

PENTEK

*Setting the Standard for Real-Time
Digital Signal Processing*

VITA 49 Radio Transport: The New Software Radio Protocol

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WinnComm 2017





VITA 49 Topics

- Rationale and Methodology
- VITA 49.0 Overview
- VITA 49.2 Overview
- Working Group Members and History
- Programs Adopting VITA 49
- Applications
- Customer and Vendor Benefits





VITA 49: Rationale and Methodology

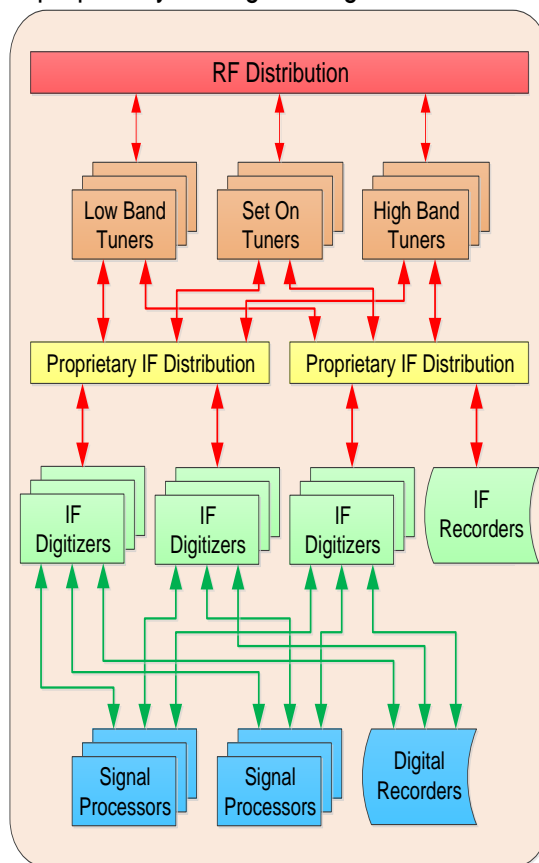
■ Traditional radios used stovepipe architectures

- 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

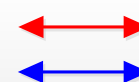
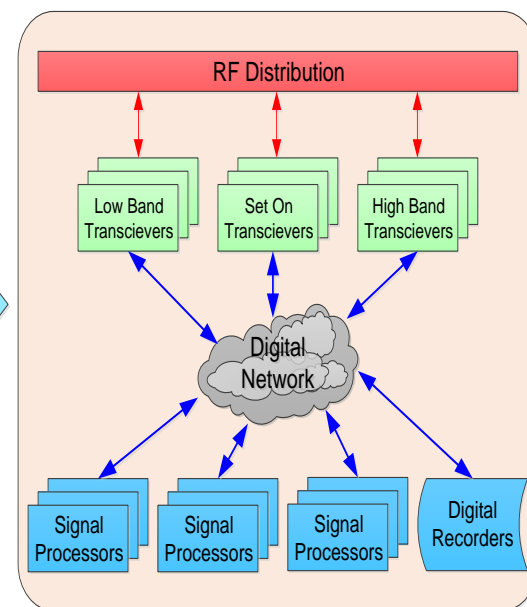
- Flexible RF transceivers deliver and accept **digitized** signals using a standardized packet protocol
- Switching, routing and distribution is done across a COTS digital network
- Metadata, control, and status packets are linked to the digital signal packets
- Configurable for a wide range of applications using the same hardware

