

Mandate for Digital Earth Geobrowsers: Status and Recommendations

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Objective of the Document

Establish consensus on the user requirements for functionality of three-dimensional Geobrowsers as part of a necessary framework for sustaining the vision of a Digital Earth. We envisage the implementation and evolution of 3-D Geobrowsers to be accomplished through the adoption and implementation of open-systems based web-enabled tools and infrastructure to support the concept of a democratic and digital world community.

Executive Summary

New technologies for instrumentation and methodologies for handling spatial data have significantly enhanced human's perspectives towards and capabilities for studying the Earth's systems and dealing with the challenges for sustainable development. Scientists and technically proficient stakeholders have begun to harness requisite baseline information and are in the process of identifying and agreeing on data quality standards for indicators at multiple scales using decade's worth of planetary remote sensing and related geospatial and environmental data. These data are urgently needed to identify and then prioritize areas where humankind's ecological footprint has impoverished life sustaining ecological services.

While scientists must continue to lead the research and integration of complex spatial, temporal environmental variables that transcend multiple scales, a platform is imminently needed to make resulting scientific data, models, and conclusions accessible to the public and to policy making fora. It has become evident from the recent global fora, such as, the World Summit for Sustainable Development that business, citizens, and NGOs are the legitimate actors for effecting actions towards

sustainable development in conjunction with government partnerships. Such a universally information utility platform must be attractive, intuitive, and provide a common spatial reference for all citizens of the planet. This platform was first articulated in the Digital Earth Vision (Gore, 1998).

The increasing rate and expansive growth of the human ecological footprint and the interdependencies of this footprint for human health and welfare demands an improvement in the methods for connecting and integrating all manner of information about society and the environment. Myriad Internet-accessible options exist for news, community communications, and investigative tools or presentations. What is pointedly required for the next phase of the Internet's service to humanity, however, is the focus upon getting spatially enabled data into the hands of millions of citizens, NGOs, businesses, and governments, without the technical sophistication associated with scientists, engineers, and technicians. At the same time, scientists and engineers need advancements in the platforms for framing critical questions and forming hypotheses. To satisfy both of these communities' needs, that of science and society, will require a significant improvement in the design and performance of user-interface tools.

A number of development efforts in the past couple of years have demonstrated the potential of utilizing three-dimensional graphic user interfaces (GUIs) to display an interactive Earth as a primary contextual information interface. An international coalition of experts has agreed to document the set of universal functional user requirements needed to harmonize the performance of what is referred to herein as digital Earth geographic browsers, or more simply geobrowsers. These geobrowsers are needed to provide a consistent approach for the access and display of the Earth's data in all domains of knowledge and science.

At present, a number of 3-D geobrowsers have evolved independently and therefore currently remain incompatible, albeit, some are beginning to incorporate open-system architectures. And therefore, the performance is limited to specific domains of data, either preconditioned in proprietary formats or available through specialized information networks. These early geobrowsers have generated considerable interest in diverse communities and portends significant expansion of the market for visualized data and information. Geobrowsers are no longer on the drawing board. At least a dozen mature systems have been identified along with their marketing expansion into international government agencies, news media, entertainment, real estate, and environmental sectors. This fact

combined with their stated importance for human affairs and goals of sustainability provide a clear and present mandate for defining and promoting digital Earth geobrowsers.

The International Society for Digital Earth (ISDE) is an appropriate mechanism for reaching consensus on the mandate for geobrowsers. The commercial sector of information technology is key to both development and implementation of the mandate. The NGO sector is key to garnering grass roots and broad based applications of geobrowsers throughout the world. Research laboratories, universities, government agencies, and industry are critical to building both content and new tools to address the challenges identified by the increasing awareness of social, environmental, and economic conditions of the planet.

The essence of this mandate for geobrowsers remains with improving the viability of digital Earth by promoting coherent development of functional specifications for interoperability and harmonized functionality among 3D geobrowsers and the underlying geospatial data sets. There is a potential opportunity to align these independent efforts, accelerate solutions, and promote new advances to realize the Digital Earth Vision.

