

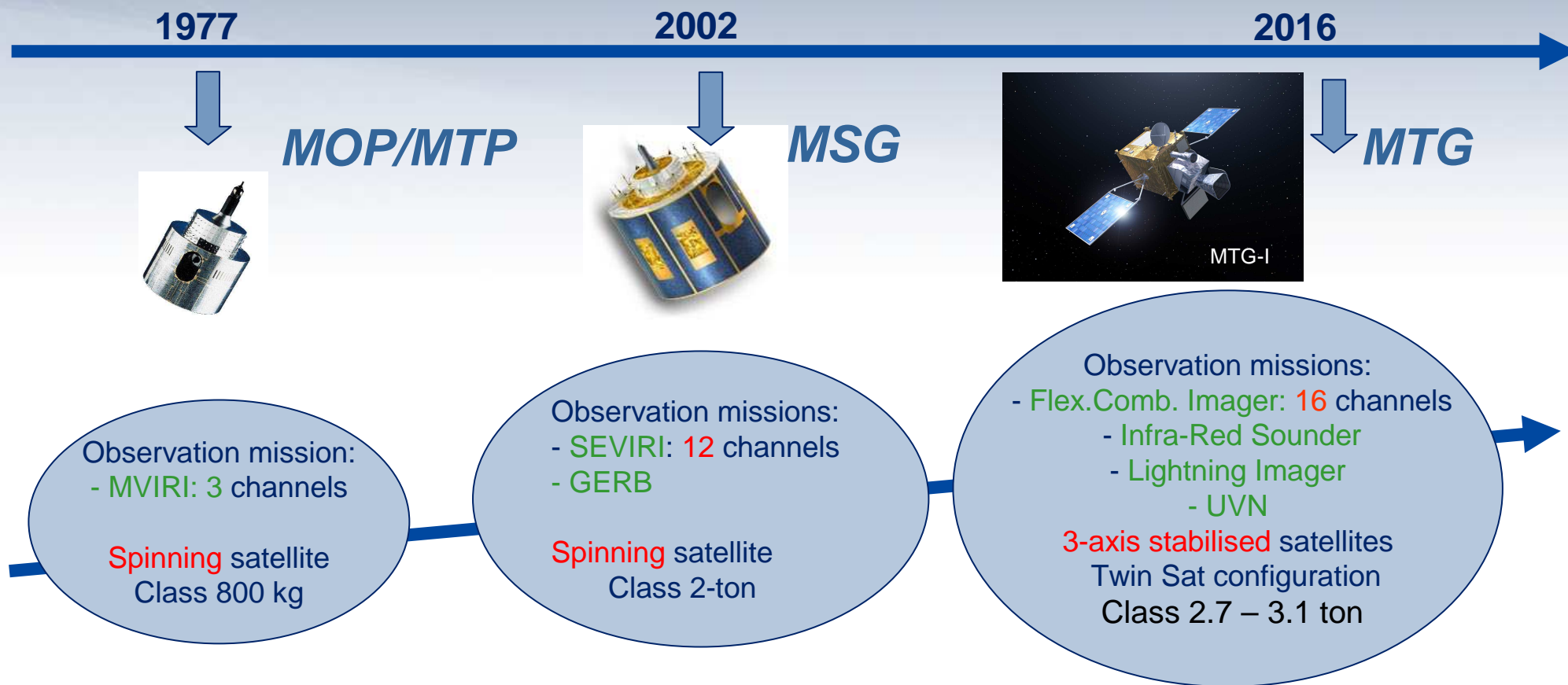


*Presentation at Warsaw
16th December, 2009*

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- Overview of the MTG Programme
- Description of the MTG Ground Segment and its procurement

MTG : continuity and enhancements of EUMETSAT GEO Services



Implementation of the EUMETSAT Mandate for the Geostationary Programme

Atmospheric Chemistry Mission (UVN-S4):
via GMES Sentinel 4
Implementing Arrangement with ESA to Council



MTG – The Five Observations Missions

The MTG Observations Missions from the Instruments on board the MTG - I satellites:

- the **Full Disk High Spectral resolution Imagery (FDHSI)** mission
 - measurements taken by the Flexible Combined Imager (FCI) Instrument over the full earth disc at a repeat cycle time of 10 minutes with a spatial resolution of 1 km/VIS and 2 km/IR;
- the **High spatial Resolution Fast refresh Imagery (HRFI)** mission,
 - measurements taken by the FCI in HRFI mission mode will be provided to Users from 4 channels on regional scales (e.g. about 1/4th of the full disk seen from the geostationary position) at a repeat cycle rate of 2.5 minutes and a spatial resolution of 0.5 km and 1.0 km;
- the **Lightning Imagery (LI)** mission,
 - continuously detecting optical pulses, over almost the full earth disc in view from the geostationary satellite position.



MTG – The Five Observations Missions

The MTG Observations Missions from the Instruments on board the MTG-S satellites

- the **InfraRed Sounding (IRS)** mission,
 - Measurements taken by the IRS Instrument , able of scan the full earth disc within 60 minutes providing a spatial resolution of 4 km, and hyperspectral imaging and sounding information at a spectral sampling interval of 0.625 cm⁻¹ in two bands, a Long Wave InfraRed (LWIR: 700 – 1210 cm⁻¹ (*)) and Mid Wave InfraRed (MWIR: 1600-2175 cm⁻¹(*)) band;
- the **GMES Sentinel - 4 (S4)** sounding mission, achieved through the Ultraviolet, Visible & Near-infrared (UVN) Instrument, covering Europe every hour taking measurements in three spectral bands (UV: 305 - 400 nm; VIS: 400 - 500 nm, NIR: 750 - 775 nm (**)) with a resolution around 8km.

