Italian approach for a “Blended and Phased Network”

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- Italferr's key data
- Italian High Speed and Conventional rails: a blended network
  - General aspects
  - Station modelling and urban interchanges
  - Systems and Rolling Stock
- Some suggestions from our experience

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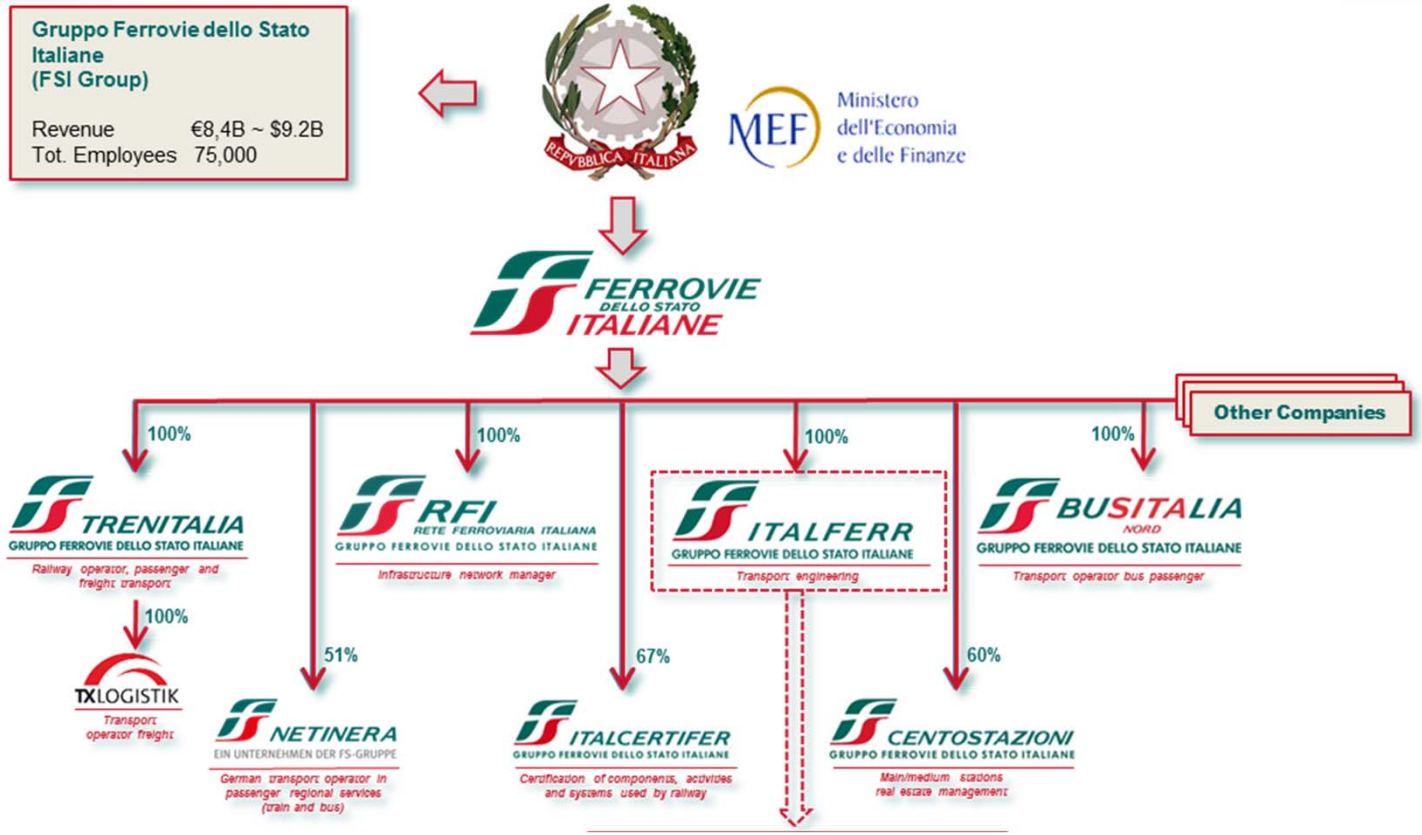
ITALFERR and the FS GROUP



- Created in 1984 to give birth to the High Speed Rail in Italy;
- The engineering company of the FS Group, the Italian State Railways;
- 1,200 employees worldwide (FS Group has a total of 75,000 employees);
- 2016 revenues of approximately $170M (FS Group 2016 revenues are $9B)

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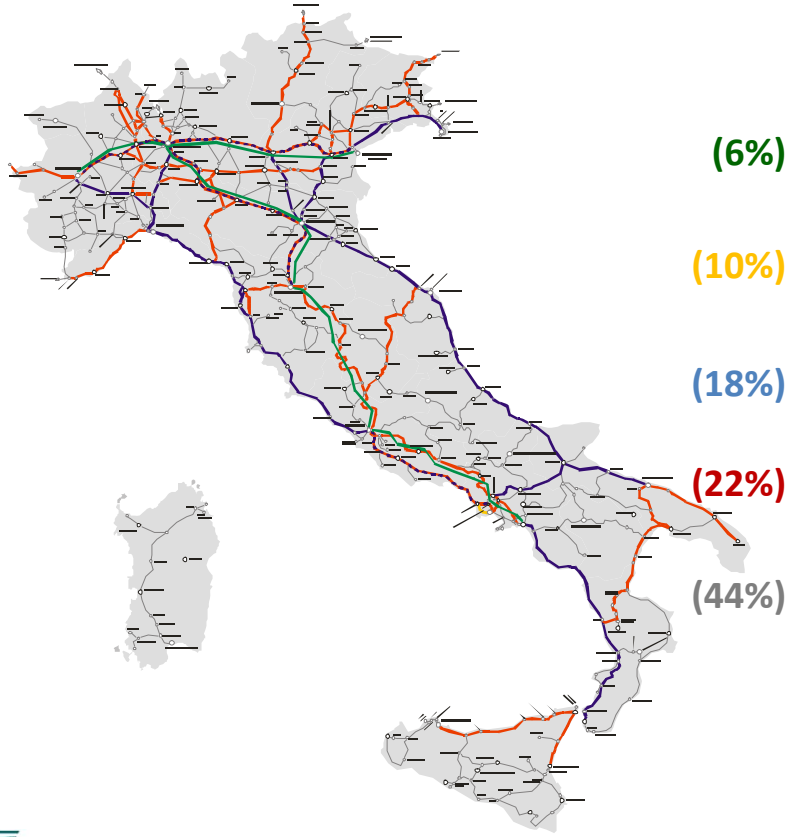
Italian Blended Rail Network: Main Projects Managed by Italferr

FS Group's main projects developed and managed by Italferr (design, management, works supervision, testing and commissioning): **Italian Blended System**

- ❑ new High Speed/High Capacity Italian Railway Network
- ❑ main upgrade of the existing Conventional Railway Network, lines and junctions.



High Speed/High Capacity Railway Network

(6%) **620 miles** Works on about 750 miles

Urban, metropolitan and regional lines

(10%) **1,000 miles**

Connecting lines to the HS/HC Rail Network

(18%) **1,800 miles**

Main lines and interchanges

(22%) **2,300 miles**

Secundary lines

(44%) **4,650 miles**

TOTAL (2013)

10,500 MILES

- New high speed lines are currently used **at 186 mph**.
- **Conventional lines** are used for **passenger and freight mixed traffic**. Typically, the max speed for passenger trains is 88 - 100 mph and for freight trains is 56 – 75 mph (average weight 800 – 1000 tons), with a capacity of double tracks lines over 180 trains/day

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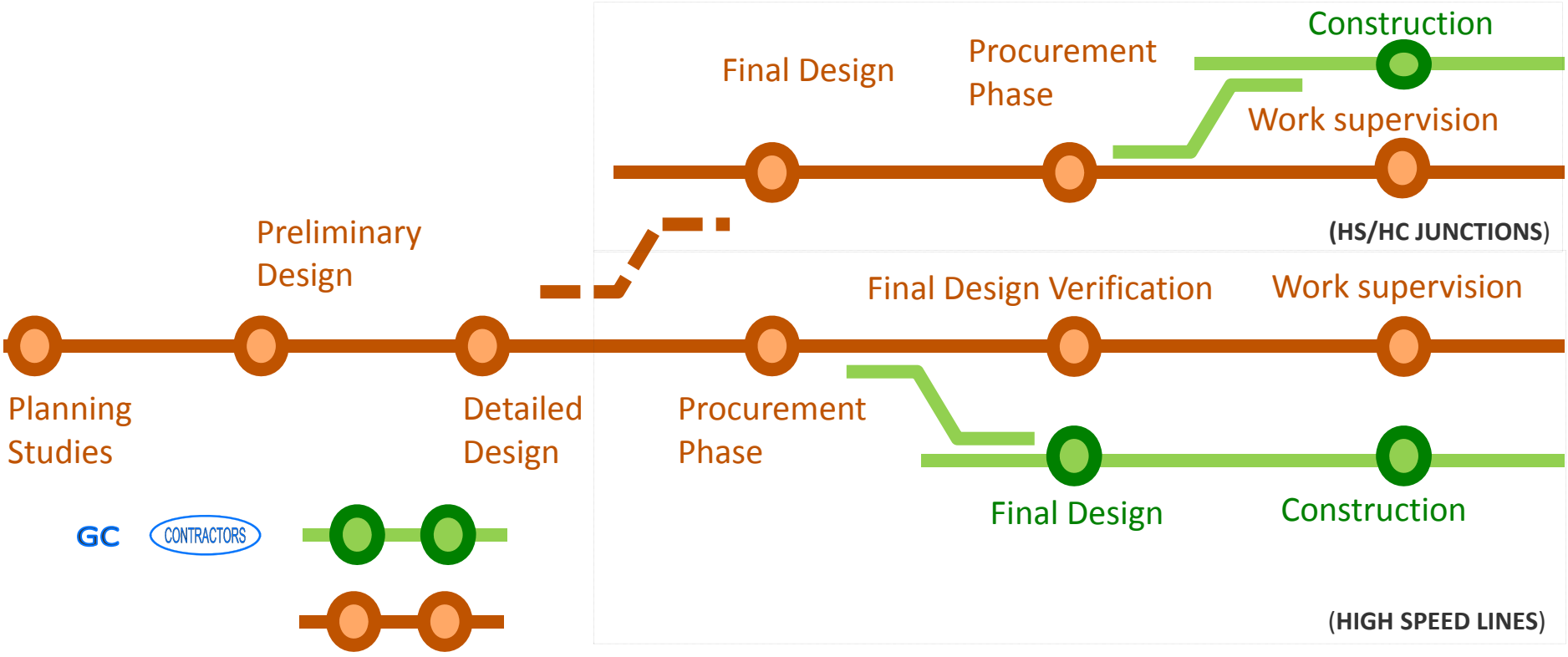
Italferr's Comprehensive Process Management

On behalf of FS Italiane Group, Italferr has developed, supervised and managed the entire High Speed/High Capacity Railway Network Design and Construction Cycles, from Feasibility Studies to Commissioning and Operation, including Investments' and Stakeholders' Management, Construction Supervision of the Work Packages performed by the several Contractors involved



