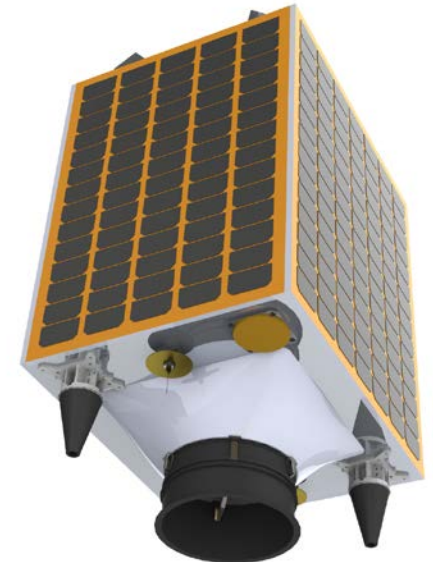
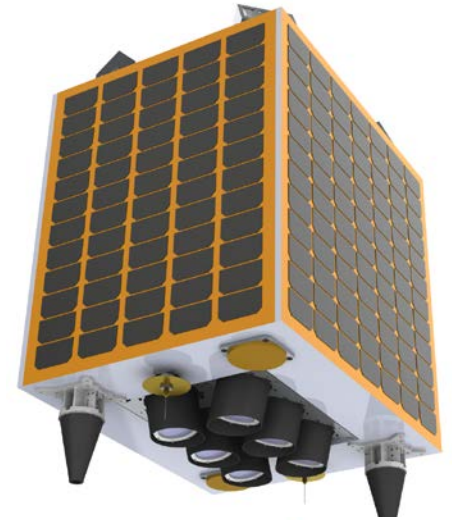


CAN in Space Applications Small Satellite Platforms

Dai Stanton, SSTL
ADCSS 24/10/2013

SSTL X - series

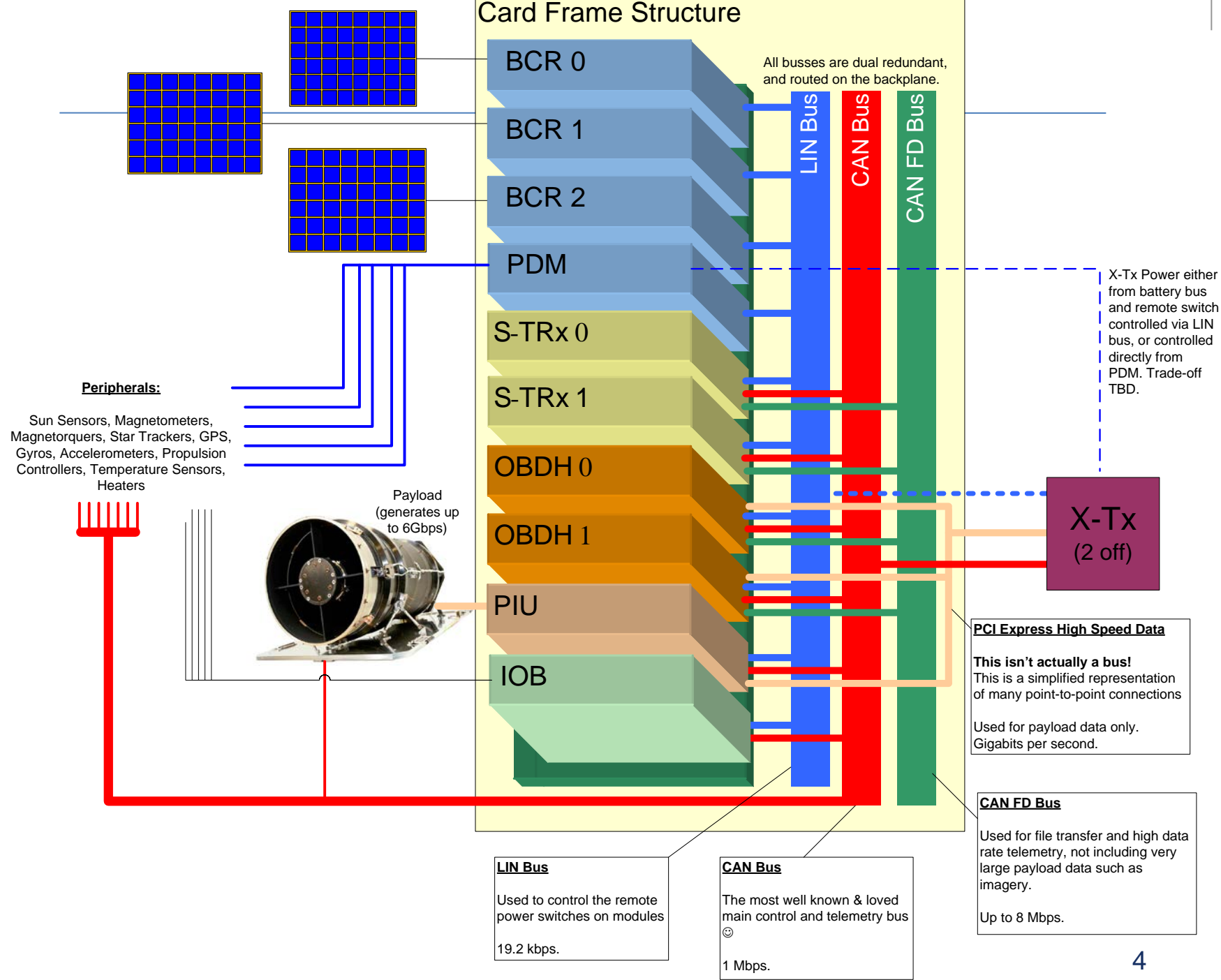
- A new range of platforms with common core features
 - 20kg to 500kg
- A single system architecture and technology designed to meet all mission applications and requirements across the entire range.
- Common, modular and expandable specification available on all platforms and missions:
 - Dual redundant systems
 - Data storage up to Terabytes capacity
 - Data bus transfer rates of Gigabits per second
 - Onboard real-time processing of Giga-instructions per second
 - High speed X-Band downlink



