



Photonic Digital Data Handling at Airbus: From High End Definition to Component Technologies

DEFENCE AND SPACE

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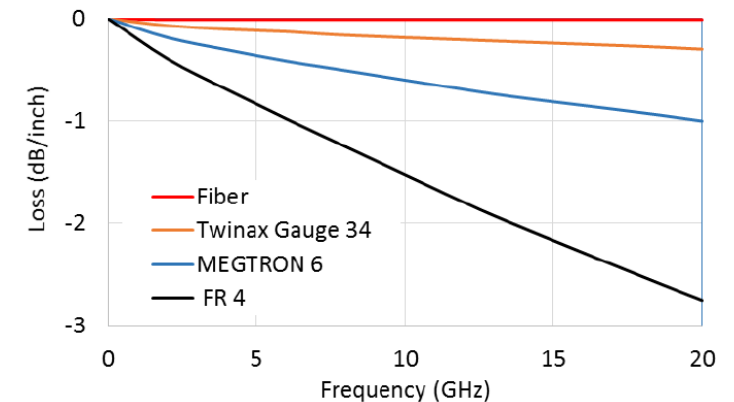
AIRBUS

Summary

- Introduction
- Applications at Airbus Defence & Space
- HSSL Definition & Component technologies
- Working challenges for HSSL Components for Space
- Conclusion

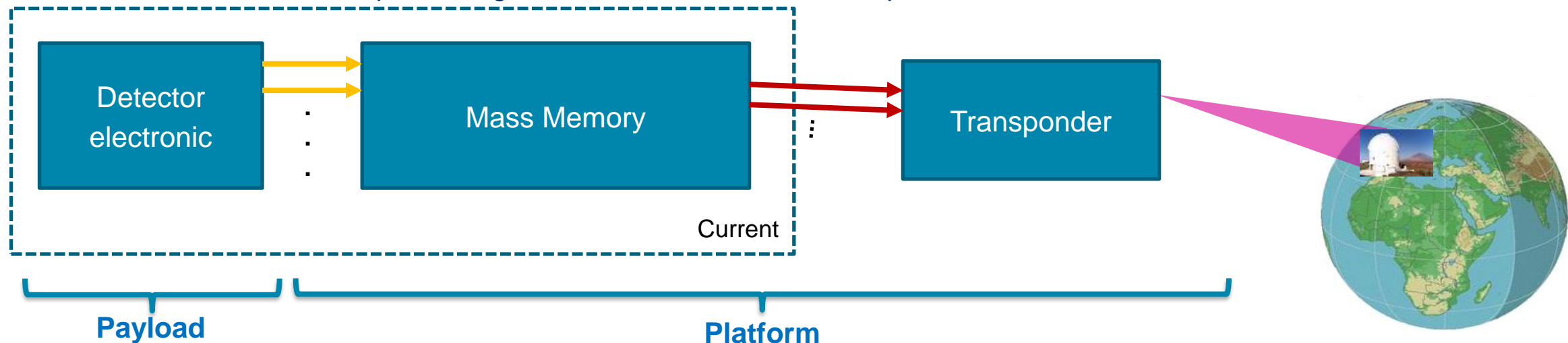
Introduction

- Optical High Speed Serial Link (HSSL) are being implemented at Airbus D&S since 2019
 - Driven by the need of performance (increase of capacity, i.e frequency/data rate)
 - Boosted by the need of increasing the accommodation flexibility in the spacecraft
 - Boosted by the need of improving the SWaP (Size, Weight and Power)
- Use of optical HSSL instead of copper allows also others benefits as
 - No sensitivity to ESD or humidity
 - Global cost reduction (per Gbit)
- Some constraints to be taken into account in comparison to copper
 - Fiber sensitivity to radiation
 - Implementation of fiber : acceptable curvature, bending
 - Price in power to pay (as active interconnect instead of passive)