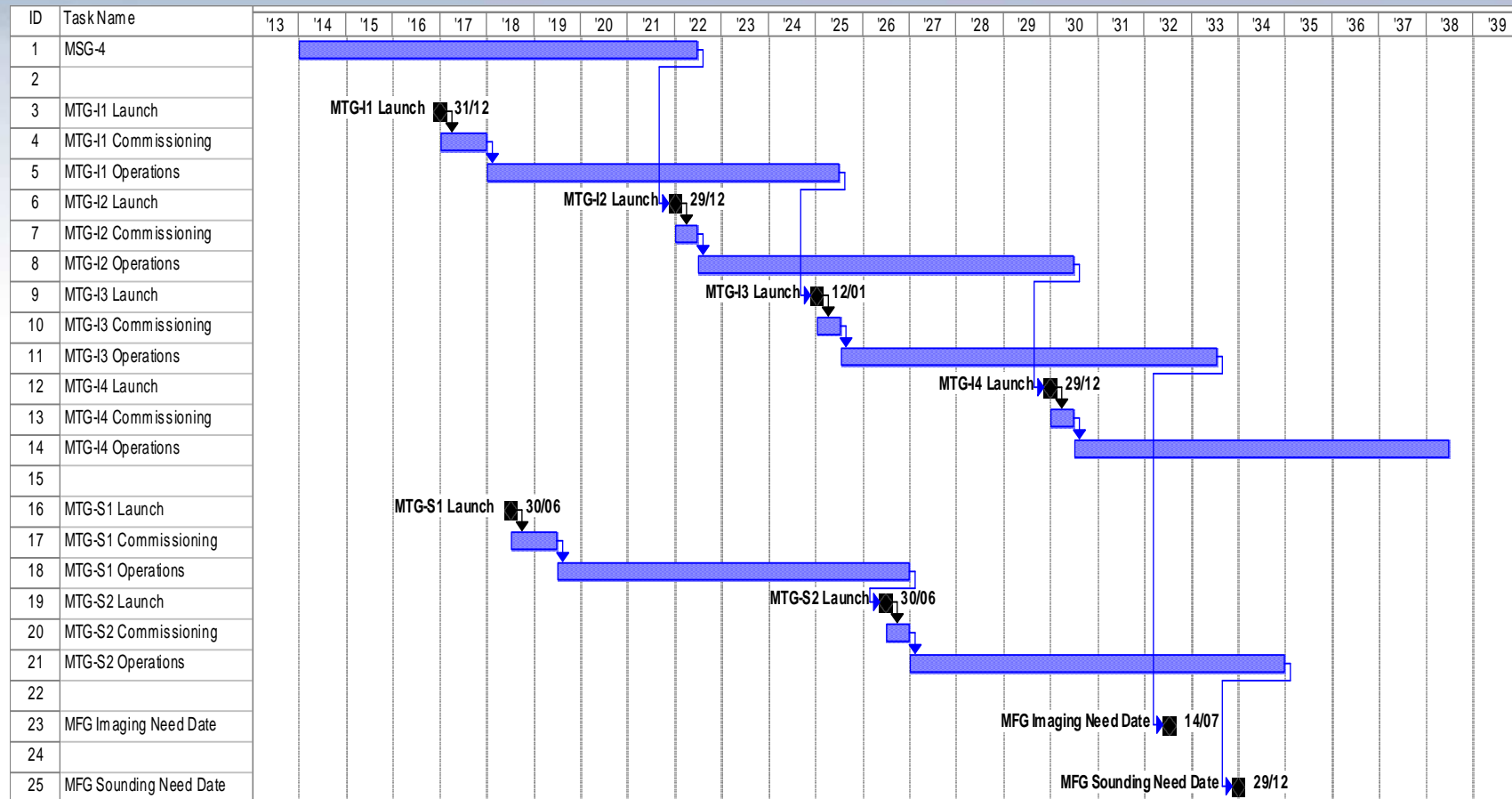
(*) wave numbers (**) wave length



MTG – Other Missions and Support Functions

- Besides the essential functions covering the optical observations, the MTG system includes functions necessary to fulfil its operational services:
 - The Level 2 product generation and extraction;
 - The processing of data received from Data Collection System (DCS) platforms, including extension of the DCS capabilities to support the relay of Argos messages;
 - The Foreign Satellite Dissemination, that collects selected data from other EUMETSAT and Third Party satellite systems for support to global applications;
 - The Search and Rescue (SAR) mission: similarly to MSG, MTG will accommodate a SAR terminal, enabling the operations of the mission under the aegis of the COSPAS-SARSAT System;

MTG Nominal MTG Satellite Deployment scenario



- ➔ - 20 years of operational service for the full disk imagery mission, with potential for 25 years - MSG-4 in parallel (rapid scan) until 2022 - Flexibility of in orbit deployment to maximise duration of the service
- 15.5 years of operational service for the IRS UVN missions (no in orbit back up) – potential for increased duration of the service



The implementation arrangements and the next steps

- ESA develops the prototype satellites as part of the ESA MTG Programme approved at C-MIN 08. Space segment requirements are established in agreement with EUMETSAT, and EUMETSAT contributes to the ESA Programme with a fixed financial contribution;
- ESA procures the recurrent satellites for EUMETSAT as part of the EUMETSAT MTG Programme, and provides the post delivery support;
- EUMETSAT and ESA are both in Phase B as part of the respective programmes, EUMETSAT at overall system level and ESA at space segment level .
 - Following C-MIN 08, the ESA MTG Programme is approved for Phase B and C/D, but requires approval of the EUMETSAT MTG Programme to start in C/D phase.



The implementation arrangements

- On going EUMETSAT activities are part of the MTG Preparatory Programme, until second half of 2010
- The Programme Proposal for the (full) MTG Programme at EUMETSAT is in preparation – Draft version has been delivered for the Autumn 2009 Delegate Body meetings
 - final version in March 2010 (EUMETSAT STG-AFG and Council) following selection of the Industrial Prime for the space segment and feed-back of Delegates from discussion of the Draft version
- The Programme approval process at EUMETSAT, subject to unanimity voting, requires completion by end summer 2010 to enable start of C/D in early 2011 at ESA space segment level
- Assuming Programme Approval is reached by end of September 2010, EUMETSAT ITTs for the major procurements could be released during first half of 2011.



