

# Centralized technical management system for expressway tunnels



**4. OCT. 2018**

**Nam-Goo Kim**

## Profile



Nam-Goo Kim

Tunnel Fire Safety Engineer

- Korea Expressway Corporation (1995 ~ ),  
Team Leader (HQ)
- PIARC TC D5 member (2008 ~ )
- Educational Background
  - B.S. on Building Equipment
  - M.S. on Architectural Environment
  - M.B.A. , PhD(c) in Business Administration

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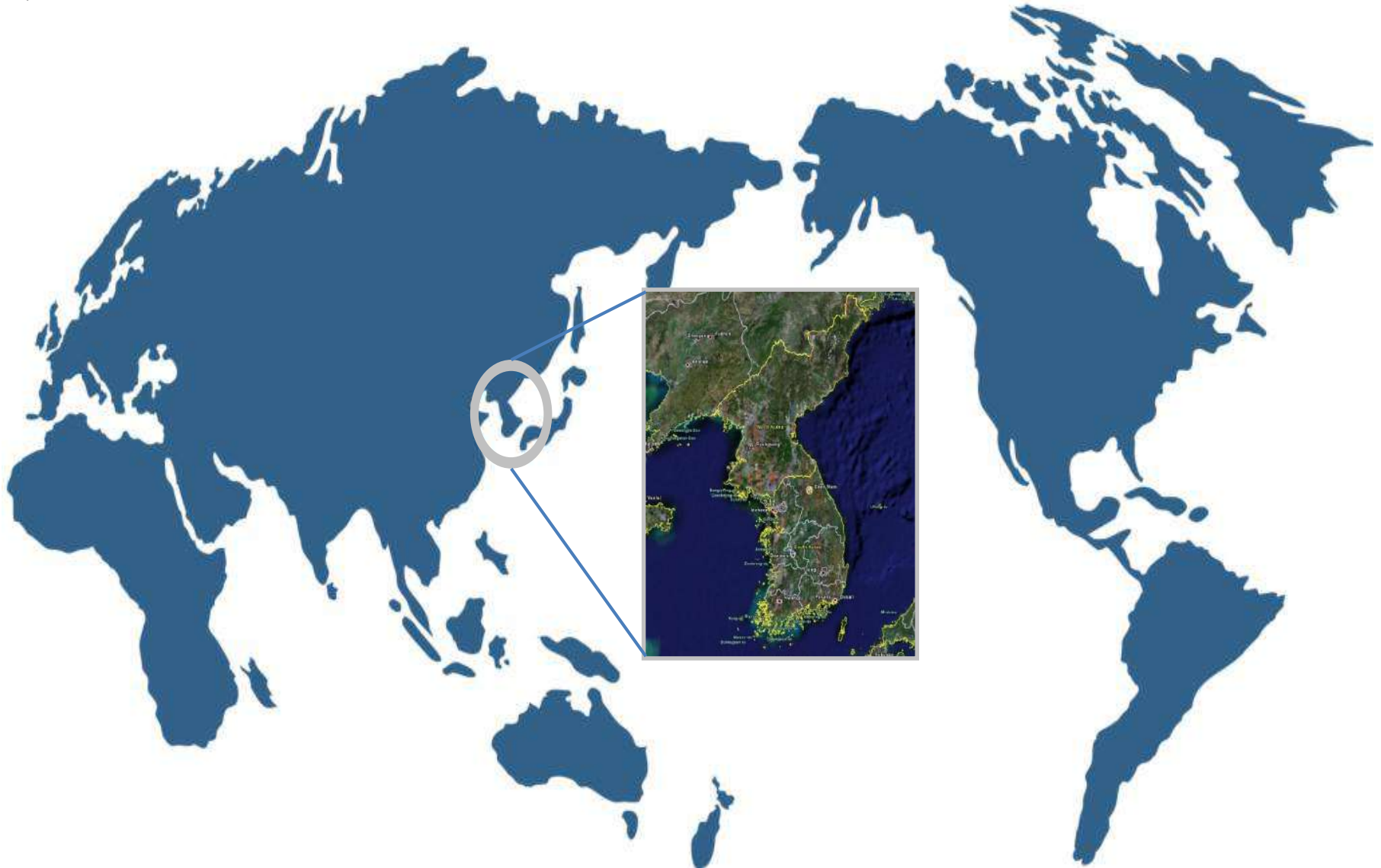
**III . Network & Zoning**

