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GROWTH OF RAILWAY NETWORK IN CHINA (1988-2002)

ABSTRACT

20.000 km of new railways were built in China in 1988-2002. The railway network has increased its topological complexity from 75 to 112 circuits and the new 3rd topological layer appeared in 1993 and the 4th will emerge in 2004 after the opening of the rail ferry Dalian - Yan-tai. The main features of the recent Chinese rail network are: 1) the predominance of meridional-ity, 2) the spatial disproportion between the eastern coastal area (with dense network) and the empty western part, 3) the low level of electrification (20%) and the low share of double-track sections (30%), 4) the land-lock orientation of the whole network and a small number of lines along the sea coasts. These disproportions are the main obstacles for a harmonic spatial devel-opment of the economic structure.

KEY WORDS

Chinese railways, railway network, topological structure of transport network, circuital framework of transport network, Jing-Jiu railway, high-speed railways, Maglev system

Table 1 - The lengths of railway networks of the biggest countries and the level of their topological complexity*

Country	Length of network, 1000 km	Number of circuits*	Number of topological layers in circuital framework*
U.S.A.	225.7	655	6
Russia	149.0**	184	4
China	70.0 (119)**	112	3
India	62.9	288	4
Germany	40.8	734	7
Canada	36.1	141	3
Australia	33.8	41	2
Argentina	33.7	167	3
France	31.9	263	6
Mexico	31.0	39	2
Brazil	30.5	32	2
Japan	23.7	107	2
Poland	23.4	317	5
Ukraine	23.4	111	3
South Africa	21.4	46	2
Italy	19.4	134	2
U.K.	16.9	254	4
Kazakhstan	14.4	13	2

* circuit – closed loop in the network, topological layers – concentric rings of circuits, which determined off the perimeter of circuital framework; circuital frame
work – aggregate (agglomeration) of circuits in the network
** total mileage of all sorts of railways are indicated, including industrial, local and forest ones

Rapid economic growth in China during the last 15 years has been followed both by spatial expansion, and by the sealing of the "economic tissue" of the territory. This process is realising a clear cut in the railway network growth, the rates of which were unique in 1988-2002 and are very similar to those at the time of railway building epoch in Europe and the USA in the second half of 19th century. If these rates keep on at the same level during the next decade, the Chinese railway network will leave behind the Russian network by its mileage and take the second place in the world following the USA (see Table 1).

China had a total of 120,000 km of railways in 2000, including 18,000 km of local, 11,000 km of forest and 20,000 km of industrial railways and the rest were state railways. The state railway mileage was increased in 1987-2002 by 33% (see Table 2). 20,990 km of 67,400 km of state railways had double tracks (see below) and 13,600 km were electrified (20.5%) in 1999.

1. DYNAMICS OF TOPOLOGICAL STRUCTURE OF THE NETWORK

Drastic changes took place not only with the mileage, but also with the topological structure of the network during 1988-2002. The highest level of disconnectivity was the main feature of the Chinese railway network at the initial stage of growth: 23 isolated sys-

Table 2 - The length of state railways of China in 1911-2002

Year	Length, km	Year	Length, km
1911	9,565	1980	49,900
1931	14,802	1985	52,100
1935	15,725	1987	52,600
1945	25,446	1990	53,378
1949	21,810	1994	53,991
1950	21,740	1995	62,615
1953	22,676	1997	66,000
1957	29,862	1998	66,400
1958	31,193	1999	67,400
1969	39,311	2000	67,500
1971	40,121	2002	70,000
1975	46,000	2005 (plan)	75,000

tems appeared in the different parts of the country between 1881 and 1943, and their connection was completed by 1937-39. The last isolated lines in Sichuan and Yunnan provinces were joined to the main network in 1956 and 1965, respectively.

The first circuit in the network was formed in 1908 (the first railway was opened in China in 1876) in the South of Manchuria, the second one – in the central part of China in 1916 (Beijing – Zhengzhou – Kaifeng – Jinan – Tianjin – Beijing; see Map 1). Two small separate circuital frameworks were generated in 1927 – in Manchuria and in 1933 – in Central China. Both frameworks were united into a big one in 1938, and this was the important structural event for the whole network. The first circuit of 2nd topological layer appeared in 1940, and the number of circuits in the network increased to 29 in 1945. At that moment the circuital framework covered only the eastern strip of Central China.

The wars in the Chinese area in 1937-49 were responsible for the decreasing of the mileage by 10,000 km and disintegration of the main circuital framework into two isolated ones – again in Central China (with 5 circuits) and Manchuria (2 topological layers with 14 circuits). Both were united again into a single big one in 1959, when the network had 23 circuits. Circuital framework and 2nd topological layer were extended in 1966-78 (see Table 3, and the Maps for 1974 and 1989, Fig. 2). The next peak of the network's growth took place in 1990s when 3rd topological layer emerged (in 1993; see Map for 1995, Fig. 2) in the heart of the country.

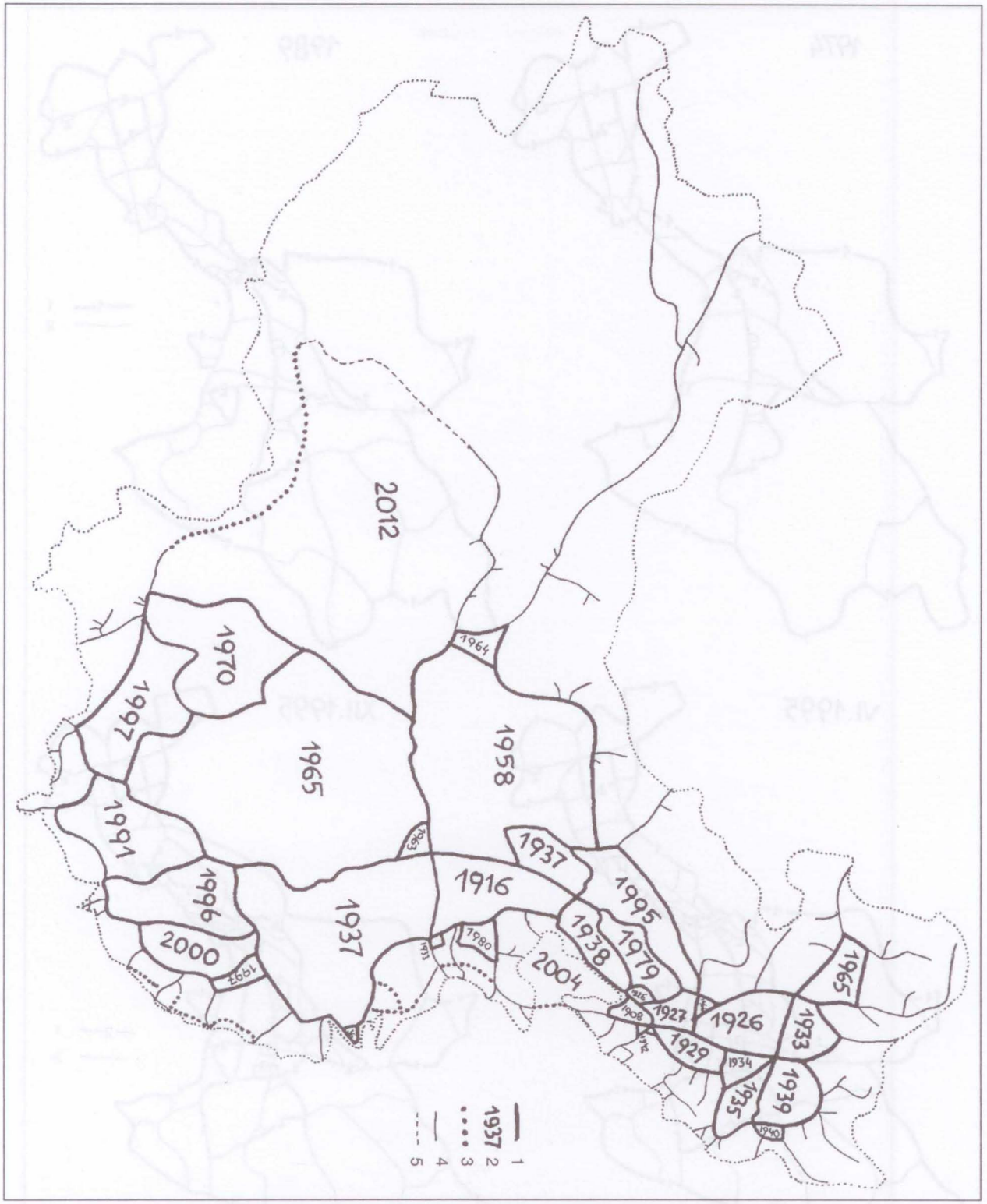
The greatest part of the area (61%) of the mainland China was covered by the circuital framework (see Map 1 and Map for 2002, Fig. 2), with 90% of all population living there. It has the core of network concentration with the biggest density in Central China (provinces of Hebei, Shanxi, Henan and Shandong). The 4th topological layer will appear in the circuital framework in 2004, after the inauguration of the ferry line Dalian – Yantai (see Map 3). This layer will emerge just 10 years after the generation of 3rd one (which appeared 53 years after the formation of 2nd layer). Thus, during 2003-2007 the Chinese railways network will overtake by its topological complexity the Russian and the Indian networks (see Table 1), giving in Germany, U.S.A., Poland, France and U.K.

The circuital framework had initially an intensive growth only in Manchuria (1927-43) and finished there in 1966; it expanded in Central China (see Map 1) as well in three stages: 1933-37 (covering the provinces of Shanxi, Henan, Hubei, Anhui, Zhejiang, Jiangsu), 1958-70 (extended to the West) and 1991-2000 (extended to the South). This expansion will finish in the South-east during the next years (after the construction of new railways in the seashore belt of the province of Fujian) and in the East – in 2003-2010 (due to the new line Dalian – Qingdao – Xinyi – Shanghai). Intensive inner growth of the cir-

Table 3 - Dynamics of the circuit and topological layer numbers in the railway network of China.

