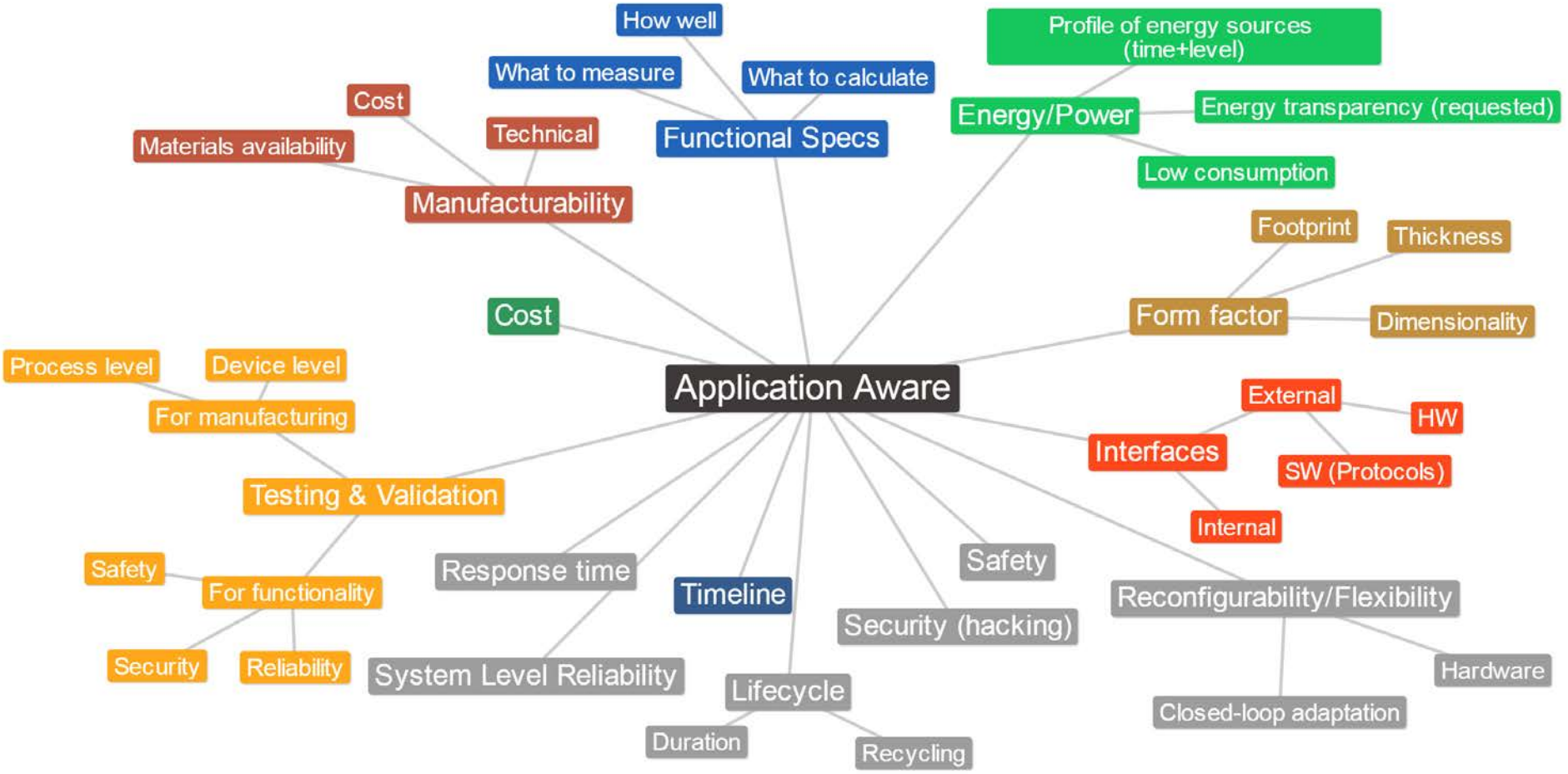
NanoElectronics Roadmap for Europe: Identification and Dissemination

2nd General Workshop

Athens, April 6-7, 2017

WP5/Task.5.1

Top-Down Approach: first draft



Aeneas Strategic Agenda

Design Technology is the essential link between the ever-increasing technology push (More Moore (MM) and More-than-Moore (MtM)) and the new products and services required to fulfil societal needs for mobility, security, health, communication, education, digital life style, and safety.

