

WORLD METEOROLOGICAL ORGANIZATION

**INTERGOVERNMENTAL OCEANOGRAPHIC
COMMISSION (OF UNESCO)**

DATA BUOY COOPERATION PANEL

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TWENTY-THIRD SESSION

ITEM: 8.3

JEJU, REPUBLIC OF KOREA
15-19 OCTOBER 2007

ENGLISH ONLY

ARGOS SYSTEM

(Submitted by the Technical Coordinator and CLS)

Summary and purpose of document

As for past DBCP meetings, this document contains, in consolidated form, the summary report from CLS/Service Argos, covering report on 2006-2007 Operations and System Improvements.

ACTION PROPOSED

The panel will be invited to comment, and particularly make decisions or recommendations, as appropriate on the following topics:

- (a) Note and comment on the information contained in this document;
- (b) Take into account the contents of the report when discussing relevant agenda items.

Appendices: None.

DISCUSSION

Section 1. REPORT ON 2006-2007 OPERATIONS

1. Space segment

The METOP-A satellite, with the two-way capability Argos 3 instrument onboard, and been launched on 19 October 2006. It has been commissioned on 21 May 2007. METOP-A data flows have been processed since 1 August 2007.

NOAA-14 (J) has been decommissioned on 23 May 2007 after more than 12 years of service.

NOAA-12 (D) has been decommissioned on 10 August 2007 after more than 16 years of service.

The Argos constellation includes 5 satellites, which are used as follows:

1.1 Basic service satellites

The basic service has been provided since December 2003 by NOAA-16 and NOAA-17.

1.2 Other satellites

METOP-A, NOAA-18 (N) and NOAA-15 (K) are used as secondary satellites. Global and Regional datasets they collect are delivered according to the “multi-satellite” service characteristics.

The TIP telemetry from NOAA-15 and NOAA-16 has been on STX2 (different polarization) since 31st August 2005.

From	July 03	October 03	Dec 03	June 04	May 05	August 06	May 07	August 07
Satellite status								
Commissioning					NOAA-18		METOP-A	METOP-A
Basic service	NOAA-16 NOAA-15 ADEOS-2	NOAA-16 NOAA-15	NOAA-17 NOAA-16	NOAA-17 NOAA-16	NOAA-17 NOAA-16	NOAA-17 NOAA-16	NOAA-17 NOAA-16	NOAA-17 NOAA-16
Multi-satellite service (additional satellites)	NOAA-17 NOAA-14 NOAA-12 NOAA-11	NOAA-17 NOAA-14 NOAA-12 NOAA-11	NOAA-15 NOAA-14 NOAA-12 NOAA-11	NOAA-15 NOAA-14 NOAA-12	NOAA-18 NOAA-15 NOAA-14 NOAA-12	NOAA-18 NOAA-15 NOAA-14 NOAA-12	METOP-A NOAA-18 NOAA-15 NOAA-12	METOP-A NOAA-18 NOAA-15
Lost		ADEOS-2						
Decommission				NOAA-11			NOAA-14	NOAA-12

Table 1: Table above displays satellites in service since July 2003

Figure 1 shows Local Equator crossing time (ascending node) and associated predictions for 3, 6 and 12 months in August 2007.

NOAA & METOP Satellite Orbits August 2007

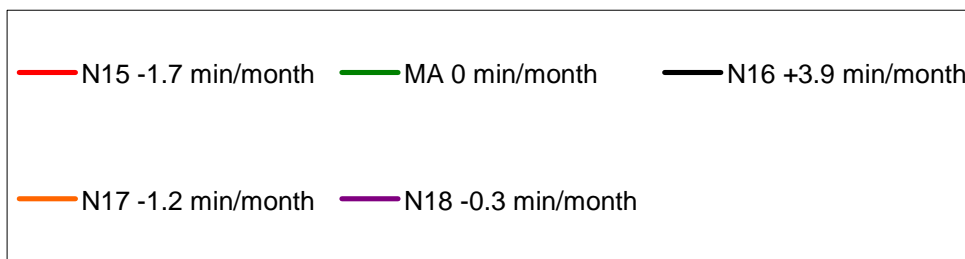
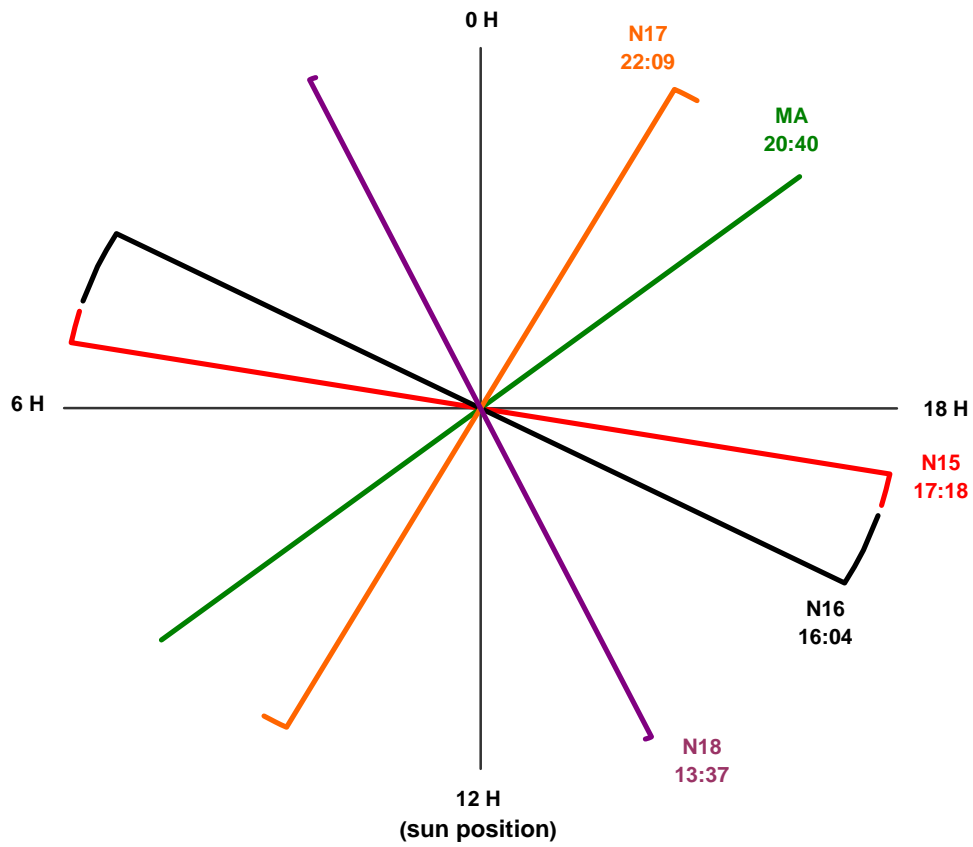
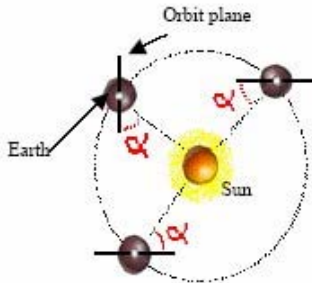


Figure 1

ABOUT ORBIT PLANES

Plane and drift of a Sun-synchronous orbit

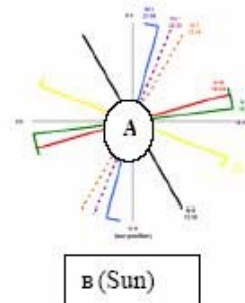


The angle (α) between the orbit plane of the satellite and the direction of solar illumination is constant if the satellite completes an orbital revolution of 360 degrees in 365.242 days (i.e., 0.9856° per day). In this case, the satellite will always be at the same angle to the Sun. The drift of the orbit is the difference between the 0.9856° per day rate of revolution and the satellite's real period. This depends, among other things, on its altitude and on the precision with which it is initially inserted into orbit.

