

Space Passive Components Days 2nd SPCD edition

European roadmap for passive components

Denis Lacombe & Léo Farhat

Passive Component Engineers
Components Technology Section

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! We are living in **an important milestone era** in the space industry !
For the first time, private actor are taking leading role in for shaping space industry community.

The first step is launchers, either in US or in Europe, launchers will be designed and manufactured by independent private companies.

Agencies step away of this critical aspect of space access.



! We are living in **an important milestone era** in the space industry !
For the first time, private actors are taking leading role in for shaping space industry community.

The second one is the arrival of new private actors, profit-oriented, that would like to challenge the current space market and want to drastically reduce the cost of satellites for mega- constellation.

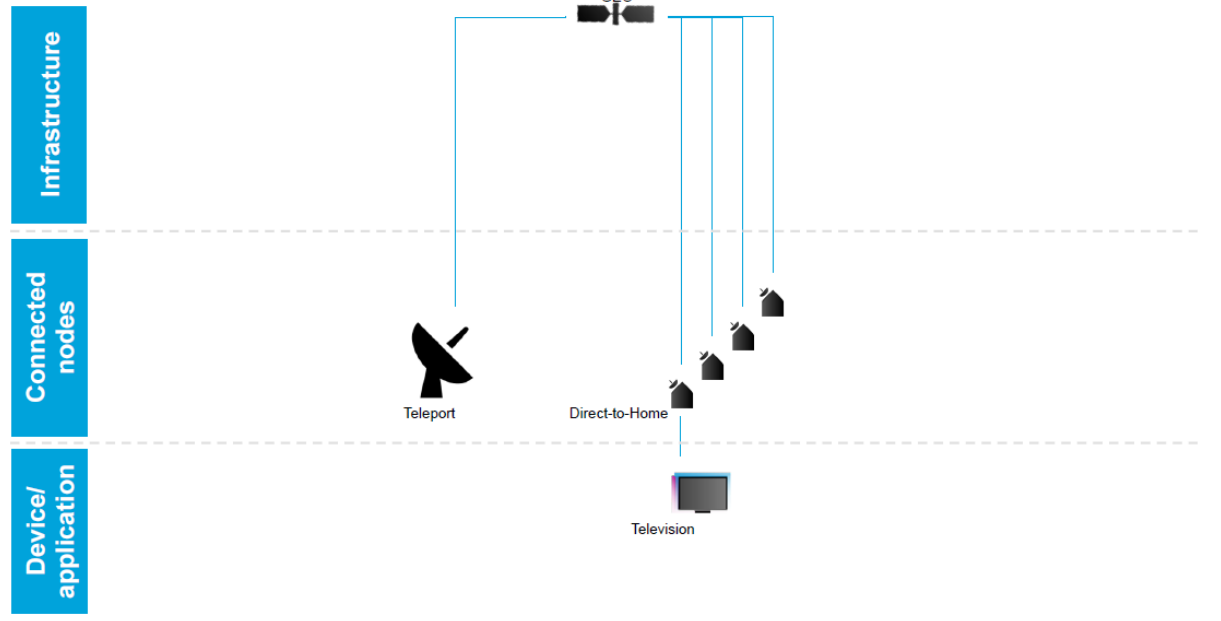


What is the impact on traditional telecom market and institutional projects?

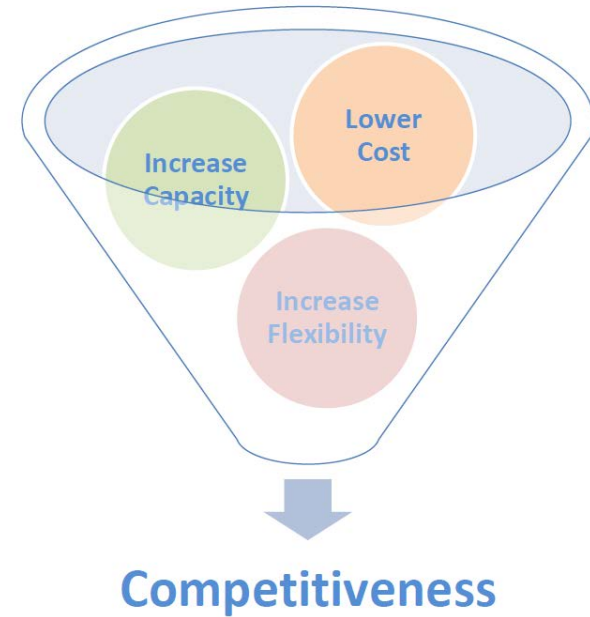
Telecommunication ecosystem is evolving

YESTERDAY

Traditional ecosystem mainly connected linear broadcast customers



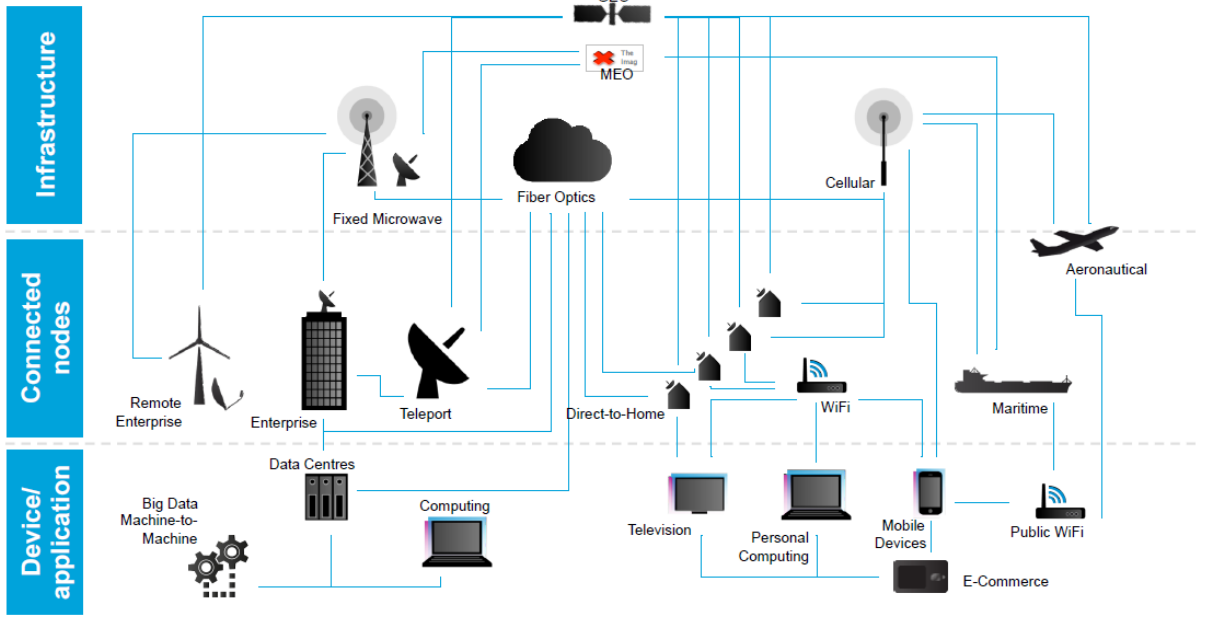
Courtesy of operators SES & Hispasat



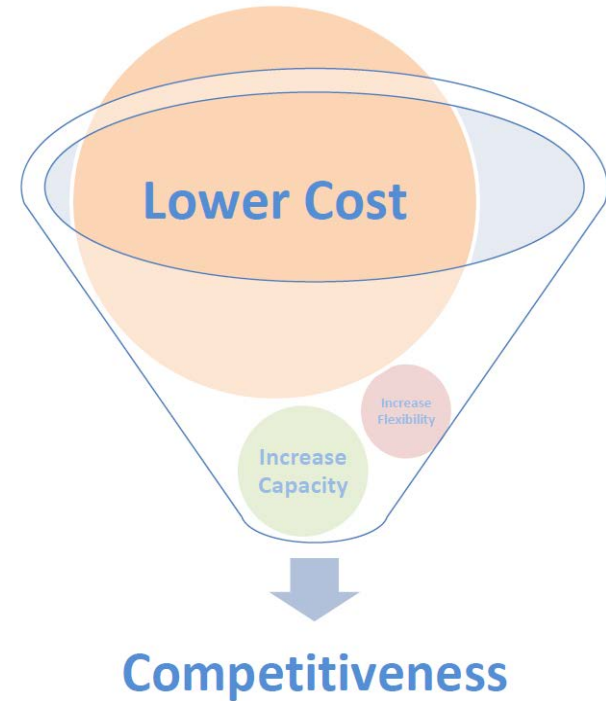
Telecommunication ecosystem is evolving

TODAY

Modern ecosystem also includes deeper networks/applications with a magnitude of connectivity options



