

Software-Defined Real-Time Mesh Networking: Protocol and Experimentation Method

Florian Greff, Ye-Qiong Song, Arnaud Samama, Laurent Ciarletta

► **To cite this version:**

Florian Greff, Ye-Qiong Song, Arnaud Samama, Laurent Ciarletta. Software-Defined Real-Time Mesh Networking: Protocol and Experimentation Method. RESCOM'17, Jun 2017, Le Croisic, France. <hal-01542911v2>

HAL Id: hal-01542911

<https://hal.inria.fr/hal-01542911v2>

Submitted on 23 Jun 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Software-Defined Real-Time Mesh Networking: Protocol and Experimentation Method

Florian Greff^{1,2}, Ye-Qiong Song², Arnaud Samama¹, Laurent Ciarletta²
¹Thales Research & Technology, France ²LORIA, University of Lorraine, France

Dynamic Mesh Networking: Bringing Flexibility to Safe Systems

Nowadays, in embedded real-time systems, there is an evolution of needs in terms of computing power and communication between applications. This is due to the changing qualities of sensors, whose data processing needs are increasing (for example in radar applications), and the emergence of new application categories such as multi-sensors. Interaction between applications and sensors is increasing, while features tend to be spread over several computing units. Communication architectures are becoming more complex.

Mesh networking of the components of such systems would reconcile their real-time constraints with the new application needs [1]. The plurality of communication paths should result in increased flexibility, resilience, scalability and load balancing characteristics. From the networking point of view, this implies the ability to dynamically allocate network resources with respect to the needs of running applications. We define this kind of platform as a **Software-Defined Real-time Network (SDRN)**.

