



ELMB Full Branch Test

Outline

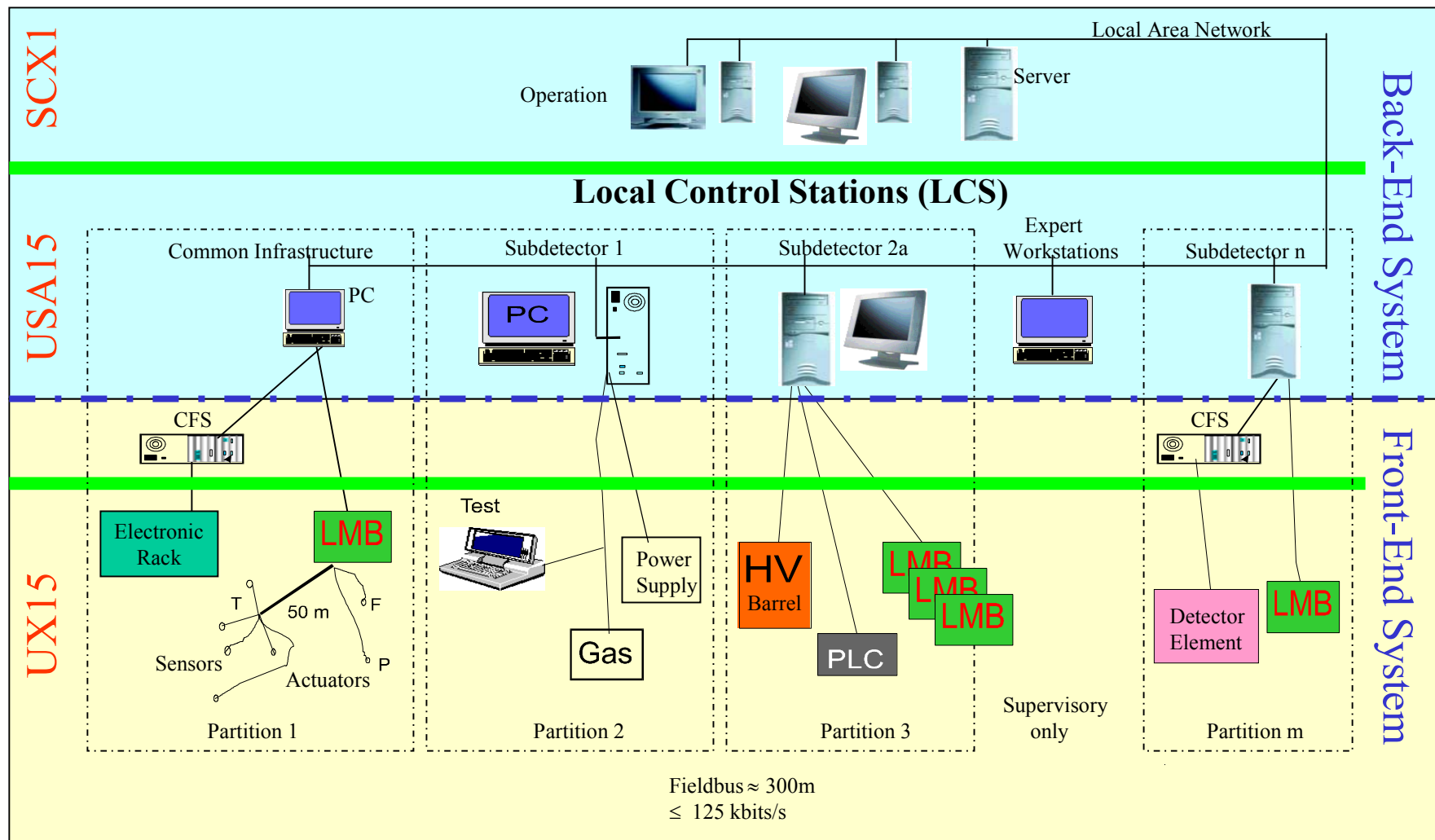
- DCS Architecture
- ELMB Full Branch Set-Up
 - Powering
 - I/O functionality
 - Bus Behavior
 - SW Architecture
- Test Procedure
- SCADA Panels
 - Run Control
 - Offline Analysis
- Findings
- *Conclusions**

*** Test currently ongoing. Results are not conclusive yet**



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Architecture of DCS





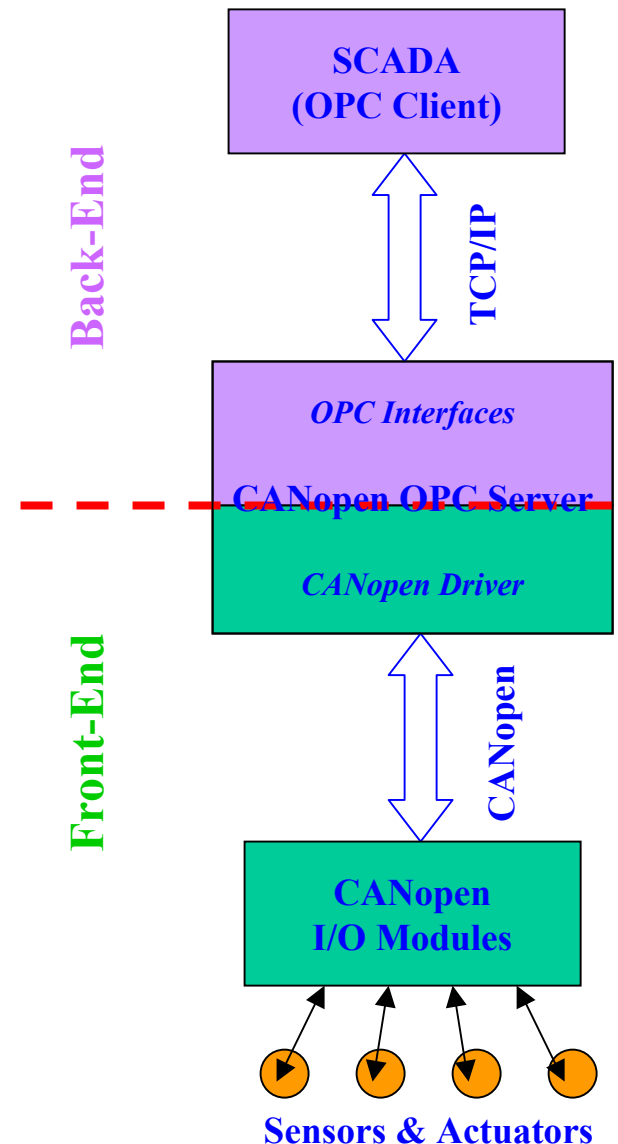
Communication FE-BE: OPC

1.- Dedicated drivers

- HW and SW dependent
- Upgrade and Maintenance

2.- OPC (OLE for Process Control)

