

IPTV Traffic "Qcast": IP Multicast Traffic Monitoring System with IPFIX/PSAMP

Shingo Kashima and Atsushi Kobayashi

NTT Information Sharing Platform Laboratories

FloCon 2010 © 2009 NTT Information Sharing Platform Laboratories



Outline

Introduction

- Motivation
- IP Multicast Streaming Traffic
- Issues in Existing Multicast Monitoring

Requirements

- Requirements
- Difficult Requirements for Current NetFlow
- Why IPFIX/PSAMP?

Our System: Qcast

- System Overview
- System Architecture
- System Evaluation

Conclusion



Motivation

 Multicast service has started in several provider networks.

 Large number of broadband users leads to heavy demand for IP multicast streaming services, such as IPTV.

Existing multicast tools work, but not well enough to monitor streaming services in large-scale networks.

Multicast ping, trace route, and multicast MIB.

Easy troubleshooting tools are required.

• IPFIX/PSAMP seems helpful.

IP Multicast Streaming Traffic

Traffic volume of an IPTV channel: 10 Mbps, 0.9 kpps.

- Packet size: from 1300 to 1400 bytes.
- IP multicast stream traffic includes two kinds of packets.
 - Media packets and FEC packets.
- IP multicast stream traffic includes RTP headers.
 - □ Packet loss can be easily detected by keeping track of RTP seq. number.
- More than 50 channels pass through an ISP network.



Issues in Existing Multicast Monitoring

Multicast ping and trace route

- Detect fault point and check continuity by using test packets.
- Do not observe real packets.
- → Inadequate for detecting service quality deterioration and confirming service quality.

Mirroring + packet capture

- □ Last resort for confirming service quality.
- But requires great care and is not suitable for always-on monitoring.



Requirements

- Requirement #1: Detect service quality deterioration and confirm service quality.
 - Detect packet loss, disorder, and duplicates within 1 minute while there is continuous packet loss at 1/1000.
 - Monitor packet delay variation.
- Requirement #2: Perform <u>always-on monitoring</u> of traffic volume and service quality of each <u>IPTV-</u> <u>channel</u> and each <u>customer.</u>
 - Always monitor per {S,G}.
 - Always monitor per VLAN in access network.
- Requirement #3: Localize failure point.
 - Localize failure point not only in a service suspension but also when service quality deterioration occurs.
- Requirement #4: Use at low cost as soon as possible.
 - Necessary because multicast streaming service has already started.

Difficult Requirements for Current NetFlow

- Requirement #1: For the current NetFlow exporter implementation, it is impractical to detect service quality deterioration and monitor service quality.
 - Flow records in NetFlow cannot include packet loss, disorder, and duplicates.
 - □ In general, many operators use random sampling to introduce NetFlow.

IPFIX/PSAMP seems helpful in meeting this requirement.



Why IPFIX/PSAMP?

PSAMP (RFC 5475)

- "Property Match Filtering" can <u>focus the monitoring</u> on IPTV traffic by selecting on the basis of packet header value.
- "Systematic Time-based Sampling" can <u>detect packet loss and packet</u> <u>interval time</u> by selecting continuous packets.

IPFIX (RFC 5153)

 "Enterprise-specific Information Elements" can export not only UDP/IP header information but also application header information.



Our System: Qcast Overview

- Probe: Captures traffic from mirror port, monitors IPTV traffic with PSAMP, and exports with IPFIX.
 - Runs on a general-purpose personal computer.
- Web-Console: Collects IPFIX information and shows it to operators.
 Monitoring,





Ocast Architecture



• Торіс 1: Packet Loss and Interval Time

Combination of PSAMP techniques in Probe

- Observe packets at input interface.
- Select multicast packet by "Property Match Filtering".
 - Example: "Destination IPv6 Address == FF38::/16"
- Extract them using "Systematic Time-based Sampling".
 - All input packets during the interval period are selected.



