

Development of Real-time Integrated Railway Safety Monitoring & Control System

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Mission & Roles

Creative Rail Innovator, **KRRI**



Mission

Develop the Korean Railway Industry through R&D on Railway Technology, Operation, Policy, and Applications



Roles

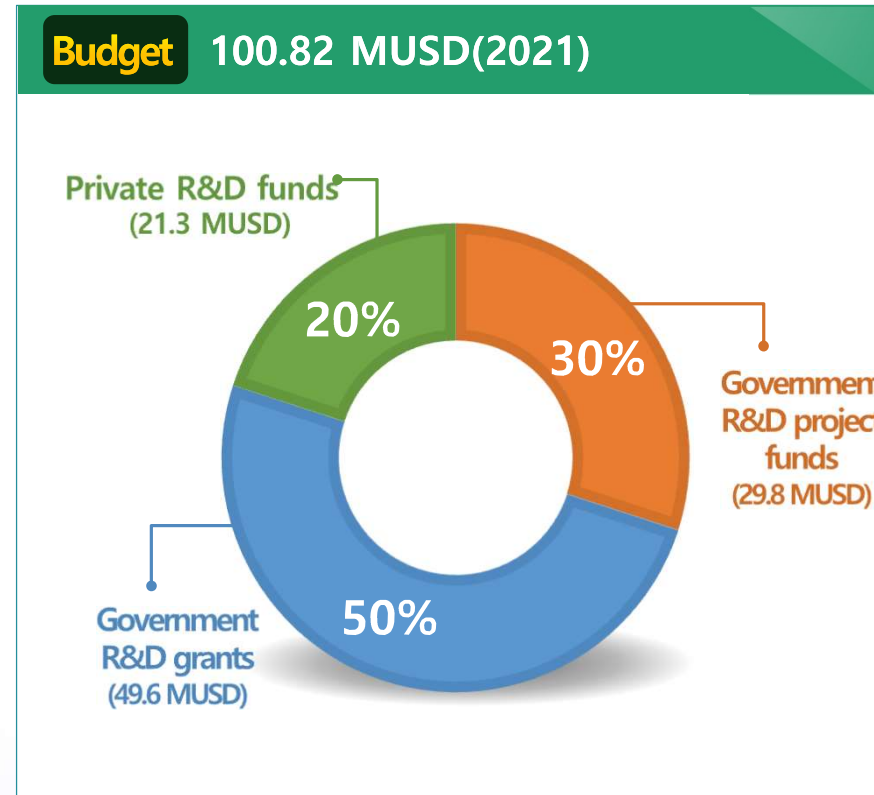
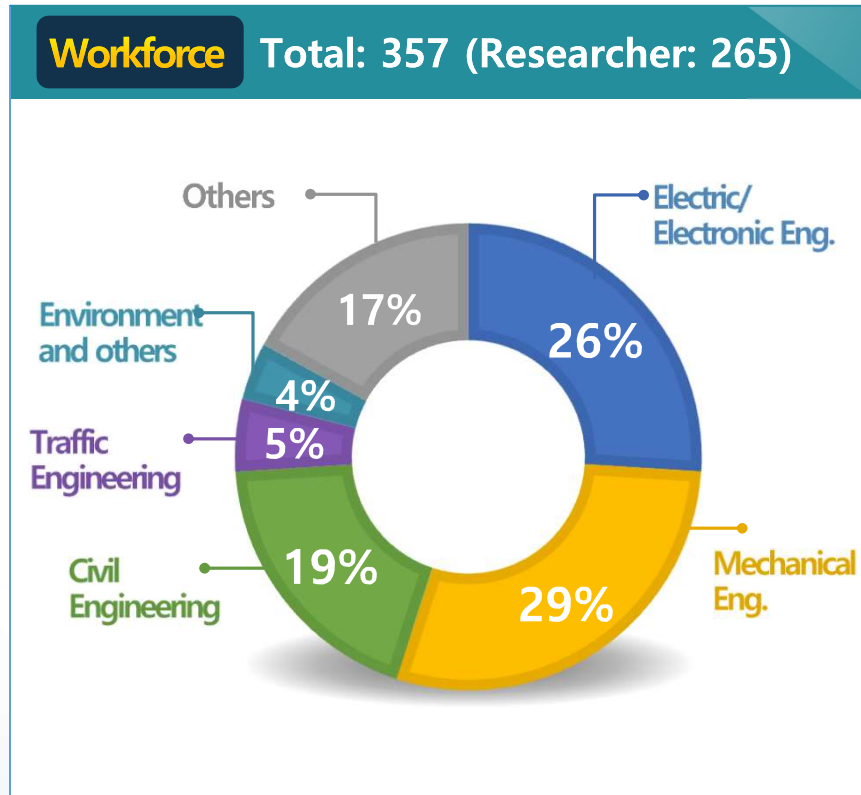


- R&D on Core Technology, Policy, Safety & Logistics
- Development & Application of HSR, LRT, TTX
- Rail Network Expansion & Continental Connections
- System Standardization, Assessment & Certification

Workforce & Budget



2021.10



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» 5. Future Plan





**Real-time Integrated Railway Safety
Monitoring & Control System
Project Overview**



Research Background (Recent Accidents)



22 Apr 2016 15:51 / Train derailment accident
200m ahead of Yulchon Station (1 Killed, 8 Injured)

- ✓ Vice engineer driver : 'I thought that I supposed to change the track at Deokyang Station.'
- ✓ Controller : 'I sent a radio to change the track at Yulchon Station'
- * During up-line drive because of track maintenance of down-line



13 Sep 2016 0:50 / Near Gimcheon-Gumi Station Casualty accident during track maintenance (Hit by KTX, 2 Killed, 2 Injured)

- ✓ Worker : 'Work schedule was approved'
- ✓ Supervisor : 'Didn't request a work'
- * Train delays due to earthquakes



2 May 2014 15:32 / Train Collision at Sangwangsimni Station
(388 Injured (serious injury : 38 people))

- ✓ Incorrect signal by fault of interlock device (stop → drive)

Requirement of **Monitoring and Control**
about **Risk of Real-time Situation**

Support of
automated decision making

Needs from analysis of current status and problems



(1) Requirements of real-time integrated railway monitoring and control system

- Although a lot of information is generated through the safety sensors and facilities in the railway field, it is not utilized properly to manage safety operation and accidents.
- It is necessary for the engineer drivers and controllers who play a major role related to safety to receive the situation of the railway field in real time.
- Also, it is necessary to improve system to detecting accident risk and responding appropriately for railway safety.

(2) Problems of existing railway safety management

- Ensure safety through safety assessment when designing and constructing system (vehicle, signal, facility)
- In operation phase, risk-based safety management is operated based data from design and construction, but it is not managed in real time.

