MultiPARTES

SEVENTH FRAMEWORK PROGRAMME

Partitioning Algorithm for Mixed Criticality Systems

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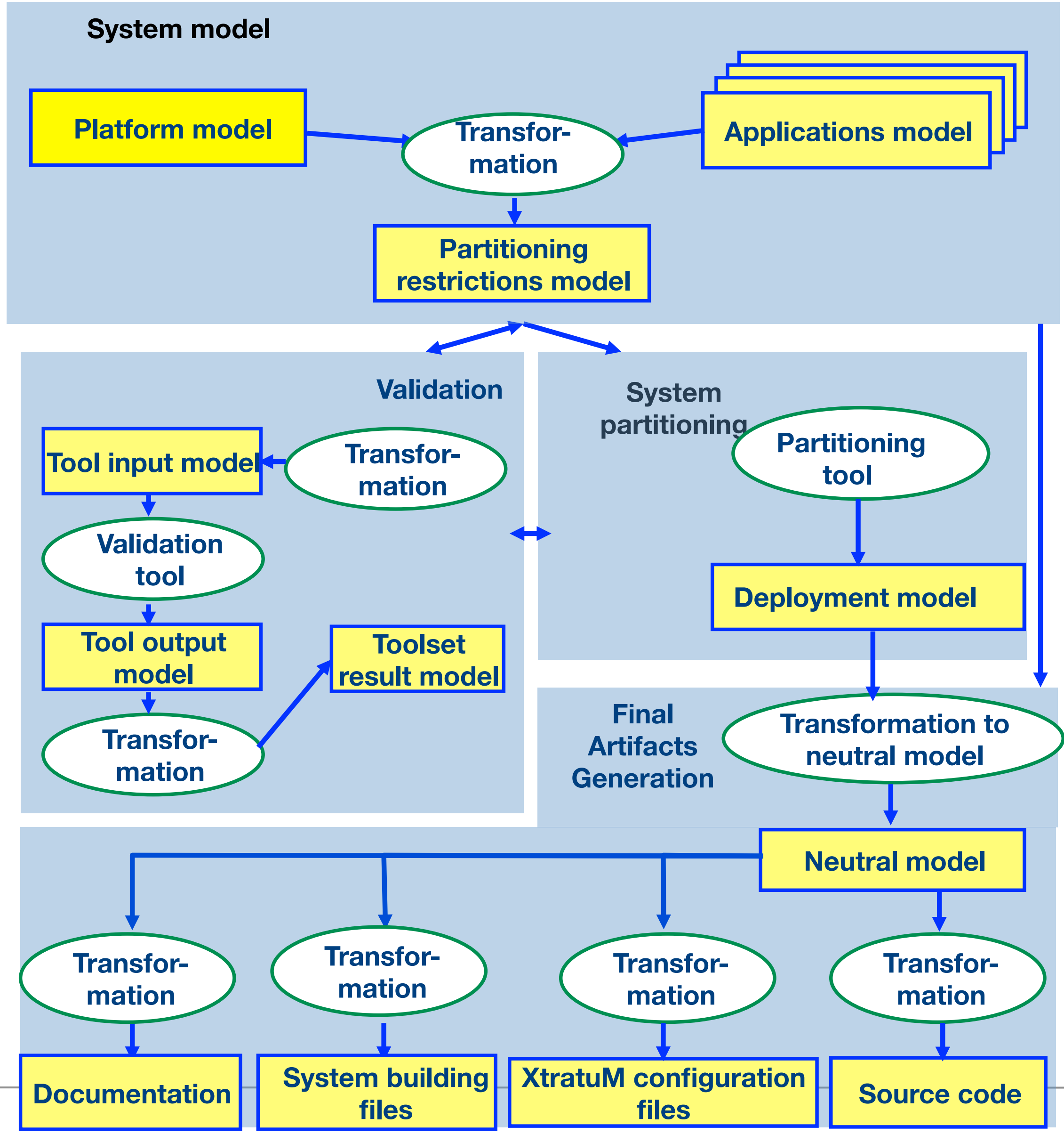
1. Introduction

