SOLUTION BRIEF

5G Network Performance Assurance

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

5G brings an explosion in the number of endpoints, multiplied by the flexibility and number of possible paths between interacting devices. This makes traditional network performance management approaches very difficult to scale. 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 build into its services platform from day one. (Building a network performance management strategy after rolling out 5G services is problematic because tight latency, loss, throughput, and availability specs are not optional). Accedian's TWAMP-compliant software stack lends itself to graceful 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 in the physical world. This paper outlines how Accedian has and continues to transform network performance and service assurance to empower 5G operators with insight into both physical network and virtual service operations.

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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 1Gbps as well as very low latency.

mMTC – Massive machine-type communication. Also known as the Internet of Things (IoT). Brings network 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, transport, cloud, network applications, and network performance management.

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 to quantify how well a particular service is working are needed.

Use Cases and Requirements

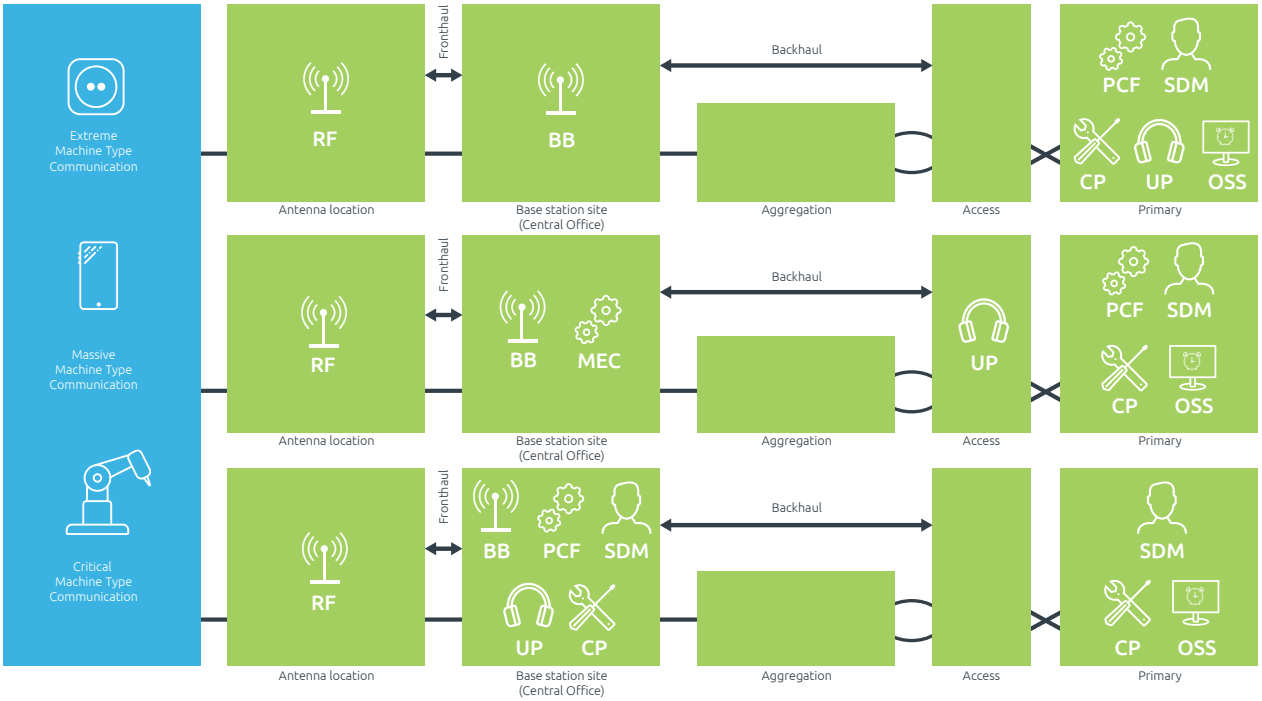
Research by Ericsson, summarized at right, outlines some expected network requirements to fulfill different 5G use cases. This gives a general idea of needed 5G quality metrics—an area where Accedian can provide expertise.

