

Prague, 21 October 2011



Information and Communication Technology On Trains

The Frecciarossa

A. Gatti – A. Ghelardini

- Fault Tolerant Ethernet Backbone
 - Redundant Vs Fault Tolerant Network
 - Proposed Architecture
 - Frecciarossa legacy constrains
 - On-board Pilot Test
 - Exploitation of the services
- Passenger oriented services: a Trenitalia –Telecom Italia project
 - Frecciarossa On-board Internet Access

Fault Tolerant Ethernet Network



Helsinki, 29th 30th July 2008

Ethernet Fault Tolerant Train Backbone

Proposal for the IEC 61375 parts

- 2-5 Ethernet Train Backbone
- 2-6 Board Ground Communication
- 3-4 Ethernet Vehicle Bus

DocID WG43-I-TRI-003-02 Trenitalia_EFTB

Redundant vs Fault Tolerant Network

There are several downsides to current redundant network designs as Trunking or Link Aggregation, Proprietary rings or Spanning Tree and Rapid Spanning Tree protocols

		Trunking		Proprietary Ring		RSTP		STP	
		Cable Out	Cable In	Cable Out	Cable In	Cable Out	Cable In	Cable Out	Cable In
UDP	Reading 1	0ms	0ms	138ms	431ms	2.423s	1.818s	31s	31s
	Reading 2	<= 5ms	<= 5ms	257ms	365ms	2.121s	1.414s	31s	31s
TCP	Reading 1	201ms	201ms	201ms	603ms	3.064s	3.015s	51s	51s
	Reading 2	201ms	201ms	200ms	602ms	3.015s	1.487s	51s	51s

		Min	Max	Min	Max	Min	Max	Min	Max
UDP		0ms	5ms	138ms	431ms	1.414s	2.423s	31s	31s
TCP		201ms	201ms	200ms	603ms	1.487s	3.064s	51s	51s

Source: The Industrial Ethernet Book Oct. 2007 - HOW ETHERNET REDUNDANCY SCHEMES AFFECT RECOVERY TIME

Redundant vs Fault Tolerant Network

Current redundant network designs deal mainly with cable redundancy

Active device also need to be doubled

Last but not least

They create twice as many network elements to manage. Regardless of whether network managers use a command-line interface or an SNMP-based system for configuration management, any policy/setting change needs to be made twice, once on each redundant component.

Layer 2 Main requirements:

☐ Ethernet Technologies:

- ☐ Standard Ethernet Technologies - Fully switched network;
- ☐ Train Backbone: IEEE 802.3ab (GbE);
- ☐ Mandatory use of IEEE 802.3ad (LACP)
- ☐ Consist Network: IEEE 802.3u (Fast Eth);
- ☐ Virtual LAN according to IEEE 802.1p
- ☐ QoS according to IEEE 802.1q
- ☐ SNMPv3 protocol
- ☐ High Level of Fault-Tolerance capability;
- ☐ Fault Recovery Time less than 0,5sec;
- ☐ Application recovery time less than 2 sec

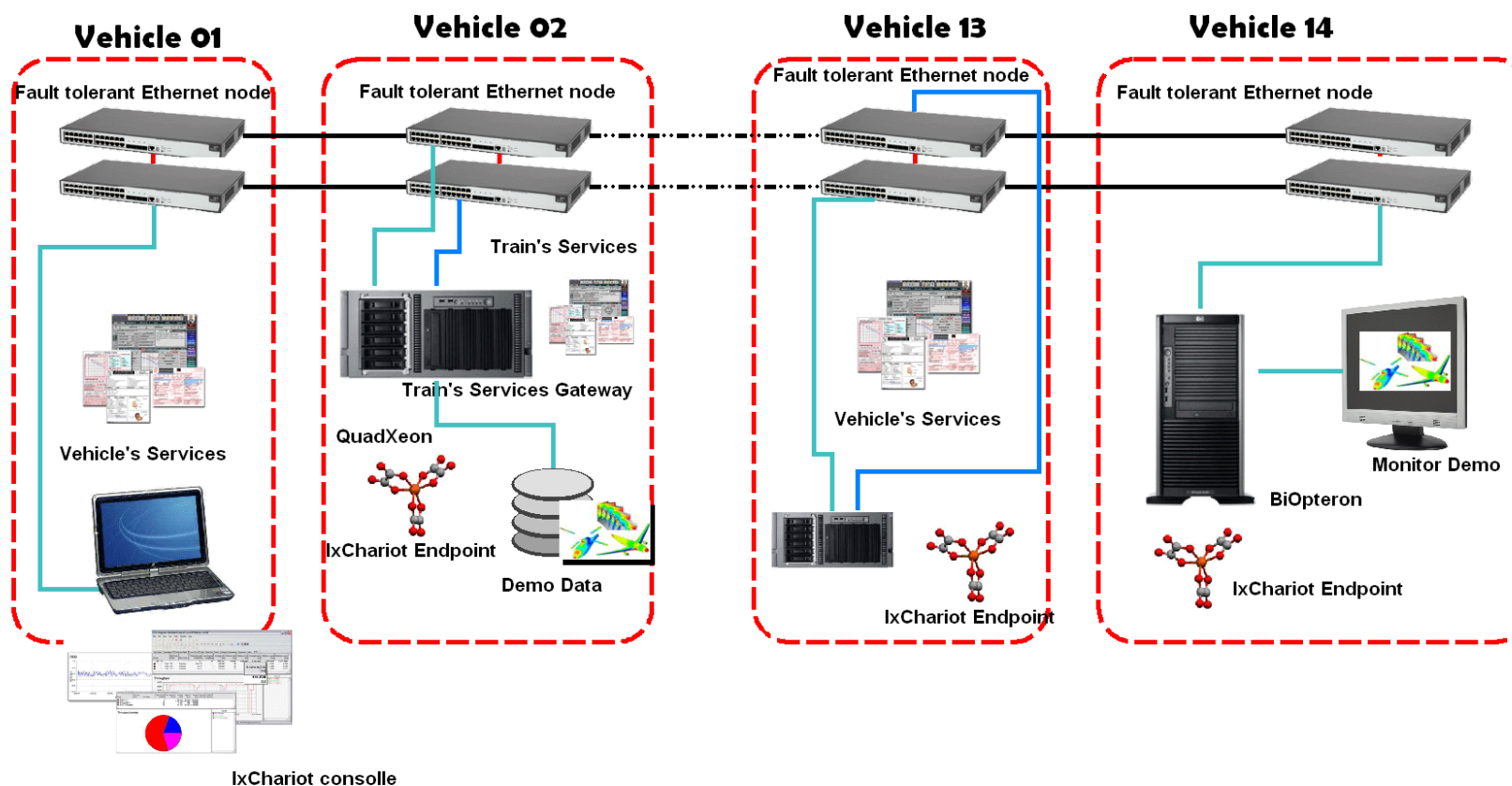
Layer 3 Main requirements:

- ☐ TCP/IP v4
- ☐ Dynamic Addressing using DHCP with host DDNS registration
- ☐ Private IP address classes - Class C (192.168.1.X/24); the use of more adjacent C classes is allowed (e.g. 192.168.0.X/23)
- ☐ Capability of address separation between the onboard Train network and the Operators' Network;
- ☐ Standard Internet approach;
- ☐ Standard Naming Convention and Dynamic Domain Name Solving;
- ☐ Functional addressing (device and IP address independent);
- ☐ Standardisation and interoperability of services

Fault Tolerant Ethernet Network

Laboratory trial test

 **Trenitalia Laboratory Configuration**



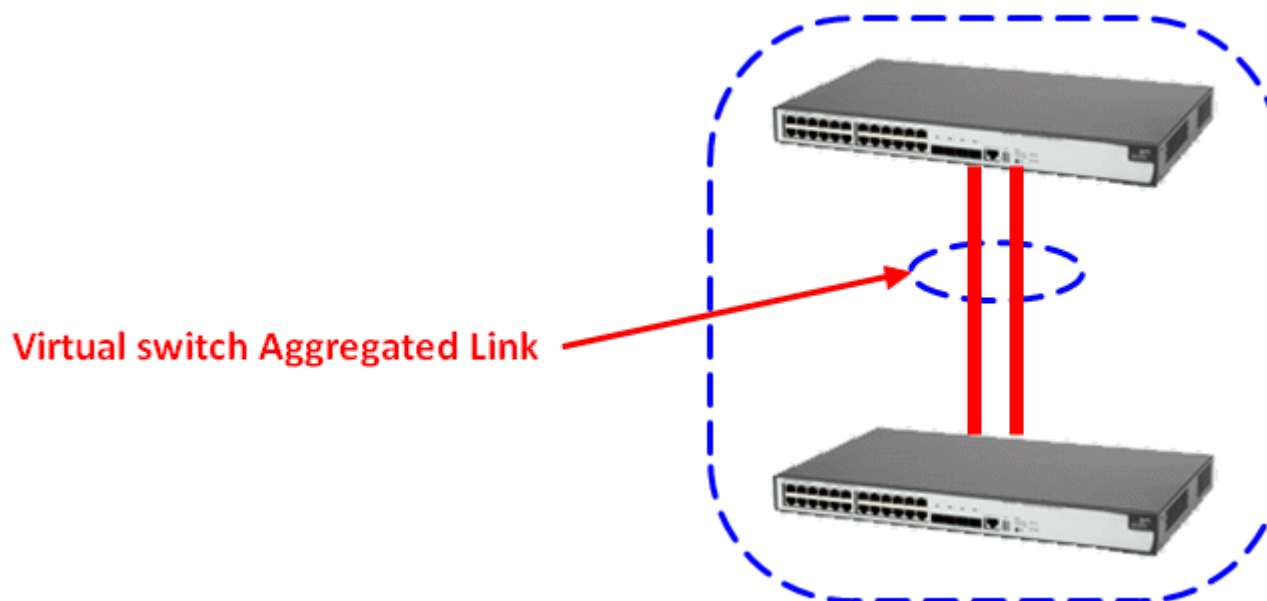
Based on:

- Virtual switch concept
- Virtual Links between devices
- Use of VLAN for Service Traffic segregation
- Fully managed devices
- Fault Tolerant Services
- Dynamic IPv4 addressing
- Internet-like Name Resolution
- Plug 'n' Play Maintenance concept

Virtual switch concept

From the Ethernet point of view it can make two switches look like one while dramatically reducing failover times in the process.

The Virtual Switch delivers a 20fold improvement in failover times and eliminates almost all layer-2 and layer-3 redundancy protocols at the same time.

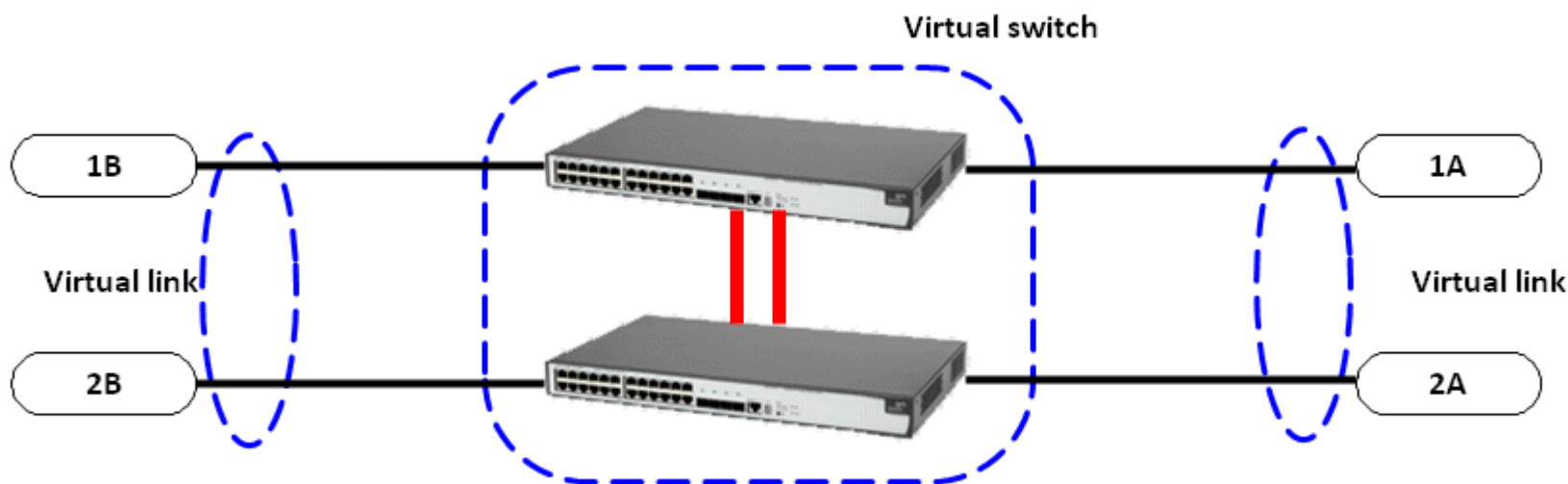


Virtual switch and Virtual Link

The use of Virtual Links (LACP based) across the Distributed Fabric (Distributed Link Aggregation) increases both performance and availability

