Integrated Embedded System Development for Automotive and Aerospace Applications:

The DECOS Concepts

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Dependable Embedded Components and Systems

(IP-Project #511764 in EU FP6 / Priority [2] IST)

- Partner (19)
  - Industry

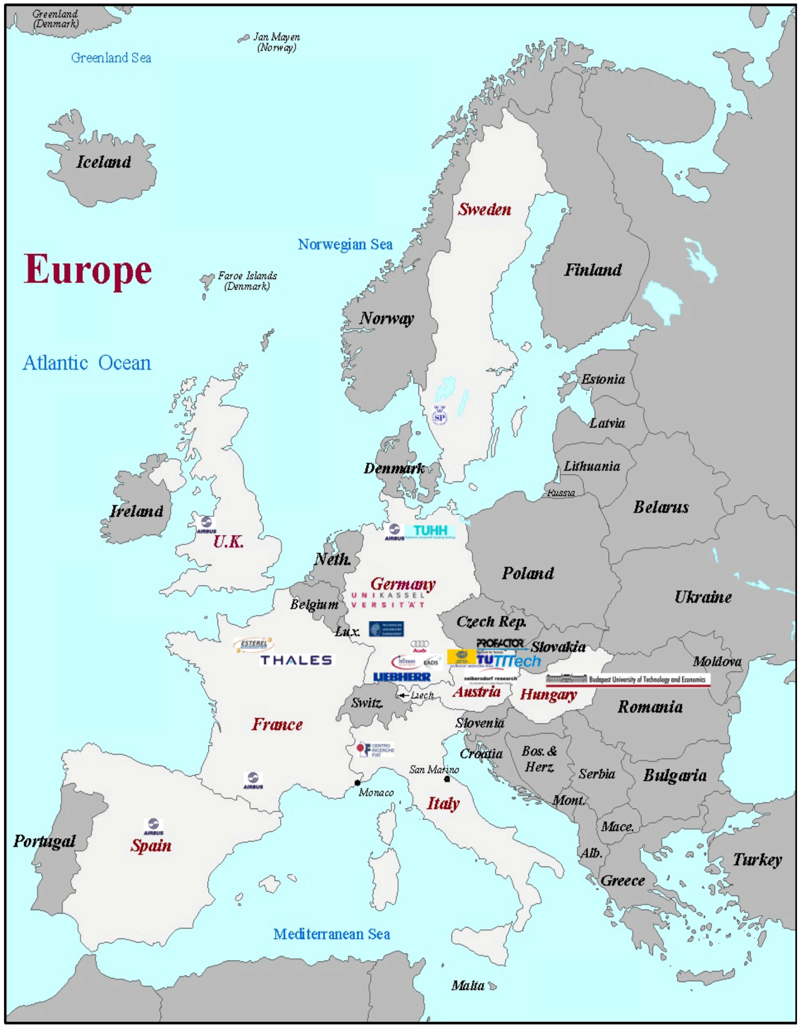
    Airbus, AEV, EADS, Infineon, TTTech, Fiat, Profactor, Hella, Liebherr, Thales, Esterel

  - Universities

    TU Vienna, TU Darmstadt,
    TU Hamburg, Uni Kassel, Uni Kiel,
    Budapest Uni of Techn. and Economics

  - Research Centres

    ARCS, SP Swedish Test. & Res. Inst.



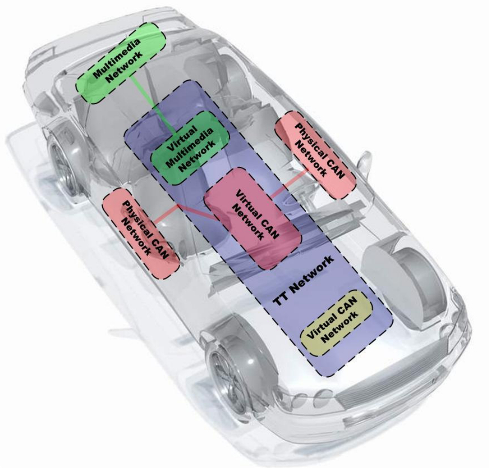
DECOS Goals

- Uniform platform for integration
  of embedded distributed (real-time) applications
  of mixed (up to highest) criticality
  - hardware reduction
  - flexibility increase

