

# TELFOR 2024

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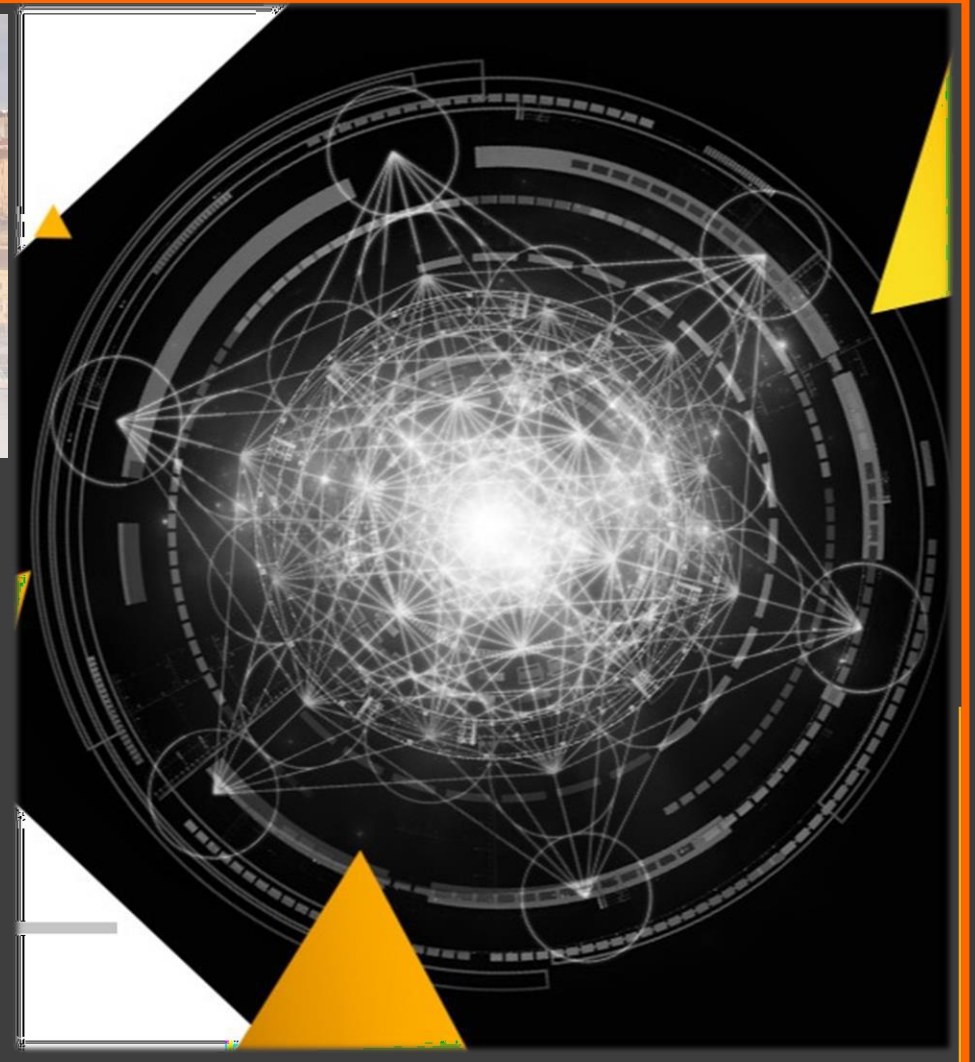
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## Latest trends in Spectrum Management and Spectrum Monitoring

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VP Products

**ATDI GROUP**



# ATDI Presentation at TELFOR 2024, Belgrade, November 27, 2024

## Today's Agenda

- 1 ATDI Background
- 2 2024 trends in Spectrum Monitoring and Spectrum Management SW
- 3 Integrated Spectrum Monitoring SW Platform from ATDI
- 4 Evolution of Radio Frequency Monitoring Processes

**2024 trends in  
Spectrum Monitoring  
and Spectrum  
Management SW**

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## BACKGROUND/INSIGHTS

- ATDI has more than 30 years experience in the domains of Spectrum Management and Spectrum Monitoring and is currently working with more 50 different regulator authorities worldwide.
- Initially, solutions delivered were mainly COTS software products.
- As of today, solutions delivered by ATDI are also including the following:
  - Spectrum monitoring with direct connection to monitoring HW
  - Web based solutions for different use cases: applications management, coverages display, workflows and processes automation ...
  - Interfaces and integration with external systems: accounting, finance, eGovernment, inventory, customs ...
- Working hand-in-hand on a daily basis with our customers we identified several trends and challenges in the domain of Spectrum Management and Spectrum Monitoring.

