



Pulsed Microwave Data Link-

Smart Wireless Switched Building Blocks for IVHM Sensor Interoperability

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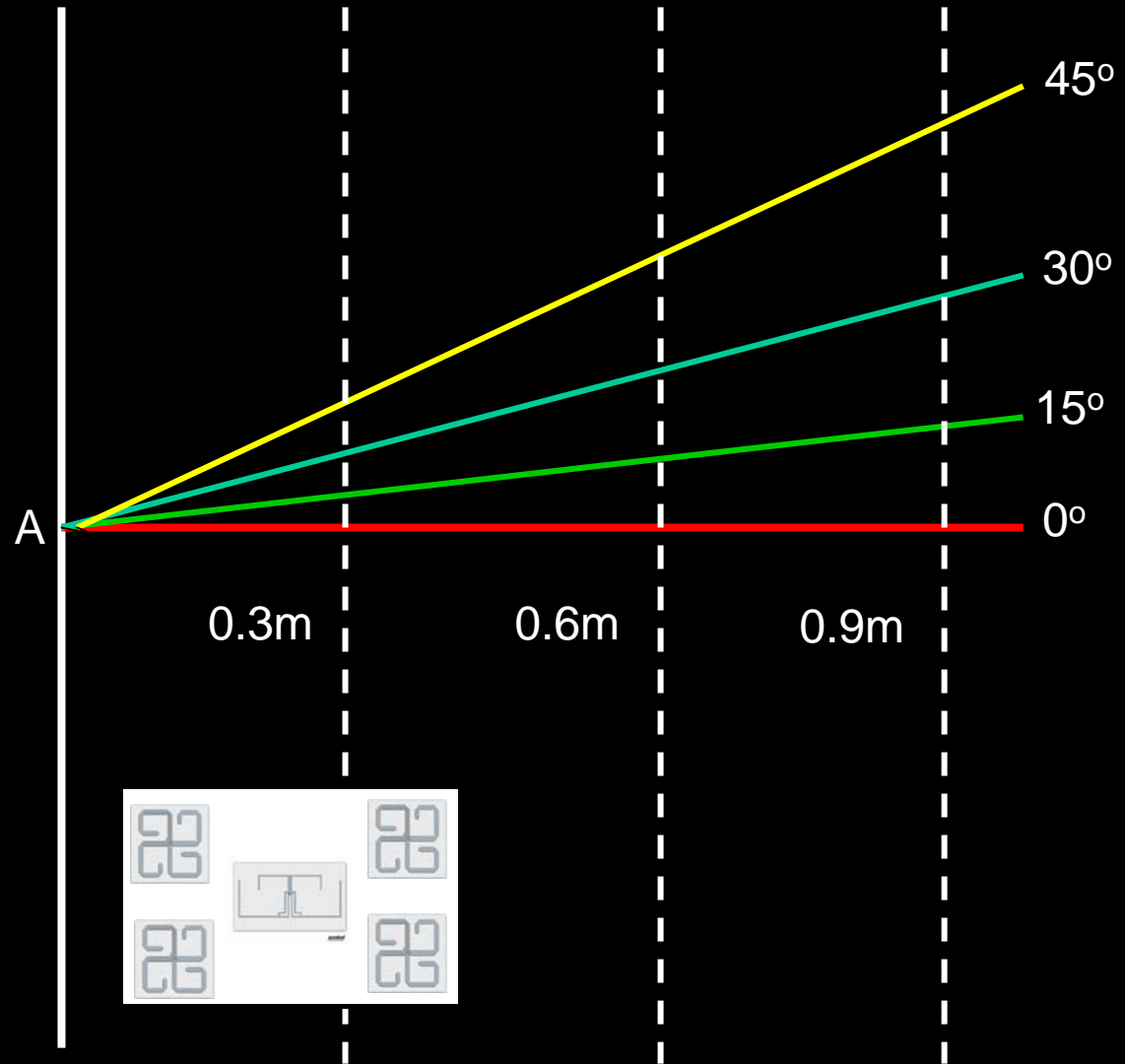
ViaLogy

- Altadena, California operations
- Original Discovery – QRI Core Technology
- 12 Patents Issued to ViaLogy
- First Patents Issued with ‘No Prior Art Status’
- Core Competencies:
 - IP-based interoperable sensor networks & policy engines
 - Sensor fusion
 - Weak signal detection

