

DESKTOP TOOLS TO WORK WITH SMPTE 2110 SYSTEMS WORKSHOPS

Emir C Onat

26 Feb 2020

FOX

WORKSHOP TOPICS

PTP GrandMaster deployment on Windows 10

- Windows 10 Client OS
- Ubuntu terminal for Windows 10
- PTPd (linux)

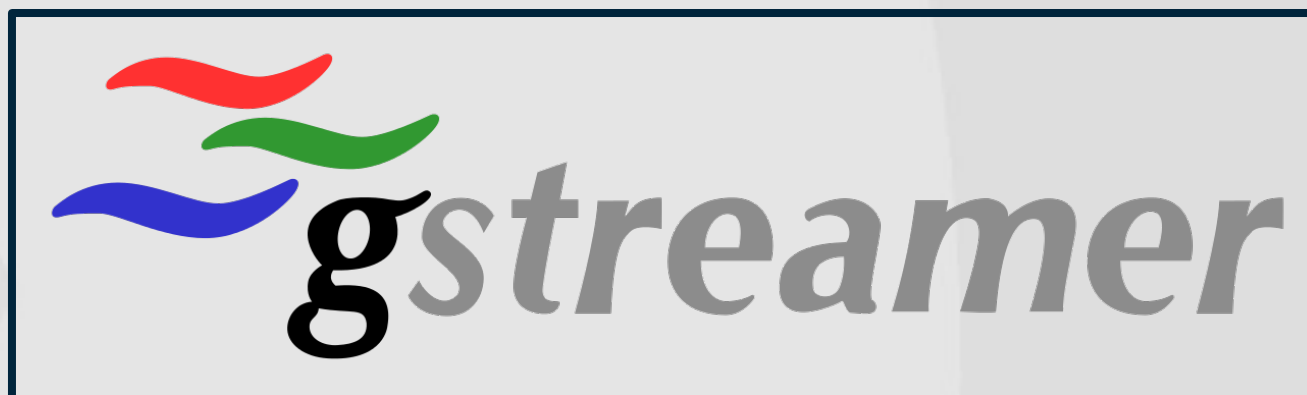


Generate a ST2110 IP signal

- SDI signal source (Phabrix TSG)
- 10G SFP to ThunderBolt 3 adapter (SONNET)
- ST2110 ENCAP SFP (embrionix)

Precision Time Protocol daemon

Portable, complete and BSD-licensed IEEE 1588 (PTP) implementation



ST2110 Realtime Playback

- gstreamer: ST2110 Realtime playback using pipelines
- FFmpeg: ST2110 Realtime playback using sdp file
- VLC:ST2110-20 (AES67) Realtime playback using sdp file



Extract just the audio packets from a ST2110 PCAP

- Wireshark: Filter and Export just the ST2110-30 packets
- Audacity: ST2110-30 (AES67/PCM) pcap file audio playback



HARDWARE

- ThinkPad Laptop Intel i9
- Phabrix SX Test Signal Generator
- SONNET 10G SFP to ThunderBolt 3
- Embrionix ENCAP SFP (ST2110)



PTP GRANDMASTER DEPLOYMENT ON WINDOWS 10

Every video signal is assumed to start at the beginning of the EPOCH Jan 1st 1970 00:00:00.0000

Microsoft Ubuntu 18.04 LTS

<https://www.microsoft.com/en-us/p/ubuntu-1804-lts/9n9tngvndl3q?activetab=pivot:overviewtab>

- Before download and installation, enable Windows Subsystems for Linux
- After installation is completed run the following two command “*sudo apt-get update*”

Precision Time Protocol daemon installation

- Run the following command within ubuntu terminal window “*sudo apt-get install ptpd*”

PTPd example configuration file

https://raw.githubusercontent.com/microsoft/W32Time/master/Precision%20Time%20Protocol/PTPd%20Configuration%20Examples/master_e2e_sock_modified_no_clock_discipline_hybrid_configuration.txt