- What's OPC?
 - Set of interfaces designed to facilitate the integration of control equipment into Windows applications.
 - Middle-ware based on Microsoft DCOM technology
 - Multi-client / Multi-server architecture
- Why OPC?
 - Unique and standard mechanism to interface several data sources and software applications
 - SCADA-independent.
 - Almost all SCADA packages provided OPC Client functionality
 - Strong support from industry.
- Drawbacks
 - Only WNT/2000

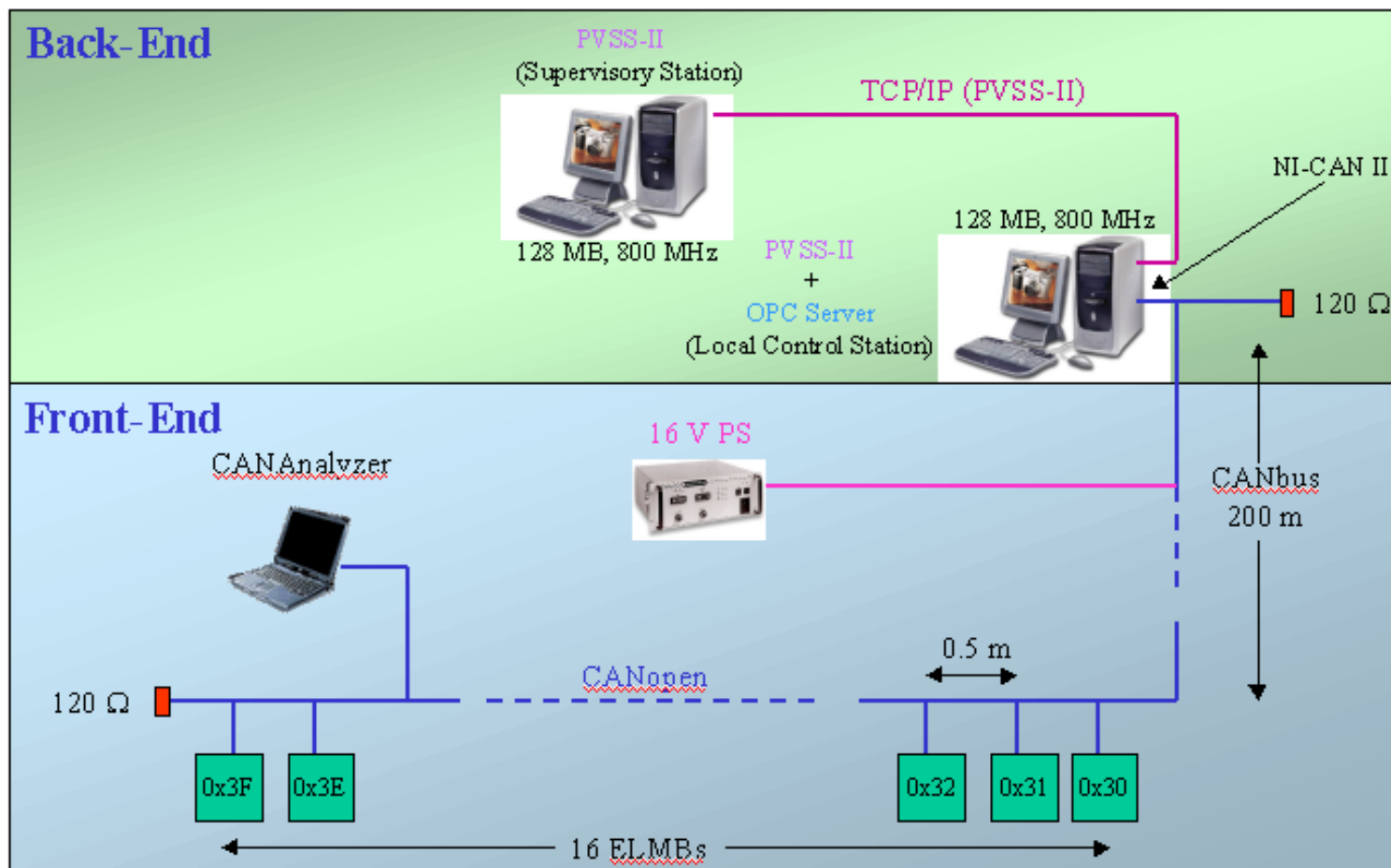




ELMB Full Branch Test

Aims:

- Powering
- Reliability
 - robustness
 - recovery procedures
- Performance
 - tuning of parameters
 - identifying bottlenecks





