JR-East Shinkansen Technology

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2013/ 4/8 Presentation for41th Modern Rolling Stock at Technical University Graz.

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- Outline of JR-East Shinkansen network
- Features of Shinkansen rolling stock
- Control center for monitoring of Shinkansen operations
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- Countermeasures against natural disasters
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- 3.11 Earthquake, restoration and recovery
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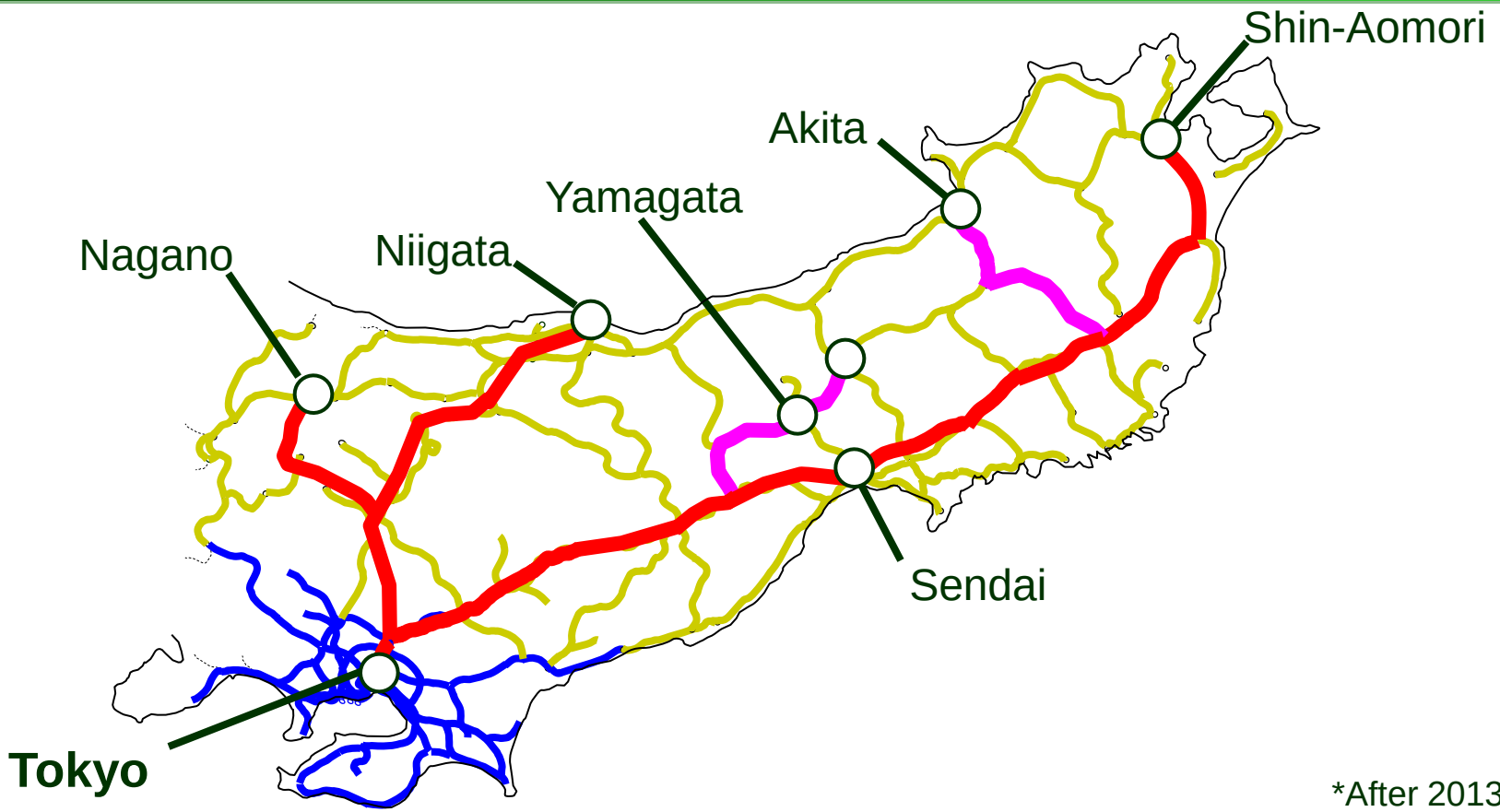
Network of JR East



*After 2013 spring

		Network	Gauge	Power supply	Max Velocity
Category 1 High speed network	Dedicated guideway	1140km	Standard (1435mm)	AC 25kv 50Hz	320km/h
	Through service into conventional line	277km		AC 20kv 50Hz	130km/h on electrified 100km/h on Non-electrified
Category 2	Tokyo urban network	2550km	Narrow (1064mm)	DC 1.5kv AC 20kv 50Hz Non-electrified	
Category 3	Local network	3586km			

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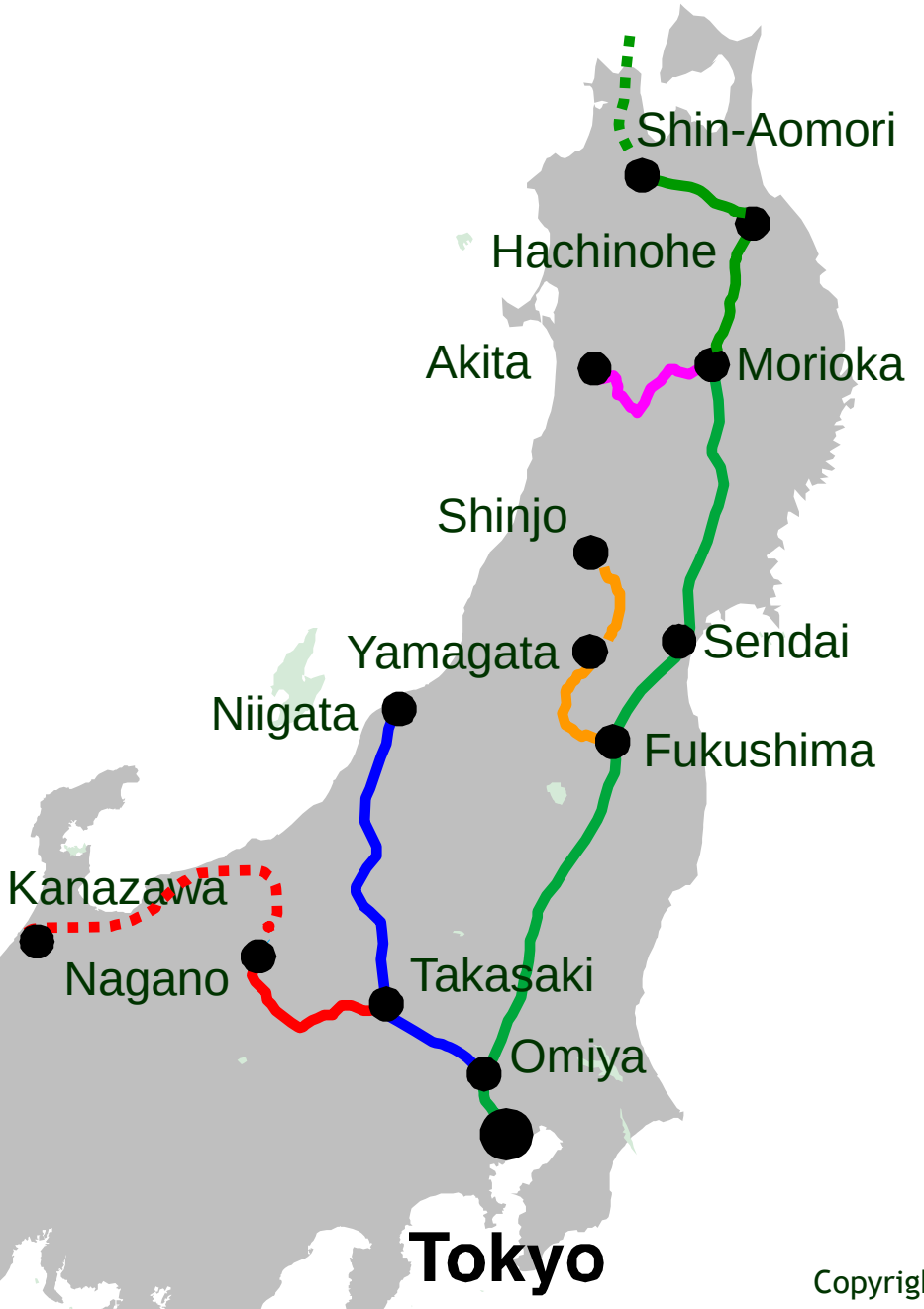
Features of JR-East Shinkansen network



