On the rails worldwide
High-speed projects from Siemens – from the Velaro to the turnkey project

As a technological innovator, Siemens has played a significant role in the worldwide development of high-speed rail transport. With a top speed of up to 350 km per hour, the Velaro is the fastest series-produced train in the world. Based on a flexible platform design, the Velaro trains can be adapted for operation in different rail networks as well as for specific customer requirements.

The low environmental impact of the Velaro platform is demonstrated by its low energy consumption equivalent to only 0.33 liters of gasoline per seat per 100 kilometers for a car – just enough to fill a can of coke. The enhanced aerodynamics play a large role in reducing energy consumption, as the aerodynamic behavior of the train has been successively improved by means of panels fitted on roof-mounted devices as well as on bogies and intercar gangways. Moreover, the electric brake system enables braking energy to be fed back directly into the power supply system, thus saving energy and costs.

Distributed force – Motorized train technology
The Velaro already has a technological design lead of ten years over other trains. The leap from concentrated push-and-pull technology to distributed traction was taken by Siemens as early as the end of the 1990s. Generally speaking, there are two different ways of moving passengers by rail: the push-and-pull method (PP) using a locomotive, and motorized train technology. As regards its technology, the Velaro is based on further developments of the successful ICE 3 motorized train concept.
As with the ICE 3, the traction components and the technical modules (for example, the traction motors, brakes and transformers) are mounted under the floor along the entire length of the train and not in two locomotives at the front and end of the train, as is the case with conventional trains. This results in around 20 per cent more space for passengers for the same length of train. Half of the axles are driven directly so that the train can accelerate faster due to better distribution of traction and can also travel on steeper sections of track. The uniform distribution of weight also reduces the force of weight acting on the individual wheelsets. This leads to less wear and tear on the rails and on the wheels of the train as well.

**Trendsetter in Spain: Velaro E**

Siemens received its first order for the Velaro from Spain in 2001. The Spanish state railway authority, Renfe, placed an order worth 705 million euros for 16 Velaro E high-speed trains, including maintenance of the trains for a period of 14 years. In March 2004, Renfe ordered another ten high-speed trains from Siemens. Known in Spain as the "AVE S 103", the Velaro can operate at speeds of up to 350 km/h and is therefore the fastest series-produced train in the world. During a test run in September 2006, the Velaro even set a new world speed record of 404 km/h for series-produced trains. There is enough space for a total of 404 passengers in the eight-unit, 200 meter-long train, which is divided into in three classes: Club, Preferente and Turista.
Since February 2008, the AVE S 103 has been running on the new 621 kilometer line between Madrid and Barcelona, completing the journey in just 2 hours and 38 minutes, cutting the journey time by over 2½ hours compared to conventional trains.

**The Chinese version: the Velaro CN**
In November 2005, the Chinese Ministry of Railways (MOR) ordered 60 high-speed trains that are now in service in China under the name Velaro CRH3. Siemens built the trains in conjunction with its Chinese partner, Tangshan Locomotive & Rolling Stock Works. The Siemens share of the overall order amounted to 669 million euros. Capable of running at 300 kilometers an hour, the trains are deployed on the Peking-Tianjin line. The first five trains started passenger services in August 2008, just in time for the Olympic Games in Peking. Since then, they have been connecting the two cities in only one hour.

Like its predecessors, the ICE 3 and the Velaro E, the Velaro CN is a purely motorized train, where the traction system and the technical equipment are arranged under the floor along the entire length of the train. Compared to the European version, the car body of the CRH3 for China is 3,265 mm wide instead of the 2,950 mm usual in Europe. There is enough space for more than 600 passengers over a total length of 200 meters.

Additional high-speed routes are currently being planned such as those from Peking to Shanghai and from Guangzhou to Wuhan. Together with Chinese partners, Siemens will supply components for another 100 trains for the 1,318 km-long route between Peking and Shanghai and they are scheduled to start operating at the end of 2010. The trains, which can run at speeds up to 350 km/h, will only need four hours for this route. One special feature is the length of the train; 16 cars with an overall train length of 400 meters will have space for 1,060 passengers, making it the world's longest single train operating on a high-speed line. The Siemens scope of supply and services includes the key components such as the electrical equipment and the bogies. The order was received in March 2009.

