

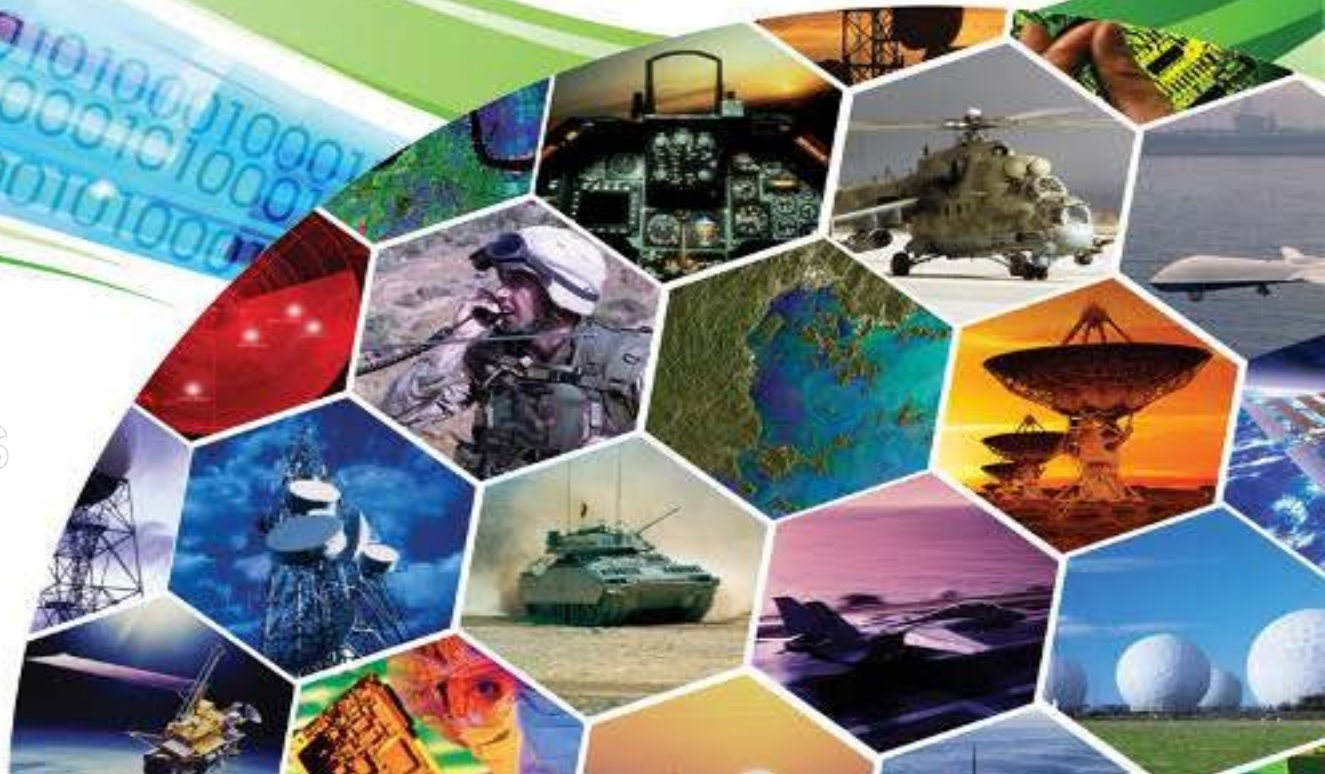
# VRT: VITA 49 Radio Transport Protocol Objectives, Overview, and Applications