Use Case	*Requirements*	*Desired Value*
Autonomous vehicle control	Latency	5ms
	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: 50Mbps / Uplink: 25Mbps
	Latency	10ms
	User Throughput	500kph
Large outdoor event	User Throughput	30Mbps (900Gbps/km2)
	Reliability	95% coverage
Massive geo-dispersion	Density	1,000,000 devices / km2
	Latency	99.9% coverage
Media on demand	User Throughput	10Mbps
	Latency	5s to start, 200ms after link interrupts
	Availability	95% coverage
Remote surgery	Latency	Down to 1ms
	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	8ms
	Reliability	99.999%
Virtual and augmented reality	User Throughput	4-28Gbps
	Latency	<7 ms

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

5G Network Infrastructure

Depending on service type (xMBB, mMTC, or cMTC) and communication path, the underlying physical network infrastructure has to behave differently to fulfill requirements. 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.



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 Director** – Northbound API instances for SkyLIGHT network performance monitoring control, automation, and results.
- **SkyLIGHT VCX** – Active and passive network monitoring probe controller.
- **SkyLIGHT PVX** - Network and application performance management for multi-layer environments.
- **SkyLIGHT Reflector Agent** – Lightweight active network monitoring endpoint.
- **SkyLIGHT DataHUB IQ** - 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:

- **Nano SFPs** – Wirespeed metering, capture, and active testing in 1Gbps SFP form factor units.
- **Ant** – Wirespeed metering, capture, and active testing in compact 1Gbps / 10Gbps optical or electrical units.
- **FSX** – Wirespeed ultra-high granularity 10Gbps or 1Gbps flow metering in small footprint, efficient network elements.

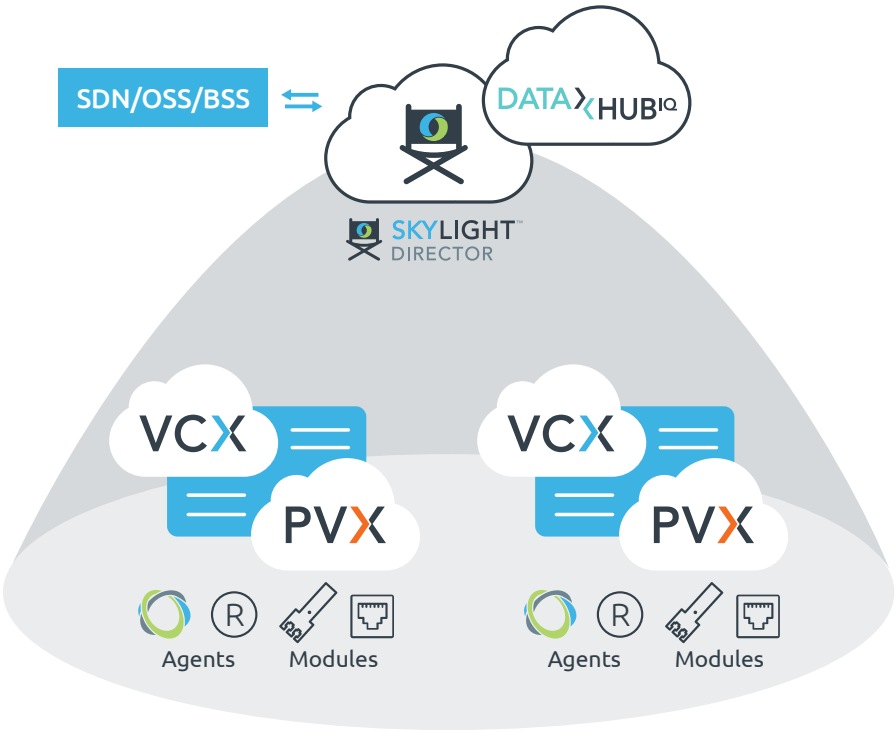
Accedian SkyLIGHT components.

SkyLIGHT is built around two foundations: VCX virtual probe controller, and PVX passive network and application performance management.

Here's how that works with VCX: the VCX controller can initiate tests either directly from the software virtual machine (VM) or through one of its attached Modules (Nano SFP / ant). VCX 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 (RFC2544). The far end of a VCX measurement is either an Accedian Module or agent, or a third-party physical network function or VNF with built-in standards-based responder (typically RFC5357 TWAMP or ITU-T Y.1731).