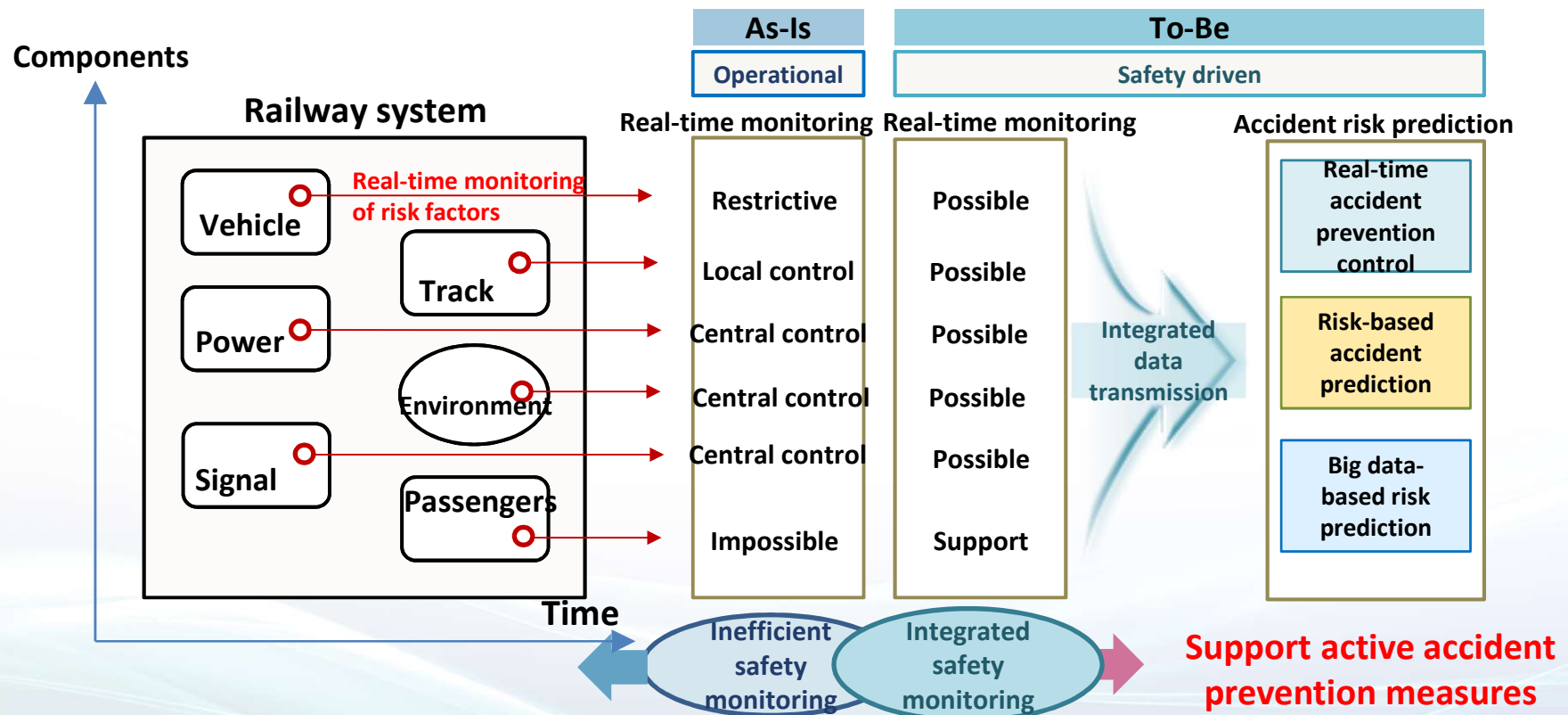
(3) Problems of existing "operation control" system

- In the existing "Operation control", some key information is collected in real-time to manage operation. However, these data are fragmented rather than integrated.
- It is not available to detects accident risk by collecting/analyzing safety information and, can not preemptively prevent accidents using safety information.

Settlement of As-Is & To-Be



- Current status of safety monitoring system in Korea
 - Data gathered from the sensors at the railway site is not utilized properly
 - Need to develop real time system for traffic controllers to evaluate risks
 - Current system is not real time and is components bases



Research Target



For World-best Railway Safety and International Competitiveness
Real-time Integrated Railway Safety Monitoring and Control System

- Development of ICT-based **Railway Safety M&C Platform** for Smart Railway Safety Management
- Development of **Accident Risk Prediction Technology** for World-best Railway Safety and International Competitiveness
- Development of **Railway Safety Decision Support System** for Reducing Railway Accident and Maintenance Costs

Railway Safety Goals of Korean Government

- ✓ Large railway accident : "Zero"ization
- ✓ 20% reduction in deaths per 100 million km compared to last year ('10(42)~'19(34))
- ✓ 3% reduction in train accidents per 100 million km compared to last year ('10(10.9)~'19(8.4))
- ✓ 3% reduction in deaths per 1 billion passengers / km compared to last year ('10(0.22)~'19(0.16))

Organization of R&D project

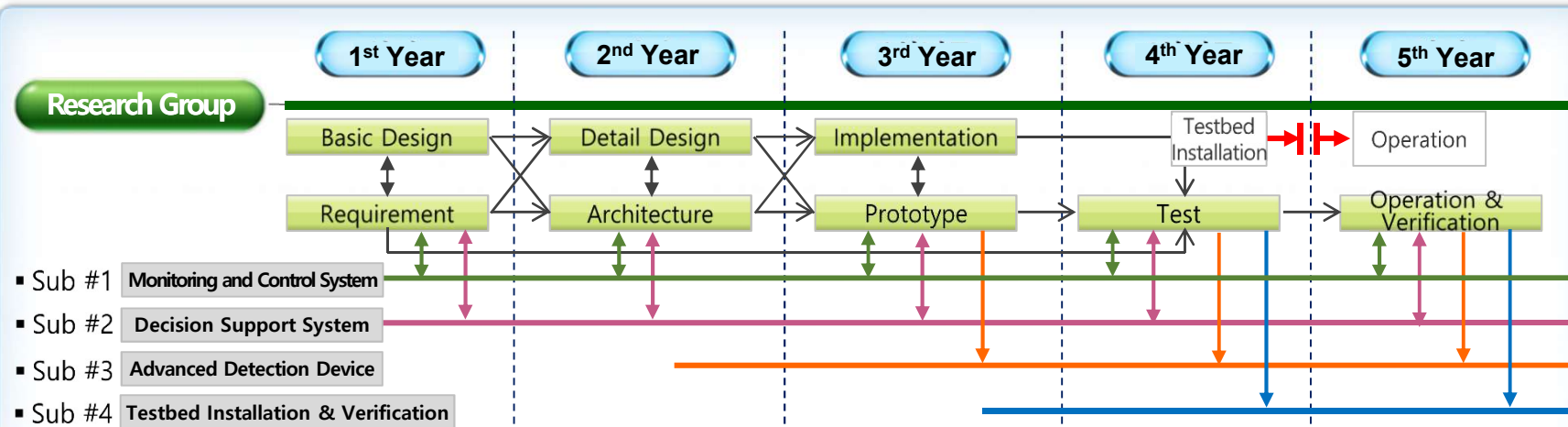


Schedule of R&D



Yearly Plan of Research Development

Total Period : Aug 2014~Sep 2019



1

Real-time Railway Safety M&C System

- Achievements : Safety M&C Platform, Interface device, Accident Prevention & Control System
- (1)Basic Design => (2)Detail Design => (3)Prototype Implementation => (4)Test and Testbed Installation => (5)Operation and Verification

2

Real-time Railway Safety Decision Support System

- Achievements : Real-time Risk Monitoring System, Big Data Integration Platform
- (1)Basic Design => (2)Detail Design => (3)Prototype Implementation => (4)Test and Testbed Installation => (5)Operation and Verification

3

Advanced Development of Safety Detection Device

- Achievements : Train Status Monitoring Device, Train Approach Indicate, Optical Intrusion Detector... (Total 6 Devices)
- (2)Device Design => (3)Device Prototype => (4) Test and Testbed Installation => (5)Operation and Verification

4

Testbed Installation & Verification of Real-time M&C System

- Achievements : Construction and installation on testbed and operation & verification of system
- (3)Design plan of testbed => (4) Construction and installation on testbed => (5)Testbed operation and verification

Scope of Research Development



[Sub-proejct#1] Real-time Railway Safety Monitoring and Control System

Real-time Railway Safety M&C Platform

- Effective **safety information sharing system**
- Safety index-based **real-time accident risk monitoring**
- GIS-based console for safety monitoring



- **Collect** real-time integrated railway safety **data** from devices
- Responding to **immediate risks** and providing **integrated safety data** to users

Interface Device

- Data collection from devices
- Protocol&Data conversion
- DDS Data transmission

[Sub-proejct#2] Real-time Integrated Railway Safety Decision Support System

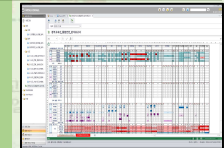
Real-time Risk Monitoring System

- Alert of predicted accident risk
- Evaluation of railway risk



Big Data Integration Platform

- Big data analysis
- Big data-based prediction of railway accident risk



- Support **decision making** for railway safety by providing **risk prediction information**