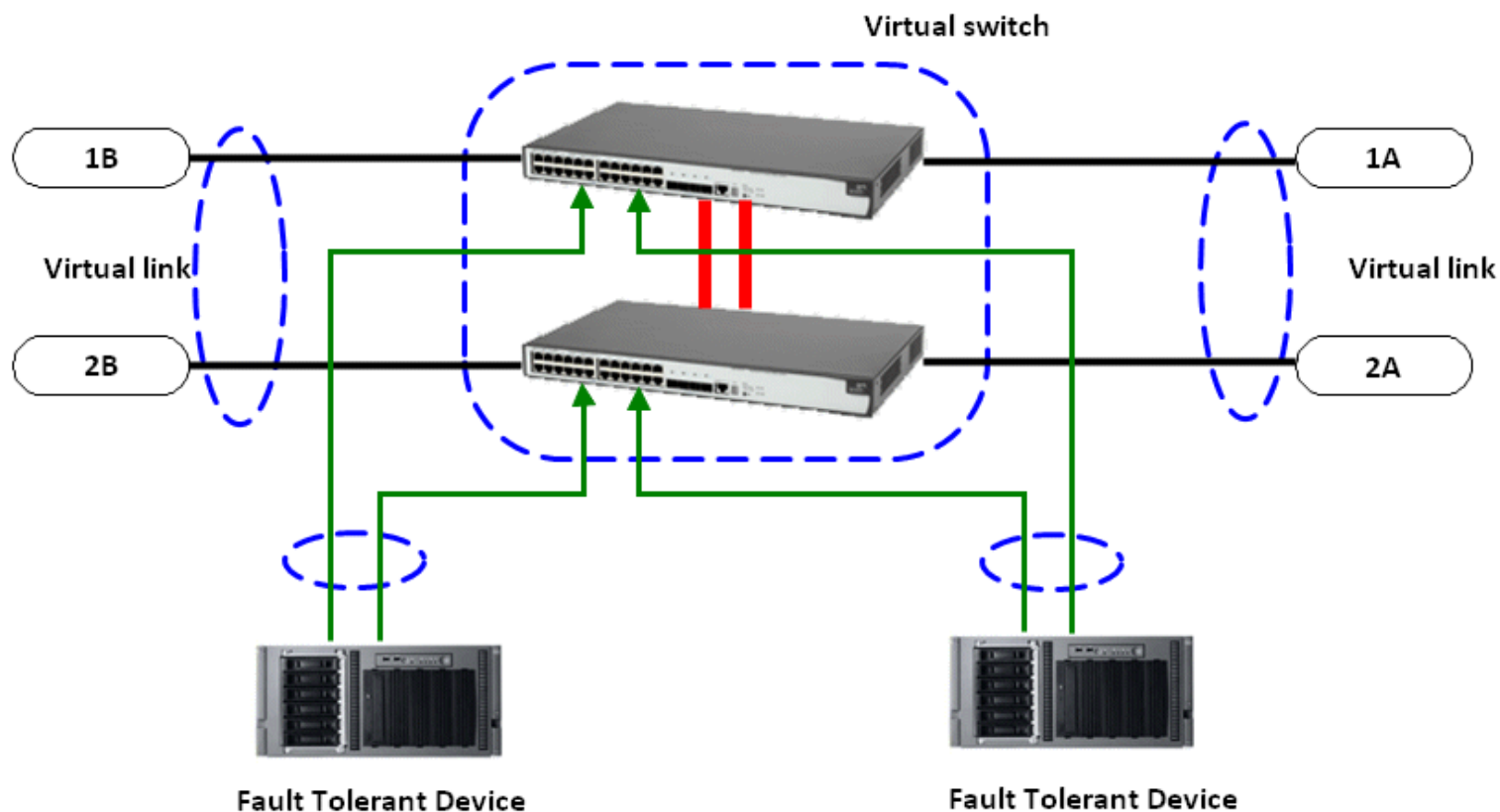
Virtual Link Recovery time less than 10 msec

Application to Application Recovery Time less than 500 msec – suitable for real time video streaming class application



Fault Tolerant Ethernet Network

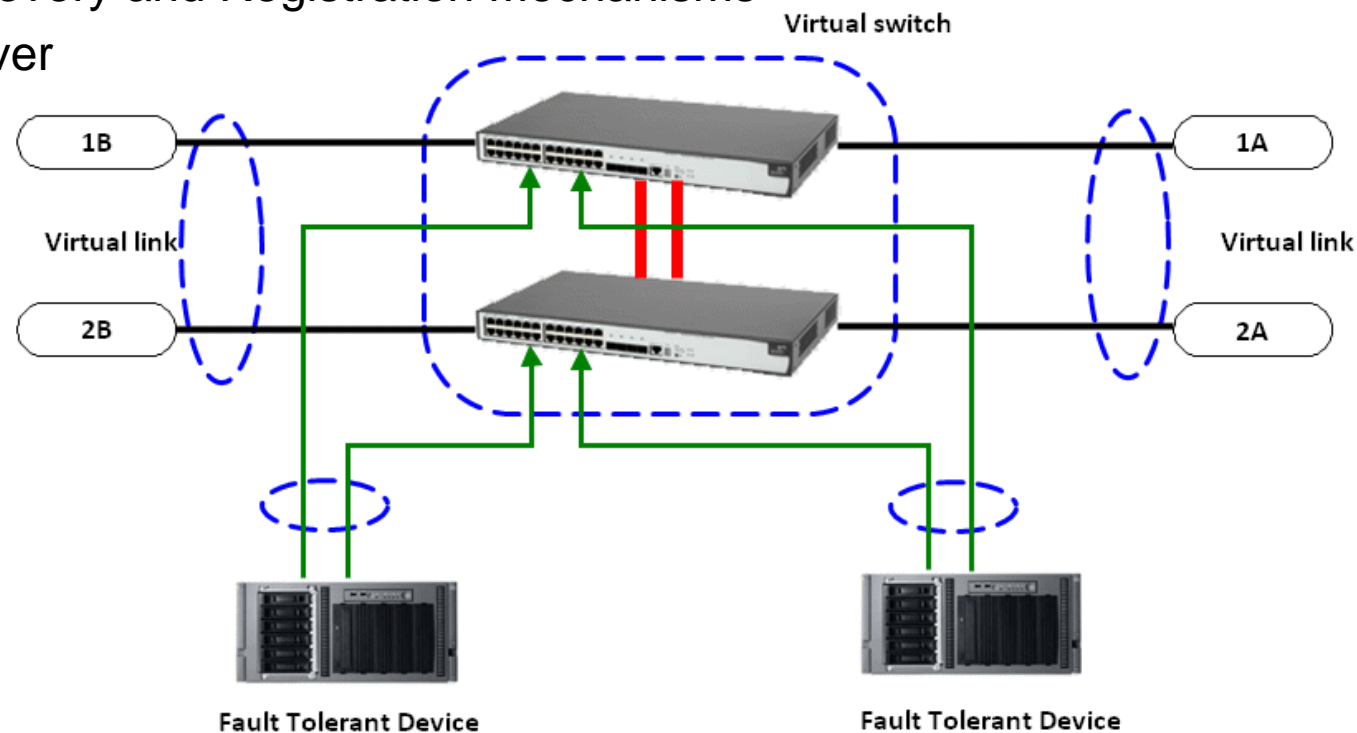
Fault Tolerant Devices



Fault Tolerant Ethernet Network

Fault Tolerant Services:

- VLAN
- NTP server – Synchronization between devices and services
- DHCP Server
- Local D-DNS server
- Services Discovery and Registration Mechanisms
- SNMP v3 server





