IAM4Rail

New Generation Train Communication Network

Yamen Alsaba, Fargeon Rodrigue, Fouzia Boukour, Marion Berbineau,
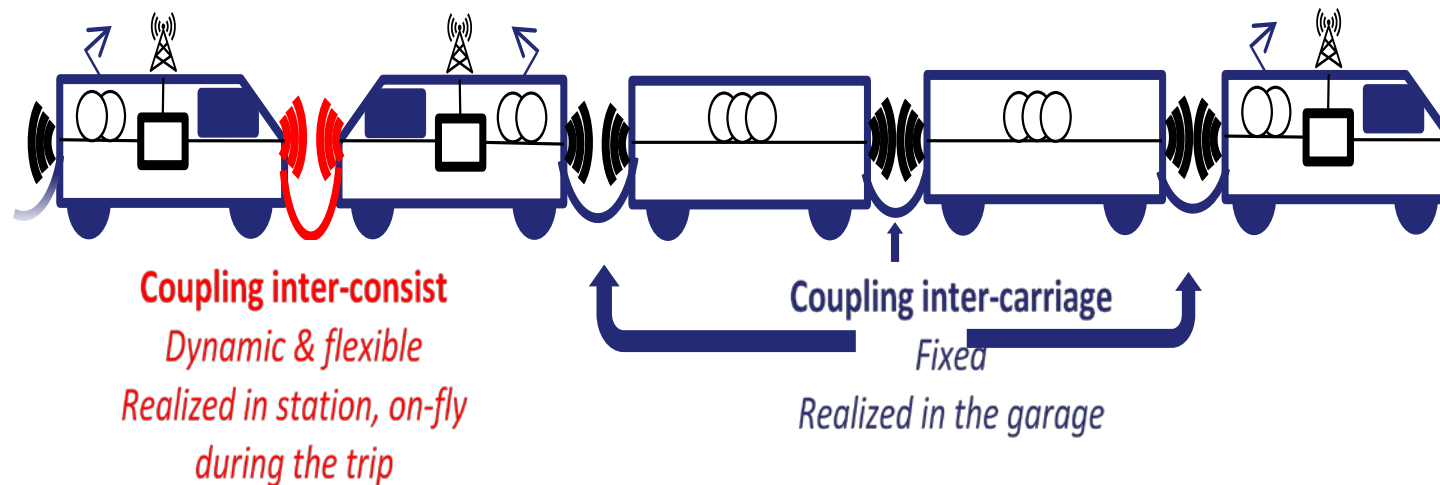
Pierre-Yves Petton, Sylviane Roullier

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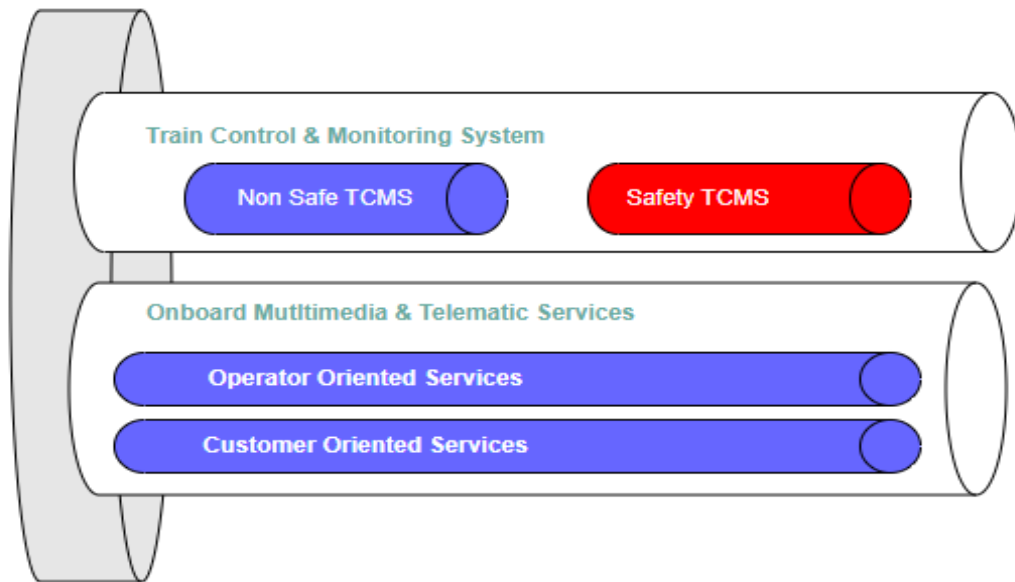
Introduction

