# CNS / ATM R&D Activities in Korea

## 2010. 11. 10

### D.M. Kim

### Korea Aerospace Research Institute

# Contents

# Introduction to KARI

## National Vision

### Rank among the top 10 aerospace industry countries by 2015

- Independently develop satellites and launch vehicles for entering the global market
- Acquire indigenous technology to develop unmanned aircraft and helicopters
- Become a supplier of small to medium aircraft and export core components and materials

**Basic Mid-to-Long Term Space Development Plan**

**Basic Aerospace Industry Development Plan**

### Satellites

- Develop 13 satellites by 2010

  - Establish the capability to domestically develop LEO/GEO satellites

  - Acquire the capability to process and utilize satellite data

### Launch Vehicles

- Acquire the capability to independently develop a LEO space launch vehicle

  - Independently launch a 100kg class LEO small satellite launch vehicle

  - Independently launch a 1.5ton LEO multipurpose satellite launch vehicle

- Establish a Space Center

### Aircraft

- Develop an innovative aircraft (Smart UAV) by 2012
- Develop a Korean transport helicopter [KHP] by 2011
- Acquire the capability to independently develop small aircraft and helicopters by 2015
- CNS/ATM
- Establish a national quality certification infrastructure

# Introduction to KARI

## History

Oct.1989 — **Establishment of KARI as an affiliate of KIMM**

※ Law for the Promotion of Aerospace Industry Development (Dec.4, 1987)

Nov.1996 — **Separation of KARI as an independent institute**

Jan.1999 — **Amendment of the legal basis for KARI**

※ Law for the Establishment, Management and Promotion of Government Research Institutes

Jan.2001 — **Institute status of KARI raised**

Oct.2004 — **Second amendment of the legal basis for KARI**

※ Law for the Establishment, Management and Promotion of Government Science and Technology Research Institutes

# Introduction to KARI



- ○ Government Founded Institute
- ○ About 700 R&D Engineers
- ○ Major Projects
  - ● **Satellites**
  - ● **Launchers**
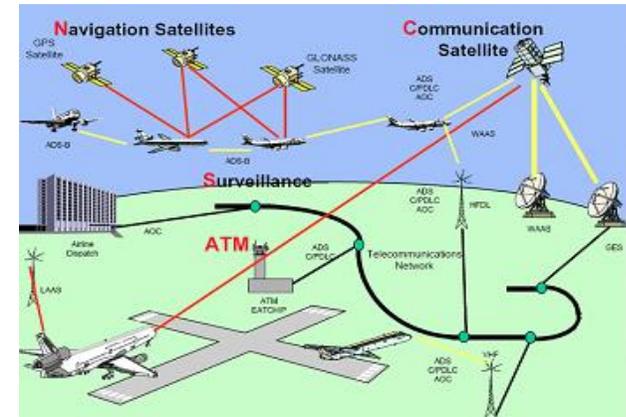  - ● **Aeronautics**

# Evolution of Air Navigation

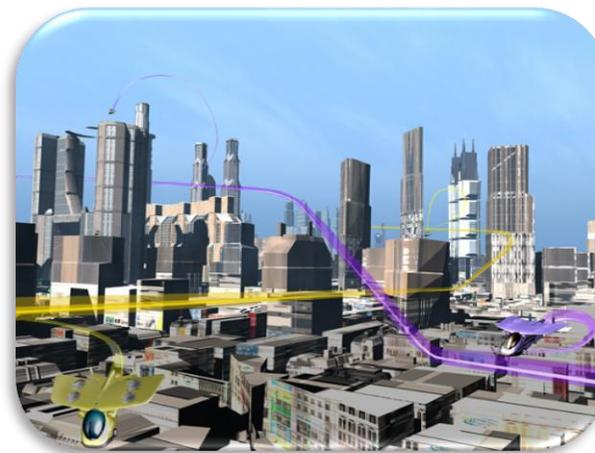

1926 Traffic Rule /1952 Radar
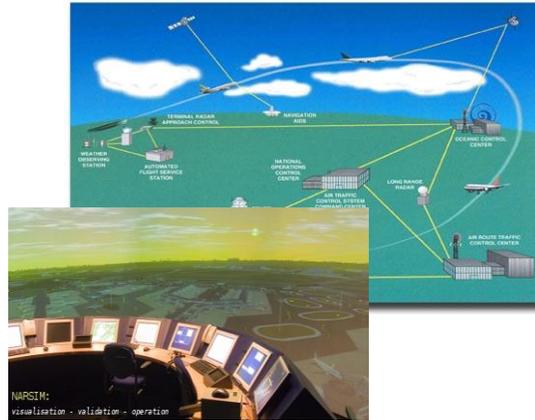
ARTS*

CNS/ATM

| Past | Current | Near Future |
|---|---|---|

Future

**Evolution Tendency**

Human Centric ⇒ Net Centric
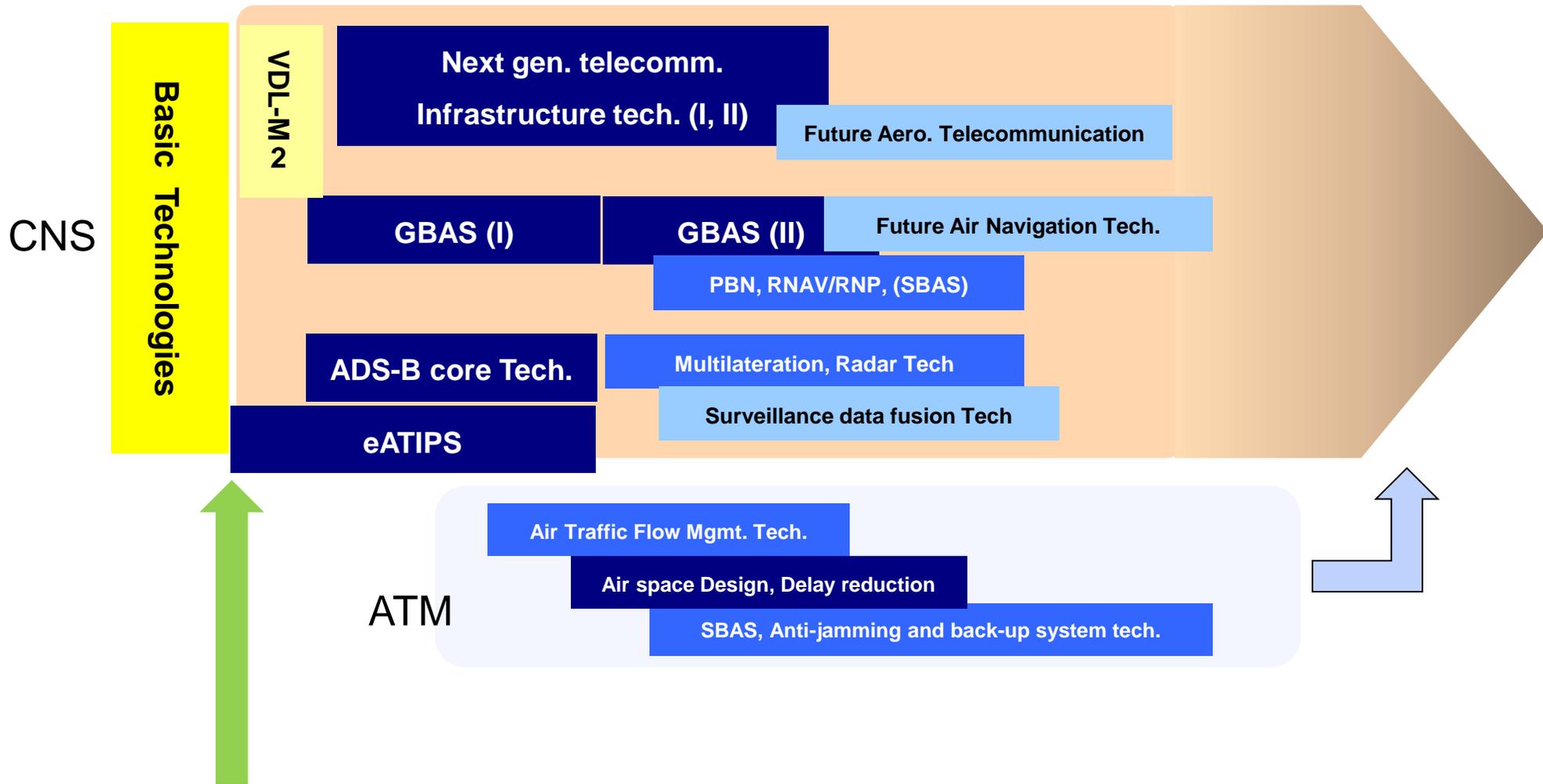Ground Based ⇒ Satellite Based
Analog, Voice ⇒ Digital, Data

For More
Safety, Efficiency, Green, Flexibility

Computerized
Autonomous
User (Pilot) Centric

* ARTS : Automated Radar Terminal System

# CNS/ATM Researches



CNS

Basic Technologies

VDL-M 2

Next gen. telecomm. Infrastructure tech. (I, II)

Future Aero. Telecommunication

GBAS (I)

GBAS (II)

Future Air Navigation Tech.

