ARTEMIS-IA
Strategic Research Agenda 2016

Workshop CPSoS: The next Challenge

Hannover Fair, April 26th 2016

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SafeTRANS

Overview

- Introduction: ARTEMIS and ARTEMIS-IA
- ARTEMIS-IA Strategic Research Agenda
- Cyber-Physical Systems of Systems in the ARTEMIS-IA SRA
- Conclusion

ARTEMIS

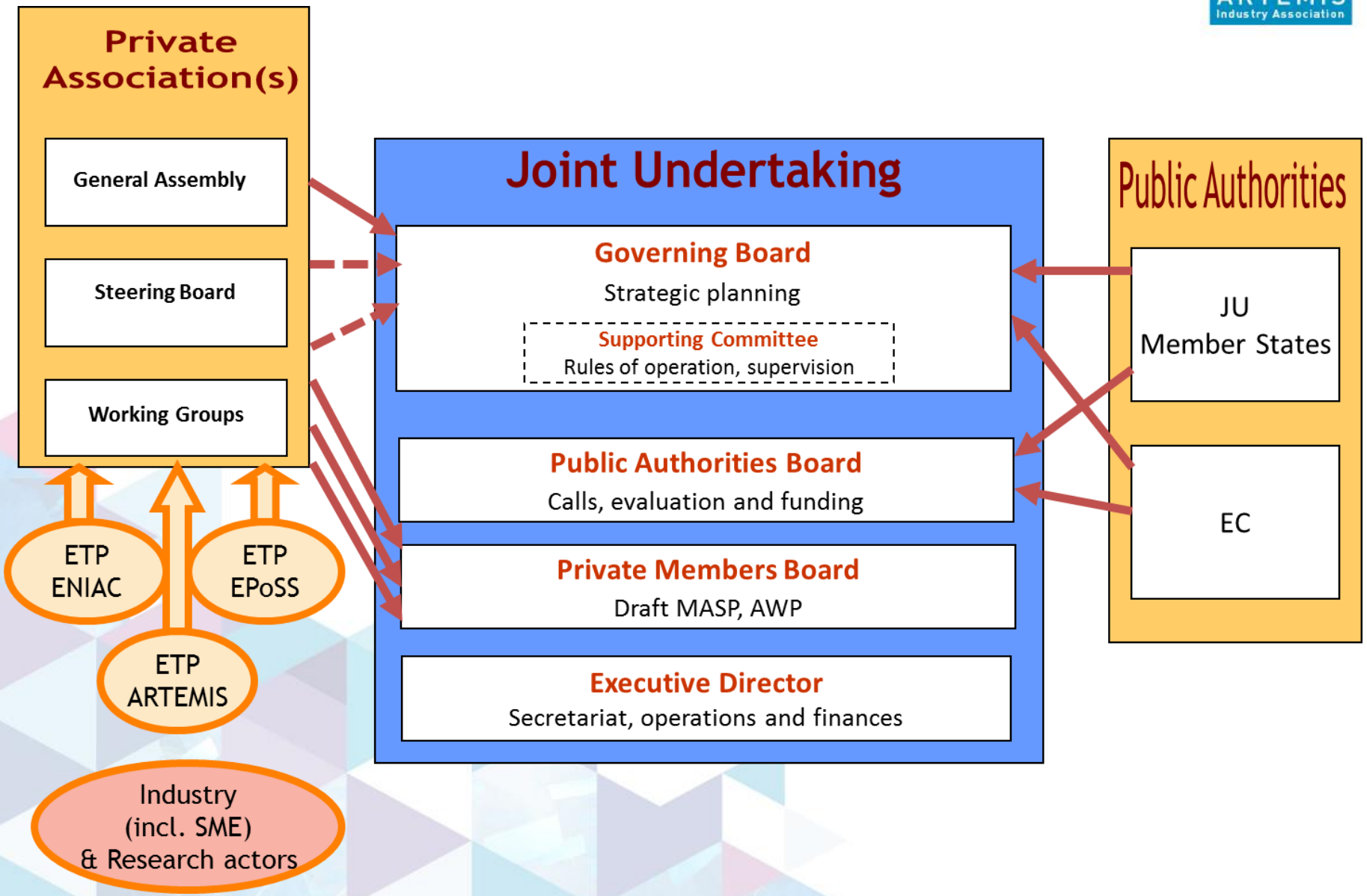
- ARTEMIS – Greek goddess
  - Goddess of chastity, virginity, the hunt, the moon and the natural environment
  - One of the most widely venerated of the ancient greek deities

