Solution Brief

5G Network Performance Assurance

5G brings an explosion in the number of endpoints and services created with network slices and chains. Network functions will be distributed in new environments and leveraging edge cloud, containers and microservices architecture. This will transform the way services are delivered to the end user, which calls for radically different approaches to network and service assurance. What's needed: strengthened automation for network performance management and effective software-based performance management tools.

The granular information and reporting timeliness built into Accedian's solutions are unparalleled in the industry, providing exactly what a 5G operator must incorporate into its services platform from day one. Accedian's standards-compliant software stack for active and passive service analytics lends itself to integration with virtual and physical elements distributed throughout the network, making management ubiquitous, real-time, and supportive of demanding 5G requirements.

For more than a decade, Accedian has provided cutting-edge solutions for continuous network visibility and assurance. This solution brief outlines how Accedian continues to transform network performance and service assurance to empower 5G operators with insight into both physical network and virtual service operations.

As early 5G services are rolled out in key markets, the importance of qualifying and assessing their performance, and that of the networks on which they run, is brought into stark focus.

The 5G Network

In short, 5G networks aim to fulfill three distinct service types or business models:

xMBB – Enhanced, extreme, or extended mobile broadband. Network users experience speeds in excess of 1 Gbps, as well as very low latency.

mMTC – Massive machine-type communications, also known as the Internet of Things (IoT), brings networks access to millions of connected devices ("things") at a reasonable cost.

cMTC – Critical machine-type communications, sometimes referred to as ultra-reliable low latency communications (uRLLC), targets applications like remote surgery and real-time, man-machine controls.

To satisfy the needs for all three service types, mobile networks must undergo a transformation in all areas and layers—including wireless access methodologies and frequencies, and management of transport, cloud, application, and network performance.

The three pillars of 5G also change requirements for the underlying networking subsystem in terms of bitrates, number of connections, resilience, and quality. Different mechanisms are needed to quantify how well a particular service is working.

Use Cases and Requirements

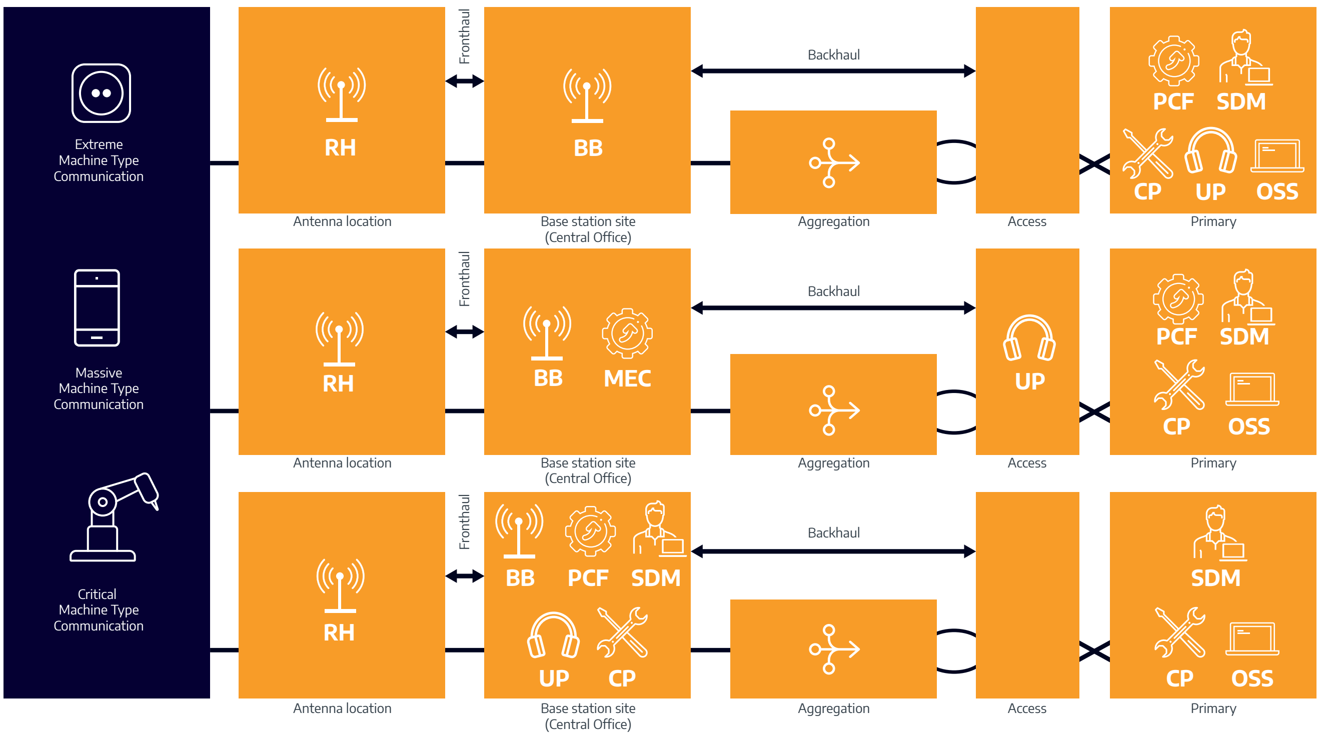
The table on the right outlines 5G quality metrics required for different services 5G quality metrics—an area where Accedian can provide expertise.

