

Organisation of Rail Transport: A Case Study in Lombardy

Lesson 2. Timetables and Passengers

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 - Our Tools: Timetables and Charts
 - Designing the Timetable
 - People on Trains: Some Examples

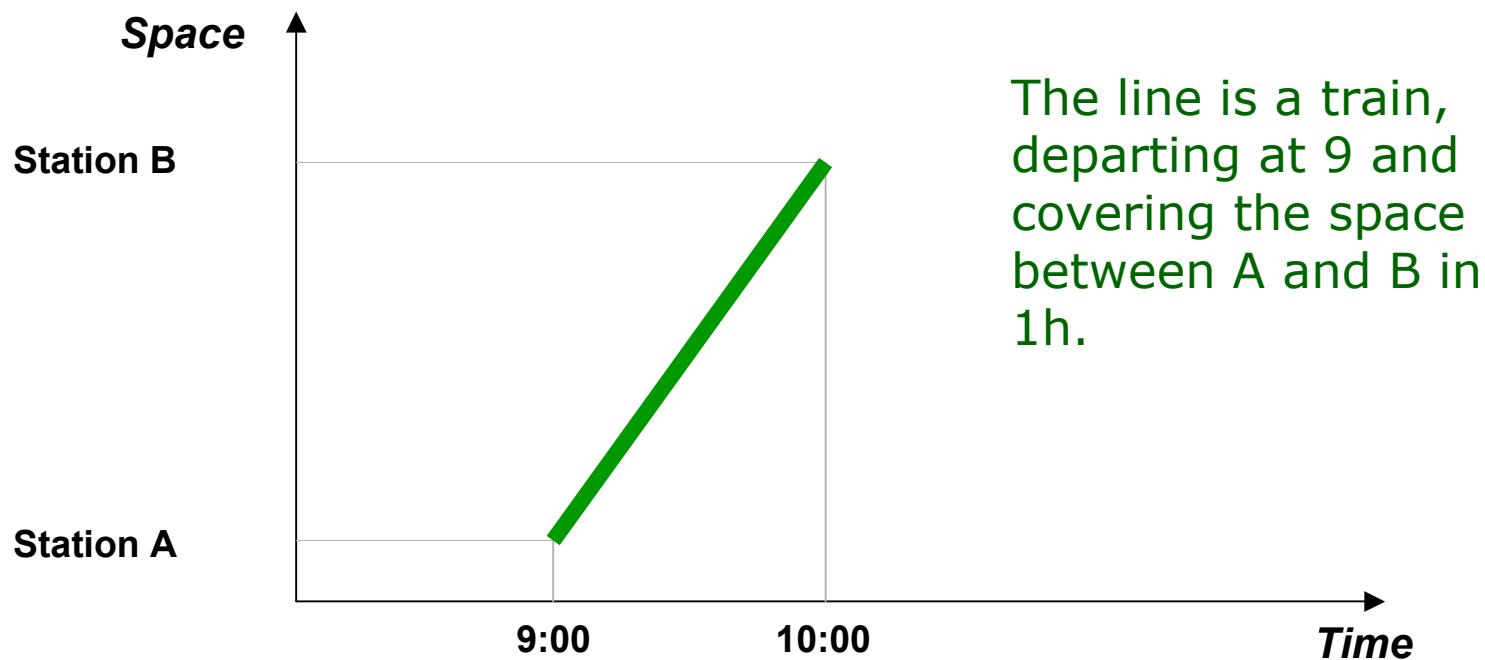


Our Tools: Timetables and Charts



Graphical Timetable: Basic

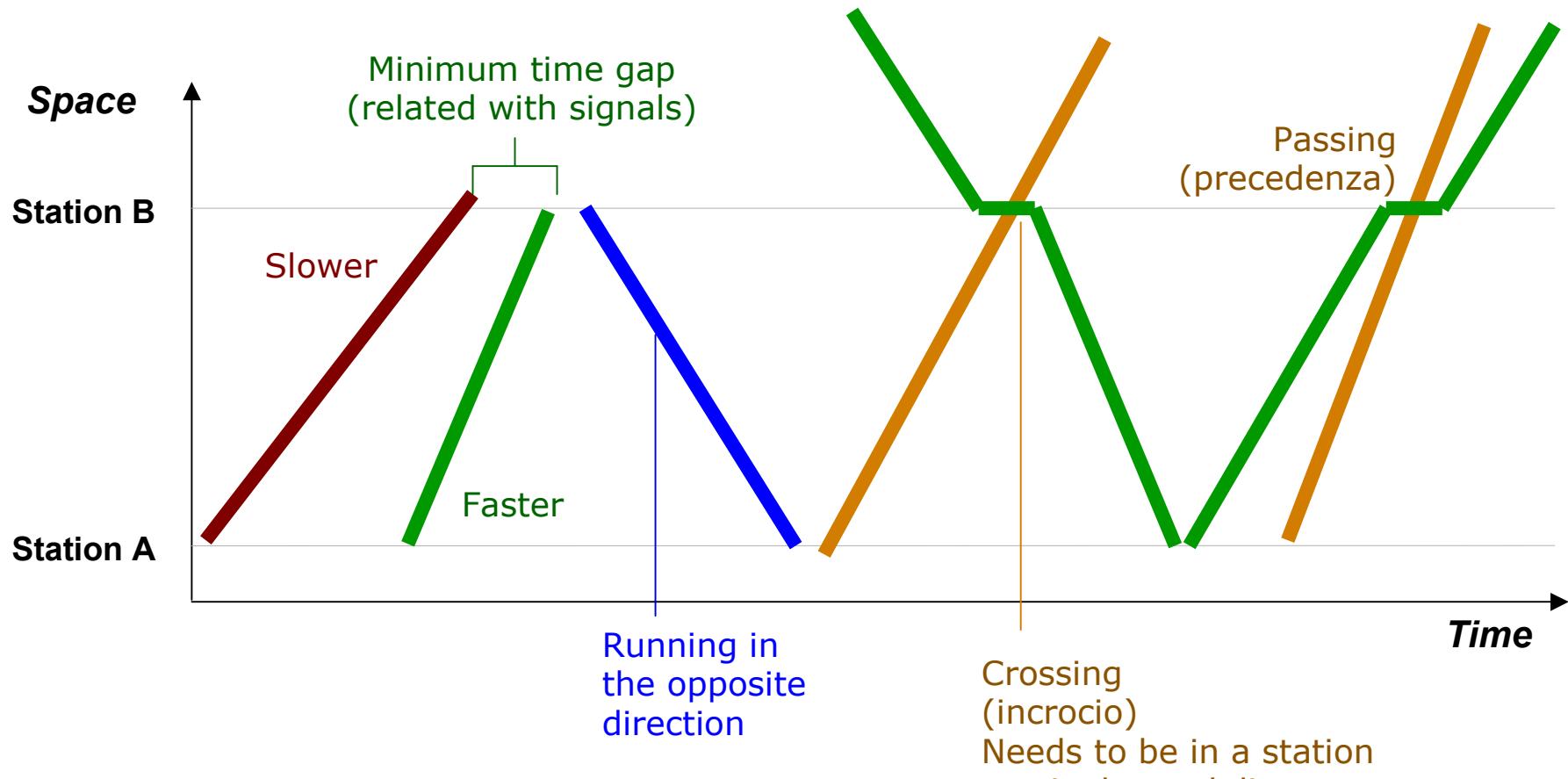
- The tool used to regulate and define the services is the **timetable**.
- **Graphical timetable** is the representation of a train on a space(time) diagram.



German speaking people put Time on Y Axis and Space on X.

Graphical Timetable: Basic 2

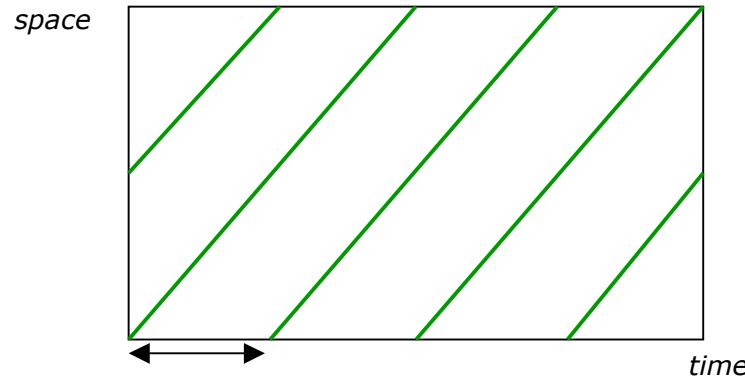
- Familiarising with timetables:



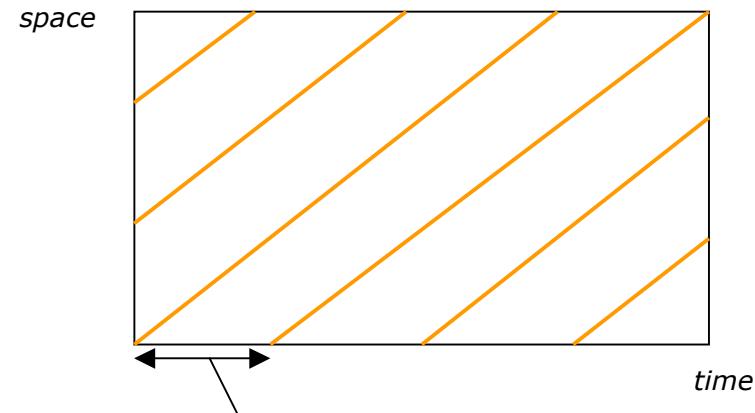
Timetabling and Line Capacity

The capacity of a line depends (also) on the way the timetable is built.

Fast trains only

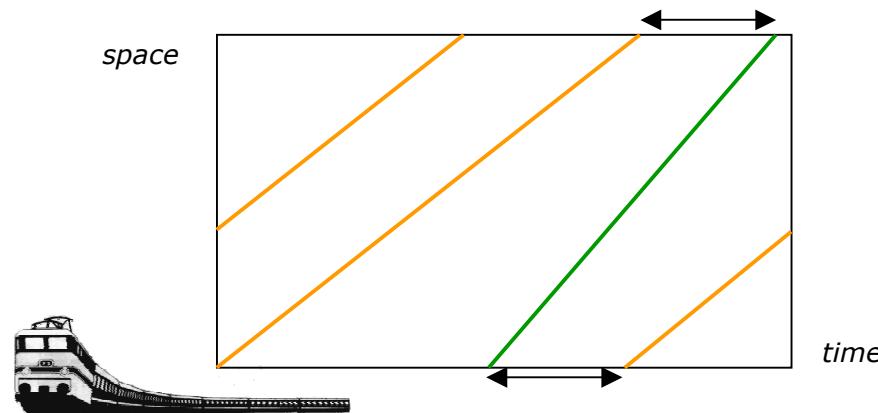


Slow trains only



Minimum headway between 2 trains

Fast and slow trains together



The capacity of a line could be increased if timetable is homogeneous (all trains have the same speed).

But in real life it is necessary to find a **compromise** between faster and slower services!

Traditional Timetable

“Focused” timetable



“Charter strategy”

Train circulates only if (considered) profitable.

The train is located in the timetable in order to maximise the highest potential demand.

