High Speed Railways
-Case of China

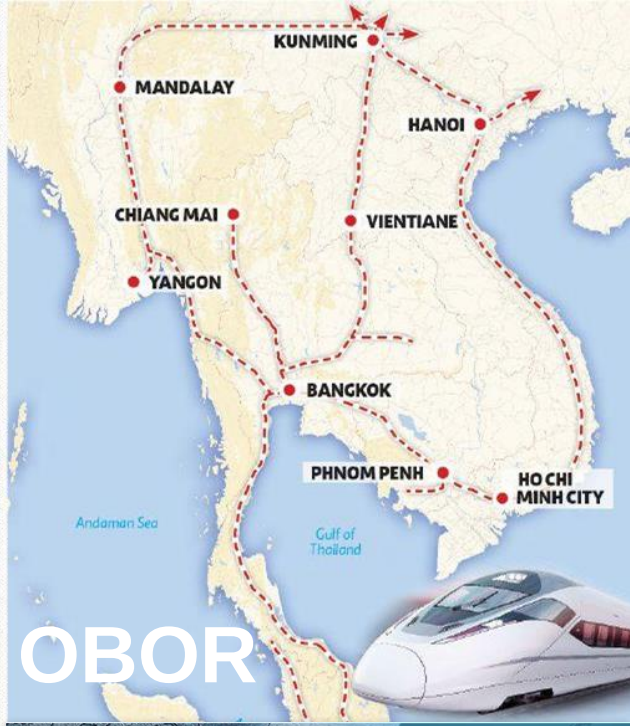
Regional EST Training Course at United Nations University

Shanshan Li, Vice Country Director, ITDP China Feb 26, 2018

A Symbol of China

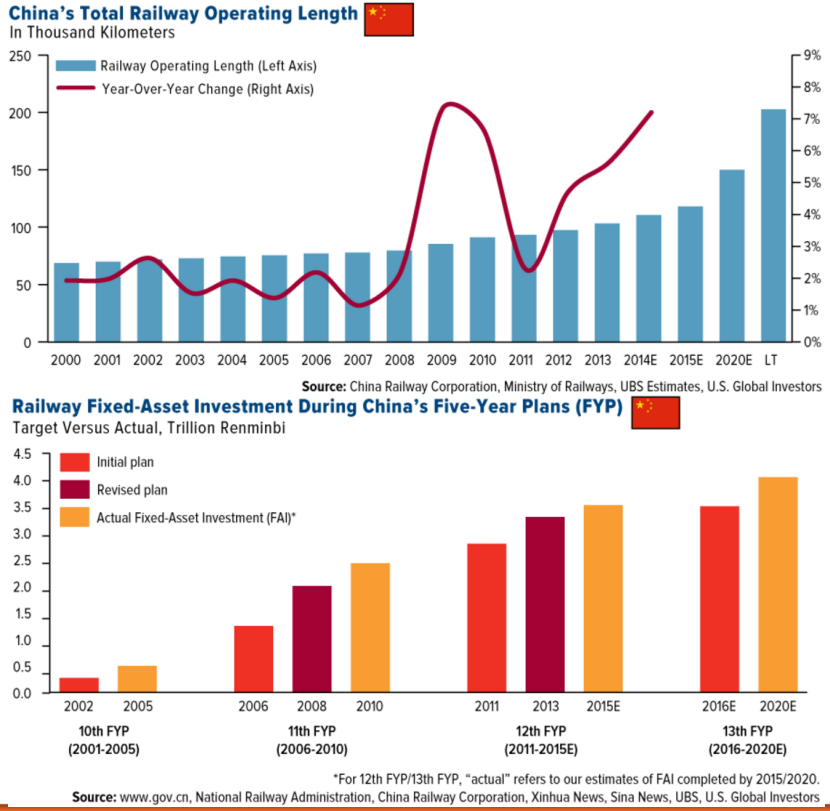
China's *One Belt, One Road* initiative and *Asian Infrastructure Investment Bank*, both highlight and also facilitate a **high-speed interconnectivity among nations and regions**. It seeks a **high-speed development on a specialized track** where China has demonstrated expertise. An influential symbol of China's fast development, interconnectivity and technical prowess is high-speed rail.

- China had built at least **34** lines of the high speed rail globally, a network exceeding **20,000km** and covered **160** cities.
- China built **5,000km** Pan-Asian HSR that connects Kunming in China to Singapore and other OBOR countries.
- Asia needs to spend **USD 40 trillion** on infrastructure by 2030 and HSR is the crown jewel of China's infrastructure export.



Broad Context of "One Belt, One Road" initiative & Asian Infrastructure Investment Bank Source: *Xinhua News Agency*

1. High speed development of HSR



How does China achieve the deed?

➔ Chinese Government Support

High-speed rail developed rapidly in China over the past 15 years thanks to generous funding from the Chinese government, especially the economic stimulus program during the Great Recession.

➔ Foreign Technology Transfer

Chinese engineers, after receiving transferred foreign technology, have been able to develop indigenous capability to produce key parts and improving upon foreign designs.

➔ Spillover Effects

Technological and socio-economic spillover effects brought about wide benefits and further scale-up high-speed rail.

