Status of Meteosat Third Generation (MTG) Pre-Phase A System Architecture Studies

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Nationaler Nutzerworkshop “Operationelle Satellitensysteme der Erdüberwachung” 7-9 November 2005, Tagungsstätte Walberberg
• 2015: NOMINAL NEED DATE FOR MTG

• 2009-2015: PHASE C/D DEVELOPMENT/ON-GROUND TEST OF MTG SYSTEM

• 2008-2009: PHASE B COORDINATED ESA & EUM PREPARATORY PROGRAMMES

  Approval of EUMETSAT and ESA MTG development programmes

• 2006-2007: MTG PHASE A STUDIES FOR SELECTED MISSION CONCEPTS (critical technologies pre-developments)

• 2001-2005: “USER CONSULTATION PROCESS” & PRE-PHASE A STUDIES
Nationaler Nutzerworkshop "Operationelle Satellitensysteme der Erdüberwachung"
7-9 November 2005, Tagungsstätte Walberberg

Pre-Phase A System Architecture studies

ALCATEL ALENIA SPACE

Requirements and Concepts

Detailed Analysis and Definition

Programmatic Aspects Wrap-up

2 Parallel Studies – 14 months duration

EADS ASTRIUM GmbH

KO October 2004

Mid-Term Review (MTR)
Mar/Apr 2005
2nd MTG UCW Locarno

Mission Architecture Review (MAR)
Sep/Oct 2005

In progress

Close-out: Nov/Dec 2005

Requirements & Trade-off tree

Candidate Concepts Characterisation

Selection mission / system Architecture (s) concepts

Observation Payload

Spacecraft & Launcher

G/S concept Data Flow

Architecture Consolidation and Justification

System Update

Planning & ROM estimates

Critical Areas
### MTG Observation Missions Requirements

<table>
<thead>
<tr>
<th>λ: spectral range/channels; Δx: spatial resolution at sub-satellite point (SSP); BRC: basic repeat cycle</th>
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<tbody>
<tr>
<td><strong>FDHSI</strong></td>
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<td><strong>BRC</strong></td>
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<td><strong>λ</strong></td>
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<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td><strong>Δx</strong></td>
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From MOP to MTG

1977 2002 2015

**MOP**
- 1 observation mission: MVIRI: 3 channels
- Spinning satellite

**MSG**
- 2 observation missions:
  - SEVIRI: 12 channels
  - GERB
  - Spinning satellite

**MTG**
- 5 observation missions:
  - HRFI: 5 channels
  - FDHSI: 22 channels
  - Lightning Imager
  - Infra-Red Sounder
  - 3-axis stabilised satellite(s)

UVS
coordinated with GMES Sentinel 4

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The following concept was selected for detailed analysis:

Implementation of the imaging mission through the combined imager

- 1 imager instead of 2 on each satellite
- Simpler satellite configuration, reduced launch mass
- Significant cost savings (space segment/launcher)

Payload accommodation (Combined Imager, IRS, LI) on multiple satellites

- Flexible system deployment and development approach
- Decoupling of higher risk sounding mission from the higher priority imaging mission
- Reduced complexity of key platform subsystems
MAR status – Combined Imager

- 10 min. FD coverage (3.3 min LAC)
- 15 core channels (22 with options)
  - ≈ 250 Kg
  - ≈ 250 W
- Data Rate ≈ 50 Mbs (all options)
- Active cooling (driven by LW channels)
- 2 axes scan mechanism

Development Issues

- Detector arrays for the IR (LWIR) channels
- Scan Mechanism (complexity, lifetime)
- Cryo-coolers
- Optical elements (coatings, filters)
- Solar inputs effects (thermo-elastic deformations -> mission availability)
Two instrument concepts analysed. Final selection still open

**Fourier Transform Spectrometer (FTS)**

- Telescope Optics
- Collimating optics
- Mecanism
- Imaging optics
- Detector array

**Dispersive Spectromter (DS)**

- Wavelength $\lambda_0$
- Slit
- Band-pass filter
- Cold stop
- Detector array
- Spectral sample $\lambda_0$

