Efficient and Effective Usage of Ka-band in Asia-Pacific

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Prospects for use of the Ka-band by satellite communication systems
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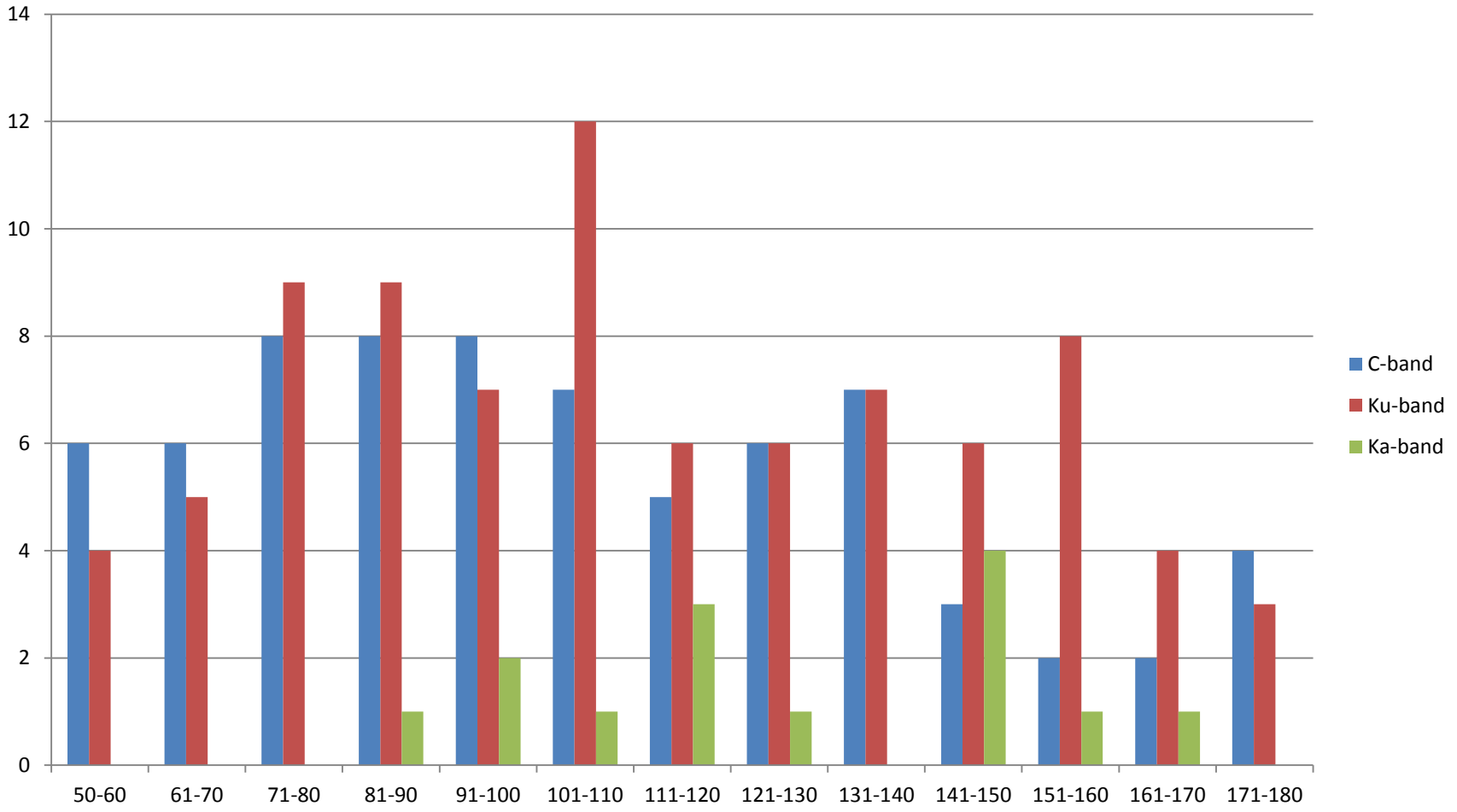
Agenda

- Advantage & Necessity of Ka-band in Asia-Pacific
- Technical: Behavior of Ka-band in high-rain zone region
- Attenuation Mitigation Techniques
- Ka-band Ground System Implementation
- Licensing

