial Data Directory
- Standards
- Spatial metadata

Factors driving the ASDI include: maximising the economic, social and environmental benefits from investment in spatially referenced information; facilitating industry development; rising community expectations for online services; globalization; technology; changing societal priorities; and environmental degradation and natural resource depletion. To a large extent, these factors are consistent with those discussed in earlier examples of national SDI initiatives.

But barriers to the implementation of the ASDI have been identified involving institutional relationships, data quality, inconsistent data access and use policies, incomplete knowledge about the availability and quality of existing spatial data, and lack of best practice in the utilization of enabling technologies.

Priority actions to address these barriers are incorporated into an ASDI Action Plan which identifies the following priority areas for implementation of the ASDI:

1. ASDI governance
2. Access to data
3. Data quality
4. Interoperability
5. Integratability (*'what needs to fit together should fit together'*)

Of these priority action areas, prominence is given to solving the issues of governance.

A technical working group provided advice on the technical considerations to be addressed in developing an online presence for the ASDI. The working group recommended use of open interoperability specifications in a generic web services model.

The importance of communications and consultation is an important underlying theme of the ASDI. For example, to communicate with and obtain feedback from all ASDI stakeholders, ANZLIC has developed the ASDI Communication Plan. Interestingly, an ASDI Brief for Senior Executives has also been developed. Workshops provide a further means for improving communications and consultation with stakeholders in the SDI process.

An innovative business approach to increase awareness about ASDI activities is to "brand" the products or services derived from these actions to acknowledge them as part of the ASDI implementation.

Implications for a future UNSDI

Consistent with the implications of the "ice-berg" of intangible influences on the operational success of an SDI that is illustrated earlier in Figure 6, the ASDI places high priority in solving issues of governance. The prominence of communications and consultation strategies in implementation of the ASDI is also of relevance to a future UNSDI. The focus in part of this strategy on briefing senior executives is of particular relevance to a UNSDI strategy, as this is a common complaint encountered during interviews with managers of spatial data users in UN agencies. Details are discussed in later sections of this report.

3.2.4 NSDI feasibility in Thailand

A NSDI Feasibility Study conducted in 2004 with grant support from the U.S. Trade and Development Agency (USTDA) developed a high-level plan for NSDI implementation in Thailand. The goals of the NSDI in Thailand were *"to provide technology, policies, and human capacity that promote the effective sharing of geospatial information throughout government, and ultimately the private sector and the public. The NSDI will allow the government to build on existing GIS investments from the past ten years and move towards a cooperative environment that will support the knowledge-based society envisioned as part of the Government's 9th Economic and Social Development Plan."*

A team of consultants consisting of the Environmental Systems Research Institute, Inc. (ESRI, Inc.), ESRI Thailand, and the Geographic Planning Collaborative, Inc. (GPC, Inc.) conducted the study with input from approximately 70 organizations that participated in the Study either as core stakeholders, stakeholders, or end users.

The assessment focused on four critical NSDI components:

- Fundamental Geographic Data Sets (FGDS)
- Technology Infrastructure
- Human and Institutional Capacity
- Policy, Legal, and Regulatory Environment

Recognizing the need for demonstrable business goals

The study notes: *'Needs for infrastructure are typically driven by common societal "business" goals. Therefore, most successful NSDI efforts are crafted around implementing FGDS layers and technologies that support demonstrable business needs.'*

Relevant business cases identified for Thailand include:

- Executive-Level Decision Support Systems: Priority information needs to be available quickly irrespective of departmental and ministerial boundaries to support decision-making in times of crisis.
- Management of Land Tenure: Depends on high accuracy geospatial information for land reform, titling, property transfer, etc. Multiple agencies collect land related data in multiple formats, often redundantly. A diverse user base

including local governments need regular access to this information. The diverse user base needs support in a standardized, consistent manner.

- Planning and Resource Management for Sustainable Economic Development: National planning and resources management for sustainable development drive this business case. Datasets are diverse and of national to local scales. Data custodianship is also diverse. Government and *ad hoc* public access required to support the planning process and information on land use. Data sharing in a distributed environment of data producers and end users is implied.
- Emergency and Disaster Management and Mitigation: A nationwide need exits for effective systems for natural disaster management and mitigation.

The need to identify and focus initial development efforts around selected basic data topics that are needed in common across the stakeholder community has been a feature of most NSDI developments. In the case of Thailand, the study notes that *'Implementation of these FGDS layers for the NSDI will be a significant undertaking that will likely take several years.'*

Further goals objectives and requirements investigated for the NSDI in Thailand include the technology infrastructure, and the human and institutional capacity requirements. Policy, regulatory, and legal requirements are also considered. A conceptual system design, implementation strategy, and comprehensive economic, legal and regulatory analysis of the project complete the feasibility process and offer an opportunity to assess the benefits of implementing NSDI in Thailand.

Benefits of Implementing NSDI in Thailand

The proposed technical architecture and implementation strategy for NSDI will realize the following quantifiable and qualitative benefits:

- Provide a significant potential economic benefit to the country.
- Promote data sharing.
- Provide a foundation for standards development.
- A plan for development and distribution of FGDS layers.
- Provide a foundation for cooperative development of geospatial information infrastructure.
- Provide important FGDS data that is needed by many in the near-term.
- More efficient data discovery and data distribution mechanisms
- Leverage the government's investment in geospatial information infrastructure.

Overall, the feasibility study for Thailand indicates: *'The NSDI implementation as a national investment shows very significant potential financial benefit to the country over the 5-year and 8-year period. The implementation of FGDS presents by far the largest cost of NSDI implementation.'* However, *"the cost of not modernizing FGDS data management and of not inducing effective data sharing through the NSDI, are an order of magnitude greater than the costs of the initial investment."*

'While the financial analysis is compelling enough, combined with intangible societal benefits of FGDS, the case for NSDI implementation is greatly expanded. NSDI presents an opportunity to carry out government work more efficiently and introduces ways to improve the governance function towards a more sustainable future.'

Implications for a future UNSDI

The NSDI study for Thailand leaves in no doubt the value of the NSDI in general and select framework datasets in particular. Meeting demonstrable business needs is again underlined as a feature of successful NSDI efforts, in this case crafted around implementing FGDS layers and technologies that support those needs.

3.3 Regional initiatives

Numerous regional initiatives promote the formation of regional geographic information networks (see Table 1). Regional initiatives have particular relevance where transnational issues are involved and/or human and material resources are in short supply. In the case of developed nations, for example in Europe, common interests in the economies of scale and increasing transnational efficiencies provide motivation for developing regional SDI initiatives. However, difficulties regarding governance and multi-national collaboration can create particular challenges beyond those encountered in the development of national SDI initiatives.

Table 1 - Present and past regional SDI-related initiatives of relevance to a UNSDI

Abu-Dhabi Global Environmental Data Initiative (**AGEDI**), http://www.ead.ae/en/
Antarctica & Arctic - SCAR Committee on Antarctic Geographic Information (**SCAR-CAGI**)
Asia GIS Association, http://www.hku.hk/cupem/asiagis/
Association for Geospatial Information in South-East Europe, http://www.agisee.org/
Euro-Geographical and European Umbrella Organization for Geographic Information (**EUROGI)** and formerly the Geographic Information Network in Europe **(GINIE).**
Executive Working Group (EWG) of the Sub-committee of Geo-information of the Committee on Development Information (**CODI-Geo**) for Africa. This is coordinated by UNECA and regional centres such as the **RCMRD** in east Africa **RECTAS** and **CRTEAN** (West Africa), and **AOCRS** (North Africa) are members of the Committee.
Geographic Information for Sustainable Development **(GISD)**: An alliance formerly promoting geo-information cooperation and capacity building in Africa.
INSPIRE: INfrastructure for **SP**atial **I**nfo**R**mation in **E**urope, a regional geo-spatial data initiative of the European Commission (EC), http://www.ec-gis.org/inspire/.
Mountain Environment and Natural Resources' Information Systems (**MENRIS**) International Centre for Integrated Mountain Development (**ICIMOD**) – Mountain Portal http://www.icimod-gis.net/
Pacific Islands GIS & RS User Forum http://www.usp.ac.fj
Permanent Committee on GIS Infrastructure for Asia and the Pacific **(PCGIAP**), http:// www.cpidea.org
Permanent Committee on SDI for the Americas **(CPIDEA),** http://www.cpidea.org
Sistema Regional de Monitoreo y Visualización para Mesoamérica (**SERVIR**) http://servir.nsstc.nasa.gov/
South Pacific Applied Geoscience Commission (**SOPAC**) http://www.sopac.org

All of these initiatives are aimed at maximizing the economic, social and environmental benefits of geographic information and promotion of SDI in the respective regions. The

UN was instrumental in the development of several these regional initiatives and remains linked through the UN Regional Cartographic Conferences to both PCGIAP and CPIDEA and to CODI through the UN Economic Commission for Africa (UNECA).

In developing countries, the promotion of SDI through regional initiatives mainly entails creation of awareness among decision makers and planners, and introduction to SDI concepts and the development process through workshops.

3.3.1 INSPIRE: INfrastructure for SPatial InfoRmation in Europe

Of the regional initiatives noted in Table 1, the experience of INPSIRE is of particular interest to the formulation of a UNSDI.

INSPIRE is a European Directive establishing the legal framework for setting up and operating an Infrastructure for Spatial Information in Europe. It is based on infrastructures for spatial information established and operated by the Member States. The purpose of such an infrastructure is in the first instance to support the formulation, implementation, monitoring, and evaluation of Community environmental policies.

This initiative intends to overcome key barriers still affecting Europe in spite of the progress in SDI developments discussed earlier. These barriers include:

3. inconsistencies in spatial data collection: spatial data are often missing or incomplete or the same data are collected twice by different organisations;
4. lacking documentation: description of available spatial data is often incomplete;
5. spatial data sets not compatible: spatial data sets can often not be combined with other spatial data sets;
6. incompatible geographic information initiatives: the infrastructures required to find, access and use spatial data often function in isolation only;
7. barriers to data sharing: cultural, institutional, financial and legal barriers prevent or delay the sharing of existing spatial data.

From the outset of this initiative, it was recognized that to overcome some of the barriers highlighted above it would be necessary to develop a legislative framework requiring Member States to coordinate their activities and agree on a minimum set of common standards and processes. This in turn requires the wide support of the Member States to the objectives of INSPIRE. Therefore, a process involving a high degree of collaboration was put in place to formulate the INSPIRE proposal. This involved the establishment of an Expert Group with official representatives of all the Member States, and Working Groups with expertise in the fields of environmental policy and geographic information to formulate proposals and forge consensus.

The European Commission adopted the INSPIRE proposal for a Directive in July 2004. Following two years of intensive negotiations, the European Parliament and the Council found an agreement in November 2006 on the text of the Directive, which is expected to come into force during the first half of 2007.

INSPIRE is complementary to other related policy initiatives, such as the Directive on the re-use and commercial exploitation of Public Sector Information or the Directive to access Environmental Information.

The problems related to the general situation on spatial information in Europe all bear relevance to the issues faced by a future UNSDI.

The INSPIRE Concept

The purpose of INSPIRE is to enable the finding of data relevant to a specific environmental problem, understand their structure, content and quality across multiple languages, administrative systems, and scientific disciplines, process the data into relevant information, and communicate this information to the interested parties in a timely manner.

The target users of INSPIRE include policymakers, planners and managers at European, national and local level and the citizens and their organizations. Possible services are the visualization of information layers, overlay of information from different sources, and spatial and temporal analysis of natural resources.

A fully operational infrastructure for spatial information in Europe can only be realized in the longer term. A stepwise approach is therefore being used in its development: the implementation of services will start immediately after the adoption of the Directive whereas the harmonization of INSPIRE data themes will be undertaken in three different phases from the adoption, up to 2013. This approach has the advantage of spreading the costs of the implementation across several years, avoiding a huge investment that is concentrated in the first years.

INSPIRE Principles

INSPIRE is an ambitious program with five underlying data management principles shown in Box 5.

- ***Data should be collected once and maintained at the level where this can be done most effectively***
- ***It should be possible to combine seamlessly spatial data from different sources and share it between many users and applications***
- ***Spatial data should be collected at one level of government and shared between all levels***
- ***Spatial data needed for good governance should be available on conditions that are not restricting its extensive use***
- ***It should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use.***

Box 5: INSPIRE principles for data management

INSPIRE Coordination

The European Commission Joint Research Centre (JRC) has played a key role in the development of the INSPIRE proposal in partnership with DG ENVIRONMENT and EUROSTAT, and a Memorandum of Understanding among these three organizations signed in 2006 recognizes this contribution, and gives to JRC the responsibility for the overall technical coordination of the Directive.

In 2006 a new formal organizational structure dedicated to SDI research and implementation was established in JRC, the "Spatial Data Infrastructures Unit". This unit is well connected with international standardization initiatives and spatial data infrastructures in the US, Canada (a trilateral agreement with FDCG and GeoConnection was signed in January 2006) and is co-chair of the GEOSS Architecture and Data Committee.

The JRC provides the scientific support to the preparation of the technical rules on data harmonization, documentation, and the network services necessary to discover, view and download data that will facilitate the coherent implementation of the Directive. It is also responsible for the development of the prototype EU Geo-portal, an Internet-based facility required by the Directive to provide a single point of entry to the environmental and geographic infrastructures maintained by the Member States.

In addition, the European Commission is supporting the development of SDI components and tools through its own Framework Programme for Research and Technological Development. Initiatives dealing with 'Risk and Crisis Management for Europe' that are closely associated with INSPIRE are the ORCHESTRA[9],WIN [10]and OASIS[11] projects. GMES[12], the European participation in the worldwide monitoring and management of planet Earth and the European contribution to GEO, also links to INSPIRE.

All of these European initiatives use common information architecture principles and have objectives convergent with a number of UN agencies.

INSPIRE participatory approach

Of particular relevance to a UNSDI is the approach adopted to develop INSPIRE, engaging hundreds of stakeholder organizations across Europe from the beginning of the drafting stages of the legislative framework. Adopting this participatory approach helped to empower stakeholders, who played a leading role in shaping the infrastructure from the outset and continue to support the INSPIRE initiative. Moreover, the establishment of a social network of key stakeholders in different regions and thematic areas provides an opportunity for long-term sustainability and use of the infrastructure. At the same time, it is necessary to recognize the complex challenges that such an approach entails. Like many pieces of European legislation, INSPIRE is a long process spanning some fifteen years from inception to full implementation.

Sustaining the momentum, mediating the different interests, coordinating the activities, managing the expectations, and delivering meaningful value to all the stakeholders is a very complex undertaking particularly when embedded in the constantly changing political and technological environment.

This approach emphasizes the importance of building a modern spatial data infrastructure through a combination of bottom-up participatory approaches across multiple stakeholder communities, and careful coordination backed up by a legal framework. Creating a broad social network with empowered stakeholders, and

[9] ORCHESTRA - Open Architecture and SDI for Risk Management
[10] WIN - Wide Information Network for Risk Management
[11] OASIS - Open Advanced System for Improved Crisis Management`
[12] GMES – Global Monitoring for Environment and Security

building on existing infrastructures, professional practices and agreements, are central features of the INSPIRE approach for a sustainable spatial data infrastructure.

Implications for a future UNSDI

As Europe represents a very significant constituency of United Nations member states, adoption of unifying principles associated with the regional ESDI underway will be critical to the development of a UNSDI. The technology and standards that comprise the INSPIRE initiative for example, such as the data management principles referenced above, will encourage adoption of similar principles by the UNSDI. Ensuring interoperability of the UNSDI with INSPIRE, along with other benchmark regional and national SDIs will be axiomatic for its future effectiveness.

3.4 Global initiatives of relevance

3.4.1 Global Spatial Data Infrastructure (GSDI) Initiative

The Global Spatial Data Infrastructure (GSDI) Association was formed to promote the SDI concept and support local, national and international spatial data infrastructure developments. As noted earlier, it is an inclusive organization of organizations, agencies, firms, and individuals from around the world it promotes international cooperation and collaboration concerning spatial data issues, data and systems that make up an SDI. The GSDI is guided by a Board and funded through membership fees. The GSDI Association Secretariat is hosted and supported by the USGS. A first GSDI conference was held in Bonn, Germany, in September 1996 with the theme "The Emerging GSDI". GSDI conferences have since been held annually and have done much to promote the SDI concept globally. The GSDI also promotes its activities and vision at major environmental forums such as during the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002.

The Global Spatial Data Infrastructure (GSDI) community is endeavoring overall to develop a global spatial data infrastructure backed by international standards, guidelines and policies to enhance data management and access, and support global economic growth, and associated social and environmental objectives. In this regard it has developed an impressive support network, "think-tank" capability, and tools such as the publication: "Developing Spatial Data Infrastructures: The SDI Cookbook" that is freely available to those requiring it. The numerous activities of the GDSI association are ultimately aimed at realizing a truly Global Spatial Data Infrastructure.

Implications for a future UNSDI

A UNSDI will be profoundly influenced by the cooperative developments underway in the GSDI. Further references to the value of a strategic partnership between the UN and the GSDI and what this entails can be found later in this report.

3.4.2 The Global Map initiative

The Global Map project is an international collaborative initiative through voluntary participation of national mapping organizations of the world, aiming to develop a globally homogeneous geographic data set at a scale of 1:1 million. The Government of

Japan spearheads this initiative and the Geographical Survey Institute (GSI) of Japan has been working as the secretariat of the International Steering Committee for Global Mapping (ISCGM, http://www.iscgm.org/) since its establishment in 1996. The ISCGM comprises members who represent national mapping and or regional geographic information organizations.

The primary objective of the Global Map project is to contribute to sustainable development through the provision of a base framework geographic dataset. Some 130 countries and regions that correspond to more than 80% of the Earth's land area are participating in the project. Data for completed countries are downloadable through the Internet from the ISCGM website. Regional and national mapping centres participate in this initiative through joint training courses and workshops.

Activities of the United Nations are emphasized in the Global Map Project, to advance its contribution to international society and Agenda 21 ideals. In recognition of the ISCGM's potential contribution to the UN, the Director of the Statistics Division formally encouraged National Mapping Organizations in 1998 to participate in the Global Map project, and in February 2005 the ISCGM was granted Roster consultative status by the (ECOSOC) of the UN.

Implications for a future UNSDI

The Global Map project will result in availability of an important framework dataset of digital cartographic information that conforms to international mapping and data standards that support is wide dissemination and use in the future. Users need to remain aware however, that all data layers are not necessarily seamless.

3.4.3 GEOSS

The intergovernmental *Group on Earth Observations* (GEO), established formally in 2005, is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next 10 years. Membership in GEO is open to all member states of the United Nations and to the European Commission. GEO also welcomes, as Participating Organizations, intergovernmental, international, and regional organizations with a mandate in Earth observation or related activities, subject to approval by GEO members. GEO may invite other relevant entities to participate in its activities as observers. Membership and participation in GEO is contingent upon formal endorsement of the GEOSS 10-Year Implementation Plan.

GEOSS works with and builds upon existing national, regional, and international systems to provide comprehensive, coordinated Earth observations from thousands of instruments worldwide; transforming the data they collect into vital information for society.

GEOSS aims to provide a broad range of societal benefits, including:

- *'Reducing loss of life and property from natural and human-induced disasters.*
- *Understanding environmental factors affecting human health and well-being.*
- *Improving management of energy resources.*
- *Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.*
- *Improving water resource management through better understanding of the water cycle.*

- *Improving weather information, forecasting and warning.*
- *Improving the management and protection of terrestrial, coastal and marine ecosystems.*
- *Supporting sustainable agriculture and combating desertification.*
- *Understanding, monitoring and conserving biodiversity.'*

The mechanisms for data and information sharing and dissemination upon which the success of GEOSS will depend, are outlined in the GEOSS 10-Year Implementation Plan. These include acceptance and implementation by information providers *'..of a set of interoperability arrangements, including technical specifications for collecting, processing, storing , and dissemination shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems…'.*

Reference is also made in the 10-Year Implementation Plan to *'..drawing on existing technologies'* including *'Internet-based services.'* The importance of *'open source'* software is also acknowledged for the most commonly used interfaces. But most significantly: *'..GEOSS will draw on existing Spatial Data Infrastructure (SDI) components as institutional and technical precedents in areas such as geodetic reference frames, common geographic data, and standard protocols.'*

GEOSS, among its many activities, will also be involved in capacity building and outreach.

Implications for a future UNSDI

GEOSS represents a significant cluster of global applications that support achievement of the UN Millennium Development Goals and sustainable development initiatives. It will draw heavily on geospatial data and technologies to achieve its vision and, in so doing, will focus on adoption of international standards for data and metadata, and utilize existing SDI components. Recognizing the mutual benefits of ensuring interoperability of the future UNSDI with the data access and sharing requirements of GEOSS, close coordination with GEOSS should be maintained during the design and specification of the future UNSDI.

3.4.4 NATO

The North Atlantic Treaty Organization NATO (http://www.nato.int/) incorporates among its many interests, a geospatial data community comprising two major groups:

- NATO geospatial group (for member states only) in the field
- NATO members for peace (NATO member states and further extended to peace partners, countries and international/regional organizations)

Implications for a future UNSDI

DPKO has a current relationship with NATO and this could be potentially expanded to include broader UN geospatial and mapping interests for the mutual benefit of all parties.

3.5 Other global support initiatives

3.5.1 International Standards Organization (ISO, http://www.iso.org/)

The ISO (International Organization for Standardization) is the world's largest developer of standards. Although ISO's principal activity is the development of technical standards, ISO standards also have important economic and social repercussions. ISO comprises a network of the national standards institutes of 156 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. Within ISO there is a technical committee for geographical information, ISO/TC211, setting a wide range of (more than 20) standards.

ISO is a non-governmental organization: its members are not, as is the case in the United Nations system, delegations of national governments. No commercial vendors are involved. As such, ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.

Implications for a UNSDI

Relevant elements of the United Nations Secretariat, agencies, funds and programmes recognize the essential requirement to adopt (or develop) widely accepted standards describing geospatial data, metadata and other components of an SDI. Standards ease access to and sharing of data, and increase the interoperability of associated information management systems. Adoption of suitable standards is the most cost effective way in which to achieve the necessary interoperability of the data and systems in an SDI. ISO, in working with members of the UN geospatial community in the past to help achieve these aims, has and will continue to be, an important partner in developing and refining a future UNSDI.

3.5.2 The Free and Open Source Software Community (FOSS)

The Open Source Initiative (OSI) is a non-profit corporation dedicated to managing and promoting the Open Source Definition for the good of the community, specifically through the OSI Certified Open Source Software certification mark and program. *"The term **Open Source (OS)** refers to a set of licenses that require unfettered access to the human-readable source code from which all computer programs are made."* (Holmes, Doyle & Wilson, 2005). Successful software products that have these properties engender confidence that the software really is "Open Source."

The basic idea behind open source is very simple: When programmers can read, redistribute, and modify the source code for a piece of software, the software evolves. People improve it, people adapt it, and people fix bugs. This can happen at a relatively fast pace compared to conventional software development. The open source community believe that this rapid evolutionary process produces better software than the traditional closed model, in which only a very few programmers can see the source and everybody else must work 'blindly'.

The Open Source GIS community in recent years has increasingly had a major influence on the technical development of Spatial Data Infrastructures around the globe. The FOSS software movement has grown to challenge commercial software in many

situations, not least of which is for developing country applications where costs are an important consideration in addition to function. Furthermore, the United Nations endorsed the use of OS software (OSS) for development in 2005 (see Box 6 below).

> ***"There is a wide consensus that the use of ICT can foster the implementation of development goals in general and those of the Millennium Development Goals in particular. Indeed, the United Nations ICT Task Force has established links between most of the targets related to the MDGs and ICT targets. In that context, and as OSS has been recognized in many instances to be a valid alternative to corresponding proprietary software, such recognition should be reflected in Member States' ICT policies for development."***
>
> ***"Policies of the United Nations System Organizations Towards the Use of Open Source Software (OSS) for Development" JIU/REP/2005/7.***

Box 6: United Nations endorsement of Open Source Software for Development

The Open Source model has numerous benefits relevant to financing and implementing the software components of a Spatial Data Infrastructure. Some of the advantages noted by Holmes et al include:

- The process is already built around communities of collaboration and governance structures that enable sharing;
- Financial risks to individual organizations are reduced, by focusing on the development of required components not those of the entire project;
- The pieces are built iteratively, by those who have the time and money to lend support
- No need of licenses means software solutions can be trialed at no software cost.

The newly created OSGEO foundation (http://www.osgeo.org) is of particular interest in this respect. '*The Open Source Geospatial Foundation has been created to support and build the highest-quality open source geospatial software. The foundation's goal is to encourage the use and collaborative development of community-led projects.*'

The foundation aspires to become an Apache.org equivalent. The Apache Software Foundation is one of the largest and most influential FOSS foundations to date (http://www.apache.org).

Implications for a UNSDI

The FOSS movement gains momentum by the day and already underpins a number of significant initiatives begun by individual agencies of the UN that complement the greater UNSDI ambitions. As noted by Holmes et al: *"The important thing behind Open Source is not the products, but the inclusive process used to develop and build upon those results. If the tools that implement the pieces needed for the Global Spatial Data Infrastructure are built on a spirit of cooperation and collaboration, then we are optimistic that such a spirit will carry over to the whole process of sharing geographic data."*

3.5.3 The Open Geospatial Consortium, Inc (OGC)

The OGC is a non-profit, international, voluntary, consensus standards organization that is leading the development of standards for geospatial and location based services. Through its member-driven consensus programs, OGC works with governments, private industry, and academia to create open and extensible software application programming interfaces for geographic information systems (GIS) and other mainstream technologies. Adopted specifications are available for the public's use at no cost.

The OGC sees its mission as serving as a global forum for the collaboration of developers and users of spatial data products and services, and to advance the development of international standards for geospatial interoperability.

At a strategic level the OGC aims to:

- Provide free and openly available standards to the market, tangible value to its Members, and measurable benefits to users.
- Lead worldwide in the creation and establishment of standards that allow geospatial content and services to be seamlessly integrated into business and civic processes, the spatial web and enterprise computing.
- Facilitate the adoption of open, spatially enabled reference architectures in enterprise environments worldwide.
- Advance standards in support of the formation of new and innovative markets and applications for geospatial technologies.
- Accelerate market assimilation of interoperability research through collaborative consortium processes."

OGC and its members offer resources to help technology developers and users take advantage of OGC's open standards. Technical documents, training materials, test suites, reference implementations and other interoperability resources developed in OGC's Interoperability Initiatives are available on the OGCNetwork. In addition, OGC and its members support publications, workshops, seminars and conferences to help technology developers, integrators and procurement managers introduce OGC plug and play capabilities into their architectures.

3.5.4 Other relevant initiatives

OASIS (Organization for the Advancement of Structured Information Standards) is a not-for-profit, global consortium that drives the development, convergence, and adoption of e-business standards. Members themselves set the OASIS technical agenda, using a lightweight, open process expressly designed to promote industry consensus and unite disparate efforts. OASIS produces worldwide standards for security, Web services, XML conformance, business transactions, electronic publishing, topic maps and interoperability within and between marketplaces. OASIS has more than 500 corporate and individual members in 100 countries around the world.

The Open Archives Initiative (OAI) is dedicated to solving problems of digital library interoperability. Its focus has been on defining simple protocols, most recently for the exchange of metadata from archives. The OAI evolved out of a need to increase access to scholarly publications by supporting the creation of interoperable digital libraries. As a first step towards such interoperability, a metadata harvesting protocol was developed to support the streaming of metadata from one repository to another, ultimately to a provider of user services such as browsing, searching, or annotation.

Members of Virginia Tech's DLRL have been involved with this process from the early stages and continue to contribute towards the development, support and advocacy of protocols and standards.

The World Wide Web Consortium (W3C) is an international consortium where member organizations, staff and the public work together to develop standards for the World Wide Web. W3C's stated mission is "To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web." W3C engages in education and outreach, develops software and interoperable technologies (specifications, guidelines, software, and tools) that support its mission. It also acts as an open forum for discussion about the Web, serving commerce, communication, and collective understanding.

Implications for a UNSDI

All of these initiatives have potential roles to play in the utilization of technologies that support best practices suitable for a UNSDI in the future.

3.6 Commercial sector partnerships

Commercial organizations such as software and systems developers are increasingly involved in the development of information management systems to support a variety of global and local SDI-related efforts. In Japan for example, private companies promote national SDI in the country through a non-profit organization, the NSDIPA, the National Spatial Data Infrastructure Promoting Association (GSDI Cookbook, 2004). Geo-Connecttions in Canada also emphasizes the role of the private sector in its national SDI development. In yet another example of commercial sector support, the Environmental Systems Research Institute ESRI, a commercial GIS research and software developer, launched the International Steering Committee for the Global Mapping (ISCGM)/Global Spatial Data Infrastructure (GSDI) Grant program to support spatial data infrastructure development by national mapping agencies and national spatial data development organizations. ESRI also recently initiated the Geography Network, a collaborative, multi-participant system for publishing, sharing, and using geographic information on the Internet.

There are many such examples of private sector partnerships that have or currently assist SDI-related initiatives around the globe. Those specifically associated with UN projects and programmes are discussed in further detail in Section 6.5.

Implications for a UNSDI

Opportunities to expand private sector involvement in the future UNSDI are of particular interest and potential, including the possible contribution of the private sector to the future development and work of national UNSDI committees (see Sections 6.3.1, 6.3.2).

3.7 Thematic initiatives

Thematic initiatives that generate or depend heavily upon spatial data and information have particular relevance to a future UNSDI. Such initiatives include a variety of resources-related, environmental and social themes for which SDI-related initiatives

exist. Typically these could include oceans, conservation, geology, water, and the broader aspects of land and environment, statistics, and emergencies.

The WDC-MARE - World Data Center for Marine Environmental Sciences operated by IOC and UNESCO, the Mersea Ocean portal (http://www.mersea.eu.org), the NOAA Ocean Planning Information System (OPIS) and the NASA JPL ocean portal, http://ourocean.jpl.nasa.gov/ are examples of oceans-related initiatives with which a future UNSDI could potentially collaborate for the benefit of involved parties. In the case of biodiversity, relevant initiatives might include the Global Biodiversity Information Facility (GBIF), (http://www.gbif.org/), the Inter-American Biodiversity Information Network (IABIN), (http://www.iabin.net/english/index.shtml) and a myriad of related undertakings regarding conservation too numerous to mention. The work of the CGIAR-CSI (Consultative Group on International Agricultural Research – Consortium for Spatial Information) is high on the list of thematic spatial data initiatives of relevance regarding agriculture, as are initiatives such GMES and UNEPnet regarding the environment. Many of the bilateral and international relief support systems that utilize spatial data and link with OCHA's ReliefWeb are also potential collaborators of interest to a wider UNSDI.

It is important to note that the above summary of thematic initiatives of interest is again simply an indicator of possibilities and should in no way be considered exhaustive. It is intended to act as a stimulant for further discussion and action among parties involved in a proposed UNDSI development.

3.7.1 Paris21

Among the thematic initiatives of interest to a UNSDI, the relationship between spatial data and statistics is perhaps the least developed on a system-wide basis. In this regard, Paris21 (Partnership in statistics for development in the 21st Century) is of particular relevance to a future UNSDI (http://www.paris21.org/).

PARIS21 was founded in 1999 by the Organization for Economic Co-operation and Development, the World Bank, the European Commission, the International Monetary Fund and the United Nations. It was launched to act as a catalyst for promoting a culture of evidence-based policymaking and monitoring in all countries, and especially in developing countries in response to the UN Economic and Social Council resolution on the goals of the UN Conference on Development. Its objective focuses on '*…nationally owned and produced data for all MDG indicators by 2010.*'

The Consortium comprises a partnership of policymakers, analysts, and statisticians from all countries of the world. Members are from governments, international organisations, professional bodies, and academic institutions. The focus of Consortium is on promoting high-quality statistics, making these data meaningful, and designing sound policies. By so doing it aims to foster more effective dialogue among those who produce development statistics and those who use them, through facilitating international events, supporting country-based activities, regional workshops, and subject matter task teams.

Implications for a future UNSDI

The UNSDI and Paris21 have considerable medium-term convergence of purpose with both expressly supporting the UN MDGs. Mutually beneficial synergies should be

explored therefore, the development of a possible strategic partnership between the two initiatives.

3.8 Academic initiatives

There are numerous academic, SDI-related initiatives of relevance to the development of a comprehensive UNSDI. Several examples related to possible candidates for future collaboration between a UNSDI and academic initiatives associated with geospatial data are set out below. Again the list below is indicative and not exhaustive, designed to provoke further discussion, identification of related initiatives and ultimately, action regarding partnerships of mutual benefit.

3.8.1 GILA

GILA is a non-profit organization associated with the Regional Center for Space Science and Technology Education for Latin America and the Caribbean (CRECTEALC) affiliated to the United Nations. The mission of GILA is to improve the quality of geo-information research in Latin America focusing on international-quality postgraduate education, http://www.gilanet.org/

3.8.2 AGILE

The Association of Geographic Information Laboratories for Europe or AGILE, (http://www.agile-online.org/) was established in early 1998 to promote academic teaching and research on GIS at the European level, and to ensure the continuation of the networking activities that have emerged as a result of the EGIS Conferences and the European Science Foundation GISDATA Scientific Programmes.

3.8.3 UCGIS

The University Consortium for Geographic Information Science UCGIS), http://www.ucgis.org/ serves as an effective, unified voice for the geographic information science research community. It fosters multidisciplinary research and education and promotes the informed and responsible use of geographic information science and geographic analysis for the benefit of society, including assessment of current and potential contributions of GIS to national scientific and public policy issues.

3.8.4 NCGIA

Initially established in 1988, the National Center for Geographic Information and Analysis (NCGIA), a consortium of three institutions: the University of California at Santa Barbara, the State University of New York at Buffalo, and the University of Maine. The primary mission of the NCGIA was to conduct basic research, but the organization was also asked, from time to time, to provide services or coordination for members of the broader Geographic Information Science community. In 1990, the NCGIA board of directors recommended that a more broadly-based organization be established to promote and support the field, especially the needs of researchers. After continued discussions in 1991, the NCGIA responded by establishing an ad hoc steering committee consisting of 16 individuals from as many institutions, representing about seven different academic disciplines. After a series of meetings at professional

conferences, sufficient momentum was gathered to establish a national conference on the issue in Boulder, Colorado.

3.8.5 Global GIS Academy

The Worldwide Universities Network (WUN) Global GIS Academy (http://www.wun.ac.uk/ggisa/) seeks to complement existing activites, such as AGILE and UCGIS, using the IT and personnel infrastructure within the WUN. This it achieves through joint initiatives with existing organisations, and also through the creation of new projects in areas in which many of the partners are extremely strong and where complementary expertise covers almost the entire breadth of GIS.

The potential advantages of collaboration are clearly many and include developing joint research and teaching in the many areas of geospatial data applications.

3.8.6 ESIP Federation

The Federation of Earth Science Information Partners (ESIP) is a unique consortium of more than 90 organizations that collect, interpret and develop applications for remotely sensed Earth observation information (http://www.esipfed.org/). Included in the ESIP network are NASA, NOAA and USGS data centers, research universities, government research laboratories, supercomputing facilities, education resource providers, information technology innovators, nonprofit organizations and commercial enterprises. The Federation's network fosters collaboration and innovation. It brings together partners to develop models and tools that make Earth observation information more useful and accessible across many different communities. Together, Federation partners leverage the value of these important data resources for the betterment of society and our planet.

Implications for a future UNSDI

These and many other academic networks offer considerable promise for developing future strategic partnerships aimed at increasing the ease and diversity of spatial data accessible worldwide via a UNSDI.

4. Emergence of a fledgling UNSDI

4.1 Background

In the past nine years, the overall financial resources managed by the UN Secretariat have doubled to $18 billion. Over the same period, the number of civilians and soldiers deployed on peacekeeping missions alone has increased from 20,000 to 80,000. The number of humanitarian and human rights operations have also dramatically increased. Such a high volume of operational activity places a greater premium on the ability of the organization to discharge the increased and more complex mandates it is given, and to manage the funds entrusted to it in an accountable and ethical manner.

From peace-keeping (see Box 7) to pandemics, from environment to economic development, the ready availability and cost-effective management of dependable geospatial information is now central to raising the operational efficiency of the United Nations. Both in terms of its short-term emergency response capacities and those required for its long-term strategic servicing of the three pillars of sustainability: human well-being, natural life-support and economic growth.

> ***"Geographic Information has been noted to be the soldier's most important weapon – second only to his gun. …"***
>
> ***Lt.Gen. Daniel Opande, Force Commander UNAMSIL, Oct. 2002***

Box 7: Priority accorded geographic information by the UNAMSIL Force Commander

4.1.1 Evolution of a spatial data user community

As noted previously, the production and use of geographic information within the United Nations has been accomplished historically by its component organizations in accordance with their individual needs and expertise. Without malice of forethought, this has resulted in considerable duplication of effort, reduced opportunities for sharing and reuse of data, and an unnecessary cost burden for the United Nations as a whole.