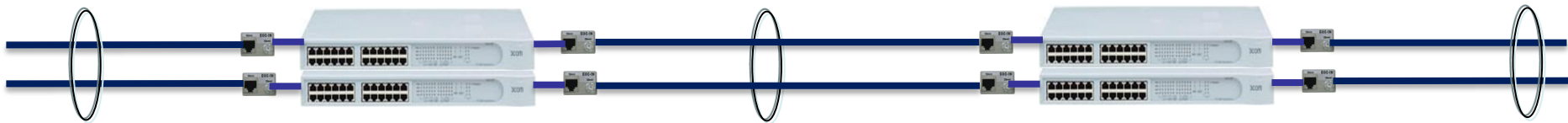
Legacy constrains

- Open train
- Installed RG213 Coax cable backbone

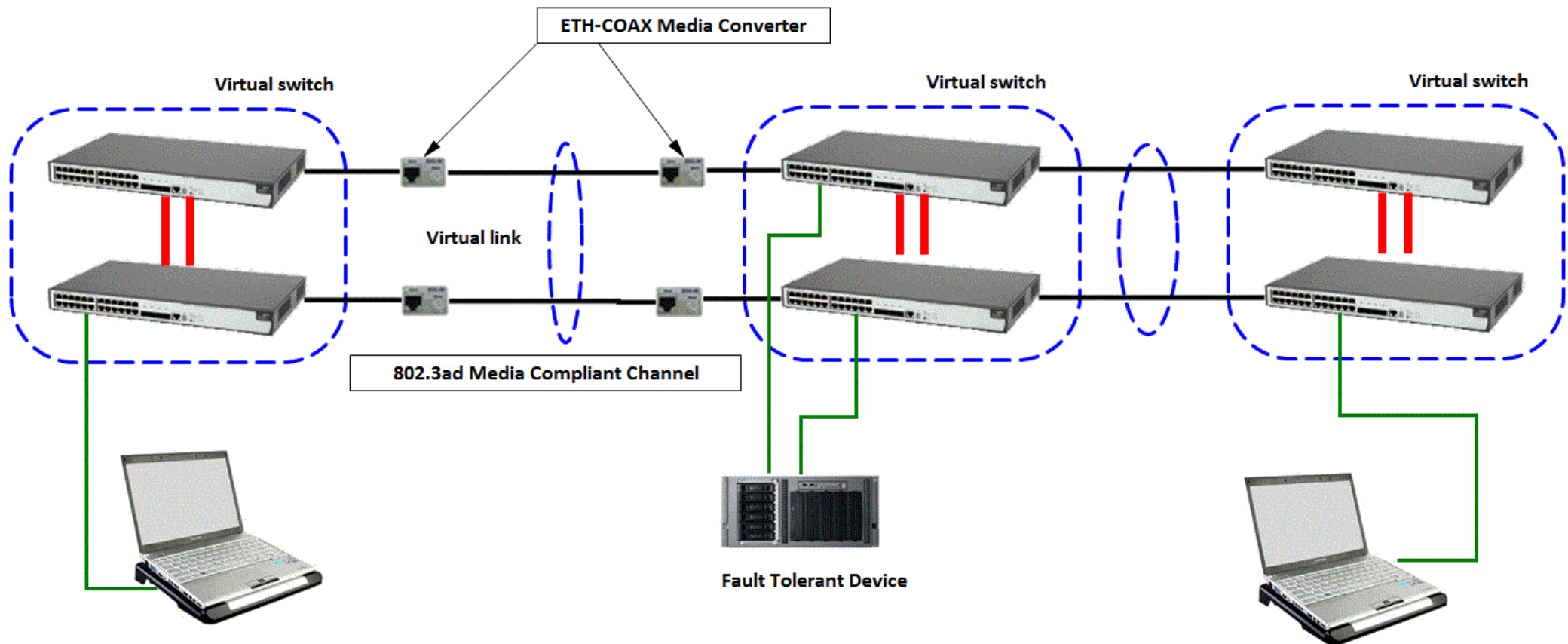
Solution

- Use of the Trenitalia 100Tx-COAX media converter

Fault Tolerant - 100 Mbps Full Duplex

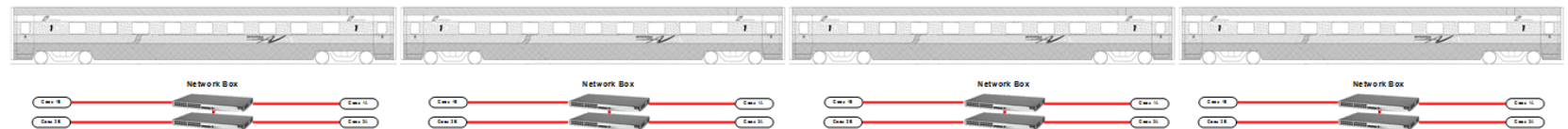
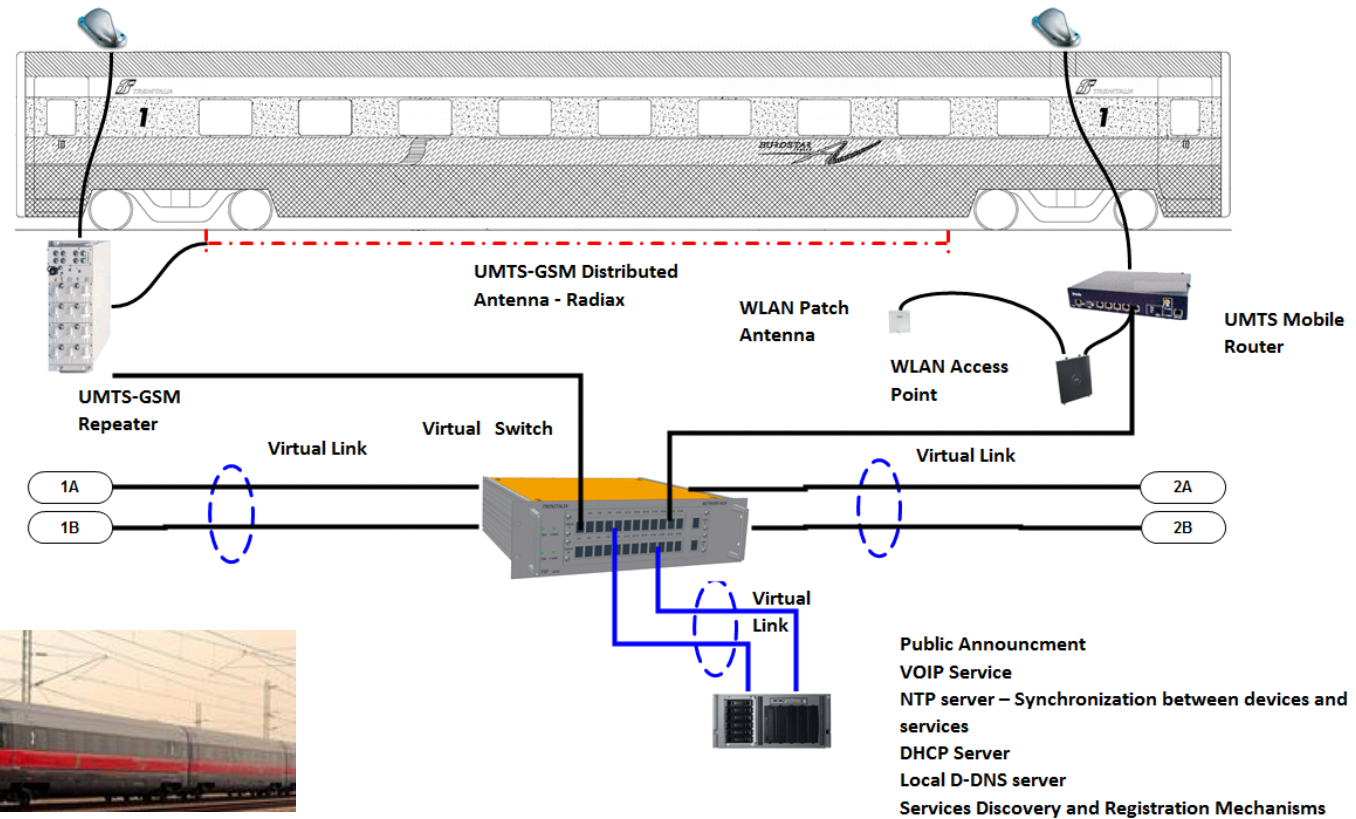