- Copy paste text into notepad and insert blank line at the end of file, save file with .conf ext (ptpdhybrid.conf)
- Modify .conf file with interface ID (eth1, eth2 etc...) seen by issuing the ifconfig command within ubuntu terminal
- Modify Domain number if needed. In this example we will be using 99 as this is the domain my slave device is set to
- Modify Announce and Sync interval: expressed as log 2^x example -3=0.125s, -2=0.25s, -1=0.5s, 0=1s, 1=2s
- ST2059 default settings: Announce -2=0.250(4Hz) Sync -3=0.125(8Hz)

Start PTPd Grandmaster

- Run “*sudo ptpd -c ptpdhybrid.conf*” as ptpdhybrid is the saved file name we used in the previous steps

Stop PTPd Grandmaster

- locate the ptpd PID by running the “*ps -aux | grep*” command
- Now issue the “kill” command for the ptpd PID

SMPTE 2059 PTP profile parameters^[4]

Parameter	Default	Minimum	Maximum
Domain number	127	0	127
Announce interval	250 ms	125 ms	1 s
Sync interval	125 ms	$\frac{1}{128}$ s	500 ms
Delay request interval	Sync interval	Sync interval	32 x Sync interval



PTP MONITORING

MEINBERG Track Hound

<https://www.meinbergglobal.com/english/sw/ptp-track-hound.htm>

MEINBERG

PTP TRACK HOUND

v1.0.6

0% (0/64 MB)

Filters

Interface(s): All

Protocol(s): All

Domain(s): All

Message(s): All

Device(s): All

Control

723

ANN

17

SYN

69

FUP

69

REQ

284

RES

284

SIG

0

MNG

0

OTH

0

Messages (723)

No.

Interface

Time

Msg. Type

Version

Sdold/Dom.

Seq. ID

Source

Destination

Device

704	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13881	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
705	Ethernet SONNET T3	2020-02-12, 20:37:29	Sync	v2	100	3488	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
706	Ethernet SONNET T3	2020-02-12, 20:37:29	Follow Up	v2	100	3488	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
707	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13882	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
708	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13882	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
709	Ethernet SONNET T3	2020-02-12, 20:37:29	Announce	v2	100	1231	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
710	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13883	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
711	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13883	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
712	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13884	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
713	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13884	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
714	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13885	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
715	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13885	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
716	Ethernet SONNET T3	2020-02-12, 20:37:29	Sync	v2	100	3489	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
717	Ethernet SONNET T3	2020-02-12, 20:37:29	Follow Up	v2	100	3489	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
718	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13886	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
719	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13886	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
720	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13887	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
721	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13887	192.168.169.10	224.0.1.129	Sonnet_FFFE120646
722	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Req.	v2	100	13888	192.168.169.101	224.0.1.129	0x40A36BFFFEA05B88
723	Ethernet SONNET T3	2020-02-12, 20:37:29	Delay Resp.	v2	100	13888	192.168.169.10	224.0.1.129	Sonnet_FFFE120646

Message Details

Delay Resp. (v2)

Length: 96 bytes

Protocol: IPv4

Domain: 100

Sequence ID: 13605

Receive Time: 04:36:54.072923

Ethernet II

IPv4

UDP

PTP

Delay Resp.

Destination: 01:00:5E:00:01:81

Source: 00:30:93:12:06:46

Type: IPv4 (0x0800)

0x0000	01	00	5e	00	01	81	00	30		93	12	06	46	08	00	45	00
0x0010	00	52	d3	e5	00	00	40	11		00	00	c0	a8	a9	0a	e0	00
0x0020	01	81	01	40	01	40	00	3e		aa	6e	09	02	00	36	64	00
0x0030	00	00	00	00	00	00	00	00		00	00	00	00	00	00	00	30
0x0040	93	ff	fe	12	06	46	00	01		35	25	03	7f	00	00	5e	44
0x0050	d2	8b	04	63	8c	e8	40	a3		6b	ff	fe	a0	5b	88	00	01

Devices (2)

Type

Identity

Address

Interface

VLAN

Protocol

Dom.

