The Ionosphere Monitoring and Prediction Center (IMPC): infrastructure and software implementation

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1. National Ground Segment focus of work

The Earth Observation Center (EOC: www.dlr.de/eoc) at the German Aerospace Center (DLR) consists of the German Remote Sensing Data Center (DFD) and the Remote Sensing Technology Institute (IMF). National Ground Segment is a department at the German Remote Sensing Data Center (DFD). It acquires, processes and archives the payload data from remote sensing and satellite science missions, among which are:

GRACE-1/2, TerraSAR-X, TanDEM-X, Sentinel-1/2, Landsat-8/9, TERRA, AQUA, Resourcesat-2, ACE, DISCVR, EnMAP, Kompsat and others...

Other responsibilities include:
- the near-real-time processing of acquired data, which includes generating and distributing thematic information products;
- operating the Calibration and Validation Test Site DEMMIN;
- development of hardware components and software tools

- Ground Stations
- Data Science & Services
- Real-time Services
- Maritime Security Lab

2. IMPC Overview and Cooperation with Institute for Solar-Terrestrial Physics

The IMPC - evolved from the predecessor projects SWIPPA (Space Weather Impact on Precise Positioning Applications of GNSS) and SWACI (Space Weather Application Center - Ionosphere) - processes more than 50 gigabytes of ionosphere-related data daily, generating 1588 products for GNSS users, 2888 ROTI products and 288 TEC products. This flexibly extensible and building block platform for data processing, archiving and delivery relies on the use of standards such as OCI (for container applications), BPMN (Business Process Model and Notation) and ESA IPF and is oriented towards the latest methods of data processing and orchestration. Both near-real-time product delivery and secure long-term archiving are applied here.

The IMPC can be used and adapted for various projects in the field of space weather and thus currently offers, among other things, within the framework of the ESA Space Safety Program (https://swe.ssa.esa.int/), as well as the ICAO PECASUS project (https://pecasus.eu/), an environment for the adapted representation and for the continuous provision of ionospheric products, which are being developed by the Institute for Solar-Terrestrial Physics in Neustrelitz.
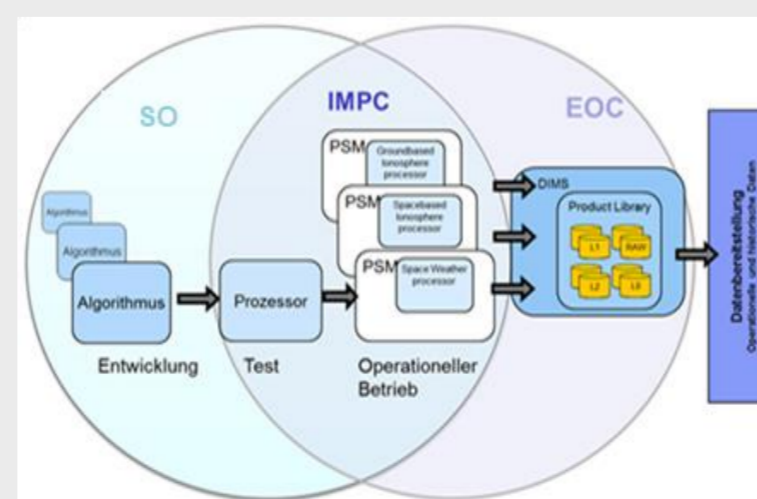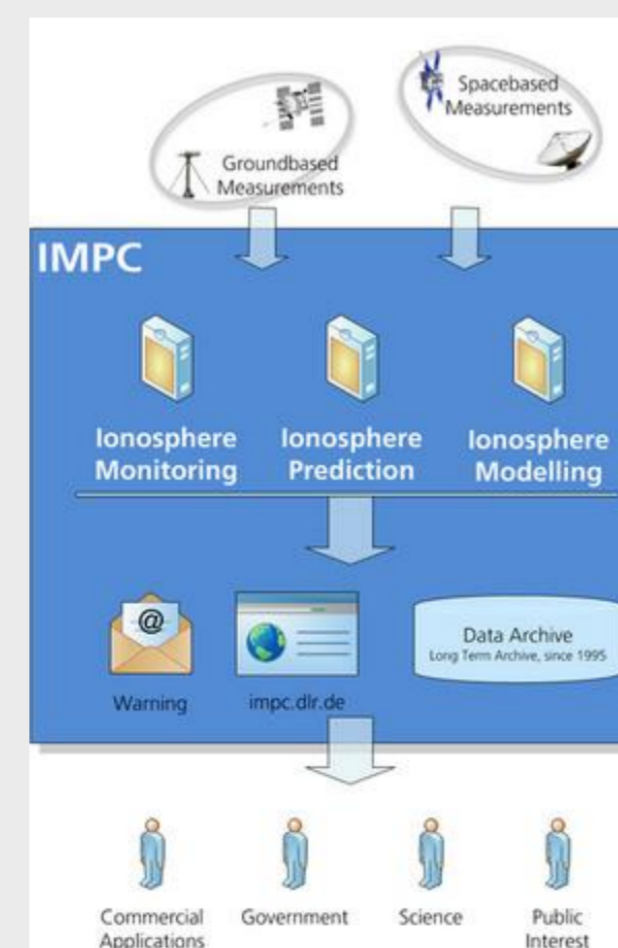