Stove-pipe architecture using proprietary analog and digital interfaces



Analog Links
Digital Links

Open architecture using VRT interfaces over a COTS digital network



Analog Links
VRT Enabled Digital Links



VITA 49: VRT - VITA Radio Transport Protocol

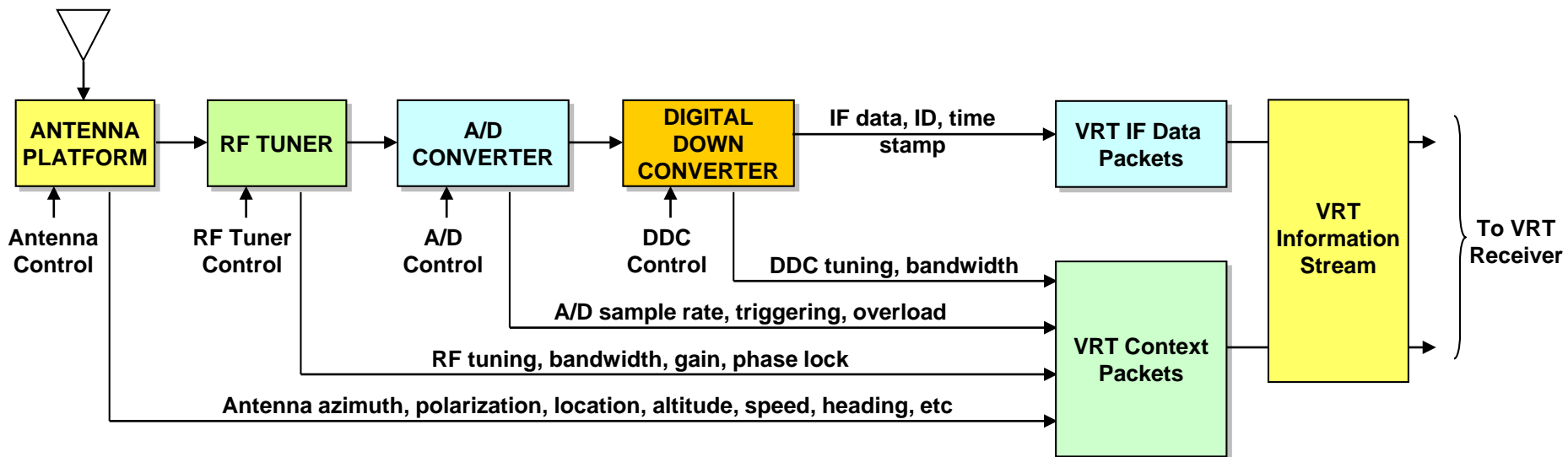
- Transport-layer protocol designed for radio equipment interoperability
 - Standardization of digitized signal sample streams
 - Standardization of metadata transport between system elements
 - Enhancements for transmitters, control functions, status monitoring, and event triggering
- Target Applications
 - 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

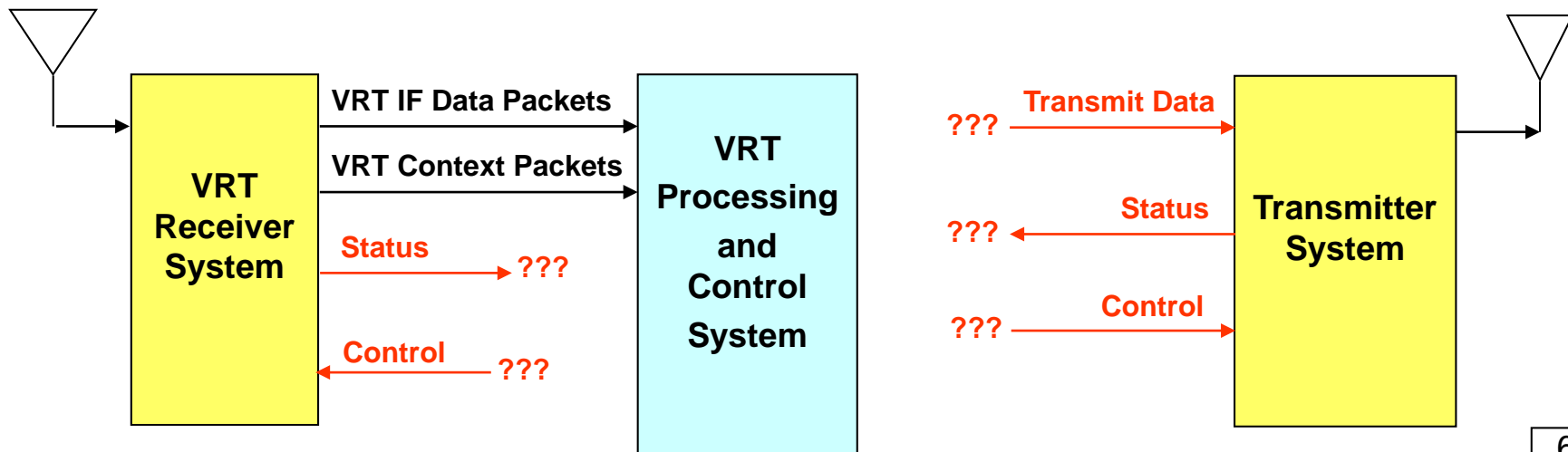
- VRT IF Data Packets contain payload data, time stamp, channel and signal ID
 - Flexible data formats and support for extremely precise time stamping
- Operational parameters are delivered across traditional control interfaces
- VRT Context Packets report all operational parameters of the radio equipment
 - 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 diverse range of applications





VITA 49.0 – A Good Start, but.....