The widely varying mandates of United Nations entities and the equally variable demands placed on them by their governing bodies, upper managements and partners has also led to very different rates of adoption and achievement across the system with respect to geospatial information and supporting technologies. As a result, a distinctly bi-modal UN user community now exists regarding competence with, and dependence upon, geospatial data and information.

Organizations that could be considered 'significant' users of geospatial data and applications in the United Nations include DPKO/UNCS, FAO, OCHA, UNEP, UNESCO, UNHCR, UNICEF, UNOSAT, WFP, WMO and WHO. UNITAR also actively propagates the use of geospatial data and applications by member states and others through training in related subjects. The applications, data management skills and related geospatial assets of user organizations have tended to be more distributed

internally in these agencies since the advent of desktop GIS. As well, skills are focused in specialist teams associated with field or project specific activities dependent upon geospatial analysis. But total numbers of staff with skills in these areas of expertise is still relatively low when considered system-wide.

Remaining departments, agencies and programmes of the United Nations that could benefit by embracing geospatial technologies in the conduct of their work, but have not done so as yet, generally either lack sufficient awareness of the benefits or the management commitment to move in this direction.

4.2 Business cases driving the UNSDI

Of the activities pioneered by individual UN organizations, there are four broad clusters of geospatial data enterprise that have been undertaken to date by the agencies involved. These represent the business cases driving the UNSDI and include:

- Provision of spatial data and information
- Development of common data services
- Capacity building
- Promotion of partnerships and cooperation

4.2.1 Provision of spatial data and information

There is a substantial and growing demand for common cartographic, geospatial data and GIS services across the United Nations system. A range of internal geospatial data services have been implemented by select UN agencies in response to improve efficiencies in carrying out their mandated tasks. To varying degrees these support cooperation with other agencies, member states and partners as well.

Cartographic data, satellite imagery and GIS services

DPKO/UNCS for instance, provides cartographic and GIS support to the Security Council and the Secretariat at global and national scales, but also at site-specific levels for the various UN peace keeping missions. Activities vary from the supply of maps dealing with international boundary issues and peace-keeping, to program management of GIS units and related base data for UN field missions. Here, common field-based GIS services and cartographic data support the operations of other UN agencies such as OCHA, WFP, UNHCR and UNICEF through links with Humanitarian Information Centers (HICs) and those of their partners on-site.

Thematic data: supporting the three pillars of sustainability

Sound resource management and responsible environmental stewardship are the main ingredients of future sustainability of life on Earth as we know it, including most importantly the prospects for humankind. Planning for sustainable development from global down to local scales depends on the evaluation of various factors such as climate, water resources, topography, soils, landuse, environmental overlays, prevailing demographic patterns and details of existing infrastructure, all of which exhibit geospatial characteristics. However, the related information is located in many different UN agencies and in diverse global, regional and national bodies. As a result, planners and resource managers scattered around the globe need networked access to the information in an environment that promotes open data access and data sharing. User

needs of the involved planning and resource management communities are therefore an important consideration in the establishment of priority components of the UNSDI.

Agencies such as FAO, UNEP, WFP, WHO and WMO have developed, either internally or through partnerships, thematic datasets that support their normative and project related activities on a variety of operational scales. These data also have potential value for other UN agencies, partners and member states dealing with issues of environmentally sustainable development and support for human health and well-being. However, awareness of, access to, and interoperability regarding these data has historically remained sub-optimal. In league with a range of donors and member states many of these same agencies have worked to develop country and sub-country level databases that support local development initiatives and emergency preparedness, but similar issues affect the more widespread use of these data as well.

Global and regional environmental observation and assessment

A number of UN agencies have long been committed to increasing the availability of quality assured spatial data and information that feed, or are planned to feed into global observing systems and international indicator initiatives such as the G3OS, GTOS, GCOS and GOOS. Contribution to the management of these data will be a future growth area for UN geospatial data enterprise with the establishment of important new global initiatives such as GEOSS that support MDGs. Cooperation, coordination, interoperability and shared access to these data remain important system-wide issues to resolve for global programmes of this kind.

Emergency response and disaster preparedness

The more than 350 natural disasters brought on by the floods, droughts, earthquakes and pandemics that occur annually, and the equal number of man-made catastrophes arising from conflict, has stimulated the international community to establish capacities for disaster preparedness and response, to mitigate the impacts of disasters on populations.

Geospatial technologies increasingly play a role in helping UN agencies, their partners and member states to anticipate, prepare and meet the challenges of disasters in a more timely and effective manner. The frontline UN humanitarian and relief agencies[13] for example, are required to respond to emergencies at a variety of scales, from regional down to national, sub-national, but also local scales in the field. Here they employ or utilize the spatial outputs of GIS applications to plan interventions as evolving circumstances dictate, but the effectiveness of this approach depends on the availability and quality of geospatial data on site. Information for example regarding the local infrastructure, population, and the resources that are impacted or threatened by a crisis is critical to developing appropriate mitigation strategies. Rapid access to the most recent satellite data through agencies such as UNOSAT and DPKO/UNCS is important in this regard to assess damage to infrastructure.

This raises several questions related to the robustness of supporting information services including how the required thematic and cartographic data are made available in the field and at short notice, and the scalability or 'fitness of purpose' of the data itself. As well, the adaptability and interoperability of applications tools that support the necessary analyses within and across the user family need to be considered. Partners outside the UN system, such as the GIST, national governments and their agencies,

[13] E.g. OCHA, UNJLC, UNHCR, UNEP, UNDP, UNICEF, UNOSAT, WFP and WHO

NGOs, donor agencies, regional and international organizations that participate in many of these field operations also need fast and reliable access to the same geospatial information. They may also want to share the information they hold with UN bodies for reasons of combining forces to address a problem. Common standards that increase interoperability and ease use of data are an issue of concern in these circumstances, as time is very often a constraint impacting on mitigation strategies.

Development agencies such as UNDP, bilateral donors and NGOs that follow in the lee of initial emergency responses also stand to benefit from increased and more timely access to reliable geospatial data and information for reconstruction planning and implementation purposes.

OCHA[14] and other UN agencies and their partners including the GIST have worked to address data preparedness issues including the vast gaps in global coverage of base maps at scales relevant to disaster risk management. But lack of geospatial metadata and GIS data models for disaster risk management and the absence of messaging standards among disaster management systems have also reinforced the proliferation of stand-alone solutions.

4.2.2 Common services

Common geospatial data services have developed along two lines in UN organizations. Initially to increase sharing and potential reuse of data internally and for immediate partners such as member states, and more recently in a bid to access and/or share a wider range of geospatial data and information available from external sources via the Internet. Rapidly growing global communications infrastructure and the emergent Internet connectivity that followed increasingly highlighted the issue of data interoperability and other factors limiting data sharing. Without adoption of common data standards and tools that foster interoperability, improvement in inter-agency and external data sharing and ease of use was destined to have remained sluggish.

Agencies initially responded to this realization on an individual basis by taking greater interest in data standards, metadata and provision of their own technical infrastructure to support spatial data web services where funds permitted. Until recently however, coordination between UN agencies in their approaches to the sharing of spatial data has been limited, with the Internet being the surrogate driver of any apparent convergence of purpose. The net result has been variable approaches to resolving these problems and unnecessary duplication of effort with obvious cost implications to each and all involved.

4.2.3 Capacity building

Internal capacity building with respect to spatial data and information management and staff resources has generally proceeded in an evolutionary manner within UN agencies. Among the more proficient and active organizations in this regard, development of internal capacities has proceeded in accordance with ‘user needs’ principles, but almost always seriously tempered by funding considerations and therefore lagging behind true needs. Project funding involving external donors has often been an important catalyst driving spatial data proficiencies forward, complemented by core funds where managements could be convinced of benefit.

[14] OCHA’s ReliefWeb is the global hub for time-critical humanitarian information on Complex Emergencies and Natural Disasters

Dealing with data for the sake of anticipated requirements of others has never been an easy row to hoe in the UN, particularly when it came to obtaining core funds for this purpose. Agenda 21 provided some justification post 1992 for agencies such as UNEP, FAO and others to proceed with development of core environmental datasets for the common good, but almost always external donors or partners have been required to ensure successes.

Agencies of the UN have a long history of external capacity building in spatial information related subjects as well. UNDP and WMO for example, implemented drought monitoring programmes in eastern and southern Africa during the late 1980s in collaboration national meteorological agencies. These initiatives helped to build enduring networks for the exchange of drought-related spatial data and information. Inputs from meteorological satellites significantly enhanced through the EU-EUMETSAT-WMO PUMA Programme for Africa concluded in 2005, still remain an important component of these regionally managed activities today.

UNEP and UNITAR were also instrumental during the 1990s in helping to raise the competence levels of government staff to utilize satellite data and add value to it through GIS applications supporting the management of natural resources and the environment in many African countries. Through normative programmes such as ARTEMIS and numerous globally dispersed field projects since the 1970s, FAO also stacked up an impressive record of national and regional capacity building that supported staff training and the acquisition, application and interpretation of geospatial data using GIS and Remote Sensing for resource management, sustainable agricultural development and early warning of food insecurity. UNDP and numerous bilateral donors sustained these initiatives over the years.

WHO has also been assisting national ministries of health over the past decade in the collection, development and maintenance of geospatial databases for public health. Through a global partnership involving WHO regional and country offices, technical partners and NGOs in the health arena, a vast storehouse of spatial information has been developed by WHO, particularly for the African continent. Thousands of health administrators, at both national and district levels have been trained on the use of GIS and WHO's HealthMapper system to incorporate spatial information in support of routine disease surveillance and public health planning and management.

4.2.4 Partnerships and cooperation

Much of the spatial data of importance to UN activities is generated by organizations external to it and over which it has no direct control. Partnerships that leverage access to data and information from these sources are therefore vital to UN operations. Cooperative activities with both internal and external partners have and continue to be important mechanisms for increasing both data interoperability of legacy data and the generation of critical new datasets. Adding value to spatial data through the development of GIS applications that assist particular UN programmes could only have been achieved with assistance of external partners on many occasions.

UN partnerships leveraging spatial data support are a continuum of arrangements involving national government agencies, regional bodies, NGOs, industry, academia and the not-for-profit sector in general. The more strategic of these partnerships are discussed later in this report in relation to the development of a UNSDI.

4.3 Recent agency proposals of significance

UN bodies dependent upon geospatial data for normative activities have steadily grown to accept the need to structure information management within their own agencies and with their partners to improve data reliability, exchange, and utilization. But prevailing internal and inter-agency policies and organization have until relatively recently, made formal exchange and distribution of geospatial data and information difficult or even impossible. Data sharing agreements rarely existed for example, or the data lacked interoperable standards to facilitate its reuse.

Availability of a reliable and interoperable infrastructure for information exchange thus remained a controlling influence on the future level of accomplishment of many UN undertakings. In this regard FAO has worked to develop interoperable metadata and data discovery tools for use within its own organization, but also with a view to improving common services applications across the UN system and those of its partners in the future. UNOSAT, in close cooperation with UNOOSA and the International Charter "Space and Major Disasters", has facilitated operational access to relevant satellite data coverage to assist in responding to natural and manmade disasters.

To address common data sharing issues, OCHA and its partners have proposed the development of modular, service-oriented, and standards-compliant web-based information architectures. These architectures feature geospatial web-services to facilitate interoperability among applications. In this way OCHA believes future preparedness and response coordination can be better supported.

UNEP too, has for some time been working to develop open standards-based notional information architecture that best binds the organization's broad and disparate data and information services together.

These and other related activities are discussed in more detail in subsequent sections of this report.

4.3.1 UNEP's notional SDI

The open standards-based notional information architecture envisaged by UNEP is a vendor-neutral, interoperable platform that needs to work effectively with the services run by its partners inside and outside the UN. It should provide a frame of reference for describing and defining scenarios and use cases that encapsulate user requirements for services such as locating and accessing data, processing them into value-added information products, displaying the results, and delivering products to users.

What is particularly instructive about UNEP's approach is that the proposed architecture makes no assumptions either about the types of computers that services are implemented on, which institutions operate the services, the software vendors and developers with whom they deal, other than their acceptance and support of open, non-proprietary standards. UNEP provides an explanatory framework within which distributed services, managed by authoritative custodians, can be implemented to support an expanding set of services.

The diversity and disparity of UNEP's own services, and those of an often ill-defined and expanding set of partners, means that interoperability can best be achieved by an approach which is not proscriptive, allows for regional and social practices, is not bound to the preferences of a single community, and has a low entry cost for those that wish to

'join the club'. The practicality of using the world-wide web to connect systems adapted to open web services has already been shown to be achievable and affordable.

The UNEP notional Architecture is thus broad based and sets a context within which a number of selected services may be identified and exercised.

4.3.2 GeoNetwork

GeoNetwork opensource is an FAO-sponsored software tool that facilitates single point of entry access to geo-referenced databases, cartographic products and related metadata located at globally distributed information sources. It provides a standardized and decentralized spatial information management environment and was first developed by FAO to enhance spatial information exchange and sharing between UN organizations and their audiences, using the capacities of the internet. GeoNetwork has since grown to include the cooperative efforts of FAO, WFP, WHO, UNEP and UN-OCHA to develop a more universally applicable ISO and OGC-standards-based information management tool for United Nations users, member states and UN partners.

The GeoNetwork software capacity enhances geospatial data access and sharing within and between distributed organizations. At the same time, it helps to avoid unnecessary duplication of data assets and results in overall information management efficiencies and cost savings for users. Cooperation and coordination of data collection and description are increased while preserving data and information ownership. As a result, the system now provides a wide community of spatial information users with easier and timelier access to available digital data including thematic maps. Thematic layers of spatial data can be integrated by GeoNetwork through InterMap, including those derived from satellite imagery, enabling a composite or 'one-window' map view of prevailing geographic, social and economic factors to be created for an area of interest. Spatial visualization using derived cartographic outputs of this kind assists communications between technicians and decision-makers, and provides a basis for more informed decisions in many situations. Not surprisingly, such outputs increasingly play a role in the work of the United Nations and its partners.

Technical considerations

The GeoNetwork opensource architecture is largely compatible with the Geospatial Portal Reference Architecture, the Open Geospatial Consortium's (OGC) guide to implementing a standardized geospatial portal. The software can be used by any interested party as a straightforward and cost-effective means of publishing geographical metadata and data on the web.

GeoNetwork opensource implements both the Portal component and the Catalogue database of a Spatial Data Infrastructure (SDI) defined in the OGC Reference Architecture and provides tools for managing and publishing metadata on spatial data and related services. GeoNetwork opensource additionally allows a distributed search providing access to a large volume of metadata that come from different data clearinghouses and provides a web-based interactive map viewer that allows people to compile composite maps, picking thematic layers from distributed servers on the internet.

Operational deployment

The GeoNetwork opensource software is deployed at a number of organizations around the world, including FAO HQ-GeoNetwork and VAM-SIE-GeoNetwork at WFP in Rome as well as its regional bureaux around the world. Following the recent WHO deployment of GeoNetwork at its HQ in Geneva, a roll out of the system is also underway to its regional offices. UNEP, CGIAR, ICIMOD, UNHCR, the Global Change Information and Research Centre (GCIRC) of China and others are additionally working on GeoNetwork opensource implementations to support their spatial information management capacities. Currently, the developers of GeoNetwork opensource are positioning to move the initiative into the OSGEO foundation, in line with several of the major FOSS geospatial applications. Furthermore, in the context of GEO(SS), ESA and FAO, building on the existing ESA Earth observation (EO) portal, the outcome of the HMA process and GeoNetwork, are working together towards using GeoNetwork as the metadata capacity and part of the user interface for the GEOportal, to be realized during 2007 and moving towards a GeoNetwork 3.0.

4.4 UN Inter-agency coordination

Numerous UN inter-agency coordination initiatives exist concerning information, many of which involve strategic partnerships that extend beyond the UN family. Typical examples are summarized in Table 2 below. The breadth and diversity of these existing initiatives highlights the considerable potential for increased ease of data and information sharing through the adoption of common standards, tools and shared infrastructure in the manner made possible by implementation of an efficient UNSDI.

Table 2: Existing cross-agency information coordination initiatives

Cross-agency coordination initiatives	Main participants	Function
Committee on Information, http://www.un.org/ga/coi/	UN system-wide, UN General Assembly	Examines and reports on UN public information policies and trends
Geographic Information Support Team (GIST)	Inter-agency initiative, involving UN agencies USAID/OFDA, ECHO/JRC, & DFID	Promotes geographic data standards & GIS in support of humanitarian relief operations. Also identifies data resources to support preparedness & emergency response
ICT- Proposed Reform at the UN http://ict.unsystemceb.org/news/20060306	UN system-wide	Examines ICT in the context of proposed UN reform
Inter-Agency Committee for the Coordination of Statistical Activities (CCSA)	International orgs. UNS	Promotes coordination, integration, & complementarity & good practices among statistical programmes of international organizations
Inter-Agency Standing Committee (IASC), http://ia.unsystemceb.org/	Key UN and non-UN humanitarian partners	Primary mechanism for inter-agency coordination of humanitarian assistance
Inter-agency working group (IAWG)-FIVIMS joint business plan	UN Inter-agency, NGO & donors – Food Insecurity & Vulnerability	Preparing inter-agency business plan for an effective FIVIMS. that promotes information & mapping systems on

Cross-agency coordination initiatives	Main participants	Function
	Information & Mapping System (FIVIMS)	food insecurity & vulnerability
Steering Committee for the Modernization and Integrated Management of United Nations Libraries	UN libraries	Established i 2003 - examining UN library policy in light of advanced technologies.
SPIDER - Space-based Information for Disaster Management and Emergency Response http://www.unis.unvienna.org/unis/pressrels/2006/unisos337.html	UN System-wide & partners in disaster management (COPUOUS)	A "gateway" to space information for disaster management support (presented for GA approval Oct 2006)
Sudan Interagency Mapping http://www.unsudanig.org/sim/	OCHA – SAHIMS, http://www.sahims.net OOSA – workshops in Africa GIST FIVIMS	Brings together the map and data working groups (north and south) and other mapping stakeholders working in Sudan in order to discuss possible ways of collaborating and coordinating on mapping activities
UN Division of Public Administration and Development Management/UN Committee of Experts on Public administration http://www.unpan.org/cepa.asp	UN system-wide	e-govt & managing their public sector data
UN Evaluation Group (UNEG), http://www.uneval.org/	UN system-wide	Enable exchange of experiences, best practices, & methods regarding evaluation policy & practices
UN Group on the Information Society (UNGIS) http://www.govtech.net/news/news.php?id=100268	UN agencies .esp. ITU, UNESCO, UNDP and WHO	Coordinates WSIS Plan Implements collective efforts on cross-cutting themes and countries, e.g. e-health and e-tourism. Also examines e-readiness strategies and policies. Toolkit for developing countries
UN Library Network, http://www.un.org/depts/dhl/sflib/libnet.htm	UN system-wide	The DEPOLIB database - an information-sharing tool enabling UN family agencies for a cohesive, cross agency view of the information services available from these agencies.
UN Office for Outer Space Affairs (UNOOSA)	UN system-wide	Compiles information on space activities across the UN
UN System Influenza Coordination (UNSIC) http://www.undg.org/content.cfm?id=1482	FAO, OIE, WHO	Unified strategy for the UN system on avian & pandemic influenza prevention
UN System Network on Rural Development and Food Security http://www.rdfs.net/index.htm	20 organizaitons including FAO, IFAD, WFP	A global partnership approach towards tackling rural development challenges at the country level.
UNDP- AIMS	A joint venture between UNDP and UNOCHA	Afghanistan Information Management Service
UNGIWG UN Geographic Information Working Group	UN system-wide	User driven, voluntary network of UN cartography & geographic information science professionals. Addresses common geospatial issues in UN.

Of these many initiatives, the GIST and UNGIWG are both expanded upon in subsequent Sections or Chapters of this report, because of their current statuses and importance to the further development of a UNSDI. Both are representative of UN best practices in respect of present and future spatial data and information management.

4.4.1 GIST

The Geographic Information Support Team (GIST) is an inter-agency initiative that promotes the use of geographic data standards and geographical information systems (GIS) in support of humanitarian relief operations. The GIST also identifies data resources to support preparedness and emergency response.

To date, membership includes, the World Food Programme (WFP), UN Department of Peacekeeping Operations (DPKO), OCHA, the UN High Commissioner for Refugees (UNHCR), Food and Agriculture Organization (FAO), UNICEF, World Bank, World Health Organization (WHO), UN Development Programme (UNDP), US Agency for International Development/ Office of US Foreign Disaster Assistance (USAID/OFDA), European Commission's Humanitarian Aid Office/Joint Research Centre (ECHO/JRC),) and UK Department for International Development (DFID).

Members of GIST are technical experts, geographic information specialists and information management officers from UN and donor agencies involved in disaster management and/or humanitarian assistance. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) acts as the GIST secretariat.

Formed in 1998, the GIST is based on the premise that common approaches to organizing and sharing information will improve information exchange and strengthen the ability of the humanitarian community to coordinate emergency response.

Specifically, the GIST seeks to enhance the use of geographic information to improve emergency preparedness and response as it:

- Works to improve humanitarian response through the improved information flow and presentation
- Provides a forum for geographic and geo-referenced information and data exchange amongst humanitarian response agencies and donors
- Develops and promotes the use of techniques and standards to enhance data and information co-ordination and exchange.

In terms of institutional collaboration, the GIST has facilitated cooperation in the face of humanitarian emergencies. With technical support of the GIST and generous donor assistance several Humanitarian Information Centers (HICs) have been established in critical regions of the world that are intended as a single stop shop for all aspects of information management and exchange (meetings, mail, database management, mapping) and are focused on providing comprehensive data to operational partners. The GIST has also been focusing on the development of standard products, tools guidelines and procedures to improve the effectiveness and efficiency of the Humanitarian Information Centres (HIC). The HIC concept has been endorsed by the Inter Agency Standing Committee (IASC).

Regional Resource Centers (RRC's) are also being developed by the GIST, which focus their activities on data preparedness and rapid response. In support of its global data management and integration needs, the GIST has also set-up a Data Repository in collaboration with the Information Technology Outreach Services (ITOS) of the University of Georgia. The GIST website, hosted by ITOS, contains public information regarding GIST activities and initiatives, and more importantly it provides a data exchange platform where the GIST members can upload and/or download data in times of emergency.

Many of these interagency, information management initiatives and operational concerns have received donor support, allowing them to perform and show specific results. There is now greater awareness of the importance of information strategies and sharing for humanitarian preparedness and response. The informal and highly practical manner in which the GIST operates allows for frank discussions, clearly developed goals, and operational results.

Implications for a future UNSDI

The GIST is an obvious and strategic partner for the future development of a UNSDI, as its aims and objectives are intimately connected with the core justification for such a data infrastructure. Further references to the future involvement of the GIST in development of a UNSDI can be noted throughout this report.

5. UNGIWG past and present

5.1 Background

Perhaps the single most important development in the evolution of a spatial data infrastructure to support the United Nations, its member states and partners has been the creation of the United Nations Geographic Information Working Group (UNGIWG) in March 2000. Since its establishment, UNGIWG has stimulated improved geographic information management within and between UN Organizations and to a degree, among its partners as well.

UNGIWG is a user driven, voluntary network of UN professionals working in the fields of cartography and geographic information science that seeks to address common geospatial issues of concern to the United Nations. These include maps, boundaries, data exchange, standards, naming conventions, and location. UNGIWG also works directly with non-governmental organizations, research institutions and industry to develop and maintain common geographic databases and geospatial technologies to enhance guidance and operational capabilities. Technical reports on these issues are prepared and distributed as required.

UNGIWG's website increases its outreach and advocacy. Public relations materials, such as a recently produced information brochure, create awareness of the group's contributions to spatial data management across the United Nations system. Information on UNGIWG's activities and achievements is also contained in a variety of publications and via other UN and none-UN web sites.

Managers of UNGIWG Task Groups regularly coordinate business with the assistance of videoconferencing. Regular reporting mechanisms are in place and announcements utilize the website and mailing lists. More effective ways of increasing participatory interaction and collaboration among the different members, partners and others on common related issues is increasingly on the agenda.

5.1.1 UNGISP

One of the working group's first substantive outputs was the commissioning, by the UN Cartographic Section, of a "Geographic Information Strategic Plan for the United Nations" (UNGISP). The document, prepared by the OGC during the period 2001-2002 and funded by the Turner Foundation, contains a comprehensive analysis of the geographic information-related activities and perceived spatial information management needs of the United Nations at that time. The document also sets out a strategy for the future development of geospatial data and information to support the Millennium Development Goals. With the ongoing advances in technology since the UNGISP proposal was tabled in 2002, and continuing apprehension among stakeholders regarding the command and control mechanism proposed for its coordination (see Section 6.2.1), only limited aspects of the UNGISP recommendations have been introduced by UNGIWG since 2001 (none formally). The UNGISP report nonetheless represents a point of departure from which to develop a strategic framework for a future

UNSDI. This Compendium is a bridging mechanism in the process of developing and implementing a UNSDI Strategic Plan.

5.2 UNGIWG structure

The structure of UNGIWG evolved under the auspices of the UN Consultative Committee on Programme and Operational Questions (CCPOQ) of the Administrative Committee on Coordination (ACC). It comprises a Secretariat and six working Task Groups (TGs) that tackle priority geospatial issues impacting on the activities of UN bodies and their member states. The Secretariat, of which FAO and WFP are Co-Chairs for 2005-2006, oversees the work of the Task Groups (see Figure 9). Chairmanship rotates between participating United Nations organizations and membership has grown to 35 UN agencies and a number of industry and not for profit partners from around the globe.

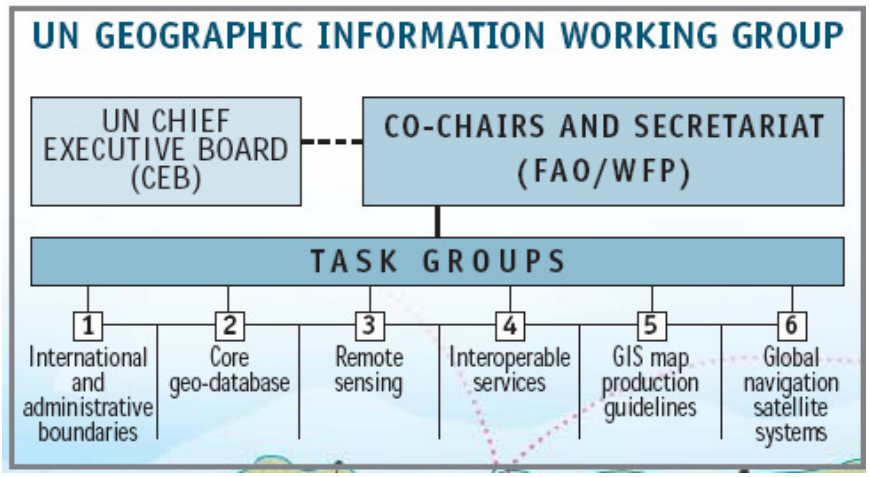


Figure 9: – Structure of UNGIWG

5.3 Specific aims of UNGIWG

The specific aims of UNGIWG are to:

- improve the efficient use of geographic information for better decision-making;
- promote standards and norms for maps and other geospatial information;
- develop core maps to avoid duplication;
- build mechanisms for sharing, maintaining and assuring the quality of geographic information;
- provide a forum for discussing common issues and emerging technological changes

5.4 Activities and Task Groups

UNGIWG meets annually in Plenary Session and reports periodically to the UN Chief Executive Board (CEB) on progress made and priority issues. This provides opportunities to create high level awareness of UNGIWG's goals, priorities, and

progress on such issues as the development of a United Nations Spatial Data Infrastructure or UNSDI.

Currently, each of the six Task Groups (TGs) within UNGIWG has agreed objectives, priority tasks and activities determined by consensus. Details of the major objectives of the different UNGIWG Task Groups are outlined briefly below.

5.4.1 TG 1: International and Administrative Boundaries

Among the different core data layers at the global level, special priority has been given to produce a consistent, worldwide coverage of:

- International boundaries at 1:1, 1:5, 1:10 and 1:25 million;
- Second Administrative Level Boundaries (SALB), including historic changes.

The aim of the International boundary initiative is to provide the UN community with a standardized, GIS compatible, dataset of international boundaries. The dataset comes with related metadata and boundary information that reflects the cartographic practice of the United Nations and is without prejudice to any Member States.

The Second Administrative Level Boundaries (SALB) dataset aims to improve the availability of information about administrative boundaries down to the second sub-national level. It is based on validated information received from the countries concerned and forms part of the UN geographic database.

As a global, digital dataset, the SALB information consists of digital maps and codes that can be downloaded on a country by country basis. To ensure consistency from one country to another, the database uses the international border standard developed in the context of the UN Geographic Database. This dataset is downloadable at no cost from the SALB website, but is not recommended for use scales below 1:1,000,000.

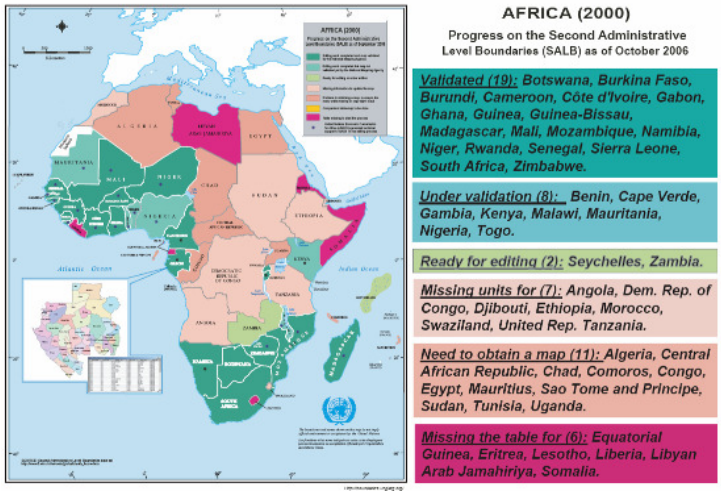


Figure 10: State of progress of SALB for the Africa region, October 2006.

These core datasets are of particular value for reuse in the applications of many UN agencies and their partners, and remarkable progress has been made by the TG in their development despite the limited resources available and the arduous nature of the task. An example of progress for the Africa region is shown in Figure 10.

Independent of the National Mapping Agencies, which play key roles at several stages in the SALB process, the project involves networking more than 50 other institutions. The necessary coordination is undertaken by the Evidence and Information for Policy (EIP) cluster of the World Health Organization (WHO).

5.4.2 TG 2: Core Geo-Database

This Task Group inventories and selects global datasets for adoption as UN Spatial Data Infrastructure core datasets. This is needed for standardizing not only the boundary maps prepared by TG1 but other important thematic maps as well, such as those illustrated in Figure 11.

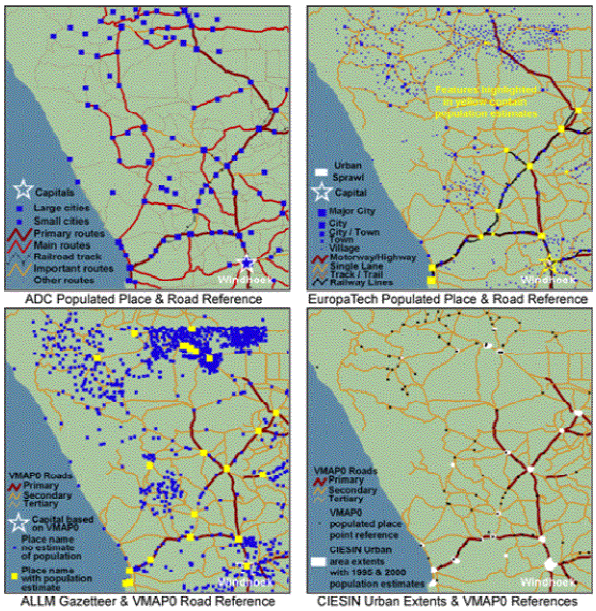


Figure 11: Examples of the same type of data -Roads and Population Centres-from four different sources.

A comprehensive UNGIWG report has been prepared on the following core thematic datasets:

- Boundaries: national, coastal, administrative;
- Human Health: boundaries, facilities;
- Infrastructure: roads, railways, airports, harbours, navigation;
- Bathymetry, Topography and Digital Elevation Model
- Hydrology: drainage, waterbodies, watersheds.

There are a number of issues related to the selection of the data sources: e.g. copyright, access and distribution limitations. However, an impressive list and ranking of the core databases available was chosen by the UNGIWG fourth meeting for its inventory report.

5.4.3 TG 3: Remote Sensing

Satellite imagery and other remotely sensed data are now an integral part of most UNGIWG members' geospatial analyses. In fact, the UN has been using global Landsat and other satellite imagery since the mid-1970s in order to analyse the changes that have occurred during the past three decades. The goal is to integrate remote sensing within GIS to have a better tool for decision-making.

This Task Group facilitates the finding and assessment of very high (VHR) resolution imagery. It promotes sharing and producing data through the UN Systems Contract and other agreements, to improve their availability and use. Requests have been made to imagery suppliers for example, to ease data access restrictions for humanitarian applications. Ongoing initiatives of the TG also target improved sharing information on dataset updates, provision of compressed Landsat mosaics and assessment of their accuracy, and population of meta-data on high resolution imagery. Investigations into the degree of duplication among UNGWIG members in purchasing VHR imagery are planned.

5.4.4 TG 4: Interoperable Services

International standards are needed to facilitate the sharing and use of geospatial information within the UN Spatial Data Infrastructure. Adoption of appropriate

standards allows members to develop and strengthen their respective geospatial capacities in a coherent and interoperable manner. As a result, substantially more geospatial data can be shared between agencies avoiding, or at least minimizing, duplication.

In this regard UNGIWG has adopted the ISO/TC211 standard number 19115 on Geospatial Metadata as its baseline. From this standard a draft minimum field subset has been developed, tested and is in the process of being recognized as a UN standard.

Overall, TG 4 therefore aims to:

- Develop guidelines that advocate greater interoperability;
- Encourage the use of Open Geospatial Consortium (OGC) and ISO/TC211 standards based software, e.g. GeoNetwork Opensource and the related Community website, as appropriate tools for achieving greater interoperability
- Develop a standardised spatial data framework model related to transport infrastructure, in collaboration with TG 2, TG 5 and TG 6

And to identify the means for:

- Promoting the principle of using open standards when designing new web services based systems by UNGIWG members. For example for new image repository services;
- Encouraging the evaluation and use of viable tools for addressing the interoperability issues such as those developed by FAO, WFP and UNEP.

5.4.5 TG 5: GIS Map Production Guidelines

This Task Group is developing guidelines for making maps using GIS software with the intention to standardize maps, scales, smallest mapping units, file interchange formats, map projections, pixel size of raster maps, etc. It has proposed technical guidelines for high resolution and low resolution scale maps and the most generalized cartographic forms regarding layout, content, marginal information, coloration, fonts, line types and symbology for scales of interest to working group members

5.4.6 TG 6: Global Navigation Satellite Systems

The Task Group works to harmonize and facilitate field data collection activities undertaken by the different UN agencies. It also:

- Revises training materials developed by various agencies to produce a harmonized set of training tools;
- Surveys the use of global positioning devices within each agency at country level to prioritize training activities.

5.5 UNGIWG and the UNSDI

At the UNGIWG Plenary in Addis Ababa in 2005, the working group recognized that its efforts to date had, in effect, been laying the foundations for a UNSDI. The accomplishments of the Task Groups in particular indicated that with manageable refinement and refocusing of current activities and organization UNGIWG can deliver the essential components of an operational UNSDI, subject to resources availability. Development of a UNSDI will likely continue in this evolutionary and stepwise manner

during the formulation of a more comprehensive, multi-year master plan that meets with UNGIWG's overall vision for this initiative.

Generic elements of a UNSDI that UNGIWG believes must be addressed include:

- Data, standards, data sharing and metadata.
- Development of common services including infrastructure, charter, and spatial data web services providing data and metadata.
- The organizational and institutional environment, that includes a policy structure, financial, Human Resources and legal issues, and an interface for information management, and how these would be structured and linked to other parties;
- Technical capacity building, interfaces with the outside world and partners (including advocacy and outreach components). Technical capacity both internal (UNGIWG and other UN agencies) and external (NSDI, regional authorities, partners and members).

Current data, technical standards, common services (e.g. UNOSAT, GeoNetwork, etc) are all elements of a wider structure that provide the generic requirements of a UNSDI. In terms of objectives, UNGIWG is already moving towards a UNSDI. A UNSDI also needs to recognize the various aspects of GIS applications in which UNGIWG members are involved including sustainable development, peacekeeping, emergency work, health and humanitarian support.

