i-LAND mIddLewAre for deterministic dynamically reconfigurable NetworkeD embedded systems

Challenges

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Outline

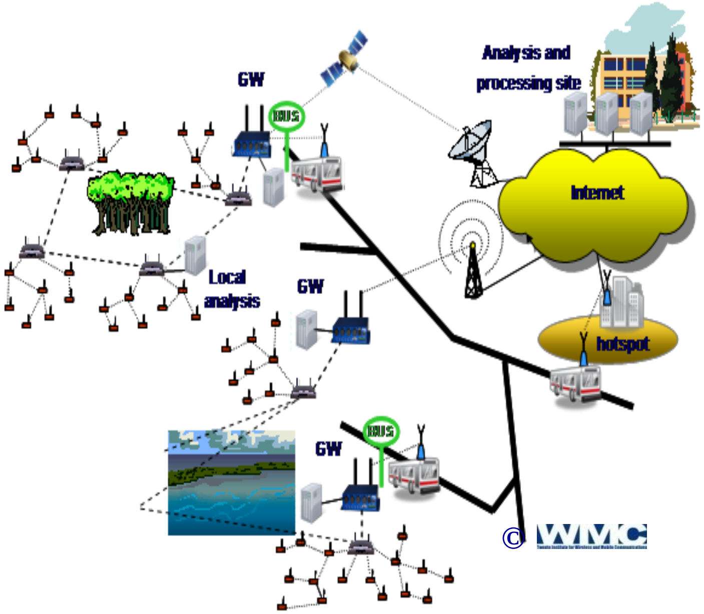
- Context and motivation
- i-LAND Architecture
- Composition and reconfiguration algorithms
- Challenges
- Conclusions