Introduction

Sustainable development has been paramount in the minds and indeed the actions of many, since the arrival of this concept on the world stage in the 1980s (WCED, 1987). Awareness regarding the interconnected dimensions of the term was further articulated at the 1992 UN Conference on Environment and Development in Rio de Janeiro, Brazil. An increasing literature regarding social, economic, and environmental conditions and trends was highlighted at the recent gathering of world leaders and activists in Johannesburg, South Africa, at the World Summit on Sustainable Development. Notwithstanding many advances, a deep understanding of the meaning, challenges, and most importantly, the solutions to this issue remains an elusive target for most regions, nations, and communities faced with ever increasing pressures from population growth, environmental decline, and social unrest and poverty. Sustainable development, in spite of the ambiguities that exists in definitions, provides the only commonly held conceptual compass heading for a growing international mass of dedicated scientists, citizens, and governments who share a belief for improving the world we live in.

Limits to human growth on the planet are pitted against a dependence upon finite resources of land, air, and water and the ecological services (Millennium Ecosystem Assessment, 2001). At the mid point of the 20th Century, Buckminster Fuller used the metaphor of Spaceship Earth to portray an eloquent picture of our self-contained life-support system. This metaphor also reminds us of the infinite resources available for energy from the sun and the limitless resource for ideas for our survival from each other through imagination and scientific communications (Sieden, 1989). Modern perspectives on the immediacy for our survival concerns began with studies of resource projections against population growth curves (Club of Rome, 1972); a refinement of Malthusian projections. While critics dismissed these projections as pessimistic statistics, perhaps ignoring the reality of suffering for billions of humans, readily accessible alternative sources of credible information was lacking. Authoritative and valid information and perspectives have not been made easily available, while they serve a critical role in fostering effective action for amelioration and change.

The spectacular Apollo photography of Earthrise provided an inspiring Earth-centric image for a new generation to appreciate the fragility of our biosphere. The introduction of satellite data into scientific toolboxes has advanced the capacity to map, monitor, and manage our planet's resources (Foresman, 1998). These advances have improved environmental assessment reports. For example, the recent UN report prepared for the 2002 World Summit on the conditions and trends for the world's environmental was based on significant geospatial data input. However, this information only reached a limited international audience and was barely mentioned in the international press, much less acted upon for policy changes by governments (UNEP, 2002). The essence of our challenge as scientists and world citizens therefore, relates to coupling human and natural systems and the complex web of relationships and feedbacks at diverse temporal and spatial scales in formulating actions for sustainable development.

Herein, we follow the hypothesis that the technological frontiers of geo-information and visualization are poised along interdisciplinary research and educational frameworks to advance the fundamental knowledge necessary to enhance humankind's mobilization for action towards sustainable development. The National Science Foundation noted that the expanded horizons of what we can study and understand about the Earth have created demand for collaborative teams of engineers and natural and social scientist (NSF, 2003). This demand further requires methods to foster interdisciplinary development for complex synthesis of environmental, social, and economic dimensions.

We further posit that the harmonization of current development activities for 3-D geobrowsers represents a round table for addressing and demonstrably advancing the litany of integration and interoperability issues previously listed. The alignment of functions among 3-D geobrowsers will not arrive at a pace commensurate with the international network's needs unless collaborative research and development efforts are promoted among private, academic, and government agencies. The ISDE is promoting the cooperation and actions among these communities and actors to foster the development of concurrent and parallel efforts as a means to coalesce the performance characteristics of geobrowsers. This in turn, is expected to act as a universal set of guidelines under common and open standards to accelerate the development of geobrowsers that meet the functional requirements of the user community. This document sets the initial phase for the beginning of this trajectory for voluntarily accepting common protocols based on a consensus and common purpose.

