WE LOOK AFTER THE EARTH BEAT

SpaceWire Backplane Project Final Presentation

Alan Senior 10/12/14

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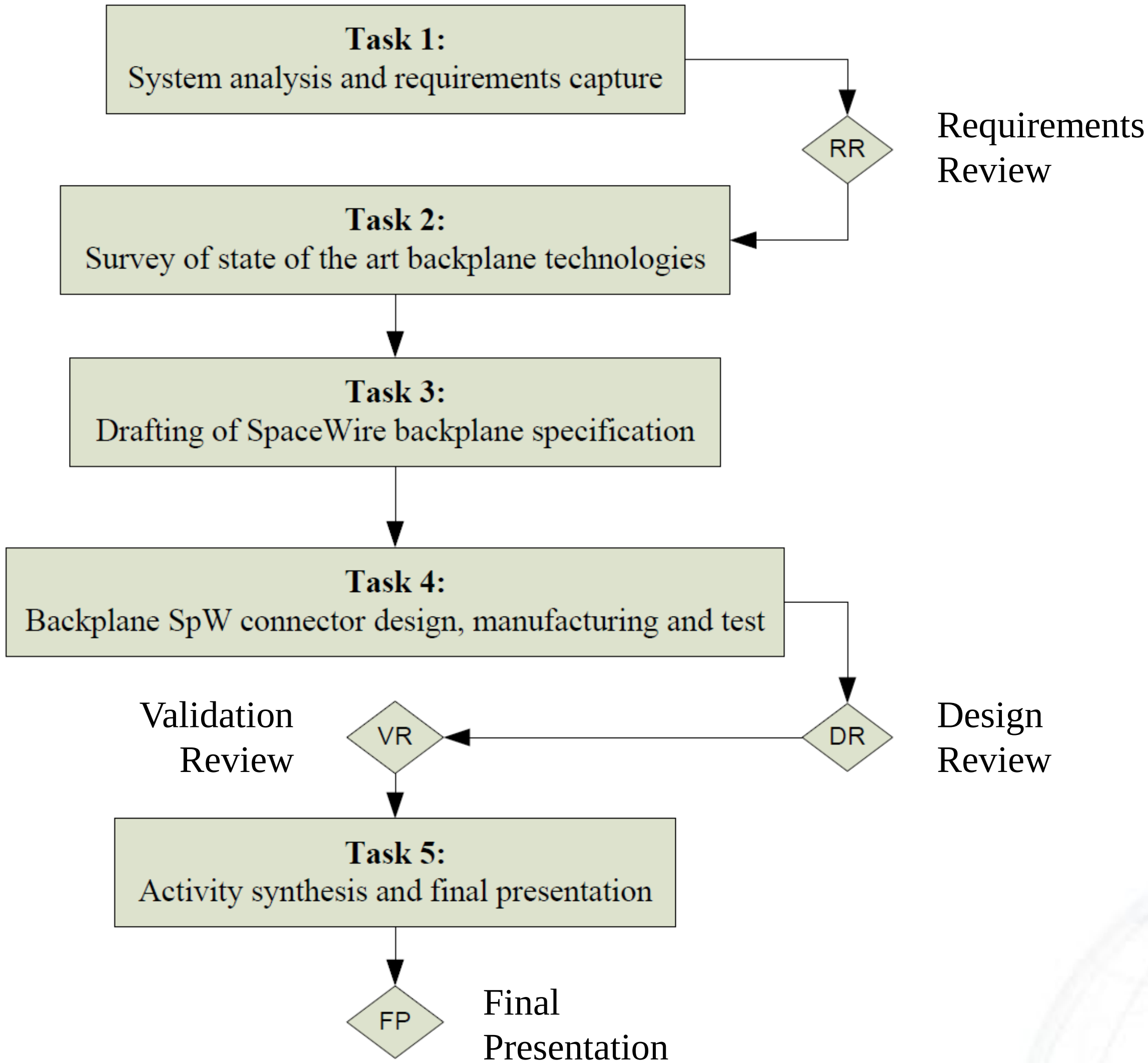
Summary

- The work presented is part of the ESA funded SpaceWire Backplane activity contract (No.4000104085, reference TEC-EPD/2010.88)
- The contract value is 130 kEuro,
- The ESA Project Manager is Jörgen Ilstad
- The principal aims of the activity were:
  - analyse and trade different backplane architectures and technologies
  - produce a SpaceWire backplane specification for standardisation with input from SpW WG members
  - identify or prototype an impedance matched backplane connector suitable for space

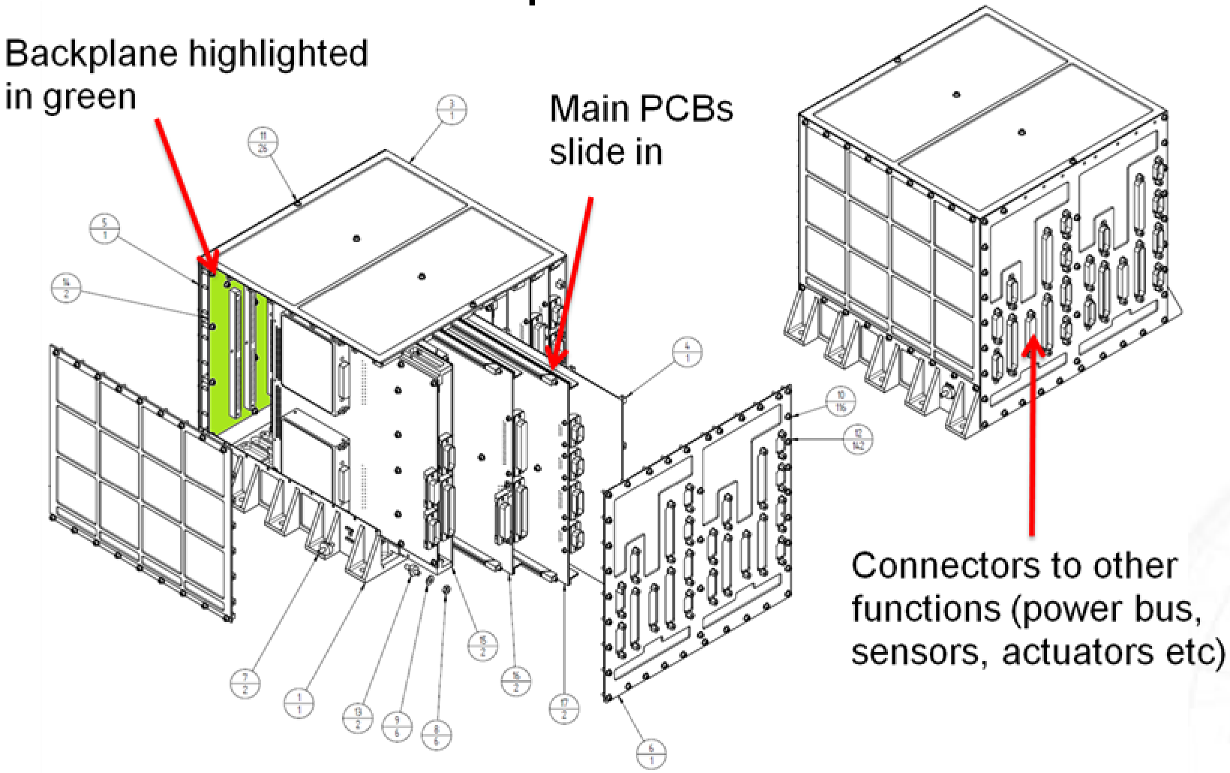
Note: The contract was originally awarded by ESA to the Space division of SEA which is now part of Thales Alenia Space - UK

Work Logic


Task 1:
System analysis and requirements capture
RR
Requirements Review
Task 2:
Survey of state of the art backplane technologies
Task 3:
Drafting of SpaceWire backplane specification
Task 4:
Backplane SpW connector design, manufacturing and test
DR
Design Review
VR
Validation Review
Task 5:
Activity synthesis and final presentation
FP
Final Presentation

