IEFT 108 PIM WG

Reliable Multicast Over the Internet

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Reliable Multicast Video Delivery

Most internet providers provide Best Effort (BE) service and no preferential treatment based on traffic types and has been the model across the internet. Due to the coordinated effort required for QOS PHB marking and scheduling policies between ISP's the mantra has been since Day 1 of the internet to provide BE service and treat all traffic equally. ISP's have not had a business driver to provide end to end QOS, since most traffic has been TCP Unicast based for both for both interactive & non interactive streaming video services using TCP with various transports HLS, MPEG-TS, MPEG-DASH, and thus can easily recover from packet loss with retransmission. Multicast on the other hand has been the unwanted step child of the internet as being UDP based unreliable delivery mechanism requires end to end PHB QOS to be viable.

There have been many publications over the years from academia on the issue, but no clear solution on how to solve the issue of how to coordinate QOS marking and Scheduling policies between all service providers around the globe from Tier 1, Tier 2 down to the broadband service providers last mile end to end QOS requirement for Multicast. Best Effort First in First out(FIFO) per hop servicing of all packets equal treatment provides for serialization of traffic and head of line blocking where large packets are queued behind small packets. This is similar to switching architecture analogy of head of line blocking versus multi core processor ASIC pipelining similar of slow path control plane processing of packets versus high speed data plane forwarding in the "fast path". The result unfortunately of BE treatment of all packets results in latency & jitter which TCP based applications can recover with retransmissions, where Multicast UDP RTP based streaming video delivery connectionless unreliable transport the packet is dropped. If the packet is dropped and is an I frame which is a reference frame pointer in the buffer the adverse effect is the video stops playing due to buffering delay.

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Some providers such as Century Link provides QOS at a premium. Their are other service providers such as Bigleaf and others that provide a tunnel based overlay SDN or SD WAN style solution to provide QOS non blocking transport slice QOS fabric no FIFO BE queueing - all SPs not having common policy challenges results in unpredictable QOS queuing results

SDN works for unicast as well as multicast overlay tunnels with regards to Intranet IPSEC tunneled traffic for P2MP DMVPN access layer transport over the internet, but does not solve native broadband or mobile users direct internet access multicast MBONE feed or any other content provider using multicast. Most content providers have drifted for years away from multicast as even a viable option over the internet due to the UDP QOS requirement and have adopted for years full blown P2P Unicast content delivery solutions with enough capacity.

As the paradigm shift happens in this day and age now with Covid-19, and now with future pandemics drives VR-Virtual Reality a “Reality” with vacationing & Entertainment industry and as well as development in the AV industry to 4K and beyond to 8k,12k, 16k, the P2P 1-1 unicast model solution will eventually will drive the requirement for ISP’s to move towards multicast 1 to many P2MP architecture as has happened with Service Provider private networks years ago. Also with Bit Torrent and other download architectures I can see PIM Bi-dir MP-MP C-Multicast trees & P-Trees making a comeback into the mainstream multicast deployments.

With the advent of DWDN and 400G and beyond petabit routing and future exabit & zettabit routing, next generation fiber optic development has put a damper on movement with QOS over the internet for UDP multicast. However I think someday the time will come that multicast will be needed as adding wavelengths will come at a higher a premium.

To achieve higher bandwidth and throughput continues to be the carrot being chased by customers, and with overlay and underlay technologies being mainstream, the eventual business justification & monetary driver to Jumbo frames over the internet from IPV4 9216 to 64k and beyond to IPv6 Jumbo grams extension header 32 bit 4.2G payloads. With QOS over the interne this can all be possible.

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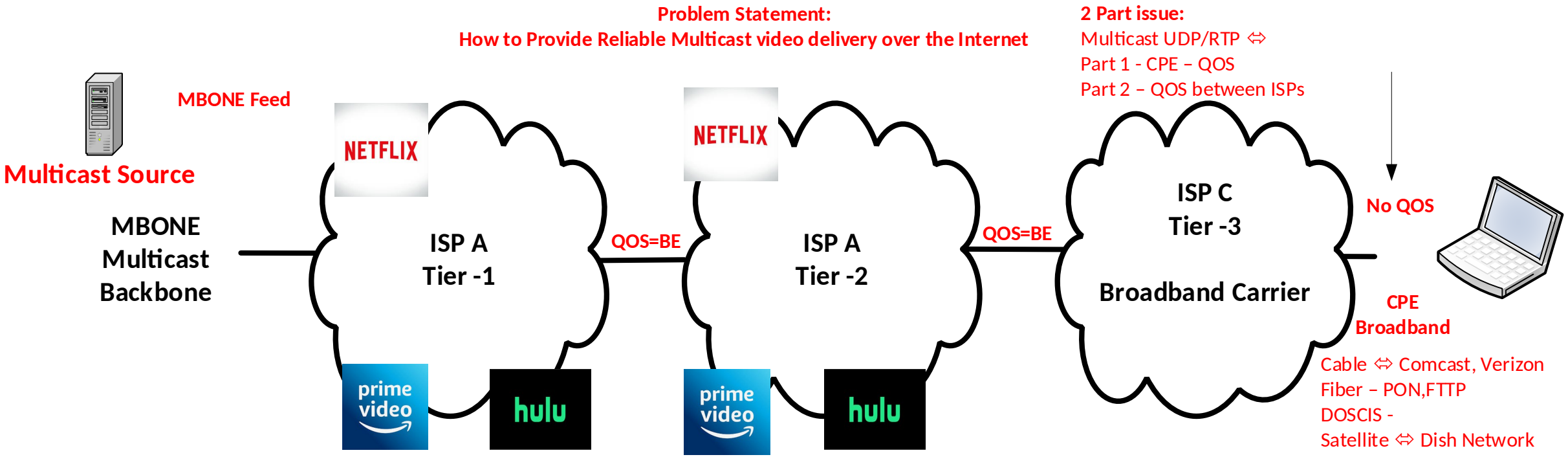

