한국철도기술연구원
Korea Railroad Research Institute

High Speed Rail in Korea and Technology Initiative

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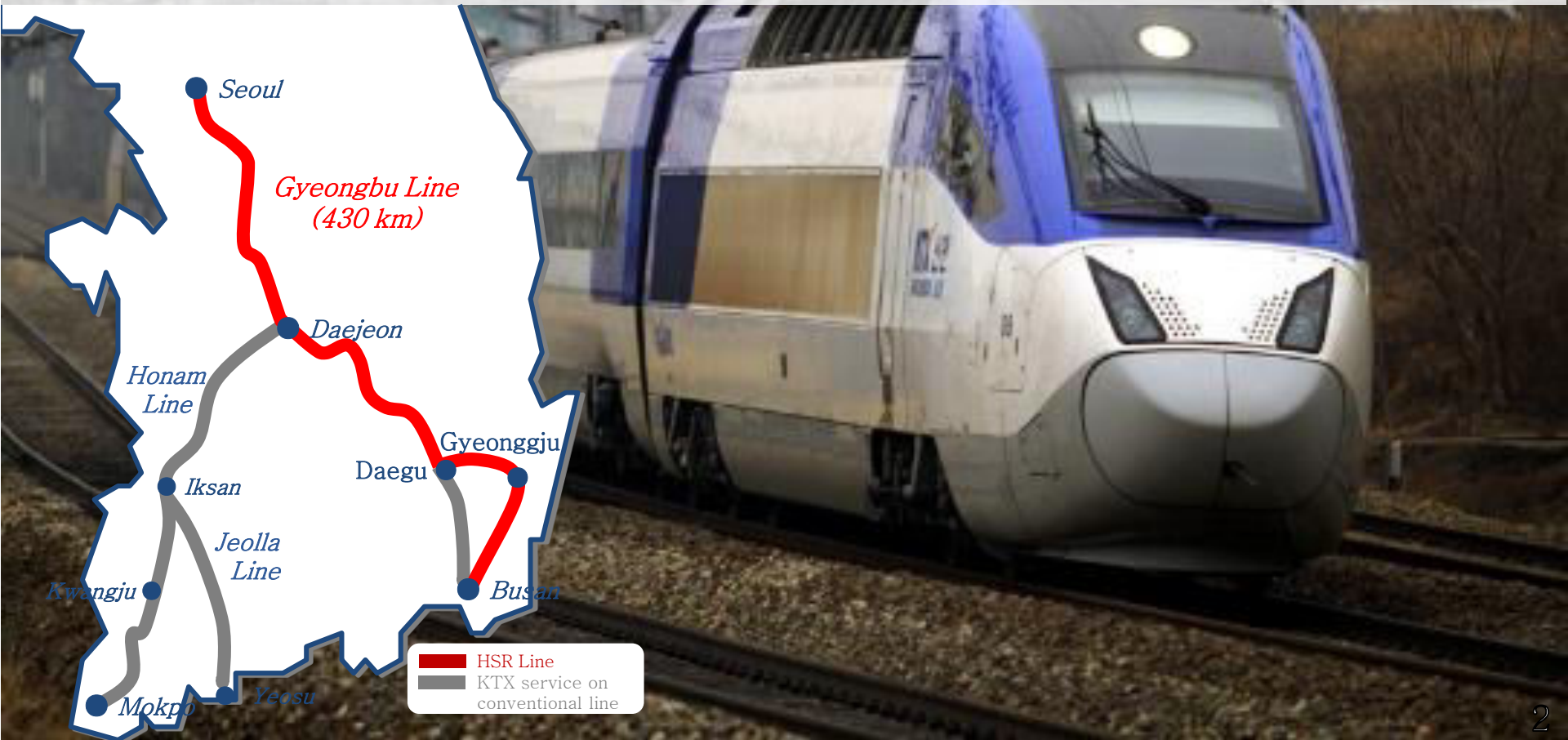
Overview of KTX Service

High-speed line service started in 2004.

Korea Train Express (KTX) started its **service in 2004**. The **new KTX trains** (called KTX-Sancheon) made by **Korea's own technology** are now in service from 2010. The **energy cost per seat** travelling 430km from Seoul to Busan is only **$1.00 USD**. In this aspect, **KTX is a green public transport mode.**

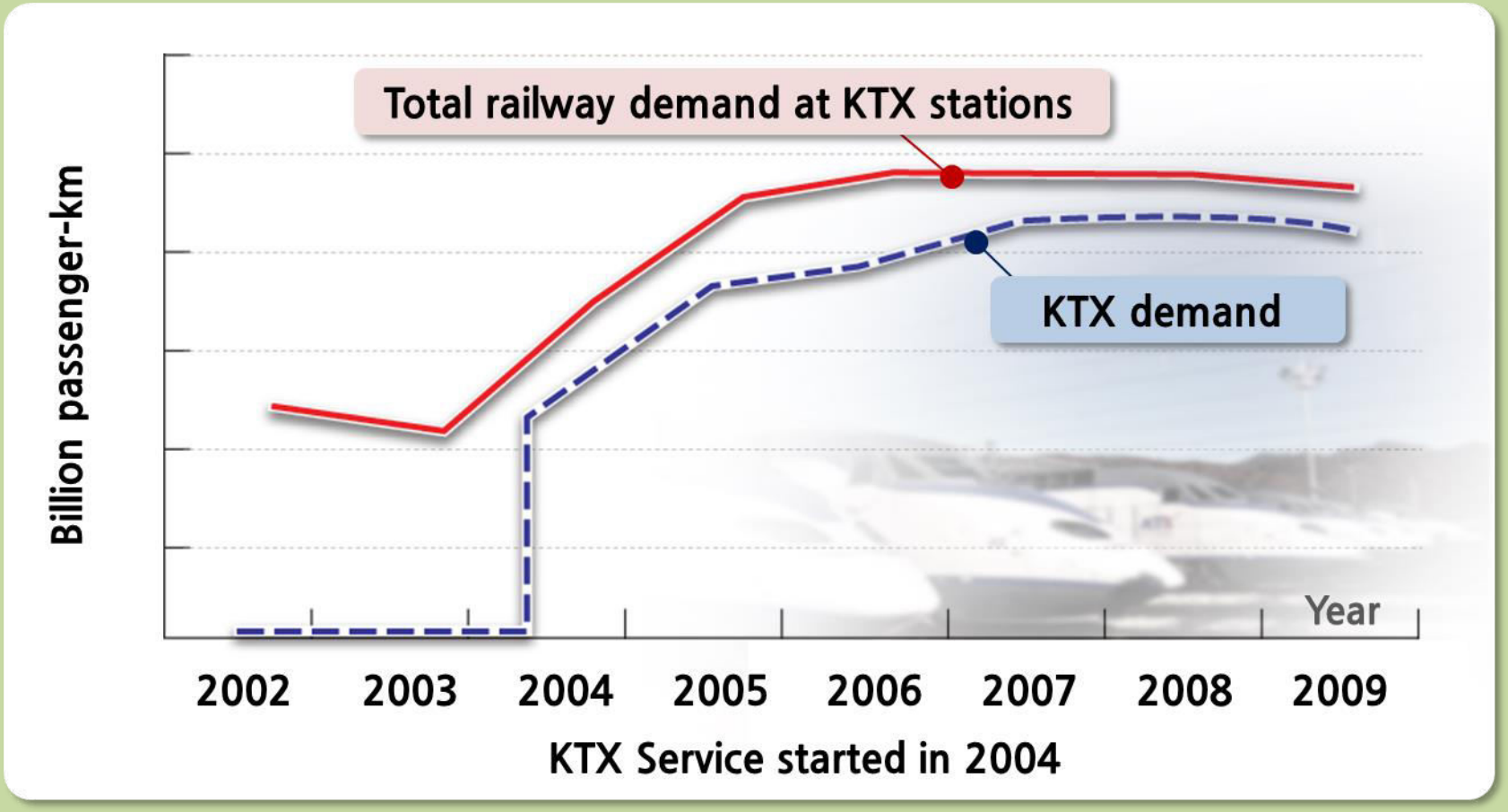
※ Car: $20 USD (CO2 emission: 6 times of railroad)



