A Fair Signalling Architecture

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Introduction

What is the best architecture for my project?

Robust & Resilient? At what price?

Centralized or decentralized data centres?

Where should interlockings' boundaries be located?

Centralized, decentralized, or distributed object controllers?

Howe to reduce cables while facilitating maintenance?

Small or large interlocking domains?

Where to place the RBC/RBC borders?

How to minimize disturbances related to radio communication hand-overs?

What is the capacity required for the RBC?

How to manage the line sustainability in a simple way?

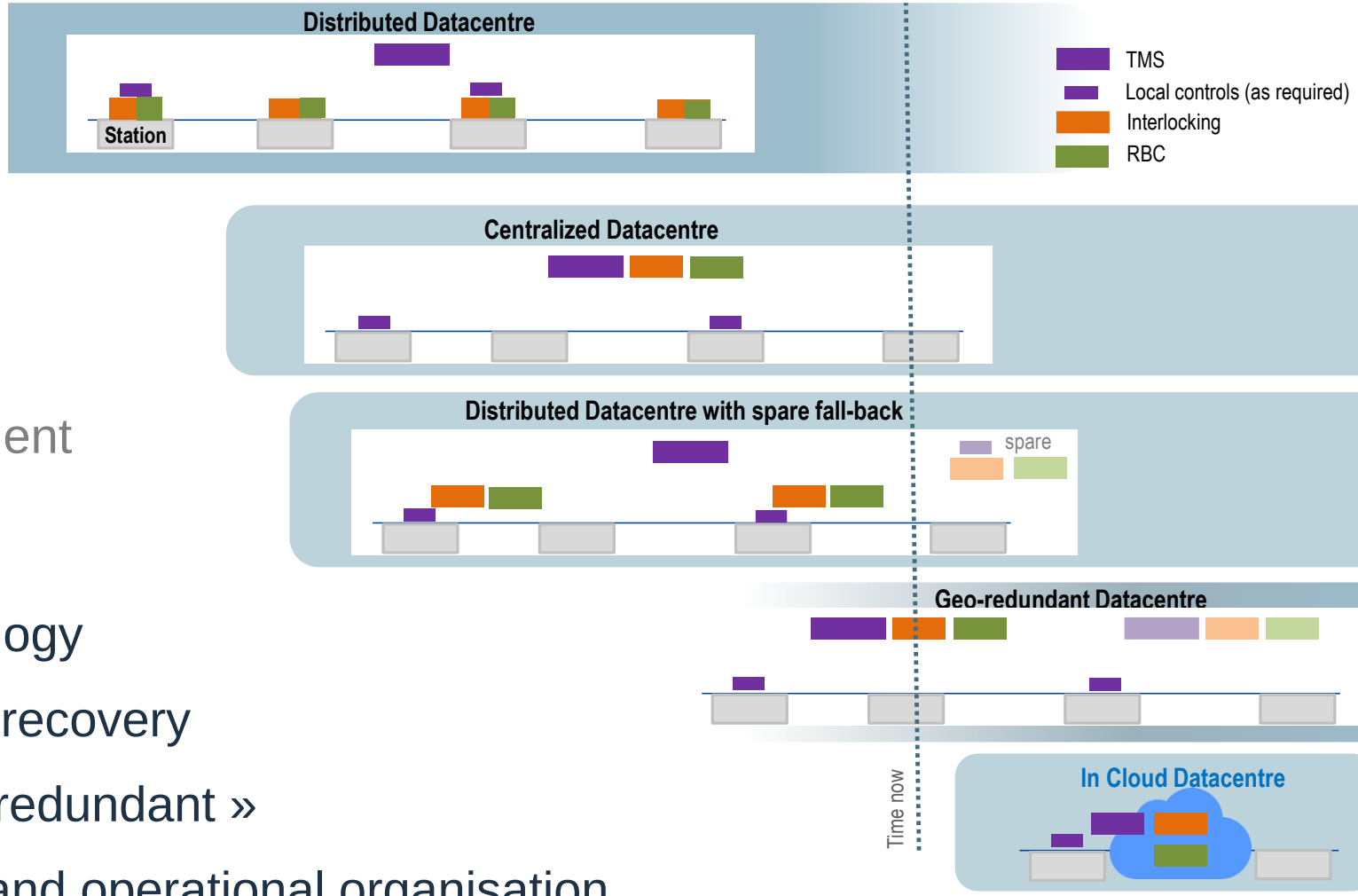
Object controllers in rack or as modules ?

What is the future ? Cloud signalling?

What type of Data Centres Architecture ?

- Driven by several parameters
  - Maintenance organisation
  - Employment continuity
  - Degraded situation management
  - Technology growth
  - Service availability vs disasters
  - Engineering/possession management
  - Life Cycle Cost
  - ..
- «Distributed» jeopardized by technology

  .. excepted for « disaster » recovery
- «Centralized» may evolve to « Geo-redundant »
- «Geo-redundant» impacts the LCC and operational organisation
- «In Cloud» not an architecture but a business paradigm shift “Signalling-as-a-Service”