ANN

GM (1)	Sonnet_FFFE120646	192.168.169.10	Etherne...NET T3	-	IPv4	100	17
Slave	0x40A36BFFFEA05B88	192.168.169.101	Etherne...NET T3	-	IPv4	100	0

Device Details

Port Identity: -

Address: -

Vendor: -

Device: -

Management: -

GM Clock Quality: -

Port State: -

Delay Mech.: -

Ann. Rate: -

Sync Rate: -

Req. Rate: -

Events

Filter:

10	2020-02-12, 20:37:25.652	Global	Master changeover (New: Sonnet_FFFE120646)
9	2020-02-12, 20:37:25.290	0x40A36BFFFEA05B88	State changed from Passive to Master
8	2020-02-12, 20:37:21.643	Global	No Master left
7	2020-02-12, 20:37:21.563	Sonnet_FFFE120646	State changed from Master to Passive
6	2020-02-12, 20:36:56.278	Global	State changed from Unknown to Master
5	2020-02-12, 20:36:55.073	Sonnet_FFFE120646	State changed from Unknown to Slave
4	2020-02-12, 20:36:54.277	Global	Type changed from Unknown to Grandmaster
3	2020-02-12, 20:36:54.098	0x40A36BFFFEA05B88	New device (Unknown, 192.168.169.10) detected
2	2020-02-12, 20:36:54.072	Global	Type changed from Unknown to Slave
1	2020-02-12, 20:36:54.072	0x40A36BFFFEA05B88	New device (Unknown, 192.168.169.101) detected



PTP MONITORING

Wireshark

<https://www.wireshark.org/download.html>

Wireshark display filters (E2E mode)

PTP: ptp

General Messages: udp.ptp == 320

Event Messages: udp.ptp == 319

Announce: ptp.v2.messageid == 0xb

Sync: ptp.v2.messageid == 0x0

Follow Up: ptp.v2.messageid == 0x8

Delay Request: ptp.v2.messageid == 0x1

Delay Response: ptp.v2.messageid == 0x09

Delay Response MAC:

ptp.v2.dr.requestingsourceportidentity ==
0x40a36bffffea077fa

*Ethernet 3 SONNET 10G

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ptp + PTP.V2 Announce | PTP.V2 Sync | PTP.V2 Delay Request | PTP.V2 Delay Response | PTP.V2 Follow Up | RTP Marker Bit | RTP PayLoad 96 Video

No.	Time	Source	Destination	Protocol	Length	Info
3897138	59.167008	192.168.100.10	224.0.1.129	PTPv2	106	Announce Message
3900636	59.218890	192.168.100.10	224.0.1.129	PTPv2	86	Sync Message
3900644	59.219009	192.168.100.10	224.0.1.129	PTPv2	86	Follow_Up Message
3904035	59.270580	192.168.100.100	224.0.1.129	PTPv2	86	Delay_Req Message
3904046	59.270734	192.168.100.10	224.0.1.129	PTPv2	96	Delay_Resp Message
3908920	59.344516	192.168.100.10	224.0.1.129	PTPv2	86	Sync Message
3908930	59.344625	192.168.100.10	224.0.1.129	PTPv2	86	Follow_Up Message
3912243	59.395604	192.168.100.100	224.0.1.129	PTPv2	86	Delay_Req Message
3912250	59.395729	192.168.100.10	224.0.1.129	PTPv2	96	Delay_Resp Message
3913749	59.417556	192.168.100.10	224.0.1.129	PTPv2	106	Announce Message

originTimestamp (nanoseconds): 0
originCurrentUTCOffset: 37
priority1: 1
grandmasterClockClass: 10
grandmasterClockAccuracy: The time is accurate to within 1 us (0x23)
grandmasterClockVariance: 28768
priority2: 2
grandmasterClockIdentity: 0x003093fffe120646

