

# **System-of Microsystems nanospacecraft as a focus for TRP activities - The NEOMEx strawman**

J. Köhler, ESA/ESTEC

- NEOMEx: Near Earth Object Micro Explorer
- To provide a focus application for a microsystem-based spacecraft concept

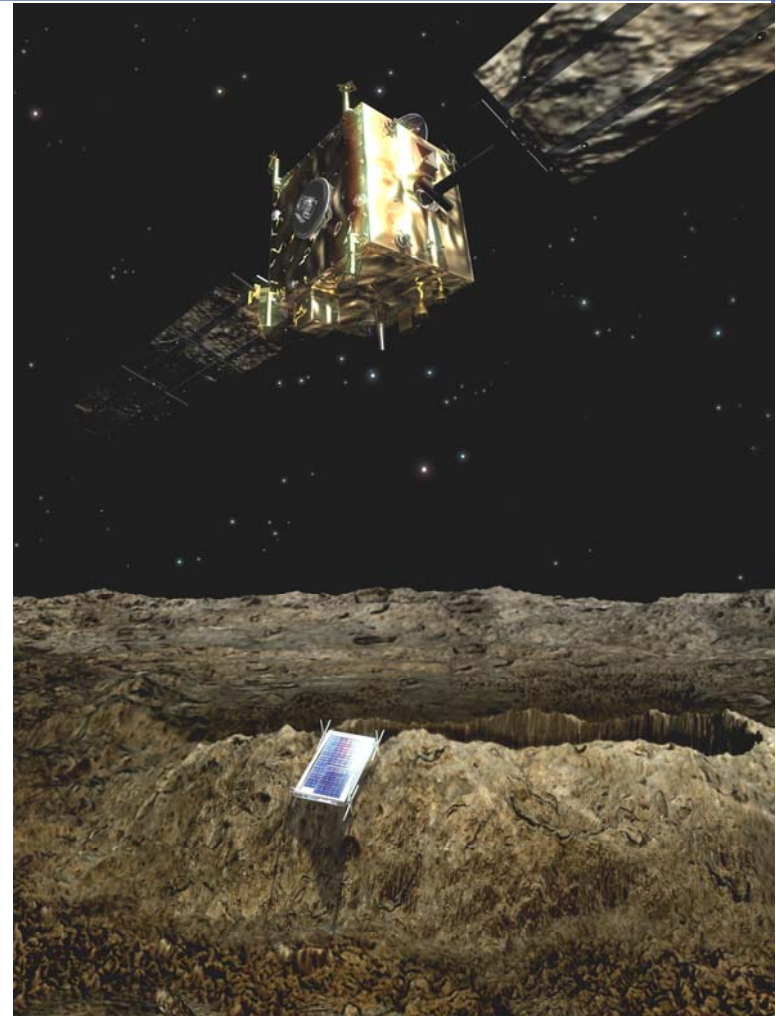
*Design driver for consolidated microsystems and miniaturisation developments*

*The Systems-of-microsystems*

- Explorer mission applications as first target.

