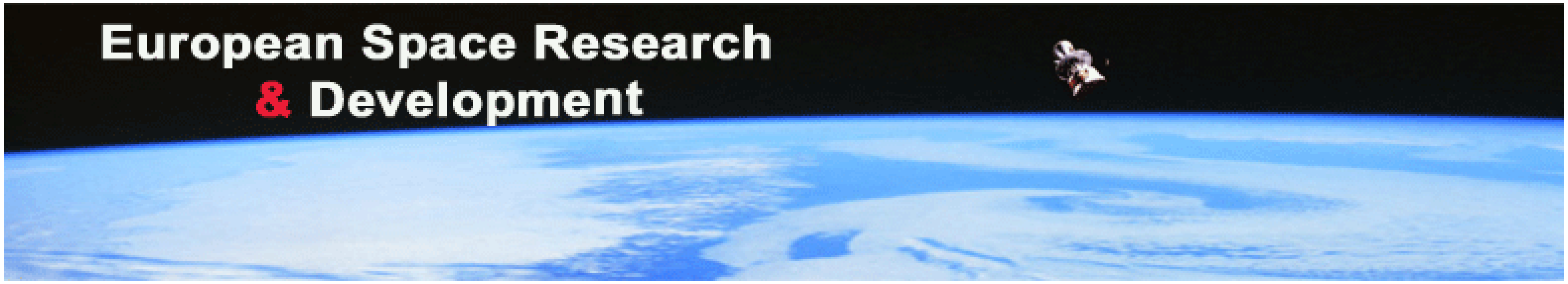
ESCCON 2011

European Space Components Conference
ESA ESTEC
(Newton 1 and 2 Conference Rooms)

Final Programme of Tuesday 15 March 2011
Chairman: A. Mouton / Astrium

14:20 – 14:40	FP7-Space:R&D activities in support of European microelectronics enabling technologies *R. Gilmore, EC (DG Enterprise and Industry, Space Research and Applications Unit)*
14:40 – 15:00	ESA Science Missions: Plans of the Cosmic Vision Programme *C. Erd, Advanced Studies and Technology Preparation Division, ESA ScienceProgramme*
15:00 – 15:20	European Technology Dependency – a view from ASD: supply chain and enabling technologies *B. Candaele, Deputy Director Hardware Engineering Competence Centre, Thales (for ASD, the AeroSpace and Defence Industries Association of Europe)*
15:40 – 16:00	Technology needs for new computer developments at RUAG Space *T. Hult, Chief Engineer Digital Products, RUAG Space AB*
16:00 – 16:20	Technology needs for AOCS / GNC sensors *S. Airey, Control Systems Division, ESA (ESTEC)*
16:20 – 16:40	The way for future power management *M. Melotte, Advance technology Coordinator, Thales Alenia Space ETCA*
16:45 – 17:45	Roundtable: Towards a sustainable supply of EEE parts for European Space Systems

ESCC



FP7-Space:
R&D activities in support of European microelectronics enabling technologies

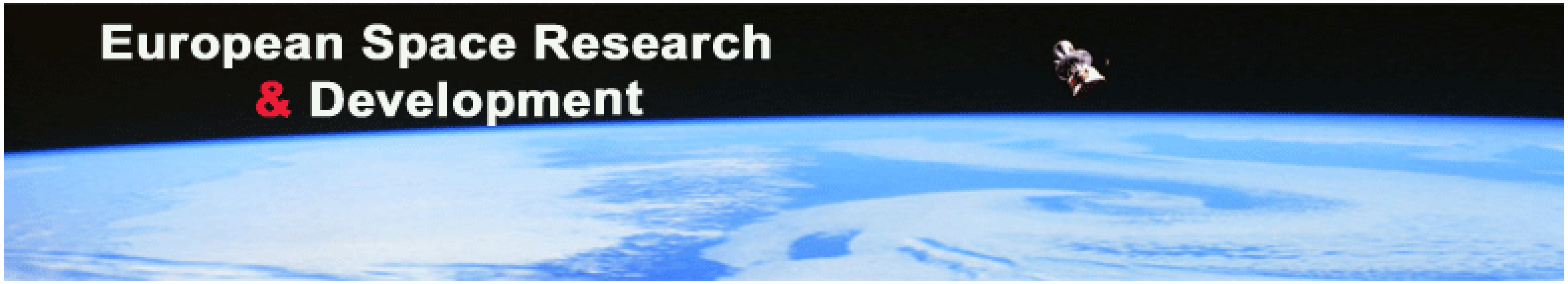
Richard Gilmore

Space Research and Development Unit

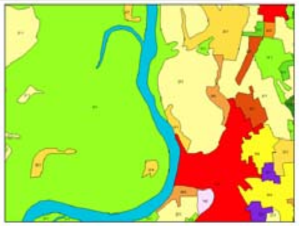
European Commission
Enterprise and Industry

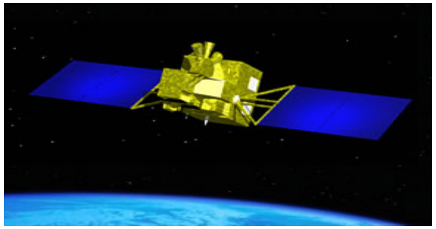
Contents

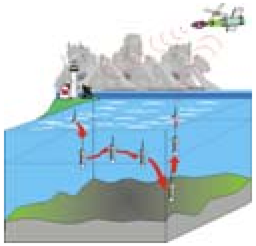
- Space research in the Framework Programme, brief history (contribution to microelectronics research)
- Work of the Joint Task Force on Critical Technologies
- Initial results for critical technologies, electronics components
- Future work



Space research in the Framework Programme, brief history







“Space” in the EU Research Framework Programmes

Space a **new activity**, first introduced in the 6th Framework Programme under the Aeronautics & Space theme - FP6 (2002-2006):

- About € 230 million over five years.
- Earth observation (GMES), Satcom, Satnav
- Focused on applications and services

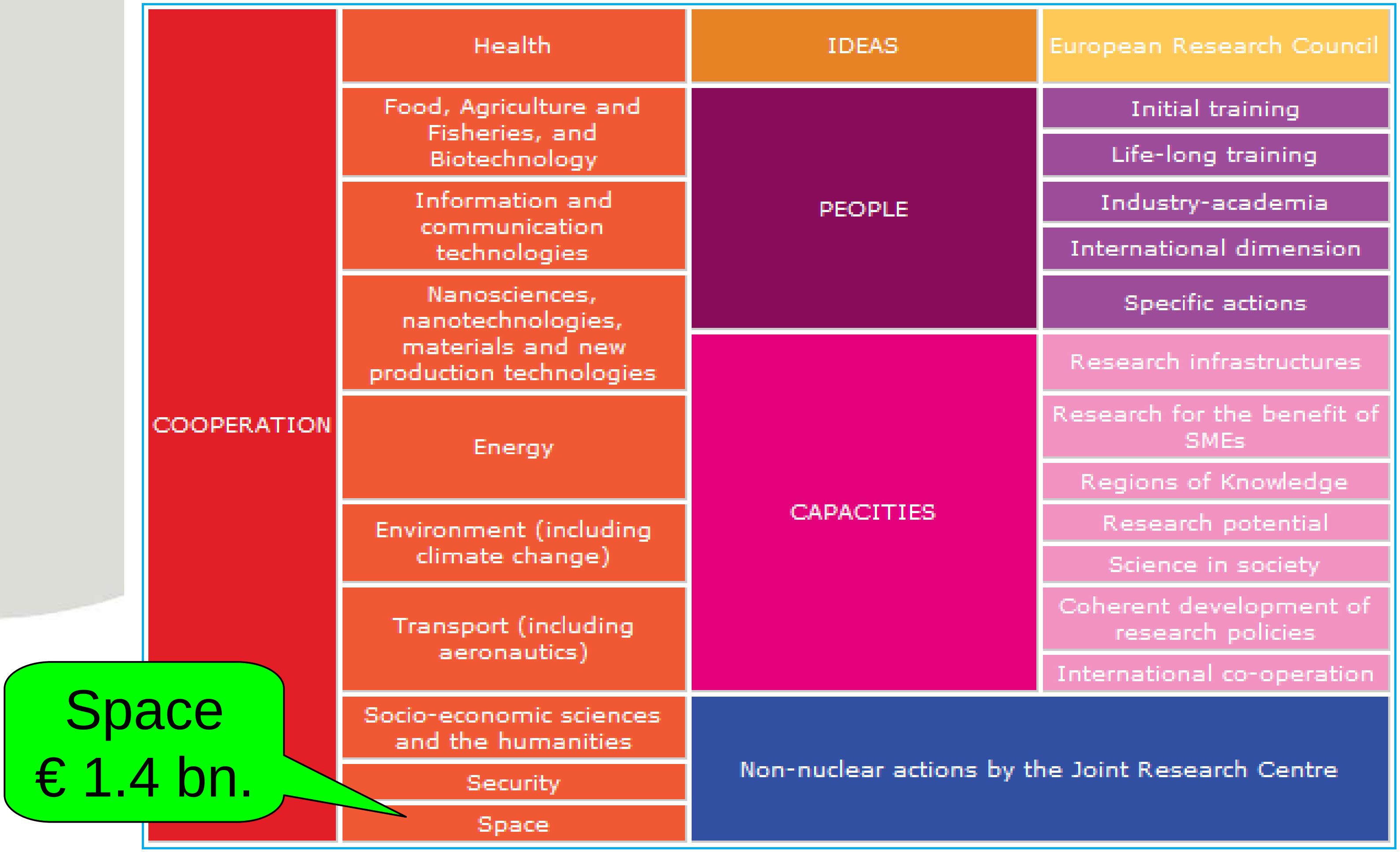
With own **Space** theme in **FP7 (2007 – 2013)**

- About € 1.4 billion over 7 years
- GMES + Strengthening Space Foundations
- Services, but also technology development

Post 2013:

- See later…

Framework Programme 7

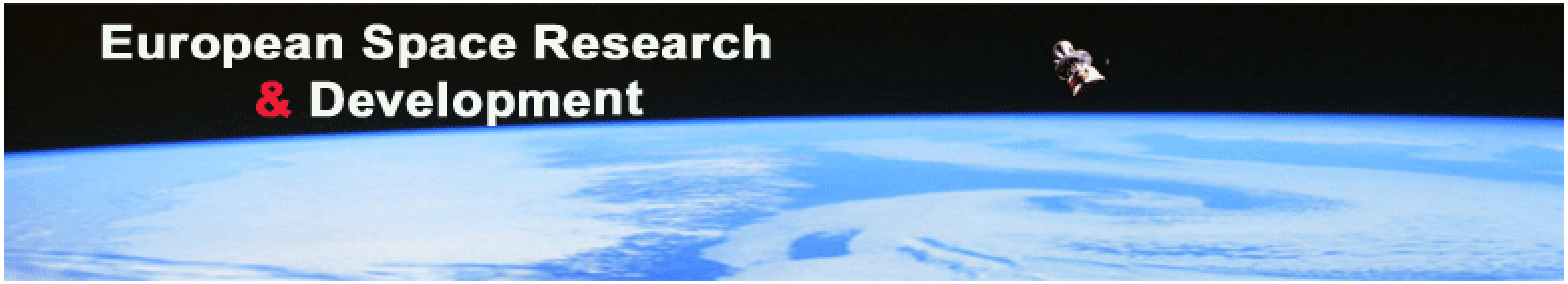


FP7-Space

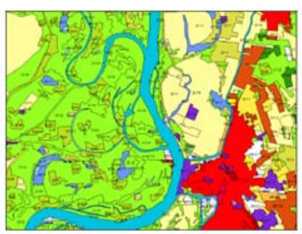
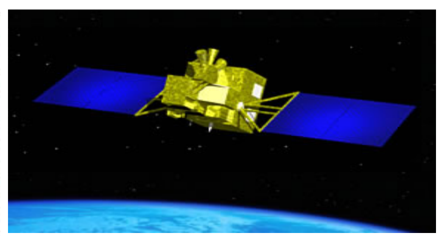
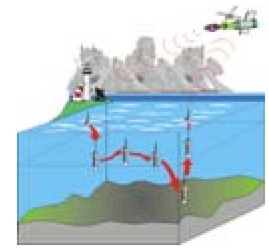
- **Space-based applications at the service of the European Society (principally GMES)**
  - *85%, half of which is delegated to ESA for Space Component and data access*
- **R&D Strengthening Space foundations (SSF)**
  - *15%, all of which dedicated to open calls*

Strengthening Space Foundations (SSF): Main topics addressed

- Space science
  (exploitation of scientific data)
- Space transportation
  (in-space propulsion, launch, entry)
- Planetary exploration
  (robotics, sample return)
- Space situational awareness
  (space debris, space weather, NEOs)
- **Key space technologies, "critical technologies for European non-dependence" (electronics…), <u>about € 10 million/year</u>**



Work of the EC-ESA-EDA Joint Task Force on Critical Technologies

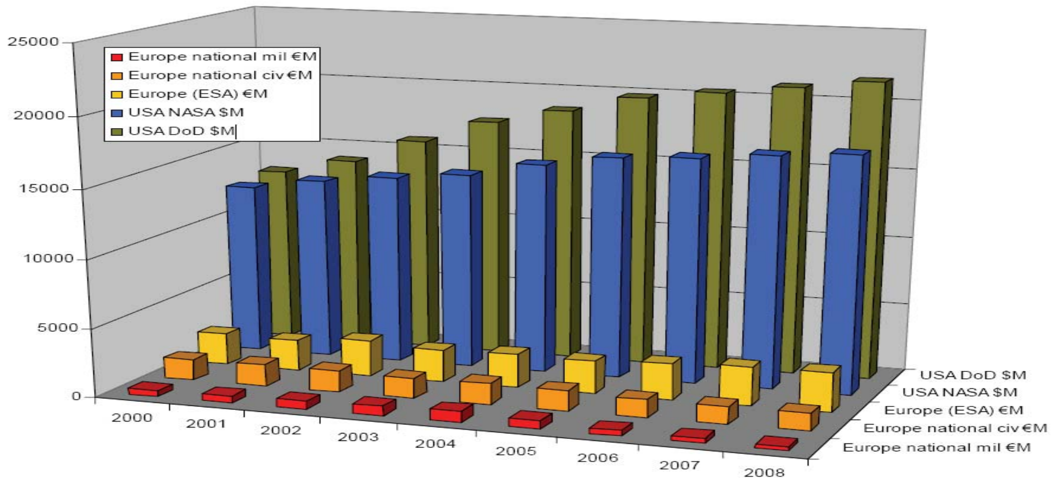
    

The Issue

Technology Gap

- Europe is 5 years behind in a number of technologies, e.g. in microelectronics
- Our market is too small
- Thus, dependence on imports (associated restrictions)
- Long term availability is not guaranteed

Funding Gap

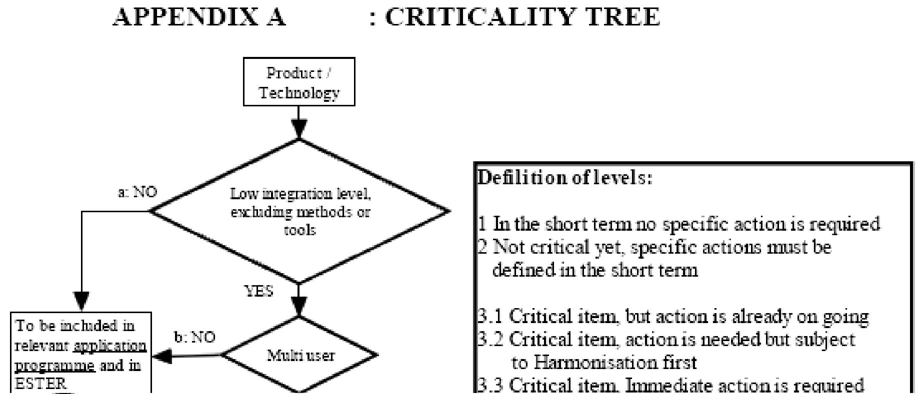


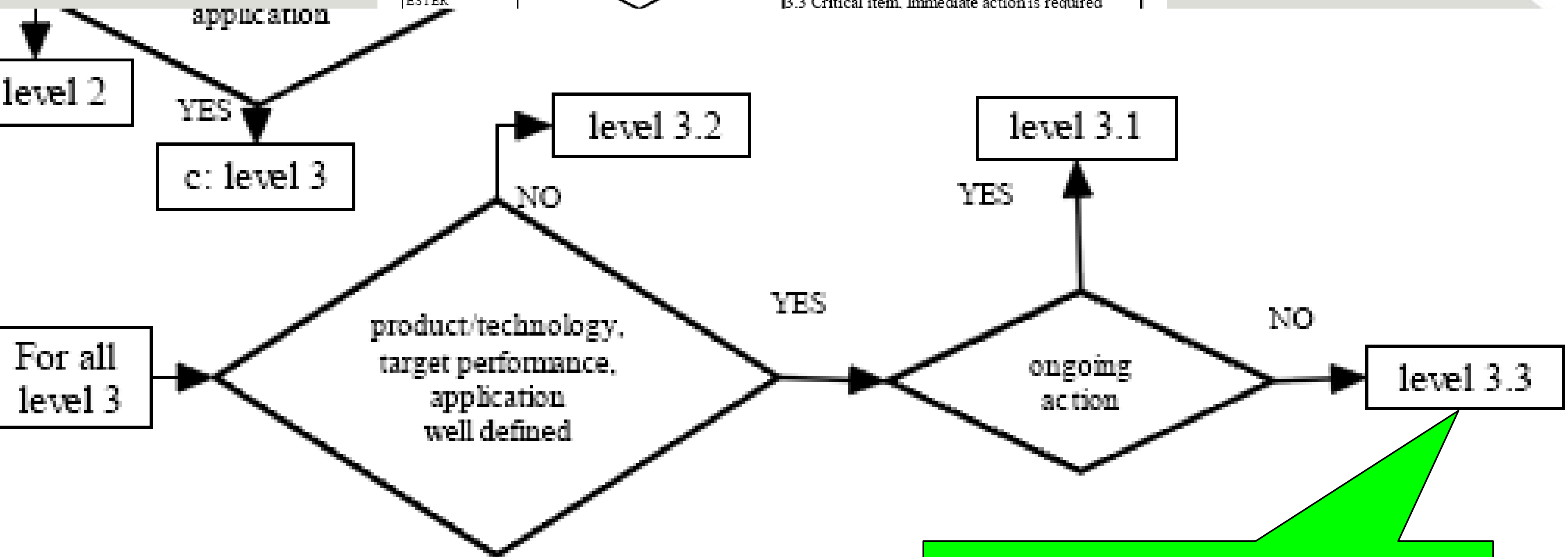
Joint Task Force Mandate/Recommendations

