Michel Leboeuf
UIC
Février 2019

INTERNATIONAL UNION
OF RAILWAYS

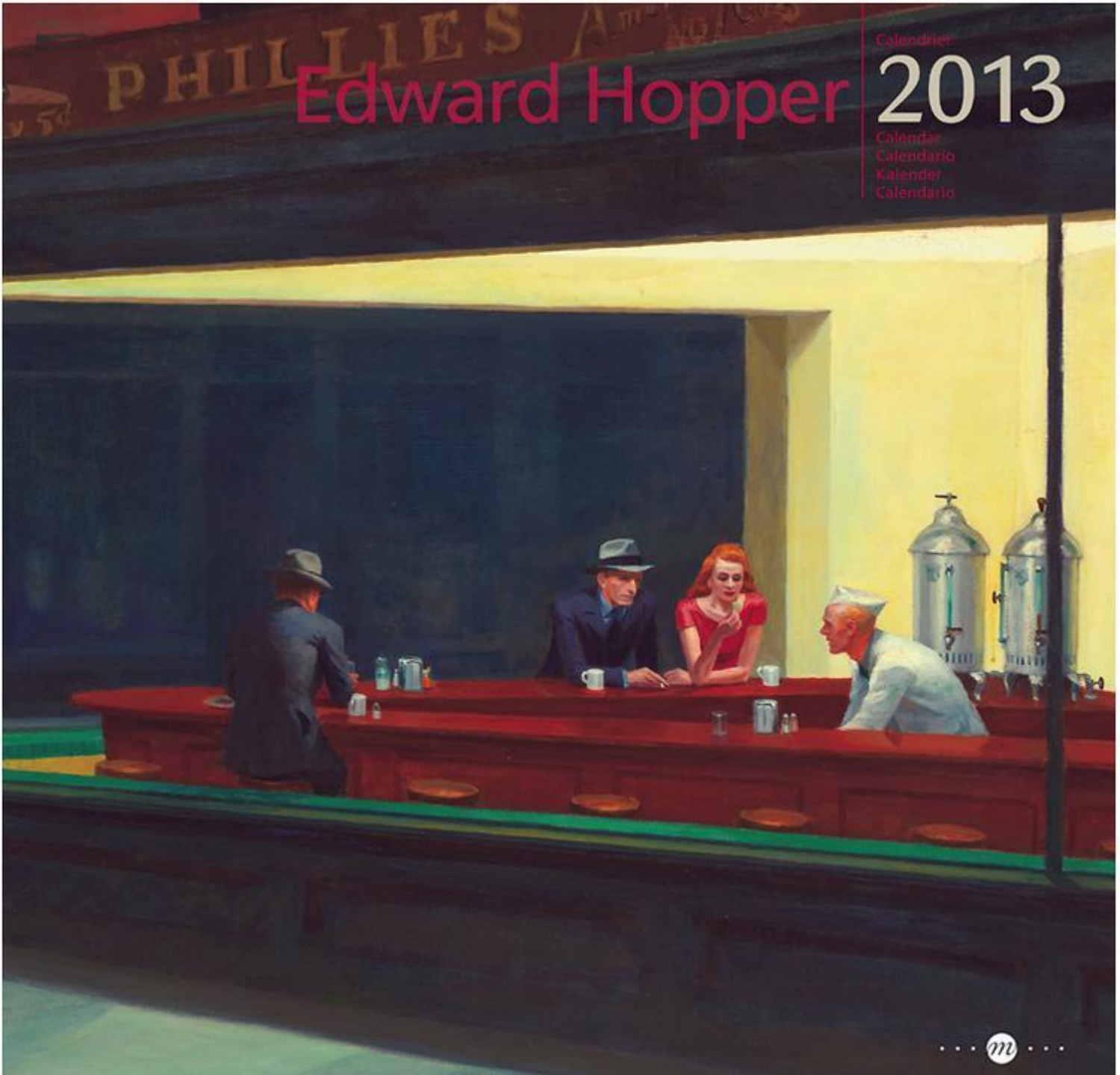
unity, solidarity, universality

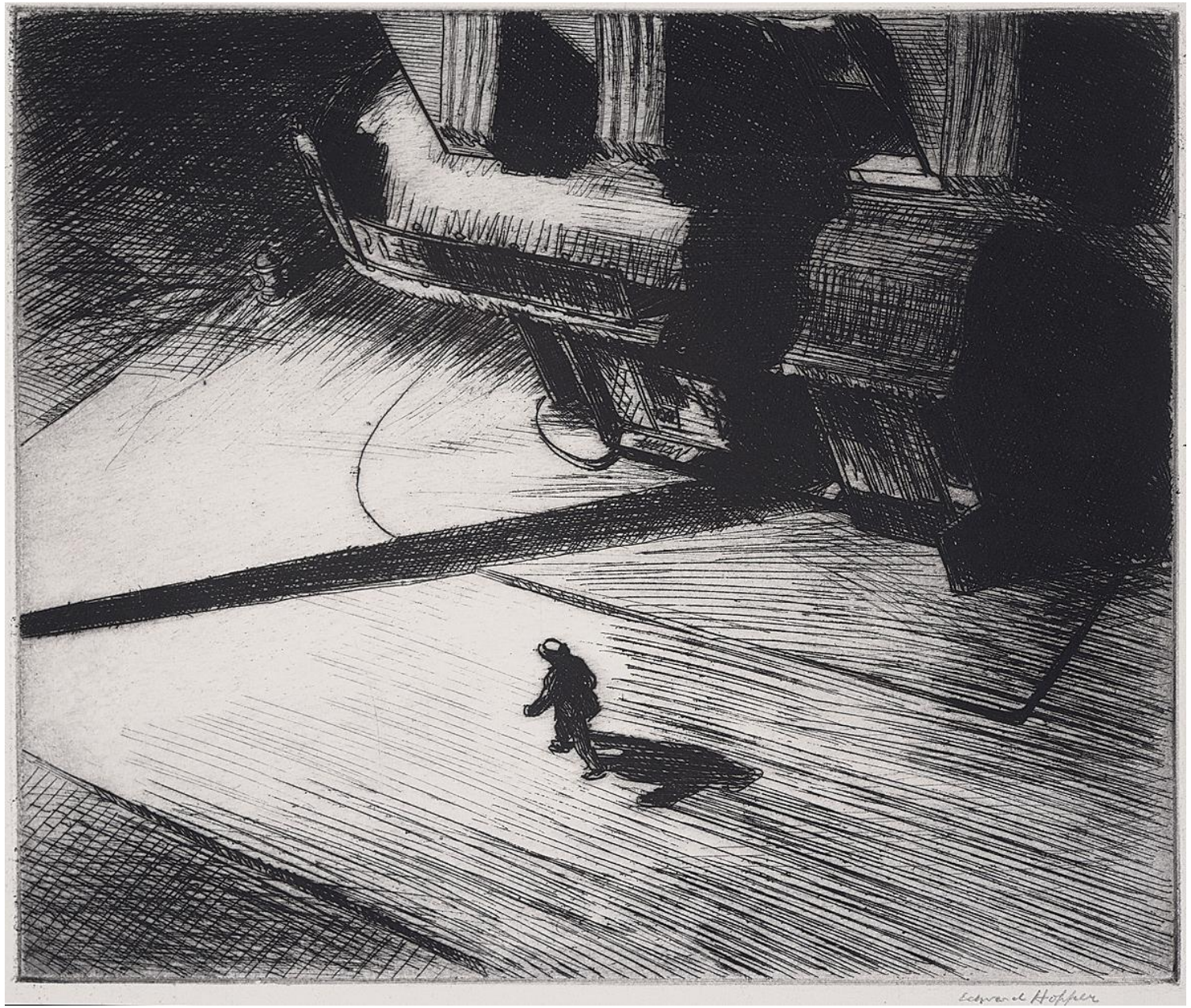
HIGH SPEED RAIL

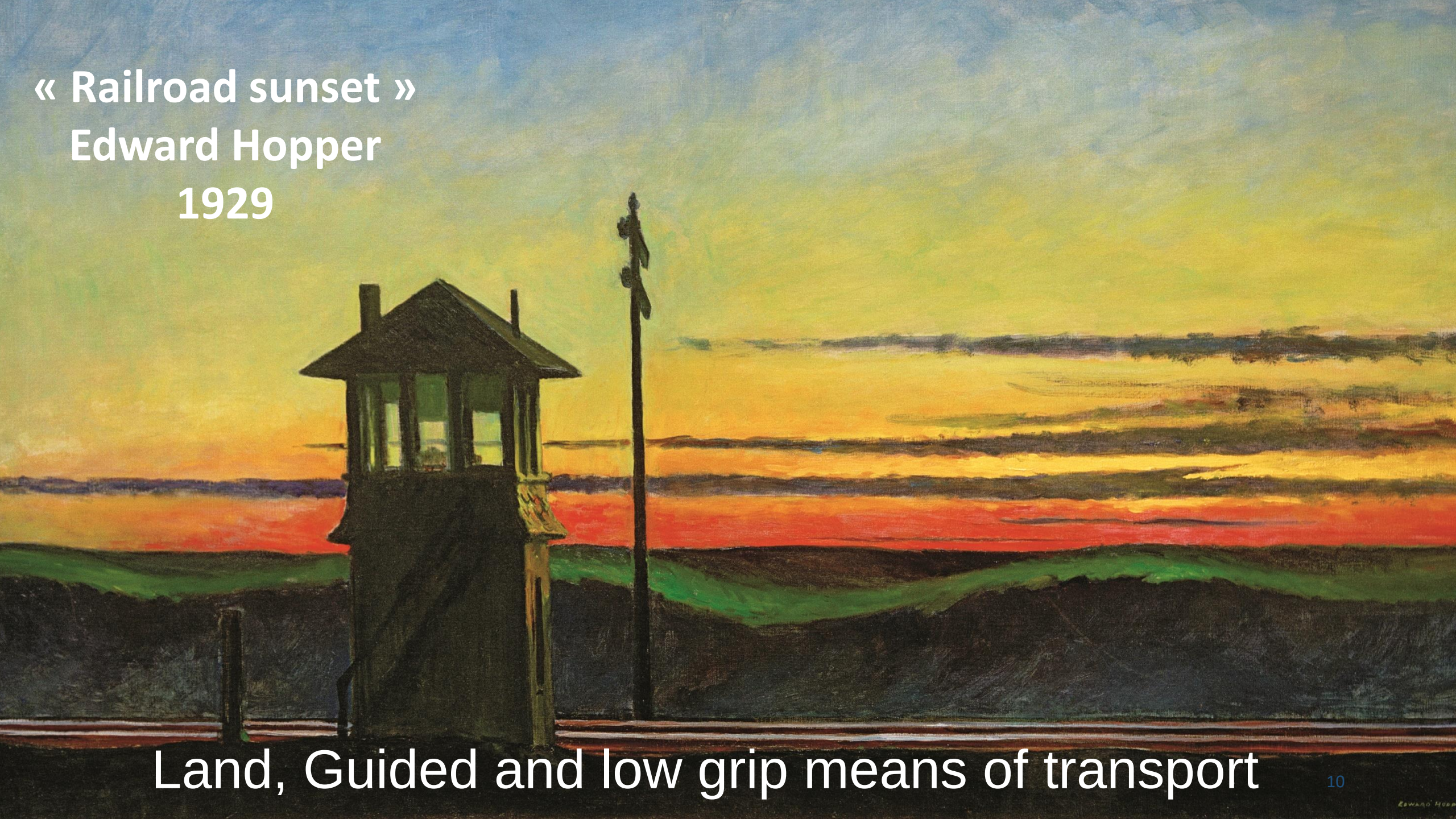
UIC – 14-15Th February 2019

Michel LEBOEUF
Honorary Chairman
High Speed Committee, UIC

INTRODUCTION


PHILLIES
Edward Hopper
Calendrier
2013
Calendar
Calendario
Kalender
Calendario


Edward Hopper

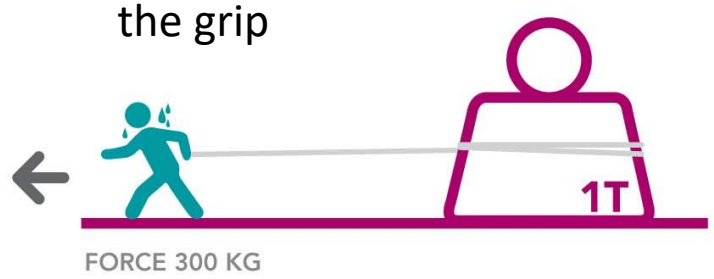


Land, Guided and low grip means of transport

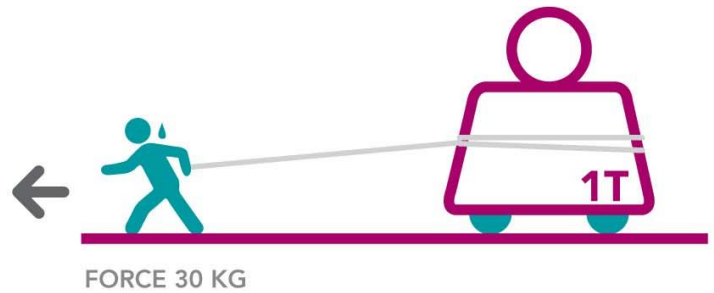
RAILWAY SYSTEM

With low grip

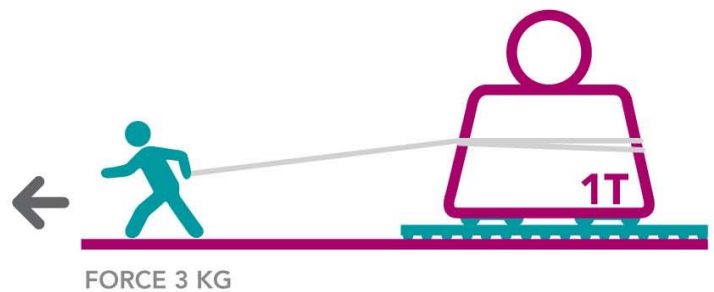
Strength to overtake the grip



On the ground



On tires



On on rail

Premier train :
Angleterre, Surey iron railway - 1803

“One small trip for horse, one giant leap for transport”

Neil Armstrong: “One small step for man, one giant leap for mankind”
(20 juillet 1969)

