



Cloud Processing Overview

Definition: A pooled set of compute resources that can be centrally managed and dynamically provisioned to provide the required computation power or storage for a specific task

Why use it:

- Enhanced compute resource management
- High data-rate applications requiring pooled compute resources
- Remote ground terminals that cannot support processing at the antenna

Processing Locations

- **Edge:** RF processing occurs entirely at satellite ground stations
- **Hybrid:** RF processing occurs partially at the edge and partially at the cloud
- **Cloud:** Digital IF data is sent to a remote cloud where IF processing occurs

Compute Types Compared

- x86, including AVX-512 extension
- Graphics Processing Units (GPU)
- Field Programmable Gate Array (FPGA)

	Speed	Latency	Price	Flexibility
x86	3	2	1	1
GPUs	2	3	3	2
FPGAs	1	1	2	3

Private Versus Public Cloud

- **Private Cloud:** Physical compute resources are local to the user and/or application and are typically managed by the user of that data; example: KSATEdge
 - Pros: more infrastructure control, could accommodate more security controls
- **Public Cloud:** Physical compute resources are not necessarily co-located with the user and/or application and are typically managed by a second party not directly involved in the use of the data processed or stored on the cloud; example: Microsoft's Azure Orbital
 - Pros: greater scalability, enterprise security, geographically dispersed signal processing, pay-as-you-go datacenter management

Resource Utilization: Cloud Versus Bare Metal

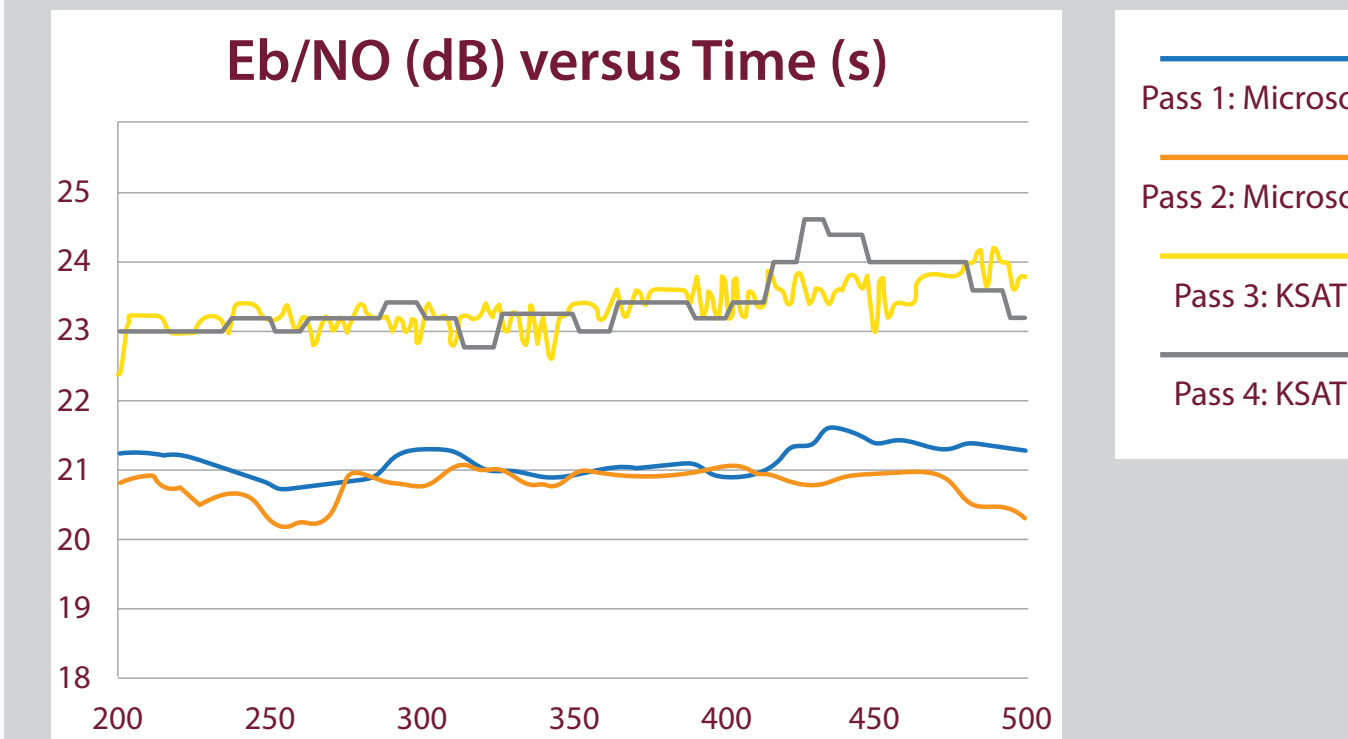
The Table below contains summary statistics of metrics collected from a Kratos qRX running in a private cloud and on bare metal. The received signal was ~1050 Mbps 8PSK with RS(255,223) on a 8100 MHz Carrier.

