



The European Technology Platform for Embedded Systems

Bilbao Event

June 22, 2006

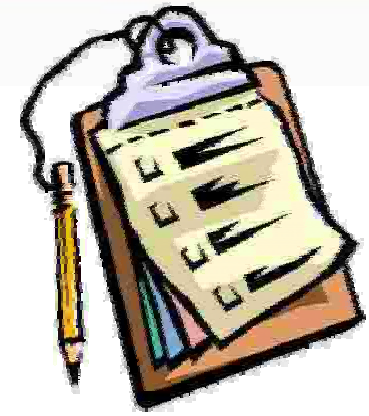
ADVANCED **R**ESearch & **T**ECHNOLOGY FOR **EM**BEDDED **I**NTELLIGENCE AND **S**YSTEMS



Overview



- EC context : What is a “Technology Platform”
- ARTEMIS
- The ARTEMIS Strategic Research Agenda
- Q&A





Technology Platforms: the Concept



Stakeholders getting together to define a Strategic Research Agenda on a number of strategically important issues with high societal relevance where achieving Europe's future growth, competitiveness and sustainable objectives is dependent upon major research and technological advances in the medium to long term.

In a strategically important area of technology

- ★ For Europe's future industrial competitiveness
- ★ With hard research or structural challenges to address

With the ability to define and pursue common vision

- ★ Capitalising on European strengths

With a committed industrial and research constituency

- ★ Agreement on objectives, challenges, specific strategies

For a Strategic Research Agenda "SRA"

- ★ Mobilising the necessary resources



Technology Platforms: Three Stages

Stage 1: Stakeholders get together

**Stage 2: Stakeholders define a
Strategic Research Agenda**

**Stage 3: Stakeholders implement the
Strategic Research Agenda**



Technology Platforms: Factors for Success



- **Industry in the Lead**
- **Flexibility**
- **Transparency: Clear Rules of Participation**
- **Openness to Wide Stakeholder Involvement**
- **Operational Focus from Early Stage**
- **Commitment of National Authorities**
- **Consider Financial Aspects at Outset**



ARTEMIS : “Embedded Intelligence” Platform Motivation

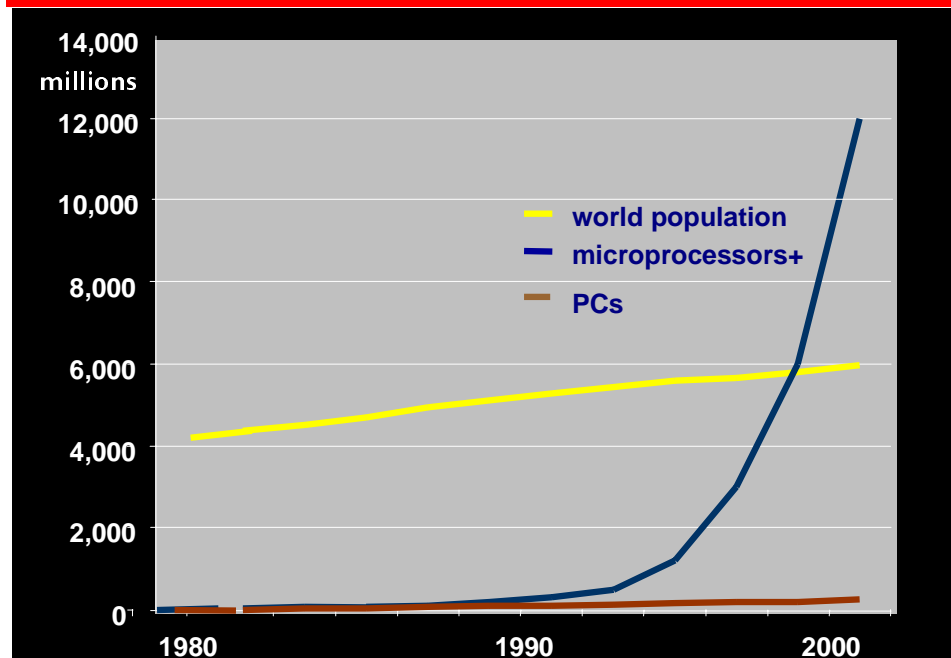
- Embedding intelligence everywhere
 - consumer electronics, mobile devices, automotive, avionics, telecoms, manufacturing automation, medical devices, ...
- Strong Drivers
 - Miniaturisation and anywhere/anything connectivity
 - Convergence and consumerisation
- An important stake for Europe
 - Huge growth potential
 - EU industry could get a leading position
- But :
 - Industry under huge competitive pressure
 - Complexity becomes unmanageable
 - Difficult technological challenges
 - Skills gap
 - EU research landscape fragmented



Facts and Figures

- **Embedded systems feature strong growth**
 - Number of embedded components expected to grow to 16 billion worldwide by 2010
 - Annual growth rate 10.3%
- **Europe has a strong research tradition in embedded systems technology**
 - Excellent university groups and public research institutes
 - Many private industrial research institutes
 - Excellent private-public funded research programs, e.g., ITEA-MEDEA

Exponential growth of embedded systems



Shift in functionality Trends and Obstacles

open

networked

physical

intelligent

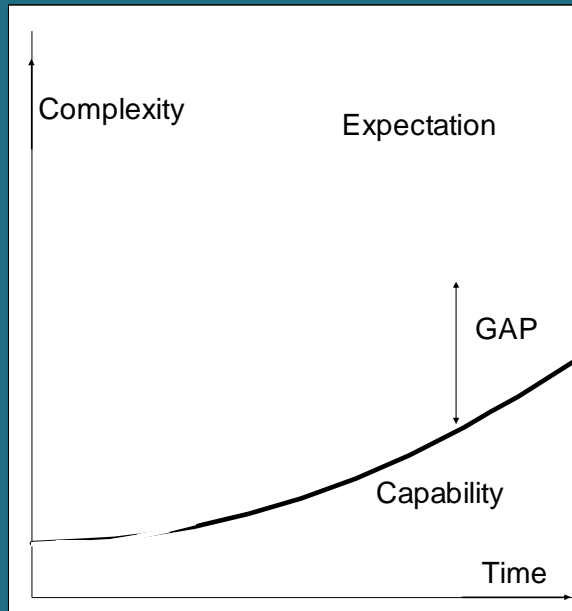


embedded functionality
that enables electronic systems that support communication, mobility,
productivity, communication, and leisure