2008 Workshop in Brussels: EC, ESA and EDA decides to join forces to address critical space technology research:

- Raise awareness on this strategic issue for Europe,
- Define an agreed common methodology for a coherent Europe-wide approach, building on the existing and recognised processes, such as the ESA led European Space Technology Harmonisation process (THAG),
- Define a common list of priorities for critical space technologies
- Identify a list of critical items for which immediate action is required (<u>for review every 2 years</u>)

Process:





Basis of list of "urgent" actions for coordinated funding

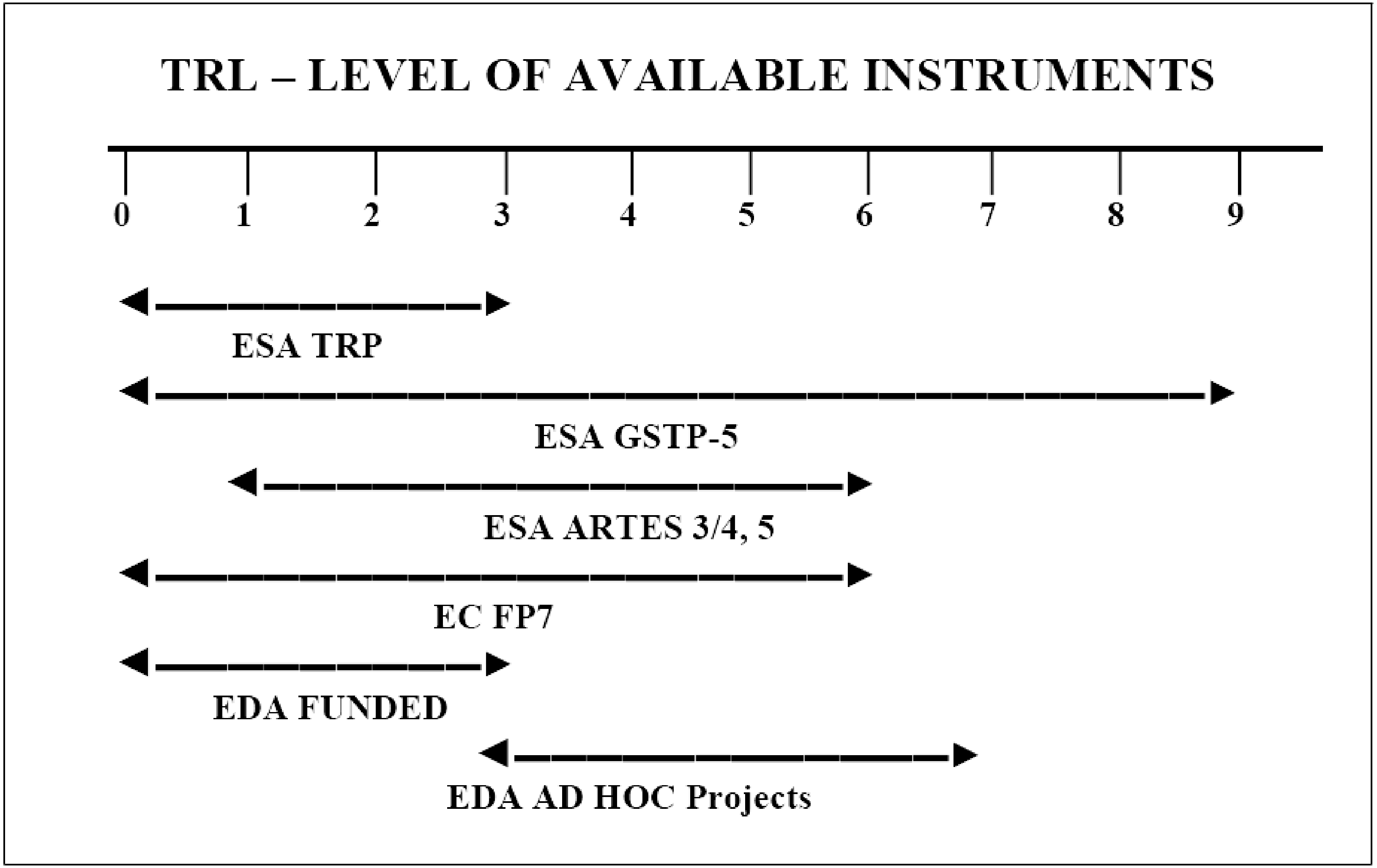
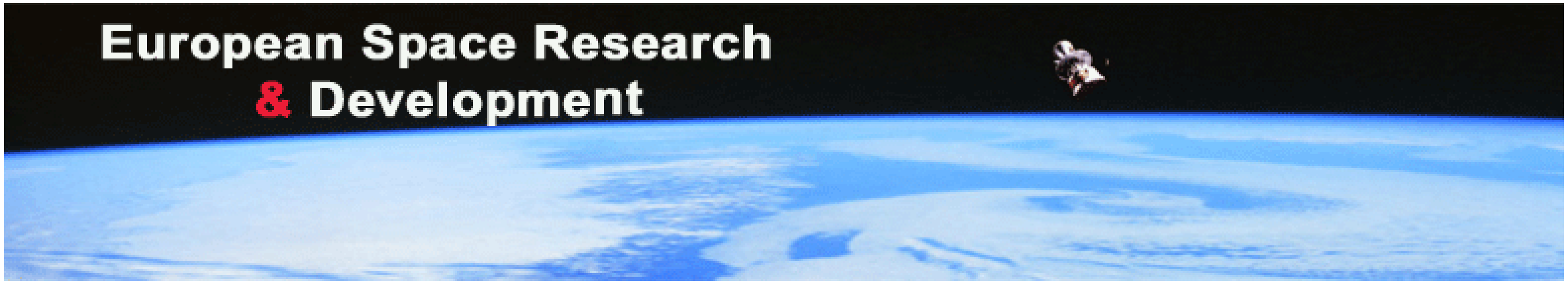


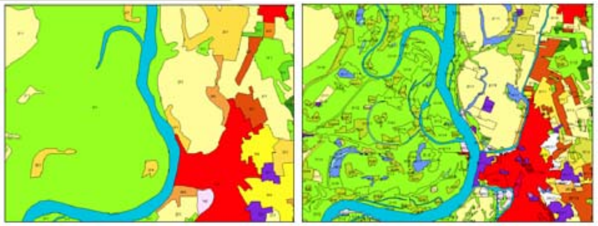
Figure 2 Funding instruments and their TRL-levels

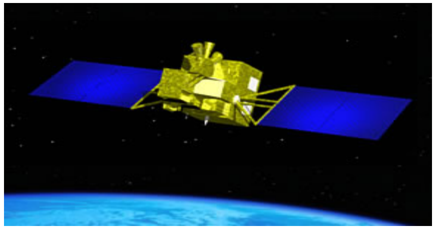
List of 25 « critical items » for which immediate action is required

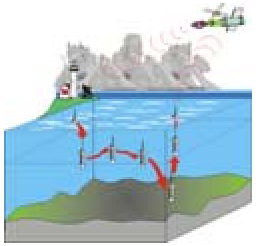
ID	Title
1	Core processors for DSP computers
2	ASICS
3	High speed DAC-ADC based on European Technology
4	Very high speed serial interfaces
5	FPGAs
6	Solid state gyroscope components
7	Power amplification: TWT materials
8	European State of the Art Dielectric Materials
9	Make available Submmw Local Oscillator Sources
10	Space-worthy solid-state laser sources
11	Enhanced performance, space-worthy 1-D + 2-D sensor focal planes operating from X-ray to the Infrared
12	Bladder tanks for bipropellants
13	Propellant flow and distribution components for electric and chemical propulsion
14	Development of Large Deployable structures
15	Development of low shock (NEA-like) initiators
16	Advanced Ablative Systems for high speed re-entry
17	Passive Components
18	Active Components
19	Very High performance microprocessors
20	Advanced microwave components - MMIC
21	Low-cost high-resolution L and X-band SAR components
22	Advanced thermal control systems
23	Advanced thermal control materials
24	High density (up to 1000 pins) assemblies on PCB
25	Space qualified carbon fibre and pre impregnated material sources for satellite subsystems



Initial results for critical technologies in FP7 (especially microelectronics)







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FP7-Space, state of play for SSF topics (after Calls 1, 2 and 3)

- Very significant interest for all SSF topics (3 to 6 fold oversubscription rates)
- Portfolio of some 120 projects
- About 66 projects under SSF topics
- Main topic groupings:
  - Space science data exploitation (9)
  - Human space exploration (2)
  - Robotics for planetary exploration (4)
  - Space transportation technol. (12)
  - International coop. with Russia (6)
  - Space weather/debris (15)
- - **Critical technol. (13)**

FP7 Space: projects funded under critical technologies topic

Call	Coordinator	Acronym	Title
1	ThalesAleniaSpace France	AGAPAC	Advanced GaN Packaging
2	E2V Semiconductors SAS, France	COMETS	Converters broadband low power high performance for telecommunications in space
2	SiCrystal AG, Germany	EuSiC	High Quality European GaN-Wafer on SiC Substrates
2	Science and Technology Facilities Council, UK	MIDAS	Millimetre-wave Integrated Diode and Amplifier Sources
2	Thales Research and Technology, France	SATURNE	Microsystems Based on Wide Band Gap Materials for Future Space Transmitting Ultra Wideband Receiving Systems
2	Chalmers University of Technology, Sweden	TeraComp	Terahertz heterodyne receiver components for future European space missions
3	Commissariat à l'Energie Atomique, France	CESAR	Cryogenic Electronics for Space Applications and Research
3	Caen Arelia Space Srl, Italy	DSPACE	Digital Signal Processor for Space Applications
3	Helsingin Yliopisto, Finland	E-SQUID	Development of SQUID-based multiplexers for large Infrared-to-X-ray imaging detector arrays in astronomical research from space
3	Austrian Institute of Technology	HARMLES	Dry lubricated Harmonic Drives for space applications
3	Universidad Carlos III, Madrid, Spain	MAGDRIVE	Magnetic-Superconductor Cryogenic Non-contact Harmonic Drive
3	Fundacion Insmet, Spain	SMARTEES	Multifunctional components for aggressive environments in space applications
3	Heinrich-Heine-Universitaet, Duesseldorf, Germany	SOC2	Towards Neutral-atom Space Optical Clocks: Development of high-performance transportable and breadboard optical clocks and advanced subsystems
4	-	-	Carbon Fibres and Pre-Impregnated Materials
4	-	-	Re-entry ablative thermal protection
4	-	-	Large Deployable Technologies
4	-	-	Miniaturized Flow Control
4	-	-	CMOS Imagers
4	-	-	Aerogels for Space Applications
4	-	-	Very High Speed Serial Interfaces

List of 25 « critical items » for which immediate action is required

Calls 1, 2 and 3

Call 4

ID	Title
1	Core processors for DSP computers
2	ASICS
3	High speed DAC-ADC based on European Technology
4	Very high speed serial interfaces
5	FPGAs
6	Solid state gyroscope components
7	Power amplification: TWT materials
8	European State of the Art Dielectric Materials
9	Make available Submmw Local Oscillator Sources
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11	Enhanced performance, space-worthy 1-D + 2-D sensor focal planes operating from X-ray to the Infrared
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20	Advanced microwave components - MMIC
21	Low-cost high-resolution L and X-band SAR components
22	Advanced thermal control systems
23	Advanced thermal control materials
24	High density (up to 1000 pins) assemblies on PCB
25	Space qualified carbon fibre and pre impregnated material sources for satellite subsystems

GaN-based technologies

GaN has emerged as the technology of choice for the next generation of high-power electronics

- **<u>AGAPAC (Coord.: ThalesAleniaSpace, FR)</u>:** Develop a space-compliant power micropackage to dissipate up to 100 W, based on innovative high thermal conductivity diamond or nanocomposites

- **<u>EuSiC (Coord.: SiCrystal AG, DE)</u>:** Develop SiC high-quality 3-inch substrate for GaN.

High-frequency Schottky diodes

Terahertz receivers are essential for scientific exploration and Earth observation

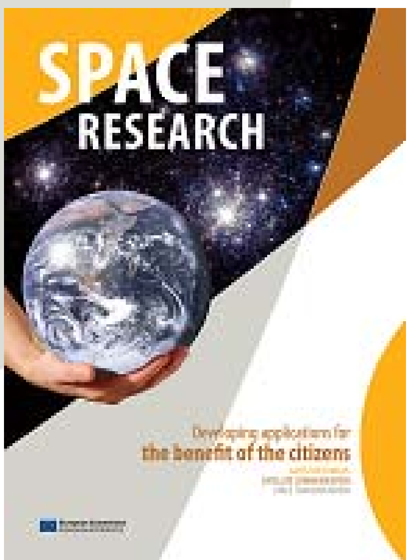
- **TeraComp (Coord.: Chalmers University of Technology, SE):**
  Development of a European industrial capability for terahertz receivers based on Schottky diodes (novel Heterostructure Barrier Varactor and mHEMT MMIC)

- **MIDAS (Science and Technology Facilities Council, UK):**
  Development of a demonstrator source delivering enough power at 300 GHz for direct commercial applications (builds on European amplifier technology, Schottky varactor diodes)

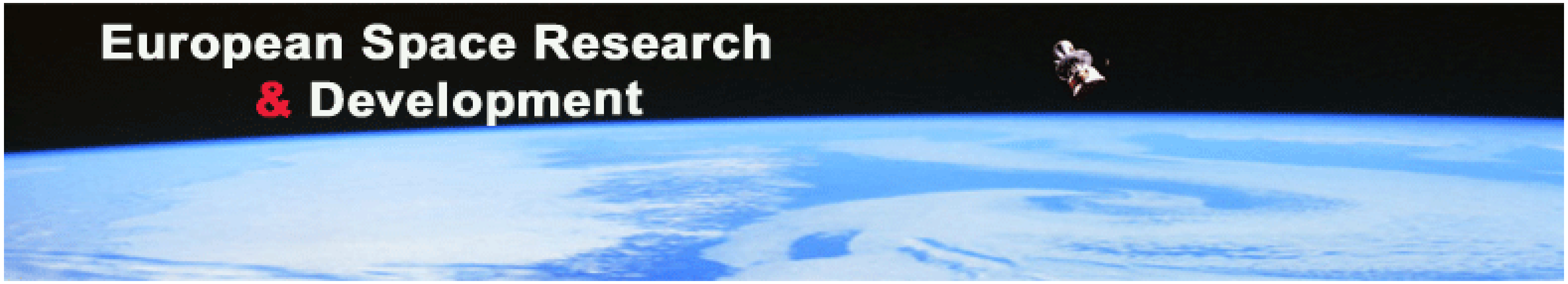
Wide bandgap semiconductors
Flexible RF front ends for versatile satellites

- **SATURNE (Thales SA, FR):**
  Realise novel types of microwave functions through Wide Band Gap semiconductors and RF-MEMS switches. Develop re-configurable, highly power-efficient communication payloads with narrow-, multi- or wide-band channel allocation.

