JR Central, the Tokaido Shinkansen

and

High Speed Rail in the US

1. High Speed Trains in Japan

2. JR Central
    - What we do in Japan
3. Market
    - Where HSRs fit most
4. Technology
    - What US and Japan have done
5. High Speed Rail in the US
    - What it should look like

History of Japanese Railway

1872 The first railway in Japan opened, linking Tokyo and Yokohama (18 miles) with 3 ft 6 in narrow gauge tracks.

1906 A law passed to nationalize the nationwide railway network.

1949 Japanese National Railways (JNR) was incorporated as a state-owned public corporation, in accordance with the US postwar policies.

1964 First High-Speed Line, Shinkansen, commenced its operation between Tokyo and Osaka (320 miles).

1987 JNR railway operation was split to 6 passenger and 1 freight companies. JR-Central and other JR companies are incorporated. At this time, they are 100% owned by the government.

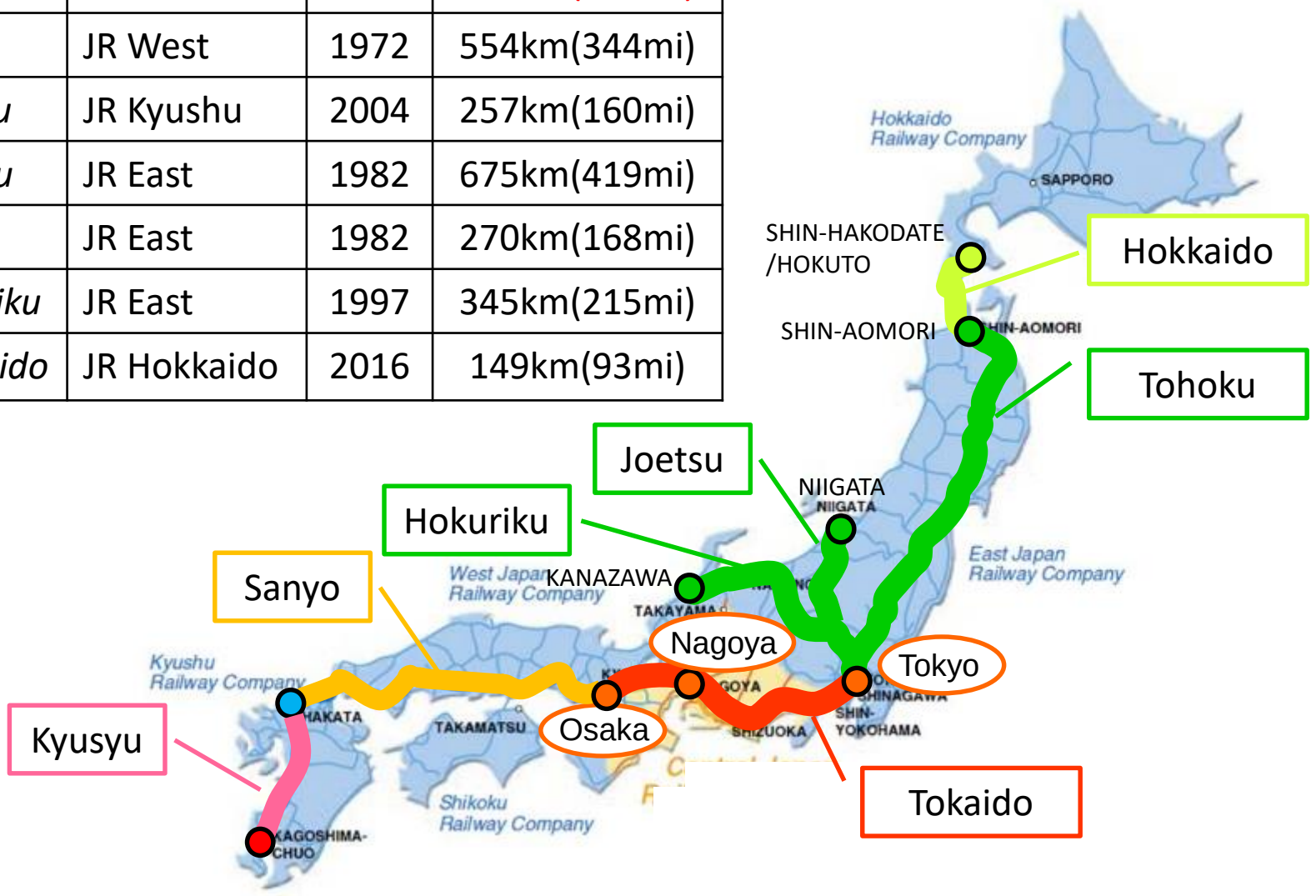
1997 JR-Central was listed on the Japanese stock markets.

