

# Integrated Spectrum Management & Monitoring Systems

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Spectrum Monitoring Systems

# Spectrum management

... comprises mainly the following tasks:

- Planning of new transmitters
  - Coverage area
  - Avoid negative impact on existing transmitter
  
- Licensing
  
- Billing

# Spectrum monitoring

... comprises mainly the following tasks:

- Interference investigations due to co-channel emissions, out-of-channel emissions and intermodulation (i.e. detect, identify, locate and “fix” transmitter which cause problems)
- Verification that licensed transmitter operate within their assigned limits
- Provide / verify management data

# Spectrum monitoring

... comprises mainly the following tasks:

- Frequency and frequency offset measurements (ITU-R SM.377)
- Field strength measurements (ITU-R SM.378)
- Bandwidth measurements (ITU-R SM.443)
- Modulation depth and frequency deviation measurements (ITU-R SM.328)
- Spectrum occupancy measurements (ITU-R SM.1880)

# Spectrum monitoring

- Radio direction finding and location, listening and identification in the HF (ITU-R SM.854), V/UHF and higher frequency ranges (to determine non-licensed stations)
- Radio direction finding and location of TDMA and CDMA signals (ITU-R SM.1598)
- Technical identification of digital signals (ITU-R SM.1600)
- DVB-T coverage measurements and verification of planning data (ITU-R SM.1875)
- ...

# Spectrum management

Spectrum management knows exactly how the world should be



# Spectrum monitoring

Spectrum monitoring knows exactly how the world really is



# Spectrum management & monitoring

- Spectrum management and monitoring need to exchange information
- From management to monitoring
  - License information
    - Reference for control of compliant operation
    - Reference for detection of unlicensed transmitters
    - Reference for identification of interferer
  - Measurement tasks
    - Spectrum management operator can define task to get required information



# Spectrum management & monitoring

- Spectrum management and monitoring need to exchange information
- From monitoring to management
  - Measurement results
    - Real data for control of compliant operation
    - Real data for detection of unlicensed transmitters
    - Real data for identification of interferer
    - Reference for coverage calculation
    - Reference for interference analysis
  - Statistic data
    - Occupancy
    - Measurement value distribution

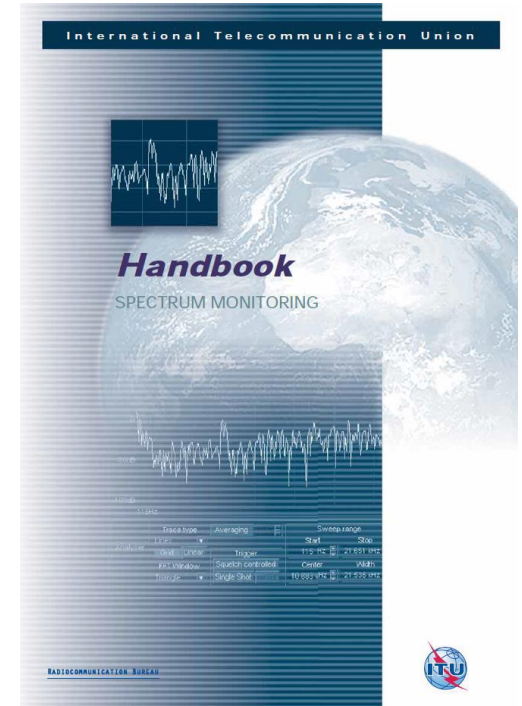
# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation

■ ARGUS: Dedicated software for ITU-compliant spectrum monitoring

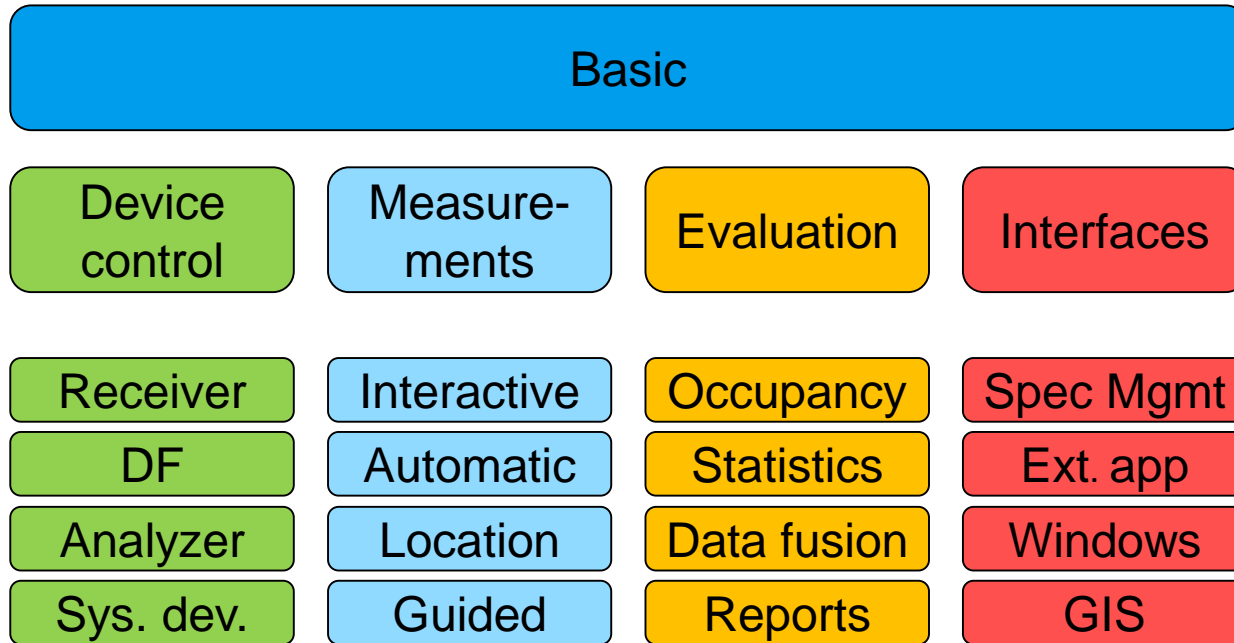
■ Key input

- ITU spectrum monitoring handbook and recommendations
- Close cooperation with operators
- Experience from 30 years in the market



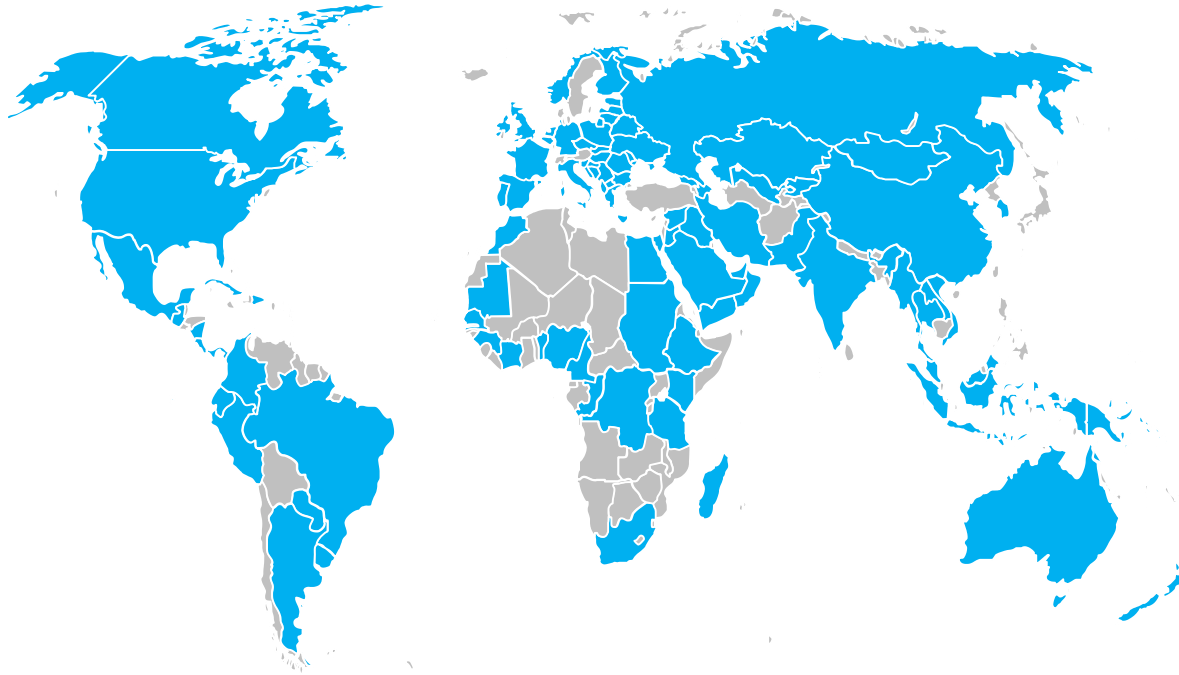
# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation



The modular structure

# The ARGUS world



# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation

- Monitoring operator can define filter criteria for license database query
- Criteria include:
  - Assigned / unassigned frequencies
  - Frequency range
  - Location
  - Service type
  - Call sign
  - License state
  - ...

Import Data from Database

**Result**

Transmitter List  
 Frequency List of Occupied Frequencies  Including Bandwidths  
 Frequency List of Unassigned Frequencies

Transmitter List: List 1

**Frequencies**

No Restriction  
 Single Frequency: 88.000000 MHz  
 Frequency Range: 88.000000 MHz - 108.000000 MHz  
 Frequency List: Demo New Tx

**Locations**

No Restriction  
 Country Code  
 Coordinates: Longitude 11 36 45.0 E, Latitude 48 7 40.0 N, Radius 50 km

**Optional Search Criteria**

Service: BC  
Signature:  
Call Sign:  
Licensee:  
License State: NG (License not yet granted)  
Transmitter Name:

**Options**

Selection of the Database: SMS4DC Automatic Update:

OK Cancel

# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation

- Example: Automatic license violation detection
- Information from spectrum management is supplemented by measurement results, clearly showing license violation

Irregular Transmitter Data Record

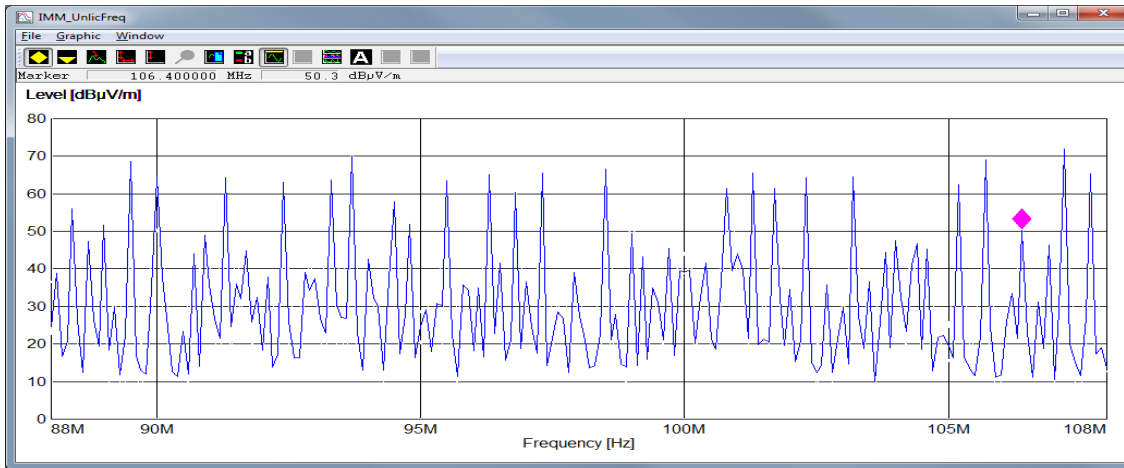
Transmitter Name	MUENCHEN	ZIP Code		Insert	
Frequency	94.5000 MHz	Telephone		Modify	
Channel Spacing		kHz	Country Code	D (Germany)	Delete
Service	BC	City		Next	
Transm. Power	0 W	Street		Previous	
Sensitivity	0 dBµV/m	Longitude	11 33 0.0 E	Cancel	
Antenna height	0 m	Latitude	48 9 0.0 N		
Polarization	<input checked="" type="radio"/> H <input type="radio"/> V	Direction to the Transmitter	10 Degree		
Signature		Distance from the Transmitter	5467.8 km		
Call Sign		Limit Value for Freq. Offset	5.000 kHz		
Licensee		Limit Value for Bandwidth	180.000 kHz		
License State	NG (License not yet)	Limit Value for Modulation	50 kHz		
Measured Level	72.900 dBµV/m	Measured Freq. Offset	-1.850 kHz		
Est. Longitude	11 36 46.4 E	Measured Bandwidth	193.062 kHz		
Est. Latitude	48 7 40.5 N	Measured Modulation	30.381 kHz		
Active	<input checked="" type="checkbox"/>	Measurement Unit	muc-tdoa		

# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation

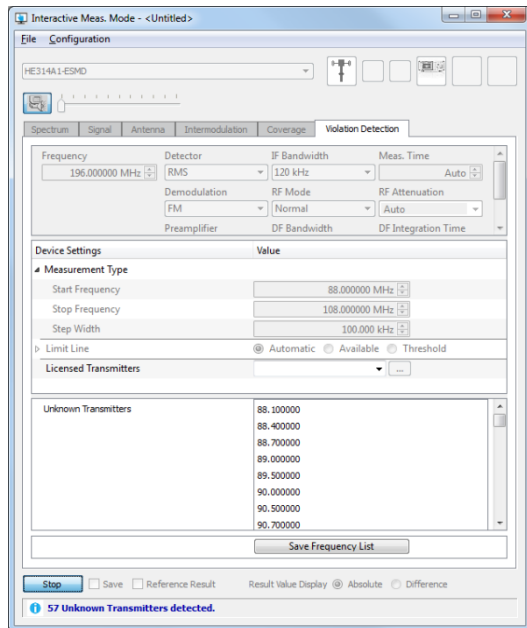
### ■ Example: Automatic interferer detection

- Procedure:
  - Scan frequency range of interest
  - ARGUS automatically detects emissions (calculates local maxima in spectrum)
  - Comparison with reference list (transmitters known to be licensed / "good" / ...)

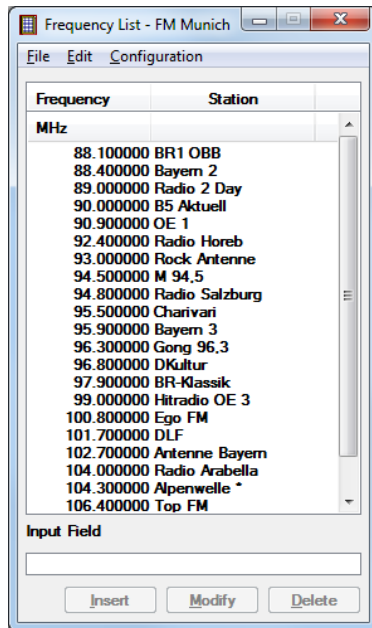


# Spectrum monitoring

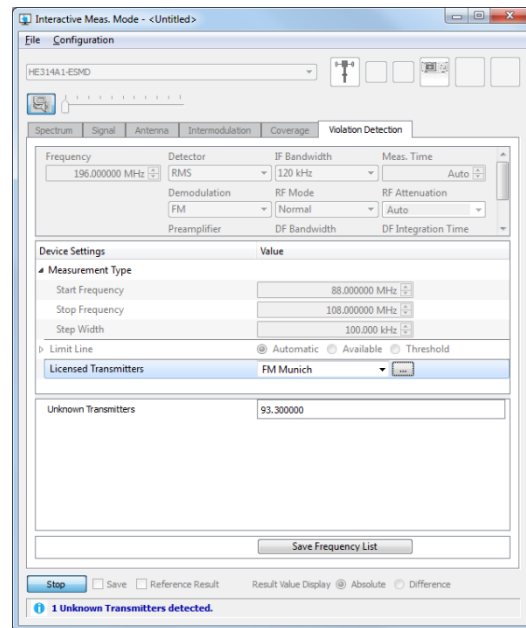
## ARGUS 6 – The 6<sup>th</sup> generation