1. Runs in 5 directions from Tokyo
2. Uses 3 types of rolling stock
3. Through-operation on converted conventional lines by hybrid type
4. Quick turn-back at terminal stations (12 minutes at Tokyo Station)
5. Maximum speed 320km/h

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Features of rolling stock

Three types of JR East Shinkansen trains

High speed

For longer trips

Series E2 275km/h

Series E5 320km/h

Hybrid type

For through service with coupling/uncoupling functions

Series E3 275km/h

Series E6 300km/h

Large capacity

For commuting

Series E4 240km/h

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Features of rolling stock

Comparison of JR-East Shinkansen typical rolling stock

Type	High speed	Hybrid type	Large capacity	High speed	Hybrid type
Series	E2-1000	E3	E4	E5	E6
Train Configuration (train length)	8M2T (251m)	4M2T (128m)	4M4T (201m)	8M2T (253m)	5M2T (148.65m)
Capacity	814	338	817	731	338
Capacity /m	3.24	2.56	4.06	2.89	2.27
Approx. Max. axle load (loaded)	13.2t	12.2t	16t	11.3t	10.8t
Max. operating speed	275km/h	275km/h 130km/h(on conventional)	240km/h	320km/h	300km/h
Intermediate Car length	25m	20.5m	25m	25m	20.5m
Body width	3380mm	2945mm	3380mm	3350mm	2945mm
Motor power (continuous)	300kW	300kW	420kW	300kW	300kW
Coupling with (in normal operation)	E3	E2	E4,E3	E6,E3	E5
Electrical system	AC25kV50Hz	AC25kV50Hz AC20kV50Hz	AC25kV50Hz	AC25kV50Hz	AC25kV50Hz AC20kV50Hz
Signalling system	DS-ATC	DS-ATC, ATS-P	DS-ATC	DS-ATC	DS-ATC, ATS-P
Year in operation	2002	1997	1997	2011	2013

State-of-the-art Series E5 & E6

High Speed

- Maximum commercial speed of Series E5 reached 320 km/h last.

Through Service

- Series E6 debuted last month
- Maximum commercial speed of Series E6 is planned to reach 320km/h by 2014.
-Series E5 & E6 can be coupled and uncoupled automatically.

Series E5

Series E6

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Operation control center

One Floor Management

Control Center Management

- Chief
  - Transportation Section
  - Passenger Section
  - Rolling Stock Section
  - Driver/Conductor Section
  - Track Section
  - Power Supply Section
  - Signal/Telecommunication Section
    - System Section

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Operation control center

Integrated intelligent transport management system

COSMOS (Computerized Safety, Maintenance and Operation Systems of Shinkansen)

COSMOS is designed to consist of seven subsystems in a dispersed pattern: even if one of the subsystems fails it will not affect the remainder.

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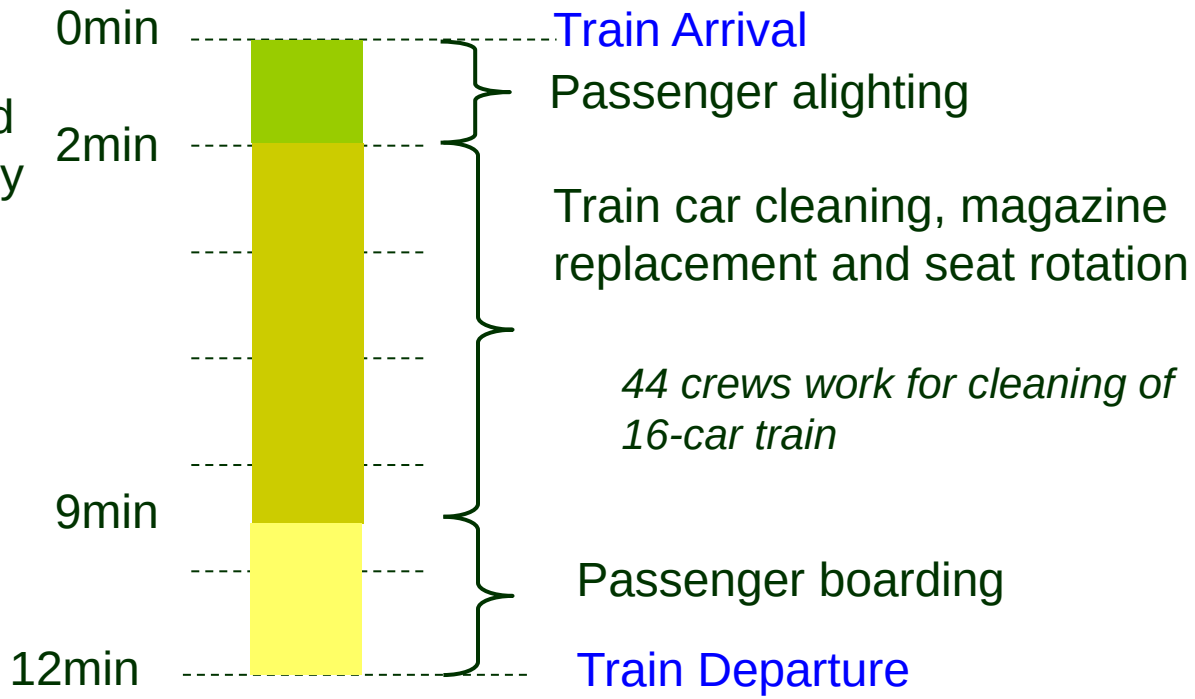
Turn back at Tokyo station

