THE GROWTH OF HSR NETWORKS AROUND THE WORLD

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Abstract

High Speed Rail (HSR) networks have been around for half a century and continue to grow. From the birthplace of HSR in Japan, to the largest network in China, expansion continues at a rapid rate in many countries. This paper is a comparative study of those networks as well as some in Europe to the proposed network in the United States. It is important that each line from one station to another is deeply considered prior to its construction and addition to the network. The paper first takes a look at the length of the networks currently operating around the world, and then a few of those networks are analyzed more closely. Lastly, the future length of the same networks is shown. Although no two networks can be compared exactly due to the geographic layout and size of each country, there is a pattern, however, that has developed in the shape of the network. There is the flow network, which takes the shape of a river connecting one region to the next, and there is the web network, which takes the shape of a spider web starting in one location and branching out in all directions. Based on the geographic shape and distance between population centers, there are several key regions in the United States in which HSR may be successful. Careful considerations must be taken if the national network is to have such success.

Keywords *- HSR networks, network length, flow network, web network*

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1. INTRODUCTION

High-Speed Rail (HSR) Networks have proven to be successful in several countries around the world. The main reason for their construction was to increase the transport capacity within a given region (Givoni & Banister, 2012). As cities became highly populated, conventional rail and other modes of transportation became stressed and unable to handle the traffic flow. A new system needed to be created and HSR was the answer. On October, 1st 1964 the first HSR line from Tokyo to Kyoto began operation in Japan (Cohen & Kamga, 2013). Today, networks span from city to city, across countries in Europe, Asia and North America. This paper is a comparative study of the proposed HSR network in the United States and those established overseas.

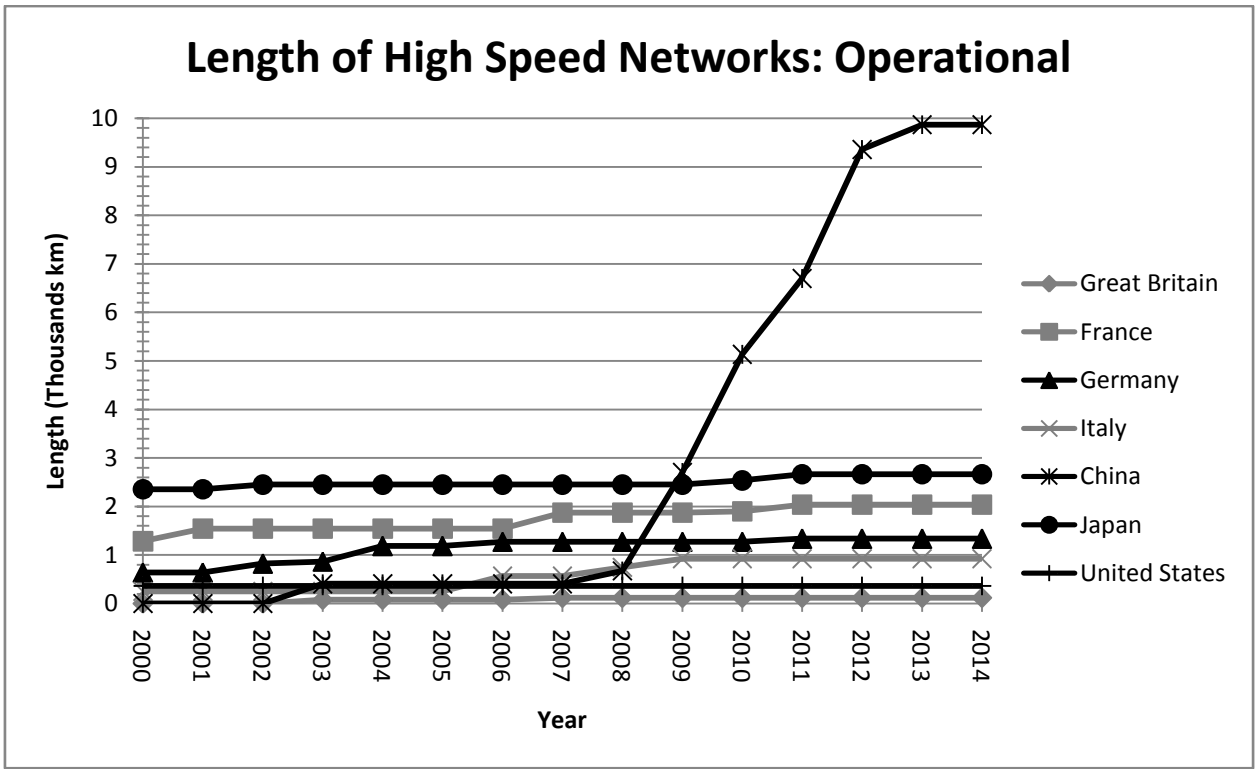
The networks overseas have taken two basic shapes when transporting passengers from city to city, based on the geography of the given region. The flow network follows a direct line from one station to the next in a river like pattern, while the web network has a centrally located city which is highly influential to the economic wealth of a region, and then branches out in all directions to other cities like a spider web. However, these networks are far from complete. As new infrastructure is built, new riders are granted access to the network (Bonnafous, 1987), and positive results, are justification for the consideration of expansion. Therefore the network length in several countries will be analyzed so that a comparison between the networks overseas and the United States can be made.

