Highly Efficient DVB-S2/RCS2 VSAT Platform For Next Generation Satellite System
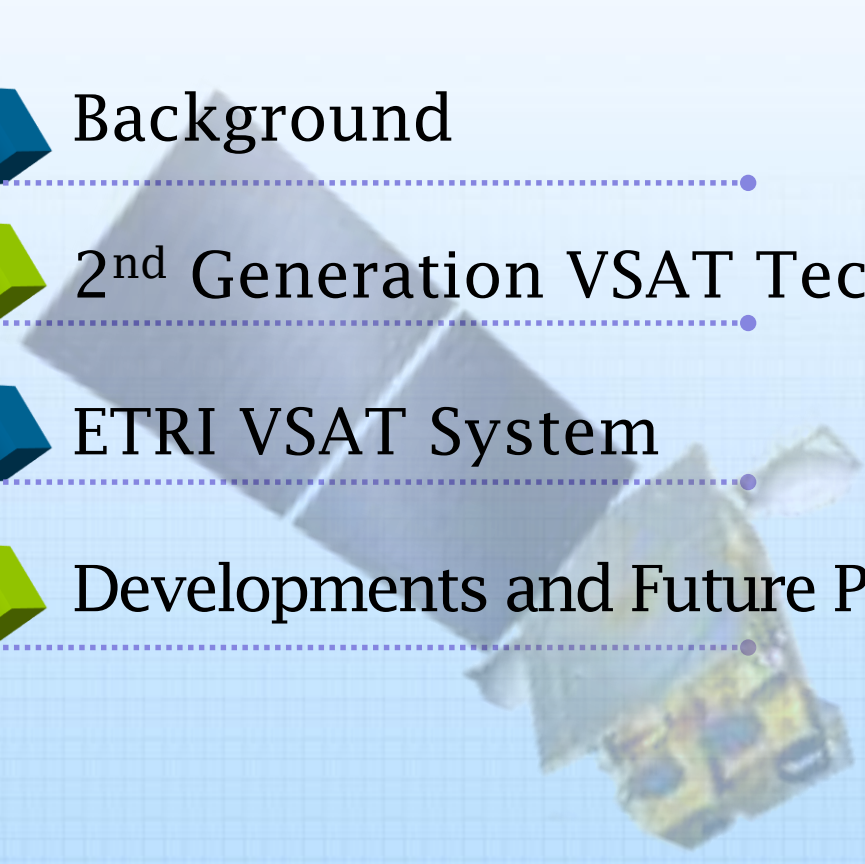
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ETRI

Electronics and Telecommunications
Research Institute

Contents

Background

- **The current emerging applications in Internet require large bandwidths and quality of service(QoS) guarantees for up and down links**
  - Broadband access, IP multicast, media streaming, content delivery servic

	Conventional VSAT	Next Gen. VSAT	Comparison
Freq. Bandwidth	Narrow band Ku	Ku + Broad band Ka	Supported Broad band service using Ka band
Service Bandwidth	Under 10 Mbps Only CCM mode	Under 100 Mbps ACM mode support	Improving transmission efficiency by more than 30%
Supported data type	Short message and voice message	Multi-media data	Internet contents have high resolution
Service	Only Voice service	Voice+ Multi-media data service	HD multi-party remote conference service supporting HD resolution
	Low speed data service	High speed data (up, down) Satellite backhaul service for 2G/3G	Social network service (SNS) require the high speed service via up and down links

- **To support those requirements, the DVB consortium approved the specification of the next generation multimedia satellite communications system in March 2011**

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2ⁿᵈ Generation VSAT Technology
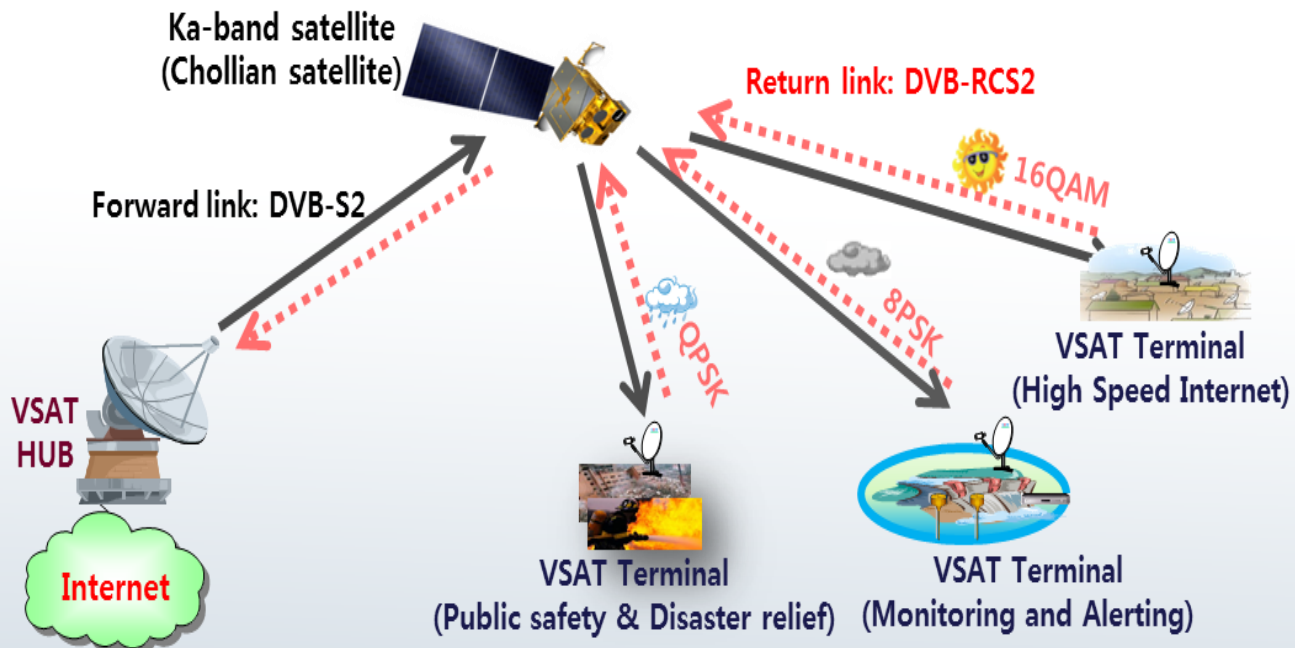
DVB-RCS vs DVB-RCS2

