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GUIDE TO THE DIRECT BROADCAST NETWORK (DBNET)

(Submitted by Secretariat)

Summary and Purpose of Document

To present the Guide to DBNet as endorsed by CBS-16 (doc 3.4(3)). The Guide to DBNet is a WMO Guideline. Referenced on the WMO WIS site here means that the Guide to DBNet is recognized as part of the Guide to the WMO Information System (WIS) and thus of official WMO regulatory material.

ACTION PROPOSED

The session is invited to note the information in this document.

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WMO Information System

WMO Space Programme

GUIDE TO THE DIRECT BROADCAST NETWORK (DBNet)

For Near Real-Time Relay of Low Earth Orbit Satellite Data

Final Draft (22 September 2016)

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CONTENTS

1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The purpose of this Guide is to define the minimum standards applicable to the Direct Broadcast Network for Near Real-Time Relay of Low Earth Orbit Satellite Data (DBNet) and to provide guidance for implementing these standards.

In the present Guide, the verb “shall” is used when referring to the standards necessary for DBNet to work properly, and “should” when referring to recommended practices. The DBNet standards are applicable to all voluntary contributions of WMO Members to DBNet.

The aims of these standards are twofold:

- To help ensure that the data provided by each particular DBNet regional network can be used operationally to meet user requirements as recorded in the WIGOS Information Resource [RD.2];
- To facilitate inter-regional data exchange and interoperability around the globe, with a particular focus on ensuring the global consistency of the DBNet datasets.

This Guide is primarily directed to the DBNet station operators and coordinating entities. It also contains provisions for consideration by providers of processing software and by satellite operators. Furthermore, it can be a useful reference for the users of DBNet products.

1.2. STRUCTURE OF THE DOCUMENT

This Guide consists of the following sections:

Section 1:	Introduction;
Section 2:	Defines DBNet and describes its components;
Section 3:	Addresses the overall DBNet coordination processes;
Section 4:	Contains common standards and practices applicable to the production of DBNet data across all DBNet regional networks;
Section 5:	Contains specific standards and practices applicable to the production of each DBNet service;
Section 6:	Conclusions;
Annexes:	Contain ancillary information which is provided separately for easier reference and to facilitate updating.

1.3. APPLICABLE DOCUMENTS

[AD.1]: WMO Manual on Codes, Volume 1.2, Parts B and C, WMO-No. 306
[AD.2]: WMO Manual on the GTS (WMO-No. 386)
[AD.3]: WMO Manual on the WIS (WMO-No. 1060)

1.4. REFERENCE DOCUMENTS

[RD.1]: Statements of Guidance for Global Numerical Weather Prediction and High-Resolution Numerical Weather Prediction
[RD.2]: WIGOS Information Resource, Observing System Capabilities Analysis and Review (OSCAR): www.wmo.int/oscar
[RD.3]: DBNet Network Status and Plan http://www.wmo.int/pages/prog/sat/documents/DBNet_Network-status-and-plans.pdf
[RD.4]: DBNet Coding Summary http://www.wmo.int/pages/prog/sat/documents/DBNet_Coding-summary.xls

2. OVERVIEW OF DBNet

2.1. AIM AND FUNCTIONS OF DBNet

The aim of DBNet is to provide near real-time access to near-global data from Low Earth Orbit (LEO) satellites, in order to meet in a cost-efficient manner the timeliness requirements of regional and global Numerical Weather Prediction (NWP) and other applications.

As a system, DBNet performs the following functions:

- Reception and acquisition of satellite Direct Broadcast signals at local DBNet stations;
- Processing of the acquired data into products;
- Near real-time delivery of products;
- Performance monitoring and quality control;
- User information;
- Coordination and planning.

2.2. JUSTIFICATION OF DBNet

Access to LEO data is normally relying on data dumps at one Command and Data Acquisition (CDA) station, which allows retrieving complete orbit data, however with a data latency resulting from on-board data storage between the time of acquisition and the time when the data is dumped

to the CDA. This on-board storage can be reduced roughly by a factor of two when two high-latitude CDAs are used, one in the North and the other in the South. Further reduction requires a whole network of mid- or low latitude stations distributed around the globe, which involves higher ground infrastructure costs and a highly complex scheduling of data storage and dumps.

When satellites have a Direct Broadcast capability, which is the case of most LEO meteorological satellites, an alternative data access route is the acquisition of the Direct Broadcast data stream at a local ground station, which allows real-time acquisition, albeit with coverage limited to the portion of orbit within the area of visibility of the local station.

The Direct Broadcast Network for Near Real-Time Relay of LEO satellite data (DBNet) overcomes this limitation in offering a cost-efficient trade-off between coverage and timeliness. It coordinates data acquisition through a globally distributed network of local Direct Broadcast receiving stations, their processing in accordance with agreed standards, and their rapid delivery to the global user community through appropriate telecommunication systems.

The substantial improvement in timeliness is crucial for NWP models with short cut-off, which otherwise cannot take advantage of the most recent satellite passes. This concept was initially promoted by the HIRLAM community and EUMETSAT for the collection of ATOVS data to support regional NWP over Europe. It was then extended by WMO to the global scale under the name Regional ATOVS Retransmission Services (RARS) and quickly adopted by the global NWP as the timeliness requirements of global models became more stringent. Impact studies have given evidence of the benefit of RARS for regional and global NWP. Several papers and posters on RARS are available on the WMO RARS web page (http://www.wmo.int/pages/prog/sat/rars-implementation_en.php#RARSdocs).

DBNet is expanding the RARS concept to other data types in support of a wider range of applications. The present Guide thus replaces the former RARS Operators Standards with a wider scope to accommodate new sensor data, to ensure interoperability with the NOAA Direct Broadcast Real Time Network and to take into account the WMO Information System.

2.3. DBNet COMPONENTS

DBNet is composed of several regional or sub-regional networks of receiving stations. The list of stations contributing to these networks is provided in [RD. 3].

A DBNet Network Coordinator is designated for each DBNet regional or sub-regional network.

The role of the regional/sub-regional Network Coordinators is to:

- Ensure coordination of the regional or sub-regional network, report to the DBNet Coordination Group, and contribute to the overall DBNet planning and coordination described in Section 3;
- Provide guidance to Station Operators for implementing new services, and oversee the validation procedures defined in Annex B;
- Ensure performance monitoring as defined in Section 3.2;
- Maintain a website providing information as listed in Section 3.3.

Table 1 contains the list of DBNet regional or sub-regional networks and coordinating centers.

Regional network	Regional Network Coordinator	Sub-regional network	Sub-regional Network Coordinator
DBNet-EUMETSAT (EARS European stations and other regional partners)	EUMETSAT		
DBNet-Asia-Pacific	BOM	Asia-Pacific North	JMA
		Asia-Pacific South	BoM
DBNet-South America		South America/North	INPE
		South America/South	SMN /CONAE
DBNet-NOAA (DBRTN US stations and other regional partners)(1)	NOAA/CIMSS		

(1) DBNet-NOAA is implemented by NOAA/CIMSS in partnership with EUMETSAT and shares some functions with EARS.

Table 1: DBNet regional or sub-regional network components

Global Monitoring Centres should perform a systematic control of product consistency. This function is assumed by the EUMETSAT NWP SAF, led by the Met Office (United Kingdom) for the IR/MW sounding service. For other services global monitoring centres have not yet been identified.

The list of Network Coordinators is maintained by the WMO Secretariat and is available online as Operational Information. (Currently: http://www.wmo.int/pages/prog/sat/dbnet-implementation_en.php#DBNetcontacts).

Each DBNet regional or sub-regional network contributes to one or several DBNet "Services". A DBNet Service is performing the acquisition and relay of a certain category of satellite data. Table 2 lists the DBNet services (current and potential).

Categories of Services	Services (Instruments)
IR/MW sounding	RARS (AMSU-A, MHS, HIRS), ATMS, VASS (MWTS/2, MWHS/2, IRAS)
IR/VIS imaging	VIIRS, AVHRR, MERSI
Hyperspectral IR sounding	CrIS, IASI, HIRAS, AIRS
Scatterometry	ASCAT, Wind RAD
MW imagery	MWRI

Table 2: Current and potential DBNet services (as of August 2016)

Significant NWP user interest has been expressed for data from the Russian MW imaging/sounding radiometer MTVZA-GY, manifested on the METEOR series of satellites. The feasibility of including this instrument in the DBNet services will be further analysed.

A service based on GNSS Radio-occultation data could be considered for DBNet, as the Metop satellites and the FY-3 satellites fly GNSS-RO instruments. Due the limb-sounding nature of the GNSS-RO such a service would not produce regional atmospheric profiles, but for space weather application there is an interest in fast delivery of global data from the ionosphere. The feasibility of such a service requires further analysis, which will be undertaken together with CGMS.

2.4. HIGH-LEVEL SERVICE SPECIFICATIONS

The DBNet Service Specifications are determined with the aim to respond to user requirements of WMO Application Areas, as recorded in OSCAR [RD.2]. For example, the requirements of Global NWP (http://www.wmo-sat.info/oscar/applicationareas/view/1) and High-Resolution NWP (http://www.wmo-sat.info/oscar/applicationareas/view/2) require for atmospheric temperature, humidity profiles and wind vector at sea surface, a timeliness of less than 6 to 15 min as a goal and 30 min as breakthrough. The DBNet specifications represent the agreed commitment by DBNet Regional Networks to contribute to meeting these requirements, taking into account the technical capabilities and resource constraints. The table below summarizes the operational service specification for each DBNet Service category.

