

Forum **TERATEC** 25

LE TRAITEMENT MASSIF DES DONNÉES DU
SONDEUR IASI-NG : UN PROCESSEUR INNOVANT
POUR UN INSTRUMENT SPATIAL INNOVANT

FORUM TERATEC
2025



BEATRICE PETRUCCI

RESPONSABLE TECHNIQUE CHÂÎNES
DE TRAITEMENT IASI-NG

CNES - DTN/CD/SA

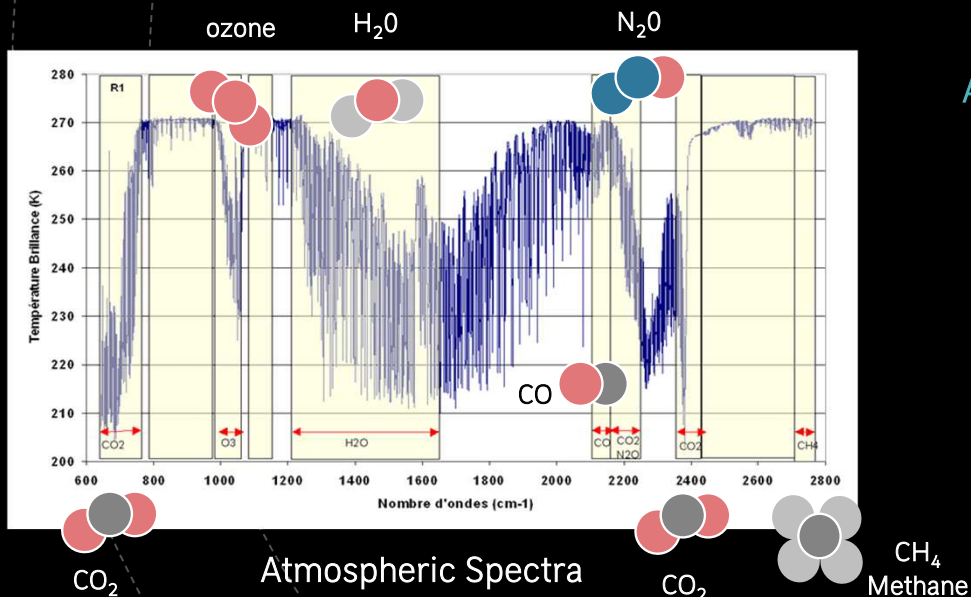
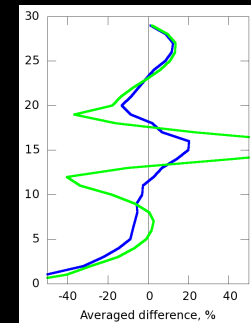
PRÉSENTATION ÉLABORÉE ET
REVUE AVEC
THALES SERVICES NUMÉRIQUES

THALES
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IASI-NG MISSION



The New Generation of IASI, already in orbit since 2006.
Passive atmospheric sounder in the infrared domain on board of Metop-SGA satellites → 3 launches between 2025 and ~2040



Meteorology



Temperature



Water vapour

Atmospheric chemistry



Aerosol

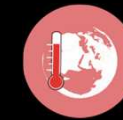


Pollutants

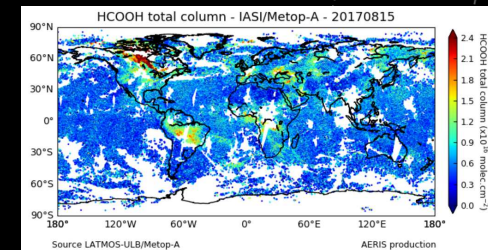


Volcanic clouds

Climatology



Greenhouse gases

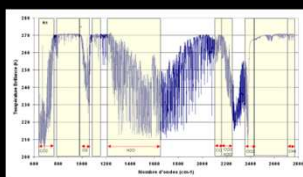


IASI-NG L1C PRODUCTS OPERATIONAL PROCESSOR = L1CPOP

L1CPOP scope

- To process the data downlinked from IASI-NG space segment to generate L1C products to deliver to users:

- ◆ Spectra fully calibrated
- ◆ Geolocalized
- ◆ Informations on the observed scene to help users exploiting the products (cloud cover, soil occupation, ...)



