Passive Components For New Space Markets

The Next Generation of Passive Component Standards for New Space Electronics

By James Spencer BSc (Hons)
in Astrophysics

A QUESTION FOR YOU…

COSTS IN SPACE ARE LOWERING,
WILL SPACE BE MORE COMMERCIALISED IN THE FUTURE?

Agenda - What We Are Going To Cover Today

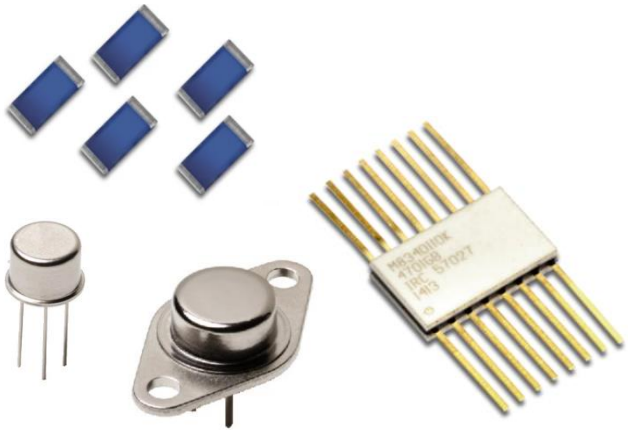
- **What is the New Space trend?**
- **What does this mean for the space industry?**
- **What is TT Electronics doing to support New Space?**
- **TaN (Tantalum Nitride) vs. NiCr (Nickel Chromium) film resistor radiation performance?**
- **Summary & conclusions**
- **Questions?**

What Is Traditional Space?

High reliability

15 year + lifetime expectation

High Reliability MIL and DSCC qualified parts



High cost parts due to labour intensive screening steps

Usually large, complex and overall, very expensive satellites

Reliability is King

Classic Space Requirements
Long development lead times
Long life missions
Harsh radiation environment
Very, very low volumes
Relatively large platforms
Only use fully hermetic parts
High reliability parts (ESA / DLA standards)

What Is New Space?

New Space is a new generation of space activity fed by private space companies

Why Now… Privatised space started in the mid 1980's, however private space companies are now having increased successes i.e. SpaceX

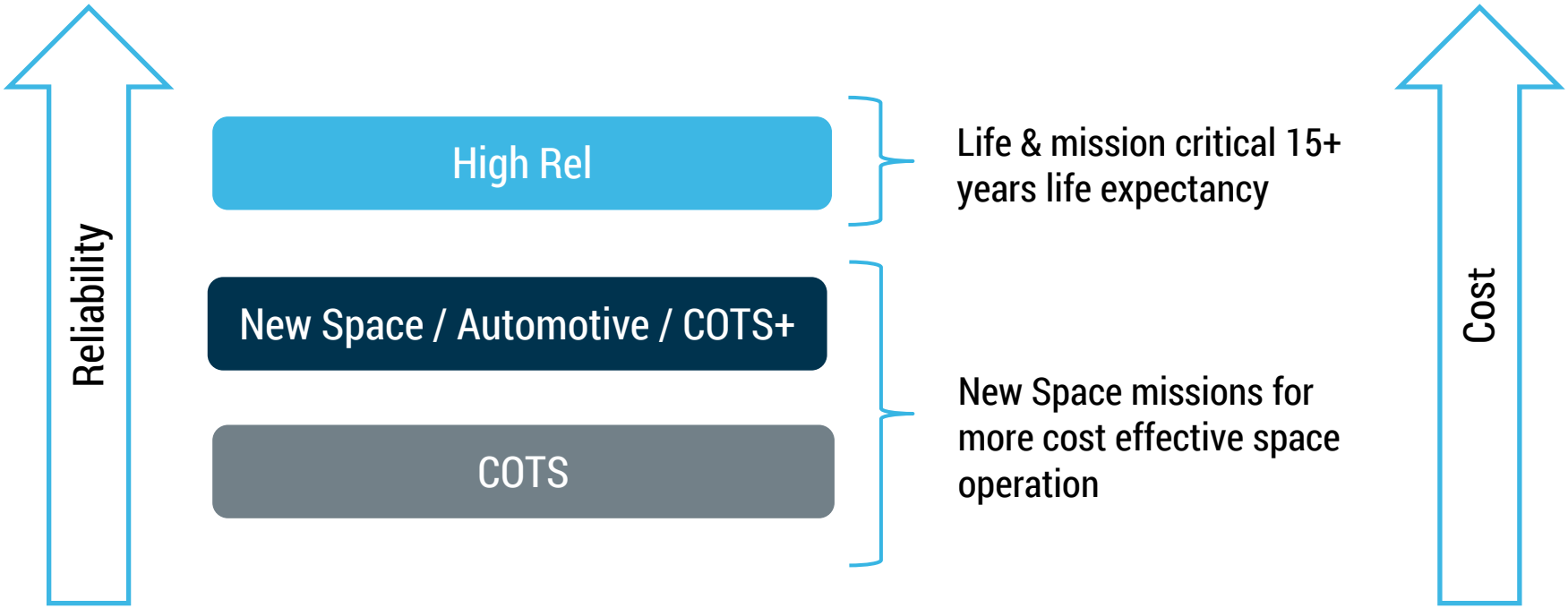
- New Space is at the forefront of reducing launch costs to make accessing and operating in space more cost effective
- Missions are changing and cost is becoming a driver in some cases