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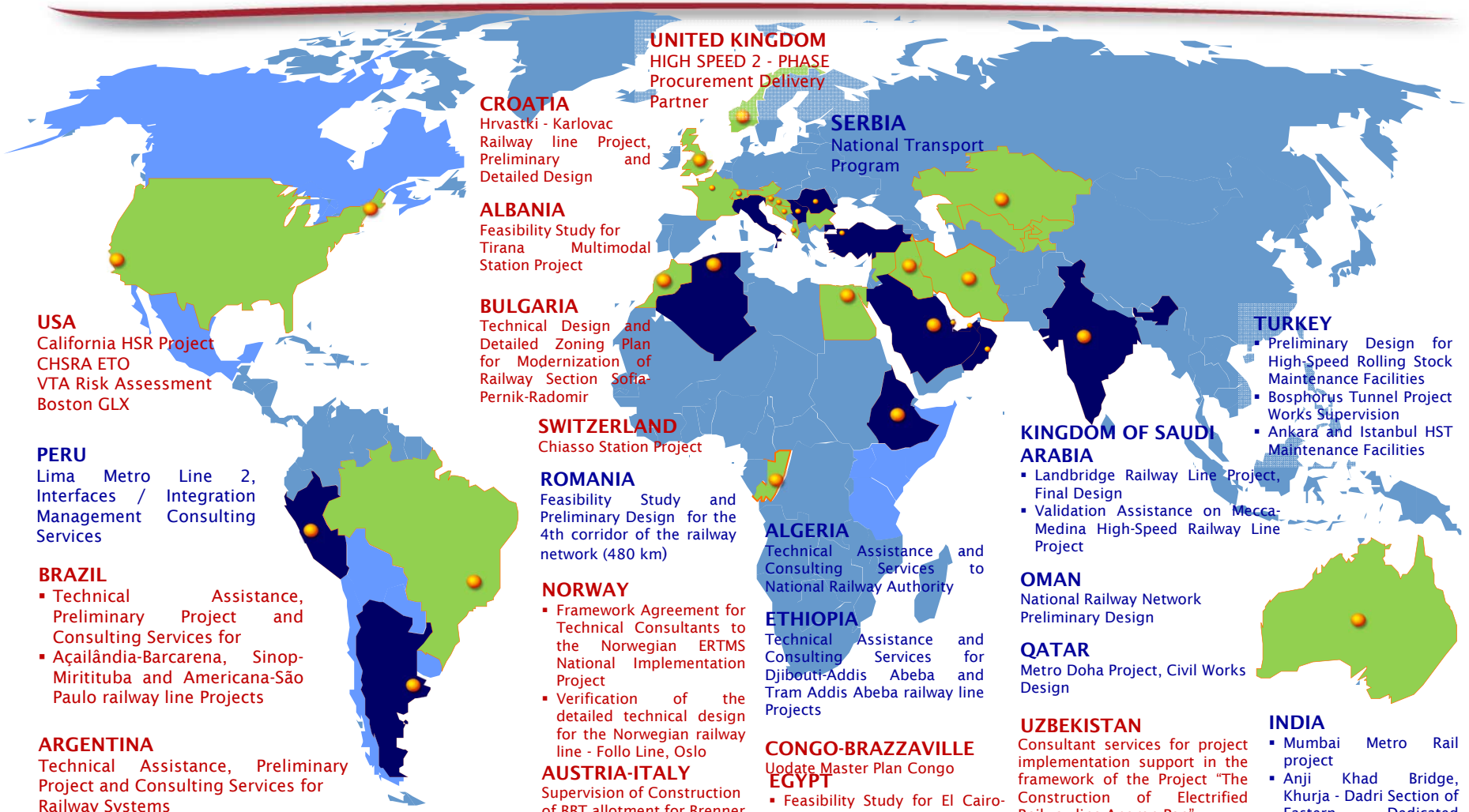
This is why we are one of the few companies that can take care of the entire process of implementing an investment project!

Italferr's Main Projects, Worldwide



USA
California HSR Project
CHSRA ETO
VTA Risk Assessment
Boston GLX

PERU
Lima Metro Line 2, Interfaces / Integration Management Consulting Services

BRAZIL
- Technical Assistance, Preliminary Project and Consulting Services for
- Açailândia-Barcarena, Sinop-Mirituituba and Americana-São Paulo railway line Projects

ARGENTINA
Technical Assistance, Preliminary Project and Consulting Services for Railway Systems
Sarmiento Passenger Line
Buenos Aires

CROATIA
Hrvastki - Karlovac Railway line Project, Preliminary and Detailed Design

ALBANIA
Feasibility Study for Tirana Multimodal Station Project

BULGARIA
Technical Design and Detailed Zoning Plan for Modernization of Railway Section Sofia-Pernik-Radomir

SWITZERLAND
Chiasso Station Project

ROMANIA
Feasibility Study and Preliminary Design for the 4th corridor of the railway network (480 km)

NORWAY
- Framework Agreement for Technical Consultants to the Norwegian ERTMS National Implementation Project
- Verification of the detailed technical design for the Norwegian railway line - Follo Line, Oslo

AUSTRIA-ITALY
Supervision of Construction of BBT allotment for Brenner Base Tunnel

BOSNIA HERZEGOVINA
Consulting Services,Technical Assistance

FRANCE
Turin-Lyon High-Speed Rail Line Project, Rolling Stock Consulting Services

UNITED KINGDOM
HIGH SPEED 2 - PHASE Procurement Delivery Partner

SERBIA
National Transport Program

ALGERIA
Technical Assistance and Consulting Services to National Railway Authority

ETHIOPIA
Technical Assistance and Consulting Services for Djibouti-Addis Abeba and Tram Addis Abeba railway line Projects

CONGO-BRAZZAVILLE
Uodate Master Plan Congo

EGYPT
- Feasibility Study for El Cairo-Alexandria High-Speed Railway Line Project
- Feasibility Study for signaling systems El Qantara - Zagazig - Abu-Kebir Railway Line Project

MOROCCO
Consulting services (signaling verification Technical Assistance) on Tanger-Casablanca Railway Line Project

TURKEY
- Preliminary Design for High-Speed Rolling Stock Maintenance Facilities
- Bosphorus Tunnel Project Works Supervision
- Ankara and Istanbul HST Maintenance Facilities

KINGDOM OF SAUDI ARABIA
- Landbridge Railway Line Project, Final Design
- Validation Assistance on Mecca-Medina High-Speed Railway Line Project

OMAN
National Railway Network Preliminary Design

QATAR
Metro Doha Project, Civil Works Design

UZBEKISTAN
Consultant services for project implementation support in the framework of the Project "The Construction of Electrified Railway line Angren-Pap".

IRAN
Tehran-Qom-Esfahan High Speed Railway Line

SYRIA
Railway Network Upgrading Project

IRAQ
Mussayeb-Samawa Railway Line Project

INDIA
- Mumbai Metro Rail project
- Anji Khad Bridge, Khurja - Dadri Section of Eastern Dedicated Freight Corridor Projects

AUSTRALIA
Strategic Study on Brisbane-Melbourne High-Speed Railway Line Project

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Countries with permanent establishments and on going projects

Countries with projects realized or ongoing

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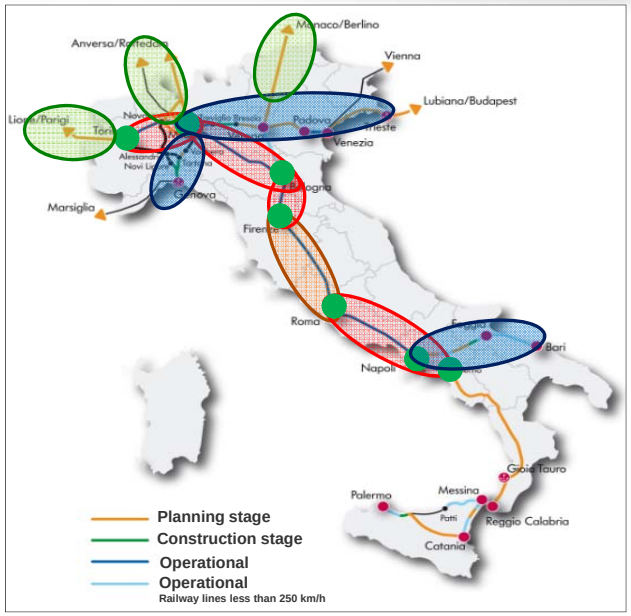
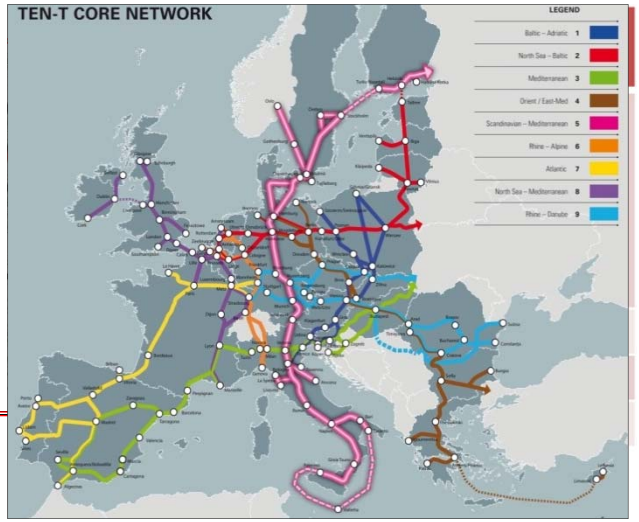
Italian High Speed and Conventional Rail: a Blended System

General Aspects

Italian Blended System:
HS/HC Network extension and development

- To date the Italian network extends over 600 miles along the most important national railway backbone Turin-Milan-Rome-Naples-Salerno:
  - 159 miles of "Direttissima" Florence-Rome (in operation since 1977 and currently being updated)
  - 413 miles of new high speed lines with 90 miles of new tunnels and 322 miles of new viaducts, bridges, trenches and embankments (in operation since 2005 and completed in 2009), developed into 4 main civil contract packages
  - 48 miles of new interconnecting lines between the HS and the conventional network
  - 7 new stations
- The current development of the Network is focussing two transversal axes Genoa-Milan and Milan-Trieste, the link Naples-Bari towards Adriatic coast and the links towards south of Italy and the rest of Europe.





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Italian Blended System:
HS/HC Network extension and development

Novara-Milan HS/HC line

25 miles

1. 2 miles tunnels

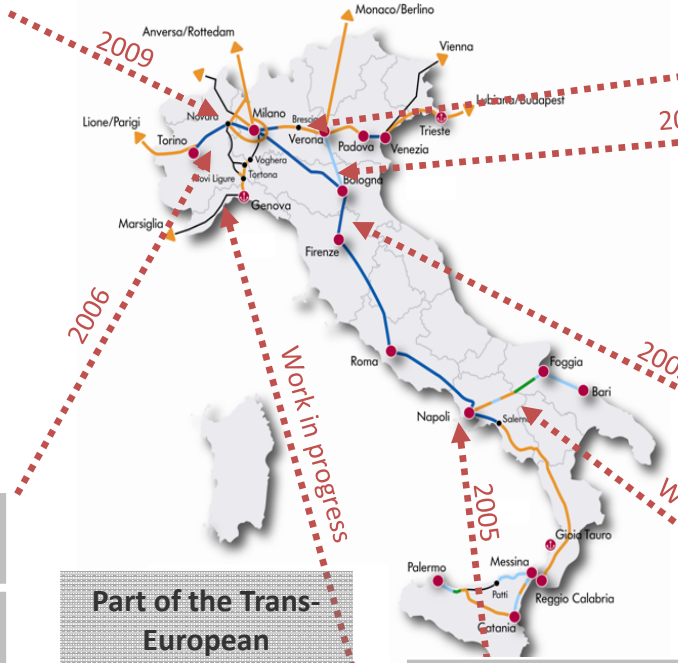
5 miles viaducts

Turin-Novara HS/HC Line

54 miles

2 miles tunnels

9.4 miles viaducts



Part of the Trans-European Transport Network TEN-T

Terzo Valico dei Giovi HS/HC Line

33 miles

24.2 miles tunnels

Rome-Naples HS/HC Line

128 miles

23.1 miles tunnels

24 miles viaducts

Milan-Bologna HS/HC Line

114 miles

3 miles tunnels

20 miles viaducts

Naples-Bari HS/HC Line

93 miles

41.2 miles tunnels

9.23 miles viaducts

Treviglio-Brescia HS/HC Line

36 miles

0.5 miles tunnels

2.5 miles viaducts

Bologna-Florence HS/HC Line

48.5 miles

45 miles tunnels

0.5 miles viaducts

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Italian Blended System:
Some Key Features of Italy's HSR Network

- ✓ Type of service: mixed (**passenger and freight**)
- ✓ Maximum grade: 1.2 -1.5%
- ✓ Maximum axle load : 25 tons
- ✓ Min. horizontal radius: 18,000 ft.
- ✓ Max. Super elevation: 4.7 inches
- ✓ Min. vertical radius: 65,400 ft.
- ✓ **Max speed of passenger trains: 187 mph (testing phase to run at 225 mph completed)**
- ✓ Gauge: 56.5 in
- ✓ Track spacing: 15 to 16.5 ft.
- ✓ Track bed width: 45 ft.
- ✓ Tunnel section: 98 sq. yards (natural tunnels)
  119 sq. yards (artificial tunnels)
- ✓ Power supply: 2x25 kV AC 50 Hz
- ✓ Signaling system: **ERTMS/ETCS Level 2**
- ✓ Communication system GSM-R (Global System for Mobile Communication – Railway)

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Italian Blended System:
Interchanges between HS lines and the existing network

The Italian HS/HC system is widely interconnected with the existing conventional railway network There are numerous interchanges between the HS lines and the existing network (Turin – Milan 4 junctions; Milan – Bologna 8 junctions; Bologna – Florence 1 junction; Florence – Rome 9 junctions; Rome – Napoli 3 junctions).

These ensure the functional interchange between the new line and the existing network, guarantee that fast passenger trains can stop and transition to the old line.