UNGIWG's perception of where its current UNSDI-related activities fit in relation to Global (GSDI), Regional RSDI) and National SDI (NSDI) initiatives is shown in Figure 12 below

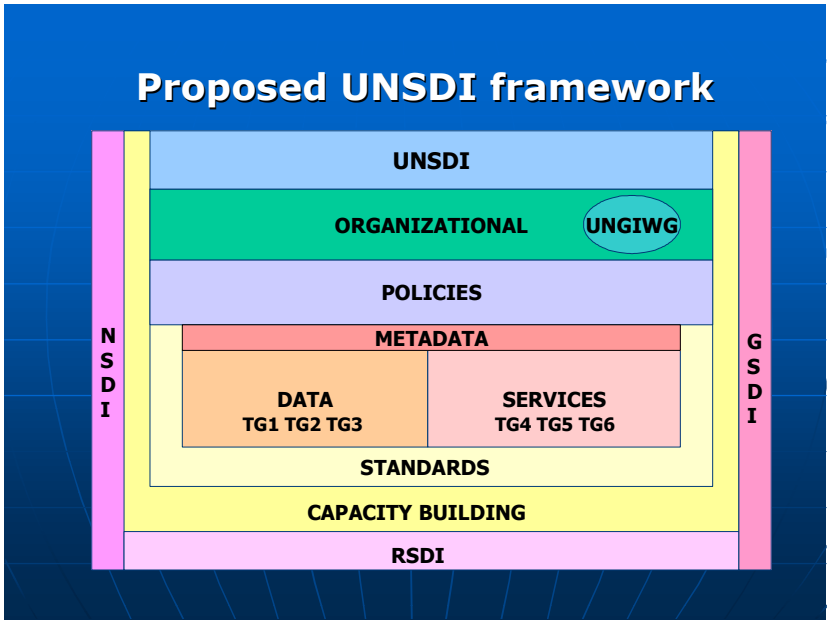


Figure 12: Relationship perceived by UNGIWG between UNSDI-related activities and Global and National SDIs.

There is a need to strike a balance between a centralized and decentralized approach in the establishment of a UNSDI as well, and a need for information exchange in an integrated, matrix-like manner, particularly across organizations. To date the evolution of an UNGIWG information infrastructure has been user-driven and meets with the other fundamental requirements of an SDI outlined in Chapter 2. But UNGIWG should not work in isolation in the development of a UNSDI, as there are significant global, regional and national-level efforts on going with which the UNSDI efforts need to coordinate.

6. Consultation with UNSDI stakeholders

6.1 Background

To obtain updated views on the needs of a UNSDI, and to develop an understanding of current GIS-related activities within the UN system, consultations were undertaken by the author in February 2006 with members and partners of UNGIWG. Feedback was realized through interviews, meetings and teleconferences held in Rome, Geneva and New York. A review of SDI related documents prepared and/or being considered by UNGIWG members or other national and international institutions that may eventually be linked to the UNSDI was also undertaken with the assistance of another UNGIWG consultant, from March 2006.

The organizations involved in discussions at each location are shown in Table 3:

Table 3: Locations and organizations participating in UNGIWG UNSDI consultations

Location	Organization
Rome	FAO, WFP, UNJLC
Geneva	WHO, UNHCR, UNOSAT, UNEP/DEWA/DEPA, ReliefWeb
	UNEPnet - Nairobi (teleconference)
New York	DPKO/UNCS, OCHA/FIS, UN-DESA, UN-DPA, DHL (Dag Hammarskjöld Library)
	CIESIN, & GSDI (teleconference)
	GIST, VAAF, USAID/OFA & ITOS (teleconference)
	OCHA/Hunter College NY

A third UNGIWG consultant simultaneously began coordination in March 2006 with relevant EU officials in Brussels and Ispra on SDI-related technical and institutional developments in the context of the EU Programmes GMES and INSPIRE. Meetings were conducted with key technical partners (Geomatics Business Park, NLR, ITC, relevant Universities and Government institutions) in the Netherlands too, to assist harmonization between the UNSDI and the UNSDI-Netherlands Coordination Office (NCO), including discussions on funding interests. This has resulted in active cooperation between ten Dutch technical institutions for enhancing geospatial data sharing and exchange in a UNSDI context, including the establishment of a www.unsdi.nl . A similar process was started up in May in the Czech Republic with seven technical government institutions and NGO's, resulting in the establishment of www.unsdi.cz. More recently, a parallel process in Hungary saw the establishment of Hungarian Coordination Office (UNSDI HUCO) following an interagency kick-off meeting held in Budapest in late September 2006, resulting in the establishment of www.unsdi.hu in December 2006

6.2 Results of consultations

The UNSDI-related issues identified during the February 2006 discussions with UNGIWG members and partners are compared with those identified by the OGC between 2001 and 2002, during the preparation of the "Geographic Information Strategic Plan for the United Nations" (UNGISP). In this way, an appreciation of the changes over time in geospatial data use and management reported by those 'working at the coalface' could be more effectively documented and followed-up. Accommodation needs to be made however, for the brevity of the discussions held in 2006 compared with the interviews and surveys conducted during the original strategic planning exercise in 2001-2002. Considerable paraphrasing of the original UNGISP findings has also been undertaken for reasons of brevity.

Questions of detail not withstanding, the summarized findings of both the 2006 discussions and those of the original UNGISP report are presented in tabular form below, clustered under each of four broad issues similar to those identified as significant in the 2001-2002 report: Policy and Organization; People and Resources; Geospatial Data and Information; Technology. Virtually the same issues dominated discussions in 2006 as previously in 2001-2002, making comparisons over time somewhat easier than expected but suggesting change in 'big-ticket items' has been slow. Actual quotations from the 2006 discussions are included where instructive. Comments from respondents regarding the various issues raised in 2006 are presented collectively in the tables and not attributed to individuals or particular departments, agencies, programmes or organizations unless the originators expressly requested the author to do so.

6.2.1 Issues of Policy and Organization

Details of the overall findings arising in relation to issues of Policy and Organization and their impact on UN geospatial data use and management in the UN are summarized in Table 4. In the perception of both UN managers and technicians interviewed across a wide selection of agencies, little in fact seems to have changed in this regard since the original assessment in 2001.

Current policies to improve geospatial data integration across the UN system for example were described as being ineffectual, inadequate or absent, echoing the findings of five years previous. No current 'rules of engagement' upon which to base cooperation between agencies are believed to exist, evidenced by the fact that most successful undertakings concerning data integration or exchange between agencies are conducted on an informal basis. Maintaining informal contacts across the system is therefore considered essential by co-operators, because this works where more formal approaches fail. The need for policies dealing with data quality, standards and responsibilities for metadata was singled out as a priority by many interviewed.

The current arrangements for management, coordination, and communications on all levels of inter-agency cooperation related to geospatial data are generally considered inadequate or missing altogether. While many consider UNGIWG and its Task Teams to be a useful platform from which to establish a UNSDI, creation and installation of an appropriate governance mechanism and leadership are first necessary to bring about effective change. The development of a strategic plan and clear business purpose for a UNSDI is therefore acknowledged as a fundamental requirement before agencies would be willing to commit considerable time and resources in pursuing the initiative further.

Ensuring consensus in strategic decision making is possibly the most frequently mentioned and important consideration in the minds of all stakeholders. A bottom-up approach to the development of a UNSDI through an open-ended working group of leading global and regional players is preferred to the alternative of the top-down approach proposed in the original UNGISP. As noted earlier, considerable scepticism remains among the majority of agencies regarding the original proposal to establish a UN Commission (GISO) specifically to coordinate geographic information management system-wide. The logic of the original proposal to provide governance and leadership via a Commission is not so much challenged as the command and control mechanism by which it would achieve its goals. In the minds of stakeholders, such a commission neither fits the culture or mandates of agencies run by a variety of governing bodies or current thinking on the scale of investment necessary to implement a UNSDI.

Table 4: Issues of Policy & Organization and their perceived impact on UN geospatial data use & management - Outcome of UNGIWG consultations: 2001 & 2006

UNCO/UNGIWG Strategic Plan 2001-2002 Specific Issues	UNGIWG Discussion Paper 2006 Specific Issues
1. No clear institutional structure or policies to coordinate data collection & sharing efforts 2. No organization fully chartered or resourced to aid enterprise-wide best practices & capacity building for geographic information infrastructure in UN 3. Insufficient organization, funds, HR in UNGIWG to accomplish its goals	1. Coordination & cooperation unstructured & unpredictable 2. UN-system internal management, cooperation & coordination underperforming 3. UNGIWG too 'tech-driven', needs organizational change as well 4. Policies on spatial data absent or loosely defined 5. Need for 'Rules of Engagement' 6. Need for a defining framework (now voluntary) 7. Need to define a strategic and business purpose 8. Future sustainability & governance of an SDI are linked 9. Communications on all levels poor 10. Advocacy weak 11. Lobby value of UN underutilized regarding improved security well being etc 12. Field/HQ relationships and communication often weak
Geographic information compartmentalized in agencies	Much geospatial information still remains compartmentalized within agencies for both organizational & technical reasons
Too few data sharing arrangements	The most effective data sharing arrangements are informal, and dependent upon personal contacts for success
No clear structure for training & recruitment related to geographic data	Managements don't yet clearly recognize the need for spatial data skills, so policies to structure training & recruitment still not in place
Varied quality of datasets	Quality of data still variable but slowly improving, especially core datasets
Untapped opportunities for collaboration	Collaboration with member states, business and academia growing, but not yet mature
Nations without SDI could benefit from UN capacity building – 'digital divide'	Capacity and consensus building with nations are both priorities for a UNSDI
Lack of a UN-wide, standards based architecture reducing Web-based data sharing	Growing interoperability of tools and adoption of data standards propagating Web-based approaches to sharing by UN
Strategic planning must be consensus based	1. Consensus essential for UNSDI strategy to work 2. Governance mechanism adopted must reflect consensus of UNGIWG members

The entrapment of legacy data in so-called 'stove-pipe' information systems is also a concern of agencies. Often willing to share their data, and wanting to access that of others, agencies currently have no affordable mechanisms to make their data more accessible and so it remains unavailable. On a practical level, internal capacity building and staff training in the skills required to manage geospatial information more effectively is identified as a major weakness that will impact negatively upon the effectiveness of a future UNSDI unless addressed from the outset.

The need for capacity and consensus building with nations is a further concern of UN agencies which consider the 'digital divide' in developing countries threatens sustainability and the perceived benefits of a UNSDI.

6.2.2 Issues concerning People and Resources and their impact on UN geospatial data use and management

Overall findings arising in relation to People and Resources and their impact on UN geospatial data use and management in the UN are summarized in Table 5.

A universal belief exists among practitioners in the UN that currently available levels of resources limit advancement of geospatial technologies system-wide. This was also found to be the case in 2001. While current funding for geospatial activities is largely opportunistic as a result of the present UN recruitment policies, some agencies 'work smarter and leaner' by employing skilled consultants for specific geospatial products or priority outputs. But the uncertain nature of these funding mechanisms does little to advance long-term sustainability of information infrastructures.

Table 5: Issues concerning People & Resources and their impact on UN geospatial data use & management - Outcome of UNGIWG consultations: 2001 & 2006

UNCO/UNGIWG Strategic Plan 2001-2002 Specific Issues	UNGIWG Discussion Paper 2006 Specific Issues
1. Financial resources will remain tight hampering recruitment 2. Insufficient organization, funds, HR in UNGIWG to accomplish its goals	1. Financial resources even tighter in 2006 2. Resources opportunistic, not programmed because no SDI to tie them to. 3. Potential to 'piggyback' on ICT funding if SDI defined in an appropriate way
Skills-base growing to meet needs, but funds & skills limit operations	1. Induction training lacking for all levels 2. Managers need guidance too on basics and methods/potentials of geospatial data 3. Funds for training still lacking
Varied skill levels across UN, a small number with advanced skills	1. Skill levels still varied across UN. 2. Short-term consultants used to fill skills gap in some agencies
Growing partnerships help use of data, personnel & training	Partnerships the secret to more people and resources

As discussed previously, inability to recruit appropriately skilled staff is a concern, but so too improving the skills of existing staff who deal with geospatial data and information. Beyond technical skills, managers of these activities feel the need for induction training and greater understanding of the subject matter so that more opportunities are capitalized upon.

New and innovative ways to engage the private sector and other external donors in partnerships is considered a must by the majority of stakeholders for the future success of a UNSDI. This extends to the funding limitations impacting on the opportunities for internal training and development of the technical skills in agencies for more widespread use of geospatial data and information in their undertakings.

6.2.3 Issues related to Geospatial Data and Information

Overall findings of consultations relating to geospatial data and information issues and their impact on a future UNSDI are summarized in Table 6.

Table 6: Issues concerning Geospatial Data and Information and its use & management in the UN - Outcome of UNGIWG consultations: 2001 & 2006

UNGIWG Strategic Plan 2001-2002 Specific Issues	UNGIWG Interviews 2006 Specific Issues
UN needs methods and tools to facilitate: ❑ Ready access to spatial data ❑ Integration of data & support visualization & decision-making	FAO, OCHA, UNEP, UNHCR WFP, WHO etc expanding metadata, data catalogues, data access and visualization through tools such as GeoNetwork, Maps-on-Demand, UNEPnet, WHO Global Health Atlas and various UN Portals.
Most legacy data locked vertically in closed systems	Much legacy data still locked vertically, but interoperability improved by new tools
Data sharing policies vary between agencies causing: ❑ Incompatible datasets ❑ Duplication of datasets	Best data sharing arrangements still informal, based on personal contacts
1. Integrating & sharing data requires expenditure of time & effort resulting in high financial burden to organizations and governments. 2. Recent standards efforts: ❑ Make processes more flexible & expandable ❑ Reduce systems integration costs ❑ Speed insertion of new technologies	1. Standards & progress still a concern 2. Fundamental datasets e.g. population, admin boundaries etc – 'golden standards' needed 3. Data availability still an issue 4. Clear political need for SDI, but data not there or not validated when needed 5. User friendliness of tools (e.g. meta-data) not yet adequate 6. Regarding data flexibility and interoperability: ❑ Tools are getting there ❑ Data not yet there 7. Adoption versus creation of standards important 8. Terminology & vocabulary: GIS & geospatial etc need clarification 9. Best practices need defining 10. Task Groups advancing adoption of standards 11. Need to keep it simple!
1. Finding and evaluating data from UN and non-UN sources important 2. Better policies & means to collect & maintain metadata required	1. Meta-data: are the producers or documenters responsible? Solutions must be found, but not clear in 2006

UNGIWG Strategic Plan 2001-2002 Specific Issues	UNGIWG Interviews 2006 Specific Issues
	2. Issue of data custodians and database maintenance
	Relevance and scalability of data important vis-à-vis data quality etc
	Primary data generation largely ignored
	Long-term preservation of data archives requires attention. CIESIN proffered solution.
	Opportunity for UN to lead in commons approach to geographic data

The issues summarized in Table 6 are by and large, those already being addressed by UNGIWG Task Groups, but agencies place particular importance on addressing data standards, best practices, and the introduction of a metadata policy as priorities. These and other data and information related issues are discussed in more detail later in this report.

6.2.4 Issues concerning Technology

The outcome of consultations relating to Technology and the impact of the issues identified on a future UNSDI are summarized in Table 7.

Table 7: Issues concerning Technology and their impact on UN geospatial data use & management - Outcome of UNGIWG consultations: 2001 & 2006

UNGIWG Strategic Plan 2001-2002 Specific Issues	UNGIWG Interviews 2006 Specific Issues
Diversity of geographic information systems is an issue. ❑ Some, but not all extendable ❑ Those using international standards have greater interoperability with other geo-processing systems	Diversity of systems still an issue, but growing trend toward interoperability and open source development is reducing this problem in UN.
UN has many islands of success in use of geographic information	Islands of success have grown in number but bridging mechanisms (e.g. GeoNetwork) and use of international standards has improved interoperability.
The desire to bridge 'islands' of success at multiple UN locations & internal & external UN applications has increased demand for portals	1. Web-based, OpenGIS solutions for delivering services are the way forward. 2. Substantial growth of portals at national, regional and international levels. Development of UN portals lagging behind thematic portals of NGOs, academia and business.
Requirements analysis shows no single vendor provides a system suitable for all organization's needs	Growth in geospatial systems development in UN is mainly open source related
Most UN agencies have interoperability problems that inhibit data sharing, resulting in: ❑ Increased costs (no reuse etc) ❑ Reduced efficiency	Interoperability is still a big problem of legacy systems. Adoption of international standards and development of tools that assist in breaking down interoperability barriers are needed. Security also an issue to consider for data sharing

Beyond an overwhelming preference for an open standards and web-based approach to the information architecture and technical infrastructure for a UNSDI, the technical proponents of geospatial data systems in UN agencies expressed preference for modular, smarter and more cost-effective ways of working. The importance of focusing on interoperable solutions that create bridges between the previously identified 'islands of success' is widely accepted as fundamental.

Funding limitations have pushed development of software necessary to support the proposed information infrastructures in the direction of open source solutions.

6.3 Engaging with member states and regional bodies

The 2006 feedback received from UNGIWG members and selected partners regarding the perceived state of play of a future UNSDI, and identification of priority issues that require resolution, represents a significant but incomplete picture of the engagement necessary with stakeholders of a future UNSDI. To round out the process, a dialogue was also initiated by UNGIWG in March 2006 with national and regional bodies regarding SDI developments underway at these two levels.

Focus of the ongoing regional and national dialogue is on making geospatial data available internationally for a number of selected applications fields, such as integrated water resources management, forest resources management, transport and logistics, cartography, agricultural extension, biodiversity, tourism and others. A number of countries including The Netherlands, the Czech Republic, Hungary and now Spain have agreed to act as pilot countries and strategic partners in this process, whereas 13 other countries and three regional organizations in Asia, Africa, Europe and central and South America have committed their general support to the UNSDI development process and are participating in the ongoing dialogue. Participatory feedback from national and regional bodies will greatly assist the development of a UNSDI, tuning it to meet not only the expectations of the United Nations community, but those of its member states and partners as well.

Details of the countries that have so far expressed interest in participating in the UNSDI dialogue and development are shown in Table 8. Preliminary details of three national pilot initiatives associated with development of a UNSDI are expanded upon in Part III, Section 9.6.3 of this report. More national initiatives are anticipated to follow after consultations between UNGIWG and national authorities are completed in early 2007.

Table 8: Countries that have expressed interest in participating in the UNSDI development process

Country	Participant
Australia	Office of Spatial Data Management, Canberra
Brazil	National Institute for Space Research (INPE), Sao Jose dos Campos &
Chile	IGM & "Sistema National de Informacion Territorial" (SNIT), Santiago
Czech Republic	Czech Republic Coordination Office (CRCO), CCSS Prague
Hungary	Ministry of Agriculture and Rural Development & NSDI institutional network, Hungarian GI Association HUNAGI
India	NRDMS & NSDI, Department of Science & Technology, New Dehli
Jamaica	Spatial Data Management Division, Ministry of Agriculture and Environment, Kingston

Country	Participant
Japan	Remote Sensing Technology Centre of Japan (RESTEC), Tokyo
Mexico	National Institute of Statistics, Geography and Informatics (INEGI), Mexico City
Mongolia	UNSDI development process Ulaanbaatar
Morocco	Le Centre Royal de Télédétection Spatiale, Rabat
Nigeria	NASRDA, NGDI, Abuja
South Africa	National Spatial Information Framework, DLA, Pretoria
Spain	gvSIG Team, Ministry of Infrastructure and Transportation of the Generalitat of Valencia IVER TI S.A, Valencia
The Netherlands	UNSDI-Netherlands Coordination Office, National Aerospace Laboratory (NLR), Amsterdam

6.3.1 Engaging with regional bodies

At the time national governments were approached in March 2006, UNGIWG also initiated a dialogue with regional organizations to solicit their involvement in the UNSDI process. The organizations listed in Table 9 have already indicated their interest to participate in the process and more are expected to follow.

Table 9: Regional organizations that have already expressed interest in participating in the UNSDI development process

CP-IDEA - Permanent Committee for the Spatial Data Infrastructure of the Americas
ICIMOD – International Centre for Integrated Mountain Development, MENRIS Programme, Nepal
RCMRD - Regional Centre for Mapping of Resources for Development, Nairobi, Kenya
RECTAS - Regional Centre for Training in Aerospace Surveys, Nigeria

There are considerable opportunities to expand regional cooperation in the development of the UNSDI in the future and these should be followed up by UNGIWG in the early stages of UNSDI implementation to maximize potential regional contributions.

6.4 Strategic partnerships

Strategic partnerships between UNGIWG and the not-for-profit sector include existing arrangements with the GSDI, GIST, OGC, ISO, technical institutes, industry and others. Together these associations have already brought, and will continue to yield, substantial benefit for the evolution of a UNSDI.

Over time these initiatives have been influential in shaping the development of approaches taken by UNGIWG members and Task Groups in developing or adopting open data and metadata standards, and tools that encourage interoperability across the UN system and beyond to link with partners around the globe. Strategic partnerships will thus form an essential component of a UNSDI strategic plan when implementation begins.

UNGIWG must also remain alert to new developments in geospatial data and information management to ensure that the design and implementation of a UNSDI

remains current and tuned to the needs of users. It is here that UNGIWG's strategic partners have much to offer UNSDI development, as their memberships operate at the cutting edge of geospatial data and information management and analysis.

In this regard, opportunities exist for UNGIWG to take leadership in evaluating and promoting promising concepts such as the "Public Commons of Geographic Data" (see Box 8).

> ***"The goal of the Public Commons of Geographic Data, using open-source and open-access technology, is to remove technical and legal barriers facing the tens of thousands of GIS users (e.g. researchers, local government agencies, nonprofit organizations, field scientists, and individual citizens) that wish to contribute, access, and use locally generated geographic information. This approach has the potential to free up currently unavailable information generated by non-federal and non-professional sources, and make it available to the widest possible range of potential users. Although not all local governments, private companies, nonprofits or individuals will want to provide access to any or all of their geographic data files a "commons licensing" environment, more people will participate once a user-friendly capability is available. The historical development of the web itself demonstrates that fact."***
>
> **Public Commons of Geographic Data: Research and Development Challenges (Onsrud et al. 2006)**

Box 8: "Public Commons of Geographic Data", a concept for future consideration

Open approaches for sharing data such as the Public Commons of Geographic Data, and for sharing labor and skills in networked environments, offer considerable potential for the effectiveness and efficiency of a future UNSDI.

6.5 Private sector cooperation

There is a long history of private sector cooperation with UN agencies since the creation of GIS and commercialization of space-borne remote sensing platforms. Agencies such as FAO, UNEP, UNITAR and WHO together with select member states, have benefited over time from subsidized products made available for development projects by satellite operators, and by software developers for GIS training in Africa and elsewhere in the developing world. Companies with a long history of cooperation in this regard include EOSAT, SPOT Image, ESRI and IDRISI.

A promising recent example of private sector cooperation involves Google. Negotiations are underway with Google to provide a facility for data storage for UNGIWG and a public face for other private sector-related aspects of data availability. OCHA, working with Hunter College NY have also begun discussions with Google regarding cooperation on other UN fronts including support for regional disaster preparedness.

Support with vital, GIS-based maps put together by ESRI (UK) also provided relief charity MapAction, the UN Disaster Assessment centre, and the Suriname Ministry of Defence with essential spatial information for dealing with a flood crisis in May 2006.

In another example of considerable importance, IBM and over 20 major worldwide public health institutions, including the World Health Organization and the Centers for Disease Control and Prevention, announced in May 2006 the Global Pandemic Initiative, a collaborative effort to help stem the spread of infectious diseases. Central to the effort will be the use of advanced software technologies, elements of which IBM intends to contribute to the open-source community, that are designed to help share information on disease outbreaks electronically and use it to predict how diseases will spread.

Among the technologies that will be used is a software framework IBM developed to allow electronic health information to be more easily shared and mined for trends, such as the outbreak of disease. Called the Interoperable Healthcare Information Infrastructure (IHII), the technology is designed to improve communication and collaboration among medical professionals and researchers by helping them collect and share health data. IBM will expand the role of IHII to include public health issues, responding to global calls for pandemic preparedness by facilitating the sharing of clinical data among medical facilities, laboratories and public health agencies.

IBM also plans to build a community of users around its epidemiological modeling framework, called Spatio-Temporal Epidemiological Modeller (STEM), which can tap the information collected from IHII, along with additional information such as roadmaps, airport locations, travel patterns, and bird migration routes around the world. It will allow users to rapidly develop models for how a disease is likely to geographically spread over time. These models can help public health experts and governmental planners develop more effective preparedness plans.

Implications for a UNSDI

Clearly, initiatives such as the IBM-IHII have the potential to change the way infectious disease pandemics are managed in the near future. The underlying information infrastructure and content will also be valuable to a future UNSDI if adequate interoperability is provided by the IBM system.

Geospatial sector support from business in general is helping to resolve humanitarian, health and development issues and offers promise for converging the purpose and greater future interoperability of local information infrastructures in times of need. Given the considerable potential to develop such initiatives in concert with a future UNSDI, details concerning possible strategies in this regard are provided in Section 7.7.5 of this report.

Part II: Building for the Future

7. Future vision and role of a UNSDI

7.1 Background

At its 6th Plenary Meeting in 2005, UNGIWG formally endorsed the concept of a Spatial Data Infrastructure (SDI) in the UN context, to support sustainable development and the MDGs. UNGIWG recognized at the time that it must engage vigorously with its members and its constituency of Member States and partners to define an effective UNSDI. Identifying and addressing key issues, finding mechanisms and resources to build national and internal capacities where necessary, leveraging strategic partnerships and determining the means by which to sustain the overall initiative were also identified as priorities from the outset.

Such a UNSDI needs to build upon the original UN Geographic Information Strategic Plan prepared in 2001-2002, taking account of subsequent user requirements, the evolving UN agenda and the experiences of organizations within the U.N system and those of its partners. In particular, it needs to take account of developments pioneered by organizations such as the GSDI, the Open Geospatial Consortium (OGC, formerly known as Open GIS Consortium), the GIST and partners in academia and industry, as well as those in national governments and regional organizations that complement the advances made by the UN Secretariat, and its Programmes, Agencies, and Funds.

The UNSDI strategic framework set out below is, for the most part, that presented by the Secretariat for consideration to the 7th UNGIWG Plenary in Santiago, Chile in November 2006. Feedback from the 7th Plenary-participants, and subsequently from additional stakeholders and strategic partners, has been incorporated into the framework below to align it more closely with current stakeholder expectations. The framework presented however, remains a work in progress and appropriately the subject of continuing, participatory stakeholder refinement.

7.2 Establishing a UNSDI vision

At its core, the UNSDI should contribute substantively to the Mission of the United Nations and realization of the UN Millennium Development Goals. By facilitating efficient global and local access, exchange and utilization of geospatial information, a UNSDI can enhance decision-making on a global basis and at all levels of societies, for the benefit of human-kind and the environment.

Decision-making is enhanced globally and at all levels of societies by the UNSDI, benefiting humanitarian assistance, sustainable economic development and environmental protection.

Box 9: The UNSDI Vision

7.3 Mission of the UNSDI

The principal objective of any enterprise is to increase stakeholder value and a UNSDI is no exception. Achieving increased stakeholder value in the milieu of UN Reform, delivering on the MDGs and attending to the remits of rapidly evolving global governance, is a difficult and complex process.

Therefore, in determining a succinct, formal Mission Statement that encapsulates the purpose and primary objectives of a UNSDI, three questions need to be answered:

1. What will the UNSDI do to increase stakeholder value?

- It will increase the effectiveness and efficiency of UN activities by providing system coherence for applications and exchange of geospatial data.

2. How will it be done?

- By providing the relevant base collection of technologies, fundamental datasets, human resources, policies, institutional arrangements, and partnerships that increase availability and access to geospatial information in an easy and secure way and across international jurisdictions
- Avoiding duplication in data collection and management and enhancing reuse of geospatial within the United Nations, and with and between its Member States and partners, using a minimum set of standard practices, protocols, and specifications
- By engaging Member States, regional organizations and partners in a participatory process, building upon consensus, good governance, and best enterprise management and information sharing practices that maximize the benefits of geospatial information worldwide in terms of social, economic and environmental development.
- With the assistance of strategic partnerships and external linkages, internal and external capacity building, and technical transfer with Member States and other stakeholders

3. For whom will it be done?

- All stakeholders including UN organizations and their staff, Member States and their citizens, regional organizations, strategic partners and other organizations and institutions involved in social, economic and environmental development.

The UNSDI Mission distilled from these considerations is shown in Box 10 below.

UNSDI is a mechanism to establish system coherence for the applications and exchange of geospatial data for UN activities

Box 10: UNSDI Mission Statement

7.4 Defining a strategy for the UNSDI

Given the nature and range of UN vocation, a distinct version of a SDI should be developed for the UN context and reflected in the name "UNSDI". The UNSDI should build upon what already exists and provide a conceptual framework that better guides all of the activities of UNGIWG, including those of its Task Groups.

To achieve this, UNGIWG must stimulate the understanding and wherewithal of the United Nations, its partners and UN member states to:

- Identify and address issues of importance for the establishment, successful operation and sustainability of a UNSDI, and define goals and actions;
- Develop a partnership strategy to guide internal and external linkages, capacity building and technical transfer with member states, regional bodies and other partners;
- Investigate options for funding of essential activities to underpin the future sustainability of the UNSDI.

In seeking to develop and implement a UNSDI strategy, UNGIWG depends upon the voluntary network of members and partners in regional organizations, Member States, industry, academia and elsewhere. The diversity and accumulated knowledge of these groups, when amalgamated by a United Nations unity of purpose, creates a potent tool for delivering an effective and sustainable UNSDI.

7.5 Addressing major issues

At a strategic level, UNGIWG goals are in line with the goals of UN reform, the Millennium Development Goals and those of the UN Charter. The past successes of UNGIWG in servicing these goals is the result of the working group's astute recognition of issues that impede spatial data discovery, access, dissemination and utilization within the United Nations system and beyond. Through efficient prioritization of these issues and the goodwill of its members UNGIWG, despite limited resources, has to date proved effective in bringing about stepwise change in the way geospatial activities are undertaken in the United Nations, the data now available, and the mechanisms to access and share it.

The outcome of recent UNGIWG consultations has enabled reassessment of issues that impact upon the development of a future UNSDI. When coupled with the original findings and recommendations of the "Geographic Information Strategic Plan" of 2001-2002, opportunities to reaffirm and/or set new goals for the UNSDI and to prioritize the specific objectives and recommended actions needed to address these issues have emerged. With this in mind, a series of 10 goals and the associated objectives and specific actions recommended to achieve them are set out below for consideration. A schematic representation of the overlapping sequence of outcomes associated with the delivery of each 'Goal' is shown in Figures 13 to 18 and 20 to 24 below. The initial outcomes anticipated are indicated in green, subsequent outcomes in yellow and those associated with each goal in purple.

7.5.1 Issue: Policy and organization

The paucity of clear policies and organization regarding geospatial data and information reduces its use and effectiveness both within and outside UN system. Currently the

rules of engagement for data users are fluid and voluntary, based largely upon informal and personal contacts. To achieve the levels of cooperation necessary for the development and operation of a successful UNSDI, minimal but adequate policies, organization and management systems need to be in place to predictably guide the process forward. Establishing appropriate governance and empowering leadership are essential first steps in this endeavour, to foster confidence among not only UNGIWG participants but also the growing legion of member nations, regional organizations, international bodies and partners from industry, academia and elsewhere involved in the UNSDI process.

Goal 1: to create a coordinated, consensus-based, and inclusive UNSDI based on strategic/business principles that provides a high level coordination framework for UNGIWG, building upon what has already been achieved. Implicit in the UNSDI development is the need for a decentralized matrix approach, connected through agreed upon, open data exchange standards and interoperability with NSDIs and major regional SDIs.

Objectives and specific actions

1. Establish a sustainable governance mechanism to oversee the implementation and coordination of the UNSDI in consultation with UNGIWG members, UN member states, international and regional organizations, and partners in industry and academia. This mechanism should take the form of a UNSDI Implementation Committee, chaired by members of the UNGIWG Secretariat, with supplementary membership drawn from UN IT and business management sectors, and the broad base of UNSDI stakeholders including representatives from industry and academia.

2. Define, approve and adopt key policies that specify the 'rules of engagement' for stakeholders and determine inclusions and exclusions of the UNSDI. Policies approved by consensus should ultimately be formalized in a Letter of Agreement to be circulated and signed by individual member organizations of UNGIWG to encourage the principle of commitment and participation.

3. Define a strategic/business purpose for the UNSDI and design enterprise architectures for the business processes, data, standards and services associated with the implementation of the initiative. Fully utilize existing UNGIWG capacities to achieve this, encouraging and building stepwise upon the activities of the Task Groups establishing and extending key UNSDI building blocks for the technical advancement of the SDI process. Small multi-agency Special Interest Groups should be formed where needed to advise on the best technical practices and strategies for UNGIWG members to implement system-wide and also on an agency basis.

4. Building upon the work already undertaken by UNGIWG, classify and document all geospatial initiatives in UN agencies to facilitate future interoperability of legacy data, systems and applications.

5. UNGIWG should develop a UNSDI Communication Plan to enable clear communications with, and obtain feedback from, all UNSDI stakeholders. The areas of activity to include in the plan embrace online resources, publications, projects and presentations. The plan should cater for a variable audience base in terms of technical capacity and interests, but especially needs to include a 'UNSDI Brief for Managers'.

6. To increase awareness about UNSDI activities, it is important that both existing and new spatial information initiatives are recognizable as UNSDI outputs. UNGIWG

should encourage bodies carrying out actions under this plan to "brand" the products or services derived from these actions to acknowledge them as part of UNSDI implementation.

7. UNGIWG should continue to play a significant leadership role in global geospatial data initiatives, encouraging best practices in data sharing and promotion. It should also maintain or formalize relevant membership and active participation in bodies such as the GSDI, OGC, ISO, and work closely with major SDI-related activities of INSPIRE, GMES, GEOSS and NATO.

8. A key activity for UNSDI implementation will be the convening of Workshops for member states and regional organizations to solicit feedback and engender and maintain a sense of ownership of the UNSDI process among participants.

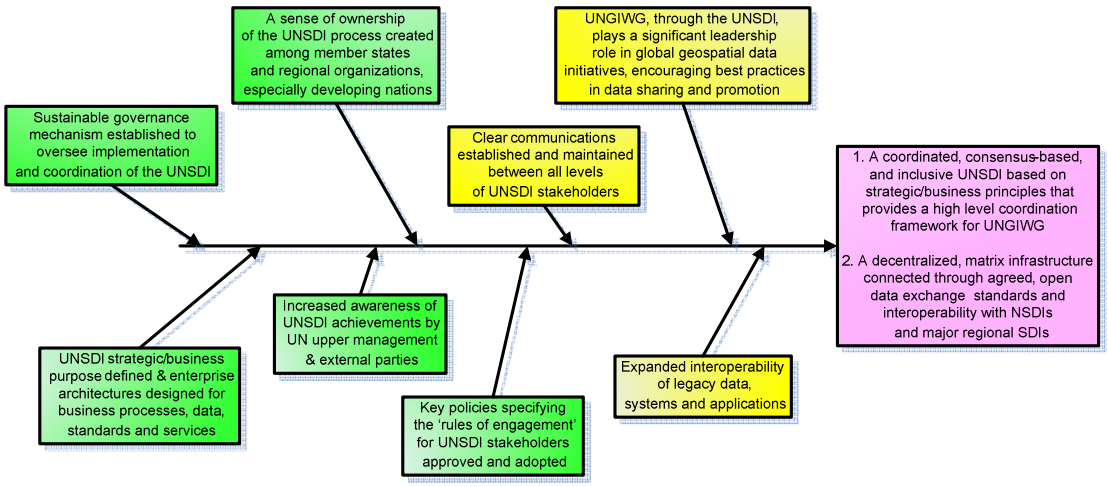


Figure 13: The overlapping sequence of outcomes linked to the delivery of Goal 1

7.5.2 Issue: People and resources

The variable maturity of geospatial data management and usage between UN agencies, coupled with the reality of today's limited resources for expanding these activities, pinpoints a gap in the internal availability of systems and trained personnel sufficient to maximize the use of geospatial data and information across the breadth of the UN. Resources to address these concerns will likely remain static without a high-level UN policy shift in the future. Internal capacity building of UNGIWG member organizations and access to geospatial data management systems appropriate for the wider UN community will therefore remain under-developed for the time being as well, despite being much needed. Meanwhile, opportunities to incorporate geospatial data and analysis for the benefit of their missions go begging in many UN agencies. This calls for consistent senior management engagement, innovative resource mobilization and partnerships to help fill the gaps in geospatial knowledge and systems availability until mainstream funding is available to support the critical mass of required UNSDI functions.

Although the UNSDI envisaged caters in the first instance for its internal UN constituency, its open-ended design recognizes a need to accommodate the requirements

of partners from outside the UN, including capacity building and technical transfer to member states and other clients who could most benefit in this regard.

Goal 2: to ensure sufficient access for UN organizations to the systems and trained personnel required to take full advantage of available geospatial technologies, data and information in meeting their organizational responsibilities and to maximize their potential contributions to UN reform, Millennium Development Goals and UN Charter.

Objectives and specific actions

1. UNGIWG should seek the voluntary participation of its members to self-assess their current organizational, technical, and policy-related capabilities for sharing and integrating geospatial information. Additionally, opinions on how each organization can build higher levels of sharing and integration capability should be sought and documented. Both can be initiated by designing and circulating a brief survey that takes account of basic capability dimensions and perceived needs. The results of the assessment will help in determining common human and material resources needs, and how to fill gaps in capability both within and across organizations. Ultimately, a mechanism to assess needs and capacity should be institutionalized, and embedded in each agencies work program.

