Byrne Seminar
The History and Future of High Speed Passenger Trains
China

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China High Speed Passenger Trains

Statistics

- People's Republic of China (PRC)
- Comparison with US

Item	*China*	*US*
Area	9.6 M km^2	9.8 M km^2
Driving side	right	right
GDP (nom)	\$ 15.3 T	\$ 22.3 T
GDP (PPP)	\$ 29.5 T	\$ 22.3 T
Population	1.4 B	328 M

China High Speed Passenger Trains

History

- First railway constructed by Chinese was Beijing-Zhangjiakou Railway
- Constructed from 1905 to 1909
- Chief engineer Zhan Tianyou
- Mountainous terrain required switchback
- Passes through Great Wall

Zhan Tianyou
(1861-1919)

China High Speed Passenger Trains

What is a Switchback ?

- Switchback also known as zig zag
- Looks like letter "Z"
- Used for climbing steep mountains
- Eliminates need for tunnel
- Reverse direction in middle of Z

Lithgow switchback

China High Speed Passenger Trains

China State Railway Group Company, Ltd

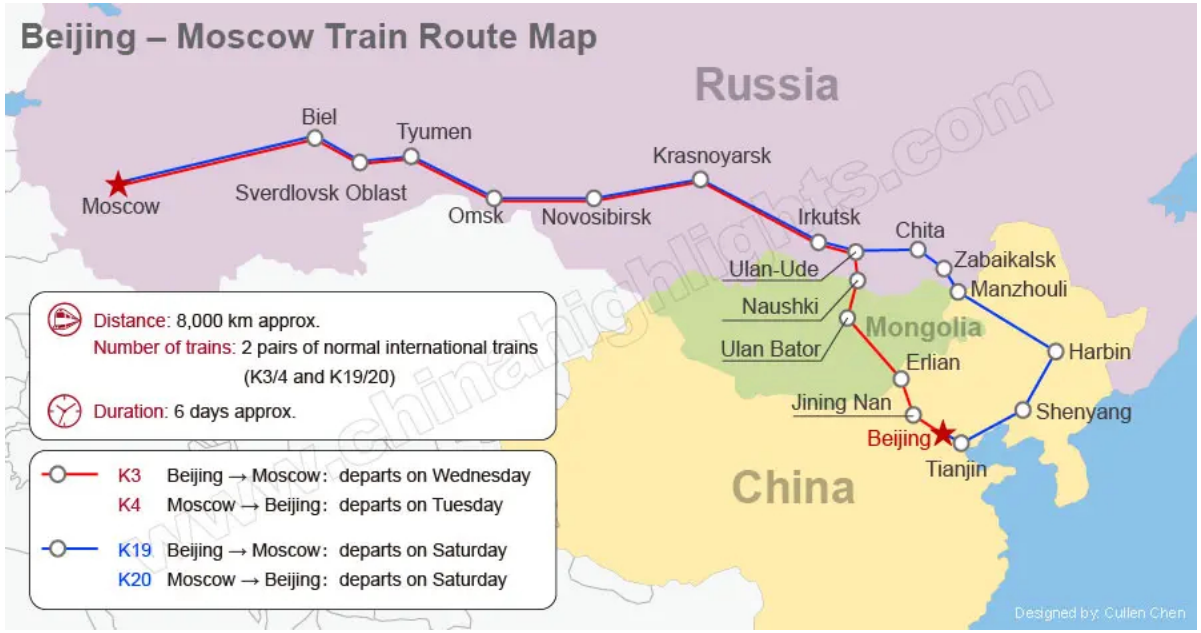
- China Railway (CR) is state-owned organization operating railway passenger and cargo services
- Organized in 2019 replacing China Railway Corporation
- Twenty-one primary subsidiary companies
- Approximately 2 million employees

China Railway Organization

China High Speed Passenger Trains

China State Railway Group Company, Ltd

- Operates passenger trains from China to Mongolia, Russia, Kazakhstan, North Korea and Vietnam (currently not operating due to COVID-19)
- Beijing-Moscow (see videos on youtube.com)
  - Three classes: Deluxe, Soft and Hard



Trans-Mongolian and Trans-Siberian routes

China High Speed Passenger Trains

China State Railway Group Company, Ltd

- Sixteen principal rail corridors
  - Eight "horizontal"
  - Eight "vertical"
- Connect 81 major cities

Gauge	*Width*	*Length*
Standard	4ft 8.5 in	79,685 km
Metre	3 ft 3.375 in	466 km
Narrow	2 ft 5.5 in	3,600 km

China High Speed Passenger Trains

Origin of China's High Speed Rail

- Deng Xiaoping visited Japan in 1978 and was impressed with Shinkansen
- A proposal was submitted in 1990 to National People's Congress to build a high speed rail between Beijing and Shanhai
- The conventional rail line between the two cities was at capacity
- Significant opposition due to cost and lack of profitability
- A feasbility study was commissioned in 1994

Deng Xiaoping
(1904-1997)

