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consorzio nazionale
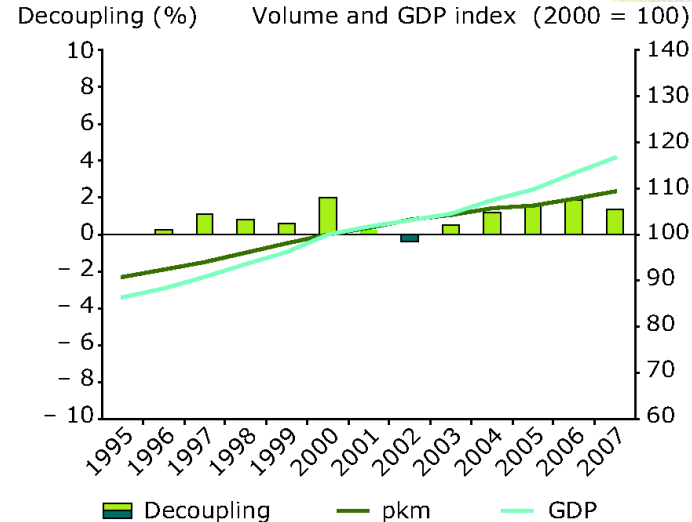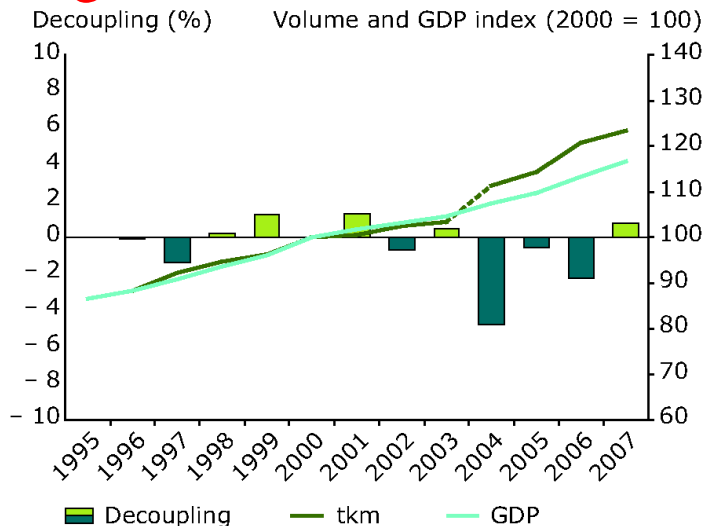interuniversitario
per le telecomunicazioni

o   There is a continuous increase in passenger / freight transport demand (Source: Eurostat and EEA)

 • The trend generally follows economical indicators like GDP.

Freight

Passenger

o Surface transport fatalities are caused by road transport accidents (Source: EEA and ref. therein)