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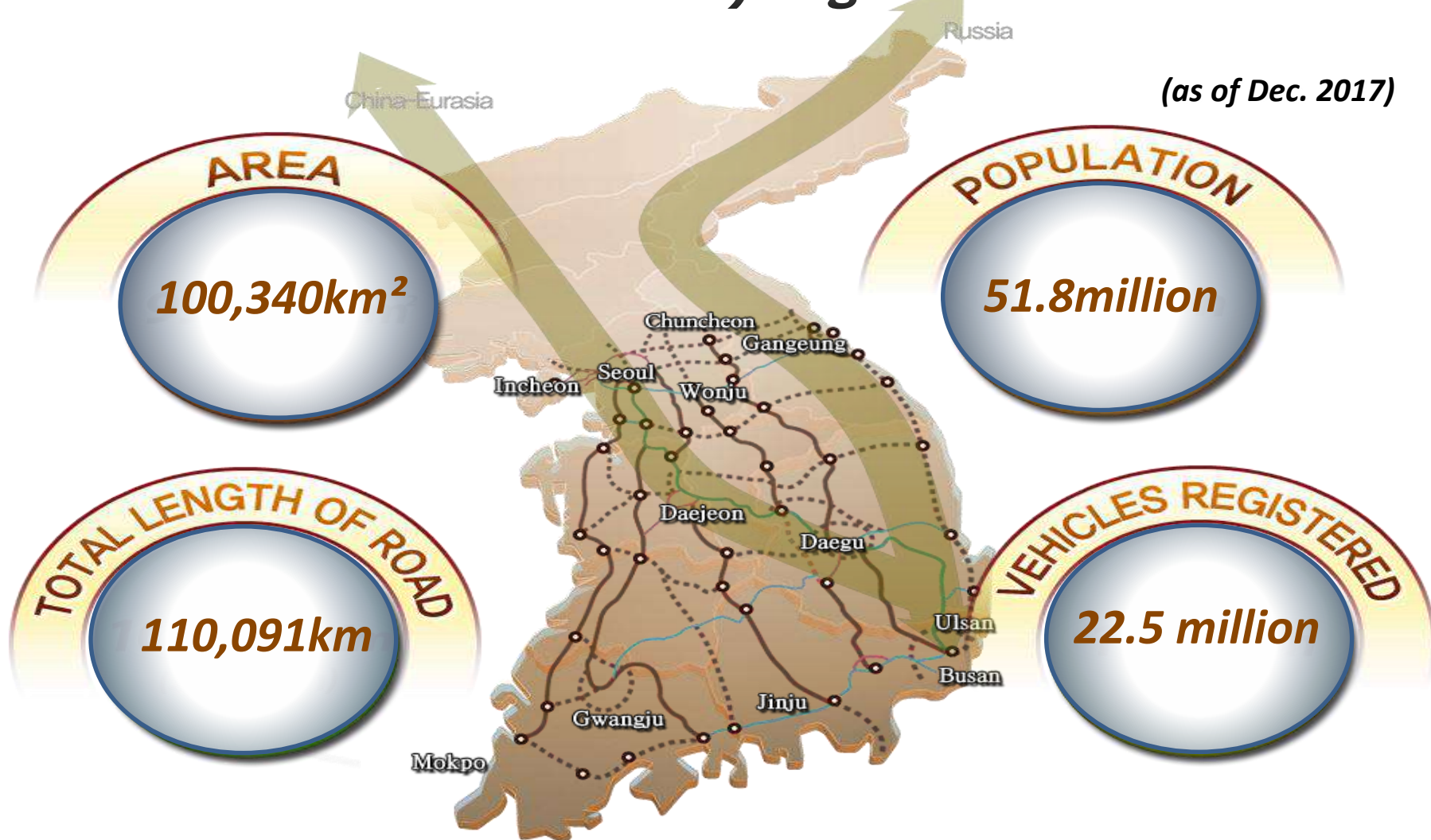
# I. Introduction of KEC

## 1 . Overview of S. Korea - location



# I. Introduction of KEC

## 1. Overview of S.Korea - Key Figures



# I. Introduction of KEC

## 1. Overview of S.Korea – Total Road Network

(as of Dec. 2017)

Type of Road	Authority	Length (km)
Total Length of Road Network		110,091
<i>Expressway</i>	<i>KEC(on behalf of MOLIT)</i>	<i>4,717</i>
National Highway	MOLIT	13,983
Special , Metropolitan City Road	Special Metropolitan City Government	4,886
Provincial Road	Provincial Government	18,055
City, County Road	City / County Government	68,650

※ MOLIT : Ministry of Land, Infrastructure & Transport



# I. Introduction of KEC

## 3. Roles of KEC

- ***Construction***
- ***Operation & Maintenance of Facilities***
- ***Traffic management***
- ***Research & Development***
- ***International Cooperation & Overseas Project***



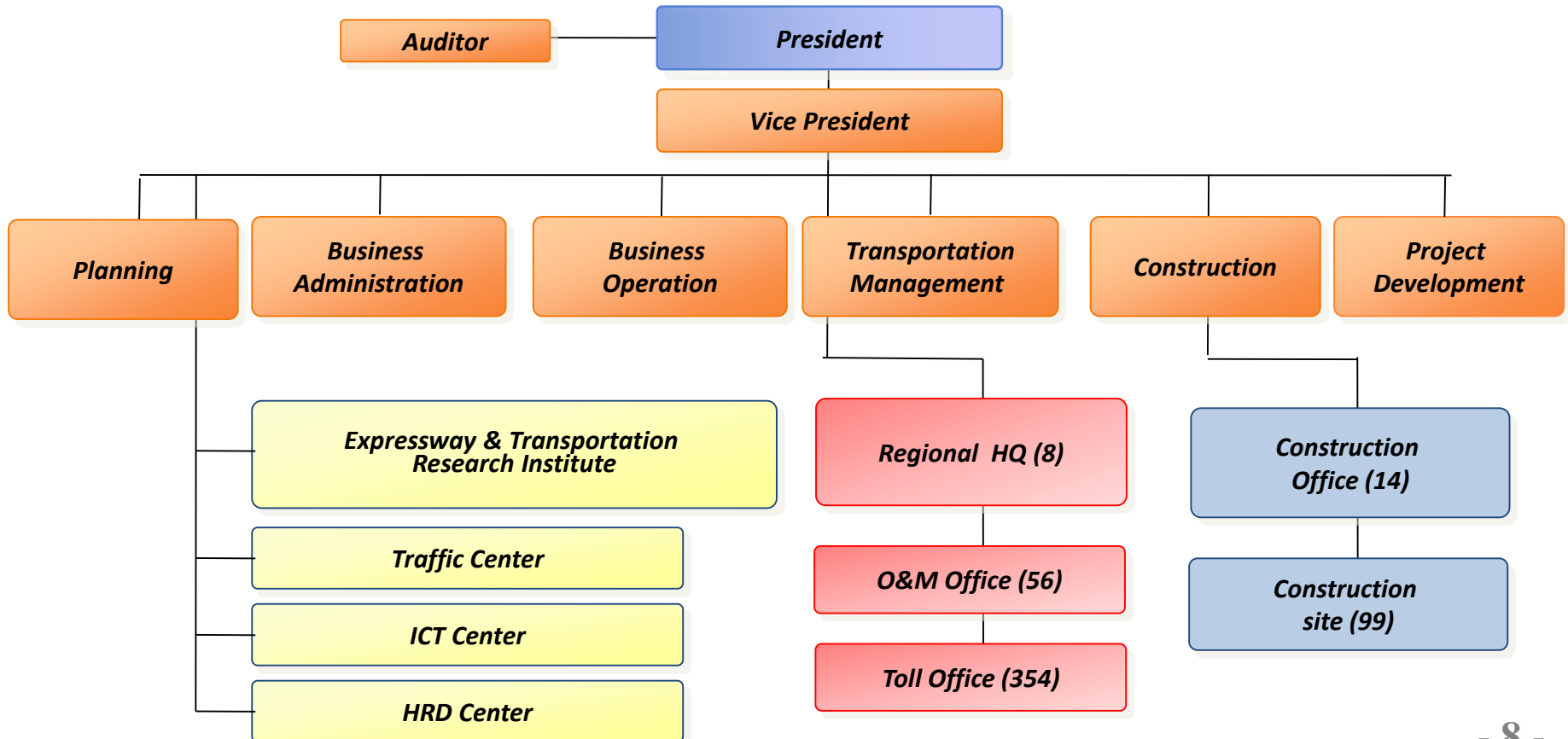
❖ *KEC performs these missions on behalf of the Korean government*