Divergence of atoms and bits

The paradigm shift



Cost of a bit is more or less flat (10-50 lines-of-code per software developer per day)

The required amount of software code increases
↓
Software cost goes up

Cost of an atom is more or less flat (0.10\$/mm² silicon)

Moore's law decreases the amount of mm² of silicon
↓
Silicon cost goes down



The ARTEMIS Technology Platform



Advanced Research and Technology in Embedded Intelligence and Systems

Aim and scope

- **Develop and drive a joint European vision and strategy on Embedded Systems**
 - R&D and educational challenges
 - Structural Challenges: IPR, open source software, standards and regulations, research infrastructure,...
- **Align fragmented R&D efforts in the ERA along a common strategic agenda at Community, intergovernmental and national levels**

ARTEMIS Steering Board



9 of the 25 top-ranked EU companies are members of the ARTEMIS Board
spending 31 b /y in R&D (30% of total R&D of TOP500 EU companies)



ARTEMIS

The setting-up



- **First High Level Meeting - Jan 2004**
 - Chaired by the Commissioner
- **Members**
 - From Industry: ABB, Airbus, Bosch, British Telecom, COMAU, ContiTeves, DaimlerChrysler, Ericsson, Finmeccanica, Infineon, Nokia, Philips, ST, Symbian, Telenor, Thales ,
 - From Research: IMEC, Parades, Verimag, U. Vienna
- **A Core Group**: DaimlerChrysler, Nokia, Philips, Thales, ST
- **Expanded to include**: ARM, Siemens, Fraunhofer Institute and Technical University of Catalonia, CEA, AVL
- **Steering Group**
 - Meeting firstly met - March 2004
 - Draft vision document
 - Definition of Working Groups
 - Timetable
- **Working groups**
 - Applications
 - Technology
 - Governance



ARTEMIS is open to additional participants in WGs:

- Fagor, FhG, France Telecom, SAP, Schneider, ESI, KU Leuven, University of Bologna, ...

The Artemis consortium

Industrial support



Erkki Liikanen
Commissioner
European Commission



Jürgen Dormann
Chairman and CEO
ABB



Noël Forgeard
Chairman and CEO
Airbus



Matt Bross
CTO
British Telecom



Daniele Pecchini
CEO
COMAU



Karl-Thomas Neumann
CEO
Continental Teves



Thomas Weber
Member of the Board
Daimler Chrysler



Håkan Eriksson
Senior Vice President
and CTO
Ericsson



Pier Francesco Guaruaglii
Chairman and CEO
Finmeccanica SpA



Gilbert Declercq
President and CEO
IMEC



Wolfgang Ziebart
CEO
Infineon Technologies

Building Artemis
Report by the High-level Group
on Embedded Systems

ADVANCED
RESEARCH
and TECHNOLOGY
for EMBEDDED
INTELLIGENCE & SYSTEMS

Information Society
European Commission

Members of the High Level Group



Jorma Ollila
CEO
Nokia



Alberto Sangiovanni Vincentelli
Founder and Director
Parades



Gerard Kleisterlee
CEO
Philips



Siegfried Dais
Deputy Chairman of the Board, corporate R&D
Bosch



Pasquale Pistorio
President and CEO
ST Microelectronics



David Levin
CEO
Symbian



Jon Frederik Baksaas
CEO
Telenor



Denis Ranque
CEO
Thales



Peter Skalicky
Rector
Vienna University of Technology



Antoine Petit
Head of STIC
CNRS/Verimag

ARTEMIS is supported by the CEO's of the top Industrial partners



The Artemis European Technology Platform



The vision

An ongoing, major evolution toward a society in which all systems, machines and objects are integrated, digital, communicating and self-managed

- Societal and economical consequences:
 - **Competitiveness** of most industry sectors will rely on embedded systems innovation capability
 - Embedded systems technologies become critically important in rebalancing **productivity growth** in Europe, the US and Asia
 - **Security, safety, health, and well-being** in our society will increasingly depend on embedded systems technologies

Europe can build on a great potential



The Artemis European Technology Platform

The mission

- **Support EU to take a leading position** in embedded systems
 - *requires a significant investment in research and development*
- **Facilitate and stimulate success** by establishing an environment supportive of innovation
 - *cooperation and competition in technological development*
 - proactively stimulating the emergence of a new supply industry
 - *components, tools, design methodologies*
 - avoiding fragmentation, effective use of resources
 - *focused research and development*