TCP versus UDP & why UDP requires QOS for reliable transport

ITEM	TCP/IP	UDP
Connection	Connection-oriented protocol - Established through a "handshake" before data can be sent	Connectionless protocol - Packets are sent individually and transported on top of IP.
Packet Entity	Segments	Datagram
Reliability	Reliable byte stream - messaging is managed and acknowledged. TCP does error checking and has recovery methods as well as traffic congestion control	Error checking through "checksum" but no recovery options.
Ordering	Transmissions are sent in sequence.	Time sensitive and time preferential. No sequencing or ordering of messages.
Recovery Methods	Lost or discarded packets are resent	No recovery
Applications	High-reliability and less critical transmission time - World Wide Web, file transfer, e-mail	Fast timing - Real time streaming protocol – Multicasting - Voice over IP, online gaming, video streaming, IPTV
Priority	Low priority since timing is not as important and delivery is confirmed	First priority due to application's time sensitivity

UDP= Requires QOS

UDP= Requires QOS

Multicast= UDP/RTP

UDP= Requires QOS

TCP versus UDP & why UDP requires QOS for reliable transport

5 Class	8 Class	QoS Baseline	13 Class	CoS	DSCP	PHB	1P1Q3T	1P3Q3T	1P3Q1T	1P7Q4T
			Network Cont.	7	56	CS7	Q1 – T3	Q2 – T3		Q2
		IP Routing *	Internetwork Cont.	6	48	CS6	Q1 – T3	Q2 – T3		Q2
Real Time	Voice	Voice	Voice	5 *	46	EF	Q2 – PQ	Q1 - PQ	Q1 - PQ	Q1 - PQ
			Broadcast Video	5	40	CS5	Q2 – PQ	Q1 - PQ		Q1 - PQ
					38	AF43 (H. Drop)				
					36	AF42 (M. Drop)				
	Video	Interactive Video	Multimedia Conf.		34	AF41 (L. Drop)	Q1 – T1	Q2 – T1		Q3
		Streaming Video	Real-time Interactive	4	32	CS4	Q2 - PQ	Q1 - PQ		Q1 - PQ
					30	AF33 (H. Drop)				
					28	AF32 (M. Drop)				
		Mission Critical *	Multimedia Streaming		26	AF31 (L. Drop)	Q1 – T1	Q2 – T1		Q4
Call Signaling	Call Signaling	Call Signaling	Call Signaling	3	24	CS3	Q1 - T2	Q2 – T2	Q2 (10%)	Q2
					22	AF23 (H. Drop)				
					20	AF22 (M. Drop)				
Critical Data /Transactional	Critical Data	Transactional Mission Critical	Transactional		18	AF21 (L. Drop)	Q1 – T1	Q2 – T1	Q3 (35%)	Q5
	Network Control	Network Mgmt. IP Routing	Network Mgmt.	2	16	CS2	Q1 – T1	Q2 – T1		Q2
					14	AF13 (H. Drop)				
					12	AF12 (M. Drop)				
	Bulk Data	Bulk Data	Bulk Data		10	AF11 (L. Drop)	Q1 – T1	Q4 – T1		Q6
Scavenger	Scavenger	Scavenger	Scavenger	1	8	CS1	Q1 – T1	Q4 – T2		Q7
Best Effort	Best Effort	Best Effort	Best Effort	0	0	DF	Q1 – T1	Q3	Q4 (25%)	Q8

Multicast Mark &
PHB Schedule

Reliable Multicast Video Delivery Solution

In theory the concept of providing end to end QOS may seem like a daunting task which it is as it requires a coordinated effort between all ISP's. However if you think of it from a simplistic point of view as building blocks and work your way to an end state solution when you step back and look at the big picture it does actually seem viable.

Most ISP's "Public ISP backbone" Tier 1, Tier 2 and Tier 3 are either IP Global table routed or single VRF "any-any" routed single "tenant" in both scenarios. In the VRF IP VPN MPLS construct is the "Internet" routing table "any-any" sits in the discrete single Internet VRF and the global table contains the topmost label connected interfaces underlay IGP OSPF or ISIS. In contrast Service providers with "Private backbones" with Private managed MPLS solutions have many tenant Customer VRFs.

