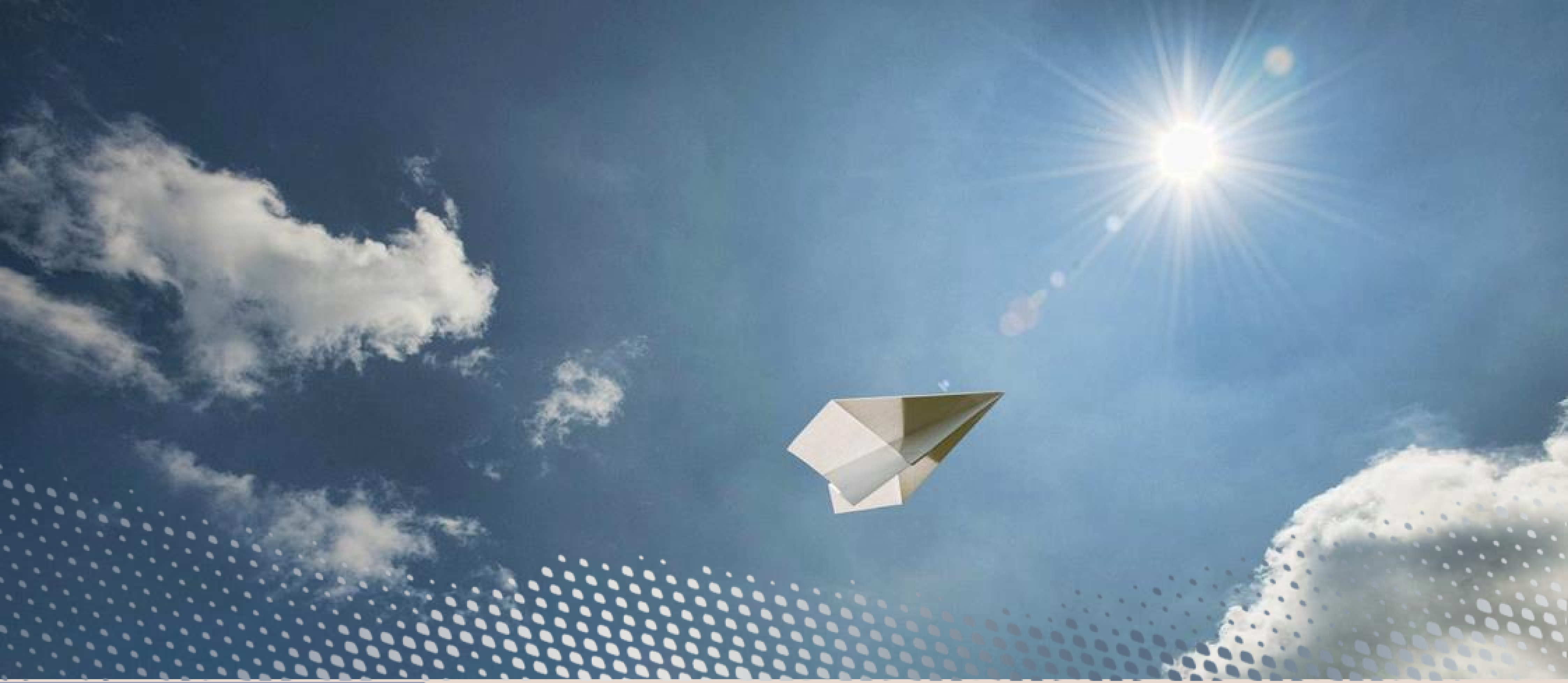

Systems for the Digital Age

Prof. Dr. Heinrich Daembkes,
Airbus Defence and Space, Electronics
29.09.2015

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Content

1. Airbus Group at a glance

AIRBUS

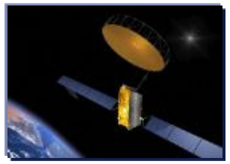

AIRBUS HELICOPTERS




AIRBUS DEFENCE & SPACE



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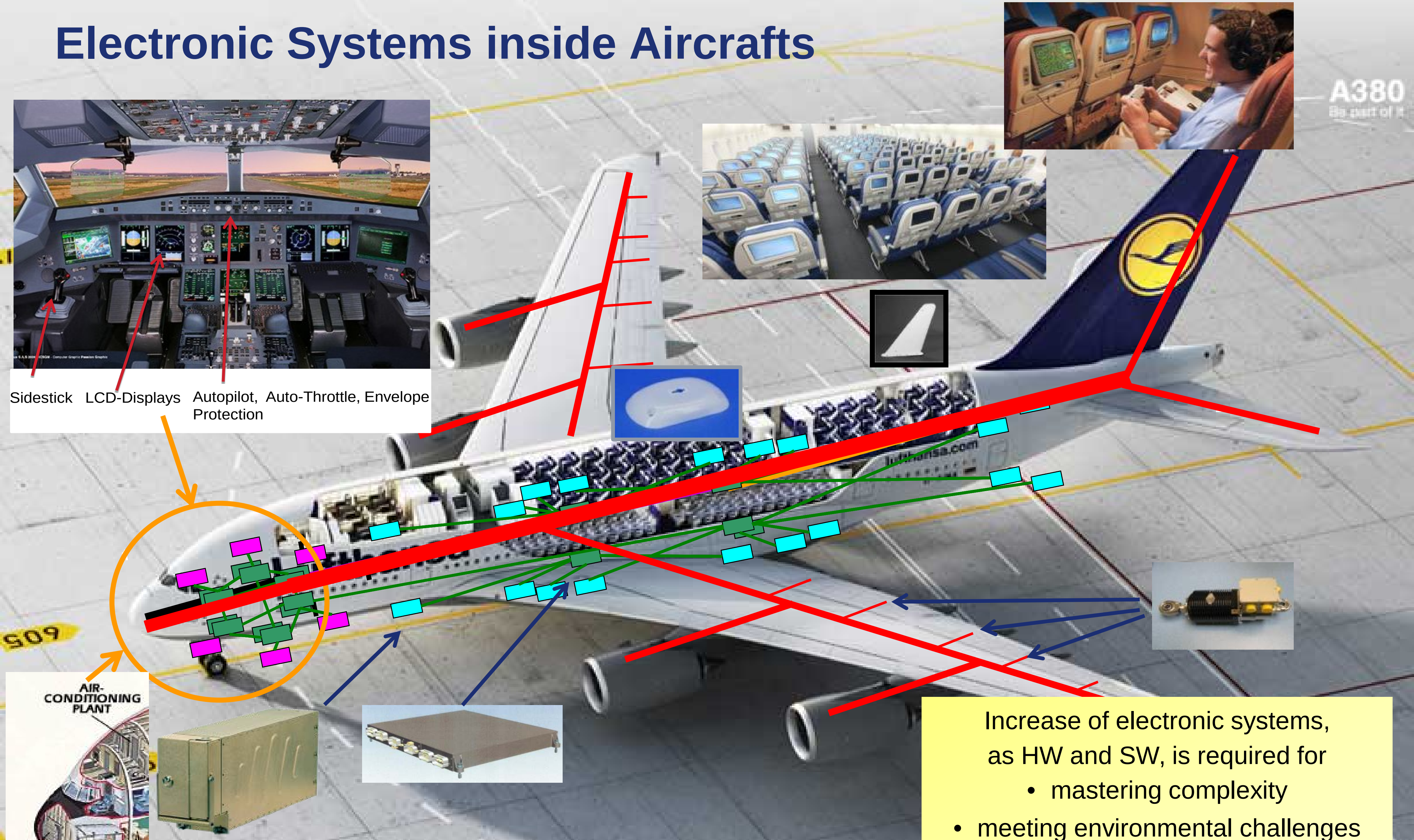
2. Trends

