TTTECH

NASA'S ORION SPACECRAFT

Systems integration with
Deterministic Ethernet

AEROSPACE
by TTTECH

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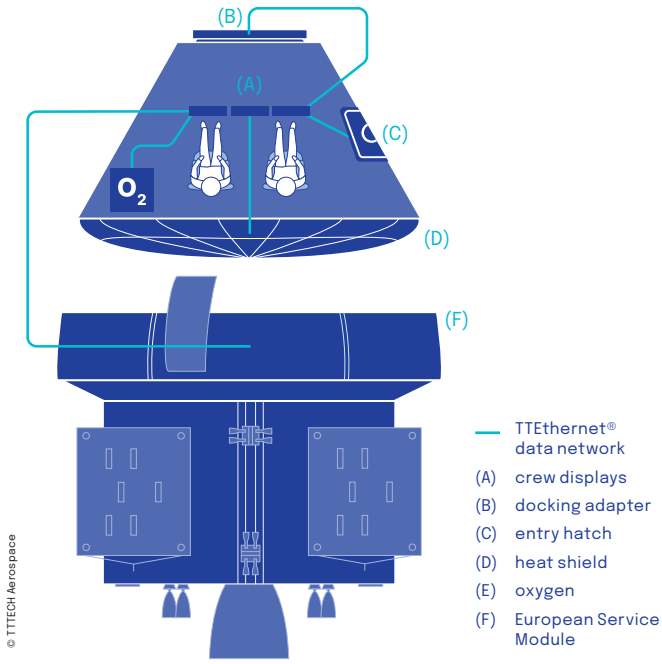
NASA ORION IS CURRENTLY THE ONLY CREW VEHICLE IN EXISTENCE THAT IS ABLE TO SURVIVE RE-ENTRY FROM LUNAR ORBIT. ORION IS AN INTEGRAL PART OF NASA'S ARTEMIS PROGRAM THAT WILL BRING HUMANITY BACK TO THE MOON AND ESTABLISH A PERMANENT LUNAR BASE.

ORION – NASA'S UNIQUE CREW VEHICLE: RELYING ON A TTETHERNET®-BASED AVIONICS NETWORK

After two uncrewed test flights in 2014 (EFT-1) and Artemis I (2022), Orion completed its first successful crew mission and lunar flyby in April 2026 ("Artemis II"), taking humans further into space than ever before. On board of all these missions was key technology from TTTECH. One of Orion's most important systems is the avionics system, often described as the "central nervous system" of the spacecraft.

It consists of a wide variety of electronics implemented into various independent systems, each responsible for performing specific, often critical functions. TTEthernet is at the core of this "central nervous system" supporting a mixed-criticality architecture. It enables the use of one single network for critical and non-critical data with three traffic classes, i.e. best effort, rate-constrained and Time-Triggered Ethernet, making it highly flexible and modular.

All independent avionics sub-systems of Orion are connected by using this single, fully deterministic high-performance Ethernet network technology developed by TTTECH and evolved in collaboration with NASA into an open standard (SAE AS6802). TTEthernet was also baselined by NASA and its international space agency partners in the International Space Interoperability Standards (IASIS) for avionics networks for Artemis and future space missions.



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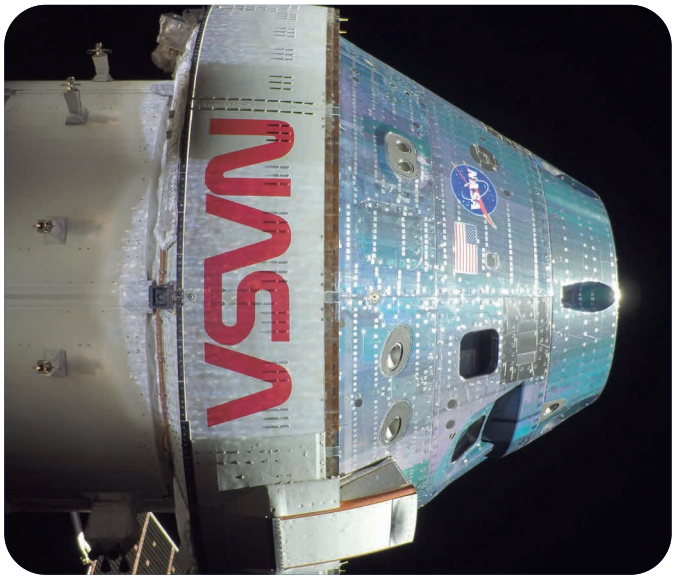

