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enablingMNT
micro nano technology

MNT Roadmaps

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-- enablingMNT Group --

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www.enablingMNT.com

NEXUS

International Technology Roadmap for Semiconductors (ITRS), updated annually

www.itrs.net

Table 4: Packaging Challenges through 2007

Difficult Challenges (Through 2007)	Summary of Issues
Improved organic substrates	Tg (Glass Transition Temp.) compatible with lead-free solder processing
	Increased wireability at low cost, substrates are a barrier to flip chip adoption
	Improved impedance control and lower dielectric lo… frequency applications
	Improved planarity and low warpage at higher proce…
	Low moisture absorption
	Low-cost embedded passives
Improved underfills for flip chip on organic substrates	Improve flow, fast dispense/cure, better interface ad… absorption
	Higher operating range for automotive and Pb free s… dispense underfills
	Improved adhesion, small filler size, and improved f… underfills
Coordinated design tools & simulators to address chip, package, and substrate co-design	Chip, package, and system level co-design tools
	Educational programs required to train engineers in …
	Faster analysis tools for integrated thermal mechanic…
	Higher accuracy, faster electrical simulation capabil… design
Impact of Cu/low κ (dielectric constant) on packaging	Direct wirebond and bump to Cu (Copper)
	Bump & underfill technology to assure low κ dielect…
	Improved Mechanical strength of dielectrics
	Interfacial adhesion
Pb (lead), Sb (antimony), and Halogen free packaging material	Lower cost materials and processes to meet new req… higher reflow temperatures.
Difficult Challenges (Bevond 2007)	
Package cost which may greatly exceed die cost	Reliability under thermal cycling (stress and moisture)
	Research investments required for packaging cost reduction are decreasing
Small, high pad count	Array I/O pitches below 80 microns

Table 93a Single-chip Packaging Technology Requirements—Near-term

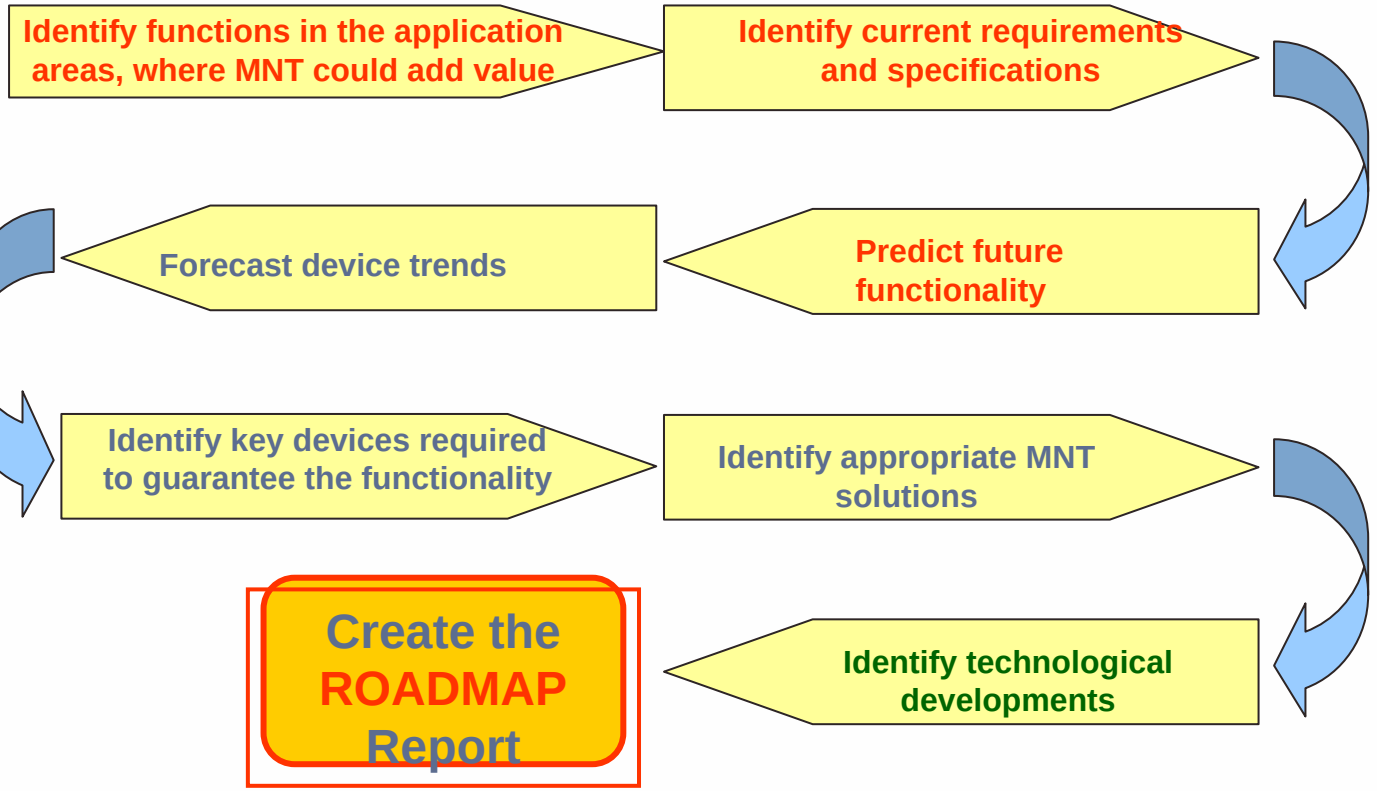
	Chip Size (mm²) [3]						
	Low-cost	100	100	100	100	100	100	100
	Cost-performance	140	140	140	140	140	140	140
	High-performance	310	310	310	310	310	310	310
	Harsh	100	100	100	100	100	100	100
	Maximum Power (Watts/mm²) [4]						
	Low-cost (Watts) [1]	2.5	2.7	2.8	3	3	3	3
	Cost-performance	0.57	0.6	0.65	0.7	0.74	0.79	0.83
	High-performance	0.48	0.51	0.54	0.58	0.61	0.64	0.64
	Harsh	0.14	0.16	0.16	0.18	0.18	0.2	0.2
	Core Voltage (Volts)						
	Low-cost	1.2	1.2	1	0.9	0.9	0.8	0.8
	Cost-performance	1.2	1.2	1	0.9	0.9	0.8	0.8
	High-performance	1.2	1.2	1	0.9	0.9	0.8	0.8
	Harsh	2.5	2.5	1.2	1.2	1.2	1.2	1.2
	Package Pincount Maximum [3][6]						
	Low-cost	112–408	122–500	134–550	144–600	160–660	180–720	180–800
	Cost-performance	600–1462	500–1600	560–1760	560–1936	800–2140	800–2400	880–2800
	High-performa…							
	Harsh							