- **The primary goals of DVB-RCS2 were to achieve major advancement in TDMA burst modem performance at multiple levels, including:**
  - New high-efficiency modulation types and FEC methods (ModCods)
  - The implementation of Adaptive Coding and Modulation (ACM) per burst
  - Improvements in link availability for low Signal-to-Noise Ratio (SNR) environments
  - Improvement bandwidth efficiency generally but especially the intermediate range of SNRs
  - Improvements in the return link encapsulation (RLE) for variable length IP packets

	DVB-RCS1	DVB-RCS2	Effectiveness
Modulation	Linear Modulation QPSK only	Linear Modulation QPSK/8PSK/16QAM	High efficiency and High speed (2bit/Hz →4bit/Hz)
		Continuous Phase Modulation (CPM)	Small terminal
Framing	Pre-amble only	Pilot symbol insertion, Pre-amble and mid-amble support	Robust frame synchronization support
Coding	Convolutional code, Turbo code (8 state)	Linear: Turbo Phi code (16 state)	Robust channel coding support
		CPM: CC/eBCH code	
IP packet processing	ATM , MPEG (Fixed length encapsulation)	RLE (Variable length encapsulation)	High efficiency support

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ETRI VSAT System(1/3)

- **ETRI VSAT system is DVB-S2/RCS2 based next-generation VSAT (Very Small Aperture Terminal) system**

- **Support High-performance DVB-RCS2 burst modem with higher order MODCODs(i.e. both 8PSK & 16QAM) and the most advanced FEC technologies**

- **Highly-efficient MAC layer protocol (RLE) scheme is used**

Ka-band satellite
(Chollian satellite)

Return link: DVB-RCS2

16QAM

Forward link: DVB-S2

QPSK

8PSK

VSAT HUB

VSAT Terminal
(High Speed Internet)

Internet

VSAT Terminal
(Public safety & Disaster relief)

VSAT Terminal
(Monitoring and Alerting)

ETRI VSAT System(2/3)

Main Features

- **Link availability can be dramatically increased with ACM and ACS technologies**
  - QPSK, 8PSK, 16QAM modulation(DVB-RCS2 compatible)
  - 16-state duo binary Turbo-code technology(DVB-RCS2 compatible)
- **Two-way Rain Fade Mitigation technology**
  - Forward link : UPC(Uplink Power Control) + ACM(Adaptive Coding & Modulation)
  - Return link : Power control + ACM + ACS(Adaptive Carrier Selection)
- **Variable length data encapsulation and decapsulation technology**
  - Return Link Encapsulation(RLE) protocol at link layer is used for IP packet processing

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ETRI VSAT System(3/3)

Specifications

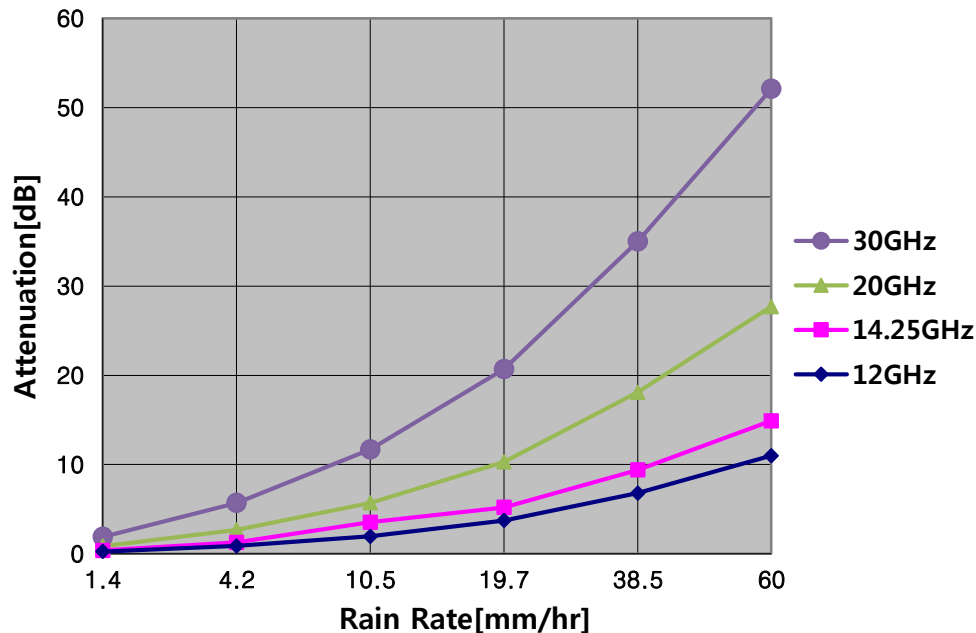|	Forward link	Return link
Standard	DVB-S2/S2X compatible	DVB-RCS2 compatible
Modulation	QPSK, 8PSK,16APSK,32APSK	QPSK, 8PSK, 16QAM
FEC	LDPC/BCH	16-state Duo-binary Turbo code
Roll-off factor	0.05/0.1/0.2/0.25/0.35	0.2
Symbol Rate	~80Msps	{0.5/1/2/4/8}Msps
IP Encapsulation	MPEG-2 TS, GSE	RLE
Rain Fade Mitigation	UPC+ACM	Power Control +ACM+ACS

