Session1 Presentation4 (pre-recorded interview)

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Focus on some specific features of the DORIS system

1 – What is the difference between the different types of beacons in the DORIS network?

In terms of technology, we are currently spreading the 4th generation beacons in order to replace the 3rd generation (which are getting old) and keep the system in good health for years.

In terms of functionalities, 90% of the network beacons are standard orbitography beacons, only emitting two frequencies and a short identity message.

Besides, 4 Master Beacons are tied to Atomic Clocks and play the role of accurate Time Reference. They also emit Broadcast Uploads, which give information to the on-orbit receivers software: terrestrial positions of the antennas, and time links for the Time Beacons.

A few beacons are fitted out with peculiar configurations: for instance, Terre-Adélie is a Time Beacon but not a Master Beacon. Grasse is tied to an Atomic Clock but is just a standard Orbitography Beacon.

2 –The DORIS system is used to propagate time (TAI, International Atomic Time) to the user satellites. How is this done?

Low Earth orbit satellites are flying at a speed of more or less 7km/s, so if you want to locate them precisely, you need to handle time with an accuracy of roughly one microsecond.

That is why Time Beacons are useful: their emission date is accurately known in ground time. During each satellite pass, their message is also precisely time-tagged by the DORIS internal clock, and a simple Time Transfer Technique gives the correspondence between the on-board clock and ground Atomic Time.

Using this, each DORIS receiver is able, when a platform Top is received, to give its value in International Atomic Time: DORIS brings TAI to the spacecraft just as a speaking clock.

3 –DORIS is used to produce a ~~Near~~ Real-Time (~~N~~RT) orbit with a system called DIODE? Could you explain how this works?

DORIS measurements are performed on board, inside the receiver, so it is possible to process them directly in real-time, using a true Real-Time Orbit Software. This one is called DIODE (for DORIS Immediate On-Board Determination), and it integrates the measurement to produce an estimation of the satellite orbit. If platform information is accurate (attitude, geometry, …) the estimation can be precise down to a few centimeters.

The satellite position is available in real-time for on-board use: for instance, AOCS may use this information for antenna pointing. Other platform equipment may also take advantage of this information, for instance the altimeter uses the altitude to optimize its return loops.

DORIS-DIODE position estimations are also downlinked in the telemetry, making them usable as soon as the payload data are on-ground.

Thus, when you have a DORIS receiver on-board, you can count on a satellite precise positioning system, and several additional real-time information.

4 –All the DORIS data are collected and pass through the Control Center in Toulouse, and you use these data to monitor system performance? Could you give 1 or 2 concrete examples of how monitor system performance?

Yes, each telemetry flow of each contributor satellite is checked as soon as received, in order to verify the system good health. For example, if a station is not present, it may be due to a recent electricity failure. If its measurements are very noisy, this may indicate that an equipment has to be renewed. If its emitting level decreases, a beacon change may be necessary.

Correct synchronization of the Time Beacons is also checked in Near Real-Time (a few minutes or hours due to the telemetry downlink delay). By this mean, in case of

any ground event, a rapid call to the station is possible (phone, e-mail), and a rapid reaction is possible.

Also, receivers' health is automatically checked by fast telemetry processing: Software Reports, DIODE Quality Index give information about the overall System Integrity.