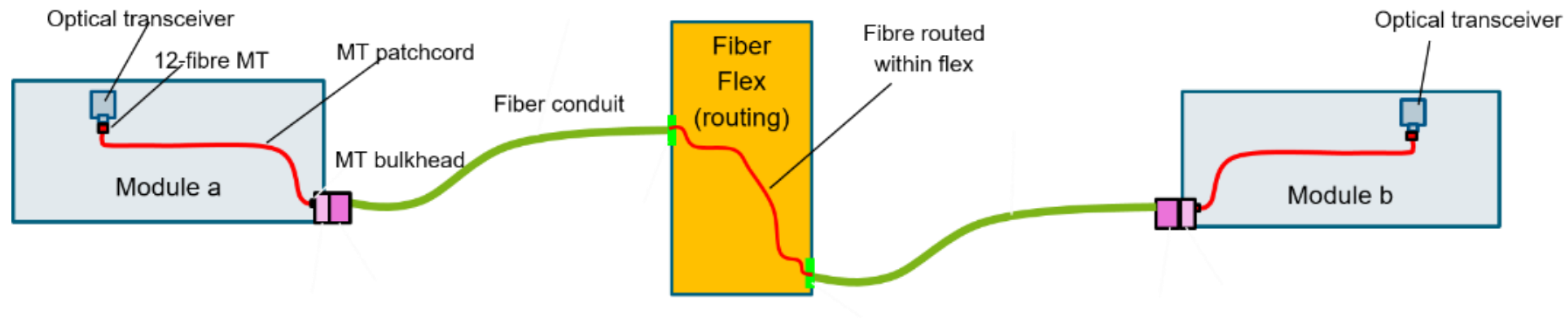
Applications at Airbus D&S – Current

- Earth observation payload application
 - New satellite generation with an imager performances increase
 - Size and quantity of data increasing
- Taking into account the necessary bandwidth, copper harness mass would be about 20 to 40 kg
 - This would lead to a misalignment of optical system → **KILLER FOR THE MISSION**
 - Optical fiber harness mass less than 1 kg → **Drastic improvement of the mass**
- First application, will be launched in 2024
 - One simple link Tx to Rx. Cold redundancy.
 - No processing of the data, use of the detector protocol



Applications at Airbus D&S – Current

- Telecom Payload application
 - Gen. 4 of On Board Processors with HSSL limited to 3.125 Gbps with copper
 - Increase of throughput needed to respond to higher capacity demands
- Gen. 5 of On Board Processor
 - Using 25 Gbps optical transmission system
 - 13 mW/Gbps power consumption
 - Optical links enabling flexibility in the accommodation using a flex shuffle.



Applications at Airbus D&S – Future opportunities

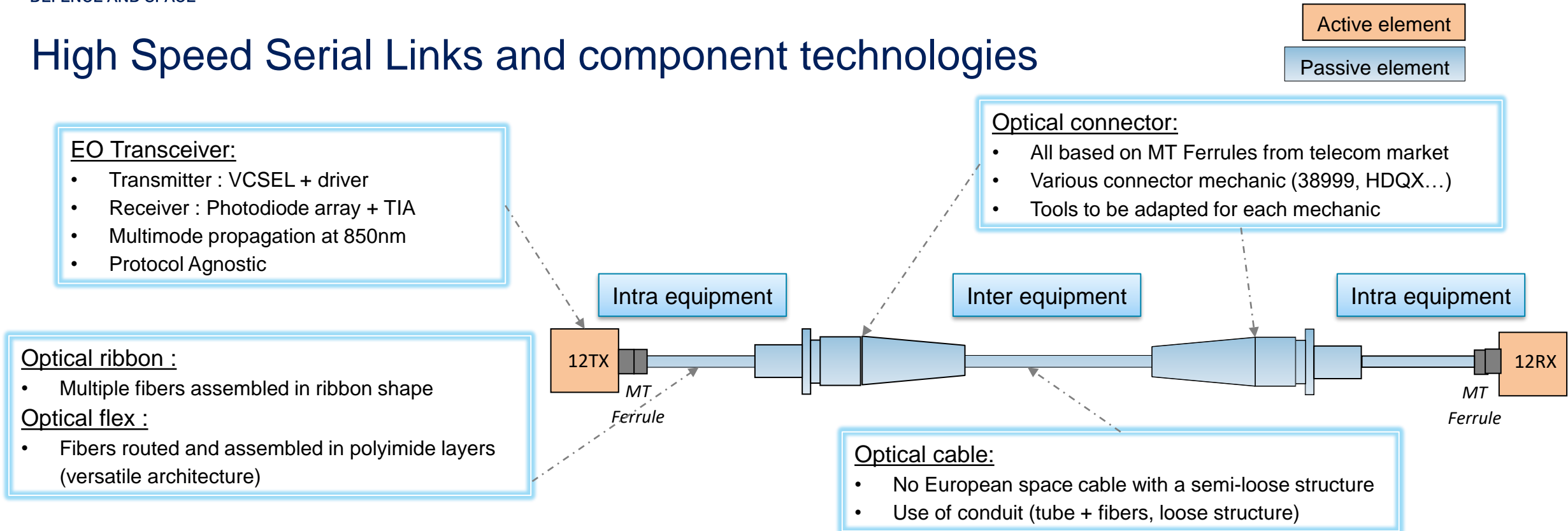
- New Applications emerging at lower data rate due to democratization of optical HSSL
 - Could be used in replacement of data busses (SpaceWire, CAN Bus...)
 - Trade-off on the global cost, taking into account:
 - Better SWaP,
 - But consumption increase for electro-optic conversion.