🕐 NTT

Topic 2: Exporting Traffic Data

- IPv6 template
 - Flow key information
 - Includes VLAN ID
 - Traffic volume information
 - Packet loss information
 - Interval time information
 - Uses "Enterprise-specific Information Elements"

Option template

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 7 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7

0	Set ID (0x0003)	Length
4	Template ID (0x0106)	Field Count (0x0003)
8	Scope Field Count (0x0001)	exporterIPv4Address (0x0082)
12	Scope 1 Length (0x0004)	samplingTimeInterval (0x0133)
16	Field Length (0x0004)	samplingTimeSpace (0x012E)
20	Field Length (0x0004)	flowActiveTimeout (0x0024)
24	Field Length (0x0002)	

	0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
0	Set ID (0x0002)	Length
4	Template ID (0x0103)	Field Count = 18 (0x0012)
, 8	octetDeltaCount (0x0001)	Field Length (0x0004)
12	packetDeltaCount (0x0002)	Field Length (0x0004)
16	srcTransportPort (0x0007)	Field Length (0x0002)
20	dstTransportPort (0x000B)	Field Length (0x0002)
24	srcIPv6Address (0x001B)	Field Length (0x0010)
28	dstIPv6Address (0x001C)	Field Length (0x0010)
► 32	droppedPacketDeltaCount (0x0085)	Field Length (0x0004)
36	flowStartMilliseconds (0x0098)	Field Length (0x0004)
40	flowEndMilliseconds (0x0099)	Field Length (0x0004)
44	vlanId (0x003A)	Field Length (0x0002)
48	protocolIdentifier (0x0004)	Field Length (0x0001)
52	ipVersion (0x003C)	Field Length (0x0001)
56	rtpIntervalAvgTime (0x8001)	Field Length (0x0004)
60	ENTERPRISE NUM	BER (0x000000D2)
64	rtpInternalMaxTime (0x8002)	Field Length (0x0004)
68	ENTERPRISE NUM	BER (0x000000D2)
72	rtpIntervalMinTime (0x8003)	Field Length (0x0004)
76	ENTERPRISE NUM	BER (0x000000D2)
80	rtpIntervalVariance (0x8004)	Field Length (0x0004)
84	ENTERPRISE NUM	BER (0x000000D2)
88	rtpPayloadType (0x8005)	Field Length (0x0002)
92	ENTERPRISE NUM	BER (0x000000D2)



Topic 3: View [1/6]

Shows four kinds of traffic information





Shows a traffic chart separated by RTP payload type.

{Media packets, FEC packets}



🕐 NTT

Topic 3: View [3/6]

Shows	packet loss	alert	<mark>④ http://192.168.1</mark> : ファイル(E) 編集(E)	08.99 - scoopFlow:Qcast 表示(<u>い</u> お気に入り(<u>A</u>) ツール(Probe View 1.0 - Micros D ヘルプ(H)	oft Internet Explorer		
Two-I	evel alert			Time: 2010 V	年 1 v 月 9 v 日 16	♥ 時 22 ♥ 分		-
• Re	ed: dangerous le	vel	Channe	I Name: (2404:1a6	:fff:feOO:2001::2, ff3e::800C	:1} 💌		
• Ye	ellow: warning le	evel	Traffic chart	🛛 Loss rate chart 🔲 Interva	l max chart 🔲 Valiance	chart		
Link t	o traffic chart		Search					
🗿 scoopElow - Ocast Probe View 1.0 - 1	Microsoft Internet Evoluter		⊙ 10min	n 🔿 60min 🔿 180min				
ファイル(E) 編集(E) 表示(V) お気に入り(A)	ッール① ヘルプ(H)					<< <) (> >> =
Alert Information			Probe VLAN QProbe03 3	ID Source Addres	Group Address	CSV Download		
[1hour] [1day] 1			[Kpps] 2.0	Traffic chart 2010-01-09 16:22:00	[Mbps]	[pps] 70	Loss rate chart 2010-01-03 16:22:00	
Time Stamp Probe 1 2010-01-09 16:22:33 Probe03 2 2010-01-09 16:22:33 QProbe03 3 2010-01-09 16:22:33 QProbe03 4 2010-01-09 16:22:13 QProbe03 5 2010-01-09 16:22:13 QProbe03 6 2010-01-09 16:22:13 QProbe03	VLAN ID Source Address Group 301 2404:1a8:ffff:fe00:2001::1 ff3e 302 2404:1a8:ffff:fe00:2001::2 ff3e 303 2404:1a8:ffff:fe00:2001::3 ff3e 301 2404:1a8:ffff:fe00:2001::3 ff3e 302 2404:1a8:ffff:fe00:2001::3 ff3e 303 2404:1a8:ffff:fe00:2001::1 ff3e 302 2404:1a8:ffff:fe00:2001::2 ff3e	up Address Loss Pkts/sec 1::8000:1 48.44 1::8000:1 48.44 1::8000:1 48.44 1::8000:1 48.44 1::8000:1 0.11 1::8000:1 0.11	1.5- 1.0- 0.5- 0.0- 1001/09 16:17	16:22 Time	15 10 5 16:27	60 50 40 20 10 10 10 10 10 10 10 10 10 10 10 10 10	16:22 Time	16.27
7 2010-01-09 16:22:13 QProbe03	303 2404:1a8:ffff:fe00:2001::3 ff3e 301 2404:1a8:ffff:fe00:2001::1 ff3e	e::8000:1 0.11 e::8000:1 48.44	■ (in pps) MP2T(33)	■ (in bps) ■ (in pps) MP2T(33) FEC(96)	☐ (in bps) FEC(96)	■ MP2T(33)	C(96)	>
8 2010-01-09 16:21:33 QProbe03 9 2010-01-09 16:21:33 QProbe03 10 2010-01-09 16:21:13 QProbe03	302 2404:1a8:ffff:fe00:2001::2 ff3e 303 2404:1a8:ffff:fe00:2001::3 ff3e 301 2404:1a8:ffff:fe00:2001::1 ff3e	<pre>::8000:1 48.44 ::8000:1 48.44 ::8000:1 0.11</pre>	•					
11 2010-01-09 16:21:13 QProbe03	302 2404:1a8:ffff:fe00:2001::2 ff3e …	9::8000:1 0.11	>					