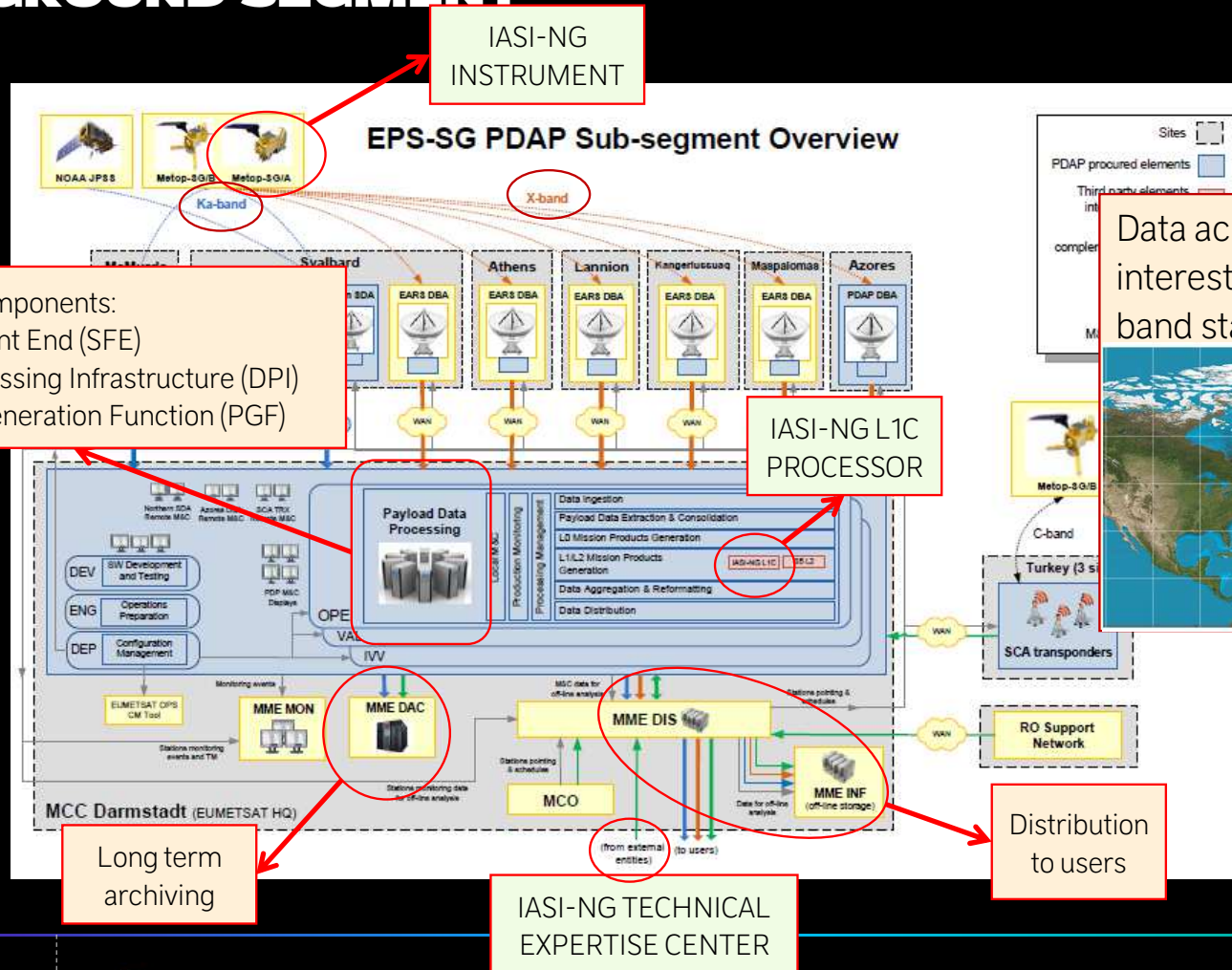
An operational processor

- Integrated in Payload Data Acquisition and Processing component within EPS-SG overall ground segment at EUMETSAT
- Running in NRT
- Assuring 24/7 service
- Operated for more than 20 years to process the data from the 3 IASI-NG instruments

- Optimized
- Automated
- Reliable
- Assuring a high level of availability

- Strong constraints in:
- Maintainability
 - Evolutivity
 - Durability

EUMETSAT POLAR SYSTEM - SECOND GENERATION GROUND SEGMENT



Data acquired over the following area of interest are downlinked in priority over X-band stations and processed quickly



