

Space Plug-and-Play Avionics



Denise Lanza, SAIC
Jim Lyke, AFRL/VS
Don Fronterhouse, SSI
Scott Cannon, USU
Wheaton (Tony) Byers, SAIC



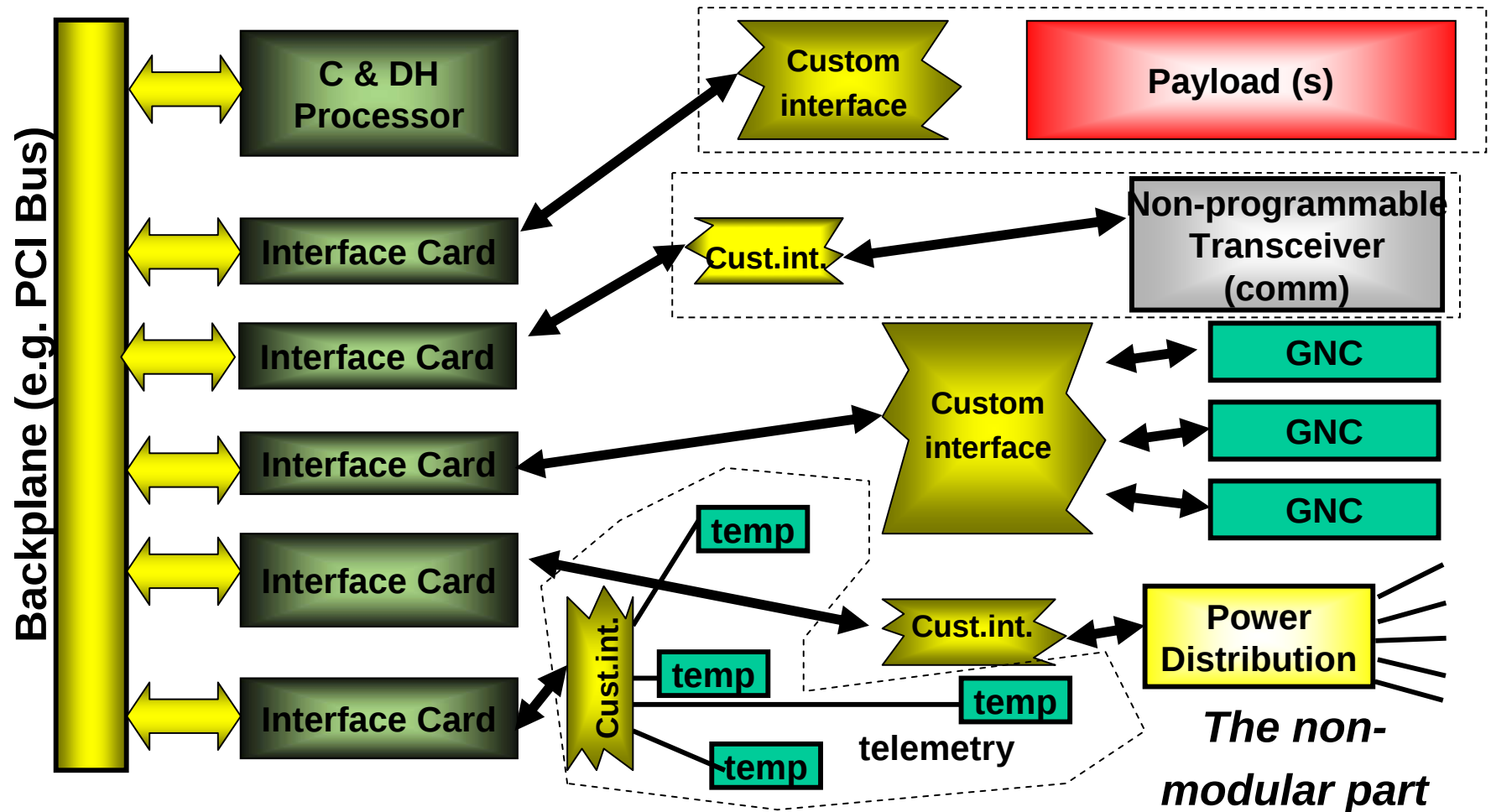
Introduction



- **DoD's Operationally Responsive Space (ORS)**
 - Dramatic reduction in timescale for fielding an operationally useful capability
 - New paradigms in designing, building, integrating, launching, and bringing online tactical space systems
- **To achieve ORS, a number of technology and culture barriers must be addressed**
 - Low-cost launch capability (e.g. DARPA Falcon program)
 - Avionics and software have significant hope for improvement utilizing “plug-and-play” (PnP) technology
- **AFRL Responsive Space Advanced Technology Study (RSATS) identified PnP technologies, especially in avionics, as providing enabling benefit to the cause of ORS**
- **AFRL is spearheading an effort to develop a SPA standard under the auspices of the AIAA**