Competitive Value and Grand Challenges

- To compete with low labour-cost countries, it is of topmost importance for Europe:
  - to develop and offer **sophisticated feature-rich innovative products** with the superior performance and quality needed **to justify a higher price tag**
  - **Time-to-market** is of crucial importance
- A seamless, open and extendable design ecosystem with
  - **standards which starts at system level**
  - **flexible design flows** for all design domains and heterogeneous subsystems
  - **(co-)design** with and for sophisticated feature-rich innovative products of superior performance and quality
- Design Technologies apply also to
  - **heterogeneous devices** comprising power
  - **AMS and communication subsystems** (RF or optical)
  - **sensors and actuators** (e.g. MEMS) based on mixed

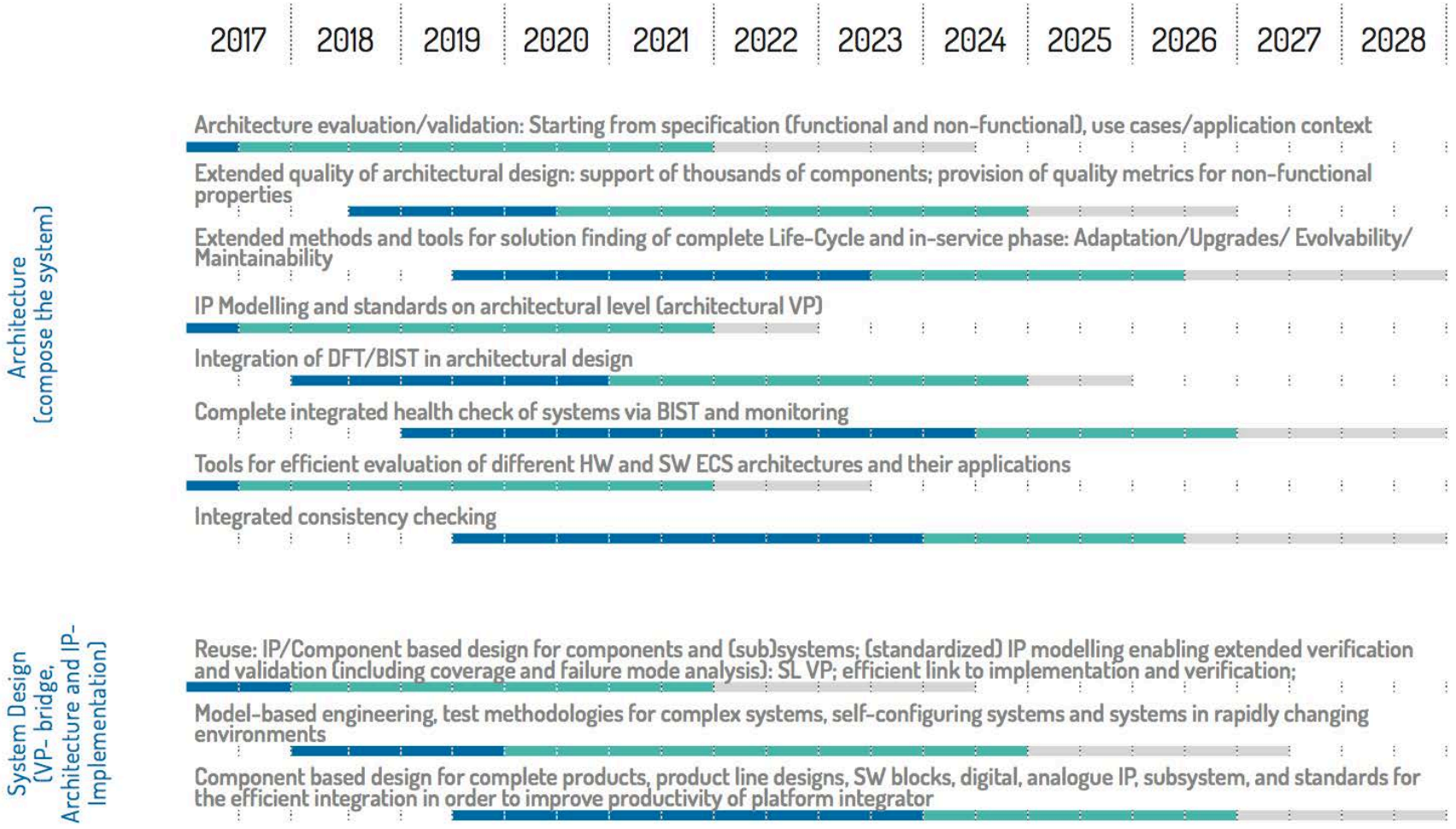
The 3 Grand Challenges

1) **Managing Complexity**
2) **Managing Diversity**
3) **Managing Multiple Constraints**

Designing these highly integrated and complex products requires improved methods for:

- On-chip integration
- Verification
- Embedded Software
- Technology downscaling

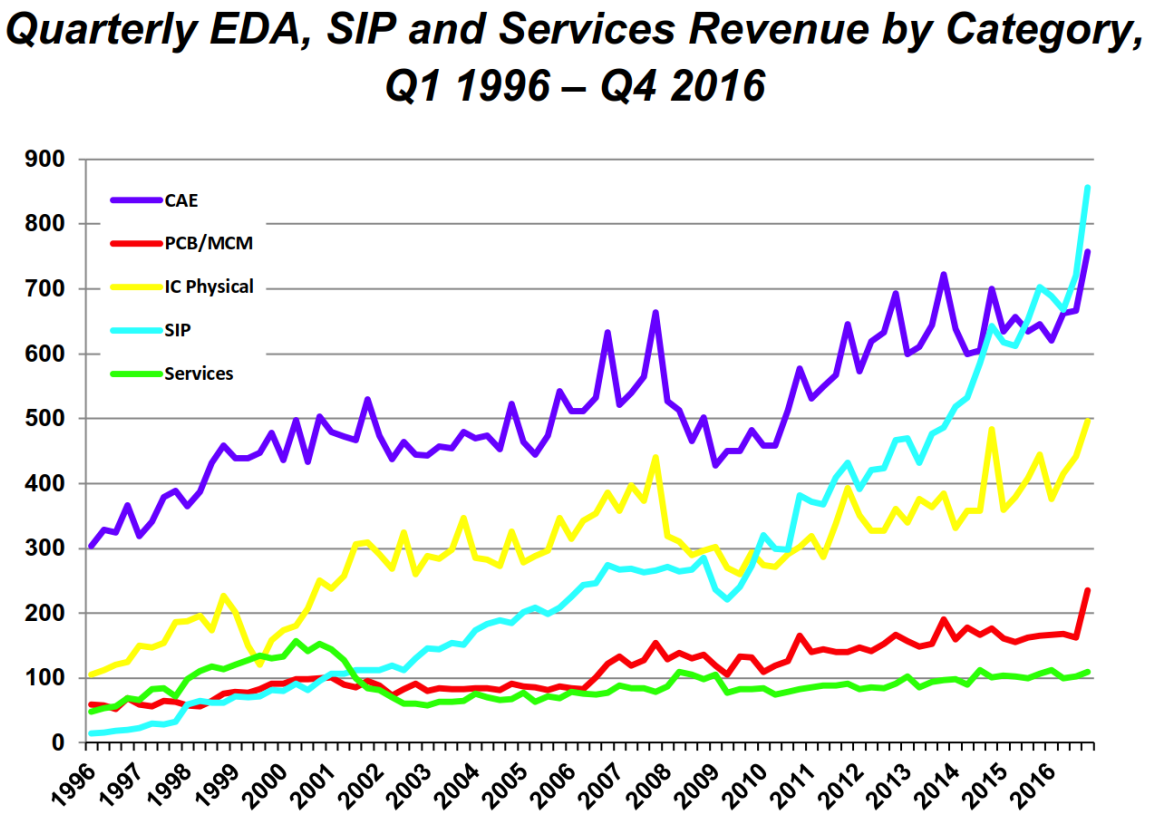
Examples from Aeneas Roadmap



Outcomes from the Experts at Domain Workshop in Lausanne March 31, 2017

Inputs from Industrial Co-Leader Ralf Pferdmenges, Infineon

- New technologies like AI, machine learning, neural networks… will change how we will design in the future
  - Europe should be one of the early users of these new technologies and their potential
- Growing activities and importance of SIP (System IP)



Most Important Outcomes

- Add **Software** in the middle, starting from the Application
- **The value is not in the Device but the Data**, the Information at Systemic Level
- **Validation**: Level of Robustness that is Acceptable, Confidence => **When is it done**?
- **Balance** of how much happens at each node and the energy for transmission (for reliability/security reasons too)
  - Where to position the intelligence
  - From Embedded Computing to Embedded Intelligence
- Definition of **Standards** for Interoperabilty. openess of standard cannot prevent monetisation.

