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A Possible Application of the Network Switch Connection for the ZEUS DAQ System

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Abstract

This note reviews the requirements for replacing the existing ZEUS transputer based event builder with a network switch based system. The results are derived from measurements made with the existing TLT and DEC Gigaswitch/FDDI hardware installed in the hall. The conclusions drawn are not specific to the hardware used and show that a replacement of the existing event builder is practical.

1 Introduction

The concept [1] of switch based event builders has existed for a number of years. The availability of moderately priced high performance commercial hardware has triggered increased interest [2] in the subject.

The characteristic elements of a switch based event builder are:

- many physically distributed event fragment sources are present,
- fragments are buffered in multiported memory,
- feeders send fragments through the switch,
- a switch provides multiple, concurrent, point-to-point connectivity,
- many physically distributed targets are present where complete events are constructed.

Multiported memory is used to buffer event fragments. This allows both the component and feeders to operate concurrently. A simple circular buffer implementation where the source updates the write (insert) pointer and the feeder updates the read (remove) pointer is sufficient.

Elements 1,2 and 3 are connected via a local bus, e.g. VME, and 3,4 and 5 via a network bus, e.g. FDDI. The feeder module is the only module which is required to support both the local and network buses.

Switch operation is smooth and transparent. Correctly addressed data packets leaving the feeder will be delivered to the target without the usage of additional switch control protocols.

The event building control architecture is either push or pull. In the push mode a manager assigns a destination for the next event and broadcasts the event number and destination identifier to all feeders. The feeders then send out the corresponding event

[1] MSU
[2] MSU
[3] DESY

fragments to the assigned destination. This requires a minimal protocol overhead and has potentially the highest throughput. However, because multiple feeders attempt to send their event fragments concurrently, they compete for the same output and, depending on the switching technology and the algorithm used to assign events to destinations, the result may be reduced throughput, increased event building latency, or loss of data (if unreliable protocol are used). In the pull mode the destination processor initiates the data transfer by requesting event fragments from each of the feeders in turn.The event fragments are therefore delivered in a known, fixed sequence, and it is implicitly clear when all the event fragments have been collected. In addition error detection and handling are relatively straight forward. The disadvantage is that the pull technique imposes the higher software control overheads.

2 The aims

The CDAQ interest in network switch event building has evolved from

- programs developed [3] to simulate event builder switch systems, and
- hardware and software experience gained from a series of FLINK [4] and TLT [5-8] upgrades.

The results presented in this note are derived from measurements of a pull event builder-analyzer implementation using the existing hardware. The builder-analyzer combines event building and TLT processing and is an extension of the last element of the switch characteristics.

The aims of this note are to determine the performance of such an implementation in the ZEUS environment and to use this understanding to set guidelines for the eventual implementation of a builder-analyzer system at ZEUS.

3 The Hardware Setup

A DEC GIGAswitch/FDDI is installed in the ZEUS hall and provided load shielding and connectivity between TLT loops, FLINK archive and CDAQ machines during the 96 running period. The switch has a maximum of 36 100 Mb/s ports and is capable of switching 6.25M connections/s with a forwarding latency of 14μs. The maximum aggregate bandwidth is 450MB/s, i.e. 36 $\times$ 100 Mb/s. The ZEUS switch currently has 12 ports.

The SGI Challenge-S (R4400 MIPS 150 MHz and 200 MHz.) are used in the hall TLT system.

The measurements described in this note have been made using the switch and TLT hardware available during the 96 running period. The FDDI cabling was reorganized to allow 11 SGIs individual port connections.

4 The Software Setup

The SGI machines have been used to host feeder, builder-analyzer, manager and sink programs. Unless otherwise stated only one instance of one program type was running on one SGI connected directly to the switch and only one manager was running.

All programs use TCP for network communication.

The task of the feeder is to receive requests for event fragments and send the requested data to a builder analyzer. The event number and builder-analyzer address are contained in the request sent by the manager. Note that the requested data is always present, i.e. the feeder has no latency.

The builder-analyzer software sends requests for events to the manager when an event buffer becomes available. The use of multiple event buffers allows a credit system to be operated with the manager. Each builder-analyzer event buffer is allocated a separate TCP socket. The socket port number and the machine ip address are used to identify the buffer targeted by the feeder. The event is complete when all the components have provided fragments. Complete events are passed through a TLT emulation and a selected fraction can be sent to the data sink. The TLT emulation is a while loop the time to complete which is the analysis time when no other activity is present on the machine.