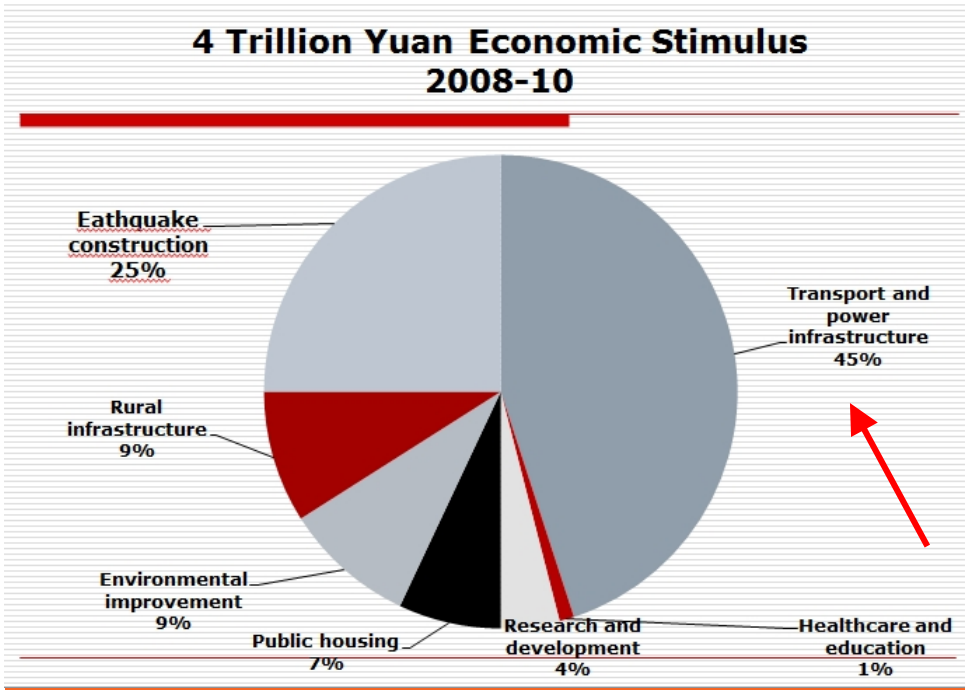
Source:

Huge investments

When the *2008 financial crisis* hit the U.S. and Europe and led to many countries there to adopt austerity measures, China made use of the opportunity to do the opposite by investing heavily in **infrastructure building** in order to stimulate the economy and to create jobs.

- In November 2018, the Chinese government announced a package worth 4 trillion yuan (US**$586 billion**) to stimulate the economy, a large part of which went into the development of high-speed railway.
- Investments in rail projects soared from **$49 billion** to **$88 billion** within one year. Since 2010, China has been spending about **$100 billion** a year on rail development.
- In 2014 it invested 809 billion yuan and in 2015, 823.8 billion yuan (or **$125.6 billion**) in railway construction.

Source:



Approximately **45%** investment focused on the transport and power infrastructure. Enormous investment on this area leads to the rapid development of high-speed rail network and property boom in recent several years. High-speed rail experienced the fastest growth during this period. Mark Stone (2014) wrote "*China has built 6,000 miles of track since 2008*".

(Mark Cranshaw, 2014)

Joint Effort

China is able to benefit from the economy of scale and the economy of standardisation in railway construction. The fine division of labour and the mass production have cut down the costs of many items of technology giving China an added advantage to developing HSR.

Scale

To develop its HSR technology almost from scratch with the introduction of foreign technology, China has been able to mobilise the resources of **25** leading universities, **11** science academies, **51** national laboratories, **500** companies and **40** government research institutes. Over **10,000** engineers, researchers and technicians took part, including **68** fellows from the Chinese academies of sciences and engineering and **500** university professors

Resources

The strong political will of Chinese leaders to do things on a grand scale and to complete projects quickly is a major contributing factor. This institutional factor speeds up China's HSR development.

Leadership

The unit cost of China's HSR infrastructure is about **$17-21 million per km**, while the comparable cost in Europe is **$25-39 million per km**. As to the costs of building railway tunnels, it is about **$10-15 million per km** in China. It is **$50 million per km** in the U.S. and **$60 million per km** in Australia.

Workforce

Source CNN

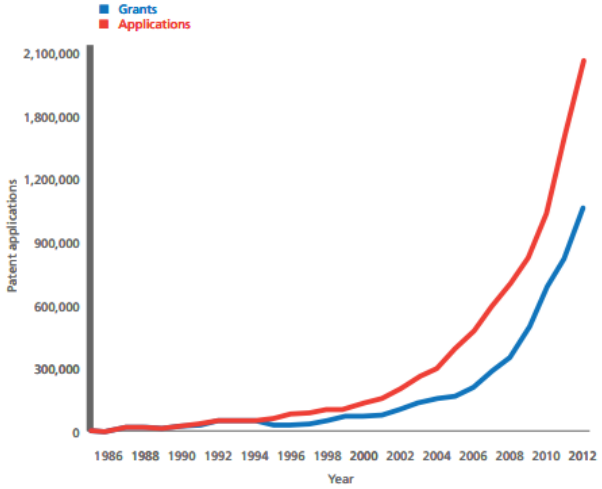
Technology Transfer & Spillover

In 2004, Four major international technology providers – *Alstom*, *Siemens*, *Bombardier* and *Kawasaki Heavy Industries* – signed **technology transfer contracts** with the two major train manufacturing conglomerates in China: *China Southern Railway Corp (CSR)* and *China Northern Railway Corp (CNR)* for **market access**.

