



V49 Spectrum Standards Enabling Spectrum Forensics

22-June-2016

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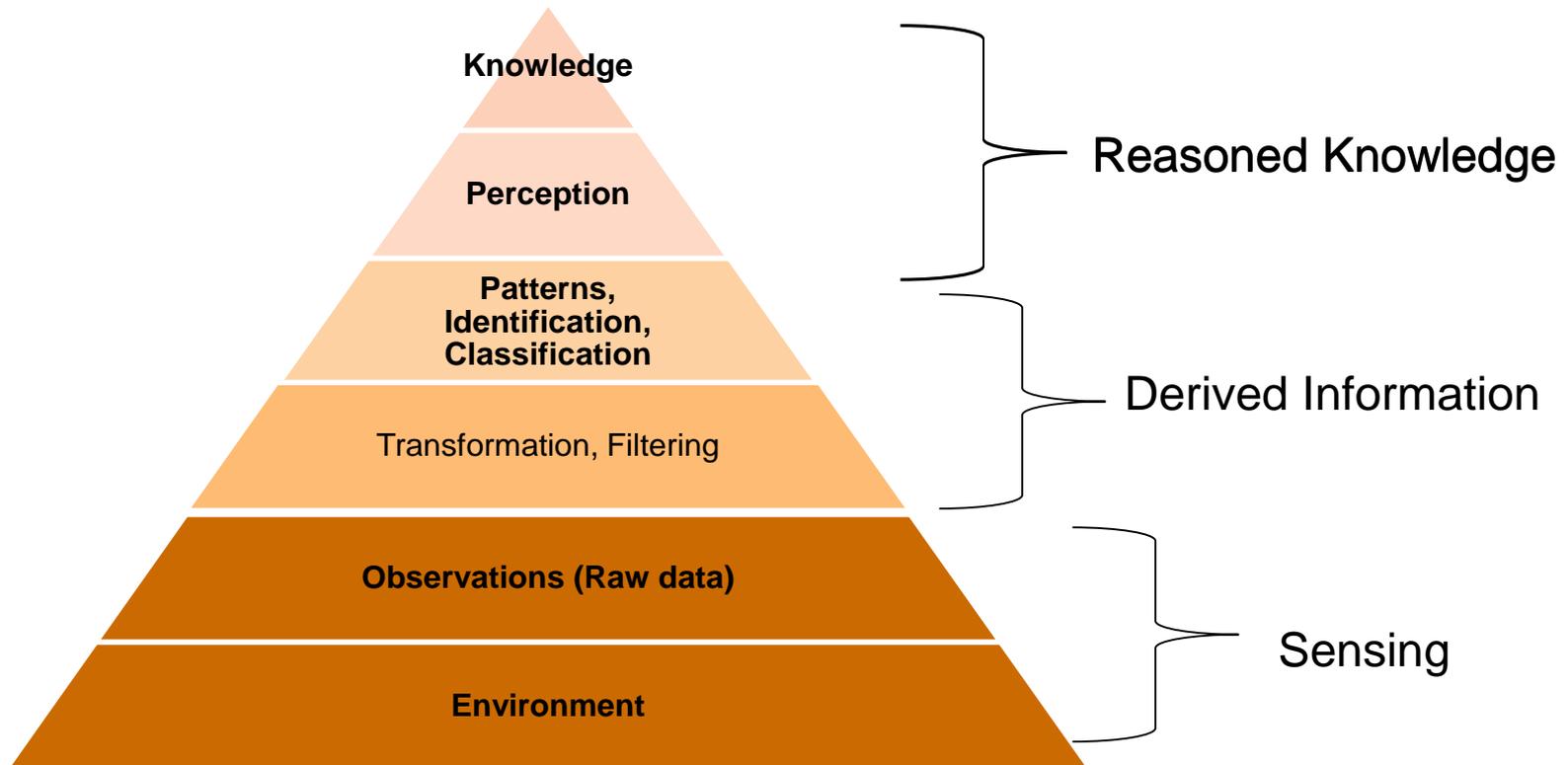
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Paul Guseman, Raj Patel

