



Kajeet's Aether Journey

Developing A Commercial Private 5G Platform

October 27th, 2022



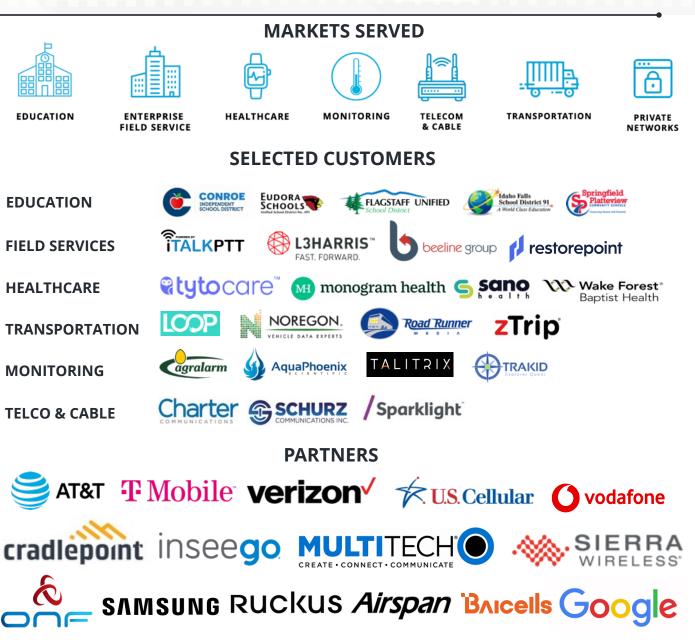


Kajeet Private Wireless Overview

Derrick Frost SVP & GM Private Wireless

kajeet. AT A GLANCE

- A Leading Wireless Managed Service
 Provider
- > Nearly two decades of experience
- Leading US provider of off-campus
 wireless internet for students
- → Over 3,000 Customers
- → Service 7 Large High Growth Verticals
- → 5.5M+ Lines Connected
- Award-Winning Sentinel/Excalibur
 Platform
- → 40 U.S. Wireless Patents
- → Launch MSP for Charter/Comcast MVNOs
- > 40+ Private Wireless Deployments



THE START OF OUR JOURNEY



< back to overview

ONF's Aether Private 5G Open Source Platform Selected by Kajeet to Build an Enterprise Private 5G Network Offering

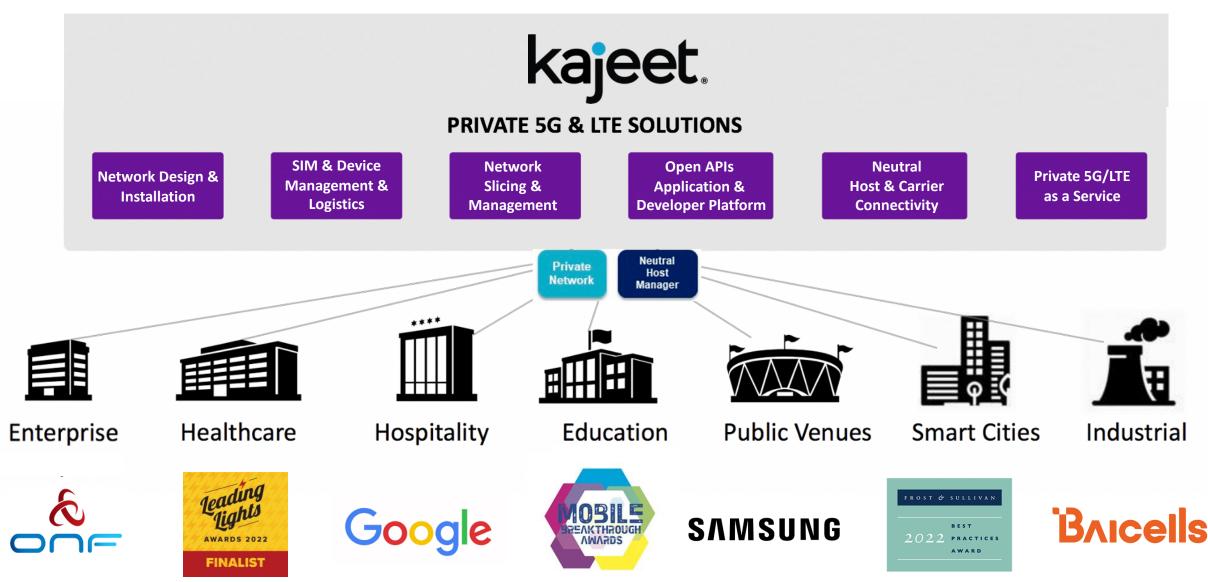
MENLO PARK, Calif., June 1, 2022 – The Open Networking Foundation (ONF) today announced continued momentum for its open source AetherTM private 5G platform, with Kajeet announcing it will leverage Aether to build their own private 5G Networks-as-a-Service offering. The Kajeet solution provides a cloud-based platform providing enterprises Private LTE and 5G, both indoor and outdoor, with seamless mobility between public and private cellular networks, as a turnkey cloud-managed Network-as-a-Service.