0000	01 00 5e 00 01 81 00 30 93 12 06 46 08 00 45 00	..^...0...F..E.
0010	00 5c 09 0f 00 00 40 11 00 00 c0 a8 64 0a e0 00	.\...@...d...
0020	01 81 01 40 01 40 00 48 3b bb 0b 02 00 40 63 00	...@.@.H ;...@c.
0030	00 0c 00 00 00 00 00 00 00 00 00 00 00 00 30	0
0040	93 ff fe 12 06 46 00 01 3d b5 05 7f 00 00 00 00	F..=.....
0050	00 00 00 00 00 00 00 25 6b 01 0a 23 70 60 02 00	%k..#p`..
0060	30 93 ff fe 12 06 46 00 00 a0	0.....F..

grandmasterClockIdentity (ptp.v2.an.grandmasterclockidentity), 8 bytes

Packets: 4275767 · Displayed: 2320 (0.1%) · Dropped: 0 (0.0%) | Profile: Default



PTP MONITORING

InterOperability Laboratory PTP Colour Filters

<https://www.iol.unh.edu/knowledge/iolptpwiresharkcolorfilterstxt>

*Ethernet 3 SONNET 10G

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ptp + PTP.V2 Announce | PTP.V2 Sync | PTP.V2 Delay Request | PTP.V2 Delay Response | PTP.V2 Follow Up | RTP Marker Bit | RTP PayLoad 96 Video »

No.	Time	Source	Destination	Protocol	Length	Info
473266	7.181142	192.168.100.10	224.0.1.129	PTPv2	106	Announce Message
473401	7.183098	192.168.100.10	224.0.1.129	PTPv2	86	Sync Message
473410	7.183225	192.168.100.10	224.0.1.129	PTPv2	86	Follow_Up Message
480029	7.284099	192.168.100.100	224.0.1.129	PTPv2	86	Delay_Req Message
480030	7.284223	192.168.100.10	224.0.1.129	PTPv2	96	Delay_Resp Message
481666	7.308962	192.168.100.10	224.0.1.129	PTPv2	86	Sync Message
481677	7.309086	192.168.100.10	224.0.1.129	PTPv2	86	Follow_Up Message
488259	7.409125	192.168.100.100	224.0.1.129	PTPv2	86	Delay_Req Message
488271	7.409280	192.168.100.10	224.0.1.129	PTPv2	96	Delay_Resp Message
489716	7.431700	192.168.100.10	224.0.1.129	PTPv2	106	Announce Message
489921	7.434638	192.168.100.10	224.0.1.129	PTPv2	86	Sync Message
489931	7.434772	192.168.100.10	224.0.1.129	PTPv2	86	Follow_Up Message

priority1: 1
grandmasterClockClass: 10
grandmasterClockAccuracy: The time is accurate to within 1 us (0x23)
grandmasterClockVariance: 28768
priority2: 2
grandmasterClockIdentity: 0x003093fffe120646

wireshark_Ethernet 3 SONNET 10G_20200222192457_a12036.pcapng | Packets: 577373 · Displayed: 312 (0.1%) · Dropped: 0 (0.0%) | Profile: Default

hex	message type
00	Sync
01	Delay_Req
02	Pdelay_Req
03	Pdelay_Resp
08	Follow_Up
09	Delay_Resp
0a	Pdelay_Resp_Follow_Up
0b	Announce
0c	Signaling
0d	Management

GENERATE A ST2110 SIGNAL



<https://www.embrionix.com/>



PHABRIX SX
TEST SIGNAL
GENERATOR

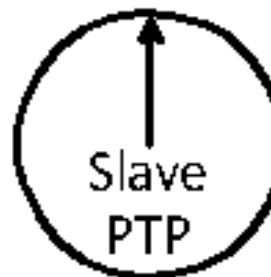
720p 59.94
SDI 1.5G

SONNET
SOLO10G SFP+

Embrionix

ST2110 ENCAP SFP

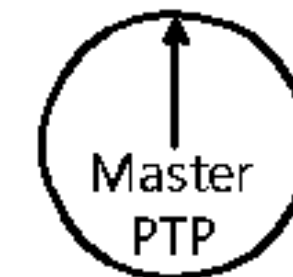
VIDEO 2110-20 (239.0.1.2)
AUDIO 2110-30 (239.0.1.3)
ANC 2110-40 (239.0.1.20)



