ESPTR: Pulsed Doppler Radar

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April 7, 2008

By transmit waveform:

- ▶ Continuous wave
  - ▶ Doppler only (police, toilet, security...)
  - ▶ FMCW
  - ▶ Noise radars

- ▶ Pulsed

- ▶ Passive

By usage:

ATC Air Traffic Control:

- ▶ Maritime: harbour, navigation

- ▶ Car mounted: parking, safety...

- ▶ Airborne: collision, meteo, fighter, Joint Stars, Bryza
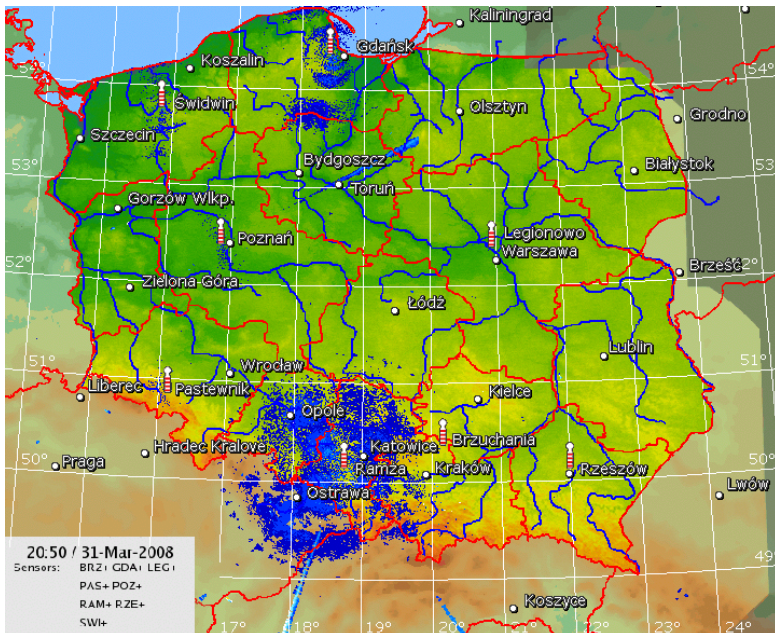
- ▶ Satellite (EO)

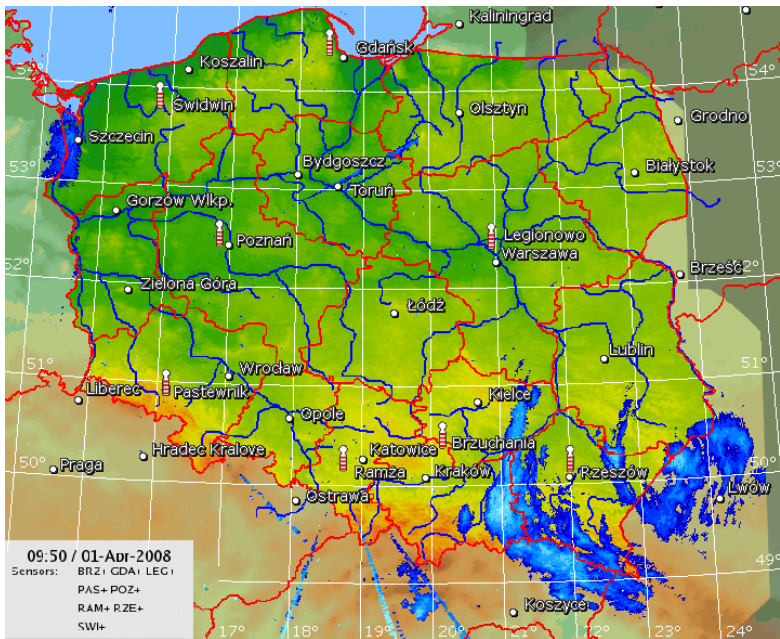By scan: fixed, pivot, rotary, electronic (+ conformal)
Search or tracking mode.

Meteo radar

- ▶ Imaging of water/ice in atmosphere
- ▶ Velocity, turbulence, wind profilers (VHF)

Techniques: Doppler, polarimetry, 3D imaging...

Velocity measurement

$\longrightarrow$ Doppler shift measurement

$$x_R(t) = A_T(t - R_0/c - vt/c)e^{j\phi_M(R_0/c + vt/c)} \, e^{j(\omega t)}e^{-j\omega(R_0/c)}e^{-j\omega vt/c}$$

Example: 10GHz, 70 m/s ....

- ▶ Min velocity: ground/sea/meteo clutter
- ▶ Max velocity (frequency): (inverse of) modulation period

ATC radar

Transmitter: Pulsed chirp (or other modulation).
Common: Antenna, scan mechanism, waveguides, rotary joint, T/R
switch Receiver:

- Protection, LNA, mixer, IF, pulse compression, quadrature
  demodulation (sin/cos problem ⟶@blackboard), range gate
  ⟶range-azimuth plane
- Clutter filter, CFAR, detection, integration, 2nd threshold
  (⟶raw video)
- Object extraction (⟶plots)
- Track initiation, plot to track association, tracking (⟶tracks)

MTI/MTD

- ▶ Clutter is low-pass (in a stationary radar): use a HF filter
- ▶ Blind speed problem $\longrightarrow$ vary the PRF

MTI pulse-to-pulse stagger

MTD block stagger

Filter characteristics with stagger: poor!
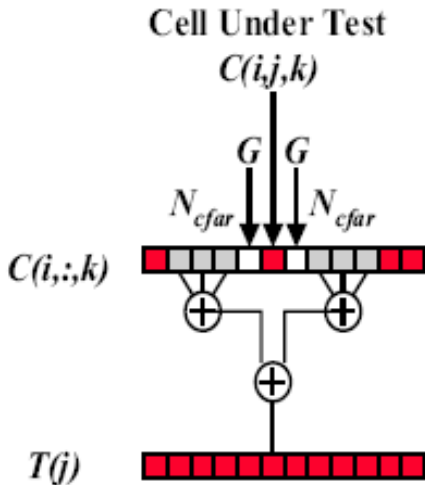$\longrightarrow$ variable coefficient filters
MTD: FFT filter bank (or equivalent)
Weather clutter: non-zero Doppler, complex filter coefficients, adaptive filters (MTI)
Velocity measurement (CRT with MTI or MTD).

CFAR

Constant False Alarm Rate

Pulse compression

BT product.

- Chirp ($\longrightarrow$compression line, electromechanical filter)
- Bi- and polyphase
- Pseudorandom

Range sidelobes.

ECM/ECCM

Chaff.

Jamming: detection + diversity, agility.

Adaptive jamming/false echoes $\longrightarrow$ pulse coding, pulse stagger