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Predict the Future of the Telecommunications Sector Remote Sensing Stations, Identify Opportunities and Threats and Solutions

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ABSTRACT: Prediction future of remote sensing stations telecommunication part, recognize opportunities and threats and present solutions during the 40 years of remote sensing, a remarkable development such as improving the resolution of imaging sensors has occurred, followed by the promotion of telecommunication subsystems in order to send, receive and analyze data with a higher bit rate or applying phased array antennas. Alongside with these developments, so many measures have been taken in order to manage the received images and present them to users. Among all, setting up GEONETCast and defining the project of networking satellites could be mentioned. However, in order for the remote sensing receiving stations to be developed well, the roadmap of the countries who already have this technology should be followed. One of the parts of the earth station which is at the forefront of developments, is telecommunication. That is because an earth station is established based on telecommunication requirements; furthermore, the telecommunication subsystems have a noticeable share in the expenditures. In this paper, regarding the present evidence, the future changes of space remote sensing have been introduced; moreover, future stations have been defined according to the previous experience. Nevertheless, as entering this new field is accompanied by opportunities and threats, they have been recognized and some solutions have been presented.

Introduction

The importance of Satellite images remote sensing and unique applications is not secret so that when users of these images is limited to the city of engineers projects, roads, mines, agriculture, forestry or military sector, is now offering coordinates of satellite images by Google, this subject finds a more general form. Forty years in the life of the operation of remote sensing satellite images, the need of users constantly enhance so that the satellite sensors are also more up to date (Press Release, 2014).

Of the most important requests users the following:

Request images with precision and higher quality

Increasing the number of bands radiometric

Reduce the time to repeat the shooting of a particular area in order to better monitor the area

Possibility seeing, Places that out of sight of land station

Possibility of obtaining different satellites at a time

Increase the number of ground stations to lower vulnerability in times of crisis (passive defense)

In order to cover the demands of one and two, the quality of satellite cameras is improved. To apply three, apart from sending more remote sensing satellites, aircraft equipped with imaging cameras and later UAV drones also joined the group receiving remote sensing data. Request four by providing data storage systems on satellite and during the night transitions satellite images were performed. Request five and six with increase the number of receive stations was solved. so that in the past four decades, gradually images accuracy from the accuracy of 80 meters to half a meter reached. But increasing the accuracy of a sensor, a direct relationship with the increasing volume of data received by satellite and to increase the volume of data the issue of increasing the bitrate sending by the satellite arises. That's why the necessity of the bit rate of 15 Mbps to bit rate of 300 Mbps and higher, reach (Morio Toyoshima, 2005) So that from 2007, worldview-1 satellite with an accuracy of half a meter and accurately captures 11 bits per pixel, could send Imaging data with bitrate 800 Mbps in X-band to Earth, and at any time seeing satellite, information stored in raid of ground station was more than forty gigabytes. The reason of increase in the bitrate, data volume received by the satellite was very high and the volume of data in a short time (The time between rise and set satellite, observer from the ground) were sent.

Along with this development the subsystems of telecommunication and servers receive online improved but there are still problems, for example if the drone was shot from a particular area takes a lot of time so a user can use the images of the area or to set up and maintain a ground station for satellite images is very expensive and imagine we have need the same number of stations for solve problem five and six. But if a network connection of LEO satellites and other remote sensing systems, due to the increase of systems Record Pictures, the possibility of reducing the time to visit again from one region to monitor the region, Provided. But still there are a lot of problems at set up a ground station and related to bandwidth and time users quick access to pictures, in which this issue was resolved with advances in optical telecommunications.

As you will see, in order to meet the needs of users, major changes in spatial section remote sensing satellites will be done that these changes will be caused fundamental changes in the telecommunications sector ground stations. But before discuss about next station, be sure to know a variety of ground stations to receive satellite imagery remote sensing.

A) Station in the GEONETCast system:

Mission of GEO NETCast system is share images of remote sensing with the following objectives (Cesar de Mello et al., 2012):

Manage crises caused by natural disasters
Analysis of meteorological data
Energy and Water Resources Management
Prevention of disasters at coastline such as the tsunami
Use on issues related to desertification

The system which is a global network, has three important center in the name of EUMETCast, GEONETCast Americas and FENGYUNGCast that these centers are the main nodes of the network.

