



Trends and Technology Of Radio Monitoring In Korea

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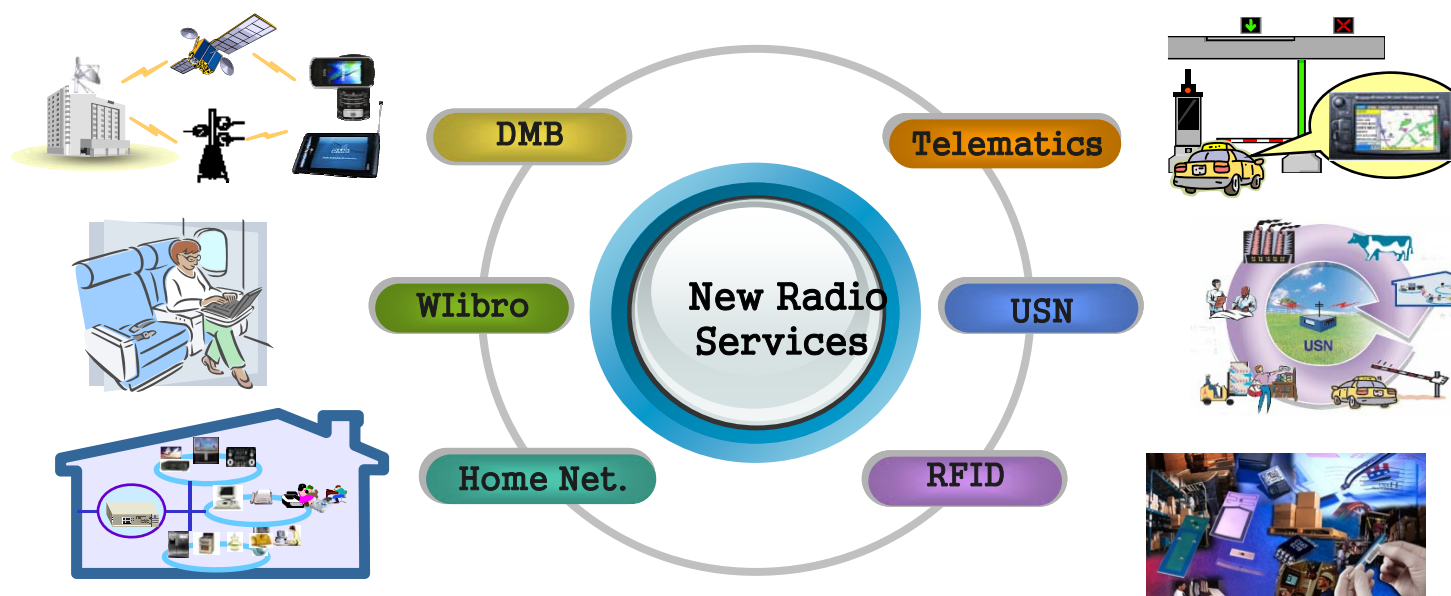


I. Trends of Radio Monitoring

Radio Spectrum Environment

Various Radio Application

- Various Radio Application & Generalization
- Convergence between mobile and broadcasting technology

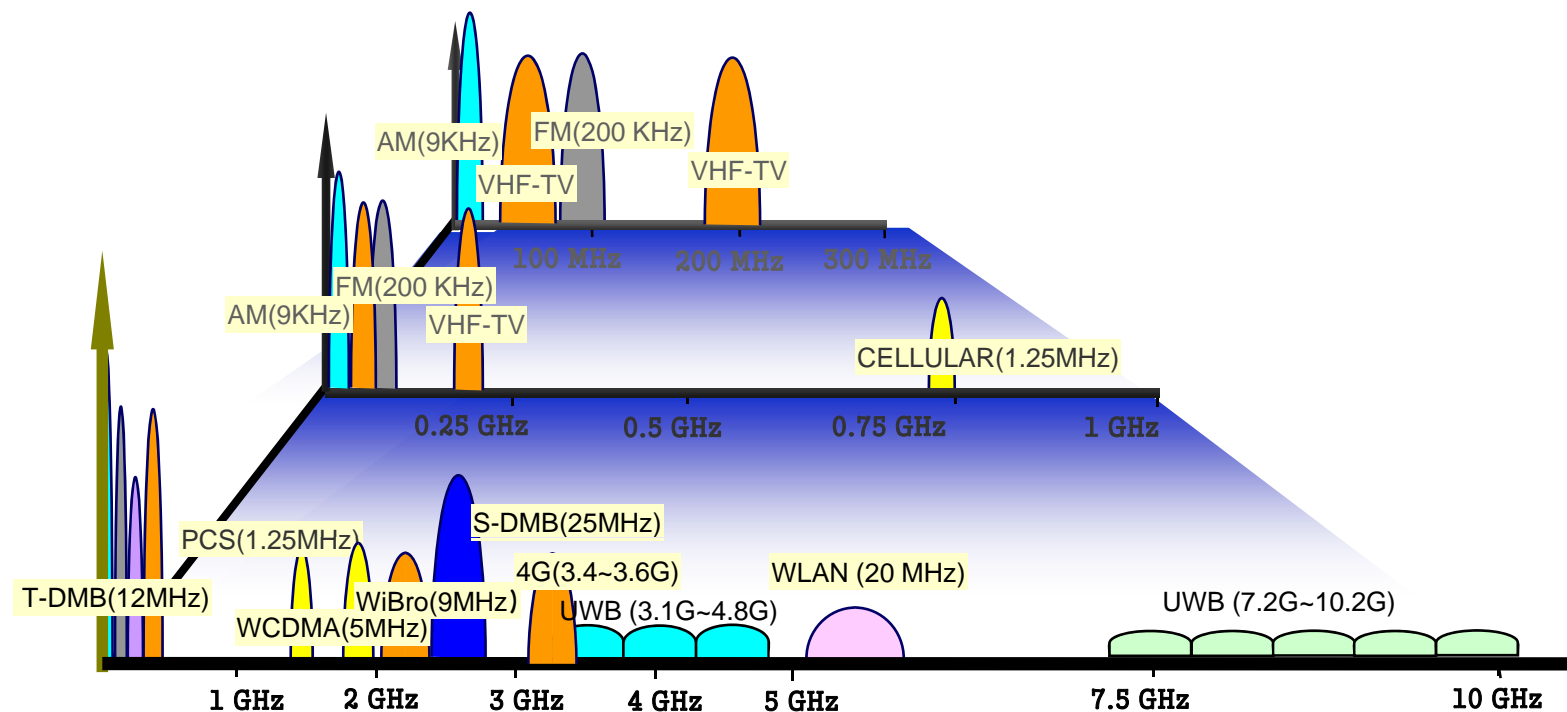


Complicated Radio Environment

Radio Spectrum Environment

New Radio Technology

- Digital Broadband multimedia & Higher Frequency technology
- Low Power density & wideband SDR based technology



Digital Wideband

Radio Spectrum Environment

■ New radio technology: Broadband & Small power

- ◆ Convergence between mobile and broadcasting technology
 - Satellite DMB, Terrestrial DMB, DVB-H, MediaFLO
- ◆ Digital Broadband Technology
 - WiBro(9 MHz), DTV(6 MHz), 3G mobile(5 MHz)
- ◆ Low power density & wideband Technology
 - UWB(more than 500 MHz)