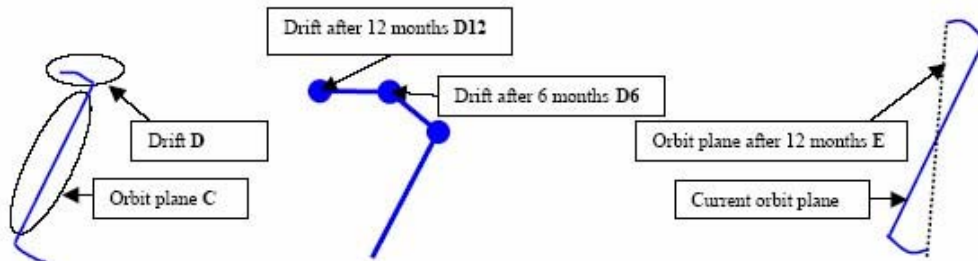
More recent satellites (NOAA17 and NOAA16) exhibit no drift, or very little, because they were positioned so precisely.

Explanation of the diagram - 4-Space segment orbit planes

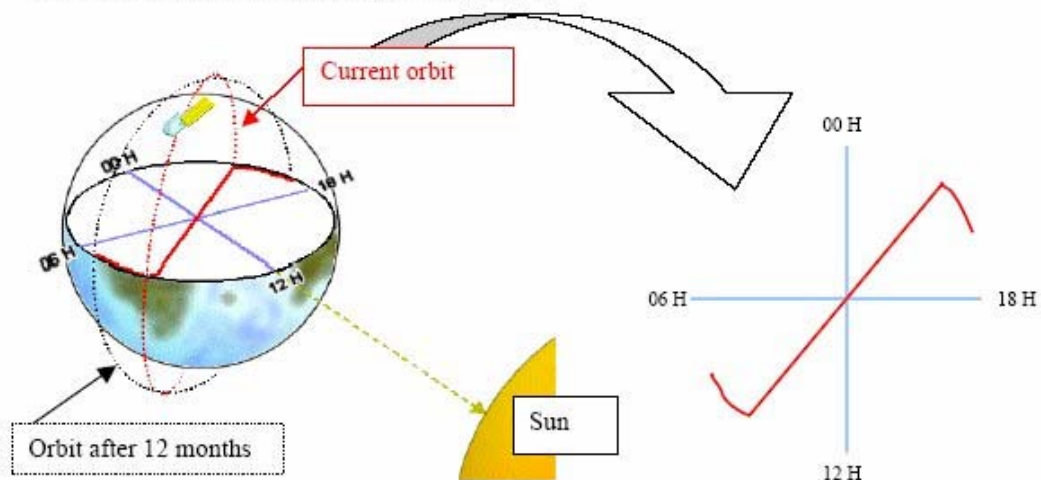
The diagram shows a "bird's eye" view of the Earth. The orbit planes intersect at the North Pole (A). The axes are expressed in solar hours, that is, in terms of the position with respect to the Sun: for example, 12 o'clock is facing the Sun (B).



The orbit plane is represented by a line segment (C). The drift (D) corresponds to the position of the edges of the orbit plane after six months (D6) or 12 months (D12), which allows us to determine the future orbit plane (E).



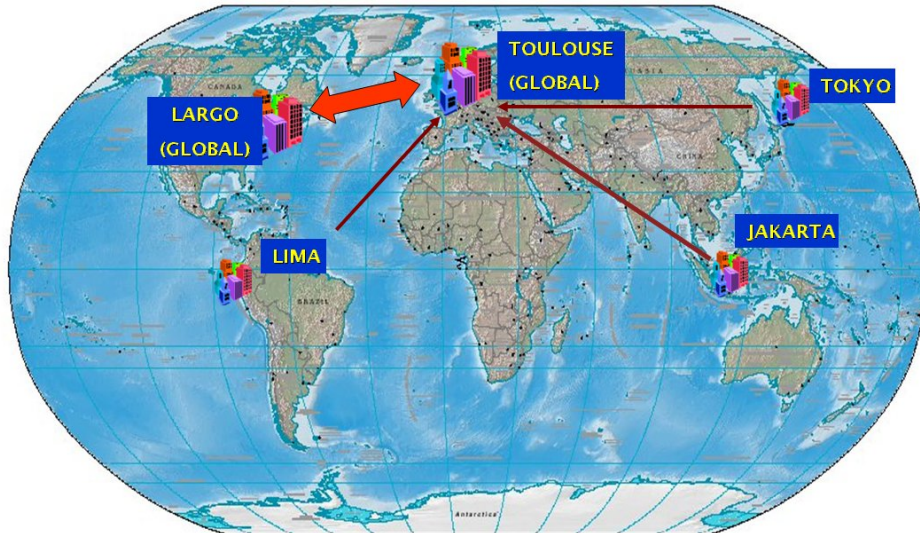
The diagram is a 2-D projection of an orbit



2. Ground receiving stations

See document 8.6.2 for details.

3. Processing centers



Global processing centers

The two global processing centers in Toulouse and Largo functioned as expected. More than 1000 data sets per day (100 STIP data sets, 900 Real-time data sets) are processed in each center. Figure 2 shows the number of datasets processed per day during the month of December 2006.