**Embedded Tech Trends**

January 2016

*Rodger H. Hosking*

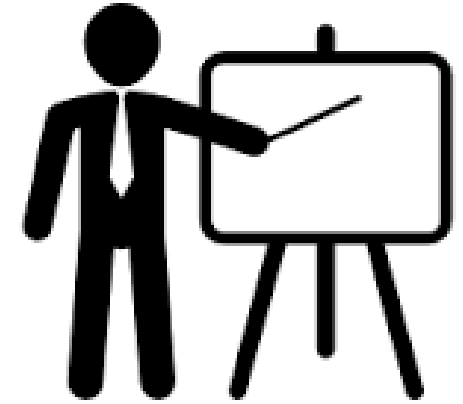
*Pentek, Inc.*





# VITA 49 Topics

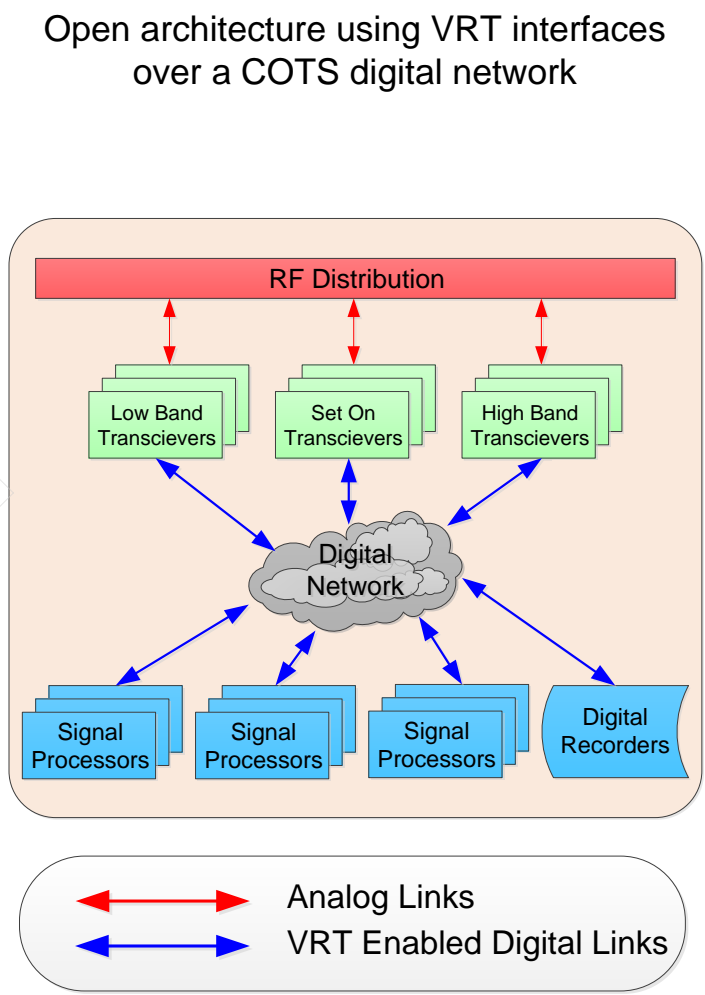
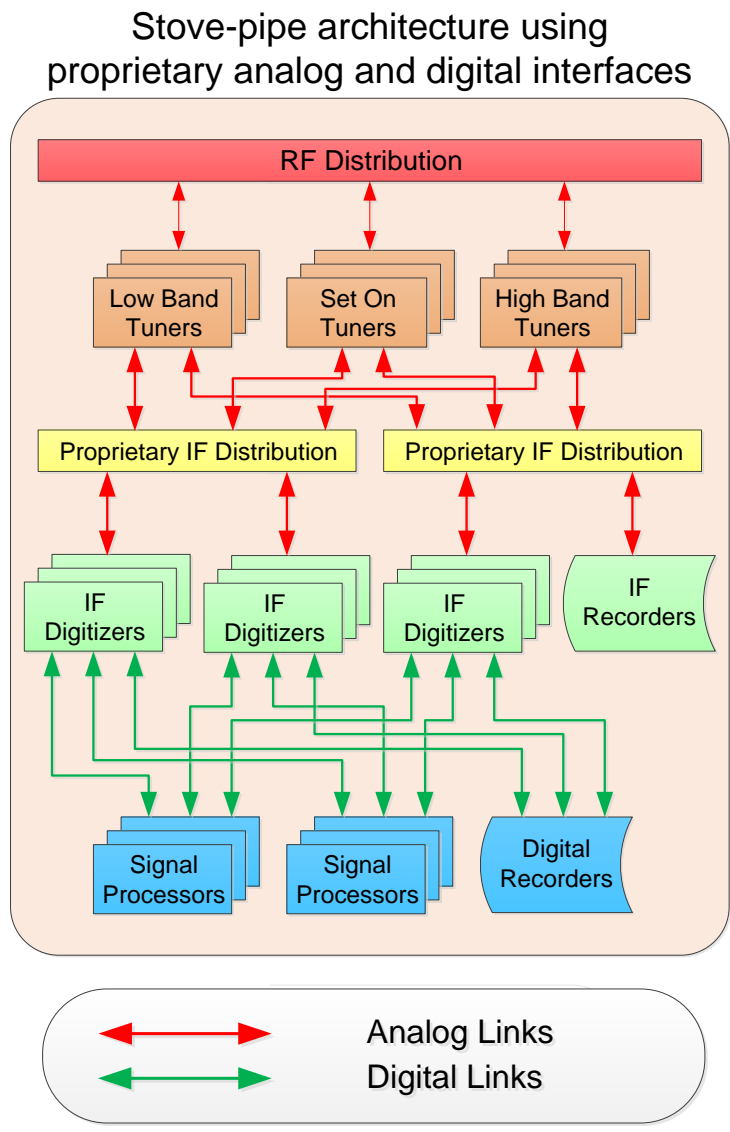
- VITA 49.0 Overview
- VITA 49.2 Overview
- VITA 49A: Spectrum Survey Interoperability
- JOASI: Joint Open Architecture Spectrum Infrastructure
- Applications
- Customer and Vendor Benefits
- Working Group Members and History





# VITA 49: Rationale and Methodology

- Traditional radios used stovepipe architectures
  - Application specific, custom **analog** RF and IF signal cabling & switching
  - Proprietary digital links and switches
  - Each system was dedicated to a specific radio application
  
- VITA 49 – VRT
  - Flexible RF transceivers deliver and accept **digitized** signals using a standardized packet protocol
  - Switching, routing and distribution is done across a COTS digital network
  - Metadata, control, and status packets are linked to the digital signal packets
  - Configurable for a wide range of applications using the same hardware