Internal Comms Architecture

- Evolve from stacked trays with harness to card chassis with common backplane
- All avionics interconnects bussed for growth, flexible redundancy and testability
- All digital interconnects
- Backplane implemented via single common connector
- Second connector on each board passed through backplane to provide board specific external I/O
- CAN FD bus replaces existing mesh network connecting Tx, RX and OBCs
- LIN bus for power control to distributed power switches/LCLs and power conditioners
- CAN bus for connection to spacecraft subsystems (including legacy items)
- High speed payload interfaces – sRIO up to approx 6 Gbps – to adjacent three card slots
- Retain existing CONOPS with ground segment simplification

Card Frame Structure



All buses are dual redundant, and routed on the backplane.

X-Tx Power either from battery bus and remote switch controlled via LIN bus, or controlled directly from PDM. Trade-off TBD.

X-Tx (2 off)

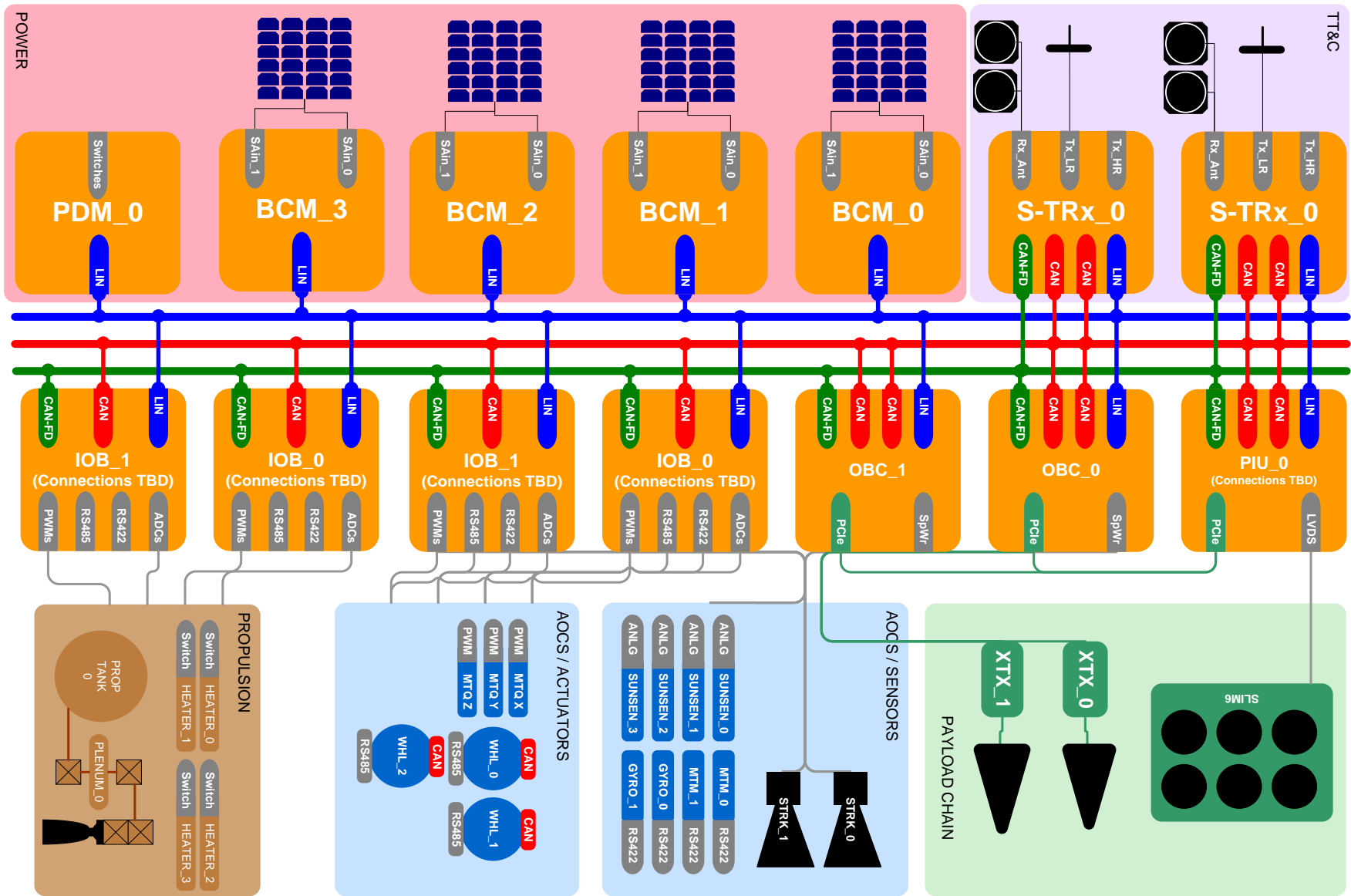
PCI Express High Speed Data
 This isn't actually a bus!
 This is a simplified representation of many point-to-point connections
 Used for payload data only.
 Gigabits per second.

