Factory Communication Systems

Assignment 2

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1. **OSI Model of CANopen:** The CANopen protocol consists of an Application layer, Presentation Layer, Session layer, Transport layer and Network Layer. The CANopen Data link & Physical layer is based on CAN protocol. CANopen assumes a physical layer according to ISO-11898-2. So it also uses other physical layer options such as ETHERNET, ETHETCAT etc.

2. **Analyzing the CANopen Message:**

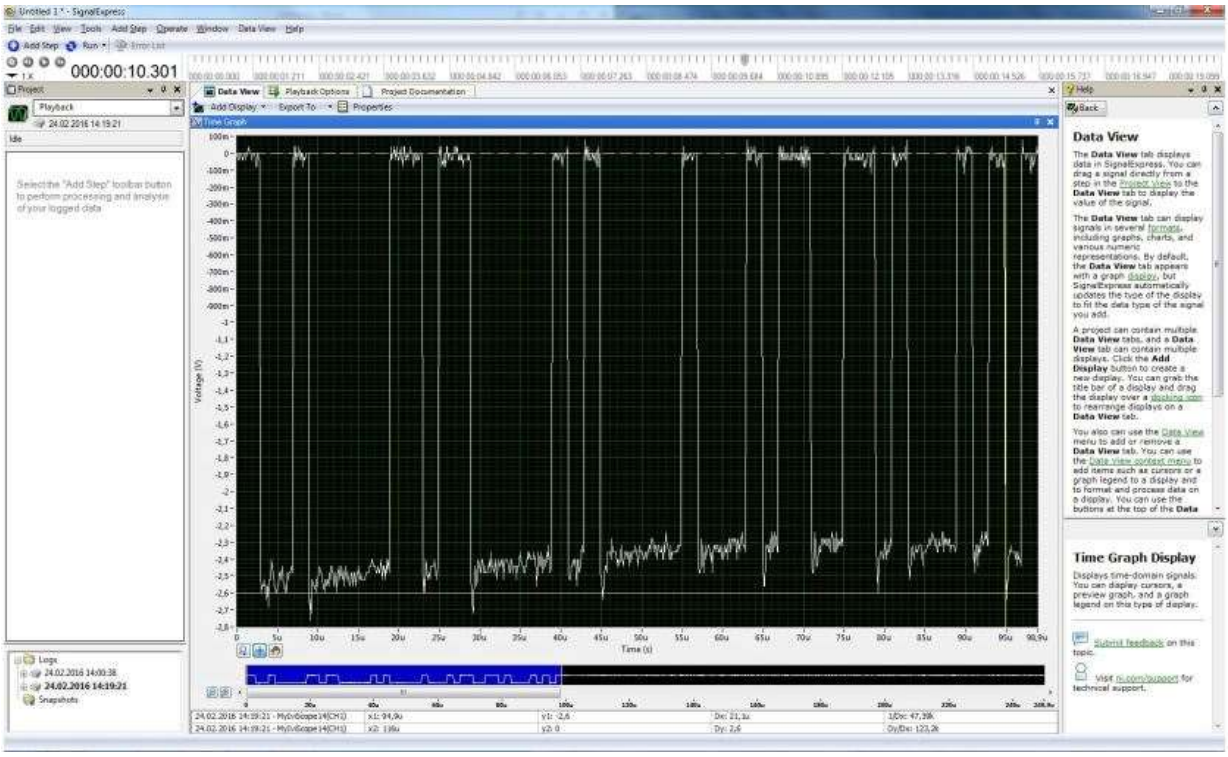

FIG 1: CANopen message captured in FAST Lab

- The bits from the message captured are:
  01110111110110000010100000110111000001011010001011111111111
- The Baud rate is 500 KB/Sec so the time required to send a single bit is 2 micro second.
- The actual data without Bit stuffing:
  0-11101111111-000001-00000101-1100000011010001-01-1111111-111
- Data = 00000101 = 05H, Arbitration = 111011111110, Control = 000001, CRC = 1100000011010001, ACK = 01.

- As IDE = 0, so Standard Data frame is used.

