KMA Report
on Status of the current and future satellite systems

Presented to CGMS-45 plenary session, agenda item [D.10]

Coordination Group for Meteorological Satellites

Current Geo-Satellite : COMS

◆ **COMS(Communication, Ocean, and Meteorological Satellite)**

   - Orbit : 128.2E (Launched on June 26, 2010)

➤ **MI : 5 Channel VIS/IR Meteorological Imager**

   - MI data Service via Satellite : Broadcast to M/SDUSs with H/LRIT

   - 16 products(CMW, Fog, AOD, cloud amount, Convective rainfall rate….)

   - Service via Landline [Website] KMA/NMSC homepage(for registered users)

   [FTP] Access to NMSC FTP(for organization with MOU)

➤ **GOCI** : Geostationary Ocean Color Imager

   - 0.5km X 0.5km(ground sampling distance) with 1hr (8 times/day)

   - L1B RGB, Chlorophyll, Colored dissolved organic matter, Suspended solid

   - http://kosc.kordi.re.kr/processingsoftward/gdaps/onlinehelp.kosc

   - http://map.naver.com (for Public user)

Low Earth Orbit Satellites : Current

- **KOMPSAT-5(Aug. 22, 2013)** with 550km mean altitude and 97.6 deg inclination

Payload	Characteristics
COSI (primary)	• SAR (Synthetic Aperture Radar) • X-band Radar with an active phased array antenna
AOPOD (secondary)	• Dual frequency GPS receiver (GNSS-RO data) – IGOR : Integrated GPS Occultation Receiver

- COSI : Corea SAR instrument, AOPOD: Atmosphere Occultation and Precision Orbit Determination
- GNSS-RO data is validated for operational use by KASI cooperating with UCAR and is distributed regularly via internet

➢ **Timeliness problem for utilization of AOPOD**
  - Data latency is several hours or even 12 hours due to data processing and transmission delay
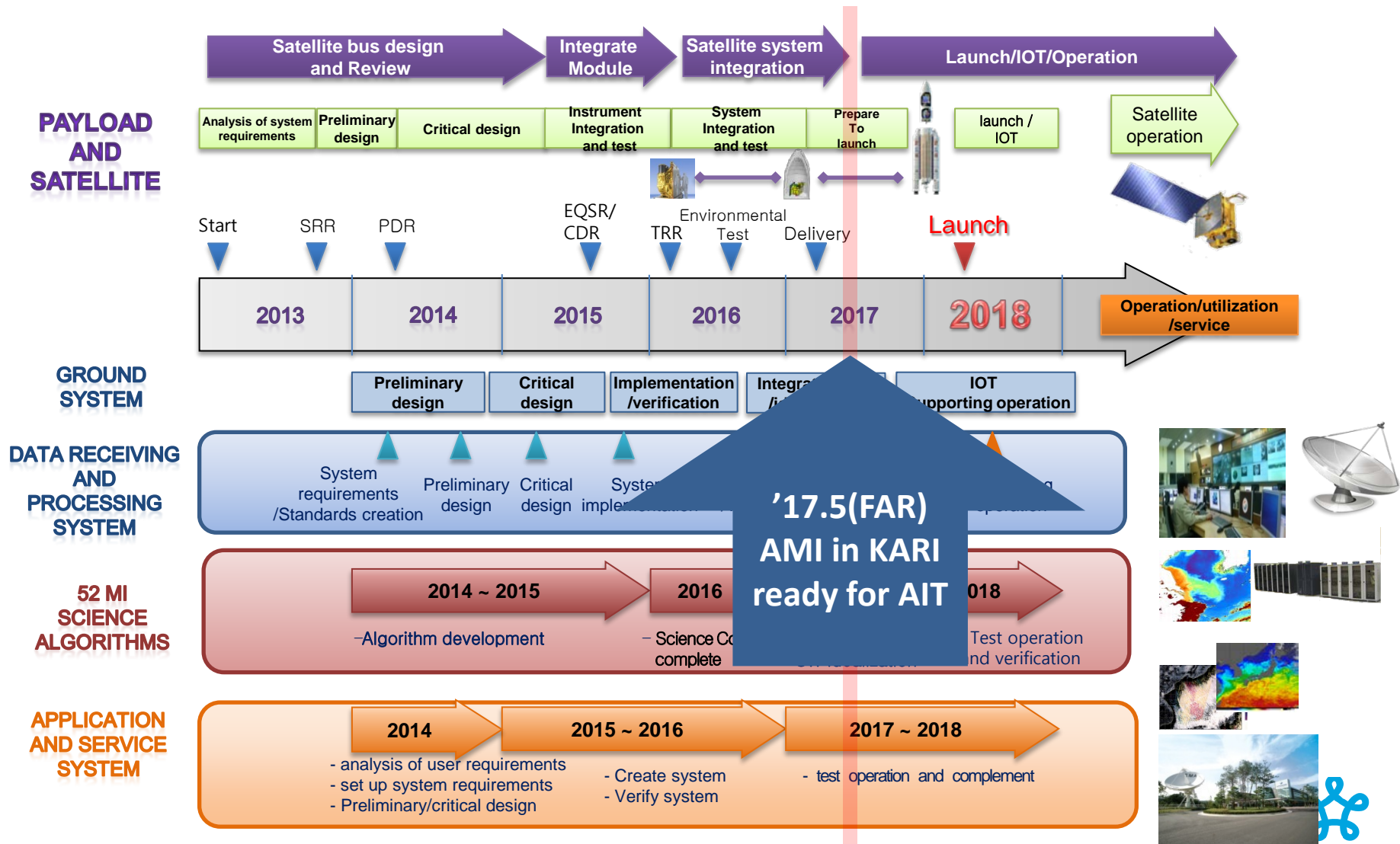 - The latency make KMA not to use KOMPSAT-5 radio occultation data in real-time into the NWP system
  - ➔ **On-going collaboration with NOAA to receive the AOPOD data at Fairbank ground station**