Background

In 1998, Vice President Al Gore communicated a vision for the future where a child could sit before a virtual representation of the Earth, a three-dimensional digital Earth, and query this advanced information utility about the planet and its resources or about issues related to humans, their history, and any other question that could be poised regarding science, art, and the humanities. This vision launched a national and international Digital Earth movement by capturing an effective metaphor that both scientists and non-scientists could embrace. A disparate community of citizens could express their concerns for the planet's future, along with scientists, industry, and government, to coalesce the Digital Earth community with a common target for promoting the cooperative use of information technology. Three-dimensional Earth-based GUIs were recognized with special interest by this community as development targets to encourage the cooperative study of, and directed actions for, the solutions towards sustainable development.

In the US, Digital Earth oriented activities were cooperatively defined by an interagency working group led by NASA. The Interagency Digital Earth Working Group (IDEWG) was the first organized effort to collectively address the visionary challenges of the Vice President. Components for 3-D Earth GUIs were divided by this group into various technological sectors to stimulate cooperative development support. While initially limited to government personnel, industry and academia were soon attending workshops to discuss different topics such as, visualization, information fusion,

standards and interoperability, advanced computational algorithms, et cetera. In March of 2000, industry representatives showcased for the IDEWG over a dozen enterprising technologies which demonstrated promising 3-D visualization prototypes. Within two years, these prototypes were captivating international audiences in government, business, science, and mass media who began to purchase the early commercial geobrowsers.

Following the Digital Earth Vision expressed by Al Gore, the United Nations Environment Programme (UNEP) realized the need to enhance decision-makers access to information for the likes of Koffi Annan and the security council. UNEP promoted use of Web-based geospatial technologies with the ability to access the world's environmental information, in association with economic and social policy issues. The design of UNEP's data and information resources reorganization was initiated in 2001 based on the GSDI/DE architecture, that is, a network of distributed and interoperable databases creating a framework of linked servers. The design concept was based upon using a growing network of internet mapping software and database content with advanced capabilities to link GIS tools and applications. UNEP.Net, launched in February 2001, provided UN staff with an unparalleled facility for accessing authoritative environmental data resources. However, a universal user interface for UNEP.net, suitable for members of Security Council, that is non-scientists, did not exist. UNEP began actively testing prototypes for a UNEP.Net geobrowser beginning in mid-2001 with a showcase for the African community displayed at the 5th African GIS Conference in Nairobi, Kenya November 2001, Figure 1a. A concerted effort within the UN community (via the UN Geographic Information Working Group) followed, including purchase of early system versions by 2002. UNEP provide further industry demonstrations for the World Summit on Sustainable Development in September, 2002 at Johannesburg, South Africa, Figure 1b. Recommendations for creating a document on the Functional User Requirements for geobrowsers resulted from the 3rd UNGIWG Meeting, June 2002, Washington, D.C. This proposal was communicated to the ISDE Secretariat and the organizing committee for the 3rd International Symposium for Digital Earth and agreement made by the Chinese Academy of Sciences sponsored Secretariat to host the first of the geobrowser meetings.

International collaboration for the Digital Earth concept has been led by the Chinese Academy of Sciences' Institute for Remote Sensing Applications, who sponsored and hosted at Beijing the 1st International Digital Earth Symposium in November 1999. The Chinese continue to sponsor international symposia and projects, in cooperation with a growing community of international agencies and NGOs addressing the imminent challenges for economic, social, and environmental well-