# VITA 49: VRT - VITA Radio Transport Protocol

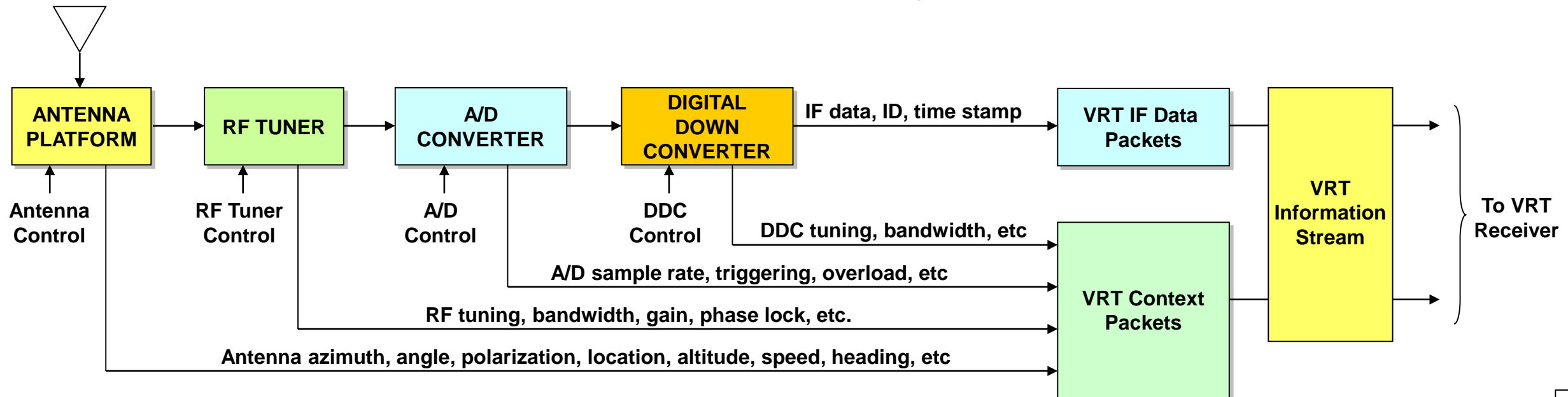
- Transport-layer protocol designed for radio equipment interoperability
  - Standardization of digitized signal sample streams for software radio systems
  - Standardization of metadata transport between system elements
  - Enhancements for transmitters, control functions, status monitoring, and event triggering
- Target Applications
  - Spectral Monitoring and Scanning
  - SIGINT and Tactical Systems
  - Communications and COMINT
  - Radar and EW Countermeasures
  - Direction Finding and Geolocation
  - Adaptive Spectrum Management
  - Cognitive Radio





# VITA 49.0 – VITA Radio Transport Protocol

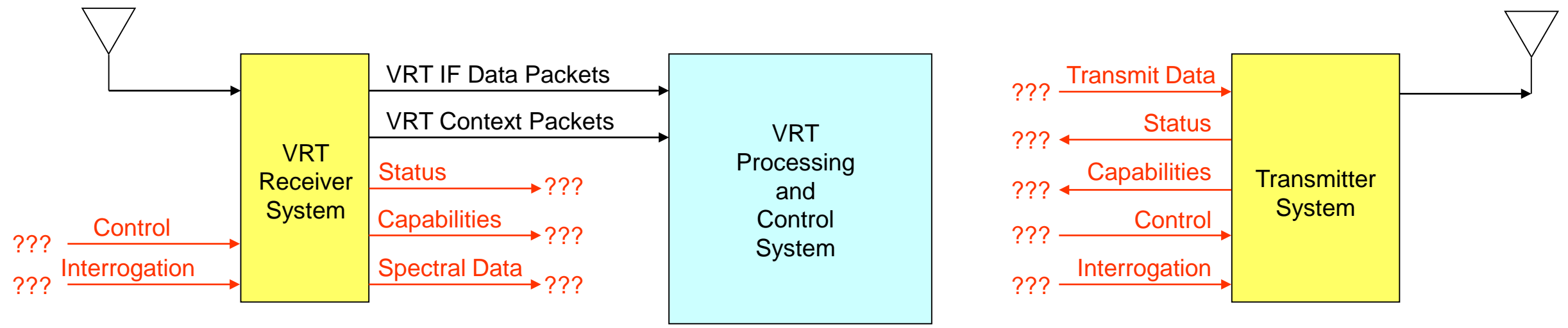
- VRT IF Data Packets contain payload data, time stamp, channel and signal ID
  - Flexible data formats and support for extremely precise time stamping
- Operational control parameters are delivered by traditional custom control interfaces
- VRT Context Packets report all operational parameter values of the radio equipment
  - Standardized methodology for a wide range of standard and unique parameters
- VRT Information Stream contains Signal Data Packets and Context Packets
  - VRT Receiver associates data and context streams appropriately for different applications
- Same radio hardware can be used for a wide range of applications





# VITA 49.0 – A Good Start, but.....

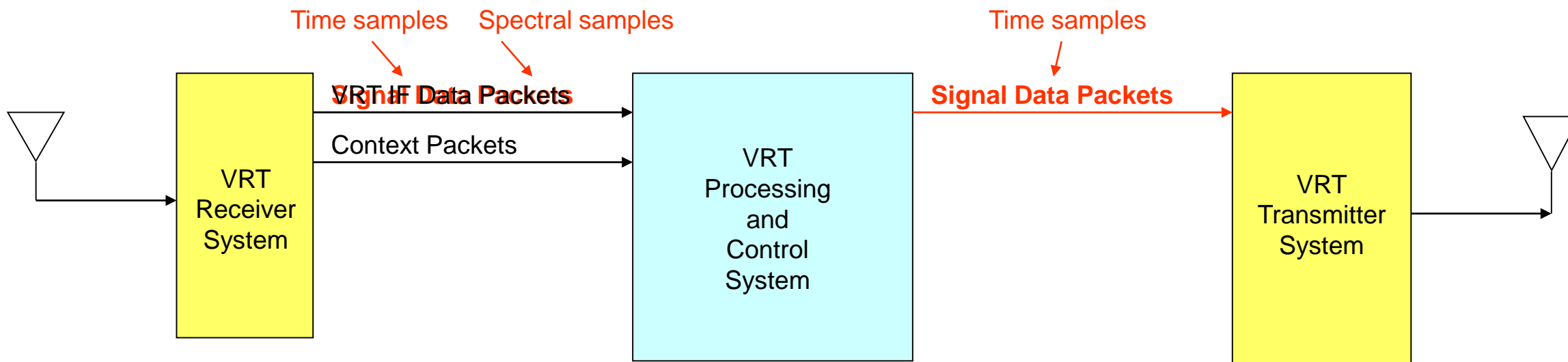
- Radio functions not supported in VITA 49.0
  - No support for transmitters or transmit data - only receivers
  - No control of radio equipment – tuning, scanning, bandwidth, antenna position, gain, etc.
  - No interrogation of radio equipment – operational status, capabilities, system health, etc.
  - No support for sending spectral data – only time samples
- In virtually every system, many of these unsupported functions must be accommodated
  - Traditional approach is proprietary controllers, interfaces, and protocols
  - Rationale for extending VITA 49.0 to 49.2