■ Frequency band of radio equipment

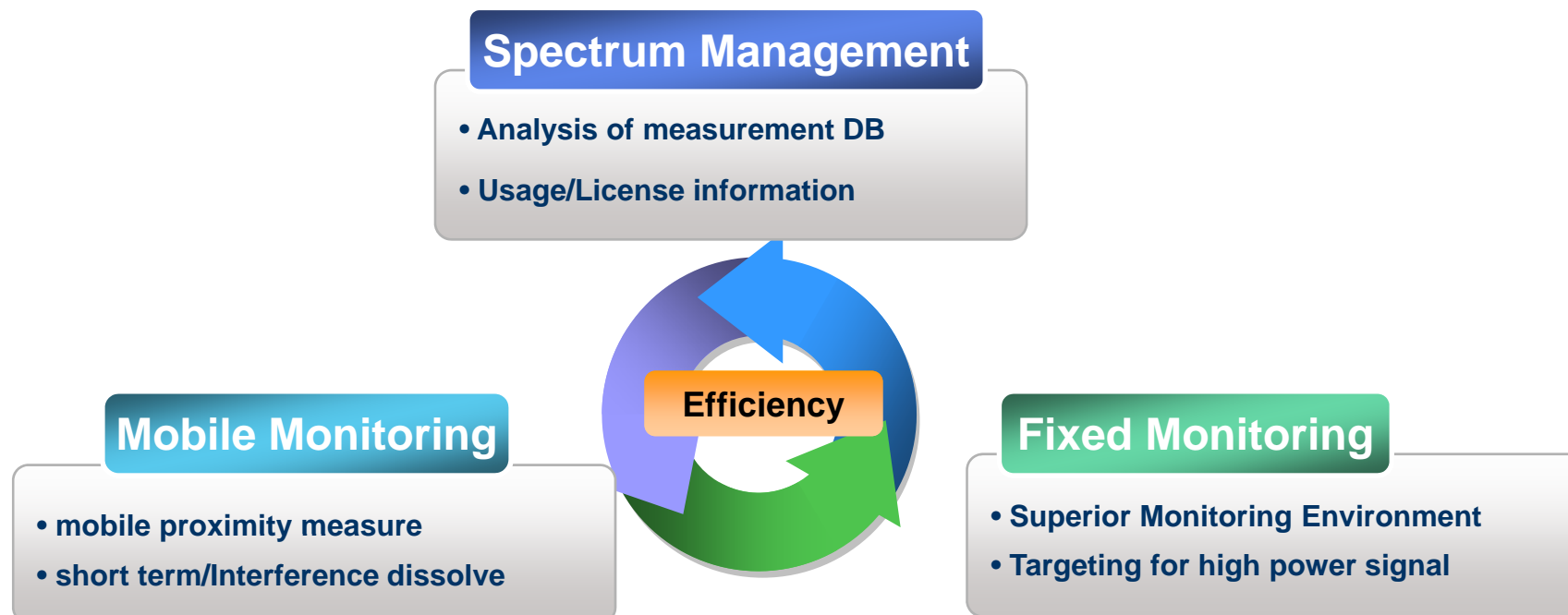
- ◆ Use higher frequency
- ◆ Satellite DMB(2.6 GHz), WiBro(2.3 GHz), WLAN(2.4/5 GHz)

■ Mobility

- ◆ Mobile communication
- ◆ Telematics Services

Direction of Radio Monitoring

- Spectrum measurement of new radio services
 - ◆ Wideband spectrum measurement
 - ◆ Mobile communications & small power
 - ◆ Frequency Coverage
- Strategies of Efficient Monitoring System
 - ◆ fixed monitoring system : General purpose spectrum measure
 - ◆ mobile monitoring system : Effective for high freq./small power