ADVANTAGE & NECESSITY OF KA-BAND IN ASIA-PACIFIC

Satellites in Asia-Pacific by orbital slots

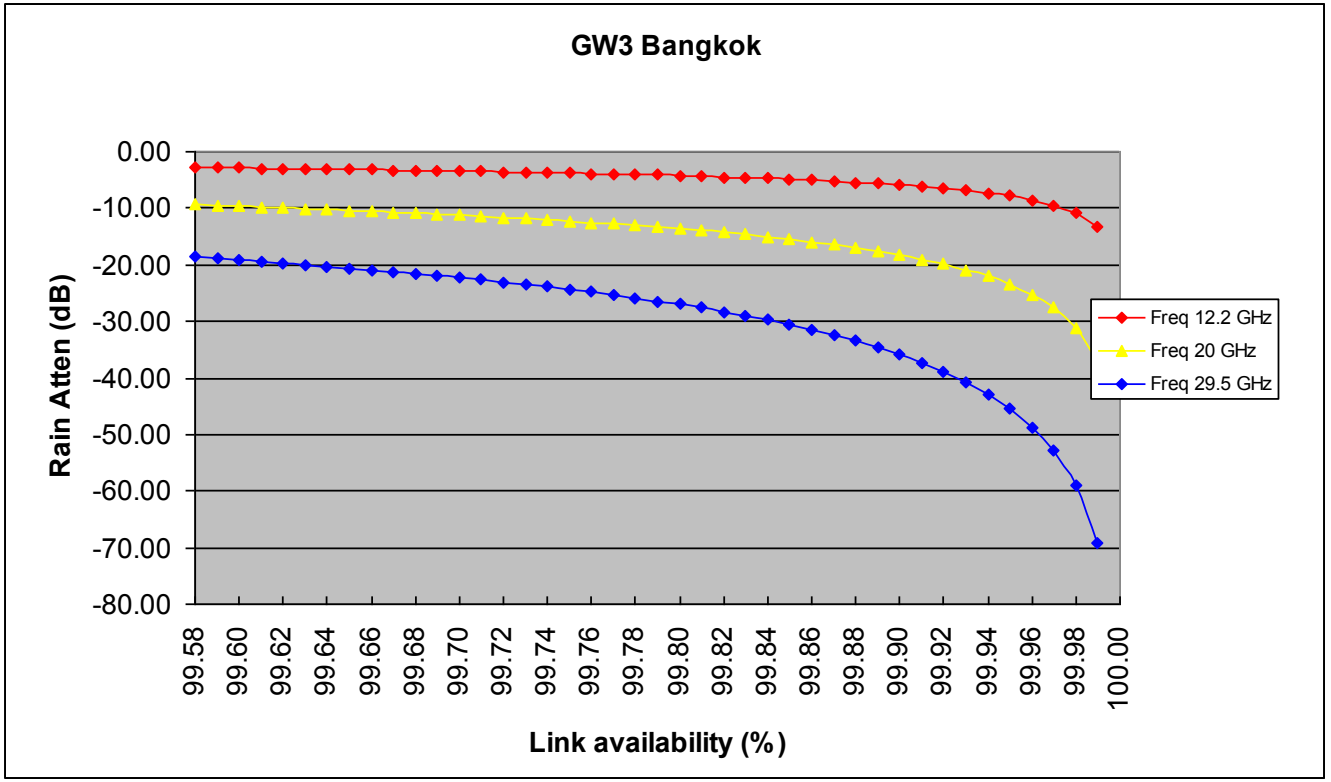


Advantages of Ka-band

- Less congestion compare to C and Ku band in this region
- Wide bandwidth available (3.5 - 4.0 GHz)
  - C-band:
    - Downlink: 3.4-4.2 GHz (BW:800MHz)
    - Uplink: 5.850-6.725 GHz (BW: 875MHz)
  - Ku-band:
    - Downlink: 10.95-11.2/11.45-11.7/12.2-12.75 GHz (BW:1.05 GHz)
    - Uplink: 13.75-14.5 GHz (BW:750 GHz)
  - Ka-Band
    - DOWNLINK: 17.7-21.2 GHz
    - UPLINK: 27-31 GHz

TECHNICAL: BEHAVIOR OF KA-BAND IN HIGH-RAIN ZONE REGION

ITU: Rain Attenuation vs. Link availability



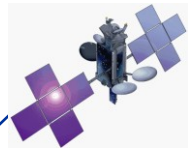
Rain attenuation divided by frequency with same location:

Freq 12.2 GHz → Max attenuation @ link avail 99.8% = -4 dB

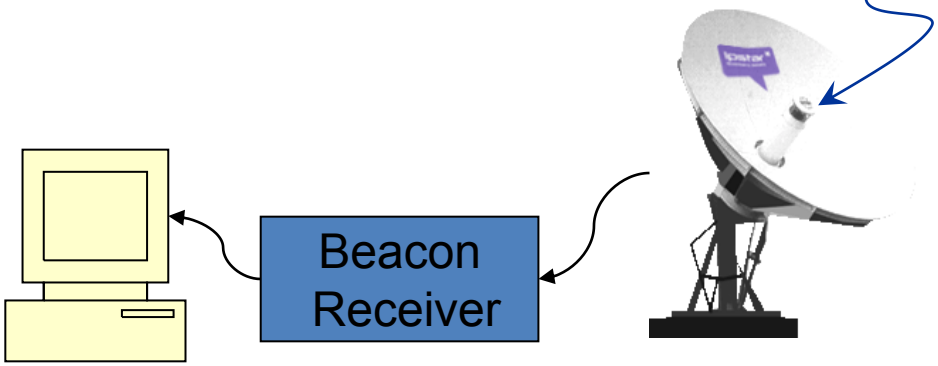
Freq 20 GHz → Max attenuation @ link avail 99.8% = -13 dB