3. IMPC as a processing platform and IMPC Products

The IMPC as a platform for automated processing of ionospheric products with a 24/7 near real-time basis needs around 1 minute process time per product including archiving and delivery time.

Approximately 4700 products are created daily.

The platform gets data from ntrip-stream or single files and uses a 3 step processing environment from development over test zone to the operational world.
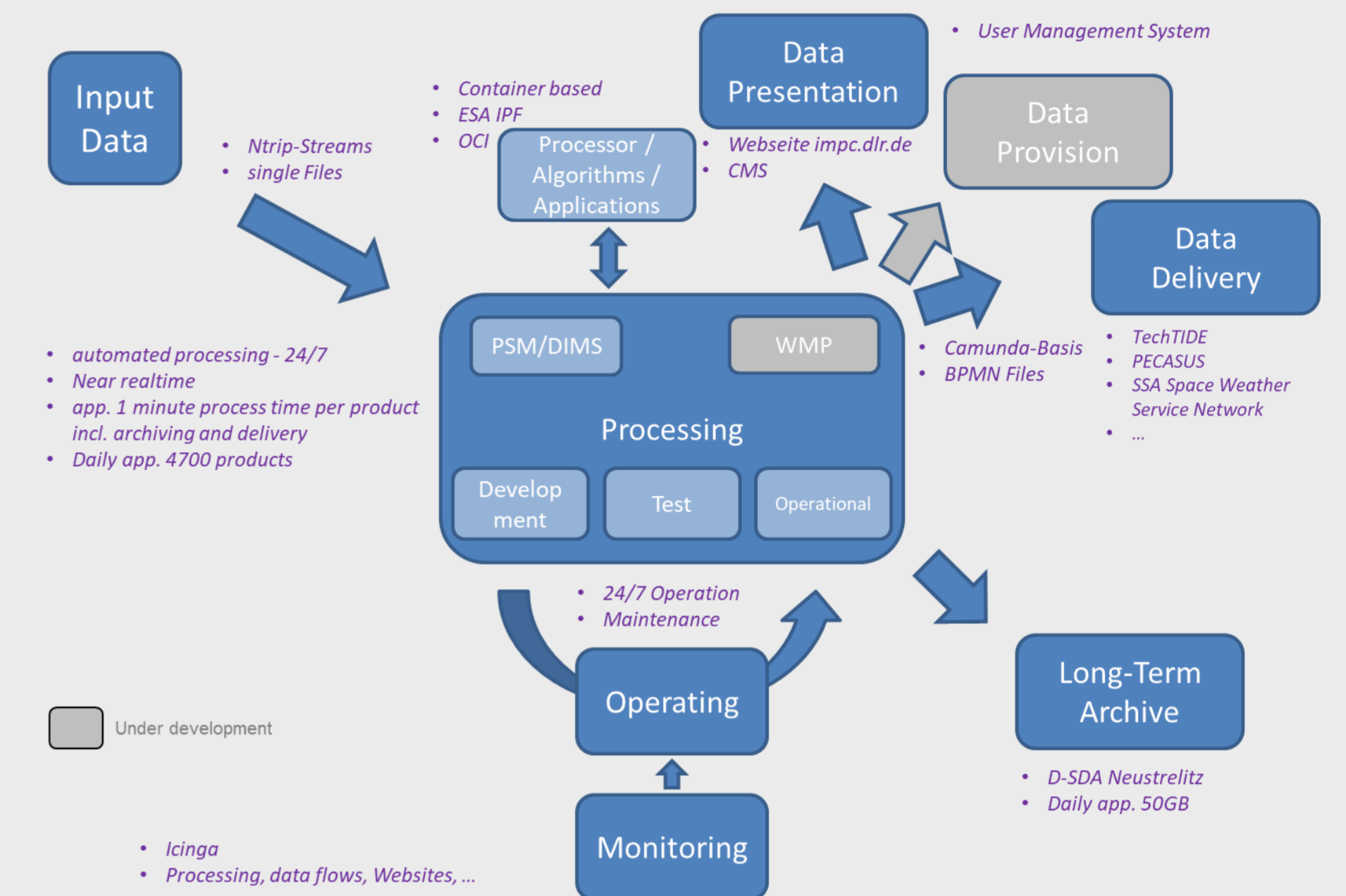