2. THE NETWORK LENGTH

There are many reasons for constructing a network. The first networks were constructed due to overcrowding on the preexisting transportation modes. Today, networks are created and expanded for other reasons as well. The largest benefit of HSR is the reduction of travel time, which grants passengers higher accessibility in given regions (Garmendia, Ribalaygua, & Ureña, 2012). Therefore, where a reduction in travel time is beneficial, an HSR network may have great success. HSR also often connects declining places to thriving places, greatly expanding economic opportunities, and creating a much larger area of interconnected regions (Florida, 2010). As the network reaches a new city, opportunities will also arise in nearby locations that have access to the network through proximity (Vickerman, 1997). Each case for HSR presents an opportunity for expansion, today, and in the future.

2.1 Expansion of HSR Networks

The expansion of HSR networks in seven countries since the year 2000 is shown in Figure 1. The data was extracted for the purpose of this article, in which high speed lines are considered to travel at or above 250 km/h.



*Note: The values are for the entire length of the network in operation. Where the graph has a zero slope no new lines began operation that year.

Figure 1: Length of Operational High Speed Networks (UIC, 2013)

France's first high speed line was opened in the early 1980's, and by the year 2000 they already had a 1,281 km network. Today they have a network of over 2,000 km, due to great success with the TGV which operates on routes such as Paris-Lyon, possibly the most ideal high speed route (Vickerman, 1997). This is because the capital city of Paris is dominant in French society and economy (Bonnafous, 1987). The geography in France is such that the web network is highly desirable. Paris is the economic hub in France and centrally located compared to the rest of the cities. The network branches out to all of the smaller cities in such a way that they gain economic wealth by being connected to Paris. They are still connecting new cities via new routes to the network. Sometime after 2020, many of these lines will be completed and their network will be above 5,000 km (UIC, 2013). Image 1 shows the French HSR web network.