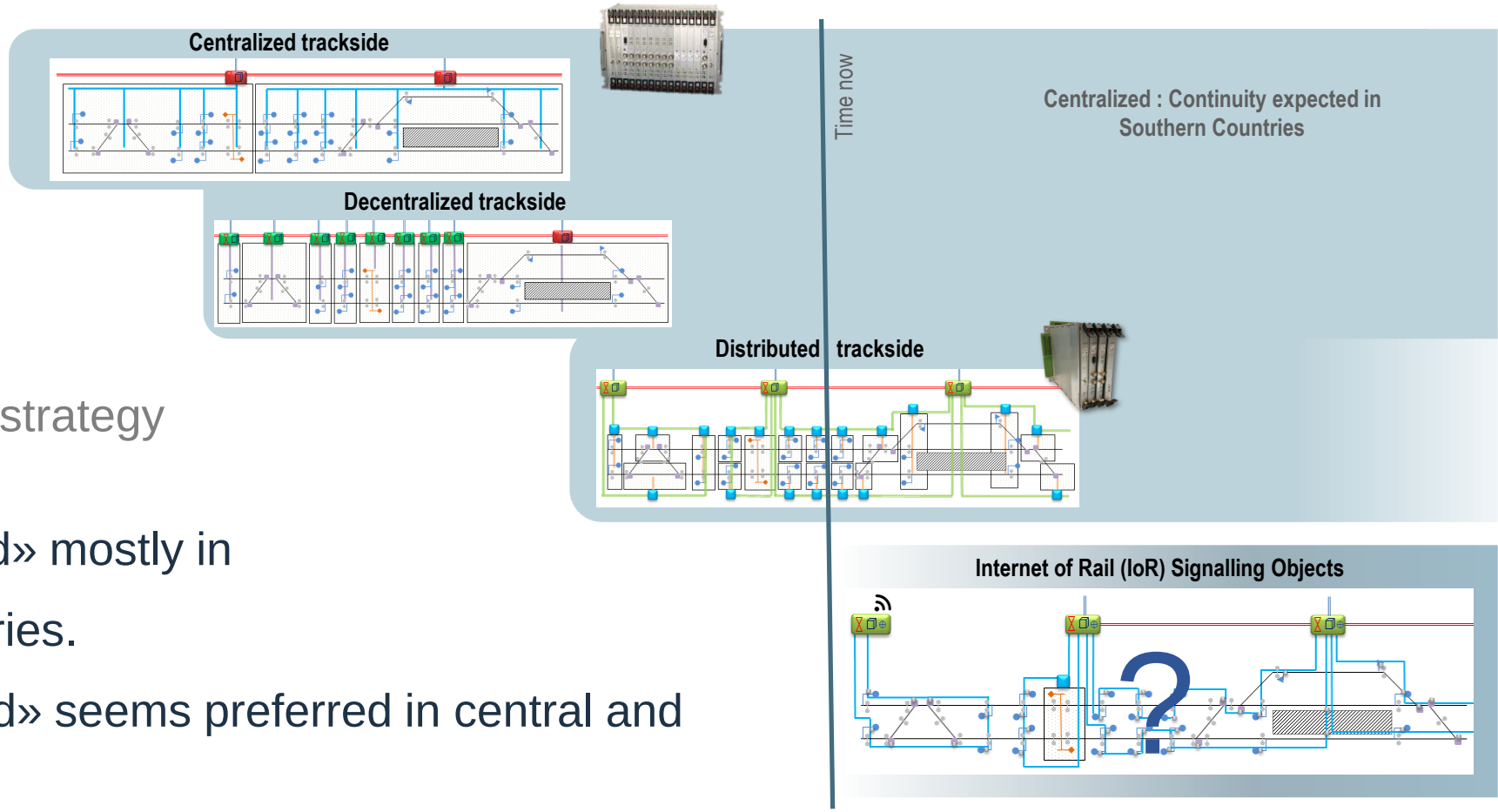


And the Trackside Architecture ?

- Driven by several parameters
  - Maintenance & track access
  - Environmental conditions
  - Environmental footprint
  - Deployment type
  - Cost of ownership
  - Legacy system & migration strategy
  - ..
- «Centralized» / «Decentralized» mostly in

  southern geographical countries.
- «Decentralized» & «Distributed» seems preferred in central and northern Europe.
- «IoR» (signalling-Internet-of-Rail) based on connected signalling object

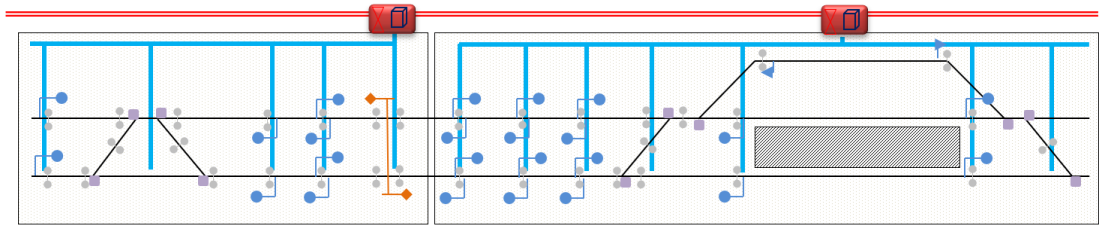
  .. migration and maintenance are threats to this approach



What type of Object Controllers ?

