ARTEMIS 2013 AIPP5

EMC²

A Platform Project on Embedded Microcontrollers in Applications of Mobility, Industry and the Internet of Things

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… in cooperation with entire Project Management Team

Motivation for EMC²

- Very fast technological advances of µ-electronics in past decades
- Amazing capabilities at lowered cost levels
- Today primarily exploited in consumer-oriented products
- Systems quickly put together since the next technology generation is already waiting around the corner
- Errors may be tolerated and a new execution attempt started
- This (and similar) way(s) of handling errors feasible for consumer products

Motivation for EMC² (cont'd)

- In professional areas this simplistic approach is not feasible
  - Industrial production
  - Automotive
  - Avionics
  - Space
  - Systems with high data volume such as multi data centers
- Have to fulfill real-time safety requirements
- It is prime task of EMC² to bring those two worlds together
- Develop methods for safe use of modern embedded multicore controllers
- Help European industry to stay competitive

Project Overview
Numbers

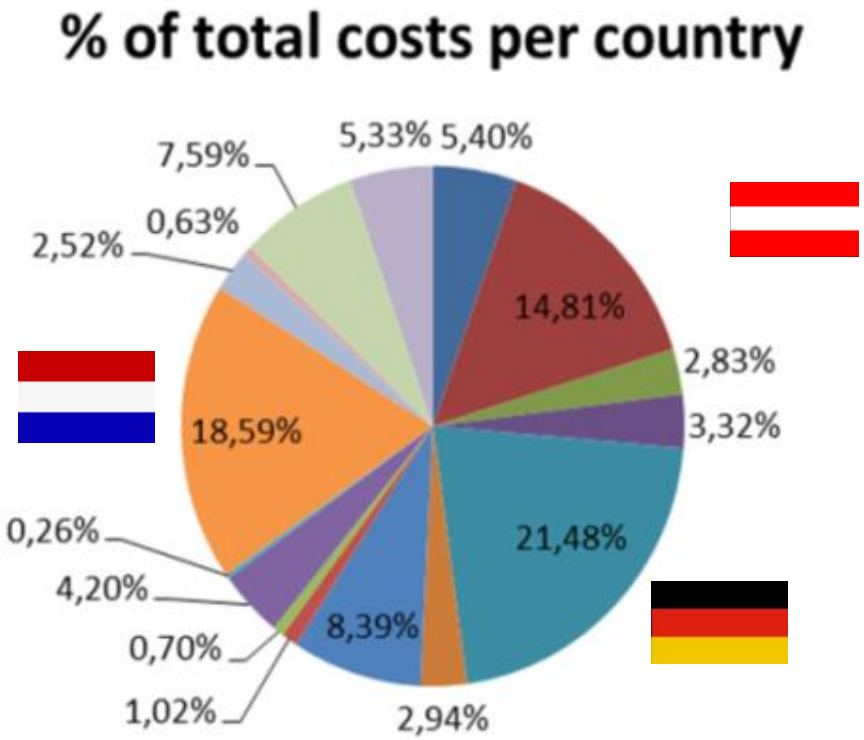
Embedded Multi-core Systems for Mixed-Criticality Applications in Dynamic and Changeable Real-Time Environments – EMC²

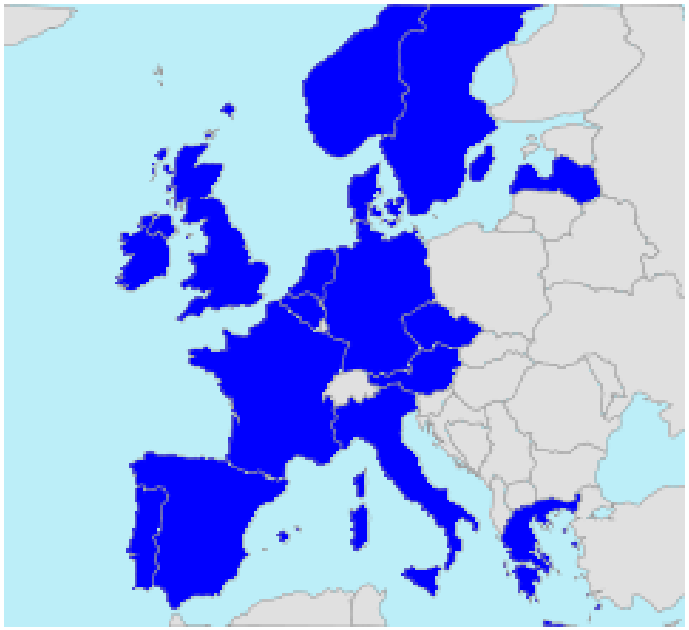
(Artemis Innovation Pilot Project (AIPP)

- AIPP 5: Computing Platforms for Embedded Systems
- Budget: 93.9 M€
- Funding: 15.7 M€ EU funding (Artemis)
  26.7 M€ National funding
- Resources: 9636 person months (803 person years)
- Consortium: 99 Partners, 16 EU Countries + Israel

→ Largest ARTEMIS-JU project ever!

