ARTEMIS-IA
Strategic Research Agenda 2016

Workshop CPSoS: The next Challenge

Hannover Fair, April 26th 2016

Jürgen Niehaus
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
  - Advance **Research and Technology in Emb**edded Intelligence and Cyber-Physical Systems
  - 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

Private Association(s)
- General Assembly
- Steering Board
- Working Groups

Joint Undertaking
- Governing Board
  Strategic planning
  Supporting Committee
  Rules of operation, supervision
- Public Authorities Board
  Calls, evaluation and funding
- Private Members Board
  Draft MASP, AWP
- Executive Director
  Secretariat, operations and finances

Public Authorities
- JU Member States
- EC

Industry (incl. SME) & Research actors
# SRA and R&D funding programmes

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<th>ETP AENEAS VMS</th>
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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...
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.
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**
- Many distributed, real-time computing systems and physical systems

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

**PHYSICAL CONNECTIONS**
- Material/energy streams
- Shared resources (e.g., roads, airspace, rails, steam)
- Communication networks

**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 networks (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, ...) networks, supply chains of manufacturing

**SYSTEMS OF SYSTEMS (SOS)**

**MANY INTERACTING COMPONENTS**
- Large industrial sites with many production units
- Large networks of systems (electric grid, traffic systems, water distribution)

**Physical Connections**
- Continuous addition, removal and modification of hardware and software over the complete life cycle (often many years)

**CONTINUOUS EVOLUTION**

- MANY DYNAMIC RECONFIGURATION COMPONENTS
- Components may...
  - Be switched on and off (as in living cells)
  - Enter or leave (as in air traffic control)

**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
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