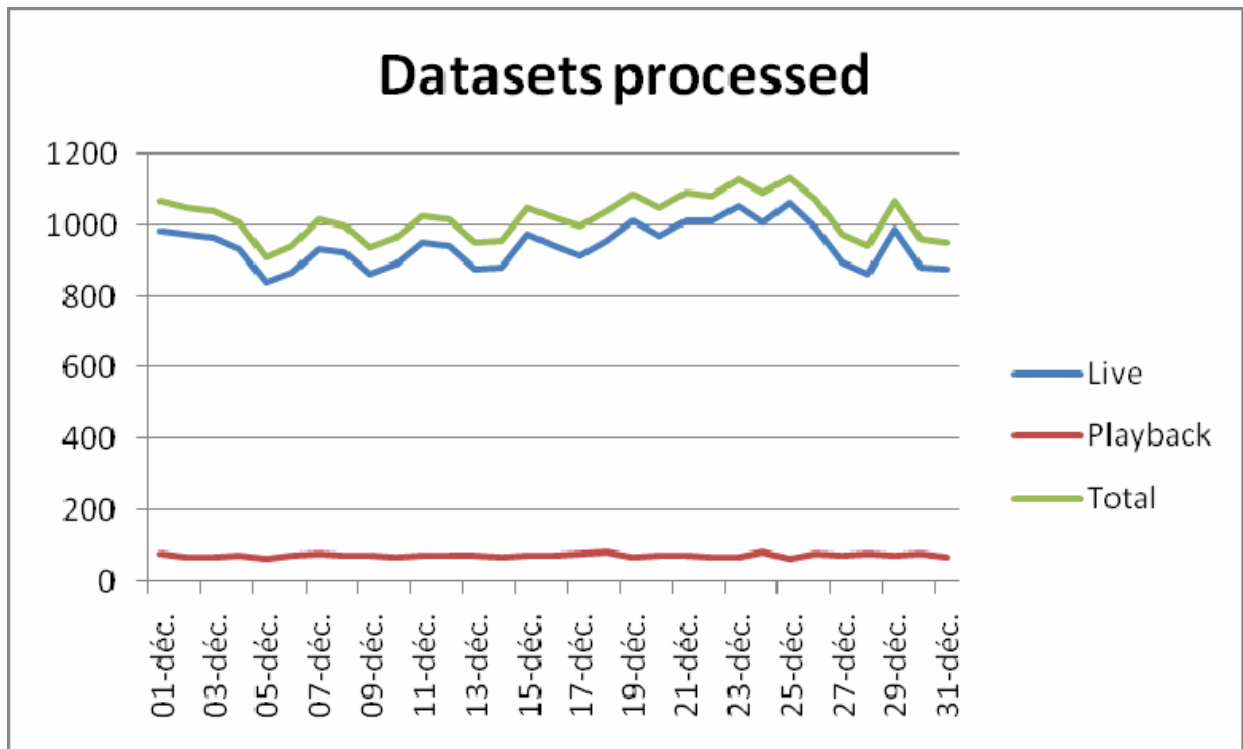


Figure 2

Operational validation of Argos2001 Phase 3A software was completed in June 2006. The new

database and screens have been installed at both global User Offices.

Regional Processing Centers

The three regional processing centers in Tokyo (Japan), Lima (Peru) and Jakarta (Indonesia) only process data sets from stations within their region. Supplementary data providing global coverage are supplied by the Toulouse center or by the LARGOS center, if necessary. No problem appeared last year in the three regional processing centers.

Processing Centers' Activity

The number of operating Argos platforms continues to increase. In June 2007, more than 9,600 platforms were seen on average per day (figure 3). However, each of the two global centers processed data from about 17,800 individual platforms during this month (figure 4).