2. In agencies identified as not yet being in a position to take full advantage of geospatial technologies for lack of internal human and/or system resources, UNGIWG should investigate opportunities for limited-term, in-service training for technical staff of these agencies in more advanced geospatial management environments operated by other member organizations. UNGIWG workshops, short courses and online learning resources are other capacity building options to investigate for raising levels of competence in required areas of expertise. Induction training for applications managers is also desirable and much neglected to date, and should also be addressed.

3. At a minimum, UNGIWG needs to routinely document and circulate a compendium of 'geospatial success stories' suitable for the consumption of senior managers and budget planners not yet convinced of the advantages of introducing or strengthening their agencies' geospatial capacities. Documentation circulated should include details of positive managerial, technical or economic outcomes arising from the application of geospatial technologies to problem solving in the UN and elsewhere. By so doing, awareness of the needs and benefits of setting aside training and material resources for this purpose will be reinforced where it most counts.

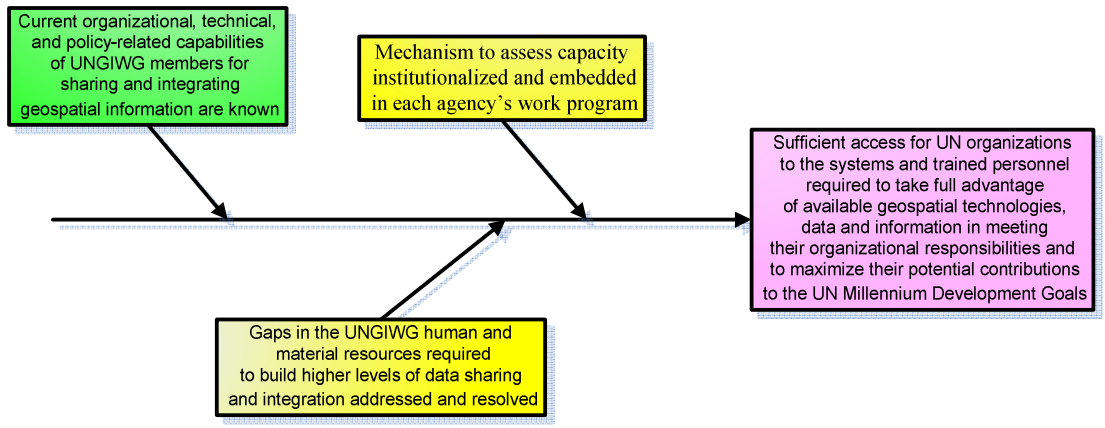


Figure 14: The overlapping sequence of outcomes linked to the delivery of Goal 2

***Goal 3*:** to identify and address external capacity building needs of member countries to accelerate the development of open and interoperable NSDIs in countries presently disadvantaged in this regard.

Objectives and specific actions

1. Seek the assistance of UN training resources, regional bodies and UNGIWG members and partners to realize this goal. Capacity building activities should to be aligned with those of partners and member states as all ultimately need to form part of the same UNSDI framework. Details are addressed separately in Section 7.5 *Linkages and partnerships*.

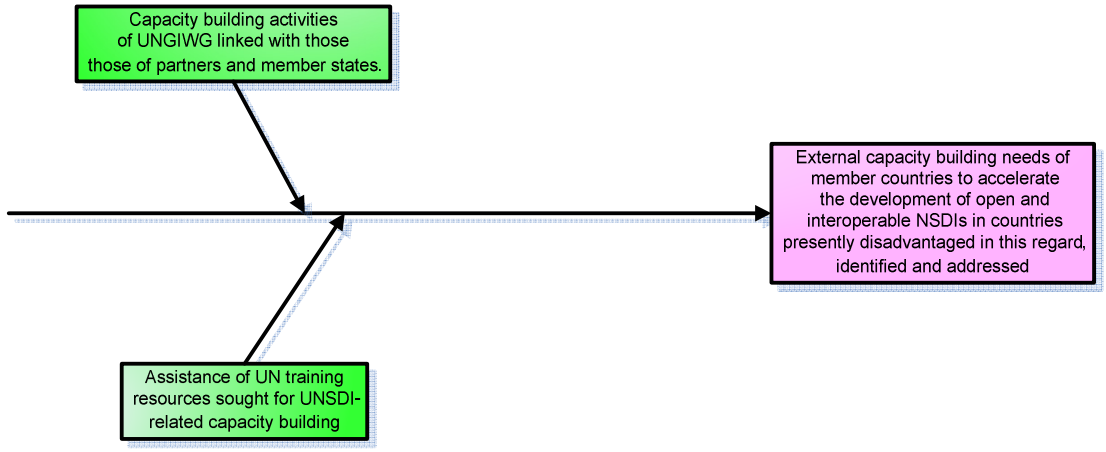


Figure 15: The overlapping sequence of outcomes linked to the delivery of Goal 3

Goal 4: to ensure adequate funding and partnership agreements are in place that support the sustainable staffing and systems required by agencies and UNGIWG to deliver programs underpinned by, or underpinning, geospatial data generation, documentation, access, and analysis.

Objectives and specific actions

1. UNGIWG needs to maintain elevated levels of advocacy in its communications with UN funding authorities and high level decision-making and advisory bodies such as the CEB, to increase awareness of the benefits to be derived from establishing and sustaining an adequate spatial data infrastructure for the United Nations.

2. Although the management and utilization of geospatial data by UN bodies generally has an applications orientation, it is also very much dependent upon underlying ICT for its technical achievements and information sharing capabilities. UNGIWG should therefore investigate opportunities for securing, at least in part, core funds to help build and sustain the UNSDI from the substantial budget pool set aside for ICT in the United Nations.

3. Link development of open and interoperable NSDI capabilities of member states in need by aligning the capacity building objectives of the UNSDI with those of the international donor community. Further details follow in Section 7.5, *Linkages and partnerships*.

4. Stimulate respected partners in industry, academia and elsewhere to jointly fund and participate in critical aspects of the UNSDI by 'franchising the logo'. Further details follow in Section 7.7, *Toward sustainable funding*.

5. Investigate opportunities for shared funding between UNGIWG members and partners, and innovative funding opportunities with the private sector (also see Section 7.7, *Toward sustainable funding*).

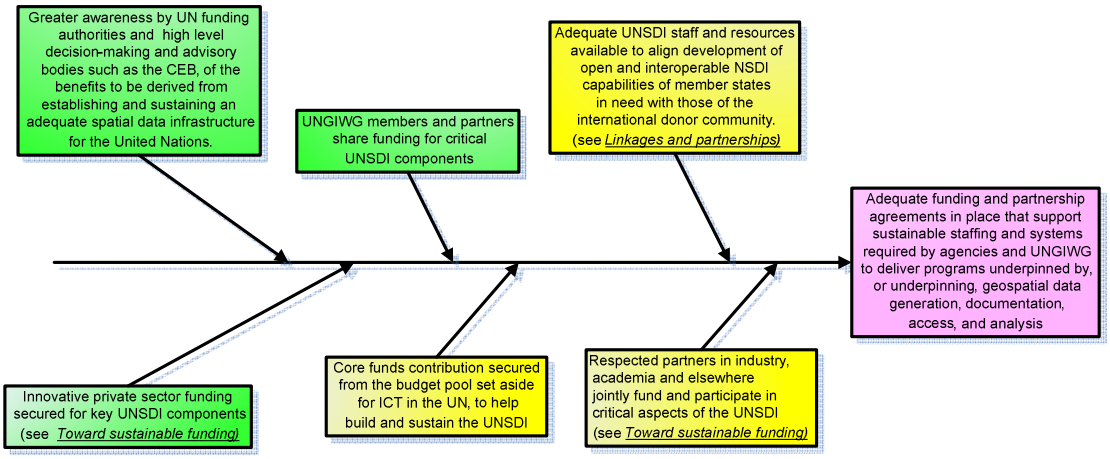


Figure 16: The overlapping sequence of outcomes linked to the delivery of Goal 4

7.5.3 Issue: Geospatial data and information

Ease of data discovery, evaluation, access and dissemination are critical to the future success of a UNSDI. Adopting open data and metadata exchange standards, and tools that promote interoperability can facilitate greater integration and sharing of geospatial data, but only if the appropriate policies and procedures are in place to enable this to happen. Data sharing agreements encapsulating the best practices of member states and partners are high on the policy and procedures requirements of a UNSDI. Establishing and/or extending key UNSDI building blocks for the technical advancement of the SDI also need to make the process more flexible and expandable, reduce systems integration costs and encourage seamless insertion of new technologies as they become available.

With these concerns in mind, the following goals and specific actions are recommended.

Goal 5: to ensure that current, quality assured[15] geospatial data and information can be easily discovered, and are immediately and openly available via the Internet from within a distributed matrix of interoperable data resources resident in UN bodies, regional

[15] Of verifiable origin, scale, date, accuracy etc

organizations, national governments, academia, industry, the NGO network and the community at large, in support of the UN MDGs.

Objectives and specific actions

1. Formalize data sharing agreements with internal and external partners, using standard geospatial terminology and incorporating the best practices trialed with success by advanced national and regional SDI operators.

2. Identify data custodians associated with developing and maintaining essential geospatial datasets, especially framework datasets – the so called 'golden standards' - that include the UNGIWG-endorsed core datasets, building upon the capacities and activities of the relevant UNGIWG Task Groups where necessary. Also specify the authority, responsibilities and mandate of nominated data custodians where possible, so that data can be managed once and managed well for the benefit of all users. Seek to formalize new agreements with data custodians as and when necessary, to guarantee data are current and quality assured.

3. Encourage adoption of international standards to facilitate the sharing and use of geospatial data and information within the UNSDI where possible, in line with the advances and recommendations made by UNGIWG Task Groups. Make recommendations on appropriate standards to encourage their adoption by members and so strengthen their respective geospatial capacities in a coherent and interoperable manner. More geospatial data can be shared between agencies and their partners as a result, minimizing duplication.

4. Promote adoption of an open standards-based approach in the design of new web services systems by UNGIWG members, such as image repository services, to encourage a universally applicable infrastructure supported by both open source and proprietary technologies.

5. By extending the activities of UNGIWG Task Groups, continue to identify, acquire and refine core datasets and other framework data for the use of all UNSDI participants. Negotiate with member states, regional organizations, partners and other relevant organizations to establish open access to additional, widely applicable framework datasets, including for example those generated for remote sensing, cartographic, demographic (esp. population), social and economic purposes. Seek partnership funding and/or participation where necessary to acquire, refine and document such datasets.

6. Building once more on the work of relevant UNGIWG Task Groups, progressively move from the creation of quality assured second (SALB) to third and fourth order administrative boundaries to service the future needs of UN agencies, members states and partners when responding to emergencies or the detailed planning requirements of sustainable development initiatives.

7. Develop and promote policies and coordination processes for the common and consistent collection of metadata based on the use of interoperable, international metadata standards, building as always on the work undertaken and recommendations made by involved UNGIWG Task Groups. In this regard the ISO/TC211 standard numbers 19115, 19119 and 19139 on Geospatial Metadata provide provide the baseline. The draft minimum field subset developed and tested by UNGIWG, when recognized, should be adopted as the UN standard for metadata.

8. Designate responsibility for the creation and maintenance of geospatial metadata at an agency level across the UN system. For example, all staff producing or publishing geospatial data within the UN system should be encouraged to accept responsibility for creating accompanying metadata, or at a minimum to oversee that relevant metadata are developed by 'metadata teams' established specifically for this purpose in the agencies concerned to update web-based data catalogues.

9. Deploy UN-sponsored tools such as GeoNetwork opensource and other relevant applications where necessary to complement the work of data developers and custodians in creating and maintaining metadata of acceptable standard within the UN, member states, regional organizations, and elsewhere as required. Work toward a UN spatial data catalogue and interconnectivity with other data catalogues, portals, clearinghouses or repositories of accessible, quality geospatial data.

11. Members of appropriate UNGIWG Task Groups should investigate and ultimately implement on a system-wide basis, geospatial data visualization tools such as those being trialled by UN-OCHA in collaboration with external partners.

12. Working with the results of legacy data surveys undertaken in relation to ***Goal 1***, establish a small, multi-agency Special Interest Group under the guidance of relevant UNGIWG Task Groups to identify priority legacy datasets of importance to the wider audience of UNSDI participants so that they can be 'unlocked', documented and rendered accessible with manageable and affordable levels of technical intervention.

13. Encourage geo-coding of statistical data by UN agencies, member states and partners during primary data collection, building on the experience available in UNGIWG Task Groups. The potential integration and value of statistical data of all types can be greatly enhanced by incorporation of geo-coded 'markers' and their common omission, while regrettable, represents a future opportunity to add value to new UN statistical data and that of its partners at a relatively small incremental cost.

14. Give consideration to long-term preservation of critical geospatial data archives. In this regard, UNGIWG should work with partners such as the Committee on Data for Science and Technology (CODATA) and CIESIN and industry to access the necessary archive support.

15. UNGIWG should capitalize on the initiation of the UNSDI as an opportunity for the United Nations to lead in the promotion of the Public Commons of Geographic Data, an approach to remove technical and legal barriers confronting users globally who wish to contribute, access and use locally generated geographic information (see Box 8). The UNSDI Implementation Committee needs to investigate opportunities of this nature and to work with reliable partners in academia and industry to further such initiatives.

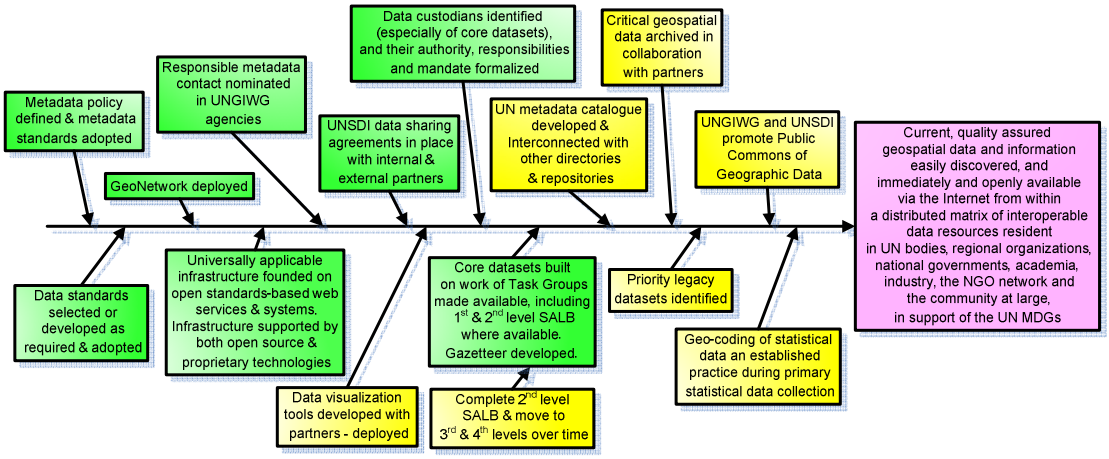


Figure 17: The overlapping sequence of outcomes linked to the delivery of Goal 5

7.5.4 Issue: Technology

Implementation of a system-wide UN architecture for distributed data access and geo-processing will require hitherto unattained levels of cooperation and resources from among UNGIWG members. But with the rapid evolution of computer technology and access to suitable communications bandwidth growing similarly, global Web-based access to, dissemination of, and applications using geospatial data is fast becoming a reality across suitable technology infrastructures. Goals and the specific actions recommended to achieve them are presented below for discussion and comment.

Goal 6: to build a UN Spatial Data Infrastructure framework around a shared enterprise architecture and technology infrastructure that is vendor-neutral, modular, and uses OpenGIS standards and Web Services. The framework should provide interoperable, open and cost-effective data and information services to users inside and outside the UN, with users linked via the Internet using conventional communications channels.

Objectives and specific actions

1. UNGIWG should seek to understand the breadth of geo-processing systems and technology available to its members and partners through surveys and consultation as a prerequisite to designing the information architecture and infrastructure for the UNSDI.

2. As a priority, UNGIWG should convene a small, multi-agency Special Interest Group selected from its relevant Task Group participants and partners to scope-out the architecture and technology requirements for the UNSDI in detail, working with technology providers as required.

3. Encourage adoption and use of the Special Interest Group recommendations by UNGIWG members when upgrading or developing their internal geospatial data management systems.

4. Continue to support and develop successful and promising UNSDI-related technology initiatives such as GeoNetwork opensource and Maps-on-Demand, and encourage their wider use to provide 'windows' into geospatial data collections via relevant portals and geospatial data servers using standards-based applications that support data integration.

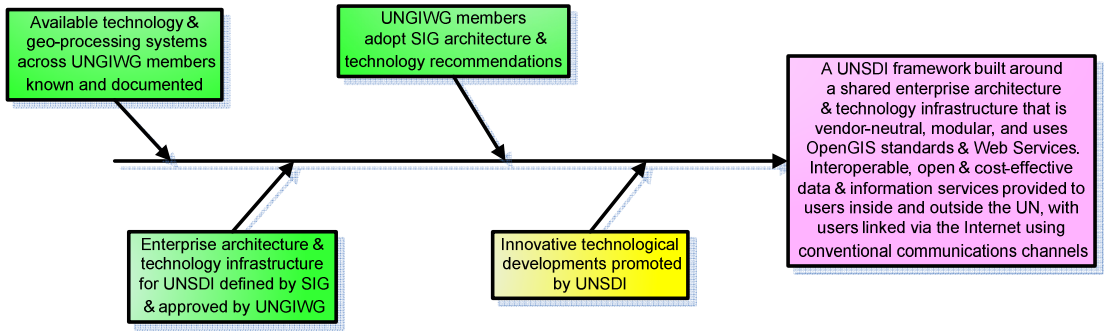


Figure 18: The overlapping sequence of outcomes linked to the delivery of Goal 6

7.6 Linkages and partnerships

UNGIWG can best engender a sense of ownership and confidence in the purpose of the UNSDI by encouraging the active participation of its member states and other partners in its formulation. 'Doors' are more likely to open as a result that can help to maximize the use of geospatial data and information worldwide. There is potential on the one hand for UN-leveraged capacity building to increase the inflow of data, information management systems and technologies to member states in need. On the other hand, new possibilities may open up for UN agencies and partners to access important national and sub-national geospatial data that support UN MDGs, as a result of data sharing agreements linked to capacity building.

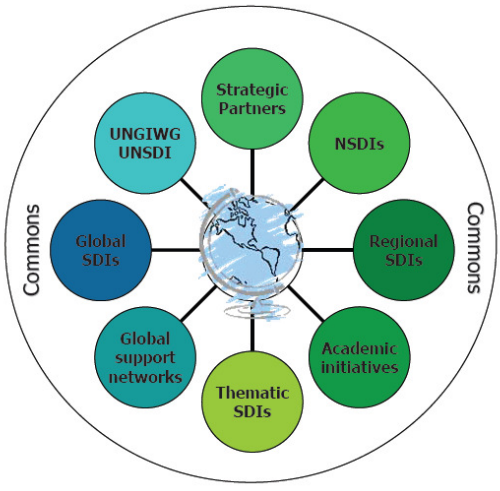


Figure 19: Linkages and partnerships served by interoperable SDIs, including a UNSDI, and the 'commons of data'

The proposed UNSDI framework, while in line with UNGIWG's own goals and objectives, therefore needs to dovetail with those of its partners outside the UN. By so doing, the UNSDI can be viewed as an extensible and inclusive initiative for the benefit of all, with linkages that extend outside the UN community; its open-ended design fostering capacity building and technical transfer to needy member states and clients, and beyond to directly support the MDGs (see Figure 19).

On another level, it is important to ensure first-rate links between UNGIWG and specialized practitioners around the world working in the fields of GIS and geospatial data management. UNGIWG should not work alone in developing the UNSDI, given the wide experience of specialized partners that have expressed willingness to collaborate in its development.

7.6.1 Increasing dialogue and shared understanding

The UNSDI should be inclusive of all member states regardless of their current level of geospatial data management and use, to better serve the needs of the states themselves as well as those of the UN. But the data infrastructure envisaged will only be as effective as its weakest links dictate. In this regard, a vigorous exchange of ideas, technology and information between local and international geospatial data specialists is paramount to the strengthening of NSDIs and ultimately, therefore, the UNSDI.

'Organic' networking of this kind is often lacking between technically advanced partners and less developed countries, reducing political and public awareness on a local scale of the potential benefits to be had from the creation of a fully functioning NSDI. To make the most of the UNSDI's open-ended design, additional outreach, capacity building and technical transfer need to be extended to member states and clients that could benefit from the support of UN agencies, the international donor community and technologically advanced members of the UNSDI.

The need for increased dialogue and shared understanding of the UNSDI is not only restricted to least developed nations. UNGIWG members and their partners in industry, academia and elsewhere can also benefit by raising the bar in this regard, as there remains a considerable disparity in the capabilities of members system-wide to generate, share and utilize geospatial data and information effectively.

Related goals and suggested actions are included below for further discussion.

Goal 7: to ensure that adequate communication, advocacy, and outreach regarding the UNSDI are extended to all UNGIWG members, member states, regional organizations, partners and the wider community of geospatial data custodians, suitably raising their awareness concerning the UNSDI and encouraging their full participation.

Objectives and specific actions

1. UNGIWG and the UNSDI Implementation Committee should work to increase awareness among national and regional organizations concerning the needs, possible design and benefits of the UNSDI. Simultaneously, the 'Committee' needs to stimulate the sharing of expertise and experience of and between member states regarding NSDIs and their possible integration with the UNSDI. This can be achieved through a vigorous advocacy and outreach campaign in line with the UNSDI Communication Policy. Web-based promotion of the UNSDI concept, newsletters, and other means as appropriate should be used to facilitate such exchanges.

2. UNGIWG should continue to engage in a dialogue with those implementing national and regional SDIs, both prior to and following the first UNSDI workshop for national and regional organizations planned for September 2006, encouraging contributions on their vision and expectations of the UNSDI and how they might participate, support and gain from it.

3. Utilize the support of UNGIWG members with offices 'resident' in developing regions and countries to extend communications and information exchange regarding the UNSDI between local organizations and geospatial data specialists worldwide.

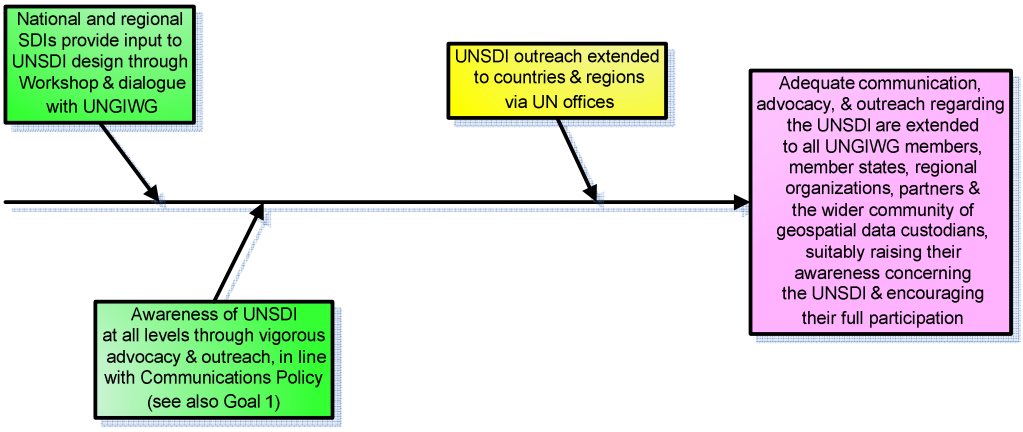


Figure 20: The overlapping sequence of outcomes linked to the delivery of Goal 7

7.6.2 Capacity building

The least developed countries have much to gain from the establishment of spatial data infrastructures that foster sustainable development and address prevailing socio-economic challenges. But investment in technology and data infrastructure, as noted earlier, is usually a low priority for governments in this situation and is unlikely to change in the short-term without external support.

The United Nations' ability to leverage capacity building in association with its partners in the donor community is of particular importance in this regard, as it has the potential to accelerate development of interoperable NSDIs in countries where the need is most evident. Despite implications for the sustainability of the UNSDI itself, donors may be apprehensive to commit long-term to establishing and sustaining NSDIs in developing nations without adequate safeguards first being in place. Issues such as prevailing organizational weaknesses, unclear governance and low availability of the trained human and material resources required to sustain NSDIs are the most common concerns of donors, but these can be addressed appropriately before assistance is agreed. UNGIWG can help to allay such concerns for example, through its authoritative advice and the development of a suite of suitable safeguards and risk management strategies for adoption by donors and incorporation into funding proposals.

These concerns notwithstanding, support can be provided internally (in terms of the UNGIWG organizations and community) and externally (in terms of partners and governments) under the umbrella of capacity building.

Goal 8: to significantly raise capacities of least developed countries to implement and sustain open and interoperable NSDIs that are compatible with the overall design and development of the UNSDI.

Objectives and specific actions

1. UNGIWG as the overseer of the UNSDI development has a unique role to play in strengthening SDI capacities in developing nations and regional organizations. In this regard, UNGIWG should work to leverage donor support for strengthening national and regional SDI capacities and encouraging their integration with the UNSDI.

2. Incorporate responsible business plans and risk management strategies into all NSDI capacity building projects to assist rigorous monitoring and evaluation during project implementation.

3. Encourage donor funding of NSDI capacity building projects contingent upon establishment of two-way data sharing agreements with the UNSDI (see Goal 5). Such measures can help to reassure donors of the usefulness and sustainability of development initiatives while providing beneficial, two-way exchanges of data and technology between the UN and national governments.

4. UNGIWG should offer (where funds permit) or generate in league with donors and partners, training possibilities for member states in need and that are designed to accelerate consolidation of national and UN data infrastructures. Consideration should be given to interactive distance learning for technical capacity building where possible.

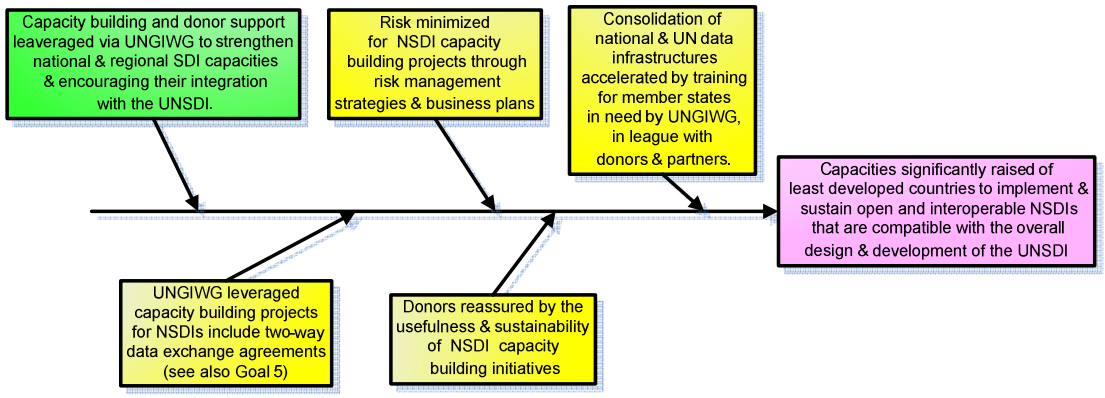


Figure 21: The overlapping sequence of outcomes linked to the delivery of Goal 8

Goal 9: to ensure currency of the UNSDI information infrastructure and the policies, organization, technology and resources that underlies it in the light of ongoing international advances and refinement of SDIs.

Objectives and specific actions

1. UNGIWG and the UNSDI Implementation Committee need to engage continuously with international partners working in SDI-related fields. This can be assisted through active participation in SDI-related forums including international meetings and workshops, and through dialogue and participation in or with organizations such as the GSDI, OGC, ISO and other strategic partners.

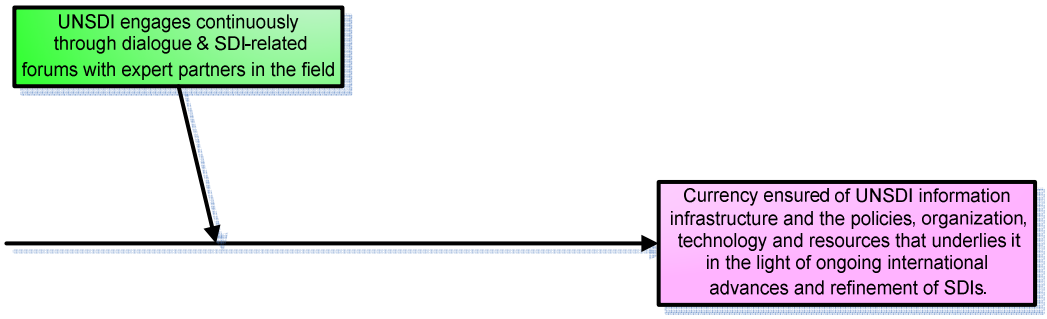


Figure 22: The overlapping sequence of outcomes linked to the delivery of Goal 9

7.6.3 Strategic partnerships

UNGIWG needs to work to promote partnerships among and between the diverse and broad range of non-state entities. This calls for increases in both the number of new actors, as well as in innovative ways of working, to facilitate increased capacity of non-state entities to respond effectively to geospatial data and information needs of the broader UNSDI community.

Goal 10: to sustain and deepen involvement of those contributing and critical to the UNSDI such as identified strategic partnership organizations.

1. UNGIWG should maintain and strengthen existing strategic partnerships such as those with the GSDI, GIST, OGC, ISO and others to capitalize on the available goodwill and knowledge concerning development of the UNSDI.

2. Foster and support global, regional and country level partnerships that potentially impact upon the UNSDI including linkages between and among civil society, private sector, philanthropy, media, and academia.

3. Support UN agencies, regional organizations, and governments in developing partnerships with non-state entities. This includes support for approaches intended to increase participation, improve linkages between efforts and strengthen the various participants' capacities for action concerning the UNSDI.

4. Move beyond the organizations already involved in the UNSDI and reach out to optimally engage the broadest range of potential sectors/actors as is practicable.

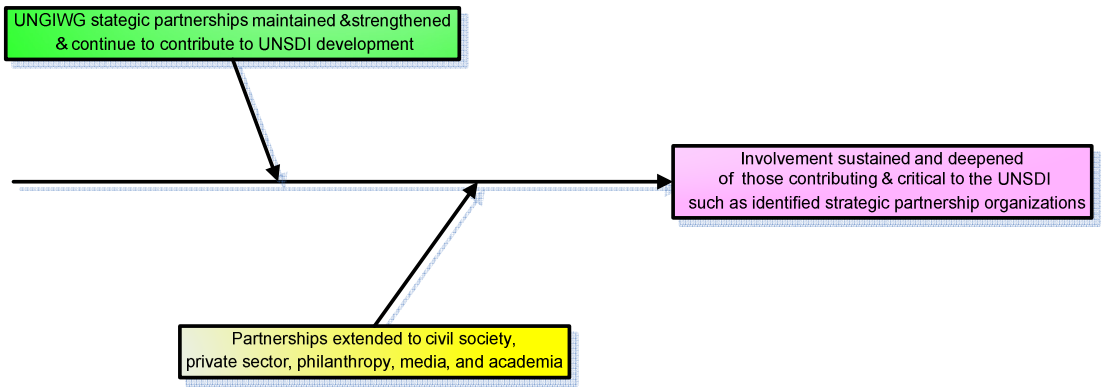


Figure 23: The overlapping sequence of outcomes linked to the delivery of Goal 10

7.7 Toward sustainable UNSDI funding

The following section reviews UNSDI funding requirements and possible mechanisms for establishing and sustaining an efficient and effective UNSDI, complement the general details concerning Goal 4 that are provided in Section 7.5.2 – People and resources. The crosscutting impact of financial resources availability on the relative success of all strategic goals is also recognized.

Severe constraints currently exist both in respect of available staff time and the resources available to perform work undertaken by UNGIWG, because of the voluntary nature of the organization. Participation and contributions from individual members of the working group have generally been justified on an agency or departmental level, in terms of the shared benefits to be derived from joint UNGWG activities. While in some cases resource mobilisation has been institutional, in others agencies have discretely looked for independent resources and funding, mostly through time-bound project funding. UNGIWG can usefully endorse approaches of this nature, helping to strengthen the case with donors where projects fit into the global UNSDI framework. At best however, these approaches are piecemeal and not long-term solutions to the sustainable funding of the UNSDI. They do however, represent a fall back option for the first several years of implementation of the UNSDI if piecemeal funding and limited availability of other resources continues.

7.7.1 General cost considerations

It might reasonably be asked at the outset if the funding required to develop a UNSDI is simply another case of: 'How long is a piece of string'? Not really, as it turns out. One of the most attractive characteristics of a well designed spatial data infrastructure is that it improves the usefulness and integration of geospatial investments and assets by identifying opportunities to collaborate and coordinate. Thus, 'sharing not wearing' the costs for multiple partners through the pooling of infrastructure and other assets. Also, since components of the infrastructure *'.. can be created, managed, refined, upgraded and resourced separately* (Atkinson, 2003) overall costs of required technologies and infrastructure can often be managed incrementally as well.

The focus on standards, interoperability, reusable services and supporting business processes reduces duplication and costs associated with spatial data management once an SDI is operational, but there are costs involved in 'getting there' and these must be budgeted for at the outset.

Experience points to the greatest costs associated with development of an SDI as being those of creating and maintaining core or framework datasets. But these costs can be met incrementally too, and are often candidates for project funding because they tie in closely with donor ambitions to support development or disaster management objectives. The stepwise progress of UNGIWG Task Groups to date in working with core data is testament to this reality.

The bottom line regarding funding is that budgetary requirements will be driven by the agreed business goals of the UNSDI and the gaps in the technology infrastructure, and the human and institutional capacity requirements to realize them. Choosing realistic and achievable business goals from the domain of the foregoing strategic ideals is critical in this regard, as only then can an implementation strategy be set out and the costs of delivering it estimated. This aspect of the UNSDI is reviewed in more detail in Part III of this report.

Irrespective of the details concerning costs, it is important to review potential funding mechanisms for the UNSDI well in advance of start-up, as there are generally long lead times involved in the actual availability of funds whether sourced from the UN, governments, the private sector or elsewhere. Some of the internal UN funding options touched on in earlier sections of this report are expanded upon below and supplemented with particulars regarding external funding opportunities worthy of further investigation.

7.7.2 Core funding

As noted above, costs and therefore funding requirements for the UNSDI at this stage of its development depend on the aims of an agreed implementation strategy. It is also apparent that costs to establish a UNSDI are not necessarily precipitous, but incremental and will depend on the business goals agreed by UNGIWG and its partners prior to its start-up. So far, UNGIWG members have managed to find only 'subsistence-level' funds for critical initiatives such as the building of core datasets, by sliding funds or personnel between internal programs or tapping into donor-funded projects with goals complementary to those of the working group.

But predictable core funding for implementing the essential elements of the UNSDI business plan needs to be forthcoming if the initiative is to be sustainable. The business case for the UNSDI is compelling and once an agreed strategy and implementation plan are available, the UNGWIG Secretariat needs to up the tempo of its *assault* on the CEB and selected funding committees of the UN Secretariat to at least secure a modicum of core funds for the UNSDI in 2007. This will also serve to solicit in-principle commitment on the part of the UN upper management to implementation of the UNSDI.

The strong links between elements of the UNSDI and the underlying United Nations ICT noted earlier in this report also need to be revisited with UN upper management, with a view to obtaining core funds for essential infrastructure upgrades and staffing from this sector of funds for common services.

7.7.3 Donor funding

While select UNGIWG members have managed to secure donor funds to undertake critical activities of Task Groups such as the refinement of core datasets to support parallel donor objectives, there is considerable potential for expanding cooperation of this type in line with an agreed UNSDI implementation strategy. Interest in strengthening NSDI capabilities of developing member states to encourage integration with the UNSDI have already been expressed by the UNSDI-NCO in The Netherlands for example, and can be extended to include the international donor community as a whole through appropriate advocacy on the part of UNGIWG. Establishing appropriate trust fund arrangements for these purposes should be investigated.

7.7.4 Franchising the logo

The principles of the UN charter, its international, multidisciplinary character and the givens of its objectiveness and neutrality provide a comparative advantage for joint-venture partners by facilitating, for example, cooperation with third parties and improving access to geospatial data and information otherwise out of reach to one or more of these same parties. 'Franchising the logo' thus involves endorsement by the United Nations of mutually beneficial joint ventures between a wide range of potential partners from state, non-state, scientific, academic and commercial sectors. Such partners would take into consideration the ideals, reputation and negotiating value of the United Nations as a contributing factor in accepting its involvement as a partner and any benefits that it may receive as result. Care is required in entering partnerships of this nature for obvious reasons, but appropriately configured they can be used to stimulate respected partners in industry and elsewhere to jointly fund and participate in critical aspects of the UNSDI.

Activities could include cost sharing with national (NSDI) and regional authorities, global partners, academia and industry to gain access to, and upgrade and distribute core datasets of importance in the future. Similarly, activities could involve launching joint projects or developments that address real needs of common interest to involved parties.