Context and motivation

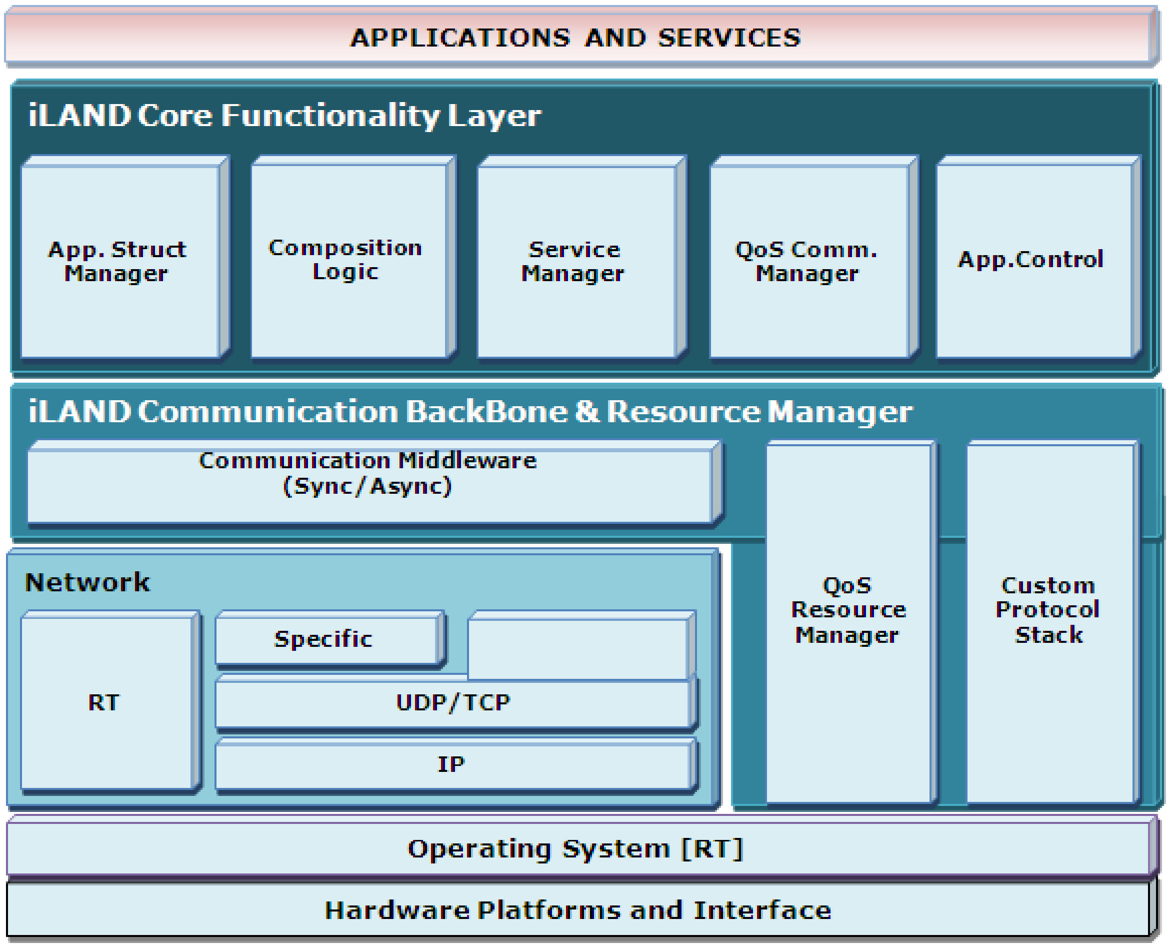
Integrated LAND

(cyberphysical inspiration)

- Heterogeneous nodes
- Decoupled interaction
- Configuration changes at any time
- Deterministic operation