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## MAIN CONCLUSIONS FROM OUR PAST EXPERIENCE

- End of separation between spectrum management and spectrum monitoring
- End of heavy and non-flexible spectrum monitoring and management solutions
- Massive usage of Artificial Intelligence is a reality
- Need for a Spectrum management and monitoring as service (Spectrum CRM)
- Need for Management of Temporary Assignments
- Need for combined civilian/non-civilian solutions

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## END OF SEPARATION BETWEEN SPECTRUM MANAGEMENT AND SPECTRUM MONITORING

- The goal is to be able to offer a 7/7 24/24 solution integrating Spectrum management and Spectrum Monitoring
- Spectrum Monitoring data to be continuously compared with Reference Situation
- Automated propagation model tuning based on permanent measurements
- Real time spectrum usage picture based on prediction and measurements
- Software part of Spectrum Monitoring more and more important
- Ability to provide dual-usage systems supporting civilian and non-civilian needs in parallel

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## NEED FOR LIGHT AND FLEXIBLE SPECTRUM MONITORING SOFTWARE

### THE CHALLENGE IS TO PROVIDE A FLEXIBLE SPECTRUM MONITORING SOFTWARE:

- Flexible deployment
- Scalability
- Multivendor support and Independency from measurement equipment
- Different type of equipment supported at the same time: “traditional” DFs and spectrum analyzers, light software designed radios (SDR)...
- Parallelized tasks
- Multithreading in measurement data processing
- Repeated usage of measurement data to obtain the necessary information
- Automatic post-processing of measurement data and results
- Real time support
- Long term statistics collection
- Dual usage: civilian and non civilian

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW ARTIFICIAL INTELLIGENCE APPLICATIONS

**INCREASED COMPLEXITY OF TASKS TO BE PERFORMED AND INCREASED AMOUNT OF DATA TO BE PROCESSED MAKES AI USAGE DRAMATICALLY IMPORTANT:**

- Need for a “Chat GPT”-like tutorials and technical support
- Integration of international (CEPT, ETSI ...) regulations in order to have them learned by machine learning platform in order to extract for example:
  - Permissible noise thresholds for each technology/service
  - Typical parameters that can be used for coexistence work (for each technology/service)
- Artificial Intelligence supporting the “cleaning” of spectrum measurement data
- Artificial Intelligence supporting the clusterisation of measurement data
- Artificial Intelligence supporting the classification of signals

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## POSSIBLE USE-CASES

### SPECTRUM MANAGEMENT AND MONITORING AS SERVICE (SPECTRUM CRM)

Give a web access (self-care workspace) to any authorized frequency user/organization with a full information related to its spectrum, including but not limited to:

- Frequency allocations, allotments and assignments
- Real spectrum usage based on measurements & prediction over the time
- Reference spectrum situation based on tuned predictions models
- Real coverage maps based on measurements & prediction over the time
- Reference coverage maps over the time based on tuned predictions models
- Administrative documents

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW

## POSSIBLE USE-CASES

### MANAGEMENT OF TEMPORARY ASSIGNMENTS

- Quick selection of the best frequency thanks to the up-to-date information on spectrum usage (both from measurements and prediction), transmitters and automated frequency selection algorithms
- Automation of the process of the request of a temporary assignments

### FULL AUTOMATION OF SPECTRUM MONITORING AND SPECTRUM CONTROL PROCESSES

- Automated identification of discrepancies between reference data and measurements
- Automated identification of unauthorized emissions
- Automated inspections management
- Automated complaints management

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW CHALLENGES

USE CASES DESCRIBED ABOVE ARE RAISING THE FOLLOWING CHALLENGES FOR AN EFFICIENT SPECTRUM MANAGEMENT SYSTEM:

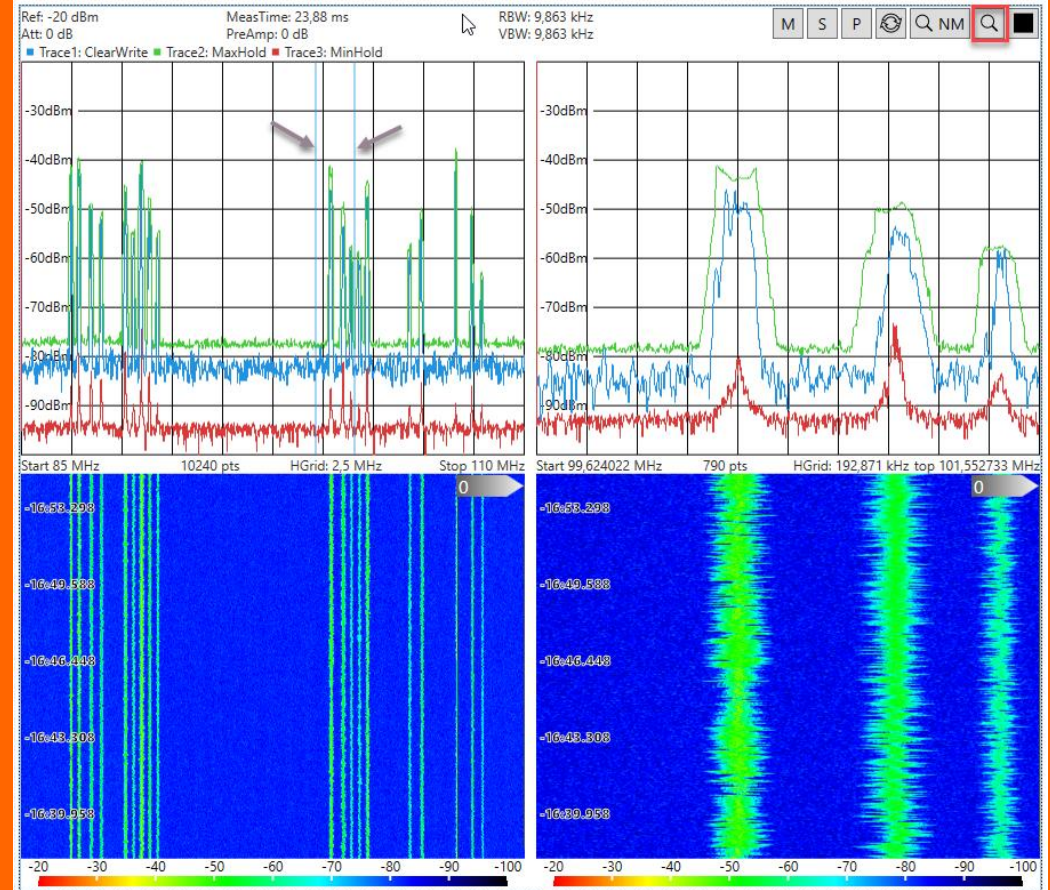
- Need to have an up-to date reference spectrum database
- Need for an accurate and fast signal prediction
- Full integration of measurements, predictions and administrative data
- Secure sharing of technical and administrative data through an open web-based platform

# LATEST TRENDS AND CHALLENGES IN THE DOMAIN OF SPECTRUM MANAGEMENT AND SPECTRUM MONITORING SW IDENTIFIED RISKS

WITH OVER 30 YEARS OF EXPERIENCE AND WORKING WITH MANY SPECTRUM AUTHORITIES AROUND THE GLOBE, ATDI IS FULLY AWARE OF THE MAIN RISKS DURING THE IMPLEMENTATION OF A SPECTRUM MANAGEMENT SYSTEM:

- “Bottleneck” applications: one “weak” module jeopardizes the efficiency of the entire system regardless of its capabilities or other modules performance
- Business logic (radio propagation, electromagnetic compatibility ...) affected by IT choices and constraints
- Business logic constraints driving to obsolete IT choices.
- Effectiveness affected by disparate technical modules
- Hard coded modules becoming an obstacle to future evolutions
- Proprietary solutions impossible to interface with external systems