- We need to meet the “Grand Societal Challenges“
  (health, demographics changes, energy, environment, transportation, resources, , ….)
- To meet grand challenges:
  Products determined by their **built-in smart electronics**: HW + SW !!!
- Role of SW is exploding
- Systems are smart and connected
- More electric vehicles: Steady replacement of subsystems
- Degree of “automation” rapidly growing.
- Products / systems are becoming **increasingly complex:**
  - A 380 consists of more than 3.000.000 parts!
  - About 1000 processors
  - Some hundred km of cables
  - Many variants have to be supported.

Electronic Systems inside Aircrafts



Electronics: communication, information processing, control
Electric systems: power generation, actors
today ca. 25 % of flyaway cost of AC is related to electronics
Trend: More electric aircraft

Increase of electronic systems, as HW and SW, is required for

- mastering complexity
- meeting environmental challenges
- competitiveness
- cost efficiency

This impact will increase!

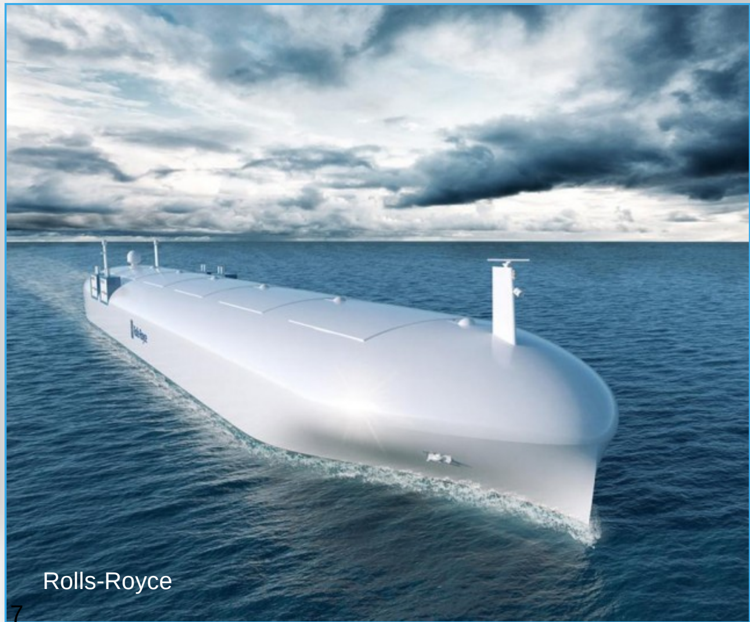
Electronics Systems: Airbus full-electric aircraft E-Fan

Automation – more than a trend!
Who is going to set the standards ?


Daimler


Google Apple car ?

Airbus


Rolls-Royce

Automation – not only on the roads: Where are we in Europe ?

What if the major part of value creation is in not mechanics but in electronics and in IT ?

Automated harvester (Wikipedia / Claas)

Google Wing

Project Wing is a Google X project aimed at developing self-flying delivery vehicles

Ascending Technologies

Logistics

Robot Mower

The role of electronics and digitisation: The unavoidable move to COTS and Global Sourcing

Modern commercially available **electronics components** are mainly driven by the consumer market (computers, smartphones, tablets…): **COTS**

DEVICE **LIFECYCLE IS SHRINKING**: Average shelf-life for some mobile phone components is currently 8-10 months!