Provide Real-time Safety Data

Provide info. of decision support

Deliver Real-time Safety Data

Off line

취급에 따른 각종 사고정보

기존 안전검지장치 및 현장 운영데이터

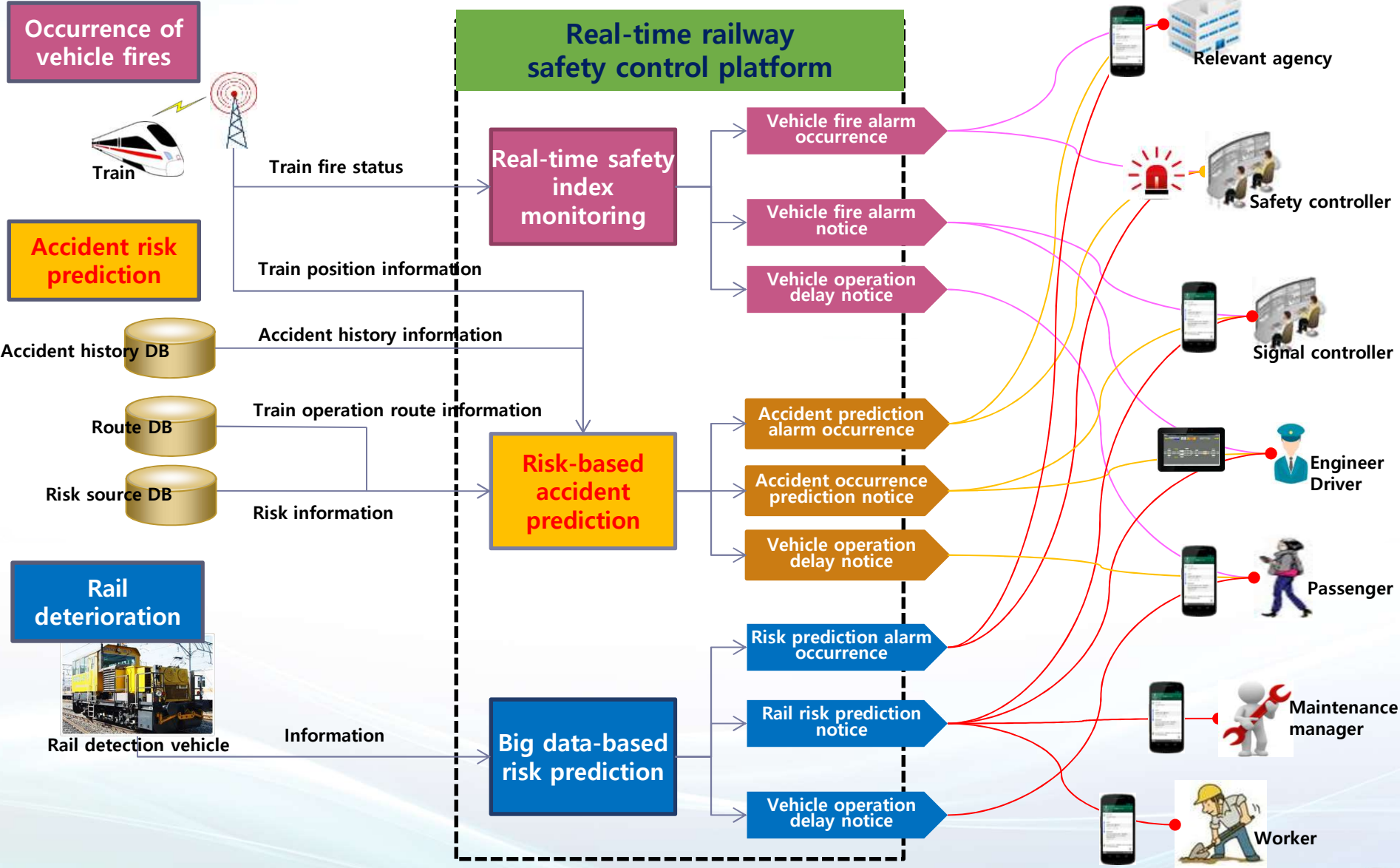
[Sub-proejct#3] Advanced Development of Safety Detection Device



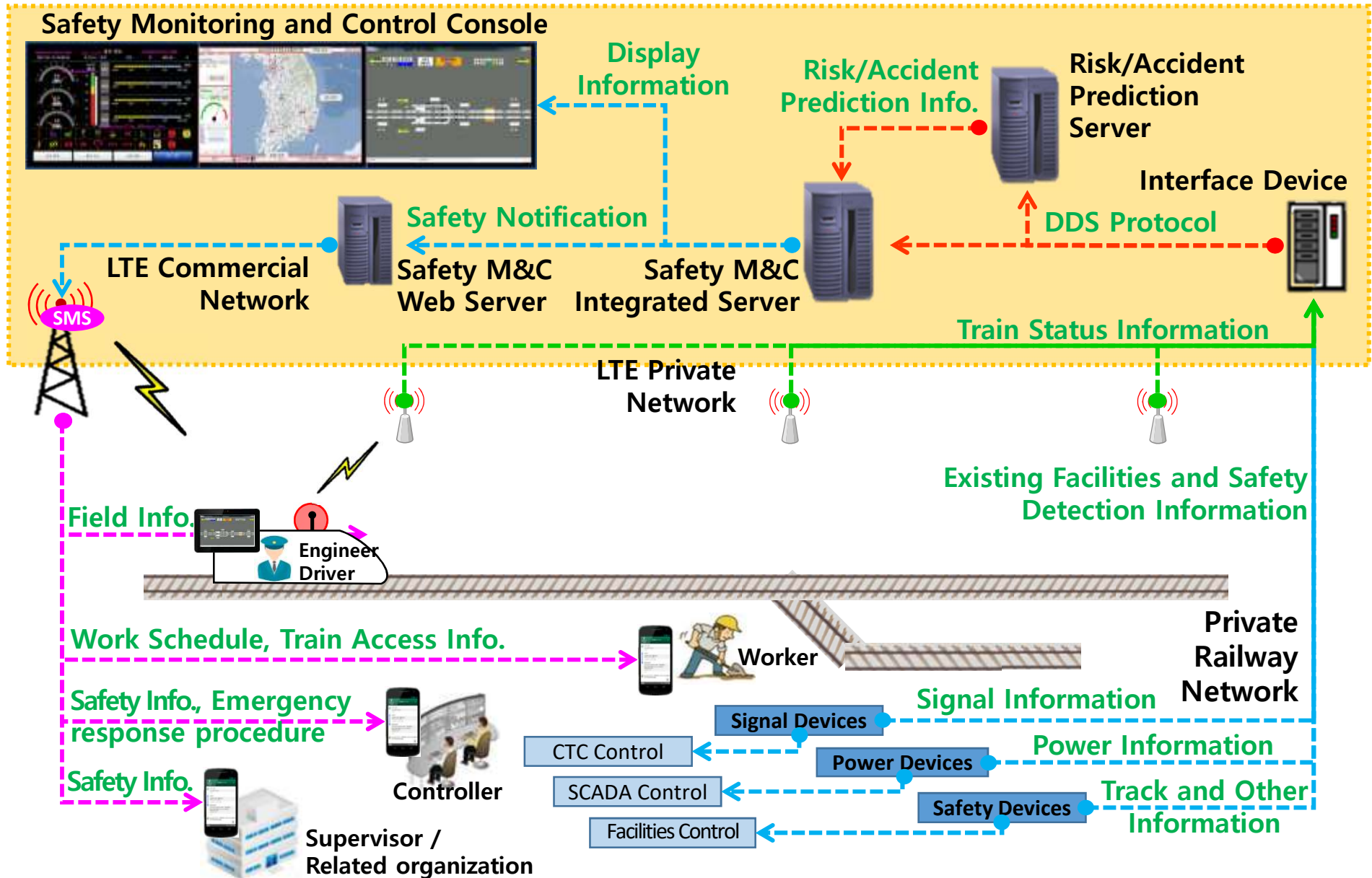
- Performance improvement and advanced development of railway safety detection device
- Provide railway safety data from device

* [Sub-project #4] install and verification of achievements of other sub-projects on testbed