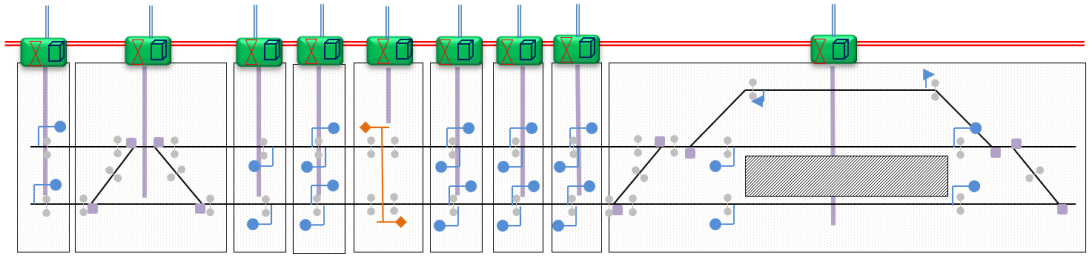
- **Mainlines**

Object Controllers
in **racks**



Centralized

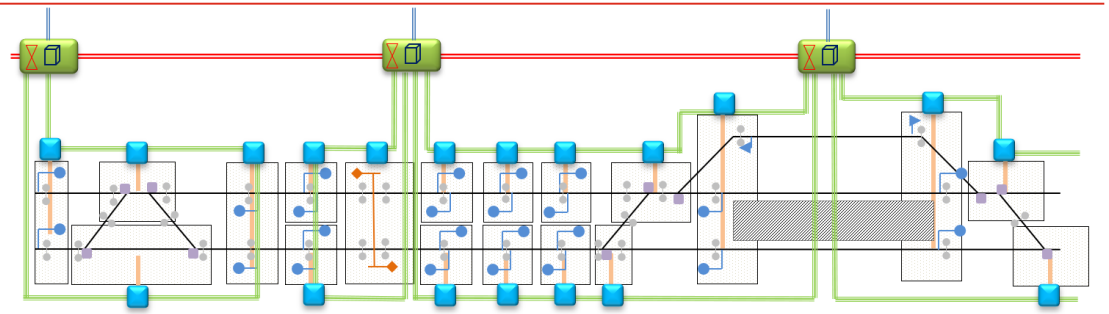
Object Controllers
as **modules or in racks**



Decentralized

- **Secondary & Regional Lines**

Object Controllers
as **modules**



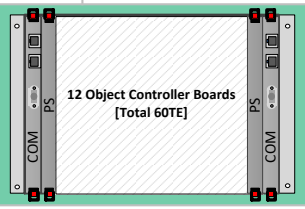
Distributed

Problem: how to solve his variabilities ?

Scalable Smart Object Controllers – Smart & Versatile

Object Controller boards				
Power Supply	Communication	Signals & Generic I/O	Point	LEU
				

LRU ⇔ OC boards

	Signals, I/O, LEU	Generic I/O and small systems (e.g. Level Crossing)		Points
Object Controllers as Functional Modules				
Signalling Control (SIL4)	8 lamps or/and 4 ETCS balises	8 lamps/relays 16 generic inputs	24 lamps/relays 32 generic inputs	2 points
Object Controllers in rack				
Signalling Control (SIL4)	According to inserted object controller boards (max 12 boards of any type Points/Signal/Generic IO/LEU)			

LRU : OC boards or Module

LRU : OC board

The Object Controller should be “all terrains”:

all needs, reduce spares, costs, training, connected

- “Scalability” is the word
  - Rack or Module
  - With or without redundancy
  - LRU: module boards or full module
  - Common LRUs for all architectures

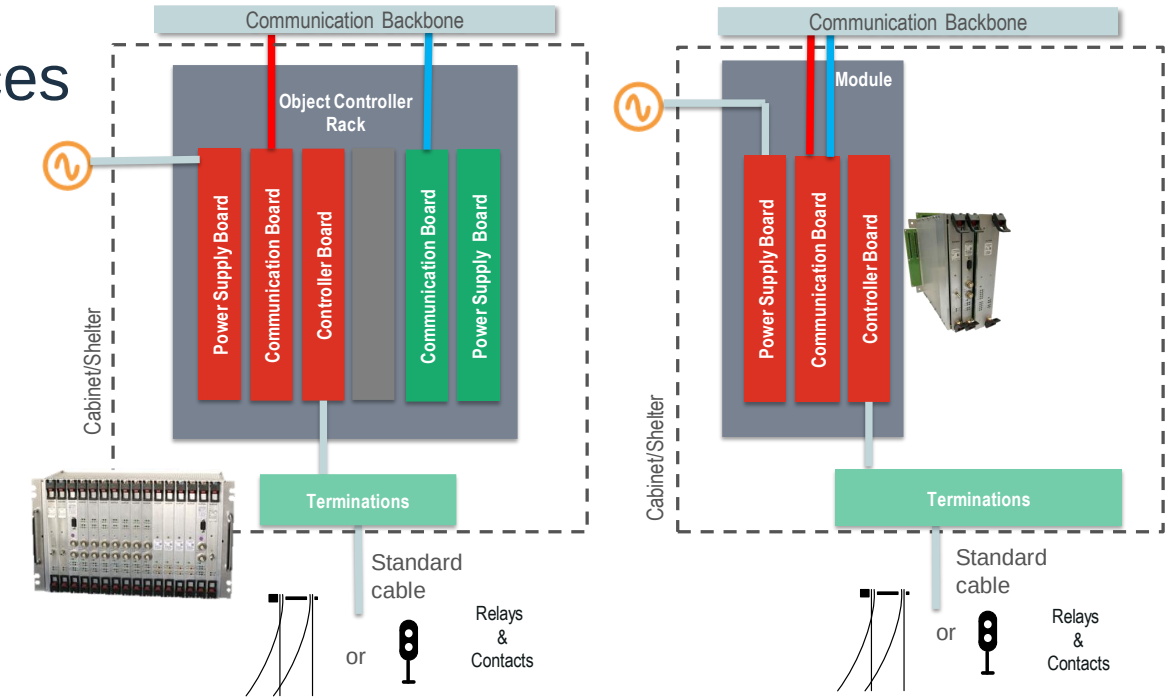
- Smart Object Controller
  - In Racks or as Module
  - Embedded Intelligence (local logic) capability
  - Signalling objects or sub-systems (e.g. level crossings)
  - SIL4 & No-SIL interfaces to objects & sensors

« One product fits all »