The manager process receives event requests from the builder-analyzer and distributes these to the feeders.

5 Measurements

The results of the measurements made are given in the Appendix partial tables. The sign '-' means that no measurement have been taken. The sign '!' is used to point out that the system behavior was unpredictable because some internal software parameters have not been tuned.

The limited numbers of switch ports allows combined number of feeders and builder _analysers to 10. The realistic number of ZEUS system would require $\sim$ 30 ports.

6 NSC EVB-model throughput rate estimation

The general supposition is that the system throughput rate - Ns may be approximated by a geometrical sum of its main constituents:
Ni - total throughput of input links;
No - total throughput of output links;
Nc - throughput rate of a software for EVB-algorithm realization;
Na - total throughput of event analyzing in TLT-processors;
that is:

$$(1/\mathrm{Ns})^2 = (1/\mathrm{Ni})^2 + (1/\mathrm{No})^2 + (1/\mathrm{Nc})^2 + (1/\mathrm{Na})^2. \quad (2)$$

The following simple equations may be written for Ni, No and Na:

$$(1/\mathrm{Ni}) = \mathrm{Li}\ /\ \mathrm{F} + \mathrm{Td}\ /\ \mathrm{Mc}^*\mathrm{Mo}, \quad (3)$$
$$(1/\mathrm{No}) = \mathrm{Le}\ /\ \mathrm{F}^*\mathrm{Mo}, \quad (4)$$
$$(1/\mathrm{Na}) = \mathrm{Tp}\ /\ \mathrm{Mp}. \quad (5)$$

where	Le - length of events,	Li - length of component bank,
	Mi - number of components,	F - FDDI link bandwidth,
	Mo - number of switch outputs,	Mc - number of builders_analysers,
	Mp - number of TLT-processors,	Np - average analyzing processor performance,
	Td - control loop dead time.	

The system scalability conditions for *constant* throughput rate may be obtained from (4): Le/Mo=const and from (3): Li=const (the second addendum is negligible when Mc>1, Mo>1). If Le=Mi*Li, then

$$\text{Mo / Mi} = \text{const.} \qquad (6)$$

It means that the lines where the system has a constant throughput rate are the straight lines in Mi,Mo-coordinates (if no-analyzing) - see dot tracks in the plots below.

6.1 Calculation of Td

Configuration : two Components (40 kB) are sending data to one TLT.
From (2.2):

$$\text{Td} = 1/\text{Ns - Le/F} = 1/92 - 80/12000 = 4.2 \text{ ms} \qquad (7)$$

6.2 Calculation of Nc

Configuration: the constant length of the component banks: Li = 16 kB, TCP/IP protocol, no analyzing.

```
Mo(TLTs)                                  TCP
6 |         590   510                  .
  |        (530) (511)               .
  |               .                .
5 |              .             380       The calculated
  |             .             (440)          values
  |            .           .              are in the
4 |         510         440                brackets
  |        (511)       (440)                 .
  |        .         .                   .
3 |       .     430               270
  |      .     (440)            . (308)
  |     .       .            .                  .
2 |   460   440         240?        220         145
  |  (511) (440)    .  (308)       (227)  .    (178)
  |      .      .                  .
1 |   416   310         180 .       118
  |  (440) (308)       (178)       (120)
  |----------------------------------------------------
 0     1     2     3     4     5     6     7     8   Mi
                                                   (COMPs)
```

The plot above shows the measured values; the group of data where Mi = Mo (Ns=const) was used for Nc calculation.

From (3) : Ni = 12000 / 16 = 750 ev/s. (8)

From (4) : No = Ni*Mo / Mi (Le = Li*Mi), then

$$(1/\text{Ns})^2 = (1/\text{Ni})^2 * [1 + (\text{Mi}/\text{Mo})^2] + (1/\text{Nc})^2. \qquad (9)$$

For Mi = Mo :

$$Nc^2 = N * Ni \ / \ \sqrt[2]{Ni^2 - 2N^2} = 790 \text{ ev/s.} \qquad (10)$$

After Nc definition the rest measured values were calculated.

