Innovations for High Performance Sensor-Actuator Applications

Technical Track

www.odva.org

Contents

- CompoNet Overview
- Technical Details
- Conclusion

CompoNet Overview

- Introduction
- System Configuration
- OSI model

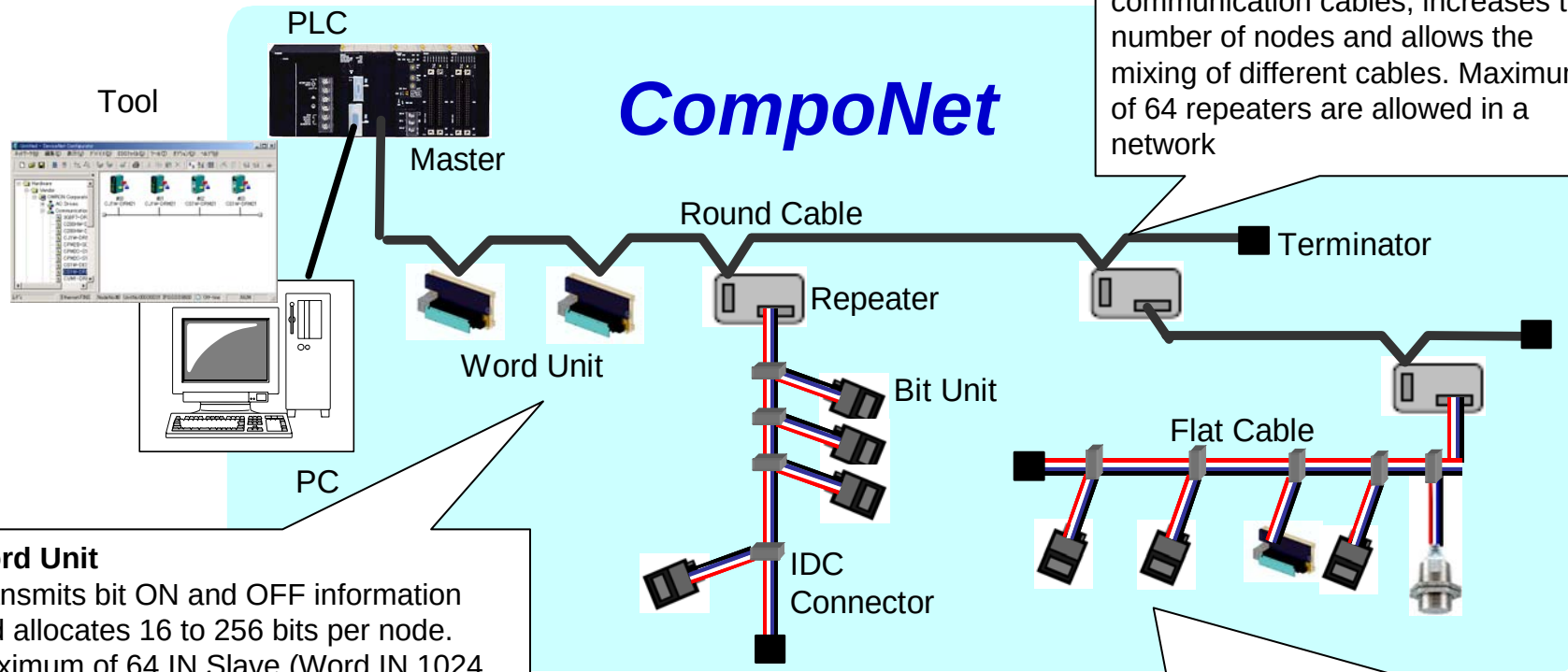
Introduction of CompoNet

Developed as a sensor and actuator network (SAN) and features;

- Strong Physical layer
  - Data rate: 93.75kbps to 4Mbps.
  - Trunk length: 30m (at 4Mbps) to 500m or 200m Flexible (at 93.75kbps), Without repeaters.
  - Total trunk length: 32,500m max. (with repeaters, 65 times longer than before, at 93.75kbps)
  - Flexible cable topology: flat cables and insulation-displacement connector (IDC)
  - Low cost round cables
- Efficient Data Link layer of high serviceability
  - High speed response (at 4Mbps, 1ms cycle time, 1000 I/O points)
  - Bit and word data processing
  - Many nodes (Slave of 384 nodes, and Repeater of 64 nodes)
  - Detection of installation and node condition
- CIP

CompoNet System Configuration

A network suitable for sensor-actuator



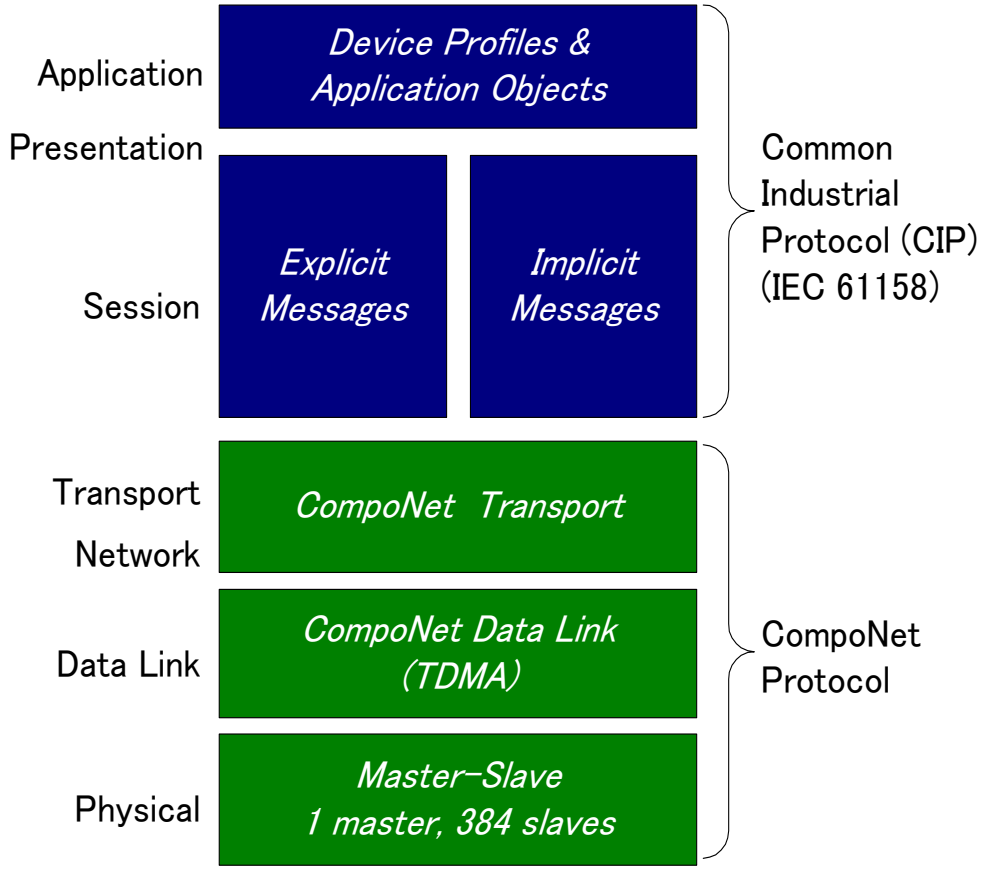
Repeater
Extends or branches the communication cables, increases the number of nodes and allows the mixing of different cables. Maximum of 64 repeaters are allowed in a network