# I. Introduction of KEC

## 4. Organization

- **6HQ with 20 division**
- **8 Regional HQ, 8 R&D office, 14 Construction Office**
- **Total Staff : 6,076**



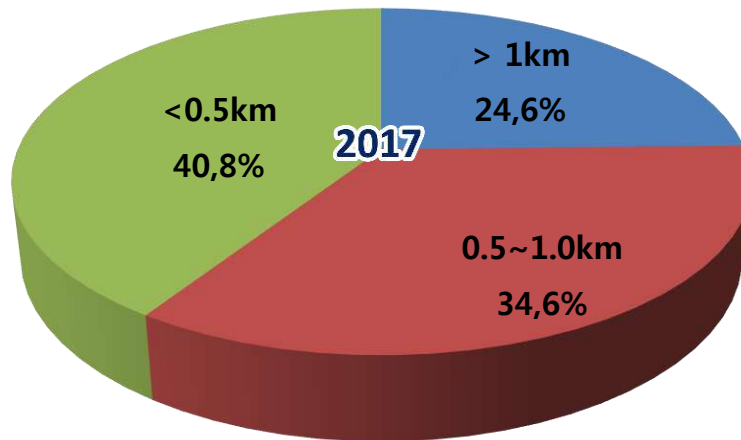


# I. Introduction of KEC

## 5. Tunnels & Bridges of Expressway

- **Tunnels : 532 (454km)**

- No. of over 1km : 131 / 1.0-0.5km : 184 / under 0.5km : 217



- **Bridges : 9,334**

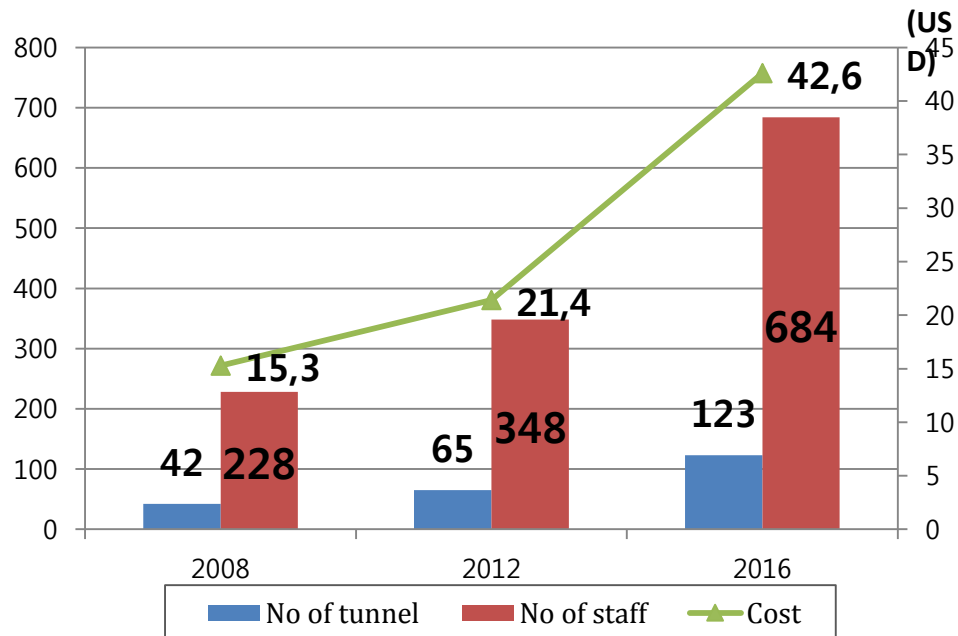
- No. of over 1km : 62 / under 1km : 9,272



# II. Background of Centralization

## Increasing number of tunnels and staff

	2008	2012	2016
No of tunnel (long tunnel)	232 (42)	316 (65)	479 (123)
No. of Staff	228	348	684
Cost(USD)	15.3mil	21.4mil	42.6mil



- To reduce increasing labor cost of operation staffs
- To increase the efficiency of tunnel O&M