Metric	Bare Metal	Open Stack
CPU Use Setup (%)	63.6	93.2
CPU Use Steady State (%)	14.3	29.4
Total RAM Available (GB)	377	47.1
Total RAM Used (GB)*	40.9	5.86
RAM Used by qRX (GB)	6.51	4.02
RAM%	10.8	12.5
Network Traffic (Gb/s)	7.65	7.65
I/O Write Setup (MB)	38.85	33.45
UDP in Diagrams	106000	106000

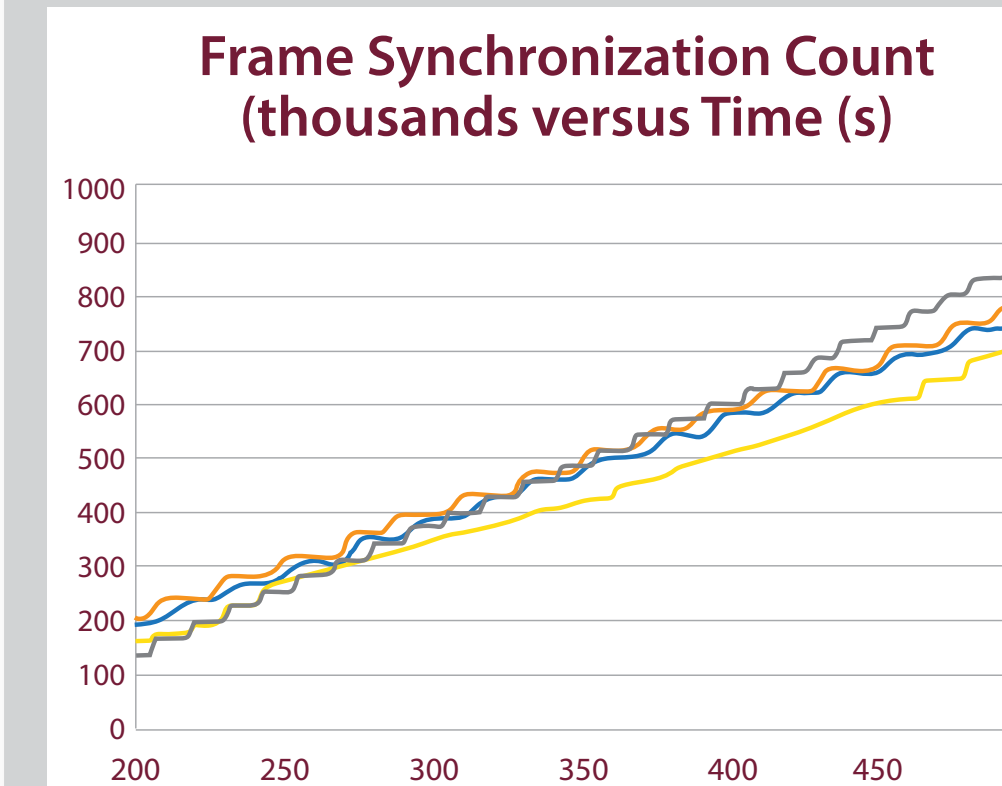
*RAM used is a function of installation allocation for RAM