Rain attenuation analysis

- ### Rain attenuation
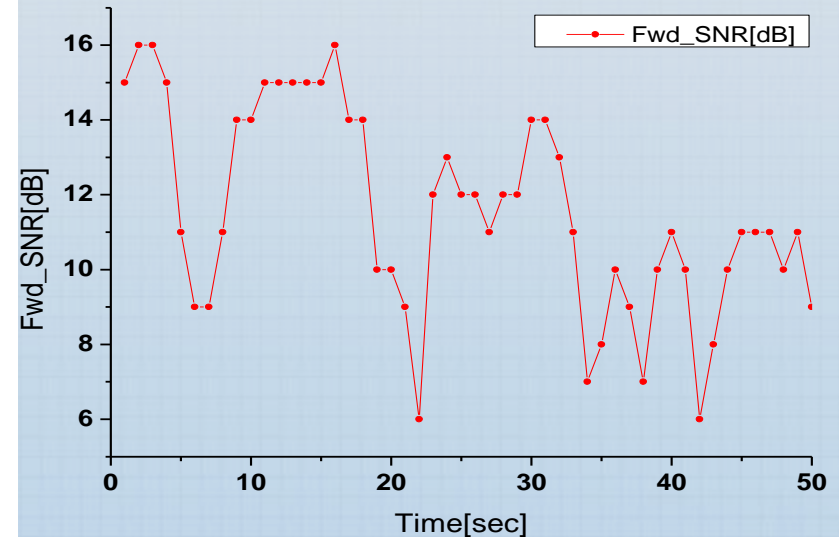 - Ku-band(14GHz) : 15dB, Ka-band(30GHz) : 52dB
- ### Rain attenuation rate
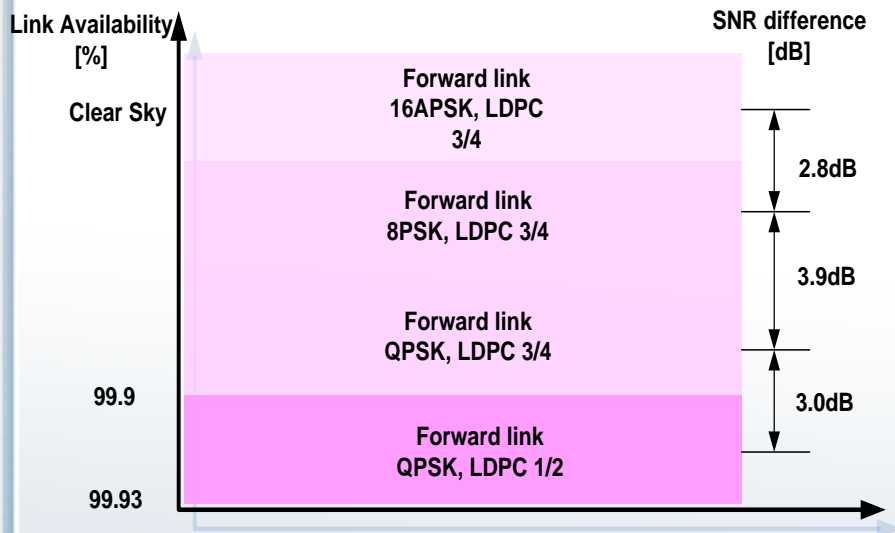 - Ku-band : ~1dB/sec, Ka-band : 3~5dB/sec

<Rain attenuation>

<Measured SNR during typhoon in Korea>

Forward link

- **ACM scheme is operated by automatically adapting the modulation type and FEC rate depending on the link condition**
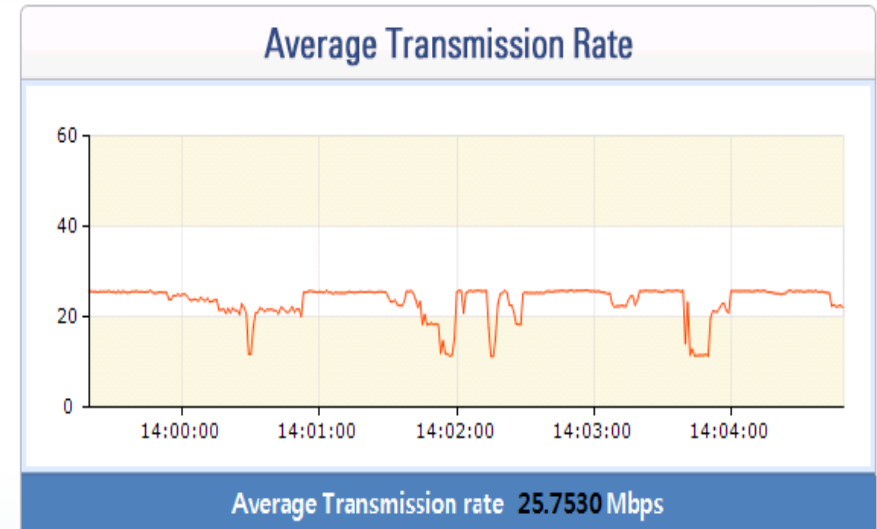
Link Availability [%]