MTG – Overall system configuration - overview

To deliver the required operational service, the MTG system consists of

- **Space Segment,**

- embedding the protoflight (MTG-I1 and MTG-S1) satellites and the recurrent imaging (MTG-I2, I3, I4) and sounding satellites (MTG-S2), plus all the related ground support elements;

- **Ground Segment,** composed of

- Ground Station Facility (GSTF)
 - TTC (Telemetry, Tracking and teleCommand), and MDA (Mission Data Acquisition);
- Mission Operations Facility (MOF);
- Instrument Data Processing Facility (IDPF);
- Application Ground Processing system:
 - Level 2 Processing Facility (L2PF);
 - Satellite Application Facilities (SAFs);
- Multi-Programme Facilities (MPF) – e.g EUMETCast, EUMETSAT Data Centre, EO Portal; Infrastructure Facilities and Supporting Facilities;

- **Launch and LEOP Provider services.**

MTG – Overall system configuration overview

GSTF:
Ground
Station
Facility (TTC-
MDA);

MOF: Mission
Operations
Facility;

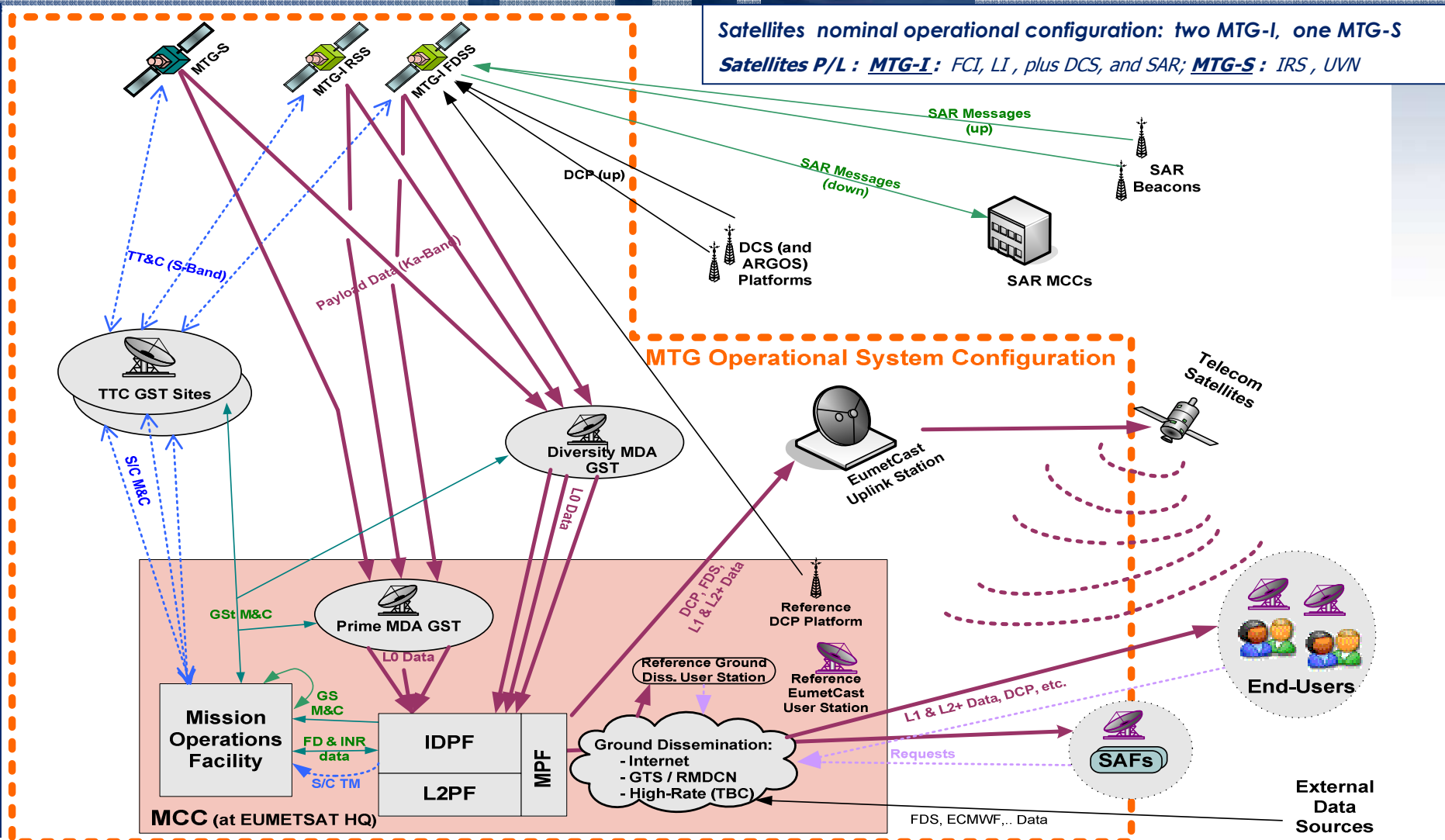
IDPF: Instr.
Data Proc.
Facility;

MPF: Multi-
Program.
Facilities;

L2PF: Level 2
Proc. Facility;

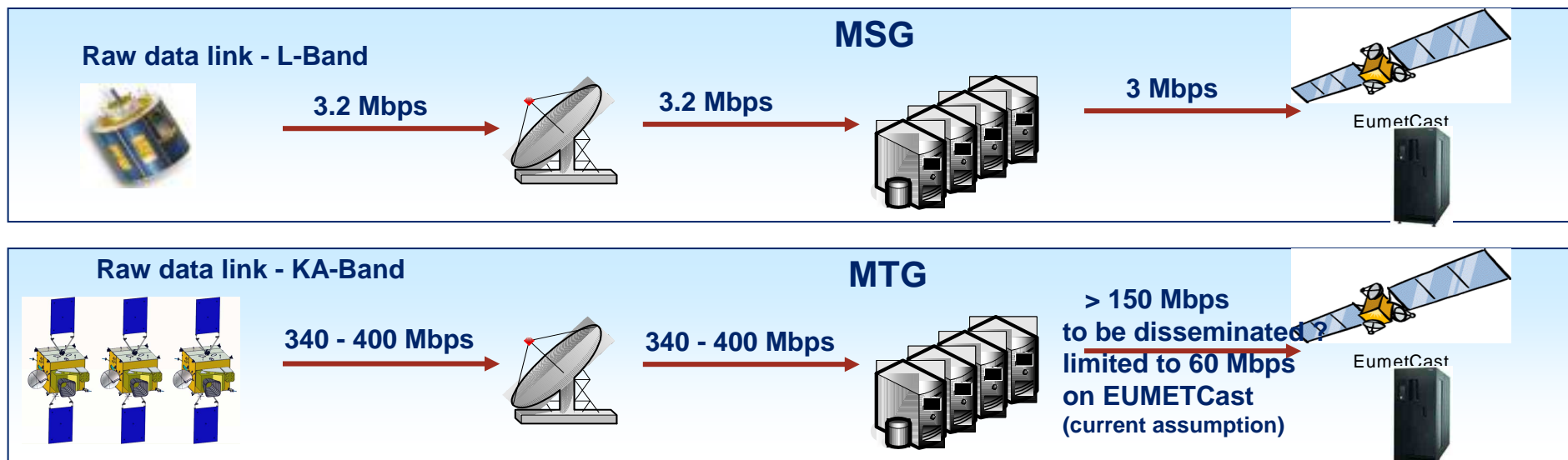
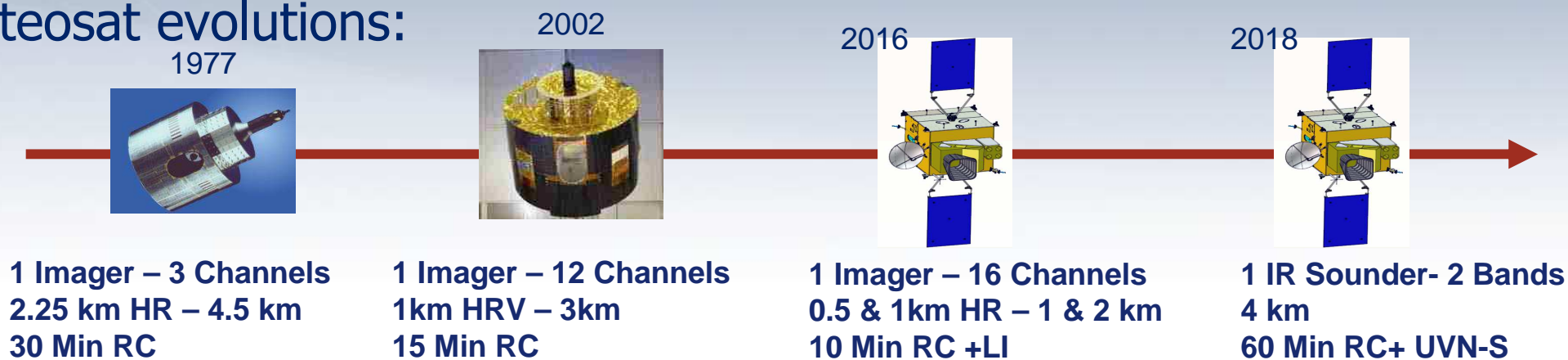
SAFs:
Satellite
Application
Facilities;

