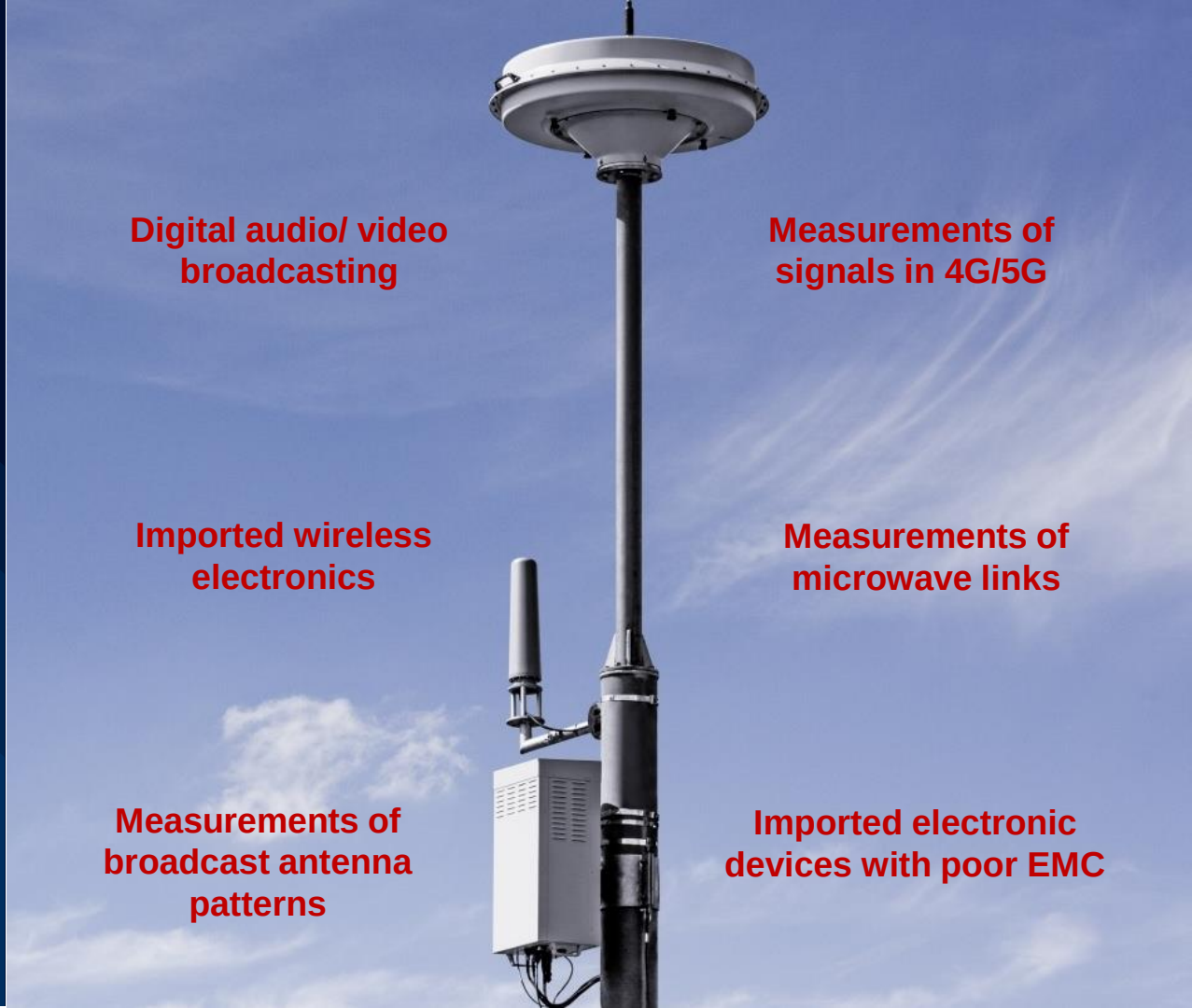
MODERN SPECTRUM MONITORING

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Product Manager Spectrum
Monitoring Sensors

ROHDE&SCHWARZ
Make ideas real

MODERN SPECTRUM MONITORING

- Today's challenges:
  - More sources of RF interference
  - More wideband broadcast signals
  - Wide bandwidth of modern communication standards
  - Limited access to emitters of interest