Cost is King

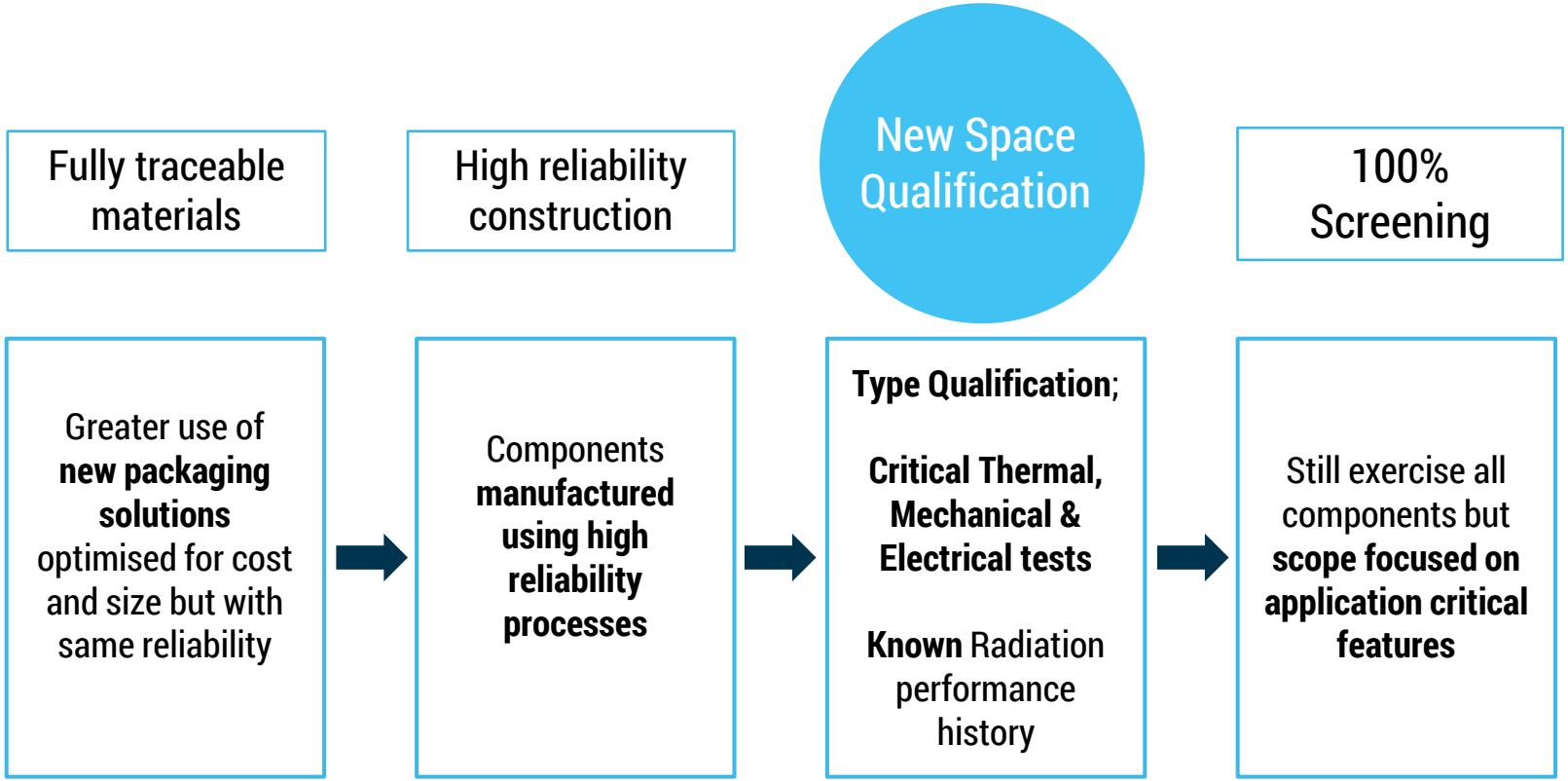
Classic Space Requirements	New Space Requirements
Long development lead times	Short development lead times
Long life missions	Shorter missions (typically <3yrs)
Harsh radiation environment	Less harsh radiation environment (LEO)
Very, very low volumes	Higher (but not high) volumes
Relatively large platforms	Typically small platforms (micro/cubesats)
Only use fully hermetic parts	Not always using hermetic parts
High reliability parts (ESA / DLA standards)	Drive towards lower cost parts