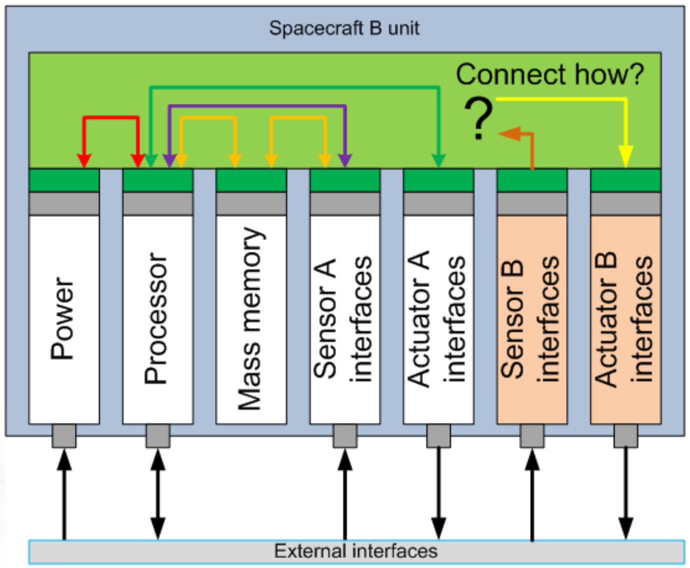
The black box view of an Spacecraft avionics unit

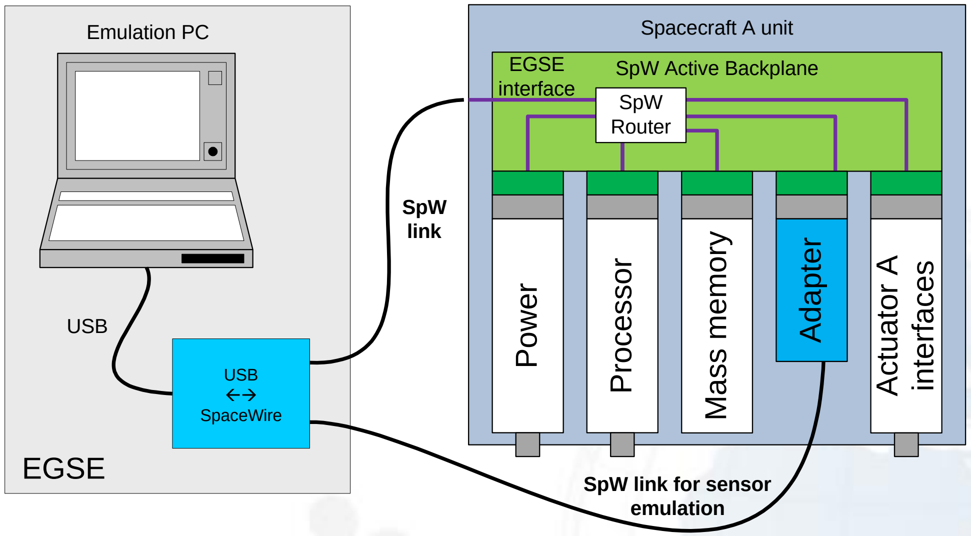
- A Spacecraft avionics unit can be considered to be a “black box” that performs a specific function within a system
- At this black box level we do not care how the internal functions are interconnected; the large number of interconnects over the backplane are hidden from view



Why do we need a SpaceWire Backplane Standard?

- The signal carrying backplane electrical interfaces within a unit are not dictated by customer requirements and are typically non-standard, consisting of discrete lines, parallel busses, device specific serial busses
- The mechanical interfaces for each PCB module are vendor specific
- Module level AIT is complicated by the large number of interface types, so emulating a module that is still in the development cycle is non trivial
- A solution is to create a Backplane Standard around SpaceWire, module reuse between missions and instruments is then practical

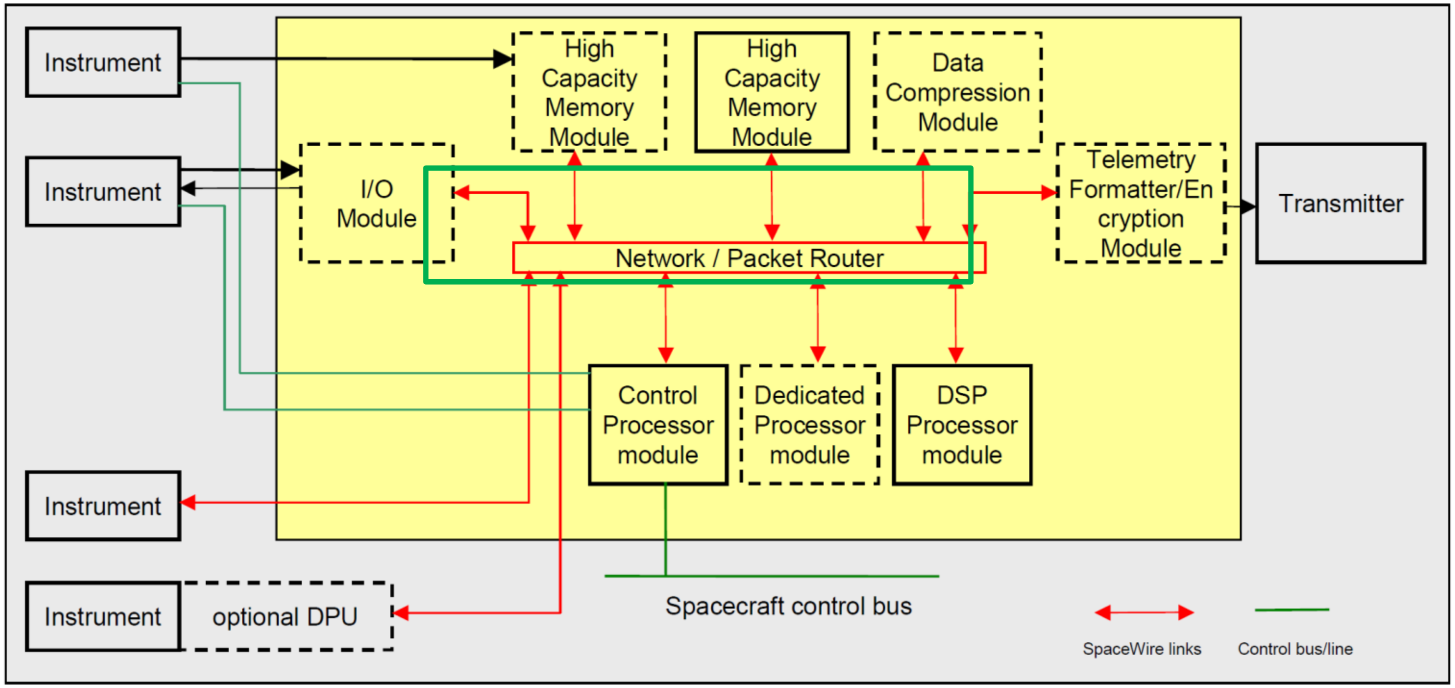




Task 1: Applications for a SpW backplane

- Any Spacecraft unit that contains a number of modules which:
  - Need to communicate with data rate in the range 10Mbps to 2Gbps
  - Contain functions that are suitable for re-use in future spacecraft
- For example:
  - Spacecraft Management units
  - Data handling units
  - Platform control units
  - Instrument control units
  - Mass memory units
- Perhaps SpW Backplane not as applicable to:
  - Low rate Remote Interface Units (RIUs)
  - Instrument and sensor front-end applications

Task 1: Data handling application of a SpW Backplane



- 8 modules in non-redundant "unit" above, but we may have more I/O modules
- Typical spacecraft non-redundant unit has 3 to 8 modules

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Task 1: Requirements survey

- A survey was published online and 33 SpW WG attendees from 13 different countries were approached
- The survey currently had 13 respondents and showed preferences and trends
- A backplane and connector requirements specification was produced with inputs from the SpW Backplane survey
- These requirements were then used as inputs into the ECSS Backplane Specification drafted within Task 3 and the prototype connector design

Task 1: Physical attributes – compatibility issues

- Board size: large or small?
  - Adopt existing standard eg Eurocard, PCI express, microTCA?
  - Existing spacecraft board sizes are driven by device level packaging:
    - 352 pin quad flat packs
    - BGA technology as used for miniature terrestrial applications not generally used
    - Backplane connector
    - Unit external interface count and connectors
- Connector card guide specification must allow for thermal conduction paths
- Board retention (e.g. Simple slot, Bircher, Camloc or Wedgeloc)
- Front panel and associated mechanical interfaces