This work was supported by the Office of Naval Research under contract
N00024-13-D-6400

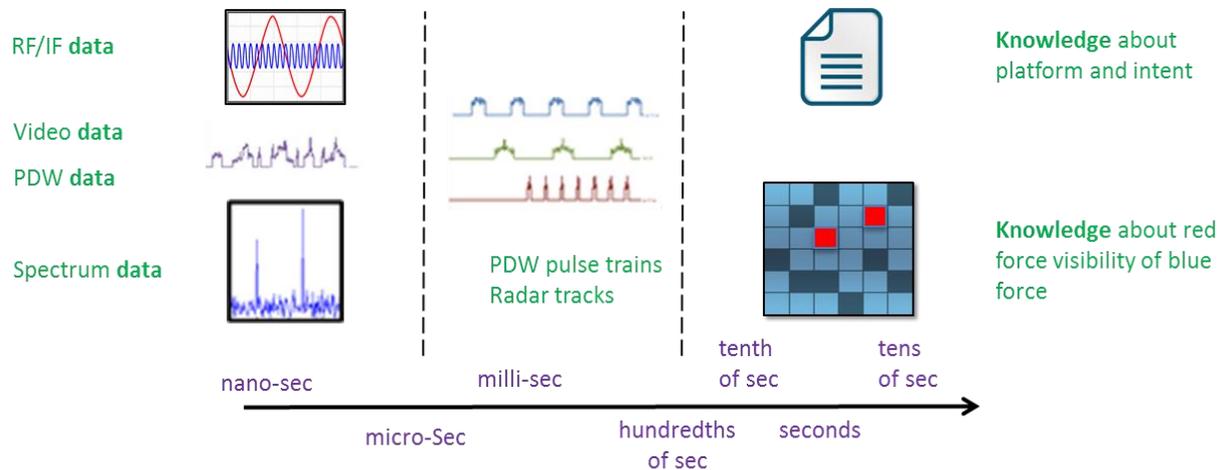
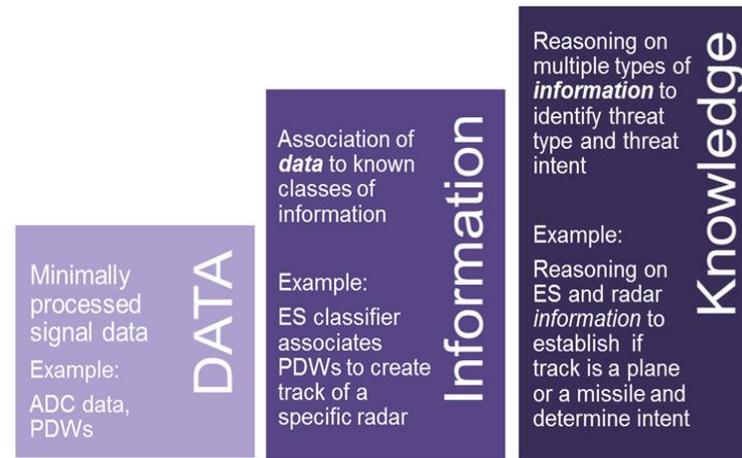


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Information Pyramid



EMS Data Types

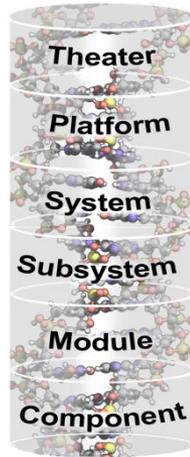


Common EMW Messaging Enables Integrated Observations and Operations



EMW Message "Elements":

- Spatial
- Time
- Kinematics
- Frequency
- Bandwidth
- Power
- Phase
- Waveform Characteristics
-others...