Why Korea pays attention to high-speed railroad?

KTX service makes railway demand double

After KTX service was started, **the mileage of railroad passenger** at HST stations increase **double**. Many people, who had traveled with airplane and automobile, diverted to high-speed train. As a result, KTX operator(KORAIL) could make profits one year after the lauching of KTX service.



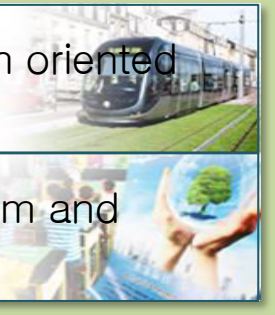
Paradigm shift for Green Public Transport

Rail investment proportion from 29% in 2009 to 50% by 2020

The **green transport policy (2009)** was set to cut **35% of CO2 emission by 2020**. This new policy **focused on** setting the public-mass-human oriented transport system with **the rail investment increase**.

Auto-road oriented transport system

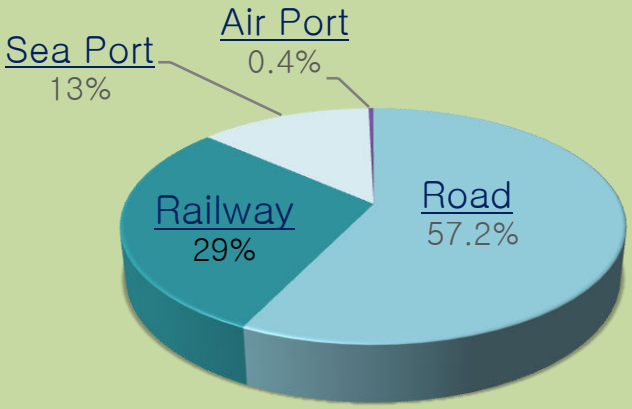
Construction oriented solution



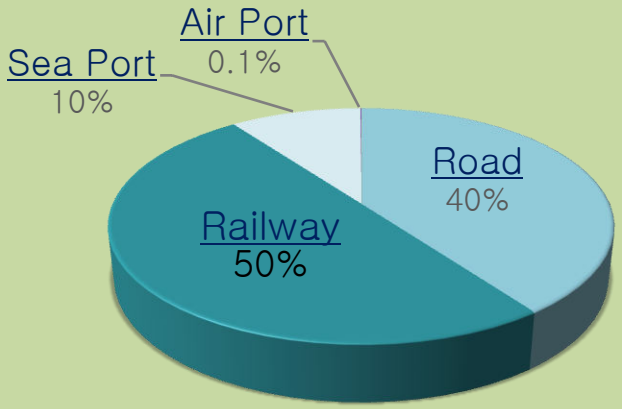
Public-mass-human oriented green transport

Set intermodal system and increase efficiency

Gov't Investment (15billion USD) in 2009



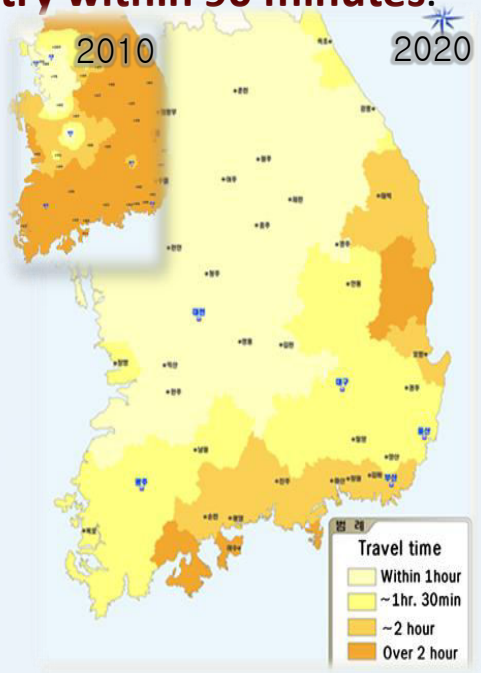
Gov't Investment in 2020



Future High-speed Train Network Plan

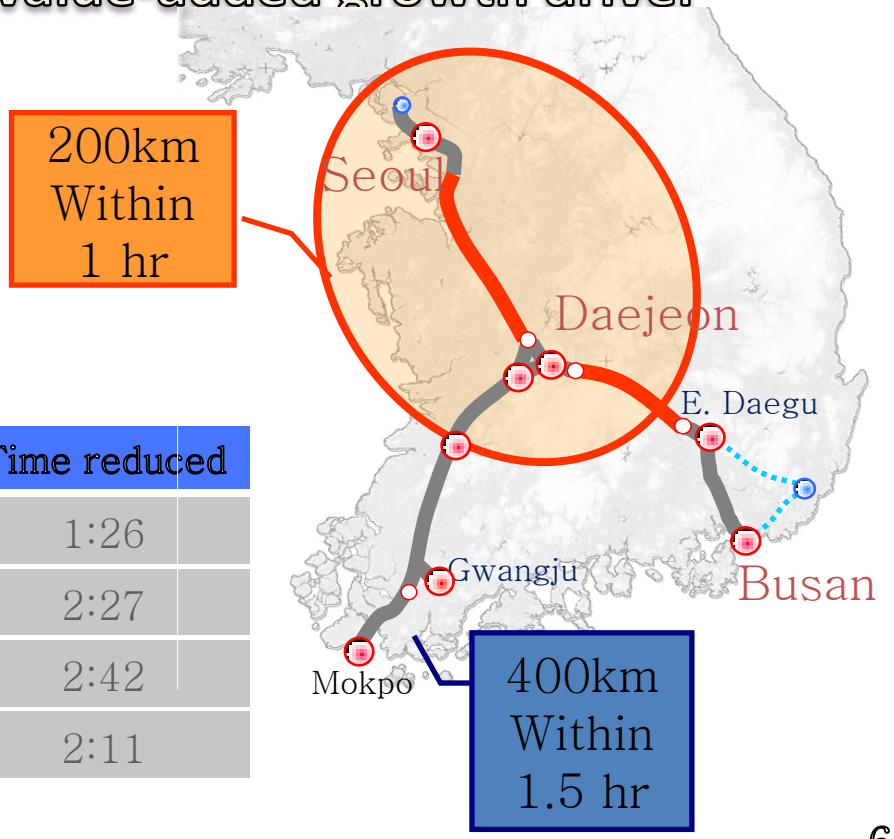
transport 90% of people within 90minutes

The **new KTX network,** which takes **"X + rectangle shape"**, was planned in **2011**. According to this revolutionary plan, people can reach **90% of the region in the country within 90 minutes**.