Artemis can help to grow the European embedded systems enterprise



The Artemis European Technology Platform



The strategy

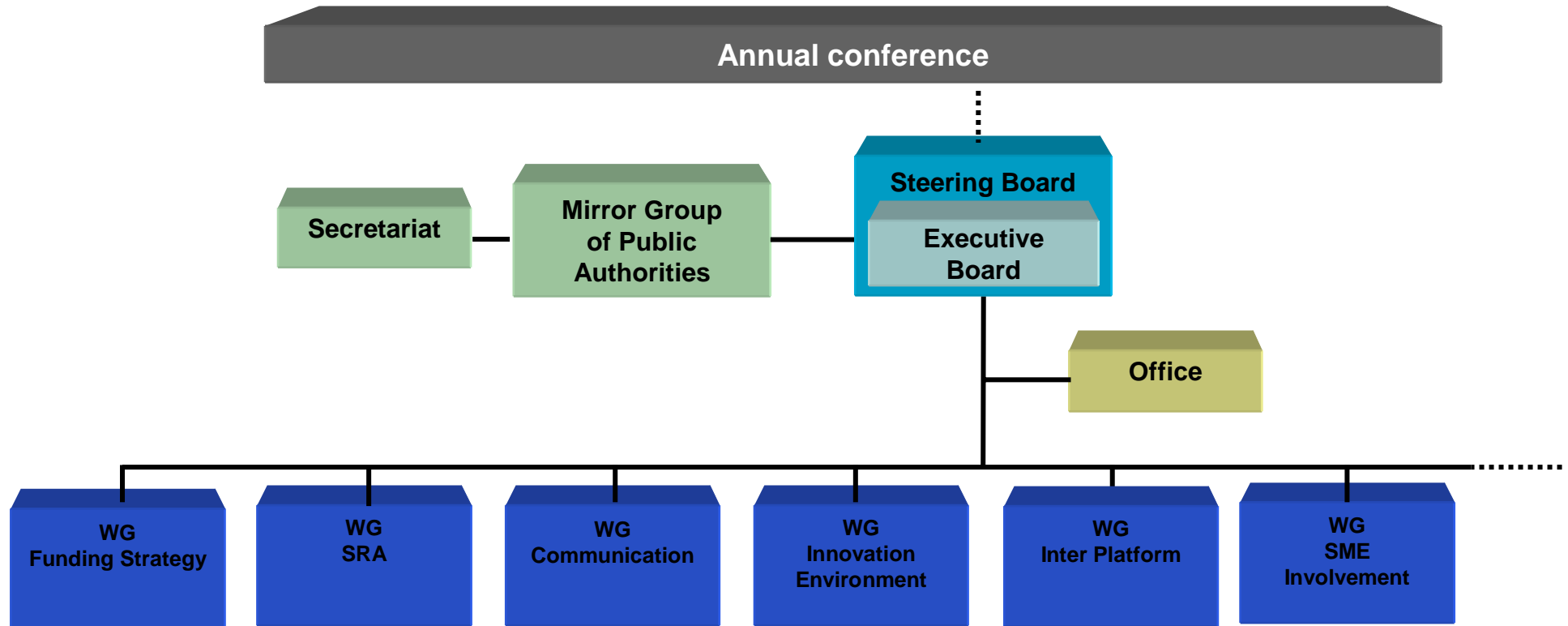
Build a European “consortium” that

- **develops and drives a joint European vision on Embedded Systems based on a Strategic Research Agenda (SRA) and corresponding roadmap**
- **aligns fragmented R&D efforts in the ERA along common SRA at Community, intergovernmental, national, regional levels, and uses EU strength**
- **benchmarks and links with relevant initiatives outside EU**
- **advises on structural, educational and regulatory matters w.r.t. IPR, open source software, standards, research infrastructure, education, and training**



ARTEMIS Governance

Today's ARTEMIS Governance





The Artemis way of working

Openness, transparency, and dissemination

- Clear rules of procedure and terms of reference
- Official press release on adoption of “Building ARTEMIS”
- A website : www.artemis-office.org & www.cordis.lu/ist/artemis
- A News Letters and a quarterly Journal.
- Annual conferences
- Public session at IST Conferences
- Approved governance structure
- Open calls for expression of interest for new sounding board members
- Mirror Group open to all member states via call for EoI
- SME involvement through European Federation of High-Tech SMEs in SB
- Active communication and dissemination by Artemis Office as of May 2005
- Official press release and adoption of the SRA

ARTEMIS is founded in open innovation



ARTEMIS Challenges



Challenges are in

– **Technology**

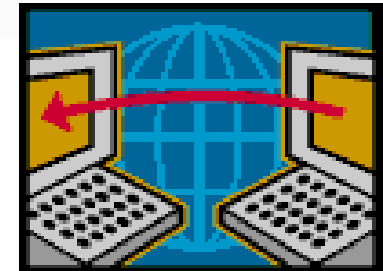
- Complexity, design productivity, programmability, interoperability, power consumption, dependability,

– **Business and society**

- Open new markets (products, applications, services)
- Society-scale applications, easy to use, cost, ...

– **Structural**

- Co-ordinated approach to funding (incl. Eureka)
- Education and training
 - Multidisciplinarity in skills
 - Research infrastructure
- Standards, certification, open source, ...





The Technology domains and challenges

System property depends on advances in the following technology fields	IP Reuse	Validation	Fault Tolerance	Security	Communication	Silicon Scaling	Sens or Actuators	Standardization
Utmost Functionality	•••	•	•	•	••	•••	••	•
Dependability	••	•••	•••	•••	•	••	•	••
Connectivity	••	•	•	••	•••	••	--	•••
Low Power	••	•	•	--	••	•••	•	••
Ease of Use	••	••	••	•	••	•••	••	••
Low Design Cost	•••	•••	••	••	•	••	•	••
Low Production Cost	•••	••	••	--	--	•••	••	•••
Time- To Market	•••	•••	•	••	••	••	•	••



The Artemis Strategic Agenda



Research objectives

- Foundational science & technology research
- Bridge physics and computing
 - Optimal use of time, space, energy and material properties
 - Hard real-time control
 - Truly novel computing architectures
 - Modular, heterogeneous, composable, self-organising, adaptive systems
 - Dependability and security
 - Correct-by-construction design

ARTEMIS research aims at establishing a scientific and technologic basis for embedded systems design in Europe