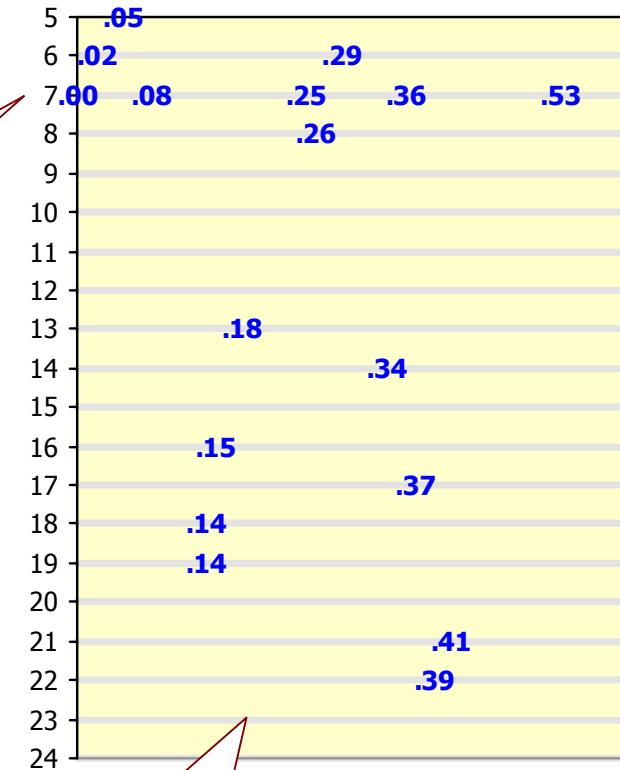
The train is dimensioned according to the foreseen demand.

Minor or secondary traffic flows are left unserved or served by other transport means.



Peak hour trips

Melegnano - 23/10/2009
(verso S. Giuliano Mil.)



An effective representation of departures from a station!

Regular Interval Timetable

Regular interval timetable

Global approach to mobility
(including other modes)

Timetable built to grant the constant availability of service:

- Departures at **regular intervals**
- Constant pattern of **appointments** at specific nodal points

The financial sustainability must look at the whole network and not to single trains (that can be losing).

The benefit for the user of having “always” a train is greater than the cost of having some trains more empty!



Melegnano - 24/10/2011
(verso S. Giuliano Mil.)

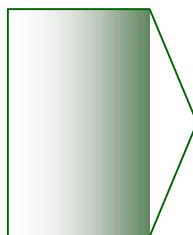
5		
6	.09	.39
7	.09	.39
8	.09	.39
9	.09	.39
10	.05	.39
11	.09	.39
12	.09	.39
13	.09	.39
14	.09	.39
15	.09	.39
16	.09	.39
17	.09	.39
18	.09	.39
19	.09	.39
20	.09	.39
21	.09	.35
22		.35
23		.35
24		

Same station,
the next year :)

Regular Interval Timetable: Why?

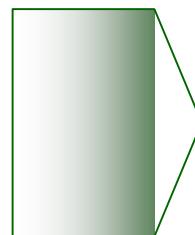
Why is regular timetabling important, especially in local transport services?

- Allows the creation of a hierachic network (train – bus – urban)
- Introduces mono- and multi-modal transport nodes
- Allows the passenger to **arrive at any time to the initial stop, avoiding the use of timetables** also when using more lines.



Increases the quality of
the trip

Reduces the perceived
cost



Increases number of users
on the network

Influences the housing
choices in peripheral areas



Symmetrical Timetable

The **symmetry** is, jointly with regularity, one of the main properties of “modern” rail timetables

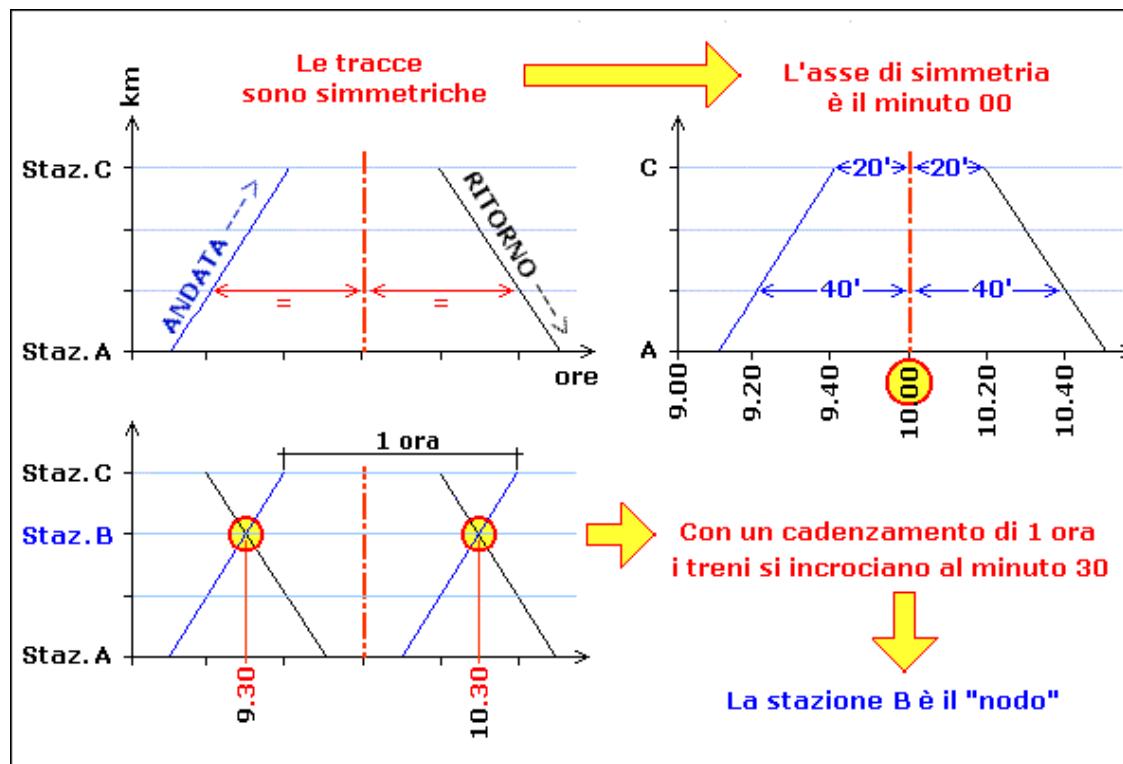
- The use of regular timetables implies the definition of symmetry axes
- The symmetry axis identifies the basic grid on which the whole timetable is built
- The symmetry axis is chosen according to commercial evaluations
- The preferred axis is **00 – 30**: if the train leaves at minute **x**, the corresponding one arrives at the same station at minute **60 – x**
- The customer can easily memorise the timetable in one direction and calculate it for the other one.



Symmetry Axis

If the train from A to B leaves at minute **10**, the corresponding train from B to A arrives at minute **50** (**symmetry** around minutes 00 – 30)

With a 00 – 30 symmetry and **1h** headway, **trains always make a crossing at minutes 00 and 30**

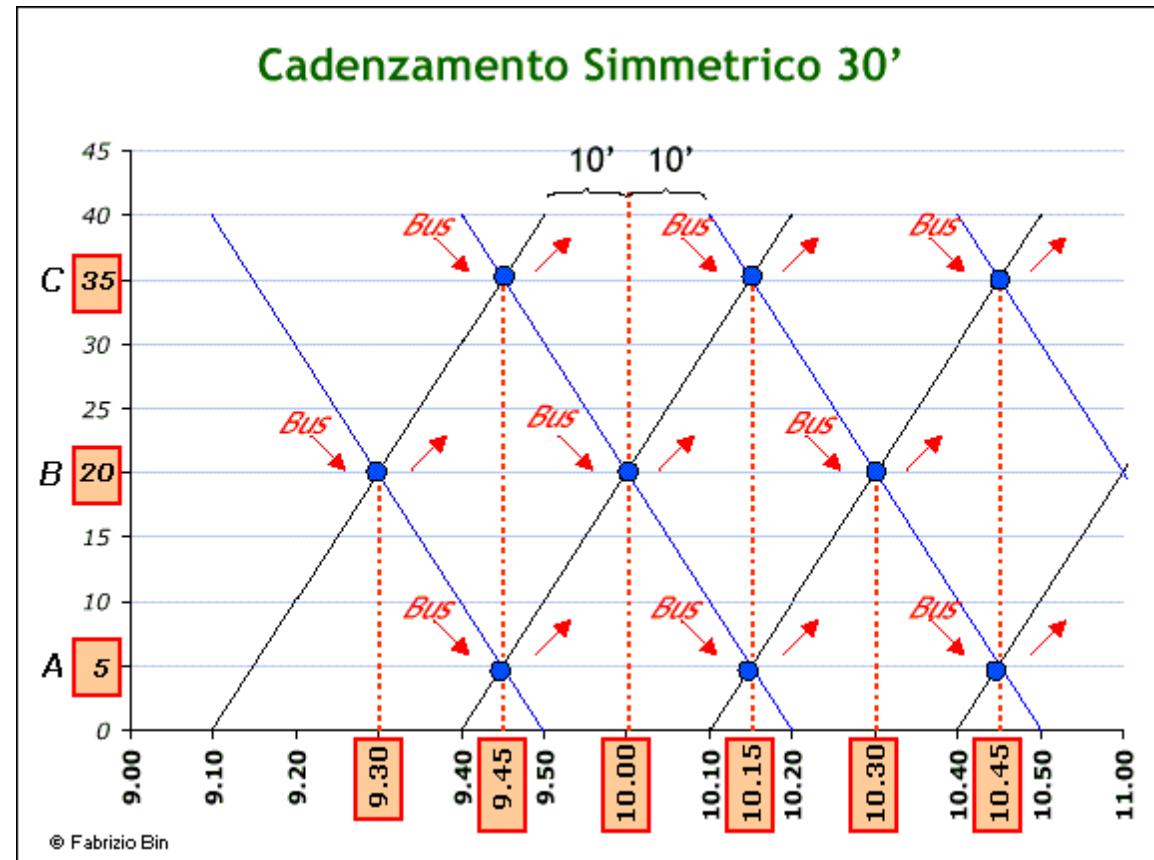


Station A

Symmetrical Timetable and Nodes

With a 30' headway two other stations become nodes, in this case at minutes 15 – 45 (because there is a crossing every 15 minutes)

Timetable planning should put nodes where it is possible to make connections: main stations, branch stations, stations with bus terminus and so on.

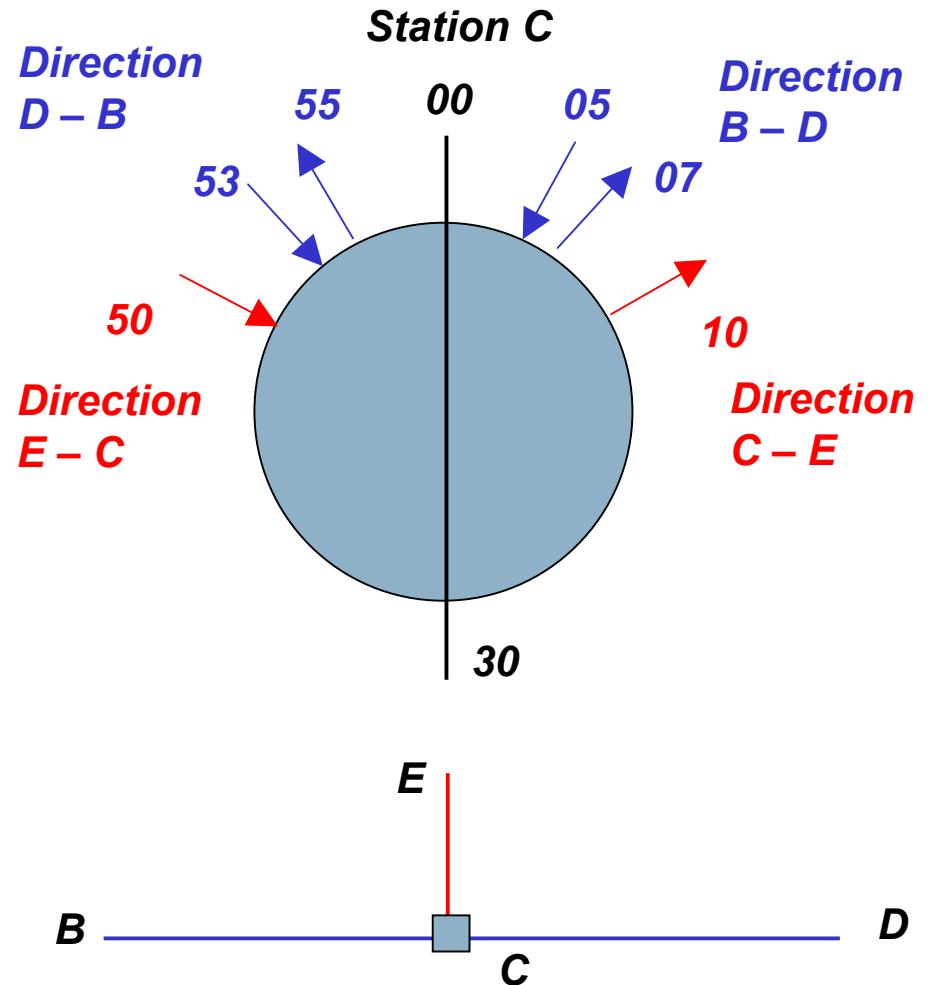


Symmetrical Timetable in Nodes

It is important that all the services are based on the **same symmetry axis**. Otherwise only mono-directional appointments are possible.

