MAVENIR

Open Virtual RAN cell site resiliency and energy efficiency

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MAVair

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1. Executive Brief

Open Virtualized RAN (Open vRAN) enables more energy efficiency and resiliency compared to traditional hardware-built wireless networks. Mavenir's resilient Open Virtual RAN (Open vRAN), part of the MAVair™ portfolio, enables support for cell site resiliency compared to existing silicon-based cell site solutions. This resiliency architecture can be used for energy efficiency based on traffic patterns and/or power availability (e.g., battery powered, or grid powered). It also provides support for emergency use cases, such as natural disasters and public safety. Open vRAN provides resiliency among suppliers by avoiding vendor lock.

2. Introduction

Open vRAN allows operators to build their networks with increased resiliency and energy efficiency built-in, a significant improvement from traditional, hardware-based networks.

Cell site configurations in today's wireless networks typically consists of three physical sectors with multiple cells or frequency bands serving each sector. Examples include, but are not limited to, 3G, 4G, 5G, NBIOT. Each sector is typically served by one or more Radio Units (RU) that are connected to a Distributed Unit (DU) server alternatively known as a Base Band Unit (BBU) located at the bottom of the cell site tower. The distributed RUs and DU's at each cell site represent the largest cost of a wireless network deployment. This is both energy-intensive and costly. Figure 1 shows a typical cell site deployment where the RU and DU are located at the tower and are connected to the centralized unit (CU) and the management system in a centralized data center location.

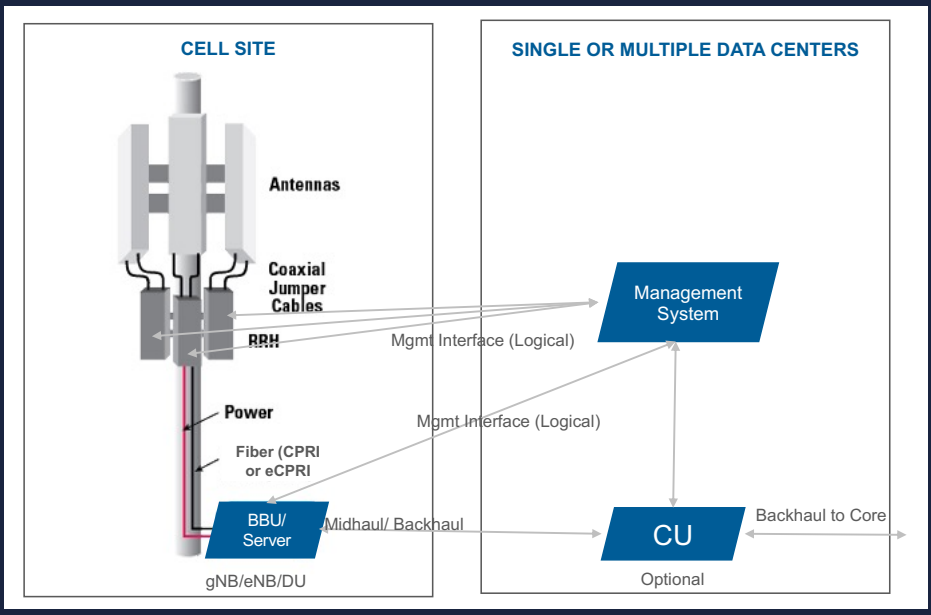

Figure 1: Wireless Cell Site

Traditional hardware-built networks are also vulnerable to outages. At each cell site, we need multiple RUs per sector for each frequency band (or group of bands) and one or more DUs or BBUs. Due to high cost of these components and volume of such hardware in a network deployment, operators, and vendors with proprietary silicon/CPRI interface solutions with dedicated connections to each radio are unable to have and cannot afford to provide redundancy for these components at a cell site. As shown in Figure 2, this will lead to an outage of a cell site (or a band/sector of a site) whenever there is a hardware failure of the RU and an outage of the complete site (across all sectors) when a BBU fails (when the site is served by a single BBU).

An outage results in loss of service for a given site until the hardware can be physically replaced, which could take several days in remote/inaccessible areas, leaving networks down. This is currently the trade-off between cost of additional hardware at the cell site versus building networks to be more resilient (100% availability of coverage at the site).

