Spaceflight Ground Support Equipment Reliability & System Safety Data

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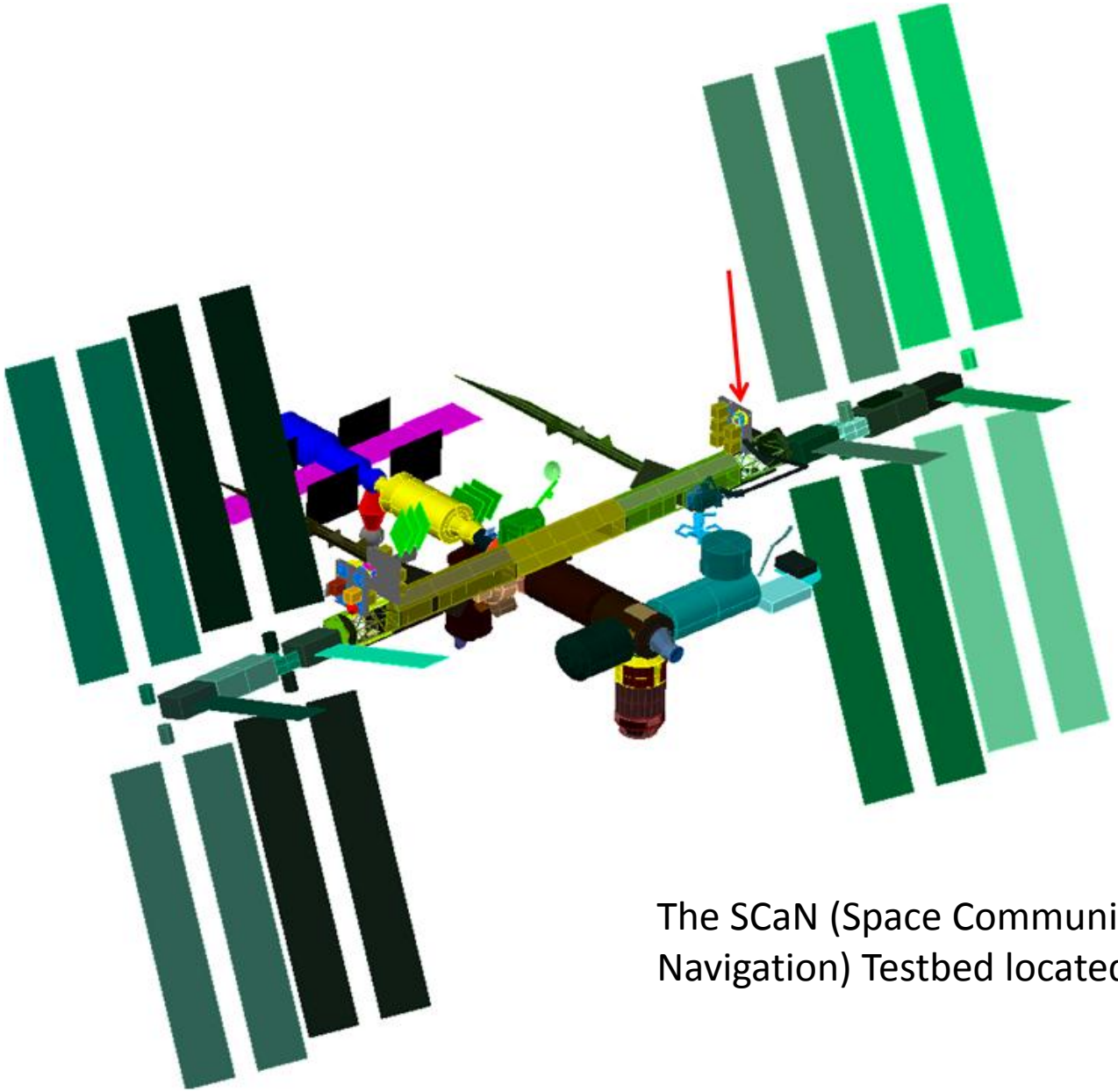
Overview & Outline