Courtesy of operators SES & Hispasat

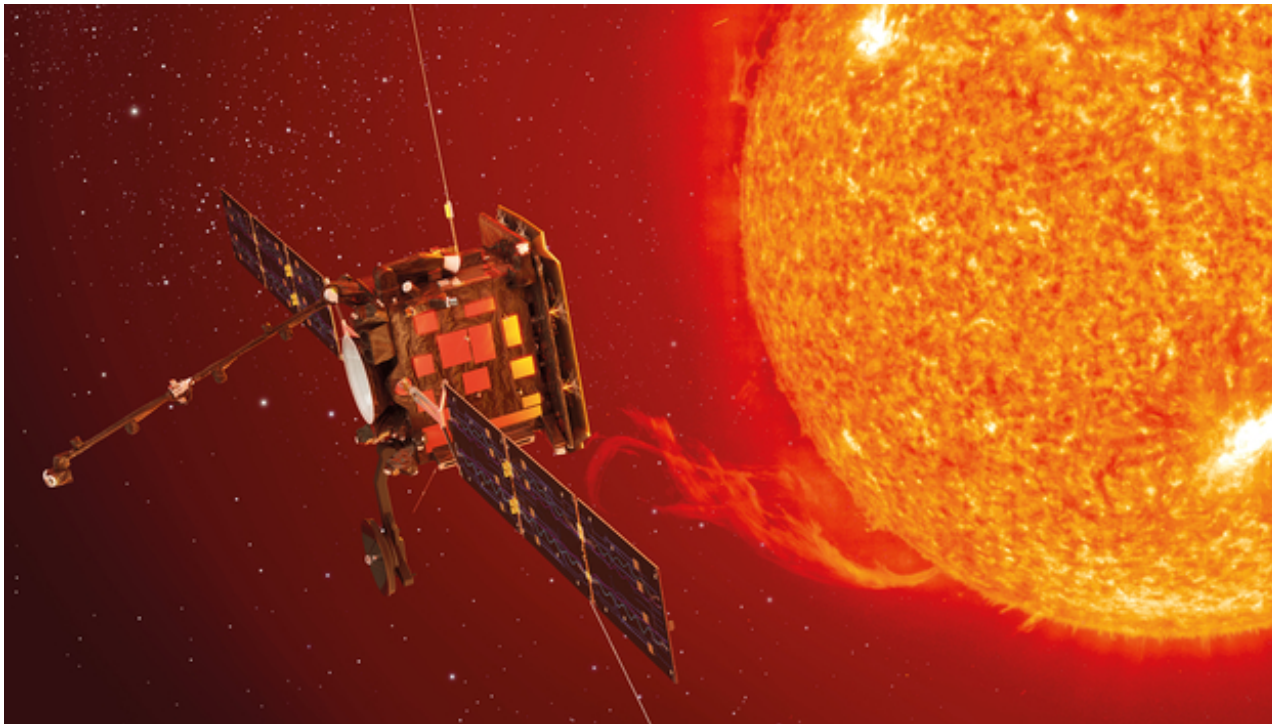


Operators choice

High cost Launch
 Launch every 10 years
 Long satellite lifetime 15 years



Low cost Launch
 Launch every 3 years
 Low satellite Lifetime

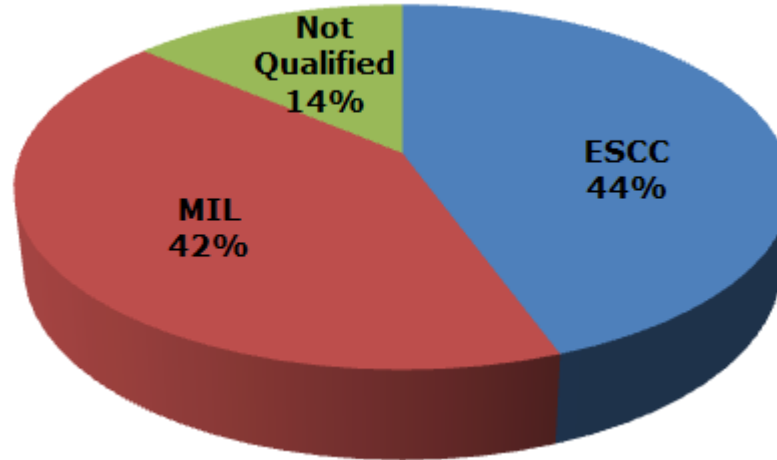


Launch planned to take place in October 2018

Solar Orbiter is a mission dedicated to solar and heliospheric physics.

The project outlines key scientific questions which need to be answered about the development of planets and the emergence of life, how the Solar System works, the origins of the Universe and the fundamental physics at work in the Universe.

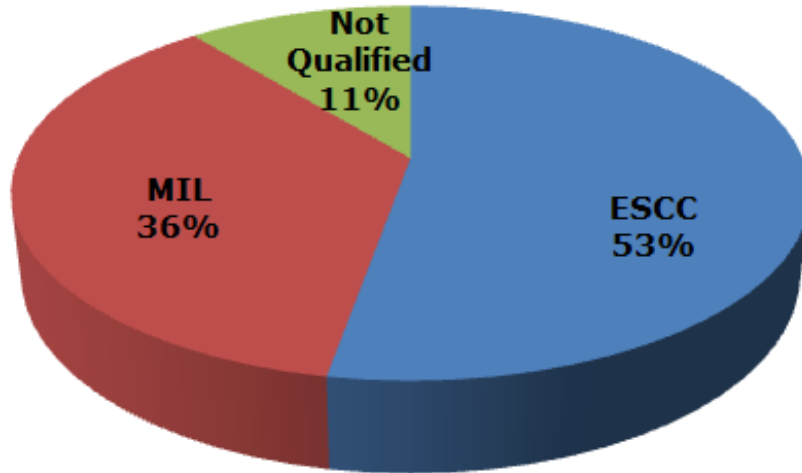
3769 line items procured for FM!



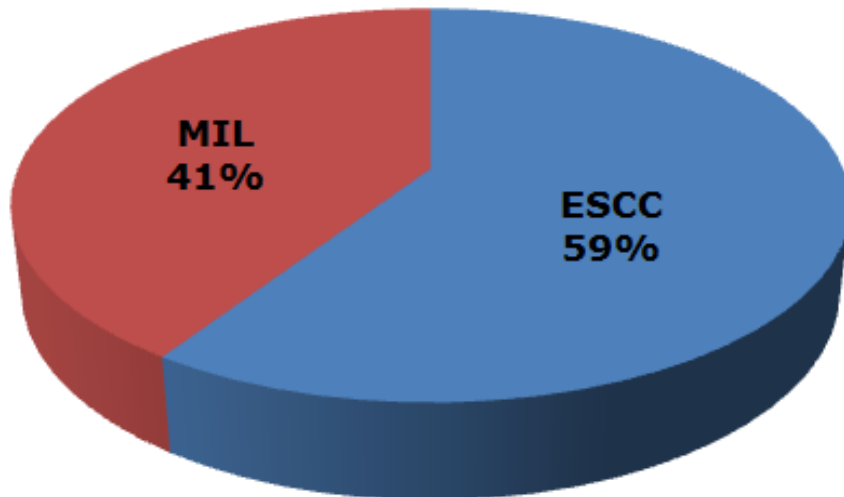
Line items	ESCC	MIL	Not Qualified	Total
Other non-Passive (Diodes; Opto; Hybrid; Transistors, etc.)	222	575	218	1015
Passive Components	1454	1000	300	2754
	1676	1575	518	3769