Higher density of parts each potentially with increasingly lower reliability

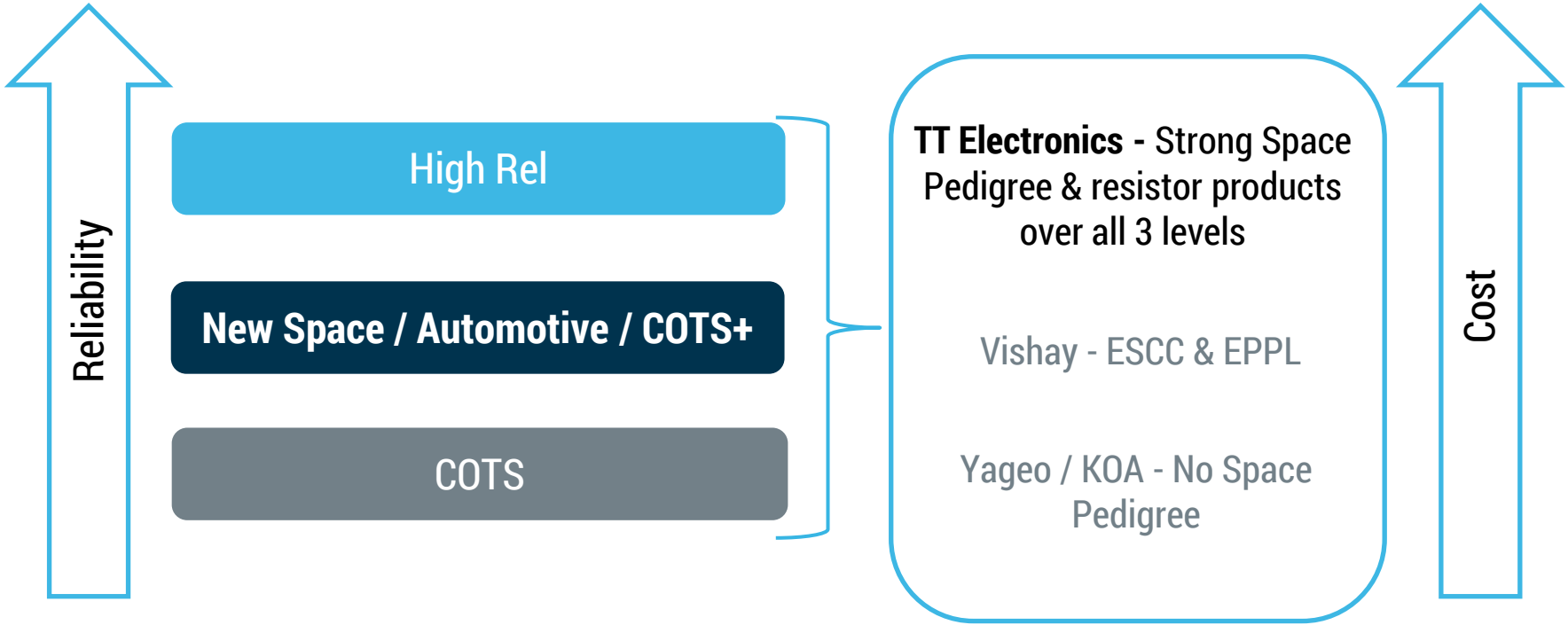
New Space - Reliability Vs. Cost



An alternative solution balancing Cost and Reliability



Where Does TT Electronics Fit?



