Development of High-Speed Railways in China

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Introduction

The rapid developments seen recently in high-speed railways in China are astonishing. The lengths and speeds of lines in operation have already surpassed Japan's high-speed rail operation, making China's high-speed network number one in the world. As someone who has played a part in the development of high-speed rail in China, I would like to explain that development, its details and necessity, as well as the factors behind technological developments, station positioning, and urban planning, etc.

State of High-Speed Railway Development

China's high-speed railway construction plan was announced in 2004 as a mid-to-long-term rail network plan. The plan has since been reviewed and adjusted, but at the end of October 2010, it consists of the network shown in Figure 1 and Table 3. The plan is to have more than 13,000 km of track by 2012, and 20,000 km or more by 2020.

Furthermore, the high-speed railway network, with trains running in excess of 200 km/h, already covers about 4900 km in 14 sections, making it the longest in the world. As part of this high-speed network, the sections offering high-speed services of 350 km/h (five sections in Table 1) are the fastest in the world. Moving into 2011, two more ultra-high-speed lines will be added by the opening of the Beijing–Shanghai (1318 km) and Beijing–Wuhan (1119 km) lines.

Necessity for High-Speed Railways

To help understand the railway system in China, Table 2 compares China and Japan. Although the comparisons are from 2008 and China's rail network is still small, the table shows that the limited rail network is used heavily to provide both freight and passenger services. Compared to Japan, China has a vast inland region, thus China's freight transportation ratio is high, meaning railway expansion is a big factor in China's economic development. Again, judging from railway density, population, and number of cities, we can see that major cities in China are linked together in the same way as they are in Japan. So even seen from the perspective of passenger transport, building of high-speed railways and intercity lines between neighbouring cities and urban lines must be sustained to maintain present and future economic development.

Table 1 Overview of Ultra-High-Speed (350 km/h) Lines

Section (classification)	Length (km)	Start-up date
Beijing–Tianjin (intercity high-speed line)	114	1 August 2008
Wuhan–Guangzhou (passenger line)	1069	26 December 2009
Zhengzhou–Xian (passenger line)	505	6 February 2010
Shanghai–Nanjing (intercity high-speed line)	301	1 July 2010
Shanghai–Hangzhou (passenger line)	202	26 October 2010
Total	2191	

Table 2 China–Japan Comparisons

Item	Ratio (China/Japan)
Land area	25x
Population	10x
Railway density (extension/land area)	0.125x
Rail volume (passenger-km)	2x
Rail share of passenger volume (comparison of passenger-km)	1.2x
Rail freight volume (tonne-km)	113x
Rail share of freight transport volume (comparison of tonne-km)	6x
Cities with population of 1 million or more	11x

(*China Railway Yearbook 2009* and *Suji-de-miru-tetsudo 2010*)

Table 3 China's High-speed Railway Construction (October 2010)