7.7.5 Corporate social responsibility programs

Strategies considered by UNGIWG to better involve the private sector in building the UNSDI include brokering public-private partnerships (PPPs) to support investment in infrastructure, incubation initiatives and south-south cooperation. Additional areas of potential cooperation include advocacy and outreach, establishment of an open UNSDI interface and synchronising the activities of UNGIWG Task Groups. These activities should build on individual agency efforts already underway, leveraging additional advantage from a coordinated and united approach from UNGIWG.

The concept of Corporate Social Responsibility (CSR) has been gaining currency around the globe for some time now in the context of public-private partnerships. It is the private sector's way of integrating the economic, social, and environmental imperatives of their activities through so called triple bottom line accounting. In practical terms, this means expanding the traditional company reporting framework to account for not just financial outcomes but also environmental and social performance.

CSR frequently involves creating innovative and proactive solutions to societal and environmental challenges, as well as collaborating with both internal and external

stakeholders to improve CSR performance. In this context, the UNSDI initiative could benefit from responsible CSR partnerships that assist its development.

Joint UNGIWG/corporate initiatives established in this way would preferably involve companies that have a significant global presence and vision, as these initiatives are more likely to be sustainable and to offer the most opportunities. Agreed policies and guidelines to responsibly govern cooperation will be a priority in setting up joint activities of this nature.

7.8 Monitoring and evaluation

Monitoring and evaluation will be essential for maintaining stakeholder and investor/donor confidence in the UNSDI development and operations. UN agencies have inbuilt systems or services that deal with maintaining efficiencies, program evaluation and audit. Both UN agencies and external partners need to maintain a strong sense that the UNSDI is going to be accountable and that its performance needs to be assessed on a regular basis. An IT enterprise architecture maturity model can be used as a self-assessment tool, as well as an IT investment maturity model. Existing tools and methodologies can and should be adapted to the UNSDI to enable the necessary monitoring and reporting processes to be put in place from the outset of implementation.

Establishing and maintaining UNSDI accountability is a cross-cutting requirement that has potential to impact on all aspects of stakeholder confidence in an enterprise-based UNSDI. Dealing with this requirement is encapsulated in the following goal, objectives and specific actions:

Goal 11: to establish credible levels of UNSDI accountability, through regular monitoring of enterprise performance and the reporting of outcomes to the UNSDI constituency.

Objectives and specific actions

1. Utilize existing UN programme evaluation and audit systems to regularly monitor performance of the UNSDI established.

2. Adapt additional industry tools and methodologies for assessing IT enterprises to support and refine the performance monitoring and reporting systems required to maintain credible levels of UNSDI accountability.

The outcomes linked with the achievement of Goal 11 are illustrated in Figure 24 below.

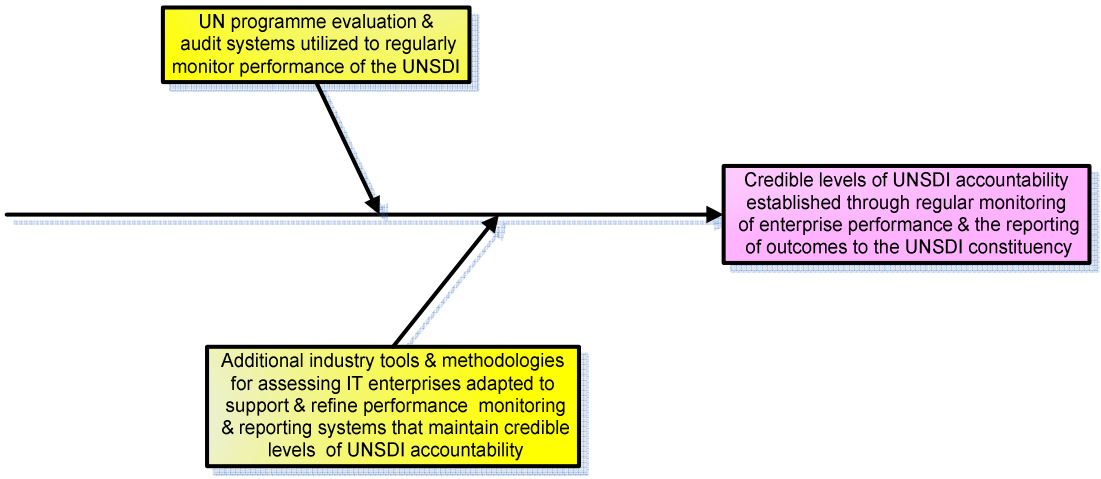


Figure 24: The overlapping sequence of outcomes linked to the achievement of Goal 11.

7.8.1 Contingencies and risk

Contingencies and risks are potential events or conditions that cannot be fully predicted and which may have an impact on the schedule, cost, quality, or overall scope of the UNSDI. Potential contingencies/risks are identified in Table.10[16] as part of overall UNSDI planning and monitoring.

There are also "status quo risks," the negative consequences of continuing current approaches to geographic information management and use in the UN System (i.e., not initiating significant efforts to improve the UNSDI)[17]..

Table10: Contingencies/risks across multiple levels of analysis

Analysis level (characteristics)	Risks/Contingencies
Global community (environmental conditions, government regulations, technology standards)	Failure to track/adapt in a timely manner to new technology/standards transformation, impacting value realized from network externalities; technology/standards change rapidly impacting value of past investments; failure to access non-UN data regulated by government agencies, limiting use of systems.
UN System (strategy choices, managerial performance, SDI development discipline, tolerance for change)	Failure to invest in infrastructure necessary to leverage and integrate new applications, resulting in reduction in realization of potential. Inadequate senior leadership in championing the initiative to ensure that it receives the resources necessary to realize its potential.
Work group (knowledge dissemination, use of team leaders to promote adoption, work group differences)	Failure to invest in training and 'slack' time to absorb changes, resulting in potential value going unrealized; turnover of personnel, slowing rate of realized value. Lack of effective knowledge sharing across work groups (to promote adoption and sort out work group differences), resulting in potential value unrealized.

[16] Adapted from Davern, M.J. and R.J. Kauffman, 2000.

[17] Thum, P. and T. Ries. 2005.

Analysis level (characteristics)	Risks/Contingencies
Business process (process design choices, system adoption subsidies, local management of chance)	Inappropriate understanding and design of incentives prompts problems with the establishment of cooperative agreements and adoption and effective use of systems, diminishing realized value.
Individual user (individual differences, experience, risk-aversion, acceptance of change)	User inexperience, lack of training or cognitive limitations lead to ineffective or limited use of the systems, leading to potential value being lost.

With due regard to possible contingencies and risks, the following Executive/Management questions should be asked concerning the establishment and role of the UNSDI[18]:

- What role do geospatial information technologies play within the UN (strategic in nature versus back-office support)?
- Will this role change over the next 5-10 years?
- Is the spatial data infrastructure appropriately designed and managed given the strategy, structure, authority, people and processes of the UN?
- Is the spatial data and technology expertise being developed and managed appropriately?
- Are risks being managed appropriately?
- Are system-wide resources spent on spatial data and related technology development and management being effectively and efficiently utilized?
- Are opportunities for using the spatial data infrastructure to add value to the business being identified and exploited?
- What changes are required? Do agencies have the resources needed to implement these changes?
- Are formal and informal information policies addressing data access, sharing, and security coherent and consistent across all organizational levels and units?
- Are formal and informal communication policies in place covering organizational and inter-organizational communication?
- How does the information infrastructure policy extend to key external relationships?
- What education/training programs are in place to ensure information and spatial data technology literacy?
- Is there a formal system for tracking new technology developments, experimenting with promising technological innovations, and assimilating new technologies into the organization?
- How does the organization manage spatial data and technology resource allocation and prioritization of GIS projects/applications?

[18] Adapted from Applegate, L.M., McFarlan F.W., McKenney, J.L., 1999.

Part III: Delivering the UNSDI Strategy

8. Implementation strategy

This section of the report outlines the process by which the target elements of a UNSDI defined earlier in the document can be built over time.

To ensure a successful and sustainable UNSDI, the implementation strategy proposed builds upon existing UNGIWG geospatial data development efforts, provides for highly visible results in the near-term, and sets an appropriate framework for medium and long-term UNSDI development and maintenance.

Applications dependent upon geospatial data and related technologies are rapidly assuming mission critical status in today's United Nations. The ever increasing convergence of geospatial and web technologies in particular has opened up exciting new prospects for the Organization to revolutionize its global business integration while at the same time strengthening its decision support, planning and operational capacities. By more effectively integrating, managing and utilizing these technologies to serve its geographic information needs, the UN enterprise stands to reap substantial political, social and economic returns on investment in these sectors (See Box 11).

> ***'…the implications of this technology convergence on workforce mobility, tighter business integration, improved decision support, and with these the realization of economic return on investments are huge. The spatial technology industry stands at the doorsteps of being a catalyst to another "new economy" in the information age, one based on exploiting location and time for more effective business planning and operations.'***
>
> ***Susan Kalweit: The Location Aware Enterprise: An Integrating Business Principle, 2005***

Box 11: Susan Kalweit of Booz Allen Hamilton, regarding the *Location Aware Enterprise* - in *Directions Magazine, January 2005*

8.1 Current implementation status

The expanding user needs of many UN departments, agencies, funds and programmes and their partners has prompted development of improvised spatial information management systems to support data integration for a variety of business purposes. Viewed system-wide, results have been highly variable and generally lacked a unity of purpose until recently, as detailed in Part II of this report. UNGIWG, representing the collective voice of the UN geospatial data communities, is raising the bar in this regard by taking onboard the system-wide challenge *'to improve the efficient use of geographic information for better decision making'* through the establishment of a UNSDI.

The information infrastructure envisaged in Part II of this report has the potential to transform 'business as usual' in the UN by integrating geospatially enabled data, technologies and applications into the globally distributed nuclei of the enterprise,

raising management efficiencies, and the timeliness and effectiveness of decision making while at the same time moderating costs.

8.2 The UNSDI business model

The need for a business and management approach in the development of a spatial data infrastructure for the UN is affirmed by stakeholder feedback and the experiences of parties that have successfully travelled parallel journeys in developing enterprise based frameworks for local, national, or regional geospatial information infrastructures (See Box 12 below).

'For other organizations to put themselves in position to realize the many benefits of a comprehensive spatial data infrastructure, requires that they commit to the systematic creation of their Location Aware Enterprise with the assistance of the five service areas ..'

- *'Organization Design and Change Management* - to facilitate the emergence of the Location Aware Enterprise, organizational architecture must be examined and optimized, including corporate/government culture, work processes, product/service portfolio and staffing. Also to be studied are current IT and GIS applications, data assets, and technology infrastructure. Emerging from these reviews will be an enhanced organizational design as well as the identification of opportunities to be realized once the enterprise is more fully spatially oriented and enabled.

- *Economic business analysis* - based upon the assessments above, a business analysis will focus on the benefits that can be achieved by building the Location Aware Enterprise and implementing strategic projects. Benefits will flow from seizing the "low hanging fruit" and from longer term projects requiring larger amounts of resources and organization change, but ultimately promising greater results.

- *Information architecture* - defines data essential to supporting business processes including the foundation layers of spatial information required by the Location Aware Enterprise. By revealing data inventories through a metadata dictionary, information available for integration can be more easily identified. Also to be defined are the standards and formats for data exchange across the enterprise.

- *Applications Architecture* - insures that applications are modified and built in ways that effectively use the Enterprise's spatial assets. The benefits predicted in earlier planning and design phases, now need to be achieved through the implementation of business solutions that exploit improved data availability and combinability, and enhanced work processes.

- *Enterprise Architecture* - is the blueprint for building the hardware/software infrastructure and integrating it with the business processes ensuring that data and applications are accessible and usable across all offices and organizations.'

The Location Aware Enterprise: Foundation for Efficient Operations and Emergency Response, Leidner 2005

Box 12: Alan Leidner of Booz Allen Hamilton, regarding creation of the '*Location Aware Enterprise'* - in *Directions Magazine, January 2005*

The resultant UNGIWG undertaking is to develop an international, geospatial enterprise architecture that encourages interoperability not only within the Organization, but across international jurisdictions and with and between all UN member states. Critical in this regard will be successfully addressing outstanding organizational and technical issues, the leveraging of investment in capacity building for developing nations and the development of strategic partnerships to complement the knowledge base of best practices for the development of the UNSDI.

The proposed UNSDI thus encompasses an enterprise geospatial data system that provides a model for internationally sharing hardware and software, people skills, processes and other resources. By facilitating coordination of the formerly disjointed efforts within the United Nations and within and between its partners, the UNSDI will stimulate data sharing, standardization, and collaboration to improve overall support for business activities and the efficient delivery of services to the UN family and beyond.

Increases in efficiency will come mainly from avoidance of duplication both with respect to data and infrastructure, and by formalizing data access arrangements. Improved ease of access to new data and the diminution of barriers to existing data will contribute to greater effectiveness of the spatial data assets and related investments in technology and people that are hosted by involved stakeholders.

In summary, the projected implementation strategy and technical architecture outlined for the UNSDI have the potential to realize benefits that strongly support the Mission of the UN and the UN Millennium Goals including:

- Promotion of international data sharing, usability and reuse.
- A foundation for standards adoption and development.
- More efficient data discovery and data distribution mechanisms
- Development, refinement and distribution of core geospatial datasets.
- Cooperative development of shared geospatial information infrastructure.
- Leveraged investment globally in geospatial information infrastructure.
- Increased NSDI capacities and interoperability in developing countries
- Substantial cost reductions for the UN enterprise and its partners over time.
- Significantly increased overall efficiency and effectiveness of the UN enterprise.

Many of these benefits are in fact quantifiable, but require documentation beyond the scope of the current brief. However, there is little doubt that the much anticipated 'bottom line' of UNSDI implementation will be clearly reflected in long-term savings and business efficiencies derived from the increased sharing, usability and reuse of location-based information and services of the UN enterprise. The increased effectiveness of the Organization's shared investment in geospatial assets such as infrastructure (hardware/software) and resources (people) will similarly contribute to a healthier 'bottom line' over time. Re-investment in the information infrastructure will also be necessary over time to maintain maximum system efficiencies.

The benefits to be derived from building geospatial capacities in developing nations and increased engagement of the UN with the wider international geospatial community are intuitively no less compelling, but more difficult to quantify at the outset of the process.

8.2.1 Return on investment

The business cases driving the establishment of the UNSDI (see Section 4.2) presently absorb the lion's share of the US$18 billion annual budget set aside for the UN enterprise. If only a small percentage of this very substantial sum were to be saved through increased efficiencies and effectiveness brought about by the UNSDI, then in economic terms alone implementing the UNSDI is going to be a very worthwhile step for the UN as a whole. But the potential benefit goes far beyond simply fiscal advantage; there are very real gains to be had in human and environmental terms as well. Improved survival rates and better health and well-being in general of populations afflicted by calamity, and the incalculable value of achieving longer-term environmental sustainability will together recompense the cost of implementing the UNSDI many times over and long into the foreseeable future.

8.3 Implementation options

History has demonstrated that implementing the UNSDI through a 'revolutionary' process requiring the establishment of an instituted authority and purpose-built organization –a UN Geographic Information Office (GISO) - appears untenable for the UN up to this time. This proposal was put forward as part of the UNGISP in 2001-2002, but has not been acted upon since by the UN administration. Despite the potential for high visibility and some rapid results with a more abrupt or 'revolutionary approach to establishing the UNSDI, the downside risk is that coordination and cooperation across the UN system may be less than optimal and stakeholders will not be able to absorb the technology or apply new capabilities in so short a period. There is also the question of the substantial investment required over a relatively short period to acquire the staffing and deploy the necessary technology and information architectures in this case.

An evolutionary, user-driven approach to the establishment of the UNSDI, one based primarily on consensus and cooperation facilitated by UNGIWG, is a more realistic option and the stated preference of the majority of stakeholders as well. It is also questionable that the introduction of another level of bureaucracy would benefit efficiency and whether in fact there is a legal framework that would extend adequate authority to the GISO in relation to the specialized agencies of the UN in the short to medium term.

Although technology can be more easily adopted by individual agencies when an evolutionary UNSDI development is pursued, improvement in efficiency and effectiveness may come more slowly than in the case of a more 'revolutionary' approach. Ultimately however, the delivery of geospatial services in a cooperative, enterprise-wide manner will improve critical services to stakeholders more effectively and at an overall lower cost. The secret being the optimal sharing of infrastructure, resources, and processes between agencies and with partners brought about by higher levels of cooperation and participation.

While the UNSDI promotes greater accessibility and use of geospatial data infrastructure in a cooperative, distributed environment that needs to go beyond departmental and agency boundaries to be effective, some UN agencies and partners still retain a strong sense of individual ownership over these assets. Largely through the user-driven efforts of UNGIWG, there is now widespread recognition that a more

coordinated approach to the use and sharing of data, for example through the introduction of common data standards and interoperable and distributed data access, will be of benefit to all data producers and user communities and to the mission of the UN as a whole. But to ensure fully committed and sustainable support for the UNSDI system-wide, the implementation strategy must still resonate well with individual UNGIWG members and their partners. An appropriate balance of technology and data components with the needs of the stakeholder community is therefore essential to smooth the progress of an information culture change.

The UNSDI organizational and technical frameworks proposed accommodate these interests and are intended to facilitate policy decisions, the development of common standards and practices, and improved system-wide data dissemination and sharing. The necessary oversight and direction to smooth the way for the widespread levels of commitment and participation required will therefore need to be moderated by a consensus-driven governance mechanism chaired by the UNGIWG Secretariat.

8.4 Implementation stages and outcomes

A first, indicative five-year Implementation Plan for the UNSDI is presented in the following pages and is envisaged to take place in four overlapping stages; Stage 1: short-term (0-12 months), Stage 2: medium-term (12-24 months) and Stage 3: long-term (>24 months). Stage 4 covers the continuous process of improvement of the UNSDI beyond the completion of Stage 3 where the UNSDI is assumed to have reached full functionality for the presently available levels of technology and resources (see Figure 25 below).

Each of these implementation stages has outcomes defined by the strategic 'Goals' and the 'Specific Actions' or tasks outlined to achieve them in Part II of this document. Related tasks need to be implemented in a coordinated, integrated manner within each Stage and according to the program components that address UNSDI issues, linkages and partnerships, and sustainable funding. See Annex 2 for details.

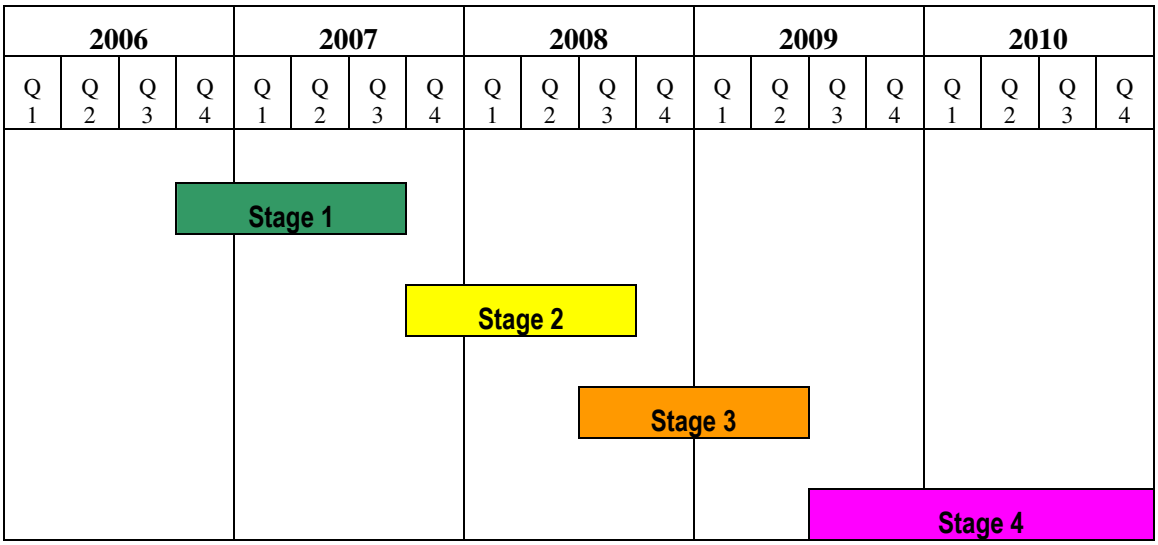


Figure 25: Major implementation stages of first, indicative five-year implemenation plan (see Annex 2 for details)

At the completion of the first five-year planning period a thorough program evaluation needs to be undertaken in addition to the annual performance evaluations embedded in the plan itself. A new five-year plan will then need to be developed since establishing a truly effective UNSDI may take upwards of 15 years, if the experience of other substantive SDI initiatives is considered. Phase I of Canada's GeoConnections for example, lasted five years, but the program is now in Phase II of implementation and budgeted for a further 5 years.

Because the UNSDI will by and large follow an evolutionary path, influenced by the availability of resources (people, technology and infrastructure), deadlines set for completion of some tasks will remain tentative until resources are secured along the way for their development. With focused leadership however, much can already be achieved in the early stages of UNSDI development by building upon the achievements of UNGIWG and its Task Groups, enhancing system-wide cooperation and organization, and the more effective utilization of existing assets. Only nominal incremental expenditures are therefore anticipated early in the UNSDI implementation process, while the benefits should be nonetheless visible and substantive.

8.4.1 Priority activities

Early stages of UNSDI implementation provide an opportunity to promote priority activities associated with the establishment and operation of the information and applications architectures that are built upon the existing achievements of UNGIWG Task Groups. Wisely chosen, priority activities will encourage confidence in the UNSDI process by providing stakeholders with the early and highly visible results alluded to earlier.

A number of critical, consensus-endorsed UNSDI priorities have in effect already been identified by UNGIWG through the deliberations of its various Task Groups. Here, specialists from the UN family and partner organizations knowledgeable in the business needs of the UN and the potential for geospatial data utilization have pooled their collective best judgments to select ongoing and planned activities for each Task Group. As these activities support the UN business cases identified, their selection as priorities for implementation has been chosen with this in mind.

8.4.2 Stage 1: Building UNSDI foundations.

Stage 1 of the UNSDI implementation addresses the establishment of an effective organizational architecture and refinement of underlying policy and standards frameworks. Building system-wide consensus for the adoption and refinement of best practices will be time consuming, but essential for developing and formalizing agreed policies and standards. Establishing an effective governance mechanism for the UNSDI development will be the linchpin in this context.

Priorities for Stage 1 include the facilitating of access to established core data sets, the initiation of critical new database developments (e.g. global gazetteer of place names), cooperatively developed visualization tools and refinement of additional core data layers. An initial 'blueprint' for integrating the technical infrastructure (hardware and software) and business processes across the decentralized matrix of UN data and applications is a particularly high priority task to be addressed. This will require

formation of UNGIWG Special Interest Groups (SIGs) early in the UNSDI process that build upon the achievements of the relevant Task Groups.

Metadata development and the distribution of associated tools such as GeoNetwork are also priorities for action during Stage 1, as they underpin the future cataloguing, discovery, interoperability and ultimately, the access to data holdings within the UNSDI. An agreed communications policy, a capacity building dialogue opened with stakeholders to strengthen NSDIs in developing countries, increased advocacy and resource mobilization, together with invigorated strategic partnerships will also be launched during Stage 1. Internal training requirements and investigation of possibilities for training UNGIWG staff need to be addressed as well at this initial stage, as do the training needs of NSDIs in developing countries.

An imperative during the Stage 1 development of the UNSDI was the presentation of the draft implementation strategy to the members and partners of UNGIWG assembled for the 7th Plenary in Santiago, Chile in November 2006.

8.4.3 Stage 2: Building the infrastructure.

The second stage of the UNSDI implementation focuses on further development of core data layers, including the datasets already identified by UNGIWG Task Groups for development but not yet implemented for lack of available resources. Metadata population and the development of catalogue services will remain priorities throughout Stage 2 of UNSDI implementation, aided by the adoption of relevant policies, standards and tools by both internal and external partners. Numerous of these 'projects' can be expected to continue well into Stage 3 of the UNSDI planning period as well.

It is anticipated during Stage 2 that resource mobilization efforts and capacity building negotiations initiated in Stage 1 will have begun to yield serious possibilities for extending the infrastructure to more developing nations and increasing the suite of services available to stakeholders. Partnerships are also anticipated to yield consolidated improvement in service delivery during this stage of UNSDI development, as standards adopted by the UNSDI increase interoperability and data agreements that enhance accessibility are negotiated incrementally over time. The design, development, and testing of site interoperability, data access and maintenance procedures will be important at this stage of infrastructure development. Nominated data custodians for example, should already be maintaining and updating data and publishing metadata associated with the data archives for which they have accepted responsibility. Remedial action needs to be initiated during Stage 2 if any concerns are highlighted during the testing of the infrastructure.

8.4.4 Stage 3: Institutionalizing the infrastructure

Stage 3 will see the institutionalizing of the information infrastructure and the dawning of operational geospatial data services across the distributed matrix of data resources that comprise the UNSDI. By the time Stage 3 implementation begins, UNGIWG agencies and partners will have significantly increased the number and capability of geospatial data portals and other data resources linked within the UNSDI. Improved access to data and distributed processing resources that leverage value from new data sharing agreements should result, but this will 'come at price'. As the number of documented and interoperable geospatial data layers increases and access to the information infrastructure becomes more widespread, the visibility of UNSDI service

levels and their responsiveness or otherwise to the user community's needs will increase. UNSDI portals therefore need to be adequately equipped, staffed, and maintained to assume operational responsibilities. Budgets available for Stage 3 must reflect this reality, before operational status is declared. Data custodians also need to be in a position to provide operational levels of data maintenance early in Stage 3 of implementation to ensure currency of archives.

8.4.5 Stage 4: Continuous improvement of UNSDI processes.

The final implementation stage involves UNSDI configuration management whereby the information architecture and technical infrastructure built up over the previous Stages is extended and refined over time, as demand for stakeholder services and finances dictate.

9. Indicative implementation plan

The UNSDI implementation plan set out in the following sections is defined according to the key Program Components that frame the UNSDI strategy. These are discussed in detail in Part II of this report and include tasks associated with the following activity clusters:

1. Addressing Issues:
    - Policy and Organization
    - People and Resources
    - Geospatial Data and Information
    - Technology
2. Linkages and Partnerships
3. Sustainable Funding

Associated with each of the Program Components are the 'Specific Actions' identified in Part II of the UNSDI strategy. When combined into a series of 'Tasks' and successfully executed, these activities deliver Milestones or 'Outcomes' that collectively satisfy the Goals of each Program Component.

Priority tasks identified from within Stage 1 are included below for each Program Component above. These are shown as timelines for the tasks concerned. An example of all priority tasks and timelines associated with the Programme Component 'Policy and Organization' is shown in Annex 3.

Throughout all stages of implementation, it will be important to periodically review the recommendations concerning each Program Component and to reconcile them with actual progress toward achievement of UNSDI goals. The implementation strategy may need to be revised in accordance with the findings, but maintaining flexibility in this regard is important.

9.1 Policy and organization

The foregoing strategy has unearthed the need for change and revitalized thinking about roles, responsibilities and organization required to successfully implement a UNSDI enterprise. Significant changes to policy and organization that are addressed in the strategy will be required as a result. But foremost among these considerations is early implementation of a sustainable governance mechanism to oversee and guide the UNSDI development and business processes. Beyond UNGIWG, no agency or authority has been formally mandated to provide governance and so UNGIWG needs to accept this responsibility if the UNSDI is to succeed. For at a minimum, sustained success will require organizational guidance that supports information development and sharing and consensus building among stakeholders. Moving eventually from implementation to operations will likely require a review of the governance mechanism adopted initially given the added responsibilities associated with stakeholder expectations.

9.1.1 Priority Tasks – Policy and organization

The proposed scheduling of priority tasks on the critical path of the Stage 1 UNSDI implementation, or the completion of which will provide greater visibility and advocacy for the initiative, are outlined below. All tasks relating to Policy and Organization are in fact considered priorities for the Stage 1 of implementation and relate primarily to the achievement of Goal 1.

In summary, the priority actions concerning Policy and Organization include:

- Creating a sustainable UNSDI governance mechanism
- Defining the strategic/business purpose of the UNSDI
- Designing enterprise architectures for business processes, data standards and services
- Increasing awareness of UNSDI achievements
- Creating a sense of ownership among stakeholders
- Developing key policies

Governance mechanisms

Governance involves the linking of strategy and business cases with operations. And for this to happen, the 'business people' and the 'UNSDI designers' and 'stakeholders' all have roles to play in guiding implementation. As outlined earlier in the strategy, this mechanism should take the form of a UNSDI Implementation Committee, chaired by members of the UNGIWG Secretariat, UN IT and business management sectors, with supplementary membership drawn from the broad base of UNSDI stakeholders. This includes representatives from industry and academia. The earlier action is taken in this regard, the sooner effective guidance can begin for the UNSDI development

The scheduling of Tasks for establishing a sustainable governance mechanism for the UNSDI is shown in Figure 26 below.

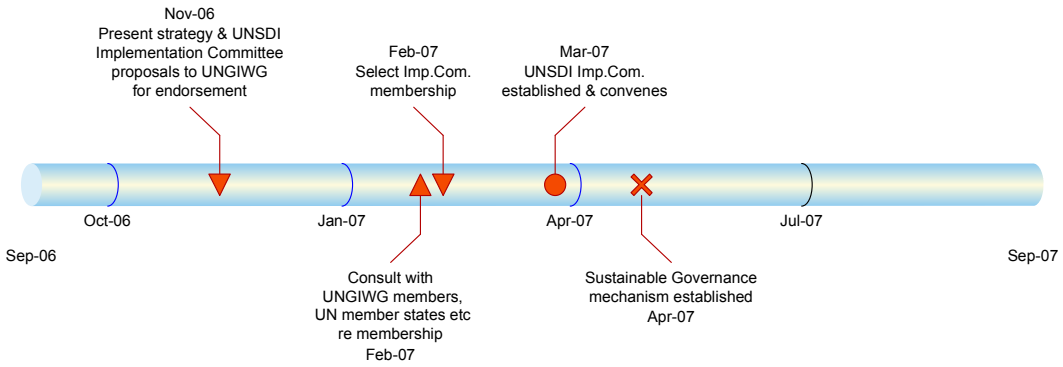


Figure 26 Schedule of Tasks required for achieving sustainable governance

Defining the Business Purpose and Enterprise Architectures

The steps and schedules for defining the strategic/business purpose and initial enterprise architectures associated with the UNSDI are shown below in Figure 27. Critical in this sequence of events has been the Task Force responsible for designing the initial enterprise architectures for the UNSDI that convened by September 2006 (see Part IV

of this document for results). Feedback from UNGIWG members will drive the process toward completion through 2007.

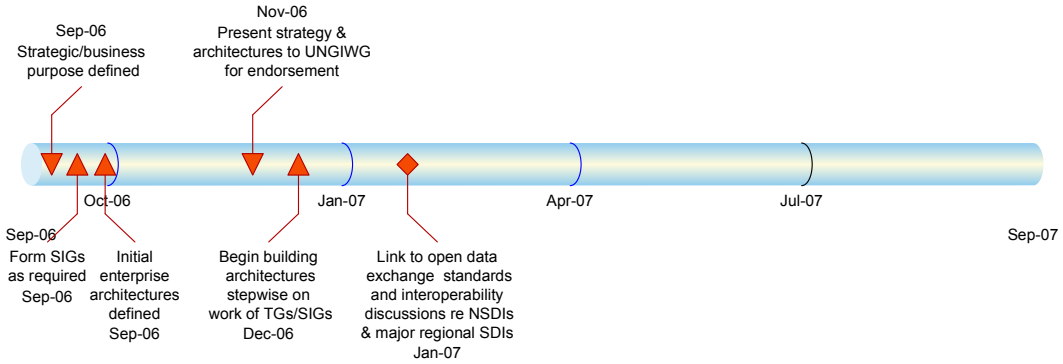


Figure 27: Schedule of Tasks to define the UNSDI strategic/business purpose and initial enterprise architectures.

Creating a sense of ownership among stakeholders

If consensus and interoperability are to be guiding principles of the UNSDI, then the early opening of dialogue between UNGIWG members and other stakeholders, particularly those from developing countries with capacity building needs, will bring timely feedback for incorporation into the planning and implementation process.

The proposed scheduled of Tasks and Outcomes related to creating as sense of ownership of the process among all classes of stakeholders is shown in Figure 28 below.

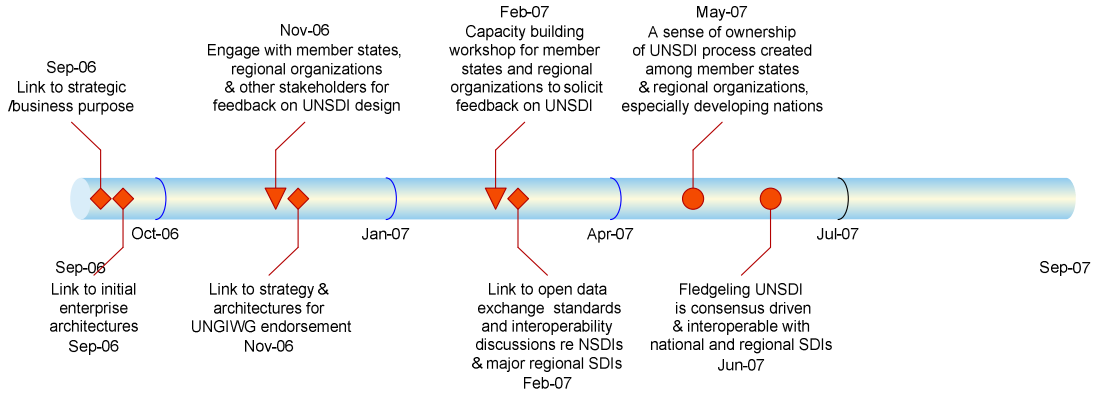


Figure 28: Schedule for creating a sense of UNSDI ownership among stakeholders

Communication with stakeholders and awareness of UNSDI achievements

Although scheduled to overlap Stages 1 and 2, the need for good communications between stakeholders and UNGIWG, and for increased visibility and advocacy provided by 'branding' are essential to develop as early in the implementation process as possible. However, developing and agreeing upon a clear communications policy will

likely take until late in Stage 1 of operations. Detailed scheduling is provided in Figure 29 below.

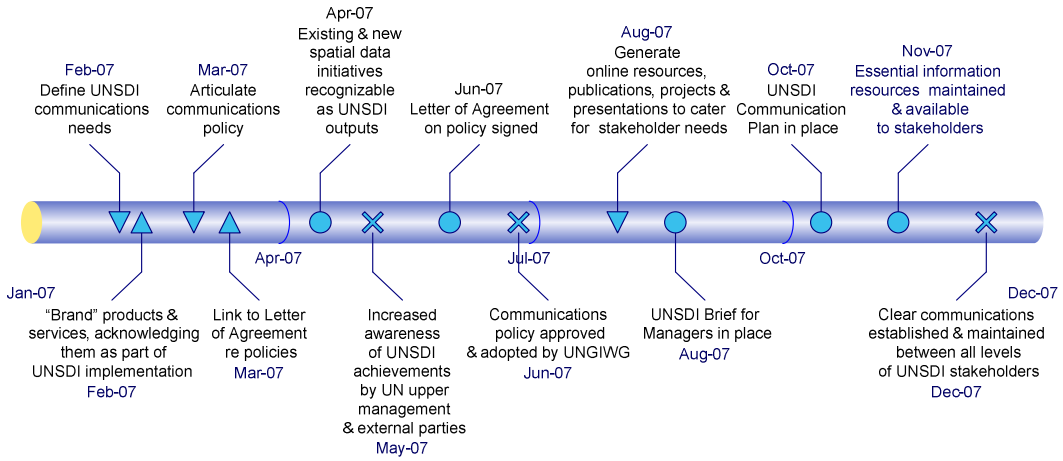


Figure 29: Schedule of tasks for developing a Communications Policy and to increase awareness of UNSDI achievements

Establishing key policies

The process of defining and adopting policies is a necessary, but time consuming process. The current absence of clear 'Rules of Engagement' or policies is unsettling for many stakeholders, whether the deficiency relates to standards, metadata creation, data access and sharing 'etiquette', or the nature of the UNSDI enterprise itself.

Effective leadership from the Implementation Committee will be the secret to success in all policy endeavours. The concept of requiring a Letter of Agreement between UNGIWG and stakeholders, particularly data custodians, is a 'necessary evil' if predictability and responsible compliance with the UNSDI policies adopted is to be expected. Details of the proposed timetable for action on policies, is outlined in Figure 30.