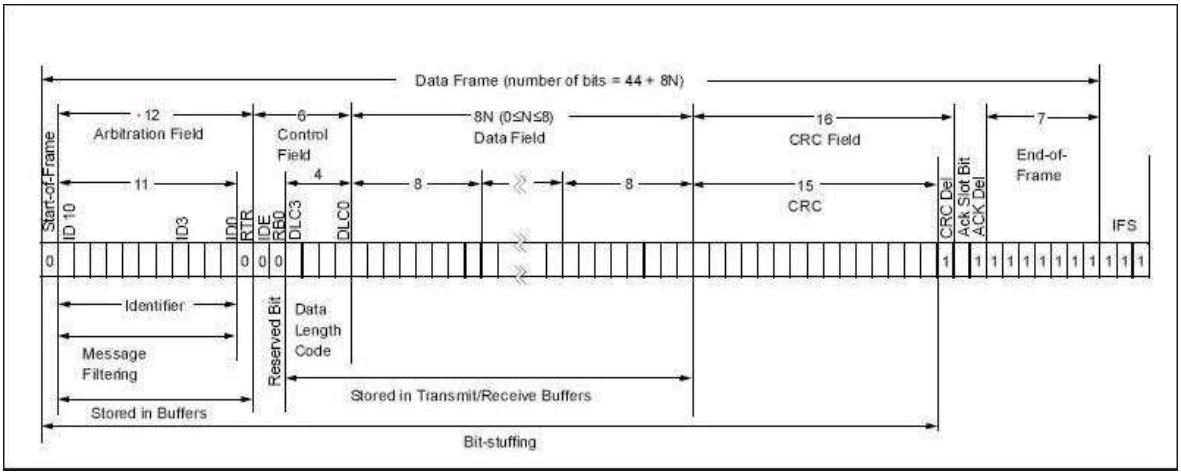

FIG 2: Standard Data Frame

[Source: http://techiscafe.blogspot.fi/p/the-controller-area-network-can.html]

3. **Recessive/Dominant Bits:** In can bus when there is no voltage across the differential pair CAN high and CAN low it is called Recessive state. This corresponds to the logic state 1 or High. And when there is voltage change across the differential pair (5V or 3.3V), which corresponds to the logic state 0 or Low. That's why high/low levels are called recessive/dominant bits. Naturally dominant bit overrides the recessive bit.

4.

	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11
NODE A	1	1	1	1	1	0	1	0	1	0	1
NODE B	1	1	1	0	0	0	1	1	1	1	1
NODE C	1	1	1	0	0	0	0	0	0	1	0
NODE D	1	1	1	0	1	0	1	1	1	1	1
NODE E	1	1	1	0	0	0	0	0	1	1	0

NODE	Points when Stops Attempting/Starts Listening
Node A	**T4**
Node B	**T7**
Node C	**T10**
Node D	**T5**
Node E	**T9**

5. **Multi Master Protocol:** A multi master protocol is a system where it can have more than one bus. All the masters listen to the bus and transmit frames when the bus is Idle. Multiple masters can also transmit simultaneously. CAN is such type of protocol where arbitration is used to avoid conflicts when more than one master tries to control the bus at the same time.

6. **Device profile in CANopen:** Device profile provides specification and standardization of specific devices and applications. The behavior and parameter of specific device or application is defined by device profile. The main advantage of device profile is interchangeability and interoperability between same types of devices. Thus it provides the user flexibility to use vendor independent devices. The current list of specified device profile and application profile is given below:

Profile number	Device class
CiA 401	Generic I/O Modules
CiA 402	Drives and Motion Control
CiA 404	Measuring devices and Closed Loop Controllers
CiA 405	IEC 61131-3 Programmable Devices
CiA 406	Rotating and Linear Encoders
CiA 408	Hydraulic Drives and Proportional Valves
CiA 410	Inclinometers
CiA 412	Medical Devices
CiA 413	Truck Gateways
CiA 414	Yarn Feeding Units (Weaving Machines)
CiA 415	Road Construction Machinery
CiA 416	Building Door Control
CiA 417	Lift Control Systems
CiA 418	Battery Modules
CiA 419	Battery Chargers
CiA 420	Extruder Downstream Devices
CiA 422	Municipal Vehicles – CleANopen
CiA 423	Railway Diesel Control Systems
CiA 424	Rail Vehicle Door Control Systems
CiA 425	Medical Diagnostic Add-on Modules
CiA 445	RFID Devices

FIG: Currently defined Device profile & Application profile

[Source: http://www.canopensolutions.com/english/about_canopen/profiles.shtml]

To manufacture a CANopen compliant pump I can check the specifications and standardization provided in CiA 402 “Drives and Motion Control” device profile. This profile covers servo controllers, stepper motors and frequency converters.

7. **Service Data Object (SDO):** The service data object is a protocol in CANopen by which a device can get access to the setting and reading values from the object dictionary of a remote device. The connection is formed on server/client basis. The device whose dictionary is accessed acts as a server and the device accessing the remote server acts as a client. The communication is always set by the SDO client and communication is viewed from the SDO server.