

Leveraging Cloud in the digital transformation of Satcom

WS11: Digital Transformation of SATCOM

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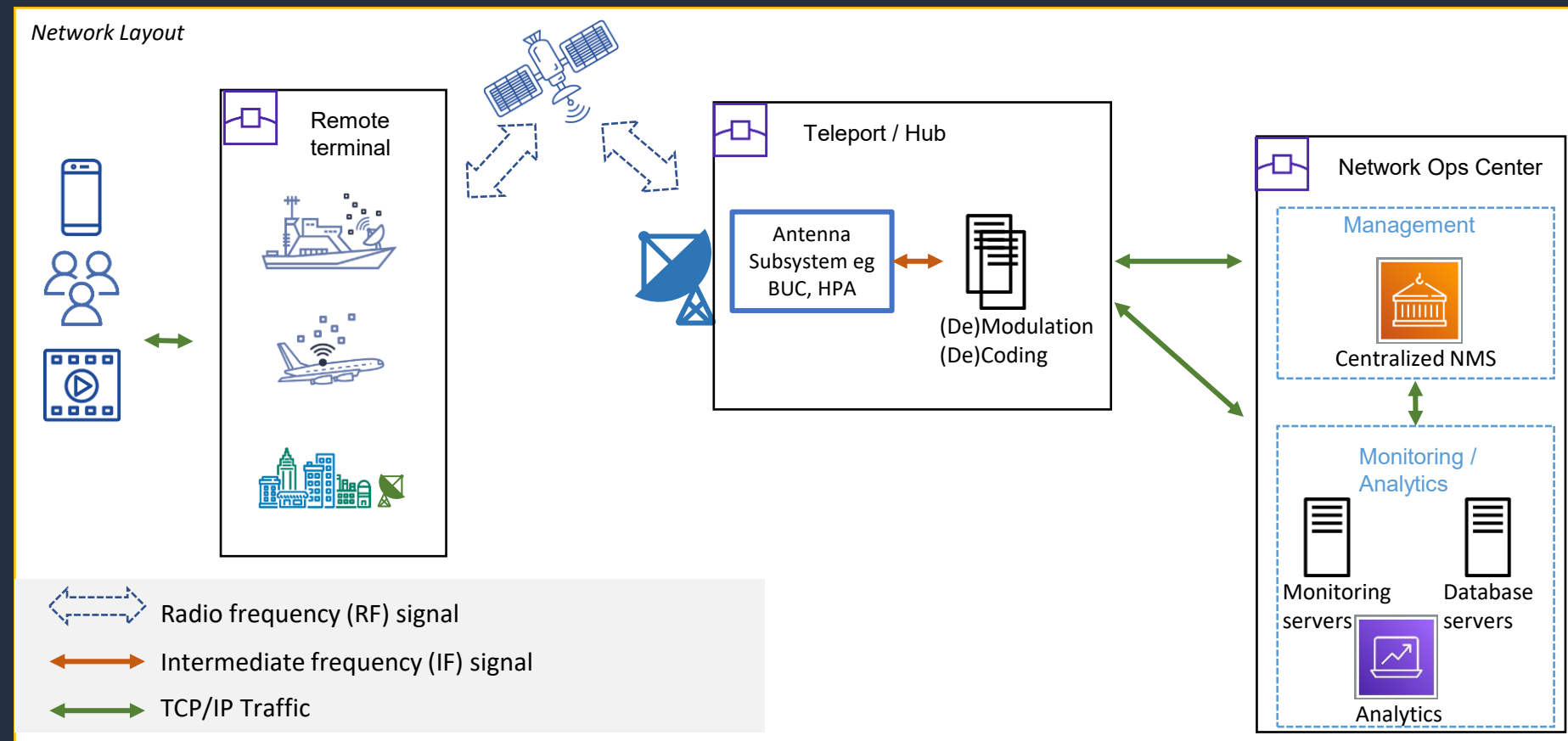
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Background

Traditional Satellite communications : Fixed hardware at teleports and Network Operations Center