- **Main Objectives / Description**
    - Design a multi-purpose resilient adaptative on-board telecom network
    - Enable NG-TCN to replace cable weight and maintenance cost
    - Leverage train virtual coupling to enhance the railway system efficacity

Coupling inter-consist
Dynamic & flexible
Realized in station, on-fly
during the trip

Coupling inter-carriage
Fixed
Realized in the garage

Train services domains

- **Train Services domains can be divided into**
  - TCMS (main command, brakes, train radio, doors, ….)
  - OMTS (CCTV, Vehicle positioning, driving assistance system, ….)

| SCOPE	DATA CLASS		DATA SIZE (octets)	DATA RATE NEED		CYCLE TIME		LATENCY [1]		JITTER	
				Current Use [2]	NG-TCN	Current Use [2]	NG-TCN	Current Use [2]	NG-TCN	Current Use [2]	NG-TCN
TCMS	Process Data	time sensitive	≤ 1432 [acc. IEC61375-2-3]	N/A	≤ 100Mbit/s	N/A	≥ 1 ms	N/A	$T_L = \sum T_{Sn}$ (Example: n=128 → $T_L = 15.92ms$)	N/A	± 1%
		normal	≤ 1432 [acc. IEC61375-2-3]	10Mbit/s	≤ 100Mbit/s	20ms	≥ 10 ms	Between 3CycleTime and 7CycleTime	$T_L = 2*\sum T_{Sn}$	N/A	± 50%
	Message Data		≤ 65388 [acc. IEC61375-2-3]	10Mbit/s	≤ 10Mbit/s	N/A	N/A	250ms	≤ 500 ms	N/A	Not relevant
	Supervisory Data		Not relevant	10 Mbit/s	≤ 10Mbit/s	Not relevant	50ms	250ms	$T_L = 2*\sum T_{Sn}$	N/A	Like process data (normal)
OMTS	Streaming Data	Audio	N/A	≤ 3.2 Mbit/s (100 Kbit/s audio channel, one per consist)		N/A	N/A	≤ 100 ms		N/A	For synchronized A/V Stream: ≤ 80ms difference (lipsynch); minimal jitter
		Video	N/A	≤ 32 Mbit/s 1 Mbit/s video stream [no needs for HD]	≤ 256 Mbit/s (one stream rear-/side-/internal view per consist 8Mbit/s video stream [HD])	N/A	N/A	≤ 500 ms	≤ 100 ms		
	BestEffort Data		≤ 4 GB	Not relevant	≥ 10Mbit/s	N/A	N/A	Not relevant		Not relevant	Not relevant