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Meteorological and Environmental Geo-Satellites : Future

Sector	Satellite in Orbit	Operator	Location	Launch date	Environmental payload and status
West Pacific	GEO-KOMPSAT-2A	KMA	128.2°E	**November 2018**	Advanced Meteorological Imager (AMI), Space Environmental monitoring payload Direct broadcast via UHRIT/HRIT/LRIT
	GEO-KOMPSAT-2B	MOF(Ministry of Ocean and Fisheries), ME(Ministry of Environment)	128.2°E	2nd Half 2019	Advanced Geostationary Ocean Colour Imager(GOCI-II), Geostationary Environmental Monitoring Spectrometer(GEMS)

- **GEO-KOMPSAT-2A, AMI(Advanced Meteorological Imager)**
  - Multi-channel capacity: 16 channels
  - Temporal resolution: within 10 minutes for Full Disk observation
  - Flexibility for the regional area selection and scheduling
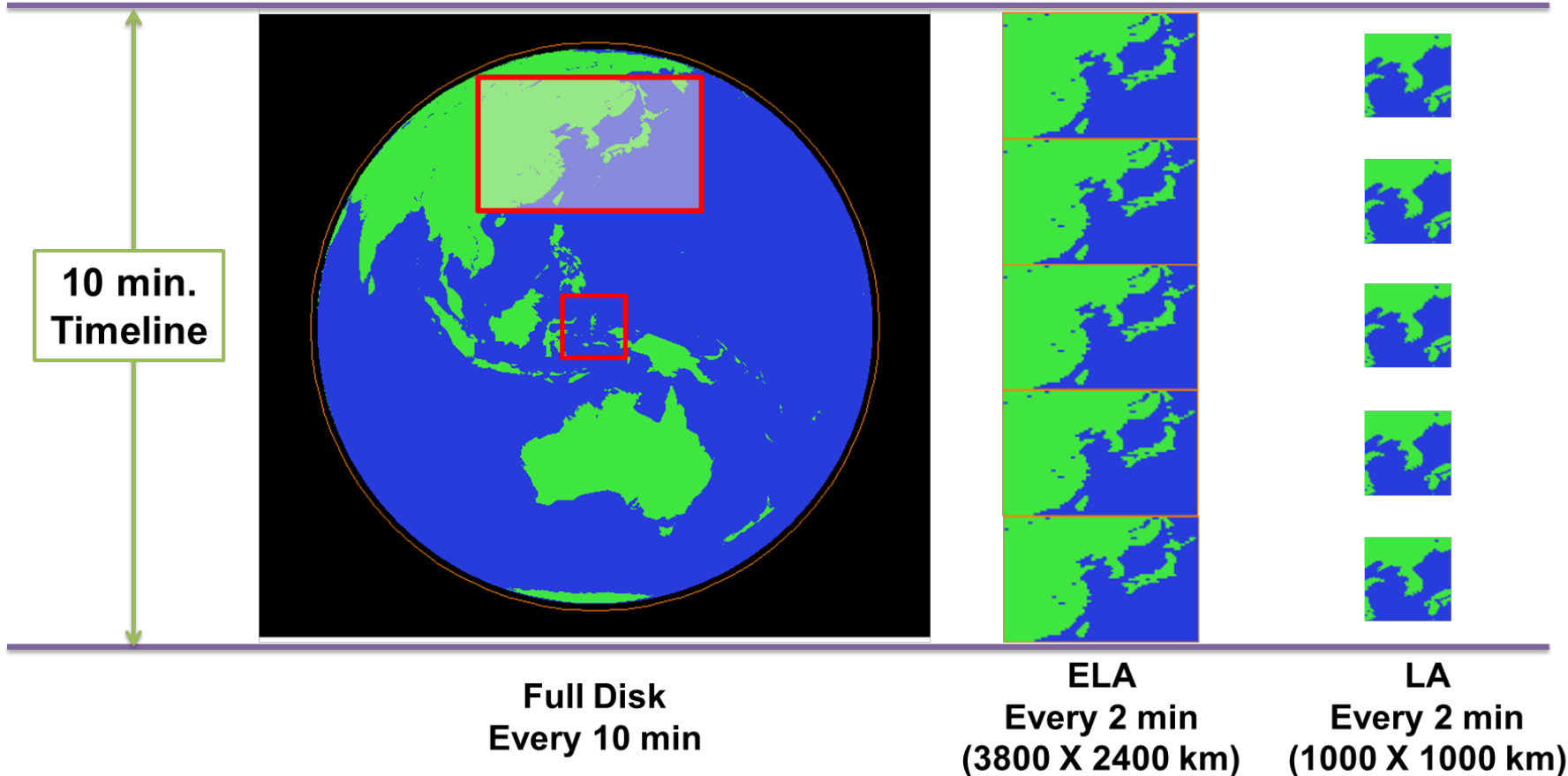 - Lifetime of meteorological mission: 10 years

GK-2A Milestone

PAYLOAD AND SATELLITE

Satellite bus design and Review → Integrate Module → Satellite system integration → Launch/IOT/Operation

| Analysis of system requirements | Preliminary design | Critical design | Instrument Integration and test | System Integration and test | Prepare To launch | launch / IOT | Satellite operation |

Milestones: Start, SRR, PDR, EQSR/CDR, TRR, Environmental Test, Delivery, **Launch**

Timeline: 2013 | 2014 | 2015 | 2016 | 2017 | 2018 → Operation/utilization/service

GROUND SYSTEM

| Preliminary design | Critical design | Implementation /verification | Integration /i... | IOT supporting operation |

DATA RECEIVING AND PROCESSING SYSTEM

System requirements /Standards creation | Preliminary design | Critical design | System implementation | ...