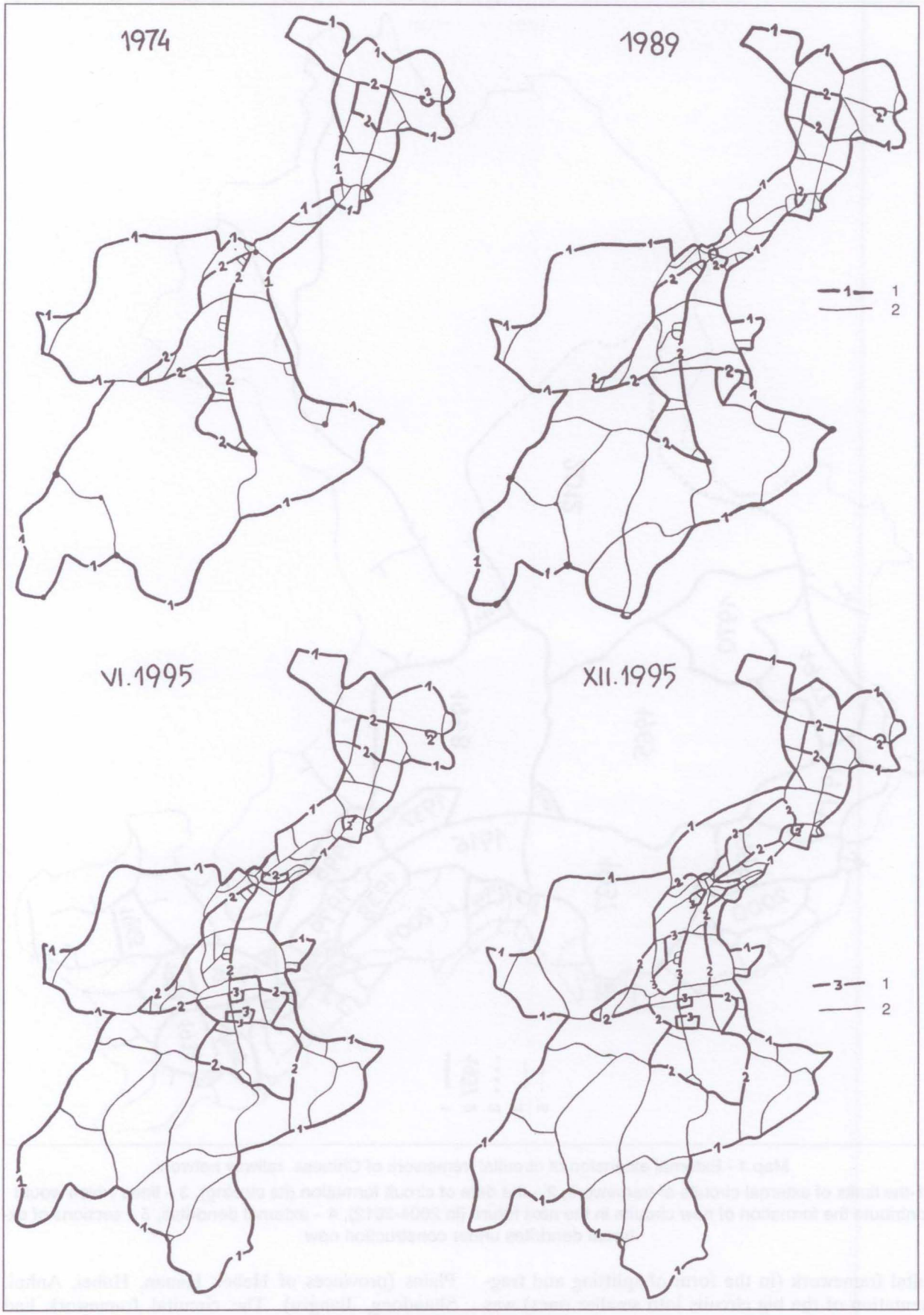
Years	Ω	μ_1	μ_2	μ_3	μ_4	μ
1909	1	–	–	–	–	1
1926	3	–	–	–	–	3
1933	–	8	–	–	–	8
1938	–	17	–	–	–	17
1940	–	22	1	–	–	23
1945	–	28	1	–	–	29
1955	–	19	1	–	–	20
1960	–	22	1	–	–	23
1973	–	33	15	–	–	48
1978	–	40	16	–	–	56
1982	–	46	18	–	–	64
1989	–	53	22	–	–	75
1992	–	57	25	–	–	82
1993	–	57	26	1	–	84
1995	–	50	34	9	–	93
1997	–	51	40	10	–	101
2000	–	51	46	10	–	107
2002	–	52	40	20	–	112
2007 (plan)	–	46	52	30	10	138

ω – number of isolated circuits, $\mu_1 - \mu_4$ – number of circuits in each topological layer, μ – number of circuits in the whole network

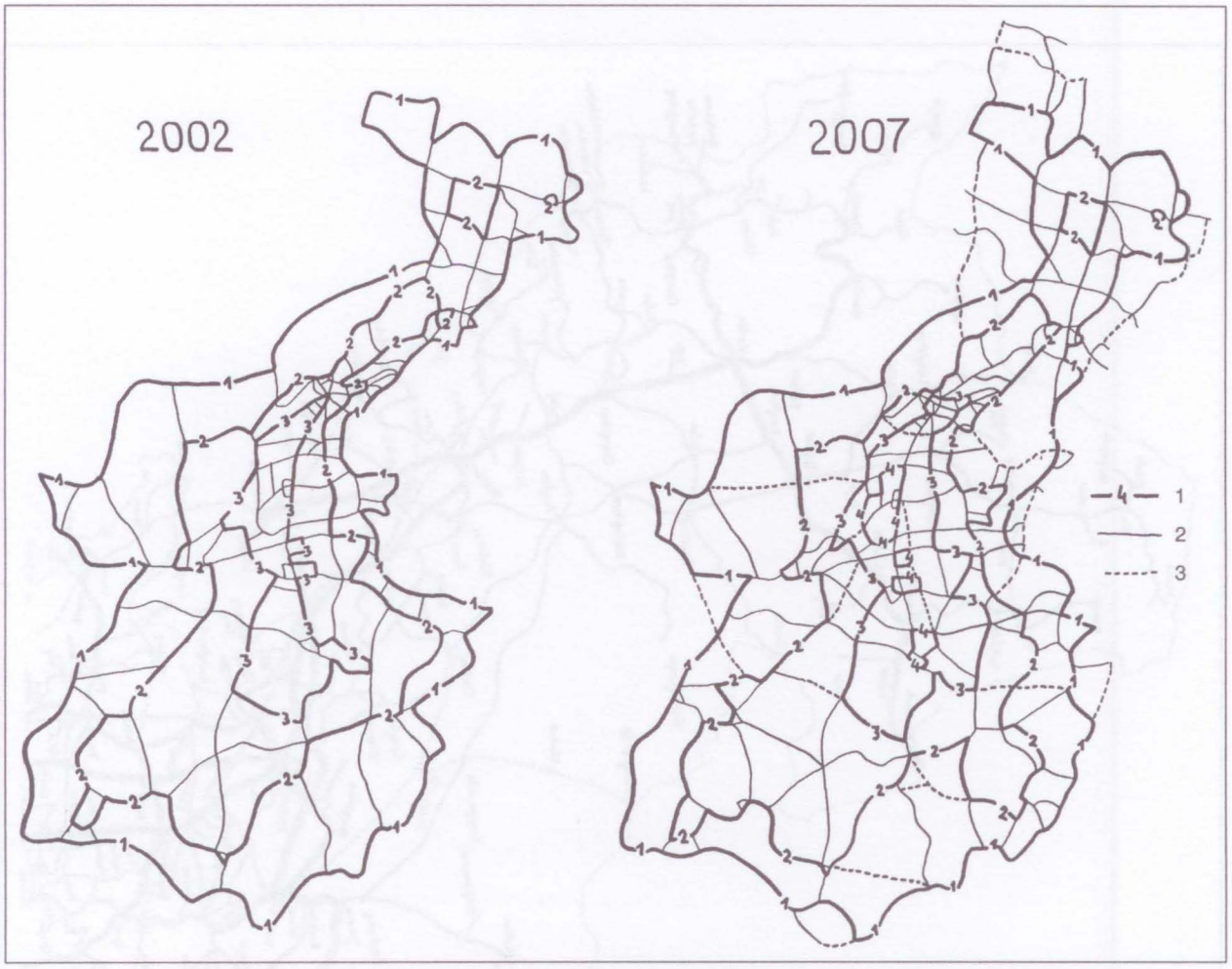


Map 1 - External extension of circuital framework of Chinese railway network.
1-the limits of external circuits of framework, 2 – the date of circuit formation (its closing), 3 – lines which would contribute the formation of new circuits in the next future (in 2004-2012), 4 – external dendrites, 5 – sections of external dendrites under construction now

cuital framework (in the form of splitting and fragmentation of the big circuits into smaller ones) was and is continuing, notably in the area of the Great Plains (provinces of Hebei, Henan, Hubei, Anhui, Shandong, Jiangsu). The circuital framework had originally the elongated configuration (pattern) from



Map 2 - (Continued on the next page)



Map 2 - The spatial growth of circuital framework and its topological layers in the Chinese railway network in 1974-2007 (continued from the previous page)