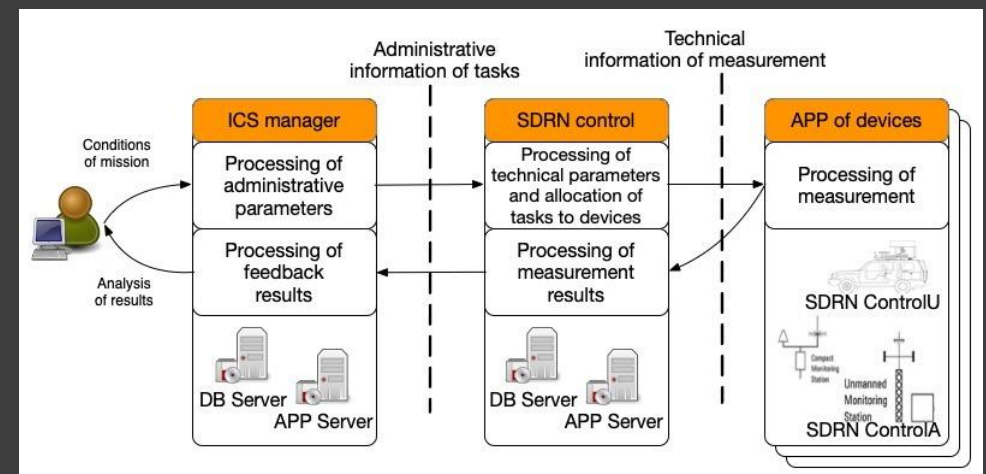
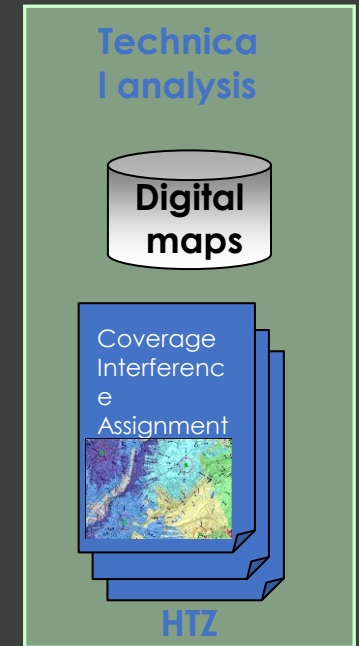
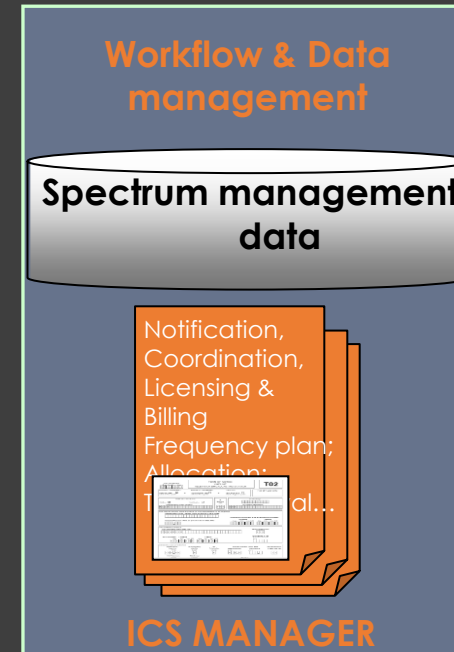
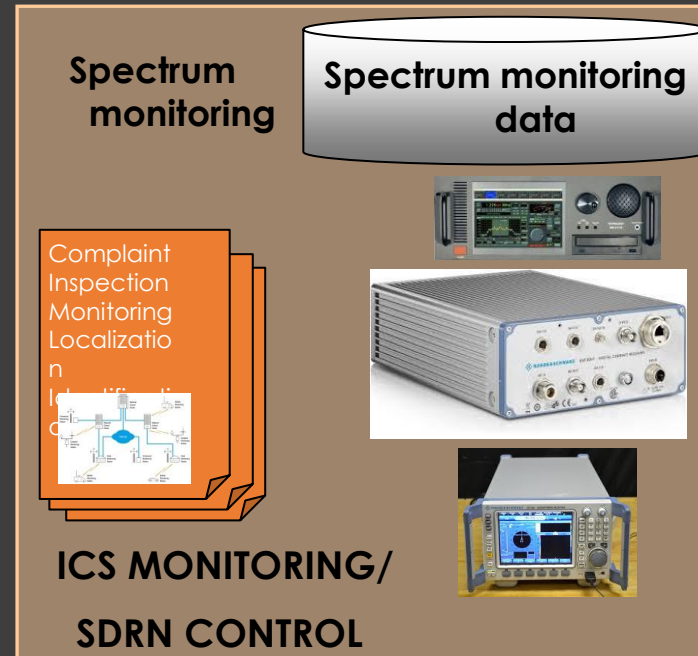
ICS MONITORING – SDRN  
CONTROL:  
MULTI-TASK SPECTRUM  
MONITORING SOFTWARE BASED  
ON  
A SERVICE ORIENTED PLATFORM



