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 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 (GNC) 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 to reach a global coverage and allow the reception of this data at very low cost (basic reception station below 2000 US $) by nearly anyone on the planet.

GEONETCast is a prominent case in which typical obstacles such as interoperability of existing systems and components re-use of existing infrastructure and interfacing with newly developed components have been resolved successfully.

Index Terms – Environmental factors, Meteorology, Satellite communication, Systems engineering

1 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 **[1]**. 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 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 September 30, 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.

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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 organisations 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 in the nine societal benefit areas of GEO **[1]**.

2 System Design

A) Initial concept

The initial system was based on EUMETSAT's experiences with their EUMETCast system **[2]** and on the World Meteorological Organisation (WMO) Integrated Global Data Dissemination System (IGDDS) **[4]**.

The EUMETCast concept is taking a managed service oriented view on data delivery and uses turn-around 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 is 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 centres take on the responsibilities for establishing a satellite based regional dissemination system and provide the same services to the common user community (Fig. 1). The concept of interconnected regional GEONETCast Network Centres (GNC) allows such an implementation (Fig. 2).

Each GNC comprises the same components of 1) Data acquisition, 2) Service management, 3) Uplink provider, 4) Turn around providers and 5) User community and additionally 6) cooperates with the partner GNCs over communication links. 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 for the needs of the users in its regional responsibility and exchanges those with the other centres to reach a global visibility (Fig. 3). All GNC 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 organisation.

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 interfaces standards and processes and service level based business-to-business relationships that facilitate 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.

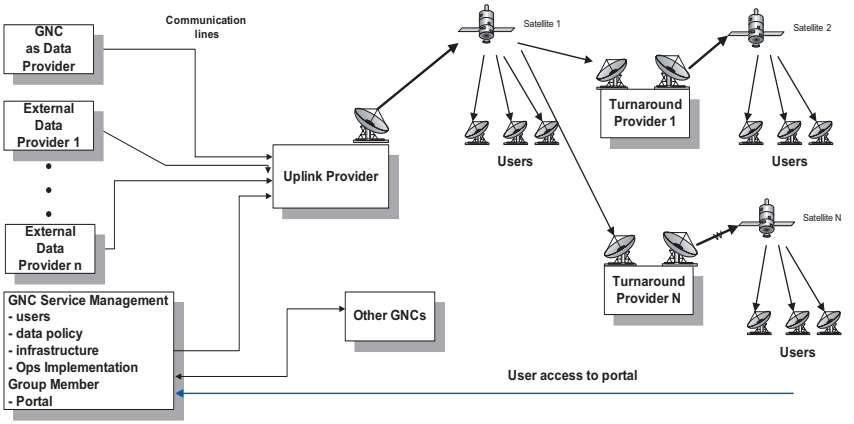

Fig. 1 GEONETCast Regional Network Centre – GNC

Assuming a common methodology in data exchange between the regional centres, 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.

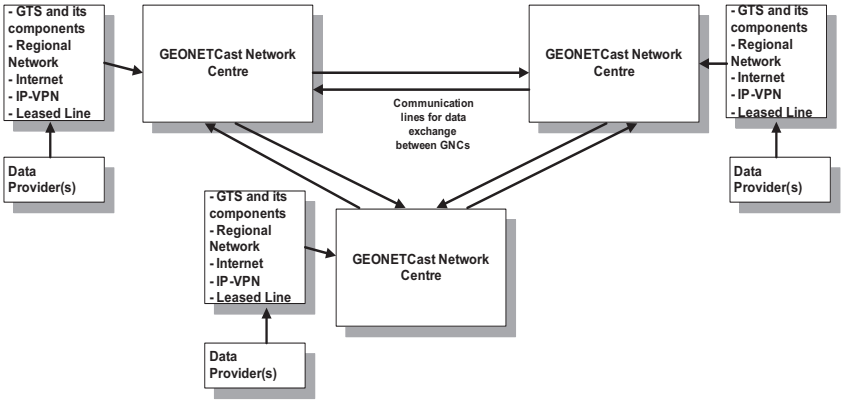

Fig. 2 High level design of GEONETCast implementation via interconnected GNC

The data acquisition part is conceptually the same for all GNC. As an example for EUMECast GNC this is a combination of its own infrastructure e.g. observing satellite, Internet, private networks, Internet protocol Virtual Private Networks (IP-VPN), 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 **[4]**.

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 services means all non-local/regional data which is meant for world wide dissemination.

C) Global Coverage

GEONETCast offers already today 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 operationally at the end of 2007 and which will cover all of the Americas.

D) Reception Systems

The reception systems **[5]** necessary are based on off-the shelf low cost components and are typically not more expensive than 1400 Euro.

Fig. 3 GEONETCast coverage

3 Challenges

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

Fig. 4 GEONETCast reception system (variations might be possible depending on GNC operator)

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]**. Those three systems are using 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.

B) Re-use of existing infrastructure

All three systems are loosely coupled and make extensive re-use 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:

- Each regional system provides a single entry point known as a Network Centre (GNC);
- The GNC can be linked together to provide data exchange between GNCs;
- Each GNC should provide connectivity and system capacity to Data Providers from all GEO Society Benefit Areas within the region;
- Each GNC should 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:

- Contributing dissemination systems should be generic, multi-service dissemination systems, based on standard Digital Video Broadcast (DVB) technology; Using commercial broadcast channels on television, direct-to-home (DTH) telecommunication satellites;
- Utilising commercial, off-the-shelf, commonly available reception equipment;
- Using Internet Protocol (IP) over DVB standard coding;

Systems should support transparent transfer of files – files should be received exactly as sent;

- Use of standard, openly described file formats is encouraged;
- Contributing systems should provide secure access control at individual file and User level;
- The systems should be open, flexible, and scalable at both the Network Centre and User Terminal level;

– Quality of service should be ensured and regularly monitored;
– Catalogues of transmitted data should be maintained and made available for consultation by Users in order to facilitate data discovery and subscription;
– Dissemination should be organised in multiple multicast channels corresponding to product categories, which are associated with Programme Identifiers (PID).

4 Conclusion

GEONETCast 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. Because 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, world wide, will register and use the service operationally.

References

[1] **C.P. Garcia**, "GEONETCast Workshop", Report, Brussels, 3rd May 2006.

[2] **L. Prahm**, "EUMETCast", *WMO Bulletin*, **Vol. 55**(4) – October 2006, pp. 245-248.

[3] **L.D., Moura**, "WMO's contribution to GEOSS and GEONETCast", *WMO Bulletin*, **Vol. 55**(4) – October 2006, pp. 256-260.

[4] **G.W., Withee**, "Integrated Global Data Dissemination Service", *WMO Bulletin*, **Vol. 55**(4) – October 2006, pp. 249-252.

[5] **EUMETSAT**, TD-15, "TD 15 - EUMETCast – Broadcast System for Environmental Data"