As it can be seen Nc is approximately equal to a constant for TCP protocol. Except a point labeled by question-mark the matching between measured and calculated values is in 15% limits. It should be mentioned that the measurement results have been taken for relatively low CPU loading level ($\sim$ 50%) and for the large number of components the reducing of throughput rate may be anticipated.

6.3 Constant length of event

TCP, no analyzing. Configuration: Le = 80 kB; the number of Components is equal to the number of TLT. In this case:

$$(1/Ns)^2 = (1/Ni)^2 + (1/No)^2 + (1/Nc)^2 \qquad (11)$$

where
from (3) : Ni = F / (Le/Mi) = Mi * 12000 / 80 (Li = Le / Mi),
from (4) : No = Mo * 12000 / 80,
from (10) : Nc = 790 ev/s.

The comparison of measured and calculated values is represented in the Table 1.

Table 1

Mi=Mo	2	3	4	5	10	15	20
Ns-meas	202	290	392	440			
Ns-calc	(204)	(295)	(374)	(440)	(634)	(707)	(740)

There is the sensible matching of the tests results and evaluated numbers given in Table 1. The extrapolation for the large numbers of components and builder_analysers has a saturation determined by Nc (10). The same remark concerning CPU power consumption may be done here.

TCP with analyzing. Configuration: 8 components are sending data to 2 TLTs; Le = 80 kB.

The formula (2) may be used for the calculations, where
from (3) : Ni = F / Li = 12000 / 10 = 1200 ev/s,
from (4) : No = Mo*F / Le = 2*12000 / 80 = 300 ev/s,
from (10) : Nc = 790 ev/s,
from (5) : Na = 2 / Tp.
The comparison of measured and calculated values is represented in the Table 2.

Table 2

Tp, ms	0	1	2	5	10	20	40	100
N, ev/s	222	222	199	160	120	75	43	19
%CPU	62	68	72	84	87	92	95	97
Ns-meas	358?	326	276	190	138	81	45	20
Ns-calc	(273)	(270)	(263)	(226)	(161)	(94)	(49)	(20)

The practical meaning in the Table 2 for the extrapolation have the results where Nc $\leq$ Np (the right part of the Table). The increasing number of components should not reduce the expected results since in the reality Tp is much more than time spent on event fragments receiving.

7 The extrapolation for ZEUS setup

Configuration: 18 components are sending data to 36 TLTs in 6 Hubs; Li_{max}= 16 kB, Le = 80 kB, Ta = 130 ms.
As there are 2 sequential output link layers, then:

$$(1/\mathrm{Ns})^2 = (1/\mathrm{Ni})^2 + (2/\mathrm{No})^2 + (1/\mathrm{Nc})^2 + (1/\mathrm{Na})^2. \quad (12)$$

from (3) : Ni = F / Li = 12000 / 16 = 750 ev/s,
from (4) : No = Mo*F / Le = 6*12000 / 80 = 900 ev/s,
from (10) : Nc = 790 ev/s,
from (5) : Na = 36 / 0.13 = 277 ev/s.

The Result : Ns = 238 ev/s; the possible Error = 10-15%. It is easy to see that the main limitation factor is TLT-processors power.

8 Conclusion

It has been shown that the extrapolation technique used to estimate realistic ZEUS EVB throughput is correct at the $\pm$ 15% level.
A FDDI based event builder with 250 ev/s throughput can be readily implemented at ZEUS, using the existing FDDI switch and a VME-FDDI interface to the EVB TPM with 4 MB/s TCP throughput and event fragments up to 16 KB/event. The throughput rate for the described network based event builder as high as 250 1/s under the condition of having the TCP bandwidth about 4 MB/s for feeders with event fragments as large as 16 KB per event.

9 References

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10 Appendix

ALL THE EVB_TLT NODES ON THE SEPARATE PORTS OF THE GIGAswitch

4 component, 1 evb_tlt node
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		25kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	20000	204	3.3	152	4.9	108	6.9	75	5.4
2	20000	281	4.5	215	6.9	150	9.6	112	6.3
4	20000	363	5.8	270	8.6	180	11.5	118	6.4
8	40000	408	6.5	294	9.4	181	11.6	117	6.7
16	40000	412	6.6	285	9.1	183	11.7	117	11.8

05.12.1996
4 component (hub 102,103; hub 111,112)
2 evb_tlt node (no hub 114,115)
Control (116)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	20000	373	3.0	282	4.5	201	6.4	101	6.5
2	20000	525	4.2	386	6.2	232	7.4	127	8.1
4	20000	671	5.4	458	7.3	243	7.8	124	7.9
8	40000	743	5.9	490	7.8	243	7.8	123	7.9
16	40000	776	6.2	419	6.7	!	!	!	