Redundancy of common resources

Racks

- Ethernet interfaces
- Com services
- Power supply



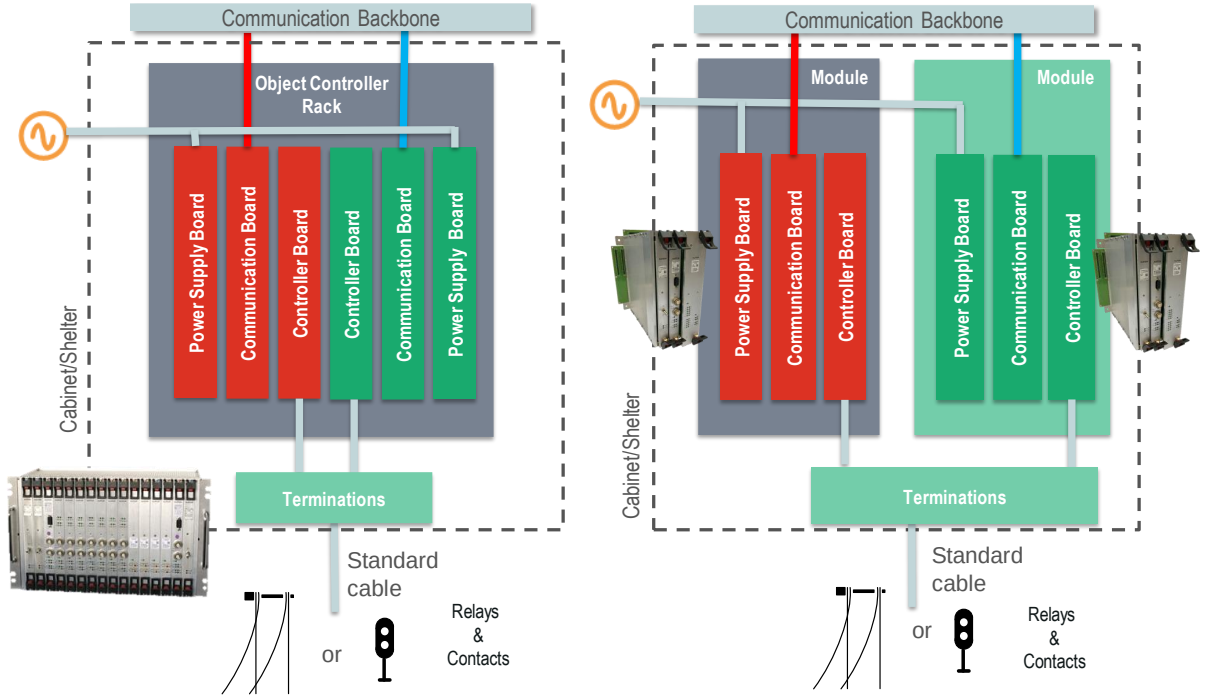
Modules

- Ethernet interfaces

Duplication of common resources is a standard

Scalable resilience: Scalable redundancy for objects interfaces

- Service availability (MTBSF) adapted thru **Partial or Full Redundancy**

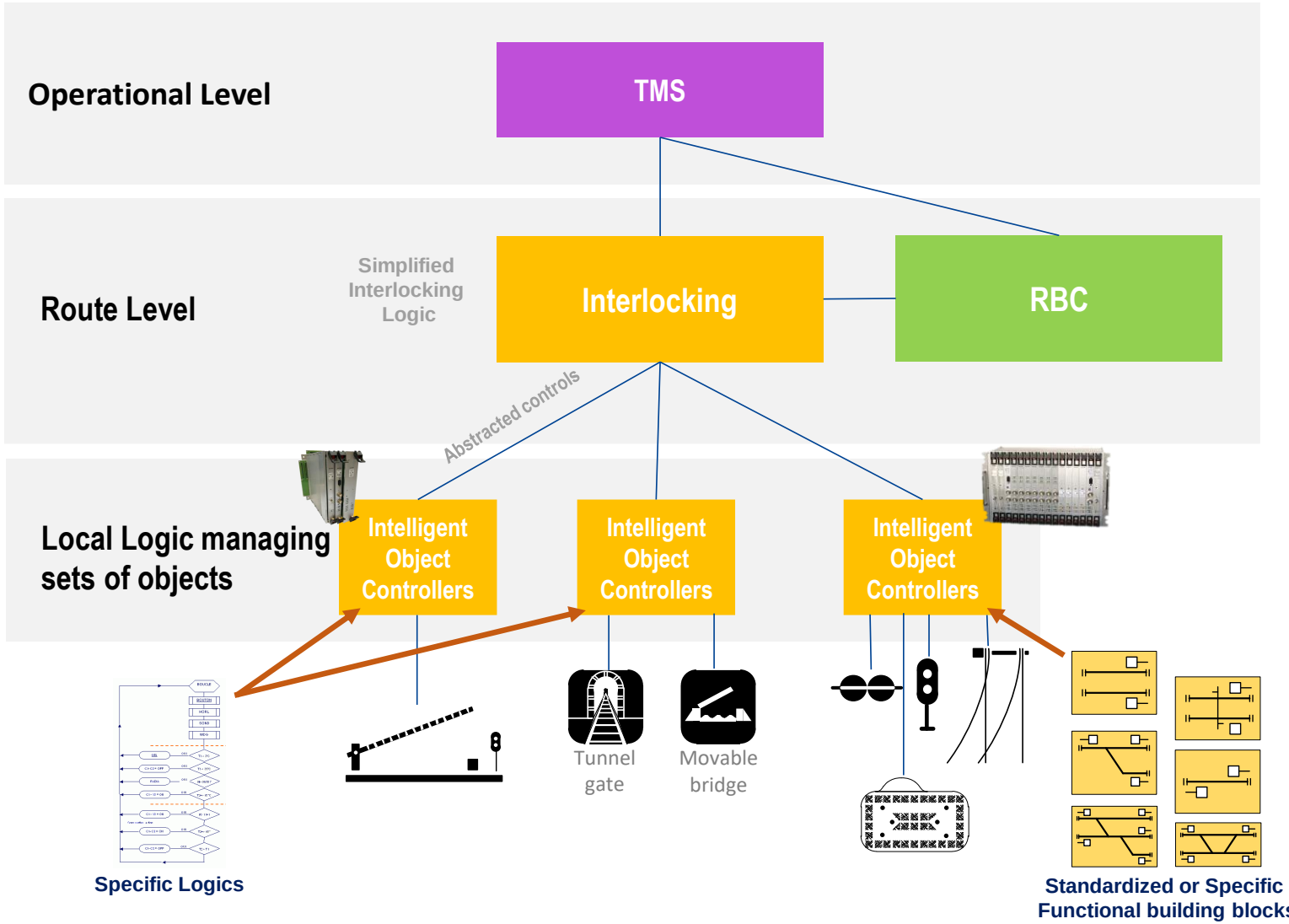


- **MTBSF multiplied by ~10 with 12h MTTRR** ➔ **High operational availability**
