

Spectrum Management of Space Services

Scott Kotler

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STOTES OF MUSIC

Outline

- 1. Satellite functions and services
- 2. Satellite orbits
- 3. ITU satellite network registration
- 4. NTIA and U.S. national process

Satellite Functions and Services

- Communications:
 - Fixed-Satellite Service (FSS)
 - Broadcast-Satellite Service (BSS)
 - Mobile-Satellite Service (MSS)
- Radiodetermination Satellite Service (RDSS)
 - Radionavigation Satellite Service (RNSS)
- Earth Remote Sensing: Earth Exploration Satellite Service (EESS)
 - Weather: Meteorological Satellite Service (MetSat)
- Scientific Research: Space Research Service (SRS)
- Others:
 - Space Operation Service (SOS)
 - Inter-Satellite Service (ISS)

Communications Satellites

- Satellite acts as relay stations in space
 - Commonly known as "bent pipe" principle
- Transmit messages from one part of the world to another wide area coverage of earth stations
- Messages can be audio, video, or data



- Aeronautical Mobile Satellite (Route) Service
- Radionavigation Satellite Service
 - Includes GPS, Galileo, and GLONASS
- Others
 - Aeronautical Mobile Satellite Service
 - Aeronautical Mobile (OR) Satellite Service

Earth-Exploration Satellite

- Better known as remote sensing satellite
- Studies Earth's surface, e.g., plant cover, chemical composition, surface water
- Also, changes in the Earth's surface, e.g., deforestation, desertification
- Information useful in farming, fishing, mining, and many other industries



EESS (passive)

- Measurement of naturally occurring radiations, usually of very low power levels, which contain essential information about the physical process under investigation
- All material is continually radiating electromagnetic energy; each molecule in the atmosphere or each surface has unique frequency characteristics, and therefore it can be recognized from its predetermined fixed spectral signature

EESS (active)

- Active observation technique differs from passive sensing in that it involves both transmitters and receivers
- In general, one considers five key <u>active</u> spaceborne sensor types:
 - Synthetic Aperture Radar (SAR)
 - Altimeters
 - Scatterometers
 - Precipitation radars
 - Cloud profile radars



Meteorological-Satellite (MetSat)

- Meteorological-satellites have many instruments:
 - cameras to provide images of cloud formations
 - instrument to measure temperature, moisture, and solar radiation in the atmosphere
- In the U.S., the National Oceanic and Atmospheric Administration (NOAA) operates MetSats in a polar orbit (Polar Operational Environmental Satellites, or POES) and geostationary satellite orbit (Geostationary Operational Environmental Satellites, or GOES)
- Using these groups of satellites, meteorologists around the world study weather and climate parameters to forecast weather, track storms, and do scientific research





Satellite Orbit

Selection of a satellite orbit depends on coverage and other requirements

- Geosynchronous and geostationary (GEO): 35,786 km
- Low Earth orbit (LEO): 500 to 1000 Km
- Medium Earth orbit (MEO): 1000 to 20,000 km
- Polar orbit & sun synchronous
- Highly Elliptical Orbits (HEO): up to about 40,000 km



GEOSTATIONARY ORBIT



Original figure from Arthur C. Clarke's article in the October 1945 edition of Wireless World





Types of Orbits







Components of Remote Sensing Satellite



http://www.thetech.org/exhibits/online/satellite/



GEO SATELLITE



Boeing 601

Earth Station

- Transmit
 - Power source
 - Interface to user or network
 - Modulator (IF)
 - Filter
 - Up-converter (RF)
 - High power amplifier
 - Transmit antenna

- Receive
 - Receive antenna
 - Filter
 - Low noise amplifier
 - Down-converter to IF
 - Demodulator
 - Interface to user or network

Example VSAT Earth Station

Gilat SkyStar VSAT:

- Outdoor unit
 - Antenna (Ku-band:
 0.55 to 1.2m, C-band:
 1.8m)
 - HPA (optional 0.5, 1, and 2 Watts)
- Terminal
 - Dimensions: 6 cm (h) x
 40 cm (w) x 34 cm (d)
 - Weight: 3.9 kg



http://www.gilat.com/

Int'l Frequency Registration of Space Services

- Advance publication Information (API)
- Coordination
- Notification

Advanced Publication Information (API)

- API date of receipt starts the DBIU (date of bringing into use) clock
 - If assignment not BIU in 7 years, filing is canceled
 - If coordination request not received within 2 years of API, the API is cancelled
- APIs published in ITU's (International Telecommunication Union) bi-weekly IFIC (International Frequency Information Circular)
- If network subject to coordination process, then information submitted is very general

International Frequency Information Circular (IFIC)

- Published bi-weekly on CD-ROM for all ITU members
 - Opportunity to verify if the intended new satellite network (or changes to existing ones) would create unacceptable interference to your network
 - 4 month time limit from date of publication to provide comments



Coordination

- Coordination publication info is created with ITU SpaceCap software
- This filing contains detailed info about satellite network
- Coordination receipt date determines coordination priority to other satellite networks
 - Earliest date is 6 months after API date of receipt