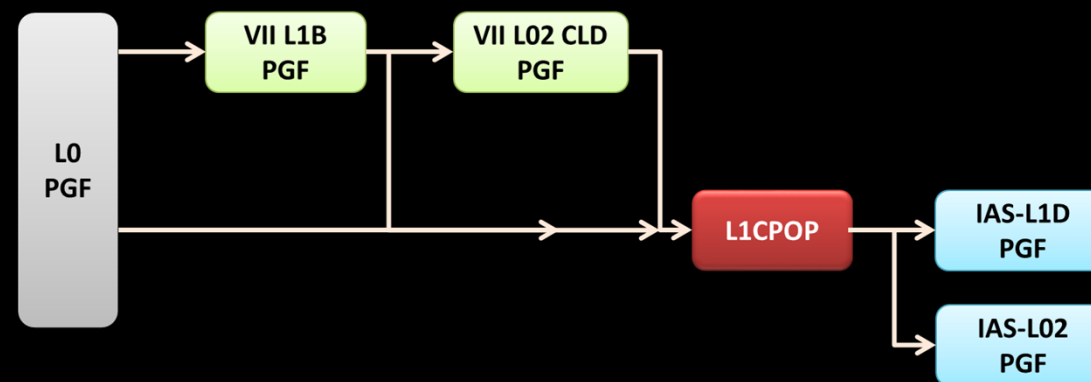
DATA PROCESSING INFRASTRUCTURE

Solution based on reuse of Processing Infrastructure (PI) developed by THALES SERVICES NUMERIQUES for EUMETSAT MTG L2PF

- Extensive use of common libraries & APIs: separating infrastructure services (i.e. data access, SW/HW resources, parallelization capabilities) from algorithms implementation
- Extensive use of open source software and COTS
- Use of Big Data technologies, virtualization and containers (Docker) for deployment, HW abstraction and data circulation
- Java based SW implementation (also for algorithms, but other languages supported where / if needed).
- Modular implementation of PGFs based on 'Plug-ins'

THE PROCESSING CHAIN

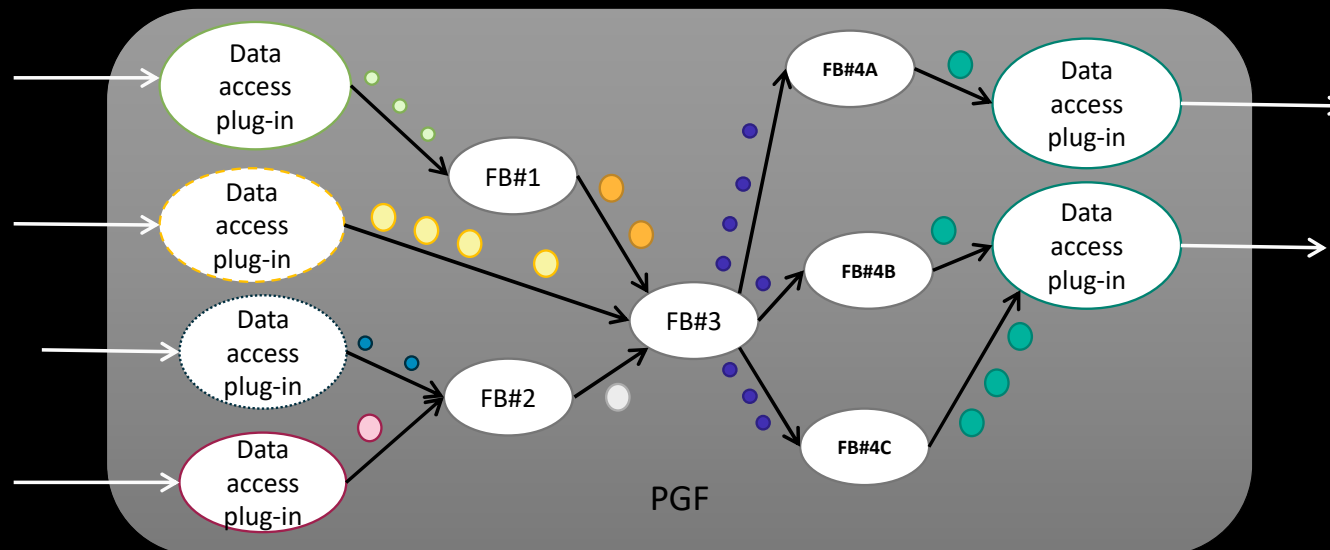
- Events-driven triggering, based on Rules Engine (**Easy Rules**)
 - ✦ Upon arrival of data at the reception station
 - ✦ The entire processing chain + each PGF are launched and kept alive until all the data of the dump have been processed
- End-to-end processing chain (sequence of PGFs) monitored and controlled via **Workflow Orchestrator (Phoebus)**
- Data are exchanged as Persisted Data Units (**PDU**) only in memory among PGFs via a Persisted Data Bus (**Kafka**)
- Data processing by chunks (PDUs) → batch processing



