Protocol Selection Guide

Version 1.8
2012-04-12
Application Note AN-ION-1-0103

Author(s)	Jürgen Klüser

Restrictions	Public Document

Abstract	This application note tries to give some hints for selecting a Higher Layer Protocol.

Table of Contents

1.0 Overview

When designing a CAN based application the question arises, if a Higher Layer Protocol should be used. More or less this question is equal to the question “Which Higher Layer Protocol shall be used?”

This Application Note cannot give you the answer to this question. It lists some of the most important aspects as a starting point for the evaluation.

There are many different criteria for a protocol selection. These include technical and commercial aspects as well as influences by industry groups or even geographical topics.

2.0 Available Protocols

There exist a nearly uncountable number of field bus solutions. One can find many so-called field bus studies such as from STA Reutlingen or Omron.

This application note focuses only on the most often used CAN based protocols, with which we have real experience and that are widely used in the markets. These are mainly CANopen®, DeviceNet and the J1939 family with NMEA2000® and ISOBUS.

The following shall give an extremely brief overview about existing protocols:

Protocol	Comment
AGATE Data Bus	Standardized by NASA. Uses CANaerospace.
ARINC 812	ARINC 812 is a protocol specification for the aviation industry, managed by www.arinc.com. It specifies communication between modules in the on-board galley (Galley Master, Galley Inserts). The focus here is on power management.
ARINC 825	ARINC 825 is a protocol specification for the aviation industry, managed by www.arinc.com. It specifies both the fundamental communication within CAN-based subsystems and between CAN sub-systems, which for example are interconnected by AFDX®. It offers addressing mechanisms, communication mechanisms, a service structure, profile descriptions and much more.
ARINC 826	ARINC 826 is a protocol specification for the aviation industry, managed by www.arinc.com. It specifies Software Data Load over CAN. The mechanisms of the more general ARINC 615A were adapted and optimized for CAN here.
CAL	Predecessor of CANopen. Used in some specific networks and formerly at Philips Medical Systems
CANaerospace	CANaerospace was developed by the company Stock Flight Systems (www.canaerospace.com). Key protocol applications are in engineering simulators, simulation cockpits and especially in the Italian field on drones (UAVs).
CAN Kingdom	Mechanism for distributed real-time control systems. No actual usage known any more.
CANopen	One of the most wide-spread protocols in nearly all application fields. Hundreds of module providers and users. Managed by CAN in Automation (www.can-cia.org) Designed for very flexible configurable embedded networks. CANopen specifies the basic communication mechanisms and device profiles, but also application profiles with specific support for selected application fields.
CleANopen	CANopen based application profile for the waste disposal industry and the garbage truck manufacturers. Managed by CAN in Automation (www.can-cia.org/cleanopen)
CCP / XCP on CAN	CAN Calibration Protocol. Designed by ASAM (www.asam.de) for data acquisition and calibration. The successor XCP is defined for several underlying bus systems. One derivative is XCP on CAN.
DeviceNet	DeviceNet is a CAN based Layer 7 protocol, which was originally developed by Allen Bradley. Operation of DeviceNet is based on an object-oriented communications model. DeviceNet is maintained by the "Open DeviceNet Vendor Association (ODVA)" and can be implemented free of license. (www.odva.org) DeviceNet is widely used in US factory automation.
EnergyBus	CANopen application profile for light electric vehicles. Still under construction.
Esalan	Former safety relevant protocol from the company Elan Schaltwerke.
FireCAN	Data bus specification for Firefighter vehicles. Managed by a consortium of many European firefighter vehicle and component manufacturers (www.firecan.info)
GMLAN	Automotive protocol from General Motors.
ISOBUS	ISO 11783. Developed on base of J1939 and the former LBS for specific purposes of the agriculture and forestry electronics. Furthermore used in some series of Public Community Vehicles.
ISO 11992	Truck-Trailer-Gateway. Based on J1939.