HS Rome-Naples line - interchange with the conventional line near Cassino

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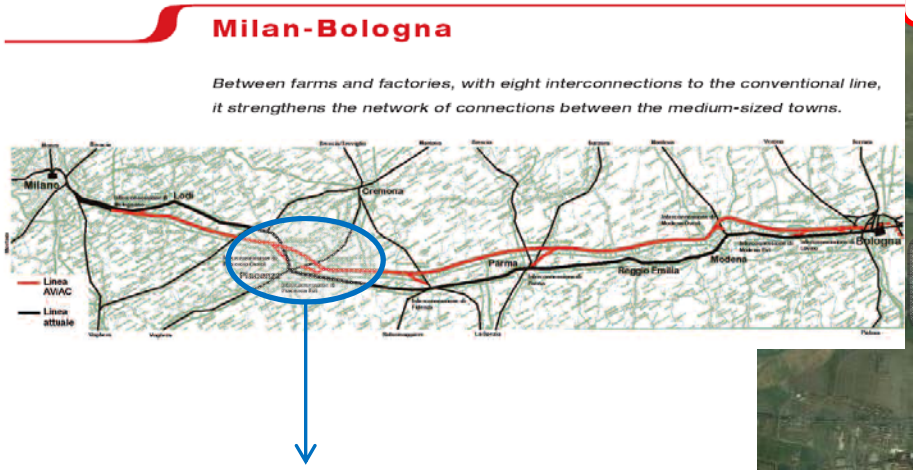
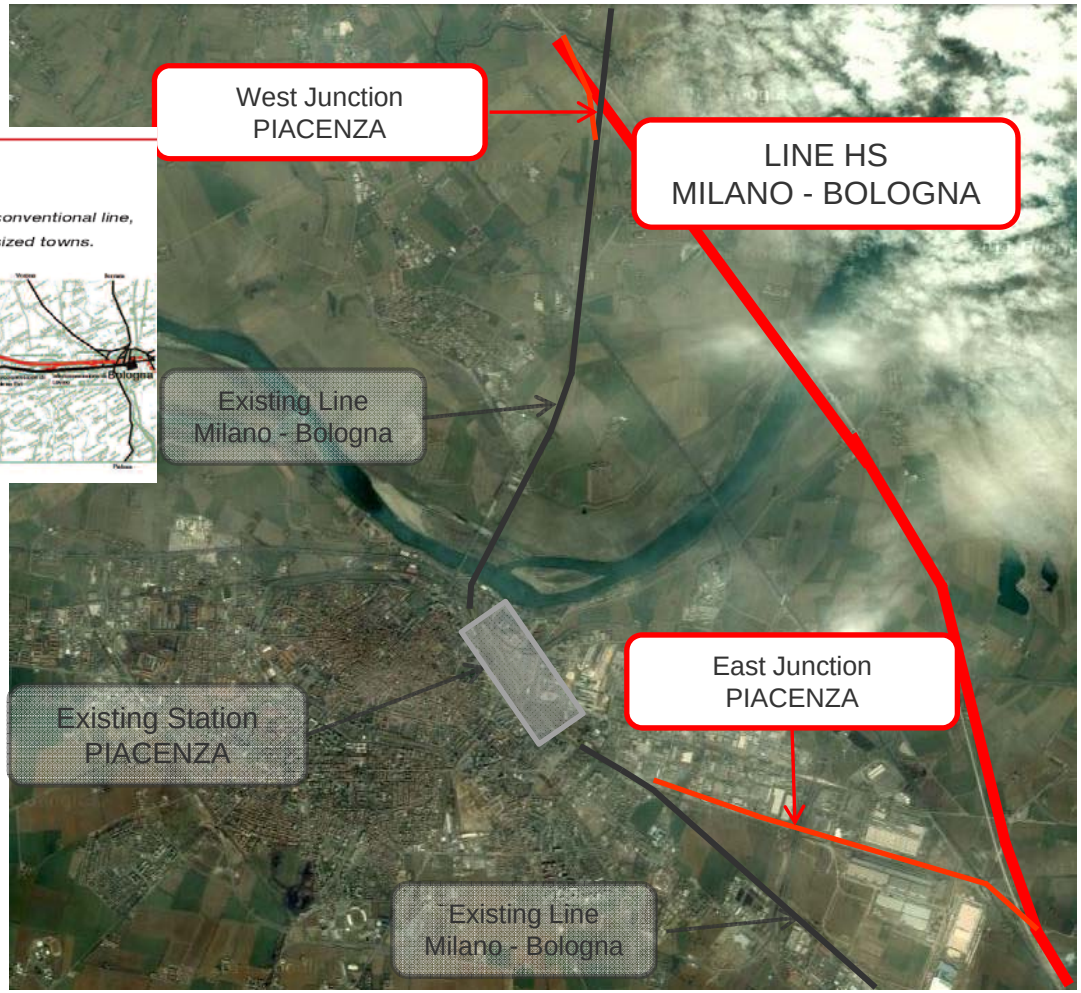
Italian Blended System:
Interchanges between HS lines and the existing network

Case of PIACENZA



Existing Station of Piacenza with east and west interchanges with the HS line



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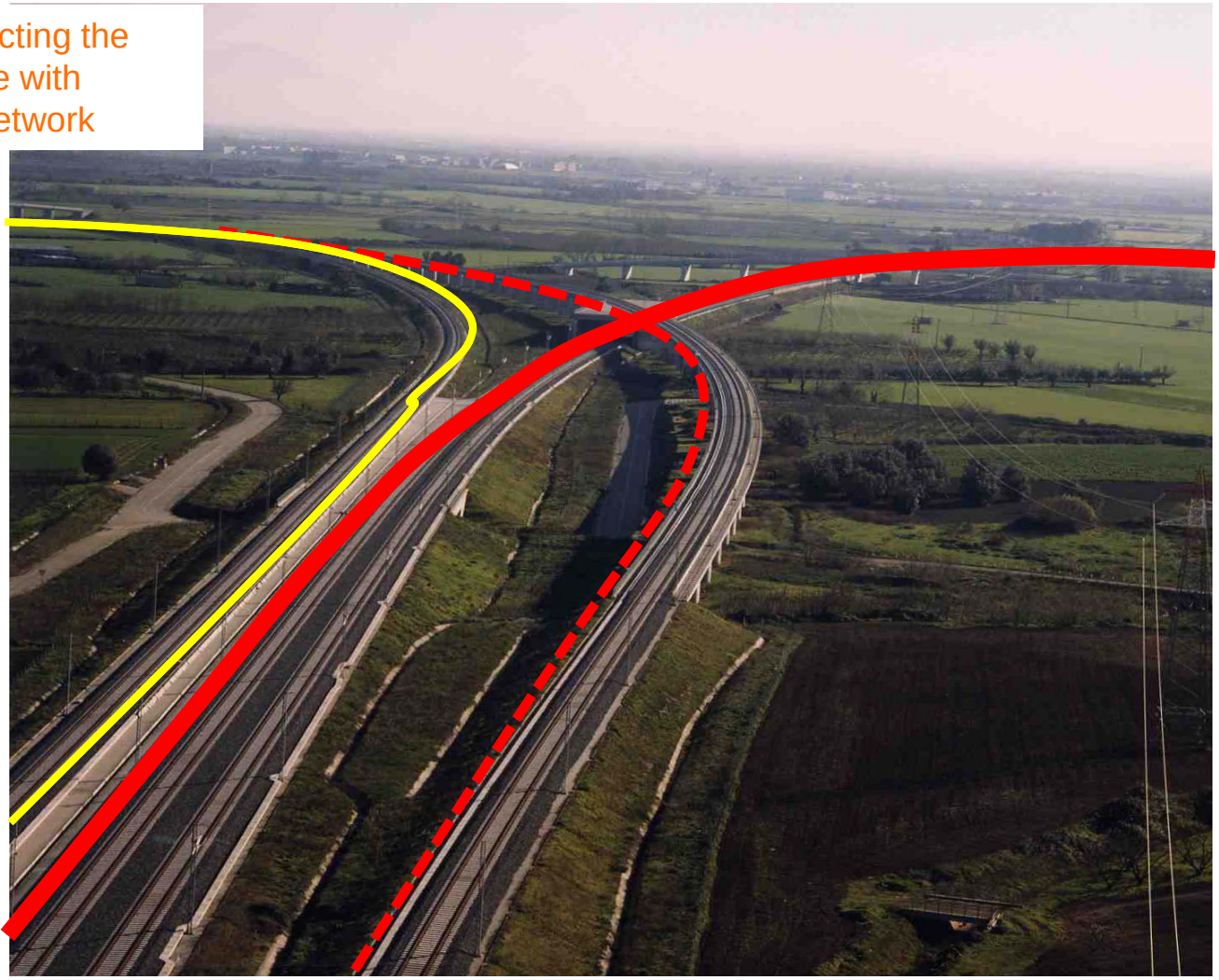
Italian Blended System:
Interchanges between HS lines and the existing network

Caserta Junction, connecting the new HS/HS Railway Line with Conventional Railway Network



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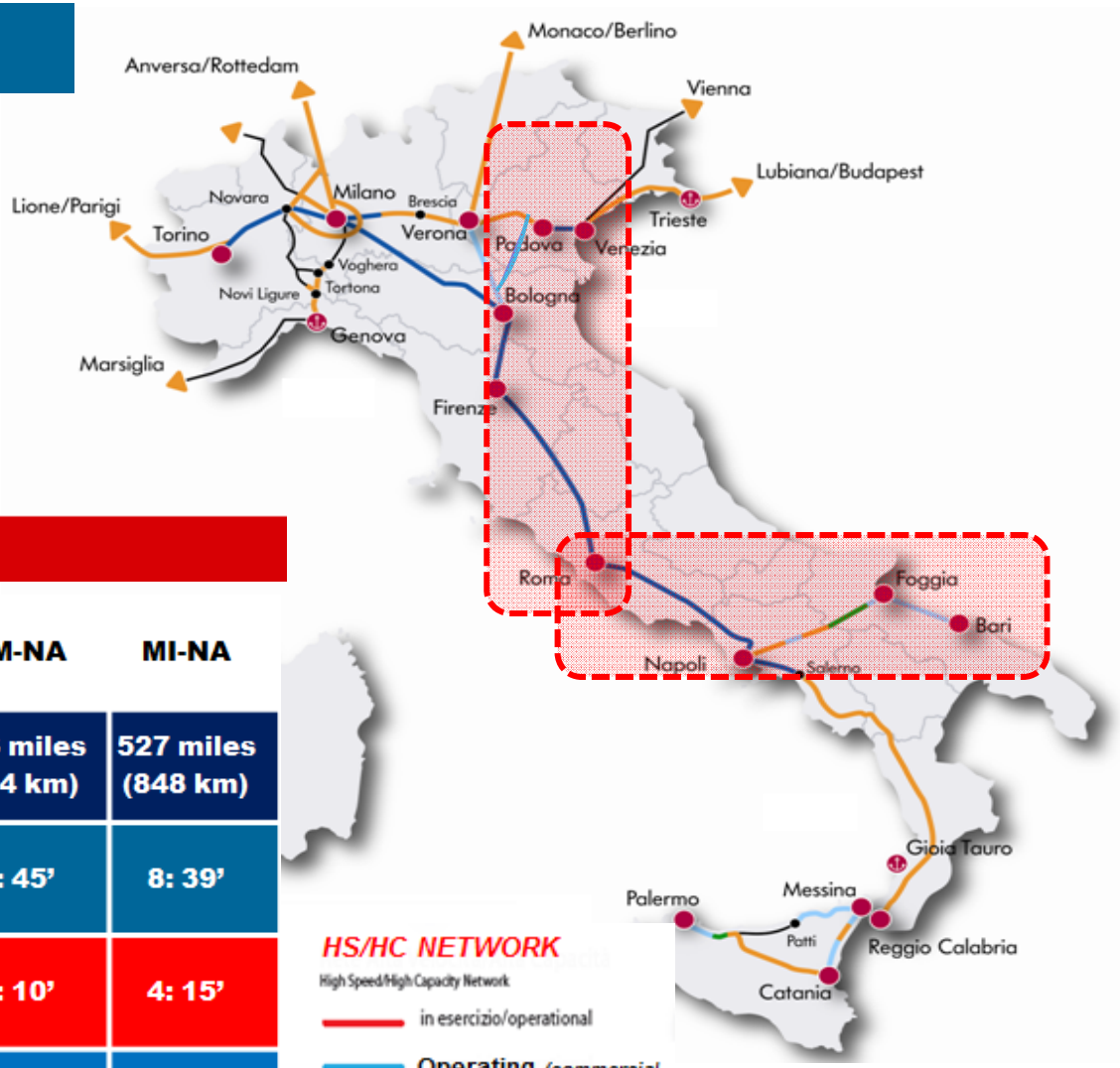
Italian Blended System:
Enhanced mobility and Journey Time Reduction

HS/HC NETWORK

	Km
2006	600
2008	800
2009	970



HS/HC Network - Travel time

Lines	RM-VE	RM-BA	BO-TO	RM-NA	MI-NA
Distance	356 miles (573 km)	313 miles (503 km)	229 miles (369 km)	133 miles (214 km)	527 miles (848 km)
No HS	5: 39'	6: 32'	3: 46'	1: 45'	8: 39'
With HS	N.A.	3:00'	2:17'	1: 10'	4: 15'
Conv. + HS	3.24'	3: 59'	N.A.	N.A.	N.A.

