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COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS

ITEM: 10

EIGHTH SESSION

GENEVA, SWITZERLAND, 14-17 APRIL 2014

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# Satellite User Readiness Navigator portal (SATURN)

*(Submitted by Secretariat)*

## SUMMARY AND PURPOSE OF DOCUMENT

The concept for the SATURN (SATellite User Readiness Navigator for the next generation of geostationary satellites) online portal is presented, together with the approach for populating the portal.

An important element of the portal is the forward-looking planning for user readiness activities, and an outline is presented for a Reference User Readiness Project, including a Reference Timeline for activities and deliveries from the satellite system development.

## ACTION PROPOSED

The eighth session is invited to:

(a) Comment on the SATURN portal and approach for population. An online demo of the portal and its initial content will be provided to the session;

(b) Comment on content and timeline for the reference User Readiness Project.

# SATURN: SATellite User Readiness Navigator for the next generation of geostationary satellites

## INTRODUCTION

The new generation of meteorological geostationary satellites being launched by NOAA, ISRO, JMA, CMA, KMA, ROSHYDROMET and EUMETSAT before the end of this decade will provide unprecedented capabilities for the key applications of severe weather monitoring, nowcasting and short range forecasting and for a number of developing application areas, but will also present unprecedented challenges for users worldwide. The main challenge is the order-of-magnitude increase in the amount of data and products to be generated from the advanced imagers and sounders on-board the satellites. In addition, novel data types from geostationary sounders and 16-channel imagers need to be accommodated for by operators and users. These capabilities will be driving the need to develop more advanced techniques for interpretation and assimilation of the data and products generated.

It is a priority of WMO and of CGMS to support the user community in light of these challenges. Satellite data users and WMO members require timely, technical information on the new satellite generation to exploit its potential operational benefits and socio-economic value. The WMO Space Programme, with the support of the CGMS member agencies, is therefore developing the online portal SATURN (SATellite User Readiness Navigator) to provide a single point of access for all information pertinent to the global user community preparations for the new generation of satellites. The support of CGMS members to achieve this goal is essential, and therefore CGMS has established a task team of agency focal points to provide content for the portal.

As of February 2014, the following focal points have been nominated

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## LOCATION AND STRUCTURE OF SATURN PORTAL

The SATURN portal is available under the URL http://www.wmo-sat.info/satellite-user-readiness, however at this point in time a casual user just sees an "under construction" message. This will be changed when the portal is made public; afterwards user registration will not be required for viewing the content.

SATURN is essentially a highly collaborative blog. All content, provided by the individual agencies, is realized as **posts** using the WordPress online developer environment. Each agency focal point is fully responsible for entering and updating posts. The SATURN Administrators (Mikael Rattenborg and Stephan Bojinski, WMO Space Programme) will ensure the overall consistency and reorder posts as necessary. The overall logic is that posts related to the satellites are ordered according to the planned launch dates, with Himawari-8 first and MTG last.

To offer different entry points for the user of SATURN, a hierarchical category structure has been developed, in accordance with the SATURN concept document. The categories are visible in the main menu structure where the 1st level categories, ("Satellite", "FAQ", "Data Access and Use", "Planning for Readiness") make up the main menu, with subcategories appearing in the dropdown menus.

Each post is attached to one or several "categories" or "sub-categories" depending on where it should appear in the navigation. The categories and subcategories used are:

### ***Satellites***

With the subcategories:

1. Himawari-8
2. FY-4A
3. GOES-R
4. GEO-KOMPSAT-2A
5. MTG
6. INSAT-3D (TBC)
7. ELEKTRO-M (TBC)

### ***Data Access and Use***

Here the subcategories are:

1. Products and Applications
2. Data Formats and Volumes
3. Data Access Mechanisms and User Registration
4. Test Data and Tools
5. Training and Resources

### ***Frequently Asked Questions***

Here the subcategories are the typical questions a user, be it an individual or an NHMS, would ask as part of the preparations for the new satellites:

1. Which data and products will be available from the operators?
2. Which formats will the data and products be in?
3. When will the different data and products become available after launch?
4. How can I get access to the data and products?
5. Can I use my old receiving equipment?
6. What do I need to change and how much will it cost me?
7. How can I use the data and products for my own application?
8. Where can I find technical and scientific training material?
9. Where can I find a community that shares my interests?
10. How can I get hold of synthetic/proxy/heritage data?