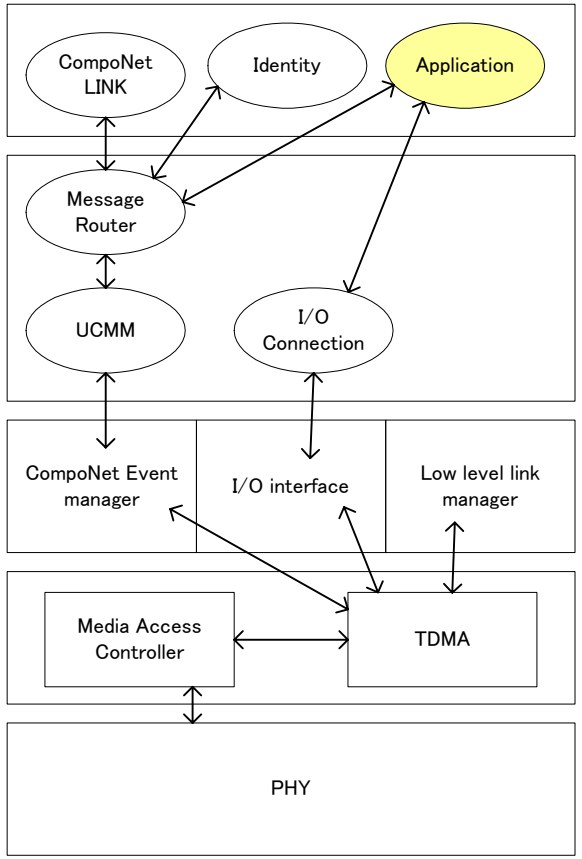
Word Unit
Transmits bit ON and OFF information and allocates 16 to 256 bits per node. Maximum of 64 IN Slave (Word IN 1024 bit max) and 64 OUT Slave (Word OUT 1024 bit max) are allowed in a network. (128 Word Units in total.)

Bit Unit
Transmits bit ON and OFF information and allocates 2 to 4 bits per node. Maximum of 128 Bit IN Slave and 128 Bit OUT Slave (Bit OUT 256 bit max) are allowed in a network. (256 Bit Units in total.)

OSI model

CompoNet is a field network that follows the Open System Interconnection (OSI) model. As with all CIP Networks, CompoNet implements CIP at the Session layer and above.





Technical Details

To realize

Strong Physical layer and

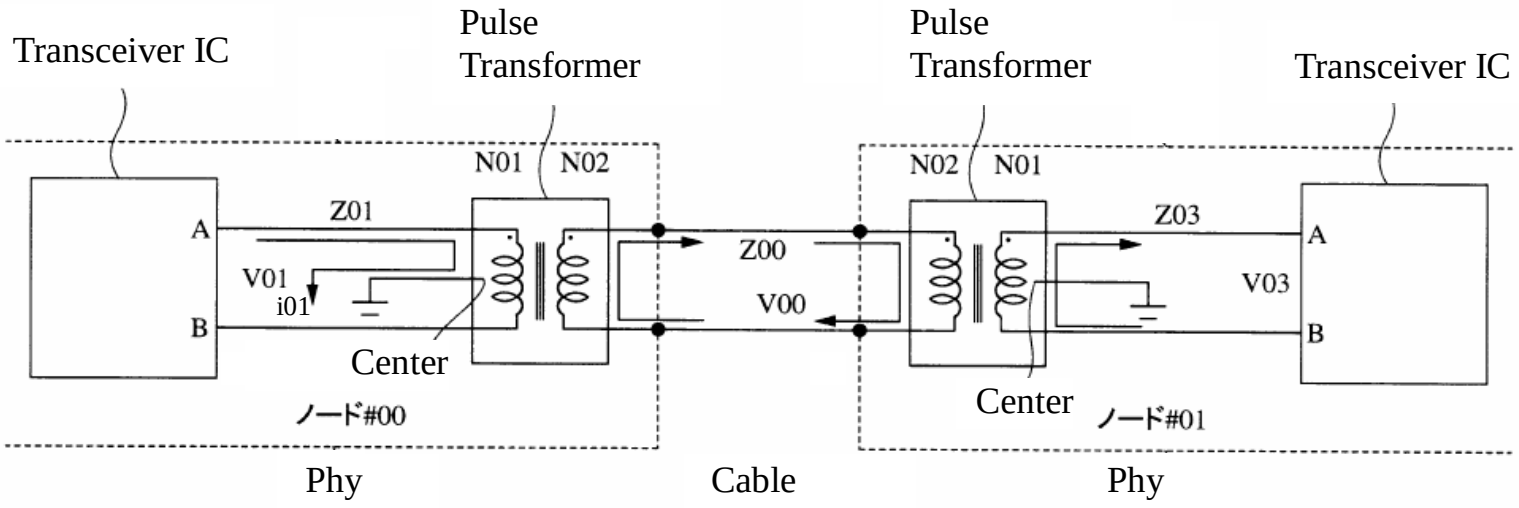
Efficient Data Link layer of high serviceability

Pulse transformer and Manchester code

Circuit that used Pulse transformers extend transmission distance.

- Ground the midpoints on pulse transformer windings near transceiver.
- Number of turns of one side and the other side in the pulse transformer is assumed to be N01 and N02. Nominal conversion ratio at transmission: N02 / (N01 / 2). Output voltage (V00) is greater.
- Input ratio is even. Bigger output extends transmission distance.

Manchester coding prevents energy storage due to pulse transformer.

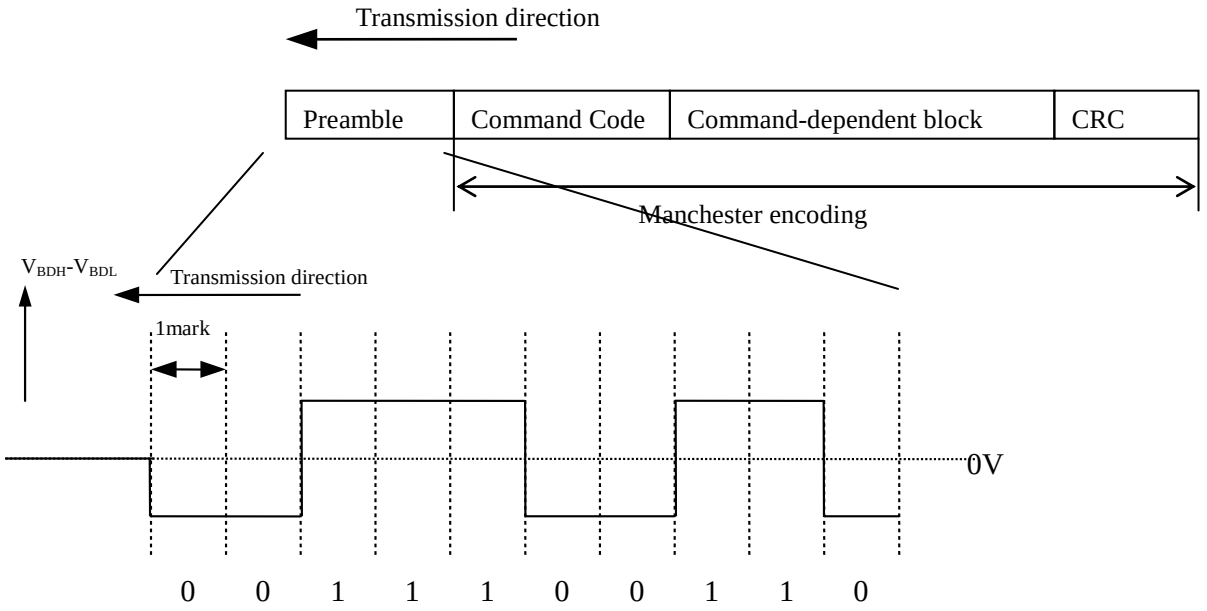


Arrow indicates the direction of electric current flow.