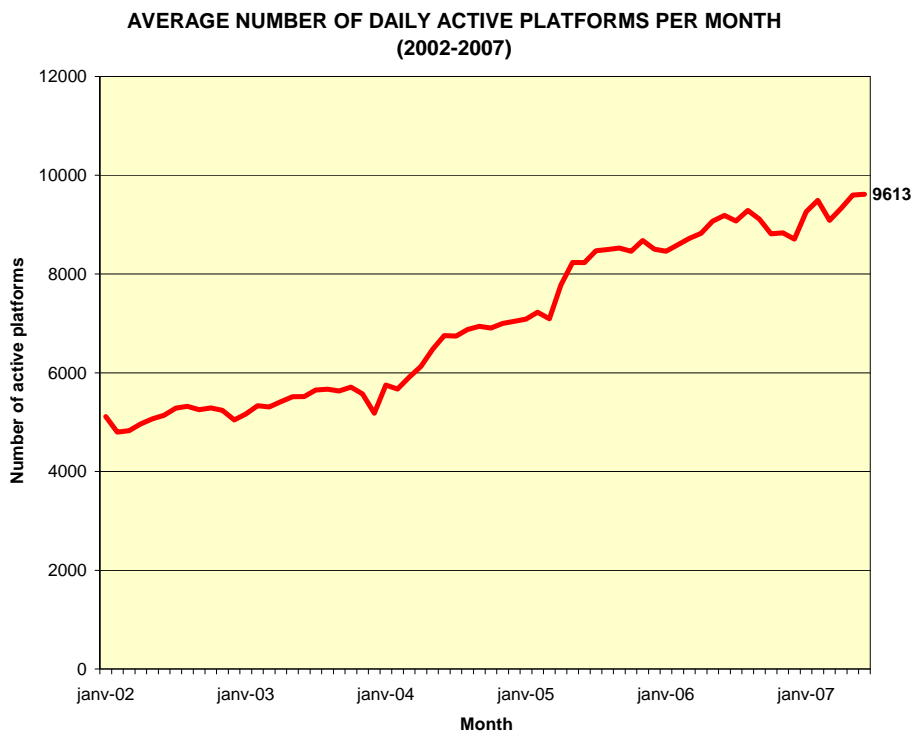


Figure 3

**TOTAL MONTHLY ACTIVE PLATFORMS
(1996-2007)**

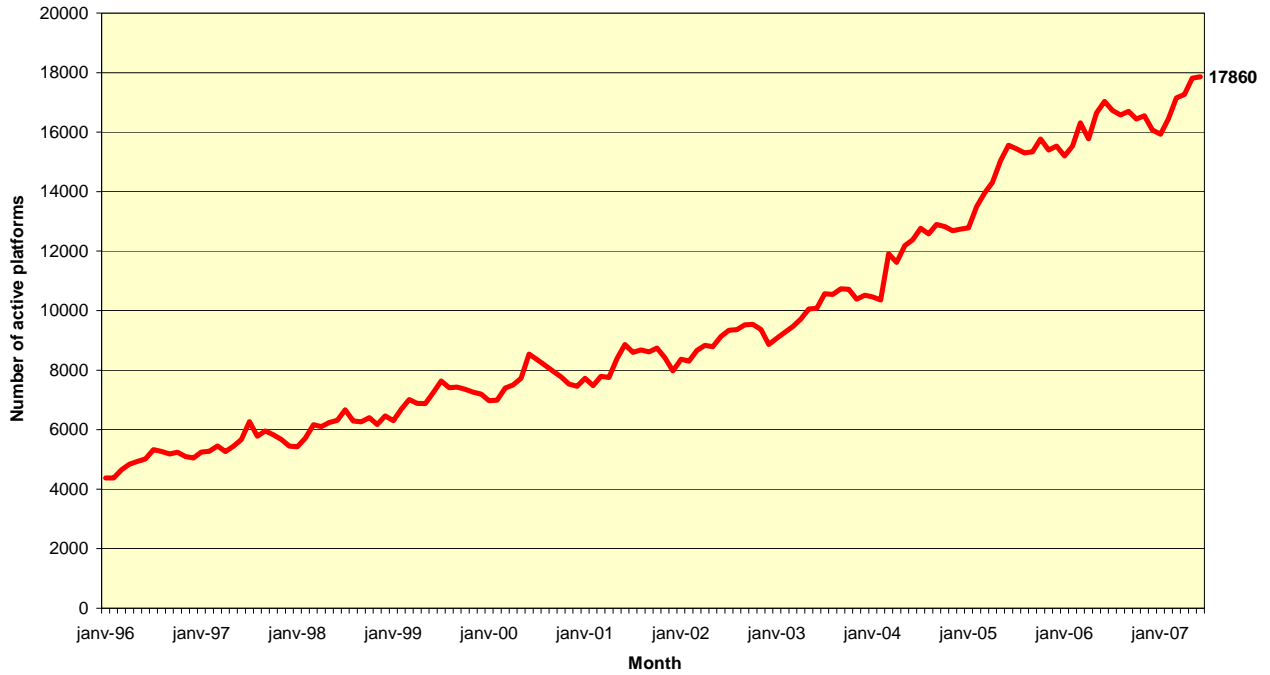


Figure 4

In June 2007, Largo and Toulouse centers processed, on average, 70,000 locations and 1,000,000 messages per day.

Figure 5 shows the ARGOS availability at CLS in 2006. In January and February 2006, ARGOS availability system was impacted by TELNET consultation anomalies. Nevertheless, the average monthly availability during this 12-month period was 99.54%. When services were unavailable in CLS, CLS America Inc. was on backup.

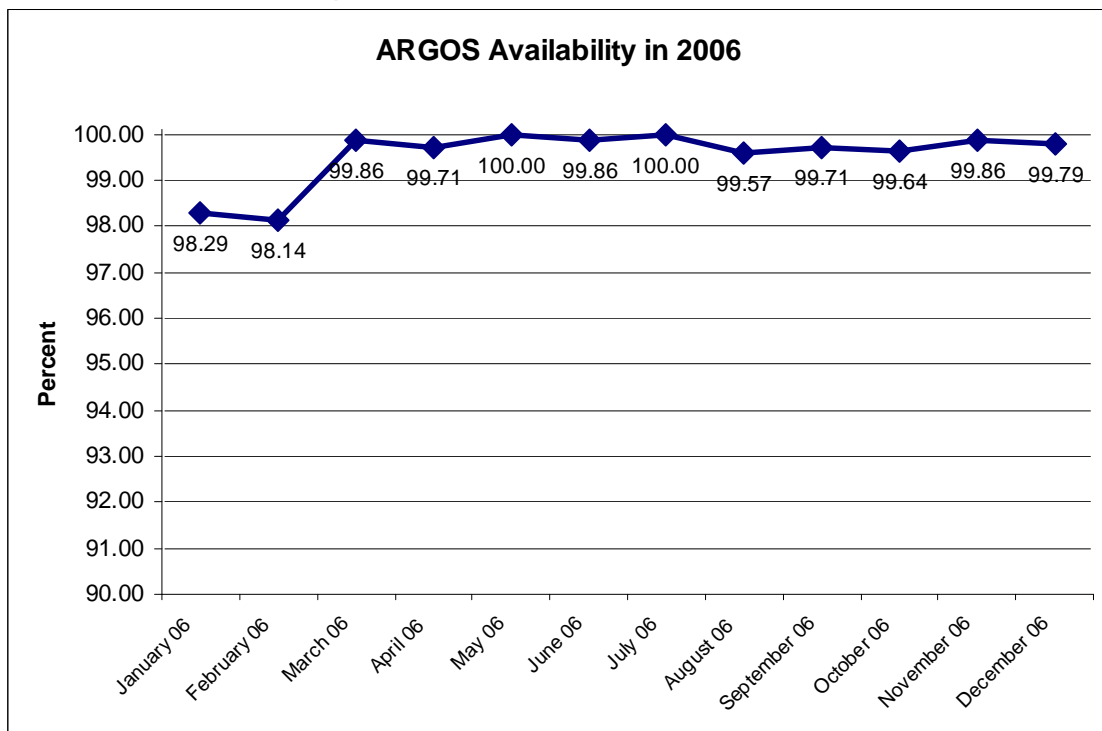


Figure 5

4. Communication links

CLS and CLS America have improved its Internet link and are now connected each other to 2 different providers: CLS America has two lines at 1.5Mbps and CLS has two lines at 2 Mbps and 4 Mbps.

The Internet is still the main communication link used to distribute processed data to users and to retrieve data sets from receiving stations. Security functionalities are available: SSH, PGP, HTTPS.

The X25 protocol at CLS America Inc., was stopped, but is continued to be used and maintained by the Toulouse center to send data to a few users (less than 20) who have security concerns, this X25 protocol will be maintained during 2006.

5. Throughput time for delivery results

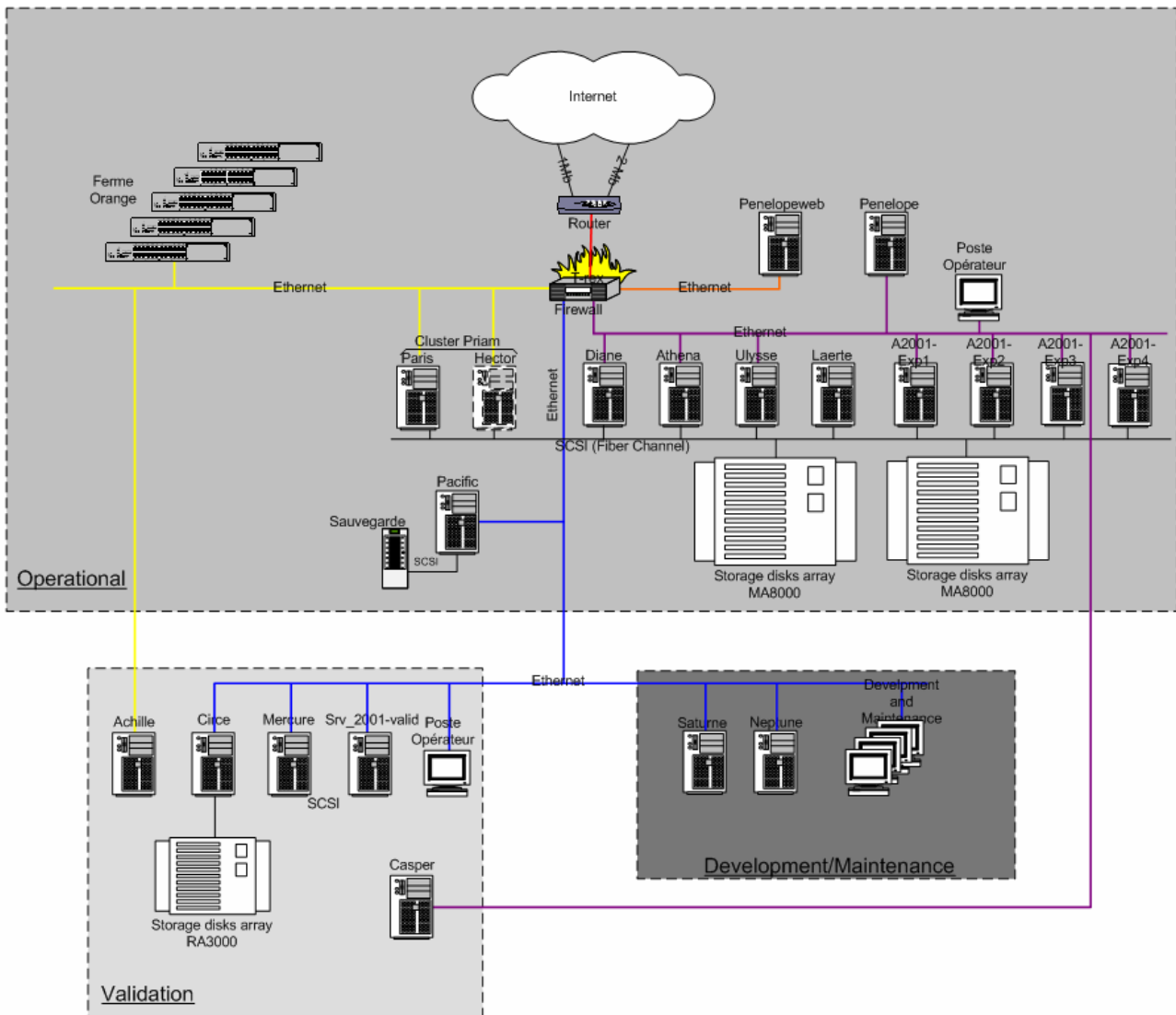
See document 8.6.2 for details.

