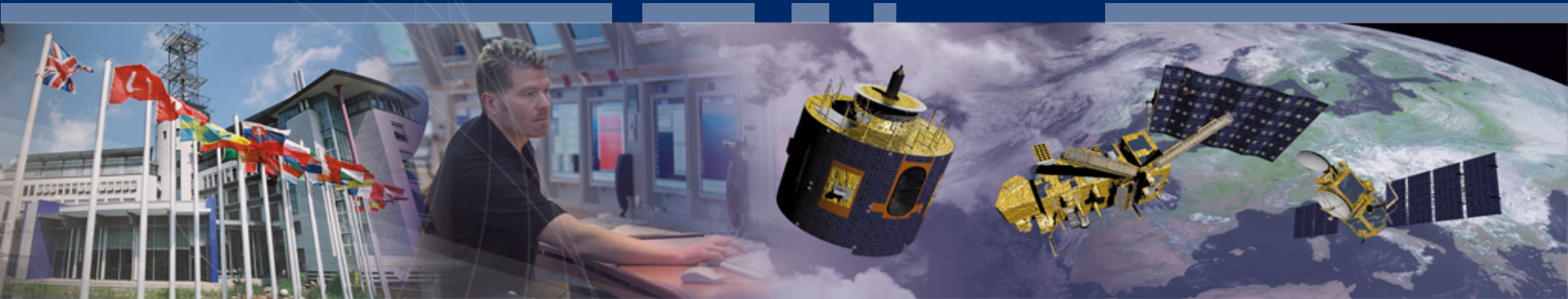


Hyperspectral Infrared Sounding Missions Future perspectives for data dissemination

Ken Holmlund
Lothar Wolf, Rolf Stuhlmann, Peter Schlüssel





TOPICS

The Problem

The Solution

The Way Forward



The Solution

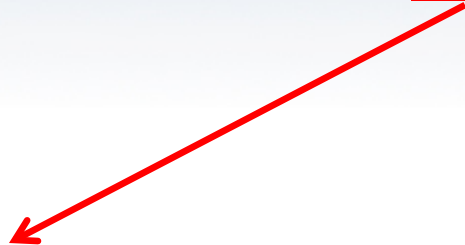
We just do what we are paid to do



The Problem

We just do what we are paid to do

Affordability



So everything is possible

But is that what you really want?



Hyper-spectral infrared sounding IASI – NG (New Generation)

Objectives

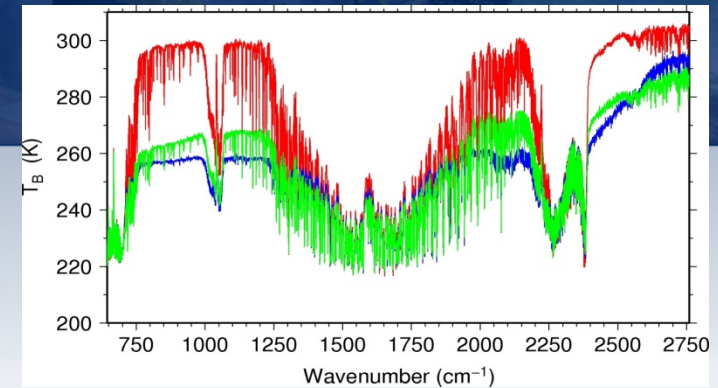
- Temperature/humidity profile at high vertical resolution
- Clouds, trace gases (O_3 , CO , CH_4 , CO_2 ,...)
- Sea/land/ice surface temperature
- Aerosols, Volcanic Ash

Implementation

Development of Fourier Transform Spectrometer IASI-NG by CNES

Key performances

- spectral range: 645 – 2760 cm^{-1}
- spectral resolution: 0.25 cm^{-1}
- radiometric calibration: 0.25 K
- stability: 0.1 K
- Radiometric noise: 0.045 – 1.1 K
- pixel size: 12 km
- spatial sampling: 25 km
- cross-track scan

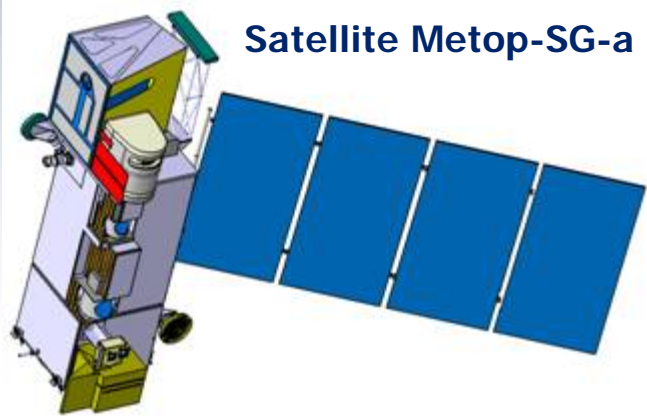


Breakthrough

- **Doubling of radiometric and spectral resolution of IASI for the benefit of weather forecast and atmospheric composition**
 - 75% more information in temperature profiling, particularly PBL
 - 30 % more information in water vapour profiling
 - Quantification of trace gases which are currently only detected
 - Vertical resolution of trace gases instead of columnar amounts only



EPS-SG in-orbit configuration



Satellite Metop-SG-a

Artist view

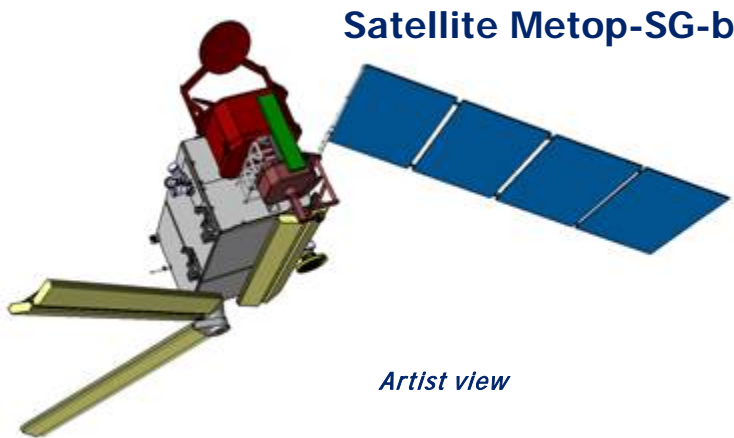
Satellite-a Payload	METImage IASI-NG MWS 3MI Sentinel-5 RO
Dry mass	~ 3250 kg
Launch mass	~ 3661 kg
Power	~ 2.3 kW
P/L data rate	~ 54 Mb/s