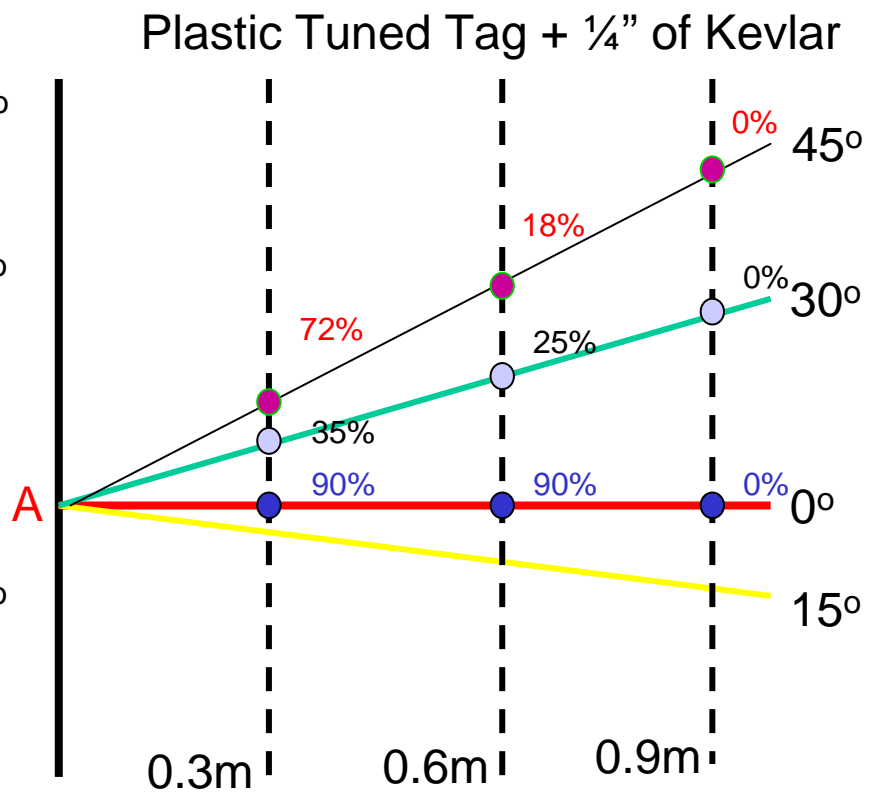
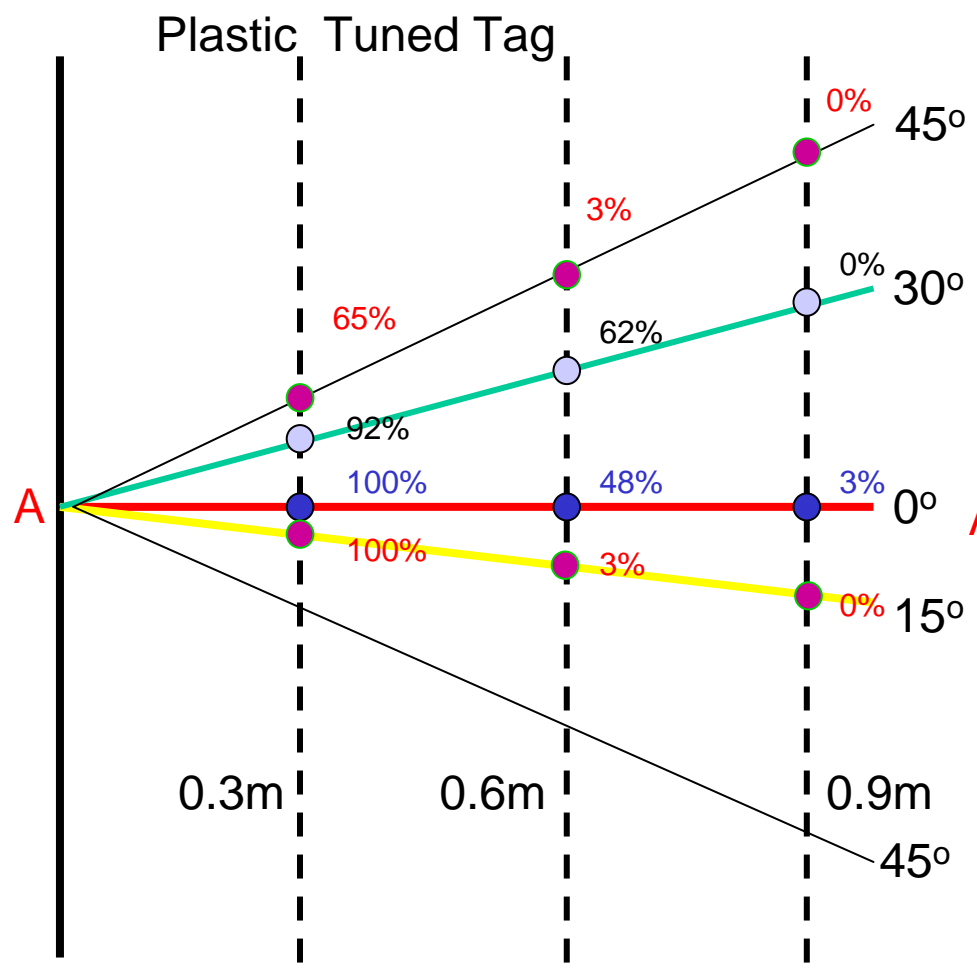
- ❑ **Demonstration Scenario**
 - ❖ 2.45 GHZ RFID system scanning tags behind Kevlar and other composite materials.
- ❑ **ViaLogy's Active Signal Processing Solution (the "A-----" solution)**
 - ❖ Qualitative Casual Physics and Quantum Resonance Interferometry
- ❑ **ViaLogy's Network Interoperability Solution. (the "B-----" solution)**
 - ❖ Sensor Policy Manager (SPM) and IPICS
- ❑ **Summary: Building Blocks Available Today.**

Experimental Procedure

1. Antenna mounted on tripod
2. Various types of tags are positioned at different distances and angles from the center of the antenna
3. DAQ is turned on for 30 seconds, sampling at 2 Hz.
4. Record the total number of tag reads after 30 seconds. Calculate the Read Percentage.
5. Repeat with tag positioned behind different composite materials.