The Artemis Strategic Agenda

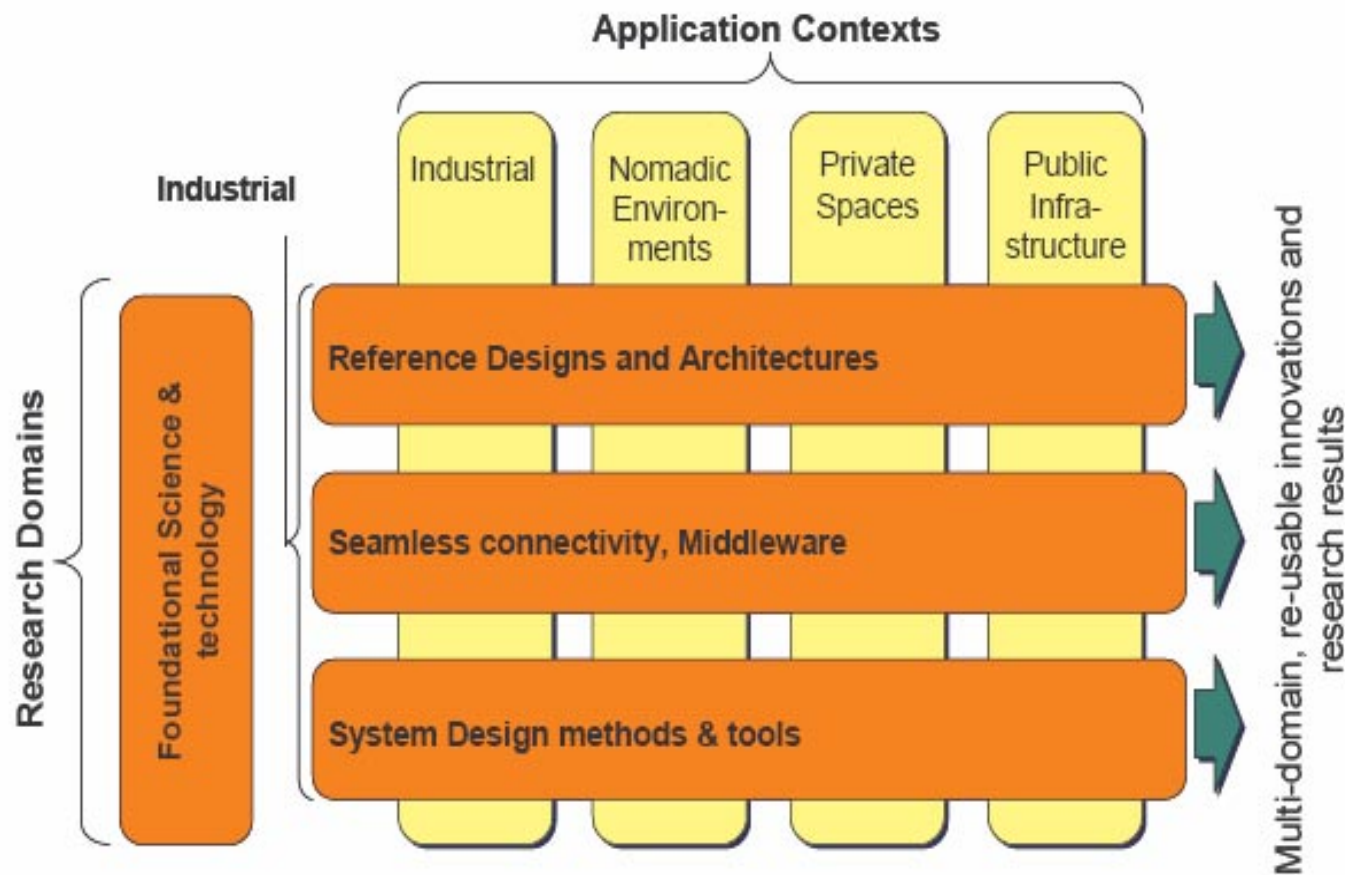
Objectives and targets to be attained by 2016

- **50% of embedded systems deploy Artemis results worldwide**
- **Twice as many SMEs engage in embedded systems supply chain**
- **Realise an integrated chain of European-sourced tools, to support development of embedded systems**
- **Achieve seamless interoperability among ambient intelligence environments, at home, travelling, at work, in public spaces, ...**
- **Generate at least 5 ‘radical innovations’, comparable to μ -processor, dsp, software radio, etc.**
- **Double the number of patents**
- **Reduce cost of system design by 50%**
- **Achieve 50% reduction in development cycles**
- **Manage complexity increase of 100% with 20% effort reduction**
- **Reduce by 50% the effort for re-validation and re-certification**
- **Achieve cross-sector reuse**

ARTEMIS imposes “objectives” that really matter

The Artemis Strategic Agenda

Research domains vs. application contexts : the complete synthesis of the SRA



Common objectives:

- Sustainability
- Design Efficiency
- Ease of Use
- High added value
- Time to market
- Modularity
- Safety / Security
- Robustness
- Competitiveness
- Innovation
- Cost reduction
- Interoperability

ARTEMIS research cuts barriers between application sectors, stimulating creativity and yielding multi-domain, re-usable results



The Artemis Strategic Agenda

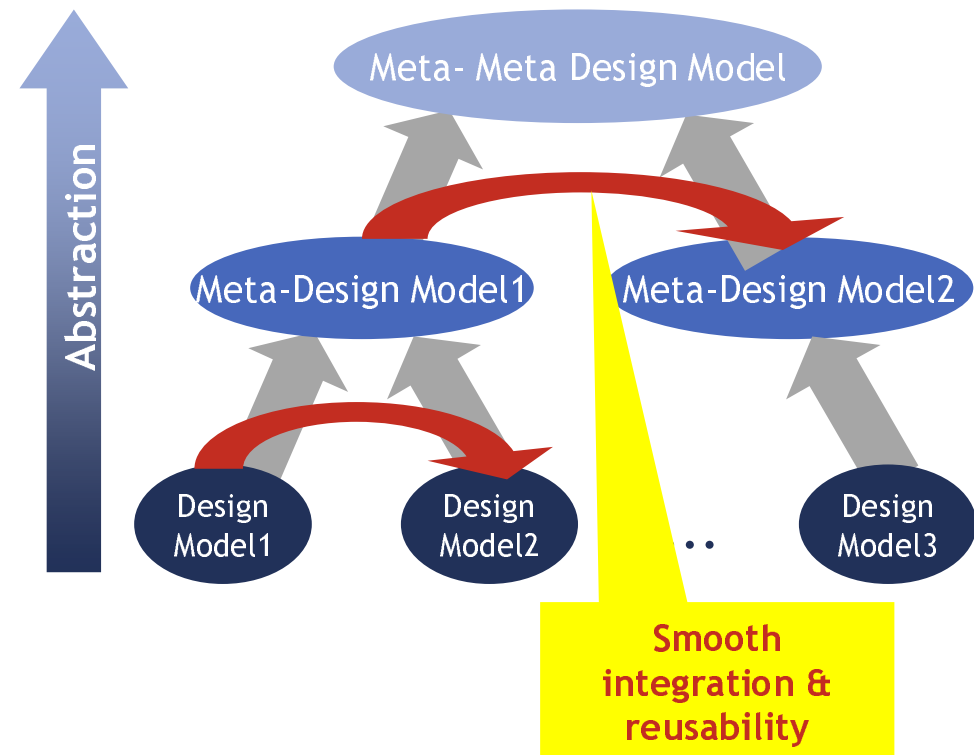
- A well-calibrated R&D strategy is necessary but not sufficient
- ARTEMIS' SRA assumes an inclusive approach:
 - The Research Agenda itself
 - Research infrastructure, stimulating innovation
 - Education
 - Standards
 - Financing mechanisms and instruments (“JTI”)
 - Governance



