



BRINGING ORBIT TO EARTH

End-to-End Satellite Simulation
for SATCOM Validation

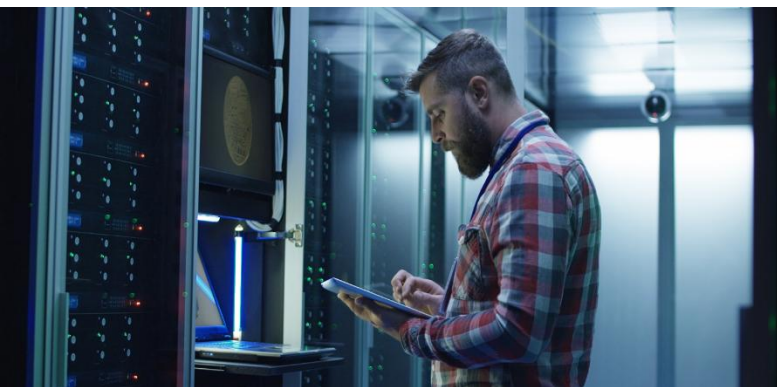
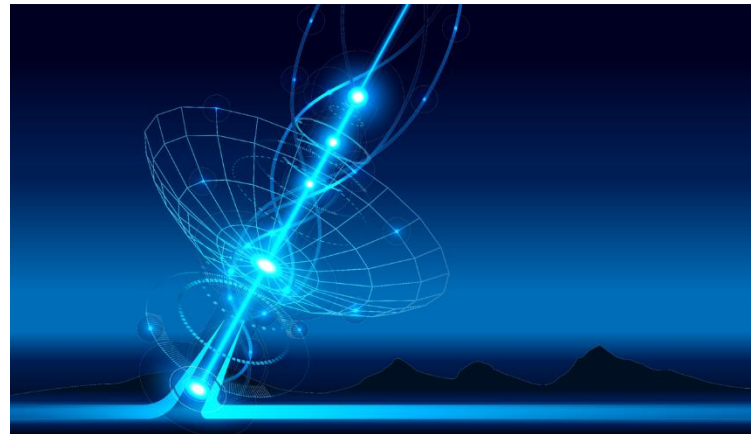
Application Note

MORE MISSIONS, MORE SYSTEMS, MORE TO TEST

Whether for defense, mobility, enterprise, or emerging 5G-NTN applications, today's satellite communication terminals must meet demanding requirements across diverse frequency bands, orbital layers, and environments. These systems are expected to maintain seamless connectivity across GEO, MEO, and LEO constellations, support multi-band and multi-network operation, and deliver consistent performance under dynamic RF conditions.

FROM LAB TO LIVE: ACCELERATING THE PATH TO OPERATIONAL DEPLOYMENT

To meet these expectations, developers, integrators, and network operators require comprehensive test environments that can simulate real-world satellite behavior, including link dynamics, propagation impairments, and network variability. Effective testing must support both lab and field scenarios, allow for end-to-end link validation, and provide detailed insight into performance metrics, all while remaining flexible, scalable, and cost-efficient.



POWERING TOMORROW'S SATELLITE CONNECTIVITY TESTBED

NOVELSAT's test equipment suite provides a modular and field-proven solution for comprehensive SATCOM terminal testing, supporting a wide variety of systems and applications including 5G-NTN, airborne terminals, tactical platforms, on-the-move solutions, and fixed installations.

HIGHLIGHTS

- Realistic SATCOM terminal testing from lab to field
- Advanced satellite channel simulation with configurable impairments
- Ka-/Ku-band transponder emulation with static and dynamic coverage patterns
- Field-recorded signal replay with Recorder/Player
- Supports use cases from 5G-NTN and On-the-Move to airborne and defense terminals
- Modular, scalable platform for development, QA, and production testing

INSIDE THE TOOLBOX: NOVELSAT'S TEST EQUIPMENT SUITE

NOVELSAT's test equipment suite includes the following systems:

SAT-SIM Satellite Channel Simulator

Emulates complex satellite channel impairments such as delay, Doppler, phase noise, attenuation, and non-linear distortions, supporting simulation of real-world conditions across LEO, MEO, and GEO orbits. Built on a software-defined radio (SDR) platform, it provides local or remote control with full script automation, a programmable AWGN noise generator, and an integrated spectrum analyzer. The system supports up to 600 MHz channel bandwidth, single- or dual-channel operation with high dynamic range, and static or dynamic modeling of all major channel effects, including trajectory-based simulation through STK integration. Flexible clocking options with internal or external references, together with a compact and cost-efficient design, make it suitable for a wide range of performance testing and validation requirements.