By 2015, over **90** Chinese cities were connected by the HSR system. CSR and CNR are now able to build 'next generation' HSR trains by developing indigenous capability and improving on **imported foreign designs**.

The top speed of **indigenous-designed** Beijing-Shanghai HSR trains reaches **380km/h**, faster than any other HSR trains in the world.

Nowadays, Chinese government has been actively promoting the **export** of HSR technology to other countries and partnering or competing with the established manufacturers in **overseas markets.**



A **42%** increase in patent applications in the cities and technology classes with HSR technology transfer after 2004. The number drops to **20%** after excluding patents that were applied for directly by CSR or CNR affiliates and HSR suppliers, but it remains significant.

Source: CentrePiece Autumn 2016 Yatang Lin

New Age

The first intercity train between Beijing and Tianjin. The new train service would cut the 120-km journey from the current 70 minutes to about 30 minutes.

“Harmony” trains stop at a high-speed railway maintenance base in Wuhan, one of the four such maintenance bases.

Harmony bullet trains sit on the tracks at a high-speed train maintenance base in Wuhan,

Next generation bullet train "Fuxing" at Beijing South Railway Station also known as electric multiple units (EMU) has top speeds of 400 kilometers an hour

China increased the maximum speed of bullet trains on the Beijing-Shanghai high-speed railway to 350 kph, cutting the journey to 4 hours and 28 minutes.

Beijing South Railway Station, northern terminal of the Beijing-Shanghai high-speed railway in Beijing

Source: Xinhua net

Types of High-speed Rail Services

G-class trains run at higher speed at top speeds of at least **250 km/h**. The G7 train from Beijing South to Shanghai Hongqiao averages **300 km/h**. G-class trains run on the high speed tracks and typically serve **long distance** trips.

D-class train runs at lower speeds and can vary widely in actual trip speed. D-class trains have distributed power system and run on regular tracks between **major cities**. The earlier generation D-class trains have a maximum speed of **200–250 km/h**

C-class ("intercity" between **two nearby cities)** train also operate on high-speed track at speeds above **250 km/h**. C-class trains on the Beijing–Tianjin ICR,reach top speeds of **330 km/h** and average **226 km/h** for the trip.

source

Maglev

The maglev hovers several centimeters above the tracks. It is propelled by electrically charged magnets, and uses specially designed tracks to keep the trains from overturning or derailing.

The Shanghai Maglev is currently the world's fastest commercially operational train, routinely zipping back and forth between the city and Pudong International Airport at **430 km/h**. The 30-km journey takes less than eight minutes.

China's first medium-low-speed maglev line with maximum speed of **100 km/h** started operations in May 2016 in Changsha.

Some maglev train line costs ran beyond budget. The commercial viability of maglev is in question. The price tag of the Shanghai Maglev was believed to be **$1.3 billion** and was partially financed by the German government.

Milestones

Aug. 1, 2008

The first HSR (Beijing–Tianjin route) opened.

Feb. 6, 2010

The first HSR built on a collapsible loess area (Zhengzhou—Xi'an route) opened.

Nov. 25, 2015

17 leaders from 17 countries took an HSR train from Suzhou to Shanghai.

CRH

Dec. 26, 2009

The longest and most complicated Wuhan–Guangzhou line (part of the Beijing–Guangzhou–Shenzhen–Hong Kong route) opened.

Dec. 1, 2012

The first HSR built on a high latitude area (Harbin–Dalian route) opened.

2. High speed interconnectivity of HSR

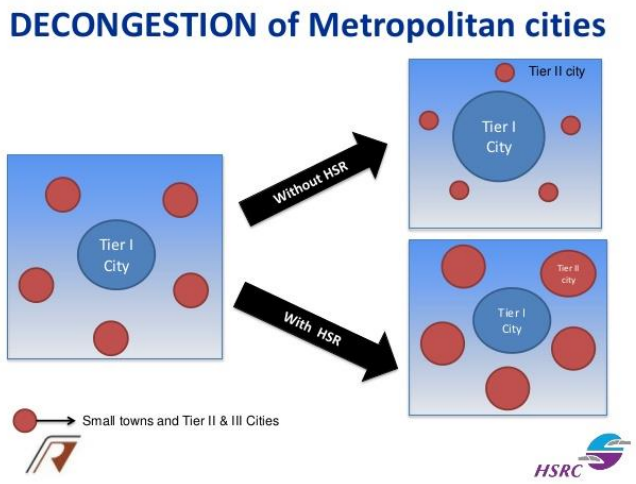
What are the effects of developing high-speed rail?

