



Design of embedded mixed-criticality CONTrol systems under consideration of EXtra-functional properties

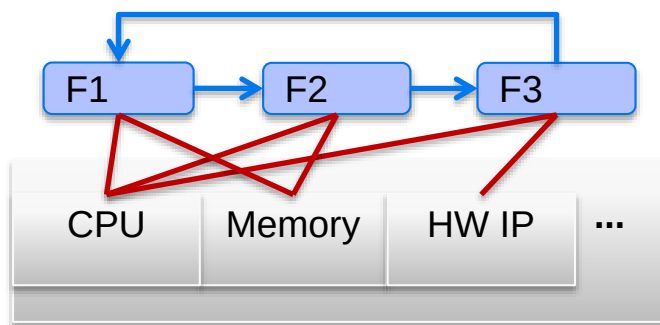
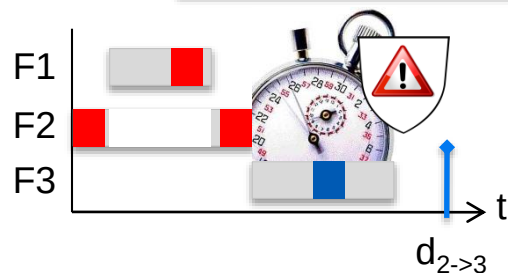


Funded by the EC under
Grant Agreement 611146

Kim Grüttner (OFFIS)

The CONTREX consortium

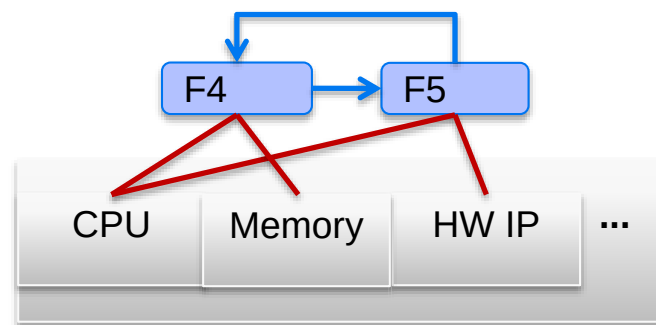
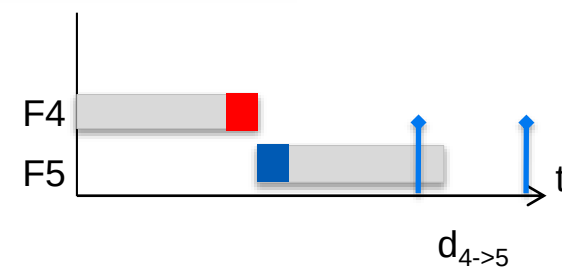
Safety relevant system



Safety critical tasks

- Hard deadlines (e.g. $d_{2 \rightarrow 3}$)
- Static schedule based on BCET/WCET analysis
- No power constraints
- No temperature constraints

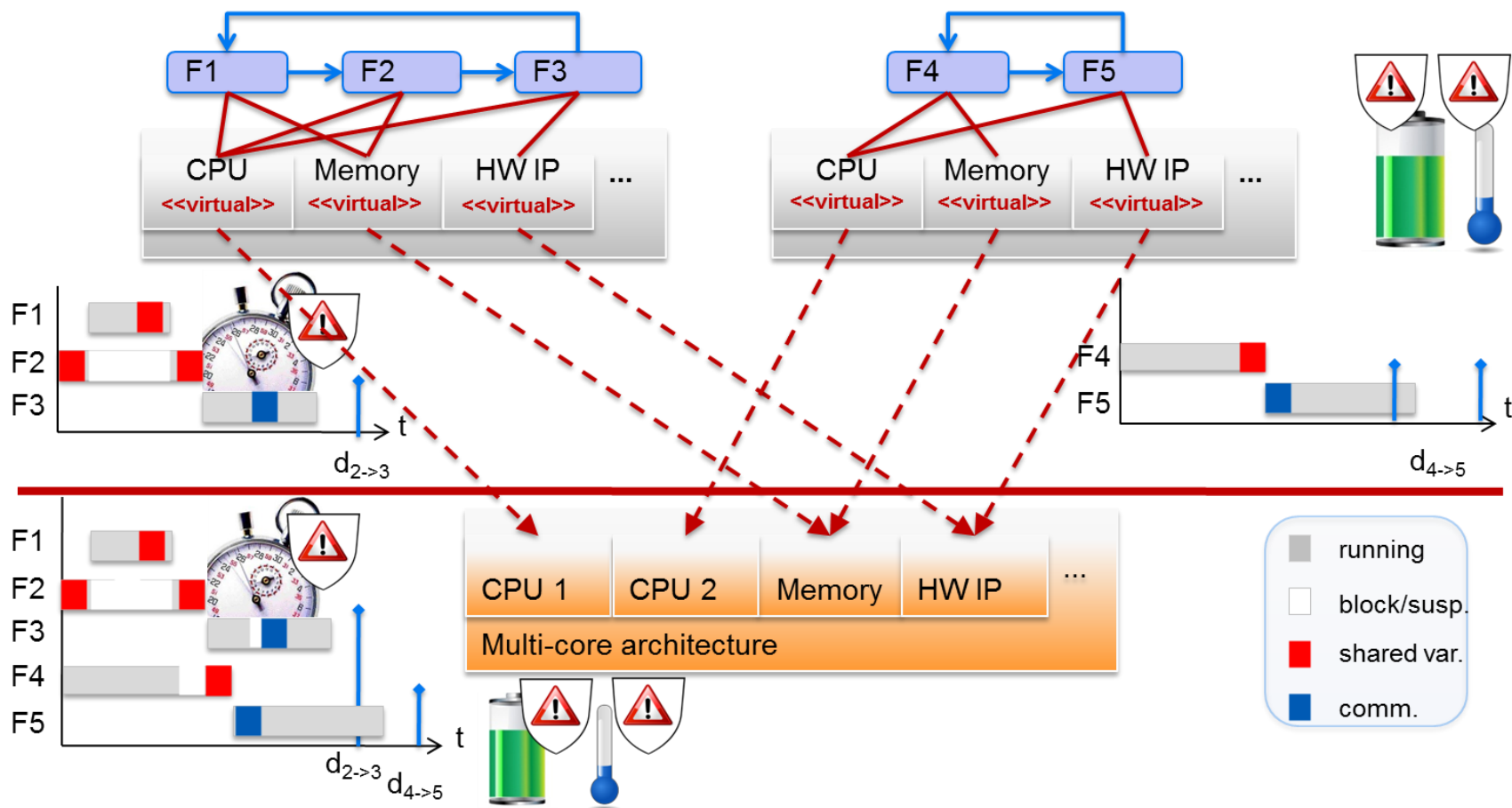
Non-Safety, performance (QoS) critical system



Mission critical tasks

- Soft deadlines (e.g. $d_{4 \rightarrow 5}$) based on QoS metrics
- Dynamic schedule
- Hard power constraints (e.g. battery limited)
- Hard temperature constraints

3 Motivation: Integration on a single chip!?



We aim at:

- **consideration of extra-functional requirements and constraints (timing, power, temperature) at design entry**
- **representation of extra-functional properties**
  - timing
  - power
  - temperature
- **in executable prototypes and**
- **analysis of these properties**
  - under different application deployments and mappings and
  - scheduling, power and thermal management decisions.

$d_{2 \rightarrow 3}$ $d_{4 \rightarrow 5}$



5 Project Overview and Consortium

PARTICIPANT NO.	PARTICIPANT ORGANISATION NAME	PART. SHORT NAME	COUNTRY
1 (Coordinator)	OFFIS e.V.	OFFIS	Germany
2	STMicroelectronics srl	STM	Italy
3	GMV Aerospace and Defence SA	GMV	Spain
4	Vodafone Automotive SpA	Vodafone	Italy
5	EuroTech S.p.A.	EUTH	Italy
6	Intecs S.p.A.	INTECS	Italy
7	iXtronics GmbH	iX	Germany
8	EDALab srl	EDALab	Italy
9	Docea Power	Docea	France
10	Politecnico di Milano	PoliMi	Italy
11	Politecnico di Torino	PoliTo	Italy
12	Universidad de Cantabria	UC	Spain
13	Kungliga Tekniska Högskolan	KTH	Sweden
14	Electronic Chips & Systems design Initiative	ECSI	France
15	ST-POLITO Societa' consortile a r.l.	ST-PoliTo	Italy
16	Intel Corporation SAS	Intel	France

Starting date: 01/10/2013

Duration in month: 36

Call identifier: FP7-ICT-2013-10

Website: <http://contrex.offis.de>

Universities and Research Institutes

Industry

Small and Medium Size Enterprises

Other

System Models
(e.g. from 3rd party model-driven
design flow)

Legacy HW/SW
(e.g. existing C-Code, VHDL, Verilog, ...)

User SW

MiddleWare (e.g. Kura)

OS with RT and
Resource manager

Actual HW
(e.g. Xilinx Zynq, ST
iNemo, ST SeCSoC)

Timing
Measurement

Power
Measurement

(Temperature
Measurement)

Starting point

System Models
(e.g. from 3rd party model-driven
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Legacy HW/SW
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CONTREX UML/MARTE
Model

Generic Task Model

Generic HW Model

ForSyDe Model

Analytical DSE for timing

*Model capturing
and (timing)
analysis*

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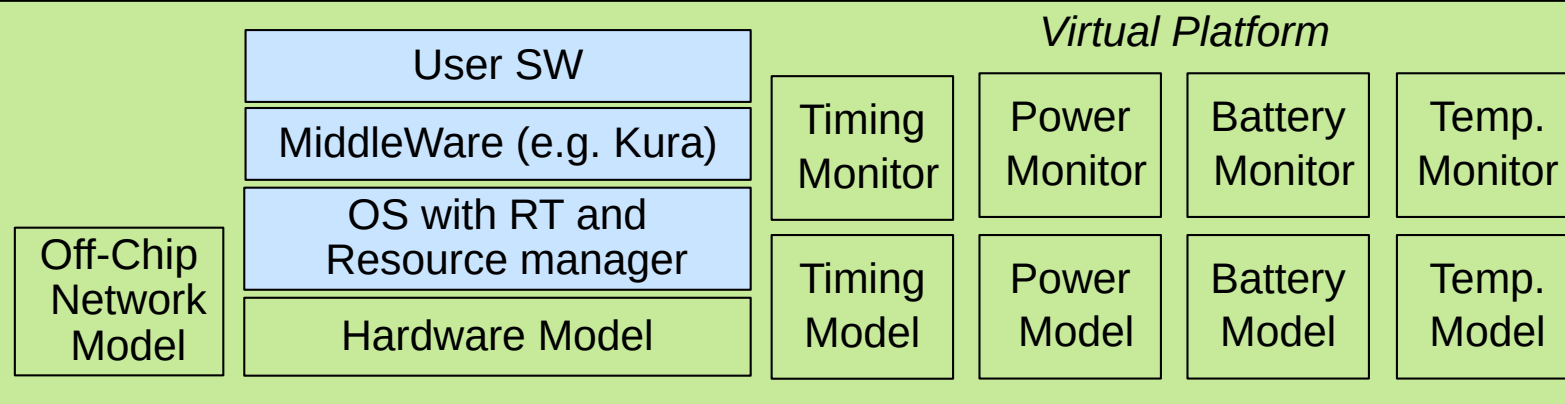
Generic Task Model

Generic HW Model

ForSyDe Model

Analytical DSE for timing

Functional and extra-functional analysis



Environment Model (functional & extra-functional)

Simulative DSE for power and temp.

Actual HW
(e.g. Xilinx Zynq, ST iNemo, ST SeCSoc)

Timing Measurement

Power Measurement

(Temperature Measurement)

6 CONTREX Reference Architecture



Starting point

System Models
(e.g. from 3rd party model-driven design flow)

Legacy HW/SW
(e.g. existing C-Code, VHDL, Verilog, ...)

Model capturing and (timing) analysis

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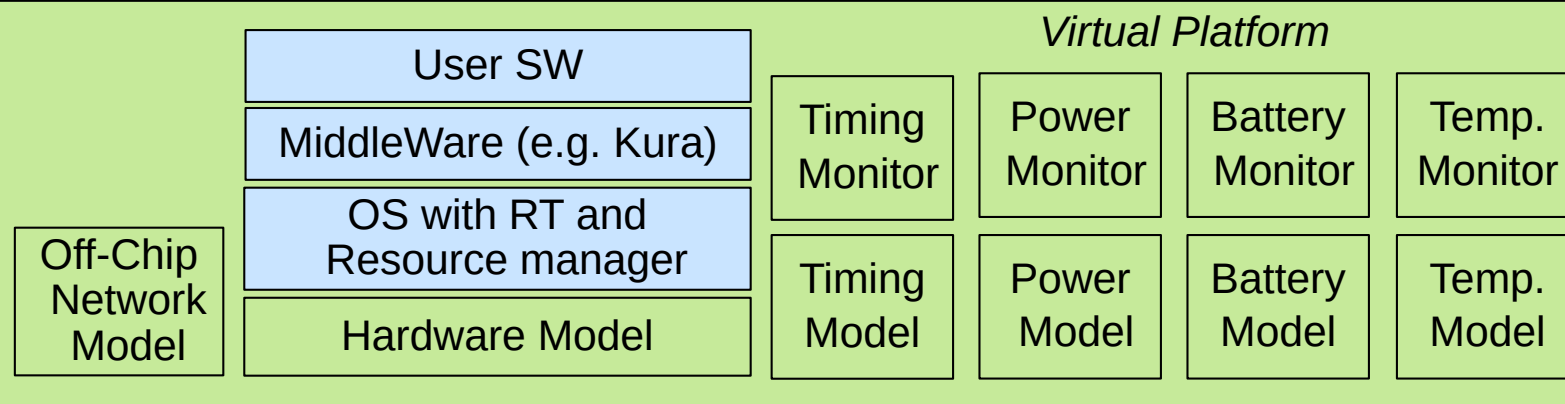
Generic Task Model

Generic HW Model

ForSyDe Model

Analytical DSE for timing

Functional and extra-functional analysis



Simulative DSE for power and temp.

Design validation

Actual HW
(e.g. Xilinx Zynq, ST iNemo, ST SeCSoc)

Tech. data: package desc., floorplan, technology, ...

HW in-the-loop facilities

Timing Measurement

Power Measurement

(Temperature Measurement)

Avionics



Flight Control Computer for a Remotely Piloted Aircraft

Goal: Executes safety-, mission- and non-critical applications on the same multi-core execution platform.

Criticalities: safety- and mission-critical

Extra-functional properties: hard real-time, power, temperature, reliability

Automotive Telematics



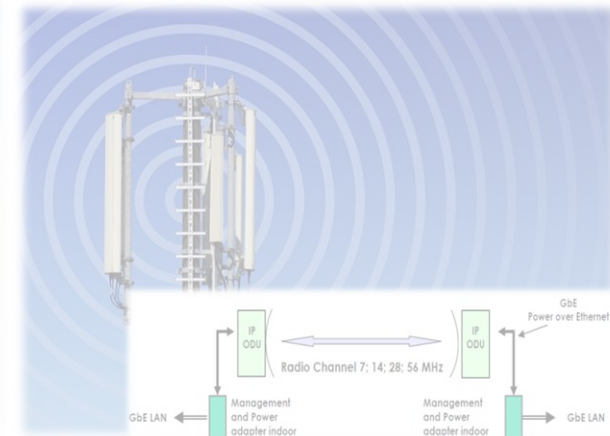
Automotive Telematics Box

Goal: Move processing from local (on-board) devices into the cloud.

Criticalities: mission- and non-critical.

Extra-functional properties: performance, power, security, reliability

Telecommunication



Ethernet over Radio System

Goal: Optimization of performance/cost characteristics of a Gbit Ethernet over radio system.

Criticalities: safety-, mission-, non-critical.

Extra-functional properties: real-time, power, temperature, reliability

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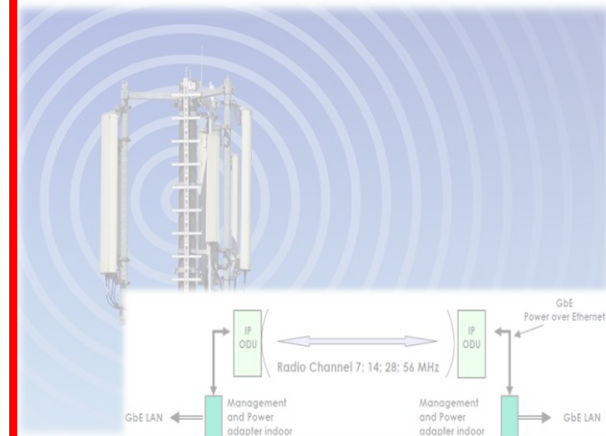
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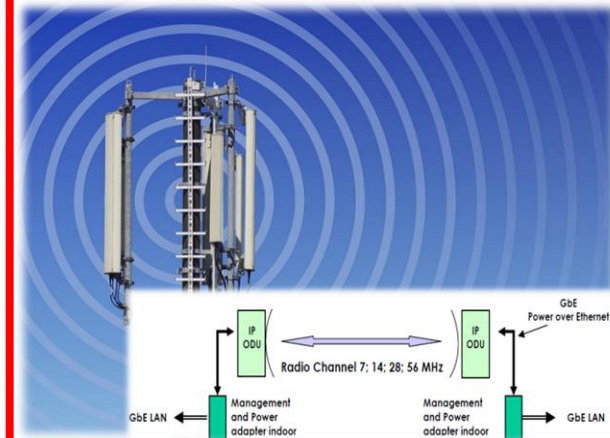
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CONTREX

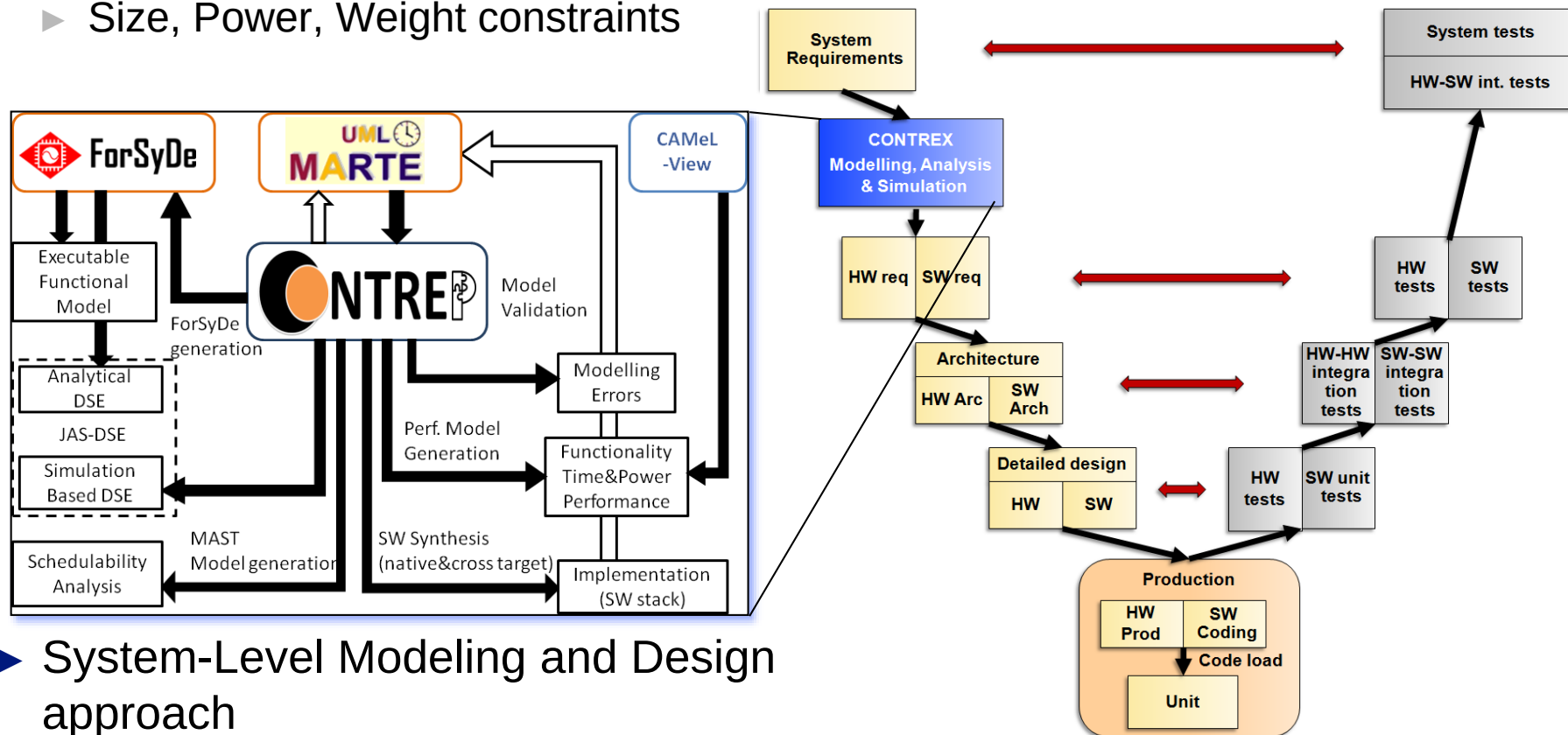
TECHNOLOGY PITCHES

Technology Pitches

MODEL CAPTURING AND (TIMING) ANALYSIS

► Integration into the V-Cycle

- Partitioning in early phases, based on design expertise
- Resource oversizing (avoid late integration issues)
- Adaption to new contexts difficult
- Size, Power, Weight constraints