*Possible mission enabler*

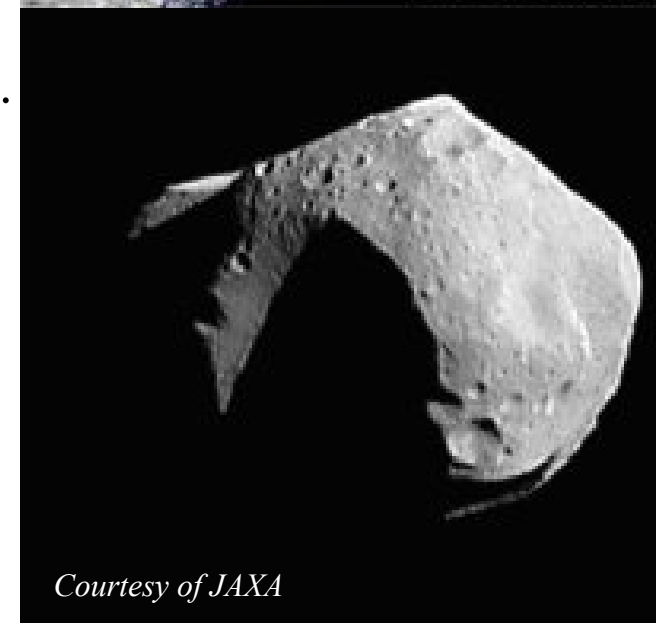
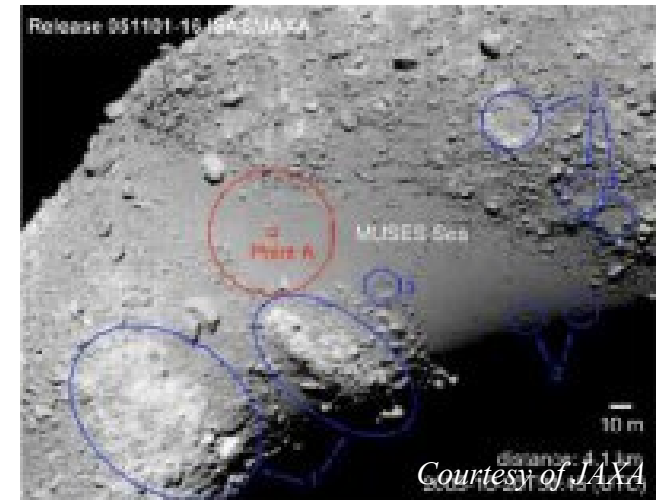
*Mass saver*

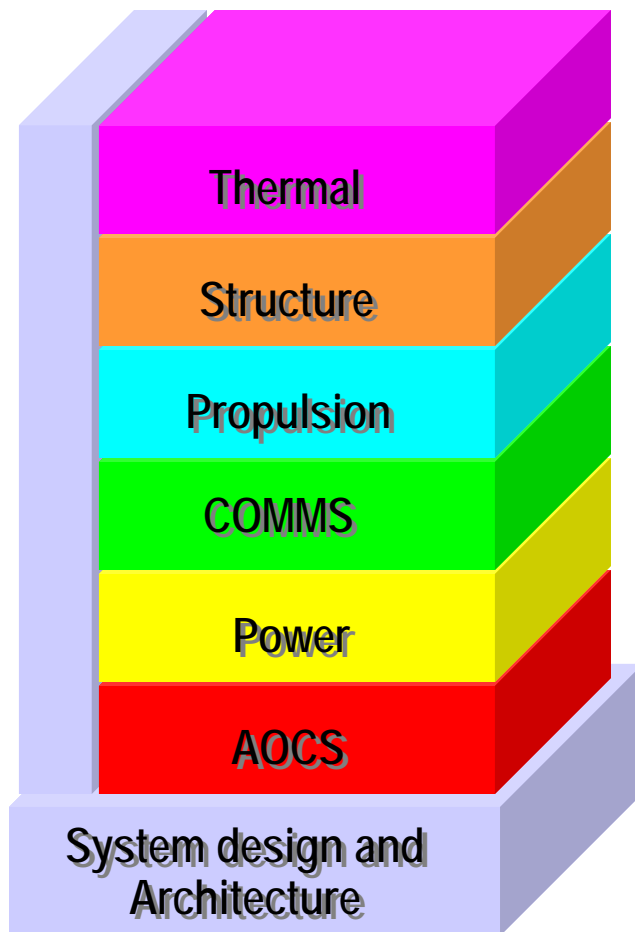


*ESA Don Quixote Mission Concept*

- **Objective:** To perform close-up scientific investigations on several sites on a Near Earth Object.
- **Constraints:** Extreme mass-limitation, 5 kg platform, 2-4 kg payload of 10-15 W
- **Challenge:** use microsystems integrated in a system to gain performance with respect to mass.