# SPECTRUM MONITORING SOLUTION BASED ON A SERVICE - ORIENTED PLATFORM

## KEY BENEFITS

- One single system gathering:
  - Spectrum management and inventory data - **ICS manager**
  - Measurements - **ICS monitoring/SDRN control**
  - Emissions analysis based on inventory and measurements - **HTZ**
- Multitask measurements
- Independency from measurement equipment
- Multithreading in measurement data processing
- Repeated usage of measurement data to obtain the necessary information
- Flexibility and scalability
- Automatic post-processing of measurement results
- Long term statistics collection



# ICS MONITORING/SDRN CONTROL “AUTOMATED TASKS”

## MAIN FUNCTIONS

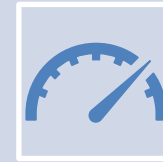
## WORKING PRINCIPLES

Readiness to perform tasks in accordance with the Radio Regulations

- Checking compliance with the conditions of assignment of frequencies
- Frequency bands usage / Channels occupation
- Study of interference cases
- Search for un-authorized emissions
- Localisation of emissions



**INSPECTION**



**MONITORING**



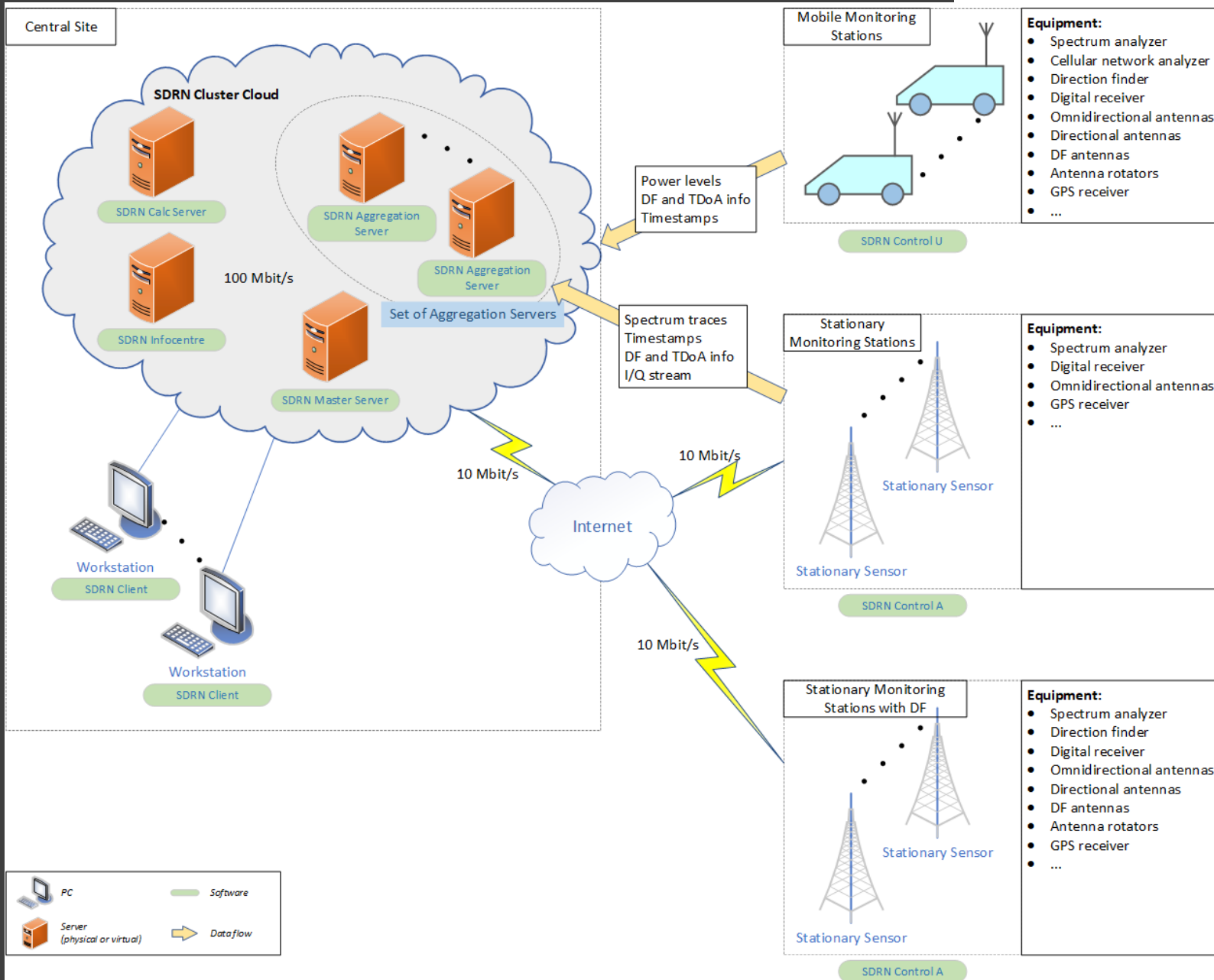
**SPECTRUM  
EFFICIENCY**

# ICS MONITORING/SDRN CONTROL "AUTOMATED TASKS"

## TYPICAL PHYSICAL ARCHITECTURE

### NON-EXHAUSTIVE LIST OF COMPATIBLE HW:

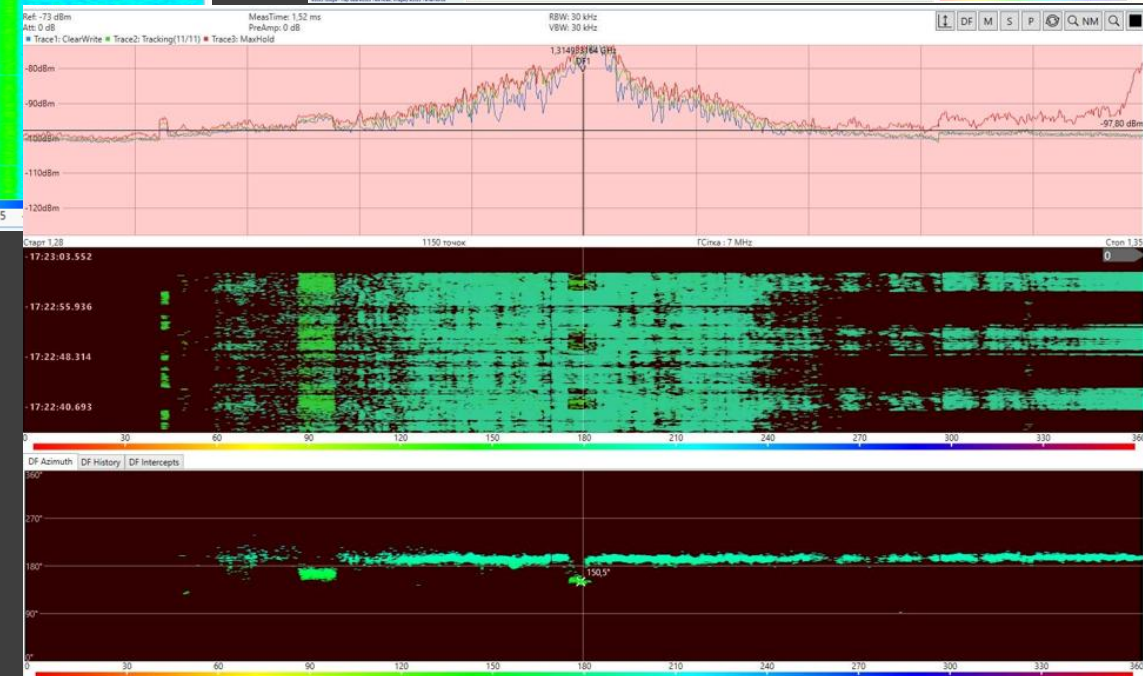
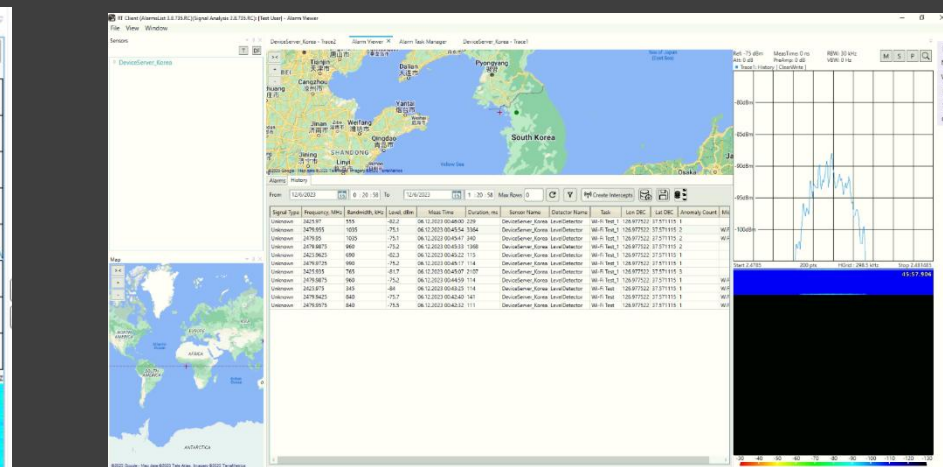
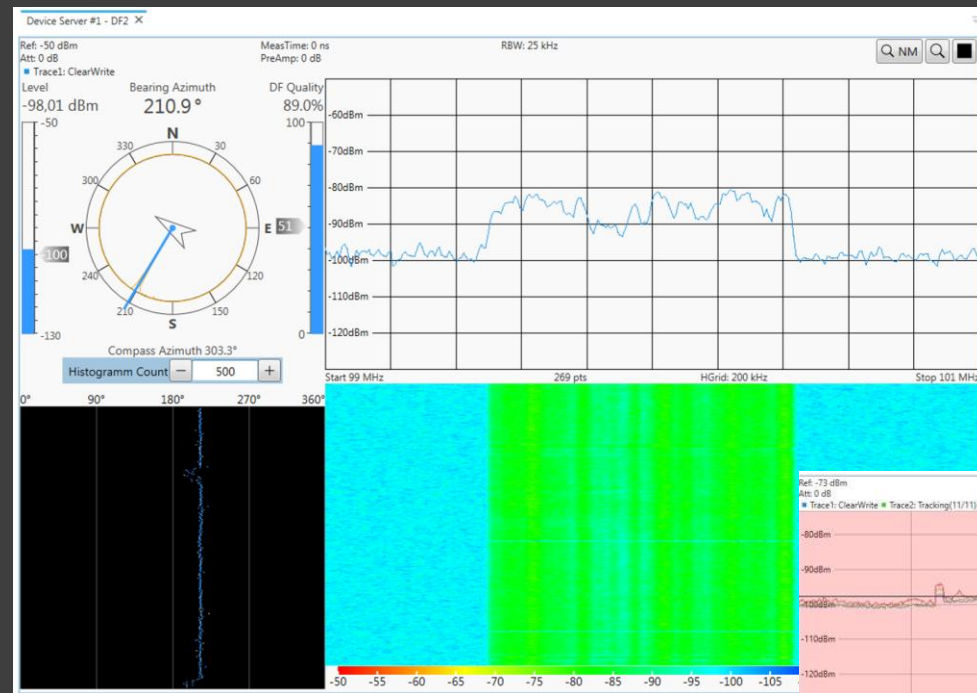
- SPECTRUM ANALYSERS:  
 ROHDE&SCHWARZ™ (FSW, FSVx, FSVAx, ESRPx, FPH, FSH4/8, ZVH), KEYSIGHT TECHNOLOGIES™ (N99XX SERIES), ANRITSU™ (MS27XX SERIES), SIGNAL HOUND™ (BB60C), NARDA™ (SIGNALSHARK) ...
- MEASUREMENT RECEIVERS:  
 ROHDE&SCHWARZ™ (EM200, PR200, DDFxxx, ESME/W, ESMD, EBD, ESMB, EB5xx), NARDA™ (SIGNALSHARK), SIGNAL HOUND™ (SM200), PLATH 2110/2115 ...
- MODULATION ANALYSERS:  
 ROHDE&SCHWARZ™ (ETL) ...
- CELLULAR COMMUNICATION NETWORK ANALYSERS:  
 ROHDE&SCHWARZ™ (TSMW, TSME, TSMA) ...



# ICS MONITORING/SDRN CONTROL "REAL TIME"

Real-time measurements provide a direct interface to the device. Real-time mode allows to perform instant tasks, which are executed and analyzed by a user in the semi-real time. The list of supported by **SDRN CONTROL RT** real-time measurements includes the following:

- observing signal spectrum and making measurements on it
- performing direction finding of a signal
- recording of spectrum traces (including waterfall) as image or as a text file
- recording of IQ stream
- setting alarms and observing their results
- managing white and black lists of signals
- localizing (AoA/TDoA/PDoA) selected signals and viewing them on the map
- classifying the signals
- identifying the signals



# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES APPROACHES TO SPECTRUM MONITORING AND CONTROL AS IT HAPPENED



It was possible to assess the electromagnetic situation only through the usage of a mobile radio monitoring station.