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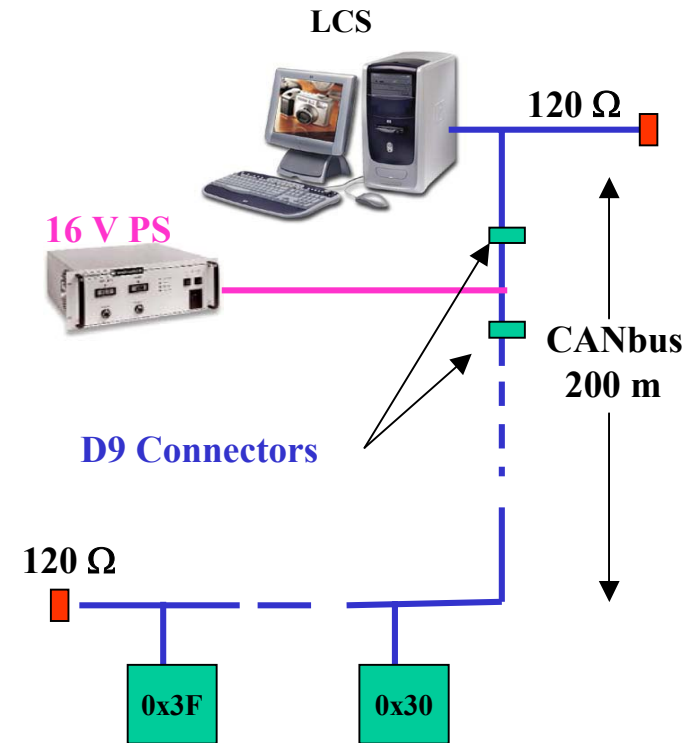


Powering

- Only one PS used.
- Digital and CAN parts of the ELMB and NI-CAN card powered via the bus.
- Analogue part powered from the digital (Power monitored by a scope).
- Bus and Interface card power lines were de-coupled (Allows for independent reset of both elements).

I/O Functionality

- $16 \times 8 = 128$ digital input lines (Sync + Async), $16 \times 2 \times 8 = 256$ digital output lines (Async)
- Input and output lines interconnected
- $16 \times 64 = 1024$ Analogue channels (Sync)
- ELMBs reprogrammed to bypass filtering in OPC server and ensure maximum data volume transfer to PVSS-II (Worst possible case)



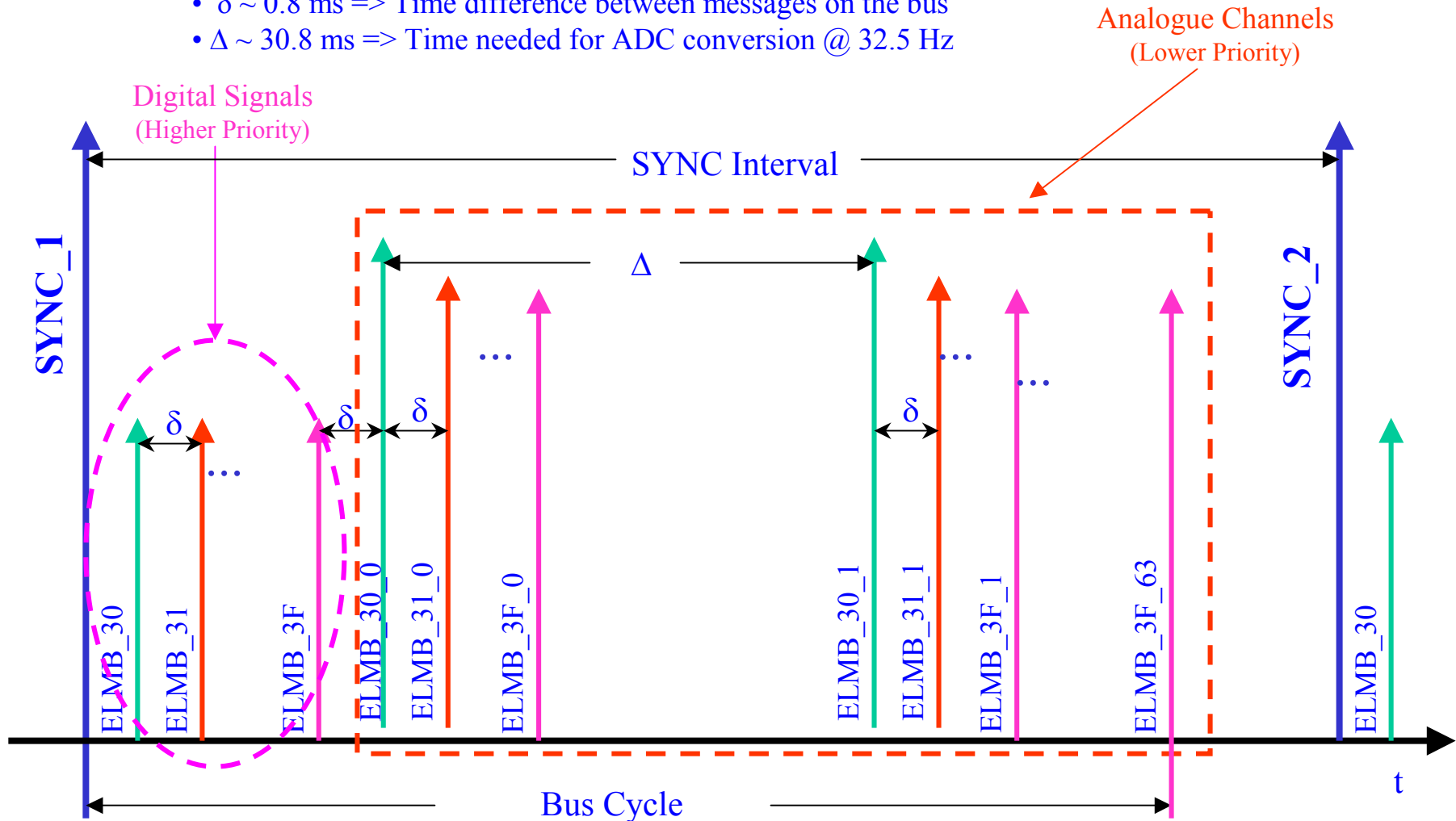


CANbus Activity, synchronous read

Example

If $v_{\text{adc}} = 32.5 \text{ Hz}$ and Bus Speed = 125 kbit/s

- $\delta \sim 0.8 \text{ ms} \Rightarrow$ Time difference between messages on the bus
- $\Delta \sim 30.8 \text{ ms} \Rightarrow$ Time needed for ADC conversion @ 32.5 Hz