KAJEET PRIVATE WIRELESS

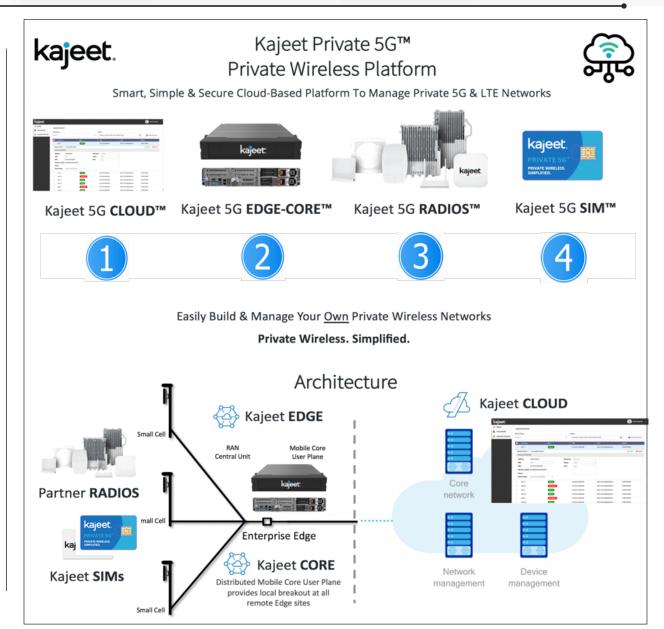
Open, Smart, Simple & Secure Cloud-based Platform To Manage Private 5G & LTE Networks





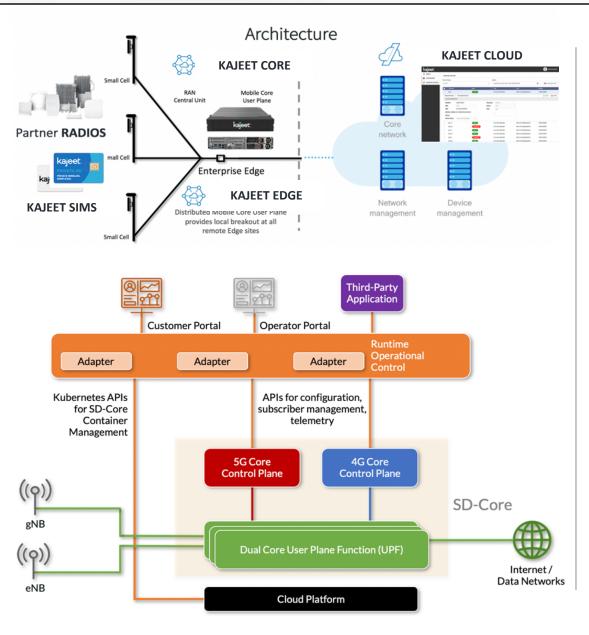
KAJEET PRIVATE WIRELESS

- Simple & Flexible Plug & Play Setup & Management To Quickly & Easily Deploy & Manage Your Own Private 5G & LTE Networks
- End-To-End Platform Complete Private Wireless Solution – Radio, Core, Edge, Cloud, SIMs & Devices
- Cloud Management & Control Cloud-Based SIM, Device & Network Management. End-To-End Smart Slicing with QOS SLA Assurance for mission critical applications.
- Mobile Edge Cloud On Premise CORE User Plane
- **Smart** Leverages Analytics, AI and ML to proactively manage network and optimize performance
- Open Ecosystem Supports Multiple RAN Vendors with Open APIs, For Full Flexibility & No Lock-in
- Managed Service Delivered "as-a-Service"
- Cost-Efficient Carrier-grade Technology & Services with Cost-effective Pricing



kajeet.

