Spectrum Analyzers
vs.
Monitoring Receivers

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75 Years of Driving Innovation

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Spectrum Management Requirements

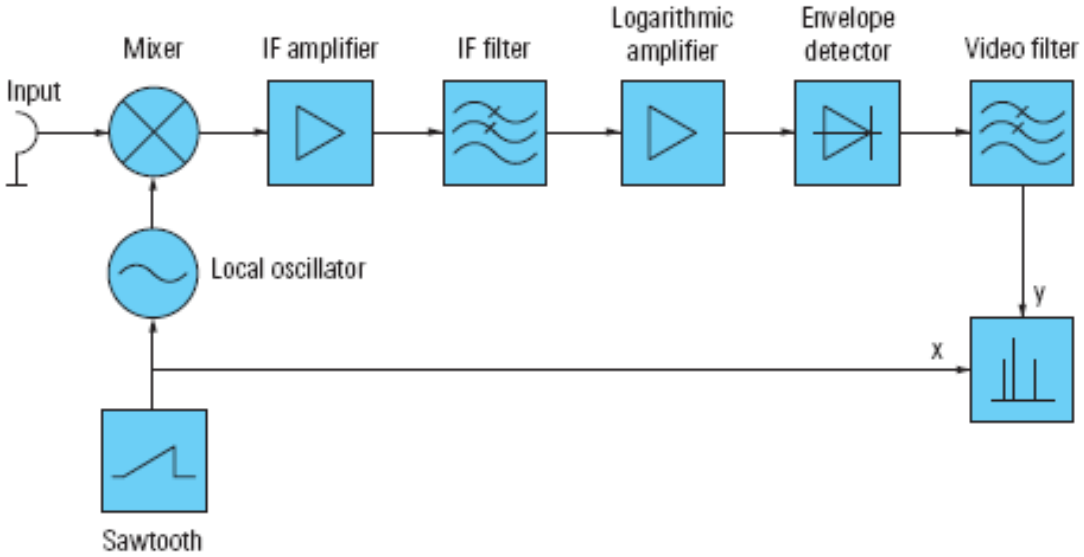
- What signals are present at which frequencies?
- Additional responsibilities :
  - Baseline existing spectrum and monitor for changes
  - Identify the source and location of signals
  - Demodulate signals
  - Analyze received signal spectrum (including noise)

Spectrum Management Tools

- Two primary tools : *spectrum analyzer and* the *monitoring receiver*.
- Two major differences between spectrum analyzers and monitoring receivers :
  - Internal architecture
    - Heterodyne principle
    - FFT (Fast Fourier Analysis)
  - Operational features
    - Spectrum analysis functions
    - Task-oriented features
    - Direction finding
    - Offline, remote, and coordianted operation

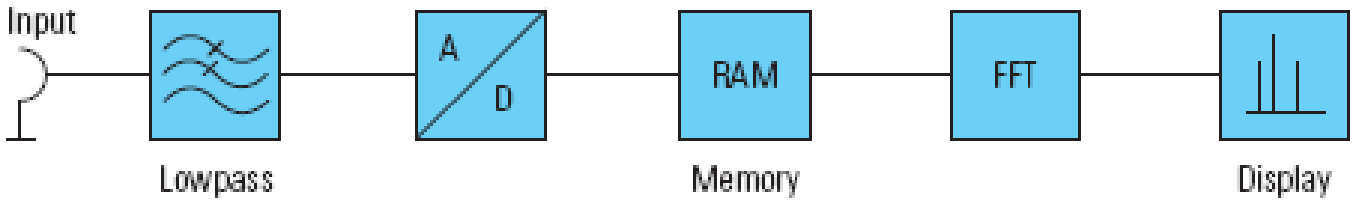
Heterodyne principle

- The basis for most spectrum analyzers
- Input signal converted to an intermediate frequency (IF) using a mixer and a local oscillator (LO)
- Signal is swept past a fixed-tuned filter to determines resolution bandwidth,
- Signal then logarithmically amplified and passed to the display.