EPS-SG space segment

Two-Satellite Configuration

Overall lifetime

21 years



Satellite Metop-SG-b

Artist view

Satellite-b Payload	SCA MWI ICI ARGOS-4 RO
Dry mass	~ 2928 kg
Launch mass	~ 3339 kg
Power	~ 2.0 kW
P/L data rate	~ 6.3 Mb/s

Earliest launch date (first satellite)

end 2020

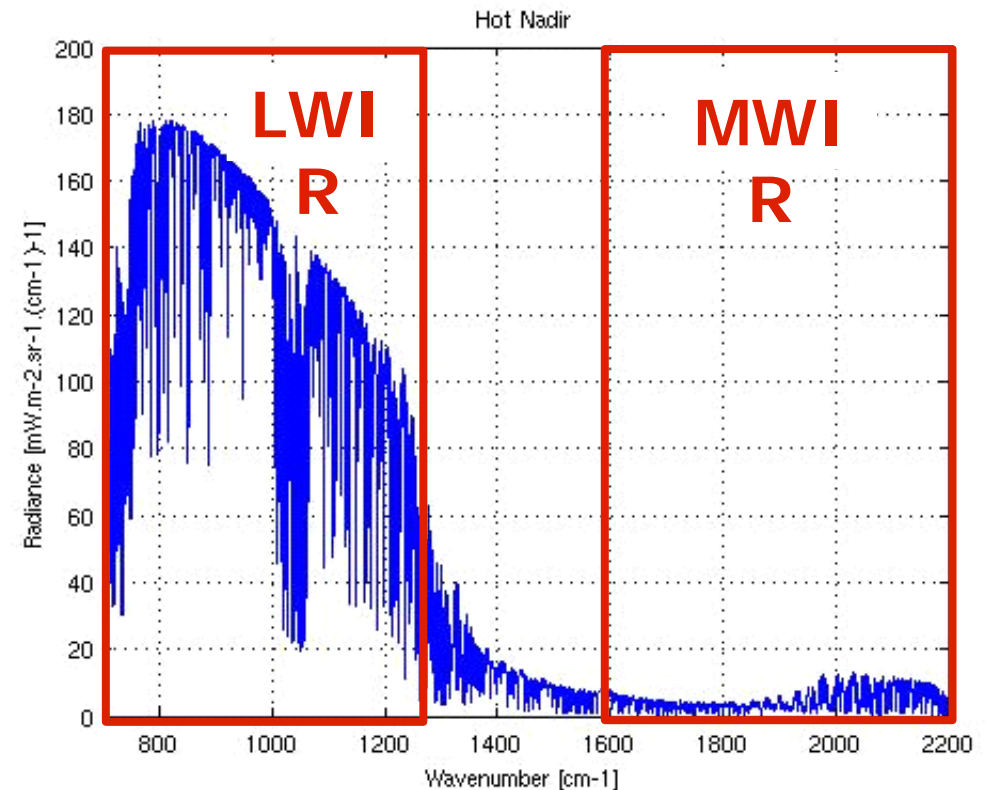
Orbit

Metop orbit @ 09:30 LT DN
 **EUMETSAT**



Spectral Performances

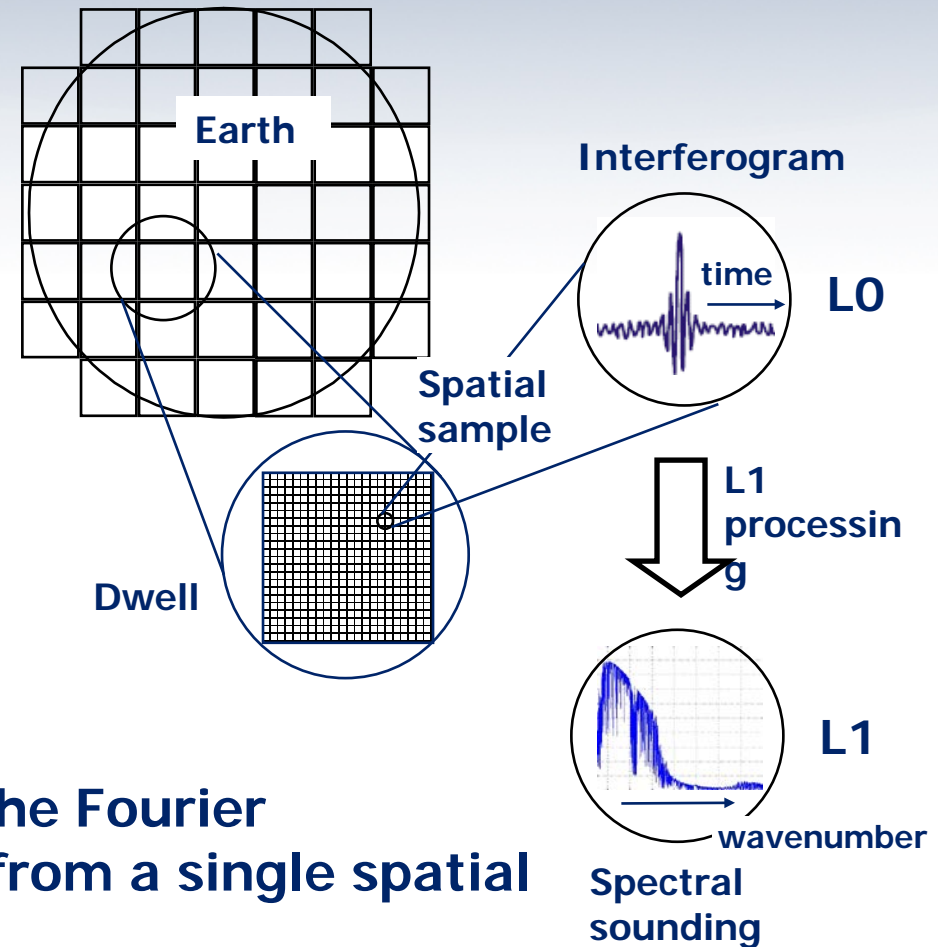
- The spectral range and resolution are dictated by the needs on vertical resolution at L2, resulting in a spectrum that entirely lies in the IR region, between 680cm^{-1} and 2250cm^{-1} ($4.44\mu\text{m}$ to $14.7\mu\text{m}$), more
- split in two non contiguous bands:
 - 680cm^{-1} to 1210cm^{-1} (LWIR band)
 - 1600cm^{-1} to 2250cm^{-1} (MWIR band)
- with a spectral resolution of 0.625cm^{-1}