Braking and capacity

Breaking distance in urgency:	
160 km/h	900 m
270 km/h	2 650 m
300 km/h	3 350 m

Headway between trains: (300 km/h):	
4 minutes	20 km
5 minutes	25 km

Breaking distances on road

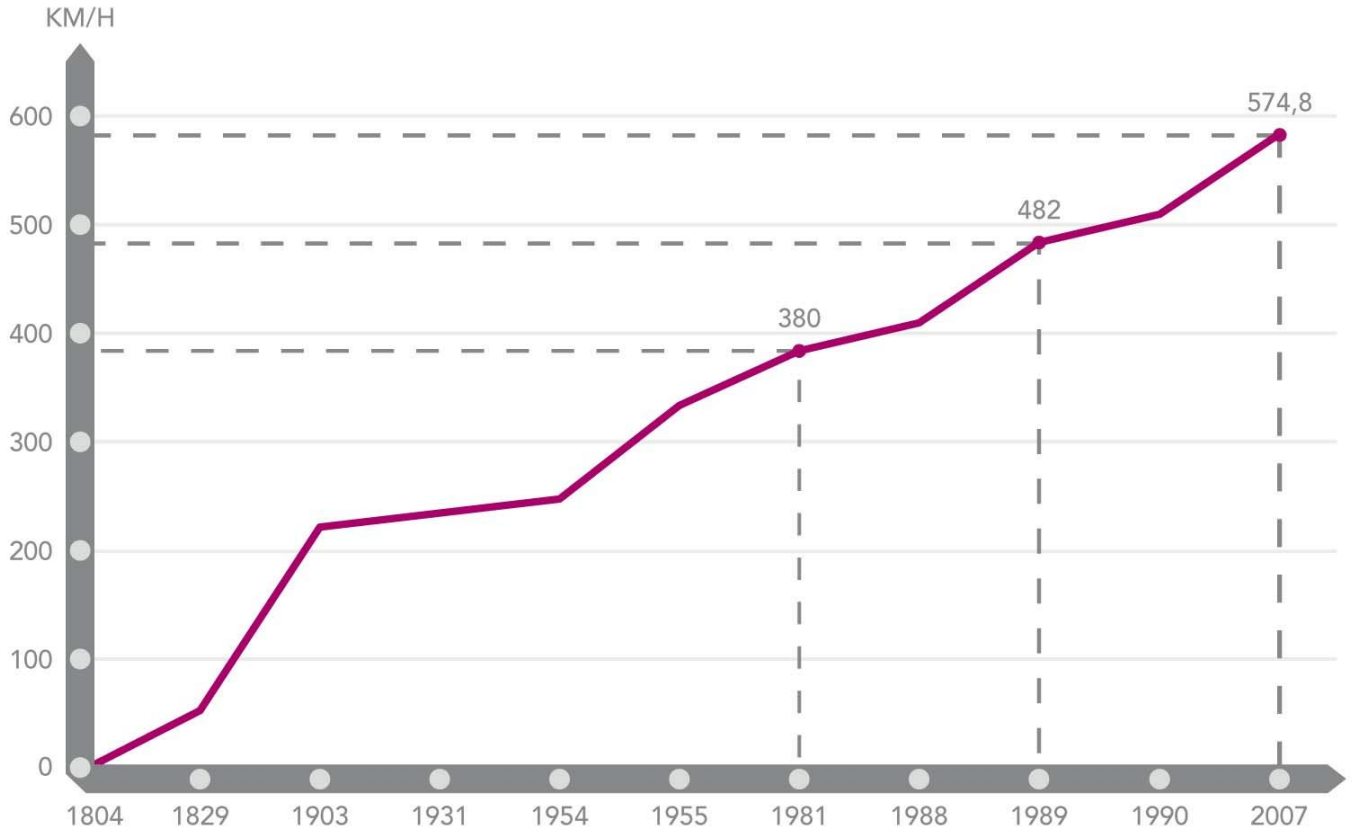
	v_0 (km/h)	v_0 (m/s)	DR (m)	DF (m)	DA (m)
City centre	30	8	8	6	14
Urban area	50	14	14	16	30
Main road	90	25	25	52	77
Highway (when raining)	110	31	31	78	109
Highway (without rain)	130	36	36	108	145

DR: distance for reaction
DF: breaking distance
DA: stopping distance

guided

Guided with low grip
=
speed

World speed records on rail

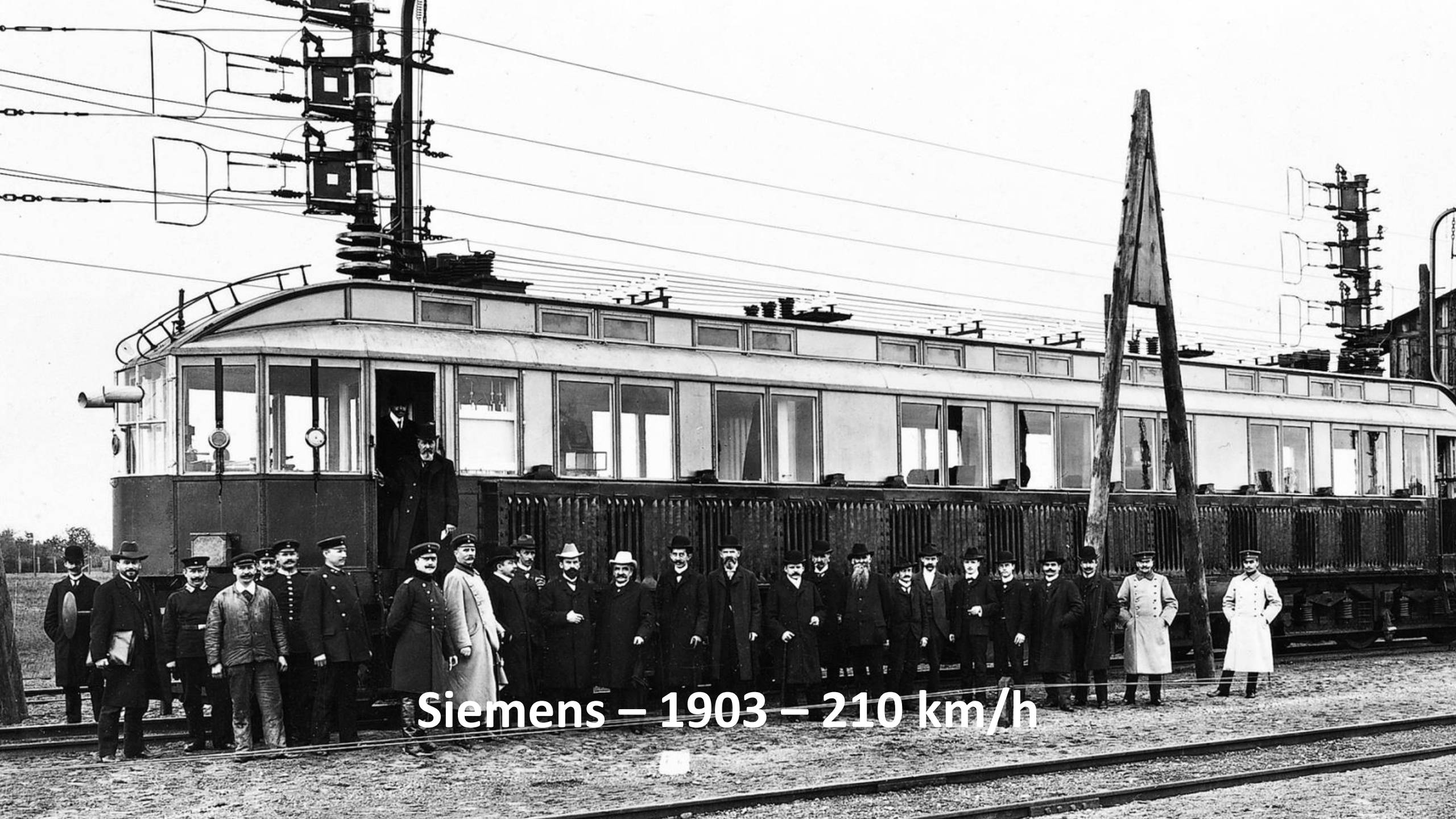



Rocket, by George Stephenson – 1829 – 50 km/h

Thomas Crampton – 1852 – 120 km/h

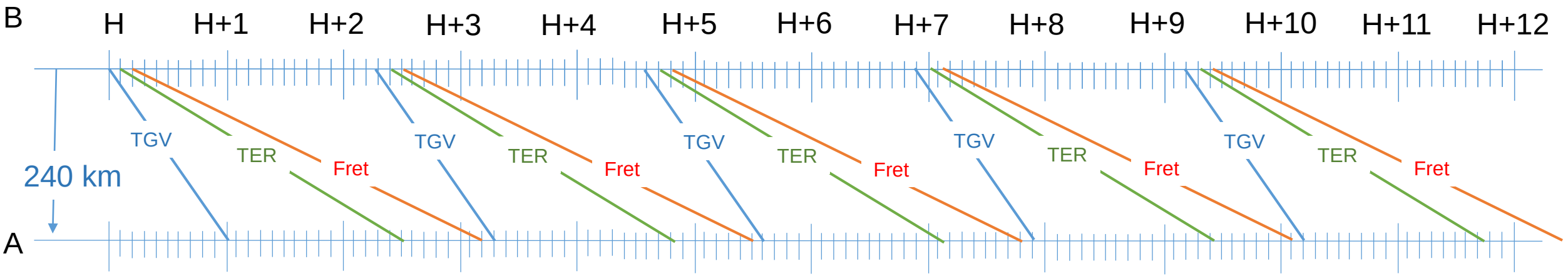
Mallard, by Sir Nigel Gresley for LNER – 1938 – 203 km/h

New York Central – 1966 – 300 km/h


Siemens – 1903 – 210 km/h

CC 7701 & BB 9004 – 1955 – 331 km/h


World Speed record
574,8 km/h


B
H
H+1
H+2
H+3
H+4
H+5
H+6
H+7
H+8
H+9
H+10
H+11
H+12
TGV
TER
Fret
240 km
A

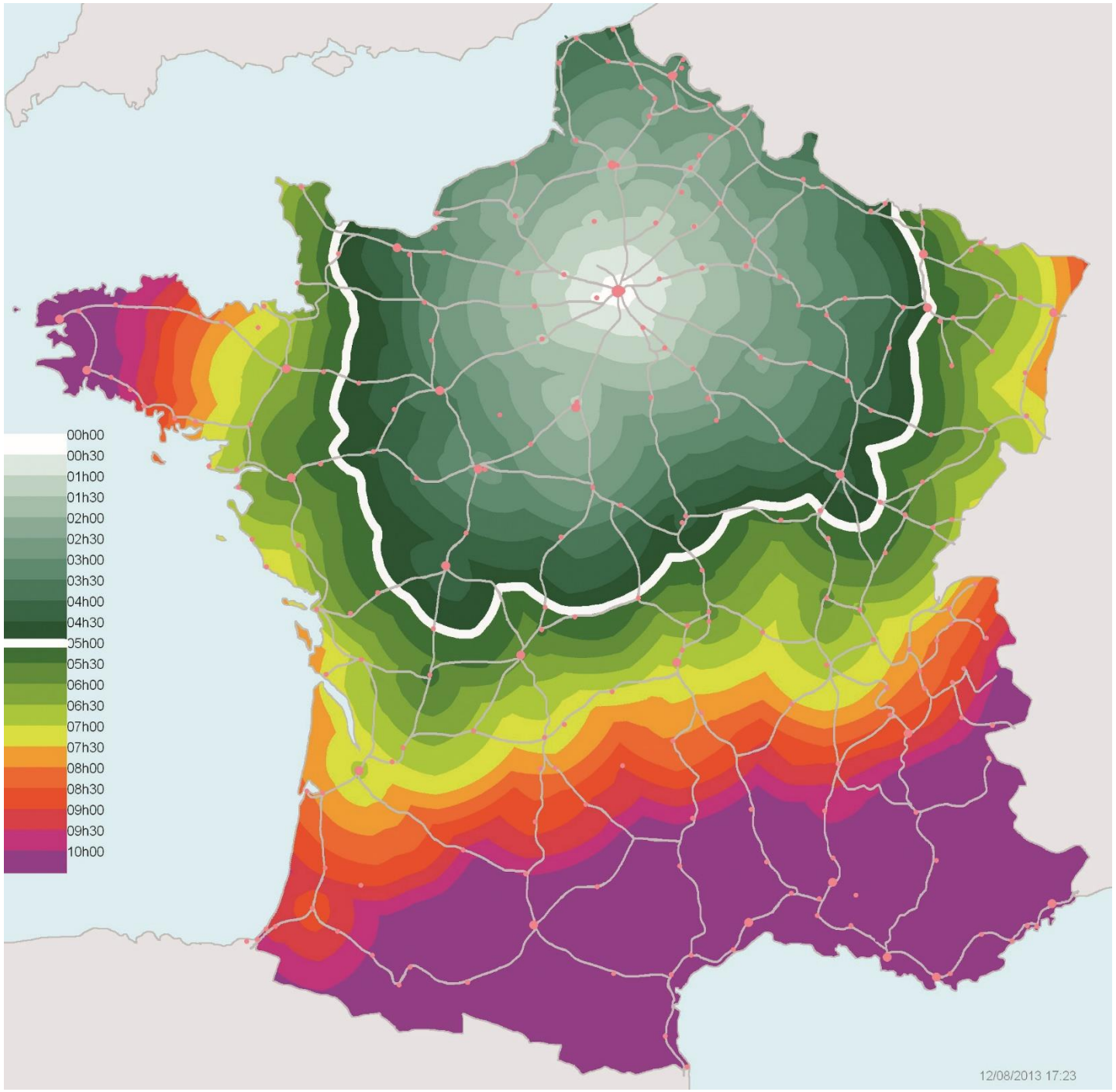
On land


MAERSK CAROLINA

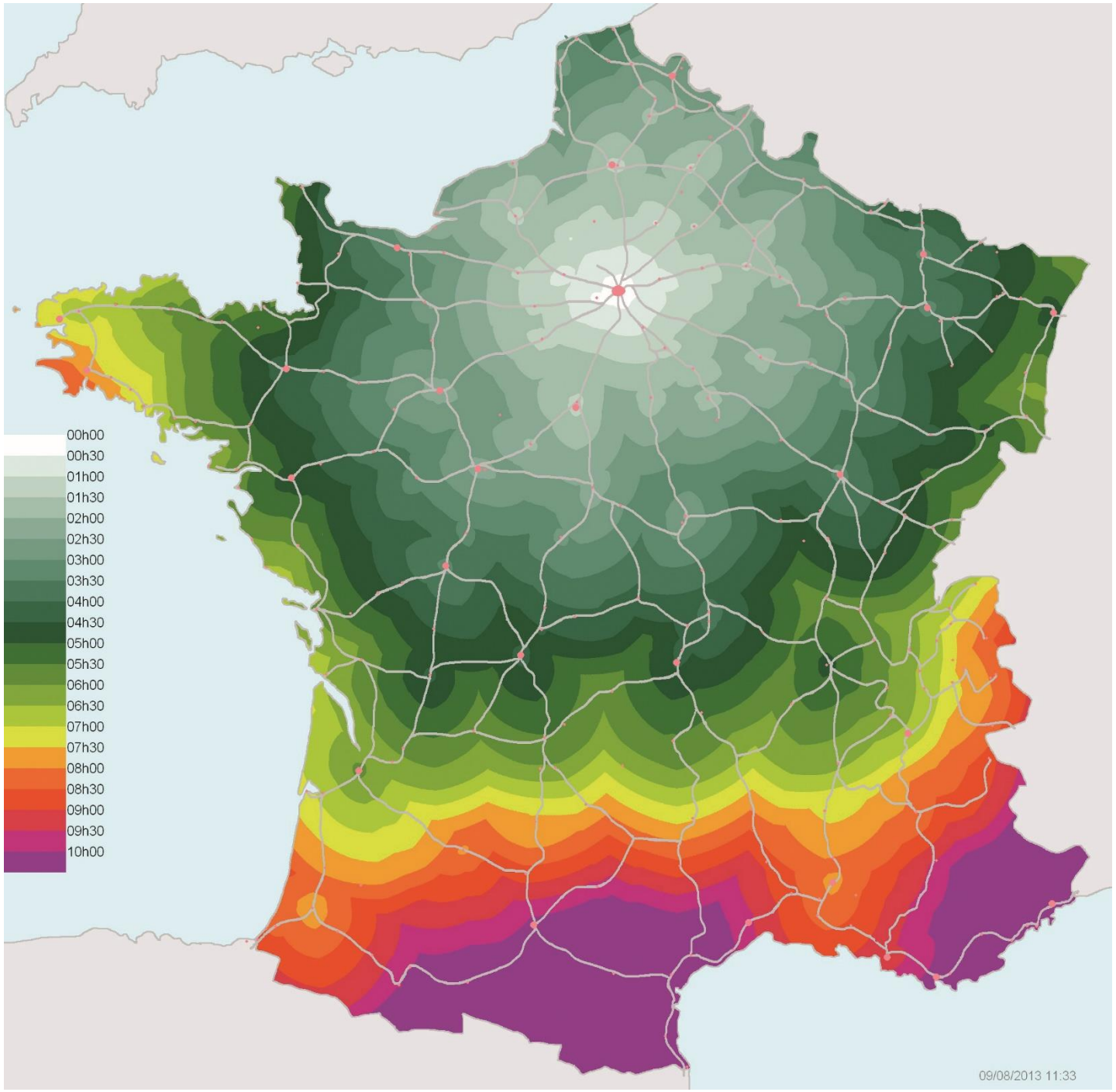

QANTAS
Spirit of Australia
A380


BL 181130


KRONE
150m³
Volumen
GigaLiner
25,25 METER
KRONE
Jump to future
150m³
Volumen
GigaLiner
KRONE