- We need components that allow us to do systems upgrades essentially by SW updates.
- As system designers we need to take more provision for modular and SW based **extendibility.**

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Our Challenge: Make it Fly and make it safest

- **COTS are mandatory** (availability)
- We must **adapt** and make ultra reliable applications using parts which are less and less reliable in our harsh environments and
- Impact of **system design** (architecture) and software rapidly growing
- We must cope with **changing regulations** (RoHS, REACH, …) under difficult competition conditions between Europe, USA and Asia

WE MAKE IT FLY

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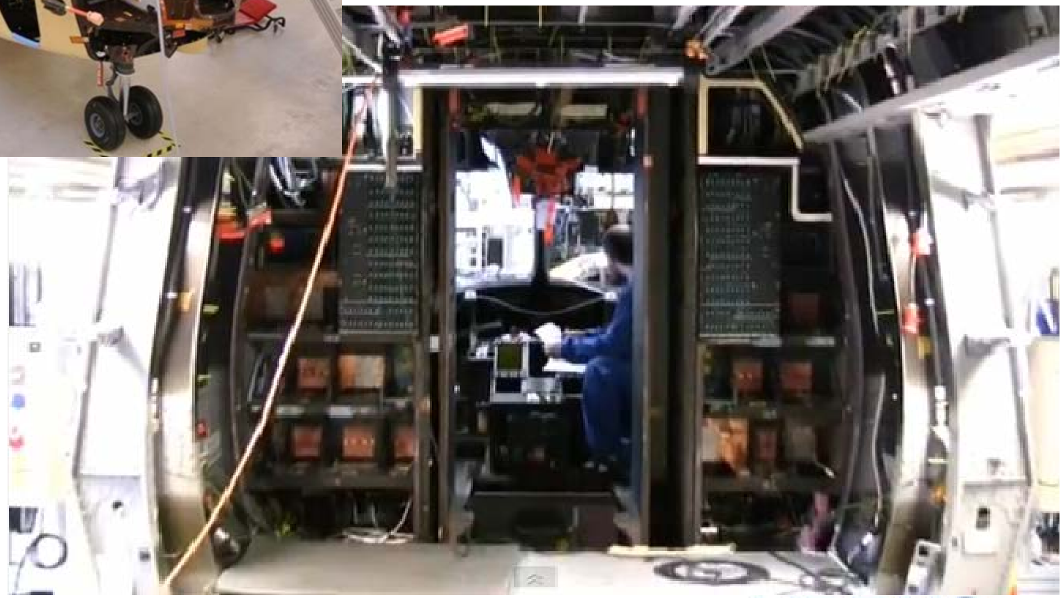
Evolution rate exploding



As designer and integrator of large systems
we are facing significant evolutions in electronics:
In 10 years,

- Computer power x 4
- Number of digital buses x 3
- Capability to run embedded software x 5
- New properties just by SW upgrades

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Electronics: The backbone of everything

Electronics are everywhere

Electronics are transversal and support more than **80%** of functional innovation in all Airbus

The electronics part is **increasing**, exceeding 20% of the total cost today

Key performance defined via **embedded SW**

"More electrical aircraft": more electronics, generalization of **power components** and advent of new specific architectures

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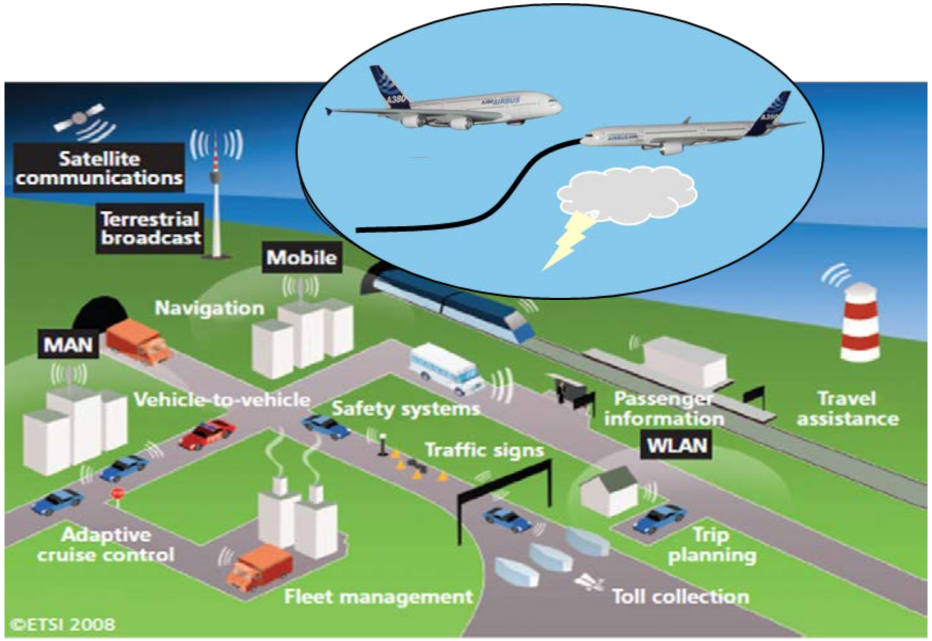
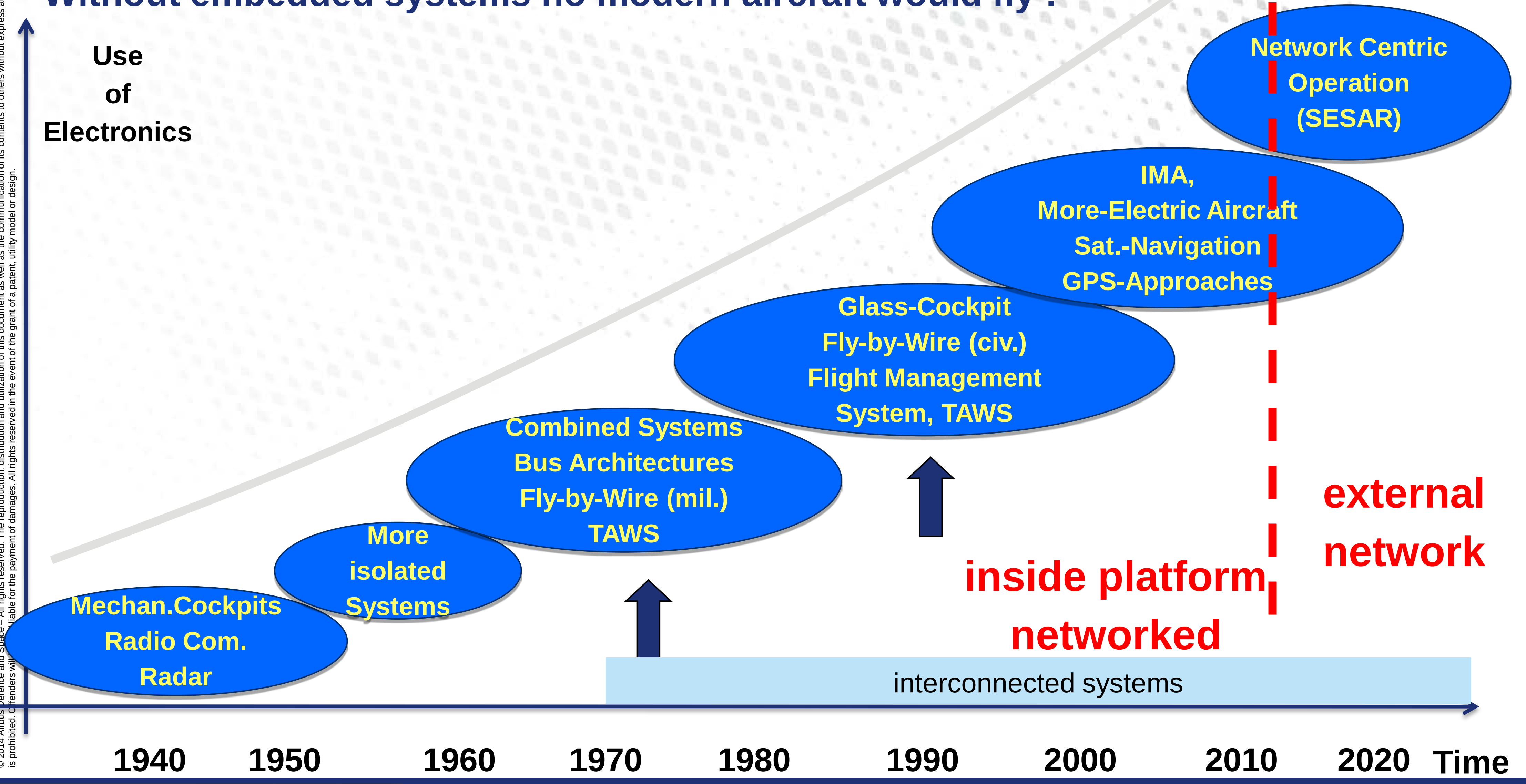
Increased Connectivity – Networked Systems