Protocol	Comment
J1939	J1939 is a communications protocol for real-time data exchange between control devices in the area of commercial vehicles. It describes the information exchanged between the control units in such a system. Managed by SAE (www.sae.org). Wide-spread usage in several application areas, mainly engine control, truck applications, railway, agriculture electronics (see ISOBUS) and maritime applications (see NMEA2000®).
LBS	DIN 9684 “Landwirtschaftliches Bussystem”. Replaced by ISOBUS.
MCNet	The MCNet standard ("Mobile Communications Network") was developed specially for networks with multimedia and information devices in vehicles. Replaced by MOST®
MilCAN	Bus system with real-time capabilities derived from J1939 (MilCAN A) and CANopen (MilCAN B).
NMEA2000®	HLP based on J1939 with extensions for use in maritime applications. Managed by NMEA2000® (www.nmea.org)
SafetyBus-p	Safety relevant protocol from company Pilz
Smart Distributed System	Developed by Honeywell as smart sensor interface.
VSCP	VSCP = Very Simple Control Protocol. A very simple and free protocol for SOHO automation tasks (Small Office Home Automation). http://www.vscp.org
WesyCAN	Developed by Sulzer Textil for textile machinery. Replaced by CANopen.

Table 1 - Protocol Overview

This list is not complete. There exists a series of more or less proprietary protocols. Even Layer 2 systems with a well-defined communication matrix i.e. stored in a CANdb database can be seen as an Application Layer.

3.0 Selection Criteria

3.1 Technical Differences

The different protocols have been designed focusing on different requirements. So there is no best or good or bad protocol. They all have their strength for certain applications.

The following compares only some facts of the two most wide-spread protocols:

Feature	CANopen	J1939
Central Master	Supports central Master approach, but also can be used as Multi-Master-System	Totally Distributed System
Slave-Slave-Communication possible	Yes	Yes
Max. Number of Nodes	127	255
Baudrates [kBit/sec]	10-1000	250

Table 2 - Protocol Differences

3.2 Application Fields / Industry Groups

Different Industry groups have different requirements. In some of them a particular protocol is established. This has several advantages. If working together with other companies, the interfacing will use less effort. Furthermore one can rely on the fact, that other companies already did evaluations on the protocols and found the chosen protocol to fit their requirement. This gives a good hint and a higher probability that it will fit also your requirements.

Application Field	CANopen	DeviceNet	J1939
Factory Automation	Many benefits for optimized high performance applications. Very complex for simple centralistic controlled applications.	X Since it is designed for very simple centralistic applications, it provides easy integration	-
Truck, Truck application (fire fighters, mobile cranes…)	X CANopen seems to get a de-facto standard in European truck applications	-	X J1939 is a de-facto standard in Diesel Engine control
Agriculture	X Used in internal networks of the implements.	-	The derivative ISOBUS (ISO11783) is the standard for harvesters and networking tractors with implements
Maritime	X Supported by many manufacturers	-	The derivative NMEA2000® is supported by many manufacturers
Medical Systems	X The main players as well as many smaller manufacturers are using CANopen.	-	-
Railway, public transport	X Many applications	-	X Control of Diesel Engines
Wind turbines	X	-	-
Building Automation	X	-	-
Printing and Copy Machines	X	-	-
Game Industry	X	-	-
Other Embedded Networks inside Machines	X	X	-

Table 3 - Protocol Application Fields

For the application of avionics networking refer to the separate application note AN-ION-1-0104 CAN-based protocols in Avionics.

3.3 Geographical Usage

Some years ago the protocols had their primary regional domains. Meanwhile they all have reached a world-wide acceptance in their appropriate application fields. Therefore the following table gives only a rough direction.

Region	CANopen	DeviceNet	J1939
USA	X	X	X
Europe	X	(-) Some providers. Only few applications.	X Mainly Engine Control in Truck/Railway. ISOBUS in Agriculture.
Far East	X	X	X Diesel engine control. NMEA2000® in maritime applications
Others	X	?	?