► System-Level Modeling and Design approach

- ▶ **EFPs and Criticalities:** Fundamental and Necessary information for DSE and for efficient design of Mixed-Critical Systems

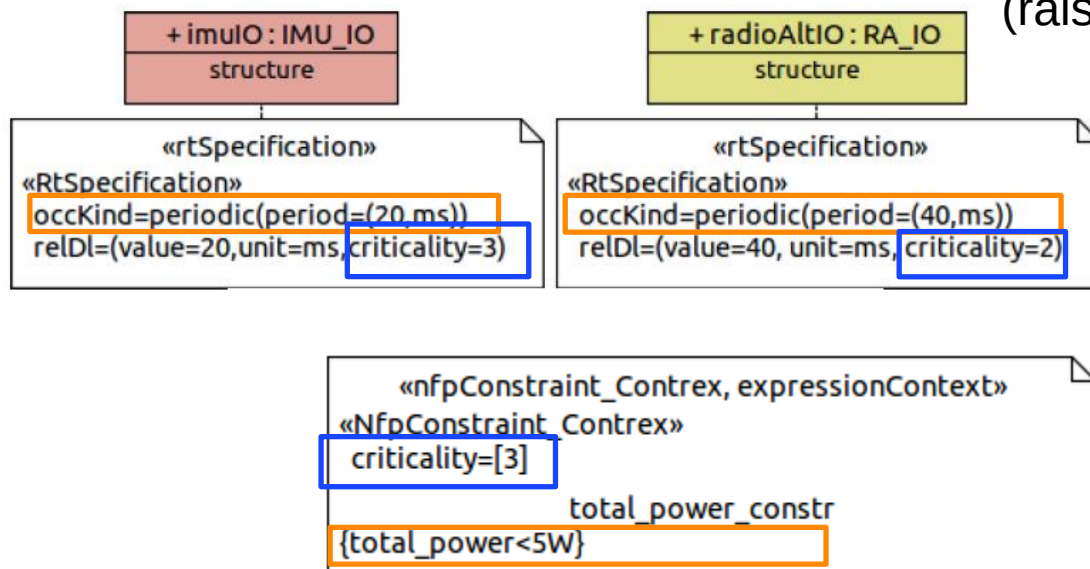
- ▶ Captured in UML/MARTE

▶ EFPs:

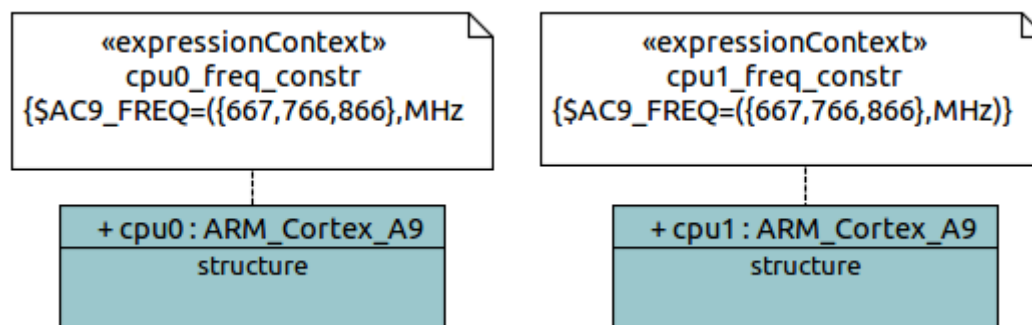
- ▶ At System Inputs and Outputs
- ▶ At Application, Platform & System Level

▶ Criticalities:

- ▶ Associated to Components and to EFPs and Performance requirements
- ▶ Novel & Minor extension of MARTE (raised to OMG)

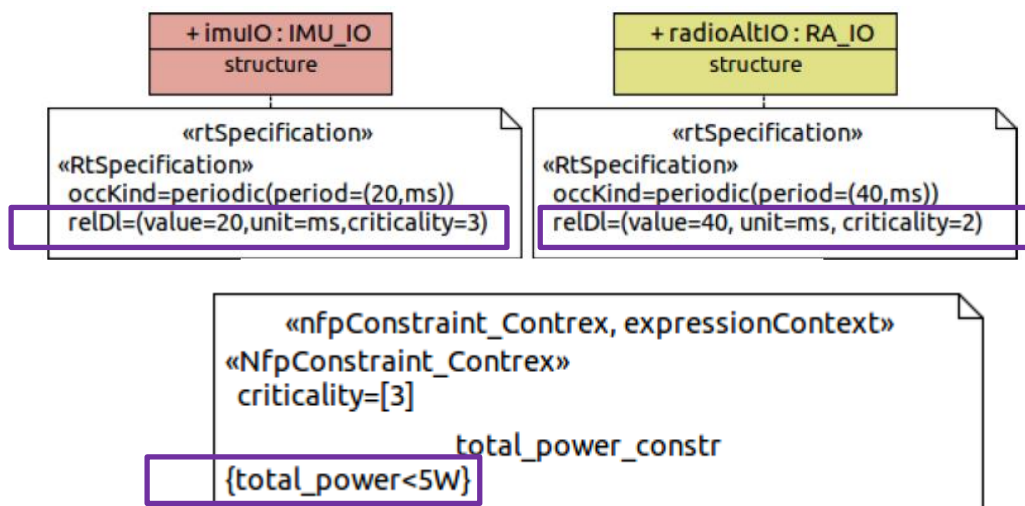


► DSE parameters: Define Design Space



► Design Space Exploration for

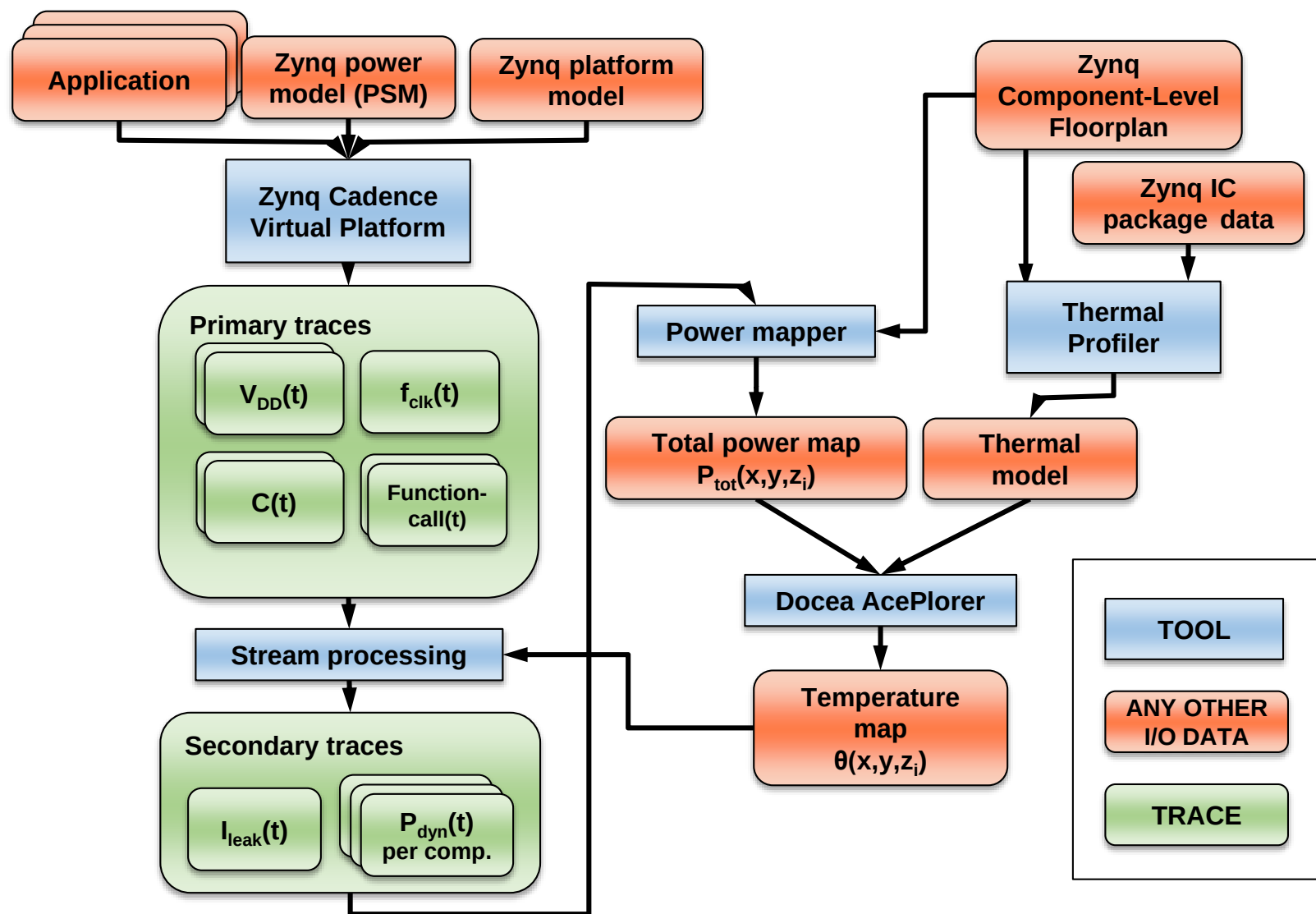
- Application parameters (e.g. task periods)
- Platform parameters (e.g. working frequency)