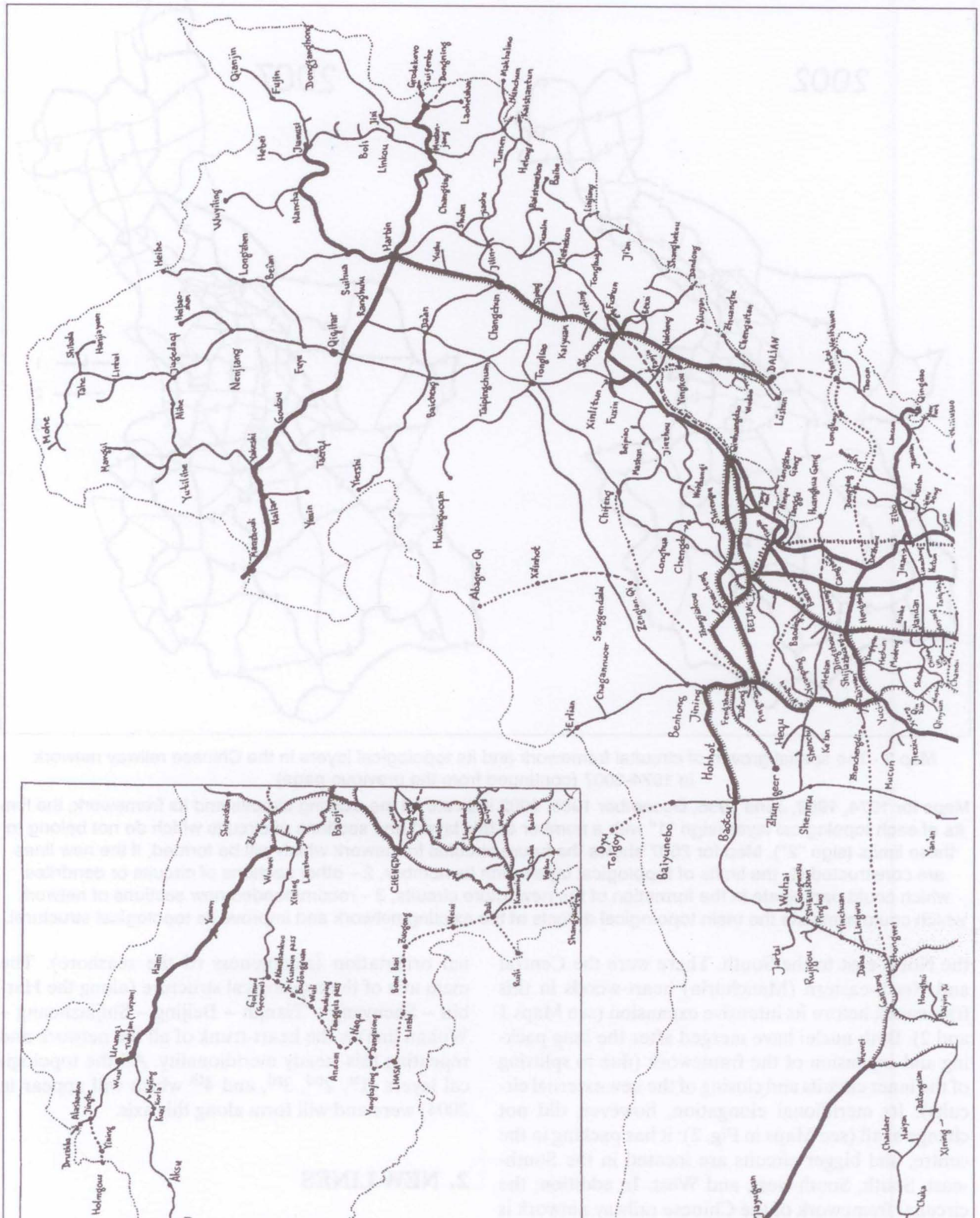
Maps for 1974, 1989, June 1995, December 1995, 2002 indicate all the existing circuits and its framework, the limits of each topological layer (sign "1" with a number of this layer) and sections of circuits which do not belong to these limits (sign "2"). Map for 2007 shows the future circuital framework which will be formed, if the new lines are constructed (1- the limits of topological layers with its number, 2 – other sections of circuits or dendrites which could participate in the formation of the new future circuits, 3 – recommended new sections of network which could eliminate the main topological defects of the existing network and improve its topological structure).

the North-east to the South. There were the Central and North-eastern (Manchuria) heart-woods in this framework before its intensive expansion (see Maps 1 and 2). Both nuclei have merged after the long packing and expansion of the framework (due to splitting of the inner circuits and closing of the new external circuits). Its meridional elongation, however, did not change at all (see Maps in Fig. 2): it has packing in the centre, and bigger circuits are located in the South--east, South, South-west, and West. In addition, the circuital framework of the Chinese railway network is disposed from the sea-shore inside the mainland, inheriting the old Chinese tradition for inner land self--isolation.

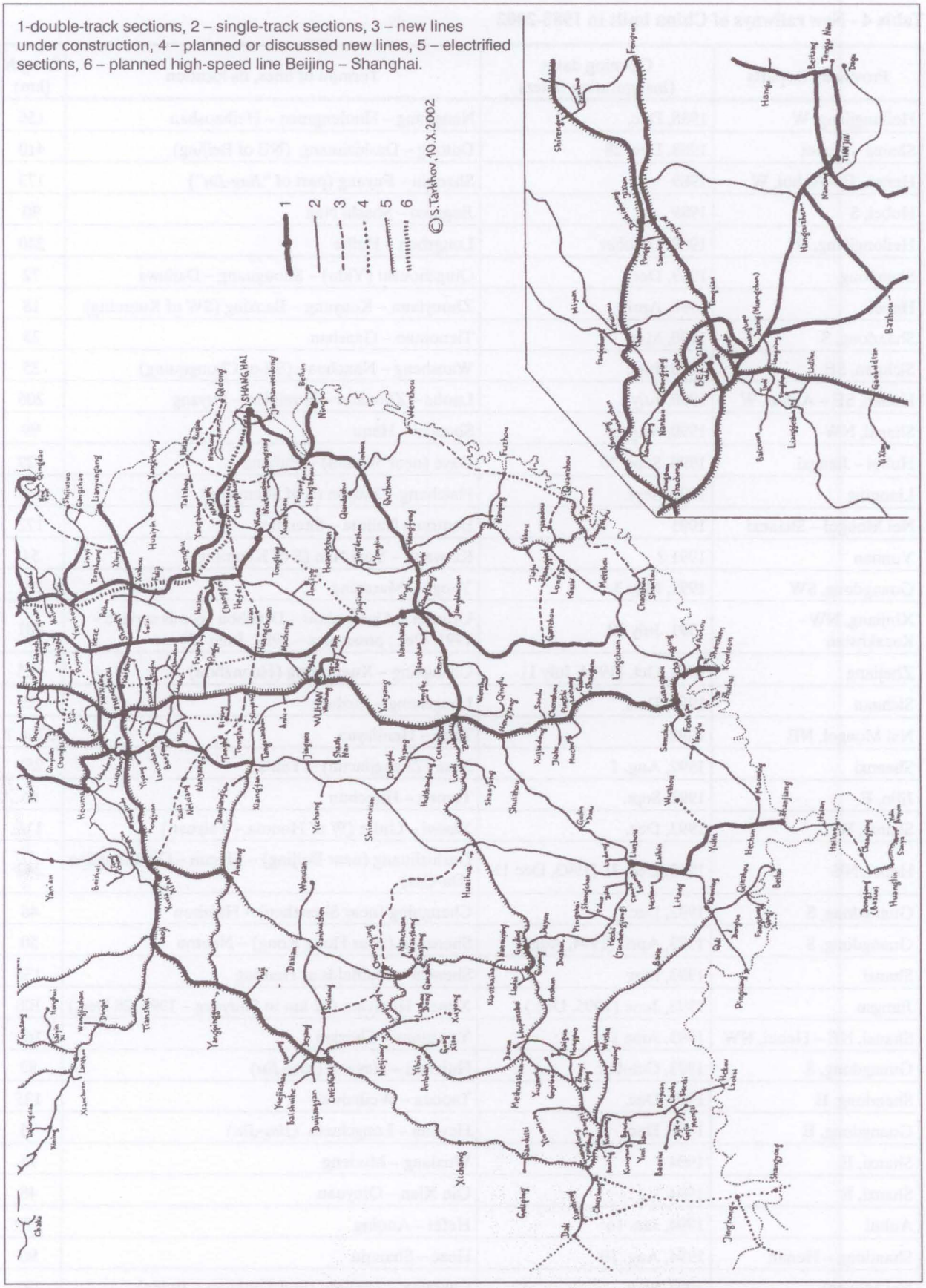
Thus, the spatial structure of the railway network of China has the following features: meridionality (elongation from the North-east to the South), internal orientation (remoteness of the seashore). The main axis of the topological structure (along the Harbin – Shenyang – Tianjin – Beijing – Shijiazhuang – Wuhan line) is the heart-trunk of all the network and repeating this steady meridionality. All the topological layers (1st, 2nd, 3rd, and 4th which will appear in 2004) were and will form along this axis.

2. NEW LINES

Near 20,000 km of new railways (see Table 4 and Map 3) have been built and opened during the last 15 years. There are among it the North-South (Jing-Jiu) trunk line from Beijing to Shenzhen and Hong Kong, coal export main lines from coal basins of Shanxi and Shaanxi to the seaports, new lines from Inner China to



Map 3 (continued on the next page)



Map 3 - Railways of China (consists of two sheets: North (with the insert for Western China) and South (with the insert of area Beijing – Tianjin)). (Continued from the previous page)