The IRS Working Principle

- The instrument works in step-&-stare mode, with the Earth disc covered through a sequence of contiguous square sub-images (dwells)
- With the current design, each dwell is taken in 10s and covers about $640 \times 640 \text{ km}^2$ (at nadir) with 160×160 spatial samples
- Within a single dwell, a set of interferograms, one per spatial sample, is produced
- A spectral sounding is the result of the Fourier transformation of an interferogram from a single spatial sample





And then there's the Sentinels!...

Sentinel-4 on MTG

UVN spectrometer in GEO!

Spectral resolution 0.5 nm or better

Spatial sampling at $45^\circ \leq 8 \times 8$ km

=> Data rate 30 Mbps

Sentinel-5 on EPS-SG

Continuation of GOME-2 on Metop

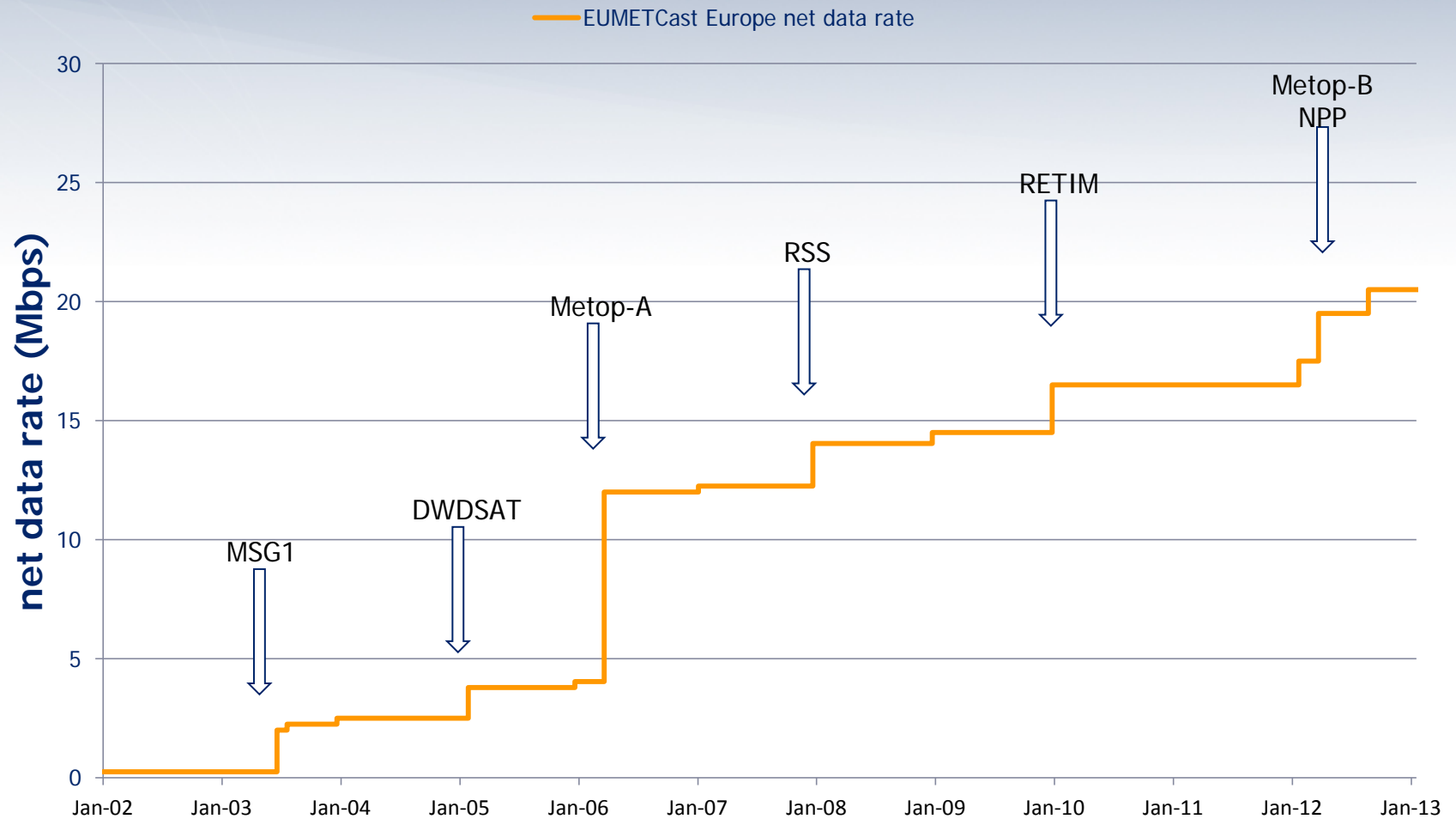
Spectral resolution 0.25 – 1 nm

Spatial resolution 80×40 km² => 7×7 km²

=> Data rate 20 MB/s

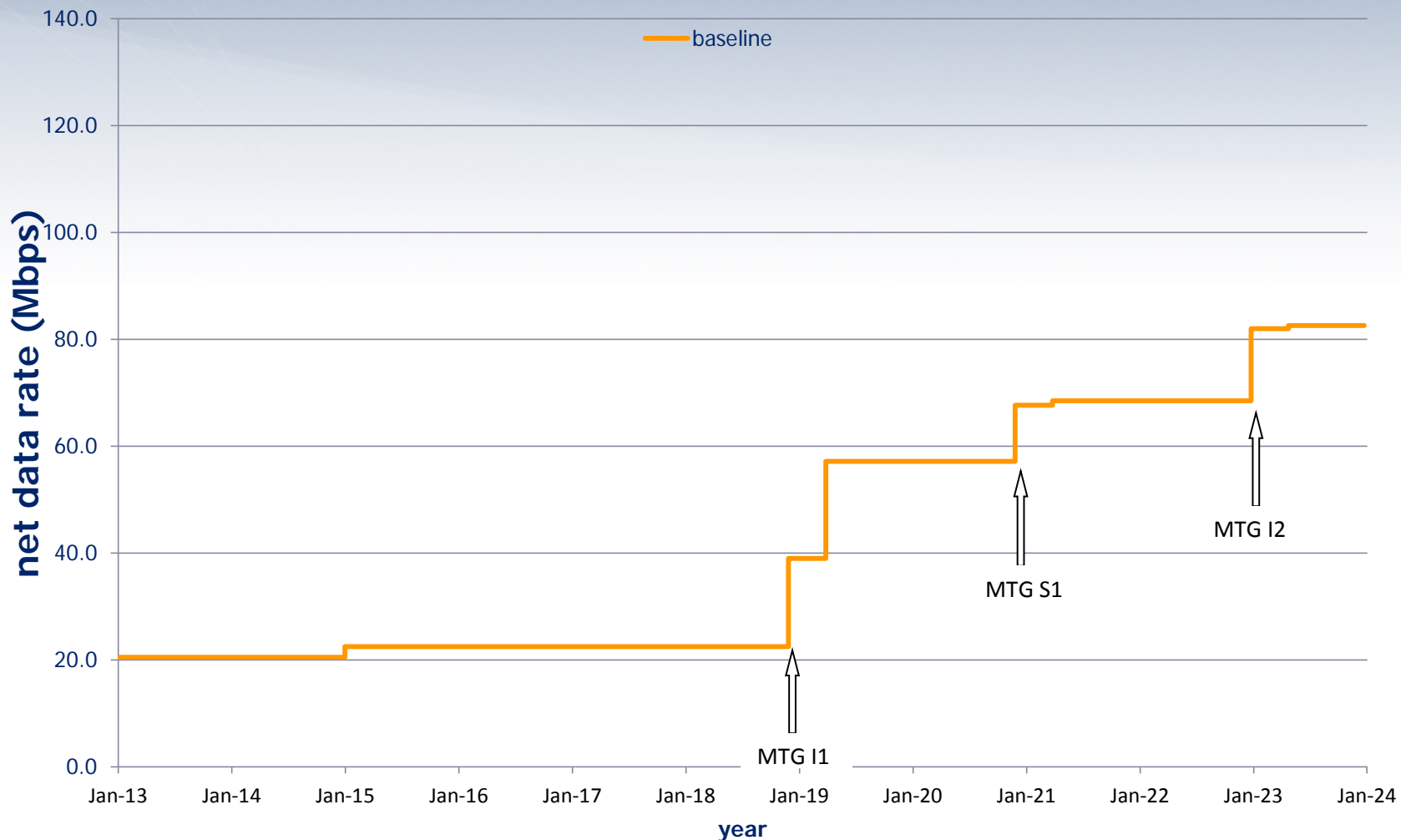


Data Rate Evolution in the Past



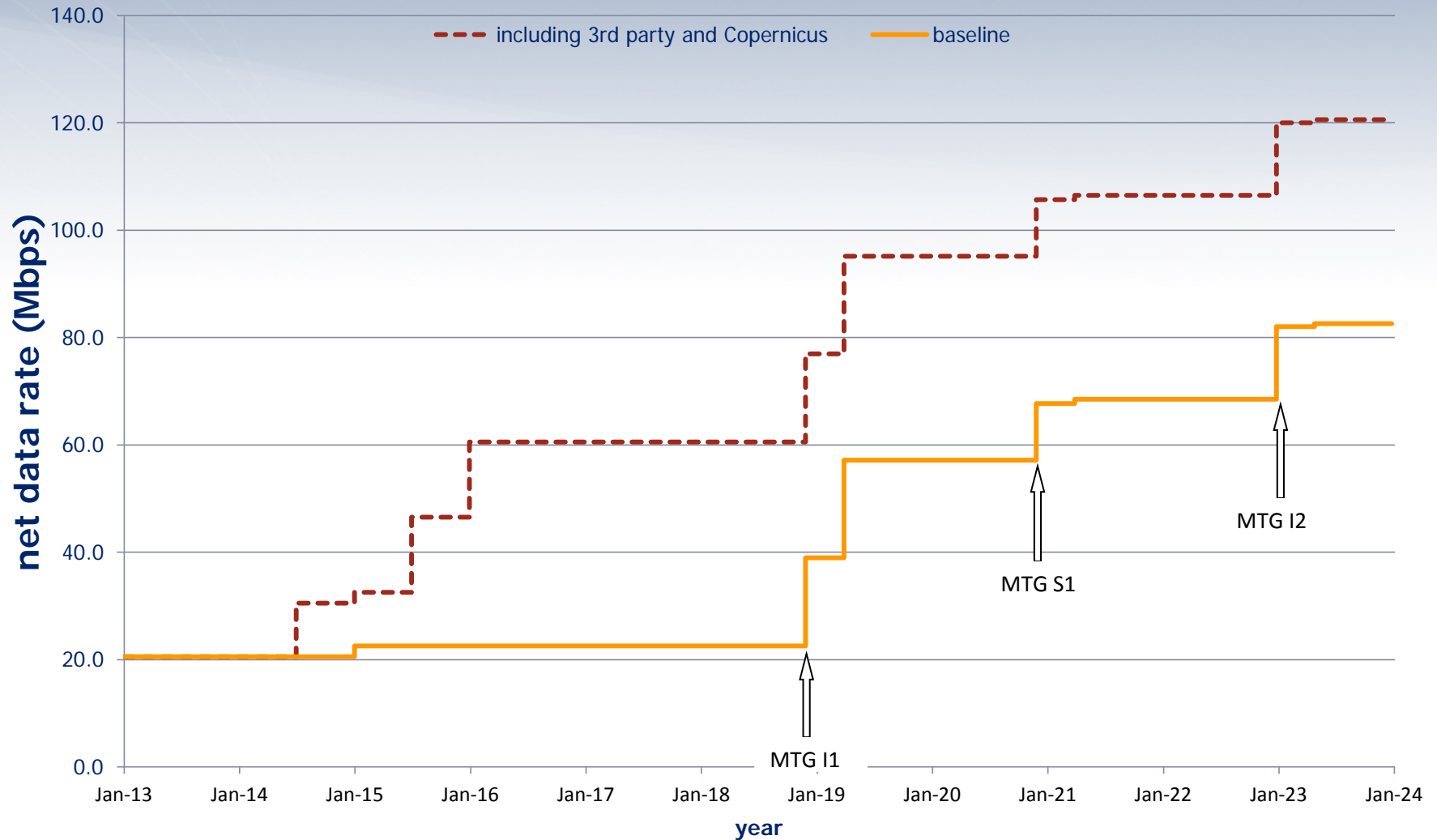