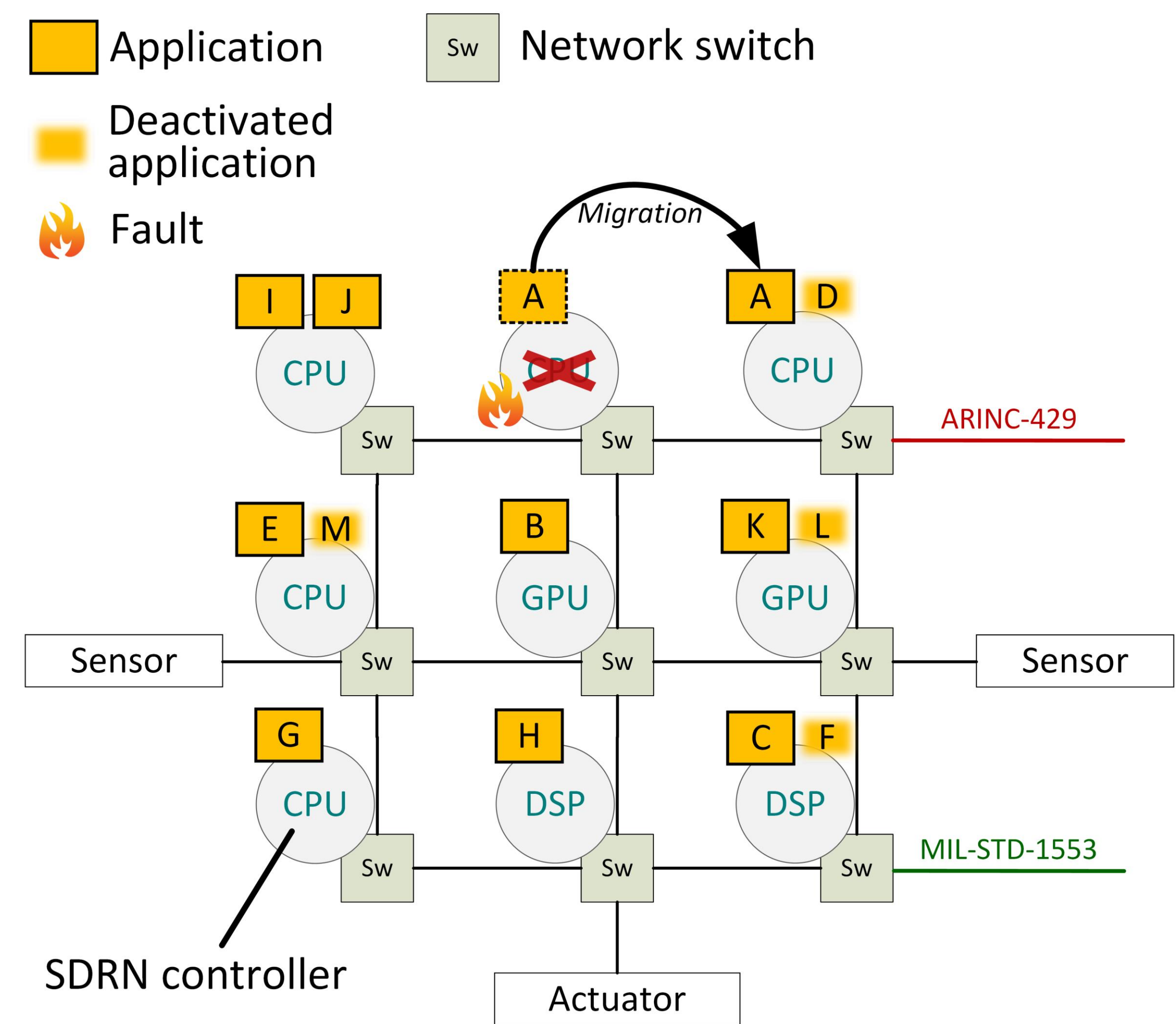


Figure 1. Dynamic system on a mesh network

First Contribution: a Protocol for the Dynamic Allocation of Network Resources [3]

Link virtualization

- Each link is divided into sub-channels
- Sub-channels are allotted to flows
- Credit-Based Weighted Round Robin scheduling

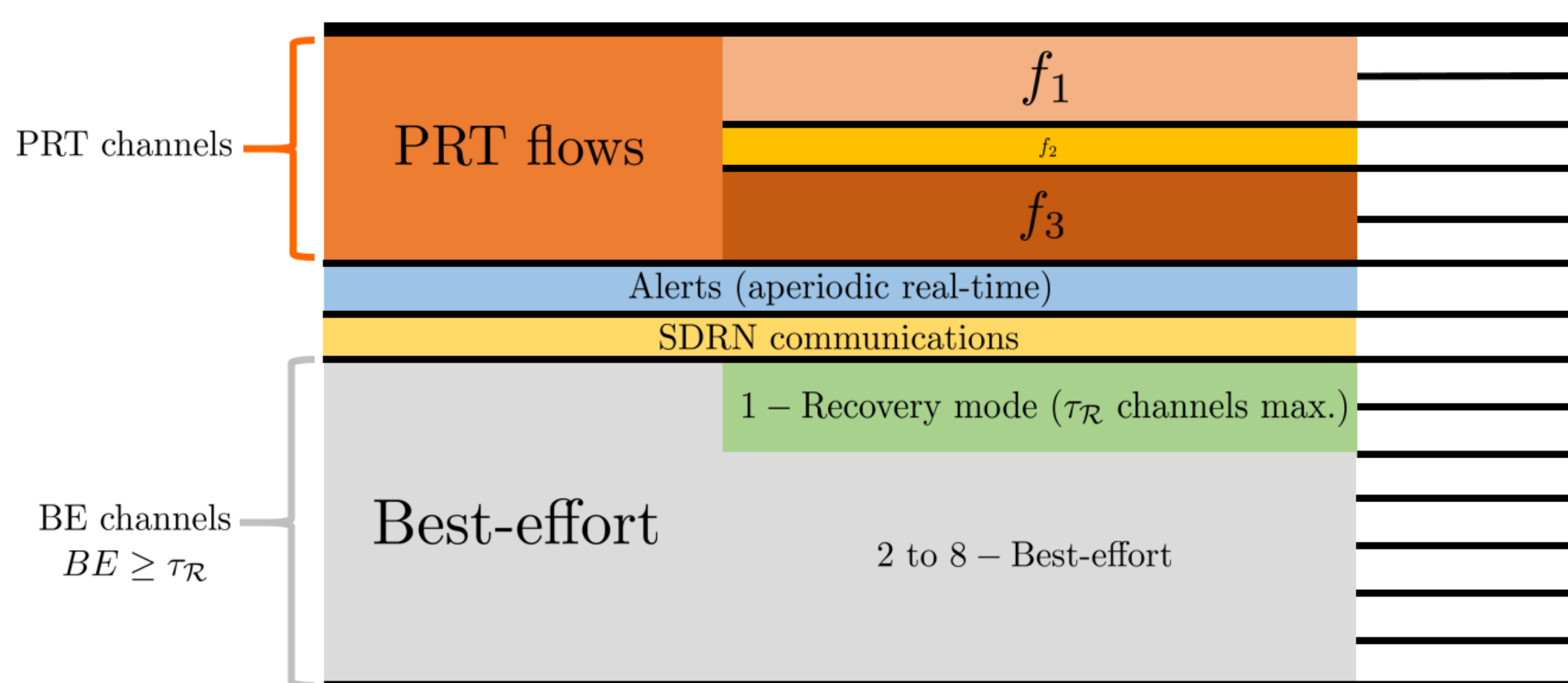


Figure 2. Link virtualization

Admission control and pathfinding

- From high-level requests: $req_f = \{T_f, S_f, dl_f, src_f, dest_f\}$
- Take an optimization criterion into account (e.g. load balancing)