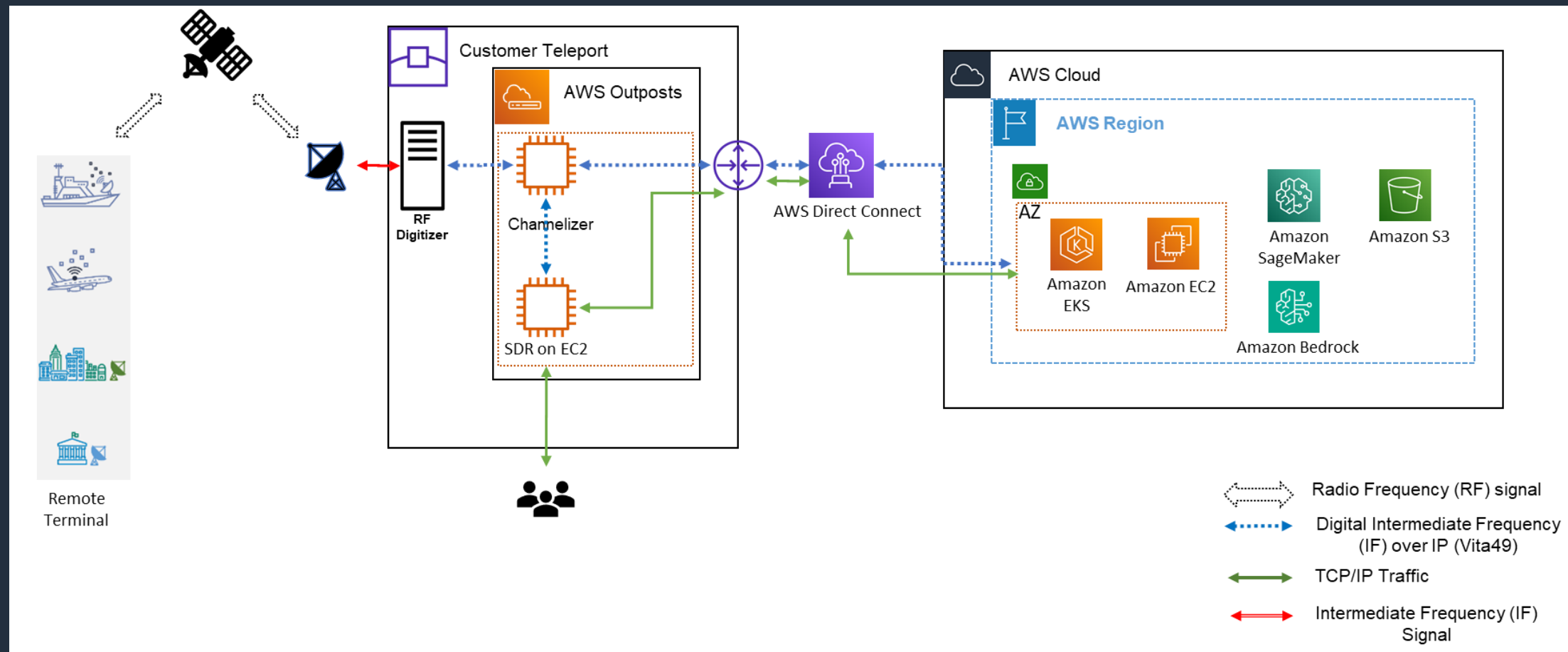


Disadvantages

- Inflexible – difficult to scale up/down
- Upfront capex – cost of modulators, demodulators
- Operations overhead – onsite maintenance at tens of teleports
- Large physical infrastructure footprint – cooling etc.
- Vendor lock
- Complex to upgrade

Agile Satcom

New Satcom : Cloud-based modulation/demodulation (SDR), high-availability Network Management, AI/ML