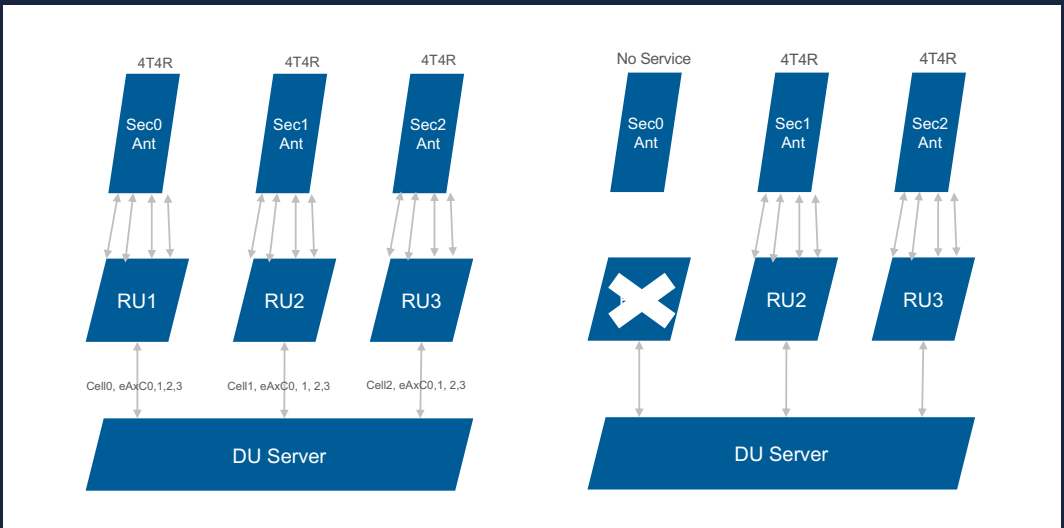

Figure 2 : Single RU Failure Resiliency

Figure 2 shows the normal logical configuration of a cell cite and the resultant loss of service should a radio unit fail. Where these configurations are fixed through dedicated fixed Silicon, service would not be available till the physical RU had been replaced.

Prior to Virtualized RAN (vRAN), wireless network operators-built networks without factoring in resiliency, given the high costs for redundant hardware at each cell site. Networks were built based on geographic coverage with overlaps. This has resulted in poor performance on the air interface, due to higher interference during normal operations and due to larger overlap in coverage. Current solutions are sub-optimal as the coverage comes at the cost of increased cell density or increased interference, leading to poor air interface performance.

3. Mavenir Open vRAN Architecture Addresses Resiliency

Open vRAN allows networks to be more resilient. Using Mavenir Open vRAN, built using the O-RAN front haul interface between the radio and the DU server, operators can address the problem of resiliency for the BBU and RU at the site without adding additional standby hardware components.

Resilient Open vRAN networks do not need to rely on increased overlap in coverage across sites/ sectors to avoid failure of one RU from rendering that cell/carrier out of service. Mavenir resilient Open vRAN enables the system to maintain operation at reduced throughput during failure. Even in sites deploying only a single carrier, based on Mavenir's resilient architecture, a failure of an RU does not lead to shut down of a cell; rather, it just reduces the MIMO capability of the cell.

The resiliency option provided by Mavenir's architecture is always better than losing coverage completely or adding more cells just for this failure duration from a cost perspective. Mavenir's resilient Open vRAN improves the air interface performance by reducing overlap during steady state normal operation and provides a low-cost option to continue the service in sectors when an RU fails with reduced throughput / MIMO layers. Once the non-working RU is replaced, the performance is restored back to normal.

4. Better Energy Efficiency

Deployment of the Open vRAN network with Mavenirs resilient functionality also allows the use of the same architecture for energy savings. By turning off RUs (by design and analogous to a failure) during the low traffic hours, networks can maximize their energy savings. This brings in a much higher energy savings compared to existing schemes where there is a need to maintain at least one RU per sector in the "POWER ON" state to provide uninterrupted coverage (even with prior known techniques such as MIMO layer shutdown or carrier shut down methods for energy saving).