Clear Sky

SNR difference [dB]

Forward link 16APSK, LDPC 3/4

2.8dB

Forward link 8PSK, LDPC 3/4

3.9dB

Forward link QPSK, LDPC 3/4

99.9

3.0dB

Forward link QPSK, LDPC 1/2

99.93

Return link

- **In order to overcome the rain fading Power control, ACS & ACM are applied**
  - **Firstly, closed loop power control**
  - **Secondly, ACM in same symbol rate**
  - **Finally, ACS(Symbol rate is changed)**
  - **By use of multiple techniques, the total dynamic range of VSAT system is over 20dB**

	QPSK 1/3		8PSK 3/4		16QAM 5/6
Es/No [dB]	-0.22	...	8.77	...	12.4
Dynamic Range	[DVB-RCS2 : 12.62dB]				
	3dB		8dB [DVB-RCS : 5dB]		

● **Symbol rate change(4Msps → 0.5Msps): 9dB**

Comparison of System Throughput

Prediction & MODCOD Decision

- MODCOD ACTIVE : 16APSK 5/6
- MODCOD RUN : 16APSK 5/6

ACM MODCOD 16APSK 5/6
8PSK 3/4
Predicted SNR
Rx SNR
QPSK 3/4
CCM MODCOD QPSK 1/2
QPSK 1/2

☑ RxSNR ☑ PredictedSNR ☐ MODCOD ACTIVE
☐ MODCOD ON ☐ MODCOD OFF ☑ MODCOD RUN

Terminal MAC Address
00:00:00:00:00:03 설정

Average Transmission Rate

Average Transmission rate **25.7530** Mbps
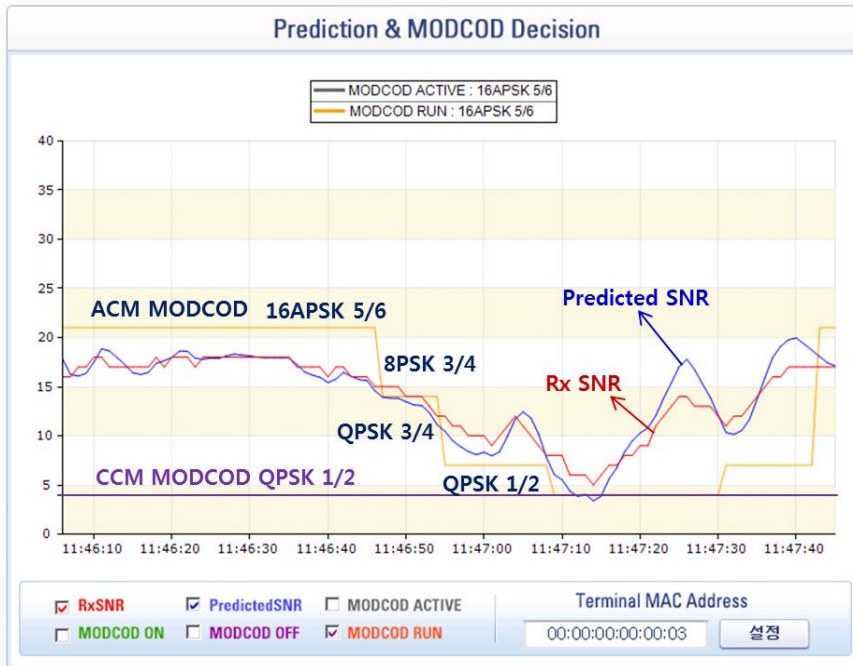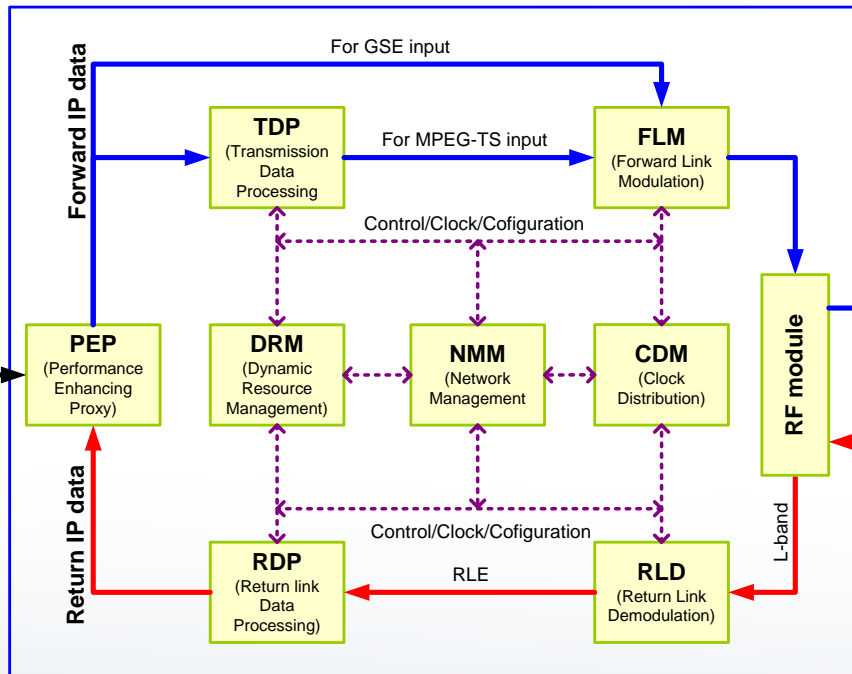
● **Results of System Throughput**
- System throughput @ CCM Mode : 10Mbps (10Msps QPSK, LDPC ½)
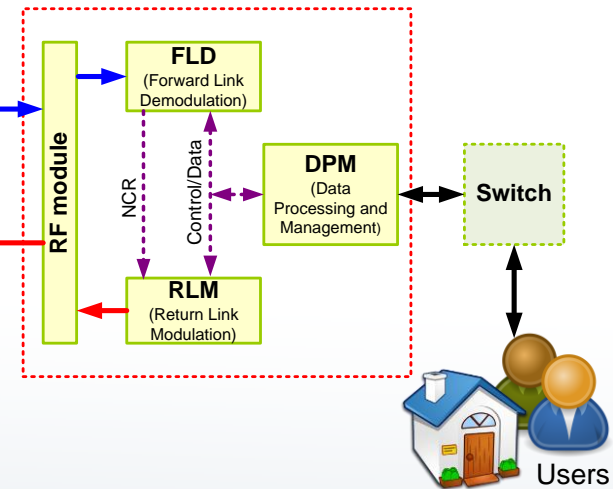- System throughput @ ACM mode : 30Mbps (10Msps)