Example Scenarios for safety monitoring and control



Real-time Integrated Railway Safety Monitoring and Control System



Monitoring and control system to enhance safety for train operation



II

Detail of Real-time Integrated Railway Safety Monitoring & Control System

Research Goal and Scope



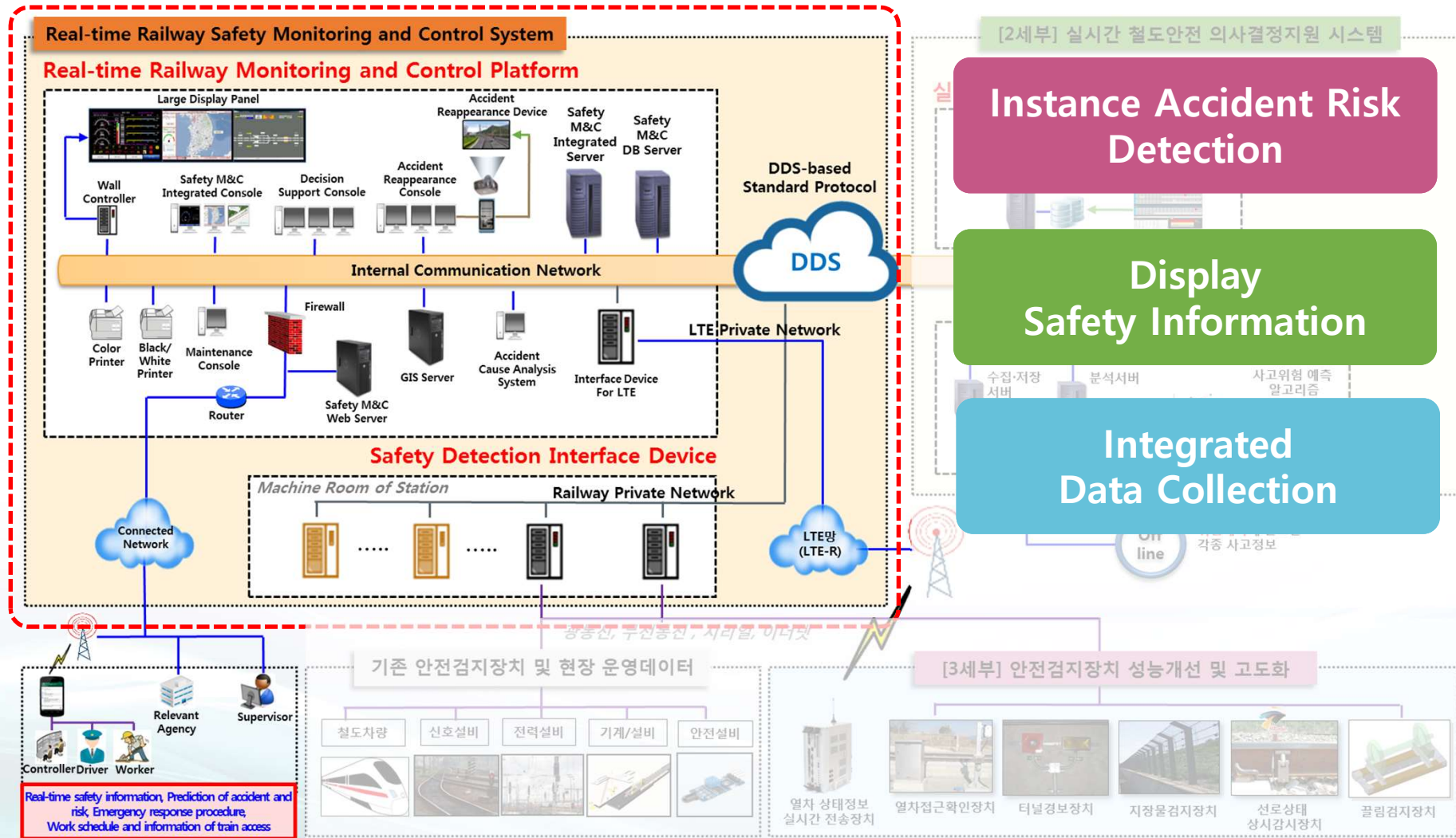
1st Year
Basic Design

2nd Year
Detailed Design

3rd Year
Implementation

4th Year
Testbed Installation

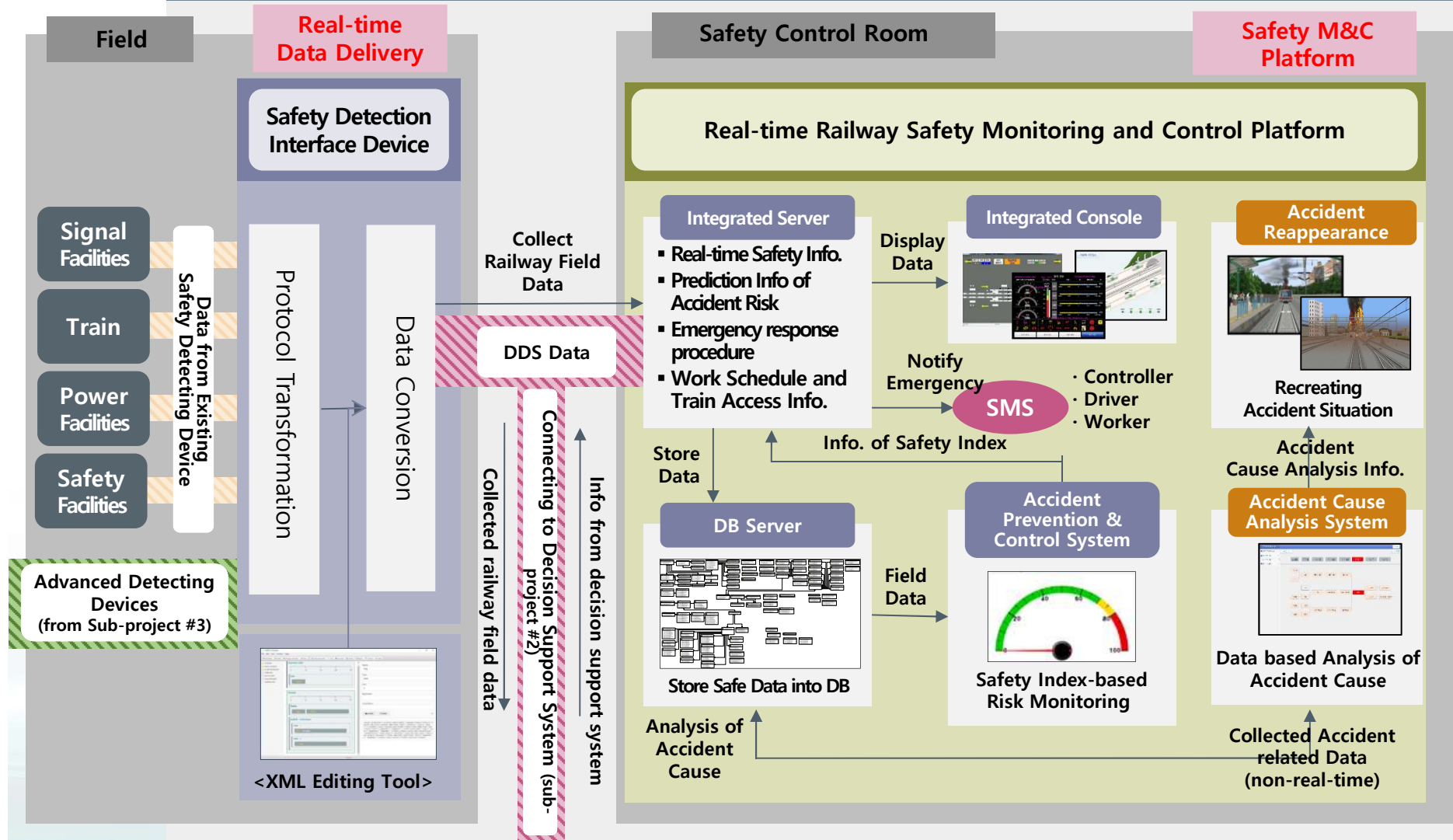
5th Year
Testbed Verification
and Supplement



Major Achievements



Real-time Integrated Railway Safety Monitoring and Control System



Real-time Railway Safety Monitoring and Control Platform



Real-time Railway Safety M&C Platform

Development of GIS-based Integrated M&C Module for Safety Facilities

- 3 Monitors for Safety Monitoring : center monitor displays GIS-based information for effective safety monitoring
- Each screen is implemented as a module for system scalability
- Implementation of Total 23 Screens for Safety Monitoring : Train Monitoring Screen(4), Signal and Station Monitoring Screen (3), SCADA Monitoring Screen (3), Facility Monitoring Screen (4), Safety Facility Monitoring Screen (9)