Solar Orbiter Statistics

2754 line Passive components procured for FM

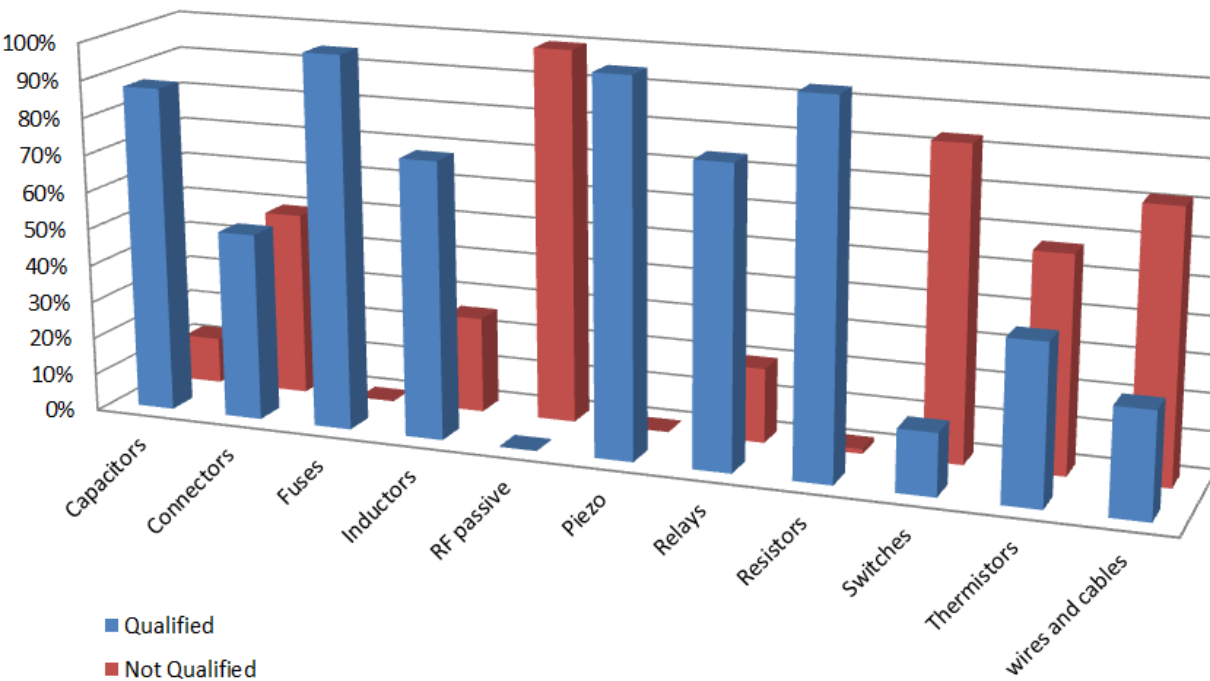


ESCC vs MIL qualified parts



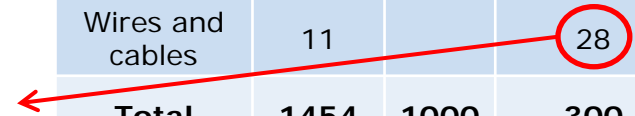
	ESCC	MIL	Not Qualified
Capacitors	391	197	83
Connectors	123	2	123
Fuses	1		
Inductors	50	2	18
Piezo	3		
Relays	4		1
Resistors	859	796	21
RF passive			2
Switches		1	5
Thermistors	12	2	19
Wires and cables	11		28
Total	1454	1000	300

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Most of High voltage and flexible cable assemblies



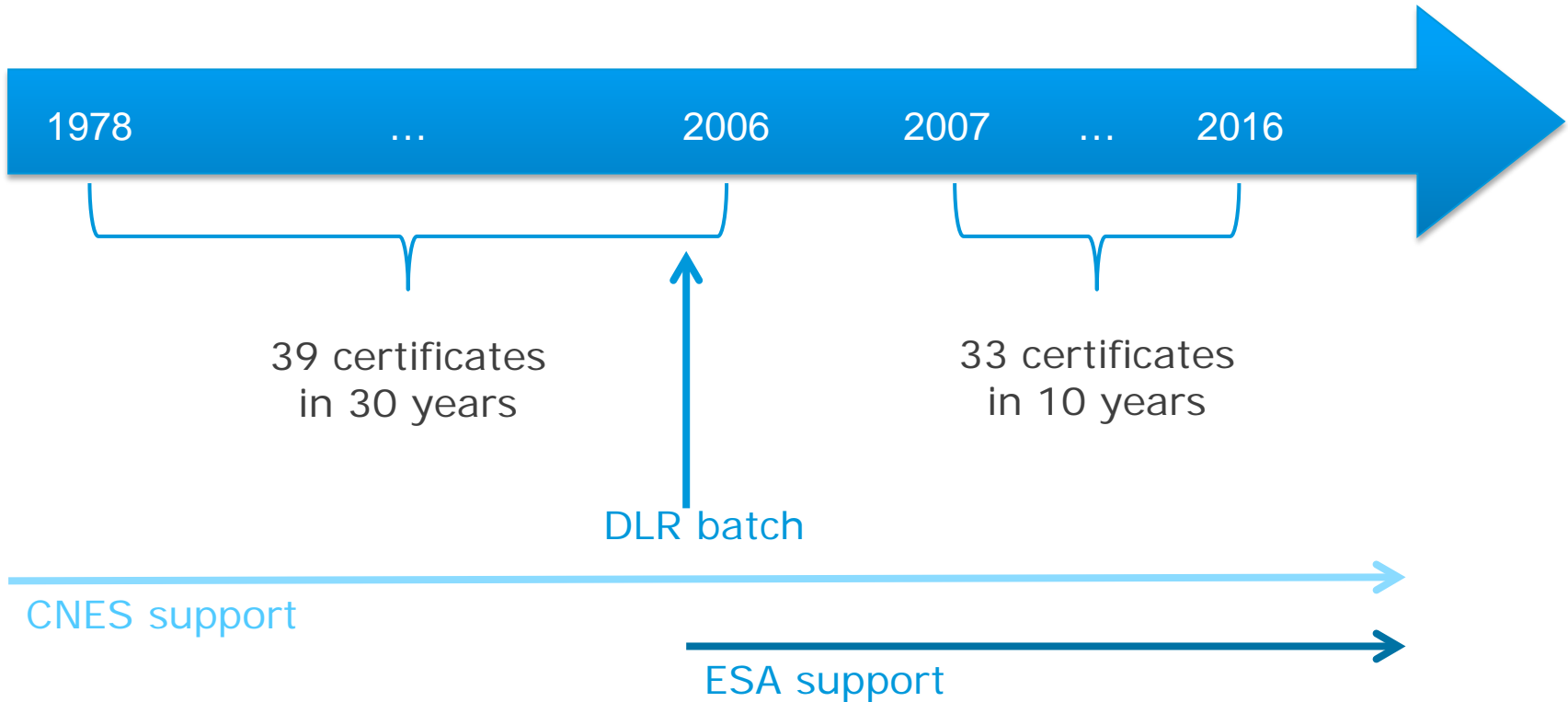
The space market is opening up for [new commercial era](#).

Commercial space-ready to use components shall bring the following benefits:

- Lower cost
- Availability
- Lead time efficiency
- Faster qualification
- Reliability level
- Required performance

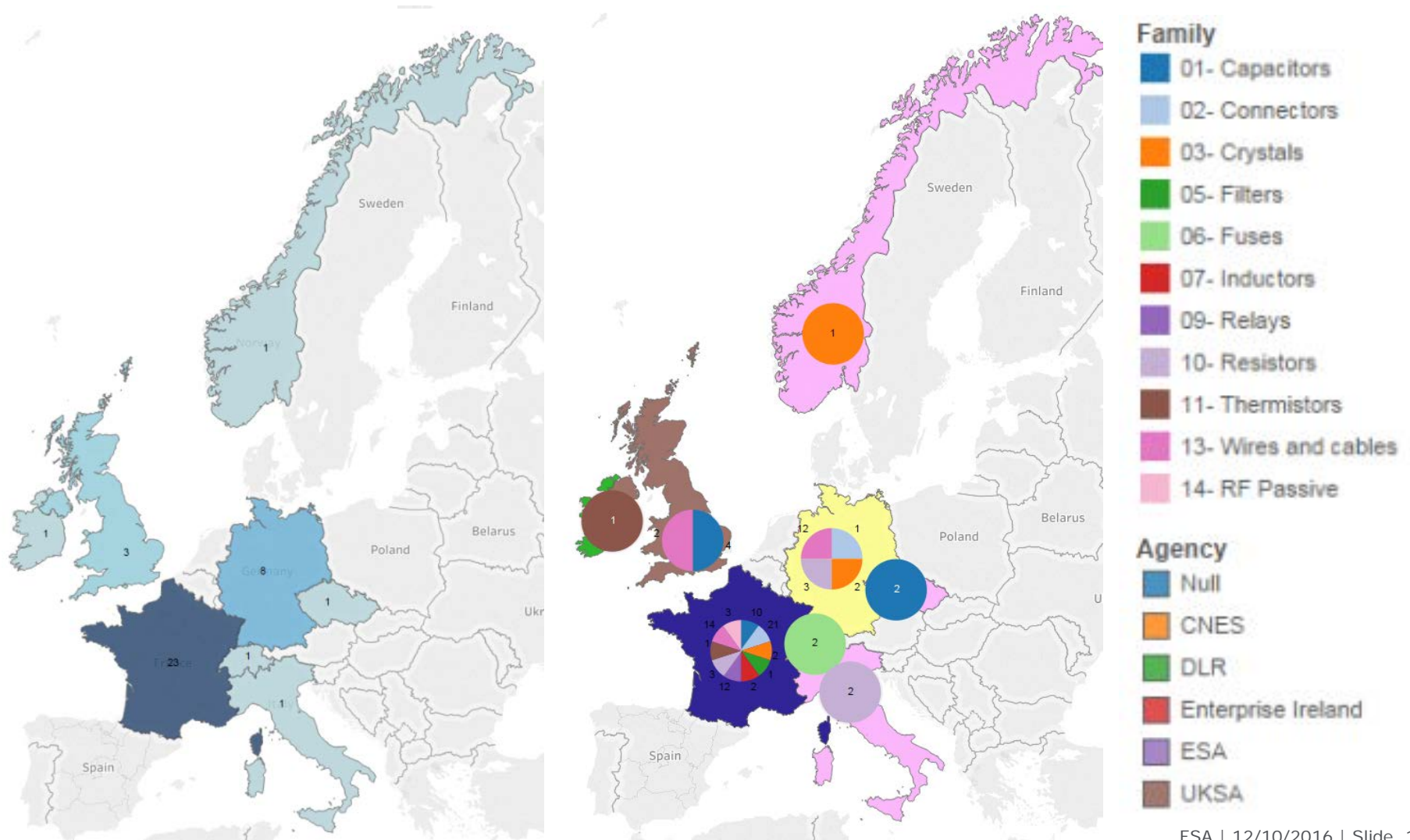
Nevertheless there is a high risk of infant failures, maverick lots or parts, and procurement or traceability errors!