Platform Architecture

Modular Structure

Hub side

For GSE input

Forward IP data

| TDP (Transmission Data Processing) | For MPEG-TS input | FLM (Forward Link Modulation) |

Control/Clock/Cofiguration

PEP (Performance Enhancing Proxy)

DRM (Dynamic Resource Management)

NMM (Network Management)

CDM (Clock Distribution)

RF module

Router

Return IP data

Control/Clock/Cofiguration

RDP (Return link Data Processing)

RLE

RLD (Return Link Demodulation)

L-band

Internet

Satellite Air Interface

Terminal side

RF module

FLD (Forward Link Demodulation)

NCR

Control/Data

DPM (Data Processing and Management)

Switch

RLM (Return Link Modulation)

Users

- **RDP (Receive Data Processor)**
- **RLD (Return-Link Demodulator)**
- **DRM (Dynamic Resource Manager)**
- **CDM (Clock Distribution Module)**
- **FLM (Forward-Link Modulator)**
- **NMM(Network Management Module)**

- **FLD (Forward-Link Demodulator)**
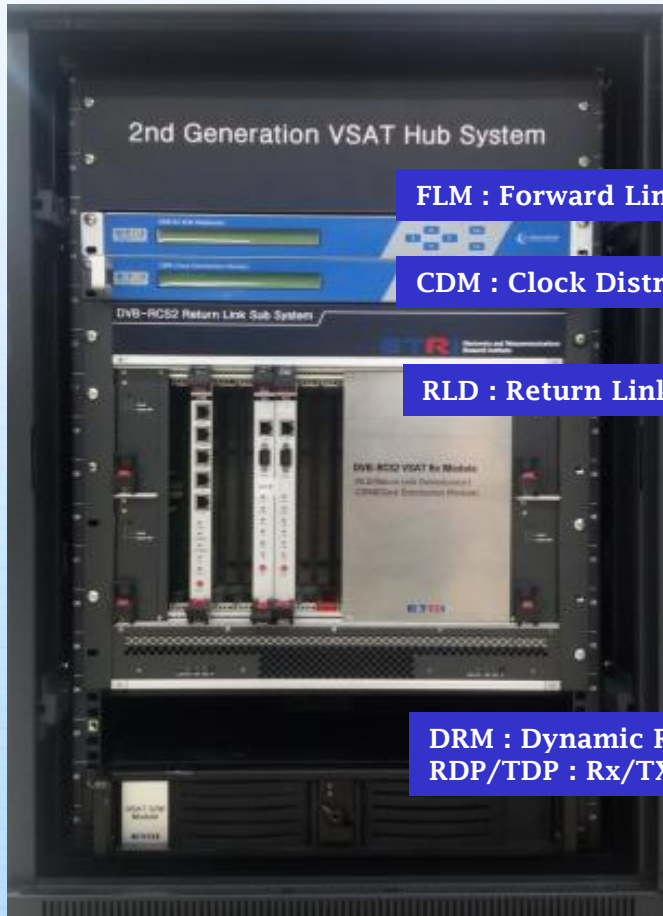- **RLM (Return-Link Modulator)**
- **DPM (Data Processing Module)**