PTP/ST2110
IP 1.5G

ThinkPad
P52 Intel i9

Thunderbolt 3



This setup is good enough to demonstrate/analyze PTP and ST2110 video. It will generate all the packets needed, but lacking a genlocked SDI source (TSG) and poor ptp clock accuracy - using my laptop as the ptp grandmaster. Grandmaster time is locked to my laptops system time.

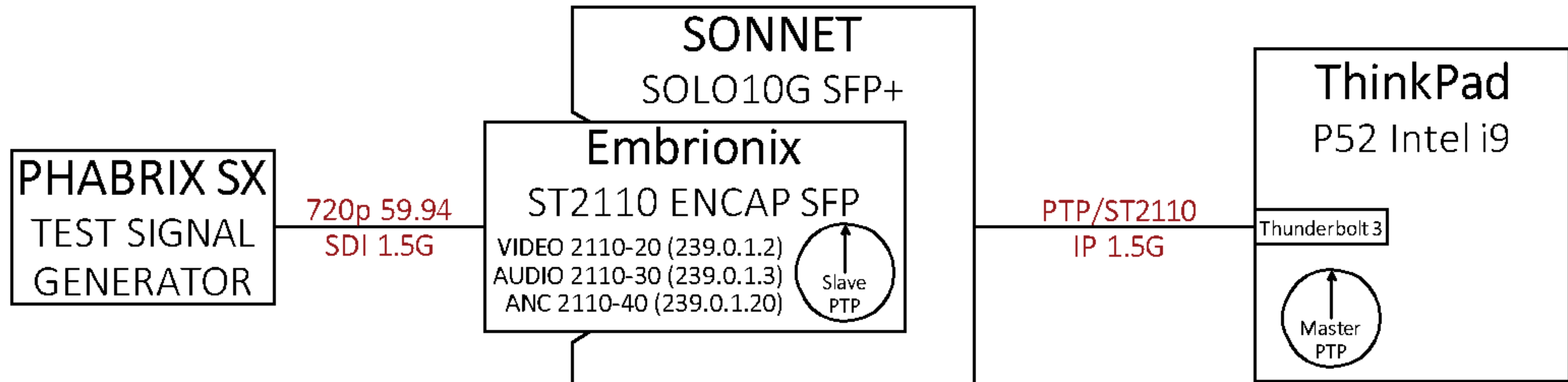
The easiest and smallest device we can use to en-cap SDI and slave/lock to PTP are these SDI to IP gateway SFP's. Here I am using one made by embrionix, for control and configuration we can use their web GUI app (emSET) running on my local Laptop

<http://localhost:8080/#/login>

PLAY ST2110 SIGNAL



<https://gstreamer.freedesktop.org/download/>



GSTREAMER pipeline: By chaining together several elements, you create what is called a pipeline running specific task.

ST2110-20 Playback:

- `gst-launch-1.0 udpsrc address=239.0.1.2 port=20000 ! queue max-size-bytes=0 max-size-buffers=0 max-size-time=0 ! "application/x-rtp, media=(string)video, clock-rate=(int)90000, encoding-name=(string)RAW, sampling=(string)YCbCr-4:2:2, depth=(string)10, width=(string)1280, height=(string)720, colorimetry=(string)BT709, payload=(int)96" ! rtpjitterbuffer ! rtpvrawdepay ! queue ! videoconvert ! autovideosink`

ST2110-30 (AES67) Playback:

- `gst-launch-1.0 -v udpsrc uri=udp://239.0.1.4:20000 caps="application/x-rtp, media=(string)audio, clock-rate=(int)48000, encoding-name=(string)L24, encoding-params=(string)4, channels=(int)4, payload=(int)97" ! rtpL24depay ! queue ! audioconvert ! autoaudiosink`

