TOWARDS A FULLY DIGITAL TELEPORT

DIFI development - Testing - Lessons Learned on Virtualization and Interoperability.

IEEE MILCOM

ST Engineering

iDirect

Microsoft Azure

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AGENDA

- New Ground
- Towards the Fully Digital Teleport
- Journey and Proof points
- DIFI at Scale – Lessons Learned
- DIFI Roadmap and Requirements

NEW GROUND TECHNOLOGY DRIVERS

GLOBAL TELCO AND IT

- Integrated networks
- Multi-network satellite systems (Access and Aggregation)
- MEF and 5G/3GPP standards

NEW SPACE

- New LEO/MEO/HEO constellations
- Dynamic Space Segment
- Multi-orbit

CLOUD DEPLOYMENT

- Generic hardware platforms
- Strong Security Requirements
- Digital Interfaces - DIFI

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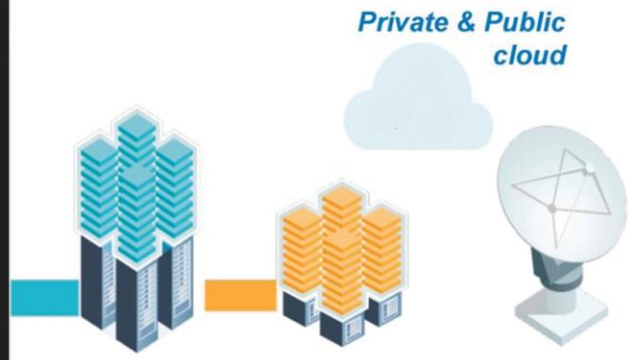
EXPLOIT FULL POTENTIAL OF SOFTWARE DEFINED SATELLITES

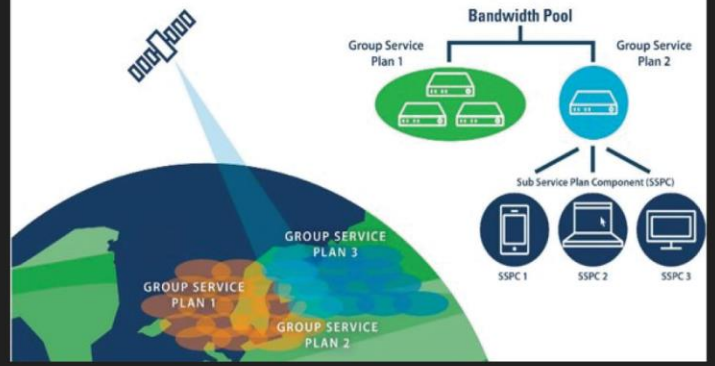
SCALABLE AND FLEXIBLE VIRTUALIZED GROUND SEGMENT

Maximize revenues for fixed and mobility services with ground segment scaling in GHz and Gbps



GLOBAL BANDWIDTH MANAGEMENT

Enabling wholesale and VNO go-to-market and QoS across HTS spot beams and Gateways



RADIO RESOURCE CONTROL SOFTWARE DEFINED PAYLOAD SUPPORT

Space-to-ground integration to unlock satellite flexibility on the ground

STRATEGIC PARTNERSHIP

Strategic Partnership

Microsoft Azure

ST Engineering

iDirect

December 9, 2021

A Strategic Partnership In the Move to the Cloud

Posted in Non-Ground, Cloud, Cloud

Back to Satellite Connection

Today we are excited to announce our **partnership** with Microsoft Azure Space!!

Through this collaboration, we will leverage the Azure software radio tools to enable our satcom solutions through the Azure cloud platform. This represents a major milestone in our strategic direction that will lead to the **virtualization** and **cloudification** of our satcom platform. Through Proof of Concepts (PoCs), testing and milestones, Microsoft Azure Space and ST Engineering iDirect will innovate to bring the **unique attributes** of satellite to the cloud.

Move to the Cloud – What does this mean for our industry?

As the **satellite industry adopts** cloud-based infrastructure there are concurrent **technology innovation trends** that are pushing satellite toward the cloud as a means of reaching its full potential. At the same time, the industry is moving away from traditional GEO satellite architectures and toward highly flexible **digitized high throughput satellites** and new **MEO/LEO/HEO constellations**. This newer generation of satellites will require a more **scalable, flexible,** and **secure** infrastructure solution, and the cloud meets those requirements.

The next generation of satellite communication systems will demand fundamental cloud elasticity.

These seismic changes are driving the satellite industry to **innovate** as never before, because satellite technology is **critical** in the **delivery** of the cloud services that are transforming the enterprise landscape. Satellite is going to be imperative as enterprises that are embracing **digitalization** need **ubiquitous cloud access**—a service that in many places can only be achieved with satellite networks.

...r our customer including the ability to scale and build out their operations; to heighten ...pen-up avenues of opportunity and grow **revenue streams**.

...ice delivery

...l of our ground segment starting with a cloud-based NMS and making our modems more ...d infrastructure transforming the economics, engagement models, and technologies for ...ty of satellite communications around the world.

...to enabling our satcom solutions on the Microsoft Azure platform. This will involve the ...rosoft Azure public cloud, followed by the virtualization of our modem so that it may be ... This will enable Azure to offer the strongest **quality of experience** and allow **seamless**

September 14, 2022

ST Engineering iDirect and Microsoft Azure Achieve Important Milestone to Virtualize Satellite Modem In Microsoft Azure Cloud

Posted in Cloud, Virtualization, Cloud, Virtualization

Back to Satellite Connection

Last year ST Engineering iDirect and Microsoft Azure entered a strategic partnership to drive the adoption of virtualization and cloud to enable the digital transformation of the ground segment.

Over the last months we have been working on the first phase in the development of a virtualized modem that can be deployed on a Microsoft Azure based cloud solution.

