Rad-Hard Plastic for Constellations

STMicroelectronics
March 2019

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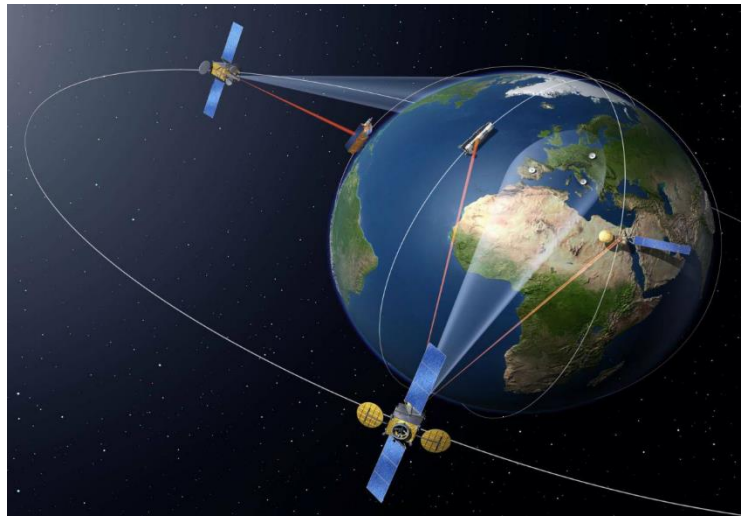
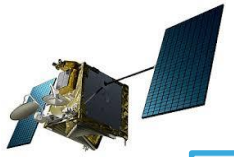
A Change of Paradigm





Historical Geostationary Satellites

- Limited number of satellites
- Long life time
- High quality & cost
- Component level quality
- Radiation Hardened electronics
- Ceramic package preferred

Low Earth Orbit Constellations

- Higher number of satellites
- Shorter life time
- Mission dependent system cost
- System level cost / quality tradeoff
- Mission dependent Radiation Hardness
- Plastic package authorized

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New Space : a semiconductor supplier perspective

- Classical semiconductor business model
  - Volume and integration key to better cost, performance & quality
    - Volume = Munit / hour
  - Challenged by Moore's law end for high density products
    - raising costs & resources / transistor

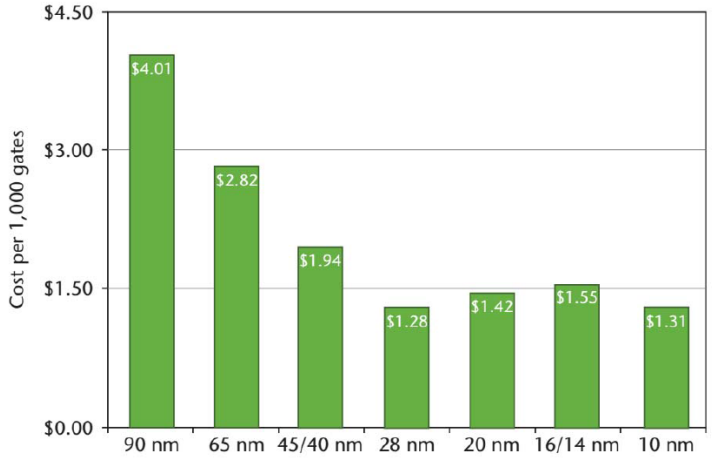

Figure 6. Cost per logic gate, with projection for 10nm technology node

Source: Jones (2015)

- A proven model for traditional space
  - Funded development + high added value products balancing low quantity
    - ECSS-Q-ST-6013 when no qualified product : very low quantity and/or high development cost
- New Space : a possible sweet spot depending on criticality & radiation hardness
  - Higher quantity and system level quality might allow competitive cost of ownership
  - Proliferation of quality level is in contradiction with semiconductor driving forces