- Design of partitioned systems requires additional development activities and roles:
  - Partitioning, hypervisor configuration
  - System architect, system integrator
- A single tool: too complex and rigid, for integrating all required functionality
- Proposal:
  - Define a methodology
  - Define a toolset architecture
  - with means for integrating additional components

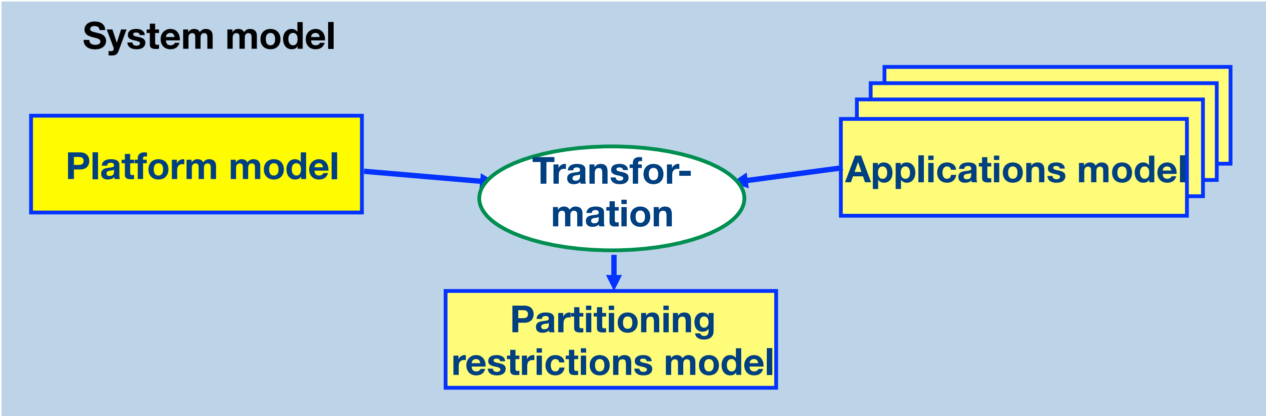
2. Toolset Architecture: Requirements

- Development of mixed-criticality systems.
- Support for non-functional requirements (NFR)
  - Specification, validation, and transformations
  - Real-time, safety, security
- Support for partitioned systems
- Support for multi-core architectures
- System modelling
  - Support legacy applications
- Support for system deployment
- Design for extensibility