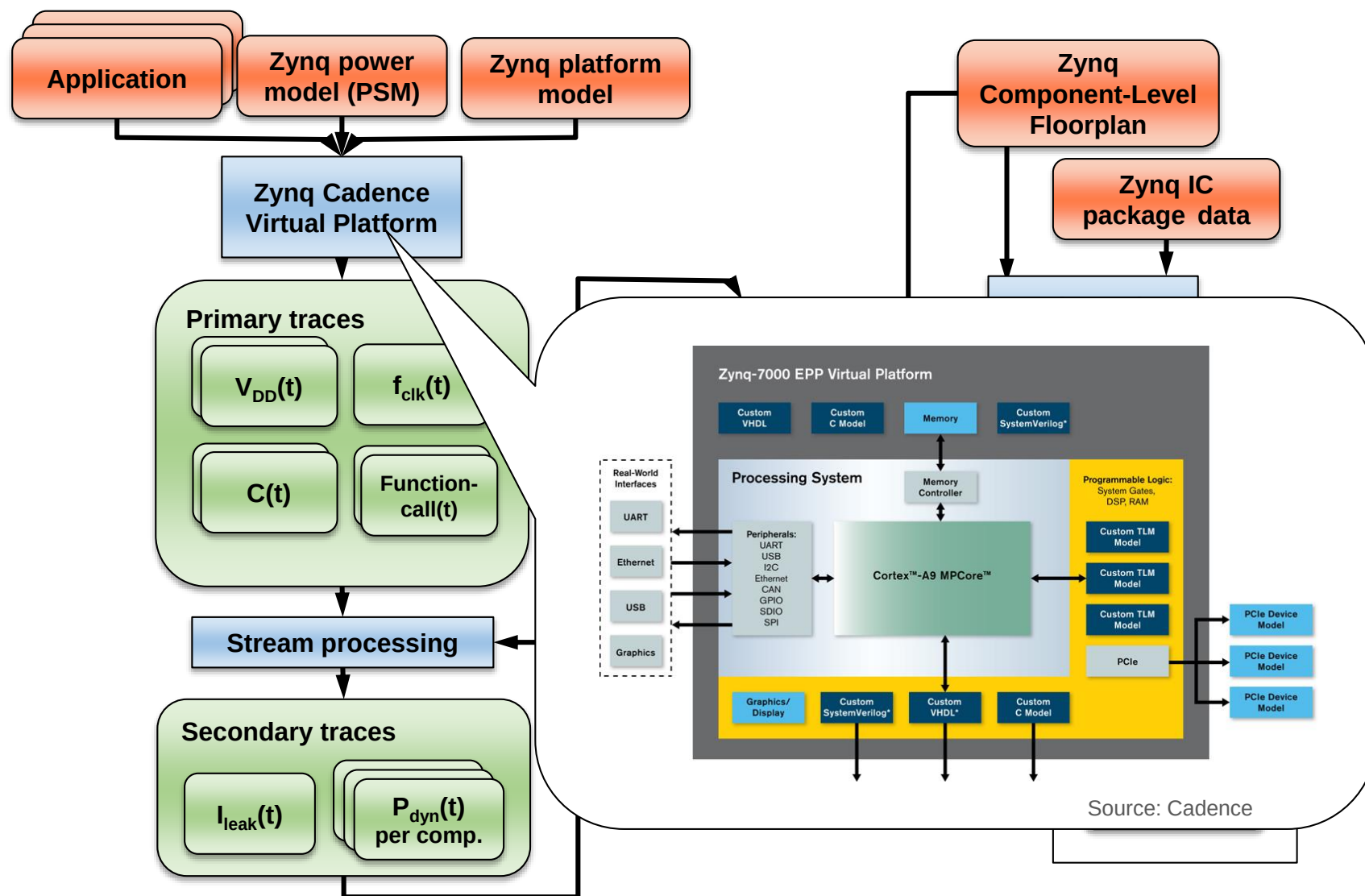


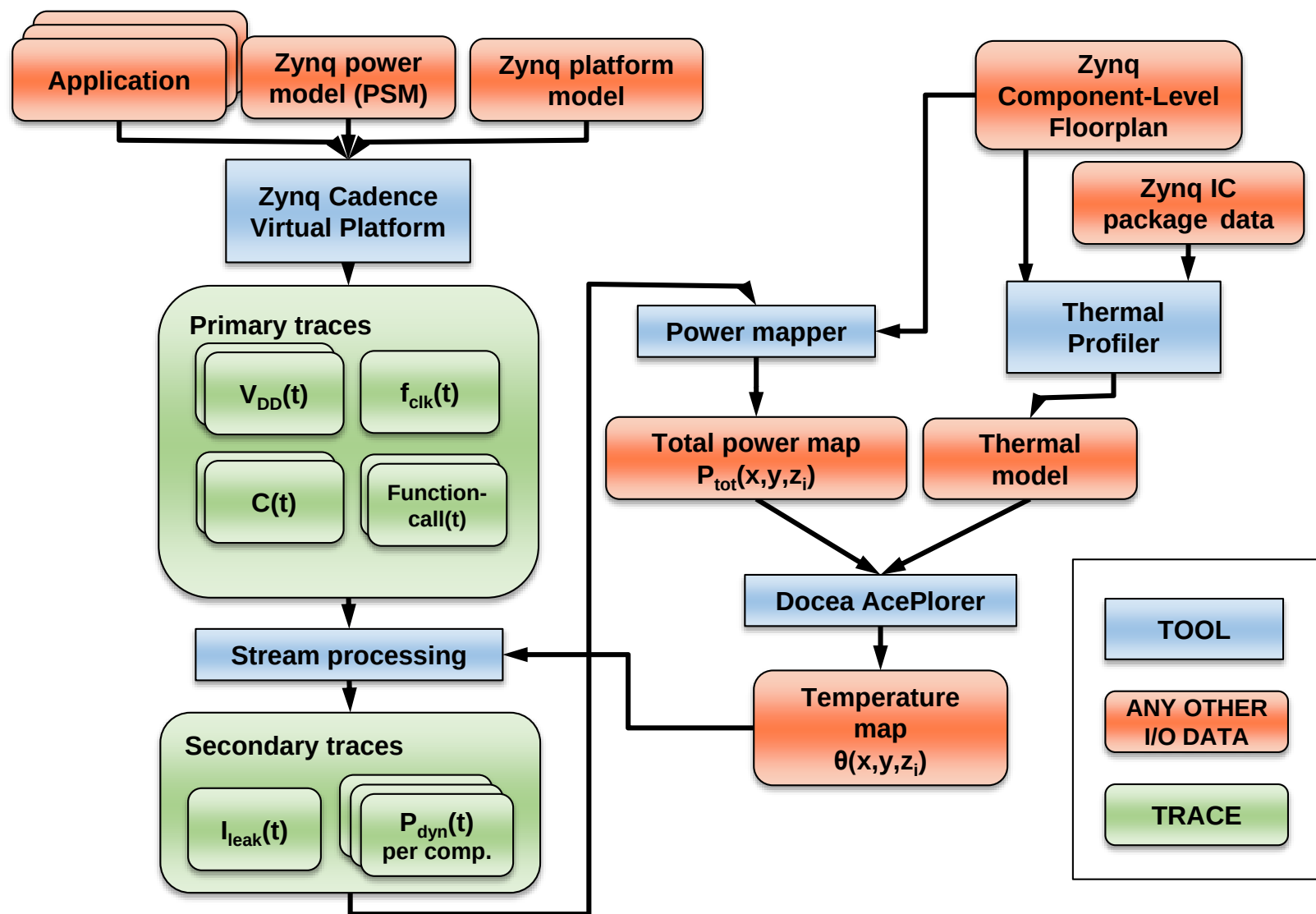
► Performance Requirements

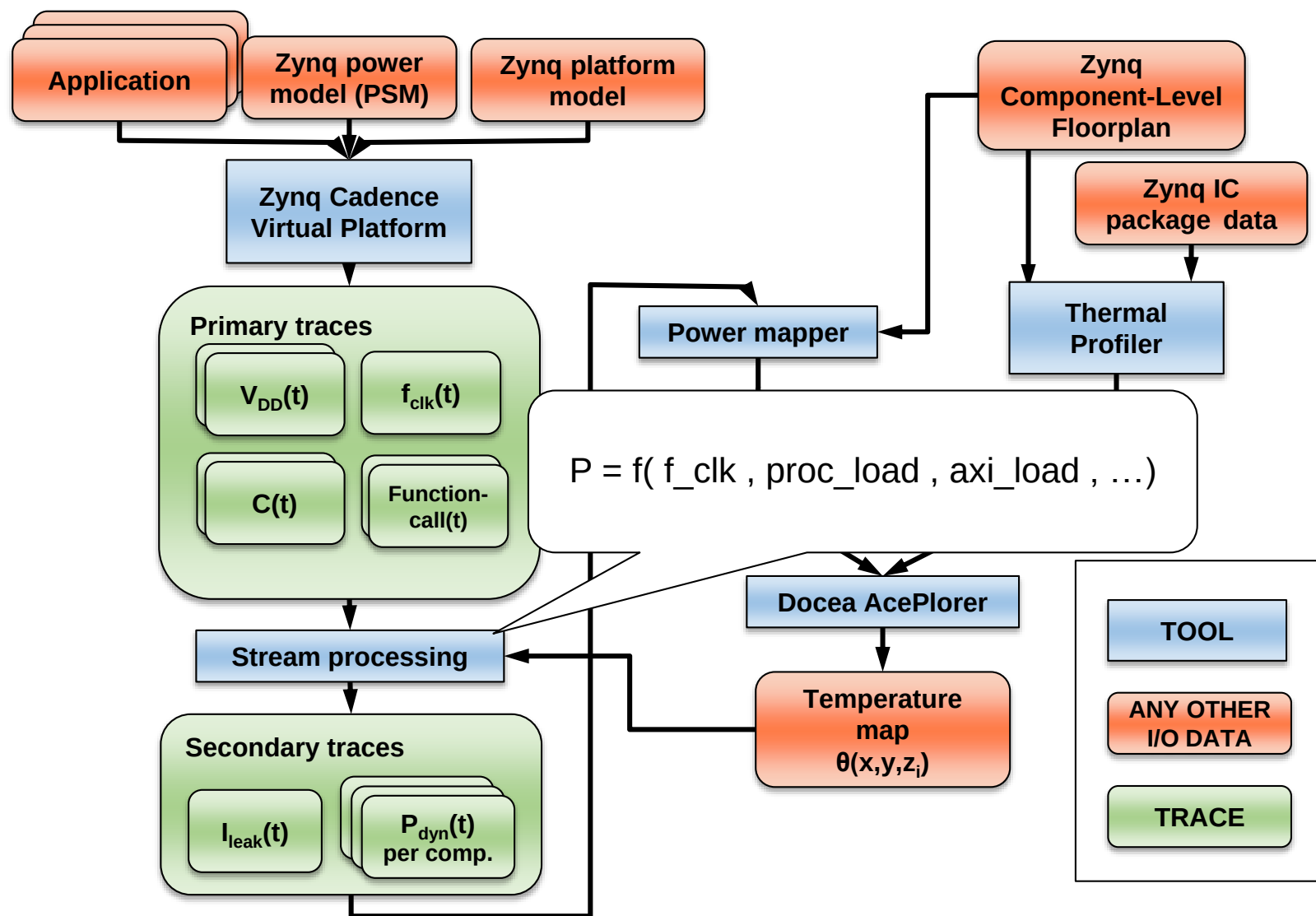
Technology Pitches

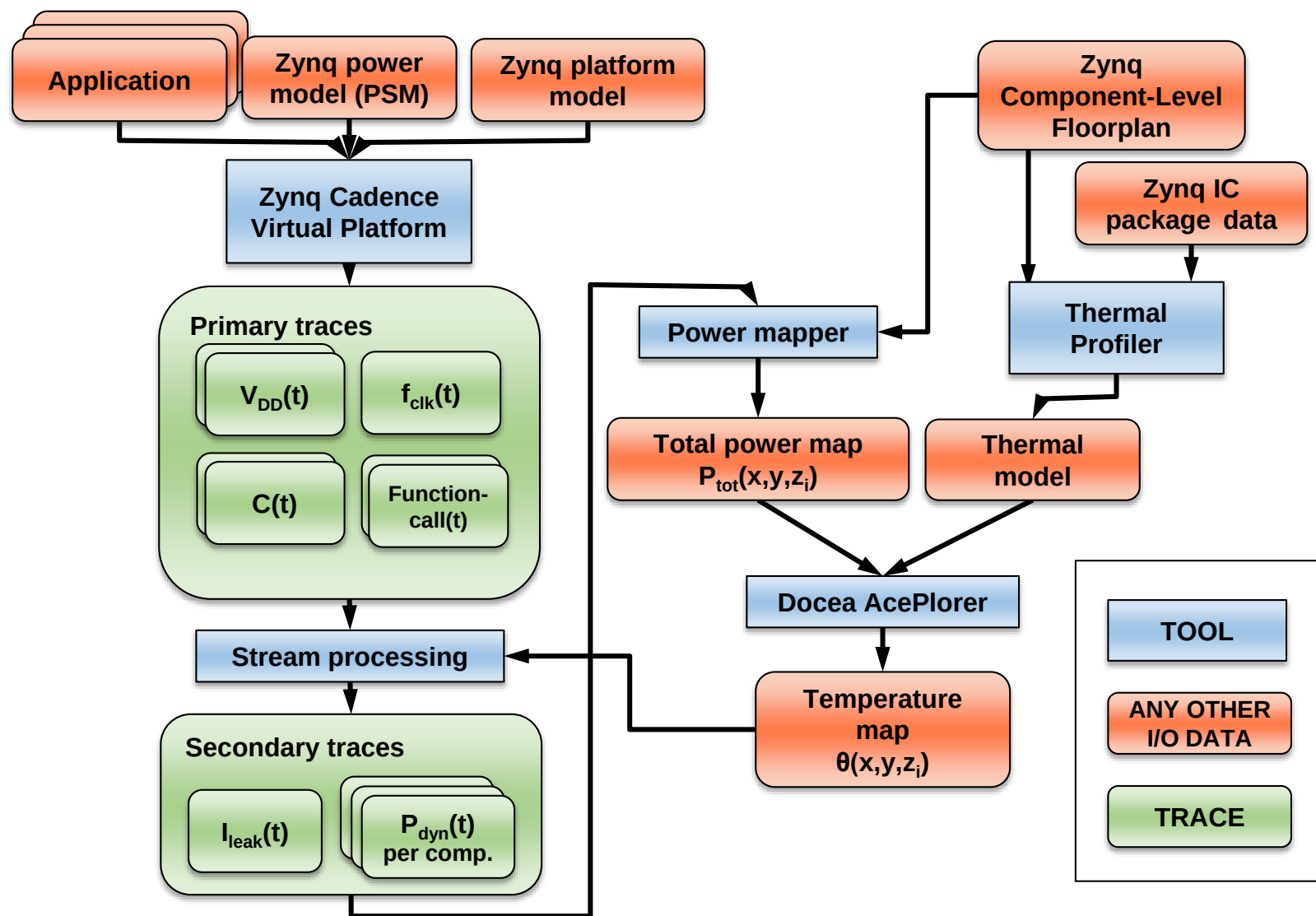
FUNCTIONAL AND EXTRA-FUNCTIONAL ANALYSIS