# VITA 49.2 – New Signal Data Packets

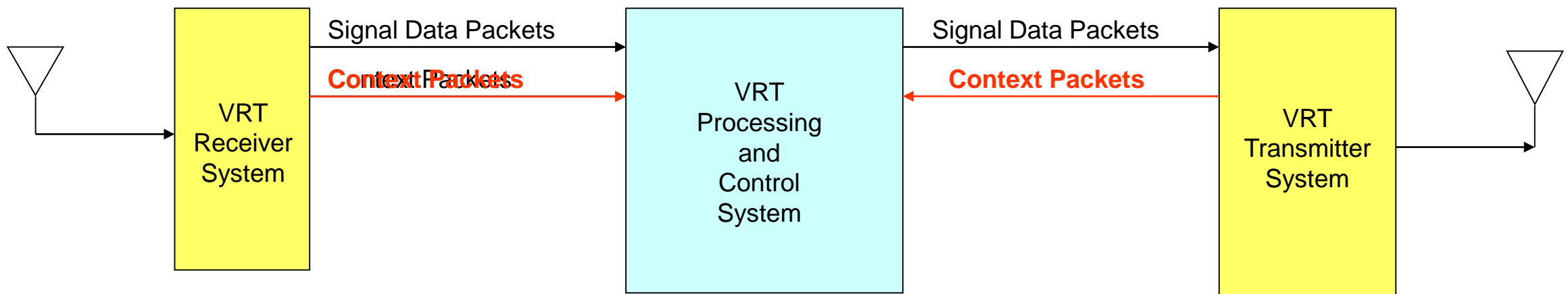
- Signal Data Packets – More Functions
  - “IF Data Packets” in VITA 49.0 are now called **Signal Data Packets**
  - Signal Data Packets support digitized RF, IF and Baseband signals – not just IF
  - Full backwards compatibility with VITA 49.0
  - Receivers can also use Signal Data Packets to deliver spectral data for spectral survey
- Signal Data Packets can now be sent to transmitters
  - Contains waveform signal data for transmission
  - Contains time stamp to specify **precisely when** the signal is scheduled for transmission





# VITA 49.2 – Adds New Context Packets

- Original VITA 49.0 Receiver Context Packet Descriptors
  - 1-D Pointing Angle, ADC Sample Rate, Bandwidth, Frequency, GPS Coordinates, Velocity Vector, Power or Gain Settings, Reference Point, Timestamp, System Latency
- New VITA 49.2 Receiver Context Packet Descriptors
  - 2-D Pointing Angle, Antenna Beamwidth, Noise Figure, Phase, Polarization, Relative Time Stamp, Scan Control, Signal-to-Noise Ratio (SNR), Waveform Type
  - Backward compatible with 49.0
- New VITA 49.2 Context Packet for Transmitters
  - Allows transmitters and other equipment to report status, capabilities and operating modes