⇒ from federated to integrated systems

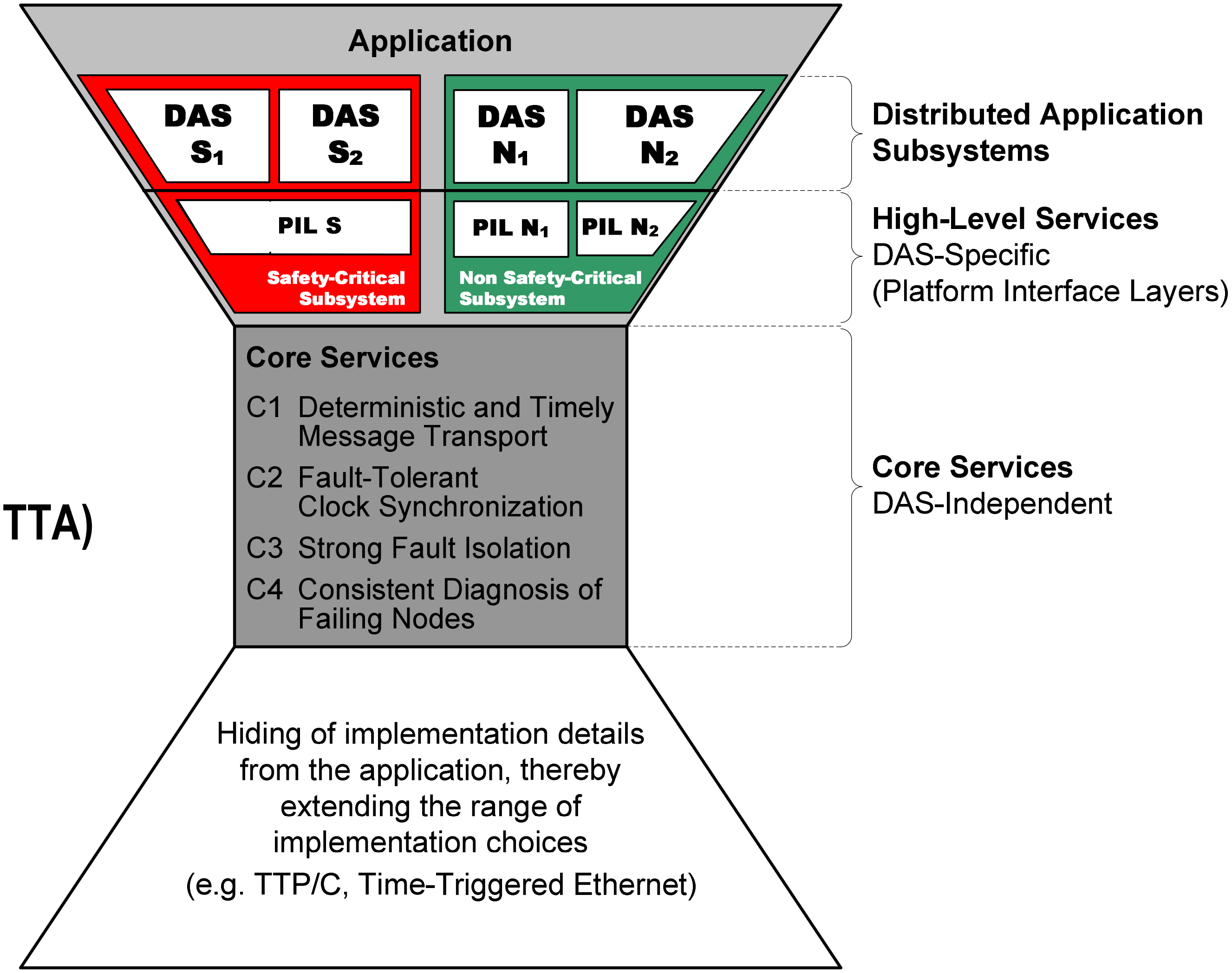
- Implication: fault-isolation of
  and non-interference between
  integrated systems has to be guaranteed

⇒ provision of appropriate
  - architectures
  - components and services
  - development and verification tools



DECOS "Wasteline" Architecture Model

- DECOS high-level services
  - Encapsulated Execution Environment
  - Virtual networks
  - Gateways
  - Diagnosis service
  - Fault Tolerance Layer
- DECOS core services
  - Prevalidated (FIT, NEXT TTA)
- Domain and Platform Independence:
  - Any core technology providing core services suffices
  - (TTP/C, FlexRay, TT-Ethernet, …)