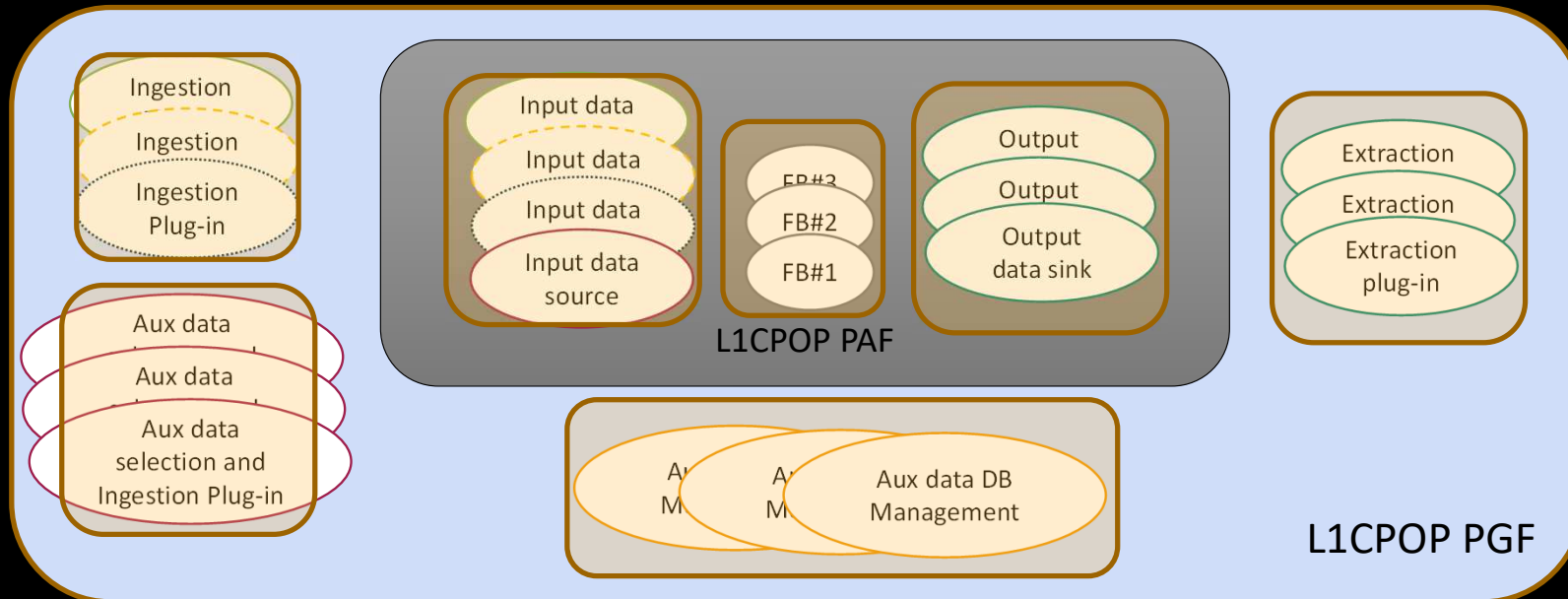
THE PGF

A chain of data access plug-ins and functional blocks plug-ins

- Each plug-in is launched at PGF start up and kept alive to be ready to process data as soon as available
- Automated execution of Functional Blocks in the PGF via streaming engine (**Storm**)
- Data are exchanged only in memory as Internal Memory Data Units (**IMDU**) among the plug-ins as Tuples via streaming engine (**Storm**)
- Continuous data processing → Stream processing



