



Voice meets data – where did my 10% capacity go?

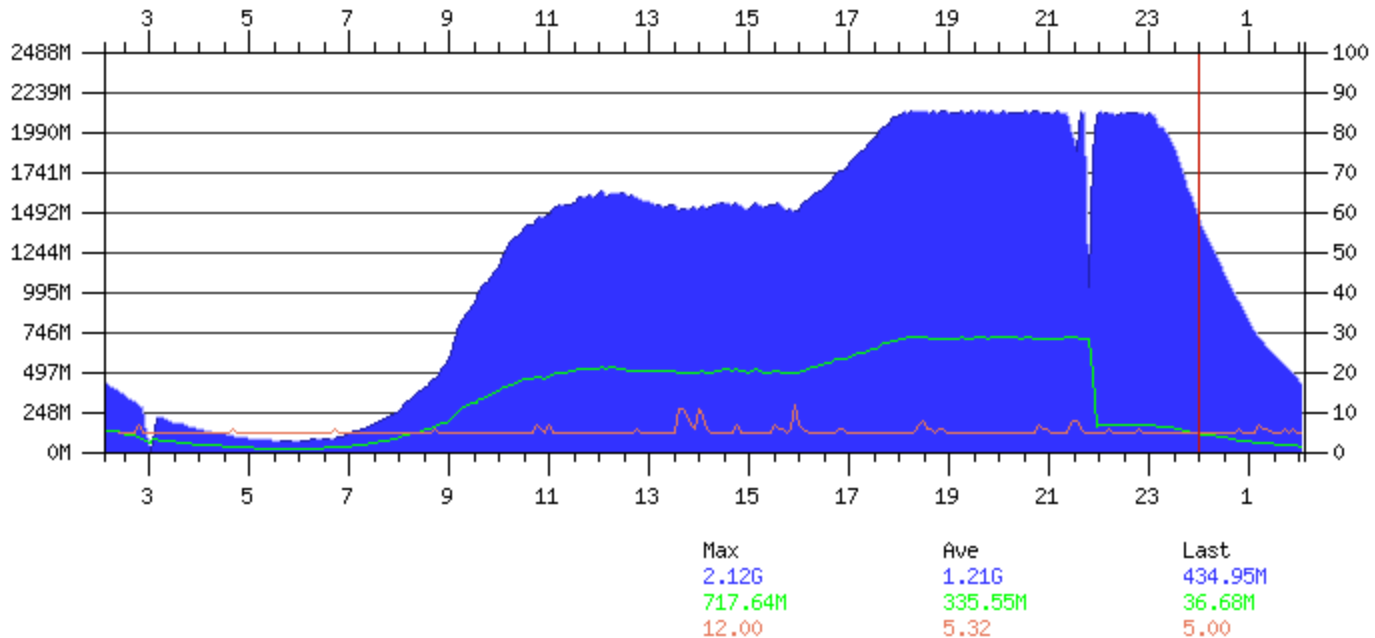
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Sprint

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Where did 10% of my POS IMT capacity go?



Background

- Mostly (90%+) VoIP traffic – burstiness not expected
- G.711 encoding
- No silence suppression
- 20msec packetization
- Egress traffic load-shared with another link
- Encap is HDLC on OC48 POS link
- So where did the 10% go?
- Peter Lothberg pointed me to HDLC framing

HDLC Frame



HDLC Frame

Flag, 7E hex

Escape: 7E => 7D-5E

7D => 7D-5D

'User data which contains 7E is resolved using an escape sequence which converts 7E to 7D-5E [with 7D being the escape character]. If 7D is used in the data stream it again is converted into 7D-5D.'

G.711 Encoding - ethereal capture

G711-packet-trace - Ethereal

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Filter: + Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Info
125	1.434736	10.77.37.137	192.168.120.19	RTP	Payload type=ITU-T G.711 PCMU, SSRC=1300597418
126	1.454754	10.77.32.10	10.77.29.249	RTP	Payload type=ITU-T G.711 PCMU, SSRC=1300597418
127	1.454761	10.77.37.137	192.168.120.19	RTP	Payload type=ITU-T G.711 PCMU, SSRC=1300597418

0000 00 08 25 01 16 2b 00 0e d6 cb cb 02 81 00 03 8e ..%..+..