Table 4 - New railways of China built in 1988-2002

Provinces, its parts	Opening dates (inauguration dates)	Termini of lines, its location	Length (km)
Heilongjiang, W	1988, Dec.	Nengjiang – Huolengmen – Heibaoshan	156
Shanxi – Hebei	1988, Dec. 28	Datong – Dashizhuang (NE of Beijing)	410
Henan, E – Anhui, W	1989	Shanqiu – Fuyang (part of "*Jing-Jiu*")	173
Hubei, S	1989	Jingmen – Shashi Nan	90
Heilongjiang, N	1989, October	Longzhen – Heihe	240
Shandong	1989, Dec.	Qingzhoushi (Yidu) – Shouguang – Dajiawa	72
Hebei	1990, April	Zhouyiaun – Kunyang – Baoxing (SW of Kunming)	18
Shandong, S	1990, May	Tienomao – Ganshan	33
Sichuan, SE	1990, June	Wansheng – Nanchuan (SE of Chongquing)	35
Henan, SE – Anhui, W	1990, July	Luohe – Zhoukou – Huaidian – Fuyang	206
Shanxi, NW	1990, August	Shenchi – Hequ	99
Hubei – Jiangxi	1990, Sept. 30	Daye (near Wuhan) – Jiujiang	129
Liaoning	1990, Sept.	Haicheng – Xiuyan (S of Shenyang)	90
Nei Mongol – Shaanxi	1991	Baotou – Daliuta – Shenmu	172
Yunnan	1991 ?	Kunyang – Yuxi Nan (S of Kunming)	54
Guangdong, SW	1991, May 3	Yaogu – Maoming	221
Xinjiang, NW - Kazakhstan	1991, July 20	Urumqi – Alashankou – Druzhba (goods service – 1991, Dec.; passenger – 1992, June 23)	481
Zhejiang	1991, Oct. (1994, July 1)	Changxing – Xuancheng (Huanzhou)	125
Sichuan	1991, Dec.	Longcheng – Luzhou	55
Nei Mongol, NE	1992	Tahe – Hanjiayan	57 + ?
Shaanxi	1992, Aug. 1	Xian (Zhangjiacun) – Yan'an	255
Jilin, E	1992, Sept.	Tumen – Hunchun	66
Shanxi, W	1992, Dec.	Xiaoyi – Liulin (W of Houma – Taiyuan)	116
Hebei, NE	1992, Dec. 21 (1993, Dec.11)	Dashizhuang (near Beijing) – Liucun – Qinhuangdao (Da-Qin)	242
Guangdong, S	1992, Dec.	Changping (near Shenzhen) – Huizhou	48
Guangdong, S	1993, April (1994, Aug.)	Shenzhen (near Hong Kong) – Nantou	50
Shanxi	1993, May	Shenchi – coalfields at Hedong	138
Jiangsu	1993, June (1995, Dec.)	Xinyi – Huaiyiun (52 km to Shuyang – 1995, 28 Dec.)	108
Shanxi, NE – Hebei, NW	1993, June 18	Yangquan – Shexian	160
Guangdong, S	1993, October	Huizhou – Heyuan (*Jing-Jiu*)	80
Shandong, E	1993, Dec.	Taocun – Weihaiwei	135
Guangdong, E	1993, Dec.	Heyuan – Longchuan (*Jing-Jiu*)	75
Shanxi, E	1994 ?	Wuxiang – Modeng	75
Shanxi, E	1994 ?	Qin Xian – Qinyuan	48
Anhui	1994, Jan. 16	Hefei – Anqing	179
Shandong – Henan	1994, Aug. 10	Heze – Shanqiu	96
Nei Mongol	1994, Sept.	Chabuga – Zhelimu (line Tongliao – Jining)	187
Guangdong, E	1994, Oct. 28	Longchuan – Xingning	70

Provinces, its parts	Opening dates (inauguration dates)	Termini of lines, its location	Length (km)
Shanxi – Henan	1994, Nov. 26	Houma – Yueshan	265
Hebei	1994, Dec.	Tianjin – Bazhou	78
Guangdong, E	1994, Dec. 28	Xingning – Meixian – Meizhou	51
Jiangxi – Guangdong	1995	Nankang – Longchuan (***Jing-Jiu***)	216
Anhui – Hubei - Jiangxi	1995, Febr. 26 (June 1)	Hefei – Gaohebu – Jiujiang	347
Zhejiang, S	1995, March (1996,April 21)	Jinhua – Jinyun (line to Wenzhou)	84
Guangxi, SW	1995, May 12	Qinzhou – Beihai	104 (95?)
Hebei – Shandong – Henan – Anhui	1995, May 21 (Sept.)	Beijing – Bazhou – Suning – Hengshui – Liaocheng – Heze – Shanqiu – Fuyang (northern part of ***Jing-Jiu***)	847
Nei Mongol – Ningxa – Gansu – Shaanxi	1995, June 8	Zhongwei – Baoji	502
Guangxi, NW	1995, Sept. 1	Nanning – Pingguo – Baise (Bose) (line to Kunming, 1st stage)	210
Guangdong, E	1995, Sept. 28	Shejiang – Chaozhou – Shantou (Swatow)	135
Ningxa	1995, Oct.	Daba – Guyaozi (branch to line Baotou – Lanzhou)	74
Nei Mongol	1995, Nov. 30	Chabuga – Sanggendalai – Benhong (line Jinin – Tongliao)	943
Fujian	1995, Dec. 28	Zhangzhou – Quanzhou – Xiaoxie (location ?); Section Jimei – Jinjiang – Shichi – Quanzhou opened 1996, June 1	120 (68)
Yunnan, W	1996	Guangtong – Chuxiong (line to Dali)	38
Jiangsu, N	1996	Shuyang – Huaiyin	56
Heilongjiang, E	1996 ?	Huanan – Xiangyangshan (762 mm), branch to line Jiamusi – Mudanjiang	31
Yunnan	1996, May	Kunming – Luoping (line to Nanning)	143
Shaanxi, N – Shanxi, NW	1996, July 1	Daliuta – Shenchi (near Ningwu)	...
Anhui – Henan – Hubei – Jiangxi	1996, Sept. 1 (1997, July 1)	New southern sections of ***Jing-Jiu***: Fuyang – Huangchuan – Macheng Macheng – Wuhan Macheng – Jiujiang Xingtang – Ji'an – Nankang	 238 80 223 409
N – S (9 provinces)	1997, July 1	Inauguration of ***Jing-Jiu*** line: Beijing – Shenzhen	2370
Shanxi, N – Nei Mongol	1997, July 1	Datong – Fengzhen – Liangcheng – Qingshuihe – Zhungeer (Jangar Qi coal field)	216+ 45
Zhejiang, S	1997, Oct.1 (1998, June)	Jinyun – Wenzhou	168
Yunnan – Guizhou – Guangxi	1997, Dec. 2	Kunming – Nanning (new sections: Luoping – Wusha – Tianlin – Baise, Wusha – Hongguo)	898 (436)
Sichuan	1997, Dec.	Chengdu – Daxian	395
Yunnan, W	1998, Aug.	Chuxiong – Dali (W of Kunming)	168
Hunan	1998, Oct. 16	Shimen – Changsha	264
Xinjiang, W	1998, Dec. 1 (1999, Dec. 6)	Kuxi (Korla) – Aksu	526
Hebei, S – Shandong	1999, March (2000,April 19)	Handan – Guangping – Liaocheng – Qihe (Yancheng) near Jinan	266
Jilin, E – Russia	1999, June (2000, July 17)	Hunchun – Makhalino	40

Provinces, its parts	Opening dates (inauguration dates)	Termini of lines, its location	Length (km)
Beijing	1999, June 15	Beijing West – Huangchun (S of Beijing)	22
360Xinjiang, W	1999, Dec. 6	Kuxi (Korla) – Aksu – Kashi (Kashgar)	974
Shanxi, N – Hebei, S	2000, May 18	Shenchi (Yuanping) – Dingzhou – Suning (line Shenmu – Suning – Huanghua coal fields)	418
Anhui	2000, Sept. 30	Bridge over Yangtze River at Wuhu + section Wuhu – Wuhu Bei instead the ferry	10,6
Fujian	2000, Dec. (2001, April)	Meizhou – Kanzhou (Kanshi)	147
Shaanxi, S	2001, Jan. 8	Ankang (Luhe) – Qinling tunnel – Yaocun (near Xian)	268 (241)
Shaanxi, N	2001, April	Shenmu – Yan'an	388
Sichuan, NE	2001, June 26	Daxian – Wanxian	156
Sichuan, S – Yunnan, N – Guizhou, NW	2001, Sept. 19 (2002, June)	Neijiang – Kunming (new section Anbian – Yanjin – Zhaotong – Meihaushan)	358
Guangdong, S – Hainan	2002, Feb. 28	Zhanjiang – Hai'an (port) + ferry Hai'an – Haikou (Hainan)	33
Yunnan – Guizhou, W	2002	Liupanshui – Shuicheng – Baiguo	126
Hebei	2002 (2003?)	Suning – Cangzhou	120

E, W, N, S – East, West, North, South
The opening dates for the same section could be different. In that case the date before the parentheses is the date of operation opening and inside the parentheses – official inauguration date. ***Bold italics*** indicate Chinese abbreviations for some main lines consisting of 2-3 first initial characters of both termini.

export seaports and land export gates, penetration lines for developing of the peripheral areas. The list of the most important sections and lines of railway network constructed during 1988-2002 is presented in Table 4.

The longest new meridional trunk line constructed in 1990s is the railway ***Jing-Jiu*** from Beijing to Hong Kong 2337 km which was laid more eastwards than the existing parallel main line Beijing – Guangzhou. It was built with two tracks (excluding the southern section) to relieve the latter and to move the goods and passengers between Beijing, the main intermediate transport nodes and Hong Kong, which since 1 July 1997 has become a part of China. Some feeder branches to big economic centres (Tianjin, Jinan, Wuhan, Hefei) were laid from this trunk line as well. This line was opened in September 1996, and the train has been covering the whole distance from Beijing to Shenzhen in 48 hours since July 1997. This line crosses 9 provinces (which covered 12.7% of the Chinese area with 37.9% of population living there). The extension of this trunk line is the renovated and electrified line Guangzhou – Shenzhen – Kowloon.

The construction of latitudinal coal corridors from coal fields of the provinces of Shanxi and Shaanxi to export ports on the Yellow Sea became the second goal for China, because the only such old corridor (Lunghai railway Baoji – Xian – Luoyang – Zhengzhou – Xuzhou – Lianyungang) was very overworked by trains. Branches to new coal-export ports Shijiusuo (Yellow Sea) and Huanhua Gang (Bohai Gulf) were built in 1985, but they had not direct links from the main coal basins. This is why the southern coal corridors Houma – Yueshan – Xinxiang – Heze – Yanzhou – Shijiusuo and Handan – Hutun – Jinan were constructed in 1986-1994, and then the middle corridor Shenmu – Ningwu – Yuanping – Dingzhou – Suning – Cangzhou – Huanghua – in 1996-2002. The 5th Northern latitudinal corridor ***Da-Qin*** (the names of Chinese railways are formed from 2-3 first characters of the termini names; for example, Da-Qin: **Da**tong = Da, **Qin**huangdao = Qin) was laid in 1987-93 as well, to link the Northern coal fields in Shanxi bypassing from the north Beijing area to the big coal-export port Qinhuangdao at Bohai Gulf. This line was extended more westwards to the new coal deposit Zhungeer in Inner Mongolia in 1997. Thus, 4 new coal corridors were added in 1985-2002 to the most southern old trunk Lunghai line.