These specs will be validated in consultation with relevant user groups, for example the GODEX-NWP as representing the global NWP data exchange community and the ITWG representing the satellite atmospheric sounding community.

The DBNet high-level specifications are summarized in Table 3.

Category of Service	Driving Application	Products	Data latency goal/threshold	Availability	Coverage
IR/MW sounding	Global and High-Resolution NWP	Level 1 brightness temperatures	20 min/ 30 min	95%	90%
IR/VIS imaging	Nowcasting	Level 1 radiance /reflectivity	10 min/ 20 min	95%	30%
HiRes IR sounding	Global and High-Resolution NWP	Level 1 radiances and PC scores	20 min/ 30 min	95%	90% (60% initially)
Scatterometry	NWP, Nowcasting and Ocean Applications	backscatter cross-sections	20 min/ 30 min	95%	50% (of oceanic areas)
MW imagery	NWP, Nowcasting,	Level 1 brightness temperatures	20 min/ 30 min	95%	30%

Table 3: DBNet High-Level Service Specifications

Data latency is defined here as the maximum time elapsed between observation time (sensor time) and the availability on the WMO Information System (WIS) core network to be satisfied by at least 90% of the data.

The availability rate is an indicator of the target uptime for a DBNet station when there is no special operational constraint (i.e. not considering particularly remote sites such as Antarctic stations). It is defined here as the percentage of days where the station is operating normally. The number of passes acquired depends on local factors (including the station latitude and the scheduling priorities) and cannot be fixed as a high-level specification, but is monitored (e.g. on a monthly basis) as a performance indicator. The availability is defined for an individual station. Adjacent stations with significantly overlapping acquisition areas can back-up each other, which is important primarily to solve possible reception scheduling conflicts.

The coverage is defined here as the percentage of the Earth's surface that can be viewed by the relevant satellite instrument and the data transmitted to DBNet stations via direct broadcast. This is calculated in merging the areas of visibility of the local stations contributing to the service. As an order of magnitude, an isolated station (not overlapping with the area of visibility of another station) without mask contributes to the global coverage by about 4%. (Note: this index takes only into account the latitudes between 82°S and 82°N which are flown over by sun-synchronous satellites.)

3. DBNet COORDINATION

3.1. DBNet NETWORK IMPLEMENTATION

The WMO Secretariat and all DBNet Network Coordinators strive to ensure smooth operation of the DBNet Services across all regional networks, to plan expansion of DBNet, to review the priorities and to take any appropriate measure to meet evolving user requirements. The regional/sub-regional Network Coordinators identify candidate stations and negotiate agreements with Station Operators with a view to expand the network and fill gaps when necessary.

This coordination is achieved through the DBNet Coordination Group, the Terms of Reference of which are provided in Annex A.

The WMO Secretariat maintains a list of DBNet contributing stations associated to each regional network with the status and plans of the different services [AD.4], based on the reports from DBNet Network Coordinators. This allows monitoring the coverage of the respective DBNet services.

The procedure contained in Annex B describes the steps to be followed for adding a station to DBNet, modifying its status, or removing it from DBNet.

3.2. QUALITY OF SERVICE

3.2.1. Quality assurance

In order to help ensure that the service provided is of an appropriate quality, the DBNet Station Operator shall:

- Uutilize an appropriate system for the tracking and resolution of operational anomalies;

- Ensure that all operations and maintenance staff are appropriately trained;
- Ensure that appropriate provisions are in place to protect against unauthorized access to the DBNet equipment (from both physical, and network security points of view);
- Ensure that the maintenance approach (e.g. levels of redundancy, spares holdings, maintenance contracts and maintenance team size) is consistent with the service availability targets (see section 2.4);
- Ensure that adequate arrangements are in place to monitor the satisfactory performance of the service (supported by the availability of validated operational and maintenance procedures.

3.2.2. Quality control

Each DBNet Regional Network shall implement appropriate quality control measures to monitor the integrity of DBNet data that are disseminated, in particular with respect to timeliness and correct formatting.

The regional/subregional Network Coordinators:

- Organize the near real-time monitoring function;
- Maintain the list of operational points of contacts of individual station operators;
- Perform overall performance monitoring (including implementation of the standards);
- Manage software updates to ensure that proper software versions are used on each station;
- Ensure an operational point of contact for resolving anomalies.

For the IR/MW sounding and Hyperspectral IR sounding services, global monitoring is performed by the EUMETSAT NWP SAF to assess the consistency of DBNet data with the global data and their timeliness. The results of this monitoring are sent to the operators and statistics are published online, see NWP SAF website http://nwpsaf.eu.

3.2.3. Issue management

Each DBNet Station operator and each DBNet Network Coordinator shall designate an Operational Point of Contact to be contacted in case of operational problems.

The contact details of Operational Points of Contact of each regional/sub-regional network will be posted on the DBNet Regional Network website to allow the users to report operational problems. Depending on the nature of the problem, the DBNet coordinating entity will contact the relevant DBNet station operator, the relevant WIS DCPC/GISC as defined in Appendix B of [AD.3], and/or the global monitoring unit (EUMETSAT NWP SAF Help Desk).

Each DBNet Network Coordinator should implement appropriate issue management processes in order to properly track and manage the resolution of problems, including notification of the providers of pre-processing software packages.

Each DBNet Processing Software Provider of a pre-processing software package should implement software anomaly management processes, for fast resolution of software problems that affect the end-users.

3.3. PUBLICATION OF SERVICE INFORMATION

The WMO Space Programme provides and maintain a DBNet e-mail list-server, which allows DBNet Network Coordinators and Processing Software Providers to support all Station Operators and operational Users by keeping them up-to-date with system changes (e.g. announcement of AAPP and CSPP S/W releases and their impact on DBNet operations).

Each DBNet regional or sub-regional Network Coordinator should also maintain a website containing an up-to-date description of the service, including:

- For each Service, the instruments and satellites from which data are collected;
- The geographic coordinates of the collection stations that form part of the DBNet data collection network, together with the associated geographical coverage maps;
- The processing software versions that are used to generate the products for the stations in the regional network;
- The target timeliness and target availability of the service;
- Details of the data distribution mechanism and any associated user reception equipment requirements (e.g., for receiving data from a satellite direct broadcast system);
- File naming and structure;
- The administrative procedures to be followed by a user to gain access to the data;
- A link to the scheduling priorities (including any instrument/satellite priorities);
- Operational points of contact of the Network Coordinator allowing users to report problems with the service (including generic e-mail addresses).

When this information is available for individual stations:

- Planned acquisition schedule;
- Acquired passes in the last 24 hour period compared to the planned acquisition schedule (referenced to the planned acquisition schedule);
- Long-term planning information that may affect the service in the future (e.g., planned outages, upgrade of software version, etc.);
- Quality monitoring results.

Each DBNet Processing Software Provider maintains on its website a record of the current recommended software versions and configurations.

For operational issues strictly related to the distribution of DBNet products through the WIS core networks (including e.g. RMDCN), WIS communication procedures must be followed.

4. COMMON DBNet STANDARDS AND RECOMMENDED PRACTICES

4.1. INTRODUCTION

The common standards and recommended practices cover aspects of DBNet operations that are not specific to a particular service and should apply for any regional network contributing to the overall DBNet network. The standards are mandatory and are only defined in areas that affect the interoperability of DBNet regional networks, the access to and the utilization of DBNet products, and the interface to the WIS. On the other aspects, some practices are recommended or indicated as guidance, but the actual implementation can be defined in an optimal manner by each DBNet regional network.

A DBNet Network Coordinator is defined as the managing entity responsible for ensuring an end-to-end service within a particular region (i.e., with responsibility for data collection from the HRPT stations, processing, dissemination of the products to users and inter-regional data exchange). If responsibility for the implementation of these functions is shared between several parties, then it is the responsibility of the lead entity to ensure that all the involved parties comply with the relevant parts of this standard.

Overall DBNet standards and recommended practices are defined in the following areas:

- Product processing and product format;
- Product registration and distribution;
- Quality of service;
- Operations and maintenance including anomaly processing;
- Publication of service Information;
- DBNet network coordination.

4.2. ACQUISITION

4.2.1. Satellite acquisition scheduling priorities

Guidelines for satellite acquisition scheduling priorities are established by the DBNet Coordination Group considering:

- Availability and timeliness of global data;
- Equatorial Crossing Time diversity;
- Instrument health;
- DB signal quality;
- Ability of NWP to assimilate instruments.

The scheduling priorities are reviewed annually or when needed. The current priorities are recorded in an Operational Information maintained on the WMO Space Programme website (www.wmo.int/pages/prog/sat). As an example, the 2015 priorities are listed in Annex C.

4.3. PRODUCT PROCESSING (COMMON ASPECTS)

4.3.1. Processing Level

Any products exchanged inter-regionally shall be at level 1, unless otherwise specified for the specific service.

Level 1 is understood to be radiances, reflectances or brightness temperatures for sounders and imagers and sigma-0 or kp for scatterometers, all on original instrument grid with geolocation data.