But... ESCC qualification remains as the best way to ensure the reliability of components while meeting the performance requirements on schedule, without additional analysis and with cost and lead time efficiency!

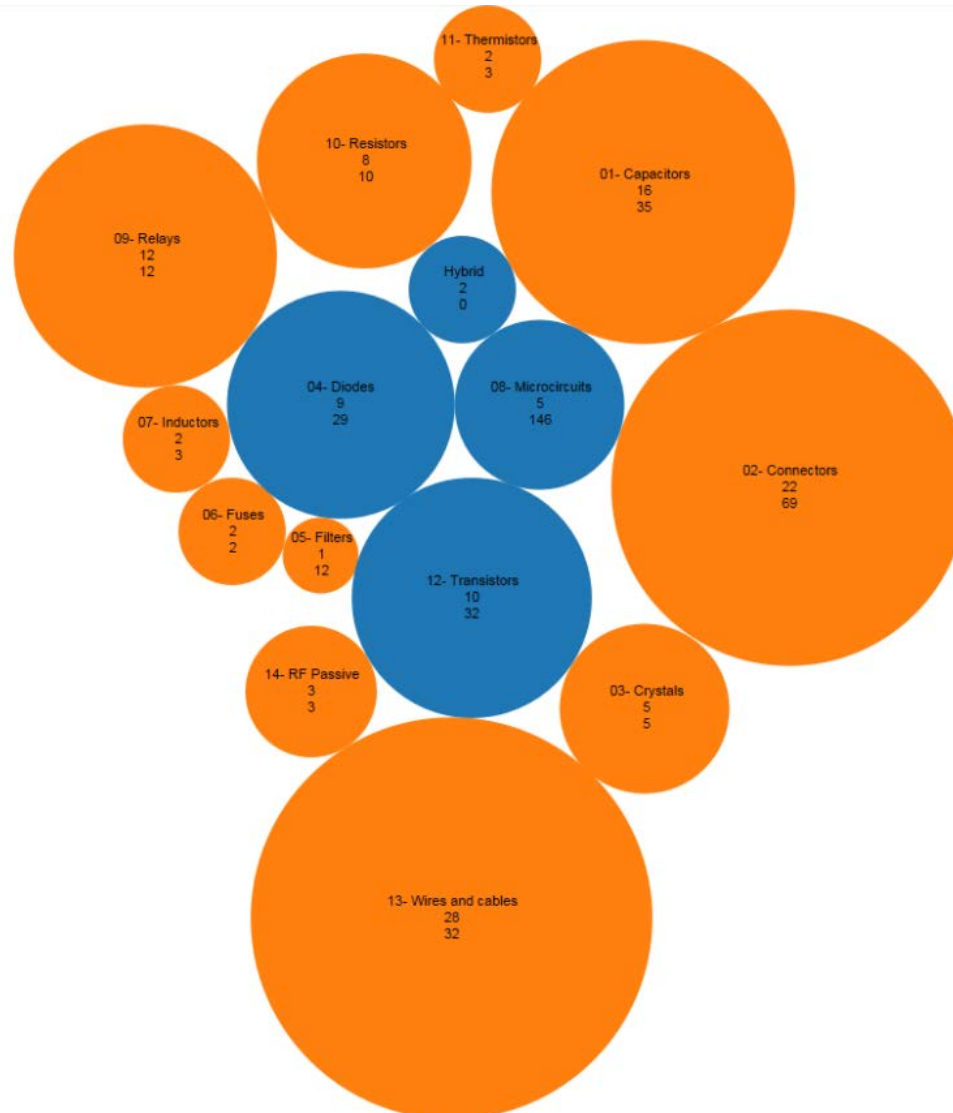


ESCC Qualification : Manufacturers

➤ 39 European manufacturers hold ESCC qualifications for passive components



➤ Passives vs Other non-Passive (Diodes; Opto; Hybrid; Transistors, etc.)



What ?

Time to market shall be faster.

Why?

Theoretically, an ESCC qualification may be done in 2 years. In reality, it takes 3 to 6 years.

ESCC evaluation is the reason (modification of design or process, test flow in series, own resources, etc.)

How?

Reducing the evaluation flow duration by doing tests in parallel.

// Evaluation and Qualification in one shot!

What ?

A qualified list of distributors.

Why?

European manufacturers have often dedicated distributors for their products in US or Asia.

This should avoid confusing situations.

How?

Introducing an ESCC qualified distributors (QDL) as it is the case in the MIL system (for distributors of semiconductor and microcircuit).



What are the **requirements**, needed performances?
What is the driving application?



What is **on-going**?
Activities and solutions under-development, evaluation
or qualification



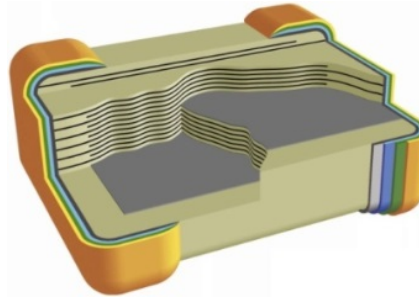
What are the **trends** ?



- Smaller sizes (down to 0402) and higher capacitance values (0402/330nF)



- Lower voltage to increase capacitor value
- ESCC Qualification activities on PME 0402 (10V, 16V, 25V) (Exxelia/Eurofarad, Fr) supported by CNES
- Detail Specifications for 0402 3009/042 and 3009/043 issued



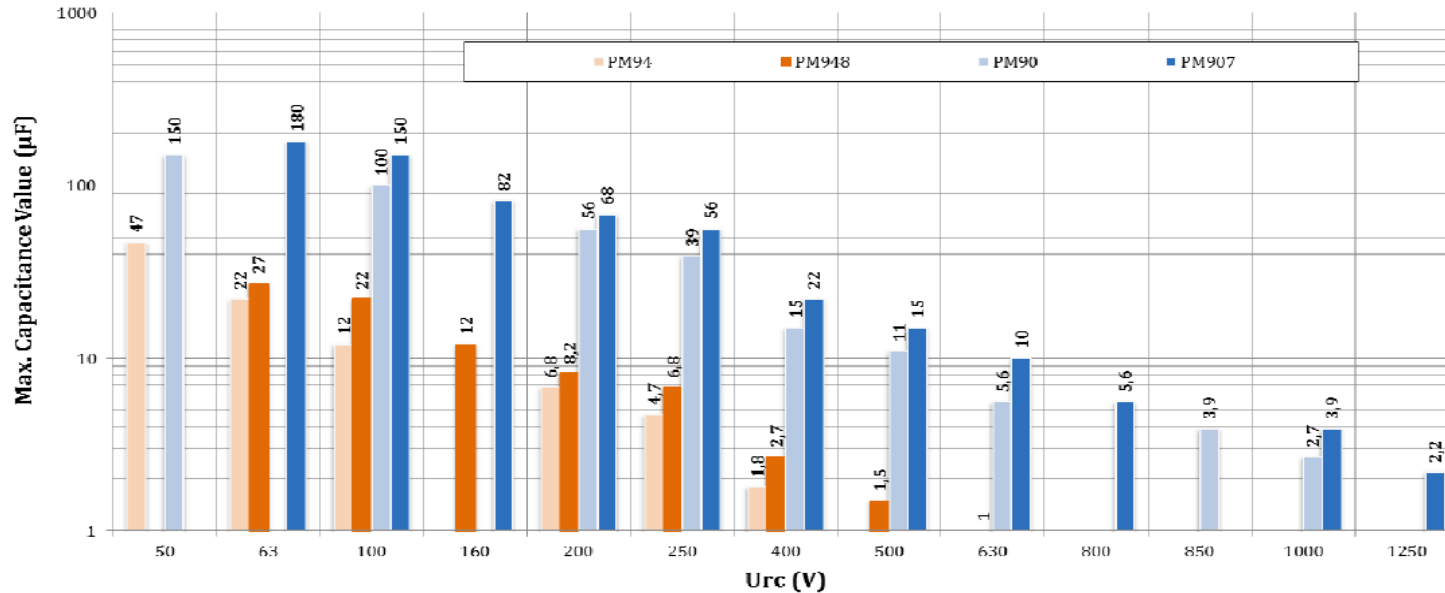
- BME Capacitors
- 0603 size ESCC qualified ESCC 3009/041 (AVX Coleraine, UK)