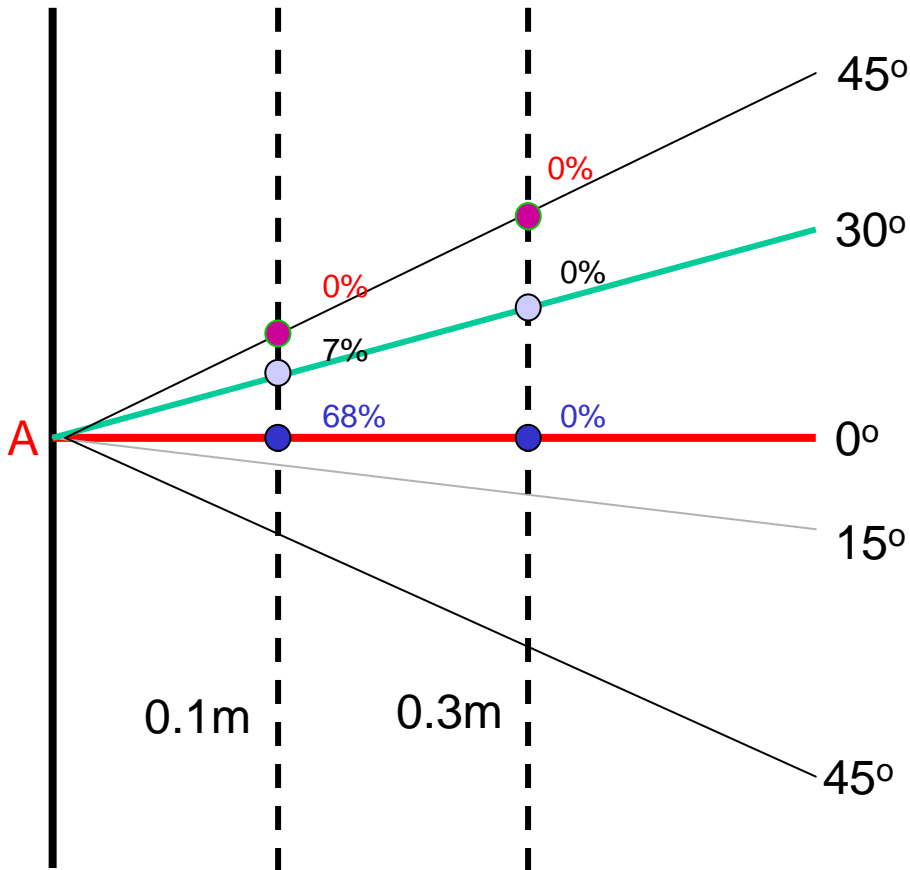


Sample Results

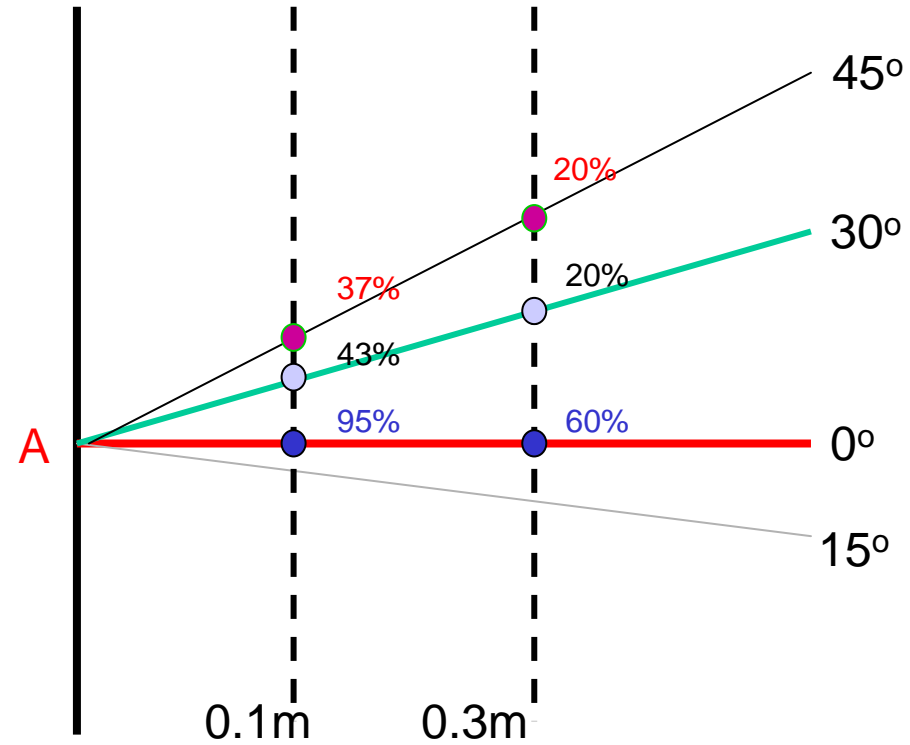


Contradictory Results?