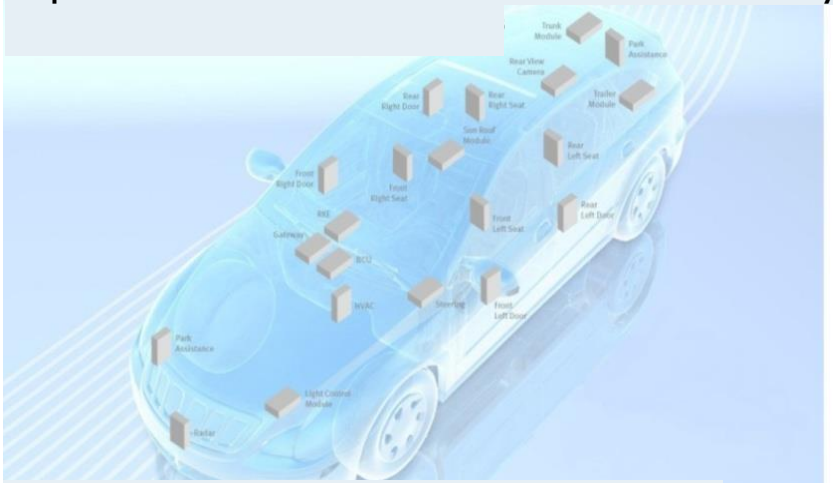
Project Overview
European Dimension



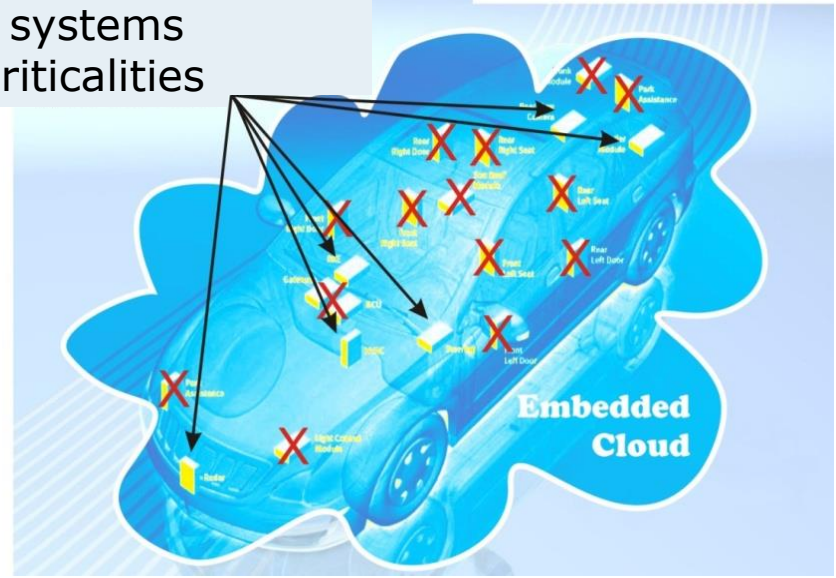


Reduce Number of Control Units
Save cost and increase performance

Many heterogeneous single-core systems, specialized for the individual criticality levels



Multi-core systems for mixed criticalities



Vision

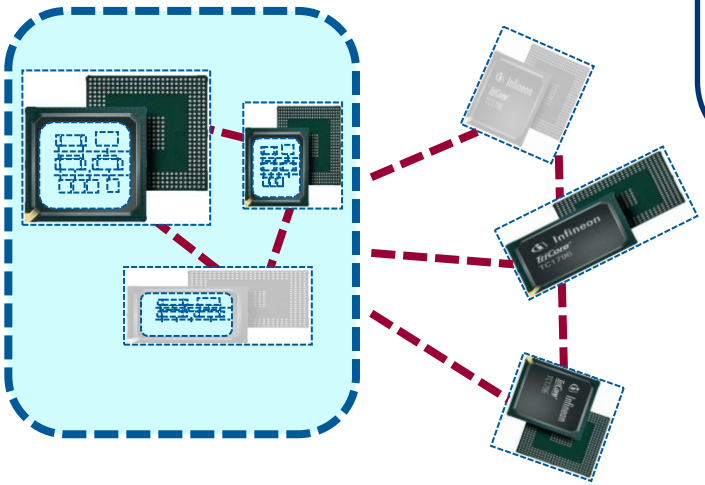
Aggregate resources
In multi/many cores,
ECU networks

Offer system properties as services and not as independent systems

Cyberphysical System: Criticality, Complexity and Dynamics in Embedded Systems

State of the art in Criticality:
- Handle different tasks in separate hardware

State of the art in Complexity and Dynamics:
- known number of control units and applications
- test before runtime
- Static scheduling of tasks, no dynamic changes at runtime