Application

DAS S_1

DAS S_2

DAS N_1

DAS N_2

PIL S

PIL N_1

PIL N_2

Safety-Critical Subsystem

Non Safety-Critical Subsystem

Core Services

C1 Deterministic and Timely Message Transport

C2 Fault-Tolerant Clock Synchronization

C3 Strong Fault Isolation

C4 Consistent Diagnosis of Failing Nodes

Hiding of implementation details from the application, thereby extending the range of implementation choices

(e.g. TTP/C, Time-Triggered Ethernet)

Distributed Application Subsystems

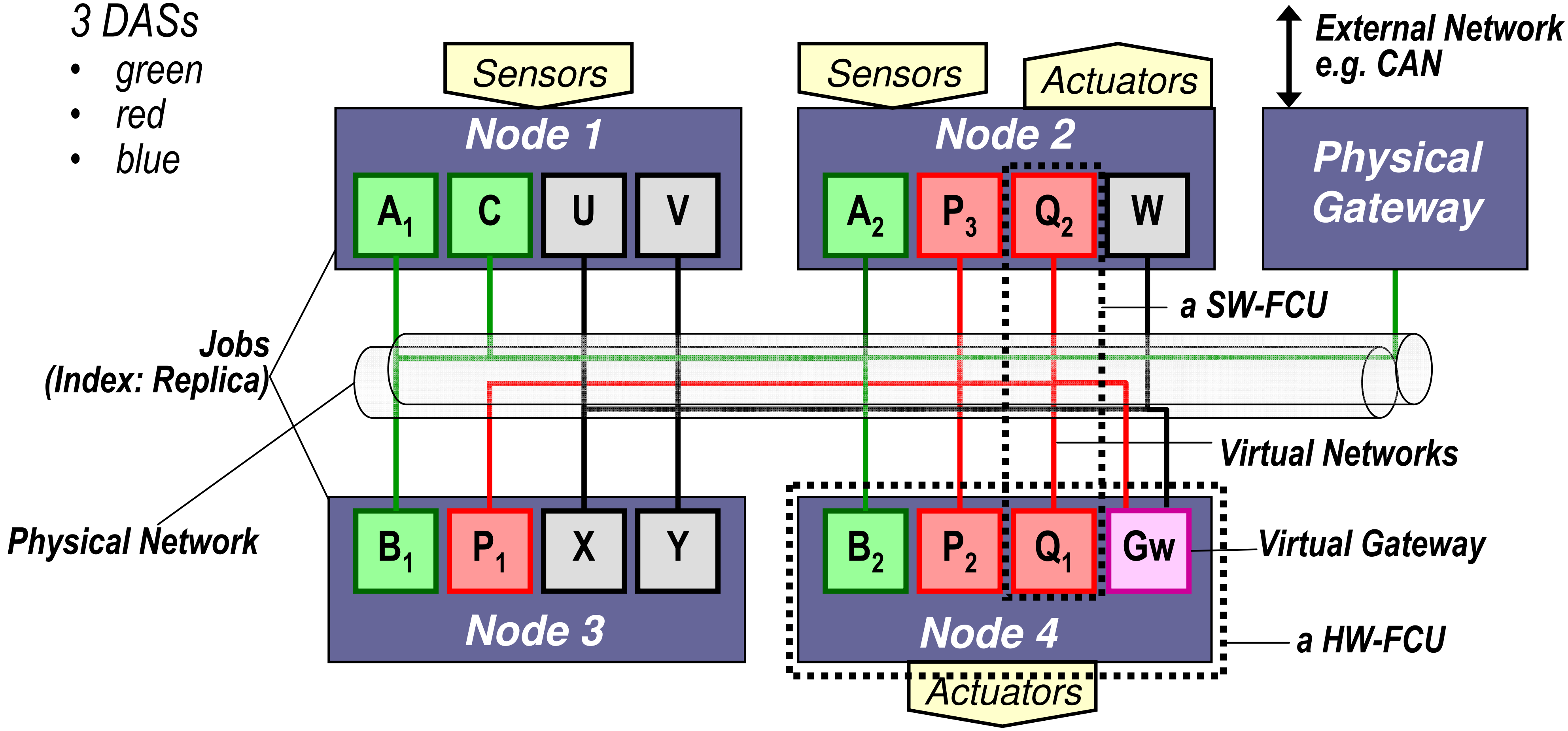
High-Level Services
DAS-Specific
(Platform Interface Layers)