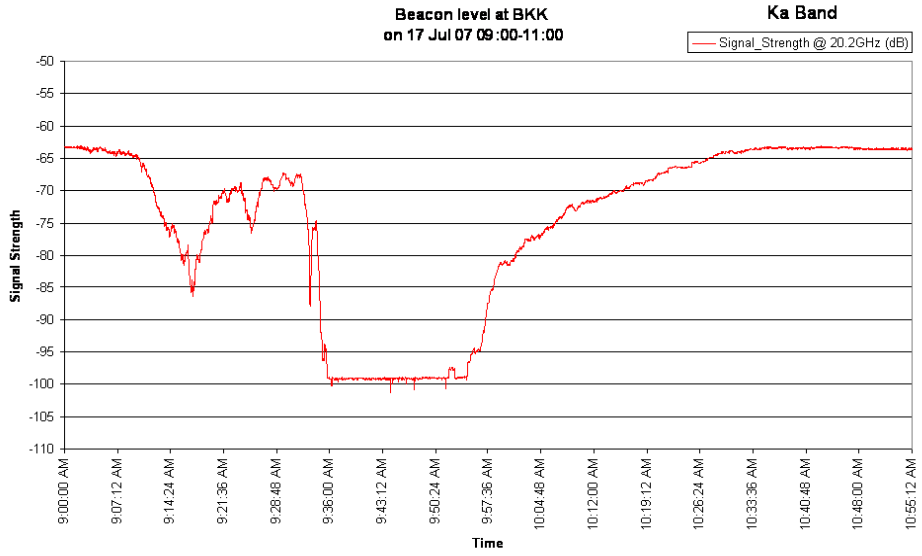
Freq 29.5 GHz → Max attenuation @ link avail 99.8% = -27 dB

Rain Attenuation Measurement: Beacon Receiver



20.199 GHz, LHCP



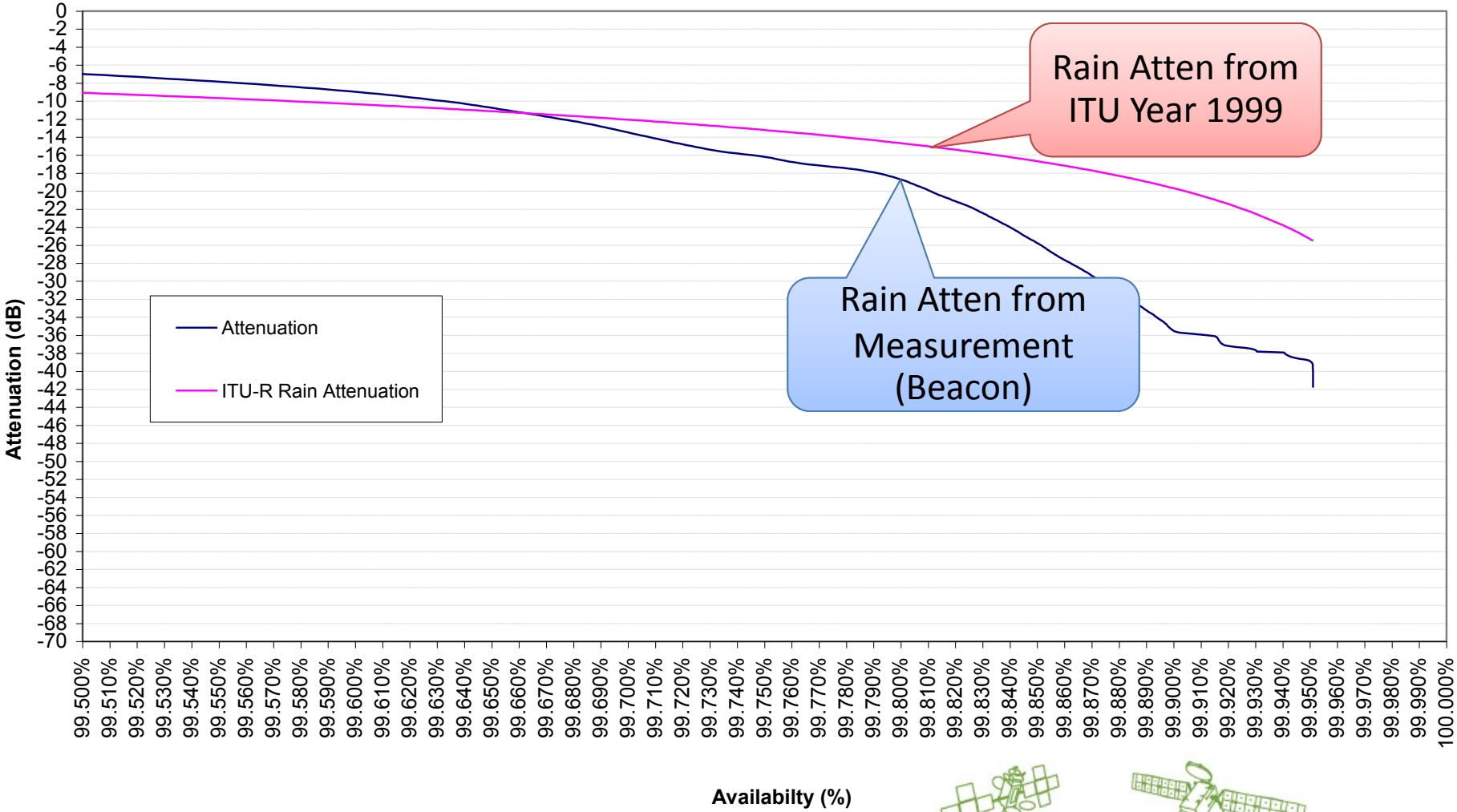


Example of signal strength of beacon level

01/04/2010 00:53:11 -062.5
01/04/2010 00:53:13 -062.5
01/04/2010 00:53:15 -062.5
01/04/2010 00:53:17 -062.4
01/04/2010 00:53:19 -062.4
01/04/2010 00:53:21 -062.4
01/04/2010 00:53:23 -062.5
01/04/2010 00:53:25 -062.5
01/04/2010 00:53:27 -062.5
01/04/2010 00:53:29 -062.5
01/04/2010 00:53:31 -062.5
01/04/2010 00:53:33 -062.5

