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A MICROSATELLITE-BASED LUNAR CONSTELLATION FOR COMMUNICATION AND  
NAVIGATION SERVICES**Abstract**

The upcoming decade will see a relevant increase in the number of human and robotic missions targeting the Moon surface. In this context, a reliable and user-friendly communication infrastructure, including a precise positioning, navigation and timing (PNT) service, is a key enabler for new missions. Argotec, in collaboration with NASA's Jet Propulsion Laboratory, is involved in the development of ANDROMEDA, an innovative Lunar multi-satellite constellation providing communication and navigation services. The constellation provides extended global coverage and 24/7 connectivity to users located in strategic areas (e.g. South Pole) and lower orbits. The microsattellites are in the 60 kg class, equipped with a dual K-band and S-band communication system capable of multi-user servicing by exploiting channel multiple access techniques. Communication sessions can be initialized autonomously by standardized proximity protocols running on board. Upon request, satellites can directly connect Moon assets with Earth for real-time data exchange, allowing audio/video calls. The protocols stack will be highly adherent to the Future Lunar Communications Network architecture specified by the Interagency Operations Advisory Group (IOAG),

which is highly based on CCSDS protocols and recommendations, to maximize the compatibility with the existing and future assets and to provide true interoperability with the terrestrial internet network. Moreover, the system will ensure secure communications providing message encryption and authentication services. The constellation will also provide a navigation service, exploiting at first standard radiometric measurements such as two-way ranging (regenerative or not) and Doppler. The constellation allows to acquire measurements from multiple satellites, collecting radiometric data along different directions and enhancing the navigation solution in the position estimation. A future implementation of the platform will allow the users to perform one-way ranging measurements through a more precise time reference and an accurate orbit propagation. As part of this service, Argotec is also developing a user terminal for ANDROMEDA's users that enables communication with the constellation. The terminal is equipped with a K- and S-band transponder, supported by an electrically steerable antenna and a control unit which handles the communication set-up with the constellation in a transparent way to the user. The system supports a variety of modulations with the most advanced channel coding techniques and it is able to autonomously adapt them to the conditions of the radio link. This feature, together with the state-of-the-art space technologies, allows the users on the Moon to exchange information at a high data rate (i.e. up to 100 Mbps) with the Earth.