## PREREQUISITES FOR CHANGES:

- More and more specific cases which are not compatible standard processes of radio frequency monitoring
- Large expenditures of time and resources (travel and logistics may take longer than the measurements themselves)
- Illegally operating radio equipment detected with random probability (lack of a systematic approach)
- The impossibility of systematic monitoring of all ranges of radio frequency reception
- Technical radio monitoring carried out only during the operation of the service radio channel, without analyzing traffic load (one channel of each base station once a month)

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## TASKS OF RADIO FREQUENCY MONITORING IN ACCORDANCE WITH ITU STANDARDS



**According to paragraph 2.1.1 of the ITU Handbook "Spectrum Management":**

- Monitoring radio emissions for compliance with the conditions of radio frequency assignment;
- Monitoring the use of frequency bands and measuring the occupancy of frequency channels;
- Study of cases of occurrence and impact of radio interference;
- Recognition and elimination of unauthorized radio emissions.

**Effective use of spectrum is impossible without:**

- Electromagnetic compatibility research;
- Measurements of radio coverage areas;
- Carrying out scientific and technical research.

**The radio frequency spectrum is used around the clock, so to achieve the goals of spectrum monitoring, it must be carried out continuously and statistically relevant.**

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## PREREQUISITES FOR CHANGE



- Changes in legislation;
- Introduction of latest radio technologies;
- A sharp increase of the number of radio transmitters;
- Limited provision of complete data collection for statistical data to analyze the effectiveness of radio frequency resource use;
- Control exclusively of downlink channel.

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## DIRECTIONS OF RADIO FREQUENCY MONITORING DEVELOPMENT



1. Transition to service delivery – identifying the needs of key stakeholders;
2. Construction and implementation of wide area (sensor) network;
3. Modernization of the fleet of mobile radio frequency monitoring systems to improve the efficiency of radio frequency monitoring, in terms of a gradual transition to assessing coverage areas and analyzing operator networks;
4. Implementation of a system for assessing the quality of radio frequency monitoring services.

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## TYPICAL REQUESTS FROM KEY STAKEHOLDERS



1. Obtaining a real map of mobile coverage areas;
2. Identification of problem areas in operator networks;
3. Assessment of used and free radio frequency spectrum;
4. Evaluation of electromagnetic exposure;
5. Monitoring violations of the use of the radio frequency spectrum, including compliance with license conditions;
6. Providing a real map of mobile coverage areas;
7. Visualization of radio emission limits;

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## TYPICAL REQUESTS FROM OPERATORS



**Get the technical information needed to improve mobile networks:**

1. Identifying problem areas in the network;
2. Analysing the occupancy of radio frequency bands (radio frequency channels) and radio transmission and reception bands;
3. Providing data on signs of intra-system interference in operator's frequency ranges;
4. Providing inputs to study cases of anomalies and interference in the radio frequency ranges of digital cellular communications;

**Expanding the capabilities of the Network Operator's Account to work with the necessary technological data - a convenient, flexible and understandable interface for obtaining information;**

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES

## SENSOR NETWORK



**The sensor network makes possible to conduct a unified assessment of the use of radio frequency resources and analyze changes in operator networks by:**

1. Round-the-clock work on data collection;
2. Recording changes in the electromagnetic environment;
3. Identification of differences between the measured parameters of base stations and the declared ones;
4. Calculation of coverage areas and areas of increased interference in operator networks;
5. Control of free and protected radio frequency bands;
6. Accumulations of distribution of signal levels across radio frequency ranges;
7. RF spectrum occupancy measurements in accordance with ITU-R SM.1880 and ITU-R SM.2256;
8. Measurements of occupied RF channel bandwidth using  $\beta\%$  and hdB methods in accordance with ITU-R SM.443.

# EVOLUTION OF RADIO FREQUENCY MONITORING PROCESSES PRODUCTION PROCESSES TO SATISFY STAKEHOLDER REQUESTS. AS IT WILL BE



1. Evaluation of data collected during drive tests;
2. Assessment of the electromagnetic environment using an abstract spectrum;
3. Assessment of occupancy of the radio frequency range;
4. Geographic information platform for the analysis of operators networks.



[www.atdi.com](http://www.atdi.com)

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OF EXPERIENCE

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