Italian Blended System:
Interchanges between HS lines and the existing network

- Advantages
  - ✓ **High flexibility** in operation;
  - ✓ Easy management of disrupted operation (interruptions, failure of the systems, etc.);
  - ✓ Possibilities of additional service options in intermediate stations (depending on patronage dynamics);
  - ✓ Possible use of **common maintenance** bases;
  - ✓ Extend the benefits of HS service for centers located **beyond the end of the HS system**;
  - ✓ Possible **phased approach** in the entrance into service of a new HS Line;
  - ✓ Possible use for specific freight services (light freight trains < 18 tons per axle).
- Disadvantages
  - ✓ Trains equipped with **different systems of signaling and traction**;
  - ✓ Impossibilities of use different gauge;
  - ✓ Electro magnetic interference problems

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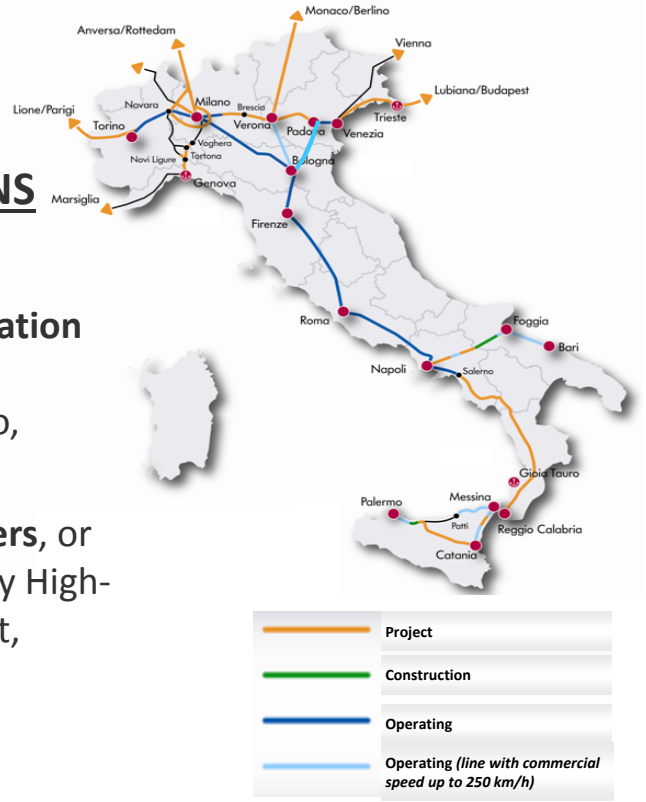
Italian High Speed and Conventional Rail: a Blended System

FOCUS 1: Station Modelling and Urban Interchanges

Italian Blended System: *How HSR systems have gained access to city centers?*
FOCUS 1, STATION MODELLING

Key features in a blended system are **urban interchanges**,

A key role was played by the **network of HIGH-SPEED STATIONS**



- In main city nodes, one opportunity is to exploit the existing **Central Station** as High-Speed Terminal, profiting from the transportation context and already established different transportation modes (regional rail, metro, bus,…).
- Another opportunity is to create new High-Speed Stations at **city borders**, or further along the High-Speed line, thus broadening the area serviced by High-Speed and its customer base. This will support in bringing development, economic growth, and jobs also to previously underserved areas.

Both cases have been fully exploited in the Italian Blended System.

Two basic questions on HS Stations planning:

1. Terminal Stations or Through Stations?
2. Adapt existing stations or build new ones?

The answer depends obviously on:
balance between benefits & cost/constraints

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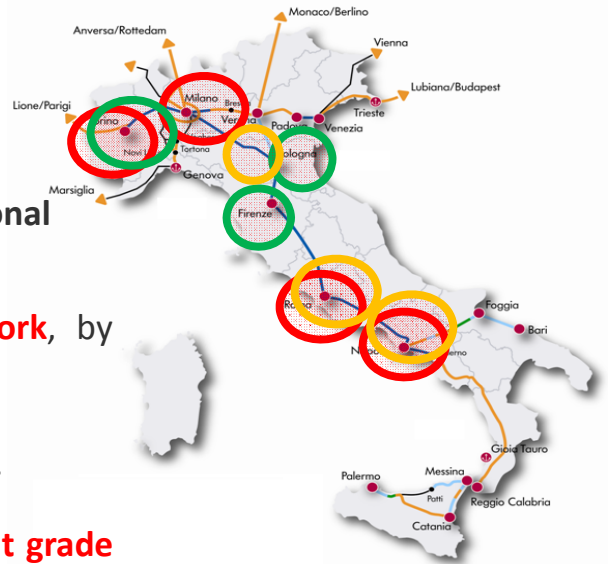
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

High Speed Stations: Location and Urban Integration



The Italian Experience

A High-Speed/High-Capacity (HS/HC) Railway Line may **interchange with conventional lines** in the following ways:

Case A - Entering of the new HS lines into the **existing urban railway network**, by reusing/upgrading of the existing infrastructures (generally using **stub-stations)**.

Case B - New crossing lines (**tunneling and through-stations vertically developed**).

Case C - New HS **Door Stations** located on the outskirts, along HS lines (usually **at grade through-Stations**).

Up to 2009

Phase 1

Adapting existing buildings in main city stations (at grade terminal stations)

Allow HS to start penetration (**Case A**)
Milano Centrale, Roma Termini, Turin Porta Nuova, Naples Centrale

2010 - 2017

Phase 2

Adding new HS lines to existing central stations of the network (vertically integrated through stations)

Speed-up total travel time (**Case B**)
Florence AV, Bologna AV, Turin Porta Susa

2013 - 2017

Phase 3

Build brand new stations (at grade or on viaduct) outside city centre

Taylor made HS Stations (**Case C**)
Rome Tiburtina, Naples Afragola, Reggio Emilia

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Italian Blended System: *How have HSR systems gained access to city centers?* FOCUS 1, STATION MODELLING

Case A: Terminal Stations

For these cases (**Milano Centrale, Roma Termini**, **Torino Porta Nuova)** the following configuration has been chosen:

- Use of the **current stub stations** for start/end services;
- **Relocation of short/medium distance transportation services** into other stations on new dedicated railway lines;
- **Upgrading and restyling of station areas**.

- Pros
  - ✓ Existing infrastructure already in place with good modal interchange
  - ✓ Rail/rail interchange possibility
  - ✓ Areas adjacent to urban centers
  - ✓ Upgrading of regional services (number and frequency)
  - ✓ Reduction of door to door travel time for passengers
- Cons
  - ✓ Increase of travel times when compared to through stations
  - ✓ Construction during the railway operation
  - ✓ More rolling stock needed
  - ✓ Limited available areas

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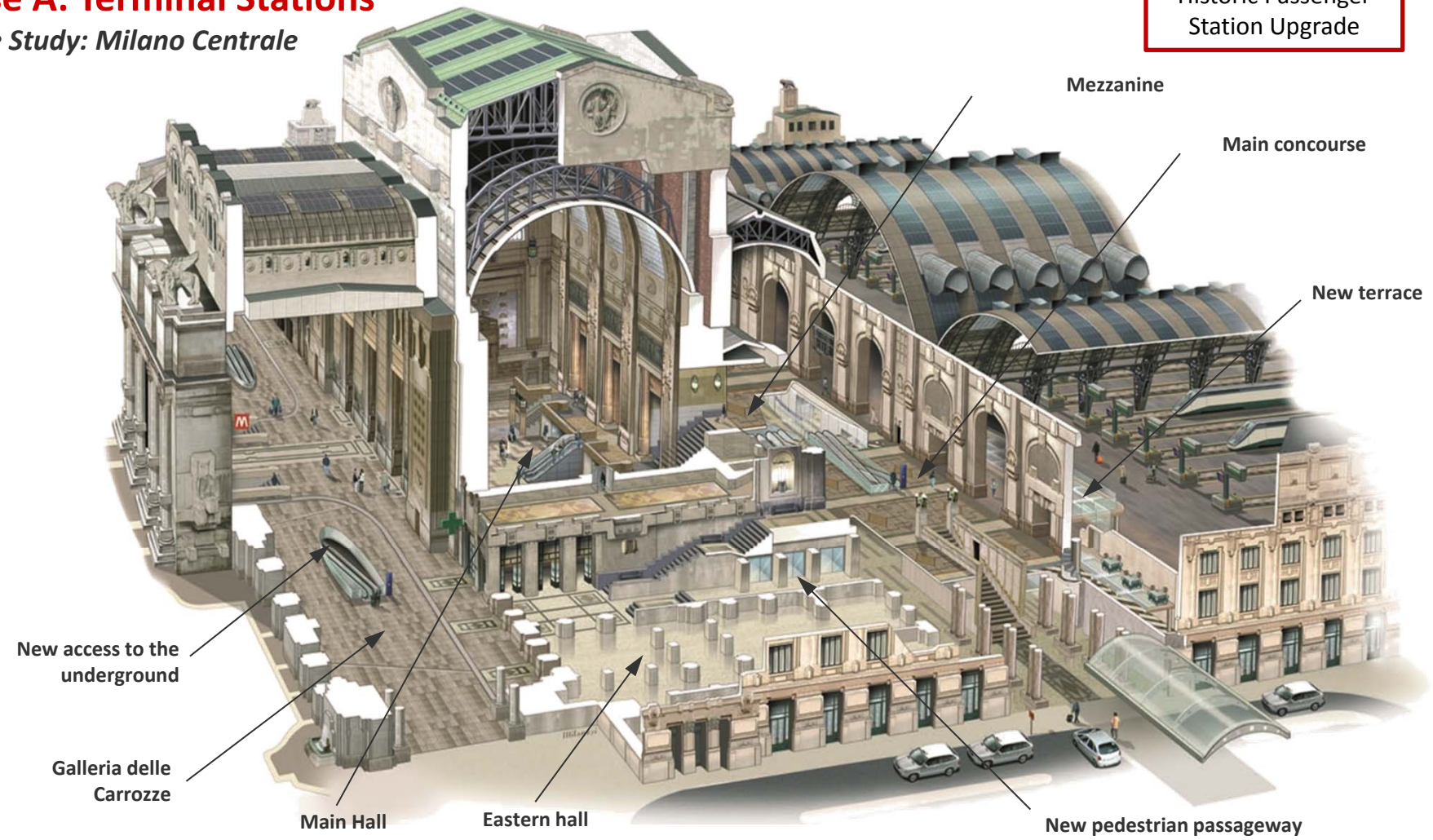
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

Case A: Terminal Stations

Case Study: Milano Centrale

Historic Passenger Station Upgrade



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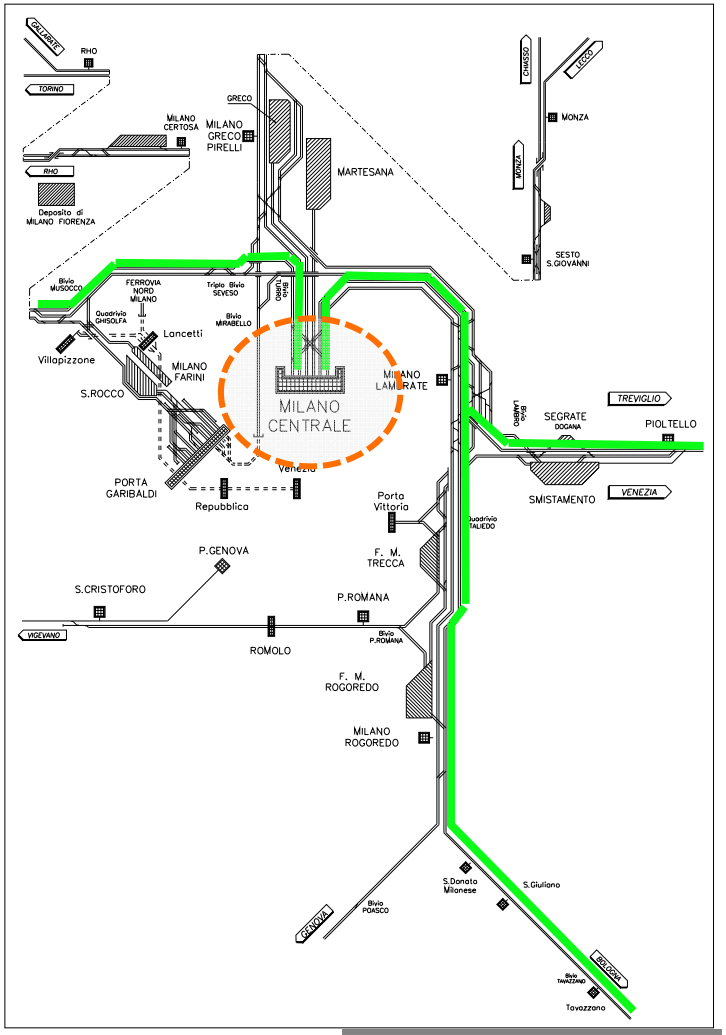
FOCUS 1, STATION MODELLING



HS lines

Regional lines

Case A – Station Modelling: Milan Node

Before HS Lines entering into the Milan urban network

Case Study: Milano Centrale

The Central Station of Milan (with regional and intercity traffic) was **at top of its capacity** and any traffic increase was not possible.