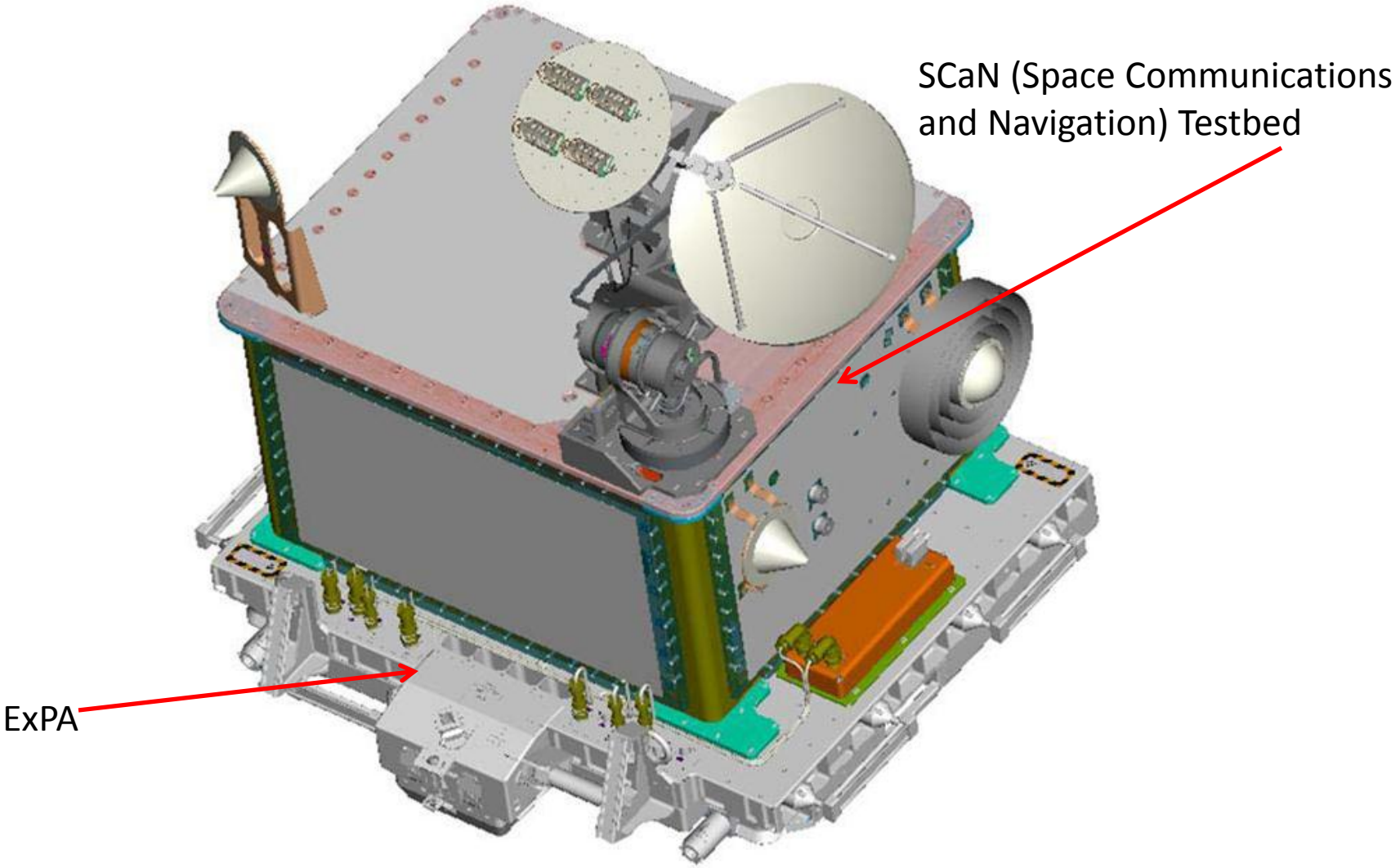
- GSE Certification Process
- Assembly, Integration, & Test
- Reliability Analysis
- System Safety
- Configuration Management
- Summary & Conclusions
- Next Steps & Future Work