High speed network in 2020

- - Connection of major cities across the country within 1.5 hours, integrating them into one commutable “Metro Area”
  - Connecting major points across the country via KTX
  - Promoting train industry as high value-added growth driver



Range	Before KTX	After 2020	Time reduced
Seoul – E. Daegu	3:03	1:37	1:26
Seoul – Busan	4:10	1:43	2:27
Seoul – Gwangju	3:53	1:11	2:42
Seoul – Mokpo	4:32	1:21	2:11

(hh:mm)

Evolution of Korean high-speed trains

KTX network plan has been supported with the development of KTX-sancheon, high speed train developed with Korea's own technology. Moreover, KTX network plan becomes realizable by the successful development of HEMU-430X.

Introduction of KTX

- Introduction from France for domestic operation (2004. 4)

Development of Korean high speed train (HSR350X)

- Development of push-pull type high speed train (1996~2007)

Commercialization of KTX-Sancheon

- Korean model of high speed train (2010. 3)

Development of Next-generation high speed train (HEMU-430X)

- Development of electric multiple unit type high speed train (2007~2015)

World leading technology?

From R&D to implementation

R&D project:

- R&D project 1996 ~ 2007
- A prototype of 7 car configuration
- Component development and system in tegration
- Rolling stock and infrastructure tests 200,000km test run

Commercialization:

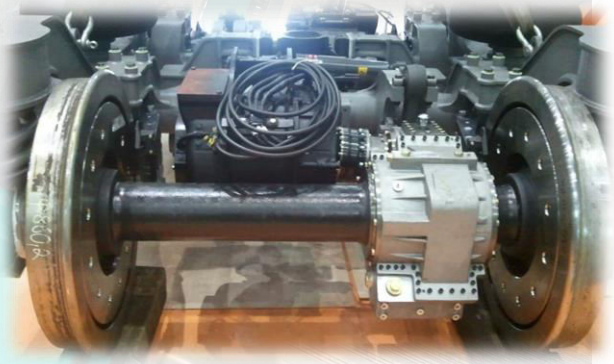
- Modified 10 car configuration
- Selected by KORAIL through bidding
- 24 train-sets in service from 2010~ 2013
- 22 train-sets for the new HSL

Systems Engineering Design Analysis → Manufacturing Factory Tests → Commissioning Tests → Commercial version

next generation
High speed train

First high-speed EMU in Korea

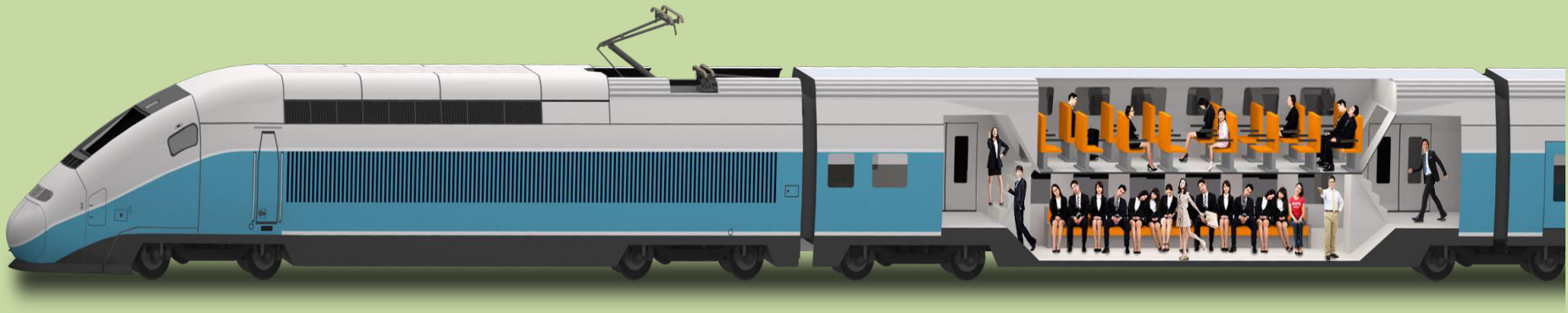
The next generation Korean high speed train, **HEMU-430X** (**High speed Electric Multiple Unit 430km/h eXperiment**), has been designed with **the maximum speed of 430kph**. Currently, the highest speed of **421.4 kph** has been achieved in test runs in **March 2013,** with further tests scheduled to reach above **430 kph**. The significantly increased speed with respect to KTX is expected to open up a new era, which essentially makes Korea one big metropolis.