MCC: Mission
Control
Centre - the
aggregate of
the Ground
Segment
elements at
the central
site.



MTG – New challenges in Information Technology

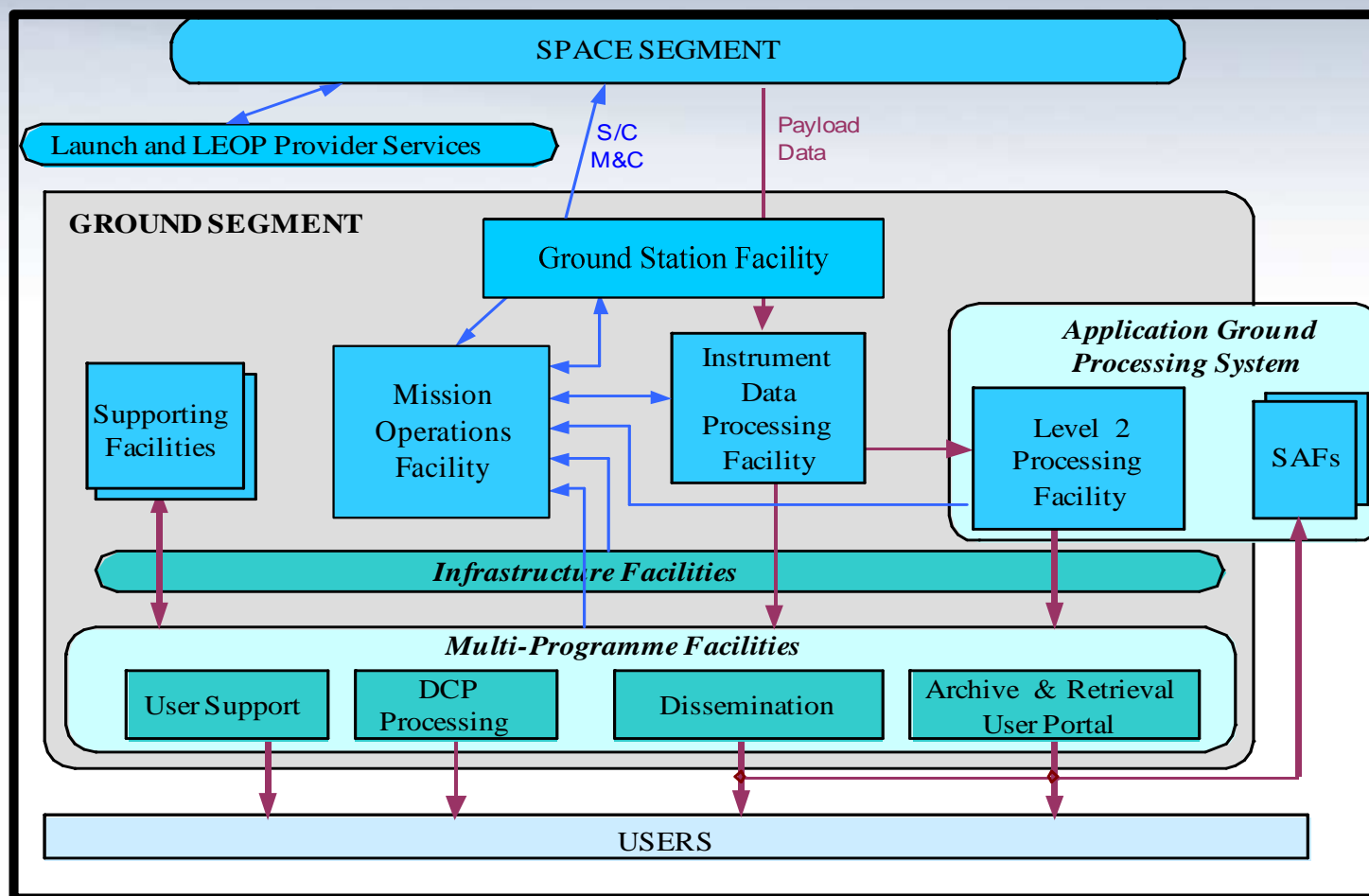
Meteosat evolutions:



MTG – Overall system configuration - overview

GS components that are mostly MTG specific are in blue .

Multi-programme facilities are in green, with the exception of the SAFs (funded by MTG for CDOP-2 and CDOP-3).



The red arrows illustrate the main streams related to payload data processing, archiving and retrieval and dissemination. The blue arrows illustrate the main monitoring and control streams.