The operational service is accompanied by the IMPC User Help Desk (impc-uhd@dlr.de) for technical, functional or thematic issues and requests from registered users, project partner or any ionospheric weather interested persons. Furthermore it is monitored by an automatic system.

The IMPC platform provides three different ways for data distribution to users, projects and networks. The first and easiest way is data presentation via the IMPC website (https://impc.dlr.de/) with near real-time products. The second way is the data delivery directly to projects and users via sftp or other individually defined ways.

The third data distribution approach is currently under development. The upcoming data provision tool will give users an opportunity to retrieve customized data packages from the IMPC product data archive.

At the moment the IMPC website provides access to the following product groups:

Total Electron Content	Ionospheric Perturbations
Near Real-Time TEC	**Local Scintillation Measurements**
NRT TEC, Europe	Kiruna
NRT TEC, Global	Neustrelitz
NRT TEC, Global (beta)	Toulouse
Forecast TEC	Tenerife
1 h FC TEC, Europe	**Rate of Change of TEC Index**
1 h FC TEC, Global	1 min mean ROTI, Europe
Beacon TEC Data	1 min mean ROTI, Global
Neustrelitz	**Equivalent Slab Thickness**
	Juliusruh
	Pruhonice
	Electron Density
	Electron Density Layers
	NmF2 Reconstructed
	NmF2 Model
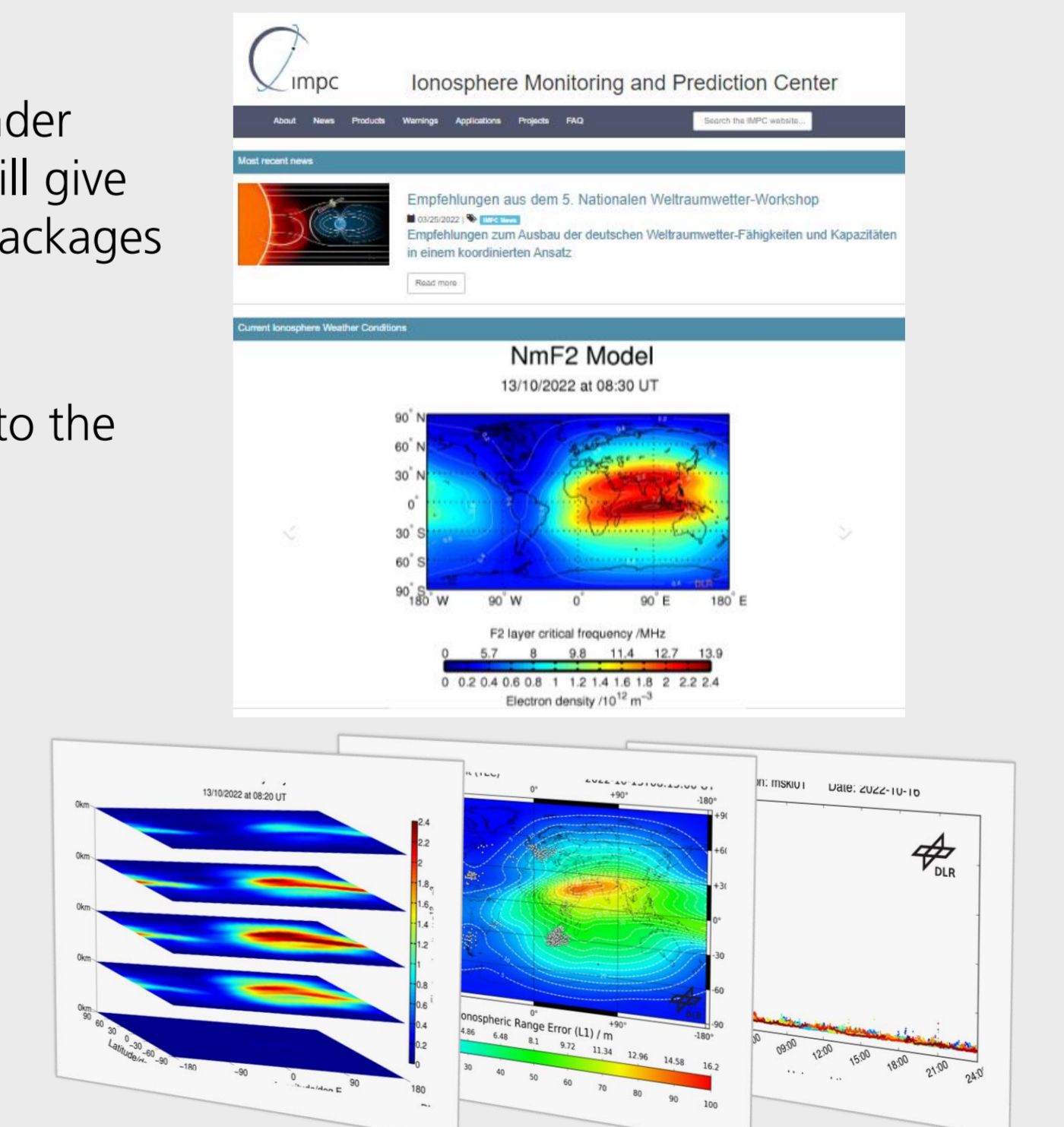
4. IMPC Processing and Archiving