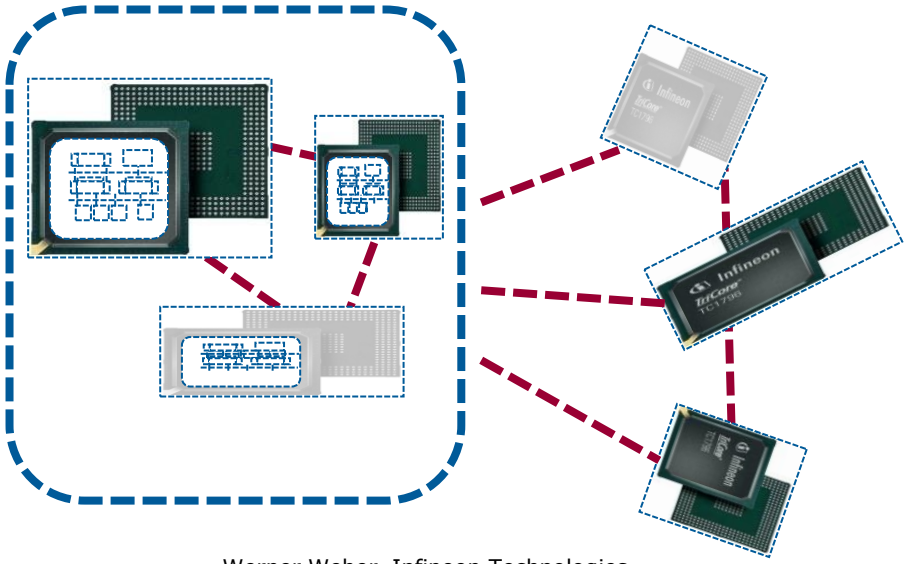


EMC² Goals:
- Handle mixed critical applications on one single die

EMC² Goals
- variable number of control units and unknown applications possible
- full range of dynamic changes possible

Technological innovation

- Mixed Criticality
  - Handle applications with different priorities
- Dynamic Re-configuration
  - Full range of dynamic changes on application level
- Hardware Complexity
  - Variable number of control units at runtime



Economic Impact of EMC²

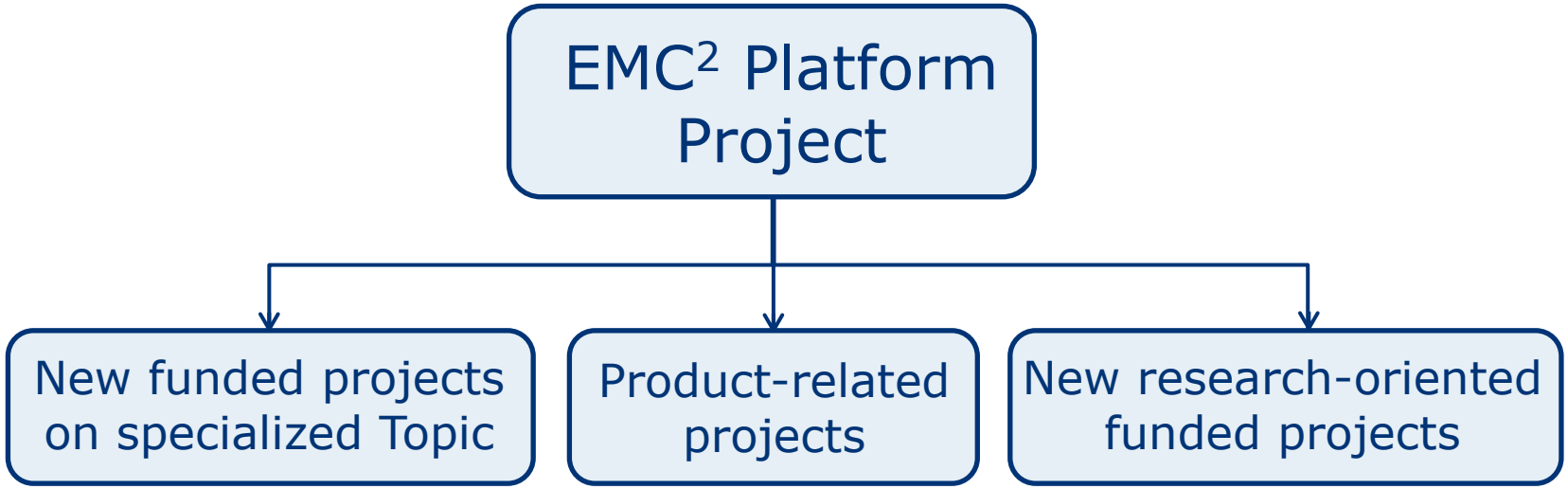
High impact of embedded systems to ***support and drive the innovation*** in many important market sectors:

- **Automotive**: key sector for the European economy, 12 million jobs, 26 billion annual invest in R&D by European car manufacturers; positive contribution to trade balance of € 90 billion p.a.; ***embedded systems enable >90% of innovations***.
- **Industrial control and factory automation**: revenue of 16.5 B€; 30% of energy consumed in the world is used for electric motors. ***Large potential for energy saving***;
- **Healthcare**: represents 25% of the EU economy; Challenges related to ***improving efficiency and effectiveness*** of healthcare

→ Multicore technology as enabler for driving the innovation!