PLAY ST2110-20 SIGNAL USING SDP FILE



<https://www.ffmpeg.org/download.html>

SDP: Session Description Protocol (RFC4566)

<https://tools.ietf.org/html/rfc4566>

- v=0 (protocol version)
- o=- 1443716955 1443716955 IN IP4 192.168.100.100 (originator info: name)
- s=emsfp-a0-77-fa 0-0-0 (session name)
- t=0 0 (start stop times)
- m=video 20000 RTP/AVP 96 (media name example: video/audio and transport address)
- c=IN IP4 239.0.1.2/64 (destination multicast address with TTL)
- a=source-filter: incl IN IP4 239.0.1.2 192.168.100.100 (SSM)
- a=rtpmap:96 raw/90000 (payload type, encoding name, uncompressed video media clock)
- a=fmtp:96 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=30; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=ST2110-20:2017; TP=2110TPN;
- a=mediaclock:direct=0 (media clock offset)
- a=ts-refclk:ptp=IEEE1588-2008:00-30-93-ff-fe-12-06-46:99 (PTP GrandMaster Clock ID with Domian)

ST2110-20 Playback using .sdp file:

- ffplay -protocol_whitelist file,rtp,udp -strict -2 -f sdp test29.sdp

ST2110 WIRESHARK (RTP TIMESTAMP/MARKER BIT)

RTP Timestamp calculation

The RTP counter is running at 90,000 ticks per second, thus we can work out the following total tick increments per frame of video

720p@30

$90000 \div 30\text{fps} = 3000$

720p @ 59.97

$90000 \text{ samples} \div 59.97\text{fps} = 1501$

720p @ 60

$90000 \text{ samples} \div 60\text{fps} = 1500$

1080p @ 30

$90000 \div 30\text{fps} = 3000$

1080p @ 60

$90000 \div 30\text{fps} = 1500$

Wireshark ST2110 Filters

End of Frame

`rtp.marker == 1` Frame

Video Packet

`rtp.p_type == 96` Video

The image shows a Wireshark capture of an RTP packet. The packet list pane shows a packet with sequence number 11408 and timestamp 4211939427, marked as a 'Marker'. The packet details pane shows the 'Marker' bit set to 'True'. The packet bytes pane shows the raw data of the packet, with the marker bit (bit 27) highlighted in blue.

No.	Time	Source	Destination	Protocol	Length	Info
1984	0.028956	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11404, Time=4211939427
1985	0.028957	192.168.100.100	239.0.1.2	RTP	862	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11405, Time=4211939427
1986	0.029000	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11406, Time=4211939427
1987	0.029000	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11407, Time=4211939427
1988	0.029001	192.168.100.100	239.0.1.2	RTP	862	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11408, Time=4211939427, Mark
1989	0.029872	192.168.100.100	239.0.1.4	RTP	630	PT=DynamicRTP-Type-97, SSRC=0x0, Seq=58179, Time=2245698095
1990	0.030394	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11409, Time=4211942427
1991	0.030398	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11410, Time=4211942427
1992	0.030399	192.168.100.100	239.0.1.2	RTP	862	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11411, Time=4211942427
1993	0.030469	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11412, Time=4211942427
1994	0.030471	192.168.100.100	239.0.1.2	RTP	1262	PT=DynamicRTP-Type-96, SSRC=0x0, Seq=11413, Time=4211942427

User Datagram Protocol, Src Port: 10000, Dst Port: 20000

Real-Time Transport Protocol

- 10... = Version: RFC 1889 Version (2)
- ..0. = Padding: False
- ...0 = Extension: False
- 0000 = Contributing source identifiers count: 0
- 1... ... = Marker: True

Payload type: DynamicRTP-Type-96 (96)

Sequence number: 11408

Timestamp: 4211939427

0020 01 02 27 10 4e 20 03 3c 00 00 80 e0 2c 90 fb 0d ..N <,...

