How Can You Dominate an Unknown Spectrum?

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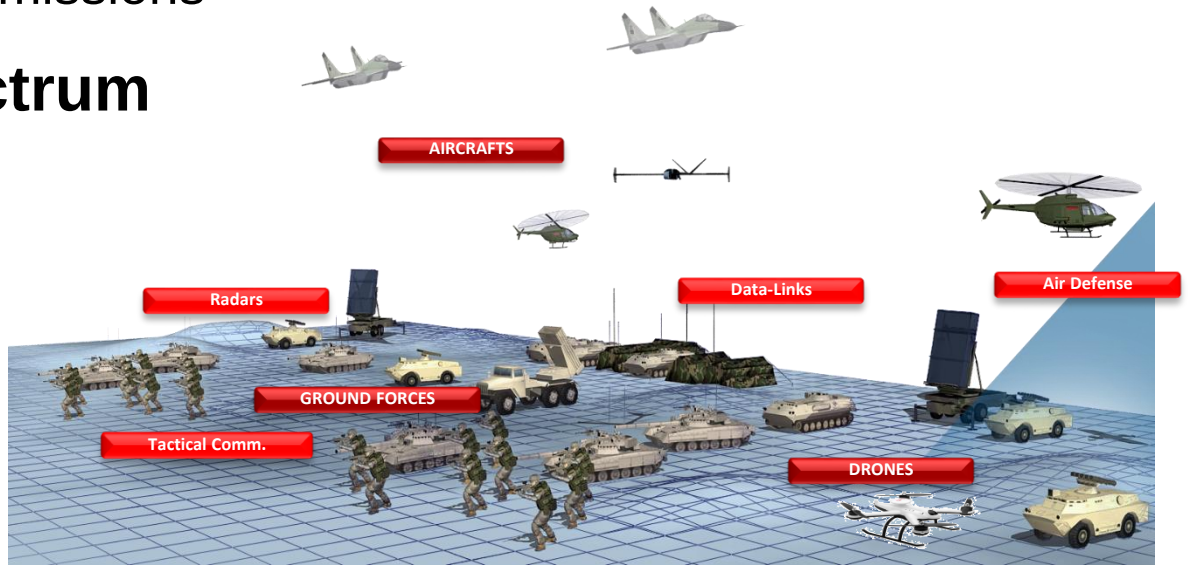
Challenges in the Operational EM Spectrum

- Dense & dynamic spectral electromagnetic environment
  - Diversity of signal types, waveforms & parameters
  - Plenty of background emissions
- **The <u>Unknown</u> spectrum**



The Unknown Spectrum

- **Unknown…**
  - Signal electronic type & waveform
  - Signals of interest
  - Dynamic spectral arena

How can you dominate an unknown spectrum?

Unknown signal electronic parameters

- Unknown type, waveform & behavior, especially for **software-defined** automatic systems
- Covert **LPI modes**; weak signals
- Significant loss in **processing gain**
- **Can we detect weak complex signals without knowing their waveform?**

How can you dominate an unknown spectrum?

Unknown signals of interest

- **Less distinction** between hostile and irrelevant signals
- **Military** threats or hostile **civilian-like** transmissions are immersed in background emissions
- EW system should Intercept "everything"
- **Do we know how to distinguish signals of interest from background?**

How can you dominate an unknown spectrum?

Unknown dynamic spectral arena

- A challenge of actionable intelligence: Signals use similar waveforms, while dynamically varying their parameters
- **Can we associate & track the intercepted signals over time?**
- **How to maintain the correctly updated EOB situation picture?**

How can you dominate an unknown spectrum?

The Unknown Spectrum

- Can we detect weak complex signals without knowing their waveform?
- Do we know how to distinguish signals of interest from background?
- Can we associate & track the intercepted signals over time?
- How to maintain the correct dynamic EOB situation picture?

How can you dominate an unknown spectrum?