- Next step is to increase the range in term of capacitance: 0805/4,7microF; 0603/2,2microF; 0402/330nF to be qualified

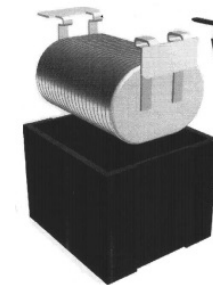


➤ Existing range (PM90S and PM94S) not optimised for 100V



➤ ESCC Qualified PM948 and PM907 (Exxelia/Eurofarad, Fr)

- Detail Specifications 3006/025 (907) & 3006/026 (948) issued



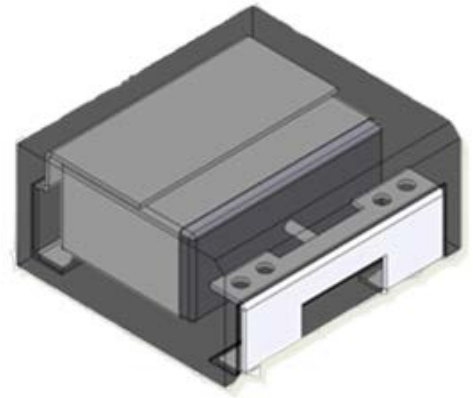


- Lower ESR values



- Polymer tantalum capacitors

- Evaluation activity on single anode capacitor (EPPL with procurement specification 3012/005)
- Hermetic tantalum capacitor in ceramic package (AVX, Cz). Not in EPPL due to assembly issues with this type of package
- On-going Evaluation of CTP-21 (Exxelia/Firadec, Fr) with plastic molding package supported by CNES.



- Multi-anode polymer tantalum capacitor (330/470 microF, 6,3V in smallest package)

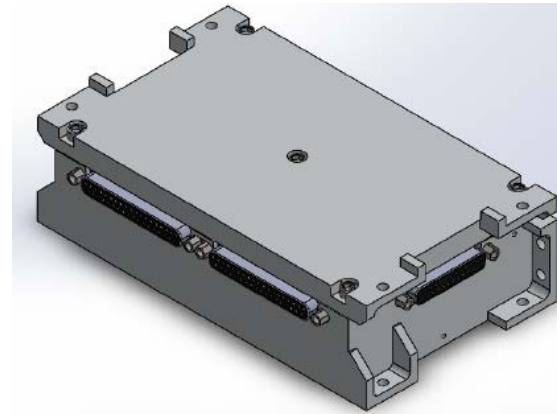


- For Satellites (High power actuators, high power Lidar, High power radar) :

Small capacitance (tens of F) and High operational temperature range 80°C
Number of cycling (> 3 millions) and Lifetime (15 years)



- On-going generic qualification of non-European supercapacitor (Airbus, Fr – EGGO and CSRC,Cz). Goal EPPL.



- Development activity (to be initiated in 2017 with Talinn university – Skeleton, Estonia) of fully electrospun Nano-fibrous electrodes



- For Launchers (pyro, EMTVAS, telemetry) :
High specific Energy (>10WJ/Kg)
High operational temperature range 80°C



- TRP activity to be initiated in 2017:
“Supercapacitor for Launcher applications”

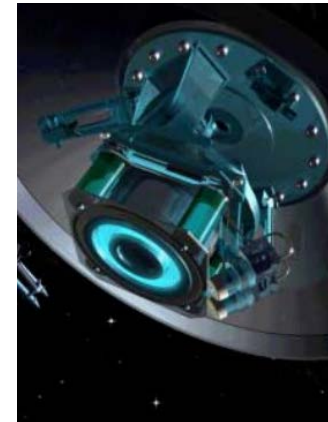




- ITAR issue -> European solution
- High Voltage (up to 2kV) relays for the electric power supply unit of Electric Propulsion systems
- High level vibration and mechanical shock



- ARTES A&T (formerly ARTES 5.1) activity in 2017 workplan. National delegation support is needed.
- Development of high voltage relay for telecom applications (GEO and 20 years in vacuum operation).

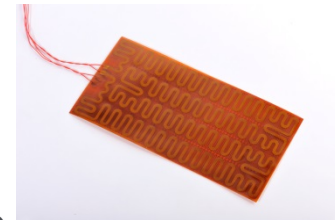


- TRP activity to be initiated in 2017:

“High Level Vibration / Shock Relays & Development and Evaluation



- Performances improvement



- Qualified Heaters (RICA, Italy and Minco Fr) according to ESCC4009/002, 003 and 004 Based on magnetic compensated heaters and pyralux material

- Development activity of thermo-switch (Comepa, Fr) supported by CNES



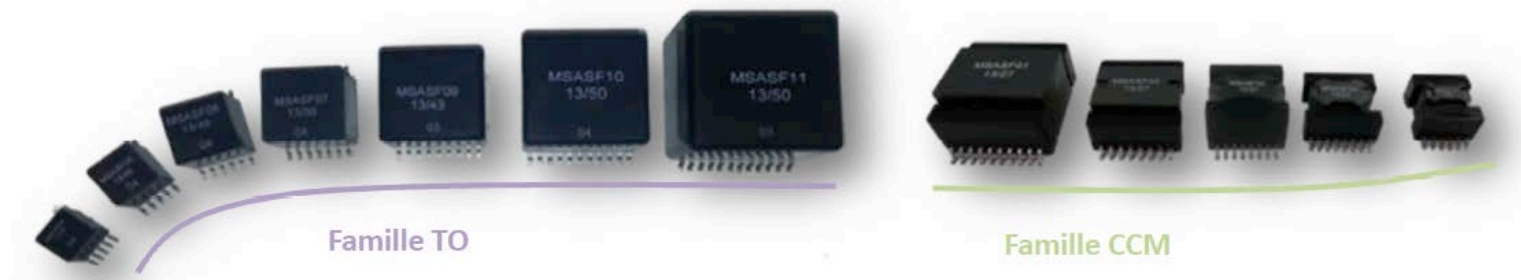
Description	TH47-ESCC	TH47-Complementary tests	TH67-Target/ Real
Power (100 Kcycles)	4A/30 VDC (100 000 cycles): 120W	1,5A/100 VDC, or 5A/ 30VDC or 3A/50VDC ... 150W	2A/100 VDC :200 W...+66%
Overload	6A/30 VDC (50 cycles): 180W	8A/30 VDC (240W/ 50 cycles)	3A/100 VDC: 300 W +66%... More ?
Mass	7 gramme	7 gramme	< 7 gramme or less
Sinus Vibration	50g (from 10 to 2 000 Hz) 30g (from 2 000 to 3 000 Hz)	100g (from 100 to 1 000 Hz) 75g (from 50 to 3 000 Hz)	100g 75g
Shocks	500g 1ms	1 500g, 1ms	1 500g, 1ms
Radiation	X	400 Krad OK	...To do...