2006 100% privatization of JR-Central was achieved, after the Japanese government sold the remaining of JR-Central stock they were holding.

Shinkansen Network in JAPAN

HTeC

Route	Operator	Opened	Route Length
Tokaido	JR Central	1964	515km(320mi)
Sanyo	JR West	1972	554km(344mi)
Kyushu	JR Kyushu	2004	257km(160mi)
Tohoku	JR East	1982	675km(419mi)
Joetsu	JR East	1982	270km(168mi)
Hokuriku	JR East	1997	345km(215mi)
Hokkaido	JR Hokkaido	2016	149km(93mi)



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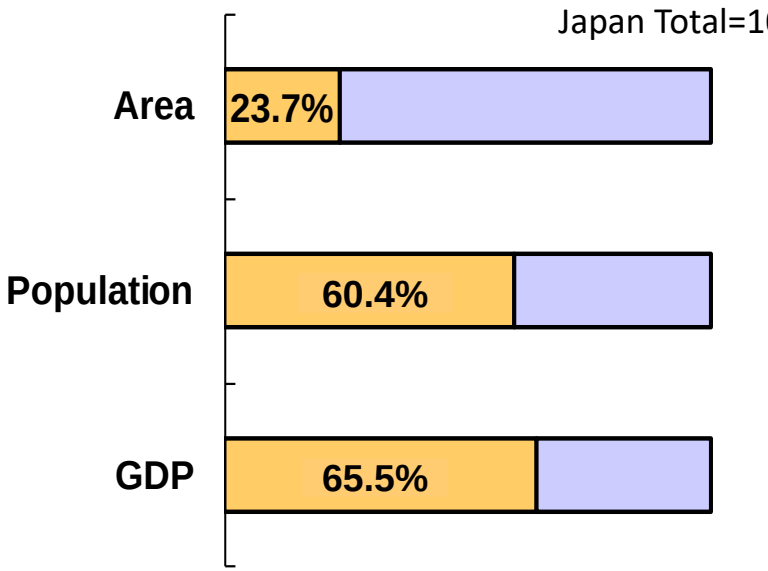
JR Central Operating Area



*Sources

Population: Population, Demographics and Numbers of Households Derived from Basic Resident Regsitration, Ministry of Internal Affairs and Communicatins

GDP: Annual Report on Prefectural Accounts, Economic and Social Research Institute, Cabinet Office

JR-Central Tokaido Shinkansen

Key Performance Statistics

- Safety

  No train accidents resulting in passenger fatalities or injuries for over 50-year operation

- High Speed

  285km/h

- High Frequency/High Capacity

  368 trains carrying 466,000 passengers/day*

- Punctuality

  Average delay less than 0.7 minute/train*

*FY2017

Technology improvement of Tokaido Shinkansen

1964 — 1985 — 1992 — 1999 — 2007

2006.3

Analog ATC | **Digital ATC**

1st generation rolling stock | 2nd generation rolling stock

- Steel carbody
- Conventional bogie
- DC motor drive

- Aluminum alloy carbody
- Bolsterless bogie
- Asynchronous motor drive (VVVF control)
- Regenerative brake

	Series 0	Series 100	Series 300	Series 700	Series N700 Series N700A
					
Trainset Weight	972 tonnes	925 tonnes	711 tonnes	708 tonnes	715 tonnes
Max. Axle Load	16 tonnes	14.5 tonnes	11.4 tonnes	11.3 tonnes	11.2 tonnes
Operating Speed	210km/h (131mph)	220km/h (137mph)	270 km/h (168mph)	285km/h (178mph)	300km/h* (187mph)