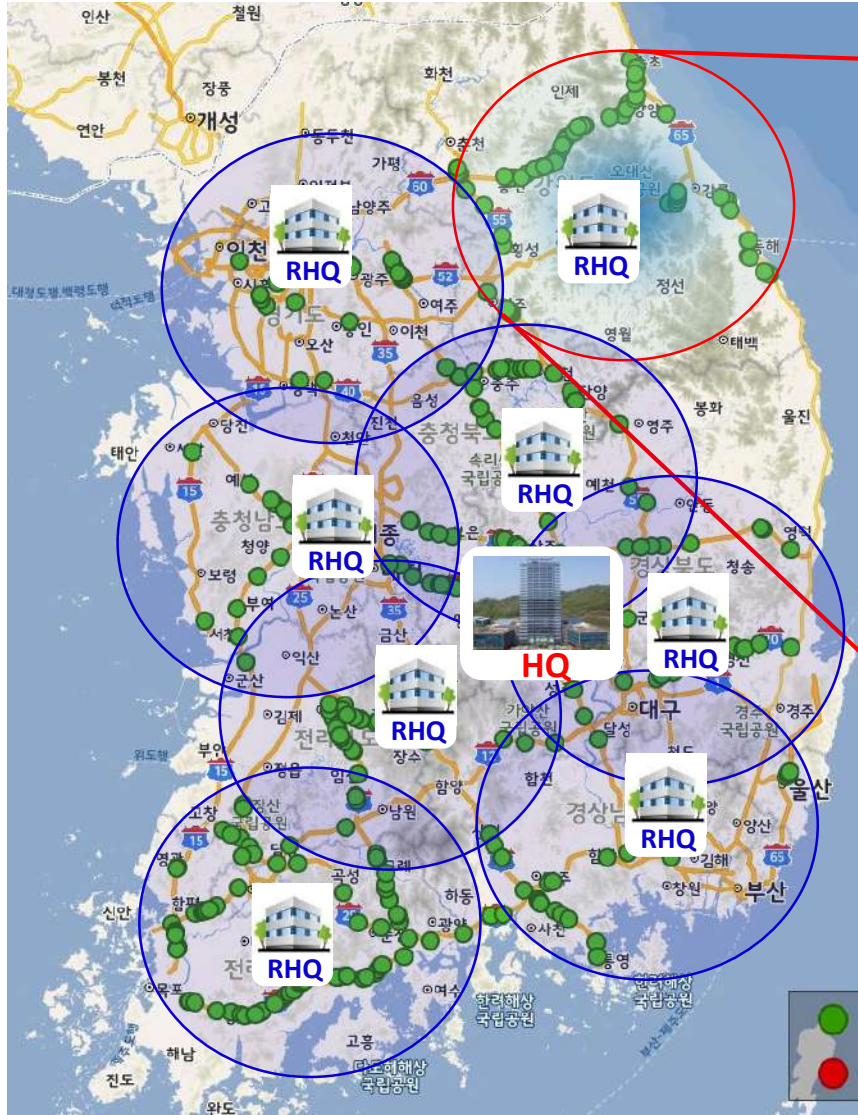
# II. Background of Centralization

## History

- ~ 1999 : Local control center & operation staffs for each tunnel
- 2000 ~ : 1<sup>st</sup> Intergrated Tunnel operation Center [Daeguanryung]
  - O&M for 12 tunnels [including 5 long tunnels]
- 2009 ~ : Adopt Centralized Management System
  - All systems of tunnels are connected by Fiber-optic network
  - Remote monitoring & control for group of tunnels  
at O&M office

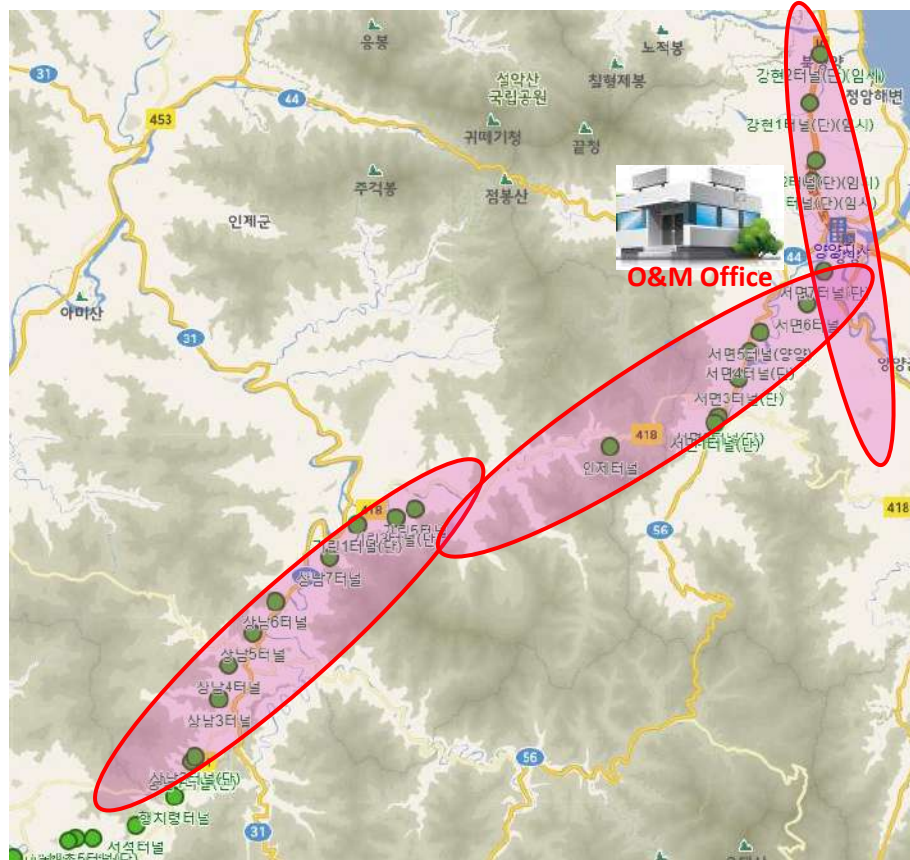
# III. Network & Zoning

## Korea Expressway Corp. HQ and 8 Regional HQ



# III. Network & Zoning

## Yangyang O&M Office



	Total	> 1km	1 ~ 0.5km	< 0.5km	Longest TN
No of tunnels	32	13	4	15	Inje tunnel(10.9km)

