KOMPSAT European Cooperation

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Abstract: The *KOMPSAT European Cooperation* aims at enhancing existing and establishing new collaborations between KARI and various European institutions. The objective is to create mutual data and information exchange possibilities and to develop new data applications of available and future space based Earth Observation sensors. In this paper, the concept of a KOMPSAT regional application center, a joint development between KARI, ARCS and other European partners is presented. This includes the establishment of an additional KOMPSAT-2 downlink in Europe, and the developments of a state-of-the-art user service system for urban and environmental security monitoring.

Keywords: KOMPSAT, downlink, Europe, Urban Application Center, urban monitoring, land use/land use change.

1. Background

With the signature of a Memorandum of Understanding (MoU) for space research cooperation by the Ministers of Science and Technology from Austria and Korea, a very important milestone in the well established scientific and technological collaboration between the Korea Aerospace Research Institute[1] (KARI) and the Austrian Research Centers - Seibersdorf research[2] (ARCS) was achieved. This MoU was signed in September 2002 and acted also as a trendsetter to develop a widened cooperation between KARI and European aerospace organizations for KOMPSAT mission preparation and utilization.

One of the ideas which were triggered was the joint development of an *Urban Application Center*, which should target the needs of the urban planning and urban monitoring domain of governmental and other non-profit organizations. It was further envisaged that the High-Resolution (HR) Earth Observing Camera (EOC) on the KARI KOMPSAT-1 satellite should provide the major input to produce "land use/land use change" products specialized to fit the needs of this user community. This vision was soon after extended to include the future KOMPSAT-2 Satellite as a data source.

2. Cooperation

The EOC of KOMPSAT-1 delivers panchromatic images with a spatial resolution of 6.6 x 6.6 m and an image swath width of approx. 17 km. These basic conditions make images recorded by the EOC very suitable for the application in and around urban and sub-urban areas.

The Very-High-Resolution (VHR) Multi-Spectral-Camera (MSC) mounted on KOMPSAT-2 (scheduled for launch in fall 2005) will provide 1 panchromatic channel with a spatial resolution of 1 x 1 m and 4 multi-spectral channels with 4 x 4 m spatial resolution and an image swathwidth of approx. 15 km.

Since such VHR sensors are not really appropriate to cover large areas routinely, applications such as the jointly planned urban and sub-urban monitoring (land use/land use change) product generation facility are the right choice.

One of the limitations for satellite data acquisition is the available downlink capacity. The increase of this capacity, especially for the future KOMPSAT-2 mission, which will deliver a much larger data volume than KOMPSAT-1, has been another target of the joint work of KARI and ARCS. An European downlink facility was conceived to be installed and to increase the accessibility of KOMPSAT data especially to the *Urban Application Center* but also to European users in general. As a side effect such an additional downlink opportunity would assist KARI in optimizing the utilization of KOMPSAT without impact on its original mission.

[1] http://www.kari.re.kr
[2] http://www.space-research.at

Since there already are highly qualified antenna systems in Europe, either under the auspices of the European Space Agency (ESA) or under the patronage of national space agencies, it was decided that KOMPSAT reception should be organized based on partnerships with European organizations operating these receiving stations.

1) Cooperation: KARI-ARCS-DLR-NLR

Consequently, the German Aerospace Center[3] (DLR) and the Dutch National Aerospace Laboratory[4] (NLR) could be successfully taken aboard and have upgraded their systems for the reception of KOMPSAT-1 and KOMPSAT-2 data streams.