The network topology is in Fig. 1. Inputs of this network are involve: recorded images by drones, Pictures remote sensing satellites, and recorded images by Oceanography.

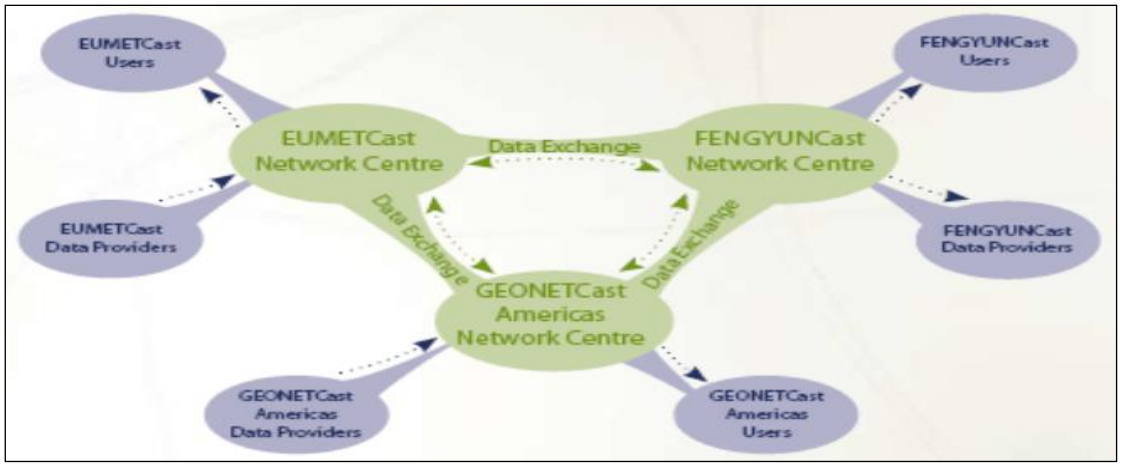

Figure 1. GEONETCast system topology

GEONETCast network coverage map is given in the figure 2 below.

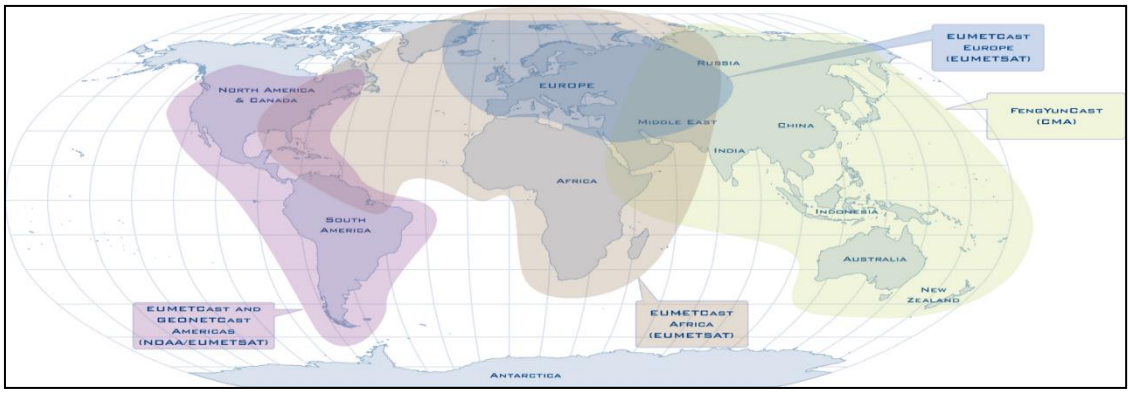

Figure 2. Global coverage map GEONETCast system

Fig. 3 shows one of nodes of GEONETCast network that related to the European sector of this network. As seen in Fig. 3, European users of the satellite HotBird-6, American users of satellite NewSkies-806 and African users of AtlanticBird-3 that all GEO satellites orbit, receive information. By this network European users able receive information with a bitrate 12Mbps, American users with a bitrate 2Mbps and 3Mbps bitrate of African users. Therefore subsystems telecommunication needed to get, was very simple and do not need tracking subsystems satellite.

