Potentials of GEONETCast for Distance Education in EO in Africa

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ABSTRACT

GEONETCast is a global data dissemination system to support the Group on Earth Observations (GEO) to deliver near-real time EO and *in-situ* data and products derived from the Global Earth Observation System of Systems (GEOSS) to the User Community. The information is relevant for policy formulation and management decision making and is covering the full range of societal benefit areas. Backbone of the data dissemination system is EUMETCast, already used globally by the meteorological organizations for near real-time data reception using low cost ground receiving stations. Large volumes of data are broadcasted and received using this one-way dissemination system. Delivery of self-training packages to users operating a ground reception system is currently possible using the so-called "training-channel" on EUMETCast. For Distance Education also two-way communication is essential. In this respect, current telecommunication developments, especially with regard to the expansion of the 3G-Network, providing wireless accelerated data speeds and simultaneous voice and data capabilities, offer new possibilities for Distance Education and E-Learning in Africa. By means of a 3G enabled modem or mobile phone, connected to a computer or laptop, larger bandwidth is obtained which can be utilized for these types of training activities, irrespective of available fixed network infrastructure. A framework is presented which is linking the one-way EUMETCast-GEONETCast data and product dissemination with the two-way telecommunication based distance education support, targeting African Academic and Regional centres. All tools and utilities that are used are Open Source or freeware and these can be obtained through a web-portal hosted at ITC or soon through a GEONETCast-Community website hosted by 52North.org. It can also be delivered to the users that are operating a ground receiving station, by means of the training-channel of EUMETCast, in collaboration with EUMETSAT. Further training based on the use of data and products disseminated via GEONETCast is needed to support improved national and regional decision making processes for better management of the natural resources and for sustainable development. Therefore National Academic and Regional centres in Africa need to incorporate GEONETCast in their curriculum to ensure that the necessary human resource capacity is developed and maintained. International organizations can contribute to further curriculum development, to embed GEONETCast in the programmes of African Academic and Regional centres, in a cost-effective manner through means such as distance education.

1. EUMETCast - GEONETCast

EUMETCast, a communication based data dissemination system, was developed by the European Meteorological Organization (EUMETSAT, www.eumetsat.int) to ensure that the images captured by the Meteosat Second Generation satellite (MSG) were at disposal in near real-time at the Meteorological Organizations, without the need to depend on the direct satellite readout possibility. Initially EUMETCast mainly carried images and data relevant for meteorological organizations, but over the last couple of years more satellite data and derived products are regularly disseminated by an increasing number of data providers. The EUMETCast system is EUMETSAT's contribution to GEO and is seen as the backbone to disseminate the images, data and products derived from the Global Earth Observation System of Systems (GEOSS). The system was renamed to GEONETCast.

The main advantage of the EUMETCast – GEONETCast data dissemination system is that with a low cost ground reception system, using locally available hardware components, a large volume of data can be received. Within the last five years EUMETCast stations have been established in Africa, e.g. by the Preparation for Use of MSG in Africa (PUMA) program but also through individual initiatives. Within the African Monitoring of the Environment for Sustainable Development (AMESD) also new ground reception stations are foreseen in the near future, their five regional implementation centres are already equipped with EUMETCast antenna's. It is estimated that by the end of 2010 a total of about 150 stations will be operated in sub-Sahara Africa, mainly by the meteorological organizations, AMESD and affiliated partners.

The C-band service that is received in Africa is currently carrying over 70 different types of images and products (http://navigator.eumetsat.int/discovery/Start/Explore/Extended.do.) relevant for a broad range of environmental applications. More are foreseen in the future through ongoing initiatives in Africa, such as DevCoCast and the services defined under AMESD but also products and images that are made available by various other international data providers, like the TAMSAT 10 day-rainfall product.

The EUMETCast data dissemination system has overcome one of the main bottlenecks of shipping large volumes of data to users anywhere in the world as it does not use a ground based (internet) infrastructure. When a local ground receiving station is operated, continuously data is received. Each ground receiving station has a unique address and the users have to register for the different services provided. Another feature of EUMETCast, relevant in this respect, is the so called "training channel". Training material and data sets, software, etc can be shipped via this satellite telecommunication system and delivered only to specific users.

As the system is relatively new, but is offering much potential for research and education, its capability still needs to be firmly embedded within the African academic centres. The main limitation of the system is that it is a one-way data dissemination scheme, at the user station it is receiving only!

2. Distance Education and bandwidth

GEONETCast in itself does unfortunately not fulfil all requirements that are needed for distance education, as for effective distance education two-way communication is essential. The main bottleneck for effective distance education is the limited extent, the unreliability and the bandwidth offered of the fixed network that is currently available in many African countries, with upload speeds of 128 Kbps and download speeds of 256 Kbps being quite common. With these speeds it is hardly possible to use streaming audio, let alone streaming audio and video.