The AAPP Software Description (http://nwpsaf.eu/site/software/aapp/documentation/) includes the following definition of processing levels:

"Level 0: HRPT data (NOAA) or PFS L0 (METOP): Raw telemetry data including housekeeping and others raw data. Data of the different instruments are merged into a HRPT stream for NOAA. One file per instrument for METOP.

AAPP level 1a: separated data for each instrument AAPP level 1b: Earth located and calibration coefficients (reversible: calibration coefficients are separated from raw data).
AAPP level 1c: Earth located and converted to brightness temperature data (non-reversible: calibration coefficients are applied to data) AAPP level 1d: Mapped and filtered data (with optional cloud mask in the case of HIRS).
PFS level 1B (for AVHRR): Earth located and calibration coefficients, flags.
PFS level 1C (for IASI): Gaussian-apodised, resampled radiance spectra, corrected for all geometrical and instrumental effects, with mapped AVHRR. Earth located.

For SNPP, JPSS and some other programmes (e.g. DMSP), NOAA have adopted the following naming convention, and these names are used in the AAPP documentation where applicable:

- Raw data records (RDR): Raw data from the instrument.
- Temperature data records (TDR): Calibrated, geolocated antenna temperatures from microwave sounder (i.e. no correction for antenna pattern). Original instrument grid.
- Sensor data records (SDR): Calibrated, geolocated brightness temperatures, radiances or reflectivities. In the case of microwave instruments, antenna correction has been applied. Either original instrument grid or re-mapped.
- Environmental data records (EDR): Geophysical quantities."

Processing to level 1, and BUFR encoding, can be done at the regional centre, or locally at the receiving station location.

The DBNet Network Coordinator is responsible for ensuring that appropriate local centre and sub-centre codes are defined and are included in the BUFR messages as described in Section 4.4.

4.3.2. Product Processing Packages

DBNet Network Coordinators and Stations Operators shall use agreed processing packages and agreed auxiliary input data such as orbit information and instrument calibration files in order to ensure that the processed products are fully consistent with the corresponding global data sets pre-processed by the respective satellite operators.

The suite of processing packages to be used by DBNet is described below and is detailed in the sections of this document addressing specific services. The list of software processing packages and organizations responsible for maintaining them is provided in the following tables. For the scatterometry and MW imagery services, information about processing packages will be included when they become generally available.

Level-0 Processing Packages			
Package	Satellites	Provider	Comment

RT-STPS	SNPP, Metop, FY-3, Aqua	NASA DRL	CADU to CCSDS Source Packets
FY3L0PP	FY-3	CMA	CADU to CCSDS Source Packets
Metopizer	Metop	EUMETSAT	CCSDS Source Packets to EPS Level-0

Table 4: Level-0 Processing Packages

Level-1 Processing Packages			
Package	DBNet Service	Provider	Comment
AAPP	RARS, AVHRR	EUMETSAT (via NWP SAF)	
OPS-LRS	IASI	EUMETSAT (via NWP SAF)	Released as an optional part of AAPP.
CSPP	ATMS, CrIS, VIIRS	NOAA (via SSEC, UW-Madison)	
FY3L1PP	VASS, MERSI	CMA	
IMAPP	AIRS, Aqua AMSU	SSEC, UW-Madison	

Table 5: Level-1 Processing Packages

Encoding Packages			
Package	DBNet Service	Provider	Comment
AAPP	RARS, IASI, ATMS, CrIS, VASS	EUMETSAT (via NWP SAF)	Requires BUFR library
IMAPP	AIRS, Aqua AMSU	SSEC, UW-Madison	
CVIIRS	VIIRS	EUMETSAT	Converts between VIIRS SDR and Compact VIIRS SDR

Table 6: Encoding Packages

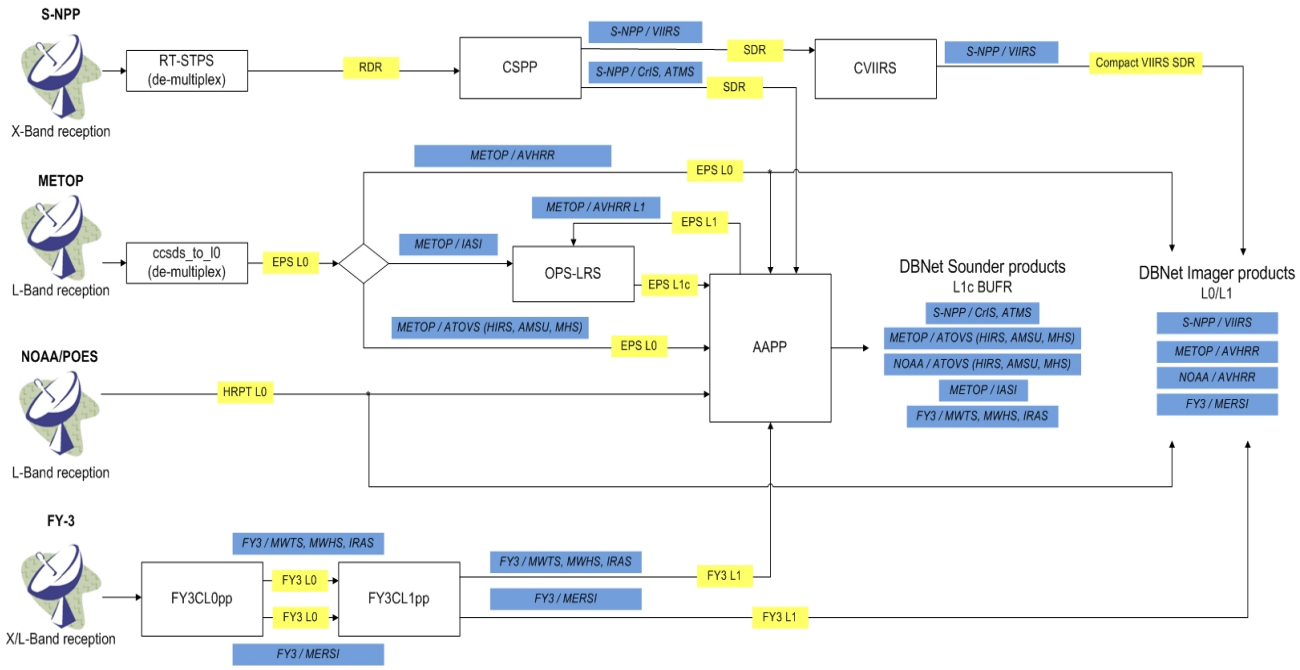

Figure 1: Schematic diagram of processing packages to be used for DBNet

4.3.3. Auxiliary Data

A Direct Broadcast station requires satellite orbit information in the form of Two Line Elements (TLE) for the prediction of future satellite passes, for antenna pointing during the acquisition of satellite data and for processing and geolocation of the sensor data. Orbital elements shall be updated at least once per day.

Additional instrument processing related auxiliary data are also required.

- For AAPP, auxiliary data files are provided by the NWP SAF (www.nwpsaf.eu).
- For CSPP, auxiliary data files for processing of VIIRS, CrIS, and ATMS are obtained periodically from NOAA operations and are made available for Internet download by the CSPP team. This includes TLEs and PolarWander files, as well as Calibration Tables. DBNet operators are encouraged to run the automated lookup table update scripts supplied with the CSPP SDR software regularly to ensure the most up to date auxiliary data are available.

Currently (August 2016) orbital data are made available directly by satellite operators at:

- Metop: http://oiswww.eumetsat.org/metopTLEs/html/index.htm (“long TLEs”) or the Multi-Mission Administration Messages contained in the Metop HKTM L0 files.
- NOAA: https://www.space-track.org (login needed) or http://celestrak.com/NORAD/elements/.
- FY3: http://www.shinetek.com.cn/eos_data/ or http://satellite.cma.gov.cn/portalsite/default.aspx.

For the future it is planned that each satellite operator will make TLE data publicly available in a standardized manner, along the lines of the service provided by NOAA for the SNPP satellite under https://msds.npoess.noaa.gov/MSDS/AUXILIARY/tle/. This will enable station operators, in an automated manner, to select the most recent reference TLE date and time in order to propagate the orbit into the future in the most accurate way, taking into account in particular spacecraft

manoeuvres. Such procedure will be further detailed and submitted to CGMS satellite operators for endorsement as a technical standard. The following description is a preliminary overview only.

- TLE files are made publicly available on the Internet based on the HTTPS protocol. The files are standard ASCII text files each containing a single set of TLE data in the well-established two-line format, see for example https://www.space-track.org/documentation#/tle.

- As indicated in Table 7, the file name starts with the satellite name and the reference date and time (starting with “r”) of the TLE. The reference date and time are defined by the satellite operator and indicate the time of the orbit determination campaign which the TLE is based on.

- The newer generations of polar orbiting satellites typically perform manoeuvres as part of routine orbit maintenance. To account for this the TLE filename should systematically include the TLE interval of validity. The interval is defined by the dates and times of the start (starting with ”s”) and end (starting with ”e”) of the validity, where the start and end are defined by the satellite manoeuvre execution times.

- If the start of validity is left undefined (all zeros), the TLE is valid until a manoeuvre as shown in the first example in Table 7. If both start and end are defined, the TLE is valid between two manoeuvres as shown in the second example in Table 7. If the end is left undefined, the TLE is valid after a manoeuvre a shown in the third example in Table 7. This scheme supports both the issuing of predicted post-manoeuvre TLEs and the issuing of determined post-manoeuvre TLEs.