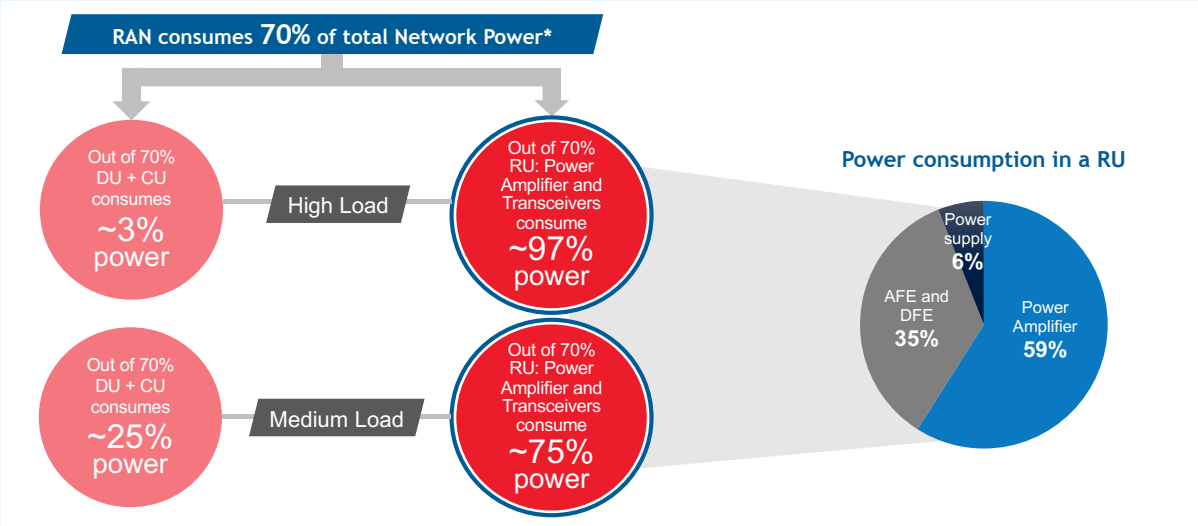

Figure 3 : Energy consumption in 5G networks

**ABI report: 5G Energy Consumption and Operator Sustainability Initiatives, March 2022*

Keeping a portion of the RU in the transmission state means that the RU cannot be completely powered off, especially the digital circuits, which are typically serving all the antennas and hence cannot be shut down fully. Mavenir's resilient Open vRAN architecture allows the use of one or more RUs across multiple sectors, with reduced throughput, while the remaining RUs can be completely shut down (except for minimal interface functions) to maximize energy savings.

5. Mavenir Resilient Open vRAN

Mavenirs resilient Open vRAN is designed using the open front haul interface from the O-RAN alliance and which is based on packet-based transmission between the elements and the eCPRI defined protocol. Using packet-based transmission and ethernet addressing allows the DU to dynamically assign the O-RAN fronthaul ethernet protocols to the specifically defined RU or in the case of a failure to dynamically assign the information to a supporting RU.

In Mavenir's resilient architecture, each antenna per sector is served by a combination of two or more RU hardware connections. This allows the physical coverage in a sector to be maintained even when one of the RU fails by using the only those antennas which are being served by the remaining working RU units in the site. This scheme can be implemented for 2T2R or 4T4R sites and is also extensible to more than 4 antennas per sector in a similar manner.

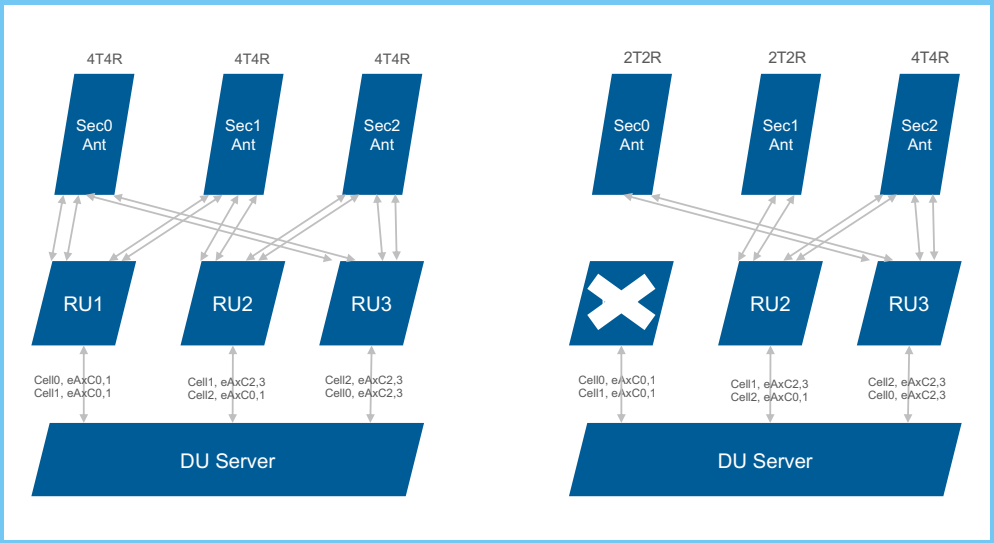

Figure 4 : Single RU Failure Resiliency

By connecting multiple RUs to a given sector, we can also achieve energy efficiency during lean traffic hours, by shutting down one or more RUs while letting the remaining RUs serve all the sectors in each site with reduced Tx/Rx Antennas/ MIMO Layers. This shut down can be rotated across RUs across days/lean hour windows to minimize switch ON/OFF cycles for a given RU unit equally across the units. (Note: the drawings above depict the logical interconnection).

The re-routing of radio packets is performed at the base band in the DU. The DU and CU computing hardware can also be designed using proven techniques for resiliency, such as hot or cold standby including the duplication of computing hardware.

In Summary, Open vRAN provides a resilient fault tolerant open interface architecture and does not require additional equipment at the cell site.

About Mavenir

Mavenir is building the future of networks and pioneering advanced technology, focusing on the vision of a single, software-based automated network that runs on any cloud. As the industry's only end-to-end, cloud-native network software provider, Mavenir is transforming the way the world connects, accelerating software network transformation for 300+ Communications Service Providers in over 120 countries, which serve more than 50% of the world's subscribers.

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