System Configuration

ETRI Hub System and Terminals

2nd Generation VSAT Hub System

FLM : Forward Link Modulator

CDM : Clock Distribution Module

RLD : Return Link Demodulator

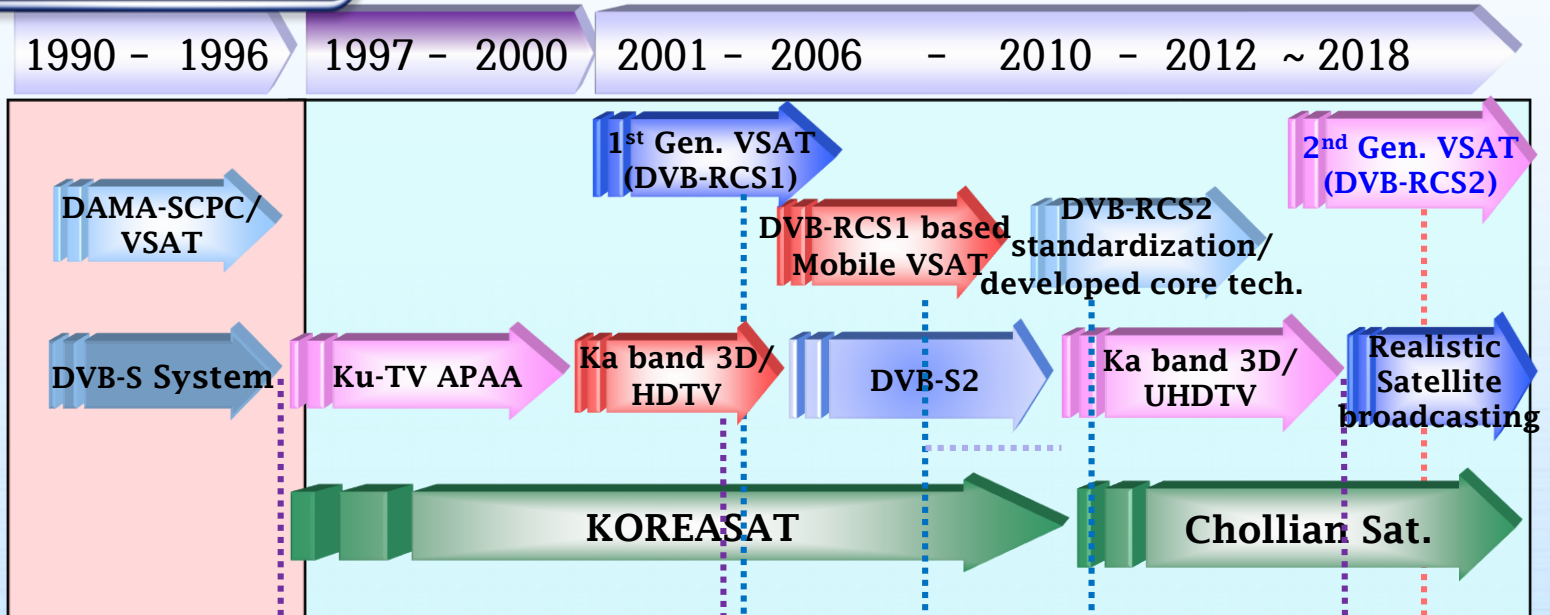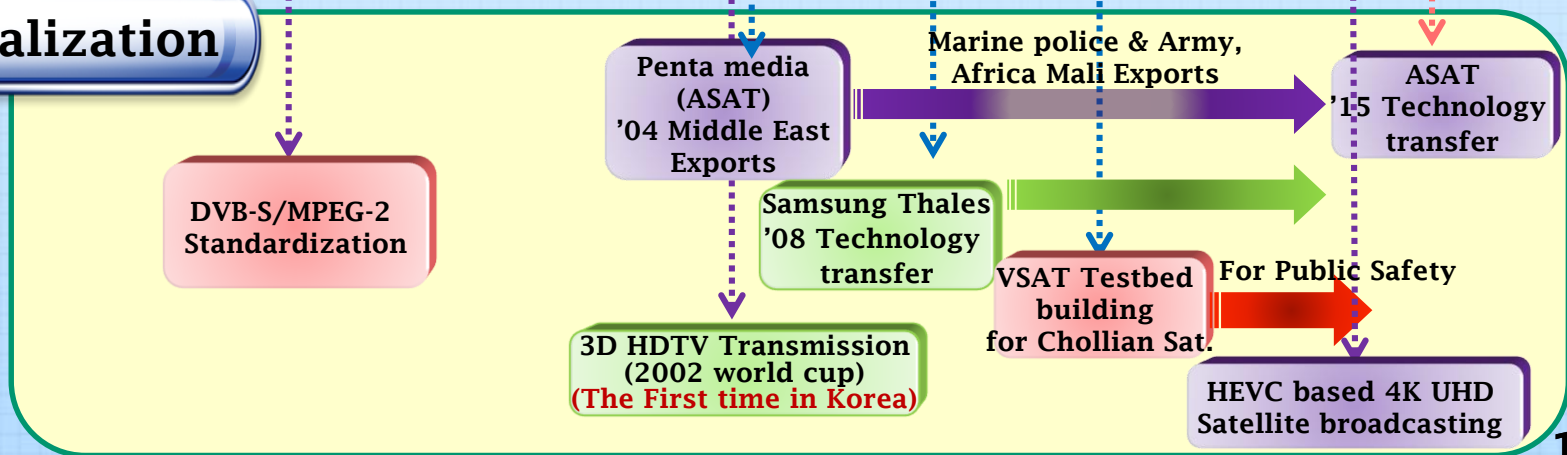**DRM : Dynamic Resource Manager**
RDP/TDP : Rx/TX Data Processor