**Step and Stare “scanning”**

256 x 256 FPA at 6.5 sec dwell time

**Pushbroom scanning in EW direction**

Array size depends on band
MAR status – Infrared Sounder

**Earth face**

- **DS**
  - \(\approx 280-320\) Kg
  - \(\approx 350\) W
  - \(\approx 400\) Mbps
- **FTS**
  - 280-330 Kg
  - 350-480 W\(^{(1)}\)
  - \(\approx 3\) Gbps \(^{(2)}\)
  - Active cooling (driven by LW channels)
  - 2 axes scan mechanism

\(^{(1)}\) Depending on level of data processing and implementation (instrument/DHSS)
\(^{(2)}\) Raw Instrument data rate before processing
Development Issues

- LWIR detectors array requires major pre-development (in different direction for the DS and the FTS)
- interferometer design (FTS), gratings (DS)
- Processing loads (FTS)
- Cryo-coolers
- Scan Mechanism (but driven by the combined imager)
- Solar inputs effects (thermo-elastic deformations -> mission availability)

Preliminary Concept Assessment

- The engineering challenges are different between the DS and FTS concepts but of the same level of complexity at instrument level;
- The FPA array/cooler technologies require development for both DS and FTS but in different directions
- DS shows better radiometric performances for most bands whereas FTS seems better for LWIR bands;
- Spectral calibration requirements more constraining for the DS concept
- FTS instrument is more difficult to accommodate (data rate, pointing stability)
MAR status – Lightning Imager

- 4 cameras 16 deg coverage (shifted N)
- 160 mm aperture
- ≈ 100 Kg
- ≈ 60-100 W
- Data Rate ≈ 100 kbps

Development Issues

- Not a “small” instrument, current concept based on reduced DE performances (DE>90% from 6 mJ.m-2.sr-1)
- APS detector with smart pixel (extraction of lightning flash events) and narrow band filter (160 mm) are technologies to be developed
- Lightning flash models (at signal level) are essential for assessing the spatial and temporal coupling of the flash event with the detection process. Different assumptions have a significant impact on the instrument sizing
MAR status – Space Segment

Imaging Satellite (MTG-I)  Sounding Satellite (MTG-S)

- Payload accommodation on two satellites: MTG-I (CI, LI, DCS) and MTG-S (IRS DS/FTS)
- Common S/C bus except communication payload and Data Handling, heritage from Telecom buses
- Launch mass: 3+ tons
- Power: 1+ kW
- PDT: L/X band for MTG-I, X/Ku band for MTG-S (on-board processing, DS/FTS selection)
- Launchers: Soyuz (3t), Ariane 5
- S band TT&C
MTG Satellite concept – Main Features

• AOCS concept heritage from recent telecom development with improved sensor performances

• CPS for orbit acquisition and station keeping, EPS options for wheels unloading (and possibly N/S S/K)

• Asymmetric solar wing and 2-yearly yaw flip (instrument thermal control)

• High thermo-mechanical stability to minimise thermo-elastic distortion in orbit and particularly at eclipse transitions

• Micro-vibration impacts (Reaction wheels, active coolers) on observing missions performance to be analysed in details in the coming development phases
8 satellites (2 MTG-I nominal + 2 MTG-I back-up; 2 MTG-S nominal + 2 MTG-S back-up) to cover the required mission lifetime (15 years + 5 years extension)

Phased deployment approach (first MTG-S two years after the first MTG-I) to cope with the critical IRS development schedule and to provide programmatic flexibility
• The pre-phase A studies have identified suitable instrument/system concepts for the implementation of the MTG system, based on the present definition of user/mission requirements

• The mission is ambitious and demanding, major technology pre-developments are required (partially already initiated by ESA)

• Phased system development and deployment approach will mitigate the risk in compliance with the MTG mission priorities

• Programmatic inputs to be analysed soon. Affordability consideration will probably drive the consolidation of mission/system requirements applicable to the coming feasibility studies at phase A level

• The operational deployment of the MTG imagery mission by 2015 is judged feasible but challenging. MTG technical and programmatic requirements to be consolidated soon in line with the objective of starting Phase A and major pre-developments by 2006