To see the demo in action, **check out this video**, and hear from Sean Yarborough, ST Engineering iDirect's VP of Product Management, and Paul Tilghman, Sr. Director of Spectrum Technologies with Microsoft Azure Space, on the strategic importance of this milestone.

Today, we are excited to announce the successful demonstration of this important milestone in our Proof of Concept: The demodulation capability of an iDirect virtualized high-speed SCPC modem running as containerized software on a COTS server located in the Azure Cloud. It is also the first time we are demonstrating how this virtualized modem is receiving high-speed traffic via a digital interface instead of the traditional analog L-band interface, furthering our innovation with the DIFI standard. DIFI stands for Digital IF Interoperability consortium and is an independent space industry group of which Microsoft Azure and ST Engineering iDirect are part of formed to advance interoperability in satellite and ground system networks.

Our joint development partnership is aligned with our phased approach in enabling our satcom solutions on the Microsoft Azure platform. Already, we have migrated our network management system to the cloud, and now have successfully demonstrated the first milestone towards fully virtualizing our remote modem. Next, we plan to migrate our network processing functions and lastly baseband processing functions to the cloud.

...nication systems will demand fundamental cloud elasticity driving us to innovate as never

SHAPING THE FUTURE THROUGH SATELLITE INNOVATIONS

The next generation of satellite communication systems will demand fundamental cloud capabilities to enable satellite operators to maximise their strategic investments.

Cloud deployment allows satellite operators to build out large scale networks in less time and with less capex-investment. A virtualized ground segment enables greater orchestration of service delivery with network resources and business systems. And when this is built on shared networking standards, it will transform the economics and engagement models of satellite operators and major network operators so they can expand the accessibility of satellite communications around the world.

That's why over one year ago **ST Engineering iDirect** started to collaborate with **Microsoft Azure Space** on driving the adoption of virtualization and cloud to enable the digital transformation of the ground segment.

Through our development, we set out to virtualize key aspects of our modem and baseband ground segment to enable our satcom solutions to run in Azure. For that, we have been working on the abstraction of the software functionality from the hardware to allow for the processing to run in the cloud while leveraging the Azure software radio tools.

Over the last 12 months we have successfully demonstrated two key milestones of deploying a virtualized iDirect modem on Azure.

- In late 2022 we showcased the demodulation capability of an iDirect virtualized high-speed SCPC modem running as containerized software on a COTS server located on Azure. It was also the first time we demonstrated how this virtualized modem is receiving high-speed traffic via a digital interface instead of the traditional analog L-band interface, furthering our innovation with the DIFI standard. This is important because once virtualized modems are in the cloud, we need to make sure they can easily interoperate with the other components through standard interfaces.
- In May 2023 we showcased the virtualization of the modulator capability of the modem to run on Azure. That marked our proof of concept of fully virtualizing a satellite modem.

Next, we plan to migrate our network processing functions to the cloud. We want to prove that satellite network architectures can be built with commercial off-the-shelf components that leverage the cloud to its fullest potential.

...hhoji, Senior Director Business Development at ST Engineering iDirect
...ilghman, Senior Director Connectivity with Microsoft Azure Space
on the strategic importance of these milestones.

Ground Segment Industry Impact

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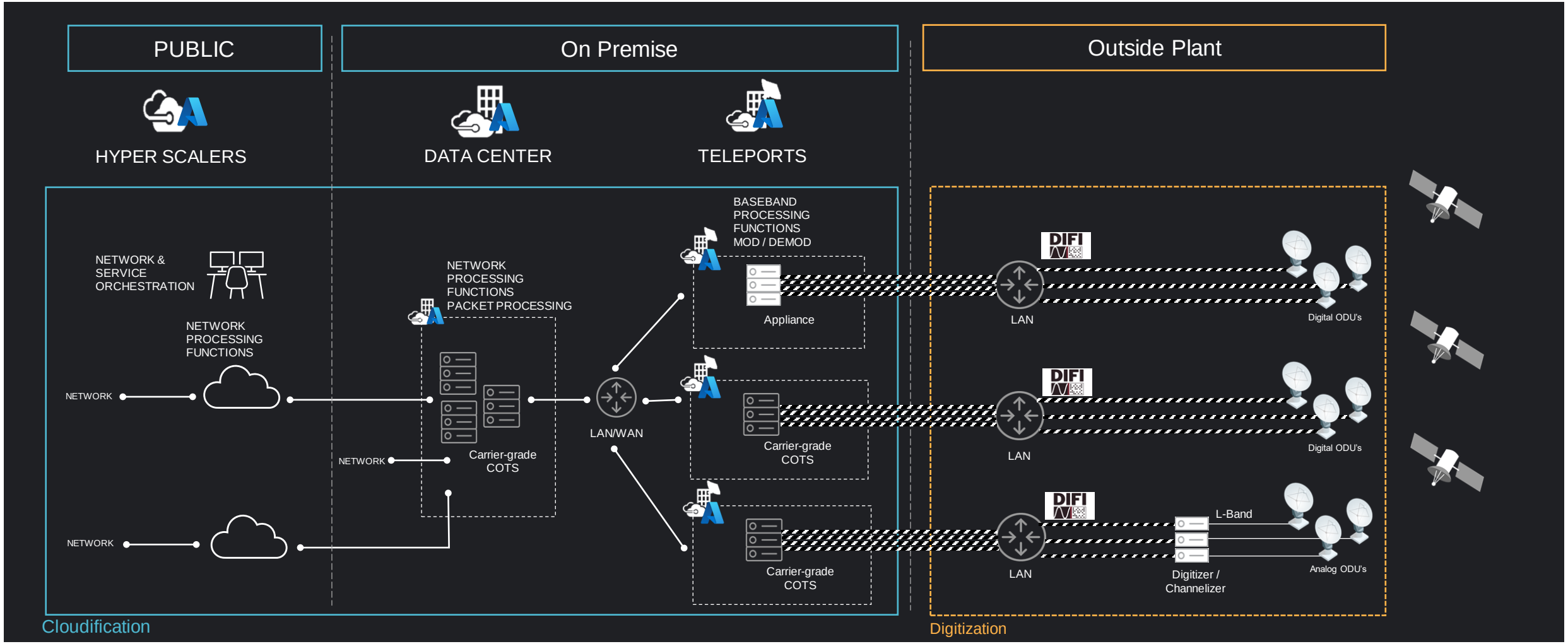
A key first step in enabling reconfigurable architectures in contested environments