Complete list of active Tx



Reference list



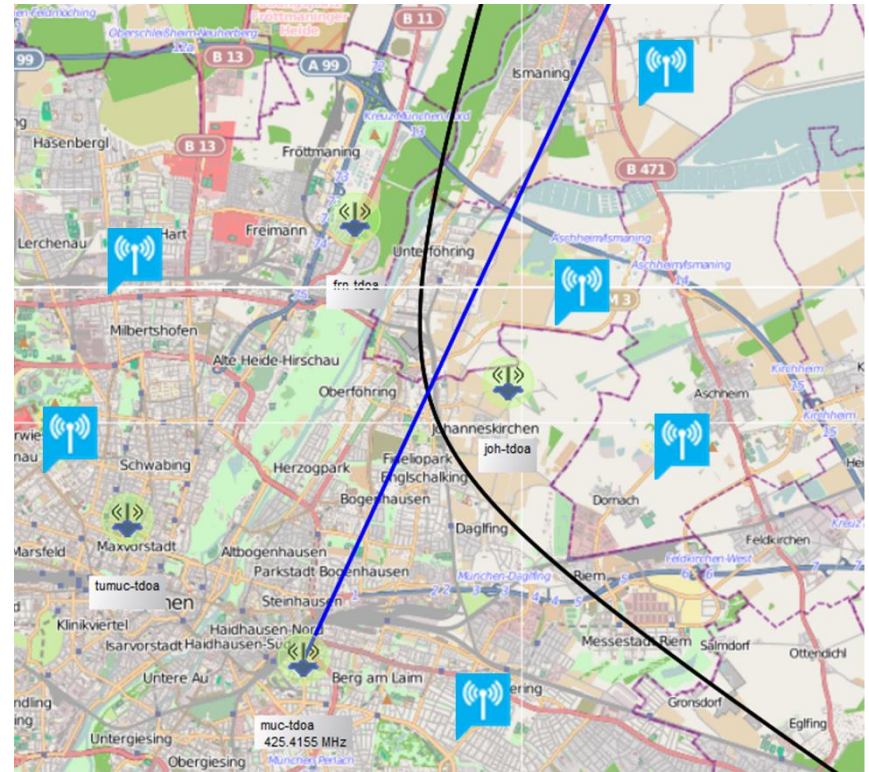
Automatically detected unknown Tx



# Spectrum monitoring

## ARGUS 6 – The 6<sup>th</sup> generation

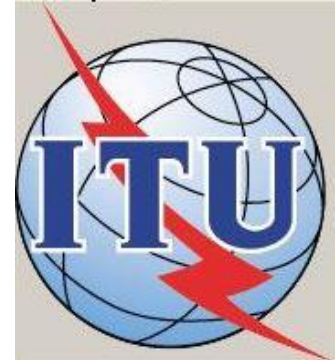
- Result of a hybrid TDOA – AOA location combined with transmitter data imported from spectrum management
- Location of interferer does not coincide with licensed transmitter



# Spectrum management

## SMS4DC

- SMD4DC operator can define monitoring task for ARGUS
- The entire available equipment in all monitoring stations can be used
- Tasks can include live comparison of measurements results with user defined thresholds (automatic violation detection)



# Spectrum management SMS4DC

## ■ Define monitoring task for ARGUS

**SMS4DC: Order Report**

General Setting | Date and Time Setting | Result Setting

Order Type: OR (Last GSP-Order: 23, March 2011)  
Order ID: ORI10323162334953  
Order Name: OrderNameTest1  
Execution Type: Automatic  
Sub-Order Task: FFM

Measurement Parameter	Occupancy	Threshold
Level	<None>	0
	<None>	0
	<None>	0
	<None>	0

Fixed Frequency: 89.5 MHz

Frequency Range:  
Start: 88.0 MHz  
Stop: 108.0 MHz  
Step Width: 100.0 kHz

No. of Meas. Points: 501

Measurement Location:  
Latitude: N  
Longitude: E

Receiver and Direction Finder Setting:  
IF Bandwidth: 120 kHz  
IF Attenuation: Normal  
Demodulation: FM  
Detector: Peak  
IF Span: 250 kHz  
RF Attenuation: Auto  
Preamp: Off  
Meas. Time (ms): Default  
Mode: Normal

Unit(Station) Name: R&S HQ Munich  
MSS\_RMC: R&S HQ Munich  
MSS\_RMC\_PC: MU708401  
MSS\_ST\_TYPE: F  
MSS\_LONG: 12.333333  
MSS\_LAT: 4  
Device\_01\_01: HE010-ESMD-DRM  
Device\_01\_02: HE500-ESMD  
Device\_01\_03: HE010-ESMD  
Device\_01\_04: ADD197-ESMD  
Device\_01\_05: ADD197-DDF255  
Device\_01\_06: ANT-FSP-FSP30  
Device\_01\_07: HK309-FM100

Frequency List... Transmitter List... Suppress List...