Advantages

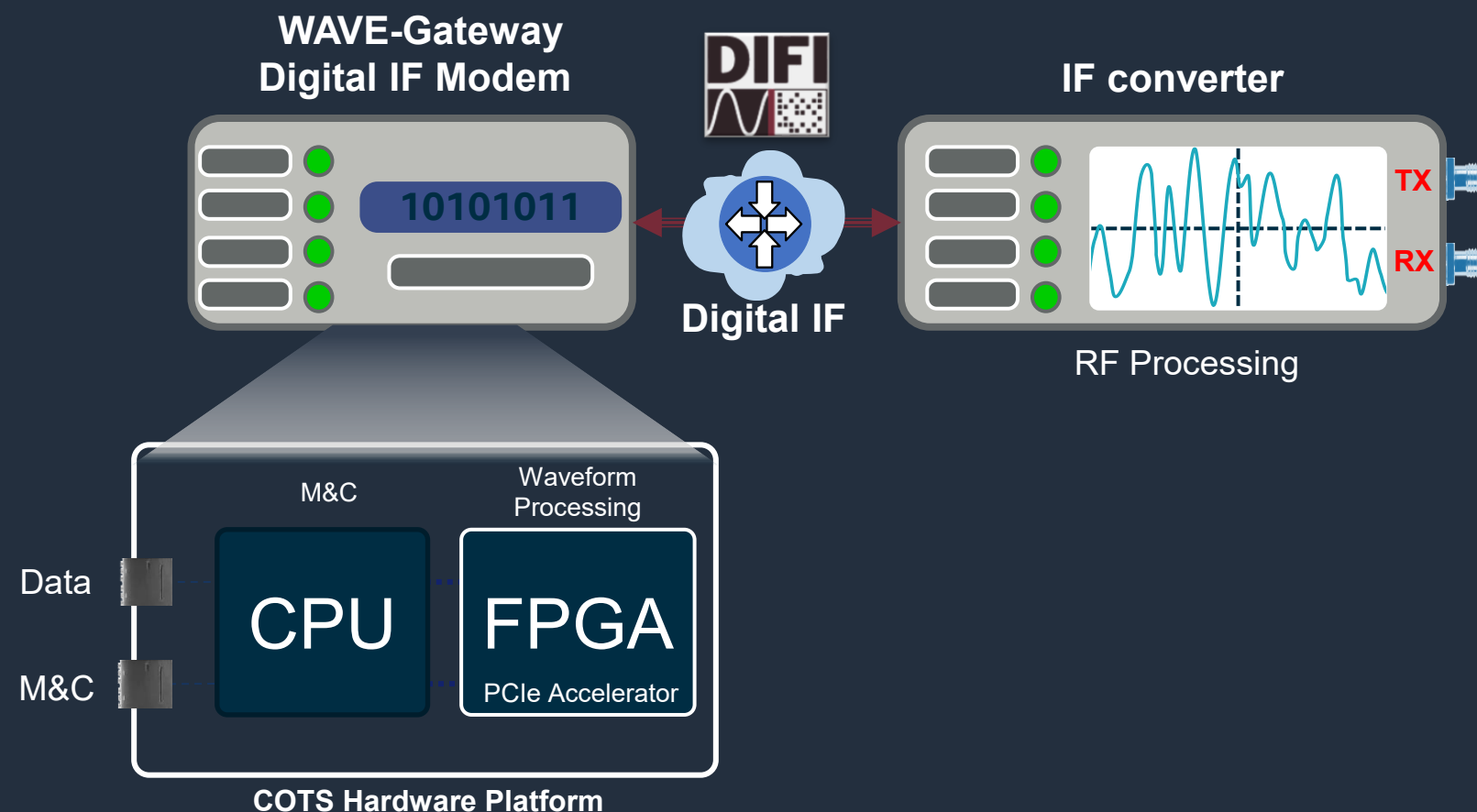
- Scale – up/down
- x86, GPU or FPGA
- Flexibility – edge or Region
- Opex model
- Simplify Operations
- Reduce physical infrastructure footprint
- Avoid vendor lock
- Performance - upgrade to new instance types
- New AI/ML business opportunities

Business value -> Digital domain enables flexibility, 5G overlay, new AI/ML use-cases

