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# VITA 49 enhances capabilities and interoperability for transporting SDR data

**Prior to the development of the VITA 49 Radio Transport (VRT) standard, each SDR receiver manufacturer developed custom and proprietary digitized data formats and meta-data formats that made interoperability of data from different receivers impossible. But now VITA 49 is aiming to solve the problem.**

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**The diversity of Software-Defined Radio (SDR) technologies continues to proliferate in modern system architectures, but the lack of a standard to convey the digitized data from the radios has made interoperability difficult. Robert presents a top-level description of the VITA 49 (VRT) standard as a solution to the interoperability dilemma, and presents an illustration using this standard for network-centric sensors.**

Prior to the development of the VITA 49 Radio Transport (VRT) standard, each SDR receiver manufacturer developed custom and proprietary digitized data formats and meta-data formats that made interoperability of data from different receivers impossible. This was problematic with respect to life-cycle support of receiver architectures, and critical with respect to correlating signal data from multiple receivers.

VITA 49, however, aims to solve this problem by providing an interoperability framework for SDRs used for analysis of RF spectrum and localization of RF emissions. The framework is based upon a transport protocol to convey time-stamped signal data in IF Data packets and meta-data in Context packets. The protocol abstracts the receiver data from specific hardware implementations, thus enabling a common software suite to be developed independent of the receiver architectures, manufacturers, and physical links. A case study is presented with Time-Difference-Of-Arrival (TDOA) as key to the equation.

### VRT features

The VRT standard resolves the dilemma of interoperability among SDR applications by providing a rich set of features for signal Data packets and Context data packets that can be used for a wide range of applications. Some of the key features of VRT include:

- Separate packets for signal Data and Context information to optimize throughput
- Sample accurate timestamping of signal Data instrumental for Direction Finding (DF), TDOA, beamforming, and other emitter localization techniques
- IF Data packets supporting a wide range of digitized sample types: 1 to 32 bits, real, complex, and floating point
- Context packets to convey a comprehensive set of receiver attributes: frequency, bandwidth, gain, delays, sample rates, geo-location, and inertial navigation parameters
- Sample accurate timestamping of Context events such as changes to receiver settings/status
- Class codes to encapsulate all the options of a VRT packet into a single 32-bit field; the class code relays how to decode the packets to the device receiving the packets
- Stream Identifiers (SID) to:
    - Associate packets from the same signal source provide multiplexing capability across a link
    - Associate signal Data packets with Context packets
    - Identify parent-child relationships between components in a receiver

The combination of these features in a standardized transport language is unique to the VRT standard and yields new capabilities for SDR architectures. For instance, a device implementing this standard can effectively convey signal data and convey receiver settings for a broad range of applications including communications, radar, Electronic Warfare (EW), and others. This enables the SDR receivers to become a multi-functional SDR receiver that can simultaneously output unique data streams for the different functions it supports. This is especially of value to DoD architectures where each unique functional requirement of a receiver is typically implemented in a custom radio for that application. In many instances, all of these functions can be implemented in a single multi-functional SDR device reducing the size, weight, and power of the combined capability.

## Packet structures make the standard

Both IF Data packets and Context packets are integral to VITA 49, helping provide the standard's interoperability benefits.

### IF Data packets

Figure 1 shows the form for the IF Data packet. The first word is a header that is common to both the IF Data packet and the Context packet. (See Table 1 for a summary of IF Data packets and Context packets.) The header contains the packet type, option bits for the extended header and trailer, a rolling counter to ensure proper reception of all packets, and the packet size. The header is followed by optional extended header words in both packet types, which include the Stream Identifier, the Class Identifier, the Integer Time-of-Day Timestamp, and a 64-bit Fractional-seconds Timestamp. In the IF Data packet, the header and optional extended header are followed by the signal data payload and a 32-bit trailer word as shown in Figure 1. In the Context packet, the timestamp field location is followed by a 32-bit Context Indicator field and the selected Context fields.

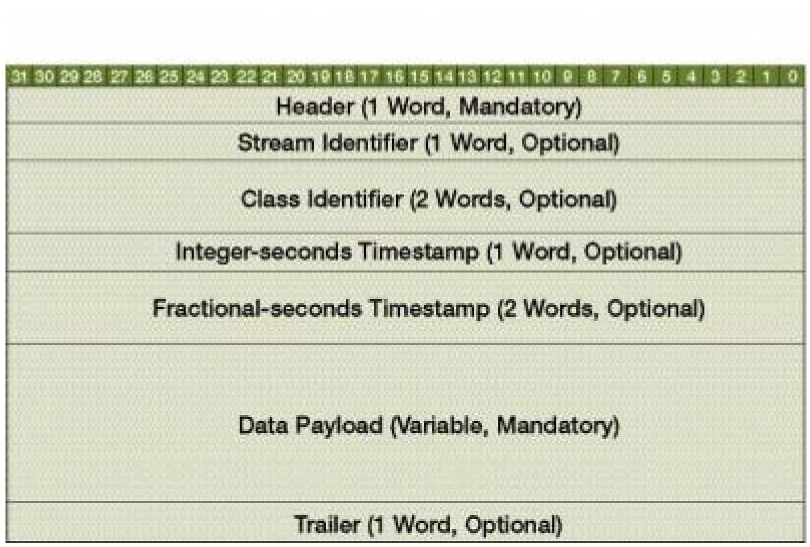


**Figure 1:**
**(click image to zoom by 1.5x)**

### Context packets

The Context packets provide a standardized language for relaying sensor attributes, such as frequency, bandwidth, gain, absolute power, relative power, internal signal delays, sampling rate, discrete events, GPS location, and inertial navigation. The fields for these attributes support most receiver attributes and have sufficient range and resolution to support enhancements to technologies well into the foreseeable future. Examples of the range and accuracy of several fields are shown in Table 2.