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TOWARDS A FULLY DIGITAL TELEPORT

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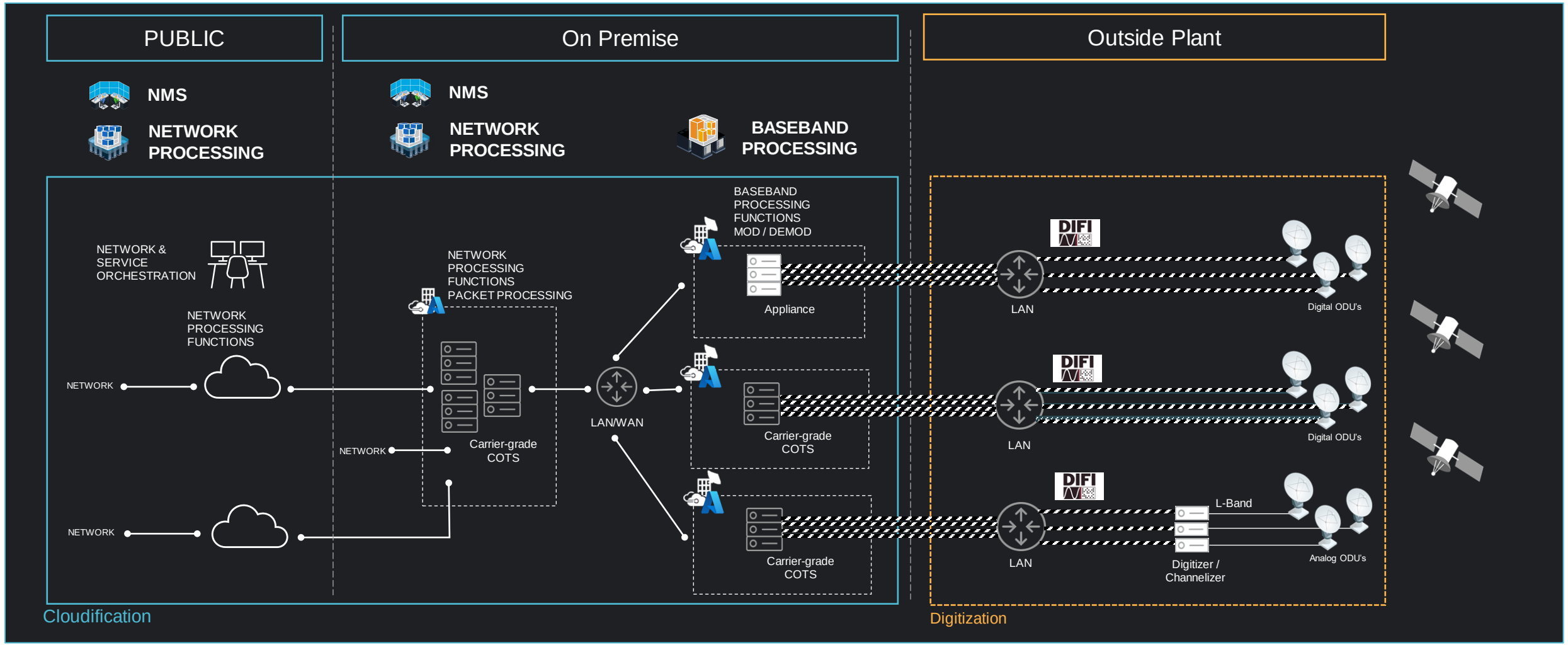
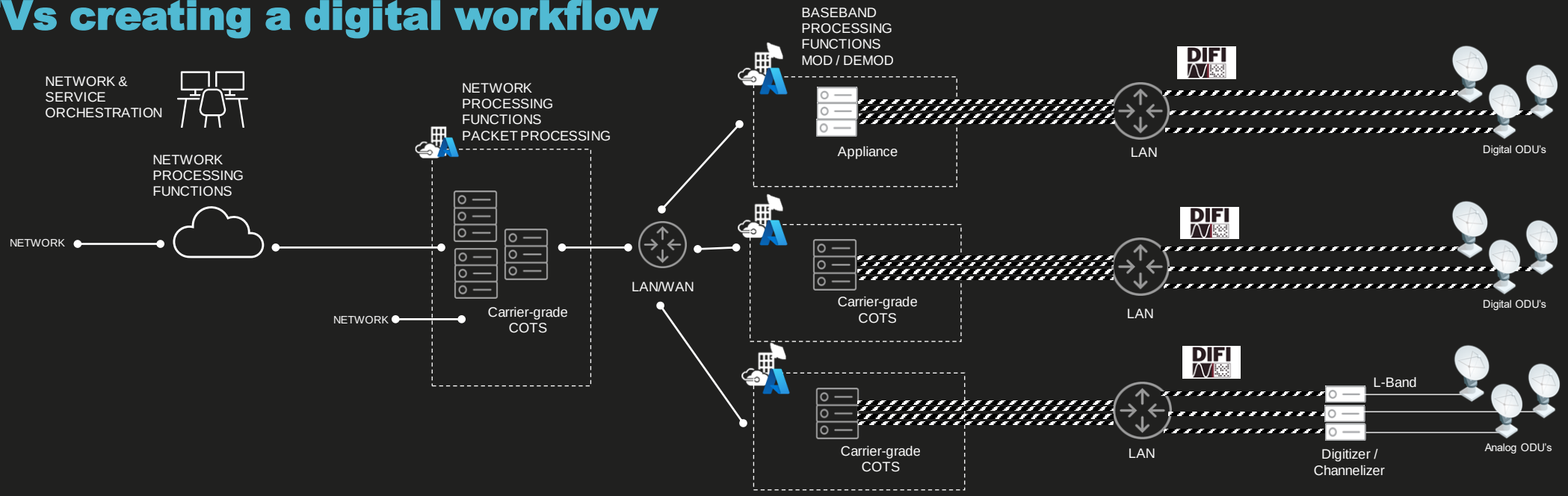
STE iDirect platform function