MTG High level System and Ground Segment components



Ground Stations

- **Ground Station Facility (Facilities)**

Made of :

- Telemetry, Tracking and Command Ground Stations (acquisition of satellites housekeeping telemetry, transmission of telecommands, tracking and ranging and the interface with the end applications at the Mission Control Centre)
- Mission Data Acquisition Ground Stations (reception of satellite payload data and interface with the front end applications of the Instrument Data Processing element)

Two classes of antennas;

- S- Band transmission/reception (TX / RX) antennas for TT&C
- Ka- Band RX antennas for Mission Data Acquisition
- S-Band Ground stations: site diversity for availability
- need for a geographical separation of the two stations by a minimum of 10° in longitude, to ensure that the necessary ranging accuracy is achieved
- MDA stations: due to rain fading in the Ka-Band, MDA antenna site diversity will be required. The two MDA sites should, be within 50 to 200 km of each other. One of MDA sites should be located close to the central site and its data processing capabilities
- The Ka-Band downlink will deliver data at a high downlink rate of up to 165Mbps for each MTG-I and up to 260Mbps for each MTG-S



Main Ground Segment components

Mission Operations Facility (MOF)

- Able of supporting multiple MTG spacecraft (up to 4 in parallel), it Includes
 - Spacecraft Monitoring & Control subsystem, composed of Satellite Commanding, Satellite control, Satellite Monitoring. SCOS-2000 based. For cost and risk reduction purposes, one instance of the Mission Operation Facility will be able to support multiple satellites.
 - Ground Segment Monitoring and Control (M&C) subsystem, based on a Central M&C and Local M&C implementation, with detailed and specialised facility monitoring and commanding via the Local M&C sub system.
 - Mission Planning & Scheduling subsystem (MPS), allowing the preparation, generation and execution of a conflict-free schedule of satellite and ground segment operations, typically covering a period of one to two weeks and including both space and Ground Segments prescribed timeline.
 - Flight Dynamic subsystem (FDS), providing standard flight dynamic functions of orbit and spacecraft attitude determination; and event prediction, manoeuvre computation and evaluation, mission planning products for command generation.
 - A Backup Spacecraft Control Centre is foreseen to ensure safety of spacecraft operations from a physically separate location and will include the same functions of the MOF.



Main Ground Segment components

Instrument Data Processing Facility (IDPF)

- The IDPF receives raw sensor data from the MDA stations and
 - extracts sensor and mission data
 - performs radiometric and geometric calibration and corrections to generate different levels of data (levels 1a, 1b or 1c)
 - Includes image navigation and geo-location
 - Monitors data / product availability, timeliness, internal consistency and evaluate the data / product quality and performance margins
- The IDPF will include processing for each of the MTG sensors/instruments
- The data rates and timeliness are challenging as are the properties of a three axis stabilised satellite in a geostationary orbit (e.g. thermal effects)
- The benefits of involving spacecraft industry have led to the intention to perform a phase B study of the level 1 processing with the spacecraft prime contractor, which may result in open competition for phase C/D or a continuing contract with that organisation (via RfQ).



Main Ground Segment components

Application Ground Processing Segment (AGPS)

- The AGPS will receive the processed instrument data records, generate specifically selected environmental data and products (from level 1b and or 1c to level 2 and higher) and format the products for further distribution.
- The AGPS is split into the following main areas:
 - L2 Processing Facility (L2PF)
 - Satellite Application Facilities (SAFs)
- The Level 2 Processing Facility (L2PF) is located EUMETSAT Headquarters and performs the generation of the L2 central products.
- The Satellite Application Facilities (SAFs) network are remotely located and perform the generation of the non-central L2 and higher level products.
- Concerning Level 2 processing, the new products to be produced by the MTG system are not yet fully defined, especially the IRS products, and are expected to pose a technical challenge in throughput and complexity.



Main Ground Segment components

Multi Programme Facilities (MPFs)

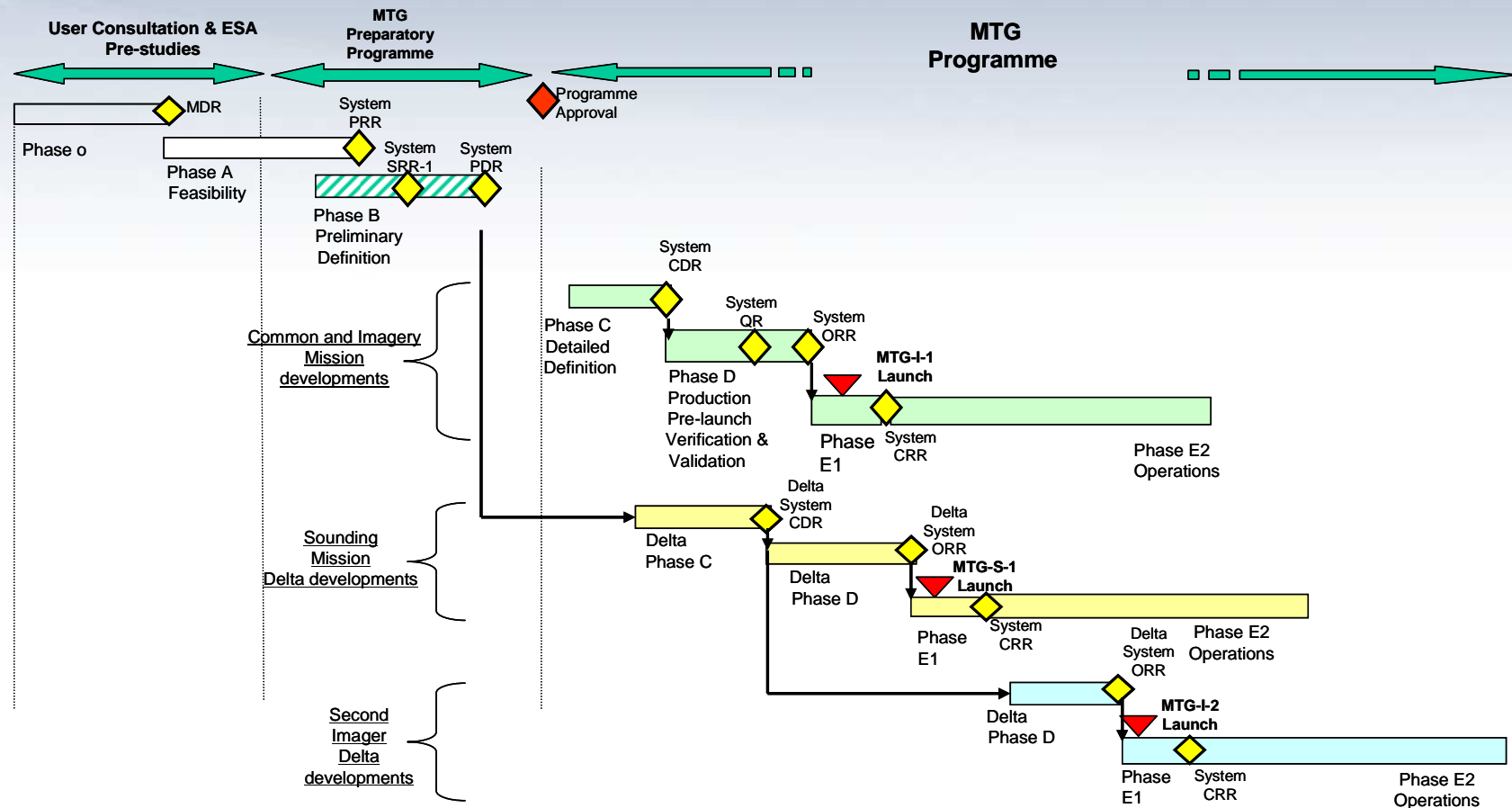
- There are various multi-programme facilities in use today in EUMETSAT operations which can be extended and/or re-used for the MTG Ground Segment.
- One of the key benefits of re-use of operational systems already in operational use in EUMETSAT is continuity of maintenance and a credible upgrade path. This is because these are already foreseen to support the lifetimes of the MSG and EPS Programmes, which will overlap with MTG and show a long term perspective.
- Among the major MPFs foreseen for use for MTG are:
 - EUMETSAT Data Centre (U-MARF) : receives and archives images and meteorological products
 - EXGATE and INGATE : provide a secure file transfer service between operational environments within EUMETSAT and with remote locations through external network interfaces
 - EUMETCast : currently distributes data files using Digital Video Broadcast (DVB) to a wide audience. In the MTG timeframe this shall be significantly extended and the dissemination system will also include components for alternative dissemination mechanisms (e.g. terrestrial links).). This is needed due to the significant increase (more than ten fold) of product volume from MTG compared with the existing missions.