ARTEMIS SRA – Holistic vision

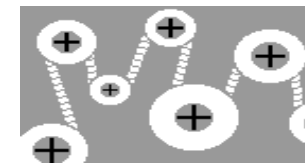
Reference Designs and Architecture

- Generic platform and suite of abstract components mappable across the application contexts assuring high re-usability.
- Platform characteristics:
 - Composability
 - Addition of application specific modules
 - Dependability & security
 - High performance
 - Low power
 - Interfacing to the environment



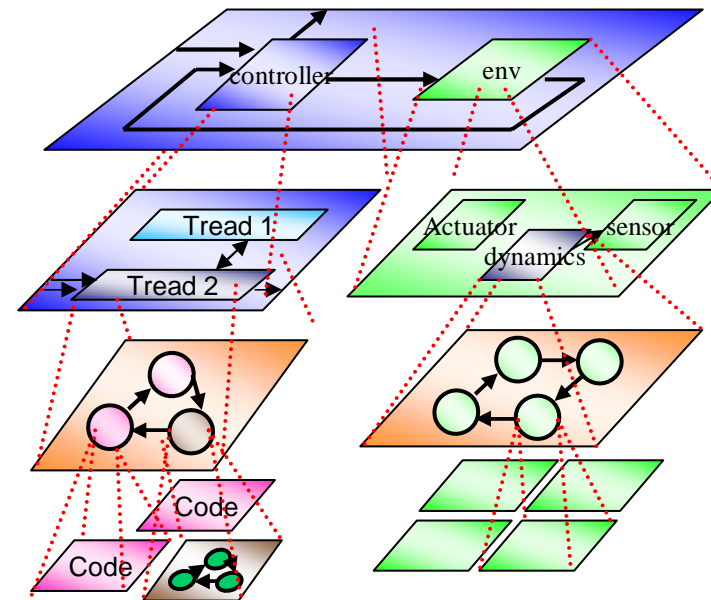
Seamless Connectivity and Middleware

- Middleware architectures
 - To support interoperability between nodes
 - To link the physical world to the application
- Ubiquitous connectivity schemes and networks for embedded systems
- Self-configuration & self organization of components



Design Methods and Tools

- Rapid design & prototyping of complex systems.
- Management of the design process
- Interoperability tools and procedures
- Simulation, automatic validation and proving
- Open interface standards