System Requirements
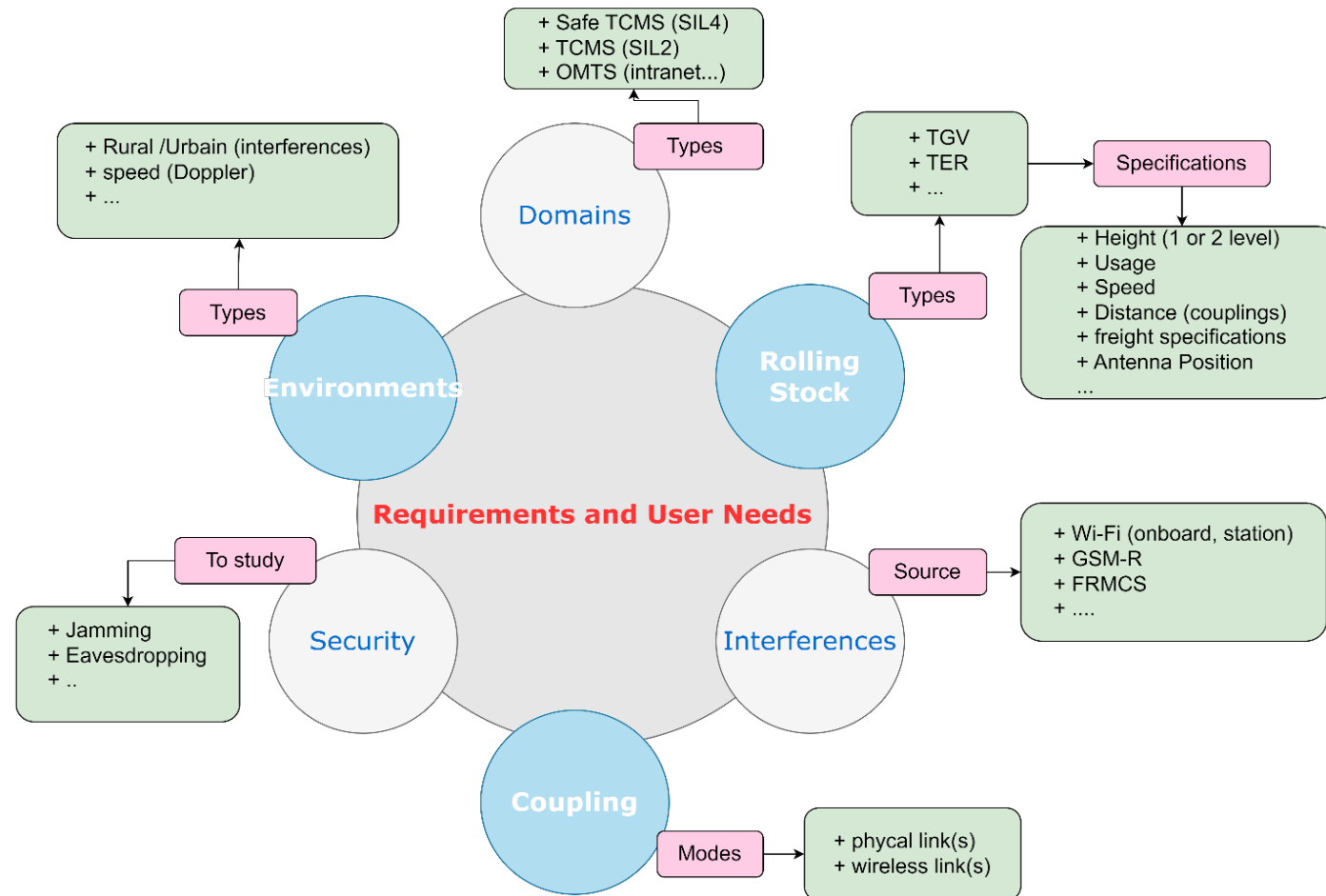
Scenarios and User Cases

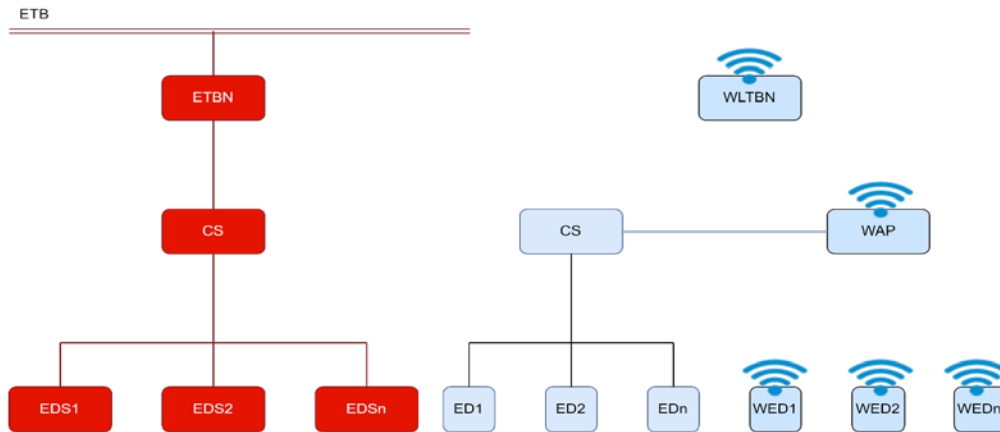- **Four main scenarios have been proposed**