FFT-based analysis

- The basis for most monitoring receivers
- Converts time domain signals into frequency domain signals using a Fourier transform.
- Digitizes a sampled signal and applies the Fast Fourier Transform (FFT).
- Very fast and gap-free : no information is missed – high probability of intercept (POI).
- Most spectrum analyzers do NOT use FFT analysis : poor dynamic range over large frequency ranges.



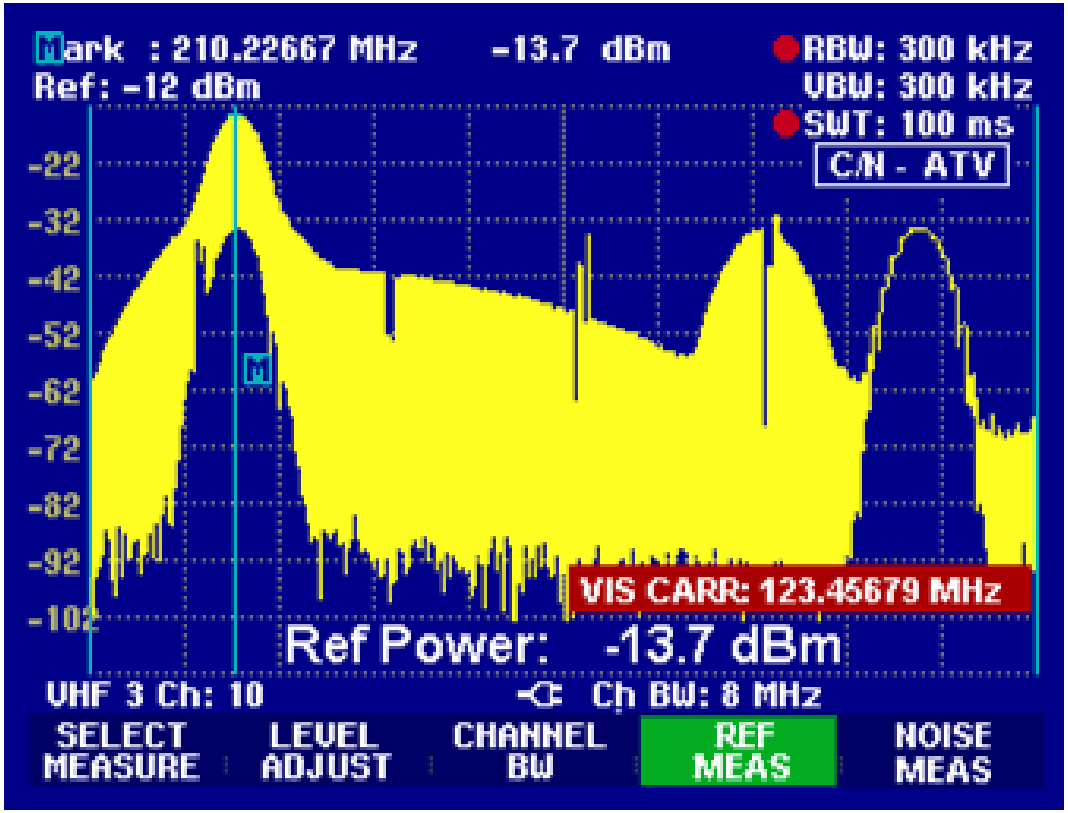
What does a spectrum analyzer do?

Make high accuracy measurements of known signals.

- User must specify a wide variety of parameters and settings.
- Measure and display modulation characteristics (e.g. EVM, ACLR, etc.)
- Verify conformance to a standard (e.g. SEM)
- Heterodyne (swept) principle : very precise measurements, but information may be missed/lost during a sweep
- Usually connected to a cable, not to an antenna
- Primary use is in a lab / production environment

Sample spectrum analyzer display

Resolution BW, Video BW, Sweep Time



Channel BW measurement

Signal analysis features (C/N = carrier/noise)

Noise measurements

What does a monitoring receiver do?