PBN, RNAV/RNP, (SBAS)

ADS-B core Tech.

Multilateration, Radar Tech

Surveillance data fusion Tech

eATIPS

ATM

Air Traffic Flow Mgmt. Tech.

Air space Design, Delay reduction

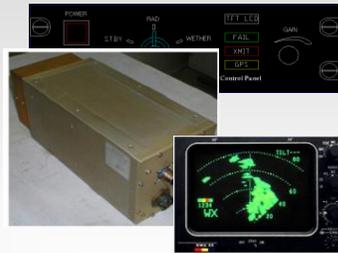SBAS, Anti-jamming and back-up system tech.

2008 : Establishment of Korean CNS/ATM R&D Road Map

# Projects Prior to R&D Road Map Establishment

CNS/ATM Achievements



SCAT-1 GBAS Test-Bed
(1998~2000)
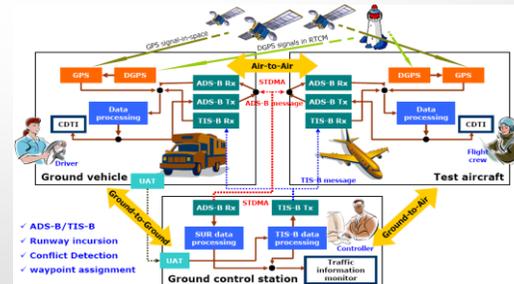(Special CAT-I
Ground Based
Augmentation System)

Multi-purpose Radar
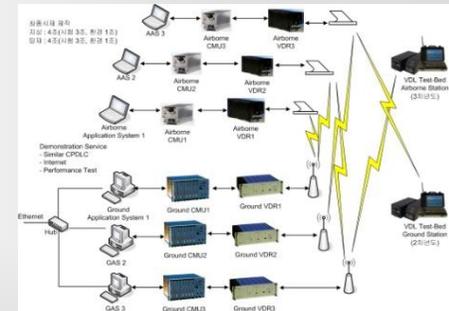(2002~2005)

CAT-1 GBAS Test-Bed
(2005~2008)

DGPS Receiver
(2001~2004)

ADS-B Basic
Research (2005~2007)

VDL Mode-2
(2005~2009)
(VHF Data Link)

'98    '99    '00    '02    '04    '05    '06    '07    '08    '09

# SCAT-1 GBAS Test Bed

➤ Feasibility Study of GBAS Ground Station

➤ Focused on Accuracy

❏ 1st year (1998)
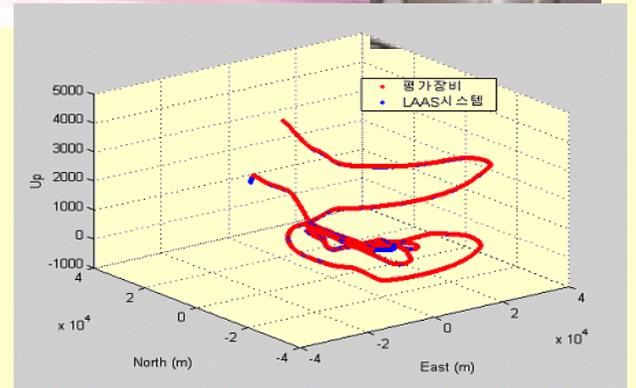  - Design of GRS and Airborne
  - Development of Basic GRS



❏ 2nd year (1999)
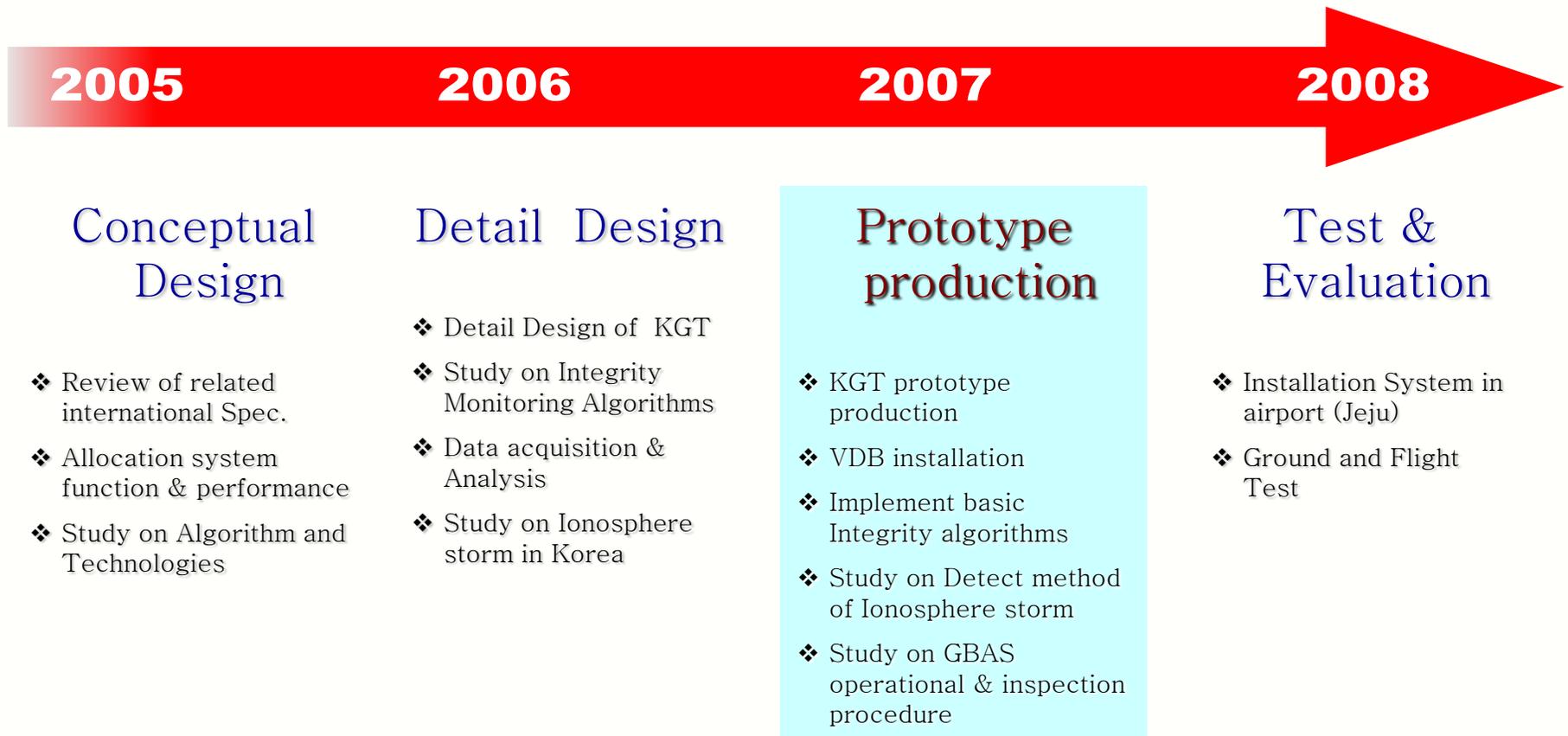  - Development of Prototype GRS
  - Ground Test



❏ 3rd year (2000)
  - Development of Monitoring System
  - Flight Test

# KGT (KARI GBAS Test-Bed)

➢ Study of ICAO GBAS Cat-I Functions and Requirements
➢ Focused on Integrity Issues
➢ Test-Bed Is Installed in Jeju International Airport.

**2005**      **2006**      **2007**      **2008**

## Conceptual Design

❖ Review of related international Spec.