# IV. Systems and Operation

## Tunnel Control Center



# IV. Systems and Operation

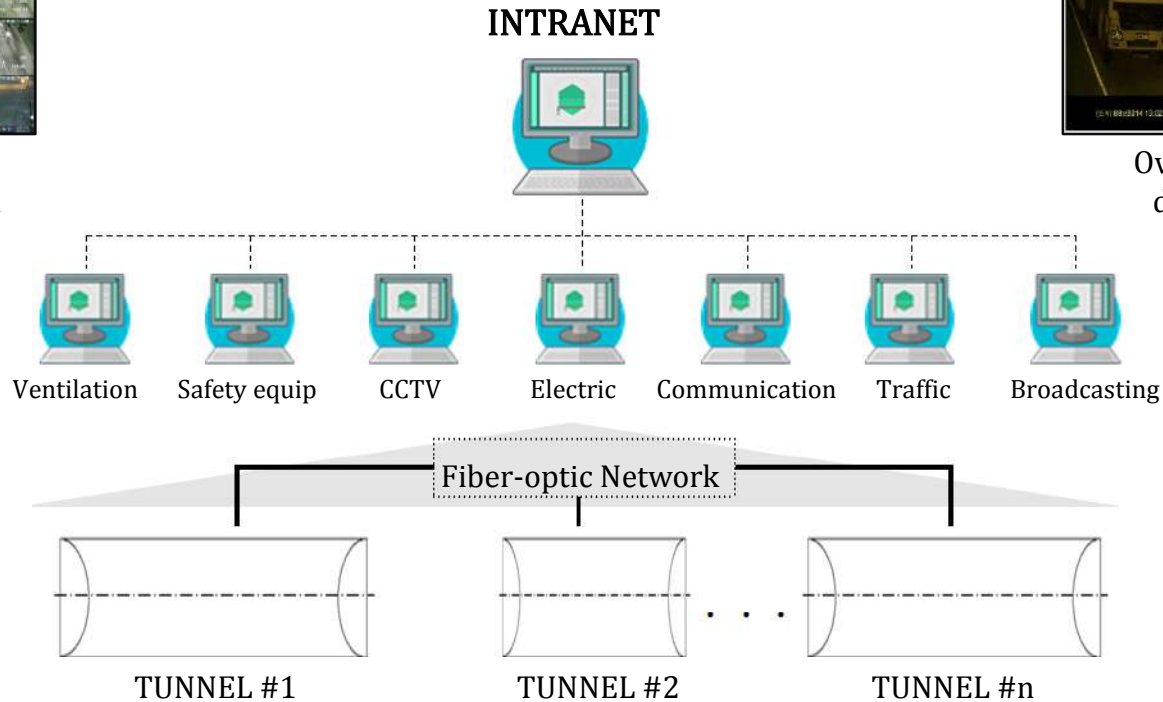
## Overview of centralized system



CCTV and Image analysis  
accident detecting System



Over-heated vehicle  
detection System



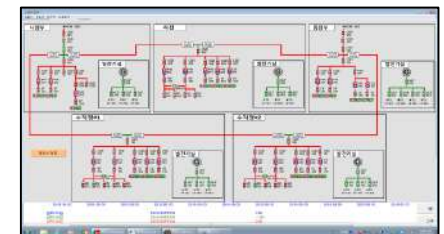
Ventilation Control System



Auto Fire-detection System



Traffic management  
System(VMS/LCS)



Electric Power Control  
System

# IV. Systems and Operation

## Overview of control center





# IV. Systems and Operation

## Ventilation control system

인제양양터널 | Main | **환기설비** | 환기모드 | 가동시간 | 관리동설비 | 소화전함 | 물분무설비 | 모니터링 | 알람 | 트렌드 | 보고서 | 2018-09-03 오후 1:17:21 EXIT

제어 권한 | 터널 | 지사 |

화제모드	기 기	VI(10-3/m)	CO(ppm)	NO(ppm)	기 기	풍속(m/s)	풍 향	기 기	VI(10-3/m)	CO(ppm)	NO(ppm)	기 기	풍속(m/s)	풍 향
수동모드	VICONO#101	0.2	0.7	0.1	풍향풍속계#101	4.0	←→	VICONO#105	0.5	0.7	0.1	풍향풍속계#105	2.8	←→
환기모드	VICONO#102	0.3	0.9	0.3	풍향풍속계#102	4.3	←→	VICONO#106	0.3	0.9	0.1	풍향풍속계#106	4.1	←→
수동모드	VICONO#103	0.4	1.5	0.2	풍향풍속계#103	5.6	←→	VICONO#107	0.4	0.4	0.1	풍향풍속계#107	3.0	←→
	VICONO#104	0.6	0.5	0.1	풍향풍속계#104	3.8	←→	VICONO#108	0.5	0.7	0.2	풍향풍속계#108	5.1	←→

VI: 0.5 풍속: 5.1  
VI: 0.4 풍속: 3.0

풍속 평균 3.9

풍속: 4.2 VI: 0.4  
풍속: 4.4 VI: 0.2

인제양양터널 | Main | 환기설비 | **환기모드** | 가동시간 | 관리동설비 | 소화전함 | 물분무설비 | 모니터링 | 알람 | 트렌드 | 보고서 | 2018-09-03 오후 1:19:04 EXIT

서울방향 환기 운전 모드

		서울방향 알람설정					
운전 진행시간 : 0[분] 0[초]		초과값	1 단계	2 단계	3 단계	4 단계	5 단계
피드백 제어	정상시 운전	VI	4.0	5.0	6.0	7.0	8.0
		CO	30.0	35.0	40.0	45.0	50.0
		NO	15.0	20.0	25.0	30.0	35.0
	정체시 운전	VI	3.0	4.0	5.0	6.0	7.0
		CO	20.0	25.0	30.0	35.0	40.0
		NO	10.0	15.0	20.0	25.0	30.0
	작업시 운전	VI	3.0	4.0	5.0	6.0	7.0
		CO	20.0	25.0	30.0	35.0	40.0
		NO	10.0	15.0	20.0	25.0	30.0

모드 및 단계에 상관없이 가동된 JET-FAN은 제어주기 완료시점에 설정값 이하로 떨어질 때까지 가동된 것은 계속 가동된다.

인제양양터널 | Main | 환기설비 | **환기모드** | 가동시간 | 관리동설비 | 소화전함 | 물분무설비 | 모니터링 | 알람 | 트렌드 | 보고서 | 2018-09-03 오후 1:19:04 EXIT

양양방향 환기 운전 모드

		양양방향 알람설정					
운전 진행시간 : 0[분] 0[초]		초과값	1 단계	2 단계	3 단계	4 단계	5 단계
피드백 제어	정상시 운전	VI	4.0	5.0	6.0	7.0	8.0
		CO	30.0	35.0	40.0	45.0	50.0
		NO	15.0	20.0	25.0	30.0	35.0
	정체시 운전	VI	3.0	4.0	5.0	6.0	7.0
		CO	20.0	25.0	30.0	35.0	40.0
		NO	10.0	15.0	20.0	25.0	30.0
	작업시 운전	VI	3.0	4.0	5.0	6.0	7.0
		CO	20.0	25.0	30.0	35.0	40.0
		NO	10.0	15.0	20.0	25.0	30.0