Use case	Requirements	Desired metrics
Autonomous vehicle control	Latency	5 ms
	Availability	99.999%
	Reliability	99.999%
Factory cell automation	Latency	Down to below 1ms
	Reliability	Down to packet loss <10-9
High-speed train	Mobility	Downlink: 50 Mbps Uplink: 25 Mbps
	Latency	10 ms
	User Throughput	500 kph
Large outdoor event	User Throughput	30 Mbps (900 Gbps/km2)
	Reliability	95% coverage
Massive geo-dispersion	Density	1,000,000 devices per km2
	Latency	99.9% coverage
Media on demand	User Throughput	10 Mbps
	Latency	5 sec to start, 200 ms after link interrupts
	Availability	95% coverage
Remote surgery	Latency	Down to 1 ms
	Reliability	99.999%
Shopping mall	User Throughput	Downlink: 300 Uplink: 60 Mbps
	Availability & Reliability	95% (99% for safety-related applications)
Tele-protection in smart grid networks	Latency	8 ms
	Reliability	99.999%
Virtual and augmented reality	User Throughput	4-28 Gbps
	Latency	<7 ms

Figure 1: KPI requirements for selected 5G services.
Source: Ericsson. "5G Systems," January 2017.

5G Network Infrastructure

Depending on the service type (xMBB, mMTC, or cMTC) and communication path, the underlying physical network infrastructure has to behave differently to fulfill requirements. For example: with a low-latency application, service peers need to be as close as possible to the user, whereas, for an IoT-type application such as a humidity sensor that reports data to a central cloud server, there are no specific proximity requirements for any service peers. The diagram below shows proximity of various service components to the user depending on service type.



RH - Radio head
BB - Baseband unit
MEC - Mobile edge compute
PCF - Policy control function
SDM - Subscriber data management
UP - User plane
CP - Control plane
OSS - Operations support system

Figure 2: Service component VNF locations in relation to the user for different service types.

The ability to flexibly locate a component of a particular service closer to or further from the user, or in an isolated network slice, means that the topology (network path) is also flexible and may vary over time. This implies that a monitoring function must adopt the same type of flexibility while still being conscious of where it resides and what it monitors.

Ideally, the monitoring function is embedded into the service virtual network functions (VNFs). If this is difficult, an Accedian monitoring VNF can be tied to a service VNF via affinity configuration.

Note that, while services and networking functions may be moving in real time, the physical network infrastructure typically does not. There are still fibers, microwave links, and copper cables dug into the ground, with termination devices to enable communication. Even in a case involving a common software-defined networking (SDN) controller, it is still necessary to employ path monitoring to help automate and speed up fault localization and malfunction detection. This potentially allows the SDN controller to make better path decisions.