Railway lines were utilized with a mixed traffic, consequently reducing their capacity.

Regional trains Milan – Turin - Bologna: **180 t/day**

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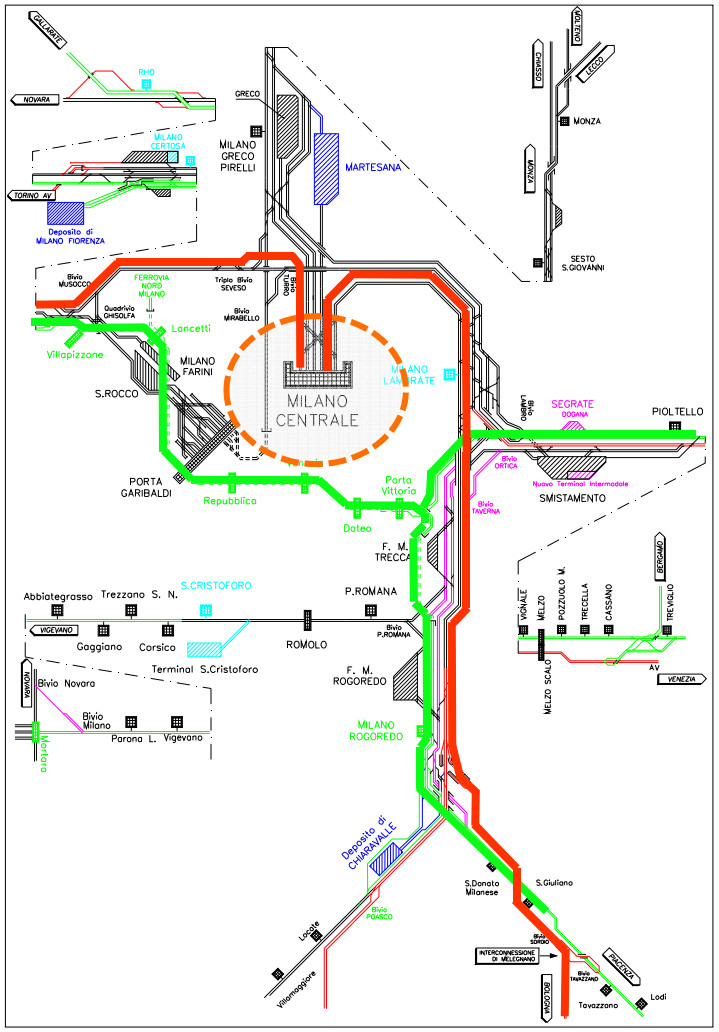

HS lines

Regional lines

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Case A – Station Modelling: Milan Node

Node reorganization after HS Lines entering into Milan

Solutions

- ✓ Construction of an underground cross city line specialized for regional trains, moving a part of traffic on the new infrastructure
- ✓ Increase of service frequency and addition of more stations in Milan Urban Centre
- ✓ Line specialization and upgrading for HS traffic
- ✓ Modernization of stations with introduction of dedicated services for HS traffic

1. New underground cross city line specialized for regional trains

2. New HS Lines reaching Milano Centrale

INCREASE OF OVERALL NODE TRAFFIC

Regional trains Milan – Turin - Bologna: **350 t/day**

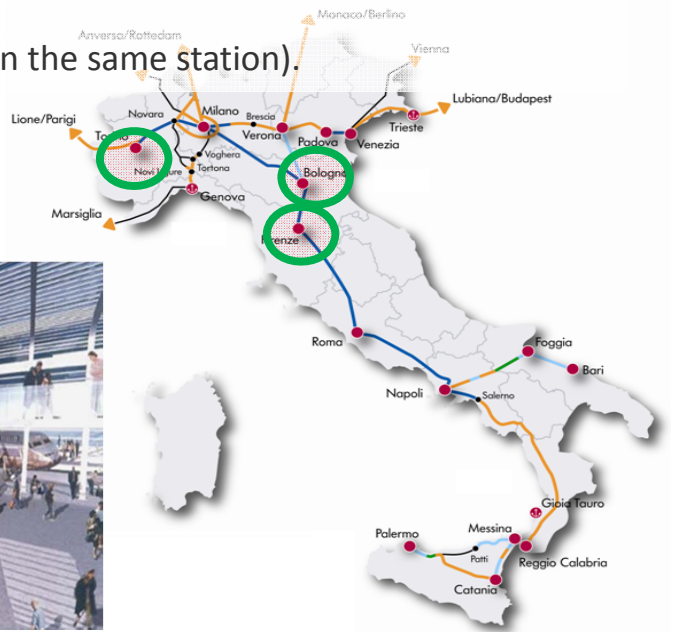
HS Trains Milan – Turin - Bologna: **100 t/day**

Italian Blended System: *How have HSR systems gained access to city centers?* FOCUS 1, STATION MODELLING

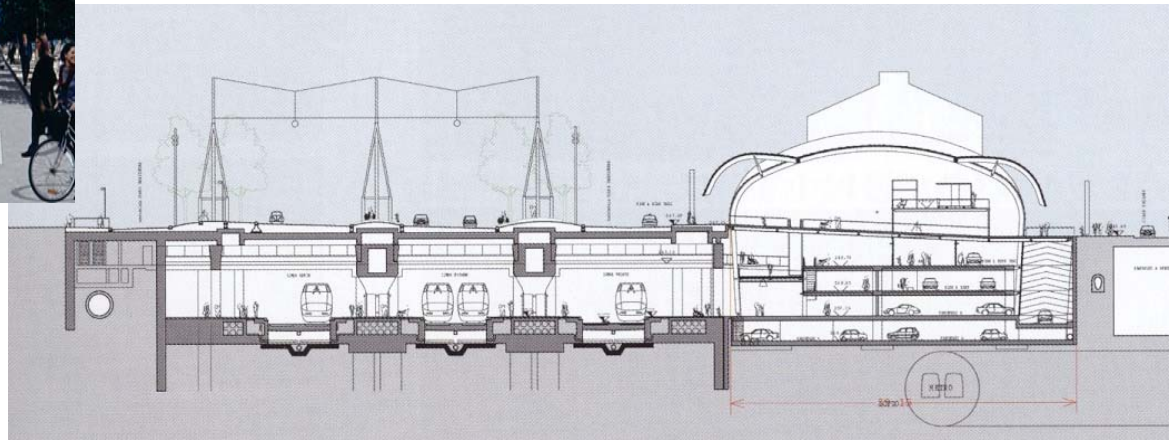
Case B: Underground Through Stations

This solution has been adopted for the Stations of **Bologna HS**, **Torino Porta Susa**, **Firenze HS**, with the construction of new underground stations close to the existing ones.
The stations are used **only** for through services (with origin/destination not in the same station).

- Pros
  - ✓ Existing infrastructure already in place with good modal interchange
  - ✓ Rail/rail interchange possibility
  - ✓ Areas next to urban centers
  - ✓ Increase of Travel times
- Cons
  - ✓ Need to develop and expand the interchanges in congested areas
  - ✓ Intervention in urban areas



Turin Porta Susa
Arch. AREP – Silvio d'Ascia and Agostino Magnaghi



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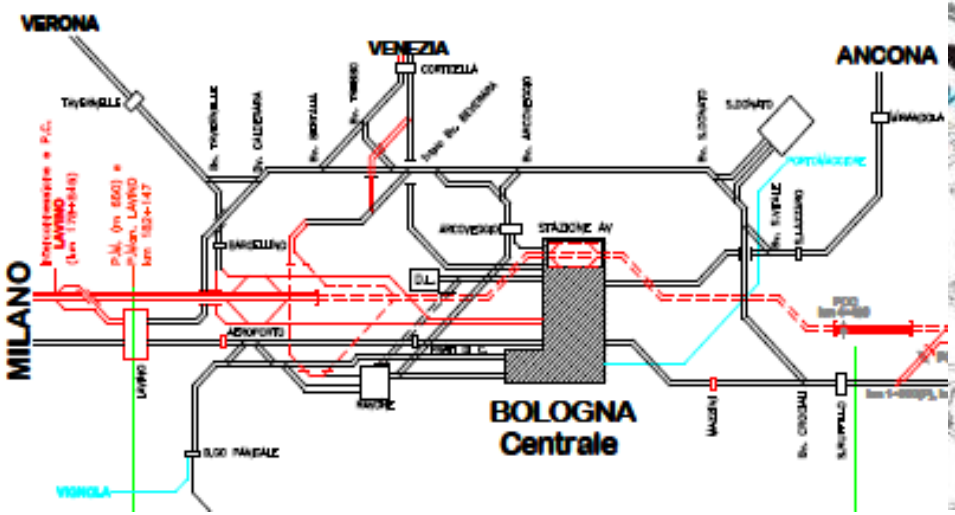
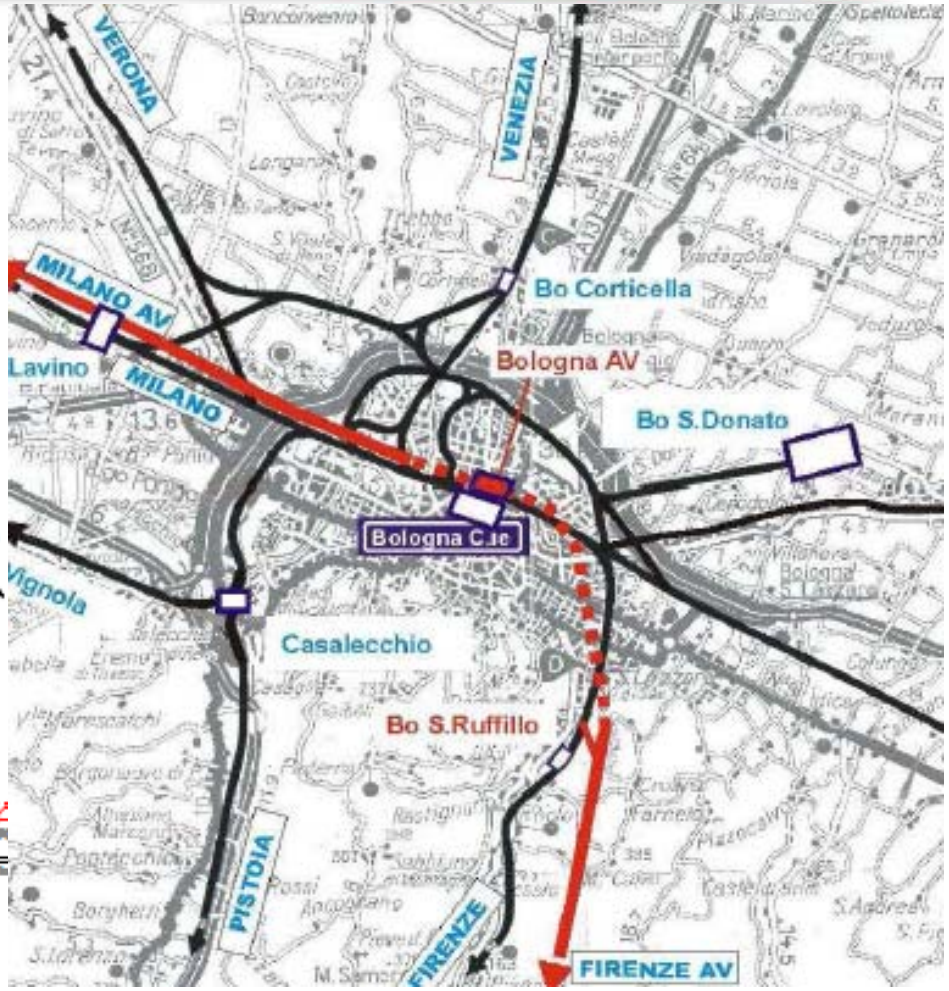
FOCUS 1, STATION MODELLING