	SpaceWire	Optical HSSL	Benefit ratio HSSL Vs SpW
Links per cable	2	12 to 24	6 to 12
Mass	40 to 85 g/m	5 to 20 g/m	2 to 17
Diameter	7mm	3 mm	2,3
Data Rate	Up to 200 Mbps	Up to 28 Gbps	140



SpaceWire in orange Vs Multi-fiber cable in blue (courtesy of Axon)

High Speed Serial Links and component technologies



- **Complex supply chain**
 - Intra equipment parts : responsibility of the equipment suppliers (multiple for Space Systems)
 - Inter equipment parts : responsibility of the prime, taking into account integration constraints
 - Active and passive parts provided by different industrials (for one HSSL 2 to 5 suppliers could be involved)
- **Impact of the variety of industrial actors**
 - For interfaces : Mandatory standardization in order to integrate correctly at prime level
 - For active parts : Standardization of the parts or inter-compatibility between the transceivers.

Working challenges for HSSL Components for Space - Transceivers

- Electro-optic transceivers have been space qualified with the support of Airbus in the last year for equipment project
- However, improvements have been identified and need to be addressed with the component suppliers :
 - Reliability of the parts:
 - Conformity with the derating norm ECSS-Q-ST-30-11C
 - Improvement of the VCSEL array
 - Operating mode under radiation:
 - Possibility to turn off channels if not used
 - Improving the drivers
 - Decrease the power per bit, in order to address higher data rate applications
 - Ensure European sovereignty
- In term of packaging, some specificities to EO Transceiver need to be taken into account
 - Surface mounting → Possibility of automatic SMT (surface mounting technology)
 - Package architecture optimized considering the thermal drain (ex: chip with a good thermal contact with the metallic package)

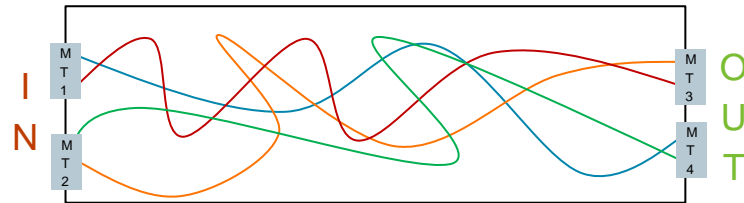
Working challenges for HSSL Components for Space - Interconnection

- Generic solution - Main expectations :
 - Compactness
 - Compatible of electronic design in “layers” / ADHA (15 mm heights maximum)
 - Optimization of size and mass
 - Robust to thermal & mechanical environment (Random vib., shock, AIT handling)
 - Outgassing compatible
 - Design allowing 1 to several MT ferrules
 - Availability of tools for inspection and cleaning of the end-faces
- Cost reduction drivers :
 - Recurrent cost → Defined by the industrial
 - Non recurrent cost → Minimized having a generic connector compatible of a variety of mission