### ***Planning for Readiness***

Here the satellite operators will provide detailed and up-to-date planning of all activities conducted in support of the user readiness projects. This will include forward planning for the provision of test data and tools, product specifications and format descriptions, data access mechanism specifications, instrument specification and performance data, training resources, operational scenarios, operational services specifications etc.

## REFERENCE USER READINESS PROJECT

### ***Scope***

The WMO guidelines on user preparations adopted at CBS-XV in 2012 urges each of the NMHSs and other operational user organizations to:

“Establish a user readiness project focused on the introduction of new satellite data streams into operations (to be initiated ~5 years prior to launch)”

One of the main constraints for the planning of such a user readiness project is the timely availability of information, specifications, data and tools developed during the satellite system development. Therefore, to establish a user readiness project, it is important to consider in detail the lifecycle of satellite system development and the relations to the user readiness planning.

It is therefore crucial, that the satellite development entities and operators provide detailed and up-to-date planning of all activities conducted in support of the user readiness projects. This should include forward planning for the provision of test data and tools, product specifications and format descriptions, data access mechanism specifications, instrument specification and performance data, training resources, operational scenarios, operational services specifications etc.

Even though user readiness is explicitly considered for ongoing satellite system development projects such as Himawari-8/9 or GOES-R, the satellite operators do not generally provide a forward planning including up-to-date schedules of deliverables to the user community.

Therefore the WMO Space Programme has analyzed how the typical satellite system development cycle relates to typical user readiness projects, and the outcome of this analysis is a summary of best practices and a generic schedule, indicating at what time (relative to planned launch) specific levels of information should be available in order to satisfy both the user preparation schedule and the constraints of the satellite system development.

The initial scope of SATURN is the new generation of GEO satellites, but for consistency, the reference project definition is considered generic, and therefore includes activities that only apply to LEO satellites.

## *User activities*

### Budgeting and planning

Budgeting and planning is of paramount importance and needs to be started early. A new generation satellite system can be in some cases the driver of significant infrastructure upgrades; the performance requirements in terms of data acquisition, storage, network, etc. should thus be known many years in advance in order to incorporate the necessary upgrades in the long-term evolution and investment plans. Realistic schedule margins and other provisions should be used to avoid planning difficulties due for example to launch delays

A main objective for a user organization like an NMHS, is to protect the investment made into existing operational programmes, and to understand early where additional investments are unavoidable in order to achieve readiness for the new satellite system. Therefore, early information about investment drivers is crucial for budgeting and planning purposes.

### R&D

In this context, R&D refers to the phase of activities that prepare for routine operations of new generation satellites from the user perspective. This typically includes development of NWP assimilation methods for the new generation satellite data where needed, or development of new or specially tailored products for specific application areas required by the individual user. The planning of such activities varies widely according to the needs and capabilities of the NMHSs, in particular for the NWP centres.

### Data handling development and testing

This activity includes design and procurement of new satellite reception systems, as well as upgrades to terrestrial network access (Internet and RMDCN) to support the increased data rates, to observational databases and short- and long-term archives as well as to internal networks and general IT capacity

### Data processing development and testing

All aspects of the processing of satellite observations need to be adapted and potentially upgraded to accommodate data from the new satellite. This may include:

- Local processing of direct broadcast data into L0 and L1 products
- Transformation of received data into intermediate local formats for observations databases and archiving

- NWP assimilation,
- Local generation of higher-level products for specific application areas
- Visualization tools, both for analysis by experts as well as for general forecasting

**Training**

Different training subjects and different target groups for training exist and it is important to identify the different categories of training as they have different time scales and require different levels of information about the new satellite system.

Identified training subjects are:

- Equipment operation and maintenance
- Interpretation of L1 data from satellite payload instruments including:
    - Imagery interpretation
    - Passive sounder data usage
    - Active instrument usage
- Use of software tools (for processing, analysis, and assimilation)
- Derived L2 product utilization and interpretation
- The physical basis of remote sensing, in particular as it applies to new instruments.
- Preparation for new generation satellites

Target groups for training are:

- Trainers (the “train the trainers” approach)
- User readiness project managers
- Operational forecasters
- NWP teams
- Decision makers
- Technical support personnel
- R&D personnel

The approach for organizing training depends very much on the needs and capabilities of the NMS and on the organizational relationship between satellite operator and users. With the advancement of e-learning technology, emphasis is clearly shifting from long-term planned classroom training towards “just-in-time-traning” based on webinars, self-study online training etc.

