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Italy joins the premier speed league

Trenitalia's 50th ETR1000 stands at Napoli's Afragola station during the opening ceremonies on June 6, as an NTV Italo service speeds past.

In our biennial survey of the world's fastest scheduled trains, Jeremy Hartill* finds that six countries now operate services with start-to-stop average speeds exceeding 250 km/h.

It is time to look once more at the world's fastest timetabled trains. Since our last review in 2015 high speed networks have continued to expand, with China outstripping the rest of the world as the country's combined length of high speed lines now exceeds 22 000 route-km. Indeed, the growth of high speed networks is in some respects a bigger story than the speed of the trains.

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To recap on the criteria for the survey, it is based on published weekday schedules operated in this year's May and June timetables. Weekend, dated and one-off services are excluded. As always, we are grateful to contributors who provide more information each time the survey is compiled, and adjustments have been made to reflect this feedback.

Perhaps the main feature of the speed tables is how little has changed. Indeed, at the top of Table I there is no change at all, with China and France occupying the first two places and a Shijiazhuang – Zhengzhou return trip still in the leading position with an average speed of 283·4 km/h.

Change is, however, evident in terms of rolling stock. First-generation high speed trains are rapidly being replaced by second or third generation fleets. But in many cases the latest rolling stock is no faster in terms of top speed than the trains they are replacing — the emphasis is increasingly on cost per seat-km rather than speed itself.

In Japan, the last of the Series 0 design that launched Shinkansen services in 1964 was consigned to history as long ago as 2008, since when the Series 100, 200 and 300 designs have come and gone. The evolution of Shinkansen designs continues, with JR Central announcing last year that it is to build a 16-car pre-series N700S trainset to test changes planned for the next generation of stock for the Tokaido and Sanyo Shinkansen (RG 8.16 p10).

In France the first generation of TGVs is fast disappearing while many of the original Eurostar sets built to operate through the Channel Tunnel route are being scrapped. Eurostar's 17-strong fleet of e320 Siemens Velaro trainsets began operating on the London – Brussels route on May 23, having previously been restricted to the London – Paris route. This is seen as a precursor to the start of Eurostar operation to Amsterdam, as only the e320s are equipped with ETCS.

In Germany, Deutsche Bahn is poised to start replacing its first generation ICE fleet with the ICE4 family. The first two pre-series ICE4 trains entered trial commercial service at the end of last year between Hamburg and München, and four more are due to join them later this year before large-scale deliveries begin. The framework contract now includes firm orders for 119 trains and envisages an eventual total of up to 300.

The great survivor among the world's high speed fleets is Britain's diesel powered HST, which entered service at 200 km/h in 1976, ranking Britain second behind Japan in our 1977 survey. These remarkable trains have been re-engined and refurbished, and it is probable that they will achieve more than 50 years in front-line service. Another intriguing possibility is that some sets may be converted to carry parcels and light cargo — perhaps the 2019 survey will have a table for the world's fastest freight trains.

Top tier

Turning to the numbers, this year's statistics confirm that the top average speeds have reached a plateau. No operator has yet exceeded a maximum of 320 km/h in regular commercial service, meaning that the 280 km/h mark is about the highest achievable start-to-stop average (Fig 1). Even then, everything has to work precisely as planned, with high speed possible over most of the route, no speed restrictions and no pathing issues.

The top four countries have not changed in the past two years, with China still in a league of its own. It operates the world's fastest trains, has the largest high speed network and runs more high speed services than any other country.

In the 'premier league' — as I called it last time — operating trains at an average speed of 250 km/h or more, Italy has become the sixth member of the group, joining China, France, Japan, Spain and Taiwan. In a remarkable coincidence, the fastest Italian timing ties with the best schedule in Taiwan at 256·4 km/h.

Runners-up

In the next tier, with best runs between 250 km/h and 200 km/h, are Germany, International trains, South Korea and Turkey. Russia's Sapsan services are only just outside this band, at almost 198 km/h, again a speed-up compared with last time. Note that this is achieved on an upgraded route shared with other trains rather than a dedicated high speed line.

In the UK the top performances have not changed, but a new entry this year is Grand Central's 19.52 from London King's Cross to Bradford. With a good evening path on the East Coast Main Line, this reaches Doncaster at an average speed of 172·8 km/h. It is the only diesel-operated service to appear in this year's survey and as far as I can tell is the fastest timetabled diesel train in the world. The service is usually operated by an Alstom Class 180 'Adelante' five-car trainset.