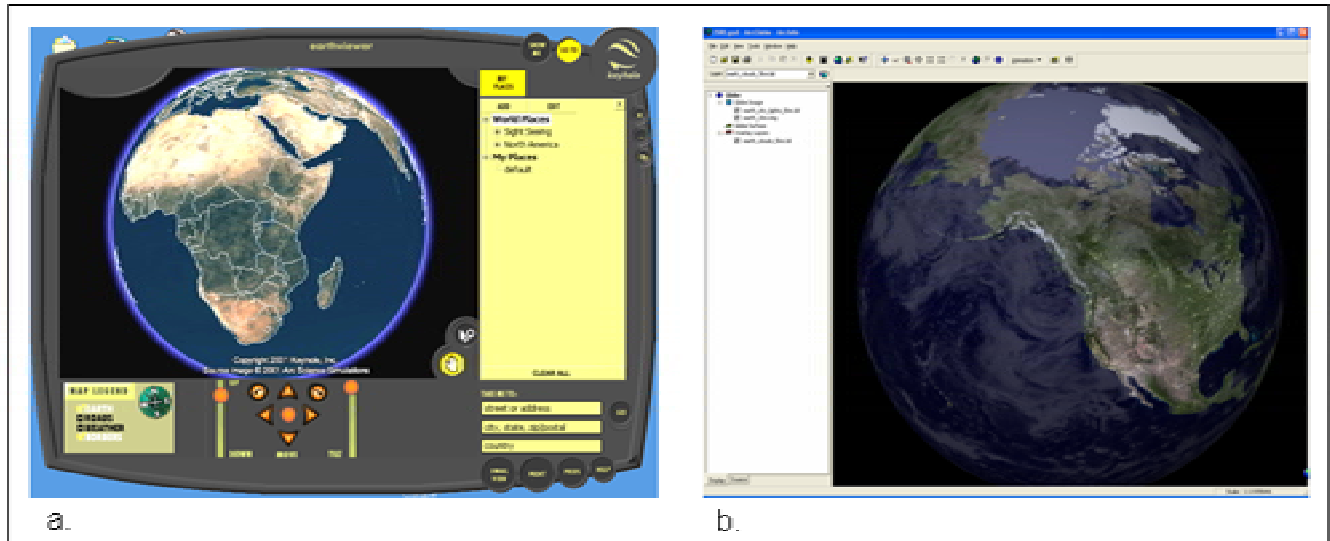


Figure 1. a. Earthviewer geobrowser (courtesy of Keyhole Inc.) b. ArcGlobe geobrowser (courtesy of ESRI)

being. Inclusion of Digital Earth (DE) technology in the Chinese government's 5-year plan attests to the influence of the Digital Earth Vision at the global scale. Today, a network of agencies and citizens is harmonizing efforts to capture the prowess of DE technology for sustainable development. A host of DE workshops are being conducted throughout Asia on a continuing basis. The formation of the International Society for Digital Earth (ISDE) was proposed and initiated by the Chinese Academy of Sciences to create a non-profit entity to act as Secretariat for this growing DE community.

In December 2002, the 1st International Digital Earth Workshop (IDEW) was hosted by the nascent ISDE secretariat to review the status of visualization and geobrowser technological advances. An impressive array of technologies and programs were highlighted at the workshop covering a range of applications including geomorphology and risk hazards, genesis and global transport of dust, epidemiology and human health, biodiversity and ecosystem assessments, and municipality design and management (ISDE, 2003). This mandate document was commissioned by the workshop experts to catalyze cooperation for defining functional user requirement of geobrowsers and promote widespread understanding of the universal need for accelerated and collaborative development efforts. Cooperation will be needed to more effectively and rapidly realize the implementation of operational systems among international and national agencies and various stakeholder communities addressing the goals for sustainable development.

Assumptions

Addressing population growth is critical to managing the Earth's resources. Equally critical is educating the populace regarding complex environmental systems that provide the basic ecological services for life on the planet. All citizens should become familiar with the fundamental knowledge regarding the dynamic transactions between and within the ecological, social, and economic domains that must be addressed in order to ensure a sustainable world. As discussed during the 3rd National Conference on Science, Policy and the Environment, titled "Education for a Sustainable and Secure Future," the inadequacies of current education systems are entrenched in an old world view, when it has been recognized by many that the state of the world demands that we think systematically about our affect on living ecosystems and the consequences of our actions. This theme was convincingly posited by Dave Orr in the landmark book, "Earth in Mind" (1994). It is this challenge that has precipitated the National Science Foundation's Advisory Committee on Environmental Science and Education (AC-ESE) to develop a plan that challenges multiple sectors to engage each other towards fulfilling this need. Both formal and informal education and the tools that enable cross cutting semantic thinking about our complex world that is available and seemingly transparent to the public are essential elements to consider. In this sense, the basic level of geobrowsers that are to be available to the public would be affordable and provocative in a manner that provides an attractive interface between the information content already available on the Internet and general users. Much more than the mere entertainment value, however, is the Earth system context that is explicitly positioned for these interface tools. It is assumed that a web geobrowser could be an enabler of this sentiment for a significant portion of the populace (those connected and the many more connecting to the Internet).