Alighting passengers and cleaning crew on stand-by

Car cleaning

Automatic seat rotation



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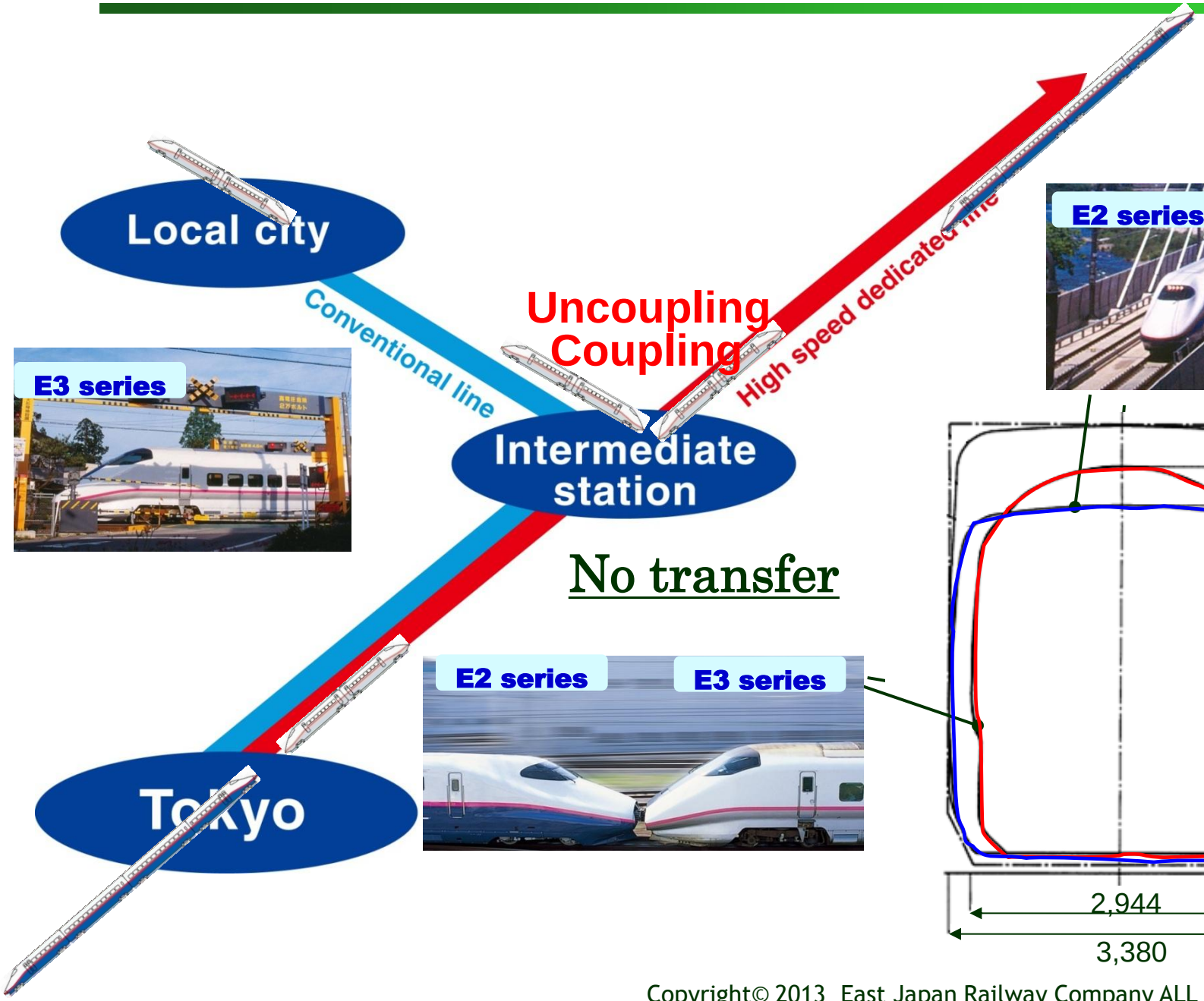
Through service



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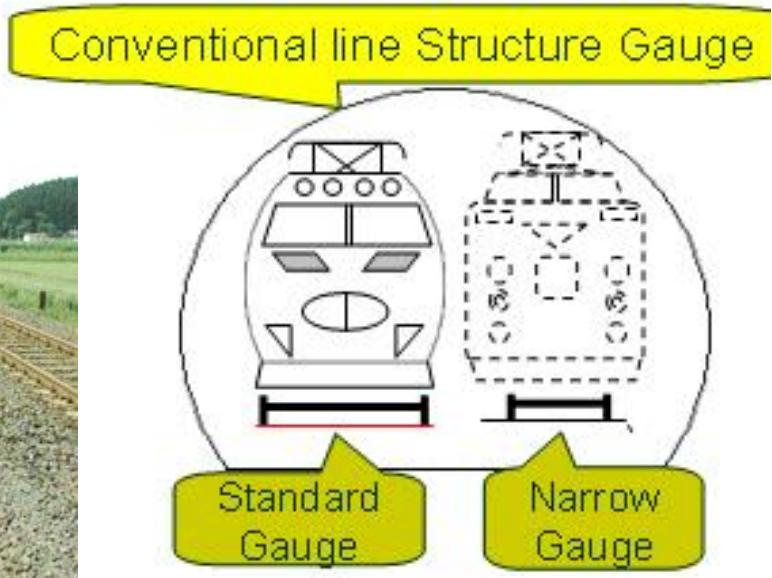
Through service

Improvement of conventional lines



The conventional lines were Improved in the following three ways;
- **constructed standard gauge instead of the narrow gauge.**
- **constructed additional rail to the narrow gauge as above.**
- **constructed standard gauge next to narrow gauge.**

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Countermeasures against natural disasters

Against earthquake

Reinforced pillars

Great Hanshin-Awaji Earthquake (1995)

Lesson

Viaducts:

- A seismic reinforcement to prevent shear failures
- No critical destruction to major structures by March 11,2011 earthquake; only bending failures

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Countermeasures against natural disasters

Against earthquake

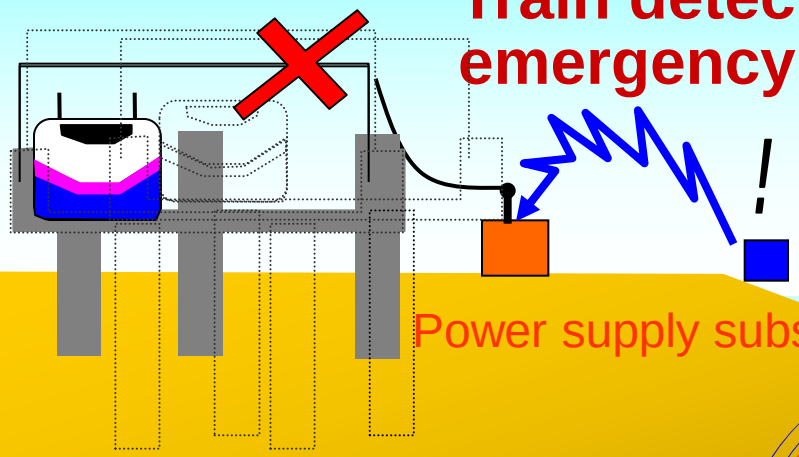
“Early Earthquake Detection System”