Toolset Architecture



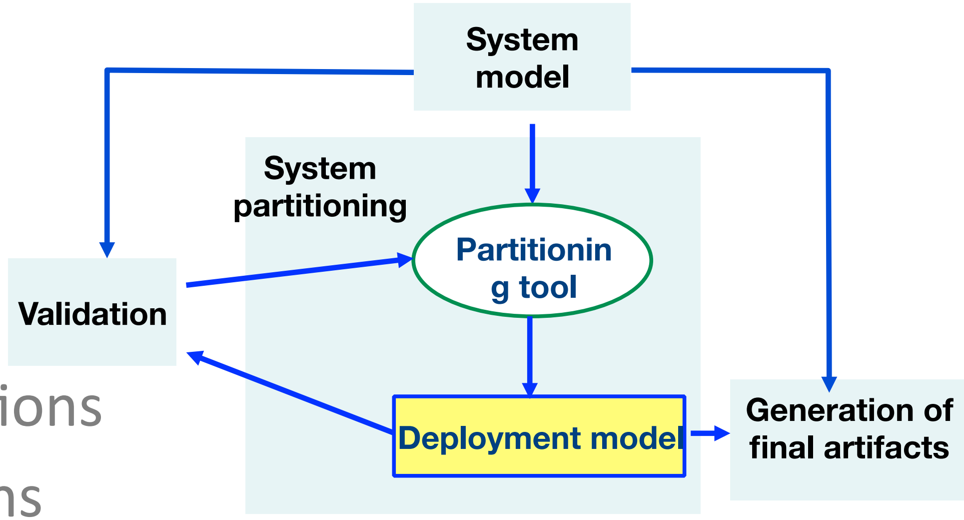
System Model



- Information for partitioning, validation & generation
- Platform & App. Models general and reusable
- Applications Model: Based on UML
  - UML-MARTE: real-time requirements and resource needs
  - Support for legacy applications:
- Platform model:
  - Hardware: UML-MARTE, with some extensions
  - Basic information on operating systems and hypervisors

System Partitioning

- System definition:
  - Applications {a1, a2..., an}.
  - Restrictions {ω1, ω2..., ωn}.
- Deployment model:
  - Allocate applications to partitions
  - Allocate resources to partitions



- A successful partitioning
  - All applications allocated to partitions
  - Partitioning restrictions are met (user or NFR defined)
  - Feasible resources assignment to partitions
  - Optimal partitioning?

Partitioning Restriction Model

- Sources of restrictions
  - Implicit: Automatically considered: OS, CPU, criticality
  - Explicit: Generated automatically from NFR
  - System integrator: based on experience or requirements
- Must be fulfilled by the system partitioning
- Types of restrictions:
  - App. that must (not) be allocated on a given partition
  - App. that must (not) be in the same partition than another

3. Partitioning algorithm

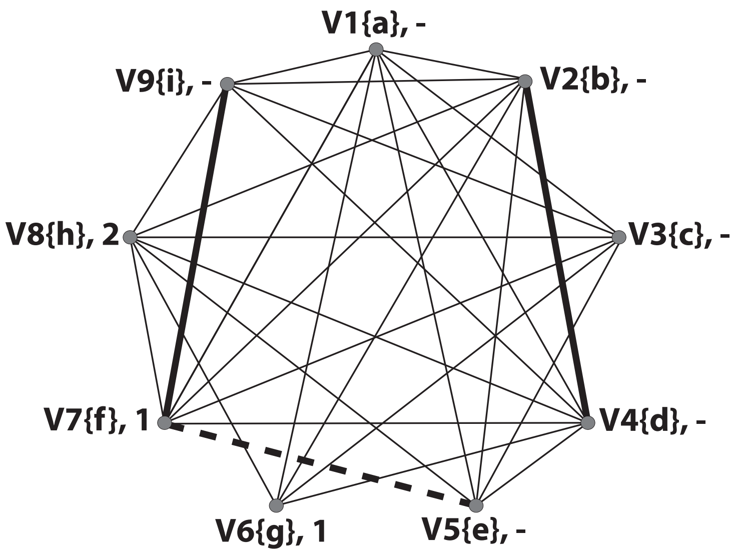
- Algorithm based on coloured graphs
  - Partitions/applications are modelled by nodes
  - Restrictions are modelled by edges and forbidden colours
  - Proper colouring: adjacent nodes with different colour
  - Colours are mapped into partitions
- Phases
  - Building graph: merging app. that go together, include edges and lists, assign colours and create forbidden lists
  - Simplify the graph
  - Colour vertices

Use case

Application	a	b	c	d	e	f	g	h	i
Criticality Level	A	C	C	C	B	A	A	A	A
Operating System	ORK	Linux	Linux	Linux	XAL	XAL	XAL	ORK	XAL