- Finally, both the start and end of the validity interval can be left undefined as shown in the fourth example in Table 7. This indicates that the satellite is either not performing manoeuvres (example NOAA POES) or that there are no recent or planned manoeuvres for the satellite.

TLE Filename	Explanation
Metop-B_r20150820120000Z_s00000000000000Z_e20150823123000Z.txt	Issued on 20 August 2015. Validity ending on 23 August 2015 at 12:30 UTC (first manoeuvre).
Metop-B_r20150820120000Z_s20150823123000Z_e20150823141100Z.txt	Issued on 20 August 2015. Validity starting on 23 August 2015 at 12:30 UTC (first manoeuvre) and ending on 23 August 2015 at 14:11 UTC (second manoeuvre).
Metop-B_r20150824020000Z_s20150823141100Z_e00000000000000Z.txt	Issued on 24 August 2015. Validity starting on 23 August 2015 at 14:11 UTC (second manoeuvre).
Metop-B_r20151005120000Z_s00000000000000Z_e00000000000000Z.txt	Issued on 5 October 2015. No validity limitations.

Table 7: Example of TLE filenames for semi-open, closed and open intervals of validity.

4.3.4. Segmentation

Classically the raw satellite data acquired by a Direct Broadcast reception station is transferred to the product processing system after completion of the full satellite pass.

To achieve the challenging DBNet timeliness requirements, it can however be necessary for certain services (e.g. IR/VIS imagery) to transfer the data in segments, shorter than the full satellite pass, during the pass. Each segment is transferred to the product processing system as soon as its acquisition is completed. The duration of a segment is a configurable parameter, typically set to 2 minutes. The last segment of a pass may be shorter to match the overall duration of the pass.

It is recommended to transfer the data as CCSDS CADU, CCSDS VCDU or CCSDS Source Packets without adding any additional structure to the data and with each segment containing a sequence of complete CCSDS packets. These formats are well defined and enable easy segmentation and concatenation. CCSDS CADU is recommended as the most generic. CCSDS VCDU or CCSDS Source Packets can be chosen if data from a subset of instruments is required and the overall bandwidth of the transfer is of concern.

A typical implementation is based on the FTP protocol with the reception station acting as the FTP client and the product processing system as the FTP server. To improve the reliability of the transfer in the presence of equipment resets on either side or short interruptions of the network, the FTP client shall implement a retry mechanism. An appropriate mechanism could be for example to retry up to 10 times with a time interval between retries of 30 seconds.

The segment file name should indicate the name of the satellite, start of pass date, start of pass time, segment start time, segment end time, orbit number and station acronym. To simplify the handling of the segments by the product processing system, it is recommended that the last segment of a pass additionally has an indication that it is the last segment, that segments are transferred in order of acquisition and that during an ongoing FTP transfer the filename has an indication that the file is temporary and incomplete, e.g. by adding a suffix of .temp and atomically renaming the file once its transfer is complete.

Further details can be found in the service-specific paragraphs below.

The data acquisition and processing architecture can further be optimized in order to eliminate duplication of data. A possible approach is the one used by the EARS pilot AVHRR service, employing line-by-line acquisition planning to ensure no overlaps between neighbouring stations. The issue of overlap will be addressed in future revisions of the guide.

4.3.5. Global and local product consistency

Global (full orbit central processing) and local (usually direct broadcast) product consistency specifications are set based on considerations of NWP requirements.

Global and local product processing shall be harmonized in that brightness temperature products derived from both paths agree within tolerances that are not greater than few tenths (goal is 10%) of the respective performance requirements for bias error at a reference brightness temperature.

As a concrete example, this implies that for the MWS instrument to be flown on Metop-SG, the relevant performance requirement is the bias variation over an orbit (0.2K) – because DBNet products will be used regionally to complement global data. So the goal for local-global consistency should be 10% × 0.2K = 0.02K.

The instrument navigation shall be harmonized in that geographical coordinates derived from both paths agree within 10% of nadir Instantaneous Field of View (IFOV) for sounder instruments and 50% of nadir IFOV for imagers. Current recommended values are displayed in the NWP SAF monitoring plots for DBNet products.

4.4. PRODUCT CODING AND FORMAT (COMMON ASPECTS)

4.4.1. Format harmonization: general principles

In order to ensure that all DBNet products are fully interoperable, it is important that all DBNet operators use WMO standard formats, with the same implementation of these formats, and follow the agreed DBNet conventions in the implementation of these formats. For instance, for BUFR the same globally defined BUFR Table D sequence descriptors (also known as templates see [AD.1]) shall be used. These templates are embedded within the BUFR tables, which along with the conversion software will be released together with the recommended service specific processing software. All DBNet Operators shall make use of this recommended, or equivalent, BUFR conversion software for format conversion.

A “DBNet product” is the result of the processing of the data acquired by one station, from one satellite pass, from one instrument. A DBNet product shall be comprised of a series of BUFR encoded messages, which shall each be included in a bulletin, which should all preferably be embedded in one file. DBNet formatting standards are thus defined at three different levels: BUFR message; Meteorological Bulletin; Filenames.

- The first level of standardization of DBNet product format is the BUFR Message encoding. For each satellite pass and each instrument (with the exception of imagery products), DBNet products are encoded in BUFR messages. Because of GTS message size limitations, a DBNet product exchanged on the GTS must be segmented into several BUFR messages. The number of BUFR messages needed for one product depends on the instrument and the duration of the satellite pass. The BUFR Message encoding should be in accordance with the Manual on Codes [AD.1] with DBNet specific provisions for Section 1 (Identification) and Section 3 (Data Description) of the BUFR message as described in Section 4.4.2.

- The second level of standardization of DBNet product format is the Abbreviated Bulletin Heading. An Abbreviated Heading is assigned to each BUFR message to form a “Meteorological Bulletin”. The bulletin heading information is used by Regional Telecommunication Hubs (RTHs) to organize the routing of the messages over the GTS. The bulletin heading is not generally used by users of the BUFR messages to interpret the information; as all the necessary information to decode the BUFR message is contained within the actual BUFR message (in combination with the associated Code Tables - see the WMO Manual on Codes). Hence there is some duplication of information between Section 1 of the BUFR message and the bulletin headings (albeit with different representations). The structure of the heading is described in “Explanation of Data Designators $T_1T_2A_1A_2$ii CCCC YYGGgg BBB ([AD.2], Vol I, Part II, 2.3.2.2/Attachment II-5)”. The different Bulletins composing a product have all the same headings, with the exception of the number “ii” which differentiates the individual Bulletins of the same product. Specific provisions are defined in Section 4.4.3 for the determination of $T_1T_2A_1A_2$ in the case of DBNet products.

  As the WIS continues to evolve, and the focus progressively shifts from bulletins to files, it is anticipated that this issue will assume less relevance. However, for the time being, bulletins remain a much-used communication mechanism within the WIS, and harmonization of bulletin headings is required within the DBNet network;

- The third level of standardization of DBNet products is the file. DBNet production centres can submit products to the GTS either directly as Meteorological Bulletins, or embedded in files. These files shall follow the WIS file naming convention: pflag_productidentifier_oflag_originator_yyyyMMddhhmmss[_freeformat].type[.compression]. Guidance for DBNet product filenames are provided in Section 4.4.4.

  [Note: More explanations on "Accumulating messages into files can be found in the Manual on the GTS [AD.2] Vol.1, Part II, Attachment II-15, as of page 158].

The DBNet conventions applicable to the BUFR identification section, the BUFR data description, the abbreviated heading and the file name are summarized in the DBNet Coding Summary [RD.4], which is posted on the DBNet website: http://www.wmo.int/pages/prog/sat/documents/RARS_Coding-summary.xls .

[Note: the template will be reviewed in order to accommodate the additional DBNet Services]

4.4.2. Encoding of the DBNet BUFR Message

The structure of the BUFR Message is defined in the Manual on Codes [AD.1]. In order to facilitate identification and use of BUFR messages containing DBNet products, a specific convention shall be followed to determine certain fields of the identification section (Section 1) and for the data description section (Section 3).

The BUFR tables and Common Code Tables (CCT) referred to in this section are extracted from the Manual on Codes, Vol. I.2 [AD.1] and can be found at: https://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/LatestVERSION/LatestVERSION.html

Section 1, Octets 5-6: Identification of Originating/Generating Centre

The Originating/Generating Centre shall indicate the centre responsible for the processing to level 1 and BUFR encoding.

If processing to level 1 and BUFR encoding are done locally at the station site, then the Originating/Generating Centre is the organization responsible for the station. If the processing to level 1 and/or the BUFR format conversion are performed, or managed by the DBNet regional centre, then the Originating/Generating Centre is the DBNet Regional Centre.

The corresponding ID is defined in Common Code Table (CCT) C-11 and recalled in [RD.4]

Section 1, Octets 7-8: Identification of Originating/Generating Sub-centre

The Originating/Generating Sub-centre shall indicate the Direct Broadcast station that receives the data. Each sub-centre is defined with reference to the Originating/Generating Centre it is functionally related to for the considered application.

