Dali virtual Fronthaul Solution

Virtualizing the Fronthaul for 5G
The Dali virtual Fronthaul Solution gives operators, neutral hosts and enterprises a groundbreaking approach to meeting the intense demands placed on the network fronthaul by 5G.

5G promises data intensive applications such as ultra-high definition video, virtual reality, the Internet of Things (IoT), and video social networking. From a network perspective, this represents a 1000x increase in capacity, significantly higher data rates and signal quality, and lower latency, far beyond what traditional fixed point-to-point fronthaul connections can provide. Current RAN architecture has significant limitations in the face of pending 5G demands for ultra-high capacity and coverage.

Dali utilizes full digitization, network function virtualization (NFV) and software defined networking (SDN) to bypass the restrictions of current protocols and deliver a highly flexible, elastic, and scalable solution that can effectively facilitate rapid network expansion, densification, and transition to 5G.

The Dali virtual Fronthaul Solution

The Dali virtual Fronthaul Solution virtualizes the radio resources of the network using a patented two-tier architecture consisting of the Dali Matrix™ suite of modular remote radio units (RRUs) and the Dali virtual Fronthaul Interface (vFI™) which provides the interface between the virtual base station (vBS) or virtual baseband unit (vBBU) and the RRUs.

The Dali virtual Fronthaul Solution works with any vBS or vBBU to deliver a complete, end-to-end virtual radio access network (RAN). In multi-operator deployments, vBSs or vBBUs can be aggregated and signals distributed out to the various venues.

**Full digitization**

Packetized signals retain quality over distance and can be routed dynamically through a multipoint-to-multipoint configuration over existing infrastructure.

**Network function virtualization**

Virtualizing the functions of the remote radio units enables large-scale resource sharing giving outdoor and in-building deployments more flexibility, elasticity and scalability.

**Software defined networking**

Network configuration and management are achieved through software, and can be done centrally, remotely, and dynamically or on demand.
Dali Delivers a 5G-Ready Network Fronthaul

Utilizing full digitization, network function virtualization (NFV) and software defined networking (SDN), Dali’s virtual Fronthaul Solution effectively delivers on the key requirements of a 5G ready network.

| High capacity:                           | - Multipoint-to-multipoint operation facilitates spectrum efficiency |
|                                         | - Dynamic capacity management – entire sectors can be shifted to high demand areas on-demand or per schedule |
|                                         | - Additional resources can be added incrementally |

| High data rates:                        | - MIMO capable – seamlessly upgrade from 10Gbps to 100Gbps to 2x2, 4x4 or higher MIMO, including Massive MIMO |

| High signal quality:                    | - All digital signal routing lengthens reach, avoids signal degradation, and minimizes noise |
|                                         | - High linearity radios support advanced signal waveforms |

| Reduced latency:                        | - Direct digital interface to the multi-point radio network removes excess conversion stages |
|                                         | - Edge computing accelerators perform latency critical processing |

| Cost savings:                          | - NFV runs in software on generic hardware |
|                                         | - Dynamic capacity allocation steering eliminates need for overprovisioning |
|                                         | - Two-tier architecture streamlines resource requirements |
|                                         | - Works with existing equipment and transport, no need to rip and replace |

### Key Characteristics of the Dali Solution:

Increased flexibility, elasticity, scalability together with cost savings, both CAPEX and OPEX to make for a financially viable migration to next generation service provision.

#### FLEXIBILITY | Designed to fit

- Works with any transport protocol: CPRI/ORI/OBSAI, Ethernet-based with new functionality split between BBU and RU, RoE, and future NGFI
- Supports different network topologies
- Accommodates IP Pass Through / backhaul
- Works with any virtual base station or virtual baseband unit
- Supports mobile edge applications

#### ELASTICITY | Designed to adapt

- Delivers a fully digital, adaptable and multipoint-to-multipoint network
- Enables dynamic sectorization
- Radio resource configuration and allocation are dynamic and elastic
- Remotely manage and configure signal routing with Software Defined Networking (SDN)

#### SCALABILITY | Designed to grow

- Supports simultaneous 2G, 3G, 4G and future 5G technologies
- New bands, radio resources, and operators can be added incrementally
- Centralized control for managing increasingly dense/heterogeneous networks
- Provides multi-operator facility with independent management domains
- Designed for both Commercial and Public Safety deployments

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Dali vFI™ | Elevating Networks from Point-to-Point → Multipoint-to-Multipoint

The Dali vFI™ is a 100% digital interface unit that sits between the vBS or vBBU and the RRUs in the network. It intelligently aggregates and then routes digital mobile radio packets and in doing so effectively constructs a virtual multipoint-to-multipoint network structure between the vBS or vBBU and the RRUs.

