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TO: P1394a Working Group

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RE: Timing computation errors in IEEE1394-1995

I found out there are four errors about timing computation in IEEE1394-1995. First two errors are concerned with the gap count. Third error relates to Arbitration Phase Time. These three errors are caused by computational mistakes. And the last error is a slight mistake for representation.

Errors about the gap count is very important, because only selecting a appropriate gap count for number of hops can optimize the performance of IEEE1394-1995.

I have corrected these errors. I think these errors should be replaced by the result of this description.

The number of table, section and page in context is in IEEE1394-1995.

(1) The computation of Table E-6 in section E.1.4 may be incorrect, although I agree the equation of Total propagation delay and the inequality to select the appropriate gap_count for the number of hops,

$$\text{arb reset gap} - \text{subaction gap} > \text{Total propagation delay} + \text{arb\_delay}. \quad (1)$$

For instance, in the case of maximum number of hops = 1 in Table E-6,

$$\text{Total propagation delay} = 0.3295(\mu\text{s}).$$

But my computation is:

Total propagation delay
$$= \text{number of hops} \times 2 \times (\text{Cable Delay} + \text{MAX\_PHY\_DATA\_DELAY})$$
$$= 1 \times 2 \times (0.022725 + 0.144) = 0.3335(\mu\text{s}).$$

The above equation to compute Total propagation delay is on page **296**. The value of Cable Delay in the case of 4.5m cable length is derived from section E.1. I set **MAX_PHY_DATA_DELAY** to the maximum value of **PHY_DELAY** in Table 4-29.

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It appears that Cable Delay setted $0.020725(\mu s)$ rather than $0.022725(\mu s)$ causes the errors.

If the Total propagation delay for any number of hops is incorrect, the relative optimal gap_count which satisfy the inequality(1) may be incorrect. Then I recompute a whole part of Table E-6 on page 297, the result should be as follows:

Table 1: Calculated gap counts

Maximum number of hops	Total propagation delay(μs)	Recomputed Gap Count	Gap Count of Table E-6
1	0.3335	1	1
2	0.6669	4	4
3	1.0004	7	6
4	1.3338	10	10
5	1.6673	12	12
6	2.0007	15	14
7	2.3342	18	17
8	2.6676	21	20
9	3.0011	23	23
10	3.3345	26	25
11	3.6680	29	28
12	4.0014	31	31
13	4.3349	34	33
14	4.6683	37	36
15	5.0018	40	39
16	5.3352	42	42

(2) According to the above item (1), Table 8-7 in section 8.4.6.2 should be repaired. And I find out a mistake about subaction gap and arb delay in Table 8-7. When Max_hops $= 1$,

$$\text{subaction\_gap} = 0.6002(\mu s)$$
$$\text{arb\_delay} = 0.0814(\mu s).$$

They may be incorrect and should be:

$$\text{subaction\_gap} = (27 + \text{gap\_count} \times 16)/\textbf{BASE\_RATE}$$
$$= (27 + 1 \times 16)/98.304 = 0.4374(\mu s)$$

$$\begin{aligned} \textbf{arb\_delay} \quad &= \quad (\textbf{gap\_count} \times 4)/\textbf{BASE\_RATE} \\ &= \quad (1 \times 4)/98.304 = 0.0407(\mu s). \end{aligned}$$

These equations are derived from Table 4-33 and Table 4-44. I think the cause of errors may be that gap_count was setted 2 rather than 1.

Finally the repaired Table 8-7 should be:

Table 2: Calculated gap counts

Max_hops	Total delay(μs)	Gap_count	Subaction_gap(μs)	Arb_delay(μs)	Total(μs)
1	0.3335	1	0.4374	0.0407	0.4781
2	0.6669	4	0.9257	0.1628	1.0885
3	1.0004	7	1.2512	0.2441	1.4954
4	1.3338	10	1.5767	0.3255	1.9023
5	1.6673	12	1.9023	0.4069	2.3092
6	2.0007	15	2.2278	0.4883	2.7161
7	2.3342	18	2.5533	0.5697	3.1230
8	2.6676	21	2.8788	0.6510	3.5299
9	3.0011	23	3.2043	0.7324	3.9368
10	3.3345	26	3.5299	0.8138	4.3437
11	3.6680	29	3.8554	0.8952	4.7506
12	4.0014	31	4.1809	0.9766	5.1575
13	4.3349	34	4.5064	1.0579	5.5644
14	4.6683	37	4.8319	1.1393	5.9713
15	5.0018	40	5.3202	1.2614	6.5816
16	5.3352	42	5.6458	1.3428	6.9855

(3) Maybe there are computation errors in Table E-2 in section E.1.1. For example, when gap_count $= 1$, Minimum Total Arbitration Phase Time of Table E-2 is:

$$\textbf{Min Total Arb Phase Time} \ = 0.1434(\mu s).$$

But my computation is as follows:

$$\begin{aligned} \textbf{Min Total Arb Phase Time} \\ &= \quad \textbf{Cable Delay} \times \textbf{N} + \textbf{arb\_delay} + \textbf{SPEED\_SIGNAL\_LENGTH} \\ &= \quad 0.022725 \times 1 + 0.04068 + 0.1 \\ &= \quad 0.1634(\mu s). \end{aligned}$$

The equation to compute Minimum Total Arbitration Phase Time is on page 294. According to Table 4-33, SPEED_SIGNAL_LENGTH is $0.1(\mu s)$. That's

why the minimum column in Table E-2 include ARB_SPEED_SIGNAL_START= $-0.02(\mu s)$ defined in Table 4-33.