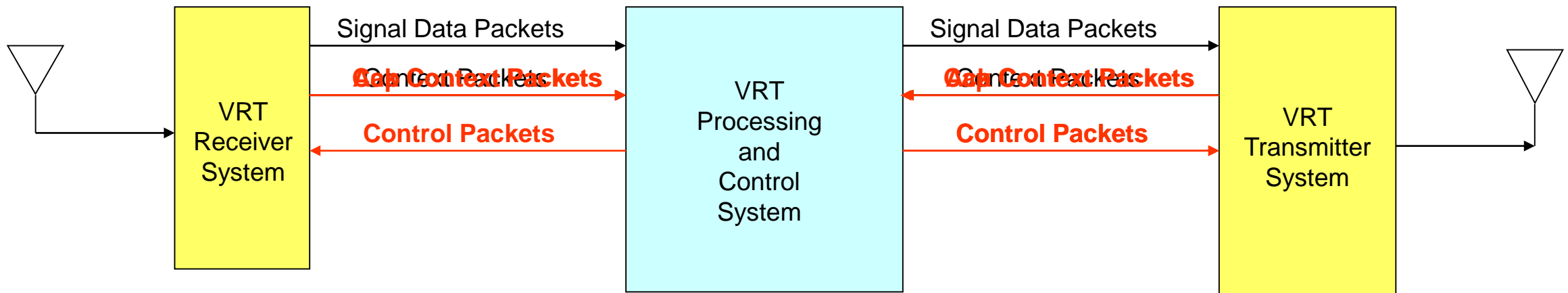






# VITA 49.2 – Control Packets

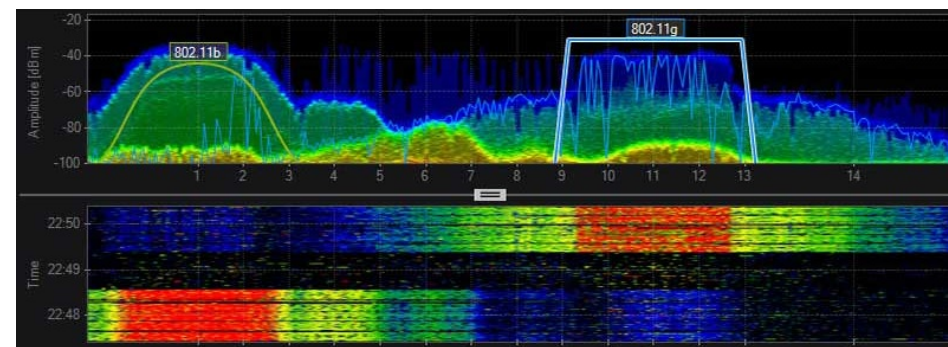
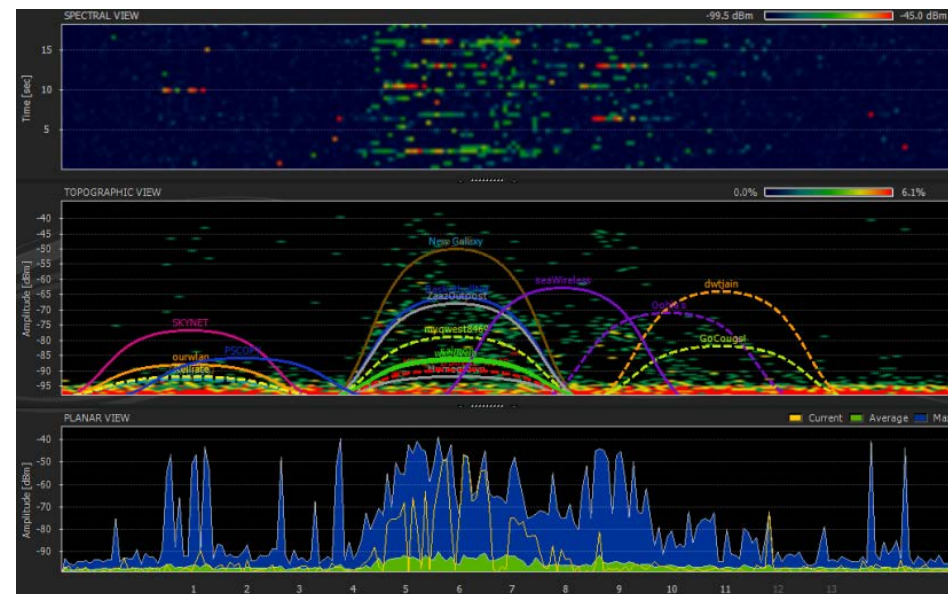
- VITA 49.2 adds **Control Packets** – not part of VITA 49.0
- Allows control of receiver and transmitters
- Uses the same fields as the Context Packet
  - Now these parameter field values are used to control the equipment
  - Acknowledgement of accepted commands are returned via ACK Context Packets
- Control packets can also interrogate devices to respond with their capabilities
  - Response is made with a Capabilities Context Packet (e.g., what is your range of tuning frequency?)
- Control packets can set up scanning modes, event triggers, and looping modes
  - High level commands help minimize control traffic for typical operations





# VITA 49A Spectrum Survey Interoperability Specification

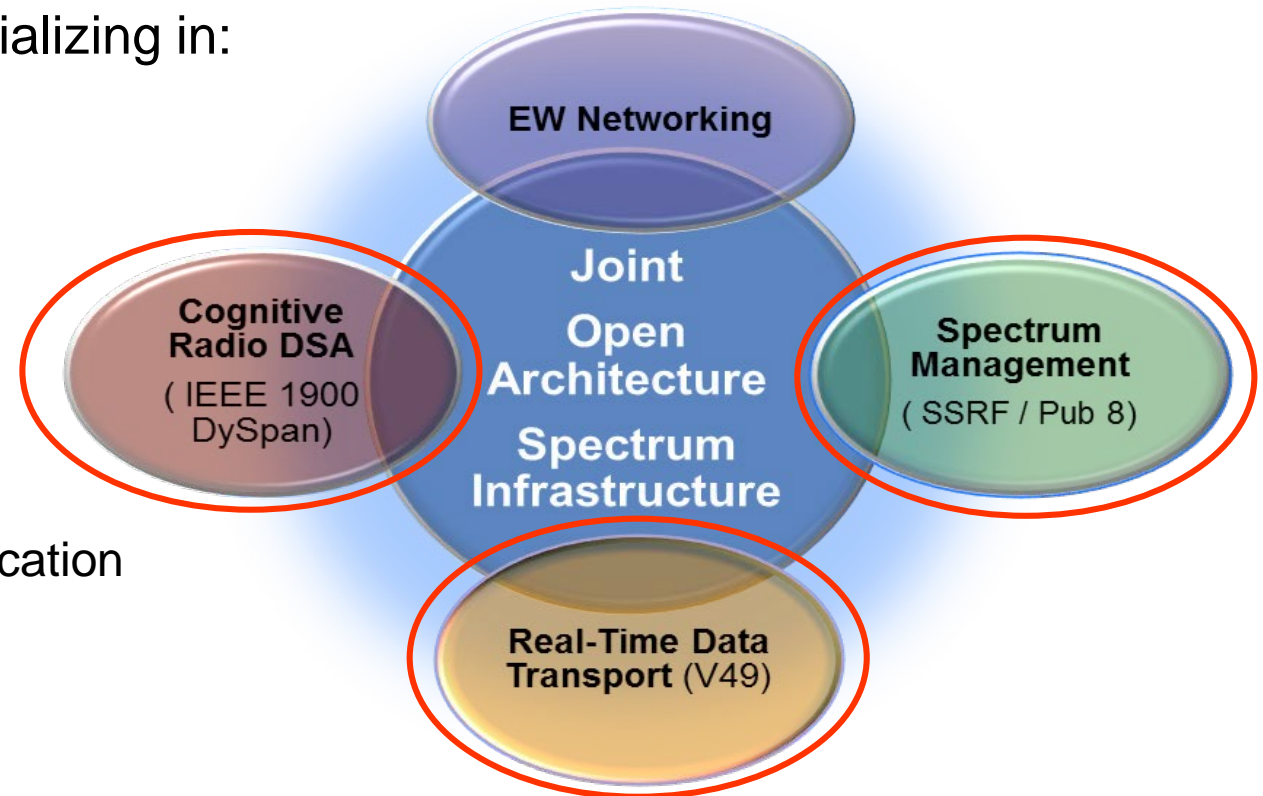
- Lightweight Subset of VITA 49 features optimized for spectrum survey applications
  - Emphasis on high-throughput, adaptable processing
  - Large-scale, network-connected environment
  - Compliance enhances vendor interoperability
- Data packets are optimized for processing efficiency
  - Defines a new Standard Data Packet
  - Optimized for 32/64 bit GPPs and FPGAs
  - Only fixed point data samples are permitted
  - Data samples aligned uniformly within each 32-bit word
  - Each packet must contain data with no event changes
  - Number of data words must be a multiple of 32
- Transfers must be UDP or TCP
  - Multicast UDP is strongly preferred
- ANSI/VITA approval in August 2015