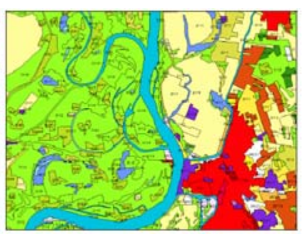
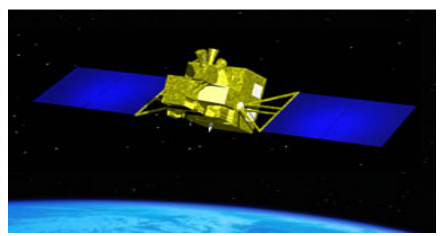
Further information available:
ec.europa.eu/embrace-space

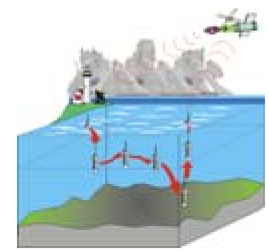


FP7 "**Let's Embrace Space**" conference, 12-13 May, Budapest, Hungary



Future work



Next steps

- Take stock of results of the first 4 calls of FP7-Space (topic will not be open in Call 5)
- Review list of urgent actions based on these results

Figure 1 European Non-Dependence Process in 2011

More information:
ec.europa.eu/**embrace-space**

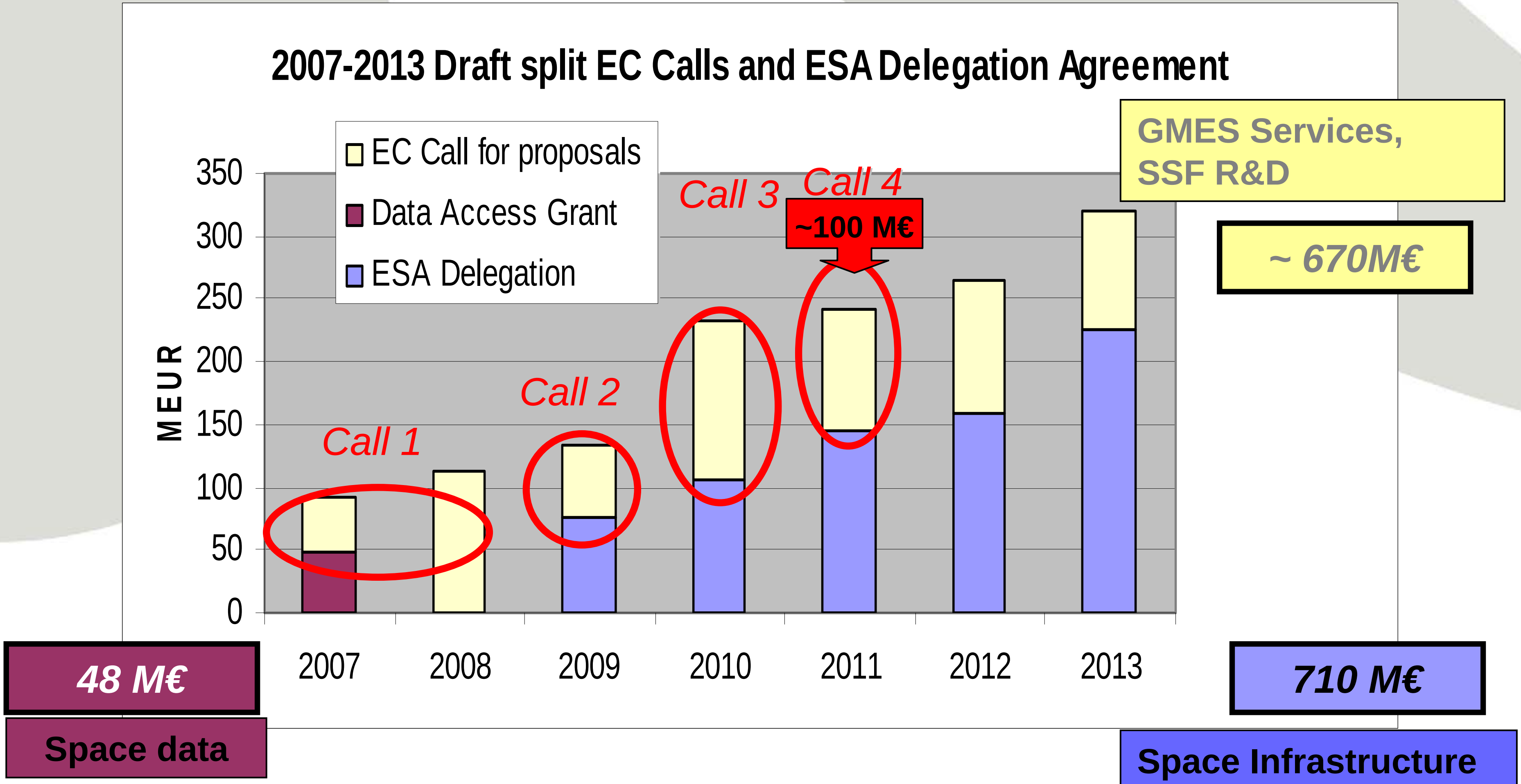
European Commission
Enterprise and Industry

Thank you for your attention

- Richard Gilmore
  Space Research and Development Unit

  richard.gilmore@ec.europa.eu

Breakdown of FP7 Space funding



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Commission Green Paper

- On 9 February 2011, the Commission adopted a Green Paper *'From Challenges to Opportunities: Towards a Common Strategic Framework for EU research and innovation funding'* (COM(2011)48).
- This Green Paper launches a public consultation on the key issues to be taken into account for future EU research and innovation funding programmes.
- The consultation website is available at: http://ec.europa.eu/research/csfri/index_en.cfm. Submissions can be made until 20 May 2011 in form of questionnaire or position papers.

Those topics closed for this call from the "list of urgent actions" are barred

ID	*Title*
1*	~~Core processors for DSP computers~~
2	ASICS
3*	~~High speed DAC-ADC based on European Technology~~
4	Very high speed serial interfaces
5*	~~FPGAs~~
6	Solid state gyroscope components
7	Power amplification: TWT materials
8	European State of the Art Dielectric Materials
9*	~~Make available Submmw Local Oscillator Sources~~
10	Space-worthy solid-state laser sources
11	Enhanced performance and space-worthy 1-D and 2-D Sensor focal planes operating from X-ray to the Infrared
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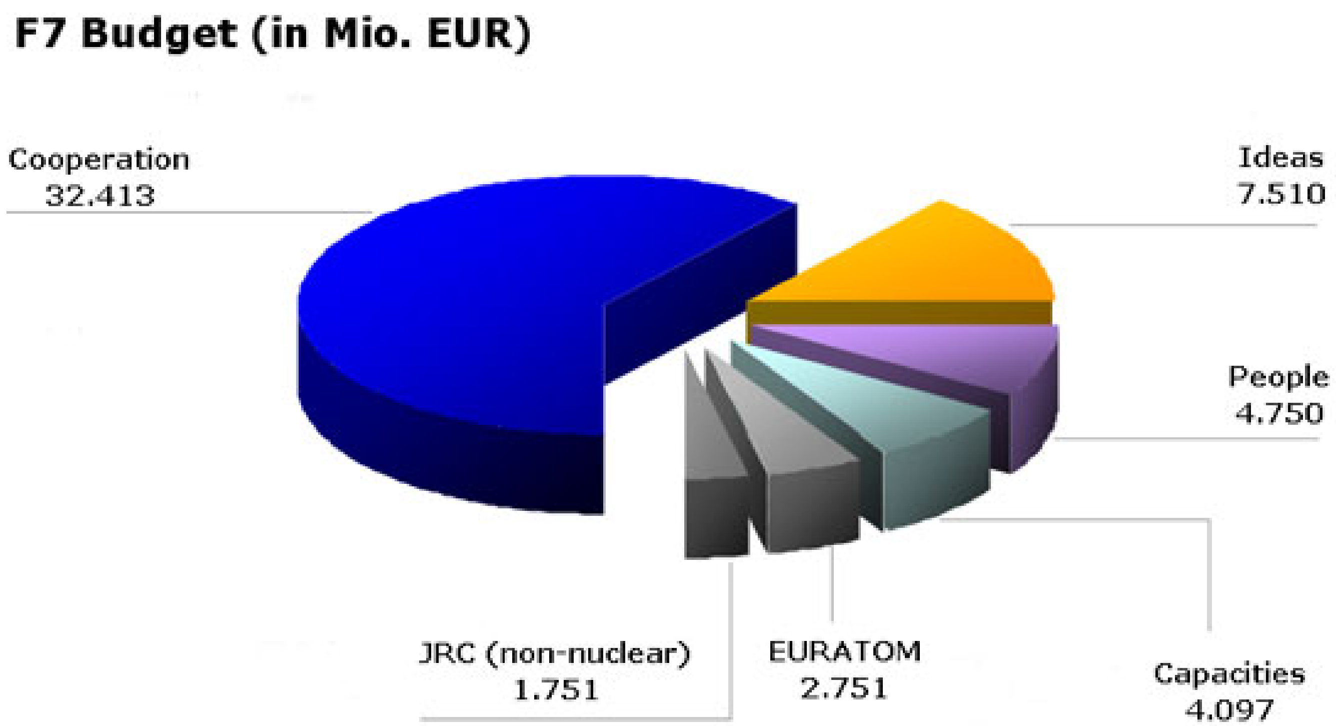
Framework Programme 7



FP7 budget

	Themes	December 2006 (****)
COOPERATION	Health	6100
	Food, Agriculture and Fisheries, and Biotechnology	1935
	Information and Communication Technologies	9050
	Nanosciences, Nanotechnologies, Materials and new Production Technologies	3475
	Energy	2350
	Environment (including Climate Change)	1890
	Transport (including Aeronautics)	4160
	Socio-economic Sciences and the Humanities	623
	Security and Space	Space 1430 Security 1400
Total COOPERATION		32413
IDEAS	European Research Council	7510
PEOPLE	Marie Curie Actions	4750
CAPACITIES	Research Infrastructures	1715
	Research for the benefit of SMEs	1336
	Regions of Knowledge	126
	Research Potential	340
	Science in Society	330
	Coherent development of research policies	70
	Activities of International Co-operation	180
Total CAPACITIES		4097
Non-nuclear actions of the Joint Research Centre		1751
Total EC		50521
Euratom for nuclear research and training activities		2751

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Main characteristics of research funding under FP7

<u>General approach</u>:

- Complementary to ESA research programmes (address gaps, target topics for which FP can bring added value, coordination to avoid duplication)
- Bottom-up approach: relatively broad definition of research topics to be addressed
- Competitive selection based on evaluation by external experts (no geo-return constraints)
- Most FP7 research projects are 50% co-funded
- Overall budgets are set from beginning of the FP

Framework Programme (FP)

- European Union’s main financial tool to support research and development activities in almost all scientific disciplines
- Initiated in 1984
- 5-year cycles (up to FP6)
- Current incarnation: FP7. Period of seven years (2007 – 2013), to be synchronised with the EC’s Multiannual Financial Framework (MFF)
- FPs are proposed by the European Commission and adopted by Council and the European Parliament following a co-decision procedure
- Now starting to prepare for the next MFF and therefore “FP8”…

Beyond FP7 (2 calls remaining)

Working assumptions:

- Lisbon Treaty means that space should remain a priority for the EU and the FP
- Budget should be similar to that of FP7, but GMES to move out of the FP
- Majority of budget therefore for SSF-type topics
- However, financial crisis…

First preparations:

- Commission Green Paper
- FP8 space research hearing, December 2010
- Input from the FP7 Space Advisory Group

JTF Recommendations

For the transitory phase until more focused instruments are in place:

- to use the first common list of critical technologies for European Strategic Non-Dependence as input for the work programmes of all the three institutions
- to launch the European Non-Dependence Process in 2nd semester 2009
- to review and update the Non-Dependence List every 2 years and monitor its status on a regular basis
- to make adequate and complementary funds available for critical technologies activities (approximately 100-120 M€/year).
- for the three Institutions to make best use of the available instruments until more dedicated programmatic instruments are set up

Proposed Common Methodology

- Build on the existing and recognized European Space Technology Harmonisation process of ESA and
- the Synchronised Programming Approach of EDA
- Expand the Technology Harmonisation Advisory Group (THAG) to EC and EDA
- Proceed to calls on the basis of the joint list

	2011 EUR million[53]	total
Call FP7-SPACE-2011-1 Activity 9.1 Space-based applications at the service of European Society : 1.1 GMES Security: exploring governance options	1	56
5.1 Marine service	28	
5.2 Atmosphere service	19	
5.3 R&D to enhance future GMES applications in the Marine and Atmosphere areas	8	
Call FP7-SPACE-2011-1 Activity 9.2 Strengthening of Space foundations: 1.1 Exploitation of Space Science and exploration data 1.2 Developments for space exploration 2.1 Space Transportation technologies	17	31
Call FP7-SPACE-2011-1 Activity 9.2 Strengthening of Space foundations: 2.2 Space Critical Technologies	10	
Call FP7-SPACE-2011-1 Activity 9.2 Strengthening of Space foundations: 3.1 Prevention of impacts from NEO	4	
Call FP7-SPACE-2011-1 Activity 9.3 Cross- cutting activities/International Cooperation 2.1. Support for "GMES and Africa" Initiative	1	12
2.2. Facilitating access to space for small scale R&D missions	8	
Call FP7-SPACE-2011-1 Activity 9.3 Cross-cutting activities 3.1. Trans-national and international coop. among NCPs 5.1. Studies and Events in support of European Space Policy	3	

Aeronautics, Space, Security and Defence
Industries Association of Europe

Industry Perspectives on European Technology Dependency

Supply chain and enabling technologies

ESCCON 2011 – ESA ESA Noordwijk, March 2011
Bernard Candaele – PoC Industry EDA Components Captech

Industry analysis
on European Technology Dependency

Outline of the presentation

1. Innovation results from 2 complementary R&T models
2. Technology capability requires collaboration between system actors - users, industrial technology suppliers and research R&T labs
3. The recent threats for European supply chain with Globalization and economic crisis impact our supply chain
4. The established European cooperation
5. Pilot case of Cross-sectorial Si Electronic Component
6. Critical Technologies – Which enabling actions for the Future?

Developing innovative systems

Reactive and affordable innovation is the result of cross fertilisation between two complementary R&T models

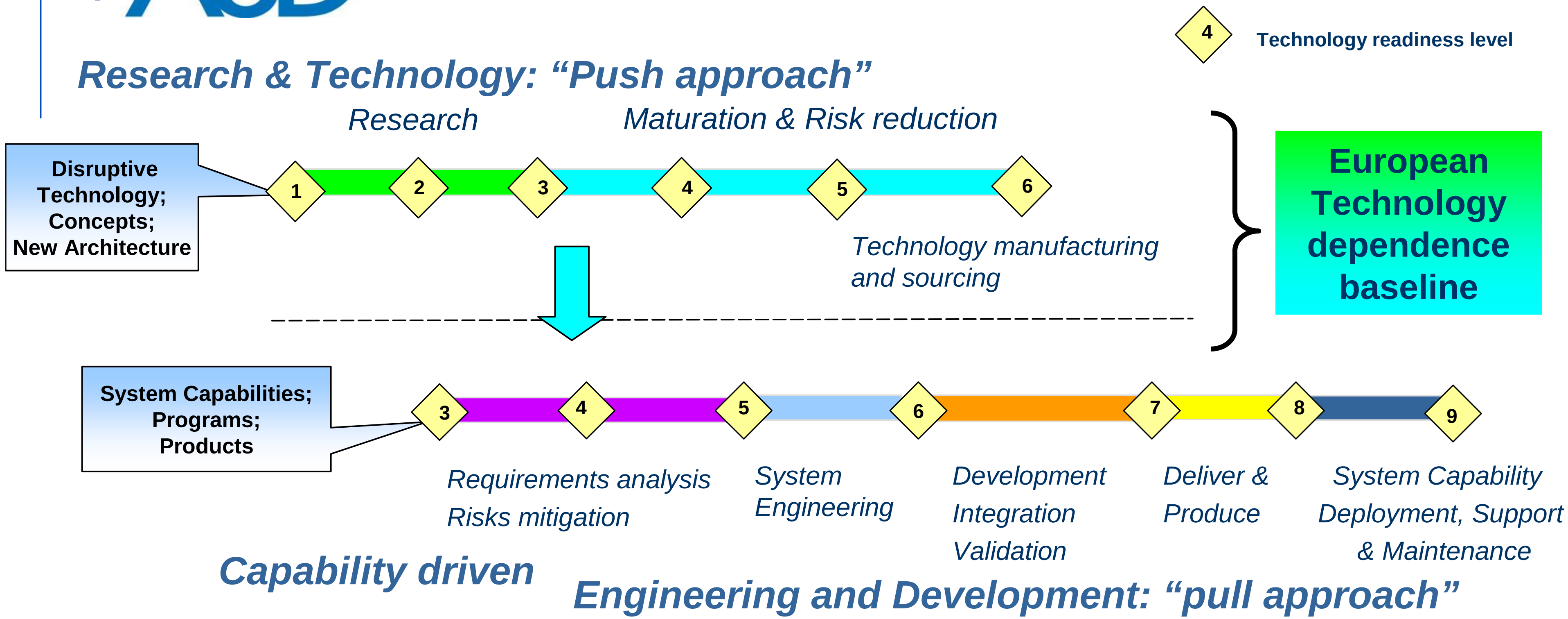
• ***A capability-driven R&T model*, **with the objective to develop ***system capabilities***, focused on ***operational systems*** (such aeronautics, military, security and space) and demonstrators**.**

• ***A technology-driven R&T model*, **with the objective to build-up ***in advance to programmes*** the ***technology basis*** from which programmes will draw off-the-shelf solutions**.**

It is improper to make a distinction only in terms of TRL, the difference is also in the level of integration

• Technology shall reach maturity (high TRLs) before insertion in a program (electronic components, detectors, …) and be manufactured
• On an integration scale (system, equipment, component,…), technology base is rather in the lower part, when capability-driven projects are rather in the upper part.