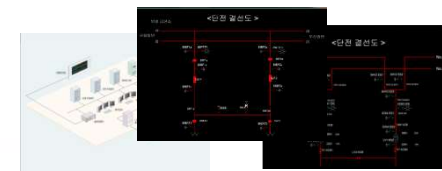
<GIS-based Console Screen Layout>



<Train Monitoring (4 screens)>



<Monitoring of Signal and Station (4 screens)>



<Monitoring of SCADA (3 screens)>



<Monitoring of Machines and Facilities (4 screens)>



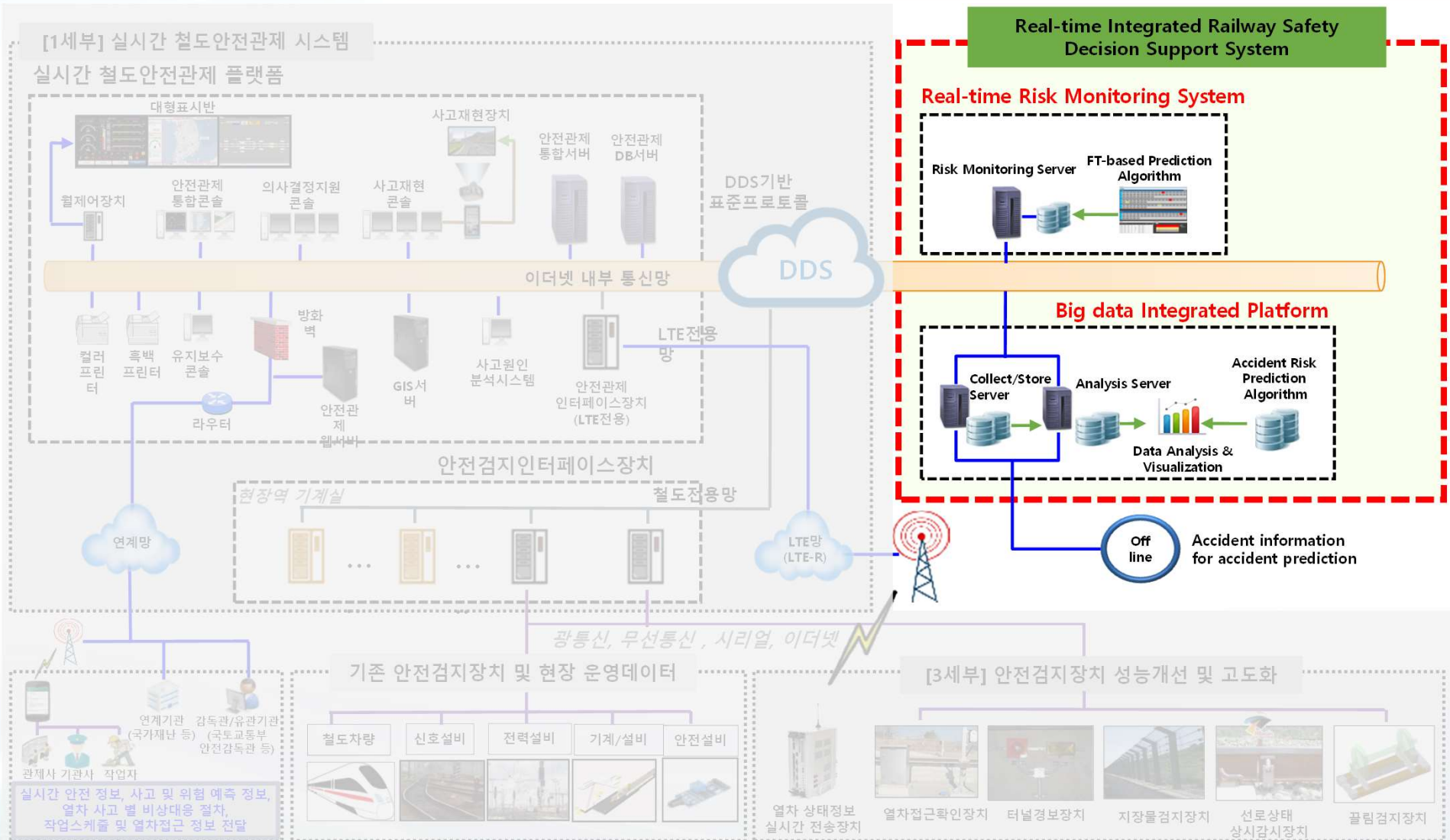
<Monitoring of Safety Facilities (9 screens)>



