SAVOIR SAIF

AOCS Sensor and Actuator Interfaces WG
Conclusions and Recommendations

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SAIF Working Group (1/3)

- This presentation summarises the work and findings of the SAVOIR SAIF (AOCS Sensor and Actuator Interfaces) Working Group.
  - Final report still under final review by the WG.

- The scope of the WG was to investigate
  - the currently used AOCS data and power interfaces and
  - the possibilities for rationalisation and standardisation of these of these within Europe.

- With the intention to
  - reduce the number of interfaces and variants in use in order to ease the burden on equipment supplier (and their EGSE),
  - to allow more and easier competition between units for users and
  - to simplify and reduce the cost of the CDMU with respect to interface support.

SAIF Working Group (2/3)

- The working group split the work into data interfaces and into power interfaces.

- The work has followed a similar approach broken down into the following steps:
  - Identify all main interface options requested currently on world market for AOCS
  - Assess the dominance and relative market importance of each type
  - Identify new interface options expected to be requested in the future
  - Assess the impact of each interface on the equipment, cost, ITAR, future developments, s/c and potential sales market
  - Finally recommend the options to support and identify supporting studies to confirm and implement these results.

- The work has been based around surveys and group discussions taking in the opinions of
  - the sensor and actuator designers/ suppliers, and
  - the providers of the interfacing hardware (e.g. CDMU).

SAIF Working Group (3/3)

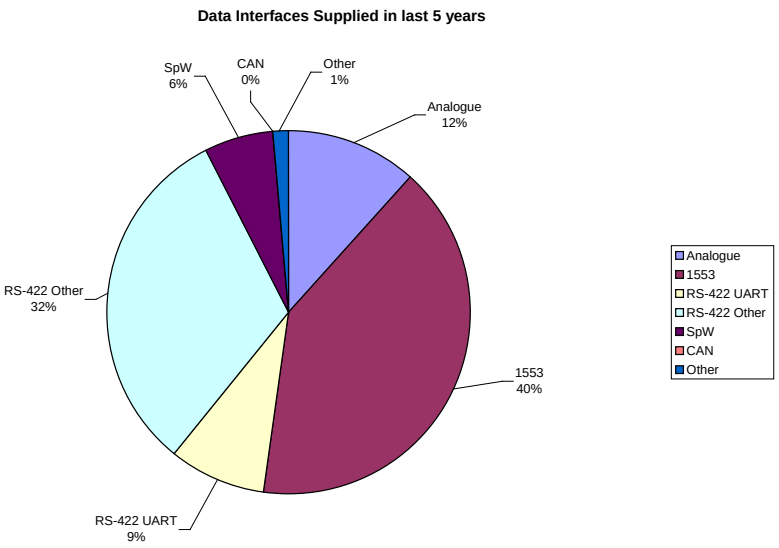
- The WG consisted of a representative cross section of all potentially interested parties in particular covering AOCS equipment manufacturers and users. The final group consisted of the members and companies shown given below. It should be noted that all members time and costs were paid by their own organisation.

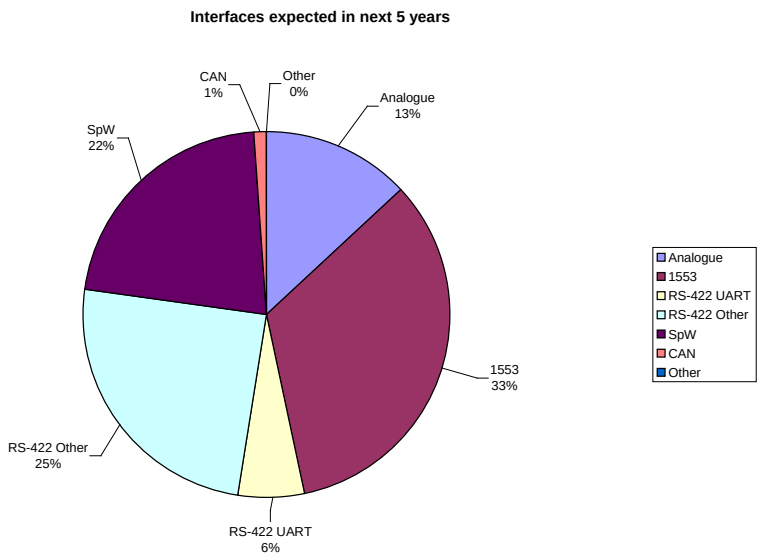
Agency Representatives:
- ESA: S.Airey (Convener)
- CNES: P.Guay
AOCS Equipment Suppliers:
- Astrium: C.Carron (Gyros, CMG)
- Bradford Engineering: P.van Put (Reaction wheels, sun sensors)
- Jena Optronik: K.Michel (Star trackers, Navigation Cameras and sun sensors)
- Lusospace: I.Vieira (Magnetometers)
- SEA: B.Olivier (Gyros)
- Selex Galileo: F.Boldrini (Star trackers, Earth Sensors, Navigation Cams and sun sensors)
- Sodern: B.Gelin (Star trackers, Earth Sensors)
- Terma: P.Davidsen (Star trackers)
Data Handling/ Interface unit suppliers
- RUAG: O.Martinsson (CDMU)
- SEA: B.Olivier (Data Interface Units)
AOCS Users/ Primes
- Astrium: C.Carron
- Thales Alenia Space: B.Alison

