Harness Reduction: Future Trends and Prospects

ADCSS 2017

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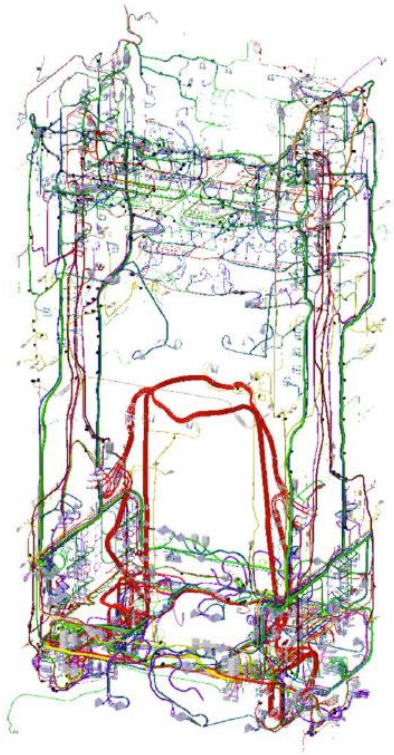
What is a harness?

The spacecraft's harness is more & more complex and highly constrained.
It could exceed **50 000** connections**,** **200 kg** and **20km** of wire length.
It becomes a critical design driver for modern spacecrafts.



Harness Derating Rules - Opportunities for ECSS improvement
M. Malagoli // 23/09/2013 // Space Passive Component Days

Types and functions

Different type of harness:

DC harness

- Low voltage
- Medium voltage
- High voltage

Current

- High current
- Low current

RF harness

Spacewire/spacefiber

Different type of functions:
Power distribution (30% harness mass)
Signal
High voltage (TWTA, propulsion)
RF harness
High data rate harness

CNES study (2009)

Satellite/harness mass	*Microsat / 7Kg*	*Pleiades / 70 Kg*	*Telecom CM / 60Kg*	*Telecom SM / 20 Kg*
Decentralised power distribution (PPCU+PDU)	- 5%	-12%	N/A	N/A
Thermal control dedicated bus for transducers acquisitions	- 2%	- 1%	N/A	N/A
Thermal control dedicated bus (PPCU + mini PDUs)	- 8%	- 15%	N/A already implemented	N/A already implemented
Aluminium cabling	- 14%	- 7%	- 25%	- 19%
Structure grounding	Power– 12% Total – 25%	Power -11% Total -18%	Baseline	Baseline
Shielding removal	- 10%	- 9%	- 5%	- 10%
Connectors miniaturisation	- 12%	- 3%	- 9%	- 10%
Cabling diameter reduction	Power -5% Total -23%	- 25 %	Power -22% Total -45%	Power -12% Total -32%