HIGH-LEVEL CHALLENGES AND RELATED ISSUES

TECHNOLOGY DEVELOPMENTS NEEDED TO ADDRESS THESE CHALLENGES

NEXUS

Methodology of the NEXUS Roadmap



Source: NEXUS Association, 2000, 2003

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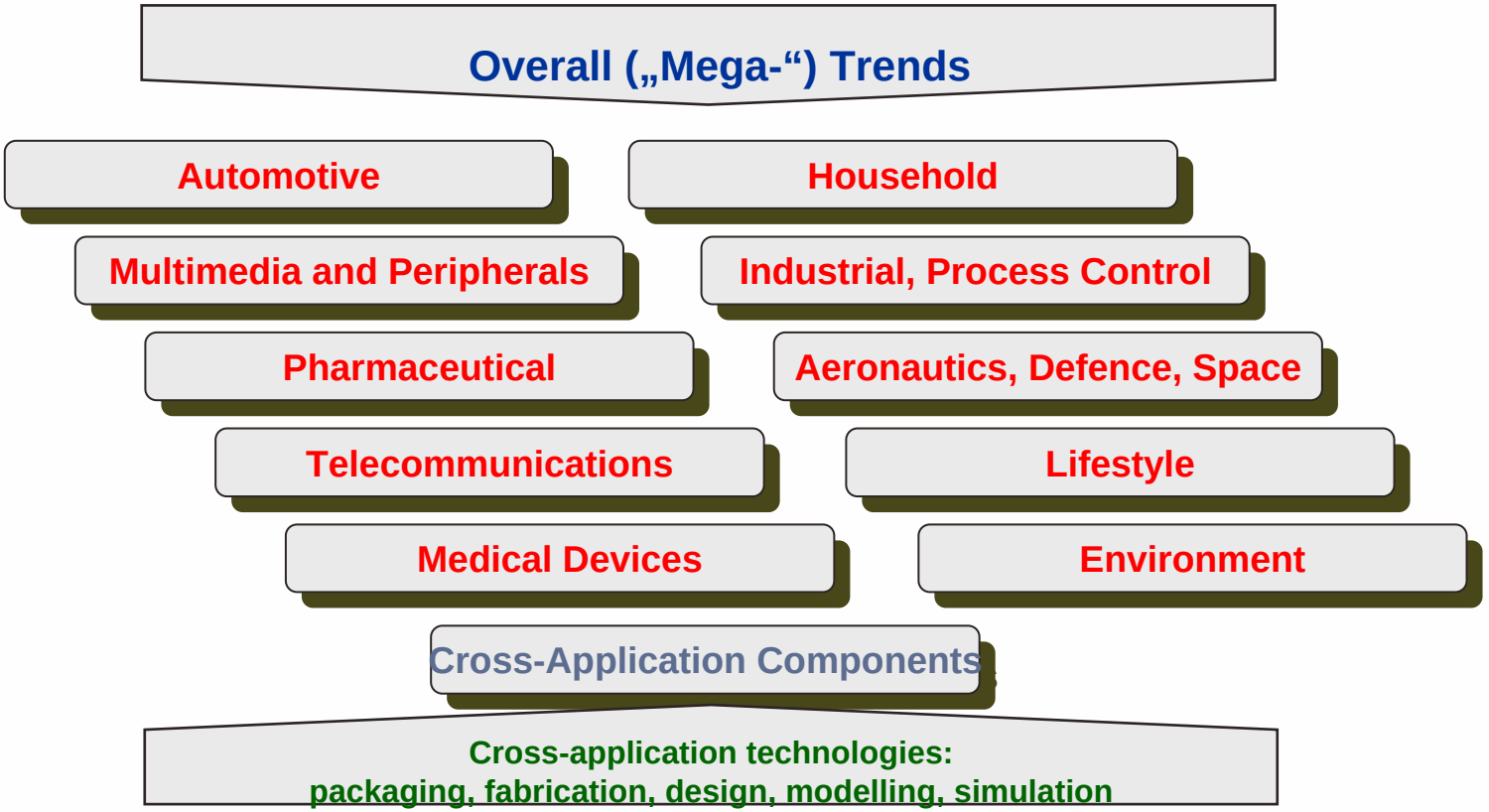
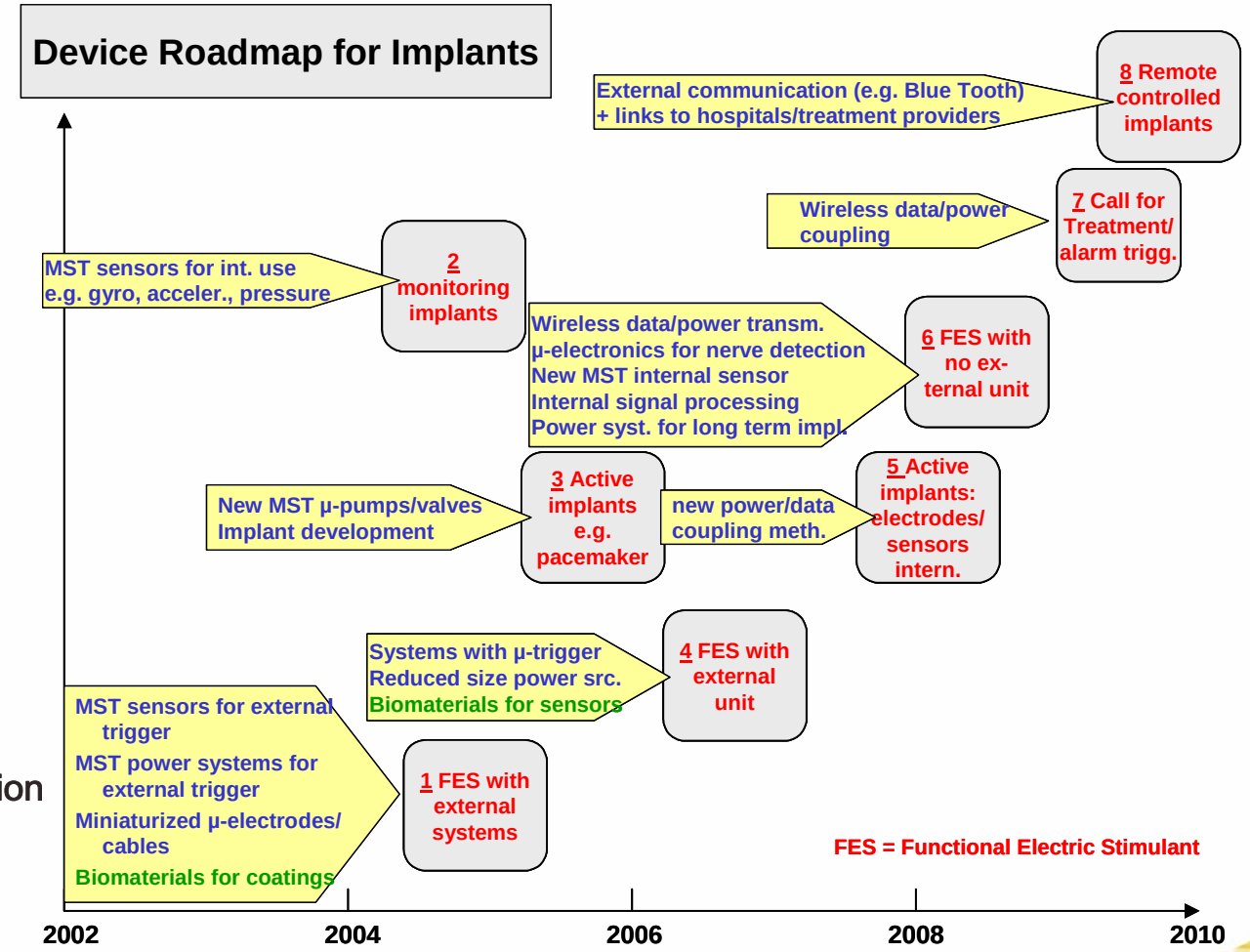
NEXUS Roadmap: Application Domains