I designate a example of maximum case. In the case of gap_count = 1 and hop = 1, Maximum Total Arbitration Phase Time of Table E-2 is:

$$\text{Min Total Arb Phase Time } = 1.8558(\mu s).$$

But my computation is as follows:

Max Total Arb Phase Time

$=$ Cable Delay $\times$ N + arb_delay $-$ ARB_SPEED_SIGNAL_START $+$ DATA_PREFIX_TIME $+$ (N $\times$ MAX_DATA_PREFIX_DELAY)

$=$ $0.022725 \times 1 + 0.04069 - (-0.02) + 0.16 + 0.144 = 0.3874(\mu s).$

I correct the original equation to compute Max Total Arb Phase Time on page 294. In the original equation, ARB_SPEED_SIGNAL_START which is time delay between data prefix and speed signal have been multiplied by -1, but I seem it is not necessary. Because I think the time of transmitting data prefix is set as a base to define the constant. So it have been a negative quantity and the absolute value of it should be added.

Maybe there is another origin of the error that MAX_BUS_HOLDE $= 1.63(\mu s)$ in Table 4-33 is used to compute, instead of DATA_PREFIX_TIME which is defined as $0.16(\mu s)$ in Table 4-33.

All elements of Table E-2 may be incorrect like above examples. Finally, I recompute a whole part of Table E-2 by using above equations, the result should be as follows:

Table 3: Total arbitration phase time

Gap Count	Minimum (μs)	Maximum 1 hop (μs)	Maximum 8 hop (μs)	Maximum 16 hop (μs)
1	0.1634	0.3874	1.5545	2.8883
10	0.5296	0.7537	1.9207	3.2545
20	0.9364	1.1606	2.3277	3.6615
30	1.3433	1.5675	2.7346	4.0684
40	1.7502	1.9745	3.1416	4.4754
50	2.1570	2.3814	3.5485	4.8823
63	2.6859	2.9105	4.0775	5.4113

(4) I find out a slight mistake in section E.1.3. Following sentence is quoted from page 295 of IEEE1394-1995.

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"There are 8 bits in an acknowledge, ...
$0.04(\mu s) <$ Ack Transmission Time $< 0.05(\mu s)$ "

It should be :

"There are 8 bits in an acknowledge, ...
$\underline{0.08137}(\mu s) <$ Ack Transmission Time $< \underline{0.08139}(\mu s)$ ".

Because in the case of S100, Ack Transmission Time is represented by a equation $8/$BASE_RATE. Then

$$\begin{aligned}
\text{Min Ack Transmission Time} \quad &= \quad 8/\text{BASE\_RATE(max)} \\
&= \quad 8/98.314 \;=\; 0.0813719(\mu s) \\
\text{Max Ack Transmission Time} \quad &= \quad 8/\text{BASE\_RATE(min)} \\
&= \quad 8/98.294 \;=\; 0.0813884(\mu s).
\end{aligned}$$

Appendix
I put tables of IEEE1394-1995 which is referred in context.

Table 8-7 Calculated gap counts

Max_hops	Total delay(μs)	Gap_count	Subaction_gap(μs)	Arb_delay(μs)	Total(μs)
1	0.3295	1	0.6022	0.0814	0.6816
2	0.6589	4	0.9257	0.1628	1.0885
3	0.9884	6	1.2512	0.2441	1.4954
4	1.3178	10	1.5767	0.3255	1.9023
5	1.6473	12	1.9023	0.4069	2.3092
6	1.9767	14	2.2278	0.4883	2.7161
7	2.3062	17	2.5533	0.5697	3.1230
8	2.6356	20	2.8788	0.6510	3.5299
9	2.9651	23	3.2043	0.7324	3.9368
10	3.2945	25	3.5299	0.8138	4.3437
11	3.6240	28	3.8554	0.8952	4.7506
12	3.9534	31	4.1809	0.9766	5.1575
13	4.2829	33	4.5064	1.0579	5.5644
14	4.6123	36	4.8319	1.1393	5.9713
15	4.9418	39	5.3202	1.2614	6.5816
16	5.2712	42	5.6458	1.3428	6.9855

Table E-2 Total arbitration phase time

Gap Count	Minimum (μs)	Maximum 1 hop (μs)	Maximum 8 hop (μs)	Maximum 16 hop (μs)
1	0.1434	1.8558	3.0119	4.3332
10	0.5096	2.2221	3.3782	4.6994
20	0.9164	2.6290	3.7851	5.1064
30	1.3233	3.0360	4.1921	5.5133
40	1.7302	3.4429	4.5990	5.9202
50	2.1370	3.8499	5.0060	6.3272
63	2.6659	4.3789	5.5350	6.8562

Table E-6 Calculated gap counts

Maximum number of hops	Total propagation delay(μs)	Gap Count
1	0.3295	1
2	0.6589	4
3	0.9884	6
4	1.3178	10
5	1.6473	12
6	1.9767	14
7	2.3062	17
8	2.6356	20
9	2.9651	23
10	3.2945	25
11	3.6240	28
12	3.9534	31
13	4.2829	33
14	4.6123	36
15	4.9418	39
16	5.2712	42