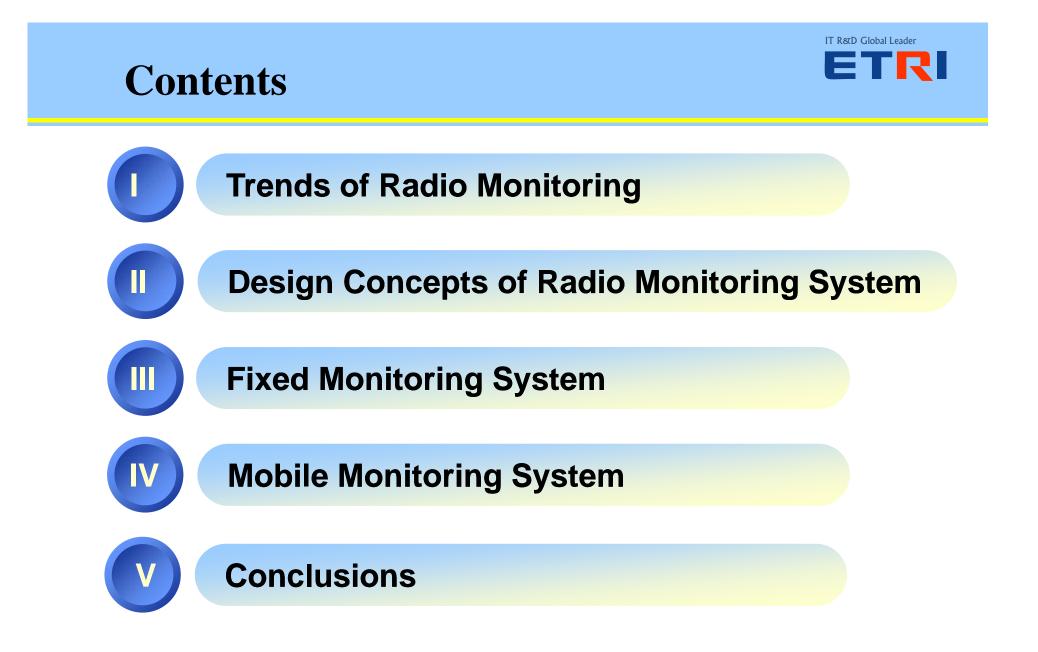
Trends and Technology Of Radio Monitoring In Korea

Sang-Tae Kim, Seong-Yun Lee

Radio Technology Research Department



Electronics and Telecommunications Research Institute



I. Trends of Radio Monitoring

Radio Spectrum Environment



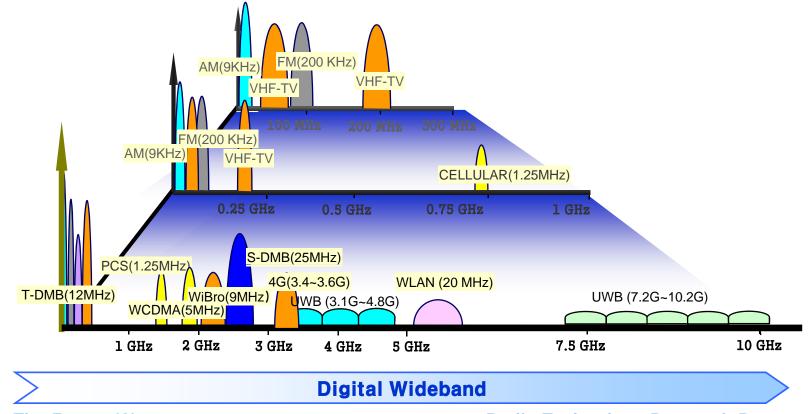
Various Radio Application

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



Radio Spectrum Environment New Radio Technology Image: Comparison of the Comparison of the

Low Power density & wideband SDR based technology



::: ETRI, The Future Wave :::

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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)