❖ Allocation system function & performance

❖ Study on Algorithm and Technologies

## Detail Design

❖ Detail Design of KGT

❖ Study on Integrity Monitoring Algorithms

❖ Data acquisition & Analysis

❖ Study on Ionosphere storm in Korea

## Prototype production

❖ KGT prototype production

❖ VDB installation

❖ Implement basic Integrity algorithms

❖ Study on Detect method of Ionosphere storm

❖ Study on GBAS operational & inspection procedure

## Test & Evaluation

❖ Installation System in airport (Jeju)

❖ Ground and Flight Test

# KGT (KARI GBAS Test-Bed)

- ➢ KGT Development Status
  - ▪ Install Integrity monitor system in KARI
    - ✓ Collecting GPS data for S/W development
    - ✓ Test & Evaluation of developing integrity algorithms for GBAS
  - ▪ Installed in Jeju International Airport
  - ▪ Feature
    - ✓ 4 Reference Receiver (NovAtel OEM-V)
    - ✓ PC-based GBAS processor
    - ✓ Telerad VDB transmitter/receiver



Integrity monitor system

KⅠ/ⅠRI KOREA AEROSPACE RESEARCH INSTITUTE

# CAT-I GBAS Test Bed

- 2003 ~ 2007 : Development of GPS Integrity Monitoring System
- 2008 ~ Current : Operatiing at Jeju International Airport

Reference Stations I Jeju International Airport

Reference Station #3

# ADS-B Study (2005-2007)



To Realize ADS-B Concept

**2 Test Aircrafts**
- ADS-B transponder
- CDTI

**4 Ground Vehicles**
- 1 UAT Equipped Vehicle)
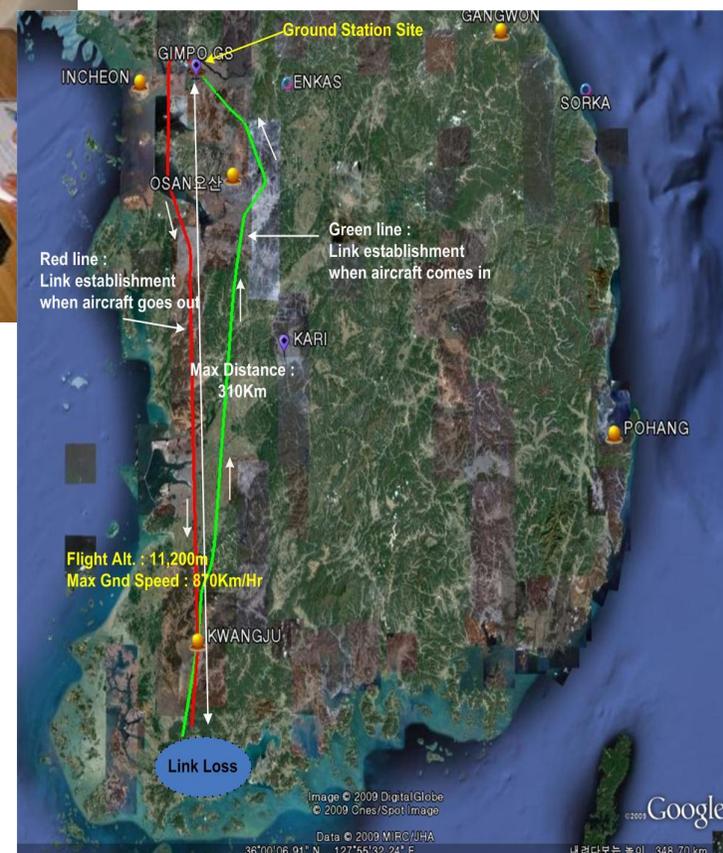- 3 ADS-B Equipped Vehicles
- Compact display unit

**Ground control station**
- ADS-B transponder
- TIS-B processor

Equipment Development & Test

❖ **System Features**

➢ **Hardware**

✓ VDR, CMU, GS, and DSP are are designed and developed

✓ Adopt generic architecture that VDL functionalities are distributed into VDR and CMU

✓ As an independent test equipment, MVDL and PVDL supplied by Aviation Data Systems in Australia are used

➢ **Software**

✓ Code written in C language

✓ Operating system on CMU and DSP is Linux (kernel 2.6)

✓ Except AOA library purchased, all S/W are designed and implemented in accordance with international standards

# VDL Mode2

- ➢ Interface and Stacks
  - ✓ Ethernet (TCP/IP) and RS-422 is used as basic interface
- ➢ Protocol Stack
  - ✓ Lower layer – ICAO VDLM2 compliant
  - ✓ Upper layer – AOA based
  - ✓ Application layer – Simplified CPDLC and ADS functions

# VDL Mode2
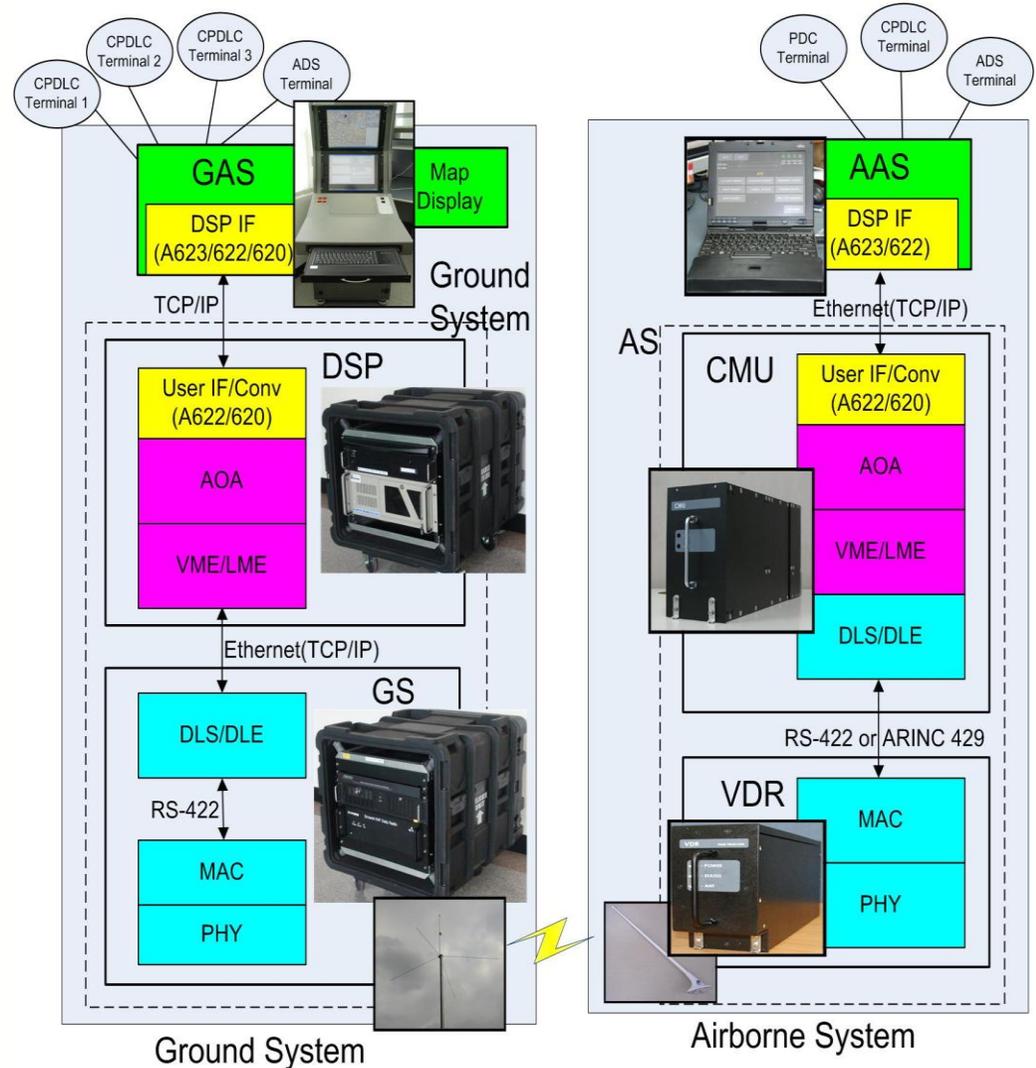
❖ Supported by aviation community in Korea
   ✓ KAC supported PDC service test using VDL M2
   ✓ KAL supported VDL M2 operational test with its aircraft

❖ Verified function and performance
   ✓ Adaptation tests to airport
   ✓ Flight tests
   ✓ Compatibility tests