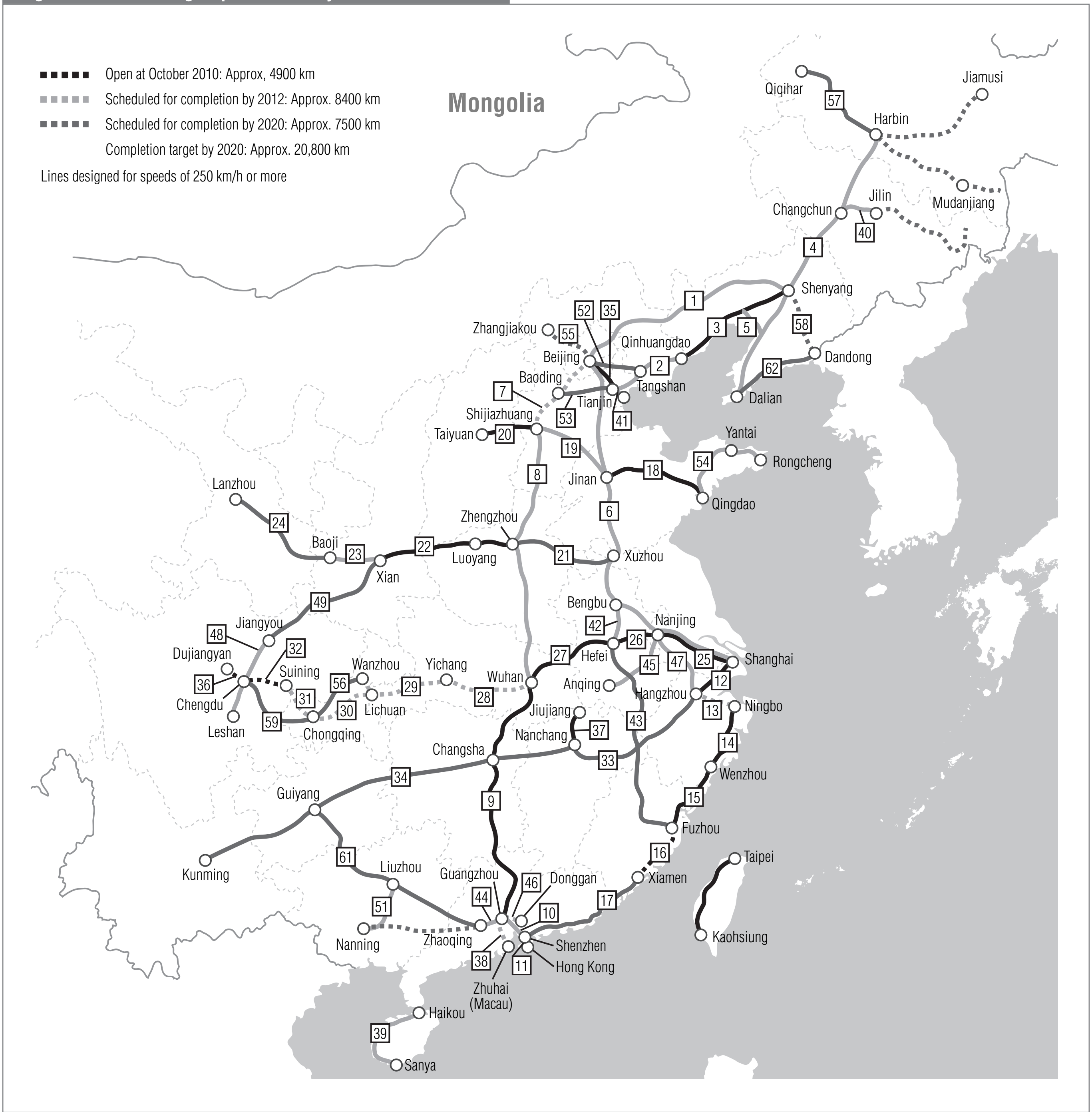
No.	Line	Length (km)	Design speed (km/h)	Start/scheduled start of work	Startup/scheduled startup	Affiliated lines
1	Beijing-Shenyang	**676**	**350**	Scheduled for 2010	2012	Beijing-Harbin passenger line (north-south line) Beijing->Chengde->Shenyang->Harbin
2	Tianjin-Qinhuangdao	**261**	**350**	November 2008	December 2011	
3	Qinhuangdao-Shenyang	**405**	**250**	August 1999	12 October 2003	
4	Harbin-Dalian	**904**	**350**	August 2007	December 2011	
5	Panjin-Yingkou	**90**	**350**	May 2009	2011	
6	Beijing-Shanghai	**1318**	**350**	April 2008	June 2011	Beijing-Shanghai passenger line (north-south line) Beijing->Tianjin->Jinan->Xuzhou->Nanjing->Shanghai
7	Beijing-Shijiazhuang	**281**	**350**	October 2008	June 2011	Beijing-Hong Kong passenger line (north-south line) Beijing->Shijiazhuang->Shengzhou->Wuhan->Changsha->Guangzhou->Shenzhen->Hong Kong
8	Shijiazhuang-Wuhan	**838**	**350**	October 2008	June 2011	
9	Wuhan-Guangzhou	**1069**	**350**	June 2005	26 December 2009	
10	Guangzhou-Shenzhen	**116**	**350**	August 2008	December 2010	
11	Shenzhen-Hong Kong	26	200	Scheduled for 2010	2016	
12	Shanghai-Hangzhou	**202**	**350**	September 2008	26 October 2010	Southeast coast passenger line (north-south line) Shanghai->Hangzhou->Ningbo->Wenzhou->Fuzhou->Xiamen->Shenzhen
13	Hangzhou-Ningbo	**150**	**350**	April 2008	December 2011	
14	Ningbo-Wenzhou	**351**	**250**	December 2004	28 September 2009	
15	Wenzhou-Fuzhou	**230**	**250**	October 2005	28 September 2009	
16	Fuzhou-Xiamen	275	200	September 2005	26 April 2010	
17	Xiamen-Shenzhen	**502**	**250**	November 2007	2013	
18	Qingdao-Jinan	**364**	**250**	January 2007	20 December 2008	Qingdao-Taiyuan passenger line (east-west line) Qingdao-Jinan->Shijiazhaung->Taiyuan
19	Jinan-Shijiazhuang	**319**	**250**	Scheduled for 2010	2012	
20	Shijiazhuang-Taiyuan	**212**	**250**	June 2006	1 April 2009	
21	Xuzhou-Zhengzhou	**357**	**350**	Scheduled for 2010	2013	Xuzhou-Lanzhou passenger line (east-west line) Xuzhou->Zhengzhou->Xian->Baoji->Lanzhou
22	Zhengshou-Xian	**505**	**350**	September 2005	6 February 2010	
23	Xian-Baoji	**148**	**350**	November 2009	December 2012	
24	Baoji-Lanzhou	**403**	**350**	Scheduled for 2010	2013	
25	Shanghai-Nanjing	intercity railway between Shanghai and Nanjing (separate table)				Shanghai (Nanjing-Hefei-Wuhan-Chongqing) Chengdu passenger line (east-west line) Shanghai->Nanjing->Hefei->Wuhan->Chongqing->Chengdu
26	Nanjing-Hefei	**166**	**250**	June 2005	18 April 2008	
27	Hefei-Wuhan	**359**	**250**	August 2005	1 April 2009	
28	Wuhan-Yichang	293	200	September 2008	January 2012	
29	Yichang-Wanzhou	377	200	December 2003	November 2010	
30	Lichuan-Chongqing	264	200	December 2008	December 2012	
31	Chongqing-Suining	132	200	January 2009	January 2012	
32	Suining-Chengdu	148	200	May 2005	30 June 2009	
12	Shanghai-Hangzhou	Southeast coast passenger line/Shanghai-Hangzhou (separate table)				Shanghai-Kunming passenger line (east-west line) Shanghai->Hangzshou->Nanchang->Changsha->Guiyang->Kunming
33	Hangzhou-Changsha	**933**	**350**	January 2009	2013	
34	Changsha-Kunming	**1175**	**350**	Scheduled for 2010	2014	