Deployment options



NFVs creating a digital workflow



CLOUD-NATIVE VIRTUALIZED AND CONTAINERIZED NETWORK FUNCTIONS

- Deployable in Public Cloud or On-Premise COTS

Scale Dynamically

BASEBAND FUNCTIONS

- Deployed on Appliances and Generic Compute
- Deployed on Cloud Provider Edge Infrastructure

Cost Optimized

RADIO OVER IP HANDOFF TO ANTENNA PARK

- DIFI standard support
- Interop with DIFI compliant Digitizers / Channelizers and Digital ODU
- Universal Baseband Node – smooth path to digital teleport

Operational Ease

JOURNEY AND PROOF POINTS

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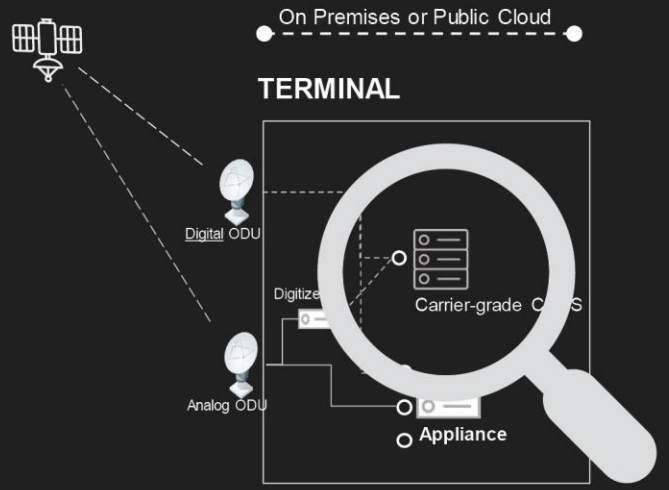
VIRTUALIZED MODEM

POC with Microsoft –Virtualized modem on Azure Cloud Infrastructure

Demo



Modulator / Demodulator @work

Azure Operator Far Edge on-premises Infrastructure

VIRTUALIZED SCPC MODEM

- Deployed on Azure Operator Far Edge on-premises Infrastructure
- SCPC modem successful demonstration
- Wideband Modulator / Demodulator functionally on COTS

VIRTUALIZED SCPC MODEM POC IS A FUNDAMENTAL BUILDING BLOCK FOR OUR CLOUD ENABLEMENT JOURNEY

- COTS based Hub Baseband Devices with distributed processing
- Building Block towards TDMA variant use cases

Global Reach Enabled

Save Time

Improve Scale and Flexibility by decoupling Hardware and Software

Connect on Demand

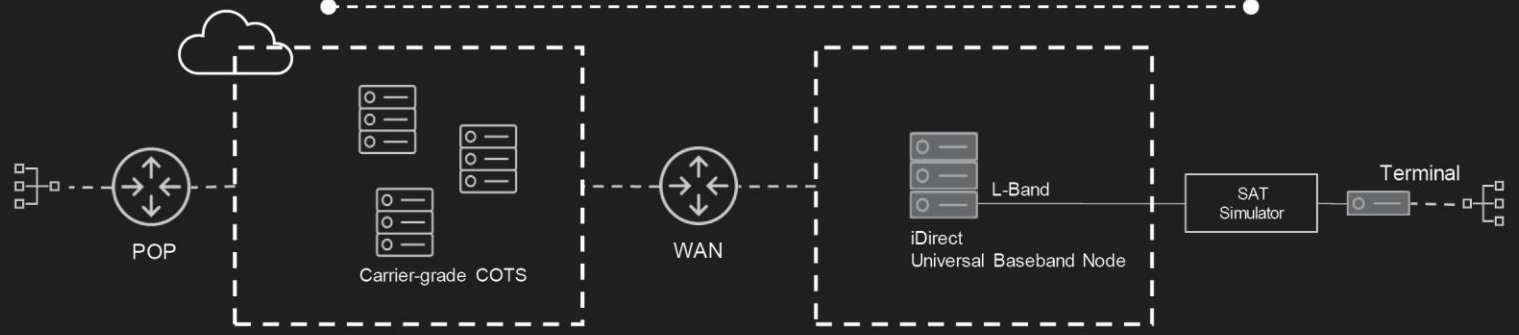
PROCESSING IN CLOUD

E2E Communication Services in Hybrid Cloud

- **Management and Control Deployed in Azure Cloud Regions**

Public Cloud Regions or Local Zones

On Premises



- **Network / Packet Processing VNFs/CNFs** deployed in Azure's Digital Ground Cloud Infrastructure