- The 20% reduction achieved in the period 2000 – 2007 is essentially related to innovation in logistics and car (active and passive) safety equipments.
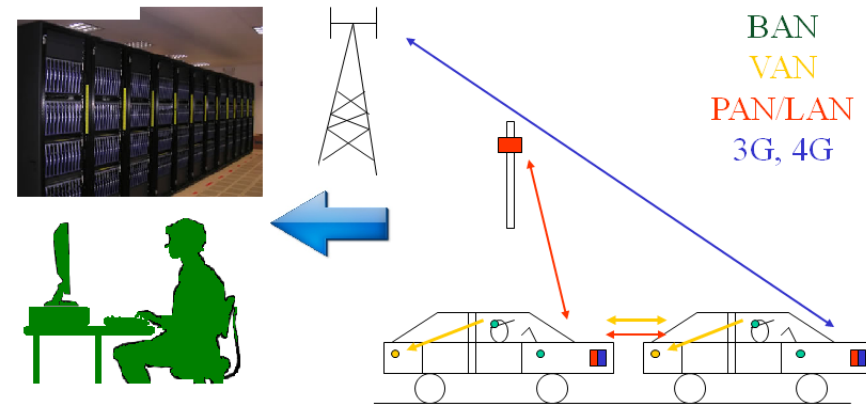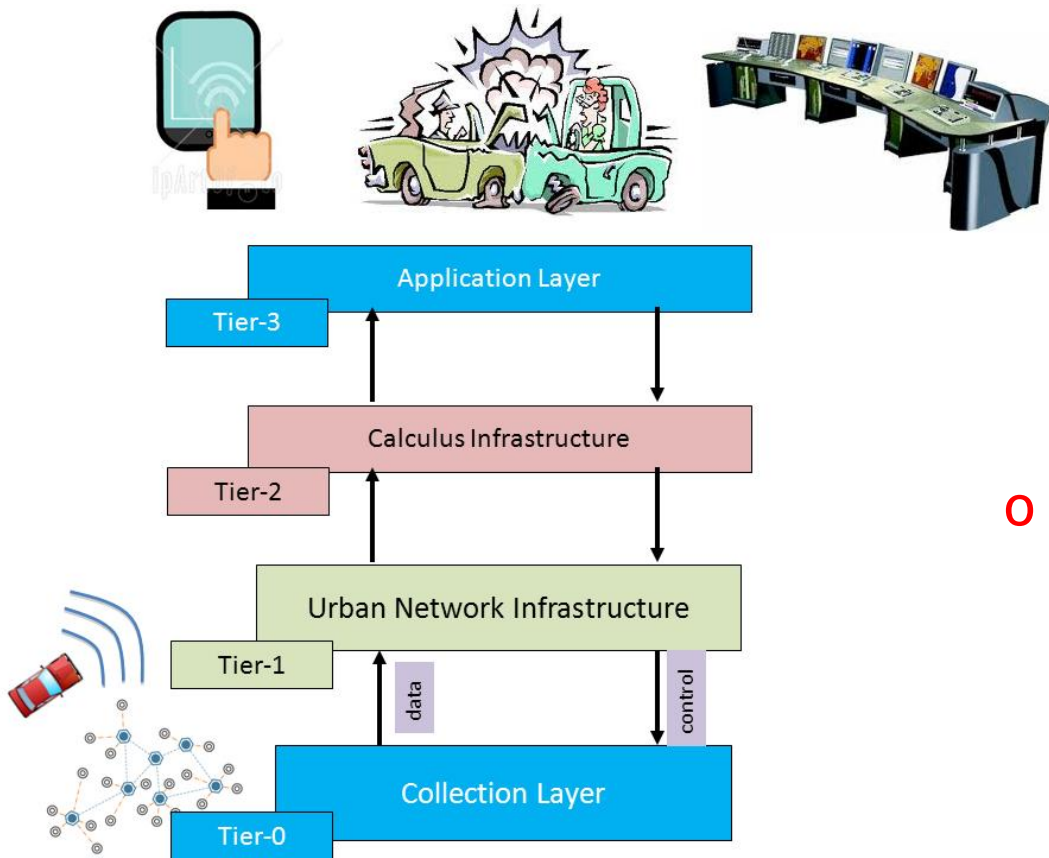

Transport fatalities relative to 2000
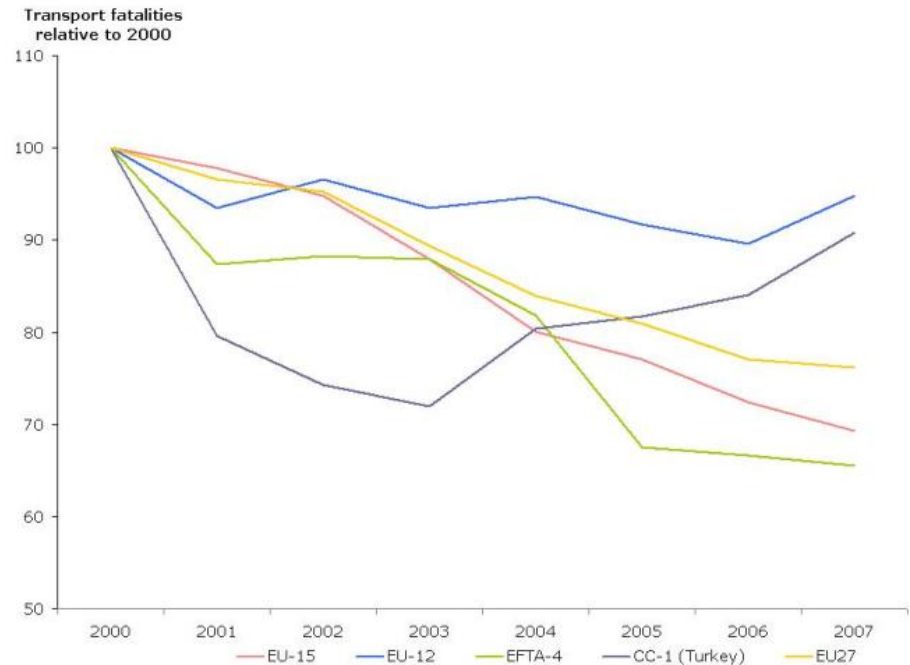
In COM(2008) 886 the EC:

o comments on the «public» costs of un-regulated road traffic; traffic congestion:

- affects 10% of the road network, and yearly costs amount to 0.9-1.5% of the EU GDP;
- accounts for 72% of all transport-related CO_2 emissions;
- road fatalities are still 6,000 above the intended target for 2010.

o criticizes the general lack of coherence in the deployment of ITS in EU members motivating to agree upon an Action Plan.

In the directive 2010/40/EU, a new regulation for ITS has been established defining priority areas:

1. Optimal use of road, traffic and travel data
2. Continuity of traffic and freight management ITS services
3. **ITS road safety and security applications**
4. **Linking the vehicle with the transport infrastructure.**

BAN
VAN
PAN/LAN
3G, 4G

Application Layer — Tier-3

Calculus Infrastructure — Tier-2

Urban Network Infrastructure — Tier-1

data | control

Collection Layer — Tier-0

o In the ITS design and implementation it is necessary to keep clearly separated (in tiers): sensors and vehicles, telco infrastructure, calculus, and final user applications

o To permit pervasiveness and continuity (large scale smart spaces), low cost devices must be adopted for both OBUs and RSUs.

o It is therefore necessary to prototype low-cost (i.e. integrating general purpose consumer electronics components) wireless solutions for both RSUs and OBUs, interoperable with backhauling networks through popular standards:

- Wireless Sensor Networks (compliant with 802.15.4 std.) as enabling technology for RSUs;
- Low computational (ARM-based) solutions configurable as OBUs and gateways interoperable with Wave (802.11p std.), 802.15.4, and CAN.
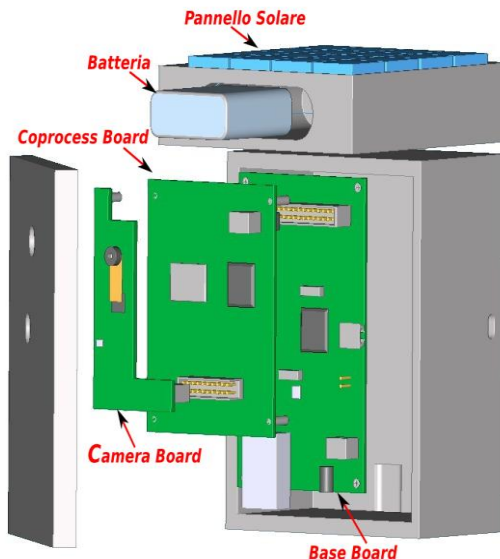

RSU

OBU
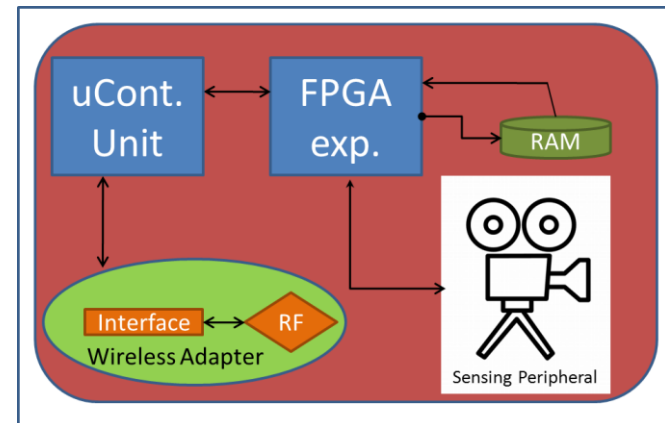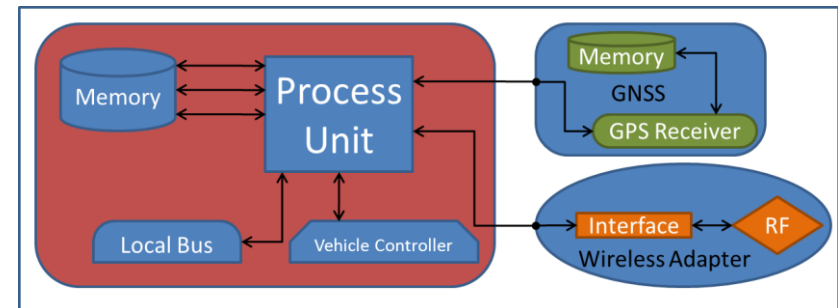
o **Micro-controller based Road Side Units making use of «Embedded Vision» are being tested in frontier research projects.**