Preamble(1)

- High-speed response: Transmission with no gaps between frames (No idle time on the communication line)
- Various topologies: Data array that minimizes signal degradation can prevent wiring efficiency.

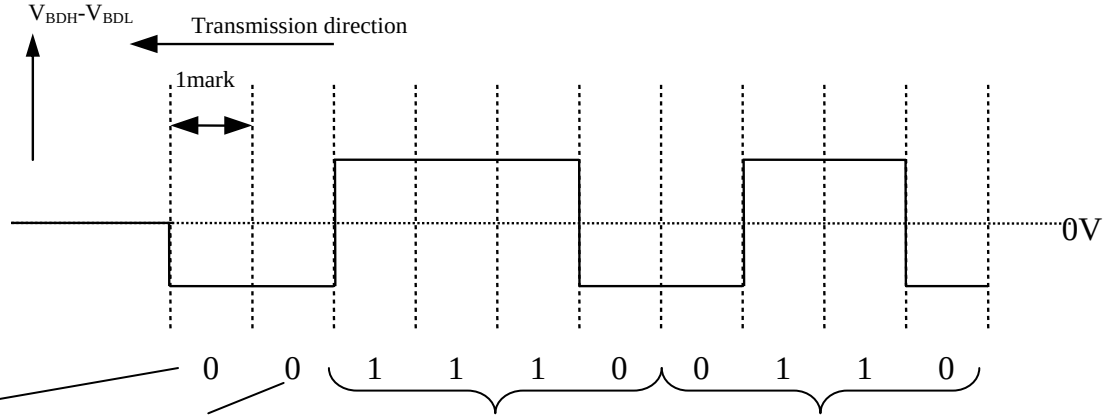
CompoNet Frame block And Preamble Waveform on Transmitting Line



Preamble (2)

Preamble data array and Improvement of waveform

Preamble Waveform on Transmitting Line



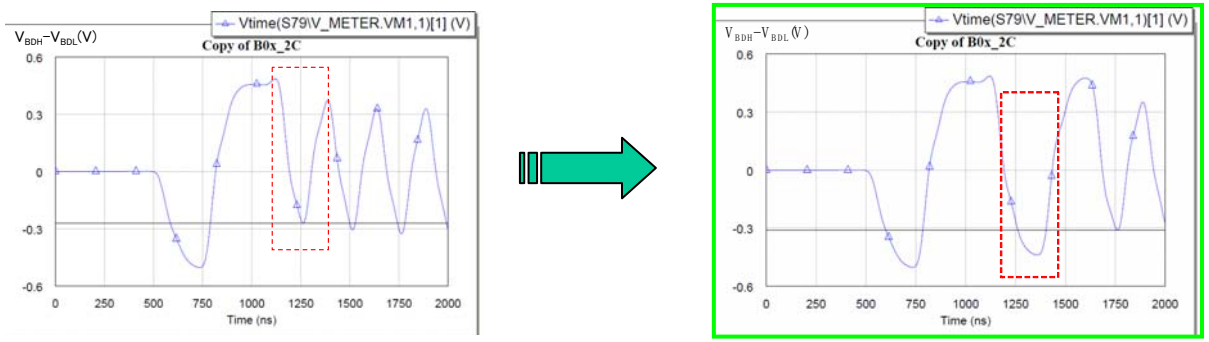
To cancel noise caused by previous frame

Reversed logic to surely recognize “111”.

To distinguish it is the frame.

To prevent affect by reflection. Make 0 and 1 output ratio in 50% each.

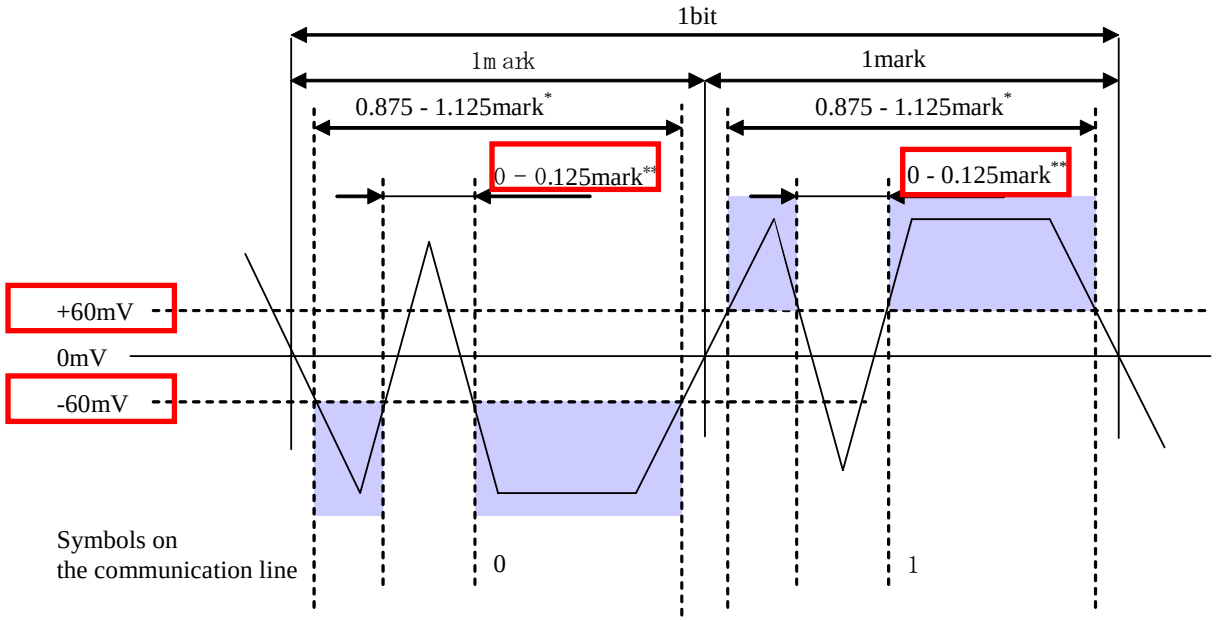
Effect of having an extra “0”; “001110” and ”0011100110”



Receive Mask (1)