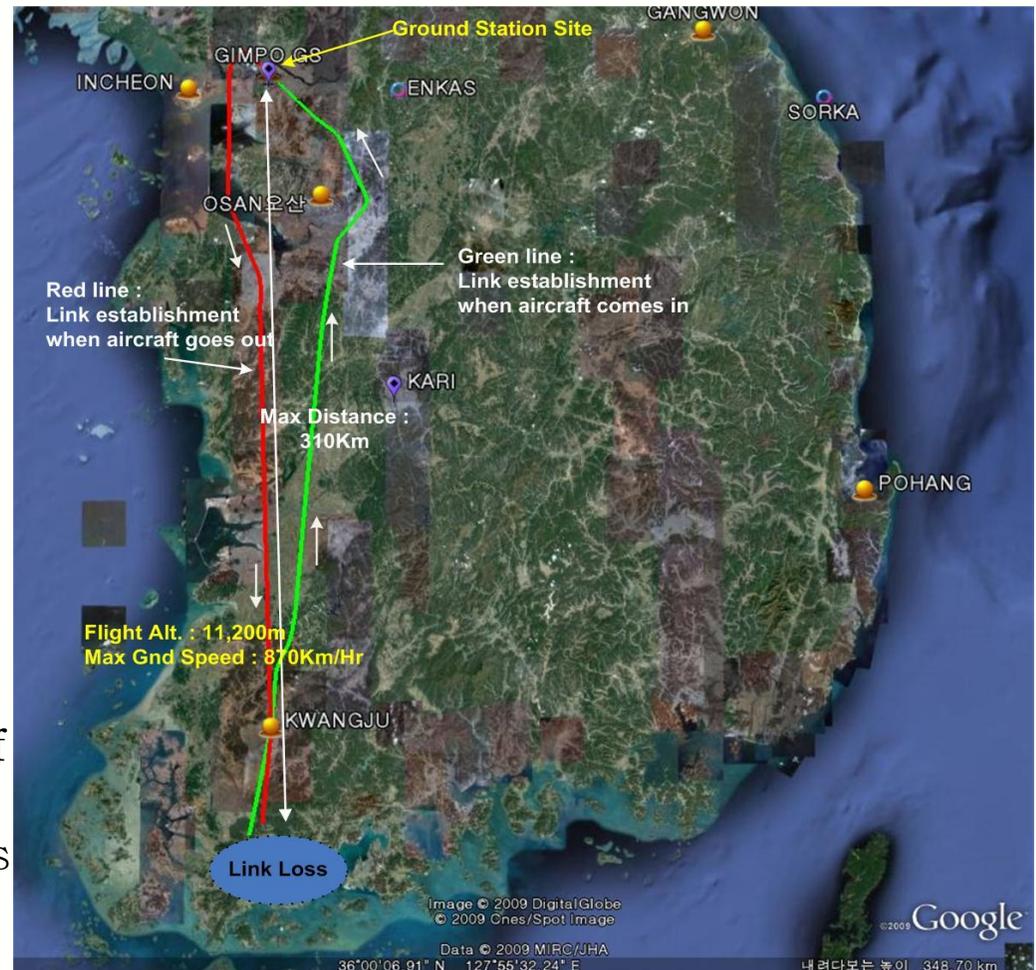*1 KAC: Korea Airports Corporation
*2 KAL: Korean Air Lines

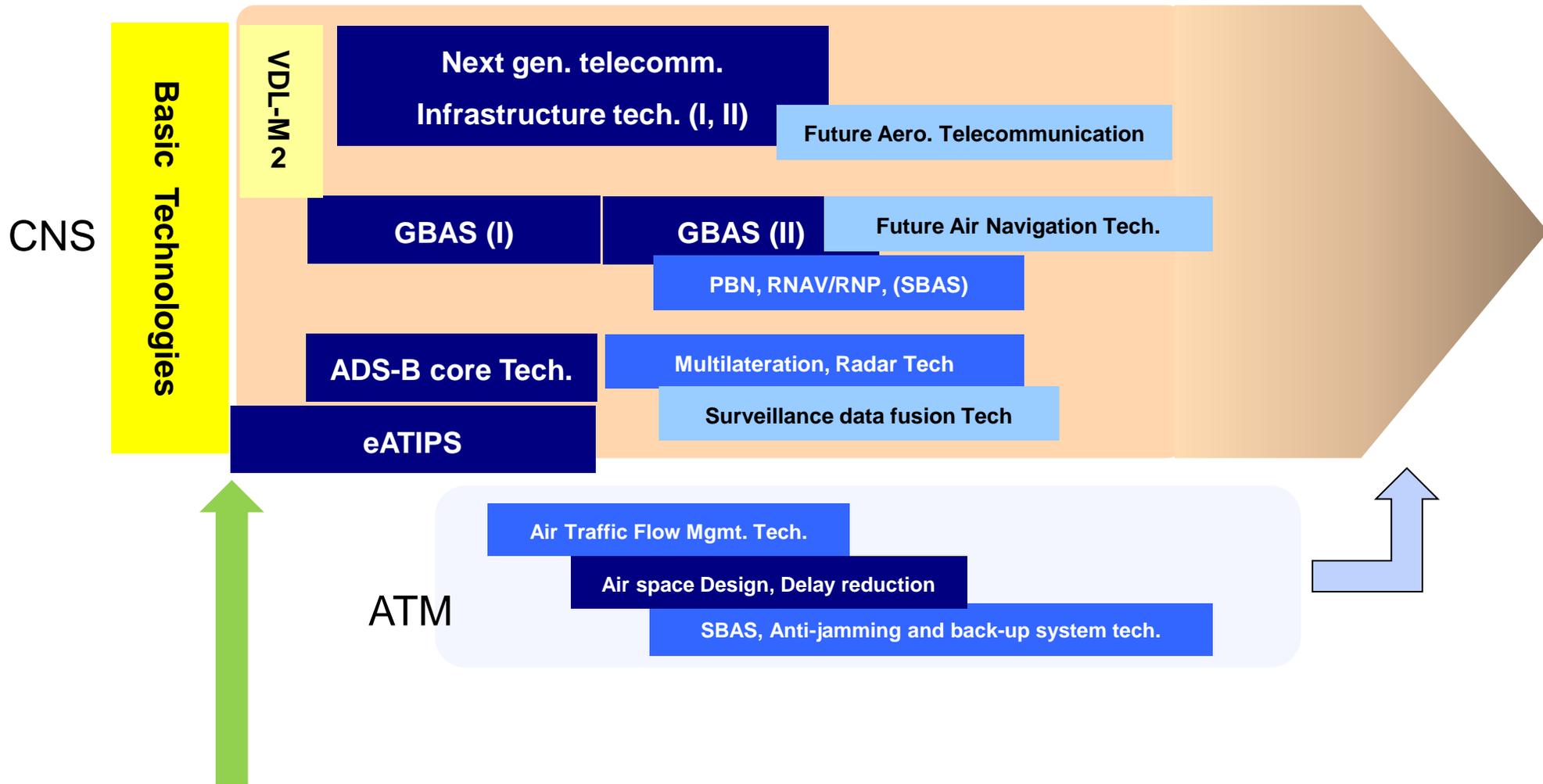❖ **Test Evaluation**
- ➢ **Test Category**
  - ✓ Unit test, Protocol Test, Environmental Test
  - ✓ Ground Mobile Test, Flight Test
  - ✓ Further Interoperability Test with Aircraft and Ground Facilities

- ➢ **Flight Test**
  - ✓ Create flight path data through ADS function during test
  - ✓ Link established to the range of over 300Km
  - ✓ On inbound course, the link was automatically re-established, then buffered data were received to GS



KARI KOREA AEROSPACE RESEARCH INSTITUTE

# Projects Being Conducted

**CNS**

Basic Technologies

VDL-M2

Next gen. telecomm. Infrastructure tech. (I, II)

Future Aero. Telecommunication

GBAS (I) | GBAS (II)

Future Air Navigation Tech.

PBN, RNAV/RNP, (SBAS)

ADS-B core Tech.

Multilateration, Radar Tech

Surveillance data fusion Tech

eATIPS

**ATM**

Air Traffic Flow Mgmt. Tech.

Air space Design, Delay reduction

SBAS, Anti-jamming and back-up system tech.