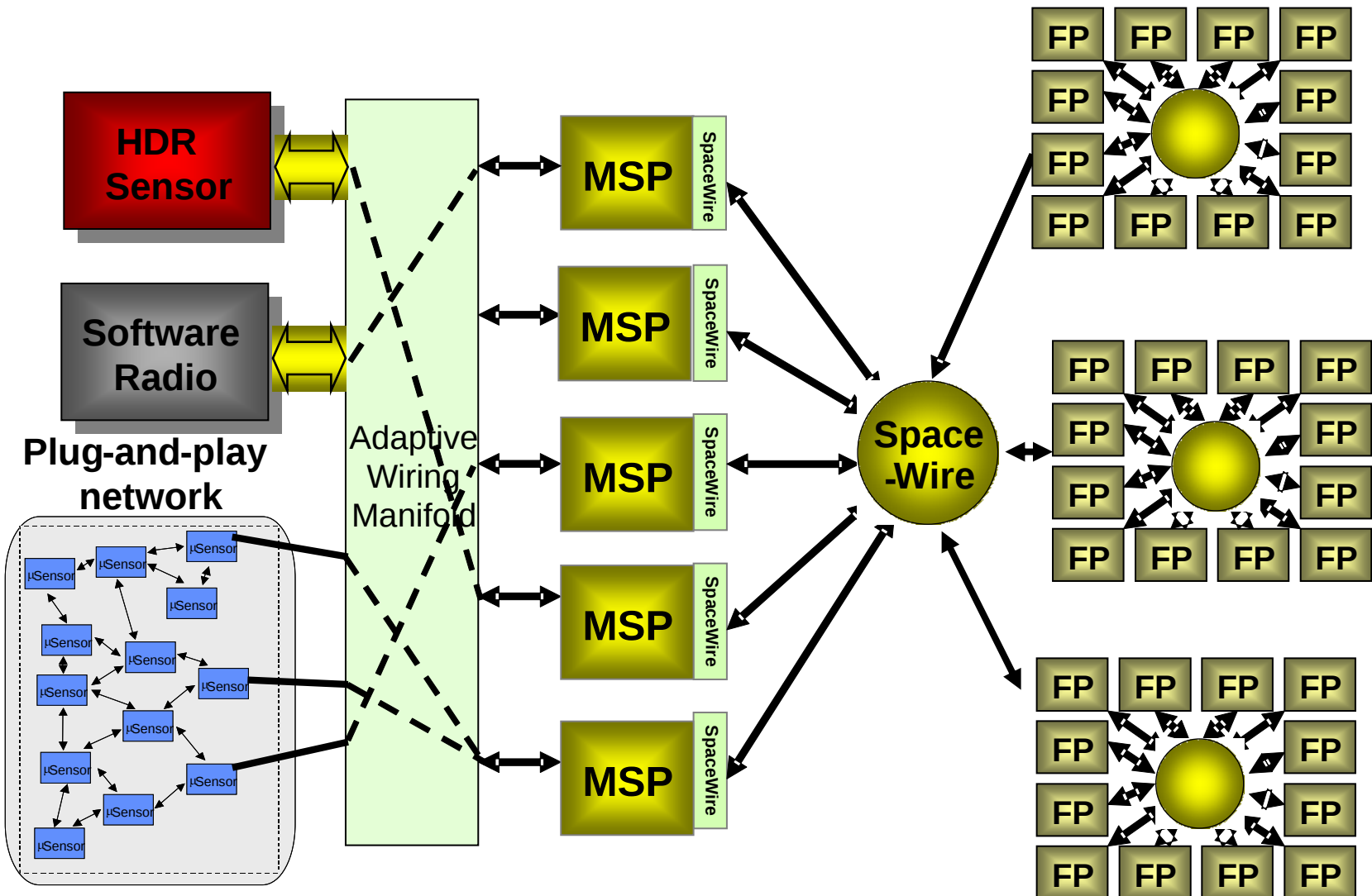


Traditional Satellite Avionics





Plug and Play Avionics High Performance Computing





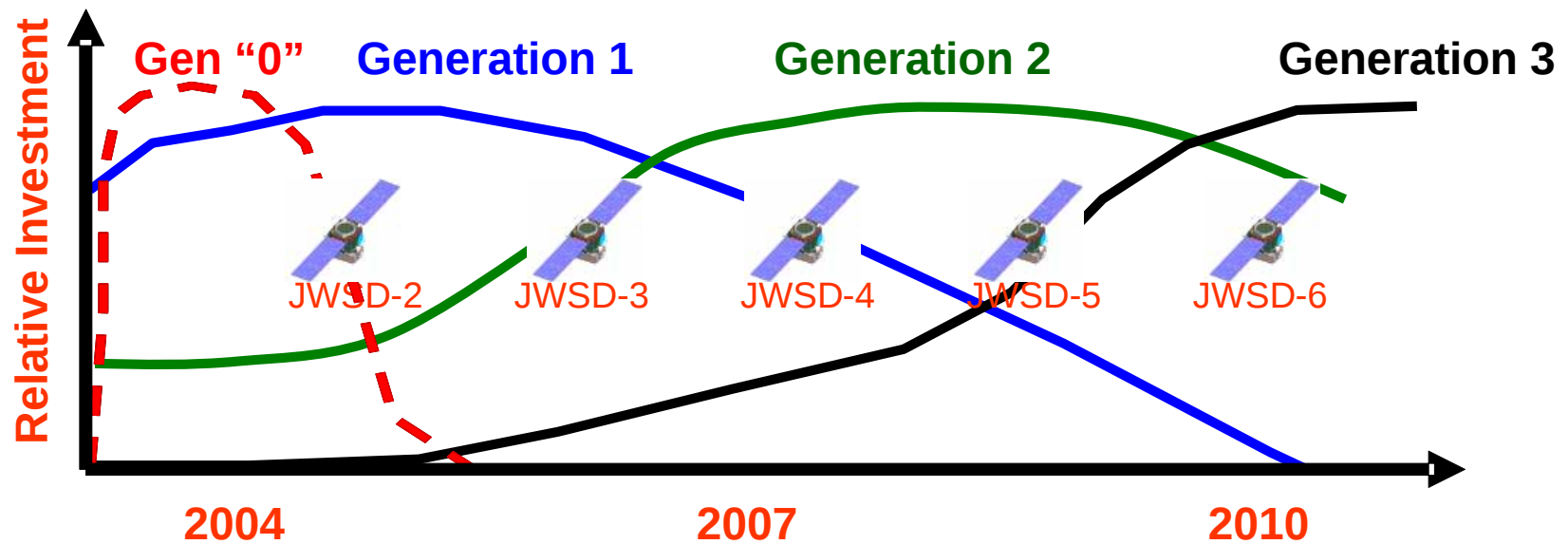
Key Tenets of SPA



- **Machine-negotiated interfaces**
 - Use of commercial standards for physical layer interface
 - Self-describing component-objects (xTEDS & CDD)
 - Managing the component-object collection using Satellite Data Model (middleware)
 - Distributed implementation to break need for centralization
- **Addition of power delivery and synchronization**
- **Applications are written to be PnP aware based on services independent of components**
 - Often more than one source of a desired quantity
 - Component availability based upon need