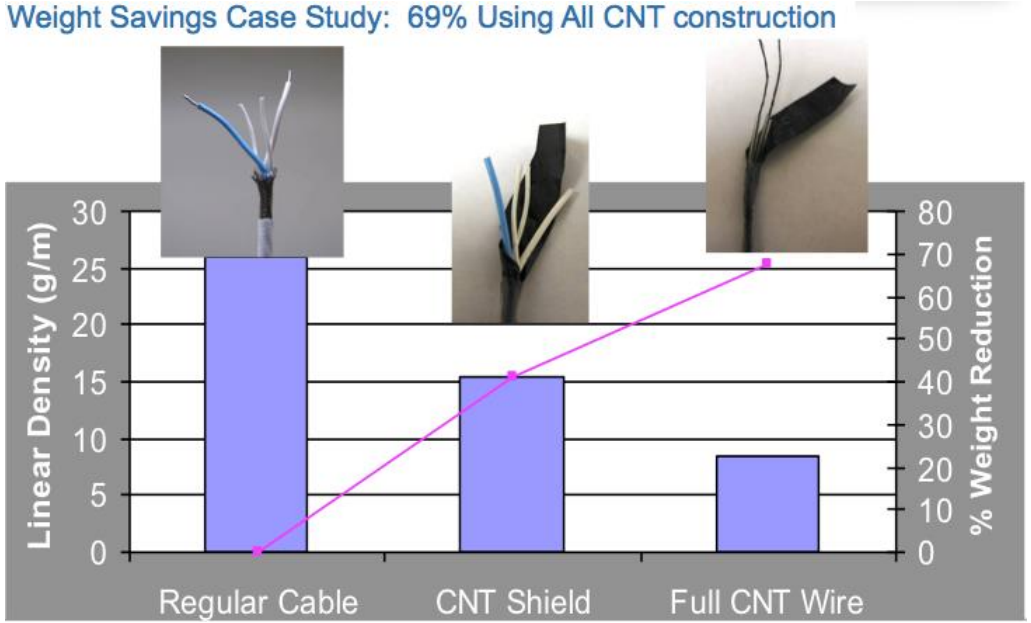
Mass reduction: individual element

Material:

Aluminum

Changement de câble	AWG20 Cu => AWG18 Al	AWG28 Cu => AWG24 Al
Résistance (Ω/km)	32.3 => 33	244 => 145
Masse linéique (g/m)	6.63 => 3.83	1.35 => 1.22

CNT



Composite (connector):

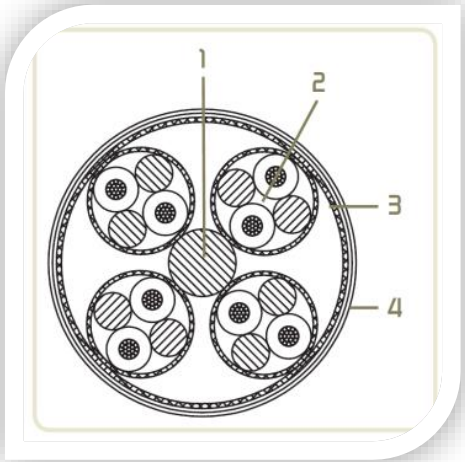
ESCC 3401/087 C&K (micro D)

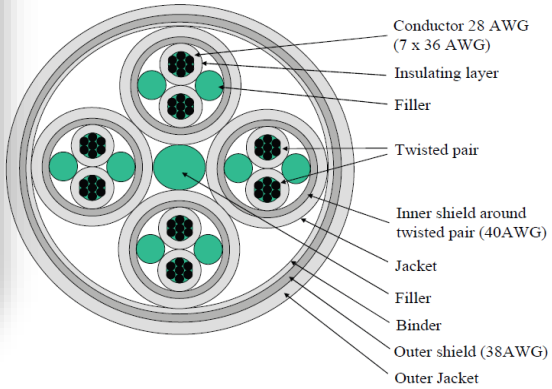
40% mass reduction according to Nicomatic