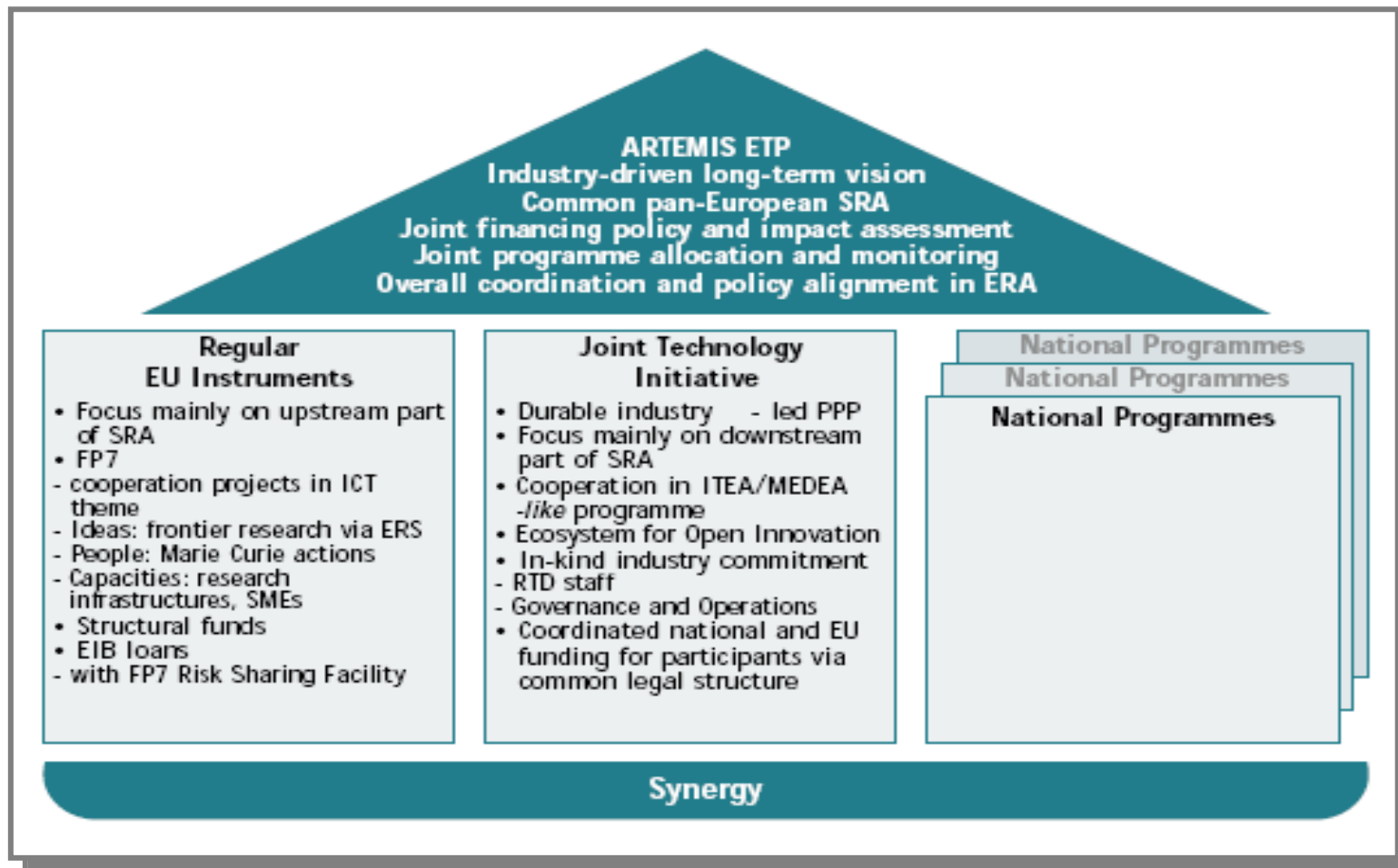


Managing complexity

Making it an financing

FOSTER CO-ORDINATING EUROPEAN RESEARCH RESOURCES

1/2





- Operations combine best of FP and EUREKA worlds
 - Annual calls for proposals
 - Common processes, unified among participating countries
 - Built-in harmonisation & synchronisation of national funding decisions
 - Contracting & processing of cost claims at national level
- Governance principles
 - Transparency & openness in participation & operations
 - Industry-led public-private partnership
 - Public Authorities decide when public money is involved
- Legal structure: Joint Undertaking based on Art. 171 EU Treaty
 - To receive and manage funds from EC, industry and possibly other sources
 - To guarantee agreed JTI processes, as basis for EC and national decisions



Making it happen: Innovation Environment

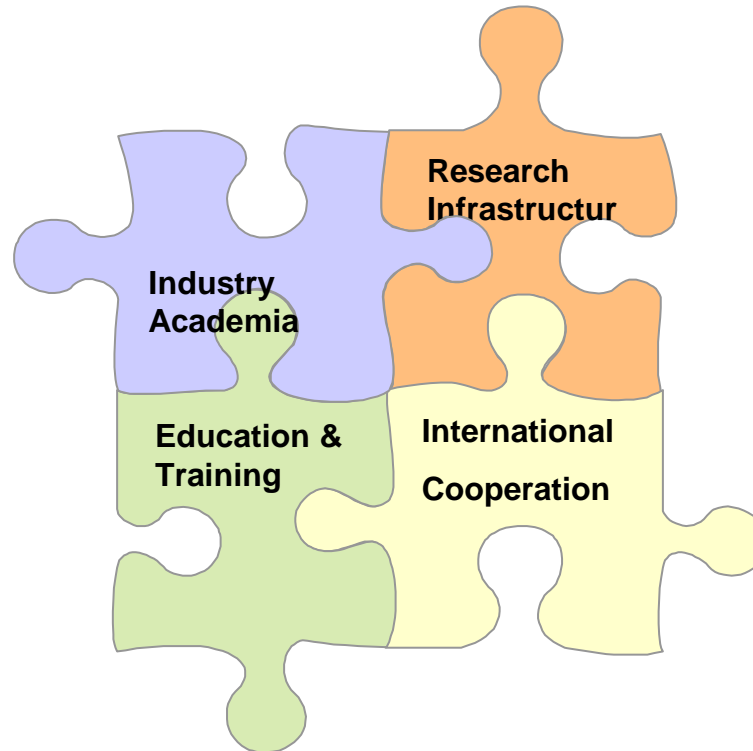


- **Engagement**
industry & academia

- **Innovative**
mechanisms for
coupling Industry &
Academia

- **Overcome gap**
academic education &
practice in industrial
applications

- **Development** new
combinations of skills



- **Establish**
centers of
excellence

- **Implementation**
Industrial research
vision

- **Fostering**
ARTEMIS
standards as a
worldwide basis.

- **Mutualisation** of
resources.



Innovation Environment : 7 + 1 PROPOSALS

- 1. CENTERS OF EXCELLENCE (COE)**
- 2. ARTEMIS SME PACT**
- 3. ARTEMIS SME OFFICE**
- 4. ARTEMIS COMMUNITY & OPEN SOURCE INITIATIVES**
- 5. SHARING RESEARCH INFRASTRUCTURES**
- 6. ARTEMIS STANDARDS & REGULATION SUPPORT INITIATIVE**
- 7. STRUCTURING THE ACADEMIC RESEARCH & EDUCATION COMMUNITY ON EMBEDDED SYSTEMS**