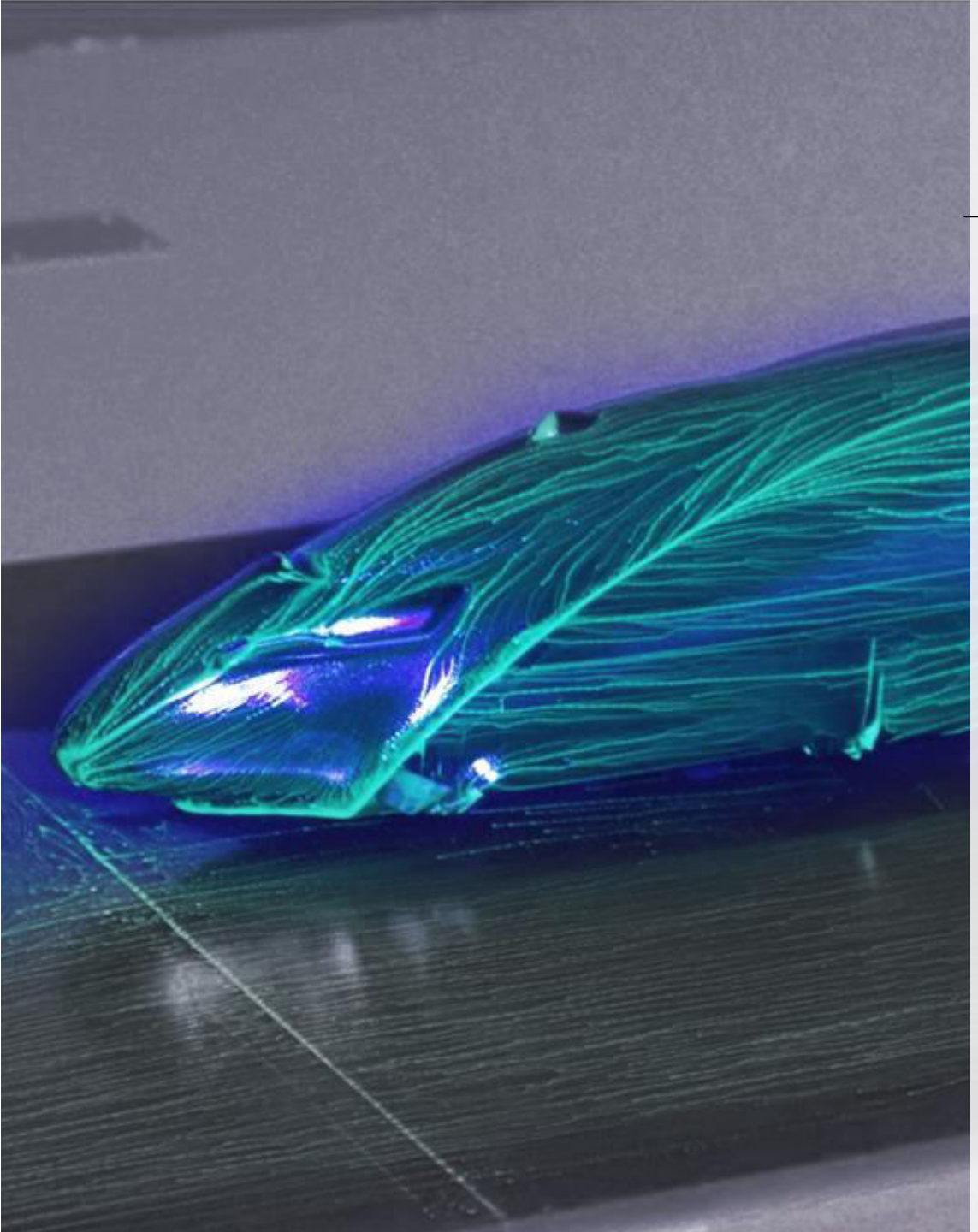
High Capacity Double-deck HST

cope with highly increasing long-distance travel demand

This double-deck train will be designed to have **standing type lower deck** and **seating type upper deck**. High capacity double-deck HST can transport the **triple of the number of passengers**, compared to the current KTX.



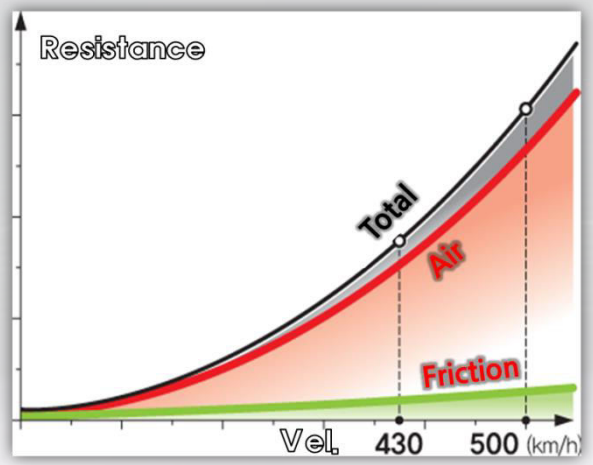
Rail	Double-deck(10car/1set)		KTX-Sancheon (10car/1set)	TGV-Duplex (10car/1set)	Shinkansen-E4 (8car/1set)	KTX (20car/1set)
	1F Seat 2F Seat	1F Standing 2F Seat				
Passengers per 1 set	512~545	858~1148	363	512~545	817	935
Passengers per 1 car	51~54	85~114	36	51~54	102	46



Air resistance

is the core issue for very high speed

Running resistance, mainly due to air resistance, rapidly increases as the speed goes up and it is the **major factor in energy consum-ption**. The energy consumption could be minimized by integrating conventional techniques such as optimal aerodynamic design with **innovative and active methods** such as plasma and air blowing.



High traction power

is the other issue for very high speed

Traction power increase, as well as the air resistance reduction, is **one of the most important factors** for reaching target speed. The target traction power of HEMU-500X is **50.2kW/T for unit mass** and it can be achieved by improving output density of motors and efficiency of inverters. These component technologies will **strengthen the competitiveness of railroad industry**.

Running safety

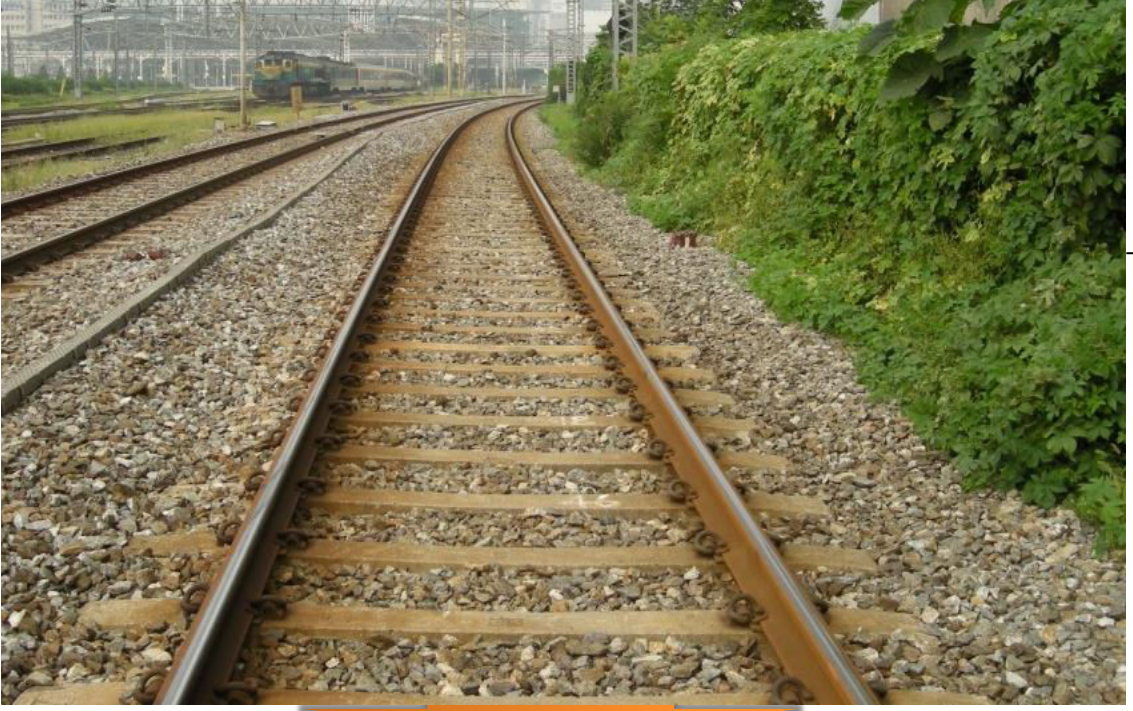
should also be secured.