France seen from Paris by train in 1900



France seen from Paris by train in 1938

Guided

+

Low grip

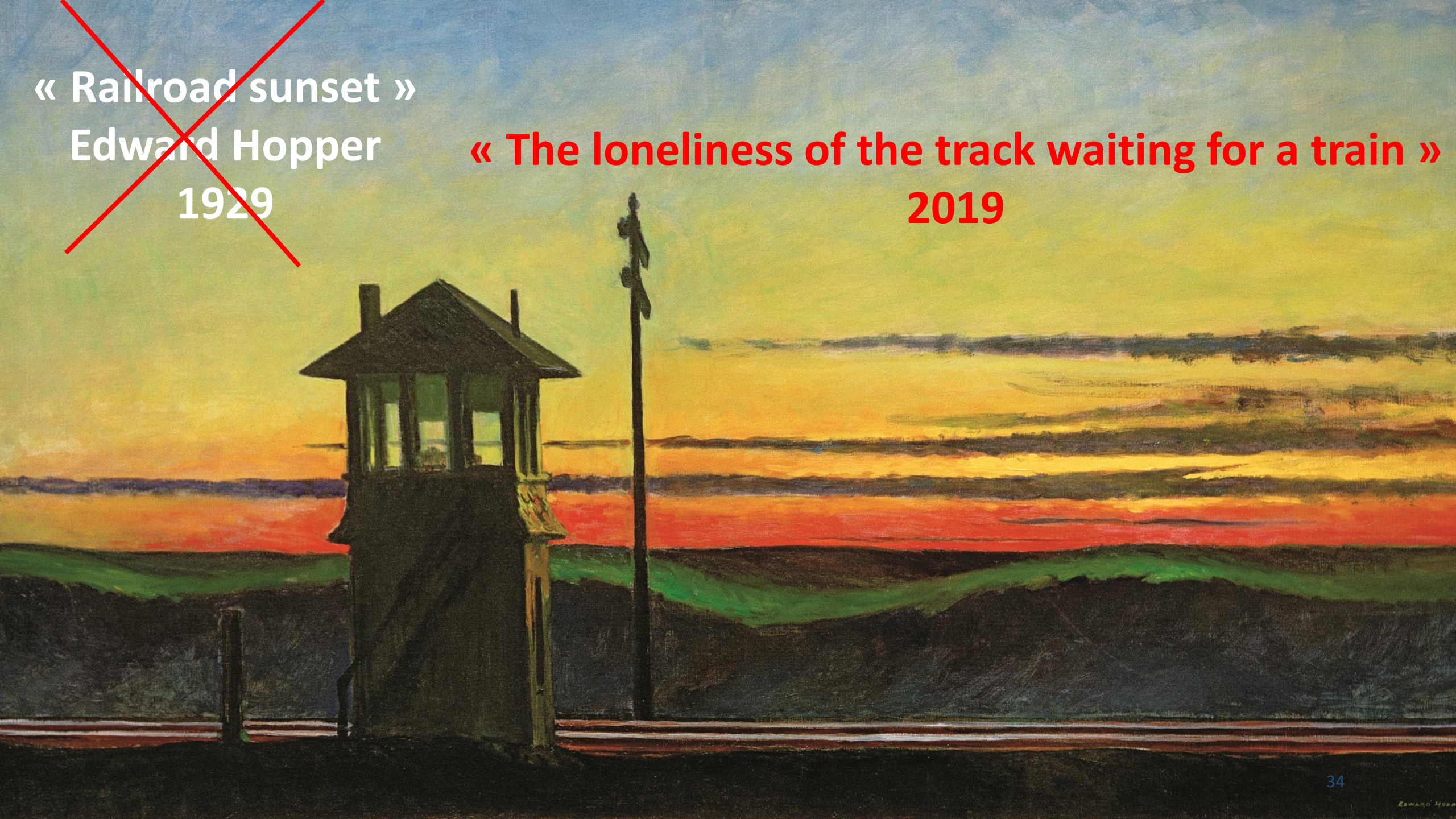
+

Land

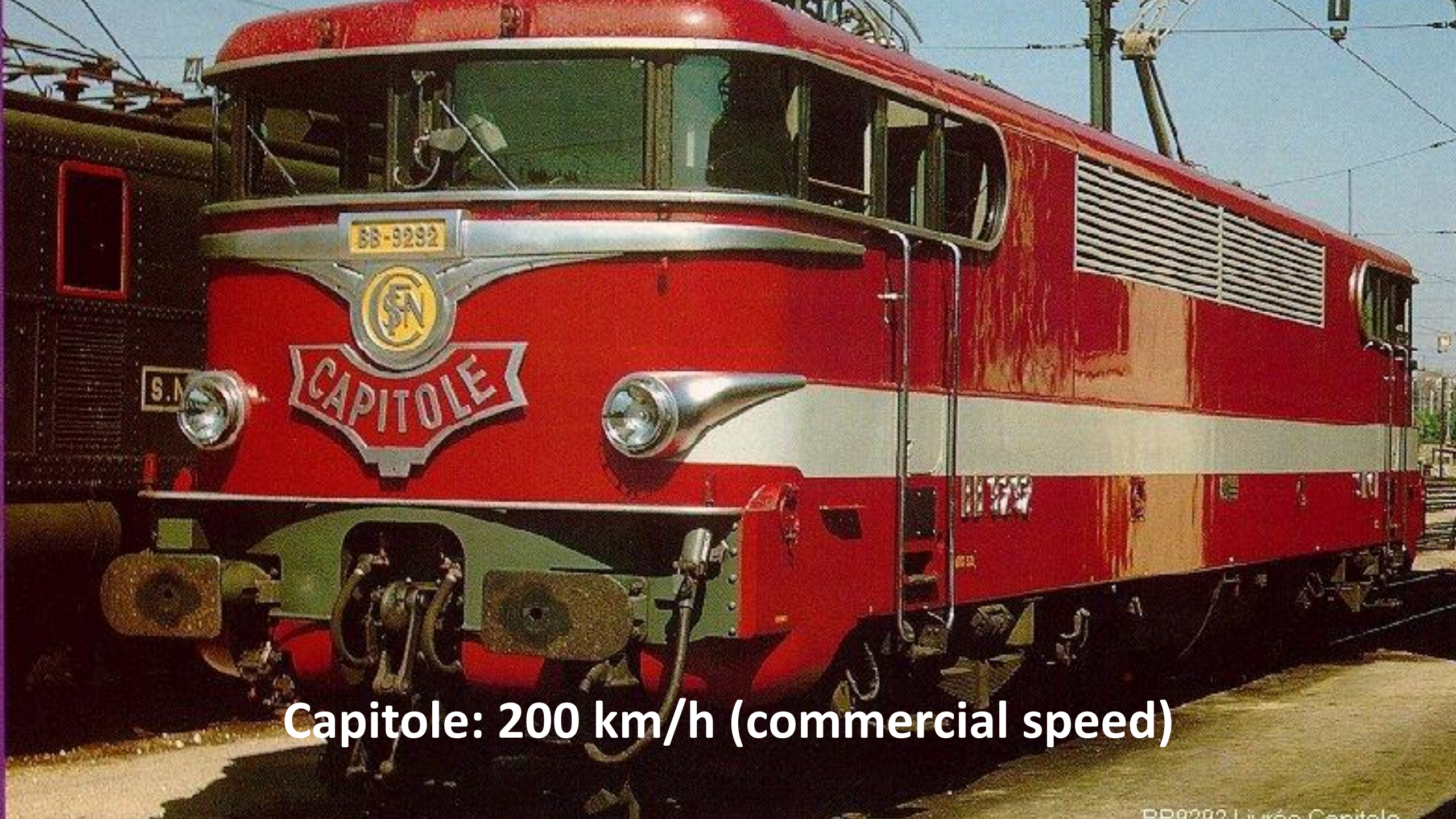
=

Mass transport


SNCF
TGV

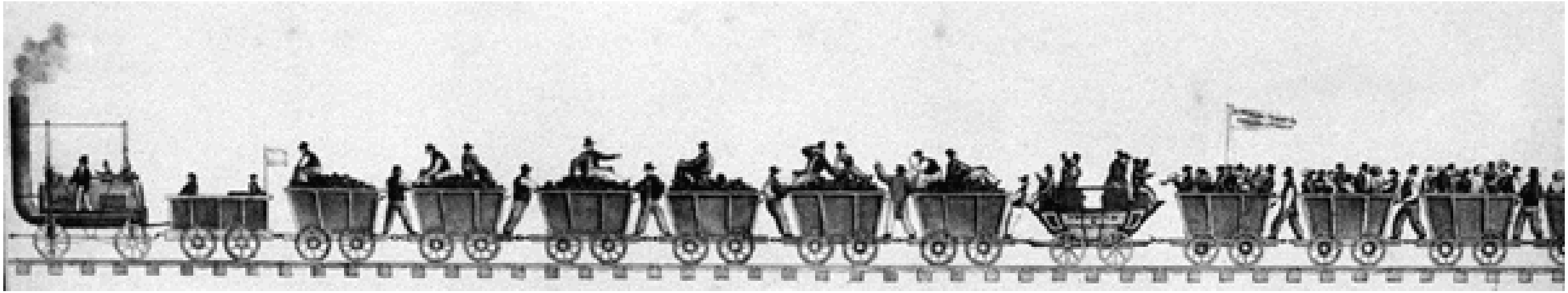

« Railroad sunset »
Edward Hopper
1929
« The loneliness of the track waiting for a train »
2019

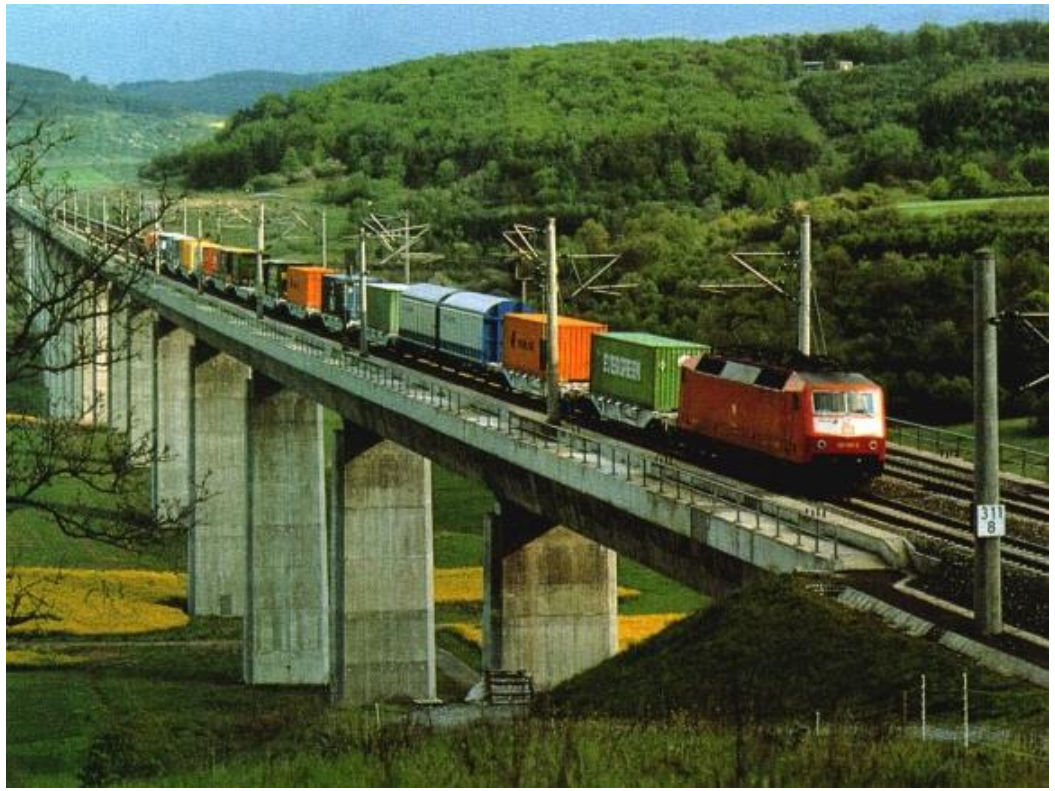
DÉFINITION of HSR



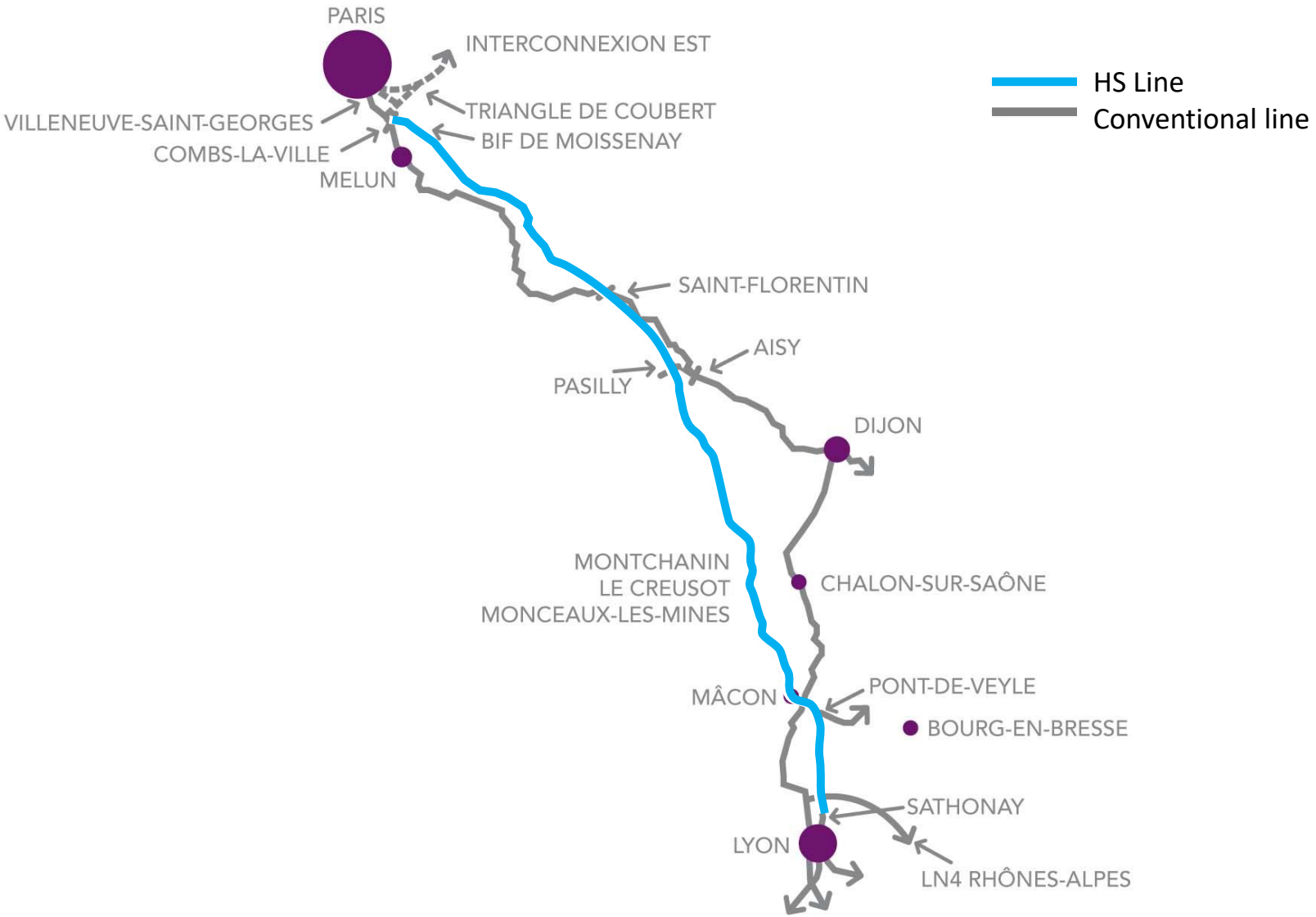
Capitole: 200 km/h (commercial speed)

Shinkansen 1964: 210 km/h (commercial speed)