Case B: Underground Through Stations

Case Study: Area of Bologna





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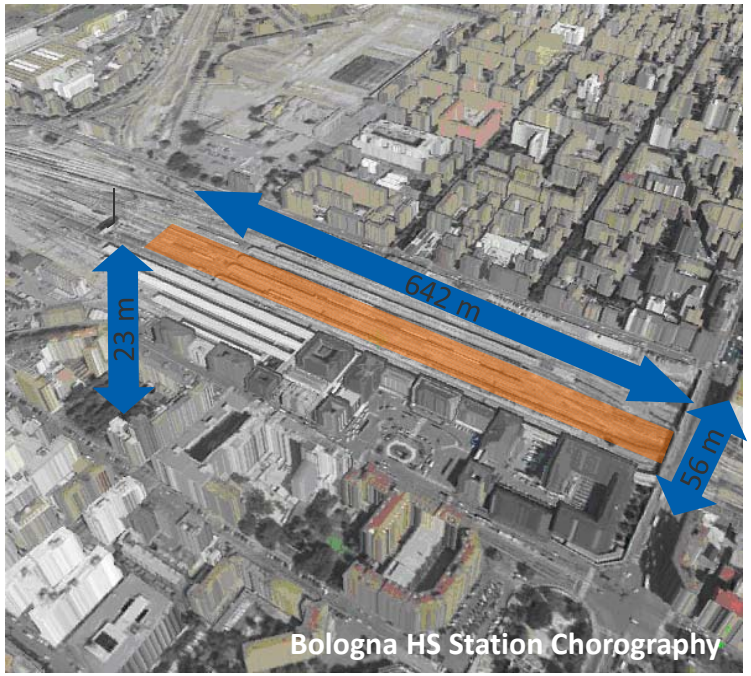
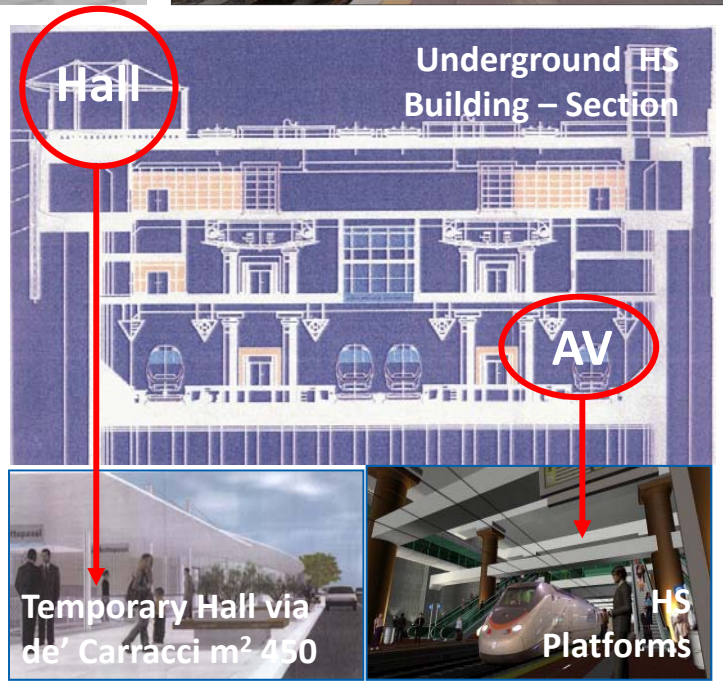
Case B: Underground Through Stations

Case Study: Bologna Centrale





Underground Station geometry:

Length = 2100 ft

Width = 135 ft

Depth slab roof – slab foundation = 75 ft

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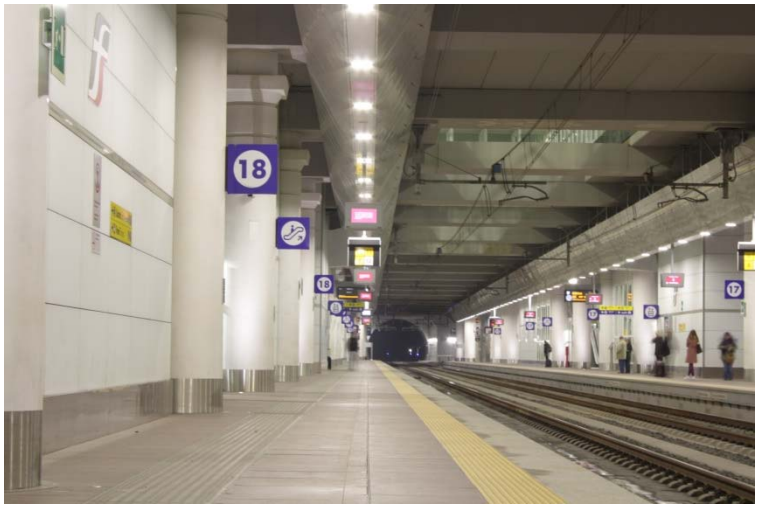

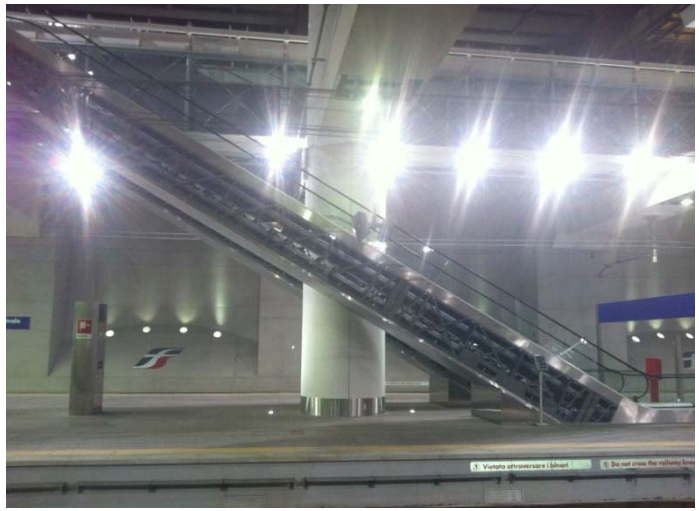

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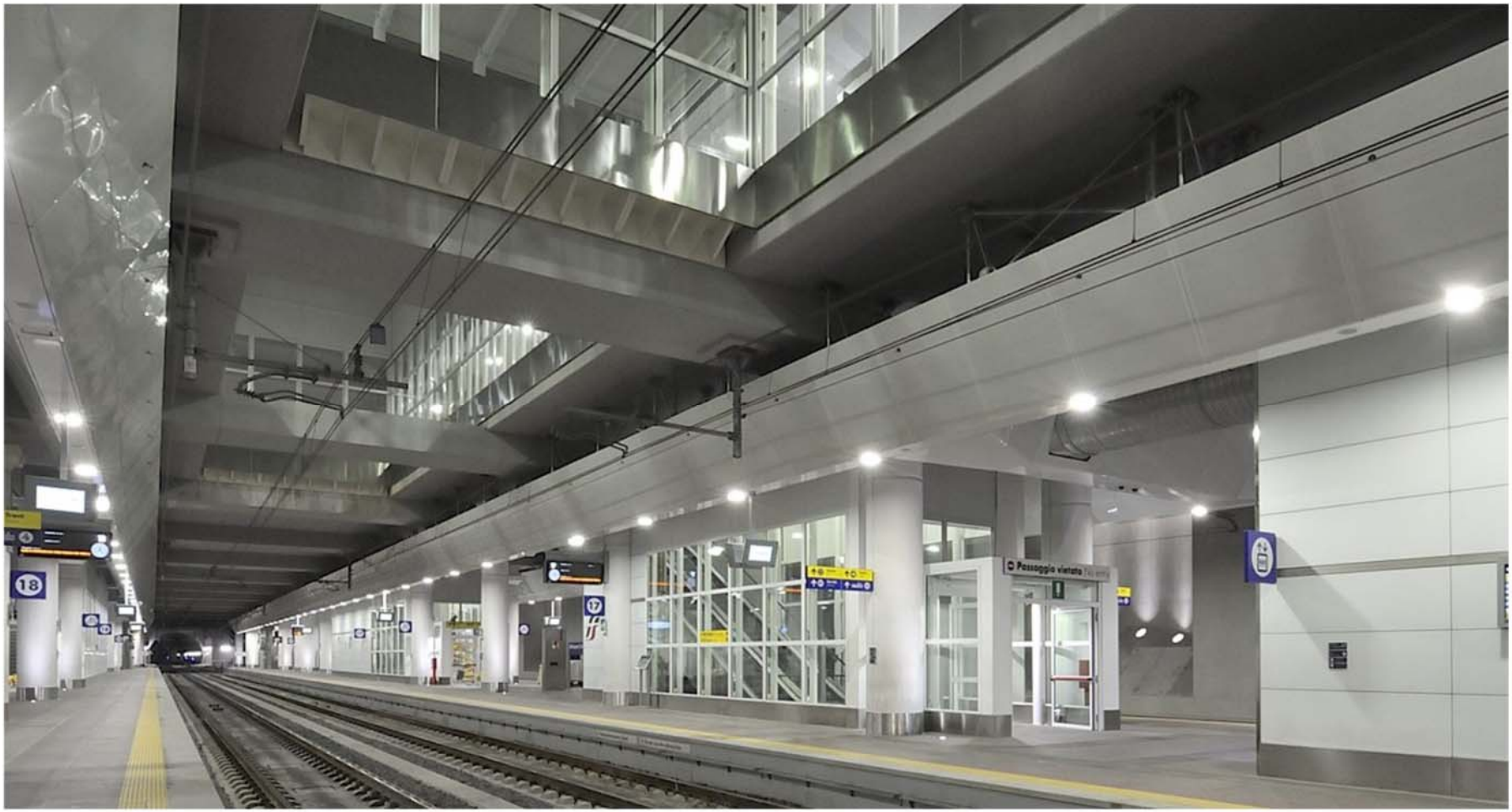
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

Case B: Underground Through Stations

Case Study: Bologna Centrale



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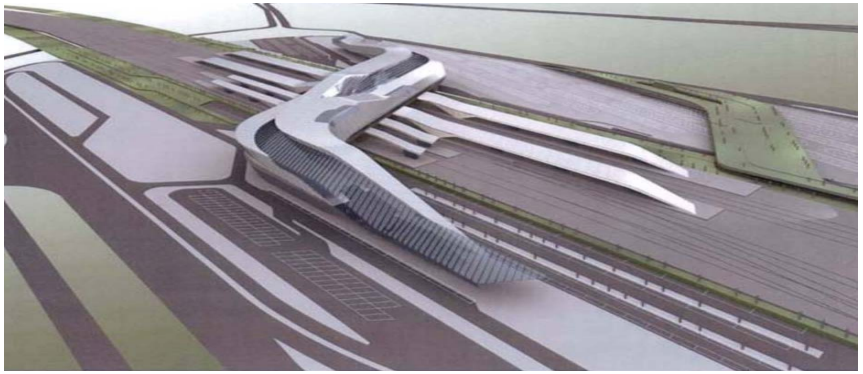
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

Case C: Brand New Through Stations

This solution has been adopted for **Reggio Emilia**, **Napoli Afragola**, **Roma Tiburtina** Stations.
The stations are used only for through services (origin/destination not in the same station). The **new stations are outside urban centers** (Napoli Afragola, Reggio Emilia) or **immediately outside city center** (Roma Tiburtina).

