MARTE extensions and modeling Mixed-Criticalities

A synthesis of modeling needs of the Contrex Project
and the solutions proposed using minor extensions to MARTE

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2 Contrex Modeling objectives

- A holistic approach for the specification, modelling, analysis and validation of mixed-critical distributed control systems
- Based on a meta-model for mixed-critical and distributed control systems, providing the required semantics support to the design methodologies used in Contrex
- Providing a comprehensive framework to manage extra-functional properties at node level in a mixed-critical scenario
  - time, power/energy, performance, temperature, reliability and QoS

- A language:
  - vocabulary, grammar, syntax, & cultural heritage + spellers , word processors.

- Modeling language
  - Ontology/Meta-models, a modeling methodology, tools and modeling patterns

4 Goals for the meta-model

- A UML Meta-Model able to capture all the relevant concepts for Contrex, taken from:
  - Architectures
  - Components
  - Networks
  - Functional and extra-functional properties and constraints
  - Models of computation
  - Validation
- Relevant Contrex system characteristics
  - Heterogeneity
  - Distributed
  - Control systems
  - Mixed-criticality

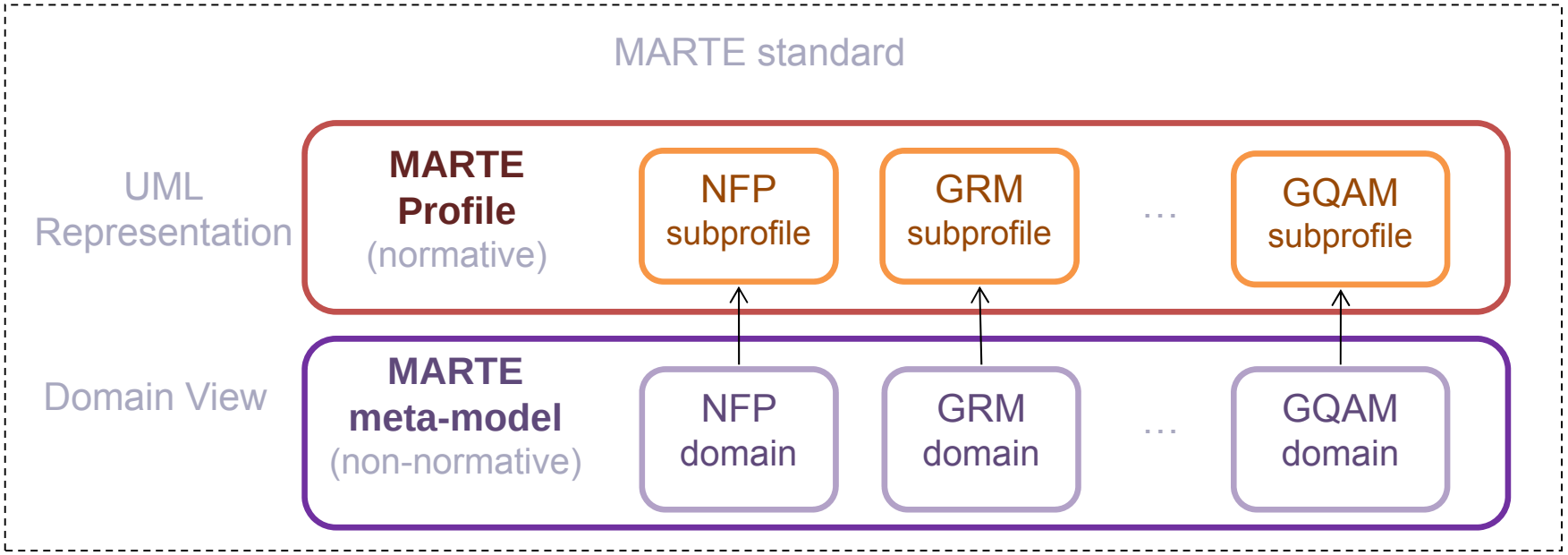
5 Requirements

- To cover all the **essential** concepts
- Organized to be generic in the essential concepts and extended/extensible to the specific domains in CONTREX
- To facilitate links/mappings to all relevant formalisms and design flows of interest in CONTREX
- To handle different levels of abstraction
- To be capable of addressing all the relevant stages in the development processes used by our industrial partners

