The Seoul-Busan high speed line cuts across the length of Korea. Seventy per cent of the population and production centres concentrate along this line, a figure which is on the increase: 1.7 times for passenger traffic and 3.8 times for freight between 1995 and 2011. Moreover, KTX (Korea Train eXpress) also serves the regions to the South-West of the peninsula, since KTX trains run on the conventional line between Daejon and Mokpo.

When it selected the TGV back in 1994, Korea became the first country in the Far East to use the French technology in regard to high speed rail. However, in order to guarantee the successful completion of a project of this scope, the organizing Authority (KHRC - Korea High Speed Rail Corporation Authority) entrusted its construction to a consortium (KTGVC) pooling French contractors with comprehensive experience of TGV construction, and Korean partners from the rail sector. The contract included the supply of 46 trainsets, catenaries, signalling and project management services among which interface management, system integration, technological transfer, assistance to operation and maintenance.

Work sharing and technology transfer were key factors in the selection of the system. As a result, Korea is now capable of creating its own high speed system and ranks among the leading players on the international railway stage. Twelve trainsets were built in France and served as a reference for the next 34 trainsets which were produced in Korea.

As a consequence of the 1997 financial crisis which swept through the Asian countries, the decision was made to split the construction of the project into two stages:

- Phase 1: operation of KTX trainsets between Seoul and Busan on a high speed track between Seoul and Daegu, excepting a number of sections through urban areas (Seoul, Daejon, Daegu). This stage includes the modernisation of certain sections of the KNR/KORAIL (Korean National Railways) line on which the KTX runs. The works include electrification, a new signalling system and a number of civil engineering worksites. Between the two terminals, the travelling time is 2.40 hours.

- Phase 2: construction of a standard high speed track on the sections through the urban areas in Daejon and Daegu, redevelopment of the whole of the section between...
Daegu and Busan, thereby cutting the travelling time between Seoul and Busan down to 1.56 hour. The new line is the largest civil infrastructure project ever built in the country. The changes in the political environment of the country could lead to other projects, among which a possible extension to North Korea, should the reunification happen.

Infrastructure
The project is most noticeable for its structures, due to the difficult and mountainous topography. Along the 410 km of the line between Seoul and Busan, there are no less than 75 tunnels, totalling 190 km in length and over 70 bridges and viaducts over 120 km in all.

Standard construction structures and methods were selected to optimise construction processes. In regard to viaducts, standard structures consist of two to three continuous 25 m spans or two continuous 40 m spans. This means that the possible length of the bridge deck is less than 80 m, doing away, in most cases, with the need to use rail expansion joints. The innovative Precast Span Method (PSM) for the construction of several viaduct decks along the line involves prefabricating, transporting and laying 25 m long and 600 tonne concrete box beams. These are prefabricated in a temporary unit near one of the ends of the bridge, carried by machinery especially designed for that purpose to the spot where they are to be installed. They are then lifted and sited using a guide structure.

Stations
Between Seoul and Busan terminals, five intermediary stations are sited in Gwangmyeong, Chonan, Daejon, Daegu and Gyeongju. Those in Seoul, Chonan and Gwangmyeong were especially built for the new line. On the Western section, the towns of Jeonju, Gwangju and Mokpo are also served from Seoul and Daejon. As a consequence, all the main economic and cultural centres in the Korean peninsula are interconnected by the high speed line.

Superstructure
The decision was made to build a ballasted track with concrete sleepers first on the 57 km long double test track, and later, on the whole line, with the exception of tunnels over 5 km long, where a track on slab of the Rheda 2000 type was used. Rails are of the UIC 60 type.

Rolling stock and system
Initially, three railway manufacturers were in competition to supply the rolling stock: Siemens (ICE), Mitsubishi (Shinkansen) and Alstom (TGV). Eventually, the French TGV technology was selected in 1994. Commercial speed is 300 km/h; the line layout and fixed equipment are nevertheless designed to cope with a maximum commercial speed of 350 km/h in future. The 46 KTX trainsets each consist of 2 power cars, 2 motorized end trailers enclosing 16 centre trailers. A complete trainset is 388 metre long, with an unladen weight of 701 tonnes; it has a capacity of 935 passengers, 127 in 1st class and 808 in 2nd class. KTX trainsets are single current: 25 kV - 60 Hz. Maximum traction power is 13,200 kW via a propulsion chain consisting of 12 synchronous traction motors.

Speed check is performed by an Automatic Train Control system (ATC) using TVM 430, a track to train transmission system. This is already in operation on the TGV Nord in France, and provides a continuous check on the train running within the safety parameters allocated to them. The control office is installed in the new Gwangmyeong station.

Depots
During the construction stage, Osong depot (located 120 km from Seoul) served as the operational centre and base for the construction, track laying and catenary assembly.
SYSTRA has been involved in the KTX project since 1989 and throughout its performance. SYSTRA provided services in many fields, either directly for KHRC or as a subcontractor of frontline contractors, among which ALSTOM, the leader of the KTGVC Consortium:

- assistance to design and supervision of civil engineering construction;
- assistance to Permanent Way (PW) design (conceptual design specifications, testing);
- supervision of track laying;
- management of the tests on the pilot trainsets in France;
- assistance to technology transfer;
- audit of the testing & commissioning process.

