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CLOUD BASED SERVICES, HIGHLIGHTING NEW GROUND STATIONS AND OPS CONCEPT

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ABSTRACT

The never ending growing need of information, the internet of things, affects the space business. This paper describes how the changing world affects our part of the space business, with focus on ground station network architecture, from geographical location, ground station design, user interface and service delivery, addressing the current and future needs of ground segment services from upcoming constellations of low earth orbiting earth observation and communication satellites. The future needs force us to re-think the ground station concept as we use to know it. SSC has implemented a concept for our new service offering SSC Infinity, based on COTS and standard IT components in combination with technology from space industry. Cloud computing is an essential part of the new architecture which enables scalability, efficiency and ease of use from customer perspective. Many constellations planned today will enable use of smaller ground apertures to lower cost of the ground segment, on the other hand more stations are needed to handle low latency and to get resilience in the network, especially when frequencies go up and becomes more weather dependent. Smart satellite design and SSC Infinity concept of operations will bring ground segment cost down and make it affordable and sustainable. Implementing cloud technology in the design is a way of optimizing terrestrial communication, move processing capacity close to the data source, and enable transparency and accessibility to received data. It also scales from small volumes to infinity.

TRENDS & DRIVERS

The need of information has never been bigger than now, maybe that will always be true, but the recent years lots of things have come to life. The Internet of Things is here and will change everything we know by moving intelligence, processing capacity and internet connectivity out to the very front ends. In our life's we already are connected via smart phones, cars, and more. Now this is moving even further out. In the manufacturing and process industry, valves, fans, electrical motors, all small components will be connected to internet. A large driver for communication and navigation information is the automotive industry. Self-driving cars will be here for real very soon. The technology in the cars is already here, the sensors are mounted and are ready to be used for real, the only thing missing is global internet connectivity and increased navigation accuracy. That's where the ground segment comes into the picture. The need of earth observation data is constantly growing, partly, this could come from all the upcoming new space startups with massive amount of satellites in their plans, but also from significant expansion of institutional earth observation such as the Copernicus Sentinel satellites. Earth observation data is used for a wider and wider variety of areas, from agriculture, forestry, weather and disaster surveillance to parking lot information, traffic, crowds, and many more areas where frequent updates and low latency is key for data to be of any use at all.

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SPACE INDUSTRY CHANGES

The trends and drivers of more connectivity and larger data amounts in general is of course affecting space industry. The internet of things evolution require sensors of all kind. The ground segment provide connections to space objects, which in their turn are components in connecting other sensors. The increasing demand for large volumes and low latency in earth observation business drives to develop new solutions. The new ground network is designed to support satellite constallations that are being launched and very large satellite constellations being planned. Supporting constallations can be done with traditional systems, but to reach a high level of efficiency new requirements are being introduced, as well as an approach for system design including both the ground and space segment to optimize the end-user service that the combined ground and space segment are providing.

SSC INFINITY SOLUTION

The relation between satellite design and efficient ground network design

In the low earth orbit business, polar ground stations and few long duration passes has been the common way of designing space systems for decades. It requires polar stations because of frequent long duration pass requirements, it also requires large antennas on gound because of the long duration passes and the satellite design with nadir pointing and not optimal link budget, especially at low elevations. Large antennas on ground is essential for critical missions such as manned missions, spacecraft emergency, launch and early orbit phase operations, deep space missions and more, but they have a high initial investment and very high cost of ownership because of the size and large mass which makes the mechanics more critical and prone to wear. Large antennas are always long lead items and it takes a long time to establish a new large antenna on a site. It also means that the customer need to pay for this at the end. In order to get the total life cycle cost down for a space system, the satellite can be designed for small ground antennas, by using sequential data recording and data download, enabling multi-ground station tracking during data download operational concept, optimizing the link budget. If the ground network is extended with more locations, the data download may be splitted between different stations, reducing the need of long passes at few stations, but many contacts per orbit instead. Low latency capability will also be a result of such design. A small antenna represents a fraction of the cost of a large one, which in the end will be reflected in the customer price for the service provided. A small antenna can be established in a short period of time, resulting in a scalable infrastructure. Use of higher frequencies will also allow for smaller antennas, both on the spacecraft and on the ground, with increased data rates and capacity. This would be a win-win design. The new ground network has an agile approach in establishment and geographical coverage, where short estabilishment time are prirotized for new sites, and redundancy are approached on a network level with a large number of stations instead of single highly redundant and, for some applications over engineered ground stations

The network design SSC have chosen will give several contacts per orbit for low altitude missions in a variety of inclinations, and is near optimal for land mass coverage constellations.