Task 2: Desirable connector characteristics

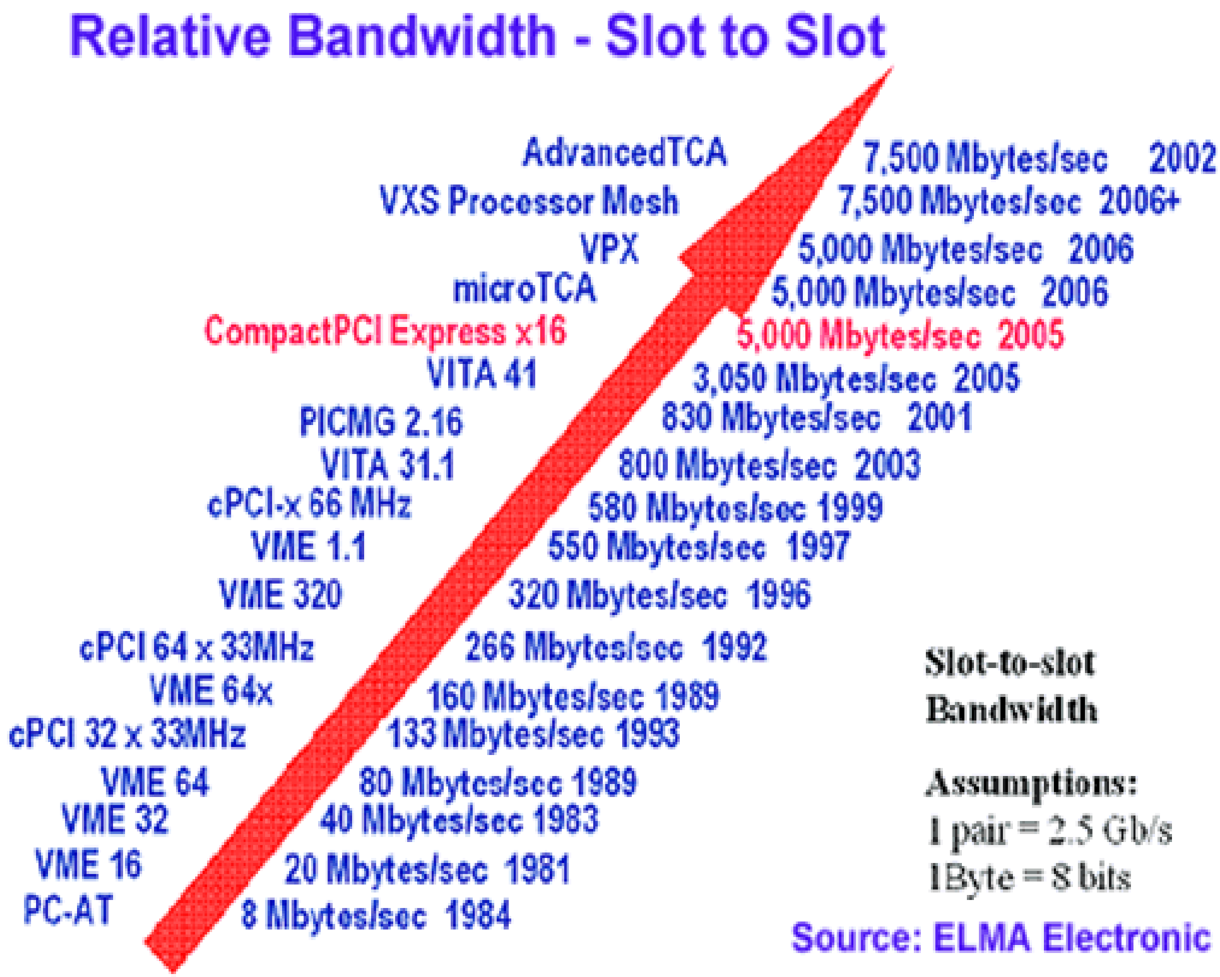
- SpW signalling rate compatible (up to 400 Mbps)
- SpFi Cu capable? (minimum 2.5Gbps, up to 5Gbps for FR4 PCB)
- Minimum of 2 SpW ports (4 SpFi Cu ports):
  - 8 impedance controlled (100 Ohm) differential pairs required
- Power:
  - Minimum of 2 pins, normally are paralleled up with many more grounds than +\- power rails
  - +28V and +5V minimum capability
  - At least 4 Amp rating (20 Watts at 5V)
- Signal lines:
  - Ideally avoided but... this is sometimes not practical
  - Typically single ended, clocks, synchronisation, on/off, FDIR etc.
  - 20 to 40 pins adequate?

Task 2: Survey of terrestrial solutions

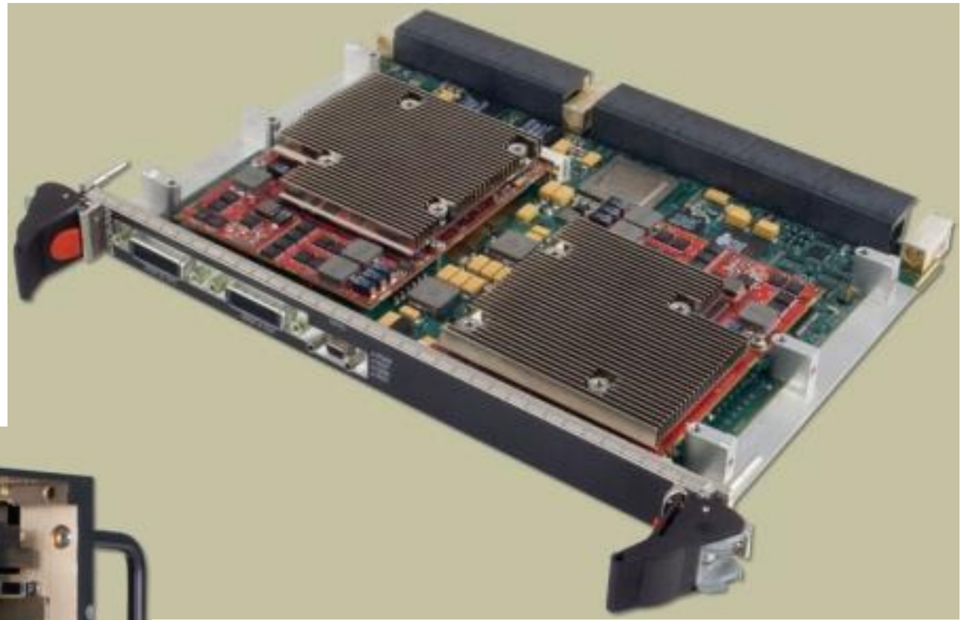
- PCI Backplanes:
  - cPCI
  - cPCI PlusIO and Serial
  - cPCI Expresss
- VITA Standards
  - VXS
  - VPX
  - VPX REDI
  - Open VPX
  - AdvancedTCA
  - microTCA

Note: SpaceVPX has only recently been introduced and hence was not surveyed

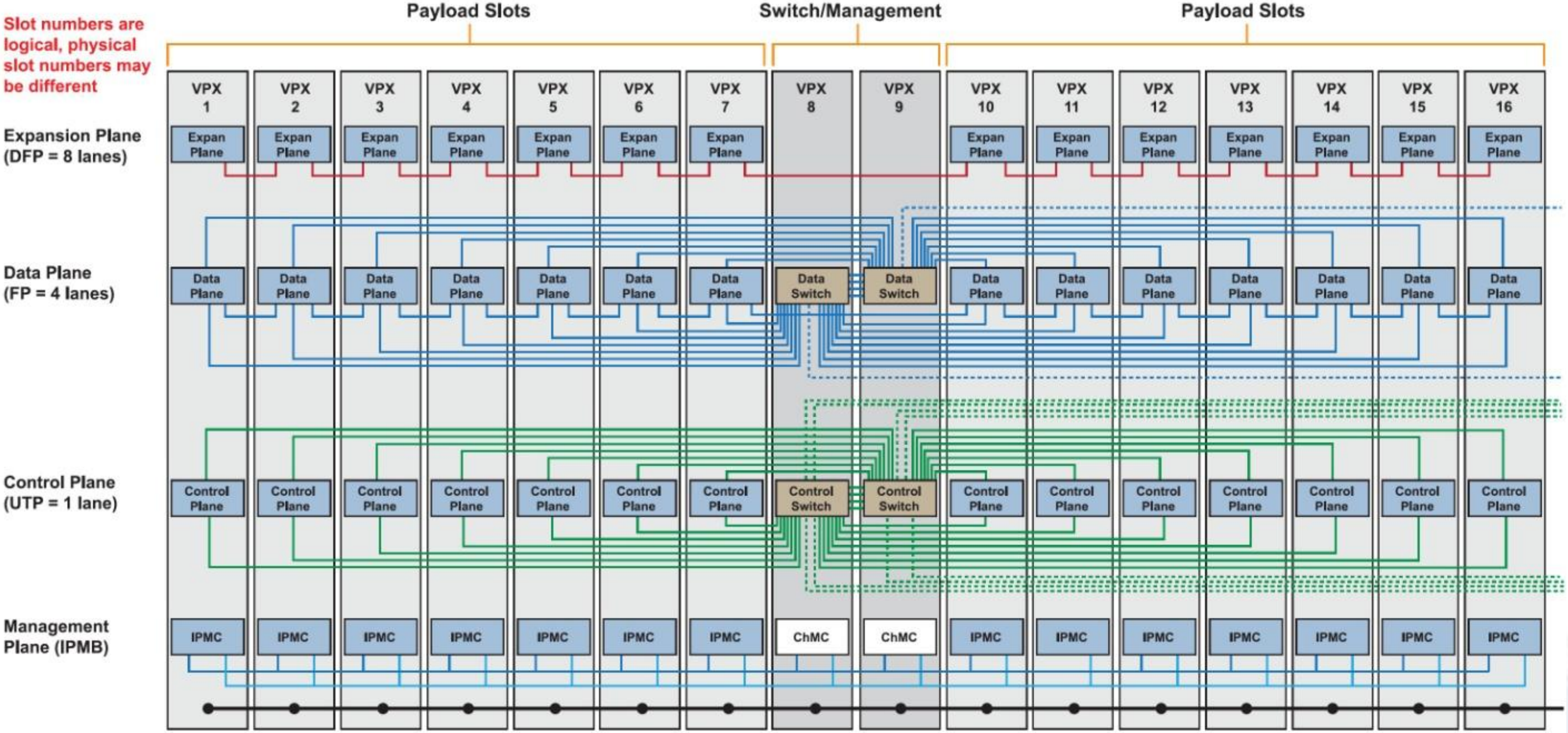
Task 2: Slot bandwidth of different standards