- → Urban Agglomeration
- → Regional Network
- → Changing Travel Mode
- → Western Development
- → Silk Road
- → Oversea Exports

Urban Agglomerations

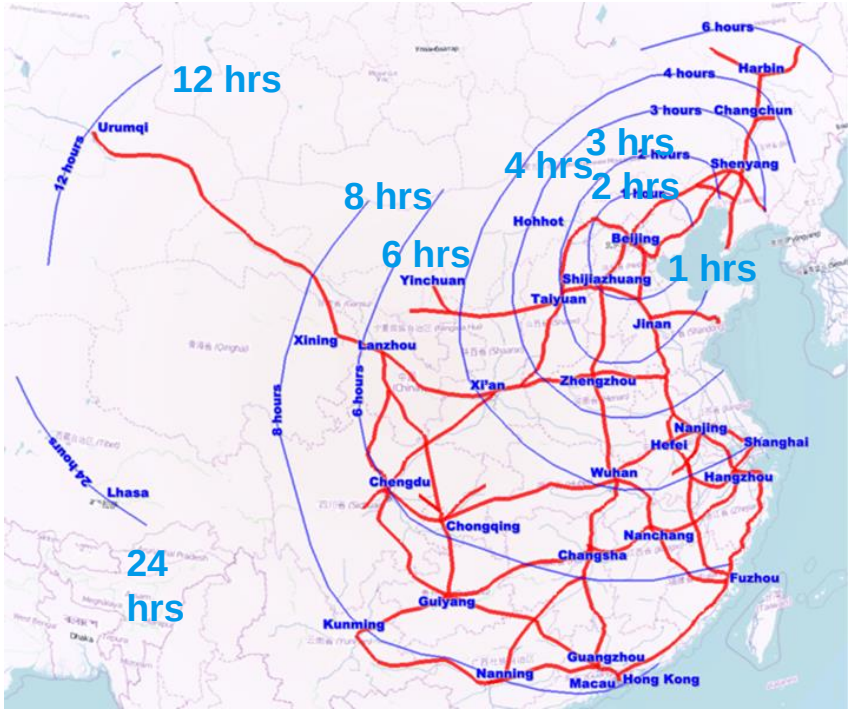
Three major urban agglomerations in China's south, east and north has emerged in socioeconomic development. These are **Jing-jin-ji** in the north, **Yangtze river delta** in the east, and **Pearl river delta** in the south. As early as 2014, these three urban agglomerations made up for **40%** of China's GDP, which showed their significance in China's development. Recent spotlight has been on Jing-Jin-Ji, the **national capital region** of China. It is the biggest urbanized region in Northern China that includes an economic region surrounding Beijing, Tianjin, and Hebei, along the coast of the Bohai Sea.

- China has approved a **$36 billion railway plan** to improve transport links between the **capital** Beijing, the port city of Tianjin, and the neighboring province of Hebei.
- Yangtze river delta is well-connected with the famed **high-speed rail Beijing–Shanghai** and Shanghai–Hangzhou part of the Hangzhou–Fuzhou–Shenzhen high-speed railway,
- Pearl river delta, which was the earliest test field of reform and opening-up, is connected by its 140-kilometer **Guangzhou-Shenzhen-Hong Kong express rail link**.



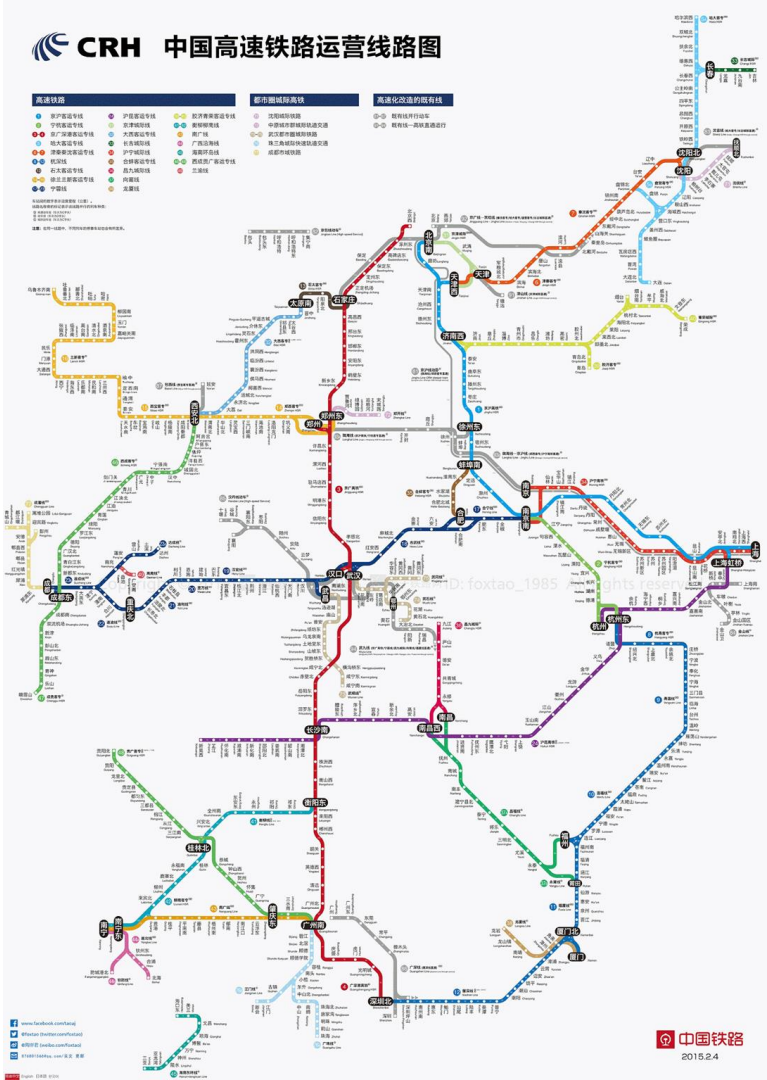
Regional Network

The advent of high-speed rail in China has greatly **reduced travel time** and has **transformed** Chinese society and economy. The network's rapid expansion means that **29** of China's **31** provinces and regions are today connected by bullet trains