# JOASI: Joint Open Architecture Spectrum Infrastructure

- Initiated by the Office of Naval Research (ONR)
- Objective: an integrated set of spectrum standards for efficient, cooperative, and non-interfering use of the electromagnetic spectrum domain
- Supports system commands, status, capabilities, observations, and policies for actionable intelligence during battle operations
- Team of 11 industry experts selected specializing in:
  - Communication systems
  - Electronic Warfare (EW) systems
  - RF Spectrum Standards (including Pentek)
- JOASI incorporates and integrates the most appropriate existing standards
  - IEEE 1900 DySpan: Cognitive Radio Dynamic Spectrum Allocation
  - SSRF Pub 8: Spectrum Management
  - VITA 49 Real Time Data Transport





# Product Example: VITA 49 Software Radio XMC Module

## ■ Customer Application

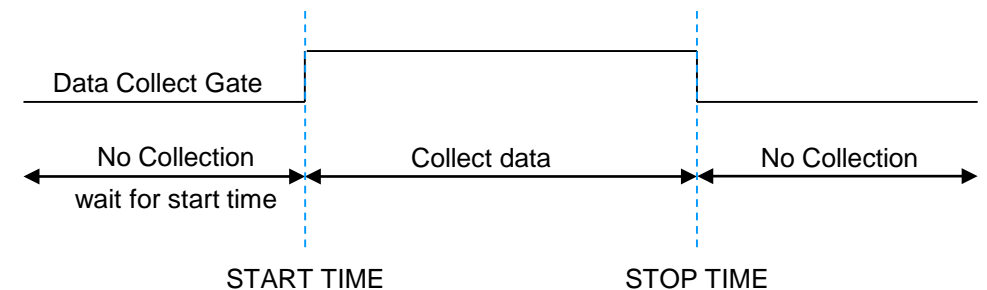
- Modification of Pentek 71661 Quad 200 MHz A/D and DDC XMC module
- Collect precisely timed blocks of A/D and DDC data
- Data to be delivered as packets across PCIe

## ■ Requirements

- Flexible programming of timing specifications for each collected block
- All timing and sampling synchronized to GPS time and frequency reference
- Start/Stop Timing resolution of 1 sample clock for each block
- Data packets need payload data and precise time stamps
- Data packets also need source identifiers (ID, channel no, customer supplied data)

## ■ Pentek Proposed VITA 49.0 Protocol to Customer for Data Delivery

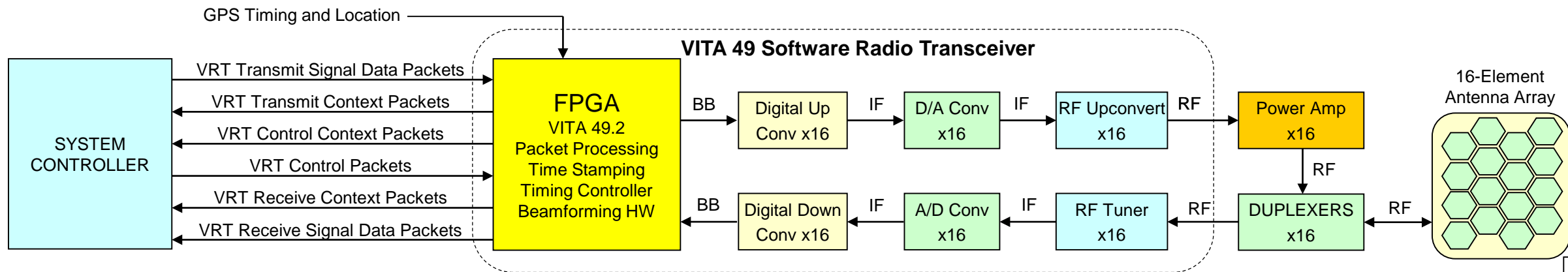
- VITA 49 satisfied all requirements
- Readily accepted by customer
- Product Delivered January 2016
- Offers market advantage to customer and Pentek