2008 : Establishment of Korean CNS/ATM R&D Road Map

# eATIPS Development Project

## Project Overview

- **Purpose** : Development of eATIPS*

- **Schedule** : 2007. 12. ~ 2014. 10. (6 Years and 10 Months)

- **Features** : Advanced Air Traffic Control System which consists of

    - Surveillance Data Processor(SDP)

    - Flight Data Processor(FDP)

    - Controller Working Position(CWP)

    - System Maintenance Console(SMC)

    - Other Support Systems

eATIPS : Enhanced Air Traffic Information Processing System

# eATIPS Development Project

## System Architecture
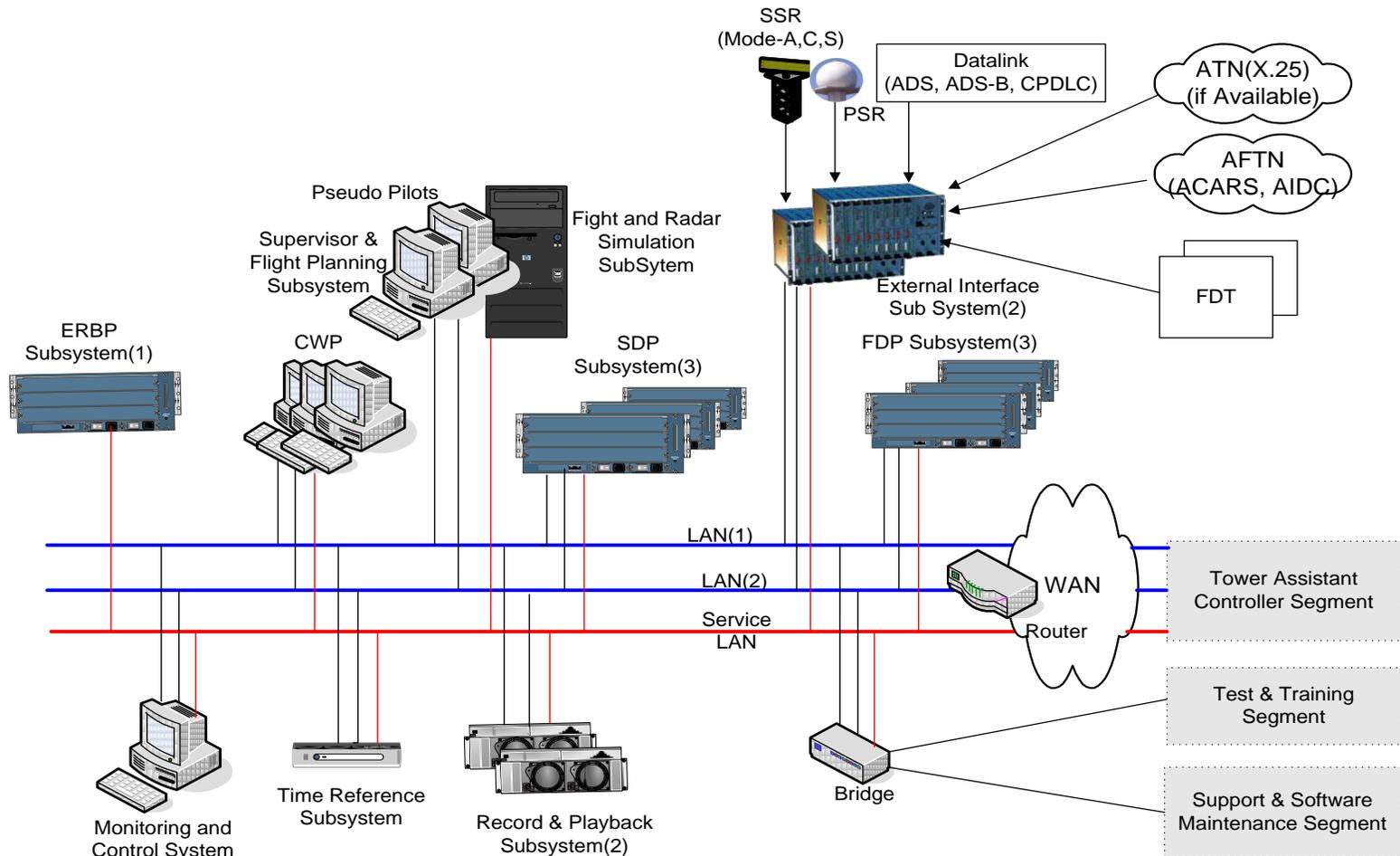
# eATIPS Development Project

## Achievements

**System Requirement Analysis**
- Functional Specification
- Interface Control Document
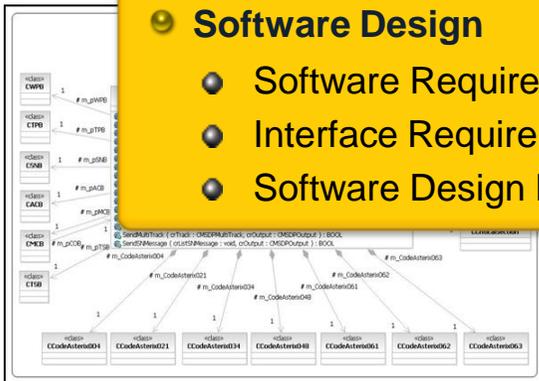- System Specification

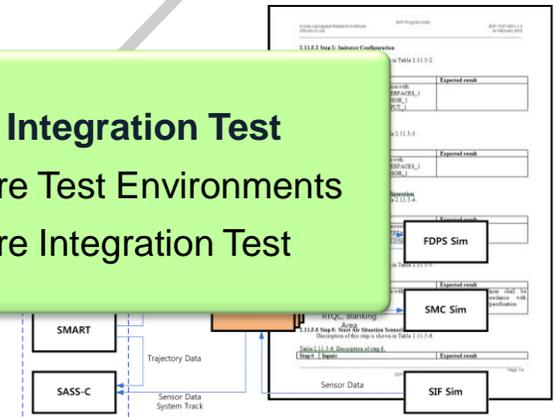**Software Design**
- Software Requirement Specification
- Interface Requirement Specification
- Software Design Description

**Implementation**
- Source Code
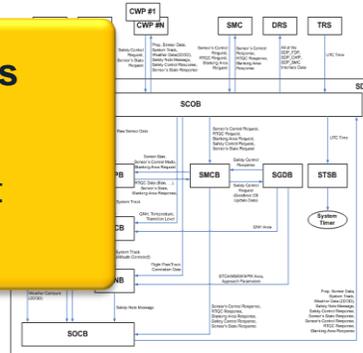
**System Integration Test**
- Live Data Interface
- System Integration Test