Chinese high-speed railway construction (intercity)

No.	Line	Length (km)	Design speed (km/h)	Start/scheduled start of work	Startup/scheduled startup	Affiliated lines
35	Beijing-Tianjin	**114**	**350**	July 2005	1 August 2008	
36	Chengdu-Dujiangyan	57	220	November 2008	12 May 2010	
37	Nanchang-Juijiang	131	**250**	June 2007	20 September 2010	
25	Shanghai-Nanjing	**301**	**350**	July 2008	1 July 2010	
38	Guangzhou-Zhuhai	117	200	December 2005	October 2010	
39	Hainan Eastern Ring Railway (Haikou-Sanya)	**308**	**250**	September 2007	December 2010	
40	Changchun-Jilin	**109**	**250**	May 2007	December 2010	
41	Tianjin-Binhai Xinqu	**45**	**350**	October 2009	December 2011	Extension of Beijing-Tianjin
42	Bengbu-Hefei	**131**	**350**	January 2009	December 2011	
43	Hefei-Fuzhou	**806**	**250**	September 2009	2013	
44	Guangzhou-Foshan-Zhaoqing	87	200	September 2009	March 2011	
45	Nanjing-Anqing	**257**	**250**	December 2008	June 2012	
46	Dongguan-Huicheng	97	200	May 2009	October 2012	
47	Nanjing-Hangzhou	**251**	**350**	December 2008	December 2012	
48	Jiangyou-Chengdu-Leshan	**319**	**350**	December 2008	December 2012	
49	Xian-Jiangyou	**519**	**350**	March 2010	June 2014	
50	Wuhan urban area	**160**	**250**	March 2009	2013	
51	Liuzhou-Nanning	**226**	**250**	December 2008	2012	
52	Beijing-Tangshan	**160**	**350**	Scheduled for 2010	2012	
53	Tianjin-Baoding	**145**	**250**	Scheduled for 2010	2012	
54	Qingdao-Yantai-Rongcheng	**299**	**250**	Scheduled for 2010	December 2012	
55	Beijing-Zhangjiakou	174	200	Scheduled for 2010	2013	
56	Chongqing-Wanzhou	**250**	**350**	Scheduled for 2010	2013	
57	Harbin-Qiqihar	**286**	**300**	July 2009	2013	
58	Shenyang-Dandong	**208**	**350**	Scheduled for 2010	2013	
59	Chengdu-Chongqing	**305**	**350**	Scheduled for 2010	–	South corridor
60	Guangzhou-Qingyuan	68	200	Scheduled for 2010	–	
61	Guangzhou-Guiyang	**857**	**250**	October 2008	2012	
62	Dandong-Dalian	**159**	**250**	Scheduled for 2010	–	