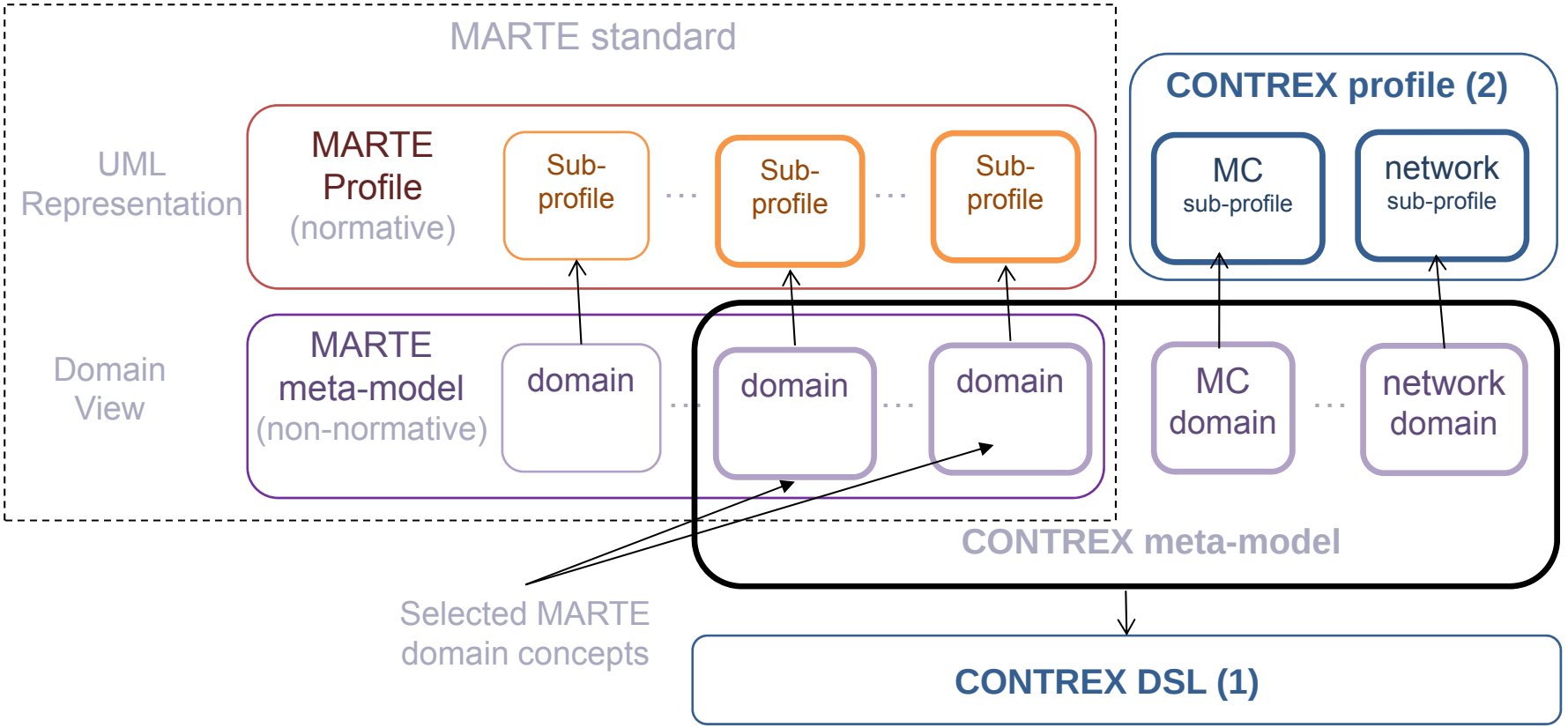
6 Our approach

- Starting point: UML+MARTE Profile
  - Covering real-time, embedded systems, DSE
- What is already covered
  - RT: schedulability, performance, nfp, clocks, timing.
  - Relevant concerns for Contrex
    - Architectures
    - Components
    - Models of computation
    - Functional and extra-functional properties and constraints
      - Of those are relevant: Timing, Energy, Memory
  - Relevant for Contrex system characteristics
    - Hierarchical scheduling
    - Control systems oriented (Hw & Sw)