Topic 3: View [4/6]

Probe view

When you select a probe from the Probe pull-down menu, the specified interface information is shown.

Channel view

 When you select {S,G} from the Channel Name pull-down menu, the specified IPTV-channel information is shown.

			<u>Prok</u>	<u>be</u>	view					<u>Cha</u>	nne	V	<u>view</u>					
🗈 Qcast Probe	View – M	icrosoft Internet Explorer						🕙 Qcast Probe	View - N	Microsoft Internet Explorer								
ファイル(<u>E</u>) 編集(<u>E</u>) 表示(V	・ お気に入り(<u>A</u>) ツール(T) ヘルブ	î(<u>H</u>)					ファイル(E) 編集((E) 表示(<u>)</u>	V) お気に入り(A) ツール(T) ヘルコ	9(<u>H</u>)							<u></u>
ö	≋ Тор	* Probe	× Channel		× Search			ö [× Тор	× Probe	× Channel		× Search					
								Chapt					1				🗹 Auto reload ON	
Probe	QProb QProb QProb	e03 e00 e01	~							2404:1a8:fffffe0 all (2404:1a8:fffffe0 (2404:1a8:fffffe0 (2404:1a8:fffffe0)	0:2001::3, ff3e::80 D:2001::1, ff3e::80 D:2001::2, ff3e::80 D:2001::3, ff3e::80	DO:1} 🚩 DO:1} DO:1} DO:1}						×
Monitorir	ng Sta	ang 103- 105: 2010- 1- 9 17:	.00 - 2010	- 1- 9	9 17:16			Monitori	ng Sta	atus: 2010- 1- 9 17:	:02 - 2010	- 1- 9	9 17:12					
[10min][1hou	ur][1day]							[10min][1hc	our][1day	1								
				Loss P	Pkts/sec	In kP	kts/sec	Probe	VI AN TO	Source Address	Group Address	Loss P	kts/sec		In kPk	ts/sec		
Probe	VLAN ID	Source Address	Group Address	Max	Time Stamp	Min Max	Min					Max	Time Stamp	Min	Max	Min		
1 OProbe03	301	2404:1a8:ffff:fe00:2001::1	ff3e::8000:1	48,44	2010-01-09 17:12:58	0.00 1.28	3 1.20 🙌	1 QProbeOO		2404:1a8:ffff:fe00:2001::3	ff3e::8000:1	0.00		0.00	1.28	1.28 🚹		-
2 OProbe03	302	2404:1a8:ffff:fe00:2001::2	ff3e::8000:1	48,44	2010-01-09 17:12:58	0.00 1.28	3 1.20 🙌	2 QProbe01	103	2404:1a8:ffff:fe00:2001::3	ff3e::8000:1	0.00		0.00	1.28	0.19 🚹		=
3 QProbeO3	303	2404:1a8:ffff:fe00:2001::3	ff3e::8000:1	48.44	2010-01-09 17:12:58	0.00 1.28	3 1.20 🚹	3 QProbe02 4 QProbe03	203 303	2404:1a8:ffff:fe00:2001::3	ff3e::8000:1 ff3e::8000:1	0.00 48.44	2010-01-09 17:11:58	0.00 9 0.00	1.28 1.28	1.28 🙌 1.20 🙌		~