Research & Technology vs Engineering



R&T to be preserved (KET*)

While maturing European silicon technologies (TRL5)

towards Security of Supply chain

Eco system and related European component Suppliers to be maintained in Europe

Most of our component suppliers get hurt by the impact of globalization (consumer electronics has left Europe)

* : Considered KET by EU task force are Advanced materials, Microelectronics, Nanotechnologies, Photonics, Biotechnologies

Tackling European dependencies

- **Addressing dependencies both in terms of :**
    - **Security of supply,**
    - **Access to emerging technology**
- **Multiple SoS current & strategic risks:**
    - **Crisis – Collapse of Suppliers**
    - **Fragility of suppliers because of a narrow aeronautics, defence, security and space market (specificities, long cycles,…),**
    - **Globalisation, shift of production (and now of R&T) to Asia and US**
    - **Strategic control of the supply chain by shareholders motivated only by economical considerations, not in a position to integrate sovereignty considerations.**
- **R&T funding for the technology base up to technology maturing is needed:**
    - **General situation of industrial policy budgets,**
    - **Prominence of capability-driven R&T.**
- **Technology Base is cross-sectorial by nature, and is a factor of innovation;**
    - **Coordination EC-ESA-EDA, Member States and Agencies, ASD and technology suppliers**

European technological dependencies

4 – A case study of established European cooperation: MMICs

MMICs : An example

- **Tripartite AMSAR (UK-FR-GE) active array antenna radar demonstrator : the capability-driven dimension**

- **UMS joint-venture : the technological dimension (AsGa)**
  - **But some other choose different route (ex :Filtronics, …)**
- **Development and consolidation of UMS as an industrial operator**

- **Coping with a technological breakthrough (GaN) : KORRIGAN**
- **Consolidating the supply chain with GaN material : MANGA**
- **MAGNUS programme expected to start in 2012 : dedicated to the development of new generation of MMICs and modules based on a stable and industrial GaN technology available at UMS (GH25 process)**

- **Towards an extension of the « UMS Club » ?**

UMS Business Model

- United Monolithic Semiconductors has been created in 1996, joint venture Thales and EADS, to provide a European source of III-V technologies and products.
- Activities: design, foundry, assembly (but no epitaxial material)
- Industrial facilities in Ulm, Germany and Orsay, France, and sales offices in USA and China.
  - 250 people, annual sales 51.2M€
  - **Four markets are:**
    - Telecommunication infrastructure,
    - Automotive and ISM,
    - Space,
    - Security and Defence.

Several models exist to manufacture European technology

UMS is one successful model serving Aerospace, Space, Security and Defence as well as European industrial markets

European technological dependencies

5 – Pilot case : silicon electronic components supply chain

First Actions from the Space Sector

ESA activities and priorities on components

- **ITAR regulation issues.**
- **Increase European non-dependence for space components and maintain the viability of European actors**
- **Current priorities : GaN, Rad Hard Power Mosfets, ASIC and DSM (Deep Submicron), non ITAR FPGA, …**
- **European Component Initiative (ECI), dedicated to components**

In Q1 2010, initial discussions to leverage component supply chain for future European System actors

- **Involved suppliers : ATMEL (ASIC with ST and FPGA provider), STM (DSM CMOS 65nm, SiC, new technology Ft>500Ghz, …), e2v (ADC 12bits/2Gsps, Imaging technologies), FPGA in 28nm**
- **Space System industries Thales Alenia Space and Astrium**
- **Question to Defense Industries : extend the solutions to Military needs**

Example

Cross-sectorial Si Electronic Component supply chain

Activities and effort in M€ (*)	Specific Part for Space	Specific Part for Defense	Specific Part for Home land Sec	Common Core investment	Total
A: 65 nm CMOS	15		8	22	45
B: assembling	10	7		17	34
C: FPGA	11	8	4	44	67
D: DSP/µP	15	10	8	70	103
E: µC 20 MIPS	8			4	12
F: CAN/CNA	10	6		4	20
G: Analog Asic	8	11	1	20	40
H: Imaging	24		13	30	67
I: Power devices	3,5	12	5	20	40,5
TOTAL	104,5	54	39	231	428,5

Several technologies to be addressed by the same supply chain eco-system for the benefit of several sectors such Defense EDTIB, Homeland security & Space

Effort about 110M€/year

* : first effort estimates

Propose a coordinated action for Micro/nano Electronic Components ?

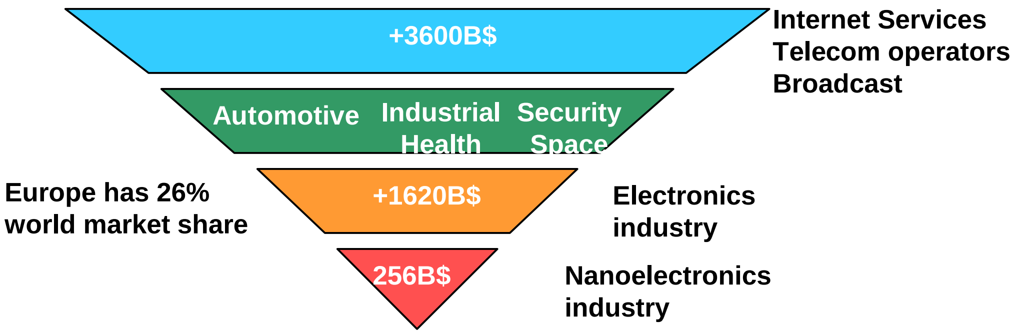
- Si Electronic Components is a real issue for aeronautics, defence, security and space (plus other sectors)
- Adressing this requires an investment in the range of €100-120M/year (all relevant sectors)
- Corresponding business is estimated at €1-2B/year
- Such business is of no interest to current semi-conductor industry which is focused on the consumer sector

Which enabling actions for the Future?

Several have now said :

FABLESS = JOBLESS

KETs* are a key enabler for added-value : microelectronics



R&T is not enough to deliver capabilities : Aeronautics, Defense, Security and Space require design solutions and manufacturing

Aeronautics, Defence, Security and Space cannot pay the alone for these factory and full component solution

The KET initiative appears to be a relevant answer to the challenge

The industry is not seeking budget for itself, it is seeking support for its supply chain

Relevant actors shall become associated to the governance at EU level for KET

* : KET : Key Enabling Technologies, Europe preparing 2020

Some back-up slides

Questions ?

What are the Keys for sustainable operations

Trends in electronic activity in Europe

Case of the Impact of globalisation on silicon electronic components

U.S.A. National Nanotechnology Initiative

US DoD Components related budget

Keys for sustainable operations

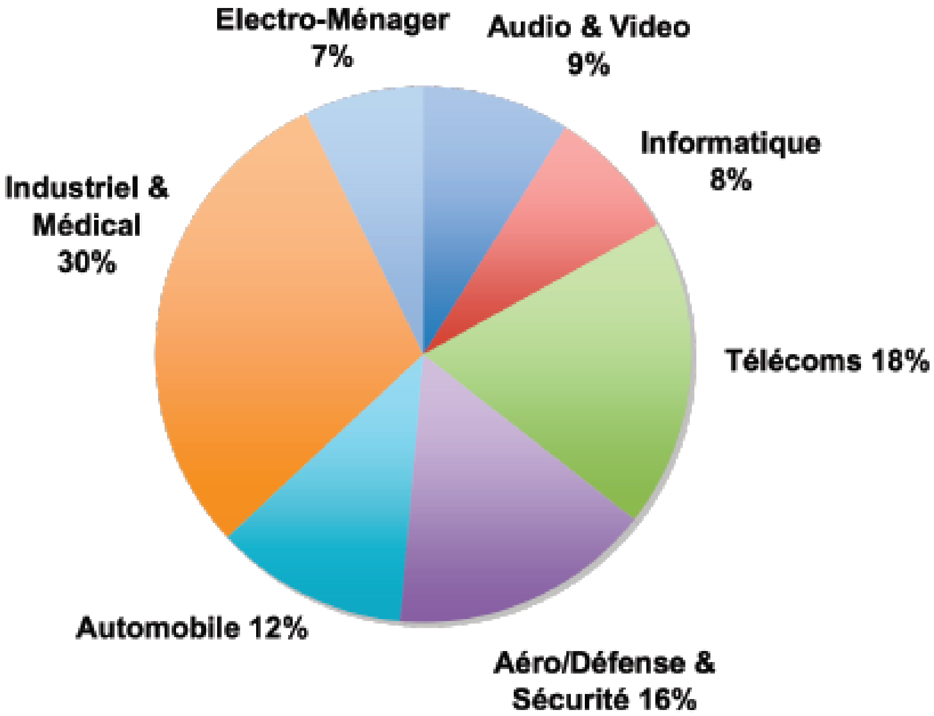
- **Address the entire supply chain, from material production to final assembly, through design and foundry:**
  - **Technology shall be ready for industrial applications (reproducibility, reliability,…);**
  - **Effort not limited to R&T (low TRL 2 ~4), development shall result in mature technology (TRL ~6).**

- **Competitiveness (both technical and economical)**
  - **A sustainable source is a source at market price, at market performance, with profitable operations (ref to some existing models).**
  - **Requires the right technical solutions**
  - **Requires usually access to a market larger than just space, or defence, or security (vertical model not a suitable one) (all grouped may not be enough) and export.**

- **Strategic control of the supply chain**
  - **A tool for maintaining business focus on strategic applications**
  - **Keeping for Europe the benefit of European investment**

Size of the electronic activity

Production d'équipements électroniques en Europe en valeur, 2009



Source DECISION, Mai 2010

Worldwide 2009 production = 1 100 B€

European 2009 production = 220 B€

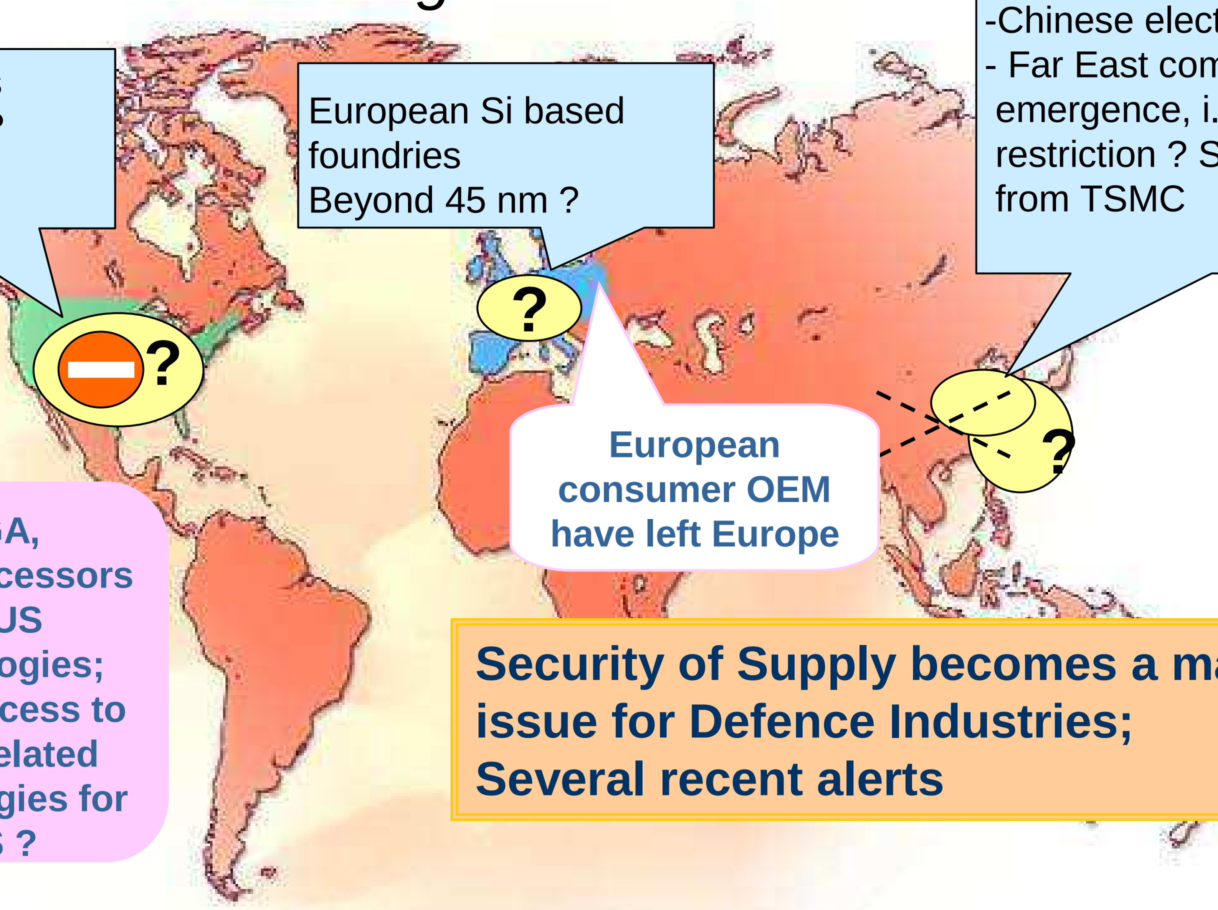
Part de l'Europe dans la production mondiale d'équipements électroniques en 2009

Secteur d'application	Part de la production mondiale
Industriel	**36%**
Aéro/Défense & Sécurité	**30%**
Automobile	**30%**
Médical	**24%**
Télécommunications	**18%**

Following the telecom crisis and the migration of its R&D and manufacturing in China, Europe specialises in electronics applications requiring safety, security and reliability compliant operation

Ex : Impact of globalisation on silicon electronic components

Today Silicon actors for Digital silicon



Tomorrow Silicon foundries accessible by ASD European Industries (pessimistic or realistic scenario ?)
Tomorrow European supply chain for industrial actors ?