It is important to consider that the evolving nature of information communication technologies (ICT) are and will continue to respond to market demands. However, the combination of 1) the needs for developing a greater collective sense of the human footprint on the Earth and 2) the potential benefits through the saturation of geobrowsers in the marketplace (from scientific to the general) demonstrates our desire to accelerate, through multi-stakeholder partnerships, the development and sustained use of geobrowsers. Already, geobrowsers are spawning incredible interest in those communities exposed to the early prototype systems, Figure 1. Furthermore, there appears to be enough diversity in the potential use of geobrowsers to suggest a need for a range of specialized capabilities. For example, within geobrowsers (through extensions or other means of scaling

functionality) differing levels of functional user requirements will need to be satisfied ranging from highly analytical tools for scientists to simple query and display for the general populace's use. In this sense, a diversity of needs could spawn the demand for products that could sustain industry research and development leading to the availability of commercial off the shelf (COTS) geobrowser applications for the range of requirements with a diverse user community.

No concise definition/description of a geobrowser whether it be a 2D or 2.5D/3D

In this document, the term "geobrowsers" refers to a robust class of software that operates around a 2.5D/3D representation of the Earth. In this context, and in the current state of the evolution of geospatial technologies, such a class of software represents the synthesis of the full range of traditional GIS architectures ranging from data management; tools; and user interfaces (Longley, *et al.*, 2001) while providing the same set of query functions already available from traditional web browsers. In fact, Geobrowsers are the next step in the evolution of GIS from which they are able to integrate and leverage both GIS networks/spatial data infrastructures (SDIs) and the plethora of traditional World Wide Web resources in ways that are consistent with a geocentric, whole-Earth-based perspective. In this way, geobrowsers ought to be able to integrate resources typically requested through the combination of Internet browsers (e.g. Microsoft's Internet Explorer, Netscape's Navigator, and Apple's Safari) and online search engines (e.g., Google, Excite, AltaVista, Northern Light) while also able to perform a basic set of GIS functions for display, query, and response. Ultimately, geobrowsers can be thought of as web 'geobrowsers' that are capable of providing a marriage between the functions of traditional web browsers and basic view, query, and analysis functions found within GIS software.

The information and communication technologies that are enabling the development of geobrowsers can be classified into a number of different components. These include operating systems, hardware platforms, network protocols (e.g., TCP/IP), Internet client standards (HTML/XML), 3-D technologies (OpenGL), sphere tessellations (data structures), Internet infrastructure/bandwidth, etc. At the intersection of these and related ICT developments lies a domain that provokes the serious consideration on the development for web-based geobrowsers. First and foremost, is the fact that it is exceedingly difficult to argue that information/data exists that is not in one way or another related both spatially and temporally. Thus, anything that is searchable through WWW search engines could be linked geographically to someplace at sometime on the Earth. Moreover, the rapidly increasing number of spatially based data sets available from increasing volumes of satellite data of the Earth's surface and through GIS technologies such as web map servers

and geographic web services is rapidly building an Earth-based contextual framework. The combination of technologies would allow anyone to explore and discover a universe of information about a place or phenomenon in a manner that is highly intuitive-facilitating a Earth-centric view of the systems interconnectedness of the human condition.