The arrangement of special economic zones along the eastern and southern seashores of China in 1980s and 1990s led to the necessity to link it by railways with the main network. New branches and lines were laid in 1986-2002 to seaports Fangcheng, Qinzhou, Beihai in Guangxi province; Nantou and Aotou (near Shenzhen and Hong Kong), Shantou and Zhuhai in Guangdong province (the latter has not been completed yet); Quanzhou and Wenzhou in the province of Fujian; Beilun in the province of Zhejiang; Weihaiwei – in the province of Shandong. Some export seaports and spe-

cial economic zones were linked (or are being linked now) together along the seashore (Trans-Guangdong line Zhanjiang – Maoming – Guangzhou – Aotou in the province of Guangdong, Shantou – Xiamen – Quanzhou – Fuzhou – Wenzhou in provinces of Guangdong and Fujian).

Two new land trans-border railway corridors emerged during the last decade (see Map 3): 1), the line Urumqi – Alashankou – Druzhba linked Xinjiang and Kazakhstan in the North-west; 2) the line Tumen – Hunchun – Makhalino between Eastern Manchuria and Primoskiy Kray (Region) of Far Eastern Russia. The third such land rail corridor between China and Kyrgyzstan & Uzbekistan is under construction now (line Kashi (Kashgar) – Torugart – Osh – Andizhan). There are drafts to lay the cut-off between Xinjiang and South-eastern Kazakhstan (line Jinghe – Yining – Holmgous – Almaty) and new trans-border lines from Yunnan to Indochina and Thailand. If these projects are realised, China will have 20 such rail corridors and 37 seaports having direct railway connections to the main network by 2010, instead of the 10 existing in 1985 trans-border railway links (2 – with Vietnam, 1 – with Kazakhstan, 1 – with Mongolia, 2 – with Russia and 4 – with North Korea) and 12 export sea-ports.

In addition to the main and export lines China built in 1988-2002 some important interregional and inner-regional sections and lines. Such lines, which connect neighbouring provinces and areas are Nanning – Kunming (linking the provinces of Yunnan, Guizhou, Guangxi), Ankang – Xian – Yan'an – Shenmu – Baotou (connected provinces of Shaanxi and Nei Mongol), Longchuan – Meizhou – Kanshi – Zhangping (between provinces of Guangdong and Fujian), Anbian – Meihuashan (Sichuan and Yunnan), Baoji – Zhongwei (Shaanxi and Ningxia). Very important lines were constructed inside the provinces of Sichuan (Chengdu – Daxian – Wanxian), Guangdong (Haian – Zhanjiang – Hechun – Maoming – Guangzhou – Longchuan – Shantou), Nei Mongol (Jining – Tongliao), Liaoning (Haicheng – Xiuyan), Guizhou (Liupanshui – Baiguo), Hunan (Changsha – Shimenxian) and shorter branches in the provinces of Henan and Shanxi.

Thus, one meridional trunk line "North – South", 4 new coal export rail latitudinal corridors, 2 land rail trans-border exits, 5 interregional and 10 inner-regional lines were built and opened in China in 1988-2002. Southern Xinjiang railway (Korla – Aksu – Kashi), lines Baotou – Xian, Jining – Tongliao, Trans-Guangdong railway were constructed to develop the peripheral areas of China as well. A new line and ferry connected the mainland China to the island of Hainan in 2002, and a new railway will connect the main network via Qinghai to Tibet in 2007.

3. GEOGRAPHICAL DISTRIBUTION OF TECHNICAL EQUIPMENT IN THE CHINESE RAILWAYS

Gauge. Almost all railways in China originally have the standard gauge (1435 mm), because they have been built by foreign companies from Europe. Some industrial, local and forest lines and branches have narrow gauge (1067 or 762 mm). The trunk lines in Manchuria were laid in the Russian standard gauge (1524 mm) in 1901-03, but in 1906-09 and 1935 were re-gauged to 1435 mm. Japanese have built some of their Manchurian lines with the gauge of 1067 mm during 1931-45, but later these were re-gauged to the standard. New branches and sections in coal basins (in the provinces of Henan, Shanxi) and 36 forest lines (mostly in Manchuria and in the south-west) were built in 1955-1975 with gauge of 762 mm. J. Yonge (1998) mentions that there were 3600 km of lines with 762 mm in 1991 (most of these in the provinces of Henan – 1600 km, Hebei – 640 km, Guangxi – 420 km, Guangdong – 350 km, Hunan – 280 km, Liaoning – 240 km). The main line from Yunnan to Vietnam built in 1910 with the gauge 1000 mm was re-gauged in 1970-71 to 1435 mm.

Double tracks. Almost all railways in China had single track during long term. First double-track sections were laid in 1920s and 1930s in the main port areas (Tianjin – Tanggu, Tangshan – Qinhuangdao, Suzhou – Shanghai) and in Manchuria (Dalian – Shenyang – Chanchung). Double-tracking was made in 1954-59 along the main line Shenyang – Tianjin – Beijing – Wuhan – Zhuzhou, in 1960-ties – along main line Zhuzhou – Guangzhou and branches to coal centres Datong, Yangcuan and line Shanghai – Nanjing. The second track was laid along the main line Tianjin – Jinan – Nanjing in 1976.

The boom of doubling took place in 1987-2001, when double-track lines formed their own circuital framework (all double-track lines are indicated on Map 3), elongated from the North-east to the South – from Qinhuangdao via Beijing – Zhengzhou – Zhuzhou – Xiangtang to Shanghai. This structure has 17 circuits and two topological layers in 2002 (the 2nd layer is located in the area of Beijing – Shijiazhuang – Hengshui with 2 circuits). Four main meridional railways (Datong – Yuci – Houma – Luoyang – Xiangfan – Shimenxian; Jiamusu – Harbin – Shenyang – Beijing – Wuhan – Guangzhou – Kowloon; Beijing – Heze – Fuyang – Xiangtang – Longchuan; Qinhuangdao – Tianjin –Jinan – Xuzhou – Shanghai) and four latitudinal (Qinhuangdao – Shacheng – Datong – Baotou, Dezhou – Shijiazhuang – Taiyuan – Houma, Lianyungang – Xuzhou – Zhengzhou – Luoyang – Xian – Baoji, Shanghai – Hangzhou – Xiangtang – Zhuzhou), and lines Shenyang – Dalian, Manzhouli –

Harbin – Mudanjiang – Suiyang, Wuwei – Yumen – Urumqi – Wuxi, Baoji – Chengdu, Liuzhou – Litang – Zhanjiang have two tracks completely.

One third of all state railways have two tracks now (near 21.000 km). Their list is shown in Table 5.

Table 5 - Double-tracking of Chinese railways in 1987-2002

Provinces	Opening dates	Termini of sections	Length, km
Guangdong	25.01.1987	Guangzhou – Changping	90
Shanxi – Hebei	31.05.1987	Datong – Shacheng (*Da-Qin*)	234
Shanxi – Nei Mongol	22.11.1988	Datong – Jinin – Huhehaote	285
Guangdong – Hunan	16.12.1988	Guangzhou – Hengyang	541
Hebei	21.12.1988	Shacheng – Dashizhuang (*Da-Qin*)	176
Henan – Shanxi – Shaanxi	1988-89	Zhengzhou – Luoyang – Xian	511
Shanxi	22.08.1989	Yuci – Houma	307
Nei Mongol	10.03.1990	Huhehaote – Baotou	134
Nei Mongol – Heilongjiang	26.07.1991	Hailar – Harbin	935
Zhejiang	25.12.1991	Shanghai – Hangzhou	187
Hebei	21.12.1992	Dashizhuang – Qinhuangdao (*Da-Qin*)	220
Guangdong	1993?	Changping – Shenzhen	57
Anhui	6.09.1994	Fuyang – Huainan	96
Gansu – Xinjiang	16.09.1994	Wuwei – Hami – Urumqi – Wuxi	1622
Zhejiang	.02.1995	Hangzhou – Jinhua	152
Hebei – Henan – Anhui	21.05.1995	Beijing – Fuyang, Bazhou – Tianjin (*Jing-Jiu*)	853+77
Shanxi	.12.1995 - .01.1997	Houma – Yueshan	265
Zhejiang – Jiangxi – Hunan	26.01.1996 (.05.1998?)	Jinhua – Xiangtang – Zhuzhou	765
Anhui – Jiangxi	1.09.1996	Fuyang – Xiangtang + 3 tracks Changping – Shenzhen	624+57
Hunan – Guizhou	25.01.1997	First section of the line Zhuzhou – Guiding	?
Jiangsu	24.12.1997	Xuzhou – Lianyungang	116
Zhejiang	.11.1999	Xiaoshan (near Hangzhou) – Ningbo	147
Shaanxi – Sichuan	26.12.1999	Baoji – Chengdu	669
Jiangxi – Guangdong	1999	Xiangtang – Longchuan	635
Guangxi – Guangdong	1999	Litang –Yulin – Zhanjiang	318
Shandong	.01.2001	Linyi – Yanzhou	138

Table 6 - Electrification of Chinese railways in 1987-2002

Provinces	Opening dates	Termini of lines and sections	Length, km
Henan	3.01.1987	Zhengzhou – Sanmexia	268
Shanxi	31.05.1987	Datong – Shacheng (*Da-Qin*)	234
Sichuan	28.12.1987	Chengdu – Chongqing	505
Hunan – Guangdong	1988	Chenzhou – Shaoguan (line Hengyang – Guangzhou)	155
Fujian	1988	Yong'an – Zhangping	105
Hebei	.05.1988	Beijing Nan – Huangtudian (circle around Beijing)	41
Shaanxi	1.10.1988	Sanmexia – Xian	265