**Software Integration Test**
- Software Test Environments
- Software Integration Test

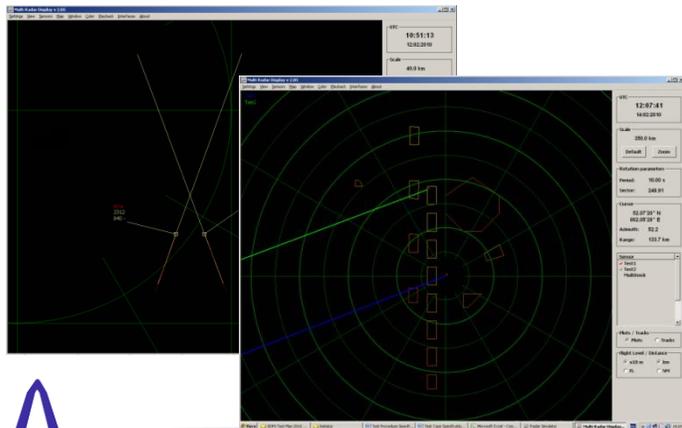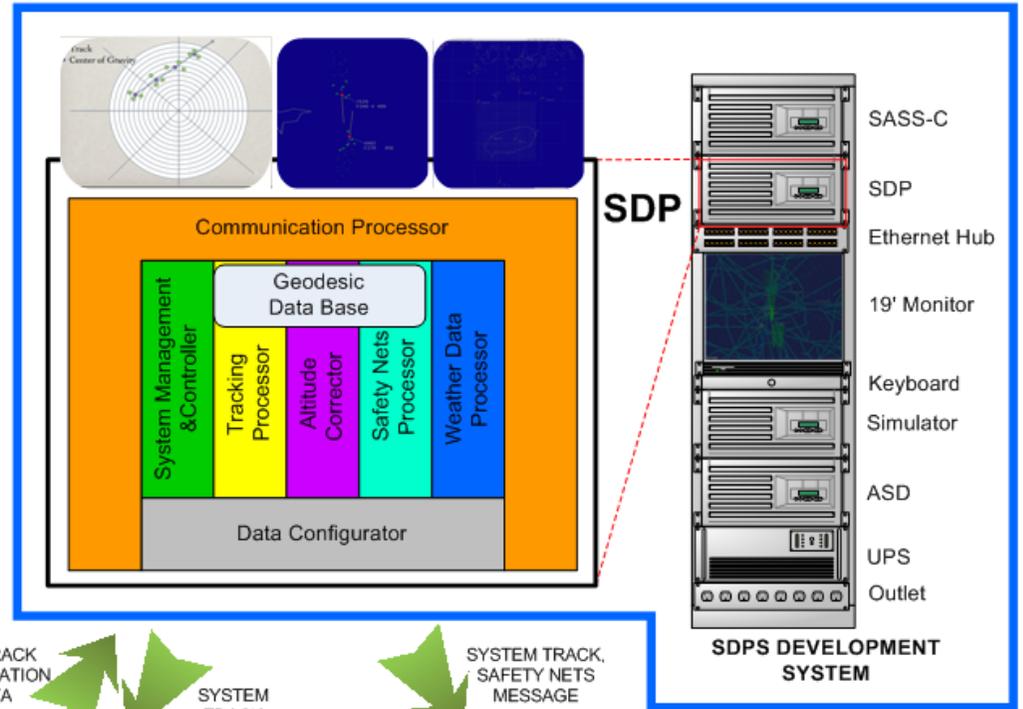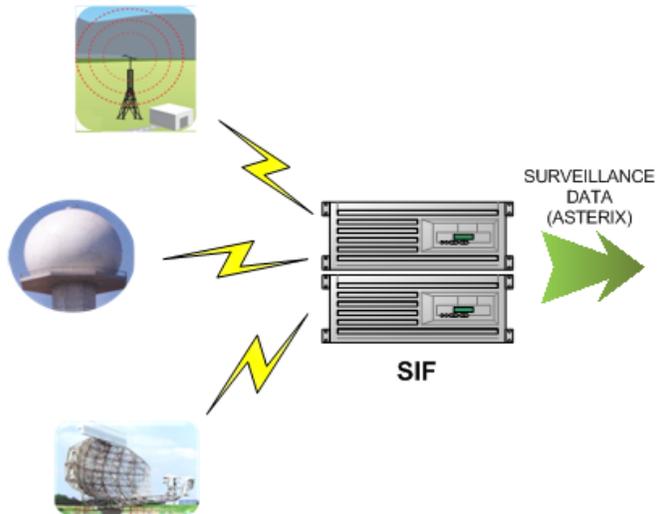| | |
|---|---|
| Completed | |
| On-Going | |

# eATIPS Development Project

## Status and Future Plan

- One set of system under development was built at Korean ACC for demonstration to and feedback from the controllers.
- Another set will be installed at Seoul Approach Center for similar purpose.
- Korean government expects that the system after the development will be used as a backup system of operational systems.
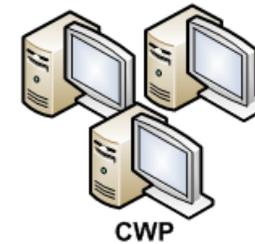
# Surveillance Data Processor Dev. (2007-)

- Multi-Sensor Tracking for Air Traffic Control
- Safety Nets Processing
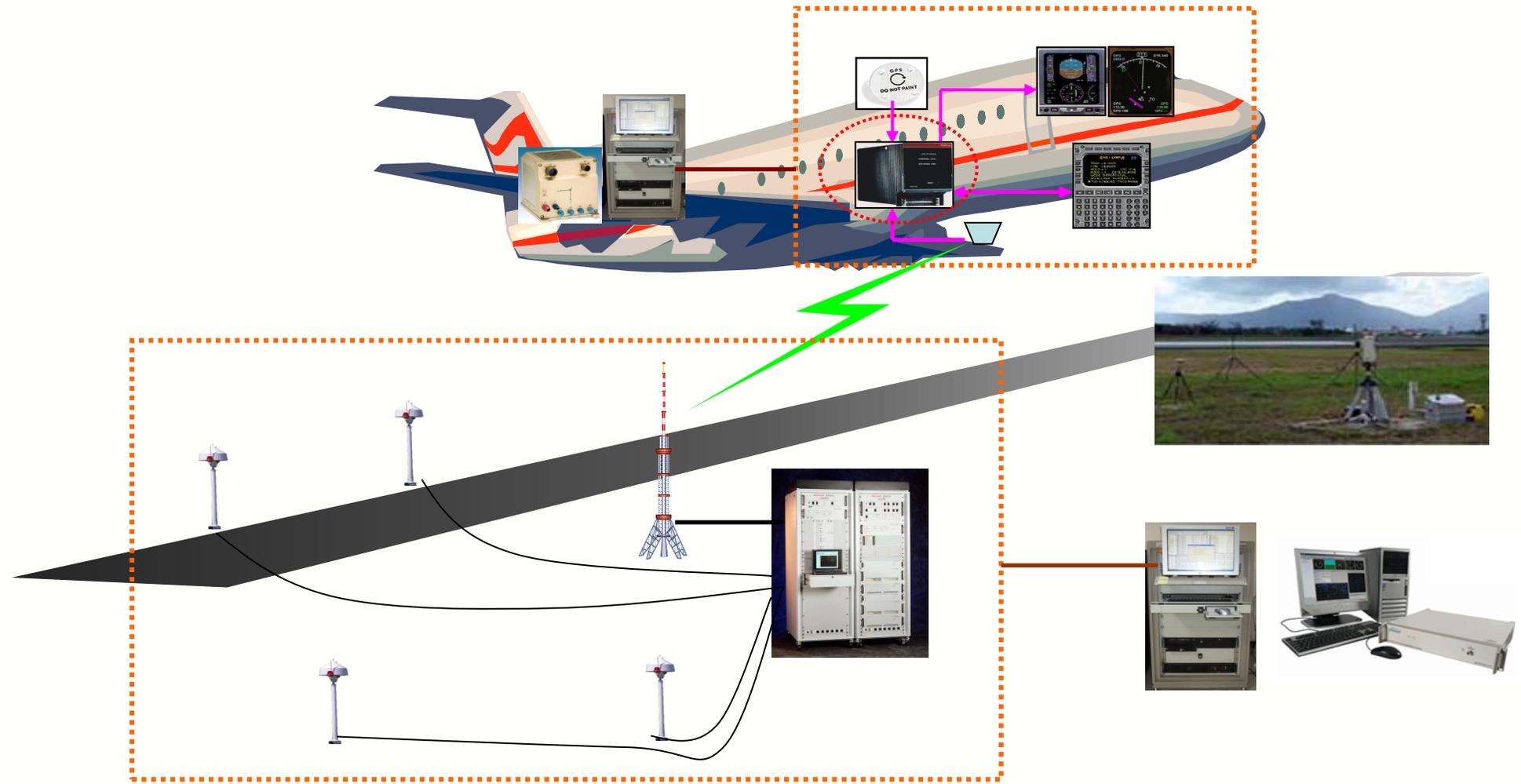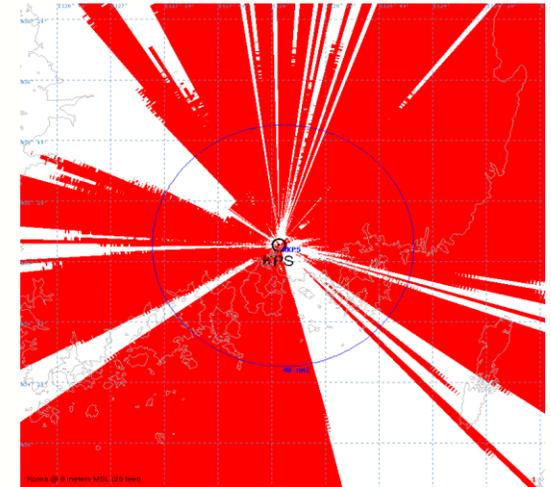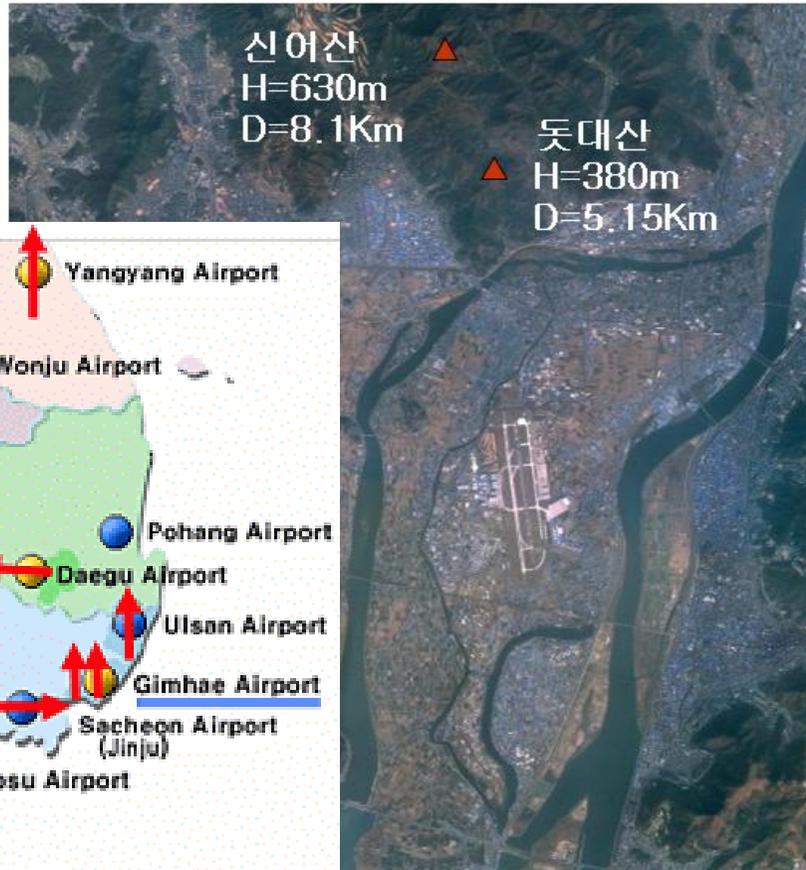
- Duration : 2010. 09. 30 – 2014. 08. 29 (3Y 11M)
- KARI / KAC / Universities (KU, KAIST, HSU)