The successfully performed, experimental reception of data from KOMPSAT-1 at European stations is seen as a test case to build-up the necessary institutional communication channels, process mechanism and partnership confidence:

- KARI builds and operates the KOMPSAT satellite series, provides access to the data, and also plays a key role in the development of the *Urban Application Center*.
- ARCS is Austria's largest Contract Research Organization (Fig. 1) and well established in the European Earth Observation community with respect to both data user and information infrastructure programs. In this cooperation ARCS is responsible for the coordination of this initiative, the development of the Urban Application Center and is the primary interface between Europe and KARI.
- DLR currently makes available resources at the wide coverage Neustrelitz receiving station (Fig. 2) and storage capacity. Future plans may include the provision of additional downlink stations as well as the development of services based on KOMPSAT data, positioned mainly in the "Disaster- domain".
- NLR brings into the cooperation their small, robust and highly mobile RAPIDS[5] station (Fig. 3), which can easily be transferred to any place in the world and be operational within a day after arrival. NLR is co-located with the Geomatics Business Park[6] (GBP), For the companies of GBP, the RAPIDS ground station is meant to serve as an access point for real time high resolution imagery for monitoring and mapping of urban and agricultural areas.

On May 19th, 2004 the first 17 x 784 km image strip from the KOMPSAT-1 satellite could be successfully downloaded in Europe at the Neustrelitz receiving station [1]. Soon after that an image acquisition from the KOMPSAT-1 satellite was also successfully carried out at NLR's RAPIDS system.

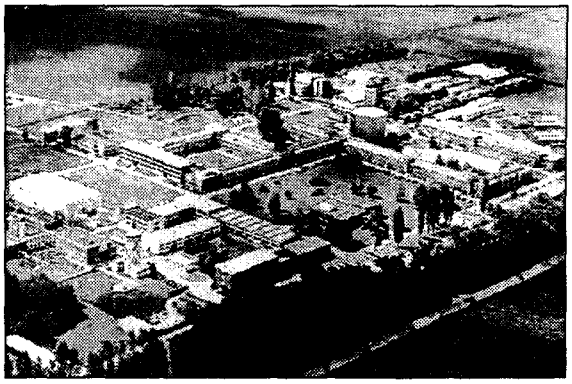

Fig. 1. Austrian Research Centers - Site at Seibersdorf , Austria

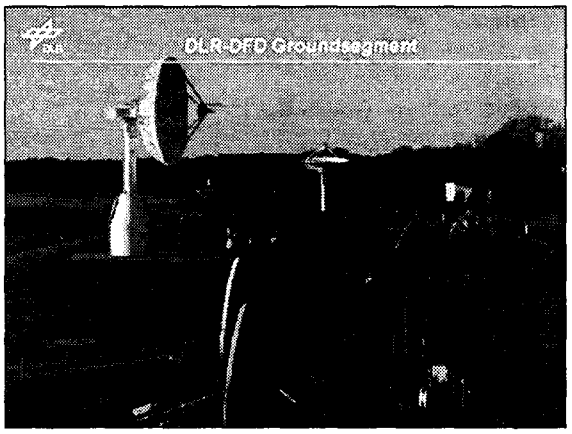

Fig. 2. The DLR Groundsegment at Neustrelitz, Germany

Fig. 3 RAPIDS Mobile Antenna System by NLR, The Netherlands

[3] http:// www.dlr.de
[4] http://www.nlr.nl
[5] http://www.rapids.nl
[6] http://www.geomaticspark.com

2) Urban Application Center

The HR imagery obtainable with the EOC mounted on the KOMPSAT-1 satellite is very well suited for change monitoring over urban and sub-urban areas. This will be even more true for the imagery expected to be delivered from KOMPSAT-2.

ARCS and KARI are jointly developing a processing chain (*Urban Application Center*) to provide data products derived mainly from KOMPSAT-2 images for the use in urban planning and monitoring processes.

In order to achieve this, mostly automatic processes have to be determined and set up. A critical issue for the development is the level of automation to be reached versus the level of accuracy needed when working with HR and VHR data. Especially the geocoding of satellite data (applying geographic coordinates to the imagery) is known to be a very tedious, time consuming and therefore expensive task. New sensor models, as will be provided with KOMPSAT-2, will help to reduce the time and costs for this necessary procedure. But also the process of analysis to create thematic products and maps requires many interactions and adaptations (depending on the input data) and it is the aim that the process can be fully automated. NLR knowledge and experience in development and integration of highly automated orthorectification tools – for rapid mapping applications - will support automation of this procedure.