The Ground Segment Procurement approach

- The procurement approach foresees incremental deliveries in line with the spacecraft deployment strategy.
- The areas for procurement are grouped into logical blocks promoting competitive proposals within Industrial areas of competence
- Major areas are foreseen for procurement / development :
 1. Ground Stations – TT&C and MDA stations and the related sites
 2. Mission Operations Facility – including space and ground M&C, flight dynamics and mission planning
 3. Instrument Data Processing Facility and the L2 Processing Facility
 4. the remaining procurements associated with other areas, such as the upgrade of the existing Multi-Programme Facilities, system engineering, integration and verification activities, networks, communications links will be handled directly by EUMETSAT.

MTG system development logic and Phases

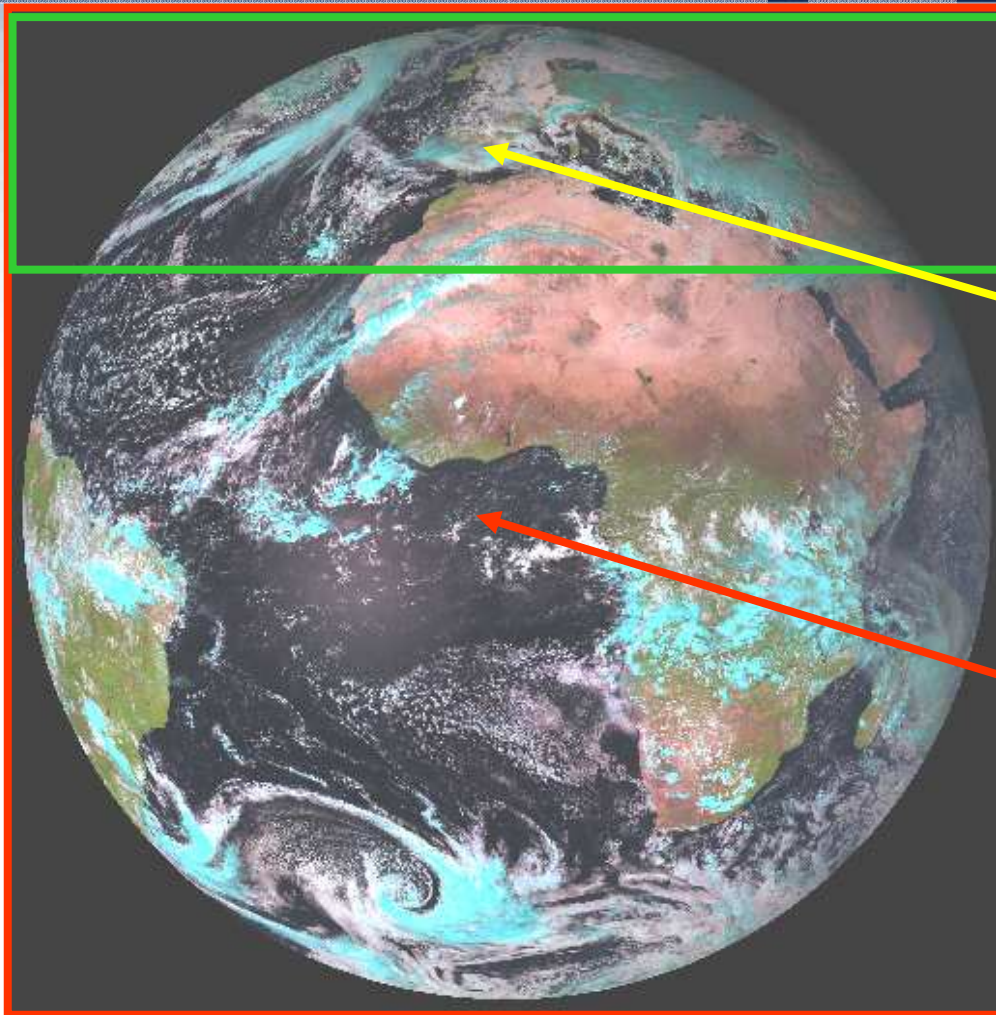


➔ **Phased implementation approach of the MTG system to reduce development risks**