PRIVATE 5G PLATFORM



Cloud-Native, Smart, Open, Flexible, End-to-End, Managed Service

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Aether Journey

Dan Rittenhouse Sr. Director Technical Operations

Aether Journey to date

SCALING ABILITIES & REDUNDANCY

- To scale the system to support 400 attached eNBs and 10k attached UEs, we have:
 - Deployed the SR-IOV UPF
 - Validated a 4 UPF configuration
 - Enabled configs on the SR-IOV NICs to support HA on the MME
 - Demonstrated an F5 SCTP Load Balancer to work around the GKE limitation encountered to support HA.
- Demonstrated large clients can be onboarded and managed on the Aether platform.
- These loads are also able to be managed and monitored via Grafana dashboards.

PROVISIONING SUBSCRIBERS AND SIMS

- New HSS subscriber APIs allow support reps to search and locate existing subscribers in the ROC dashboard / third party system consuming ROC APIs.
- Support reps can update subscriber information, including APN values, as needed via these same methods.
- SIMs can be provisioned via the ROC dashboard as well.

OPERATIONAL CAPABILITIES

- SNMP MIBs developed and being consumed by Datadog, Kajeet's monitoring tool, for Baicells eNBs.
- Operational monitoring data is integrated into Datadog.
- Grafana dashboards display key system metrics as well as more detailed views of system components.



Functionality Enhancements to the Aether Platform

MULTI-TENANCY AND IP ALLOCATION

- Virtual APNs can be allocated, allowing for multi-tenancy and the ability to define gateway-specific APNs (multiple PGW with single APNs).
- Static IP allocation is also allowed, providing the ability to configure IP pools for different APNs.

ANTHOS HYBRID CLOUD DEVELOPMENT & MANAGEMENT

• Centralized management of application deployment.

SECURITY FEATURES

• An audit trail tracks configuration and other changes made by users.



Resolution of Aether Platform Bugs

PERFORMANCE ISSUES

- 30% packet loss in UPF when running multiple UPFs (multiple UPFs compete for CPU resources).
- Cannot attach users to more than one UPF.
- Inability to delete a UPF.

API LAYER

• Database not receiving SIM and device value updates (POST API context deadline exceeded error).



Performance Testing Summary

Scenario 4 UPFs and 4, 8, 12 UEs

- Small packets we were able to attain a throughput of 250Mbps
- Medium packets we were able to attain a throughput of 3.6Gbps
- Large Packets we were able to attain a throughput of 8.9Gbps

From information and full testing results https://arterra.atlassian.net/browse/KPW-361



Next Steps

Bugs to Resolve

- In Progress Unable to provision at scale via ROC UI (maximum message size in gRPC).
- Keycloak user admin UI does not save changes into the database. Must use backend file upload process.
- Unable to delete SIM via ROC UI.

OPERATIONAL ENHANCEMENTS

- Database not receiving SIM and device value updates (POST API context deadline exceeded error).
- In Progress Unable to provision at scale via ROC UI (maximum message size in gRPC).
- Automate SIM provisioning.

PERFORMANCE ENHANCEMENTS

- Validate 30k UE load.
- Achieve redundancy at every system component.

SECURITY ENHANCEMENTS

- Integrate with our IDP platforms Azure AD / Okta.
- Further analysis is required to establish all the security tenants needed in production.



Next Steps

SOLUTION ENHANCEMENTS

- Finish certification of Ruckus and Airspan RAN integrations.
- Implement a version that does not have all the overhead and limitations we encountered with Google Anthos. (Small single tenant)
- Create and validate fully multi-tenant solution.
- Build out MEC app developer platform.
- Implement a fully-cloud hosted solution (small customer implementation solution) if customers have a need.
- Maturity around caring and feeding for this open-source platform. This will require a significant amount of investment to keep the public code base and our code base in sync, tested and stable.
- Engage the TST at ONF to adopt current OS platforms and automated test frameworks.
- Re-visit static IP solution so that a UPF is not consumed by a static pool.

Utilizing Aehter in new interesting ways

- As the core for a MOCN gateway solution to support higher ED
- To provide core for large public library systems allowing them to leverage the Core capabilities and our Sentinel filtering and reporting capabilities.



Contributing Back to the Community

- Identified and resolved 15 bugs that we will check back in to the mainline code
- Still working through how to contribute back new features/enhancements