Example (same symmetry):

- Line B – D: Intercity train
- Line C – E: regional train
- **We can go from B to E and from E to B**

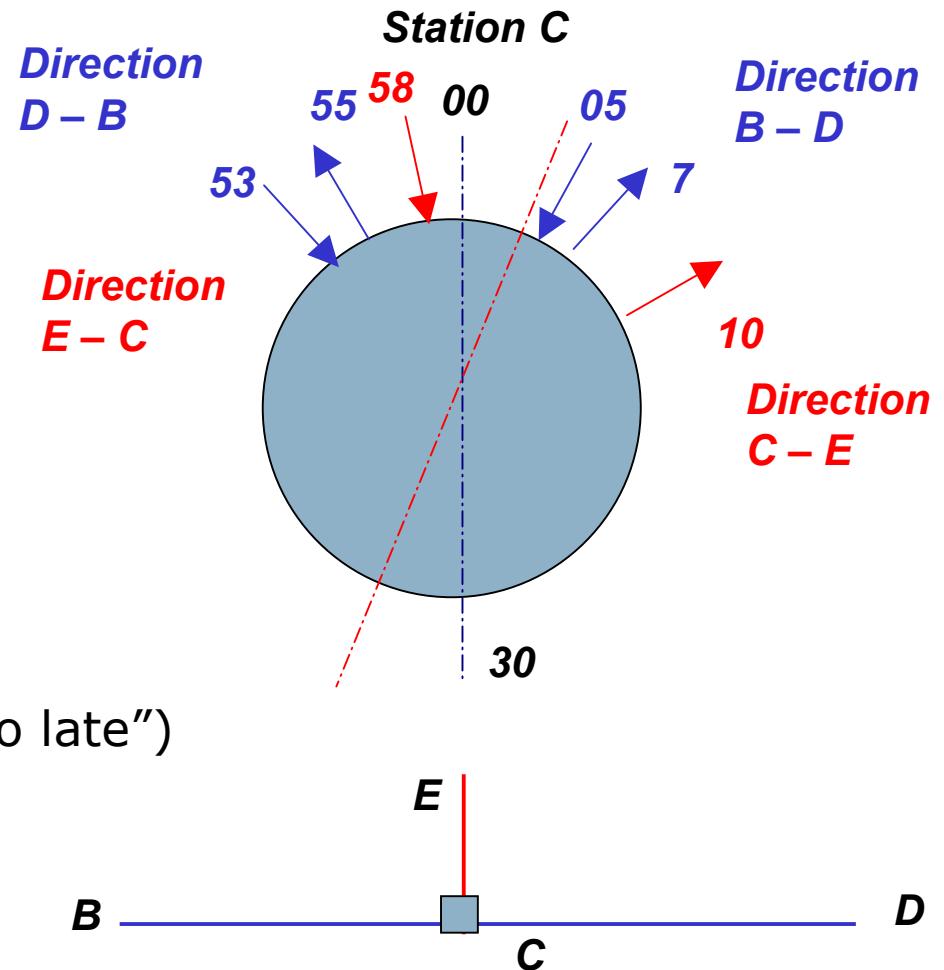


Asymmetrical Timetable: a Connection is Missing

If, for example, the Regional service is designed with another symmetry axis, connection works only in one direction.

- Line B – D train IC
- Line C – E train R
- We can go from B to E
- **We CAN'T go from E to B**

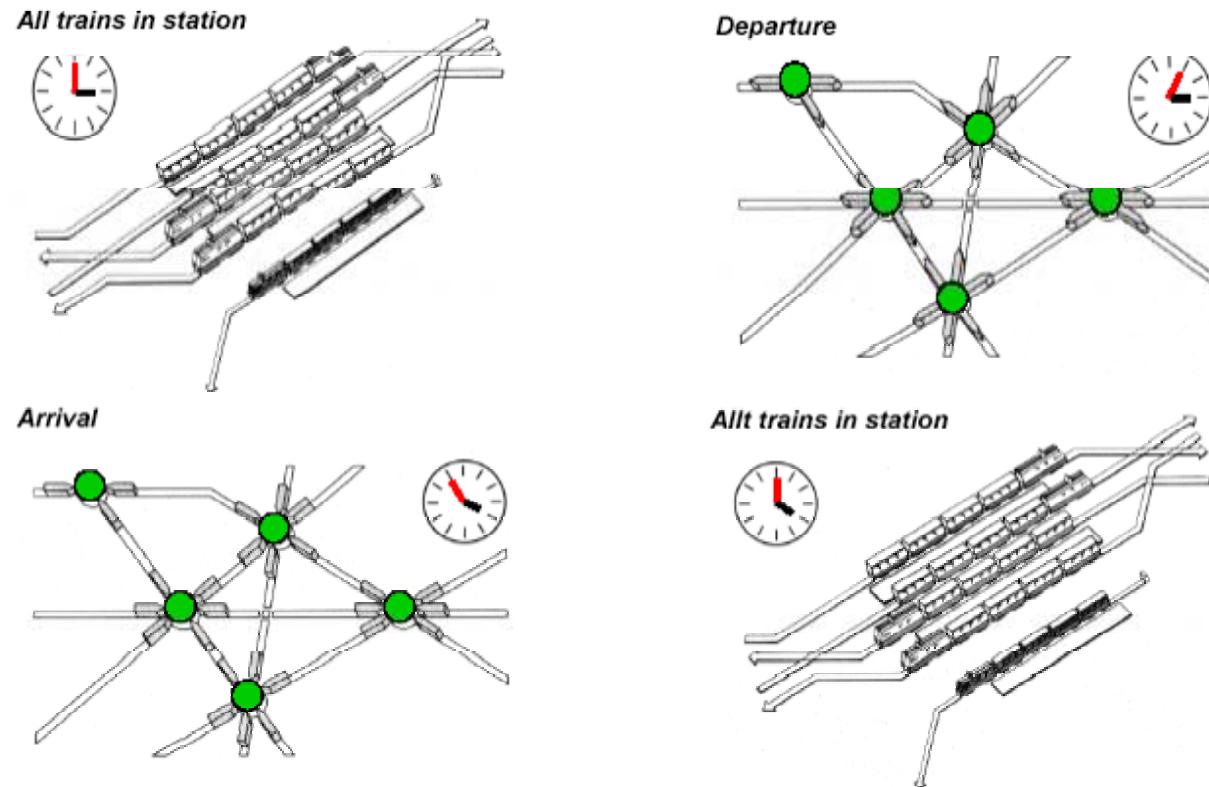
(the Regional trains arrives “too late”)



Symmetrical Timetable: the Network

Regular timetabling together with symmetry allows the creation of **network systems** at a regional scale (or even national)

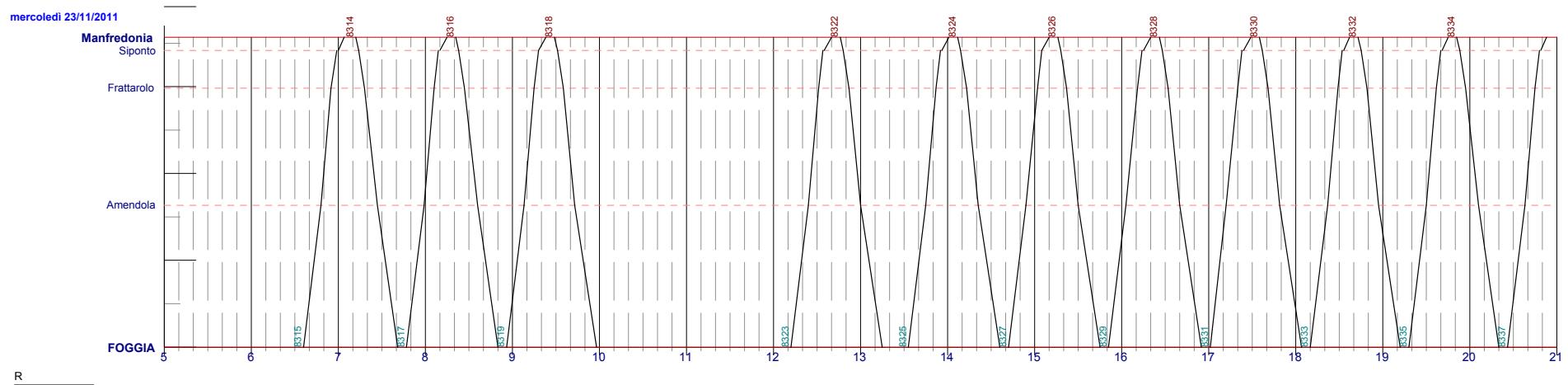
→ Application of the **hub&spoke** model also to railways



Designing the Timetable



The Easiest Way



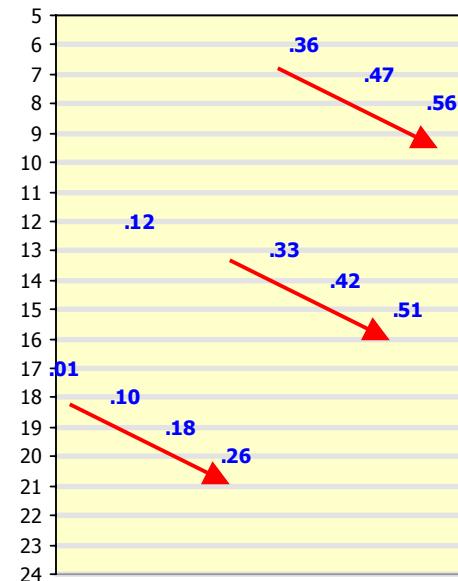
Line Foggia-Manfredonia

- A single train is going to and from Manfredonia, with a stop of few minutes in each terminus
- Highest efficiency in using rolling stock
- Worst case for users: **cannot guarantee a standard frequency**, except lucky case in which travelling time is just a bit lower than 30 (or 60) minutes (this is not the case!)