EMC² a large-size project

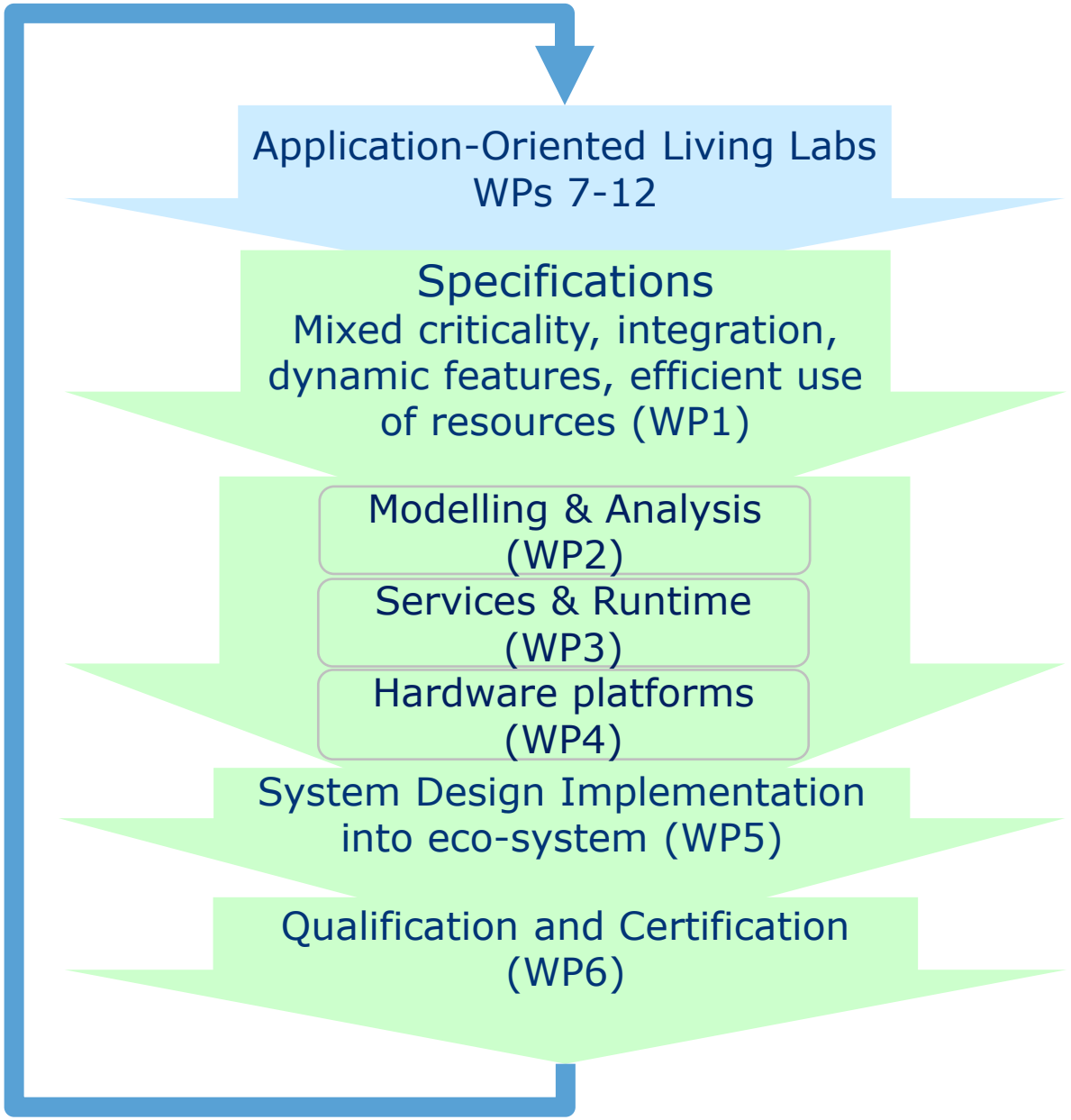
Large Size **platform project EMC²**
encourages and catalyzes new consortia on EU level
for product-oriented and successive funded projects



Project Management

- A project of this size can be technically managed although it requires significant dedication
- Project Management cares for
  - the overall structure and organizational framework,
  - Contracts (GA, CA, Deliverables)
  - the point of external contact,
  - inter WP relations,
  - the homogeneous look of the project
- A certain degree of de-centralization is necessary: two levels: WP management level; partner level
  - All demos developed on the level of a few partners

Bracket between WPs in EMC²



Application and technology innovation oriented WP structure

➢ Technology innovation oriented work packages

- WP1: SoA - Embedded system architecture
- WP2: Executable Application Models and Design Tools for Mixed-Critical, Multi-Core Embedded Systems
- WP3: Dynamic runtime environments and services
- WP4: Multi-core hardware architectures and concepts
- WP5: System design platform, tools, models and interoperability
- WP6: System qualification and certification

➢ Application innovation oriented WPs (Living Labs)

- WP7: Automotive
- WP8: Avionics
- WP9: Space applications
- WP10: Industrial manufacturing
- WP11: Internet of things
- WP12: Cross domain applications

EMC² Project Architecture

What is unique about EMC²?