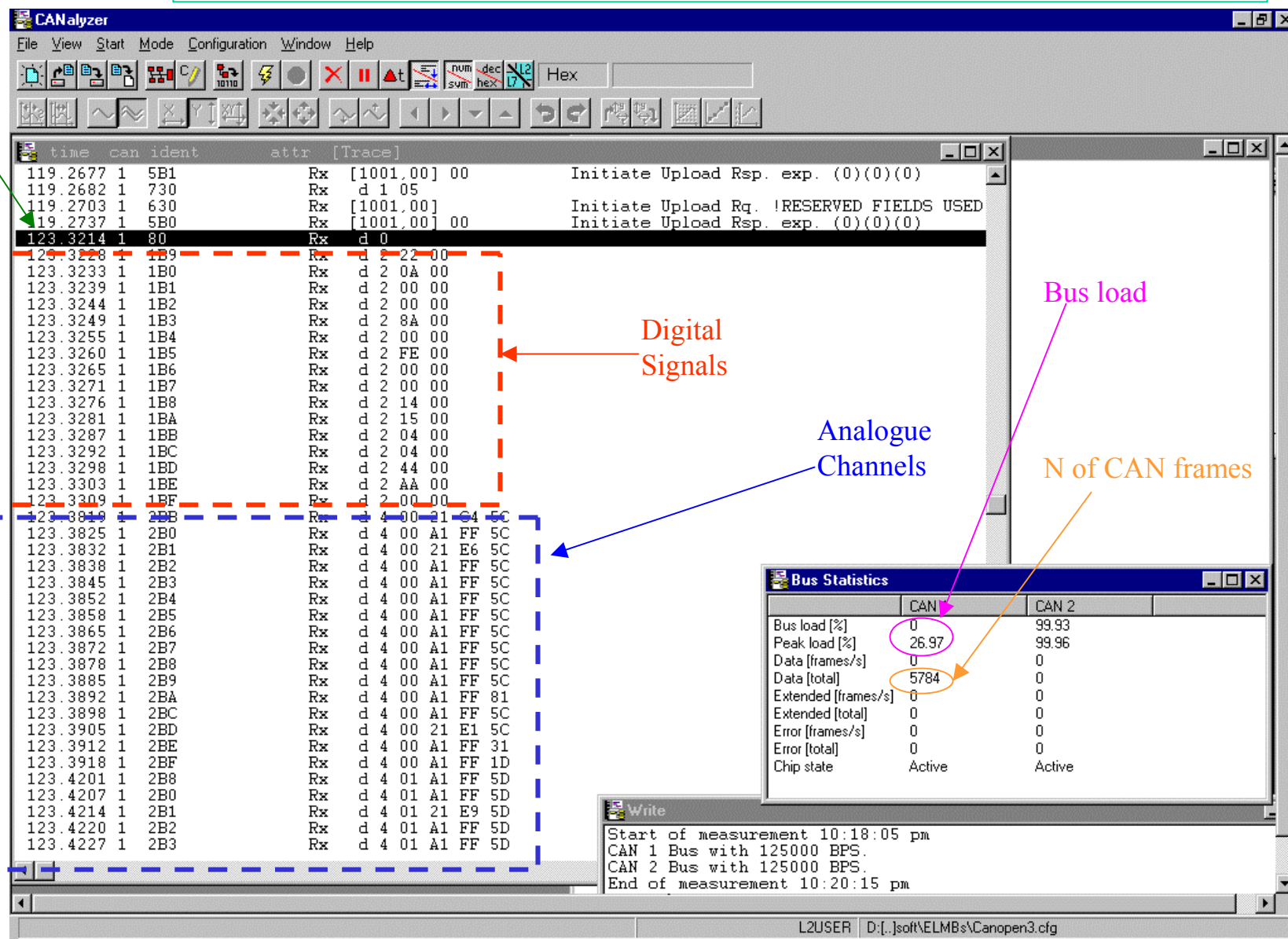




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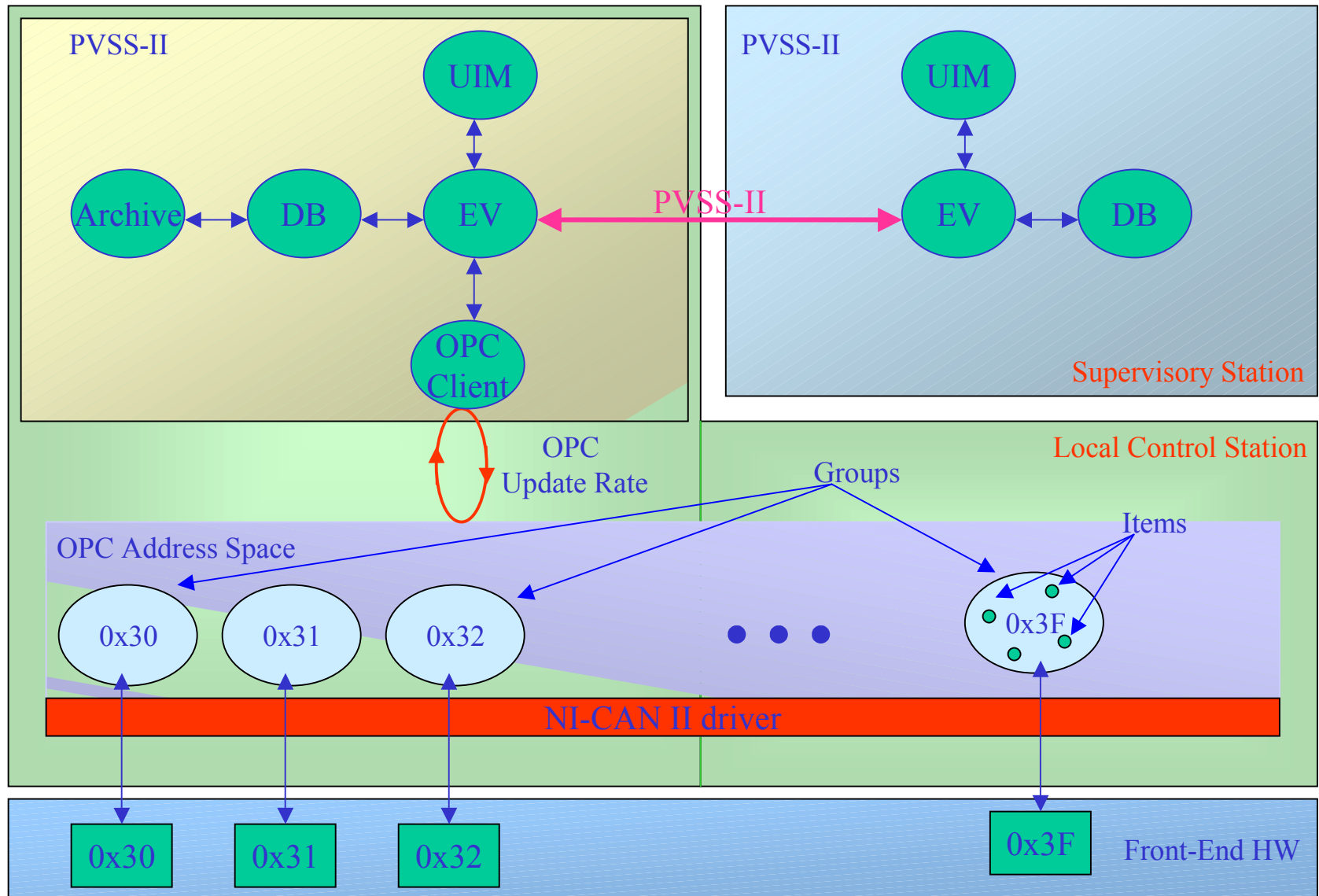
CAN Analyzer Diagnostic Tool