IT Standards for Interoperability:

We are, arguably, at a crossroads in the future development of geospatial technologies. With IT standards in place, protocols such as HTML, XML, ZOPE, and SOAP effectively minimize previous barriers to interoperability between data formats. As server-side processing continues to grow again, the exchange of information through the Internet using web services via accessing, Universal Discovery and Description Integration (UDDI) services and clients capable of ingesting the XML speak that servers provide, opens doors previously not possible. Consequently, interoperability becomes evermore possible, as XML is the epitome of an open protocol allowing servers to wrap data in such a manner that doesn't impede any particular vendors domain for competing against each other to provide function and performance of their particular markets.

User Considerations

It has become our considered opinion that solutions to satisfy multiple stakeholders must assume increased awareness of Earth and human-ecosystems as exemplified in the Earth Chart, first and foremost to promote consideration and understanding of interconnectedness at all scales. David Orr postulated that the leadership for balanced, ecological sound practices must be institutionalized in all higher education and systems development. With the advent of the Internet and subsequent web browsers has come an immediate faculty for anyone, virtually anywhere, to spontaneously explore the world of accessible information through a collection of increasingly verbose sets of information links and documents about the world in which we live. This ability to explore, an arguably inherent trait in the human species, has led to an increase in a fundamental, subconscious, and innate understanding of the connectedness of a globalized planet. To enable a more natural, Earth-centric, understanding of these relationships would be to "geo-enable" the Internet. Concepts such as "geo-Google"; where the user sees the World Wide Web through an Earth-based browser or geobrowser. Such geobrowsers can allow for basic WWW searches or more complex interactions though the display, and at least, basic GIS query capabilities.

The progression evident in the human-interface for information began with the advent of the Internet (from the ARPANET origins), to the Web browsers in the last decade. The human information interactions witness a surge in 2.5-D and 3-D software solutions by the end of the decade, leading to the current set of Web-based technologies establishing market positions on a global scale. This progression is summarized as follows:

Stages of Human Information Interactions

1. Internet 1969>
2. Browsers 1994>
3. Geobrowsers 1999>
4. Web Geobrowsers 2001>

Design Considerations

Ultimately there exist a number of design elements that the geobrowser class of applications should have in common, which express a consistent basic set of cross-vendor functions that are as intuitive as using any current geographic viewer/search engines in response to user needs. This will inevitably lead to some need for familiarizing oneself with the operation of the current suite of geobrowsers but common functions such as zooming, panning, navigating, place locations (gazetteer) should all be registered as fundamental to any geobrowser.

The operation of a geobrowser ought to take into consideration the ease from which one uses a standard physical globe. Abilities to navigate around the earth with virtual hands to be able to zoom into a particular location through virtual manipulation or through a textural search can provide the user with a greater ability to explore the planet. Linking these tools with textural based links (via HTML) allow for one to project there content of interest through the geobrowser transparently conveying the geographical linkages between any particular subject of interest. Additional considerations could include filtering abilities, to be able to provide a user the ability to choose areas more or less related to one particular topic of interest. For example, limiting a geo-based www search to sites related directly to the connections between biodiversity and cultural history of a local indigenous population within the lower Amazon basin. Such a search can lead to a better understanding of the historical trajectories between a given culture and the impacts globalization has on their populations and their local ecologies. Coincident searches between topical areas and their respective spatial/temporal delineations also communicate through disciplines and across scales providing a real look into the transcending

effects between circulating local - global – local circulation patterns. Additionally, the need to filter based on credible and authoritative sources of data and information is paramount for scientific and decision support purposes.

Future Considerations

The linkages between a geobrowser leveraging both the non-spatial entities available, already, on the Internet and the increasing amount of geospatial information will have real impacts on a large portion of our society understanding the fundamental principles outlined in “Our Common Future” (WCED, 1987). Such future considerations may lead to providing heightened level of hypothesis generating ability for finding solutions to these complex relationships.