Glass Tuned Tag



Glass Tuned Tag + 1/4" Kevlar



Is it logical to use low value sensors to protect high value assets?

Yes, if we can implement a mathematical solution that can deal with highly non-linear outputs.

What we really need is a Situational Calculus Solver

- automatically reasoning about the kinds of changes that occur and their effects
[*Frame Problem*, McCarthy & Hayes]
- interpreting what changes and what does not
- reasoning under uncertainty

- **Qualitative Causal Physics** [J De Kleer, Xerox]
- **Understanding the paths of causal interaction formulated as a constraint network is fundamental to robust monitoring and control.**
 - ❖ **Adjacency: basis for all interaction - physical, electromagnetic, thermal, electrical, ..., adjacency**
 - ❖ **difficulty: multiplicity of interactions possible, some of which are unusual or subtle**

no-function-in-structure principle

laws of the subsystem may not presume the functioning of the whole system

locality principle

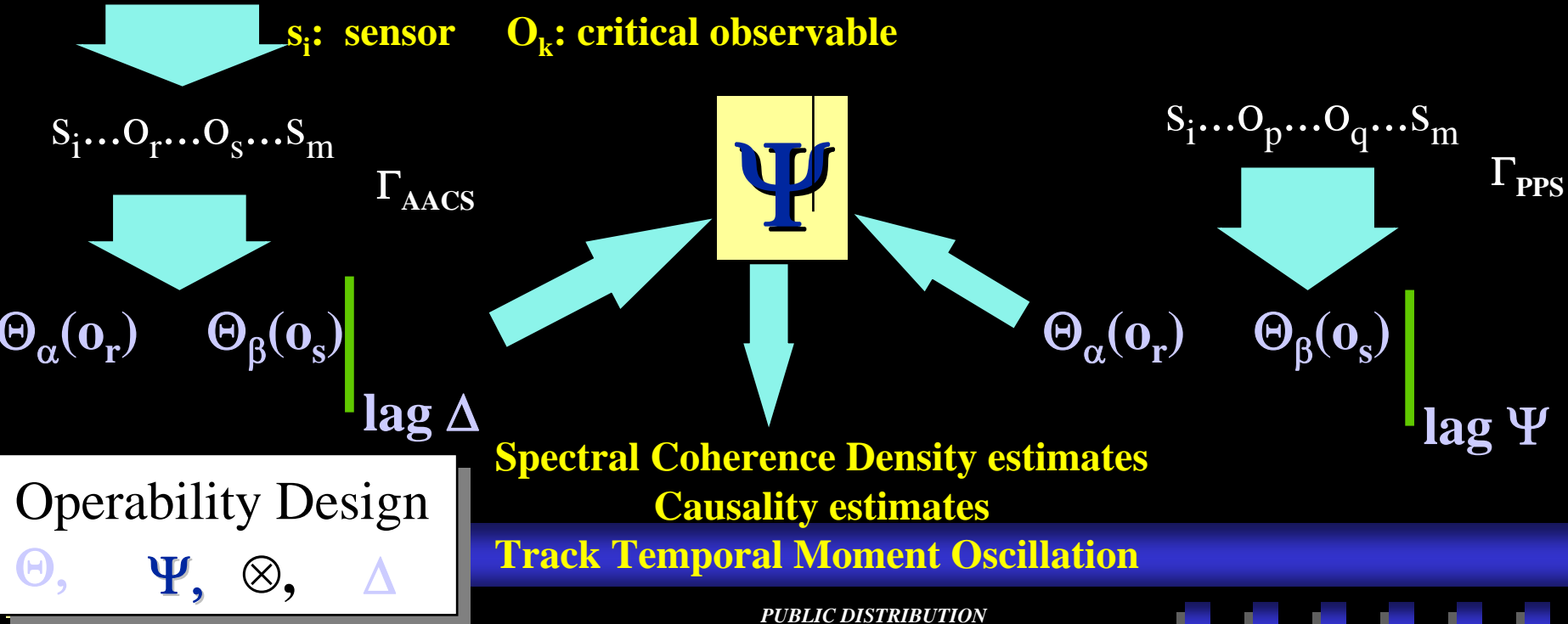
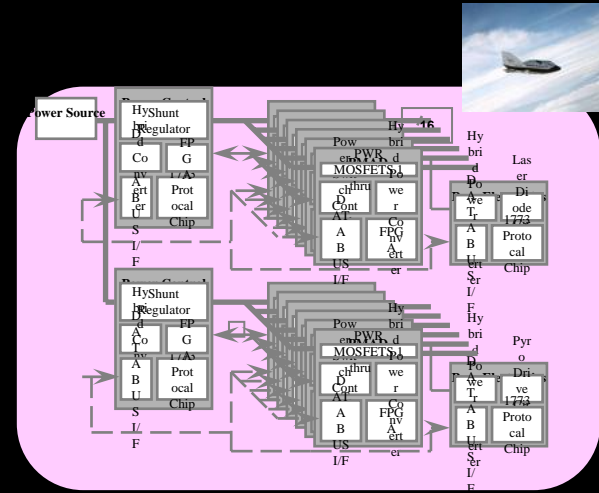
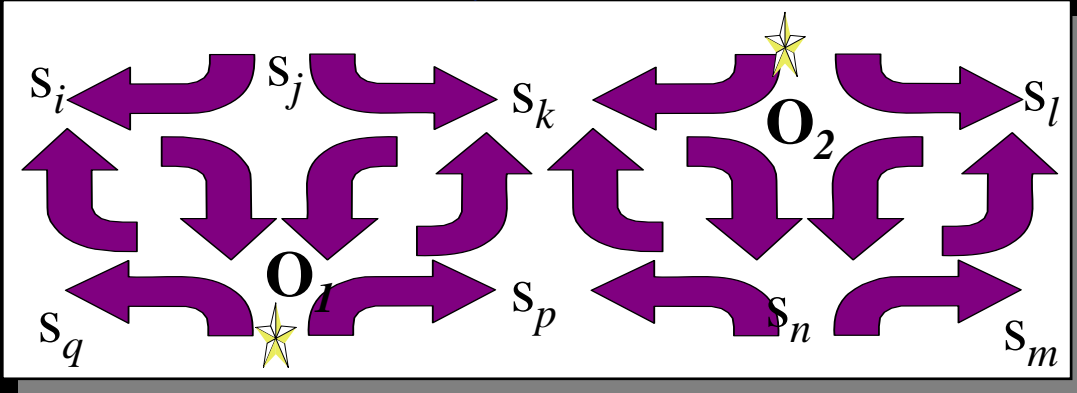
laws for a subsystem cannot specifically refer to any other subsystem