- **Modulation and Demodulation PNFs** deployed in ST Engineering iDirect Labs

Multi-Services Datapath

Modulator / Demodulator @work

Scale Dynamically

Reduce complexity

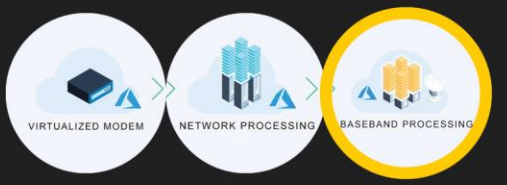
Automated, Software Defined and Open APIs

Provide 'value-added' solutions/ services

Managed Services

DIGITAL TELEPORT

Radio over IP – Standards based DIFI

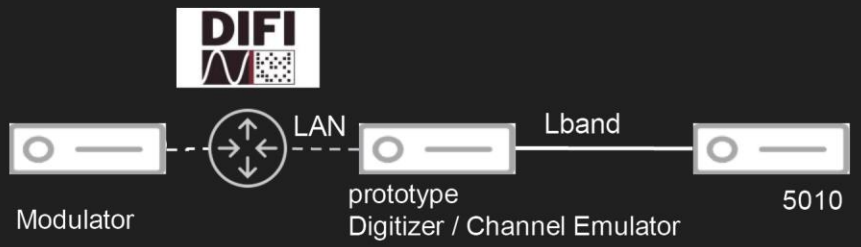


Demo

DIFI Digital Interface

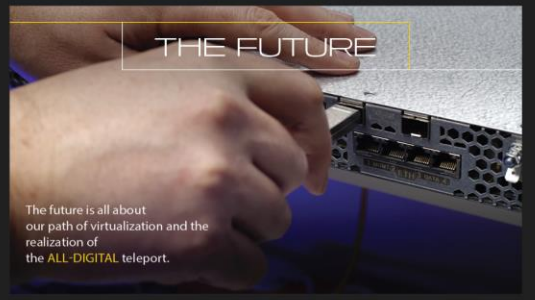
March 2023 – Successfull DIFI Interop

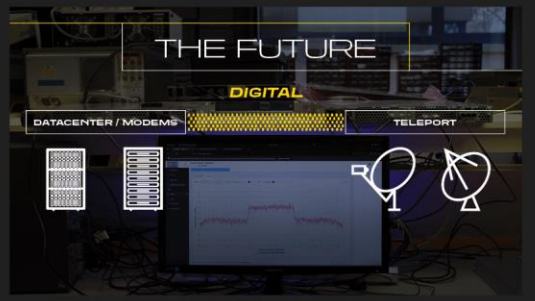
August 2023 – Proving our Radio over IP expertise by adding Digitizer / Channel Emulator in DIFI pipeline