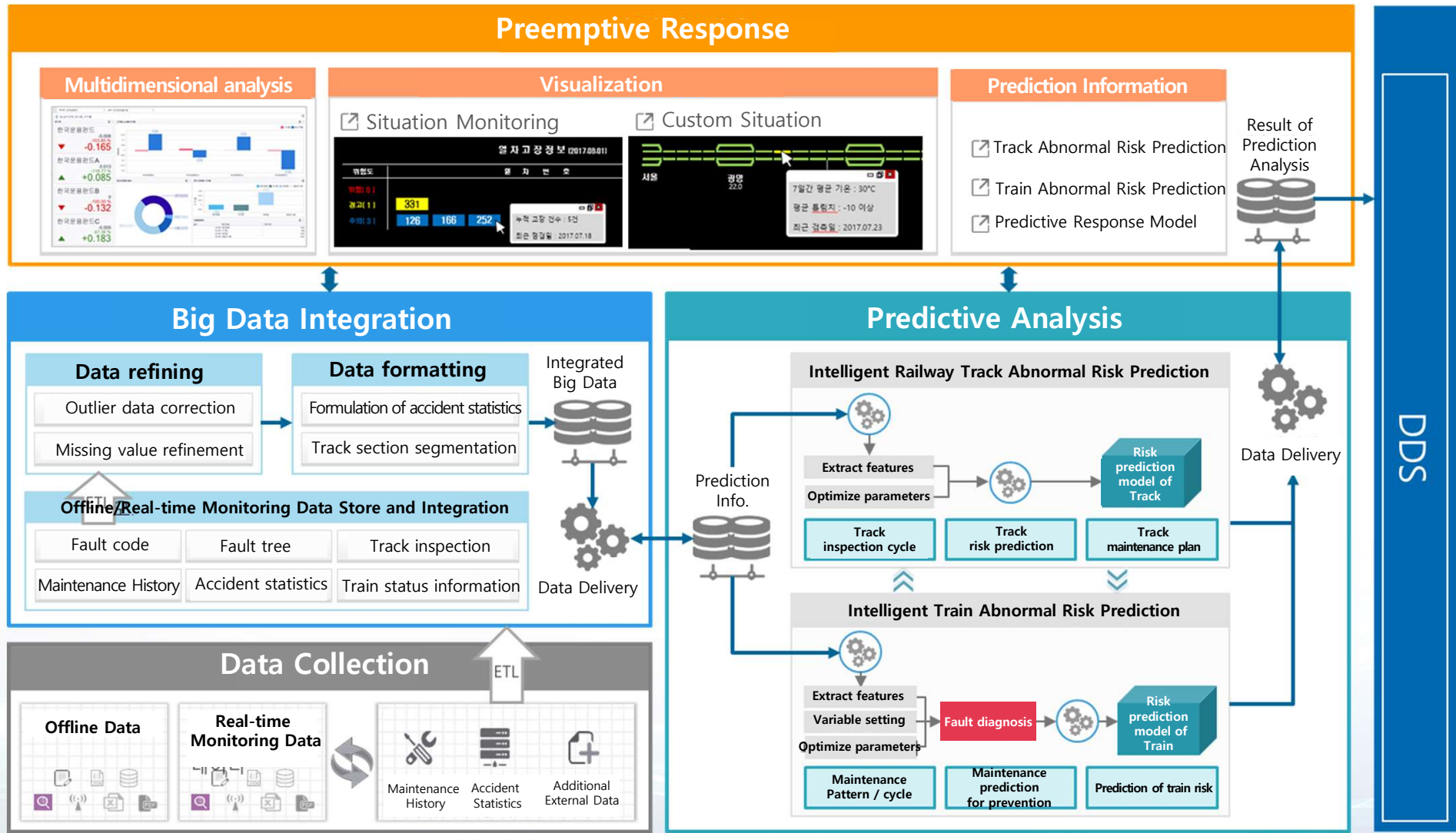
III

Big data-based Railway Accident Risk Prediction System

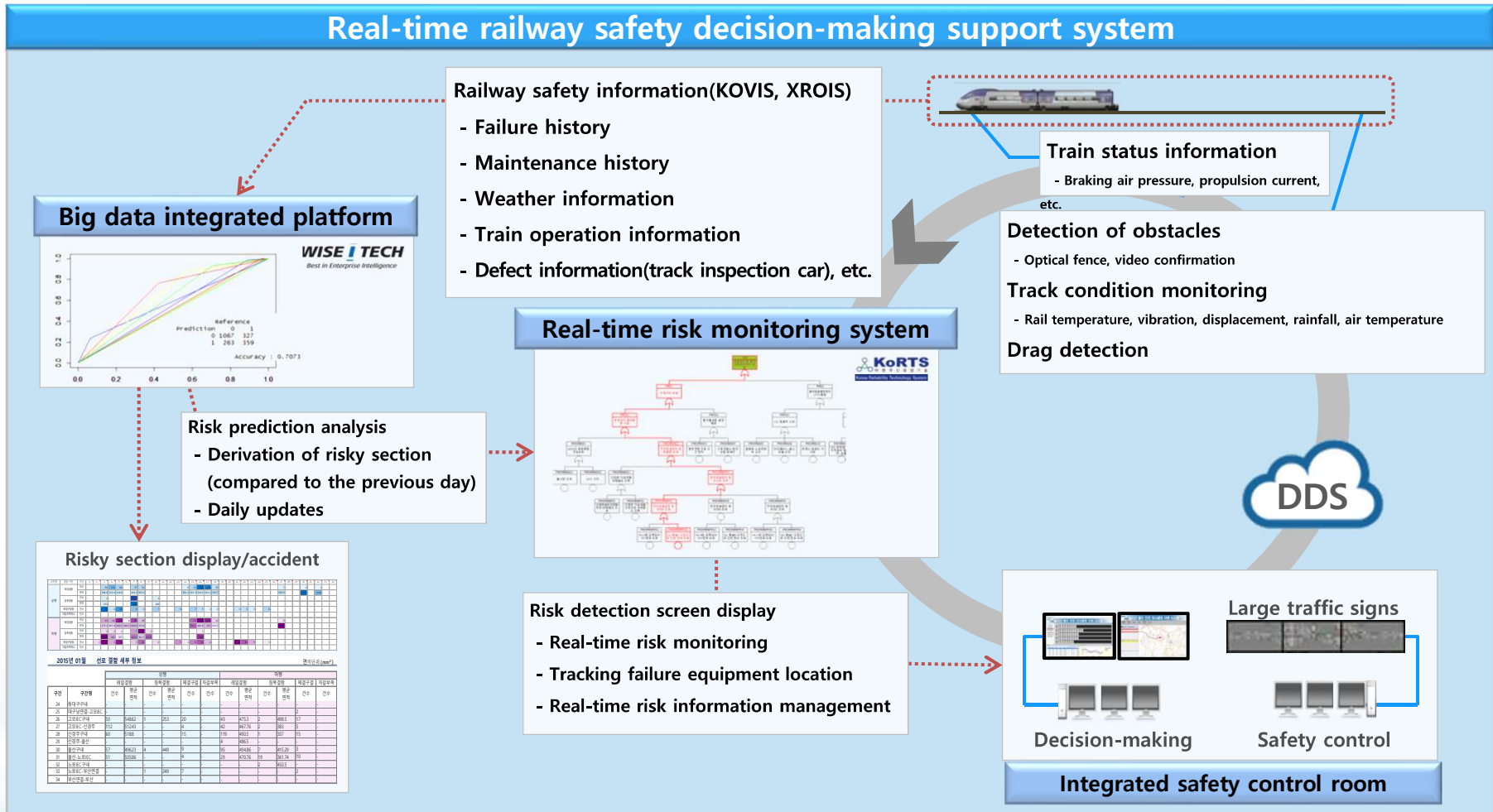
Research Goal and Scope



Big Data Integrated Platform



Major Achievements





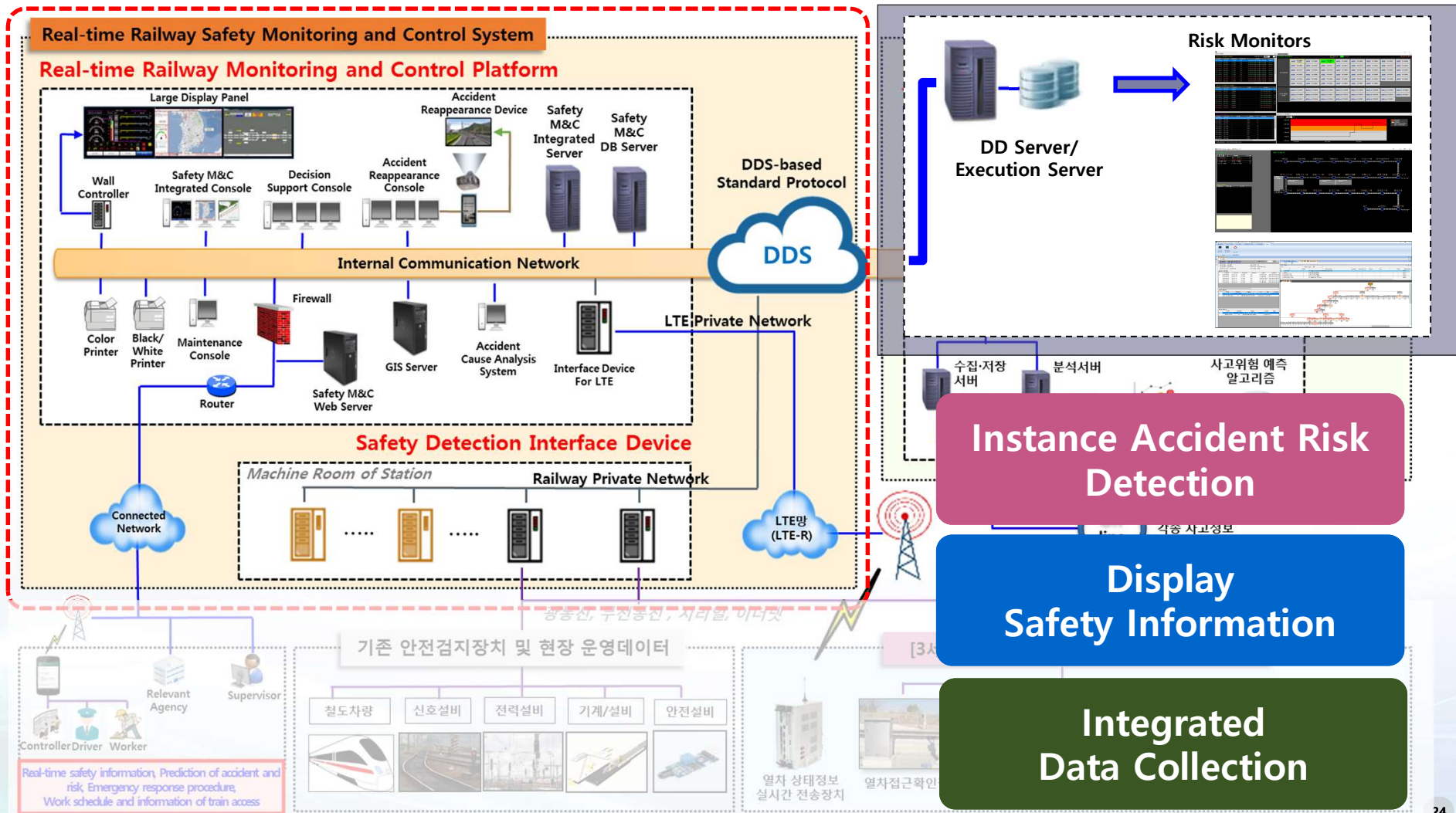
IV

Real-Time Risk Monitoring System

Scope and Configuration



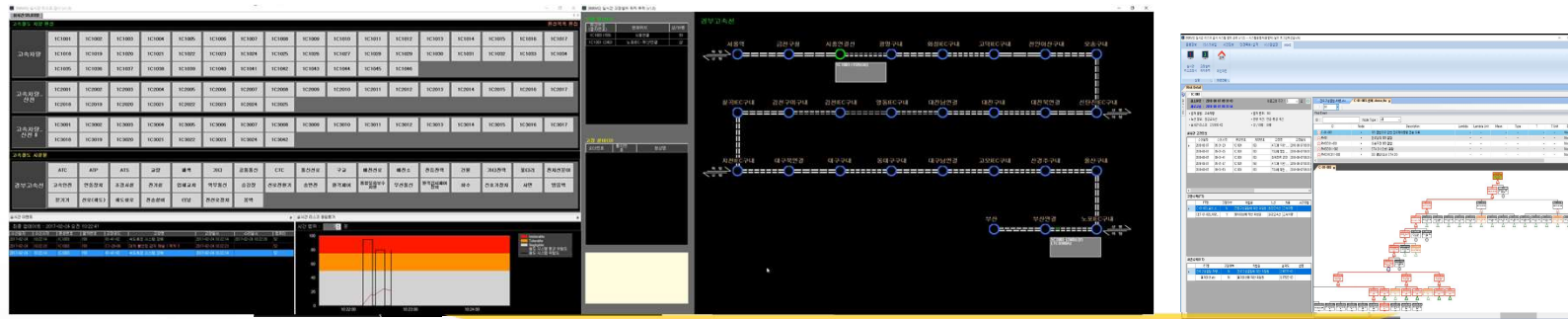
Real-Time Risk Monitoring System



Features



- ❑ Monitors hazard(s) of railway system that occur during the operation
- ❑ Evaluates the current risk of the train system given the hazard(s), based on pre-defined FT/ET models
- ❑ Locates and displays the position of failure(s) along with the movement of rolling stock in operation