China High Speed Passenger Trains

Origin of China's High Speed Rail

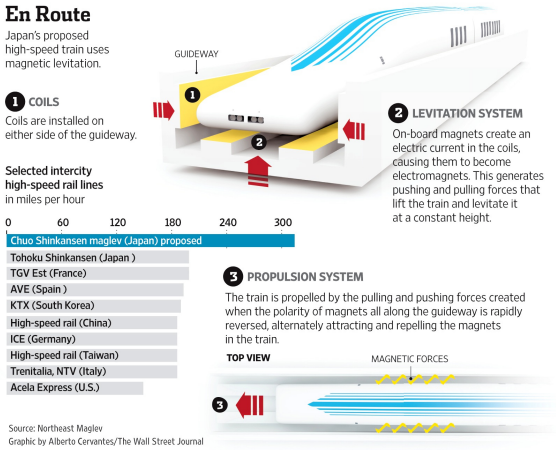
- Initial efforts in development of high speed rail considered two technologies
  - Conventional standard rail gauge
  - Maglev
- Shanhai purchased a Maglev system from Germany in 2000 for the 30.5 km link between Shanhai Pudong Airport and Shanghai
- The Shanghai Maglev began operation in 2004 with peak speed of 431 km/hr

Zhu Rongzhi
(1928-)

China High Speed Passenger Trains

What is Maglev ?

- Maglev is Magnetic Levitation
- Two sets of magnets
  - One set pushes train off track
  - One set to move train along track
- No friction



Maglev principle

Shanghai Maglev

China High Speed Passenger Trains

Where are Maglev trains ?

Train	*Country*	*Operation*	*Length (km)*	*Speed (km/hr)*
Shanghai	China	2004	30.5	431
Linimo	Japan	2005	9	100
Daejeon Expo	South Korea	2008	1	n/a
Incheon Airport	South Korea	2016	6.1	110
Changsha	China	2016	18.5	160
S1 Line (Beijing)	China	2017	9.1	160

Incheon Airport Maglev

China High Speed Passenger Trains

What Happened to Maglev in China ?

- Germany refused to share maglev technology and produce maglev trains in China
- Opposition from local residents concerned with noise and EM radiation
- Testing conventional high speed rail technology on Qinhuangdao Shenyang route (485 km)

Chinese D Class trains

- Chinese DJF2 train set record of 292.8 km/hr in 2002
- China Star (DJ32) train set record of 321 km/hr in 2002
- Chinese State Council adopts conventional high speed rail in 2004

China High Speed Passenger Trains

Development of China High Speed Rail

- Chinese DJ series considered unreliable
- Request for Propoal (RFP) announced in 2004 for 200 high speed train sets operating at 200 km/hr
- Requirement for technology transfer to enable development of domestic high speed rail
- Bids submitted by Alstom (France), Siemens (Germany), Bombardier (Germany) and Kawasaki (Japan)
- Contracts awarded to all except Siemens with deliveries beginning 2006

CRH1 (Alstom)

CRH2 (Bombardier)

CRH5 (Kawasaki)

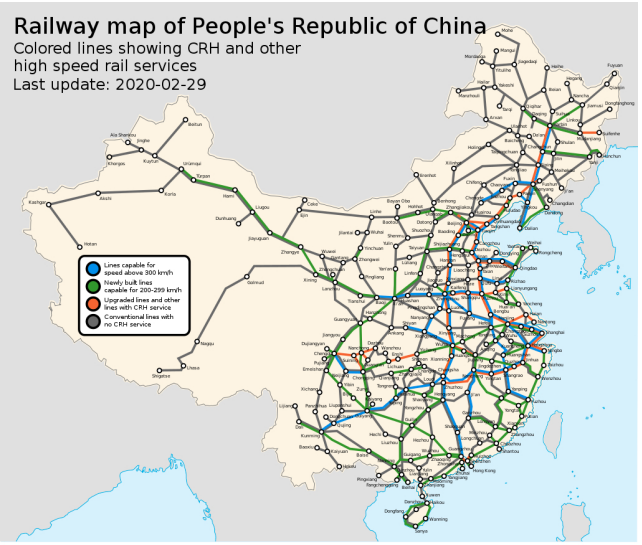
China High Speed Passenger Trains

Development of China High Speed Rail

- Major decision to expand high speed rail
- Government investment in rail

Year	*Total Investment*†
2004	\$14 B
2007	\$26.2 B
2008	\$49.4 B
2009	\$88 B
2020	\$300 B

†All rail lines



China High Speed Passenger Trains

Comparison with US

- US Government support of AMTRAK

Year	*Annual*
2004	\$1.2 B
2005	\$1.2 B
2006	\$1.3 B
2007	\$1.3 B
2008	\$1.3 B
2009	\$1.5 B
2010	\$1.6 B
2011	\$1.5 B
2012	\$1.4 B
2013	\$1.3 B
2014	\$1.4 B
2015	\$1.4 B
2016	\$1.4 B