Coordination (cont'd)

- Coordination publication analyzed by ITU staff
 - Checks data submitted conforms with the Convention, Table of Frequency Allocations, other provisions of the Radio Regulations
- ITU determines networks for which a specific filing requires coordination



Coordination (cont'd)

- WRC-12 adopted Definitive List of Networks for Coordination
 - All Administrations have opportunity to add effected networks to the list in which the satellite network must coordinate
- Coordination between Administrations takes place to resolve anticipated difficulties



Notification

- Notification takes place prior to the end of the 7 year DBIU period and lists coordination status
- Favorable finding by BR allows network to be added to the MIFR (Master International Frequency Register)
 - Frequencies registered in the MIFR have obtained international recognition



Bringing Into Use & Suspension

- WRC-12 Adopted provision No. 11.44B on Bringing Into Use assignments for GSO Networks
 - Requires a GSO satellite to be capable of transmitting/receiving the frequency assignment
 - Requires 90 day deployment at orbital position
- WRC-12 revised provisions for suspending assignments
 - Administrations must suspend assignments not in use for at least 6 months within 6 months of suspending use
 - Administrations now have 3 years to resume use of an assignment
 - To bring back into use an assignment for a GSO network must deploy a GSO satellite for 90 days having the capability of transmitting/receiving the frequency assignment





NTIA & U.S. NATIONAL PROCESS





IRAC FUNCTIONS

- The Interdepartment Radio Advisory Committee (IRAC) assists NTIA in assigning frequencies to U.S. Government uses and developing procedures, and technical criteria
- IRAC is the principal mechanism for NTIA to get Federal Agency advice on spectrum issues being considered by the FCC
- The IRAC includes 6 subcommittees and several Ad Hoc groups – it is chaired by OSM Administrator
- IRAC has been operating since 1922









SPACE SYSTEMS SUBCOMMITTEE (SSS)

- The SSS is responsible to the IRAC for international registration of U.S. Federal Government satellite systems with the ITU.
- All agencies operating satellite systems are entitled to participate



SSS Mission

- (a) review, modify, develop, and maintain the procedures for national implementation of the space related provisions of the ITU Radio Regulations;
- (b) advance publish, coordinate, and notify Government space systems under the applicable provisions of the ITU Radio Regulations;
- (c) respond to the data furnished by other Administrations and the BR regarding proposed space telecommunications systems in accordance with the applicable provisions of the ITU Radio Regulations;
- (d) normally process all internationals actions through the FCC.

Excerpt from 3.3.2 Provision of Information Regarding Satellite Networks in Planned Satellite Systems:

As a matter of policy, advance publication information, coordination information (as necessary), and notices of frequency assignments relating to space systems shall be submitted to the BR. Exceptions to this policy will be made only by the NTIA on a case-by-case basis.

It is the practice of the United States not to submit space system information to the BR if: i) the intended use is for a short period of time (on the order of 12 months or less); ii) the intended use is not in accordance with the Table of Frequency Allocations of the ITU RR, or iii) national security is affected.



Contact

Scott Kotler NTIA/U.S. Dept of Commerce 1401 Constitution Ave., NW Washington, DC 20230 Phone: 202-482-7983 skotler@ntia.doc.gov





Additional Information



INTELSAT FSS Satellite



Intelsat satellites are multi-frequency communications satellites that provide voice, video, data transmission, and distribution to virtually any location in the world.

http://ssloral.com/





GOES



GOES spacecraft deliver simultaneous, independent imaging and sounding from the geostationary orbit. They also feature a flexible earth-scanning capability supporting near-term forecasts for local areas

http://ssloral.com/



Hurricane Images from Meteorological Satellites



http://www.thetech.org/exhibits/online/satellite/



http://www.thetech.org/exhibits/ online/satellite/home.html





LANDSAT-7



Landsat is the longest running remote sensing satellite program in the world. It gathers data from Earth's land surface and surrounding coastal region, providing info on deforestation, receding glaciers and crop monitoring.

http://landsat.gsfc.nasa.gov/







Images of Deforestation from Earth-Exploration Satellite





http://www.thetech.org/exhibits/online/satellite/





SOHO



SOHO is designed to study the internal structure of the Sun, its extensive outer atmosphere and the origin of the solar wind, the stream of highly ionized gas that blows continuously outward through the Solar System.