Makes rapid measurements of unknown signals

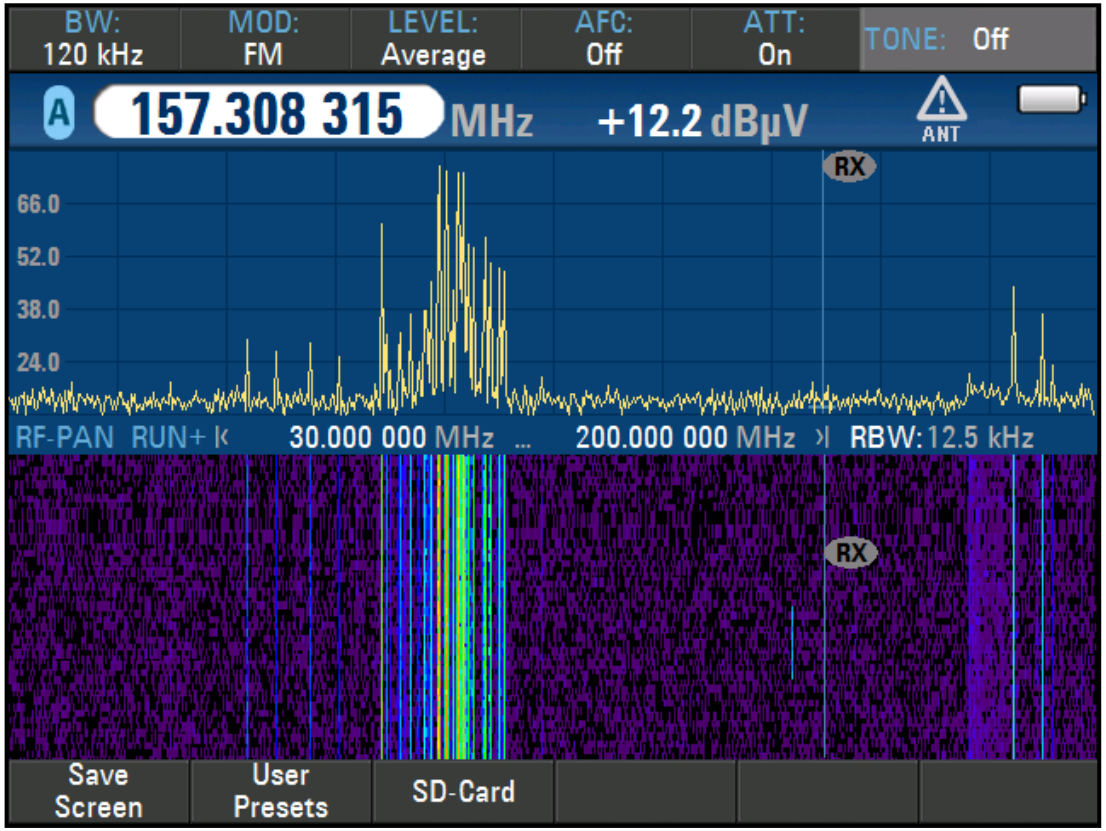
- Gap-free and designed for speed
- Signals can be demodulated and monitored.
- Can make measurements at discrete frequencies (scanning).
- Received signals almost always impaired/distorted, so features like attenuation, AGC, preselection, etc. needed

