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Author: Mr. Joao Lousada
GMV GmbH, Germany

Mr. Han Wessels
ESA - European Space Agency, Netherlands (Kingdom of the)
Ms. Mirjam Boere
ESA - European Space Agency, Netherlands (Kingdom of the)
Mr. Benoit Leger
Centre National d'Etudes Spatiales (CNES), France
Dr. Morgane Steckiewicz
Telespazio, France
Mr. Etienne Allart
Airbus Defence & Space, Germany
Mr. Tristan Hermel
GMV GmbH, Germany
Mr. Alexander Nitsch
European Space Agency (ESA), Germany

ESA CONCEPT OF OPERATIONS FOR ACES AND PRELIMINARY LESSONS LEARNED

Abstract

The Atomic Clock Ensemble in Space (ACES) is an ESA mission in fundamental physics, based on highly accurate and highly stable atomic clocks, operated aboard the International Space Station (ISS). The main on-board instruments are the caesium clock PHARAO (Projet d'Horloge Atomique par Refroidissement d'Atomes en Orbite), and the active hydrogen maser SHM (Space Hydrogen Maser). The 100 MHz signals from PHARAO and SHM are compared in the Frequency Comparison and Distribution Package (FCDP), and the resulting signal can then be compared with ground clocks by usage of two independent transfer links: the Microwave Link (MWL) and the European Laser Timing (ELT) optical link. The ground segment includes a network of dedicated, worldwide distributed MWL ground terminals and satellite laser ranging (SLR) stations, which provide the interface between the ACES clock ensemble, in space, and the atomic clocks on the ground. The comparison between space-based and ground-based clocks will allow the testing of Einstein's theory of general relativity, particularly regarding the gravitational red-shift measurements, the identification of time variations in the fundamental constants, and the testing of the Standard Model Extension. This paper focuses on the operational concept that was developed on ESA side, by the ESA/CNES integrated team, at the CADMOS User Support and Operations Centre and by Airbus. The different aspects considered include the overall sharing of responsibilities between the different stakeholders, new interfaces and new operational processes established, the challenges encountered, and the preliminary lessons learned during the installation and early commissioning phases of ACES.