AOCS Equipment Data Interfaces (1/3)

Comparing the results of the equipment suppliers and the users it would appear as though the interface options for AOCS equipment could be reduced to four main candidates.

- MIL-1553
- RS-422 with a UART implementation
- Spacewire
- Analogue (only where difficult to remove due to equipment principle, e.g. analogue sun sensors)





AOCS Equipment Data Interfaces (2/3)

- These key characteristics (in order of preference) for these interfaces could be summarised as:
- In AOCS data interfaces, the top characteristics for the users are:
  - Point to point support
  - Good EMC properties
  - Fixed protocol as well as electrical standard
  - ITAR free
  - Multi-drop or multi-point support
  - Number of wires (harness mass) minimised
  - Support for redundancy
  - Low cost of components to implement the interface
- And for the equipment manufacturers are:
  - Low cost of components to implement the interface
  - Low power use
  - Data rate
  - ITAR free
  - Fixed protocol as well as electrical standard
  - Point to point support
  - Good EMC properties

I/F	For	Against
MIL-1553	Large market support in US and EU Bus structure reduces harness if used with multiple units Very safe	Most parts ITAR restricted Not favoured by world market outside of US and EU Components are expensive and large I/F is quite power hungry Bus structure can impose limitations on data rates and in-orbit failure investigations (i.e. image download difficulties for STR/ Nav cam)
Analogue	Simple i/f with few impacts on the AOCS unit Very low power ITAR free	Low data rate Can lead to high harness masses Impact on data handling system Not suitable for complex units High impacts on the OBC (connector numbers and ADC/ signal processing)
RS-422	Large market support outside of US and EU Simple i/f with few implementation issues (especially UART) ITAR free	Lack of protocol standard also there are variations on the electrical implementation. Data rate limitations for some applications (but can be mitigated by point to point nature of i/f) Leads to relatively high number of connectors on OBC.
Spacewire	Readily implementable with low impact on unit (power, dimension, mass) Variable data rates to suit application – AOCS applications use the lowest data rates of SpW.	New interface for AOCS units so lack of widespread support Harness mass Unclear whether point to point or network is best option. Potential ITAR issues for 3.3V line drivers. Concern that lots of parts are from Aeroflex (US) Impacts on AOCS system (especially cross coupling and FDIR issues) are unclear.

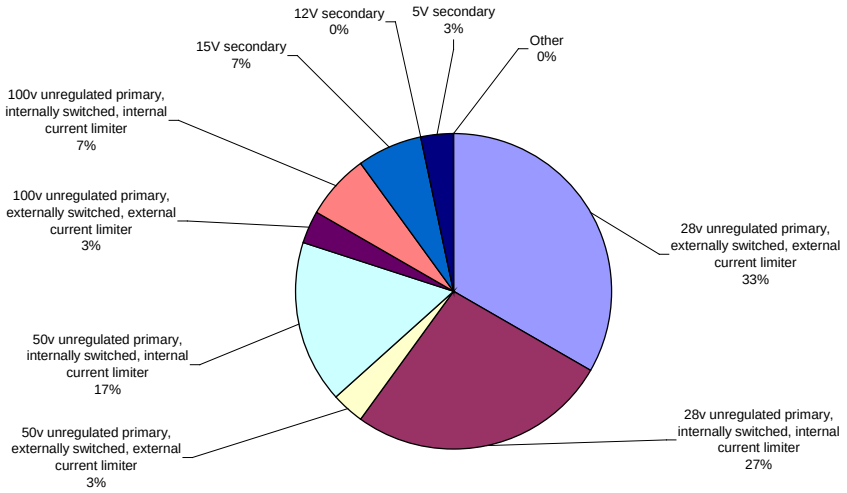
AOCS Equipment Data Interfaces (3/3)