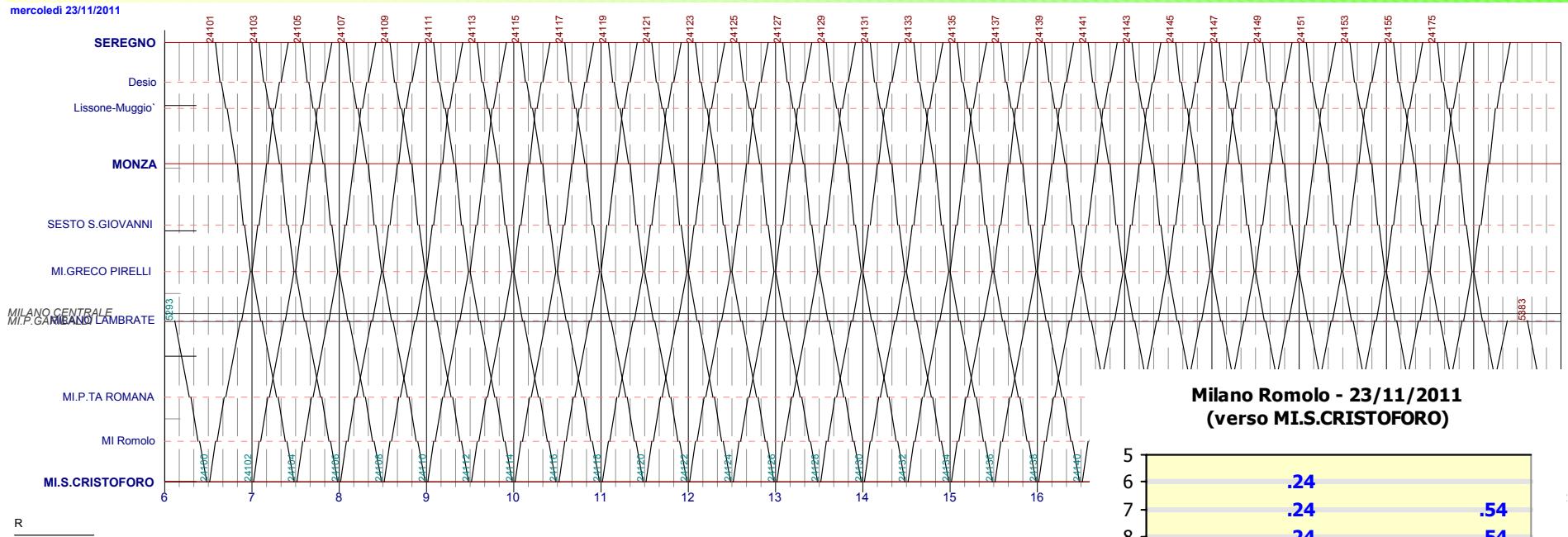


Departure time “loses”
about 10 minutes per trip

FOGGIA - 23/11/2011
(verso Amendola)



The Best Way (in Our Opinion)



Line S9 Milano S.Cristoforo-Seregno

- Constant frequency of 30' for the whole day
- Good efficiency in using rolling stock
- Best case for users.
- Peak hours can be managed using double compositions (easy with EMUs, more complex with Loco+Coaches)

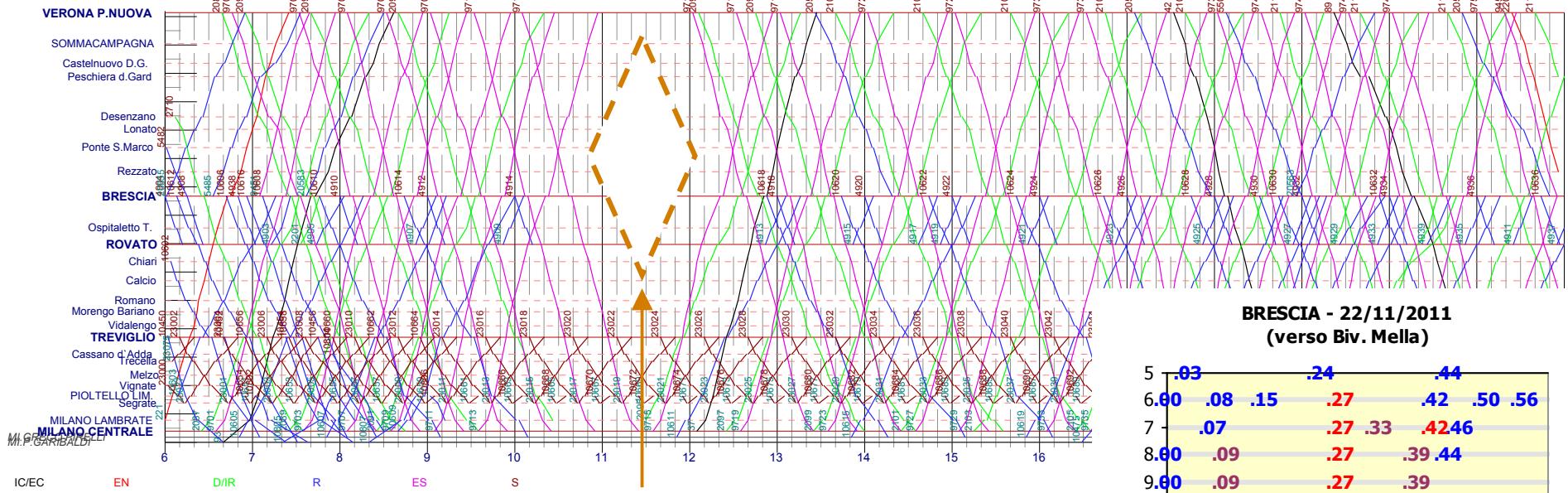


Milano Romolo - 23/11/2011
(verso MI.S.CRISTOFORO)

6	.24	
7	.24	.54
8	.24	.54
9	.24	.54
10	.24	.54
11	.24	.54
12	.24	.54
13	.24	.54
14	.24	.54
15	.24	.54
16	.24	.54
17	.24	.54
18	.24	.54
19	.24	.54
20	.24	.54
21	.24	.54
22		
23		
24		

A Complex World (Main Line)

martedì 23/11/2010



BRESCIA - 22/11/2011
(verso Biv. Mella)

5	.03	.24	.44
6.00	.08 .15	.27	.42 .50 .56
7	.07	.27 .33	.42 .46
8.00	.09	.27	.39 .44
9.00	.09	.27	.39
10.00	.09		.39
11			
12			.39 .49 .53
13.00	.09	.27	.39 .44
14.00		.27	.39 .44
15.00		.27	.39 .44
16.00		.27	.39 .44
17.00	.09	.27	.44
18.00	.09	.27 .31	.39 .44
19.00	.09	.27	.39 .53
20.00	.09 .17	.27	.39
21.00		.27	.39 .44
22	.06 .18	.27	
23			
24			

R D/IR S IC/EC ES EN



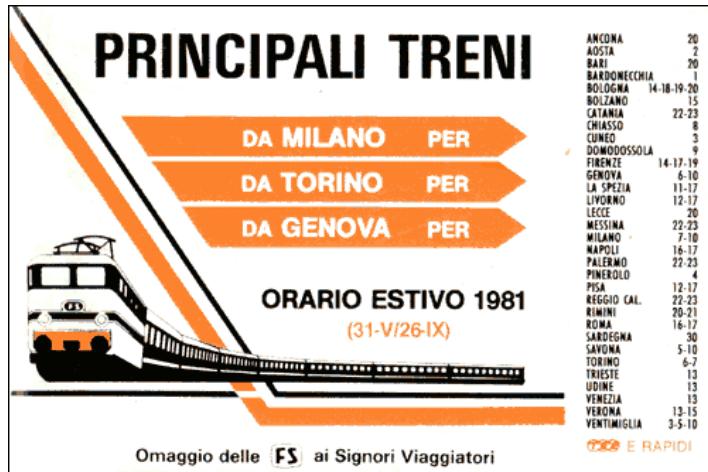
Line Milan-Verona

- Eurostarcity Milan-Venice, Interregio Milan-Verona, local traffic Brescia-Rovato (to Bergamo) and Brescia-Milano **must share the same tracks**
- Although “out of structure” trains still exist, a good structure is important to standardise traffic (*useful for both users and operators!*)
- In suburban area (Treviglio-Milan) **4 tracks are required** to have also S Lines (S5-S6)

People on Trains: Some Examples



1981: "Prehistoric" Timetables even on Main Lines



Milan-Rome:

- Three *Trans Europ Express* (around 6h), each one with its own name:
 - "Settebello" (ETR.300)
 - "Vesuvio" (to Naples)
 - "Ambrosiano"
- One *Rapido* to Naples
- Two *Rapido* on partial route Bologna/Florence-Rome

Thats all!

1 c	1 c	1 c	1 c	1 c	1 c	1 c	7	1 c	1 c	1 c	1 c	1 c	1 c	1 d
7.50	...	11.50	12.50	16.50			p. MILANO C.	a.	13.55	17.40	20.30	H	23.05	23.42
9.42	13.05	13.47	14.55	18.53			p. BOLOGNA C.	a.	12.00	15.46	18.20	17.12	21.07	21.48
6.50	10.59	14.17	15.01	16.09	20.08		p. FIRENZE S.M.N.	a.	10.42	14.23	16.55	15.57	19.41	20.34
9.38	13.48	17.13	17.46	19.15	23.05	Va.	a. ROMA TERM.	p.	7.50	11.27	13.45	13.00	16.25	17.40
...	...	...	20.10	21.42	...		NAPOLI C.	p.	...	...	11.30	...	15.30	19.12

a Napoli Mergellina. – b Milano Lambrate. – c Sospeso ⚡. – d Sospeso ⚡.

Increasing the **number of trains per day** (and thus the number of **seats**) is a good measure of "progress" in railway, even more than increasing **speed** and performances.



1985: a New Era in Italian Timetables



Every 2 hours:

- Intercity Turin-Milan (1h35)
 - Direct train Turin-Milan (1h47)
 - Intercity Milan-Venice (2h45)
 - Direct train Milan-Venice (3h)
 - Intercity Milan-Genoa
 - Express train Milan-Ventimiglia
 - Direct train Genoa-Ventimiglia



The first “really new” timetable in FS history: a structured service in North-West Italy.

Milan-Rome, from Intercity to *Frecciarossa*

TRENI INTERCITY																		
MILANO CENTRALE - ROMA TERMINI																		
	IC 511	IC 575	IC 547	IC 519	IC 521	IC 523	IC 525	IC 577	IC 553	IC 527	IC 528	IC 531	IC 533	EC 37	IC 535	IC 537	IC 559	IC 541
a					b			c		d								e
MILANO C. p.		6.55		7.55	8.55			11.55		12.55	13.55	14.55	15.55	da	16.55	17.55		19.55
BOLOGNA C. a.		8.38		9.38	10.38			13.38		14.38	15.38	16.38	17.38	WIEN	18.38	19.38		21.38
VENEZIA S.L. p.			7.25						12.26					16.36				
BOLOGNA C. a.			9.00						13.50					18.00				
VERONA P.N. p.									12.30									
BOLOGNA C. a.									13.50									
BOLOGNA C. p.		8.42							13.42									
BARI C. a.		15.18								20.18								
LECCE		17.35							22.36									
BOLOGNA C. p.		5.42		9.04	9.42	10.42				14.04	14.42	15.42	16.42	17.42	18.04	18.42	19.42	20.04
FIRENZE S.M.N. p.		6.46		10.08	10.46	11.46				15.08	15.46	16.46	17.46	18.46	19.08	19.46	20.46	21.08
ROMA T.N.I. a.		6.55		10.17	10.55	11.55	12.55	13.55		15.17	15.55	16.55	17.55	18.55	19.17	19.55	20.55	21.17
ROMA T.N.I. a.		9.07		12.27	13.05	14.05	14.50	16.05		17.27	18.05	19.05	20.00	21.05	21.27	22.05	23.05	23.27



Yesterday (**1987**)
The Intercity system:
9 connections Milan-
Rome in **5h10**

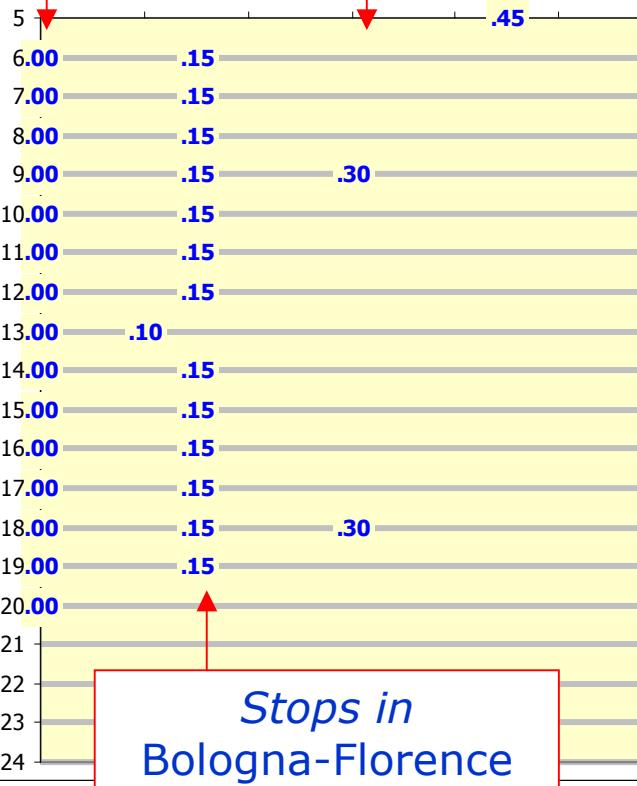


Today (**2011**) →
The *Frecciarossa* system:
32 connections Milan-
Rome:

- **17 non stop (3h)**
- **15 with stops (3h30)**

Non Stop
Milan-Rome

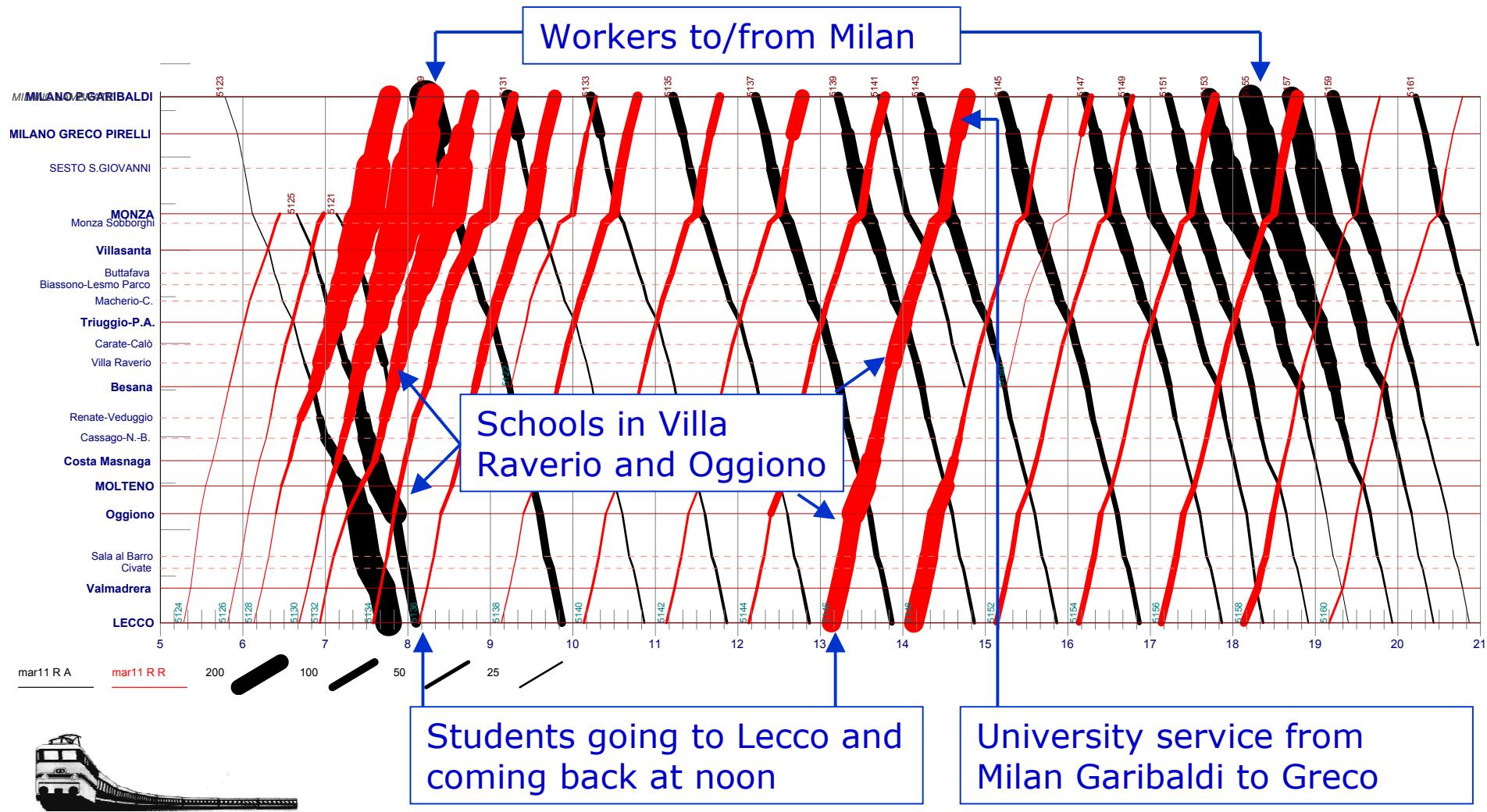
Stazione di MILANO CENTRALE
Direzione: ROMA (AV)



People on Board (another use of timetable charts)

Line Milan-Molteno-Lecco (S7)

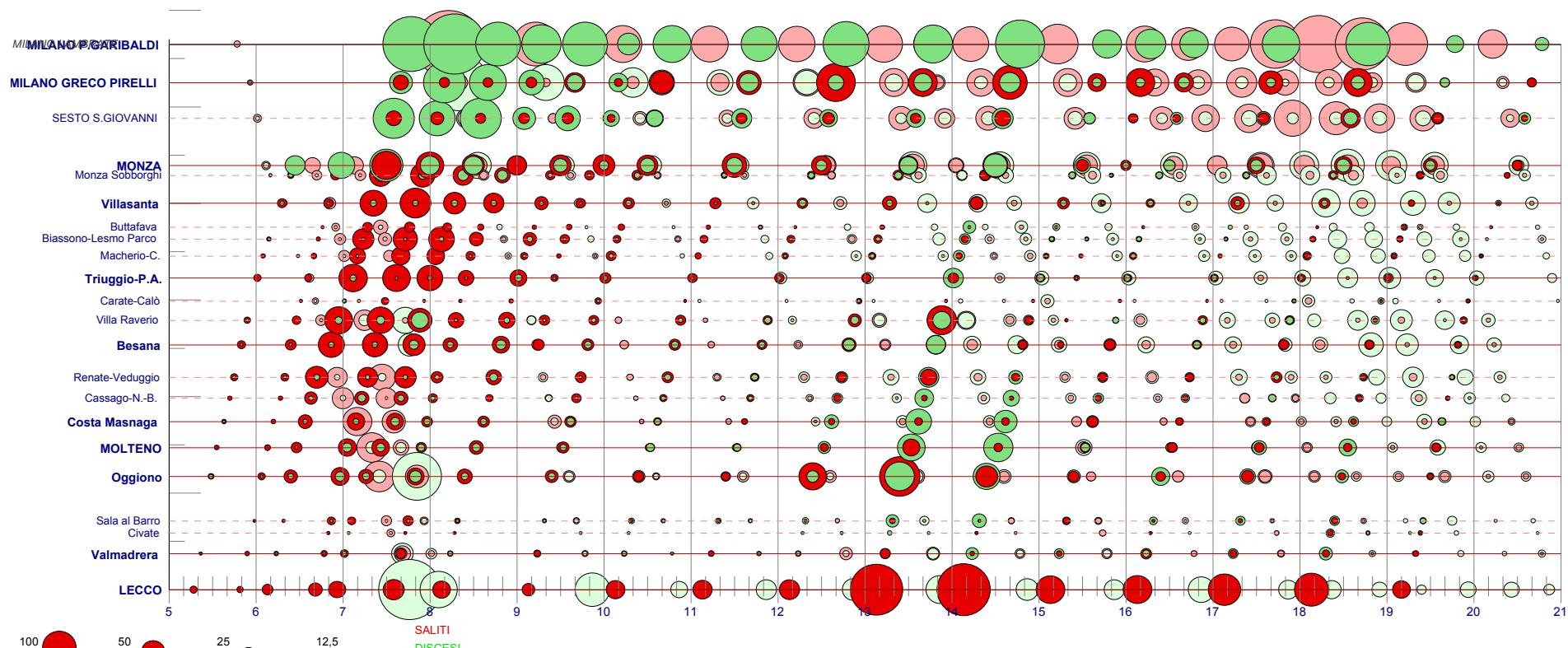
- Thickness represents the number of passengers in each section



People on Board: Getting On and Off the Train

Line Milan-Molteno-Lecco

- Areas of the circles represent passengers getting **on** and **off** the train

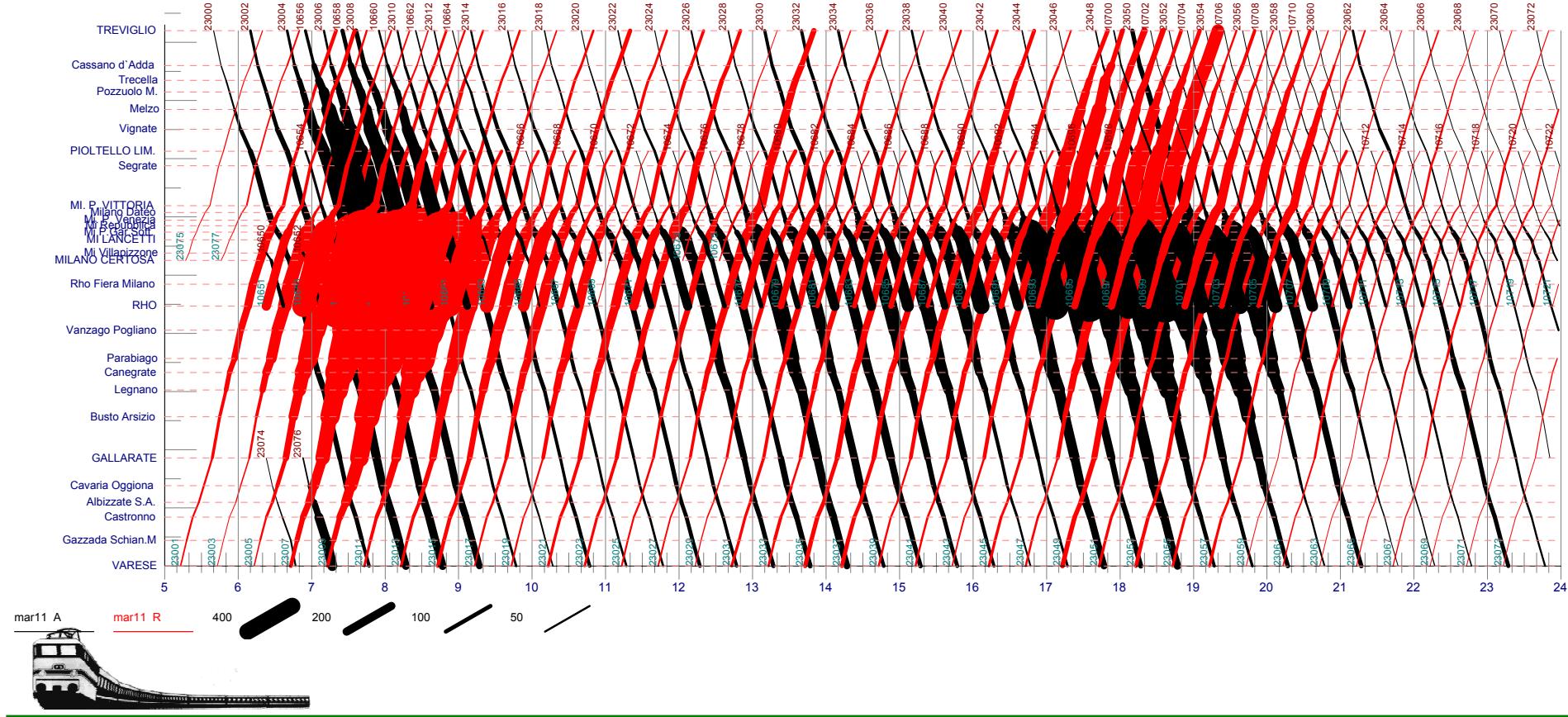


People on Board: S Lines

Line **S5** Varese-Treviglio travelling along the Passante (every 30 minutes from 6 to midnight)