Projected future Dissemination Data Rates (already including limited IRS data rates = 300 PCAs)





Projected future Dissemination Data Rates

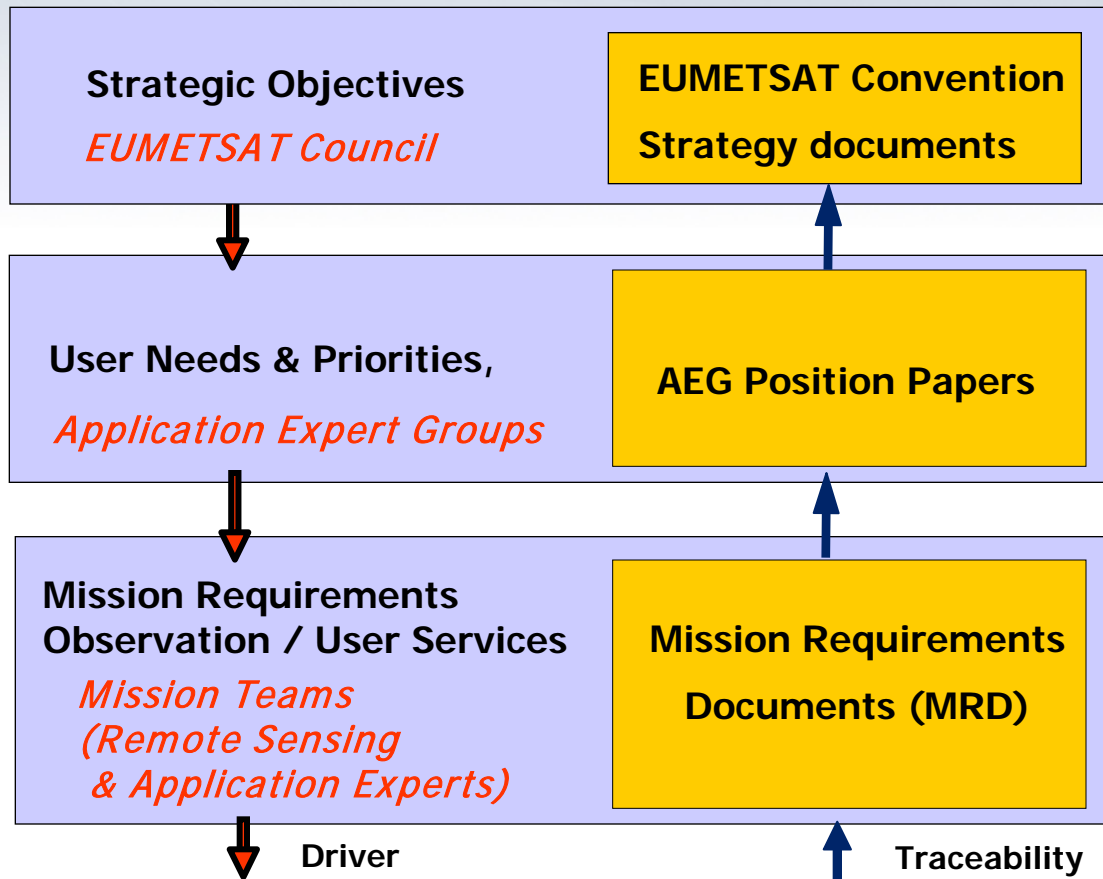




User Consultation and Future Programmes

Requirements & Logic

Documents



External Requirements:
WMO
GCOS

MTG
Numerical Weather Prediction
Nowcasting

Post-EPS
Atm. Sounding / Wind Profiling
Cloud, Precipitation, Land Imaging
Ocean Topography, Imaging
Atmospheric Chemistry
Climate Monitoring