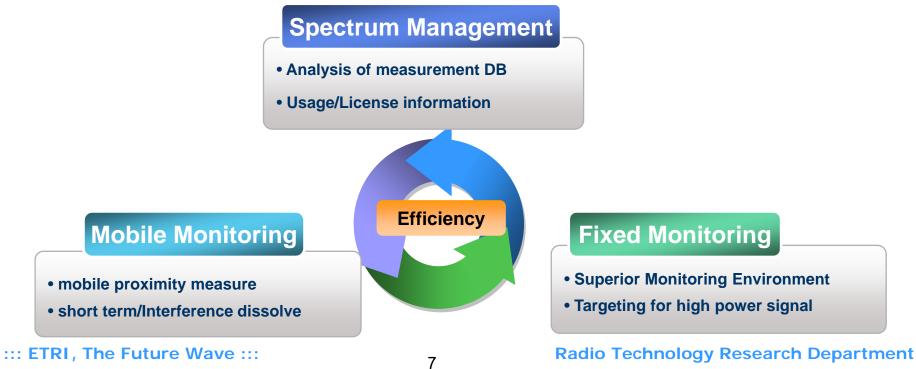
Mobility

- 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

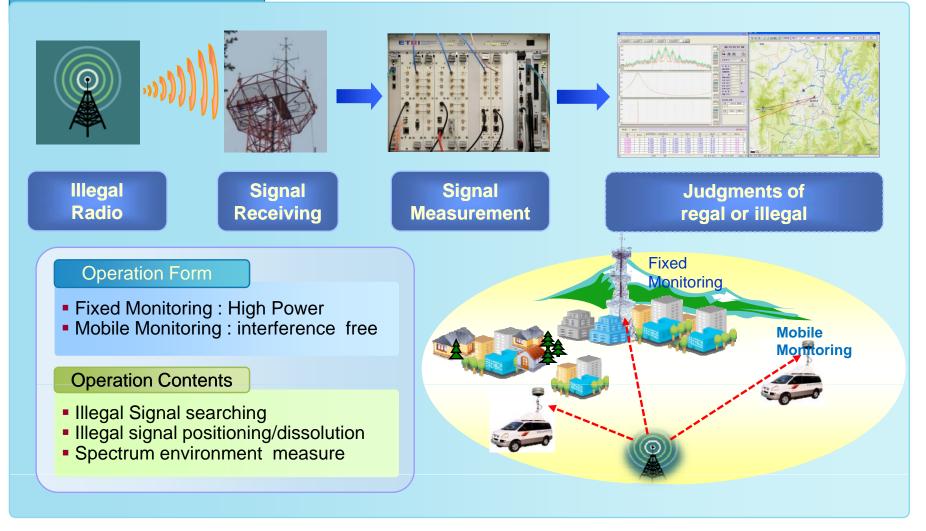


II. Design Concepts of Radio Monitoring



Radio Monitoring Operation

Radio Monitoring





Design Concepts

Expansion of measuring Radio frequency

Measurement frequency (20MHz ~ 3GHz)

Wideband measurement (IMT-2000, DTV etc.)

Measurements for Radio management

Regional Radio spectrum Measurement

Frequency usage measurement

Data for frequency assignment and withdrawal

Intelligent Radio Monitoring

Automatic & Intelligent Radio Monitoring

Visual spectrum monitoring

Expansion of DF function for fixed & mobile

Intelligent Measurement Analysis

Application of New IT techniques

Wideband Digital signal Processing (SDR basis)

Wireless data network for mobile monitoring (measurement control & access to license DB)

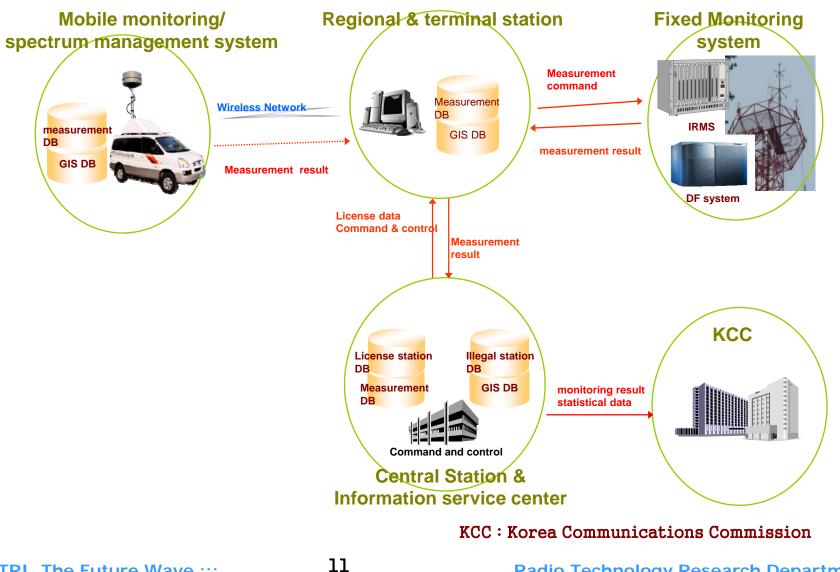
Data storage with digital compressed format (Measured spectrum & Audio)

::: ETRI, The Future Wave :::