IPERMOB

http://www.ipermob.org

o **People are working along this direction also for vehicular units:**

- H. Guo and Y. Wu. An Integrated Embedded Solution for Vehicle Communication & Control (RIIT'09);

- NEC® LinkBird-MX™ : "Test Platform for Evaluation of Vehicular Communications Protocol";

- Arada® 's LocoMate™ supporting 802.11p DSRC, 1609.2/3/4/11, Bluetooth, and GPS

Pannello Solare
Batteria
Coprocess Board
Camera Board
Base Board

o ARM main (400 MHz) core embedding local non-volatile storage modules;

o Set of enabled I/O peripherals:

- Controller Area Network (CAN) bus;
- Global Positioning System (GPS) receiver;
- an IEEE802.11a/p compliant radio transceiver.

o Optionally an IEEE802.15.4 compliant transceiver can be hosted for establishing a POS with WSN (Gateway configuration).

The Fully Networked Car
Geneva, 2-3 March 2011
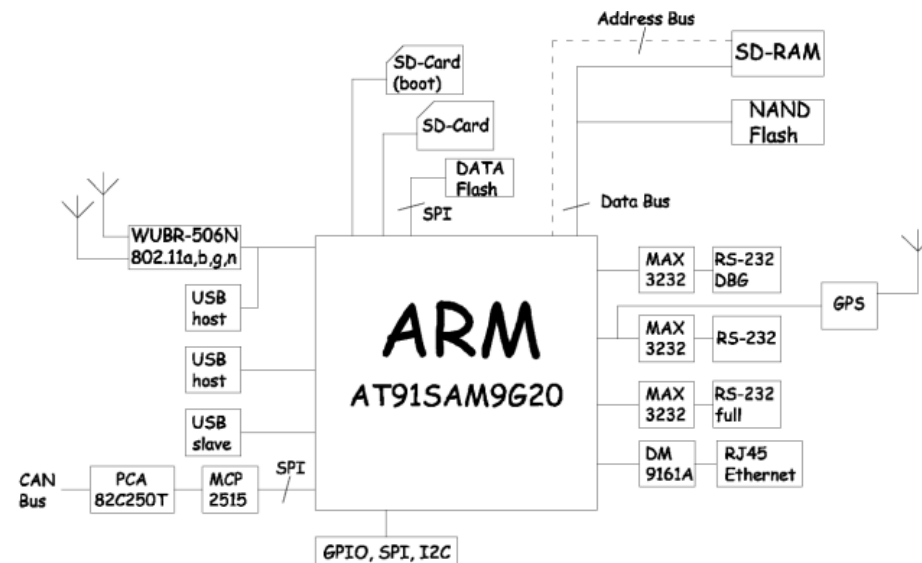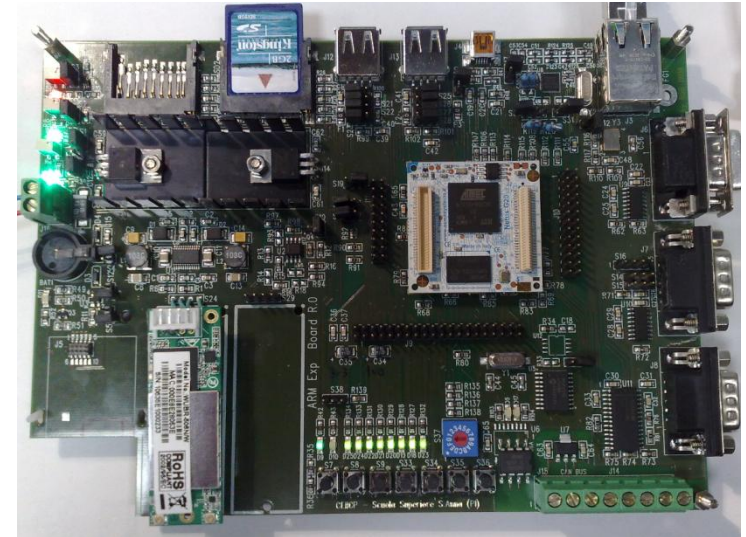
Scenario:

o Exponentially increasing #ECS enabled vehicle attributes, features and services, system interdependencies, 100 M lines of code are running in our cars.