7 UML/MARTE Domain view



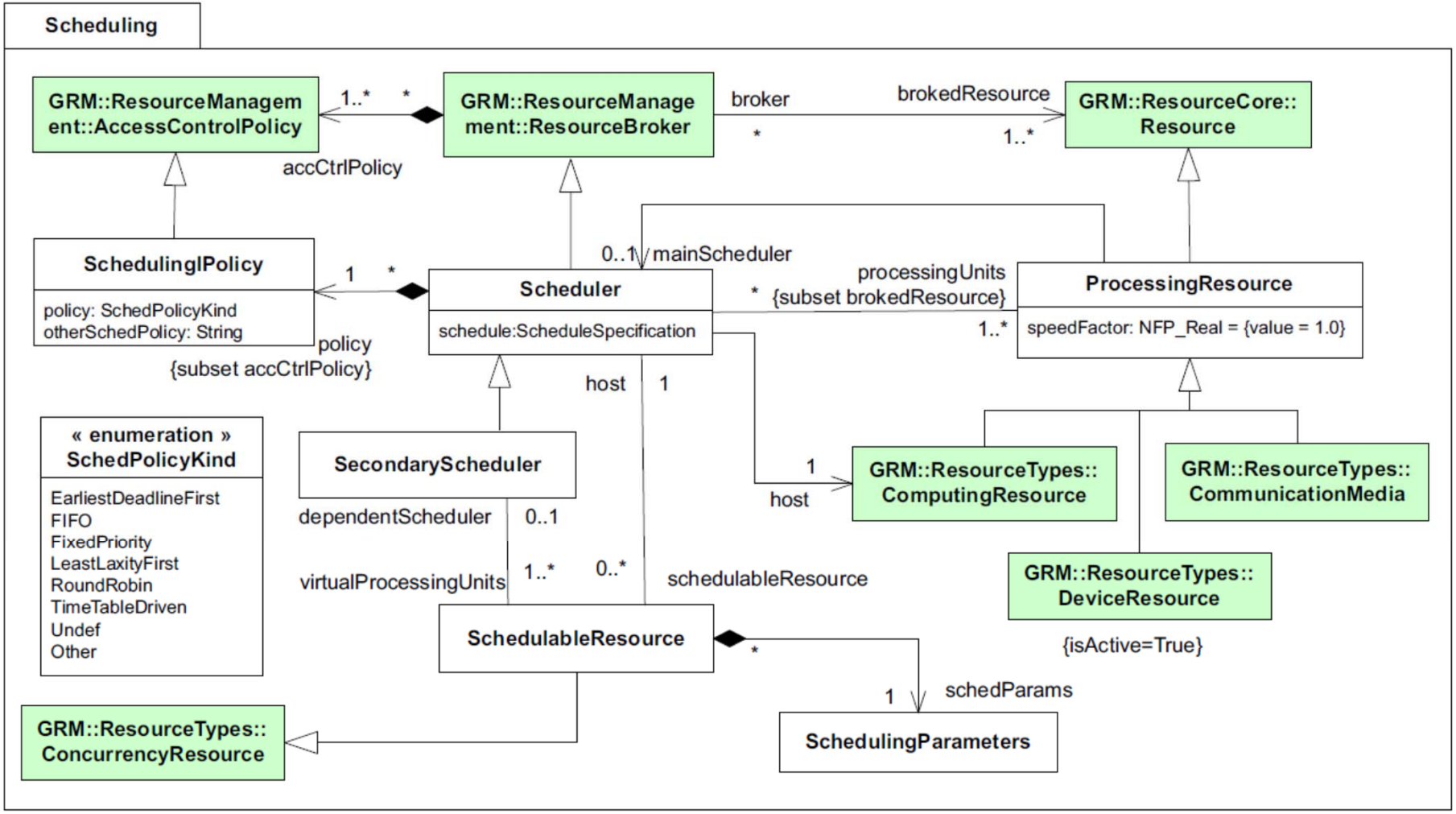
8 Required extensions



9 Required extensions to MARTE

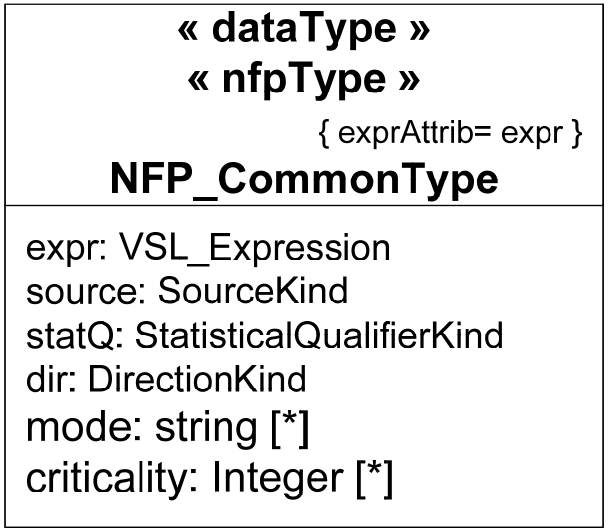
- Specific modeling elements for mixed criticality, and general purpose distribution technologies and networks
  - MC - Annotation of multiple non-functional properties for mixed-criticality systems
  - NW - Expressing complex overhead models and topologies of general purpose Networks