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AT A GLANCE

CUSTOMER / PROJECT	NASA/Lockheed Martin/Honeywell Aerospace - on-board TTEthernet data network and TTEthernet testing infrastructure
CHALLENGE	The customers required a future-proof, high-bandwidth data network with advanced safety features (fault tolerance in particular) for upcoming deep space missions.
SOLUTION	TTTECH Aerospace offered a certifiable, Ethernet-based solution which can handle both synchronous and asynchronous traffic without any conflicts and thus maximizes data throughput on Gbit/s Ethernet lines while minimizing latency and jitter.
TTEthernet:	TTEthernet solution: uniquely integrates three standards i.e. IEEE 802.3, ARINC 664 part 7 and SAE AS6802 (Time-Triggered Ethernet). It is also used as digital backbone in the Ariane 6 launch vehicle and the Time-Triggered Ethernet traffic class is now also covered by an ECSS standard.

FUTURE-PROOF DIGITAL BACKBONE

TTEthernet® is a highly deterministic version of Ethernet and is fully compatible with the standard IEEE Ethernet networks found in every office around the world. On board of Orion, TTEthernet is capable of connecting up to 48 communication endpoints over 18 deterministic switches.

TTEthernet moves data at a rate 1,000 times faster than in Space Shuttle era human-rated spacecraft.

As a single network, TTEthernet supports all of Orion's data transfers and communication with reduced cabling (less mass). In addition, the simpler architecture enabled significant cost savings with respect to software development and integration/testing. NASA and its prime contractor Lockheed Martin can seamlessly integrate highly critical real-time functions like flight controls and life-support systems with lower priority data on one single physical network while guaranteeing predictable system behavior.

TTTECH Aerospace provided TTEthernet chip IP, software, scheduling tools and various TTEthernet equipment for ground-based development and test purposes (switches with and without monitoring capability and interface cards in different form factors).

TTE Network Interface Cards

TTE Monitoring Switch

> *Every display, every control input, every thruster firing – every bit of data inside the vehicle travels across the Time-Triggered Ethernet network. And the good news is that we never hear a word about the avionics system or the network. It's performing perfectly. The crew never has to think about it. It just works.*

TODD SMITHGALL
Senior Customer Solution Architect at TTTECH

TTTECH

ABOUT TTTECH AEROSPACE

TTTECH Aerospace supplies and develops highly dependable networking and embedded computing platform solutions for time-, mission- and safety-critical applications. Its products are based on open data networking standards (Ethernet, ARINC 664 part 7, TSN), time-triggered technology, and deep know-how in safety certification. Its network switches and network interface solutions are used by global champions and technology leaders such as Collins Aerospace, Honeywell, or Thales, and can be found, for example, in the Airbus A- 220, Boeing 787 and Embraer C-390 aircraft, NASA's Lunar Gateway, the Ariane 6 launch vehicle and in critical infrastructure.

TTTECH Aerospace is a business entity of the TTTECH Group, a globally operating group of high-tech companies, founded and headquartered in Vienna, Austria. TTTECH is the innovator of Deterministic Ethernet and a driving force behind the IEEE TSN and the SAE AS6802 Time-Triggered Ethernet standards. TTTECH North America Inc serves the US market with offices in Andover, MA, and Houston, TX.

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