Section 2. SYSTEM IMPROVEMENTS

1. Hardware and software configuration

1.1. Hardware Configuration

The computing architecture dedicated to the Argos system is still the same and no significant modification is to be mentioned since last year.



The heart of the architecture is composed of two high-performance disk storage arrays on which are connected, via fiber channel links, the servers involved in the process of the Argos data.

The operational configuration is of course dedicated to the acquisition, the processing and the dissemination of the Argos data, 24 hours a day, all along the year. The development and the maintenance of the Argos software are performed on a dedicated architecture. The third configuration, the validation configuration, is used to validate all the software modifications and corrections before being installed at the level of the operational configuration.

Our project of creating a second computing center in CNES ("Disaster Recovery Plan") in addition to the existing CLS computing center is still alive even if the installation of the communication links between both centers caused a big delay in the project. It seems that the problems are now fixed.

The project can go on.

1.2. Ground Segment Architecture

Eight new stations were added to the Argos network during the year.

Three receive the HRPT from the 4 NOAA working satellites (15/K, 16/L, 17/M, 18/N): Andersen, Guam Is., and USA, operated by USAF
Hikam, Hawaii, USA, operated by USAF
Valley Forge, Pennsylvania, USA, operated by Lockheed Martin

Four receive the HRPT from 3 NOAA working satellites (15/K, 17/M, 18/N):
Elmendorf, Alaska, USA, operated by USAF
Kadena, Japan, operated by USAF
Lajes, Azores, Portugal, operated by USAF
Sembach, Germany, operated by USAF

One receives the HRPT from 3 NOAA working satellites (16/L, 17/M, 18/N):
Cape Ferguson, Queensland, Australia, operated by USAF



This network was built as time goes by, usually to answer to the needs of covering specific areas of the world and sometimes by taking advantage of the cooperation opportunities, which were offered.

Even if we are ready to consider any new opportunity of cooperation, we would like to focus now our efforts on adding new ground stations compatible with NOAA and METOP satellites.

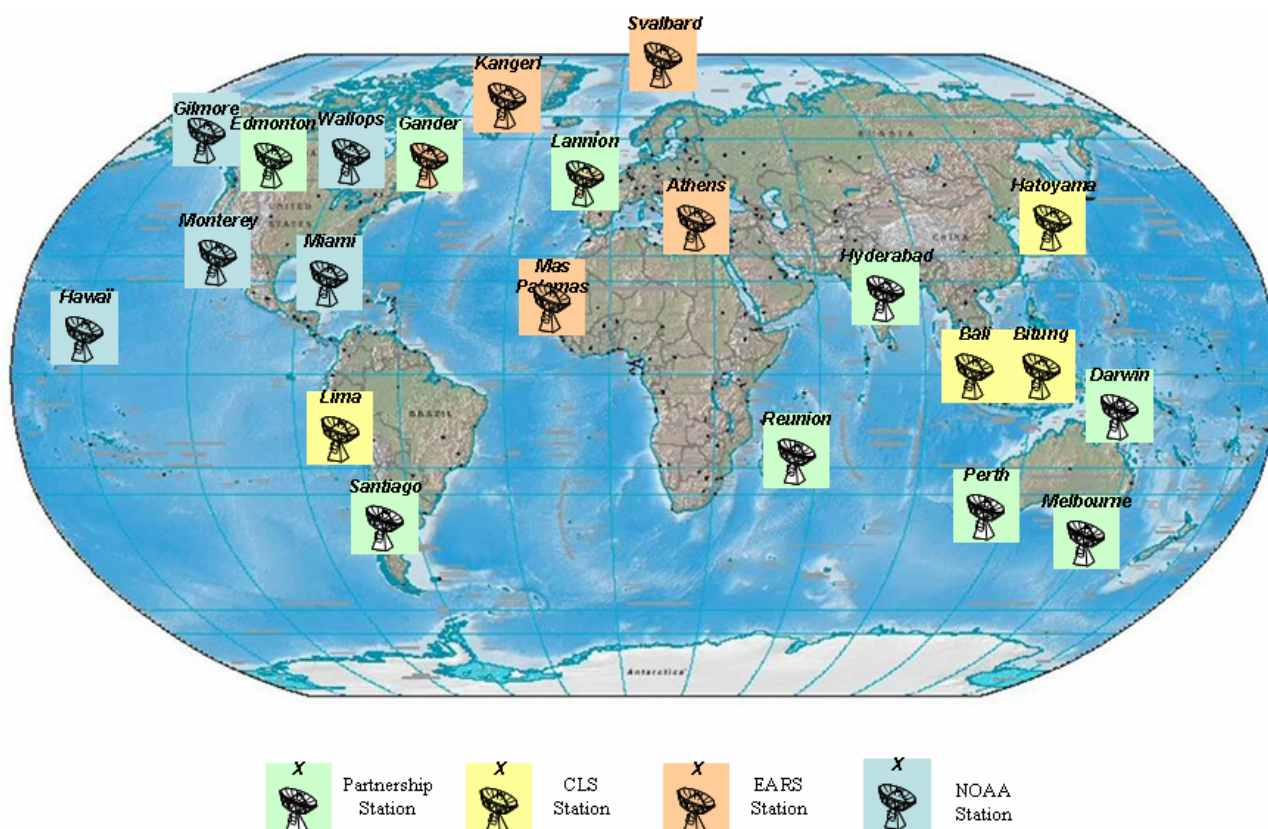
To initiate this new acquisition network, CLS has based its strategy according two main axis:

- to invest in its own NOAA/METOP stations,
- to cooperate with a partnership network.