L1CPOP PGF: A SET OF COMPONENTS



- + plug-in sequence definition
- + configuration files

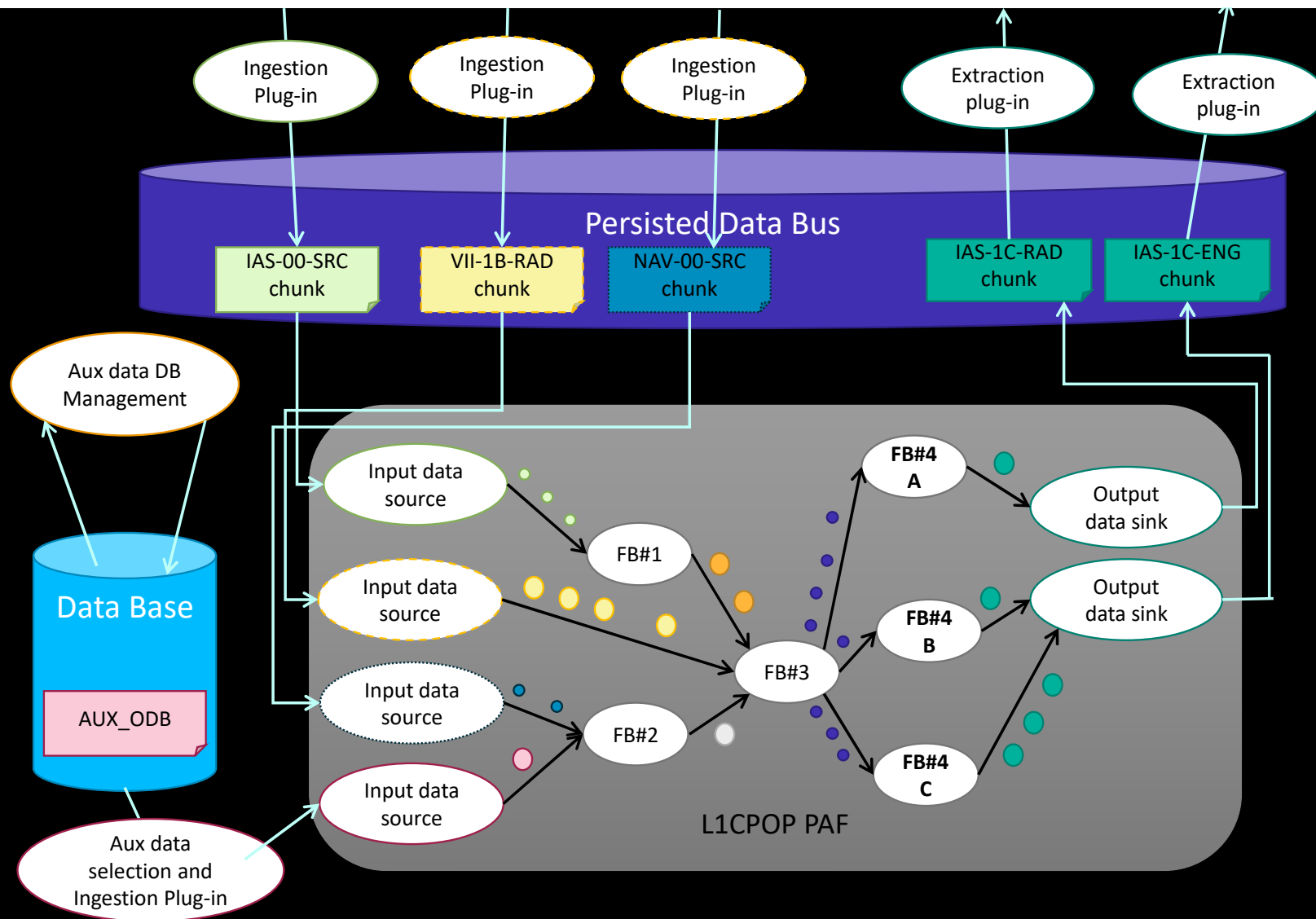
- + Reuse of DPI services:
 - Logging and M&C
 - Auxiliary data management
 - Historical data management

- + Reuse of DPI common libraries:

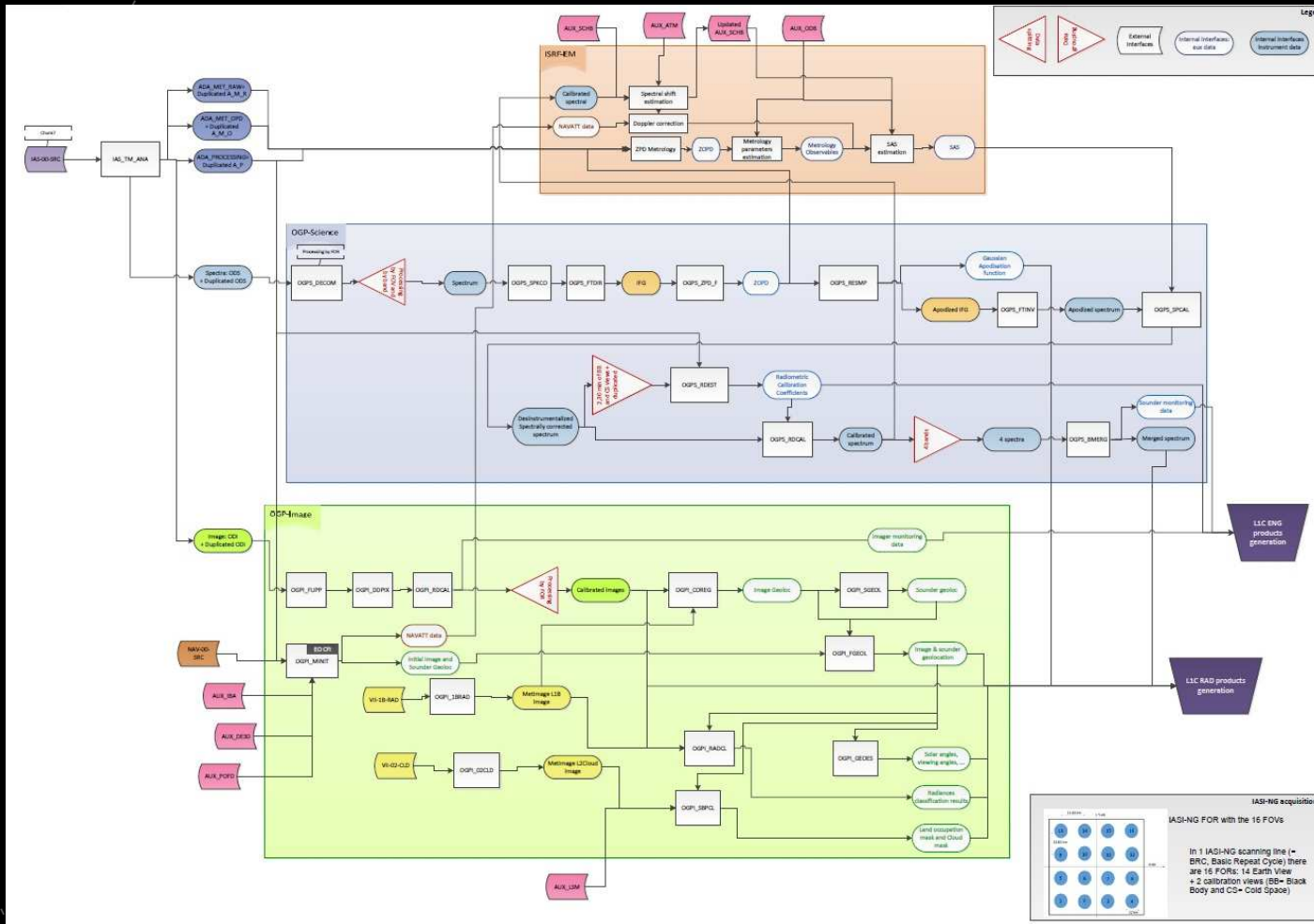
- Data access and formatting
- Data consistency checking
- Standard numerical computations

- + Reuse of business libraries

- Orbit, geometric, attitude and time related computations: EOCFI



L1CPOP ALGORITHMS: LOGICAL VIEW



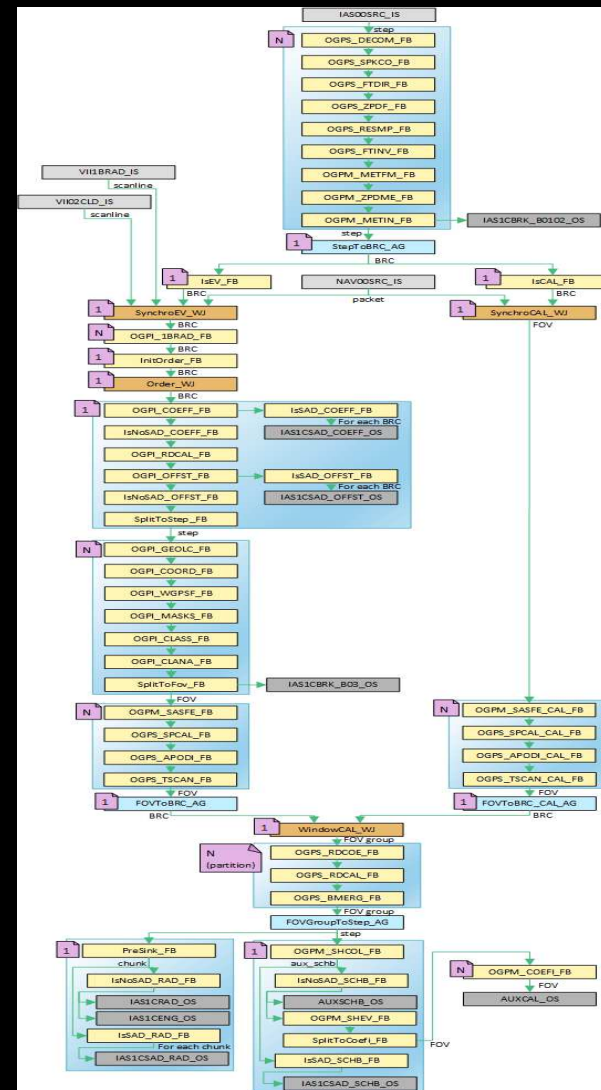
L1CPOP a scientific processing chain:

- In addition of IASI-NG data several other data are needed
- Strong constraints on the order of the unitary algorithms and the “granularity” of the data processed
- Data processed in parallel on cores on different servers need to be collected in a unique “ordered” product

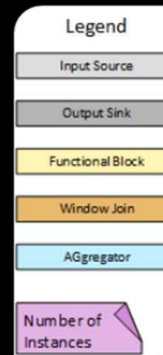
SETTING THE L1CPOP IN MUSIC

L1CPOP topology setup

- Checking on the fly input PDU data
- Managing IMDU data wrt to input PDU data and FB algorithmic dependencies
- Splitting data into smaller data granularities for better parallelization
- Taking into account in the design the desynchronization of data input

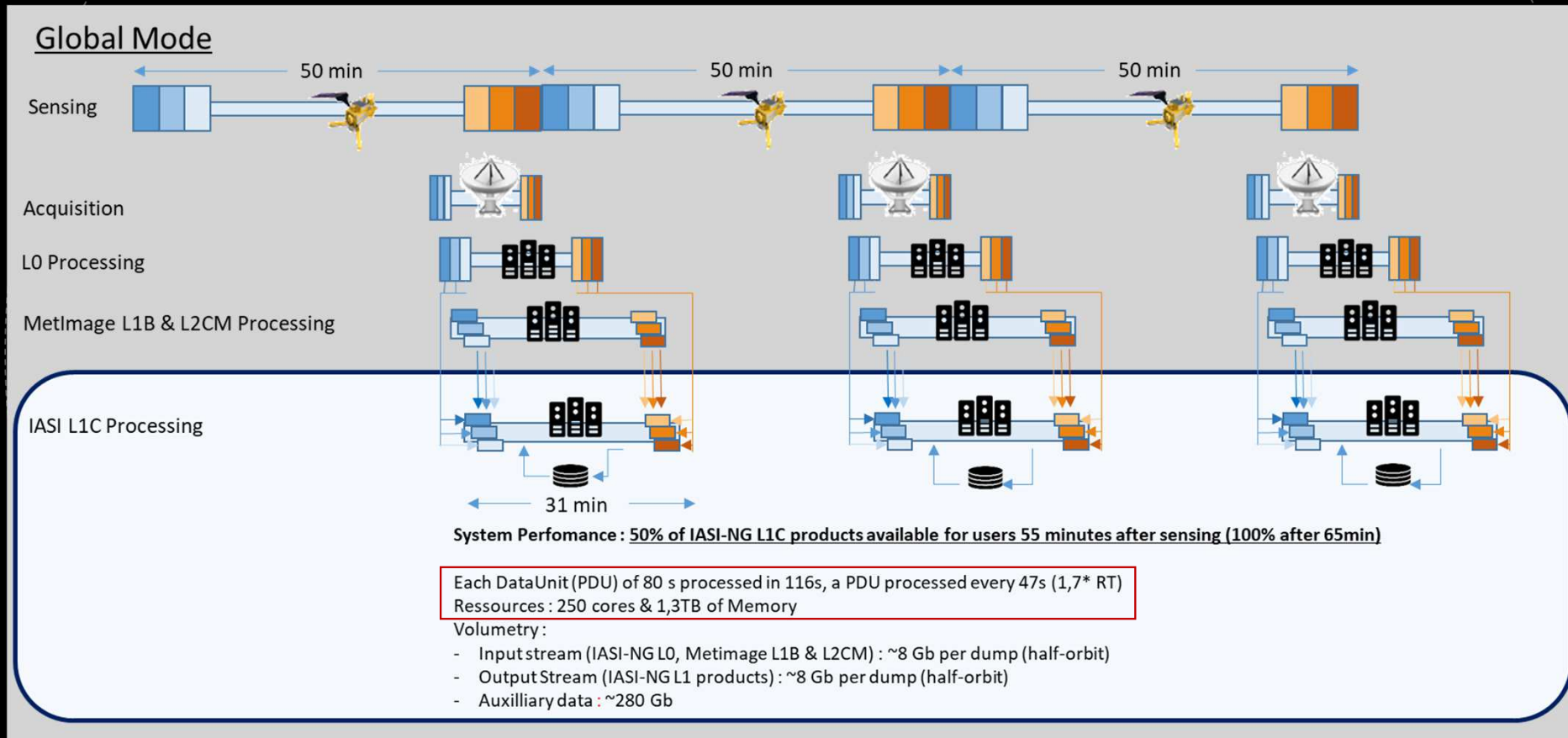


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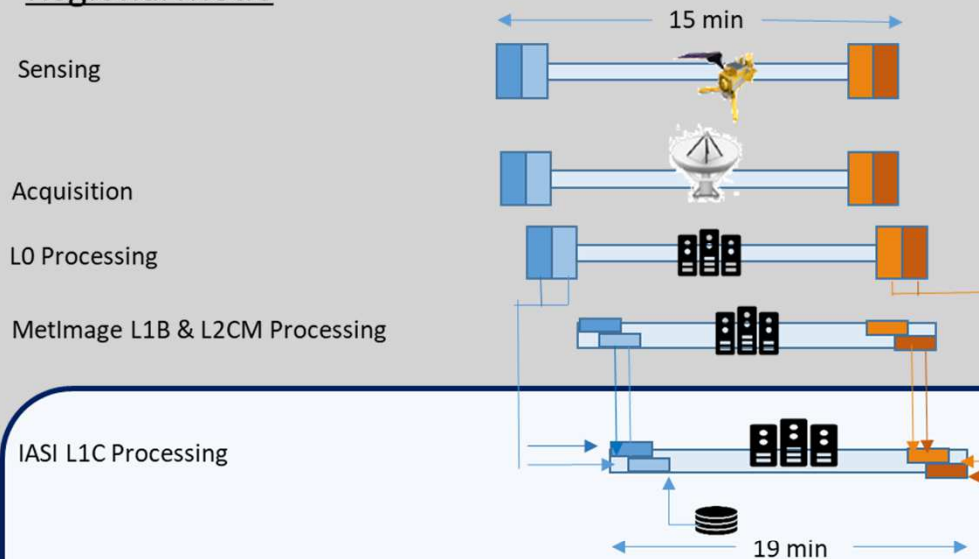
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L1CPOP PROCESSING PERFORMANCES



L1CPOP PROCESSING PERFORMANCES

Regional Mode



System Performance : 50% of IASI-NG L1C products available for users 15 minutes after sensing (100% after 25min)

Each DataUnit (PDU) of 80 s processed in 145s, a PDU processed every 89s (0,9* RT)

Ressources : 76 cores & 665MB of Memory

Volumetry :

- Input stream (IASI-NG L0, Metimage L1B & L2CM) : ~2,5 Gb for 15 minutes sensing time
- Output Stream (IASI-NG L1 products) : ~2,5 Gb for 15 minutes sensing time
- Auxilliary data : ~280 Gb

L1CPOP PROCESSING PERFORMANCES

A solution required to meet performances

- Reduced latency compared to a legacy processing solution, thanks to a shared processing infrastructure (for L0, MetImage, IASI-NG L1C, ...) with all data managed in memory (no time lost for read/write operations)
- Highly parallelized PGF processing, spread over processing HW infrastructure
- Data driven PGF processing allowing to :
 - Start the processing as soon as first PDU of the downlink is available
 - Synchronize input stream (IASI-NG L0, NAV, MetImage L1B & L2CM)
- Sustained high incoming data rate
- Constraint for algorithm development: Data Processing Infrastructure (DPI) and algorithm Product Generation Function (PGF) are highly coupled
- Use of cunning to introduce in the processing some “caption point” to dump the data from memory to file in order to validate the implementation of the algorithms and the scientific results obtained



QUESTIONS