Also running on the ECML at the same time of day, Virgin Trains East Coast's 18.57 York – Stevenage service is the fastest locomotive-hauled train to appear in Table I; in fact this is a push-pull trainset with the Class 91 propelling from the rear.

This train just manages to beat a new entry from Austria, which achieves a timetabled speed of 176·6 km/h. Completion of the rebuilding programme for the Weststrecke from Wien to Linz has enabled ÖBB's 230 km/h locomotive-hauled Railjet services to pass the 170 km/h mark.

In the USA, Acela Express services on the Northeast Corridor have slipped back a little, although Amtrak's recently-delivered ACS-64 Cities Sprinter electric locomotives achieve a spirited run on the Baltimore – Wilmington leg of

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256·4 km/h

FASTEST TIMING IN BOTH ITALY AND TAIWAN

South Korea's Supreme Railways is only the second open access operator to launch its own high speed series (p36).

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Table I. Fastest timetabled start-to-stop runs between different station pairs

Train	From	To	Distance km	Time min	Speed km/h
China (305 km/h)					
G66/79	Shijiazhuang[1]	Zhengzhou	382·6	81	283·4
G87	Beijing Xi	Zhengzhou Xi	693·0	148	280·9
G1/2	Beijing Nan[1]	Nanjing Nan	1021·9	219	280·0
126 trains	Beijing Nan	Tianjin	118·0	34	208·2
France (320 km/h)					
TGV 9871	Champagne-Ardenne TGV	Lorraine TGV	167·6	37	271·8
TGV 6105	Lyon St Exupéry	Avignon TGV	215·5	48	269·4
TGV 9561	Paris Est	Strasbourg	439·6	104	253·6
Ouigo 12.22	Marne-la-Vallée-Chessy	Lyon St Exupéry	430·4	104	248·3
Japan (320 km/h)					
Komachi[1]	Omiya	Sendai	294·1	66	267·4
10 Nozomis	Kokura	Hiroshima	192·0	44	261·8
Nozomi[1]	Shin Yokohama	Nagoya	316·5	77	246·6
Toki 311	Omiya	Niigata	269·5	74	218·5
Spain (310 km/h)					
AVE 3062	Zaragoza-Delicias	Guadalajara-Yebes	242·3	56	259·6
Several AVEs	Madrid Atocha[1]	Barcelona Sants	621·0	150	248·4
AVE 5141	València Joaquín Sorolla	Madrid Atocha	391·0	98	239·4
AVE 2072	Madrid Atocha	Córdoba	343·2	100	205·9
Taiwan (300 km/h)					
14 trains	Zuoying	Taichung	179·5	42	256·4
3 trains	Taichung	Banquio	152·6	38	240·9
Italy (300 km/h)					
5 Frecciarossa	Milano Rogoredo	Reggio Emilia AV	145·3	34	256·4
3 Italo*	Roma Tiburtina	Milano Rogoredo	560·3	158	212·8
2 Italo*	Roma Termini	Napoli Centrale	222·4	67	199·2
10 Frecciarossa	Roma Termini[1]	Napoli Centrale	222·4	67	199·2
Germany (300 km/h)					
ICE 724	Frankfurt Flughafen	Siegburg	143·3	36	238·8
ICE 125	Köln Hbf	Frankfurt Flughafen	168·2	47	214·7
4 ICEs	Nürnberg	Ingolstadt	90·1	27	200·2
7 trains	Leipzig Hbf	Erfurt Hbf	120·8	42	172·6
International (300 km/h)					
Several Thalys	Paris Nord	Brussels	313·6	82	229·5
Several Eurostars	Paris Nord	London	491·1	137	215·1
ICE 9555	Paris Est	Saarbrücken	357·1	107	200·2
Several Thalys	Rotterdam Centraal[1]	Antwerpen Centraal	95·0	32	178·1
South Korea (300 km/h)					
KTX 503	Gwangmyeong	Cheonan-Asan	74·0	20	222·0
KTX 548	Gwangju	Iksan	92·7	27	206·0
Several KTX	Dongdaegu	Daejeon	133·3	40	200·0
Several SRT*	Dongdaegu	Daejeon	133·3	40	200·0
Turkey (250 km/h)					
YHT 92106	Konya	Sincan	285·0	80	213·8
YHT 91210	Konya	Polatlı	220·0	63	209·5
YHT 91008	Eskisehir	Sincan	221·0	67	197·9
YHT 91302/304	Eskisehir	Konya	339·5	103	197·8
Russia (250 km/h)					
Sapsan 770	Bologoye	Chudovo	201·0	61	197·7
Sapsan 767	Tver	Chudovo	365·0	119	184·8
Sapsan 751	St Petersburg Glavny	Moscow Oktyabrskaya	650·0	215	181·4
Sapsan 752	Moscow Oktyabrskaya	St Petersburg Glavny	650·0	215	181·4
UK (300 km/h)					
7 trains	Stratford International	Ashford International	80·8	27	179·6
19.42	Stafford	Watford Jcn	186·8	63	177·9
18.57	York	Stevenage	259·0	88	176·6
19.52*	London King's Cross	Doncaster	250·7	87	172·9
Austria (230 km/h)					
Several Railjets	Wien Meidling[1]	St Pölten	61·0	21	174·3
Several Railjets	St Pölten[1]	Linz	123·1	46	160·6
USA (240 km/h)					
Acela 2117	Wilmington	Baltimore Penn	110·1	39	169·4
Several trains	Baltimore Penn	Wilmington	110·1	41	161·1
Vermonter	Baltimore Penn	Wilmington	110·1	42	157·3
Sweden (200 km/h)					
14 trains	Nässjo	Alvesta	87·0	31	168·4
X2000 437	Katrineholm	Skövde	179·3	64	168·1
14 trains	Alvesta	Nässjo	87·0	32	163·1
Several X2000	Södertälje Süd[1]	Skövde	275·0	102	161·8
Finland (200 km/h)					
2 ICs	Tikkurila	Lahti	88·4	32	165·8
Uzbekistan (250 km/h)					
Afrosiyob	Tashkent	Samarkand	344·0	128	161·3
Afrosiyob	Samarkand	Tashkent	344·0	130	158·8