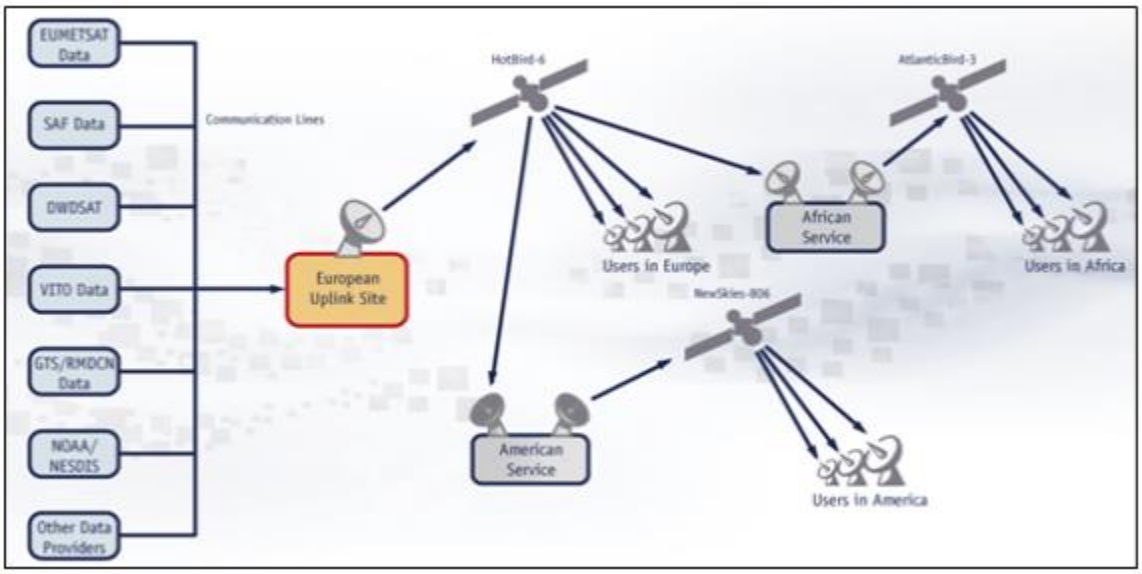

Figure 3. Nodes European section GEONETCast network

Specifications required to set up a ground station GEONETCast system is as follows:
Reflector 1.5m
C-band feed
DVB card is installed on the computer.
The application to receive and process images
The total cost of setting up a ground station is about six thousand dollars.

Fixed ground stations

Although GEONETCast system has the advantages benefits of the operation of the satellite network and reduce the size of the antenna and totally reduce the price of ground stations but to satellites with low Accuracy Local is limited.
So if we need to high-resolution images, have to use fixed ground station with characteristics Table. 1.
As an inferred from Table 1, the cost of setting up a fixed station is More than half a million dollars (Björn Gütlich et al., 2014) than it has other disadvantages that are mentioned below:
High maintenance costs
Limit construction of the station at any point since the establishment of the station must be flat noise survey area and in flat place so that the Earth is spherical.
Low coverage radius. Receive system similar table 1 can be covered area with a radius of 2,800 km.

Table 1. Characteristics of a fixed ground station for satellite remote sensing images

Reflector	Cassegrain with a diameter of ten meters
feed	Four X-band horn
Tracking system	mono-pulse
RF section	Including subsystems, lowering frequencies up to 720MHz
IF section	Including subsystems the EQ and signal distribution
Modulator	Has the ability to receive different satellites with a bit rate of 320 Mbps
Section servo control	Equipped with amplifiers the error signal to apply to servo motors and gearboxes
Servo Motor	Has the ability to move antennas to rate
Server	High-speed computers capable of receiving and processing online

Moving ground stations

These stations to receive data from remote sensing satellites with high rates are used and they are far more than a strategic ground stations hence when aware of the danger, can be moved to another place. Characteristics these stations is like a table 1 with the difference that Antenna reflector is less than five meters in diameter.

Future changes of ground stations is based on recent developments space section, so first we will discuss the developments in the space sector. In the future space sector, with help the optical telecommunication will achieve two important features: first the possibility of transmitting data at high rates provided second with improved light sources satellite communications capability to 45,000 km will become available.

History optical telecommunication in space:

For the following reasons optical telecommunication in space is growing by the day (Dave Robie and Simon Drygalla, 2014)

Frequency Rules are not included it

Ability to send and receive rates up

Jamming protection

Communication via optical telecommunication is divided to two section, inside satellite telecommunications and between satellite telecommunications.