52 MI SCIENCE ALGORITHMS

2014 ~ 2015 → 2016 → ...018

- Algorithm development
- Science Co... complete
- Test operation and verification

APPLICATION AND SERVICE SYSTEM

2014 → 2015 ~ 2016 → 2017 ~ 2018

- analysis of user requirements
- set up system requirements
- Preliminary/critical design

- Create system
- Verify system

- test operation and complement

'17.5(FAR) AMI in KARI ready for AIT

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❖ **1 FD**(Full Disk) **+ 5 ELA**(Extended Local Area) **+ 5 LA**(Local Area)

10 min. Timeline

Full Disk
Every 10 min

ELA
Every 2 min
(3800 X 2400 km)

LA
Every 2 min
(1000 X 1000 km)

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● Structure of Product Development
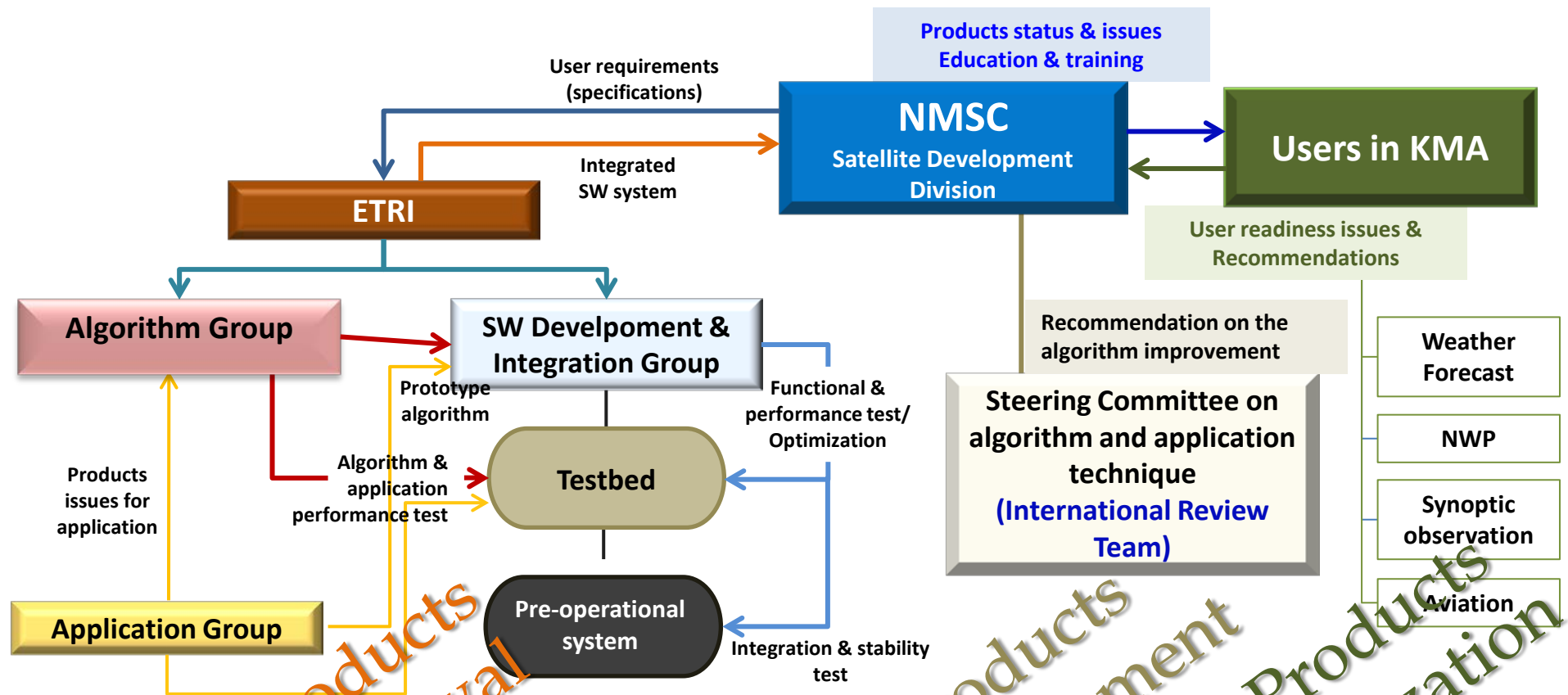
ETRI: Electronics and Telecommunications Research Institute

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GEO-KOMPSAT-2A: Activities of Meteorological Products

❖ **Current Status**: The prototype algorithms of meteorological products were completed in February 2017.

❖ **Activities of Development and Utilization**

- **Algorithm Improvement** by regular review meeting of developers and the International Review Team (IRT)

- **Product Validation** using Himawari-8/AHI data as a proxy data
  - evaluating product maturity

- **User Readiness and Training**
  - Under constructing Convective Cloud and its Pre-environment Monitoring System
  - Application feedbacks from users (e.g., forecasters)
  - Training of how to utilize and analyze GK-2A meteorological products

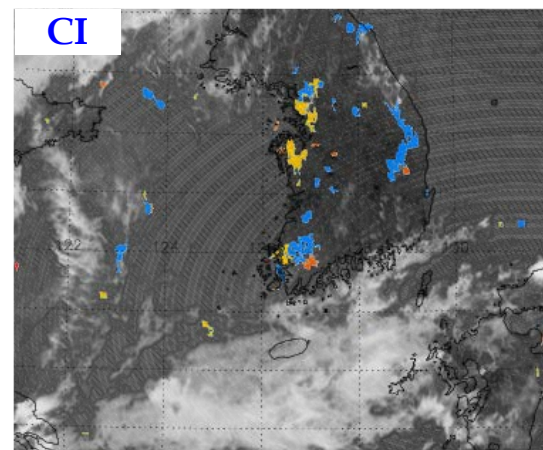# GEO-KOMPSAT-2A: Examples of meteorological products
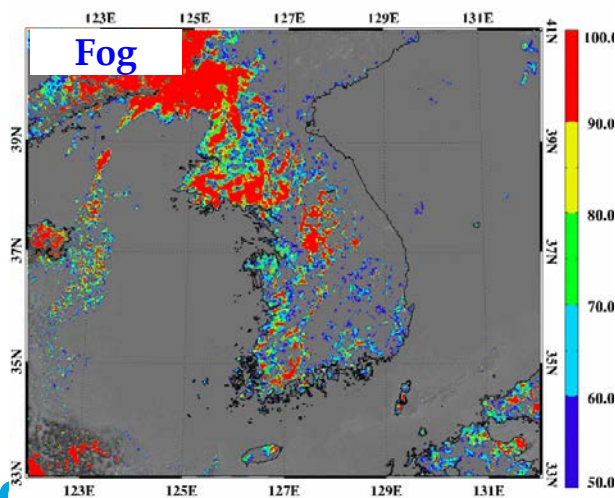