China High Speed Passenger Trains

Wuhan-Guangzhou High Speed Rail

- China's first cross-regional high speed rail
- Service began December 2009
- Length 968 km
- Maximum speed 350 km/hr
- Duration 3 hr
- Previous duration 10 hr 30 min

China High Speed Passenger Trains

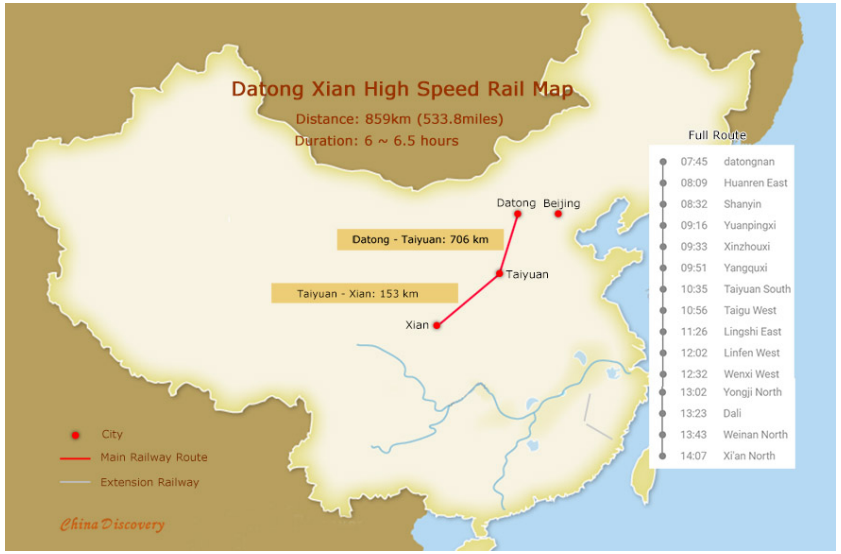
Beijing-Shanghai High Speed Rail

- China's second cross-regional high speed rail
- Service began June 2011
- Length 1318 km
- Maximum speed 380 km/hr
- Duration 4 hr 18 min
- Ridership 180 M (2017)
- Annual profit 6.6 billion yuan (2015)

China High Speed Passenger Trains

Datong-Xi'an High Speed Rail

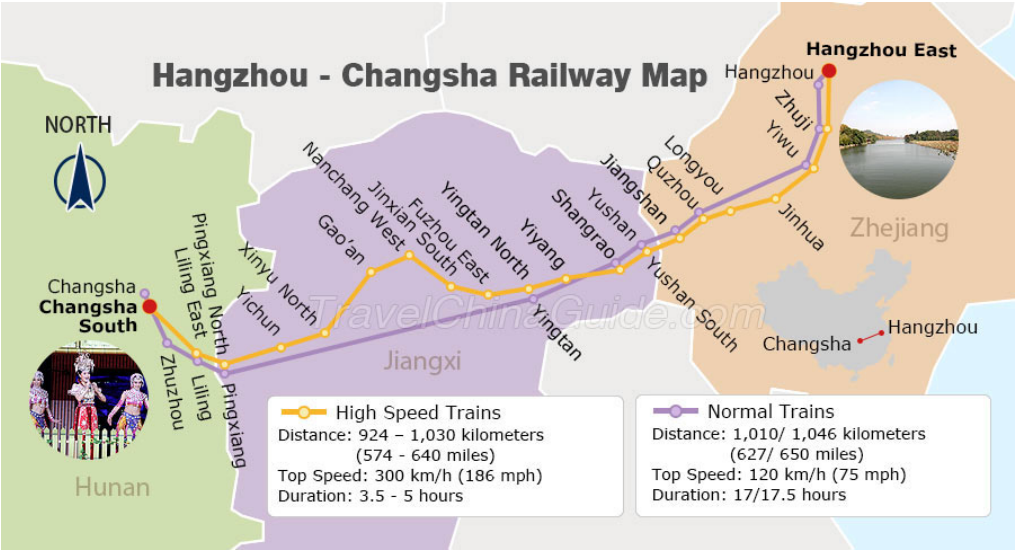
- Construction began December 2009
- Service on portion began 2014
- Length 859 km
- Maximum speed 250 km/hr
- Duration 3 hrs
- Previous duration 16.5 hrs



China High Speed Passenger Trains

Hangzhou–Changsha High Speed Rail

- Construction began December 2009
- Service began December 2014
- Length 921 km
- Duration 3 hr 36 min



China High Speed Passenger Trains

Lanzhou–Xinjiang High Speed Rail

- Construction began November 2009
- Service began 2014
- Length 1776 km
- Maximum speed 250 km/hr
- Reaches altitude of 3607 m
- Highest altitude of high speed rail

China High Speed Passenger Trains

Summary

- Longest high speed rail in the world
- Total length 36,000 km in 2020
- Plans to reach 70,000 km in 2035
- Newer lines are three types
  - Passenger dedicated lines at 350 km/hr
  - Regional lines at 250 km/hr
  - Intercity lines at 300-350 km/hr
- Agreements to build high speed rail systems in Turkey, Venezuela, Argentina, and Indonesia