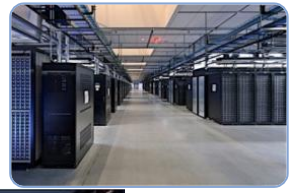
- All domains: Home Automation through Automatic Driving
- All areas: Sea, Land, Air and Space
- All driven by Embedded Computing
- All running a mix of applications
- All using Multi-Core ...

… but so far nobody knows how.

Application innovation

- EMC^2 - Embedded Multi-core Systems for Mixed-Criticality Applications in Dynamic and Changeable Real-Time Environments
- Applications: Automotive, Avionics, Space, Industry, Health care; Infrastructure
- Improve performance, lower cost
- Improve energy efficiency







Application Topics in EMC²

- Automotive
- Avionics
- Space
- Industrial manufacturing
- Logistics
- IT-infrastructure (‘Internet of Things’)
- Healthcare
- Railway
- Seismic surveying







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- **Healthcare**
- Railway
- **Seismic surveying**










EMC² - Medical Imaging (Philips, TNO, Vector Fabrics, TUDelft)

Objective / Scope

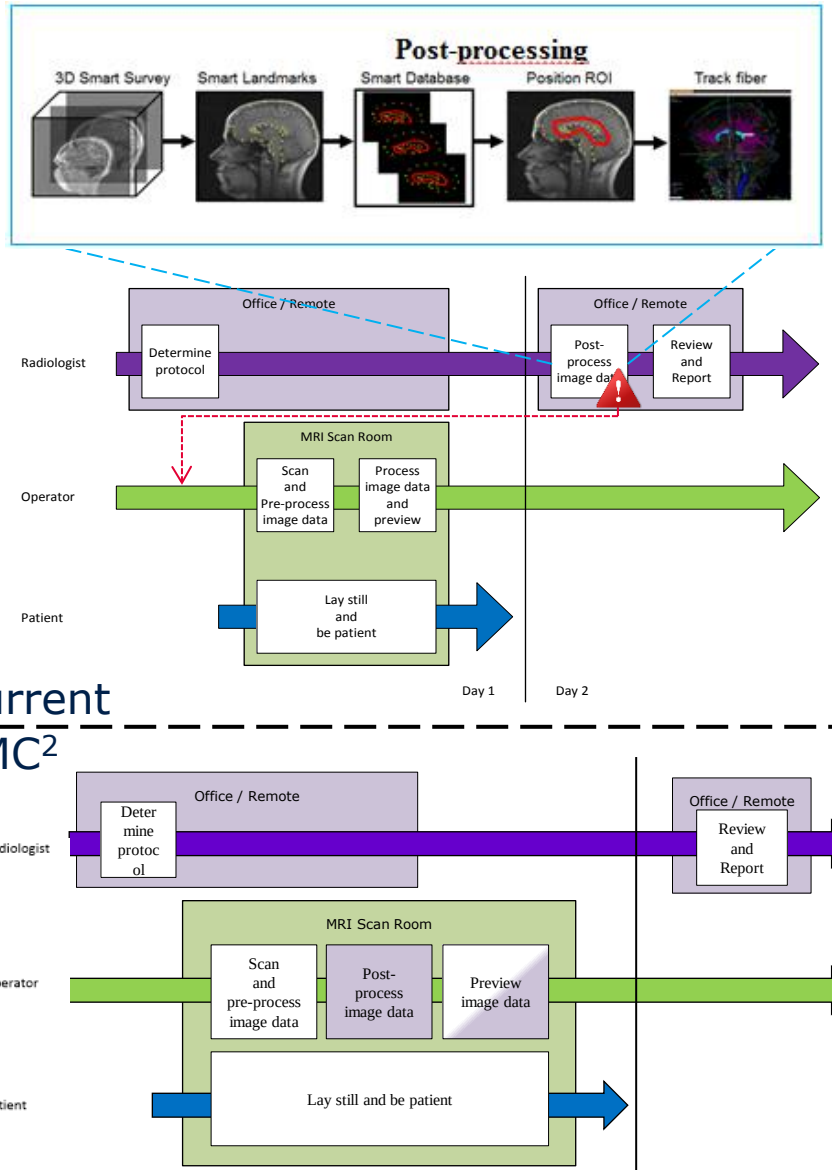
- Today: problems in data acquisition not visible to the operator in examination room → often rescan needed.
- Prevented when multiple mixed-critical systems are combined on hardware level.
- Challenges to manage mixed-criticality