0030 18 63 00 00 00 00 b4 8e 03 20 02 cf 03 c0 80 06 .c.....

0040 38 00 63 80 06 38 00 63 80 06 38 00 63 80 06 38 8.c..8.c ..8.c..8

0050 00 63 80 06 38 00 63 80 06 38 00 63 80 06 38 00 .c..8.c ..8.c..8

Marker (rtp.marker), 1 byte

Packets: 328549 · Displayed: 328549 (100.0%) · Dropped: 0 (0.0%)

Profile: Default

SMPTE ST2110-20 Wireshark Dissector/Tools

<https://github.com/NEOAdvancedTechnology>

ST2110-20: <https://github.com/NEOAdvancedTechnology/smp2110-20-dissector>

ST2110-40: <https://github.com/NEOAdvancedTechnology/smp2110-40-dissector>

Right click payload type from the main window, select “Stream Analysis” from the RTP dropdown within the “Telephony” menu option

wireshark_Ethernet 3 SONNET 10G_20200216214350_a14640.pcapng | Packets: 245528 · Displayed: 245528 (100.0%) · Dropped: 970 (0.4%) | Profile: Default

ST2110 PCAP AUDIO EXPORT



<https://www.audacityteam.org/download/>

Sample per IP packet

Audio payload size (bytes) ÷ 3 bytes

$576 \div 3 = 192$ samples

Number of Audio Channels

$4477506 - 4477458 = 48$

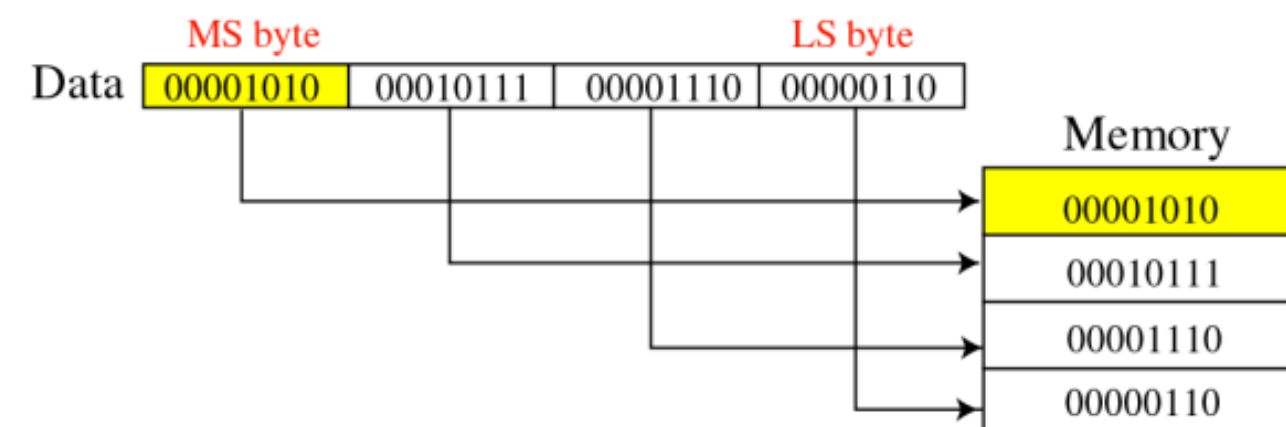
$192 \div 48 = 4$ Audio Channels

Export raw Audio packets

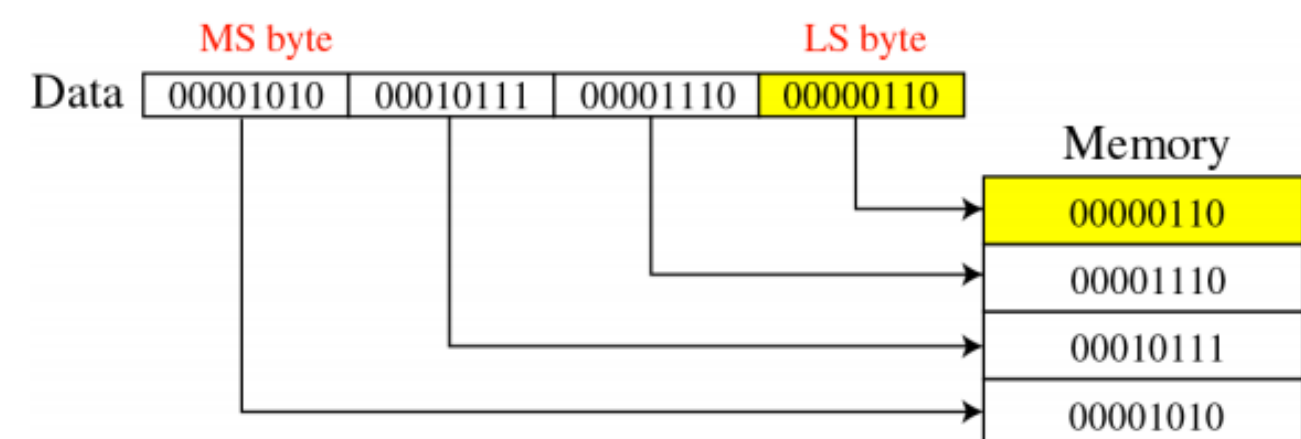
Select “Stream Analysis” from the RTP dropdown within the “Telephony” menu option.

Save using the “Unsynchronized Forward Stream Audio” with the .raw extension.

Big-Endian:



Little-Endian:



10.. = Version: RFC 1889 Version (2)
..0. = Padding: False
...0 = Extension: False
.... 0000 = Contributing source identifiers count: 0
0... = Marker: False
Payload type: DynamicRTP-Type-97 (97)
Sequence number: 27744
Timestamp: 4477458
Synchronization Source identifier: 0x00000000 (0)