At a first step the thematic information extracted from the satellite data will use a classification schema based on 6 classes (vegetation, sealed areas, arable land, water, shadow, clouds). Later, if possible , the level of detail of the information extracted from the satellite data will be refined to represent the European CORINE[7] (Coordination of Information on the Environment) standards. The processing and analysis of the imagery will be done mostly with a combination of IDL/ENVI and eCognition[8]. Details about the processing schema and the resulting products are described in the complementing paper [2].

The European Node (Fig. 4) of the *Urban Application Center*, located in ARCS, will provide coverage of larger cities in Europe, Africa and the Near East. The corresponding Korean Node, located in KARI, will cover Asia, Australia, and for the time being the American Continent. Special attention will be placed on urban change products over so called third-world "Megacities". There, often the most basic spatial planning tools and maps do not exist and satellite based imagery and derived information products can provide valuable guidance and tools to locate where and which changes are taking place in and around fast changing sub-urban areas.

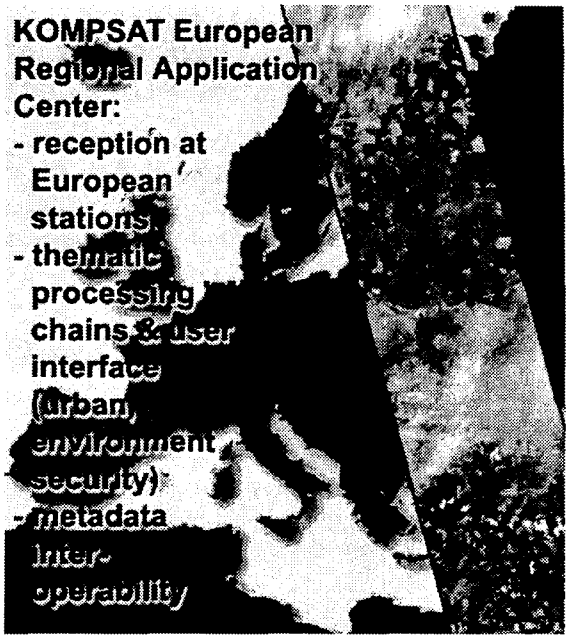

Fig. 4. Elements of the KOMPSAT European Services

3) Catalog

The developments for the *Urban Applications Center* will include the possibility to search, view, and order available data and derived products. To attain this, metadata (information about the data) needs to be generated and made available as a catalog via various means. Here, the future clearly points to build-up and implement interoperable systems which can connect to and be accessed by larger entities (e.g. portals of space agencies like KARI or ESA[9]) allowing a wider community to gain information about the existence of a certain service and access to the data and products available.

So far many space agencies and data provider already have Catalogs in place, each of them acting differently and often only accessible via its own interface. To find available data one needs to canvass multiple sites using many different interfaces and logistic systems.

ARCS and industry partners are currently enhancing the existing INFEO[10] catalog system, to be reinitiated by ESA in the eoPortal[9], by adding XML/SOAP (Extensible Markup Language/Simple Object Access Protocol) interfaces to overcome many existing problems, hindering an interoperable strategy allowing mutual interconnectivity and searches in multiple catalogs.

KARI is participating in this project and currently develops a new catalog system fully compatible with the specifications applying XML[11] and SOAP[12] technology. The final catalog outcome will be connected with ESA's INFEO catalog systems and from both ends all

[7] http://terrestrial.eionet.eu.int/CLC2000
[8] http://www.definiens-imaging.com

[9] http://www.esa.int
[10] http://www.eoportal.org/about.html
[11] http://www.w3.org/XML/
[12] http://www.w3.org/TR/soap/

connected catalogs will be accessible via their single entry point. The *Urban Application Center*'s catalog will be built following the same standards and will finally also be connected to ESA's eoPortal[13].

