Quality of Service in the Syniverse IPX Network

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The growth of the mobile market, along with continued advancements in the development of mobile devices, has generated an increasing need among device manufactures, service providers, and IPX network providers to refine and establish tighter controls over how they implement features and services that maintain ever-improved levels for quality of service (QoS).

With developments in new-device technologies supporting newly advanced data networks, it has become critical for service providers to create an optimal experience for the mobile user in order to increase revenues and minimize subscriber churn.

One key function of creating a high-level experience is successfully managing the IP traffic flow between providers. The implementation of an internetwork packet exchange is one significant step in developing a secure, high bandwidth, and controlled global network and the growth of IPX networks and how they have become a cornerstone of mobile connectivity is, in many cases, directly attributed to a continual focus on quality and improvement. This involves establishing a protected and reliable delivery of services that conforms to previously agreed-upon QoS levels while guaranteeing benefits for all players involved, including users.

By placing a strong emphasis on end-to-end QoS and service level agreements (SLA's) that are instituted among service providers and IPX network providers, operators can establish premium levels of service quality.

This principle is articulated in a report by the GSMA titled "IP exchange, providing a Quality Based Solution for IP Interconnect":

> *SLAs guarantee performance*
>
> *With QoS performance for different IP services monitored against mutually agreed SLAs, the delivered quality will maximize the user experience. There will be a system of governance that will ensure that each IPX provider adheres to the agreed performance and quality criteria for each IP service. The same governance will also ensure that interconnectivity is provided between any Service Providers where there is clear demand and that charging transparency is maintained.*

To meet the demands imposed by establishing high levels of quality of experience necessitated by the user, it is essential that IPX providers adhere to SLA commitments on the IPX network that relate to network delay, jitter, packet loss rate, throughput and availability. For each of these metrics, targeted values are provided for different types or classes of service.

The following information will further explore the areas of Class of Service and Quality of Service, as well as delve into the specific architecture Syniverse employs to support both quality and class of services.

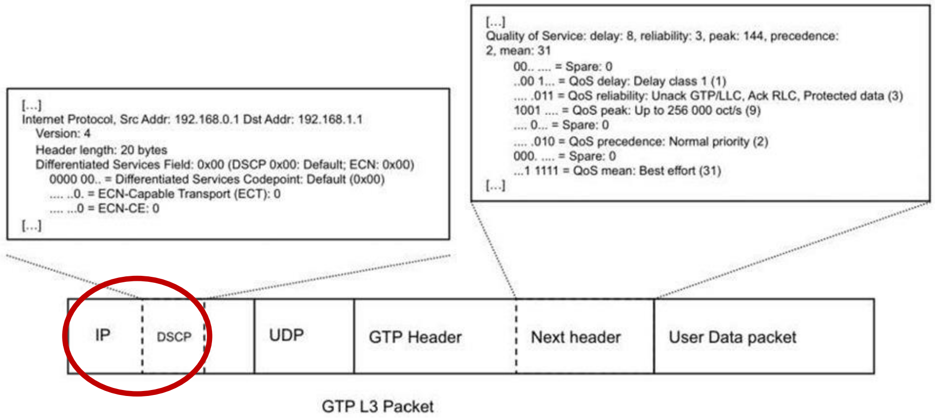
Further Defining IPX Quality of Service (QoS) & Class of Service (CoS)

Syniverse's IPX QoS architecture uses the differentiated services or the diffserv model to perform complex QoS functions, such as classification and marking of packets. The objective of classification is to support the QoS function by classifying a packet based on a specific set of criteria and thus placing it in a queue based on priorities and the sensitivity of the traffic. The marking of packets then labels each packet with specific criteria. This lets other devices within the network route the packets accordingly and define the forwarding treatment of a packet at each router (hop) along a forwarding path toward a destination. Each defined forwarding treatment is called a per-hop behavior (PHB).

There are four defined classes of service with Syniverse's IPX network: conversational, streaming, interactive and best-effort. The different differentiated services and differentiated services code point (DSCP) values are mapped to these IPX classes of service in the table below. The GSMA recommends specific diffserv markings for each application.

Forwarding Class/ Queue	Differentiated Services Code Point/Decimal	IP-PREC/EXP	Traffic Type	Traffic Requirements
CONVERSATIONAL (EF)	101110 (46)	5(101)	RTP/Voice traffic	▪ High or low bandwidth ▪ No loss ▪ Low latency and jitter
STREAMING (AF41)	100010 (34)	4 (100)	Video streaming	▪ High or low bandwidth ▪ Low latency and jitter ▪ Very low loss
INTERACTIVE (AF31, AF21, AF11)	011010 (26) 010010 (18) 001010 (10)	3 (011) 2 (010) 1(001)	Signaling traffic (SIP, Diameter) DNS	▪ High or low bandwidth ▪ Low loss ▪ Low latency and jitter
BEST-EFFORT (BE)	0000000 (0)	0 (000)	Best-effort IP traffic	▪ High bandwidth ▪ No latency, loss and jitter requirements

Traffic marking (packet marking) is instituted by the service providers and updates packet header fields and allows providers to partition a network into multiple priority levels or CoS to help ensure a consistent QoS experience over the entire IPX network. The management of traffic congestion can be realized by prioritizing traffic based on the marks using queuing technologies that can respond to traffic classes.