High-level guidance for training in satellite meteorology is available in the Strategy for the CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (http://www.wmo-sat.info/vlab/wp-content/uploads/2012/02/SAT-ST-09_VL-5year-strategy_V2.pdf, 2009-2014 version)

**Capacity building**

Capacity building is vital for ensuring that all WMO members can maximize their capability to exploit the value of the new generation of satellite data. Such CB activities can take the form of bilateral NMHS partnerships, regional collaborative projects like the RA-II WIGOS project or major projects providing technical and scientific infrastructure and training for less developed WMO members (e.g. AMESD and MESA).

**Contributions to Calibration/Validation**

Participation of NWP centres in instrument Cal/Val activities have become standard practice both for LEO and GEO satellites. Monitoring of FG-OBS departures for L1 products are an important contribution to the Cal/Val activities of satellite operators.

## ***Satellite system development phases***

The life cycle of space projects is typically divided into 7 phases, as follows:

- Phase 0 – Mission analysis/needs identification
- Phase A – Feasibility
- Phase B – Preliminary Definition
- Phase C – Detailed Definition
- Phase D – Qualification and Production
- Phase E – Utilization
- Phase F – Disposal

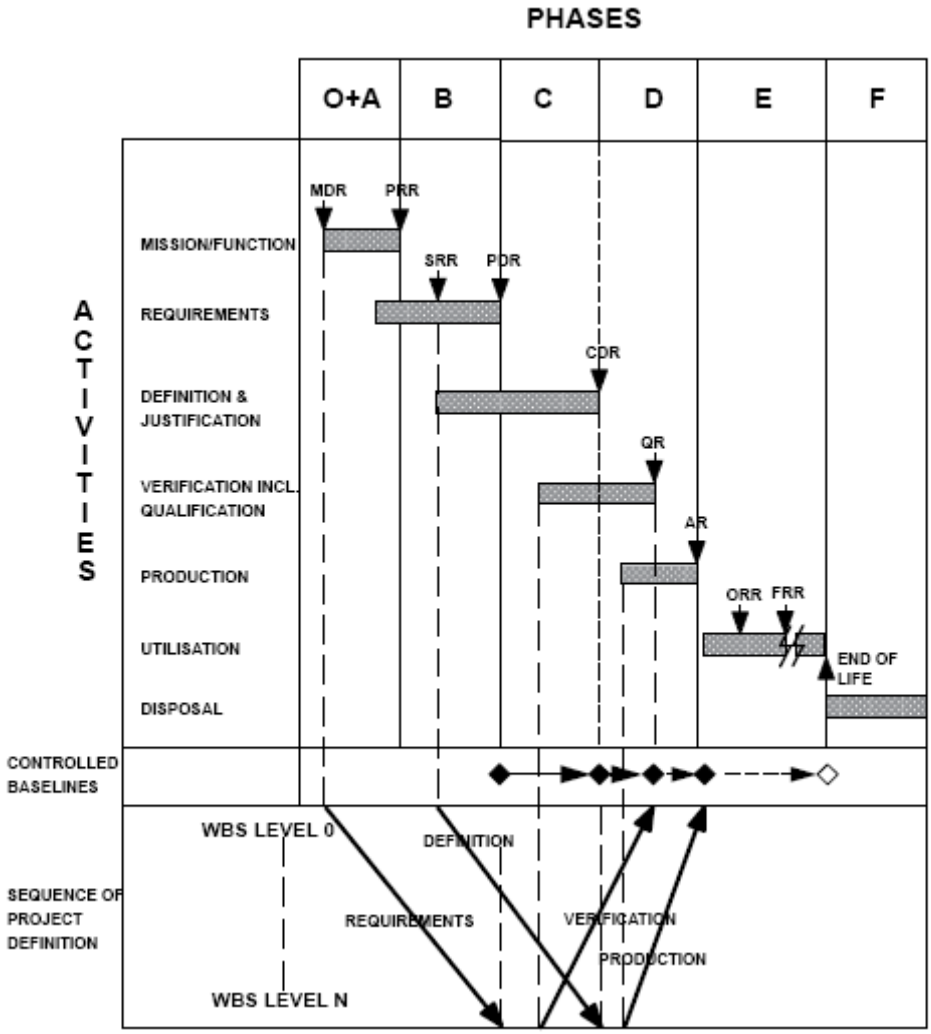


*Figure 1: Reference satellite system development lifecycle (according to ECSS)*

Phase C (detailed definition) is concluded with the System Critical Design Review (CDR), at which point the definition of the system (satellite and ground segment) will be complete down to the lowest level, and after which full production (Phase D) of the system will start. If the development follows a nominal schedule, the System CDR will take place 3 years before launch. Phase E (utilization) starts with the shipment of the satellite to the launch site and the start of launch preparations, and is subdivided into phases E1 (launch and commissioning) typically lasting until 6-12 months after launch and phase E2 (routine operations).