4) WebMapServer (WMS)

To access and search the Catalog of the *Urban Application Center* directly, but also to select, present and later also access the available data at the *Urban Application Center* a WebMapServer (WMS) has been implemented. The software basis is formed by the OpenSource WMS of the University of Minnesota, which already provides a WebFeatureServer (WFS) and soon will provide a WebCoverageServer (WCS) and which is compliant with the standards of the OpenGis Consortium (OGC). While the WMS allows the maps to be constructed and viewed (i.e. as pictures in standard formats like JPG, PNG, etc.), the WFS can be used to distribute actual vector data (e.g. thematic products). Finally, the WCS will provide a way to access the full raster data and will therefore be used as a distribution mechanism.

The data management backbone of the implemented system is formed by the Postgres/PostGIS database connected to the WMS/WFS via extensive PHP-processing functions developed at ARCS. The implemented WMS can also act as a cascading WMS, combining layers of information of other WMS with the local available datasets and vice versa. After going public, it will also allow to be accessed by other WMS and may deliver certain information contents to be included by those WebMapServers.

5) Multi-Application Service Support / Service Support Environment (MASS/SSE)

The data processing steps required in the Urban Application Service will form a work-flow which is intended to be implemented using recent European EO system developments. The MASS/SSE[14] currently developed for the European Space Agency will be used as system platform. Not only catalogs are combined but complete service chain building blocks are made accessible via a common interface. The developed SSE toolbox provides the utilities for service and data providers to present their services and make them directly accessible by users. Furthermore, there exists the possibility to combine such building blocks of services of various providers, forming new chains of processing and products according to their needs.

The service providers formulate encapsulate tasks for a single well defined service by describing the input and output interface in a standardized way using XML and WSDL[15] (Web Service Definition Language). With this technique an automated and controlled data flow is possible in a synchronous (online) or asynchronous (offline) way.

ARCS already achieved system provider status for the MASS/SSE and will tie the *Urban Application Center* service chain into the SSE system.

3. Conclusion

In recent years the fast technological developments, especially around the Internet, encouraged a more globalized view, concurrently creating new perspectives about the understanding of the "Spaceship Earth". Earth Observing (EO) Satellites represent by definition tools to monitor a wide range of events on Earth, mostly on a large scale. Due to the many limitations when building and operating satellites (e.g. monetary), a collaboration of EO satellite operators, targeting data and information exchange, will benefit all (cf. International Charter of "Space and Major Disasters"). The need to combining the existing available resources and to increase their efficiency can also be found in ESA's OXYGEN initiative [3].

Nowadays, the internet allows easy access to and exchange of data providing a wider satellite data user community and allowing a better utilization and therefore optimization of the available resources. The problems which still need to be solved are about "collaboration" between and "how to locate information" at data and service providers.

The described *KOMPSAT European Cooperation* tries to establish such an interoperable collaboration network providing easy data and information exchange possibilities.

References

[1] **URL:** First KOMPSAT-1 Earth Observation Data downlink at European Receiving Stations, Available at: http://www.space-research.at/space/. First_Image_Kompsat.html

[2] Kressler, F. P., Y. S. Kim, K. Steinnocher, G. Triebnig, 2004. KOMPSAT - Urban Application Center, *Proceedings of the International Symposium on Remote Sensing, Oct..27-29,* Jeju, Korea, in this publication

[3] Achache, J., 2003. A New Perspective for Earth Observation: The Oxygen (02) Project, European Space Agency, at http://esapub.esrin.esa.it/eoq/eoq71/suppl.pdf

[13] http://catalogues.eoportal.org

[14] http://services.eoportal.org/

[15] http://www.w3.org/TR/wsdl