U.S.A. National Nanotechnology Initiative
Actual 2009 Agency Investment per Program Component Area ($M)

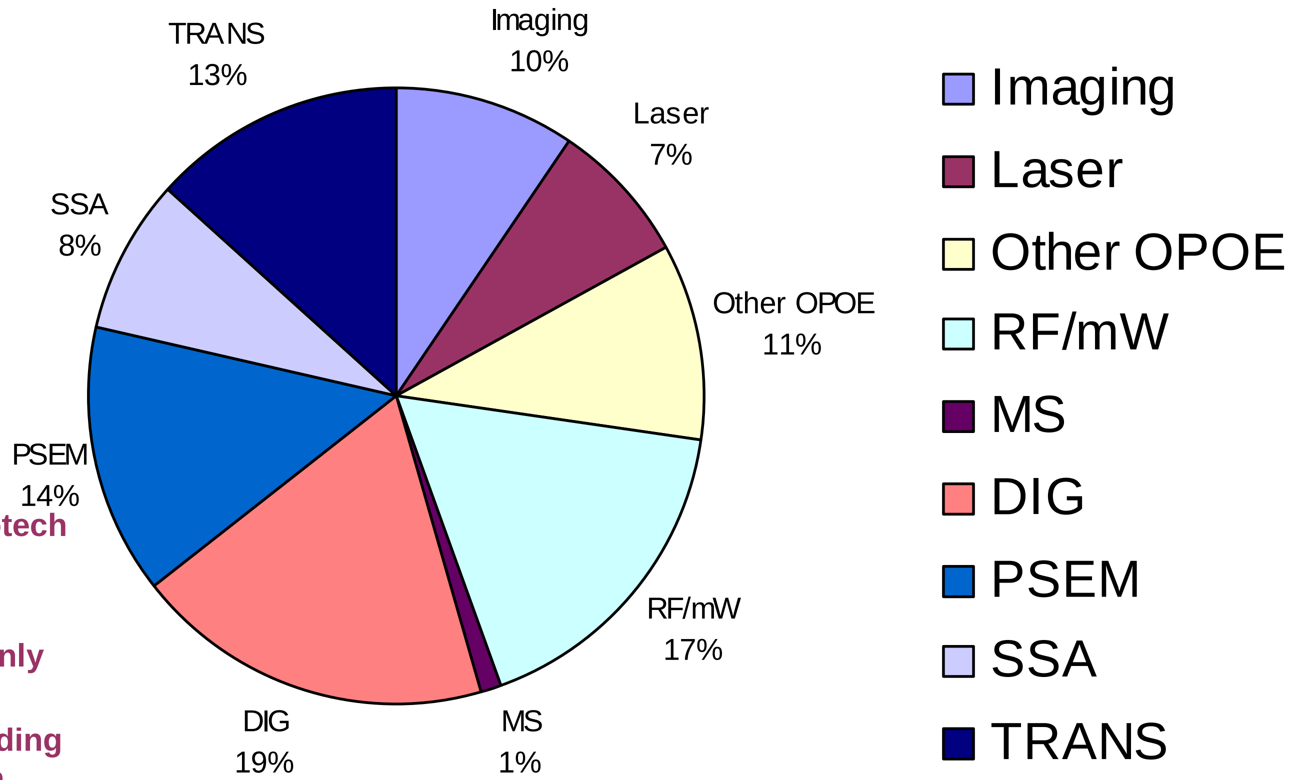
Who supports ?		1. Fundamental Phenomena & Processes	2. Nanomaterials	3. Nanoescale Devices & Systems	4. Instrument Research, Metrology & Standards	5. Nano-manufacturing	6. Major Research Facilities & Instr. Acquistion	7. Environmental, Health, and Safety	8. Education & Societal Dimensions	NNI Total
DOE	1	99.8	92.8	7.9	21.1	6.9	100.5	3.1	0.5	**332.6**
NSF	2	143.6	72.42	54	21.44	27.5	31.5	26.8	31.3	**408.56**
HHS/NIH	3	46.7	73.9	172.4	17.5	2.3	13.5	12.0	4.5	**342.8**
DOD	4	162.8	67.5	166.9	9	29	19.7	4.1	0	**459**
DOC/NIST	5	23.1	8.5	17.0	19.4	9.4	12.4	3.5	0.0	**93.4**
EPA	6	0.2	0.2	0.1	0	0	0	11.1	0	**11.6**
HHS/NIOSH	7	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	**6.7**
NASA	8	0	8.6	5.1	0	0	0	0	0	**13.7**
HHS/FDA	9	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0	**6.5**
DHS	0	0	3.7	5.3	0	0.1	0	0	0	**9.1**
USDA/NIFA	11	1.0	2.0	5.7	0.0	0.2	0.0	0.5	0.5	**9.9**
USDA/FS	12	2	1.4	0.7	1.1	0.2	0	0	0	**5.4**
CPSC	13	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	**0.2**
DOT/FHVA	14	0	0.9	0	0	0	0	0	0	**0.9**
DOJ	15	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	**1.2**
TOTAL		**479.2**	**331.92**	**435.18**	**90.82**	**75.55**	**177.56**	**74.5**	[illegible]	**$1,701M**

Source: Executive Office of the President of the United States
Presentation A.Wild ENIAC JU – Nanoforum Madrid 11/2010

US DoD Components related budget

US DoD IAP1 related RDE&T - programs and budget in 2008

Total 1B$



As reported during EDA Discotech study and SRA

Refer to

- **Non confidential programs only (black programs not listed)**
- **Related R&D programs including integration and validation with higher TRL are part of system capability /platform /equipment procurement programs : they are not included in the 1B$ USD effort**

735 M$ DARPA related to Components
328 M$ RL Air Force, Army and Navy

Source: EDA Captech IAP1 program – Discotech SRA

Technology needs for new computer developments at RUAG Space

15 March 2011

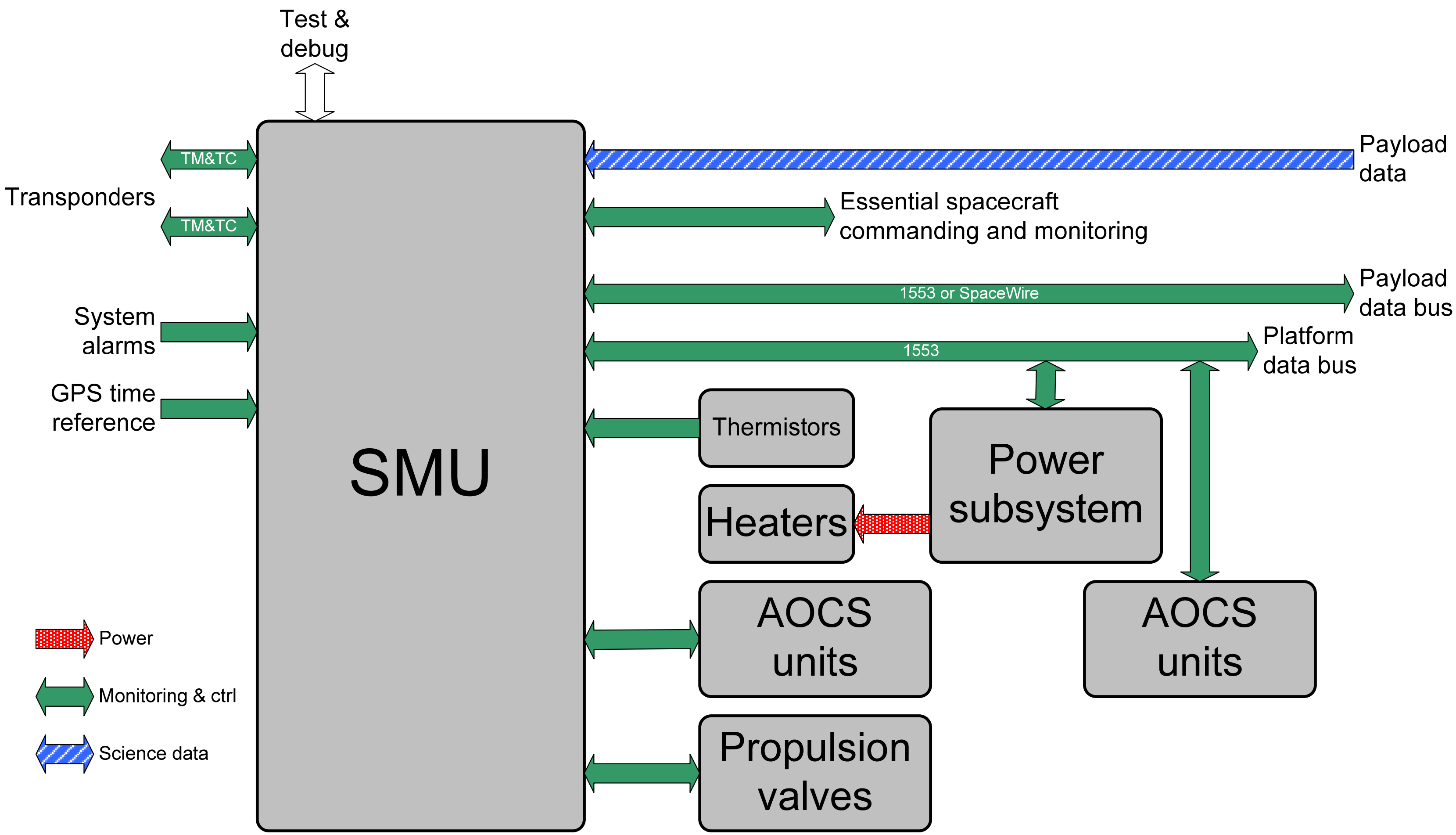
Torbjörn Hult

What is an SMU?

RUAG

- Spacecraft Management Unit (SMU) tasks
  - Ground protocol handler, Telecommand and Telemetry
  - Processing capability and application program interface
  - Timing and synchronisation management
  - Mass memory (platform memory or small science data memory)
  - Discrete I/O interfaces (standard I/O, AOCS, propulsion)
  - Fault Detection, Isolation and Recovery (FDIR) to supervise and manage the processing function

The SMU location in the spacecraft

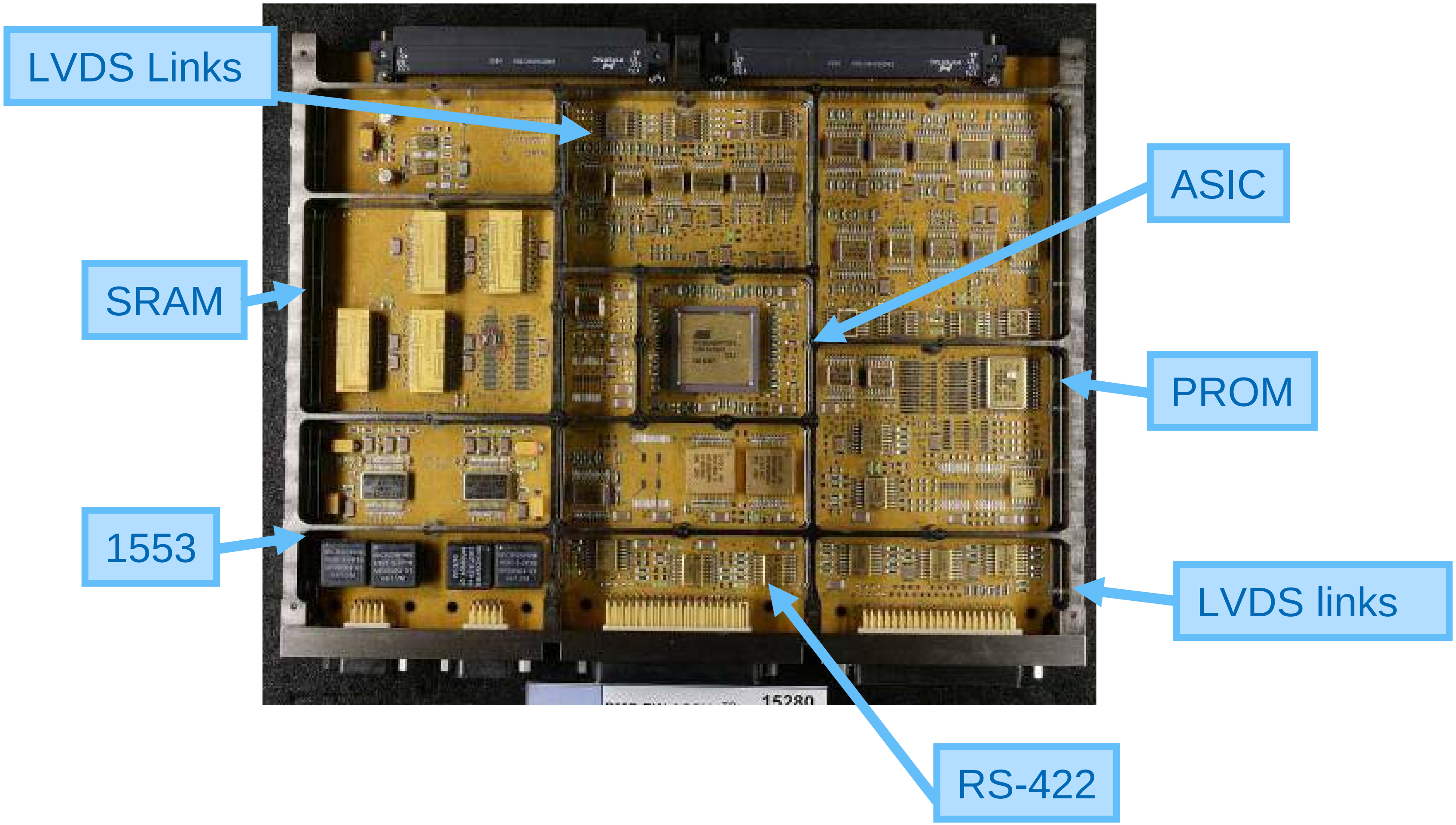


Computer technologies in use

RUAG

- Basic key technologies for current computer generation
  - Rad hard ASIC technology with 0.35 and 0.18 µ feature size
  - Mixed ASIC technology 0.35µ and larger
  - PROM, EEPROM, SRAM, SDRAM and Flash memories
  - Analog multiplexers
  - FET transistors of various sizes
  - XO, TCXO and sometimes OCXO
  - Interface circuits for RS-422, LVDS, 1553 and sometimes RS-485
  - Printed circuit boards with dual-sided mounting and up to 18 layers using buried via holes
  - HDD and MDM type external connectors

Typical processor board



Problem areas

RUAG

- For “discrete” ICs, packages from the 70-ies still used
  - 1 mm^2 chip becomes 200 mm^2 board area
- Rising vibration and shock requirements
- ECSS standardisation efforts not always reflected in available technology:
  - SpaceWire: No European LVDS supplier
  - Discrete I/F: No European RS-422 I/F supplier
  - CAN: Old RS-485 technology still used
  - 1553: European alternatives exist, but with problems

Problem areas cont'd

RUAG

- No European low cost ASIC capability
- No European PROM capability
- Paper administration when using "new" technology
- Non-standardised functionality prevents investments in new technology
- Short technology lifetime is not compatible with end customer needs for qualified products
- Is the space industry even losing its position as leaders in trailing edge technology ?

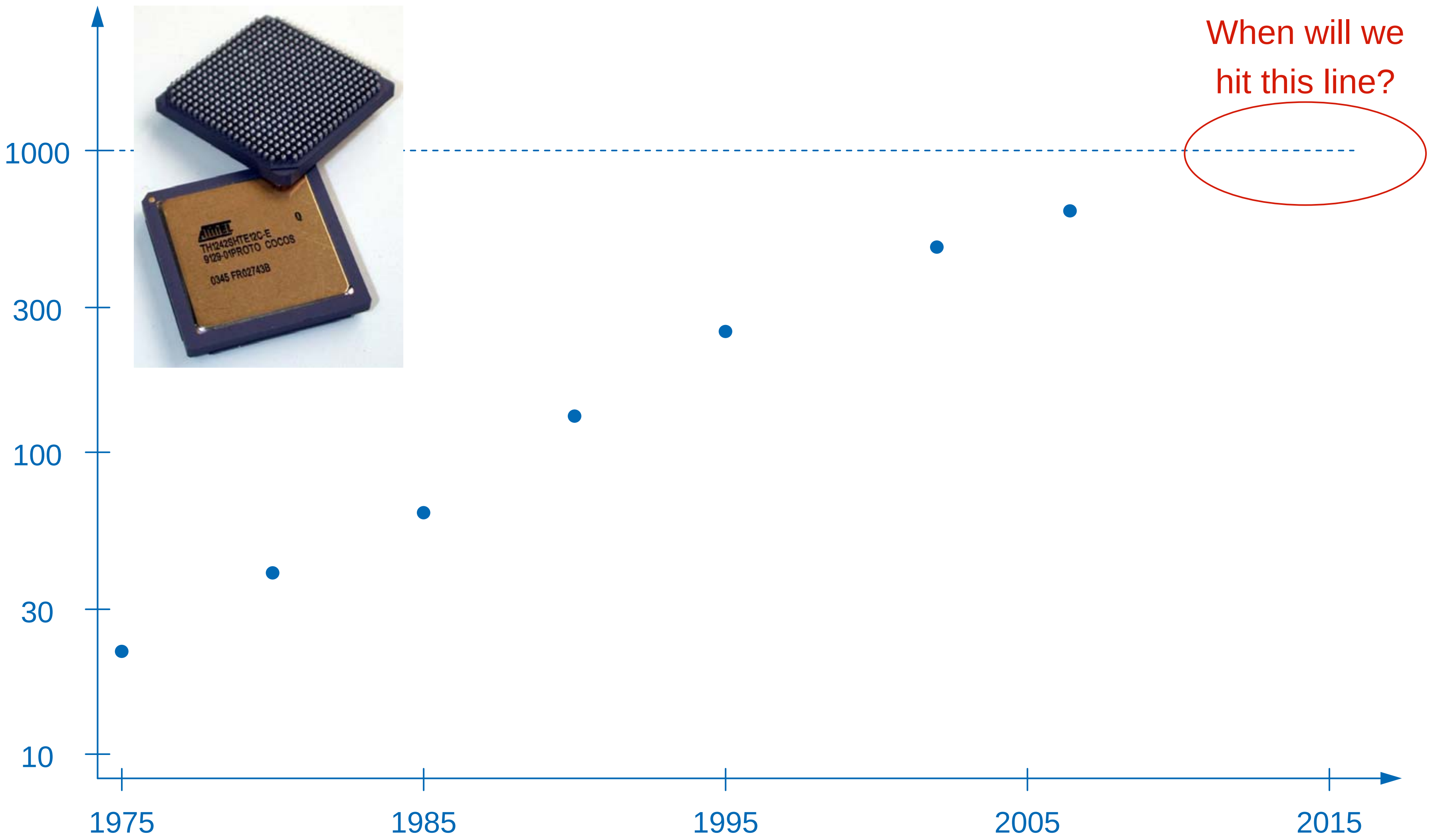
Current trends

RUAG

- Single source is becoming more common
- European supply of complex functions like ASICs and FPGAs is fading
- Commercial evolution towards lead-free processes affects parts availability and drives process development
- Or is this just extending the problem list ?