- **MTBSF multiplied by ~4 with 1 year MTTRR (equivalent to Signalling periodical inspection)**

➔ **Allows low cost maintenance organisation & logistic centres reduction**

A fair distribution of roles

- Intelligent object controllers approach to support:
  - **Central Logic simplification**
  - **Reaction time reduction**
  - **Objects abstraction**
  - **Engineering cost reduction**
  - **Adaptability to specificities**

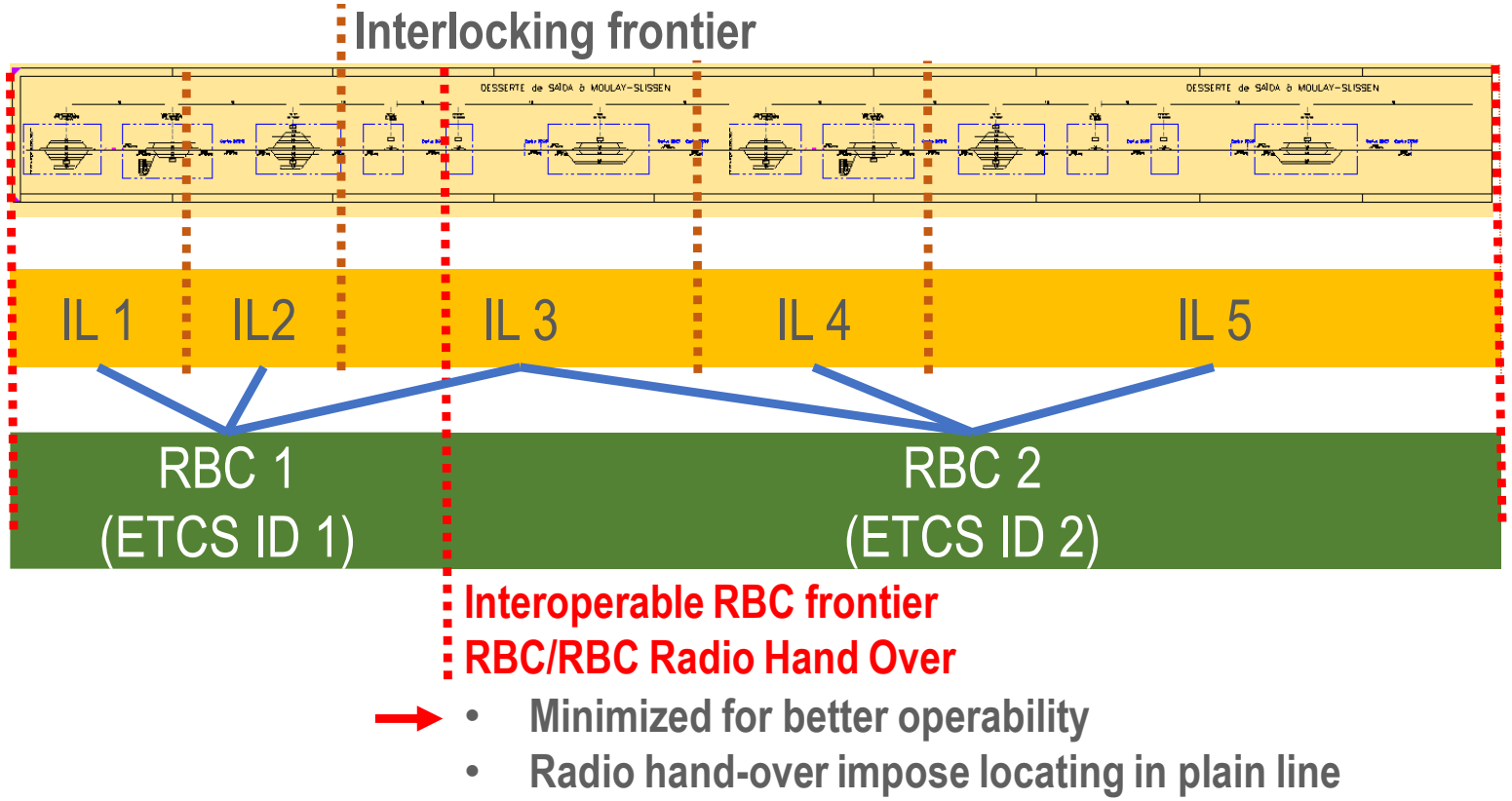


Why are RBC and Interlocking area so different ?