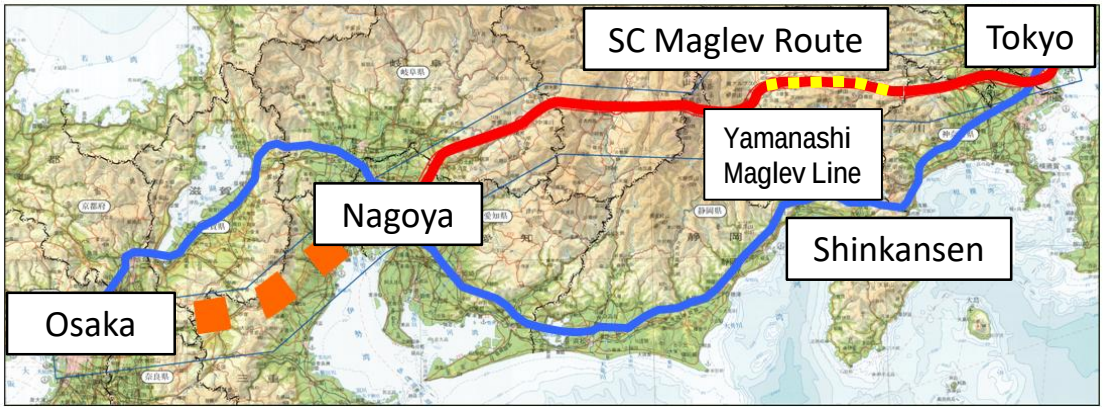
* Sanyo section

Overview of the SC Maglev Project in Japan

	Distance	Journey time	Expected Launch
Tokyo-Nagoya	178mi (286km)	40 min.	2027
Tokyo-Osaka	273mi (438km)	67 min.	2045 (may be expedited by using loan)

History of the SC Maglev Technology

1962		Research of SC Maglev train started
1977		Miyazaki Test Track Completed
1987	Apr	JR-Central was incorporated
1997	Mar	Yamanashi Maglev Line Completed (18.4km=11.4miles)
	Apr	Running tests started
	Nov	Running speed of 500km/h(311mph) was achieved
2013	Aug	Yamanashi Maglev Line was extended and upgraded (42.8km=26.6miles)
2015	Apr	Current World speed record of 603km/h(375mph) was achieved