CLS has already bought four NOAA/METOP ground stations. Two of them are located in Indonesia, in Bali and Bitung. One is installed in Lima. One is installed in Hatoyama (Japan) and is already operational for METOP.

Regarding the partnership network, CLS is in contact with NOAA, EUMETSAT (EARS network) and several other meteorological agencies such Environment Canada, Meteo Chile, Météo France, INCOIS (India) and Bureau of Meteorology (Australia).

Today, the expected NOAA/METOP network is the following:



	Antenna	Country	Operator
1	Darwin	Australia	BOM
2	Melbourne	Australia	BOM
3	Perth	Australia	BOM
4	Bali	Indonesia	CLS
5	Bitung	Indonesia	CLS
6	Hatoyama	Japan	CLS
7	Lima	Peru	CLS
8	Kangerlussaq	Greenland	EARS - Danish Meteo Institute
9	Svalbard	Norway	EARS - EUMETSAT
10	Athens	Greece	EARS - HNMS (Meteo)
11	Mas Palomas	Spain	EARS - INTA
12	Edmonton	Canada	Environnement Canada
13	Gander	Canada	Environnement Canada
14	Hyderabad	India	INCOIS
15	La Réunion	France	IRD

16	Santiago	Chile	Meteo Chile
17	Lannion	France	Meteo France
18	Gilmore / Fairbanks	USA	NOAA
19	Hawaii	USA	NOAA
20	Miami	USA	NOAA
21	Monterey	USA	NOAA
22	Wallops	USA	NOAA

In term of coverage, we could expect:



1.3. Software configuration

CLS continues to focus most of its software development efforts on the Argos 2001 and Argos 3 projects – see paragraph 2. “Projects”. At the same time, the team regularly works on corrective software maintenance and upgrades that are vital to continue meeting user requirements.

1.4. Regional processing centers

The three regional processing centers (Tokyo, Lima and Jakarta) operated without any major hitch in 2006-2007.

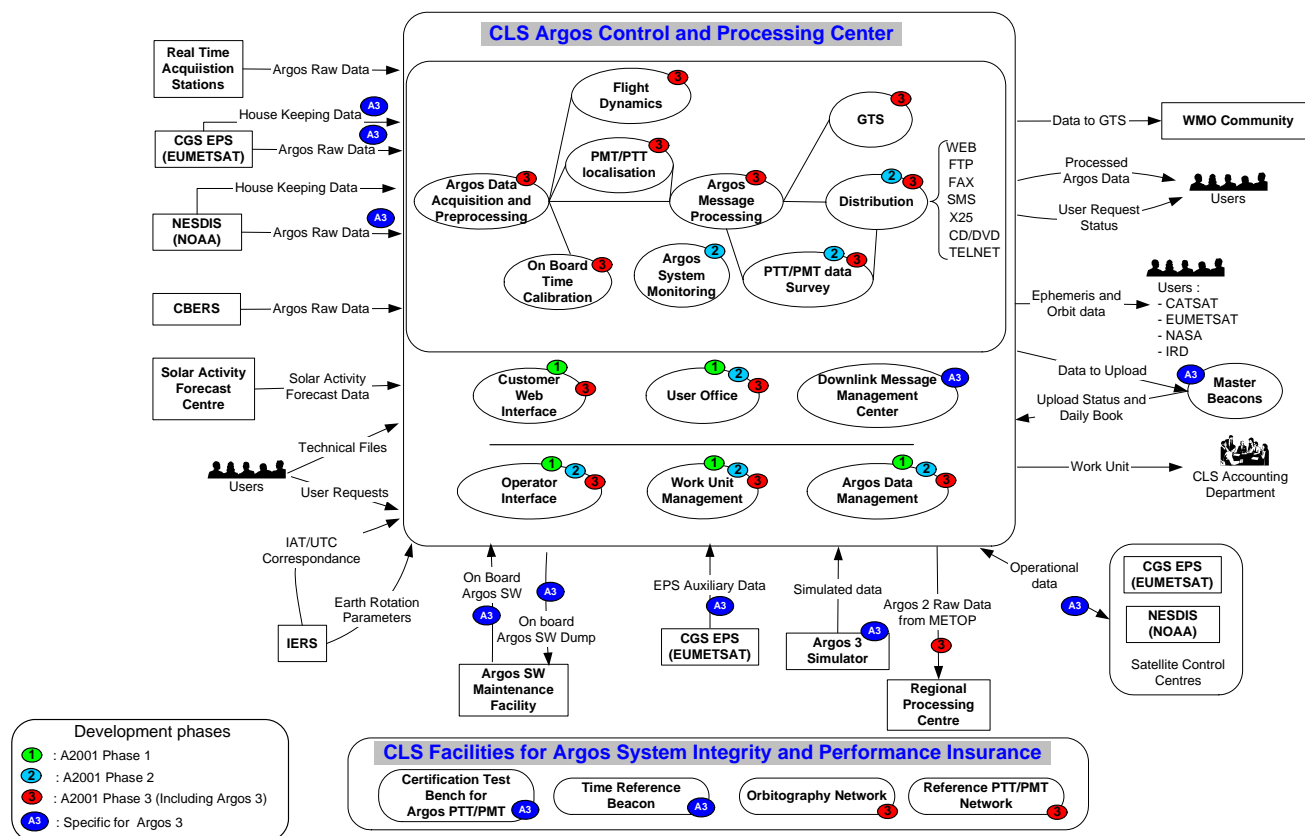
In Melbourne, there is no longer a regional processing center but the User Office is still operational for regional users, mainly for Australia and New Zealand.

2. Projects

The Global Argos Control and Processing centre is being improved through two projects:

- Argos 2001 project (see chapter 2.1),
- Argos 3 Ground Segment project (see chapter 2.2).

The figure below gives an overview of all components and the interface of the processing center, which have been added or modified during the development described in the following paragraphs.



2.1 Argos 2001

The purpose of the Argos 2001 project is to upgrade the entire Argos processing system. This ambitious project is vital for the long-term continuity of the Argos system and its users.

This project is scheduled in three phases:

Phase I: Development and implementation of a new user interface allowing users to access data and view and update technical files via a Web server. The System Use Agreements database is also implemented during this phase. Data will be stored and managed by a database management system designed to be responsive to users' needs.

Phase II: Improvement and development of value-added services and tools for the monitoring of the Argos system.

Phase III: Redesign of the core Argos processing system. This phase has been subdivided into 2 sub phases:

- IIIA : Redesign of Argos (messages) processing chain
- IIIB : Redesign of GTS (observations) processing chain

Current status:

Phases I and II have been operational for several years.

Phase III:

Phase IIIA will be put in operation in September 2007 and Phase IIIB at the beginning of 2008.