Task 2: Open VPX and VPX REDI offer mechanical standards



Task 2: OpenVPX 6U topology example



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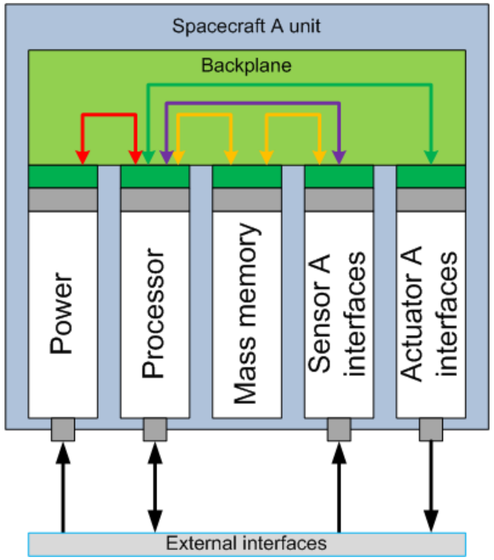
Task 2: Conclusions

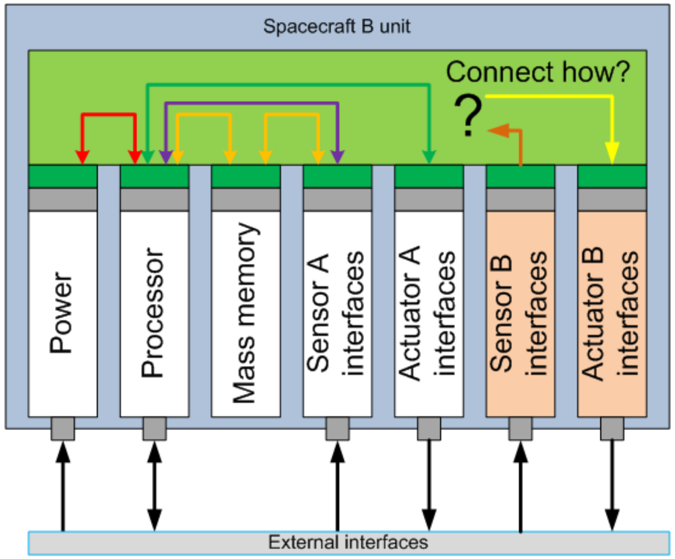
- VITA OpenVPX standards offer the flexibility and potential to be adopted with tailoring
- A connector and backplane requirements specification was produced and with inputs from the SpW Backplane survey
- The connector specification was submitted to Hypertac for evaluating potential design solutions in Task 4

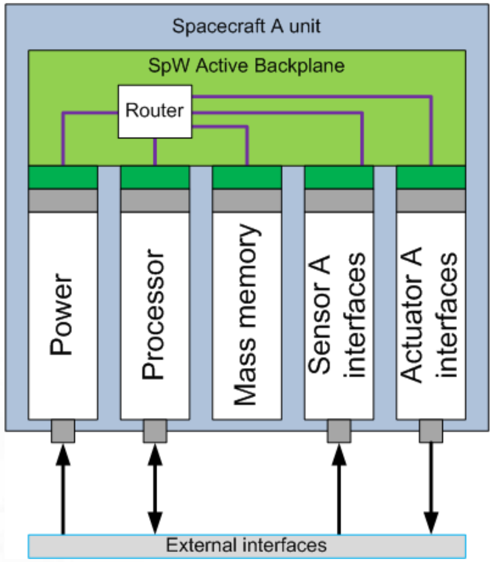
Drafting of ECSS Backplane Specification

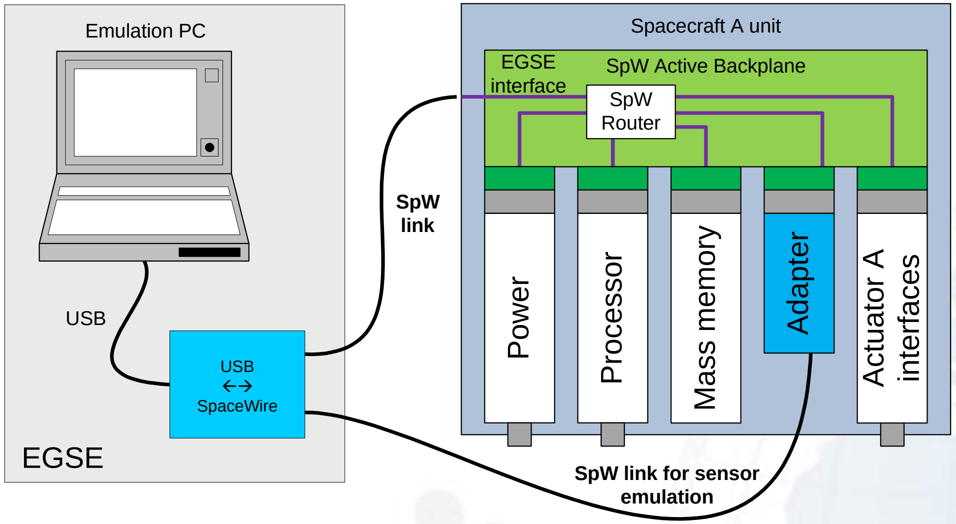
- The ECSS draft SpaceWire (SpW) Backplane Specification offers the opportunity timprove re-use of developed functions
- reduce development costs
- simplify integration/test activities
- permit Modules from multiple vendors to be integrated together within a unit

Task 3: SpW backplane standard - advantages









Task 3: Drafting of ECSS Backplane Specification

- A draft standard has been produced and released for comment to selected SpW Working Group Members
- The draft focussed on the electrical functions rather than the mechanical or thermal aspects
- Comments have been collated for incorporation into a future version
- While drafting the specification SpaceVPX came onto the scene
- The draft is NOT currently under control of the ECSS system
- Potentially the ECSS Specification could tailor SpaceVPX and hence gain leverage from that standard in particular for the mechanical aspects