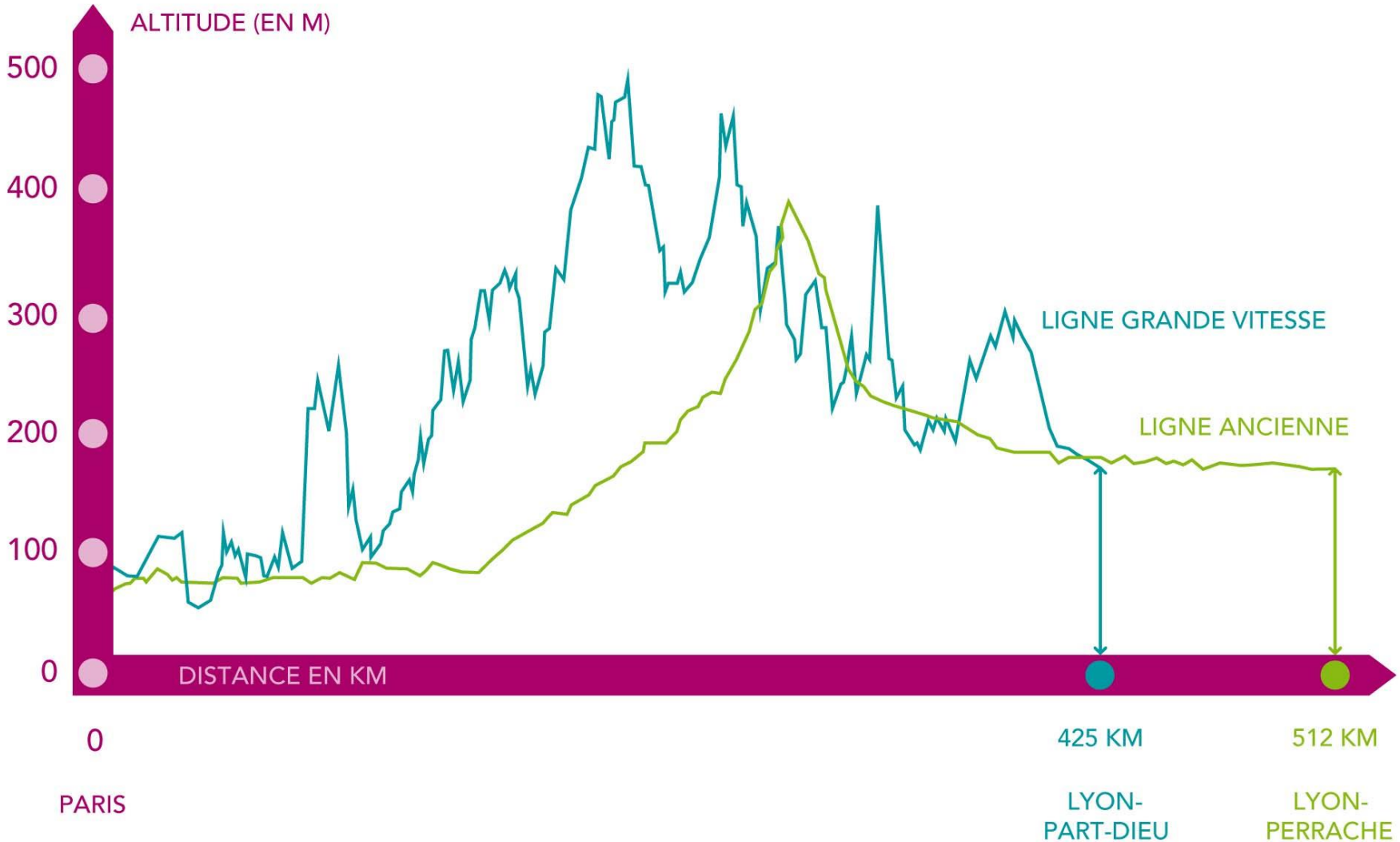


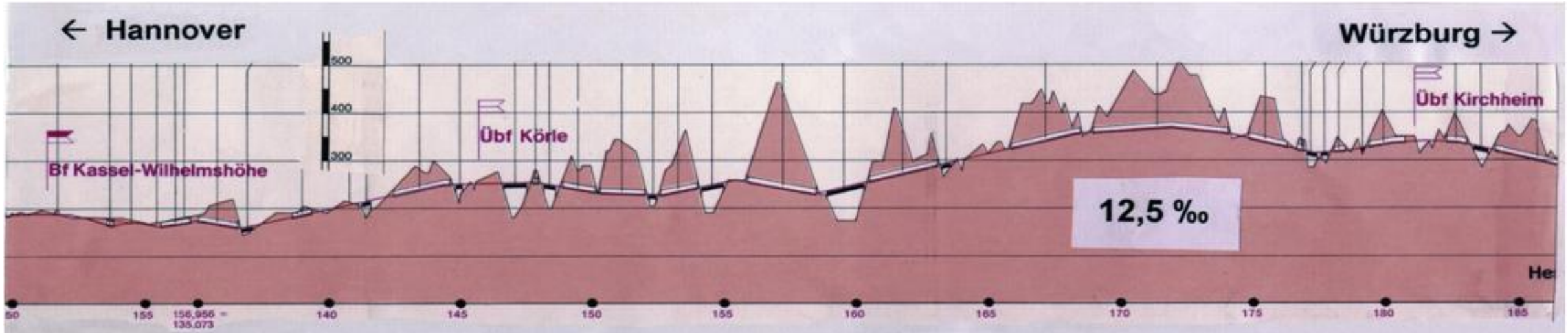


High speed line and conventional line from Paris to Lyons

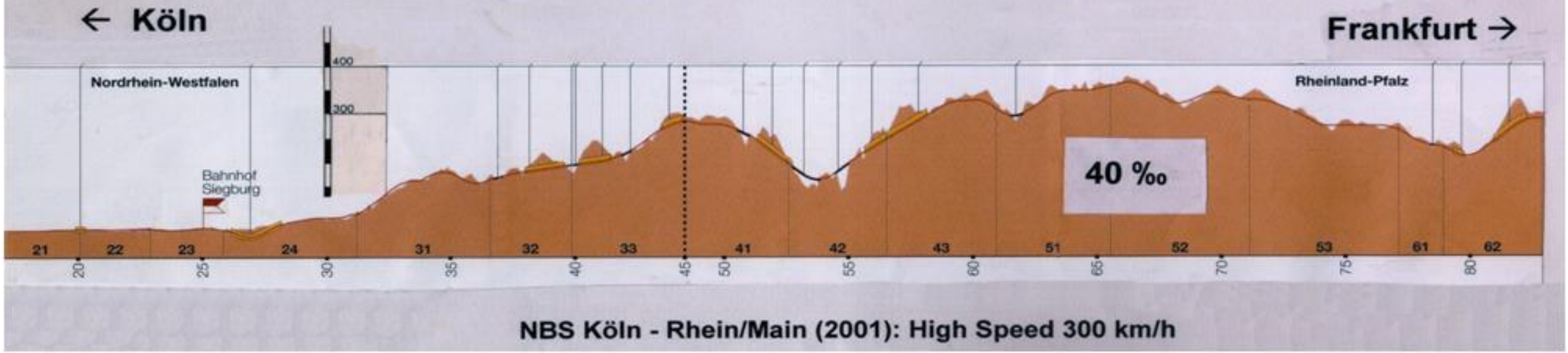


Vertical profiles of the conventional and the high speed lines





NBS Hannover - Würzburg (1991): High Speed + Freight Trains



NBS Köln - Rhein/Main (2001): High Speed 300 km/h

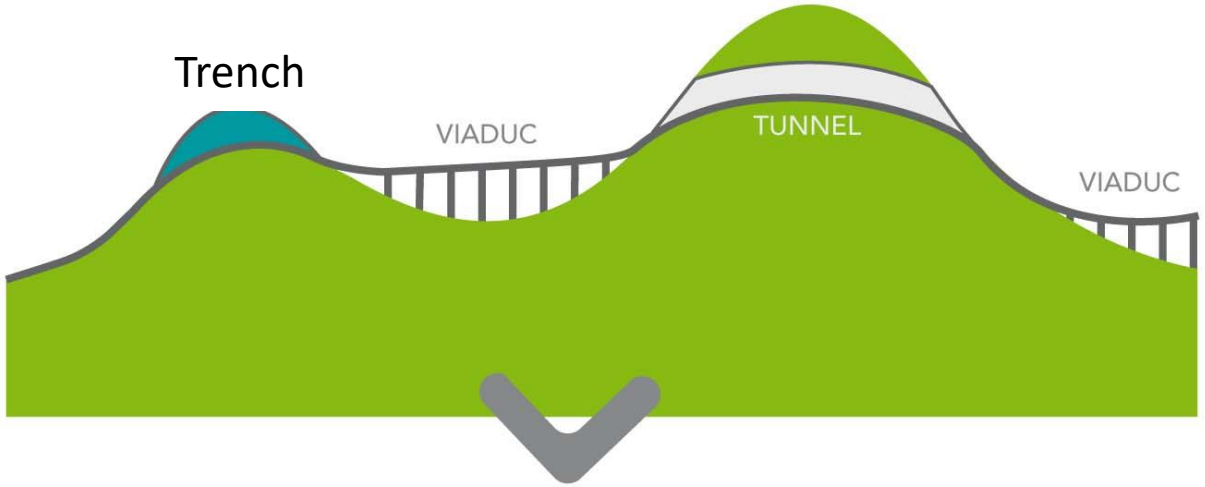
HSR:

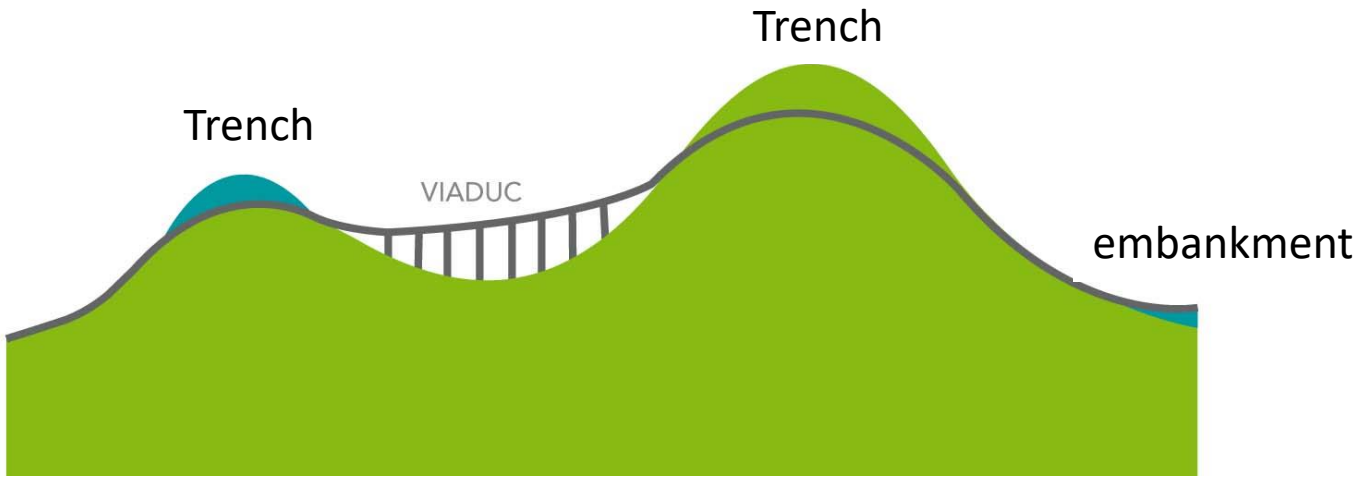
A chnage in paradigm
(specialization of the infrastructure)

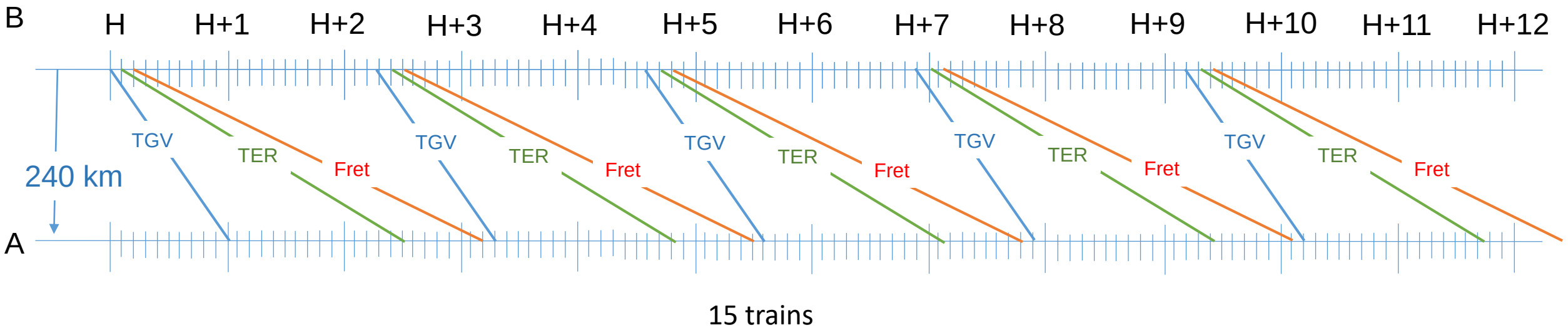
More than

a mere increase in speed

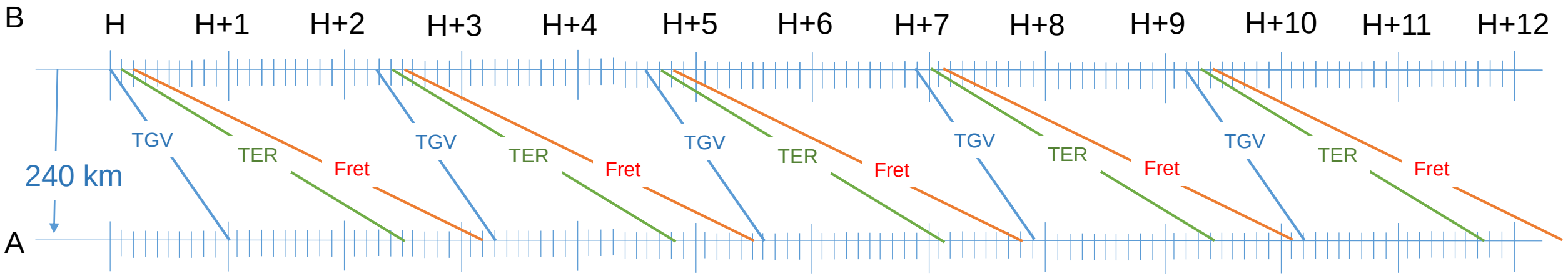
Change of the vertical profile
In regards with then speed