Source: NEXUS Association, 2003

NEXUS Roadmap: Medical Applications



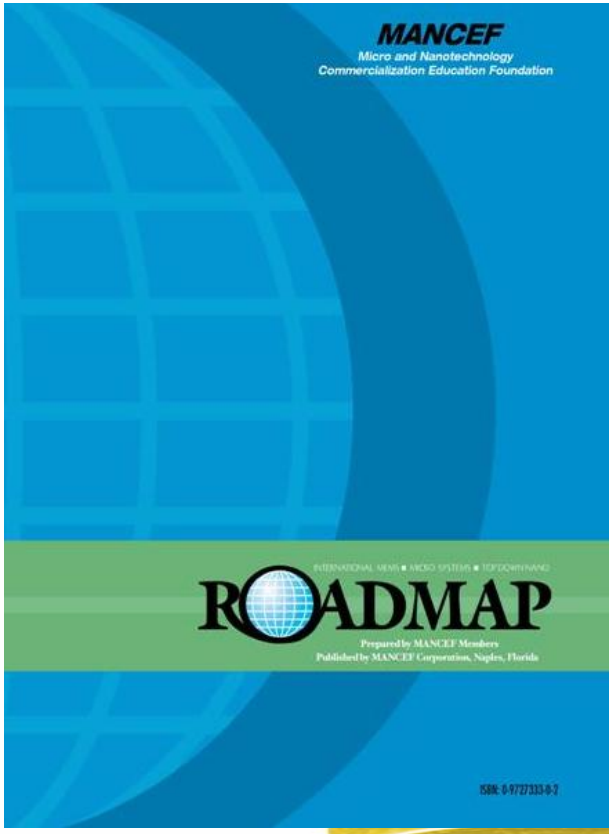
Source:

NEXUS Association

2003

MANCEF International Micro-Nano Roadmap 2nd Edition, 2004

MANCEF
www.mancef.org



Contents

Source: Mancef, 2002, 2004

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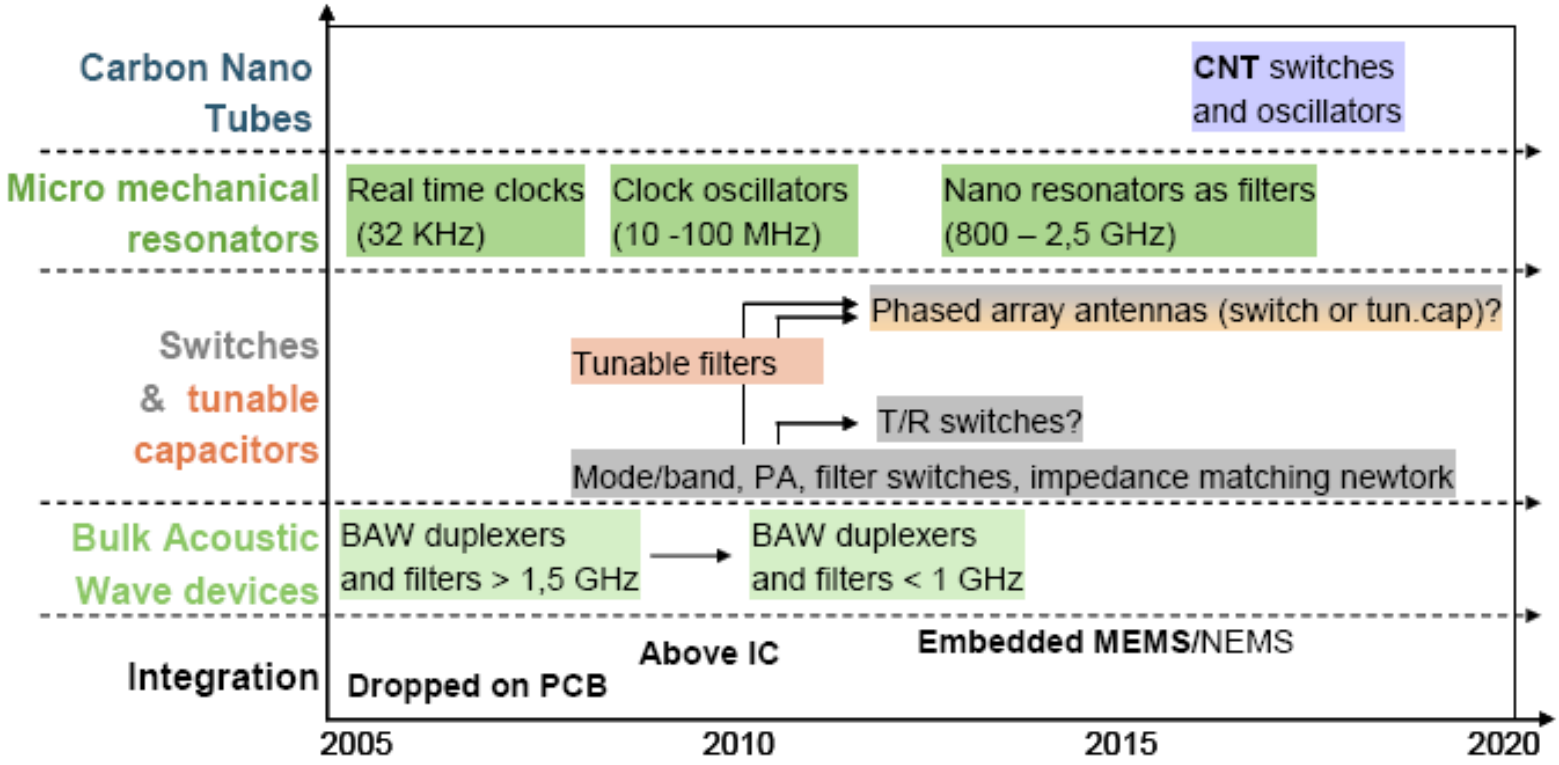
MIMOSA Integrated Project: Ambient Intelligence Roadmap