CAN FD Bus
 Used for file transfer and high data rate telemetry, not including very large payload data such as imagery.
 Up to 8 Mbps.

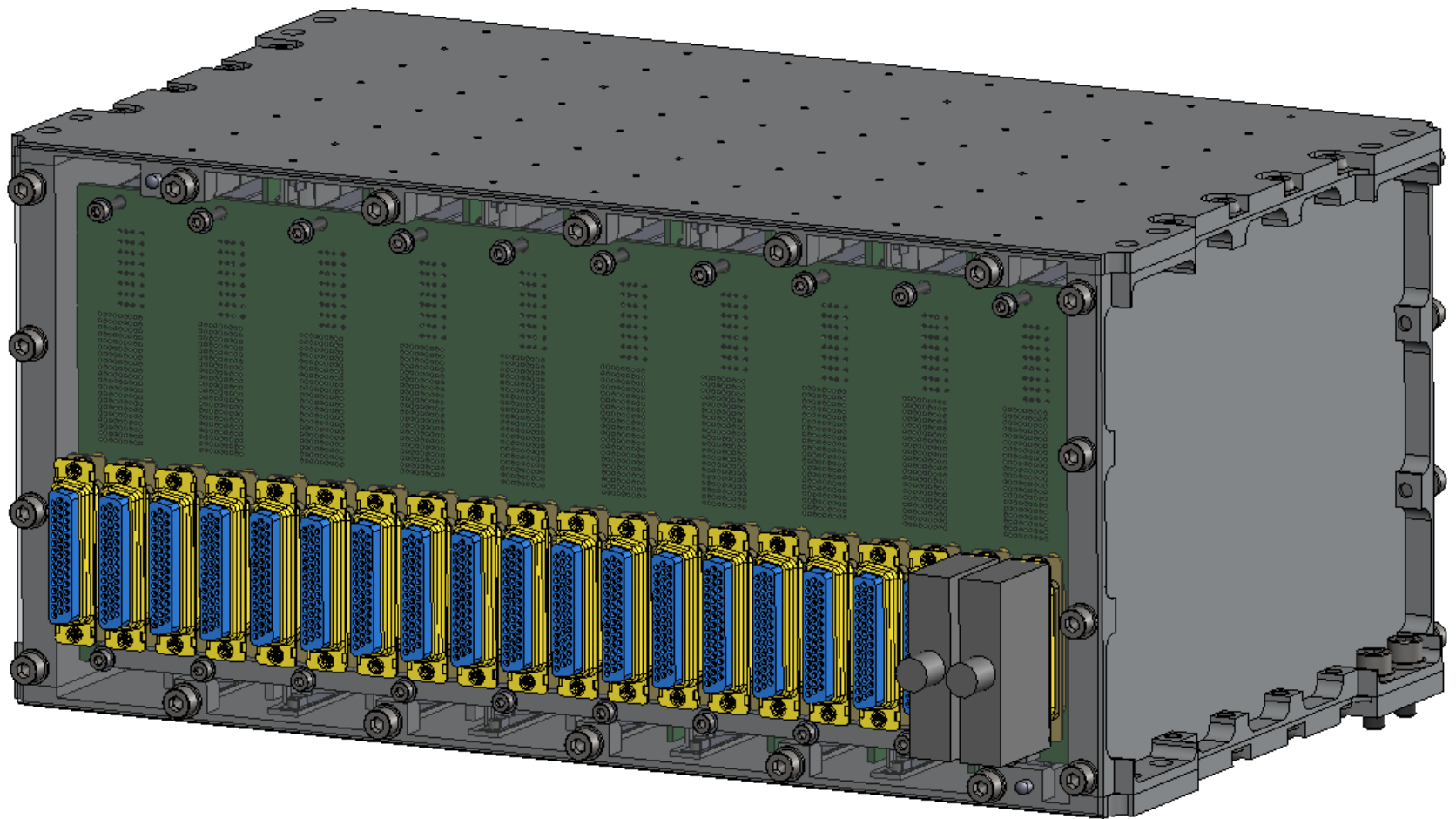
LIN Bus
 Used to control the remote power switches on modules
 19.2 kbps.