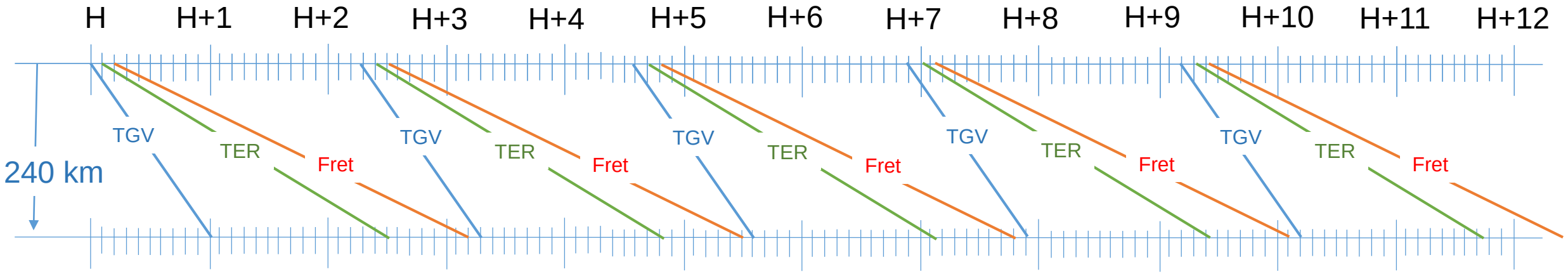




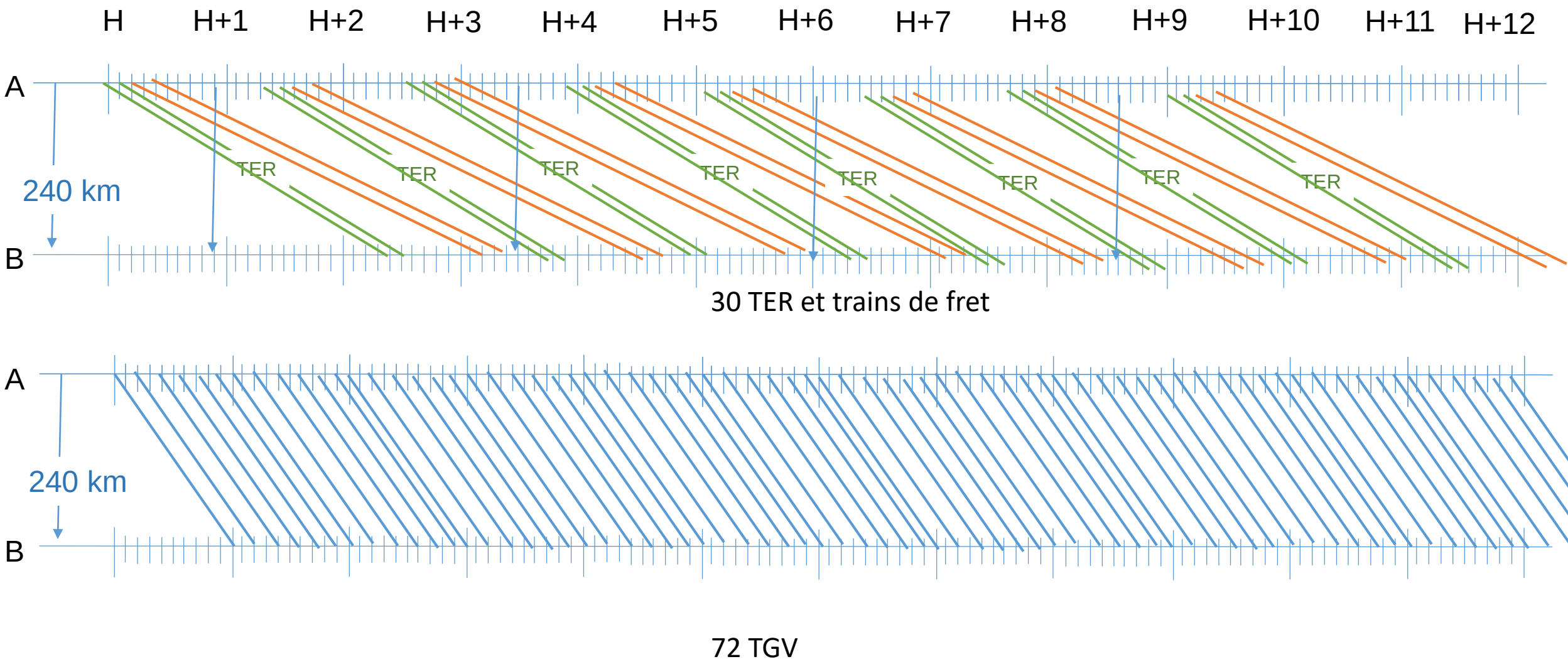
15 trains



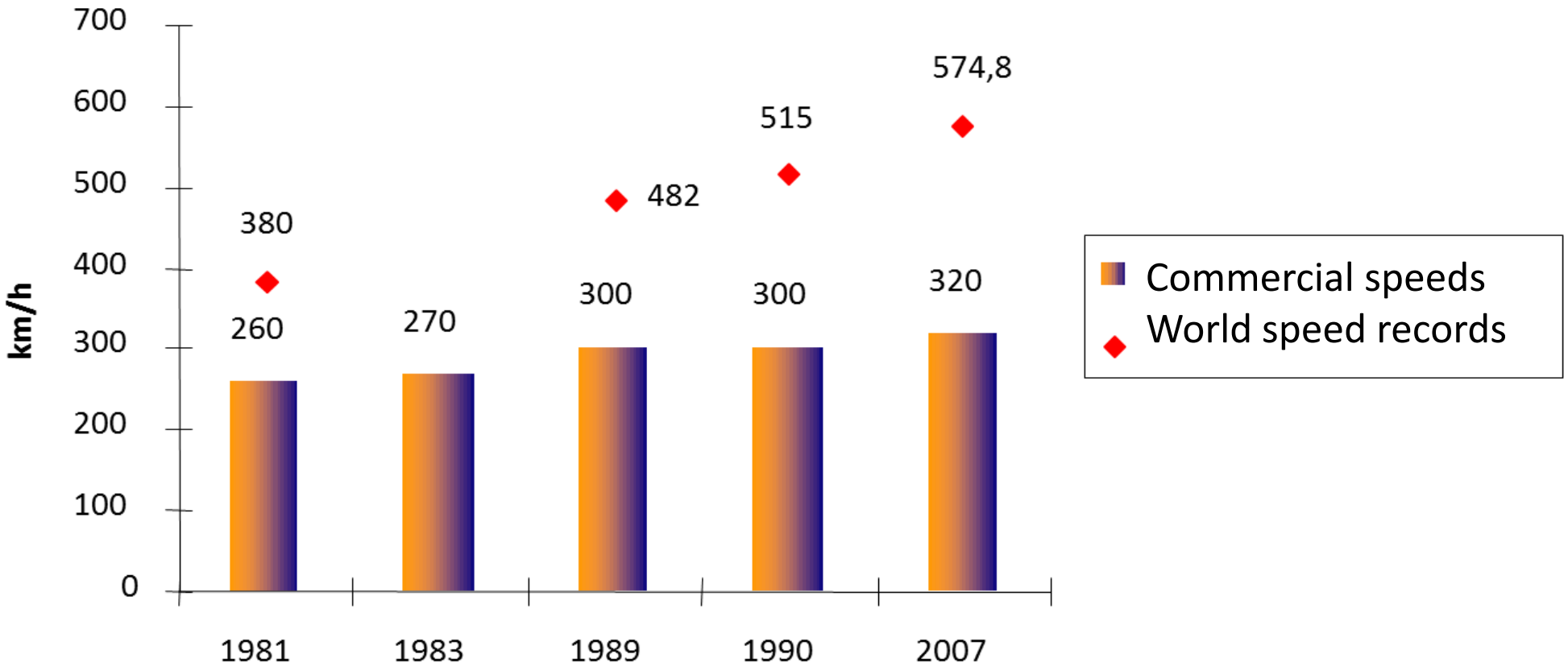
15 trains



15 trains


H
H+1
H+2
H+3
H+4
H+5
H+6
H+7
H+8
H+9
H+10
H+11
H+12
A
B
240 km
TER
TER
TER
TER
TER
TER
TER
TER
30 TER et trains de fret
A
B
240 km
72 TGV

OPTIMAL SPEED?


700
600
500
400
300
200
100
0
km/h
380
482
515
574,8
260
270
300
300
320
1981
1983
1989
1990
2007
Commercial speeds
World speed records

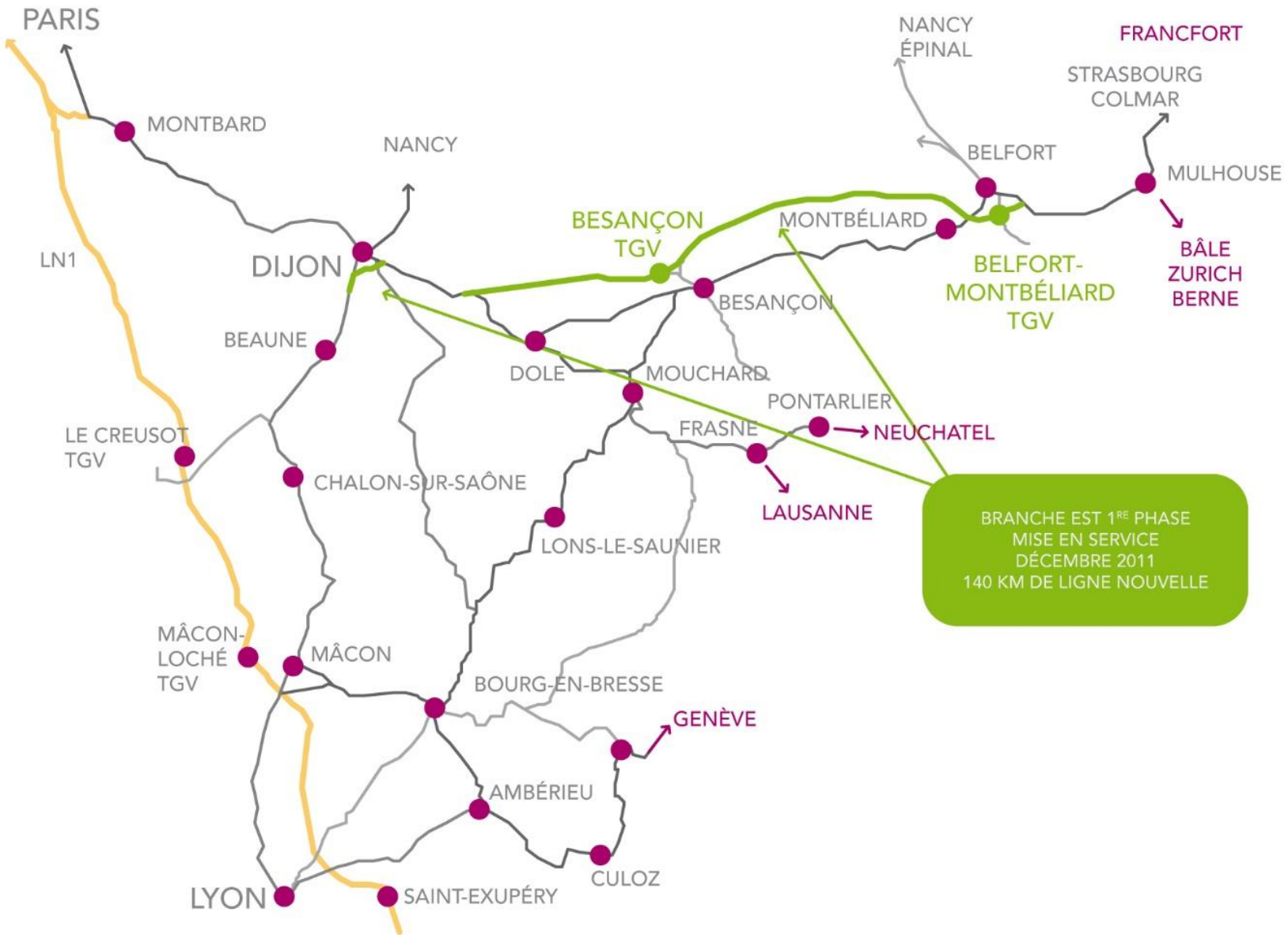
3 main difficulties:

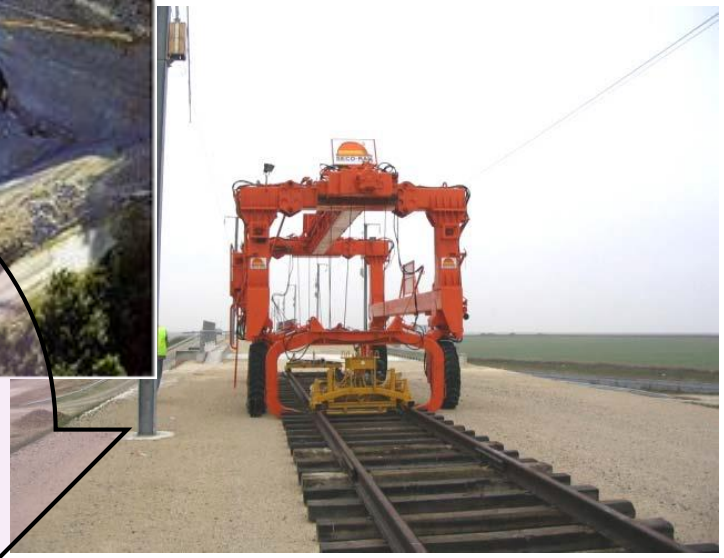
- Noise
- Flying ballast and transitions
- Capacity

2 criteria:

- Optimal carbon speed
- Optimal socio-economic speed

Rhin- Rhône HS Line
1st Phase



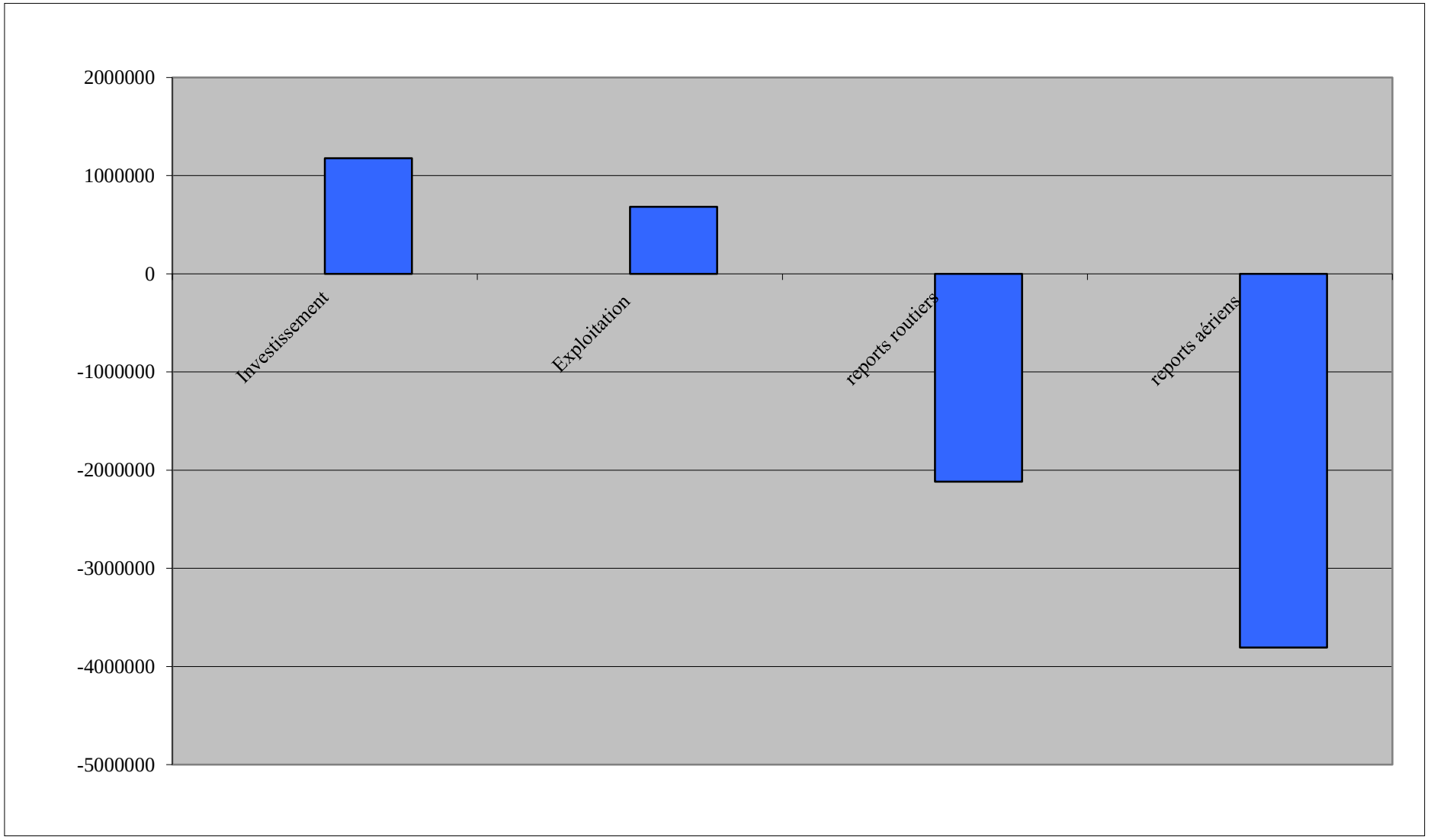


Life cycle

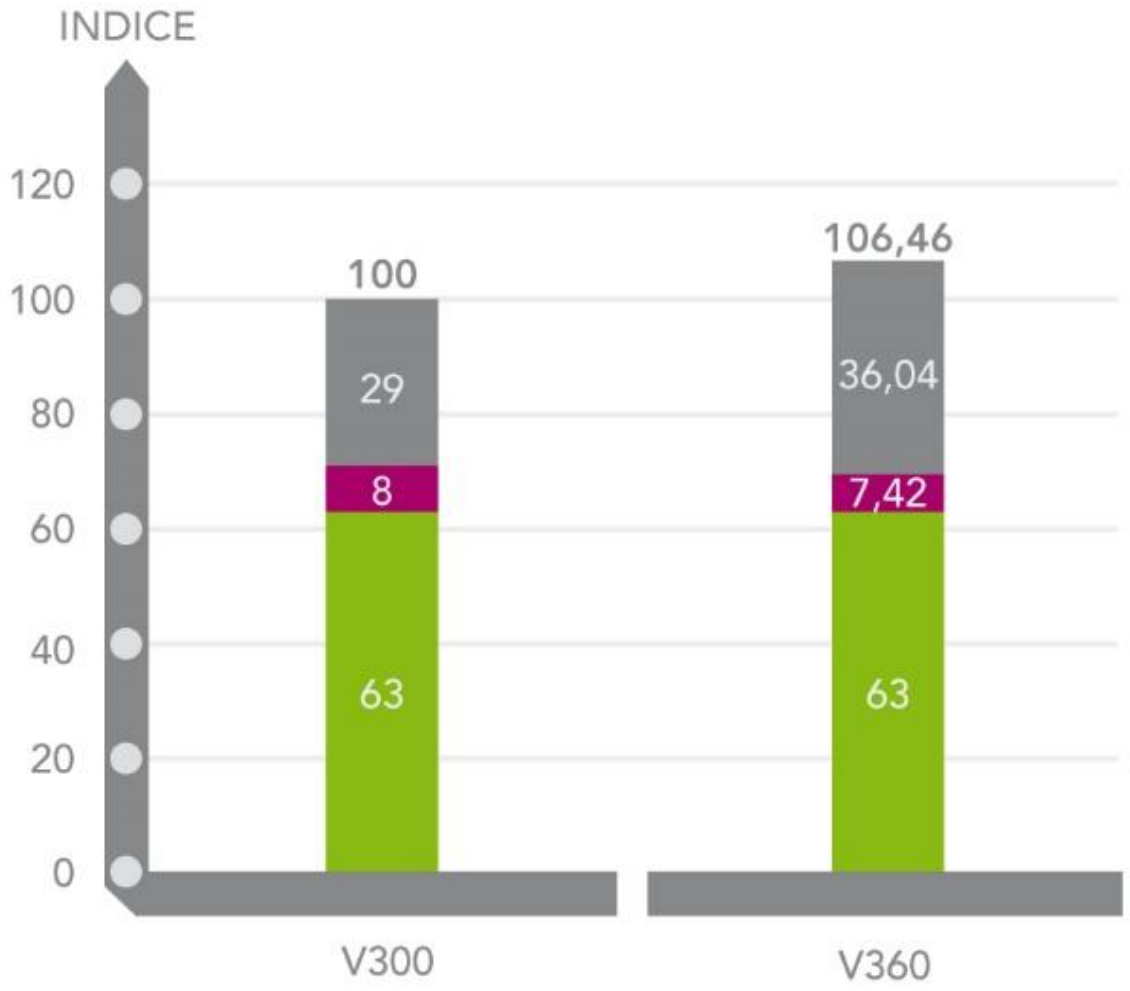
Traffic shifting from air

Traffic shifting from road

Carbon balance of the Rhin-Rhône HS Line



Variation of OPRATING EXPENSES with speed



Charges growing with speed
Charges reducing with speed
Charges which are not affected by speed

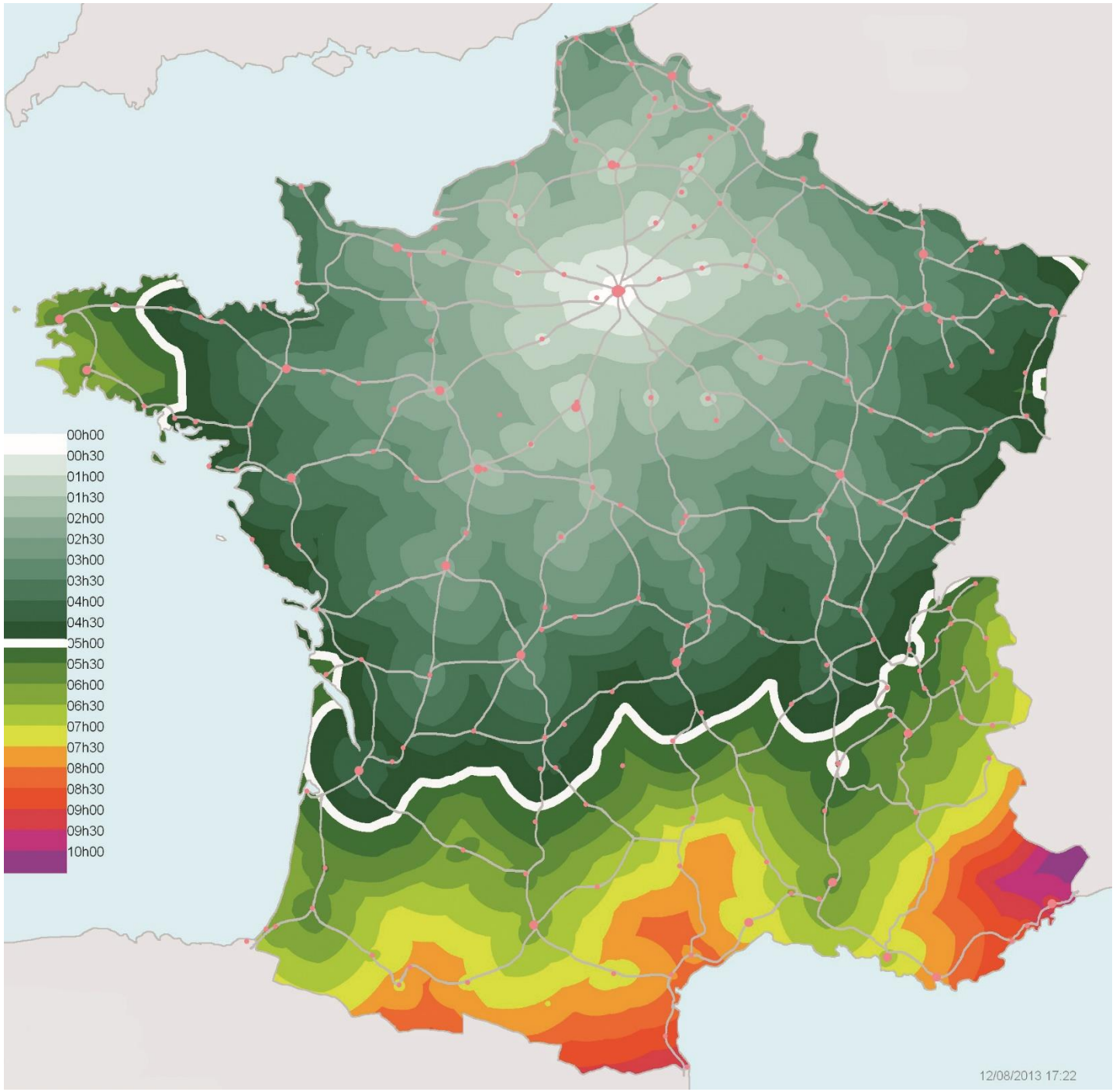
HSR
in FRANCE

Impact on territory management

253 stations are served

AACHEN HBF - AÉROPORT CDG TGV - AGDE - AGEN - AIGLE - AIME LA PLAGNE - AIX EN PROVENCE TGV - AIX LES BAINS - ALBERTVILLE - AMSTERDAM CS - ANCENIS - ANGERS - ANGOULÊME - ANNECY - ANNEMASSE - ANTIBES - ANTWERPEN CENTRAAL - ARCACHON - ARLES - ARRAS - ASHFORD INTERNATIONAL - AUGSBURG HBF - AURAY - AVIGNON CENTRE - AVIGNON TGV - BADEN-BADEN - BAR LE DUC - BARDONECCHIA - BASEL/BALE - BAYONNE - BEAUNE - BELFORT MONTBELIARD TGV - BELLEGARDE - BERNE - BESANÇON FRANCHE COMTÉ TGV - BESANÇON VIOTTE - BÉTHUNE - BÉZIERS - BIARRITZ - BORDEAUX ST JEAN - BOULOGNE VILLE - BOURG EN BRESSE - BOURG ST MAURICE - BREST - BRIGUE - BRIVE LA GAILLARDE - BRUGES/BRUGGE - BRUXELLES MIDI - BRUXELLES NATIONAL AÉROPORT - CALAIS FRETHUN - CALAIS VILLE - CANNES - CARCASSONNE - CHALON SUR SAÔNE - CHÂLONS EN CHAMPAGNE - CHAMBÉRY - CHAMPAGNE ARDENNE TGV - CHARLEROI - CHARLEVILLE MÉZIÈRES - CHÂTEAUROUX - CHÂTELLERAULT - CLUSES - COLMAR - CROIX WASQUEHAL - CULMONT CHALINDREY - DAX - DIJON VILLE - DOL - DOLE - DOUAI - DUISBURG HBF - DUNKERQUE - DÜSSELDORF HBF - EBBSFLEET INTERNATIONAL - ÉPINAL - ESSEN HBF - ÉTAPLES LE TOUQUET - ÉVIAN - FACTURE - FIGUERAS - FORBACH - FRANKFURT MAIN HBF - FRASNE - FUTUROSCOPE - GAND/GENT - GENÈVE - GRENOBLE - GUINGAMP - HAZEBROUCK - HENDAYE - HYÈRES - IRUN - JUVISY - KAISERSLAUTERN HBF - KARLSRUHE HBF - KÖLN HBF - LA BAULE ESCOUBLAC - LA ROCHE SUR FORON - LA ROCHE SUR YON - LA ROCHELLE - LA SOUTERRAINE - LA TESTE - LAMBALLE - LANDERNEAU - LANDRY - LANNION - LAUSANNE - LAVAL - LE CREUSOT TGV - LE CROISIC - LE HAVRE - LE MANS - LE POULIGUEN - LENS - LES ARCS DRAGUIGNAN - LES AUBRAIS ORLÉANS - LES SABLES D'OLONNE - LEUK - LIBOURNE - LIÈGE GUILLEMINS - LILLE EUROPE - LILLE FLANDRES - LIMOGES BÉNÉDICTINS - LONDON ST PANCRAS - LONS LE SAUNIER - LORIENT - LORRAINE TGV - LOURDES - LUNÉVILLE - LUXEMBOURG - LYON PART DIEU - LYON PERRACHE - LYON ST EXUPERY TGV - MÂCON TGV - MÂCON VILLE - MANNHEIM HBF - MANTES LA JOLIE - MARNE LA VALLÉE - MARSEILLE ST CHARLES - MARTIGNY - MASSY PALAISEAU - MASSY TGV - MENTON - METZ VILLE - MEUSE TGV - MILANO PORTA GARIBALDI - MIRAMAS - MODANE - MONACO - MONS - MONTAUBAN - MONTBARD - MONTÉLIMAR - MONTPELLIER - MONTREUX - MORLAIX - MOUCHARD - MOUTIERS SALINS - MULHOUSE VILLE - MÜNCHEN HBF - NAMUR - NANCY VILLE - NANTES - NARBONNE - NEUCHÂTEL - NEUFCHÂTEAU - NICE VILLE - NÎMES - NIORT - NOVARA - NURIEUX - ORANGE - ORTHEZ - OSTENDE/OOSTENDE - OULX - PARIS EST - PARIS GARE DE LYON - PARIS MONTPARNASSE 1-2 - PARIS NORD - PAU - PERPIGNAN - PLOUARET TRÉGOR - POITIERS - PONTARLIER - PORNICHET - QUIMPER - QUIMPERLÉ - RANG DU FLIERS - REDON - REIMS - REMIREMONT - RENNES - RETHEL - ROSPORDEN - ROTTERDAM - ROUBAIX - ROUEN RD - RUFFEC - SAARBRUECKEN HBF - SABLÉ - SALLANCHES - SARREBOURG - SAUMUR - SAVENAY - SAVERNE - SCHIPHOL - SEDAN - SÉLESTAT - SÈTE - SIERRE SIDERS - SION - ST AVRE LA CHAMBRE - ST BRIEUC - ST DIÉ - ST ÉTIENNE CHÂTEAUCREUX - ST GERVAIS LES BAINS - ST JEAN DE LUZ - ST JEAN DE MAURIENNE - ST MAIXENT - ST MALO - ST MICHEL VALLOIRE - ST NAZAIRE - ST OMER - ST PIERRE DES CORPS - ST RAPHAËL - STRASBOURG - STUTTGART HBF - SURGÈRES - TARBES - TGV HTE PICARDIE - THIONVILLE - THONON LES BAINS - TORINO PORTA SUSA - TOUL - TOULON - TOULOUSE MATABIAU - TOURCOING - TOURS - ULM HBF - VALENCE TGV - VALENCE VILLE - VALENCIENNES - VALLORBE - VANNES - VENDÔME VILLIERS - VENTIMIGLIA - VERCELLI - VERSAILLES CHANTIERS - VIERZON VILLE - VISP - VITRÉ - VITRY LE FRANCOIS - ZÜRICH HBF

(Service 2012)



France seen from Paris by train in 1980


Cherbourg
Brest
Le Havre
Saint - Malo
Caen
Lorient
Calais
Argentan
Metz
Nancy
Strasbourg
Chaumont
Rennes
Rouen
Amiens
Mulhouse
Nantes
Troyes
Angers
Le Mans
Lille
Reims
Paris
Tours
Orleans
Dijon
La Rochelle
Bourges
Moulins
Clermont
Limoges
Poitiers
Lyon
Angouleme
Brive
Bordeaux
Valence
Grenoble
Annecy
Avignon
Agen
Marseille
Biarritz
Montpellier
Toulon
Toulouse
Gap
Pau
Beziers
Nice
Perpignan
Foix

HSR
in EUROPE


Hamburg
Berlin
Warsaw
Birmingham
Amsterdam
Hannover
Rotterdam
Halle
Leipzig
London
Antwerp
Leuven
Cologne
Erfurt
Brussels
Siegburg
Calais
Liège
Düren
Zawiercie
Frankfurt
Ebensfeld
Würzburg
Nuremberg
Mannheim
Karlsruhe
Rastatt
Paris
Stuttgart
Ingolstadt
Strasbourg
Offenburg
Vienna
Ulm
Augsburg
Munich
Rennes
Buggingen
Attnang-
Puchheim
Belfort
Basel
Wörgl
Rothrist
Voldars-B.
Graz
Dijon
Mattstetten
Erstfeld
Frutigen
Biasca
Klagenfurt
Visp
Milan
Lyon
Brescia
Turin
Bologna
Genoa
Bordeaux
A Coruña
Bilbao
San Sebastián
Montpellier
Florence
Santiago
Marseille
Vitoria-Gasteiz
Perpignan
León
Burgos
Ourense
Huesca
Vigo
Valladolid
Roma
Zamora
Zaragoza
Barcelona
Madrid
Naples
Salerno
Plasencia
Toledo
Valencia
Badajoz
Alicante/Alacant
Córdoba
Murcia
Seville
Utrera
Granada
Málaga
Jerez


Río Júcar
renfe
AVE

Interoperability


Training
Hiring staff
Premisses in stations
Reservation of pathes
Compatibility with ERTMS
Rolling stock certification
Right to run
Safety certificate
Licence of railway undertaking

NTV

TRENITALIA

HSR
in other parts
of the WOrld

Ürümqi
Hami
Jiayuguan
Zhangye
Xining
Lanzhou
Baotou
Hohhot
Ulanqab
Yuanping
Shijiazhuang
Taiyuan
Yan'an
Jinan
Yantai
Rongcheng
Qingdao
Jiaozuo
Zhengzhou
Xuzhou
Baoji
Xi'an
Shiyan
Bengbu
Hefei
Nanjing
Shanghai
Hangzhou
Ningbo
Jiangyou
Dujiangyan
Chengdu
Emeishan
Dazhou
Yichang
Wuhan
Anqing
Jiujiang
Jinhua
Chongqing
Nanchang
Changsha
Wenzhou
Hengyang
Ganzhou
Nanping
Fuzhou
Guiyang
Guilin
Xiamen
Dali
Kunming
Nanning
Guangzhou
Jiangmen
Shenzhen / Hong Kong
Zhuhai
Zhanjiang
Fangchenggang
Beihai
Haikou
Sanya
Taipei
Kaohsiung
Qiqihar
Harbin
Jiamusi
Changchun
Jilin
Hunchun
Shenyang
Dandong
Dalian
Seoul
Gangneung
Wonju
Suwon
Cheonan
Daejeon
Mokpo
Gwangju
Busan
Sapporo
Hakodate
Aomori
Hachinohe
Akita
Morioka
Yamagata
Niigata
Fukushima
Kanazawa
Nagano
Takasaki
Omiya
Tokyo
Tsuruga
Nagoya
Osaka
Hiroshima
Okayama
Hakata
Tosu
Nagasaki
Kumamoto
Kagoshima
Beijing
Airport
Pinggu
New Airport
Zhuozhou
Langfang
Tangshan
Gu'an
Tianjin
Bazhou
Tianjin Binhai
Baoding