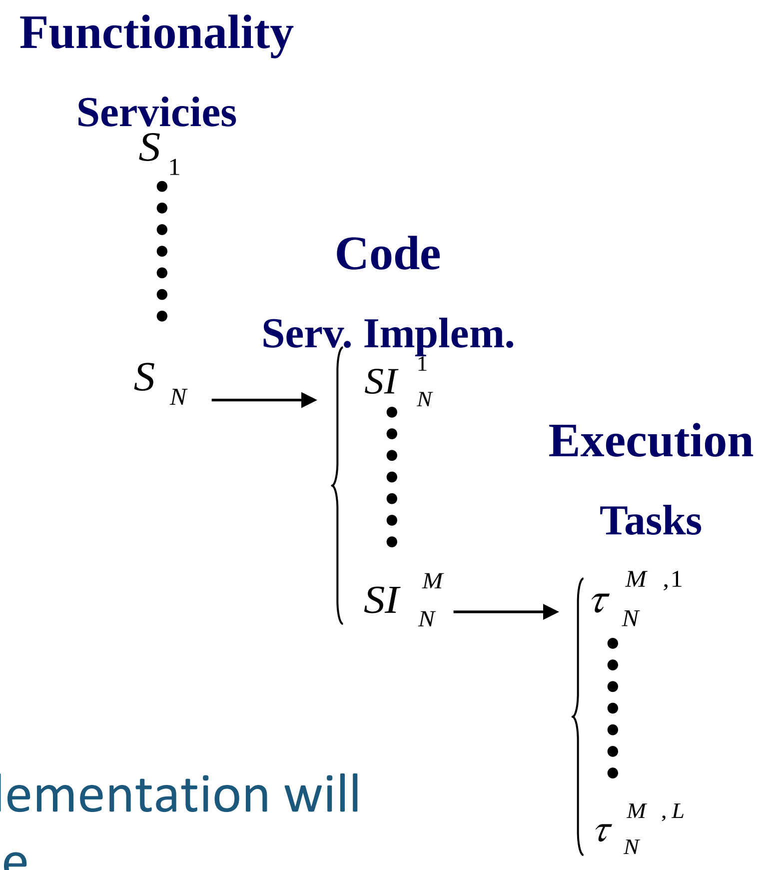
i-LAND Architecture



- UC3M's i-LAND reference implementation v0.1

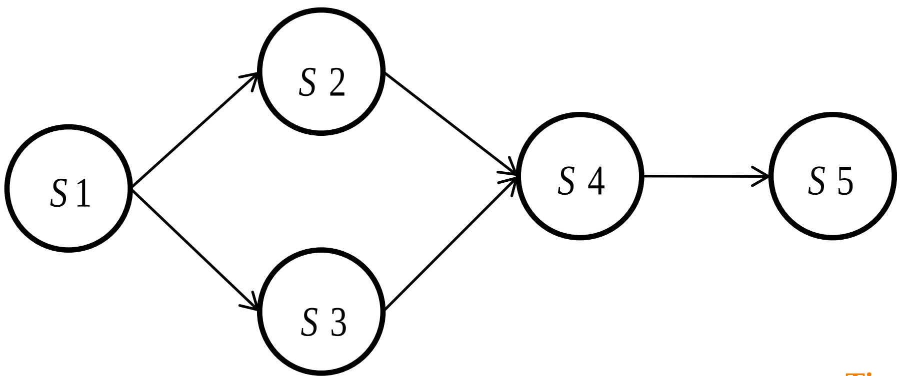
Service Model

- Services
  - Defined by their **functionality**,
  - Materialized in Service Implementations
- each Service Implementation:
  - Different temporal and QoS characteristics,
  - Residing in different physical nodes.
- Each one of the invocations to a Service Implementation will materialize in a unique task in a physical node.

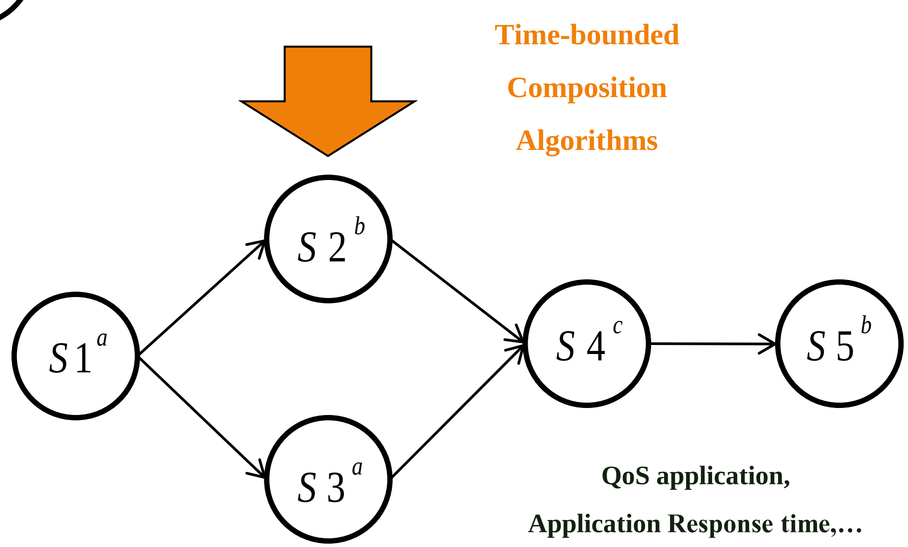


Time bounded Composition Algorithms

- Selection of service implementations to achieve QoS constraints of the whole application and system



- Application period
- Desired Deadline
- Desired QoS
- Set of composition criteria
- Set of service implementations



Distributed Algorithm

- Based on the definition of:
  - Heurístics to determine the number of paths to be explored
    - For each service, the amount of service implementations to explore is restricted
      - Fixed amount $c_i = c$
      - Variable amount