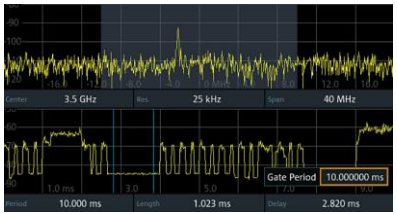


MODERN SPECTRUM MONITORING

The challenges in modern spectrum monitoring ask for various specialized tools

Transportable monitoring station





Gated spectrum measurement



Aerial monitoring station

Fixed monitoring station





Mobile monitoring station

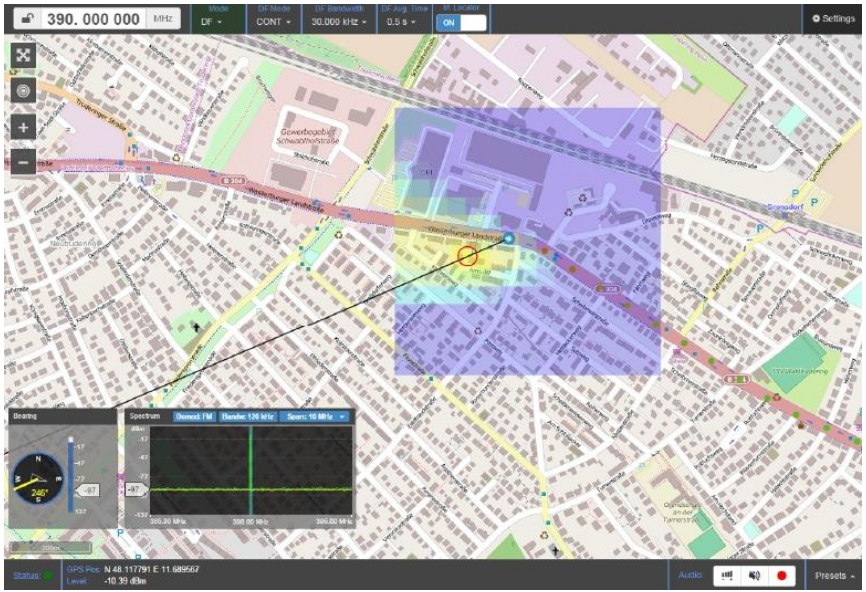


Handheld monitoring equipment



Flexible mobile monitoring station

MODERN SPECTRUM MONITORING

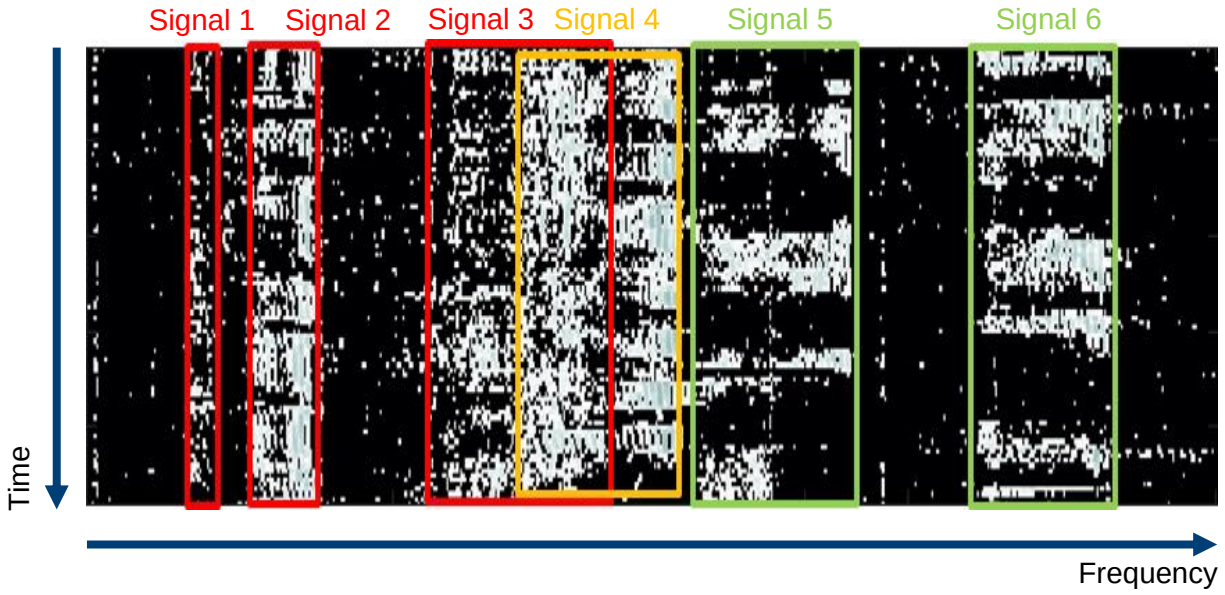


- Modern spectrum monitoring is based on powerful system software and sophisticated software tools
  - Example: automatic homing software for mobile monitoring stations
- Measurements runs automatically with proper setings
- Knowledge and results are shared between stations and agencies via cloud based solutions

AI IN SPECTRUM MONITORING

- Rohde&Schwarz uses artificial intelligence (AI) in spectrum monitoring today already.
- AI is used for automatic signal detection in wide frequency ranges.
- Manual signal detection would require many well-trained operators.