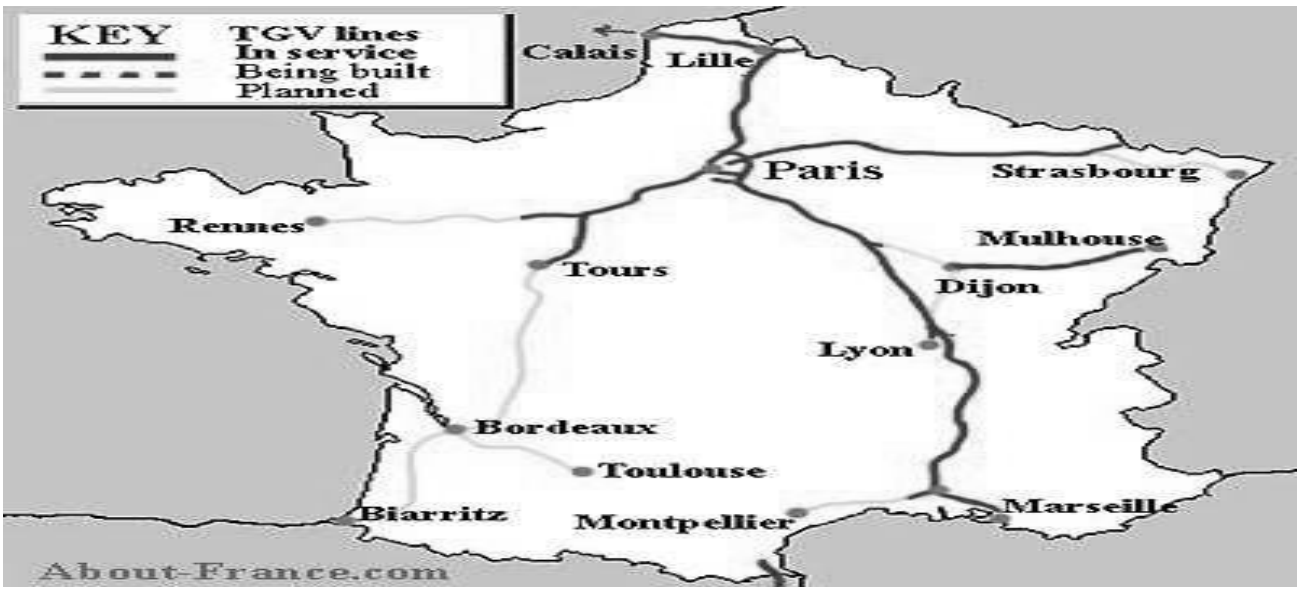


Image 1: French National HSR Network ("Train and rail travel in France - About-France.com," 2014)

China opened its first high speed line in 2003, spanning 405 km and connecting Qinhuangdao to Shenyang. Today they have the largest network with 9,867 km of HSR. This is the largest network of all seven countries considered in this study. HSR services are most attractive in densely populated/employed cities which would have a high demand route (Hang, 2011). Since China is a large country with dense population centers that are a great distance from one another, their routes are perfect for HSR. The web network appears again in the shape of China's network, which has the appearance of a spider web built in a corner. The reason for the difference is due to the geographical location of major cities in China. With such demand for high speed routes, China is working on expanding their network to 16,000 km by the year 2020 (Hong, Dong, & Song, 2012). They are currently planning routes that will give them a network length of 22,726 km, however a date of completion is unknown at this time (UIC, 2013). Image 2 shows the Chinese web network.