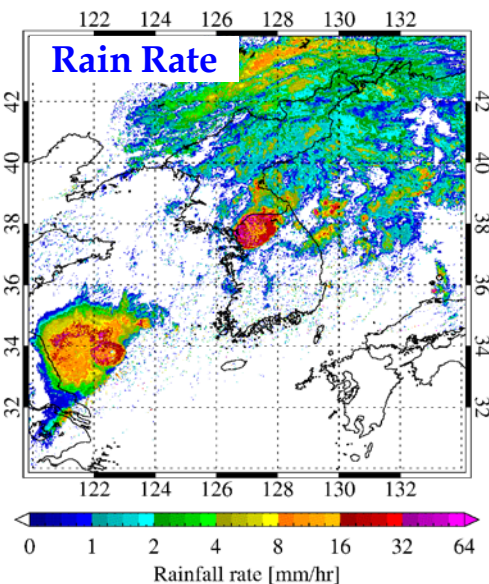CAPE — GK-2A CAPE (20150807, 0400UTC)
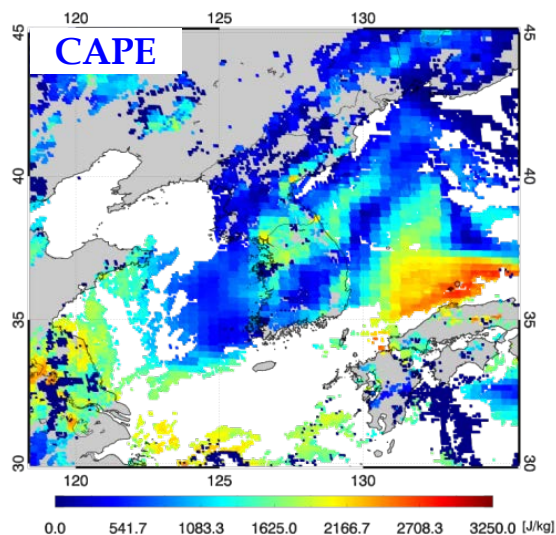
TPW — GK-2A PW (20150807, 0400UTC)
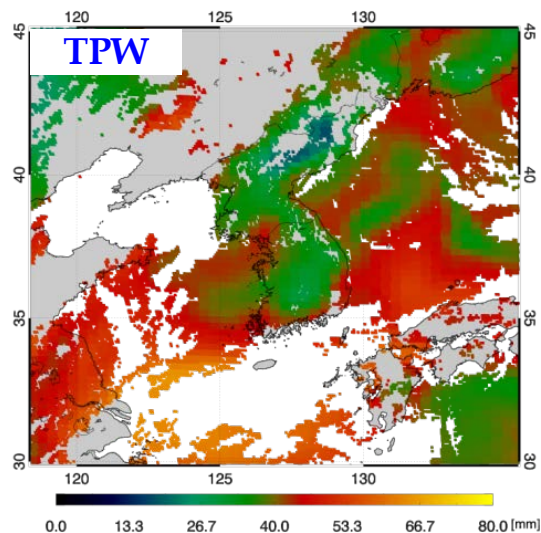
CI — 20150807 1430 KST