The coastline seismometer detects a primary wave

Signal is transmitted to the power supply substation

Power is automatically shut down

Train detects the power shutdown and emergency brakes automatically applied



Coastline seismometer

Power supply substation

Secondary wave Secondary wave

Primary wave

Epicenter

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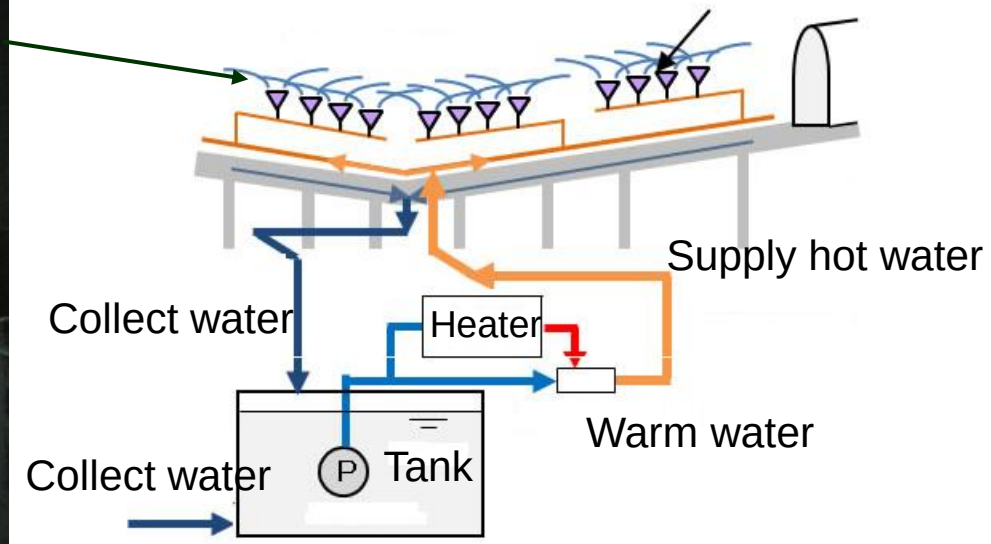
Countermeasures against natural disasters

Protection from snow damage of infrastructure and train



Sprinkler

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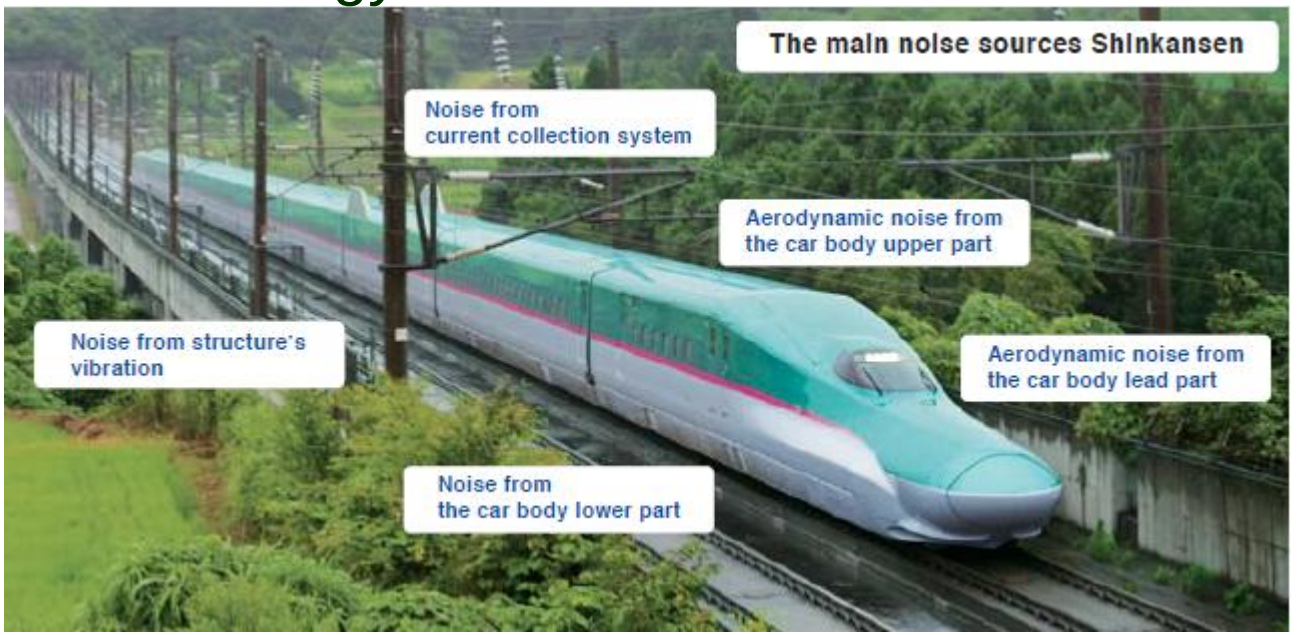
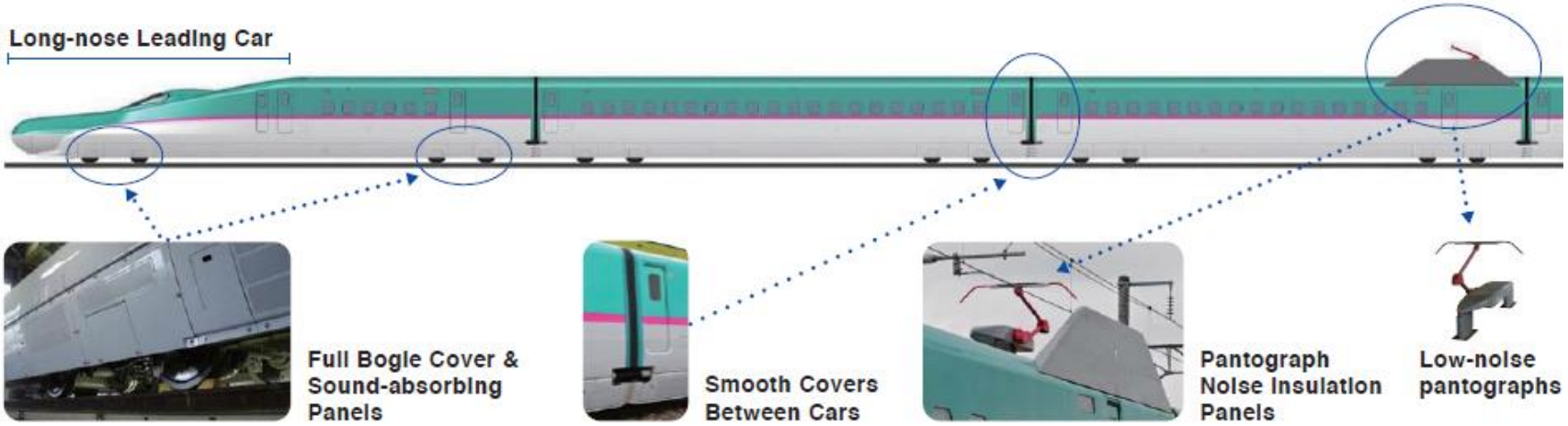
Environmental technology

Noise-abatement technology





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Environmental technology

=*Countermeasures on the Ground*=

To reduce micro-pressure wave

- Construction or extension of tunnel entrance hood
- Improvement of tunnel entrance hood