2.2 Argos 3 Ground Segment (SSA3 Project)

In March 2003 started, a new and major project for Argos named: SSA3 (Argos 3 Ground Segment). This project aims to take into account all the changes in the current Argos ground segment brought by the third generation of Argos instruments. It includes the downlink and the new format for the uplink messages (new modulation, high bit data rate...) as well as the interface with EUMETSAT. The sub-systems of the Argos 3 Ground Segment development have been completed and validated before the launch of the first METOP satellite, on October 19 2006, and during its commissioning. This project is driven in parallel with the Argos 2001 Phase III project.

The Project covers the 4 following developments:

- Software evolution of the Argos Processing Center: It includes all sub-systems modified due to the Argos 3 capabilities and characteristics, including the DMMC (Downlink Message Management Center),
- Time Reference Beacon,
- A new network of master beacons (high data rate platforms),
- Argos PTT/PMT test bench.

2.2.1 Argos 3 Control and Processing Center

The Argos Processing center is made of several sub-systems. Each sub-system is independent regarding the integration and validation of the center. These subsystems are:

- o ACQ/PTR: it acquires the mission telemetry from the regional antennas or the global receiving stations. Then, it processes the telemetry to provide the other subsystems with "clean" and homogeneous Argos telemetry.
- o LOC: it calculates the platform localization by using the frequency measurements made by the instruments.
- o DAT/ORB: The relation between the on board time and UTC, used to time stamp the Argos messages, is assessed by the DAT subsystem. ORB is in charge of the production of ephemeris data used to localize the satellites.
- o TRM and GTS are two subsystems related to A2001 Phase III. They provide new capabilities to the users for encoding and distributing the data they transmit through Argos.
- o DMMC: It is the Downlink Message Management Center. Due to the failure of ADEOS II mission, DMMC is now fully dedicated to Argos 3 instrument. It was delivered in September 2005.

The integration tests with EUMETSAT started in July 2005. The data are now received from EUMETCAST.

The Integration, Validation and Verification (IV&V) phase started in April 2005. The full IV&V of the Argos 3 ground segment is done in parallel with the IV&V of the A2001 Phase III. It started in December 2005 and it is still in progress. All functions involved in Argos 3 telemetry processing and downlink message management have been tested, including functions requiring the onboard instrument to be commissioned.

2.2.2 Time Reference Beacon

The new generation of the Time Reference beacon is operational and has been successfully used during the Argos 3 commissioning phase.

2.2.3 Master Beacon

Three Master Beacons, compliant with Argos 3 instrument, have been installed in Svalbard, Fairbanks and Toulouse and are operational.

2.2.4 Certification Test Bench for Argos PTT/PMT

This facility is used to check the new PTT/PMT series regarding the Argos general specifications. This test equipment is now planned to be upgraded to improve its performances and to add functionalities. These improvements are driven by CNES.

2.3 PTT/PMT for users

The Argos-3 satellite generation will allow users to have a two-way communication as well as a better control of uplinks at a higher data rate. To access these new facilities, users will have to implement a PMT (Platform Message Transceiver) in place of their current PTT.

This module, working as a modem, will support:

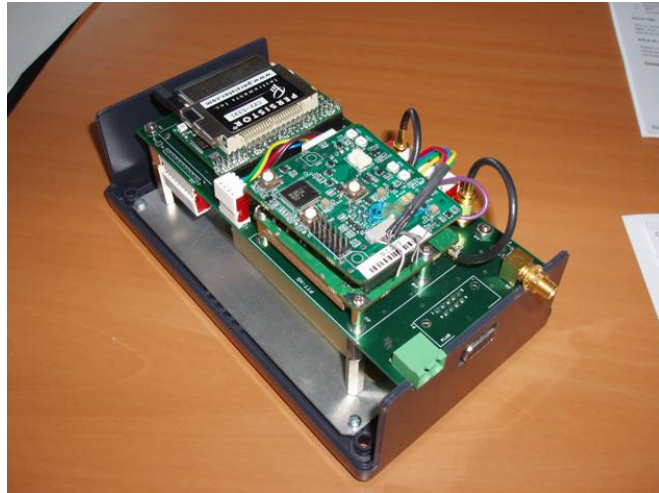
- Transmission of uplink messages using several possible modulation links as well as satellite pass predictions
- Reception and processing of downlink messages (commands, predefined messages, satellite acknowledgement...)
- Communication with the platform for the acquisition of sensors and the delivery of an acknowledgement when data have been correctly transmitted and acknowledged by satellites.

Users will access these functions in two steps: The first one through "PMT demo units" or first generation PMTs, currently available. The second one through "Industrial PMT RF modules" that will be available at the beginning of 2008.

A. First Generation PMT

The CLS project of developing a PMT started in 2002 with Bathy Systems (Boston, USA) and Seimac Ltd (Halifax, Canada), a major transmitter manufacturer. A set of 80 "First Generation" PMTs is now available.

These PMTs work on both BPSK and GMSK modulations (downlink at 400 bits/sec and new data rate uplink at 4800 bits/sec).

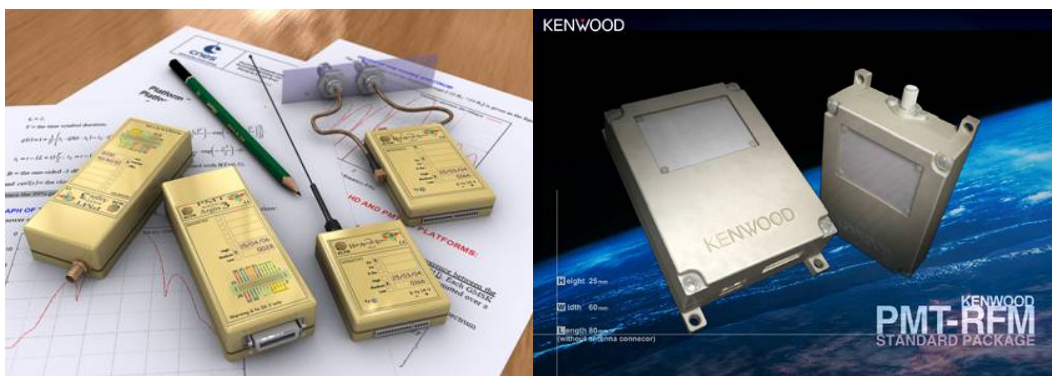


The first interactive session on May 10, 2007 between METOP-A and PMT worked perfectly well.

B. Industrial PMT RF module

Part of the success of the Argos 3 project will be based on the availability of low cost, low consumption and tiny “PMT RF modules”. These modules have the same functions as the First Generation PMT demonstration units but they are designed “from scratch”. In other words, the complete product is designed to be a simple single “electronic board”. This design will reduce the size, the cost, the complexity of the product (less controllers and interfaces) and the consumption.