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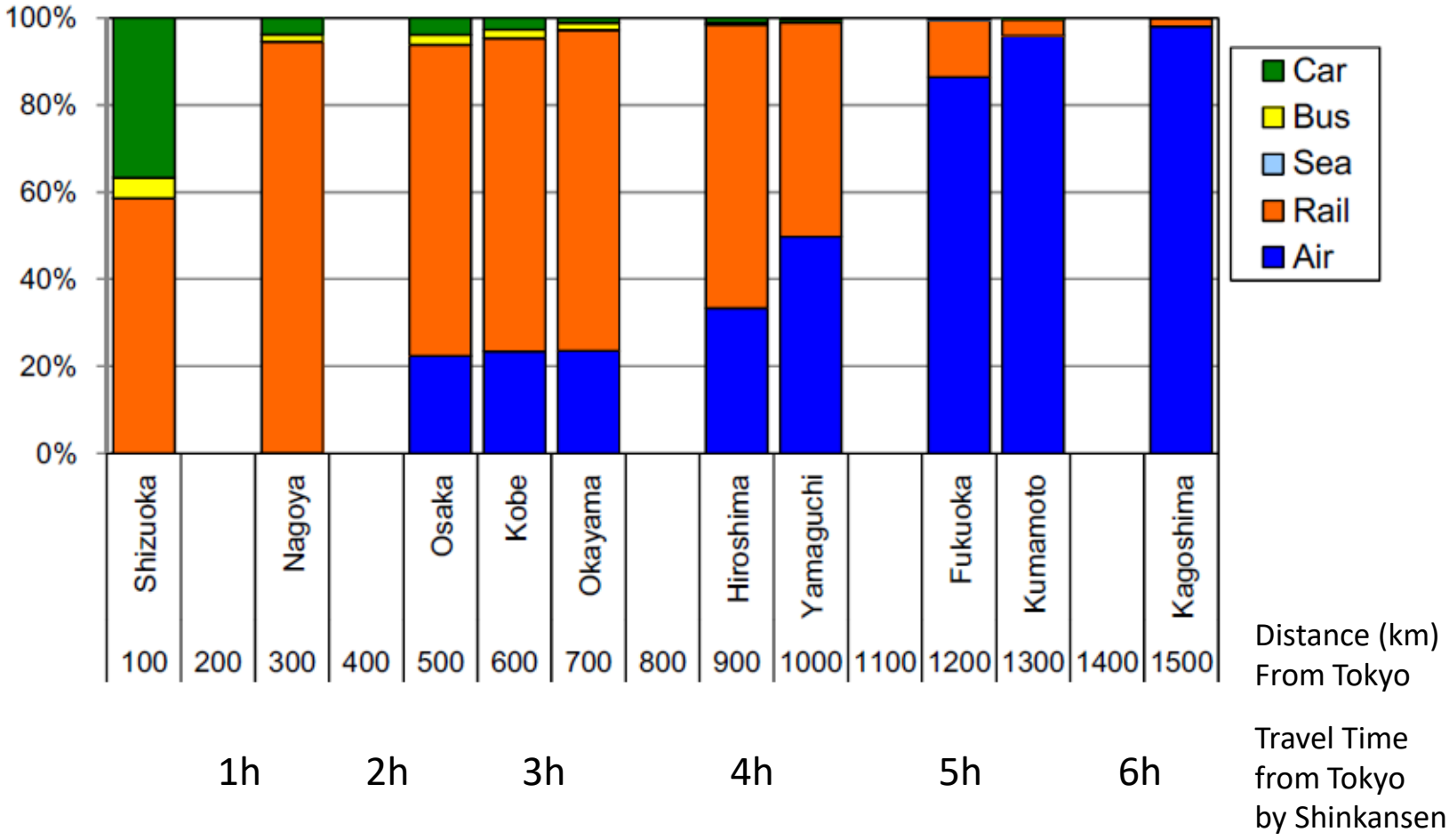