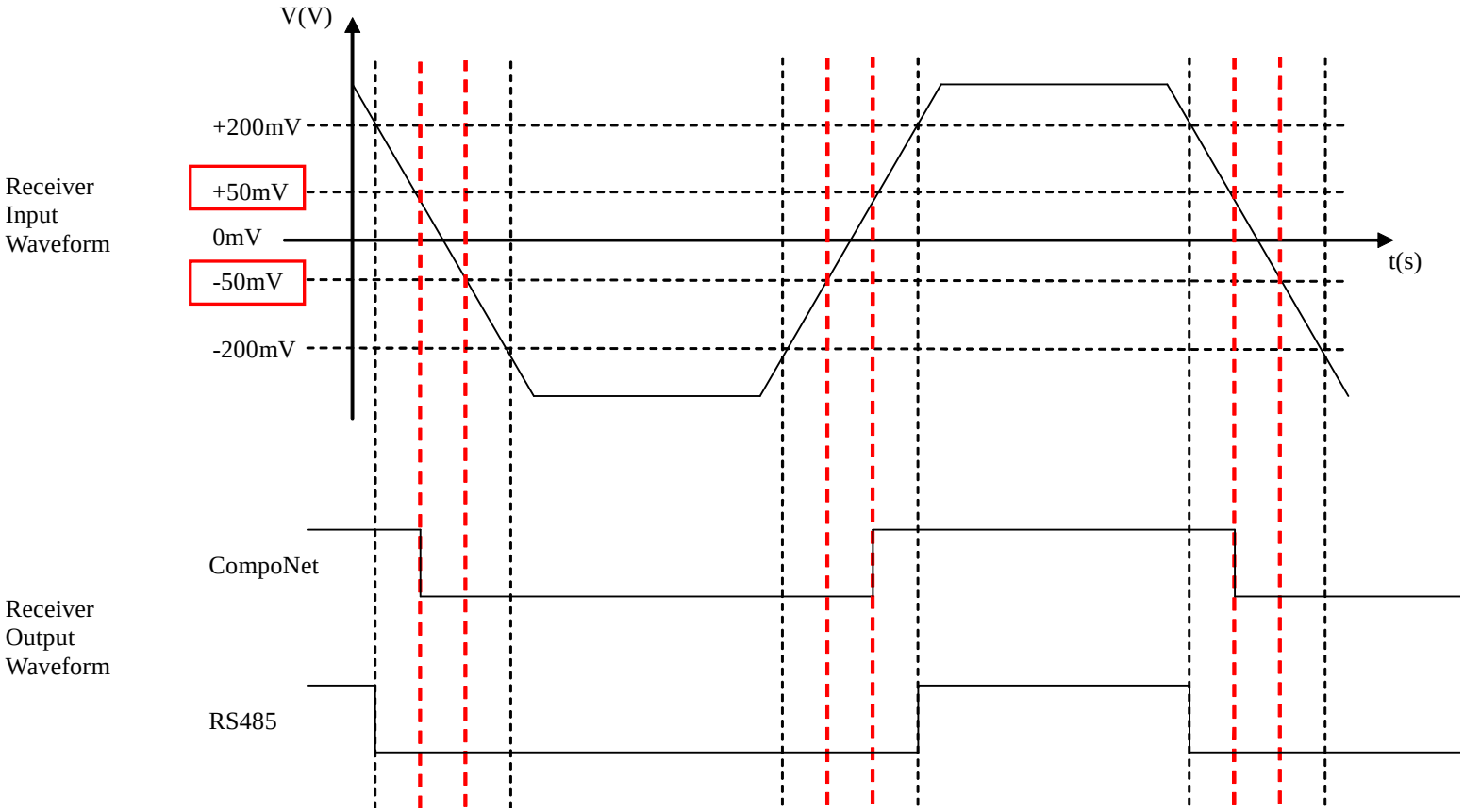
- Available unshielded cables with various electrical characteristics.
- Enables branches and high speed transmission at 3Mbit/s and 1.5Mbit/s

Receive Mask3



Receive Mask(2)

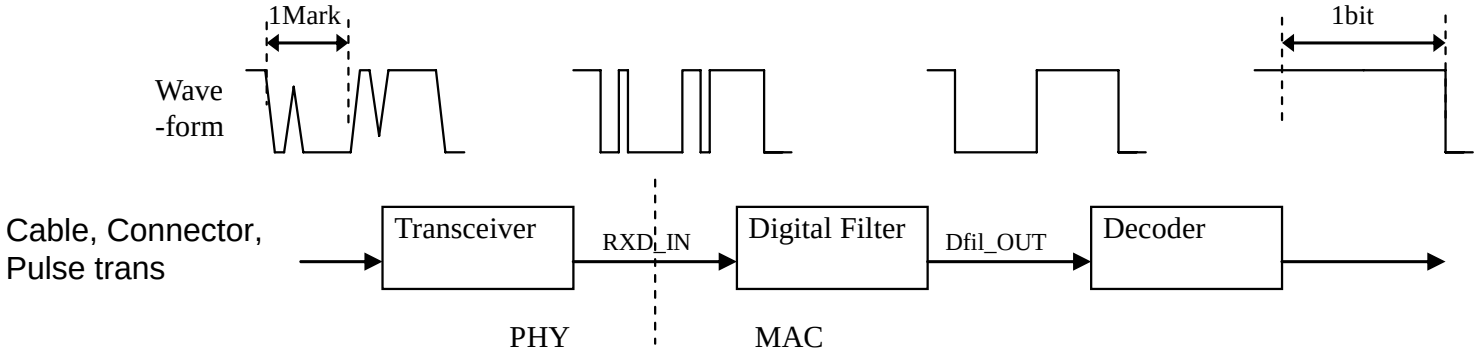
- Minimizes input threshold voltage. As a result, it can receive attenuated small waveforms and distorted waveforms.



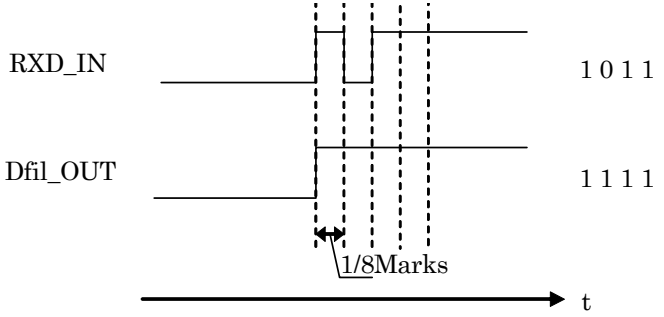
Receive Mask(3)

- MAC circuit to realize branches with high speed transmission

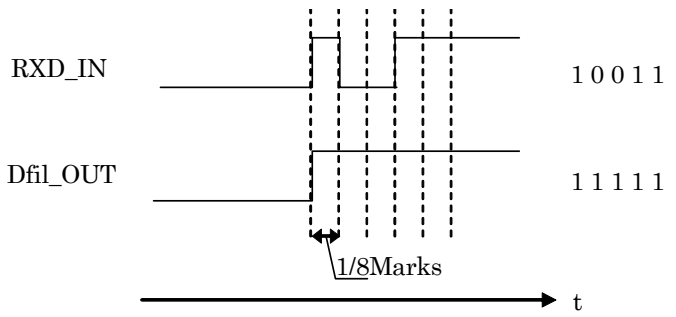
Receiving circuit blocks and waveforms



Reforming of waveform with 1/8 of a mark inverted



Reforming of waveform with 2/8 of a mark inverted

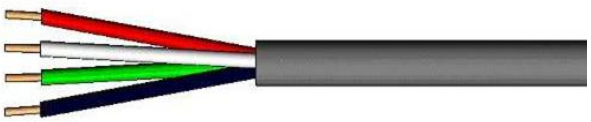


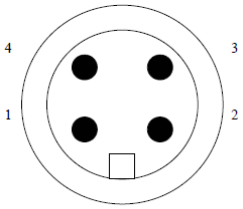
Cable and Connectors (1)

Available Cables or Connectors

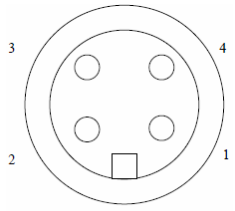
Round I

Round II





Plug(pins)



Jack(socket)