Rain Attenuation ITU vs. Measurement

Compare Rain Attenuation between Beacon level records and ITU-R model at Bangkok Main 2010



ATTENUATION MITIGATION TECHNIQUES

Key Mitigation Techniques

RF Part

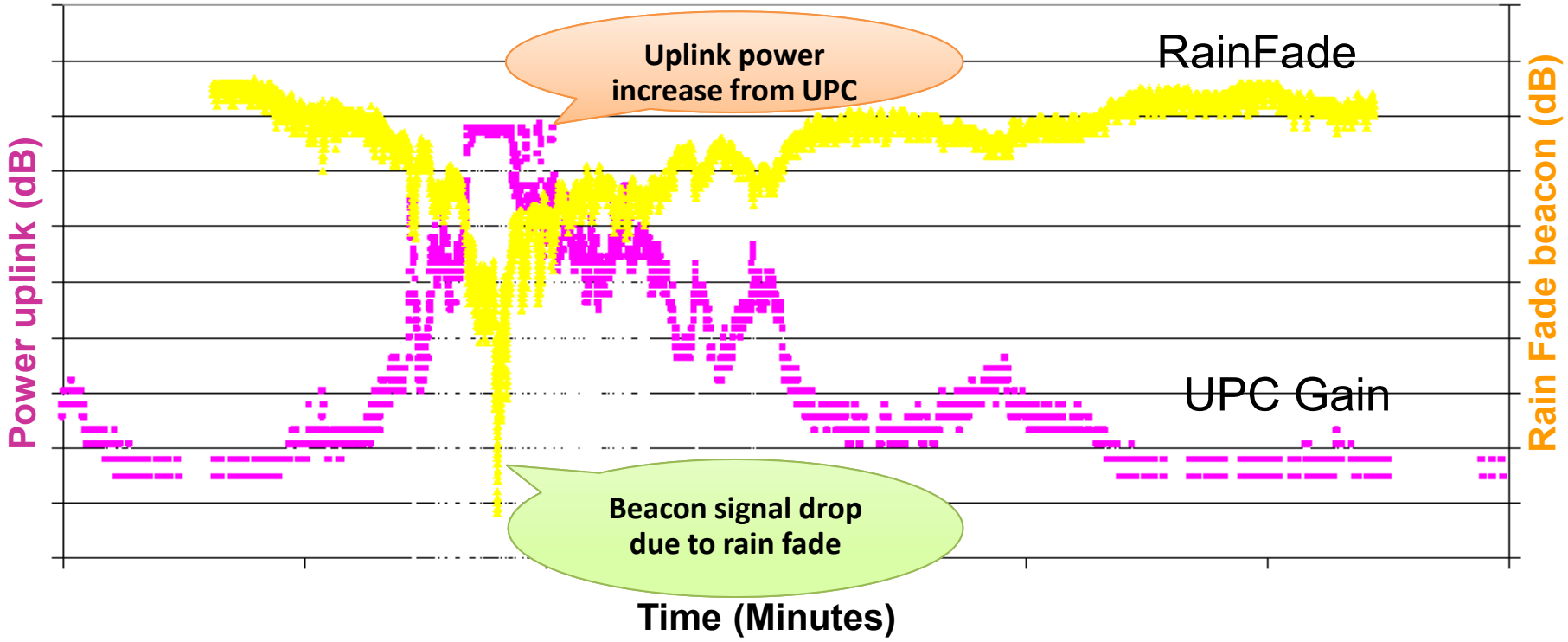
- Uplink Power Control (UPC) Function
- Site Diversity Switching (DSS)