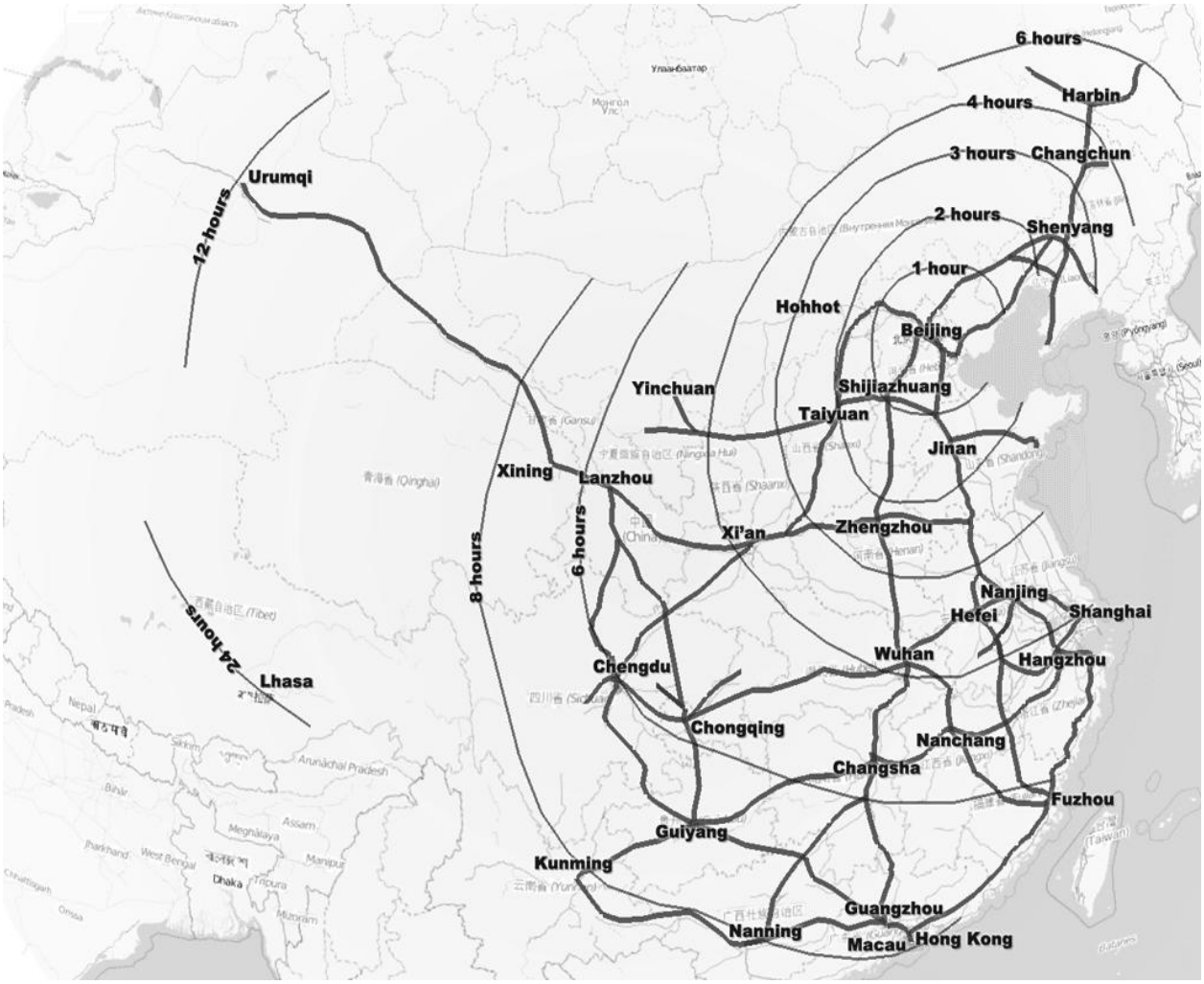


Image 2: Chinese National HSR Network ("High-speed rail in China," 2014)

Japan had the first high speed line in the world. In 1964 Japan revolutionized public transportation with the opening of the first Shinkansen bullet train connecting Tokyo to Osaka a distance of 515 km. By the year 2000, they still led the world with had 2,353 km of HSR. Today they have 2,664 km making them second only to China. The creation of their HSR network eased the tension off other transportation modes which were over capacitated at the time. The geography in Japan is such that the flow network is highly desirable. Since stops equate to a slower travel time, most services are non-stop. This means that no matter where on the 'river' a passenger gets on the network, and whether they wish to go up or down the river, they can get to their destination on a direct line. This is highly beneficial when one looks at the geographic shape of Japan, a long and narrow country. Although they were the first to construct an HSR network, they have not yet completed it as they continue to expand to new cities. They have lines under construction set to be completed in the next few years, and more to be completed by 2035. A few lines are also currently being planned, which do not yet have a completion date, will give Japan 3,622 km of HSR (UIC, 2013). Image 3 shows the Japanese flow network.

Image 3: Japanese National HSR Network ("Shinkansen - High-speed Railway," 2014)

The United States is a different story. At some point Amtrak increased the speeds at which their trains operate in the US. Today there are currently 362 km of track at which trains may travel 250 km/h. The US is currently planning out their HSR network and have plans for 1,139 km of HSR sometime in the future (UIC, 2013). The Federal Railroad Administration plans to use HSR construction to stimulate economic development, and has long-term plans to develop a national rail network by connecting population centers that are 160-960 km apart (Lane, 2012). The United States is in an extremely beneficial position, since little remains of its rail network today compared to its peak in the 20th century. Therefore upgrading existing track is not possible in many cases (Lane, 2012). This gives them the opportunity to lay new dedicated tracks creating an exclusive HSR network connecting cities together, increasing accessibility and creating a new economic region. Secondary transport networks also need to be built up along with HSR in order to connect it to sub-regional spaces creating a successful intermodal transport system (Garmendia et al., 2012). Intermodality is the use of multiple transport modes in a passenger's door-to-door journey. Image 4 shows the planned HSR network by the United States High Speed Rail Association in the US.