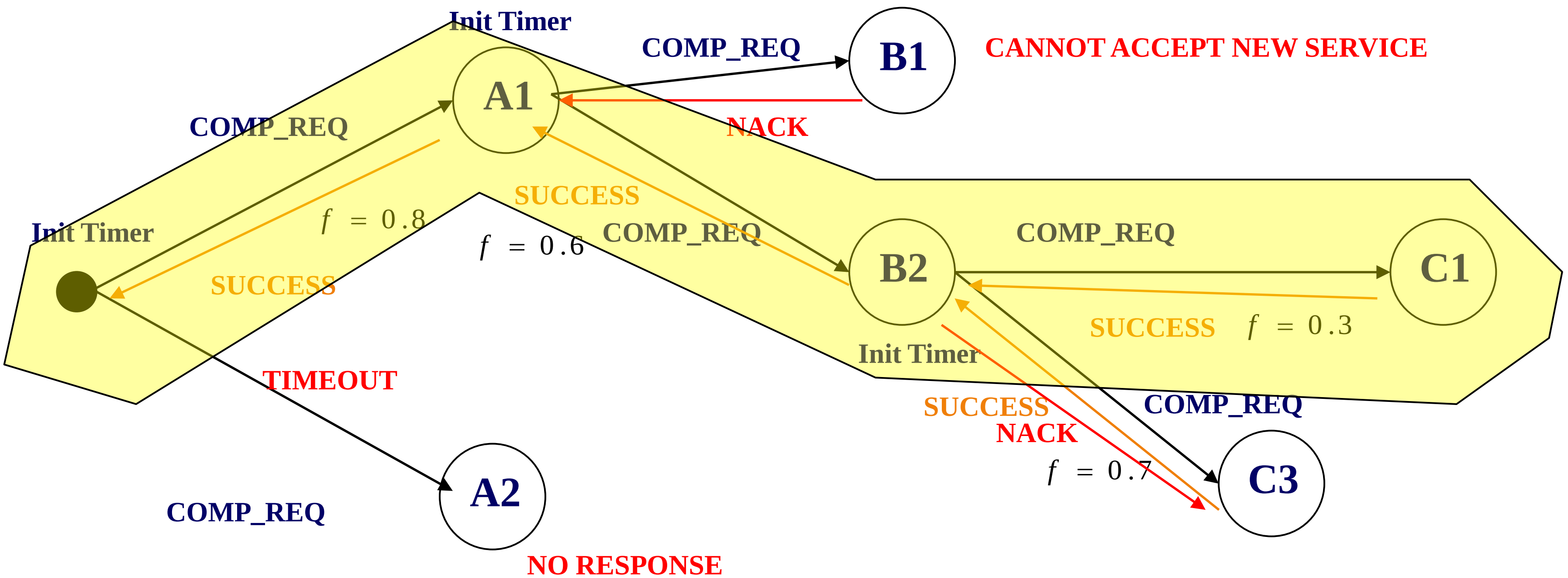
$$c_i = size(P_s);\ P_s = \{ p \in P(S_i) \mid f^r(p) \leq \mu_{f^r} - 0.5\sigma_{f^r} \}$$

  - Relative figures of merit to determine what services are explored

$$f_{\min\ Rapp} = \frac{R_{app}}{D_d} \Rightarrow f^r_{\min\ Rapp} = \frac{C_p}{D_d}$$

  - QoS contracts between peers.
  - Maximum response time, that each node waits for its children
- It explores fewer combinations in a bounded execution time.