Source: Wikipedia Common, the Transport Politics

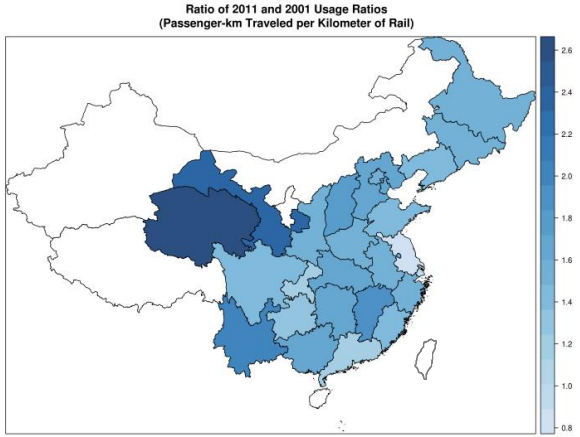
Changing Travel Mode



More Chinese are choosing to **ride rather than fly**. This is because train terminals tend to be located closer to city centres, and, unlike at airports, security screenings and check-ins are much speedier. High-speed rail is almost like a “scaled-up subway” system serving the whole country. **500k** passengers take China's busiest HSR route from Beijing to Shanghai per day

Western Development

- The high-speed train industry comprises several sectors and has a spillover effect on China's **industrial upgrading** and **economic restructuring**.
- It will have a far-reaching impact on the economic **development** of the economically backward **western** part of the country.
- It takes about **5½ hours** to travel from Beijing to Xi'an in Shaanxi province by a high-speed train, compared with more than **11 hours** by normal-speed trains.



Over the past 30 years, China has adopted a progressive development strategy with priority to the **eastern coastal region**, because their proximity to the sea makes import of raw materials and export of finished products easier.

With the world's major economies facing economic difficulties, China cannot sustain its export-oriented economic growth and instead focuses on boosting **domestic consumption**.

China has concrete plans of developing its vast western region. The idea of "**western development**" was put forward 14 years ago, but progress was unsatisfactory, partly because of lack of infrastructure. High-speed rail is a jumpstart to change.

Silk Road

China's high-speed railway program is crossing borders. The expansion of the high-speed rail network will provide the **boost to the development** plans for **West China** because it will connect the region not only with the **developed eastern provinces**, but also with the **vast markets** in **Central Asia, Russia and Europe**. This will facilitate the extension of China's economic links with its northern and western neighbors and create an **alternative regional market** that can offset the impact of the recession or downturn in the big trading powers of America and Europe.

- **Thailand** has agreed to build a $12.2-billion railway line connecting to China. It is to be extended through **Malaysia** to reach **Singapore**.
- China is building a high-speed rail network through Central Asian countries such as **Kazakhstan**, **Uzbekistan**, **Turkmenistan**, and Middle East nations like **Iran** and **Turkey**.
- In the north, China is negotiating with **Moscow** to build a line stretching from Heilongjiang province to Russia's northern regions. Besides, some **African** countries could get China's help to build more railways.
- As the economic **links** among the countries in the region **strengthen**, the regional economy will **consolidate** and become more **stable** to the benefit of all the countries involved.

Oversea Exports

China's high-speed railway exports

Country	Route	Distance (km)	Estimated cost (US$b)	Status
Turkey	**Ankara-Istanbul**	533	**1.3**	Completed in 2014
Thailand	**Bangkok-Nakhon Ratchasima**	250	**5**	Construction to begin in Dec
Indonesia	**Jakarta-Bandung**	150	**5**	Awarded in Sep 2015
Russia	**Moscow-Kazan**	770	**20**	Chosen; now in design stage
Bangladesh	**Dhaka-Jessore**	169	**3.1**	Awarded
Hungary	**Budapest-Belgrade**	350	**1.6**	Awarded the Hungarian section
Laos	**Vientiane-Yunnan**	427	**6**	Broke ground
Bidding war continues				
India	**Mumbai-Ahmedabad**	500	**14.7**	India signed agreement for technical and financial assistance from Japan
Malaysia	**Kuala Lumpur-Singapore**	350	**10.5**	Planning/Bidding stage
US	**Los Angeles-San Francisco**	558	**68**	Broke ground; selecting builder

SCMP

Source: South China Morning Post

China's high-speed trains have been sold to **102** countries and regions. **US$18 billion** worth of HSR-related agreements were signed in 2016, a 40 per cent increase from 2015. In 2015, China outbid Japan to win a **US$5.5 billion** project in Indonesia.