Table 1: Applications characteristics

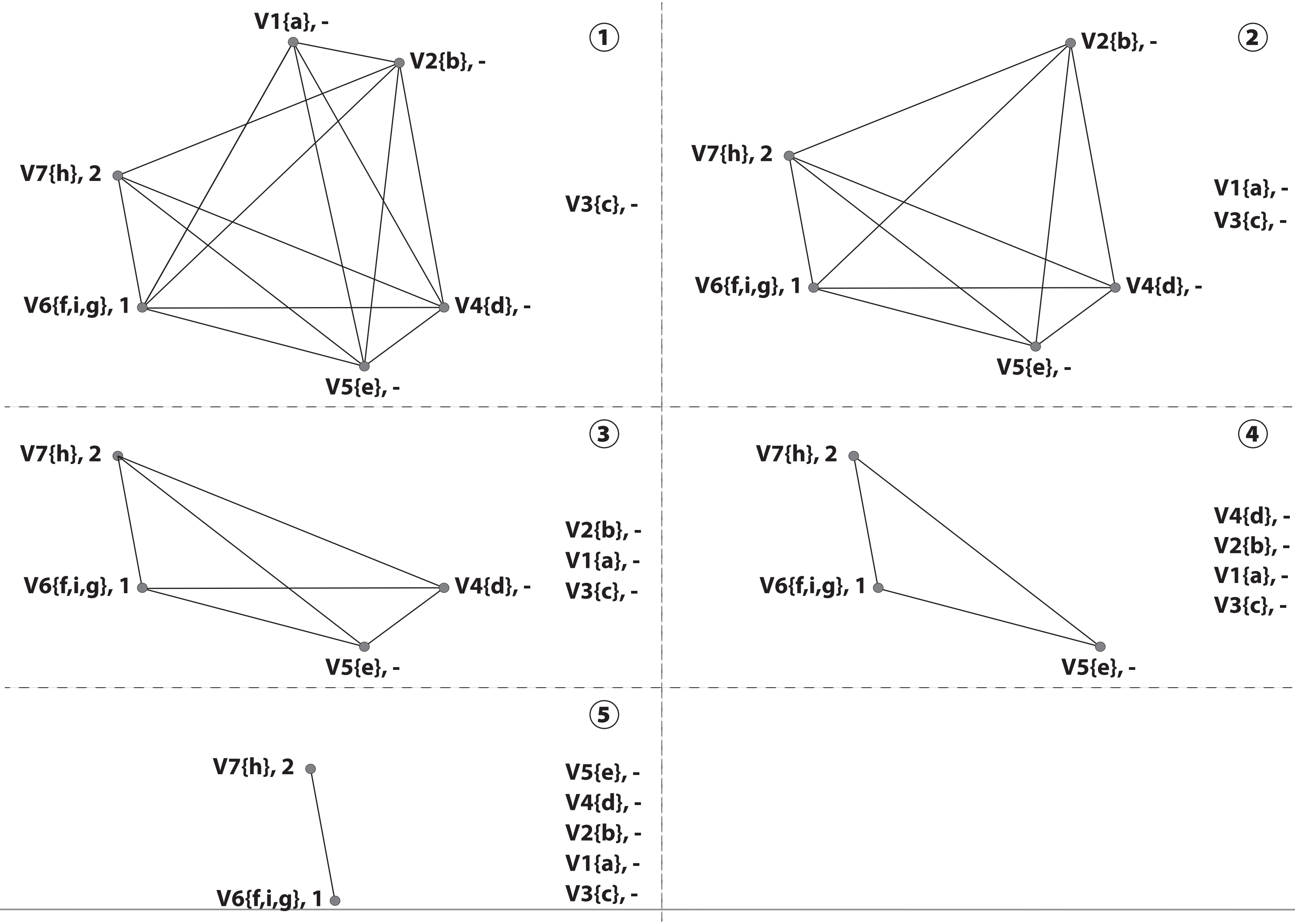
- Internal restrictions: OS, Criticality level
- External restrictions:
  - **b** must go with **d**
  - **f** must go with **i**
  - **f** must not go with **e**
  - **g, f** in partition 1
  - **h** in partition 2



Graph simplification

- Remove vertex to a queue, accordig to their degree
- Keep vertex that are coloured