- 8. ARTEMIS ORCHESTRA CONTEST**

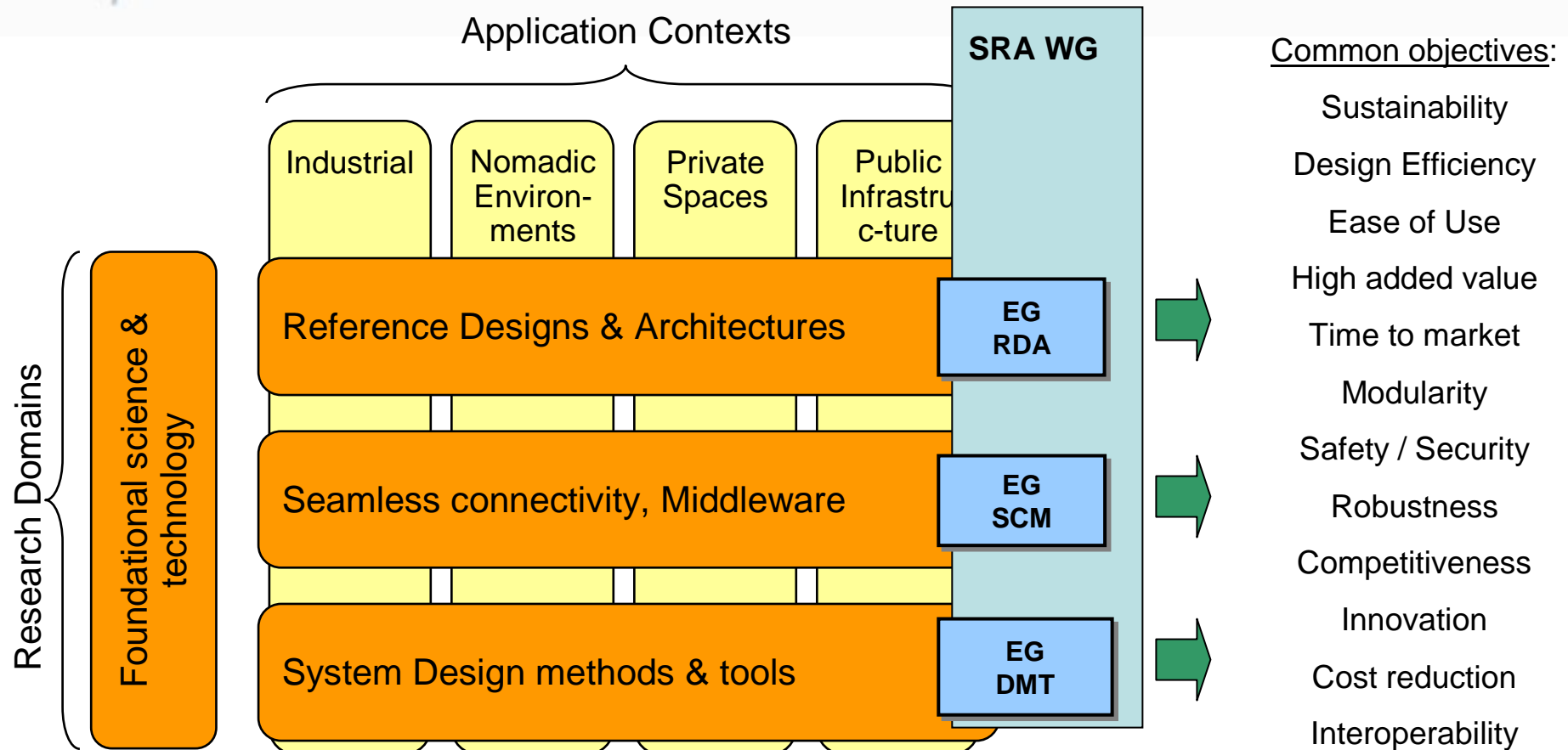


SRA Development

3 Expert Groups to identify the research priorities in each of the 3 main research domains

- **The Reference Design and Architecture SRA:**
 - establishes common requirements and constraints for future embedded systems, and will establish generic reference designs and architectures that can be tailored optimally to their specific application context.
- **The Seamless Connectivity & Middleware SRA:**
 - addresses the needs for communication at the physical level – networks; at the logical level – data; and at the semantic level – information and knowledge.
- **The Systems Design Methods and Tools SRA:**
 - sets out the priorities for research to optimise the balance in achievement of often conflicting goals such as system adequacy to requirements, customer satisfaction, design productivity, absolute cost, and time to market.

SRA Update (full version)



- **Initial round of SRA “Road-mapping” expert-groups’ work completed**



Reference Designs and Architectures

Methodology to Arrive at the Research Priorities

The working group has adopted the following procedure to arrive at the research priorities:

1. Collection of concrete *requirements* and *constraints* that were considered relevant from the point of view of different application domains
2. Classification of the collected requirements and constraints from the point of view of different application domains.
3. Evaluating the state of the art in meeting these requirements and constraints
4. Identification of research needs and priorities.



Reference Designs and Architectures

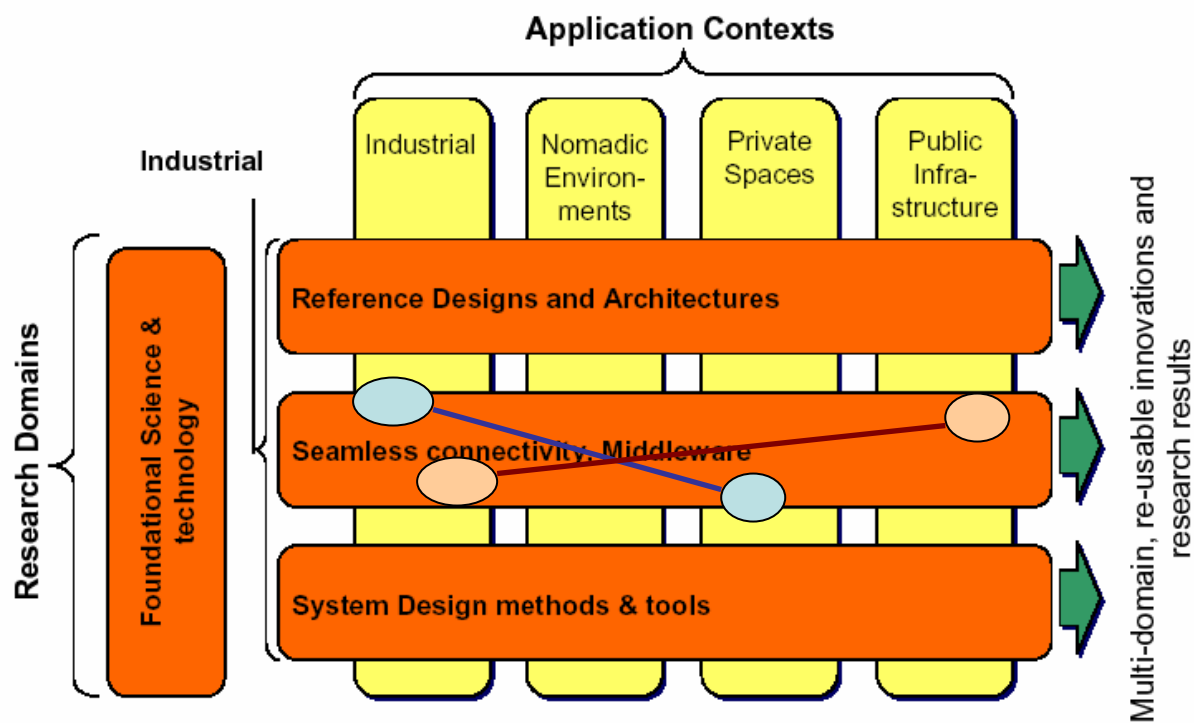
The Seven Key Challenges of *ARTEMIS*

- ***Composability***
- ***Networking and Security***
- ***Robustness***
- ***Diagnosis and Maintenance***
- ***Integrated Resource Management***
- ***Evolvability***
- ***Self Organization***



Seamless Connectivity and Middleware

Which middleware infrastructure?