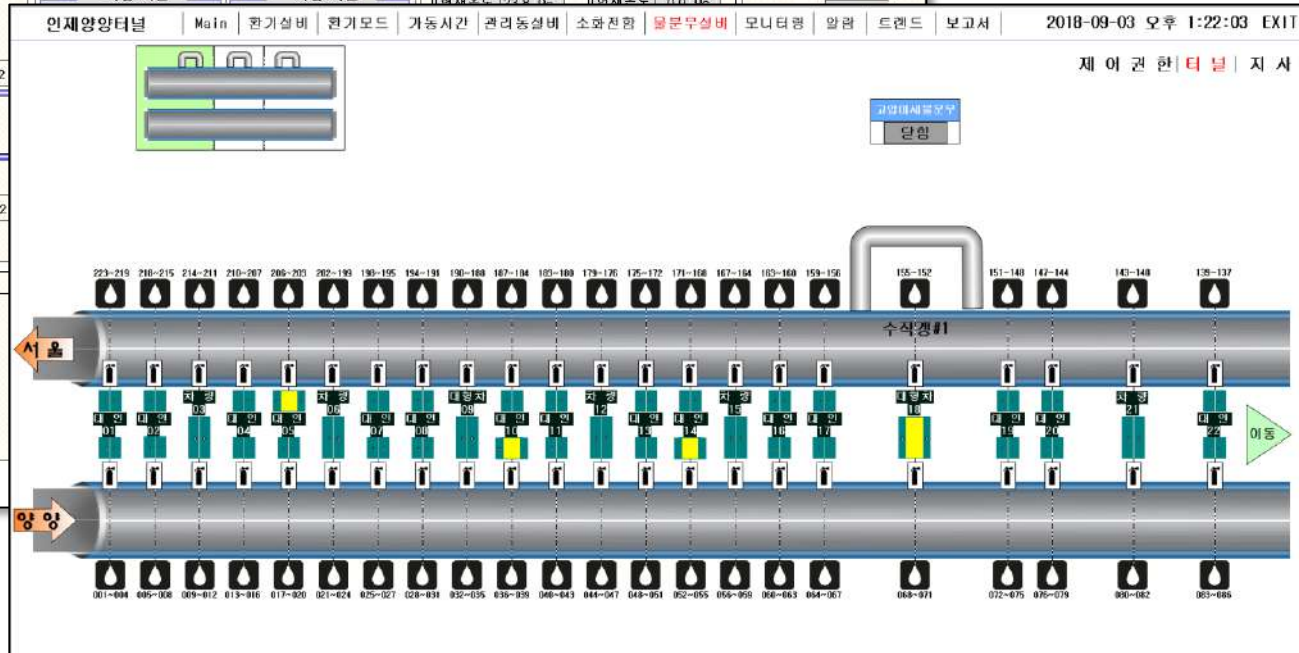
모드 및 단계에 상관없이 가동된 JET-FAN은 제어주기 완료시점에

Ventilation Control System

Air-quality Monitoring and Control System

# IV. Systems and Operation

## FFFS and Mechanical control system

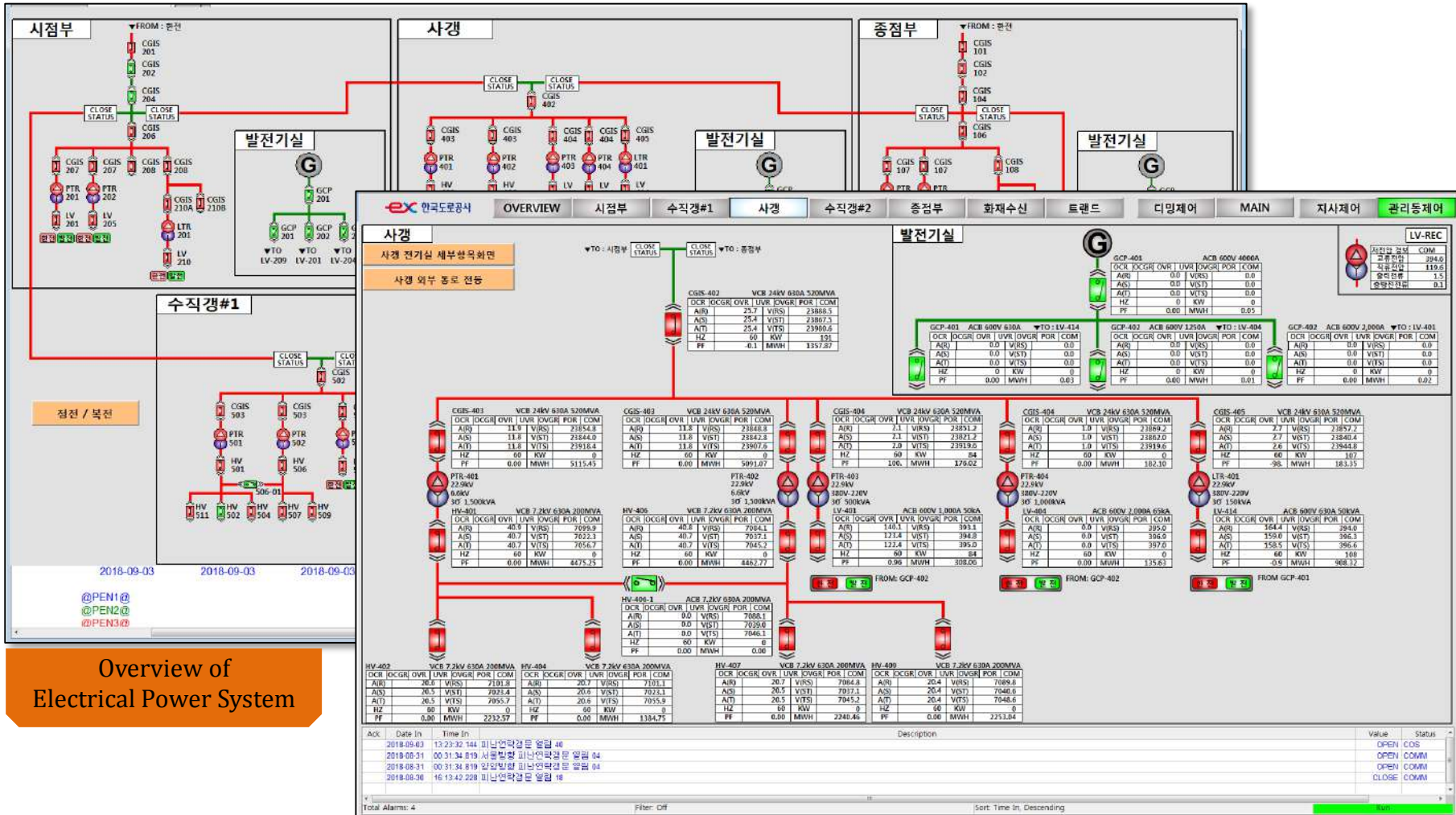


Mechanical Control System

Fixed-Fire Fighting System

# IV. Systems and Operation

## Electrical power control system



Overview of Electrical Power System

# IV. Systems and Operation

## Lighting control system

The screenshot displays a comprehensive lighting control system interface. At the top, there are navigation tabs for different system areas: OVERVIEW, 시점부 (Viewpoint), 수직경#1 (Vertical View #1), 사경 (Tilt), 수직경#2 (Vertical View #2), 중점부 (Center Point), 화재수신 (Fire Alarm), 트랜드 (Trend), 디밍제어 (Dimming Control), MAIN, 지사제어 (Local Control), and 관리동제어 (Management Control). The interface is divided into several functional sections:

- Overview/Status:** Shows various lighting levels and statuses for different levels (LV-201 to LV-209) and areas (ATD, UPS-201, UPS-202).