Core Services
DAS-Independent

DECOS Cluster Architecture (Example)

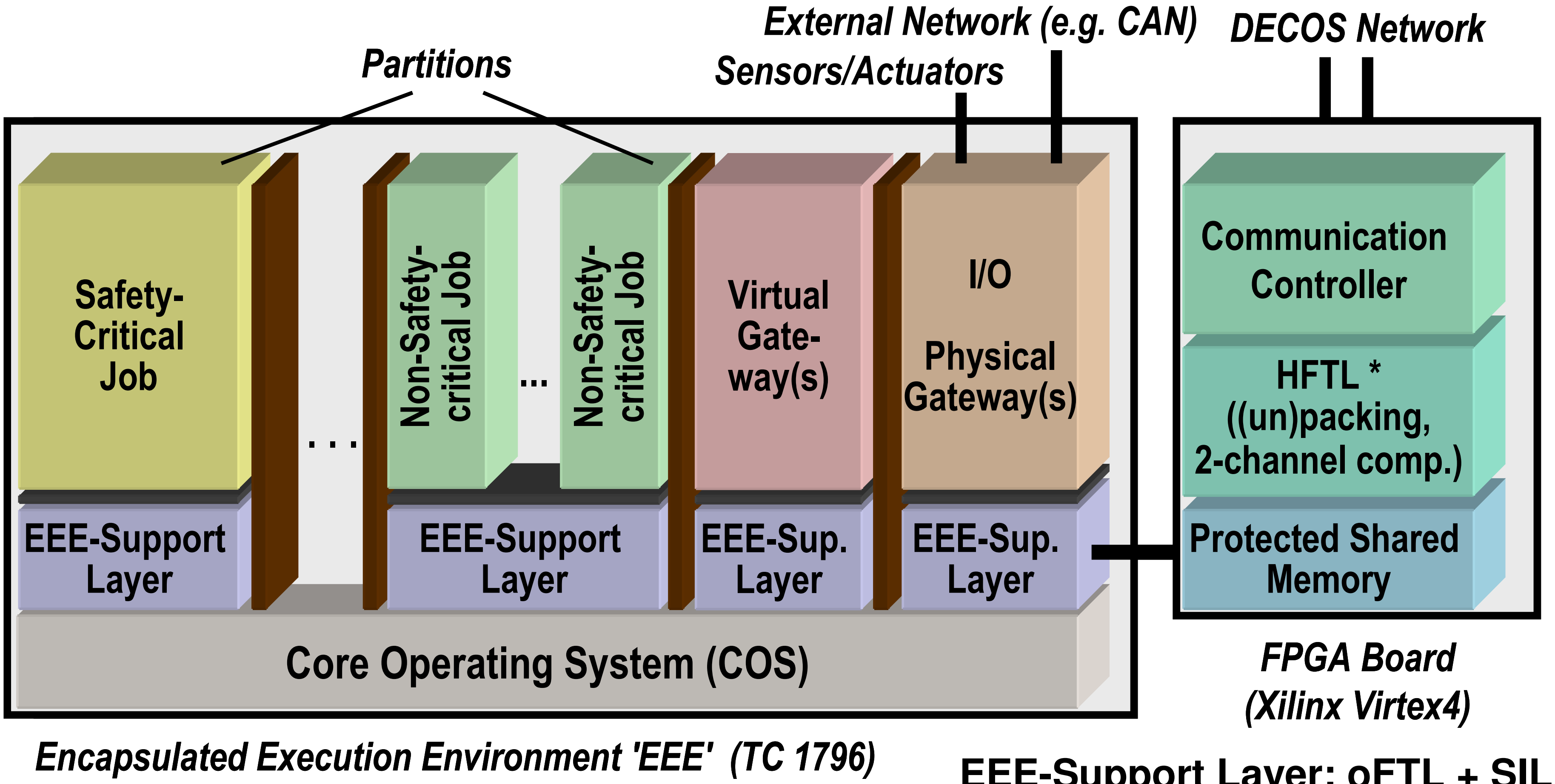
3 DASs

- *green*
- *red*
- *blue*



Fault-Containment Units (FCU): Hardware – Node, Software – Job (all replicas)

Implementation on DECOS Platform



EEE-Support Layer: oFTL + SIL
(optimized FTL + System Interface Layer)