Pilot Test

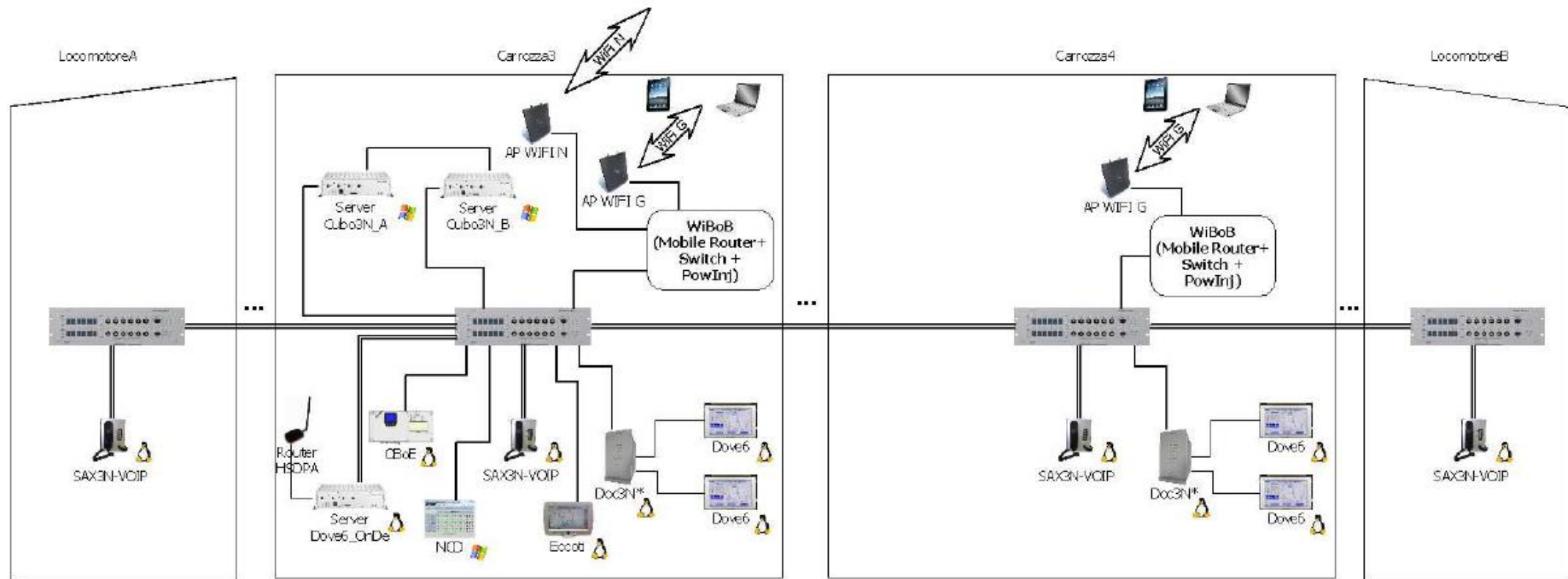


Frecciarossa Fault Tolerant Ethernet Network

Train Test



Exploitation



Frecciarossa Fault Tolerant Ethernet Network

Dynamic Test Report			
Route	Napoli C.Le – Firenze S.M.N.		Network Quality
Consist	ETR500-024		
Date	29/08/11		
Front Coach	Input PER Front	Input PER Rear	Rear Coach
C1	6.366034E-07	8.274195E-07	C2
C2	5.223889E-07	5.788480E-07	C3
C3	3.752256E-07	3.469214E-07	C4
C4	2.284564E-07	1.651468E-07	C5
C5	3.917328E-07	4.292416E-07	C6
C6	8.000087E-07	8.086918E-07	C7
C7	1.061548E-06	1.006410E-06	C8
C8	5.390681E-07	4.453152E-07	C9
C9	1.601207E-06	1.203716E-06	C10
C10	3.693870E-06	1.780264E-06	C11



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IEC TC9 WG46 - Passenger oriented services