Back Up Slides

Flexible Combined (FC) Imager

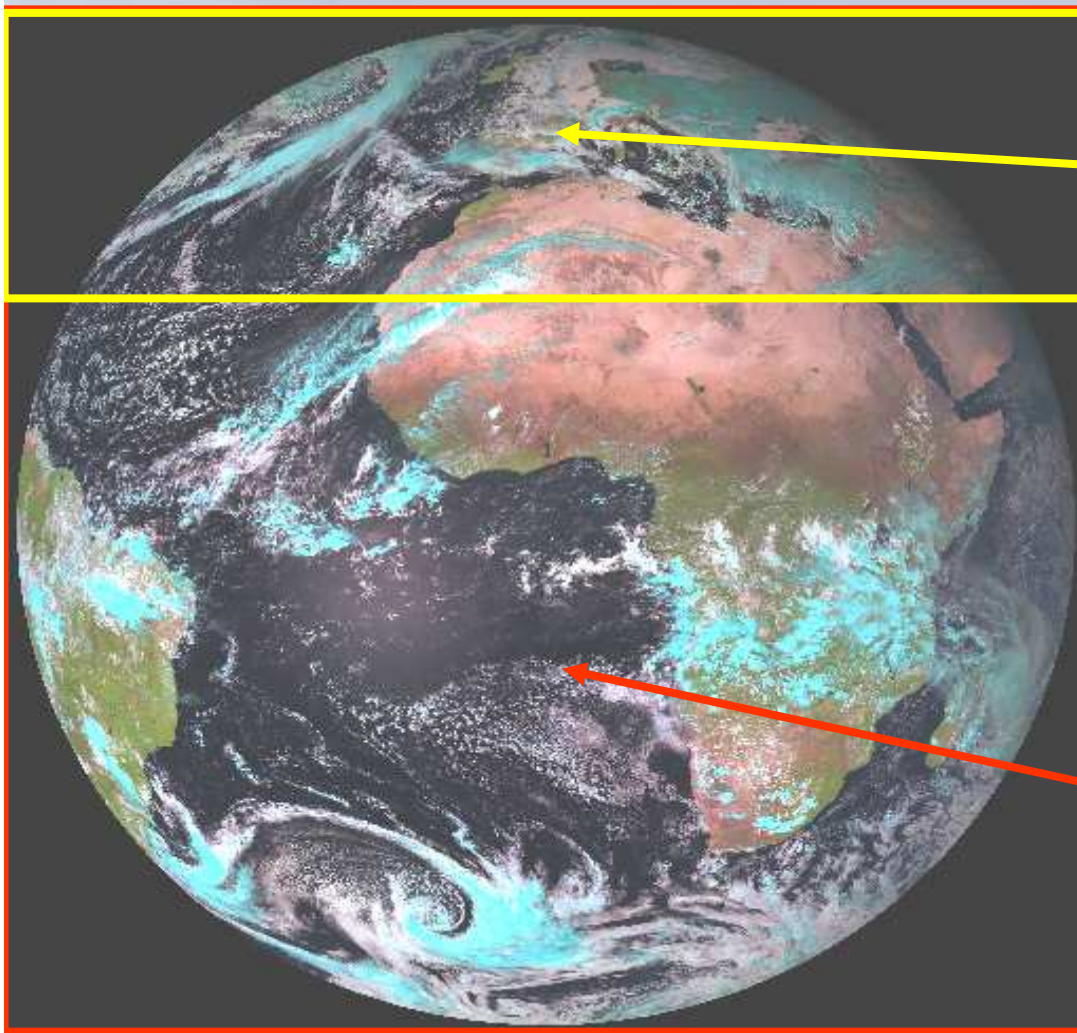


- *The Flexible Combined Imager supports the FDHSI and HRFI missions.*
- *Basic repeat cycle of 10 min Full Disk coverage*
- *The Local Area Coverage zone can be positioned anywhere over the Full Disk Coverage. Possible repeat cycle of 10/2, 10/3 or 10/4 minutes, with the coverage reduced proportionally.*

Challenges compared to MSG:

- *improved Spatial Resolution (0.5 - 2 km)*
- *faster basic repeat cycle (brc = 10 min)*
- *better spectral coverage (more channels)*
- *improved spectral accuracy*
- *improved radiometric accuracy*

MTG IR Sounding Mission



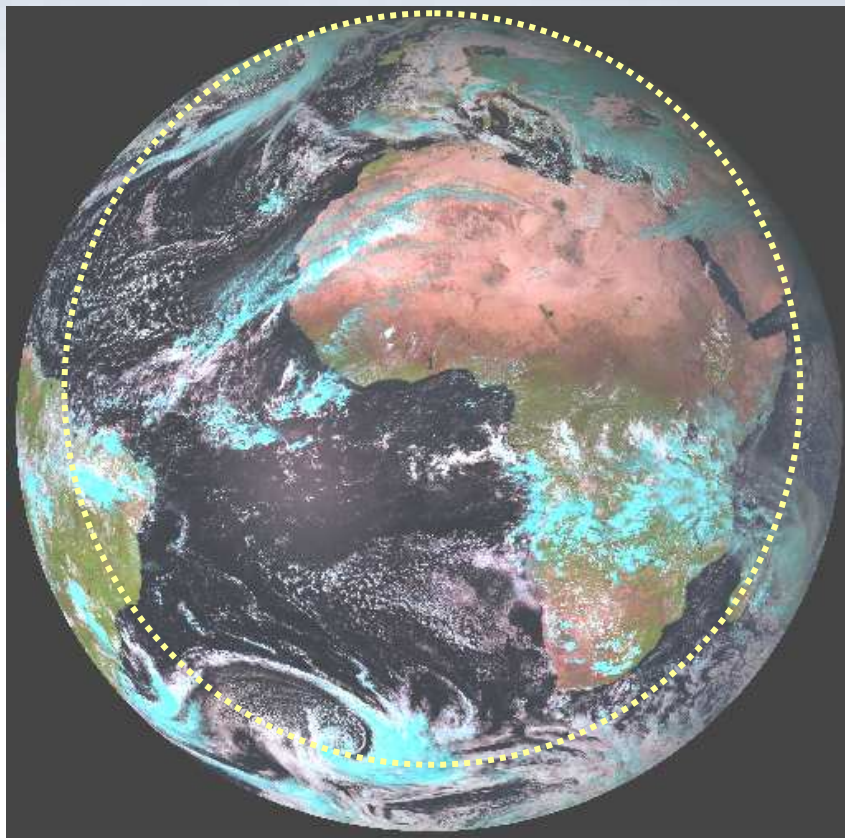
Repeat sequence selectable from four Local Area Coverage (LAC) zones.