0010 08 00 45 b8 00 c8 fb aa 00 00 3d 11 2e 26 0a 4d ..E..... ..=&.M

0020 20 0a 0a 4d 1d f9 d6 56 d3 a6 00 b4 00 00 80 00 ..M...V

0030 c9 f0 00 00 21 48 4d 85 8a aa ff 7e 7e 7e 7e 7e!HM.~

0040 7e 7e 7e 7d 7e 7e 7d 7d 7d 7d 7e 7e 7e 7e 7e ~~~}~~}} }~~~

0050 7e 7e fe fe fe fe fe 7e 7e 7e fe 7e 7e fe fe ~..... ~.....

0060 fe fe fe fe fd fe fe fe ff fe fe fe 7e 7e fe fe ~.....

0070 fe fe fe fe fe fe fe ff ff ff ff 7e 7e 7e 7e ~.....

0080 7e 7e ff ff ff ff ff ff ff 7e 7e 7e 7e 7e 7e ~..... ~.....

0090 7e fe fe fe 7e 7e 7e fe ff ff fe fe fe ff ff ~.....

00a0 fe ff ff 7e 7e 7e 7e ff ff ff ff ff ff fe fe ~.....

00b0 fe fe fe fe fe fe fe 7f ff 7e 7e 7e 7e ff ff ~.....

00c0 7f 7f fe 7f 7f 7f ff ff ff ff 7f 7f ff ff ff ~.....

00d0 ff 7e ff 7f ff ff 7e 7e 7e 7e ~.....

File: G711-packet-trace 200 KB 00:00:08 | P: 860 D: 860 M: 0

Notice many the '~' and '}'? But why?

G.711 μ -law codec

Ask people who know:

Here is a correspondence with Prof. Dave Petr (<http://www.ittc.ku.edu/~dwp/>):

all of the bytes are just pcm codewords (digital representations of the voice sample values), and it just turns out that 7E is one of the codewords representing a very small signal amplitude (hence the frequency of this codeword in silence portions).

i would guess that you also see a bunch of 7F, FE and FF codewords as well -- these 4 represent the 2 smallest amplitudes, both + and -. looking at the trace just now, i see that this is indeed the case.

G.711 spec

Well, if you care to investigate further, here is the URL:
<http://www.itu.int/rec/T-REC-G.711/en>

T-REC-G.711-198811-1 PDF-E.pdf - Adobe Reader

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TABLE 2b / G.711
 μ -law, negative input values

Segment number	Number of intervals \times interval size	Value at segment end points	Decision value number n	Decision value x_n (see Note 1)	Character signal	Quantized value (value at decoder output) y_n	Decoder output value number
					Bit number 1 2 3 4 5 6 7 8		
1	1 \times 1	-31	0	0	0 1 1 1 1 1 1 1	-2	1
			1	-1	0 1 1 1 1 1 1 0		
	2		-3	(see Note 2)			
2	16 \times 2	-95	16	-31	0 1 1 0 1 1 1 1	-33	16
			17	-35	(see Note 2)		
32	-95		0 1 0 1 1 1 1 1				
3	16 \times 8		33	-103	(see Note 2)		32

Conclusion

- 7E, 7D are just code words that represent low voice activity
- HDLC uses two bytes to transmit them
- So it happens that it takes more bits down the POS/HDLC wires when people are not talking
- The effect is not counted on router interface counters
- Resulting in seemingly lost capacity

Silence audio trace statistics

Here is the lab captured audio:

Byte Type	Count
7E	19,611
7D	1,995
Total packets	405
Payload Bytes per packet	200
Total bytes	81,000
Total 7E/7D bytes	21,606
extra %	27%



hindsight

- G.711 was developed in 1980's
- HDLC in the 1990's
- *[soap box] HDLC could have used another byte pattern for flag, if the data guys consulted the voice guys*