The IMPC processing system is in a state of transition. Established processing chains have been integrated by using components from the Data and Information Management System (DIMS).
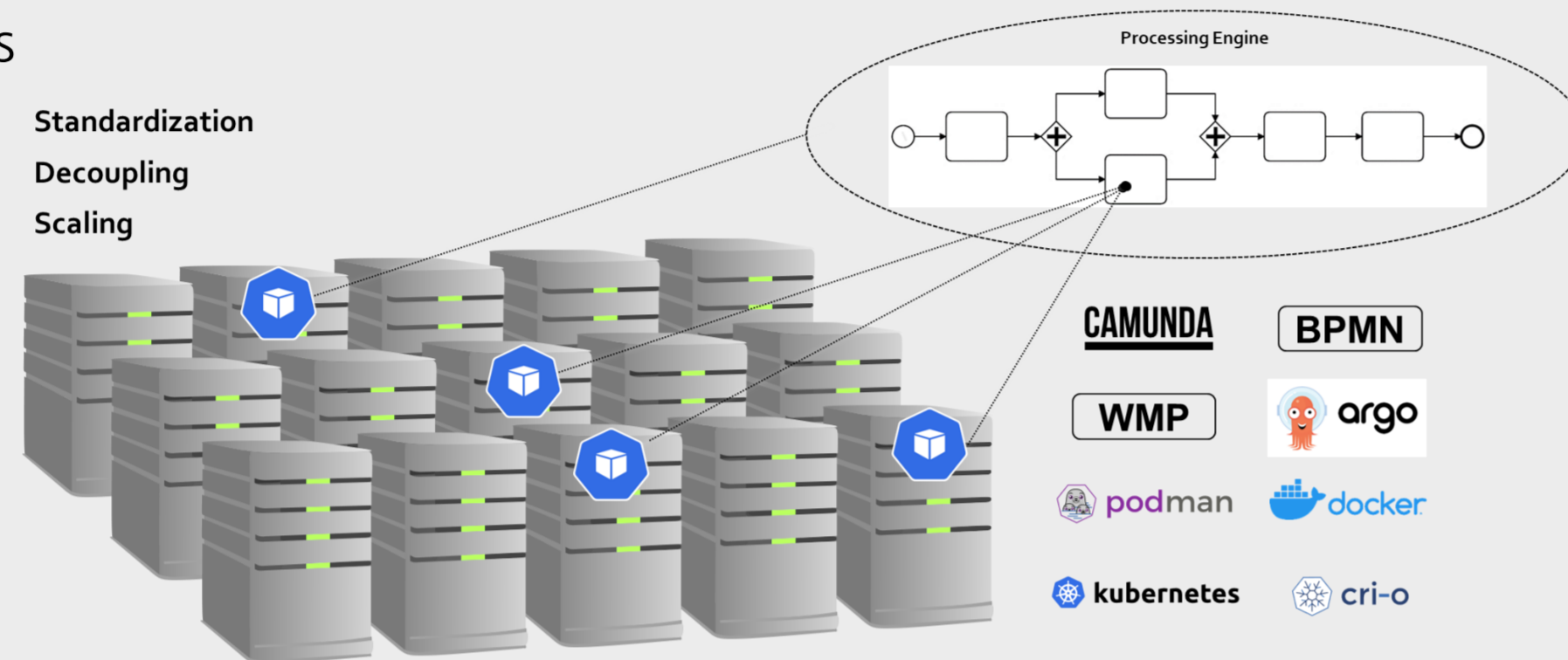
This is a functionally as well as geographically distributed system that offers standardized interfaces for access management, production management and long-term archiving.

Upcoming processing chains will be implemented by using container for a standardization, the Workflow Management Platform (WMP) and the Business Process Model and Notation (BPMN) for defining the workflows.

Great importance is attached to standardization by using a uniform format for all components (containers) and to facilitate deployments, interchangeability and upgrades.

Also decoupling of all components from the actual runtime environment (executable in all compatible container runtime environments) has an extremely high priority.

Our partner for the development of DIMS and WMP is WERUM (https://www.werum.de/).

Standardization
Decoupling
Scaling

Processing Engine

CAMUNDA BPMN
WMP argo
podman docker
kubernetes cri-o

DLR's German Satellite Data Archive (D-SDA) in Neustrelitz and Oberpfaffenhofen is one of the most modern long-term archives in the world. It serves to archive all of the Earth Observation Center's remote sensing data and products in both the short- and long-term, as well as providing access for users.

Long-term archiving is used to ensure sustainable availability and usability of Earth observation data.

The D-SDA currently is containing app. 135 million files and 25 Pbyte of data.

