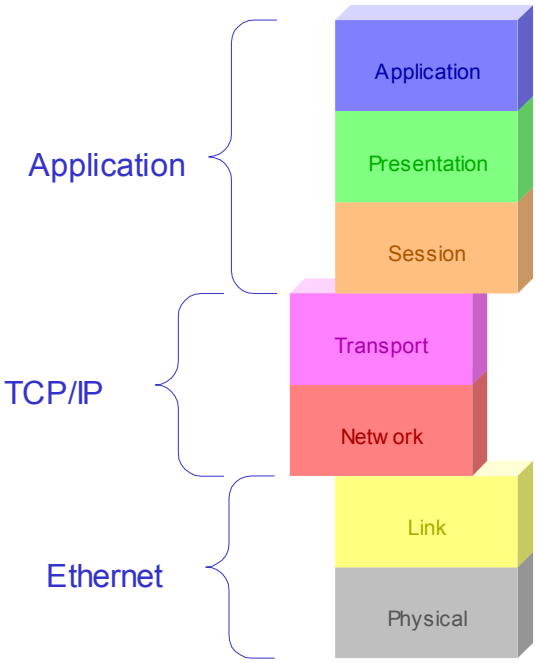
	Date	Documents	Version	Author
BARIX	24/03/09	Bit rate calculation	03.00.00	Giacomo Trovato

BIT RATE CALCULATION WITH BARIX DEVICES

With this document we want to explain how to calculate the total bit rate flowing on an Ethernet cable connected to a Barix device.
The total bit rate is equal at the audio bit rate plus the overhead due to the encapsulation of audio packet inside the layers of OSI stack (http://en.wikipedia.org/wiki/Osi_model).



We have used for the test an Instreamer 100 (with standard firmware) configured first in RAW UDP and then in RTP, and an Exstreamer 1000 (with STL firmware).

RAW UDP STREAMING MODE

Ethernet Packet (http://en.wikipedia.org/wiki/Ethernet)

Field	Number of bit
Preamble*	56
Start-of-Frame-Delimiter*	8
MAC destination	48
MAC source	48
Ethertype/Length	16
CRC32*	32
Interframe gap*	92
Data (IP Packet)	
Total (without data)	**300**

* As the Ethernet hardware filters the Preamble (plus Start-of-Frame-Delimiter) and Interframe gap, it is not given to Wireshark or any other application. Most Ethernet interfaces also either don't supply the CRC32 to Wireshark or other applications, or aren't configured by their driver to do so (http://wiki.wireshark.org/Ethernet).

IP Packet (http://en.wikipedia.org/wiki/Ipv4)

Field	Number of bit
Version	4
Header length	4
Type of Service (now DiffServ and ECN)	8
Total Length	16
Identification	16
Flags	3
Fragment Offset	13
Time to Live	8
Protocol	8
Header Checksum	16
Source Address	32
Destination Address	32
Data (UDP Packet)	
Total (without data)	**160**

UDP Packet (http://en.wikipedia.org/wiki/UDP_packet)

Field	Number of bit
Source Port	16
Destination Port	16
Length	16
Checksum	16
Data (Audio Packet)	
Total (without data)	**64**

Total Bits of Overhead per Packet

Packet	Number of bit
Ethernet	300
IP	160
UDP	64
Total	**524**

The Audio Bit rate is expressed in bit/sec but the Overhead is expressed in bit/packet.

So we have to translate the Overhead (bit/packet) in Overhead rate (bit/sec).
For this we need to know the amount of packet/sec, that depends by Audio Format and is measurable with Network Protocol Analyzer software like Wireshark.