The corresponding ID is defined in CCT C-12 and recalled in [RD.4].

The sub-centres ID are allocated by the relevant centres and shall be shared with the WMO Secretariat for inclusion in CCT C-12 and [RD.4]

Section 1, Octet 11: International Data Category

The data category indicated in Octet 11 is defined by BUFR Code Table A which gives e.g. “3” for satellite vertical sounding data, “12” for satellite surface data, “21” for satellite radiance data, “24” for scatterometry, and “101” for satellite image data. (See Annex D)

Section 1, Octet 12: International Data Sub-category

Subcategories of the above categories are defined by CCT C-13 for specific instruments (AMSU-A, AMSU-B, HIRS, MHS, IASI, SSMI, ASCAT, CrIS, ATMS, VIIRS) or for generic types of instruments (IR sounding, Hyperspectral sounding, MW sounding, radio-occultation).

Octet 12 of section 1 (BUFR Edition 4) must be populated using an appropriate International sub-category. When an instrument specific entry exists in CCT C-13, this should be used. If there is no specific entry in CCT C-13 for the instrument, the most appropriate generic instrument category entry should be used. If no generic entry in CCT C-13 is applicable, a request should be made to have such an appropriate entry added to the table.

Additional details can be provided in Octet 13, which is available to indicate a local sub-category (e.g. to differentiate instruments of the same sub-category, or different operating modes of an instrument, see Annexes D and E).

Section 3: The Data Description section (Section 3) includes a definition of the elements that are used to build the message. This definition usually takes the form of a single Table D sequence descriptor. It is recommended that WMO-approved sequences are used, as given in the following table.

Instrument	Sequence (F-X-Y)	Comment
HIRS	3-10-008	20 channels
AMSU-A	3-10-009	15 channels
MHS	3-10-010	5 channels
IASI	3-40-008	Channels + PCs (variable)
CrIS	3-10-060	Channels (variable)
ATMS	3-10-061	22 channels
MWTS-2	TBD	
MWHS-2	TBD	
IRAS	TBD	

Table 8: Section 3 data descriptor sequences

If an agreed Table D sequence is not available (the case for FY-3 instruments as of August 2016), then a list of Table B descriptors may be used.

Consistency with the equivalent global data should be maintained. Usually the agency responsible for dissemination of the global data is responsible for defining the BUFR sequence.

4.4.3. Bulletin Headings

The structure of the abbreviated bulletin heading is: **$T_1T_2A_1A_2$iiCCCCYYGGgg(BBB)** as described in [AD.2] “Explanation of Data Designators $T_1T_2A_1A_2$ii CCCC YYGGgg BBB (Manual on the GTS, Vol I, Part II, 2.3.2.2/Attachment II-5)”.

For DBNet products, the following implementation shall be applied:

- **T_1T_2** should be set to “IN”;

- **A_1** identifies the instrument (i.e. A=AMSU-A, B=AMSU-B, H=HIRS, M=MHS…..). Harmonization of instrument identifiers in the bulletin heading and the filename is desirable (i.e. the value of A_1 in the bulletin heading and the <data designator> value in the filename should be harmonised). (See Annex E)

- **A_2** is the geographic area designator - as per Table C3 of the Manual on the GTS (see https://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/WMO_386/AHLsymbols/TableC3.html). Concerning the value of A_2, a Regional Indicator or a Global Indicator ("X") can be used, depending on the most appropriate characterisation of the coverage. Where meaningful, the use of regional indicators is encouraged (e.g. "N" for Arctic and "S" for Antarctic stations).

Examples:

Bulletin headings from Casey:

INAS01 AMMC YYGGgg	(for AMSU-A data)
INBS01 AMMC YYGGgg	(for AMSU-B data)
INHS01 AMMC YYGGgg	(for HIRS data)

4.4.4. Filenames

i) DBNet data files shall follow the GTS file-naming convention (with pflag=W) (see [AD.2]);

ii) A metadata file (which would generally be static) shall be associated with each DBNet data file.

The filename structure should be of the form:

W_productidentifier_oflag_originator_yyyyMMddhhmmss[_freeformat].type[.compression]

Where:

productidentifier is a variable length field that describes the nature of the data in the file. It consists of 2 parts; a "static part" and an "optional part" – which is not used in the context of DBNet.

The **"static part"** is the product description and consists of**:**

<**location indicator**>, <**data designator**>, <**free description**>

Where <**location indicator**> defines the producer: Country, Organization and the Production Centre. For example: for Brazil <**location indicator**> could be "br-INPE-cp"

Where <**data designator**> specifies the type of data with reference to the categories and sub-categories defined in the Common Table C-13 of the Manual on Codes, with "+" used to indicate composite data.

In the context of DBNet the following convention is used:

<**data designator**> should be the instrument name without a separator, for example: amsua, amsub, hirs, mhs, iasi or ascat (See Annex F).

<**free description**> should be used to indicate satellite and originating HRPT station, and should be preceded by "DBNet". For example: for data from NOAA-17 from Cachoeira Paulista the <free

description> should read “DBNet+noaa17+cpt”. Note: For backward compatibility “rars” can be used instead of “DBNet”.

(See details in Annex F.)

oflag – at this time the only admissible value of **oflag** is “C” – indicating that the <originator> field will be decoded as a standard CCCC country code (and the use of the CCCC value in filenames and bulletins should be consistent).

originator is a variable length field indicating where the file originated from (and is decoded according to the value of <oflag>). For example: “SBBR” for Brasilia Airport.

yyyyMMddhhmmss is a fixed length date and time stamp field, containing the **time of BUFR file creation.**

[_freeformat] in the context of DBNet should be “_(AAPP filename)_bufr”. This usage needs to be shared with users of DBNet data.

type in the context of DBNet this value would typically be set to “bin” to indicate file containing data encoded in a WMO binary code form such as BUFR.

So a typical filename for AMSU-A data from NOAA17 provided by CPTEC/INPE in Brazil, from the HRPT station in Cachoeira Paulista, could be:

W_br-INPE-CP,amsua,DBNet+noaa17+cpt_C_SBBR_20110701090858_(AAPP filename)_bufr.bin

4.5. DBNet PRODUCTS REGISTRATION AND DISCOVERY

4.5.1. WIS discovery metadata

In order to make the DBNet products discoverable in the WMO Information System they shall be registered in the WIS discovery metadata catalogue with a metadata entry (Manual on WIS [AD.3] Appendix C). This enables any WMO Member to be aware of the availability of these products through the WIS catalogue and, if interested, to request them from the relevant WIS centre, i.e. Global Information System Centres (GISC) or Data Collection and Production Centres (DCPC).

4.5.2. Recording in Vol.C1

In addition, the Abbreviated Headings of Meteorological Bulletins are recorded in the Catalogue of Meteorological Bulletins (WMO Publication No. 9, Vol.C1). This enables any WMO Member to be aware of the availability of these bulletins and, if interested, to request them from the relevant Regional Telecommunication Hub (RTH). However, when DBNet products are embedded in “files” they are not systematically recorded in Vol. C1. In order to make the DBNet products more easily discoverable, it is recommended to record the DBNet bulletins in Vol.C1 even if embedded in a file.

The procedure for recording Meteorological Bulletins is described in: http://www.wmo.int/pages/prog/www/ois/Operational_Information/VolC1_en.html under “UPDATING PROCEDURES AND METHODS OF NOTIFYING THE WMO SECRETARIAT OF AMENDMENTS / ADVANCED NOTIFICATIONS”. The WMCs and RTHs on the Main Telecommunication Network (MTN) shall maintain Vol. C1 as regards bulletins issued from the zone for which they are responsible. The format to record a bulletin is described in: http://www.wmo.int/pages/prog/www/ois/Operational_Information/VolumeC1/AN_RecordFormat_en.html.

Table 9 provides guidance to complete the fields 9-15 of this record.

Field N°	Field	Value

9	Category	“E” (Essential data/products)
10	TTAAii	(Indicate TTAAii as defined by the DBNet coding
11	CCCC	(Indicate CCCC as defined by the DBNet coding convention)
12	CodeForm	“FM 94-XIV”
13	TimeGroup	"AS AVAILABLE"
14	Content	“DBNet”
15	Remarks	“TRANSMITTED AS A FILE”

Table 9: Guidance to record in Vol.C1 a DBNet bulletin sent as a file

4.6. PRODUCT DISTRIBUTION

The DBNet regional networks shall strive to make DBNet products available to the global user community and in particular to the NWP centres worldwide, through the WMO Information System.

The recommended route for DBNet data access within a region is to be defined at the regional level in consultation between the GISC/DCPC and the DBNet regional nodes taking into account the level of connectivity of the main regional users.

Inter-regional data exchange shall be implemented between regional nodes and GISCs, taking into account the recommendations of the GODEX-NWP group, which keep under review the requirements of NWP centres for inter-regional exchange of satellite data.

It will be the matter of a trade-off between the benefit provided by additional data and the resulting load on the telecommunications. While the primary distribution means will be the GTS/RMDCN networks), the use of a satellite broadcast service such as EUMETCast or CMACast or Internet is an advantage for users with limited WIS/GTS connectivity. A schematic illustration of the telecommunication scheme is provided in Figure 2.