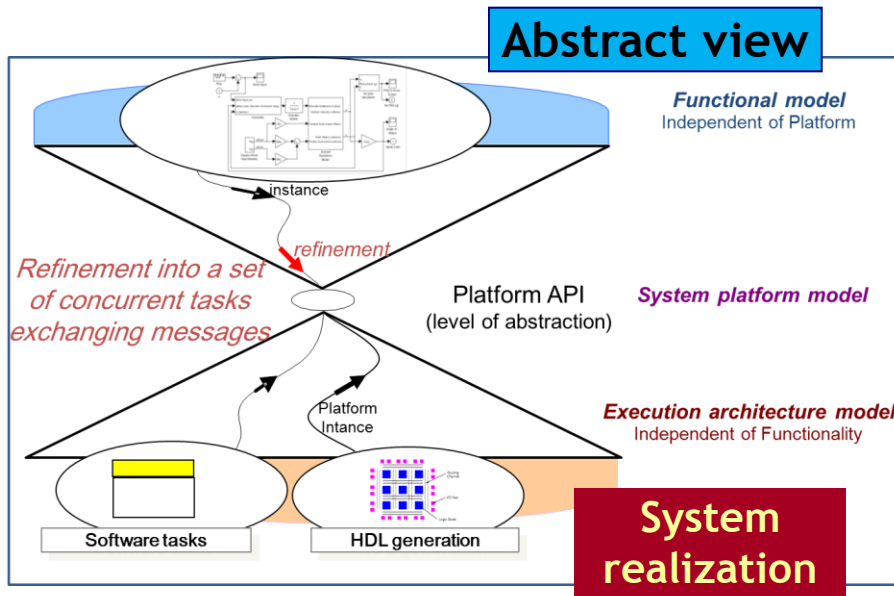o Collapse of the *Federated Architecture* concept. Move towards *Integrated Architectures* with reduced #ECUs supporting a large # of smart sensors & actuators;

o Need to separate the purchase and development of functionality from the basic SW and the HW platform.

CAN	Controller area network
GPS	Global Positioning System
GSM	Global System for Mobile Communications
LIN	Local interconnect network
MOST	Media-oriented systems transport
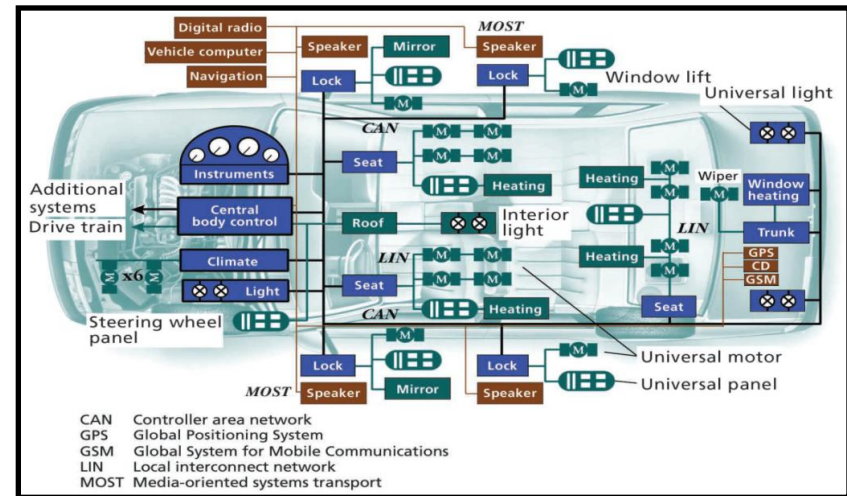
Consequences:

o SW functionality and HW platform are increasingly decoupled;

o Enabled by/Requires an open, interoperable architecture (AUTOSAR)

o Correct integration and deployment optimization requires advanced analysis and verifications features (model-based design)

Abstract view

Functional model
Independent of Platform

Refinement into a set of concurrent tasks exchanging messages

refinement

instance

Platform API
(level of abstraction)

System platform model

Platform Intance

Execution architecture model
Independent of Functionality

Software tasks   HDL generation

System realization

Our OBU is provided with SW and tools to enable modern Model Based Design and Platform Based Design:

- high-level (SysML, AUTOSAR) description of the system-level model and the HW platform;
- Simulink description of the functional behavior (controls);
- Maintaining alignment of the two models.