1. Trains run in each direction
* Open access operator

the *Vermonter*. Table I concludes with no change in Sweden, a slight increase in Finland and no change in Uzbekistan.

It is worth noting that a 1 min adjustment in a train's timings between two stops can make a significant difference to the average speed, particularly over relatively short distances. This can work both ways, as shown by a 1 min speed-up in South Korea which raised the average speed between Gwangmyeong and Cheonan-Asan from 211 km/h to 222 km/h. At the other end of the scale a 1 min slowing of their fastest bookings has seen both Switzerland and Portugal drop out of the list.

Competing operators

This year's survey features three open access train operators. Italy and South Korea both have open access companies running high speed trains in competition with the national state-owned operators. In the UK Grand Central, owned by Deutsche Bahn subsidiary Arriva, vies for traffic on the East Coast Main Line with franchise holder Virgin Trains East Coast. In terms of performance there seems to be little difference, probably because infrastructure and pathing are the controlling factors. The selling point of open access operators tends to be focused more on service quality or price rather than speed.

The launch of more open access operations, at least in Europe, may be hindered by the lack of suitable second-hand rolling stock. It appears that when high speed trains are taken out of service by the state-owned railways they are at once dispatched for scrap, thus denying any potential competitor the opportunity to make use of them.

An interesting set of comparisons can be made on France's LGV Est from Paris to Strasbourg, which is home to France's fastest trains, with TGVs sprinting between Champagne-Ardenne TGV and Lorraine TGV at an average of 271·8 km/h.

While this runs entirely in France, the service is provided by a mix of TGVs and ICEs with SNCF and DB competing to some extent for the same traffic. On the Strasbourg – Paris section the

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best TGV timing is 105 min, giving a start-to-stop average of 251·1 km/h. By comparison, the best ICE time is 1 min slower, giving an average of 248·8 km/h. However, it does produce the irony that the fastest timetabled ICE service runs in France rather than Germany. It is also worth pointing out that logs of individual trips submitted to the Railway Performance Society have demonstrated that both TGVs and ICEs can in practice cover the 439·6 km in less than 104 min. One TGV was recently recorded achieving 101½ min, at an average speed of almost exactly 260 km/h.

Although not featuring in this year's table, as it does not open for commercial service until July 2, the LGV Sud Europe Atlantique route extending the southern arm of LGV Atlantique from Tours to Bordeaux (RG 3.17 p38) will launch a major acceleration of services (p29). The 06.28 non-stop from Paris Montparnasse to Bordeaux currently takes 3 h 11 min, but over the new route the 07.52 will reach its destination in just 2 h 4 min.

