The CAN Bus – From its Early Days to CAN FD
By Friedhelm Pickhard (ETAS/P)
ETAS
Introduction to ETAS Group

- Founded 1994
- Shareholder 100% Robert Bosch GmbH
- Headquarters Stuttgart, Germany
  18 additional offices worldwide

Function & Software Development

Prototyping

Operating Systems & AUTOSAR RTE

ECU Access & ECU Hardware

Test & Val.

Meas. & Cal.

ASCET
INTECRIO
EHOOKS
RTA-OSEK
ES900
ES1000
RTPRO-PC

LABCAR
Testing Systems

INCA
ES400 & ES600
ES500
ES700
ETK/XETK

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The CAN Bus – From its Early Days to CAN FD

Agenda

1. The History of CAN
2. CAN as Enabler for E/E-Evolution
3. CAN – Quo Vadis?
From discrete interconnections ... towards bus topologies

Source: Bosch 2008, Fakultätskolloquium Dr. S. Dais
# The CAN Bus – From its Early Days to CAN FD

## Historical Outline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>Bosch start development on CAN</td>
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<tr>
<td>84</td>
<td>CAN patent filed</td>
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<tr>
<td>85</td>
<td>CAN published at SAE congress Detroit</td>
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<tr>
<td>86</td>
<td>First CAN chips from Intel and Philips</td>
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<tr>
<td>87</td>
<td>CAN introduced first in weaving machines</td>
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<td>88</td>
<td>First Mercedes-Benz S-class with CAN</td>
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<td>89</td>
<td>Foundation of CAN in Automation</td>
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<tr>
<td>90</td>
<td>Standardization of CAN in ISO 11898</td>
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<tr>
<td>91</td>
<td>CANopen protocol published by CiA</td>
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<tr>
<td>92</td>
<td></td>
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<tr>
<td>93</td>
<td>Specification of several ISO 11898-x:</td>
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<tr>
<td>94</td>
<td>data link layer</td>
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<tr>
<td>95</td>
<td>high-speed physical layer</td>
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<tr>
<td>96</td>
<td>fault-tolerant physical layer</td>
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<tr>
<td>97</td>
<td>TTCAN low-power mode</td>
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<td></td>
<td>selective wake-up</td>
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<tr>
<td>98</td>
<td>Introduction of TTCAN</td>
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<td>99</td>
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<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Invention of CAN FD (ISO 11898-7)</td>
</tr>
</tbody>
</table>

Source: CiA
The triumphant success of CAN:

- Field bus systems in automation technology
- Aeronautic technologies (Networking of avionic systems)
- Medical technology (Communication between medical devices)
- Agricultural machinery and railway technology
- Building technology (Control of elevators)
- Consumer goods area (Washing machines, stoves, and products in consumer electronics)
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The First In-vehicle CAN Bus

Daimler S class W140 (1991)

Source: Daimler AG

Engine Control
(fuel injection)

ABS/ASR

Transmission Control
and Ignition
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Increase of In-Vehicle Bus Communication

Number of Systems

Computing Performance

Code Size

Communication

Source: VW 2005, Fachkongreß Automobil-Elektronik

Source: NEC, 2006; Bosch

Source: Daimler-Chrysler 2004; Philips

Source: BMW, Frischkorn, BoCSE 2002
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Today’s CAN Bus Architecture

- CGW
- CAN LIN FlexRay MOST
- Central Gateway

Body
- Powertrain
- Vehicle Motion & Safety
- Infotainment

CAN
LIN
FlexRay
MOST
Central Gateway
1. First “real” protocol bus in the vehicle, allowing complex functionality while reducing the need for wiring

2. The open license policy of Bosch drove fast availability of CAN on chip on the market

3. CAN is low-cost and requires small silicon area and low computing power

4. Compared to time-triggered protocols, CAN has a low planning effort and is highly flexible in adding unplanned nodes to the network

5. CAN resolves network collision via bit arbitration, such that the message with higher priority is sent
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Complexity and Number of Functions

Source: Bundesministerium für Wirtschaft und Technik: “eCar-IKT-Systemarchitektur für Elektromobilität”
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Data Rates and Implementation Cost

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Possible Future E/E-Architecture with CAN FD

Domain architecture with **Ethernet** “Back-Bone”

1) Range Extender
2) Driver Assistant System
3) Camera for top view
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Challenges of High-Speed Communication Networks

### Classical System

- Data Plane and Control Plane in sw
- CPU controls directly the communication controller
- **High, variable latency, high jitter, low throughput**
- **Low performance data handling with high CPU load**

### ETAS Data Engine

- Data Plane implemented in hw
- CPU controls directly the hw engine
- **Low, constant latency (< 5µs), negligible jitter, high throughput (up to 3 Gbit/s)**
- **High performance data handling with minimum CPU load**
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Future Trends and Bus Technologies
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Thank You!

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