10



System Configuration

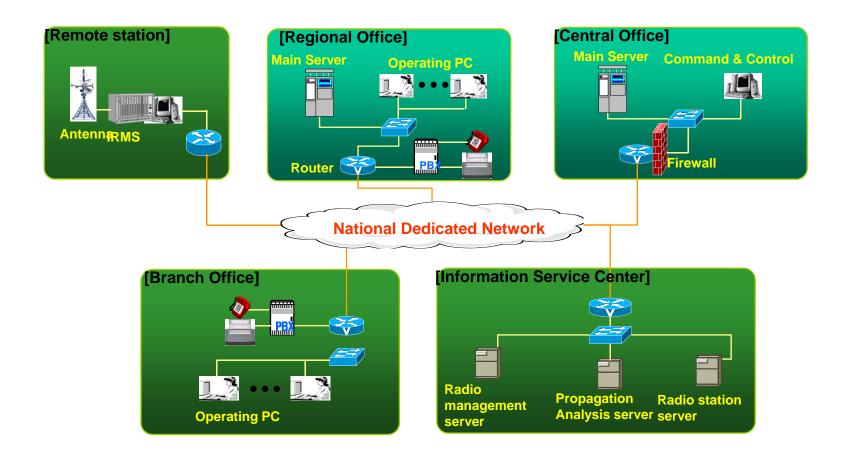


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Networking of Monitoring Systems



System is Operated by IP method using National Dedicated Network

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III. Fixed Monitoring System 13

Key Features of fixed monitoring System

- Frequency Range : 20 MHz~3 GHz
- Measurable Signal bandwidth : max 10 Mz
 - 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

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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

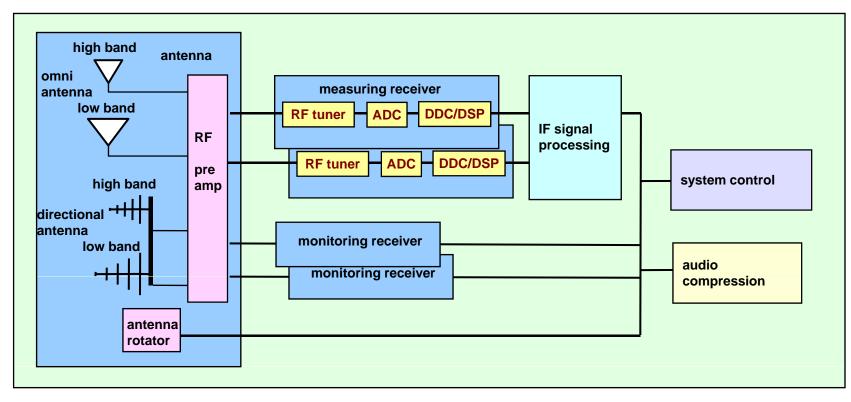


System Architecture

Subsystem

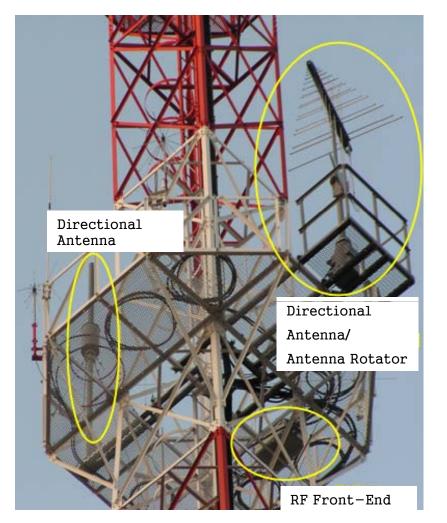
Antenna, receiver (measuring, monitoring), IF signal processing, system control

SDR oriented design



Radio Monitoring system at CRMO, Daejeon

Monitoring Antennas



Monitoring system

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Fixed DF system at CRMO, Daejeon