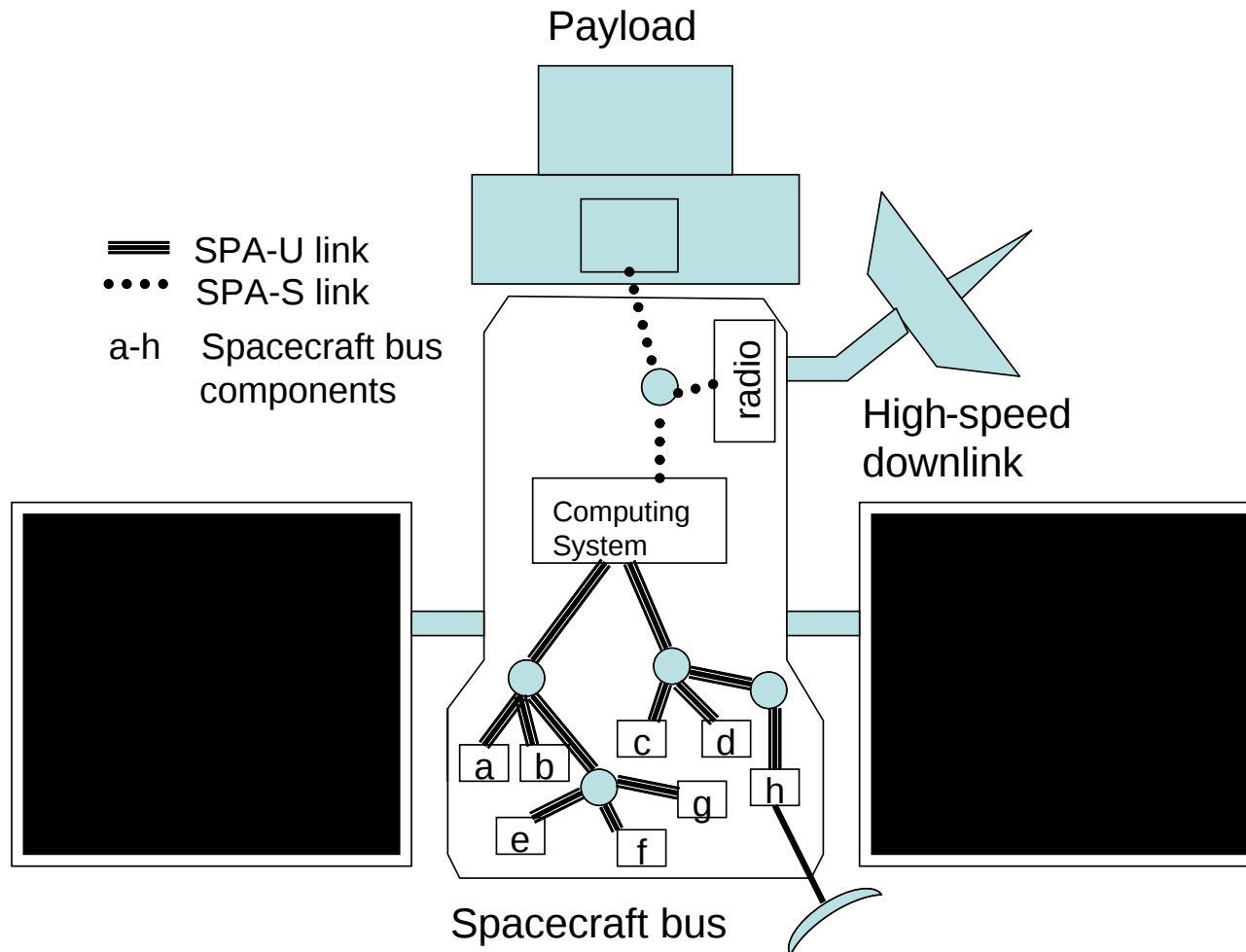


A Phased Approach To SPA Development





Spacecraft as a collection of objects