Sample monitoring receiver display

Attenuation / Automatic Frequency Control

Direction finding features

Demodulation bandwidth and demodulation type

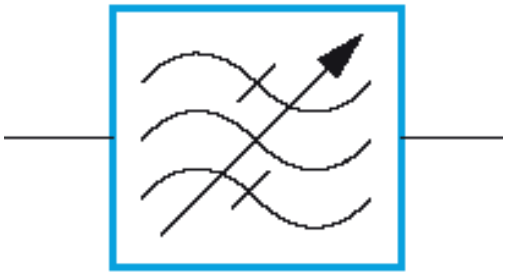


Field strength measurements

Waterfall display

Preselection

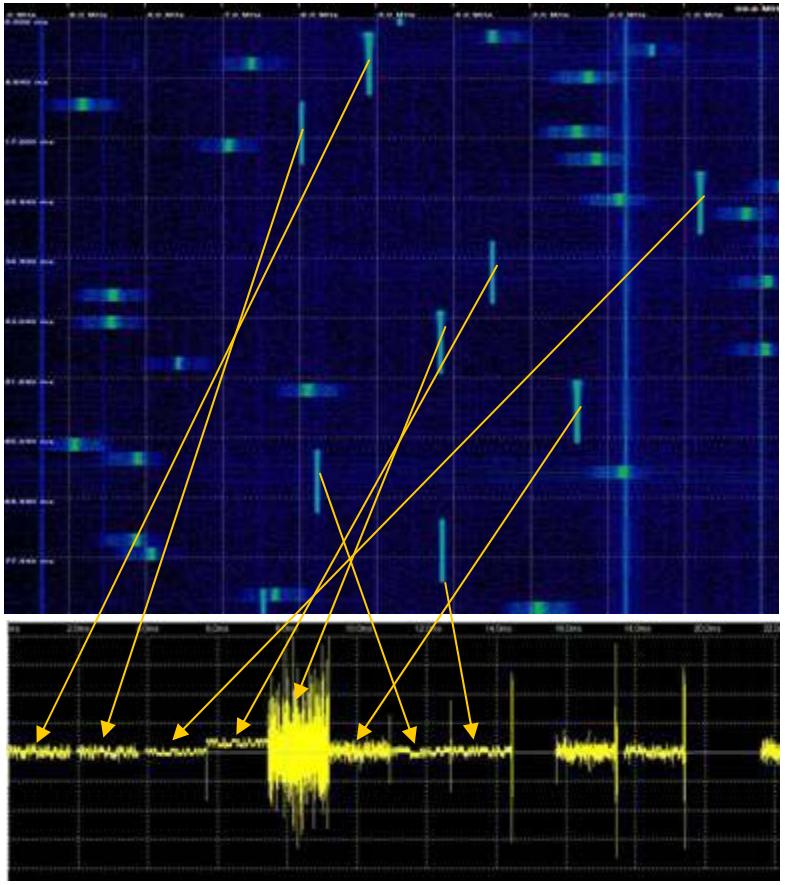
- Subdivides the input frequency range into subranges via switches and filters
- Spectrum analyzers :
  - Do not have preselectors
  - Measured signal is known and relatively stable
  - Sum load of all signals is on the input of the first mixer
- Monitoring receivers :
  - Preselection is a must
  - Frequency range split in sub-ranges
  - Reduce the signal sum load on the input of the first mixer
  - Allows monitoring of widely different signals