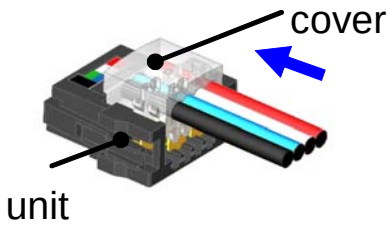
Flat I
(Same cable as
DeviceNet Flat II)

Flat II

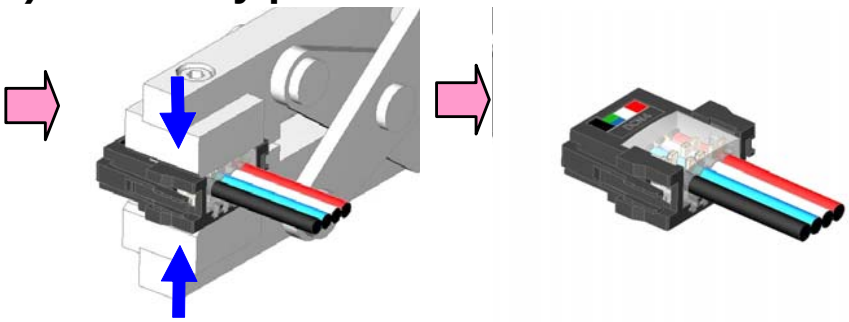
Cable and Connectors (2)

Saving wiring effort of communication cables

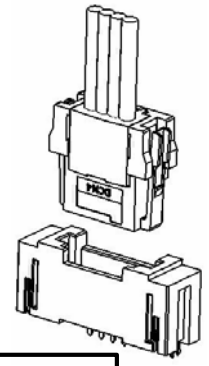
1) Insert a cable and fix it.



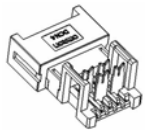
2) Weld it by pressure tool.



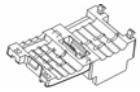
3) Connect to a node.



unit



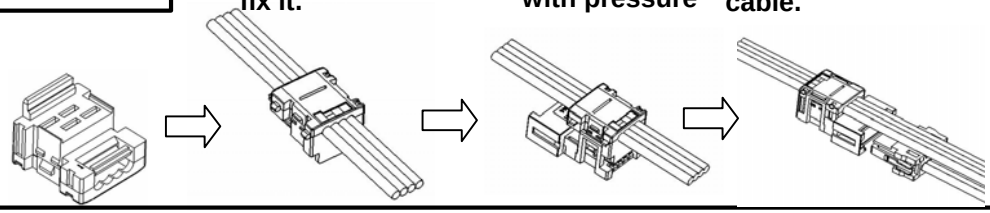
cover



For Branching

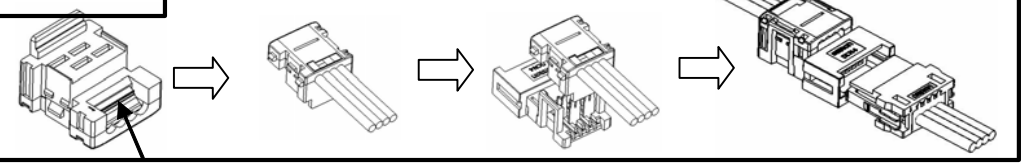
Insert a cable and fix it. **Weld the unit with pressure** **Connect to the other cable.**

cover



For Extension

cover

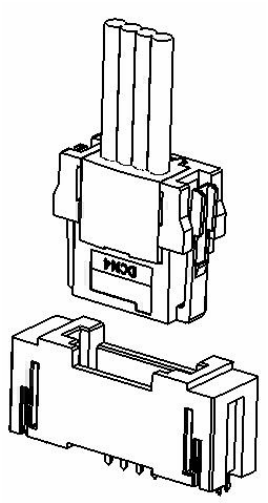


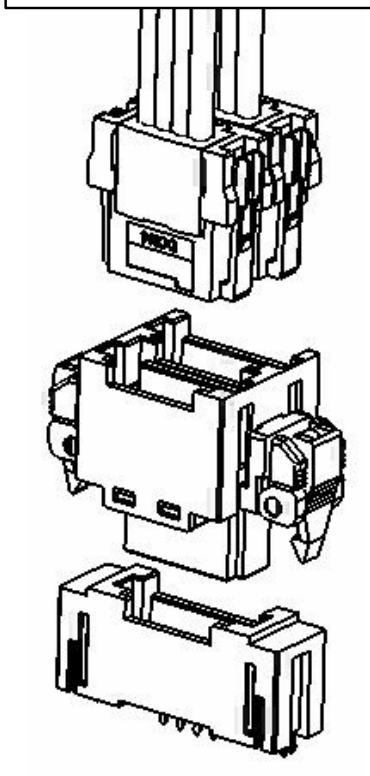
Cable Stopper
For extension, press a cable stopper with fingers, and keep pressing it until you hear a sound that indicates locking is completed, and **fixation** is **firm**.
This operation is not necessary for branching.

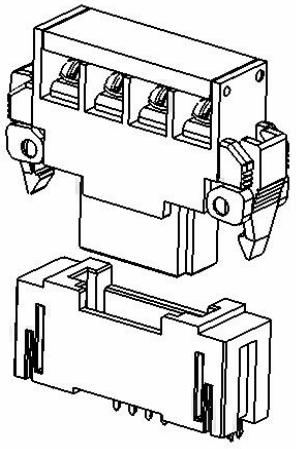
Cable and Connectors (3)

Various wiring methods and cable supports

Flat cable connection	Multi-drop connection of flat cables	Multi conductor round cable