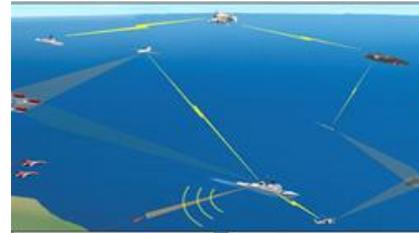


EMW messaging is an enabler:

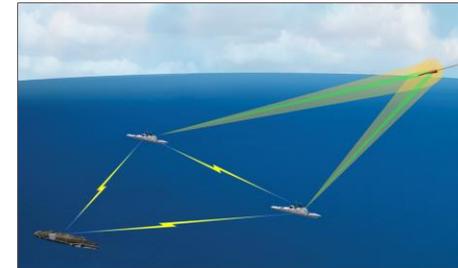
- Interoperability: Elimination of stove-pipe interfaces
- Rapid capability insertion
- Management of EMS emissions across fleet
- Real-time fleet-wide EMW optimization
- Synchronization and coherency
- Autonomous data fusion from disparate sensors
- Collaborative, Cooperative and Coherent EMW effects

Example Applications

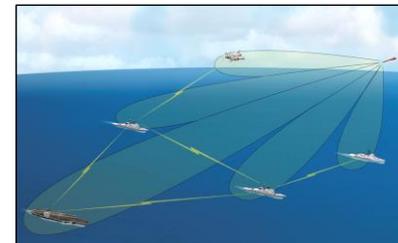
Battle space awareness



Coordinated Affects



Threat Intent



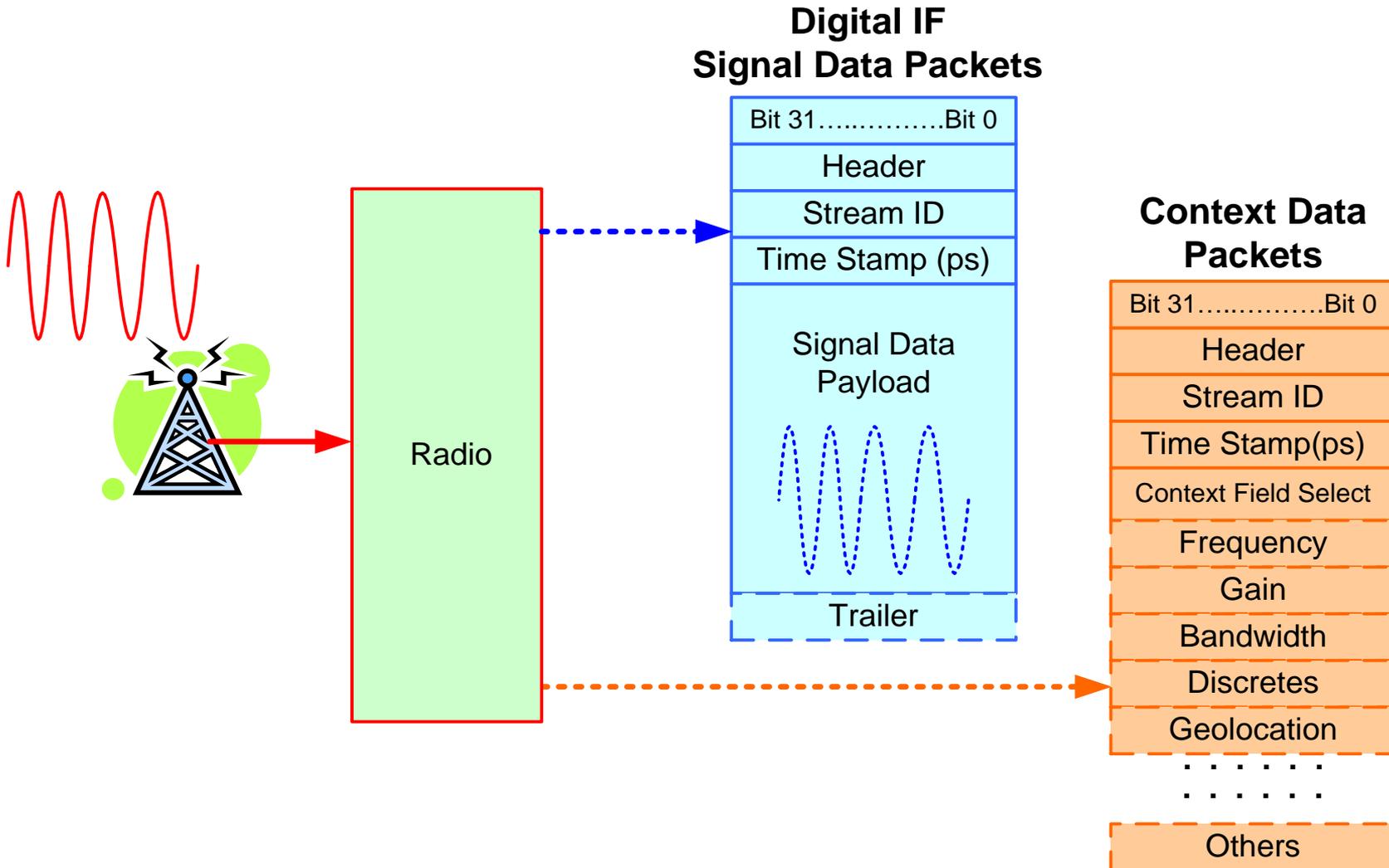