Graph simplification



Graph colouring

- Retrieve candidate from queue
- Colour the vertex
  - Avoid forbidden colours and colours of adjacent nodes
  - All rest of colours are possible
  - If there are no colour possible, create a new one
  - If several colours are possible: alternatives

Graph colouring

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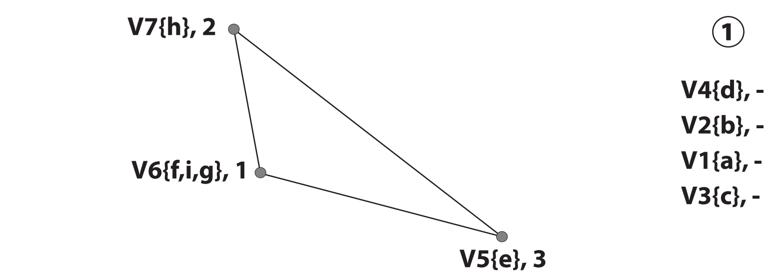
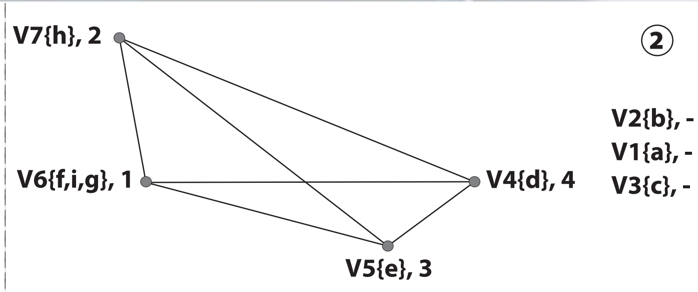
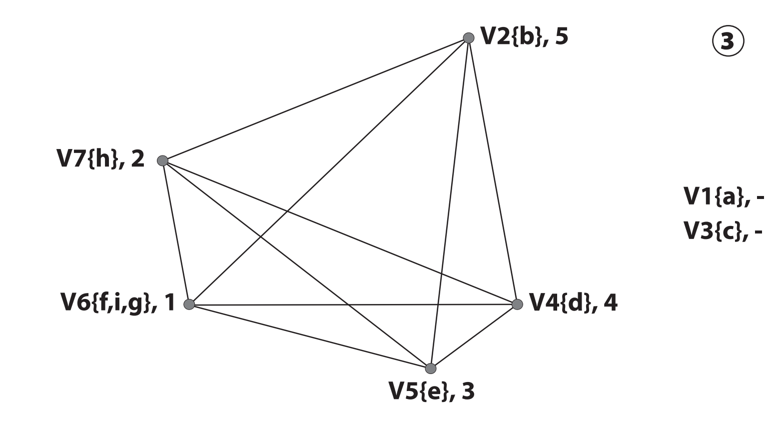
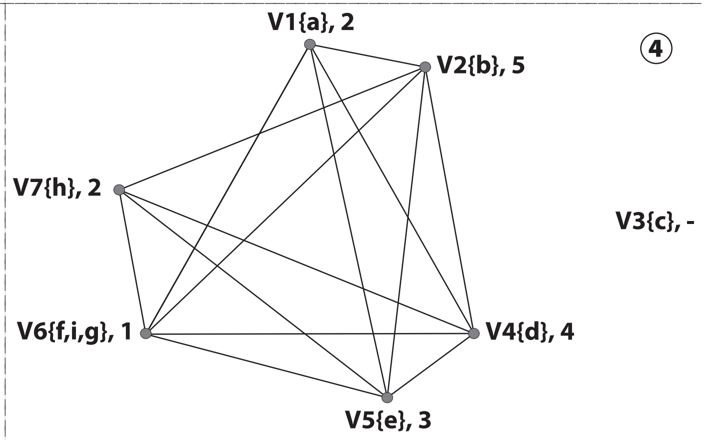
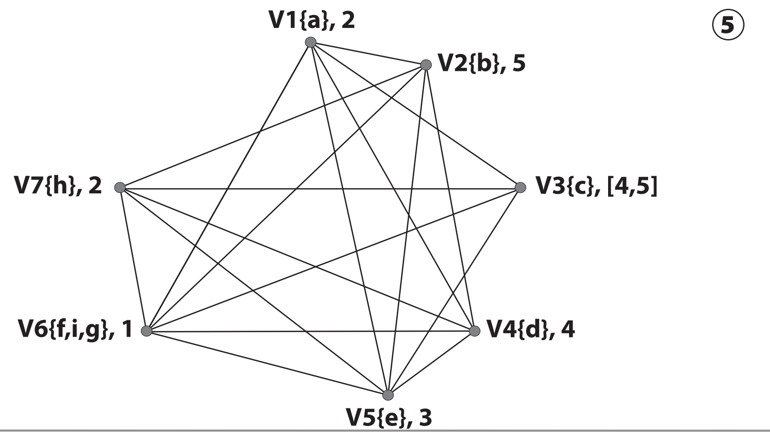