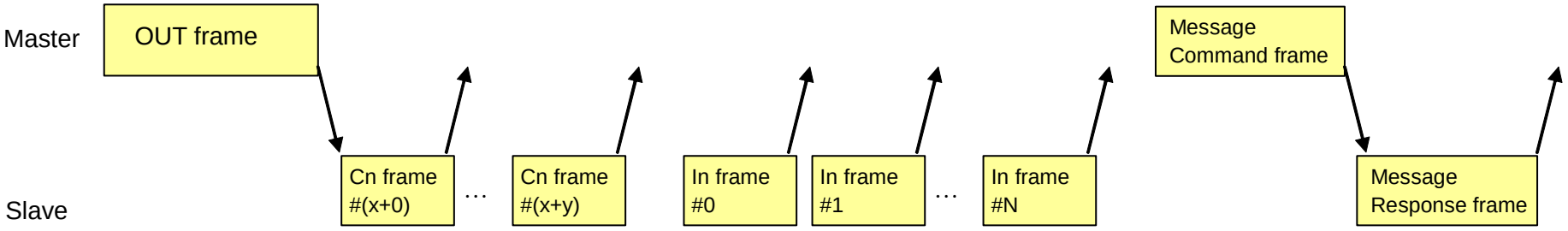




TDMA

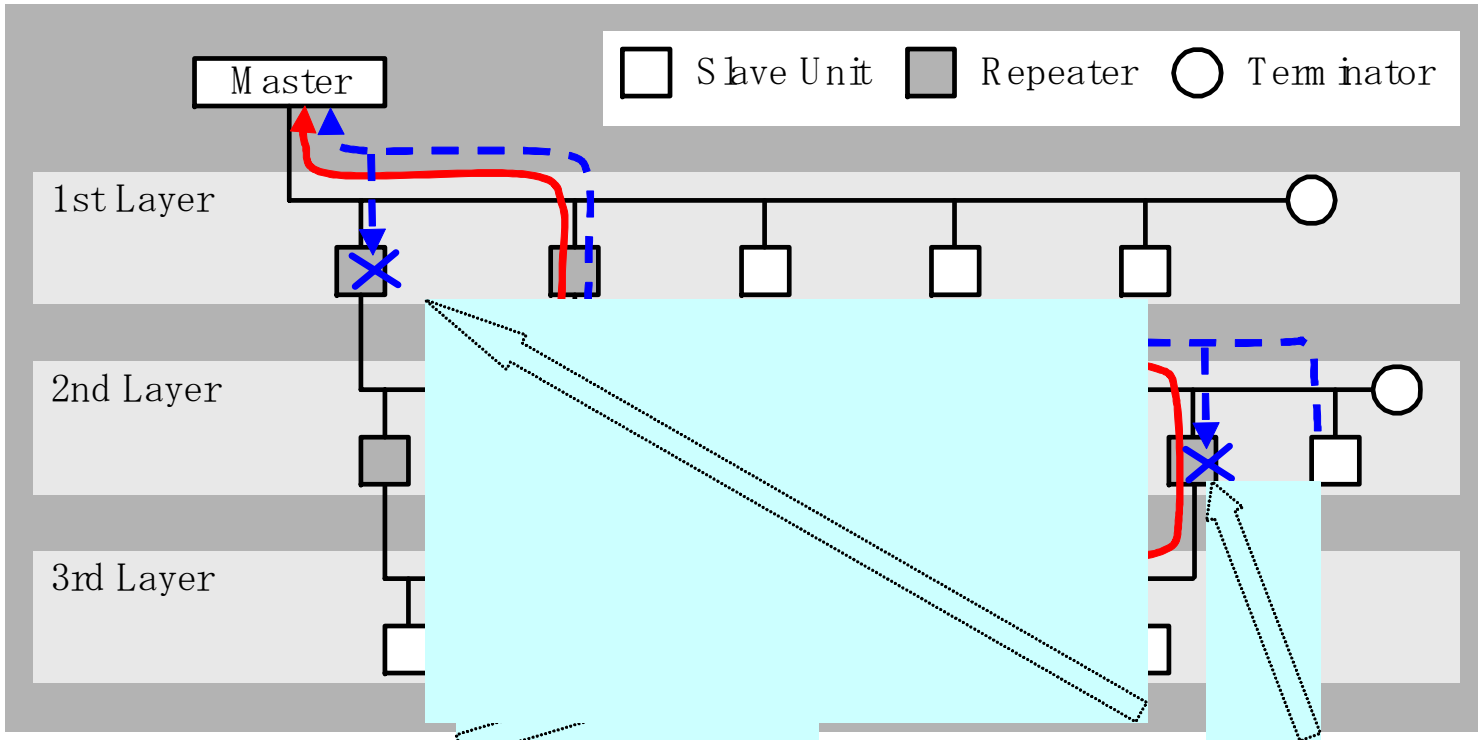
Highly efficient communication protocol

- CompoNet uses Time Domain Multiple Access (TDMA) technology.
- TDMA controls transmission and receiving of frame data.
- Multiple slaves and repeaters send back CN and IN_Frame based on one frame.
- A master controls communication and avoids frame collision



High Speed Repeater(1)

- High-speed response: Minimized response delay due to repeater connection.
- Various topologies available: Expanded installation field and the number of connectable nodes, and allowed mixed use of different cables.



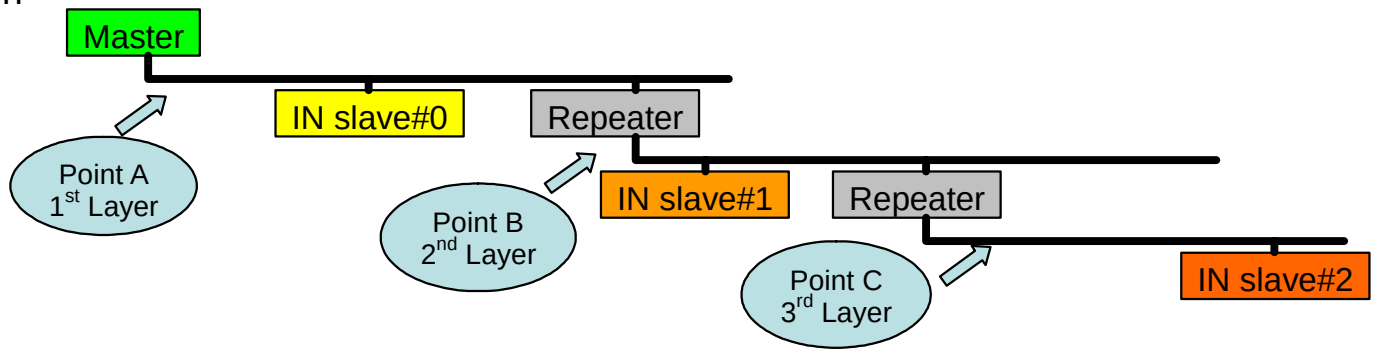
Slave's data is transmitted **slightly** earlier considering the network hierarchy.

Slave's transmission data is not repeated from the upper layer to the lower layer.

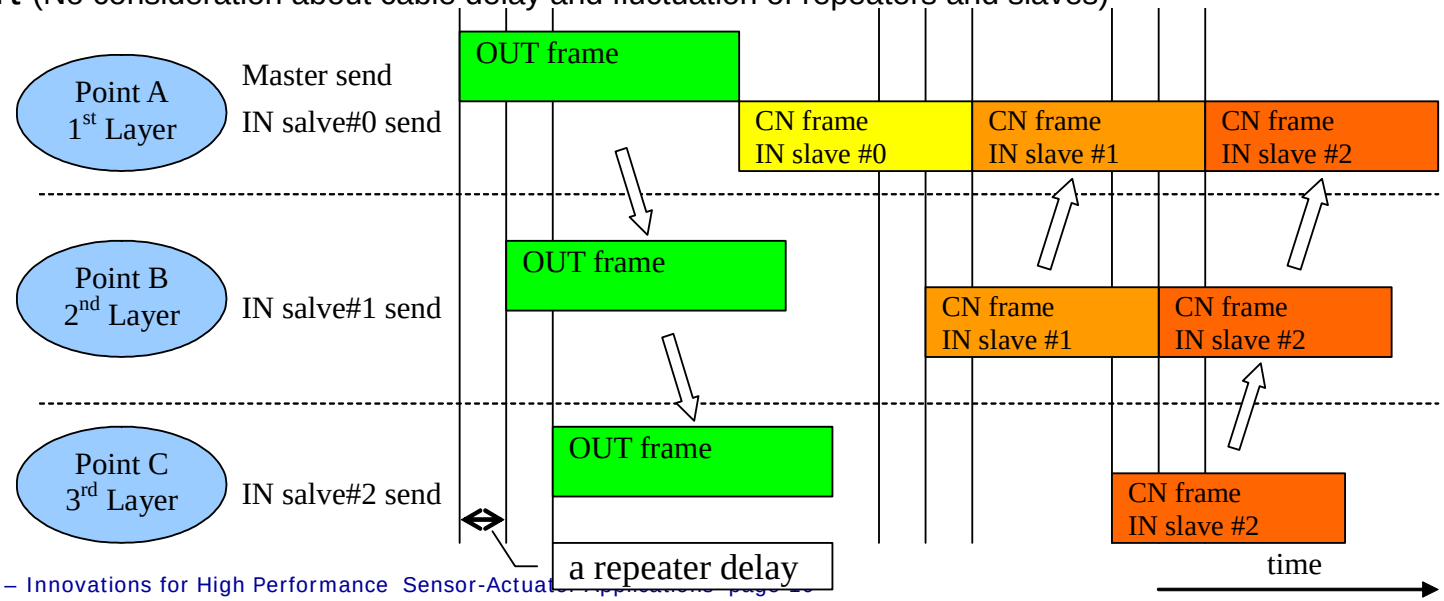
High Speed Repeater (2)

TDMA minimized delay time in repeaters.

