



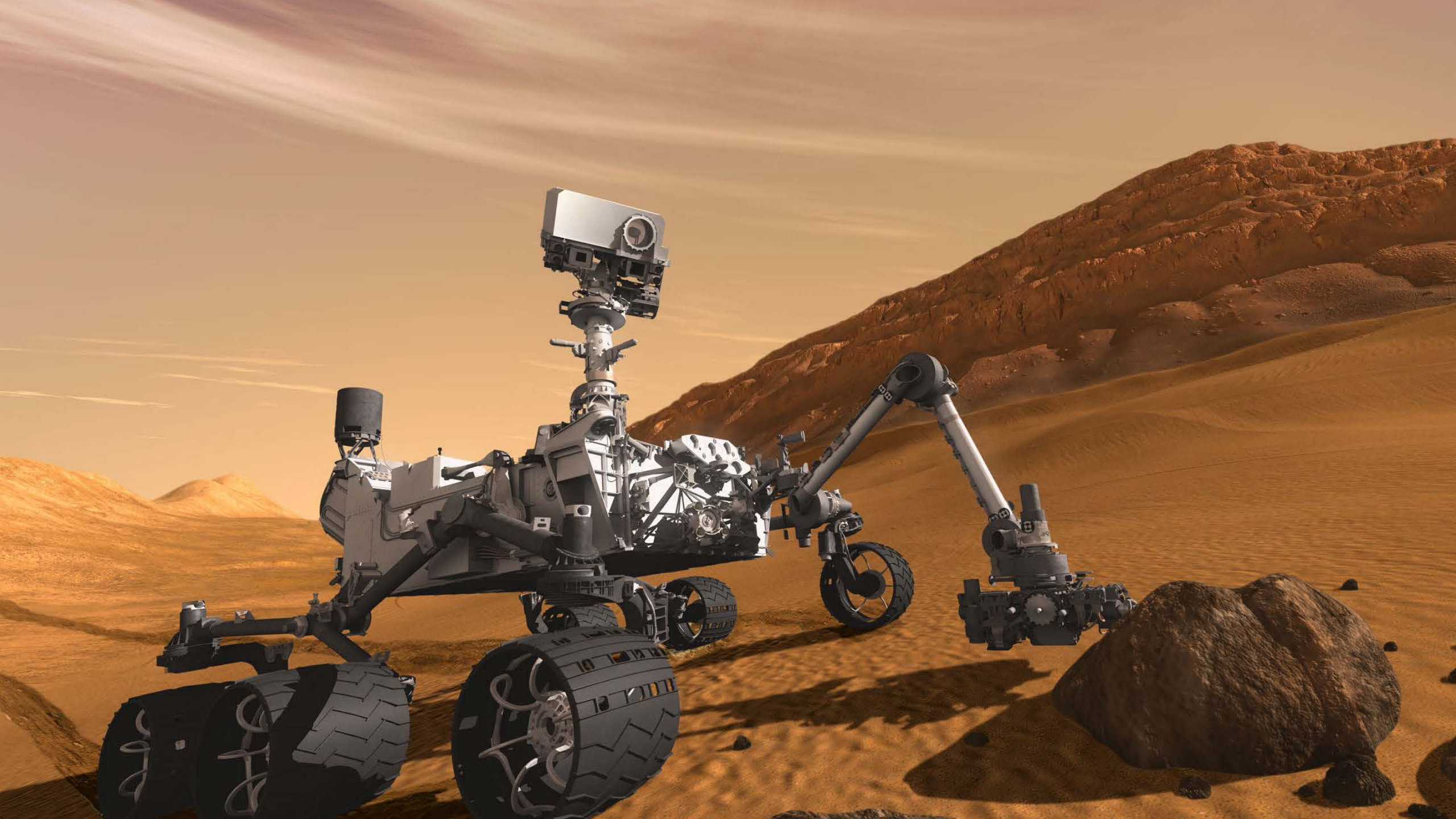
Space CompactPCI® Serial and Conduction Cooling Solutions