Shanxi – Nei Mongol	24.11.1988?	Datong – Huhehaote	285
Hebei	21.12.1988	Shacheng – Dashizhuang (***Da-Qin***)	176
Shaanxi	24.12.1988	Xian – Baoji	173
Guizhou	26.12.1988	Guiyang – Guiding – Yangping	325
Shanxi	1.08.1989	Datong – Taiyuan	340
Guizhou – Yunnan	29.12.1989	Liupanshui (Suicheng) – Xuanwei	132
Nei Mongol	10.03.1990	Huhehaote – Baotou	134
Yunnan	17.07.1990	Xuanwei – Kunming	258
Fujian	16.06.1991	Yingtan – Yong'an	409
Guizhou	20.10.1991	Guiyang – Zunyi (line Guiyang – Chongqing)	150
Henan	30.12.1991	Zhengzhou – Xinyang (line Beijing – Wuhan)	302
Gansu	26.01.1992	Lanzhou – Dachaigou (line Lanzhou – Wuwei)	166
Gansu	2.09.1992	Dachaigou – Wuwei	282
Hebei	21.12.1992	Dashizhuang – Qinhuangdao	220
Henan – Hubei	31.12.1992	Xinyang – Wuhan	232
Sichuan	.07.1993	Zunyi – Chongqing	275
Guizhou	.07.1993	Suicheng (Liupanshui) – Guiyang	390
Fujian	28.12.1993	Zhangping – Xiamen	181
Fujian	28.12.1993	Guokeng – Zhangzhou	11
Shanxi	1995	Houma – Yueshan	253
Shaanxi – Ningxa	1.06.1995	Baoji – Zhongwei	498
Fujian	1.05.1996	Xiamen – Quanzhou	68
Gansu	1996	Gangtang – Wuwei	172
Hunan	1996	Huaihua – Loudi	317
Henan	1996	Zhengzhou – Anyang	187
Guizhou – Hunan	.04.1997	Yangping – Huaihua	130
Shanxi – Nei Mongol	1.07.1997	Datong – Zhungeer	264
Hebei	.10.1997	Shijiazhuang – Anyang	225
Yunnan – Guangxi	2.12.1997	Kunming – Nanning	898
Hebei	.08.1998	Beijing – Shijiazhuang	266
Guangdong	28.08.1998	Guangzhou – Changping – Zhenzhen	147
Gansu – Ningxia	10.11.1998	Lanzhou – Gantang – Zhongwei – Yinchuan – Shizuishan	565
Hunan	18.01.1999	Zhuzhou – Loudi	125
Sichuan – Yunnan	30.09.2000	Chengdu – Kunming	1100
Shaanxi	8.01.2001	Xian – Ankang	267
Liaoning – Jilin – Heilongjiang	8.08.2001	Shenyang – Harbin	550
Sichuan – Yunnan	19.09.2001	Neijiang – Anbian – Meihuashan	358
Hubei – Hunan	.09.2001	Wuchang (Wuhan) – Changsha – Zhuzhou – Chenzhou, Shaoguan – Guangzhou	690+220
Liaoning	30.11.2001	Shenyang – Dalian	400
Liaoning	End of 2002	Qinhuangdao – Shenyang (high speed line)	406

The construction of the second tracks is continuing and the following sections and lines were under way in 2002: Baoji – Lanzhou – Wuwei, Lanzhou – Gantang – Zhongwei – Baotou, Ankang – Chongqing, Zhuzhou – Guiding – Guiyan – Liupanshui, Litang – Nanning, Xinxiang – Heze – Linyi – Shijiusuo (coal rail corridor), Hefei – Yuxikou (Wuhu), Qingdao – Yantai.

Electrification. Only two short industrial branches (Fushun West Pit line in Liaoning with 30 km, 1200 V D.C., which has been transformed into 1500 V D.C. in 1937; and industrial circular line serving the metallurgic works at Anshan opened in the same province in 1950s) and one mountain section Baoji – Fengzhen in July 1961 (with 25 kV 50 Hz) were electrified up to mid-1970s. Electrification at 25 kV 50 Hz was made in 1975-87 along the single-track mountain sections in the West and inside the coal province of Shanxi.

The following lines and sections were electrified (see Table 6 and Map 3) in 1988-2002: main meridional line Beijing – Zhengzhou – Wuhan – Zhuzhou, western part of Lunghai line (Zhengzhou – Xian – Baoji – Lanzhou – Wuwei), coal rail corridor Zhungeer – Datong – Qinhuangdao, meridional coal line Baotou – Datong – Taiyuan – Yueshan – Houma, and the lines Wuwei – Zhongwei – Yinchuan – Shisuishan, Zhongwei – Baoji, Chongqing – Guiyang, Chengdu – Kunming – Nanning, Kunming – Liupanshui – Guiyang – Huaihua – Zhuzhou, Neijiang – Anbian – Meihuashan, Foshan – Guangzhou – Shenzhen, Yingtan – Yikou – Xiamen – Quanzhou. Electrification of Southern Manchurian railway (Dalian – Shenyang –Changchun – Harbin) was completed in 2001 and is under way along lines Chongqing – Daxian and to Fuzhou now. The lines Xining – Golmud (Geermu) in the province of Qinghai, Wuwei – Yumen in the provinces of Gansu and Xinjiang, Zhuzhou – Yingtan – Hangzhou – Shanghai – Nanjing will be electrified in 2003-2010. Only 20% of the state railways of China have been electrified now.

Railway ferries. Before the completion of two long bridges via the Yangtze River there were two railway ferries at Wuhan and Nanjing, and one via Huang Ho at Fengingdu (the border between Shanxi and Shaanxi provinces).

The new sea rail ferry between the mainland (Haian) and the island of Hainan (Haikou) 33 km via Quiongzhou straits was inaugurated in February 2002 together with the new line Zhanjiang – Haian which links the main network with the island. When the new section along the island is completed, the new trunk line Yue-Hai (Guangdong – Hainan) will have 543 km and provide reliable connection of this new economic zone with the mainland. This is the first sea ferry line in China. There is a draft design for an 18 km long tunnel construction under the straits for the future.

The second rail ferry line of 157 km will be opened in 2003-2004 and connect seaports Yantai (the province of Shandong) and Dalian (Liaoning) via Bohai straits. This line will link by shortest way two very advanced provinces of China and open direct connection between the North-eastern and Eastern & Central parts of the country bypassing the overcrowded transport nodes at Qinhuangdao, Tianjin, Beijing. The construction of the new terminals in both ports, double track Lancun – Yantai, and the new cut-off line Qingdao – Jiacoxian – Xinyi – Haian – Shanghai (along the shore of the Yellow Sea) are under construction now and will increase the capacity of old facilities in this transit corridor. One ferry could carry 53 railway cars, 50 trucks, 1400 passengers. Nine ferries will operate here from 2004.

Big railway bridges. No bridges had existed via the Yangtze River until 1957 and the train crossed it by ferries at Wuhan, Wuhu and Nanjing. Two bridges were built via Huang Ho River before 1920 – at Zhengzhou (2899 m) and near Jinan at Loukou (1225 m).

The Huang Ho River has been spanned by the new railway bridges at Fenglingdu in 1960-61, for the second track at Zhengzhou in 1960 (3 km), for the second track near Jinan - in 1976 (5698 m), at Dongxian - in 1986 (10,2 km), at Sunkou (line Jing-Jiu) – in May 1995 (6685 m). The Yangtze River was crossed at Wuhan by double-deck bridge in October 1957 (1670 m), at Chongqing – in 1960 (820 m), at Nanjing – in October 1968 (6 km), at Jiujiang – in 1996 (7675 m) and at Wuhu – in September 2000 (10,5 km). Some long bridges have been built over other big rivers, including the bridge via Qiantangjiang near Hangzhou (1073 m) in the province of Zhejiang.

Railway tunnels. Some railways in China cross mountain ridges. To avoid long and steep slopes the Chinese Railways have built many tunnels. The longest one (Qinling, 18,450 m) was opened in 2001 in the middle of the new line Xian – Ankang. The second place belongs to the Dayaoshan tunnel (14.390 m) near Lechang (line Hengyang – Guangzhou, South of the country). Other very long tunnels are Mihualing (9630 m, location is unknown), at Hangzhou (8950 m), Jundushan (8460 m, to the North of Beijing, line Shacheng – Dashizhuang), Yuntaishan No. 1 and No. 2 (8100 m and 8170 m, near Lianyungang (Xinpu)), Fenshui (4700 m, line Daxian – Wanxian), Wuzhishan (4455 m, near Shenzhen).

The construction of under-water tunnels is planned: 1) 6.7 km under the Yangtze River at Nanjing for the future high-speed line Beijing – Shanghai; 2) 18.2 km under Quiongzhou straits between the island of Hainan and the mainland.

High-speed railways. The plan of high-speed lines was developed in the mid-1990s, which included the

trunk lines Beijing – Shenyang – Harbin, Beijing – Shanghai, Beijing – Zhengzhou – Wuhan – Changsha – Guangzhou, Haizhou – Zhengzhou – Xian – Lanzhou. The priority was given to the high-speed line Beijing - Shanghai (under abbreviation ***Jinghu***) 1330 km. It is the direct parallel to the existing line Beijing – Tianjin – Jinan – Xuzhou – Bengbu – Nanjing – Shanghai with some deviations (indicated on Map 3 by sign "6"). The high-speed goods and passenger trains would cover all the distance in six and a half hours by the plan with speed at 250 km/h. Twenty-four stations would be built here. This plan was developed in 1993, but never realised due to financial reasons.