Configuration



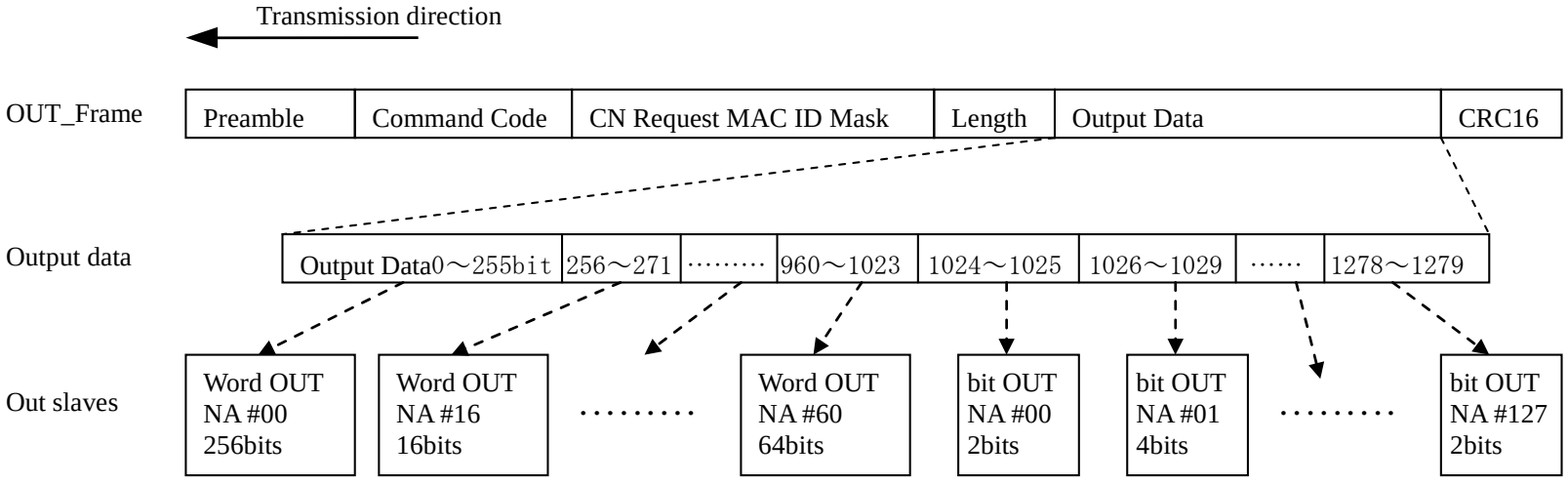
Timing chart (No consideration about cable delay and fluctuation of repeaters and slaves)



Highly efficient frames

- CompoNet has OUT, TRG, BEACON, CN, IN, A_EVENT, B_EVENT frames.
- OUT frames transmit data in multicast to improve transmission efficiency from masters and slaves.
- OUT and IN frames can change length according to their data length. A_EVENT and B_EVENT frames can the same.

Relationship between OUT_Frame and OUT Slave data acquisition



Highly serviceable Protocol (1)

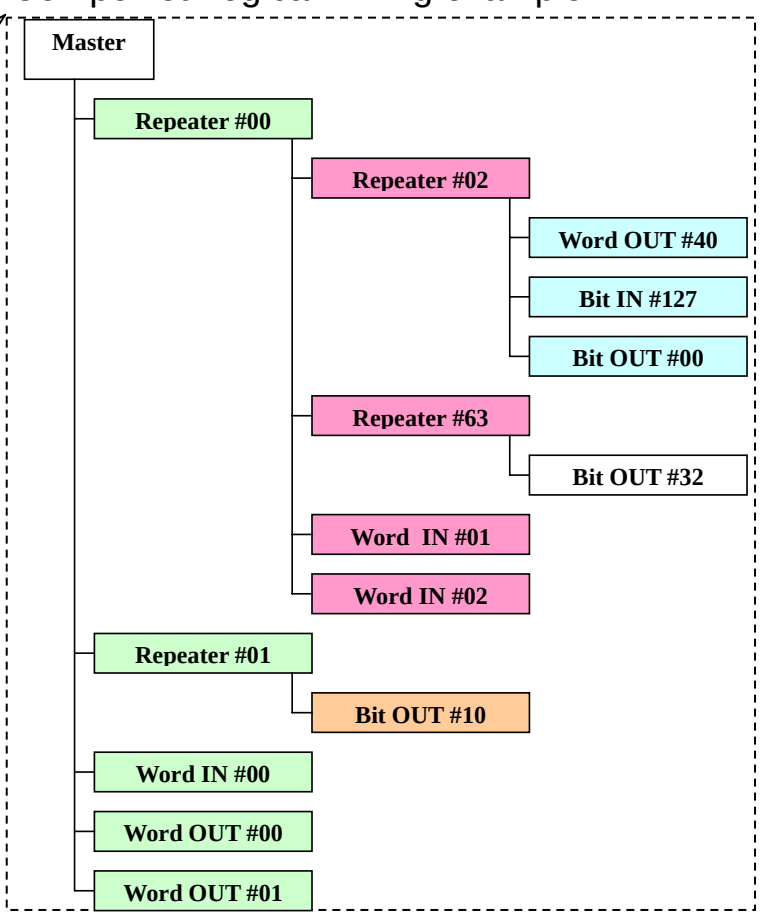
Simplified start-up and maintenance improve time efficiency.

- Configuration control per segment:
  - Beacon and STR frames
  - Network management by the master
- Node alarming by slaves and repeaters:
  - Warning or alarming bit is provided in CN frames.
- Auto baud rate detection:
  - Data rate notification bit is provided in Beacon frames.
- Duplicated address detection:
  - Management of non-participated or participated status
  - CN frames
  - STW

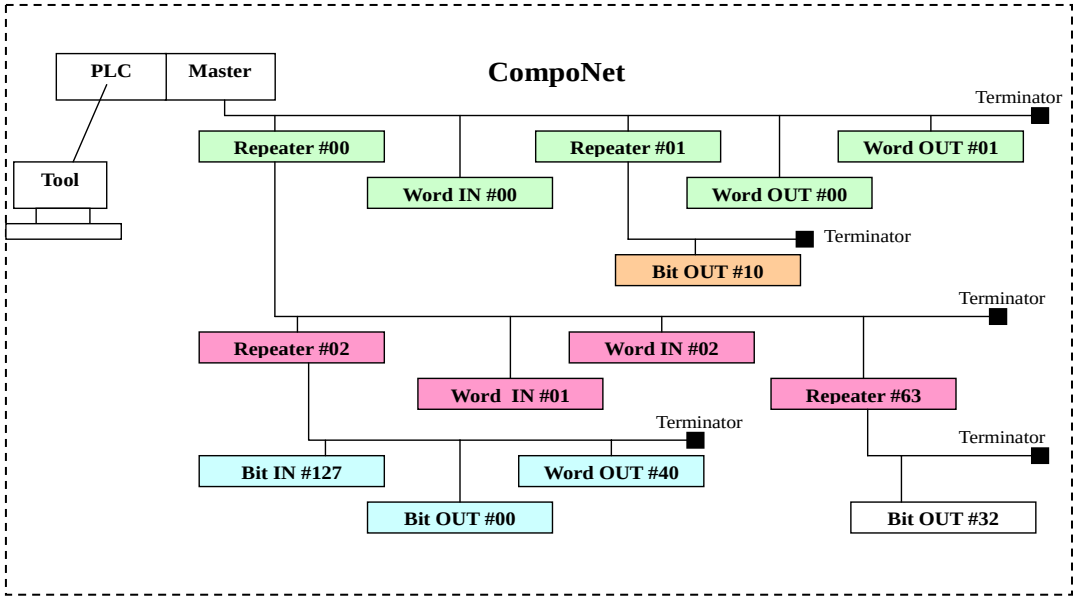
Highly serviceable Protocol (2)

