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LoLaSat: The Pioneer in satellite communication with minimum signal propagation delay

In data transfers often delays of fractions of a second play a key role, by example in safe autonomous driving of networked cars or transport drones, but also in a broad spectrum of applications ranging from emergency support actions over on-line gaming to high frequency trading of shares. Advantage of 5G-telecommunication via satellite is the coverage of large areas. Traditional geostationary satellites in 36.000 km altitude exhibit the disadvantage of significant signal propagation delay due to the huge distances. Here LoLaSat (**Low Latency communication Satellite**) orbits the Earth surface much closer at around 300 km altitude.

The European Space Agency ESA issued the contract for LoLaSat after an European-wide competition to develop the ambitious key technologies for a telecommunication satellite in Very Low Earth Orbit (VLEO). To take advantage of VLEO, the innovative start-up company S⁴ – Smart Small Satellite Systems GmbH as prime contractor will develop technology concepts for the challenges of the remaining thin atmosphere. While Elon Musk placed up to now already more than 1800 Starlink satellites in orbits at 550 km altitude, the plans in several years are to send in phase 3 of Starlink thousands of satellites in VLEO at about 320 km altitude to improve real-time performance.

The European space agency ESA addresses already now in its ARTES-program a first telecommunication satellite for such extremely low orbits. The CEO of the winning team S⁴ GmbH, Prof. Dr. Norbert Menke, underlines the importance of the LoLaSat (**Low Latency communication Satellite**) mission: „Here first time the enormous potential of extremely low orbits for real-time communication via satellite is explored. We expect a very high economic potential, when by multi-satellite-formations a global coverage for the emerging Internet of Things is reached. We appreciate that based on that contract from ESA we can initiate disruptive innovations !“

Dr. Walther Pelzer, board member and Head of German Space Agency in the German Center for Aerospace (DLR), emphasizes: „Start-ups enrich the space technology sector. They bring a fresh breeze to this sector and push technology developments. We promote this evolution and back strongly young companies in the German space technology landscape. Therefore, we are very glad that the consortium led by the start-up S⁴ GmbH from Würzburg received the contract of the European space agency ESA to develop, realize and operate the innovative demonstration satellite LoLaSat “.

Such very low orbits were avoided with very few exceptions, as the satellite here has to comply with the remaining atmospheric particles and the Ionosphere environment. Therefore, the propulsion system of LoLaSat has to compensate the deceleration of the satellite due to the remaining atmosphere, otherwise a crash within a very short period occurs. While S⁴ GmbH realizes the satellite, TESAT has responsibility for the telecommunication payload and Center for Telematics for operations of the ground station as well as for software implementation. The mission objective is to achieve in an altitude between 200 km and 300 km in Ka-band data transfer rates up to 100 MegaBit per second at a latency of less than 10 ms. In detailed experiments data transfer and connectivity to 5G-networks will be characterized. For this purpose, the nano-satellite LoLaSat (**Low Latency communication Satellite**) with dimensions

of 10x10x30 cm and 4 kg mass will be used. LoLaSat employs the modular building blocks of S⁴, based on the CubeSat standard, allowing to flexibly configure the specific satellite design (see image 2). This approach supports efficient production of larger quantities by advanced robotic automation lines. LoLaSat might allow to cost-efficiently form networks of small satellites for future “Internet of Space (IoS)”, combining traditional and small satellites for a best performance solution to serve the “Internet of Things” with real-time connectivity (see image 3).

The basis was laid already 2005 with the first German pico-satellite UWE-1 from University Würzburg. On 28. September 2020, the team ZfT/S⁴ GmbH placed the formation NetSat in orbit, consisting of 4 similar nano-satellites (see www.telematik-zentrum.de/netsat). This challenging mission provided crucial experiences for LoLaSat. In particular, the precision attitude control system is of relevance, in order to orient the thrust vector of the propulsion system for drag compensation with appropriate accuracy as well as to track the ground station with the antenna despite the high relative velocity.