In 1990, the optical telecommunication system for sending and receiving TB (Terabyte) in different parts of the International Space Station was used so that the first application of optical telecommunications in satellite was formed. Because of using the optical telecommunication system in satellite ,due to low weight and volume, non-interference and low power optical systems, respectively(Nikos Karafolas et al., 2009).

VCSEL laser source used in the satellite, which is made of gallium arsenide and its wavelength is 850nm. The rate of sending information with this source, arrives to 110 (Nikos Karafolas et al., 2009).

In between satellite telecommunications, sending information takes place from satellite or UAV to GEO satellites.

In optical telecommunications between satellites, the send subsystems, from Satellite or UAV to GEO satellite based on optical telecommunications and sending and receiving system based on laser, works. (Press Release, 2014; Nikos Karafolas et al., 2009).The laser system result of over thirty years of union shop space and Airbus Europe as project the communication between the satellite is designed.

The first generation of laser communication was the communication between the American NFIRE and TerraSAR-X of Space Union Europe in year 2007(Figure Three), the two satellites were in LEO orbit at distances of about 5000 km, by laser with wavelength 1064nm able to send and receive data with bit rates of 5.625Gbps (Simon Drygalla, 2014).

Importantly, that after more than seven years, the system is still active (Simon Drygalla, 2014).

The laser system uses an antenna with a diameter of 12.5 cm that total weight was 3 kg and power consumption lower than 1000mW (Nikos Karafolas et al., 2009).

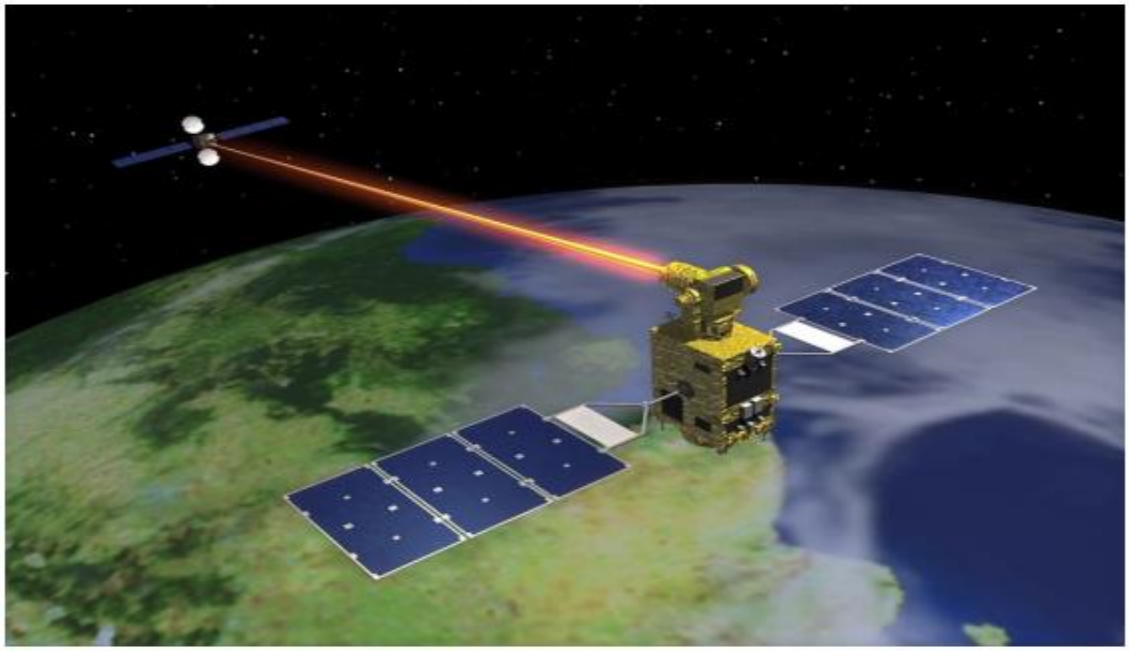

Figure 3. Connection between two satellites on LEO orbit was the first laser connection between satellites.

The second generation laser communication was established in 2013. The new generation laser communication with 1.8Gbps bandwidth, had been established between a satellite in LEO orbit and a satellite in GEO orbit, which were 45000 km away from together (Fig. 3) (Simon Drygalla, 2014).