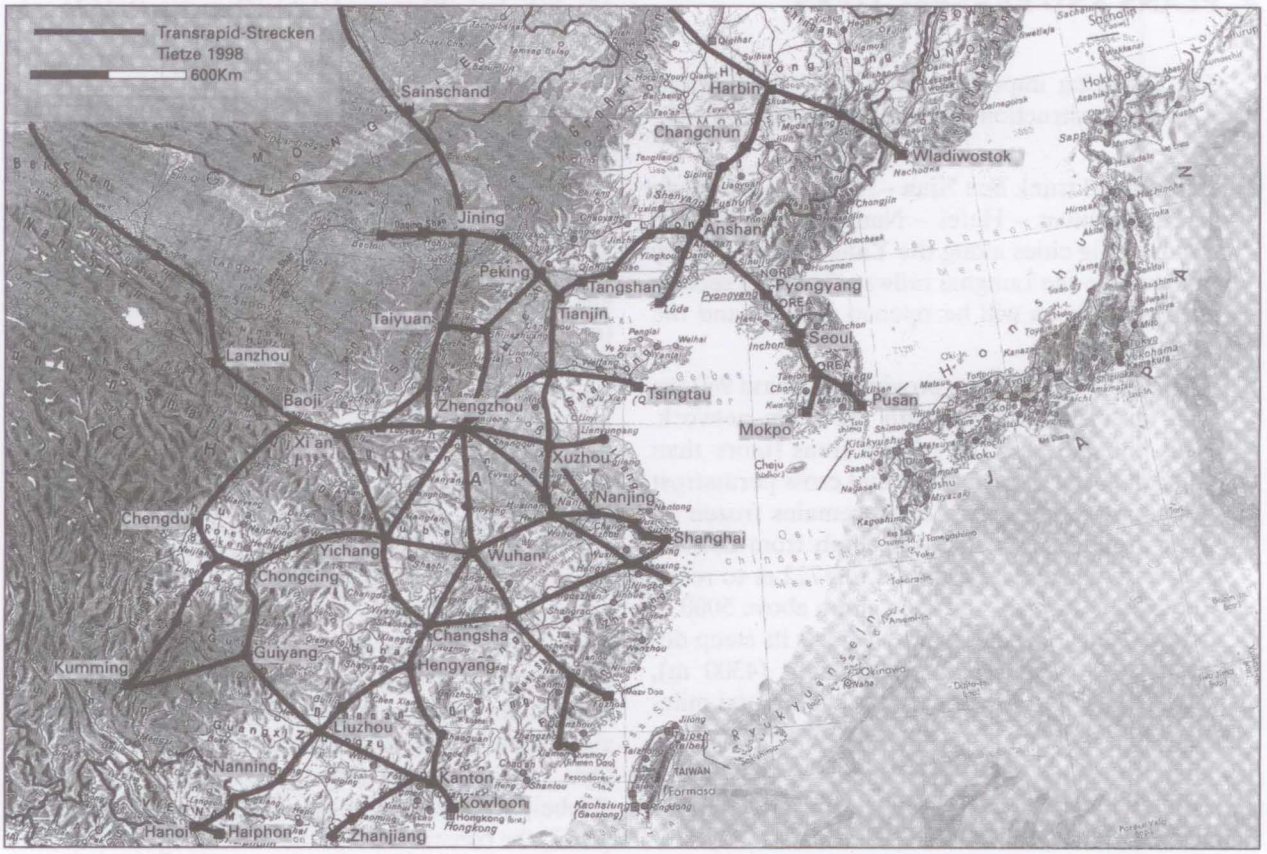
A new step was made in 1998, when the idea to construct an experimental section with speed at 300 km/h (Beijing – Tianjin or Shanghai – Nanjing) appeared. However, this decision was not realised until now. The destination of this high-speed line would depend on the success of Maglev line, which is currently under construction in Shanghai suburb. If this system is efficient and technically proved, Maglev technology would be adopted for the Beijing – Shanghai high-speed line; if not, the Chinese Railways have an intention to use Japanese wheel technology of Shinkansen. The construction of this line would start not earlier than 2006 and only on the first section between Shanghai and Nanjing (with an under-water tunnel).

The high-speed experimental section between Shanghai and Hangzhou (170 km) with the usage of German technology "Maglev" (magnet air-cushion between track-bed emerging by powerful electromagnets located in the bed and under the train) was under discussion in 1996, but the high construction costs were the main reason for rejecting this idea. After long discussion they decided to build the short trial section 30 km between Shanghai and its new international airport at Pudong area, and, if this idea is efficiently realised, to extend the line then to Hangzhou.

Map 4 suggests a Transrapid net for China; the map is reprinted here from Chu, Shjao-ying: Transrapid - New Thought to China's Traffic Confusion.

The construction of experimental "Transrapid" line 31 km between Pudong International airport and Longyang Road in the South-eastern suburb of Shanghai started in November 2001 by the German Transrapid consortium, comprising Thyssen Krupp and Siemens. The first train, produced in Germany, arrived in Shanghai in August 2002. It will run at the speed of 430 km/h and cover the whole distance in 5 minutes. The operation is scheduled to open on 31 December 2003.

At the same time as realising these experiments, the Chinese Railways started the renovation of the main trunk lines and increasing its train speed. The



Map 4

trains with 160 km/h started their operation along the line Guangzhou – Shenzhen since 23 December 1994, covered the distance of 147 km in 67 minutes after big reconstruction of track bed. Regular service here was opened in March 1995. The speeded-up operation till 160 km/h has been introduced along the lines Beijing – Shanghai, Beijing – Guangzhou, Beijing – Harbin, Shenyang – Dalian, Lianyungang – Xian since 1 July 1998, and Beijing – Tianjin - since 18 October 2000 (135 km in 79 minutes). The trains Guangzhou – Shenzhen have operated with the speed at the level of 200 km/h since January 2001.

The construction of the first passenger-dedicated speed railway Qinhuangdao – Shenyang (422 km) with the technology applied at Guangzhou – Shenzhen quasi-speed line started in August 1999 and will follow the existing line (which is overcrowded by enormous number of goods and passenger trains) with some southern deviation just near Shenyang. Special trains for 200 km/h will operate there since the end of 2002 – beginning of 2003. This line would be the trial section for the future high-speed trains which would serve the line Beijing – Shanghai. A plan for high-speed passenger line Chongqing – Chengdu in the province of Sichuan is being drafted.

4. PLANS AND PERSPECTIVES

The following important lines and new sections were under construction in 2002 (see details on Map 3).

1) Latitudinal trunk line Xian – Nanyang – Xinyang – Huangchuan – Hefei – Nanjing 1129 km will connect big cities along the Yangtze River valley and relieve the Lunghai railway. The first section to Huangchuan will be opened in 2007 and the rest – in 2010.
2) Line Golmud (Qinghai province) – Lhasa 960 km will link Tibet Region with the main network. This line will pass the Alpine areas (more than 4000 m above the sea level) and cross permafrost (600 km section where earth remains frozen all year around). The line will climb from 2800 m above sea level near Golmud to 4722 m to reach the Khunu-la pass, and then climb above 5000 m to the Tanggula pass, where it starts its steep descent to Anduo (4600 m), Nagchu (4300 m), Dangxiong, and Lhasa (3590 m). The total mileage of tunnels will be 30 km. The formation of the first section 147 km from Gormo to Wangkun was completed in November 2001. The line would be opened in 2007.
3) Quasi high-speed passenger dedicated line Qinhuangdao – Shenyang 422 km (see above).
4) Ferry line Yantai – Bohai straits – Dalian 157 km will be opened in 2003 (see above).
5) Line Nanjing – Qidong 357 km along the northern bank of the Yangtze River up to its mouth will develop up the seashore areas of the province of Jiangsu.
6) Line Xinyi – Jiaoxian (near Qingdao) 302 km will cut-off the link between Shandong peninsula and Shanghai.
7) Line Kashi (Kashgar) – Torugart (Kyrgyz border) – Osh (Kyrgyzstan) – Andizhan (Uzbekistan) 300 km will connect the South Xinjiang trunk line of the Chinese network with the railways of Central Asia, Iran and Turkey until 2005.
8) Line Suning – Chongqing – Huaihua 625 km will link the provinces of Sichuan and Hunan in 2006.
9) Ganzhou – Longyan 280 km will connect the provinces of Jiangxi and Fujian in 2006.
10) Wenzhou – Fuzhou 352 km will develop up the shore of the Eastern-Chinese Sea in the provinces of Zhejiang and Fujian until 2005.
11) 1900 km of local lines in the province of Hebei in 2002-2010.
12) Xinyi – Haian – Changxing 571 km in the province of Jiangsu will arrange the North-western bypassing of Shanghai.
13) Xilinhot – Shangendalak – Zhenglan Qi 152 km in the Eastern part of Nei Mongol will supply the electric power stations there by fuel.

All these lines are under construction and indicated on the Map 3. The total mileage of the state railways will reach up to 75,000 km by 2005.

In addition, there are some not completed lines and sections and lines under project or plan. They are: Jiandou (Zhangping) – Quanzhou (province of Fujian), Guangzhou – Foshan – Zhuhai – Macao 150 km (construction not finished, province of Guangdong), Quanzhou – Fuzhou 212 km (Fujian), Yulin – Wuzhou 220 km (Quangxi), Tongling – Jiujiang 237 km (Anhui – Jiangxi provinces, along the right bank of the Yangtze River), Xiuyan – Zhuanghe (Liaoning), Chaozhou – Zhangzhou (near Xiamen) 220 km (province of Guangdong), Changzhi – Taiqian 495 km (Henan), Datong – Baoding – Bazhou (provinces Shanxi – Hebei), Ji Xian – Tianjin Harbor 180 km, Jinghe – Yining – Holmgous 300 km (Western Xinjiang), Dahushan – Panjin (Panshan) – Yingkou 146 km (Liaoning), Suiyang – Dongning 100 km (Heilongjiang, near Grodekovo), Zhongwei – Taiyuan (Ningxia – Shaanxi – Shanxi), Bayan Obo (near Baotou) – Oyu Tolgoi 290 km (Mongolia), Chifeng – Datong (Hebei). After the completion of Golmud – Lhasa line (2007) the construction of the second leg to Tibet 1594 km is planned from the province of Yunnan via Dali – Weixi – Zuogong – Basu – Bomi – Linzhi to Lhasa.

There are some chances to lay the railway lines from Yunnan to Myanmar (Burma) and Thailand: from Dali to Ruili – Myitkyina (Myanmar) and Dali – Jinghong – Chiang Rai – Chinag Mai (Thailand), Jinghong – Ban Pakou – Vientiane (Laos) – Nong Khai.

