5G Mobile Networks for Military Air Services

The application of emerging high-speed wireless networking technologies is critical to efficient peacetime military operations and future battlespace scenarios. Military service branches with air assets are some of the first to study the use of 5G new radio (NR) technologies.

Aircraft are considered critical tactical resources in almost every unified military strategy and keeping these limited resources in a state of preparedness or in the air is of upmost importance. Doing so requires an in-depth understanding of how a particular plane has performed during its previous mission, enabling preemptive maintenance before larger issues arise or warning crews of potential problems as they prepare for their next operation. This analysis must be performed as rapidly as possible to reduce the length of time an aircraft is grounded but given the incredible amount of data these modern aircraft produce, this is no easy task.

To get an understanding of exactly how much data, we can look at today's commercial aviation fleets. Continuously monitoring nearly 500 distinct parameters and collecting up to 10,000 data points per second, the engines alone can produce around one terabyte of data on each flight. A significant subset of this data must be systematically downloaded then analyzed for anomalies and compared with historical statistics using the type of processor-intensive machine learning algorithms historically only available within centralized data centers. This is all easily achievable in the controlled environments of an airline hub where high-speed fixed broadband connections are readily available at terminal gates and compute capacity is already present for serving the general operational needs of the airport. Airline schedules also provide plenty of time for these actions to be performed.

Even during peacetime training maneuvers, forward operating air bases do not enjoy these same, dependable, amenities and there is little time to spare when it comes to readying for the next flight. When that peace is broken, the nature of airfields become even more ad-hoc and the urgency to get aircraft refueled and back in the air ever greater. Among other things, this means starting the data collection and analysis process the second wheels touch down on the runway. With applications like this in mind, enhanced mobile broadband (eMBB) is one of the three corner stones of 5G NR.

Employing spectrum in the millimeter wave (mmWave) band, with multiple input/multiple output (MIMO) antennas featuring the latest beamforming, steering and switching techniques to mitigate the high propagation loss, eMBB can deliver fiber-like broadband speeds to mobile endpoints. Designed to support fast moving vehicles and trains, 5G NR's antenna tuning technologies operate much faster and more robustly than their 4G LTE predecessors, allowing for handoff between the increased number of access points to occur without adversely effecting service. This is particularly important given the large size of airfields and the dramatically reduced range of new radio – even when there is nothing restricting the line of sight.

For a typically runway alone, a 1,000ft effective signal range would require six to eight 5G base stations to be

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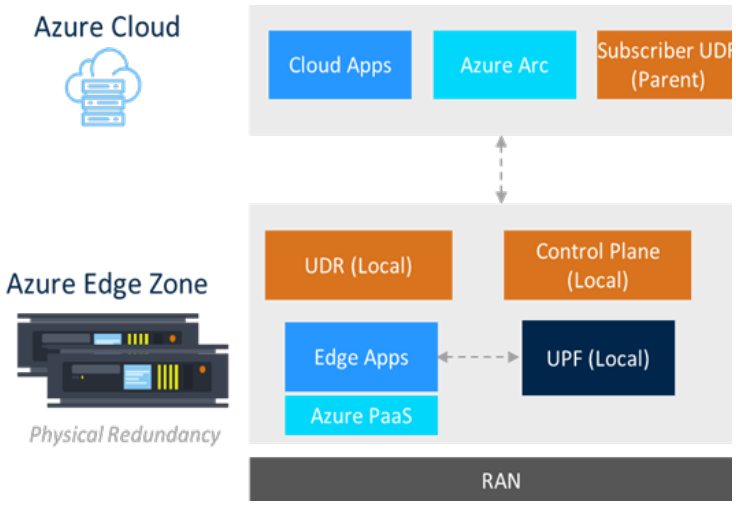
installed. While this sounds daunting, there are several architectural and technological advancements in 5G that will dramatically simplify the process. The distributed nature of the standardized open radio access network (O-RAN) enables antennas to be implemented with a limited subset of gNodeB (gNB) functionality. An optimal configuration when using mmWave MIMO, devices supporting simply the remote radio unit (RU) and distributed unit (DU) can be dropped along a runway and taxiways. A common central unit can then control the operation of the DUs, including load-balancing between RUs. The combination of one CU supporting multiple RU/DU's create a single logical gNB.

There is another big advantage of this distributed RAN in battlefield scenarios in that Integrated Access and Backhaul (IAB) techniques can eliminate the need for wired connections between base stations. IAB allows for multi-hop wireless backhaul using either dedicated frequencies and antenna arrays or the same frequencies and arrays employed for the user equipment. With IAB, the RU/DUs would simply need power - which could even be supplied from self-contained battery packs on a temporary basis - enabling the entire RAN to be operational within an incredibly compressed timeframe. Once the RAN has been successfully established, the 5G core (5GC) must be instantiated.

Like the radio access network, the 5GC components must be lightweight but highly robust. A minimal subset of key 5G core and service-based architecture (SBA) elements must be locally deployed, using as few compute resources as possible and in a manner that allows them to operate even when completely disconnected from centralized network functions. Metaswitch Fusion Core was built with exactly these deployment scenarios in mind. Our control (SMF/AMF) and user plane functions (UPF) require only a handful of CPU cores of a ruggedized edge server platform. This leaves ample processing capacity to support not only the O-RAN CU and the underlying network routing services but also the data processing applications, themselves. The more analytical intelligence that can be applied at this point, to the information being received from the aircraft, the quicker that data can be acted upon.

Fusion core is also uniquely architected to operate completely independently of a larger 5G infrastructure, if backhaul interfaces to centralized SBA elements or



A tactical 5G cell platform

data networks are unavailable. This is achieved by locally replicating the required subset of subscriber information and synchronizing when such connectivity is available. In this indirect mode of operation, Fusion Core can function independently for a couple of hours or a few months. Fusion Core also features an exclusive 4G-5G interworking function (IWF) that enables LTE eNodeB (eNB) radio access networks to coexist with NR infrastructure within the airbase. This facilitates support for subscribers and user equipment employing older wireless access technologies without the need to deploy or maintain a legacy evolved packet core (EPC).

An increasingly intrinsic part of future multi-domain battlespaces Microsoft Azure, Metaswitch Fusion Core and our RAN partners are delivering on the promise of a highly survivable, tactical 5G cellular platform for land and sea. Microsoft Azure provides defense departments the peace of mind of a government accredited cloud. Ideal for serving remote strategic airfields, Azure Private Edge Zones are small footprint extensions of Azure that, when deployed on ruggedized hardware with uninterruptable power supplies, are perfect for military-grade applications.

Like Fusion Core, Azure Edge Zones continue to support the complete suite of Azure services even when there is no direct or continuous connection to the cloud. Even in these demanding deployments, operations are simplified through Azure services such as SIM provisioning and management tools like Azure Arc, which standardizes the command-and-control interface across this broad range of large-scale resources and diverse locations.