Frecciarossa On-board Internet Access

On-board Internet Access

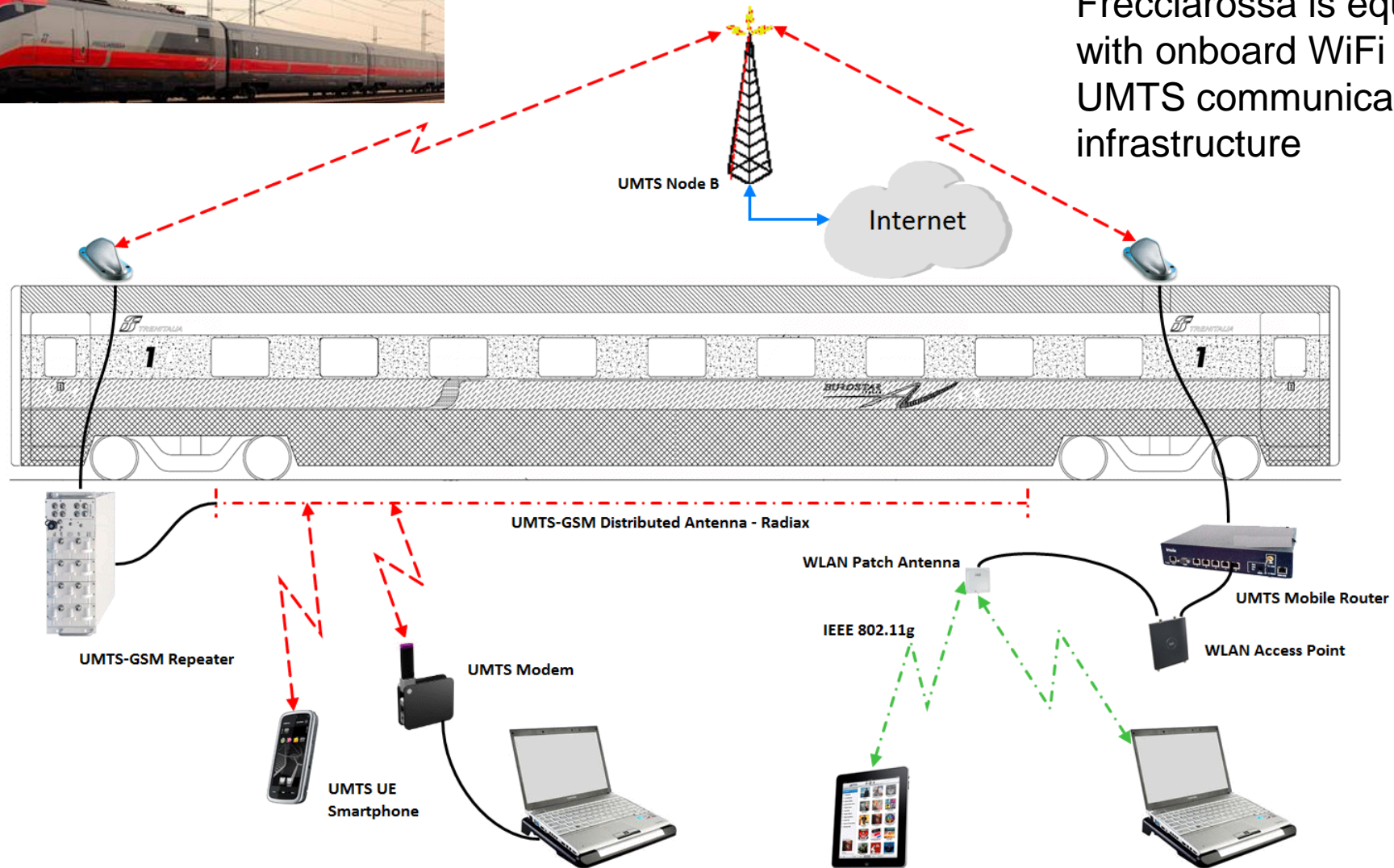


After two years of research and design efforts the FS-Telecom Italia project is on the home stretch.

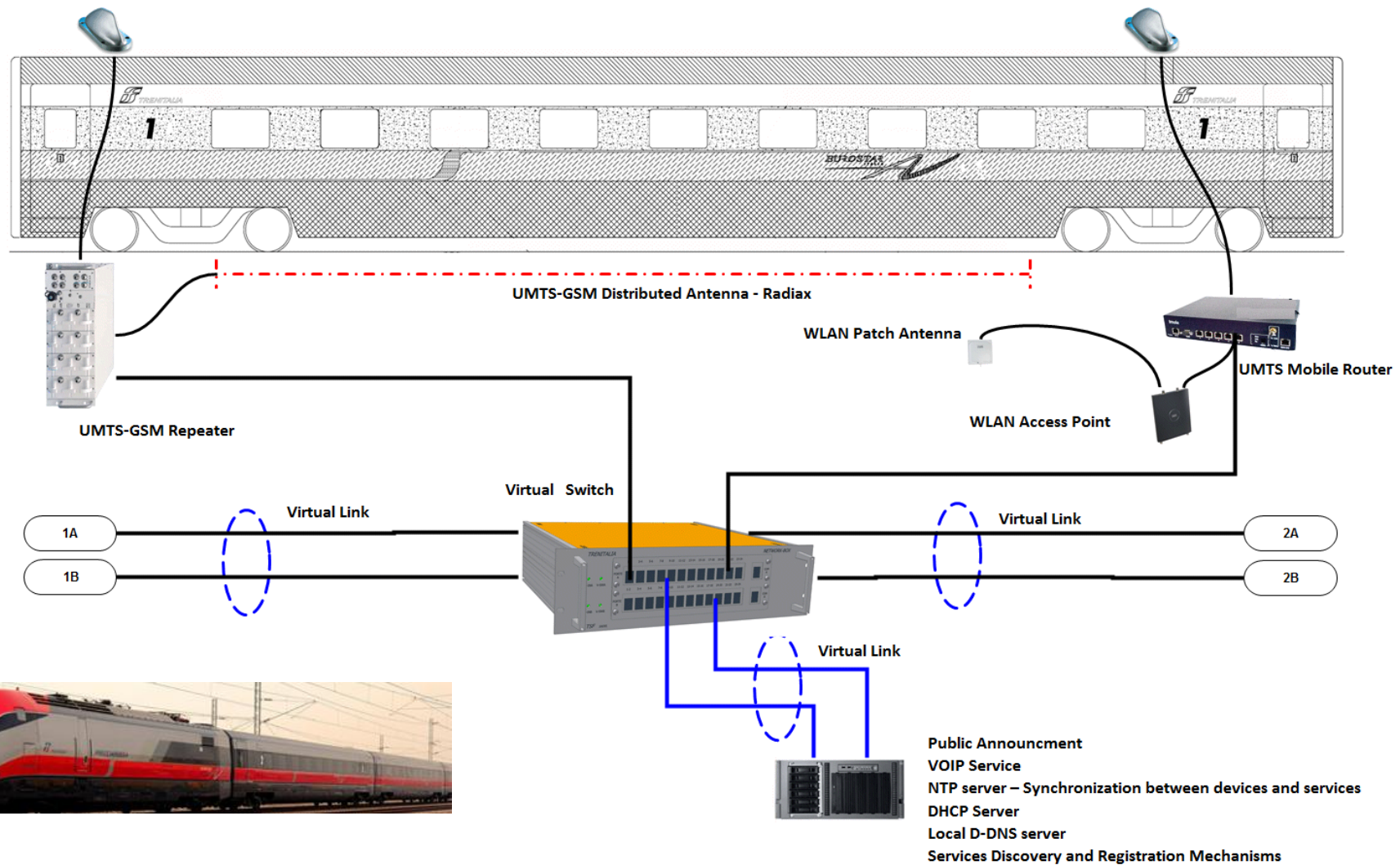
As from December 2010 the Frecciarossa passengers will be able to enjoy internet access with their own devices.

The Frecciarossa turns into a mobile office, with reliable and good quality Radio Mobile Internet connection.