CAN Bus
 The most well known & loved main control and telemetry bus
 ☺
 1 Mbps.

Avionics Block Diagram



Avionics Card Frame



CAN-FD

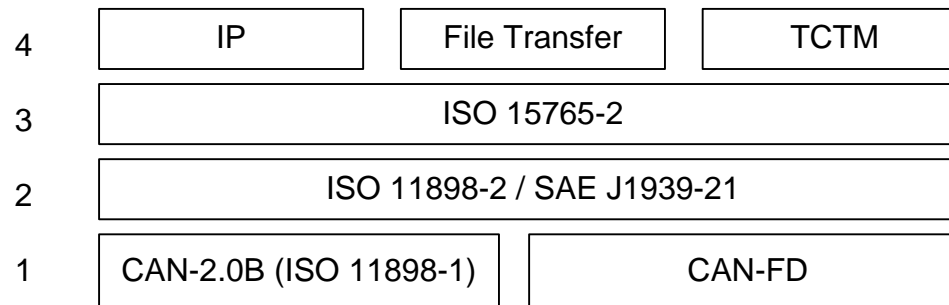
- CAN Flexible Data
- Payload field has flexibility in clock rate and data encoding and also allows up to 64 octet payload
- Throughput up to about 8Mbps possible
- Developed by Bosch and supported by all major European car manufacturers
- Field bus with guaranteed longevity, long term support, no threatening technologies
- But:
 - Devices only just starting sampling. IP cores currently expensive

CAN Protocol

- CANopen studied but discounted
 - + Most widely supported industry protocol
 - + Will (eventually) support CAN-FD
 - Very hungry stack (memory, CPU load, bus performance)
 - Costly – we would need to buy in a stack and have it customised to our platforms
 - Doesn't match our service (peer to peer) model
- ISO15765-2 (ISO-TP) Adopted
 - + Offers everything we need and nothing we don't
 - + Lightweight and simple to implement
 - + SAE J1939 addressing scheme
 - + Automotive grade solution
 - Doesn't natively support transfers larger than 4kb, however use of a reserved field overcomes this without violating the specification

ISO15765-2 (ISO-TP)

- Layer 3 protocol, natively supporting
 - Addressing (both Physical Device and Functional Groups)
 - Message Prioritisation
 - Robust multi-packet transfer and reconstruction
 - Layer 4 identification fields
- Works natively with CAN-2.0 or CAN-FD without adjustment
- Layer 4 is either:
 - IP Frames
 - Legacy File Transmission (<1Mb)
 - TC/TM