Tunnel entrance hood

To reduce noise

- Block sound waves

Noise-blocking wall

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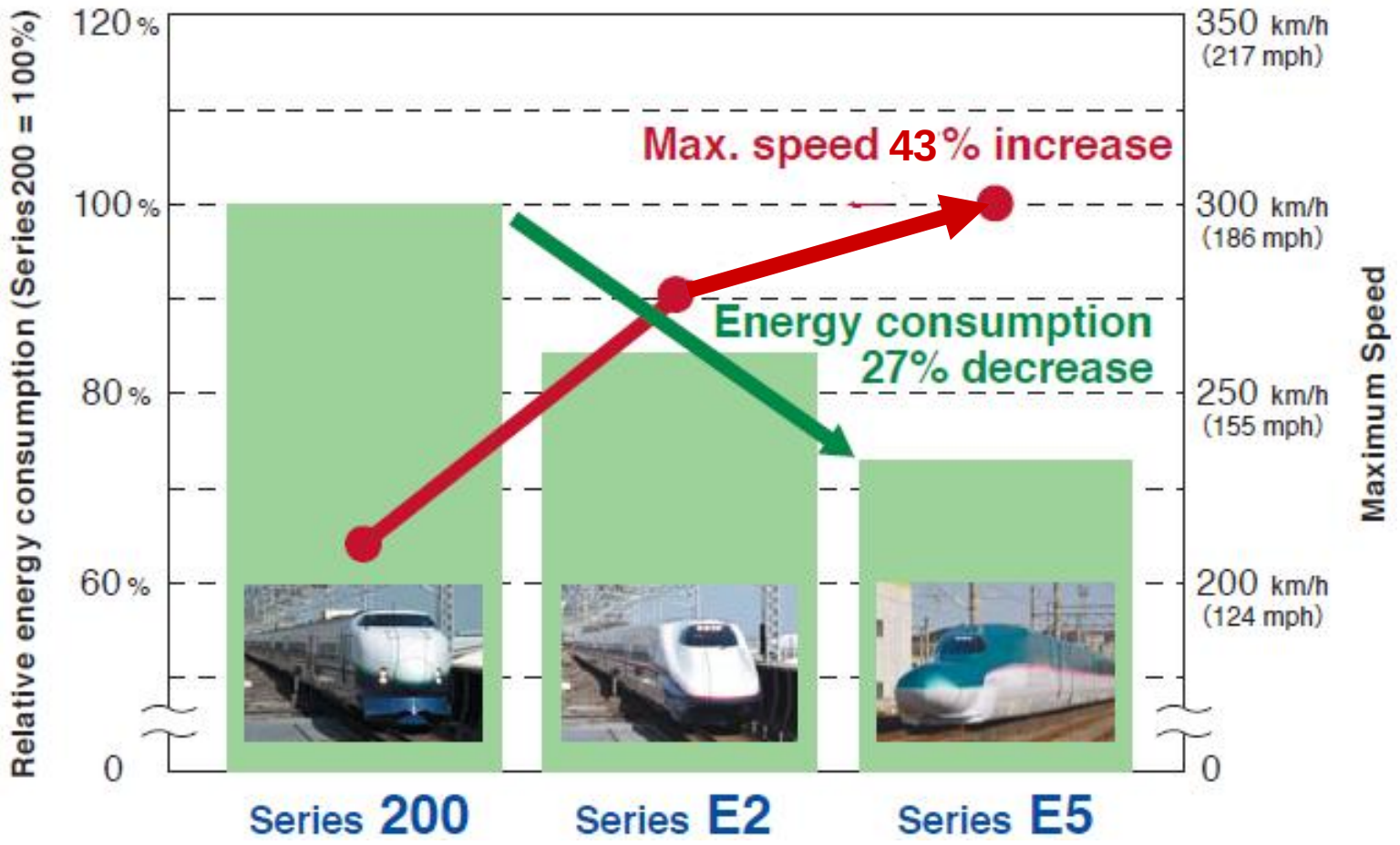
Environmental technology

Reduced energy consumption, higher speeds



Reasons 1.Light weight 2.Improvement of power control
3.Improvement of braking system

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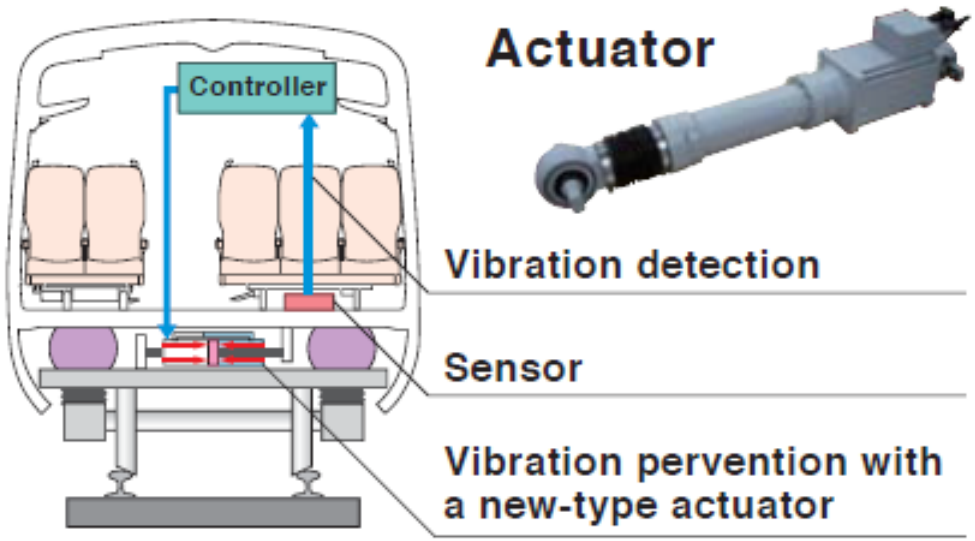
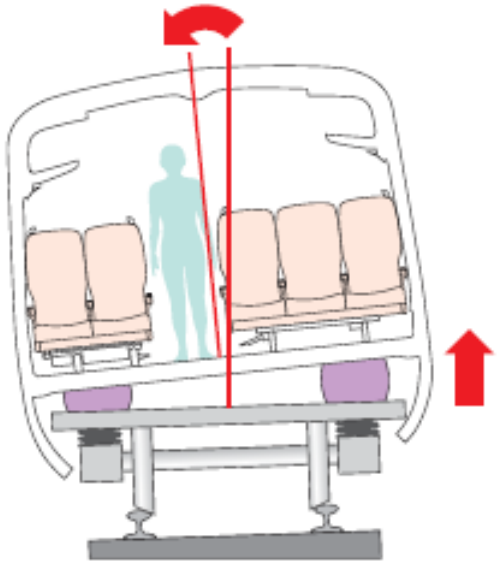
Riding comfort technology



Full-active suspension



Car body tilting system

With the latest technologies, including car-body tilting equipment to negotiate curves and a full active suspension to suppress lateral movements of the car body, ride quality is further enhanced in our high-speed operations.