In section Rho-Passante-Pioltello(-Treviglio peak only), frequency is 15 minutes thanks to overlapping with S6

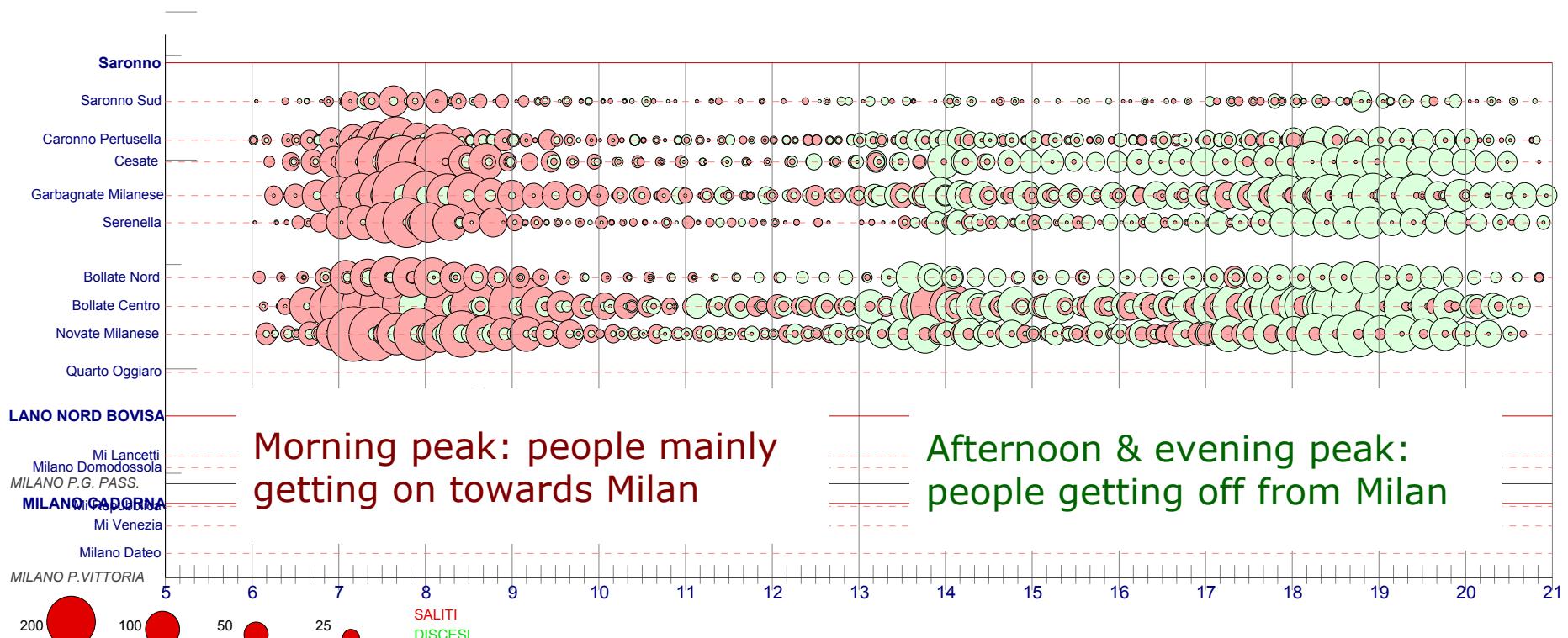
- In peak hours trains are crowded in both directions (Passante effect)
- The performance is very good along the whole day



Getting On and Off the Train: S Line

Line **S1+S3** Milano-Saronno, frequency of 15 minutes all day

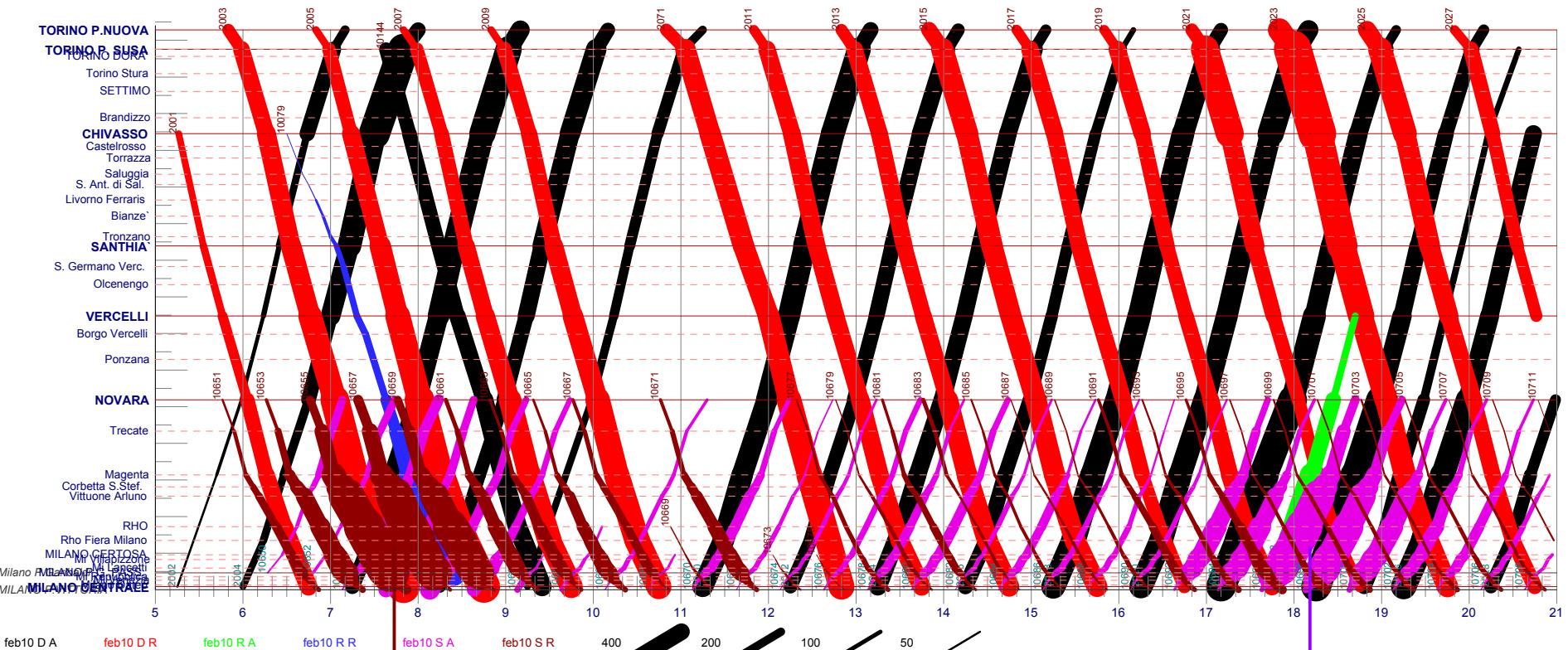
- Peaks are relevant, but there are passengers along the whole day



People on Board: Interregio Traffic

Line Turin-Milan, an **Interregio** every hour. Stops every 15' in each node (Chivasso, Santhià, Vercelli, Novara, Magenta, Rho):

- Excellent performance from early morning to late evening!



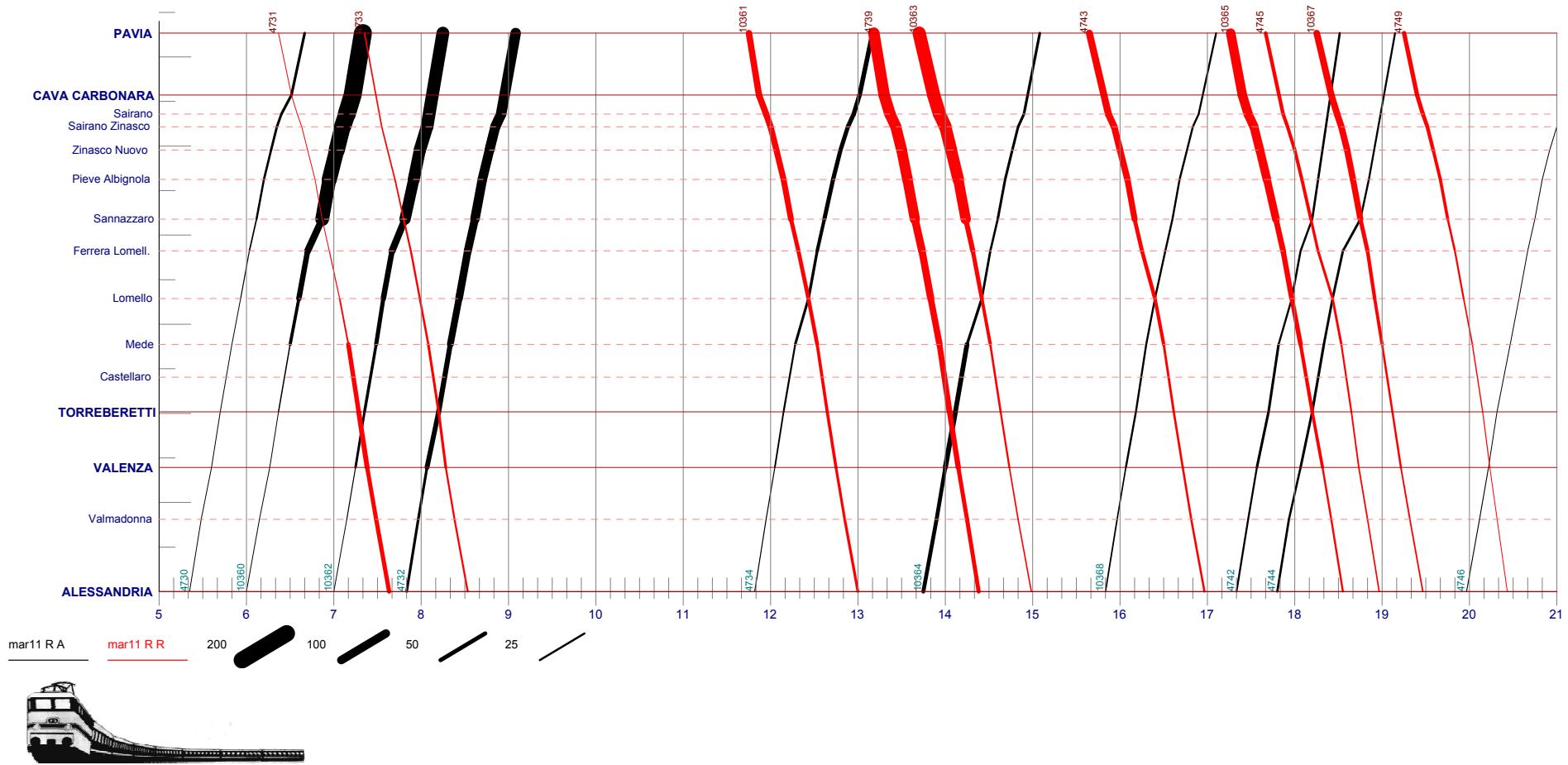
Novara-Milan: Line **S6** (especially crowded in peak hours)



People on board: non structured lines

Line Pavia-Alessandria (diesel railcars)