SYNC





SW Architecture





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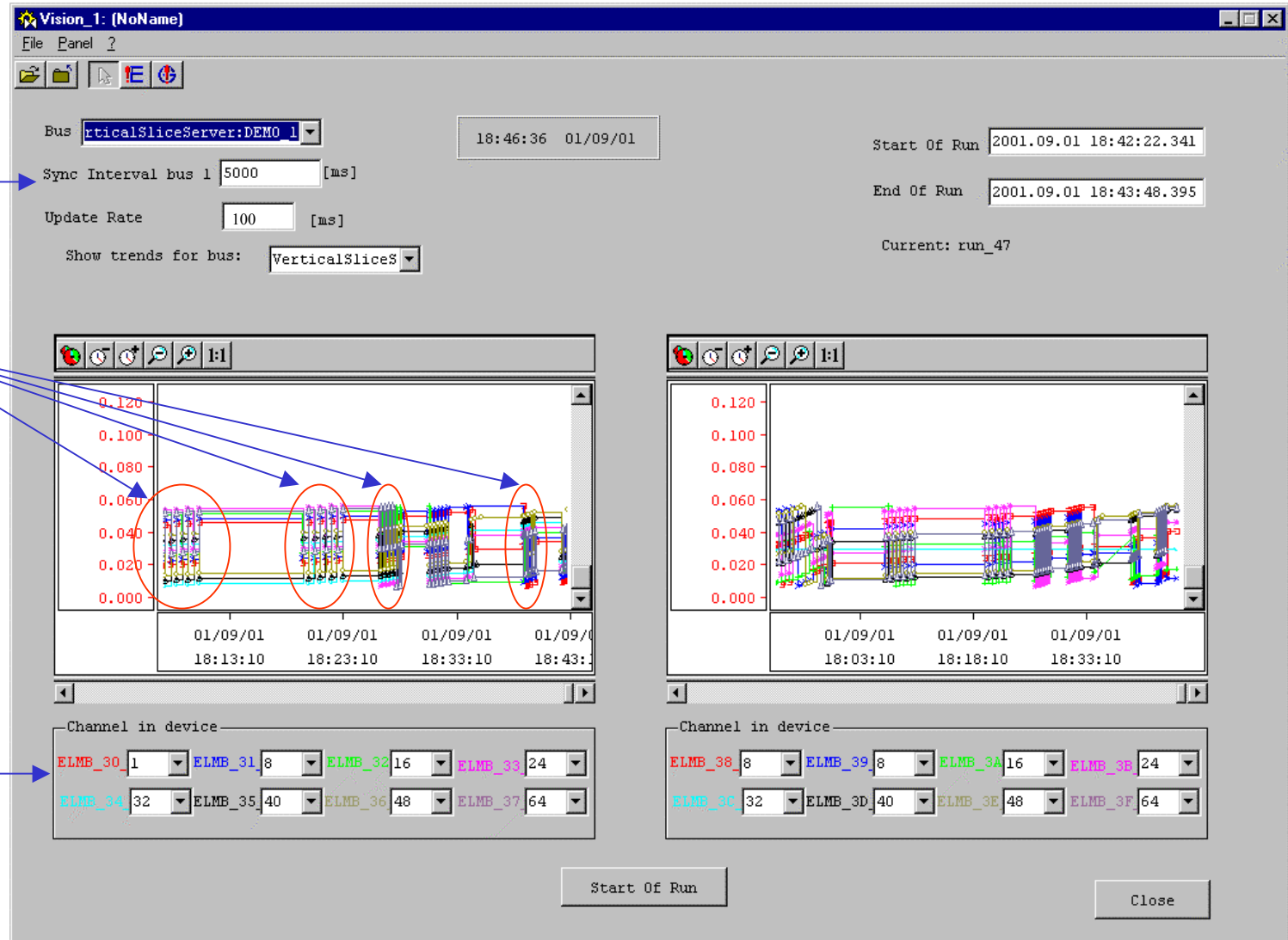
SCADA Supervisor SW

Run Control

Readout rate for
current run

History of Runs
at different rates

ELMB Channel
displayed





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SCADA Monitor SW

Offline Analysis

QuickTest_: (NoName)

File Panel ?