Background & introduction

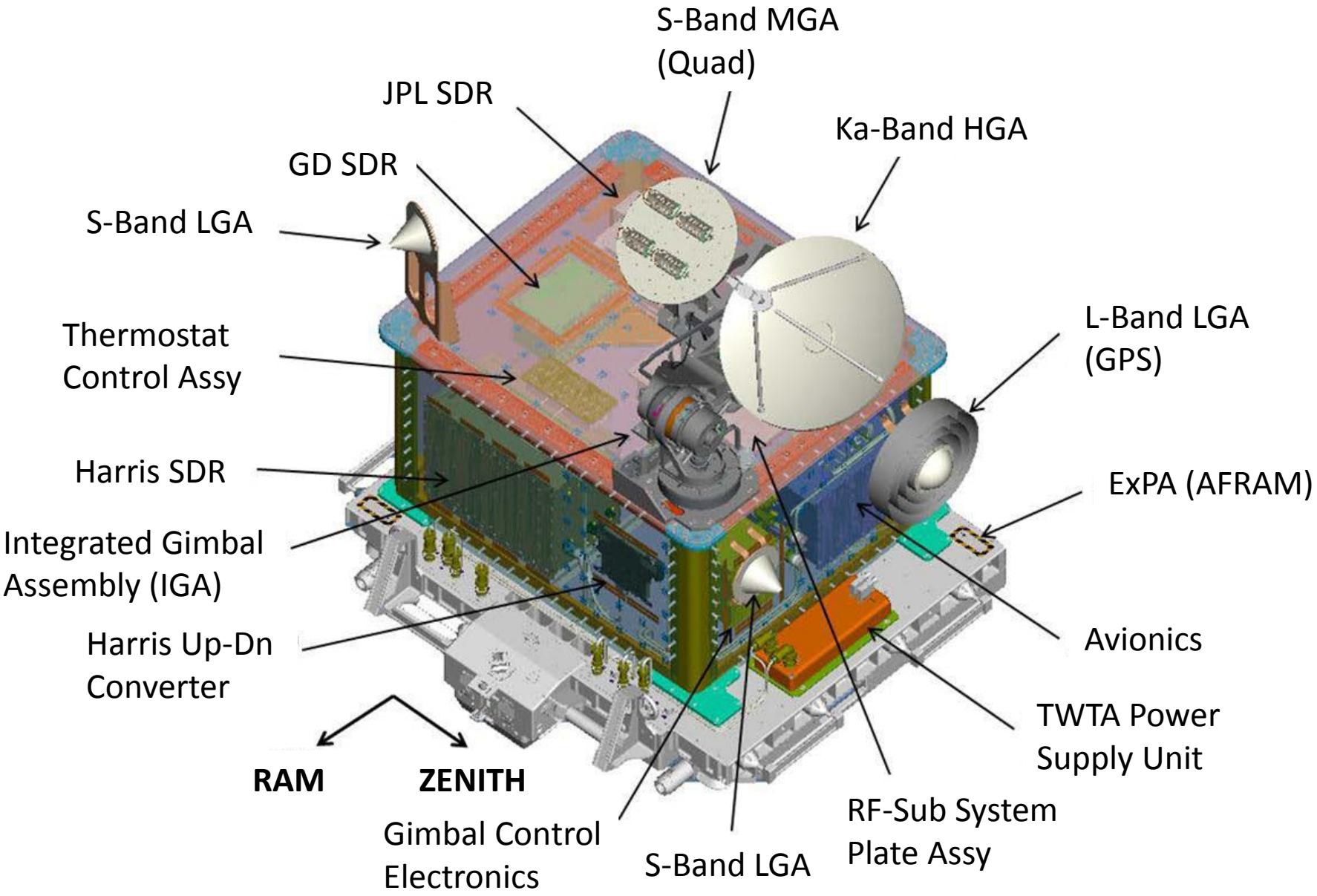


The SCaN (Space Communications and Navigation) Testbed located on the ISS

SCAN Testbed integrated onto the ExPA (ExPRESS Pallet Adapter)