Xemulator Satellite Transponder Emulators

Simulates real transponders across Ku and Ka bands, with indoor and outdoor models available for both lab and field environments. The system can operate as a standalone unit or be integrated into a hub setup, supporting full RF performance testing without live satellite coordination. It features an L-band interface with programmable gain and attenuation, a wide coverage angle option for field deployment, and a rugged yet compact design that ensures consistent operation across diverse testing conditions. Low power consumption, flexible configuration, and straightforward setup make it ideal for outdoor and field testing. Moreover, Xemulator supports both cross-polarization (X-pol) and the more challenging co-polarization (co-pol) scenarios across a wide frequency range, enabling highly versatile and realistic test conditions.



SAT-SIM Recorder/Player

Captures live RF signals in the field and replays them in the lab with full waveform fidelity, enabling repeatable testing of edge-case scenarios and complex RF environments. Designed to seamlessly complement the SAT-SIM Satellite Channel Simulator, it supports up to 250 Msps complex sample rate across up to four subchannels and records full satellite transponders up to 216 MHz bandwidth. Swappable SSDs allow extended-duration recording, while excellent spurious signal rejection ensures accurate reproduction of real-world conditions.

Together, these tools provide a complete end-to-end simulation and emulation environment, supporting static or mobile terminal testing and multi-terminal validation.

BRIDGING THE GAP BETWEEN DEVELOPMENT AND DEPLOYMENT

Designed for both lab and field use, NOVELSAT's test equipment suite delivers a flexible and realistic environment for validating satellite communication systems across a wide range of operational scenarios:



5G-NTN Testing

The SAT-SIM and Xemulator test suite offers a complete environment for testing dynamic RF conditions for 5G-NTN ground terminals. It enables full simulation of the satellite RF conversion and channel transfer functions, including Doppler shifts, delay, attenuation, and dynamic impairments, across both forward and return links. Simply connect your gNodeB or NTN Hub to the Xemulator, and your user terminal to the other end, to emulate the entire space-ground channel without requiring access to satellite capacity.



On-the-Move SATCOM Simulation

For testing SATCOM-on-the-move terminals in realistic conditions, the Xemulator can be installed inside a hangar (suspended from the ceiling) or mounted on the edge of a building. This setup allows dynamic testing of handheld, vehicle-mounted, and airborne terminals, including drones and UAVs, while they are in motion. The system emulates realistic satellite transponder behavior, ensuring repeatable and precise testing for mobility applications.



LEO Satellite Field Simulation

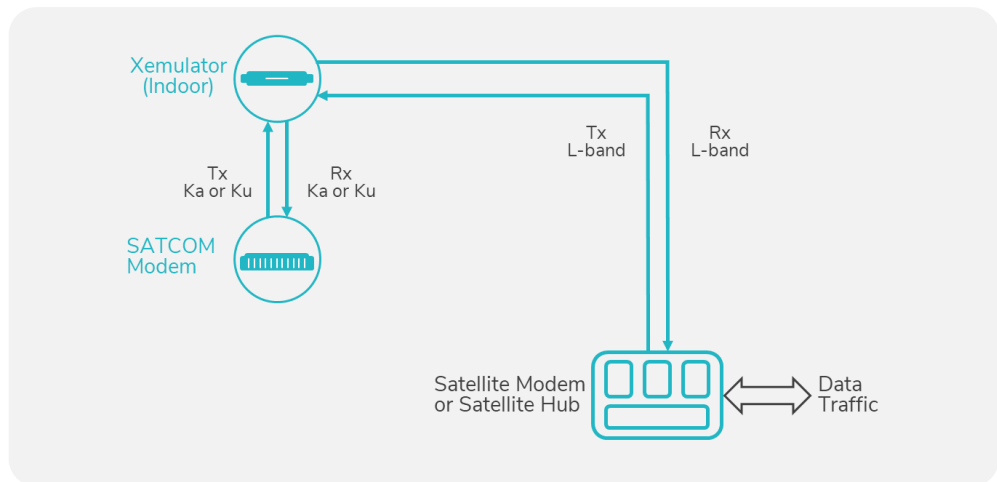
Before your satellite is in orbit, test your ground segment with a drone-mounted version of the Xemulator. By simulating a live LEO satellite transmission and trajectory while testing both fixed and on-the-move ground terminals in the field, you can validate communication links, antenna tracking, and end-to-end system behavior in highly dynamic, real-world conditions. Ideal for both fixed and mobile terminals, this comprehensive field setup reduces development risk, shortens integration cycles, and brings your LEO system one step closer to readiness.