Task 3: Draft ECSS specification

ECSS-Standard-ST-Number
ECSS Standard Issue Date

EUROPEAN COOPERATION
ECSS
FOR SPACE STANDARDIZATION

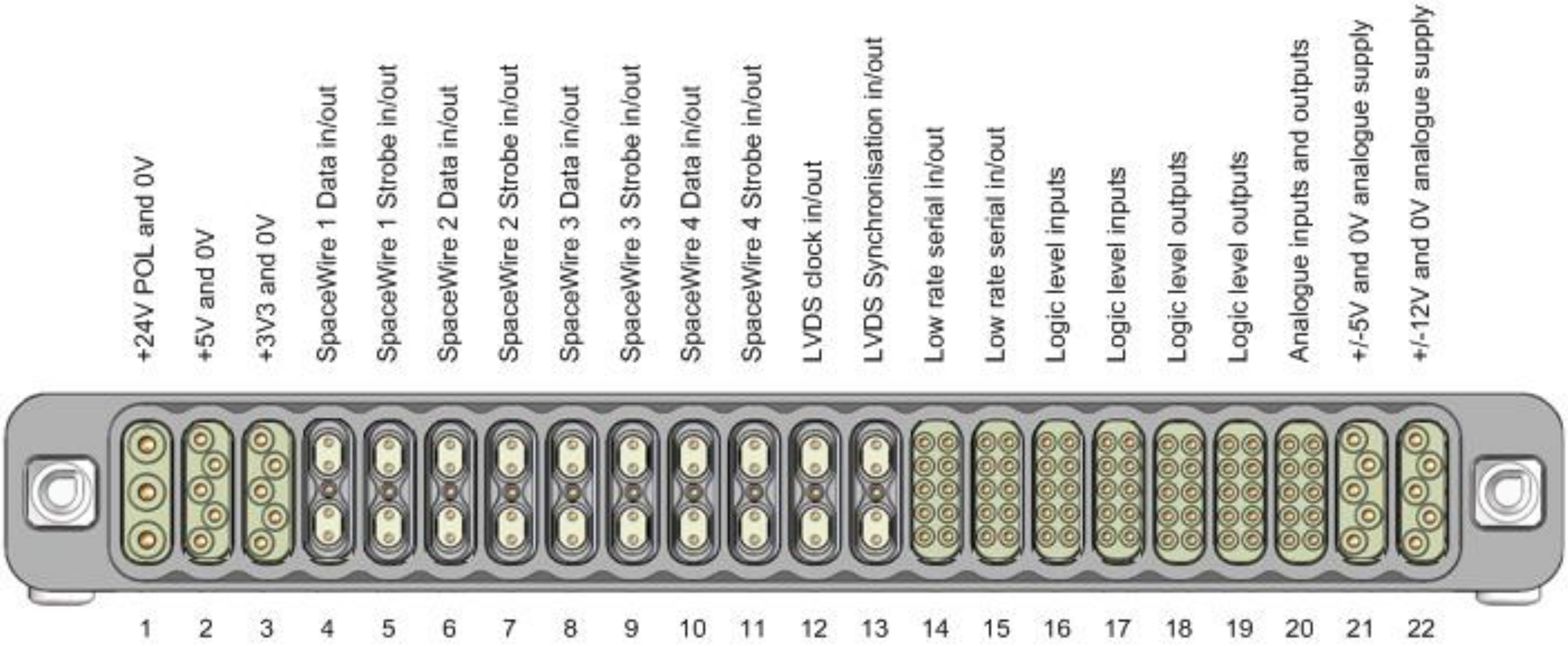
Space engineering

SpaceWire Backplane

This document has been written by SEA. It is an output from the ESA SpaceWire Backplane activity, ESA contract number 4000104085. Within the contract this deliverable document has a reference designator D04-1.
Authors: Sanjay Sharma, Alan Senior. ESA Project Manager: Jørgen Ilstad
DISCLAIMER (for drafts)
This document is an ECSS Draft Standard. It is subject to change without any notice and may not be referred to as an ECSS Standard until published as such.

ECSS Secretariat
ESA-ESTEC
Requirements & Standards Division
Noordwijk, The Netherlands

Task 3: ECSS example function allocation: Cluster Module



View of mating face of module connector

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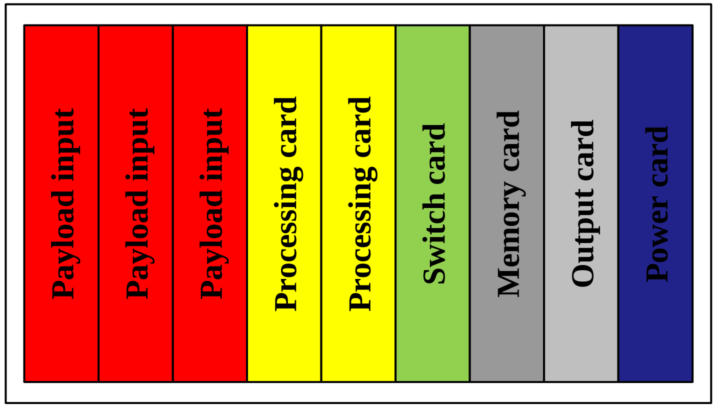
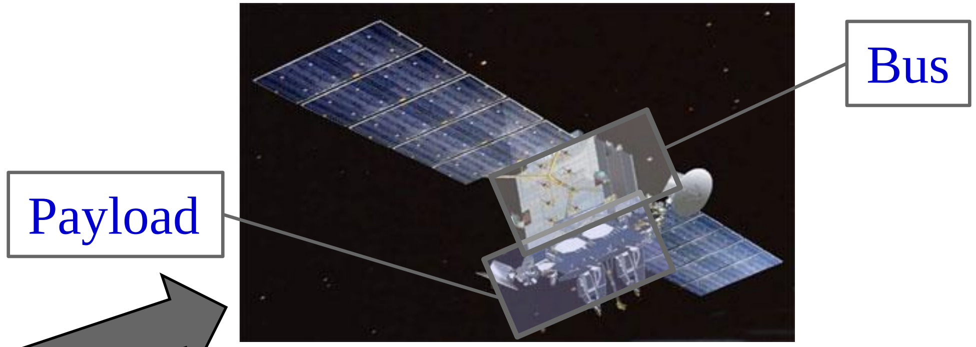
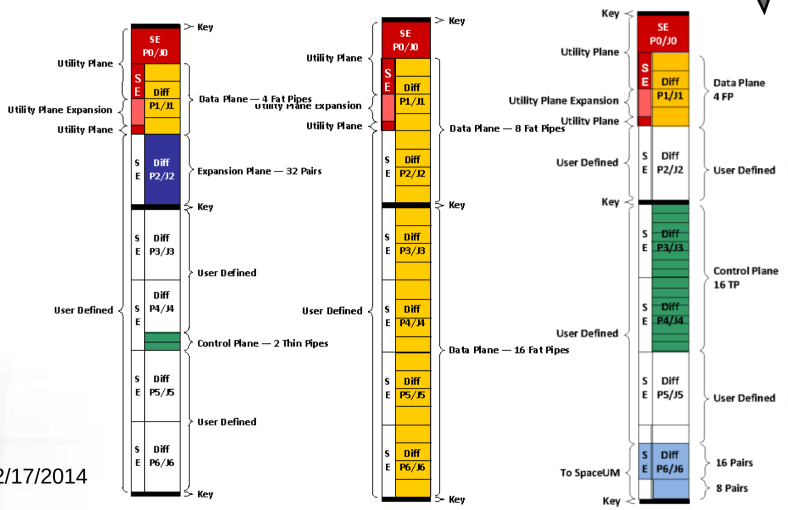
Future -tailoring of SpaceVPX via the ECSS standard?

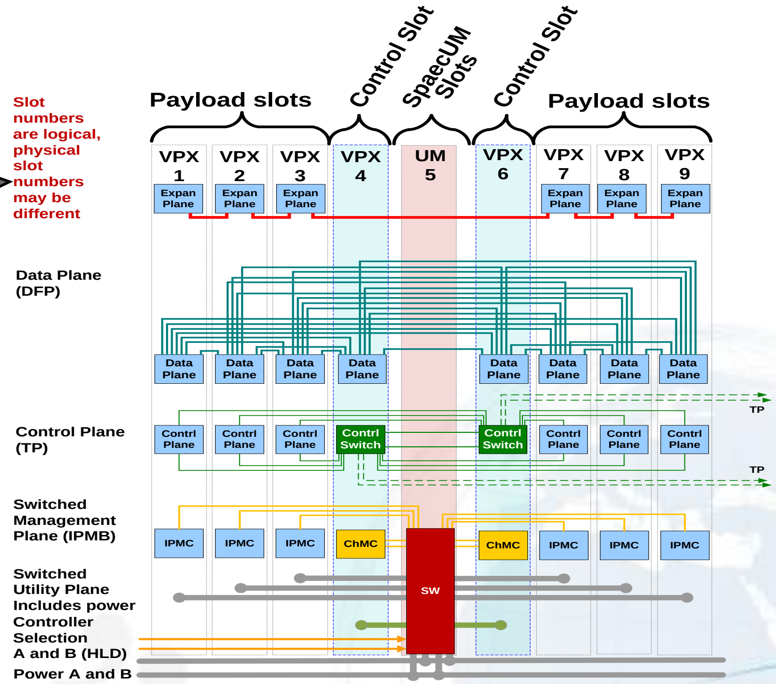
- Protocol agnostic
- Defines mechanical interfaces