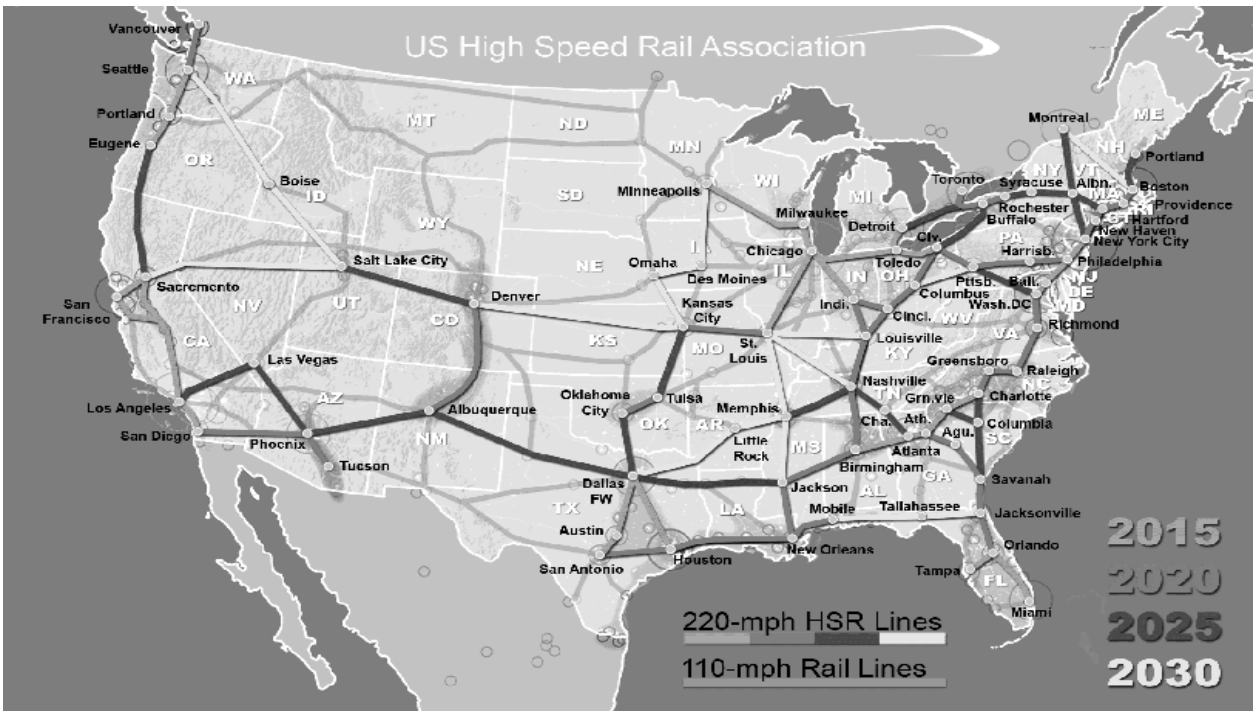
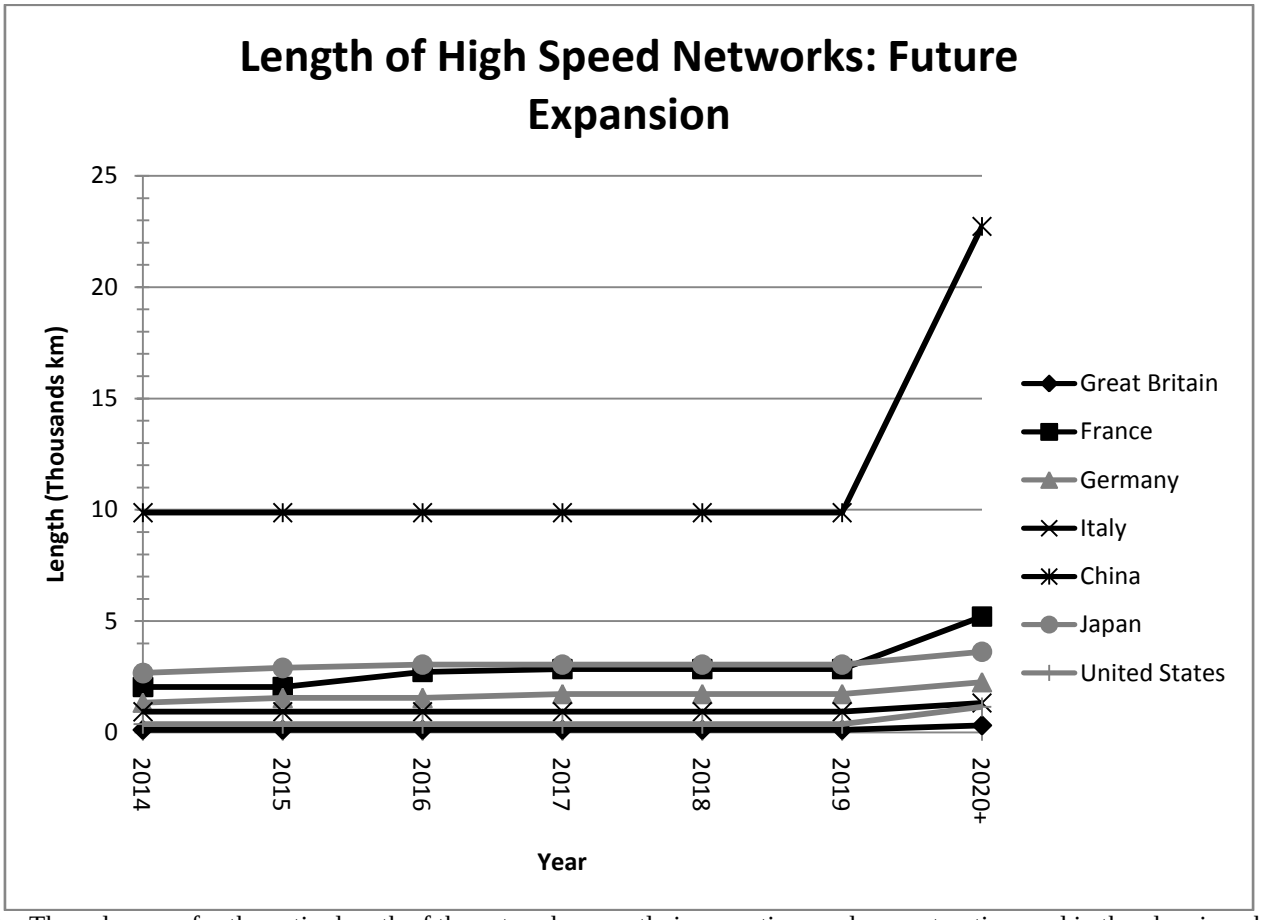