和谐号
CRH


YHT
TCDD

HSR at a glance

574,8 km/h

Record du monde de vitesse (France 2007)

350 km/h

Vitesse maximum en service (avril 2015)

43 483 km

de lignes à grande vitesse dans le monde

80%

de part modale détenue par les trains à grande vitesse par rapport au transport aérien dès lors que le temps de parcours en train est inférieur à 2,5 heures

1964

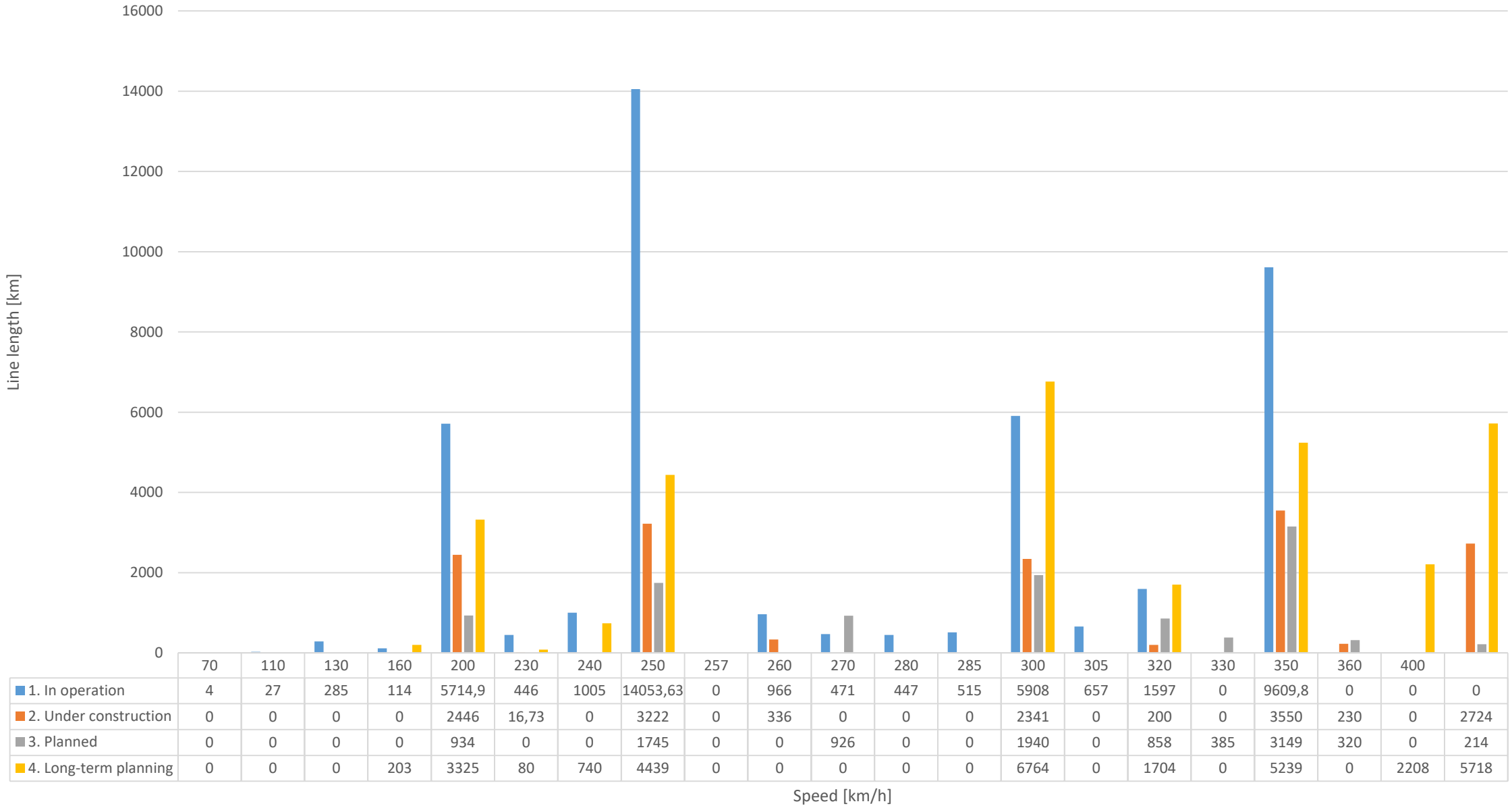
1er octobre : premier train à grande vitesse entre Tokyo et Osaka

Plus de **2 milliards**

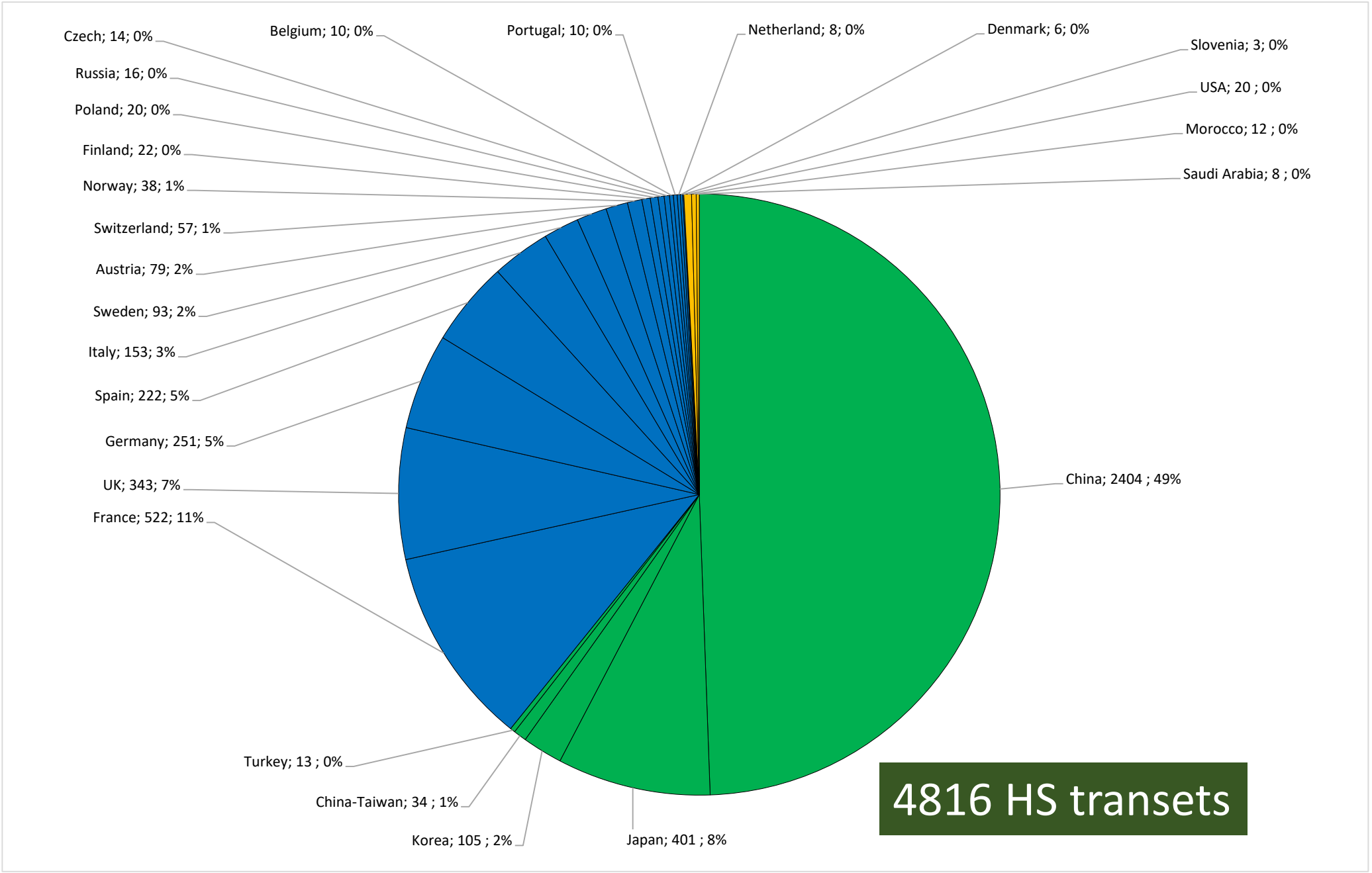
de voyageurs par an transportés par des trains à grande vitesse dans le monde :

130 millions en France
427 millions au Japon
1 221 millions en Chine
et **312 millions** dans le reste du monde

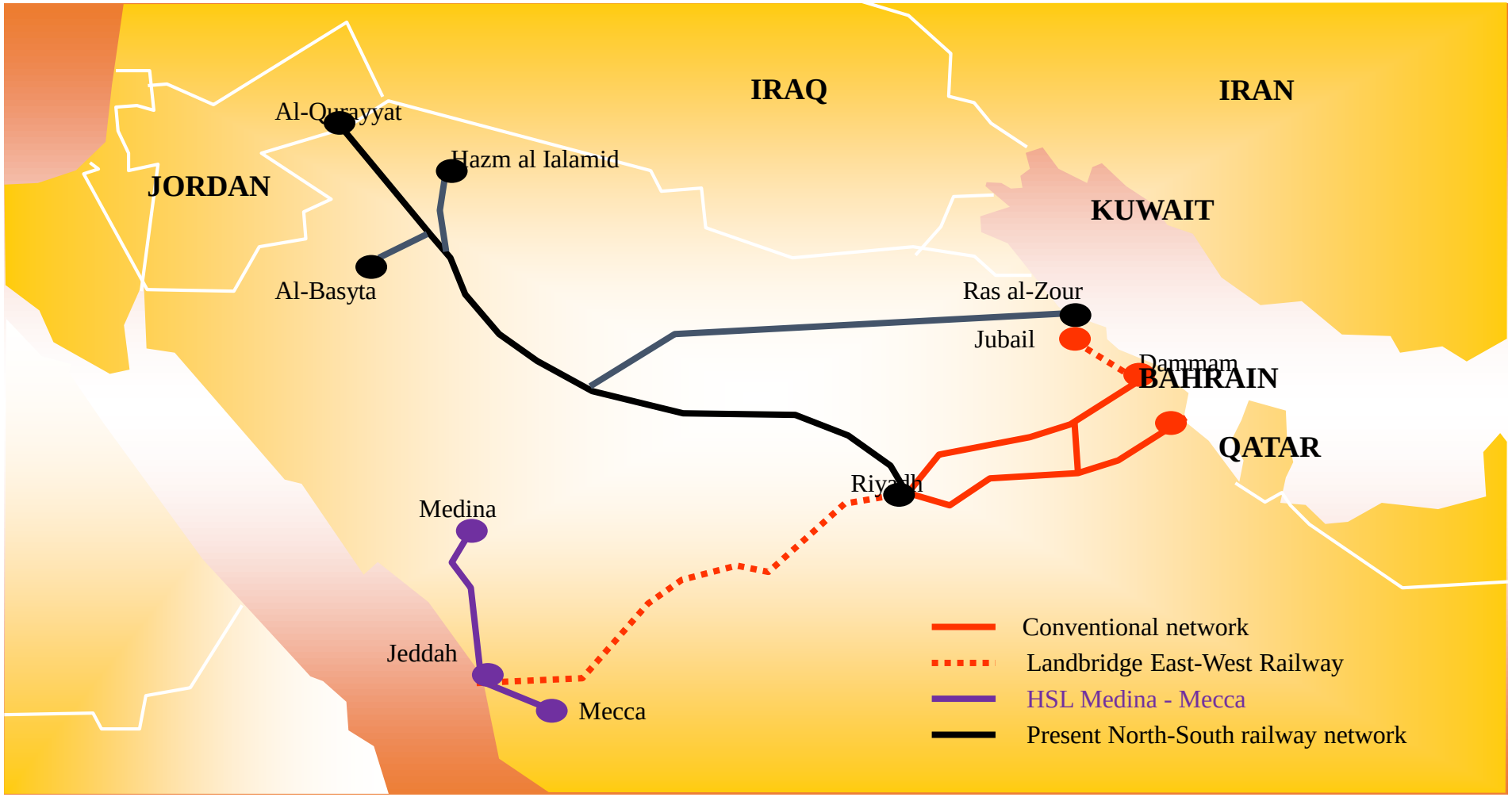
4 816 rames à grande vitesse en service dans le monde



	70	110	130	160	200	230	240	250	257	260	270	280	285	300	305	320	330	350	360	400	
1. In operation	4	27	285	114	5714,9	446	1005	14053,63	0	966	471	447	515	5908	657	1597	0	9609,8	0	0	0
2. Under construction	0	0	0	0	2446	16,73	0	3222	0	336	0	0	0	2341	0	200	0	3550	230	0	2724
3. Planned	0	0	0	0	934	0	0	1745	0	0	926	0	0	1940	0	858	385	3149	320	0	214
4. Long-term planning	0	0	0	203	3325	80	740	4439	0	0	0	0	0	6764	0	1704	0	5239	0	2208	5718

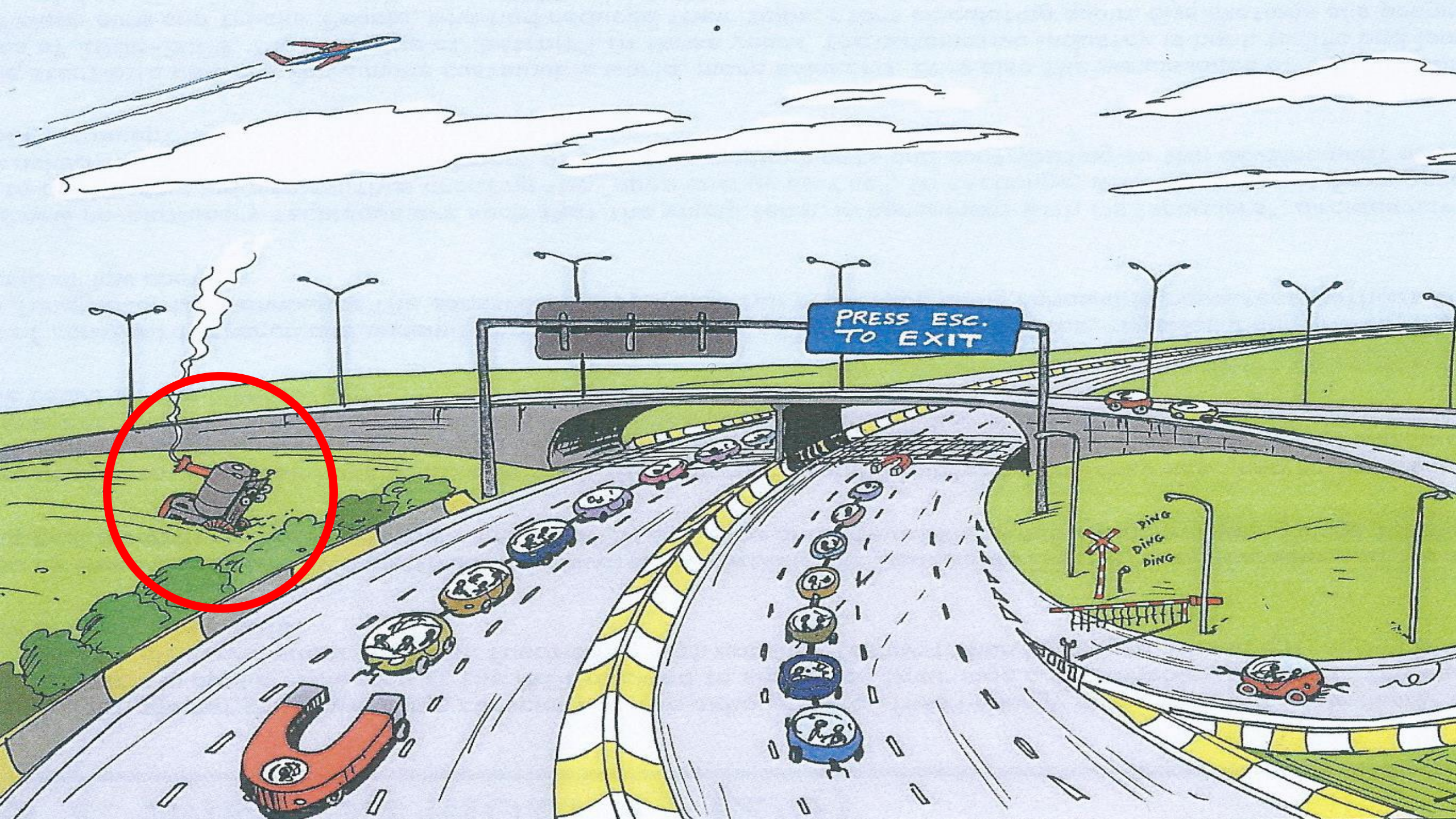

Czech; 14; 0%
Belgium; 10; 0%
Portugal; 10; 0%
Netherland; 8; 0%
Denmark; 6; 0%
Slovenia; 3; 0%
Russia; 16; 0%
USA; 20 ; 0%
Poland; 20; 0%
Morocco; 12 ; 0%
Finland; 22; 0%
Saudi Arabia; 8 ; 0%
Norway; 38; 1%
Switzerland; 57; 1%
Austria; 79; 2%
Sweden; 93; 2%
Italy; 153; 3%
Spain; 222; 5%
Germany; 251; 5%
UK; 343; 7%
France; 522; 11%
China; 2404 ; 49%
Turkey; 13 ; 0%
China-Taiwan; 34 ; 1%
Korea; 105 ; 2%
Japan; 401 ; 8%
4816 HS transets