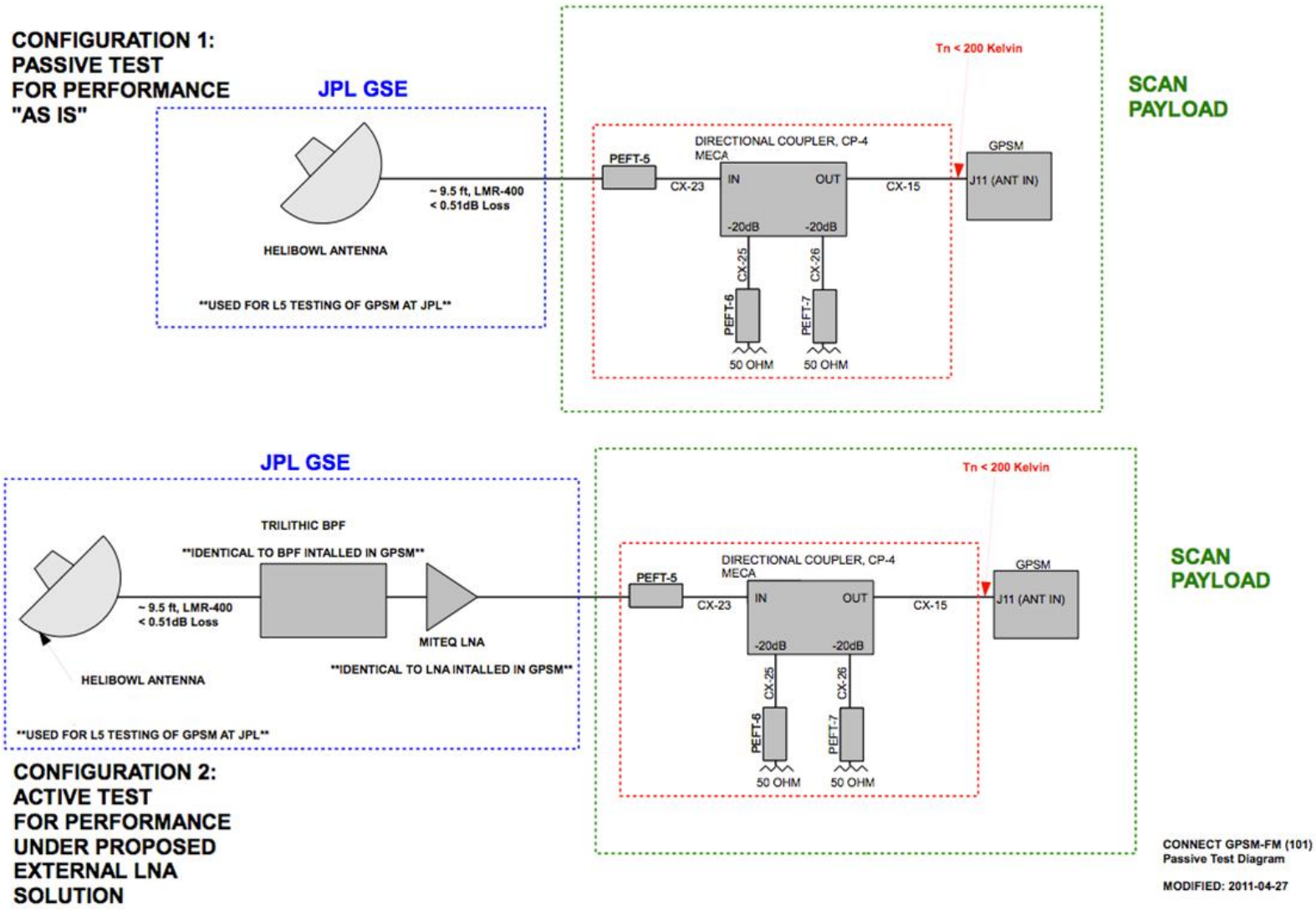
SCAN Testbed, ExPA, Radios and Infrastructure