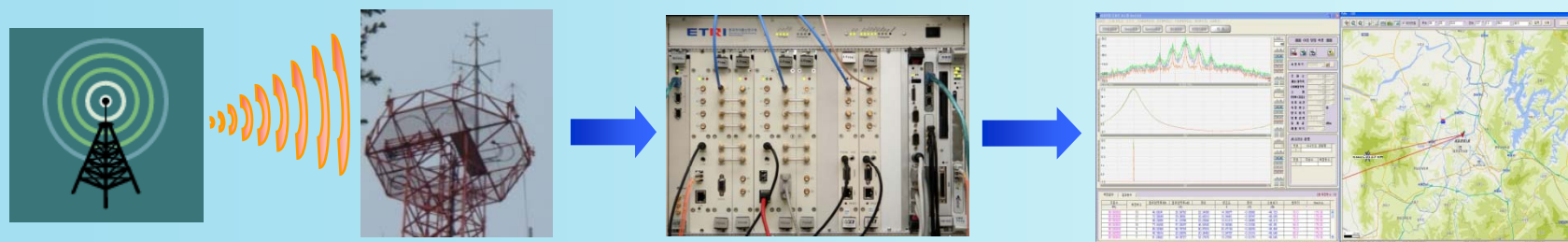




II. Design Concepts of Radio Monitoring

Radio Monitoring Operation

Radio Monitoring



Illegal Radio

Signal Receiving

Signal Measurement

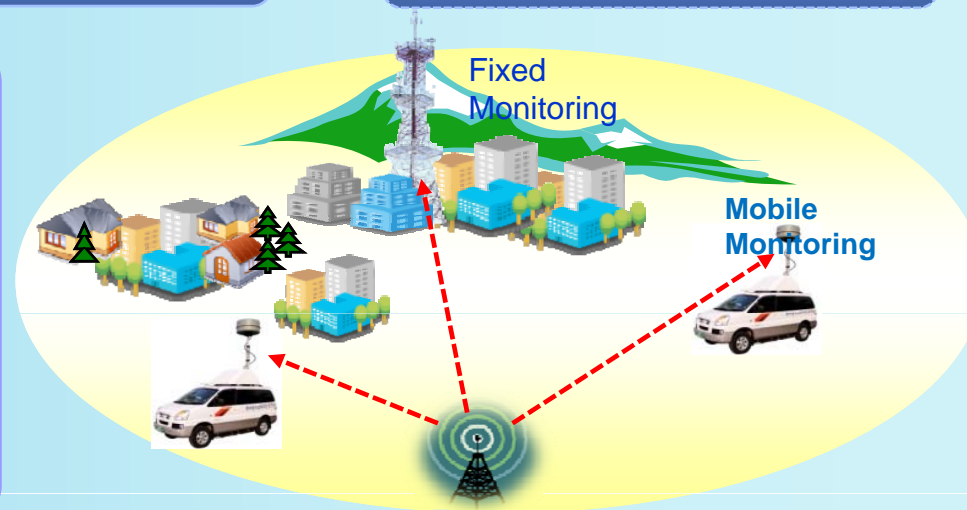
Judgments of regal or illegal

Operation Form

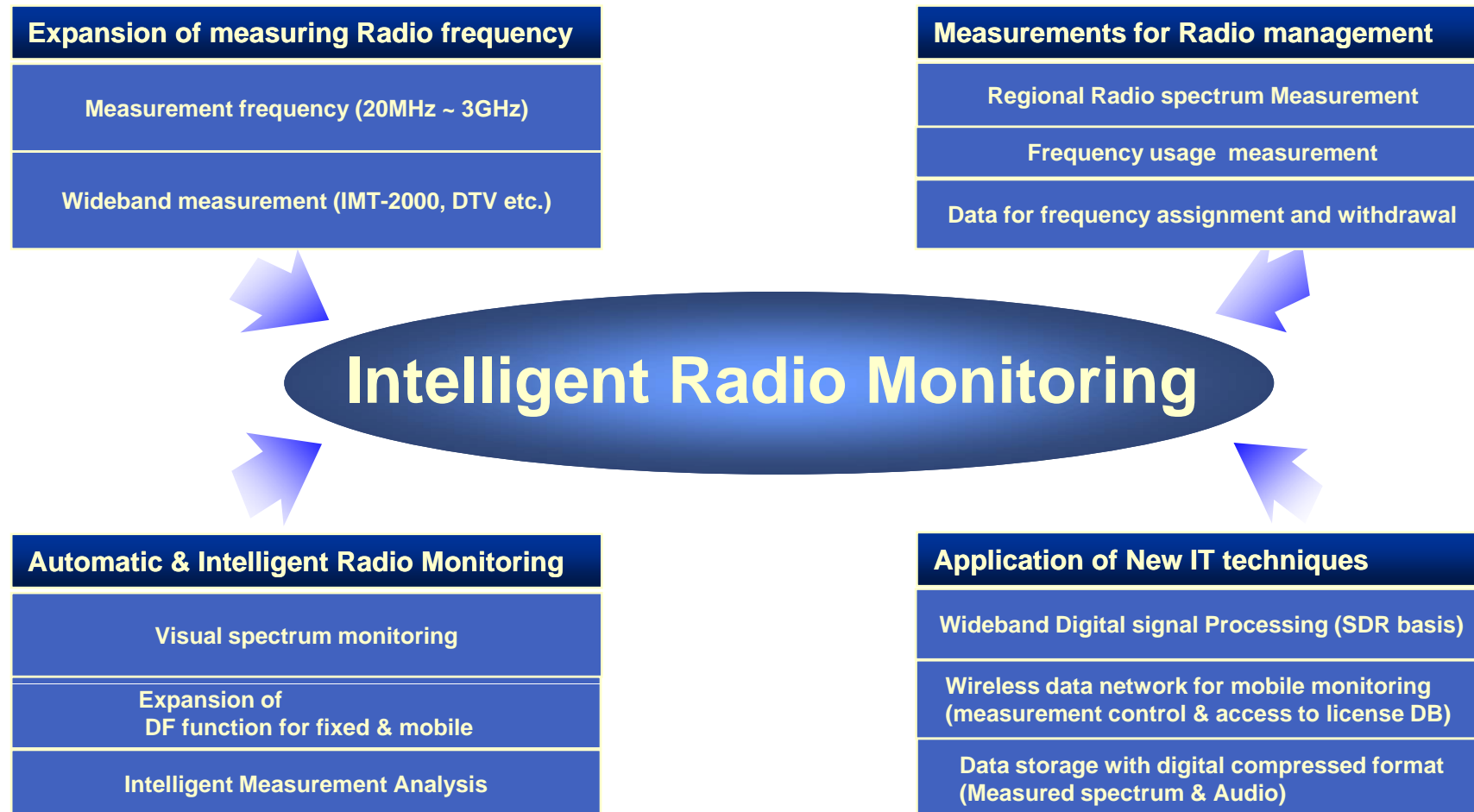
- Fixed Monitoring : High Power
- Mobile Monitoring : interference free

Operation Contents

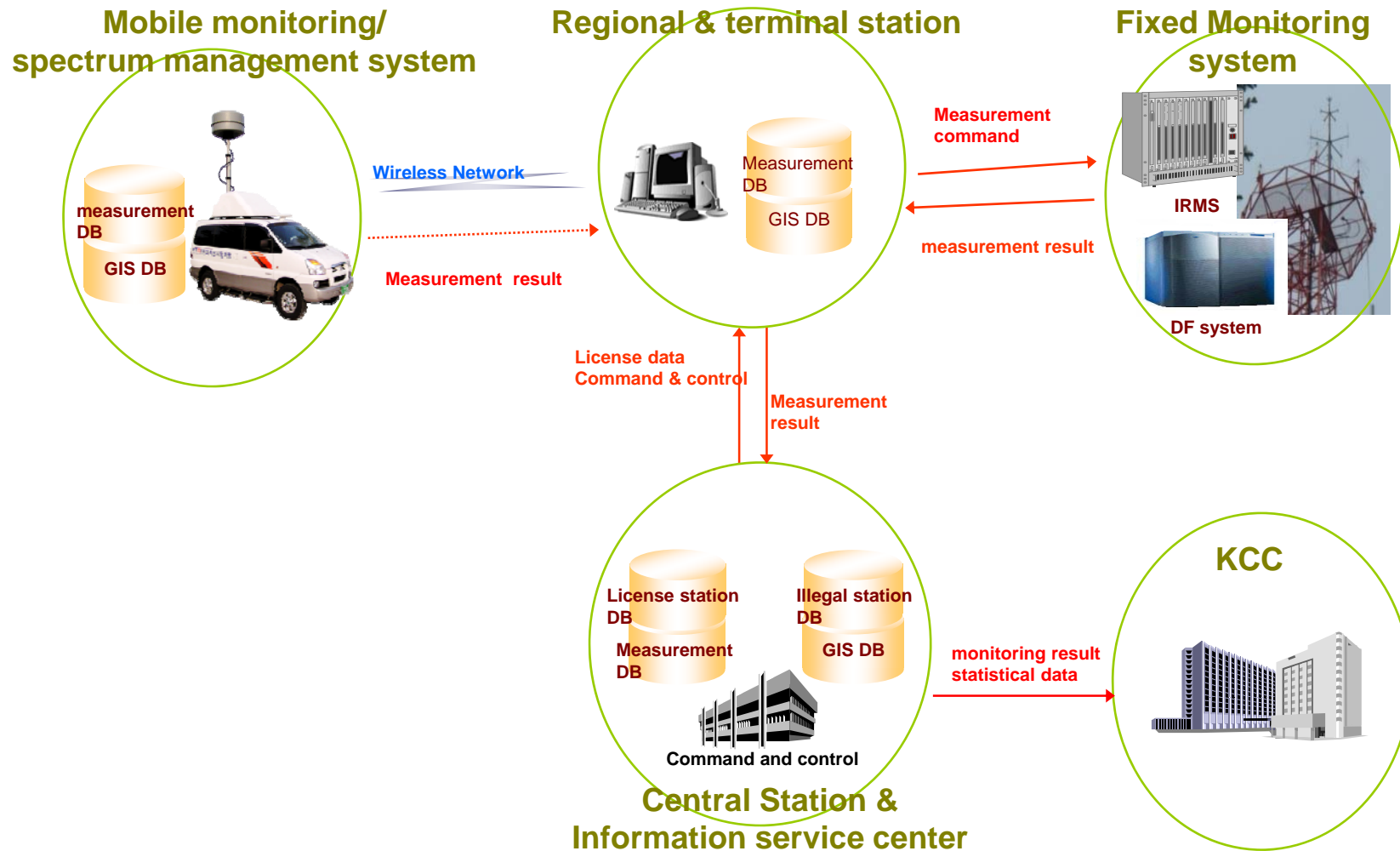
- Illegal Signal searching
- Illegal signal positioning/dissolution
- Spectrum environment measure