<Hub System>

<Small Terminal for Consumer >

<Professional Terminal for Enterprise>

Development and Future plan (1/4)

Development Activities

1990 – 1996	1997 – 2000	2001 – 2006 – 2010 – 2012 ~ 2018

Satellite Communication System

- DAMA-SCPC/ VSAT
- 1st Gen. VSAT (DVB-RCS1)
- DVB-RCS1 based Mobile VSAT
- DVB-RCS2 standardization/ developed core tech.
- 2nd Gen. VSAT (DVB-RCS2)

Satellite broadcasting system

- DVB-S System
- Ku-TV APAA
- Ka band 3D/ HDTV
- DVB-S2
- Ka band 3D/ UHDTV
- Realistic Satellite broadcasting

Satellite

- KOREASAT
- Chollian Sat.

Commercialization

- DVB-S/MPEG-2 Standardization
- Penta media (ASAT) '04 Middle East Exports
- Marine police & Army, Africa Mali Exports
- ASAT '15 Technology transfer
- Samsung Thales '08 Technology transfer
- 3D HDTV Transmission (2002 world cup) (The First time in Korea)
- VSAT Testbed building for Chollian Sat.
- For Public Safety
- HEVC based 4K UHD Satellite broadcasting

Operation of public service based on DVB-RCS1 VSAT system

Service Status

Cholllian sat.

KMA

- Korea Meteorological Administration
- Current ~ 2010
- Weather station in Baengyeong island
  - To report meteorological data and media stream from CCTV

KIOST

- Korea Institute of Ocean Science & Technology
- Current ~ 2014
- Research station in Sochung island
  - To transfer sensor data from sensor node on the sea