MODEM Part

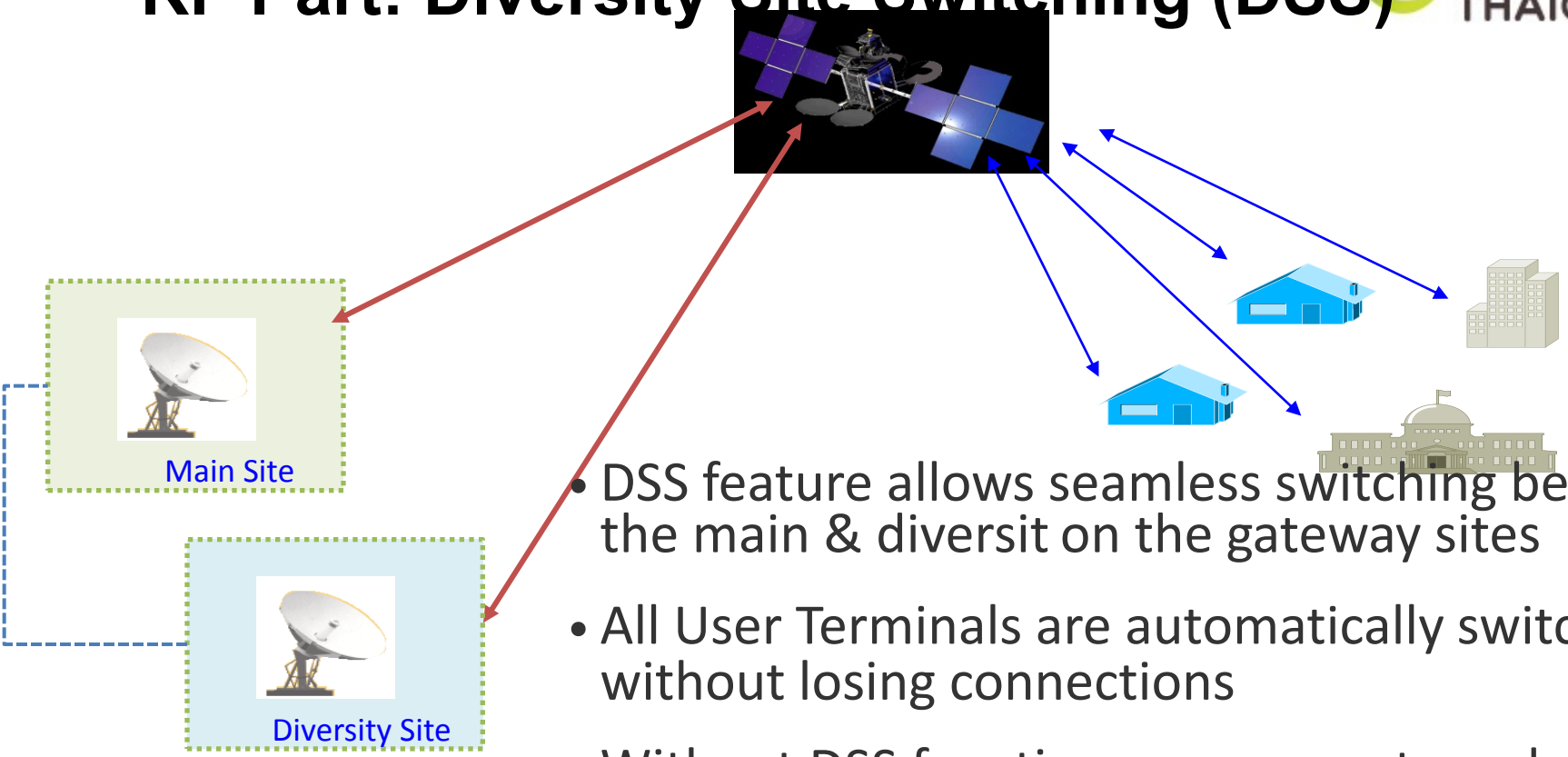
- Advanced Coding Technology
- Adaptive Code and Modulation (ACM)

RF Part: UPC function

- Usually this will be used for the GWs which have plenty of HPA power margin. The system reserves some HPA power as “UPC margin” in clear sky operation.