Payload: 060031060031060031060031076d51076d51076d51...

Payload (rtp.payload) 576 bytes

Packets: 207872 · Displayed: 3156 (1.5%) · Dropped: 0 (0.0%) | Profile: Default

WEB LINKS/REFERENCES

Windows PTPd instructions

<https://techcommunity.microsoft.com/t5/networking-blog/windows-subsystem-for-linux-for-testing-windows-10-ptp-client/ba-p/389181>

PTPd .conf example file

https://raw.githubusercontent.com/microsoft/W32Time/master/Precision%20Time%20Protocol/PTPd%20Configuration%20Examples/master_e2e_sock_modified_no_clock_discipline_hybrid_configuration.txt

Ubuntu Terminals for Windows Download

<https://www.microsoft.com/en-us/p/ubuntu-1804-lts/9n9tngvndl3q?activetab=pivot:overviewtab>

Ubuntu Thermals for Windows Overview

<https://ubuntu.com/tutorials/tutorial-ubuntu-on-windows#1-overview>

Meinberg PTP Track Hound

<https://www.meinbergglobal.com/english/sw/ptp-track-hound.htm>

WireShark Download

<https://www.wireshark.org/download.html>
[files-thomas-edwards/](#)

InterOperablty Laboratory PTP Colour Code

<https://www.iol.unh.edu/knowledge/iolptpwiresharkcolorfilterstxt>

Gstreamer

<https://gstreamer.freedesktop.org/download/>

Ffmpeg

<https://www.ffmpeg.org/download.html>

RFC4566

<https://tools.ietf.org/html/rfc4566>

WireShark ST2110-20/ST2110-40 Dissector/Tools

<https://github.com/NEOAdvancedTechnology>

Embrionix emSET Download

<https://www.embrionix.com/product/emSET>

Audacity Download

<https://www.audacityteam.org/download/>

Audacity AES67 PCAP playback

<https://www.linkedin.com/pulse/listen-audio-from-aes67st-2110-30-pcap->

GOT QUESTIONS ?

THANK YOU

Emir C Onat

Email: emir.onat@fox.com

Cell: 310-854-9687