# VITA 49 UAV Synthetic Aperture Radar

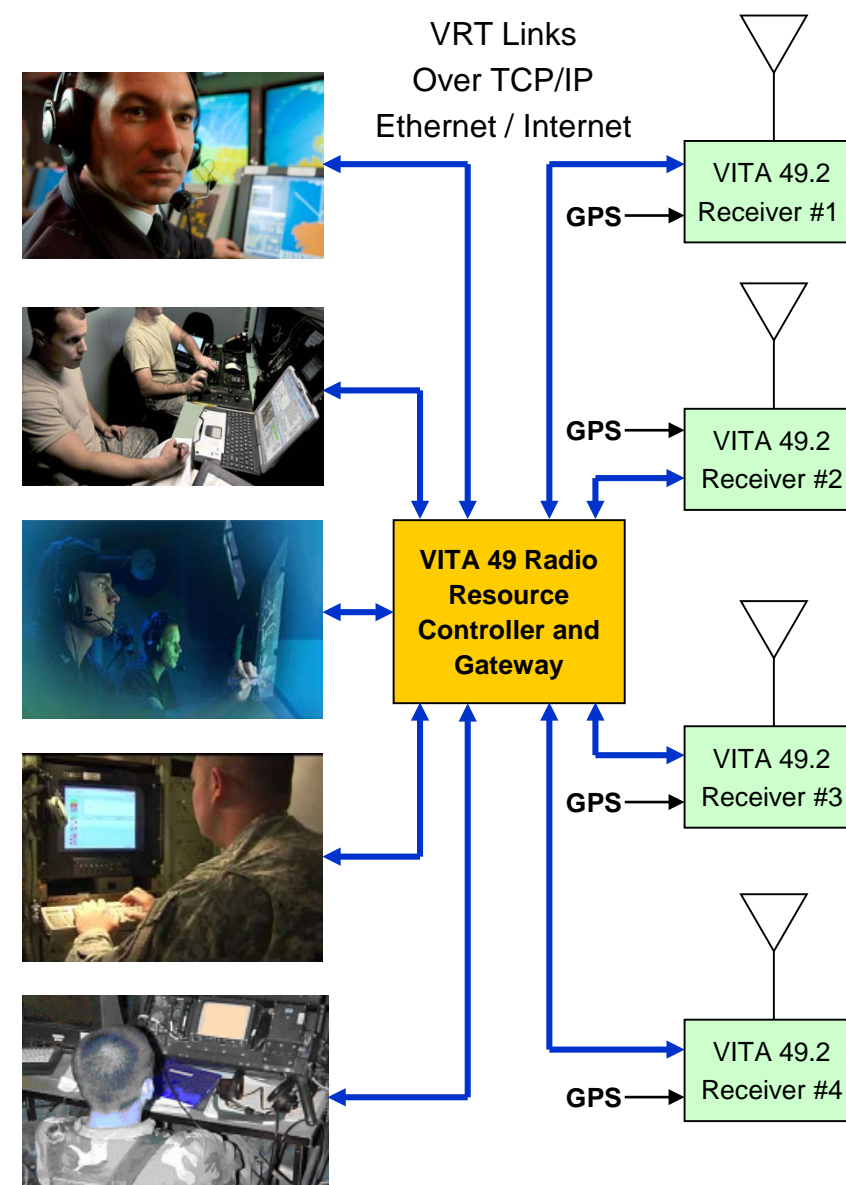
- 16-Element Synthetic Aperture Radar Antenna
  - No moving parts, extremely agile in frequency and direction, lightweight
  - Receive and transmit beam directions controlled by phase offsets applied to each element signal
- VITA 49.2 Software Radio Transceiver
  - VRT Signal Data packets deliver transmit waveforms plus transmit timestamp
  - VRT Signal Data packets return beamformed receive signals with timestamp
  - VRT Control packets deliver tuning parameters, steering angle, receive range gate, gain, etc.
  - VRT Context packets return Signal Data Context and operational status
- High-level VRT commands provide portable, flexible, but yet very precise control
  - Critical timing is performed within the FPGA, synchronized through GPS