Mass reduction: individual element

Design

Light weight space wire





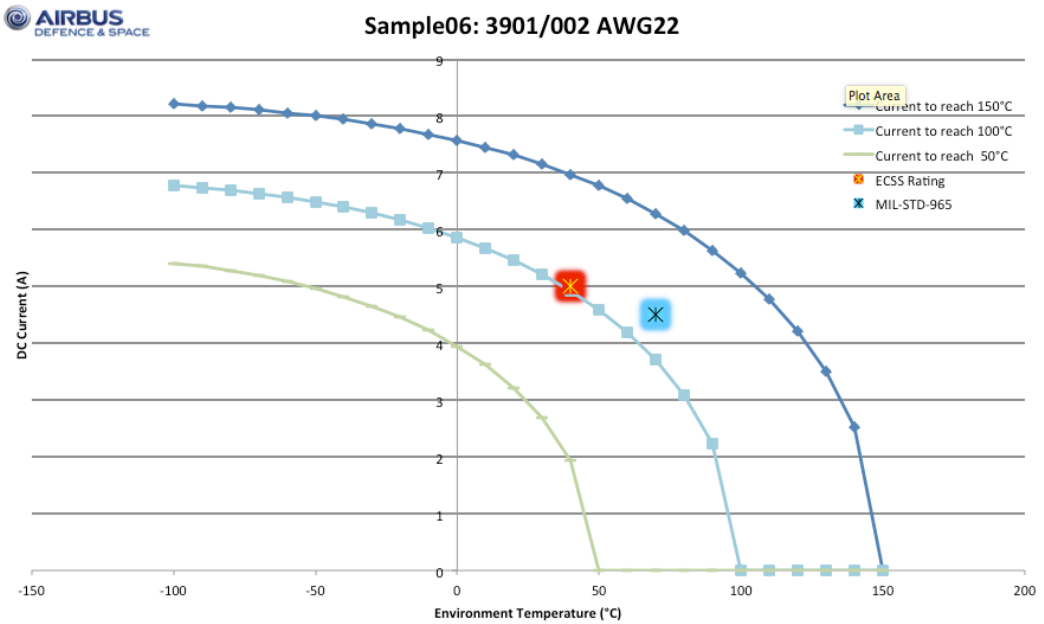
Shielding

	Poids non blindé	Poids avec blindage	Pénalité de masse
Paire torsadée AWG28	2.7 g/m	5.7 g/m	+ 111 %
Paire torsadée AWG26	4.42 g/m	8 g/m	+ 81 %
Paire torsadée AWG24	5.91 g/m	10.5 g/m	+ 78 %

Mass reduction: Bundle optimisation

Derating

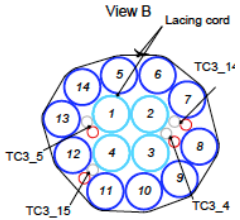
Improved design and use of electrical harnesses (TRP)



Mass reduction: Bundle optimisation

Bundle optimisation

Simulation



Improved design and use of electrical harnesses (TRP)

Bundle shape

For use in large format (75m wing span) UAV. First flight due 2017

Mass reduction: system optimisation

Harness shall answer to several requirement impose by the satellite design (mechanical, thermal, electrical)

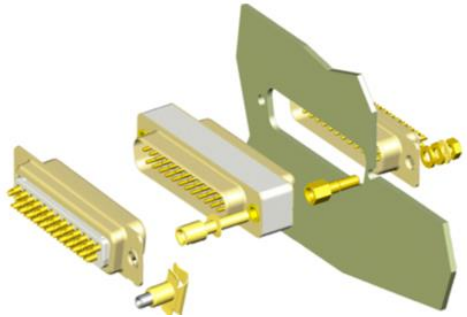
- Routing: distance between equipment, concentration of cable due to structure
- Segregation of different class of signal
- Dismountability may increase the number of point then manufacturing operation

Real gain can be done if the harness routing and design is considered at satellite design.

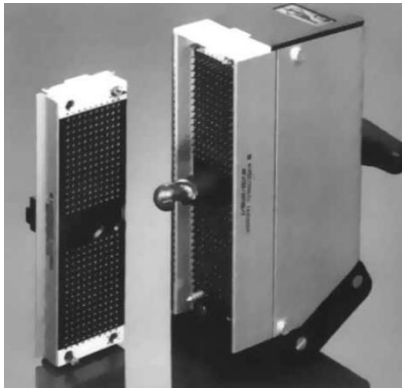
Integration and test

Fast locking

ESCC 3401/085 (C&K)



High density connector (ARTES)



HYPERTAC

AMPHENOL

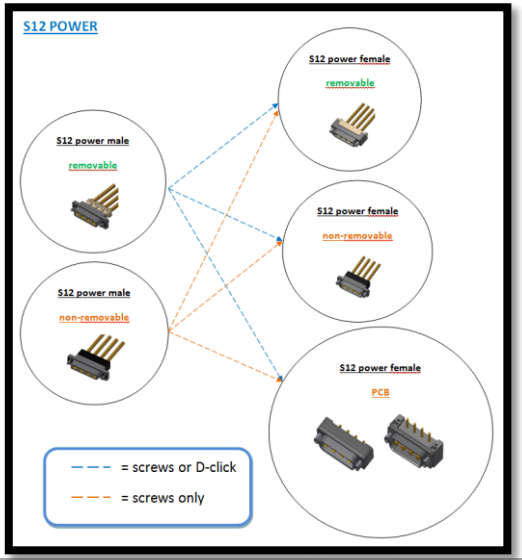
GLENAIR

Integration and test

Modular connector

MINIATURIZATION OF

POWER/COAXIAL CONNECTORS (TRP)



CombiTac from
Stäubli Electrical Connectors