Using Gigabit connections in Europe, distance education is gradually developing into a mainstream teaching activity. Lecturers and students don't move from one university to another to follow a lecture, instead the lectures can be followed in special rooms equipped with (full high definition) screens and camera's and from these locations they can actively participate in the (distant) lecture (UT Nieuws, 20-08-2009). In Europe and South East Asia (e.g. Japan and Australia) Eduroam (EDUcation ROAMing) is gaining popularity. This is a roaming infrastructure used by the international research and education community that provides the user the capability of opening the laptop and be online (further info on: http://www.eduroam. org/). With these facilities available, lectures can be followed everywhere, provided that the user is registered and in the neighbourhood of a wireless access point!

The telecommunication industry is also quickly evolving in Africa. Kenya's national network is already connected to the rest of the world by the East African Marine System (TEAMS) cables. Another initiative, the Eastern Africa Submarine Cable System (EASSY) will connect the East African region to the rest of the world through South Africa. West Africa will be connected by the South Atlantic 3 / West Africa Submarine Cable (SAT-3/WASC), just to mention a few of these initiatives. Through direct physical connection, using fibre optic cables directly connected to the rest of the world, the speeds will improve for voice and data transmission.

Next to this also the wireless based communication network has strongly developed. Currently in many African countries the 3rd Generation Wireless Technology and Network (3G network) is installed or preparations for installation are under way. The minimum bit-rate requirements to be considered 3G are 2 Mbps in in-building environments and these enable rich data applications such as VoIP, video telephony, mobile multimedia, interactive gaming, etc. (Hearmon, 2007). Advantage here is that 3G enabled mobile phones and modems can be used to directly link the computer to the internet, irrespective of the fixed network infrastructure. Telecommunication companies are offering reasonably priced mobile internet packages, including modem and payment is only required for the amount of data transferred.

To deliver a distant lecture using streaming video with audio, using a screen resolution of 320 by 240 pixels, the minimum speed requirement would be slightly over 1.1 Mbps. With the advertised speeds of the 3G network (up to 7.2 Mbps downlink speeds) it is possible to use standard distance education support tools that require low to moderate band width. Experiences in Europe by various 3G Network users has shown that the

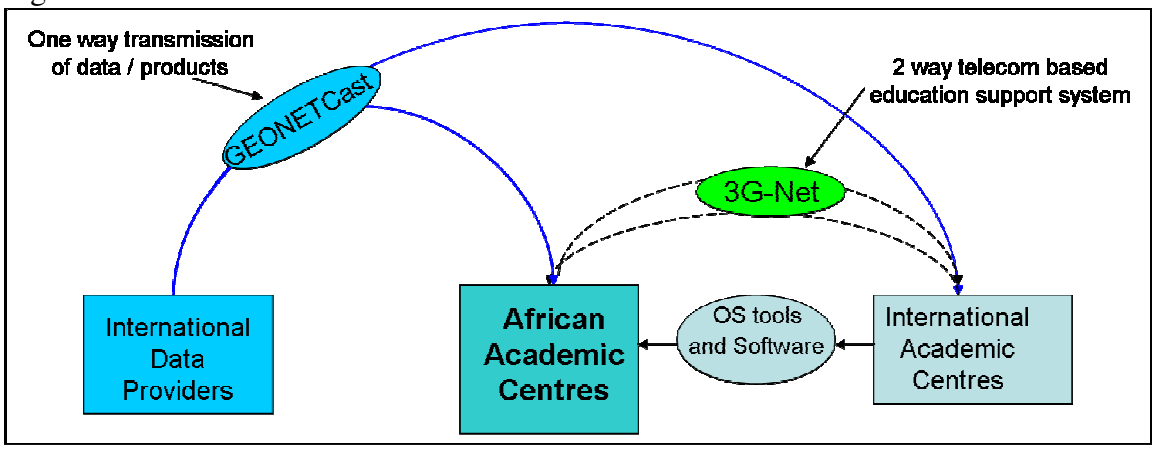
advertised speeds are hardly obtained, more realistic speeds are in the order of 2 to 3 Mbps.

With these speeds freeware distance education support tools available, such as Gtalk, Skype, TeamViewer can be effectively used. A licensed utility that requires minimum bandwidth is Elluminate, larger bandwidth is needed by applications such as WebEx and Adobe Connect Pro. The Meteorological organizations make use of VISITview and use a Moodle based education management system. At ITC use is made of Elluminate, TeamViewer, Skype, Gtalk to deliver distance education and use BlackBoard for management, eventually the content can also be offered off-line. Most of the utilities mentioned meet the requirements of the speeds as provided by the 3G network.

3. GEONETCast and distance education

Taking into consideration the capabilities as indicated above, a conceptual framework, presented in figure 1, has been developed linking GEONETCast and Distance Education for Africa.

