COMPASSO: In-orbit verification of optical key technologies for future GNSS

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GNSSs are facing increasingly demanding performance requirements in particular in terms of robustness, availability, accuracy, precision and integrity. GNSS introduced PNT services are omnipresent in daily life applications such as air traffic management, automotive/maritime navigation, autonomous driving and flying of manned and unmanned vehicles, financial transactions, synchronization of critical infrastructure (e.g. power grits and cellular networks) and many more. In order to master the upcoming and current challenges for GNSSs, new technologies, concepts and architectures are needed in order to provide resilient PNT services with the required performance measures. DLR proposed already several years ago a new GNSS architecture, called Kepler, which relies on optical technology for time keeping and improvement of the precise orbit determination of the MEO (medium earth orbit) satellites. DLR was further developing the required optical technologies, i.e. compact optical clock technology and optical inter-satellite links exhibiting communication, synchronization and ranging capabilities. All activities are currently culminating in an in-orbit validation mission called COMPASSO to be launched in 2026. The COMPASSO payload will be installed on the Bartolomeo platform, which is attached to the Columbus module of the International Space Station. The main payload elements of COMPASSO consist of two compact absolute optical frequency reference systems using molecular iodine vapor as spectroscopy unit, one optical high-performance frequency comb and one bi-directional optical terminal for communication, time-transfer, ranging and frequency transfer. The combination of the optical frequency reference with the optical frequency comb results in an optical clock with radiofrequency output.

In this paper we will give insight in the COMPASSO mission and present an update on the current status of the developments. We will highlight the possible improvements of GNSS enabled by optical technologies in different implementation scenarios and we will prove our findings by simulations mainly on the signal in space range error and a possible reduction of the required ground segment of a GNSS constellation using compact optical clocks and/or using optical inter-satellite links within the MEO segment enabling ranging and synchronization between the linked satellites.