GEONETCast—Delivering Environmental Data to Users Worldwide (September 2007)

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Abstract—GEONETCast, a near real-time global environmental information-delivery system by which in situ, airborne, and space-based observations, products, and services are transmitted to users through communication satellites, was accepted as a GEO initiative by the second GEO Plenary. GEONETCast is an interconnected global network of regional dissemination systems that are each focused on a specific geographic region under the respective satellites’ footprints. Data from each region can be disseminated outside the originating region through data-exchange links between regions, such as through dedicated lines, overlapping satellite footprints, or use of the Internet or other existing networks. The regional components include one or more data collection, management, and dissemination hubs that receive, process, prioritize, and schedule the incoming data streams or products originating within the particular region. These GEONETCast Network Centres (GNCs) forward the prioritized data stream to the uplink ground station, which receives it, wraps it in a DVB-S dissemination protocol, and uplinks it to a communication satellite for dissemination at Ku- or C-band frequency. The data GEONETCast delivers is specifically targeted to address nine society benefit areas such as natural and human-induced hazards, environment and health, environmental-related energy issues, climate change, water management, weather, ecosystem management, sustainable agriculture, and desertification and biodiversity, with the aim of reaching a global coverage and allow the reception of this data at very low cost (basic reception station below $US2000) by nearly anyone on the planet. GEONETCast is a prominent case in which typical obstacles such as interoperability of existing systems and components reuse of existing infrastructure and interfacing with newly developed components have been resolved successfully.

Index Terms—Environmental factors, meteorology, satellite communication, systems engineering.

I. INTRODUCTION

MINISTERS agreed at the third Earth Observation Summit in February 2005 to develop the Global Earth Observation System of Systems (GEOSS) to meet the need for timely, quality, long-term, global environmental information as a basis for sound decision making and to enhance delivery of the benefits to society [2]. GEONETCast is a dissemination system under development by which GEOSS environmental satellite and in situ data and products from participating Data Providers will be transmitted to Users through satellites using a multicast, access-controlled, broadband capability. This capability is especially useful in parts of the world where high-speed land lines and/or Internet are not available. Participation in GEONETCast as a Data Provider, end user, or dissemination infrastructure provider is voluntary. The intergovernmental Group on Earth Observations (GEO) has defined the GEONETCast task as Capacity Building Task #CB-06-04 with oversight by the GEO Architecture and Data Committee. It is critical, however, that the task also works with the GEO User Interface and Capacity Building Committees and others to identify additional data, products, and services to meet the needs of all nine societal benefit areas under GEO. U.S. Co-Chair Conrad Lautenbacher, based on discussions between the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the United States/National Oceanic and Atmospheric Administration (NOAA), presented the concept to the GEO Executive Committee on 30th of September 2005. EUMETSAT and NOAA then presented it to the second GEO plenary meeting in December 2005—which adopted the concept in principle. GEO Members and participating organisations recognized that GEO could add value to existing operational and prototype technological efforts underway to enhance the delivery of data and information to users.

A. Concept and Benefits

A key feature in increasing the use of environmental data globally is to make it accessible to all nations in a cost-effective and efficient manner. Given the rapidly increasing volume and diversity of data and products, particularly from Earth observation and environmental satellites, this presents a real challenge. Adding to the complexity of the situation is the diversity of organizations and national entities involved in Earth observation satellite systems, in situ observations and production activities. The introduction of a coordinated, coherent, global dissemination scheme that addresses the existing problems of data dissemination is to be welcomed, and GEONETCast has the potential to achieve these goals in coordination with other data dissemination methods. GEONETCast promises to facilitate and enhance access, particularly for developing countries, to key environmental data [5] in the nine societal benefit areas of GEO [2].

II. SYSTEM DESIGN

A. Initial Concept

The initial system was based on EUMETSAT’s experiences with their EUMETCast system [4] and on the World Meteorological Organisation (WMO) Integrated Global Data Dissemination System (IGDDS) [6].
The EUMETCast concept is taking a managed service oriented view on data delivery and uses turnaround implementations to enhance the footprint coverage. Data providers are sending their contributions to an uplink site from where the data is up-linked to a commercial satellite and broadcast to users. The data are then relayed to other commercial satellites to increase the footprint coverage.

B. GEONETCast

The conceptual idea of a global GEONETCast implementation is that several regional centers take on the responsibilities for establishing a satellite-based regional dissemination system and provide the same services to the common user community. Such regional centers are called GEONETCast Network Centres (GNCs). Each GNC consists of the same main logical and technical components which are: 1) a number of data providers for data acquisition; 2) service management responsible for managing data dissemination, user requests and data providers; 3) an uplink facility and a multicast dissemination service using commercial DVB-S dissemination capabilities; 4) potential further turn-around services to extend the coverage; 5) a user community; and 6) cooperates with the partner GNCs over communication links (Fig. 1).