The most significant consequence of this lifecycle with respect to the user community is that the deliverables made available to the user community before the System CDR (ie at the end of Phase C) will be based on requirements, whereas deliverables based on the real characteristics of the system will only become available after this time, during phase D and E1.

This lifecycle reflects actual experience from MSG and COMS, and also the status and planning for GOES-R and MTG. Variations do exist for specific programmes, for example is the planning for Himawari-8 development somewhat compressed compared to this, the System Critical Design Review was completed in January 2012, only 30 months before the planned launch summer 2014.

## ***Deliverables to user activities***

### Instrument characterization

Details of instrument characterization and performance are of general interest to the user community, but are particularly critical for the adaptation of NWP assimilation of L1 data. Initially these data are based on instrument specifications, but following on-ground instrument testing, actual instrument characterization data will become available from the satellite manufacturer based on this testing. The provision of these data from industry to the satellite operator is generally regulated in the overall satellite contract, and subject to a significant set of contractual constraints.

### Product specifications

This includes scientific specifications of the product algorithms, detailed specification of formats for dissemination as well as on-demand requests, information on timeliness and expected data volumes, all for both L1 and L2 products.

### Data access mechanism specifications

This includes specifications of mechanisms for direct-readout, direct dissemination and DVB-based dissemination. These specifications are required for procurement of all user reception systems.

Also required are specifications of offline data mechanisms, including archive retrieval and other on-demand data access means.

Where user registration is required for access to products and services, detailed description of the user registration process is required before launch, so that the processes can be exercised during the commissioning phase.

### Test data and associated tools

Different categories of test data exists, with different life cycles. The categorization used in the SATURN portal is:

- Synthetic data: No scientific value, but realistic sizes and formats. Used for user dataflow testing
- Proxy data: Data simulated by forward Radiative Transfer Model (RTM) calculations. Proxy data are used to test processing and visualisation tools. It should be noted that as these data are produced based on NWP model data, they generally do not contain realistic spatial structure and temporal variability.

- Heritage data: Actual data sets from relevant precursor instruments, i.e. 2.5 min data from Meteosat-10 for MTG-FCI, 1 min super rapid scanning data from GOES for GOES-R ABI or IASI/AIRS data for FY-4A GIIRS and MTG-IRS. Heritage data are used in early training on capabilities and application areas. It is also possible to use heritage data to construct test data similar to proxy data by adding RTM simulated data for channels to the ones present in heritage mission or by using interpolation in time and space.
- Pre-operational data: Live data generated as part of the commissioning activities, but before full validation has been completed.

The operators should provide all of these categories of test data, as well as software tools provided for the use of the test data, during the pre-launch development and during the post-launch commissioning activities.

**Software**

L1 pre-processing software: It is needed for the procurement of the user data processing functions, but realistically is only available from an operator after Ground Segment acceptance. Any contracts for procurement of data processing systems need to take this need into account.

**Operations plans and schedules**

For the user readiness it is of high importance that both long-term operations plans, as well as routine operations schedules are made available before the start of routine operations. This includes:

- Fly-out plan for overall satellite programme, including planning for launches, orbital positions and end-of-life dates, including information about overlap with existing operational satellites
- Routine operations schedule, include areas of coverage for flexible scanning operational scenarios and process for scenario switching, e.g. activating of Super Rapid Scanning operations for severe storms and tropical cyclone tracking.
- If appropriate, conditions for user inputs into the operations schedule (e.g. requests for special mode operations)
- Planning for routine spacecraft maintenance activities, like orbital maneuvers, seasonal spacecraft reorientation (yaw-flip), instrument decontamination etc.
- Schedules for activation of LEO direct broadcast where applicable.
- Schedules for routine dissemination for both direct broadcast and re-broadcast via telecommunications satellites.