MILSATCOM System





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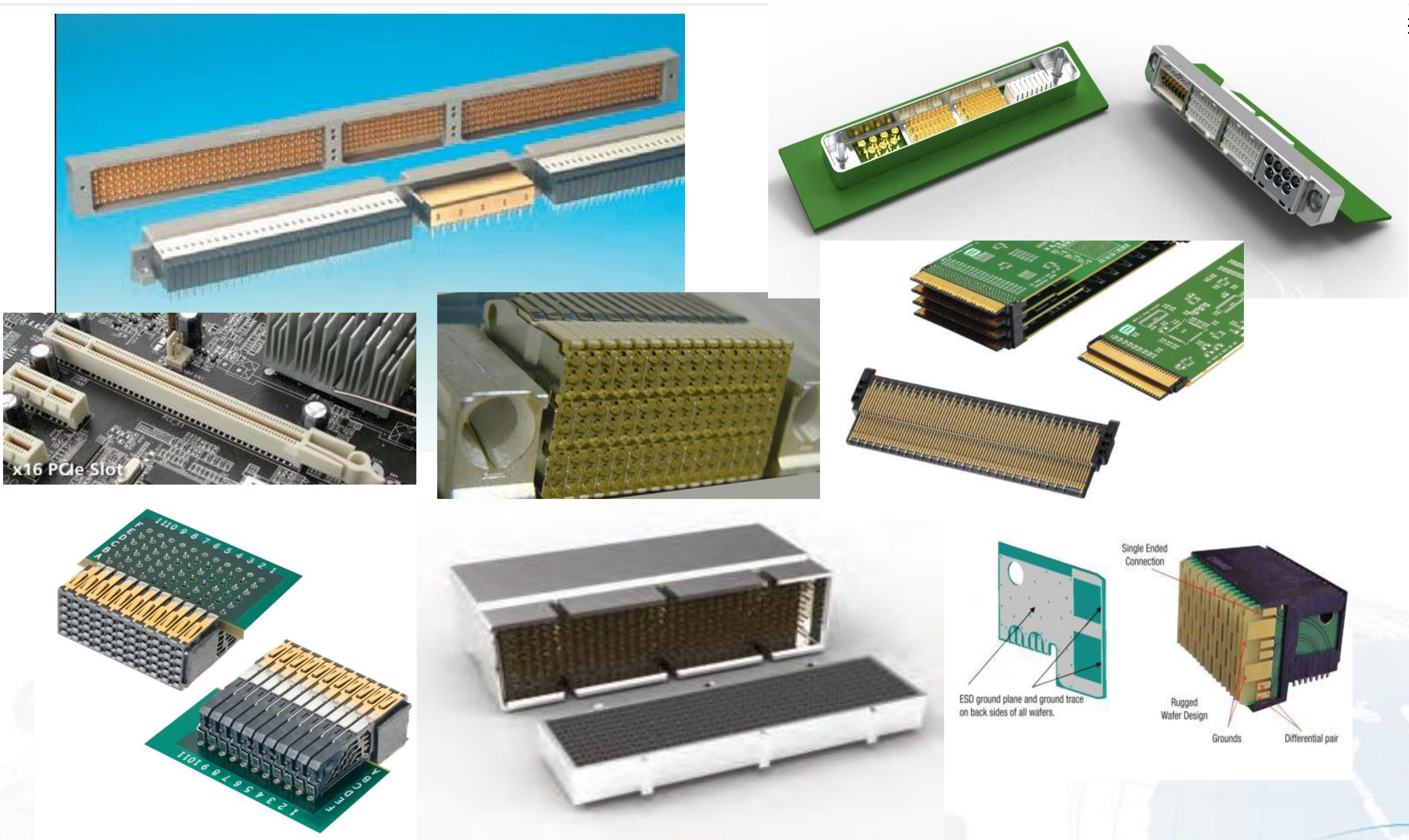
Task 4: Connector survey

- VME 64X
- cPCI
  - 3M UHM
  - Hypertronics cPCI
- VPX
  - Multigig RT2
  - Viper Modular interconnect
  - Hypertronics KVPX
- Advanced TCA
- microTCA
  - Con:CARD
- Generic
  - Fortis ZD
  - High Speed Ruggedized (HSR)
  - IMPACT
- SpaceWire
  - Hypertac HPH-SpW