Preselection

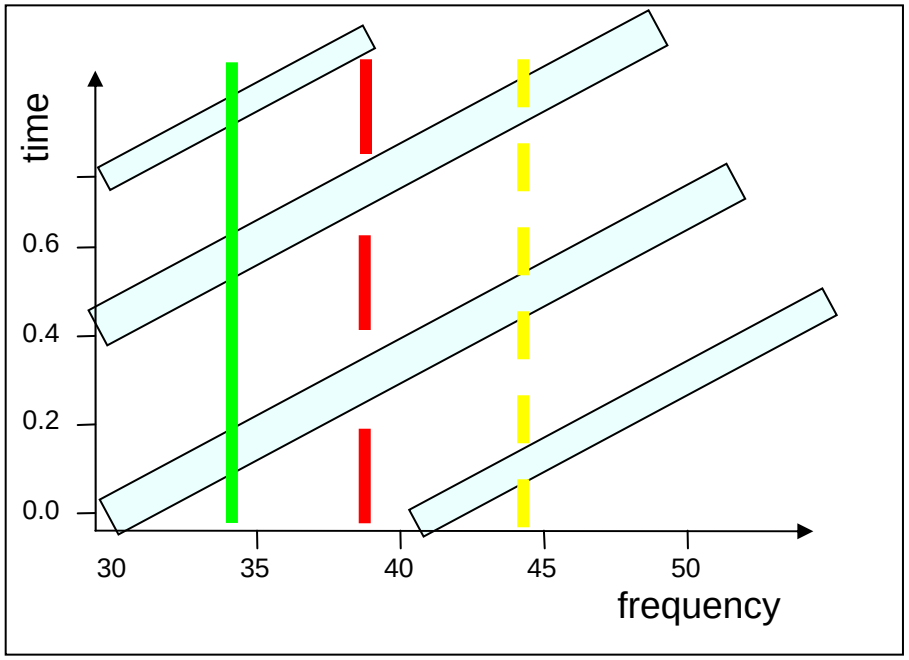
Speed vs. accuracy

- Biggest difference is speed.
- Spectrum analyzers are (relatively) slow, but highly accurate over a wide frequency range.
- Monitoring receivers are less accurate, but are very fast (real-time) and gap-free. POI within the demodulation bandwidth is 100%.
- Short duration (low POI) signals
  - Digital data
  - Frequency hoppers
  - Radar pulses
  - Noise sources
  - Clandestine transmitters