Design Concepts

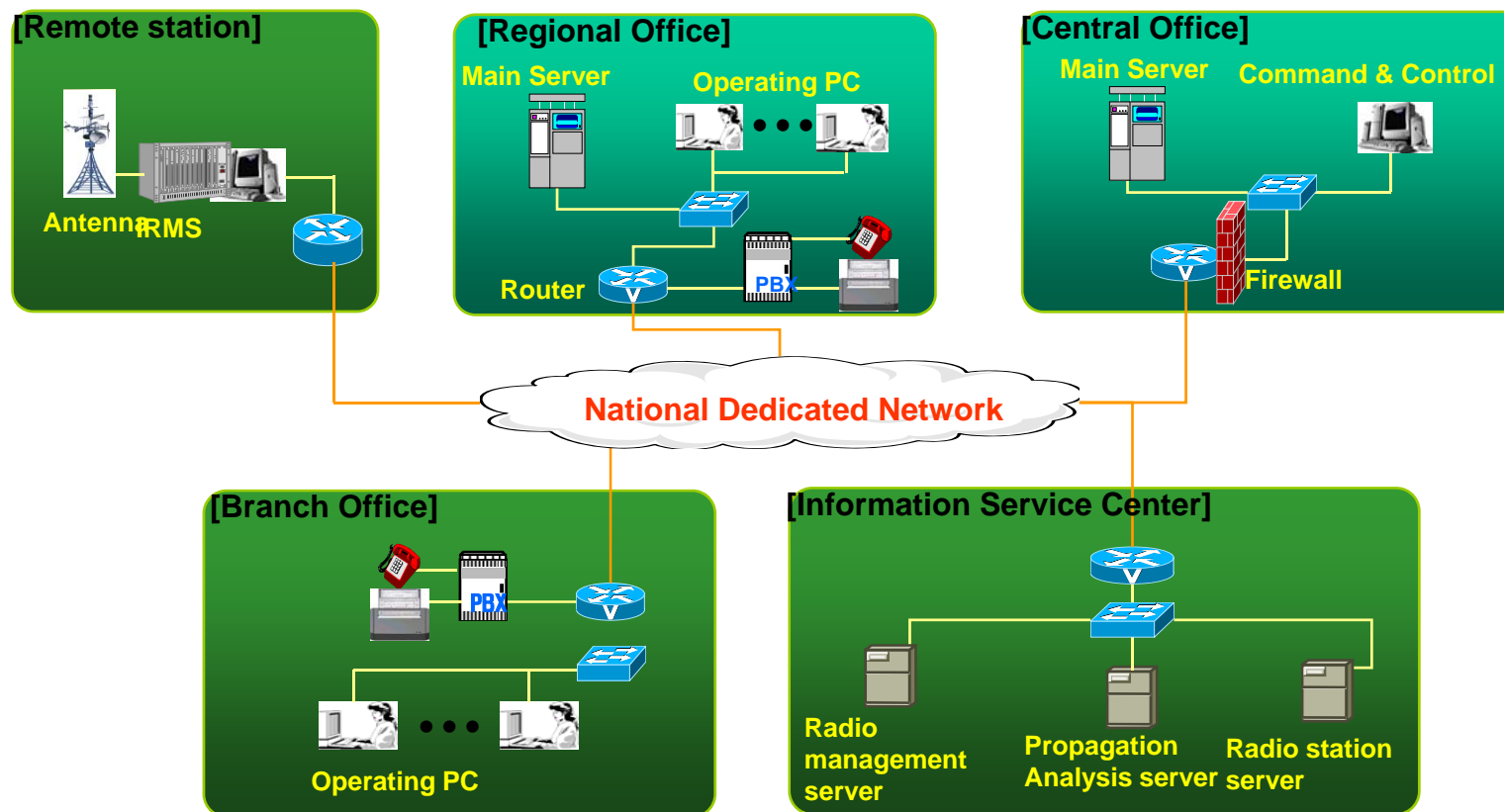


System Configuration



KCC : Korea Communications Commission

Networking of Monitoring Systems



System is Operated by IP method using National Dedicated Network

III. Fixed Monitoring System

Key Features of fixed monitoring System

- Frequency Range : 20 MHz~3 GHz
- Measurable Signal bandwidth : max 10 MHz
 - ◆ Measurement : dBm, dBuV, dBuV/m, uV/m
- Diverse antennas: Directional & Omni-directional
- Rotator for Directional antenna (1~10 rpm variable)
- Analysis of measurement data by statistics tool and graphical representation of the results
- Spectrum Display of unlicensed and licensed band
- Real-time scan for illegal radio station
- Measurement of channel / band occupancy and spectrum usage
- networks: connected via dedicated networks

Key Features of Fixed DF System

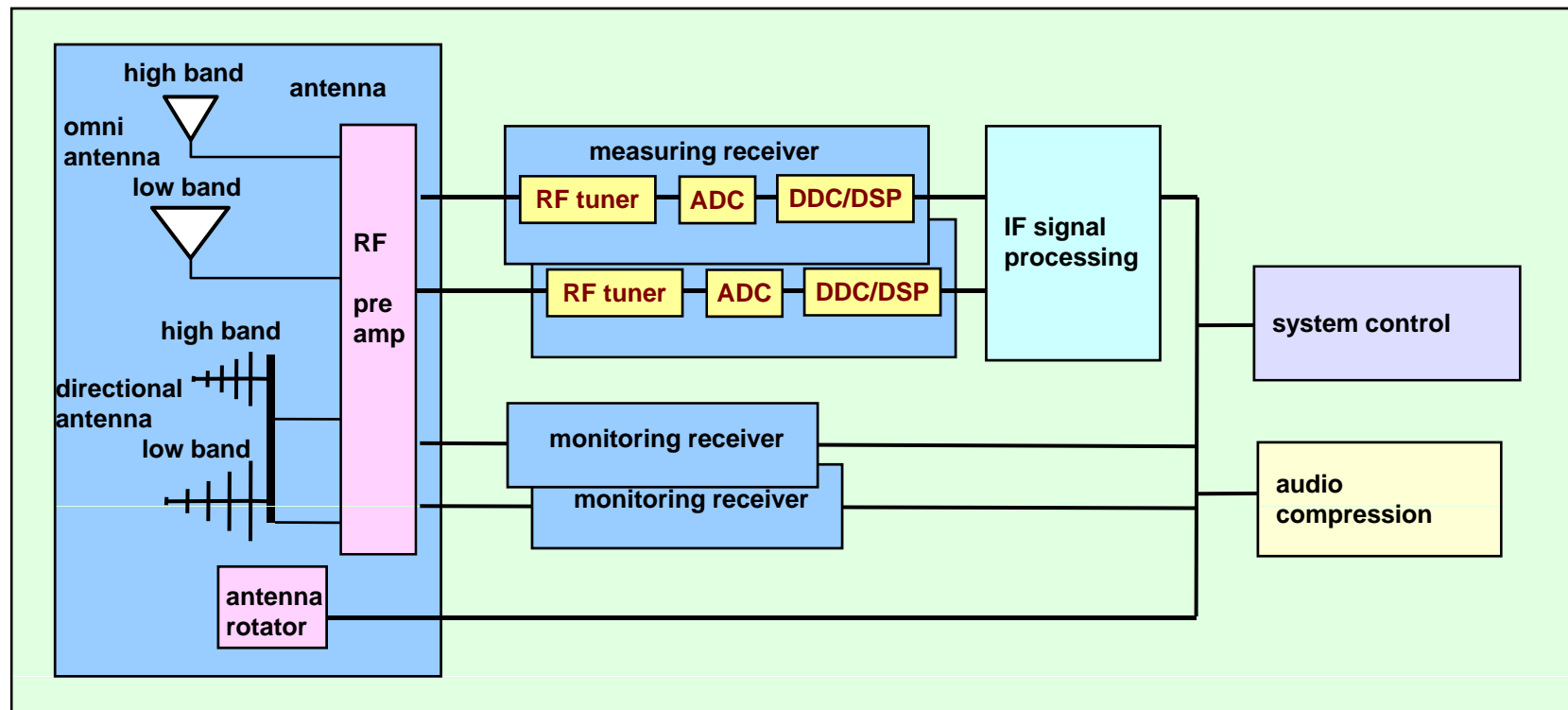
- Frequency range : 20 MHz~3 GHz
- Accuracy of DF: 1~2 deg RMS error in LOS condition
- DF Algorithm: MUSIC (Multiple Signal Classification)
- Real-time location of illegal radio station
 - ◆ In cooperation with Fixed Monitoring System
- Remote control support
 - ◆ All DF system can be controlled at control & command center
 - ◆ DF system at neighbor site is operated together to locate radio station

