



OpenSpace quantumRX

- Software Receiver for Wideband Missions

With the increasing amount of information being collected and received from the current and next-generation of Earth Observation (EO) and Remote Sensing (RS) satellites, there is increasing pressure for ground systems to become more agile, cost-effective, and scalable.

OpenSpace Family – Enabling Digital Transformation
Capitalizing on the benefits of virtualization, Software-Defined Networking (SDN) and cloud technologies, Kratos has developed OpenSpace®, a family of solutions that enable the digital transformation of ground systems to become a more dynamic and powerful part of the space network.

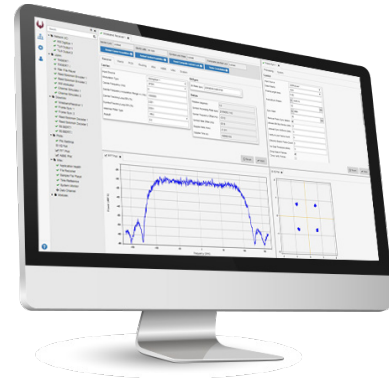
OpenSpace quantum – Virtualizing Ground Infrastructure

The OpenSpace quantum™ products are individual Virtual Network Functions (VNFs) that replace traditional hardware. OpenSpace quantumRX is a complete wideband software receiver that uses no FPGAs or GPUs and runs on general purpose compute.

OpenSpace quantumRX – Virtual Wideband Receiver
quantumRX takes advantage of standard x86 server architectures and can be deployed easily on bare metal, virtual machines or in containers to meet different scalability needs, to drive higher capacity utilization and to reduce costs.

The software-based receiver offers high performance for carriers from 500 Ksps to 350 Msps, supporting over 1 Gbps of throughput for downlinks.

quantumRX is an ideal solution for new satellites and ground stations due to its performance and economic efficiency. The virtualized receiver reduces operational



OpenSpace quantumRX displays signal performance, the spectrum, and the IQ plot.

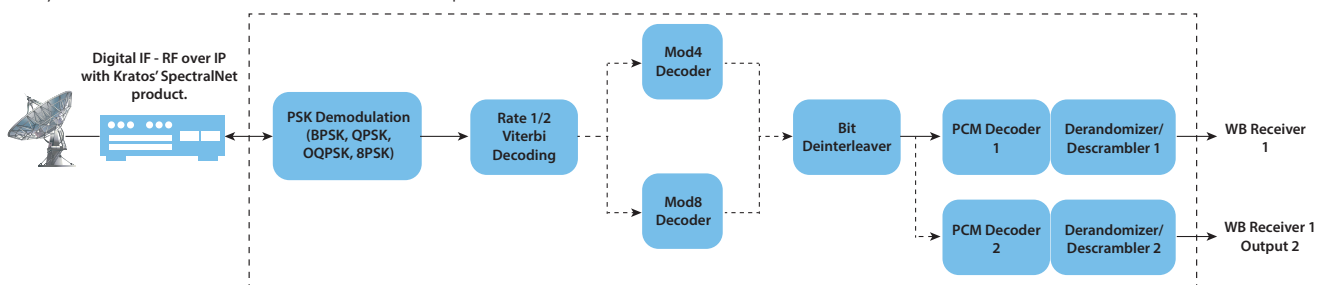
costs, enhances troubleshooting, and supports the newer digital IF signaling capabilities.

quantumRX provides demodulation of several common waveforms, decoding, and forward error correction methods. Add diversity combining capability to the system with quantum Best Source Select (qBSS). qBSS does automatic frame by frame comparison and determination of a best source signal to provide the highest quality output. Monitoring and control is performed using the HTML5 graphical user interface, using the REST API or GEMS.