# VITA 49 Flexible SIGINT Receiver / Beamformer

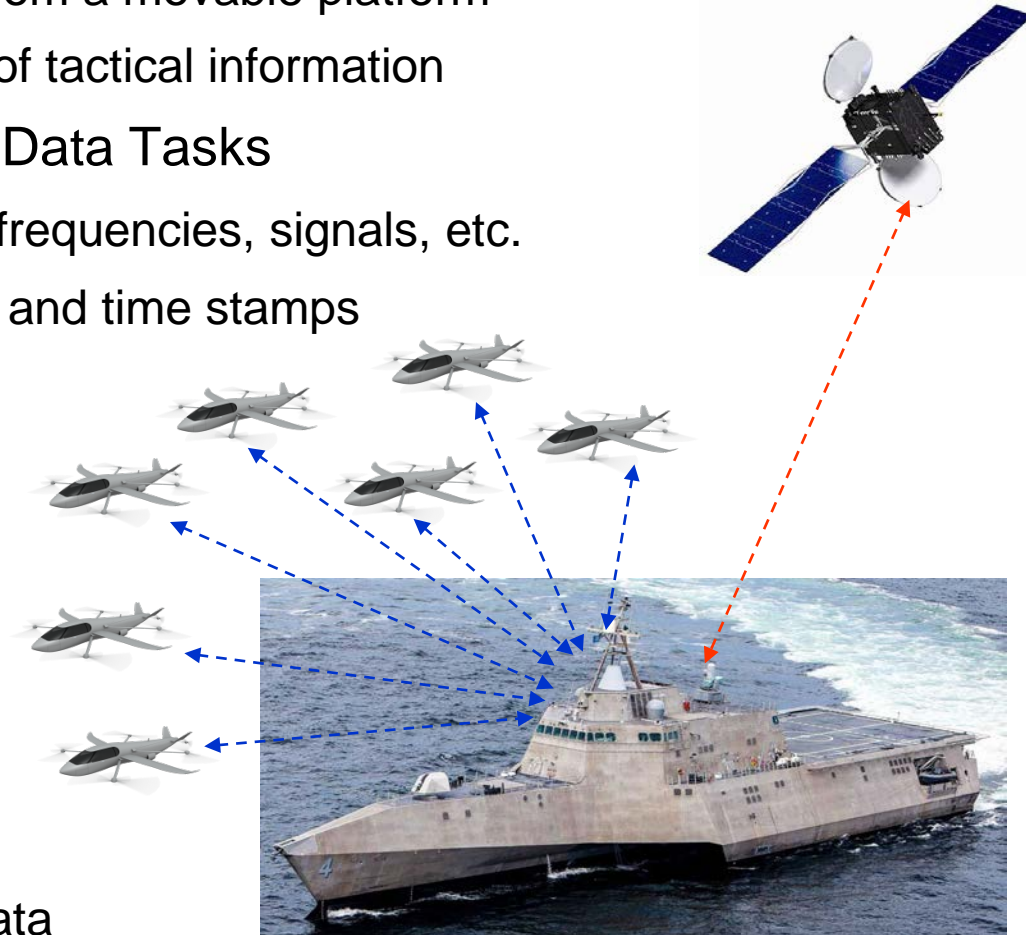
- Collection of VITA 49.2 Radio Receivers
  - Same or different frequencies, bandwidths, capabilities
  - Locations can be the same, in an array, or remote
  - VITA 49 for control, status, and signal data packets
- Diverse Group of Users
  - Signal analysts, language translators, key word monitoring
  - Deployed units in the field gathering tactical mission information
  - Command center aggregating battlefield intelligence
- Resource Controller and Gateway
  - Connects users to radios using VITA 49 links
  - TCP/IP links across LAN, Internet, or Secure Wireless Networks
- Flexible Modes
  - Each user can request signals of interest from each receiver
  - Receivers can be coordinated for beamforming operations
    - Direction Finding, Diversity Reception, Beam Steering
  - Shared common hardware for diverse applications





# US Navy Tactically Exploited Reconnaissance Node (TERN)

- \$93M DARPA Contract Awarded to Northrop Grumman December 2015
  - Smaller Navy ships will host a large fleet of drones for reconnaissance and surveillance
  - Littoral Combat Ships can get close to shorelines, straits, and shallow water
  - Vertical takeoff & landing UAVs handle strategic missions from a movable platform
  - Lowers the cost for greatly expanding worldwide collection of tactical information
- VITA 49 Offers Ideal Solution for Managing Control and Data Tasks
  - Each UAV needs mission directives: antenna scan angles, frequencies, signals, etc.
  - Each UAV delivers received signal packets with context, ID and time stamps
  - Shipborne systems manage the UAV fleet over radio links
  - On-board analyst teams can redirect UAV missions
- SATCOM links ship to theater of operations center
  - Command center analysts can aggregate information from multiple platforms to develop actionable intelligence
  - Ships can be redeployed for intensified surveillance at hot spots around the world
  - Standardized VITA 49 protocols handle radio control and data





# VITA 49: Benefits for Customers and Vendors

- **Standardized Signal Data and Metadata Transport**
  - Connects transceivers to signal processor
  - Wide variety of signal types and waveforms
  - Context packets identify and provide rich details about each signal
  - Allows multiplexing of multiple signals across a single link
- **Flexibility**
  - Scalability from one channel to multiple channels
  - Common hardware allows reconfigurable architectures
  - Flexible connections between transceivers and users
- **High-Precision Timestamping**
  - Correlation and synchronization of data across channels and sites
  - Beamforming, direction finding, TDOA, recording, array processing
- **Control, Status and Monitoring of Radio Systems**
- **Wide Range of Applications**
  - Radar, Comms, SIGINT, SATCOM, Surveillance
  - Electronic Warfare & Countermeasures







# VITA 49: Members, History and Looking Forward

- The most successful standards groups have members from government, universities and industry
- Current VITA 49 Working Group Members
  - Government
    - Army CERDEC, Kirtland AFB, Maryland Procurement Office, US Naval Research Lab
  - University
    - Georgia Tech, Johns Hopkins Applied Physics Lab, MIT Lincoln Labs, Penn State
  - Industry
    - DRS SS, DRTI, Eclipse, ELMA, GD AIS, Harris GCSD, Mercury, NGC ES, Pentek
- History
  - VITA 49 VSO working group formed in 2004
  - VITA 49.0 ANSI/VITA Approved May 2009, Updated May 2015
  - VITA 49.1 ANSI/VITA Packet Encapsulation Approved May 2015
  - VITA 49A ANSI/VITA Spectral Survey Approved August 2015
  - VITA 49.2 Draft Under Review Now
- Standards Available at: [www.vita.com](http://www.vita.com)