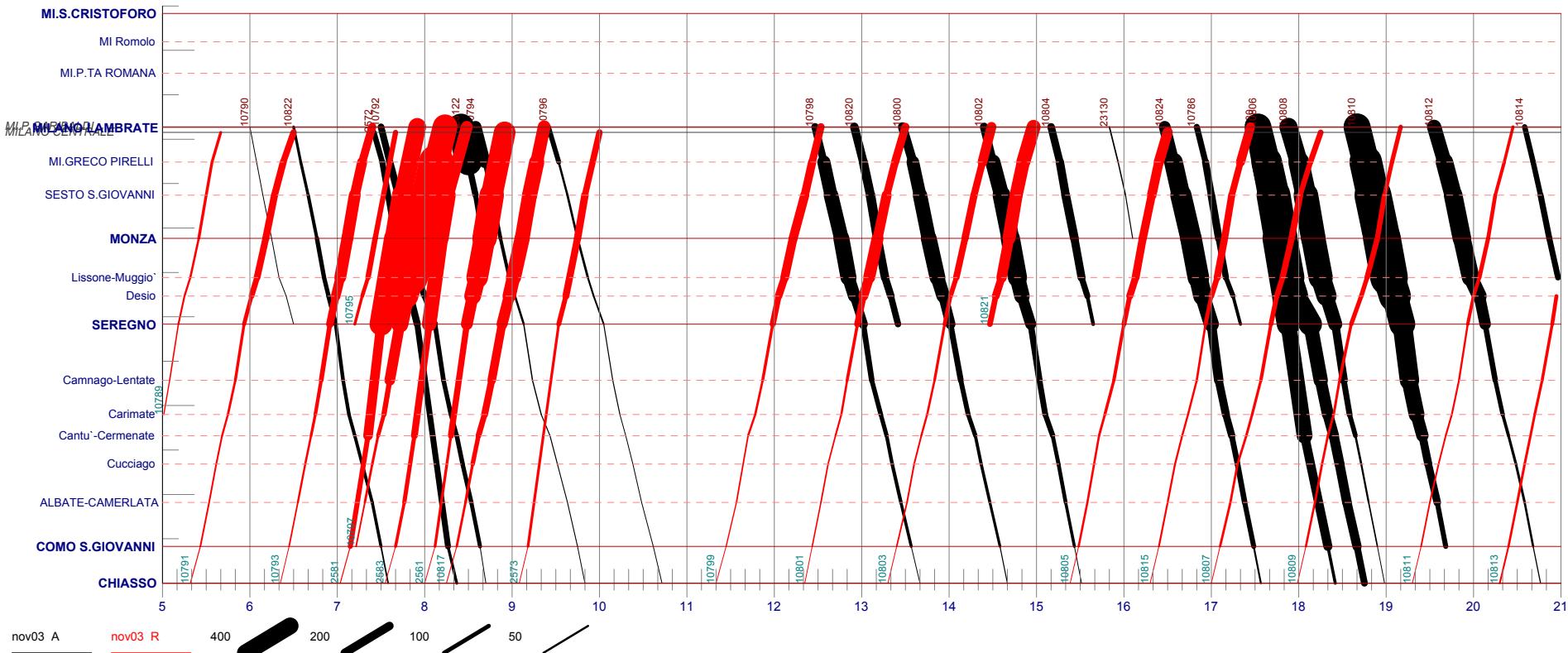
- Non structured timetable. Mainly for students (see passengers from Pavia between 13 and 14). It's difficult to reach outstanding performances.



People on Board: Structuring the Service - Before

Line Milan-Chiasso, November 2003

- The line has international long distance traffic (Gotthard) but regional service is not structured.

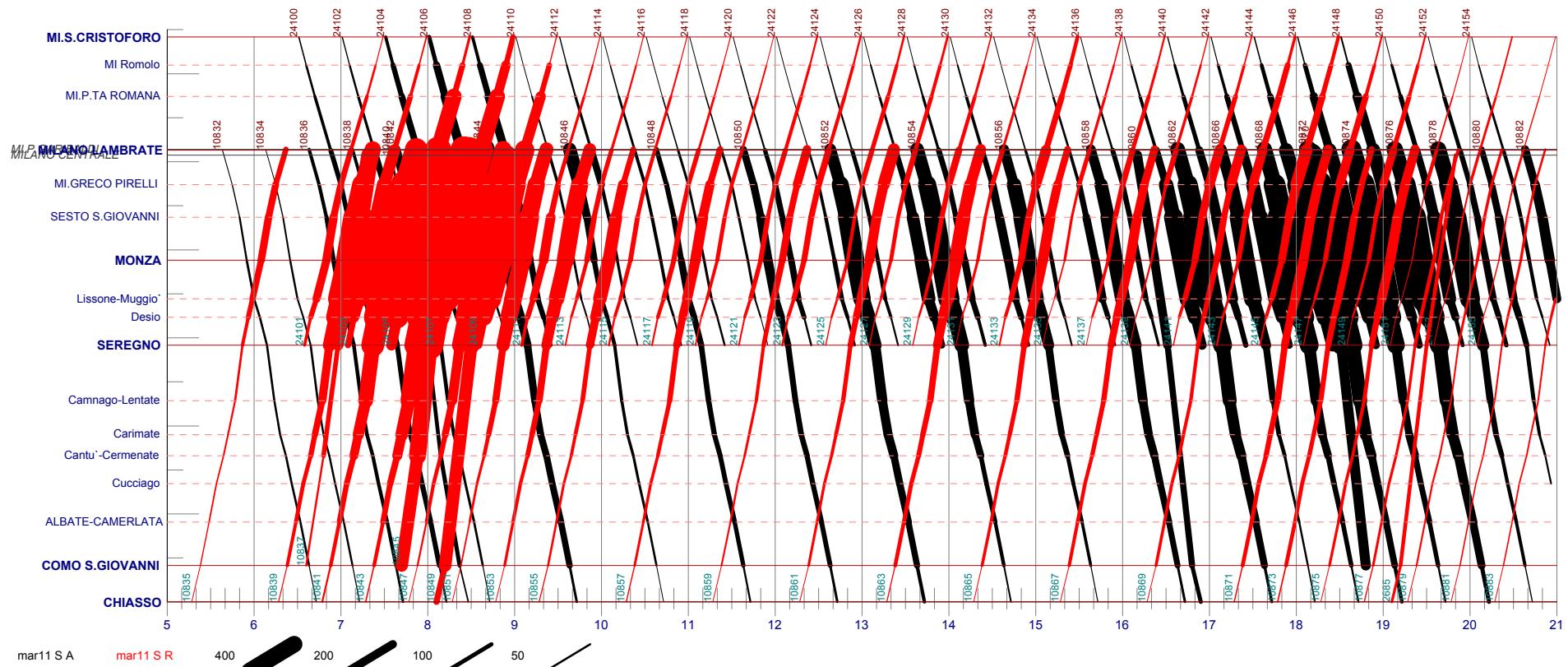


- Trains only in peak hours. Absolutely nothing in mid morning.
Mainly addressed to “traditional” commuters
 - It’s difficult to increase passengers



People on Board: Structuring the Service - After

Line Milan-Chiasso, today (March 2011)



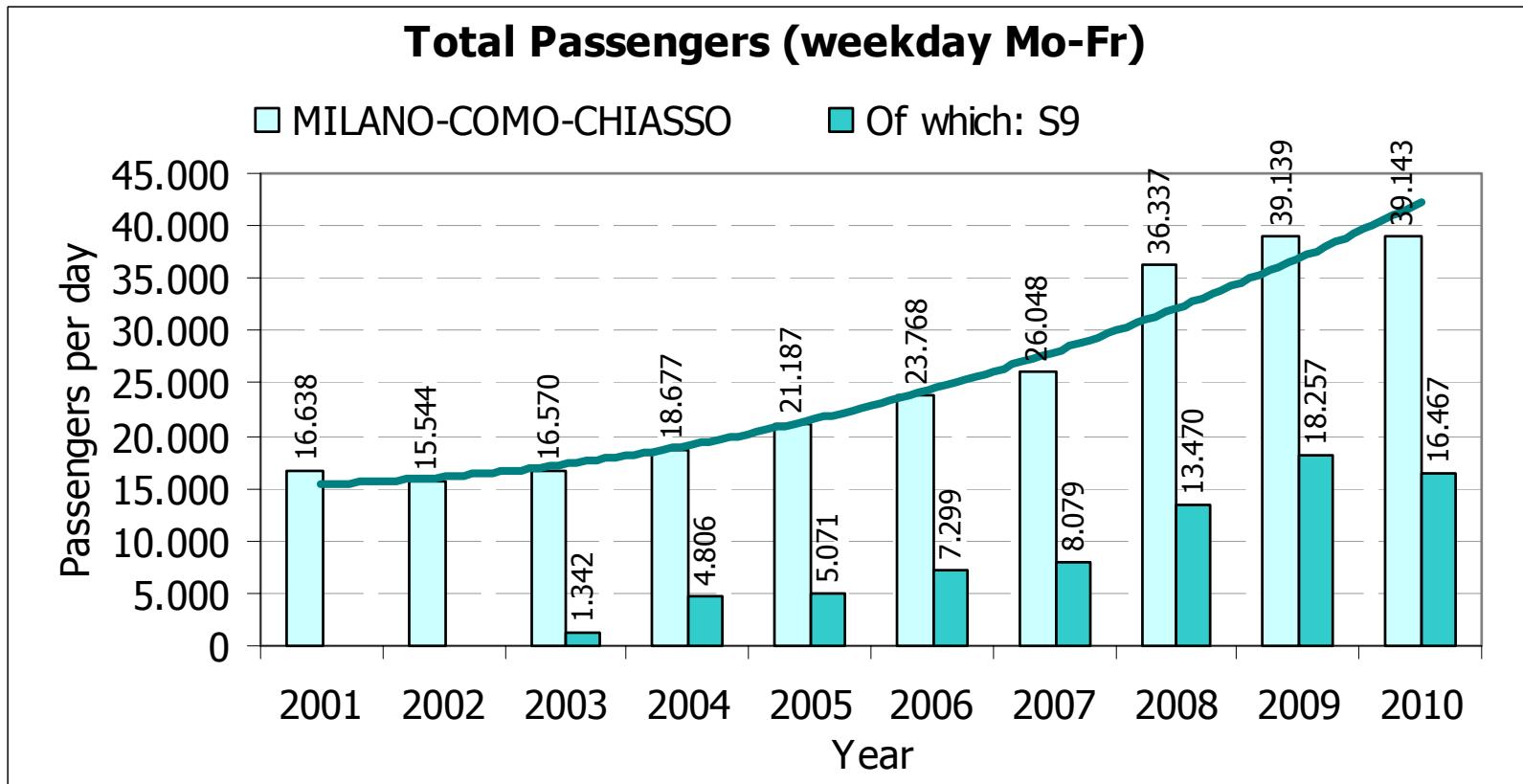
- **S9** Milan-Seregno every 30' all day + **S11** Milan-Chiasso every 60' off-peak / 30' peak + Direct trains Milan-Chiasso-Bellinzona (CH)
- Excellent performance



Structuring the Service - Year after Year

Line Milan-Chiasso 2001-2010:

- from 16000 to 39000 passengers per day = **+145%**

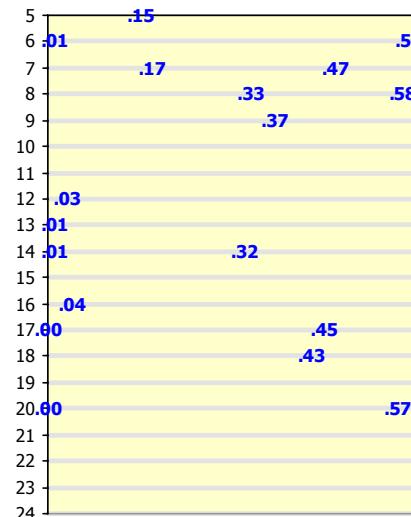


Structuring the Service - Year after Year

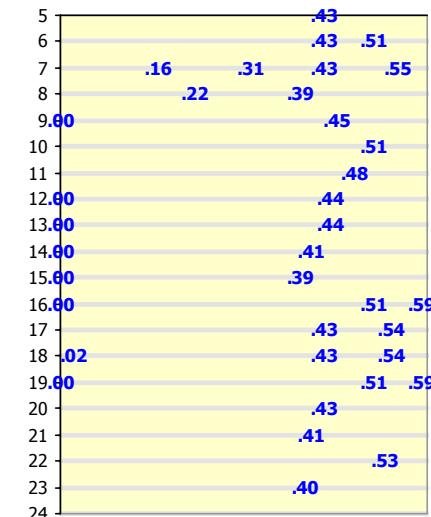
Line Milan-Chiasso 2003-2011

No need to explain!