Create Order

# Spectrum management SMS4DC

## ■ Define schedule

**SMS4DC : Order Report**

General Setting | **Date and Time Setting** | Result Setting

**Defined Time Span**

Start : 23.03.2011 12:00:00  
Stop : 23.03.2011 14:00:00

**Periodic Measurement**

Start Date : 23.03.2011 Stop Date : 23.03.2011 Days : **Every Day**  
Sunday  
Monday  
Tuesday  
Wednesday  
Thursday  
Friday  
Saturday

Daily Start : 12:00:00  
Daily Stop :  14:00:00  Daily Start + 02:00:00

**Measurement Continuity**

Interval : 01:00:00 > Duration : 00:30:00

Create Order

# Spectrum management SMS4DC

## ■ Define output and alarms

**SMS4DC : Order Report**

General Setting | Date and Time Setting | **Result Setting**

Save Results as:

- Measurement Result
- MaxHold
- Compressed Measurement Result
- Measurement Result during an Alarm
- Begin and End of an Alarm
- Measurement Result during and Compressed Measurement Result outside an Alarm
- Text

Settings

Compress Time Interval : 10 min

Alarm by Overshoot

- Off
- Limit Value : 0 dBuV
- Limit Line...

Alarm by Undershoot

- Off
- Limit Value : 0 dBuV
- Limit Line...

Count for Triggering Alarm : 1

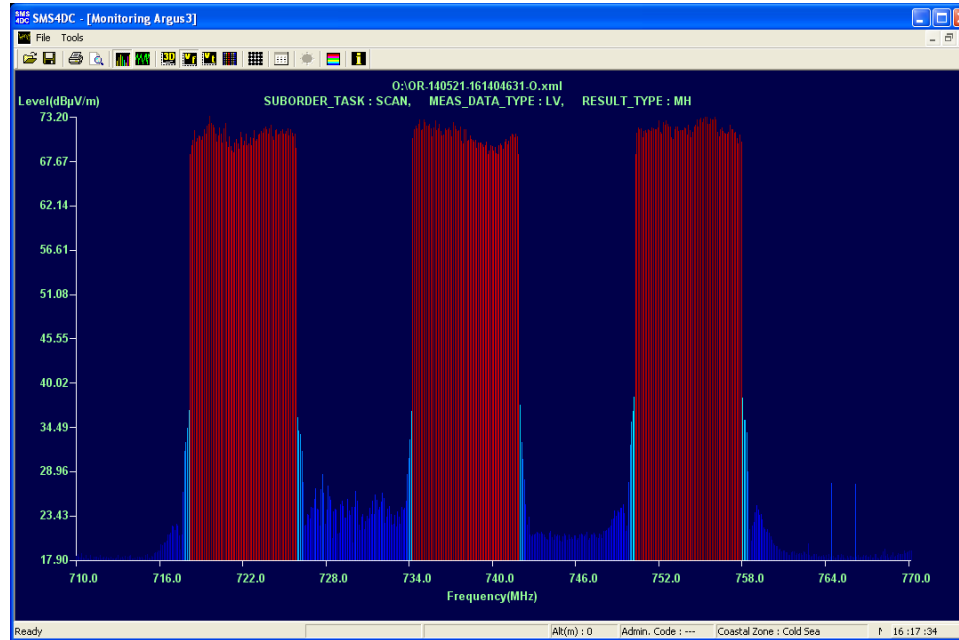
Measurement Description :

Create Order

# Spectrum management

## SMS4DC

- Measurement results from ARGUS displayed and analyzed in SMD4DC



# Integrated spectrum management and monitoring systems

