For service providers and large enterprises, migrating from legacy network infrastructures, such as time-division multiplexing (TDM), frame relay and asynchronous transfer mode (ATM), to more scalable, flexible and efficient Internet protocol (IP) networks, such as multiprotocol label switching (MPLS) and IP multimedia subsystem (IMS), is required for rolling out new converged IP services (voice, video, and data) and supporting applications. However, this migration introduces significant challenges as network operators must now manage and monitor real-time services across more complex, multivendor environments to continuously assure customer/user experience expectations are met, while the services are in fact being deployed.

With the introduction of these real-time, performance sensitive IP services, including IP television (IPTV), video on demand (VoD) and voice over IP (VoIP), network operators are faced with significant management and visibility challenges. While typical IP network performance issues, like packet collisions, retransmissions and latency, have a limited effect on data applications, these issues can be detrimental to the performance and quality of experience (QoE) of new customer-facing services and directly impact churn and average revenue per user (ARPU).

Once housed in the network equipment at the network core and central office locations, the intelligent functionality is adding to this management challenge since it is now moving closer to the customer with endpoint devices like residential gateways, customer premise equipment (CPE), IP phones, mobile handsets and set-top boxes (STBs). Traditional network management systems are ideally suited for managing data and mature circuit-switched networks. While these tools are primarily used to gather device- and port-specific information as well as network statistics, they are limited in their capabilities to measure and monitor real-time, end-to-end quality and service performance metrics for verifying service-level agreements (SLAs) and users’ quality of experience (QoE).

In order to continuously ensure QoE expectations, network operators must implement a service assurance solution that can provide complete end-to-end service performance visibility from the core to the subscriber/user endpoint. The great struggle for network operators is how to simplify the collection, correlation and reporting of IP performance and service quality metrics from hundreds to thousands of endpoint devices and establish a unified view into multiple services. This need will only continue to grow as network convergence expands and IMS architectures are introduced over next-generation networks. With increased mobility, new interactive applications and more complex network infrastructures, a positive or negative subscriber/user QoE will ultimately determine the success or failure of these services. As a result, having visibility into measuring service quality is essential for network operators.

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One of the greatest pain points being experienced by service providers and enterprises today is the lack of visibility to monitor service performance at the user’s home, handset or remote office. Without endpoint performance metrics, it is difficult for network operators to properly detect and solve service issues before problems impact the end-user. The resolution generally involves deploying costly field/network technicians to conduct on-site troubleshooting and diagnostics. By reducing these expensive deployments (truck rolls and technician time) with more automated remote monitoring capabilities, network operators can save significant costs, reduce mean time to repair and provide a better service offering.

As more users and subscribers rely on IP services, uncertainties in the performance and availability of these services are driving the need to support new standard methods for gathering performance metrics. These rapidly emerging standards, such as RTCP-XR and SIP Media Loopback, are being deployed for the purpose of collecting and reporting performance metrics from endpoint devices and providing the ability to extend this information to management applications that can correlate the metrics, provide end-to-end service visibility as well as measure and monitor QoE.

The implementation of standards provides both network operators (service providers and enterprises) and equipment manufactures with competitive quality of service (QoS) advantages. For network operators, they gain the ability to comprehensively monitor their network and service performance to guarantee SLAs and meet QoE expectations. For equipment suppliers, standards allow them to embed inexpensive QoS mechanisms into their products and position their offering with a quality-enabled competitive advantage.

End-to-End Service and Performance Monitoring
Gain visibility to the endpoint with real-time control protocol-extended reports [RTCP-XR] performance metrics

THE IMPORTANCE OF ENDPOINT PERFORMANCE MONITORING

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WHAT IS RTCP-XR

The Internet Engineering Task Force (IETF) published real-time control protocol extended reports (RTCP-XR) as RFC 3611 to define a set of performance metrics for assessing VoIP media session quality and identifying problems. Embedded into voice gateways, IP phones, STBs and residential gateways, RTCP-XR is a cost-effective mean to define a set of metrics for service quality analysis.

RTCP-XR provides information on call quality by measuring the following performance metrics:

- **IP (packet loss/discard):** RTCP-XR reports the packet loss rate, packet discard rate due to jitter, and the distribution of lost and discarded packets.