The laser system uses an antenna with a diameter of 25 cm that total weight was 150 kg and power consumption lower than 40mW (Nikos Karafolas et al., 2009).

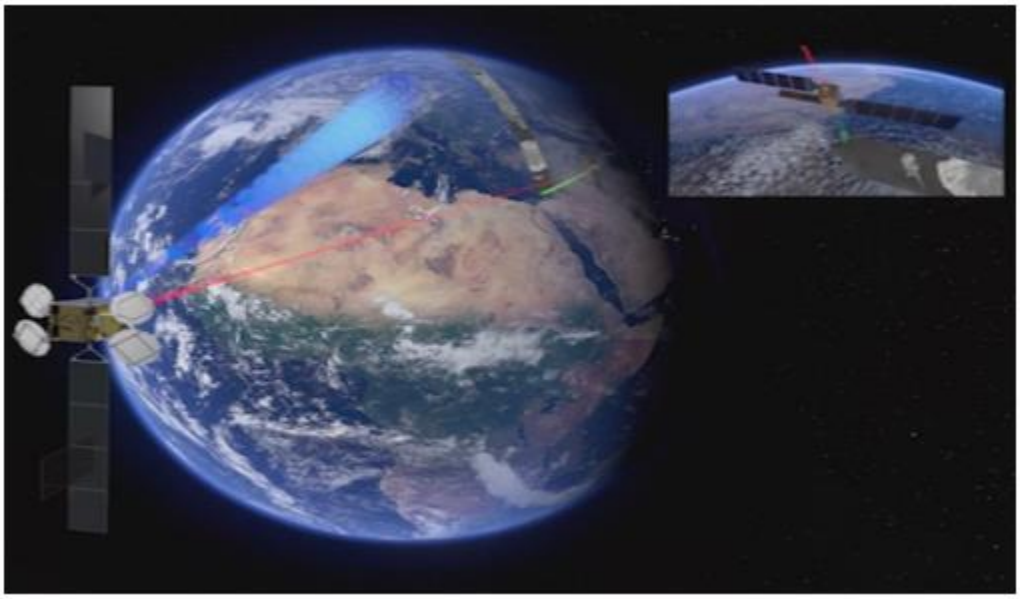

Figure 4. Connection between imaging satellite on LEO orbit with satellite on GEO orbit by laser system

Current laser system capable of sending data at a bit rate of 1.8 Gbps to GEO satellites, so the beneficiaries of this system will be able to get high quality pictures (Michael Witting et al. 2012).

Given the positive results of recent tests, the European Space Union that is leader of EDRS project, reported from the project's completion until mid-2017 (Michael Witting et al. 2012).

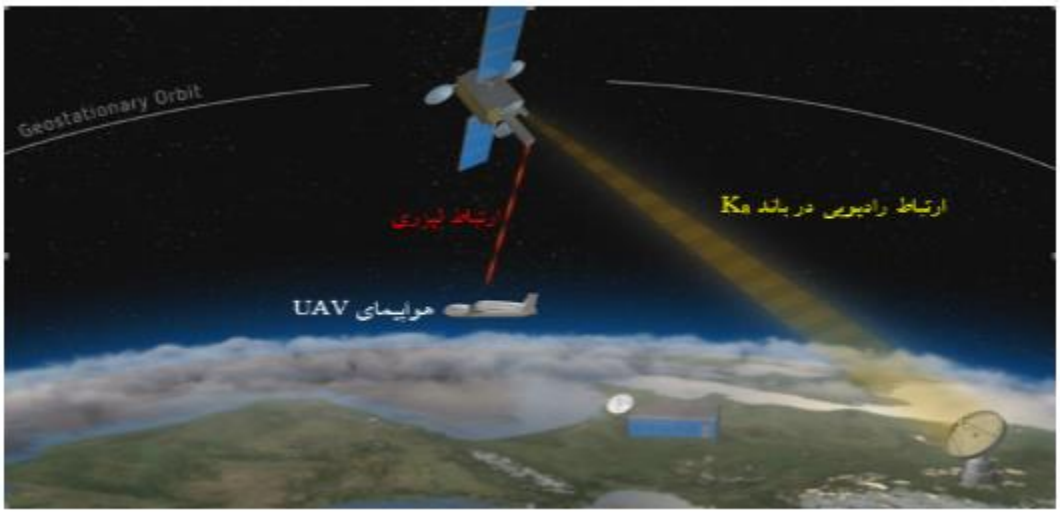

Figure 5. Connection between UHV imaging aircraft on LEO orbit with satellite on GEO orbit by system

Achievement using optical telecommunication between satellites

Because equipping a variety of systems remote sensing images Such as optical and radar satellites and drones to Laser transmitter, the possibility time of revisiting of a region decreases. (Nikos Karafolas et al., 2009).