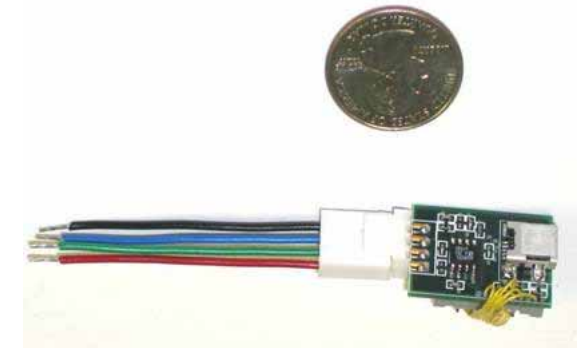
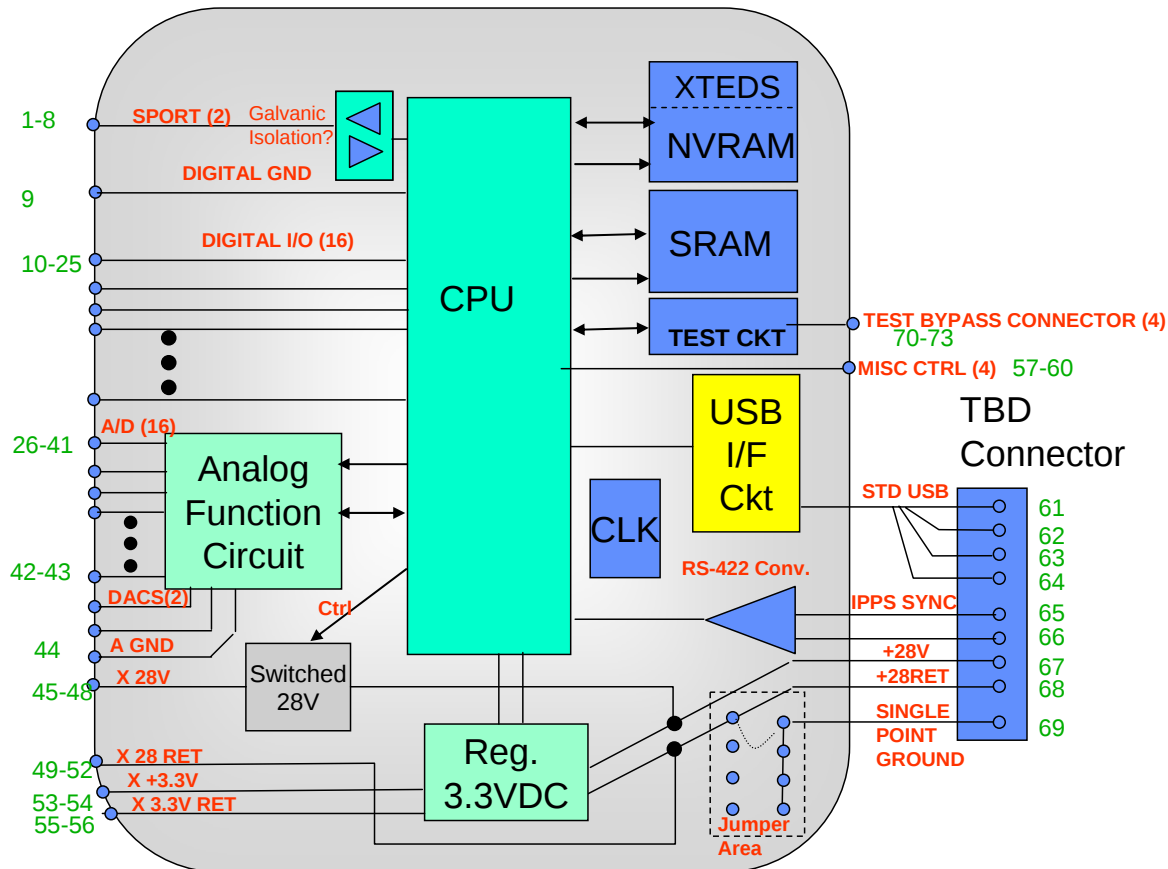




SPA-U Appliqué Sensor Interface Module (ASIM)