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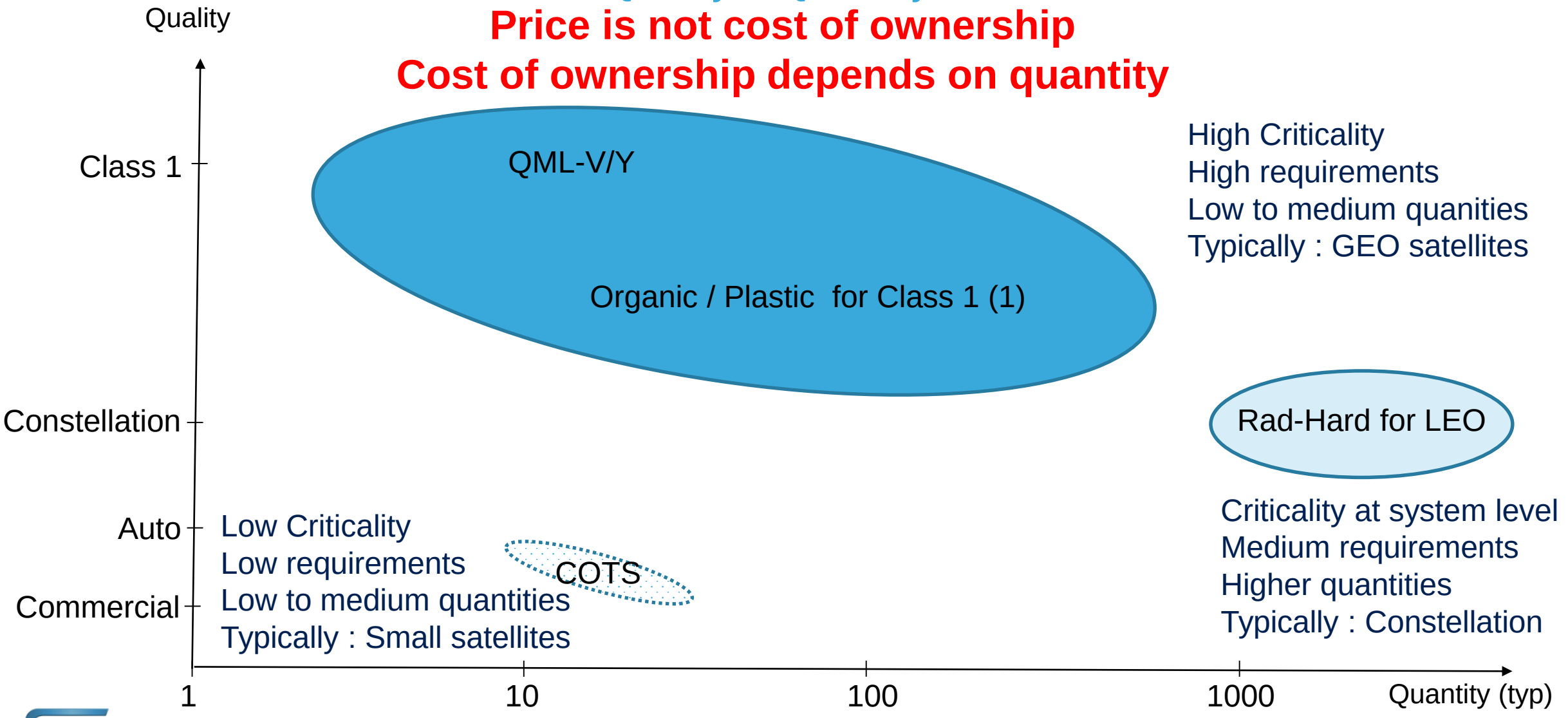
EEE components Space Segmentation

Quality – Quantity – Price – Radiation Hardness

Price is not cost of ownership

Cost of ownership depends on quantity



Bubble area : selling price – Bubble density : Radiation Hardness

(1) If justified by delta performance vs QML

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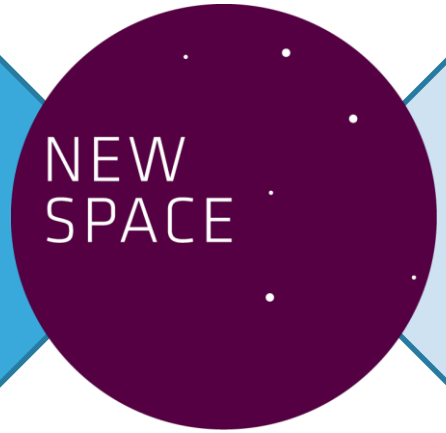
The New Space Sweet Spot