Running safety becomes more important for very high speed trains. The **suspension parameter optimization** for HEMU-500X's bogie will secure the dynamic stability at 550km/h and higher. Moreover, the target for wheel-rail adhesion performance is 10% in dry condition and 30% in wet condition.

High-speed catenary system

enables the stable powering

The strength of catenary is an important factor for stable powering in high speed. KRRI has developed **the world's first 400km/h catenary** and the field test is being planned. The performance of the developed catenary will be continuously improved for the stable powering in 500km/h range.



Fast Concrete Track Changing

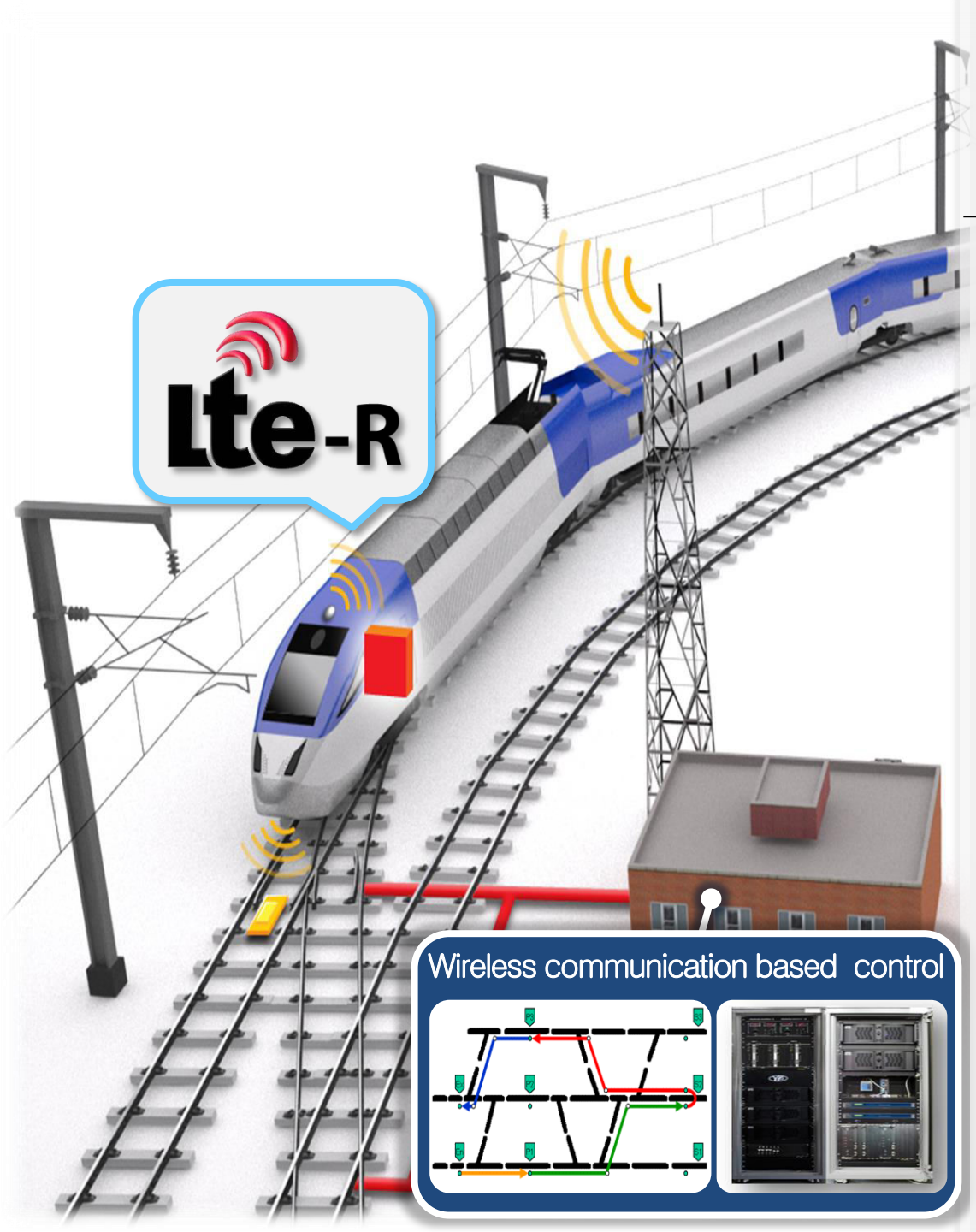
decrease the maintenance cost

For the speed increase in the **ballast track** of Gyeongbu high speed line phase 1 (Gwangmyeong-Daegu), large amount of time and cost is required for the maintenance. The **maintenance cost** can be **reduced by 75% by changing to concrete track.** Consequently, the operation delay due to maintenance is minimized. **Replacement from ballast track to concrete track can be done in less than 4 hours** with KRRI's technology and economical construction of high speed infra-structure is possible in short period of time.

High-speed Turnout System

ensures operation safety

High-speed turnout system is closely related to the accidents and operation delays and it is a core equipment for securing the operation safety. Large portion of high-speed turnouts in use in Korea is based on foreign technology and there has been difficulties in handling emergency situations. Development of **Korean high-speed turnout system** will provide strong infrastructure for continuous speed increase.