Image 4: United States National HSR Network ("High Speed Rail Around the World," 2013)

The United States is much larger than all of the previous countries analyzed. There are six major corridors in which HSR would have great success. These corridors are Los Angeles to San Francisco, Seattle to Portland, Chicago to St. Louis, Chicago to Detroit, Washington, DC to New York City to Boston, and Charlotte to Washington, DC (Garmendia et al., 2012). If you break the planned national rail system into regions, the west coast appears to be a desirable location for a flow network, while the northeast is a desirable location for a web network. The difference is the geography of the areas and the location of major population centers in relation to one another. Once all the individual regions have been connected together, decisions can be made as to how to connect them to create a national rail system.

The future expansion of HSR networks in the same seven countries until 2020 and beyond is shown in Figure 2.



*Note: The values are for the entire length of the network currently in operation, under construction, and in the planning phase. Where the graph has a zero slope no new lines began operation that year.

Figure 2: Length of High Speed Networks in the Future (UIC, 2013)

3. CONCLUSIONS

In this paper, the HSR networks in Europe, Asia, and North America were compared. The length of the networks in seven countries was shown, and four of those countries were analyzed more closely. The four countries were France, China, Japan, and the United States. It was shown that France's centrally located city of Paris makes it a highly successful web network. The network branches out from Paris in all directions allowing the other cities to be connected and share in the economic wealth. China also has a web network. However, it does not have a single centrally located city, but rather several influential cities, and the majority of the network sits in the southeast corner of the country. Japan is a long and narrow country which gives its flow network great success. With the option of traveling from one's current location to anywhere on the network via a direct service, passengers are granted greater accessibility and the desired reduction in travel time that HSR offers. The United States is far behind when it comes to HSR, but they are in a beneficial position of being able to establish a dedicated network, and build up the secondary transport around HSR.

No two countries' network lengths can be directly compared to one another, as not all countries are the same. Rather, the network length should be compared based on a factor of the size of the country, and the distance between population centers. Although Japan's network is much shorter than that of China's, it will never be larger than China's due to the

simple fact that its size does not require as large a network. China is much larger and has a greater distance between population centers, which gives cause for China to have such a large network. On the other Hand, the United States is larger than all of Europe combined, and yet its HSR network has not reached the same level of success. China only opened its first line in 2003, and continues to rapidly expand its network. This means that there is still a chance for the United States to establish a successful HSR network, but in order to do so, careful considerations need to be taken.

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