Railway network in Morroco


IRAQ
IRAN
Al-Qurayyat
Hazm al Ialamid
JORDAN
KUWAIT
Al-Basyta
Ras al-Zour
Jubail
Dammam
BAHRAIN
QATAR
Riyadh
Medina
Jeddah
Mecca
Conventional network
Landbridge East-West Railway
HSL Medina - Mecca
Present North-South railway network


Sacramento
San Francisco
Transbay terminal
San Jose
Diridon station
Merced
Fresno
Madera
Las Vegas
Rosedale
Bakersfield
Palmdale
Victorville
San Fernando Valley
Ontario Airport
Los Angeles
Union station
Riverside
Anaheim
Irvine
San Diego

CONCLUSION


PRESS ESC.
TO EXIT
PING
DING
DING

Technology


Avelia Liberty

Maglev
Japon

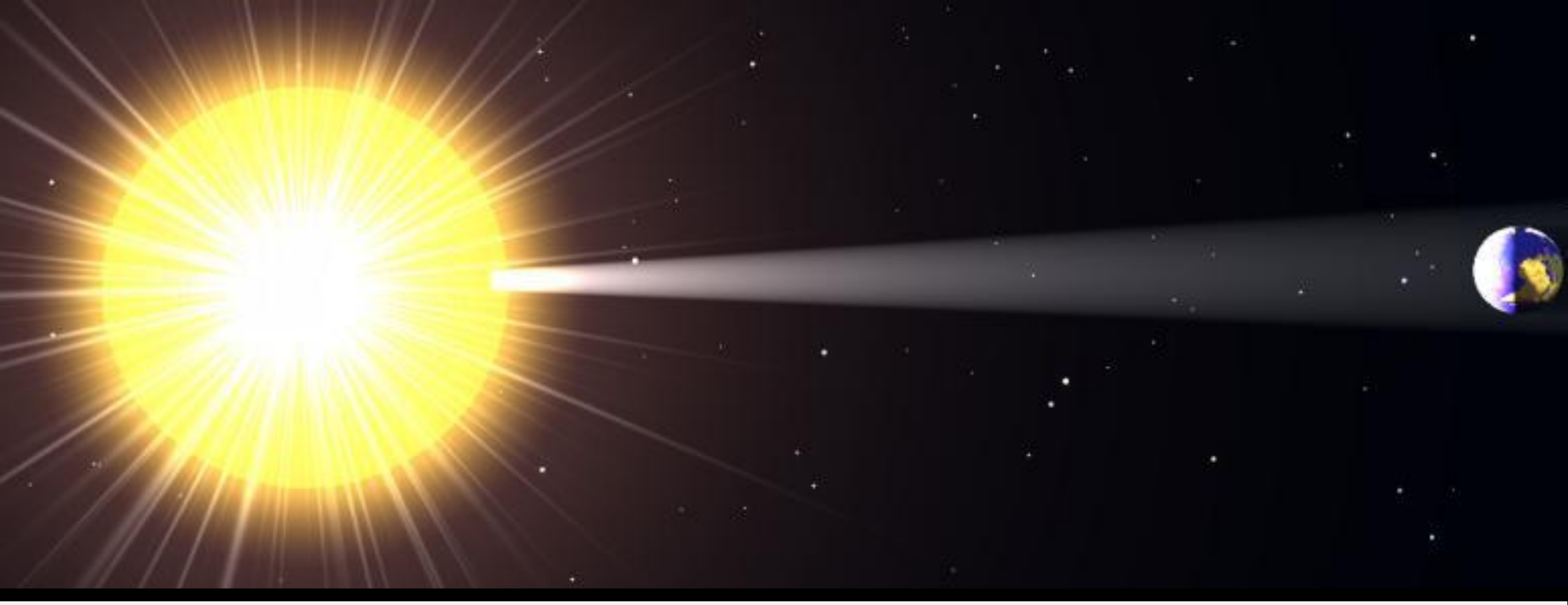
Hyperloop One

Marginal cost

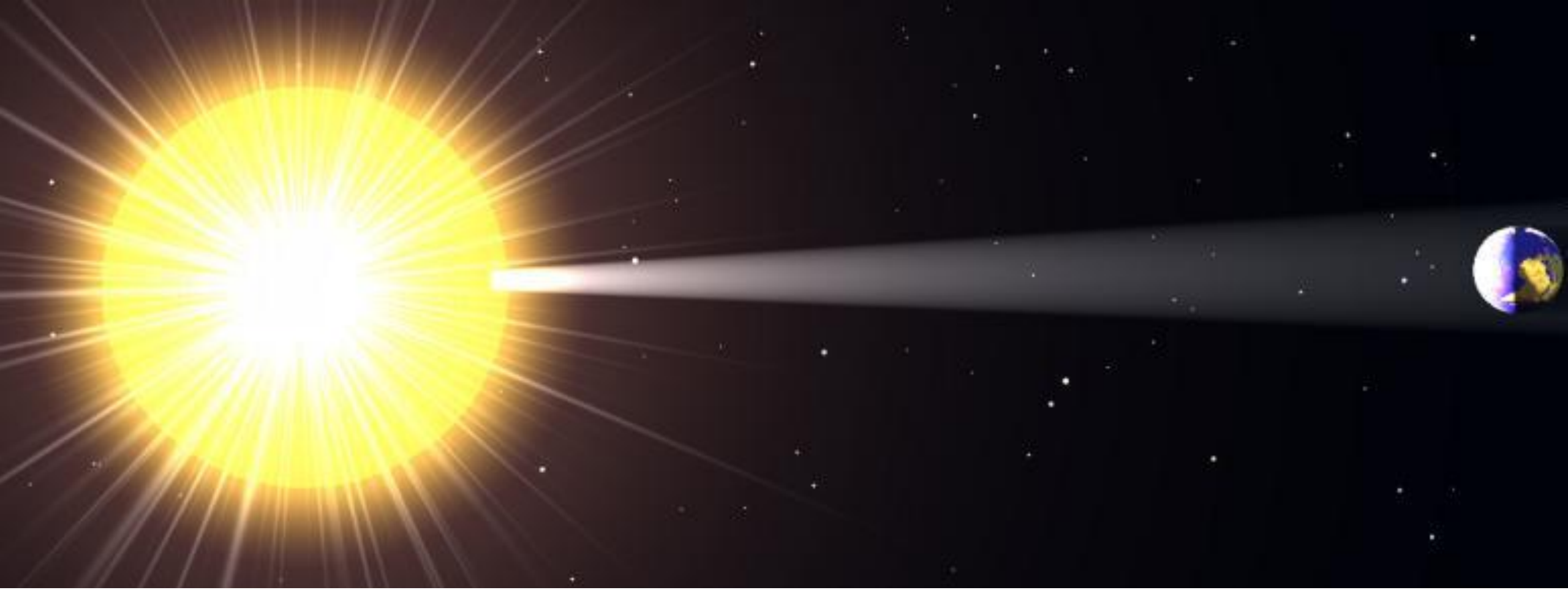

FUXING HAO

TGV du futur

Environnement

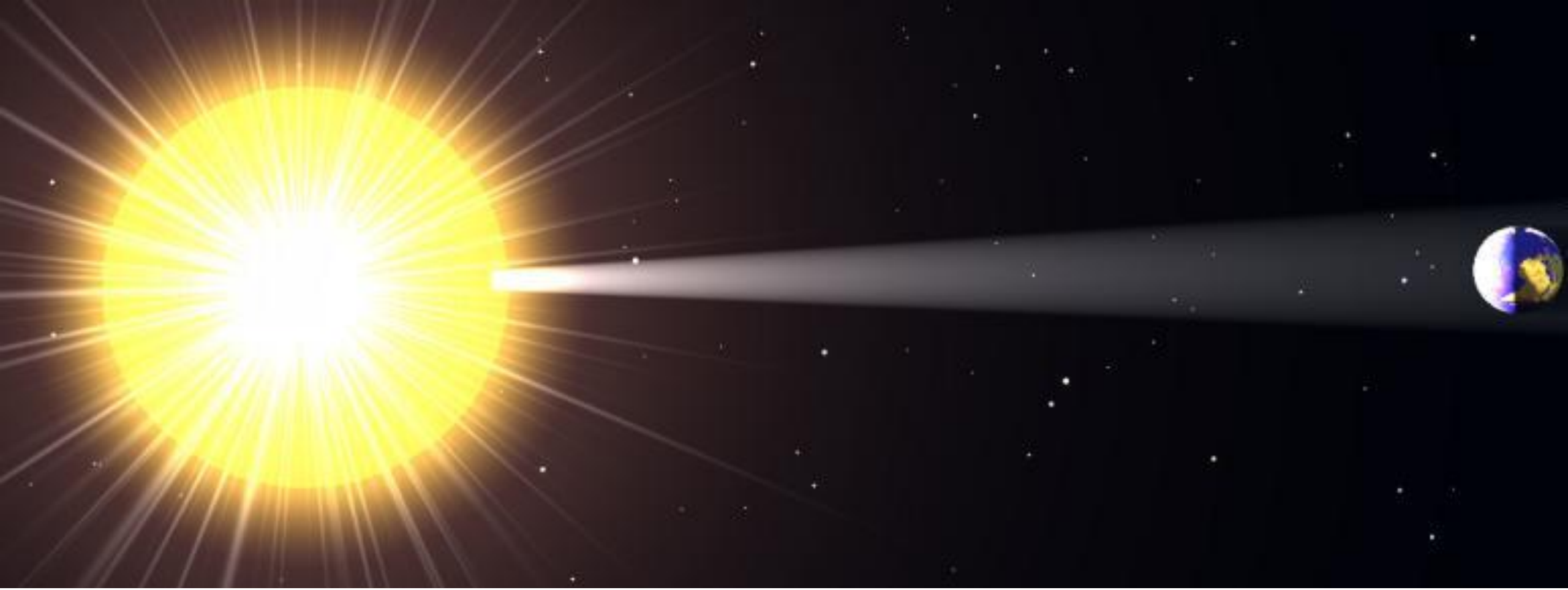


… However we get 3 766 800 EJ per year



1 EJ (Exajoule) = 10^{18} J = 1 000 000 000 000 000 000 J

1 kg m = 9,8 J
1 J = 1 Ws (1 watt pendant 1 seconde)
1kWh = 3 600 000 J
1 Calorie = 4,18 J



3 766 800 EJ par an

10^{18} kWh* = 10^{9} TWh

2 million times
Electric French consumption

50 000 times
World electric consumption
Whatever the energy sources

Solar Impluse

Toyota Mirai

Cartouche d’hydrogène


KNORR-BREMSE
GSP
SCHALTBAU
HYDROGENICS
SPHEROS
xperion
AKASOL
Selectron
CORADIA iLINT
nip
Wasserstoff - Energie für die Schiene
95 80 0654 601-3 D-ALHB
7L
8L
evb
R 100 m
G1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EAST
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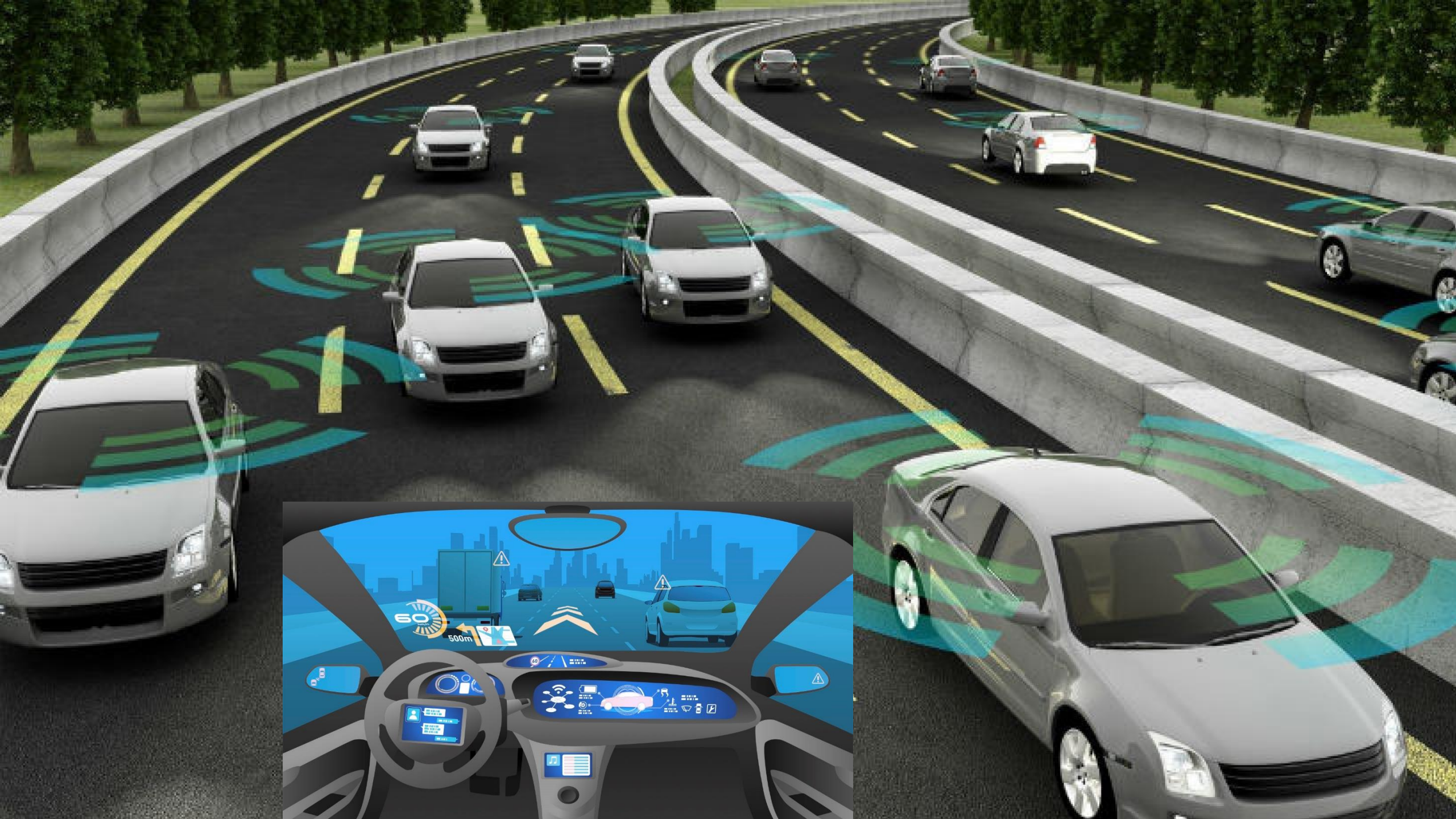
Artificial Intelligence


60
500m

« La durée poignardée »
Magritte
1938

Thank you for your attention

Michel Leboeuf
mleboeuf78@gmail.com