This concept of interconnected regional GNCs allows implementation and provision of similar services to a global user community (Fig. 2).

Currently, there are three GNCs participating: EUMETSAT with EUMETCast, NOAA with GEONETCast Americas, and the Chinese Meteorological Administration (CMA) with FENGYUNCast.

Each GNC has the same functionality, services, and obligations and is based on the same technical framework (Fig. 1). The GNC caters to the needs of the users in its regional responsibility and exchanges those with the other centers to reach a global visibility (Fig. 3). All GNCs are, for the purpose of GEONETCast management and administration, loosely coupled and steered by an Implementation Group. The GNC Implementation Group
with its distributed infrastructure, responsibilities, and services will allow the end user and data providers a single point of entry. This concept of a multilateral service-level-based business-to-business relationship forms basically a GEONETCast virtual organization.

A fundamental premise in the design of a GEONETCast capability for interoperability is that the regional systems are as loosely coupled as possible to maximize each region’s flexibility to implement optimal solutions based on its own unique regional challenges. However, they must possess common interface standards and processes and service-level-based business-to-business relationships that facilitate the exchange of data in both directions in a way that minimizes (but not necessarily eliminates) the burden on participants, including infrastructure providers, data providers, and end users.

Assuming a common methodology in data exchange between the regional centers, the actual multicast scheme can differ between the regions. Based on the geographical location of the user, each user chooses the appropriate GNC during registration for a service.

The data acquisition part is conceptually the same for all GNCs. As an example for EUMETCast GNC, this is a combination of its own infrastructure, e.g., observing satellite, Internet, private networks, Internet protocol virtual private Networks (IP-VPNs), Regional Meteorological Data Communication Network (RMDCN), and the Global Telecommunication System (GTS). The concept allows full conformity with the ideas of interoperable data exchange in the context of the Global Earth Observation System of Systems (GEOSS) and the WMO’s IGDDS [6].

Furthermore, a data-exchange concept between the GNCs for the exchange of data for the global GEONETCast service is part of the design (Fig. 3). Technically, those links can be implemented differently by making use of overlapping footprints and/or point-to-point private networks which could already exist due to bi-lateral infrastructure. In this context, data for a “global” GEONETCast service means all nonlocal/regional data which is meant for world-wide dissemination.

C. Data Acquisition and Dissemination

Following the concept of a GNC (Fig. 1), each GNC obtains its data from the associated data providers. Such data providers produce and collect data, sometimes enhance and reprocess data, such data can be of various kind and some data providers are specialized to a certain domain. The data is then sent via terrestrial links to the GNC. The GNC then manages the data dissemination via its multicast system in accordance with the data provider agreed, priority, timeliness, and service level.

Typically, the GNC groups similar data into individual services to which the end user can then subscribe. This is conceptually very similar to TV broadcasts with the difference that on GEONETCast data files are disseminated and not streams like on TV.

Each GNC manages data for its regional user community but also the data that is agreed for global dissemination. Such agreements are made on bilateral basis between the GNCs but also supported by the GEONETCast Implementation Group. The data for global exchange is then exchanged with all partner GNCs, which then disseminate such data via their multicast systems.
D. System Performance and Scalability

Even though there are no formal service level agreements in place, the overall system is operating on a very high standard. The root cause for this is the fact that each regional system is used by the local operator for their operational data dissemination.

The usage of DVB-S multicast for dissemination makes the system independent to a growing user community and the schema of commercial service provision with regards to the dissemination bandwidth makes the system also very scalable towards growing data needs. Currently standard transponder bandwidth is in the range of 3–6 Mb/s net throughput. Each satellite provides several such transponders. In reality, the current amount of data for global exchange is in the area of 2 Mb/s. The highest regional contributor, EUMETSAT, operates regional data, including the GEONETCast contributions, at a continuous 14.5 Mb/s with over 99.99% availability to several thousand user stations. Therefore, it is obvious that technically there is a lot of scope for further data contributions in this current architecture.

E. Global Coverage

Today, GEONETCast offers already nearly global coverage based on the contributions of EUMETCast for Europe, Africa, and South America, with FENGYUNCast covering all of Asia/Pacific (Fig. 3) and the GEONETCast-Americas system, which is expected to be operational at the end of 2007 and which will cover all of the Americas.

G. User Community and Data Usage

Data received via GEONETCast can be used by any decision makers to help them plan their resources or any national specialized centers, universities but also end-users.