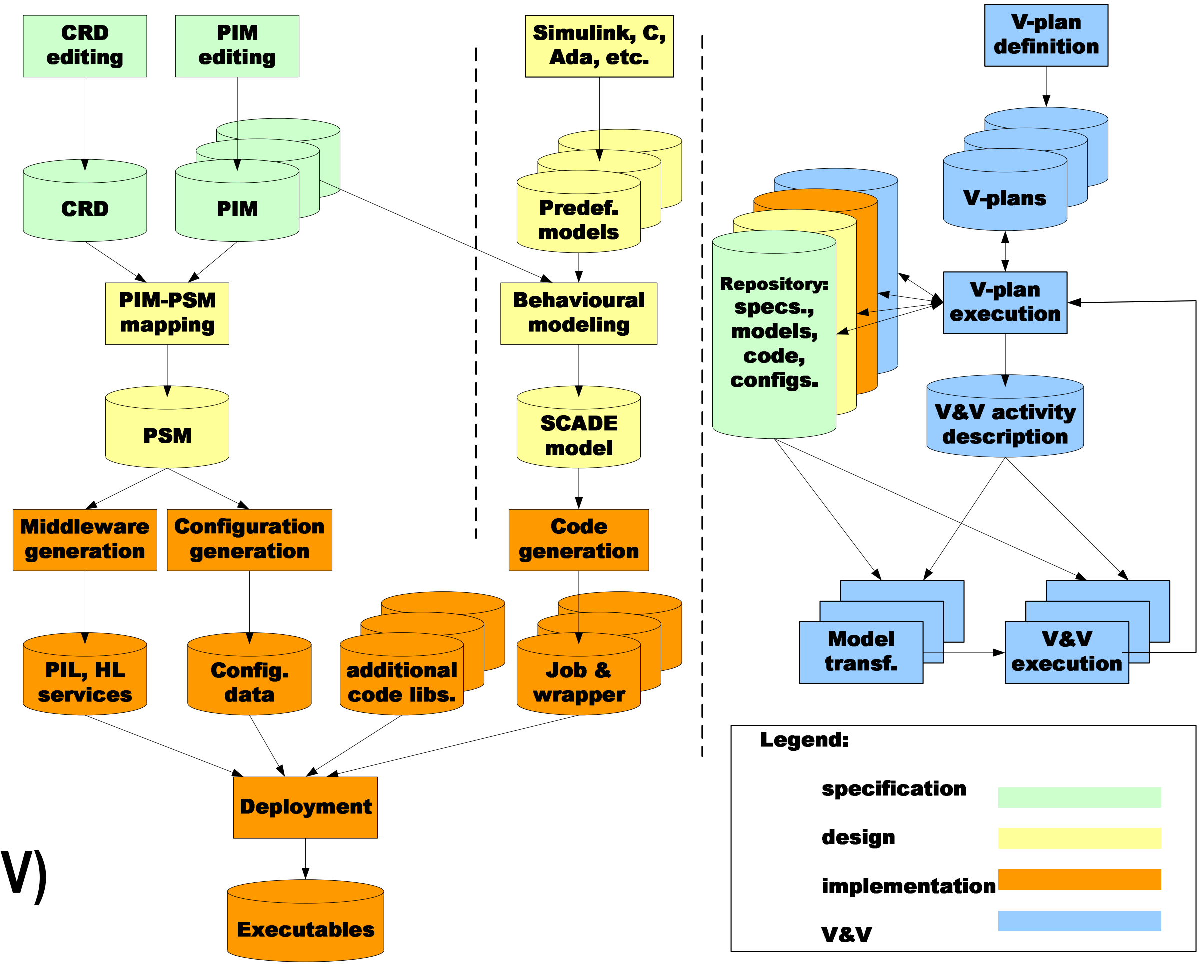
Per partition: - **memory protection**
- **execution time slot „separation in space and time“**