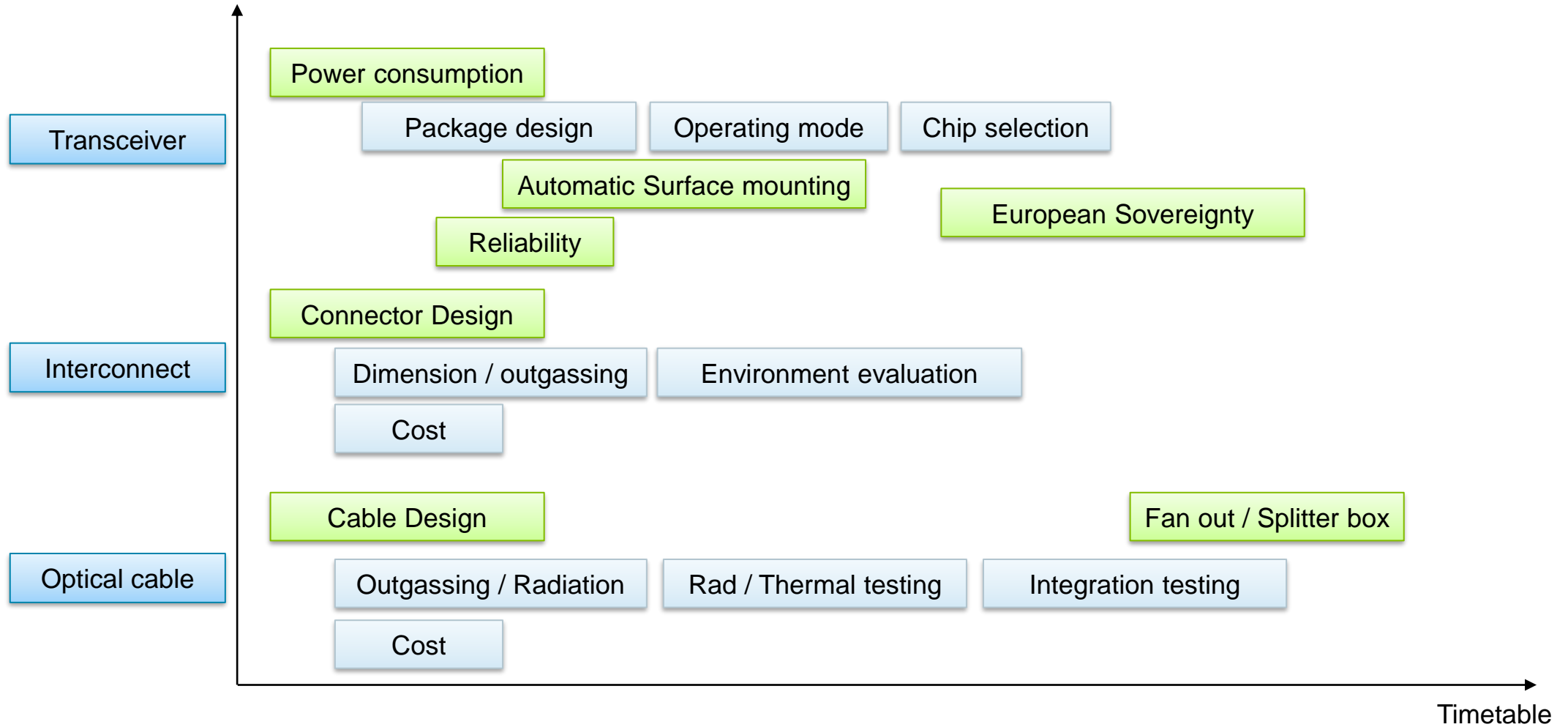


Working challenges for HSSL Components for Space - Optical cable & Integration

- Optical cable Generic solution – Main expectations :
 - Improvement of compactness → Especially mass optimization
 - Outgassing compatible
 - Harshened for radiation (100kRad up to 20MRad)
 - Good thermal behavior (shrinkage) and integration constraint (fixing mechanism, torsion, kinking...)
 - Cost reduction
- Addressing complex routing solution
 - Fan out solution
 - Passive splitter box solution
- Integration of optical harness
 - Optic specificities : inspection and cleaning are mandatory for good performance
 - This will lead to special training of integration teams.



Working challenges for HSSL Components for Space - Synthesis



Conclusion

- Presentation of current developments of optical HSSL at Airbus Defence & Space for earth observation and telecom satellites
- HSSL definition and its applications show various needs and complex supply chain to be consolidated, aiming to the requirement of standardizing HSSL components
- Improvement to carry out on components and their use have been identified:
 - Transceivers
 - Reliability
 - Power consumption with optimization of the design for thermal drain
 - Surface mounting with possibility of automation
 - European sovereignty
 - Optical harness
 - Generic solution covering all type of missions
 - Improvement of compactness
 - Addressing complex routing
 - Cost for the whole optical transmission system will need to be decreased
 - Integration challenges of optical links : inspection and cleaning to ensure good performances.

→ Opportunity to improve HSSL and enlarge its use for lower data rate application