Solution Components

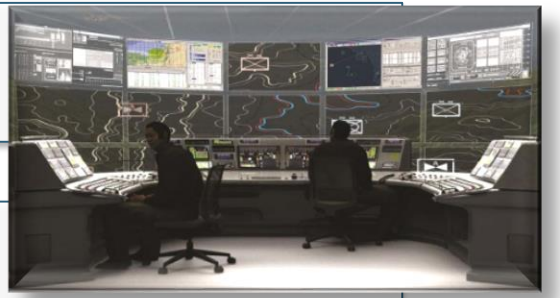
- **A comprehensive approach at all system levels**, supported by artificial intelligence (AI) capabilities

  - Open & flexible receivers
  - Combination of local processing & networking
  - Cognitive on-the-fly smart processing
  - AI-based association
  - Integration with supporting information, anomaly reports
  - Insights & advice tailored to user & mission

Different Operational Users

Intelligence centers

- Producing situation picture, alerting



Intelligence experts

- Researching for insights & data analysis

Spectrum dominance systems

- Supporting spectrum management of active operations (EA)

Field units

- Using tactical spectral data for local immediate actions

Requirements

Operational Users

Intelligence centers
- Producing situation picture, alerting

Intelligence experts
- Researching for insights & data analysis

Spectrum dominance systems
- Supporting spectrum management of active operations (EA)

Field units
- Using tactical spectral data for local immediate actions

Solutions

- Open & flexible receivers
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Different requirements

- Type of actionable intelligence
- Response time
- Quantity, Accuracy
- Artificial Intelligence level

Common requirements

- High POI
- Distinguishing & association
- Maintaining spectral picture

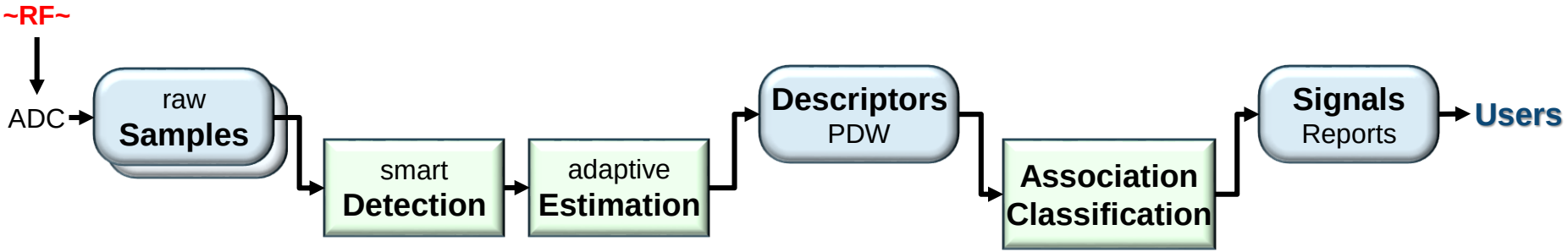
Receiving systems

- Open collection systems for high POI
  - **Wide** instantaneous spectral coverage
  - **Multi-channel** to support spatial coverage and all DF methods
- Fully digital for flexibility & adaptive processing
  - **Software defined** systems
  - Strong **processing power**
  - High duty-cycle **on-the-fly processing**

Processing

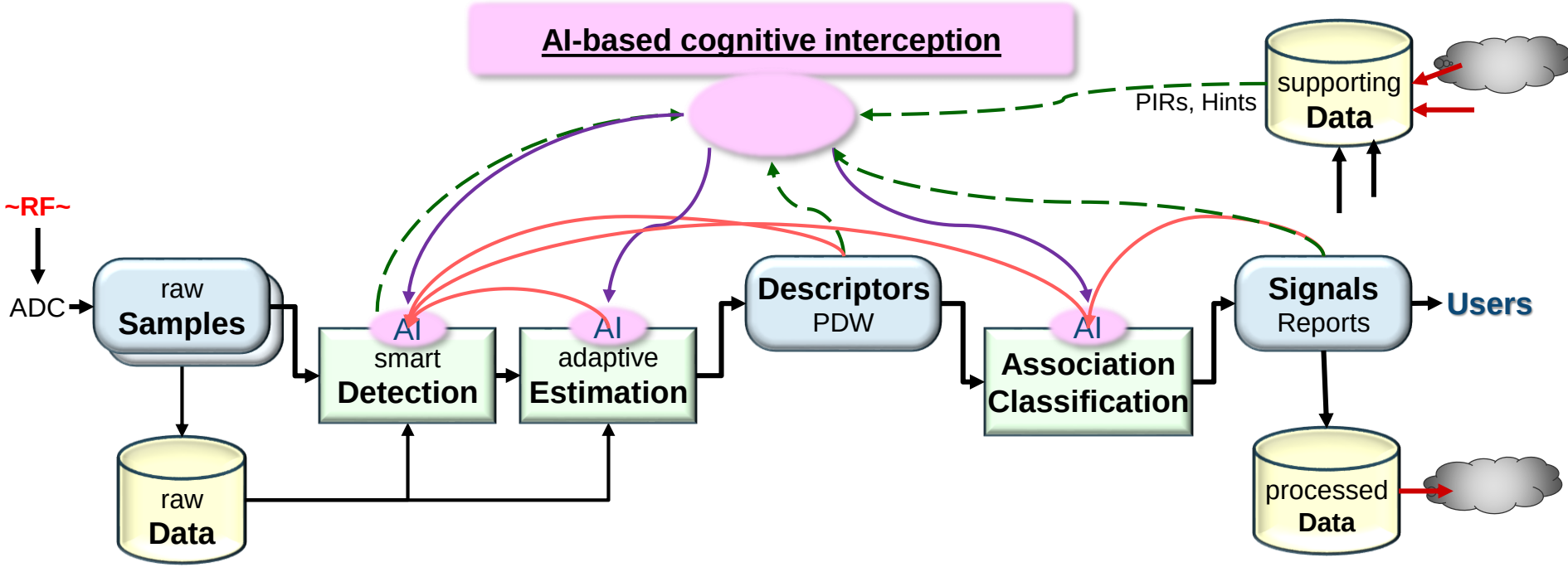
- Adaptive samples processing
  - Powerful, **optimal for each signal type** (up to "matched filter" gain)
  - Software defined, but SW & HW implemented
  - On-the-fly processing
    - High duty-cycle, wide-bandwidth operation, low-latency results
- Smart cognitive processing
  - Automatic, AI-based, cognitive management
  - Flexible to all signals & tasks