QoS mechanism based on outer IP packet header

Source: what-when-how.com

There are four QoS parameters that should be covered in a Service Level Agreements. These are as follows:

- Network delay
- Jitter
- Service throughput and availability
- Packet loss rate

These parameters are further defined below along with target values that Syniverse utilizes as guidelines for the successful routing of data packets over an IPX network.

Network Delay

Network delay, or latency, characterizes the time difference between the reception of an IP packet at a Syniverse IPX ingress point of presence (POP) and its transmission to another Syniverse egress point of presence. Network delay is usually influenced by the following subcomponents:

- **Propagation Delay -** Propagation delay is constrained by the speed of light in a medium and for optical fiber is around 5 milliseconds per 1,000 kilometers. This value can vary as the underlying transport topology changes, such as when a fiber failure triggers a reroute of the current circuit paths.
- **Switching delay -** Switching or processing delay is the time difference between receiving a packet on an incoming router interface and the enqueuing of the packet in the scheduler of its outbound interface. This value is negligible in the Syniverse network because of the high-performance routers that are used on the IPX network.
- **Scheduling delay -** Scheduling (or queuing) delay is defined as the time difference between enqueuing of a packet on the outbound interface scheduler, and the start of clocking the packet onto the outbound link. This value is determined by the scheduling algorithm and the scheduler queue utilization. Syniverse’ s IPX QOS addresses scheduling delay by using class-of-service (CoS) schedulers to define the properties of output queues on all the backbone routers. These

properties include the amount of interface bandwidth assigned to the queue, the size of the memory buffer allocated for storing packets, the priority of the queue, and the drop profiles associated with the queue. Additionally, Syniverse has implemented “Priority Scheduling” as defined in RFC 3246 (more information on RFC3246 available at http://www.ietf.org). This feature determines the order in which an interface transmits traffic from queues, and it ensures that queues containing important traffic, such as VoLTE traffic, are provided faster access and result in low delay, jitter, and loss services.

- **Serialization delay -** Serialization delay is the time taken to clock a packet onto a link and is dependent upon the link speed and the packet size. Serialization delay is considered negligible on the Syniverse IPX network because of link speeds higher than optical carrier 3 OC3 speeds. (Link speed in the backbone is 10Gs and 40Gs at the time of writing this document.)

Below are two tables listing the round-trip target values for data being routed between regions:

Target Values for Round-Trip Delay for Conversational and Streaming Traffic (EF, AF41) between Regions in Milliseconds:

	North America, West	North America, East	Europe, West	Europe, North	South Central Asia	East Asia	Southeast Asia
North America, West	40	90	200	215	334	285	310
North America, East	90	40	120	130	306	340	360
Europe, West	200	120	55	45	171	340	360
Europe, North	215	130	45	40	145	350	360
South Central Asia	334	306	171	145	80	152	108
East Asia	285	340	340	350	152	150	165
Southeast Asia	310	360	360	360	108	165	145

Target Values for Round-Trip Delay for Interactive Traffic (AF31, AF21, AF11) between Regions in Milliseconds:

	North America, West	North America, East	Europe, West	Europe, North	South Central Asia	East Asia	Southeast Asia
North America, West	48	108	260	258	401	342	372
North America, East	108	48	156	156	367	408	432
Europe, West	260	156	66	54	206	408	432
Europe, North	258	156	54	48	174	420	432
South Central Asia	401	367	206	174	96	182	130
East Asia	342	408	408	420	182	180	198
Southeast Asia	372	432	432	432	130	198	174

Jitter

Jitter is the differences in delay over time from point to point within a network. Jitter is caused by the variation of the subcomponents of network delays listed in the previous section and by congestion in the IP network. It is usually computed as the variation of the delay for two consecutive packets. Syniverse's IPX QOS addresses this variation through priority scheduling addressed in the previous section, Network Delay.

Target values for jitter are shown below:

Target Values for Jitter

Link Type	Jitter (Milliseconds)
Intracontinental	5 milliseconds
Intercontinental	10 milliseconds
Peering	20 milliseconds

Loss

Packet loss is basically the loss of packets along the data path, which can severely degrade an applications ability to produce a quality form of communication. Within the IPX backbone, loss characterizes the packet drops that occur between the ingress link of an IPX ingress point of presence and the egress link of an IPX egress point of presence.

Target values for packet loss are shown below.

Target Values for Loss

Class of Service	Average Monthly Packet Loss
AF11	<0.1%
AF31	0.05% to 0.08%
EF + AF41	0.1%

Class-based Policing

For applications that require the prioritization of packets in order to produce a certain level of quality output, it's necessary for the policing of packets to ensure that high-priority data is routed unencumbered to its proper destination. Class-based policing limits the input or output transmission rate of a class of traffic based on user-defined criteria. This criteria is managed through the use of packet marking as described earlier and listed in the following table, which defines how a traffic type will be prioritized based on the differentiated services code point marking.

Elevating Experience Is the Ultimate Goal

The eventual goal of implementing such rigorous controls over QoS and implementing strict levels of CoS is to create a high-quality mobile experience for mobile consumers, whether they are streaming data or engaged in conversation. When it comes to specific applications, such as voice services, the importance of establishing and monitoring service levels that influence packet priorities based on data type needs to be placed high on the priority list.

For more information on Syniverse's IPX services, please visit http://www.syniverse.com.