Skylight Assurance Components and Architecture

Accedian's tools for monitoring next generation networks are part of the overarching Skylight solution portfolio. Skylight encompasses physical and virtual monitoring components, co-existing to provide best-of-breed visibility into physical and virtual infrastructure quality. Accedian Skylight software platform components and VNFs consist of:

Skylight orchestrator – Centralized management for network performance elements, and SFP compute and module devices.

Skylight sensor: agents – Container based microservices testing framework with open APIs for closed loop automation and instant result data streams. Agents utilize active (synthetic) test traffic.

Skylight sensor: control – a virtualized software test platform that can combine with Skylight hardware modules and SFPs to collect performance data from Layer 2 to Layer 4 across multi-vendor networks utilizing active (synthetic) test traffic.

Skylight sensor: on premises and cloud – Passive network and application (DNS, TCP, HTTP, ...) performance management for multi-layer environments.

Skylight performance analytics – Cloud-native service analytics platform for quality of experience (QoE) reporting, on-demand service
assurance, and real-time closed-loop automation.

For physical network access, the Skylight solution offers:

Skylight sensor: SFP compute & modules – Wirespeed metering, policing, capture and active testing in compact 1G/10G form factors.

Skylight performance elements – Wirespeed ultra-high granularity 10Gbps or 1Gbps flow metering in small footprint, efficient network elements.

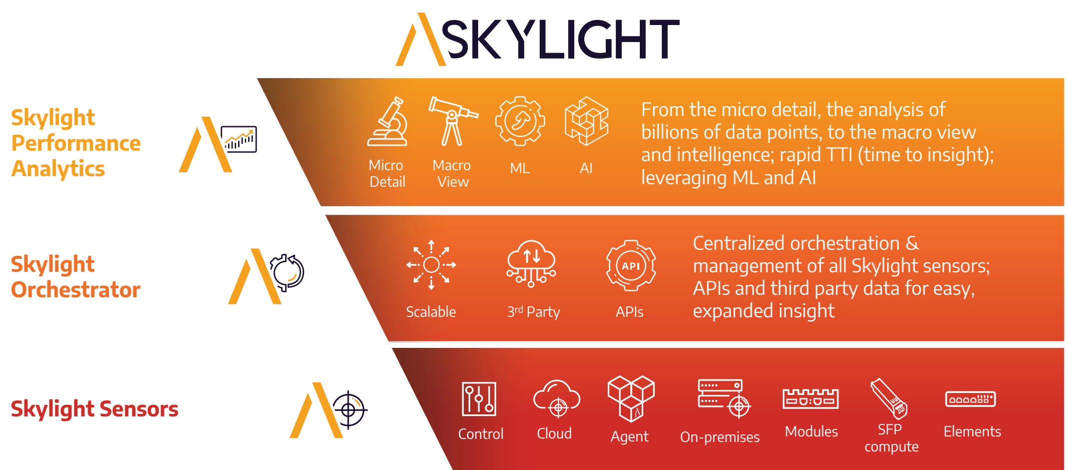


Figure 3: Accedian Skylight portfolio

Here's an example of how Skylight might be deployed. The control sensor initiates tests either directly from a software virtual machine (virtual machine or container) or through one of its attached SFP compute or module units. The sensor then calculates and reports on real-time performance monitoring (PM) metrics such as one-way delay, jitter, delay variation, loss (percent or consecutive bursts), and generates full wirespeed throughput tests (RFC 2544). The far end of a sensor measurement is either an SFP compute or module unit, or a third-party physical network function or VNF with built-in standards-based responder (typically RFC 5357 TWAMP or ITU-T Y.1731).

Northbound of the sensors, Skylight orchestrator and Skylight performance analytics coordinate, correlate and report on KPIs from multiple sensor instances as well as 3rd party data feeds. Skylight orchestrator provides manual or API-access to ad hoc testing, as well as batch processing, of test topology changes. Skylight analytics, leveraging machine learning and cloud-scale correlation techniques, provides unparalleled insight into service path performance, as well as pinpoints likely fault locations. Skylight components are available as VM-based VNFs or containers for easy deployment with any 3rd party service orchestrator.