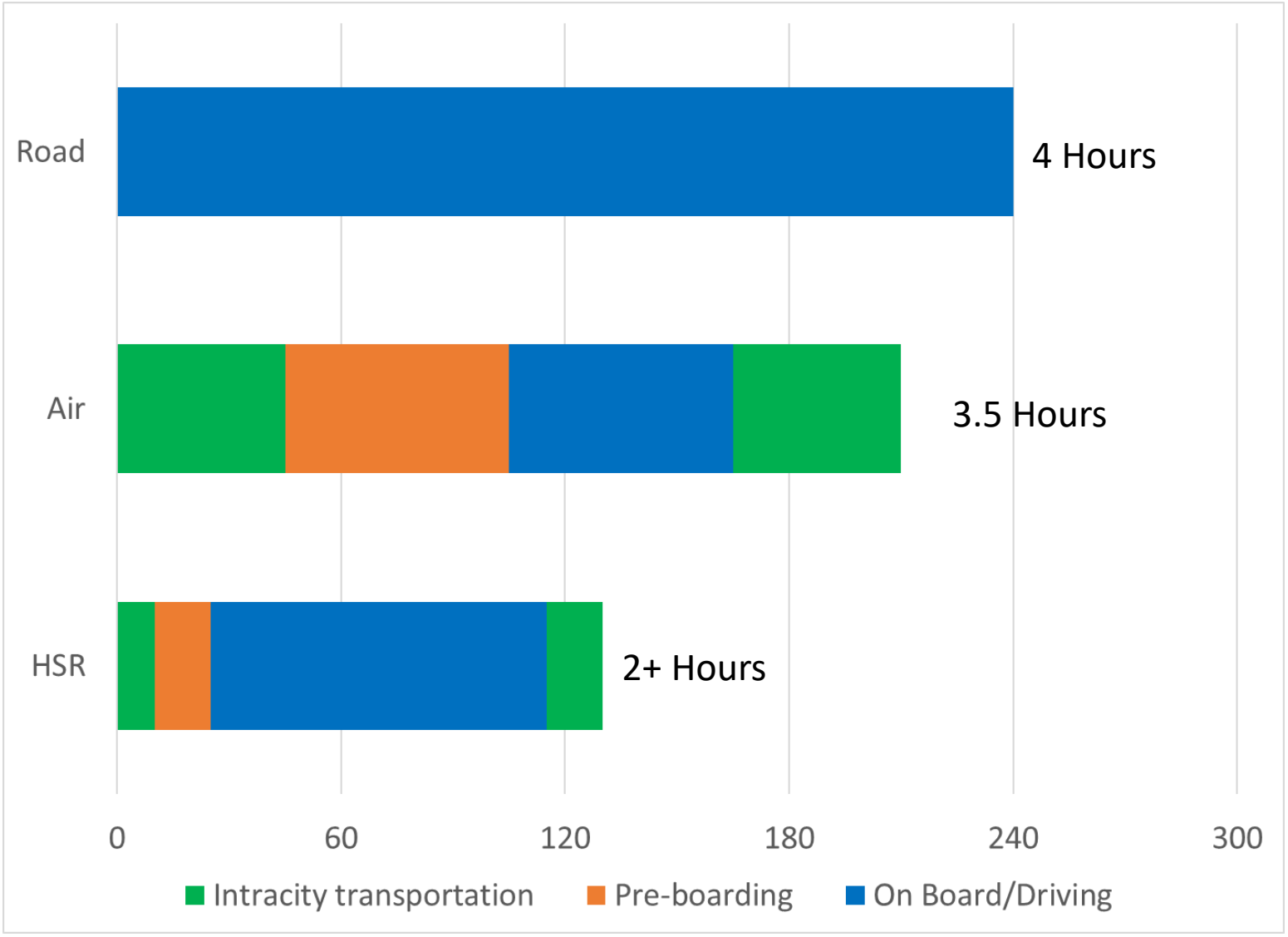
HSR Market Share in Japan