- Pros
  - ✓ New urban expansion areas
  - ✓ Acceptable travel times
- Cons
  - ✓ Increase of door to door travel times
  - ✓ Realization of new interchange infrastructure



Naples Afragola
Arch. Zaha Hadid

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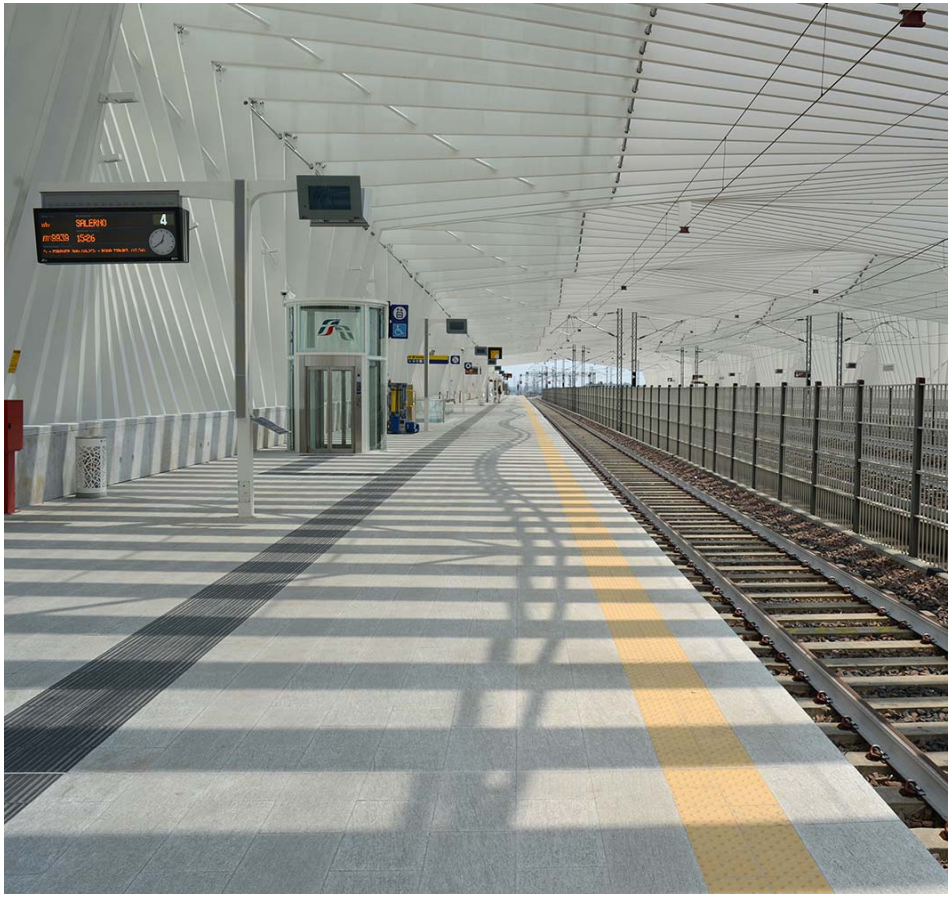
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

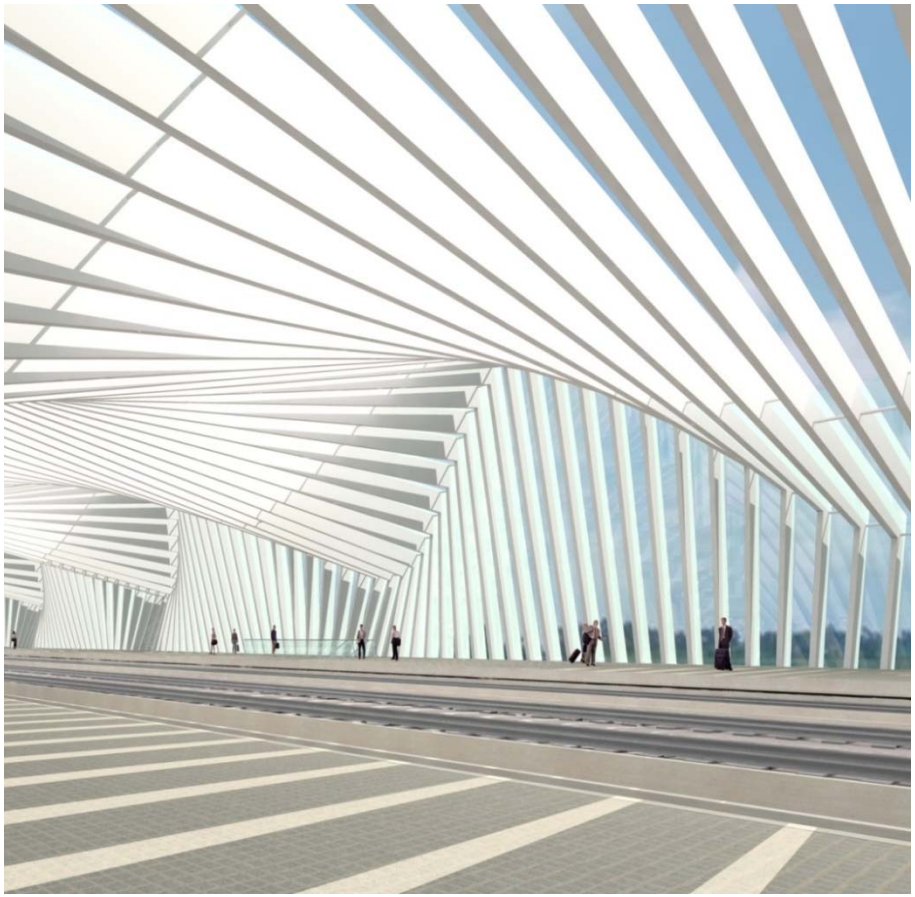
Case C: Brand New Through Stations

New Reggio Emilia High Speed/High Capacity Passenger Station
Arch. Santiago Calatrava

Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

Case C: Brand New Through Stations





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FOCUS 1, STATION MODELLING

Case C: Brand New Through Stations

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FOCUS 1, STATION MODELLING

Case C: Brand New Through Stations - Roma Node

Prior North South HS traffic flow and construction of the Tiburtina Through Station

HS lines

Regional lines

1. HS trains between Rome-Florence
2. Regional trains Rome-Pescara

40 t/day

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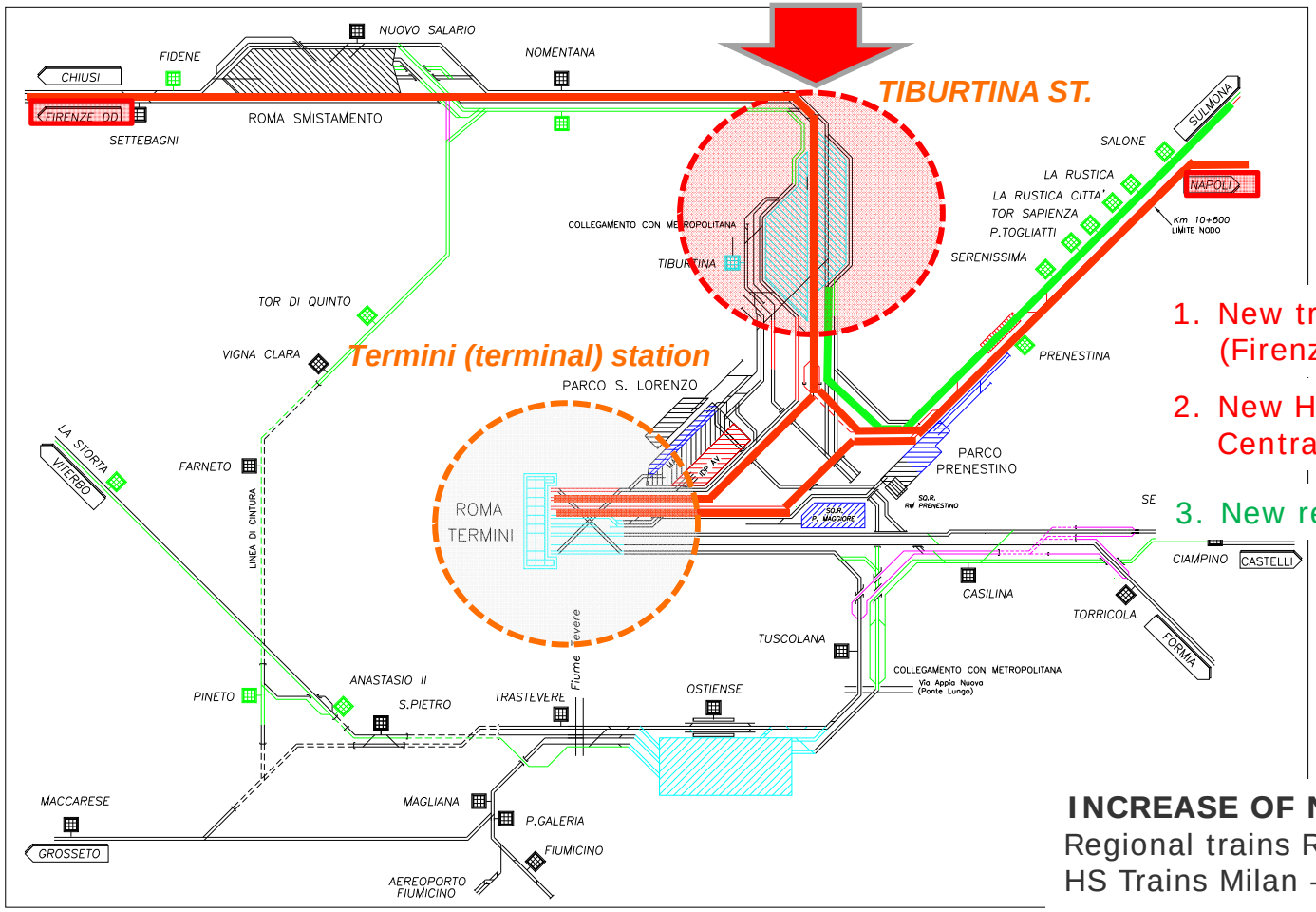
Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

Case C: Brand New Through Stations - Roma Node

After North South HS traffic and construction of the Tiburtina Through Station



HS lines

Regional lines

1. New transit HS trains North-South (Firenze Naples)
2. New HS trains reaching Rome Central Station
3. New regional trains Rome-Pescara

INCREASE OF NODE OVERALL TRAFFIC

Regional trains Rome - Pescara: **110 t/day**

HS Trains Milan – Rome - Naples: **150 t/day**

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Case C: Brand New Through Stations

Case Study: Rome Tiburtina

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Case Study: Rome Tiburtina

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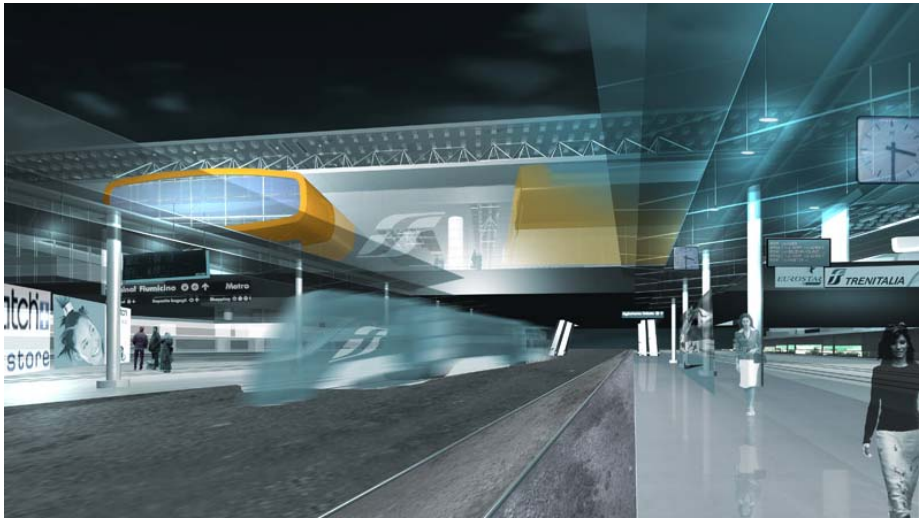

View from platform
the design and the works done!

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Italian Blended System: *How have HSR systems gained access to city centers?*
FOCUS 1, STATION MODELLING

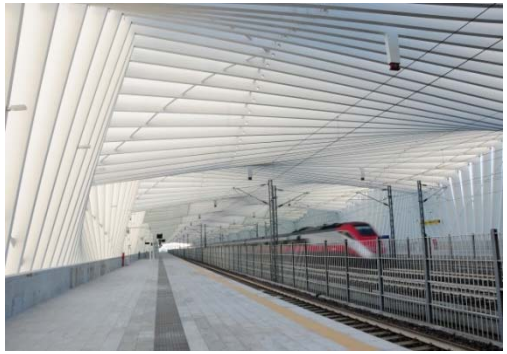
As seen, the stations designed to accommodate High-Speed trains have been upgraded or built from scratch on projects of “archi stars”.

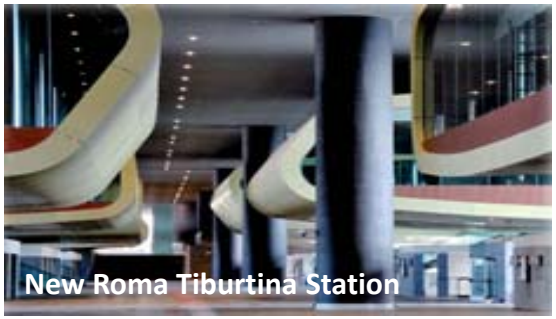
Indeed, these stations are the most important factor of major urban rehabilitation projects and the expression of a new architectural style

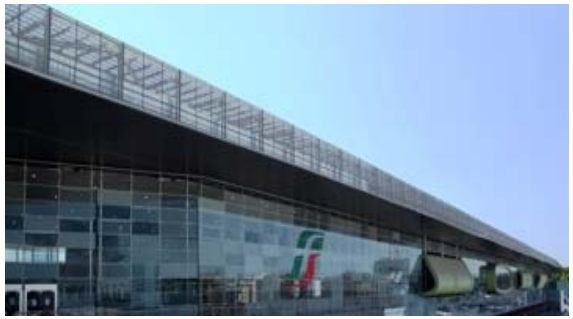
Spaces no longer dedicated merely to train operations, but also as interaction and communication places.