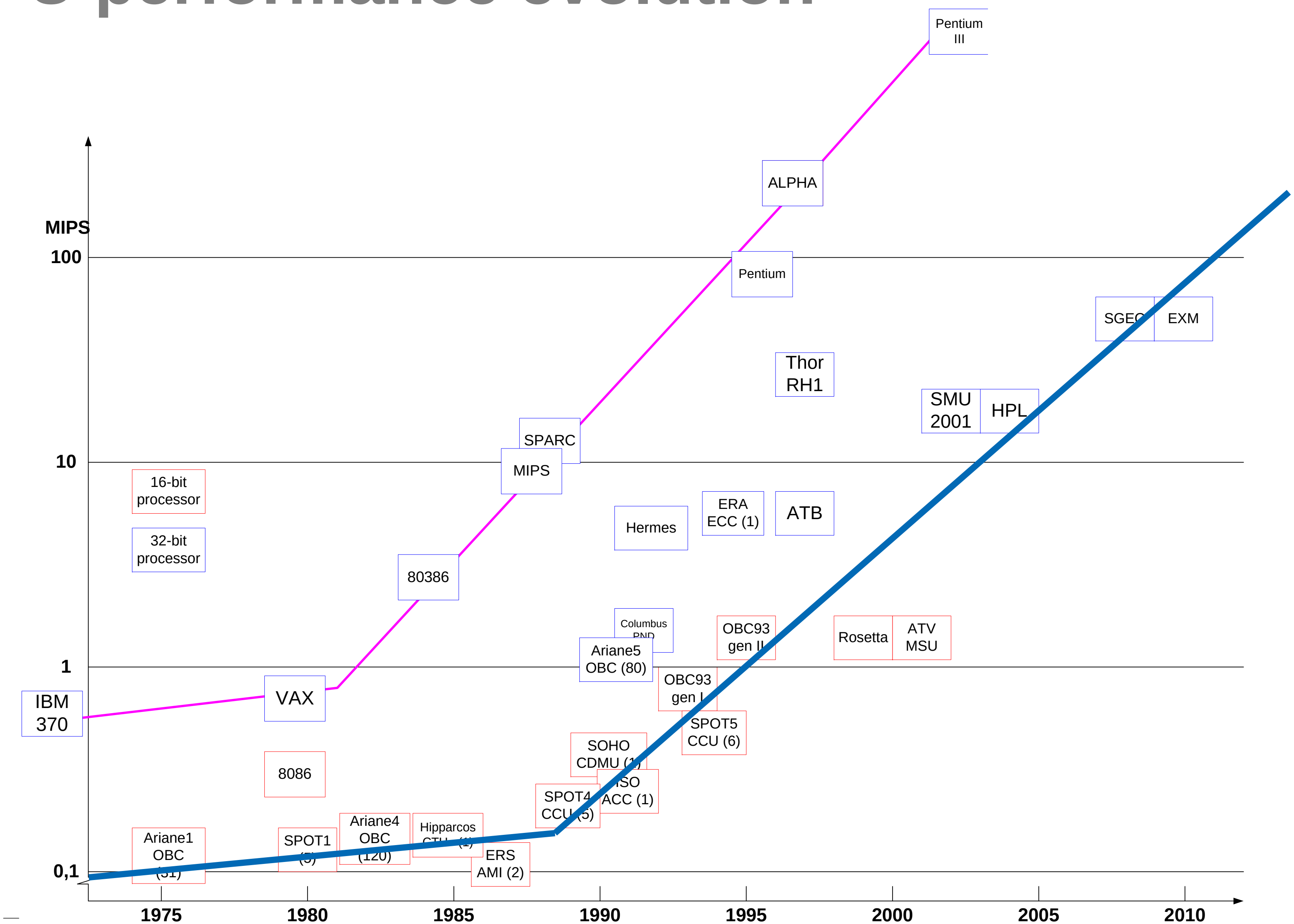
Package pin count evolution

RUAG



CPU performance evolution

RUAG



How to meet future challenges

RUAG

Requirements	**Developments**
☝ Lower mass and power	➢ More integrated ASICs ➢ Work with 3D stacking technology ➢ Work on methods to solve the repair problem
☝ Higher performance	➢ Prepare for multi-core CPU ➢ Fast communication link architectures
☝ Increased functionality	➢ More integrated ASICs ➢ Flexible IP blocks ➢ Support standardisation activities

Investments needed at design house level

- Solve the problem areas, e.g. reliable non-volatile storage
- Master new Deep Submicron technology
  - Design process
  - Fault models and reliability
- Master “rad-hard by design” techniques
- Master spin-in of commercial technology
  - Opportunistic process since we cannot influence the development
- Master more compact packaging

Thank you for your attention!

Component Technology Needs for AOCS / GNC Sensors

ESCCON 2011, Presented by S.P.Airey (TEC-ECC)
Stephen.airey@esa.int

Technology Needs For AOCS / GNC Sensors

Contents

Purpose and Scope

- Purpose
  - To highlight the key EEE component issues affecting AOCS hardware suppliers and development
  - To draw attention to the difficulties caused by EEE components
  - To hope to encourage more European space component development, qualification and long term supply security
  - To hope to encourage an increase in the number of parts on the EPPL
- Scope
  - Generalisations made across units and manufacturers
  - Presentation mainly from an industrial equipment providers point of view
  - Only common issues reported – not specific issues for 1 product (although examples are given)
  - Only main issues reported - numerous minor issues are not discussed
  - Only AOCS equipments are discussed
    - Mainly: STR, Gyro, IMU, Reaction wheels
    - Also: New miniature sensors, accelerometers, MTM

Technology Needs For AOCS / GNC Sensors

Introduction

- Background
  - EEE components are the key cost driver (typically 30 to 50% of the equipment price) and schedule driver for many AOCS equipments.
  - Rapidly changing ITAR rules and component obsolescence issues are the primary cause of NRE and re-design activities (after customer custom interface requests) and cause continuous investment need to maintain a product
  - The range of EEE components available as fully qualified products for space use is shrinking which limits equipment design.
  - Defending and justifying the use of EEE components not on the EPPL is now almost universal for every product and project and is expensive and time consuming.

Technology Needs For AOCS / GNC Sensors

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ITAR Issues

- Impacts
  - Reduced market potential
    - 30 - 40 % of European AOCS hardware sales need to be ITAR free. It is these sales that maintain the ability of European industry to be profitable. Without them we would certainly lose EU competence and capability. EU industry needs ITAR free parts to survive!
    - US components are all at risk of being made ITAR restricted (see Intersil)
    - Often major design impacts to remove ITAR parts due to no alternatives
  - Increased lead time and schedule risk
    - Delivery schedule risk is increased (especially when ITAR rules change): desired signature to delivery times for equipments are reducing though
    - Can get prolonged additional delays, especially for launches in India and Russia
  - Increase procurement cost and overhead.
    - Increase ITAR paperwork and schedule chasing adds further cost, typically between 4K and 6K Euro per part type!!
  - Less flexibility to move unit around (e.g. for testing)

Technology Needs For AOCS / GNC Sensors

Main ITAR parts concerns 1

- Mosfets (all equipments)
  - NMOSFET & PMOSFET (e.g. from International Rectifier)
  - Often no alternatives, EU versions (from STM) in development but still not available
- PROMs (mainly STR, navigation cameras and RDV sensors)
  - Typically Aeroflex or Intersil parts
  - 32K * 8bit, 3.3V most needed (STRs mainly)
  - Very small capacities also useful (<8k*8bit – cal parameter storage)
  - No alternatives (see UT28F256LVQLE or HS-6664RH as example)
- 1553 RT and Transceivers (STR, wheels and gyros)
  - E.g. alternative to Aeroflex 3.3V transceiver or DDC ‘all in one’ soln.
- DC-DC convertors (most AOCS equipments)
  - No European convertors suitable for small and low power applications (e.g. <5W, < 10*10*10cm units).

Technology Needs For AOCS / GNC Sensors

Main ITAR parts concerns 2

- Multiplexers
  - Multiplexers (8 input and 16 input, high-Z on power off)
    - Used in gyros and also many other equipments for HK TM capture
    - e.g. Intersil HS1840
- FPGA (many equipments)
  - No alternatives for US high performance/ high gate count components from Actel
    - Difficulties with Atmel MH1RT ASICs make this more acute
    - See later slides

Technology Needs For AOCS / GNC Sensors

Examples of issues with ITAR

- Example 1:
  - During MAIT (between procurement and delivery of the component) a 1553 transceiver became ITAR restricted resulting in 4 month delay and >200KEuro additional costs to adapt the design for a different part.
- Example 2:
  - Between PDR and CDR of an equipment, the TEC (Thermo-Electric Cooler) and 1553 RT became ITAR restricted. These issues resulted in the need for a new custom ASIC and were the major contributor to a 2 year delay.

Technology Needs For AOCS / GNC Sensors

Obsolescence, Single Source, Qualification and Long Lead Issues

- Commercial electronics developments moving at ever increasing rates and diverging away from typical space procurement and testing requirements. At the same time the commercial world market volume is huge and consolidations in the component manufacturing industry leads to fewer suppliers.
- Commercial component life cycles are very short whereas space development for the equipments using them can be very long (typically >5 years) and product life even longer >15years
  - → Perceived little interest from manufacturers in space
  - → Higher and faster rates of obsolescence, fewer options, fewer suppliers
- Obsolescence and excessive (often unexpected) long lead times lead to constant redesign and NRE
- Move to mixed signal ASICs is also bringing lower availability for relatively simple parts (e.g. multiplexers, DACs etc)

Technology Needs For AOCS / GNC Sensors

Obsolescence: the key concerns

- There are a number of key common concerns regarding Obsolescence and single source or obsolescence risk. They are almost universal amongst all AOCS hardware:
  - MH1RT ASIC technology from Atmel (major issue for STR & Gyros)
    - 0.35um no longer supported
    - Increasing cost, lead time and yield issues at Atmel
    - Alternatives currently have high batch qualification costs
  - EEPROM (& PROM) (e.g. 58C1001)
    - Single source for dies
    - Old die, virtually single source, probably not available much longer (RENESAS)
    - Some equipments only need very small EEPROM (a few kbits! 4K *8bit), others need a large EEPROM (512K *16bit)
    - (Note Atmel provide an EEPROM 1Mb (AT28C010 - 4Mb in development) for FPGA support but long term availability is currentl too uncertain).
  - Sample and holds
    - Commercial and military use fallen dramatically
    - Availability difficult and package sizes are large
    - NSC and Intersil seem to be living off stock wafers and are US

Technology Needs For AOCS / GNC Sensors

Obsolesence: Example

- One manufacturer asked to supply same equipment for two spacecraft, the first in 2001 and the second in 2006. Five key parts went obsolete in this intervening period including FPGA, Buffers, SRAM, ADC and an OpAmp. The impact resulted in VHDL code change, significant circuit and PCB layout changes and all associated re-verification, re-analyses and re-qualification leading to a 1 year additional delay and had a major cost impact.

Technology Needs For AOCS / GNC Sensors

Long Lead Issues: The key concern

- A number of components and component types suffer from excessive lead times. The dominating component that seem to continually cause problems with respect to this and for all units are diodes:
    - Power Diodes (e.g. IN5811, 6626, 5822…)
    - Zener Diodes (Mostly in 5 to 10V range but also up to 70V, e.g. IN5622, 4622)
    - Small Signal Diodes (e.g. IN6642)
    - Microsemi are most used, IR are more expensive, still US and some are ITAR.
- Examples:
    - Microsemi diodes, quoted lead time 48 weeks but regularly taking up to 68 weeks to deliver!
        - This is incompatible with most delivery schedules for equipments.

Technology Needs For AOCS / GNC Sensors

Component developments needed for future equipment development and competitivity.

- Component developments are needed in the future for:
  - Miniaturisation
    - Package types etc
  - Increased functionality and flexibility
    - Microcontrollers, FPGAs, IP cores
  - Improved performance
    - ADCs
    - DACs
    - Active Pixel Sensors
    - RAM

Technology Needs For AOCS / GNC Sensors

Component developments needed for future equipment development and competitivity: Miniaturisation

- Qualification of small SMD passives packages (e.g. 0603 and 0402 format capacitors and resistors)
    - Needed for miniaturisation
- SMD packaged crystals and/or cheaper SMD oscillators (especially 10, 20, 48 and 80MHz, 3.3V)
    - Current components have typically have very large footprint (and often through hole pin style – especially crystals)
    - Current oscillators can be very expensive (up to 2KEuro/piece)
    - These are especially needed for miniaturised and lower cost units

Technology Needs For AOCS / GNC Sensors

Component developments needed for future equipment development and competitivity: Increased functionality

- European ITAR free rad hard FPGAs
  - Needed for future STR, navigation camera, RDV/Docking sensors
  - Real alternatives for RTAX2000, RTAX4000
  - Requirements:
    - Integrated rad hard RAM (the more the better!)
    - 250K to >500K gates
    - > Qualified associated IP core library (DSP, Processor, PLL, 1553 RT etc)
    - Rad hardness similar to rad hard ASICs (Hard flip flops, harden clock trees, etc.)
    - Antifuse preferred (even though new dev plans are all SRAM-based)
- RAM
  - Obsolescence risk due to rapidly moving commercial market
  - Compatibility issues (timing) with respect to space qualified FPGAs for DRAM
  - Component footprint vs memory size far too big
  - Need >=512K * 32bit and 16bit, 20ns access time, low upset rate, single chip
  - Examples: UT9Q512E, AT60142H/HT

Technology Needs For AOCS / GNC Sensors

Component developments needed for future equipment development and competitivity: Increased functionality

- Space qualified Microcontrollers
  - Useful for increasing functionality in small reaction wheels and enabling cost effective miniaturisation of gyros, IMUs and MTMs
  - Example potential requirements:
    - Core requirements (TBC):
      - 16bit micro controller, 8-16MIPS, Integrated RAM (256kbyte), Integrated NVM (16kbyte)
      - Integrated serial data bus drivers – preferably RS-422, CAN and SpW
      - EDAC, Watchdog
      - Low Power
    - Optional peripherals
      - Integrated ADC + DAC, 12 bit 96ksps
      - Clock generators, POR, PWM
      - Optional 1553 RT

Technology Needs For AOCS / GNC Sensors

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Component developments needed for future equipment development and competitivity: Increased performances

- ADCs
  - Needed mainly for IMUs and gyros, must be ITAR free
  - Requirements:
    - 12 bit, 16bit and 18bit versions
    - 10 – 20 Msps, low power, <1LSB INL
    - Also IP core versions would be useful for some applications
- DACs
  - No EU options for 16bit (and higher) resolution
- Active Pixel Sensors
  - Currently world leaders but technology moving fast due to consumer market
  - Need to have best sensors in world to maintain STR, Navigation camera and RDV sensor market.
  - Stable, dependable long term supply guarantees

Technology Needs For AOCS / GNC Sensors

Contributors

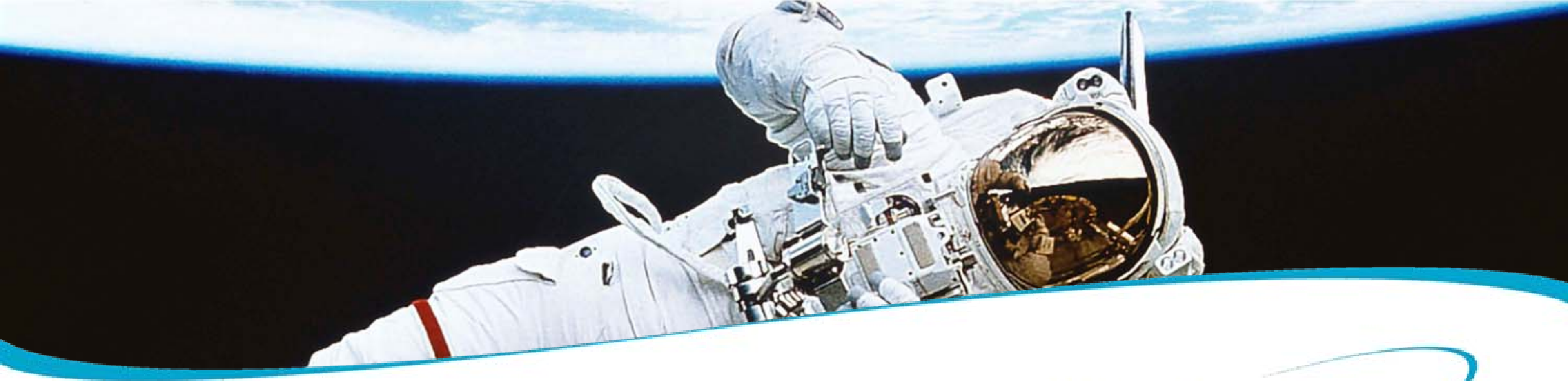
- Thanks to the following companies for providing inputs to this presentation regarding their EEE parts difficulties:
  - Jena Optronic (STR)
  - EADS Sodern (STR, ES)
  - EADS Astrium (Gyro, CMG)
  - Rockwell Collins (RW)
  - SEA (Gyro, accelerometers + electronic units)
  - Selex Galileo (STR, ES, Miniaturised units)
  - Terma (STR)
  - ESA TEC-EXX and TEC-QXX (various people)

Technology Needs For AOCS / GNC Sensors

Final Thought

- Component issues can sometimes be solved by system design/ specification changes – not just new components
  - E.g. Issues with 1553 EEE components could be solved by using other interfaces
  - E.g. Issues with DC-DC convertors (and some mosfets and diodes) could be solved or eased with different power supply architectures.
  - E.g. Issues with radiation hard RAM may be solved with larger amounts of softer RAM

- These system solutions may not always be practical or attractive but system engineers need to consider parts issues when designing and writing specifications.