Fault tolerance: hybrid routing

- In **nominal mode**, routing is source-based
- In **recovery mode**, routing is hop-by-hop
- Sub-channels are reserved for flows in recovery mode

Ongoing work

- In-silicon implementation
- Using the SDN paradigm for node configuration

Second Contribution: ERICA, a Framework for Conducting Hybrid Experiments

ERICA helps building hybrid experimentation stacks in order to assess new network mechanisms [2]. Adaptation mechanisms allow to build a custom experimentation stack and to run the same application layer on top of different kind of networks (either real or simulated), thus maximizing relevance, portability and reusability.

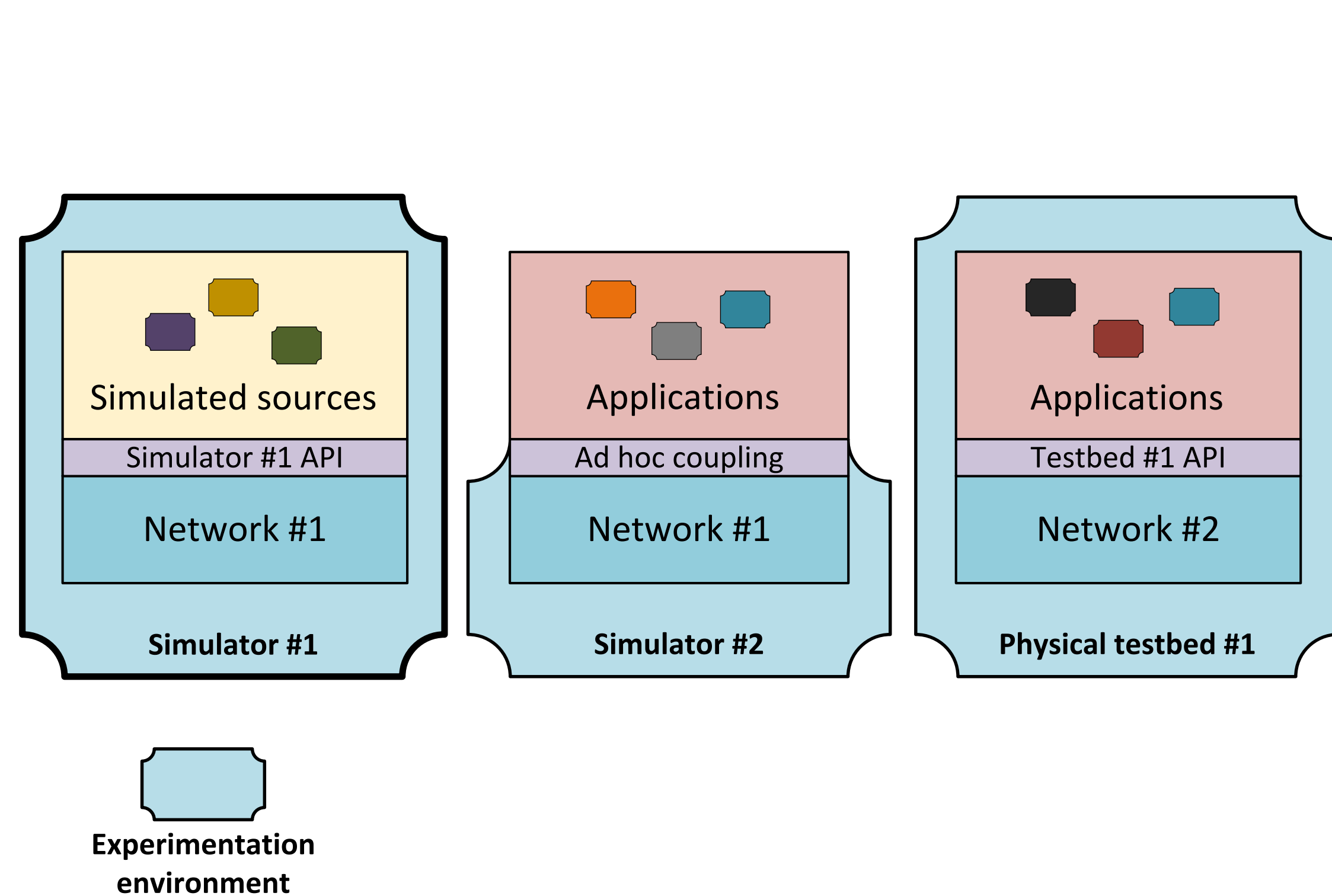