Run Number: 7

Time range for SQL Query: 2001.08.31 13:00:23.221 to 2001.08.31 13:05:09.733

Run description: syncInterval (30 s) >> Bu

Buses in Run: VerticalSliceServer:DEMO

SyncInterval: 30000

Number Of Syncs: 9

Readout rate

Expected number of entries in DB per channel

ELMB_3F_1	ELMB_3E_1	ELMB_3D_1	ELMB_3C_1
ELMB_3B_1	ELMB_3A_1	ELMB_39_1	ELMB_38_1
ELMB_37_1	ELMB_36_1	ELMB_35_1	ELMB_34_1
ELMB_33_1	ELMB_32_1	ELMB_31_1	ELMB_30_1: M= 1

Number of channels missing any reading

Elmb Channels

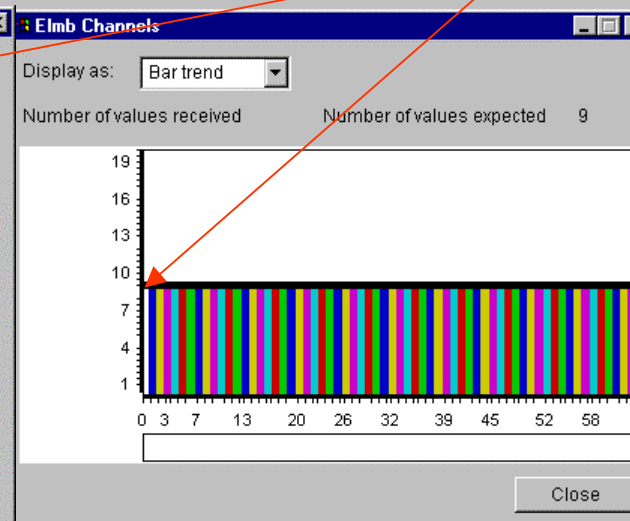
Display as: Table

Number of values received: 0

Number of values expected: 9

0	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9

Close





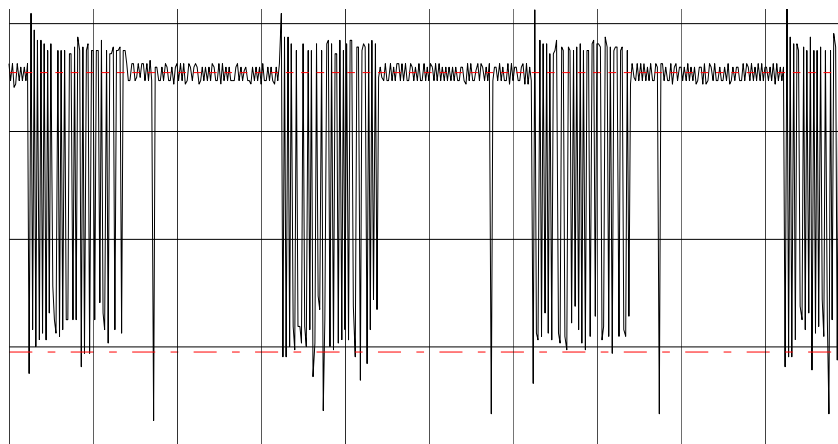
Findings

Powering

Problem: Working at $V_{PS_ANALOGUE} = 9\text{ V}$ some ELMBs do not reply to a SYNC (Analyzer files)

Reason: Voltage level of the ADC is too low ($< 4.5\text{ V}$)

Cable Resistance	37.5 Ohm / Km	7.5 Ohm in 200m			
				Voltages	
Currents (mA)				VPS_CAN (V)	16
CAN	16x20	320		Velmb_16_CAN (V)	11.05
ADC	16x10	160		VPS_Dig+Ana (V)	16
CAN	16x15	240		Velmb_16_Dig+Ana (V)	8.26
Grounding					
Drop G_CAN (V)	2.63			Drop DP+AP (V)	3.88
Drop P_CAN (V)	2.31			Drop DG+AG (V)	3.88
Difference (V)	0.32			Difference (V)	0
Digital + Analogue Voltage drop during ADC activity (V)					1.44





Findings

Parameters:

- Loop time (Sync interval)
- OPC update rate
- ADC frequency

Sync Interval (s)	OPC Update Rate (ms)	Bus Load (Peak in %)	N. of Syncs	Entries in DB	Expected	Transfer Rate (%)
30	100	11.43	5	5120	5120	100
30	100	11.49	6	6144	6144	100
15	100	11.75	7	7168	7168	100
15	100	11.73	8	8192	8192	100
10.5	100	11.74	8	8128	8192	99.22
10.5	100	11.48	6	6144	6144	100
10.5	100	11.03	10	10240	10240	100
10.5	100	11.56	9	9126	9126	100