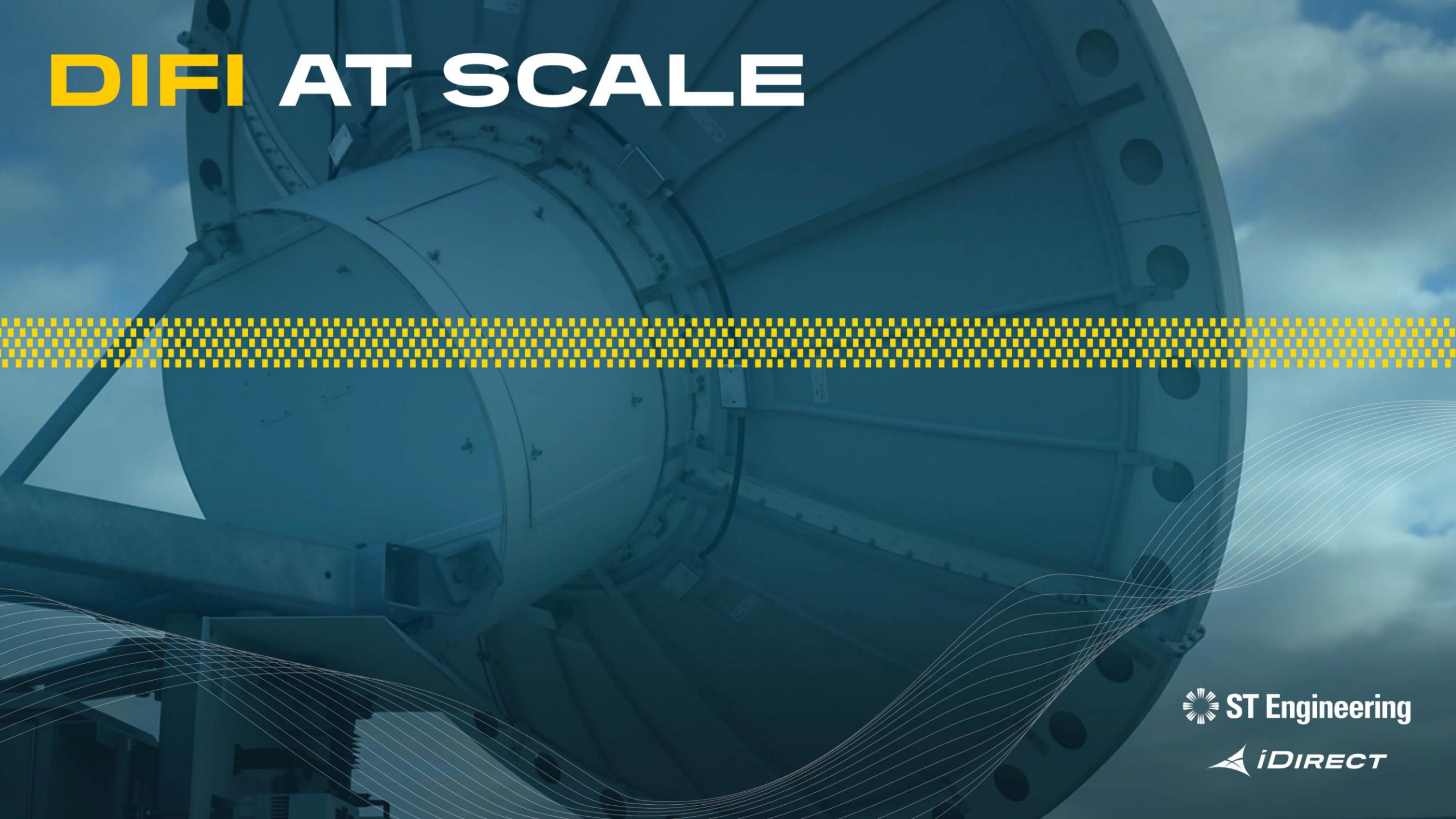
ALL DIGITAL TELEPORT

- Path of Virtualization requires full Digitized Radio over IP handoff
- Loss-less local transmission
- Simplified local signal level management
- Flexible routing/switching
- Standardized GW design (less error-prone)
- Network engineers vs RF engineers
- Flexible band-selection
- Allows for cloud 'COTS HW' baseband processing
- Improved monitoring options





DIFI AT SCALE



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DIFI at Scale

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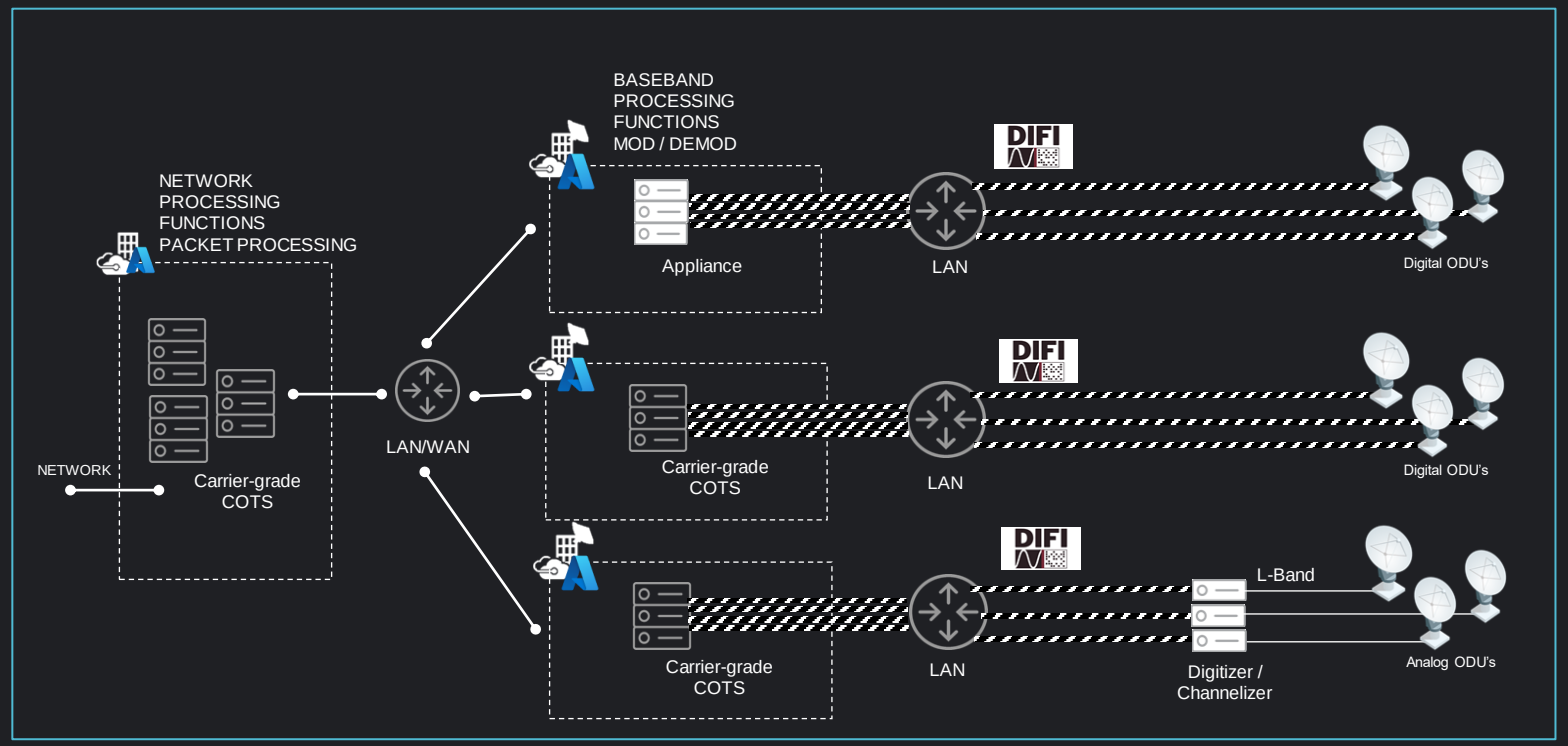

Example Gateway Specification

Per Antenna – FWD: 3G/POL , RTN: 1.5G/POL

iDirect Digital Modem adopting this use case

TX (S2X) : Ranging 140-150Gbps DIFI streams per 1RU
RX (S2X): Ranging 60-80Gbps DIFI streams per 1RU

Aggregated bitrates at Scale

Up to 1.5Tbps per 42RU

Ground Segment Scaling requirements in GHz and Gbps

Ability to provide flexible deployment options and keep control on TCO

Datapath traffic – central versus distributed approach

Need for further reduction of bandwidth at the Edge?