- An aircraft is no longer an isolated island in the air with respect to:
  - it‘s own **electronic systems and SW**
  - Ubiquitous (or permanent) **connectivity of its passengers**
  - Communication **exchanges with others** (airports, a/c…) through Air Traffic Management
- **Connected systems** create enormous opportunities and challenges in the air and on ground (seamless mobility, intermodal transportation, optimized use of resources, ..)
- Connected systems require **significant efforts to maintain security and safety** of operation



Increasing use of Electronics in Aeronautics

Without embedded systems no modern aircraft would fly !



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3. Impact of digitisation

- In our products
- In our processes
- New business opportunities

Digitisation in our products

- Sensors and actuators: Digital interfaces
- Communication:
  via digital busses inside
  via digital technologies to outside
- Control system: Fully digital

- Entire system performance:
  - behaviour digitized
  - envelopes: Digitised, parametrised
- Adaptation: just different parameter sets

- In flight: Continuous monitoring of relevant parameters
- Continuous reporting to ground
  → in service data !

Digitisation in our processes

Development tools are based on digitised information, requiring respective models.
Cooperation with partners/suppliers:
Common structures and interfaces.
Digital development chains will lead to (quasi) "full electronic certification"

Factory of the future will be highly automated, requiring paradigm changes in our processes.
3D printing, fully connected procurement, development, and production are examples

Data exploitation is the new frontier:
Towards full digitalization and
Big Data processing
for preventive actions and for improvement.

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4. Changes of paradigms ?

Challenge: **Minimize the risk of false action / hazards**

System Design *Functionality*	HW Design *Reliability*	SW Design *Quality*
Goal: • Safe function with minimized risk	**Goal:** • Limited probability of HW failure	**Goal:** • Safe function with minimized risk
Method: • Processes, organisation • Model centric development • FHA, FTA, FMEA • Automated validation (earlier: Statistical valid.)	**Method:** • Component failure rate • Design principle: Segregation, redundancy	**Method:** • Process, organisation • Coding rules • Reviews, verification • Automated SW testing

Aeronautic: Covered by ARP 4754 + DO 178N + DO 254 ..

System Modeling | Automotive: Covered by ISO 26262

Increasing complexity requires automated methods to asses the probability of failures

See also:
M. Fausten, Bosch: Absicherung von FAS und AD Systemen
Haus der Technik Fachbuch Band 137, 2015