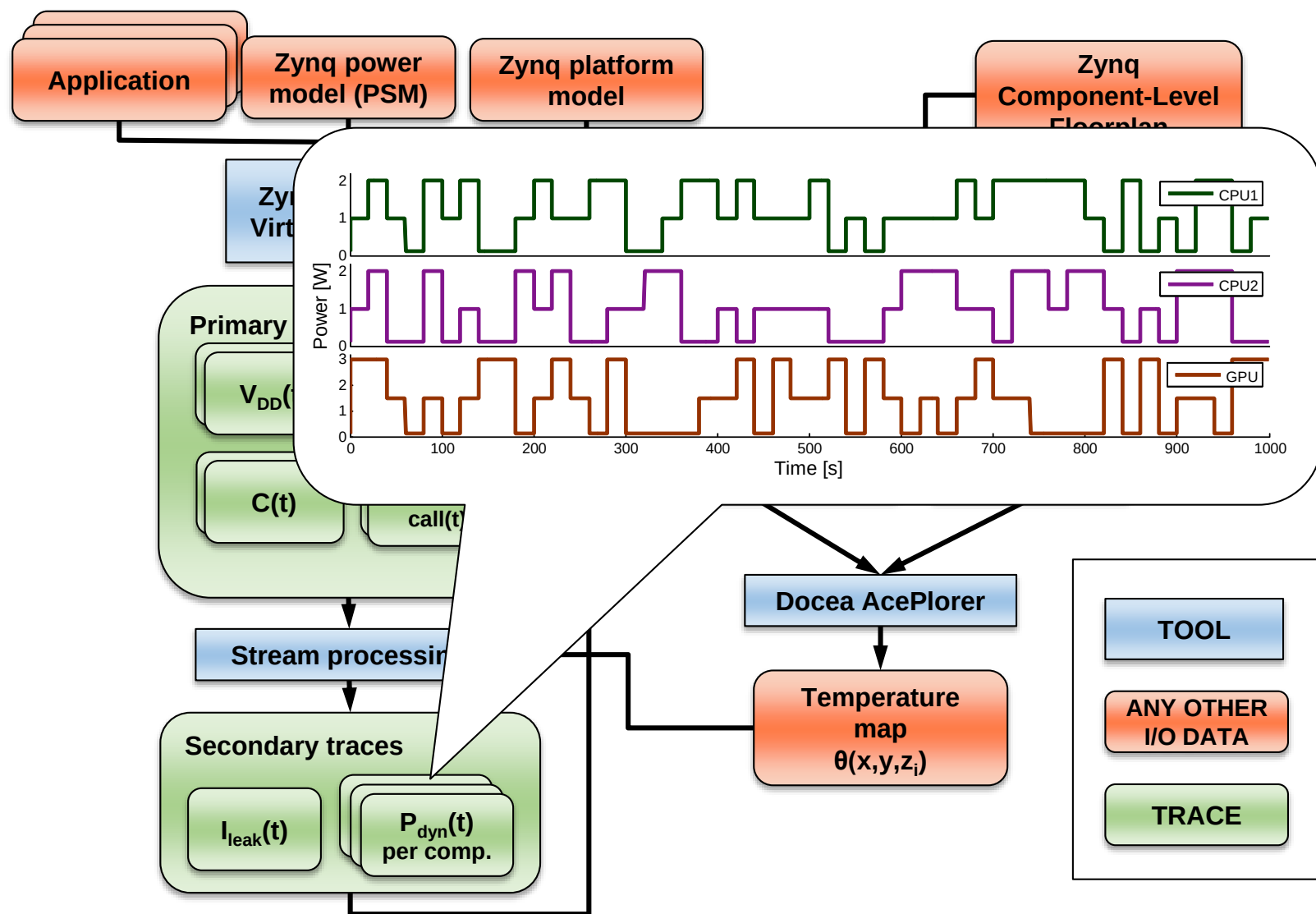


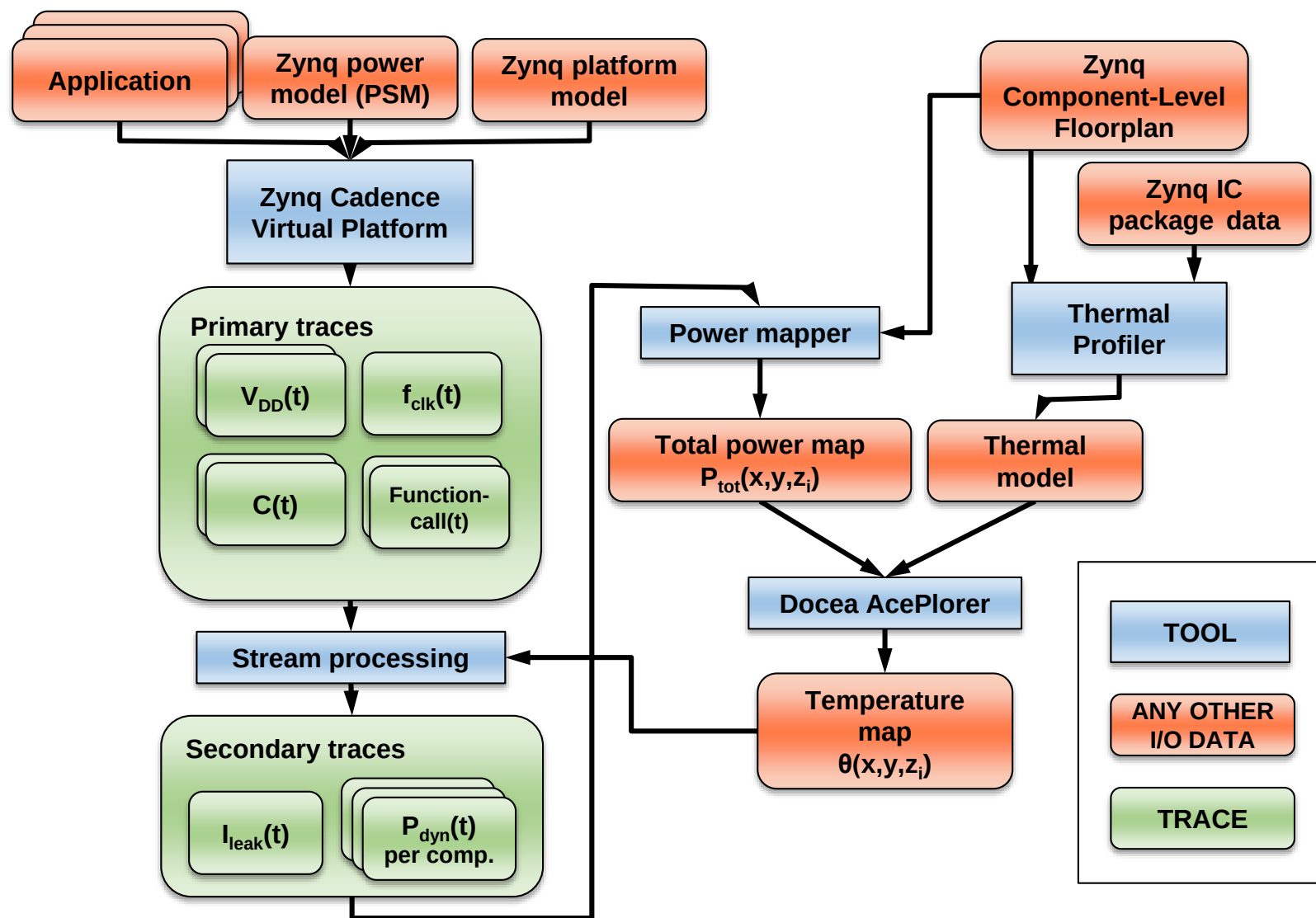


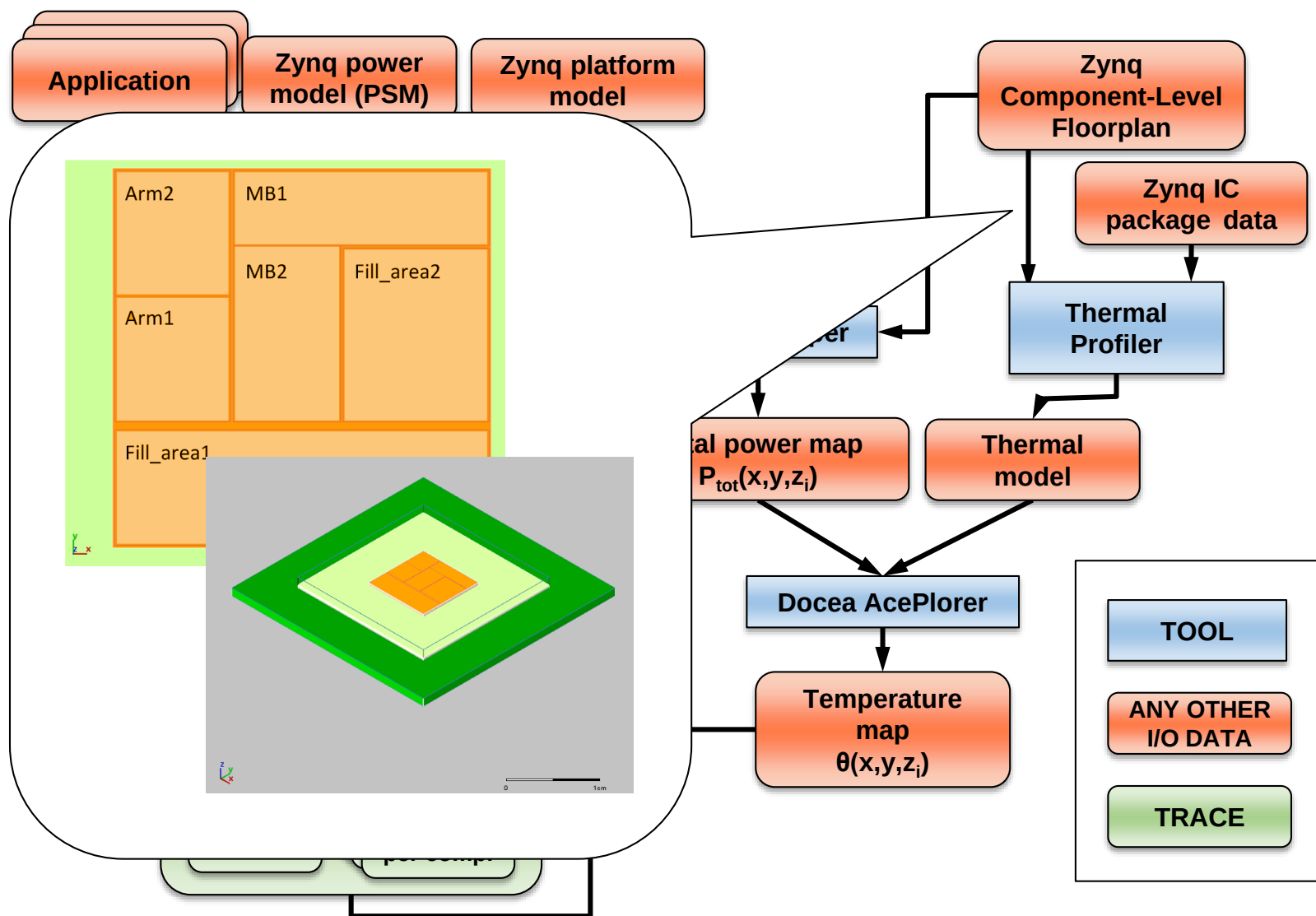


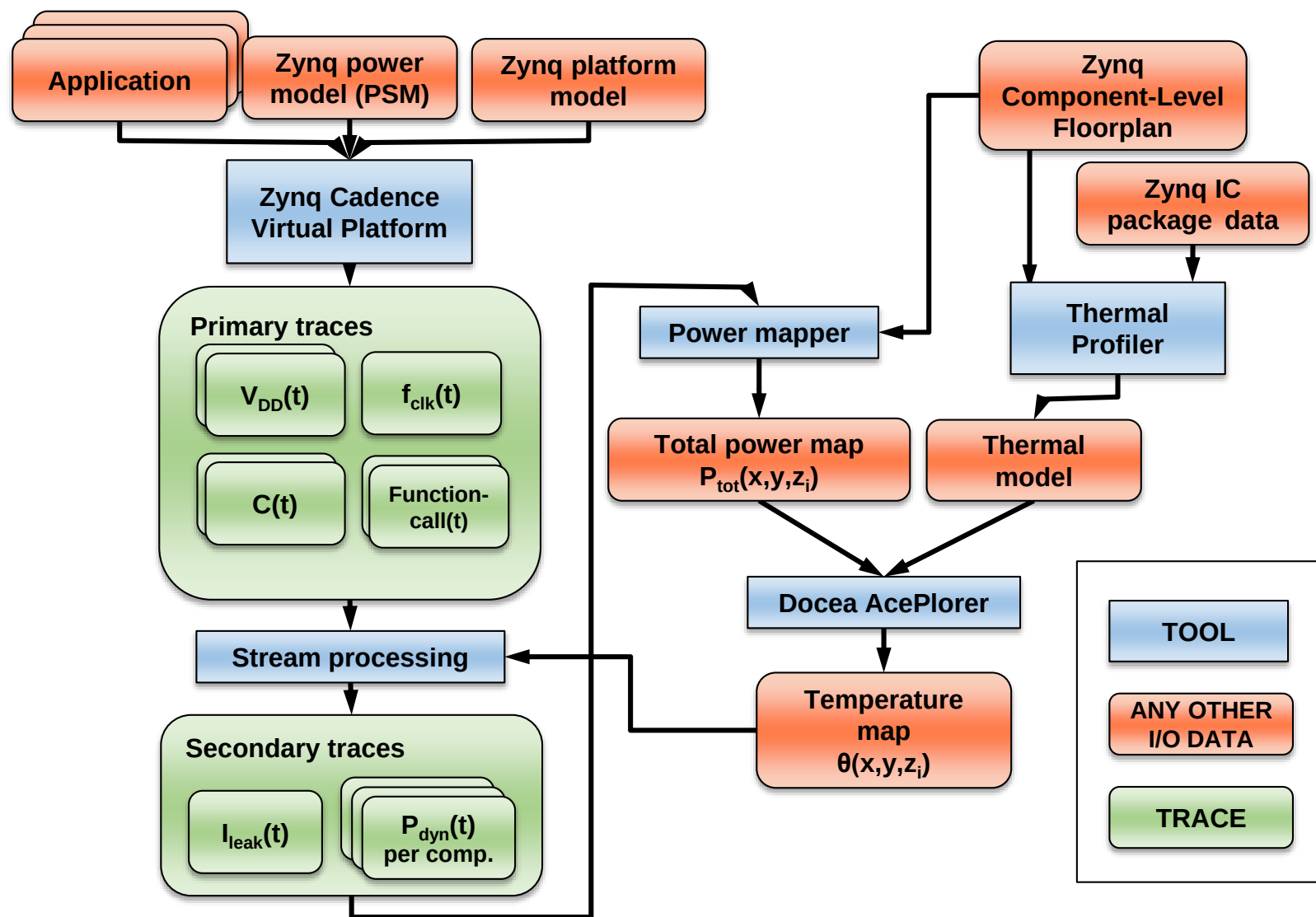


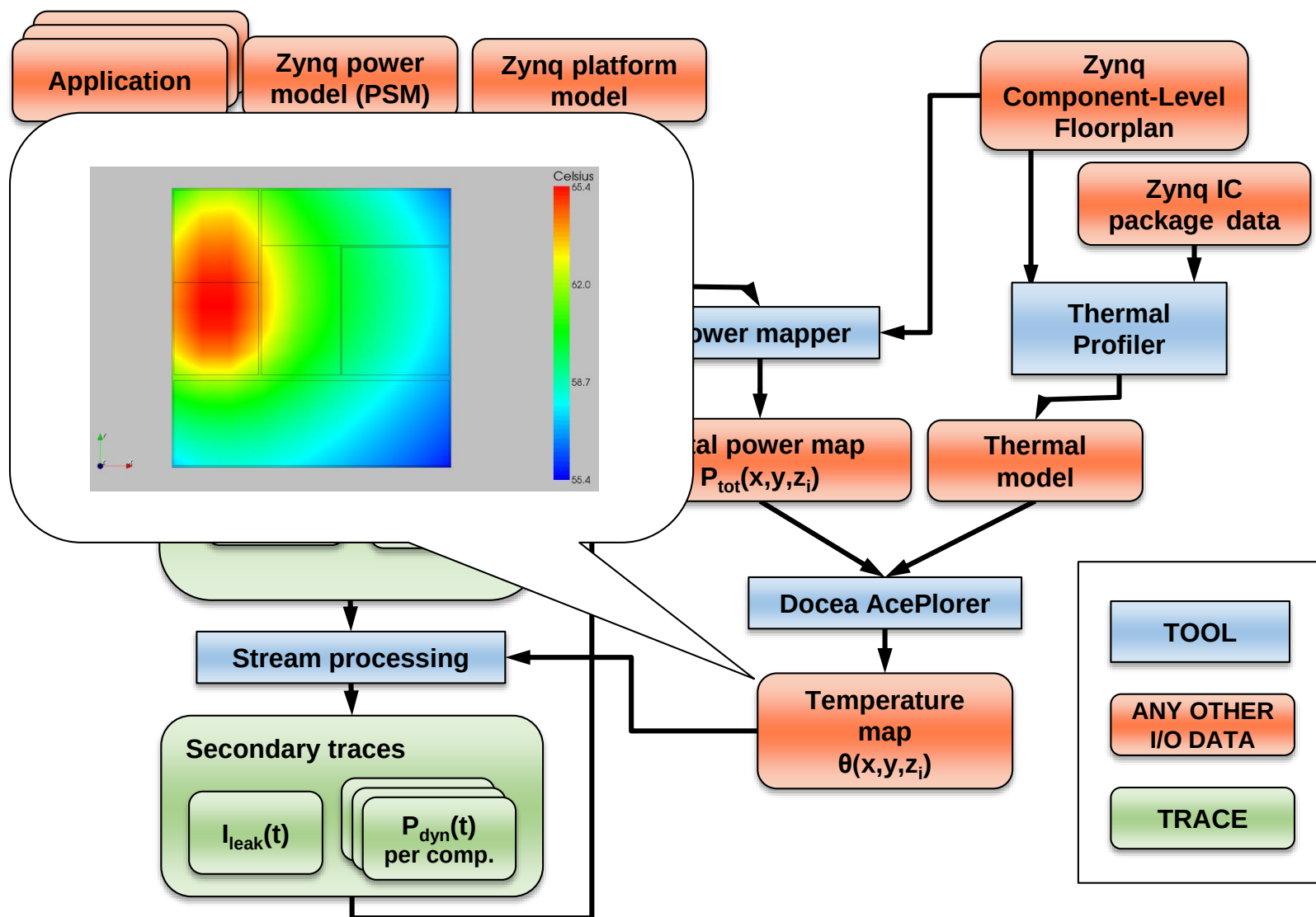


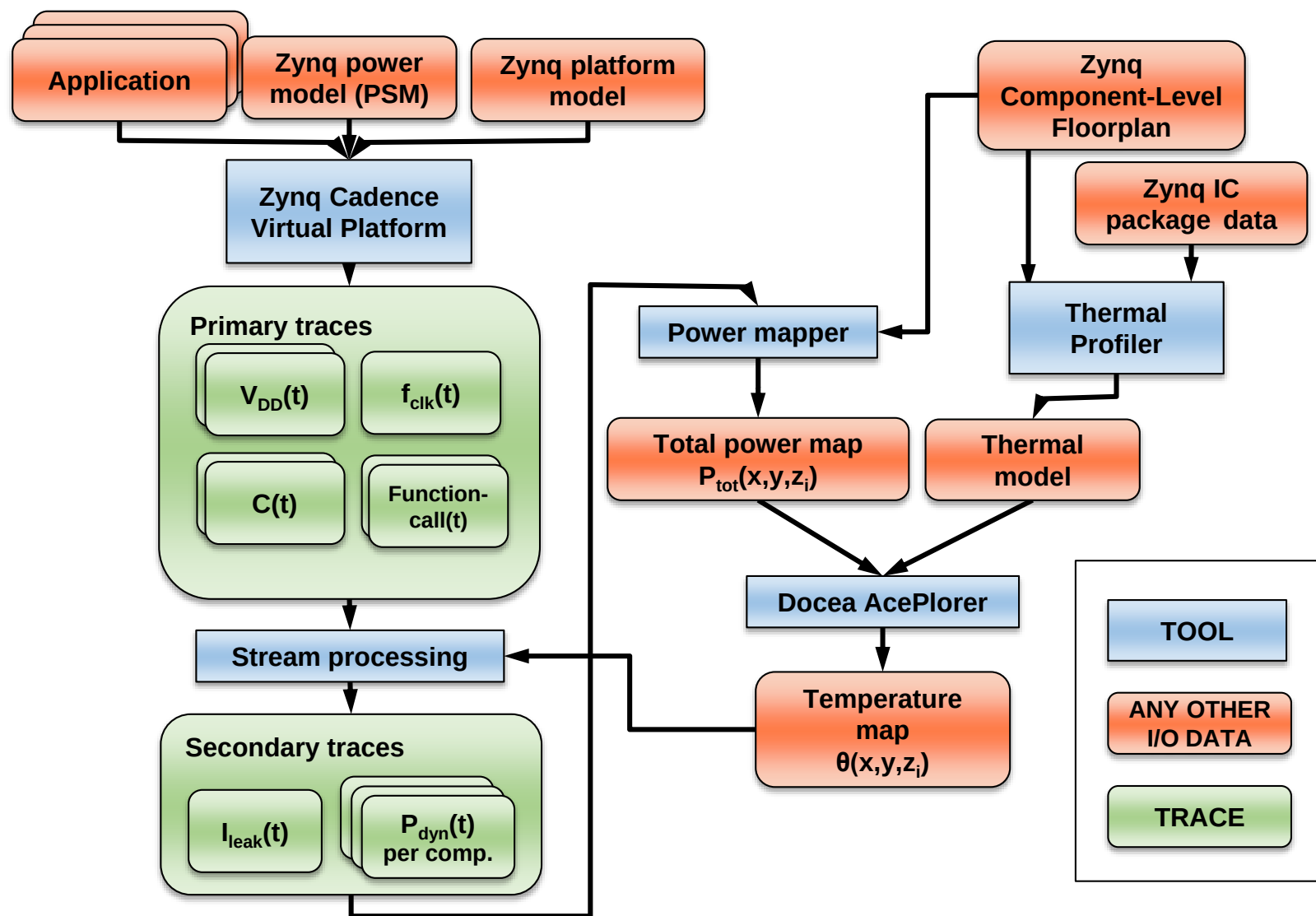












Technology Pitches

RUN-TIME MANAGEMENT

► Motivation

- Resources: homogeneous & heterogeneous
- Configuration: can change even during applications execution
- Extra functional properties (EFP): hard to manage fully at design time
- Portability: across platforms and applications
- **Mixed critic. → need of mixed design-time/run-time design and fmw**

► Levels where to apply run-time management strategies

► Application-Level

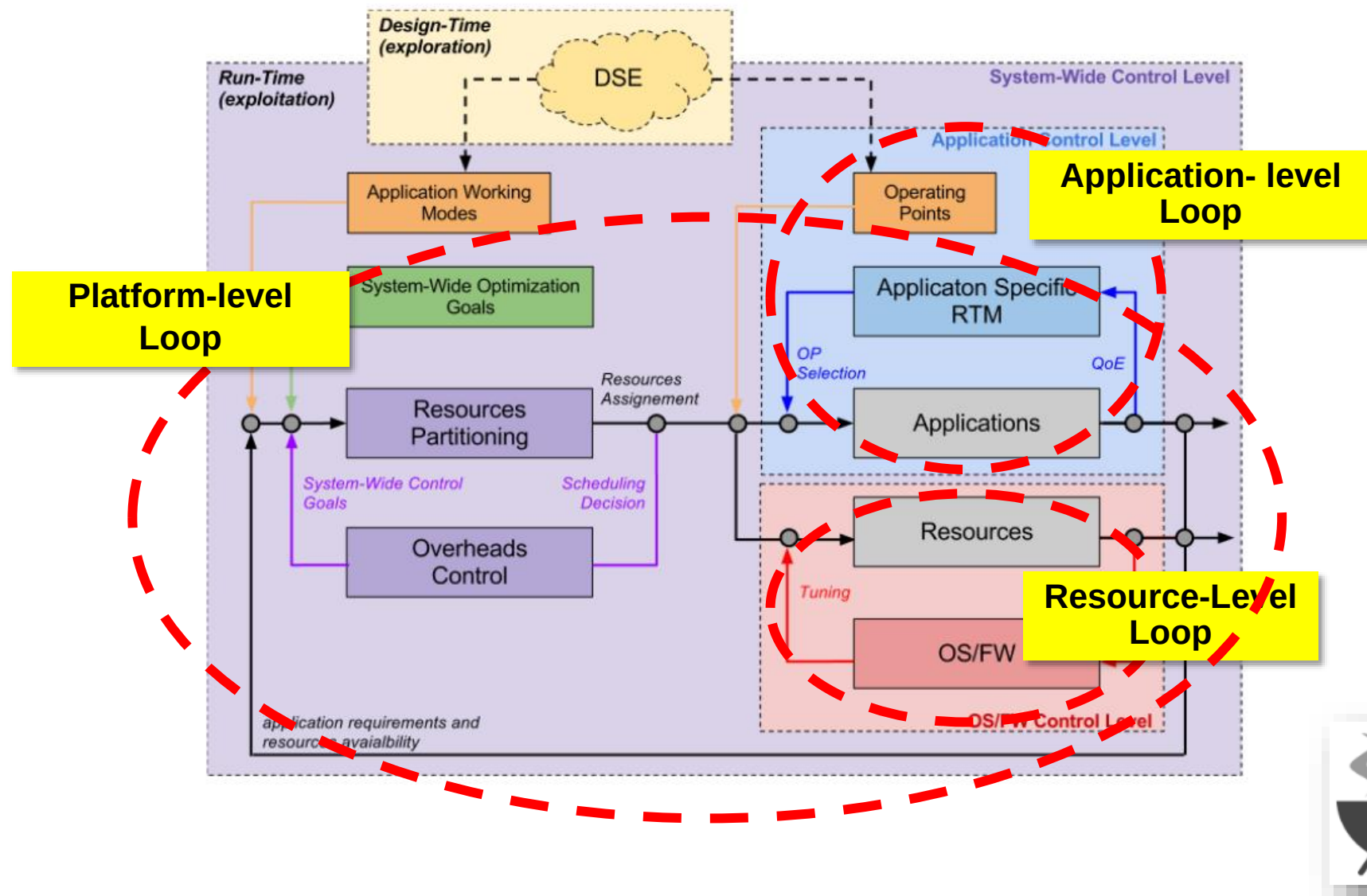
- Configure the application in terms of different operating modes
- Application configuration is driven by the application status and/or extra-functional requirements (e.g. key-on/key-off for automotive) or by resource status (e.g. battery level)

► Resource-Level

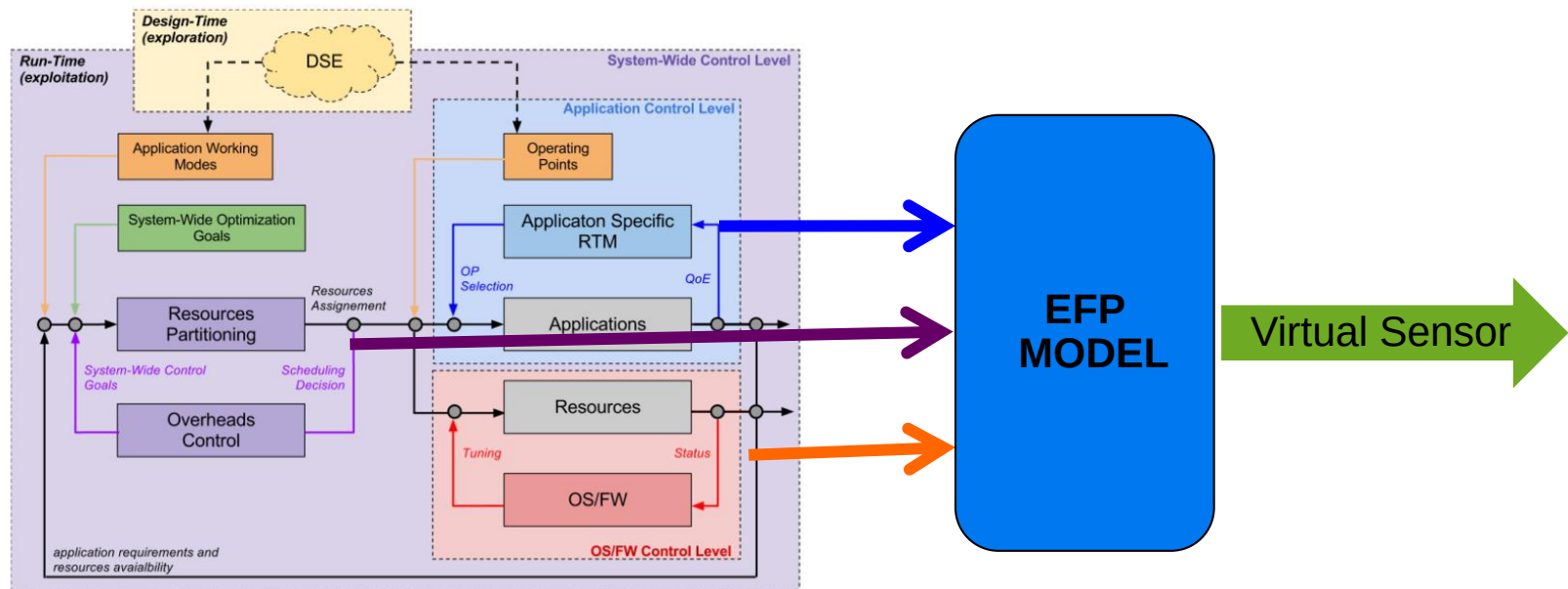
- Configure the resources in terms of different Power States (V/F)
- The resource configuration is driven mainly driven by its usage or application status

► Platform Level

- Assign Bandwidth and Shared resources to each application running
- The resource assignment is driven by their availability due to power/thermal constraints and application requirements in terms of criticality or QoS level.



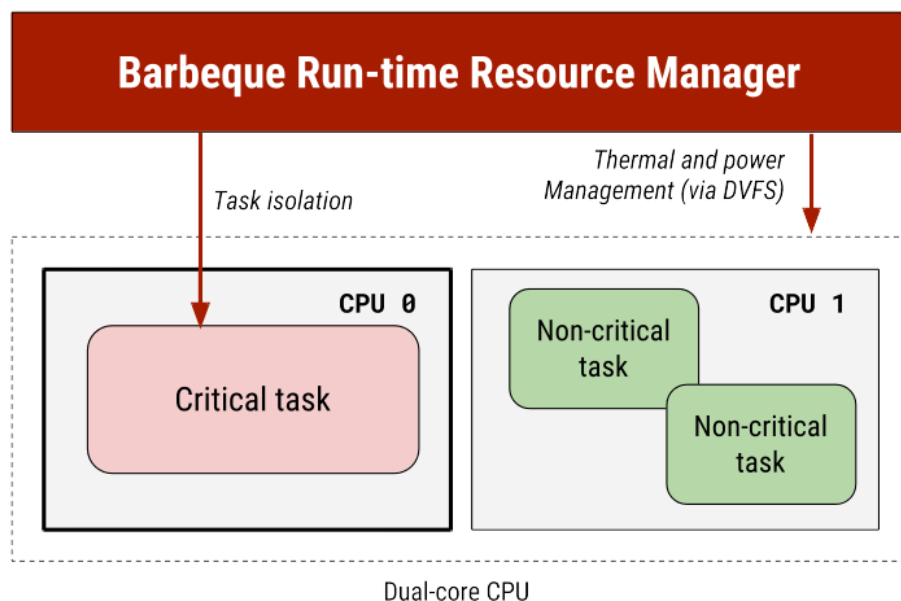
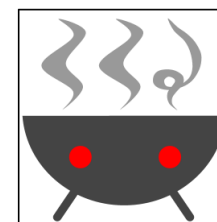
- ▶ Run-Time Management Decisions should rely on an heterogeneous set of information coming from the running system at all levels (e.g. application, resources and platform)
- ▶ To make them available to the CONTREX-RTM not only in raw format, the concept of “virtual sensors” have been developed
- ▶ A “virtual sensor” provides EFP values, also when they are not directly measurable into the system, by pre-processing the measured data and thus facilitating the RT decisions



- ▶ According to Use Case requirements 2 different RTM have been implemented in CONTREX starting from the same basic concept:
- ▶ BBQ-RTRM – User Space Daemon
  - ▶ It is an extension of a previous RTRM (designed for many core architectures) for managing Mixed-Critical applications
    - ▶ The **resource accounting** phase grants resources to *High-priority/Critical workloads* while optimizing (if possible) resource usage by *Low-priority/Low-criticality workloads*
    - ▶ It relies on the resident operating system/mechanisms for resource allocation
  - ▶ Porting done on the CONTREX target Xilinx Zynq (Linux-based OS)
  - ▶ Resource allocation based on power/thermal constraints
- ▶ BBQ-Lite RTM – Application-Library
  - ▶ Newly developed RT-Manager for ultra-low-power sensor nodes
  - ▶ Porting done on the ST-iNemo platform for the Automotive Use Case
  - ▶ Management only of Application modes and Resources power states to minimize the power consumption and battery-duration for key-off services



- ▶ **Priority-based** system resources partitioning
  - Isolate *critical* and *non-critical* tasks into separate computing resources partitions
- ▶ Prevent **power-budget violations** due to non-critical tasks execution
- ▶ Prevent **thermal hot-spots** due to non-critical tasks



BarbequeRTRM
Open-Source Project
<http://bosp.dei.polimi.it/>

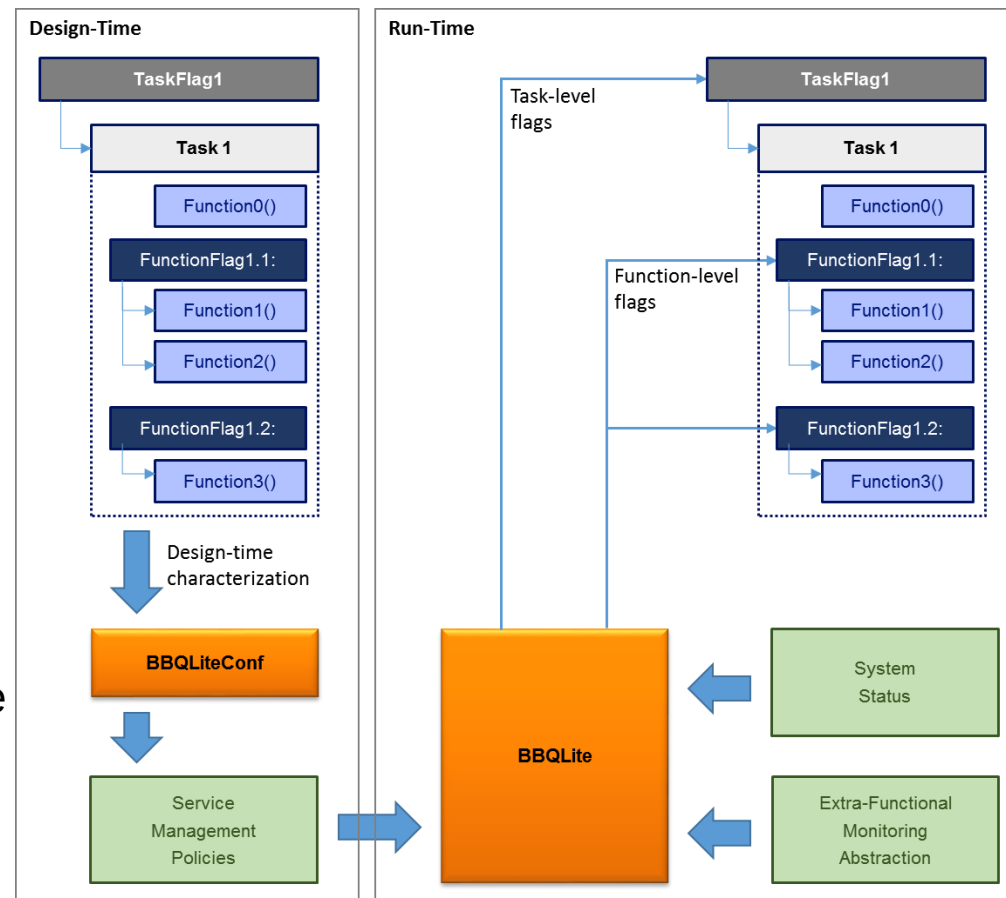
- ▶ Manages the behaviour of the system based on:
  - ▶ Vehicle status (key-on, moving...)
  - ▶ Non-functional aspects (e.g. Battery charge)

▶ Two components

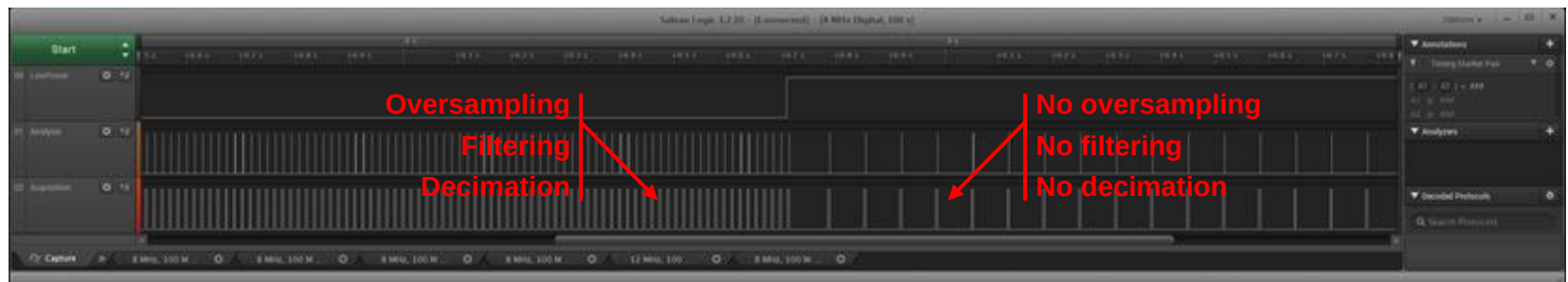
- ▶ Design-time:
  - ▶ Based on simulation results, helps defining management policies
- ▶ Run-time:
  - ▶ Based on the operating mode and the extra-functional figures applies the policies defined at design-time