At October 2010: 4889 km; Completion by 2012: 8413 km (Total: 13,302 km); Completion by 2020: 7493 km (Total: 20,795 km)
Bold: ≥250 km/h design speed: 18,680 km (October 2010: 3977 km)

Figure 1 China's High-speed Railway Construction Plan



In any event, China needed to bolster its rail capacity for economic development, so the national 1997 Ninth Five-Year Plan decreed that existing lines should be speeded up, which was achieved to reach a maximum speed of 160 km/h for passenger trains by the fifth speed-up in April 2004. However, it was presumed that overseas technologies would be needed for the sixth speed-up on 18 April 2007 (final year of scheme), so high-speed trains from Japan, France, and Canada were introduced, and a maximum speed of 200 km/h (250 km/h on some sections) was reached by the sixth speed-up.

Nevertheless, as the prime objective of China's railway system was to transport freight and passengers over long distances, construction of new lines was imperative in order to drastically increase transportation capacity. First, to strengthen freight carriage on existing lines, passenger-only lines were constructed alongside existing lines to transport passengers separately. Next, intercity rail links were built to transport passengers within cities and out to the suburbs in areas that until then had lagged behind in terms of rail services. The results can be seen in Figure 1 and Table 3, which show China's high-speed railway status.

High-speed trains based on Japanese technology transfers (JARTS)

In the case of Japan's Tokaido and San'yo shinkansen, the tracks stretch 1180 km, with eleven 1-million-plus cities *en route* and up to 100 million people living near the line. Naturally, a densely populated area like this needs a high-speed passenger dedicated line. With the population along the Beijing–Shanghai line said to be 300 million people, it is logical for China to have a high-speed railway network ten times or so the size of Japan's. Moreover, in comparison to Japan, China's inner-city and intercity railways lag way behind, but China is working rapidly to rectify this situation.

Development of High-Speed Railway Technologies

Essentially, China's national policy is to make its own products. With respect to construction of high-speed railways, China first set out to build its own high-speed lines. In order to do this, it studied high-speed railway technologies from around the world, and trial manufactured two proprietary designs for 300-km/h operation (a locomotive hauled train and a distributed-traction type electric train) as well as building a 50-km, high-speed passenger-only test track from Qinhuangdao to Shenyang, where overseas and domestic technologies were introduced and trains built and tested. Japan's slab track technology was introduced here using published technical data without assistance from Japan. However, in the end, Japan was asked to provide technical support. In any event, China's approach is to trial produce necessary products at least once, and then to procure technical guidance, in order to make the technology their own.

Nevertheless, China realized that it could not meet its own construction speed goals using this approach, so intra-governmental revisions were made in 2002, and vital technologies were introduced from leading overseas nations. At the time, high-speed railways around the world fell into two camps: the German and French locomotive (concentrated traction) system, and the Japanese shinkansen (distributed traction) system. China opted to use the distributed-traction system, and as a result, nearly all the world's high-speed railways have taken distributed traction as their standard.