Roadmap of micro-nano HW technology for communication in Ambient Intelligence

www.mimosa-fp6.com

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ARRRO - Applied Research Roadmaps for RF MEMS Opportunities: Roadmapping process

- Define where we want to go
  - Define a list of **key capabilities:** technical parameters relevant to assess the impact of the technology for each application.
  - Define objectives in 5 to 15 years with regard to key capabilities
- Define where we are today
  - Quantifying performance / key capabilities today of RF MEMS as well as competing technologies
  - Identify limits of technologies, options for improvements
- Define how to get there
  - Define scenarios for evolution of the technology
  - Create single graphs roadmappings/ key capability
  - Create scenarios for overall roadmap

Extensive discussion with lead users

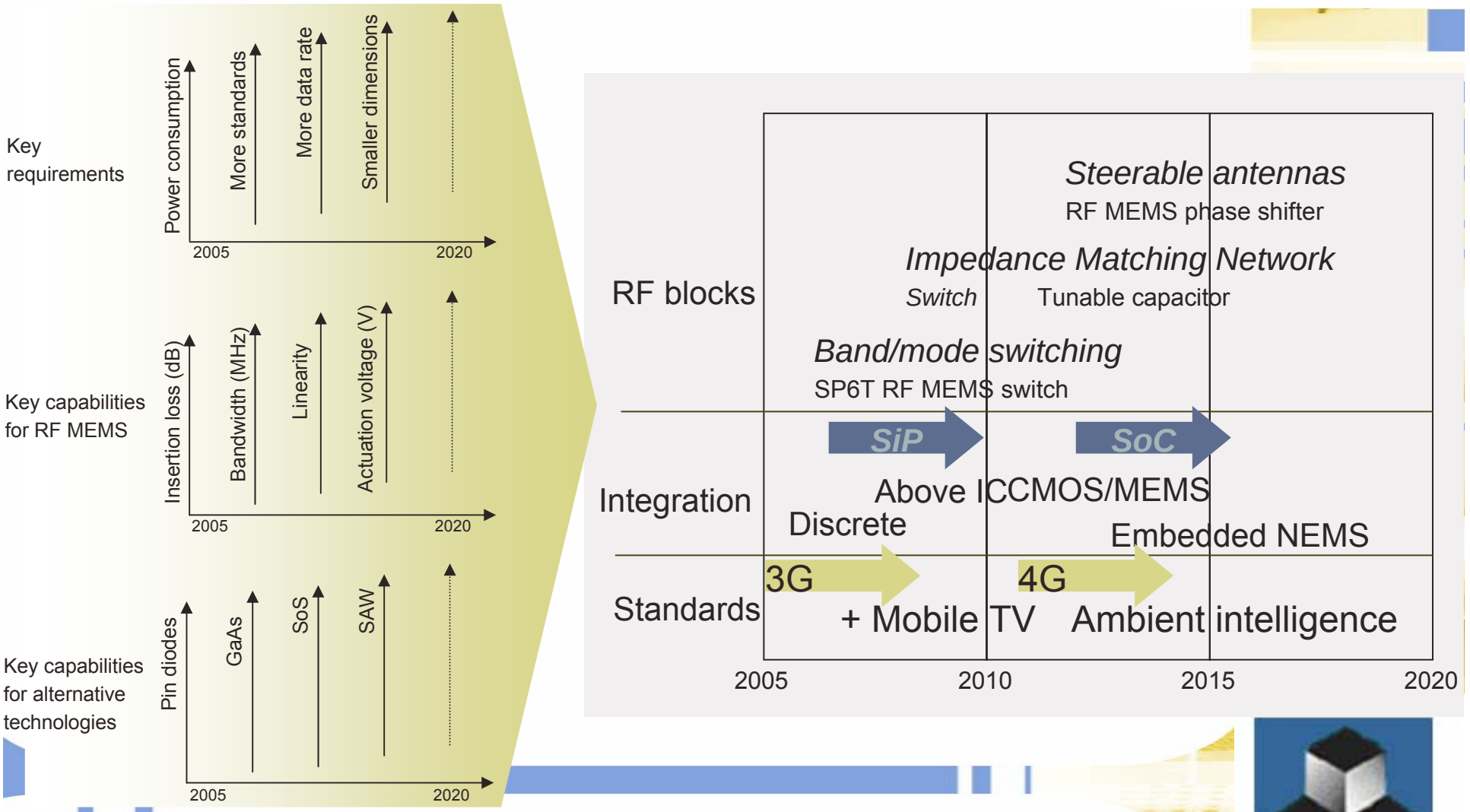
Desk research & interviews with leading R&D groups *(academic and industrial R&D)*

Brainstorming, definition of scenarios

Validation of scenarios with lead users and R&D groups *(iterative process)*

ARRRO - example: mobile handsets

ARRRO RF MEMS ROADMAP



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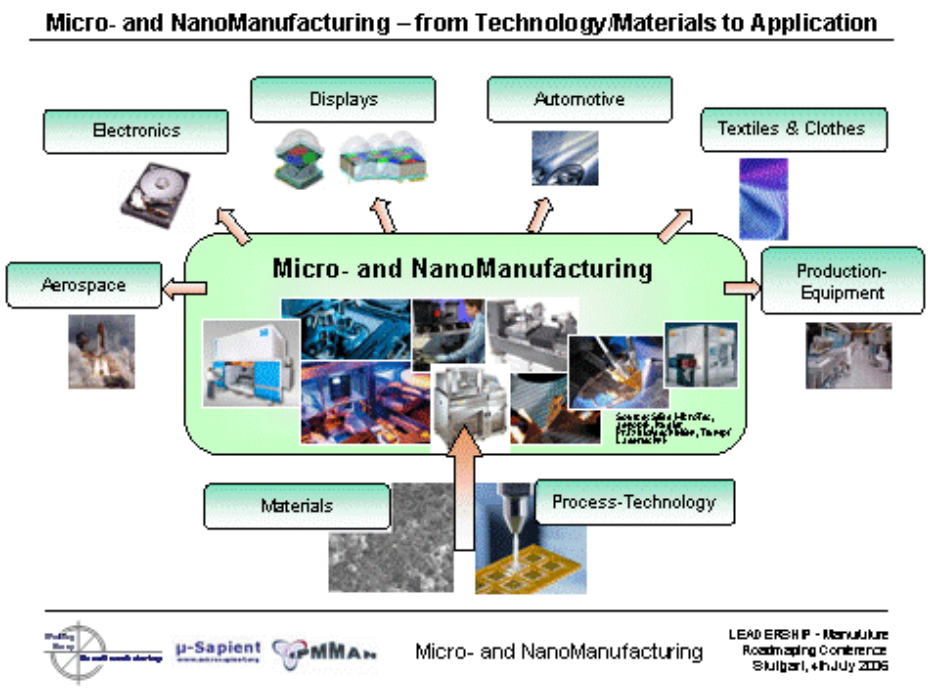
EC Working Group on NanoManufacturing