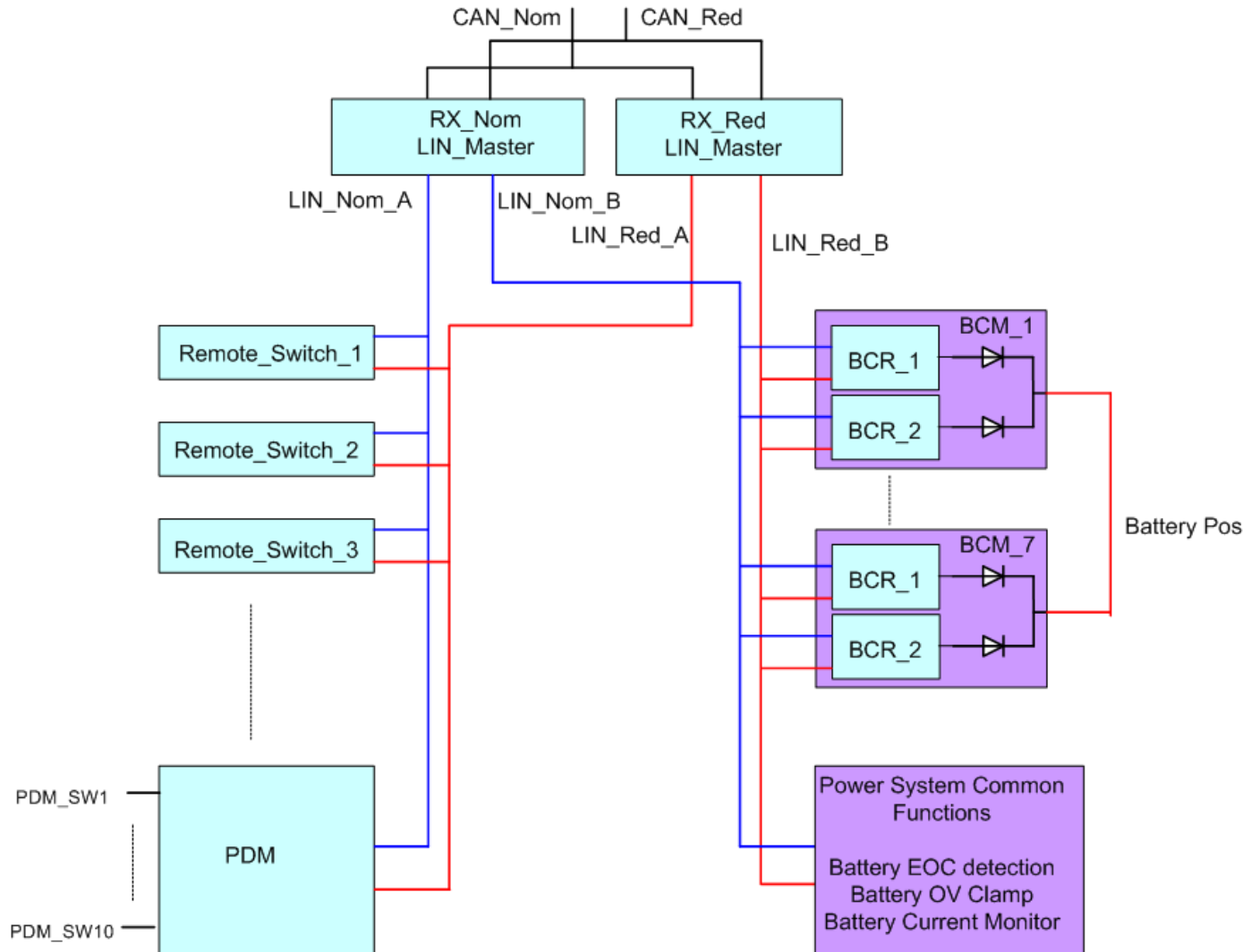
Space-Ground Comms

- Direct access to CAN-FD, CAN and LIN bus via link packet payload
- CCSDS compatibility via VHDL change

Backdoor		TT&C	File Transfer
CAN/ CAN-FD	LIN	Bespoke	Saratoga
AES-128		TCP	UDP
		IP/IPSEC	
HDLC, 16bit CC-ITT CRC			
NRZI, G3RUH Scrambling (James Miller)			
BPSK			
Uplink 2.025GHz – 2.110GHz Downlink 2.200GHz – 2.29GHz			

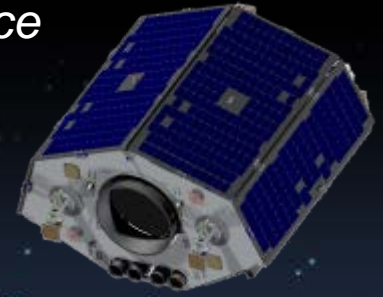
LIN Bus

Single ended, low rate (19200 bps), half duplex, bi-directional bus
 Power consumption < 100 μ s



Rapid IO

- High speed – up to 6 Gbps
- Same PHY as PCIe
- Simple peer to peer operation – doesn't need root complex
- Adopted by Next Generation Spacecraft Interconnect Standard working group



Thank You