**NEOMEx will ultimately demonstrate all critical functions of a spacecraft in an integrated manner**








- General platform with mission-specific platform and payload modules
- Modularity and integration on system-of-microsystems level with allow maximum reusability
- Appropriate selection from a set of microsystem modules, according to the mission
- **Microdevices to microsystems, microsystems into systems-of-microsystems**  
*without compromising the miniaturization or performance.*

**Microsystems for space today still suffer from:**

-  *Poor heritage*
-  *Insufficient integration (bulky interfaces, packages, and harnesses)*
-  *Little space technology experience in microsystems industry*
-  *Little microsystems experience in space industry*

**The set of microsystem modules needed for the modular system-of-microsystems nanospacecraft (e.g. NEOMEx) will also find other applications:**

-  *in other planetary exploration missions*
-  *in other space missions*
-  *in other terrestrial markets*

**Microsystems R&D are strong in many areas (but not in space)**

 *Automotive*

 *Medical*

**Miniaturisation architectures, reliability guidelines, and standardisation processes for microsystems**

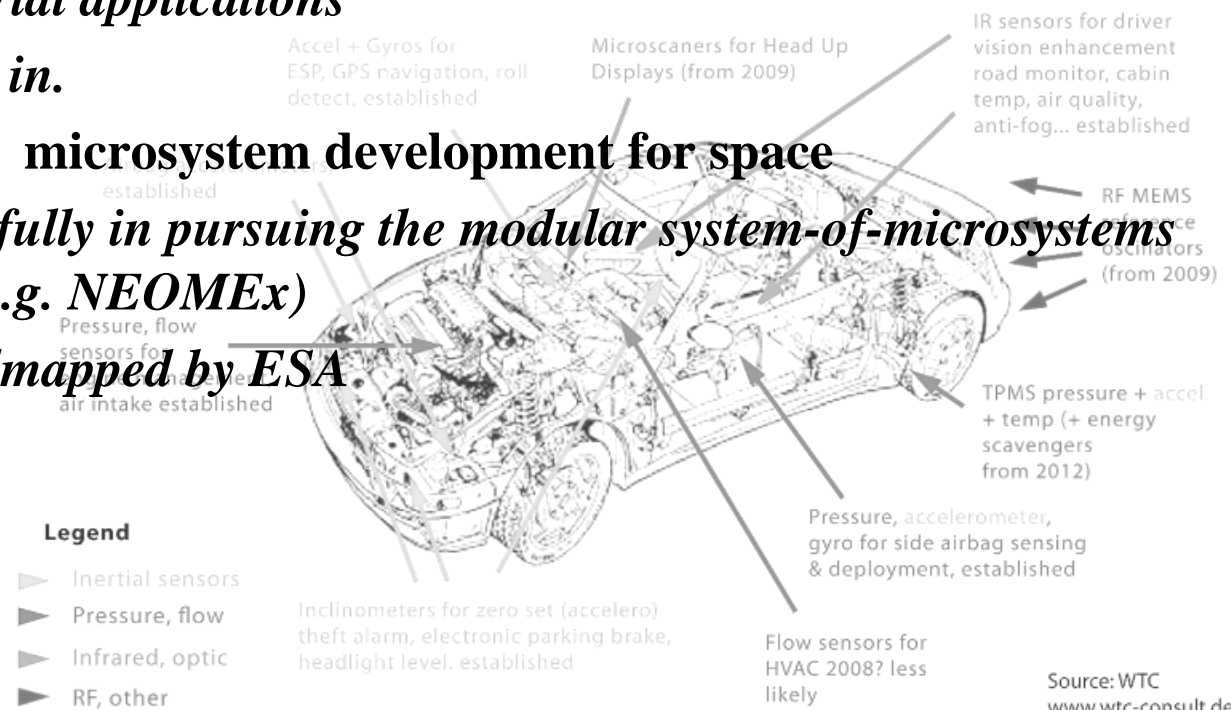
*Heritage in terrestrial applications*

*These can be spun in.*

**On-going and planned microsystem development for space**

*Should be utilised fully in pursuing the modular system-of-microsystems nanospacecraft (e.g. NEOMEx)*

*Surveyed and roadmapped by ESA.*



# NEOMEx in context

NEOMEx mission  
*Piggy-back to NEO*  
*New payload modules*  
*First science/ exploration*  
*demonstration mission*