Working Group NanoManufacturing

"Vision and Strategic Research Agenda" of NanoManufacturing forum

- Strategy paper January 2006
- 1st Questionnaire and first evaluation Meeting January 2006
- Expert groups: 49 experts and 6 coordinators
- Draft for 1st Input 7th framework → EC



Members of the working group

- 200 Persons (mailing list / member list)
- 80 companies and research institutes
- networks and projects are involved
- about 40 participants in each meeting

www.nanomanufacturing.eu

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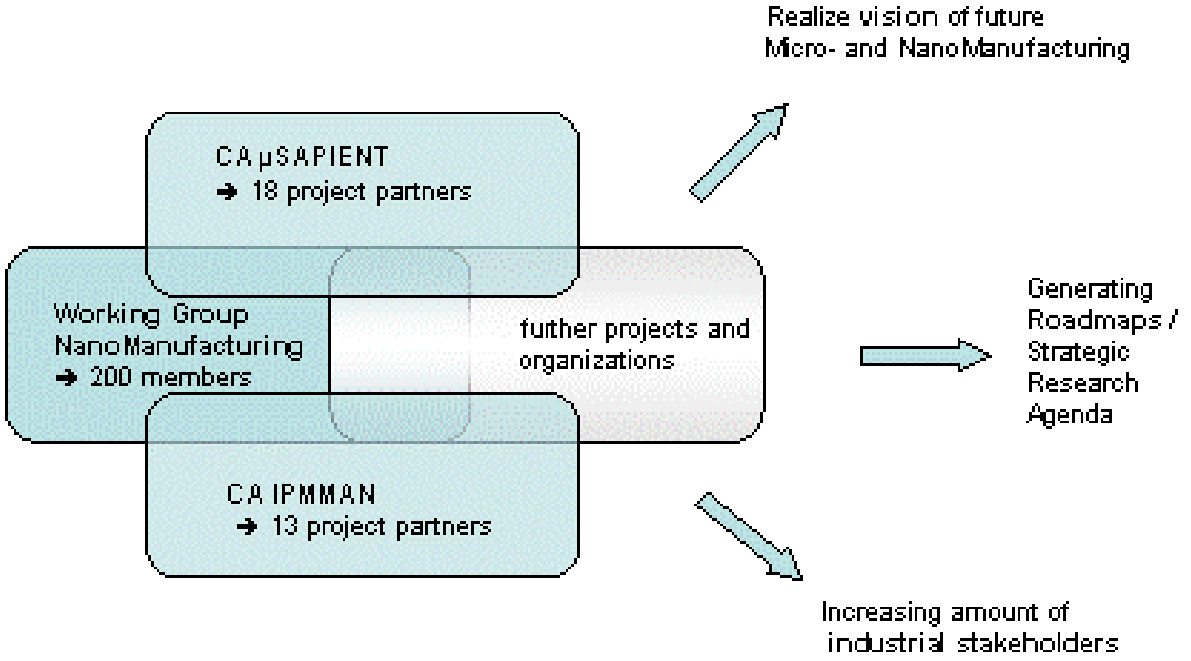
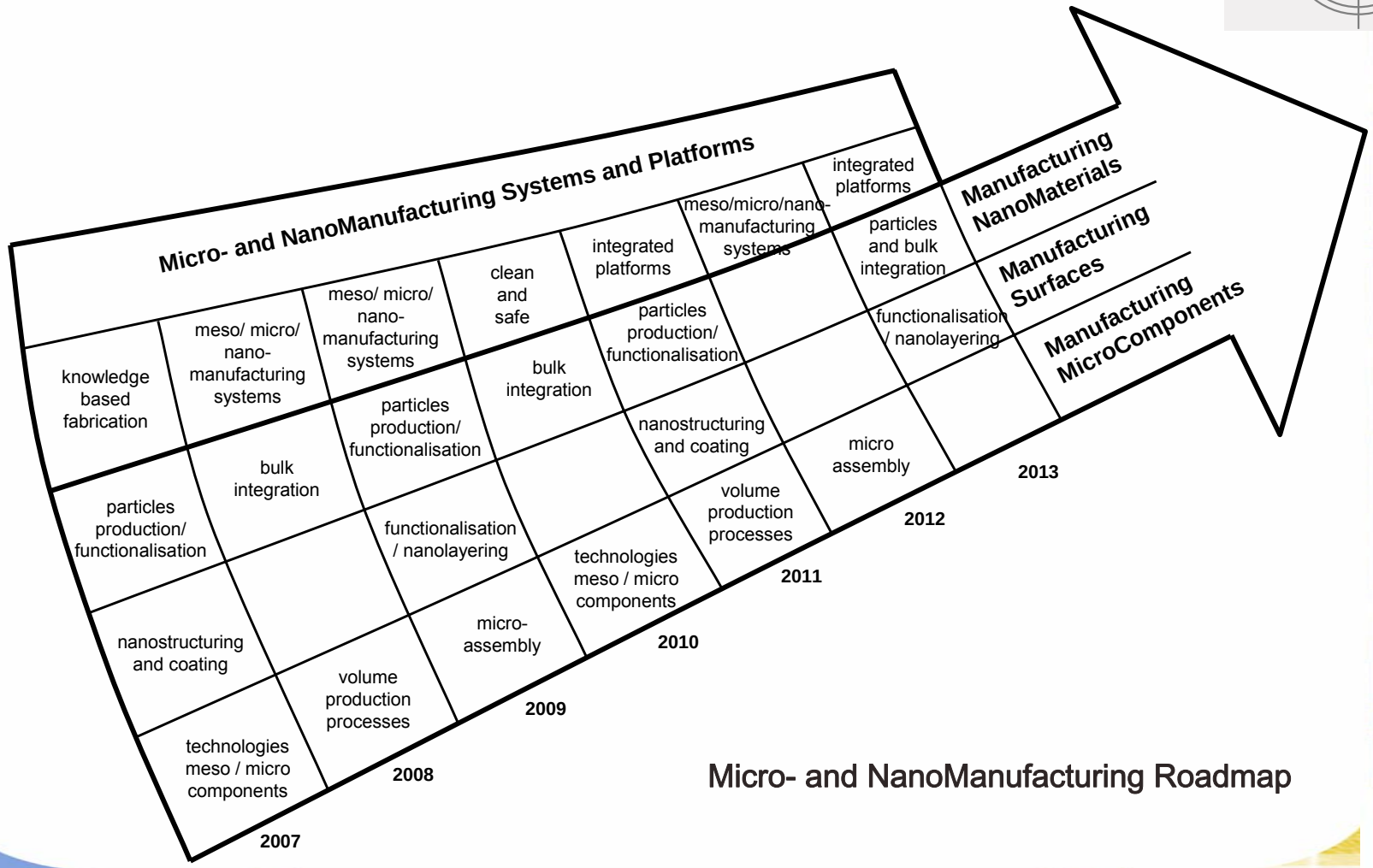
EC Working Group on NanoManufacturing