Process for user requirements elaboration



Users



User Needs

Can't always formulate

User needs/priorities from application, technology-free perspective

Assessment of observing techniques suitable from GEO/LEO

Can be updated on demonstration of new capabilities

Should drive



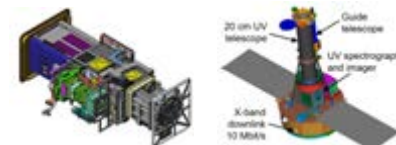
User Requirements

Trigger / justify evolution

Open possibilities

Constrain the fulfilment

Are not always aware of



Technological Capabilities



Process for user requirements elaboration



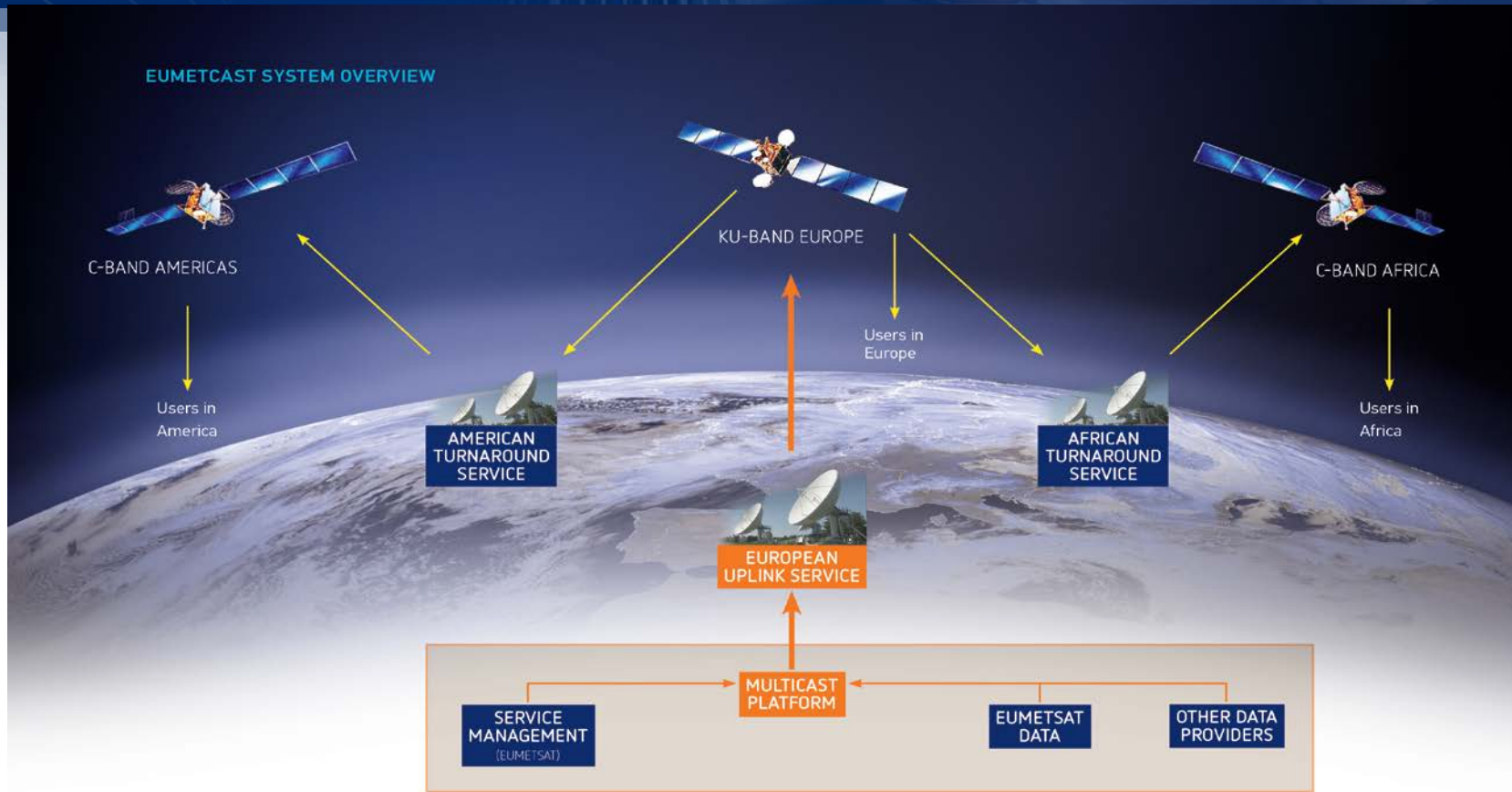