Fog — FOG 20151103 1800 UTC

Rain Rate

Dust/Smoke — HIMAWARI-8 Aerosol Detection Product 2016/04/22 03:00UTC

Meteorological Satellites

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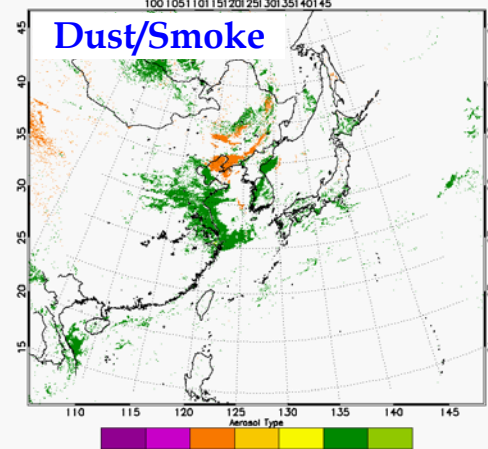
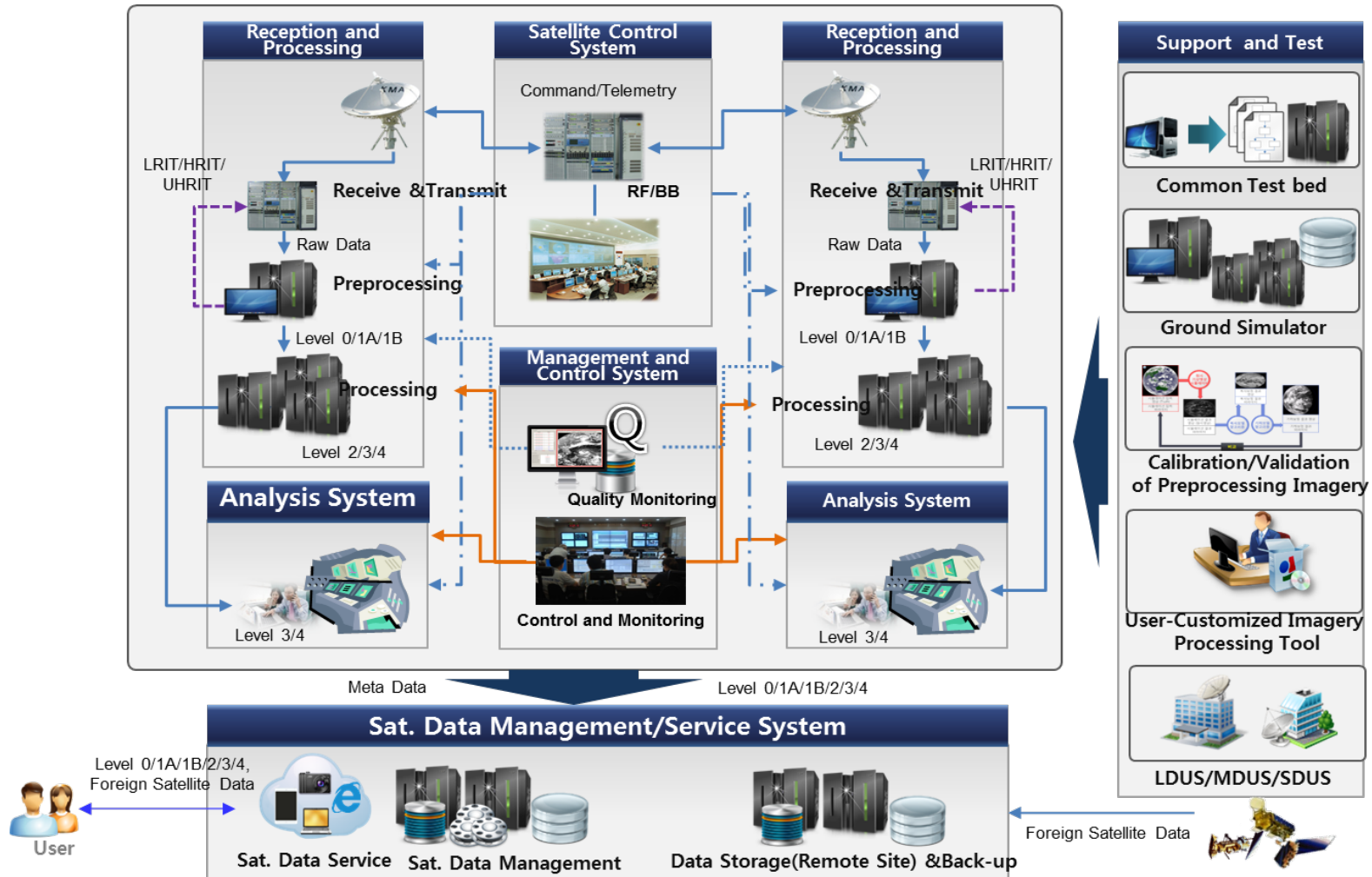# The status of Application Projects using Satellite(2015~2019)

❖ Purpose
  ● More user friendly satellite data support
  ● To maximize the satellite data and product usability, together with all available auxiliary information (eg. conventional observations, NWP forecast, other satellite products)
❖ Target : application techniques for various satellite data users - 4 categories.

Areas	Contents
Nowcasting	• Objective cloud analysis based on satellite • Convective cloud lifetime monitoring and analysis • Precipitation merging and analysis • Satellite Imagery forecast technique
Typhoon & Ocean Analysis	• Typhoon analysis system based on Satellite • Ocean monitoring(Ocean Front, Upwelling, Ocean eddy, Vessel Icing, SST change) • Satellite-based 3D winds
Hydrology & Surface Analysis + Foundation Skills	• Soil moisture, Drought and Floods • Fire(Risk, Fraction of Burned Area, Radiative Power) • Verification, Satellite data Blending and Downscaling
Climate & Environmental Monitoring	• Aerosol concentration, height, vertical distribution • Greenhouse gases, atmospheric composition • Air Quality model applications

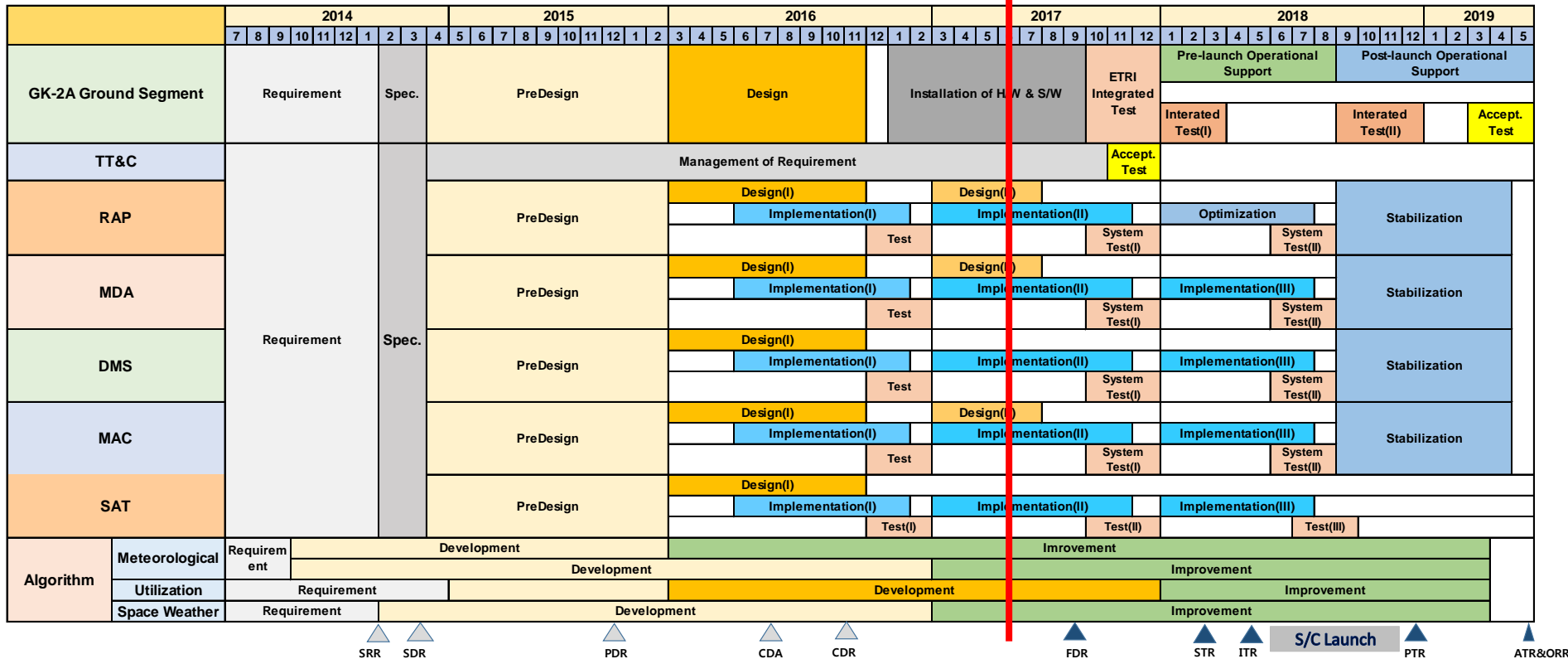# Development Current Situation for GK-2A Ground Segment