Working Group NanoManufacturing

A new Micro- and NanoManufacturing community is ready to succeed



EC Working Group on NanoManufacturing



Micro- and NanoManufacturing Roadmap

EC 4M Project: Application Requirements for 4M Manufacturing Technologies

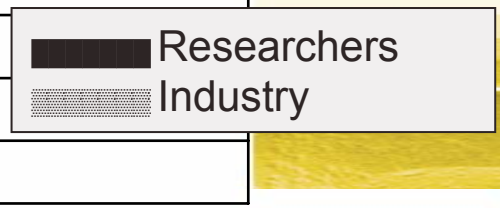
Application requirement	Perceived Importance
A Low cost / volume production	
B Interdisciplinary, design, and process/technology knowledge	
C 3D features, surface properties	
D Technology / maturity / standards	
E Function and physical integration	
F Quality/reproducibility/reliability	
G New/improved/multi materials	
H Integrated process chains	
I Process / machine technologies	
J Assembly & packaging	
K Nano-micro or micro-meso integration	

Researchers
Industry

A roadmapping study in Multi-Material Micro Manufacture. S.S. Dimov, C.W. Matthews, A. Glanfield, P. Dorrington. To appear in: 4M2006 Second International Conference on Multi-Material Micro Manufacture Proceedings, eds. W Menz, B Fillon, and S Dimov, Elsevier, 200

EC 4M Project: Importance of 4M Manufacturing Technologies

Technology	Perceived importance
3D Printing	
Milling	
Powder injection moulding	
Reel to reel embossing	
Nanoimprint lithography (NIL)	
Injection moulding	
Nanoimprinting	
Multi-component injection moulding	
Laser ablation	
Selective laser sintering	
Metal Forming	
Plasma machining	
E beam lithography	



A roadmapping study in Multi-Material Micro Manufacture. S.S. Dimov, C.W. Matthews, A. Glanfield, P. Dorrington. To appear in: 4M2006 Second International Conference on Multi-Material Micro Manufacture Proceedings, eds. W Menz, B Fillon, and S Dimov, Elsevier, 20

EPoSS - European Technology Platform on Smart Systems Integration

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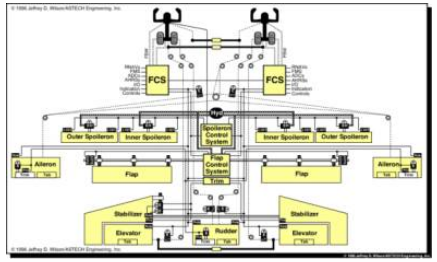
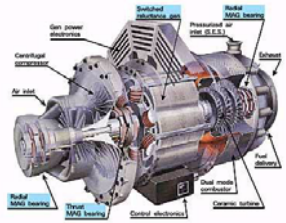
www.smart-systems-integration.org

EPoSS – from the Strategic Roadmap on Aeronautics (draft)

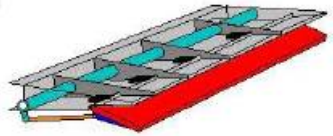
EPoSS
European Technology Platform on Smart Systems Integration

The electrical aircraft

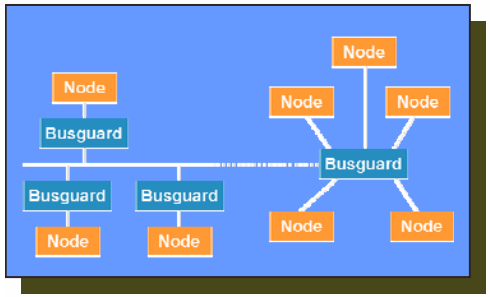




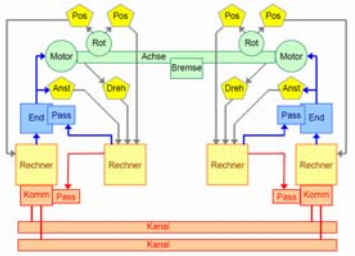
By-light functions
Next generation of optical components and optical sub-systems



Fuel cell APU
Sensors, process monitoring and control



By-wire functions
Smart sensors and actuators



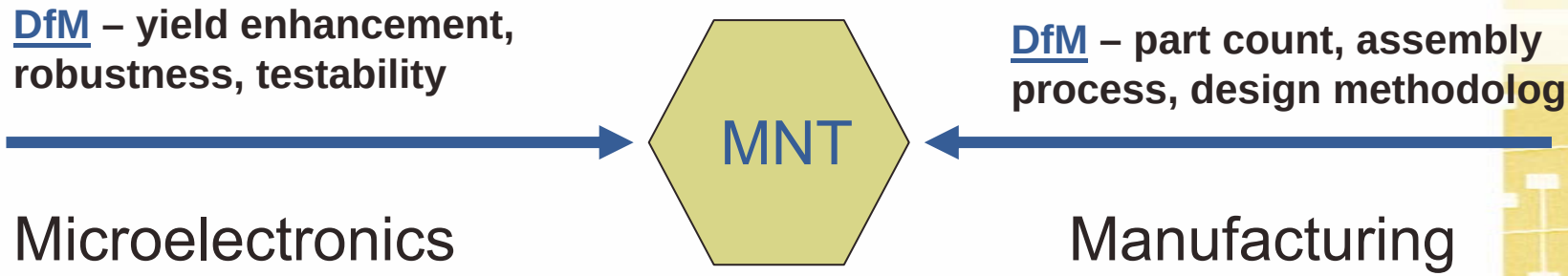
Electrical power management
Detection and control devices for power network

2005 2010 2015 2020

NEXUSplus EC FP7 Workshop: **MNT Roadmaps**, Patric Salomon
4M2C PATRIC SALOMON GmbH, Berlin -- enablingMNT Group

NEXUS

Network of Excellence: Design for Micro & Nano Manufacture (PATENT-DfMM)"



Objectives:

- Integrate European Research in DfMM
- Offer services to industry, especially SMEs:
  - Research type services
  - Databases: Failure modes, packaging and test solutions, etc.
  - Consulting: Improve production processes, test, yield, reliability, etc.
  - Design services
  - Subsystem development
  - Training courses, education

www.patent-dfmm.org

PATENT-DfMM Project: Packaging Roadmap

1 - Constitution of High Level Challenges and Related Issues Table

- **Questionnaires + browsing through existing deliverables from the project**
- **1st workshop (30 experts, half industrialists) at Heriot-Watt in February 2006**