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21 January 2016

Lockheed Martin ARTC ATMS Project Utilizes Satellites







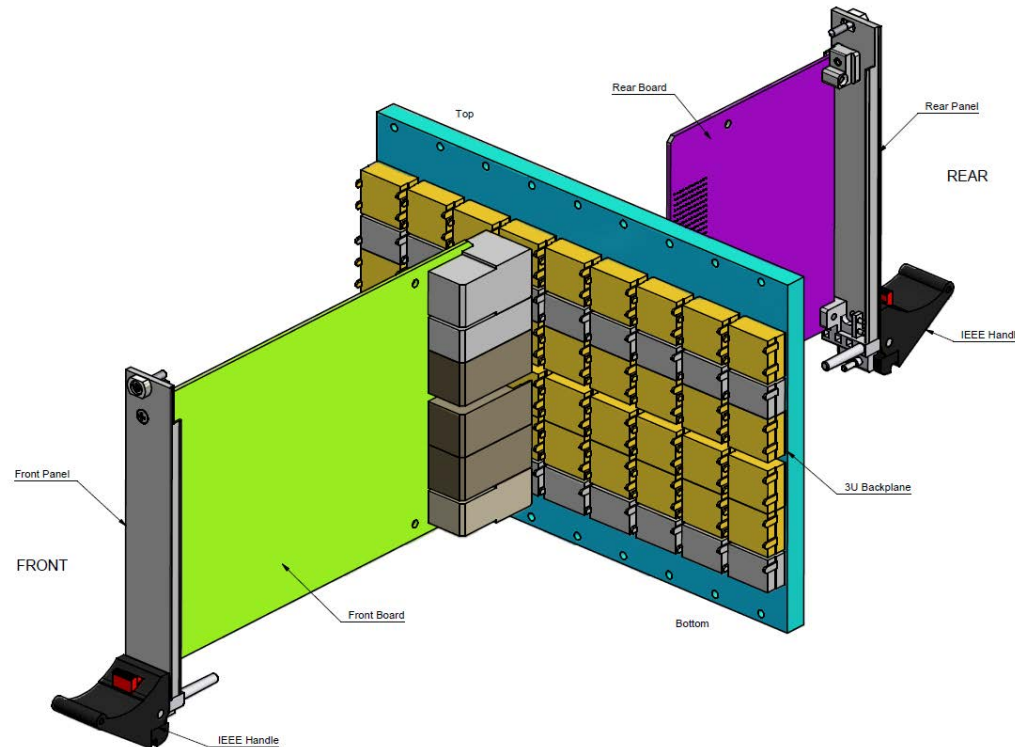
What is *CompactPCI Serial*?

CompactPCI[®] Serial (PICMG CPCI-S.0)



Extension of the well-established CompactPCI standard, ratified in 2011

- Overcomes the I/O speed limitations of the parallel CompactPCI bus interface
- Uses exclusively high-speed serial bus communications, available concurrently across the midplane
- Uses existing mechanics (Eurocard)