Figure 1: GEONETCast and distance education



The various international data providers will ensure that a large volume of data is delivered to the global user community through GEONETCast. The African Academic centres need to establish a low cost ground receiving station at their premises in order to receive the data stream. Free data reception permissions can be obtained from EUMETSAT. Once having established a ground receiving station, (a selection of) the data has to be made accessible via a shared file server so various users within the Academic Centres can process the data for their respective applications as well as the use for educational activities.

The software needed for structured storage, archiving and processing is already available as freeware (Maathuis et al, 2008, Mannaerts, 2009) and can be downloaded from various locations, for example see: http://www.itc.nl/Pub/organisation/Introduction-Scientific-departments /WRS/WRS-GEONETCast/GEONETCast-toolbox.html. Eventually these utilities could also be disseminated using the EUMETCast training channel, together with relevant training materials and training data sets.

In order to fulfil the training requirements, through means such as distance education, use can be made of the 3G network which is furthermore offering independence with respect to the local available fixed network infrastructure. Again the utilities in support of the distance education process are mainly freeware and most of the packages mentioned before require low band width.

4. Putting things in practice

In order to make use of GEONETCast at the local African academic centre a ground reception infrastructure needs to be established. Experiences have already been gained in this respect, e.g. at the National University of Rwanda (CGIS-NUR) (Maathuis et al, 2006), the Regional Centre for Mapping of Resources for Development (RCRMD) and the University of Cape Town. All these stations operate satisfactory. The GEONETCast toolbox, an ILWIS based plug-in is used here, to archive and process the data. The software can be downloaded from the ITC and 52North.org websites respectively. Currently developments are ongoing to build a GEONETCast Community Twiki, hosted by 52 North.org. It is envisaged that most of the relevant information, sample data, etc. will be available from this location and individual users can add their own content, like application examples to demonstrate the use of the data disseminated.

Already from the ITC GEONETCast webpage training materials are made available. Additional exercises and data sets as well as sample data will be available here as well, so potential users that do not have an operational GEONETCast ground reception infrastructure can already start to utilize the system capability for educational purposes.

From the African side it is furthermore required to make an investigation with respect to the local availability of the 3G network and subscribe to an internet package. Safaricom, a Kenyan telecom provider, is currently selling packages at reasonable prices, 1 GB for 2.500 Kshs, about 25 Euro. A 2 GB package includes even a 3G enabled modem (see also: http://www.safaricom.co.ke/ index.php?id=24).

Subscription to GEONETCast services is required. This can be done online (see also: http://www.eumetsat.int/Home/Main/Access_to_Data/Delivery_Mechanisms/SP_1117714355151?l=en). A new user will be provided with a EUMETCast Key Units (EKU). These USB devices are used in conjunction with the EUMETCast Client Software to facilitate the reception of licensed or restricted services. ITC has obtained from EUMETSAT additional EKU's that can be used for training purposes and these can be made available on a temporary basis.

With the one way data transmission and two way communication system requirements taken into consideration, as indicated in figure 1, the necessary technical infrastructure is in place. What remains to be done is to acquire further experience in distance education based GEONETCast station support and application training using the suite of distance education support tools that are currently available.

At ITC an internal proposal was accepted to develop a "*Distance Education course on exploration of GEONETCast through E-Learning*". Through this initiative collaboration is foreseen with a number of African Academic centres and ITC staff. The idea is to have a one week kick-off meeting between the interested centres and ITC staff. This can be hosted by the RCMRD, first quarter next year. This workshop will focus on the technical infrastructure needed for GEONETCast and E-Learning. Once the infrastructure is in place various e-learning sessions will be organized between ITC and the centres. These sessions will deal with system support, use of software tools, data processing, etc. In this respect use will be made of the various low to medium bandwidth e-learning tools to support e.g. a single system administrator but will also be tested in a class-room environment with multiple students attending.

The experiences gained will be made available in the form of a document describing the "best practices" and can be used by other African Academic centres to guide the implementation of their e-learning infrastructure.

5. Conclusion

It seems that gradually all requirements are becoming available to support the use of GEONETCast education for the various scientific domains related to natural resources management in Africa. Firstly the data is freely and timely available; secondly several tools and utilities that can be used for data processing are available as freeware and adhere to Open Source standards and lastly training materials and distance education based support can be offered by the International Academic centres to support the African counterparts in their efforts.

Looking at the telecommunication developments in Africa the enhanced capabilities offered by the 3G network seems to be the most promising in the short term. In order to experiment with these new capabilities, ITC is prepared, in collaboration with a number of interested African Academic partners and those from relevant regional centres, to put these into practice and gain further experiences to develop "distance education based GEONETCast best practices" to enable these centres to prepare for the use of GEONETCast within their Curricula.

The need for sustainable development, informed planning and management of the African natural resources requires a multitude of geo-information. A substantial portion of the required data is provided through GEONETCast. Universities have the obligation to teach their students the state of art and this is why this capability should be firmly embedded in the curricula of the various relevant departments of the African Academic centres.

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