- Dimming Control:** A central panel for selecting dimming zones (시점부, 수직경#1, 사경, 수직경#2, 중점부) and setting dimming levels (0%, 30%, 100%). It also displays current lux levels (e.g., 10298 Lux) and dimming speed settings.
- System Settings:** Includes options for local control, remote control, and various system parameters like CPU usage and power status.
- Alerts and Logs:** A section for managing alarms and viewing system logs, including a table with columns for Ack, Date, Time, and In.
- Control Buttons:** Large buttons for '경보 발생' (Alarm Occurred), '공동구 경보 발생' (Manhole Alarm Occurred), and '화기 리미트' (Fire Limit).

Lighting Control System

Dimming Control System



# IV. Systems and Operation

## Traffic control system

서울양양선  
강원본부 > 양양지사 > 백두대간인제터널 (139.02Km, 10965m)

유고상황관리 교통시설제어 시스템관리 보고서관리

소통원활 UPDATE : 2018년 09월 05일 14시 22분 44초

### 백두대간인제터널(MAIN)

서울

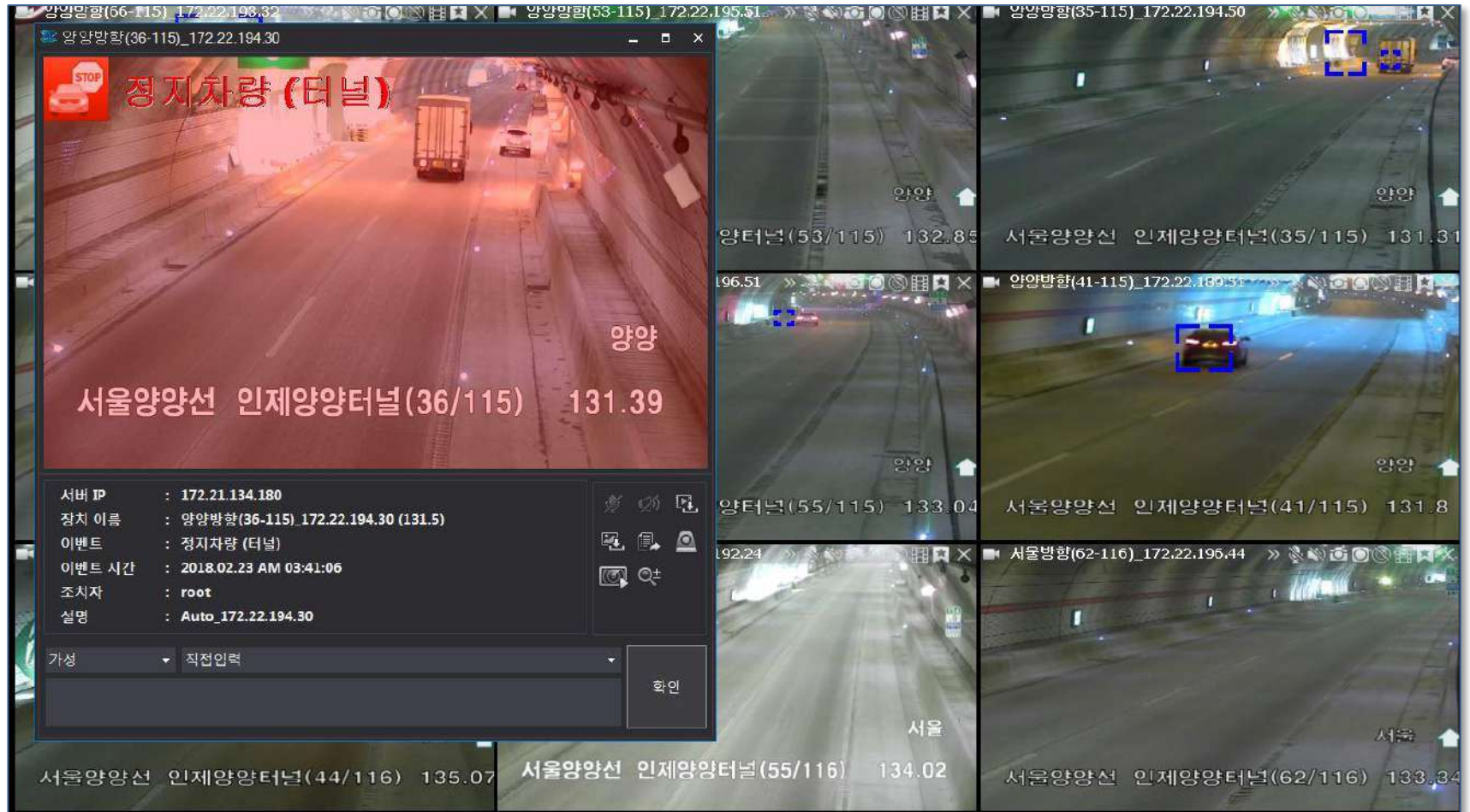
### 백두대간인제터널

[알림정보] 유지보수 연락처 : 054-811-3692 [본사]