Scalable architecture on all levels

Ground station infrastructure, an attractive location with an antenna, radio, power and communication are the basic needs. To make the ground segment scalable and flexible, small apertures in combination with a fixed architecture is key. SSC Infinity ground station concept can be reproduced at any location of interest in a short period of time, lowering risk and giving our customers the service they need on time.

The scalability concept is then applied to customer interface, on-site virtual environment, the monitor and control system, using a process industry standard system, a combination of on premise and public cloud data storage, processing capability and data distribution to allow the network to grow with a maintained low cost of ownership, support and service quality.

Customer interface and accessibility

After initial setup, everything a user needs is accessible on the customer portal, a web portal where the customer connects through a web browser for manual interaction or via our web service to hook up the network into the customer planning system. It gives instant access to the network for scheduling, on-orbit services and reporting. Schedule updates and radio configuration are transferred to ground stations for autonomous operation. Via the established network connection, real time S-band data may be transmitted to a satellite and S/X-band data received. Ka- and UHF-band capabilities will be incorporated on customer need basis.

On site environment

The on-site environment at each site is based on a virtual platform with software defined firewalls, monitor and control servers, on premise cloud data storage and application hosting capacity. A standard IT service bus ensures consistent message handling and configuration control between the central system and the different ground stations.

Monitor and Control

The way SSC designed the service assures scalability, performance and sustainability by choosing a process industry standard SCADA system as the main platform for monitor and control, giving all features of such a system with a real time database, trends and analysis tools, report tools, GUI builders, security and user control. The system can handle thousands of front end equipment and we use it for all types of information from antenna and radio data to cameras, weather information, temperatures in antenna radome, equipment shelter and more.

On premise and public cloud combination

The data handling architecture is based on a combination of on premise and public cloud services. The on premise solution will, from a customer perspective give full transparency to customer data received on different ground stations, all data will appear in one place despite the fact it reside at different physical locations. It also allows customer processing software to be hosted locally where the data reside, making it possible to conduct first stage processing and determine data quality such as level of clouds or similar, giving the opportunity to discard a set of data early to save terrestrial communication or public cloud data retrieval cost. Data can be retrieved by using the public cloud as data carrier, data will be uploaded from the on premise cloud to nearest public cloud data center accessible from everywhere.

CHALLENGES

The architecture described here is not “Rocket Science”, it just a combination of off the shelve systems and standard IT, and the space specific part of the service chain is still a challenge. Especially for a commercial service provider, always aiming for multi mission capability to give all customers a share of the economy of scale that comes with sharing resources, exactly as all the large cloud service providers do.

Space specific technology

The antenna is the simplest part of a ground station, it has looked the same for many decades, and the challenge in handling large volumes and many different customers comes in the next step, the radios. There are many different radios used today, and there is currently no radio that is truly multi mission. The radio component itself is still very expensive and not that versatile. There are many software defined radios on the market, but most of them with decent performance are still expensive. But, this is a fast developing area, and the introduction of general purpose SDR systems will make life easier, especially in combination with virtual environments and scalable processing power, and will drive cost down as more standards are used and the low level processing capacity increases.

Standardization

The lack of standardization for space systems is a challenge and touch on in section above. There are many different protocols and interfaces used today in every step in the chain from scheduling a satellite pass, send a command and receive data from a spacecraft. In comparison with process industry where automation and large volumes has driven the standardization way ahead of the space industry with widely used process buses, front end equipment interfaces and monitor and control systems.

Security

When introducing cloud computing, which by definition is to share resources among many users to reach scalability and economy of scale, security concerns will arise. Can the provider assure data integrity and system protection? The commercial cloud providers are growing fast and put in large efforts to convince us that they can. This is not an easy question to answer. The question may be what level of security am I willing to pay for? On the other hand, a cloud based solution may provide a far more reliable system than a pure on premise solution with a comparable or lower cost, so there are many aspects of security to consider.