State of Knowledge Survey Plans

A coterie of geobrowser enthusiasts were hosted by the Chinese Academy of Sciences for the first geobrowser workshop at the Institute for Remote Sensing Application in Beijing, 11-15 December 2002. The purpose of this workshop was to begin defining the functional user requirements for universal geobrowsers. The development of a robust survey that encompasses all aspects of the operation of geobrowsers is required for the purpose of identifying critical elements that need to be developed or fine-tuned. International representatives from Japan, China, Russia, and the US reviewed the current status of geobrowser technologies and addressed the initial steps in defining the fundamental components. Preliminary results provided the following taxonomy of the major characteristics for the geobrowser environments (See Appendix).

Platform/Server Hardware – the hardware requirements for the server side software operating in conjunction with processors, memory, and other systems components.

Operating System – the operating systems that the software must run on.

3-D Rendering – the methods and algorithms applied to the graphic presentation of three-dimensional objects determining the performance and hence functional limits.

Tessellation – the method used to enable dynamic, local to global, seamless display of framework data.

Client/Server – the architectural strategy for hardware and operating systems performance across a network.

Data Type – the capacity to handle different types of and formatted data.

Volumetric Rendering – the methods and flexibility for addressing three-dimensional displays and models for volumetric applications.

Time Series – the strategy and algorithms for integrating time series data link to the viewers domain.

Internet – the performance characteristics for operating on multiple and distributed databases.

Client Hardware – the assumptions for the user’s system.

Multi-Layer Capability – the methods for handling multiple layers of raster and vector data formats with flexibility for transparency and defining display priorities.

GIS Identification – the identification of appropriate and priority databases with all associated attributes.

Entity Selection – the ability to address any entity identified and manage the use of the entity for additional operations, such as query, search, access, and download.

Multiple Connections –the ability to link simultaneously with distributed data resources.

Data Compression – the methods applied to manage data compression in accordance with web standards.

How will we implement this?

Identifying the components for implementing an adequate survey of the required components for enabling the use of geobrowsers in as wide a deployment as possible was initially established during the first geobrowser meeting noted above. The next stages for the survey must extend the survey to include current limitations. This must be conducted through a consortium of multiple stakeholders representing industry, government, NGO, and international organizations, to allow for a diverse approach to defining the development of geobrowser applications.

Discussion of methods formation [meetings]

A series of meetings will be conducted to further refine and take forward, with emphasis on industry, as the developers and implementers of the technologies into the public at large. Emphasis should be placed on the development of Commercial off the shelf (COTS) software development to leverage the sector with commercial grade stability, reliability, and sustaining support for geobrowsers.

This should include representatives from the following already identified technological components involved in the geobrowser concept:

[Rank list below by development timetable]

Internet Service Providers (ISPs)

- AOL
- Microsoft
- Earthlink
- Cable companies
- DSL Companies (E.G. Verizon;

Networking Hardware (ROUTERS/SWITCHES/ETHERNET/DSL/CABLE)

- Cisco
- IBM
- Siemens
- Intel
- 3Com

Video:

- NVIDIA
- ATI

Operating System

- UNIX - SUN, IBM, HP, FreeBSD
- Windows
- LINUX

Programing language

Windows.NET
J2EE

Software:

Search Engine companies
Google; Excite; Northern Light; ManyOne

3D rendering
SGI-OpenGL
Java

Database
IBM
Microsoft
Oracle

Webservers
Microsoft
Apache Group
IBM (Websphere)
Iplanet

Servlet Engines
Apache Group (Jakarta-Tomcat)
NewAtlanta (ServletExec)

Implementation and Results

Discovery of current or potential standards research needs to be included

Proposed Recommendations

The development of geobrowsers ought to represent full buy in from every sector to ensure adequate consideration from a diversity of perspectives. In this way, the consultative process is identified as a common need and developed as a common resource to meet that need. The process forward in the development of geobrowsers should be tiered to gradually engage each of ICT industry sectors that has a role to play commensurate with their involvement. Given the leading role the geospatial community and their pre-existing involvement with computer technology industries, we recommend that the early meetings engage the geospatial community and industry first with support from a sampling of NGOs, governments, international organizations, and universities.