Unfortunately, middleware requirements are not homogeneous within application contexts

Modularity

Weak clusters:
Common Requirements

Strong clusters:
Common Infrastructure



Seamless Connectivity and Middleware

Six domain clusters

- Critical
- Device & plant
- Private
- Nomadic
- Ad Hoc Connectivity
- Systems of systems



Seamless Connectivity and Middleware

Main Research Priorities

- Programming model
- Organization and Deployment
- Resource Management
- Data distribution
- Robustness and Diagnosis
- Global connectivity
- Provable correct systems
- Security



Design Methods and Tools

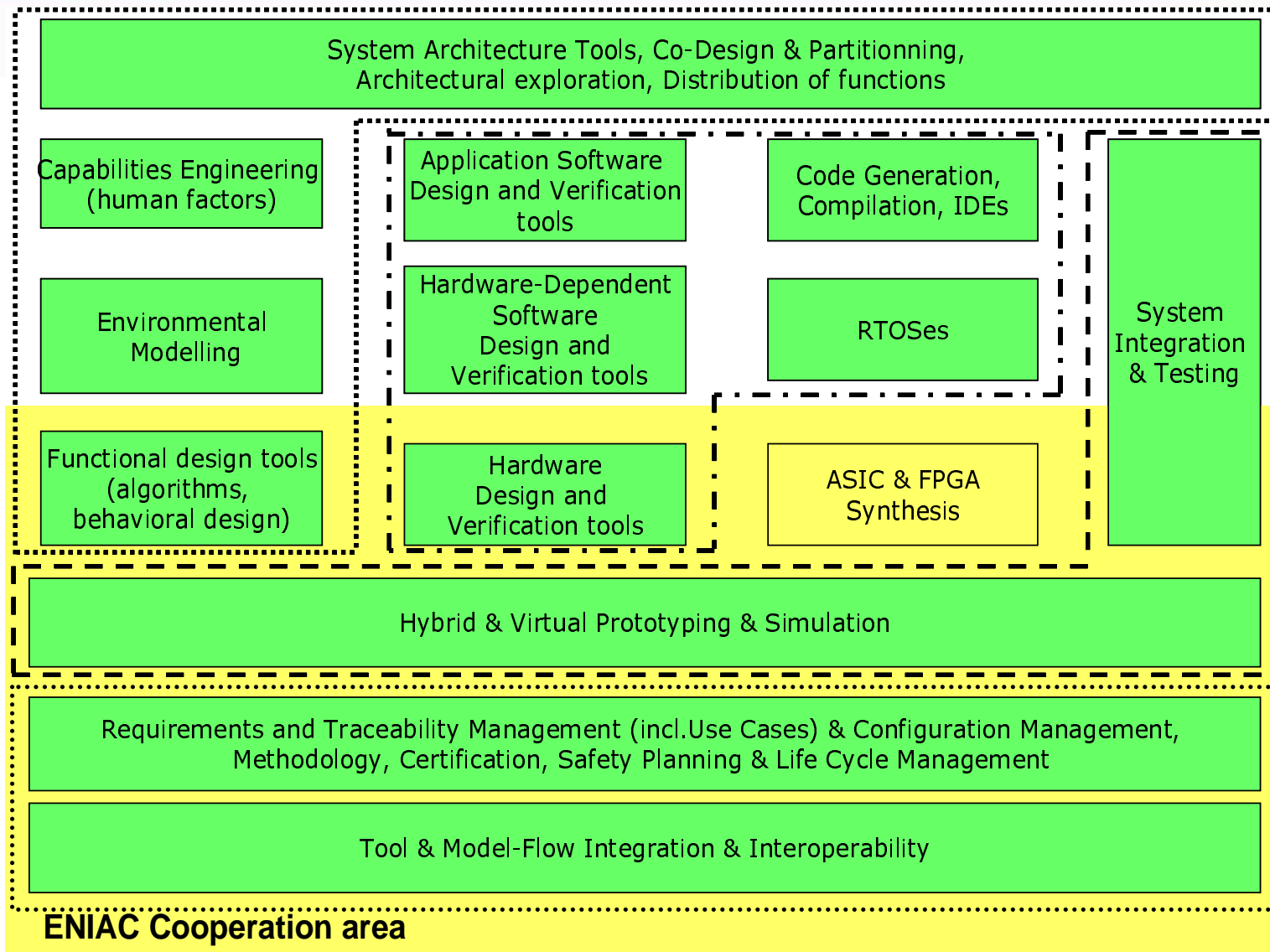
Work Group Report Structure

- Context overview and ‘Tool Reference Framework’
- Research towards implementation of the Tool Reference Framework, and research to enable end-to-end process optimisation.
- For each theme, an outline of:
 - Problems faced by industry at present;
 - Present state of methodological and tool support;
 - Desires and prospects for future methods and tools.
- Description of each research topic:
 - objectives for the research into that topic;
 - the ways in which the research should contribute to the Artemis objectives;
 - and approximate expectations for the timescales in which results may be expected.



Design Methods and Tools

ARTEMIS Tool Reference Framework





ARTEMIS SRA

Transition to Implementation

VISION → **SRA** → **IMPLEMENTATION**

Where do we stand today

- July 2004 (Rome) : vision document “Building Artemis” prepared by leading industry players
- June 2005 (Paris) : First short-form SRA to stimulate feedback from a wider audience
- 2006 (March) : Official release of the “Short SRA” : With feedback from the Public Authorities
- 2006 (May) : Extended SRA: Short SRA augmented with 4 detailed sections :
 - 3 “Detailed Research Priorities”, plus 1 on “Innovation Environment”
 - Research directions and how to structure activities
 - All sections developed around the original visionary themes by Groups of Experts



ARTEMIS Achievements so far



Working Group	Start Date	Deliverables
Technology WG Applications WG	3/2004	Several Position Papers and Presentations
Governance	3/2004	-12/2004: Report on Governance and Terms of Reference
SRA WG	9/2004	6/2005 :“Preliminary Short Version”of SRA - 3/2006 : ”SRA : Short Version “- 5/2006 : Detailed Research Priorities for -Reference Design and Architecture, -Seamless Connectivity and Middleware, -Deign Methods and Tools
Innovation Environment	9/2004	5/2006 : ARTEMIS Innovation Environment : Innovation and Eco-Systems, Standards and regulations, technology Frontiers.
Funding Strategy	11/2004	Reports on financing - restricted distribution



Next steps

VISION → ***SRA*** → ***IMPLEMENTATION***

- We now have a strong platform, from which future research and innovation environment into ES are addressed
- But, this is only the beginning....