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

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Japan High Speed Passenger Trains

Japan

- Statistics

Item	*Specification*
Archipelago	6,852 islands
Capital	Tokyo
Currency	Yen (106 yen = 1 USD)
Driving side	left
GDP	5.413 trillion USD
Population	125,960,000
Size	377,975 km^2

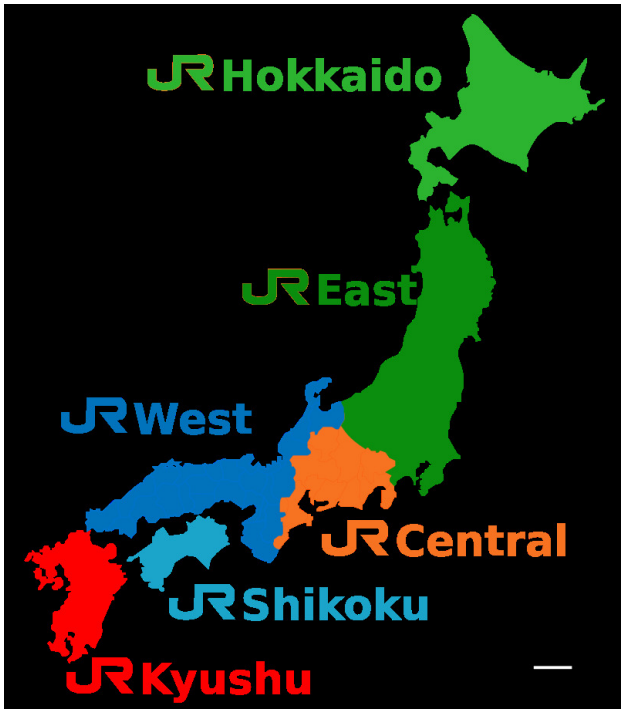
- First country to establish high speed passenger trains in 1964

Japan

Japan High Speed Passenger Trains

Japan Railways Group

- The Japan Railways Group (JR Group) comprises seven for-profit companies operating the railways in Japan
- Established in 1987
- Operate a large proportion of intercity rail service including the high speed rail lines known as Shinkansen
- Total ridership 7.589 billion (2014)
- Total passenger km 260 billion (2014)
- System length 30,625 km



Japan Railways

Japan High Speed Passenger Trains

Japan Railways Group

- Rail system

Gauge	*Size*	*Length*	*Function*
Narrow	1.067 m (3 ft 6 in)	15,222 km	Passenger/freight
Standard	1.435 m (4 ft 8.5 in)	4,251 km	High speed line, subways
Misc	1.372 m (4 ft 6 in)	96 km	Keio line branches
	0.762 m (2 ft 6 in)	48 km	Regional

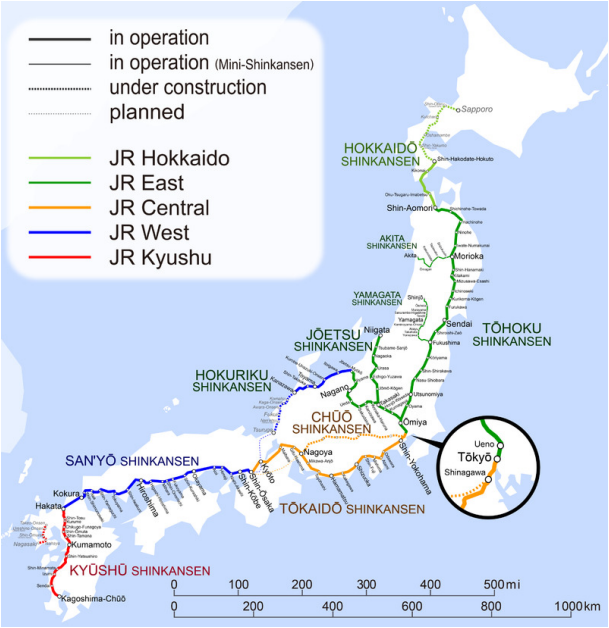
- Narrow gauge introduced into Japan by the United Kingdom when the first railroad was constructed between Shimbashi and Yokohama in 1872
- Narrow gauge is also known as Cape gauge
- The name Cape gauge originates from its adoption in 1873 by the Cape Colony which later became part of the Union of South Africa
- Narrow gauge was originally for horse-drawn railways in England and Wales, and later for steam railways in Australia and Canada