- Two-step simulation of the system behaviour:
    - 1st stage - Logical time (no architecture);
    - 2nd stage - Platform-aware (back-annotating the model with platform-specific communication and computation delays);
- early prototyping and automatic code generation:
    - From RTW-EC or TargetLink for functional part;
    - From AUTOSAR/MDA for architecture-specific part.

Our OBU is being provided with:

- Simulink-based development;
- A custom blockset (similar to DSpace's RTI blockset with possibly even higher abstraction) for connecting functionality to platform-specific functions;
- External tool support to define:
  - Selection of BSW support;
  - Mapping of functionality to tasks and tasks to ECU;
  - Automatic generation of platform-dependent code;
  - Automatic generation of model components for simulating platform delays.
- Enabling:
  - Extending the functional model as independent from the platform;
  - Optimize the SW architecture design with respect to functional performance on the given execution platform;
  - Selection of the appropriate «run-time» environment (Operating System, RPC, middleware) depending on the application needs (e.g injection control vs. entertainment).

OSEK/VDX

Open systems and the corresponding
interfaces for automotive electronics
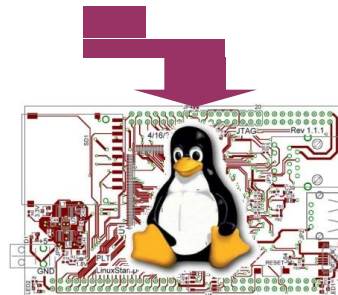
**POSIX
(Linux embedded)**

o Navigation systems OEM can profit of real-time information gathered by the ITS and acquire it in digital form via the IEEE802.11a/p module; high level services like "park finder", and "path discovery" would be more reliable avoiding to make use of statistics on historical data series.

o In case of accident (or other kind of danger notified by the ITS) the system warns the driver by visual and acoustic signals acting on the dashboard display and the speakers; if active safety is considered, the OBU can in turn trigger the brake system OEM and slow-down the vehicle;

o The calculated mean value for fuel consumption is used for predicting the residual vehicle autonomy and displaying such information on the dashboard. In the ITS, the OBU can acquire information about the altimetric profile of the route together with fresh updates about the track: the resulting prediction will be therefore more precise.
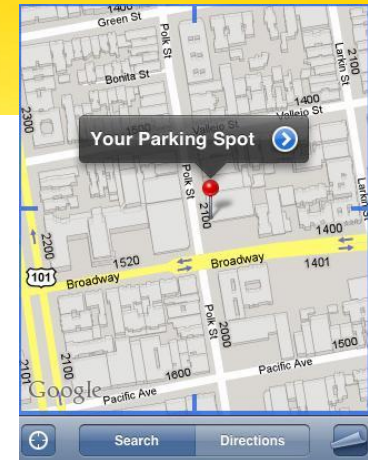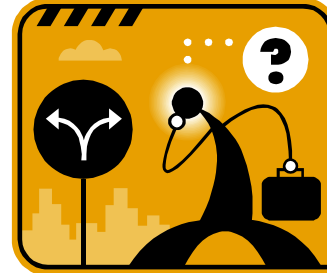
o Active and passive car safety equipments reduced road fatalities by 20% in the period 2000-2007;

o There is a general increase trend in transport demand; EP defined ITS scope and objectives in the 2010/40/EU directive;

o It is necessary to upgrade the data collection tier (RSUs and OBUs) in order to exploit pervasiveness and continuity for ITS;

o New concepts for RSUs and OBUs are aquiring market share.

o New equipments MUST be flexible (to run different types of firmware) and low cost (embedding consumer electronics components);

o Wireless technology (Wave, WSN) enables for large scale smart spaces;

o Model-driven engineering can decouple functions and fabric layer hardware allowing for safety critical and non-critical software development;

o The selection of SW (e.g. OS, middleware) components is therefore left to the system «realization» step.