System Architecture

Subsystem

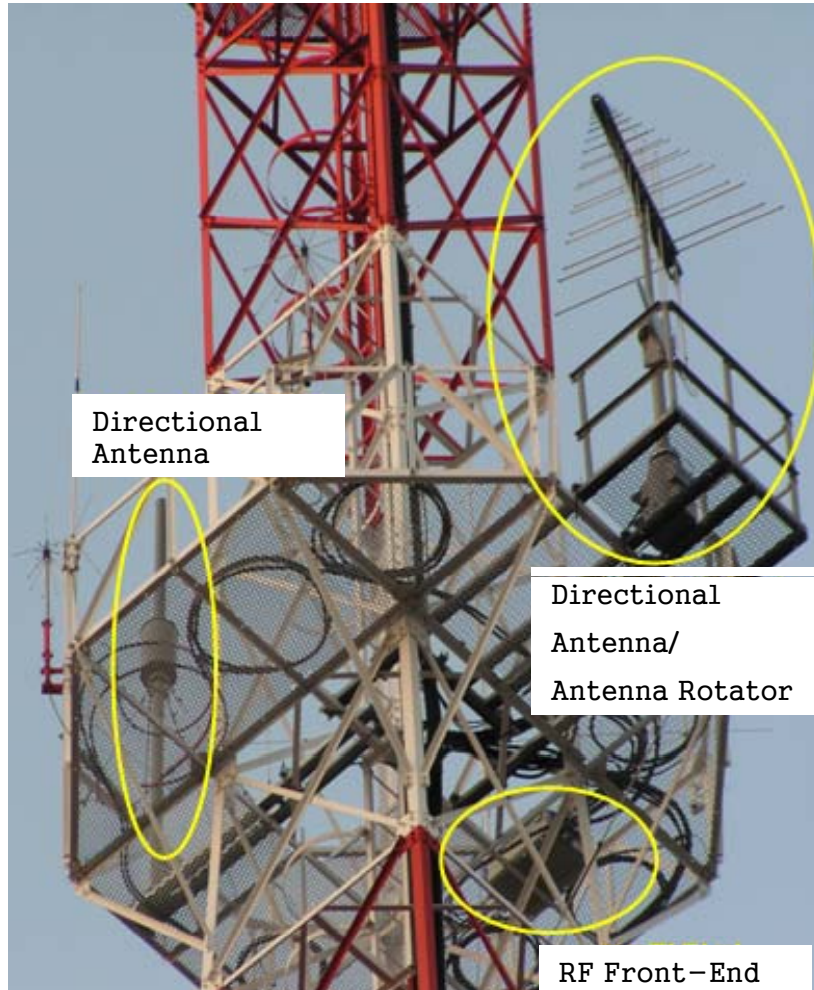
- ◆ antenna, receiver (measuring, monitoring), IF signal processing, system control