Japan High Speed Passenger Trains
Narrow Gauge Trains

EMU Sangi Railway 270 series arrives at Sohara Station on the Hokusei Line

Japan High Speed Passenger Trains
Shinkansen

- The Japanese high speed passenger rail is known as Shinkansen
- Shinkansen translates as "new trunk line"
- Also known as bullet train due to its aerodynamic shape
- Initially constructed to connect distant Japanese regions with Tokyo
- Operated by five Japan Railways Group companies



Shinkansen routes

Japan High Speed Passenger Trains
Shinji Sogo

- Fourth president of Japanese National Railways
- In the 1950s public opinion considered passenger rail to be outdated and replaced by air travel and automobile travel
- A similar sentiment existed in the US
- Shinji Sogo convinced the Japanese government to develop a high speed passenger rail system
- His vision became an extraordinary success
- Shinkansen has carried over 10 billion passengers without a single passenger fatality or injury due to train accident

Shinji Sogo
(1884-1981)

Japan High Speed Passenger Trains
Tokaido Shinkansen

- The Japanese government approved the high speed passenger project in December 1958
- Construction of the first segment between Tokyo and Osaka, known as Tokaido Shinkansen, began in April 1959
- The total cost was approximately 400 billion yen, more than twice the initial estimate
- Shinji Sogo resigned to assume responsibility for the cost overrun

Tokyo-Osaka route

Japan High Speed Passenger Trains
Tokaido Shinkansen

- Tokaido Shinkansen opened in 1964
- The name is translated as "East Sea Route New Trunk Line"
- Operated by Central Japan Railway Company (JR Central)
- Oldest high speed rail system in the world

Japan High Speed Passenger Trains
Tokaido Shinkansen

- Prior to the opening of the Tokaido Shinkansen, the fastest available service between Tokyo and Osaka was six hours and forty minutes
- The early Shinkansen trains reduced the time to four hours
- Later the trip duration was reduced further to three hours and ten minutes

N700 train

- Today the time is two hours and twenty four minutes
- At the 50th anniversary in 2014, Tokaido Shinkansen was carrying 391,000 passengers per day and operated 18 hours per day

Japan High Speed Passenger Trains
Tokaido Shinkansen

- Total track length 515.4 km
- Standard gauge
- Electrification 25 kV, 60 Hz
- Operating speed 285 km/hr
- Total weight 715 ton (16 car set)
- Traction system 56 x 305 kW
- Total power output 17.08 MW

N700 Economy seating

Japan High Speed Passenger Trains
San'yo Shinkansen

- San'yo Shinkansen connects Osaka with Fukuoka
- Osaka and Fukuoka are the two largest cities in western Japan
- Operated by West Japan Railway Company (JR West)
- Opened 1972
- Travel time two hours thirty minutes
- Maximum speed 300 km/hr

Japan High Speed Passenger Trains
San'yo Shinkansen

- Total track length 553.7 km
- Standard gauge
- Electrification 25 kV AC, 60 Hz
- Sixteen cars in consist
- Total passenger capacity 1,323

N700 Train

Japan High Speed Passenger Trains
Tohoku Shinkansen

- Tohoku Shinkansen connects Tokyo with Aomori
- Operated by East Japan Railway Company (JR East)
- Two mini-Shinkansen branch lines
  - Yamagata Shinkansen
  - Akita Shinkansen
- Opened 1982
- Maximum speed 320 km/hr