Transportation modes used for travels from/to Tokyo metropolitan area along Tokaido/Sanyo Shinkansen route



Source: 2010 Inter-Regional Travel Survey in Japan, MLIT

Selecting Markets – Dallas to Houston



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US Contribution to the World Railroad

Buffers and Chain Coupler

Photo: Ludek /Wikipedia

Photo: Deutsche Fotothec /Wikipedia

Automatic Coupler

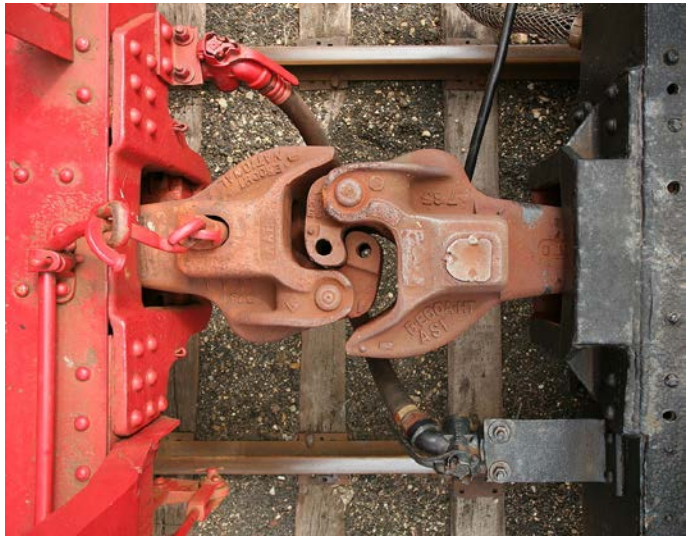


Photo: Daniel Schwen/Wikipedia

Photo: François Melchior/Wikipedia

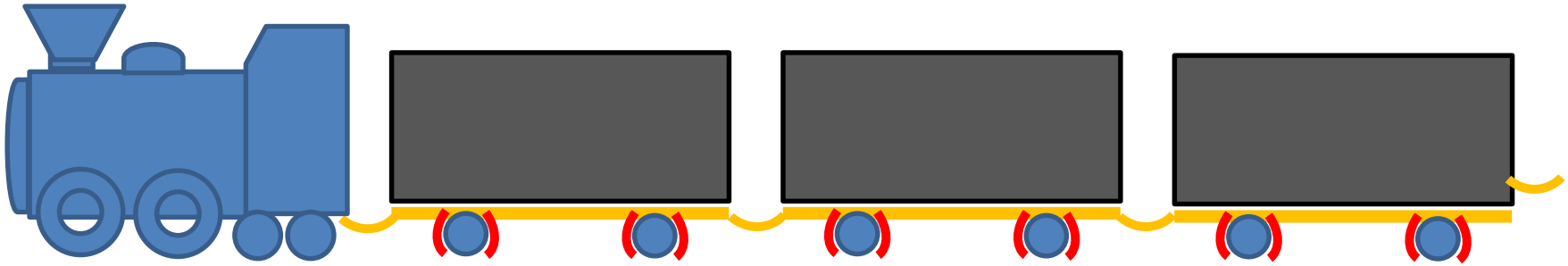
1873 Eli H. Janney received a patent.

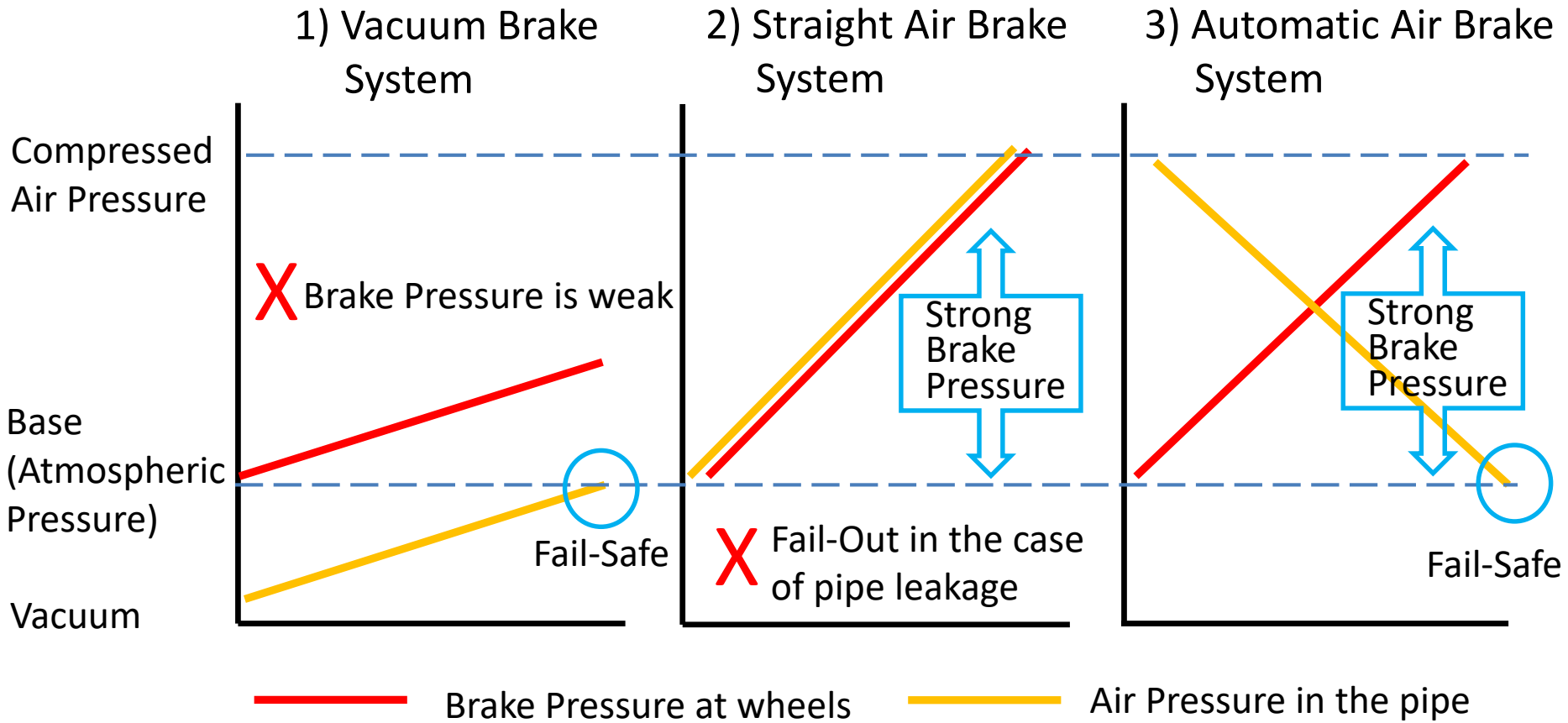
1893 In the US, Railroad Safety Appliance Act passed.