Other services were provided in the context of the «Associated Services» contract signed with ALSTOM in February 1995:

- assistance to the French and Korean consortium for the preparation to operation and maintenance of the Core System (rolling stock, catenaries and signalling),
- production of the maintenance and driving documents;
- training of the maintenance personnel;
- definition and supply of a driving simulator;
- supervision of the maintenance departments in charge of the Core System prior to commissioning and during the warranty period.

Civil engineering contracts
SYSTRA became involved in the project back in 1994, after the main technical decisions had been made and the construction of the test track had started. Its involvement, which was minimal at first (definition of the design criteria, audit of the designer of the time, etc.), developed when SYSTRA helped KHRC solve a number of technical problems arising from design criteria specific to high speed, in regard to the infrastructure as a whole: bridges, tunnels, stations, etc.

In 1996, after works had come to a halt, KHRC requested SYSTRA to redo the design works, through to constructional design for all the viaducts in the project, i.e. circa 130 km. On that occasion, SYSTRA also developed new construction methods in Korea to help contractors and cut down the construction time for the project. In this respect, SYSTRA also re-designed a WP (8-2) with wide span mixed structures, including Moam 1 arch bridge, with a 124 m span, which was swung over a motorway without stopping traffic.
Owing to the highly favorable reception of SYSTRA’s design work for KHRC by all the construction contractors involved in the project, they then sub-contracted civil engineering design services to SYSTRA. SYSTRA also became involved in the supervision of civil engineering construction for three of the new line sections, i.e. over 30 km (21 viaducts, 4 tunnels) and in the construction of Goyang rolling stock depot.

Track laying supervision contracts
SYSTRA was involved in the supervision of track laying along the whole line: for the test track between Chonan and Taejon which was placed into operation in 1999, for the North section of the line between Gwangmyeong and Chonan (154 km), and finally for the South section from Daejon and Daegu. The services were sub-contracted from KHRC for the North section and from Saman, the contractor in charge of laying, for the South section.

Maintenance plan
SYSTRA defined the maintenance policy, cycles, scope and organisation of the maintenance operations and the resources needed.

Personnel training
SYSTRA organised and undertook the training of the various personnel categories (managers, trainers, team leaders, drivers and traffic control office operators) in France and in Korea, to use and maintain the installations. From 1996 to 2003, SYSTRA trained 174 students, organised 660 weeks of training courses and drew up 170 manuals.

The services were provided under a subcontract from ALSTOM.

Driving simulator
SYSTRA designed the TGV driving simulator for the future Korean drivers, from the production of the specifications to acceptance on site and the training course for the users. The simulator was built by CORYS, and was supplied in 1999.

Maintenance manuals
SYSTRA drew up the user and maintenance manuals for the system and associated tools and, among other aspects, produced 600 documents tailored to the specific characteristics of the elements supplied to Korea.

Centralised traffic control centre
During the period prior to commissioning, SYSTRA seconds 3 supervisors to assist the Client with the operation of the control centre, plus one supervisor specialising in driving.

Audit of the testing & commissioning process
The audit mainly focused on the documents supplied by KHRC and was followed by 3 missions on site to specifically attend several tests. The results of the audit were validated by a committee representing U.I.C. and D.B. The audit found no flaw in the procedure adopted for testing & commissioning.

Phase 2 (Daegu-Busan)
Since 2007, SYSTRA is providing assistance to the consortium for signalling design and works; SYSTRA, associated with a Korean company, is also supervising catenary design and installation.

The Project

Facts and Figures
- Length: 412 km
- Number of stations: 7 (Seoul, Gwangmyeong, Chonan, Daejon, Daegu, Gyeongju, Busan)
- Estimated ridership in 2011: 330,000 passengers/day
- Number of trainsets: 46 single current trains (25 kV-60 Hz), with a capacity of 935 seats per trainset (of which 127 in first class)

Organisations involved
- Owner: Korea High Speed Rail Construction Authority (KHRC)
- Core System Supplier: Korea TGV Consortium (KTC), consisting of 12 companies and led by EUKORAIL and ALSTOM Transport, consisting of one System Integration Group (led by ALSTOM) and 4 industrial groups.
- Operator: KNR/KORAIL (Korean National Railways)

Cost
- Estimated TOTAL (2002): 18.4 trillion Won (i.e. circa 14 billion US Dollars)
- phase 1: 9.8 billion USD / 12.73 trillion Won
- phase 2: 4.4 billion USD / 5.69 trillion Won

Finance Package
- State: 45 %: Subsidies: 35 % Loan: 10 %
- KHRC: 55 %: Bonds: 29 % Foreign borrowings: 24 % Private funding: 2 %

Milestones
- May 1989: decision to build a high speed line between Seoul and Busan
- August 1991: launch of the call for tenders with GE A Thalys (TGV), Mitsubishi (Shinkansen) and Siemens (ICE) as contenders
- January 24, 1992: beginning of the civil engineering works
- August 20, 1993: selection of the French TGV technology
- June 1994: signing of the contract for the Core System (rolling stock, signalling, catenaries)
- May 29, 1997: presentation of the first Korean TGV trainset
- 1998: project construction is split into two stages
- December 16, 1999: inauguration of the test track
- July 31, 2001: beginning of the works for the electrification on the 271 km long conventional track
- 2002: test on site of the first 12 trains
- April 1, 2004: placing of phase 1 into commercial operation
- 2010: placing of phase 2 into commercial operation