Each LAC zone covers a quarter of the Full Disc Coverage (FDC), described by a circle of 17.7° centred on the Sub-Satellite Point (SSP)

LAC zone can be positioned anywhere over the FDC.

A LAC zone is scanned within 15 minutes. The full disc is scanned in 60 Minutes

MTG Lightning Mission



The LI continuously monitors lightning flashes
- In Cloud (IC), Cloud to Cloud (CC), and Cloud to Ground (CG) - during day and night, covering an area of the earth disk within a circle of 16° in diameter subtended from the geo-stationary position and shifted northward to cover EUMETSAT member states.

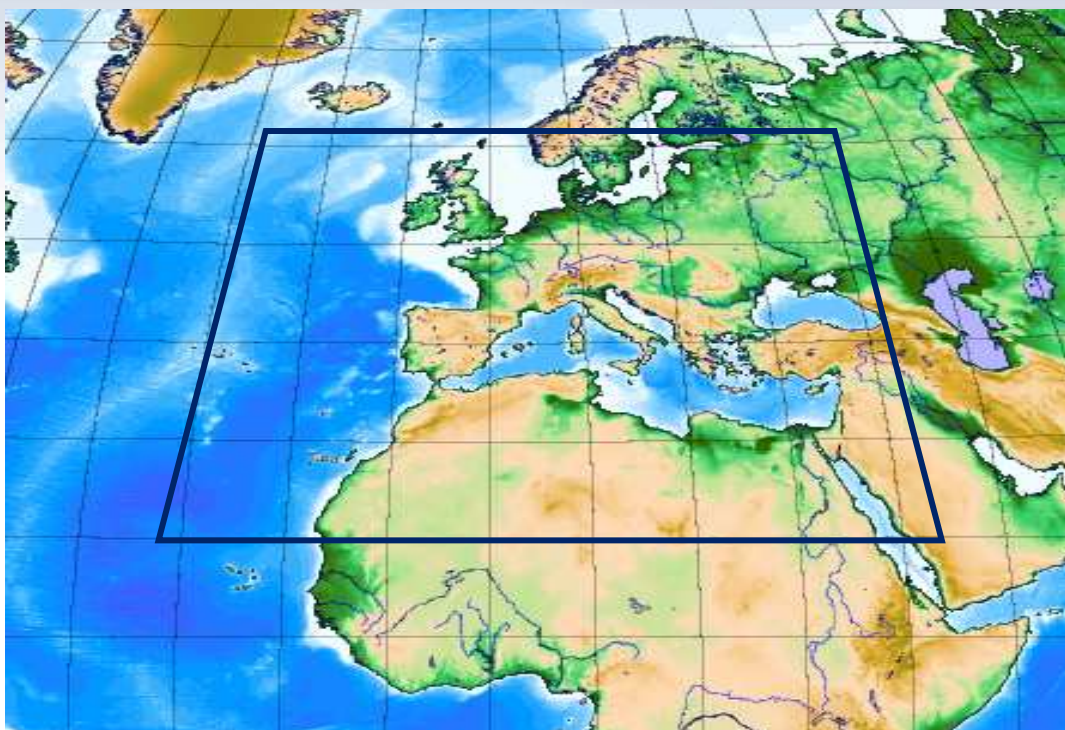
Detection efficiency maximised over Europe

[DE=90% for $E > 10 \text{ mJ.m}^{-2}\text{.sr}^{-1}$ over Europe and 70% elsewhere - to be assessed for energies below $10 \text{ mJ.m}^{-2}\text{.sr}^{-1}$]

On ground correction for achieving the specified False Alarm Rate [350/s with 50% cloud cover and 80% albedo (worst case conditions). FAR=2/s after level 1b processing on ground]



MTG UVN- S4 Mission Coverage



The GMES Sentinel -4 (S4) sounding mission is achieved through the Ultraviolet, Visible & Near-infrared (UVN) Instrument accommodated on the MTG-S satellites

- covering Europe every hour
- taking measurements in three spectral bands (UV: 305 - 400 nm; VIS: 400 - 500 nm, NIR: 750 - 775 nm)
- with a resolution around 8km.

The primary data products are O₃, NO₂, SO₂, HCHO and aerosol optical depth. In addition the MTG-IRS is expected to provide information on O₃ and CO.

Continuation, Improvement and Enhancement of GEO Capabilities

Absorbed Shortwave Radiation	Cloud Top Phase	All Sky Radiances
Active Fire Detection / Monitoring	Cloud Top Pressure	Rainfall Potential and Probability
Aerosol/Dust Detection	Cloud Top Temperature	Rainfall Rate/ Multisensor QPE
Aerosol Optical Thickness	Cloud Type	Reflected Solar Radiative Flux TOA
Aerosol Particle Size	CO Concentration	Scene Analysis
All Sky Radiances	Convection Initiation	Sea & Lake Ice/Age
Aircraft Icing Threat	Atmospheric Motion Vectors	Sea & Lake Ice/Concentration
Air Mass Analysis	Downward Longwave Irradiance	Sea & Lake Ice/ Displacement and Direction
Atmospheric Moisture Profile	Downward Shortwave Irradiance	Sea & Lake Ice/Extent and Characterization
Atmospheric Temperature Profile	Emitted Longwave Radiative Flux TOA	Sea Surface Temperature
Capping Inversion Information	Enhanced Overshooting Top Detection	Snow Cover
Clear Sky Masks	Fire Radiative Power	SO ₂ Concentration
Clear Sky Radiances	Fire Radiative Energy	Surface Albedo
Clear Sky Reflectance Map	Flood/Standing Water	Surface Emissivity
Climate Data Set	Global Instability Indices	Total Precipitable Water
Cloud Coverage	High Resolution Precipitation Index	Total Water Content
Cloud Ice Water Path	Humidity Products (upper/midlevel rel. Hu)	Turbulence
Cloud Imagery	Ice Covered Land	Upward Longwave Radiation at Surface
Cloud Layers / Heights and Thickness	Land Surface (Skin) Temperature	Vegetation Fraction LAI
Cloud Liquid Water	Lightning Detection Nowcasting Applications	Vegetation Index
Cloud Mask	Low Cloud and Fog	Visibility
Cloud Optical Depth	Moisture Flux	Volcanic Ash
Cloud Particle Size Distribution	Ozone Layers	Wind Divergence
Cloud Top Height	Ozone Total	

MTG Flexible
Combined Imager

MTG Infrared
Sounder

MTG Lightning
Imager

UVN applications: GMES S4 atmospheric chemistry