*** Hardware FTL**

Tool Chain: Model-Based Integrated Development Support

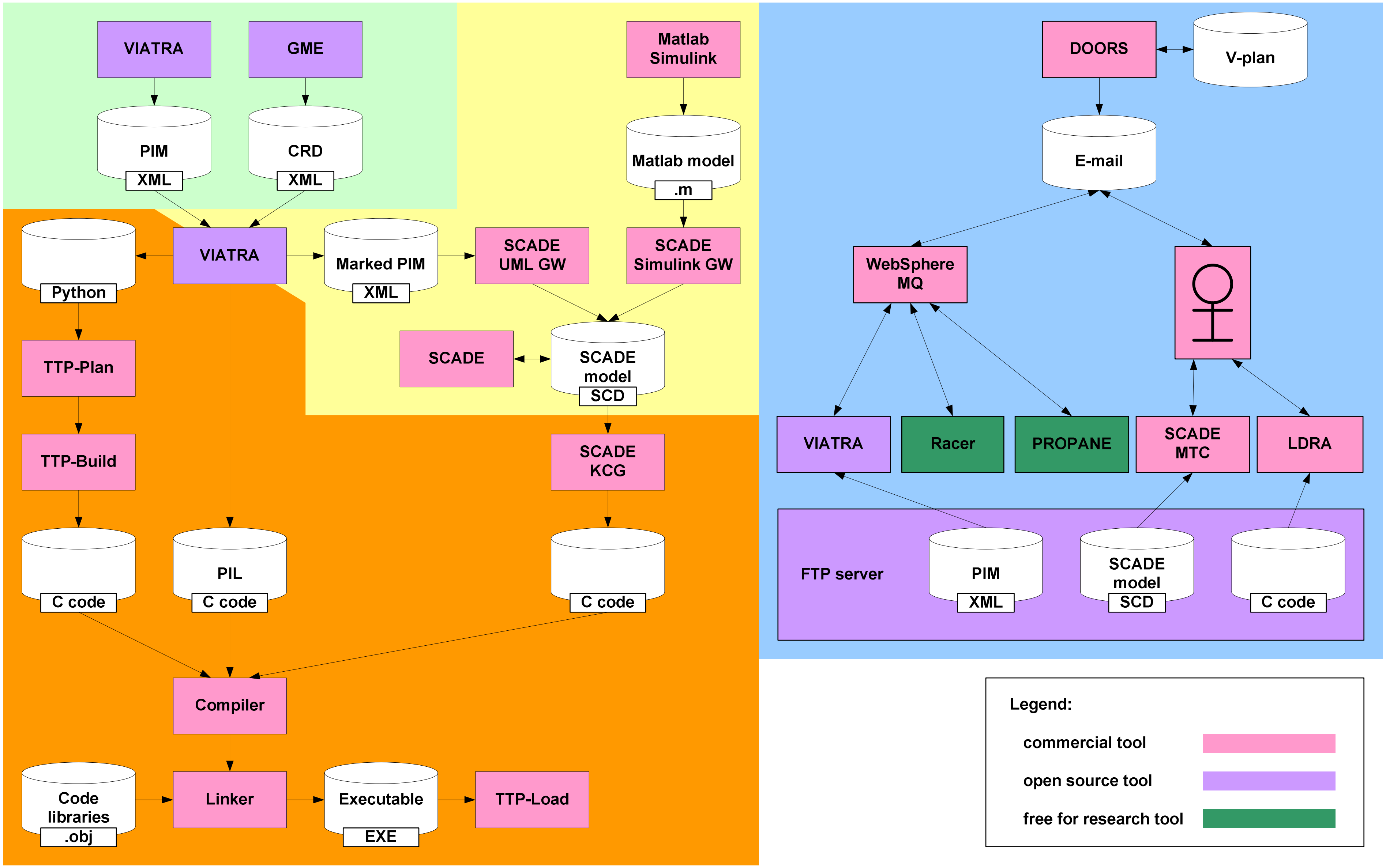
"From Requirements To Deployment"

1. Requirements
   - functional, performance, dependability
2. Cluster modelling
   - nodes, network
3. Behaviour modelling
   - of jobs
4. Configuration
   - allocation and scheduling
5. Middleware generation
   - APIs, fault-tolerance
6. Deployment
   - compile, link, download
7. Verification & Validation (V&V)
   - accompanying (Test Bench)