Traffic Monitoring and VMS/LCS Control System

# IV. Systems and Operation

## Automatic Accident Detection System



CCTV and Image Analysis Accident Detecting System

# IV. Systems and Operation

## Overheated Vehicle Detection System

ex 한국도로공사 과열차량 알림 모니터링 (서울)    조회    보기    설정    닫기    환경별    현재온도: 21.8°C    심각    경계    주의    관심

실시간 이미지 : 2018-09-03

21.3°C

1차선(승용): 55누3667 13:55:06    (좌측) 정상 26.1°C    속도: 120.9Km/h    (우측) 정상 31.7°C    속도: 120.9Km/h

2차선(승용): 05누1638 13:55:03    데이터 처리중    (우측) 정상 36.3°C    속도: 97.8Km/h

실시간 정보통계 : 2018-09-03

온도(°C)	승용	승합	트럭	특수
최대	153.7	84.4	251.7	196.6
최소	17.5	19.2	17.8	26.2
평균	30.4	33.9	45.1	55.5

실시간 교통량 : 2018-09-03

차량/기준온도	승용	승합	트럭	특수	한계
심각	0 / 300°C	0 / 300°C	0 / 300°C	0 / 300°C	0
경계	0 / 270°C	0 / 270°C	0 / 270°C	0 / 270°C	0
주의	0 / 250°C	0 / 250°C	1 / 250°C	0 / 250°C	1
관심	0 / 200°C	0 / 200°C	0 / 200°C	0 / 200°C	0

실시간 그래프 : 2018-09-03 12:40:05 - 2018-09-03 13:55:09

▲ ▼    승용    승합    트럭    특수    차량량    배경색

실시간 교통량 : 2018-09-03

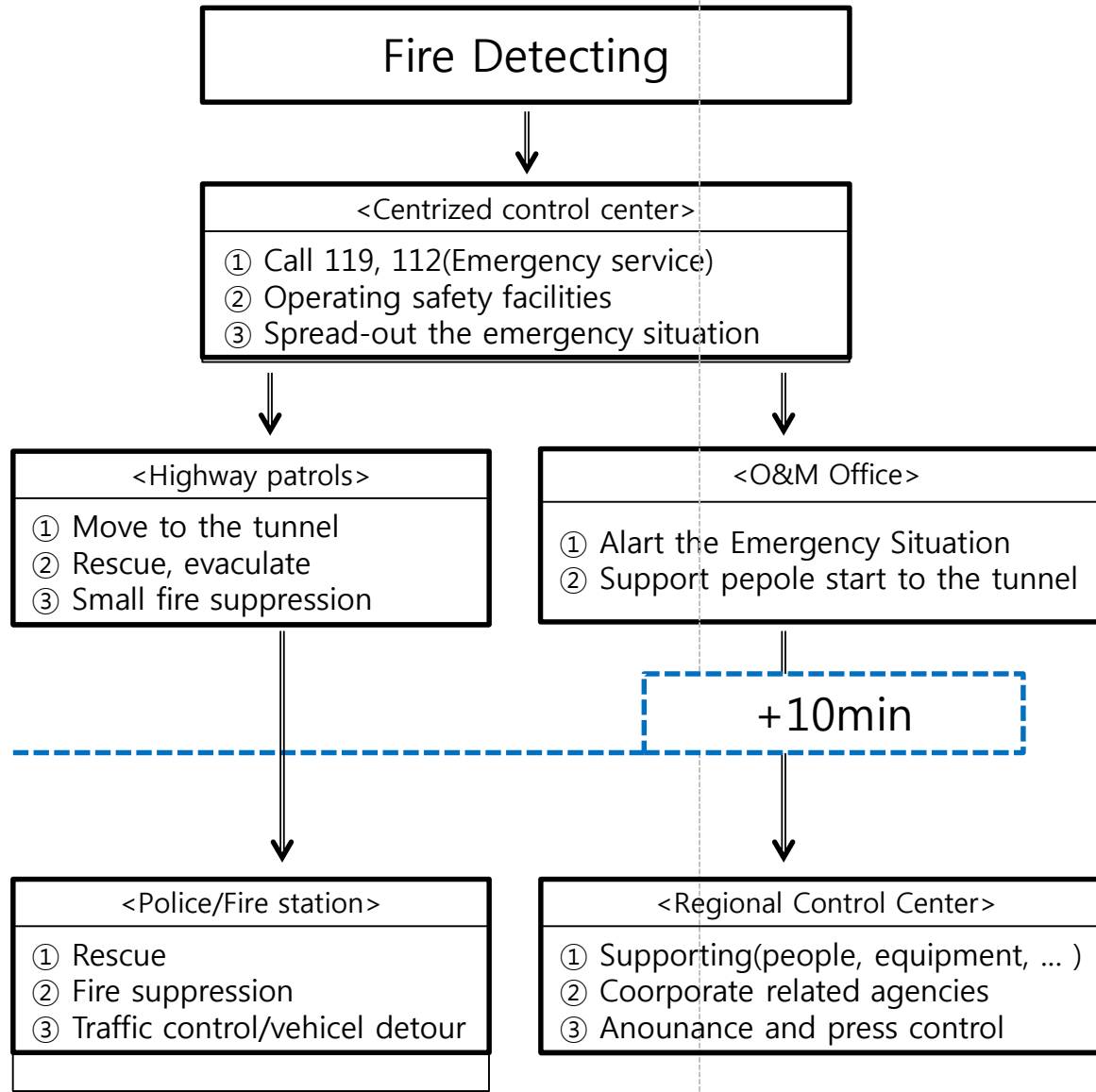
(대)(Km/h)	승용	승합	트럭	특수	합계: 4344
1차선 주행	1910	96	102	2	2110
평균속도	113	110	111	111	112
2차선 주행	1669	98	403	64	2234
평균속도	95	99	84	64	92

Over-heated Vehicle Monitoring and Control System



# IV. Systems and Operation

## Fire-accident response process



# V. Operational Issues & Lessons

- Too many kind of systems for tunnel operation

- ➔ Need more education and drill for operators

- ➔ Simple procedure for emergency situation

- Network capacity, speed & stability are very important

- ➔ Ring network, Duplex server, Hacking prevention

- Accessibility & Quick response

- ➔ Need very high level of availability of safety systems

- ➔ Close cooperation between emergency services.



**Q & A**

**Thank you for your attention  
Merci pour votre attention**