Details on the need dates are provided in the timeline below.

**Communication channels**

It is essential that the satellite operator establish 2-way communications channels to the user community to provide general and specific information, to allow users to make information inquiries and provide other feedback during the preparations phase and to provide routine user support starting in the commissioning phase.

Such communication should include Regional satellite user coordination mechanisms (such as the Coordination Group on Satellite Data Requirements for Region III and IV; RAIDEG), regional user conferences (such as the Asia-Oceania Meteorological Satellite Users Conference) and training events (such as the GOES-R Event Week), as well provide support for inquiries and feedback from individual users.

## ***Timeline for Reference User Readiness Project***

The table below shows the overall timeline of user preparedness activities and the planning for the different deliverables from the satellite system development needed to support the user activities.

Each user deliverable in the reference project has an associated sub-category in SATURN, so that the portal will provide up-to-date links to all deliverables when these become available from the satellite system development.

Collaborative efforts like training and user conferences are shown under user activities.

| Time relative to Launch Date ("L") | Satellite System development Activities and Milestones | User readiness Project Activities and Milestones | Needed deliverables from operators |
|---|---|---|---|
| L-5y (years) -> L-4y | Ground Segment Development Phase C | Initiation of NMHS user readiness Project.<br>Initiation of cooperative projects addressing needs of less developed WMO members. | Overall specifications of user segment, including high-level definition of migration path from existing user segment.<br>Preliminary schedule for deliverables to users |
| L-4y -> L-3y | System Critical Design Review | Identification of drivers for investment and running cost.<br>Planning and allocation of human resources and budgets for investments and running costs.<br>Establish prioritized data requirements, as clear priorities for current and future products allow the best preparations to be made for establishing data access and delivery capabilities.<br>Initial training on capabilities for trainers and decision makers. | General description of NRT dissemination mechanisms.<br>Detailed specifications of L2 and L1 products to be available at start of operations (Day-1 products).<br>Heritage test data.<br>Plans for evolution of products after start of operations (Day-2 products). |
| L-3y -> L-2y | System Production<br>On-ground characterization of instruments | Design of new reception system.<br>Design of comms network changes, including GTS/RMDCN capacity.<br>Design of new data handling and processing functions.<br>Training on specific application areas, based on proxy data. | Specifications of instruments performance.<br>Proxy test data<br>Detailed specifications of NRT dissemination mechanisms.<br>Detailed specifications of Direct Broadcast mechanisms, including frequency and signal characteristics.<br>General description of offline data access.<br>Data/product volume estimates.<br>Data/product format definitions.<br>Data access conditions (e.g. licensing, key units, etc).<br>L1 pre-processing software.<br>Establish and use 2-way communication channels for user inquiries |

| Time relative to Launch Date ("L") | Satellite System development Activities and Milestones | User readiness Project Activities and Milestones | Needed deliverables from operators |
|---|---|---|---|
| L-2y -> L-1y | Ground System acceptance | Procurement, installation and acceptance testing of systems.<br>Software design for data processing, including NWP ingest. | Synthetic test data<br>Continuous periods test dissemination of synthetic test data.<br>Long-term operations plan.<br>Planning for data exchange to serve global community. |
| L-1y -> L-6m | Flight readiness of satellite | End-user training (forecasters) | Start of regular updating of plans for launch and commissioning. |
| L-6m -> L | Operational System Validation and Launch preparations | Data processing software testing (using proxy data).<br>Technical training on reception systems and other system elements.<br>Data acquisition system testing (using synthetic data). | Proxy data based on on-ground instrument characterization.<br>User documentation for dissemination mechanisms and delivered software tools.<br>Routine operations schedules. |
| L->L+6m | Satellite In-orbit verification<br>Commissioning of L1 products | Full system and software testing (using pre-operational data).<br>Support to operators CAL/VAL activities, in particular through NWP assimilation. | Early dissemination of un-validated L1 data.<br>Early switch-on of Direct Broadcast<br>Pre-operational L1 data dissemination.<br>In flight characterization of instrument performance.<br>Start of routine User Support |
| L+6m->L+2y | Commissioning of L2 products | Scientific data exploitation (iterative based on increased understanding of real data).<br>Post-launch training based on real data.<br>Declaration of user operational readiness | Operational L1 data dissemination, from both old and new satellites (as long as possible, but minimum until L+1y). |