Northbound of the VCX controller, SkyLIGHT Director coordinate and reports on KPIs from multiple VCX instances. SkyLIGHT Director provides manual access to ad-hoc testing as well as robust RESTful APIs for automation of the monitoring infrastructure. All SkyLIGHT software components can be instantiated and controlled using third-party VNF managers and NFV orchestrators. SkyLIGHT components are currently available together with service descriptors for some typical proof-of-concept scenarios for deployment on OpenStack. The reflector agent is available in Linux binary application form, as well as a Docker container and a standalone KVM VNF.

The process is similar for PVX.



DATA HUB IQ

Cloud-native service analytics platform.

SKYLIGHT DIRECTOR

Performance assurance services controller.

VCX

Active synthetic performance monitoring for Layers 2-3.

PVX

Passive network and application performance management for Layers 2-7.

Performance Modules

Compact (SFP/optical/electrical), programmable units for wirespeed metering, capture, and active testing.

Agents and Reflectors

Lightweight active network monitoring software endpoints.

Accedian SkyLIGHT architecture.

All SkyLIGHT software components can be instantiated and controlled using third-party VNF managers and NFV orchestrators. SkyLIGHT components are currently available in the RIFT.io VNF catalog, together with service descriptors for some typical proof-of-concept scenarios for deployment on OpenStack. The reflector agent is available in Linux binary application form, as well as a Docker container and a standalone VNF.

With the SkyLIGHT solution deployed, in either virtual or hybrid physical and virtual form, the operator using it can perform highly accurate performance monitoring (PM), 1-second granular utilization metering using FlowMETER™, flow-based packet capture with FlowBROKER™, and up to wirespeed service activation tests (SAT) using RFC2544 or Y-1564.

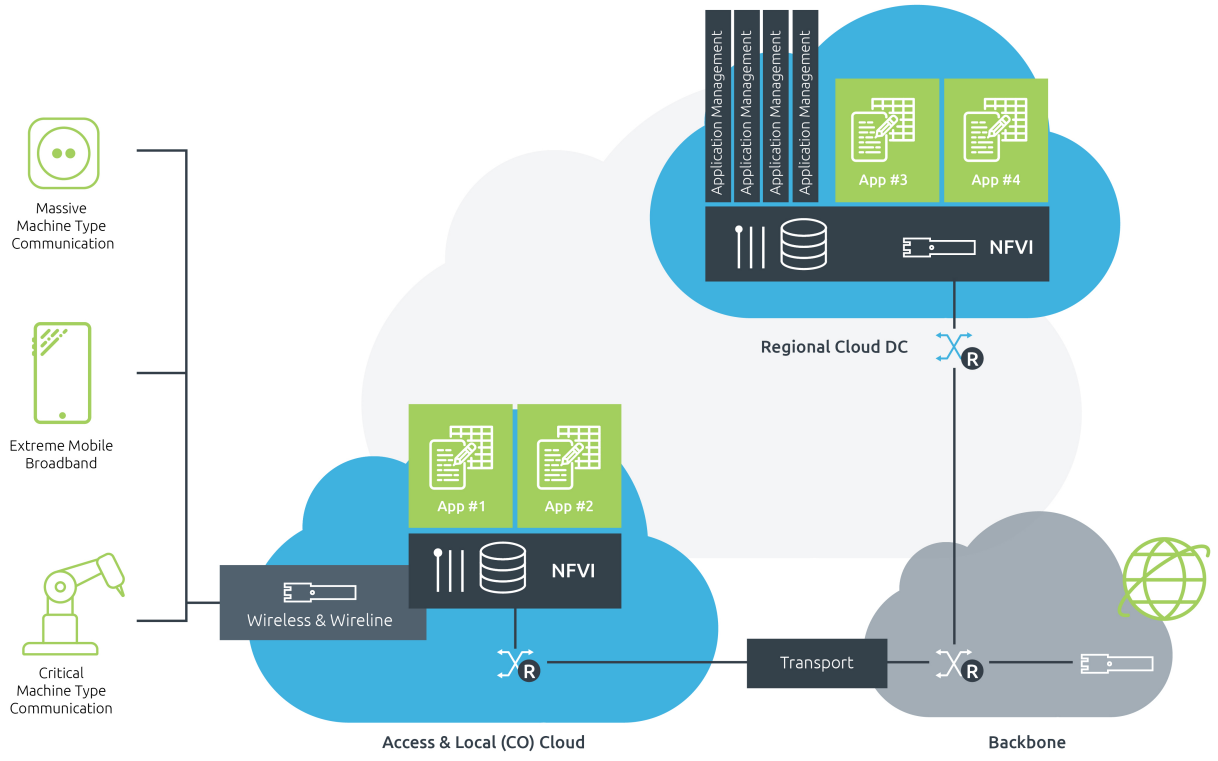
Use SkyLIGHT to Monitor a Virtualized 5G Network