APL EMW Message Efforts

EMW Standards
V49.2 + V65

EMW Cores
C++
VHDL

Reference
Designs
ES, EA,
EMS emulators

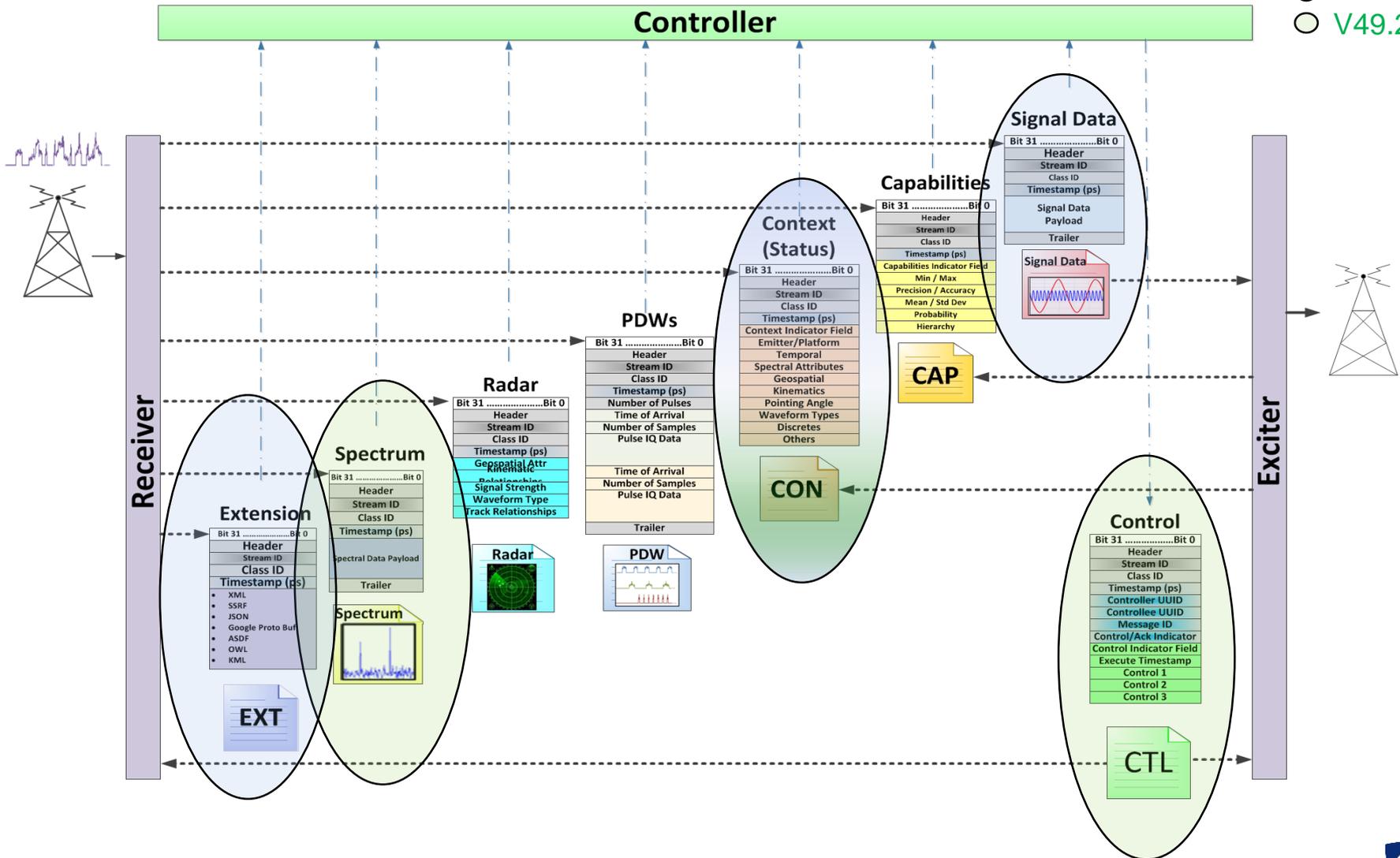
Functional Description of VITA 49.0 Rx



V49.0 Existing and V49.2 Packet Types



- V49.0
- V49.2



V49.2 Meta Data Categories

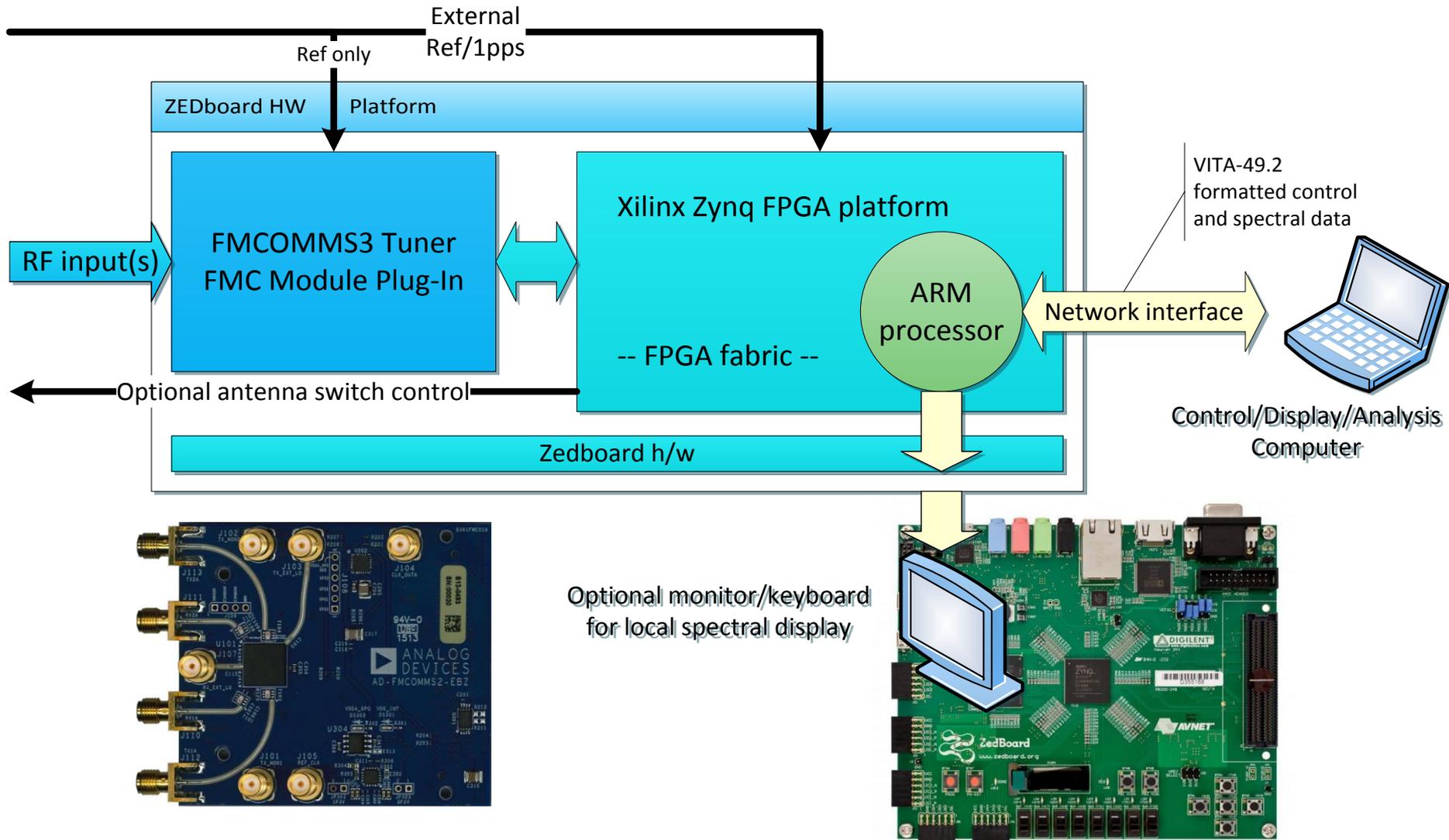


Category	Types of V49.2 Fields
Temporal	Precision Time Stamp , TOA, pulse width, period, rise-time, fall-time, modulation on-time, shelf_life, age
Spatial/Kinematic/Aperture	Location , 2D pointing angle structure, 2D pointing angle , beamwidth, polarization, phase, range, spatial scan, way-point, spatial reference
Spectral	Doppler, spectrum analyzer control, spectral occupancy
Signal	Frequency(RF, IF) , bandwidth , power , gain , SNR, Noise Figure, 2 nd order intercept, 3 rd order intercept, compression point, detection threshold, sampling rate
Waveform	Signal type, modulation type, emitter type, country & operator identifier, BER
Identifiers	Device ID , reference point , parent ID, child ID, track ID, object ID, UUID, Priority code, modelID
Miscellaneous	Discrete IO , over range count , temperature , time stamp calibration time , state/event indicators