WAVE – a new standard driving the Satcom industry

Waveform Architecture for Virtualized Ecosystems

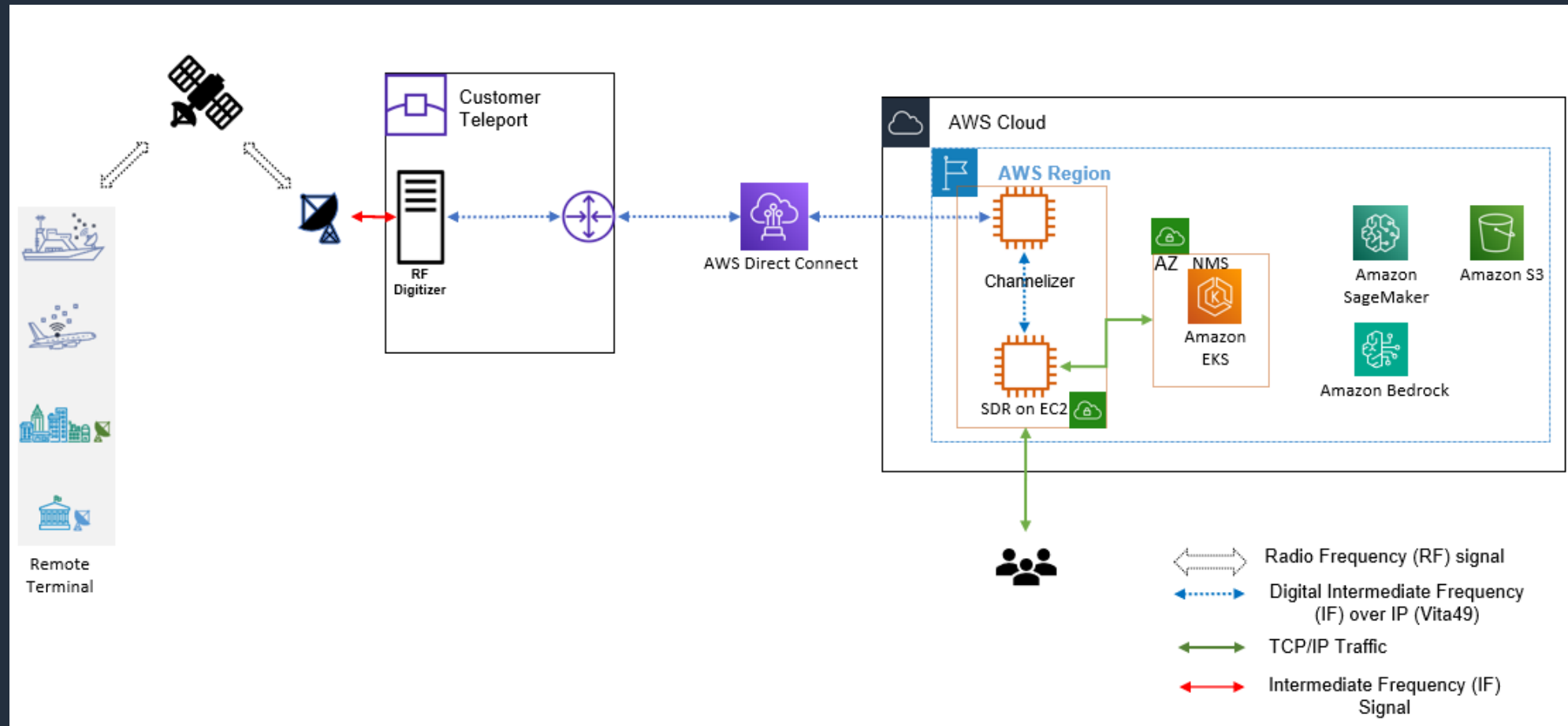
- The Telecommunications industry has had well established standards (3GPP) for >25 years.
- WAVE will help drive Satcom to an interoperable ecosystem with virtualized networks.