▶ Integration into existing firmware

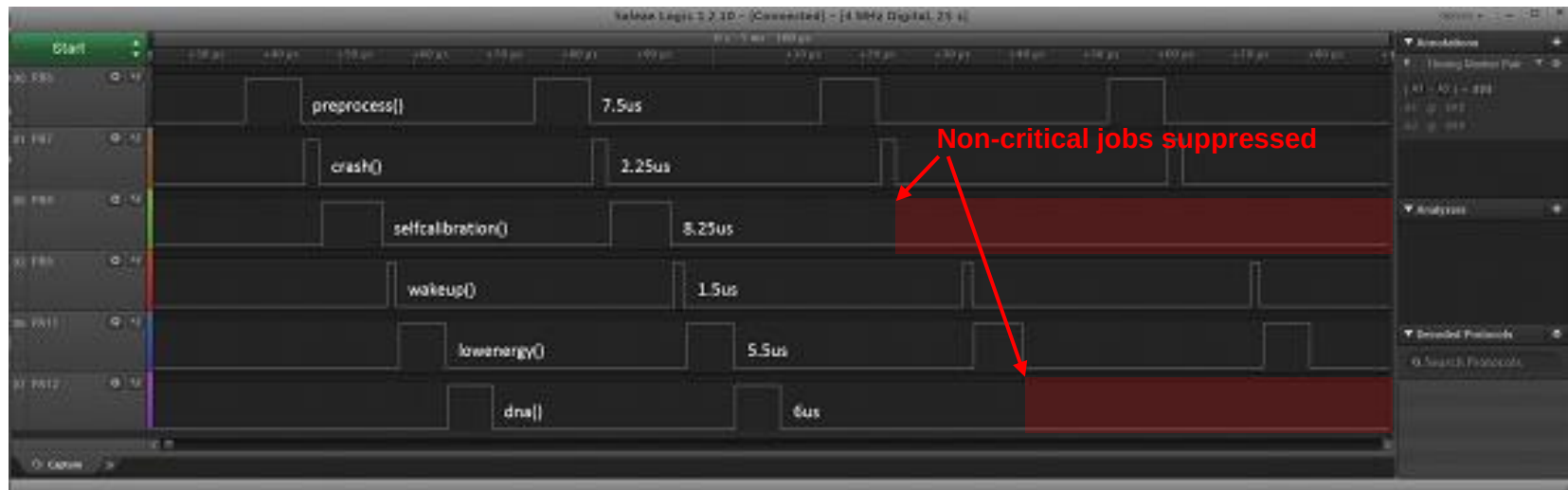
- ▶ Most of the code is generated
  - ▶ Simple API
- ▶ Limited intervention on the firmware
  - ▶ One dedicated, isolated task
  - ▶ Few calls to test user-defined flags



- ▶ Driver control: Power reduction by reducing sampling rate



- ▶ Task control: Power reduction by functionality degradation



▶ Example of virtual sensors: **battery models**

- ▶ Convey EFP values characterizing the *power dimension* of the system
  - ▶ Based on processing of power consumption characteristics of the operating modes of applications/devices
- ▶ Useful whenever relying on batteries for energy (e.g., key-off services)

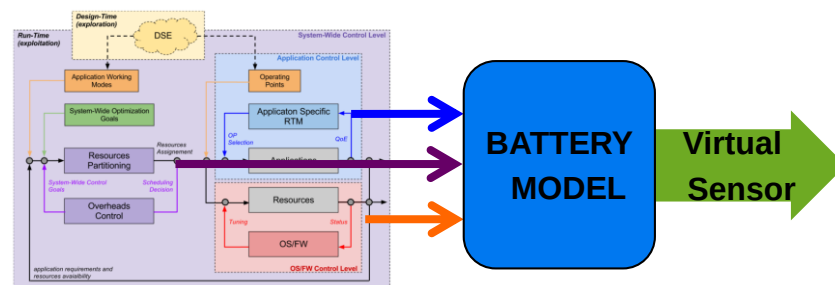
▶ Used for **RTM configuration**:

▶ **Static**

- ▶ Profiling of different operation modes (pre-processing)
- ▶ Get statistics about discharge-rate of the battery per unit time for each operating mode

▶ **Dynamic**

- ▶ Consider runtime demand for power (runtime processing)
- ▶ Estimate corresponding battery state-of-charge and discharge-rate over time
- ▶ **Guides the RTM Management Decisions** towards the most suitable performance/power consumption tradeoff



Technology Pitches

SUPPORTED HARDWARE

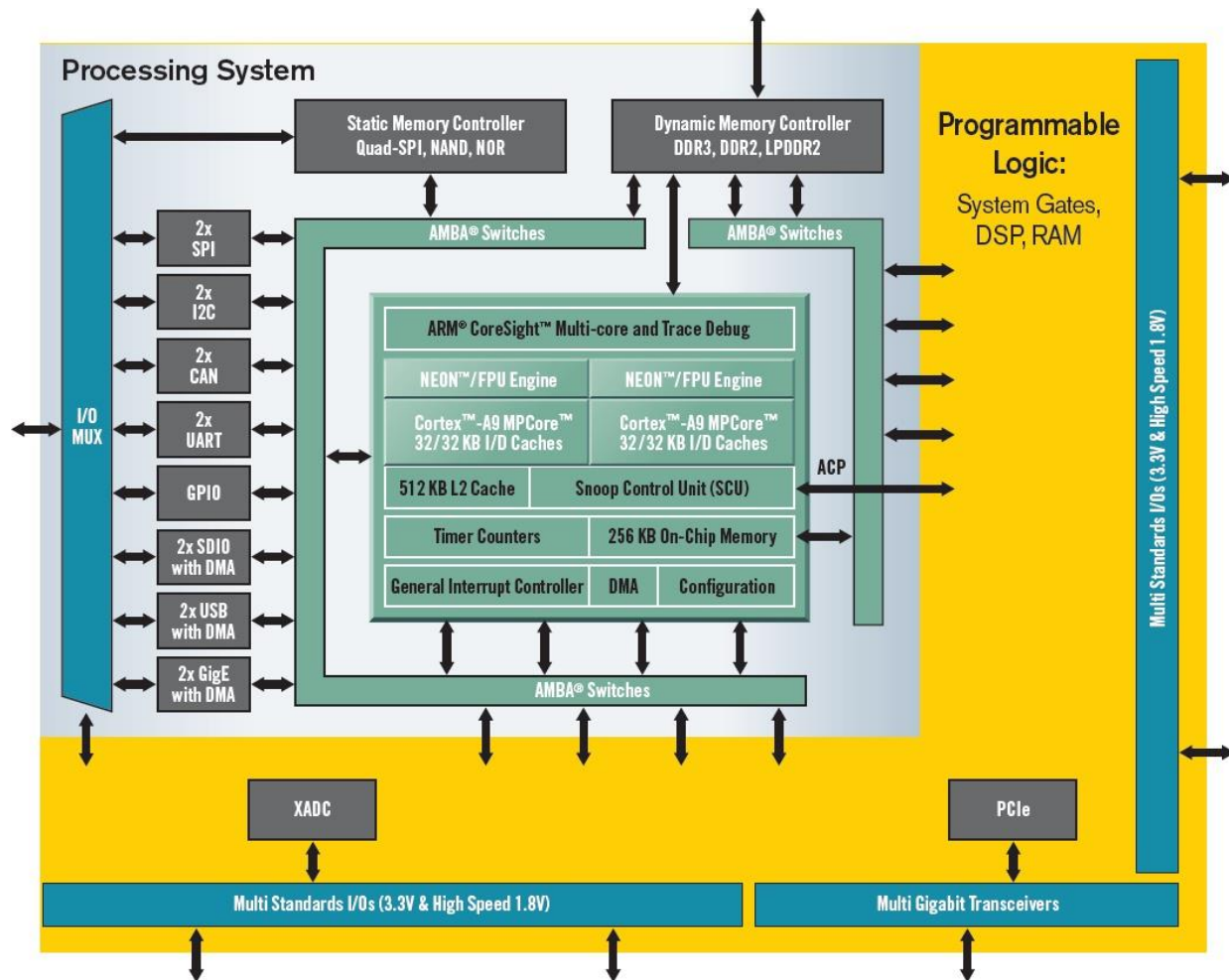
40 Use Case 1: Xilinx ZYNQ heterogeneous MPSoC platform

► MPSoC execution platform

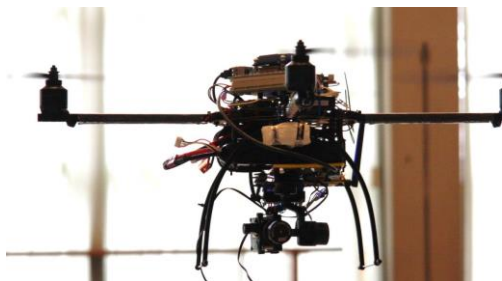
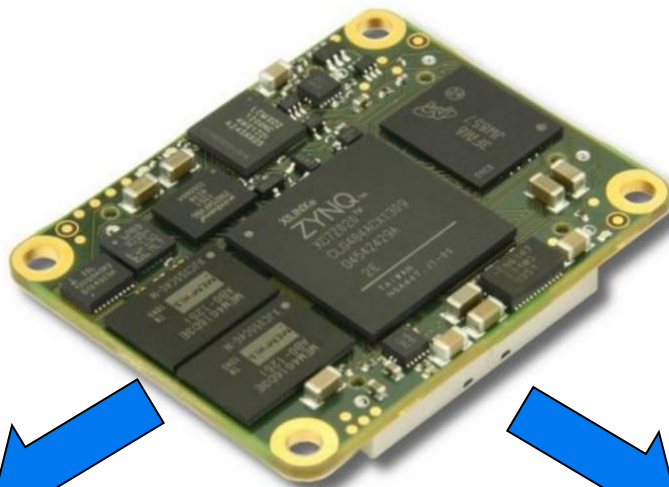
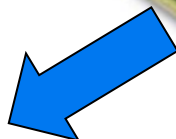
- Xilinx ZYNQ 7020: ARM dual-core Cortex-A9 (866MHz) & Artix-7 FPGA (85k logic cells)
- Input/Output: 152 FPGA I/Os & 14 Interfaces (I²C, UART, CAN, etc.)



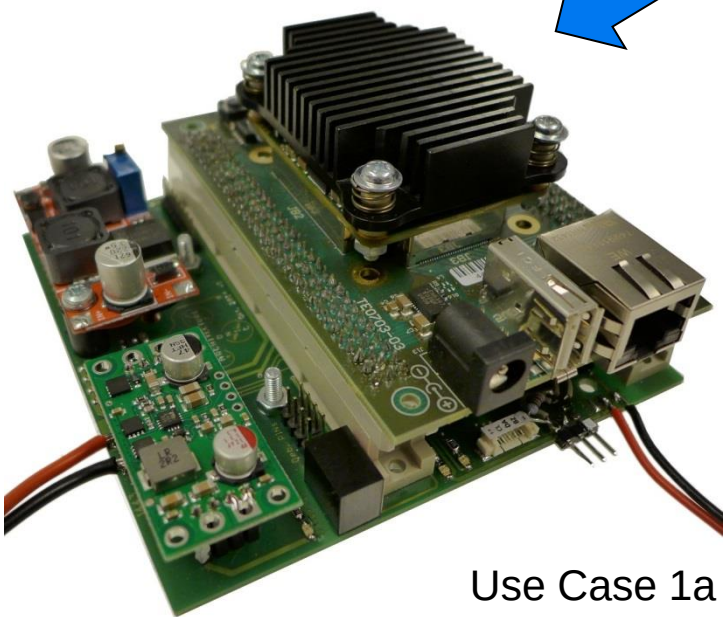
Source: <http://www.bdti.com/InsideDSP/2011/03/30/Xilinx>



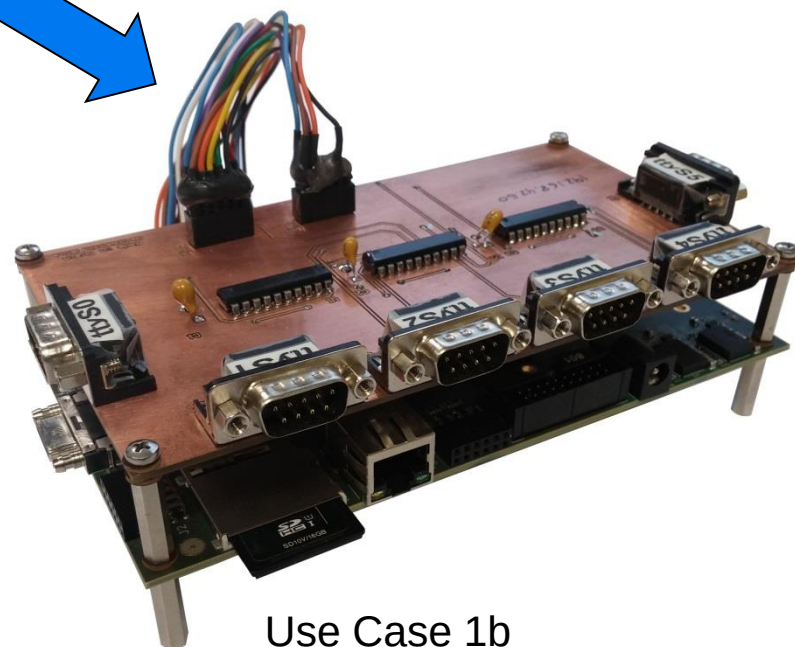
41 Use Case 1 (Avionics): Heterogeneous MPSoC Hardware Platform



Source: <http://www.trenz-electronic.de/de/produkte/fpga-boards/trenz-electronic-tre0720-zynq.html>

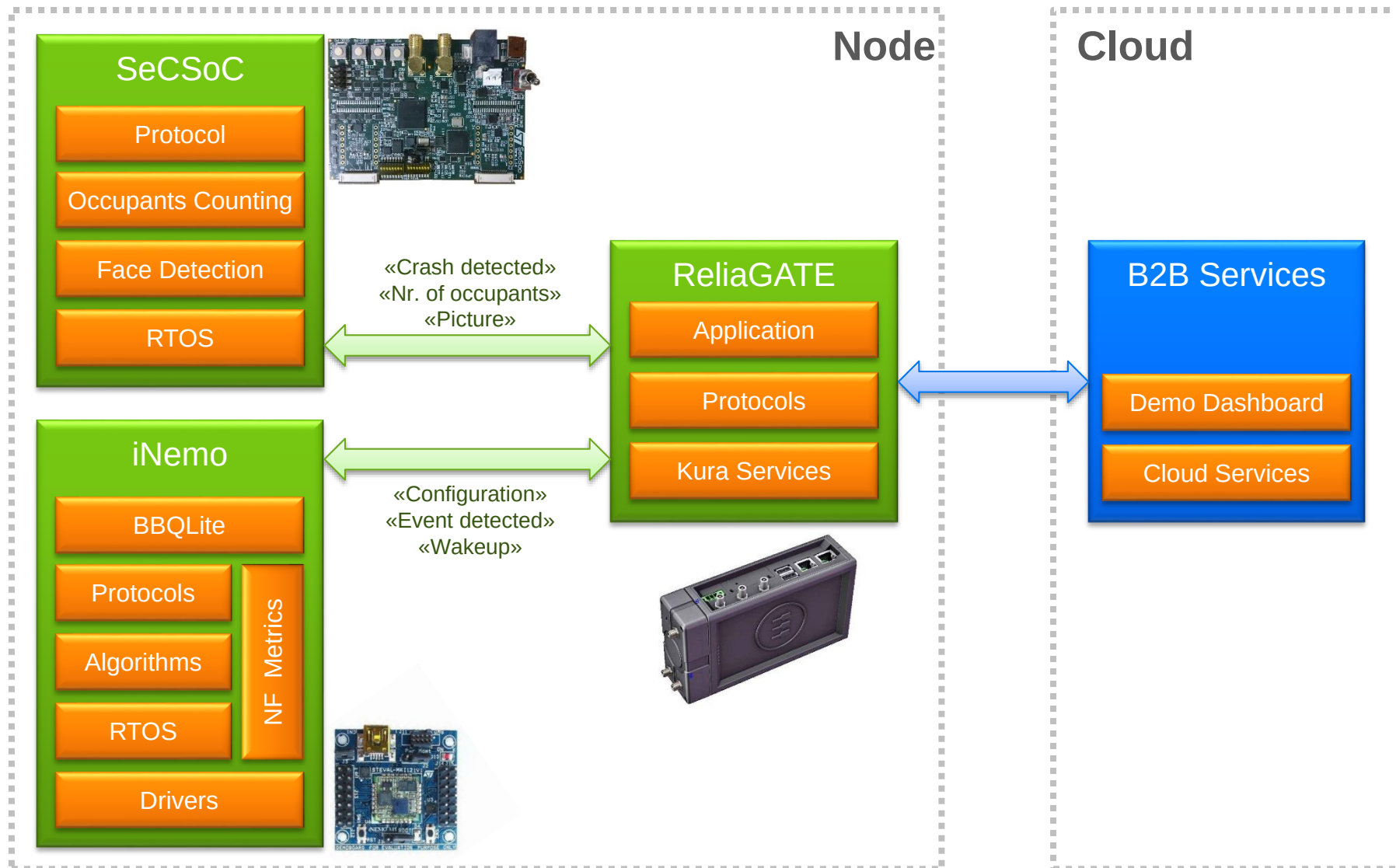


Use Case 1a

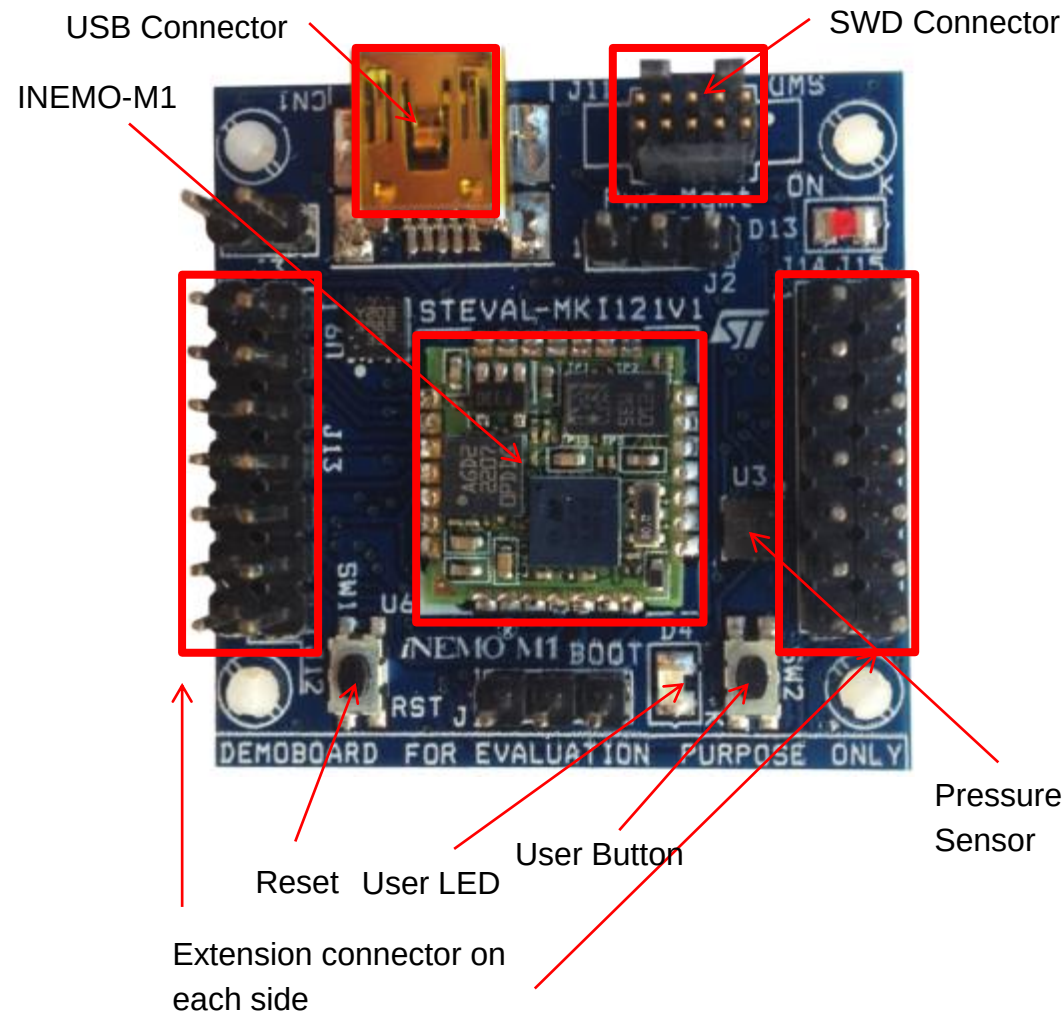


Use Case 1b

42 Use-Case 2 (Automotive): Hardware Platform Usage



43 iNemo-M1 evaluation platform for sensor fusion



Main Features

Compact "10DoF in one board 35x35 mm²

- INEMO-M1: 6-axis geomagnetic module, a 3-axis gyroscope and an ARM® Cortex™ M3 32-bit microcontroller unit
- Integrated pressure sensor LPS331AP
- USB connector
- SWD connector for debugging and programming
- Several power supply options (5V via USB or 2.4V to 3.6V DC via external supply)
- The extension connector with all iNEMO-M1 pins enable building more complex applications by using an extension board