TT Electronics is the ideal partner to work with for New Space applications

Study On Radiation Effects In TaN (Tantalum Nitride) Film Resistors

1. Five TaN (Tantalum Nitride) film networks were tested with varying resistance values of 50Ω, 25kΩ and 50kΩ

2. Resistance measurements were taken before and after neutron radiation, 1013/cm2, fast neutrons and gamma radiation, 100kRads from a Cobalt-60 source

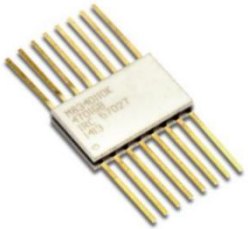
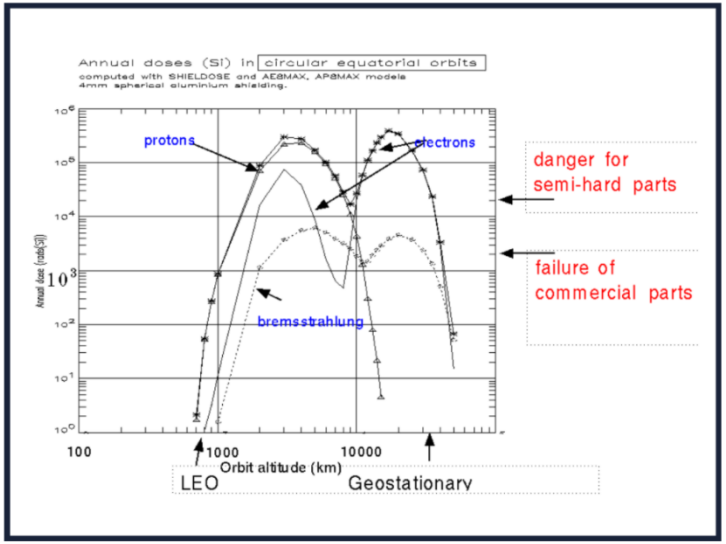


Fig 2: TT Electronics Tantalum Nitride thin film network
https://www.ttelectronics.com/products/categories/resistors/resistors/m83401xxxxa(fp)/



Source: Daly, E. & Drolshagen, G. & Hilgers, A. & Evans, Hugh. (1996). *Space Environment Analysis: Experience and Trends*. 392. 15.

The above chart indicates the typical radiation levels which you would find in LEO orbit i.e. up to 100kRads TID / year

Results:

Network Resistance		Network #1 % DELTA R/R	Network #2 % DELTA R/R
	Avg.	-0.008	0.011
	Sigma	0.027	0.045
	Max.	0.050	0.127
50Ω	Min.	-0.052	-0.036
	Avg.	0.006	0.005
	Sigma	0.007	0.002
	Max.	0.028	0.008
25kΩ	Min.	0.000	0.004
	Avg.	0.003	-
	Sigma	0.002	-
	Max.	0.006	-
50kΩ	Min.	0.002	-

Table 1: TT Electronics Radiation Results

- Overall, **LEO levels** of radiation have **very little effect** on **TaN resistor** networks
- **TT Electronics TaN (Tantalum Nitride) WIN** chip series resistance changes proved to be an **order of magnitude lower** versus other more wide spread test methods such as load life, dry heat and temperature cycling tests

TaN (Tantalum Nitride) Vs. NiCr (Nickel Chromium) Film Resistor Radiation Performance

Resistor Technology	Radiation Test Criteria	Results
TaN Film Resistor Network Source: TT Electronics	10^{13}/cm^2 fast neutrons and 100kRads gamma radiation	One order of magnitude lower variance when compared to standard reliability tests
TaN film versus NiCr film resistors Source: M.M.Ramsay	10^{16}/cm^2 fast neutrons and 10^8 Rads gamma radiation	NiCr fell by 0.035% with a considerable TCR increase TaN film increase of 0.02% TCR remained constant

Summary & Conclusions

- **TaN (Tantalum Nitride) film resistor** networks performed well after radiation testing
- Results were an **order of magnitude lower** in comparison to standard resistor tests i.e. load life, dry heat and temperature cycling tests

- TT Electronics is certifying its range of **TaN (Tantalum Nitride) film** chips resistors, **WIN series**, to **AEC-Q200** qualification level
- With **radiation tolerant TaN (Tantalum Nitride) film** in combination with **AEC-Q200** qualification and reengineered to be **more cost efficient** based on **MIL qualified components**, TT Electronics **WIN series** is perfect for **emerging New Space** applications

Technology is shaping the future of humanity -

and it's all made possible through advancements in electronics.

Thank you for listening!

Any questions?

James Spencer

Business Development Engineer (UK + Nordic)
M: +44(0) 7741843091
E: james.spencer@ttelectronics.com