Rad-Hard Products

- Rad-Hard by Design
- Limited product portfolio
- Long life time
- Security of Supply
- Limited technologies portfolio
- Stable to declining market
- Low volumes driving high price
- Known cost of ownership
- Unified agency standards



COTS Products

- Radiation up-screen by wafer/lot
- Enlarged product portfolio
- Short to medium Life time
- Limited security of supply
- New technologies
- Growing market
- Higher volumes driving price down
- Variable cost of ownership
- Industry driven qualification

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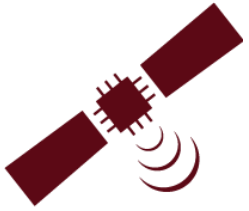
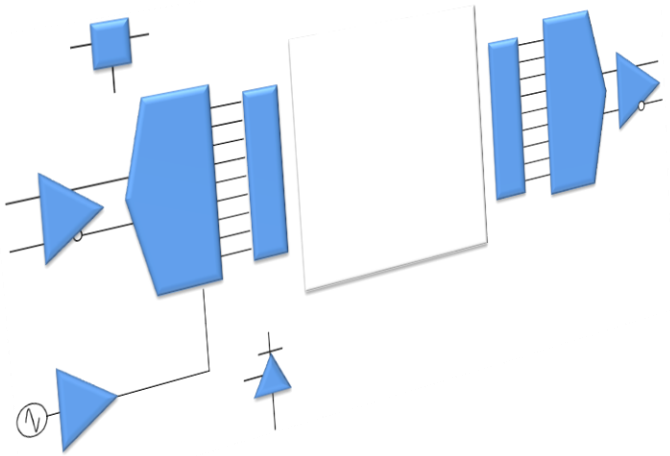
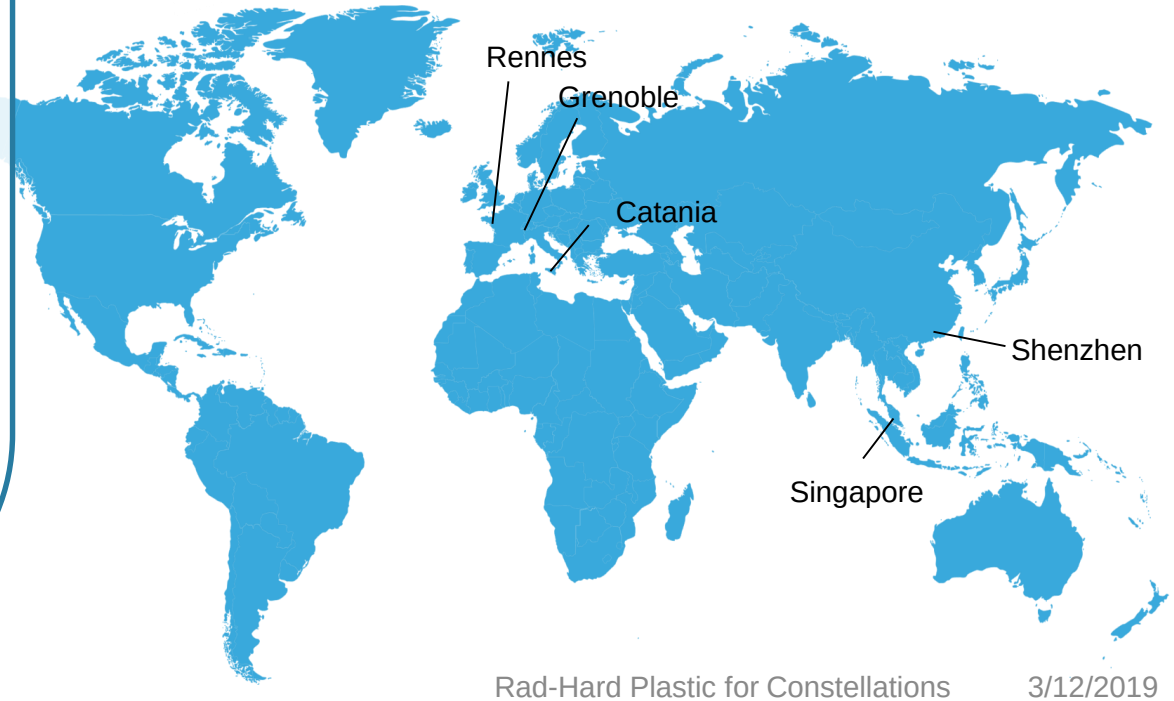