AWS is a founding member of the WAVE consortium



Deployment options - #1 Region-based SDRs



Pros

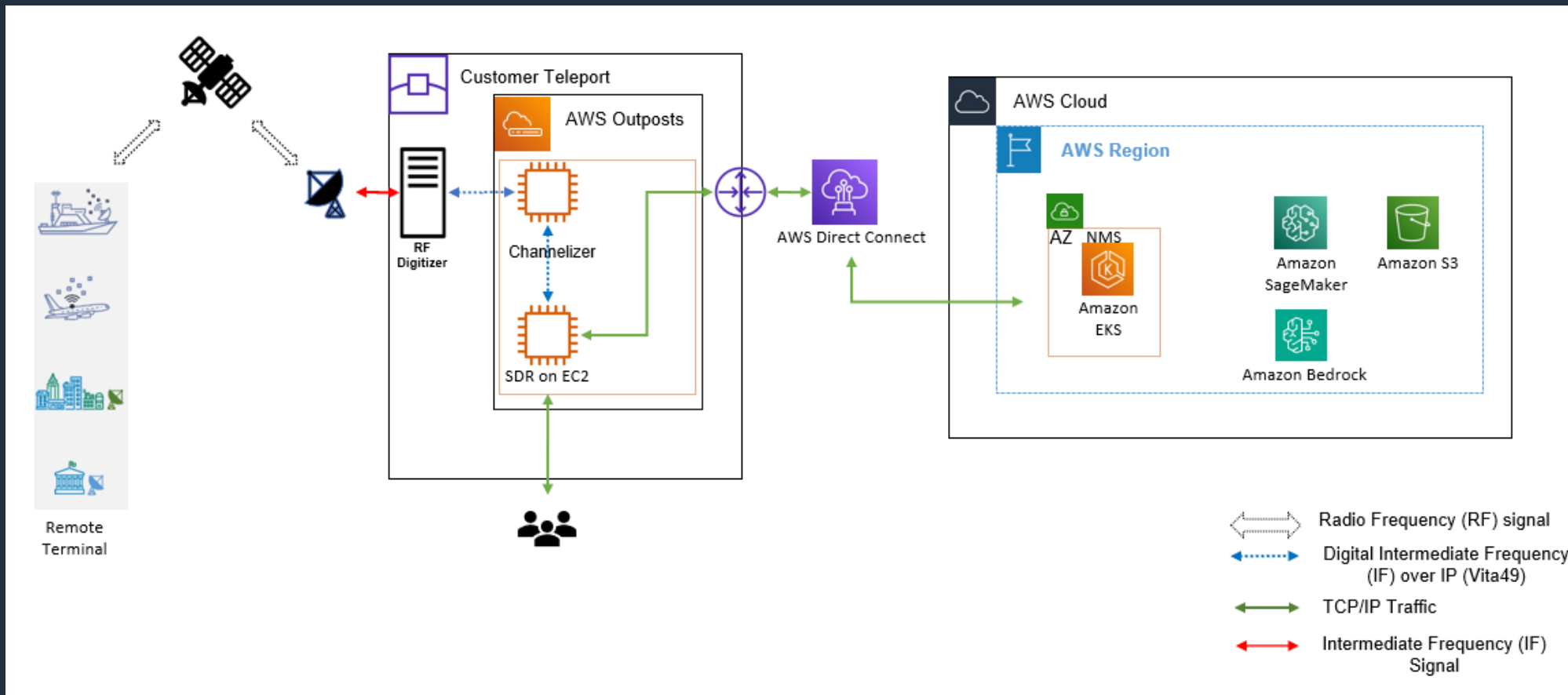
- Scale – up/down
- Opex model
- Simplify Operations
- Reduce physical infrastructure footprint
- Avoid vendor lock
- Performance - upgrade to new instance types
- New AI/ML business opportunities

Cons

- Egress costs *
- Higher latency

* New – DXFR – AWS DirectConnect Flat Rate – vastly reduces egress costs

Deployment options - #2 AWS Outpost-based SDRs



Pros

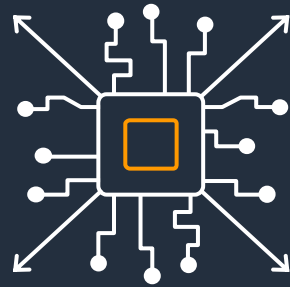
- No egress costs
- Low latency
- Support higher RF bandwidth
- Simplify Operations
- Single pane of glass
- New AI/ML business opportunities

Cons

- Less flexibility (than Region)
- Lead-time

Amazon EC2 accelerated computing instances

Specialized EC2 instances that use Hardware Accelerators



Hardware accelerators

for computationally intensive workloads

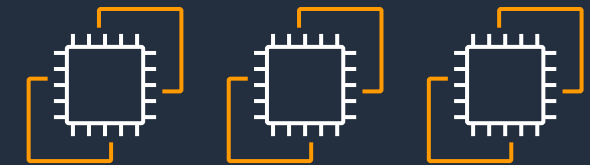
Offer more parallelism for higher throughput



Higher efficiency

than software on CPU

Perform functions—such as floating-point number calculations, graphics processing, or data pattern matching—more efficiently



Broad portfolio

of accelerator choices

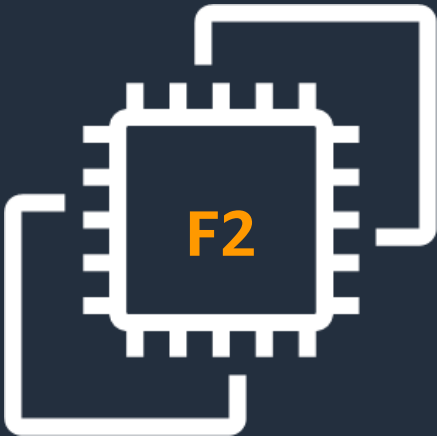
Address various workloads using GPU, FPGA, or custom ASIC-based instances