This work started in early 2005 with technical and marketing studies. The kernel of the product was clearly identified. It is made of a receiver, a transmitter, a relay to switch the unique antenna from reception to transmission and a controller to manage the satellite protocol and to support the communication with outside. A tender was issued and two manufacturers (Kenwood in Japan and ELTA in France) were selected in February 2006 to provide users with industrial PMTs at cost equal or lower than the current one-way PTTs. The commissioning tests are on their way and a first set of PMTs should be available at the beginning of 2008.



3. Review of Users Requirements

3.1 Data Buoy Cooperation Panel requirements

3.1.1 Keep NOAA-12 and NOAA-14 in operation

Requirement: *The Argos data relayed by NOAA 12 and NOAA 14 are of considerable value as part of the multisat service. The DBCP has made a strong request to keep NOAA 12 and 14 in operation.*

Status: NOAA-14 has been decommissioned on 23 May 2007 and NOAA-12 has been decommissioned on 10 August 2007. Both satellites were Argos-1 instruments, with a reception frequency range of 24 kHz centered on 401.650 MHz. Now the constellation is made of 5 satellites: 4 NOAA and 1 METOP.

3.1.2 Activate Svalbard Ground Station

Requirement: *The lack of a capability to download blind orbit data from the NOAA Polar Orbiting Satellites contributes significantly to the Argos data delays on the GTS. A possible solution to this problem is the early activation of the Svalbard NPOESS ground station to enable it to capture blind orbit POES data.*

Status: Under the Initial Joint Polar System (IJPS) agreement between NOAA and EUMETSAT, the elimination of blind orbits for NOAA-18 is obtained with the addition of a EUMETSAT antenna in Svalbard, Norway. The acquisition of NOAA-18 datasets in Svalbard has been operational since 9 August 2007.

Because the IJPS agreement covers only NOAA-18 and newer satellites, the older satellites, NOAA-17, NOAA-16 and NOAA-15, cannot use the IJPS Svalbard antenna. With this situation, engineers in OSO (Office of Satellite Operations) worked with engineers at the NOAA Integrated Program Office (IPO) to develop a concept of operations for using the IPO antenna at Svalbard. This antenna is separate from the EUMETSAT antenna, under-utilized operationally due to delays in the NPOES Preparatory Project (NPP), and is a NOAA controlled asset. It is expected that operational data recovery from NOAA-17, NOAA-16 and NOAA-15 can be provided by later on.

3.1.3 Acquire Data from Brazilian LUT's

Requirement: *In order to enhance the timeliness of Argos data, particularly in tropical areas, a tentative cooperation with the Brazilian Space Agency is still a work in progress. In addition to the possibility of processing data from the Brazilian DCS within the Argos system, there was the additional possibility of using Brazilian LUT's to obtain standard Argos data that would improve observational coverage for the ISABP, amongst others.*

Status: Two satellites, SCD1 and SCD2 are delivering data. Further to oral agreement between INPE and CLS, real time SCD1 and SCD2 datasets are downloaded by INPE station in Cuiaba (central Brazil) and then transferred to Lima to be processed by CLS Peru that is interested in real time fishing vessel data. Data includes only data messages since the INPE system do not provide locations. No processing is done by global processing centers at this step.

3.1.4. Various GTS sub-system Enhancements.

GTS will be included in the new Argos 2001 processing system

When Phase IIIB is operational, the GTS sub-system will be an entire part of the full Argos processing system. All data (Argos outputs and GTS formatted data) will be delivered by the same system.

BUFR Encoder

Requirement: *Under Agenda Item 8.2 of DBCP 19 the panel agreed that it would be desirable to employ data compression to achieve significant reduction in message length. It therefore requested the Chairman to bring a recommendation to the Argos JTA to enhance the current GTS BUFR encoder to include data compression.*

Status: The implementation of the compression of the BUFR files was completed in September 2005.

TAO Salinity computation

A new algorithm has been developed for the GTS sub-system to accommodate the new TAO mooring data formats and assemble salinity and temperature observations for a given level, prior to the QC step. It was implemented in mid-October 2004 and after a PTT declaration-tuning run properly end October.

Duplicates

In some circumstances, the Argos GTS time tagging process generated duplicated observations. This impacted some BUOY and TESAC bulletins. A routine has been developed to suppress these duplicates. It was implemented in September 2005 and corrected in Spring 2006.

ARGO, APEX 28-bit format

The new code concatenates the 40 last bits of the previous float message to the next message, and then processes it. S-T-D samples are then complete.

This was implemented in September 05 and definitely corrected in June 06.

ARGO – AOML redundancy

Action pending.

ARGO – Speeding-up the data distribution

The new routine picks up the total number of data samples transmitted coded in the first message and sums up the number of data samples received. As soon as all the data samples are received, the profile starts being processed.

In case a message is missing, the profile is calculated, using all messages available, after the pre-set duration has elapsed (18 hours). This routine was implemented in October 2004. Declaration tunings were applied in 2005.

ARGO – Meta data dissemination to Ifremer or others

All ARGO data processed by the CLS GTS subsystem are delivered to Coriolis (at Ifremer) via ftp.

VARIOUS FORMATS and GTS transmission

CLS has been working with IABP coordinator to accommodate Ice Mass Buoys (IMB) data processing – using dedicated Campbell formats – and data are now sent onto GTS.

CLS has been working with Bill Scuba, SCRIPPS, to send adequate data from hurricane buoys onto GTS. This work led to the design of an enhanced data transmission format and related GTS processing template. Tests are successful. Deployments took place in Summer 2007.

3.1.5 Falklands/Malvinas LUT

UK and South Africa will be invited to report on the current status of establishing a data telecommunication link for Argos TIP data from Falklands/Malvinas Islands LUT to the Argos network. The UK will be particularly invited to report on the current status of the 64K telecommunication line to its Met Office headquarters in Exeter and whether appropriate software to transfer Argos TIP data via FTP and through local firewall has been written.

DBCP chairperson D. Meldrum reminded UK Met Office about this topic. A reply should be forthcoming soon.

3.1.6 St Helena Island LUT:

CLS installed an antenna in Gabon in April 2007. This increases the real time coverage in South Atlantic. There is currently no LUT receiving station on St Helena Island but UK Met Office is ready to maintain and operate one. For the moment, CLS has no plan to supply a LUT in St Helena.

3.1.7 South African LUTs:

In 2006, CLS made a proposal to the South African Weather Service for three reception stations (LUTs): Gough Is., Marion Is. and SANAE (South African National Antarctic Expedition). In addition, CLS offered to upgrade the Cape Town LUT if SAWS ordered the 3 LUTs. For the moment, SAWS who should take a decision in 2008 are assessing the proposal.

3.1.8 Easter Island LUT:

No antenna, no infrastructure available.

3.2 Issues arising from the Argos Operations Committee

In 2006, during the DBCP22 meeting, a representative of CNES organized a discussion on the users and manufacturers' requirements for the Argos-4 instrument. This next generation should be installed for the first time onboard the first NPOESS satellite of NOAA, around 2013.

On September 7th, 2007, CNES and CLS will meet for a review of the Argos-4 mission specifications.

Appendix: None.