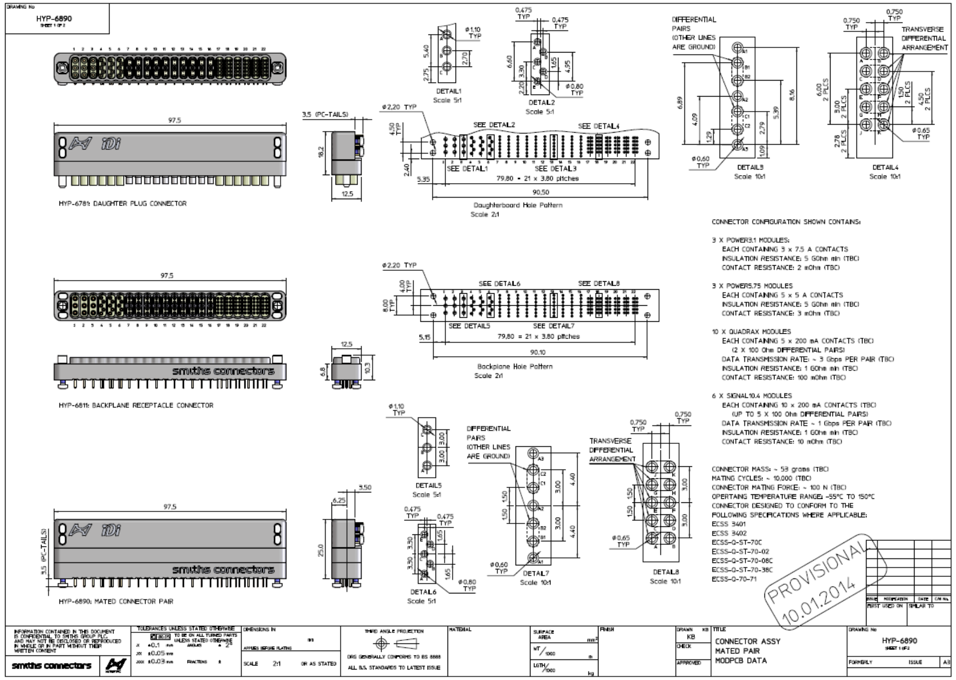
Task 4: Potential connector candidates

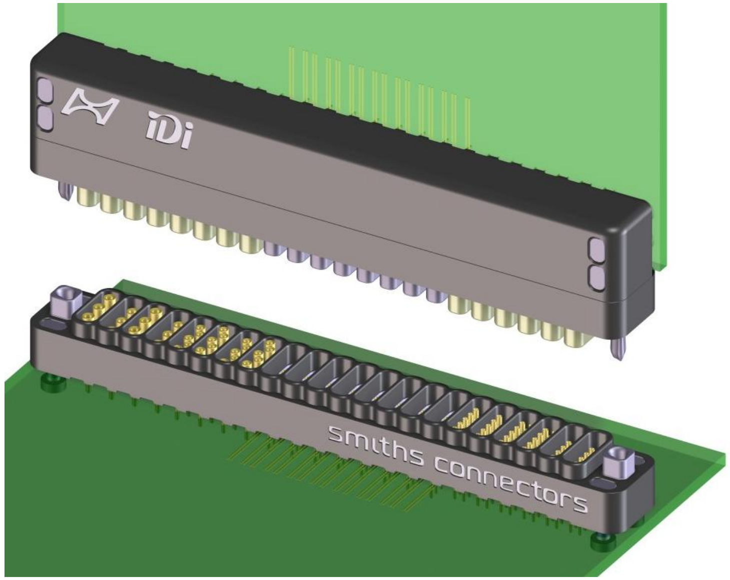


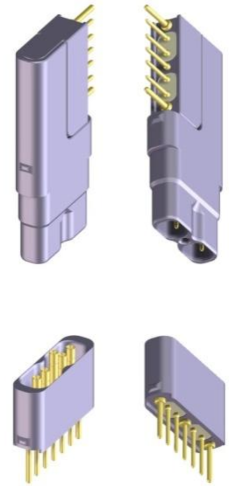
Task 4: Survey conclusion

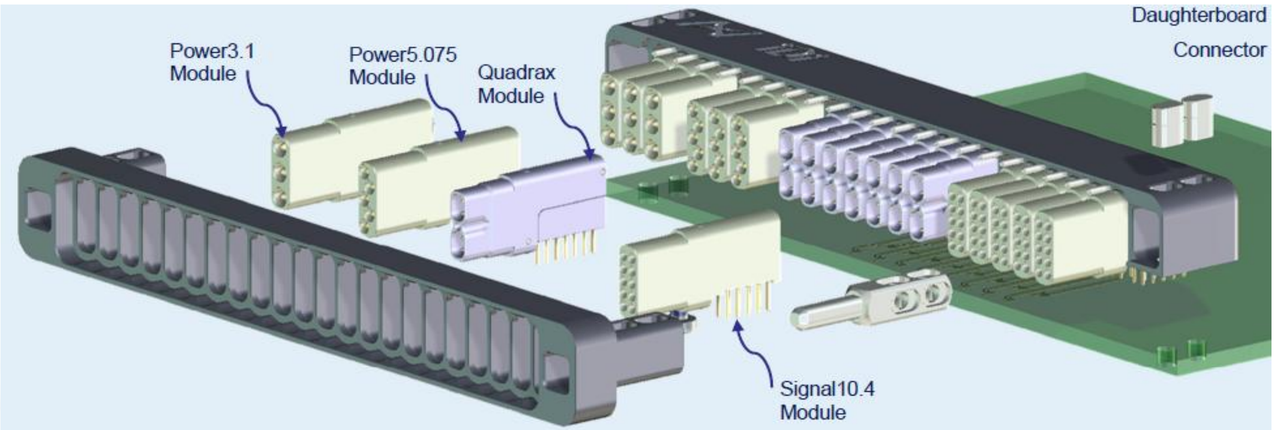
- Hypertronics connectors offer the greatest promise for the SpW backplane connector from “existing” terrestrial
- Possibility of a dedicated Hypertac modular connector development targeted at high speed signals not excluded
- Issues:
  - ITAR restrictions on Hypertronics parts
  - Is Hypertronics KVPX connector actually in production?
  - Can a dedicated SpW backplane connector development be justified?
  - How will the need for lower cost systems be accommodated in is the avionics development phases

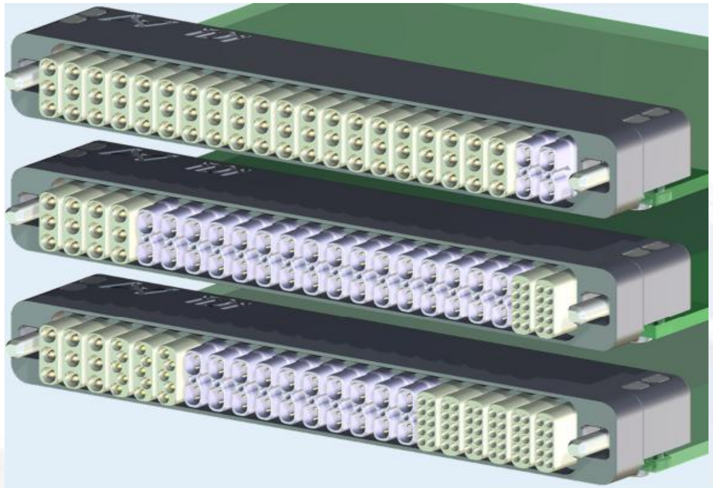
Task 4: Hypertac (Smiths Connectors) Nexus connector development











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Task 4: ESCC Detail Specification – draft generated

ESCC
European Space Components Coordination

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CONNECTORS AND SAVERS, ELECTRICAL, RECTANGULAR, NON-REMOVABLE PCB CONTACTS