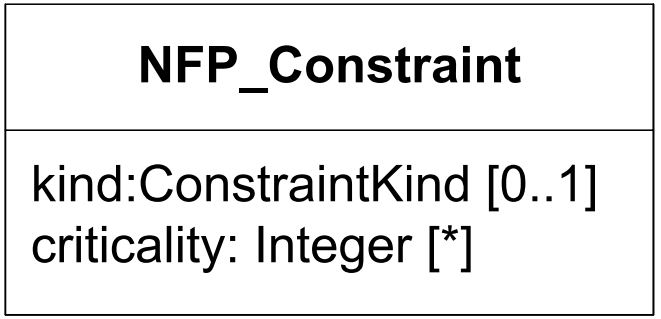
Hierarchical scheduling in MARTE



MC – extensions: NFP & Constraints

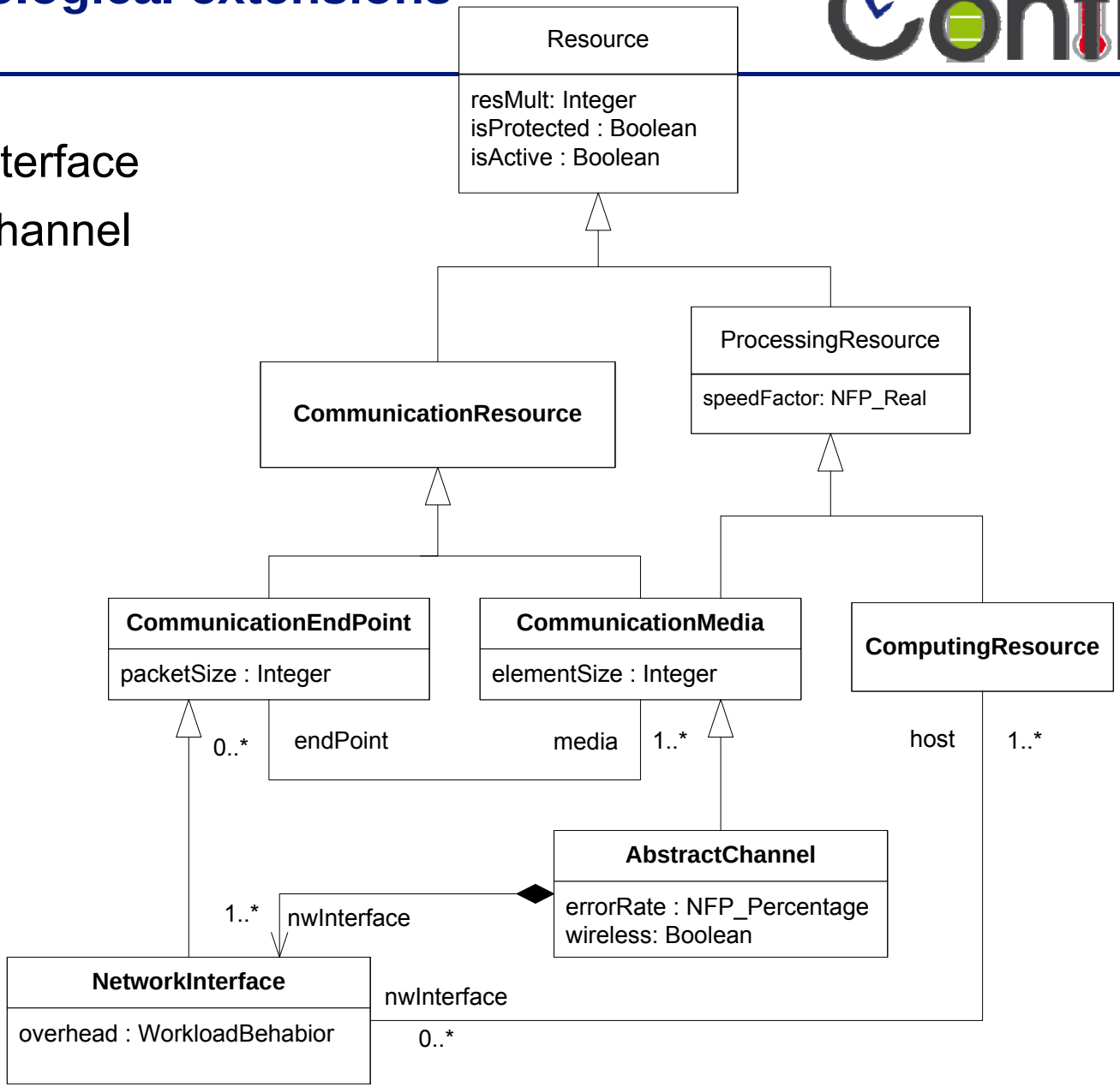
- The extensions to the normative library of MARTE implies in practice tooling support for the mechanism to manage the annotation of values in VSL expressions.
  - A deep review of safety standards have been made to support this activity (IEC 61508 , IEC 26262 , DO-178, IMA –[RTCA DO-297])