"Sapsan": The Russian peregrine falcon
The newest member of the family is the Velaro RUS. The Russian version of the Velaro will start running between Moscow and St. Petersbourg at the end of 2009. With a maximum operating speed of 250 kilometers an hour, which can be upgraded to 300 km/h, the travel time on the route will be reduced by 45 minutes. Later, the Velaro trains are also to run between Moscow and Nishni Novgorod. For the Russian
State Railways (RZD), Siemens will supply eight ten-unit Velaro RUS trains by 2010 and will service the trains for a period of 30 years. The value of the order, including the servicing contract, amounts to 600 million euros. The Russian railway operator, RZD, has given the name "Sapsan", Russian for "peregrine falcon", to the new fleet of trains.

The falcon has ten cars with space for more than 600 passengers and has been specially adapted to the technical and climatic conditions in Russia. All elements of the train such as the technical equipment, the insulation and the lubricants have been chosen for their ability to cope with the extreme climatic conditions in Russia. The Sapsan can therefore operate at outdoor temperatures as low as -50° Celsius. In order to protect the traction components from ice formation and snow drifts and, at the same time, provide adequate cooling, the cooling air during winter is conducted through special air ducts that lead from the roof into the almost hermetically sealed floor pans. The bogie material has also been enhanced and its strength at extremely low temperatures had to be verified.

With their widened bogies, the trains are designed for the Russian broad gauge and are around 33 cm wider than the ICE 3. Unlike the other Velaros, the Velaro RUS has ten instead of eight cars and is therefore 50 meters longer than the "Velaro E" of the Spanish railways. This is made possible by the longer station platforms in Russia.

Some vehicles for the Velaro RUS fleet are being supplied as dual-system trains and can be used in both direct-current and alternating-current railway networks.

**Velaro D for Germany and Europe**

As recently as December 2008, the German Railways (Deutsche Bahn AG) ordered 15 Velaro high-speed trains from Siemens, with a total order volume of around 500 million euros. The multi-system trains will be used by Deutsche Bahn as a continuation of the ICE 3 trains. It is the fourth and latest version and has been developed on the basis of the Velaro platform.

In future, the eight-unit ICE 3 trains are to be used for cross-border transportation between Germany, Belgium, the Netherlands and France on the new LGV Rhin-Rhone high-speed route, as well as in Switzerland. Flexible use of the trains in the German system is also possible as the Velaro D can be coupled to the ICE 3. The first vehicles are to start operating at the start of the winter timetable in December 2011 and all 15 high-speed trains are to be delivered by 2010.
The trains can travel at speeds up to 320 km/h and have an output of 8,000 kilowatts, corresponding to approximately 11,000 hp. With up to 485 seats, the 200 meter-long train has more seats than the conventional ICE 3 but offers the same level of comfort.

**Competence in electrification and railway automation: turnkey project in the Netherlands**

A comprehensive railway network and an efficient infrastructure are essential for a competitive high-speed transportation system. Siemens is one of the leading vendors of railway automation and electrification of high-speed routes. One of the best-known projects is the first high-speed line in the Netherlands, or "HSL Zuid" ("Hogesnelheidslijn-Zuid" – high-speed line South), which is one of the most important railway infrastructure projects in the Netherlands. The 98-kilometer long high-speed route runs from Amsterdam to the Belgian border via Rotterdam, thus linking the Netherlands to the European high-speed network via Brussels and Paris. The two-track route was approved for passenger transportation on September 7, 2009 and halves travel time from Amsterdam to Rotterdam to 43 minutes. From December 2009, the high-speed trains from Amsterdam to Paris will run on the new route and travel time will then be shortened from 4:09 hours to 3:18 hours.

The equipment for the turnkey project was supplied by the Infraspeed consortium, which was formed by Siemens together with its partners BAM N.V. (track construction) and Fluor Infrastructure B.V. (project management). During the five-year construction phase, Siemens was responsible for the design and turnkey erection of the complete E&M equipment (power supply and overhead line, signal technology (ETCS), communications equipment, safety technology and installation systems including tunnel equipment). The Siemens share of the order for the Infraspeed consortium amounted to around 400 million euros. In addition to supply, Siemens is involved as part of a maintenance company in servicing the route for over 25 years with a total share of a further 130 million euros.

Construction was financed by a PPP (public private partnership) model. The HSL Zuid contract is the largest PPP project for construction of a high-speed line in Europe and the most extensive PPP contract the Dutch government has ever participated in.