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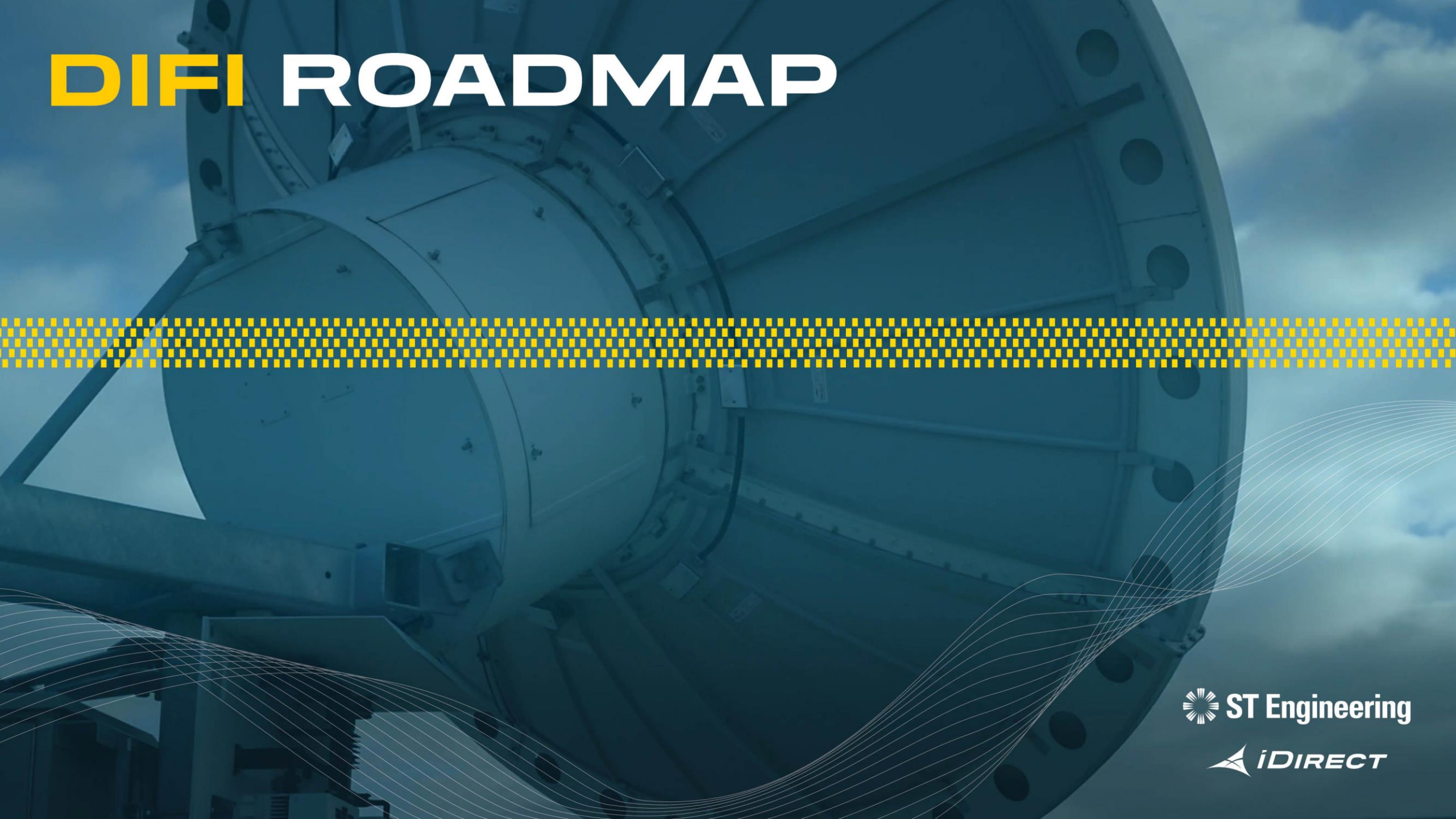
DIFI ROADMAP



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DIFI Roadmap

What is required to be successful ?

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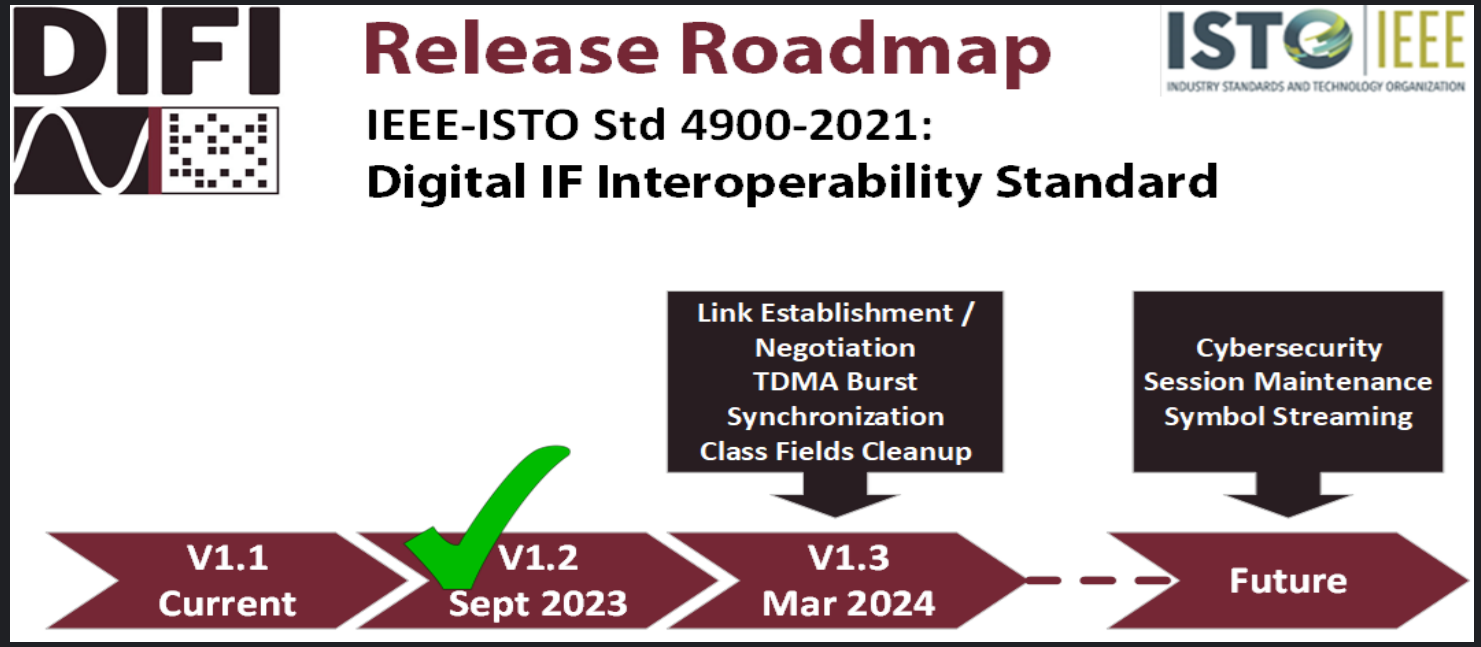