Tool-chain Integration

DECOS



Legend:

commercial tool 🟪

open source tool 🟪

free for research tool 🟩

Generic Test Bench – V&V Tool Integration

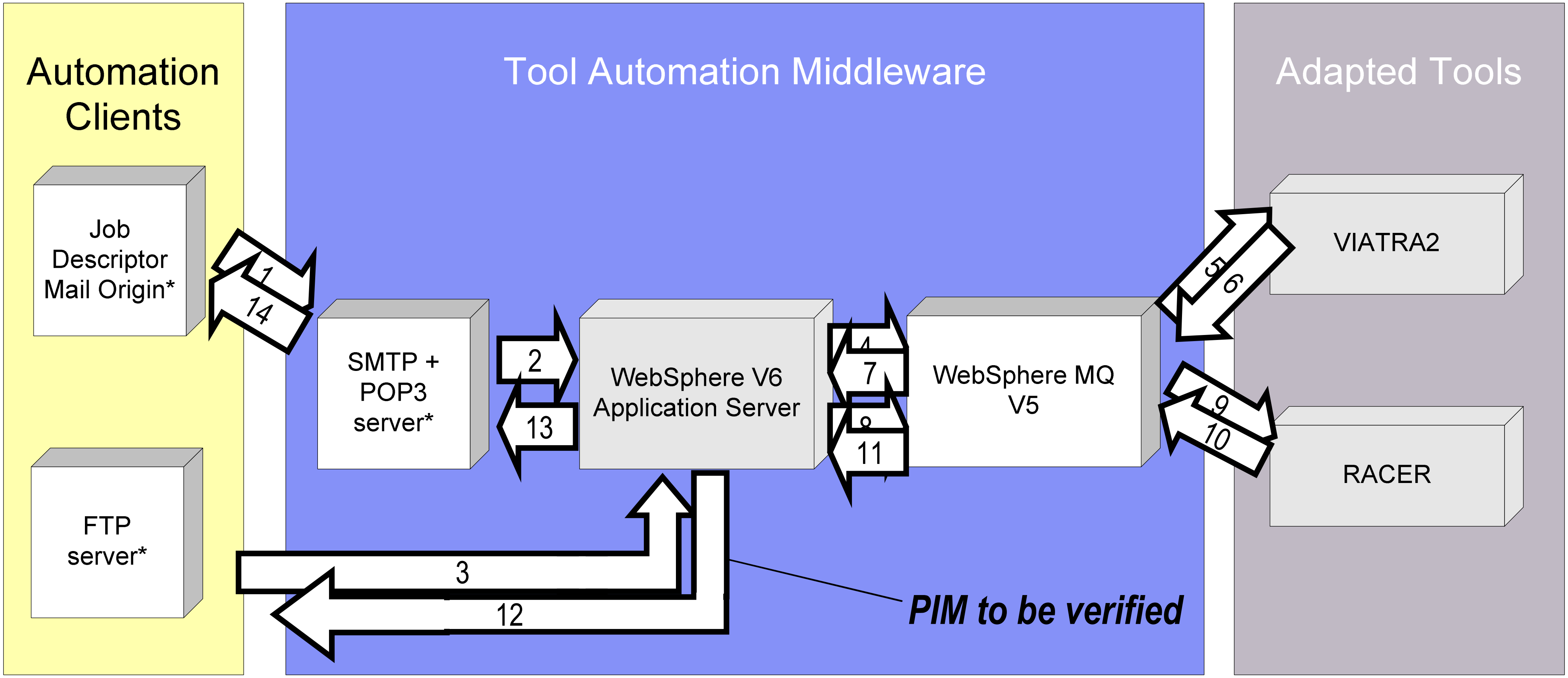
Tool integration levels

- **No external tool:** e.g. Checklist
  - Tool implemented in DOORS
- **Manually executed external tool:** e.g. PROPANE (SWIFI)
  - Start of tool in dialog ("pressing a button")
- **Automatically executed external tool:** e.g. RACER (Ontology based consistency and completeness check)
  - Start of tool by "mailing" to corresponding server (no user interaction)
- **External test bench:** e.g. EMI Hardware Test Bench
  - Tool runs on separate hardware, feedback by email/message flow