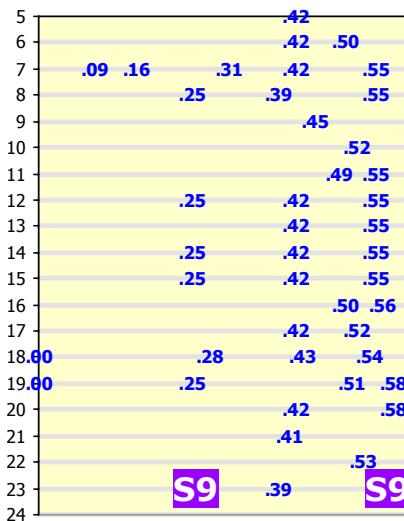
Desio - 24/11/2003
(verso Lissone-Muggio`)



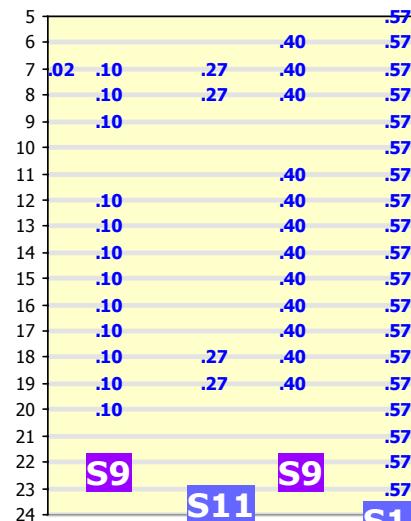
Desio - 23/11/2005
(verso Lissone-Muggio`)



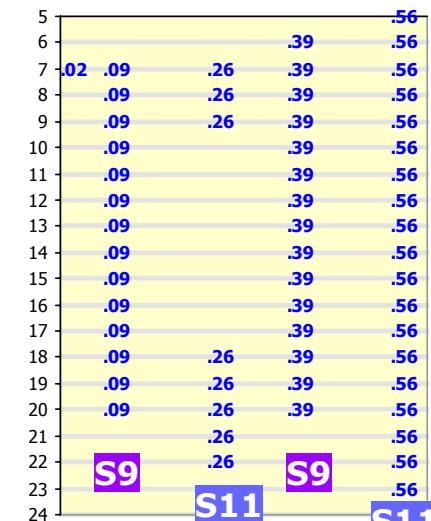
Desio - 23/11/2007
(verso Lissone-Muggio`)



Desio - 23/11/2009
(verso Lissone-Muggio`)



Desio - 23/11/2011
(verso Lissone-Muggio`)

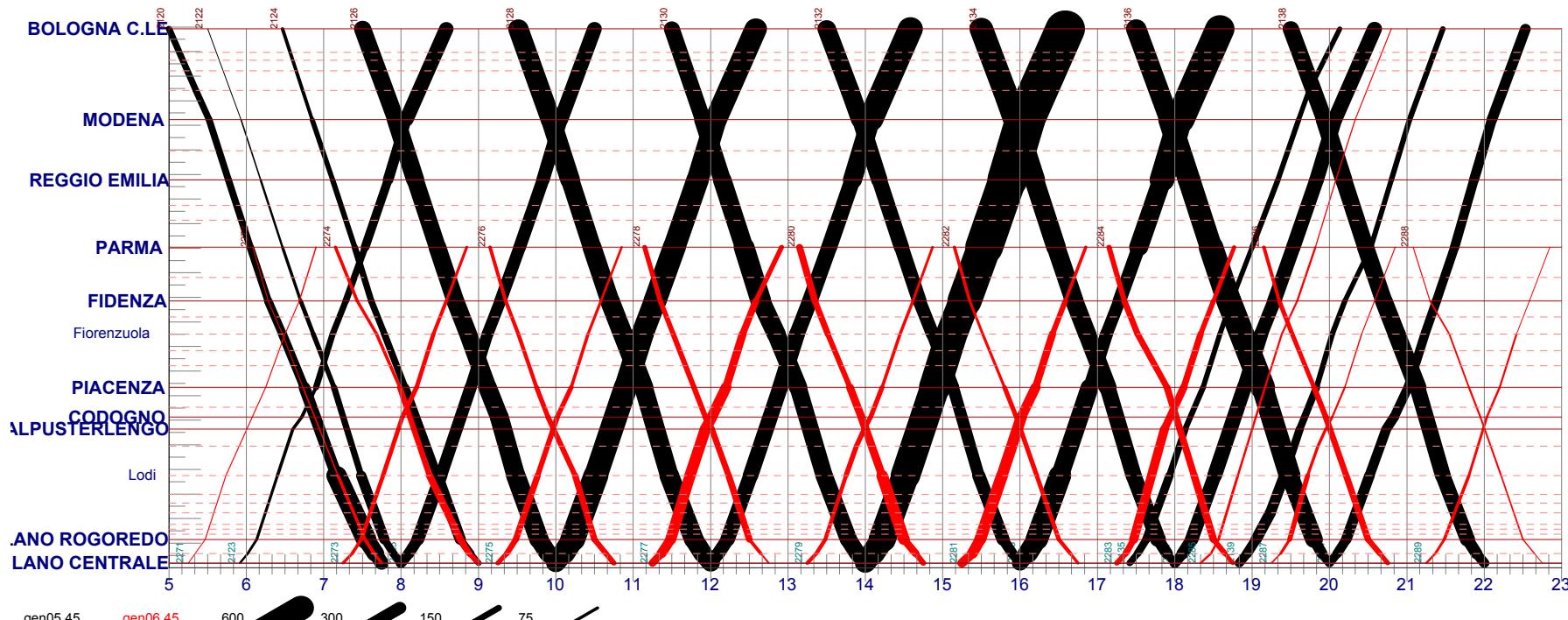


Train journey is related with number of stops

In 1987-2005, Direct trains connected Milan with Bologna, and had exceptionally good performance (number of passengers)

In 2005, trains were limited to Milan-Parma journey. The number of passengers decreased dramatically.

- The more a train is direct (fewer stops), the more it requires a "minimum journey" to capture enough people



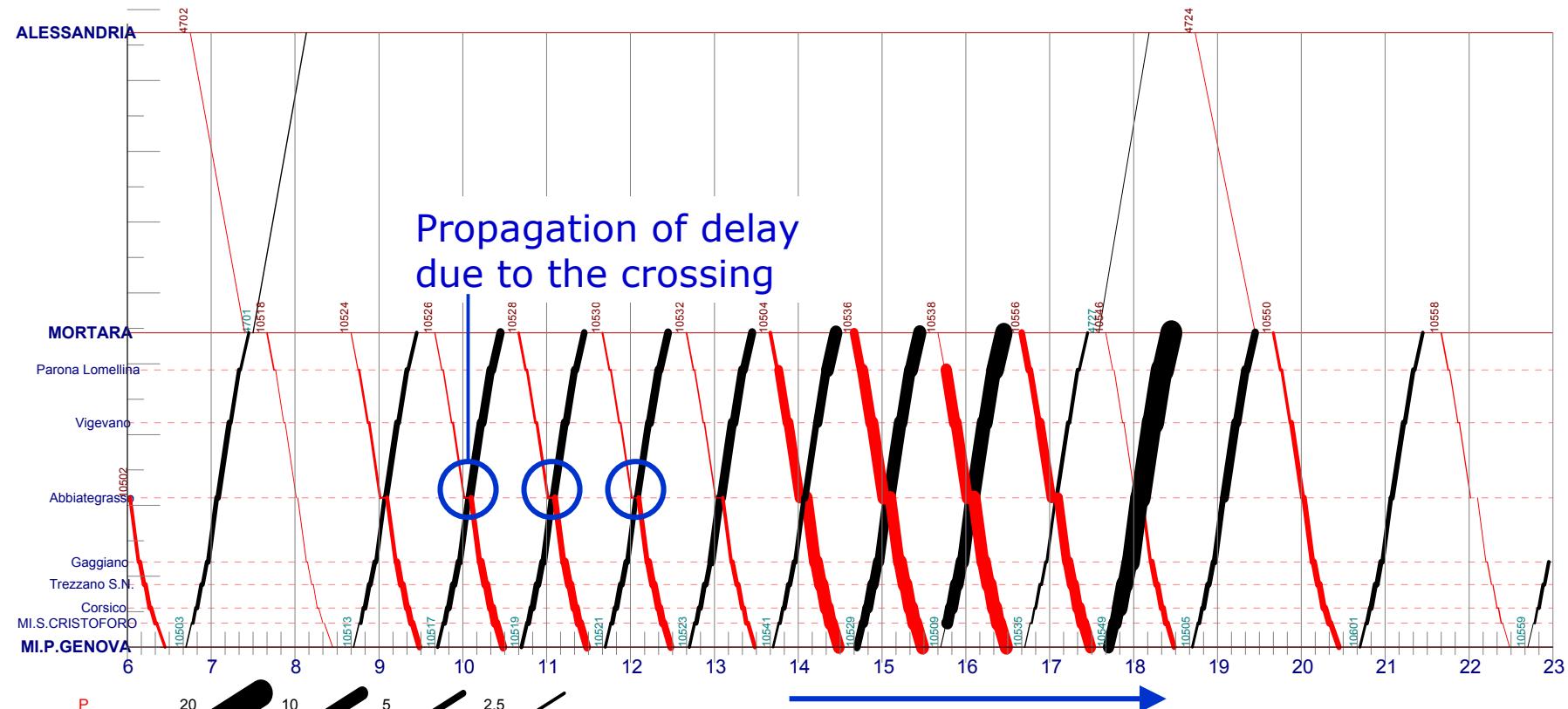
Saturday, 2005 winter time:
Milan-Bologna

Saturday, 2006 winter time:
Milan-Parma

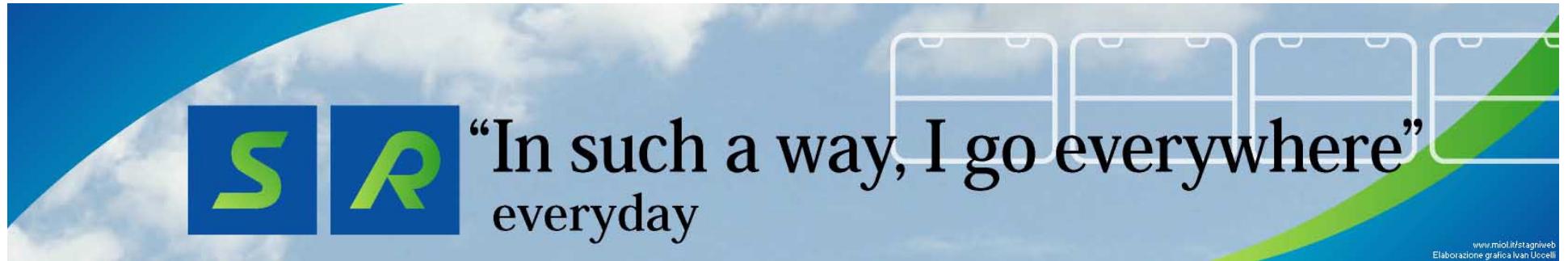
Delays (another use of timetable charts)

Line Milan-Mortara, June 2004, Sundays

- Thickness represents the average delay (minutes)



Propagation of delay from one trip to the next!
(with progressive increase of average delay)



Learning more:

www.miol.it/stagniweb

Thank you for your kind attention and... **have a nice trip!**