[GK-2A Ground Segment Architecture Overview]

Development Current Situation for GK-2A Ground Segment

HW & SW Implementation

[GK-2A Ground Segment Development Schedule]

Lv2 Algorithms Development

- **CDA : Critical Design Audit(16/07/18~07/20) , CDR : Critical Design Review(16/10/31~11/02), FDR : Final Design Review(17/09),**

  STR : System Test Review(18/02), ITR : Integration Test Review(18/05), S/C Launch(second half of 2018), PTR : Post Launch Test Review(18/12),

  ATR : Acceptance Test Review(19/05), ORR : Operation Readiness Review(19/05)

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Data Service Plan : Geo-KOMPSAT-2A

[Via GK-2A broadcast]

- **Broadcast all 16 channels data (UHRIT, full resolution)** of meteorological observations
- Maintain **L/HRIT broadcast** corresponding to COMS five channels

[Via Landline]

- Real-time service similar to Himawaricloud will be implemented (completed in 2018)
- GK-2A data also will be available in DCPC-NMSC (http://dcpc.nmsc.kma.go.kr)

[L1 Data Format]

- netCDF4(for each channels), with GSICS information

[L2 Data Format]

- netCDF4(for each products)

L1 Data Header Structure

General Information

Output Information

Pixel File Information

Projection Information

Star Measurement Information

INR Characteristics Information

Image Geometry Quality Information using Star Measurements

Registered Image Information

Quality Area Image Information

Data Service Plan : LDUS System Development(Under detail design)

- AMI 16ch data will be serviced by CCSDS formatted UHRIT Telemetry on DVB-S2 Broadcasting Standard
- Service Area is same as COMS(El > 10°) but required antenna diameter depends on the rain degradation margin.

Area1(-1dB, EL=55°)

Area2(-2dB, EL=37°)

Area3(-3dB, EL=10°)
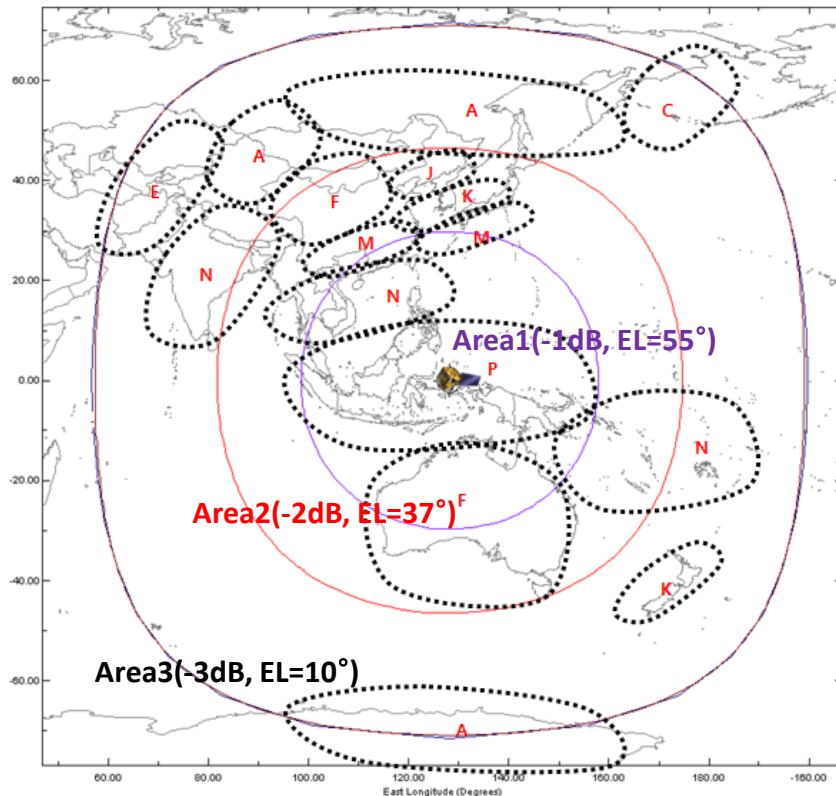
[UHRIT Service Area and Rain rate Map by ITU-R]

Required Hardware

Component	Design
Antenna	3.5m ~ 8m
RF Chain	X-Band(8070/20MHz, LHCP)
Receiver	DVB-S2 Receiver
Reception Server	CPU: Intel 3.0Ghz, 16Cores RAM: 32GB
Storage	> 130TB/year

required antenna Diameter :