- ARTEMIS – European Technology Platform
  - **A**dvance **R**esearch and **T**echnology in **EM**bedded **I**ntelligence and Cyber-Physical **S**ystems
  - ETP: Platform/Forum for all stakeholders in Embedded and Cyber-Physical Systems in Europe
    - Networking with experts
    - Discuss and harmonize Research Priorities
    - Develop **Strategic Research Agenda**
    - R&D Project Incubation
    - …
  - Organized and supported by the ARTEMIS Industry Association

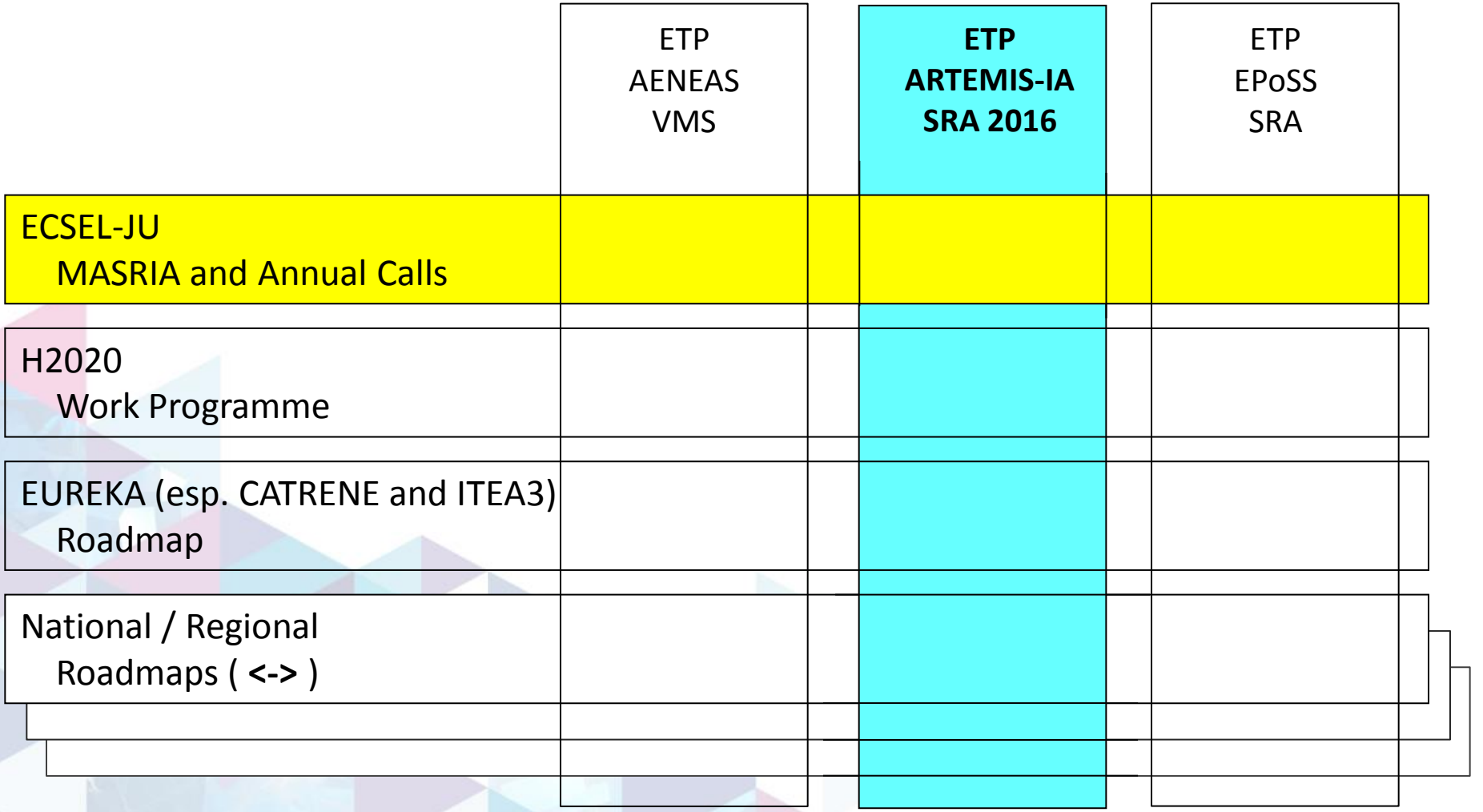
ARTEMIS-IA

- ARTEMIS Industry Association
  - Not-for-profit association
  - Members:
    - Founding: Daimler, Nokia, Philips, STMicroelectronics, Thales
    - Today: ~ 170 members (Large Industry, SME, Research)
  - Two purposes
    - Community building: ARTEMIS ETP
      - Organize Meetings, Workshops
        - » Spring Event, Summer Camp, Project Brockerage, Technology Conference,…
      - Organize Working Groups
        - » On Standardization, Platforms, Tools,…
      - Issue and regularly update Strategic Research Agenda
      - Represent members to European Commissions, Funding programmes, etc.
