CAN Over Ethernet Gateways
A Convenient and Flexible Solution to Access Low Level Control Devices

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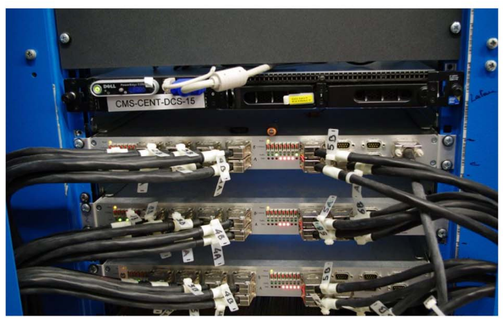
CAN @ CERN

- A **recommended** fieldbus at CERN
- **Thousands of CAN nodes** monitored and controlled from Front-End (FE) servers
- Technically challenging locations (strong magnetic fields, radiation areas)
- Long CAN cabling distance (> 100 m)
- CAN interfaces based on PCI and USB
- Communication via SIMATIC WinCC Open Architecture and OPC

Current Status and Limitations



Rack equipment co-location example

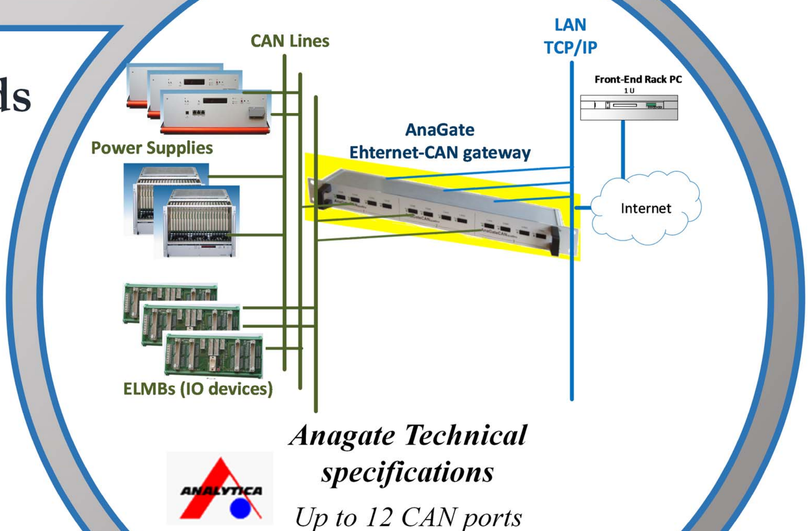
- **Co-location** of FE servers and CAN interfaces for PCI or USB
- Racks **space limitation**
- Requires direct connection to a single FE server
- Prevents from virtualization and redundancy

Selection and Evaluation Methods

User Requirements → Market Survey → Hardware Selection → Tests Specifications → Hardware Evaluation

Needs?

- High density of CAN ports
- Rack mounted solution
- Independent CAN controllers
- Very high reliability
- Windows and Linux API

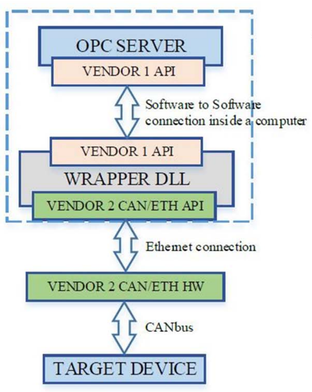


Anagate Technical specifications

Up to 12 CAN ports

Linux running ARM CPUs

Windows and Linux API



OPC-wrapper-CAN API software layout

Wrapper DLL

- Maps API calls between existing OPC Servers and Anagate hardware.
- C re-entrant multithreaded library
- Transparent recovery mechanism in case of LAN/Power/CAN failures

Test application tool

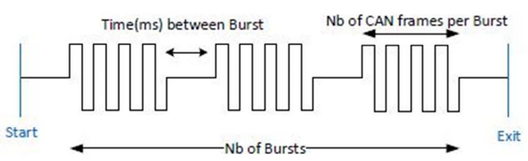
Automated tests via batch scripts

Execution of individual or scenarios of consecutive commands

Independent sending and receiving threads for each CAN port and Control of traffic pattern

Latency Statistics

Records the delay between sending and receiving a given frame



CAN frames transmit pattern

Max-Load (Z) Number of Ports (Y) Baud-Rate (X)

	100	125	250	500	1000
1	100% 800fr/s	100% 1000fr/s	100% 2000fr/s	100% 4000fr/s	100% 8000fr/s
2	100% 1600fr/s	100% 2000fr/s	100% 4000fr/s	100% 8000fr/s	60% 9600fr/s
3	100% 2400fr/s	100% 3000fr/s	100% 6000fr/s	80% 9600fr/s	30% 7200fr/s
4	100% 3200fr/s	100% 4000fr/s	90% 7200fr/s	40% 6400fr/s	20% 6400fr/s

Throughput measurement results (5 mins duration test)

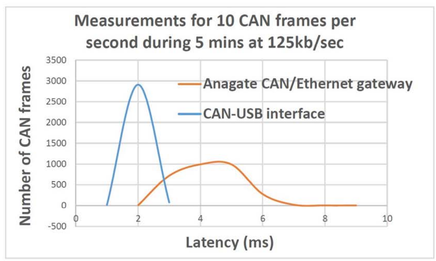
Results

Performance

- The maximum load percentages are the thresholds at which no frames are discarded by the Anagate
- Maximum throughput corresponds to data provided by the company

Latency

Distribution of latency when transmitting via Anagate in comparison to USB-CAN interface



Latency measurements results

Resilience

How well the hardware behaves?

Failure mode	Successful recovery
Power	✓
LAN	✓
CAN network	✓

Usability -Web server provided for:

- CAN ports configuration
- CAN frames statistics (sent, received and discarded)
- Firmware update

AnaGate CAN quattro

IP Settings
CAN Settings
Advanced Settings
Status
Firmware
Lua
Copyright

AnaGate CAN quattro status

Press the clear button to delete the diagnostic messages. The counts could be zeroed by an reboot only.

Counter

	CAN A	CAN B	CAN C	CAN D
TCP Receive:	360000	360000	360000	360000
TCP Transmit:	336354	333894	327602	348594
CAN Receive:	337978	336455	329086	348851
CAN Transmit:	347923	347788	340455	353959
CAN Discard:	13704	14785	21032	6301
CAN Receive Error:	0	0	0	0
CAN Transmit Error:	0	0	0	0
Network Error:	0	0	0	0

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Online CAN frames statistics

Practical Experience in CMS DCS

- Integrated the Anagate gateways into the CMS DCS
- Tested with main CAN-based hardware (Wiener Power Supplies, crates, ELMBs)
- More than **54 billion CAN frames** processed over a period of 4 months
- Very **high reliability** & **robustness** in **production** environment

Hardware Type	Devices	Buses	Baud rate
Wiener VME Crate	88	8	500 kb/s
Wiener Power Supply	136	10	100 kb/s
ELMB	104	8	125 kb/s

CMS CAN bus test applications

Conclusions

- Good **performance**, **stability** and **robustness**
- **External solution** (no direct connection to the FE server)
- Web interface for online configuration and CAN frames statistics
- Viable **alternative** to PCI and USB interface types
- Enables evolution towards **virtualization** and **redundancy**
- Ongoing studies towards integration with OPC Unified Architecture

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