DLR has more then 20 years of experience with the SAM-FS in 365 days/24 hours operations with ~47.000 product transfers per day.
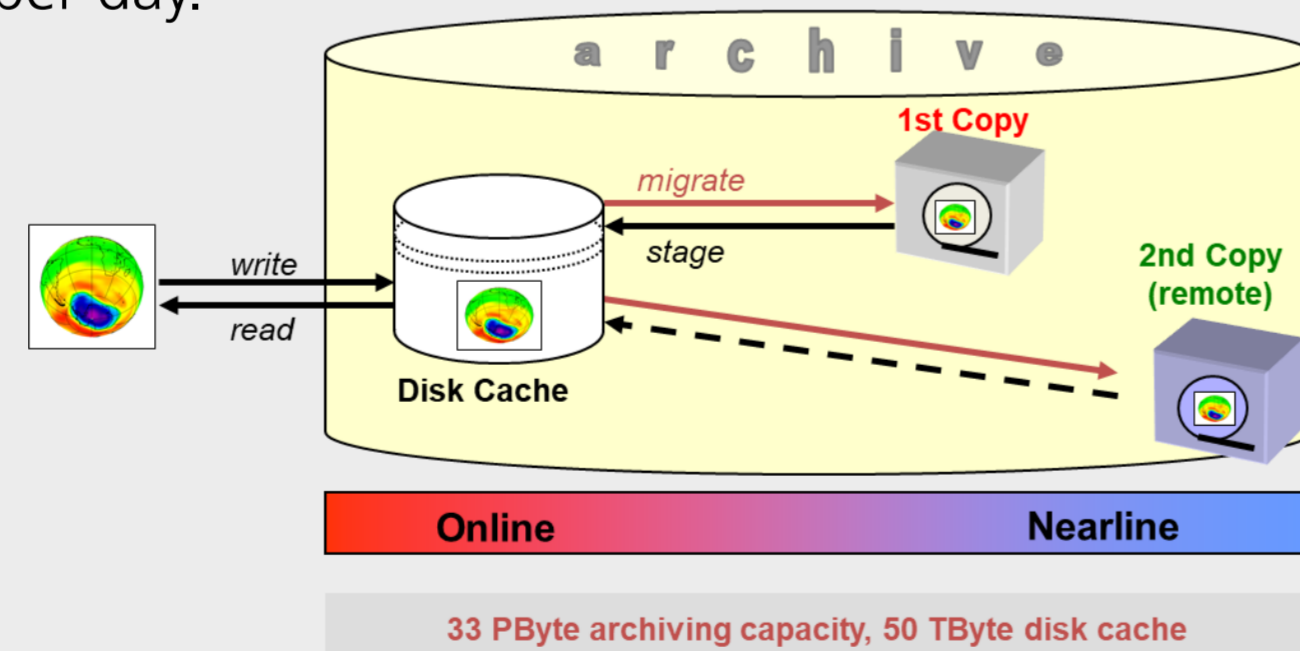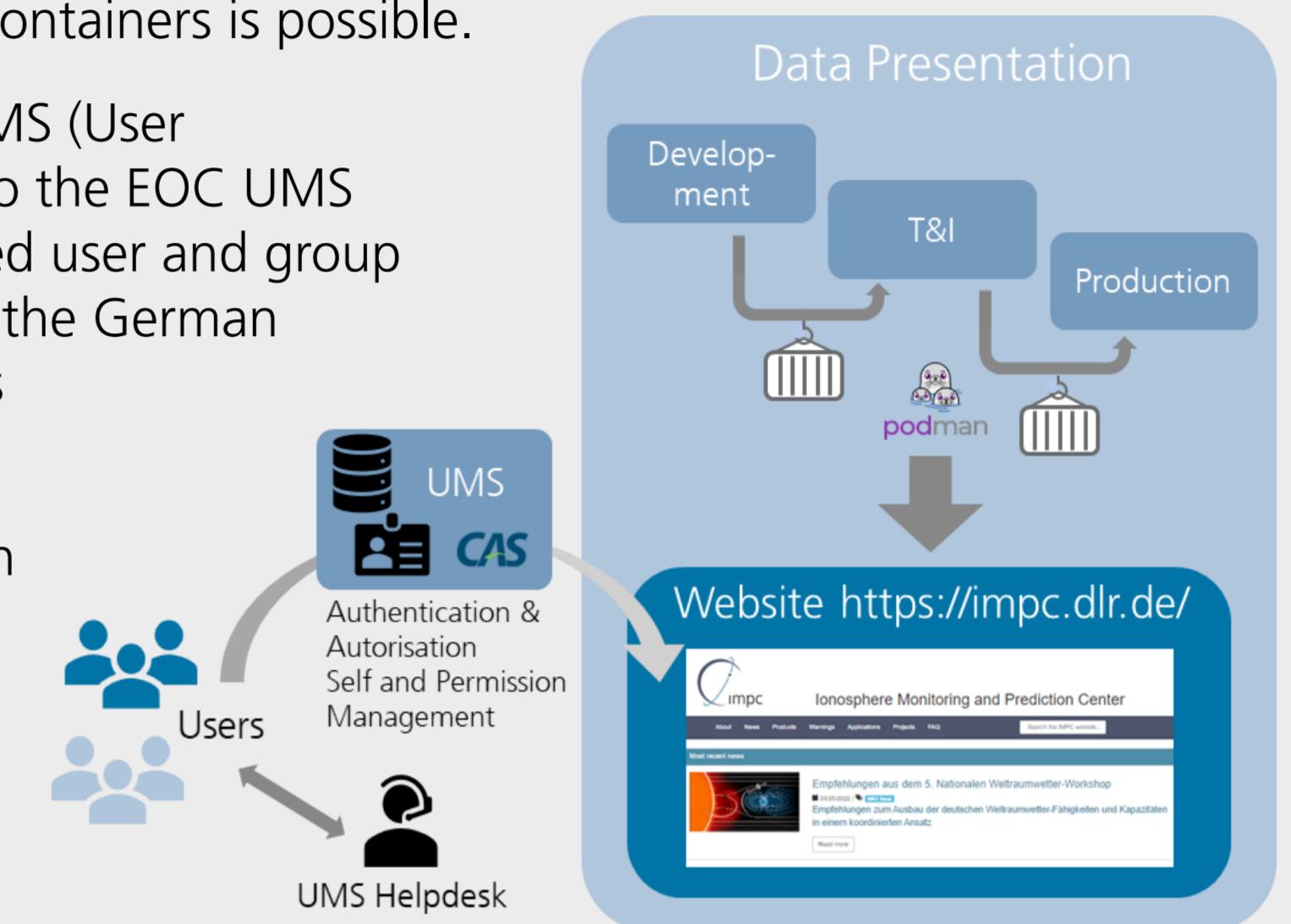
For IMPC data and products the permanent archiving is an important component without time limitation, fast data delivery to users and a high availability.