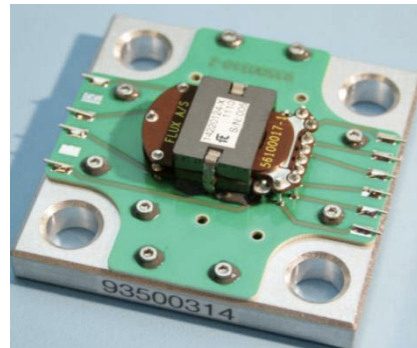
- Different qualification approach, needs for a better integration and high voltage



- Capability approval with Microspire to open the possibility to some level of customization



- Qualification of planar transformer
- Development of high voltage planar transformer

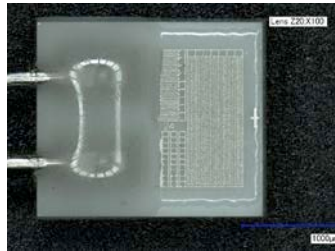




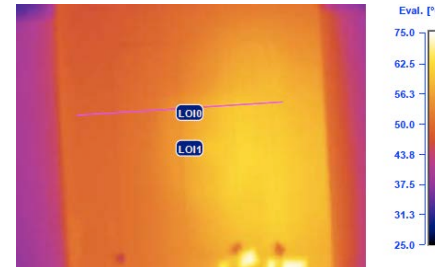
- ITAR issue -> European solution



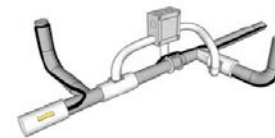
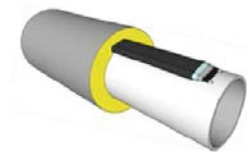
- Qualification activity of Platinum sensors (IST, Switzerland)



- Development activity on printed heaters and sensors (ITI, OHB)



- Auto regulated cable





- ITAR issue -> European solution



- MGAS fuses (Schurter, Switzerland) qualified according to ESCC4008/001 since 2008.



- HCSF (Schurter, Switzerland) qualified up to 15A according to ESCC4008/002

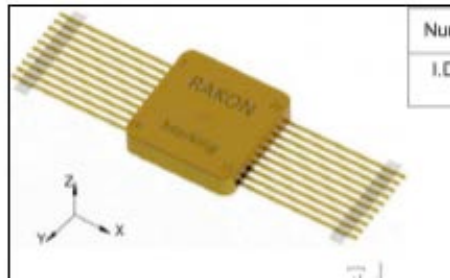




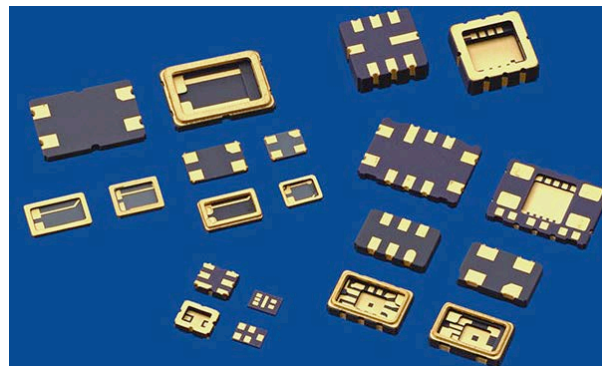
- New European standard for XO oscillator qualification



- On-going qualification of XO oscillator (Rakon, France)



- Qualification of complex oscillators based on quartz up to OCXO
- Development of SMD solution

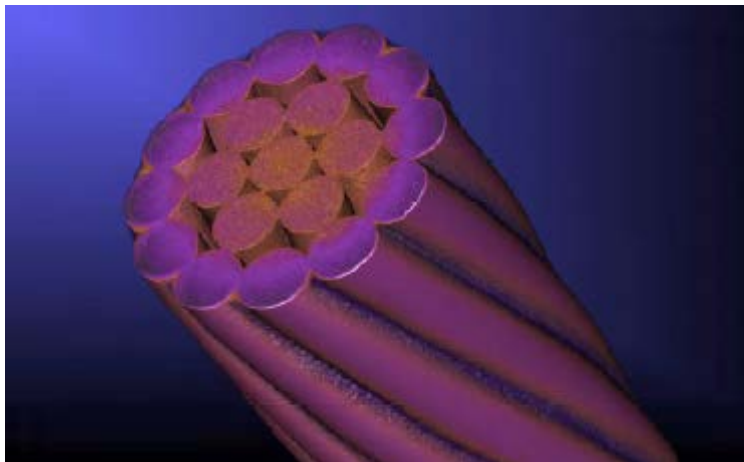




- High Current Handling and High Operating Temperature



- ESCC qualification of high temperature 250°C cable (Axon, Germany) with determination of the derating rules for usual operating ambient temperature. Test successful except for resistance to ergols.

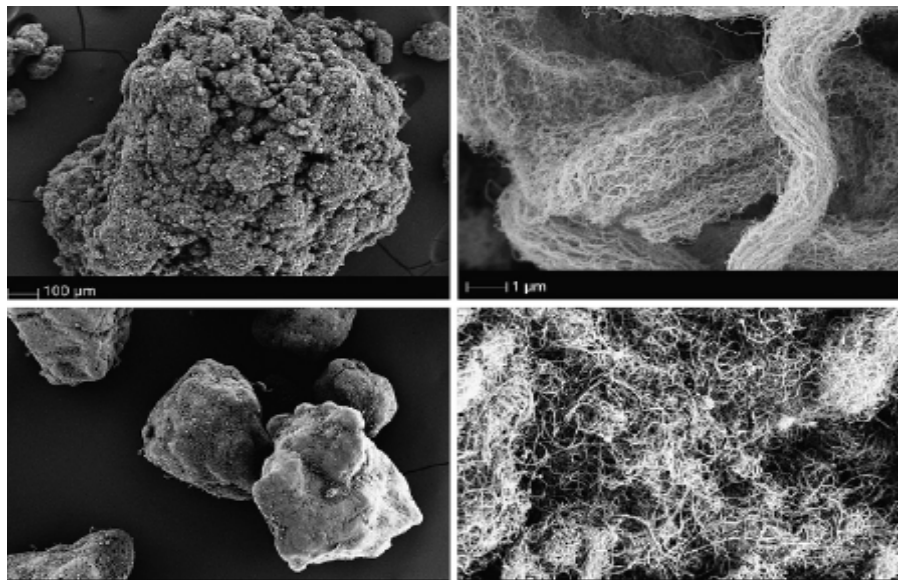


Gauge	Max Amp ESCC 3901 (A)	Max Amp improvement
AWG 1237	23	35
AWG 2219	5	9
AWG 2419	3.5	6
AWG 3007	1.5	3



- Anti-static cables outside the satellite structure :
Solar panels, Electric propulsion.

- Development activities of anti-static cables based on ETFE insulator.
 - Test of commercial master batch of antistatic material (Axon, Fr)
 - Development of an anti-static ETFE based on nanocomposite (LIST, Luxembourg)

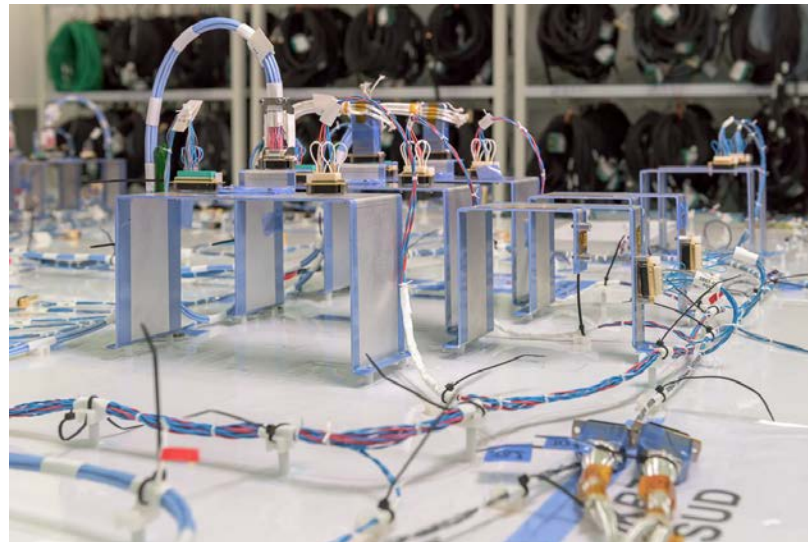




- Mass and Cost reduction



- Study activity (Airbus, Fr) in order to upgrade the harness design practices by:
 - Proposing an update of the ECSS-Q-ST-30-11C Rev 1 (ESA, 2011)“ Space Product Assurance, Derating- EEE Components”
 - Opening the door to further optimizations by using thermal simulation tools





- Miniaturization



- NanoD connectors (Axon, Fr) successfully developed. In EPPL with procurement spec 3401/086



- Evaluation of Micro modular connectors (Axon, Fr) for removable power and coax contacts