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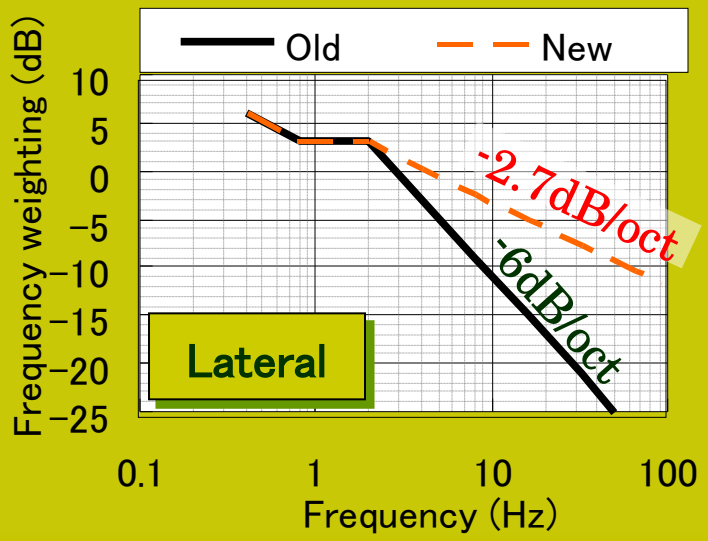
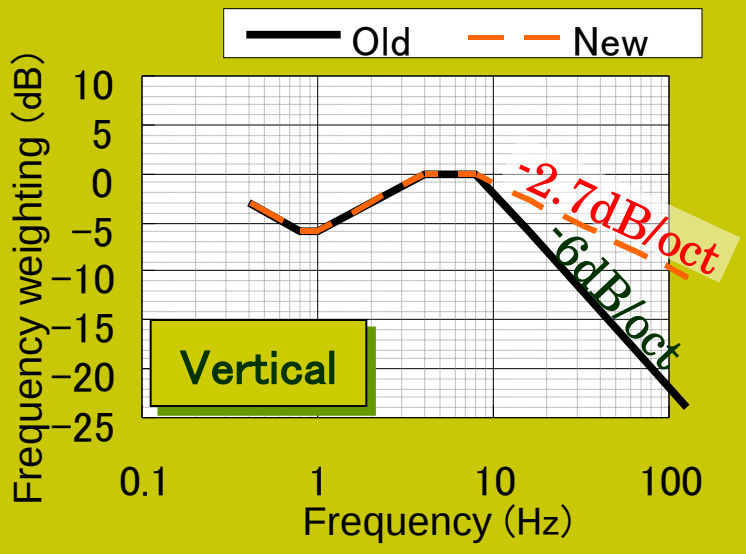
Riding comfort technology

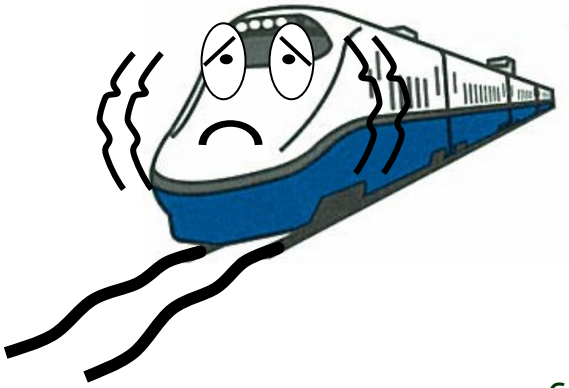
Track maintenance with riding comfort filter

Improved riding comfort filter





Evaluate high frequency vibration



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High speed operation technology

Power supply system: Catenary

Wave propagation speed must be fast enough = lighter weight and higher tension

Design parameters

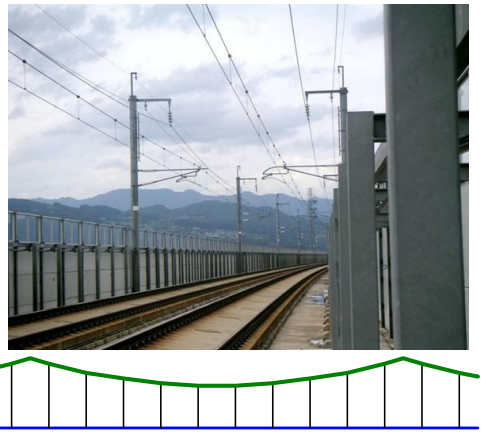
Speed, Capacity, Strength against vibration
Avoiding breakage, Low maintenance work,..

⇨ Material, diameter, tension, structure…

Heavy compound catenary system

Heavier weight but high tension
Aimed at reducing vibration by pantograph

CS catenary system



Lighter weight and high tension

-introduced to newly extended lines

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Riding comfort technology

Introduction of the highest grade seats car with excellent service

GranClass

on the Series E5

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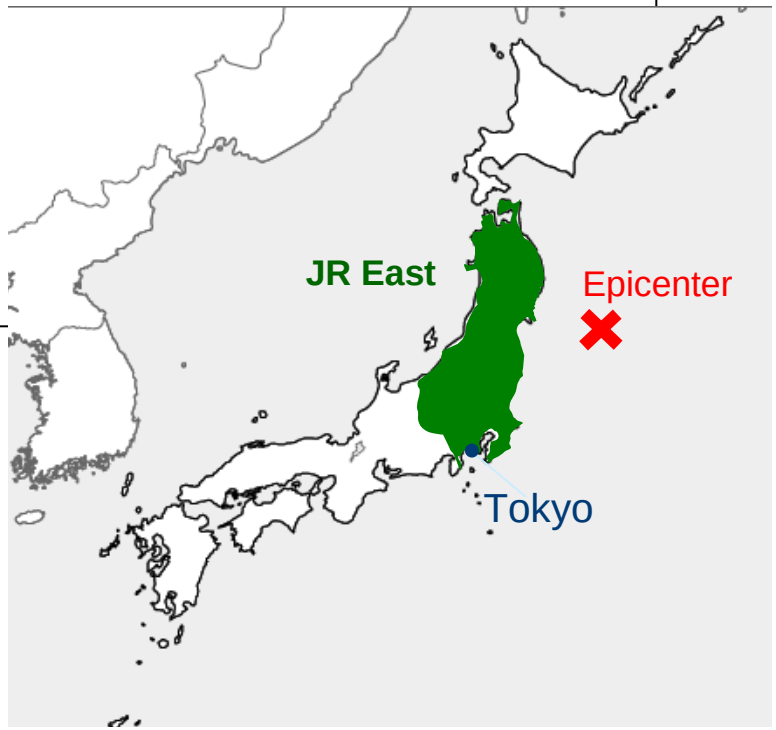
3.11 Earthquake and Damage to JR East

Outline of the Tohoku Region Pacific Coast Earthquake

- **Date and time of occurrence:**
  At approximately 14:46 on Friday, March 11, 2011

- **Strength of the earthquake:**
  Magnitude 9.0 on the Richter scale
  (The largest in the recorded history of Japan)

- **Number of deaths and missing:**
  18,591 (As of December 26, 2012)
  (Resulting from earthquake-induced shock and vibration, tsunami and fire)



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Damage to JR East

- Shinkansen

Toppled electrification masts

Distorted pillar

Fallen ceilings on the platform

- Conventional line

Large-scale landslide

Collapsed embankment

Tracks washed away by tsunami

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JR East countermeasures against earthquakes