    - 1- Ethernet Intra Consist-Hybrid Inter Consist Network
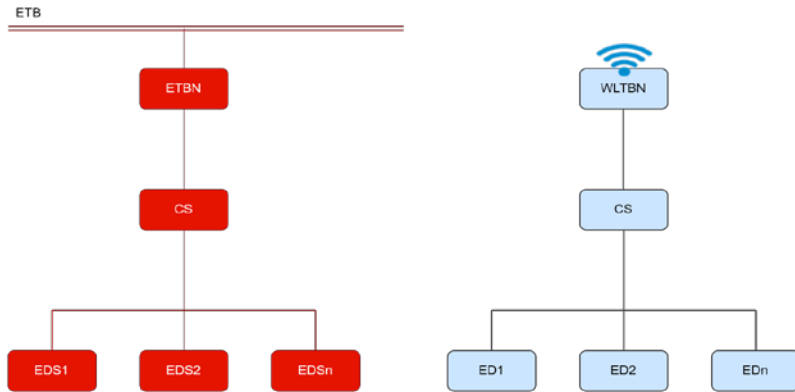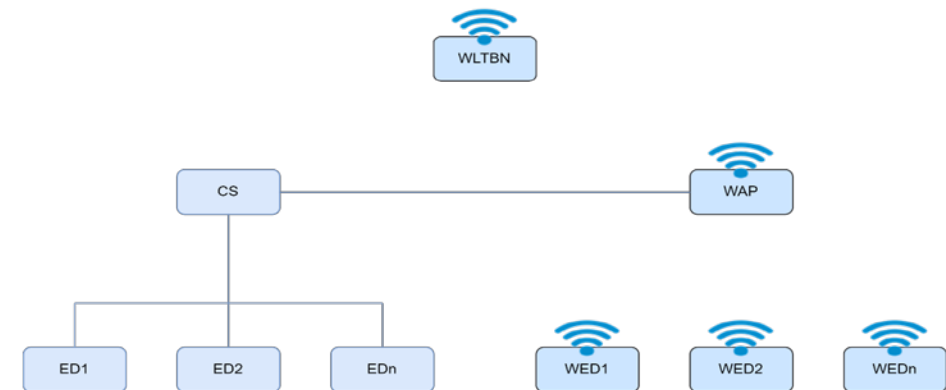
    3- Ethernet Intra Consist-Wireless Inter Consist Network
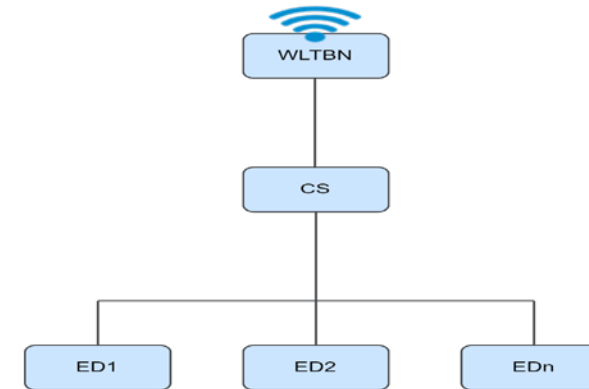
    - 2- Hybrid Intra Consist-Hybrid Inter Consist Network

    4- Hybrid Intra Consist-Wireless Inter Consist Network

Potential Wireless Technologies

- **Several wireless technologies have been investigated in terms of KPIs of interest**

Technology / KPI	Throughput	Delay
LTE-V2X	27Mbps	50-100ms
UWB	27Mbps	NAN
Wi-Fi	2Mbps-4.8Gbps	1-20ms
ITS-G5	27Mbps	1-20ms
NR-V2X	FR1: 450MHz-6GHz FR2: 24.5 GHz-52.6GHz	1-4ms

Conclusion and Future Work

- **Design NR-V2X System that takes into consideration the proposed scenarios, system requirements and use cases.**

- **Consider modifications to NR-V2X to adopt the railway environment**
  - Investigate spectrum sensing techniques
  - Define V2V path loss and power delay profile models
  - Propose the potential frequency bands of the system

- **Design a demonstrator (TRL 4) to test the proposed system in real scenarios that might include open source modules and SDR cards.**

Thank you for your attention
Questions and Answers