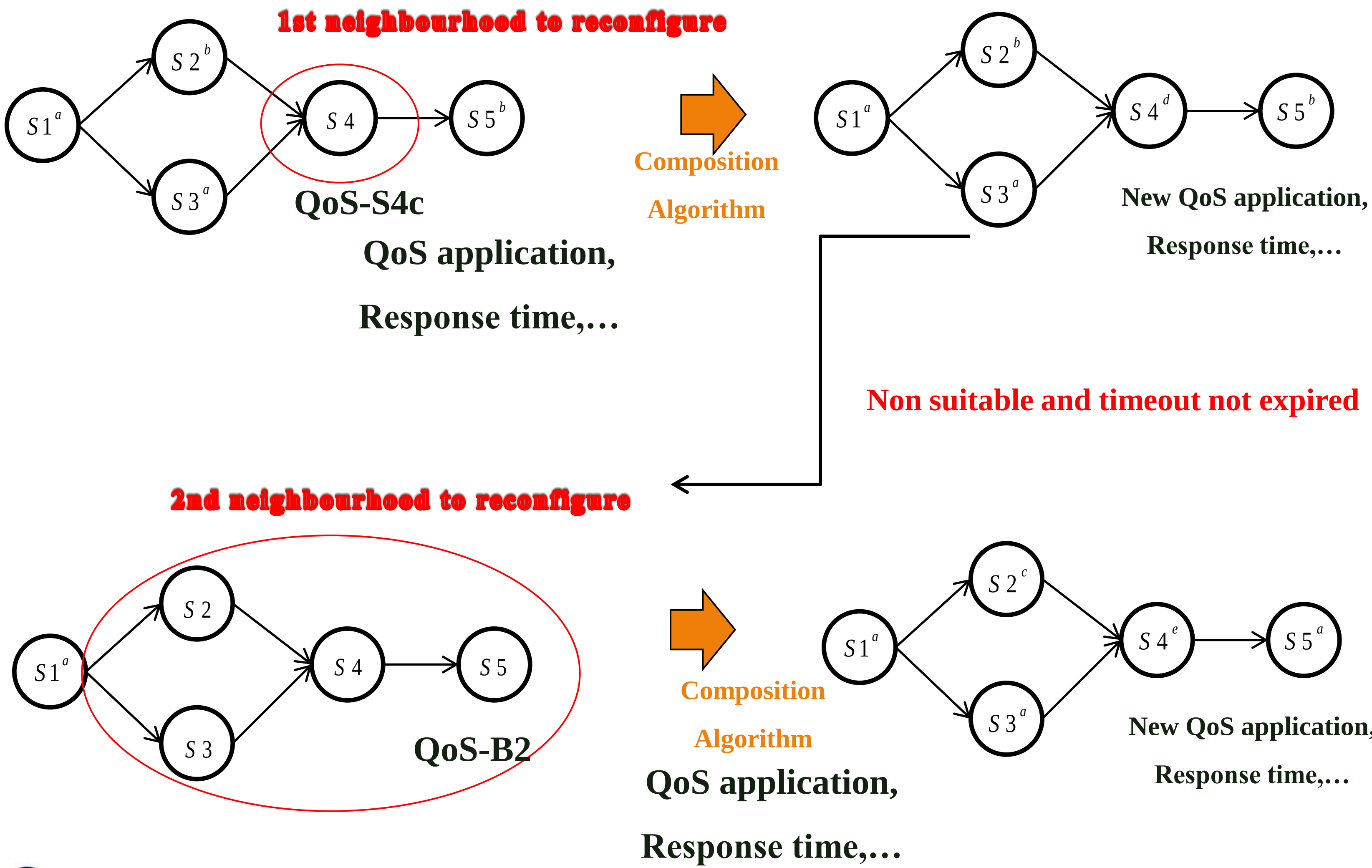
Distributed Algorithm



Reconfiguration Algorithm

- Aims:
  - Tries to keep reconfiguration time as small as possible
  - Time-bounded
    - Uses time-bounded composition algorithms
    - Timeout
  - Allows degradation of applications
- Defines reconfiguration neighbourhoods:
  - Applies the composition algorithm to the whole application graph in order to select the suitable service implementations of the services within the reconfiguration neighbourhood maintaining the rest of the execution graph of the application.

Reconfiguration Algorithm



Challenges

- Modelling of real-time service-based applications
  - Marte UML profile
- Network support
  - Modelling of the network
- QoS support
  - Network
  - Physical nodes
- Composition processes of real-time service-based applications must be aware of the underlying platform
- Definition of suitable distributed composition and reconfiguration algorithms

Conclusions

- i-LAND project aims to offer flexibility and dynamism to heterogeneous networked embedded applications that must reconfigure to cope with context changes
- Some challenges arise:
  - Modelling of the services and service-based applications
  - Modelling of the network
  - QoS support
  - Composition and reconfiguration of the applications
    - Schedulability and QoS
    - Centralised and distributed

Thank you