- ❑ Helps the operator to perform the preventive action to deal with the failures



Fault location and Risk display

Risk evaluation using FT/ET





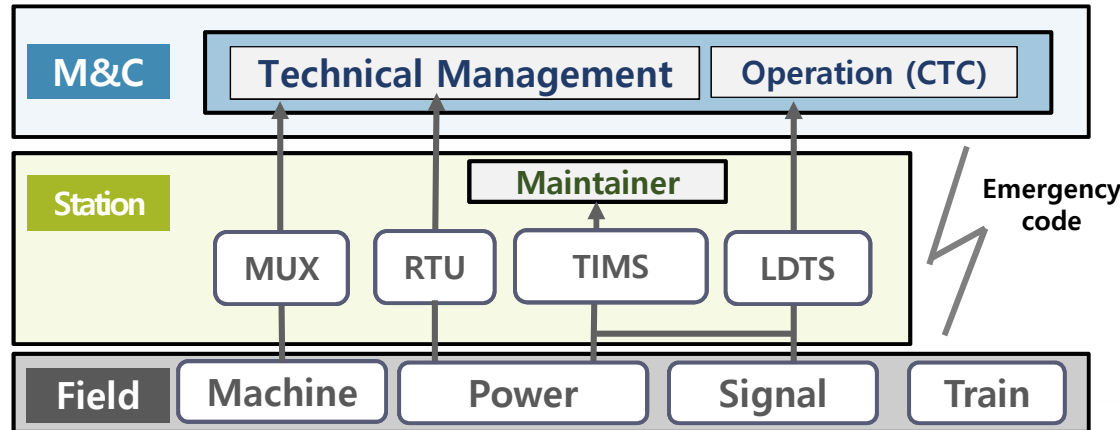
Advantage & Future Plan



Technical Advantages

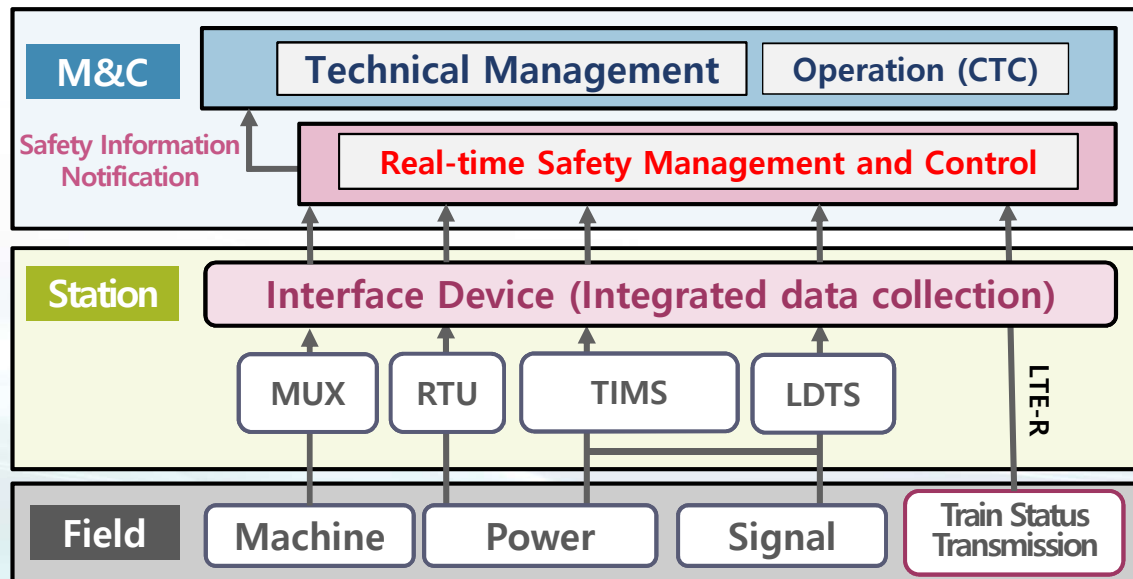


Existing operation control(AS-IS)



- Non-real-time data collection
- Fragmentation of information
- Limited information sharing system

Real-time Integrated Railway Safety Monitoring & Control System (TO-BE)



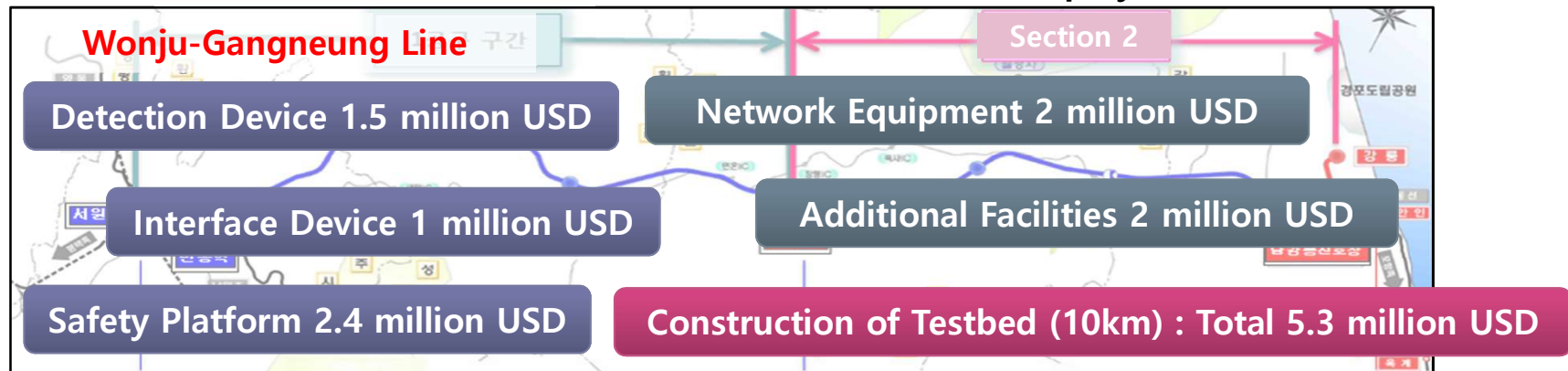
- Real-time data collection
- Integrated analysis of information
- Effective information sharing system

How to Use & Expand it



Construction of testbed

(Sub-project #4, from 2016)