Making but not imposing

The absolute necessity of private sector support for this initiative cannot be understated. The private sector ensures, through the process of supply and demand the quality, efficiency, and the sustained creation and maintenance for the marketing of geobrowsers. However, the success of the development of geobrowsers depends greatly on a shared, generalized reciprocity between all the stakeholders that provides each a feeling of being critical to the whole while not feeling a burden. This is essential, while complicated, and ought to include shared industry, university, government, NGO, and international organization resources in such a way to generate the synergy required for the effort akin to the UN's Type 2 Partnerships. It is the private sector that will spur healthy competition within their sector while the whole benefit from the facilitation of their own respective niches. Governments alone and through international organizations will spur the development process while industry and university will respond with research and development efforts. NGOs involvement will range in a plethora of roles including guidance, status reports, assessments and research.

Rephrase to emphasize an important role of each stakeholder while giving special attention to the private sector for the concerted development of geobrowsers. Opportunities for industry to invest in their corporate responsibilities while demonstrating the possibility of sustaining a healthy evolving industry at the same time.

Include graphic

**[ISDE provides organizing structure and leadership]
Specifications for common geobrowser will emerge**

Future Plans and Development Scenarios (tbd)

The ISDE web site in cooperation with an increasing network of international nodes, representing a distributed secretariat, will maintain regular updates on the standards and progress of technology and program development related to geobrowser. ISDE network will provide for communication and coordination among the interest parties fostering the DE vision and various activities around the globe. This international collaboration can be expected to advance the realization of universal geobrowsers through the active participation of myriad enthusiast(s) for designing, and applying technologies geared toward solving the dilemmas that are encircling sustainable development.

Education and outreach activities from ISDE will be organized through the major media and education communities. Connections through existing networks will facilitate the leverage required to accomplish the rapid expansion of users as the capabilities of geobrowser improves.

Acknowledgement of the commercial sector's contributions to the DE and geobrowser targets is foremost in balancing the realities of free-market enterprise with the aspirations for sustainability

development and improving the human conditions for all people. The ISDE community's contributions for reside in communication, cooperation, and collaboration in defining the ideals of how a global information system should perform. ISDE can further contribute by fostering new generations of college graduates and individuals to direct their energies and career paths along with hundreds of thousand like-minded and dedicated individuals and organizations. Allowing for increased recognition that individuals do make the fundamental difference in villages, neighborhoods, and communities can be part of the enabling power of fully functional geobrowsers. Resources and recognition are known ingredients for making change in peoples lives at the local levels, which provide the cumulative impacts for improvements at regional and global scales. While these noble concepts have been well presented at international summits and efforts such as the Earth Charter, the implementation via the technological enablers has no better champion that the diverse group of visionaries and developers of Digital Earth. It becomes incumbent upon the ISDE community and geobrowser working group to engender cooperative and shared ownership of all aspects regarding this initiative through a progressive campaign to:

- highlight successes in use of information of sustainable development activities
- foster increased applications using geobrowser technology for multiple discipline research and development
- generate sponsors and scholarship support for academic and individual case studies
- provide for international recognition and awards for best practices

Rapid success in numerous disciplines and communities is needed to address the many compelling issues challenging the international communities and people of this planet. While not envisioned as a panacea, the geobrowser initiatives are being conceived as the next stage in the information evolution due to the inherent and natural benefits of the Earth metaphor to capture attention and promote holistic or systems perspectives. Many hopes are embraced within this international cooperative effort.

Acknowledgments

Reviewers: tbd

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Reference

Club of Rome, 1972
Foresman, 1998

Millennium Ecosystem Assessment, 2001

NSF, 2003

Sieden, 1989

UNEP, 2002

WCED, 1987

Appendix and Supporting Documents

Historical Documents

Previous Meetings and Participants

Other Literature

Charter for ISDE

Papers on Economic Impact of Spatial Data

Impact of Making Public Data Public

Acronyms

N. America: USGS One-Stop-Shop

International: UNGIWG, UNEP

Asia: CAS

OGC?