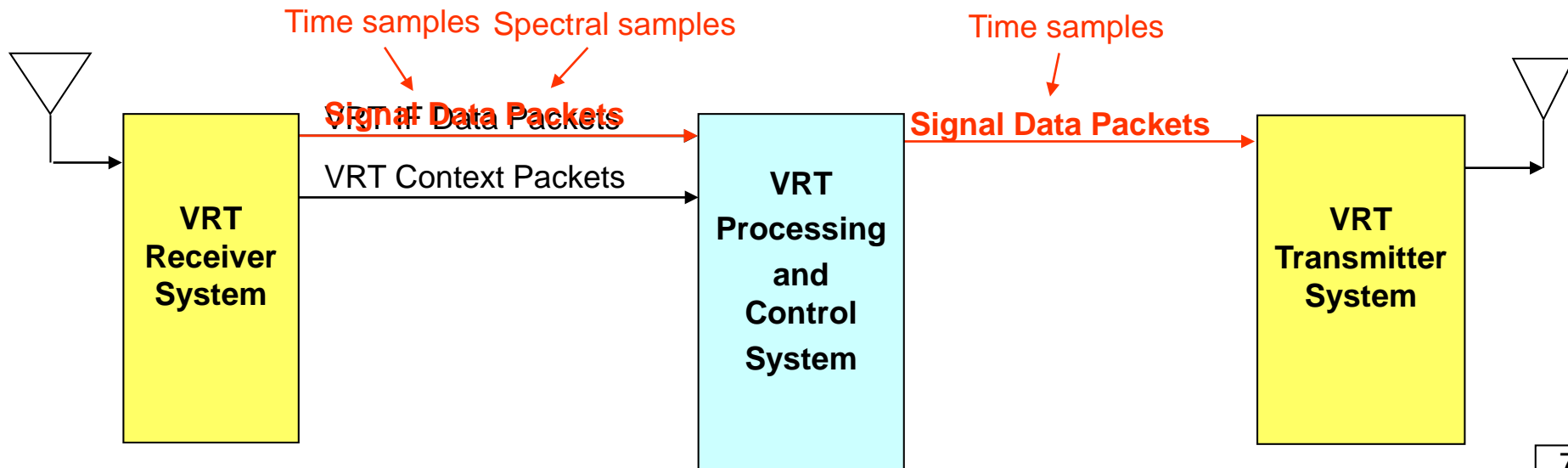
- Radio functions not supported in VITA 49.0
 - No support for transmitters or transmit data - only receivers
 - No control of radio equipment – tuning, scanning, bandwidth, antenna angle
 - No interrogation of radio equipment – operational status, health
 - In virtually every system, most of these unsupported functions must be accommodated somehow
 - Traditional approach is proprietary controllers, interfaces, and protocols
- ➔ • Rationale for extending VITA 49.0 to 49.2





VITA 49.2 – New Signal Data Packets

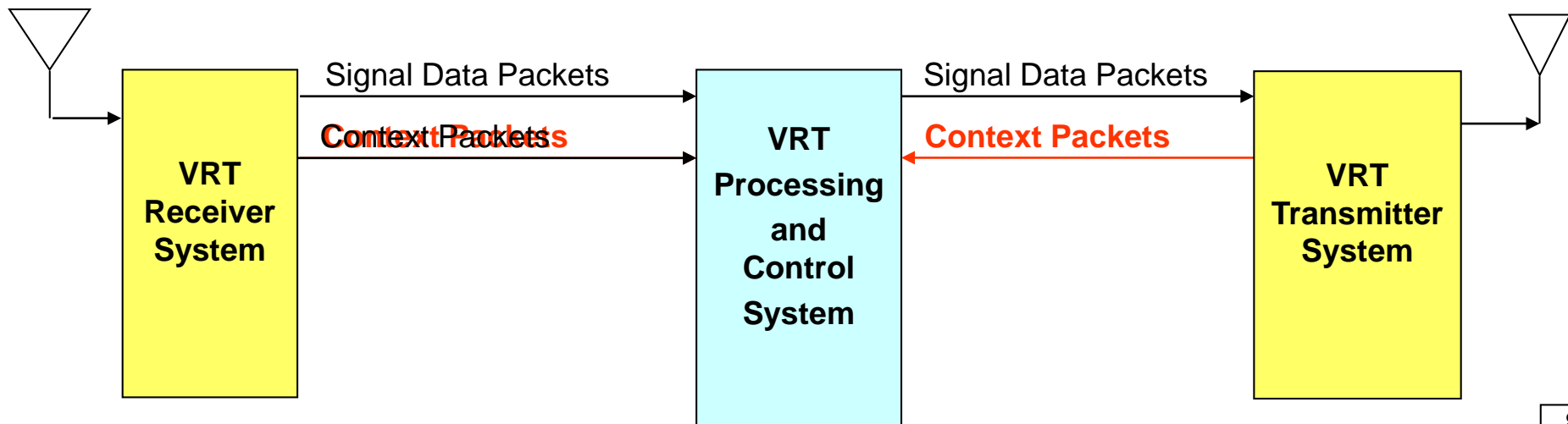
- Signal Data Packets – More Functions
 - Old “IF Data Packets” in VITA 49.0 are now called **Signal Data Packets**
 - Signal Data Packets support digitized RF, IF and Baseband signals – not just IF
 - Full backwards compatibility with VITA 49.0
 - Receivers can use Signal Data Packets for spectral data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