## ESA Microsystem-based spacecraft development thrust

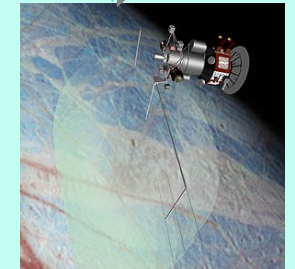
Microsystem-based  
nanosatellite demonstrator

*First in orbit demonstration,*  
*builds heritage.*

*Low cost, simple mission*

*architecture (launch, communications).*

*Basic modules*  
*demonstration*



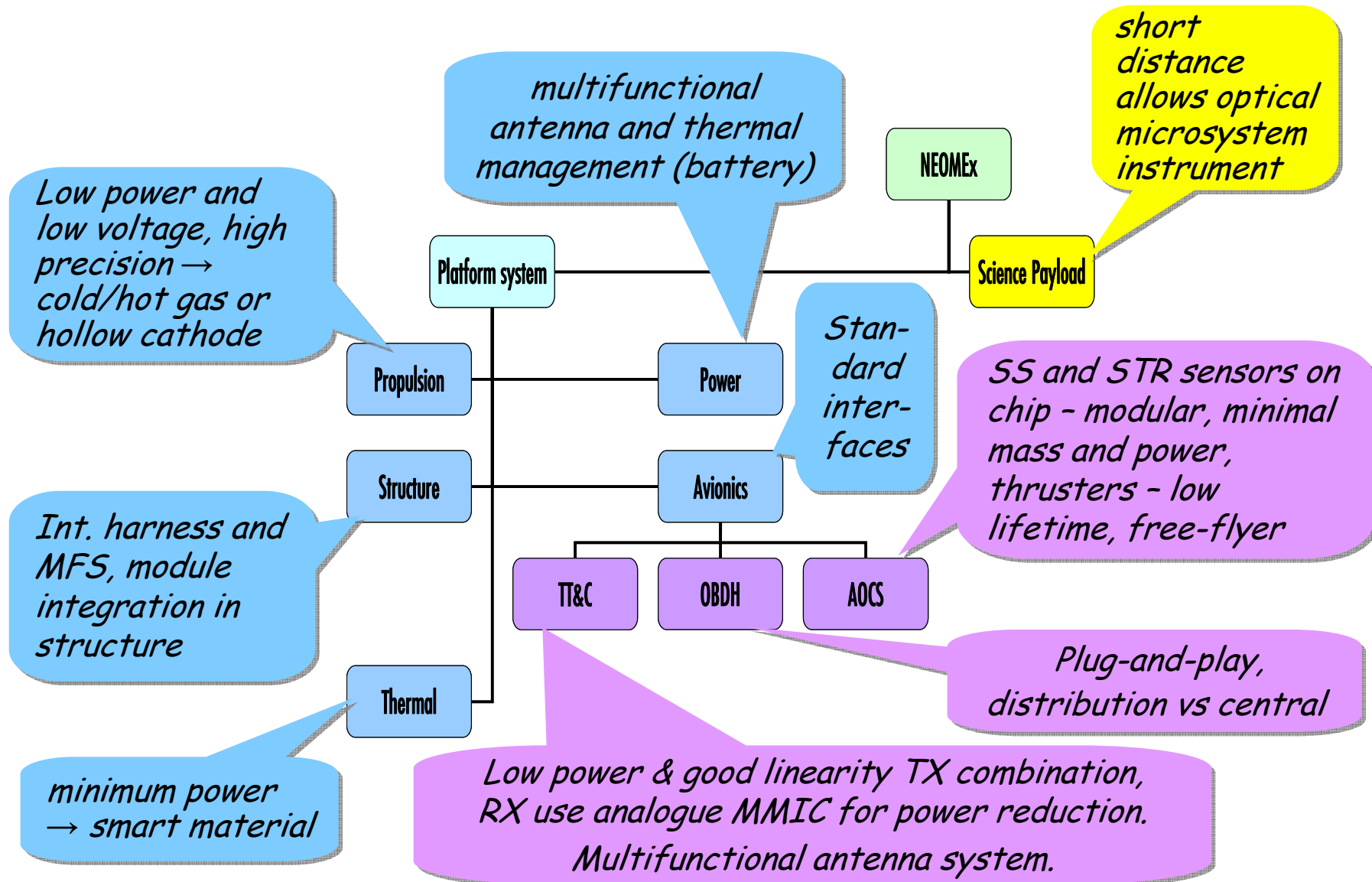
Fully fledged Science or  
Exploration Missions