a r c h i v e

1st Copy

migrate

write

stage

2nd Copy
(remote)

read

Disk Cache

Online Nearline

33 PByte archiving capacity, 50 TByte disk cache

5. IMPC Website and UMS

The IMPC website (https://impc.dlr.de/) offers information about the IMPC background and about the current state of the ionosphere, related forecasts and warnings. It offers also graphs and data from current near real-time products. The development and operation of the IMPC web server environment is also protected through the use of three levels of development (development – test & integration - production). For the convenient operation of the website security and its different versions, containerization is implemented. Thus root rights on the server are not required and network communication between the containers is possible.

For the IMPC user management the EOC UMS (User Management System) is used. Connection to the EOC UMS enables Single Sign-On (SSO) with centralized user and group management. The system is compliant with the German Satellite Data Security Act (SatDSiG) and has a well-established science user support.

The IMPC website is General Data Protection Regulation (GDPR) complient and maintains the individual terms and conditions, licence contracts and privacy policies.

Data Presentation

Develop-
ment

T&I

Production

podman

UMS
CAS

Authentication &
Autorisation
Self and Permission
Management

Users

Website https://impc.dlr.de/

impc Ionosphere Monitoring and Prediction Center

UMS Helpdesk

6. Upcoming next

- Data provision tool for archive search

- Integration of GIFDS data and alerts

- Update of Scintillation Products (API access, interactive maps and time series plotting)

- Perturbance indices (e.g. DIX-SG, AATR, GIX, PPP errors) based on NRT GNSS

- Products based on operational physical (CTIPe) and empirical (NEDM, NTCM-Azpar) model runs

- Interactive 4D visualisation of ionosphere model based on joint development with the DLR Institute of Data Sciences (MEDUSE)

- Integration of operational GISM products for providing global scintillation indices (climatological)

7. Registration

Extended access for registered users:
- additional products
- further information on Warnings and Applications

email:
impc-uhd@dlr.de

New User Registration

SCAN ME

https://impc.dlr.de/

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