Japan High Speed Passenger Trains
Tohoku Shinkansen

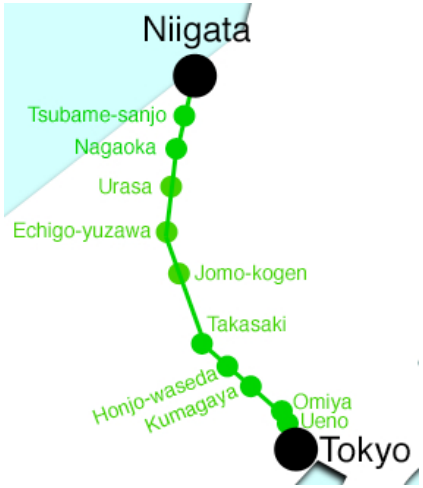
- Total track length 674.9 km
- Longest Shinkansen line
- Standard gauge
- Electrification 25 kV, 50 Hz
- Ten cars in consist
- Total passenger capacity 731

H5 Shinkansen

Japan High Speed Passenger Trains

Joetsu Shinkansen

- Joetsu Shinkansen connects Tokyo and Niigata
- Operated by East Japan Railway Company (JR East)
- Actually doesn't pass through the city of Joetsu !
- Opened 1982
- Maximum speed 240 km/hr



Japan High Speed Passenger Trains

Joetsu Shinkansen

- Total track length 269.5 km
- Standard gauge
- Electrification 25 kV, 50 Hz
- Twelve cars in consist
- Total passenger capacity 934

E7 Shinkansen

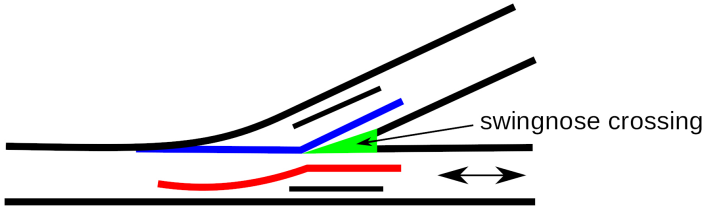
E7 First Class ("Gold Class")

E7 Economy Class ("Ordinary Class")

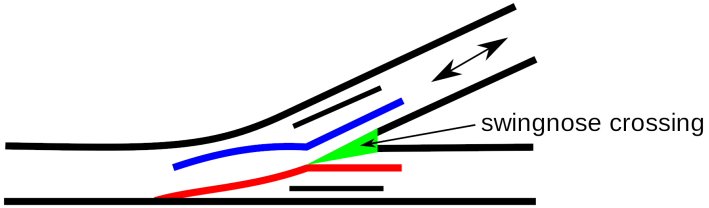
Japan High Speed Passenger Trains
Shinkansen Technology

- Track is standard gauge (4 ft 8.5 in)
- Continuous welded rail (CWR) used to form continuous rail
  - First introduced in Germany in 1924
  - Sections are welded end-to-end
- Swingnose crossing points

Welded rail



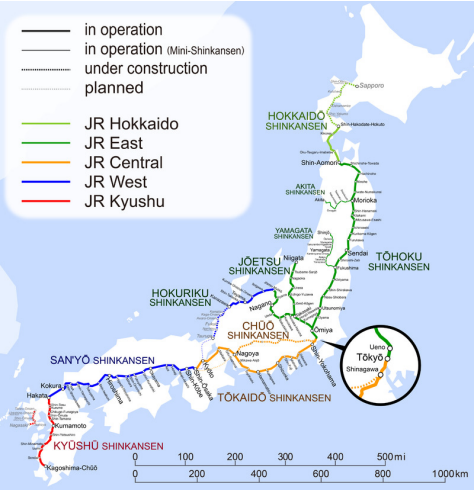
Train moves to right



Train moves to left

Japan High Speed Passenger Trains
Shinkansen Economics

- In 2016 the average delay from schedule per train was 24 seconds including delays due to uncontrollable causes
  - The record is 18 seconds set in 1997
- The estimated economic benefit is 500 billion yen per year due to savings in time for commuter travel