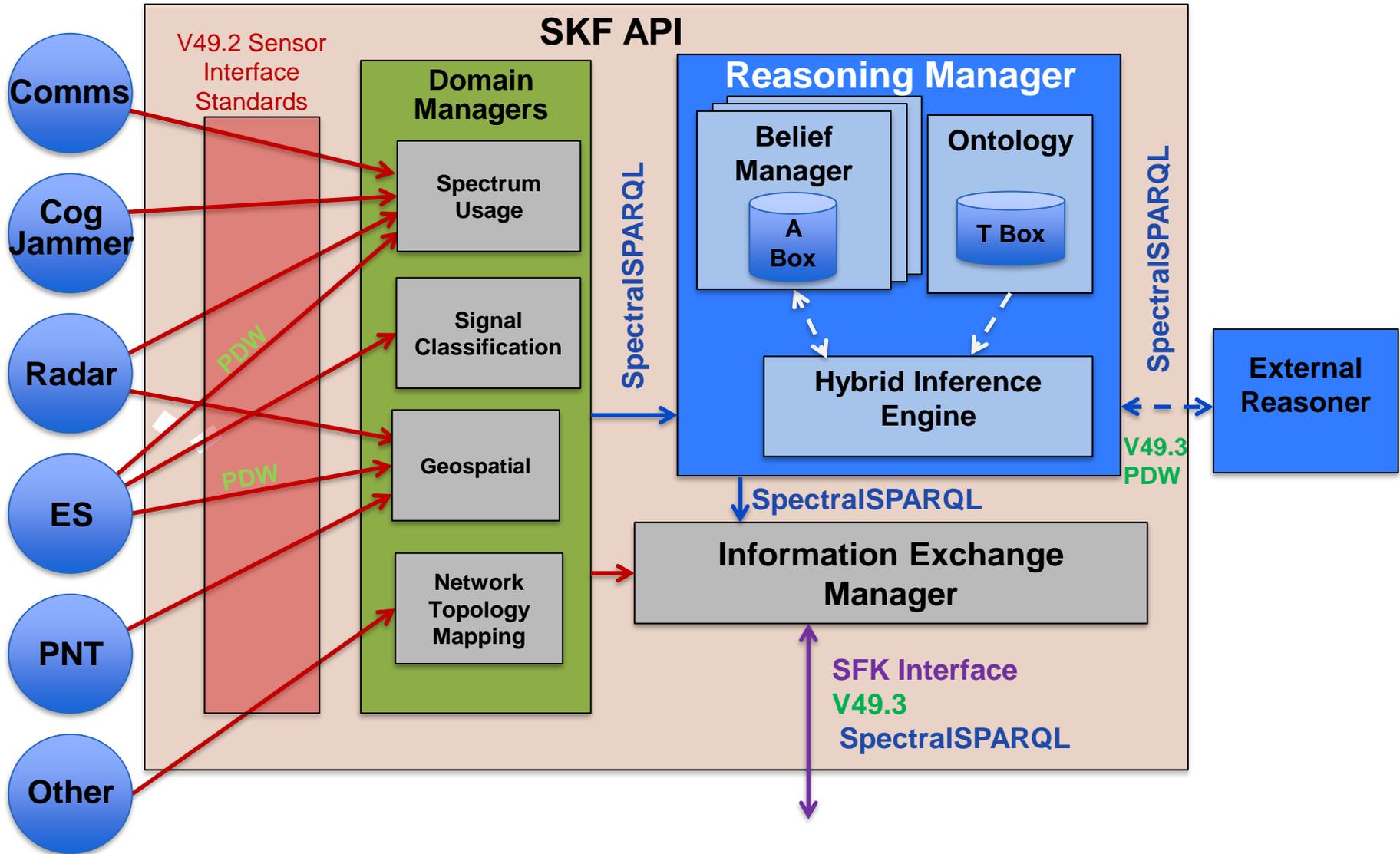
Blue – indicates legacy V49.0 attribute



Hardware Development Platform



Vision for SKF API





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Proposed V49.3 Enhancements



- **Formalize V49.3 as a standard**
 - **Flexible Array of Structures**
 - Example: dynamically configurable PDW Packet
 - **Spectrum Representation Enhancement**
 - Probability of Spectrum Occupancy

- **Properties applicable to all V49 fields**
 - **Derivatives** value, rate, acceleration,...
 - **Range** min,max
 - **Uncertainties** precision, accuracy
 - **Beliefs** mean, std deviation
 - **Priority** communication, operation
 - **Sub-field Identifier**
 - Example: Center frequency, modulation frequency, chip rate, bit rate

- **Hierarchical expression of capabilities and signal flow**
 - Platform, sensor, receiver, exciter, processing
 - Blue Force and Red Force

Proposed V49.3 Enhancements



Source.Field.Sub_Field.Properties.Format.Relationships

SOURCE

- Observations
- T-Box (datasheets, EW DB)
- A-Box (perception of environment)

Field (nouns)

- Identifiers (knowledge)
- Temporal
- Spatial
- Spectral
- Signal
- Waveform