*CRETE Europa Orbiter*

*NEXT*

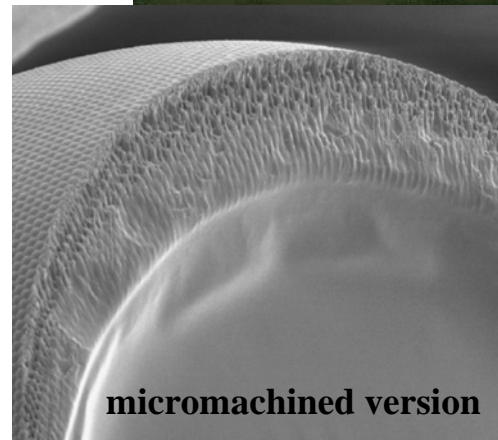
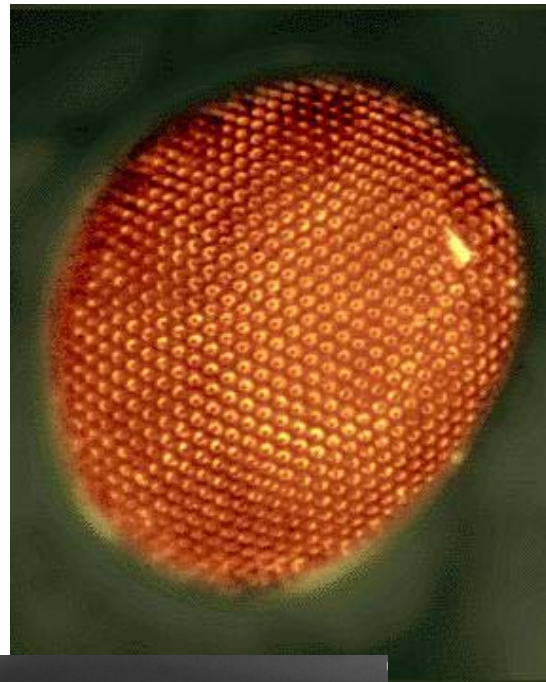
*Mars Sample Return etc.*

# Critical issues for System-of-Microsystems spacecraft





- Performance evaluation of compound imaging in space
- Compound imaging to
  - Reduce image processing power
  - Combinations of optical instruments
  - Wide FOV imaging
  - Rapid motions
- Mass: 500 g
- Power: 2 W
- Applications
  - Planetary/NEO missions
  - Nanospacecraft missions
  - Rovers
  - UAV



- **Optics limits the performance in payloads**
- Trade with
  - Sampling distance (#fotons)
  - Coherent swarm sampling
  - Reduce spectral range
- Additional instrument concepts:
  - THz imaging microsystem
  - Microspectrometers
    - (coded/adaptive apertures, Fourier transform, lamellas, PMDG based)

*Above: Courtesy of CERN,  
Below: Courtesy of Luke Lee,  
ETH, Zürich.*

## Who will benefit?

There are a number of missions that will significantly benefit from NEOMEx:

- Planetary Exploration (rovers and orbiters)
- Piggy-back microexplorers to fly-by objects  
*e.g. Comet explorers, NEO explorers, ...*
- Constellations for distributed sensing  
*e.g. Space weather monitoring*
- Inspector spacecraft  
*e.g. In-situ failure mode detection, servicing*
- Planetary navigation networks  
*e.g. Martian or Lunar positioning system*
- Earth monitoring with LEO constellations  
*e.g. Fire detection, Ocean roughness monitoring*



- Activities in support of the NEOMEx strawman mission will be proposed as part of ESA's BASIC TECHNOLOGY RESEARCH PROGRAMME, 2008-2010.
- This limited set of activities will demonstrate the viability of a microsystem-based spacecraft.
- The systems-of-microsystems concept can:
  - Improve the performance per mass in e.g. exploration missions*
  - Enable mass savings in several missions*
  - Increase mission reliability*