**Safety**
- SCARD
- Safety Plan
- Hazard analysis
- Safety Case (Design & Implementation)
- Updates to Operations Manual
- Operational risk assessment

**ATC**
- Operational requirements
- GLS instrument flight procedures
- ATC procedures
- AIP / NOTAM procedures
- ATC training

**Program Management**
- PMP
- WBS and schedules
- Project reports

**GBAS CAT-I Services**

**System Engineering**
- System requirements
- System design
- Siting, installation and facility support specification
- T&E plan
- System management plan
- Airways engineering instructions
- TechCert
- Radhaz report
- OT&E reports

**OEM Deliverables**
- Equipment manual
- Technical data package
- SDA
- OEM training
- OEM support

**Facility Installations**
- Environ mgmt plan
- OH&S plan
- Site construction doc
- Site lease
- Civil works contract
- Cut-over plan
- AsA works plan
- Installation inspections / ground tests
- Site acceptance test
- Flight test
- Commissioning document

**System Approval** → **Facility Approval** → **Service Approval**

# Integrity Algorithm

## Korean Iono Environment



**GPS Signal**

| DQM | SQM | EXM I |

| TRC | Smoothing | Correction | MQM |

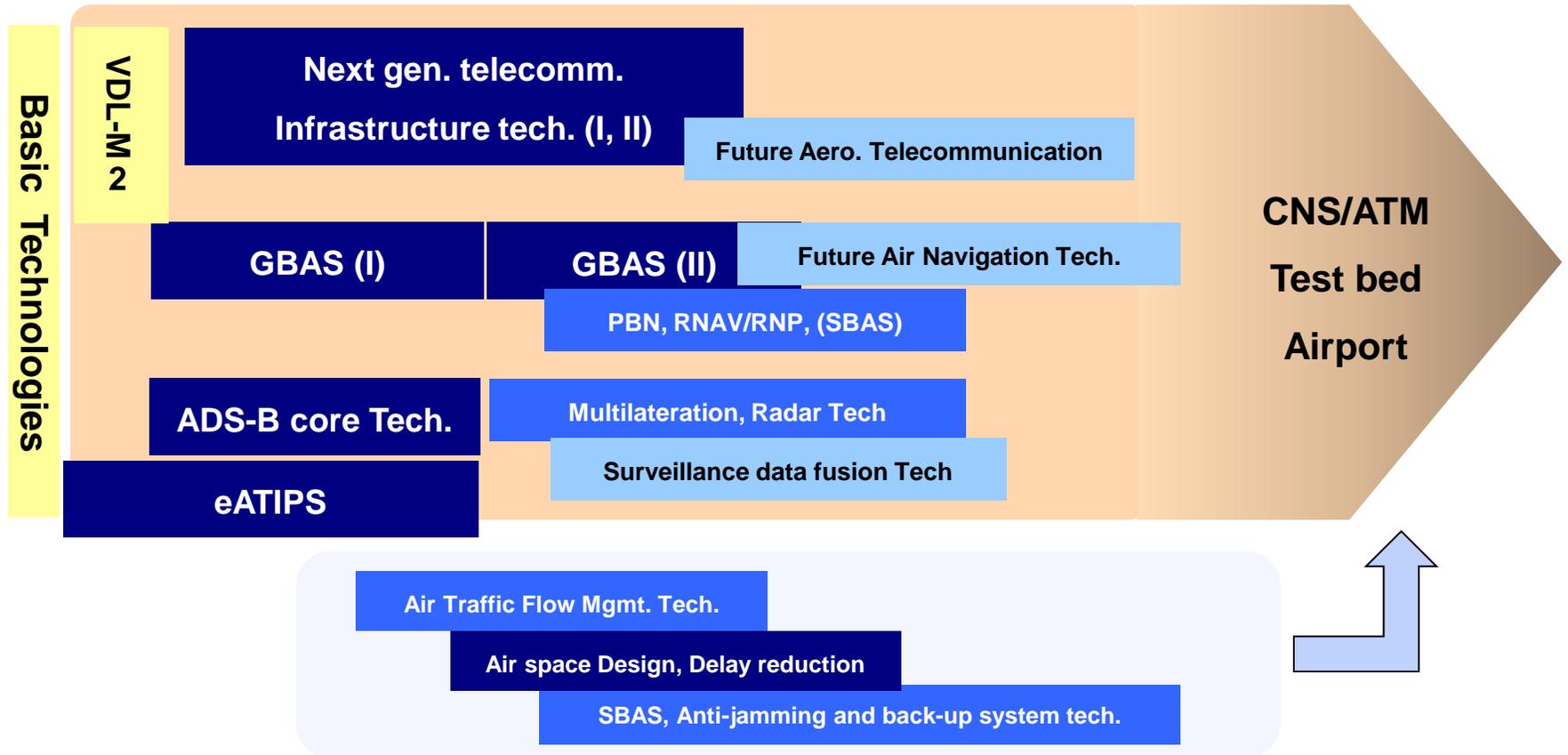| MFRT | MRCC | BVG |
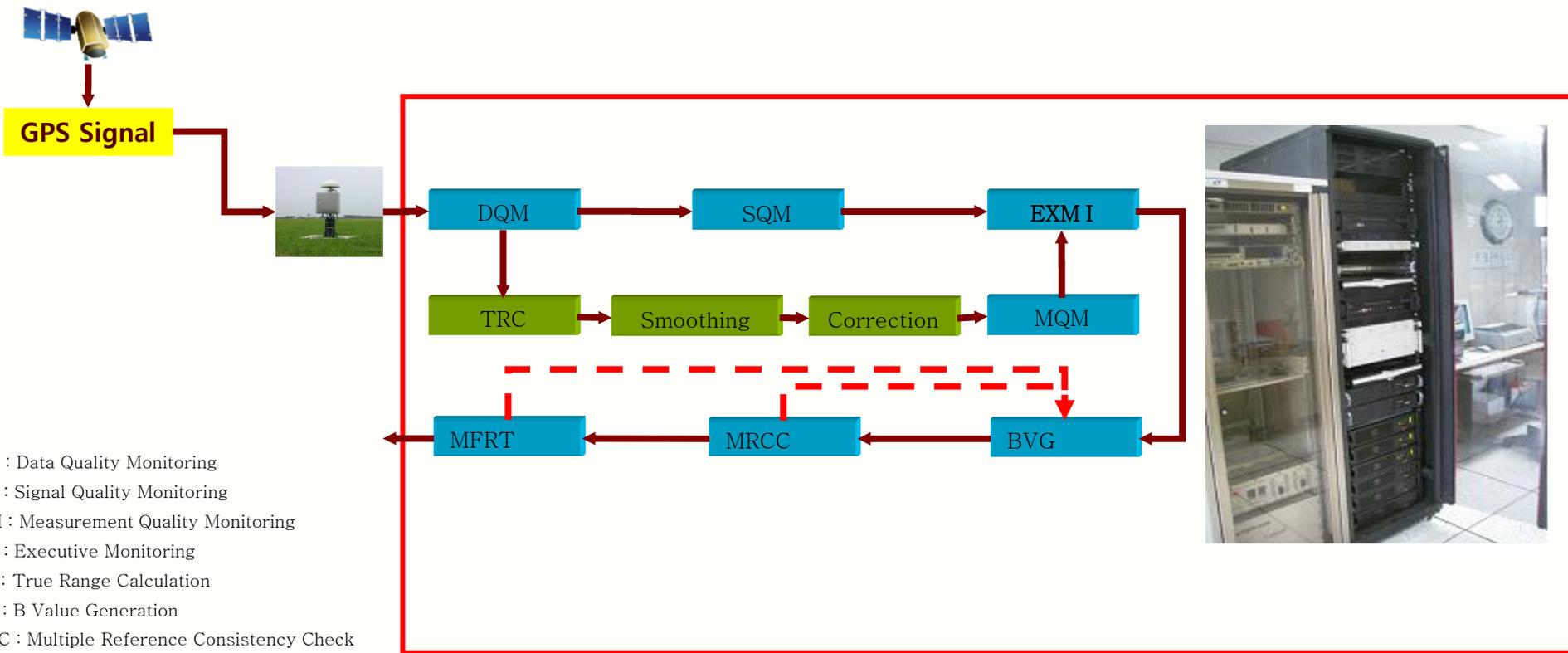
❖ DQM : Data Quality Monitoring
❖ SQM : Signal Quality Monitoring
❖ MQM : Measurement Quality Monitoring
❖ EXM : Executive Monitoring
❖ TRC : True Range Calculation
❖ BVG : B Value Generation
❖ MRCC : Multiple Reference Consistency Check
❖ MFRT : Message Field Range Test