06.12.1996
4 component (no hub, 105,114,115,116)
2 evb_tlt node (103,113)
Control (111)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	10000	97	6.3
2	10000	137	8.8
4	10000	144	9.3
8	10000	141	9.1

06.12.1996
4 component (no hub, 105,114,115,116)
4 evb_tlt node (no hub 110,111,112,113)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	10000	600	2.4	544	4.3	388	6.2	210	6.7
2	10000	740	3.0	682	5.5	440	7.0	204	6.5
4	10000	816	3.3	765	6.1	460	7.4	200	6.4
8	20000	880	3.5	808	6.5	433	6.8	! !	!
16	20000	900	3.6	800	6.4	! !	!	! !	!

06.12.1996
6 component (no hub, 105,114,115,116,110,111)
2 evb_tlt node (no hub 112,113)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port					
1	10000	302	3.6	231	5.5	156	7.5
2	10000	388	4.6	298	7.1	196	9.4
4	10000	425	5.0	332	7.9	223	10.6
8	20000	488	5.7	354	8.5	222	10.6
16	20000	519	6.2	371	8.9	213	10.3

06.12.1996
4 component (no hub, 105,114,115,116)
4 evb_tlt node (no hub 110,111,112,113)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB + 8kB + 16kB + 32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	10000	252	3.8
2	10000	244	3.7
4	10000	236	3.3

07.12.1996
6 component (no hub, 105,114,115,116,110,111)
1 evb_tlt node (no hub 112)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port					
1	10000	158	3.8	120	5.7	78	7.5
2	10000	212	5.1	153	7.3	105	10.1
4	10000	270	6.5	192	9.2	117	11.2
8	20000	294	7.0	204	9.7	118	11.3
16	20000	312	7.5	202	9.6	112	10.8

07.12.1996
2 component (no hub, 105,114)
1 evb_tlt node (no hub 112)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	10000	263	2.0	204	3.2	149	4.7	99	6.3
2	10000	384	3.0	322	5.1	250	7.9	151	9.7
4	10000	555	4.4	454	7.2	312	9.9	156	10.0
8	20000	625	4.9	540	8.6	317	10.1	158	10.1
16	20000	689	5.5	500	8.0	312	10.0	156	10.0

07.12.1996
2 component (no hub, 105,114)
2 evb_tlt node (no hub 112,113)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	10000	481	1.9	392	3.1	291	4.6	178	5.7
2	10000	714	2.8	570	4.5	412	6.7	225	7.2
4	10000	908	3.6	800	6.3	470	7.5	214	6.9
8	20000	1066	4.2	832	6.6	434	7.0	203	6.5
16	20000	1126	4.5	832	6.6	420	6.7	192	6.2

07.12.1996
2 component (no hub, 105,114)
4 evb_tlt node (no hub 112,113,110,111)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	10000	760	1.5	697	2.8	484	3.9	228	3.7
2	10000	1031	2.0	908	3.6	540	4.3	216	3.5
4	10000	1194	2.4	1031	4.2	512	4.1	!	
8	20000	1342	2.7	1044	4.2	500	4.0	!	
16	20000	1337	2.7	1021	4.1	!		!	

07.12.1996
2 component (no hub, 105,114)
6 evb_tlt node (no hub 112,113,110,111,115,116)
Control (103)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 4kB		8kB		16kB		32kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port							
1	10000	973	1.3	813	2.1	618	3.3	240	2.5
2	10000	1153	1.5	1050	2.8	618	3.3	240	2.5
4	10000	1303	1.6	1152	3.0	588	3.1	!	
8	20000	1345	1.7	1124	3.0	546	2.9	!	
16	20000	1578	2.2	1131	3.0	!		!	