Order code: STEVAL-MKI121V1

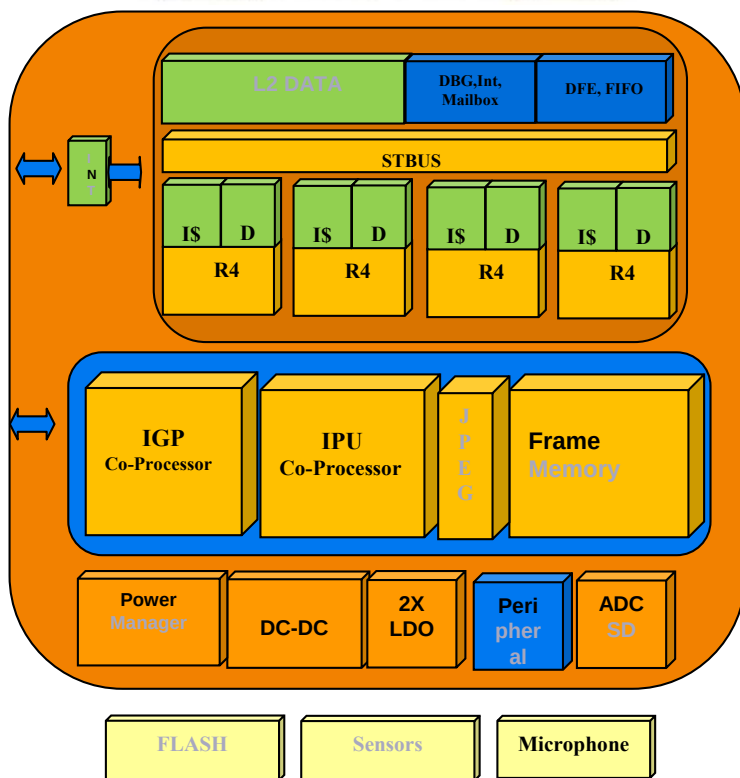
- ▶ The RELIAGATE 10-11 is a multiservice gateway for IoT application:
  - ▶ ARM Powered (TI AM335X CPU) with optimum performance for intensive workloads at just 2W.
  - ▶ IoT Ready:
    - ▶ connectivity options: global cellular modem, Wi-Fi, BLE, Fast Ethernet;
    - ▶ fieldbus interfaces, including CAN bus ports, opto-isolated digital I/Os, protected USB and serial ports;
    - ▶ GPS, temperature sensor, accelerometer;
    - ▶ Open Platform with native Kura and ESF support.
  - ▶ Industrial and Automotive Grade:
    - ▶ wide operating temperature;
    - ▶ wide range power supply with transient protection;
    - ▶ CE, FCC, E-mark, IC 60950-U, RoHS2, REACH, FCC, PTCRB, IP40, MTBF >40000h or 5 years.
  - ▶ Globally Deployable, with support for ReliaCELL 10-20, the global cellular module with leading carrier pre-certifications.
  - ▶ <http://www.eurotech.com/en/products/ReliaGATE 10-11>



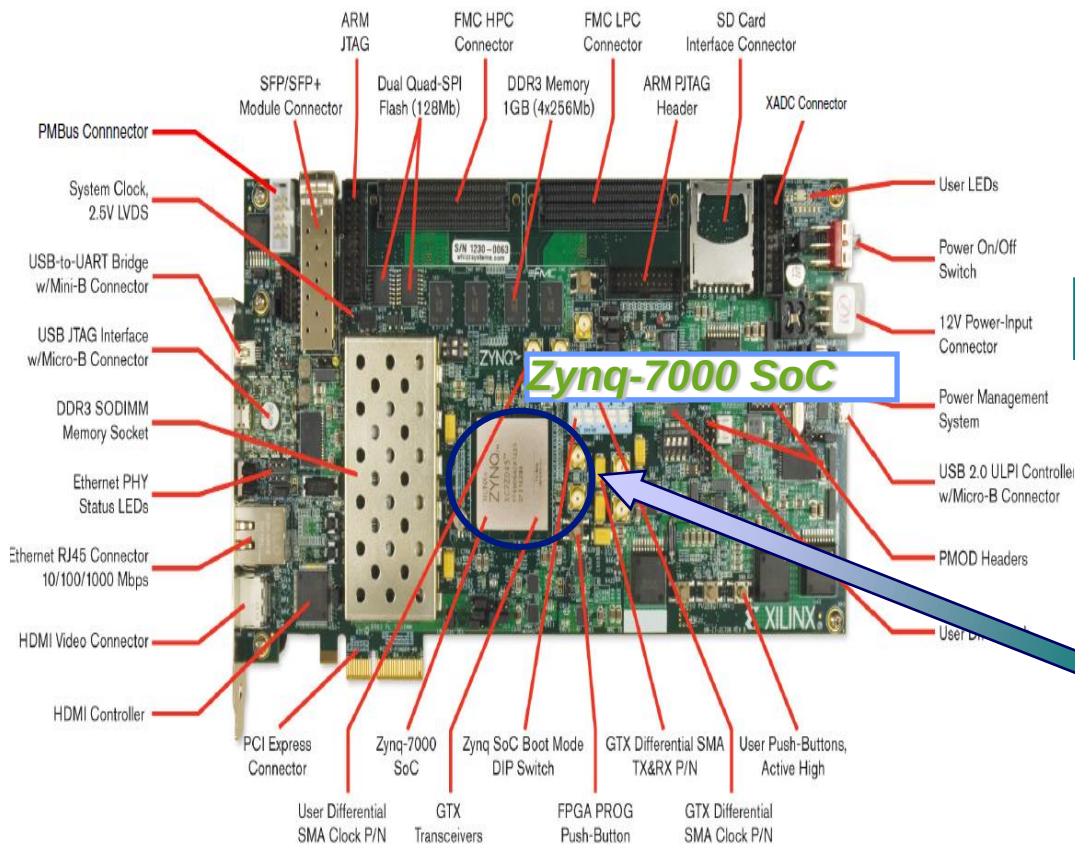
45 SecSoC: ST test chip for imaging processing



- ▶ Key added values:
  - ▶ dedicated co-processors for image based processing (IPU)
  - ▶ Four microcontroller-DSP for imaging elaboration Wide frame memory, 1MB
  - ▶ MJpeg compression
  - ▶ Integrated dc-dc, power island, retention
  - ▶ ADCs
- ▶ Chip main characteristics:
  - ▶ R4DSP Ck freq: Up to 120MHz
  - ▶ IGP/IPU Ck freq: Up to 120MHz
  - ▶ Peak Dyn Power: 40mW
  - ▶ Standby Power: 10uW
  - ▶ Technology: 65LPnm
  - ▶ Area: 25sqmm



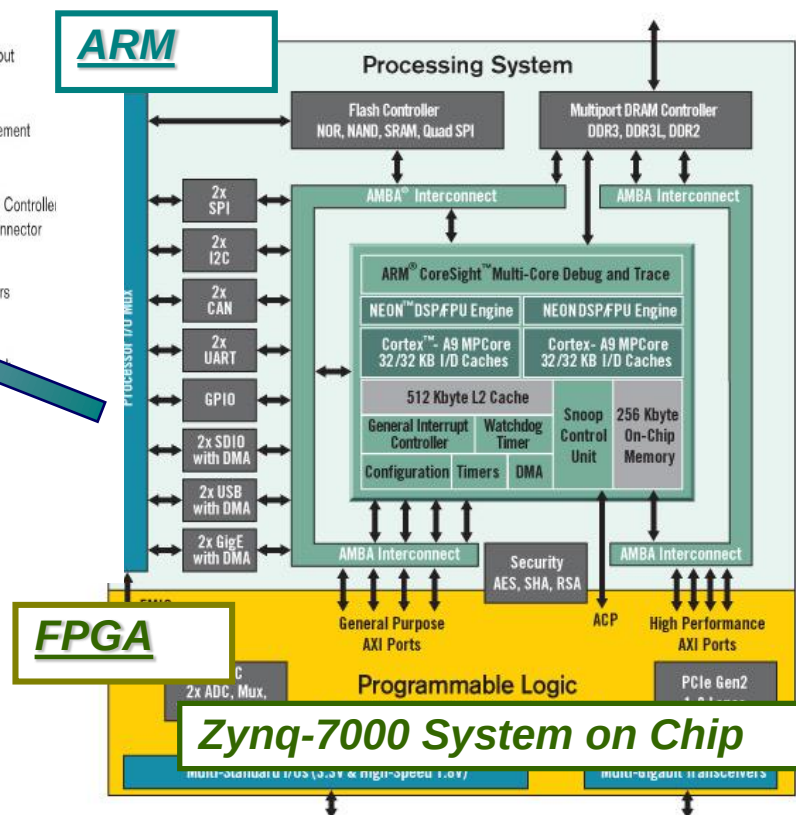
46 Use-Case 3 (Telecom): Hardware Platform Usage



**ZC706 evaluation board
with the Zynq-7000 XC7Z045
FFG900-2 AP SoC part**

Zynq-7000 products incorporate in a single device:

- ✓ **Dual Core ARM Cortex-A9** based Processing System (PS)
- ✓ **Xilinx Programmable Logic (PL)** in a single device.



CONTREX **SUCCESS STORIES**

48 Success Story 1: Avionics use-case and CONTREX MDE tool integration

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Extra-functional properties: hard real-time, power, temperature, reliability

Automotive Telematics



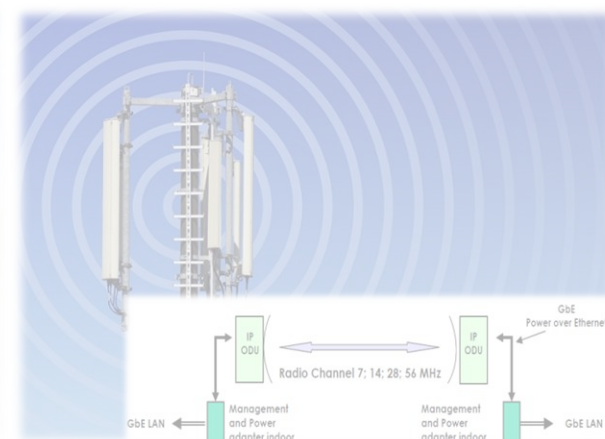
Automotive Telematics Box

Goal: Move processing from local (on-board) devices into the cloud.

Criticalities: mission- and non-critical.

Extra-functional properties: performance, power, security, reliability

Telecommunication



Ethernet over Radio System

Goal: Optimization of performance/cost characteristics of a Gbit Ethernet over radio system.

Criticalities: safety-, mission-, non-critical.

Extra-functional properties: real-time, power, temperature, reliability

- ▶ Basic components of a **R**emotely **P**iloted **A**ircraft **S**ystem (RPAS) are:
  - ▶ the aircraft (RPA),
  - ▶ the pilot station (ground station) .
  - ▶ and the command and control link (C2)
- ▶ **GMV** developed the (FCC) Flight Control Computer of the Remotely Piloted Aircraft.
- ▶ **GMV** developed the ATOL (ground station).
- ▶ Aircraft characteristics
  - ▶ Length 4,5 m
  - ▶ Wingspan 8 m
  - ▶ Payload 60 kg
  - ▶ Altitude 12.000 ft
  - ▶ Range 200 km
  - ▶ Payload EO/IR

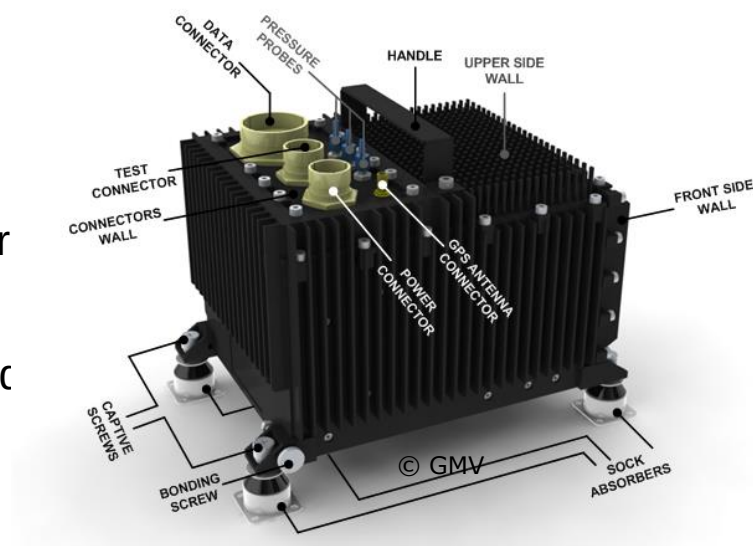


▶ GMV's FCC HW elements:

- ▶ Navigation sensors: (IMU), GPS Receiver, Absolute and differential Pressure transducers, Magnetometer. Radar-altimeter (external to the FCC chassis)
- ▶ CPU board: customized board
- ▶ Power Supply converter and EMI/EMC filters car
- ▶ Hold-up card
- ▶ I/O panel for wiring and external connections and lightning protections

▶ The FCC SW components:

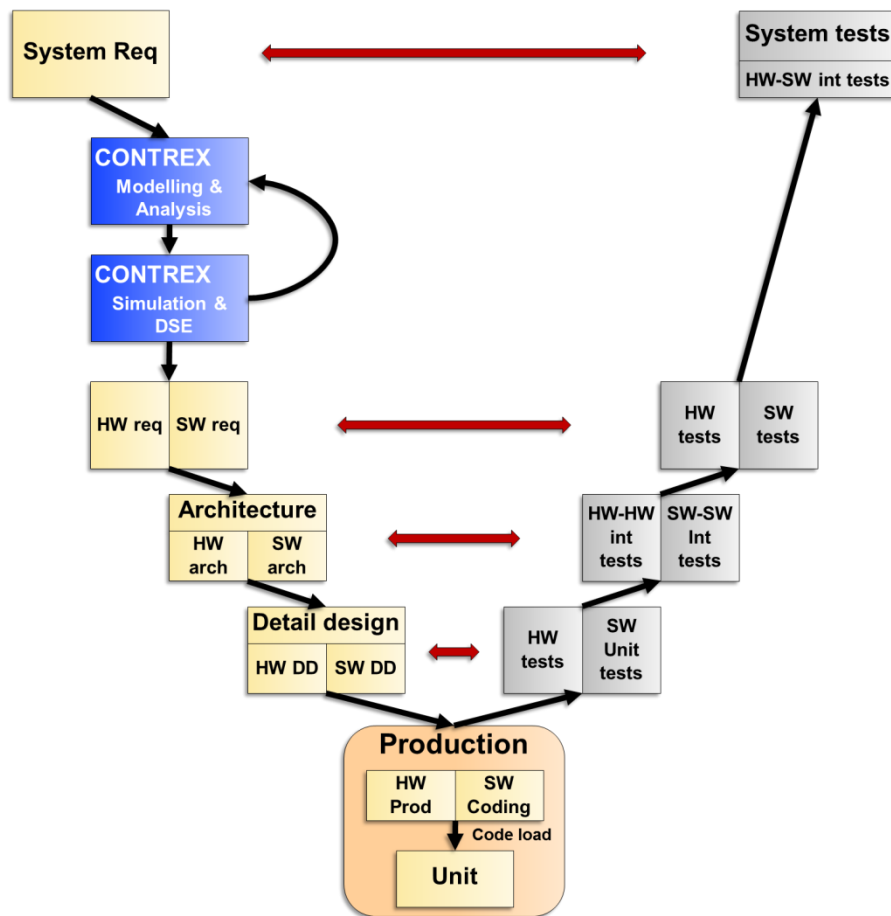
- ▶ Input/output
- ▶ Navigation
- ▶ Flight control laws.
- ▶ Fault Detection, Isolation and Recovery (FDIR)



Flight Control Computer chassis

- ▶ GMV goal is to tailor its **FCC** system developed for light RPAs platforms.
- ▶ For light RPAS equipment size, weight and power (*SWaP*) constraints are a key factor. The **adaption of the FCC SW** to diverse commercial all-purpose platforms and low-cost avionics sensors is required
- ▶ As our current avionics flow is focused on custom platforms for systems under construction, **it was required a more flexible approach** that enabled:
  - ▶ An **early assessment of the system performance** on different (COTS) platforms.
  - ▶ The **efficient (automatic) exploration of wider design spaces** (consisting of different HW/SW mappings, different platform configurations, etc.).

- ▶ **CONTREX enhances the current avionics flow** by introducing extra stages for system modelling, model-based analysis, simulation and DSE during the design phase.



- ▶ The analysis, simulation and DSE results gathered during these can be used to:
  - ▶ make architectural decisions based on reliable figures about system performance on the different platforms.
  - ▶ find those configurations that optimize system performance.

- ▶ During CONTREX project, a demonstrator based on GMV's legacy FCC system has been developed using CONTREX integrated flow.
  - ▶ The resulting **demonstrator** will not be directly exploited as a product on the market but serves as prototype for evaluation purposes.
- ▶ This activity has produced an advance in knowledge about current techniques **on analysis, modelling and design space** exploration as well as a set of relevant evaluation results. It has enabled the **assessment** of the **applicability of CONTREX approach** to the tailoring of existing FCC system to light RPAs.
- ▶ The CONTREX integrated flow has demonstrated its potential to perform early and reasonable (in terms of cost and time) assessment of the performance of the system on new platforms.

54 Success Story 2: New low-power telematics box

Avionics



Flight Control Computer for a Remotely Piloted Aircraft

Goal: Executes safety-, mission- and non-critical applications on the same multi-core execution platform.

Criticalities: safety- and mission-critical

Extra-functional properties: hard real-time, power, temperature, reliability

Automotive Telematics



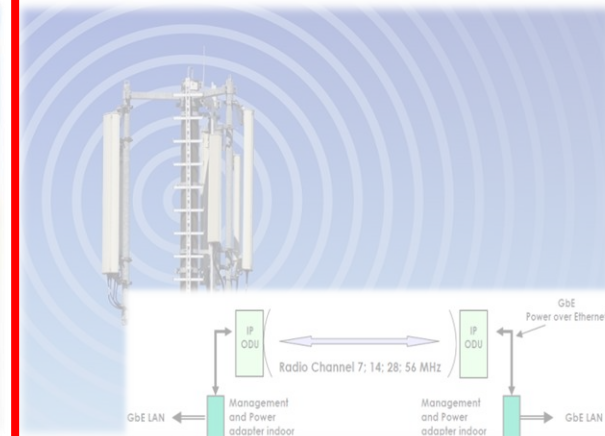
Automotive Telematics Box

Goal: Move processing from local (on-board) devices into the cloud.

Criticalities: mission- and non-critical.

Extra-functional properties: performance, power, security, reliability

Telecommunication



Ethernet over Radio System

Goal: Optimization of performance/cost characteristics of a Gbit Ethernet over radio system.

Criticalities: safety-, mission-, non-critical.

Extra-functional properties: real-time, power, temperature, reliability

More safety on the roads, less frauds for the insurances, more value per money for the customers, even when a vehicle is parked for months!

Telematic boxes for vehicles mainly monitor the driver journey and his driving style. The main benefit up to now is to obtain a discount on the car insurance fee.

At present, companies provide private and/or fleet vehicle drivers with a support service in case of accident. The architecture exploits three components:

- i) a **sensing unit** installed on the car for acceleration/orientation measurements
- ii) a **localization** unit for GPS reading, and
- iii) a **data processing and communication** for identification of accidents and communication of position data either to public authorities (e.g. hospital or police) or private support providers.