SDR oriented design



Radio Monitoring system at CRMO, Daejeon

Monitoring Antennas



Monitoring system

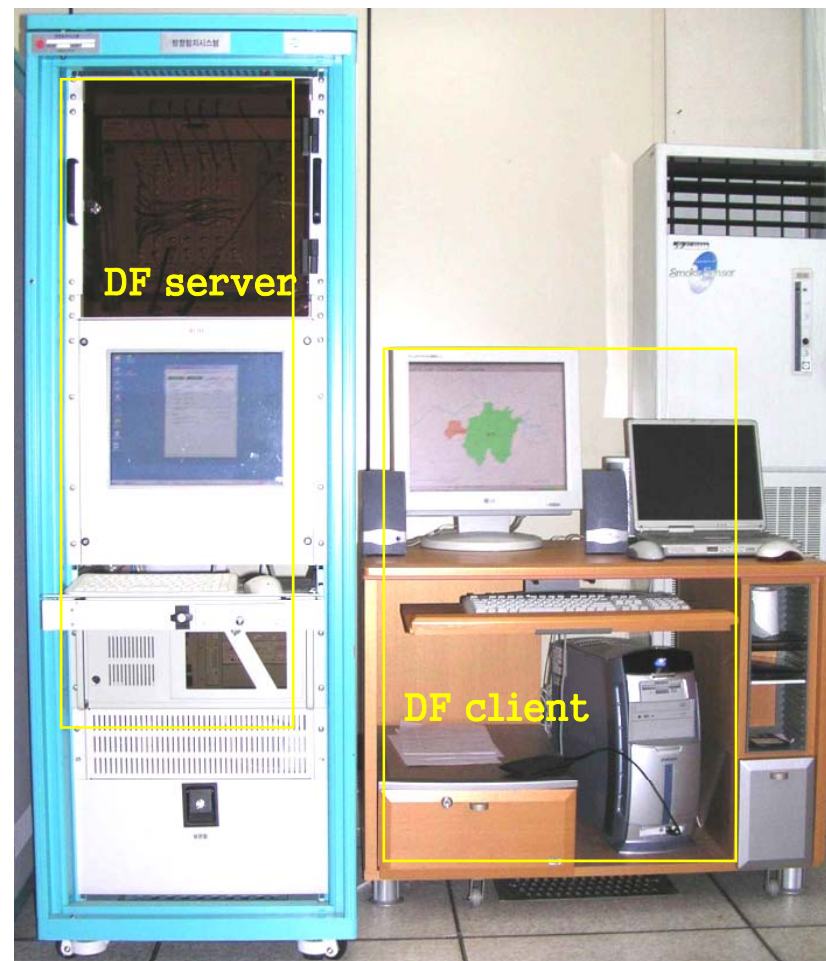


Fixed DF system at CRMO, Daejeon

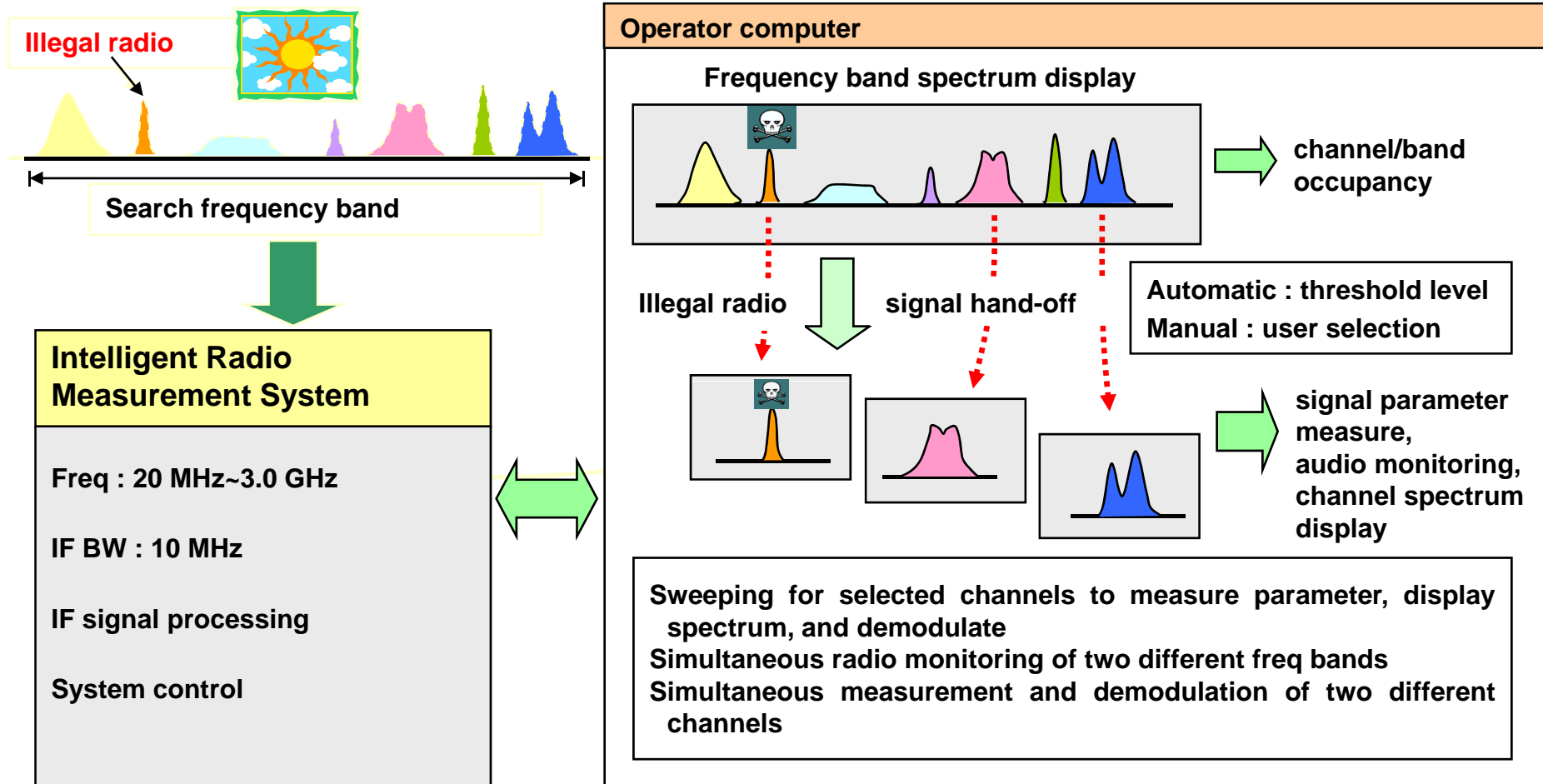
DF antenna



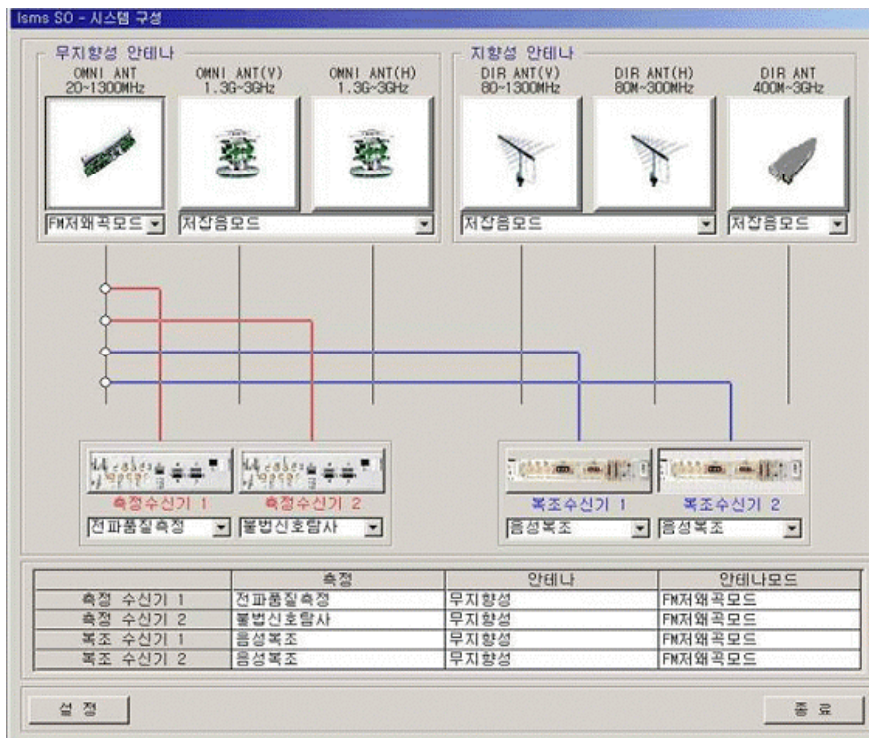
DF system



Handoff

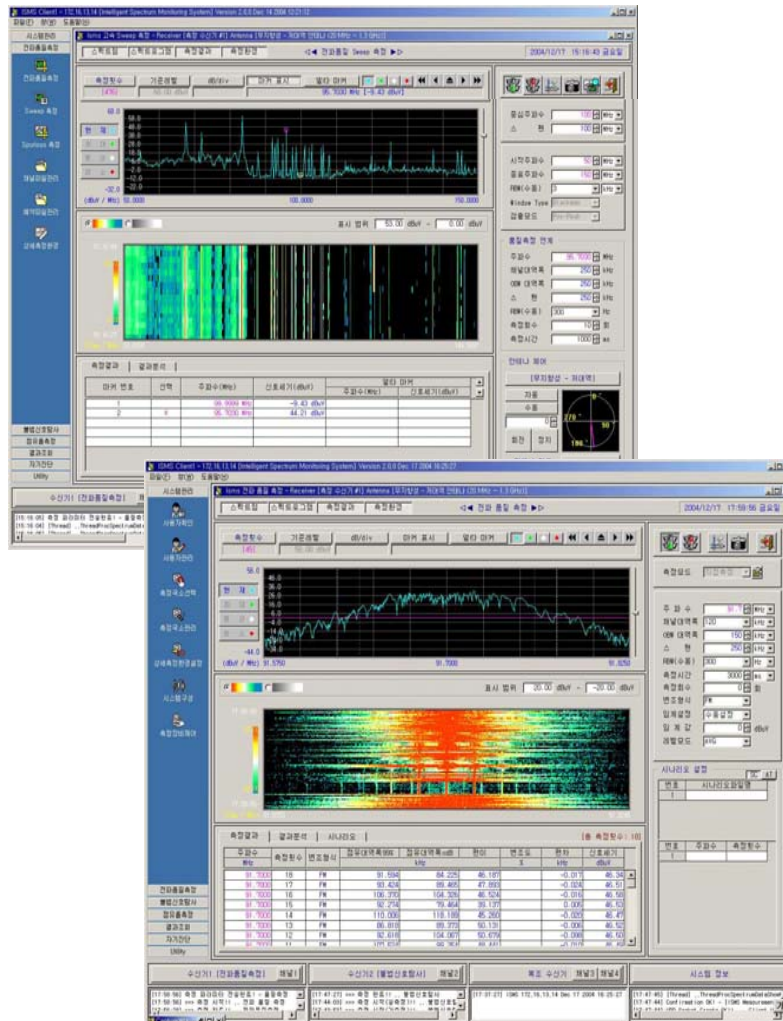


Flexible Antenna Selection



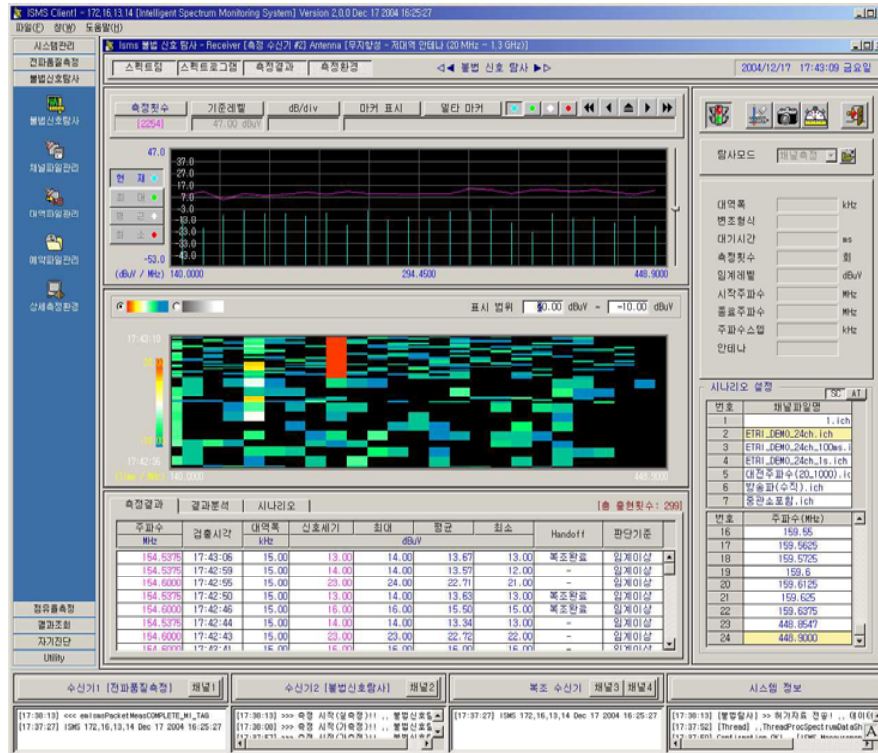
- Independent antenna output feeding to all receivers
- Multiple mode of RF front-end
 - ◆ low distortion
 - ◆ low noise
 - ◆ high power signal suppression
- High speed rotation of directional antenna

Radio Signal Measurements



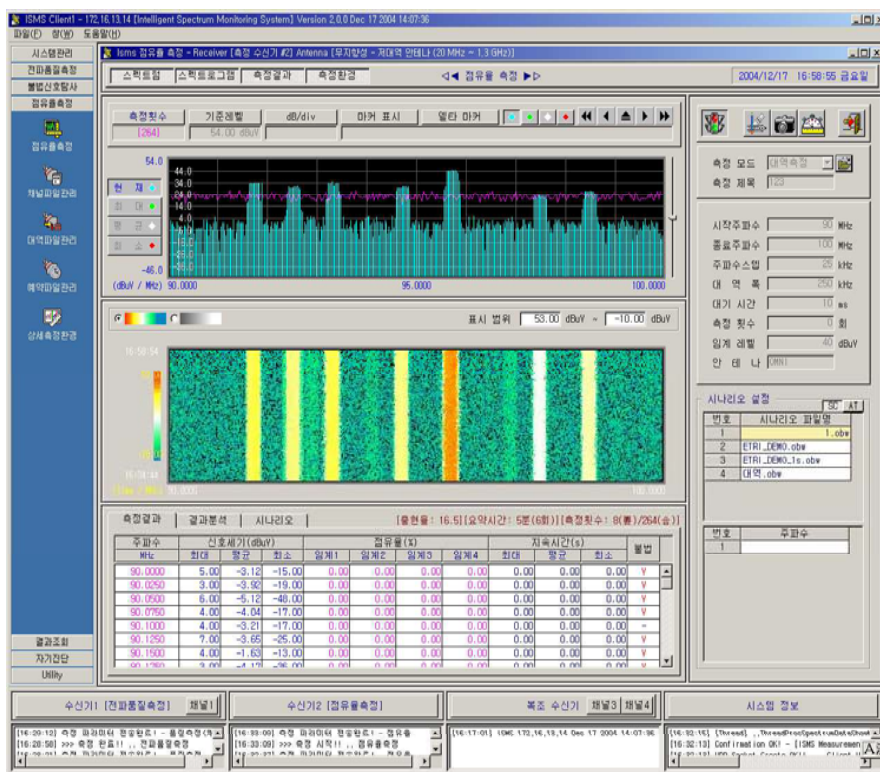
- High-speed spectrum measurement
- parameter measurement
 - ◆ carrier frequency offset
 - ◆ FM frequency deviation
 - ◆ occupied bandwidth