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 Nano SFP or ant Module 1G or 10G 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 Nano SFP can monitor thousands of destinations, through hundreds of VLANs or virtual routing and forwarding instances (VRFs), effectively assuring and troubleshooting physical and virtual layers. FlowMETER 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 cloudlet, 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 Nano SFP and ant Modules are typically installed out-of-line, they add no additional point of failure. Built-in port separation (FlexMonitor™) 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 (RFC5357 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, FlowMETER remote packet capture and FlowMETER utilization metering can be set up in out-of-line mode.



Example: a high-level 5G network with SFP Modules placed at strategic points of interest.

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

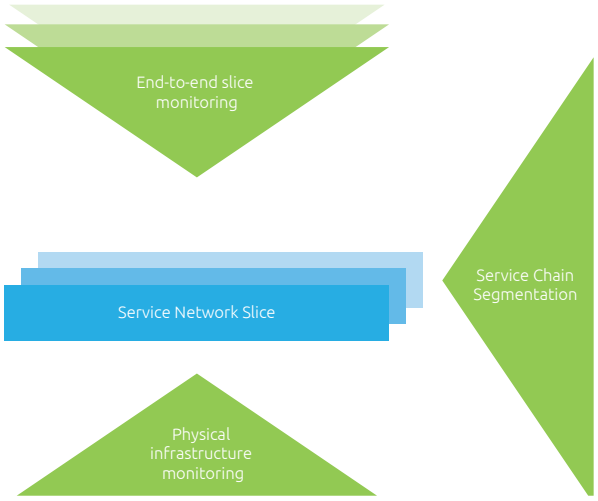
Virtual Service Monitoring

Once physical infrastructure is properly instrumented, virtual service monitoring can be addressed. In a 5G scenario this means establishing visibility into the performance of various service network slices. Since a network slice may span across the whole network infrastructure, and also that of a third-party service provider, Accedian's solution uses a model that involves end-to-end monitoring coupled with select fixed physical anchors and service chain performance segmentation.