DF antenna

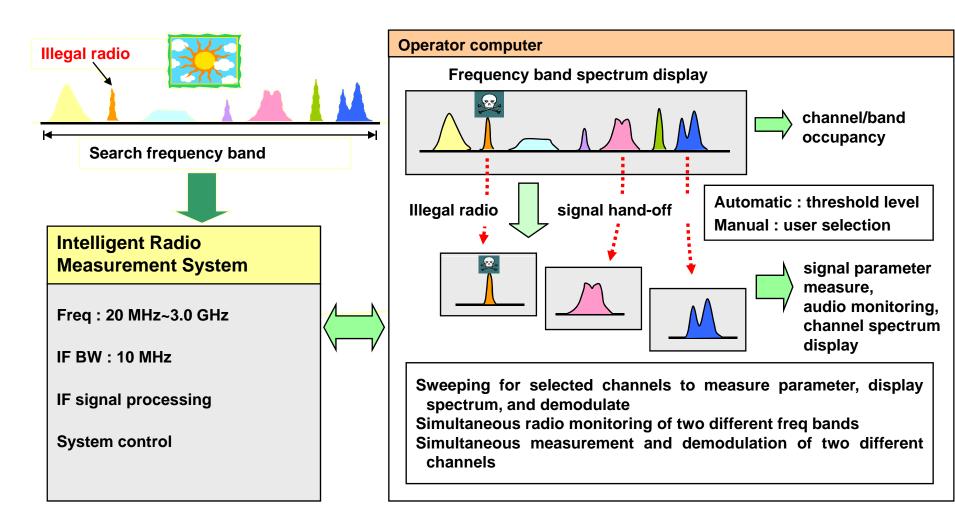


DF system



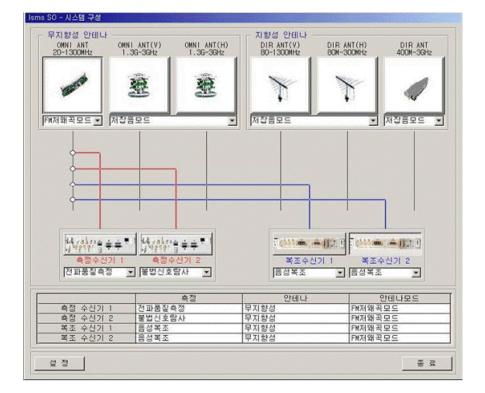


Handoff



Flexible Antenna Selection





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

Radio Signal Measurements

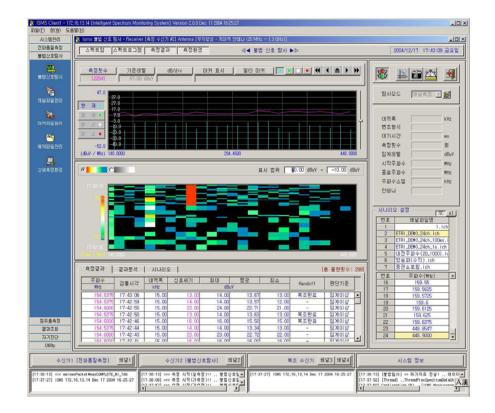


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- High-speed spectrum measurement
- parameter measurement
 - ♦ carrier frequency offset
 - FM frequency deviation
 - occupied bandwidth
 - ♦ signal level
- spurious measurement
 - spectrum mask
 - channel power
 - ♦ adjacent channel power ratio
- hand-off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

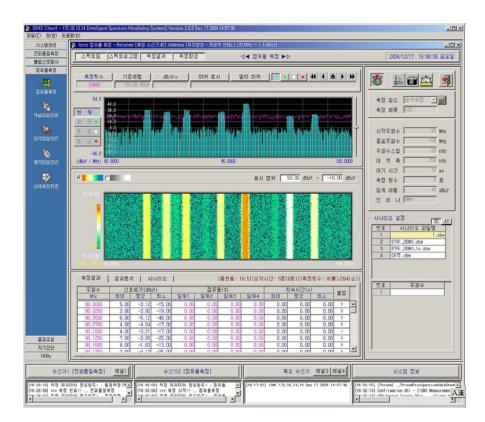
Unlicensed Radio Detection





- 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

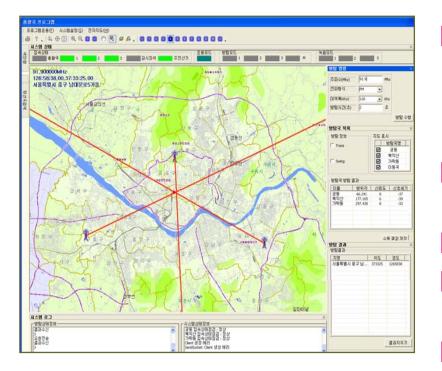
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 statistics report and spectrum display

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



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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



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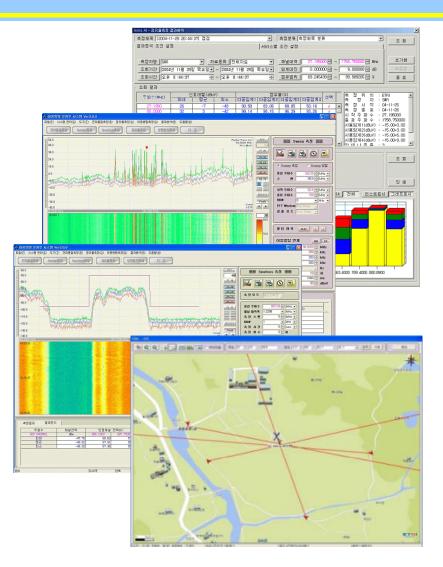
Operation of Mobile Monitoring System

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.







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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