 - ◆ signal level
- spurious measurement
 - ◆ spectrum mask
 - ◆ channel power
 - ◆ adjacent channel power ratio
- hand-off for illegal radio detection

Unlicensed Radio Detection



- High-speed search and hand-off of illegal radio station
 - ◆ channel search
 - ◆ band search
- Automatic detection of illegal radio station by comparison with assigned frequency
- Audio monitoring and storage of illegal radio station
- Illegal radio detection, and signal handoff for location and measurement

Occupancy Measurement of Spectrum



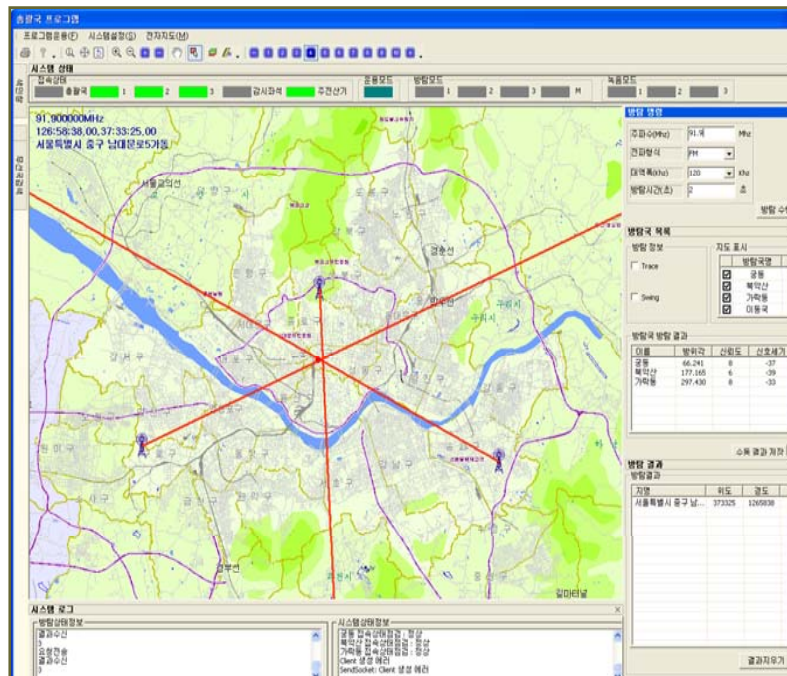
□ occupancy measurements

- ◆ channel occupancy
- ◆ band occupancy
- ◆ multiple threshold level

□ occupancy database

- ◆ query by various measurement condition : time, day, month, multiple threshold
- ◆ statistics report and spectrum display