locus of causal interactions must be determined a priori

So how should we model this?

a typical subsystem Γ_i : AACS



□ CORE HYPOTHESIS

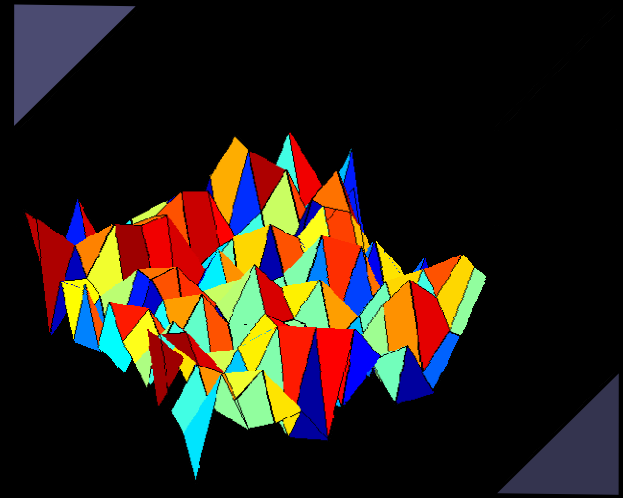
- ❖ Spacecraft/system treated as arbitrarily large, complex multidimensional signal where the information actually resides within a low dimensional space
- ❖ initially the total diagnostic space covers all sensors, command and executing flight software
- ❖ rigorously developed algorithms to automatically determine the “information space” of the system over all operating modes
- ❖ formally showed that “reduced and reconstructed information space” can actually and quantitatively capture all diagnostic and degradation information (guarantee complete state coverage with arbitrary fidelity)

Step 1: Develop a “Quantum Expressor Function” (QEF) i.e. QSR model characterizing the system noise, ultimate limit of detection and precision.

Step 2: “Destroy” the QEF model by injecting signal.

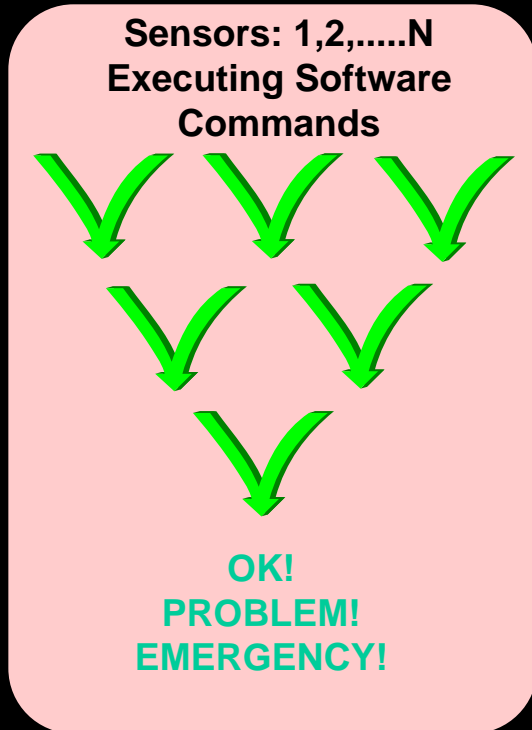
Three QRI Modes:

- a. Generate a QSR for signal of interest and match transition rate to QEF**
- b. Feed the output of signal QSR to input of QEF and adjust transition rate**
- c. Construct an idealized QEF based on theoretical principles, inject the real data and track the deviation**