5. Managing complexity

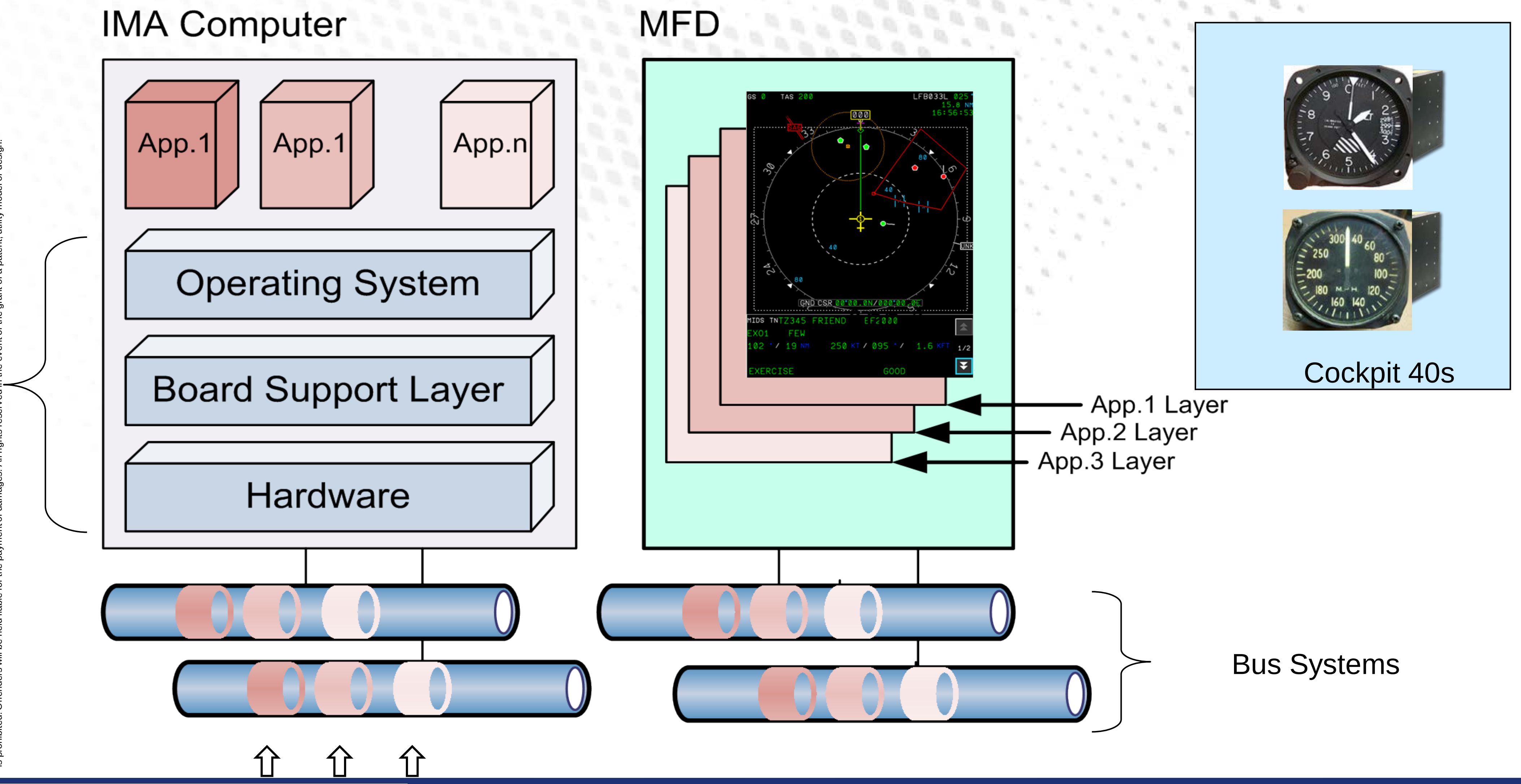
Concepts and approaches:

- Cut the elephant into slices before eating it:
  Partition the problem into well defined subsystems
  - with clear boundaries and interfaces (→ CESAR, CRYSTAL)
  - each of the subsystems well testable

- **Use model centric design** process with
  - well structured processes
  - suitable models that support the aspects / viewpoints to be covered (→ SPES-XT)

- **Identify emergent behaviour** esp. for connected systems
  (research topic !!!)

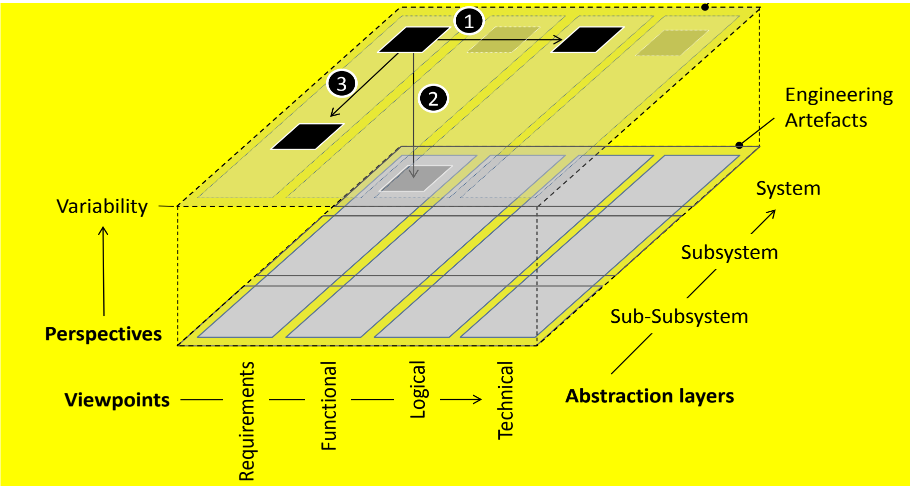
Example: Separation of Functions on IMA Computer and Network



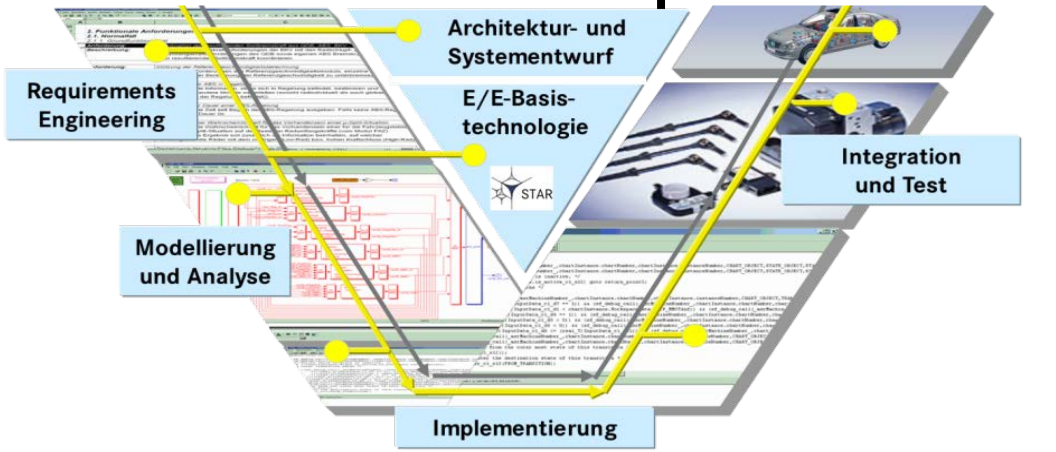
SPES_XT Research Project
Example: Management of Variants