If all these lines are completed, the circuital framework of the Chinese railway network will add the 4th topological layer, significant thickening and structural complication will take place. However, different causes (including the physical and geographic ones) lead to the formation of the topological defects in the network structure. To eliminate these defects, it is necessary to construct some new lines and sections (indicated on the Map for 2007 Figure 2 by dotted lines), which could cut off the distances between neighbouring provinces and the main transport nodes. Their directions were determined using the method of finding-out and removing the topological defects in the network structure offered in the author's dissertation (Tarkhov, 2002). We recommend the laying if the following railway lines to improve the existing network structure of the Chinese railways (the names of the provinces are indicated in the parentheses):

- Chifeng – Huolinguoqin – Yiershi – Yimin (Nei Mongol)
- Mangui – Bishui (Nei Mongol)
- Linhai – Heibaoshan – Heihe (Heilongjiang)
- Xiuyan – Fenghuangcheng – Tonghua (Liaoning)
- Baihe – Helong (Jilin)
- Hunchun – Dongning – Suiyang (Jilin – Heilongjiang)
- Datong – Baoding – Bazhou (Shanxi – Hebei)
- Tanggu (Tianjin) – Huanghua Dong – Dajiawa – Longkou – Yantai – Weihaiwei (Hebei – Shandong)
- Zhongwei – Taiyuan (Ningxia – Shaanxi – Shanxi)
- Lanzhou – Guangyuan – Daxian (Gansu – Sichuan)
- Wanxian – Shimenxian (Hubei)
- Liuzhou – Wuzhou – Sanshui (Guangxi – Guangdong)
- Hengyang (or Zhuzhou) – Ganzhou (Hunan – Jiangxi)
- Beihai – Zhanjiang (Guangxi – Guangdong)
- Wenzhou – Ningbo (Zhejiang)
- Jiujiang – Jingdezhen – Jinhua (Jiangxi – Zhejiang)
- Ankang – Luoyang (Shaanxi – Shanxi)
- Changzhi – Houma (Shanxi)
- Handan – Puyang – Kaifeng – Fugou – Zhoukou (Hebei – Henan)
- Bengbu – Huaiyiun – Lianyungang – Gangshan – Shijusuo – Qingdao (Anhui – Jiangsu –Shandong).

5. CONCLUSIONS

Meridionality of topological structure of circuital framework from the North-east to the South is the main spatial characteristic of the Chinese railway network. This framework covers the Central and the Eastern part of the Chinese mainland, but it does not fill up the whole area of the country. The 1st, 2nd, 3rd topological layers of the circuital framework are extended in the same configuration. Smaller circuits (regarding the area) are concentrated along the main trunk axis Beijing – Wuhan (provinces of Hebei, Shanxi, Henan) and the bigger ones – in the South-west, South, South-east. Manchuria is still keeping as the second sealing focus of framework.

Intensive growth of the network during the last 15 years has led to inner sealing of circuital framework, its expansion to the south, with appearance of the 3rd topological layer in 1993 (covering the provinces of Hebei, Shanxi, Henan) and to a significant complication of its structure. The opening of the ferry rail line Dalian – Yantai in 2003 will lead to the expansion of circuital framework to the East and North-east, with the emergence of 4th topological layer, and further network growth – to the extension of this layer.

Despite the speed, the inner and external growth of the circuital framework of the Chinese railway network, the low level of transport, developing of less populated areas is continuing and will keep continuing in the Western (Chinese "Central Asia") and Northern Mongol (Chinese "Siberia") parts of the country. More than half of the Chinese territory is like an "economical desert". The railway network is concentrated in its Eastern half with the heartland of high level of density in the Central China (provinces of Shanxi, Henan, Hebei, Shandong, Anhui).

There are 6 meridional and 13 latitudinal trunk lines inside the circuital framework of the Chinese railway network, and two long external dendrites of economic penetration in the West (in Xinjiang and Qinghai).

The mileage of the state railways in China increased from 52,000 to 70,000 km and the number of its circuits – from 74 to 112 during the last 15 years (1988-2002). Nevertheless, this is not sufficient for such a large country as China. The network must have at least 125,000 km, it will be much more dense, and will cover the whole South, South-east and especially the Eastern seashore.

The share of double-track sections (30%) and electrified sections (20%) is very low and needs to increase drastically. There should be an increase in the number of railway transborder exits from Manchuria to Russia, and the sea-ferry rail link between mainland and Taiwan need to be organised.

Thus, in spite of the unique high rates of network growth in the world, the concentration of network in the Central parts, its meridional extension in the Eastern half of the country, almost complete lack of the network in the Western half, inner land (not seashore) orientation of network structure are the main spatial barriers and disproportion in the Chinese railway network.

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РЕЗЮМЕ

РОСТ СЕТИ ЖЕЛЕЗНЫХ ДОРОГ КИТАЯ

В течение 1988-2002гг. в Китае построено более 20 тыс. км новых железных дорог. Топологическая сложность сети китайских железных дорог за это время возросла с 75 до 112 циклов; в 1993г. в сети возник 3-й топологический ярус и 4-й такой ярус появится в 2004г. после открытия железнодорожного парома Далянь – Янтай. Основными пространственными диспропорциями в современной сети железных дорог Китая являются: 1) меридиональность ее структуры, 2) диспропорция между приморским востоком (с густой сетью) и слабо заселенным западом (с низкой плотностью сети и отсутствием дорог), 3) низкий уровень электрифицированности сети (20%) и низкая доля двухпутных участков (30%), 4) внутренняя ориентация всей сети и недостаточное количество линий вдоль морского побережья. Эти пространственные диспропорции в структуре сети железных дорог тормозят экономическое развитие страны.

КЛЮЧЕВЫЕ СЛОВА

железные дороги Китая, сеть железных дорог, топологическая структура транспортной сети, циклический остов транспортной сети, железная дорога Цзин-Цзю, скоростные железные дороги, система Маглев

LITERATURE

Periodicals

[1] *Cart Actual* (Budapest), 1965-1993
[2] *Chinese Railways* (Beijing), 1996-2001
[3] *Geographical Digest* (London), 1962-2000
[4] *International Railway Journal (IRJ)*, 2000-2001
[5] *Railway Gazette International (RGI)*, 1990-2002

Books and articles

[1] *The brilliant 50 years history of China railway development* // Chinese Railways. – 1999 – Vol. 7. – No. 2. –pp. 3-14
[2] **Chang Kia-Ngau**: *China's struggle for railroad development.* – New York, 1943 – p. 340
[3] **Chang Kuei-Sheng**: *The changing railroad pattern in mainland China* // Geographical Review. – 1961 – Vol. 51 – No. 4. – pp. 534-548
[4] *Chemins de fer chinois: Cinquante ans de heurs et malheurs* // Rail international. – 2000 – Septembre – pp. 2-10
[5] **Cheng Lin**: *The Chinese railways. A historical survey.* – Shanghai, 1935 – p. 214
[6] *China. Map. Scale 1:4.000.000.* – Vancouver: International travel maps, 2001
[7] *China. Men of insight must not let this opportunity slip through their fingers* // RGI. – 1993 – November – pp. 751-754
[8] *China. Railway station list 1988* – Exeter: Quail Map. Co., 1992 – p. 94
[9] *China speeds up again* // RGI. – 2001 – December – p. 801
[10] *China to build line to Tibet* // IRJ. – 2001 – March – p. 5
[11] *Chinese east-west corridor starts* // RGI. – 2000 – July – p. 400
[12] *Chinese focus moves west* // RGI. – 2000 – April – p. 202; August – pp. 482-483
[13] *Chinese projects start to roll* // RGI. – 2001 – February – p. 92
[14] *Chinese step up expansion drive* // RGI. – 1993 – June – p. 359
[15] *Eight corridors at heart of five-year plan* // RGI. – 1998 – September – pp. 611-613
[16] **Han Shuqing**: *Introduction to new railway lines in 1999* // Chinese Railways. – 2000 – No. 2 (15). – pp. 50-55
[17] **Han Zhubin**: *Le perfectionnement du reseau ferroviare chinois* // Rail international. – 1998 – Mai – pp. 29 -32
[18] *High stakes in Shanghai* // RGI. – 2002 – May – p. 227
[19] *History of the railways in Manchuria* // Far Eastern Review. – 1940 – January – pp. 19-25
[20] **Huenemann R.W.**: *The dragon and the iron horse: The economics of railroads in China* 1876-1937 – Cambridge, 1984 – p. 347
[21] **Leung C. K.**: *China: Railway patterns and national goals* // The University of Chicago, Department of Geography, Research paper No. 195 – 1980 – p. 243
[22] *Lhasa go ahead* // RGI. – 2001 – March – p. 142
[23] **Lin G., Jianhua G.**: *Railway trends in China* // Japan Railways and Transport Review. – 1999 – No. 21 – September – pp. 34-37
[24] **Lin Zhonghong**: *Description of the Turpan – Kashi Railway Project* // Chinese Railways. – 1997 – No. 1 (8). – pp. 47-50
[25] **Lixin Qian**: *Jing-Jiu trunk line boosts north-south capacity* // RGI. – 1997 – July – pp. 455-458
[26] *Maglev projects may flop* // RGI. – 2002 – April – p. 174
[27] *Quiongzhou tunnel planned* // IRJ. – 2001 – December – p. 4
[28] *Rails to conquer the Tibetan plateau* // RGI. – 2001 – May – pp. 319-320
[29] *Railways* // China. Handbook. 1937-1945. – New York, 1947, pp. 213-216, 818
[30] **Stringer H.**: *The Chinese railway system.* – Tientsin, 1925 – p. 174
[31] **Tarkhov S.A.**: *The spatial regularities of transport networks evolution process.* – Dissertation for Dr. hab. –

Moscow: Institute of Geography, Russian Academy of Sciences, 2002 – p. 244 (Manuscript in Russian)

[32] *Ten major railway projects scheduled for construction in the Tenth 5-year plan* // Chinese Railways. – 2000 – No. 2 (15). – pp. 23-24

[33] *Tian Chang-hai. Investment drives western expansion* // RGI. – 2002 – May – pp. 251-256

[34] *Tibet link study* // RGI. –1998 – October – p. 629

[35] *Tietze W. 50 Jahre Eisenbahn in der Mandschurei. Ein Beitrag zur Verkehrsentwicklung im Fernen Osten* // Int. Archiv fuer Verkehrswesen. – 1953 – No. 24 – S.569-572

[36] *Wang Linshu. Past and future development of Chinese Railways* // Chinese Railways. – 2001 – No. 1(16). – pp. 17-22

[37] *Work begins on Tibet line* // RGI. – 2001 – August – p. 495

[38] *Work starts on Maglev link* // IRJ. –2001 – December – p. 2

[39] *Xining – Lhasa railway* // Chinese Railways – 2001 – No. 1 (16) – cover page

[40] **Yonge J.**: *China railway atlas.* – Exeter: Quail Map Co., 1993 – p. 20

[41] ***Yonge J.***: *China railway atlas.* 1998 – 2nd edition. – Exeter: Quail Map Co., 1999 – p. 40

[42] **Zhou Zhenyuan**: *Review of railway construction during the eight 5-year plan period and guidelines for the ninth 5-year plan* // Chinese Railways – 1997 – No. 1 (8) – p. 13-19