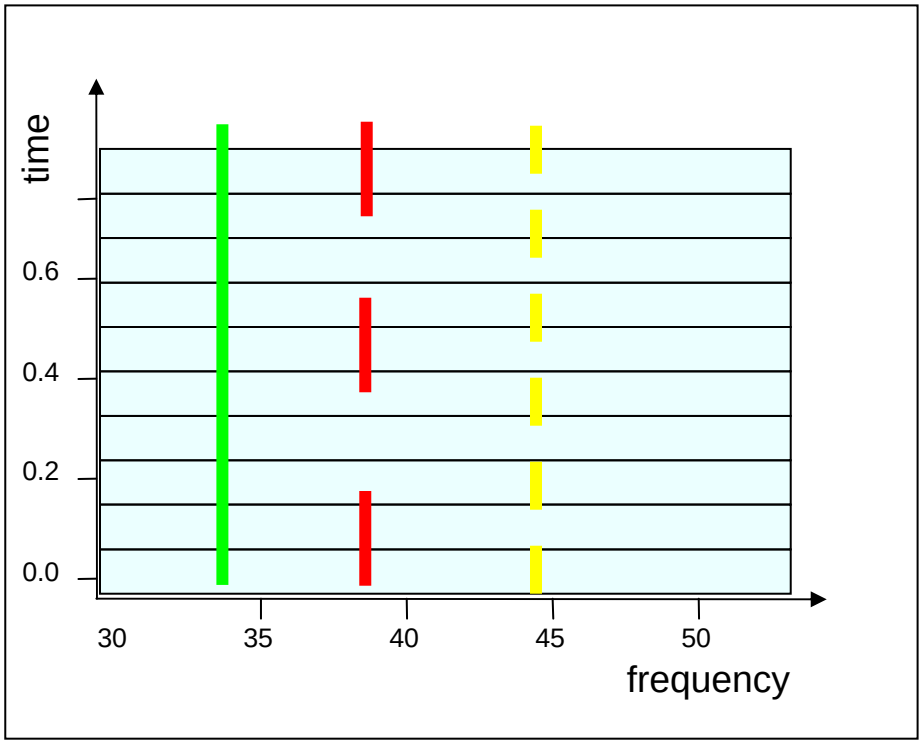


Reassembly of a frequency-agile signal

Monitoring short duration signals



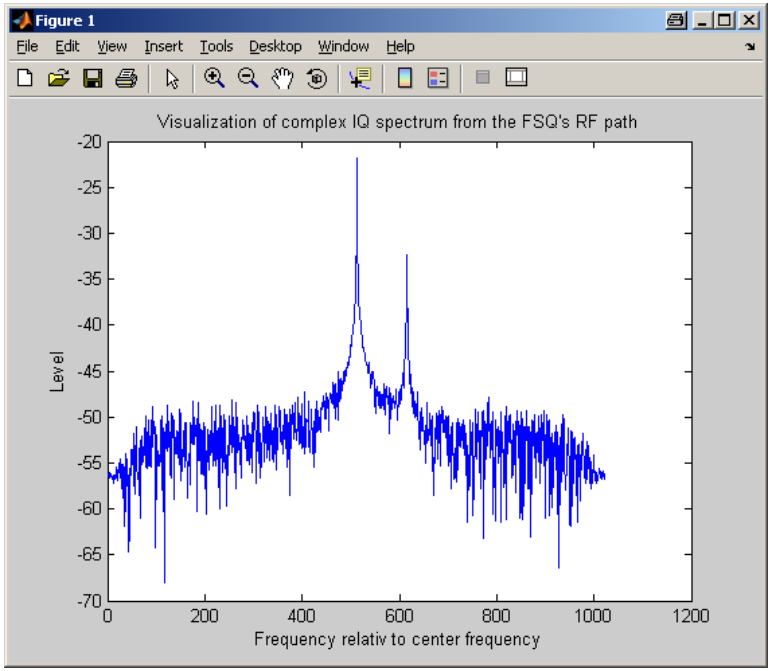
Spectrum analyzer
(swept / heterodyne principle)

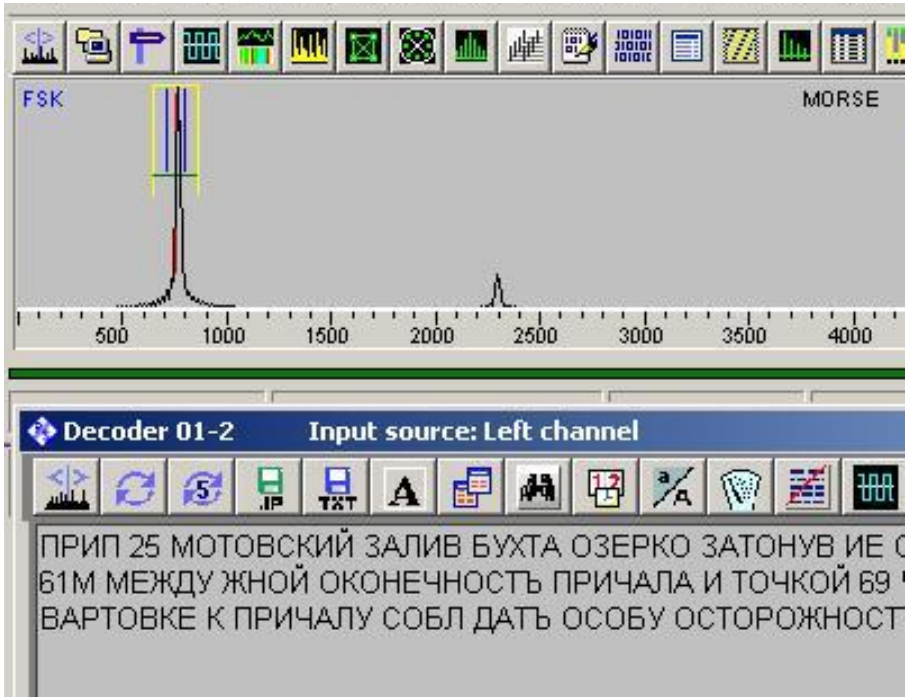


Monitoring receiver
(FFT based)

Demodulation and analysis

- Spectrum analyzers are optimized for checking that a signal meets certain parameters (*modulation analysis)*
- Monitoring receivers are optimized for *demodulating* signals, i.e. extracting intelligence from them.