III. CHALLENGES

A global implementation of a system such as GEONETCast presents a number of technical challenges such as interoperability, reuse of existing infrastructure, and standards such as service and technical standards. GEONETCast is a prominent example of a successful answer to those challenges.

A. Interoperability

Currently GEONETCast is operated with three systems: EUMETSAT’s EUMETCast, NOAA’s GEONETCast Americas, and CMA’s FENGYUNCast support by WMO’s contributions [3]. These three systems use different multicast solutions, but, due to strict coherence to the overall architecture (Fig. 1), standards and the definition of clear interfaces between the three GNCs, all three systems are fully interconnected. The GEONETCast Implementation Group, consisting of all members of all participating organizations, has mutually agreed on all standards and concepts and ensures that those are consistently met.

B. Reuse of Existing Infrastructure

All three systems are loosely coupled and make extensive reuse of their existing internal components such as technical infrastructure, administrative processes for user registration, and bi-lateral agreements in relation to data exchange.

C. Standards

Each of the dissemination systems which together form GEONETCast is compliant with a number of Service Standards based on the agreed common requirements as listed below.

— Each regional system provides a single entry point known as a GNC.
The GNCs can be linked together to provide data exchange between GNCs.

Each GNC shall provide connectivity and system capacity to data providers from all GEO society benefit areas within the region.

Each GNC shall provide bandwidth to support data dissemination from outside the region.

GNC operators are responsible for managing and interfacing with users in coordination with data providers located within the region.

GNC operators are responsible for managing and interfacing with users in coordination with the other GNC operators acting in place of data providers of the other regions.

At the technical level, a number of standards have emerged as forming the baseline for dissemination systems which contribute to the GEONETCast infrastructure and have been formulated in the requirements listed below.

Contributing dissemination systems shall be generic, multiservice dissemination systems, based on standard Digital Video Broadcast (DVB) technology, using commercial broadcast channels on television, direct-to-home (DTH) telecommunication satellites.

Utilizing commercial off-the-shelf, commonly available reception equipment.

Using IP over DVB standard coding; systems shall support transparent transfer of files—files should be received exactly as sent.

Use of standard, openly described file formats is encouraged.

Contributing systems shall provide secure access control at individual file and user level.

The systems shall be open, flexible, and scalable at both the GNC and user terminal level.

Quality of service should be ensured and regularly monitored.

Catalogs of transmitted data shall be maintained and made available for consultation by users in order to facilitate data discovery and subscription.

Dissemination shall be organized in multiple multicast channels corresponding to product categories, which are associated with program identifiers (PIDs).

In particular, the technical aspects allow also industry to develop standard low-cost reception systems.

IV. CONCLUSION

GEONETCast, which is at time of writing in wide parts already fully operational, offers a “one-stop-shop” delivery mechanism, allowing users to receive many different data streams using one low-cost reception station. It provides highly scalable system architecture, allowing data capacity to be simply increased with no impact on the reception stations. The interfaces within GEONETCast are well defined, allowing an increase in the number of GNCs to provide even better coverage around the globe. Through data exchange between the GNCs, data and products of global interest are exchanged and disseminated across all footprints in near real time. As GEONETCast delivers data for all nine society benefit areas such as health, energy, disasters, weather, climate, water, agriculture, ecosystems, and biodiversity in near real time, it is expected that users worldwide will register and use the service operationally.

REFERENCES


Lothar Wolf graduated in Meteorology from the University of Applied Science, Cologne, Germany, and received the M.Sc. degree in computing for commerce and industry from the Open University, Milton Keynes, U.K.

After his graduation, he started to work as Software Developer initially with the German Meteorological Service and then with the European Centre for Medium Range Weather Forecasts, Reading, U.K. During this time, he specialized in wide-area data dissemination systems. Since 2004, he has been leading EUMETSAT’s expert engineering team for dissemination services. He is involved in various projects related to the European Commission and the World Organisation of Meteorology (WMO) and is the project manager for GEONETCast implementation at EUMETSAT.

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He then joined Dundee University, Scotland, to work in the Remote Sensing Satellite Centre. Here, he developed tracking and reception systems for environmental remote sensing satellites such as Meteosat, NOAA, and Nimbus-7, and image processing systems. Then, he moved on to ESA’s Space Operations Centre (ESOC), Darmstadt, Germany, to work in Meteosat Satellite and System operations, and then on to EUMETSAT, where he manages the operations of all of EUMETSAT’s operational satellite systems—which currently include Meteosat first- and second-generation geostationary systems, and the Metop polar-orbiting system.