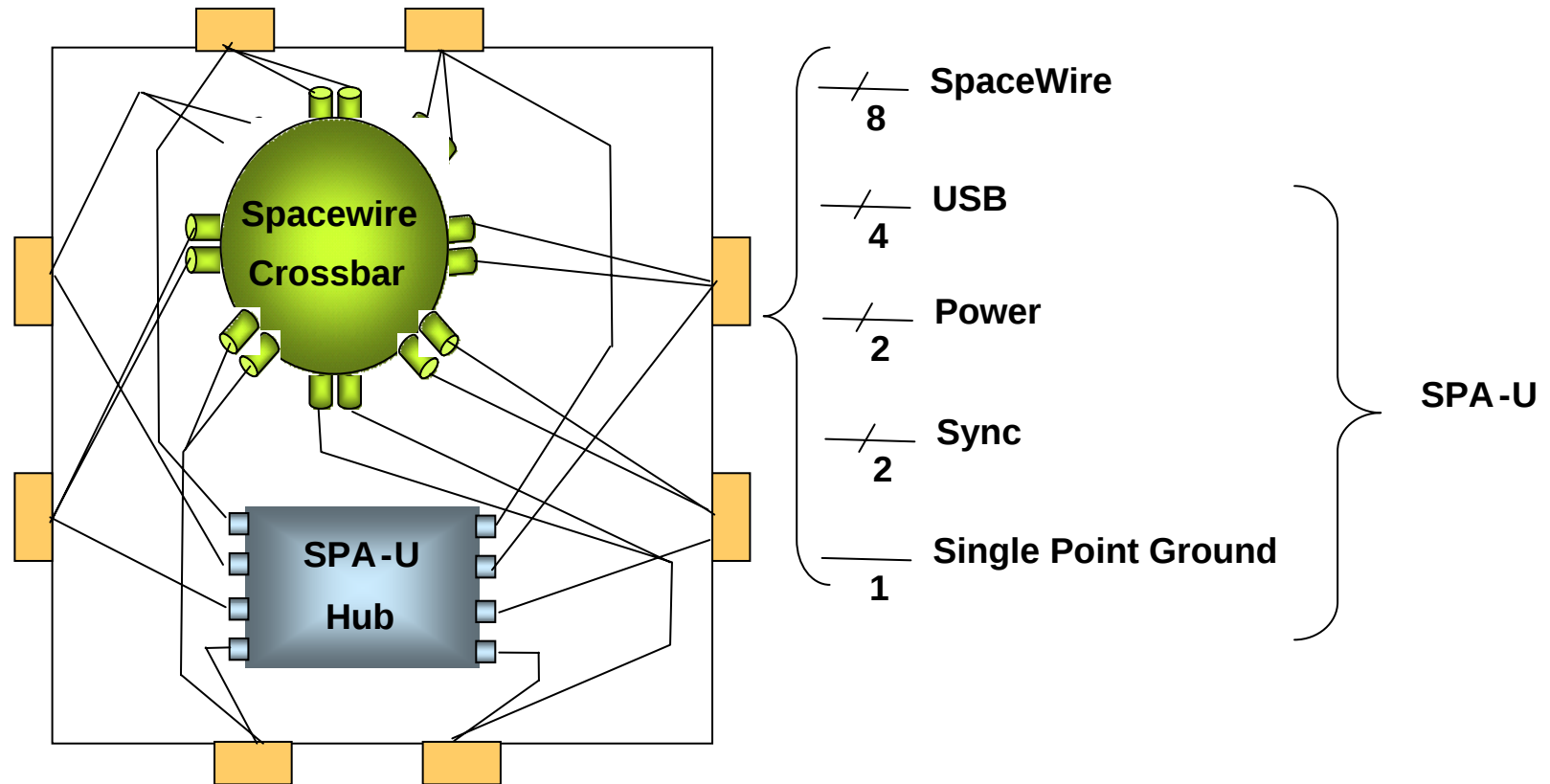


ASIM bridges legacy components to the Plug and Play network





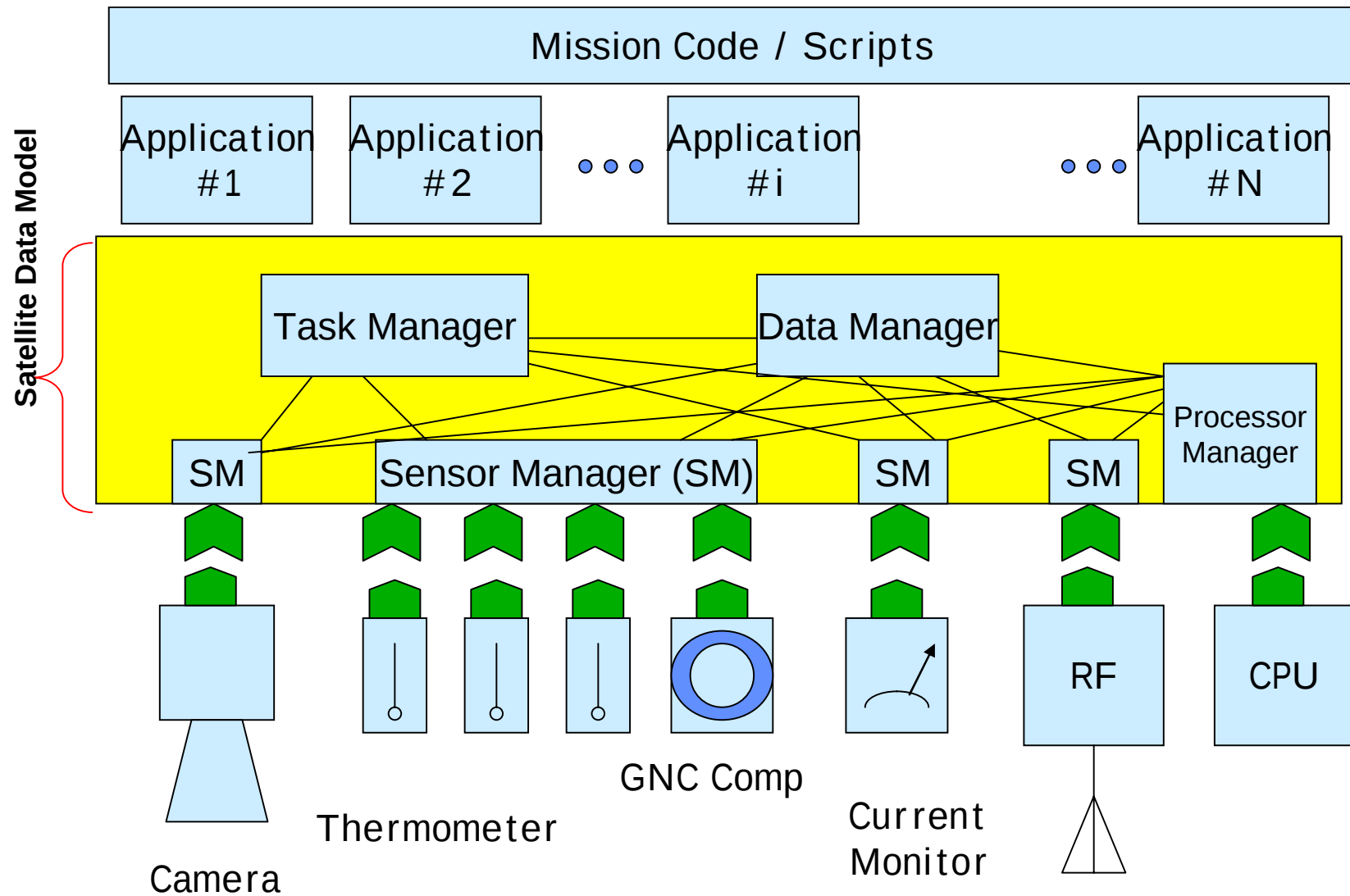
SPA-S = SpaceWire + SPA-U



Combination of high-speed data transfer and device control



Satellite Data Model

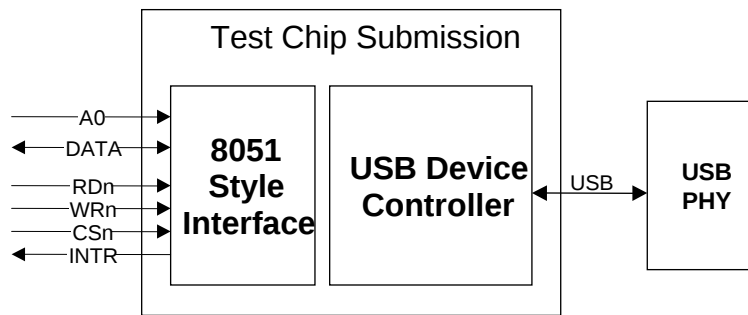




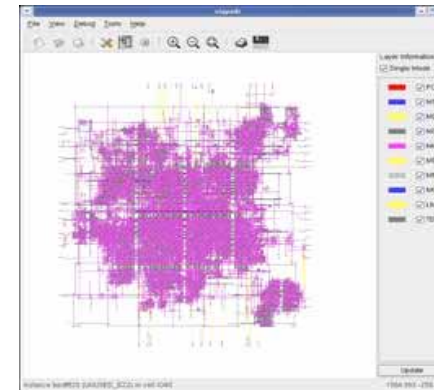
SPA Development Status



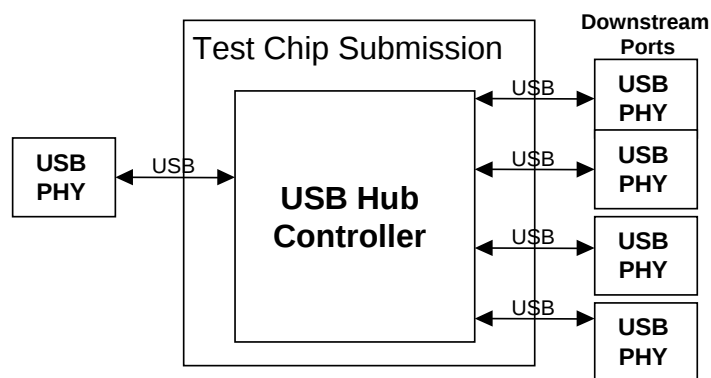
- There are currently four working groups that have been defined by the SPA Technical Committee to develop SPA technologies and documents:
 - **Gen 0.** The Gen 0 working group pursues the development of near-term hardware interface concepts based on commercial off-the-shelf (COTS) technologies
 - **Gen 1.** The focus of the Gen 1 working group is similar to Gen 0, but focuses on the creation of radiation-hardened reference implementation.