AWS solutions – FPGA compute

- F2 instance is a strong fit for Digital satcom waveforms
 - Uses same underlying FPGA fabric (AMD Xilinx VU47P) as several modem vendors use
- 2nd generation of FPGA-powered instances
- [AWS FPGA SDK](#) available on AWS GitHub provides easy to use data movement infrastructure, drivers, and examples
- *“Agile satellite communication ground systems with Amazon EC2 F2 FPGA solutions”* blog & github repo [here](#)

Now Available – Second-Generation FPGA-Powered Amazon EC2 instances (F2)

by Jeff Barr | on 11 DEC 2024 | in Amazon EC2, Announcements, Featured, Launch, News | [Permalink](#) | [Comment](#)
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Instance Type	FPGAs	vCPU	FPGA Memory (GiB) [HBM / DDR4]	Instance Memory (GiB)	Local Storage (GiB)	Network Bandwidth (Gbps)
f2.6xlarge	1	24	16 / 64	256	1 × 940	12.5
f2.12xlarge	2	48	32 / 128	512	2 × 940	25
f2.48xlarge	8	192	128 / 512	2,048	8 × 940	100



What new business opportunities are there with Cloud-based satellite ground infrastructure?



RF noise / interference detection – v1 – ML



Functional Objectives

Build a solution that: -

- Ingests IQ data from RF Digitizer at Earth Observation Ground Station or Digital Satcom chain
- Raw IQ Samples → Clustering → Feature Extraction → Classification
- Detects Phase v Amplifier noise v Interference based on shape of clusters

Advantages:

- Fast, performant, lightweight

Limitations:

- Labeled data
- Data Scientist

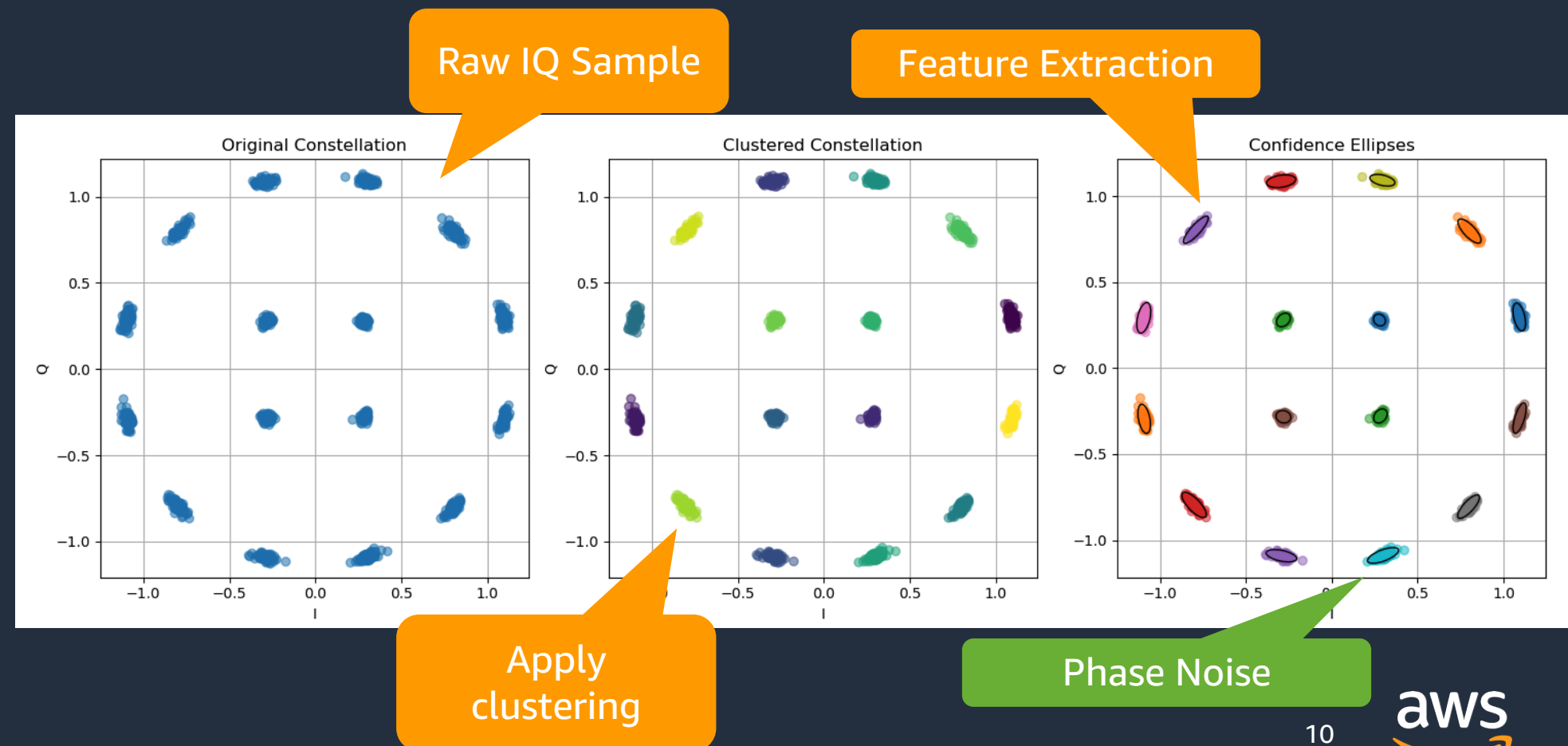
AWS technologies:



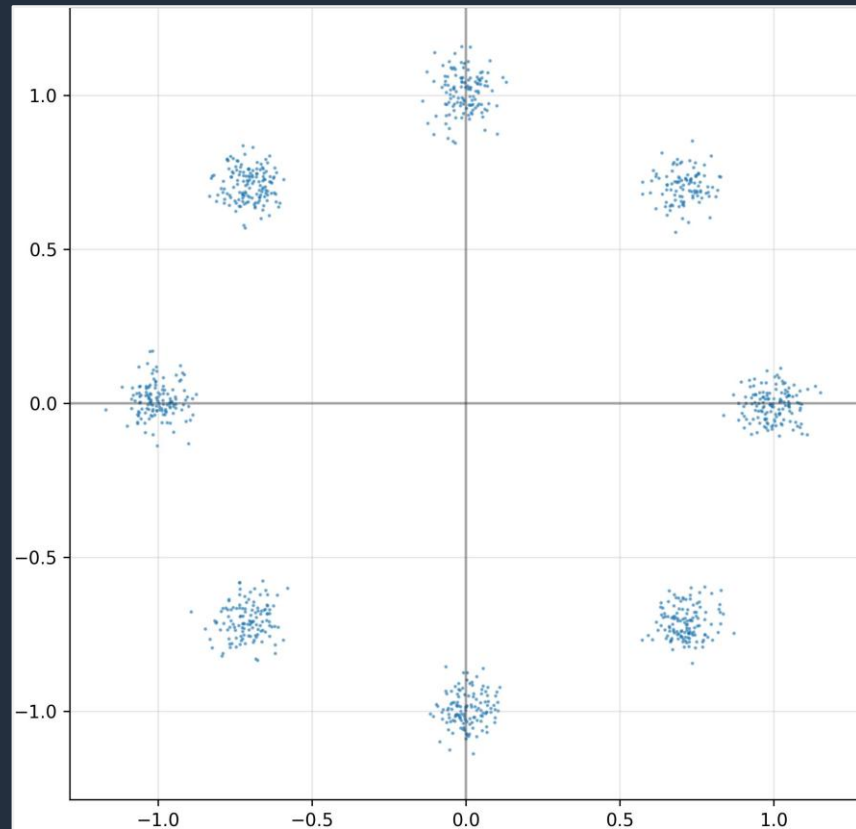
Amazon SageMaker AI



Amazon S3



RF noise / interference detection – v2 – Generative AI



PROMPT

"You are an RF Analyst looking at IQ constellation modulation diagrams. You need to determine the modulation type. You also need to determine if the constellation has noise present, and if so what type of noise or imbalance? Finally indicate the typical causes of the noise."

CLAUDE SONNET

Looking at this IQ constellation diagram, I can make the following analysis:

1. Modulation Type:

- This appears to be an 8-PSK (8-Phase Shift Keying) modulation

2. Noise Present:

- Yes, there is visible noise in the constellation
- The spread appears to be roughly Gaussian in nature

3. Typical Causes:

- Additive White Gaussian Noise (AWGN) is likely the primary contributor
- Could be caused by:
 - * Low signal-to-noise ratio (SNR)
 - * Channel interference
 - * Phase noise in the local oscillator
- There doesn't appear to be any significant amplitude or phase imbalance, as the constellation points are relatively symmetrical

Overall, while there is noticeable noise, the constellation points are still clearly distinguishable, suggesting this is still a functional communication link