On-board Internet Access



On-board Internet Access



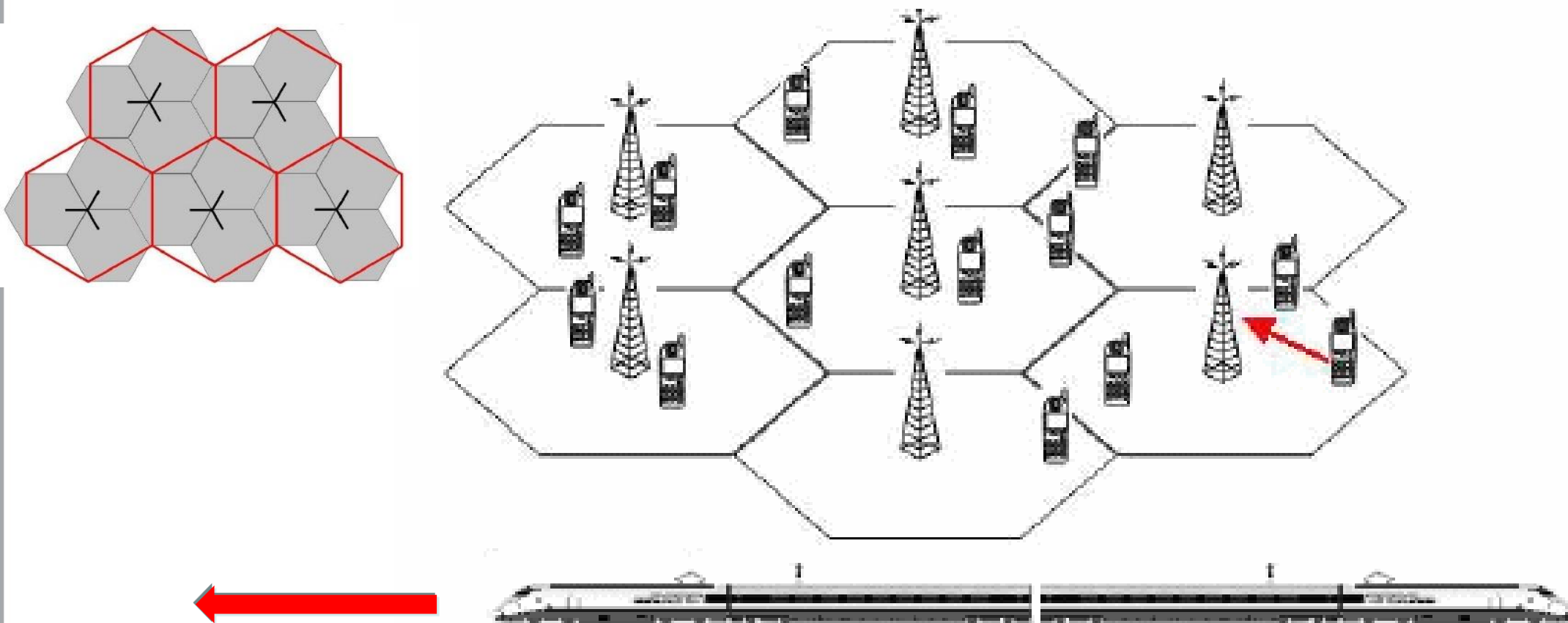
On-board Internet Access



Radio-mobile Cellular Network coverage are assured on the Italian High Speed Rail Networks