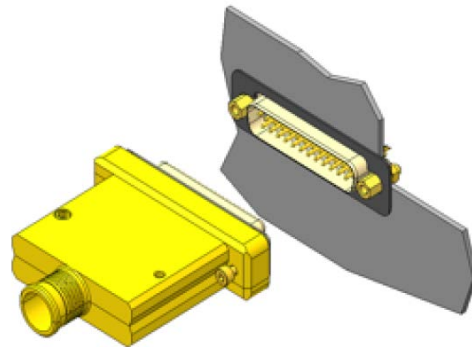
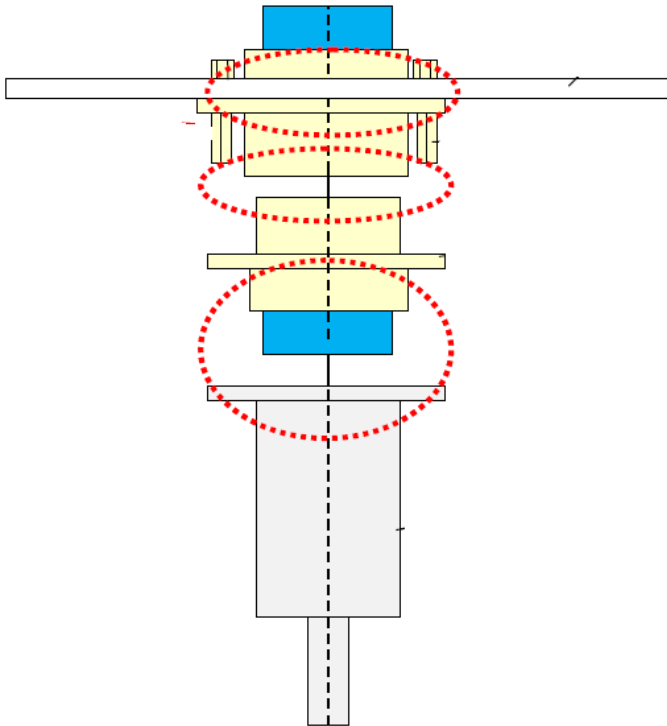
- Assessment of High density connectors (Eggo, Cz) for AIT



- Performances improvement : EMI



- On-going development activity on EMI tight rectangular connectors (Airbus, Fr - C&K for D-Sub – Axon for MicroD)



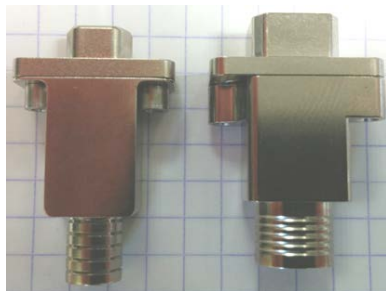


- Performances improvement : High data rate up to 10Gbit/s



- Development activity on Ultraminiature high speed connectors (Hypertac, Fr) supported by CNES

- On-going development and evaluation activity on Spacewire connectors (Axon, Fr) for high data rate without increasing the size compared to 9pin microD



- Association with SpW cables for high data rate cable assemblies
- HDR generic specification to be issued



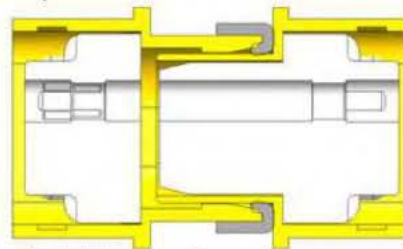
- Improvement of D-Sub performances



- Development activity on Light weight D-Sub connectors (C&K, Fr) with extended properties, supported by CNES



Keying feature



EMC sealing feature



SMT termination



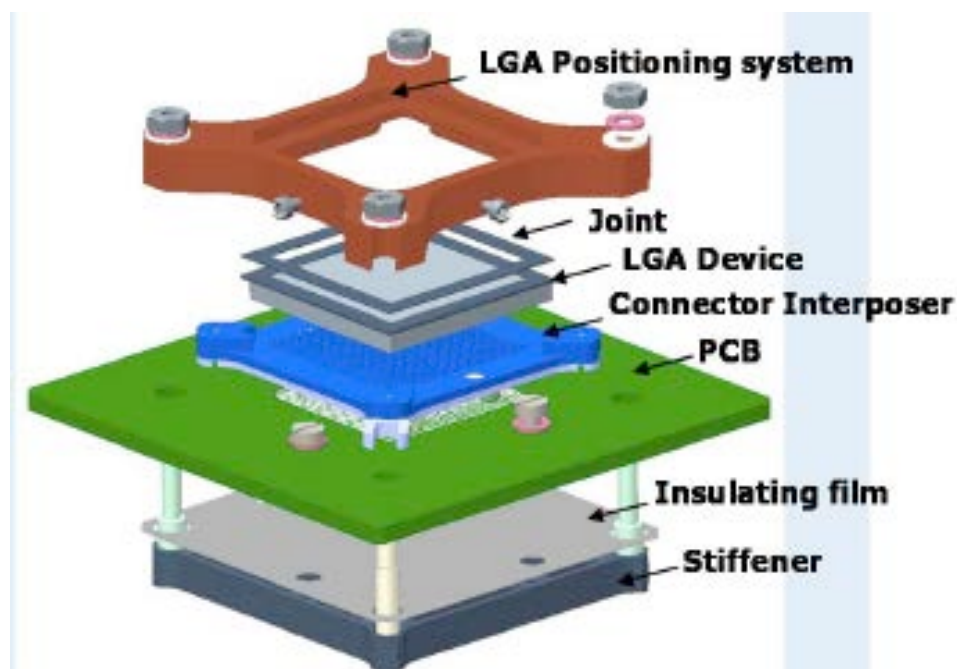
Dimple on the shell



- Interposer for high pin solderless assembly (LGA devices)



- Follow-up evaluation activity on high pin count solderless interposer (Hypertac, Fr)





- Higher frequencies for RF Connectors with low return loss (23db)



- Qualification of 2.4mm connectors (Radiall, Fr) up to 50 GHz supported by CNES



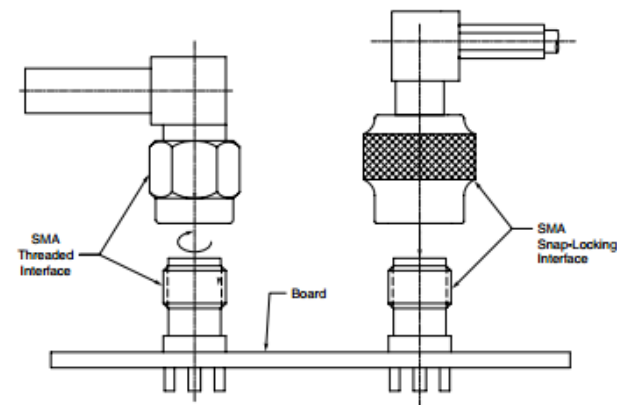
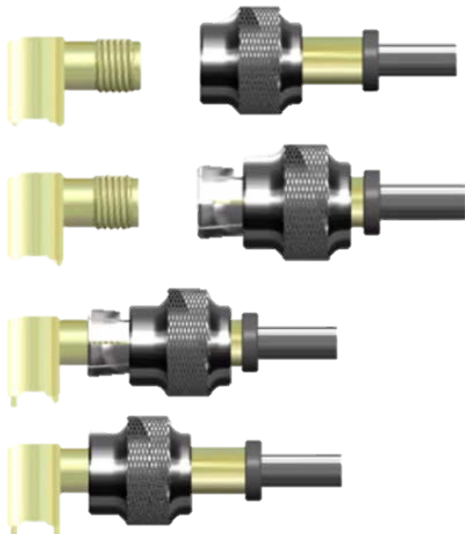
- Higher frequencies up to 65GHz -> Qualification of 1.85mm



- Ease AIT – Cost and time saving



- ARTES A&T (formerly ARTES 5.1) activity in 2017 workplan. National delegation support is needed.
- Development of SMA Fast locking connectors: SMA-lock plug connectors, compatible with a standard SMA jack connector.