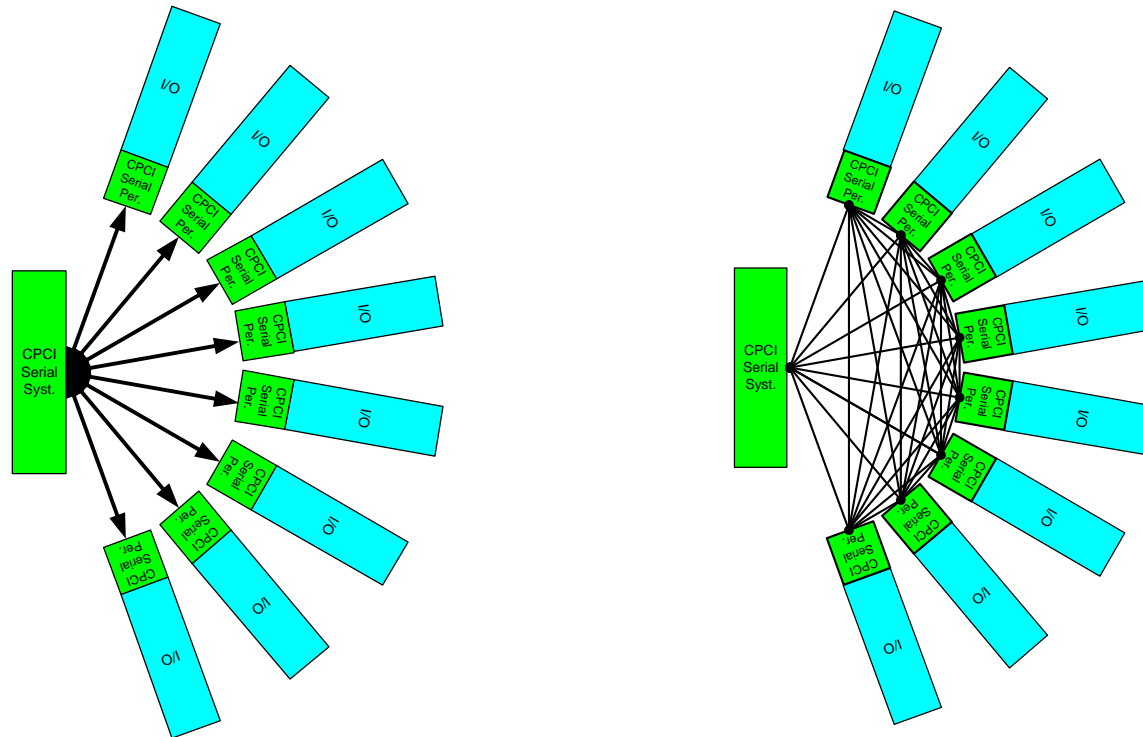


CompactPCI Serial Architecture



All serial interconnects available simultaneously over the backplane

- Simple star for PCI Express, SATA and USB
- Combined with a complete mesh for Ethernet
- Functions without switches and bridges



CompactPCI Serial Application Example - Railway



- Advanced Train Management System (ATMS) to increase capacity and safety
- **Partitioning of vital and non-vital applications on one platform**
- Vital 6U CompactPCI system based on board-level 2003 architecture
- 3U CompactPCI hybrid system based on 2 CompactPCI PlusIO Intel Core 2 Duo CPU cards
- **Certifiable up to SIL4 (VxWorks Cert, Linux)**
- Full EN 50155 compliance (railways)