Most Important Outcomes

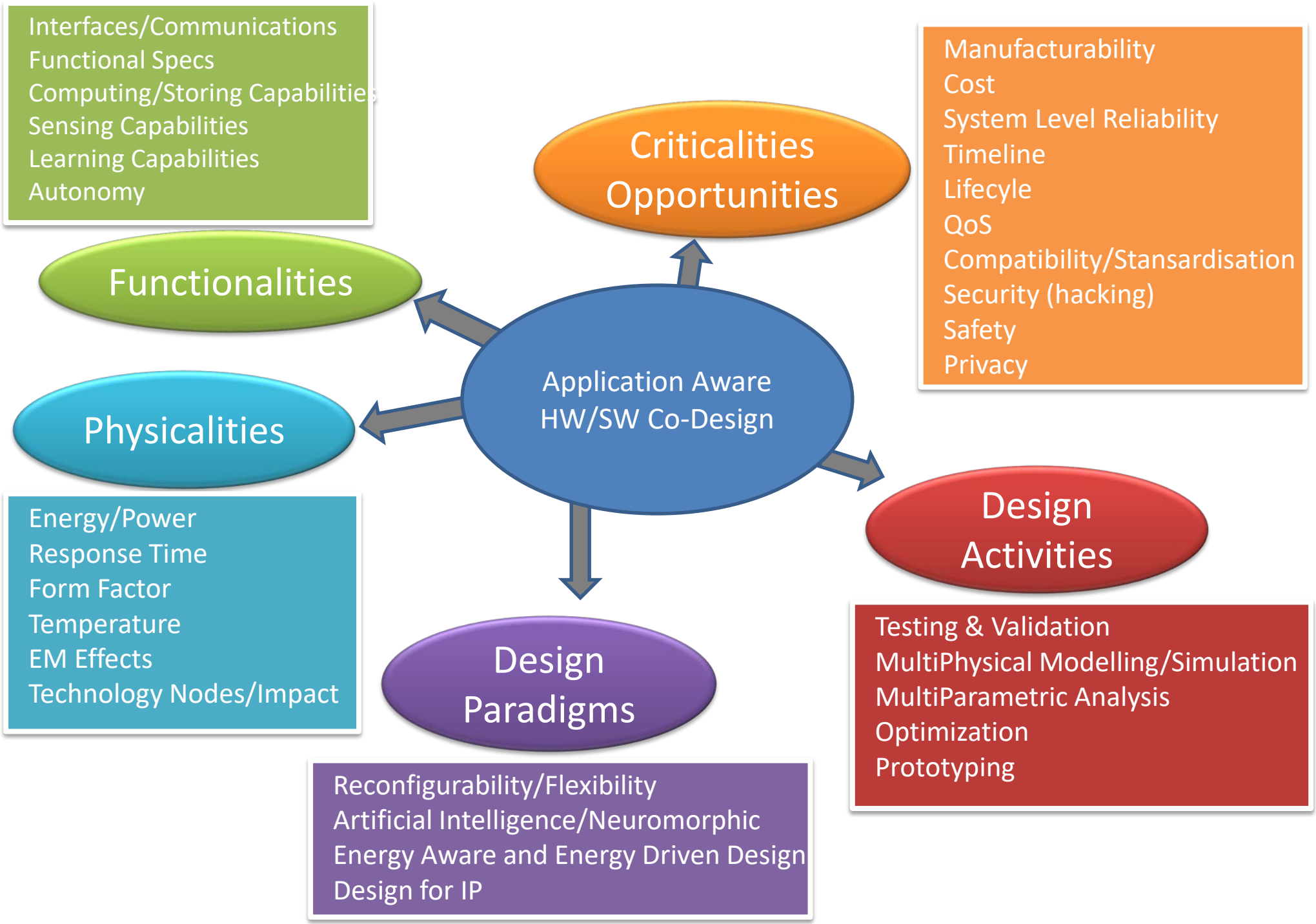
- **Re-Usability / Reconfigurability**
  - Software-like re-programmability with (almost) hardware like efficiency
- **Energy**
  - Management
  - Consumption when is necessary only
  - Importance **of categorizing the application in terms of Energy Boundaries**
- **Automated Design Space Exploration** and **Automated Design Decisions**
- **From Connected Devices to Distributed Embedded Systems** (System of Systems) => Network Synthesis, Network is a Design Dimension
- **Very Good opportunity for Europe to drive the increase in System Knowledge**

Most Important Outcomes

- **Environment is Part of the System**

- Simplify the list => Reduce the 1st level Concepts/Technologies
  => Decided to follow the scheme of Alex Yakovlev
  - Functionalities:
    - Compute, Sense, Communicate, Store, Learn, AD Convert, DC-DC Regulate …
  - "Physicalities":
    - Time, Power, Temperature, EM effects, Size, Technology nodes …
  - Criticalities:
    - Reliability, Performance, QoS, Cost, Autonomy, Survivability, Compatibility, Manufacturability, Productivity …
  - Design Paradigms:
    - Codesign(s), Low Power, Real-Time, Real-Power, Model-based, Reconfigurable, Scalable …
  - Design Activities:
    - Specification, Modelling, Analysis, Simulation, Optimization, Testing & Validation, Prototyping, …