Korea	Indonesia	Philippines	Thailand	Sri Lanka	Taiwan	Bangladesh	Australia
3.65	4.33	4.09	4.59	6.49	3.65	5.46	3.44

Software : User Intuitive Design

<Summary screen>   <Imagery search>   <Statistics>

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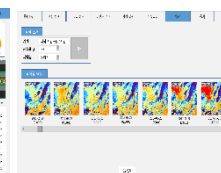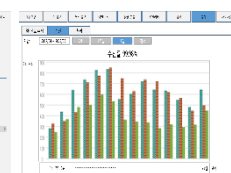
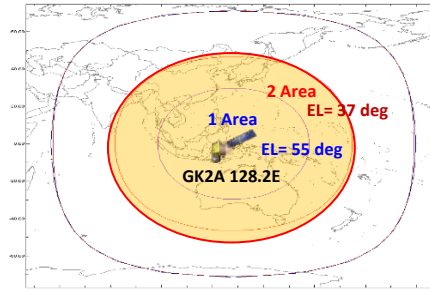# Data Service Plan : SUDS/MDUS System Development(Under detail design)

[SDUS]

- LRIT service is redesigned for using on a ship mounting with an Omni directional antenna.
- Minimized SDR(Software Defined Radio) Receiver
- Contents will be satellite images, weather fax, etc.

[Services Area]
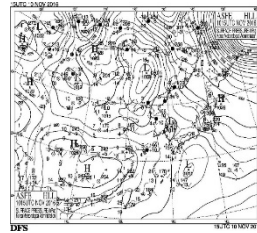
[SDUS Contents]
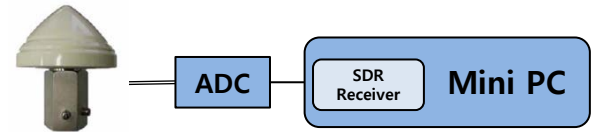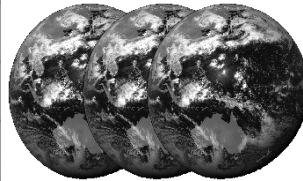
[SDUS System]

[MDUS]

- Downscaled 5 ~ 14ch data(TBC) will be serviced by COMS compatible HRIT telemetry.
- Compact SDR(Software Defined Radio) Receiver built in Receiving Server
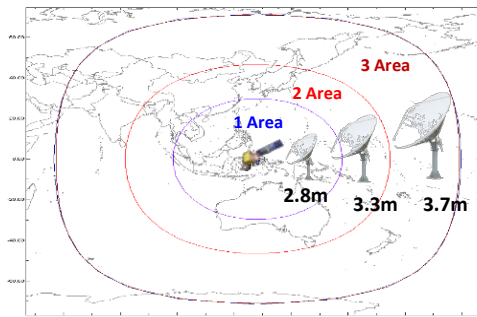
[Services Area]

[MDUS System]

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Development Status of KSEM and its Ground System, SWDPS

➢ **KSEM** is **in the final phase of FM development**, which PER is scheduled to July. Final instrument level milestone of SOSMAG will be performed separately from other parts of KSEM and **SOSMAG** will **be delivered to Korea by the mid of July** from **ESA**.

➢ **CDR of SWDPS** (Space Weather Data Processing Subsystem) was finished in **Nov. of 2016** and **unit level functional test** is scheduled **on the end of 2017**.

GK-2A Missions
- AMI
- KSEM (NEW)

PD (Particle Detector) 3 Sensor Heads
MG (Magnetometer) 2 FG + 2 AMR, Boom, DPU
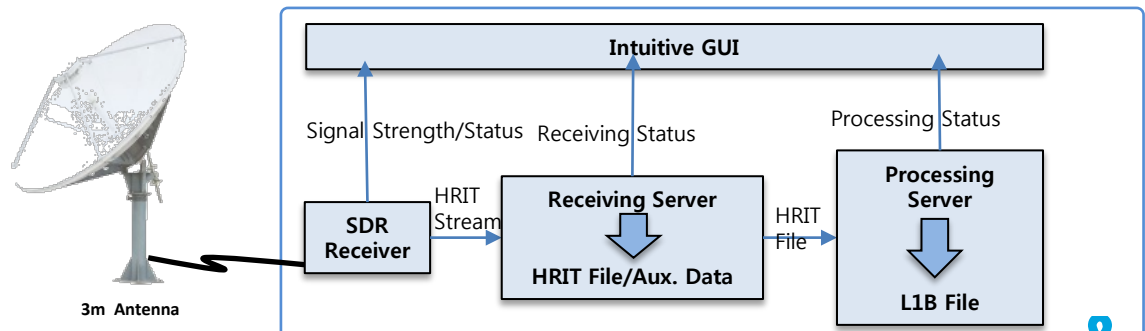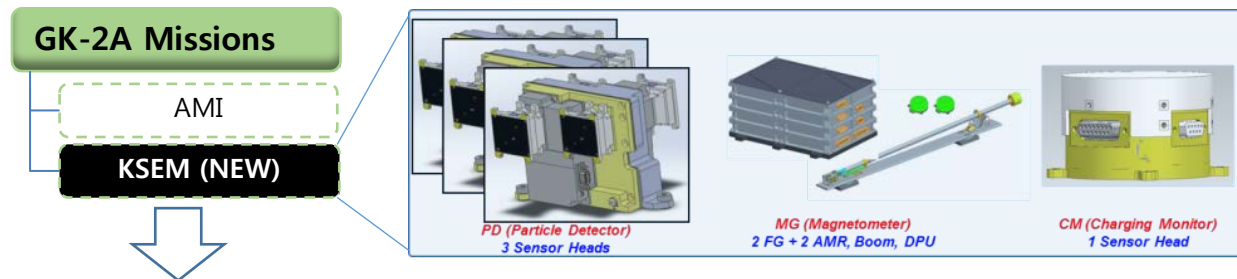CM (Charging Monitor) 1 Sensor Head