Process for user requirements elaboration





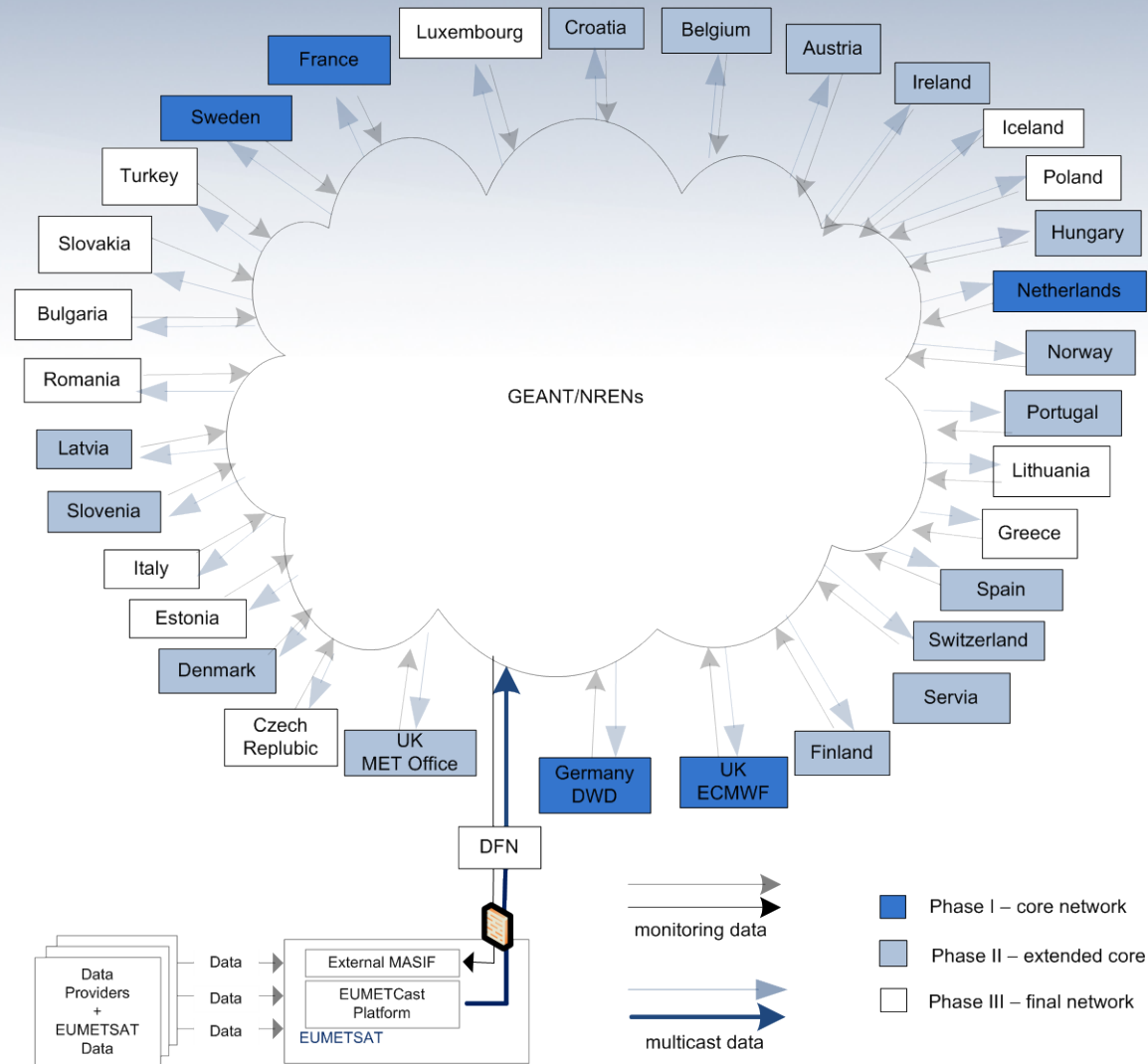
System Overview of EUMETCast Satellite Data Redistribution



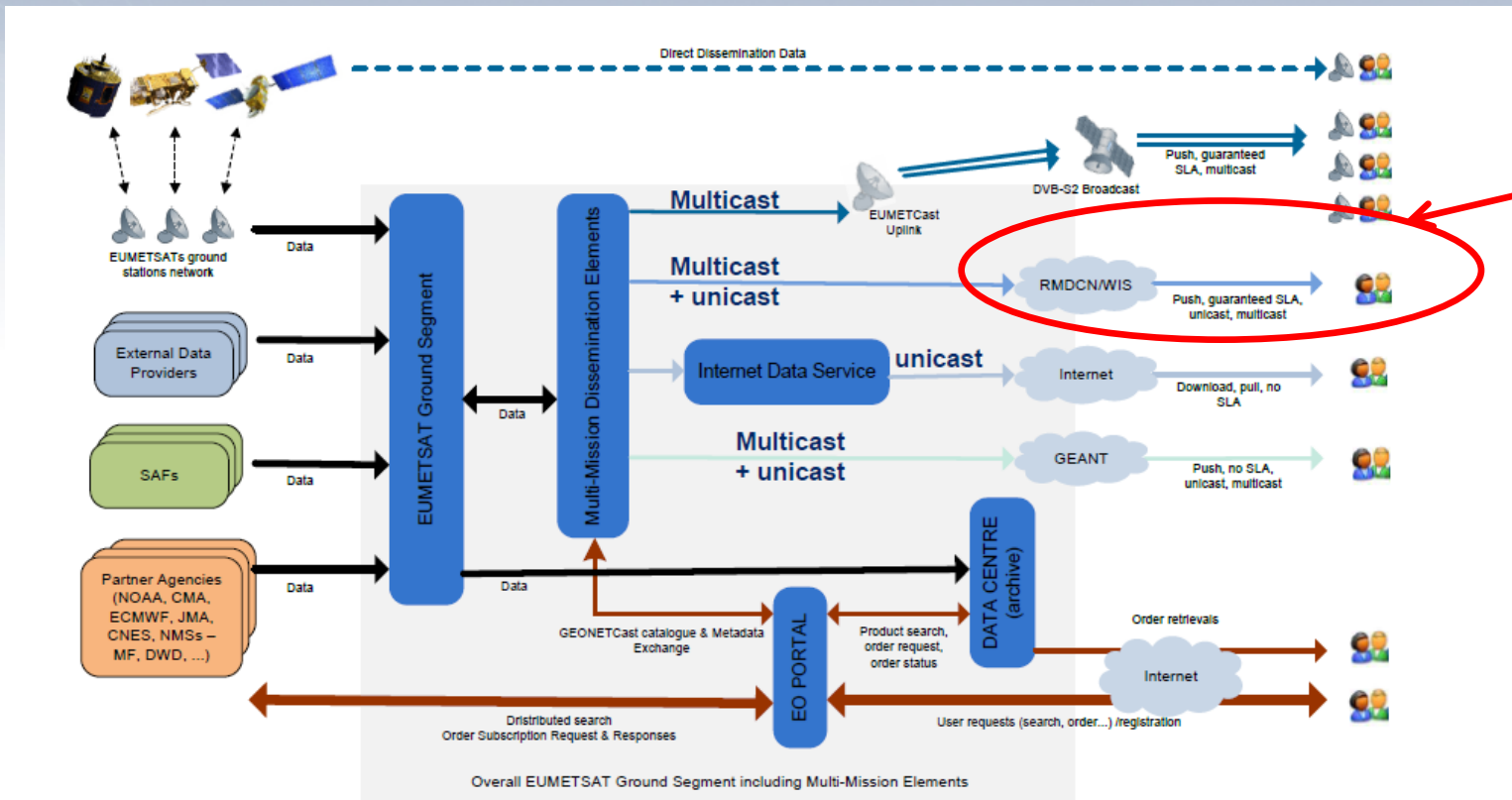


Complementary terrestrial EUMETCast component

- Complementary terrestrial multicast service using GEANT infrastructure;
- Currently in the design phase;
- Will accommodate data that is not disseminated via EUMETCast Satellite;
- Subscription based approach for joining the service;
- Same EUMETCast reception station and user management as per satellite service;
- Expected service readiness Q3 2014