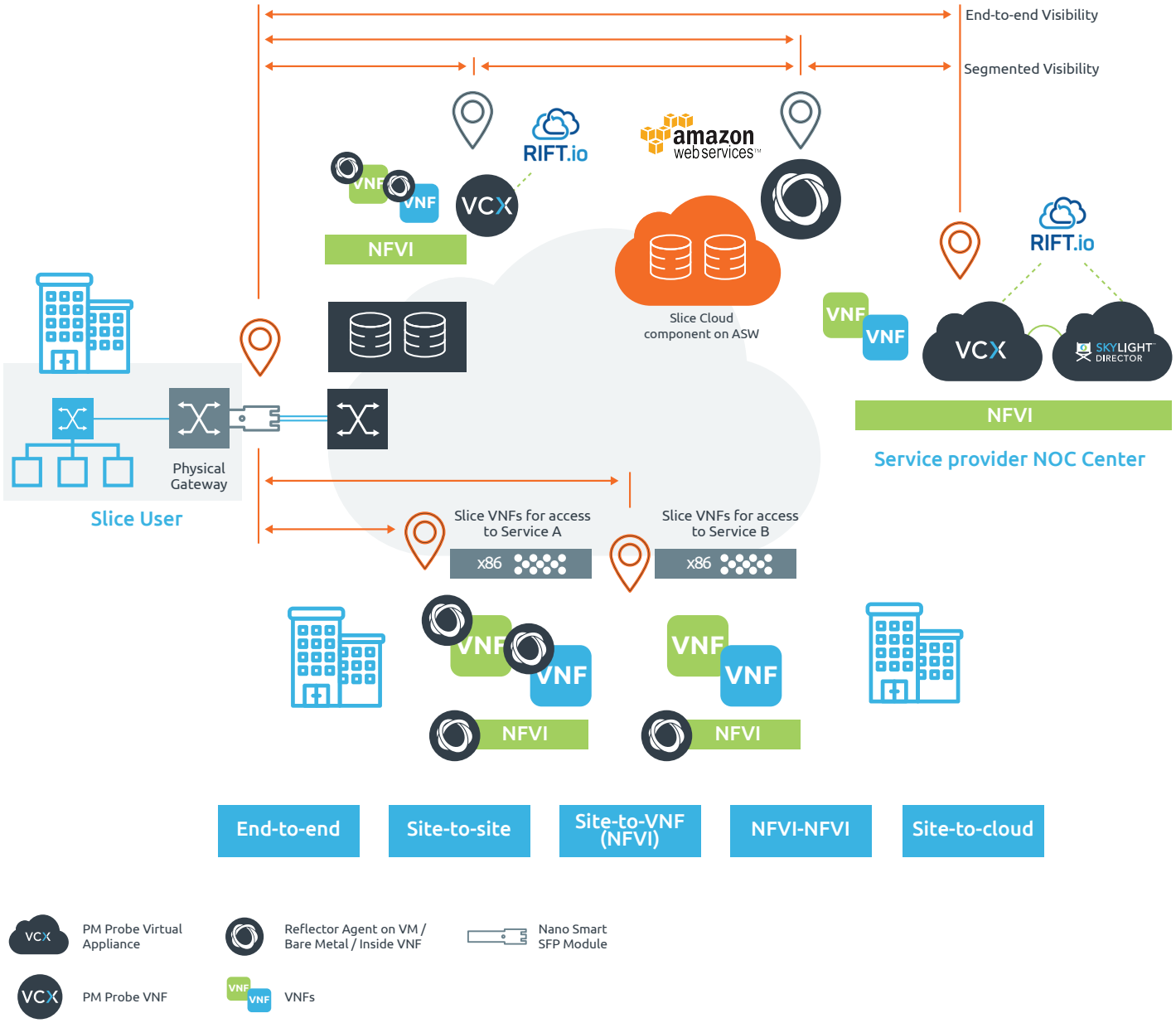
To accomplish an end-to-end view of a network slice, software (or potentially hardware) agents need to be deployed at service endpoints, ideally outside the service chain to properly instrument the full path. A virtualized service chain may have VNFs at one or both ends, not necessarily located where the user of the service resides. Because the end-to-end path may not be readily accessible to the service provider, some simplifications may be necessary, depending on where the edges of the slice are located. 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-to-handoff monitoring of the performance of the slice that is within the boundaries of the operator's responsibility.

The VNF service chain that enables slice functions throughout the service provider's network is also a target for assurance, and as such should be instrumented to allow monitoring and troubleshooting of its functions. Accedian software agents and standards-based monitoring responders within the VNFs allow this to be done in a fully automated fashion.

A dedicated Accedian monitoring VNF (VCX instance or TWAMP reflector agent) can be automatically deployed alongside a service VNF, or the Accedian agent can be instantiated as an application within the VNF itself. On the next page is a diagram of a routed network slice with physical demarcation points instrumented using SkyLIGHT VCX probing and SkyLIGHT reflector agents tied to VNF instances in the service chain.



Bottom-up physical and top-down VNF monitoring with service chain segmentation



Example: Service chain segmentation monitoring proof-of-concept with Accedian SkyLIGHT and RIFT.io's RIFT.ware.

Conclusion

Accedian SkyLIGHT components are able to 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's machine-to-machine (M2M) APIs allow orchestration of all configurations in the monitoring topology, as well as intelligent auto-discovery and auto-provisioning of Accedian hardware Modules to ensure a fully automated mode of operation. 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 delivers exceptional end-to-end network and application performance visibility, for control over the best possible user experience.

Full visibility across network services and application chains—spanning virtualized, cloud, software-defined, and physical infrastructure—empowers service providers and enterprises to embrace transformation, make most efficient use of digital assets to realize business goals, and strengthen their competitive position.

Accedian is an established expert at instrumenting networks of every size, with SkyLIGHT™ platform solutions that scale to monitor enterprise and service provider networks.

Since 2005, Accedian has partnered with its customers to deliver solutions across the globe, helping them and their users Experience Performance.

Learn more at **Accedian.com**

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