- Individual interlocking area definition driven by replaced interlocking area, phasing, degraded operation management, ..
- **RBC/RBC frontiers kept minimized**

➔ Interlockings and RBCs areas are rarely superimposed

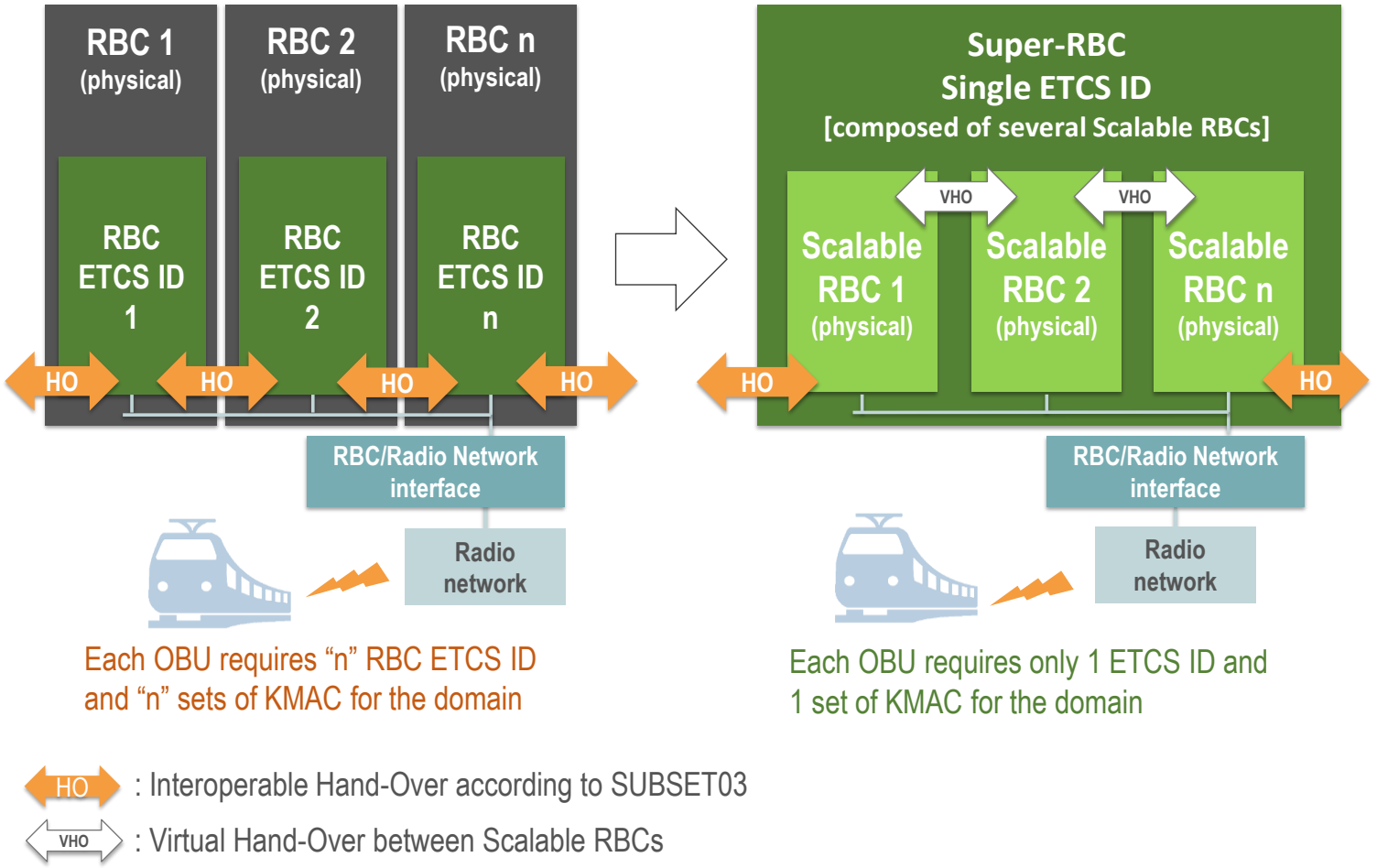
➔ RBC engineering requires extended possessions



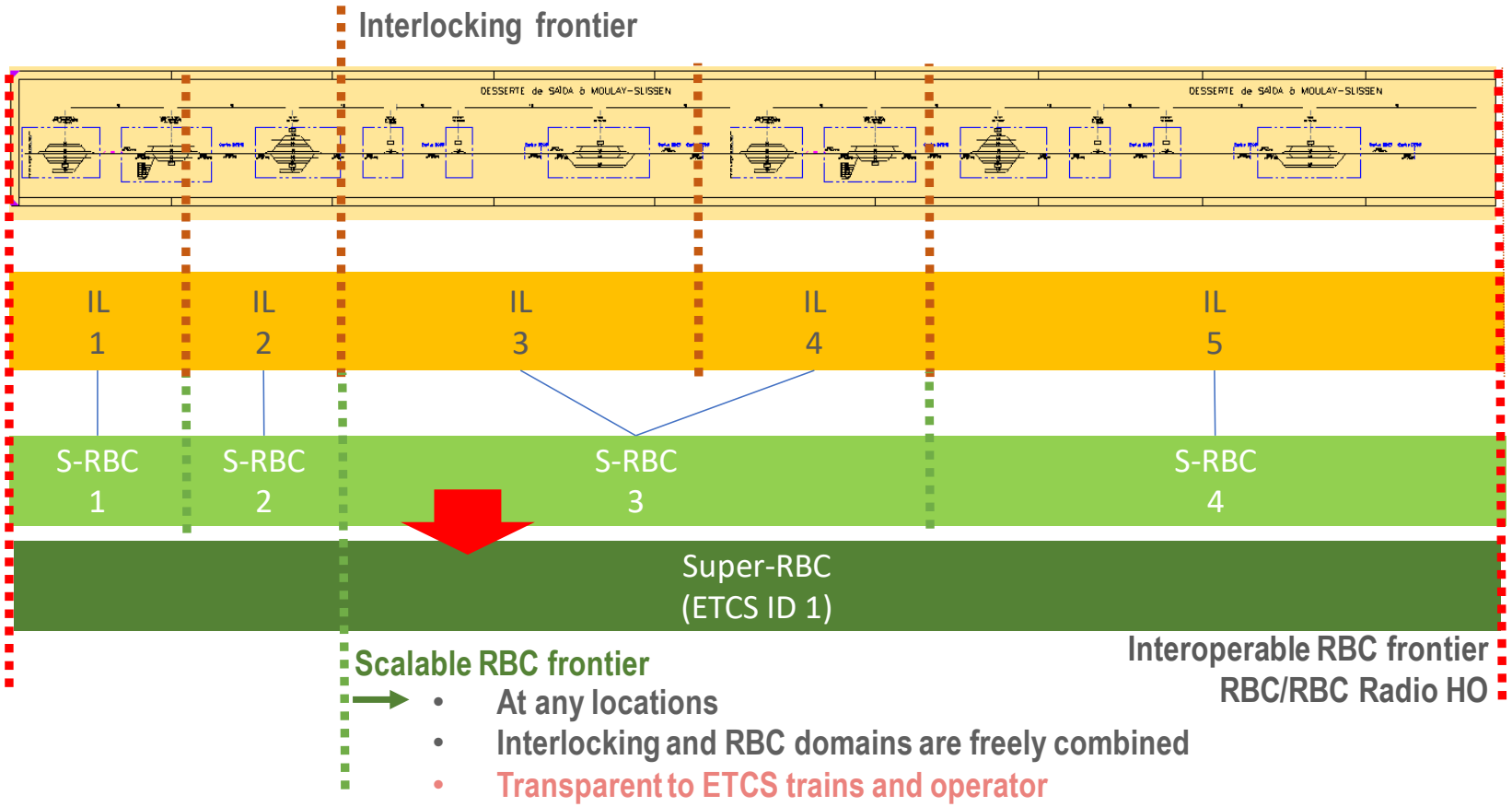
A Transparent Scalability – More capacity less RBC frontiers