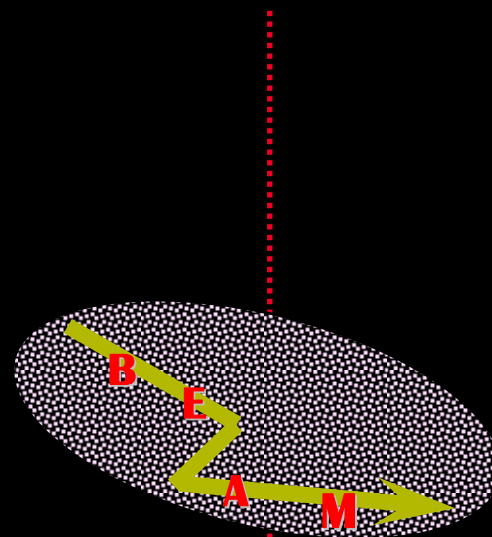


PMDL COMPUTATIONAL ELEMENTS

ON SPACECRAFT/AIRCRAFT



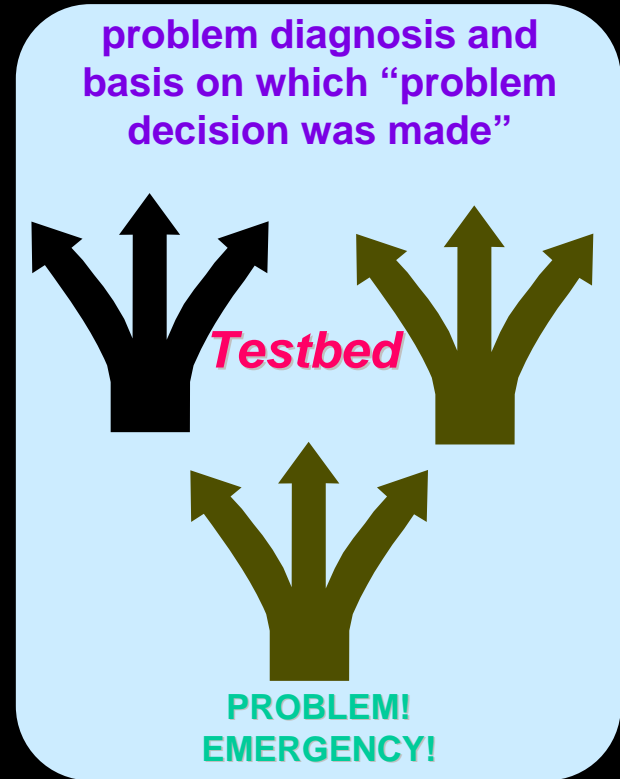
ON-BOARD
FUSION
OPERATOR



HYPERCOMPACT
OPERATING
MAP

- Impact Reporting
- Time-to-criticality
- Degradation Assessment
- Residual-life
- CBM (inspection) Tasking

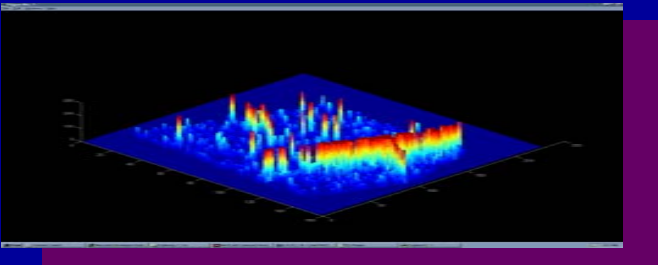
ON GROUND



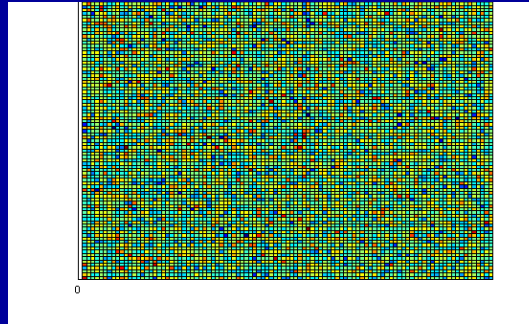
ON-GROUND
BACK PROJECTION
OPERATOR

Existing Example: Quantum Resonance Interferometry and Gene Expression

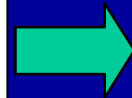
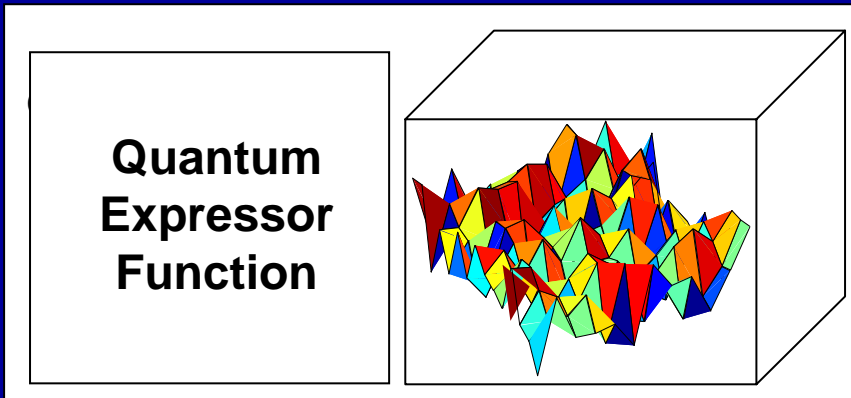
Empty &
Non Specific
"Training" Data Sets