### Case study: TDOA techniques and VRT

A typical application is the localization of an RF emitter by TDOA techniques. This is shown in Figure 2, illustrating a scenario with one RF signal emitter in the center of the picture and four radio receivers enabled with the VRT transport. The VRT standard is used in each receiver to transport the digitized signal, the time of arrival of signals, and the location of each receiver. All of this information is sent over a network and correlated by a remote processor using TDOA algorithms to provide the precise location of the emitter.

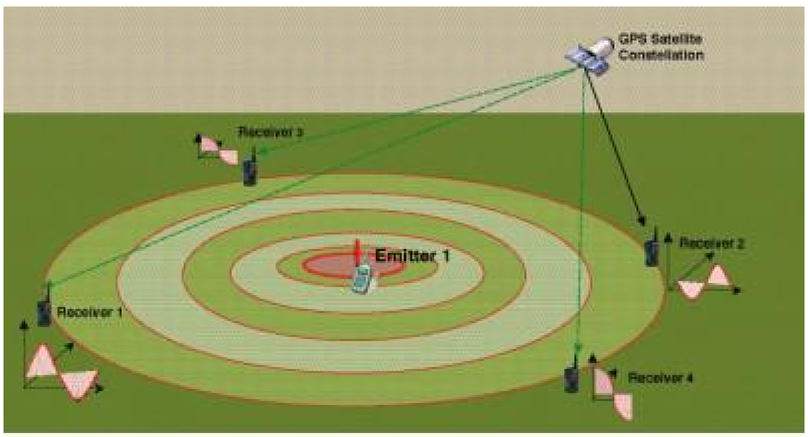


**Figure 2:**
**(click image to zoom by 1.8x)**

The same scenario is depicted with respect to the time domain and generation of packet streams in Figure 3. The receivers are equipped with GPS devices so they time-stamp the arrival time of the signal relative to the 1 Pulse-Per-Second (PPS) signal generated by the GPS device. Each radio detects the RF emission at different times with respect to their distance from the emitter. The unique timestamps are inserted into the VRT IF Data packets and Context packets for each radio. This is combined with a unique stream identification number for the packets from that radio, shown as SID 1 through SID 4. The combination makes it possible for all four streams to be multiplexed onto a common data link and sent to a remote processor for analysis. The signal processor receiving these packets utilizes the SID and the timestamps to reorganize the incoming packets into time ordered data buffers for each receiver. The processor then correlates the signals to provide precise geo-location of the emitter.

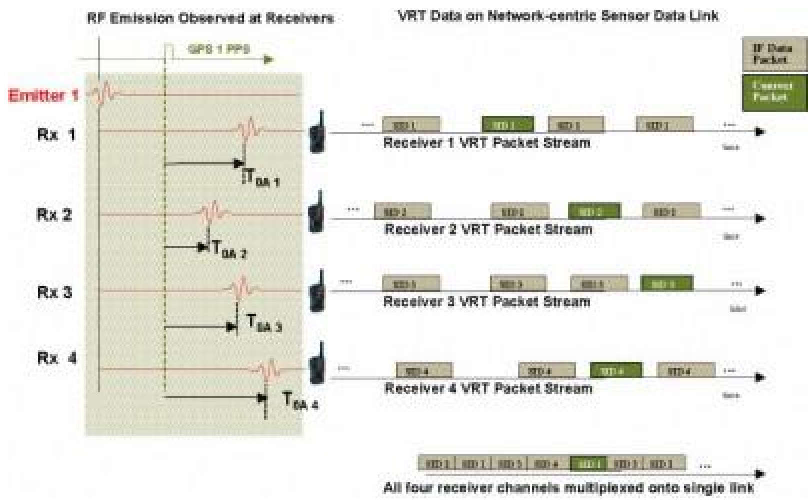


**Figure 3:**

(click image to zoom by 1.7x)

The geo-location capabilities that VRT enables are not limited to TDOA; they can also be applied to direction finding, beamforming, and other geo-location receiver architectures.

### VRT implementations now available

DRS-SS and other companies, including receiver and DSP providers, have emerging products that can be deployed with the VRT transport including SHF/UHF receivers and digital recorders. DRS-SS will also soon provide both HF and microwave receivers outfitted with the VRT transport. In addition, several graphical analysis software tools are available for VRT packets. A VRT-based GUI for analyzing VRT Data packets with respect to the VRT transport protocol is available. Signal analysis GUIs are also being developed to provide a variety of displays from the VRT packets including time domain displays, frequency domain displays, relative phase, and time of arrival displays.

### VRT provides a framework for open system architectures

Prior to VRT, there was no standard to enable the transport of data for a dynamically configurable SDR architecture used for a range of applications. VRT provides a framework that can be implemented in future or existing RF receivers and signal processors. The interoperability provided by this standard improves the life-cycle support of an architecture since it is an open, scalable, and adaptable transport interface.

Architectures based upon the VRT packet classes will reduce developmental costs and integration time. It achieves this by defining a transport packet framework that can be used ubiquitously across many receivers and applications. Having this common transport simplifies integration of components, eliminates dependency upon a single source, and provides a framework that is adaptable to evolving requirements.

The standard also provides enhanced capabilities to architectures such as the ability for disparate receivers in a sensor network to improve signal detection and emitter localization. The VITA 49 standard, approved by VITA on November 21, 2007, is ready for use by the industry. For more information, visit www.VITA.com.

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