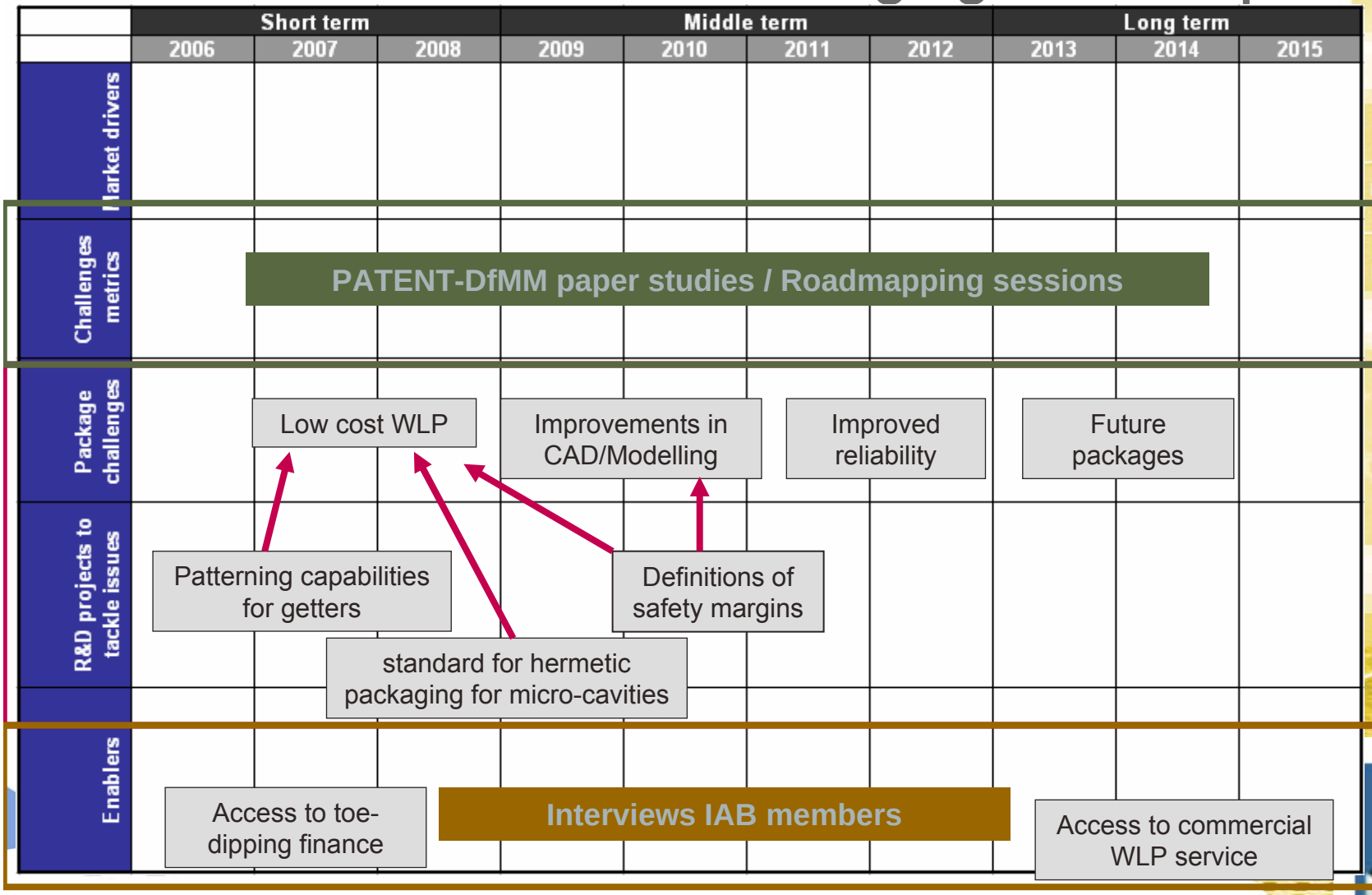
Summary of issues	(S)hort/(M)edium/(L)ong term	Priority (H / M / L)	RF / MOEMS / Both
Reducing costs of packaging	M/L	H	Both
Integrating active and passive components	M	H	Both
Development/integration of new materials for higher resonant frequencies	M	H	Both
Technologies that allow in-package tuning of RF devices	M	H	RF
[illegible]	S/M	H	RF
Development/integration of new materials for higher resonant frequencies	M	H	Both
Technologies that allow in-package tuning of RF devices	M	H	RF
Surface treatment of structures to prevent molecular absorption	S/M	H	RF

2 – Constitution of Technology Requirements for selected Challenges

- **Choice of a High-Level Challenges by experts**
- **2nd workshop at Fraunhofer IZM in June 2006**

3 – Write - up Roadmap

PATENT-DfMM Project: Packaging Roadmap



PATENT-DfMM Project:

Next Roadmapping Activity (Sept 2006 – March 2007):

Design, Modeling, Simulation Tools Workshop: 25-26 Jan 2007, Berlin

- User needs
- Tool company plans / roadmaps

→ Research/development needed to improve software

→ New projects / Funding needs

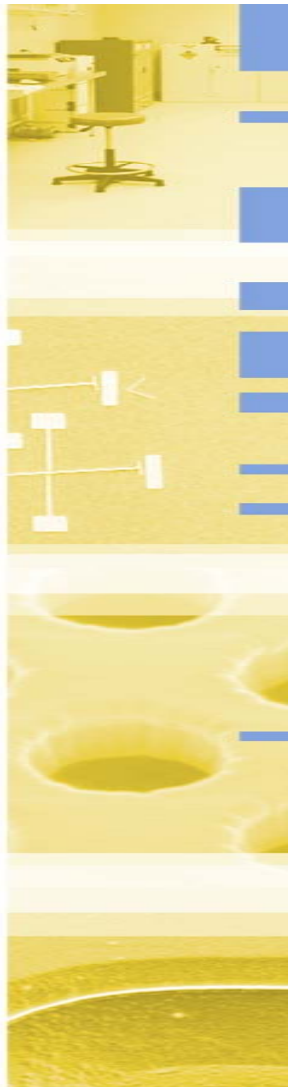
Contributions/collaboration needed for Roadmap:

- (Industrial) users of software tools (fabless designers, integrated manufacturers, etc)
- Suppliers/vendors of software tools
- Existing roadmaps/reports: Mancef, MIG, NEXUS

Contact: Dagmar Peters (Univ. Bremen), Patric Salomon (4M2C / enablingMNT)

Other Roadmapping Activities

- ENIAC wafer technology roadmap
- Nanoroadmap (NRM) Project
- NanoRoad SME project
- Microfluidics roadmaps
- etc.