The way to future power management

Michel Mélotte

Objective:

Discuss trends in components fields for future space power system

- Evolution for the next 5 years . . .

Remarks:

- Power supply are ubiquitous . . .
- Power supply are very often “mission critical”
- Power supply are considered like a “constraint”

Looking to industrial business can be a source of inspiration

- This field is bourgeoning with innovative solutions
  - improve performances and costs

Lets try to imagine the future power supply . . .
. . . But do not forget the constraints

The main space constraints

Mechanical constraints

- Vibrations and shocks during launch
- Weight constraint on structure

Thermal constraints

- We are in the vacuum of space . . . No air for cooling

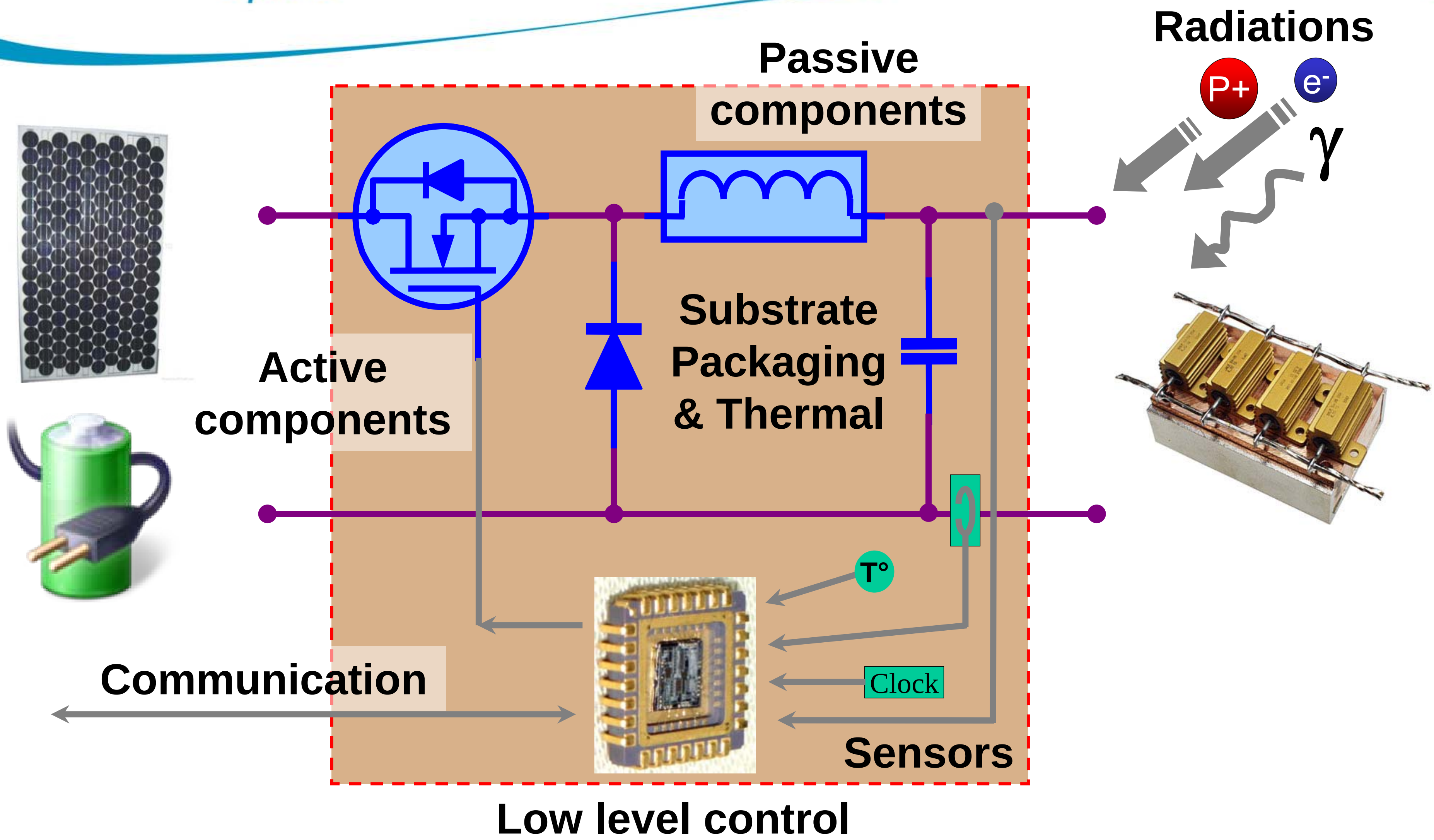
Reliability constraints

- 15 to 18 years of mission life time – High availability
- No maintenance possible . . . No failure accepted (at system level)
- Reliability and failure mechanisms must be under control

Ionising radiations constraints

- Degradation of physical and electrical parameters
- Corruption of data inside electronic systems - ! Availability impact !
- Use of hardened components is mandatory

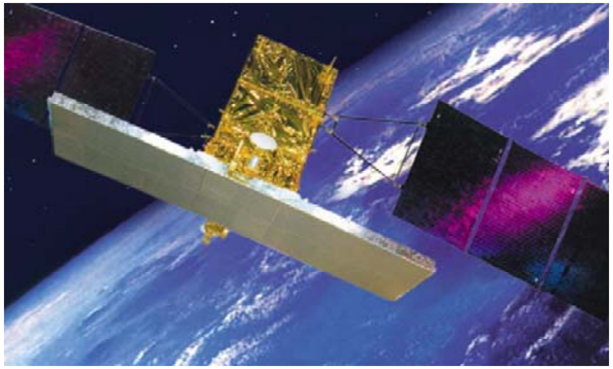
Basic components



Today, Si based power MOSFET are the unquestionable leader

Looking to industrial market the new device developments are oriented toward WBG (Wide Band Gap)

- Especially GaN for power electronics
  - Push by the electrical vehicle business
  - Push by supply for server business
  - Push by renewable energies
  - Why not by space business ?



Why GaN ?

- Baliga Factor of Merit
  - BFOM = $\varepsilon \mu E_c^3$

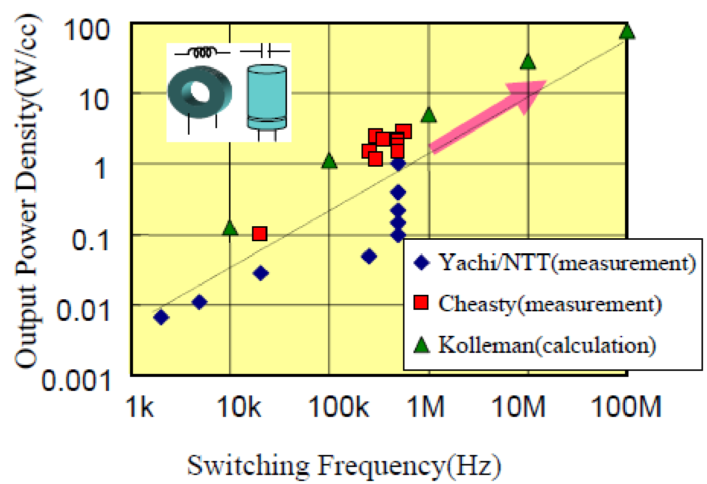
Material	E_g (eV)	ε_s	μ_n (cm²/Vs)	E_c (MV/cm)	v_{sat} (10^7 cm/s)	n_i (cm⁻³)	BFOM*
Si	1.12	11.8	1350	0.3	1.0	1.5×10^{10}	1
GaAs	1.42	13.1	8500	0.4	2.0	1.8×10^{6}	17
4H-SiC	3.26	10	720	2.0	2.0	8.2×10^{-9}	134
6H-SiC	2.86	9.7	370	2.4	2.0	2.4×10^{-5}	115
2H-GaN	3.44	9.5	900	3.0	2.5	1.0×10^{-10}	537

E_g, bandgap; ε_s, dielectric constant; μ_n, electron mobility; E_c, critical electric field; v_{sat}, saturation velocity; n_i, intrinsic carrier density.
*BM=$\varepsilon \mu E_c^3$, BFOM was normalized by the BM of Si.

Electrical Properties of Wide Bandgap Semiconductors Compared With Si and GaAs

GaN advantages

- Expected improvement 3 to 4 orders of magnitude for Ron.S
- Breakdown voltage BV about 10 times higher
- Robustness (overdrive and radiation)
- GaN Unipolar devices (HEMT)
  with high voltage and
  high frequency operation (x10 vs. Si)
  - Higher Efficiency
  - Compacter modules
  - Lighter modules



Ref : ESCCON 2011.
Date : 15 March 2011.

ESCCON 2011 15 March

https://escies.org

Challenges

- Normally-off devices
  - Needed for correct failure mode management
- High reliability
  - New devices
- Modelling and design
  - New topologies ? !
- Thermal Management and packaging
  - Use of flip-chip ? !
- GaN on Si substrate (for low cost)
  - Not really needed for space ! ?
- Other components “GaN Ready”
  - See here after . . .

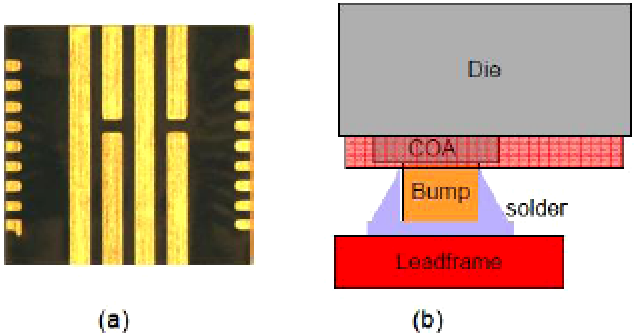


Fig. 10. (a) bottom view of QFN-style package showing board connections. (b) cross-section through plated bump.

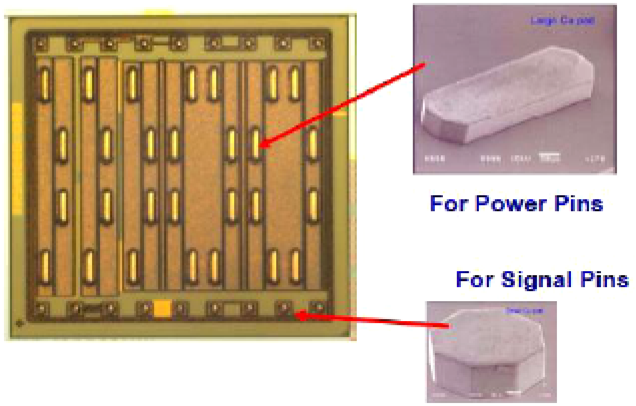


Fig. 11. (left) top view of die. (right) SEM views of plated bump connections.

GaN devices already exist . . . (not exhaustive)

- USA:
  - International Rectifier (AlGaN/GaN HFETs on Si)
  - EPC (Efficient Power Conversion corp.) (AlGaN/GaN HFETs on Si)
  - . . .
- Japan:
  - Sanken Electric co, (20mΩ, 750V, high power, AlGaN/GaN HFETs on Si)
  - Furukawa Electric co, (GaN power transistor, on Si, on Sapphire)
  - Toyota Central R&D Labs inc. (vertical structures with p-type GaN)
  - Sharp (AlGaN/GaN recessed MISgate HFET for power)
  - Panasonic (AlGaN/GaN HFETs on Sapphire)
  - Toshiba (AlGaN/GaN HFETs on SiC or Sapphire)
  - . . .

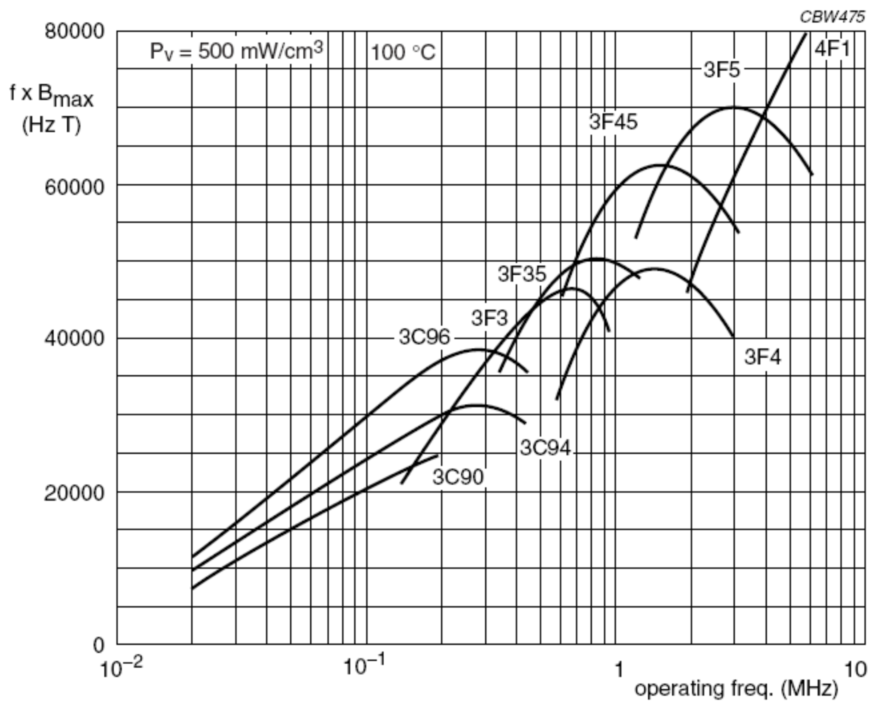
GaN devices already exist . . . (not exhaustive)

- Europe:
  - IMEC (Interuniversity Micro Electronics Center, Leuven)
    - AlGaN/GaN/AlGaN double hetero struct HFET on Si substrate
  - Ferdinand BRAUN Institute (Berlin) & TESAT Spacecom (Backnang)
    - p-type GaN gate in AlGaN/GaN/AlGaN structure
  - Fraunhoffer Institute (Freiburg)
    - AlGaN/GaN HEMT Id 50A BV 600V (power, only normally on!)
  - LAAS/ CNRS-CRHEA (projet MOreGaN)
  - Alcatel-Lucent - Leti - Thales III-V lab
    - Work today on RF normally_on GaN
  - . . .

- Remark: Today, main activities are done in laboratories.
  We have to look for an industrial supply chain ! ! !

Switching at higher frequency require new ferrite materials

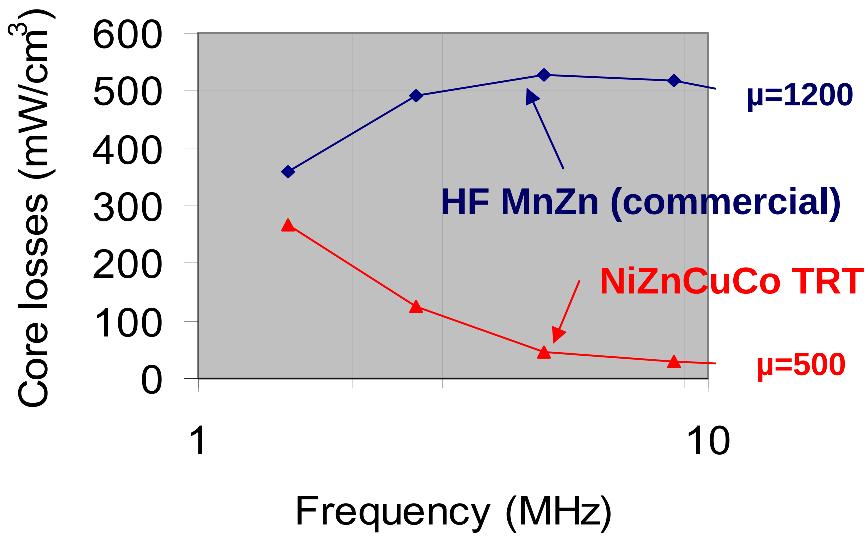
- Merit factor: $f \times B_{max}$
  - Frequency x maximum magnetic flux density
- B.f product of different magnetic materials assuming a maximum value of 500 mW/cm^3 for core losses (source Ferroxcube)



Low core losses at high frequency

- New material developed by TRT
  - NiZnCuCo
  - Can be co-sintered . . .
  - Thales Research & Technology

Measured at 37.5 MHz.mT



Ferrite	permeability	Core losses at 3 MHz – 12.5 mT
3F4	900	> 300 mW/cm^3
3F45	900	≈ 235 mW/cm^3
3F5	650	> 200 mW/cm^3
4F1	80	< 300 mW/cm^3
TRT ferrites	80 to 500	< 100 mW/cm^3

Best power ferrites at high frequency = NiZnCuCo ferrites

Look out : do not forget skin effect in winding !