- **The Scalable RBC allows for super-RBC with no drawbacks**

  - **Facilitated deployment phasing**
  - **No RBC/RBC hand-over**
  - **More resilient to radio failure**
  - **Free RBC frontiers positioning**
  - **RBC frontiers in stations**
  - **Less operational disturbances**
  - **Jeopardizes computer capacity**
  - **Less balises**
  - **One KMAC set per super-RBC**
  - **50% less GSM-R frequency slots (in Circuit Switching)**



Scalable RBC: Flexibility and Operational Efficiency



- **Several RBCs "as one"**
- **Interoperable RBC frontier:**
  - Radio interface capacity reached
  - Interface between different RBC manufacturers
- **RBC areas aligned or superimposed with Interlockings areas**

Several RBC cubicles are combined to composed a single super-RBC

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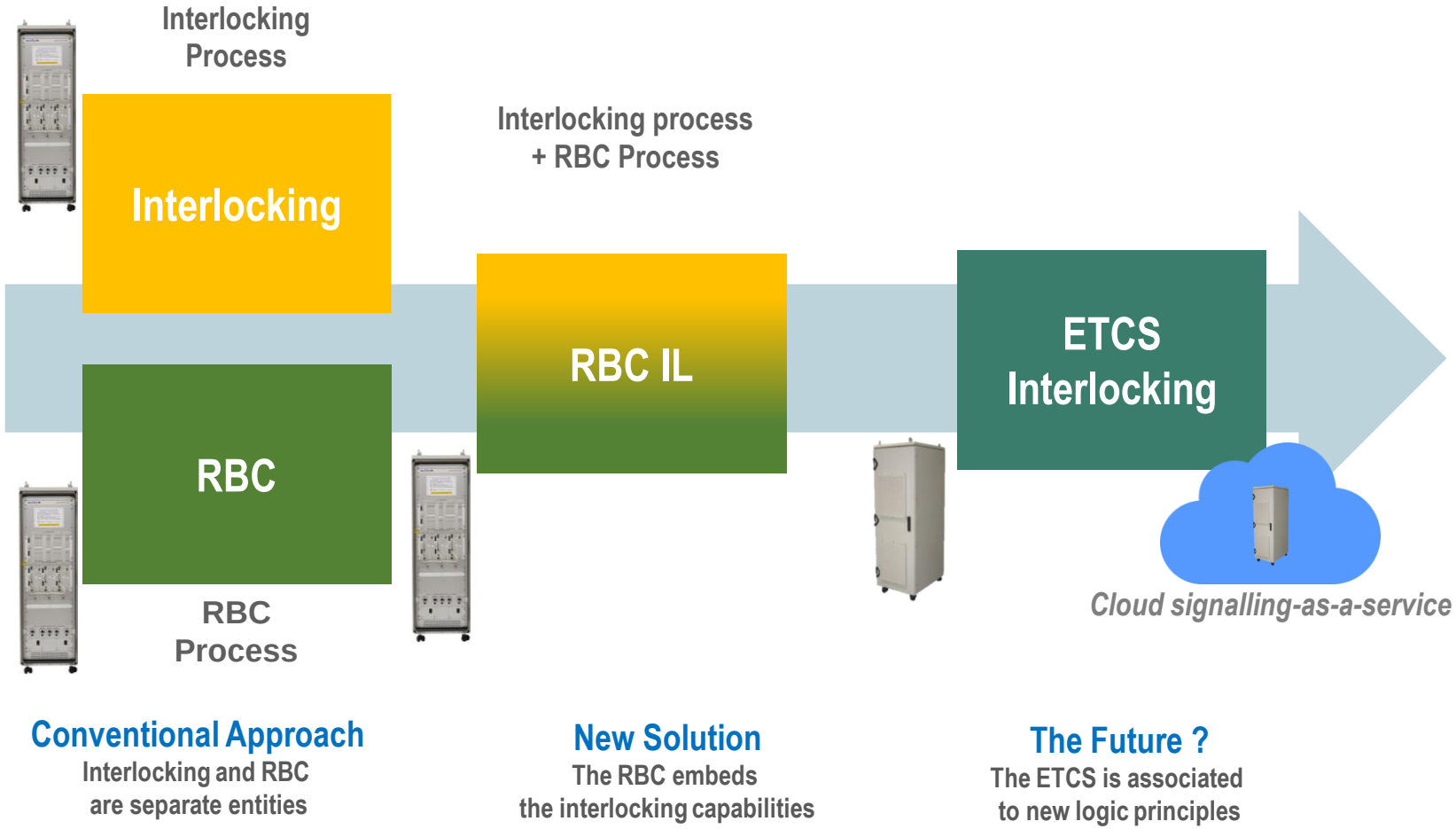
From « Track-based » to « Train-based » Interlocking ?