08.12.1996
6 component (no hub, 105,114,115,116,110,111)
1 evb_tlt node (no hub 112)
Control (103)
(Analyzing: 100ms delay, no data sending)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB	2x4kB+2x8kB+2x16kB
		Rate for TCP - ev/s	
1	2000	9.09	9.95
2	2000	9.95	9.95
4	2000	9.95	9.95
8	2000	9.95	9.95
16	2000	9.95	9.95

08.12.1996
6 component (no hub, 105,114,115,116,110,111)
1 evb_tlt node (no hub 112)
Control (103)
(Analyzing: 100ms delay, data sending to the sink 113, output ratio = 1/10)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB	2x4kB+2x8kB+2x16kB
		Rate for TCP - ev/s	
1	2000	8.84	9.85
2	2000	9.90	9.95
4	2000	9.80	9.90
8	2000	9.85	9.90
16	2000	9.80	9.95

08.12.1996
6 component (no hub, 105,114,115,116,110,111)
1 evb_tlt node (no hub 112)
Control (103)
(Analyzing: 100ms delay,40% CPU load,
data sending to the sink tlt113, output ratio = 1/10)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 8kB	16kB	2x4kB+2x8kB+2x16kB
		Rate for TCP - ev/s		
1	2000	9.66	8.66	9.70
2	2000	9.95	9.80	9.90
4	2000	9.95	9.80	9.95
8	2000	9.95	9.80	9.95
16	2000	9.95	9.80	9.95

09.12.1996
6 component (no hub, 105,114,115,116,110,111)
1 evb_tlt node (no hub 112)
Control (103)
(Analyzing: 100ms delay,40% CPU load. No data sending to the sink)

Number of EVB_TLT buffers (COMBs)	Events sent	Event Fragment Length 16kB
		Rate for TCP - ev/s
4	2000	9.95

09.12.1996
6 component (no hub, 105,114,115,116,110,111)
2 evb_tlt node (no hub 112,113)
Control (103)
(Analyzing: 100ms delay,40% CPU load.
No data sending to the sink)

Number of EVB_TLT buffers (COMBs)	Events sent	Event Fragment Length 16kB — Rate for TCP - ev/s
1	2000	17.80
2	2000	19.95
4	2000	19.85
8	2000	19.85
16	2000	19.85

09.12.1996
8 component (no hub, 105,110,111,112,113,114,115,116)
1 evb_tlt node (100)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 8kB — Rate for TCP - ev/s	and for FDDI - [MB/s]/port
1	20000	84	5.4
2	20000	108	6.9
4	20000	129	8.2
8	20000	129	8.2
16	20000	129	8.2

09.12.1996
9 component (no hub,102, 105,110,111,112,113,114,115,116)
1 evb_tlt node (100)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 8kB — Rate for TCP - ev/s	and for FDDI - [MB/s]/port
1	20000	79	5.7
2	20000	99	7.1
4	20000	114	8.2
8	20000	116	8.4
16	20000	114	8.2

10(11).12.1996
10 component (no hub,102,104,105,110,111,112,113,114,115,116)
1 evb_tlt node (106)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 10x8kB		10x7.2kB		10x6.4kB	
		Rate for TCP - ev/s and for FDDI - [MB/s]/port					
1	20000	75	6.0	80	5.8	83	5.3
2	20000	97	7.9	95	6.9	107	6.9
4	20000	108	8.7	115	8.3	122	7.8
8	20000	111	8.9	121	8.7	128	8.2
16	20000	109	8.7	118	8.5	128	8.2

10(11).12.1996
10 component (no hub,102,104,105,110,111,112,113,114,115,116)
1 evb_tlt node (106)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 24kB + 16kB + 10kB + 8kB + 6kB + 3x4kB + 2x2kB = 80kB			
		Rate for TCP - ev/s and for FDDI - [MB/s]/port			
		from small to big		from big to small	
1	20000	80	6.4	77	6.2
2	20000	100	8.0	97	7.8
4	20000	110	8.8	106	8.5
8	20000	112	8.9	108	8.6
16	20000	108	8.6	106	8.5

10(11).12.1996
10 component (no hub,102,104,105,110,111,112,113,114,115,116)
1 evb_tlt node (106)
Control (101)
(Analyzing: 100ms delay. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 8kB
		Rate for TCP - ev/s
1	2000	9.05
2	2000	10.00
4	2000	9.95
8	2000	9.95
16	2000	9.95