Cloud-based Satellite Capacity forecasting



Functional Objectives

Generate satellite capacity forecast per Beam

- Include weather in model
- Account for peak surges

AWS Technologies used: -

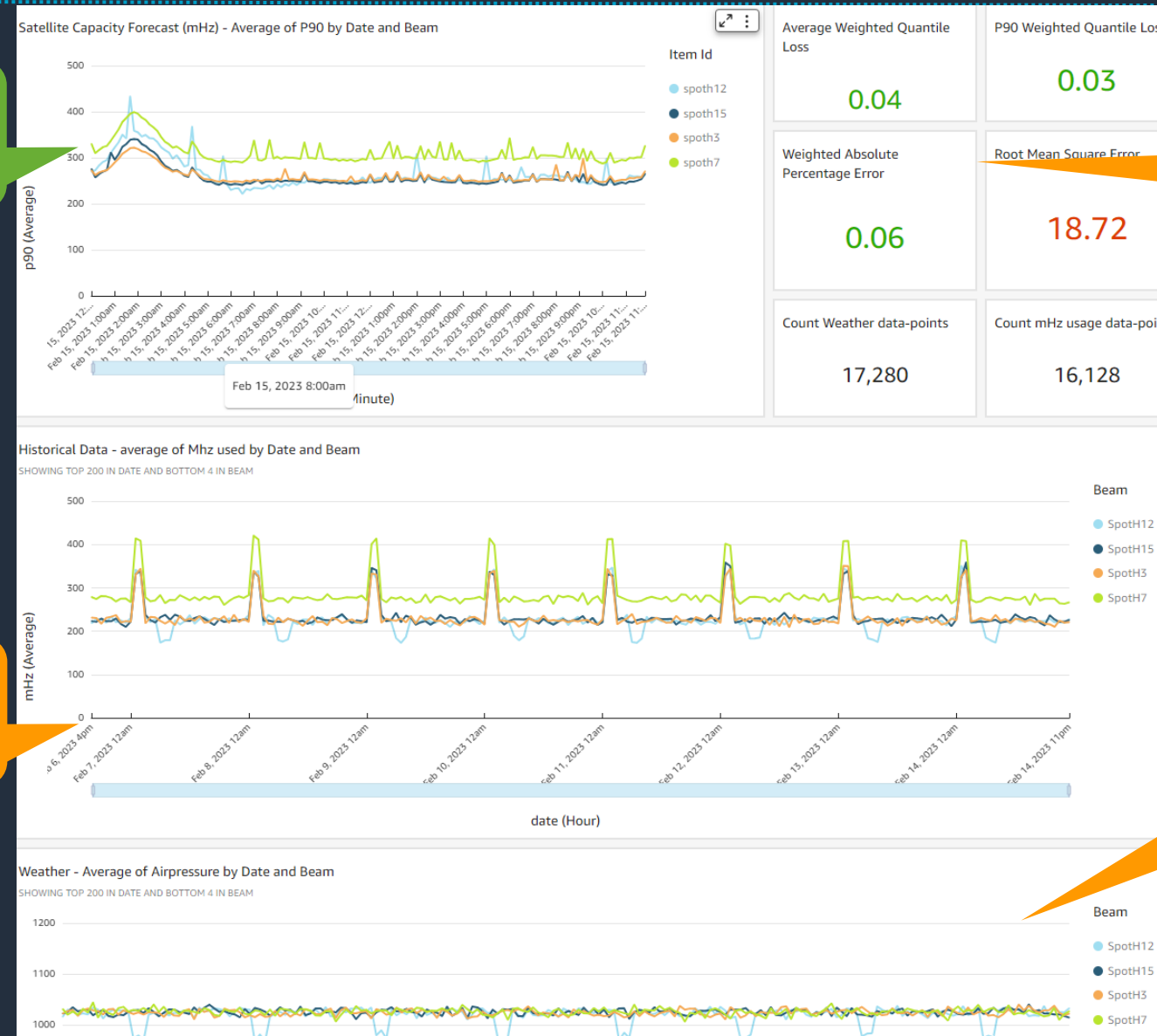
- Amazon SageMaker time series – ML based outcome prediction
- Amazon S3 – scalable storage

Predicted Sat Capacity (MHz)

Historical data (usage)

Accuracy metrics

Historical & forecast data (weather)



Summary

- Opportunity to deliver more agile satcom ground systems
- Leverage Cloud-based GPP or FPGA-based accelerated instances to demodulate digital IF streams
- Flexible deployment models - in-region or at teleport (AWS Outposts)
- Monetize ML & Generative AI Satcom value-add solutions

Thank You