    - Be the ‚private partner' (~ represent its members) in Joint Undertakings ARTEMIS and ECSEL
      - Large Scale R&D funding programmes
      - Large Scale R&D funding programme (several hundreds Mio Euro funding)
      - ARTEMIS: 2008-2014
      - ECSEL: 2014- 2020

Private Partner in JU ECSEL



SRA and R&D funding programmes



ARTEMIS SRA 2016

The Pathway to the Digital Transformation
An Opportunity for Europe

- Third edition of the SRA (after 2007 and 2011 + 2013 addendum)
- Published: April 2016
- Presented to European Commission and National Authorities during CPSWeek 2016 (April 11-14, 2016, Vienna)
- Download at http://www.artemis-ia.eu

SRA content

1. Introduction
2. The new rationale: digital transformation
3. The ARTEMIS Vision, Ambition, and Main Objectives
4. The Digital Transformation in economic and societal challenges

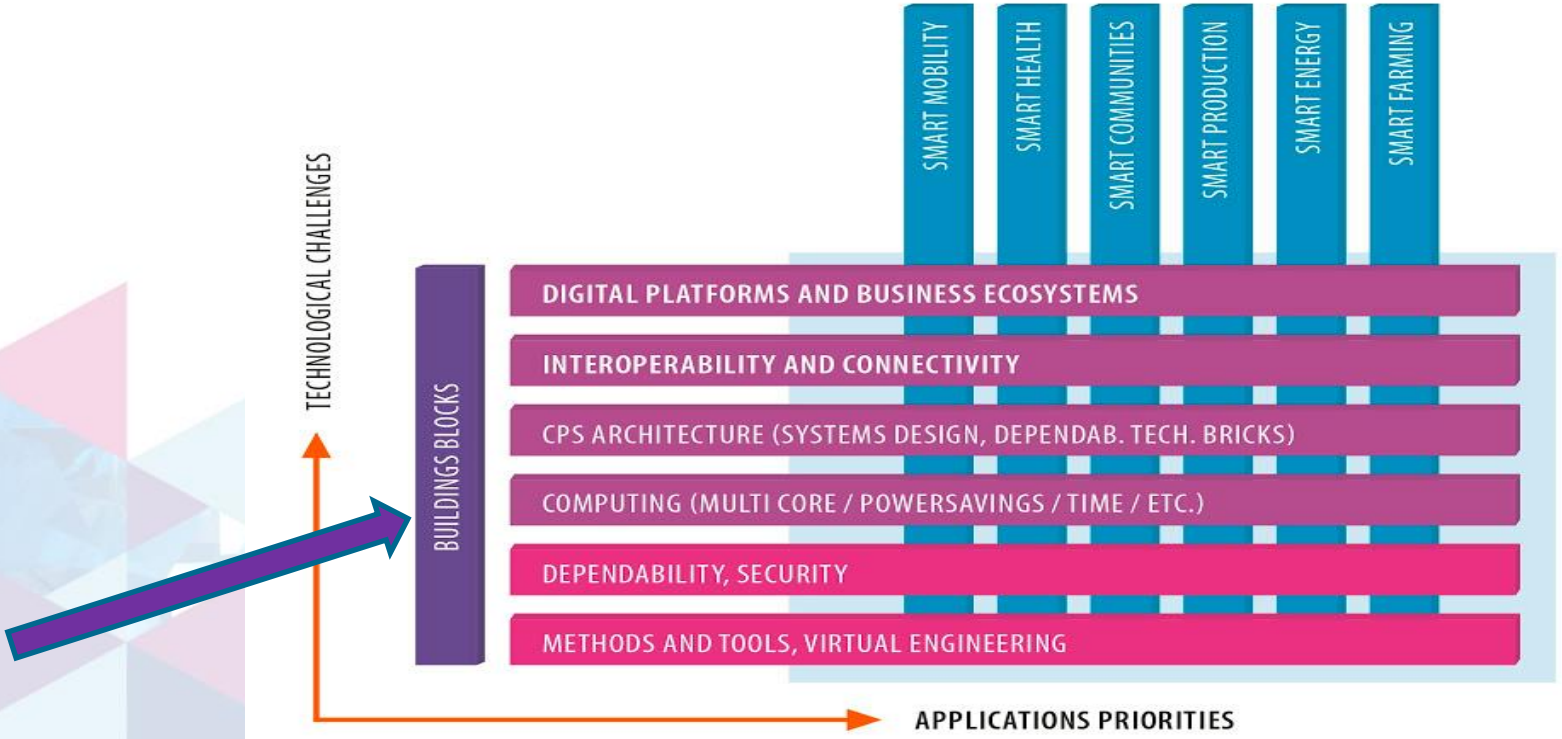
5. ARTEMIS Innovation Strategy and Research Priorities
   - 5.1 ARTEMIS Priority Targets
   - 5.2 Innovation Strategy
   - 5.3 Strategy Implementation
   - 5.3.1 Cross domain Approach
   - 5.3.2 Strategic Research Challenges