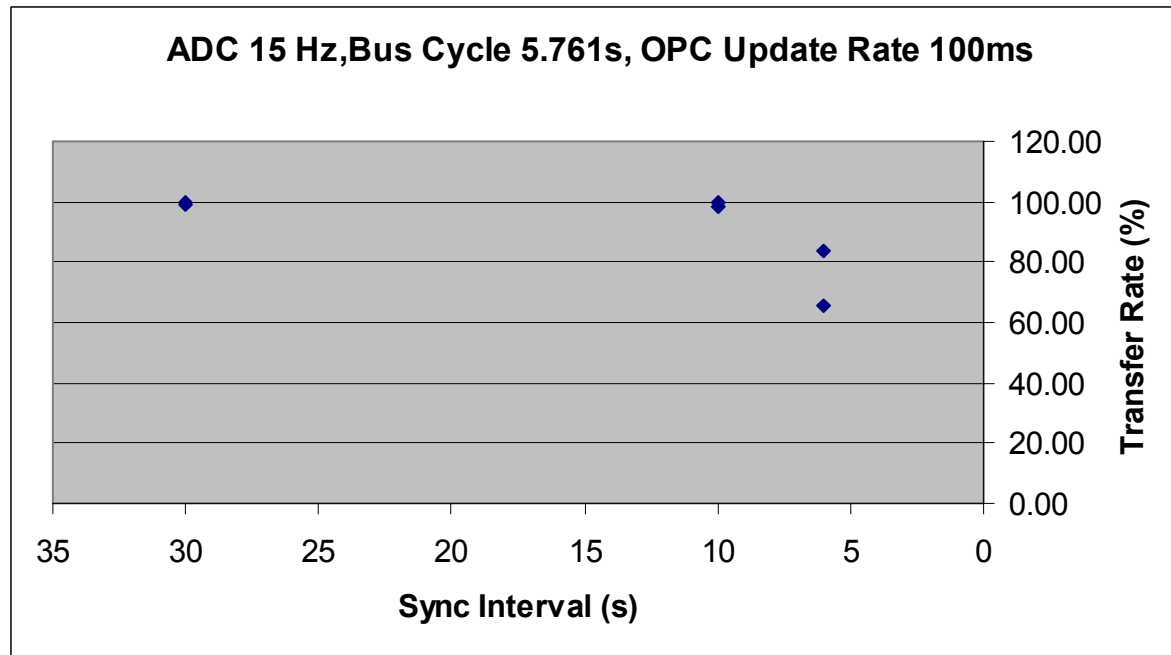
Table 3, ADC conversion rate 7.51 Hz, Bus cycle 10.019 s.

Sync Interval (s)	OPC Update Rate (ms)	Bus Load (Peak in %)	N. of Syncs	Entries in DB	Expected	Transfer Rate (%)
60	30000	6.77	4	4096	4096	100
60	30000	6.63	4	4068	4096	99.32
40	30000	6.55	3	3072	3072	100
40	30000	6.55	4	4096	4096	100
36	30000	6.56	5	5120	5120	100
36	30000	6.48	3	3072	3072	100

Table 3, ADC conversion rate 1.88 Hz, Bus cycle 35.571 s.



Findings



Data get lost at higher data rates when SYNC Interval -> bus cycle

Bottlenecks:

- NI CAN interface card (buffer overflow) ??? => Need for a new interface (cost and characteristics).
- PVSS archiving (CPU consumption) => Better distribution of the tasks performed by SCADA.



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ELMB Full Branch Test: Example of Overflow

$$v_{adc} = 32.5 \text{ Hz}$$

```
C:\WNT\System32\cmd.exe
DLC=4, data(hex): 20 a1 ff 8c
=> Recvd msg# 839: COB=PD02-Tx <280>, NodeID=58, at 21:31:31:523
DLC=4, data(hex): 20 a1 ff 80
=> Recvd msg# 840: COB=PD02-Tx <280>, NodeID=48, at 21:31:31:523
DLC=4, data(hex): 20 a1 ff 8c
=> Recvd msg# 841: COB=PD02-Tx <280>, NodeID=49, at 21:31:31:523
DLC=4, data(hex): 20 21 ff 0c
***ERROR poll_can_msg: Read Queue Overflow
===> CANopen Interactive Control Tool (v2.2) <===
===> (NIKHEF, Henk B&B, n48@nikhef.nl) <===
Initialising NI *PCI-CAN* CAN-interface (bitrate = 125 kbit/s)
...done
=> Recvd msg# 1: COB=PD02-Tx <280>, NodeID=56, at 21:31:32:008
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 2: COB=PD02-Tx <280>, NodeID=54, at 21:31:32:008
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 3: COB=PD02-Tx <280>, NodeID=62, at 21:31:32:009
DLC=4, data(hex): 2d a1 ff 2e
=> Recvd msg# 4: COB=PD02-Tx <280>, NodeID=52, at 21:31:32:015
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 5: COB=PD02-Tx <280>, NodeID=53, at 21:31:32:016
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 6: COB=PD02-Tx <280>, NodeID=58, at 21:31:32:016
DLC=4, data(hex): 2d a1 ff 8d
=> Recvd msg# 7: COB=PD02-Tx <280>, NodeID=48, at 21:31:32:017
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 8: COB=PD02-Tx <280>, NodeID=49, at 21:31:32:017
DLC=4, data(hex): 2d 21 e9 1a
=> Recvd msg# 9: COB=PD02-Tx <280>, NodeID=51, at 21:31:32:017
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 10: COB=PD02-Tx <280>, NodeID=55, at 21:31:32:017
DLC=4, data(hex): 2d a1 ff 1a
=> Recvd msg# 11: COB=PD02-Tx <280>, NodeID=57, at 21:31:32:017
DLC=4, data(hex): 2d a1 ff 1a
```

Overflow in read buffer
of the NI-CAN II interface

Vision_1: SQL

File Panel 2

All/Alert Select From Remote Where Timerange Sort/Group Data

Data

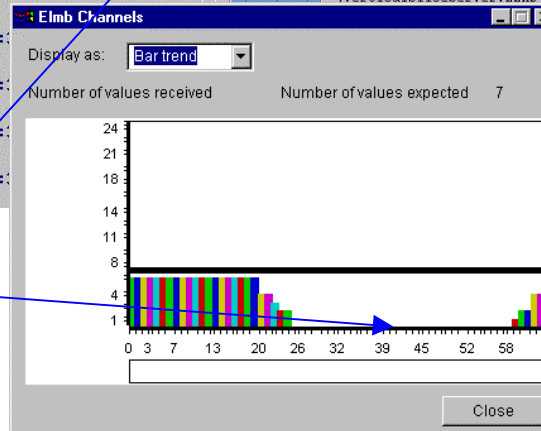
VerticalSliceServer:ELMB_35_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_30_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_33_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_31_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_32_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_34_1.ch20.value	0.0207	2001.09.02	11:54:55.1
VerticalSliceServer:ELMB_38_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_36_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_3E_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_35_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_34_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_3B_1.ch60.value	0.0361	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_30_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_37_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_31_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_3A_1.ch60.value	0.0113	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_33_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_39_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_3D_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_3C_1.ch60.value	0.0363	2001.09.02	11:54:57.1
VerticalSliceServer:ELMB_32_1.ch60.value	0.0363	2001.09.02	11:54:57.1
1.ch60.value	0.0363	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1
1.ch61.value	0.0367	2001.09.02	11:54:57.1