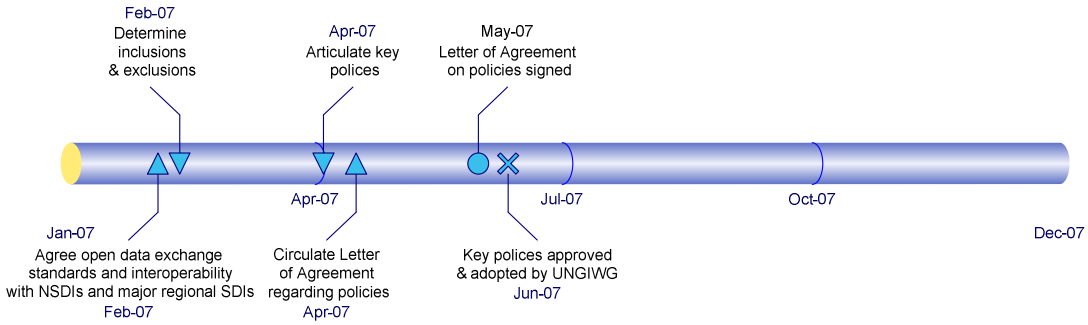


Figure 30: Schedule for establishing and approving key UNSDI policies

9.2 People and resources

To take full advantage of the UNSDI, it is important that UNGIWG members have sufficient access to trained personnel and systems that support effective geospatial data management and applications. The data providers, users and value-adders of the UNSDI are be the staff or 'people resources' employed by stakeholders. The material resources are the technical infrastructure and information architectures that underpin operations. Together they represent resources critical to the future UNSDI enterprise and compatibility of individual agencies with it.

The strategy development has unearthed considerable variation in the geospatial skills and material resource bases of different UNGIWG members, highlighting the need for technical capacity building among practitioners at the coalface, awareness-raising regarding the UNSDI among managers and upgrading of material resources.

The main requirements associated with UN agencies achieving sufficient access to the personnel and material resources necessary for an efficient and effective UNSDI relate to achievement of the outcomes prescribed collectively by Goals 2 and 3.

These include:

- Ensuring that current organizational, technical, and policy-related capabilities of UNGIWG members for sharing and integrating geospatial information are known
- Resolving gaps in the UNGIWG human and material resources required to build higher levels of data sharing and integration
- Linking capacity building activities of UNGIWG with those of partners and member states

9.2.1 Priority tasks – People and resources

The priority actions proposed to address the 'people and resources' requirements associated with establishment of the UNSDI are set out in detail below:

Assessing geospatial UNGIWG capabilities and addressing member's needs

Understanding the current capabilities of UNGIWG members in relation to sharing and integrating geospatial data and information is critical to the further development of the UNSDI. Filling gaps in both the human and material resources that are required can only reasonably begin from an understanding of the current status of these assets.

Scheduling details of the Tasks and Outcomes involved in addressing the issues of People and Resources are set out in Figure 31 below.

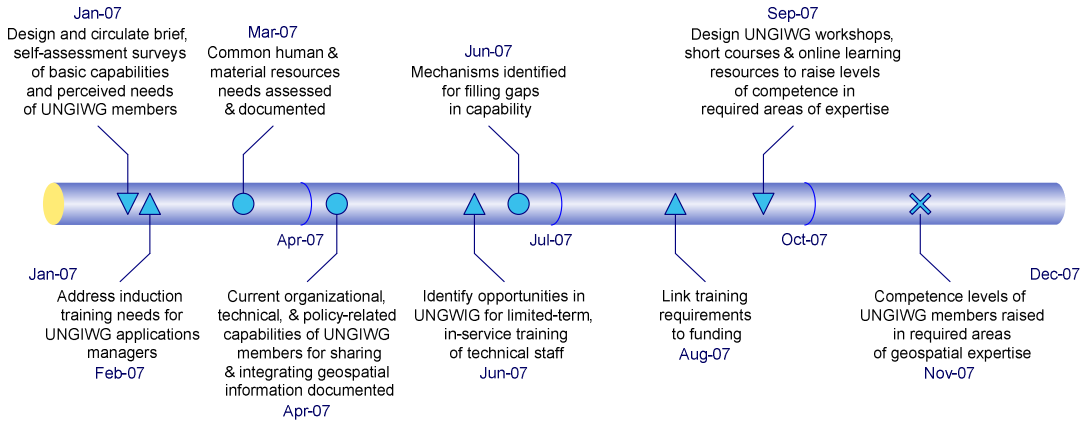


Figure 31: Scheduling details of the Tasks and Outcomes involved in addressing the geospatial capabilities and needs of UN agencies

Assessing external capacity building needs of member countries

An objective of the UNSDI strategy is to help establish or strengthen open and interoperable NSDIs that are compatible with the UNSDI in countries presently disadvantaged in this regard (see Goal 3). Tasks and Outcomes involved link strongly with the program component 'Linkages and Partnerships' (see Section 9.6) and are dealt with comprehensively in that section of the report.

Suffice it to say at this juncture that the UNSDI Implementation Committee will need to seek the assistance of UN training resources, regional bodies and UNGIWG members and partners to realize this outcome.

9.2.2 Tasks and outcomes related to funding and partnerships that sustain staffing and systems

Sourcing financial resources adequate to support sustainable staffing and systems has historically been the main constraint on wider utilization of geospatial technologies by UNGIWG members. But of themselves, financial resources can be as much an effect as a cause of slow uptake of geospatial technologies for UN business processes. Resources can almost always be sourced where justification is adequate and it is here that UNGIWG must focus to change the mindset of likely funding sources, particularly within the UN. Advocacy and outreach are important in this regard.

Partnerships also have potential to facilitate mutually desired outcomes beyond the reach of individual parties, either by direct cost sharing, the sharing of skills or from collective contributions of other necessary resources. Such partnerships obviously need to be cast in a way that provides adequate advantage and motivation for both parties to succeed, but offer a mechanism for delivering outcomes essential for the realization of the UNSDI that would otherwise remain unattainable.

9.2.3 Priority Tasks – Resource mobilization

Resource mobilization and partnerships are two of the highest priorities associated with the issue of People and Resources and will profoundly influence the success and visibility of the UNSDI. All associated activities in this case contribute to the achievement of outcomes prescribed by Goal 4.

Attempting to schedule implementation of the component Tasks and Outcomes is in one sense irrelevant, beyond simply recommending that the priorities below be initiated as soon as possible in 2006 and continue throughout the life cycle of the UNSDI. Tasks include the following:

- UNGIWG must elevate levels of UNSDI advocacy in communications with UN management and funding authorities such as the CEB. The Secretariat and Implementation Committee have obvious responsibilities in this regard.
- The UNGIWG Secretariat should investigate opportunities for securing, at least in part, core funds from the ICT budget of the UN. The approach should be linked to advocacy in communications with senior UN management
- Stimulate external funding support by 'franchising the logo'.
- Investigate opportunities for UNGIWG members and partners to share funding of key UNSDI components of mutual interest and benefit
- Leverage PPP funding for key UNSDI components
- Cross-link with mechanisms for results-based reporting, so that potential funders have confidence of a return on their investment.

These Tasks above are expanded upon under '*Sustainable Funding*' later in this report.

What is essential in all these undertakings is that UNGIWG presents 'one face' to prospective internal and external funding sources, and to potential joint partners.

9.3 Geospatial data and information

Given that data are the most expensive element of the information infrastructure, priorities need to be set that meet the key information needs and business drivers of the UNSDI enterprise. The work of UNGIWG Task Groups needs to be refined with the assistance of a SIG specifically qualified to select from among the available options regarding core datasets. Pressing priorities raised by stakeholders include high resolution population datasets, a global gazetteer of place names, physical infrastructure layers and select environmental data.

Critical in the development of the enterprise information system is the need to facilitate the development, publishing and acceptance of data standards. These will be the key to successful data aggregation, sharing and dissemination within the enterprise, as they are used to promote interoperability and ease of integration of different datasets..

9.3.1 Priority Tasks – Geospatial data and information

All activities associated with 'Geospatial data and information' contribute to the achievement of Goal 5 outcomes.

The priority Tasks and Outcomes related to 'Geospatial data and information' to be initiated, and desirably achieved, during Stage 1 of implementation are as follows:

- Development of UNSDI data sharing agreements
- Metadata standards and policy developed and defined, including nomination of metadata contacts in UNGIWG agencies. Establishment of a Metadata SIG drawing on Task Group experience will be essential in this regard.
- Core Geographic Data Sets identified in the Strategy are progressively made available via the UNSDI as they are completed and quality assured

- GeoNetwork deployment should be extended to UNGIWG members and partners as required, to facilitate metadata development and discovery
- Data custodians identified and responsibilities confirmed and agreed with UNGIWG
- Data standards selected/developed and adopted with the assistance of Standards SIG
- Universally applicable information infrastructure founded on open standards-based web services and systems designed by the SIG and trialled during Stage 1. This process should be initiated in 2006 and the infrastructure implemented as soon as practicable.
- Data visualization tools developed with partners and deployed after testing and approval of UNGIWG Task Groups
- UNGIWG should capitalize on the initiation of the UNSDI as an opportunity for the United Nations to lead in the promotion of the Public Commons of Geographic Data. Initial contacts and negotiation with partners should begin in Stage 1 of UNSDI implementation, with a view to implementation in Stage 2.

It will be important to monitor and report on progress during the implementation of these priority activities, as there is considerable scope for slippage over time with such dependence on multi-agency negotiation and, in some cases, the input of external partners. Deadlines for delivery of outcomes can best be set, monitored and amended by a SIG comprised of representatives drawn from appropriate UNGIWG Task Groups.

9.4 Technology

The express goal of the UNSDI strategy is to establish a framework built around a shared enterprise architecture and technology infrastructure. Modularity, interoperability, dependence upon the Internet and open and cost effective services are requirements of the UNSDI technology recommendations that support achievement of Goal 6.

The specific Tasks, Outcomes and broad scheduling required to deliver the kind of enterprise architecture desired for the UNSDI are described further below and in full detail in Part IV of this report. :.

9.4.1 Priority Tasks - Technology

The following tasks are considered priorities for initiation during Stage 1 of the UNSDI implementation:

- The breadth of geo-processing systems and technology available to UNGIWG members and partners needs to be understood through surveys and consultation before proceeding with implementation of a final technology infrastructure.
- UNGIWG should convene a small, multi-agency Special Interest Group or SIG selected from its relevant Task Group participants and partners to scope-out the possible architecture and technology requirements for the UNSDI during 2006. Results should be presented to the 7th UNGIWG Plenary for approval and formalization of the technology architecture to be implemented at the earliest opportunity in a stepwise and modular fashion.

- Gaps in recommended technology and infrastructure will need to be identified and costed

The results and recommendations concerning Technology have evolved in considerably more detail since the identification of the original UNSDI strategy outlined in Part II of this report, as a result of the first meeting of the Technology Task Force (SIG), having been convened in September 2006.

While the SIG is the desirable prime mover for overseeing implementation and monitoring of the Technology infrastructure, as a general principle implementation of the remaining Tasks associated with Goal 6 should be initiated as early in Stages 1 and 2 of the overall UNSDI implementation process as is practicable.

9.5 Linkages and partnerships: Communications and advocacy

To suitably raise awareness concerning the UNSDI and encourage full participation of all UNGIWG members, member states, regional organizations, partners and the wider community of geospatial data custodians, UNGIWG needs to increase communication, advocacy, and outreach regarding this initiative. Partnerships and consensus are the foundation stones of the UNSDI and without awareness of its potential benefits, participation of the wider geospatial community in the UNSDI process will be attenuated. Actions related to 'Communications and Advocacy' contribute primarily to the achievement of Goal 7 outcomes, but also play a substantive role in elements of Goal 1 outcomes. Therefore, actions related to advocacy and outreach should be linked through the Communications Policy development and the Workshops for stakeholders discussed earlier in this report.

9.5.1 Priority Tasks – Communications and advocacy

Priority Tasks link strongly with development of the Communications Policy and Plan discussed under 'Policy and Organization' earlier in this report. Awareness raising and the consensus and capacity building aspects of the Workshop programmed for February 2007 link directly with the need to encourage greater participation of partners and member states in developing a consensus-endorsed UNSDI.

Thus, building upon the Communications Policy and other communications tools specified in the Communications Plan, the UNSDI Implementation Committee should:

- Work to increase awareness among national and regional organizations concerning the needs, possible design and benefits of the UNSDI from early in Stage 1 of its implementation.
- Stimulate the sharing of expertise and experience of and between member states regarding NSDIs and their possible integration with the UNSDI.
- Use Web-based promotion of the UNSDI concept, newsletters, and other means as appropriate to facilitate such exchanges.

9.6 Linkages and partnerships: Capacity building

At country and regional levels there remains considerable requirement for accurate, up-to-date, and comprehensive geo-referenced information, especially for monitoring,

management and conservation of renewable natural resources and the environment. Weakness of national spatial data and information infrastructures prevents most developing countries from filling this gap adequately and slows or limits sustainable development. The relevance and comparative advantage of the UN in helping to bridge this information divide is a compelling argument for UNGIWG's proposed strategy to leverage donor support for strengthening national and regional SDIs. By facilitating investment in capacity building of this kind, greater overall levels of interoperability will result between the UNSDI, NSDIs and regional data infrastructures with consequent increases in data availability and access on both sides of the information divide.

Tasks and Outcomes associated with significantly raising the capacities of developing countries and regions to implement and sustain interoperable NSDIs support achievement of Goal 8. As noted previously under the Program Component: 'People and Resources', capacity building and training needs of UNGIWG members and member countries should be linked since all UNSDI participants will ultimately share a common information architecture. UN training resources and those of regional bodies and UNGIWG partners can be utilized to meet identified training needs and significantly raise capacities of developing countries to implement and sustain NSDIs compatible with the UNSDI.

9.6.1 Priority Tasks – Capacity building

All aspects of national and regional capacity building should be reviewed during Stage 1 of UNSDI implementation, and feedback solicited from prospective national partners and donors in preparation for major capacity building programmes in 2007 given the likely delay between project identification and donor funds availability. The UNGIWG workshop proposed for February 2007 represents both an ideal opportunity to establish a consensus regarding the design of the UNSDI with a range of stakeholders and to jointly review the issues that need to be addressed in capacity building future projects.

Establishment of a UNGIWG Special Interest Group (SIG) to guide capacity building developments from early in 2007 onwards is highly desirable. Representatives of the SIG need to be drawn from donors/partners, member states and UNGIWG members. In particular, representatives of national bodies participating in the UNSDI development such as The Netherlands, Czech Republic and Hungary that have reserves of geospatial skills at hand should be encouraged to share their expertise with developing countries in defining capacity building needs and projects to address them.

A schedule of priority Tasks and Outcomes associated with the development of UNSDI related capacity building for developing countries is presented in Figure 31.

UNGIWG leveraged capacity building

The elements of UNGIWG leveraged capacity building are inherent in achievement of Goal 8. Arguments presented earlier in the UNSDI strategy suggest that mutual benefit for both donors and recipients is also possible through the linking of two-way data exchange agreements with UNGIWG-leveraged support for building capacities of NSDIs (see Goal 5). Given the link therefore with capacity building in general, the scheduling of relevant Tasks and Outcomes of Goal 5 are integrated into Figure 32 concerning the activities associated principally with Goal 8.

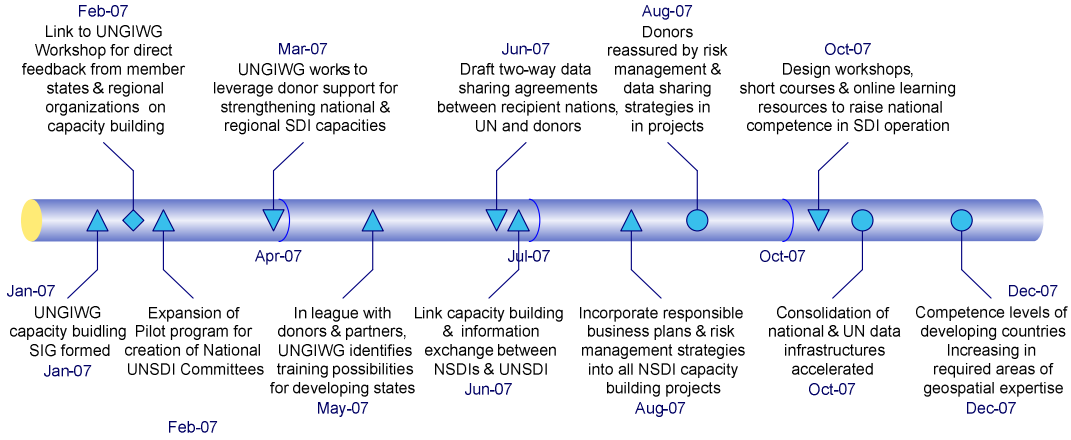


Figure 32: Schedule of priority Tasks and Outcomes associated with the development of UNSDI related capacity building for developing countries.

9.6.2 UNSDI National Committees

Development of the UNSDI, in addition to promising improved efficiencies and effectiveness for UN business processes, opens up unique opportunities for global participation in design of the UNSDI through a consultative process between UNGIWG and UN member states. This promises increased utility and benefit of the UNSDI to national stakeholders, but also reveals a conduit for leveraging the support required to strengthen SDI capacities in developing nations. The spinoff for the UN is the potential to strengthen future system-wide operations and expanded support for achievement in the medium-term of the MDGs.

UNSDI national committees are UNGIWG's chosen mechanism by which to strengthen the effectiveness and utility of the UNSDI with the assistance of member states. Table 8 in Section 6.3 provided details of countries that have so far expressed interest in participating in discussions concerning the UNSDI. Other countries have a presumed interest in participating in UNSDI design, but have not yet had adequate opportunity to consider and respond to initial feelers put out by UNGIWG in 2006.

Many of these countries may have a separate coordinating body (or focal point) for space/remote sensing activities, as well as for statistical coordination. Down the road, it is important that the UNSDI facilitates a cohesive dialogue between the GIS, remote sensing, and statistical communities. Details of countries and contact points are provided in Annex 1 of this report.

Additional points of entry include mapping agencies, statistical agencies, and university geography departments worldwide:

- http://www.unescap.org/icstd/SPACE/resap/icc/icc_nfp.asp
- http://whc.unesco.org/en/mapagencies
- http://www.statssa.gov.za/asc/delegates.asp
- http://univ.cc/geolinks/

Details regarding the three confirmed national coordination offices contributing to the development of the UNSDI are set out below as potential models for future national pilot activities.

UNSDI-Netherlands Coordination Office

The UNSDI concept recognizes and underscores the importance of actively linking a UNSDI with national SDI capacities, both in developed and developing countries. In this regard, constructive action has already been taken with The Netherlands Government where a UNSDI – Netherlands Coordination Office (NCO) has been established at the National Aerospace Laboratory (NLR) in Amsterdam. This was the outcome of a potential UNSDI partners meeting with eight leading Dutch technical institutions on 7 March 2006.

Formulating the overall goals of the NCO was important preparatory process for briefing the 7th UNGIWG Plenary, and include:

- Fulfilling national government's policies with respect to issues relying on the use of geo-information, whether it be national governments themselves or in order to support sustainable development or resource management in developing countries;
- Coordination and execution of geo-information disclosure activities for large enterprises or companies in order to fulfil their Corporate Governance goals;
- Creation of an operational link between users and suppliers of geo-information to the United Nations Spatial Data Infrastructure (UNSDI) through GeoNetwork, in order to make the information and/or services of the suppliers accessible for sustainable development purposes world-wide.

To this end, the UNSDI-NCO plans to coordinate and execute a series of programmes aimed at bridging the gap between users and suppliers of geo-information. The different programmes address needs ranging from those of Small and Medium size Enterprises (SMEs), Non Governmental Organizations (NGOs), Regional Organizations, and UN Organizations to National Governments.

Primary areas of application are water management, forestry, transport/logistics, food security, disaster relief, humanitarian aid, agriculture, fisheries, biodiversity, migratory pest control, and climate change goals in the context of sustainable development. Focus will be on integrated water resources management (IWRM), forest resources management and transport/logistics.

The UNSDI-NCO will rely on the expertise and capabilities of its national partners in order to contribute to the realization of its programmatic goals. These partners include institutes, universities, NGOs, SMEs and larger companies. For implementation of the programmes UNSDI-NCO will rely on its primary United Nations partners and international research organizations.

Information regarding the activities of the UNSDI-NCO can be found at www.unsdi.nl.

UNSDI coordination in the Czech Republic

Similar processes to those ongoing in The Netherlands have been initiated between UNGIWG and the Czech Republic. A UNSDI-Czech Republic Coordination Office (CCO) has been formed to establish participation of local partners and formulate modalities for follow-up. Czech partners comprise a wide variety of organizations

representing interests ranging from trans-European activities to those of the national government agencies and down to local and municipal authorities, universities and scientific societies. Expertise of Czech partners ranges from agriculture, forestry, environment and natural resources in general to local planning, cadastre, cartography communications, geodesy, geo-informatics, to GIS and IT.

Initial focus of the CCO will be on two main areas of activity: How to make spatial data available to the UNSDI? And, which Czech national activities can be identified or initiated that fit with the programmatic directions of the UNSDI.

In terms of priorities, preliminary indications of Czech national interests lie in the following areas of endeavour:

- Building and testing of catalogue services based on different platforms
- Building a solution for terrain data collection
- Solving the problems associated with cartographic visualization
- Building extended services such as game solutions, OAS etc

UNSDI coordination in Hungary

Hungary is the third pilot nation to establish a national coordination office for the UNSDI in Europe after The Netherlands and the Czech Republic. (see www.unsdi.hu). Supported unanimously by 16 major spatial data providers, value adders and users in Hungary, HUNAGI (Hungarian Association for Geo-information) was authorized to act as the UNSDI Hungarian Coordination Office (HUCO) at foundation discussions held in Budapest during late September 2006.

Agencies participating in HUCO consider the establishment of an interagency coordination board for SDI in Hungary an ideal opportunity to provide a national-level contribution to the more effective work of the United Nations, through mapping and beyond. HUCO is firmly committed to INSPIRE principles and the synergy provided by the active participation of HUNAGI in regional (EUROGI) and global (GSDI) SDI-related interdisciplinary networking will no doubt assist future integration of a UNSDI with European and global SDI initiatives.

The Coordination Board, comprising the delegated contact persons of stakeholders, will serve as the HUCO steering committee. The Coordination Office will report to the UNGIWG Secretariat with no financial or budget commitments given the pilot nature of the activities.

In addition to The Netherlands, Czech Republic and Hungary, Spain is presently actively moving twoards a spanish UNSDI Coordination Offie (SCO), led by the University Jaume I in Castellòn in the Valencia area, and foreseen for April 2007.

9.7 Strategic partnerships

The drivers of business efficiency in the emerging ‘knowledge economy’ reside in expanded connectivity and intangibles. The ‘UN information enterprise’ needs therefore to cultivate and expand strategic partnerships that complement its knowledge base of SDI best practices for the effective development of a UNSDI. Strategic partnerships are a mechanism for leveraging a variety of resources and competencies, including funds for critical activities or infrastructure development. They also enlarge

the potential for advancing the UNSDI by opening up collective energies, knowledge bases and capacities that far exceed those of any one UN organization or UNGWIG as a whole for that matter. Priority Tasks and Outcomes associated with strategic partnerships directly support achievement of Goals 9 and 10.

Of particular interest for the future is the potential for cost sharing (or funds substitution) that can be derived from the sharing skills and/or resources specified by partnership agreements. Shared investment in mutually desired outcomes is a likely win-win situation in such cases.

9.7.1 Maintaining currency of UNSDI competencies

Strategic partnerships operate on several levels in relation to the activities of UNGIWG and the UNSDI, as noted in Part II of this report. On one level strategic partnerships assist UNGIWG to develop and maintain the currency of internal UN competencies concerning geospatial data management and utilization, on another to build SDI capacities in developing countries by drawing on the substantive external competencies and resources available through these partners. On yet another level, strategic partnerships open doors to geospatial data resources and applications that can be shared with the wider UN community and other stakeholders.

Formal relationships already exist between some UNGIWG members and a number of established strategic partners such as the GSDI, GIST, OGC, ISO and CIESIN and select international organizations, regional and national bodies, and elements of the private sector. This better enables UNGIWG members to maintain currency of ideas and methods regarding geospatial data availability, development and utilization. It also offers opportunities for UNGIWG to influence the direction of geospatial data initiatives being developed by its strategic partners and to remain alert to evolving user needs.

There are additional opportunities for the UN, through UNGIWG, to take future leadership in evaluating and promoting promising information management concepts with strategic partners, as outlined in Part II of this report. These opportunities should be acted upon during the Stages 1 and 2 of the UNSDI implementation, to allow adequate lead-up time for their development, testing and implementation.

The sequence of Tasks and Outcomes associated with ensuring and maintaining the currency of the UNSDI over time is shown schematically in Figure 32.

9.7.2 Expanding strategic partnerships

There is a need for UNGIWG to extend internal and external linkages, capacity building, and technical transfer with its member states, regional bodies and other partners, beyond the current levels of engagement. Existing partnerships help UNGIWG to maintain currency and relevance of the UNSDI and access to geospatial data and information, but there is additional benefit to be gained from both strengthening existing and expanding the number and type of future partnerships. In particular, future strategic partnerships should include a greater diversity of organizations, financial institutions and research bodies with concordant interests in an open and effective UNSDI.

Possibilities include formalizing or expanding agreements with global initiatives such as GEOSS, the UN System-Wide Earthwatch and G3OS, GMES, ICSU and the CGIAR, regional initiatives and to elements of civil society, the private sector, philanthropy, media, and academia. The more representative, open and inclusive the geospatial information framework provided by the UNSDI becomes, the greater the opportunities for the UN to draw on a diverse pool of information, technical and social resources that support the UN MDGs and other elements of the UN Charter. The possible expansion of strategic partnerships also links directly to earlier proposals for UNGIWG to become involved in development of the 'Commons of Geographic Data'.

UNGIWG additionally needs to support UN agencies, regional organizations, and governments in developing relevant partnerships with non-state entities. This includes support for approaches intended to increase participation, improve linkages between efforts, and to strengthen the various participants' capacity for action concerning the UNSDI.

9.7.3 Priority Tasks – Strategic partnerships

Strengthening and expanding strategic partnerships to ensure currency and competencies of the UNSDI

The suggested schedule of priority Tasks and Outcomes shown below in Figure 33 includes components associated with both the 'Policy and Organization' and 'Linkages and Partnerships' components of the Programme, given the convergence of outcomes.

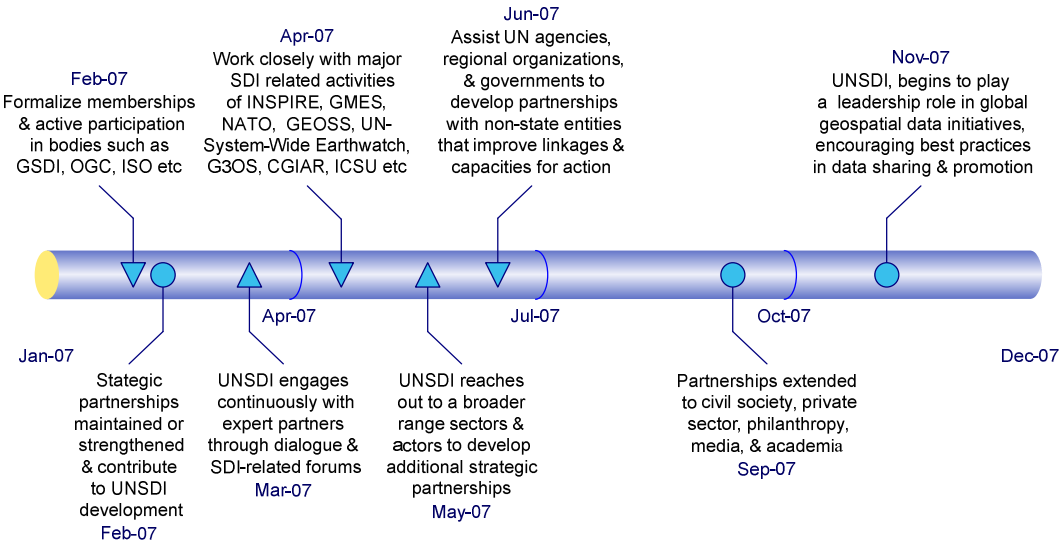


Figure 33: Scheduling of Tasks and Outcomes that utilize strategic partnerships to facilitate maintenance and currency of UNSDI technology and resources

9.8 Sustainable funding

The incremental costs for transforming the geospatial aspects of UN *business as usual* through the UNSDI need not be crippling. The UNSDI is about working smarter, not harder or more expensively. By building upon the existing achievements of UNGIWG Task Groups and fettling enterprise architectures around a modular and shared technical infrastructure, profound and relatively inexpensive advances in UN efficiency and effectiveness are possible in the short-term. Coordination, cooperation and innovation are the main ingredients for UNSDI success, not money.

But there is no escaping the fact that a modest amount of predictable and sustainable core funding will be required to kick-start, operate and maintain the essential elements of the UNSDI. UN core funds, UNGIWG cost-sharing, donor and private sector partnerships are some of the possibilities that can be called upon to meet the needs of the UNSDI over time. These are ingredients of the resource mobilization strategies proposed in Part II of this report. Each is revisited briefly below with specific reference to the kinds of outcomes intended and the recommended strategies to realize them.

Whatever route is chosen, evidence of effective UNSDI governance and an enabling environment will be crucial to the decision makers controlling access to the required funds. UNGIWG should be prepared to communicate progress in this regard to engender confidence in relevant administrations.

9.8.1 UNSDI core funds

Core funds for the implementation and operation of the UNSDI are most likely to be obtained from one, or a combination of the following sources:

- Cost sharing by UNGWIG members
- A CEB-endorsed, UN budget allocation
- Allocation of UN ICT funds
- Donor or partnership-derived funds

Cost sharing by UNGWIG members

Currently, core UNSDI development costs are being borne by a select few UNGWIG members. This is not a sustainable situation and must be addressed if the UNSDI is to reach its full potential as an enterprise-wide solution to the geospatial data needs of the UN. It remains however, the most likely short-term funding mechanism available to take the UNSDI forward into the initial stage of implementation.

A CEB-endorsed, UN central budget allocation for the UNSDI

The resources needed to administer the early stages of UNSDI implementation are in fact quite modest, but nonetheless a continuing strain on the current time-sharing staff arrangements operated by contributing UNGWIG member organizations. The additional resource mobilization strategies outlined in Part II of this report therefore need to be invoked as soon as possible.

The UNGIWG Secretariat for instance, needs to urgently lobby the CEB for funding sufficient to oversee the core administrative tasks of UNSDI development. The CEB will no doubt ask two questions when put in such a position: ‘for what’ and ‘how much’? It would be appropriate therefore for the Secretariat to prepare answers to these questions in advance. This can be achieved by scoping out details of the required core

staffing and resources ahead of time and in the context of a small, fully costed programme or project.

It may also be tactically advantageous to broaden the basis of negotiations when first approaching the CEB for support, linking the request to tangible and deliverable UNSDI outcomes that are readily understood and endorsed by CEB members. For example, the generation of one or more core datasets presently unavailable or incomplete, but guaranteed to impact positively on peacekeeping , disaster preparedness, or disaster mitigation in situations of potentially high political or humanitarian 'visibility'.

UN ICT funding and the UNSDI

Earlier in this report, precedents were shown to exist in developed nations whereby the business plans of government agencies linked the process and funding of their transformations to geospatial enterprise systems with that for their IT infrastructures. This is equally justifiable for the UNSDI, but negotiations need to be initiated early enough in Stage 1 between the UNGIWG Secretariat and those responsible for UN ICT funding to allow time for any funds allocated to come on stream during Stage 2. Endorsement for a funding link between the UNSDI and ICT could usefully be sought by the UNGIWG Secretariat from the CEB as well. Again, it is important for the UNGIWG Secretariat to be well prepared in advance by integrating the technology infrastructure proposed by the technology SIG into its negotiations with ICT decision makers.

Donor or partnership-derived funds

This is the least likely source from which funds to administer the UNSDI implementation will come, but some provision for these activities should be built into all capacity building projects or partnership agreements where cost sharing is involved.

9.8.2 External capacity building

Donor funding for the development of NSDIs in least developed countries and their integration with the UNSDI has been based primarily on official development assistance in the past, directed through multilateral or bilateral donor agencies. This will likely remain the major source of capacity building support for the UNSDI proposal to strengthen NSDIs as well. However, attention should be also given to ways of increasing foreign direct investment in geospatial technologies in developing countries and avenues to establishing Public Private Partnerships besides the traditional sources of donor financing.

Given the broad base of potential funding support for national capacity building associated with the UNSDI, it will be important to coordinate the convergence purpose and effort of these inputs. UNGIWG should assume the role of 'catalyst' or 'facilitator' in this regard, providing an enabling environment for consultation and strategic planning between involved parties. In this regard, the UNSDI workshop proposed for March 2007 will be pivotal for kick-starting the capacity building process.

Workshop on consensus building, partnerships and resource mobilization for UNSDI implementation and capacity building (1-2 March 2007)

An impressive list of interested parties has agreed to participate in this workshop including representatives of UNGIWG, the donor community, technical experts from

countries with operational SDI capacities, and regional organizations and developing countries (see Part II of this report) concerned with building their SDI capacities.

This approach needs to facilitate the development of a participatory and transparent process bringing together the relevant national and international partners in a multi-partner framework. One desirable outcome of the workshop should be the concept of integrating the principles and priorities of the UNSDI into governmental as well donors' planning frameworks that support information for decision-making and achievement of the UN MDGs.

The following recommendations are made therefore, for inclusions on the agenda of the March 2007 workshop, to assist in mobilizing partners and resources for UNSDI implementation and the building of related capacities:

- Establishment of a permanent consultative mechanism of bilateral, multilateral, regional and national partners concerned with UNSDI and NSDI development and interoperability
- Development of planning and coordination mechanisms for donors and recipients
- Formulation of concepts for developing implementation, monitoring and evaluation tools for NSDI development
- Governance and risk management strategies
- Staffing, training and infrastructure requirements
- Data and information requirements, including access to core datasets, two-way data sharing agreements etc
- Tools and common services (e.g. GeoNetwork, Maps on Demand etc)

9.8.3 Building UN system-wide capacities

Included here are not only the requirements for obtaining the resources for training and infrastructure development associated with the UNSDI, but its operational capacities to deliver common services and geospatial data across the planned UN information infrastructure.

In this regard, UNGIWG will need to look closely at opportunities for resource mobilization that go beyond requests for core funds from the UN administration. UN funding is tight, the technology and benefits of the UNSDI are not well understood by administrators and time delays for funds secured in principle to come on stream may hinder smooth development of the implementation if relied upon. Further development of core datasets for example, will be relatively costly and therefore likely require support through external donors or in kind inputs derived from the extension of strategic partnerships to advance the process during Stage 1 implementation of the UNSDI. For less costly undertakings, UNGIWG members and partners should examine possibilities to share funding of key UNSDI components of mutual interest to reduce the financial burden on individual members. There are also untapped opportunities to 'franchise the logo' as outlined in earlier sections of this report. Efforts to leverage support from external sources in this way link strongly with possibilities for obtaining CSR funding for key UNSDI components. Actions to further opportunities for establishing CSR funding are discussed separately below.

9.8.4 Tapping into Corporate Social Responsibility programmes

The UNSDI initiative could usefully be promoted with potential CSR partners as an innovative and proactive solution to societal and environmental challenges on the part of the UN. The need to address the various business cases outlined earlier in this report and the growing corporate awareness of the business value of enterprise solutions for geospatial information management (e.g. the Location Aware Enterprise), fit well with the need for UN reform and could provide entry points for discussion with corporations.

Certainly, joint UNGIWG/corporate initiatives established in this way would preferably involve companies that have a significant global presence and vision for the reasons of sustainability and opportunity noted earlier. The visualization initiatives pioneered by OCHA in collaboration with Google are a good example of the potential for developing CSR initiatives.

Future initiatives concerning the UNSDI would also benefit from direct negotiations through UNGIWG as an entity, to affirm the established levels of coordination and governance regarding the UNSDI.

Proposed actions

The following priority actions to encourage CSR programmes are proposed for consideration during Stage 1 of UNSDI implementation

- Provide a forum in which senior officials from the private sector can have a focused dialogue about the needs, priorities and challenges of a UNSDI
- Provide a venue for corporations and other private institutions to channel already pledged, but as yet unallocated, assistance
- Identify vehicles for channelling such targeted assistance through a menu of credible organizations and/or projects
- Enable private sector representatives to highlight contributions already made, share experiences, and discuss best practices regarding the effective application of resources
- Maintain the momentum of international support for sustainable development

9.9 Next steps

UNSDI strategies and implementation plans will remain meaningless unless translated into concrete actions at the national, regional and global levels. In this regard, the next steps involve turning theory into practice and plans into actions. Selecting the highest priorities for action from among the many priority actions identified elsewhere in this report. This will require the convening of relevant UNGIWG SIGs during the remainder of 2006 and early 2007, to focus on implementation of critical path components of the UNSDI and the generation of visible outcomes as follows:

Establishment of the framework for UNSDI implementation

- Institute a sustainable governance mechanism by initiating the process of creating a UNSDI Implementation Committee as soon as practicable
- Focus on standards development and adoption in SIGs

- Define the information architecture and technology infrastructure of the UNSDI enterprise by October 2006, for approval of the UNGWIG Plenary in November 2006.
- Promote mechanisms that encourage the publishing of metadata and link these to early agreement on policies, standards, provision of tools (e.g. GeoNetwork), data custodianship and responsibilities for populating data directories
- Implement standards/Web protocols for the UNSDI
- Make available core geospatial datasets via established UNGIWG portals
- Select a subset of high priority core datasets for completion or initiation, including the development of a UN Gazetteer of place names and locations, and datasets of sub-country population and vital infrastructure for developing regions of the world. Build on the work of UNGIWG Task Groups, strategic partners and donors to achieve this.