CONNECTING THE DOTS: REAL-WORLD SETUPS AND SCENARIOS

The following test setups illustrate how NOVELSAT's suite of simulation and emulation tools can be applied by developers and operators to model complex link dynamics, reproduce real-world signal conditions, and evaluate performance across both lab and field environments.

1. Lab Unit Testing:

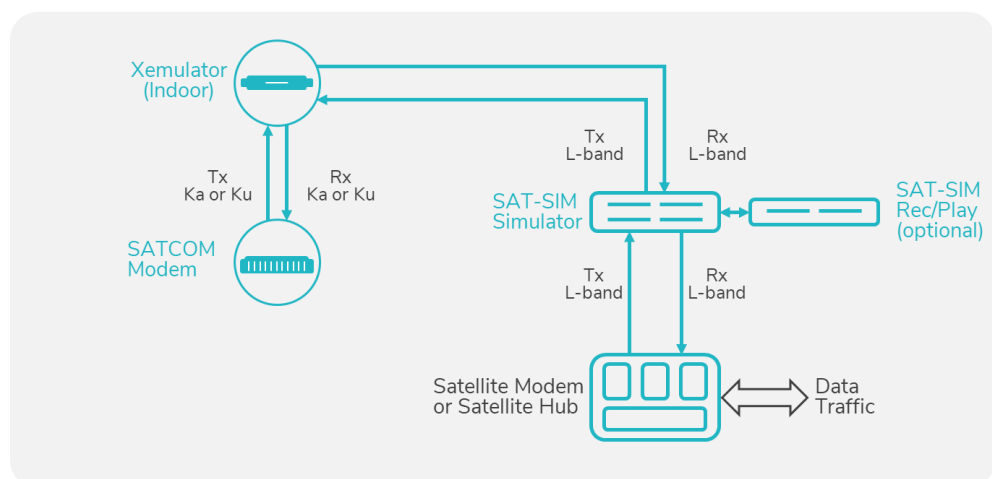
Single Modem Testing Using Indoor Xemulator (Ka/Ku)



SATCOM Lab

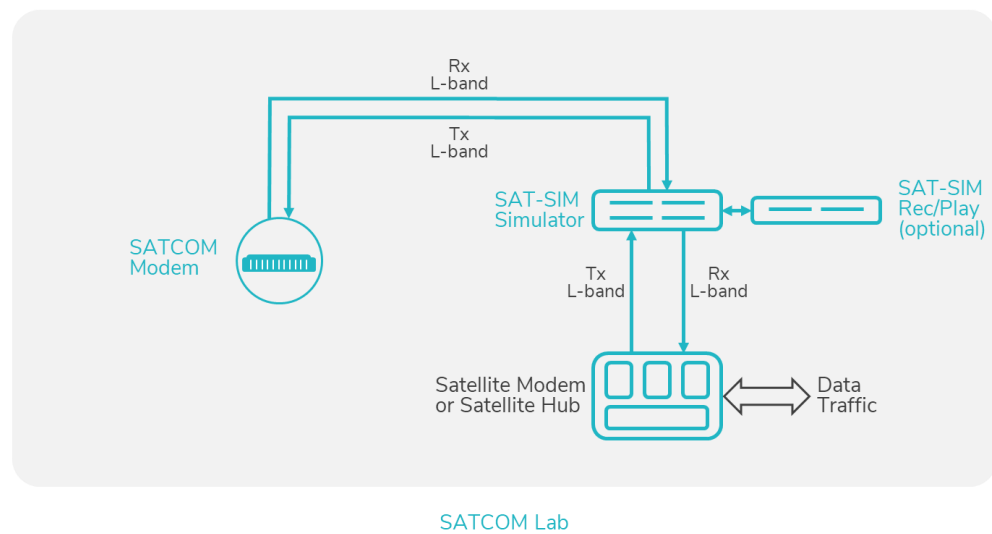
2. Lab Unit Testing:

Single Modem Testing Using Indoor Xemulator (Ka/Ku) and SAT-SIM

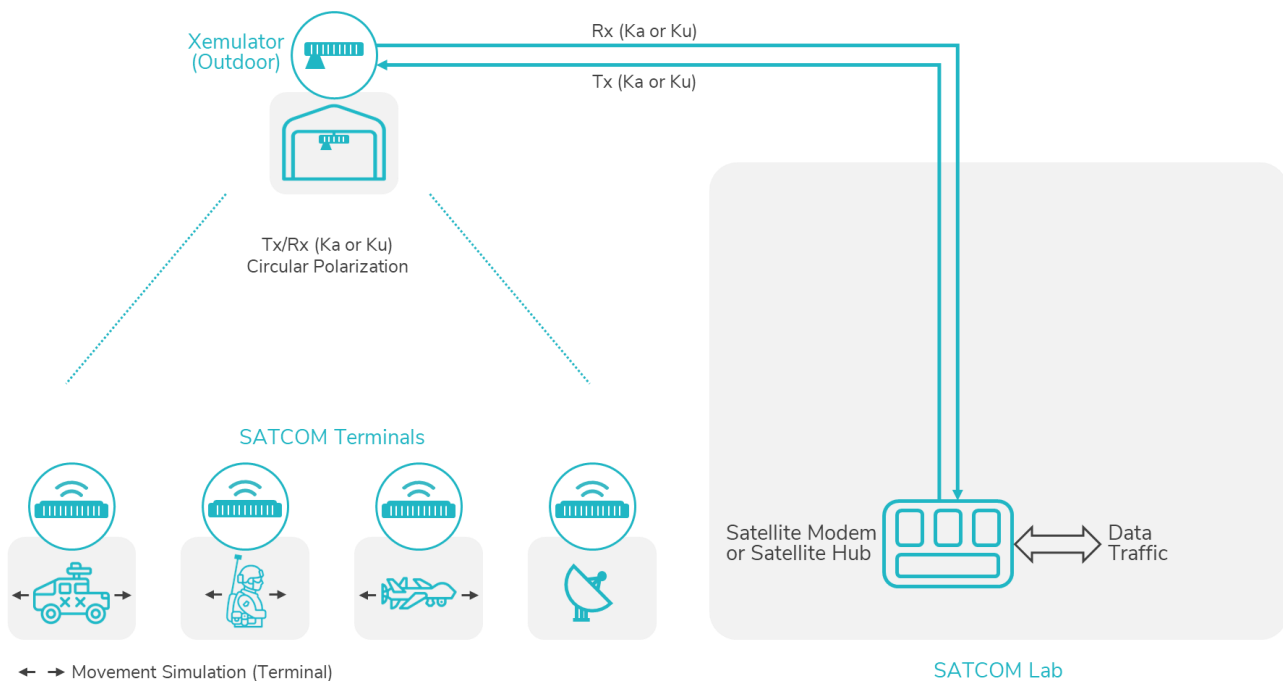


SATCOM Lab

3. Lab Unit Testing: Single Modem Testing Using SAT-SIM