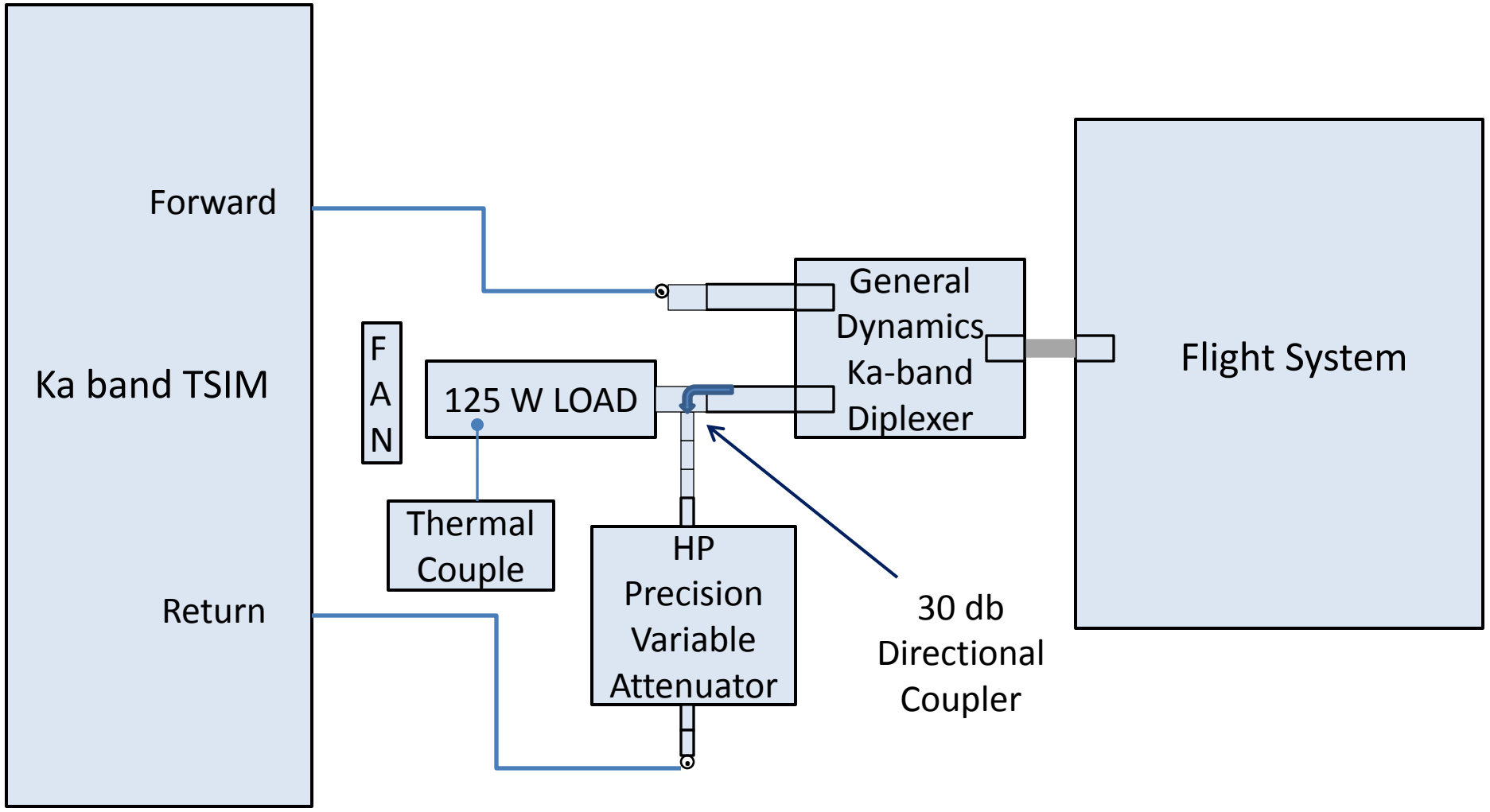
CoNNeCT's approach to GSE (Ground Support Equipment)

- Tailoring NASA-STD-5005C
  - CoNNeCT designed GSE
  - Commercial Off the Shelf (COTS) GSE
  - GRC built GSE Cables
- Assembly Integration & Testing
  - Vibration
  - Thermal/Vacuum
  - ElectroMagnetic Interference / ElectroMagnetic Compatibility
  - TDRSS Compatibility
- System Block Diagrams
- FMEAs
- PHAs
- Parts Quality Searches (GIDEP & CPSC)
- Configuration Management