Optical ports on the incoming side of the vFI are configured to accept mobile radio packets or ‘signals’ according to the network’s transport protocol, and stream forming technology on the outgoing side directs the signals ensuring that signals are delivered to their associated remote radio units only as required. Signals received by the vFI can originate from one or more air interfaces be that 2G, 3G, 4G, 5G or any future technology, and also from one or more mobile operators. The vFI can also be placed at one or more points within the same network, wherever intelligent aggregation and routing is required.

The Wonders of ‘Multipoint-to-Multipoint’

The intelligent routing facility of the vFI sends signals to wherever they are required. To do so it must treat radio resources as logical resources. As a result, it transforms the point-to-point connections of the traditional fixed network into the multipoint-to-multipoint connections of a virtual network. This virtualizes the radio resources. Once radio resources are virtualized, any such resource can be allocated where and when needed, based on the dynamic payload of the network. Capacity provisioning can now be varied according to the level of user traffic, with more, or less, capacity allocated towards a single or multiple RRU as needed.

In terms of implementing 5G this new level of virtualization has a significant impact.

Network efficiency: ‘Multipoint-to-Multipoint’ operation eliminates the need to provision every destination point in the network with the peak capacity. As a result, systematic capacity over-provisioning is no longer an issue. This increases the utilization of valuable base station resources and spectrum assets, drives down the Total Cost of Ownership (TCO) for mobile operators and improves the overall mobile experience for users.

Bandwidth management: Different inputs (either frequency band or carrier) can also be dynamically selected for delivery to the different RRUs. This reduces the total fronthaul bandwidth required, again driving costs downward.

Streamlined scaling: ‘Multipoint-to-Multipoint’ operation also streamlines network scaling as it enables additional resources to be added centrally on an incremental basis and distributed virtually to any connected remote radio units within the network.

Dali Matrix® Remote Radio Units (RRUs)

The Dali Matrix® RRUs are available as low or high power units to support any type of application. The RRUs can process instantaneous bandwidth of up to 320 MHz on the uplink path and up to 320 MHz on the downlink path over a single optical wavelength. The RRUs are modular, which makes reconfiguration easier, and can support additional frequency bands as required. Dali Matrix RRUs support a star, daisy chain, or hybrid star/daisy chain configuration. In daisy chain configuration the number of RRUs in the chain is limited only by the round trip delay of the specific air interface technology. As a result, the RRUs are easily scaled to support any type of application ranging from an individual vertical deployment, to high density urban areas, to complete city areas.

Network configuration and management can be done remotely and on demand, allowing for rapid reconfiguration of the network on a national and regional basis.
Deployment Scenarios

By deploying Dali’s virtual Fronthaul Solution, mobile operators take advantage of:

- Flexible resource sharing and slicing to optimize network efficiency
- A “pay-as-you-grow” or scalable implementation model in which capacity and operators can be added incrementally
- Reduced footprint and power consumption from eliminating the high power radio attenuators that serve as the analog interface to base station remote radio heads
- Reduced network complexity and improved network performance
- The ability to rapidly innovate and adopt new technologies and business models
- Overall reduced capital and operational expenditure
- A future-proof platform that is 5G ready

Dali’s virtual Fronthaul Solution can be scaled to any size to support any type of application. It can support complete city areas, high density urban areas or individual vertical deployments from a centralized or virtual data center.
Virtual Fronthaul Interface (vFI™)

The vFI™ provides the fronthaul interface between the vBS or vBBUs and the Dali Matrix RRUs – hd30™ and hd43™. The vFI is a 1 RU unit that can fit in a standard 19” rack.

Each vFI has sixteen 10 Gbps optical interfaces that support CPRI, ORI, OBSAI and NGFI bit rates. The vFI enables centralized processing of multiple vBS or BBUs and can aggregate multiple data streams at different data rates to deliver the content to the network of Dali Matrix RRUs. The processing capability of the vFI can be increased by cascading multiple vFIs. Each vFI also has four 1 Gbps Ethernet interface that provides backhaul to carry IP traffic from WiFi access points or other IP appliances such as IP cameras and small cells.