Because of getting data from GEO satellites do not need to have a system with characteristics from table1, but can be used of high-quality information received by the telecommunication subsystems GEONETCast system (Michael Witting et al. 2012).

Optical technology has several benefits over the radio communication that including it possible to reduce power requirements and weight of optical systems as well as cost noted.

Future ground stations

Performance of future stations, is a combination from fixed stations and GEONETCast system (Michael Hirka, 2014).In the future remote sensing satellites and UAV aircrafts instead of sending data to ground stations relay that to GEO satellites (the four and five) and then the same GEONETCast system, ground stations with the simple telecommunication subsystems (Like what was in GEONETCast stations) receive this information.

Future stations without need for tracking systems, receive with high bitrate from data GEO satellites. Because of reduce size of antennas, used in future stations, its price is significantly lower and therefore can be easily installed several stations in different areas till Receive operations are not disrupted in a crisis. Because of reduce size of antenna, design ground station is much easier and receiving station can even be installed on Ferries and ships to easily design. Note that receiving systems of GEO satellite that installed on the ship are already exist.

Results and discussion

By investigation Road map Countries that have laser technology such as Germany (Morio Toyoshima, 2005) and Serious determination of European Space Union to launched Operational network between satellite (Michael Witting et al. 2012) no doubt the use of the communication system between satellite is in the near future, In addition to the evidence presented, Another witness Is the claim of the German Aerospace Center, Which says: " optical telecommunication in space is one strategic technology" and even their own laser development program until 2036 is also planned (Morio Toyoshima, 2005) as well as a comparison in the table 2 about receiving stations Remote sensing images is taken place It is quite obvious that the new generation of remote sensing ground stations all cover Indicators of Case Opinion, including considerations of user, price and passive defense, cover.

Before any action is required opportunities and threats associated with the new approach of the space and ground-based remote sensing to be checked.

Opportunities

Access to full cover image in less time
Reduce the time to repeat viewing area
Ability to view the out-of-sight antennas
Reduce the cost of installation of new stations
Reduce maintenance costs and reduce the cost of station staff
Ability to receive information at any hour of the day
Due to the reduced dimensions of the antenna can be easily hidden in a cover (passive defense)

Table2. Comparison between ground stations to meet the needs of users

	The major Requests of users	To respond to user needs by GEONETCast system	Fixed ground station	Moving Ground station	Future station
1	Pictures with precision and higher quality	×	√	√	√
2	Increasing the number of radiometric bands	×	√	√	√
3	Reduce the repeat shooting	√	×	×	√
4	Possibility seeing, Places that out of sight of station	√	×	×	√
5	The operation of the satellites at one time	√	×	×	√
6	Increase the number of ground stations to lower vulnerability in times of crisis	√	Costly	Costly	√

Threats

Because the technology is available to European countries and America Possible monitoring of sensitive sites with less visitors and provided with cameras with resolution more.

If in the best condition to be accepted as one of the users of the system, Access to areas out of sight of the current antenna is still there.

Because the information complex in a central, the possibility of further analysis of area with images interpreter software, increase. For example, in the IRS satellite images from other sensors bands in images are used 2.5 meters White and black and so the colored 2.5m image is produced which has many applications.

Since the network between satellites is still not in operation and will be operational by 2020. It is suggested that preventive measures are as follows:

Identify and support projects with a focus on decoding transmissions data of GEO satellites. In this context, Design and construction projects modulator and decoder with high bitrate also been successfully completed.

Planning organizations and institutions in the field of remote sensing to join the GEONETCast system for basic familiarity with key parameters of a fixed station GEONETCast. It's a similar experience for fixed ground station has been very successful ten-year history .which led to the production of two land Native fixed station.

accelerate the projects of the National Space remote sensing satellites

Design related projects in space optical telecommunication in graduate and Ph.D. Sections.

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