BASED ON TYPE NEXUS

ESCC Detail Specification No. 3401/xxx

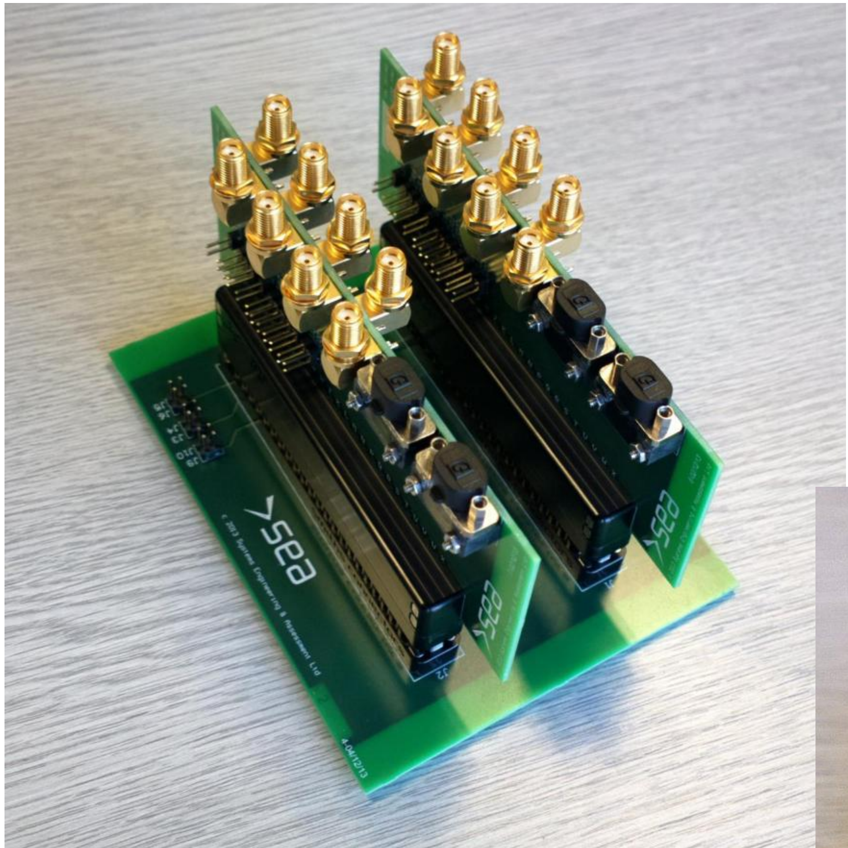
DRAFT

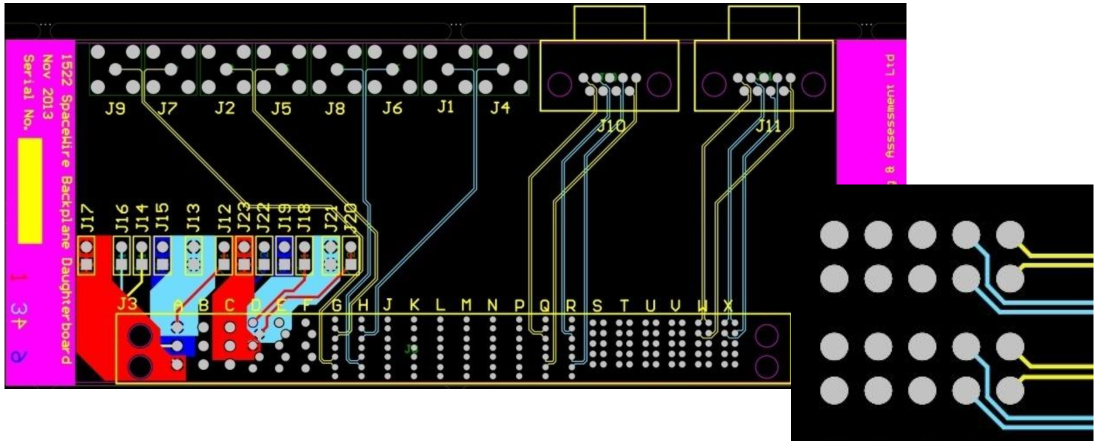
Issue 1	April 2014

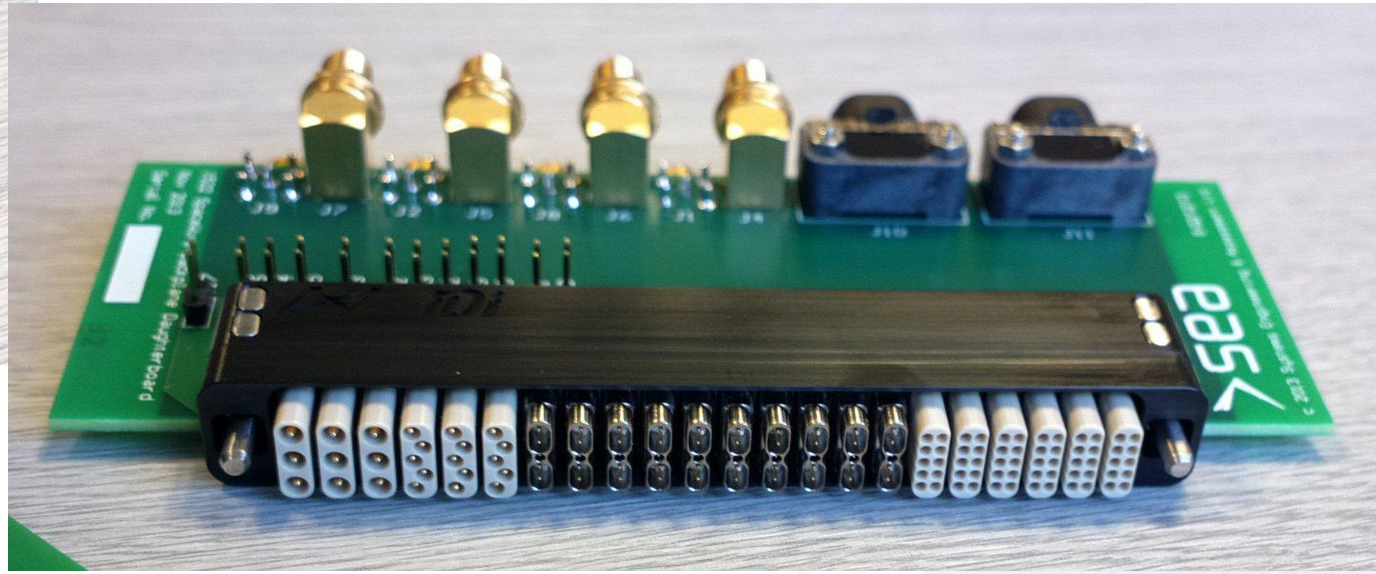
esa

https://escies.org

Task 4: Test boards







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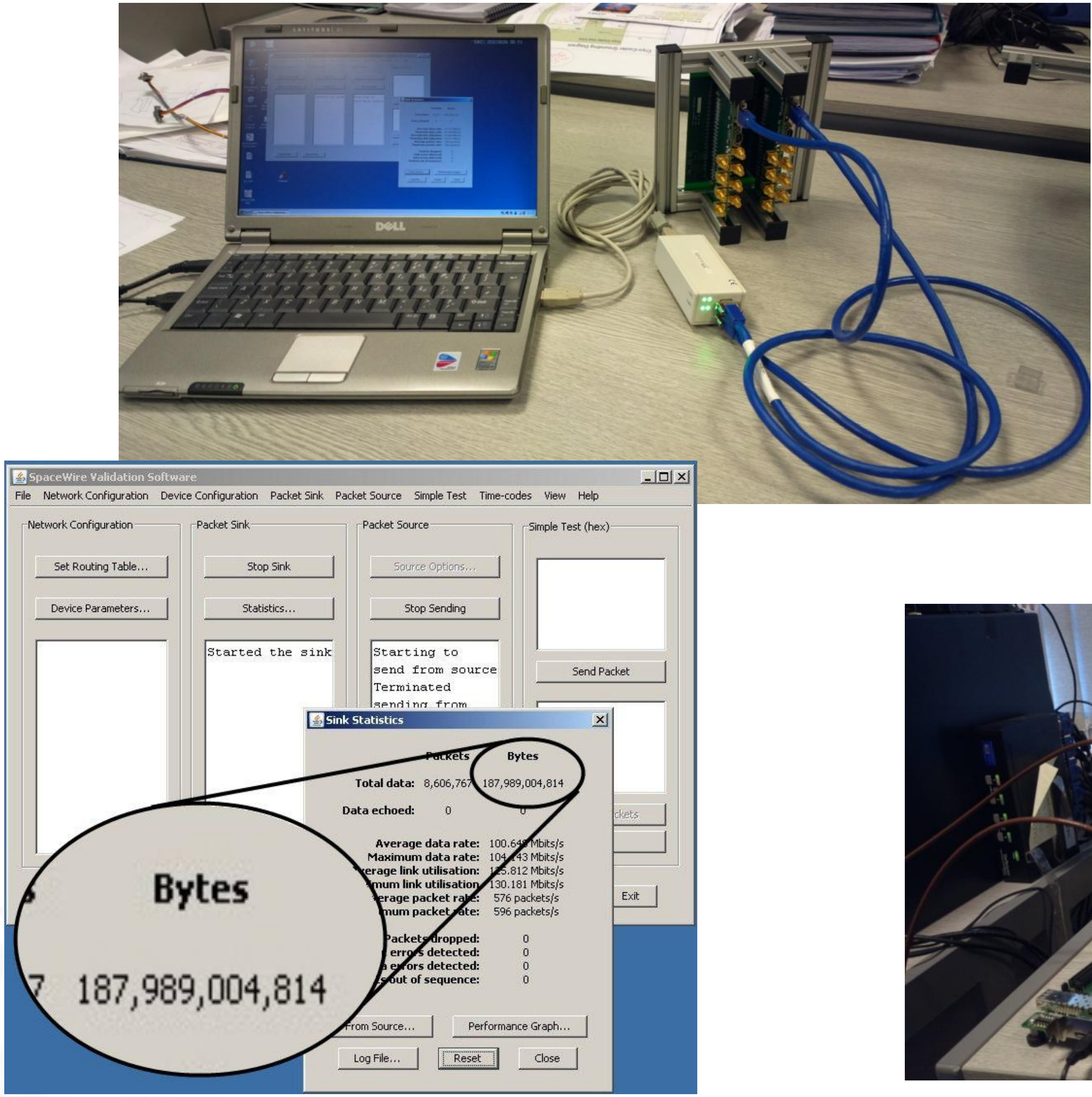
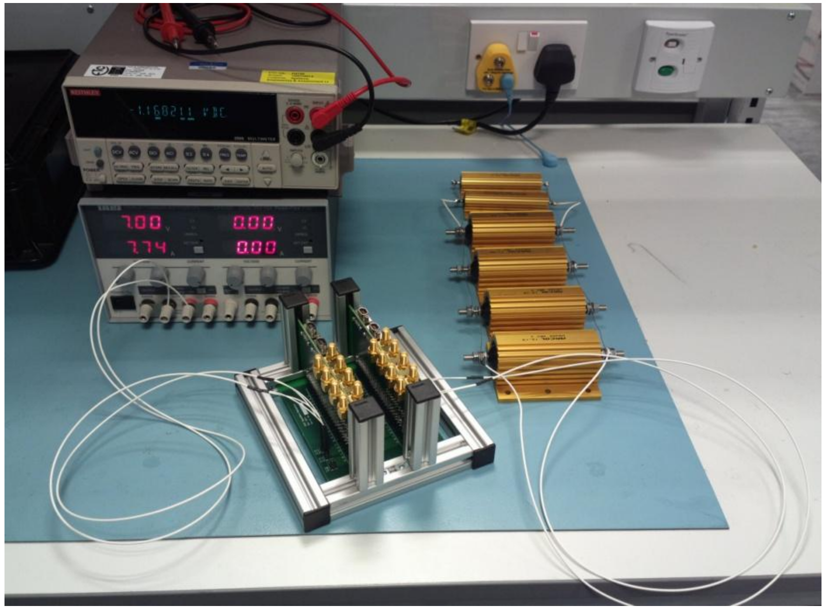
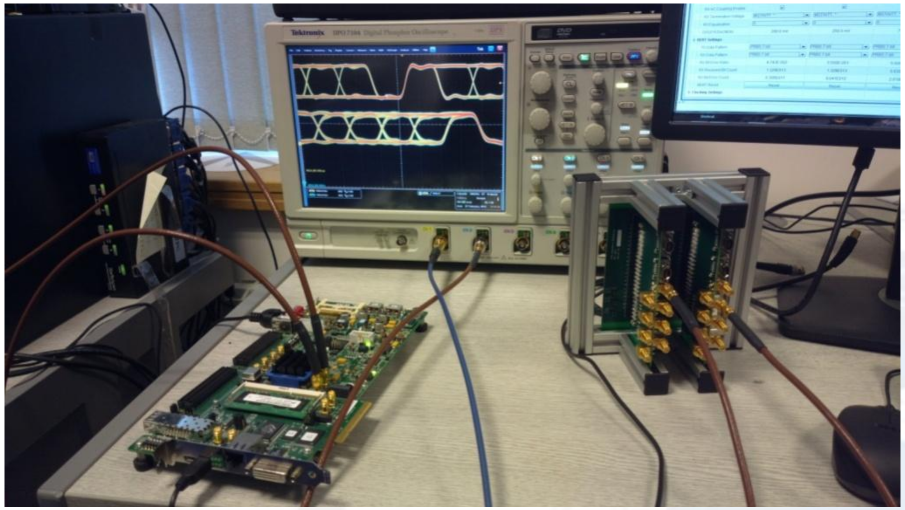
Task 4: Connector test setups







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Task 5: Synthesis and Final Presentation

- The activity concluded with:
  - Review of test results
  - Identifying other target markets for Nexus connector
  - Commercial evaluation of Nexus connector development for
    - Space market
    - Military market
  - Identifying future developments and activities
  - Summary Report
  - this presentation!

Thank you – any questions?