Figure 3. Environment-driven experimentation architectures

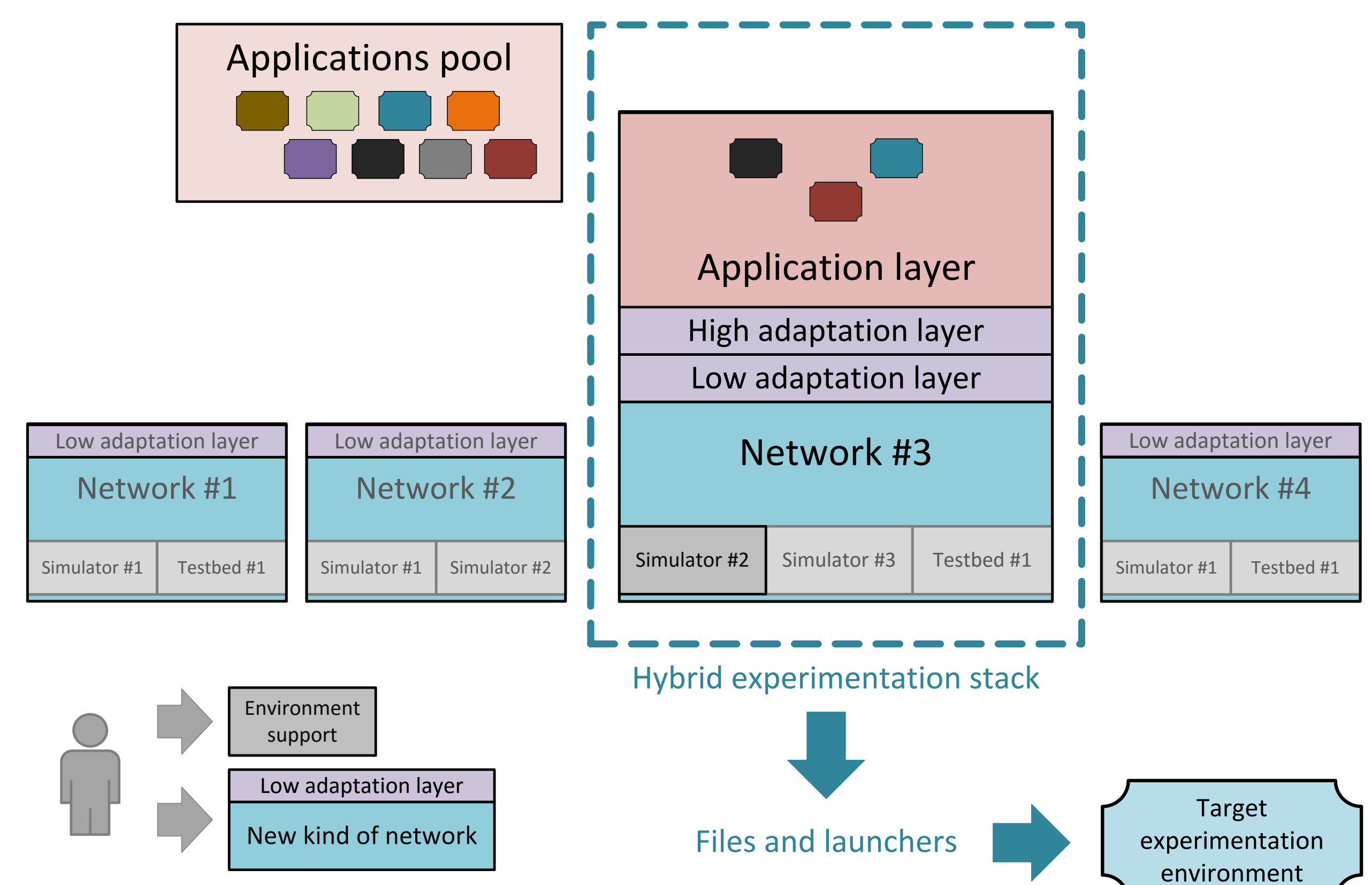


Figure 4. ERICA architecture

Contact

Florian GREFF, PhD candidate
 Thales Research & Technology
 LORIA, University of Lorraine
 florian.greff@loria.fr

[1] F. Greff, Y-Q. Song, A. Samama, L. Ciarletta, "Réseaux maillés dynamiques pour applications temps réel à criticités multiples: problématique et analyse", École Temps Réel, 2015

[2] F. Greff, E. Dujardin, A. Samama, Y-Q. Song, L. Ciarletta, "A Symbiotic Approach to Designing Cross-Layer QoS in Embedded Real-Time Systems", ERTS², 2016

[3] F. Greff, Y-Q. Song, L. Ciarletta, A. Samama, "A Dynamic Protocol to the Design of a Software-Defined Real-time Mesh Network", IEEE WFCS, 2017