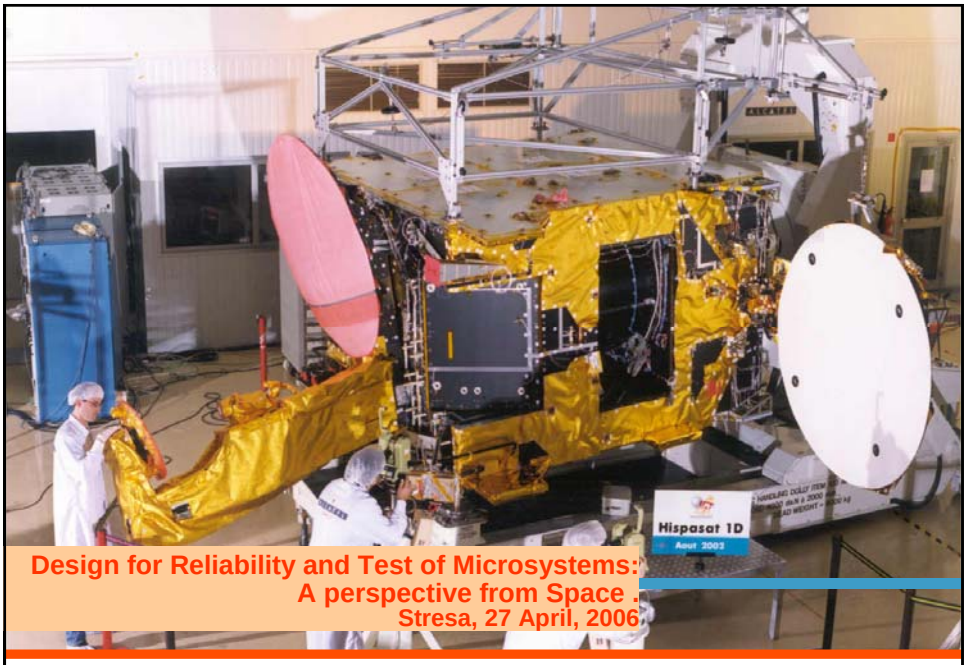

Design for Reliability and Test of Microsystems:
A perspective from Space .
Stresa, 27 April, 2006

Introduction

- Microsystems are attractive for Satellites:
  - Low mass
  - Low power consumption
  - High miniaturisation potential for complex subsystems
- Design for Reliability and Test is paramount in view of the demanding requirements in this industrial sector.
- Advances in DFRT for Satellite applications have an important fallback in other industrial sectors.

Applications

- Accelerometers and Gyroscopes for Inertial navigation
- RF MEMS: Switches, variable capacitors,..
- Bolometers, Magnetometers,…
- Propulsion: microthrusters, miniaturized ion-thrusters, gas thrusters,..
- Optical: switch matrices, micro-mirrors
- Bio sensors

How do we do it?

- Reliability calculation is part of the design process.
- Lack of field data hinders the introduction of Standard Microsystems in the satellites.
- Design for testability is foremost: Customers require (and pay for) a high level of test coverage.
- For commercial devices we define a delta qualification programme based on existing standards and propose specific tests for a full space qualification programme,

Space constraints:

- Humidity and salt atmosphere before launch
- Vibration and shocks during launch
- From room temperature to –120°C in 3' during launch (freezing, outgassing, …)
- in flight constraints
  - ✓Microgravity
  - ✓Vacuum
  - ✓Radiation
  - ✓Extreme Temperatures if outside.

ALCATEL ALENIA SPACE
An Alcatel/Finmeccanica company
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Vacuum:

- Requires hermetic packaging
- Heat extraction (no convection)
- Electrical discharge (flashing)

Microgravity:

- May affect devices with moving parts and fluids.

Vibration & Shocks:

- Shocks may not be very limiting due to the low mass of the µsystem.
- Mechanical design should avoid device natural frequencies that may resonate with launch vibration frequencies.

Thermal shocks:

- Depends on the mission and on the position of the µsystem in the satellite. In some cases could have a strong design impact.

Radiation:

- When using passivation or glassivation layers, radiation level may induce charge trapping and parasitic drift biasing on the actuators
- Heavy ion bombardment may induce atom displacements and crystal defects
- Total Ionising Dose may induce charging effect as observed on teflon and cables under high level ; question is open for other macromolecular materials when used (fluids or other);
- Radiation may change mechanical behaviour (tribology) and physical properties (change in transparency for example) of macro-molecular materials if any.
- Mirrors may be contaminated by residual atmosphere around the satellite and be activated by radiation flux.