국민안전처 Ministry of Public Safety and Security
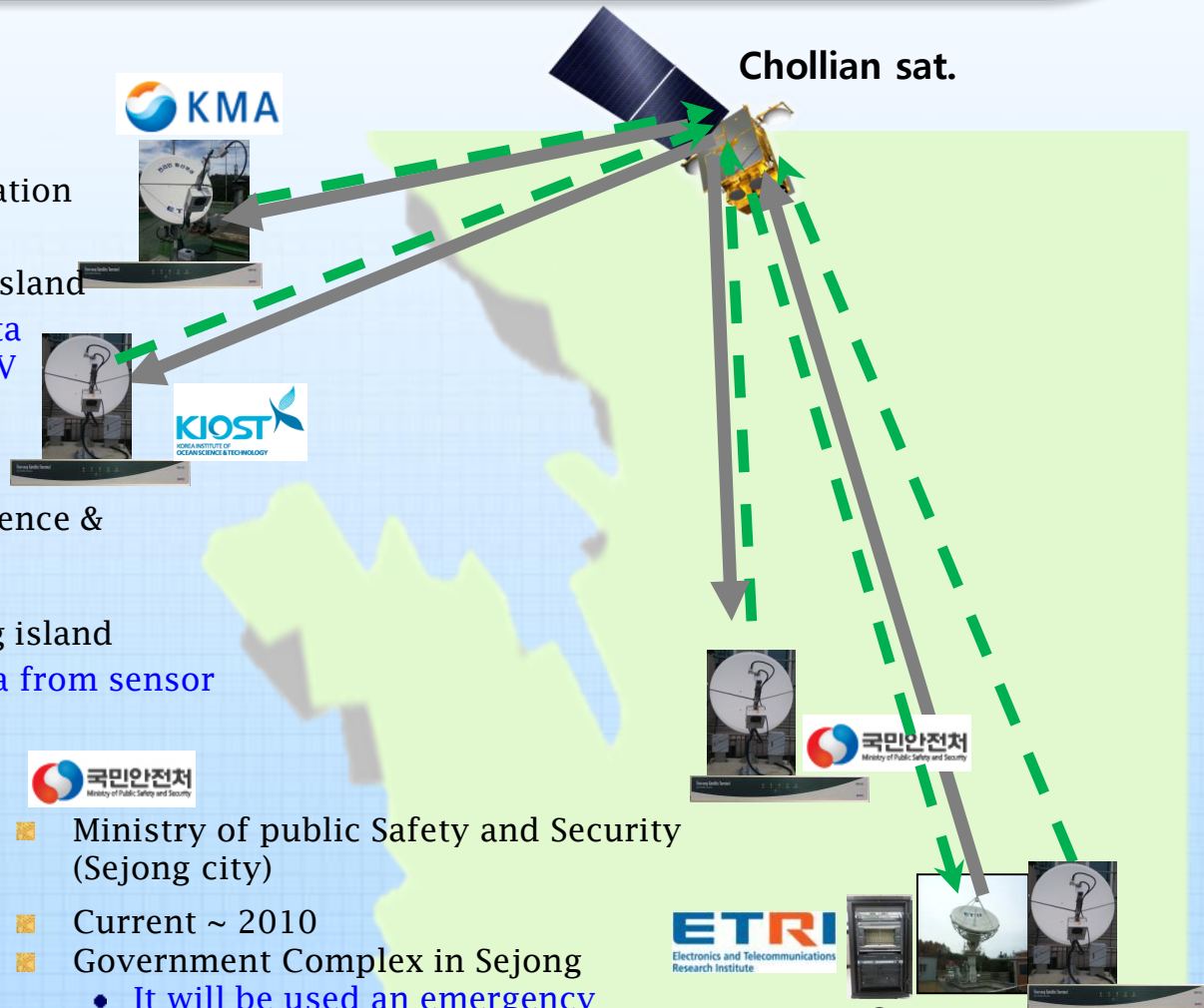
- Ministry of public Safety and Security (Sejong city)
- Current ~ 2010
- Government Complex in Sejong
  - It will be used an emergency communication network when terrestrial network has problem
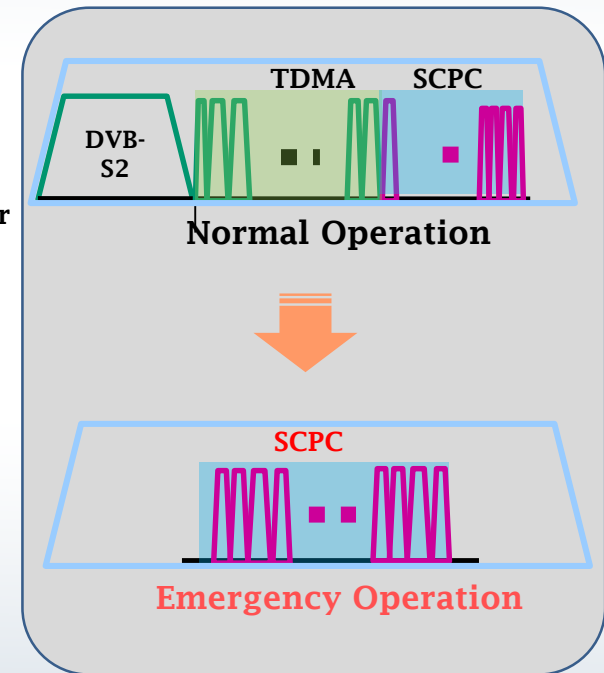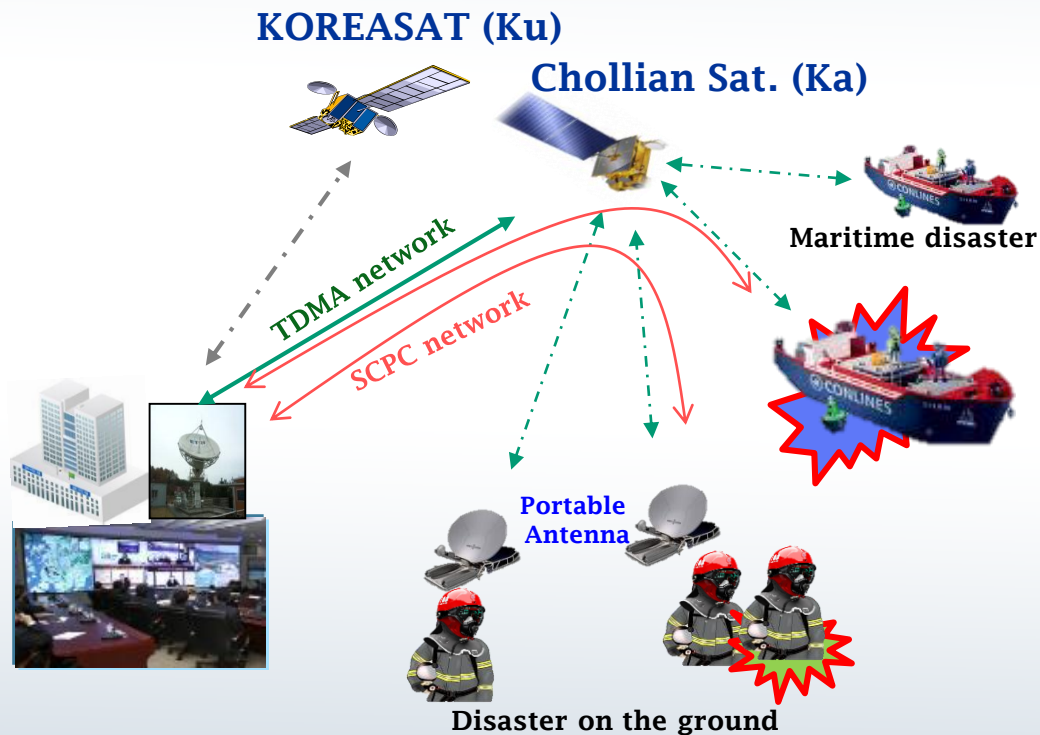
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Hub system at Daejeon

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Exhibition and Press release

<CommunicAsia2015 Exhibition@Singapore>

< Press release, 2016.05 >

Development and Future plan (4/4)

Future plan

- **VSAT System supporting high operational efficiency for TDMA and SCPC hybrid networks**
  - Integrated management scheme for TDMA/SCPC
  - Return Link transmission using Spread Spectrum

KOREASAT (Ku)

Chollian Sat. (Ka)

TDMA network

SCPC network

Maritime disaster

Portable Antenna

Disaster on the ground

TDMA   SCPC

DVB-S2

Normal Operation

SCPC

Emergency Operation

Thank you!!

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