Extended application

Easy extension to other railway routs

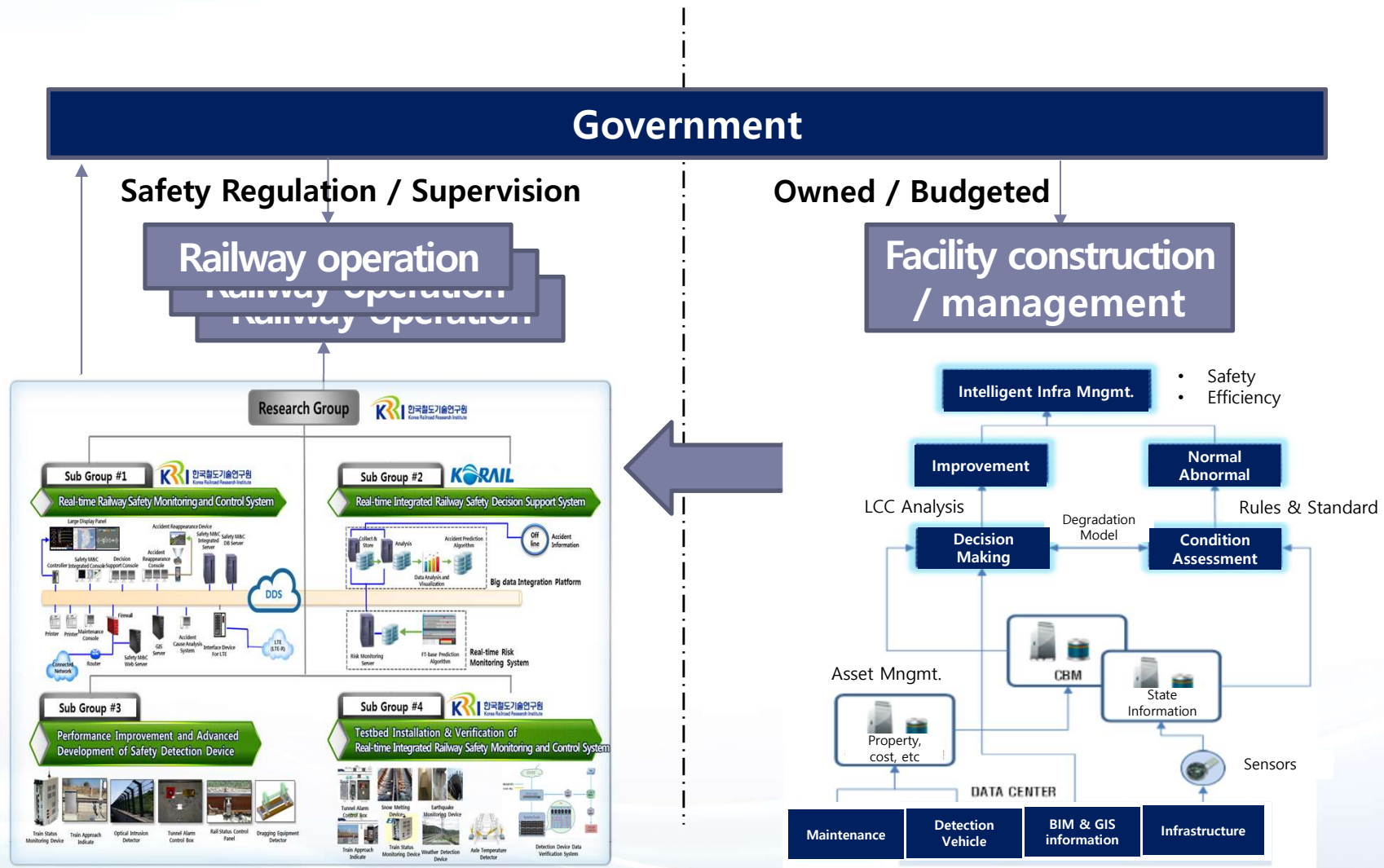
- Only additional detection device, interface device, network equipment is required for extension

* Platform and additional facilities are already installed

System operation and commercialization

- **(Operation)** Automated system that can be operated by minimum number of operators by integration with existing operation system
- **(Commercialization)**
 - Installation cost of existing operation control(CTC) : 3 million USD per line
 - Installation cost detection device : 0.7 million USD per km (seems to be cost-effective)
- **(Partial Commercialization)** Available of partial commercialization by customizing of each device and system

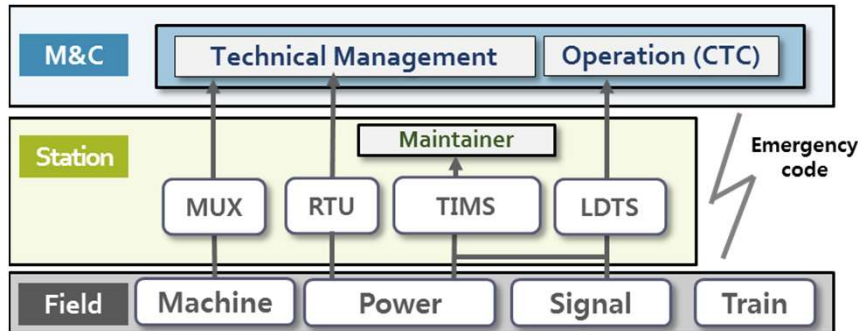
How to Use & Expand it



How to Use & Expand it

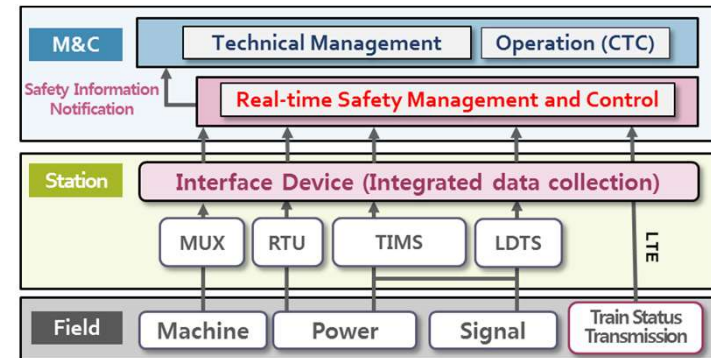


Existing systems



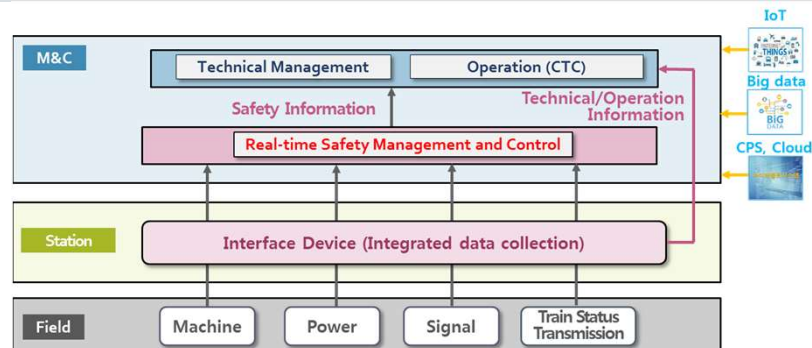
- SENSING : X
- COMM : OPTICAL
- Analysis, Prediction & Control : CONTROL
- IoT/Cloud : X

Features of this R&D



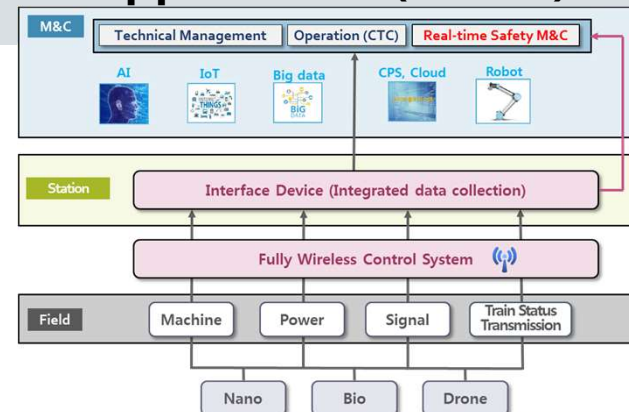
- SENSING : O (Limited)
- COMM : Wired/wireless, Middleware
- Analysis, Prediction & Control : Big data Analysis(Machine Learning)
- IoT/Cloud : IoT

Further applications (~2030)



- SENSING : Intelligent, Non-powered
- COMM : Wired/wireless, Middleware
- Analysis, Prediction & Control : Deep Learning
- IoT/Cloud : IoT, Cloud

Further applications (2030~)



- SENSING : Nano, Robot, Drone
- COMM : Wireless, Middleware (Tiny-DDS)
- Analysis, Prediction & Control : Fully unattended monitoring control, AI
- IoT/Cloud : IoT, FoG

감사합니다

Thank You for your attention!!
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