Multi-Mission Dissemination Ground Segment Infrastructure



And the GTS



Reducing Data volumes

Compression:

Lossless, Lossy

Noise Reduction

PC-scores, averaging

Sampling

Spatial, Temporal, Spectral

Higher Level Products

e.g. Level 1 vs Profiles

A potential model to help us evolve our dissemination strategy

	NWP power users	Other users	Climate applications	Air Quality/ Atmospheric Constitution	Research
Lossless compressed full spectra	NRT		Several hours	Several hours	Offline
Subset of channels		NRT			
PC-scores	NRT	NRT			Offline
PC-residuals	NRT				Offline



The main user groups

Hyperspectral Power Users

Meteo France, Met Office, DWD, ECMWF

Limited number of users, potential alternatives to EUMETCast could be explored, eg. future RMDCN

Hyperspectral Offline/non-NRT dissemination

e.g. Climate, Air Quality/Atmospheric constitution

No requirement for EUMETCast timeliness/reliability

Potential large volumes/all data

Alternatives could be eg. ftp-push over internet

Hyperspectral PC-scores and residuals in NRT

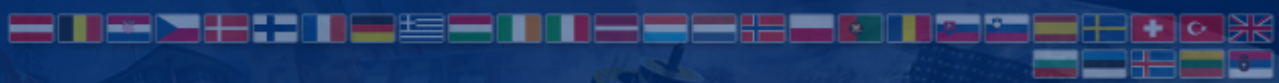
Similar approach as for Power Users

OR

Derivation of PC-scores and residuals by the users themselves

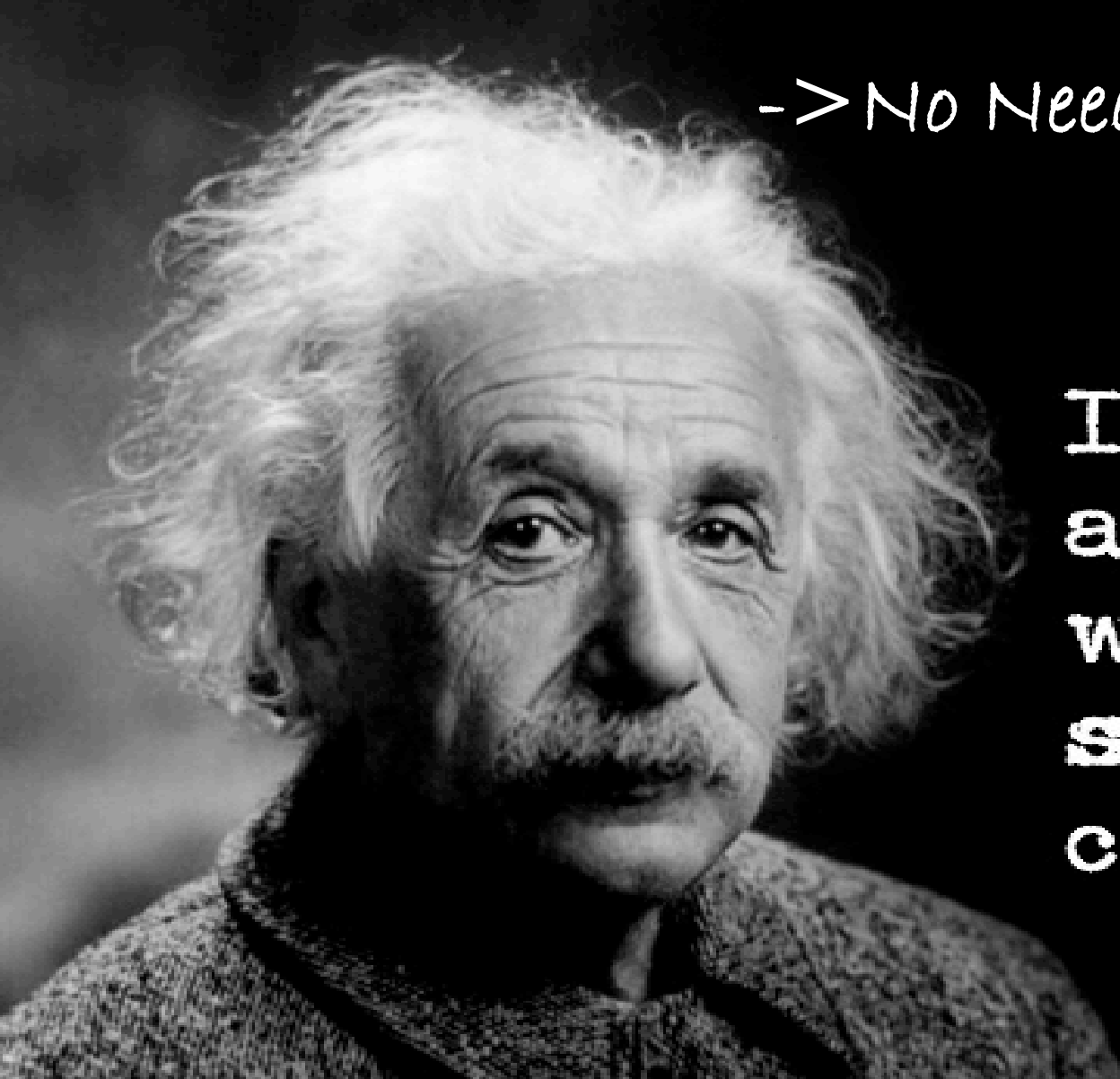
Research

Data Centre retrievals should be sufficient



Questions?

-> No Need- I'm here



I used to go
away for
weeks in a
state of
confusion.

- Albert Einstein
www.quotesworthrepeating.com