(1) Reinforcement of infrastructures

(2) Detect the earthquake and stop the trains as quickly as possible

(3) Prevent trains from a large scale deviation in case of a derailment

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Enforcement of viaduct

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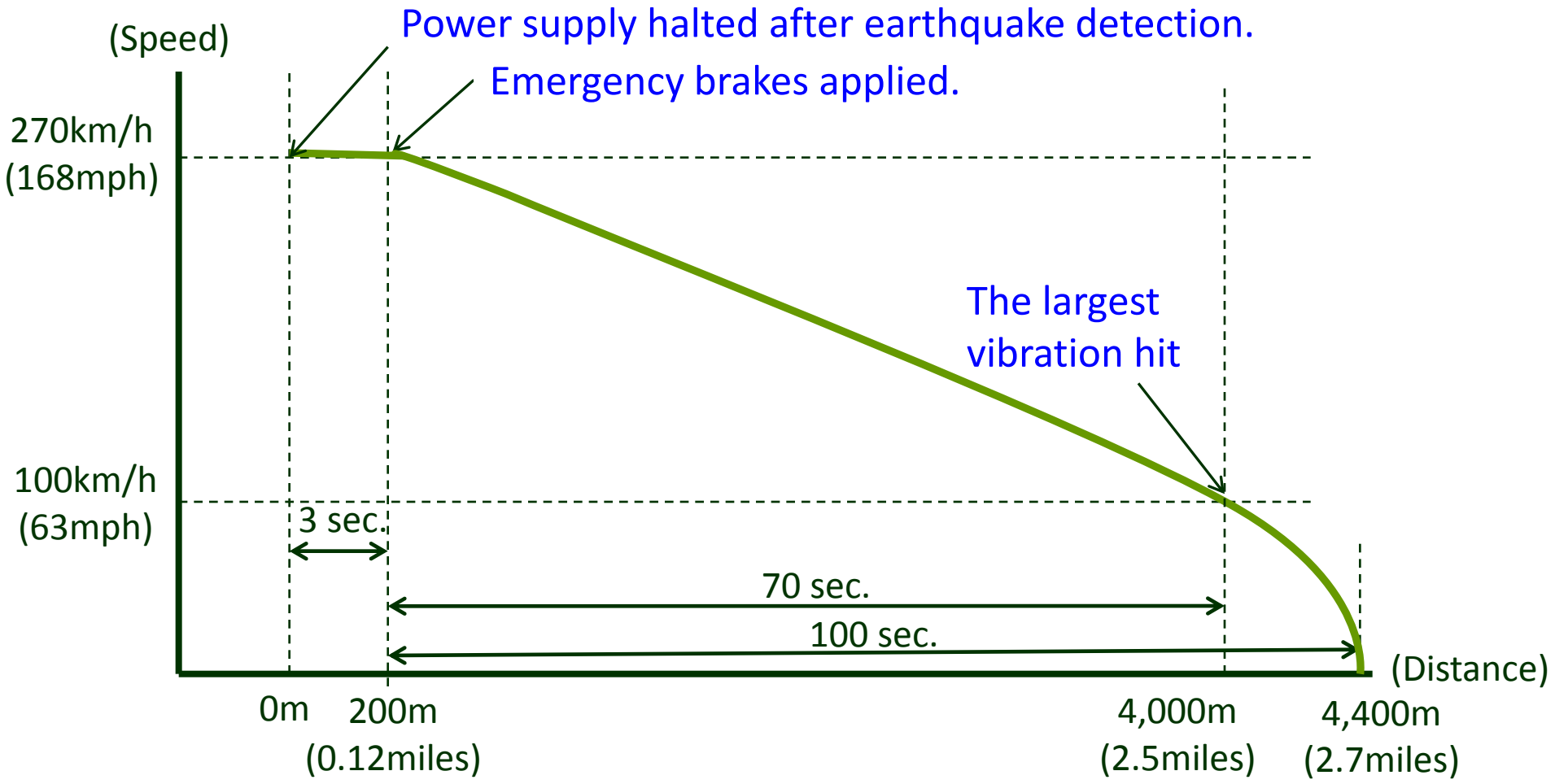
Early Earthquake Detection System



After the emergency brakes on the train running at 270 km/h were applied, in the next 100 seconds this train ran approximately 4,200 meters and stopped.

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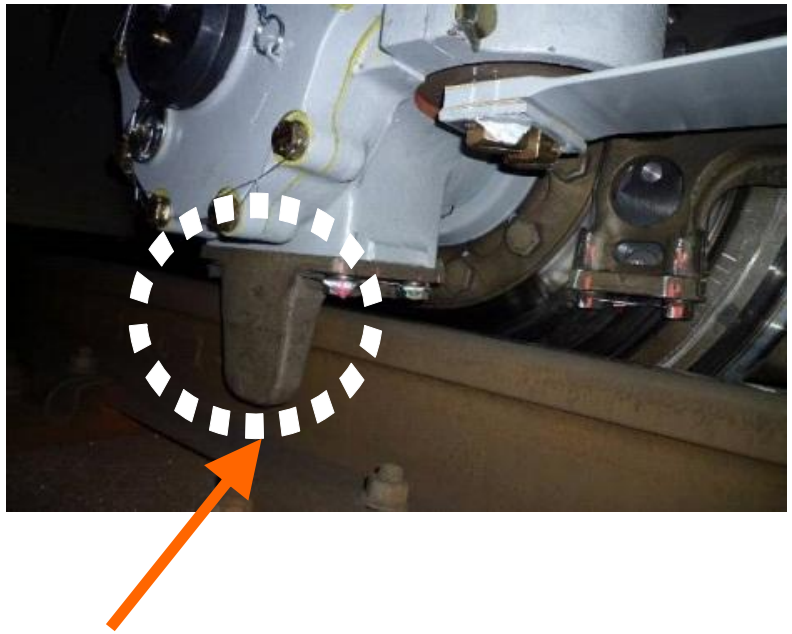
Preventing trains from large scale deviation



A Shinkansen derailed, but did not deviate on a large scale, because the parts of car bogie caught the rail head to halt.

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Consequences of the Earthquake & Tsunami

- Shinkansen (HSR): **27** trains in service (Tohoku Shinkansen: between Tokyo and Shin-aomori) at moment of earthquake
  - ・Aseismic reinforcement
  - ・Early earthquake detection system

⇒No derailment of commercial trains

- Conventional lines : **670** trains in service at moment of earthquake

  Station staff and train crews successfully led our customers to emergency evacuation areas before the tsunami hit.