## Using IMT & GBAS

# Future Plan



**Basic Technologies**

**VDL-M 2**

Next gen. telecomm. Infrastructure tech. (I, II)

Future Aero. Telecommunication

GBAS (I)

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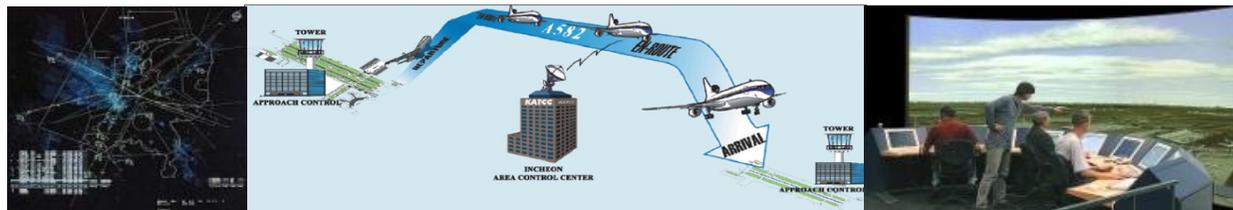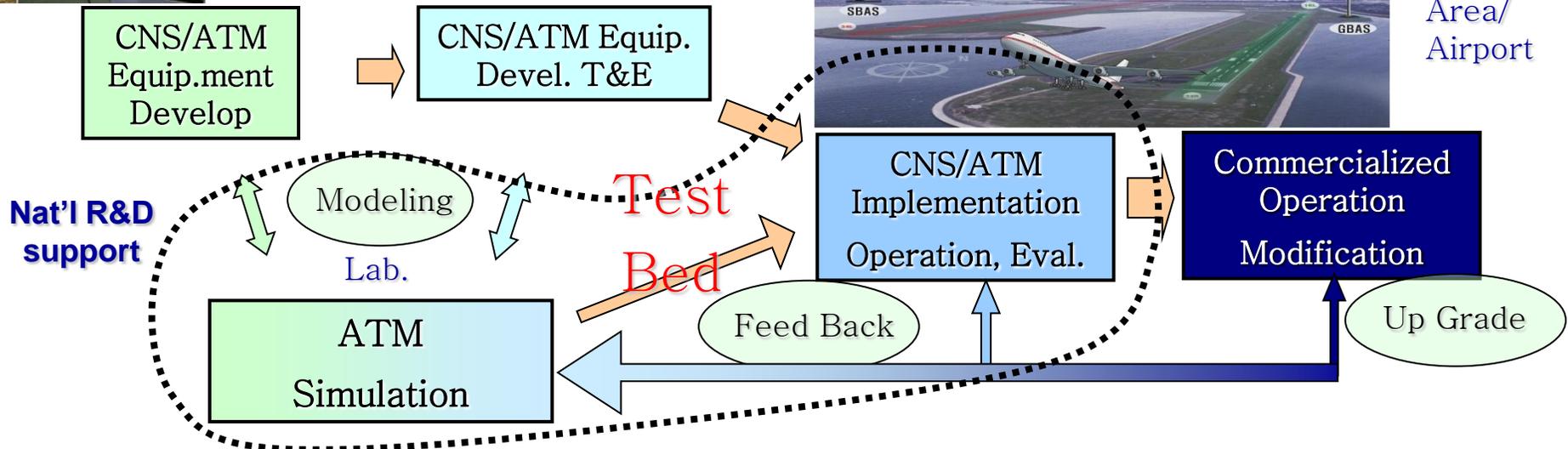SBAS, Anti-jamming and back-up system tech.

CNS/ATM Test bed Airport

# Future Plan and Direction

Technology development of **ATM related R&D Equipment and facility**
- Related to the systems of Operation, Procedures, Regulations, Certification, Conformity
- Focus on Ground facility (national infrastructure) rather than on-board equipment
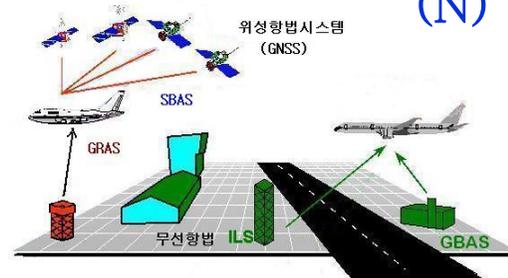
Country/
Area/
Airport

CNS/ATM Equip.ment Develop → CNS/ATM Equip. Devel. T&E

**Nat'l R&D support**

Modeling Lab.

Test Bed

ATM Simulation

Feed Back

CNS/ATM Implementation Operation, Eval.

Commercialized Operation Modification

Up Grade

# Summary

## Communications (C)

Voice
Data
VDL-2*, 4
SATCOM
UAT

항공통신서비스
(CDDLC,ADC 등)

데이터링크
(VDL,HFDL 등)

항공종합통신망(ATN)

## Navigation (N)

위성항법시스템
(GNSS)

SBAS

GRAS

무선항법  ILS
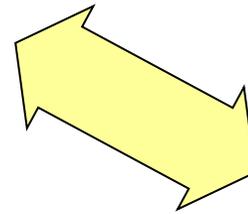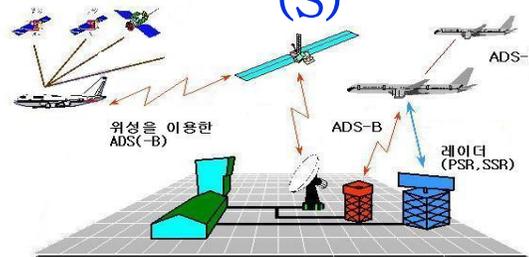
GBAS

Ground NAVAIDs
ILS
SATNAV*
GBAS*
SBAS

## Surveillance (S)

Radar (SSR, PSR, ASDE)
ADS-A/B*, Mode S
Multilateration

위성을 이용한
ADS(-B)

ADS-B

ADS-B

레이더
(PSR,SSR)

## Air Traffic Management (ATM)

ATS*
ASM
ATFM

KARI Experience Areas
• VDL  M2 : VHF Data Link Mode 2
• GBAS  :  Ground Based Augmentation System
• ADS-B :  Automatic Dependent Surveillance – Broadcast
• ATS  :  Air Traffic Service (Surveillance Data Processor)

# Summary

O SCAT-I GBAS / IMT

O ADS-B Study

O VDL mode-II

O R&D Road Map Establishment ('08)

**Test Bed Airport**

O eATIPS

O GABS Operation & Approval → CAT II/III Technology

O ADS-B Core Tech.

O Next Gen. Communication

O ATM