3. Four Vertical and Four Horizontal

"**Four Vertical and Four Horizontal**" network: The centerpiece of China's Ministry of Railways' expansion into high-speed rail is a national high-speed rail grid that is overlaid onto the existing railway network. The grid is composed of eight high-speed rail corridors, four running north-south and four east-west, and has a total of **12,000 km**.

Four North-South HSR Corridors

Beijing–Harbin High-Speed Railway	350 km/h	1,700 km
Beijing–Shanghai High-Speed Railway	350 km/h	1,433 km
Beijing–Guangzhou–Shenzhen–Hong Kong High-Speed Railway	350 km/h	2,229 km
Hangzhou–Fuzhou–Shenzhen High-Speed Railway	350-250 km/h	1,495 km

Four East-West HSR Corridors

Qingdao–Taiyuan High-Speed Railway	250 km/h	873 km
Xuzhou–Lanzhou High-Speed Railway	350 km/h	1,363 km
Shanghai–Wuhan–Chengdu High-Speed Railway	350–200 km/h	2,078 km
Shanghai–Kunming High-Speed Railway	350 km/h	2,066 km

Four North-South HSR Corridors

- **Name:** Beijing–Harbin Passenger Dedicated Line (PDL)
- **Length:** 1,300 km
- **Design speed:** 350 kph
- **Main stops:** Beijing Nan, Tianjin West, Qinhuangdao, Shenyang North, Changchun West, Harbin West

It connects Northeast China with the national capital, Beijing and cuts the journey time from 12 hours to 6 hours between Beijing and Harbin.

- **Name:** Beijing–Shanghai HSR
- **Length:** 1,318 km
- **Design speed:** 350 kph
- **Main stops:** Beijing Nan, Jinan West, Nanjing South, Suzhou North, Shanghai Hongqiao

It connects two popular cities and reduces the journey time from 12 hours to 5 hours (2 hours by air).

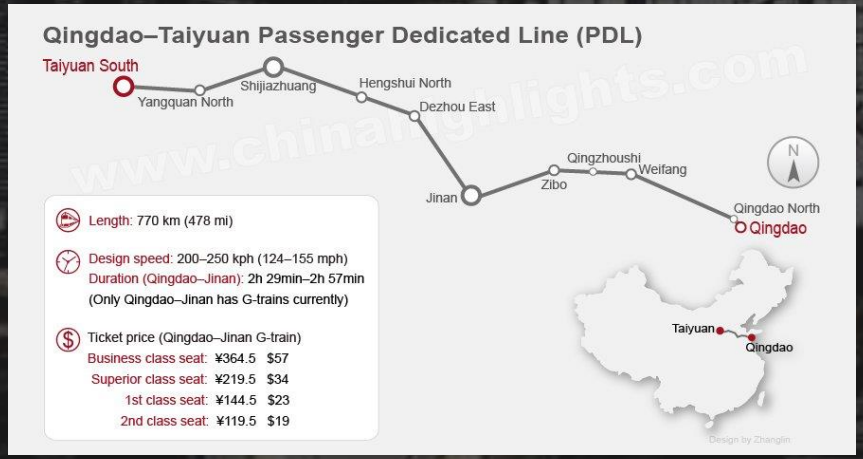
- **Name:** Beijing–Guangzhou–Shenzhen–Hong Kong HSR
- **Length:** 2,240 km
- **Design speed:** 350 kph
- **Main stops:** Beijing West, Shijiazhuang, Zhengzhou East, Wuhan, Changsha South, Hengyang East, Guangzhou South, Shenzhen North, Hong Kong

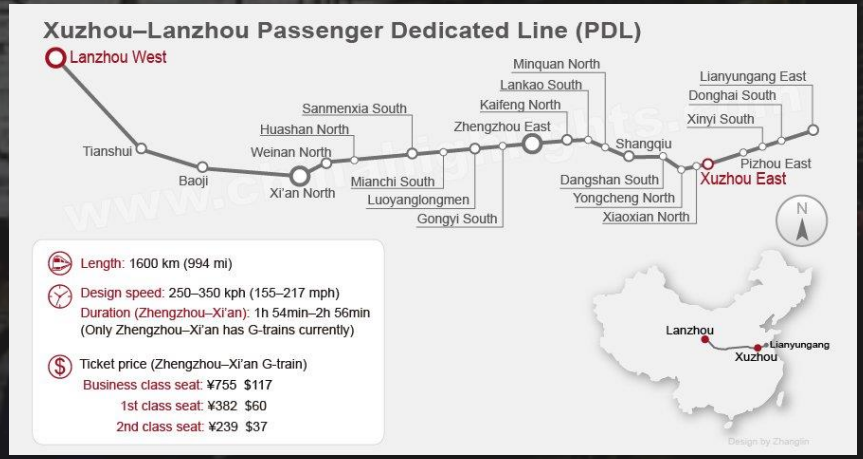
It is the longest passenger dedicated high-speed rail line in the world and connects North China, Central China, and South China.

- **Name:** Hangzhou–Shenzhen HSR
- **Length:** 1,600 km
- **Design speed:** 250–350 kph
- **Main stops:** Hangzhou West, Ningbo, Fuzhou South, Shenzhen North

It connects the Yangtze River Delta and the Pearl River Delta. There are only D-trains (running at 180–250 kph) in operation, and the journey takes about 10½ hours.