New Torino Porta Susa Station


New Reggio Emilia Station




New Roma Tiburtina Station




New Bologna Station

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Italian High Speed and Conventional Rail: a Blended System

FOCUS 2: Different Systems Working Together

Italian Blended System:
FOCUS 2: DIFFERENT SYSTEMS WORKING TOGETHER

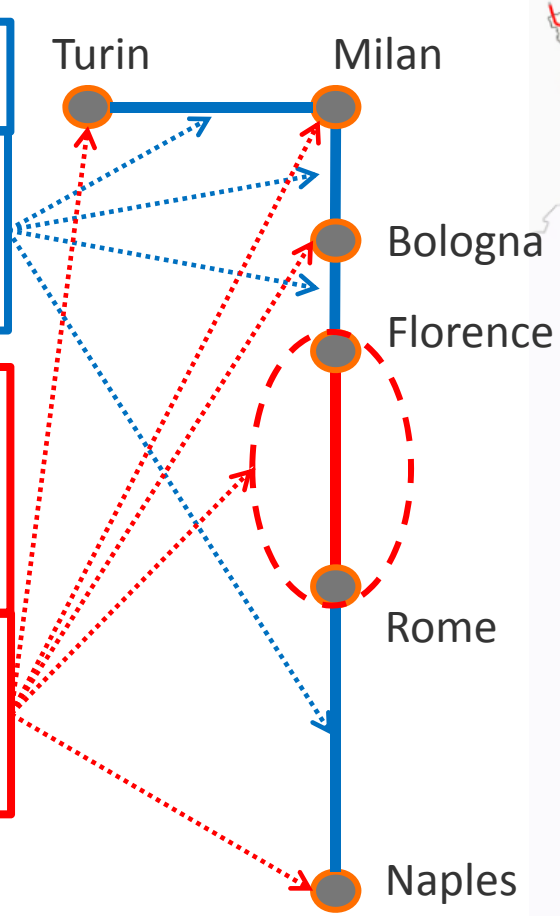
Line	Power supply	Signaling system
High speed	25 kV	ERTMS L2
Conventional	3 kV	SCMT (Traditional Wayside signaling)

PROPER HIGH SPEED SECTIONS

Electrical System: 2x25kV AC
Signalling System: ERTMS

URBAN AREAS, DIRETTISSIMA AND ALL OTHER CONVENTIONAL LINES,

Electrical System: 3kV DC
Signalling System: SCMT



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Italian Blended System:
FOCUS 2: TRAIN CONTROL SYSTEMS - TRANSITION ZONES

Transition between ERTMS to SCMT – announcement signal

Transition

Train under the traditional system

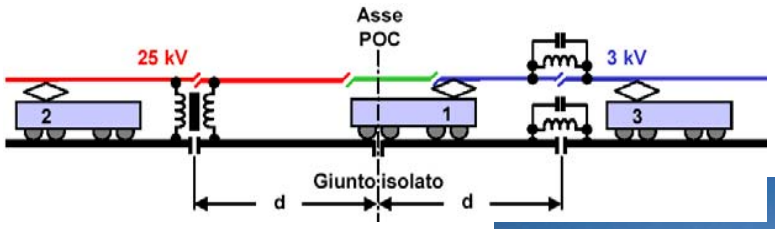
Italian Blended System:
FOCUS 2: LINE ELECTRIFICATION

✓ Italy is characterized by two different overhead supply systems:
- **3 kV DC on Conventional lines**
- **25 kV AC on High-Speed lines**

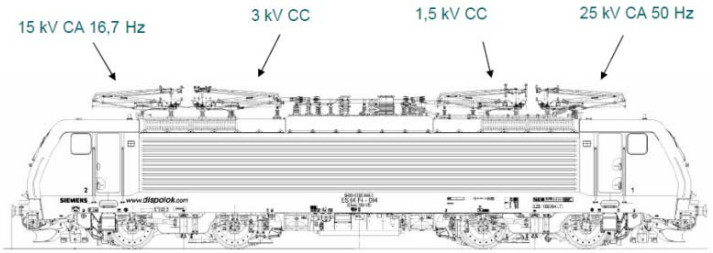
Line	Power supply
High speed	25 kV
Conventional	3 kV

25 kV AC was not used on conventional lines because of the lack – at the time – of suitable technology apt to safely and economically transfer and manage such a high tension. it is now worldwide implemented on High-Speed lines, enabling
- higher power with less frequent electrical sub-stations,
- lower electromagnetic emissions towards Communities, environment, railway plants.

The two overhead supply systems interface in blended networks: in order to avoid the outbreak of possible adverse effects of induction and conduction, a suitable Point of Change (POC) has to be implemented and equipped with suitable transformers and filters.



Rolling stock has to be equipped with TWO sets of pantographs to operate on both High Speed and Conventional lines.



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Italian Blended System:
FOCUS 2: DIFFERENT INFRASTRUCTURE? - ROLLING STOCK SOLUTIONS

✓Typical trains currently in operation in the Italian High-Speed network are:

- ETR 600, "***Pendolino***": the latest generation of the Pendolino tilting train series, capable of running at 155 mph (250 km/h), and capable of **achieving an additional 30% speed increase on curved sections, compared to standard rolling stock.**

- ETR 1000 ("***Frecciarossa***"): maximum commercial speed of
  - ❖ 224 mph (360 km/h), with power supply at 25 kV (the highest revenue speed in the world)
  - ❖ 186 mph (300 km/h) with power supply of 3 kV

  and acceleration > 2.29 ft/s2 (0,7 m/s2)

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High Speed and Conventional Network: Some Suggestions From Our Experience

Our Italian experience:
Main results achieved in our country

Our modern railway system has been the greatest development opportunity for Italy since the 1970s

Mobility

- Development on trans-European corridors across dense areas
- Journey time reduction
- New trains and stations
- New exclusive services
- Commercial speed and transport production increase
- Capacity increase

New Technologies

- ERTMS level 2
- Maximum standard of safety guaranteed
- GSM-R system
- On board sub-systems

HS Benefits

- Rail modal split increase
- Metropolitan urban centers decongestion
- Reducing air pollution and CO_2 emissions
- Specialized lines (free up space with resulting benefits for local passenger and cargo transport)

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Very different environments

US and Canada

- Independent, privately owned railroads
- No on-going public capital funds
- Financially distressed, freight profitable, passenger not
- Freight oriented services, pax service allowed if not unduly interfering with…

Italy

- Government owned and passenger oriented
- Electrified lines
- Built up new, dedicated standard gauge, electrified high speed lines interconnected with improved conventional lines
- Infrastructure and technology investments
- Incremental upgrade of passenger train

Definitely a more challenging environment!

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Some possible suggestions from our experience

- To build a completely separate high speed rail network is **cost prohibitive**;

- On the other hand, it is **very difficult to achieve competitive speeds**, frequencies and dependability on the existing railroad network.

Potential Scope –Map

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Some possible suggestions from our experience

An phased and blended approach

- ✓ in which conventional infrastructure is **upgraded and integrated** with new high-speed lines
- ✓ with **low-cost improvements** that can be implemented quickly, building ridership and revenues as the big investments are being planned and carried out
- ✓ with **flexible train sets** using both sections of new dedicated High-Speed track and existing and upgraded conventional tracks
- ✓ **developed in stages** to maximize efficient use of capital.

Potential Scope –Map

could be the optimal solution!

Viewing these individual projects as a series of building blocks allows the network to be built in phases.

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Some possible suggestions from our experience

- A **business plan** should be carried out to analyze the possibility to blend the two actions above by building **strategically located segments of high speed while simultaneously upgrading feeder lines**, following a phased approach in which new segments are constructed as building blocks of an evolving system;
- Determining a **minimal viable segment** will be the first step toward network development;
- A **sequencing strategy** for the next phases of network development will be based on the business case potential of the other service levels

Potential Scope –Map

High-performance trains using both High-Speed and conventional tracks, just as cars and buses use both Interstate Highways and local roads in a single trip!

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We are ready to work!

Midwest High Speed Rail Association
REINVENTING TRAVEL. REINVENTING THE MIDWEST.

Preliminary Business Plan
for
High Speed implementation in the Mid-West

Technical and Financial Proposal

August 2017

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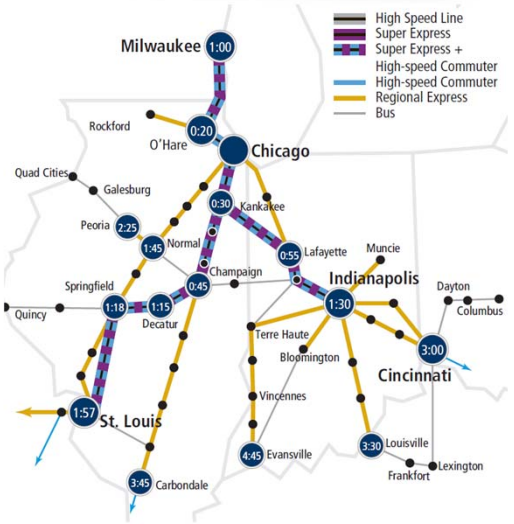
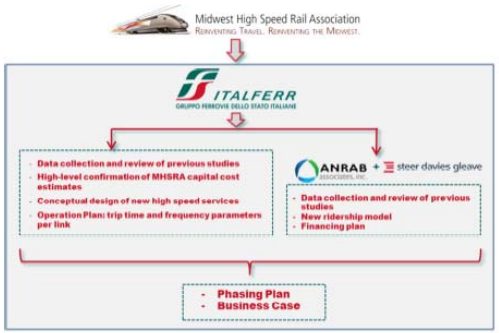
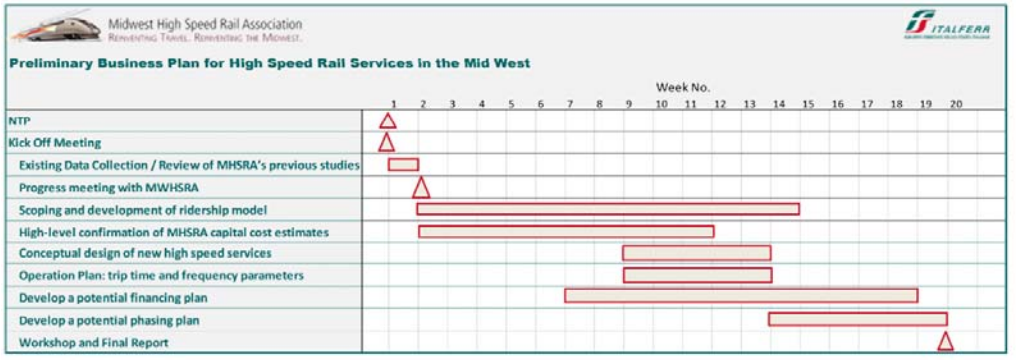


Potential Scope –Map





Work Plan Timeline

THANK YOU FOR YOUR ATTENTION

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Very different environments but still some similarities

As Italy, most Midwest States already possess the basic railroad infrastructure needed to make high-quality train service a reality.

To add frequencies and cut travel times

- In some cases, modest track maintenance can dramatically reduce travel times.
- In other cases, reconstructed track or double-tracking, new overpasses or underpasses, signal and crossing improvements, electrification and modern rolling stock will be required

Indeed, some **low-cost improvements** can be implemented quickly, building ridership and revenues as the big steps are being planned and constructed.

Viewing these individual projects as a series of building blocks allows the network to be built in phases.

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Our Italian experience:
An incremental and blended system for passenger services

- To create a blended system, the new High-Speed network needed to be harmonized with the existing conventional lines, and to this extent **interventions had to be foreseen also on the conventional network**.

- Once the blended system was in place, **part of the long-range passenger operations were shifted to the new High-Speed network**, leaving room in the existing conventional network to increase also the conventional operations.

- **Junctions** between conventional and HS lines realized our blended network increasing the commercial offer for passenger services

- Key features in a blended system were **urban interchanges**, where a conventional transport system hub was already in place and the inter-modality between transportation means could thus be implemented to the maximum extent.

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