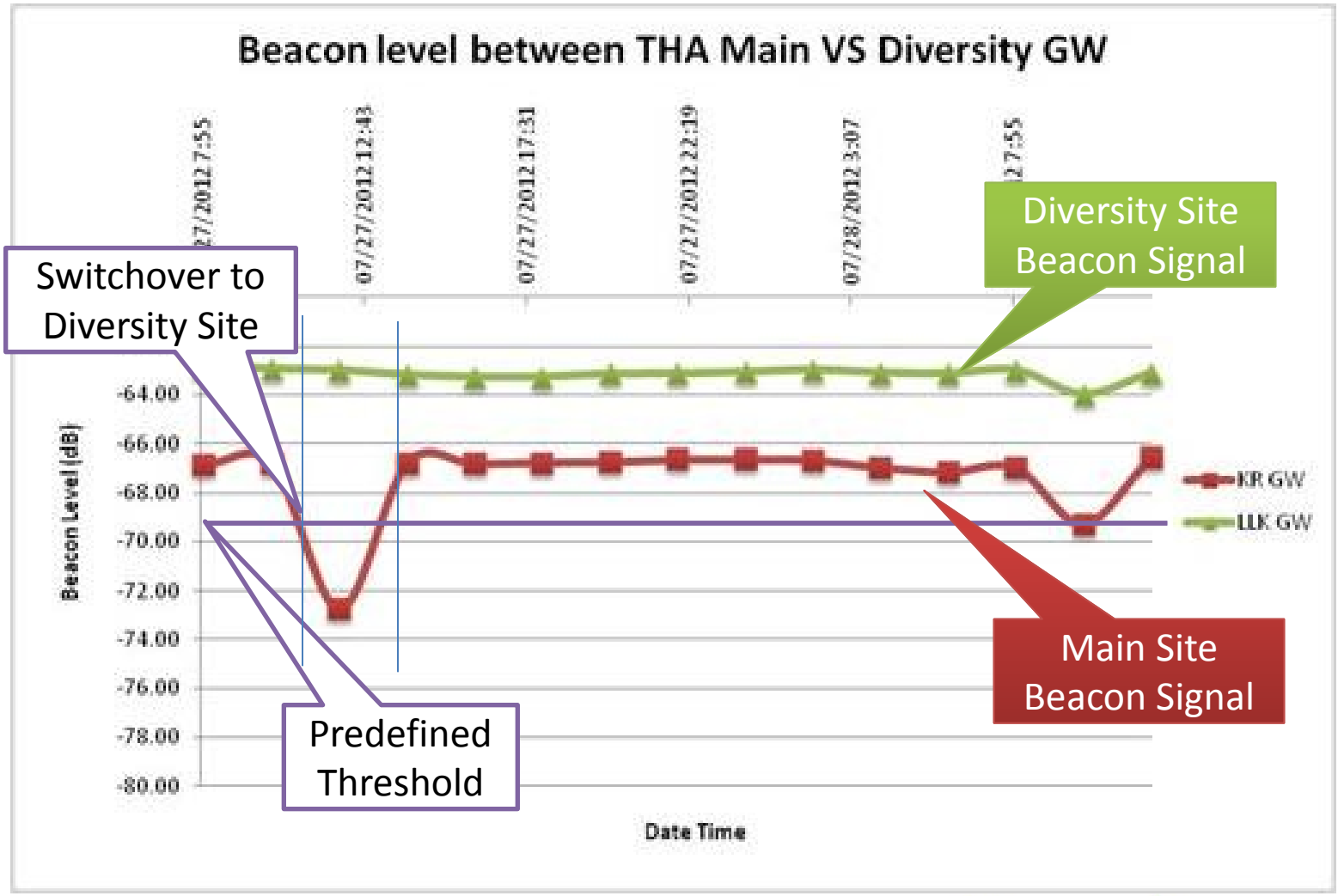


RF Part: Diversity Site Switching (DSS)



- DSS feature allows seamless switching between the main & diversit on the gateway sites
- All User Terminals are automatically switched without losing connections
- Without DSS function, average outage during heavy rainfall ~ 20-30 mins while it is ~5 mins with DSS
- The DSS feature is now commercially operational & is able to simultaneously switch ~60K concurrent users

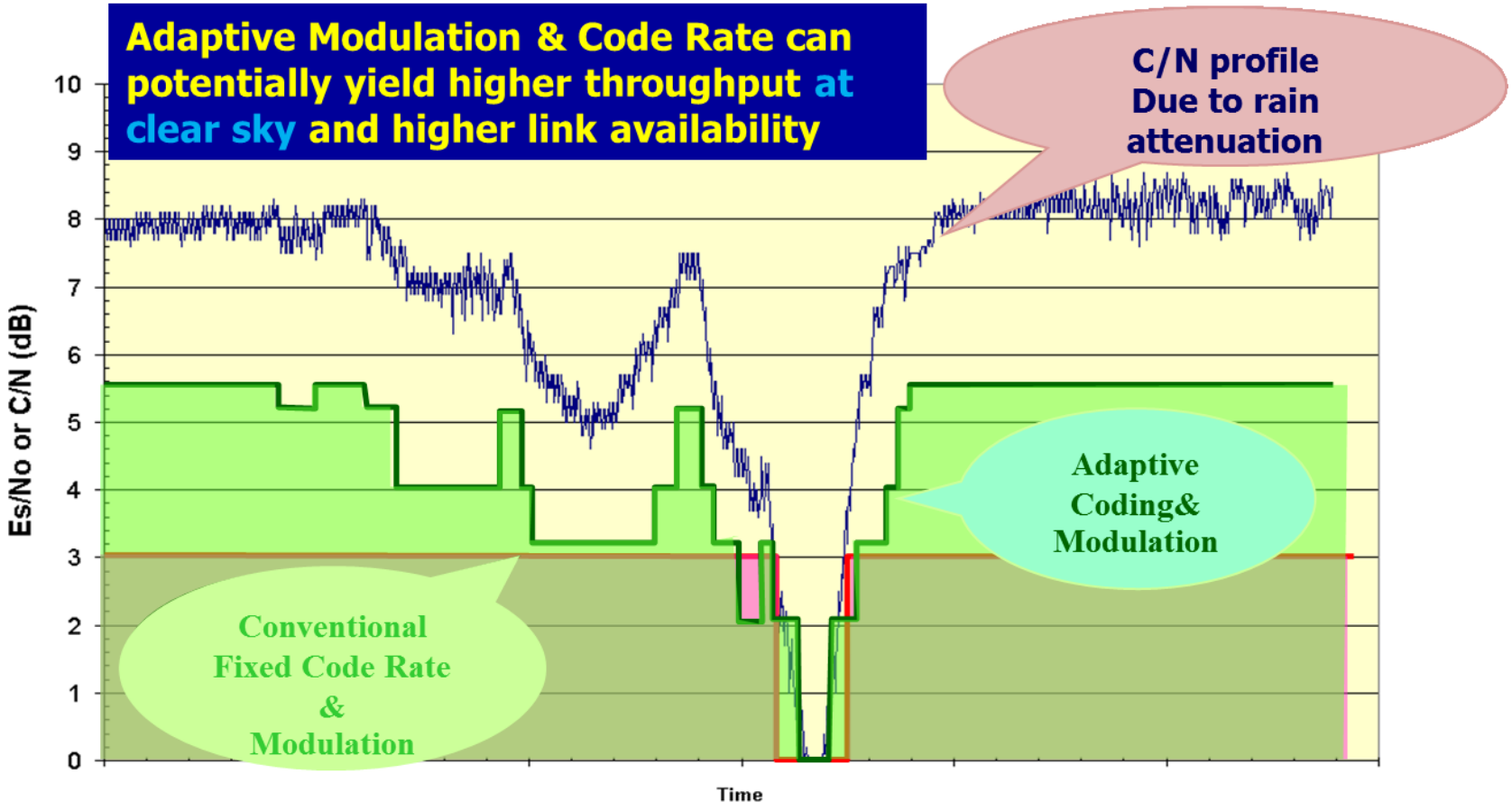
RF Part: Real Time DSS



MODEM Part: Advanced Coding Technology

- Effective error correction coding requires less power to detect signal in noisy environment
  - The minimum requirement is about 0 – 1 dB
- Effective time adjustment (ACM) to overcome rain depth requires less margin
  - The required margin is about 1 -2 dB