Four East-West HSR Corridors



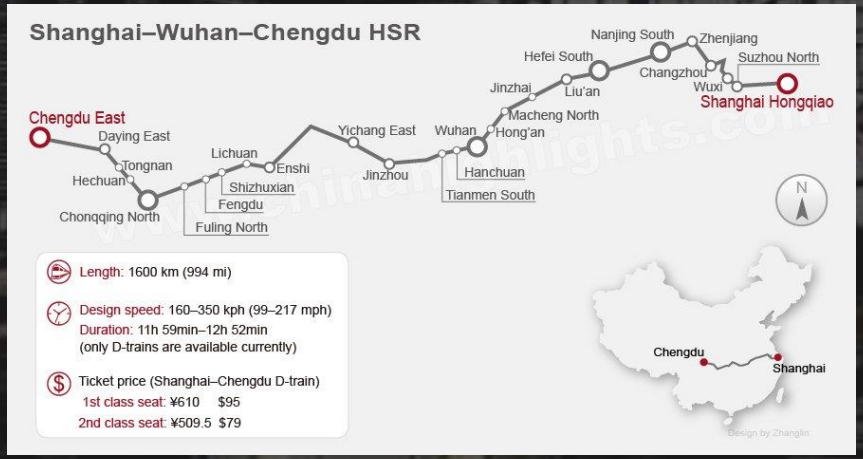


- **Name:** Qingdao–Taiyuan Passenger Dedicated Line (PDL)
- **Length:** 770 km
- **Design speed:** 200–250 kph
- **Main stops:** Qingdao, Jinan, Shijiazhuang, Taiyuan South

It takes less than 3 hours to travel from Qingdao and 1½ hours from Shijiazhuang to Taiyuan.

- **Name:** Xuzhou–Lanzhou Passenger Dedicated Line (PDL)
- **Length:** 1,400 km
- **Design speed:** 250–350 kph
- **Main stops:** Xuzhou East, Lianyungang, Zhengzhou, Xi'an North, Baoji, Lanzhou

It takes 2 hours to travel from Zhengzhou to Xi'an on the fastest train, G97 and The other G and D trains take 2 to 3 hours due to more stops on the journey.



- **Name:** Shanghai–Wuhan–Chengdu HSR
- **Length:** 1,600 km
- **Design speed:** 160–350 kph
- **Main stops:** Shanghai Hongqiao, Nanjing South, Hefei South, Hankou, Yichang East, Chongqing North, Chengdu East

It is built alongside the Yangtze River. The high-speed trains on most of the route have an average speed of 200 to 250 kph, except from Shanghai to Nanjing (350 kph), and from Yichang to Wanzhou (160 kph) because of the curves in the track that were designed to get around the area's landforms.

- **Name:** Shanghai–Kunming HSR
- **Length:** 2,266 km
- **Design speed:** 350 kph
- **Main stops:** Shanghai Hongqiao, Hangzhou East, Nanchang Xi, Changsha South, Guiyang North, Kunming South

It connects East China and Central China with Southwest China.

4. Eight Vertical and Eight Horizontal

In 2016, the National Development and Reform Commission (NDRC) announced the plans to **extend** the almost completed "**Four Vertical and Four Horizontal**" network to a new "**Eight Vertical and Eight Horizontal**" network. The new network comprises eight north-south ("vertical") corridors and eight east-west ("horizontal") ones, almost **doubling** the route length

Eight Vertical Corridors

Line	Passing Cities	Change from 4+4 Network
Coastal Passageway	Dalian (Dandong)-Qinhuangdao-Tianjin-Dongying-Weifang-Qingdao (Yantai)-Lianyungang-Yancheng-Nantong-Shanghai-Ningbo-Fuzhou-Xiamen-Shenzhen-Zhanjiang-Beihai (Fangchenggang)	Extensions of Hangzhou–Fuzhou–Shenzhen High-Speed Railway; north from Hangzhou to Dalian/Dandong, and south from Shenzhen to Fangchenggang.
Beijing-Shanghai Passageway	Beijing, Tianjin, Jinan, Nanjing, Shanghai (Hangzhou)	Incorporates all of Beijing–Shanghai High-Speed Railway and other parallel line sections connecting Beijing and Shanghai.
Beijing-Hong Kong (Taipei) Passageway	Beijing-Hengshui-Heze-Shangqiu-Fuyang-Hefei (Huanggang)-Jiujiang-Nanchang-Ganzhou-Shenzhen-Hong Kong (Kowloon)	New line.
Beijing–Harbin, Beijing–Hong Kong (Macau) Passageway	Harbin-Changchun-Shenyang-Beijing-Shijiazhuang-Zhengzhou-Wuhan-Changsha-Guangzhou-Shenzhen-Hong Kong, and Guangzhou-Zhuhai-Macau.	Merger of Beijing–Harbin High-Speed Railway and Beijing–Guangzhou–Shenzhen–Hong Kong High-Speed Railway, with a branch line to Macau.
Hohhot–Nanning Passageway	Hohhot-Taiyuan- Zhengzhou-Xiangyang-Changde-Yiyang-Shaoyang-Yongzhou-Guilin-Nanning.	New line
Beijing–Kunming Passageway	Beijing-Shijiazhuang-Taiyuan-Xi'an-Chengdu (Chongqing)-Kunming, including Beijing-Taiyuan-Zhangjiakou-Datong.	New line
Baotou (Yinchuan)–Hainan Passageway	Baotou-Yan'an-Xi'an-Chongqing-Guiyang-Nanning-Zhanjiang-Haikou (Sanya).	New line
Lanzhou (Xining)–Guangzhou Passageway	Lanzhou (Xining), Chengdu (Chongqing), Guiyang, Guangzhou	New line