Signal Processing on Private and Public Clouds

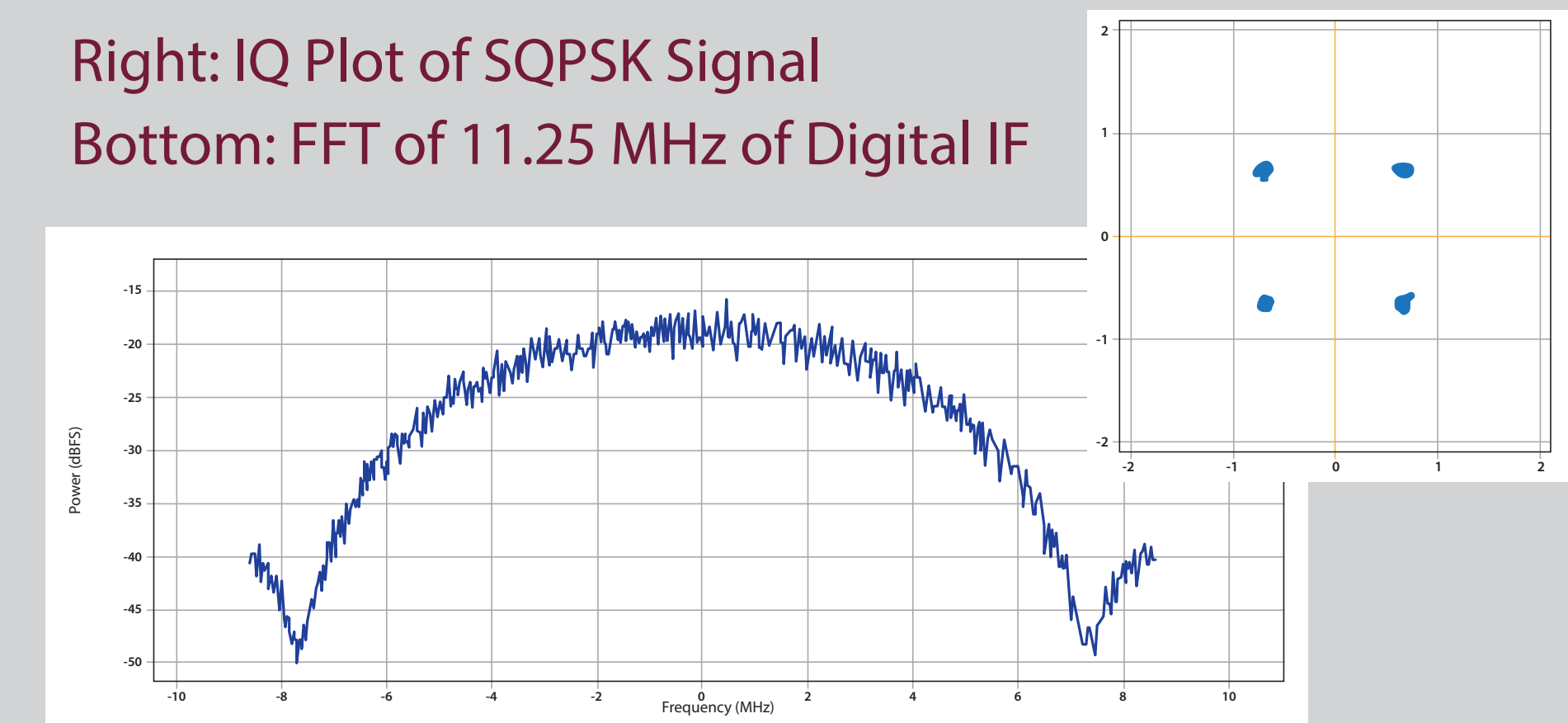
15 Mbps SQPSK with RS Coding



Eb/No variation between Microsoft and KSAT due to antenna variations, including G/T

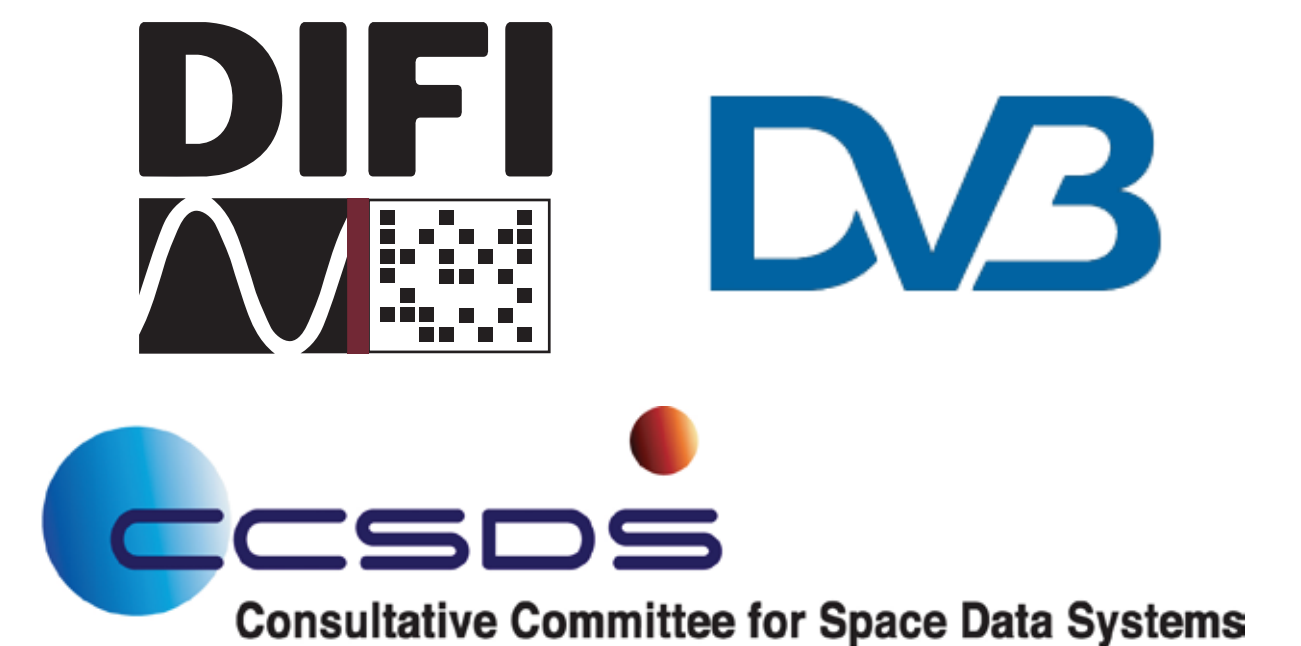


Right: IQ Plot of SQPSK Signal
 Bottom: FFT of 11.25 MHz of Digital IF



Looking Forward: Enabling Technologies

Waveform Standards



Software Platforms



Infrastructure SR-IOV // NUMA // SIMD