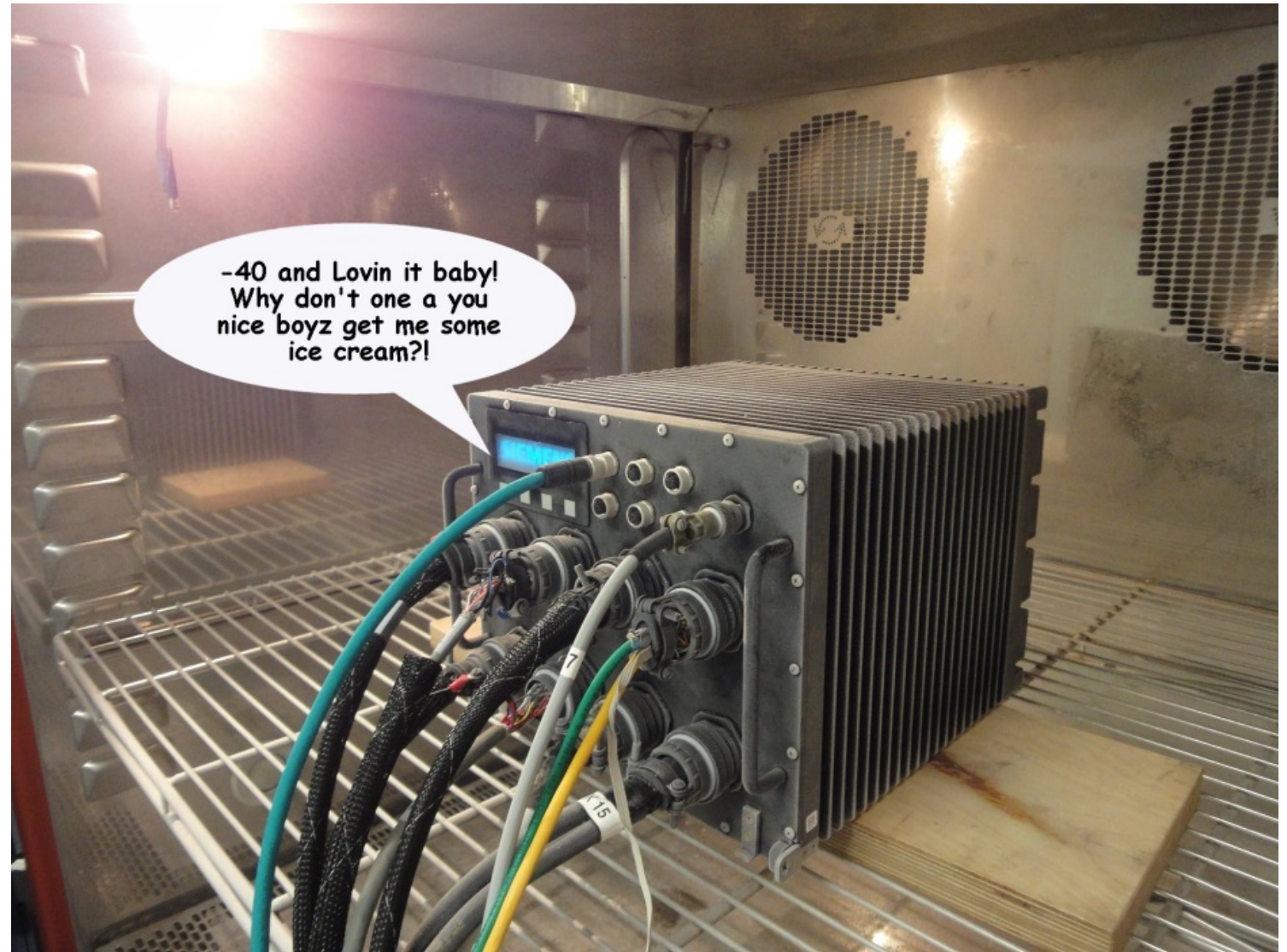


CompactPCI Serial Application Example - Railway



AREMA

American Railway Engineering and
Maintenance-of-Way Association





Oilfield Server & Communications Hub

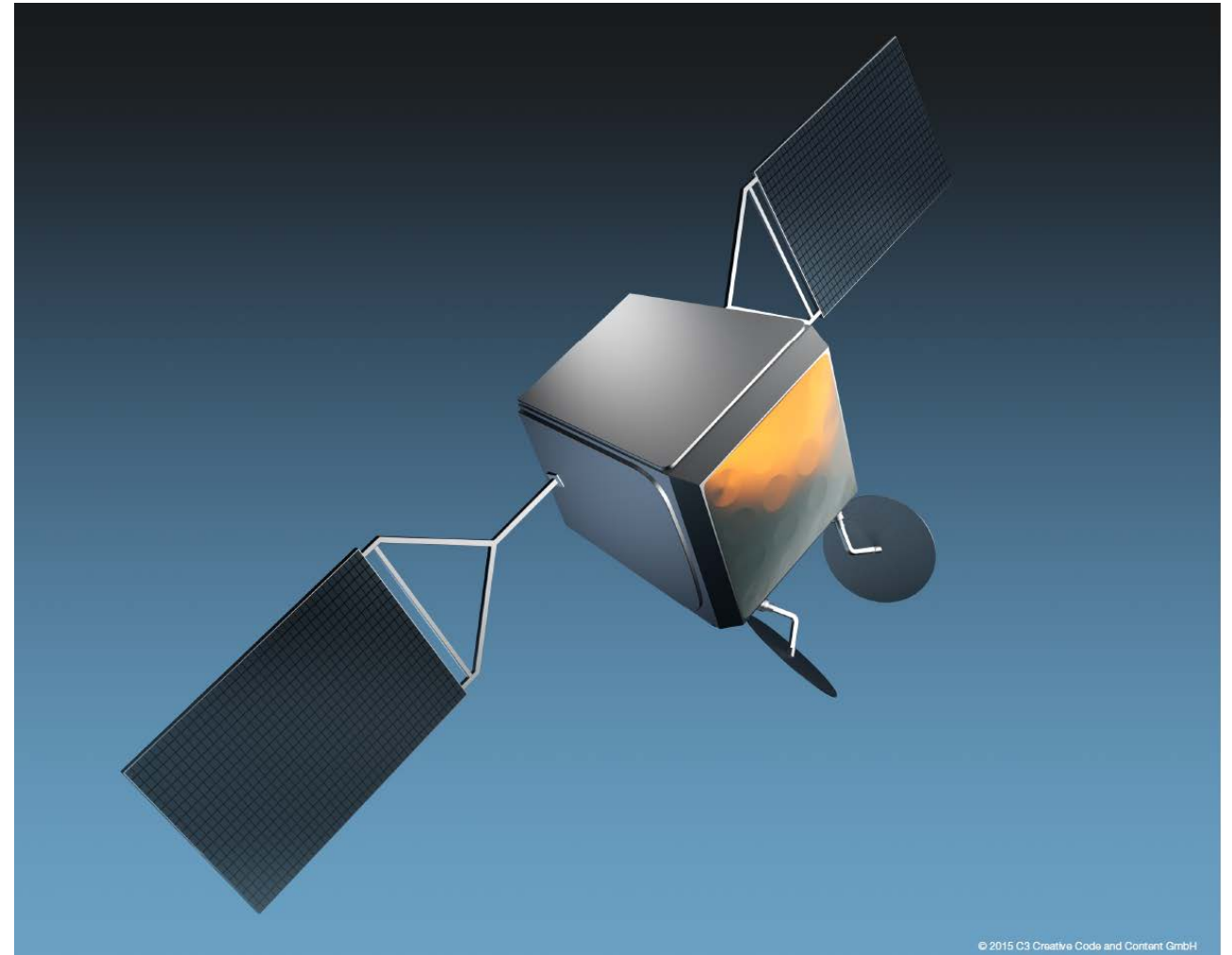


What is *Space CompactPCI Serial*?

Impetus Behind Space CompactPCI Serial Working Group



- Airbus Defense & Space
- Secured contract for OneWeb
- High speed, space based internet access
- Design & build 900 satellites
- First orbiting fleet in 2018
- Less than 150 kg
- Build up to 4 per day
- Size – up to person's hip



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- Satellite projects have traditionally employed federated avionics architectures
- Each computer system is only designed for one specific function
 - Satellite attitude
 - Orbit control
 - Instrument control
 - Payload data processing
- Each computer system uses a different operating system (e.g. RTEMS, VxWorks, etc.)
- Many different busses, networks, and point-to-point connections are used to transport data



How The Challenges Are Being Addressed



- Replace federated avionics architecture with Integrated Modular Avionics (IMA)
- Common computing platform can be leveraged for more than one function
- Open Modular Avionics Architecture for Space Applications (OMAC4S) consortium
- Extend *CompactPCI Serial* to address:
 - **Single-point failure tolerance through redundant power distribution and fault detection**
 - Spare modules that can be powered on and off
 - System management with support for new features
 - Robust system diagnostics
 - **Support for serial interconnections like SpaceWire, TT-Ethernet, and Rapid I/O**



Why CompactPCI Serial for Space?



- Simplicity of the architecture
 - Reduced cost and time-to-market
- Highly defined standard for better interoperability
- Flexibility of the architecture = wide range of applications
- High pin density
- Support of conduction cooling with reduced effort
- CompactPCI Serial is cost optimized
 - Industrial and military / aerospace applications
- Able to address traditional challenges related to space
 - Harsh environment, lifecycle management, weight and volume



Why Did Airbus Select CompactPCI Serial for Space?