VITA 49.2 – Adds New Context Packets

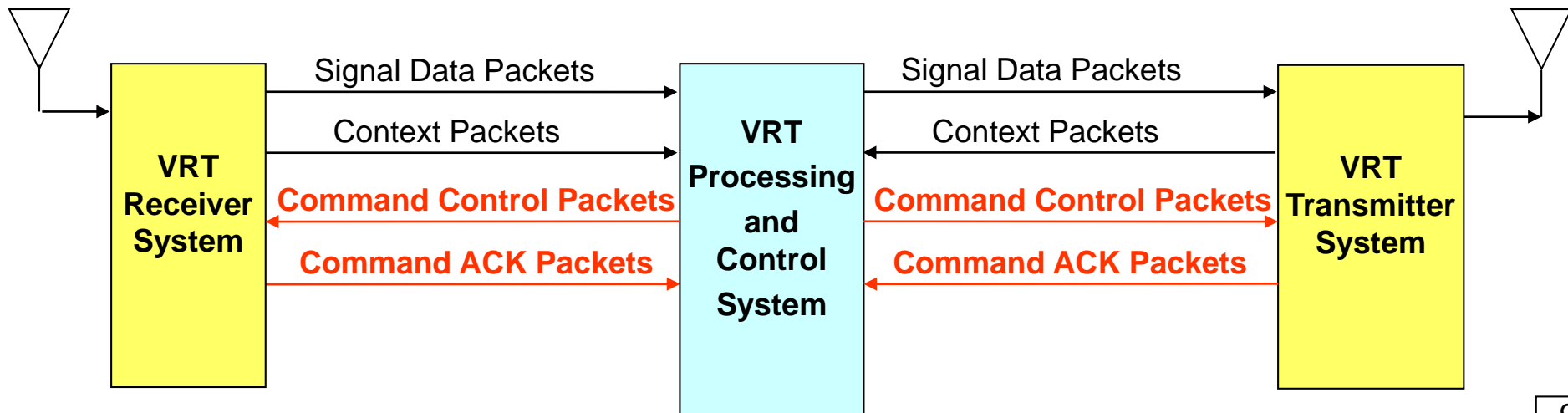
- Original VITA 49.0 Receiver Context Packet Descriptors
 - 1-D Pointing Angle, ADC Sample Rate, Bandwidth, Frequency, GPS Coordinates, Velocity Vector, Power or Gain Settings, Reference Point, etc.
- New VITA 49.2 Receiver Context Packet Descriptors
 - Adds 2-D Pointing Angle, Antenna Beamwidth, Noise Figure, Phase, Polarization, Relative Time Stamp, Scan Control, Signal-to-Noise Ratio, ADCs & DACs, Amplifiers, Decoders, Demodulators, Channelizers, etc.
- New VITA 49.2 Context Packet for Transmitters
 - Allows transmitters and other equipment to report status, operational parameters, and operating modes





VITA 49.2 – Command Packets

- VITA 49.2 adds **Command Packets** – not part of VITA 49.0
- Command Control Packets
 - Send operational parameters to control the receiver and transmitter
 - Time stamp defines the precise execution time of control parameters
- Command Acknowledgement Packets
 - Reports the success or failure of each Command Control Packet
- High level commands help minimize control traffic for typical operations
 - Can program and verify all programmable parameters
 - Precisely timed scan modes, event triggers, and looping modes