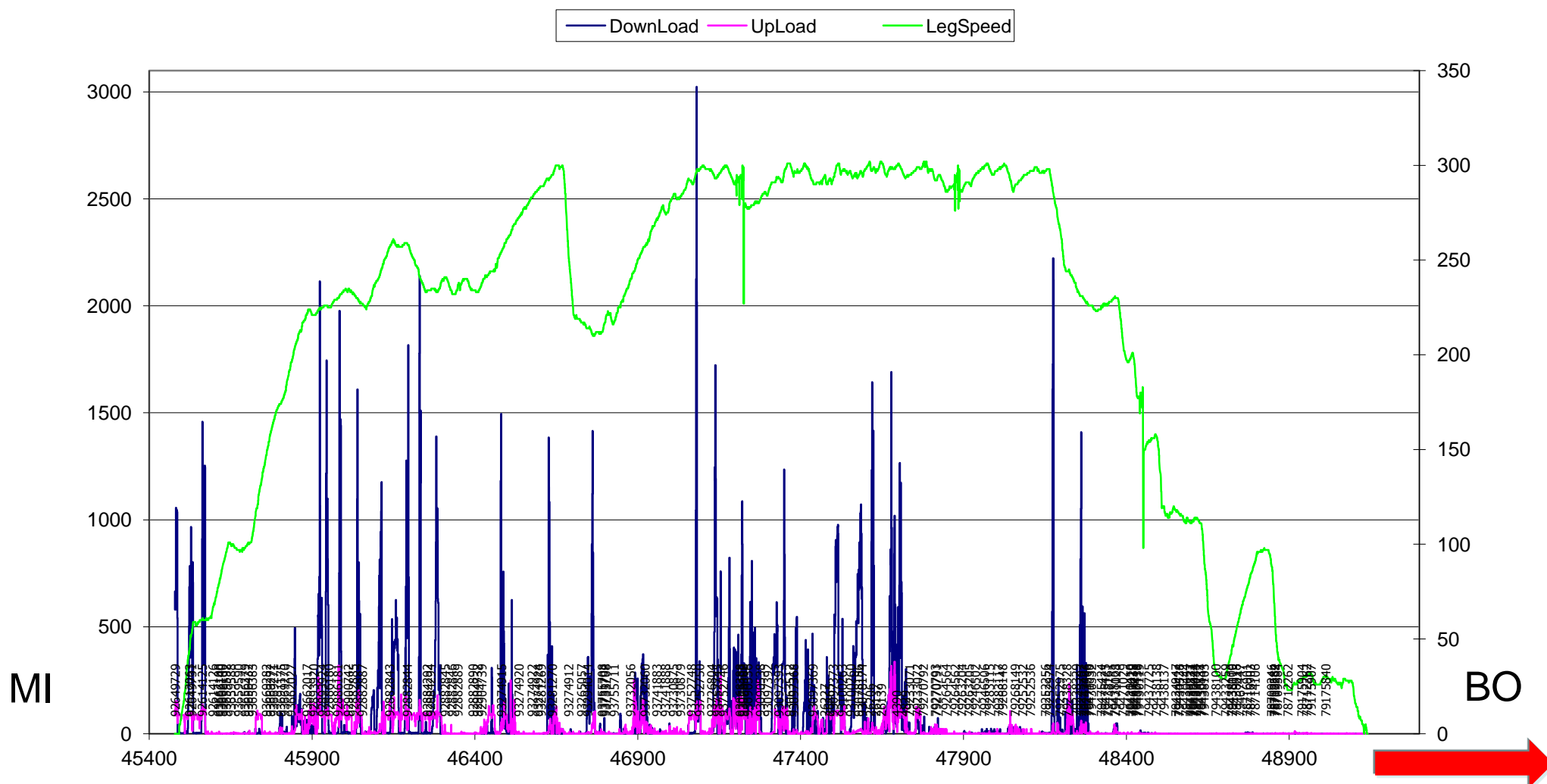
On-board Internet Access

Radio-mobile Cellular Network geometry



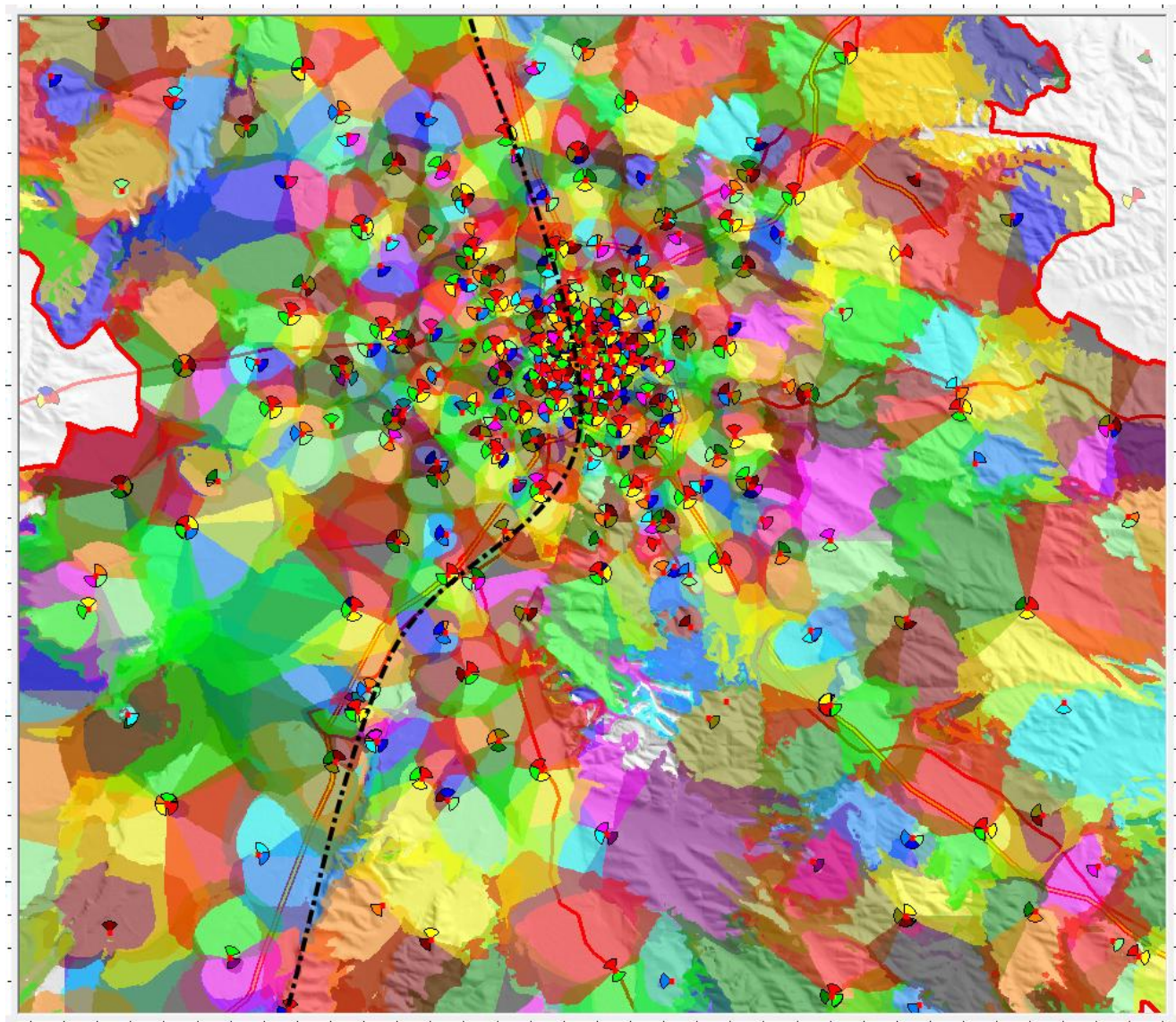
On-board Internet Access

Radio-mobile Cellular Network geometry



On-board Internet Access

The Radio-mobile Cellular Network was specially tuned to support high speed UMTS users.

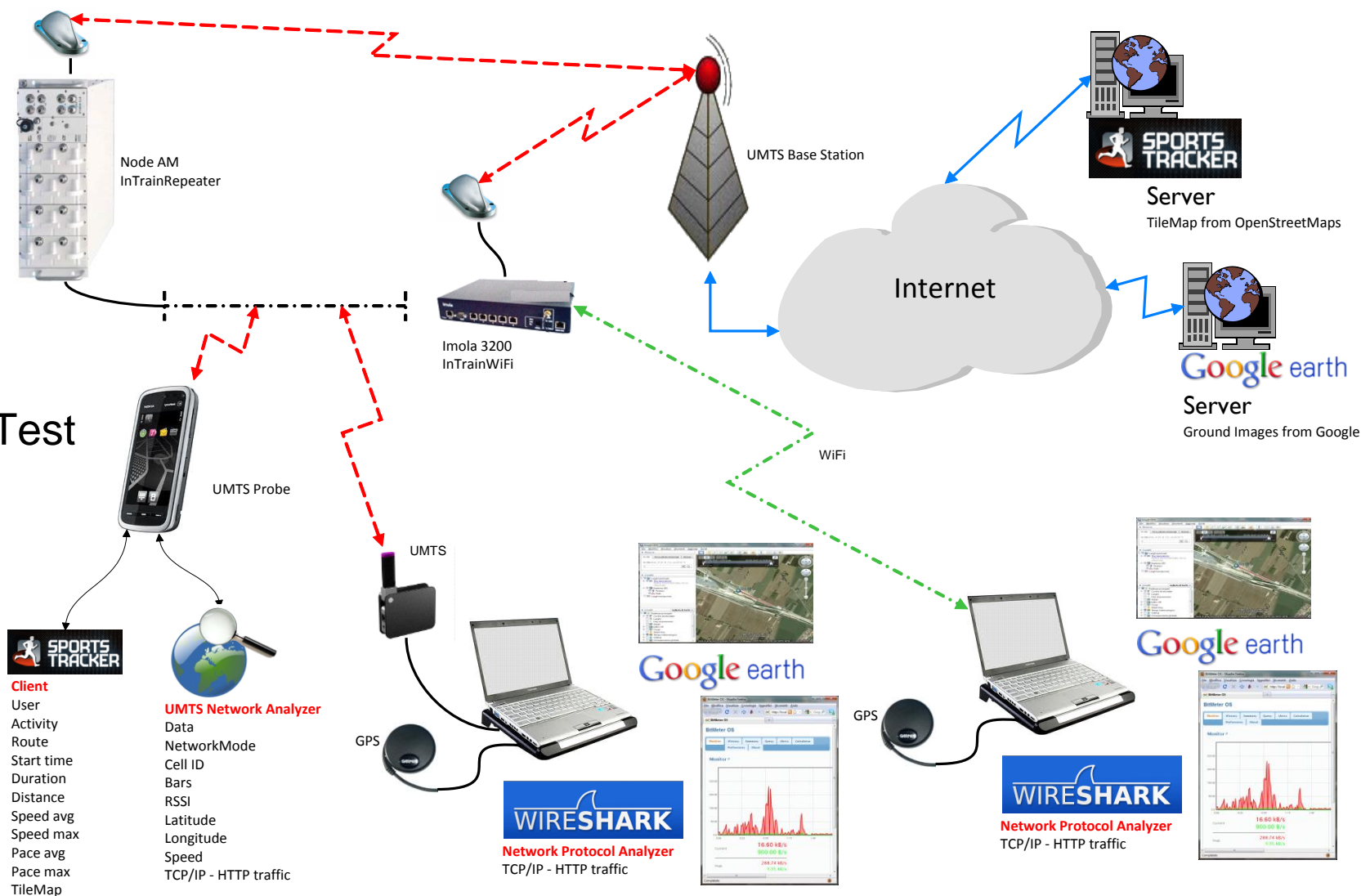


On-board Internet Access

Mobile Network Quality Analysis Test Suite

The UMTS probe is based on SymPA v1.0

University of Málaga, Spain



Questions ?



**Thank you very much
for your kind attention**

For more information

an.gatti@trenitalia.it

a.ghelardini@trenitalia.it