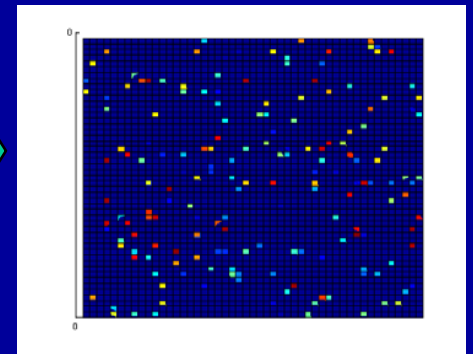
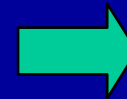
Microarray Dataset



Gene Expression
Pattern

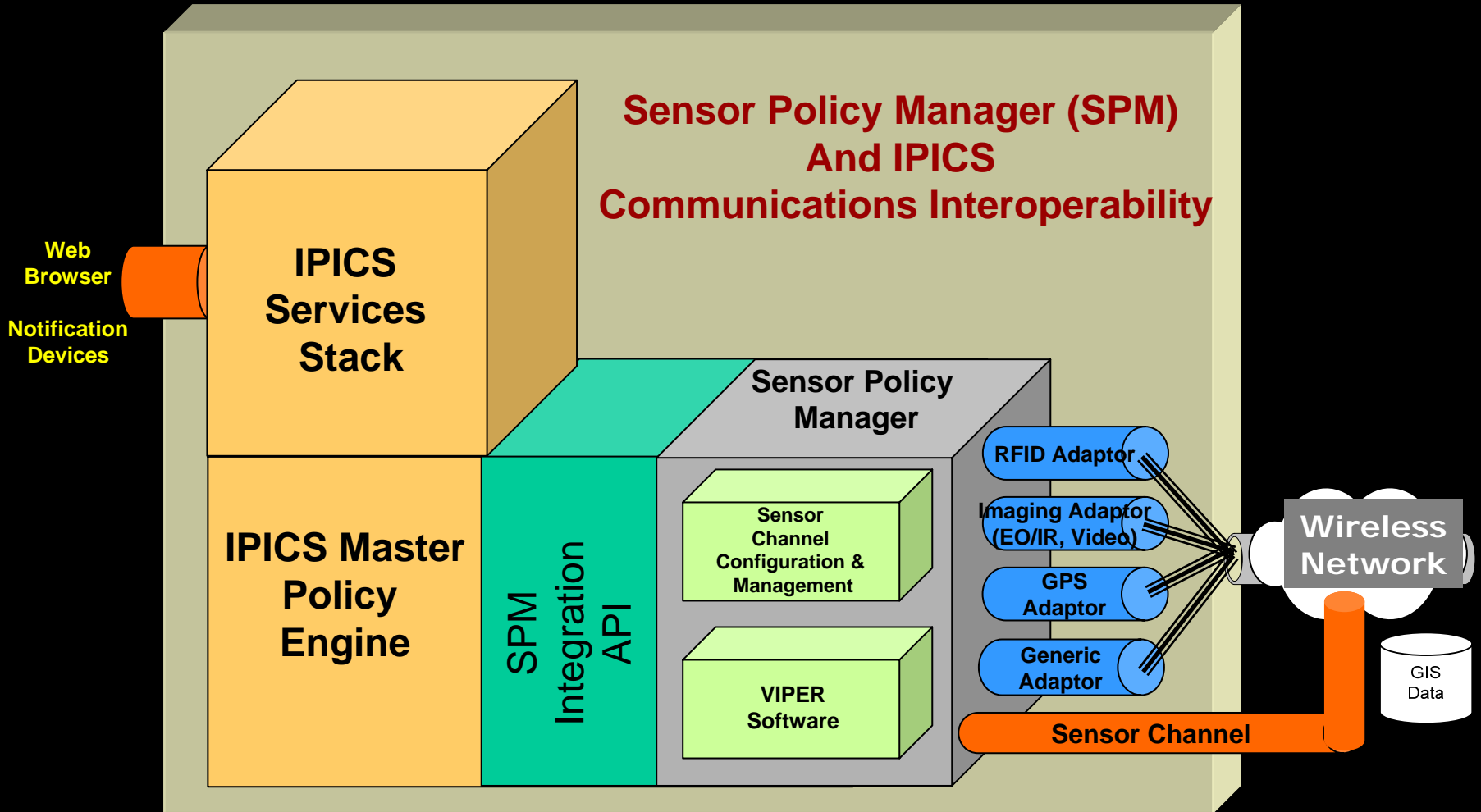


QRI
Processing
(few ms)



- **Why do I need “artificial intelligence?” – you “paid” for the wireless innovation, why not take full advantage of it.**
- **Wireless networks allow us to integrate “expert opinion” (real people) into the decision loop.**
- **ViaLogy’s Sensor Policy Management (SPM) and Sensor Fusion**
- **RFID tags is just another sensor input**