The New Map


Interfaces/Communications
Functional Specs
Computing/Storing Capabilities
Sensing Capabilities
Learning Capabilities
Autonomy
Criticalities
Opportunities
Manufacturability
Cost
System Level Reliability
Timeline
Lifecyle
QoS
Compatibility/Stansardisation
Security (hacking)
Safety
Privacy
Functionalities
Application Aware
HW/SW Co-Design
Physicalities
Energy/Power
Response Time
Form Factor
Temperature
EM Effects
Technology Nodes/Impact
Design
Activities
Testing & Validation
MultiPhysical Modelling/Simulation
MultiParametric Analysis
Optimization
Prototyping
Design
Paradigms
Reconfigurability/Flexibility
Artificial Intelligence/Neuromorphic
Energy Aware and Energy Driven Design
Design for IP

Functionalities

i) Functionalities		
a) Key research questions or issues		
Functional Specs		
Interfaces/Communications		
Computing/Storing Capabilities		
Sensing Capabilities		
Learning Capabilities		
Autonomy		
b) Potential for application or Application needs and Impact for Europe		
c) Technology and design challenges		
Functional Specs		
- What to Measure		
- What to Calculate		
- How Well		
Interfaces/Communications		
- Hardware		
- Software		
- External		
- Internal		
d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)		
e) Other issues and challenges, and interaction with other Tasks/WPs.		
Beyond CMOS, WP2		
Advanced Logic and Connectivity, WP 3		
Functional Diversification, WP4		
Heterogeneous Integration, Task 5.2		

Functionalities

c) Technology and design challenges		
Functional Specs		
- What to Measure		
- What to Calculate		
- How Well		
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Physicalities

ii) Physicalities		
a) Key research questions or issues		
Energy/Power		
Response Time		
Form Factor		
Temperature		
EM Effects		
Technology Nodes/Impact		
b) Potential for application or Application needs and Impact for Europe	…	…
c) Technology and design challenges	…	…
Energy/Power		
- Profile of Energy Sources		
- Energy Transparency (requested energy)		
- Low Consumption		
Form Factor		
- Size		
- Footprint		
- Dimensionality		
d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)		
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Heterogeneous Integration, Task 5.2		

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c) Technology and design challenges
Energy/Power
- Profile of Energy Sources
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Heterogeneous Integration, Task 5.2

Criticalities / Opportunities

iii) Criticalities/Opportunities		
a) Key research questions or issues		
Manufacturability		
Cost		
System Level Reliability		
Timeline		
Lifecyle		
QoS		
Compatibility/Stansardisation		
Security (hacking)		
Safety		
b) Potential for application or Application needs and Impact for Europe		
c) Technology and design challenges		
Manufacturability		
- Technical		
- Cost		
- Material Availability		
Lifecyle		
- Duration		
- Recycling		
Security (hacking)		
- Trusted Executing Environment		
- Design for Security		
d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)		
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Advanced Logic and Connectivity, WP 3		
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Equipment and Manufacturing, WP6		

Criticalities / Opportunities

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Manufacturability
- Technical
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Equipment and Manufacturing, WP6

Design Paradigms

iv) Design Paradigms		
a) Key research questions or issues		
Reconfugurability/Flexibility		
Artificial Intelligence/Neuromorphic Computing		
Energy Aware and Energy Driven Design		
Design for IP		
b) Potential for application or Application needs and Impact for Europe		
c) Technology and design challenges		
Reconfugurability/Flexibility		
- Hardware		
- On Site Reconfigurability (Critical? Safe?)		
- Closed-loop Adaptation		
d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)		
e) Other issues and challenges, and interaction with other Tasks/WPs.		

Design Paradigms

c) Technology and design challenges
Reconfugurability/Flexibility
- Hardware
- On Site Reconfigurability (Critical? Safe?)
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d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)
e) Other issues and challenges, and interaction with other Tasks/WPs.

Design Activities

v) Design Activities		
a) Key research questions or issues		
Testing & Validation		
MultiPhysical Domain Modelling and Simulation		
MultiParametric Analysis		
Optimization		
Prototyping		
b) Potential for application or Application needs and Impact for Europe		
c) Technology and design challenges		
Testing & Validation		
- For Manufacturing		
Device Level		
Process Level		
- For Functionality		
Reliability		
Safety		
Security		
d) Definition of FoMs (quantative or qualitative) or planned evolution (based on SoA @ 2017 and evolution vs time)		
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Design Activities

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Testing & Validation		
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Thank you!