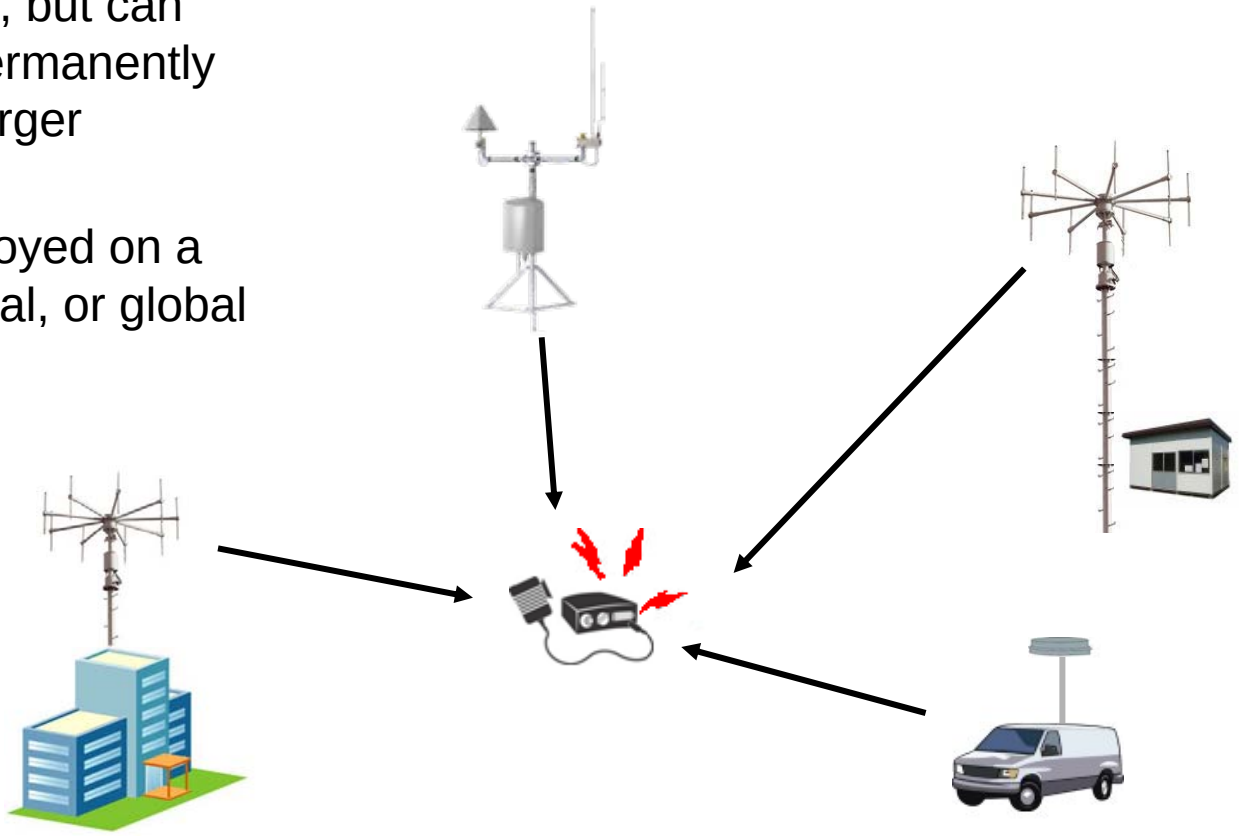


Direction finding / radiolocation

- Directional antennas used with hand-held instruments to measure received signal strength
- Monitoring receivers often have DF-specific features (tone out)
- True bearing measurements require special DF hardware and functions
- Ability to combine and map bearings in software

DF systems using multiple receivers

- Monitoring receivers with direction finders can be used as stand-alone solutions, but can also be combined (permanently or temporarily) into larger systems
- Systems can be deployed on a local, regional, national, or global scale.



Integrated DF with multiple bearings

Practical considerations

- Dramatic changes over the last 10 years :
  - Exponential increase in the number of wireless devices
  - New (especially digital) modulation schemes and bandwidths
  - Higher spectrum occupancy : more transmitters / MHz
  - Frequency-agile and short-duration signals
  - Spectrum reallocation / refarming

For more information

- Rohde & Schwarz Radiomonitoring and Radiolocation home :
  http://www2.rohde-schwarz.com/en/products/radiomonitoring/
- *Radio Interference Detection and Analysis* – Application Brochure
  www2.rohde-schwarz.com/file/PR100_app_bro_en.pdf