On the downlink (DL) path, the vFI accepts multiple digital data streams from different vBS or vBBUs at different data rates. It aggregates, translates and frames the content into single or multiple 10 Gbps CPRI serial data streams. The content is then transported directly to multiple Matrix RRUs through fiber optic cable. On the uplink (UL) path, the vFI receives optical serial data streams from multiple RRUs. The data streams are de-serialized and translated to different CPRI, ORI, OBSAI and NGFI bit rates. The desired line bit rate data streams are then delivered to the vBS/vBBUs.

hd30™ - Low Power Remote Radio Unit (RRU)

The hd30™ is a low power modular radio unit that can process up to 4 RF frequency bands simultaneously. The hd30 is connected to the vFI over a single optical fiber link with a data rate of 10 Gbps and an optical link budget of 15 dBo to 30 dBo. It can also accommodate a 1 Gbps or higher IP backhaul over 4x1 Gbps Ethernet interfaces with Power of Element (PoE). On the DL path, the hd30 receives the digital data stream from the vFI and converts the signal back into RF for transmission over the antenna.

On the UL path, the hd30 converts the RF signal into a digital data stream and transports the signal over a single optical fiber to the vFI unit. The hd30 can process aggregated RF bandwidth of up to 320 MHz on uplink and up to 320 MHz on the downlink path. The hd30 can be connected to the vFI in a star, daisy chain, or hybrid star/daisy chain configuration. Dali’s ability to support multiple topologies enables greater system design flexibility, and reduces fiber requirements and installation costs.

hd43™ - High Power Remote Radio Unit (RRU)

The hd43™ is a high power modular radio unit that can process up to 4 RF frequency bands simultaneously and transport data over a single optical fiber at a data rate of 10 Gbps. It has an optical link budget of 15 dBo to 30 dBo and can accommodate 1 Gbps or higher Ethernet backhaul via 4 ethernet interfaces with PoE. On the DL path, the hd43 receives the digital data stream from the vFI and converts it back into RF for transmission over the antenna.

On the UL path, the hd43 converts the RF signals into digital data streams and transports the signal over a single optical fiber back to the vFI. The hd43 can process aggregated RF bandwidth of up to 320 MHz on uplink and up to 320 MHz on the downlink path. The hd43 can be connected to the vFI in a star, daisy chain, or hybrid star/daisy chain configuration. Dali’s ability to support multiple topologies enables greater design flexibility, and reduces fiber requirements and installation costs.
### Virtual Fronthaul Interface (vFI™)

**Optical**
- Optical Ports: 16 x LC/UPC
- Optical Transport Data Rate: 2.4576 | 3.072 | 9.8304 Gbps

**Environmental**
- Operating Temperature: -5 to +55 °C
- Relative Humidity: ≤ 90%

**Mechanical**
- Size (W x H x D): 3.9” x 7” x 24” | 99 x 178 x 610 mm
- Weight (Fully loaded): 5 lbs / 2.3 kg

### hd30™ - Low Power Remote Radio Unit (RRU)

**Radio Frequency (RF)**
- Number of Supported RF Band Modules: 4
- DL Maximum Output Power: 30 dBm per band

**Environmental**
- Standards: IP65 | NEMA 4/4X
- Operating Temperature: -30 to +55 °C
- Relative Humidity: ≤ 90%

**Others**
- Operating Power: -48 VDC
- Size (W x H x D): 16.5” x 17.8” x 7.3” | 420 x 454 x 185 mm
- Weight (Fully loaded): 53 lbs / 24 kg

### hd43™ - High Power Remote Radio Unit (RRU)

**Radio Frequency (RF)**
- Number of Supported RF Band Modules: 4
- DL Maximum Output Power: 43 dBm per band

**Environmental**
- Standards: IP65 | NEMA 4/4X
- Operating Temperature: -30 to +55 °C
- Relative Humidity: ≤ 90%

**Others**
- Operating Power: -48 VDC
- Size (W x H x D): 15.7” x 31” x 6.9” | 398 x 788 x 176 mm
- Weight (Fully loaded): 77.4 lbs / 35.1 kg
Dali virtual Fronthaul Solution - Virtualizing the Fronthaul for 5G

Benefits:
- Reduced Footprint
- Spectrum Efficiency
- Supports Open Mobile Edge Cloud for IoT
- Future Proof – 5G Ready

Learn more at www.daliwireless.com/virtual-Fronthaul-Solution