Further information:

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LoLaSat prime contractor S⁴ – Smart Small Satellite Systems GmbH:

S⁴ is a start-up, founded 2017 in Würzburg (Germany), supplying advanced components and subsystems (such as AOCS, OBDH,...) for nano-satellites. It offers to customers also complete nano-satellites to host their instruments and payloads, in order to place and operate them in a cost-efficient way in orbit. S⁴ uses a modular construction kit based on the UNISEC electrical interface and the CubeSat standard to flexibly implement according to mission requirements a related specific satellite design. This includes realization of multi-satellite system with small satellites, too, either in form of constellations or of self-organizing formations. Main application areas concern telecommunication and Earth observation.

The employees of S⁴ represent extensive expertise with small satellites since 2005. S⁴ owns and uses modern laboratory rooms with most modern development tools for implementation and test of microelectronic components, as well as advanced robotic facilities for integration and test of satellites. On 28. September 2020 the team ZfT/S⁴ GmbH placed the formation NetSat, consisting of 4 3U-CubeSats, in orbit for technology demonstration of formation flight in 3D.

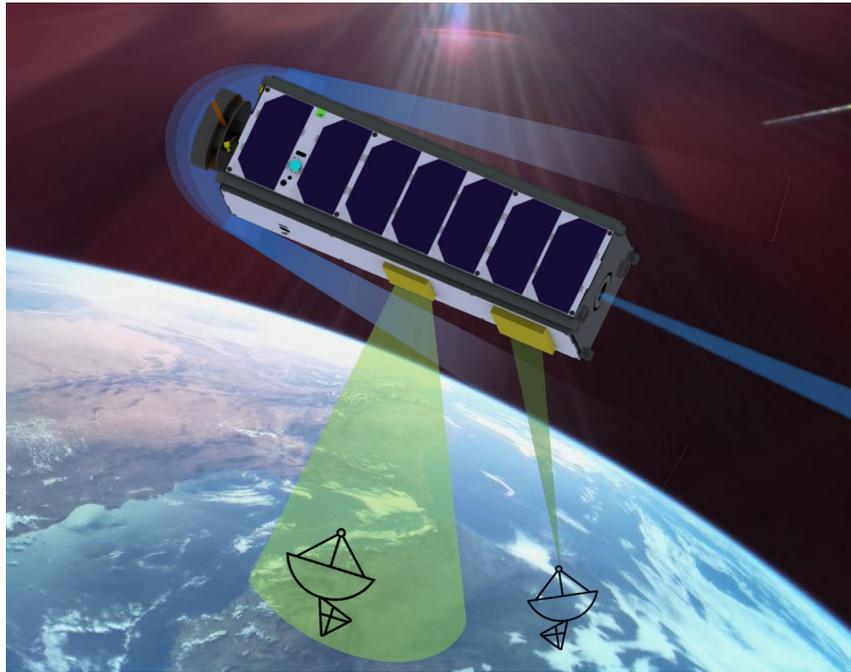


Image 1: The LoLaSat satellite operates in an orbit in the Thermosphere to realize communication with minimum signal propagation delays (source: S⁴ GmbH)