Advocacy and communications

- Refine and communicate the business case for the UNSDI enterprise to higher level officials of the UN and major donors and partners
- Establish a Communications Policy and Plan as early as practicable
- Engage UNGIWG members, member states and partners in regular dialogue regarding the status of the UNSDI
- Fully brief UNGIWG members and partners on the UNSDI during the 2006 Plenary

Capacity building

- Engage stakeholders and donors in a continuing dialogue to establish capacity building programmes for developing nations
- Develop a capacity building strategy during the workshop in February 2007 that brings together UNGIWG members, partners, donors, regional bodies and member states
- Review training and education requirements of UNGIWG members to strengthen internal geospatial data capacities

Partnerships

- To achieve more with less, the UNSDI needs to be selective, not exhaustive in the responsibilities it undertakes unassisted. It should strive for excellence in key areas, rather than for good performance in many. Tapping into the resources of others for the remainder of its requirements will be the key to its future success
- Strategic partnerships should therefore be strengthened and the range of partners expanded in accordance with earlier recommendations, including greater engagement with civil society, the private sector, philanthropy, media, and academia

Resource mobilization

- Present 'one face' of UNGIWG members to prospective internal and external funding sources, and to potential joint partners

- Focus on providing the recommended forum for senior officials from the private sector to discuss challenges of implementing the UNSDI
- Pursue and support existing negotiations of UNGIWG members with the private sector for support including those of OCHA and UNEP underway with the Google Corporation.

Part IV: Architecture for the UNSDI

10. Overview

10.1 Scope

The UNSDI Architecture section provides a first draft outline of requirements and implementation strategies that enable the building of a UN Spatial Data Infrastructure as outlined in the previous sections of this document. The principal guideline followed while developing this architecture can be summarized as “re-use what is existing and identify opportunities where relevant”.

Developing a UNSDI, as noted previously, is all about re-use; re-use of data, re-use of technical capabilities, re-use of skills developed, re-use of invested intellectual effort and capital. Re-use minimizes the up-front (initial) investment needed to join the game and realizes a more rapid return on investment. It means learning from others' experience and avoiding pitfalls as well.

Where SDI's do not yet exist - within or beyond the bounds of the UN - it is in the UN's interest to foster their development as a means of fostering re-use. The UNSDI aspires to enabling interoperability between SDI’s – spatial data infrastructures operating within UN agencies, amongst groups of UN agencies sharing common interests, and between the UN, member states, and their regional and their thematic groupings and partners sharing their data and technical advances in overlapping interests - health, environment, humanitarian or others.

The UN's unique added business value is that its mandate and obligations require it to work across jurisdictional boundaries. A valid UNSDI will use and extend other SDI’s to support specific cross-organizational projects, by enabling these SDI's to better operate collaboratively.

A UNSDI architecture does not provide a one-size fits all solution for Spatial Data Infrastructures. Even within the UN system, domain specific components are required to run the business. Rather it tries to establish a coherent umbrella architecture in which essential components become interoperable and can be reused by the individual agencies for different purposes at different scales and times and for different purposes. Domain specific components should thus inherit core properties as defined at the UNSDI architecture level. The UN should where appropriate actively participate, assist or develop domain specific components (SDI templates) to improve data interoperability, taking into account the higher level UNSDI architecture.

10.2 Goals and mechanisms

This section identifies a common set of requirements and solutions for implementing SDI’s able to contribute to a shared SDI. It considers these requirements from a number of viewpoints- enterprise, information and computation - and is consistent with the current global best practices and reference models described earlier[19].

19 Such as the Open Geospatial Consortium (OGC) Reference Model (ORM), the GSDI cookbook, W3C Web Services and 'grid' architectures

The common “Information Architecture” identifies and defines the key information elements that need to be shared between SDI’s before business benefits can be realized. This document is far too brief to aspire to being a comprehensive definition of the architecture. Rather, it is notional in form and identifies key characteristics and principles for *any* architecture finally adopted for a UNSDI.

A successful UNSDI will depend on agreed **governance and technical standards**. It must adopt a **service-oriented** approach that builds upon shared **component modules** embodying **open standard web services.** Users must be able to **discover** and **access** data and services over the **Internet** based on information held in coordinated **registries**. It must be **simple to use** and **adapt** for nations, regions and sectors presently lacking SDI’s but seeking to adopt best practices aligned with the UNSDI. It must enable users to meet their needs by providing the simplest possible, but comprehensive tools that have an added value to these localised efforts.

The UNSDI must establish **governance** that ensures that reliable components of the SDI are managed respecting their intellectual and institutional origin, their authority, suitability and operational integrity. It should also provide **registries** that support sharing **reusable, standardized data models** as simple **modules** that users can discover and access**.**

The architecture must enable useful levels of *semantic interoperability* so that related domains are able to understand each other’s vocabularies. This level of interoperability must be *extensible* by nature.

The architecture must also promote propagating successful SDI design and standards to new domains of interest. Acceptance of these designs and standards depends crucially on a “light touch” approach, with accessible reference implementations through which potential users can verify their suitability for purpose, as well as their ability to meet performance targets and integration in advance. These characteristics will also promote maintenance of the core SDI components over extended lifecycles and help meet budget or functional targets.

Finally, a UNSDI must provide a range of data models that allow for the transparent aggregation of isolated data collections into consistent, uniform data layers. Examples are data models for transportation networks, administrative boundaries, land cover, protected areas et cetera.

11. A UNSDI reference model

11.1 Introduction

Based on the current design and implementation strategies taken by most, if not all of the significant SDI initiatives, the UNSDI architecture must be build using the Reference Model of Open Distributed Processing (RM-ODP) standard as the conceptual framework. The RM-ODP standards constitute among others the conceptual basis for the ISO 19100 series of geographic information standards as well as the OpenGIS Reference Model (OGC 2003). Following the RM-ODP process is also in line with the existing efforts within the UN that work towards providing geospatial services.

11.2 RM-ODP overview

The Reference Model of Open Distributed Processing is an international standard for architecting open, distributed processing systems. It provides an overall conceptual framework for building distributed systems in an incremental manner.

The RM-ODP approach constitutes a way of thinking about architectural issues in terms of fundamental patterns or organizing principles and provides a set of guiding concepts and terminology.

The RM-ODP approach addresses different aspects of a system through viewpoints that identify top priorities for architectural specifications and provide a minimal set of requirements to ensure system integrity.

The RM-ODP defines five viewpoints. These are:

The *enterprise viewpoint*: A viewpoint on the system and its environment that focuses on the purpose, scope and policies for the system.

The *information viewpoint*: A viewpoint on the system and its environment that focuses on the semantics of the information and information processing performed.

The *computational viewpoint*: A viewpoint on the system and its environment that enables distribution through functional decomposition of the system into objects that interact at interfaces.

The *engineering viewpoint*: A viewpoint on the system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system.

The *technology viewpoint*: A viewpoint on the system and its environment that focuses on the choice of technology in that system.

The engineering viewpoint and technological viewpoint are not of relevance to the UNSDI architecture document as they concern system implementation aspects.

11.3 Enterprise viewpoint

The Enterprise Viewpoint adopted here is that specific organizations – whether UN, inter-agency, governmental or collective – create and maintain geospatial data services

according to their own internal business requirements, but that they support the interchange of data to participate in a 'Geospatial Marketplace' where both suppliers and customers benefit. Such a UN subscribed "Geospatial Marketplace, would enable triple bottom line based on financial, social and environmental accountabilities.

Spatial data creators, maintainers and suppliers create different data models for capturing, maintaining, producing and publishing the geospatial data for which they are either the point of truth, custodian or point of supply. Internal data models used by the suppliers are for their own business purposes but reaching the goal of interoperability in a web services environment requires formalisation and acceptance of the shared governance rules which include standard definitions of the content of the messages and for message protocols when data is exchanged.

The types of components managed within the domain of each SDI or spatial data provider will, of course, vary with their business requirements. By and large, however, their existing (and planned future) operations will tend to fall into the seven key

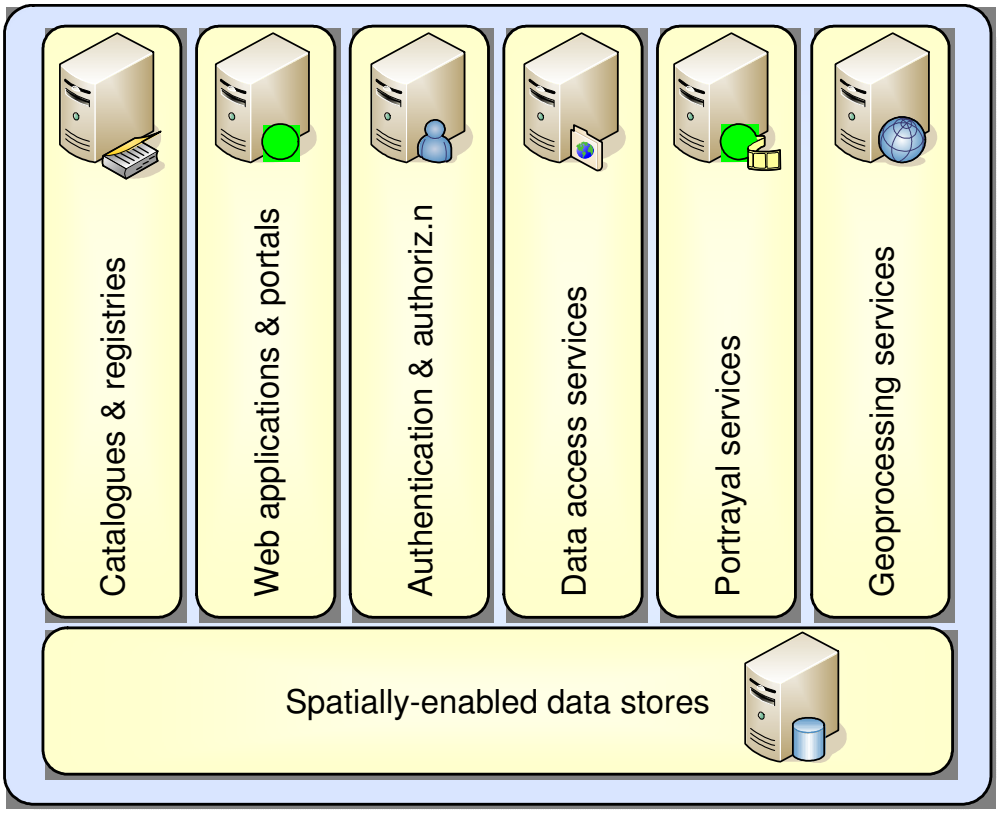


Figure 34: Key Components of SDI and Other Geo-enabled Enterprise Platforms

component categories represented in Figure 34 including:

- Catalogues and registries aiding discovery
- Applications interfacing to the internet and providing the user experience to web clients
- Means for identifying and accounting for users, and where necessary authenticating and authorizing their use of services
- Means for actually accessing and extracting required data

- Generating portrayals of data, such as maps
- Perform geographic processing on data
- The actual data bases and file systems that hold the data

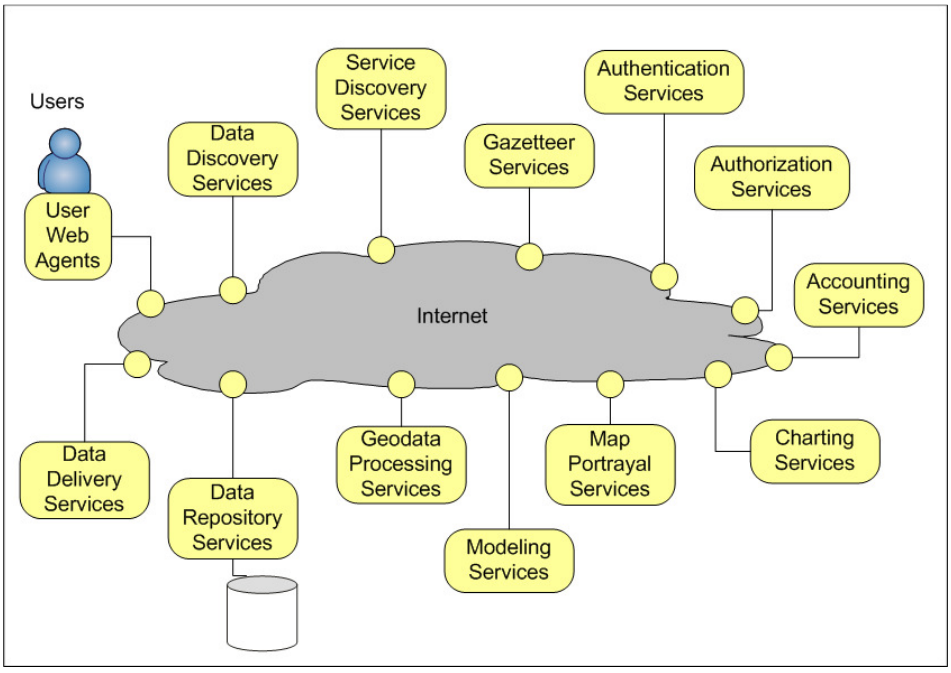


Figure 35: The Internet Bus model

One key goal of a UNSDI will be the recognition and characterization of these types of component groups across UN agencies and their partners.

A successful UNSDI will reduce the clients' view of the current complex of inconsistent and disconnected set of services to one. This harmonisation will provide a consistent experience within which the user will be able to discover and access a variety of services offered by numerous disparate providers. At the same time the content and behaviour of these services will be predictable allowing the user to anticipate the results and use the services through a normal Internet connection. This idealized approach is represented in Figure 35 as an “Internet bus” approach.

An operational marketplace requires consistency at service and data level through the use of standards. For example, a request for information on a particular location should yield a response having **identical basic content** irrespective of the supplier or of the time at which the request is made. Additional content may be provided by a supplier as a market differentiator.

Successful SDI’s aggregate services and content. Users and maintainers confronted with unnecessary complexity when designing systems that rely on more than one service will revert to developing 'stovepipes' – non-re-usable applications. Smart SDI development understands the roles of participants and works on “encapsulating this complexity” i.e. hiding the complex details to make it appear deceptively easy to use and manage. Services for viewing maps are a good start, but the UNSDI architecture must promote improved data availability and should therefore provide a clear roadmap

for implementing a data access framework of benefit to the UN, its member states and the general public.

The UNSDI must provide a proven option for standardisation of data products. Currently, service providers are in the uncomfortable position of knowing that they should adhere to data standards yet unsure how to achieve this in the face of significant development efforts. In the absence of data models applicable at a global level, the usual response has been to withhold any serious effort to create data access capabilities. SDI's must represent the requirements of its users. The UNSDI has an important role in supporting users to ensure that the vendors and developers of the enabling technologies meet these requirements.

The main ingredients required are:

- Models for framework data within particular domains
- Tools to support framework data management and access
- Registries of resources to aid data standardization
- Domain model exemplars for thematic data
- Tools to support creation and maintenance of data that implement a thematic data model
- Registries of data sources
- Governance arrangements to allow sustainable business decisions within appropriate legal frameworks.

The common themes in these ingredients are:

- **Governance** – the need for persistent governance arrangements to enable commonality at all levels of the architecture
- **Mechanisms** – the need for mechanisms to integrate results of disparate SDI developments
- **Information architecture** – a need for an agreed plan defining coherent, reusable modules within data standards

The common characteristics that the ingredients bring to the UNSDI are:

- **Reusability** through collaboration realising mutual best interests
- **Manageability** through standards
- **Extensibility** through component modularity
- **Persistence** allowing components to continue being used after the context of their origin ceases to apply.

These points are examined further in the following sections.

11.3.1 Intellectual Property and Digital Rights Management

The UNSDI architecture must address in practical terms the legitimate concerns of data and information providers regarding protection of intellectual property rights, and provides scope for effective Digital Rights Management (DRM). These matters are not restricted to concerns about re-use of licensed commercial data products. They extend to domain such as ensuring legitimate use of restricted products, ensuring accreditation for contributed content, ensuring that the provenance of data is well described, and ensuring fitness for purpose.

Many of the UN's constituents and partners are also already addressing DRM issues in their own contexts. Each Member State has its own policies that the UN is obliged to respect. The INSPIRE programme is a regional example that inevitably has to find operational solutions to disparate DRM policies across the EU member states; the Canadian CGDI is an exemplar dealing with some interesting aspects of commercial services versus public service integration. If the UNSDI is to interoperate with these SDI's, it will require a strategy and an implementation for interacting with others and governing these matters in its own domain.

The UN will not necessarily need to invent operational responses to these matters. Many of them are already under consideration in consortia such as OASIS and the OGC. Reference models and implementations are being developed, such as the OGC's geoDRM reference model, and will likely provide at least the basis for UNSDI DRM mechanisms.

11.3.2 Integrating SDI's

"Only through common conventions and technical agreements will it be easily possible for local communities, nations and regional decision-makers to discover, acquire, exploit and share geographic information vital to the decision process. The use of common conventions and technical agreements also makes sound economic sense by limiting the cost involved in the integration of information from various sources, as well as eliminating the need for parallel and costly development of tools for discovering, exchanging and exploiting spatial data. The greater the limitation on available resources for SDI development, the greater the incentive for achieving alignment between initiatives to build SDI." [GSDI Cookbook]

Box 13 – Integrating SDIs

Aggregation of data, not duplication of data management

The UNSDI should aggregate the content of collaborating SDI's, and should certainly not duplicate governance. Different deployment architectures are possible, but the goal is to create single point of truth authorities for each data set. In many cases this will mean devolving governance of subsets to a local level. In this case the point of truth for the data is different from the point of truth for the data type (and a data standard is required).

The UNSDI must drive the development and use of some basic profiles that can be adopted by collaborating SDI's and so enable such aggregation. Figure 36 shows the information flows needed to create integration between SDI tiers. The need for data standards to be provided at a global level is clear. National, regional and sectoral SDI's will be unable to fully realise the benefits of local SDI's without such a mechanism: data that does not conform to agreed standards will not be accessible by the upper tiers of the SDI. Figure 37 represents how, with appropriate governance mechanisms in place, the UNSDI would support emergence of new domain SDI's (in this case, a humanitarian one) which in turn benefited from integration of products and services for other domain and geographic SDI's.

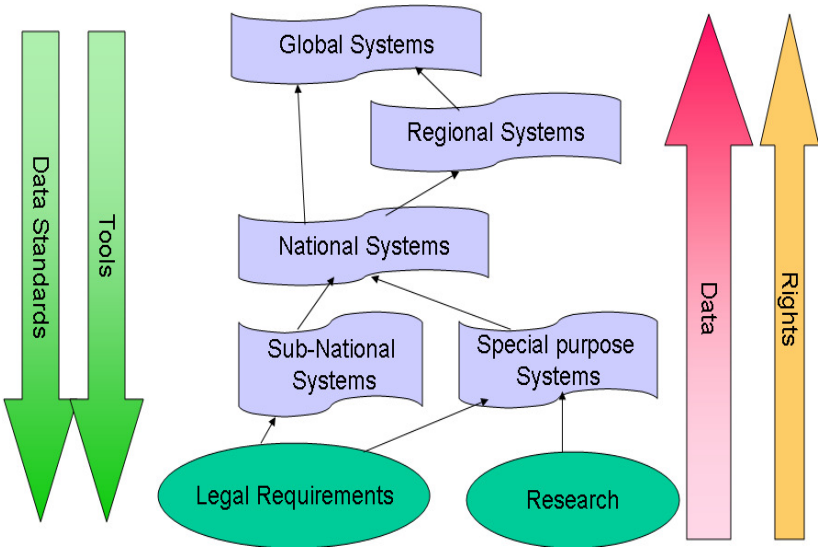


Figure 36: Basic Integration Mechanisms

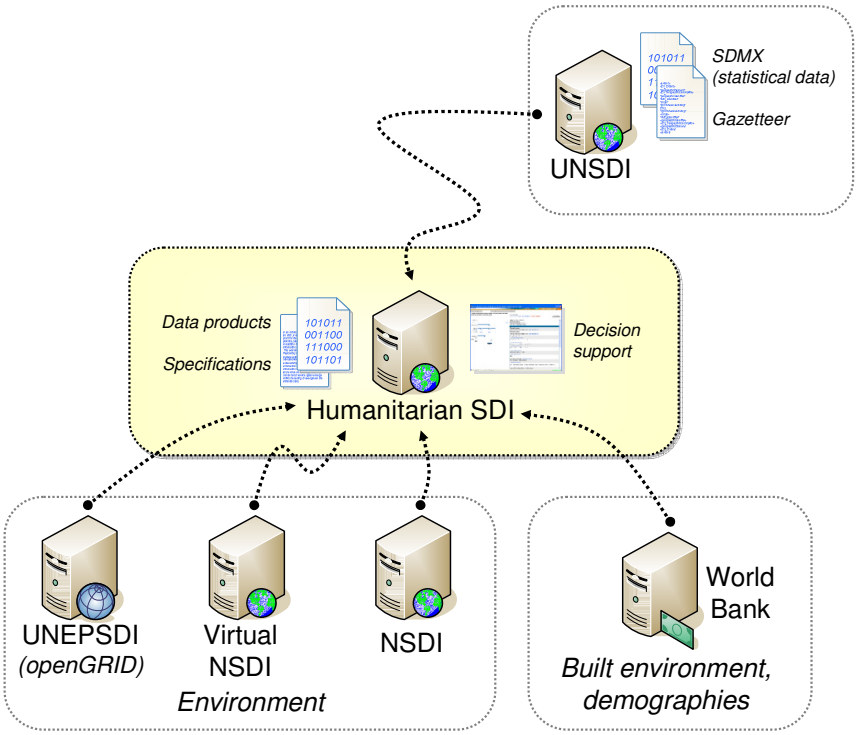


Figure 37: Cascading SDIs – Interoperating without Duplicating Governance: an example

Architectural inheritance

The UNSDI should provide ancillary resources, architectural context and design constraints to make individual components simple, predictable and interoperable. Amongst the components of the UNSDI are other domain or region specific SDI's. Logically the UNSDI benefits if it provides as much as possible of the required architecture to implement each sub-global tier. The mechanisms for inheritance between SDI architectures, down to the "leaf nodes" of the inheritance tree – individual operational systems – need to be defined, agreed and documented. Here lies the issue at the heart of this UNSDI architecture for SDI implementation: identifying the **necessary** inheritance patterns to support the requisite levels of and for information interoperability.

Implementation architectures exist within an **architectural context.** At the very least, they should exist within an enterprise environment that constrains and supports the lifecycle of the system. The reality is however that operational systems that manage data generally do so in the context of some external drivers for the data itself – a need, an opportunity, a free supply, ad hoc demands accountability or what have you.

Enterprise environments need to maintain capability to maintain implementations, and this means that they are typically the gatekeepers and provide support for a set of technical implementations, which constrain architectures to either an open standard approach or a proprietary technology.

Figure 38 shows how the relationships between different architectural tiers can be decomposed into key influences between the viewpoints of those architectures.

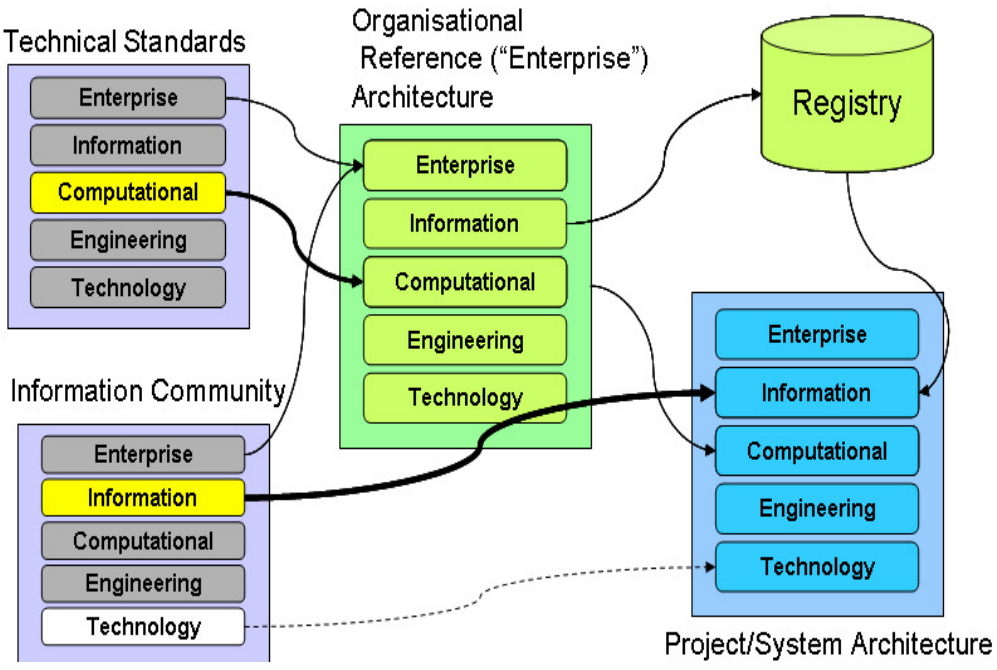


Figure 38: Architectural Inheritance - key drivers

The notion of building a UNSDI solely on one proprietary technology can be dismissed at this point. It simply does not make sense to force synchronised update or upgrade of

enterprise systems across organisational boundaries. There is no single authority or scalable pattern. Exchange of information according to published (and governed) standards whilst maintaining their existing infrastructure, is difficult enough but far more practical. Service Oriented Architectures have emerged to support this "wrapping" of private implementations with well-known public interfaces. Successful information communities rely upon managing those interfaces, and this reference architecture explores mechanisms for doing so.

Further work is required to characterize the patterns of influence and to suggest a set of appropriate mechanisms that become core to the reference architecture that can apply at all tiers of the SDI.

Deployment Architectures

SDI components can be deployed in many different ways. We will explore a number of these options here primarily from the business perspective. In the future the Engineering Viewpoint will need to be elaborated to explore the limiting characteristics of the different models.

The way in which multiple sources of data can be combined is heavily influenced by the business requirements taken into account during the design and implementation phase of the component services.

Common services

If common services systems are deployed, then integration can be achieved by clients invoking services according to suitable business logic. Generally, the client components or users need to be highly capable to achieve integration of data, but the approach is still far better than attempting to understand and manipulate differently structured data from multiple sources. This is usually a necessary precursor to other, easier to use approaches, which may be added at any time.

Aggregated (forward-cached) nodes

In this case, data is preloaded to an automated node where consolidated views of data from multiple sources can be accessed via a single query. It requires much less client logic or user interaction, and yields improved performance. Issues may arise with data held in third party systems and with ensuring that updates to data propagate quickly enough.

Virtual systems

Virtual systems provide a single point of access to distributed, federated data sources. Business perspectives, for example, user access rights, performance expectations, terms of use etc. need to be propagated from source to the virtual point of access.

Governance

The key factor in reusability of components is to establish the governance requirements of each component to allow for reuse. Every opportunity for re-use will need to be assessed in terms of the following issues:

- Who maintains the component?
- For what purpose?

- What is its lifecycle?
- What resources are available to support use?
- What technical risks are involved in using the component?
- What are the risks associated with change?
- What are the costs now?
- What are the risks that costs may change in the future?
- Who else will likely use the same component?
- Is the skills base available?
- What opportunities are there to influence the future of this component?

These issues are primarily **governance** issues that address usage. Governance also has a significant impact on the discovery or awareness of the existence of the option to use the component. Generally, discovery will start with either knowledge of the appropriate source of governance of the component, or from a "weighted search" that reflects the relative importance of the governing body or the component itself.

Persistence

Within an SDI approach the lifecycle of information becomes more important than the lifecycle of an implementation technology, or the project that initiates data collection. This requires a shift in practice and thinking that needs to be introduced and supported at the planning and funding level.

The issues of persistence of all components of an SDI - including governance arrangements, data standards, data sets, implementations and skills – is key to the stability and cumulative benefits of the UNSDI as a framework within which realistic business decisions can be taken.

A key type of artifact arising from this need is the "Service Level Agreement" whereby the intended persistence of all components should be declared. The reality is that many components face an uncertain future after short term imperatives disappear. If necessary sunset clauses, or designation of an alternate source (e.g. a 'repository of last resort' or archive), should be established for the ongoing maintenance of shared components if the original point of truth is unable or unwilling to continue provision of services.

Mechanisms for SDI management include "repositories of last resort" and "distribution nodes" where custodians who do not wish, or feel it is inappropriate, to provide long term access to data can store it. Often data may be transferred from an operational setting to an archive at such a node.

This in turn highlights the need for common information architecture to allow efficient management of such repositories, and critically, efficient transfer of data and service capability from projects to common nodes. The same set of requirements is required for "Virtual" services.

Data standards

There is little debate about the critical role of data standards in enabling SDI components to be effectively shared, and in particular to allow decomposition of responsibilities within a hierarchy of global to local jurisdictions.

"The Cookbook authors recommend that Core and non-Core data be modeled and shared in the designs of national SDI's using emerging ISO standards by following the

rules for application schema, publishing a feature catalogue, and standardizing the encoding of the data." [GSDI Cookbook]

There is however very little detail, and virtually no practical guidance on suitable approaches to this problem. Analysis of this issue has highlighted significant gaps in many of the architectural overviews available, which this reference architecture is explicitly attempting to resolve at a level that allows implementation planning.

Data standards as a business issue

Choice of data standards during a project is fundamentally a business issue: what are the costs and benefits to adopt a data standard. However, the institutional costs and benefits also need to be taken into account – if project data and technical developments are to be "thrown away" at the end of the project then the benefits of the project to the sustainable development of the organization should be questioned, or certainly reflected in the opportunity and real costs of undertaking the project.

Potential Costs:

- Research time to identify options
- Benchmarking standards against local business requirements
- Benchmarking technology support against data standards
- Development of tools to support data standard (if legacy systems exist)
- Purchase of proprietary tools required to implement the standards identified
- Development of capacity to address standards issues
- Time to establish governance arrangements, access to third party components and service level agreements
- Cost of accessing the component(s)
- Potential Benefits:
- Compliance with external requirements
- Reduced time to design and implement a new system, or new interface to an existing system
- Reduced risk that design will fail to meet needs
- Reduced need to create new data documentation
- Increased value of data
- Increased value of skills and capacity
- Familiarity with data standards in advance of specific requirement

Enablement strategies

The goal of the SDI implementation architecture is to reduce potential costs, maximize potential benefits and ensure the accumulation of a sustainable infrastructure.

Clearly, from examination of the listed potential costs and benefits, the key requirement is to establish a mechanism to propagate implementation experience and capacity along with the data standard.

The key enablement strategy for global SDI integration is to create **reference implementations** of components, (software and configuration examples). These should have the following characteristics:

- Open source (to allow extension to meet local requirements and to serve as a reference for commercial implementers)
- Freely distributable and available on the Internet
- Tested against interoperability requirements of target data standards
- Clearly identified as the reference implementation
- Supported by sufficient resources

Governance and modularity

The major barrier to implementing data standards is the cost of establishing and maintaining appropriate governance arrangements. As a consequence, the cost of developing an entire data standard is high if the entire model has to be developed from scratch. Obviously, if each domain only had to design and manage the parts of the data model **unique to the domain**, the scale of the problem would be significantly reduced. In addition, data integration between domains would be facilitated.

Establishing **mechanisms** for **modular** development of data standards will lower these barriers. This means the ability to share modules, and clear governance arrangements to allow these modules to be used and re-used.

This information architecture is designed to provide some of the necessary mechanisms, with an emphasis on the **Feature Type Catalog** implemented as a register, allowing modular management and reuse of data elements.

Use case analysis

It is necessary to model the lifecycle of data standards within an SDI implementation to ensure components of the infrastructure are implemented in a sustainable way. A systematic analysis of the establishment, governance, renewal and integration of components will show the level of detail required in the model to meet the business requirements of its users.

Use Case Analysis is at the foundation of this modeling process. Exploitation, Implementation and Management Use Cases need to be described and analyzed for each of the required components of a UNSDI. This will allow to explain to potential contributors and allies precisely how the components of the UNSDI relate, how they are managed, which components need development, and how contributions will successfully and persistently contribute to the evolving infrastructure.

The large and complex tasks of analysis and modelling of a particular domain requires UN wide collaboration as well as collaboration with parallel efforts in consortia such OGC or OASIS, or within other common interest groups such as DGIWG. Different UN agencies' perceptions of the implementation and management frameworks need to be analysed and resolved in a way that yields enough points in common for a collective approach to be meaningful. UNGIWG Task Groups with cross-agency participation could be set up and mandated to identify system-wide priorities and align them with at least one particular agency's priorities as a sanity check.

11.4 Information viewpoint

11.4.1 Goals

The key goal of this Reference Architecture is to identify the necessary mechanisms to achieve information interoperability between components in an SDI. The principles explored in the Enterprise Viewpoint largely serve to justify the information architecture detailed here.

11.4.2 Conceptual Building Blocks

As noted previously, identifying and defining the appropriate component models that handle information within *and between* SDI communities will be crucial to the UNSDI's ability to interoperate amongst SDI's. The key issue is that each domain or community

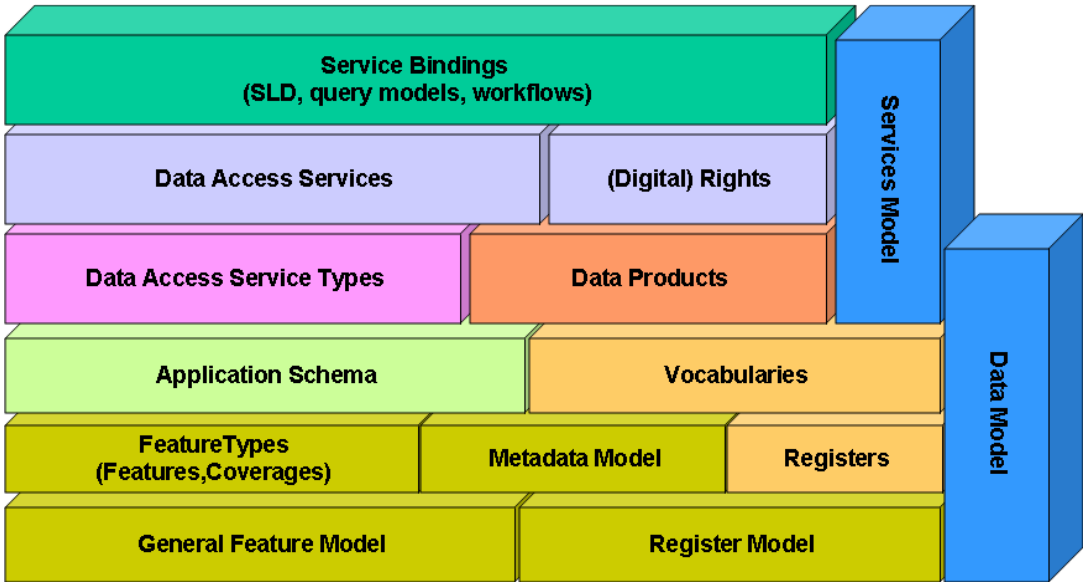


Figure 39: Conceptual Building Blocks

most likely started developing and implementing models appropriate to that community. For an integrating SDI this presents the problem of achieving a useful degree of harmonization across these existing communities. It also requires allowing for the definition and implementation of new models in future.

The proposed approach to these requirements is the *meta-modeling* of the domain models i.e. abstracting their relevant characteristics to sufficient level to provide a meaningful core of information that is or should be part of all domain models. Figure 39 portrays the relationships between a core set of the meta-models. In general, those towards the top are the instances that service-consuming clients are most aware of. Those towards the bottom are increasingly generalized or abstract and address component meta-models that tend to be valid irrespective of the *type* of the particular service in question.

The UNSDI will require common interest groups, perhaps convened under the UNGIWG task teams, to develop or expand these meta-models.

11.4.3 Modularity mechanisms

Modularity allows reusing components, and this in turn enables:

- Ease of design
- Interoperability at a component level
- Common implementation resources
- Clear governance and lifecycle management

The "Publish-Find-Bind" model (see Figure 40) is a useful model that is used in the services-oriented architecture. Creators of components **publish** descriptions (metadata)

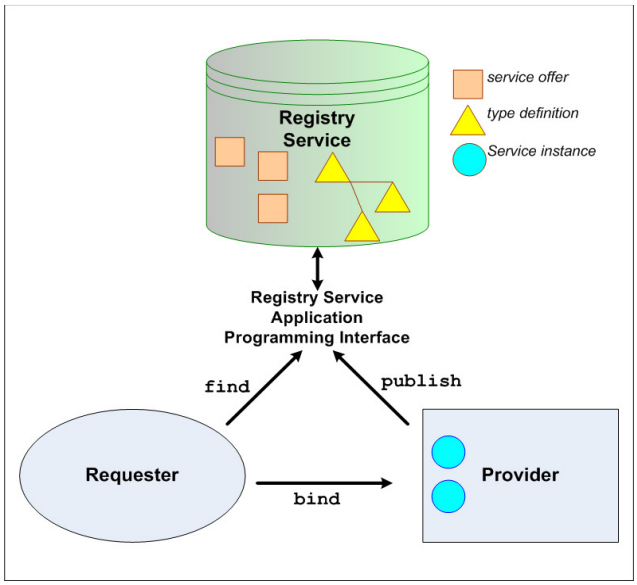


Figure 40: The Publish-Find-Bind Model

of these components in registries for data, services, portrayal rules and so on. Clients (people or computer systems) seeking components are able to **find** these by querying the appropriate registries. Clients are then able to **bind** to selected services using information in the registry records that describes how to communicate with the component when connecting.