DF Results Display



- DF Operating Mode
 - ◆ single channel DF
 - ◆ multiple channel DF with channel scan
- Map display using GIS with 20 layers
- Zoom in and out of map display
- Storage and retrieval of DF command and results
- Statistical processing and graphical plot of DF results

V. Mobile Monitoring System

Features of Mobile Monitoring System

- Multi-functional radio monitoring
 - ◆ Direction finding & signal measurement
 - ◆ Compliant with ITU recommendations
- Antenna structure minimizing the radio interference
 - ◆ Design techniques minimizing mutual coupling
 - ◆ Adoption of adjustable non-metallic antenna mast
- Adoption of high capacity battery & Precise position information
 - ◆ Comfortable operating environment without noises
 - ◆ Adoption of DGPS & GPS Compass
- Wireless networked system
 - ◆ Remotely controlled by fixed & mobile stations
 - ◆ Homing operation & geolocation

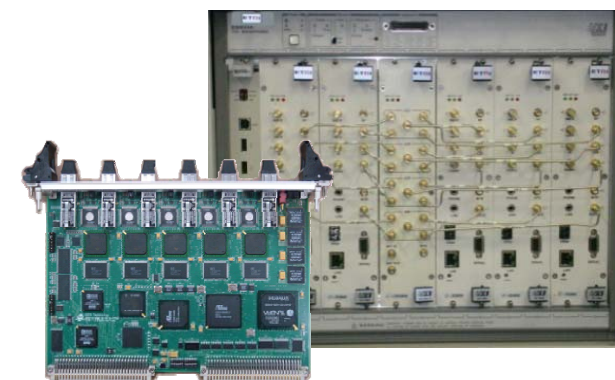


Configuration of Mobile Monitoring System

■ Specifications

- ◆ Frequency range : 20 ~ 3000 MHz
- ◆ IF bandwidth : 10 MHz
- ◆ DF accuracy : 1.5° rms
- ◆ Sensitivity : -110 dBm
(@12dB SNR,CW)

- ◆ Mast height : 5 m
- ◆ Battery capacity : 8 hr



Operation of Mobile Monitoring System

Operation mode

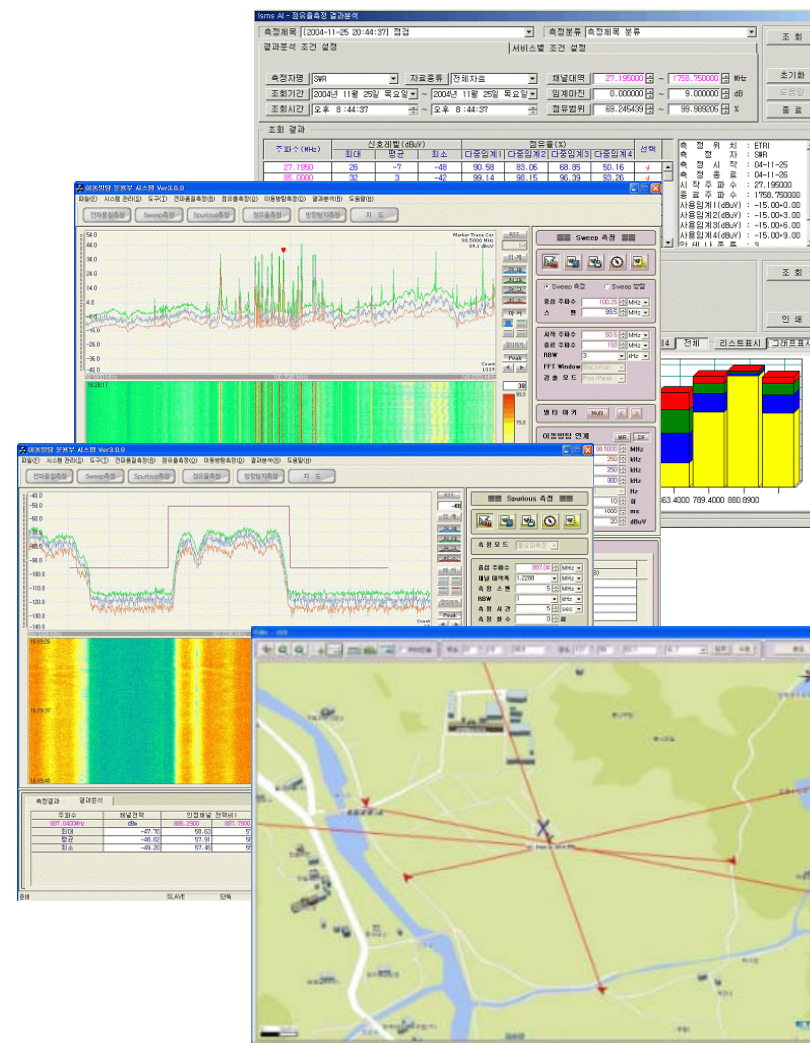
- ◆ Fixed frequency mode
- ◆ Memory & frequency scan mode
- ◆ Wideband detection mode

DF homing and geolocation

- ◆ DF polar & geographic map display

Signal measurement

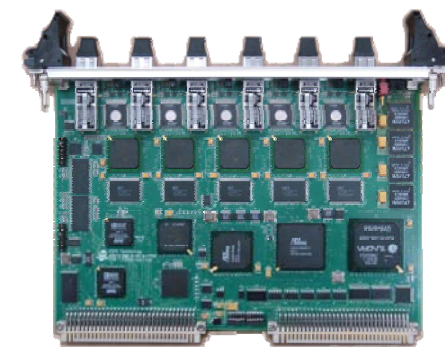
- ◆ Spectrum measurement
- ◆ Bandwidth measurement
- ◆ Spectrum occupancy measurement
- ◆ Illegal frequency detection



Configuration of Mobile Monitoring System

Configurations

- ◆ Low profile DF array antenna
- ◆ Array front-end unit
- ◆ Multi-channel RF receiver
- ◆ Signal processing unit & control unit
- ◆ DGPS, GPS compass, etc.



VI. Conclusions

Conclusions

- Designed various radio system with wideband measurement and software functions will be used as an infrastructure of IT Korea
- Keep Radio environment as interference-free as possible by removing illegal radio stations and some intentional interference sources
- Measure the spectrum use and make the spectrum map for efficient use of spectrum
- Store the measurements at common DB to apply the measurement results to spectrum policy in Korea