The values of Audio Data for audio format, sampling frequency and quality (MP3 bitrate average), come from Instreamer Manual (firmware V3.0 – page 20 - www.barix.com/downloads/file/Instreamer_Manual_V300_PDF/7231/81)

Mono input with MS-Stereo encoding disabled

Encod./Quality	0	1	2	3	4	5	6	7
MPEG1 48kHz	72	76	80	88	96	112	144	160
MPEG1 44.1kHz	65	68	73	80	90	105	125	140
MPEG1 32kHz	52	56	64	72	80	96	112	136
MPEG2 24kHz	38	44	48	52	60	80	96	112
MPEG2 22.05kHz	35	38	40	45	50	60	75	90
MPEG2 16kHz	28	30	34	40	44	48	56	64

Stereo inputs

Encod./Quality	0	1	2	3	4	5	6	7
MPEG1 48kHz	88	96	104	120	144	160	176	192
MPEG2 16kHz	35	38	44	48	56	64	80	96

Overhead/sec = Overhead/Packet x Packet/sec

Total Bit Rate (Kbit/sec) = Audio Data Rate (Kbit/sec) + Overhead/sec (Kbit/sec)
(1 Kbit = 1000 bit)

Audio Format	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead (bit)	Overhead/ sec (Kbit/sec)	Total Bit Rate (Kbit/sec)
PCM 16 bit 8 Khz, mono	128	13.551	524	7.1	135.1
PCM 16 bit 24 Khz, mono	384	42.213	524	22.12	406.12
uLaw 8 Khz, mono	64	6.7	524	3.5	67.5
ALaw 8 Khz, mono	64	6.7	524	3.5	67.5
ALaw 24KHz, mono	192	20.28	524	10.62	202.62
uLaw 24 Khz, mono	192	20.28	524	10.62	202.62
MPEG1 48KHz quality 0, stereo	88	16.46	524	8.62	96.62
MPEG1 48KHz quality 4, stereo	144	22.56	524	11.82	155.82
MPEG1 48KHz quality 7, stereo	192	27.81	524	14.57	206.57
MPEG1 48KHz quality 4, mono	96	16.08	524	8.42	104.42
MPEG1 44.1KHz quality 0, mono	65	12.27	524	6.43	71.43
MPEG1 44.1KHz quality 4, mono	90	15.76	524	8.25	98.25
MPEG1 44.1KHz quality 7, mono	140	25	524	13.1	153.1
MPEG2 16KHz quality 0, mono	28	5.8	524	3.03	31.03

Audio Format	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead (bit)	Overhead/ sec (Kbit/sec)	Total Bit Rate (Kbit/sec)
MPEG2 16KHz quality 4, mono	44	7.58	524	3.97	47.97
MPEG2 16KHz quality 7, mono	64	11.5	524	6	70

Total Bits of Overhead per Packet (without Ethernet Overhead)

Packet	Number of bit
IP	160
UDP	64
Total	**224**

Audio Format	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead without Ethernet (bit)	Overhead/ sec (Kbit/sec)	Total Bit Rate without Ethernet (Kbit/sec)
PCM 16 bit 8 Khz, mono	128	13.551	224	3.04	131.4
PCM 16 bit 24 Khz, mono	384	42.213	224	9.46	393.46
uLaw 8 Khz, mono	64	6.7	224	1.5	65.5
ALaw 8 Khz, mono	64	6.7	224	1.5	65.5
ALaw 24KHz, mono	192	20.28	224	4.54	196.54
uLaw 24 Khz, mono	192	20.28	224	4.54	196.54
MPEG1 48KHz quality 0, stereo	88	16.46	224	3.69	91.69
MPEG1 48KHz quality 4, stereo	144	22.56	224	5.05	149.05
MPEG1 48KHz quality 7, stereo	192	27.81	224	6.23	198.23
MPEG1 48KHz quality 4, mono	96	16.08	224	3.6	99.6
MPEG1 44.1KHz quality 0, mono	65	12.27	224	2.75	67.75
MPEG1 44.1KHz quality 4, mono	90	15.76	224	3.53	93.53
MPEG1 44.1KHz quality 7, mono	140	25	224	5.6	145.6
MPEG2 16KHz quality 0, mono	28	5.8	224	1.3	29.3
MPEG2 16KHz quality 4, mono	44	7.58	224	1.7	45.7
MPEG2 16KHz quality 7, mono	64	11.5	224	2.58	66.58