Because of its extremely high bandwidth, CompactPCI Serial is particularly well suited for high speed / high bandwidth data communications applications. CompactPCI Serial is well suited for industrial markets including robotics, machine control, industrial automation, research, computer telephony and telecommunications, medical equipment and energy sector applications, and ground transportation and shipbuilding and other mobile markets. **Proven Eurocard mechanics, and conduction cooling capability make CompactPCI Serial an ideal solution for low and moderate cost, modular, mission critical military, and aeronautics applications.**

*Open Modular Computing Platforms in Space
(Airbus a key contributor to this white paper)*

Switch Fabric Slot Slot (proposal)

- Only 2 Ethernets instead of 8
- 14 switched fabric “roots”

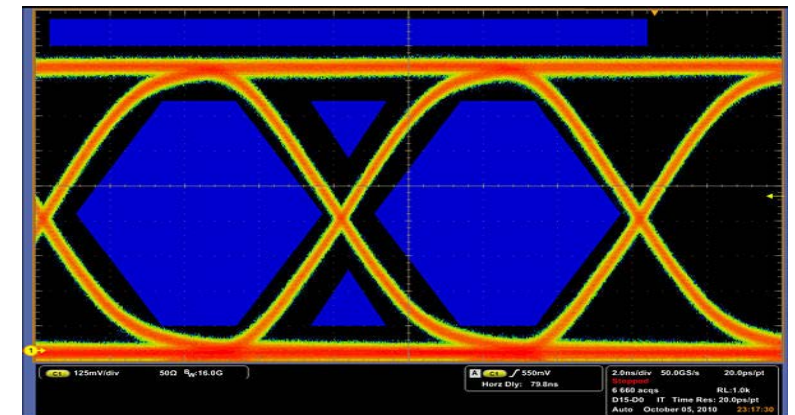
Node slot (proposal)

- Like a normal system slot, but
- Only 2 Ethernets instead of 8
- 2 Switched Fabric Endpoints are defined

Peer-to-Peer Bandwidth

- Up to 100 Gb/s per link (consists of 4 bidirectional differential lanes)

Node Slot	Fabric Switch Slot
2 x SF EP	14 x SF EP
2 x ETH	
I/O	I/O
8 x PCIE Root Compl.	2 x ETH
8 x SATA	1 x SATA
8 x USB	1 x USB
CPCI-S. 0 Master	CPCI-S. 0 Mast/Slave