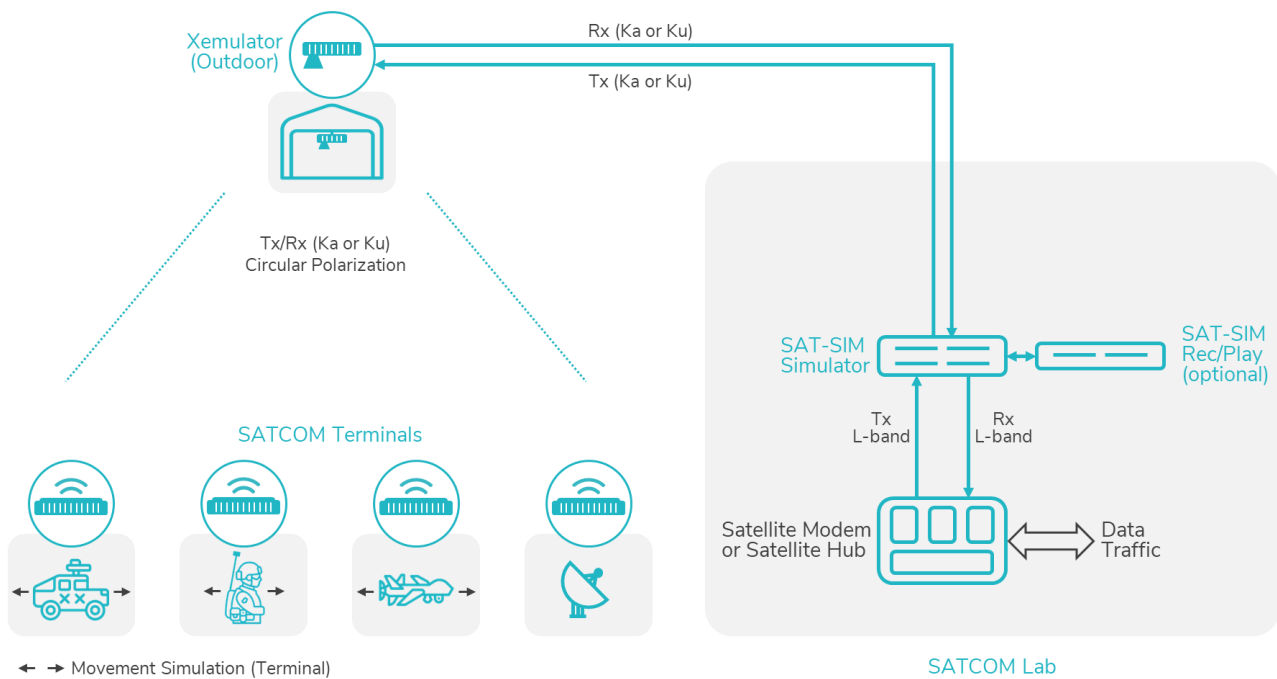


4. Field System Testing: Multiple Terminals Testing Using Fixed Outdoor Xemulator (Ka/Ku)



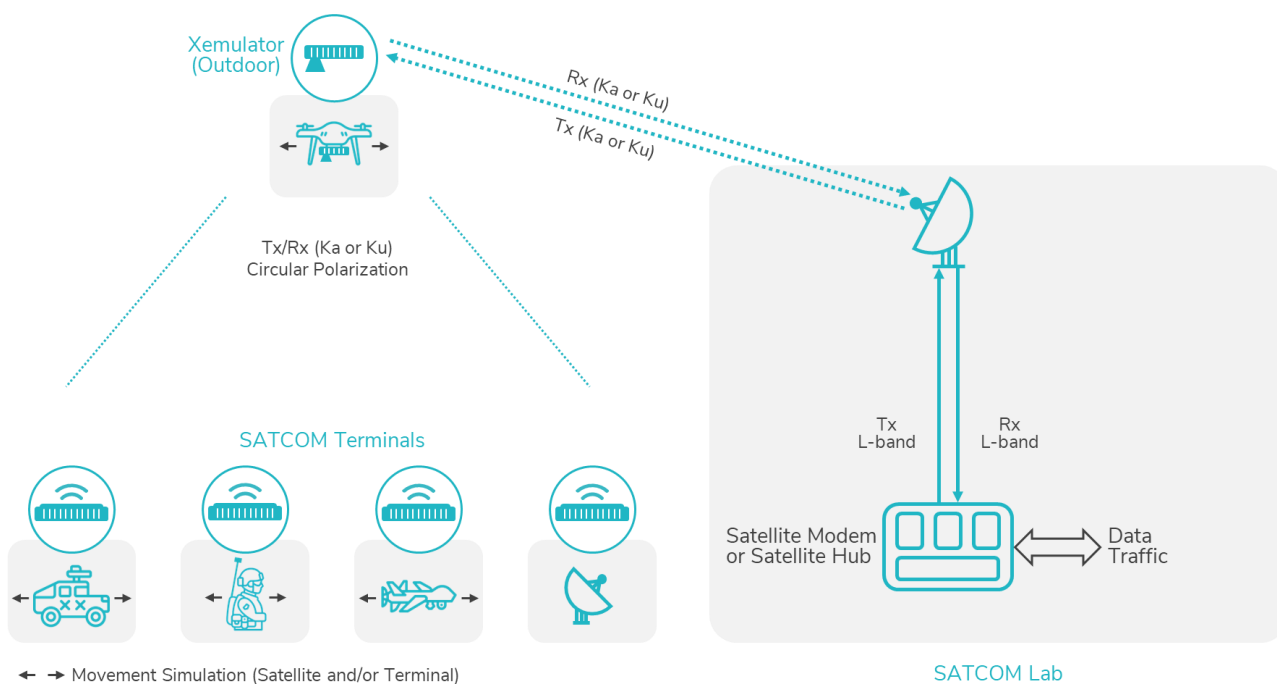
5. Field System Testing:

Multiple Terminals Testing Using Fixed Outdoor Xemulator (Ka/Ku) and SAT-SIM



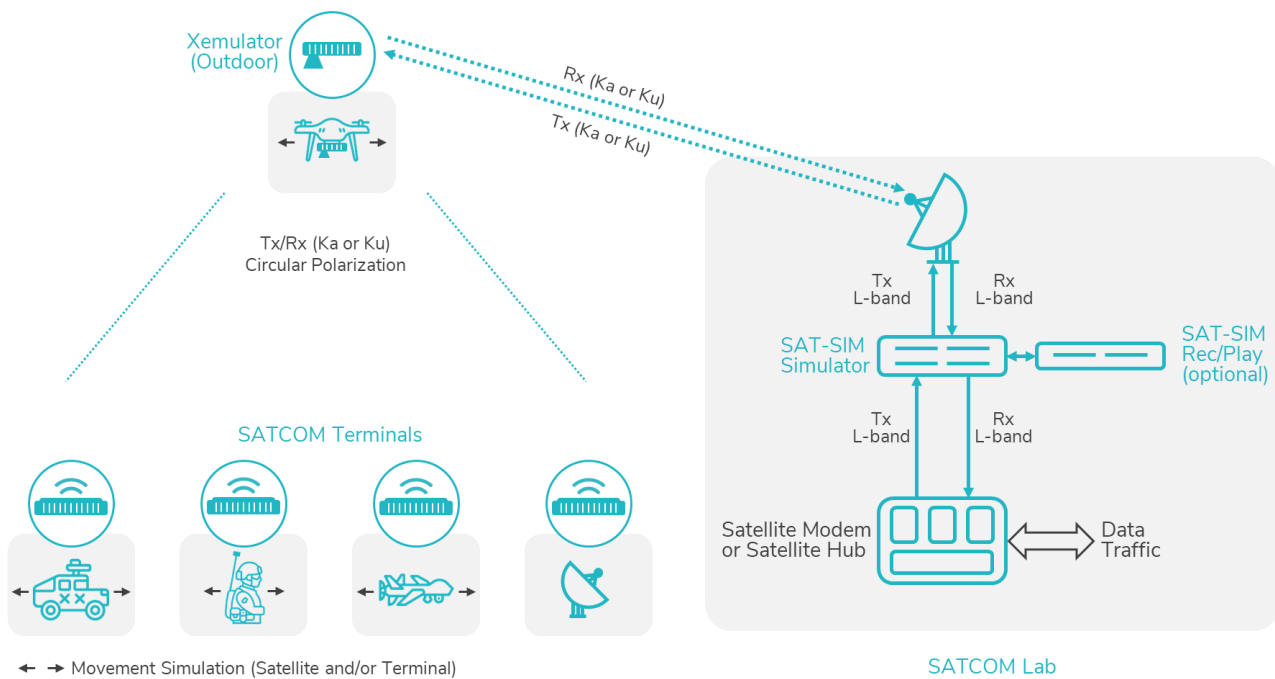
6. Field System Testing:

Multiple Terminals Testing Using Airborne Outdoor Xemulator (Ka/Ku)



7. Field System Testing:

Multiple Terminals Testing Using Airborne Outdoor Xemulator (Ka/Ku) and SAT-SIM



From early prototyping to final qualification, NOVELSAT's test equipment suite enables developers, integrators, and operators to replicate the exact conditions their systems will face in orbit and on the ground. By combining satellite transponder emulation, channel impairment simulation, and real-world signal replay in a single, integrated environment, it delivers the accuracy and control needed to validate performance with confidence. Whether in the lab or the field, across GEO, MEO, or LEO missions, it empowers teams to accelerate development, reduce risk, and ensure flawless operation from day one.