High frequency capacitor exist

- Ad hoc dielectric materials are known and used for RF components (like NPO)

But . . .

- Range of values is limited to 100 pF . . . 100 nF
  - Large size => parasitic inductance
- Look out for power losses induced by high current

Solutions

- Use of HF capacitor only in the “converter loop”
- Use of capacitor assemblies
  - With various dielectric materials
  - For wide bandwidth

Drawback

- Cost !

Industrial converter goes to the digital world . . .

. . . Why not the for space applications ?

- A high-growth domain for the past five years on ground
  - 45% growth predicted by 2013 (Darnell – Feb. 2009)

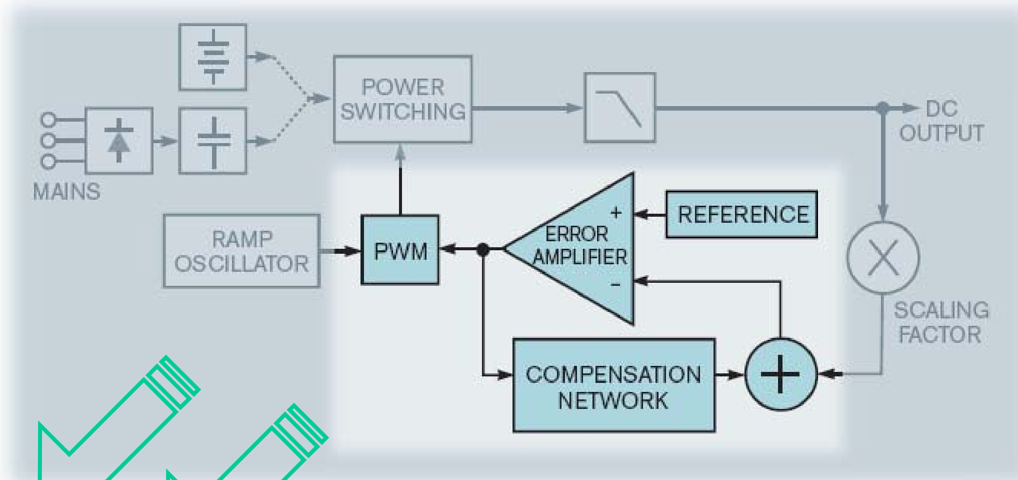
Objectives of the controller:

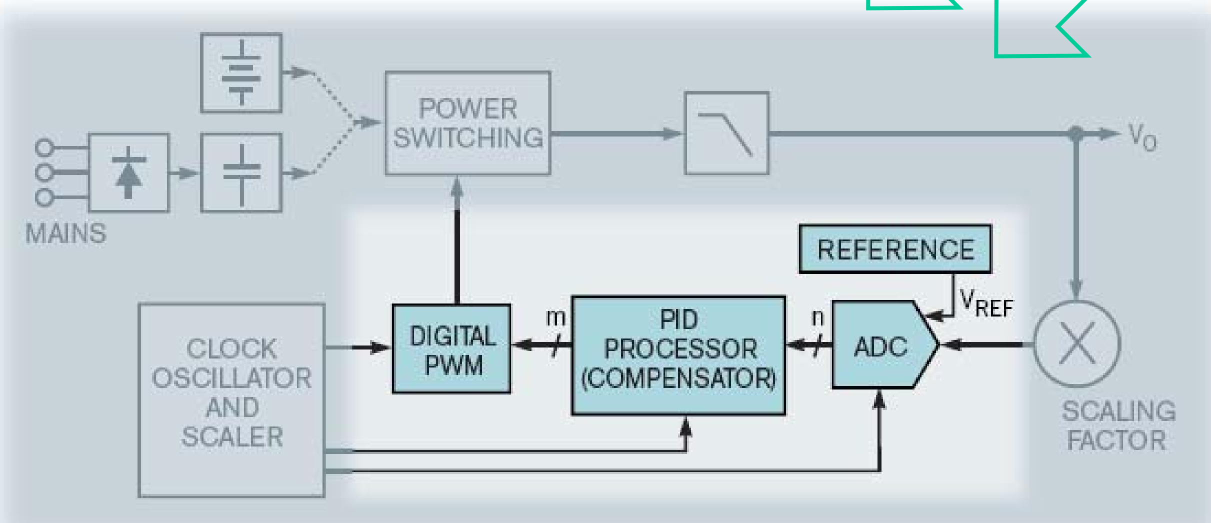
- Management of power devices via digital rather than analogue techniques
- Brings about flexibility and cost reductions

But space constraints must be taken into account . . .

- Radiations
- Reliability and availability

An analog SMPS control loop compares a scaled sample of the output voltage with a fixed reference and controls the PWM timing to force the two quantities to match.





A digital SMPS control loop replaces the error amplifier with an ADC. The digital PWM requires a high-speed clock to provide the necessary edge-timing resolution.

A BIT OF POWER digitally controlled power conversion
JULY 21, 2005 | **EDN** 59-66
BY JOSHUA ISRAELSOHN • TECHNICAL EDITOR

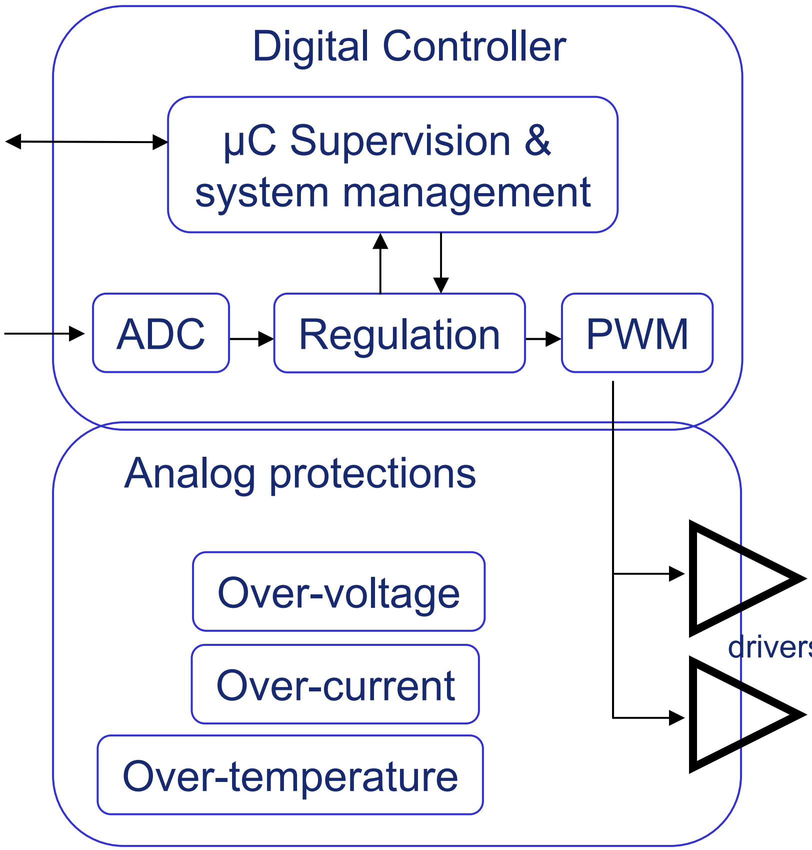
As it is done today on ground digital controllers, around basic regulation we can easily add:

- Non-linear regulation (fast transient suppression)
- Temperature drifts compensation
- Double regulation on either side of a galvanic barrier
- Complex loop filter with high rejection
- Inrush current limitation
- Alarms & protections: under-voltage, over-voltage, over-current, …
- Multiple outputs with voltage sequencing
- Low output voltage (synchronous rectifier)
- Power-up, power-down control
- Estimate output current without current sensor
- Complex topologies (e.g. resonant converters)

Thank to the flexibility of digital solution

Controller component features => Mixed-mode IC

- Non-volatile memory
- High speed ADC with differential inputs
- DAC
- PLL
- Glue logic
- Serial data communication module
- Digital fast regulation engine
- Digital PWM generator
- Supervision & system management µC
- Timers, watchdog
- Debug functions
- Low pin count



For distributed Power supply : POL

- Key technologies for supplying digital IC (FPGA, mass memory, . . .)
- Good efficiency in small volume and small weight
- More details see ref. 1

POL are already available in IC form

- Linear Technology, intersil
- And some modules

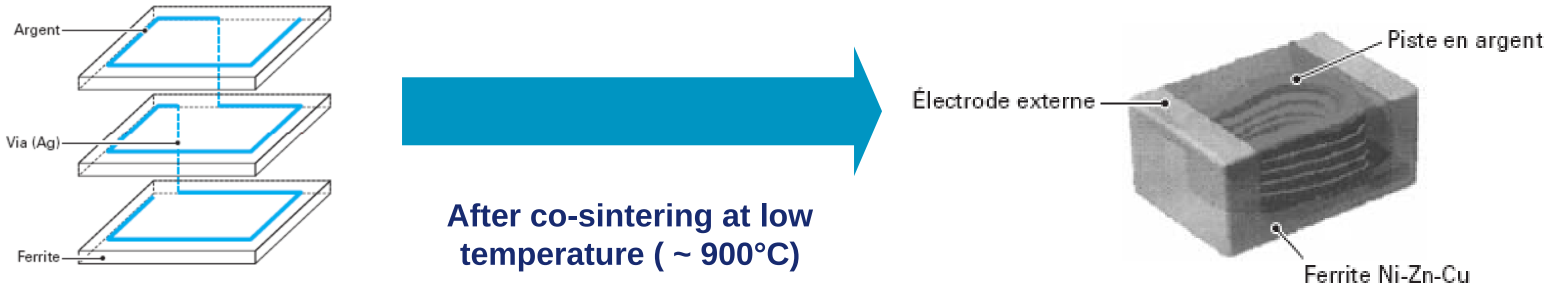
No failure management are included . . .

. . . How can we improve the integration

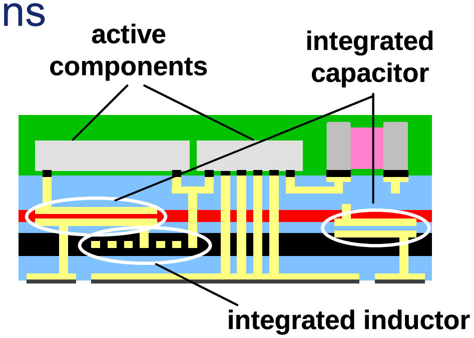
Ref 1: Points of Load Converters and distributed power architecture approach - ESA Technology Innovation Day(s) , Feb 18th, 2010 - F. Tonicello – M. Triggianese - TEC-EPC, ESA-ESTE

Point Of Load future integration . . .

- As frequency increase, the volume of passive components decrease
- Use of the multilayer LTCC technology for magnetic components
  - Low Temperature Co-fired Ceramics



- Objective: co-sintering together different materials for developing complex substrates including both inductive and capacitive functions
- Co-sintering of:
  - magnetic materials (ferrite NiZnCuCo)
  - dielectric materials
  - conductive paths



We expect a bourgeoning field also in space business

- GaN, ferrites, capacitors and controllers
- All these progress will improve performances and/or cost

As power supply are often “mission critical”

- Innovative solutions must be introduced carefully
- They need costly, lengthy developments and qualifications
- Some improvements imply a “cultural revolution” in system design and industrial practices

We hope that component manufacturers will follow these trends

- A good supply chain is key for the business

To push improvement, we must dream !

- Thank you to have followed me during these few minutes

Thank you for your attention

ESCCON 2011

ROUND TABLE

Towards a Sustainable Supply of EEE Parts for European Space Systems

ESCCON 2011

Ambition

- We want this Roundtable to be a complement for the presentations made during the day, allowing for a more informal exchange on some key issues that will drive sustainability in the future.
- We have a great panel, composed by well known authorities in their domains, representing both the manufactures and users

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Members

- Georges BERNEDE , EUMETSAT
- Massimo COMPARINI, TAS
- Thierry GOUVERNEL, E2V
- Amar GUENNOUN, ATMEL
- Emmanuel LANCE, EUTELSAT
- Pascal LE BOHEC, PEREGRINE
- Michel LE MOINE, ASTRIUM
- Mikko NIKULAINEN, ESA
- Dominique VIGNOLO, VISHAY

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Format

1. Moderator will field a question and prompt one or two members to give a first answer
2. Other members may add their point of view
3. Depending on time, the Audience could also intervene with one or two statements
4. Total duration for one topic should be between 10 and 15 min.

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1st Question

- The EEE components industry continues its relentless and enormous growth driven by terrestrial applications in all major industrial sectors – mobile computing, telecom, automotive, consumer, …
- **A consequence of this is an acceleration of technology and product obsolescence which in turn leads to an increasing number of single source situations producing a critical dependence on these suppliers,**
- **what are the options for the Space Sector?**

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2nd Question

- The past 20 years have seen a clear trend away from mostly dedicated ‘spatial’ front- and back-ends towards a model with dedicated back-ends only.
- **Do you believe that, twenty years from now, this will still be the dominant model?**
- **Is it inevitable that the space component market will follow the trend of using fables suppliers at least for complex digital products based on very advanced processes ?**

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3rd Question

- The public-private investment in space programmes is changing with the emergence of larger privately funded initiatives both at the customer and system, equipment and components provider segments.
- **How does this new dynamic affect the space market and what are the best responses to the new opportunities?**

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4th Question

- Regulatory constraints, mainly Export Control, have been strong contributors to the current shape of the Space Components Supply Chain resulting in heavy investment worldwide to multiply sources**.**
- **Do you believe this situation is sustainable long term?,**
- **Will the market regulate itself ?**

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5th Question

- Space ambitions of particular nations in the emerging markets are widely known. In order to meet its ambitions in front of Regulatory constraints, these countries need to be autonomous for most of their component needs.
- **Do you see this likely future availability of emerging market components as an opportunity to improve the competitiveness of European Space Hardware manufacturers ?**

6th Question

- The ‘Space Technological Gap’, i.e.: the gap between the introduction of a new technology in non-Space applications and its qualification for Space use keeps widening.
- There are many reasons for this: lack of suitable supply chain, high cost for qualification, apprehension of operators…..,
- **is this trend sustainable long term?,**
- **do we really need the ‘latest’ Technology ?**

7th Question

- The business today is driven by our customers requirements (how do to) with more and more limited budgets.
- The space industry has now a long experience and heritage on space systems, equipments and components. Most issues today are not directly linked to given or not given requirements.
- Therefore, it would be tempting to let the industry again to define the level of requirements to be implemented in line with the performance requirements of our customers.
- **Faster-better-cheaper second try ?**

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Questions for Round table participants :

1. The EEE components industry continues its relentless and enormous growth driven by terrestrial applications in all major industrial sectors – mobile computing, telecom, automotive, consumer, industrial… A consequence of this is an acceleration of technology and product obsolescence which in turn leads to an increasing number of single source situations producing a critical dependence on these suppliers, what are the options for the Space Sector? (Vignolo, Le Moine)

2. The past 20 years have seen a clear trend away from mostly dedicated 'spatial' front- and back-ends towards a model with dedicated back-ends only. Do you believe that, twenty years from now, this will still be the dominant model?, Is it inevitable that the space component market will follow the trend of using fables suppliers at least for complex digital products based on very advanced processes ? (Gouvernel, Guennoun)

3. The public-private investment in space programmes is changing with the emergence of larger privately funded initiatives both at the customer and system, equipment and components provider segments. How does this new dynamic affect the space market and what are the best responses to the new opportunities? (Lance, Comparini)

4. Regulatory constraints, mainly Export Control, have been strong contributors to the current shape of the Space Components Supply Chain resulting in heavy investment worldwide to multiply sources. Do you believe this situation is sustainable long term?, Will the market regulate itself? (Nikulainen, Le Bohec)

5. Space ambitions of particular nations in the emerging markets are widely known. In order to meet its ambitions in front of Regulatory constraints, these countries need to be autonomous for most of their component needs. Do you see this likely future availability of emerging market components as an opportunity to improve the competitiveness of European Space Hardware manufacturers? (Comparini, Le Bohec)

6. The 'Space Technological Gap', i.e.: the gap between the introduction of a new technology in non-Space applications and its

qualification for Space use keeps widening. There are many reasons for this: lack of suitable supply chain, high cost for qualification, apprehension of operators….., is this trend sustainable long term?, do we really need the 'latest' Technology? (Guennoun, Lance)

7. The business today is driven by our customers requirements (how do to) with more and more limited budgets. The space industry has now a long experience and heritage on space systems, equipments and components. Most issues today are not directly linked to given or not given requirements. Therefore, it would be tempting to let the industry again to define the level of requirements to be implemented in line with the performance requirements of our customers. Faster-better-cheaper second try? (Bernede, Le Moine)

Round Table Format:

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