6. Innovation environment context – Make it Happen

The Applications Drivers: CPS in…

Innovation Strategy and Research Priorities

Strategy implementation : The Cross-domain approach



To share communalities and synergies to overcome the fragmentation and create critical mass for the investments and to embrace the technology challenges

Innovation Strategy and Research Priorities

Strategic Research Priorities

- CPS Architectures Principles
- Design Methods, Tools, Virtual Engineering
- Trust, security, Robustness and Dependability
- Autonomous and Robotic Systems and Cooperation
- Seamless Connectivity and Interoperability
- Cyber-Physical System of Systems
- Computational Blocks
- Digital Platforms
- Basic Research, fundamental Research

ARTEMIS Innovation Strategy and Research Priorities

Example: Challenges Cyber-Physical System of Systems

CYBER-PHYSICAL SYSTEMS (CPS)

TIGHT INTERACTION

of many distrubuted, real-time **computing systems and physical systems**

Examples
- Airplanes
- Cars
- Ships
- Building with advanced HVAC controls
- Manufacturing plants
- Power plants
- ...

MANY INTERACTING COMPONENTS

Examples
- Large industrial sites with many production units
- Large networks of systems (electric grid, traffic systems, water distribution)

PHYSICAL CONNECTIONS

Examples
- Material/energy streams
- Shared resources (e.g. roas, airspace, rails, steam)
- Communication networks

SYSTEMS OF SYSTEMS (SOS)

MANY DYNAMIC RECONFIGURATION COMPONENTS

COMPONENTS MAY ...
- be switched on and off (as in *living cells*)
- enter or leave (as in *air traffic control*)

CONTINIOUS EVOLUTION

Continious addition, removal and modification of hardware and software over *the complete life cycle* (often many years)

EMERGING BEHAVIOUR

The overall SoS shows behaviours that do not result from simple interactions of subsystems

Usually not desired in technical systems, may lead to reduced performance or shut-downs

Examples
- Power oscillations in the European power grid
- Oscillations in supply chains

PARTIAL AUTONOMY

Local actors with local authority and priorities

Autonomous systems ...
- cannot be fully controlled on the SoS level
- need incentives towards global SoS goals

Examples
- Local energy generation companies
- Process units of a large chemical site

EXAMPLES OF CYBER-PHYSICAL SYSTEMS OF SYSTEMS

Integrated large production complexes
- Major source of employment and income in Europe
- Major consumer of energy and raw materials
- Many interconnected production plants that are operated mostly autonomously with distributed management structures

Transportation netwroks (road, rail, air, maritime, ...)
- Vital to mobility of EU citizens and the movement of goods
- Large integrated infrastructures with complex interactions, also across national borders
- Involve multiple organizational and political structures

Many more examples, e.g. smart (energy, water, gas, ...) netwroks, supply chains of manufacturing

ARTEMIS Innovation Strategy and Research Priorities

Example: High level Research Priorities CPSoS

- Decision structures and system architectures
- Self-organisation, structure formation, and emerging behaviour in technical systems of systems
- Real-time monitoring, exception handling, fault detection and mitigation of faults and degradation
- Adaptation and integration of new components
- Humans in the loop and collaborative decision making
- Trust in large distributed systems

Conclusion

- ARTEMIS Strategic Research Agenda
  - R&D strategy and priority topics for Embedded Intelligence and Cyber Physical Systems
  - Cyber Physical Systems of Systems: Challenging topic with high visibility within the SRA 2016
- Way forward
  - Disseminate (refined) R&D topics to various European and National Funding Programmes
  - Implement SRA by multitude of strategically aligned R&D projects
  - Technology transfer and result dissemination through ARTEMIS Community with its Centers of Innovation Excellence.

You are welcome to join!

Thank you