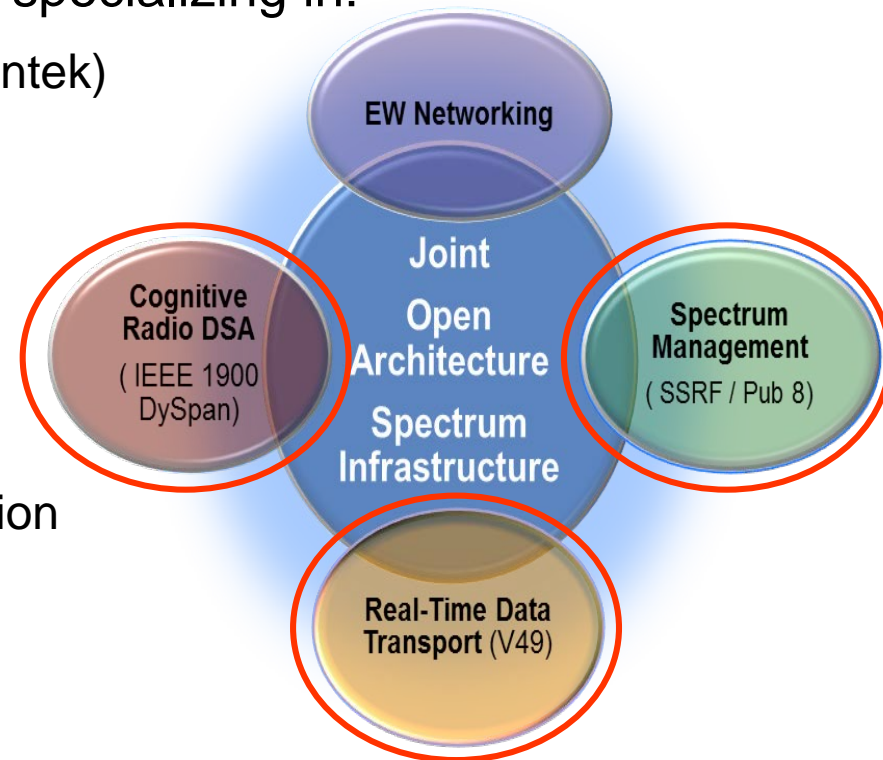
VITA 49: Members and History

- The most successful standards groups have members from government, universities and industry
- Current VITA 49 Working Group Members
 - Government
 - Army CERDEC, ONR, Kirtland AFB, MPO, NRL, Navy SPAWAR
 - University
 - Georgia Tech, Johns Hopkins Applied Physics Lab, MIT Lincoln Labs
 - Industry
 - GD AIS, Pentek, BAE EI&S, Harris GCSD, Boeing, NGC ES
 - Pentek is very active and responsible for major contributions to the original standard
- 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 ANSI/VITA Specification Approved May 2017



Joint Open Architecture Spectrum Infrastructure

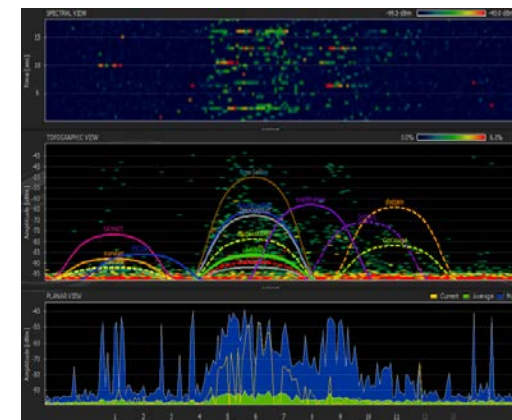
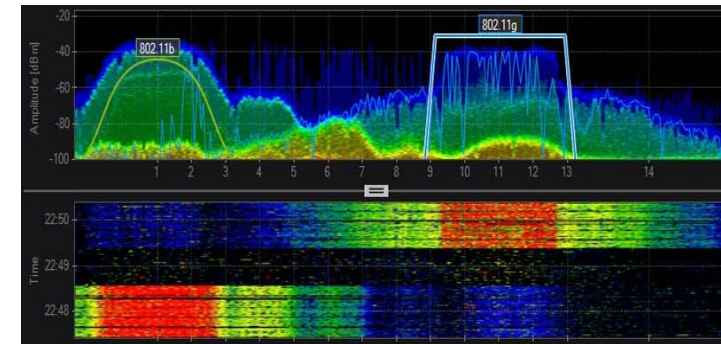
- JOASI: Initiated by the Office of Naval Research (ONR)
- Objective: an integrated set of spectrum standards for efficient, cooperative, and non-interfering use of the electromagnetic spectrum
Supports system commands, status, capabilities, observations, and policies for actionable intelligence during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