Key Features and Benefits of quantumRX

OpenSpace quantumRX provides the following features and benefits for satellite operators, service providers and Ground Station-as-a-Service providers (GSaaS):

Features	Benefits
Software defined radio solution enabling multiple waveform demodulation and decoding options	Provides high performance and pass-to-pass configurability
Uses industry standard interfaces	Web-based GUI, REST API and GEMS
Decouples the processing from purpose-built hardware	Lowest costs by using generic x86 compute resources
Eliminates dependency on dedicated hardware	Deploys flexibly on bare metal, virtually or in the cloud
Common cloud compatible infrastructure	Easily fits into existing ground architectures from private to public cloud
Instantiate application instances through automation and virtualization	Scales on demand by spinning virtual instances up and down as needed



OpenSpace quantumRX System Architecture

Technical Specifications

Description	Specification
Number of Receive Channels per instance:	1
Direct Demodulation Types:	BPSK, QPSK, OQPSK, 8PSK (Inverted Gray 1 mapping, Natural 1 with TCM enabled) 16QAM
Direct Symbol Rate:	500 ksps to 250 Msps QPSK BPSK, OQPSK, 8PSK and 16 QAM for GEO 5 Msps to 250 Msps LEO
Direct Information Rate	250 Mbps - BPSK, 500 Mbps - QPSK, 500 Mbps - OQPSK, 750 Mbps - 8PSK
DVB-S2	500 Ksps to 250 Msps on Intel scalable 2nd generation processor 500 Ksps to 350 Msps on Intel scalable 5th generation processor QPSK to 32APSK Short & Normal Frames Variable Coding & Modulation (VCM) with Pilot Frames
DVB-S2X	500 ksps to 250 Msps on Intel scalable 2nd generation processor 500 Ksps to 350 Msps on Intel scalable 5th generation processor QPSK to 32 APSK Short and Normal Frames ACM with quantumTX v1.0 or later Variable Coding & Modulation (VCM) with Pilot Frames Higher Order Modcodes - 64 APSK (Max 166 Msps) 128 APSK (Max 145 Msps)
PCM Decoding	NRZ-L,M,S, Modulo-4 (QPSK Only), Modulo-8 (8PSK Only)
Viterbi Decoder	Single Viterbi Decoder per Channel -OR- Dual Viterbi with QPSK Rate = 1/2 (K=7) CCSDS Polynomial G1=1111001 G2=1011011 G1 / G2 Invert Support Punctured Viterbi 3/4, 5/6, 7/8 Stacked Viterbi Reverse order mode (G1 / G2 output order is reversed) Bypass mode supported
Viterbi Decoder: Supported Modulation Types & Rates	BPSK, QPSK, OQPSK, 8PSK 375 Mbps per channel Max Bit Rate. (MaxBit Rate assumes 8PSK)
LDPC/CCSDS	CCSDS 131.0-B-5 TM Synchronization and Channel Coding
4D-8PSK-TCM	Modes supported: 2.0, 2.25, 2.50, 2.75 bits/symbol Maximum bit rate 687.5 Mbps
Reed-Solomon	Reed-Solomon Decoding (223, 255), (239, 255) Virtual Fill up to 7 bits per frame Block Interleaving (CCSDS compliant) Viterbi Decoding can be concatenated with Reed-Solomon Decoding Can support up to 19 code blocks at an interleave of 2 Output supports w/ or w/out ASM re-appended 750 Mbps per channel Maximum Bit Rate (Data rate includes ASM and check symbols; Max Bit Rate assumes 8PSK)
Acquisition Time	< 1 sec
Doppler Range	+/- 1 MHz for > 20Msps +/- 10% for < 20 Msps (DVB-S2)
Doppler Rate (max)	50 kHz/sec for > 20 Msps 400 Hz/sec for < 20 Msps
Matched Filter	RRC values 0.2-1.0 support performance at all modulation types
VITA-49 Support	8 or 12 bit samples only



Kratos' OpenSpace family of solutions enable the digital transformation of satellite ground systems to become a more dynamic and powerful part of the space network. The family consists of three product lines: OpenSpace SpectralNet for converting satellite RF signals to be used in digital environments; OpenSpace quantum products, which are virtual versions of traditional hardware components; and the OpenSpace Platform, the first commercially available, fully orchestrated, software-defined ground system. These three OpenSpace lines enable satellite operators and other service providers to implement digital operations at their own pace and in ways that meet their unique mission goals and business models.



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