Software Plattform Embedded Systems 2020

1. Extension of Modeling Theory



2. Seamless Methods, Embedded into Development Process



3. Implement in Tools

Requirements Viewpoint

Functional Viewpoint

MATLAB SIMULINK

pure::variants

Logical Viewpoint

AUTOSAR

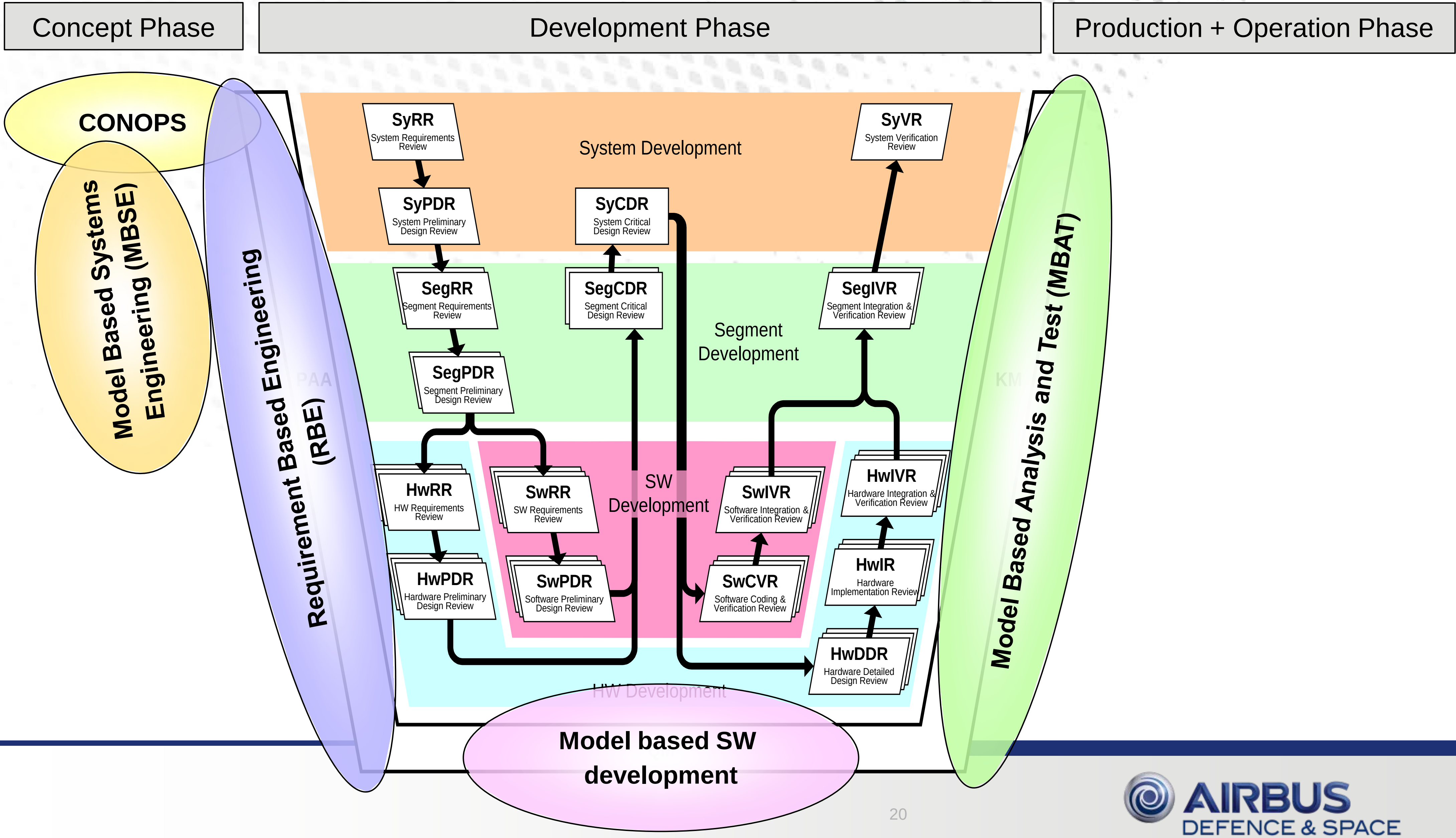
Technical Viewpoint

Bedatung

4. Case Studies

Approach well proven!