With the Skylight solution deployed, in either virtual or hybrid physical and virtual form, the operator using it can perform highly accurate performance monitoring, 1-second granular utilization metering using the flowmeter feature, flow-based packet capture with flow broker feature, and up to wirespeed service activation tests (SAT) using RFC 2544 or Y.1564.

Use Skylight to Monitor a Virtualized 5G Network

Operators implementing a 5G network must assess and assure quality for both physical infrastructure and virtual connections. Building performance monitoring topologies from the bottom up greatly improves the ability to troubleshoot and decreases mean time to repair (MTTR).

To monitor a virtualized 5G network using Accedian's Skylight solution, an operator can equip physical infrastructure with SFP compute or module devices at strategic locations (typically, out-of-line). This covers physical and virtual service monitoring, and is a very efficient, low-cost, scalable arrangement. For example, a single SFP compute device can monitor thousands of destinations, through hundreds of VLANs or virtual routing and forwarding instances (VRFs), effectively assuring and troubleshooting physical and virtual layers. The flowmeter feature provides passive monitoring, showing utilization of a specific protocol or slide down to the millisecond level.

What constitutes a "strategic location" in this context? It might be a highly important core aggregation point, a central office or edge cloud site (macro aggregation), a regional/local datacenter, or a network demarcation point (handoff). For low-latency services, very fast and direct X2 interfaces may exist that bypass the core network, warranting dedicated physical layer monitoring. Because SFP compute and module devices are typically installed out-of-line, they add no additional point of failure. Built-in port separation means these units can perform passive or active monitoring even in off-line implementations.

From these strategic locations, the operator can enable physical network monitoring towards any networking device supporting PM (RFC 5357 TWAMP/Y.1731) and SAT throughput (flow loopbacks) standards. This is possible using pico, micro, and macro base stations; aggregation switches; and routers as well as some evolved packet core (EPC) components. Optionally, the flow broker remote packet capture and flowmeter utilization metering features can be set up in out-of-line mode.

Accedian's solutions can also monitor across air interfaces using SFP compute or module devices connected to LTE endpoints, or with software reflector agents running on customer premises equipment (CPE), phones, and generic x86 servers.