Looking further ahead, the 2019 survey is likely to include Morocco, where the Tanger – Kénitra LGV is due to open in mid-2018. This will bring Africa into the top table for the first time. Similarly, the planned opening of the Haramain high speed line between Makkah and Madinah by March 2018 will see Saudi Arabia join the growing club of high speed operators. And perhaps we may also see some more sprightly performances on HSL-Zuid in the Netherlands.

Commercial imperatives

This year's data reveals a general slight easing of timings, with a minute inserted here and there while the headline time is retained for key trains. There also seems to be an increase in the number of stops, which tends to lower the average speed as a longer run is needed to attain a high average.

It would seem that the economic benefit of serving more stations may be a factor here, perhaps underlaid by the dictum that fast running over long distances applies in the good times but more stops are needed in hard times.

SNCF trimmed 13 min off the Paris – Marseille timing when the line speed on LGV Paris – Sud-Est was raised from 270 km/h to 300 km/h. For comparison, the 320 km/h maximum on LGV Est offers a 4½ min saving between Paris and Strasbourg compared with 300 km/h, and a mere 30 sec between Avignon and Aix-en-Provence. The price to pay for the higher speed includes tamping twice as frequently as on lines where the limit is 300 km/h, while ballast will have to be renewed earlier than anticipated. Further experience and better understanding of ballast behaviour will perhaps help to mitigate these costs over time.

Energy costs are also very significant as the power needed to propel a train rises as the square of the speed. The Chinese have been clear that this is part of their decision to stay with a maximum of 305 km/h.

In Germany, the ICE4 fleet will be limited to 250 km/h, so the question of how fast to go is still an open one. It may well be that the next review will see Portugal and Switzerland back in the table with 160 km/h runs. Trains run through the 57 km Gotthard Base Tunnel at 200 km/h, and the intention is to lift the maximum to 250 km/h in due course.

In summary, it seems clear that in terms of train performance we are now at the limit for what can be reliably achieved in day-to-day operation on routes where the line speed is 300 or 320 km/h. It is also probable that the additional costs of faster running may not improve the bottom line when that only delivers a small time advantage — although it may not be the case if very long distances are involved. I predict that the short and medium term future will bring little increase in terms of speed but a considerable rise in the length of high speed routes worldwide, with China continuing to dominate the statistics. The expansion of high speed infrastructure will be matched by the introduction of many more services, but at similar speeds as today.

Finally, it is worth noting some aspects of high speed operation that are not revealed in the tables. In the UK, for example, there is only a relatively short section of dedicated high speed route between London and the Channel Tunnel. Nevertheless, there are now 428 runs on weekdays averaging 160 km/h or more on upgraded conventional lines — a significant achievement. ■

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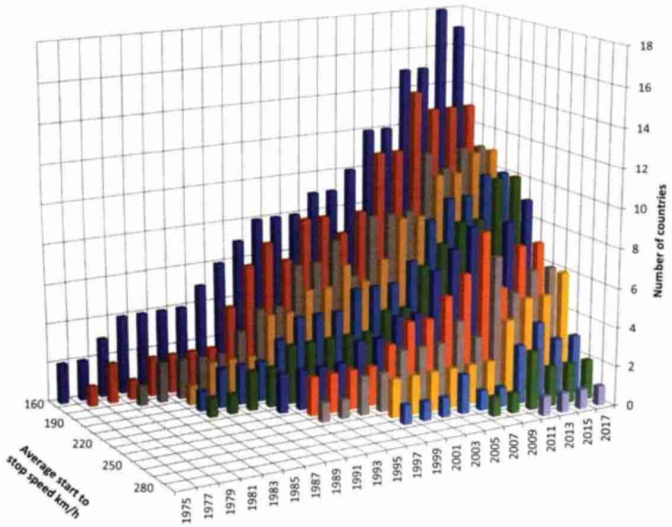

Fig 1. The number of countries in which trains operate in different speed bands has increased steadily over the past 40 years.

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Photo: Andrew Benton

Top: World's fastest diesel train. A Grand Central Adelante DMU passes Peterborough on the UK's East Coast Main Line.

Above: The CRH380A sets operating on Beijing – Guangzhou services via Zhengzhou have the fastest timetabled trips in China.