GSE Block Diagram for a GPS test on JPL SDR



GSE Block Diagram for Ka-Band TSIM GSE



Ka-Band TSIM GSE FMEA

ID	Subsystem	Signal Name/ Conn/Pin	I/O	Function/Signal Characteristics	Failure Mode	Failure Causes	Failure Effects	Criticality	Mitigation
1	Diplexer Circuit	Return Link Rx	I	Path for attenuated TWTA output signal to Down Converter	Reflection of Return Link signal	Load mismatch from open/shorted connectors in Return Link path	Loss of transmission of TWTA output signal to the TSIM. Reflected signal will be attenuated by 60 dB in Ka-Band RF Load Circuit and will not damage the Harris SDR LNA (overload of LNA possible)	3	Inspection, acceptance test
2	Diplexer Circuit	Forward Link Tx	O	Path for combined Up Converter output signal and injected RF interferer signal to Harris SDR LNA	Excess signal power from Up Converter	Malfunction or incorrect adjustment of Up Converter	Possible damage to or overloading of LNA	3	Confirm maximum output power < -31 dBm
3	Diplexer Circuit	Forward Link Tx	O	Path for combined Up Converter output signal and injected RF interferer signal to Harris SDR LNA	Excess injected RF interferer signal	Malfunction or incorrect adjustment of signal generator	Possible damage to or overloading of LNA	3	Limit/monitor output of signal generator
4	Diplexer Circuit	Forward Link Tx	O	Path for combined Up Converter output signal and injected RF interferer signal to Harris SDR LNA	Output connector open or shorted	Damage to connector, poor workmanship	Loss of transmission of TSIM signal to Harris SDR	3	Visual inspection

Ka-Band TSIM PHA

FLIGHT PRELIMINARY HAZARD ANALYSIS

Program: Communications, Navigation, and Networking reConfigurable Testbed (CoNNeCT), RF Load Circuit
Engineer: John Brinkman **Date:** 10/5/2010

Item	Hazard Category Description	Affected Systems	Cause	Effect	Hazard Level / Assessment	Recommendations/Solutions	Applicable Requirement
1.0 Collision: Hazards which occur when GSE elements fail, break loose, or are allowed to make uncontrolled contact with other elements, typically resulting in the propagation of failure to equipment and/or health risk to personnel.							
1.1	Collision Collision or inadvertent contact with broken pieces of flight hardware.	Entire GSE assembly	Handling during installation, changeout, and/or transportation.	Personnel injury. Damage to equipment	Level:	Review of material usage by GRC M&P. Fan contained within housing and two finger guards	29 CFR 19010.212 (a) machinery and machine guarding
1.2	Collision Collision or inadvertent contact with broken off pieces of rotating or translating equipment.	Cooling fan	Failure of motorized systems.	Personnel injury. Damage to equipment	Level:	Fan will not be operated outside of acceptable range. Review of material usage by GRC M&P. Fan contained within housing and two finger guards.	29 CFR 19010.212 (a) machinery and machine guarding
2.0 Contamination of Workspace: Release of toxic, flammable, oxygen-depleting, corrosive, condensible, or particulate matter into the workspace where the GSE will be utilized.							
Not Applicable. No contamination hazard exists.							
3.0 Corrosion: The structural degradation of metallic and nonmetallic equipment, possibly resulting from leakage of caustic/corrosive materials, joining of dissimilar metals or environmental extremes.							
Not Applicable. No sources of corrosion.							
4.0 Electric Shock and Electric Damage: Personnel injury or fatality and/or adverse effect on performance and operation of equipment because of contact with a live circuit, either through failed protection measures, procedural error or inadequate design.							
4.1	Electric Shock and Electric Damage Personnel injured from contact with energized	Fan, power cord	Accidental contact with live circuit through: - inadequate insulation - erroneous connection - cutting through	Personnel injury. Damage to equipment	Level:	The circuit does not include the actual connection to the flight system: this will be either by waveguide, flex waveguide, or a coaxial cable. Waveguide or flex-guide is preferred.	NPR 8715.3 - 3.6.1.a - 3.6.1.b - 3.6.1.c

Summary & conclusions

- GSE NASA-STD-5005C tailored approach involved applying appropriate Requirements, S&MA discipline expertise, & Configuration Management
- GSE mods necessary because failure modes & hazards were identified during the analysis that had not been properly mitigated.
- Strict Configuration Management was applied to changes (whether due to upgrades or expired calibrations) in the GSE
- SCaN Testbed has successfully undergone AI&T and shipped to the launch site without incident.
- Steps taken to safeguard the flight system when it was interfaced to the various GSE were successful.

Next steps and future work