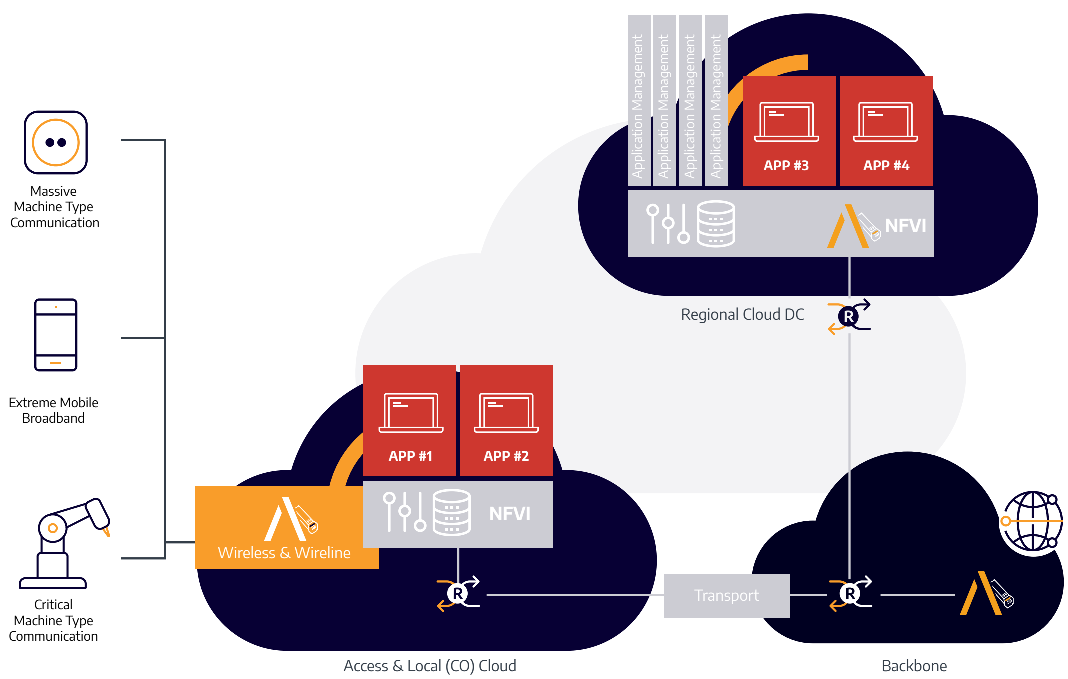


Figure 4: Example: a high-level 5G network with SFP compute devices placed at strategic points of interest.

Virtual Service Monitoring in the Edge Cloud

Once the physical infrastructure is properly instrumented, virtual service monitoring can be addressed. In a 5G scenario this means establishing visibility into the performance of user or business services carried in various network slices to the edge or regional cloud locations. Since a network service slice may span the entire network infrastructure, and also that of a third-party service provider, Accedian Skylight provides end-to-end monitoring combined with service chain performance segmentation.

For an end-to-end view of a network slice, software agents (or hardware if necessary) need to be deployed at service endpoints, ideally both outside as well as inside the service chain in order to properly instrument the full path. A virtualized service chain may have VNFs at one or both ends, not always where the user of the service resides. Using Accedian modules to enable slice demarcation at a handoff point is one possible approach. The transport path of a slice between two service providers can be instrumented with Accedian hardware or software components, allowing edge-to-VNF handoff performance monitoring of the slice within that operator's area of responsibility.

Implementing an edge cloud capability (MEC or MA-MEC) complicates the topology even more. Within a specific service slice, some traffic may be steered using DNS towards an edge cloud service while other traffic may be backhauled to the core network. One example could be a partially distributed mobile gaming service. Low-latency and frequently used service components would be deployed closer to the user at MEC locations, while less demanding tasks may be served by a central gaming cloud. Ensuring that the mobile gaming service is operating in an optimal way involves both active network monitoring as well as passive (DNS) monitoring of the traffic steering function.

The VNF service chain that enables slice functions throughout the service provider's whole network needs to be monitored for performance and troubleshooting of any functions. Accedian active and passive software agents, as well as standards-based monitoring responders within the VNFs, allow this to be done in a fully automated fashion. A dedicated Accedian monitoring VNF (a control sensor for active monitoring or a passive agent) can be automatically deployed alongside a service VNF, or the Accedian agent can be instantiated as an application within the VNF itself. With its container-based architecture, the agents can be deployed automatically on-demand where service quality monitoring is required. This could include TCP-based throughput testing, passive and active DNS request/response analysis or connectivity tests to common HTTPS locations.