RTP STREAMING MODE

Ethernet Packet (http://en.wikipedia.org/wiki/Ethernet)

Field	Number of bit
Preamble*	56
Start-of-Frame-Delimiter*	8
MAC destination	48
MAC source	48
Ethertype/Length	16
CRC32*	32
Interframe gap**	92
Data (IP Packet)	
Total (without data)	**300**

IP Packet (http://en.wikipedia.org/wiki/Ipv4)

Field	Number of bit
Version	4
Header length	4
Type of Service (now DiffServ and ECN)	8
Total Length	16
Identification	16
Flags	3
Fragment Offset	13
Time to Live	8
Protocol	8
Header Checksum	16
Source Address	32
Destination Address	32
Data (UDP Packet)	
Total (without data)	**160**

UDP Packet (http://en.wikipedia.org/wiki/UDP_packet)

Field	Number of bit
Source Port	16
Destination Port	16
Length	16
Checksum	16
Data (RTP Packet)	
Total (without data)	**64**

RTP Packet (http://en.wikipedia.org/wiki/Real-time_Transport_Protocol)

Field	Number of bit
Ver.	2
P, X, CC, M, Payload Type	14
Sequence Number	16
Timestamp	32
SSRC identifier	32
Payload (Audio Packet)	(+32)*
Total (without data)	**128**

** the MP3 data are transferred in the MPA wrapper (inside the RTP payload), which has an extra 32 bit header.*

Total Bits of Overhead per Packet

Packet	Number of bit
Ethernet	300
IP	160
UDP	64
RTP	128
Total	**652**

The values of Audio Data for audio format, are the same of table above, since the transmission protocol doesn't affect audio bit rate.

Overhead/sec = Overhead/Packet x Packet/sec

Total Bit Rate (Kbit/sec) = Audio Data Rate (Kbit/sec) + Overhead/sec (Kbit/sec)
(1 Kbit = 1000 bit)

Audio Format	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead (bit)	Overhead/ sec (Kbit/sec)	Total Bit Rate (Kbit/sec)
MPEG1 48KHz quality 0, stereo	88	41.7	652	27.19	115.2
MPEG1 48KHz quality 4, stereo	144	41.7	652	27.19	171.2
MPEG1 48KHz quality 7, stereo	192	41.7	652	27.19	219.2
MPEG1 48KHz quality 4, mono	96	41.7	652	27.19	123.2
MPEG1 44.1KHz quality 0, mono	65	38.3	652	24.97	90
MPEG1 44.1KHz quality 4, mono	90	38.3	652	24.97	114.97
MPEG1 44.1KHz quality 7, mono	140	38.3	652	24.97	164.97
MPEG2 16KHz quality 0, mono	28	27.8	652	18.12	46.12
MPEG2 16KHz quality 4, mono	44	27.8	652	18.12	62.12
MPEG2 16KHz quality 7, mono	64	27.8	652	18.12	82.12

Audio Format (STL)	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead (bit)*	Overhead/ sec (Kbit/sec)	Bit Rate Wireshark (Mbit/sec)**
ALaw 8 Khz, mono	64	50	620	31	0.09
PCM MSB 16 bit 8 KHz mono	128	50	620	31	0.16
PCM MSB 16 bit 11.025 KHz mono	176.4	50	620	31	0.2
PCM MSB 16 bit 12 KHz mono	192	50	620	31	0.22
PCM MSB 16 bit 16 KHz mono	256	50	620	31	0.29
PCM MSB 16 bit 22.050 KHz mono	352.8	50	620	31	0.38
PCM MSB 16 bit 24 KHz mono	384	50	620	31	0.41
PCM MSB 16 bit 32 KHz mono	512	50	620	31	0.54
PCM MSB 16 bit 44.1 KHz mono	705.6	70	620	43.4	0.75
PCM MSB 16 bit 48 KHz mono	768	75	620	46.5	0.81
PCM MSB 16 bit 8 KHz stereo	256	50	620	31	0.29
PCM MSB 16 bit 11.025 KHz stereo	352.8	50	620	31	0.38
PCM MSB 16 bit 12 KHz stereo	384	50	620	31	0.41
PCM MSB 16 bit 16 KHz stereo	512	50	620	31	0.54
PCM MSB 16 bit 22.050 KHz stereo	705.6	70	620	43.4	0.75
PCM MSB 16 bit 24 KHz stereo	768	75	620	46.5	0.81
PCM MSB 16 bit 32 KHz stereo	1024	100	620	62	1.08
PCM MSB 16 bit 44.1 KHz stereo	1411.2	137	620	85	1.5
PCM MSB 16 bit 48 KHz stereo	1536	150	620	93	1.63