Topic 3: View [5/6]

Probe view

- Also shows traffic volume chart built up from all channels.
- Useful for capacity planning.

	pe view – M	nerosone internet explorer									
ファイル(E) 編集	集(E) 表示(⊻	♪ お気に入り(A) ツール(D) ヘノ	vプ(H)								<i>R</i>
Ő	× Тор	× Probe	Channel	×	Search						^
									🗹 Auto re	load ON	
Prob	e: QProl	beO3	*								
			А	ll Chan	nel						
:	60										
sd	50 - 40 -									{	240
sdqW	50									{ {	240 240
sdqW	50 - 40 - 30 - 20 - 10 -									{: {:	240 240
sdq W	50 40 30 20 10 10 10 10 53	16.59 17.00 11	01 17.02	17.0	3 1704	17.05	1	7,06	17,07	{ { { {	240 240 240
80.0 0 1000	50 40 30 20 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	16 <mark>.</mark> 59 17.00 17	01 17.02	17 ⁵ 0 Tim	3 17 ¹ 04 e	17:05	1	7:06	17:07	{ { { 17:08}	240 240 240
30 4 10.0	50 40 30 20 10 10 0 9 10 9 16:58	16 ⁵ 59 17 ⁵ 00 17	:01 17:02	17 ^{'0} Tim	3 17.04 e	17:05	1	7:06	17:07	{ { { { { { 17:08}}}	240 240 240
Monito	50 40 30 20 10 10 51/09 16:58	16 ⁵⁹ 17 ⁰⁰ 1 / tus: 2010- 1- 9 1	201 1702 5:59 - 2010-	17 ¹⁰ Tim - 1- 9	3 17 ¹ 04 He 17:09	17:05	1,	7.06	17:07	{ { 17:08	240 240 240
Monitor	50 40 30 20 20 10 0 0 0 100 16:58 ring Sta	16.59 17.00 17 1 tus: 2010- 1- 9 1 (ioi 17:02 5:59 - 2010-	17:0 Tim - 1- 9	3 17.04 e 17:09	17:05	1	7.06	17:07	{ { { 17:08	240 240 240
Monitor [10min][1]	50 40 30 20 20 10 0 0 105 16:58 ring Sta	16:59 17:00 1 1 tus: 2010- 1- 9 1 (]	201 1702 5:59 - 2010-	17:0 Tim - 1- 9 Loss Pk'	3 17:04 te 17:09 ts/sec	17.05	1' In kPk	7:06 ts/sec	17:07	17:08	240 240 240
Monitor [10min][1] Probe	50 40 30 20 20 01 00 10 01 00 10 10 01 00 10 53 8 7 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10	16.59 17.00 1 I tus: 2010- 1- 9 10] Source Address	² 01 17:02 5 :59 - 2010 - Group Address	17:0 Tim - 1- 9 Loss Pk [*] Max 1	3 17:04 17:09 ts/sec time Stamp	17:05 Min	1 [°] In kPk Max	7.06 ts/sec Min	17'07	{ { 17:08	240 240 240
Monitor [10min][1] Probe 1 QProbe0	50 40 20 20 01 00 10 01 00 10 10 01 00 10 10 10 01 00 10 1	16:59 17:00 1 Itus: 2010- 1- 9 10 J Source Address 2404: 1a8: ffff: fe00: 2001: :	¹ 01 17.02 5:59 - 2010- Group Address 1 ff3e::8000:1	17:0 Tim - 1- 9 Loss Pk [*] Max 1 48.44 2	3 17:04 e 17:09 ts/sec Fime Stamp 2010-01-09 17:09:08	17:05 Min	1 In kPk Max 1.28	7.06 ts/sec Min 1.20	17:07	{ { { 17:08	240 240 240
10X Monitor [10min][1] Probe 1 QProbe0 2 QProbe0	50 40 20 20 0109 16:58 hour] [1day] VLAN ID 3 301 3 302	16.59 17.00 1 Itus: 2010- 1- 9 1(Source Address 2404: 1a8: ffff: fe00: 2001:: 2404: 1a8: ffff: fe00: 2001::	201 17:02 5:59 - 2010 Group Address 1 ff3e::8000:1 2 ff3e::8000:1	17:0 Tim - 1- 9 Loss Pk ⁺ Max 1 48.44 2 48.44 2	3 17.04 17:09 ts/sec Fime Stamp 2010-01-09 17:09:08 2010-01-09 17:09:08	17:05 Min 0.00	T In kPk Max 1.28 1.28	7.06 ts/sec Min 1.20 1 1.20 1	17.07	{ { 1738	240 240 240