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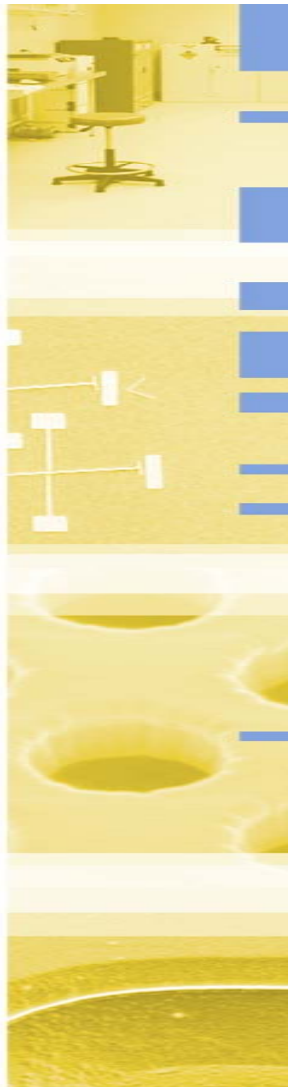
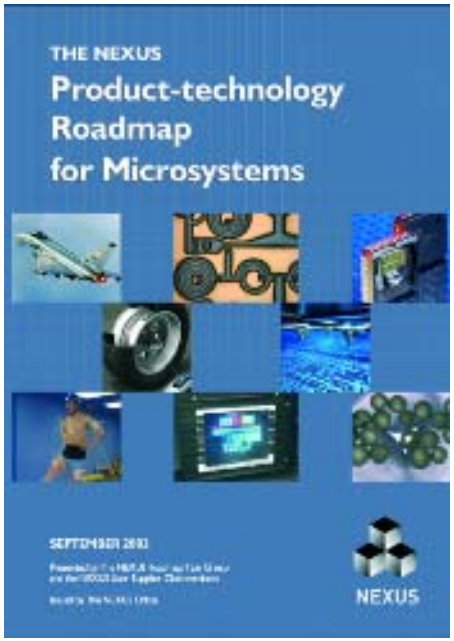
European Technology Platforms (MNT)

- EPoSS: Smart Systems Integration
- MINAM: Nanomanufacturing (within Manufuture Platform)
- ENIAC: Nanoelectronics
- ARTEMIS: Embedded Systems
- Photonics21
- Rapid Manufacturing
- Medical…
- more…



NEXUS

International Networks and Roadmapping Activities



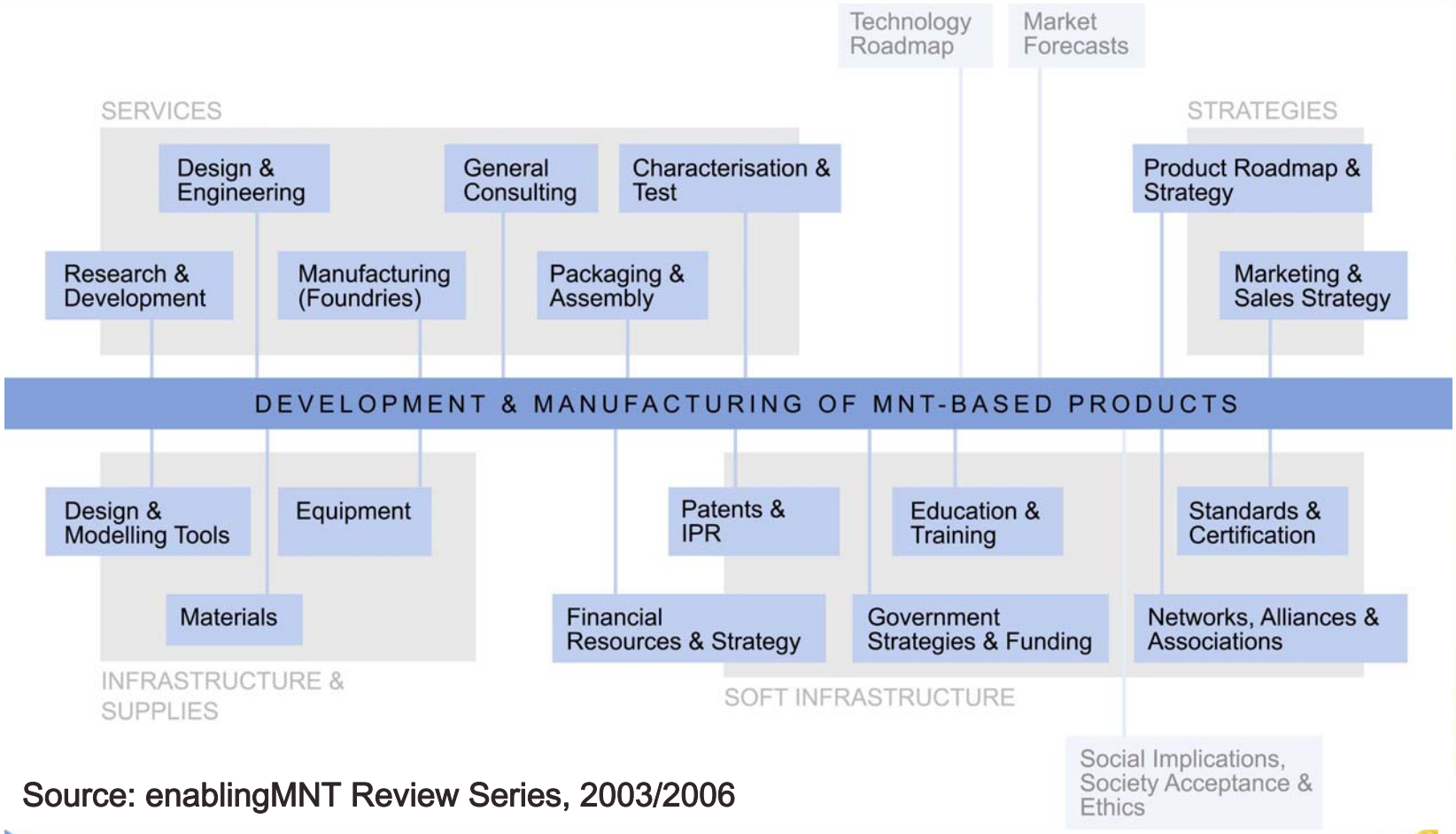
DfMM
NoE PATENT

Strategic
Role

MANCEF
www.mancef.org

NEXUS

Supply Chain for MNT-based Products



Source: enablingMNT Review Series, 2003/2006

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Further Information

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www.enablingMNT.com

NEXUS Roadmap Report

NEXUS Market Analysis (also available on CD now)

MANCEF Roadmap

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