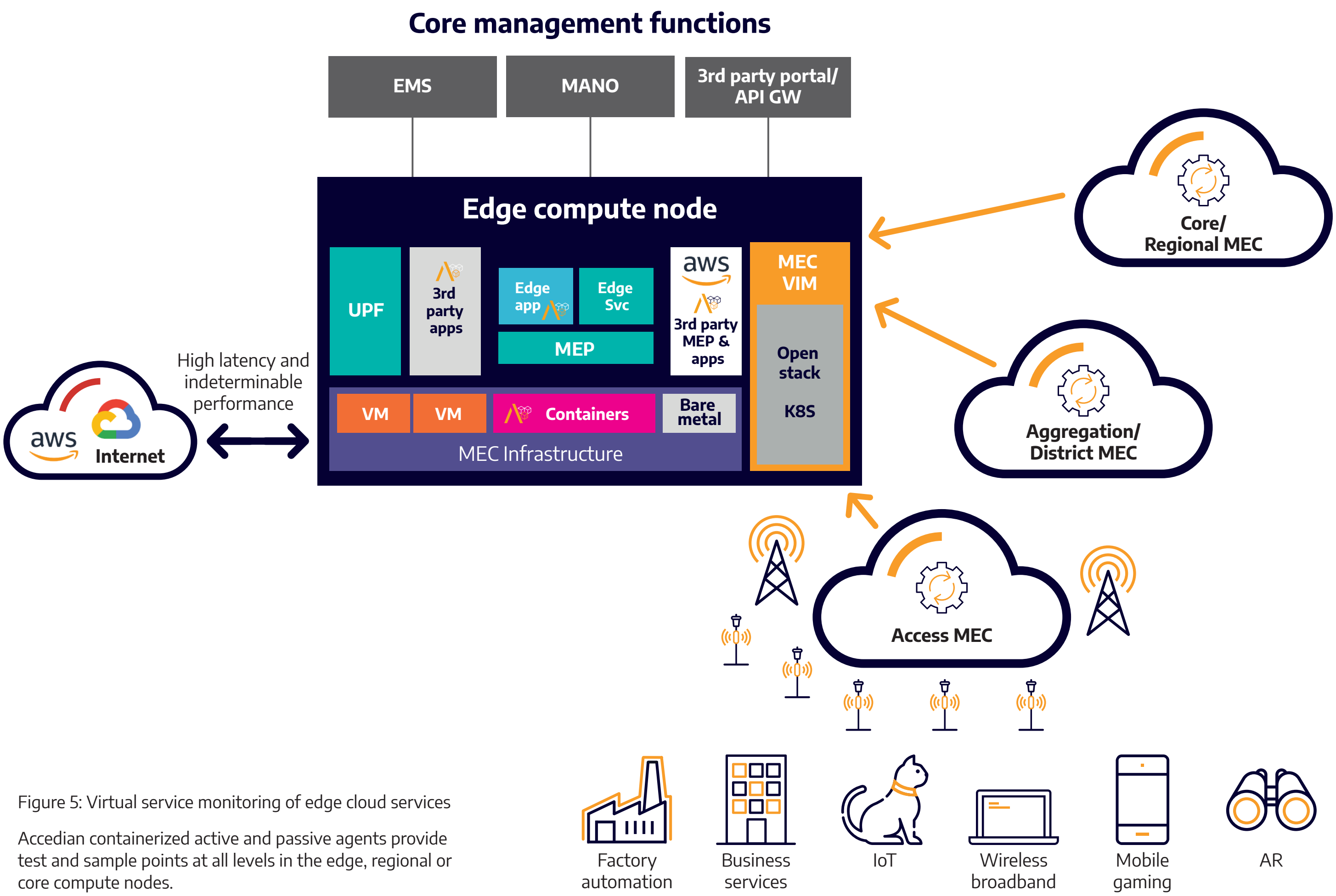


Figure 5: Virtual service monitoring of edge cloud services

Accedian containerized active and passive agents provide test and sample points at all levels in the edge, regional or core compute nodes.

Conclusion

Accedian Skylight components can instrument virtually any network infrastructure, and can be deployed as pure software, pure hardware, or in a software-hardware hybrid fashion. Our software uses the latest technologies available to achieve unprecedented accuracy for software-based measurements, leveraging microsecond-accurate timestamps from NFVi network ports, and streaming protocols to deliver the monitoring metrics in near real-time. Skylight handles very large amounts of KPI data easily; our most dense deployment delivers more than 20 billion KPIs per day running on all-COTS (commercial off-the-shelf) servers.

Skylight APIs allow orchestration of all configurations in the monitoring topology, as well as intelligent auto-provisioning of Accedian SFP compute and module to ensure fully automated operations. When used with an orchestrator, Accedian VNFs can quickly and easily be deployed on popular OpenStack managed infrastructure running either KVM or VMware ESXi.

The lightweight Accedian reflector agent is ideal for direct deployment on hypervisor operating systems or inside VNFs as a micro service.

Accedian actively participates in the standards bodies for Ethernet and IP performance assurance and is implementing Yang models for its products and monitoring protocols as they become available.

About Accedian

Accedian is the leader in performance analytics and end user experience solutions, dedicated to providing our customers with the ability to assure their digital infrastructure, while helping them to unlock the full productivity of their users.

Learn more at accedian.com

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