Train Control with LTE-R

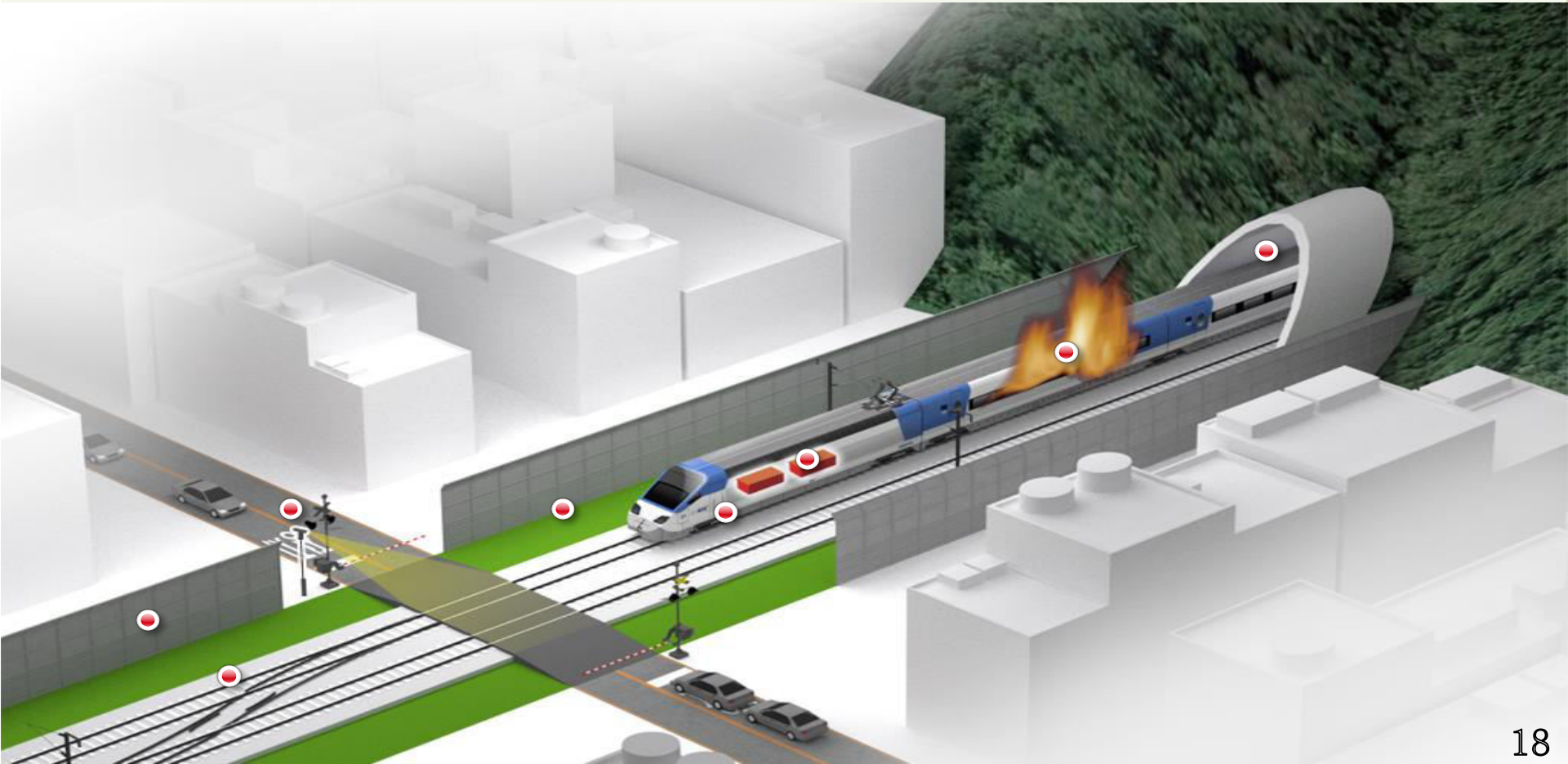
enables accurate train control in the high speed

High speed communication network (LTE-R) makes **precise train control possible in high speed** and provides favorable condition for high speed train control. Compared to GSM-R of other countries, LTE-R (4th generation communication) is has the competitiveness since it supports fast transmission of large amount of data at high speed. It is currently in **performance tests** and will be commercialized **in 2016**.

Real-time Safety Monitoring System

makes much safer & efficient railroad service

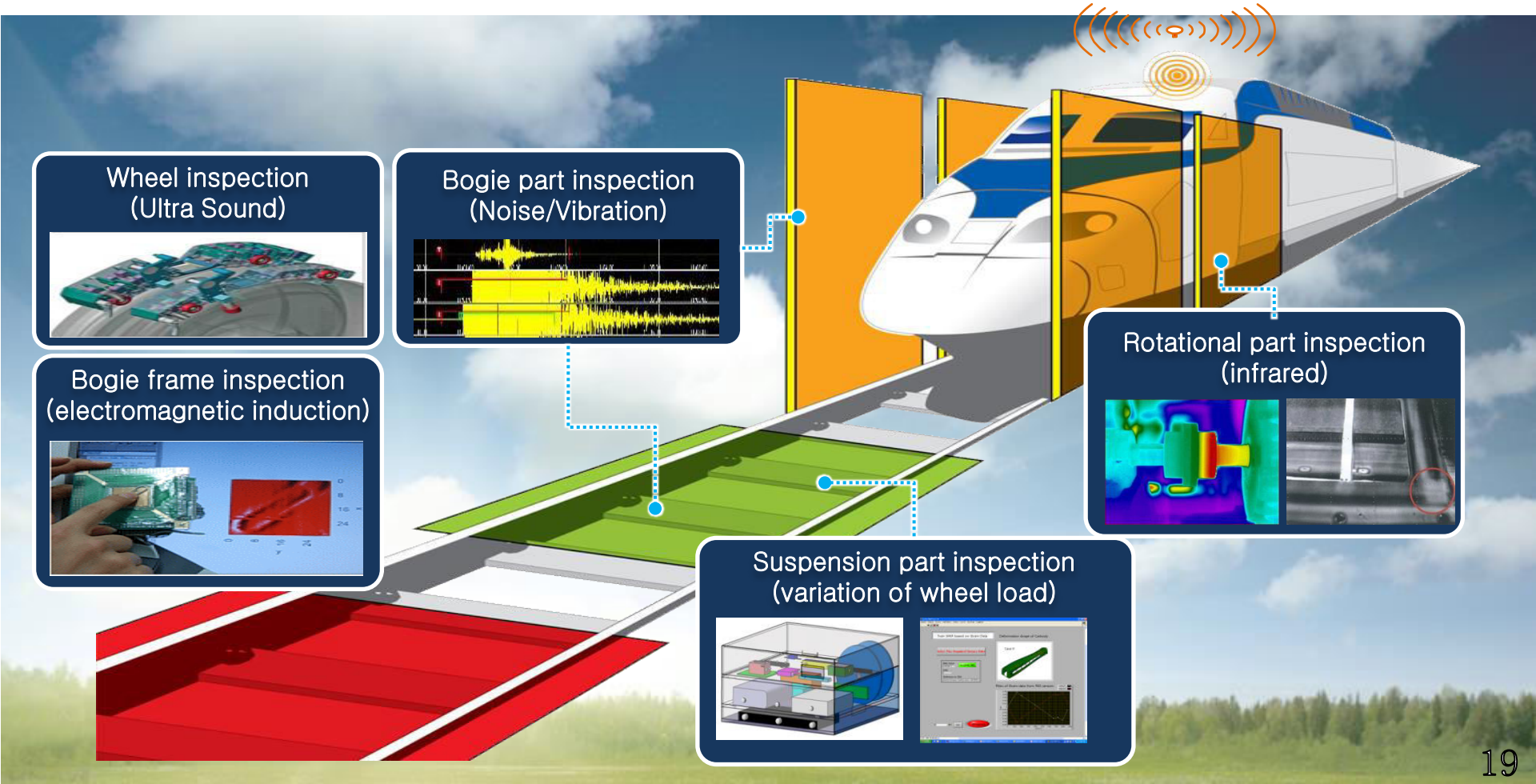
High speed railway service demands higher safety requirements. R&D projects are conducted on the **real-time safety monitoring** for the status **of infrastructures** (track defects, crossings, catenaries, natural disasters, tunnel fire and etc.) and **the rolling stocks** (fire detection, propulsion malfunction, derailment detection and etc.). The system enables rapid and efficient actions in emergency situations.