MODEM Part: Adaptive Coding and Modulation (ACM)



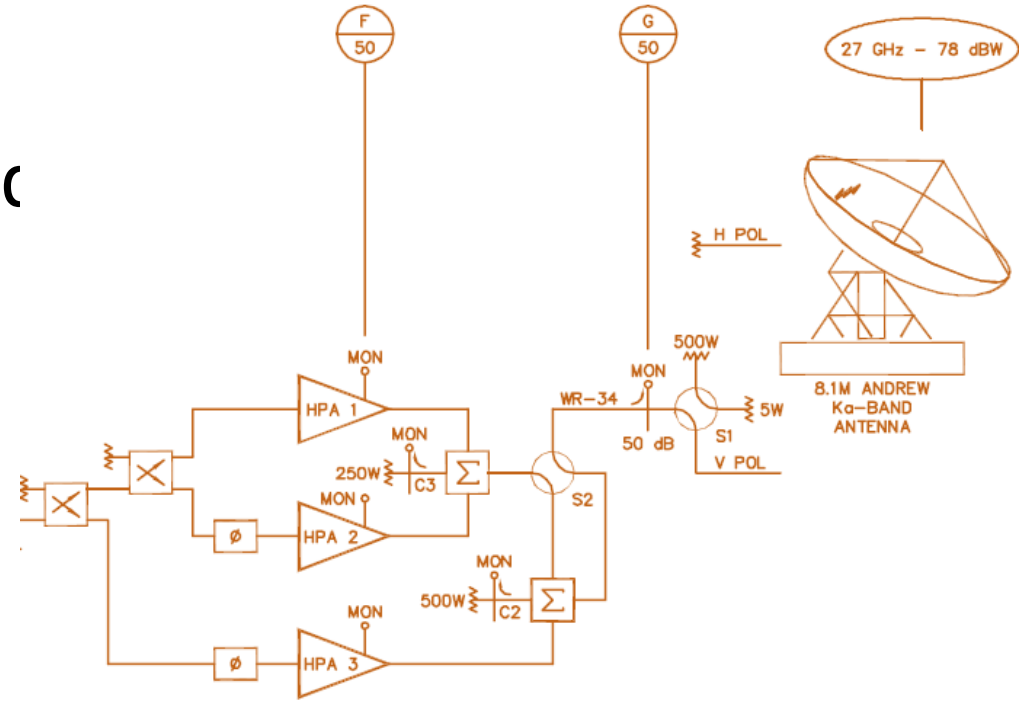
KA-BAND GROUND SYSTEM IMPLEMENTATION

Challenges on Ground System Implementation

- EIRP requirement
- Service availability
- Off-the-Shelf RF ground system equipment

EIRP requirement

- During early 2000s , not big Ka-Band HPA size with 3GHz wide are available
- How to achieve hi
  size?
- What is for Nowac



Service Availability

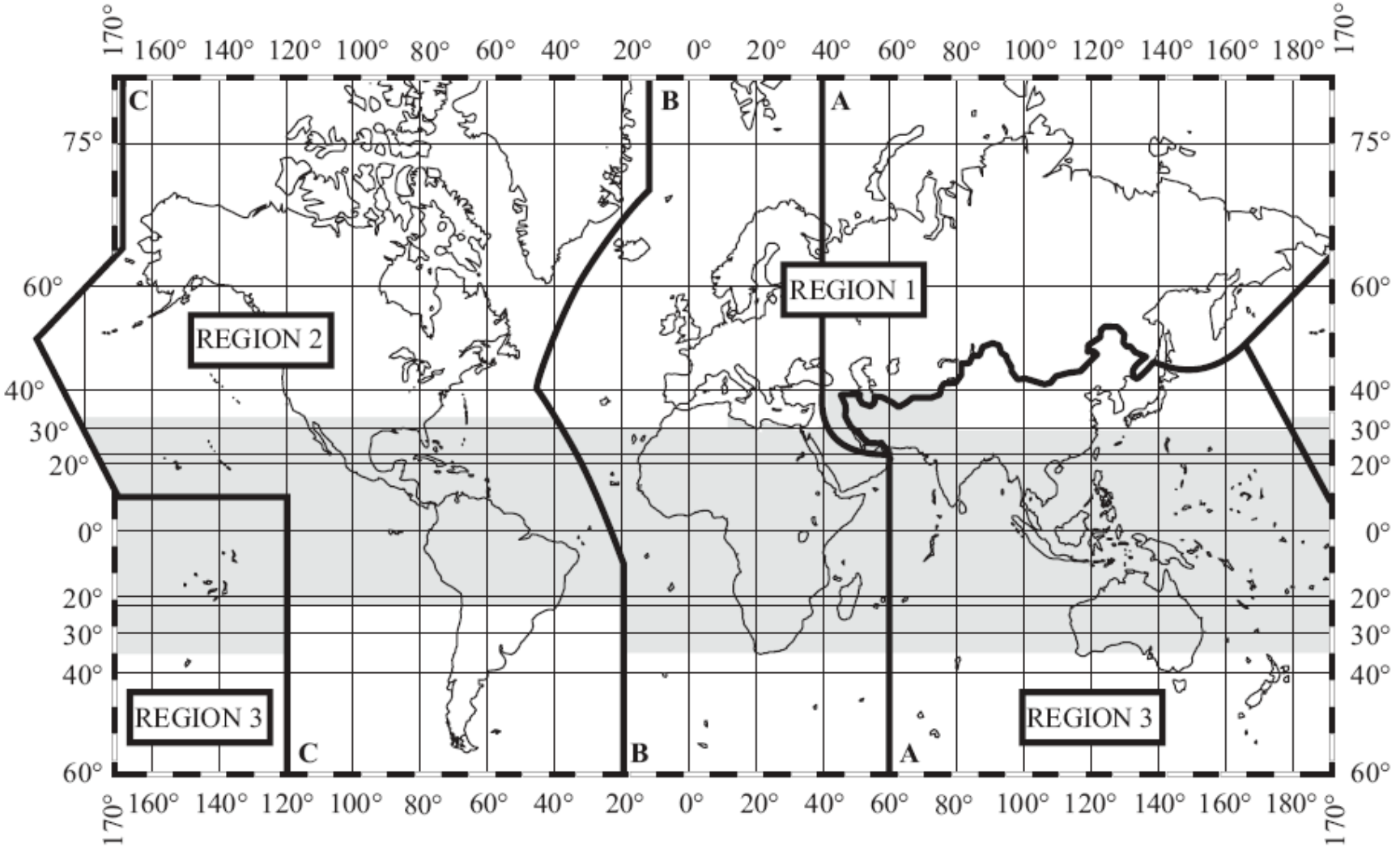
- There is a trade-off between design for higher uplink EIRP and required of site diversity.
- Optical fiber links are required for diversity sites solution.
- There is a trade-off between RF site diversity and full system diversity
  - RF site diversity required “dark fiber” to link between two RF sites and it lead to high operation cost of “dark fiber” link.
  - Full system diversity required double of baseband and RF ground equipment. Double of CapEx.