[Development Schedule]

		2016											2017												2018												2019				
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
KSEM	PD, CM, IDPU	△CDR (including SOSMAG)			EM building and Test								FM buiding and Test						FAR	Assembly, Integration and Test													In Orbit Test						
	SOSMAG			FM Manufacturing and Test								HAR		FM Delivery to KARI																			
SWDPS		Desing(I)				Test(I)		Design(II)			Test(II)						Test(III)		Sup./Stabilization In Orbit Test					
		Implementation(I)					Implementation(II)					Optimization/Stabilization					

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Korean Space wEather Monitor (KSEM) on Geo-KOMPSAT-2A

KSEM Level 2 products and its processing algorithm

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┌─────────────────────┐          ┌─────────────────────┐
│   External Data     │          │       GK-2A         │
│ (Solar Wind, NOAA   │          │       KSEM          │
│   GOES, Kp, Dst)    │          │                     │
└─────────────────────┘          └─────────────────────┘
```

| Kp Prediction Algorithm (< TBD) | Dst Prediction Algorithm (< TBD) | Magnetospheric particle flux prediction Algorithm (< TBD) |

GEO particle flux prediction Algorithm (< TBD)

Spacecraft Charging prediction Algorithm (< TBD)
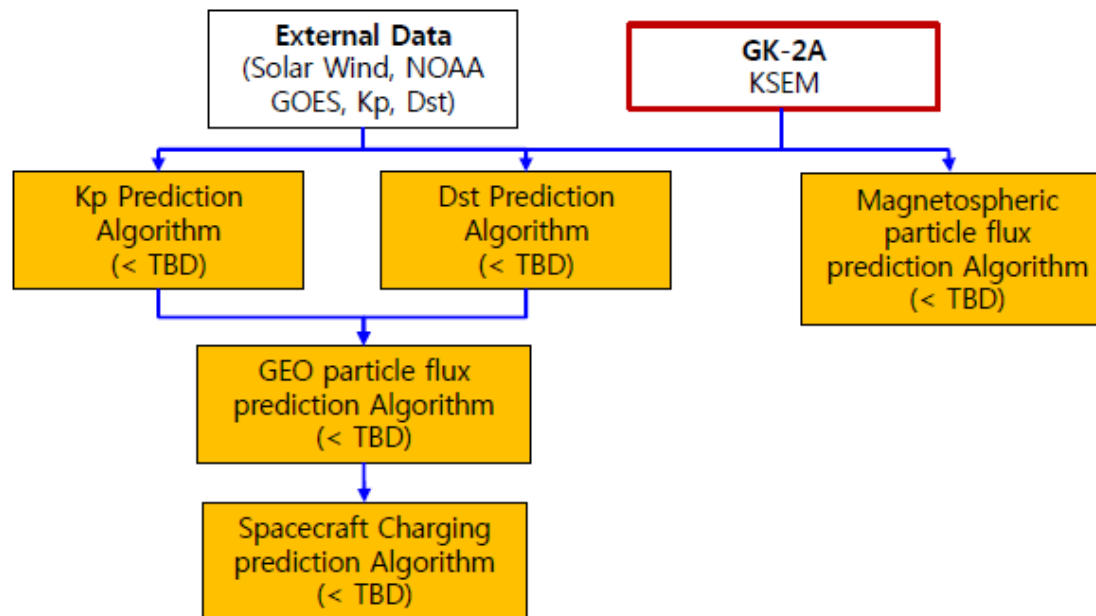
	Data	Size	Processing time (TBD)	Remark
LV 2^	Magnetospheric Particle Flux	240 KB/day	< 1 hour (simulated)	Update every 1 hour [TBC]
	Dst index prediction	3.5 KB/day	< 10 min. (simulated)	Update every 1 hour for 1 day prior data [TBC]
	Kp index prediction	2.0 KB/day	< 1 min. (simulated)	Update every 1 hour for 1 day prior data [TBC]
	GEO flux Prediction	6.0 KB/day/sat	< 20 min. (simulated)	Update every 1 hour for 1 day prior data [TBC]
	Spacecraft Charging	3.0 KB/day	< 20 min. (simulated)	Update every 1 hour [TBC]

FUTURE LEO SATELLITES for meteorological use

Plan research 2015-16

User requirement of LEO satellite
- Prepare report for feasibility test
- two projects are started.

Secure a budget 2017

Feasibility test for LEO satellite (Dec **2016 ~ Sep 2017**)
- Execute the feasibility test for securing budget for LEO satellite including technical and economical validity

Development of the LEO satellite
- Kick-off development of LEO satellite program
- Satellite bus, system integration and developing testing technique
- Ground segments development and secure a image quality technique

Satellite development 2018-

Launch /Utilization 2022-

Application of data Utilization plan
- Apply to weather, climate, earthquake, volcano, disaster, etc.
- Data utilization research for global water/climate, etc.
- Supply standard input data of numerical model

Coord
Meteo

FUTURE LEO SATELLITES for meteorological use

➢ Development (plan) : ~ 2022

➢ Altitude/orbit : ~800km / Sun-synchronous, dawn-dusk orbit

➢ Satellite : ~500kg / Instrument : ~150kg

➢ Possible Instrument : **MW Sounder (ATMS-like)**

 ~ one or two instrument due to the weight of payloads(~150kg)

➢ International cooperation / joint development for payload and sensors

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Announcements by KMA

❖ **Improvement of Meteorological Satellite Data Analysis and Application Competence**

- November 2017 / Jincheon, Korea

- RA II & RA V countries (18 participants from 16 countries in 2016)

❖ **KMA International Meteorological Satellite Conference (KIMSC-2017)**

- 4th quarter of 2017

❖ **14th INTERNATIONAL WINDS WORKSHOP (IWW14)**

- April 23 - 27, 2018 / Jeju, Korea

- http://cimss.ssec.wisc.edu/iwwg/iwwg.html

Thank you