Use Processes:
Airbus Development Process with Model Support



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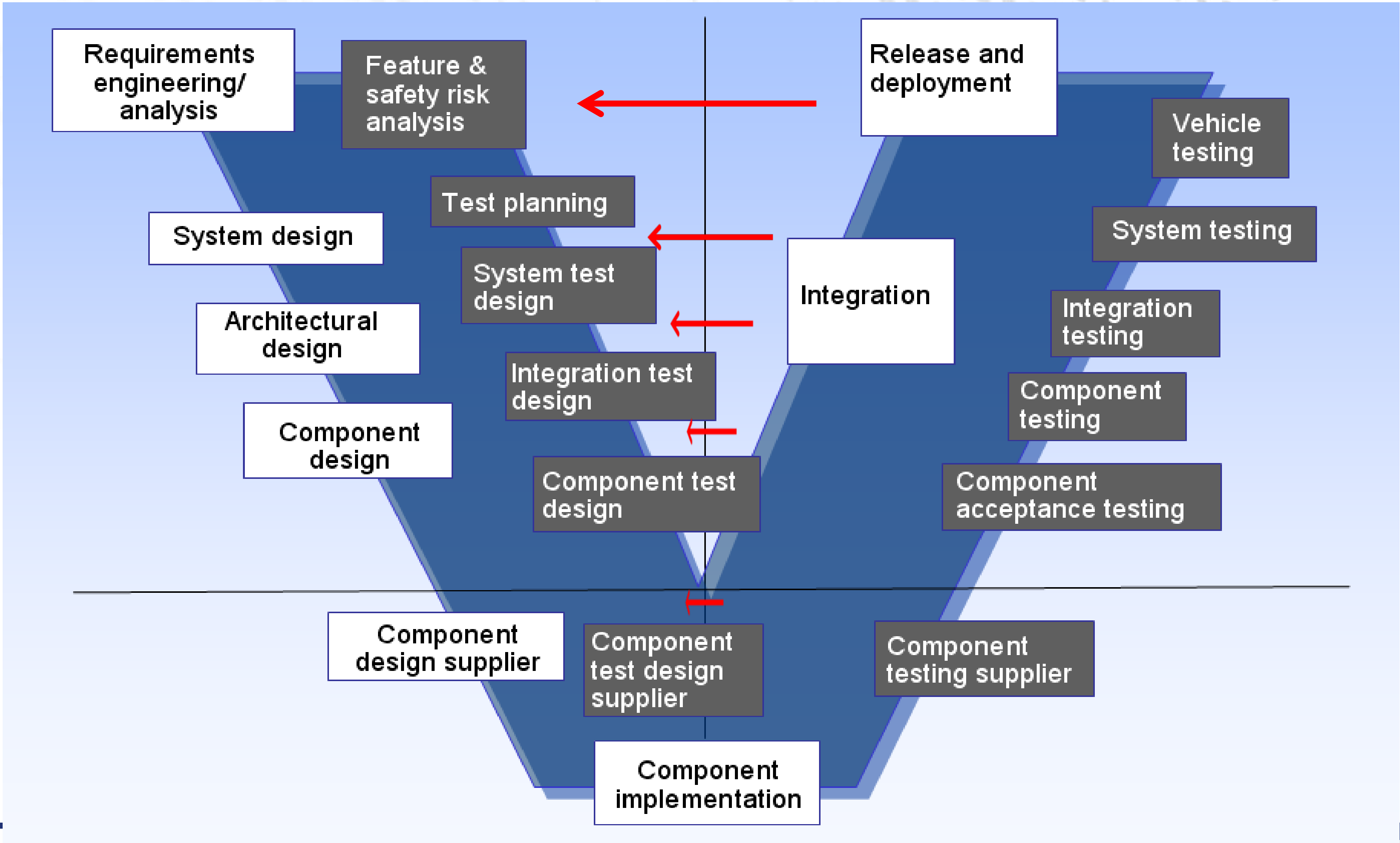
Model Based Analysis and testing: MBAT Project

V&V process improvement measuring

Testing inside V Model



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Example for new projects to handle complexity : Proposal for EU-Flagship Project

ECSEL Stakeholder Meeting
Flagship Proposal

European Platform for Leadership in Automated Vehicles

Heinrich Daembkes
Airbus Defence and Space

together with
AVL, Daimler, Finmeccanica, Thales
18.09.2015

Potential main players:
BOSCH, DAIMLER, BMW, AIRBUS, INFINEON, THALES, AVL, FINMECANICCA, VALEO, RENAULT, VOLVO, ..

Smart and connected highly automated vehicles*:

Leading edge technology and strongly growing market

Pre-conditions to be mastered for leading position:

- **Technology:** System architecture of interconnected systems
  Hardware (sensors, processors, ..)
  Software
  Integration
  Validation Testing
  New methods required, change of paradigm,
  conventional methods are not sufficient any more !
  → New effective and efficient development and validation platforms **are urgently needed to assure European advancement !**
- **Standards** to be developed, giving **competitive advantage**
- **Market:** customer acceptance
  cost efficient !

. * vehicles: cars, airplanes, ships, farming machines, trains, ..

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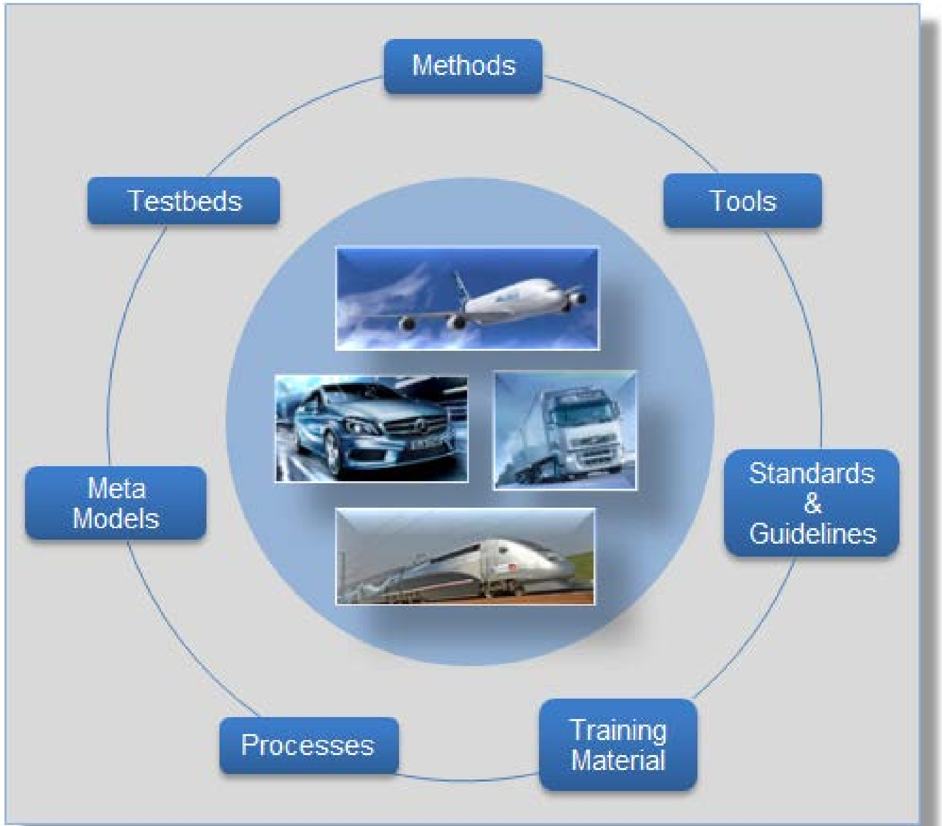
Platform Objectives:

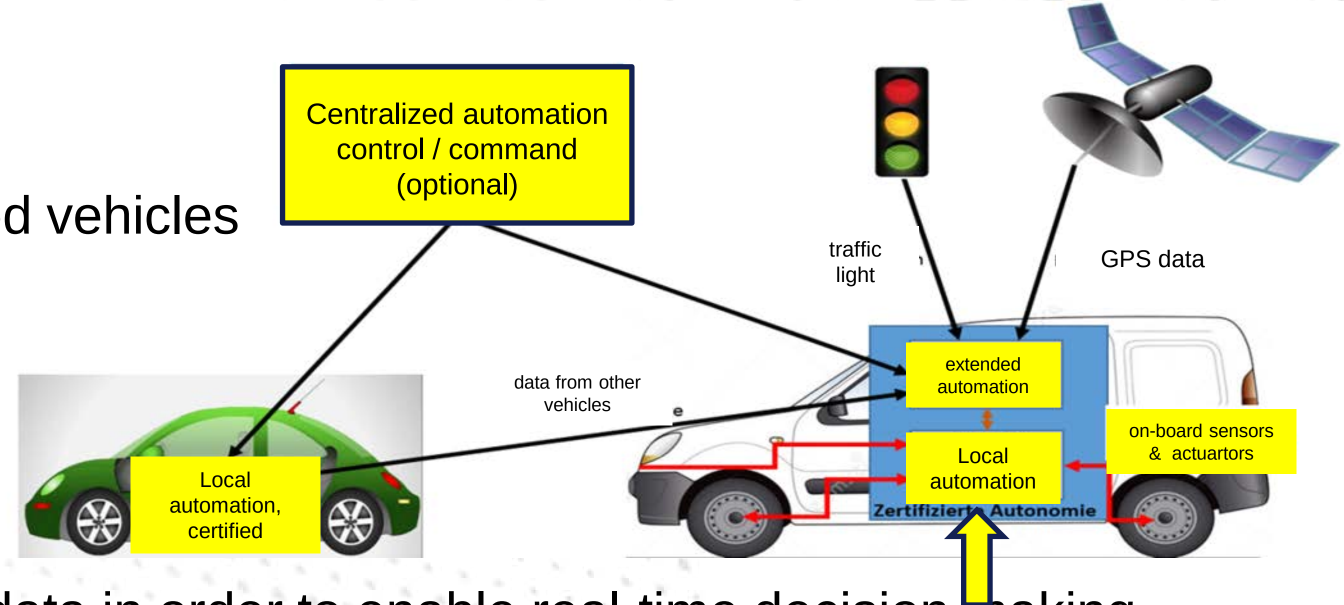


European Platform for Leadership in Automated Vehicles

- Develop the **necessary functionality,** software and HW-components, **pre-certified** to build advanced **secure and safe vehicles**.
- Continue to develop **technology for automated vehicles to make it available for large volume mass market** in doing research to improve production, optimize hardware and software components (e.g. by creating **standardized frameworks** for re-use **(**standardized sensors) and **better cooperation with partners**, etc.)
- Research on **design, development and in-use methodology and tools for automated vehicles**

All in order gain **competitive advantage** of the European industry over the new upcoming competitors in this area.

Challenges



- **Architecture** of automated vehicles itself and as parte of SoS
- **Sensors and actuators** incl. their SW for real-time data acquisition and management
- **Big data**: Handling of big data in order to enable real-time decision making
- Development and **standardization** of **common model of environment:** **Key standard for automation** !
- **Communication** and transfer of relevant information between vehicles and between vehicles and infrastructure.
- **Safety and security** aspects, esp. for communication (inside and outside vehicle)
- **Human interface aspects**, human centric design.
- **Legal** aspects

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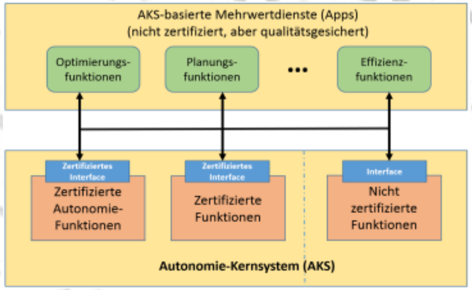
Example for complex connected systems:



Generic Concept of "Autonomy Kernel System"

Principal Layer Approach

Layer N Applications and Services

Layer x

Layer 4

Layer 3 Interaction with other mobile u

Layer 2 Interaction with infrastructure

Layer 1 local automation

Safety requirements increase

Services and Applications,
Impacting local functions and behavior

Local rules, impacting local functions,
potentially **overriding higher levels**

Transfer of local info to near by units
Transfer / update of "model of environment"
"Car2Car", or local info in SESAR

All info locally generated to be independent within limited envelope.
Local decision making for safety and performance
Local independence, **subsidiarity principle**

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Challenges for the near future

Increase of smart electronic systems in our products, as HW and SW, allows us to

- master complexity of systems and use cases
- meet environmental challenges
- Improve competitiveness and cost efficiency

- **Digitisation** is taking a **dominant role**, we need to be faster in development and deployment. Time is of essence, lead time need to be reduced
- We need to invest more effort in **Systems Engineering** and **SW engineering** to match this trend
- **Cooperation** with R&I actors and supply industry shall
  - Provide components that allow us to generate system updates just based on new software
    relaxing the clash of life cycles
  - Provide deeper insight into designs (models, documents) to support certification
  - Enable **better prediction of emergent behaviour** in complex systems

Good R&D cooperation in progress on national & European level,
Let's bring it into application and into the market !

PLENTY OF WORK FOR ALL OF US TOGETHER !

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Thank you

for your attention!

Questions ?