Design Requirements for Space Applications



Design Assurance
Level up to DAL-A

Accordance with
DO-254 / DO-178B

Reliability and
Redundancy

FPGA Designs

**Conduction
Cooling**

AFDX-based
Communication

SEU Resistance

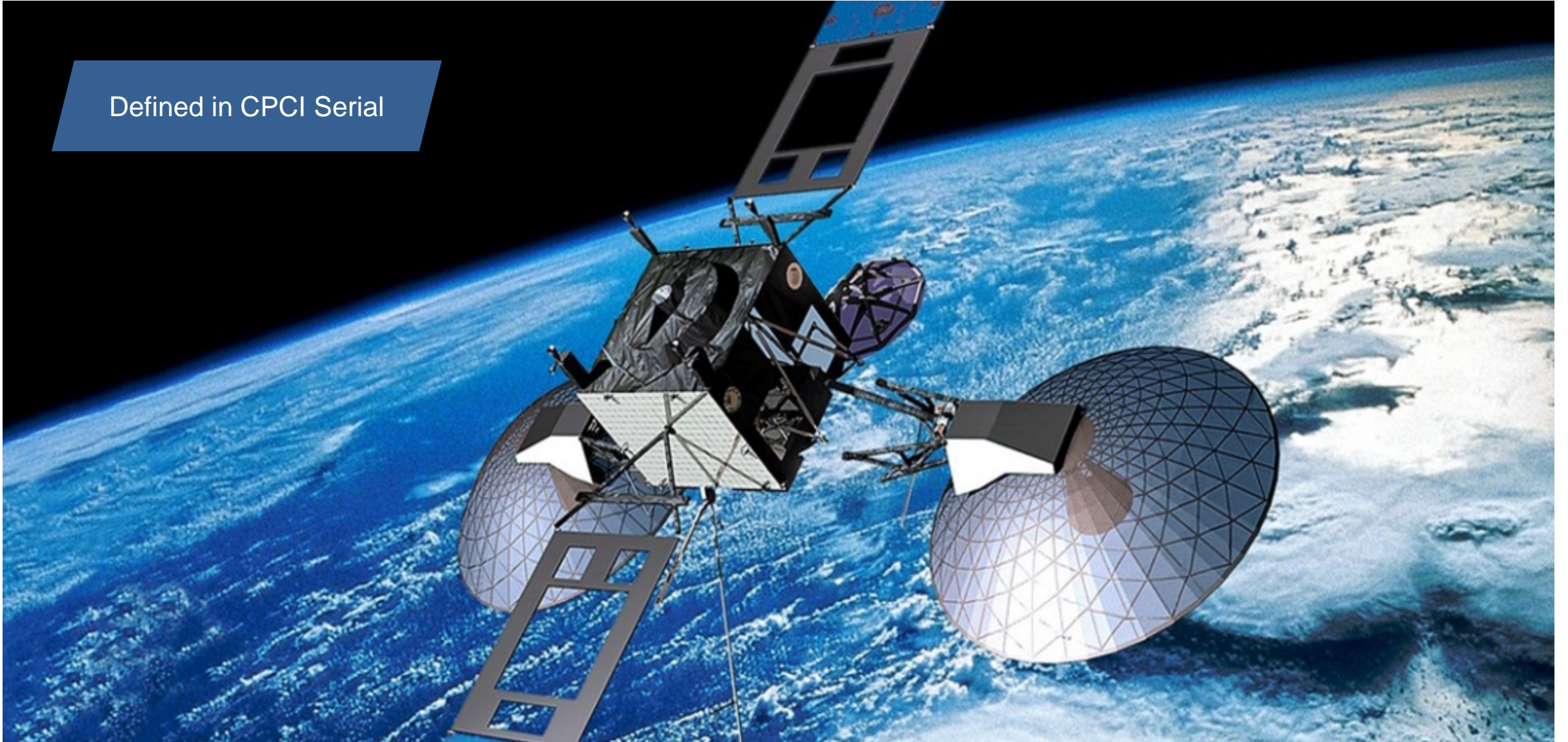
Shock / Vibration
Resistance

Conformal Coating

Conduction Cooling



Defined in CPCI Serial



From COTS to Conduction Cooled



- All 3U CompactPCI Serial convection cooled boards can be converted into a 3U Conduction Cooled Assembly (CCA) version
- Mechanical fixing and thermal coupling of CCA frame to enclosure via wedge-lock technology
- No special PCB layout necessary
- Boards from different vendors can be used
- Very flexible (low NRE, short time to market)
- Extremely robust



The Thermal Concept for Conduction Cooled Boards



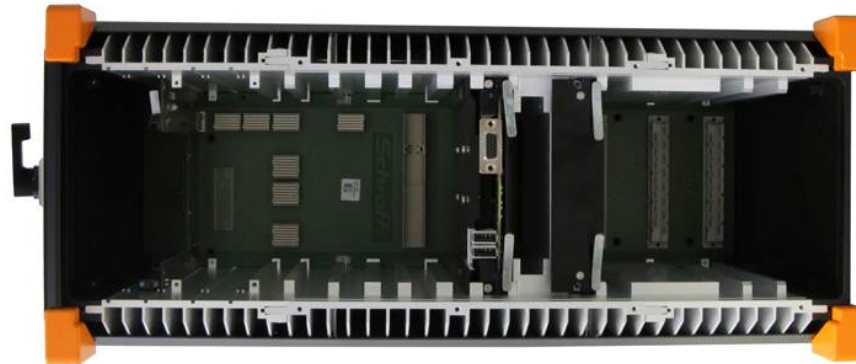
- The frame of the cartridge is replaced by the frame of the board
- Using the PCB helps to transport the heat to the frame
- **The hottest components are coupled directly to the cover**
- The cover transports the heat to the frame and so to the wedge-locks



From Board-Level to System Design



- 3U CCA technology can also be used for system design
- Cooling infrastructure does not require additional space
- Reliable connection without cabling
- Robust and EMC protected





Bringing CompactPCI[®] Serial Technology to Space Applications

A new working group for PICMG's *Space CompactPCI Serial* standard is being assembled. Interested companies are invited to join by contacting info@menmicro.com.