HF SIGNAL ANALYSIS – AI (DEEP LEARNING) BASED SIGNAL DETECTION

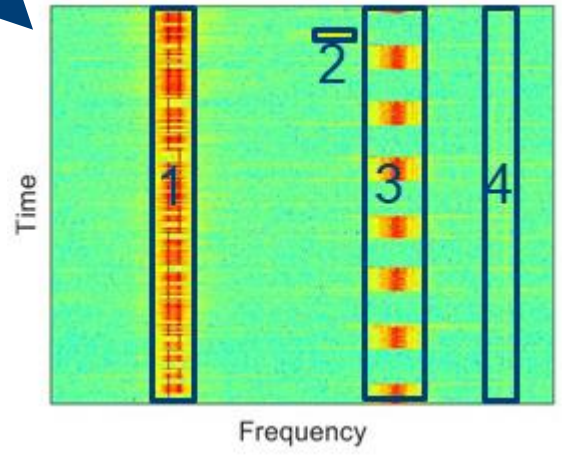


AI IN SPECTRUM MONITORING

- Starting point is the automatic detection of objects in images.
- Here, objects are signals in the waterfall display.
- Localization of each signal in two dimensions: time and frequency.

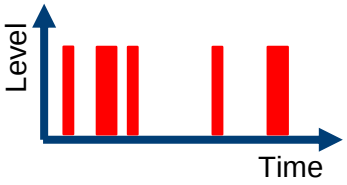
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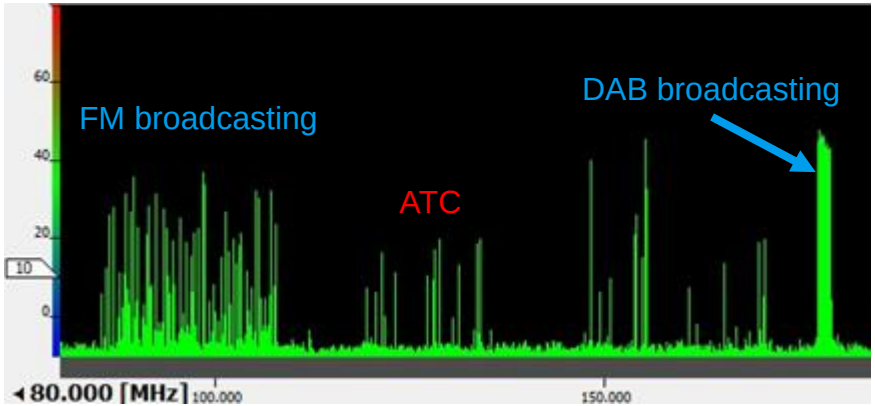




AI IN SPECTRUM MONITORING: SPECTRUM OCCUPANCY MEASUREMENTS

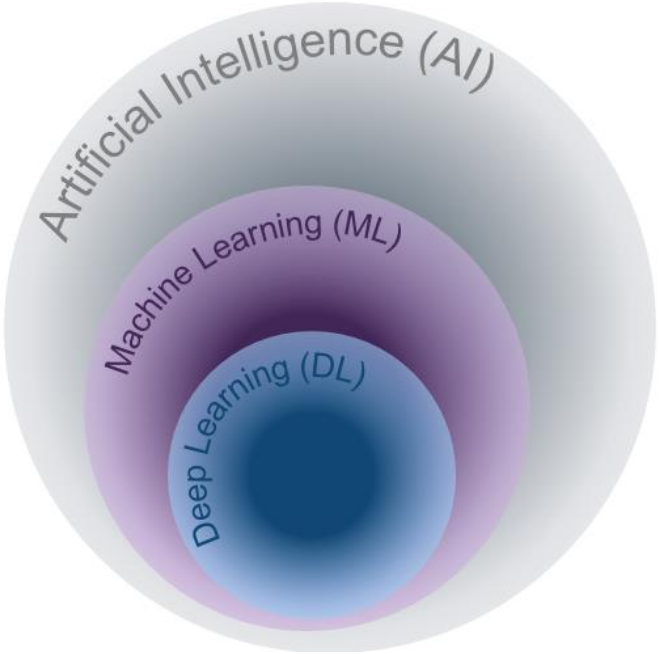






- The determination of spectrum occupancy requires repeated measurements on the frequency channel of interest.
- The frequency and duration of this measurement depends strongly on the timing behavior of the signal of interest.
  - Continuous emissions (e. g. broadcasting) require only one measurement per day.
  - Short bursted emissions may require many measurements per minute.

OUR VISION: AUTOMATIC PARAMETERIZATION OF SPECTRUM OCCUPANCY MEASUREMENTS



- Automatic parameterization of spectrum occupancy measurements based on Deep Learning.
- The frequency channels of interest will be measured to learn about the timing behavior of the signals active in those channels.
- Operators are not required to have knowledge about the signals and statistics anymore.

SPECTRUM MONITORING IN THE FUTURE



- Extended frequency range
  - 5G goes up to 71 GHz.
  - 6G will go up to 100 GHz and beyond (under discussion).
- Wider bandwidth
  - 5G signals are up 400 MHz wide.
  - 6G signals will be up to 2 GHz and wider (under discussion).
- Susceptibility to RF interference
  - Higher modulation depth equals higher susceptibility to RF interference. 6G will have a higher modulation depth than 5G.