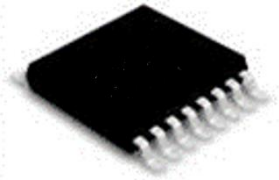
To answer this new challenge

- STMicroelectronics is strategically engaged to support the new market of Low Earth Orbit space integrated circuits, thanks his strong experience and position in Rad-Hard market
- ST's products and competence centers to support developments : Grenoble, Catania and Rennes
- **New product line LEO** is started to develop product portfolio of Analog & Mixed-Signal and Logic products
- These new products will be packaged in **plastic packages** with assembly in ST's high volume back-end manufacturing site, on assembly line used for AEC-Q100 qualified products





Rad-Hard for LEO : Key Feature

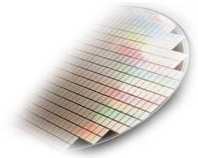


- Plastic Packages
- Bonding with Gold Wires
- Finishing: Ni/Pd/Au *(whisker free)*
- Assembly on lines used for AEC-Q100 qualified products
- Guaranteed at 50 krad(Si) + SEL free @ 43 MeV.cm2/mg
- AEC-Q100 based qualification, screening, quality assurance and Logistic
  - Qualification : Based on AEC-Q100 + Radiation
  - Screening : Based on AEC-Q100 + Radiation
  - Quality Assurance : Based on AEC-Q100
  - Logistic : Typical MOQ = 1000 pieces

ST Proprietary Manufacturing

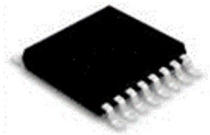
Design
Mask preparation

- Grenoble
- Catania



Front-End

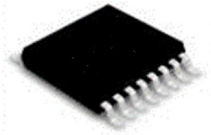
- Singapore
- Crolles/Grenoble



Back-End
Assembly

- Shenzhen (TSSOP)
- Muar (Power SO)

Assembly reports



Final Test

- Shenzhen
- Muar

-40°C, +25°C, +125°C

Product
Qualification

- Grenoble
- Catania
- Rennes

AECQ100-like

Radiation tests
TID / Heavy Ions

- Rennes

TID on each new lot
SEE on qualification lot

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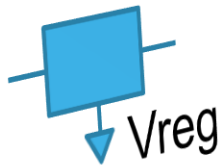
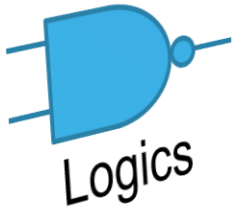
Rad-Hard for LEO : Roadmap

- Starting with Analog, Logics and Voltage Regulators
- 3 new products each Quarter





CP	Function	Plastic Package	Sample	Flight Model
LEOAC14	HEX SCHMITT INV	TSSOP20	Q2'19	Q3’19
LEOAC00	QUAD 2-in NAND	TSSOP20	Q2'19	Q3’19
LEOAC244	BUS TRANSCEIVER	TSSOP20	Q2'19	Q3’19
LEO3910	VREG	PSO20	Q3	Q1'20
LEOLVDSRD	LVDS Transceiver	TSSOP20	Q3	Q4’19
LEO1009	VREF	TSSOP8	Q4	Q1’20
LEOAC74	DUAL D FLIP FLOP	TSSOP20	Q3	Q1'20
LEOAC32	QUAD OR	TSSOP20	Q3	Q1'20
LEOAC08	QUAD 2-in AND	TSSOP20	Q3	Q1'20

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Thank You