VITA 49A Spectrum Survey Interoperability

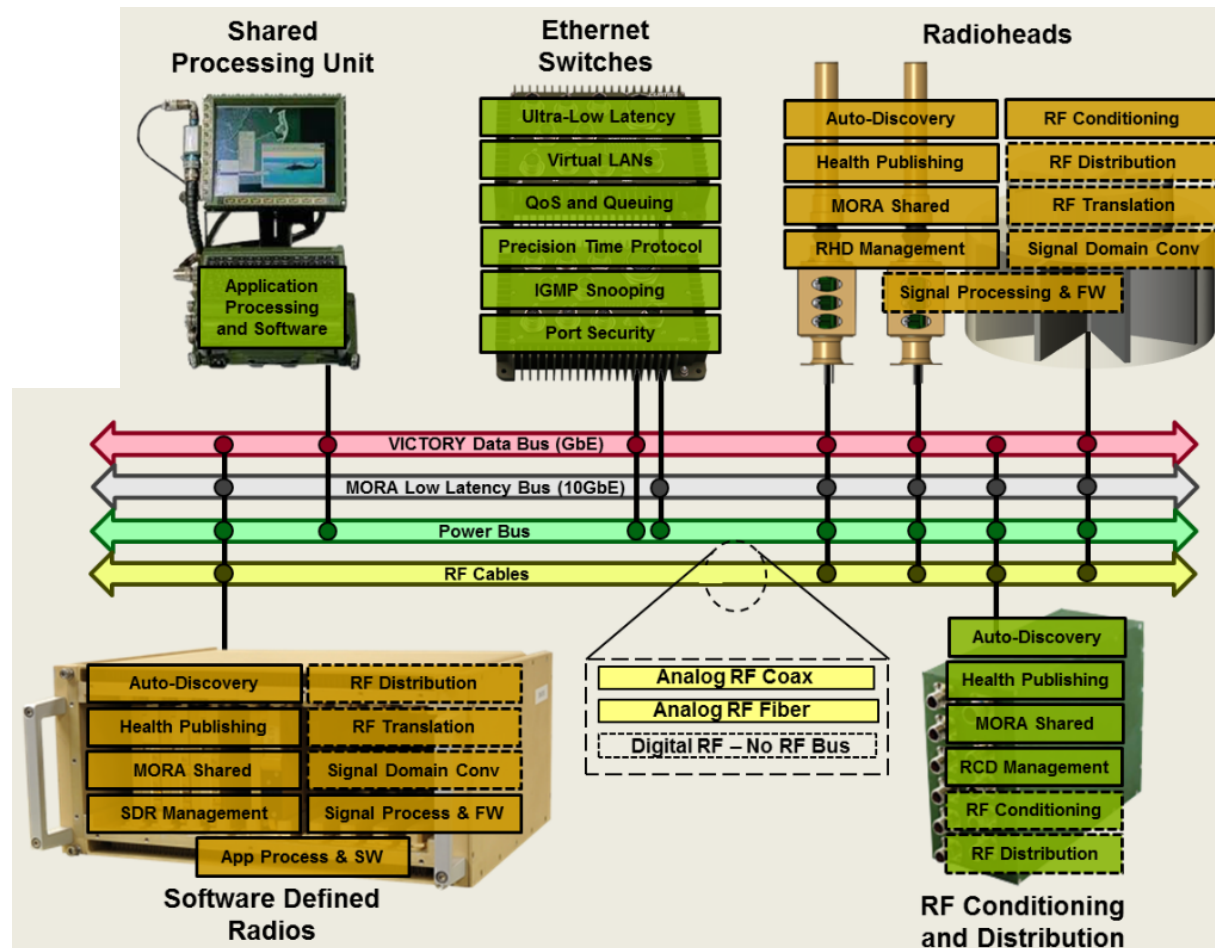
- Lightweight Subset of VITA 49 features optimized for spectrum survey applications
 - Emphasis on high-throughput, adaptable processing
 - Large-scale, network-connected environment
 - Compliance enhances vendor interoperability
- Data packets are optimized for signal processing efficiency
 - Optimized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





MORA: Modular Open RF Architecture

- U.S. Army CERDEC Initiative for C4ISR and EW Systems
 - Use common hardware platform for multiple application systems
 - Exploit open architectures and standards
 - Reduce SWaP
 - Software reconfigurable
 - Network connected
 - Ease new tech insertion
- Standards Adopted
 - OpenVPX
 - Victory Radio Bus
 - Ethernet Switches
- VITA 49.2 Role
 - Replace coaxial cable RF signal distribution with digital VRT packets
 - Flexible, fast, extensible
 - More reliable than RF cables and connectors