- **Delay:** RTCP-XR measures the round-trip delay using RTCP and adds reporting information that includes the codec and jitter buffer.

- **Signal/noise:** RTCP-XR reports on the signal-to-noise ratio (SNR) at each endpoint to make it easier to identify signal and noise level problems.

- **Echo:** If the endpoint is equipped with an echo canceller, RTCP-XR reports on the uncancelled echo to more accurately calculate call quality and detect echo problems easier.

- **Configuration:** RTCP-XR reports on the overall configuration of an endpoint, including jitter buffer size.

- **Call quality:** Using embedded algorithms, RTCP-XR can report a mean opinion score (MOS) rating or R-factor for the call.

Access to this performance data from a number of endpoint devices allows network operators to easily and cost-effectively diagnose problems remotely. By using next-generation, IP-optimized probes to gather call quality metrics, network operators can rapidly resolve quality issues by determining the exact cause and location. This is absolutely necessary as more and more intelligent endpoints are deployed into the network. Network operators can no longer just expect quality to be acceptable; they must be proactive and utilize solutions that can support standards and can continually monitor and ensure end-to-end quality. In addition to supporting standards, a service assurance solution utilizing probes for both active testing and live service monitoring can provide network segmentation to significantly reduce problem resolution times, signaling insight, and the ability to correlate signaling and media metrics for multiple IP services.

THE BRIX SYSTEM: LEVERAGING RTCP-XR FOR END-TO-END VISIBILITY

By leveraging the RTCP-XR (RFC 3611) standard to collect service performance and quality metrics, EXFO Service Assurance’s converged service assurance solution, the Brix System, simplifies the collection, correlation and reporting of this extensive data for the purpose of monitoring endpoint performance. EXFO Service Assurance delivers the actionable information network operators need to proactively ensure SLAs and QoE expectations from the core to the endpoint.

Supporting RTCP-XR, SIP Media Loopback and other industry standards, the open architecture of the BrixWorx service assurance and performance management software engine provides network operators with a unified source of quality and service performance management with endpoint visibility. By implementing a BV-4000 verifier for live service monitoring, BrixWorx provides correlated visibility into the signaling and media paths, and delivers visualization and analysis of key performance indicator (KPI) information (packet loss, jitter, etc.) from RTCP-XR or SIP Media Loopback enabled devices, such as VoIP gateways, handsets, IP phones, cable and DSL gateways, IP STBs, etc. By setting KPI thresholds, BrixWorx alerts network operators of problems, automates additional active testing for fault isolation, and provides the reporting and visualization to proactively manage and monitor end-to-end service and network performance.

In adding capabilities to monitor a pervasive set of endpoint devices, the Brix System enables network operators to gain the end-to-end visibility required to guarantee service quality, properly implement QoS, cost-effectively roll out new services, retain customers, and keep their networks running smoothly and at peak performance. As for service providers establishing peering relationships, each provider can further leverage the Brix System to quickly identify service degradation issues and determine which provider is responsible for the repair before subscribers are impacted and quality is compromised.
As more functionality is moved to the endpoint and as service providers and enterprises roll out new real-time, interactive applications and services, monitoring end-to-end service performance and quality becomes even more critical. With its support for collecting RTCP-XR performance metrics, EXFO Service Assurance allows network operators to:

- Provide a single source of performance management to deliver multivendor endpoint quality and service performance monitoring
- Improve customer satisfaction, problem resolution and overall operational efficiency
- Leverage existing infrastructure and standards to collect and correlate third-party performance metrics
- Support application-centric testing and monitoring of VoIP, video/IPTV and data
- Provide QoS metrics reporting and service performance visibility

The importance of industry standards, such as RTCP-XR, SIP Media Loopback, TR-069, RFC 2925, Two-Way Active Measurement Protocol (TWAMP), NCS Media Loopback, etc., is playing an integral role in delivering greater visibility into service quality. In conjunction with next-generation probes (Brix Verifiers) as well as strong correlation and analysis capabilities (BrixWorx software), network operators can harvest intelligence from existing network elements and endpoints to gain a comprehensive network and service performance view, enabling them to guarantee SLAs and QoE expectations.

Figure 3. The Brix System gives peering partners visibility into each other’s performance using RTCP-XR