From NASA



Image of the Sun from SOHO Satellite



From NASA



GEO Example: XM RADIO

• GEO System

- Rock @ 115W
- Roll @ 85W
- DARS Digital Audio Radio Service
 - 2310-2360 MHz







HEO Example: Original Sirius Radio



- HEO System using 3 satellites with 8 hour "operational" orbits

- Perigee -24,470 km





FIXED-SATELLITE SERVICE

GOVERNMENT (DOD)

- USGCSS (DSCS)
- MILSTAR
- FLTSATCOM (8/7, 40/20GHZ)
- GBS/JBS

NON-GOVERNMENT

- Intelsat (merged w/ Panamsat)
- SES World Skies (merged w/New Skies)
- Telesat Canada (merged w/Loral Skynet)



MOBILE-SATELLITE SERVICE

DOD

- USGCSS (DSCS)
- MILSTAR
- FLTSATCOM (8/7 GHZ)
- UHF (MARISAT, LESAT, FLTSATCOM)
- GBS/JBS

DOC

- COSPAS-SARSAT (SEARCH & RESCUE) NON-GOVERNMENT
- INMARSAT
- LightSquared (formerly MSV and SkyTerra)
- IRIDIUM
- GLOBALSTAR
- THURAYA



RADIONAVIGATION-SATELLITE SERVICE (RNSS)

DOD

• NAVSTAR GPS (operated by DoD)

FOREIGN

- GLONASS (RUSSIA)
- GALILEO (Europe)
- COMPASS (China)
- Japan (QZSS)



EARTH EXPLORATION-SATELLITE SERVICE

DoC/NASA/DoD

• <u>AQUA</u>

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- <u>AURA</u>
- CALIPSO
- CORIOLIS
- EOS AM
- EOS PM
- GIFTS
- <u>ICESAT</u>
- <u>LANDSAT</u>
- <u>NMP/EO-1</u>
- <u>PICASSO</u>
- <u>VCL</u>

NON-GOVERNMENT

- QUICKBIRD
- ORBIMAGE
- IKONOS

FOREIGN

- IRS (IND)
- JERS (J)
- RADARSAT (CAN)
- SPOT(F)



NOAA (DOC)

- GOES
- NOAA/TIROS

FOREIGN

- GOMS (RUSSIA)
- FY (CHINA)
- GMS (JAPAN)
- METEOSAT/MSG (EUROPE)





INTER-SATELLITE SERVICE

DOD

• MILSTAR

NON-GOVERNMENT

• IRIDIUM



SPACE RESEARCH SERVICE (NASA/DoD)

• ACE

- ACRIMSAT
- AURA
- AXAF-1
- CASSINI
- CHIPS
- COMET
- ERBS
- FAST
- FUSE
- GALEX
- GALILEO
- GRAVITY PROBE-B
- GRO OMNI
- HELIOS-1
- HESSI
- HETE
- IMAGE
- INTNL SPACE STN ACS
- ION-F
- ISS ECOMM
- ISTP POLAR
- ISTP WIND
- MAP
- MICROLAB-1
- NIMBUS-7
- NOAA-KLM

- PIONEER-10
- PIONEER-11
- PIONEER-6
- PIONEER-7
- PIONEER-8
- QUIKSCAT
- QUIKTOMS
- SAMPEX
- SEASTAR
- SNOE
- SORCE
- SPACE SHUTTLE
- ST OMNI
- SWAS
- SWIFT
- TERRIERS
- TIMED
- TOMS-EP
- TOPEX/POSEIDON
- TRACE
- TRMM
- UARS
- USAGENESIS
- VCL
- VOYAGER-1
- VOYAGER-2
- WAKE SHIELD FACILITY
- XTE



BANDS (SAMPLE)

MSS(ESta)

137	138	EESS	SOS	SRS
148	149.9	SOS	SRS	MSS(ESta)
149.9	150.05	MSS(ESta)		
235	322	MSS		
335.4	399.9	MSS		
400.15	401	EESS	SRS	MSS(ESta)
401	403	EESS		
406	406.1	SRS		
410	420	SRS		
460	470	EESS		
1164	1189	RNSS		
1189	1215	RNSS		
1215	1240	RNSS		
1525	1559	MSS		
1559	1610	RNSS		
1610	1626.5	MSS(ESta)	RDSS	
1626.5	1660	MSS		
1675	1710	METSAT		
1761	1842	SOS		
2025	2110	SOS	SRS	EESS
2110	2120	SRS		
2200	2290	SOS	SRS	EESS
2290	2300	SRS		

2483.5	2500	MSS(ESta)		
7125	7190	SRS		
7190	7235	SRS		
7250	7300	FSS	MSS	
7300	7450	FSS	METSAT	mss
7450	7750	FSS	mss	
7750	7850	METSAT		
7900	8025	FSS	MSS	
8025	8400	FSS	EESS	METSAT
8175	8400	FSS	EESS	mss
8400	8450	SRS		
8450	8500	SRS		
13400	14050	SRS		
14500	15350	srs		
17800	20200	FSS		
20200	21200	FSS	MSS	
22550	23550	ISS		
24450	24750	ISS		
25250	25500	ISS		
25500	27500	ISS	EESS	
30000	31000	FSS	MSS	
31800	32300	SRS		
33000	36000	FSS		
37000	38000	SRS		
39500	40500	FSS	MSS	
40500	41000	FSS?	MSS?	
42500	45500	FSS	MSS	
45500	47000	MSS		
48200	50200	FSS		
50400	51400	FSS	MSS	
59000	65000	ISS		
71000	76000	FSS	MSS	
81000	86000	FSS	MSS	

mss

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