Table 4 - Geographical Usage of Protocols

3.4 Historical Reasons

If one is already using a protocol there have to be good reasons to change, since this is combined with costs and building-up of new knowledge.

3.5 Development Support

When selecting a protocol it is important to get development assistance. The following questions should be answered:

- Are Development Tools available? Because of the dynamic character of some of the protocols layer 2 based CAN tools may not be enough. Specific Tools with protocol support will decrease efforts in simulation, development, testing and bug-fixing.
- Do I need to implement the protocol myself? Or are there commercial high-quality protocol stacks available?
- Are Training Classes available?
- Do I need consulting services? If so, what companies can provide that know-how?
- Do I need additional implementation services? Which companies can provide know-how and resources?

4.0 Conclusion

Selecting a protocol is a complex task. Considering the criteria given above and even some more will help putting some light on it.

It is strongly recommended to contact other companies in the same application field. Perhaps some consulting will be helpful. Here consultants should be chosen, that do not have a commercial interest in one specific of the potential protocols.

5.0 Additional Resources

The following material may provide further information:

VECTOR APPLICATION NOTES
AN-ION-1-0104 CAN-based Protocols in Avionics
AN-ION-1-3100 Introduction to J1939
AN-ION-1-1100 Introduction to CANopen
AN-AON-1-1101 Introduction to CANopen Documentation Family

6.0 Trademarks

All mentioned names are either registered or unregistered trademarks of their respective owners.

AFDX® is an Airbus' registered trademark.

7.0 Contacts

Germany
and all countries not named below:

Vector Informatik GmbH
Ingersheimer Str. 24
70499 Stuttgart
GERMANY
Phone: +49 711-80670-0
Fax: +49 711-80670-111
E-mail: info@de.vector.com

France, Belgium, Luxemburg:

Vector France SAS
168 Boulevard Camélinat
92240 Malakoff
FRANCE
Phone: +33 1 42 31 40 00
Fax: +33 1 42 31 40 09
E-mail: information@fr.vector.com

Sweden, Denmark, Norway, Finland, Iceland:

VecScan AB
Theres Svenssons Gata 9
41755 Göteborg
SWEDEN
Phone: +46 31 764 76 00
Fax: +46 31 764 76 19
E-mail: info@se.vector.com

United Kingdom, Ireland:

Vector GB Ltd.
Rhodium, Central Boulevard
Blythe Valley Park
Solihull, Birmingham
West Midlands B90 8AS
UNITED KINGDOM
Phone: +44 121 50681-50
Fax: +44 121 50681-69

E-mail: info@uk.vector.com

China:

Vector Automotive Technology (Shanghai) Co., Ltd.
Sunyoung Center
Room 1701, No.398 Jiangsu Road
Changning District
Shanghai 200050
P.R. CHINA
Phone: +86 21 6432 53530
Fax: +86 21 6432 5308
E-mail: info@cn.vector.com

India:

Vector Informatik India Pvt. Ltd.
4/1/1/1, Sutar Icon, Sus Road,
Pashan, Pune - 411 021
INDIA

Phone: +91 20 2587 2023
Fax: +91 20 2587 2025

E-mail: info@in.vector.com

USA, Canada, Mexico:

Vector CANtech, Inc.
39500 Orchard Hill Place, Suite 550
Novi, MI 48375
USA

Phone: +1 248 449 9290
Fax: +1 248 449 9704
E-mail: info@us.vector.com

Japan:

Vector Japan Co. Ltd.
Tennozu Yusen Bldg. 16F
2-2-20 Higashi-shinagawa,
Shinagawa-ku,
Tokyo 140-0002
JAPAN
Phone: +81 3 5769 7800
Fax: +81 3 5769 6975
E-mail: info@jp.vector.com

Korea:

Vector Korea IT Inc.
#1406, Mario Tower,
222-12 Guro-dong, Guro-gu
Seoul, 152-848
REPUBLIC OF KOREA

Phone: +82 2 807 0600
Fax: +82 2 807 0601
E-mail: info@kr.vector.com