Project Goals

- Reduce number of systems
- Bring reconstruction and post-processing into examination room

Exploitation

- Prevent patient recall
- Reduce hardware and maintenance cost



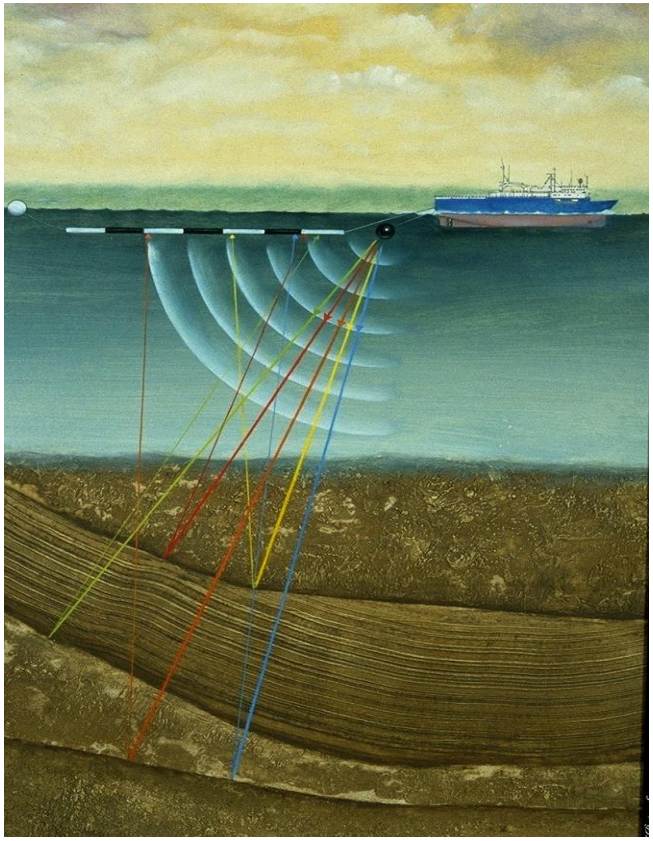
EMC² Seismic processing

(WesternGeco, Simula, U. Oslo, Fornebu, KTH)

Purpose: Produce images of geological features and their structure below the surface of the earth

On sea:

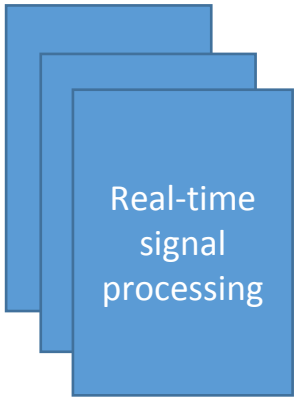
- Networked computers
  - In the streamers > 2 000 computers
  - Onboard the ship > 200 computers
- Compute power > 2 Tflops
- Number of sensors > 200 000
- Huge Data rate 1-3 Gbit/s
- Disk capacity > 100 Tbytes



EMC² Seismic processing
(WesternGeco, Simula, U. Oslo, Fornebu, KTH)

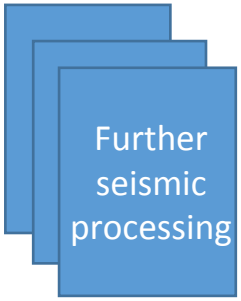
Real-time processing on sea:

300 Mbit/sec per streamer

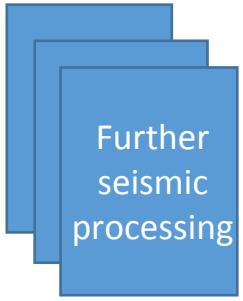


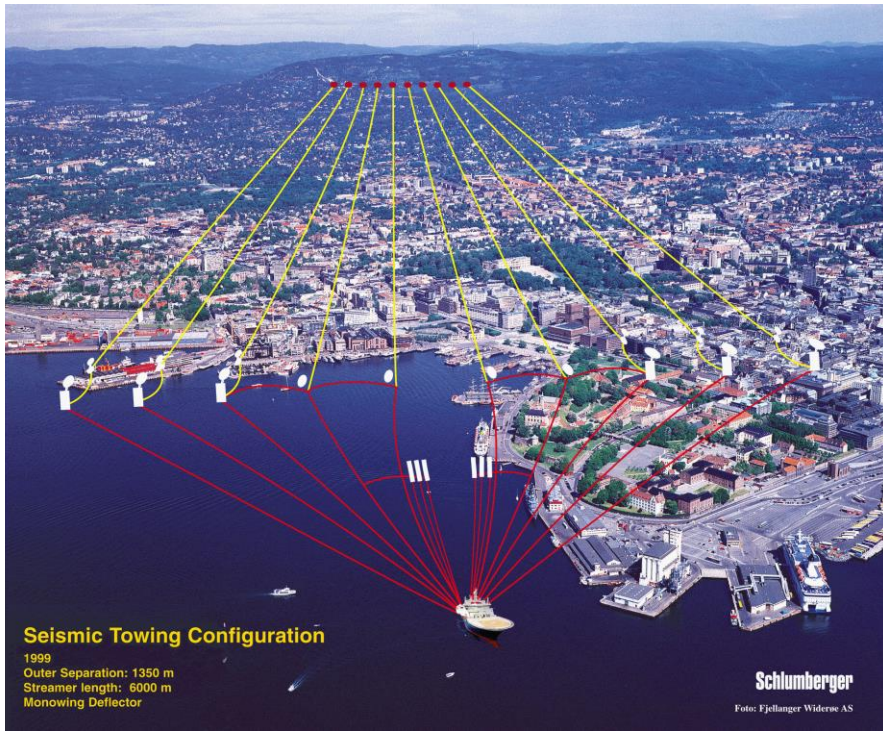
300 Mbit/sec per streamer

On ship:



On land:





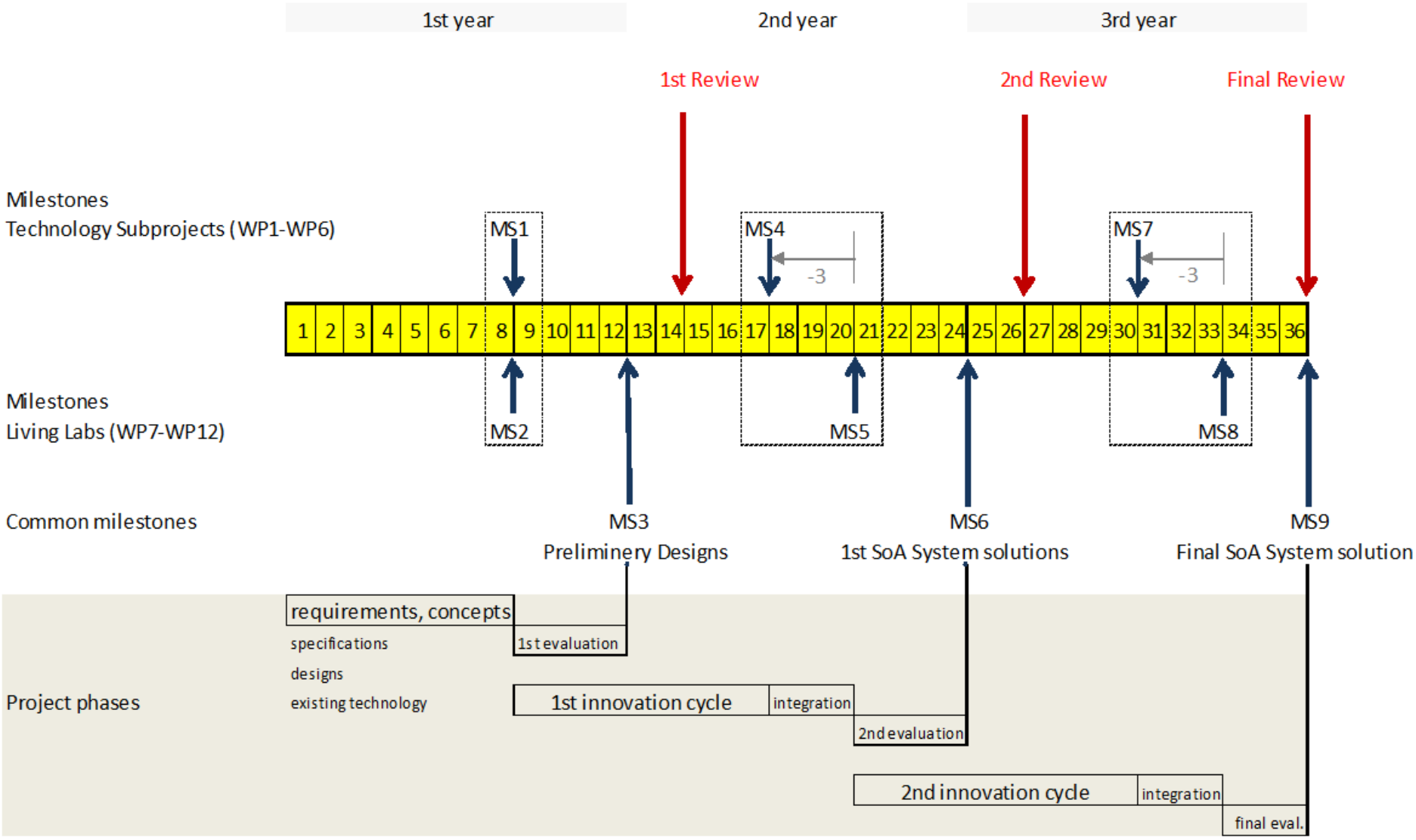
200 computers with 4 000 cores

8-14 streamers behind ship
Streamer length 10km - 14 km
100 - 200 computers per streamer
200 000 sensors per streamer