Real-time Non-destructive Scanning

enables convenient and efficient maintenance

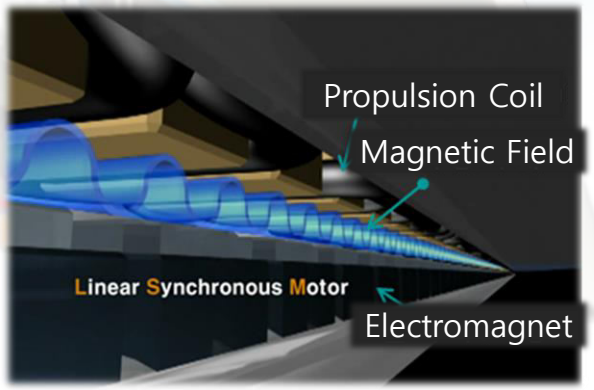
As the speed of rolling stocks increases, more sophisticated components are used and the frequency and the cost of maintenance have also increased. **Non-destructive scanning** technology, **real-time diagnosis of trains** without disassembling or contacts as they enter the depot, enables efficient maintenance and economical automated inspection.



Linear LSM propulsion

to overcome adhesion limit

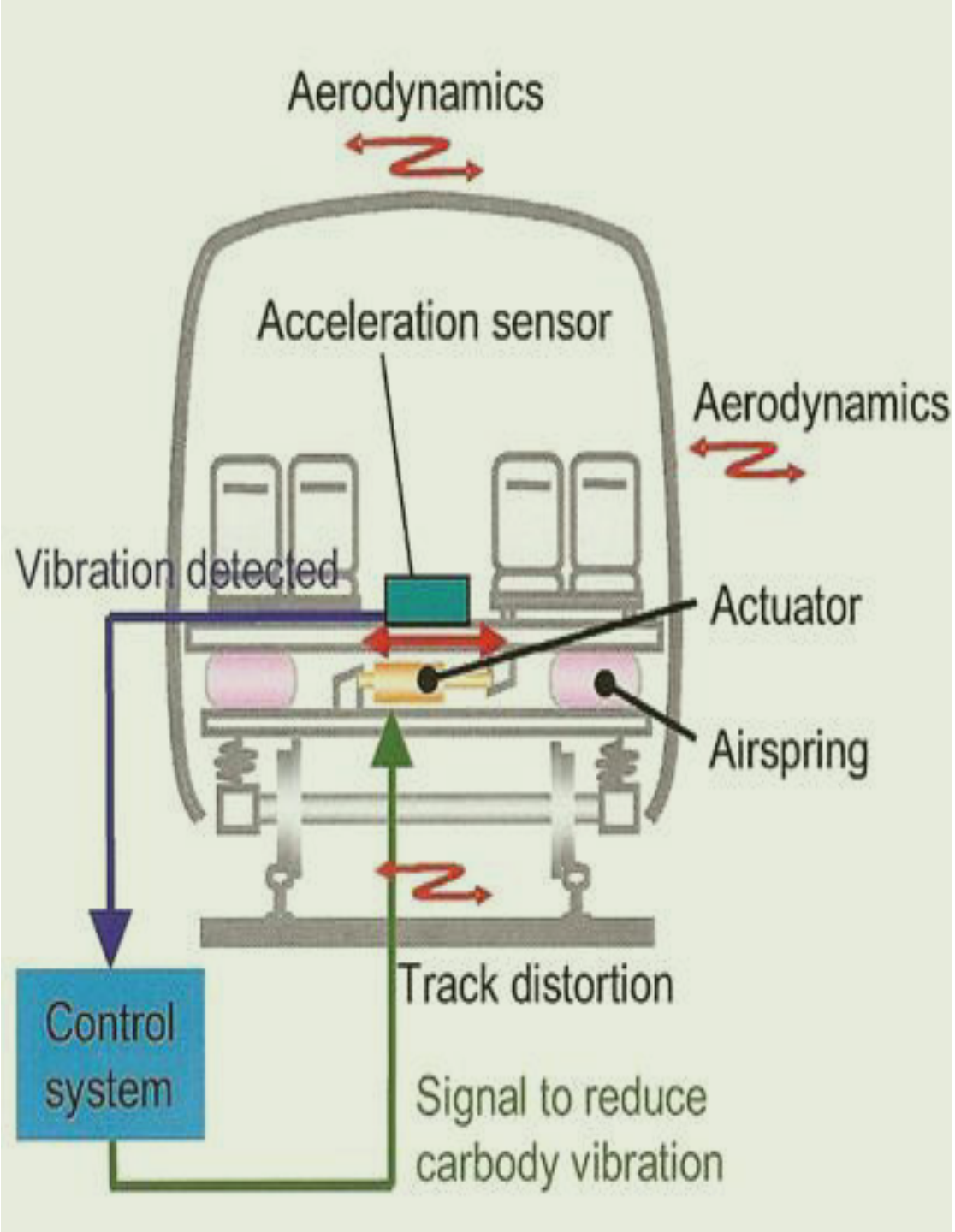
It is difficult to generate sufficient propulsion force for 600km/h speed with conventional wheels and motors mechanism. Therefore, **linear synchronous propulsion** is to be applied to generate force, undeterred by the adhesion limit. Moreover, **the attractive force** generated by linear synchronous motors has **restrains the derailment or the rollover of trains**.



Wireless power transfer

enables supplying high power at very high speed

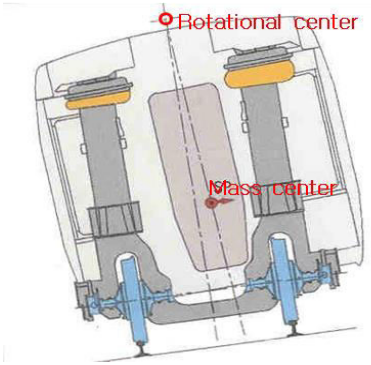
Stable power supplying is essential for the speed increase of high speed trains. However, the conventional pantograph system has the limit. As the replacement of the catenary and pantograph system, high capacity **wireless transfer system** can secure the **stable powering**. The related technology is being developed to **remove the catenaries by 2020**. The tram has been successfully demonstrated in Osong test track in Jun. 2013.