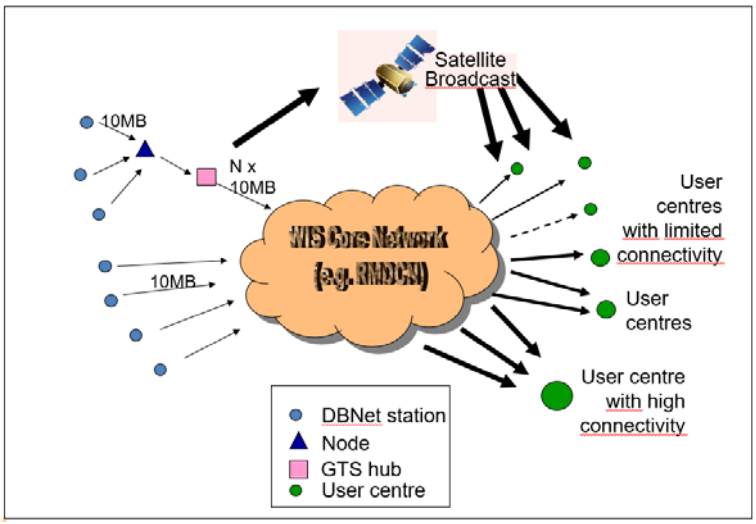

Figure 1: DBNet connectivity to GTS/RMDCN

Specific aspects of DBNet-WIS connectivity:

- DBNet stations with direct access to a core WIS node (GISC or DCPC) should directly inject into the WIS (e.g. Kyose/Tokyo, Crib Point/Melbourne);
- DBNet station with GTS access should directly inject into the GTS (e.g. New Delhi);
- DBNet station with no WIS/GTS access should send their products either to a GTS or WIS core node via FTP (e.g. Maupuia to Melbourne, Cordoba to Buenos Aires, Cachoeira Paulista to Brasilia, Jincheon to Seoul);
- As an alternative, DBNet stations which are part of a coordinated regional/sub-regional network should send their products to the regional/sub-regional node that will send the whole DBNet product package to a GTS hub/GISC/DCPC (e.g. EARS stations concentrated by EUMETSAT via VPN, before being sent to GISC/RTH Offenbach; Natal, Cuiaba via Cachoeira Paulista, before being sent to GISC/RTH Brasilia).

5. STANDARDS FOR SPECIFIC DBNet SERVICES

These standards and best practices are applicable to the provision of individual DBNet services. The DBNet services are defined in terms of groups of equivalent or similar instruments, potentially flying on different satellites. A particular DBNet operator may only provide a subset of the defined services. The scope of the overall DBNet includes the services listed in Table 2.

The areas covered by these standards are service-specific aspects of product processing, formats, quality control and monitoring.

5.1. IR/MW SOUNDING SERVICE

This service is provided for the ATOVS suite of instruments flying on NOAA/POES and EUMETSAT/Metop satellites as well as from equivalent instruments flying on CMA/FY-3 and NOAA/SNPP and JPSS satellites.

5.1.1. Product Processing Software

To ensure global consistency of the DBNet dataset, the DBNet operator shall make use of the AAPP (ATOVS and AVHRR Pre-processing Package) software for product processing for the ATOVS suite of instruments, of CSPP for ATMS and of the FY-3 L0/L1 pre-processing software package for MWTS, MWHS and IRAS.

The AAPP package is supplied and maintained by EUMETSAT's Numerical Weather Prediction Satellite Application Facility (NWP SAF). The package is freely available (subject to the signing of a license agreement) and the process for obtaining the package is fully described on the NWP SAF AAPP web pages (http://www.nwpsaf.eu). General background information on the AAPP software is also available on this web-page. The version of the AAPP software to be used shall be the latest release as defined on the AAPP web-page.

For changes affecting the data output, this latest release shall be implemented operationally within 1 month of release by the NWP SAF, otherwise the latest release shall be implemented operationally within 3 months.

For SNPP ATMS, The product processing shall be performed by AAPP and CSPP software. CSPP performs Level 1 processing which delivers Sensor Data Records (SDR) in HDF5 format for ATMS. AAPP ingests these SDRs, and carries out BUFR encoding. CSPP can be downloaded from: http://cimss.ssec.wisc.edu/cspp/

FY-3 pre-processing software: FY-3 data are pre-processed by the FY3L0/L1pp software packages distributed by CMA, see http://satellite.cma.gov.cn/portalsite/ “Tools”.

AAPP can ingest the SDRs of MWTS, MWHS and IRAS, and can BUFR encode them.

5.1.2. Processing Level

Any products exchanged inter-regionally shall be at the level of brightness temperatures with geolocation on the original instrument grid.

5.1.3. Quality Checking and Quality Flags

The pre-processing software includes quality checking, and any products distributed shall include quality flags. For AMSU-A, MHS, HIRS and ATMS quality flags are available in the BUFR product. It must however be noted that currently (August 2016) quality flags are not available in the BUFR products for VASS (MWTS-2, MWHS-2 and IRAS), instead suspect measurements values are set to “missing”.

5.1.4. Product Quality Monitoring

Routine monitoring of DBNet IR/MW sounding data quality is performed by the NWP SAF. Monitoring results are available on the “Monitoring reports” section of the NWP SAF website http://www.nwpsaf.eu.

5.2. IR/VIS IMAGING SERVICE

5.2.1. Product Processing Software

For SNPP VIIRS, the product processing shall be performed by the CSPP software, followed by CVIIRS. For MERSI, the product processing shall be performed by the FY3L0/L1pp software packages.

For NOAA AVHRR, raw data are currently disseminated, therefore no product processing or encoding is required at this point in time (August 2016).

For Metop AVHRR, Metopizer or similar software is needed to first create EPS level 0.

5.2.2. Processing Level

The processing level shall be either raw HRPT (NOAA POES / Metop) or at the level of radiances/reflectivities (VIIRS / MERSI).

It is preferable for the orbit pass to be segmented to enable on-the-fly transmission of product segments in order to ensure low latency and to facilitate handling of large data sets.

As it is important to provide seamless imagery (without missing lines or overlaps) the acquisition schedules of the local stations shall be coordinated and where feasible the acquisition source shall be switched from one station to the next one at a defined imagery line.

Data compression is critical, efficient compression procedures shall be used. For VIIRS a compact SDR format has been developed and implemented in DBNet-EUMETSAT. This format provides a compact representation of VIIIRS Geolocation, Angular Information and Measurement Data. For further info see:
http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_VIIRS_SDR_PF_UG&RevisionSelectionMethod=LatestReleased&Rendition=Web.

5.2.3. Quality Checking and Quality Flags

Not applicable to raw data.

5.2.4. Product Quality Monitoring

Not applicable to raw data.

5.3. HYPERSPECTRAL IR SOUNDING SERVICE

5.3.1. Product Processing Software

For IASI EUMETSAT has implemented a computer at each station running AAPP together with the IASI Level 1 processor (OPS-LRS). Both AAPP and OPS-LRS are distributed by the NWP SAF (http://www.nwpsaf.eu/) and are freely available to any interested user. AAPP requires Metop Level 0 as input (Note: If not already delivered by the receiving station, the Level 0 can be generated by the "Metopizer" freeware available from EUMETSAT: http://www.eumetsat.int/website/home/Data/DataDelivery/SupportSoftwareandTools/index.html.

For OPS-LRS the IASI instrument auxiliary files are made available by the NWP SAF (www.nwpsaf.eu) to registered users of the package and announced via the NWP SAF AAPP Announcements Forum. Due to the interdependency between on-board instrument configuration and the on-ground processing software, it is essential that DBNet Station Operators install the updated auxiliary files into AAPP before corresponding on-board configuration changes are uploaded to Metop by EUMETSAT operations. Details on the installation process are found in the OPS-LRS User Manual.

For SNPP CrIS, the product processing shall be performed by AAPP and CSPP software. CSPP performs Level 1 processing which delivers Sensor Data Records (SDR) in HDF5 format for ATMS, CrIS and VIIRS instruments. AAPP ingests these SDRs, performs CrIS channel selection, and BUFR encodes. CSPP can be downloaded from: http://cimss.ssec.wisc.edu/cspp/

For HIRAS the availability of a product processing package has not yet been confirmed.

5.3.2. Processing Level

Any products exchanged inter-regionally shall be at channel subset of level 1 radiances, optionally supplemented with Principal Component (PC) Scores that allow a reconstruction of the full spectra with minimal loss of information. The definition of the set of selected channels for each of the hyperspectral sounders as well as the selection of the appropriate PC score representation is performed by the agencies, in consultation with users, according to the following table.

Service	Channel selection	PC score selection	Apodization

	responsible	responsible	applied
IASI	EUMETSAT	EUMETSAT	Yes
CrIS	NOAA	TBD	Yes
HIRAS	CMA	TBD	Yes
AIRS	NOAA	N.A.	No

Table 10: Data selection for hyperspectral sounders

In brief, at the PC encoding step each spectrum is projected onto a set of orthogonal basis functions (eigenvectors) and the resulting amplitudes are the PC scores. In a reverse process, the DBNet user can reconstruct radiances when he has the PC scores and the eigenvectors. The number of PCs is defined by the agency, with the aim to preserve as much as possible of the real atmospheric signal, while discarding PCs that contain only instrument noise.