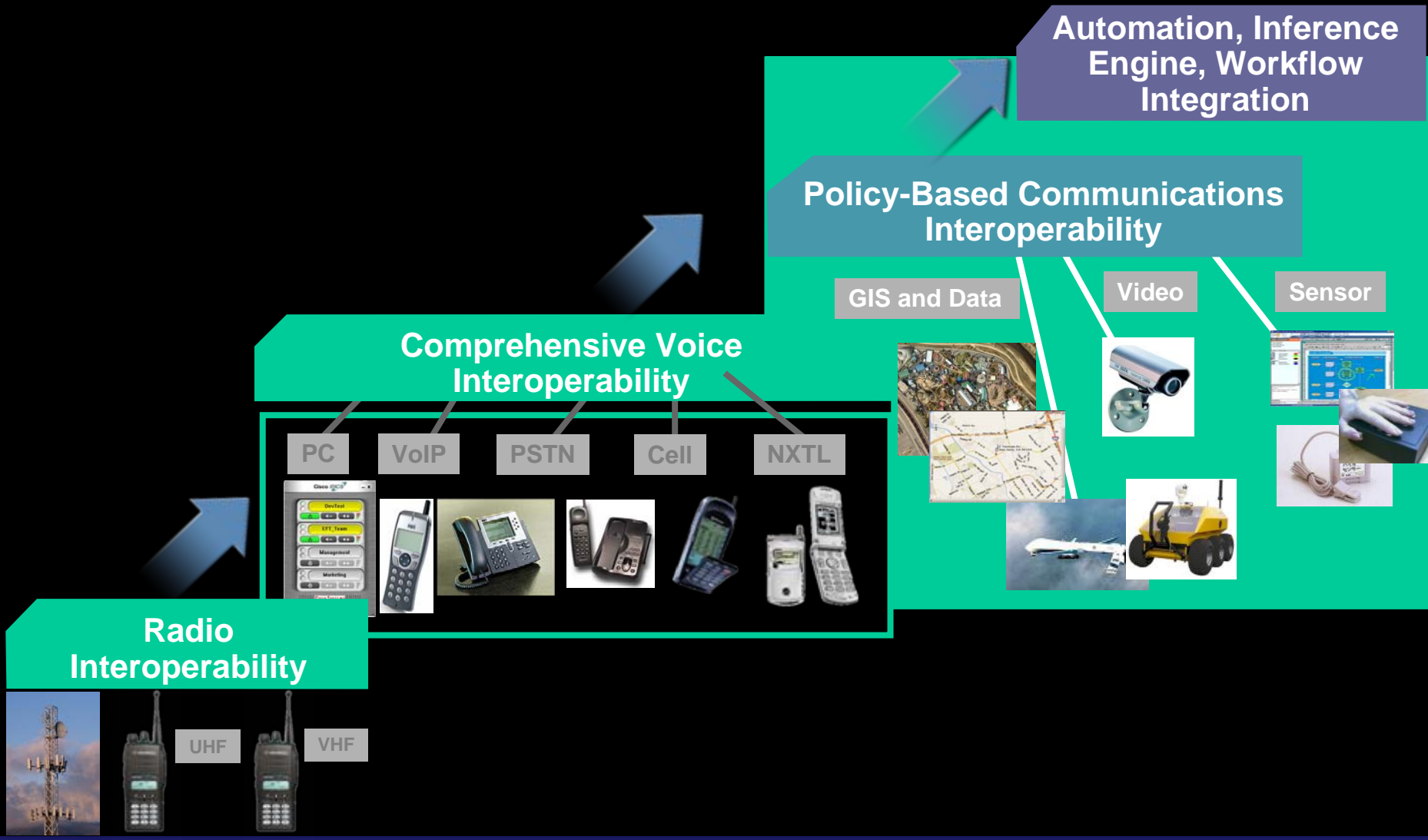
SPM/IPICS Architecture



- **Data combined with knowledge creates valuable information.**
- **IP Interoperability & Collaboration System (IPICS)/ Sensor Policy Manager (SPM) for communicating**
 - ❖ **the right information**
 - ❖ **in the right format,**
 - ❖ **to the right person,**
 - ❖ **at the right time****using diverse sensor/communication networks.**

A logical extension of the Skype, Wikipedia, IM, YouTube, and email-based technology work culture of today...

What does SPM/IPICS Enable?



□ IPICS/SPM

- ❖ Sensors are cheap. People add value.
- ❖ Human in the loop confirms decisions- experts establish alert criteria.
- ❖ But all data is available for review- experts can subscribe to data channels
- ❖ Decisions and data can be reviewed anywhere at anytime
- ❖ Flexible use of experts only at critical events.

□ Available Today

- ❖ QRI – Quantum Resonance Interferometry
- ❖ IPICS
- ❖ SPM
 - Video adaptors (2.1 to 5.1 megapixel)
 - GPS adaptor
 - Chemical adaptor (O_2 , CO_2 , methane)
 - Bio adaptor (PCR)
- ❖ Custom SPM sensor adaptors within 72 hrs.

□ Coming Soon

- ❖ Mobile Access Router (PC104 form factor) with video streaming.