- The following recommendations can be made for future work on data interfaces:
  - Develop a fixed standard for RS-422 covering also the protocol.
  - Limit the number of ESA supported data interface types for AOCS equipment developments (MIL-1553, standard RS-422, SpW and Analogue).
  - Actively work on moving towards fully digital interfaces (where feasible) and removing the analogue interfaces.
  - Ensure availability of IP-cores and low cost ITAR free implementations of the three main digital data interfaces.

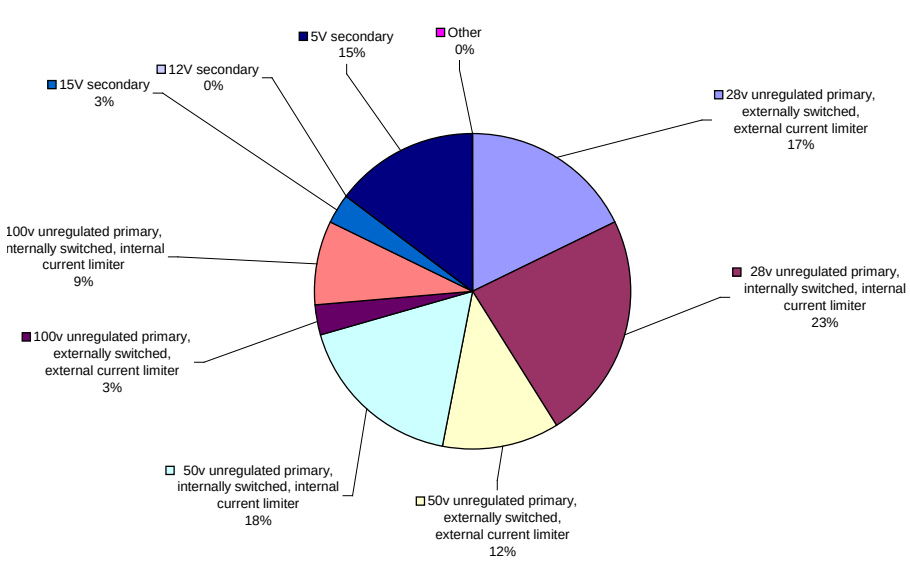
AOCS Equipment Power Interfaces (1/3)

- Rationalisation and standardisation on the AOCS power interfaces would be possible and beneficial.
- The extreme weight of heritage coupled with the high cost of changing existing platforms would mean that a very large initial investment would be needed.
- The 28V systems are clearly dominant and have advantages at unit level compared to higher voltage systems. At unit level it is likely possible to standardise a 28V interface such that it covers all 28V variants currently existing.
- Extending this to also cover the 50V systems may be possible but with some probable reduction in cost efficiency.
- The 100V systems are clearly an outlier and are difficult for units to support due to EEE component costs, size and availability.