Off-the-Shelf RF ground system equipment

- Since early 2000s, Ka band is new to satellite communication, then
  - High cost
  - Long lead time
  - Reliability of equipment is yet to be proved.
- Some frequency bands are not cover by standard off-the-shelf product
  - Standard range that widely available is 27.5 to 30.0 GHZ and 30.0-31.0 GHz
  - Satellite may use frequency range from 27.0 to 31.0 GHz

LICENSING:

Regions and areas



Ex. Frequency Allocations: ITU vs. Country

THAICOM

Allocation to services		
Region 1	**Region 2**	**Region 3**
18.6-18.8	**18.6-18.8**	**18.6-18.8**
EARTH EXPLORATION-SATELLITE (passive)	EARTH EXPLORATION-SATELLITE (passive)	EARTH EXPLORATION-SATELLITE (passive)
FIXED	SATELLITE (passive)	FIXED
FIXED-SATELLITE (space-to-Earth) 5.522B	FIXED	FIXED-SATELLITE (space-to-Earth) 5.522B
MOBILE except aeronautical	FIXED-SATELLITE (space-to-Earth) 5.516B 5.522B	MOBILE except aeronautical
mobile	MOBILE except aeronautical mobile	mobile
Space research (passive)	SPACE RESEARCH (passive)	Space research (passive)
5.522A 5.522C	5.522A	5.522A
18.8-19.3 FIXED		
FIXED-SATELLITE (space-to-Earth) 5.516.B 5.523A		
MOBILE		
19.3-19.7 FIXED		
FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 5.523B		
5.523C 5.523D 5.523E		
MOBILE		
19.7-20.1	**19.7-20.1**	**19.7-20.1**
FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B	FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B	FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B
Mobile-satellite (space-to-Earth)	MOBILE-SATELLITE (space-to-Earth)	Mobile-satellite (space-to-Earth)
5.524	5.524 5.525 5.526 5.527 5.528 5.529	5.524
20.1-20.2 FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B		
MOBILE-SATELLITE (space-to-Earth)		
5.524 5.525 5.526 5.527 5.528		
20.2-21.2 FIXED-SATELLITE (space-to-Earth)		
MOBILE-SATELLITE (space-to-Earth)		
Standard frequency and time signal-satellite (space-to-Earth)		
5.524		

Japan Table of Frequency Allocation	
Ka-band frequency (GHz)	**FIXED-SATELLITE being share with other services**
17.3-17.7	None
17.7-18.1	FIXED,MOBILE
18.1-18.4	FIXED,MOBILE
18.4-18.6	FIXED,MOBILE
18.6-18.8	EARTH EXPLORATION-SATELLITE(passive),FIXED,MOBILE except aeronautical mobile,space research(passive)
18.8-19.3	FIXED,MOBILE
19.3-19.7	FIXED,MOBILE
19.7-20.1	FIXED,MOBILE
	Mobile-satellite
20.1-20.2	FIXED,MOBILE
	Mobile-satellite
20.2-21.2	FIXED,MOBILE
	MOBILE-SATELLITE, Standard frequency and time signal
27-27.5	FIXED,MOBILE,INTER-SATELLITE
27.5-28.5	fixed,mobile,radiolocation
28.5-29.1	fixed,mobile,radiolocation,Earth exploration satellite
29.1-29.5	fixed,mobile,radiolocation,Earth exploration satellite
29.5-29.9	Earth exploration satellite,Mobile-satellite, fixed, mobile,radiolocation
29.9-30	MOBILE-SATELLITE
	Earth exploration satellite,radiolocation
30-31	MOBILE-SATELLITE
	Standard frequency and time signal , fixed, mobile

Problems in getting license

- Lack of public regulatory information e.g. standard of equipments and services
- Unclear procedures

THANK YOU