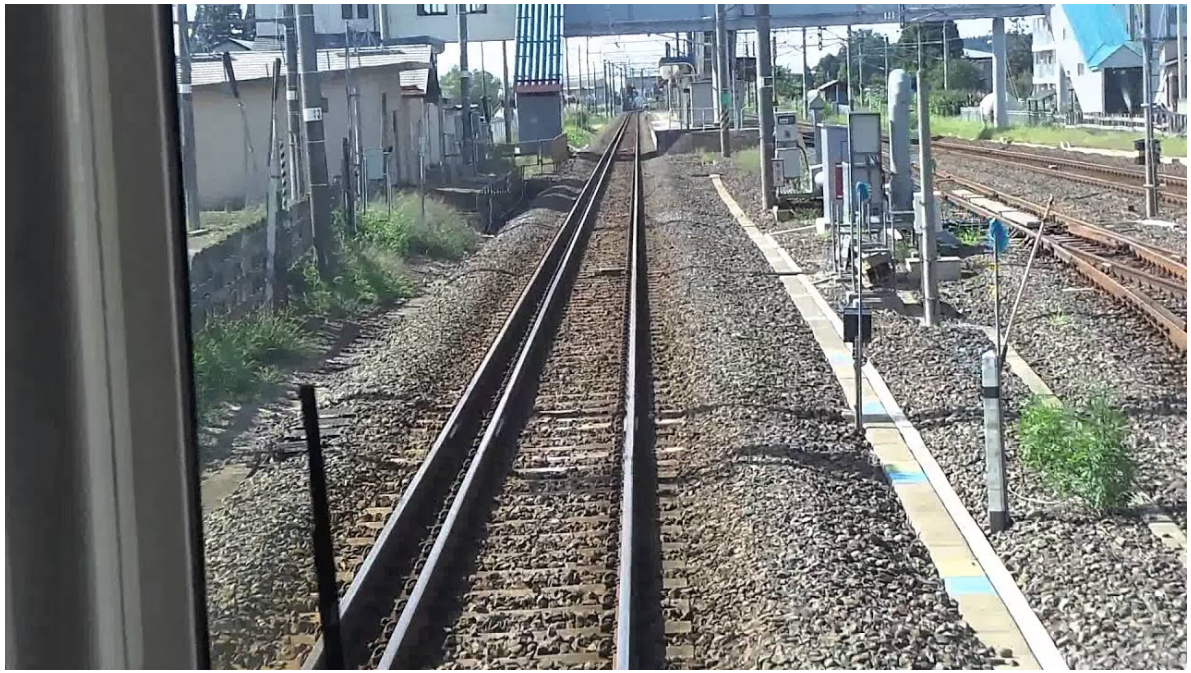


- Travel by train reduces emissions
  - Tokyo to Osaka by Tokaido Shinkansen produces only 16% of the carbon dioxide equivalent by car per passenger

Japan High Speed Passenger Trains

Movies

Japan High Speed Passenger Trains
How Can You Accommodate Two Different Gauges ?



Akita Shinkansen dual gauge railroad line

Japan High Speed Passenger Trains
ALFA-X

- Class E956 (ALFA-X) is a ten car train to evaluate technology for future trains operating at up to 360 km/hr (220 mph)
- Advanced Labs for Frontline Activity (ALFA)
- Operated by East Japan Railway Company
- Test run on setions between Sendai and Shin-Aomori of Tohoku Shinkansen line

ALFA-X

Japan High Speed Passenger Trains
ALFA-X

- Evaluates body designs to reduce vibration and likelihood of derailment in event of major earthquake
- Uses eddy current brakes and aerodynamic spoilers
- First train unveiled in May 2019
- Reached speed of 320 km/hr in May 2019 and 400 km/hr in December 2019

ALFA-X

Japan High Speed Passenger Trains
ALFA-X

- Specifications

Item	*Value*
Number built	1 set (10 vehicles)
Formation	10 cars
Car length	24.5 m
	26.25 m
Width	3.35 m
Height	3.7 m
Electric system	25 kV AC, 50 Hz
Track gauge	1.435 m (4 ft 8.5 in)

ALFA-X