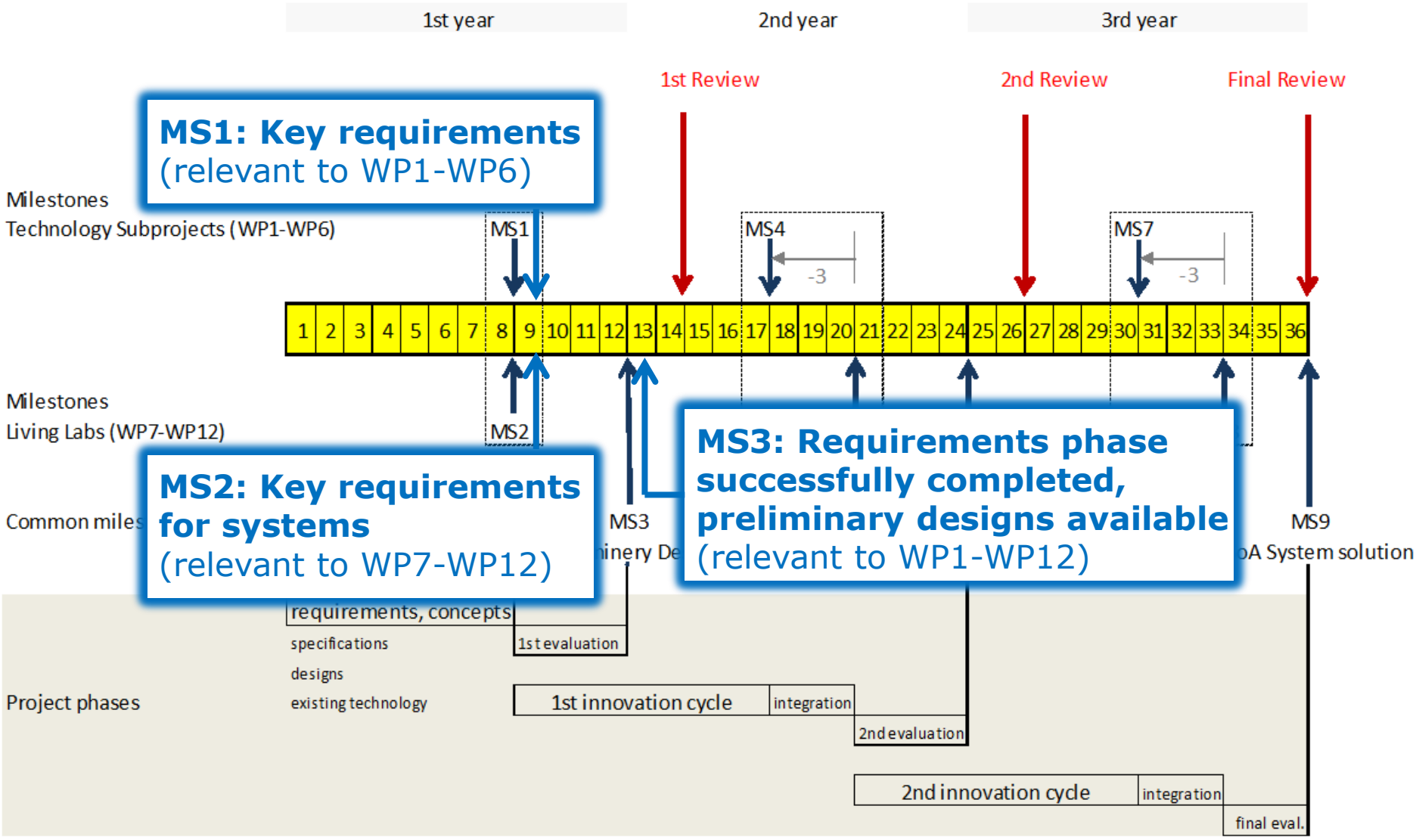
Public project website

- First version online at project start: www.emc2-project.eu
- New and significantly extended version online since beginning of July 2014: www.artemis-emc2.eu
- Website is updated whenever news, events and other information for publication becomes available (latest update after finalisation of the 2nd EMC² Newsletter)

Work Plan


1st year
2nd year
3rd year
1st Review
2nd Review
Final Review
Milestones
Technology Subprojects (WP1-WP6)
MS1
MS4
-3
MS7
-3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Milestones
Living Labs (WP7-WP12)
MS2
MS5
MS8
Common milestones
MS3
Preliminery Designs
MS6
1st SoA System solutions
MS9
Final SoA System solution
Project phases
requirements, concepts
specifications
designs
existing technology
1st evaluation
1st innovation cycle
integration
2nd evaluation
2nd innovation cycle
integration
final eval.

Project monitoring: Milestones MS1, MS2, MS3 achieved



Conclusion

- Project Ramp-up and specification phase successfully completed
- Project on track
  - all deliverables available
  - milestones MS1, MS2, MS3 achieved
  - minor delay compared to plan;
    likely to be recovered during P2 and P3
- Now project heads for implementation of preliminary designs