10(11).12.1996
10 component (no hub,102,104,105,110,111,112,113,114,115,116)
1 evb_tlt node (106).
Control (101)
(Analyzing: 100ms delay, 40% CPU noise. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 8kB — Rate for TCP - ev/s
1	2000	8.3
2	2000	10.0
4	2000	10.0
8	2000	10.0
16	2000	10.0

11.12.1996
1 component (no hub,105)
2 evb_tlt node (100, 102)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB — Rate for TCP - ev/s
4	20000	458
8	20000	438
16	20000	434

11.12.1996
1 component (no hub,105)
1 evb_tlt node (100)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB — Rate for TCP - ev/s	and for FDDI - [MB/s]/port
4	20000	416	6.6
8	20000	408	6.5
16	20000	408	6.5

11.12.1996
3 component (no hub,105,114,115)
3 evb_tlt node (100,102,110)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB Rate for TCP - ev/s and for FDDI - [MB/s]/port	
4	20000	432	6.9
8	20000	415	6.6
16	20000	406	6.5

11.12.1996
3 component (no hub,105,114,115)
6 evb_tlt node (100,102,110,116,111,112)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	-	
2	20000	-	
4	20000	514	4.1
8	20000	504	4.0

11.12.1996
6 component (no hub,105,114,115,116,110,111)
3 evb_tlt node (100,102,113)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	-	
2	20000	-	
4	20000	234	8.1
8	20000	272	8.7
16	20000	260	8.3

11.12.1996
8 component (no hub,105,114,115,116,110,111,112,113)
2 evb_tlt node (100,102)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB Rate for TCP - ev/s and for FDDI - [MB/s]/port
1	20000	-
2	20000	-
4	20000	142 9.1
8	20000	147 9.4
16	20000	144 9.2

11.12.1996
5 component (no hub,105,114,115,112,102)
5 evb_tlt node (100,116,110,111,113)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 16kB Rate for TCP - ev/s and for FDDI - [MB/s]/port
1	20000	377 6.0
2	20000	425 6.8
3	20000	434 7.0
4	20000	440 7.0
5	20000	437 7.0
8	20000	383 6.2

12.12.1996
4 component (no hub,105,114,115,112)
4 evb_tlt node (116,110,111,113)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 20kB Rate for TCP - ev/s and for FDDI - [MB/s]/port
1	20000	335 6.7
2	20000	387 7.8
3	20000	392 7.8
4	20000	372 7.5
8	20000	348 7.0

12.12.1996
3 component (no hub,105,114,115)
3 evb_tlt node (116,110,111)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 26.7kB — Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	250	6.7
2	20000	290	7.7
3	20000	285	7.6
4	20000	267	7.2
8	20000	255	6.8

12.12.1996
2 component (no hub,105,114)
2 evb_tlt node (116,110)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 40kB — Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	170	6.8
2	20000	202	8.1
3	20000	198	7.9
4	20000	190	7.7
5	20000	182	7.3

12.12.1996
2 component (no hub,105,114)
1 evb_tlt node (116)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 40kB — Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	92	7.4
2	20000	134	10.7
4	20000	135	10.8
8	20000	135	10.8
16	20000	134	10.7

12.12.1996
1 component (no hub,105)
1 evb_tlt node (116)
Control (101)
(No analyzing. No data sending to the sink)

EVB-TLT buffers number (COMBs)	Events sent	Event Fragment Length 80kB — Rate for TCP - ev/s and for FDDI - [MB/s]/port	
1	20000	75	6.1
2	20000	101	8.1
4	20000	100	8.0

12.12.1996
8 component (no hub,105,114,115,116,110,112,103,104)
2 evb_tlt node (111,113)
Control (101)
(Event length = 80 kB. No data sending to the sink)

Analyzing time (ms)	Events sent	Number of builders_analysers 2 — TCP - ev/s	and for FDDI - [MB/s]/port	4 — TCP - ev/s	and for FDDI - [MB/s]/port
0	20000	202	8.1	222	8.9
1	10000	194	7.8	222	8.9
2	10000	184	7.3	199	7.9
5	10000	159	6.3	160	6.4
10	10000	119	4.7	120	4.8
20	2000	75	3.0	74	2.9
40	2000	43	1.7	43	1.7
70	2000	26	1.0	26	1.0
100	2000	19	0.8	19	0.8
130	2000	15	0.6	15	0.6