- Customer fatalities : 0
- Customer injuries : 0

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Strengthening of Electrification Masts

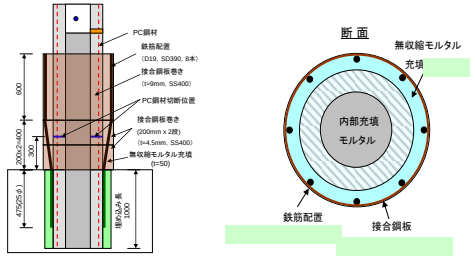
Repaired concrete masts

■Clarified weakness and fact

Type of mast	Broken	Leaning
Iron masts	0	3
Concrete masts	120	416

Concrete masts with mortar foundation cannot stand as long as those with sand filled foundation when a bigger earthquake hits

Developing a new type mast which may bend, but not break in earthquake



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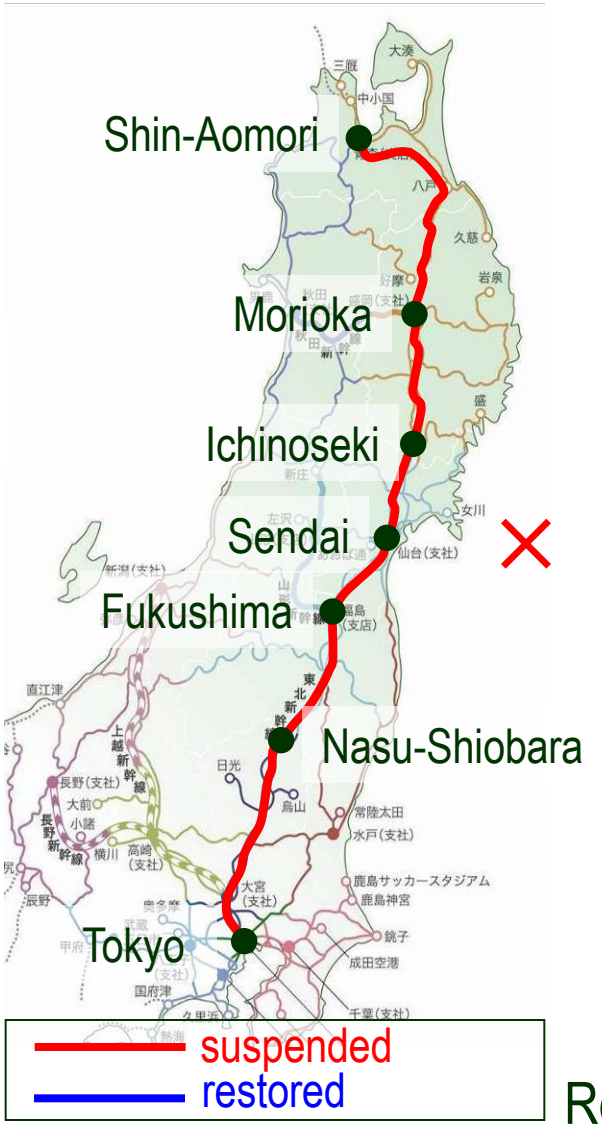
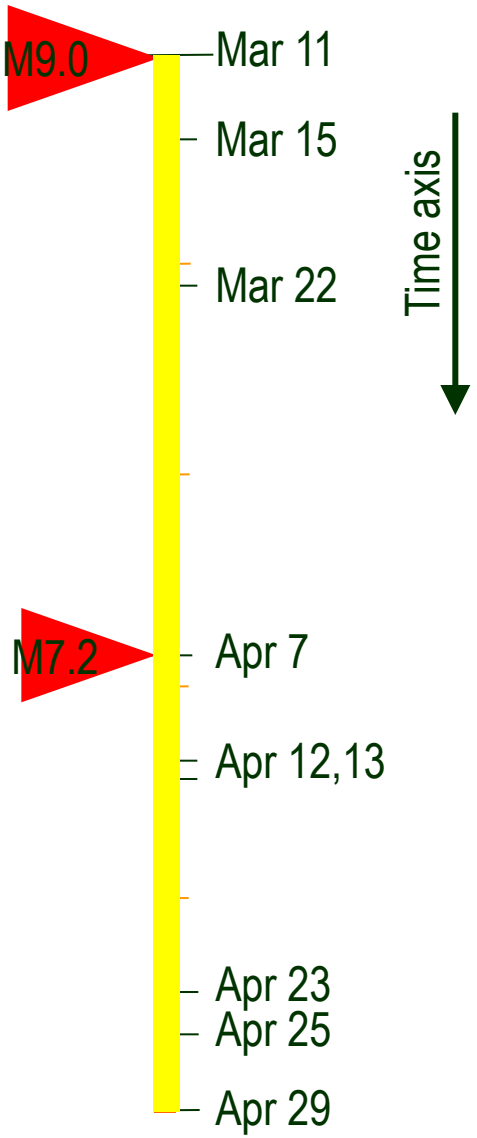
Restoring Shinkansen Operation after 3.11

◆ Tohoku Shinkansen





Restored whole operation at the 50th day after 3.11

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Future Plans

New Shinkansen Segments opening soon

3 years from now (to Shin-Hakodate)

Tohoku Shinkansen Extension

2 years from now (to Kanazawa)

Hokuriku Shinkansen Extension

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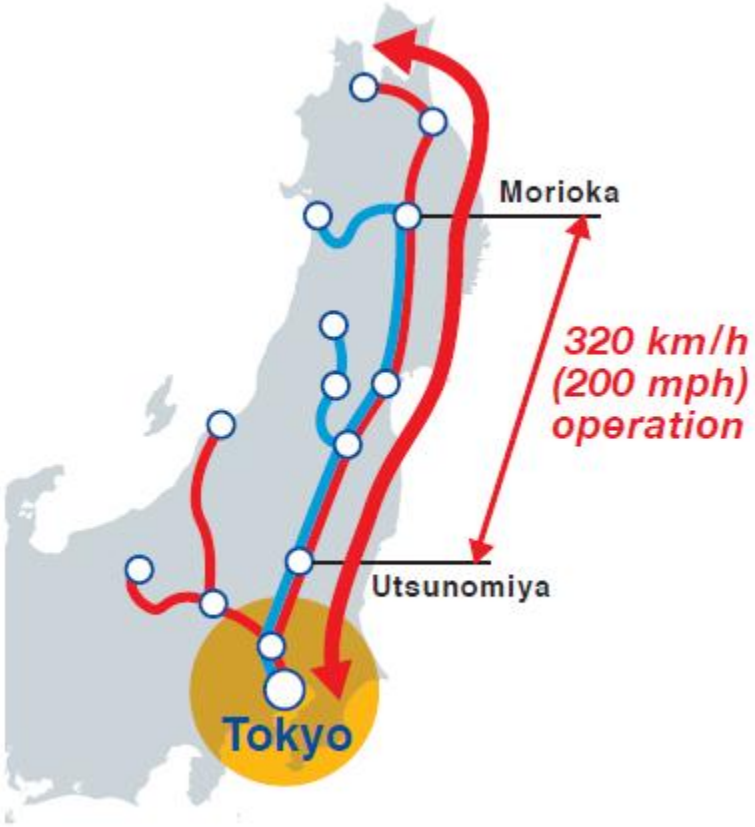
Future Plans

High-speed

Technological development to exceed 320 km/h



Speed-up of JR East Shinkansen (Test Running)

1988-1991 → **1991-1998** → **2002-2009**

Series 400
(Yamagata Shinkansen, "Tsubasa")
top speed:
345.8 km/h (215 mph)

STAR21
High-speed test train,
top speed:
425 km/h (265 mph)

FASTECH360
- Improved transport
- High reliability
- Top comfort
- Eco-friendly

In the future we will speed up to 360km/h.

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Thank you for your attention