Signal Interception



Real-time wideband collection & processing

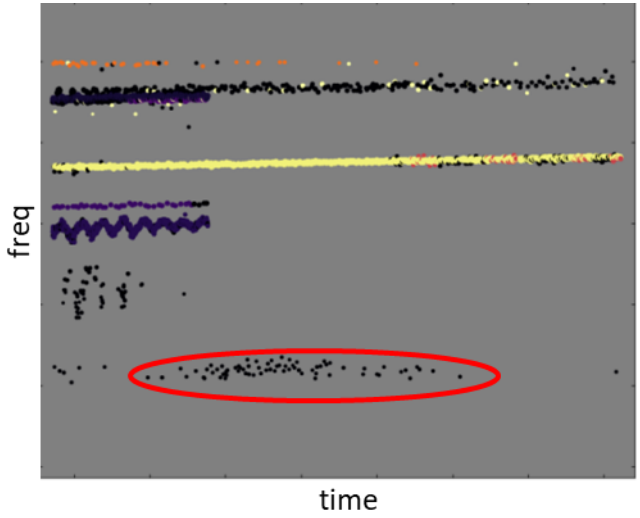
Cognitive Interception

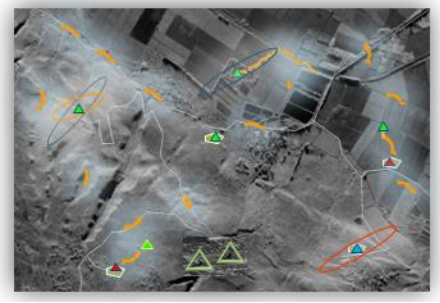


Real-time self-optimized to spectral environment

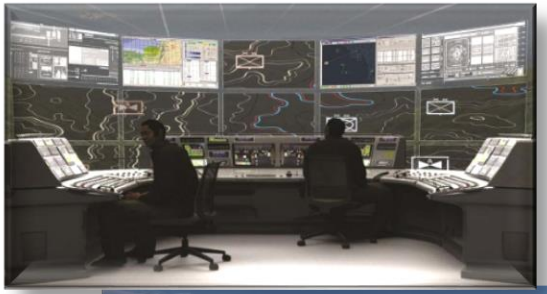
Integration & Insight

- Integration
  - AI-based association
  - Integration with supporting information
  - AI-based tracking
- Insights & recommendations
  - Maintaining an EOB picture
  - Anomaly observation
  - Alerting to significant events
  - … Information tailored to user & mission





Tailoring to Operational Users



Intelligence centers

- Need sensors update to maintain the situation picture and alert to significant events

Intelligence experts

- Expect all data to apply enhanced analysis

Spectrum dominance systems

- Need accurate & timely signal parameters

Field units

- In-situ AI (sensors with edge AI) providing tactical local recommendations

Conclusion

- Dominating an UNKNOWN spectrum is a great challenge
- The solution demands a comprehensive approach, supported by AI capabilities, at all system levels: From basic interception to operational user insights