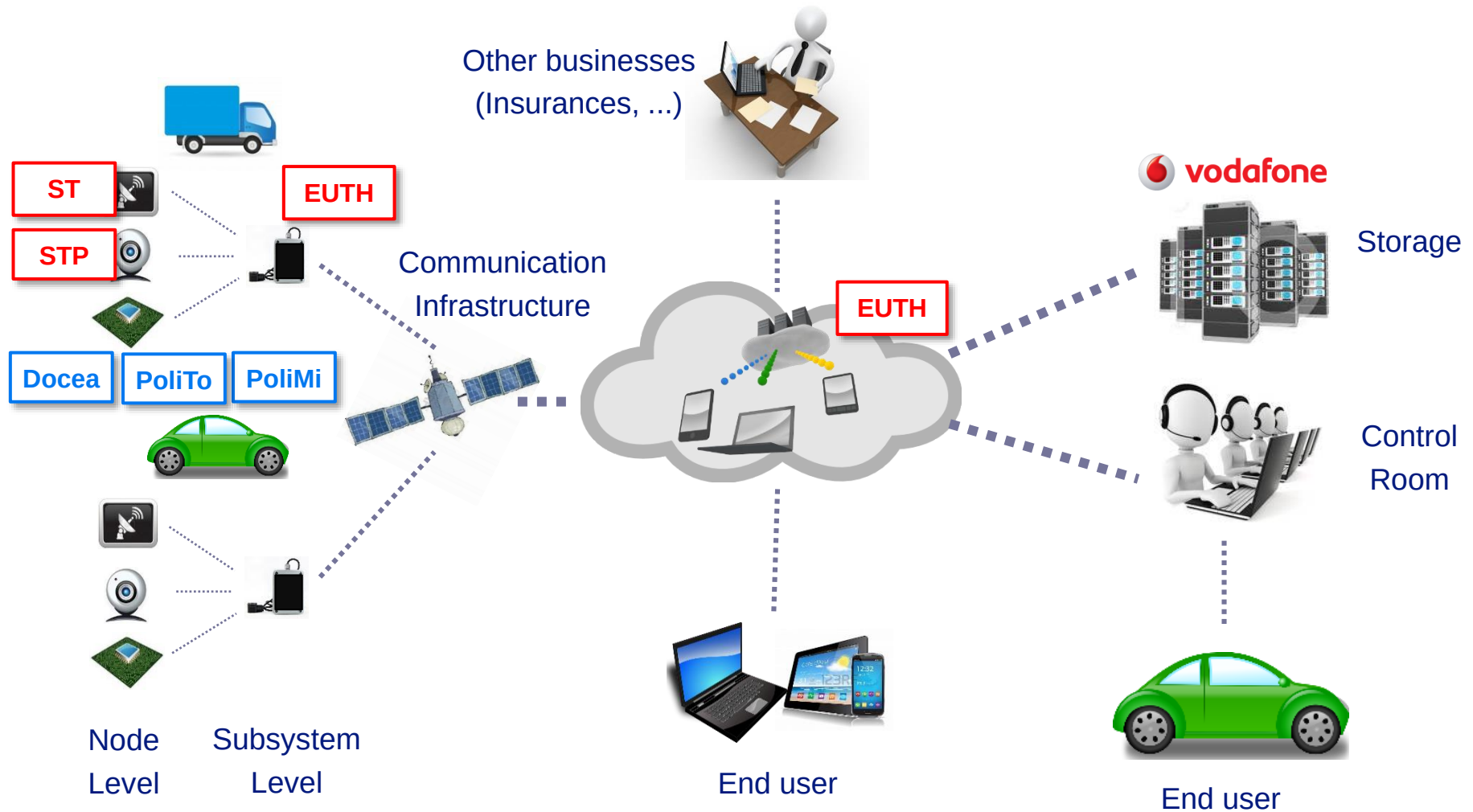


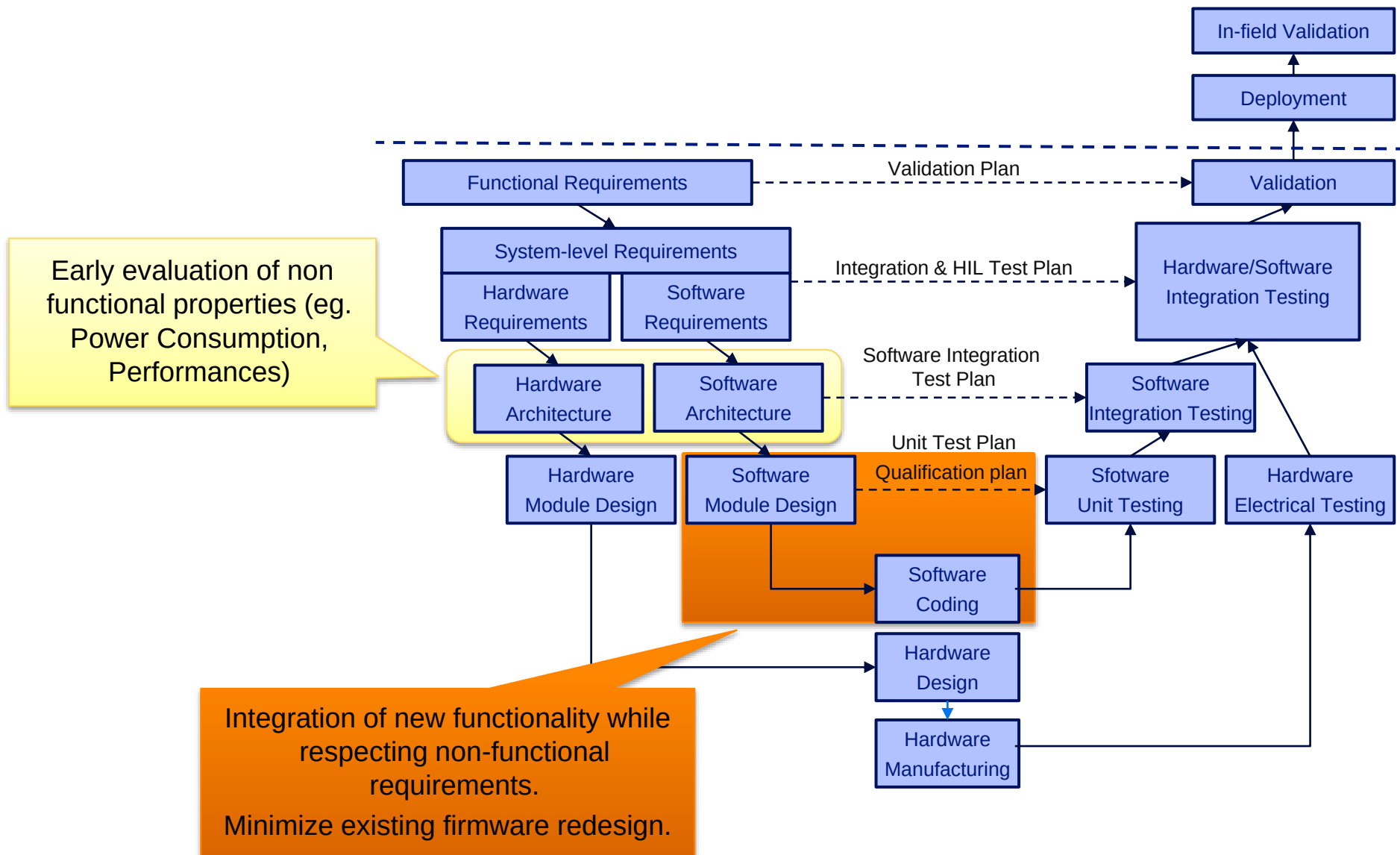
Automotive Telematics Appl.

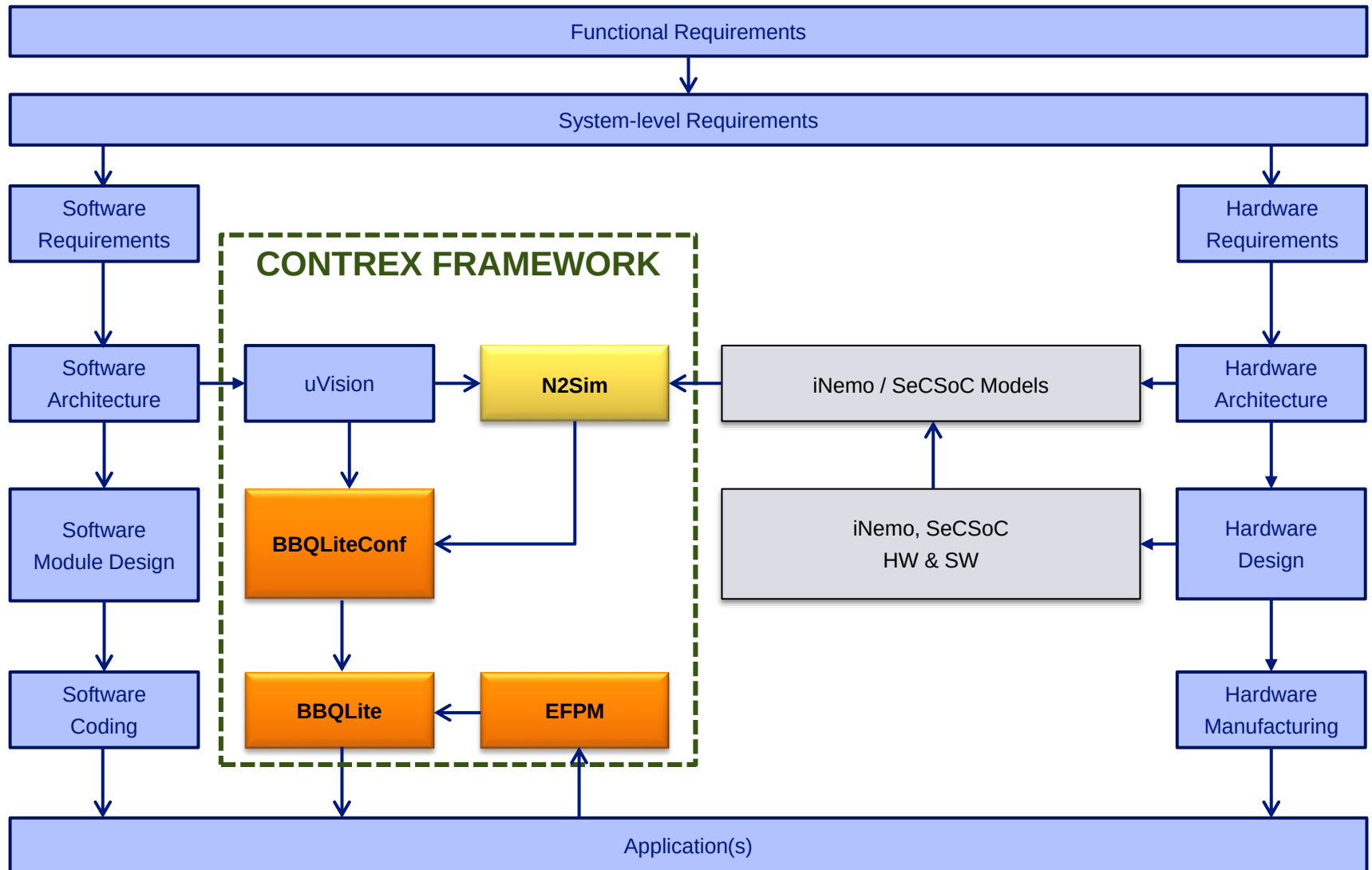
Goal: *Balance processing between local (on-board) devices and server.
Evolution towards the cloud*

Criticalities: *mission- and non-critical*

Extra-functional properties: *performance, power, security, reliability*

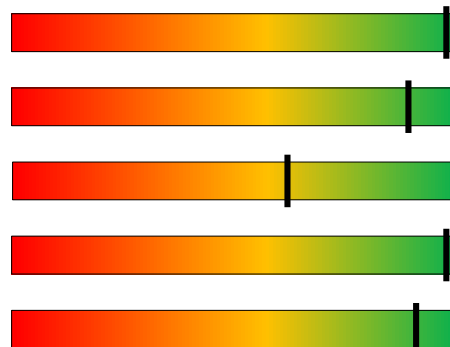
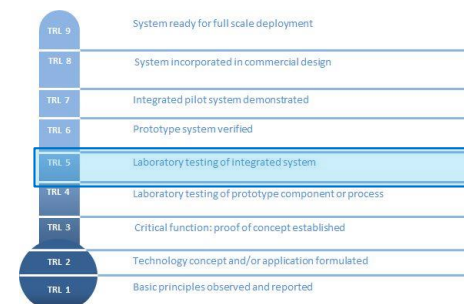






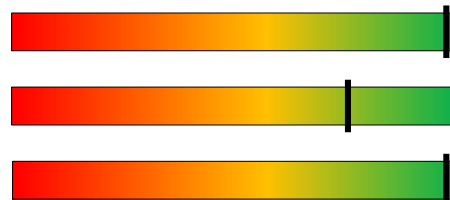
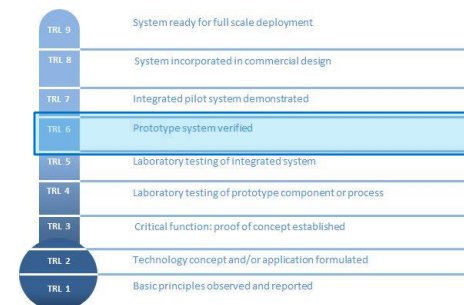
► N2SIM: Non functional simulator

- Integration in the existing design flow
- Hardware platform modelling
- Software application modelling
- Presentation/interpretation of results
- Accuracy of the results



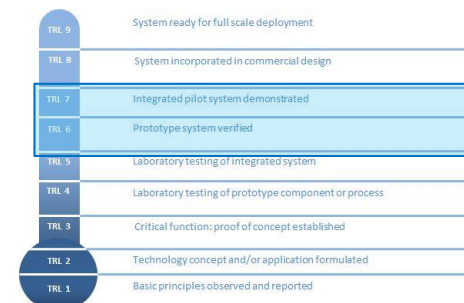
► EPFM: Extra-functional property monitoring

- Integration into existing software
- Configuration
- Integration with run-time manager



► BBQLite: Run-time management

- Integration into existing software
- Integration with EPFM
- Benefits (power consumption reduction)



► Simulation

- Will be used for core portions of the application for early assessment of power requirements of new generation products
- Modelling of MEMS, microcontrollers, ... shall be extended to new components

► Monitoring and Run-time management

- Currently used in prototype devices in the field
- The increasing complexity and variety of the functionality of next generation devices will benefit from adoption of run-time management
  - Non-functional property management is being considered for real cases
  - Low-level management (i.e. CPU) is already adopted (around 150K devices)
  - Higher-level functional/non-functional management will be evaluated for adoption in production devices

► New generation devices

- Boxes for motorbikes being designed/improved using the CONTREX flow
- Expected market: 2K devices/month starting Q2 2017

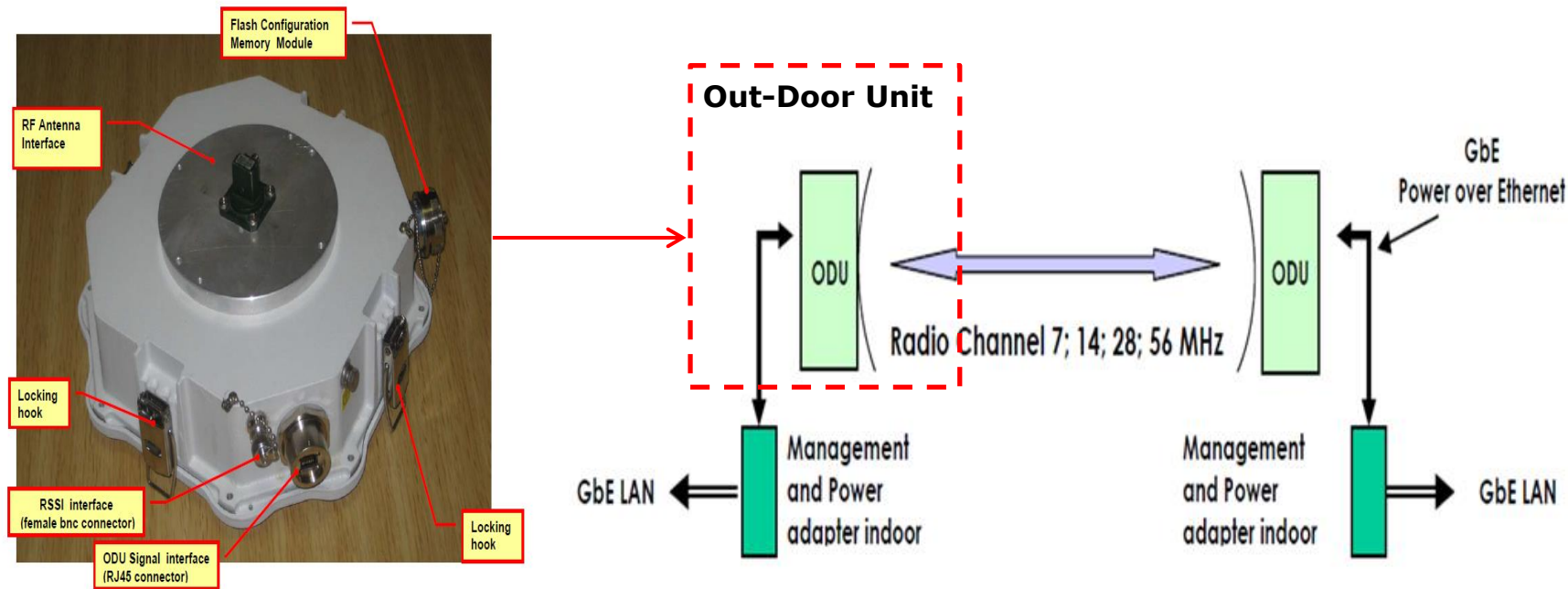
The logo for Contrex, featuring the word "Contrex" in a bold, sans-serif font. The letter 'C' is stylized with a blue checkmark inside. The letter 'o' is replaced by a green battery icon with a white plus sign. The letter 't' is replaced by a red thermometer icon showing a high temperature.

Extra-functional properties:
*hard real-time, power,
temperature, reliability*

Extra-functional properties:
*performance, power, security,
reliability*

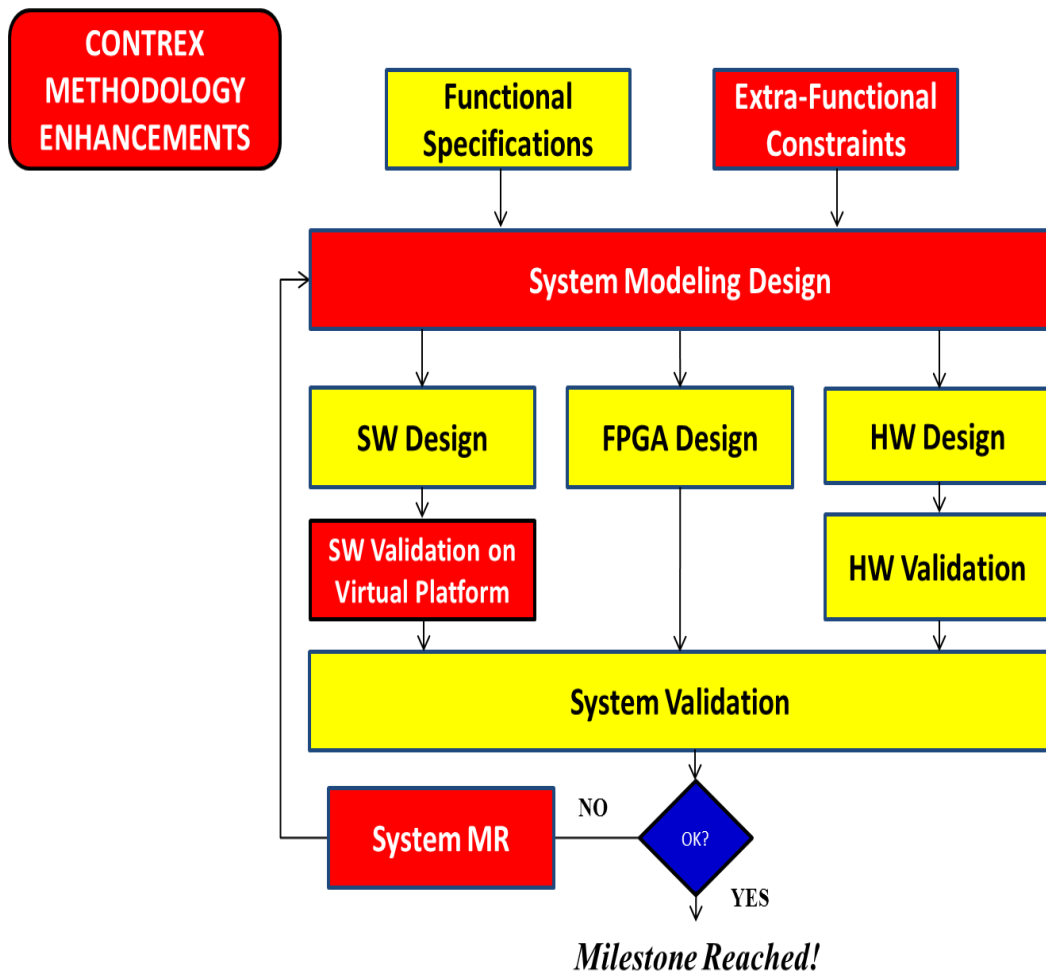
Extra-functional properties:
real-time, power,
temperature, reliability

The Telecom Demonstrator is based on the Point-to-Point (P2P) Ethernet over Radio Microwave Wireless System