Topic 3: View [6/6]

Channel view

 Also localizes fault point by comparing traffic charts of multiple probes.



FloCon 2010

🗟 scoopFlow : Qeast Probe View 1.0 - Microsoft Internet Explorer

ファイルビン 編集(ビ) 表示(い) お気に入り(A) ツール(T) ヘルプ(H)

Traffic Chart



Evaluation of Probe

Experimental assumptions:

- □ Packets of 20–100 IPTV channels pass through a probe.
 - Traffic volume of an IPTV channel: 10 Mbps, 0.9 kpps.
 - IPTV channel includes two kinds of packets (Media, FEC).
- We evaluated the probe by varying the sampling interval period.
 - Sum of the sampling and spacing interval period was kept at a fixed value of 1000 ms.
 - Flow active timeout had a fixed value of 10 s.



Experimental environment:

 CPU: Core 2 Duo 2.0GHz, Memory: 3.5 GB, Interface: Intel 1GbE NIC, OS: CentOS 5.3



Experimental Results for Probe

- Exported flow number and packet loss rate obtained by changing the interval period from 100 to 999 ms.
- Performance had no limitation for interval period from 100 to 900 ms.



NTT

Packet Loss Detection Probability

- We evaluated the detection probability for packet loss within the given monitoring interval (*n*) by changing packet loss rate (*p*) and sampling interval time (*d*).
 - On the condition that *n* is 1 min and packet rate (*r*) is 0.9 kpps, the experimental results are shown. 1 $(1 - n)^{r \cdot n \cdot d/1000}$
- Detection probability is almost 100% if the sampling interval period is 900 ms and packet loss is 1/1000 for over 1 min.



-1/100 - 1/1000 - 1/10000



Evaluation of Web-Console

Experimental assumptions:

- IPFIX packets were input to a Web-Console.
 - A IPFIX packet includes 10 flow records.
- We evaluated the Web-Console by varying the flow rate and number of flow.
 - Flow rate: 10-200 flow/sec (1-20 pps)
 - No. of flow: 200-1000 flow (20-100 packets)

Experimental environment:

CPU: Xeon 3.6Hz, Memory: 3.5 GB,
 OS: CentOS 5.3, DB: PostgresSQL 8.37



Experimental Results for Web-Console

- We measure the number of inserted flow into traffic database in time by changing the following conditions:
 - No. of input flow from 2,000 to 10,000
 - Input flow rate from 10 to 200 flow/sec.
- The performance limit seems to be as follows:
 - □ 50 flow/sec: 9,000 flow
 - 100 flow/sec: 4,500 flow
 - 150 flow/sec: 4,000 flow
 - 200 flow/sec: 2,200 flow

That is to say:



- When flow active timeout is 180 sec, 90 probe (9,000 flow) is supported.
- □ When flow active timeout is 45 sec, 45 probe (4,500 flow) is supported.
- When flow active timeout is 26 sec, 40 probe (4,000 flow) is supported.
- When flow active timeout is 11 sec, 22 probe (2,200 flow) is supported.



Summary

- We presented a new traffic monitoring method for IP multicast streaming services, such as IPTV, and the implemented system using IPFIX/PSAMP (Qcast).
- We showed the feasibility of the Qcast.



Thank you very much.

Please come and see our demonstration.

This study was supported by the Ministry of Internal Affairs and Communications of Japan.