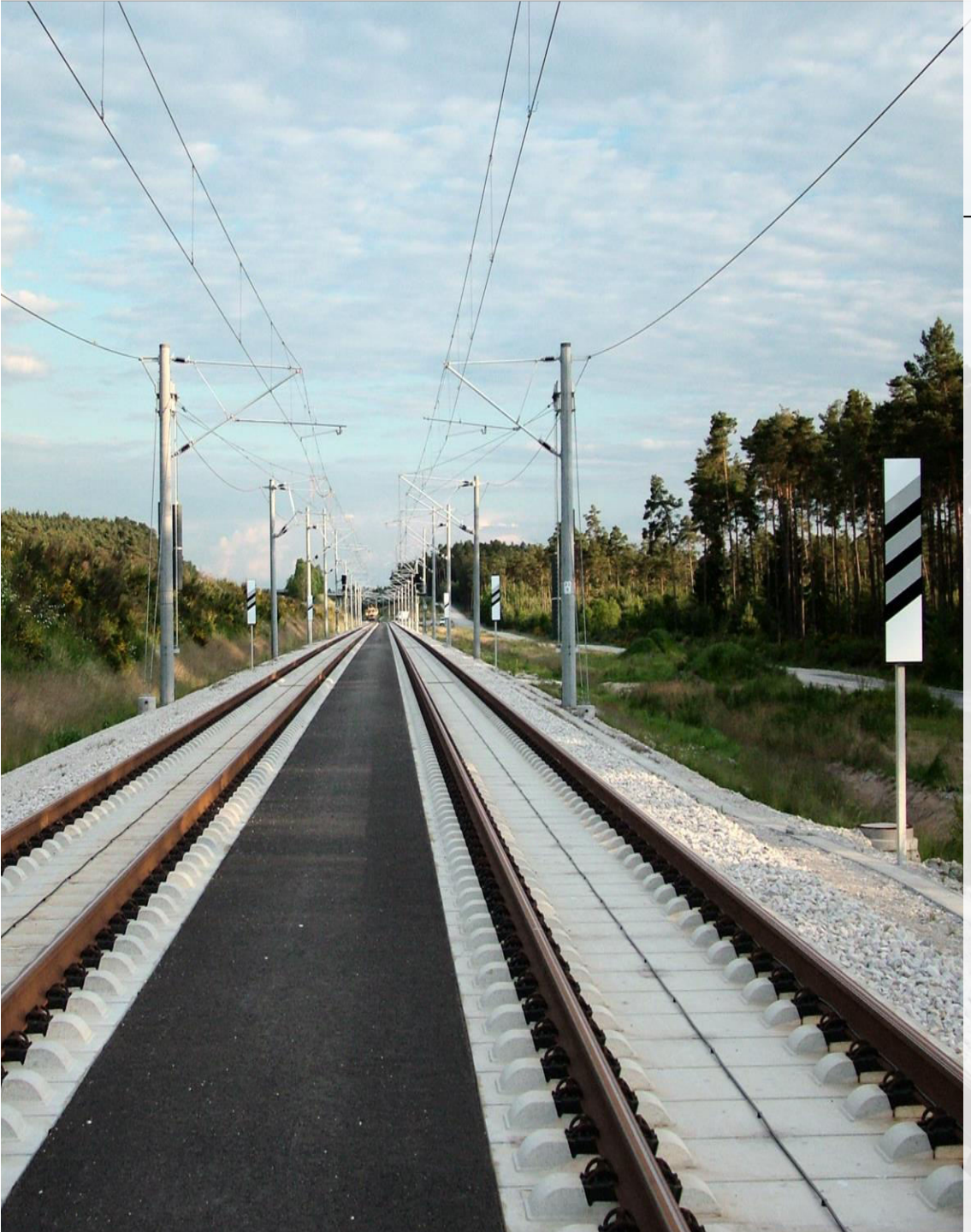


Active suspension bogie

for high speed curving

To achieve 600km/h in existing high speed lines, it is necessary to develop the bogies that are capable of running 7000m radius curves at 550km/h. Various technologies are necessary such as **tilting mechanism for low center-of-mass and high rotational center** and **active suspension system** for vibration reduction in super high speeds. Such development of high performance rolling stocks **minimizes** the improvement **cost for infrastructures.**

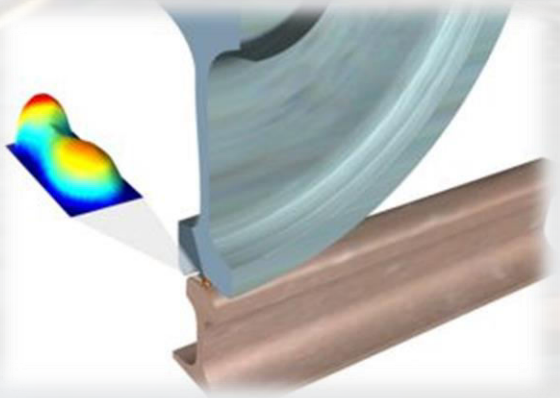




Strengthening of track and roadbed

for securing safety in very high speed

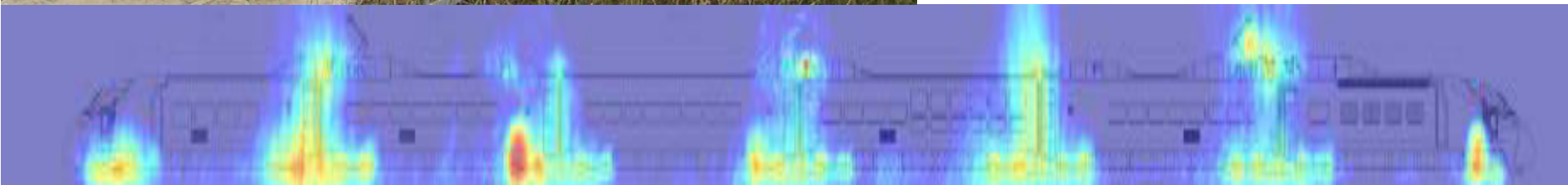
For the stable driving of very high-speed trains, improvement of tracks and roadbeds is mandatory over certain level. The **track irregularities must be monitored more precisely** as the speed becomes super high. Technologies for rail weight increase and **appropriate rail profile design** are to be developed in addition to the material improvement.



External noise reduction

with innovative technology

There is no single solution for the rapidly increasing noise as the speed goes up and **multiple methods** must be integrated **for noise reduction**. It is necessary to develop the **core technology to reduce the source of noise.** In addition, the noise barrier and innovative top device technology to block the noise routes should be applied.



Continuous efforts towards speed increase

for creating railroad demand and enhancing industrial competitiveness

High speed railroad has not only increased its speed, but also brought large changes in railroad industry and domestic transportation policy. It exploded **the demand of the entire railroads** and this demand will be continuously larger with the **increase of operation speed**. However, the **economical feasibility** has been **limiting** the **operation speed**. **KRRI** is trying to **increase the economical speed** of high-speed railroad **with innovative technology** development. And it will be achieved by the **500km/h and 600km/h very high-speed trains**.

The very high speed railroad system requires innovative and interdisciplinary fusion technology. We will expect **your cooperation** with KRRI makes more people **happy all around the world**.

KRRI is not only working for today

but for the Future

Thank you!