For information on the implementation of PC scores in AAPP, please see the document NWPSAF-MO-UD-022 "IASI Principal Components in AAPP: User Manual", available from http://www.nwpsaf.eu/deliverables/aapp/index.html.

Regarding channel selection for CrIS, NOAA has documented a recommended channel selection of 399 channels, in "Methodology and Information Content of the NOAA NESDIS Operational Channel Selection for the Cross-Track Infrared Sounder (CrIS)" by Antonia Gambacorta and Christopher D. Barnet. IEEE Transactions on Geoscience and Remote Sensing, Vol. 51, No. 6, June 2013.

Regarding channel selection for IASI, EUMETSAT has documented a recommended channel selection of 500 channels in the IASI Level 1 Product Guide http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=pdf_iasi_level_1_prod_guide&RevisionSelectionMethod=LatestReleased&Rendition=Web.

The channel selections for the hyper-spectral IR sounders will be revisited in the future based on increasing capabilities of the users, improved WIS capacity for global product distribution and changes in instrument capability (for example upon transition from SNPP to NOAA-20).

5.3.3. Quality Checking and Quality Flags

The processing software includes quality checking, and any products distributed shall include quality flags. For IASI and CrIS all quality flags in the native sounder products formats are transferred to the BUFR formatted product.

5.3.4. Product Quality Monitoring

Routine monitoring of DBNet hyperspectral sounding data quality is performed by the NWP SAF. Monitoring results are available on the “Monitoring reports” section of the NWP SAF web site http://www.nwpsaf.eu. Consistency between global and local data products is monitored, and also the consistency between raw and reconstructed radiances.

5.4. SCATTEROMETRY SERVICE

This service is currently provided by the EUMETSAT EARS network for the ASCAT instrument flying on Metop-A/B.

5.4.1. Product Processing Software

For ASCAT, the processing software used is the ASCAT Level 1 Product Processing Facility (PPF) software, ported from the EUMETSAT EPS Central Ground Segment.

Availability of a Wind RAD (FY-3) processing package has not yet been confirmed

5.4.2. Processing Level

Any products exchanged inter-regionally shall be at level 1 (backscatter cross-sections) or at level 2 (winds and soil moisture).

5.4.3. Quality Checking and Quality Flags

The pre-processing software includes quality checking, and any products distributed shall include quality flags.

5.4.4. Product Quality Monitoring

TBD

5.5. MW IMAGERY SERVICE

This service is currently not provided, but is under consideration for the MWRI instrument on FY-3.

5.5.1. Product Processing Software

Availability of a MWRI processing package has not yet been confirmed

5.5.2. Processing Level

TBD

5.5.3. Quality Checking and Quality Flags

The pre-processing software includes quality checking, and any products distributed shall include quality flags.

5.5.4. Product Quality Monitoring

TBD

6. CONCLUSION

The provisions contained in this document contain the standards to be followed by DBNet Operators to:

- Ensure that an appropriate level of service is provided regionally;
- Facilitate the inter-regional exchange of DBNet data;
- Ensure the global consistency of the DBNet datasets.

ANNEXES

A. TERMS OF REFERENCE OF THE DBNet COORDINATION GROUP

1. A DBNet Coordination Group is established by the WMO Space Programme in order to support the development and implementation of the Direct Broadcast Network for Acquisition and Near Real-Time Relay of Low Earth Orbit Satellite data (DBNet).

2. The aim of the DBNet Coordination Group is:

    - To keep under review the High-Level Specifications of DBNet Services, in consultation with the users;
    - To coordinate the implementation and expansion of DBNet Services responding to the user needs;
    - To define and maintain the standards ensuring interoperability and Inter-regional exchange of DBNet products, and the consistency with the WMO Information System;
    - To monitor the performance of DBNet components and define actions to improve this performance as appropriate;
    - To keep under review the priorities for filling coverage gaps and for scheduling the acquisition of satellite data;
    - Identifying issues to be submitted for consideration by CGMS satellite operators.

3. The DBNet Coordination Group is composed of DBNet regional or subregional network coordinators, organizations providing software for L0/L1 processing, technical experts designated by organizations contributing to the global DBNet network, planning or considering to contribute to it, and the WMO Secretariat.

4. A focal point is designated within the DBNet CG to ensure liaison with IPET-DRMM.

5. The DBNet Coordination group meets nominally once a year, or more frequently if necessary.

6. The DBNet Coordination Group reports on its activities to CGMS and to the WMO Commission for Basic Systems through the Inter-Programme Expert Team on Satellite Utilization and Products (IPET-SUP). It receives guidance from CGMS, from CBS through IPET-SUP, and from representative user groups such as the International TOVS Working Group (ITWG).

B. PROCEDURE FOR ADDING/MODIFYING A STATION IN THE DBNet NETWORK

The purpose of this procedure is to guide the station operator on the steps to be followed when including a new station in the DBNet network, or modifying the operation mode of a station, ensuring appropriate coordination and information of all parties involved.

The following steps shall be followed for adding a new station:

Step 1: The Station Operator (or the regional/subregional coordinator) informs the WMO Space Programme Office (WMOSP) of the WMO Secretariat of the characteristics of the new DBNet station:

- Latitude and Longitude of the station (in degrees, with decimals);
- Name of the station;
- Three-letter abbreviated name;
- Centre administratively responsible for this station;
- Identifier of the centre in Common Code Table (CCT) C-1/C-11 (if available);
- Identifier of the station as sub-centre of this centre in CCT C-12 (if available);
- RTH/GISC which will transmit the data over the GTS/WIS Core Network;
- CCCC identifier of this RTH/GISC;
- DBNet Services which will be supported by the station.

Step 2: If the Centre is not yet identified in CCT C-11, or if the station is not yet identified in CCT C-12 as a sub-centre of this centre, the operator requests the addition of a code for the centre and/or the sub-centre in the relevant Common Code Tables. The procedure for amending the tables is to send a request from the Permanent Representative (PR) to the Secretary-General, or from the focal point for codes and data representation matters of the country/territory to the WMO Secretariat (OBS/WIS/DRMM with copy to OBS/SAT). The procedures for amending the tables are initiated after each update implementation in May and November.

Step 3: The Operator implements the operational processes for acquisition, pre-processing, processing, coding and routing of DBNet products in accordance with the applicable DBNet standards defined in Sections 3 and 4.

Step 4: The Station operator sends file samples by FTP for validation during a minimum test period of one week:

- To the RTH in charge of transmitting the data into the GTS (if different from the Operator);
- To the relevant DBNet regional coordinating center;
- To the DBNet monitoring centre.

Step 5: The RTH, the Regional Coordinator check the consistency with DBNet conventions and regularity and timeliness of the products. The Global DBNet Monitoring centre checks the consistency of the products with global data and their timeliness. They interact as appropriate with the Station Operator until full compliance is demonstrated.

Step 6: Once the test is successful, the Operator:

- Informs the WMO Space Programme Office of the planned start of the routine dissemination, and of any change to the bulletin headings and file naming (if relevant);

- Requests the responsible RTH Focal Point in an appropriate manner so that the Focal Point can update relevant parts of the Vol. C1 with respect to the new bulletins at least two months in advance. A/N (advanced notification) of Vol. C1 will be released to WMO Members;

- Updates the discovery metadata record to share with the responsible DCPCs or GISCs.

Step 7: The PR of the Operator's country/territory or the regional/subregional coordinator informs the WMO Secretariat of changes to the DBNet operation and provides input for inclusion of an announcement in the World Weather Watch Operational Newsletter (http://www.wmo.int/pages/prog/www/ois/Operational_Information/index_en.html); the Secretariat, updates the DBNet documentation accordingly and takes any other appropriate action to inform the satellite community.

In case of modification or termination of a DBNet station operation, the Operator informs the Space Programme Office of any change of status of the station, for instance if an additional DBNet Service is ready to be implemented at the station. The production associated with the new Service is implemented following Steps 3 to 7 above.

If a Service is cancelled, or the overall operation of a station is terminated, the Operator:

- Informs the WMO Space Programme Office of the planned termination;

- Records the end of the bulletins in Vol. C1;

- Deletes the discovery metadata record.

The WMO Space Programme Office updates the DBNet documentation accordingly.

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C. DBNet RECEPTION SCHEDULING PRIORITIES

Last update: May 2015

Satellite	**Orbit and satellite status** (D=descending, A=ascending)	**Instrument health**	**Global data** (DBNet impact is largest when global data are late)	**Direct broadcast transmission**	**DBNet priority** (H/M/L)
SNPP	NOAA Prime Polar Orbiter PM 1330A	Good	1 dump per orbit	Good (X-band). Occasional short gaps due to solar array obscuration.	H
Metop-B	Primary AM service. 0930D	Good	Very good: Arctic and Antarctic dumps	Good (L-band)	H
NOAA-19	Prime NOAA Services Mission PM. Close to SNPP 1400A/0200D	Good	1 dump per orbit	Good (L-band)	H
NOAA-18	Has drifted to an early morning orbit 1700A/0500D	Good. HIRS degraded	Some blind orbits	Good (L-band)	H
Metop-A	Same orbital plane as Metop-B 0930D	Good	1 dump per orbit	Limited geographically	M
NOAA-15	Close to NOAA-18 0530D	Poor. AMSU-B and HIRS not working. AMSU-A is still useful.	Some blind orbits. Low priority in NESDIS L1 processing.	Poor signal strength (L-band), can only be received by large dishes	L
FY-3C	1030D	MWTS-2 not working, MWHS-2 OK.	Significant delays	Good (L-band for sounders, X-band for MERSI)	L

D. EXTRACT OF THE MANUAL ON CODES: EXTRACT OF COMMON CODE TABLE C-13

The present extract contains the satellite-related entries as of August 2015.