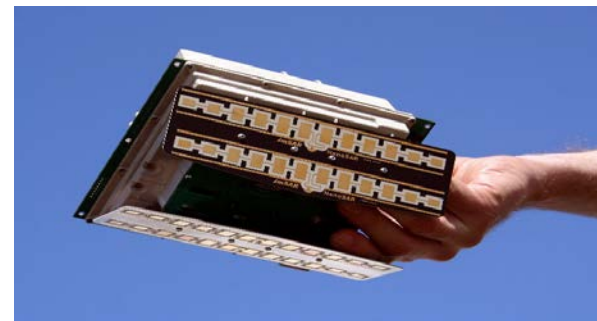




VITA 49.2 UAV Synthetic Aperture Radar

■ 16-Element Synthetic Aperture Radar Antenna

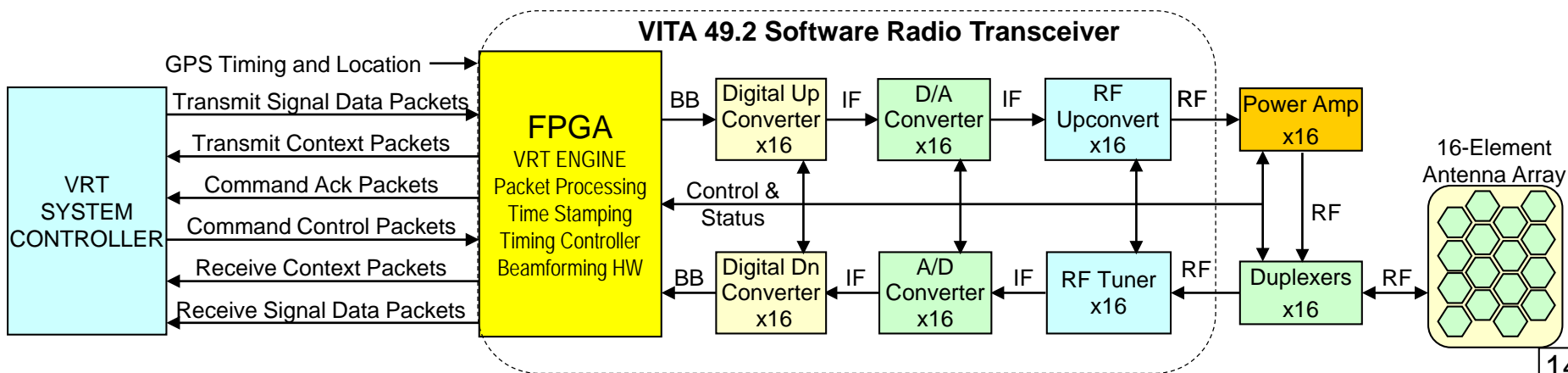
- No moving parts, extremely agile in frequency and direction
- Receive and transmit beam directions controlled by phase offsets applied to each element signal



■ VITA 49.2 Software Radio Transceiver

- Signal Data packets deliver transmit waveforms plus transmit timestamp
- Signal Data packets return beamformed receive signals with timestamp
- Receive and Transmit Context packets provide metadata
- Command control packets send tuning parameters, ant. angle, receive range gate, etc.
- Command ACK packets confirm control execution and operational status
- Critical timing is performed within the FPGA, synchronized through GPS