The main technical imports from abroad include carriages, signalling/transport management and ballast-less tracks. For carriage technology, China introduced models based on the Swedish high-speed commuter train, *Regina* (built by Bombardier of Canada), the JR East *Hayate* E2-1000 (built by Kawasaki Heavy Industries) and the German ICE3 (built by Siemens). The method involves modifying the designs to suit Chinese needs in areas such as body width and interior fittings. Thus, only a few completed trains are imported. Ultimately, of all models introduced, about 20% of the parts are made in the countries of origin and the other 80% are made in China under licence. These trains are in service on high-speed (350 km/h) sections shown in Table 1. Furthermore, a new train locally revised and capable of


Laying (left) and completed (right) test slab track (JARTS)

380 km/h has been launched on the Shanghai–Hangzhou line opened on 26 October 2010. Likewise, a speed of 380 km/h is scheduled for the line opening between Beijing and Shanghai in 2011.

For ballast-less tracks, China introduced Japanese slab track as well as three systems from Germany. A test track was built using each system and all the technologies were mastered to create the Chinese systems. All four systems are now in use on rail lines nationwide, according to their special attributes.

In a mere 10 years or so, China has studied data in the public domain, introduced principal technologies from foreign nations, nurtured its own railway industry, and is developing that industry further. Technologies are managed centrally using the required test tracks. These technologies are now being adopted one after another in high-speed railway construction across the country.

Having joined the high-speed rail business later than others, China has made the most of the benefits derived from starting late to combine various developments in individual technologies (such as speed control technology, which has advanced rapidly in recent years) to raise speed limits imposed by train and track combinations. China is already conducting R&D into a train that will run at 400 km/h or more in the near future. I look forward to seeing how this turns out, because the ample infrastructure for this project currently under construction suggests that the speed limit bar will be raised again.

Station Positioning and Urban Development

At the start, the Wuhan–Guangzhou passenger line opened in December 2009 had 18 stations, of which only Guangzhou North Station incorporated the existing station into the new one. All the others are new stations. Even the two termini at Wuhan Station (there was no Wuhan Station on the old line) and at Guangzhou South Station are both new. With 15 platforms and 28 tracks, Guangzhou South Station is the biggest in Asia. It was built on farmland well away from the city centre, but it is not just the enormous size of the station that stands out. There are other development plans for the surrounding area, such as a station-front plaza and a car park. In the future, there is also a plan to build a subway to link the city with the station, making it the southern hub of Guangzhou City and stimulating further development. Likewise, other new stations are involved in similar plans, with stations becoming focal points of urban development, which will transform them into fully fledged urban locales.

Due to China's dual urban and rural registration systems, it is impossible to transfer family registration freely. For this reason, cities are crammed full of rural citizens drawn by work prospects but who are not on urban family registers, which has become a social problem. One approach to resolving this problem involves accelerating urban development so that urban areas around cities increase to absorb the influx of rural citizens, who will be placed on urban family registries as part of the process of absorbing them. Against this background and because farmland can be bought easily and construction speed is fast, there has been a sharp increase in the number of new stations springing up around the country.

Advantages of Public Land Ownership

In China, all land is owned publicly but is managed by provincial governments. Under this system, approval can be given for leasing or selling/buying land. However, that said, there is no way a provincial government would give such approval to a private individual wanting to build a home. Instead, approval is offered on public-works land either to villages or entire regions that are prepared to enter into projects to develop regions or likewise build roads and

Visualization of Guangzhou South Station (JARTS)

railway lines, etc., or to private developers who want to carry out large-scale development. Therefore, when deciding to approve the land usage, the provincial government considers its own urban development plans and provides guidance, meaning that large-scale urban development can move ahead more effectively and speedily than in Japan. Moreover, land leasing provides tax revenue that boosts local government finances, so provincial governments are keen to lease out land—in other words to turn land over to development schemes; land usage fees are determined at the discretion of the provincial government. Thus, when it comes to development along a newly constructed railway line, the provincial government can obtain the money brought by rises in land prices as a result of railway construction in advance. Further, this money can then be used to repay debts created by the railway construction. In Japan of the past, big private railway companies joined together to build lines and develop the surrounding areas, taking a lot of time (10 years or more). By contrast, in China, the same kind of projects are now being implemented easily and, what is more, on a grand scale.

Conclusion

Construction of high-speed railways in China is essential from the perspective of the massive Chinese population, the locations of cities, and the development of the economy. Construction will result in ever-greater human movement, development of new urban areas along the rail lines, and massive economic benefits. It is hoped that the increasing urban population will help rectify the economic disparities between rural and urban citizens, an issue of great concern in China. Although I am not sure which way things will go, I watch these railway developments with interest. ■

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