Contrasting the two flavors the Private MPLS servicing many customer VPNs requires QOS remark into a discrete IP SLA bucket offerings such a Gold, Bronze, Silver solutions so is more complex in that regard as mapping remarking is required from customer CPE to SP QOS policy and the many variations as mentioned of service offerings.

In contract to "Private MPLS" we have the two flavors 1-Global table routing 2-Internet IP VPN both of which are "single customer tenant any-any" model and thus the remarking of traffic requirement at the edge is simplified to the extent that default mapping can be utilized for the mapping DSCP to EXP in the MPLS IP VPN scenario. This same concept of simplicity for the Public Internet backbones of ISP's applies to Segment Routing SR-MPLS, SR-MPLSv6, SRv6.

So that being said due to the simplicity if you imagine you had either the Global table or Single MPLS VRF option if all Service Providers used the same default mapping re-marking and marched to the same IETF QOS public marking standard in theory we could instantly have "End-End" QOS over the internet. That solve the PHB scheduling as well as the marking as if each SP in a coordinated effort now trusts each others markings they would not have to do any remarking between SPs. The customer edge would be the trust boundary where we re-mark to the IETF SP standard marking solution.

Another possible idea could be to provide a dynamic QOS marking capability using a new BGP path attribute for QOS and a Flowspec style controller style method of pushing QOS policy throughout the Internet top down from the Tier 1 down to all the downstream providers similar to how routes are propagated.

Reliable Multicast Video Delivery Solution – 4 Edge markings & PHB

eduling

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VOIP

Interactive Video

Multicast

File transfer

SP-SP = Trust
Customer Edge =
Trust Boundary Remark

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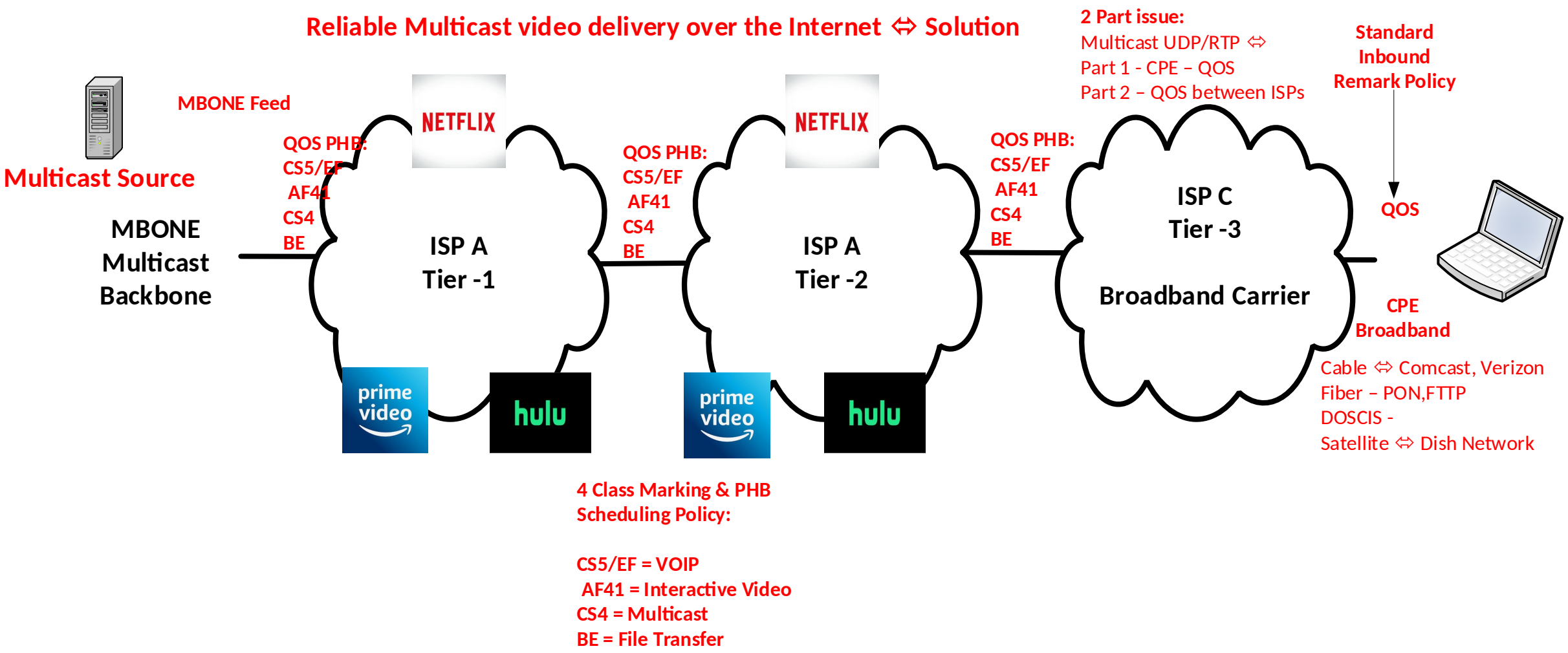


Q&A

THANK YOU