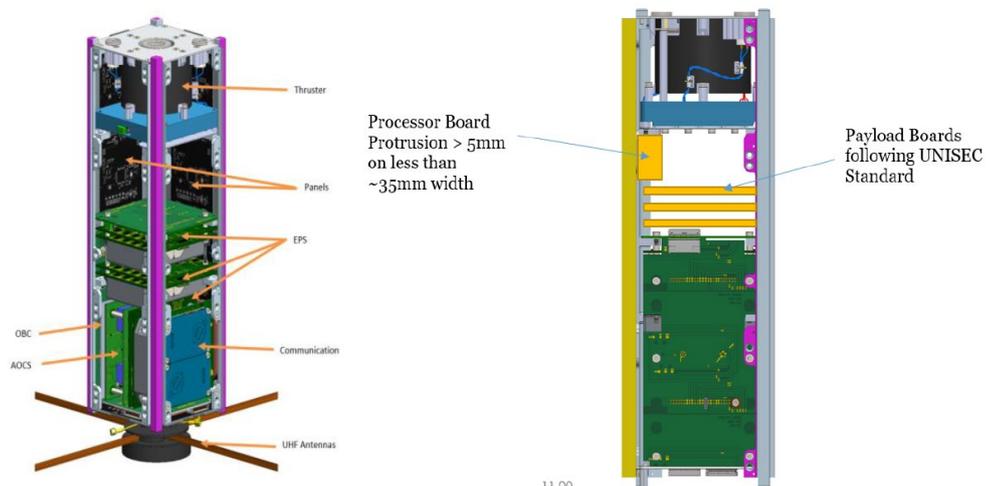


Image 2: A view into the interior of LoLaSat illustrates the modular CubeSat concept from S⁴ GmbH (source: S⁴ GmbH)

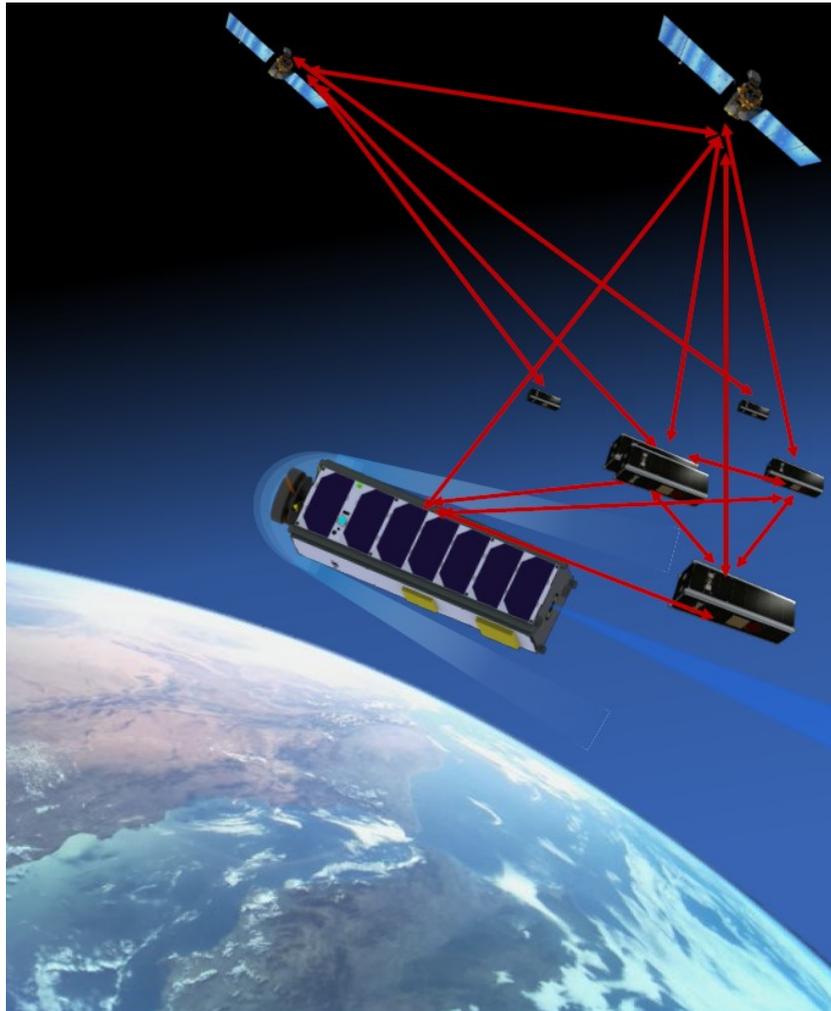


Image 3: The vision of future „LoLaSat“ formations of small satellites, complementing traditional satellites, to support crucial real-time performance applications such as autonomous driving, control of drones for transports, and emergency response in a cost-efficient way. (Quelle: S⁴ GmbH)