Delete table Start query

_1.ch.value" TIMERANGE("2001.09.02 11:53:46", "2001.09.02 11:55:35", 1, 0) SORT BY 2

? Save Load Create query Close

Hole in DataBase

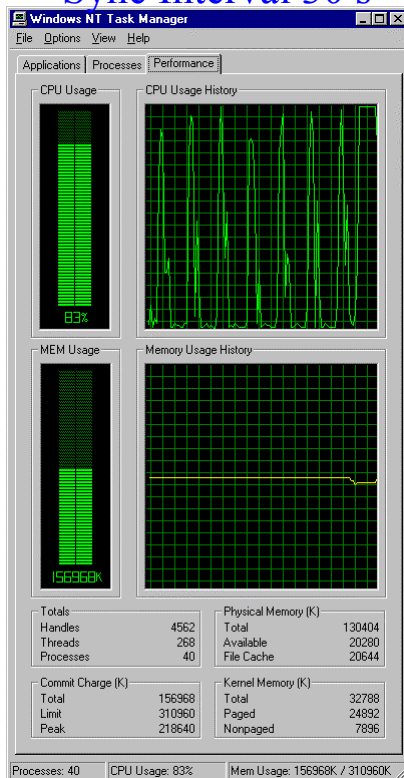




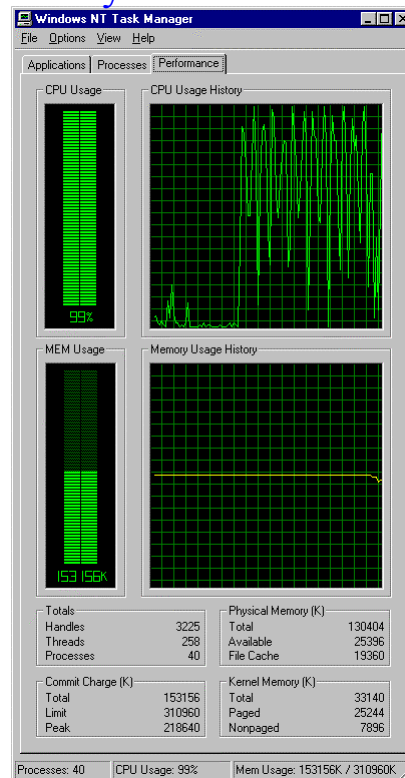
CPU Behavior

ADC Conversion Rate 32.5 Hz

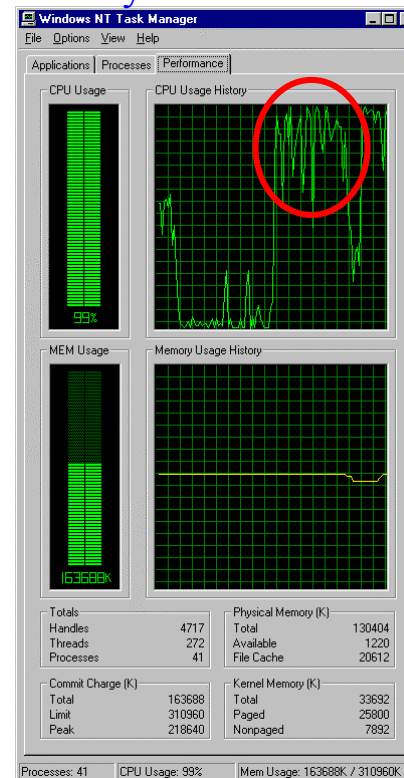
Sync Interval 30 s



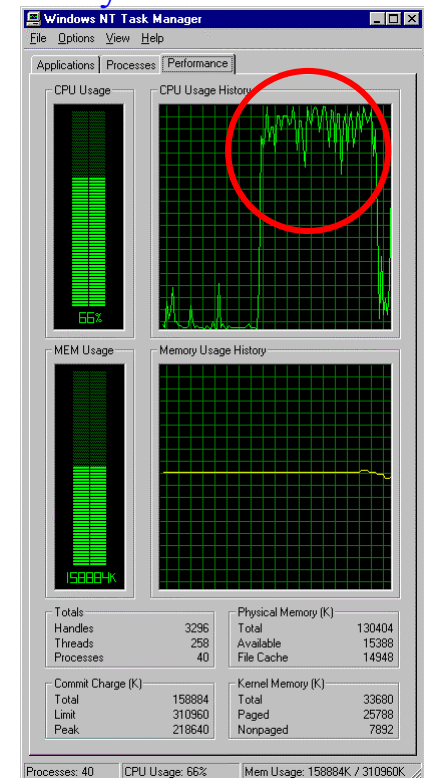
Sync Interval 10 s



Sync Interval 5 s



Sync Interval 3 s



Most of the CPU time is consumed by the PVSS archiving manager.
OPC takes about 60 % during the avalanche of analogue channels.



Conclusions

- Full ELMB Branch successfully operated.
 - I/O channels of the order of magnitude of some subdetectors in ATLAS
 - Preliminary studies of the powering has been carried out.
 - The test tried to reproduce the “worst possible case” => All ELMBs transmitting at the same time.
 - The system has shown excellent performance for $v_{adc} < 15.1$ Hz :Transfer rate of 100% for
 - messages on the bus different priorities on the bus
 - and different transmission types.
 - Several issues were identified at higher v_{adcw} when SYNC → Bus Cycle
 - Overflows in the read buffer of the NI-CAN interface
 - High CPU consumption by the PVSS archiving manager
- => Input for new tests with a better design -> Results can be improved!!!

Final results of this test, together with the obtained in radiation tests, will define the bus behavior, CANopen network topology in ATLAS and the distribution of tasks between the different elements of the Vertical Slice.