Link to Current version:
http://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/LatestVERSION/WMO306_vI2_CommonTable_en.docx

Data categories		**International data sub-categories**	
BUFR Edition 4 Octet 11 in Section 1		BUFR Edition 4 Octet 12 in Section 1	
Code figure	**Name**	**Code figure**	**Name (corresponding traditional alphanumeric codes are in brackets)**
3	Vertical soundings (satellite)	0	Temperature (SATEM)
		1	TIROS (TOVS)
		2	ATOVS
		3	AMSU-A
		4	AMSU-B
		5	HIRS
		6	MHS
		7	IASI
		20	IR temperature/humidity sounding
		30	Hyperspectral temperature/humidity sounding
		40	MW temperature/humidity sounding
		50	Radio occultation sounding
12	Surface data (satellite)	0	ERS-uwa
		1	ERS uwi
		2	ERS-ura
		3	ERS-uat
		4	SSM/I radiometer
		5	Surface temp./radiation (SATOB)
		6	Quikscat
		7	ASCAT data
		8	Soil moisture
		9	Normalized differential vegetation index (NDVI)
		10	Normalized radar backscatter
		11	Surface emissivity
		12	Sea surface temperature
21	Radiances	0	Earth radiation budget

	(satellite measured)	5	Cross-track infrared sounder (CrIS)
		6	Advanced technology microwave sounder (ATMS)
		7	Visible/infrared imager radiometer suite (VIIRS)
22	Radar (satellite) but not altimeter and scatterometer	0	Cloud and precipitation radar
		1	Synthetic aperture radar
23	Lidar	0	Lidar based missions (for wind, for cloud/aerosol, for water vapour, for altimetry)
24	Scatterometry (satellite)	0	Wind scatterometry
25	Altimetry (satellite)	0	Radar altimetry
26	Spectrometry (satellite)	0	Cross nadir shortwave spectrometry (for chemistry)
		1	Cross nadir IR spectrometry (for chemistry)
		2	Limb sounding shortwave spectrometry
		3	Limb sounding IR spectrometry
		4	Limb sounding sub-millimetre wave spectrometry
30	Calibration dataset	0	Sub-setted data
		1	Collocated data
		2	On-board calibration data
		3	Bias monitoring
		4	Near real-time correction
		5	Re-analysis correction
101	Image data (satellite)	0	Multi-purpose VIS/IR imagery
		1	Conical scanning MW imagery (intermediate frequencies)
		2	Low frequency MW imagery
		3	Ocean colour imagery
		4	Imagery with special viewing geometry
		5	Lightning imagery
		6	High-resolution shortwave imagery for land observation
		7	SMOS data

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"A_1" Data type designator in GTS Headings "T_1 T_2 A_1 A_2ii" **defined in the Manual on the GTS, WMO-No. 386 Vol. 1 [AD.2]** See current values in Table C6 in the Explanation of Data Designators: http://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/WMO_386/AHLsymbols/TableDefinitions.html		
Definition	Comment	Corresponding category/sub-category in CCT C-13 (WMO-No. 306) [AD.1]
With T_1 T_2 =IN : **A AMSU-A** **B AMSU-B** **C CrIS (selected channels)** **H HIRS** **I IRAS** **J HIRAS** **K MWHS/MWHS-2** **M MHS** **Q IASI (PC scores)** **S ATMS** **T MWTS/MWTS-2**	Level 1 sounding products (Code values extracted from Table C6 as of 1/01/2016)	 003 / 03 003 / 04 021 / 05 003 / 05 003 / 20 003 / 30 003 / 40 003 /0 6 003 / 07 021 / 06 003 / 40
Additional codes (for information only)		
With T_1 T_2 =IE: A AMSU-A/METOP D IASI L2 products H HIRS/METOP M MHS/METOP Q IASI (PC scores)	Used by EUMETSAT with T_1T_2 =IE for products from EUMETSAT satellites.	 003 / 03 003 / 07 003 / 05 003 / 06 003 / 07

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F. PRODUCT IDENTIFIER FOR DBNet PRODUCT FILENAMES

<table>
<tr><th colspan="3">Product identifier = <location indicator>, <data designator>, <free description>

In the filename structure defined in the Manual on the GTS [AD.2]</th></tr>
<tr><th>DBNet convention for the location indicator</th><th>DBNet convention for the data designator</th><th>DBNet convention for the free description</th></tr>
<tr><td><Country ID - Organization- Production Centre></td><td><instrument>

Where:

IASI = iasi
CrIS = cris
ATMS = atms
MWTS = mwts
MWHS = mwhs
IRAS = iras
HIRAS = hiras
AMSU-A = amsua
AMSU-B = amsub
MHS = mhs</td><td>“DBNet+<satellite>+<station>”

Where <satellite> is:

NOAA-xx = noaaxx
METOP-A = metopa
METOP-B = metopb
Suomi-NPP = snpp
FY-3A = fy3a
FY-3B = fy3b
FY-3C = fy3c
FY-3D = fy3d
JPSS-1 = noaa20
JPSS-2 = noaa21

Where <station> is the Direct Broadcast receiving station (same as “Originating sub-centre” in the BUFR Section 1)</td></tr>
<tr><td>For example:

“br-inpe-cpt” for a product generated by INPE in Cachoeira Paulista (Brazil)</td><td></td><td>Example: “DBNet+metopb+ath” for a DBNet product generated with METOP-B data received in Athens.</td></tr>
</table>

[Note: More explanations on “Accumulating messages into files can be found in the Manual on the GTS (WMO-No. 386) Vol.1, Part II, Attachment II-15, as of page 158]

[Note: the identifiers “rars” and “npp” are accepted as alternatives to “DBNet” and “snpp” for backward compatibility]

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G. GLOSSARY

ATOVS	Advanced TIROS Operational Vertical Sounder (instrument package including HIRS, AMSU-A and AMSU-B)
CCSDS	Consultative Committee for Space Data Systems (http://public.ccsds.org/default.aspx); “CCSDS” also designates the data format standard defined by this committee.
CCSDS to L0	The conversion from CCSDS to EPS level 0 is generally included in the receiving station software. It is also available from EUMETSAT as part of the « Metopizer » software.
CDA	Command and Data Acquisition station, major ground facility of a Low Earth Orbit satellite programme
CSPP	Community Satellite Processing Package provided by NOAA through the University of Wisconsin for Direct Broadcast users.
DBNet Coordinator	Regional coordinator in charge of providing technical guidance to operators, monitoring the timeliness, and maintaining on line information for users, for a regional component of the global DBNet network
DBNet Monitoring centre	Organization in charge of DBNet product quality monitoring at the global scale (NWP SAF, Met Office/UK)
DBNet Operator	Organization responsible for data acquisition and pre-processing
DBNet Station	Facility including a Direct Readout station that acquires the data
DBNet:	Direct Readout Acquisition and Relay System for LEO Satellite Data. It is a system based on the concept of RARS, but expanded to address a broader range of data and products, and a variety of formats and protocols while complying with a set of standards and best practices which are described in the present guide.
EPS	EUMETSAT Polar System
GISC	Global Information System Centre
GODEX-NWP	Group for establishing and maintaining requirements for Global Data Exchange for NWP centers
HIRLAM	High Resolution Limited Area Model, developed and maintained through a cooperation of European meteorological institutes for operational short-range weather forecasting.
ITWG	International TOVS Working Group
JPSS	Joint Polar System Satellite programme. The JPSS-1 and JPSS-2 satellites of the JPSS programme will be renamed NOAA-20 and NOAA-21 after successful launch.
LEO	Low Earth Orbit

NWP	Numerical Weather Prediction
OPS-LRS	IASI “Operation Software for Local Reception Station”, which processes IASI instrument data from Level 0 (raw instrument data) through to level 1c (calibrated, geolocated, Gaussian-apodised radiances). OPS-LRS is provided by EUMETSAT through the NWP SAF as part of the AAPP deliverable.
PFS	Product Format Specification (EUMETSAT)
RARS	Regional ATOVS Retransmission Service. It is an arrangement among HRPT station operators to acquire, pre-process, and share satellite sounding data from ATOVS instrument package aboard NOAA and METOP satellites, in near real-time, in accordance with agreed standards, in support of NWP.
RDR	Raw Data Record
RMDCN	Regional Meteorological Data Communication Network
RTH	Regional Telecommunication Hub of the Global Telecommunication System (GTS)
RT-STPS	Real-time Software Telemetry Processing System, a generalized CCSDS data processing package that ingests telemetry data from a spacecraft transmission in real-time, performs multi-mission protocol processing, and produces output to a file or TCP/IP socket. RT-STPS is provided by the NASA Direct Readout Laboratory.
SDR	Sensor Data Record
SNPP	Suomi National Polar-orbiting Partnership
WIS	WMO Information System
WMOSP	WMO Space Programme Office, within the WMO Observing and Information Systems Department (OBS/SAT)

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