** in PCM and A/uLaw streaming mode, there is not MPA wrapper.*

*** 1 Mbit = 1000 Kbit.*

Total Bits of Overhead per Packet (without Ethernet Overhead)

Packet	Number of bit
IP	160
UDP	64
RTP	128
Total	**352**

Audio Format	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead without Ethernet (bit)	Overhead/ sec (Kbit/sec)	Total Bit Rate without Ethernet (Kbit/sec)
MPEG1 48KHz quality 0, stereo	88	41.7	352	14.67	102.67
MPEG1 48KHz quality 4, stereo	144	41.7	352	14.67	158.67
MPEG1 48KHz quality 7, stereo	192	41.7	352	14.67	206.67
MPEG1 48KHz quality 4, mono	96	41.7	352	14.67	110.67
MPEG1 44.1KHz quality 0, mono	65	38.3	352	13.48	78.48
MPEG1 44.1KHz quality 4, mono	90	38.3	352	13.48	103.48
MPEG1 44.1KHz quality 7, mono	140	38.3	352	13.48	153.48
MPEG2 16KHz quality 0, mono	28	27.8	352	9.78	37.78
MPEG2 16KHz quality 4, mono	44	27.8	352	9.78	53.78
MPEG2 16KHz quality 7, mono	64	27.8	352	9.78	73.78

Audio Format (STL)	Audio Data Rate (Kbit/sec)	Packet/sec (Wireshark)	Overhead without Ethernet (bit)*	Overhead/ sec (Kbit/sec)	Bit Rate Wireshark (Mbit/sec)**
ALaw 8 Khz, mono	64	50	320	16	0.0.8
PCM MSB 16 bit 8 KHz mono	128	50	320	16	0.14
PCM MSB 16 bit 11.025 KHz mono	176.4	50	320	16	0.2
PCM MSB 16 bit 12 KHz mono	192	50	320	16	0.2
PCM MSB 16 bit 16 KHz mono	256	50	320	16	0.27
PCM MSB 16 bit 22.050 KHz mono	352.8	50	320	16	0.36
PCM MSB 16 bit 24 KHz mono	384	50	320	16	0.4
PCM MSB 16 bit 32 KHz mono	512	50	320	16	0.52
PCM MSB 16 bit 44.1 KHz mono	705.6	70	320	22.4	0.72
PCM MSB 16 bit 48 KHz mono	768	75	320	24	0.8
PCM MSB 16 bit 8 KHz stereo	256	50	320	16	0.27
PCM MSB 16 bit 11.025 KHz stereo	352.8	50	320	16	0.36
PCM MSB 16 bit 12 KHz stereo	384	50	320	16	0.4
PCM MSB 16 bit 16 KHz stereo	512	50	320	16	0.52
PCM MSB 16 bit 22.050 KHz stereo	705.6	70	320	22.4	0.72
PCM MSB 16 bit 24 KHz stereo	768	75	320	24	0.8
PCM MSB 16 bit 32 KHz stereo	1024	100	320	32	1.05
PCM MSB 16 bit 44.1 KHz stereo	1411.2	137	320	43.84	1.45
PCM MSB 16 bit 48 KHz stereo	1536	150	320	48	1.58

** in PCM and A/uLaw streaming mode, there is not MPA wrapper.*
*** 1 Mbit = 1000 Kbit.*