1925 In Japan, all the couplers were changed in one day. In Honshu, it was on July 17, when couplers of passenger cars were replaced after the train arrived at its final destination. Freight services were cancelled all day on July 17 for this exchange.

Westinghouse Air Brake

Compressed air/Vacuum generated in the engine is transmitted to cars through the air pipe.





Westinghouse Air Brake

1872 George Westinghouse invented the automatic air brake.

1893 In the US, Railroad Safety Appliance Act passed.

Continuous brake is required under this act.

1919 The Japanese government decided to use the automatic air brake in the national network. The preparation started in 1921 and it was 1930 when the system installation covered all the freight trains.

Japanese Contribution to the World Railroad

Shinkansen – Dedicated System for High-Speed Train

In the early 1960s, it became obvious that the Tokyo-Osaka railroad corridor required enhancement to get more capacity.

To achieve the enhancement, many options were discussed. Those included:

- Adding 2 more tracks along the existing narrow-gauged 2-track line making it 4-track;
- Building a new narrow-gauged line bypassing the most heavily-used section of the route;
- Building a new narrow-gauged line on the entire route;
- Building a new standard-gauged line.

Shinkansen – Dedicated System for High-Speed Train

Many options tried to use the existing conventional line network. Those had advantages in the viewpoints of:

- cost; and
- interoperability.

However, decision was made to build new standard-gauged tracks, a route exclusively for high speed trains, i.e. independent from the existing national network.

The benefit of the high-speed, high-volume operation was considered to be far surpassing the limited, temporary effect that would have been derived from patching the narrow-gauged network.

Shinkansen – Dedicated System for High-Speed Train

In 1872, British people brought a narrow-gauged railroad to Japan. Since then, Japanese railroad had been struggling with low-capacity and technological inferiority of the system.

Paradoxically, the inferiority of the system worked positively in the decision of building the “True High-Speed Railroad”. The options were discontinuous and polarized – pay more and get more by building a true high-speed rail, or pay less and get less by continuing to use the small-capacity network. The discussion point was simple.

Question

Q: What is the common challenge in the following railroad technology breakthroughs?

- Automatic Coupler
- Automatic Air Brake
- Dedicated High Speed Rail Line

Question

Q: What is the common challenge in the following railroad technology breakthroughs?

- Automatic Coupler
- Automatic Air Brake
- Dedicated High Speed Rail Line

A: They have little compatibility with the technology of the previous generation.

With a clear vision of what to achieve, the hurdle was cleared.

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Strategy for the US HSR

Strategy must focus on:

- Selecting the market (cities to be linked)

  HSR is not an almighty transportation tool, especially in such a large country as the United States. Use that tool where it performs best.

- Having a clear vision of the target to achieve

  Analyze the market and choose the best technology to achieve the goal.

Case Study - Korea and Taiwan

Korea

- HSR opened in 2004.
- Core System : French Technology
- Interoperable with standard-gauged conventional lines.
  - HS trains are sharing tracks to get into Seoul citycenter
  - HS trains used to share tracks to get into the citycenters of Daejeon and Daegu, until the HSR lines were completed.

Case Study - Korea and Taiwan

Taiwan

- HSR opened in 2007.
- Core System: Japanese Technology
- Dedicated HSR Line – not interoperable with the narrow-gauged conventional lines.
- Except the terminals (Taipei and Kaohsiung), the stations are located a little outside the citycenters. (5-30 minutes by public transport)

Case Study - Korea and Taiwan

Getting into the citycenters has great value only when the city can provide convenient transport system within the city.

Seoul, Daejeon, Daegu, Busan, Taipei, Kaohsiung have it.
(All cities have a metro system.)
So do many European cities.

Interoperability is a strong tool in those cases, because it may facilitate the access to a citycenter.

However, if the last-mile transport relies on cars, airport-style location selection also works – like Texas case.