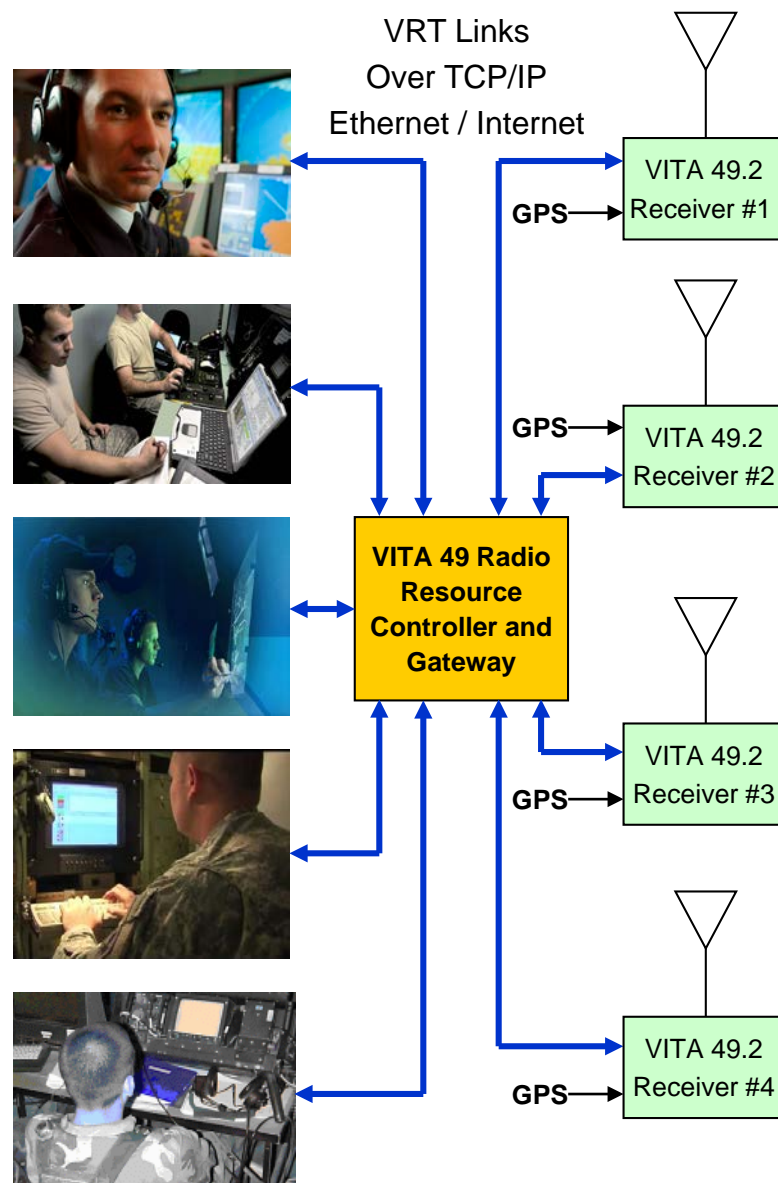
■ High-level VRT commands provide portable, flexible, but yet very precise control





VITA 49.2 Flexible SIGINT Receiver

- Collection of VITA 49.2 Radio Receivers
 - Same or different frequencies, BWs, capabilities
 - Single- or multi-location, one or more antennas
 - VITA 49 handles control, status, and signal data
- Diverse Group of Users
 - Signal analysts, translators, key word monitoring
 - Deployed units gathering tactical mission info
 - Command center merging battlefield intelligence
- Resource Controller and Gateway
 - Connects users to radios using VITA 49 links
 - LAN, Internet, or Secure Wireless Networks
- Flexible Modes
 - Each user can request signals from any receiver
 - Precise synchronization supports direction finding, array steering and diversity reception
 - Receivers can be coordinated for beamforming
 - Shared common hardware receiver resources support diverse applications





VITA 49 Benefits for Military Systems

- Standardized Transport for Signal Data and Metadata
 - Connects transceivers to signal processors and waveform generators
 - 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
- Standardized Control, Status and Monitoring
 - Consistent interface across platforms
- High-Precision Time Stamping & Timed Control
 - Synchronization of data and control execution across channels and sites
 - Beamforming, direction finding, TDOA, recording, phased array processing, & diversity receivers
- Flexibility
 - Scalability from one channel to multiple channels
 - Common hardware allows reconfigurable architectures
 - Flexible connections between transceivers and users





VITA 49: Increasing Customer Interest

- Wide Range of Key Applications
 - Radar & Communications
 - SIGINT, SATCOM & Surveillance
 - Electronic Warfare & Countermeasures
 - Tactical Warfighting & Reconnaissance
- Pentek Customers Are Using VITA 49 Now
 - Requirements driven by US Dept of Defense
 - General Dynamics & many Government Primes
 - Johns Hopkins APL, Naval Res Labs, & MIT LL
- VITA 49 Offers Advantages Across the Board
 - Open standard promotes collaboration: Government, Industry, & Research
 - Simplifies upgrades, reconfiguration, and new technology insertion
 - Multi-vendor competition reduces government acquisition costs
 - Standardization helps extends life cycle management





For More Information

- VITA Standards Organization (VSO)
 - www.vita.com/VITA-49
- Article “The Future of Software Radio – VITA 49”
 - www.pentek.com/pildocs/6982/pipelines/pipe252.pdf
- Pentek Model 71664 Software Radio Module
 - www.pentek.com/products/detail.cfm?model=71664
- Email
 - rodger@pentek.com