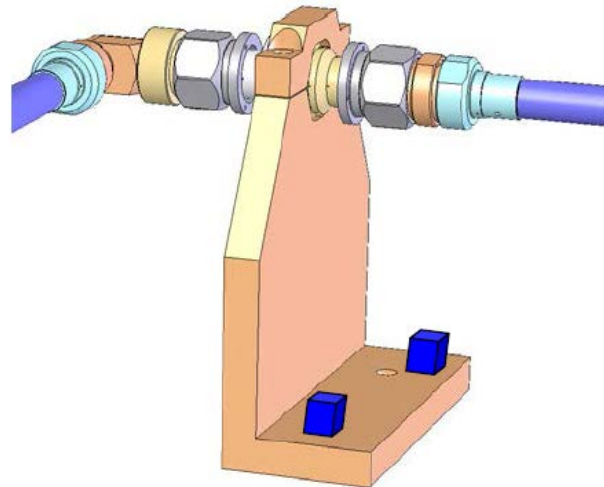




- Performances improvement : Higher Power handling (up to 250W in L-band and 150W in C-band)

- ESCC on-going qualification of RF TNC connectors and cable assemblies (Radiall, Fr)

- ESCC generic specification 3408 for RF cable assemblies should be issued before end of 2016

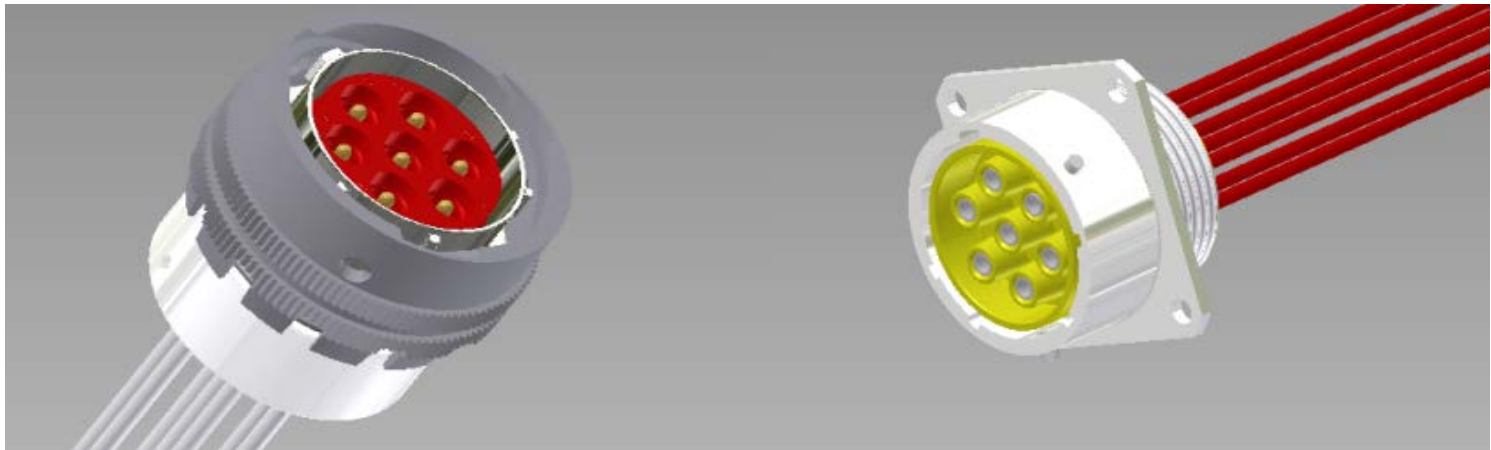




- Performances improvement : High Voltage



- Ongoing ESCC qualification activity on high voltage cable assemblies (Teledyne, UK). Range definition is on-going
 - ESCC generic specification to be drafted





- Performances improvement : High Power handling (250W in L&S-bands and 110W in C-band)



- On-going ESCC qualification activity on High Power Isolators (Cobham, Fr)



- Higher power levels (up to 360W in S-band)



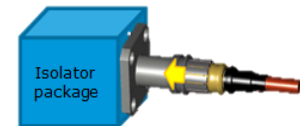
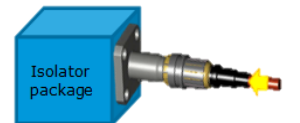
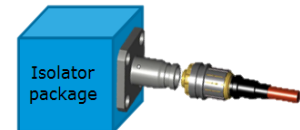
- Performances improvement : Higher frequencies
Miniaturization and cost saving



- ESCC qualified ka-Band isolator (Cobham, Fr) with detail specification ESCC3202/026



- TRP activity to be initiated in 2017:
“ Development of Ka-band SMD isolators”



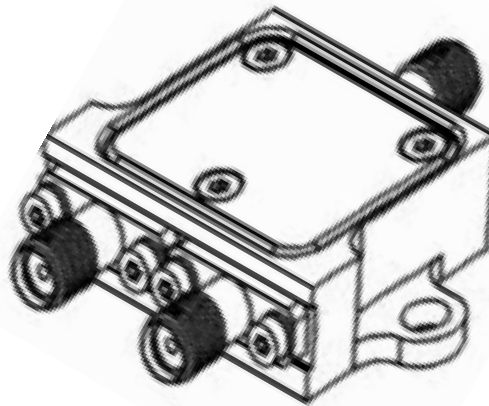
- Using SMP-lock connectors for isolators
- Development of SMD isolators at higher frequencies
- Microstrip technologies for mega-constellations



- Miniaturization and cost reduction



- On-going development activity of high isolation 2-way dividers (Cobham, Fr) supported by CNES
 - Drafting the generic specification ESCC3204



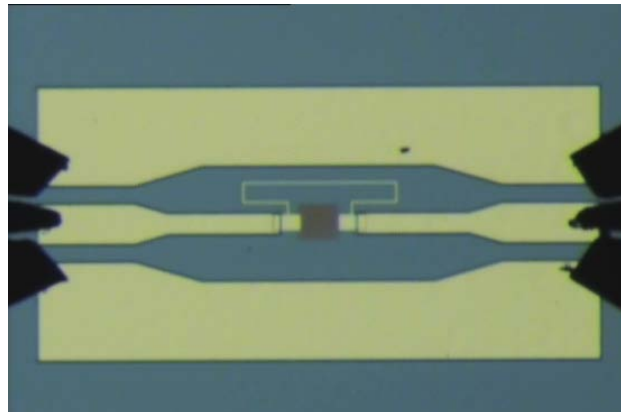
- Development of iso-dividers with N-ways ($N > 8$) at higher frequencies (Ka-band)



- Size reduction of the RF line-up of frequency converters at higher frequencies



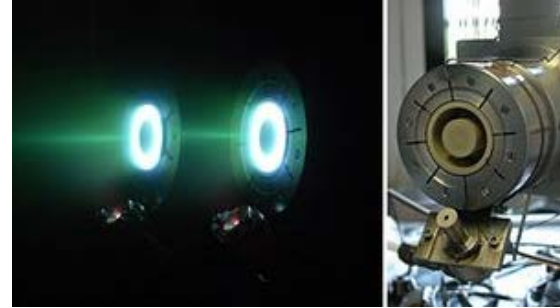
- On-going development activity of SAW filters (IMT, Romania) based on GaN operating at frequencies above 5 GHz



- Nano-lithographic process, alternative solutions (LWR or FBAR filters?)

➤ Electric propulsion

- High voltage capacitors
- High voltage relays
- Cable assemblies for electrical propulsion
- Planar transformers



➤ Point of Load

- Decoupling capacitors: ceramic, tantalum, silicon?
- Planar transformers
- High current chip inductors

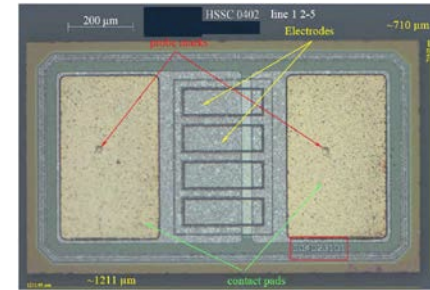
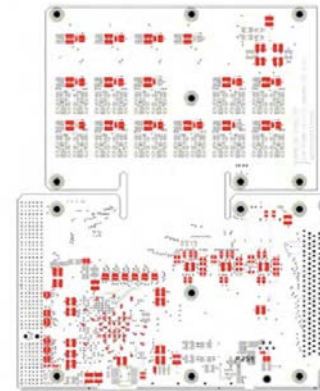
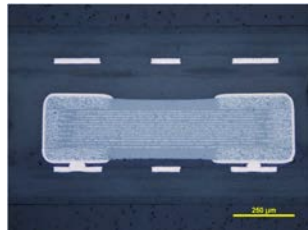


➤ High temperature/GaN

- High temperature cable for outside satellite structure applications
- Capacitor and resistor for GaN applications

➤ Miniaturization

- Embedded components



➤ RF application are led by the increase of power and frequencies

- High power Circulators, Isolators and Loads
- Iso-Dividers: Power dividers with Integrated isolators

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European roadmap for passive components

Denis Lacombe & Léo Farhat

Passive Component Engineers
Components Technology Section

ESA/ESTEC – 12/10/2016

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