The use of XML schema modules is considered the most appropriate method to achieve this. Two suitable alternatives exist:

UML models (packages)

Registers (where modules are defined by the contents of registers)

UML offers a standard visual modeling environment, whereas registries offer the ability to manage and distribute implementation-ready resources.

UML suffers some issues with module interoperability while registries are bound to particular technologies, and no standard for such a binding exists. They are therefore insufficiently interoperable to achieve the goals of a ubiquitous modularization of a global architecture. A proposed solution is to model the implementation of SDI's in UML, with a normative binding to registry implementations to enable access and management of semantic components. This means that the most appropriate UML modeling idiom for this task has to be identified.

Requirements

The modularity mechanism must:

- Be expressible in UML
- Allow modules to be distributed via registries
- Allow meta-models to be governed separately from instances (so that multiple instances from different sources can interoperate)
- Allow serialisation of meta-models into registries

11.4.4 SDI Interoperability

Key Registers for SDI Interoperability

Feature Type Catalog

The Feature Type Catalog is considered the critical mechanism required to publish and share definitions of data objects. There is a relevant ISO package (ISO19110), but there is no formal UML model to guide interoperable implementations. A work item to partially implement the "DataDictionary" view has been initiated (ISO19126).

Service Types and Profiles

The Service Types package requires considerable thought. To date, different vendors and open source communities have mapped OGC service capabilities into different meta-models, and there is a need for a coherent approach.

Service types declare message types allowed in supported operations. Real SDI implementations will need to create constrained profiles of generic services to ensure practical levels of interoperability of data. For example, such service profiles may define the set of data types that can be operated on by a type of Web Processing Service – maybe a route finder or a service that extracts a profile from the intersection of a locus and a 3D coverage.

In a simple case, a Web Map Service may be expected to support a particular Spatial Reference System and set of display scales, and use certain types of legend and metadata reference.

These profiles need to be managed in a separate package within a registry, but the meta-model for service profile description should be standardized in a package owned by for instance the OGC or ISO.

Metadata

Most of the current SDI registry implementations are restricted to provide access to data and visually combine disparate data services. They are characterized by providing:

- Metadata (ISO 19115 meta-model instances) about offline data sources
- Metadata about files that can be downloaded
- Links to gazetteer and Map Portrayal services like WMS that can be interrogated to discover names of objects or visualize maps.

Business requirements will require future SDI registries to provide means for information interoperability. At present there is no standardized mechanism to express this potential for **information interoperability**. Quite simply, there is no formalism for

how to express that two data sets have identical information models. This is easily rectified by adopting the ISO 19131 Data Product Specification to the point of having a register that at least records the name of common data standards. A Feature Type Catalogue will allow further technical details to be published.

Service Bindings

There are a large number of service binding artefacts that need to be managed – symbology, query models, map context documents, workflows etc. Work needs to be done to define a meta-model for these, and then allow specific packages to be created.

11.5 Computational viewpoint

The computational viewpoint describes service interfaces and components required to implement an architecture. The computational viewpoint can be broadly described by the OGC Reference Model (ORM). An SDI perspective adds additional constraints to the computational viewpoint.

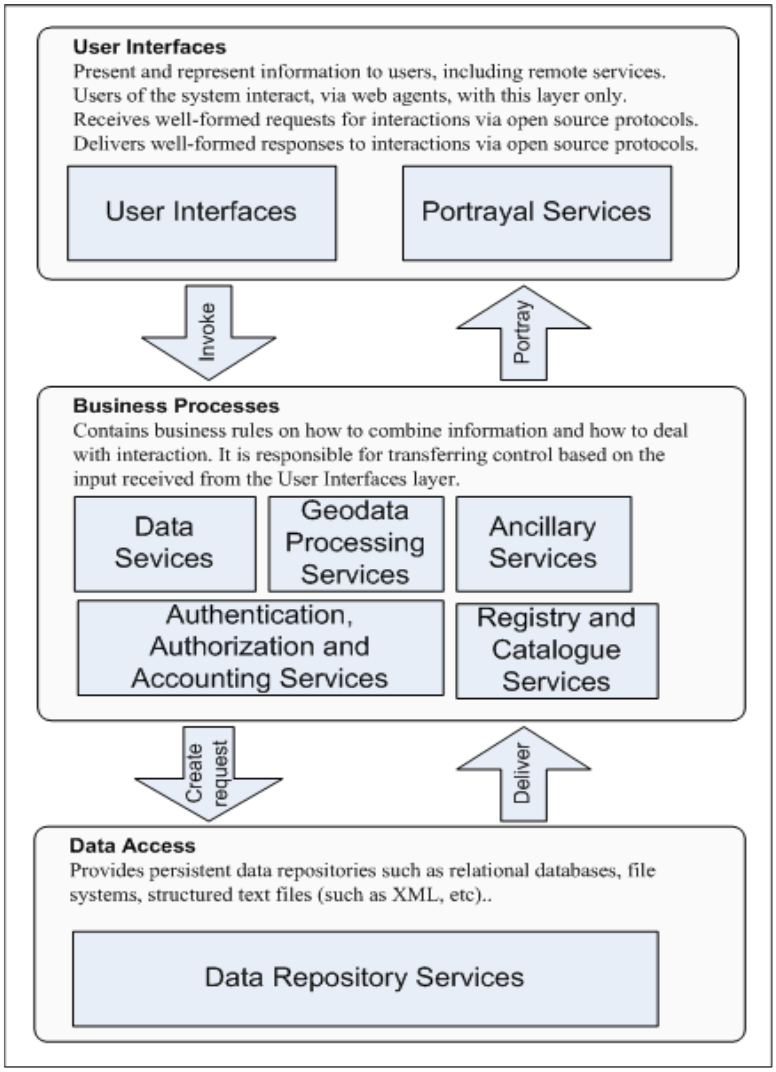
The components are best characterized as part of a service layer in the ISO 3-tier model used by the OGC Reference Model (Figure 41).

- The top tier is the only one with which clients (people or systems) deal directly. It provides the interfaces to describe and use the services offered;
- The middle tier embodies all the business processes required to respond to requests issued by clients. The services in general embody everything from authentication to complex geoprocessing on sets of data from various repositories and from generation of map views to statistical charts that the client gets back at the end of the process;
- The lower tier provides read and/or write access to data, whether it's geospatial data, accounting records, or catalogue entries stored in any of a dozen different types of registries.

Of crucial importance to note is that a three-tier approach, combined with a services-oriented architecture, yields some quite stringent constraints on the means of communication between processing components, not only between levels but even amongst components at the same level. Namely, they must be **loosely coupled**, communicate only via well-known protocols (tcp/ip, http) and, ideally, use stateless protocols to transport well-structured queries formed according the services announced **capabilities** statement and receive predictably-formatted responses packed in well-known forms of XML, such as GML.

Much of the initial work for a UNSDI will be focused on enhancing existing web services to meet these requirements. Proprietary applications and legacy systems that use non-standard communication protocols and non-standard, incompatible data formats need to be enhanced by developing components (known as wrappers or translators) that hide the custom interfaces and data formats and provide a standards-based interface to the service

Figure 41: ISO 3-tier Model



11.5.1 Minimal Service Requirements

A generic SDI must be capable of supporting key functions:

- Discovery of components of the SDI (all types)
- Access to prepared portrayals of data (small footprint views of data as prepared by relevant experts)
- Access to data and associated metadata

Other services can be added according to specific needs, but the services listed here provide the basis of the infrastructure. The challenge is to make these services **seamlessly accessible from other SDI implementations** and ensure information interoperability through aggregation based on meta-models**.** For example, a regional SDI should be able to access global data sets and national data sets within the region using the same service profiles.

11.5.2 Service Profiles

Services will generally require a minimal subset of the possible capabilities. The more general the SDI, the smaller the subset of capabilities required will and should be. However, in general there is a need to propagate minimal requirements from broader SDI's to participating specialized SDI's.

There is thus an urgent need to define unambiguous, minimal profiles of key OGC services from a GSDI perspective, or at the very least from global systems such as GEOSS and the UNSDI.

11.5.3 Registry Services

A UNSDI will require one or more Registry services, capable of supporting multiple **Registers**. The governance of these registers demands that mechanisms for management of the content by the SDI participants are provided. This may needs to be achieved at a more accessible level than the OGC catalog service transactional interface.

11.5.4 Tools for Registering Content

The UNSDI must provide tooling to support the registration of content, data standards, best practice etc. within the appropriate registers. Fundamentally, the crucial requirement is that it is simple to re-use existing *metadata* when publishing to the registry. Re-use of schemes for classifying content will promote the sharing of vocabularies between contributors, leading to simpler discovery by users. To achieve this goal, the registration tool must be bound to the registry, enabling many of the metadata fields (or choices of values) to be pre-populated by extracting information from the registry. Furthermore, the registration tooling must provide multilingual support through cultural and linguistic adaptability.

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Part IV

BPEL

GEODRM reference model

GSDI Cookbook

ISO 11179 Information Technology – Metadata Registries

ISO 19100 series (19110, 19115 etc)

ISO 19763 Information Technology – Framework for Metamodel Interoperability

OASIS ebXML Registry Information Model v 3.0

OASIS ebXML Registry profile for Web Services

OGC Reference Model (03-040)

OGC-Australasia: SIDP Notional Architecture

ORCHESTRA Reference Model (RM-OA)

OWS 4 Notional Architecture (many other position papers etc.)

13. Appendices

Appendix 1: SDI coordinating bodies, GIS associations/societies, and mapping organizations known to advocate SDI

Country	Potential national "points of entry" for SDI coordination
Afghanistan	Afghan Geodesy and Cartography Head Office (AGCHO)
Albania	
Algeria	
Andorra	
Angola	
Antigua & Barbuda	
Argentina	Proyecto Sistema de Información Geográfica Nacional de la República Argentina (PROSIGA); Instituto Geografico Militar
Armenia	
Australia	Commonwealth Office of Spatial Data Management (OSDM); Spatial Information Council; PSMA Australia
Austria	Austrian Umbrella Organization for Geographic Information
Azerbaijan	
Bahamas	Bahamas National GIS
Bahrain	Central Informatics Organisation (GIS Directorate)
Bangladesh	Bangladesh Society of Geoinformatics (BSGI)
Barbados	
Belarus	
Belgium	
Belize	Biodiversity & Environmental Resource Data System of Belize (BERDS); Land Information Center (LIC), Ministry of Natural Resources, Environment & Industry
Benin	SIG Environnemental, L'Agence Beninoise pour l'Environnement
Bermuda	Bermuda Government's Geospatial Information Committee (GIC); Bermuda Maps
Bhutan	National GIS Coordination Committee (NGCC); Center for GIS Coordination, Department of Survey and Land Records, Ministry of Agriculture
Bolivia	
Bosnia/Herzegovina	
Botswana	National GIS Coordination Committee; Department of Surveys and Mapping
Brazil	National Commission of Cartography's (CONCAR)/Sub-commission to Spatial Data (SDE); Brazilian Institute for Statistic and Geography-IBGE; National Institute for Space Resources-INPE
British Virgin Islands	British Virgin Islands National GIS
Brunei Darussalam	National LIS Steering Committee
Bulgaria	Bulgarian National Spatial Data Infrastructure (BNSDI);Bulgarian Association for Geospatial Information Systems (BAGIS); Ministry of Regional Development and Public Works
Burkina Faso	Conseil National de Gestion de l'Infrastructure Nationale des Données Spatiales (INDS); Institut Géographique du Burkina (IGB)
Burundi	
Cambodia	GIS Task Force, Ministry of Land Management, Urban Planning and Construction
Cameroon	
Canada	Inter-Agency Committee on Geomatics; Canadian Council on Geomatics (CCOG)
Cape Verde	Environmental Information System Portal of Cape Verde
Cayman Islands	Cayman Islands GIS; Cayman Islands Lands and Survey Department, Ministry of District Administration, Planning, Agriculture and Housing
Central African Republic	
Chad	
Chile	Sistema Nacional de Información Territorial de Chile; Instituto Geográfico Militar (IGM)
China	National Geomatics Center of China

Country	Potential national "points of entry" for SDI coordination
China, Macao	Macao Cartography and Cadastre Bureau
Colombia	Comité de Coordinación Infraestructura Colombiana de Datos Espaciales (ICDE)
Congo	Centre de Recherche Geographique et de Production Cartographique (CERGEC)
Cook Islands	
Costa Rica	Centro Nacional de Alta Tecnología (CeNAT); Instituto Geografico Nacional de Costa Rica (IGN)
Cote d'Ivoire	Centre de Cartographie et de Télédétection
Croatia	Croatian Cartographic Society; State Geodetic Administration
Cuba	Infraestructura de Datos Espaciales de la República de Cuba (IDERC); National Geospatial Portal
Cyprus	National Integrated Land Information System (NILIS); Department of Lands and Survey
Czech Republic	Czech Association for Geoinformation (CAGI)
D. R. of Congo	
Denmark	Geoforum; National Survey and Cadastre Agency
Djibouti	Laboratoire National de Cartographie du Centre d'Etudes et de Recherches de Djibouti (CERD)
Dominican Republic	Concejo Nacional de Asuntos Urbanos (CANAU) (National Council of Urban Concerns) DATAURBANA; SIGpaS (Electronic Health Atlas)
Dominica	
Ecuador	Consejo Nacional de Geoinformática (CONAGE); Instituto Geográfico Militar; Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos
Egypt	Ministry of Communications and Information Technology; Egyptian Geography Network (EGN)
El Salvador	Centro Nacional de Registro; Ministerio de Medio Ambiente y Recursos Naturales - Sistema de Información Ambiental
Equatorial Guinea	
Eritrea	
Estonia	Estonian Public Sector Spatial Data Infrastructure
Ethiopia	Ethiopian SDI Committee (dormant)
Fiji	Fiji Land Information Council; Fiji GIS User Group
Finland	Finnish Association for Geographic Information
France	Conseil National de l'Information Géographique (CNIG); Association Française pour l'Information Géographique
Gambia	
Germany	German Umbrella Organisation for Geoinformation (DDGI)
Ghana	
Greece	Geoinfo-Society for NAGI^2 project; National Geographic Information Infrastructure (NAGI^2), Hellanic Mapping and Cadastral Organization (HEMCO); Hellenic Geographic Information Society (HellasGIS)
Grenada	
Guatemala	Secretaría de Planificación y Programación de la Presidencia (SEGEPLAN); Instituto Geográfico Nacional
Guinea	
Guinea Bissau	
Guyana	National Policy on GIS; NSDI mentioned in ICT4D Guyana National Strategy; Guyana Integrated Natural Resources Information System (GINRIS)
Haiti	
Honduras	Sistema Nacional de Información Ambiental
Hong Kong	Association of Geospatial IT Professionals (AGITpro)
Hungary	Hungarian Association for Geo-Information (HUNAGI)
Iceland	Organisation of Geographical Information in Iceland (LISA)
India	National Spatial Data Committee (NSDC) and Executive Committee (EC); Department of Science and Technology; Survey of India; National Map Policy; Natural Resources Data Management System (NRDMS)
Indonesia	National Coordination Agency for Surveys & Mapping (BAKOSURTANAL)
Iran	National Council of GIS Users (NCGISU) (summary)
Ireland	Irish Organisation for Geographic Information; MOSAIC Programme (Northern Ireland)
Israel	
Italy	Intesa GIS; The Land Agency; Servizi Integrati catastali e Geografici per il Monitoraggio Amministrativo del TERritorio (SIGMA TER); AM/FM GIS Italia

Country	Potential national "points of entry" for SDI coordination
Jamaica	Land Information Council of Jamaica (LICJ); Land Administration and Management Programme
Japan	Committee on the Advancement of Satellite-based Positioning and GIS; NSDI Promoting Association; Geographical Survey Institute (summary); Geographic Information Systems Association of Japan (GISA)
Jordan	Royal Jordanian Geographic Center
Kazakhstan	
Kenya	NSDI Secretariat, Survey of Kenya; NSDI in Kenya
Kiribati	
Korea (North)	
Korea (South)	National Geographic Information Institute (NGII)
Kosovo	Kosovo Cadastral Agency (KCA)
Kuwait	National Committee for Geographic Information Systems; Kuwait Integrated Environmental Information Network (KIEIN-III)
Kyrgyzstan	
Lao P.D.R.	
Latvia	Council of Geodesy and Cartography, State Land Service of Latvia (SLS)
Lebanon	
Lesotho	Committee on Environmental Data Management (CEDAMA); metadata workshop report
Liberia	Liberian Institute for Statistics and Geo-Information Services (LISGIS), Department of Statistics, Ministry of Planning and Economic Affairs
Libya	Advisory Committee to the Chairman of the General Authority for Information (LSDI committee in development)
Liechtenstein	Geodateninfrastruktur (GDI) Liechtenstein
Lithuania	Lithuanian Geographic Information Infrastructure (LGII); National Land Service (NLS)
Luxemburg	Le Groupe de Travail Interministériel – Systèmes d'Information Géographique (GTIM-SIG)
Macedonia	
Madagascar	Association du Réseau des Systèmes d'Information Environnementale (ARSIE)
Malawi	Malawi Geographic Information Council (MAGIC); National Spatial Data Centre
Malaysia	National Committee on Mapping and Geospatial Data; Malaysian Centre for Geospatial Data Infrastructure (MaCGDI)
Maldives	
Mali	National Committee for Geographical Information (CNIG), Malian Geographic Information Centre (CIGMa), Institut Geographique National
Malta	National Mapping Agency, Environmental and Planning Authority (Malta Environment & Planning Authority Map Server)
Mauritania	
Mauritius	
Mexico	Comité Técnico Consultivo de Información Geográfica, Instituto Nacional de Estadística Geografía e Informática (INEGI); Sistemas Nacionales Estadístico y de Información Geográfica (SNEIG); Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT)
Monaco	
Mongolia	Mongolian Society of Photogrammetry and Remote sensing; Administration of Land Affairs, Geodesy and Cartography (ALAGaC)
Monserrat	Montserrat Geographic Information System (GIS) Project
Morocco	Royal Centre for Remote Sensing (CRTS)
Mozambique	National Directorate of Lands (DINAT); Land Information Management System
Myanmar	
Nagaland	Nagaland Geographical Information System (GIS) Centre
Namibia	Inter-ministerial NSDI Committee (dormant)
Nepal	Nepal National Geographic Information Infrastructure Programme
Netherlands	Netherlands Council for Geographic Information; GeoNovum
New Zealand	Land Information New Zealand; Spatial Information Council
Nicaragua	Sistema Nacional de Información Ambiental de Nicaragua (SINIA); Instituto Nicaragüense de Estudios Territoriales (INETER)
Niger	Système d'Information Géographique du Niger (SIGNER)
Nigeria	National Geospatial Data Infrastructure Committee; National Space Research and Development Agency (NASRDA)

Country	Potential national "points of entry" for SDI coordination
Norway	GI Norden
Oman	
Pakistan	National GIS Committee; Pakistan Society of Geographic Information Systems (PSGIS)
Palestine	
Papua New Guinea	Papua New Guinea User Group; National Mapping Bureau
Panama	Secretaría Nacional de Ciencia, Tecnología e Innovación (SENACYT); Sistema Nacional de Información Ambiental; Instituto Geografico Nacional 'Tommy Guardia'
Paraguay	
Peru	Infraestructura de Datos Espaciales del Perú (IDEP); Proyecto SITPeru
Philippines	Inter-Agency Task Force on Geographic Information (IATFGI); National Mapping & Resource Information Agency (NAMRIA)
Poland	National Land Information System Users Association (GISPOL)
Portugal	Sistema Nacional de Informação Geográfica
Qatar	The Center for GIS, State of Qatar
Republic of Moldova	
Romania	National Agency for Cadastre and Land Registration (ANCPI)
Russian Federation	Federal Service of Geodesy and Cartography of Russia; National Committee of Cartographers of the Russian Federation; FCC Zemlya
Rwanda	Centre for Geographic Information Systems and Remote Sensing
Saint Vincent & the Grenadines	
Saudi Arabia	Arriyadh Development Authority; Saudi Geographical Society
Senegal	Groupe Interinstitutionnel de Concertation et de Coordination en Géomatique (GICC); Centre de Suivi Ecologique
Serbia/Montenegro	
Sierra Leone	Sierra Leone Information System (SLIS), Development Assistance Coordination Office (DACO); Encyclopedia
Singapore	Land Data Hub (LDH) - LandNet (Land Information Network Infrastructure) & Integrated Land Information Service (INLIS)
Slovakia	Working Group for GIS (WGGIS); Geoportal, Geodesy, Cartography and Cadastre Authority (GCCA); Slovak Environmental CDS, Ministry of Environment
Slovenia	Surveying and Mapping Authority of the Republic of Slovenia
Somalia	FAO Somalia Water and Land Information Management System (FAO-SWALIM)
Spain	Infraestructura de Datos Espaciales de España (IDEE); Asociación Española de Sistemas de Información Geográfica
Sri Lanka	Geo-Informatics Society of Sri Lanka (GIS-SL) (summary)
South Africa	Committee for Spatial Information; National Spatial Information Framework; National Working Group on Space Science and Technology
Saint Lucia	National GIS Committee, National Emergency Management Oganisation (NEMO)
Sudan	
Suriname	Suriname Ground and Land Information System (GLIS)
Swaziland	NSDI Committee, Surveyor's General Department; Swaziland Association of Geographic Information Systems
Sweden	Geoforum - Swedish Development Council for Geographic Information
Switzerland	Swiss Organization for Geographic Informatiom (SOGI / OSIG)
Syria	General Organization of Remote Sensing
Tajikistan	
Tanzania U. R. of	NSDI Committee, Survey and Mapping Division (SMD), Ministry of Lands; University College of Lands and Architectural Studies (UCLAS), Tanzania GIS Users Group (TZGISUG)
Thailand	Geo-Informatics and Space Technology Development Agency (GISTDA); Royal Thai Survey Department Clearinghouse
Timor Leste	GIS User Group, Directorate of Land and Property / Direcção Nacional de Terras e Propriedades (DNTP)
Tunisia	National Geomatics Program
Turkmenistan	
Togo	

Country	Potential national "points of entry" for SDI coordination
Turkey	General Command of Mapping; NTGIS (national association for GIS)
Tuvalu	
Uganda	Geography Department, Makerere University; NIMES
U.A.E.	Military Survey Department
United Kingdom	Association for Geographic Information (AGI)
Ukraine	Research Institute of Geodesy and Cartography
Uruguay	Work Group on National Cadastre Program and SDI; Clearinghouse Nacional de Datos Geográficos del Uruguay
USA	Federal Geographic Data Committee
Uzbekistan	
Vanuatu	
Venezuela	Instituto Geografico de Venezuela Simon Bolivar
Vietnam	Department of Survey and Mapping, Ministry of Natural Resources and Environment
Yemen	
Zambia	Zambia Forum for Environmental Information and Network Management Systems (EINMS); Zambia Association for Geographic Information Systems (ZAGIS) (dormant)
Zimbabwe	Zimbabwe SDI Steering Committee (dormant); Surveyor General Department

Appendix 2: Summary of goals and proposed actions for UNSDI implementation

UNSDI implementation					
Goals	**Proposed actions**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Policy and organization					
Goal 1: to create a coordinated, consensus-based, and inclusive UNSDI based on strategic/business principles that provides a high level coordination framework for UNGIWG, building upon what has already been achieved. Implicit in the UNSDI development is the need for a decentralized matrix approach, connected through agreed upon, open data exchange standards and interoperability with NSDIs and major regional SDIs.	Establish UNSDI implementation committee				
	Define Letter of Agreement on "rules of engagement"				
	Form Special Interest Groups on strategic/business purpose				
	Classify and document geospatial initiatives in UN				
	Develop a UNSDI Communication Plan				
	Encourage bodies to "brand" actions under UNSDI activities				
	Formalize relevant membership with OGC, ISO, INSPIRE, etc.				
	Convene Workshops for member states and regional organizations.				
People and resources					
Goal 2: to ensure sufficient access for UN organizations to the systems and trained personnel required to take full advantage of available geospatial technologies, data and information in meeting their organizational responsibilities and to maximize their potential contributions to UN reform, the Millennium Development Goals and UN Charter..	Self-assess current capabilities for sharing geospatial info.				
	Investigate opportunities for limited-term, in-service training				
	Document a compendium of "geospatial success stories"				

UNSDI implementation					
Goals	**Proposed actions**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Goal 3: to identify and address external capacity building needs of member countries to accelerate the development of open and interoperable NSDIs in countries presently disadvantaged in this regard	Seek the assistance of UN training resources for capacity building				
	Align capacity building activities with those of partners and member states (Link esp. with Goal 8)				
Goal 4: to ensure adequate funding and partnership agreements are in place that support the sustainable staffing and systems required by agencies and UNGIWG to deliver programs underpinned by, or underpinning, geospatial data generation, documentation, access, and analysis.	Increase awareness and endorsement of UNSDI benefits through CEB				
	Investigate opportunities for securing core funds from the budget pool set aside for ICT in the UN				
	Link capacity building objectives with those of the international donor community				
	Stimulate partners to jointly fund and participate in critical aspects of the UNSDI by "Franchising the logo"				
	Investigate opportunities for shared funding between UNGIWG members.				
	Broker public-private partnerships (PPPs) with 'one face' of UNGIWG				
Geospatial data and information sharing					
***Goal 5*:** to ensure that current, quality assured[20] geospatial data and information can be easily discovered, and are immediately and openly available via the Internet from within a distributed matrix of interoperable data resources resident in UN bodies, regional organizations, national governments, academia, industry, the NGO network and the community at large, in support of the UN MDGs.	Formalize data sharing agreements with int./ext. partners				
	Identify data custodians				
	Formalize agreements with data custodians				
	Encourage adoption of international standards				
	Promote adoption of an open standards-based approach				

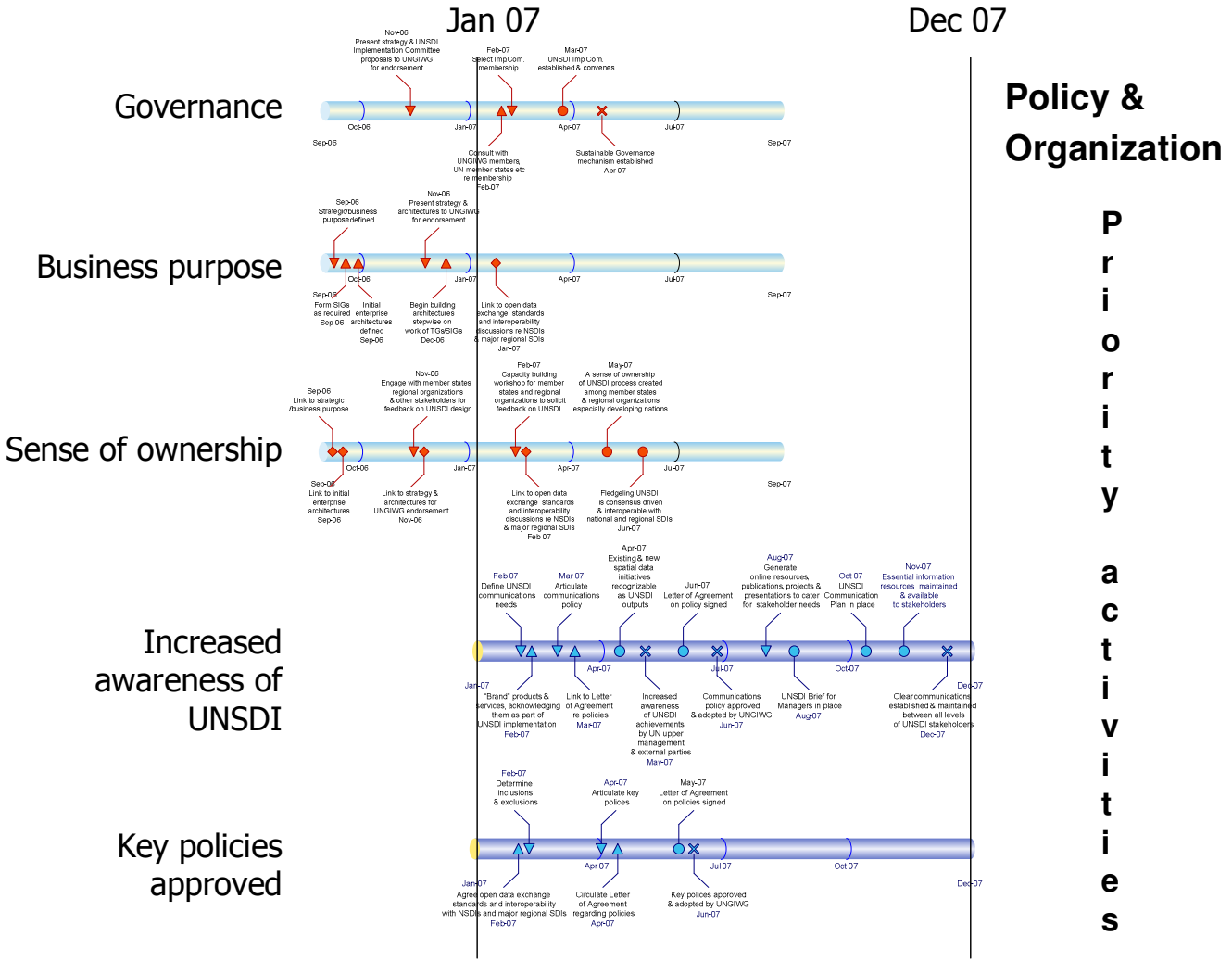
[20] Of verifiable origin, scale, date, accuracy etc

UNSDI implementation					
Goals	**Proposed actions**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Goal 5: Continued from previous page.	Continue to identify, acquire and refine core datasets				
	Negotiate with member states to establish open access to framework datasets.				
	Develop and promote policies for consistent collection of metadata				
	Designate responsibility for the creation and maintenance of metadata				
	Work toward a UN spatial data catalogue				
	Investigate and implement geospatial data visualization tools				
	Establish a Special Interest Group to identify legacy datasets of importance to the wider audience				
	Encourage geo-coding of statistical data during primary data collection				
	Give consideration to long-term preservation of critical geospatial data archives				
Technology					
Goal 6: to build a UN Spatial Data Infrastructure framework around a shared enterprise architecture and technology infrastructure that is vendor-neutral, modular, and uses OpenGIS standards and Web Services. The framework should provide interoperable, open and cost-effective data and information services to users inside and outside the UN, with users linked via the Internet using conventional communications channels.	Understand the breadth of geo-processing systems and technology				
	Convene a Special Interest Group to scope out the architecture and technology requirements				
	Encourage adoption and use of related S.I.G recommendations				
	Continue to develop UNSDI-related technology initiatives				

UNSDI implementation					
Goals	**Proposed actions**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Linkages and partnerships					
Goal 7: to ensure that adequate communication, advocacy, and outreach regarding the UNSDI are extended to all UNGIWG members, member states, regional organizations, partners and the wider community of geospatial data custodians, suitably raising their awareness concerning the UNSDI and encouraging their full participation.	Increase awareness among national and regional organizations concerning the needs and benefits of the UNSDI.				
	Stimulate the sharing of expertise and experience of and between member states regarding NSDIs and their integration with the UNSDI				
	Continue to engage in a dialogue with those implementing national and regional SDIs				
	Utilize the support of UNGIWG members with offices "resident" in developing regions and countries to extend communications and information exchange.				
Goal 8: to significantly raise capacities of least developed countries to implement and sustain open and interoperable NSDIs that are compatible with the overall design and development of the UNSDI.	Strengthen SDI capacities in developing nations and regional organizations				
	Incorporate responsible business plans and risk management strategies into all NSDI capacity building projects				
	Encourage donor funding of NSDI capacity building projects contingent upon data sharing agreements (see Goal 5)				
	Offer or generate in league with donors and partners, training possibilities for member states				

UNSDI implementation					
Goals	**Proposed actions**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Goal 9: to ensure currency of UNSDI information infrastructure and the policies, organization, technology and resources that underlies it in the light of ongoing international advances and refinement of SDIs.	Engage continuously with international partners working in SDI-related fields such as the OGC, ISO and other strategic partners.				
Goal 10*:* to sustain and deepen involvement of those contributing and critical to the UNSDI such as identified strategic partnership organizations	Maintain and strengthen existing strategic partnerships such as those with the GISD, GIST, OGC, ISO etc.				
	Foster and support global, regional and country level partnerships including linkages between and among civil society, private sector, philanthropy, media, and academia.				
	Support UN agencies, regional organizations, and governments in developing partnerships with non-state entities.				
	Engage the broadest range of potential sectors/actors as is practicable				
Monitoring and evaluation					
Goal 11: to establish credible levels of UNSDI accountability, through regular monitoring of enterprise performance and the reporting of outcomes to the UNSDI constituency.	Utilize UN programme evaluation and audit systems to regularly monitor UNSDI performance				
	Adapt IT tools and methodologies for performance monitoring and reporting				

Annex 3: An example of the collective task inputs and timelines for Priority Tasks concerning Policy and Organization



Annex 4: List of main acronyms and abbreviations

AGEDI	Abu-Dhabi Global Environmental Data Initiative
AGILE	Association of Geographic Information Laboratories for Europe
ANZLIC	The Australian and New Zealand Land Information Council
ASDI	The Australian Spatial Data Infrastructure
CEB	UN Chief Executive Board
CGDI	Canadian Geospatial Data Infrastructure
CGIAR	Consultative Group on International Agricultural Research
DPKO	UN Department of Peacekeeping Operations
ECOSOC	United Nations Economic and Social Council
ESA	European Space Agency
ESIP	Federation of Earth Science Information Partners
ESRI	Environmental Systems Research Institute
EUROGI	Euro-Geographical and European Umbrella Organization for Geographic Information
FAO	Food and Agriculture Organization of the UN
FGDC	US Federal Geographic Data Committee
G3OS	The three Global Observing Systems
GCIRC	Global Change Information and Research Centre
GCOS	Global Climate Observing System
GEOSS	Global Earth Observation System of Systems
GILA	Geographic Information in Latin America
GIS	Geographical Information System
GISD	Geographic Information for Sustainable Development
GIST	Geographic Information Support Team
GMES	Global Monitoring for Environment and Security
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GSDI	Global Spatial Data Infrastructure
GTOS	Global Terrestrial Observing System
HIC	Humanitarian Information Centere
HMA	Heterogeneous Missions Accessibility
HQ	Headquarters
ICIMOD	International Center for Integrated Mountain Development
ICT	Information and computer technology
IMF	International Monetary Fund
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
ISCGM	International Steering Committee for Global Mapping
ISO	International Organization for Standardization
ITC	International Institute for Geo-Information Science and Earth Observation
MDGs	Millennium Development Goals
NATO	North Atlantic Treaty Organization
NCGIA	National Center for Geographic Information and Analysis
NCOs	National Coordination Offices
NGO	Non Governmental Organization
NMA	National Mapping Agencies

NSDI	National Spatial Data Infrastructure
OASIS	Open Advanced System for Improved Crisis Managemen
OECD	Organisation for Economic Co-operation and Development
OGC	Open Geospatial Consortium
ORCHESTRA	Open Architecture and SDI for Risk Management
PPPs	Public-private partnerships
RCMRD	Regional Centre for Mapping of Resources for Development
RECTAS	Regional Centre for Training in Aerospace Surveys
RM-ODP	Reference Model of Open Distributed Processing
RSDI	Regional Spatial Data Infrastructure
SALB	UN Second Administrative Level Boundaries dataset
SCAR-CAGI	Antarctica & Arctic - SCAR Committee on Antarctic Geographic Information
SDI	Spatial Data Infrastructure
SG	United Nations Secretary General
UCGIS	University Consortium for Geographic Information Science
UN	United Nations
UNCS	United Nations Cartographic Section
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGISP	United Nations Geographic Information Strategic Plan
UNGIWG	United Nations Geographic Information Working Group
UNHCR	Office of the United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNITAR	United Nations Institute for Training and Research
UNJLC	United Nations Joint Logistics Centre
UNOCHA	United Nations Office for Coordination of Humanitarian Affairs
UNOOSA	United Nations Office for Outer Space Affairs
UNOPS	United Nations Office for Project Services
UNOSAT	The operational programme of UNITAR for satellite applications
UNSDI	United Nations Spatial Data Infrastructure
VHR	Very High Resolution Imagery
W3C	World Wide Web Consortium
WB	The World Bank
WDC	World Data Center system
WFP	World Food Programme
WHO	World Health Organization
WIN	Wide Information Network for Risk Management
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development