- **Scalable RBC put RBC and Interlocking finally together !**

  - **Improved reaction time**
  - **Eased engineering**
  - **Eased project phasing**
  - **Eased line engineering**
  - **Less central computers**
  - **A need for ETCS Level 3**



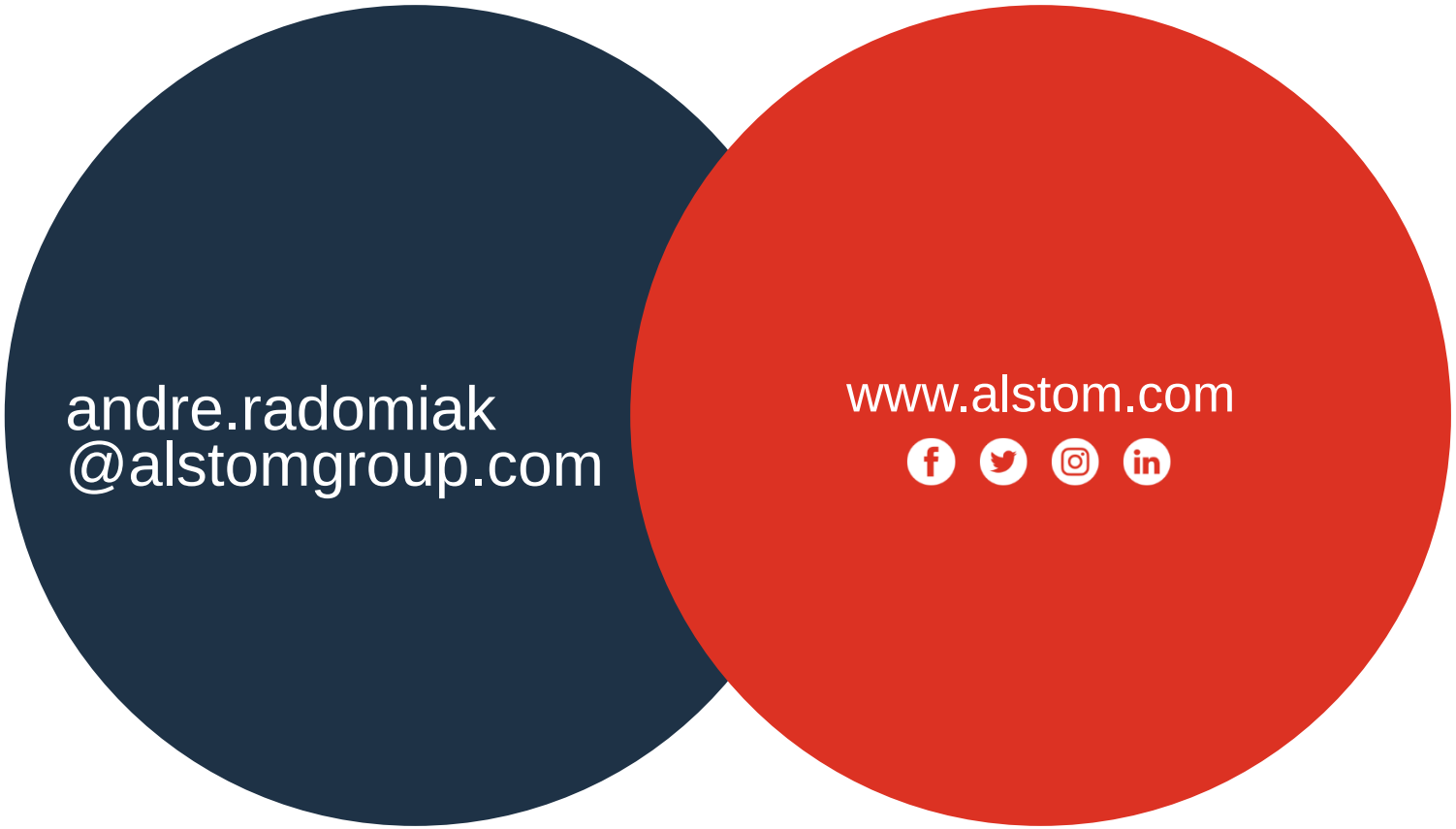
Conclusions

- A fair signalling architecture is capable to adapt by
  - **Scalability at each level** ➔ Central computers & Object controllers
  - **Scalability in service availability** ➔ Disaster recovery, Service availability, Maintenance
  - **Functional abstraction** ➔ «Dumb» or «Intelligent» object controllers
  - **Constraints free RBC frontiers** ➔ Improved Operability & Signalling Engineering
  - **Interlocking/ RBC Integration** ➔ Performances, Train-based interlocking

- Migration & maintenance are threat to new architectures such as «IoR»

- « In Cloud » signalling is a paradigm shift to « Signalling-as-a-Service »
  - Is not directly linked to the technology, but to the business model ➔ are IMs ready ?
  - Justifies interface standardisation (EULYNX / RCA)
  - Supports for technology step-up in central computers

Thank You for Listening



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