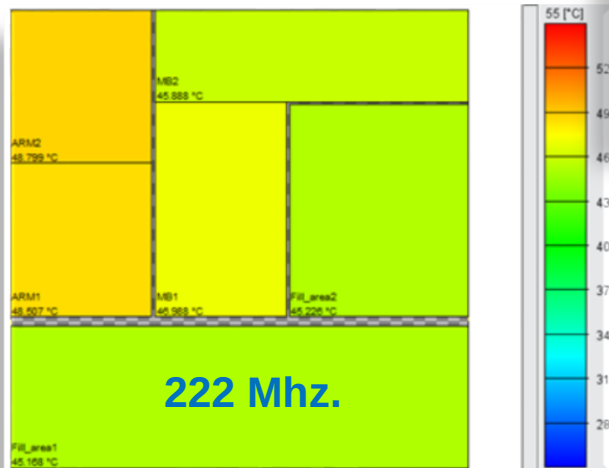
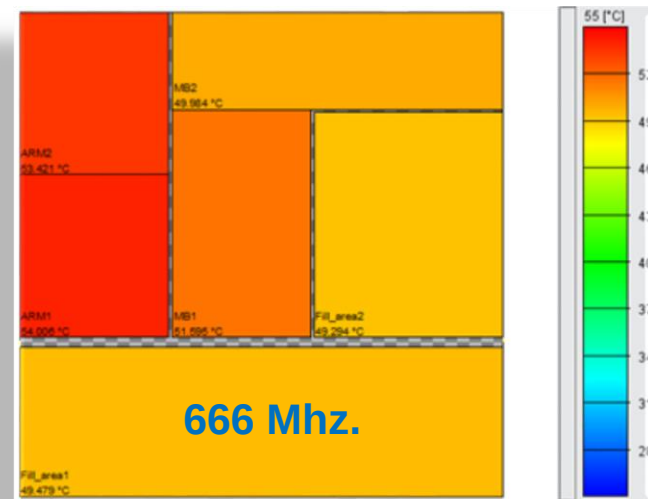
- ▶ Software components developed within Intecs (except for L2Switch + Modem - FPGA)
- ▶ High reliability
- ▶ Automatic Transmit Power Control (ATPC)
- ▶ Timing guarantees
- ▶ Power, temperature, weight, and size constraints

63 Intecs needs and expectations: Design Flow Enhancements



- ▶ These are the points of intervention into the current industrial workflows
  - ▶ Mechanisms provided to capture extra-functional properties / constraints
  - ▶ A layer of pre-development modelling capacity
  - ▶ Early validation capability provided through a virtual platform for the software
  - ▶ Uplifting of individual SW / HW / FPGA Modification Requests (MR) to System MR, capable of being treated in the system modeling layer

Comparison of the of the thermal behavior on the simulation platform to the behavior on the real platform



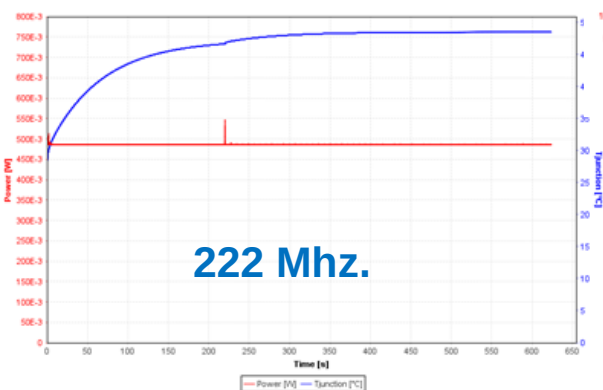
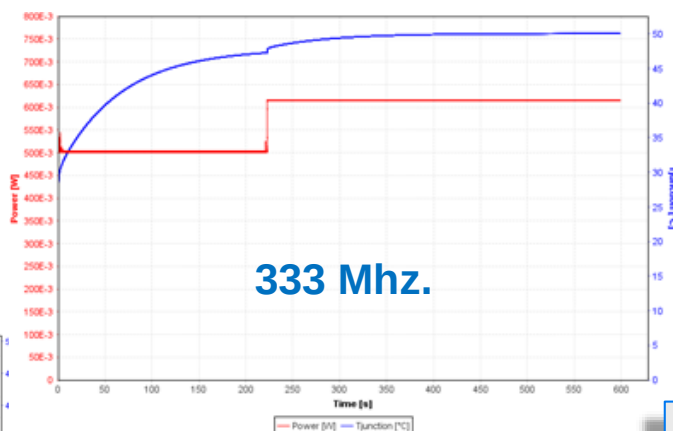
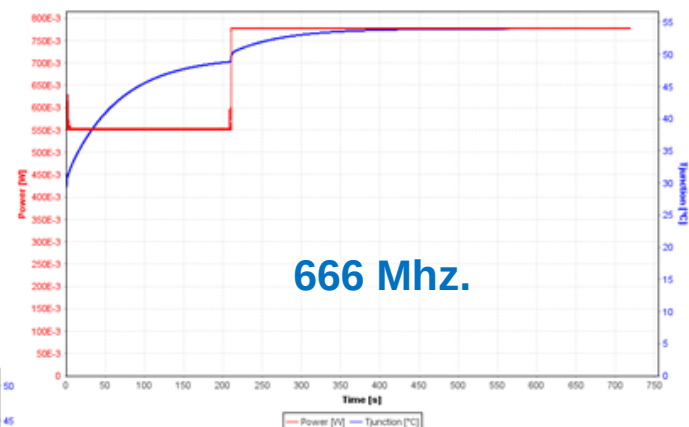
Maps the temperatures in different areas

Aceplorer temperature maps for increasing CPU clock speeds. Normalized temperature scale (25°C to 55°C)

65 Power and Temperature Graphing

Temperature $T_{junction}$

Power [W]



High fidelity of power graphs – essential for design of the complex adaptive modulation and ATPC functionalities that must also minimize power consumption

CONTREX

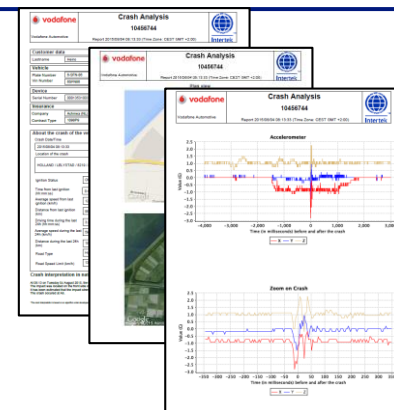
INDUSTRIAL EXPLOITATION

- ▶ Automotive usecase proves the concept for Inemo solution as off the market telematics box (complementary to on the market automotive solutions provided by ST)
  - ▶ combo sensor market in automotive field use is accelerating rapidly – combos are finding favour as a way to save costs.
  - ▶ a couple of million accelerometers have been sold in 2014 for telematics applications
  - ▶ MEMS accelerometer is included in the telematics box
    - ▶ Following eCall specification in Europe
- ▶ Internal exploitation: SecSoc testchip
  - ▶ SW SDK augmentation based on virtual platform developed in CONTREX

- ▶ GMV aims to tailor its **FCC** system developed for a Large RPA to future light RPA platforms.
  - ▶ In particular, to **light RPAs** (<150 kg) for new markets and countries, enabling to maintain a competitive supply base in Europe.
- ▶ For light RPAs equipment, size, weight and power (SWaP) constraints are a key factor. Thus, the adaption of the FCC SW to commercial all-purpose MPSoC platforms and low-cost avionics sensors is required.
- ▶ CONTREX developments suppose a solid base towards an operational design flow that enable the design and validation of legacy FCC SW for the aforementioned platforms and sensor equipment, as required by the future customers of the light RPAs platforms.

► Enhanced and semi-automated crash

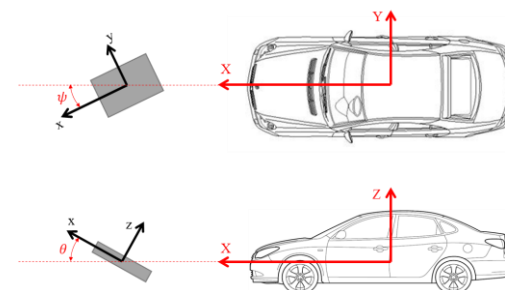
- **Reconstruction:** feature extraction
- **Classification:** events description
- **Filtering (over 90% of false events)**
- **Reporting:** Extended crash reports



- Recognition of **low energy crashes**, to identify not only severe crashes but also **vandalisms or crashes when the car is parked**. This feature will be **activated both on new products and 200k devices** already on the field by the end of 2016. Roadmap started for active low energy at **key-on**.

- **Self calibration of the device**, with the capability to recognize autonomously the orientation of the device w.r.t. the vehicle.

Included by default in all products from fall 2016.



- **Extreme low energy requirements** of the black box installed on the car to make possible a **365/24 monitoring of the vehicle**, even when the car is parked for months. Improvement of one order of magnitude the power consumption .

- **Opening of a new market** for the **motorbike**, due to the reduced energy requirements.

- ▶ POLIMI tools as well as the use of jointly developed software to support the new advanced functionalities in commercial products
- ▶ A startup has been created by some members of the POLIMI team in July 2017, The goal is to jointly work with Vodafone Automotive to the development of a **new product for the motorbike market**
- ▶ The algorithms for crash detection have been reused to develop a **pilot product for the rally cross racing WRX**. The goal is to collect telemetry and crash information for the entertainment.
- ▶ **Perspective evolution towards cloud-based services**
- ▶ **A commercial version of the i-nemo component and other STM inertial sensors are considered for the architecture of the new SCD Box**

- ▶ EUROTECH exploitation activities have been focused on three technological areas:
  - ▶ internet of things (IoT) embedded software technologies;
  - ▶ embedded multiservice gateway for industrial and transportation application;
  - ▶ cloud-based machine-to-machine (M2M) integration solutions.
- ▶ Exploitation activities performed:
  - ▶ creation of an open source IoT community;
  - ▶ creation of new products;
  - ▶ consolidation of the device-to-cloud approach and solution;
  - ▶ consolidation of the products roadmap.
- ▶ Exploitation results:
  - ▶ Kura Framework (and the commercial version Everyware Software Framework);
  - ▶ RELIAGATE 10-11 multiservice gateway;
  - ▶ Everyware Device Cloud M2M integration platform.
- ▶ Project WP reference: WP3 and UC2.

- ▶ CONTREX environment enables migration of key use case IPR into new product areas
  - ▶ ATPC and adaptive modulation techniques on more powerful, modern processors
- ▶ Prospective exploitation areas
  - ▶ Used in LTE base stations to optimize low power consumption and offer mixed criticality transmission
    - ▶ Wireless backhaul link of traffic to the core network
  - ▶ The E.U. is making CfP for bringing broadband to C & D zones (few customers, reluctance of providers to lay fibre)
    - ▶ In sub-backhaul bring Ethernet Over Radio to the street cabinet, enabling VDSL within the urban area over existing copper lines

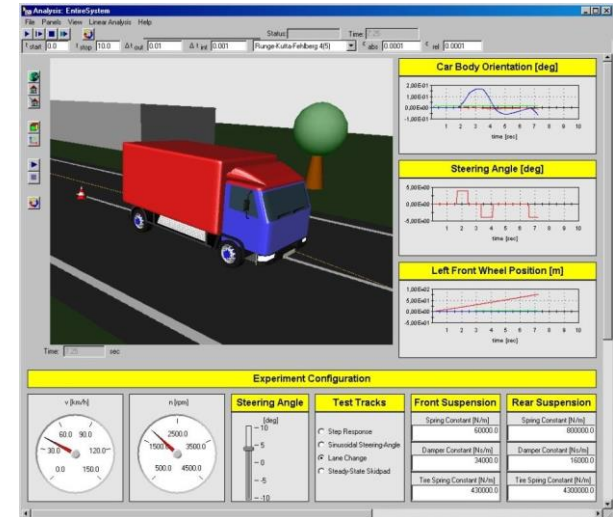
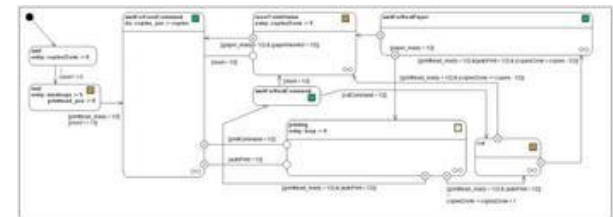


LTE base station



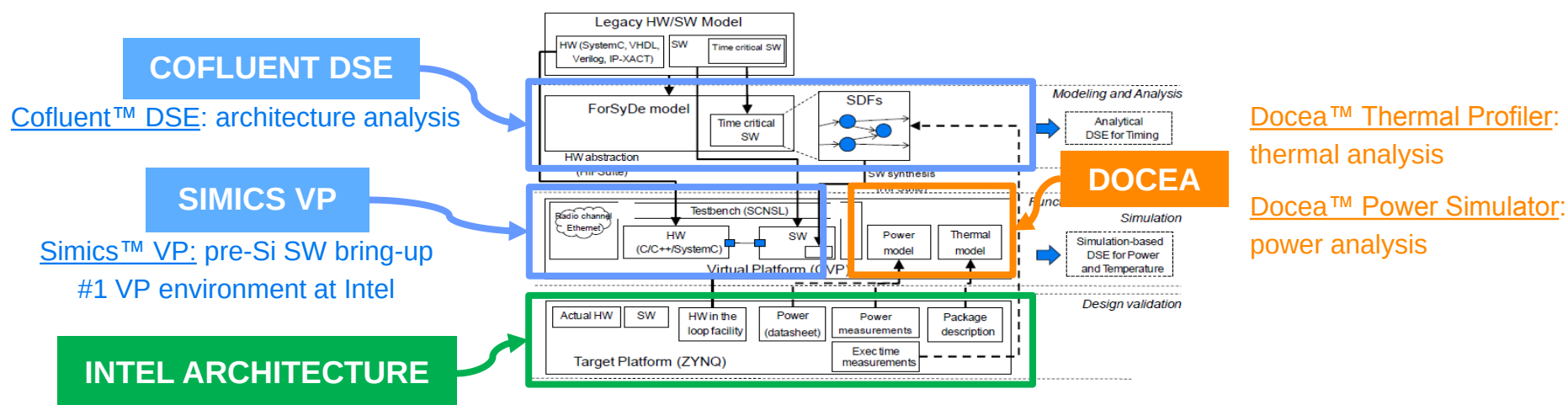
Street cabinet

- ▶ iXtronics aims on the market for control engineering and control system modelling with a strong focus on the automotive and aircraft industry.
- ▶ iXtronics offers with “CAMEL-View” the only integrated tool for model-based development that supports cross-domain modelling and analysis (mechanics, control engineering, hydraulics, and test rig connection (HiL)).
- ▶ iXtronics developed the new CAMEL-View CONTREX software toolbox for the modelling and execution of mixed critical applications on control units under hard real time conditions.
- ▶ CONTREX design methods enable iXtronics within its business field “engineering” to offer new services for the design of control systems with mixed criticality applications.

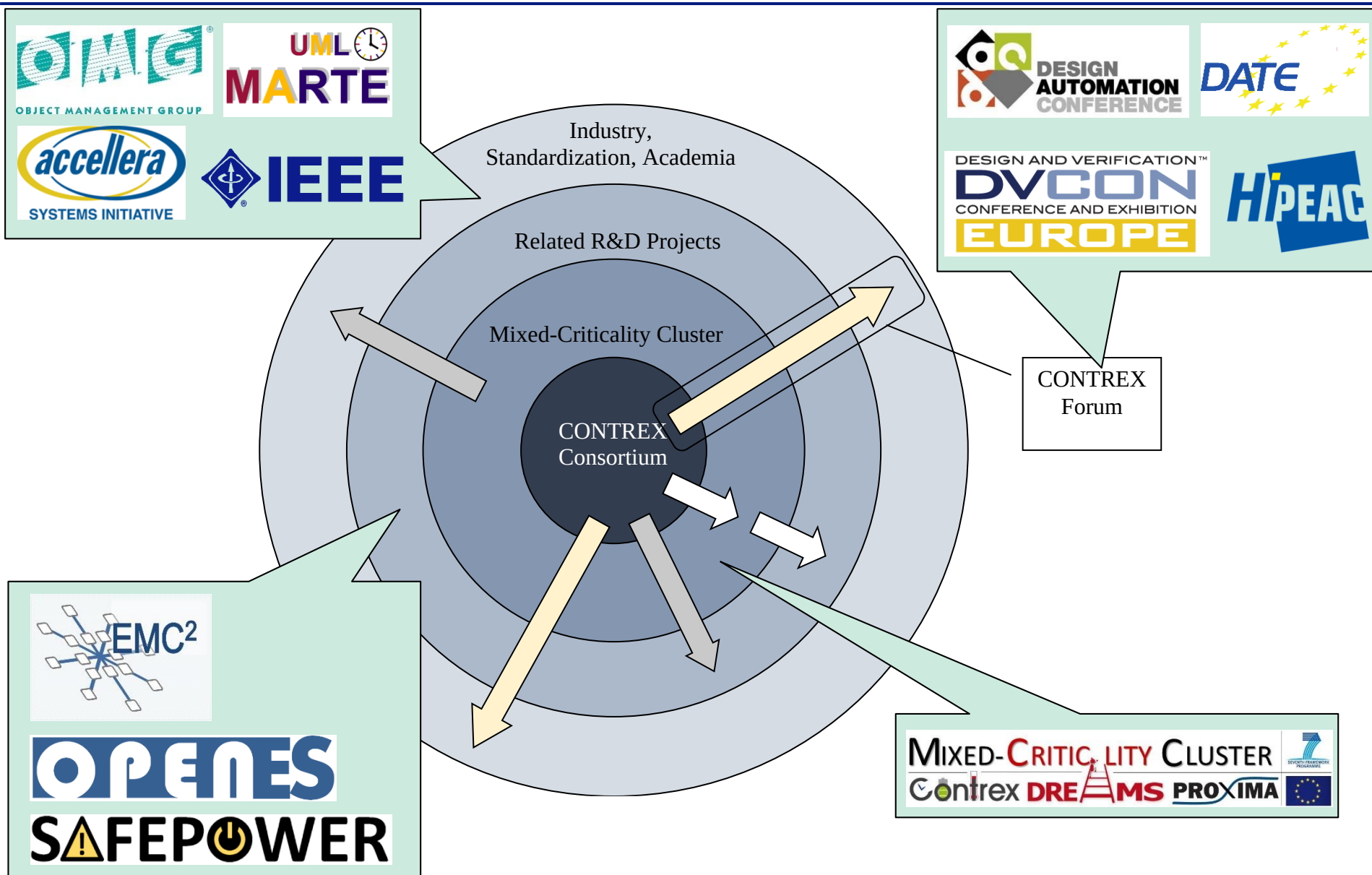


- ▶ EDALab exploitation activities have been focused on:
  - ▶ **HIFSuite** toolchain for manipulation of IP-XACT descriptions involving extra-functional properties
  - ▶ HIFSuite toolchain for virtual platform integration
  - ▶ generation of power state machines to be integrated into virtual platforms.
- ▶ These extensions are part of the roadmap on **virtual platform integration** while the last one is also part of roadmap on **verification**.
- ▶ Exploitation activities performed:
  - ▶ a **new HIFSuite website** with an ad-hoc domain name to improve visibility and use of Google Analytics to collect statistics (about 100 visits/month);
  - ▶ a **free demo version of HIFSuite** (about 30 downloads in the first year);
  - ▶ active participation to **industrial exhibitions** like DVCon 2015 and 2016;
  - ▶ a **new HIFSuite newsletter** sent to contacts collected during the exhibitions and from the HIFSuite website (about 150 recipients);
  - ▶ direct interactions with possible **product customers**;
  - ▶ direct interactions with possible **service customers**.

- ▶ Contrex helped us develop a design flow coupling power and thermal analysis with behavioral analysis and functional simulation
- ▶ Opens several exploitation areas for Docea's tools
  - ▶ Power and thermal vs performance pre-Si trade-off analysis
  - ▶ Power and thermal management software shift-left (earlier software testing)
  - ▶ Pre-Si software related power and thermal budget prediction
- ▶ Primary exploitation area at Intel: development of a system pre-Si design flow
  - ▶ Leverages Intel's system simulation solutions
  - ▶ Brings unique capabilities and versatility to help the design of the cloud and smart, connected devices – key objective following acquisition of Docea by Intel in August 2015
  - ▶ Link with Simics under deployment – traction in several BUs (servers, mobility, memories)



CONTREX **DISSEMINATION**



- ▶ Workshops with Industry:
  - ▶ DAC'15, DAC'16 System to Silicon Performance Modeling and Analysis Workshops
  - ▶ DVCon Europe 2014, 2015
  - ▶ DATE 2016 OpenES & CONTREX Workshop
    - ▶ F2F Meeting: Roadmap for SystemC Standardisation
    - ▶ F2F Meeting: Roadmap for Accellera CCI-WG
  - ▶ DATE 2016 IMPAC Workshop (Getting more for less: Innovative MPSoC Architecture Paradigms for Analysability and Composability of Timing and Power)
- ▶ Conference Special Sessions:
  - ▶ MCSDIA @ DSD 2014, 2015 & 2016 Conference
  - ▶ High Integrity Multi-Core Modelling for Future Systems (Hi-MCM) @ FDL 2015
- ▶ Educational Tutorials
  - ▶ HiPEAC'16 Tutorial
  - ▶ DATE'16 Tutorial
- ▶ CONTREX Project Video

Find more information at:

<http://contrex.offis.de>



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