For all levels, corresponding interaction workflows provided

Example for automatically executed external tool

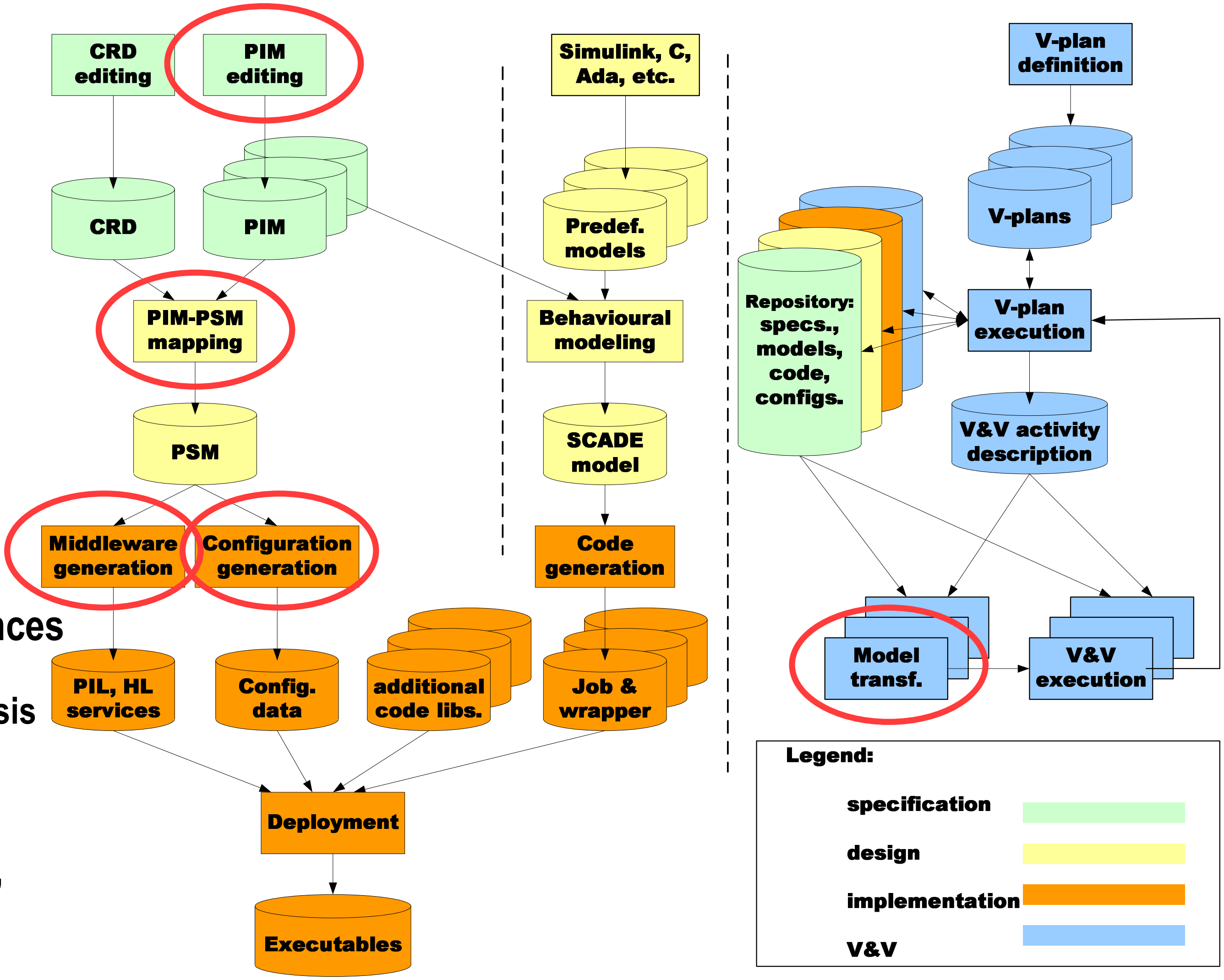
PIM-validation with Racer



VIATRA2 by BUTE

DECOS

- Modelspace
  - Multi level metamodeling
  - Base concepts:
    - entity, relation
    - inheritance, instantiation
  - Multiple domains
  - Multiple source
    - Import, export
    - ➢ Tool integration !
  - Multiple views (e.g. DSE)
- Transformation language
  - Graph transformation part
    - with patterns & rules
  - Abstract State Machine part
    - with control structures
  - Interpreted execution
  - Big abstraction level differences are easy to handle with it
    - e.g. xforms to formal analysis domains
- Implemented as Eclipse plug-in
- Open source version is available, commercial is coming soon (Spin-off SME: OptXWare)



Summary

- *Architecture* and *methodology* has been elaborated for

  specify, design, implement, validate & verify

  real-time embedded systems

  with safety-critical and non safety-critical components

  in an integrated way.

  - Model Driven Development
  - Model Driven Architecture
  - Demonstrated in automotive, aerospace, industrial control domains

- *Tool integration* is realized by

  1. well defined architecture & development process
  2. well defined extension points for development steps (Generic Test Bench for verification & validation)