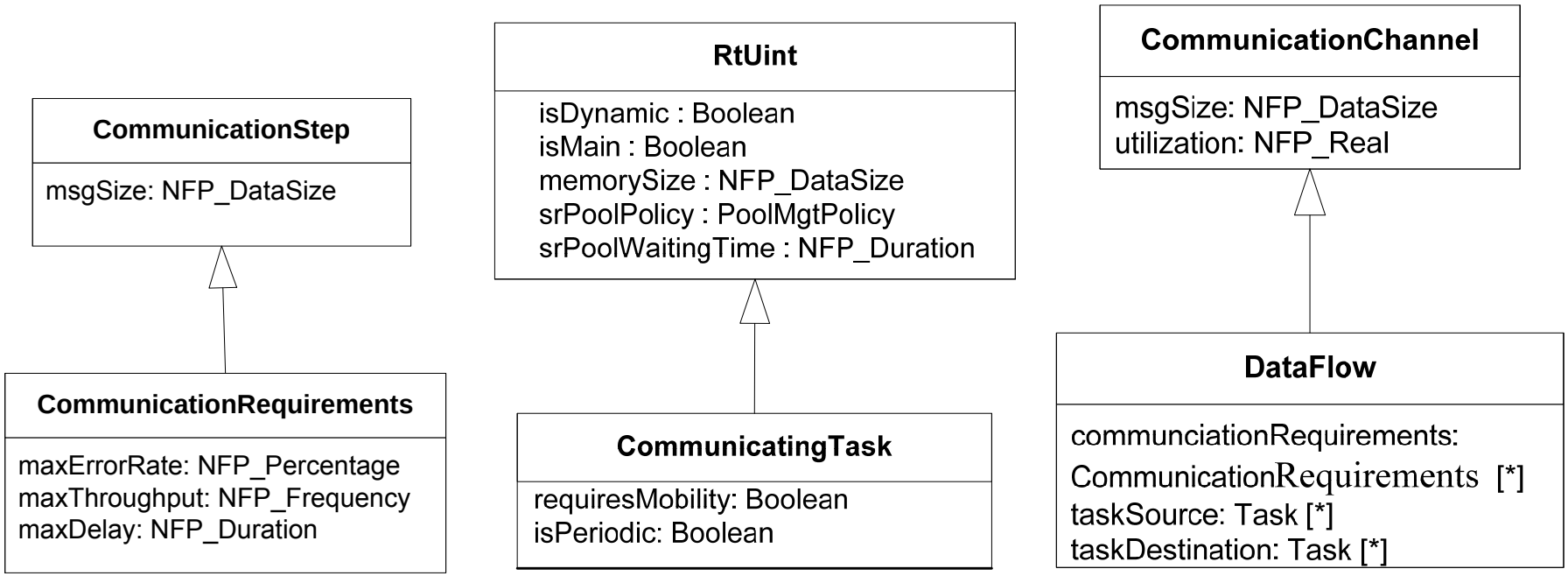
NW – Topological extensions

- Network Interface
- Abstract Channel



NW – Workload and allocation

- Communication Requirements
- Communicating Task
- Data Flow



Methodological aspects

- As a validation of the conceptual proposals an initial profile has been produced as an extension of the MARTE profile.

- Contract based design
  - The foundational concepts for a library of NFP constraints has been developed

- Modelling configurations: the “mode” attribute
  - Stages in the development process: Refinement and abstraction
  - Perspectives viewpoints and views
  - Management of V&V for specific extra-functional properties

- Links to other formalisms
  - Synchronous Data Flow has been studied and initial models for the exploitation of MARTE have been proposed

15 References

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