Journey to Deployments at Scale

Timing Synchronization
Essential for Shared Medium operation (eg ATDMA, Mx-DMA)

Lossless IP flows at Scale
Redundancy mechanisms
Reduction in bandwidth
Introducing of Symbol Streaming
Optimized Channelization
Flow Orchestration
Interop with Radio Resource Control

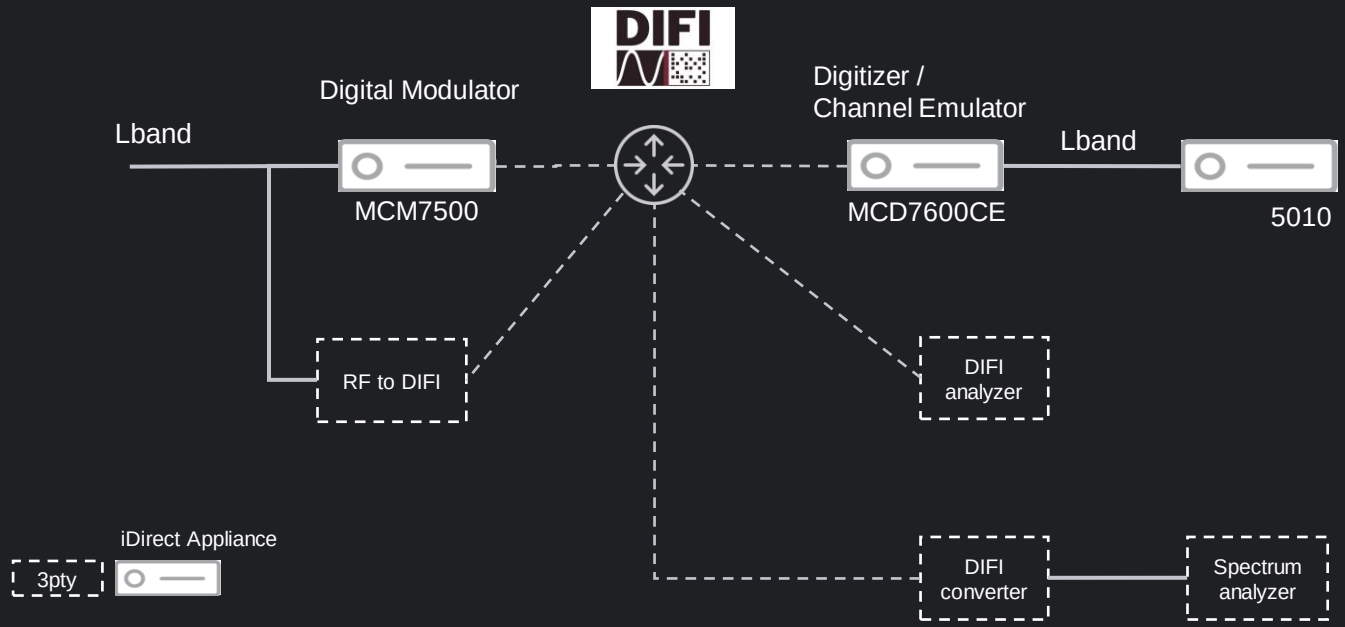
L-band <> DIFI
Digitization / (De-)digitization use cases

DIFI > DECODE/DEMOD
ATDMA / Mx-DMA use cases

Interop Programs

DIFI Interoperability and PlugFest

Results and lessons learned



Test Scenarios

- 12.5 Msps @16 bit (400 Mbps)
- 150 Msps @16 bit (4.8 Gbps)
- 250 Msps @ 6 bit (3 Gbps)
- 500 Msps @ 8 bit (8 Gbps)
- 750 Msps @ 12 bit and 6 bit (18 and 9 Gbps)

Results

- All vendors were able to receive ST iDirect signals (250Msps* and 500Msps*)

*Limited by current appliances under test.
Lower sample rates now possible, were limited in software

What did we learn ?

- Plugfest focused on 1.1 Specifications
- Effect of High-Bitrate UDP streams – packet loss – how to handle / how to overcome ?
- Variety of sample rates - iDirect can handle, but worth evaluating them in the DiFi specs Jitter – max sizing to be explored and proposed to DIFI consortium
- Limited IP networking topology during Plugfest
- Dedicated IP networking setup – how do other vendors networks behave (Jitter, Routed Traffic, etc)
- Buffer Sizes – dynamic versus static - advised

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SHAPING THE FUTURE

of How The World Connects Through Satellite Innovation