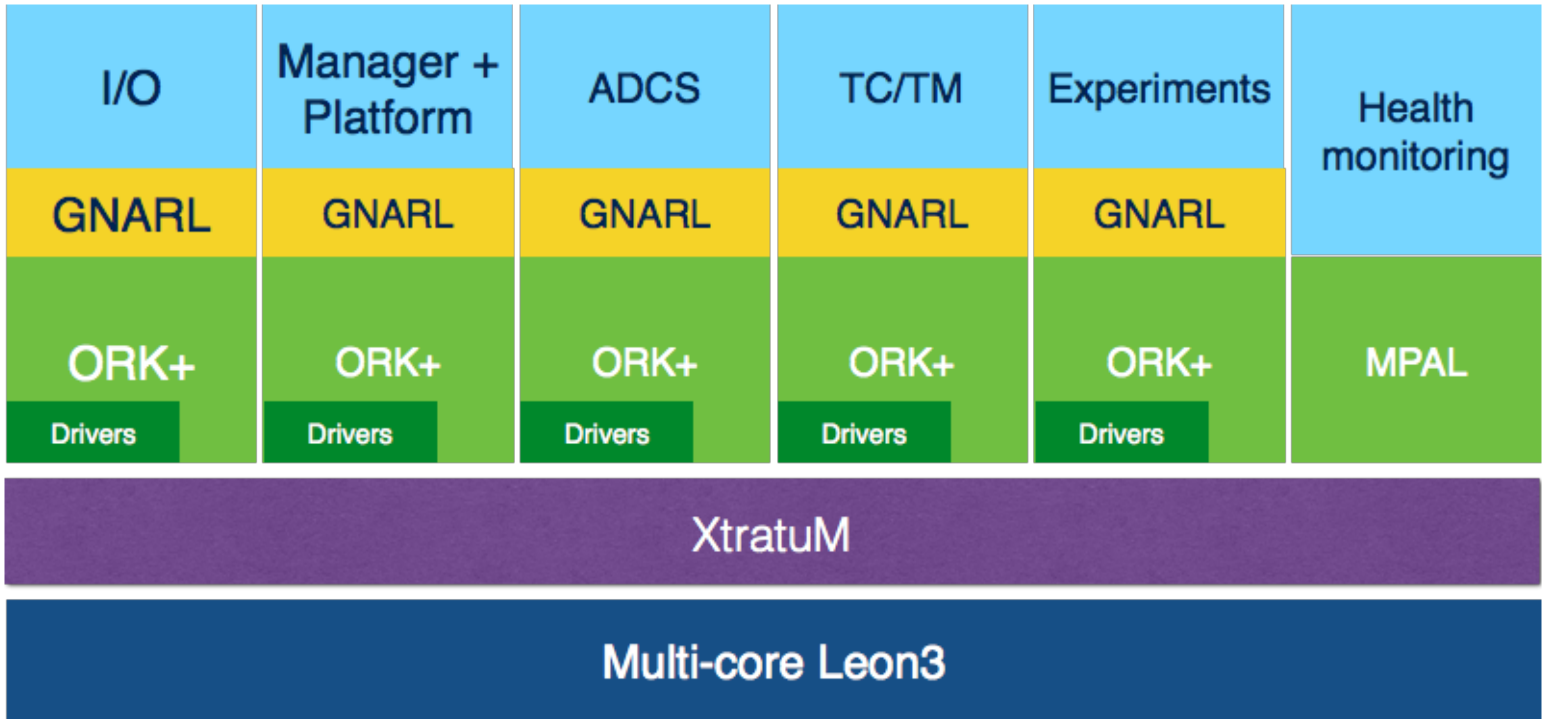


System Partitioning

- Proposed partitioning
  {f, i, g}, {a, h}, {e}, {d, c}, {b}

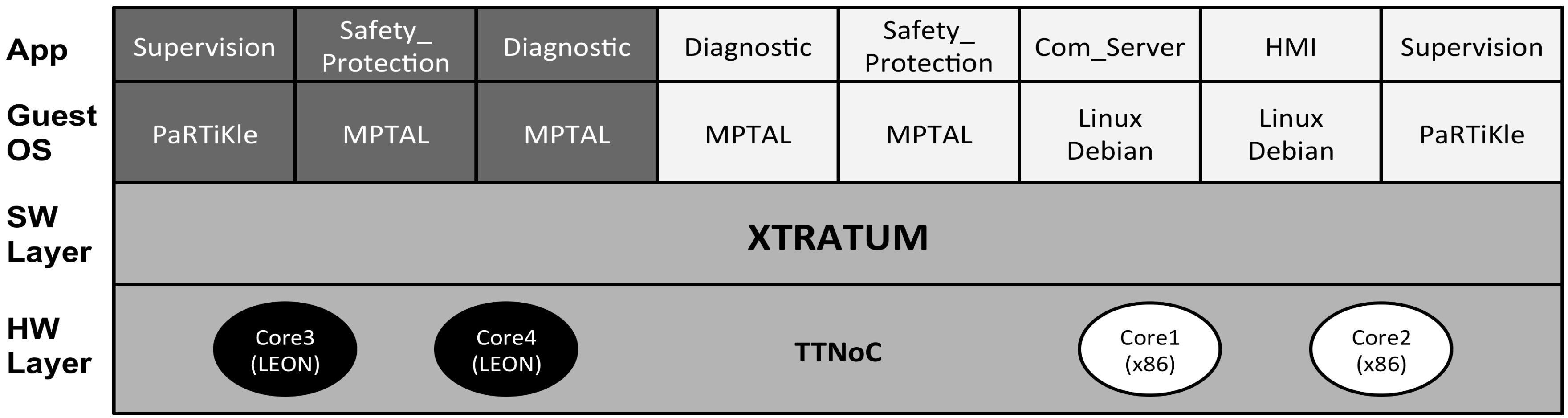
- Alternative partitioning
  {f, i, g}, {a, h}, {e}, {b, c}, {d}

6. Use cases: UPMSat2 Satellite



Wind-Turbine

- Use case with Ikerlan & Alstom Wind
- Input:
  - Application models: include criticality level, CPU, OS
- Restrictions: applications that must be alone
- The tool generated this partitioning



7. Conclusions

- Toolset for mixed-criticality systems
- Partitioning tool
  - Rely on restrictions: Improve extensibility
  - Based on coloured graphs
  - Able to generate alternative solutions
- Future work
  - Demonstration is being done
  - Additional evaluation with more complex systems
  - Integration of optimality criteria