Power interface variations supplied in last 5 years

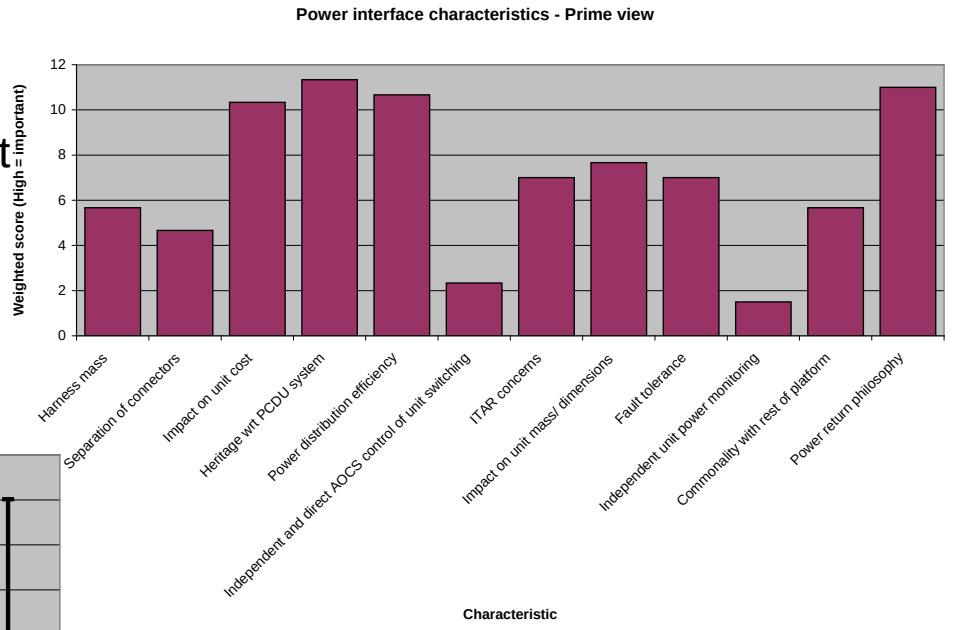


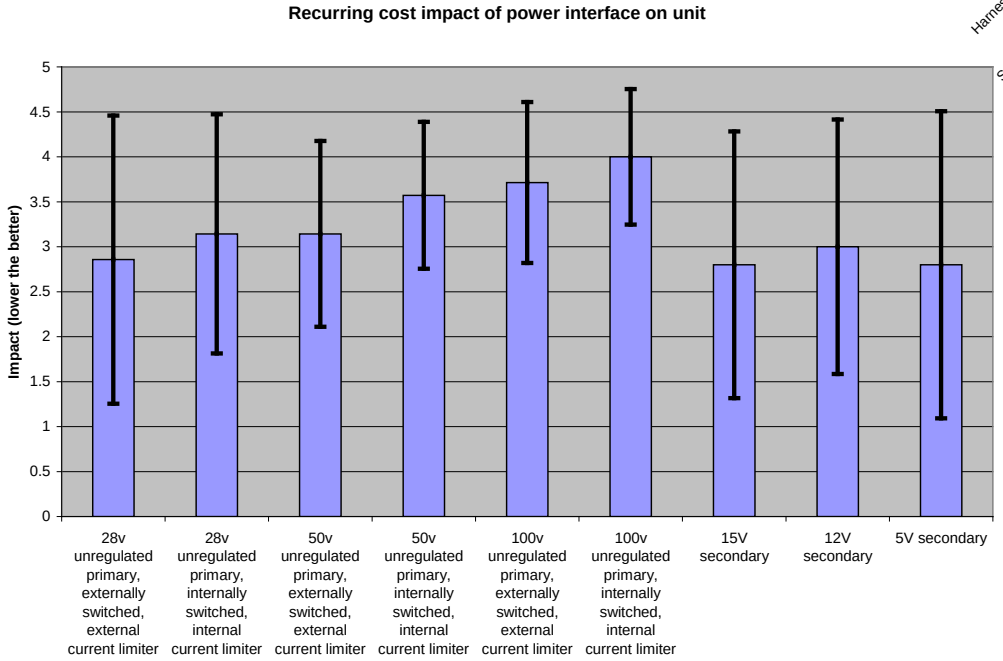
Power interfaces expected in next 5 years



AOCS Equipment Power Interfaces (2/3)

Ranking the importance of the different power interface characteristics, show that main drivers are PCDU heritage, power return philosophy, power distribution efficiency, and recurring unit cost, … (at prime level).





The impact on recurring cost at equipment level is directly linked with the primary voltage.

AOCS Equipment Power Interfaces (3/3)

- The following recommendations can be made for future work on power interfaces:
  - Specify in detail a ‘Standard’ power supply specification for 28V covering the current implementations (regulated and unregulated) to be used as a baseline for the development of future AOCS equipment. Investigate feasibility and impact of extending to also include 50 V.
  - Develop a standard for secondary power supply to AOCS equipment (5-7 V TBC).

Conclusions

- The AOCS Sensor and Actuator Interface Working Group has investigated
  - the currently used data and power interfaces and
  - the possibilities for rationalisation and standardisation of these within Europe.

- The working group has provided several recommendations both for data interfaces and power interfaces (as presented), considering prime and equipment provider views (as reflected by the WG members).
  - The final report is still out for final review.

- Thank you to all the members in the Working Group for their participation and effort.

- ESA will consider these recommendations in future work and standardisation.