 - **Software.** The software working group emphasizes the development of the Satellite Data Model, the definition of xTEDS, and the creation of a Common Data Dictionary
 - **Advanced Technology.** This working group explores trade studies and technologies and concepts beyond the Gen 1 horizon.
- *SPA Guidebook* - Draft
 - Provides a comprehensive overview of the SPA-U, SPA-S, and SDM technologies
 - Spawn a series of standards and guidelines under the auspices of the AIAA as the primary standards development organization.



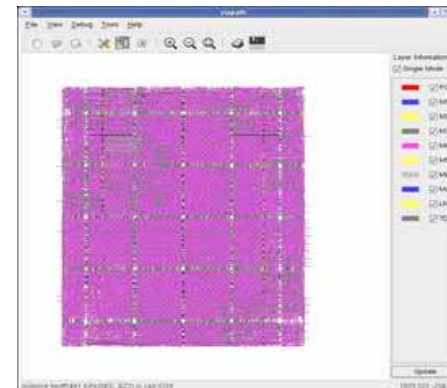
USB 1.1 Endpoint



Design-hardened structured ASIC



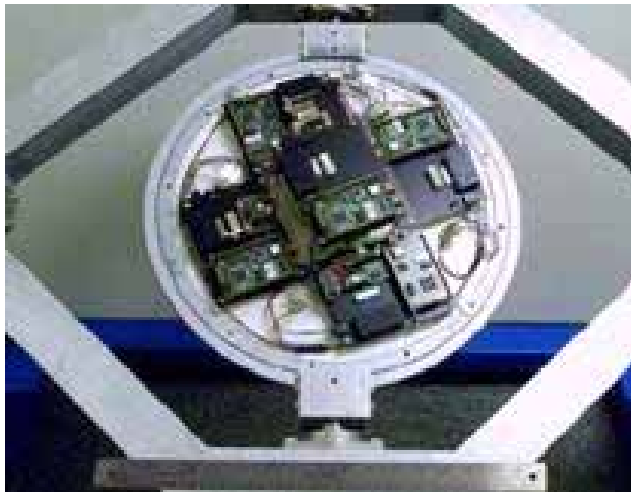
USB 1.1 five port hub



Design-hardened structured ASIC



Recent Demonstrations



Pre-prototype Gen0 PnP



Concept Plug and Play Panels



Gen0 Radiation Test Board



Prototype AWM



Summary



- Introduced a new approach to achieving plug-and-play (PnP) in aerospace systems motivated by Operationally Responsive Space
- SPA seeks to achieve a PnP technology capable of rapidly forming a dynamic self-organizing system exploiting machine-negotiated interfaces
- Commercial interconnect standards, including USB, Spacewire, and Ethernet have been chosen for initial implementation
- Interconnect standards by themselves are not sufficient to achieve PnP
 - Distributed power
 - Time synchronization
- Software infrastructure makes possible a deeper idea for PnP
 - Support automatic component identification independent of computing topology
 - Provide a data based approach to software development
 - Device independent interchange, robustness, and flexibility