Eight Horizontal Corridors

Line	Passing Cities	Change from 4+4 Network
Coastal Passageway	Dalian (Dandong)-Qinhuangdao-Tianjin-Dongying-Weifang-Qingdao (Yantai)-Lianyungang-Yancheng-Nantong-Shanghai-Ningbo-Fuzhou-Xiamen-Shenzhen-Zhanjiang-Beihai (Fangchenggang)	Extensions of Hangzhou–Fuzhou–Shenzhen High-Speed Railway; north from Hangzhou to Dalian/Dandong, and south from Shenzhen to Fangchenggang.
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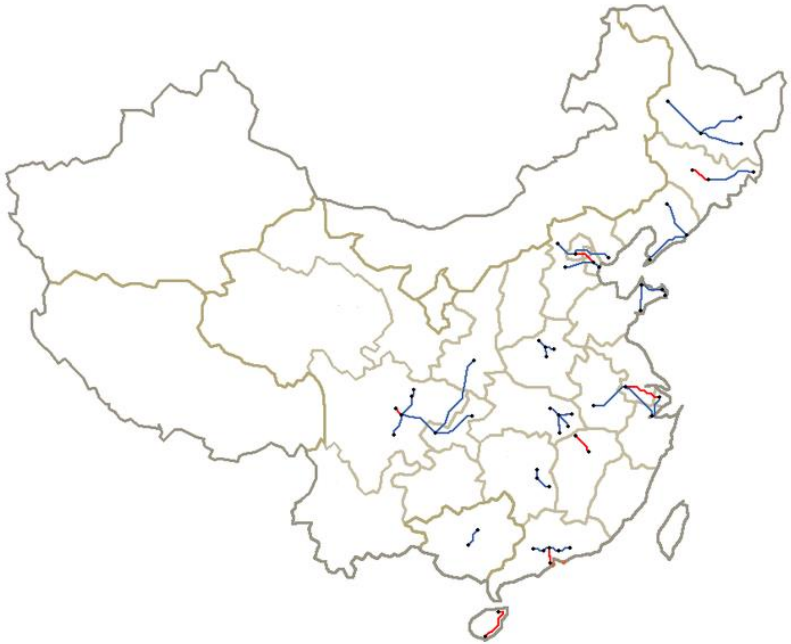
Beijing–Harbin, Beijing–Hong Kong (Macau) Passageway	Harbin-Changchun-Shenyang-Beijing-Shijiazhuang-Zhengzhou-Wuhan-Changsha-Guangzhou-Shenzhen-Hong Kong, and Guangzhou-Zhuhai-Macau.	Merger of Beijing–Harbin High-Speed Railway and Beijing–Guangzhou–Shenzhen–Hong Kong High-Speed Railway, with a branch line to Macau.
Hohhot–Nanning Passageway	Hohhot-Taiyuan- Zhengzhou-Xiangyang-Changde-Yiyang-Shaoyang-Yongzhou-Guilin-Nanning.	New line
Beijing–Kunming Passageway	Beijing-Shijiazhuang-Taiyuan-Xi'an-Chengdu (Chongqing)-Kunming, including Beijing-Taiyuan-Zhangjiakou-Datong.	New line
Baotou (Yinchuan)–Hainan Passageway	Baotou-Yan'an-Xi'an-Chongqing-Guiyang-Nanning-Zhanjiang-Haikou (Sanya).	New line
Lanzhou (Xining)–Guangzhou Passageway	Lanzhou (Xining), Chengdu (Chongqing), Guiyang, Guangzhou	New line

5. High-speed intercity railways



Intercity railways are designed to provide regional high-speed rail service **between large cities** and **metropolitan areas** that are generally within the same province. They are built with the approval of the central government but are financed and operated largely by **local governments** with limited investment and oversight from the China Rail Corporation.

HSR Line	Distance (km)	Design Speed (km/h)	Duration
Beijing–Tianjin Intercity Railway	115	350	35–57min
Shanghai–Nanjing Intercity Railway	301	350	1h 7min–3h 33min
Nanchang–Jiujiang Intercity Railway	131	250	1h–1h 10min
Shanghai–Hangzhou Intercity Railway	169	350	1h
Chengdu–Dujiangyan Intercity Railway	65	220	19–39min
Changchun–Jilin Intercity Railway	111	250	40–50min
Guangzhou–Zhuhai Intercity Railway	117	200	59min–1h 24min
Guiyang–Kaiyang Intercity Railway	62	200	48 min–1h 7min

Thank you!

"Cities require connectivity rather than territory in order to drive their economic stability and growth."

- James Scott, Institute for Critical Infrastructure Technology

Source:

ITDP 交通与发展政策研究所
Institute for Transportation & Development Policy
Promoting sustainable and equitable transportation worldwide.