Sub-Field (modifiers)

- none
- Pre-Defined per field (Frequency)
 - Center
 - Modulation
 - Chip rate
 - Bit Rate
- Custom . Examples:
 - Cyclostationary frequency 1
 - Cyclostationary frequency 2
 - Cyclostationary frequency 3

Properties (modifiers)

- Standard
- Derivatives (0 to 7)
- Range (min-max)
- Step-Size
- Uncertainties
 - Precision
 - Accuracy
 - Resolution
- Beliefs
 - Probabilities
 - Variable
 - Confidence
- Temporal Qualities
 - Beginning
 - Age
 - Shelf Life
 - Decay Rate
- Priority
 - Communication
 - Execution

Format

- Binary (standard V49.2)
- Course Binary (?)
- Float16
- Float32
- Float64
- XML

Relationships

- Subject
- Predicate
- Object
- Complex logical relationships for events

Overview of SKF Extension to V49



- **Multiple Beliefs**
 - Support multiple hypothesis generation
 - Support multiple trajectory planning

- **Hybrid information types**
 - Framework to support “hybrid reasoning”
 - Logical qualitative reasoning
 - Continuous quantitative reasoning

- **Uncertainty**
 - Precision and accuracy
 - Probability, statistical and confidence

- **Temporal attributes**
 - Beginning
 - Age
 - Shelf-Life/Staleness
 - Information Decay