- Master controls the network configuration per segment.
- With Beacon and STR frames, Master gets information about segment configuration and hold it.
- By using configuration tool, the data is quickly retrievable even through PLC and other CIP network.

CompoNet Logical Wiring example

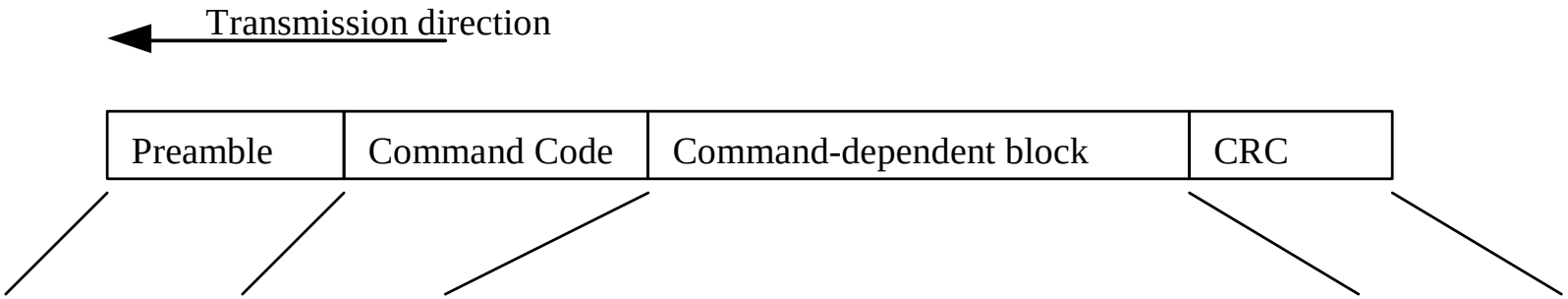


CompoNet Actual Wiring



Highly serviceable Protocol (3)

Beacon Frame

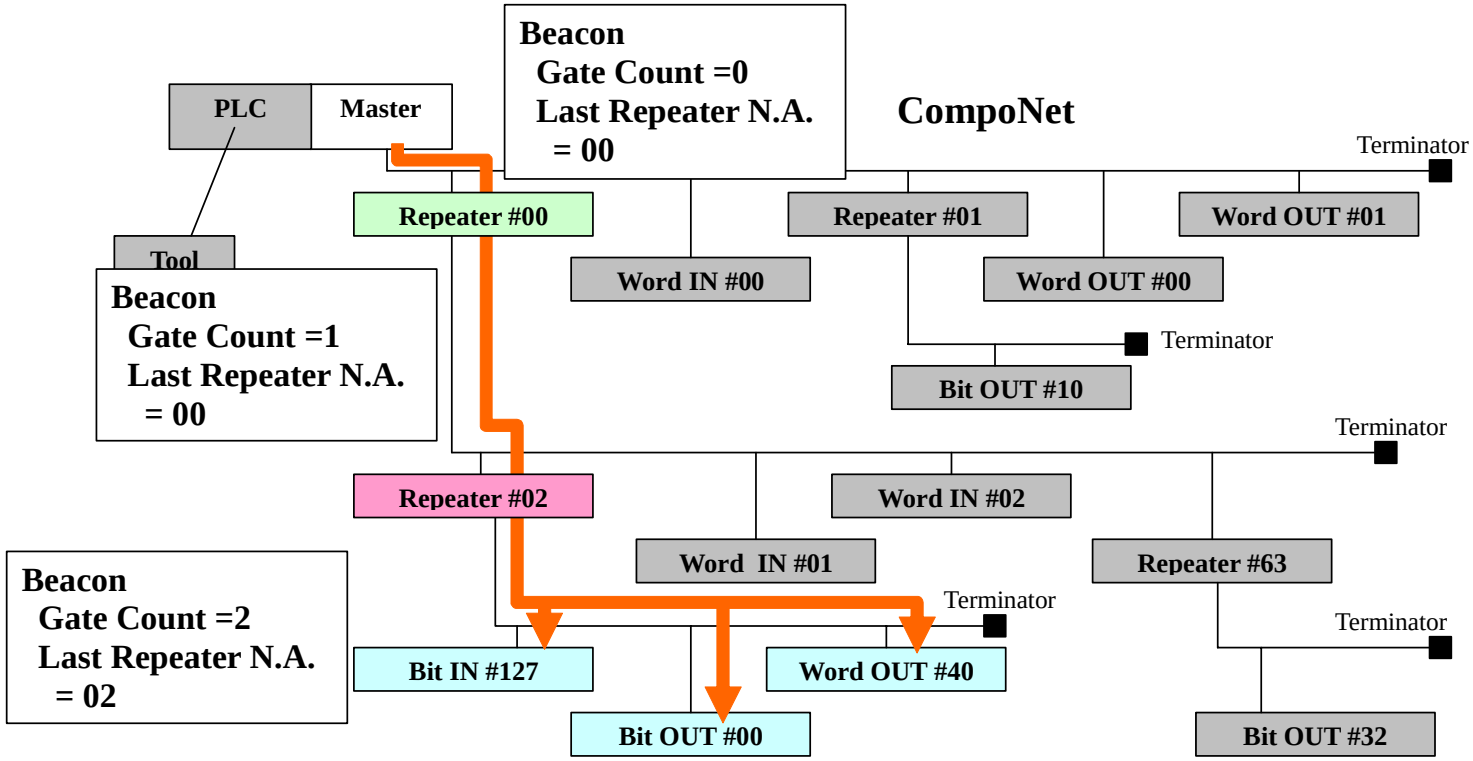


Preamble	Command Code	Control Code	Speed Code	**Last Repeater Node Address**	**Gate Counter**	CRC8
5Bits	5 Bits (00001)	2 Bits	3 Bits	6 Bits	2 Bits	8 Bits

Command Code	BEACON frame
Control Code	The number of permissible CN frames
Speed Code	Transmission speed
Last Repeater Node Address	Address of the last repeater that the frame passed through
Gate Count	The number of repeaters that the frame passed through

Highly serviceable Protocol (4)

- A master transmits Beacon_Frame.
- Gate Count and Last Repeater Node Address in the Beacon_Frame are overwritten as the frame run through a repeater.
- Beacons let the slaves and repeaters know on which layer they are connected. Slaves save the Gate Count and the Last Repeater Node Address.



Slaves and Repeaters receive and hold the Gate Count value and the Last Repeater Node Address.

Highly serviceable Protocol(5)

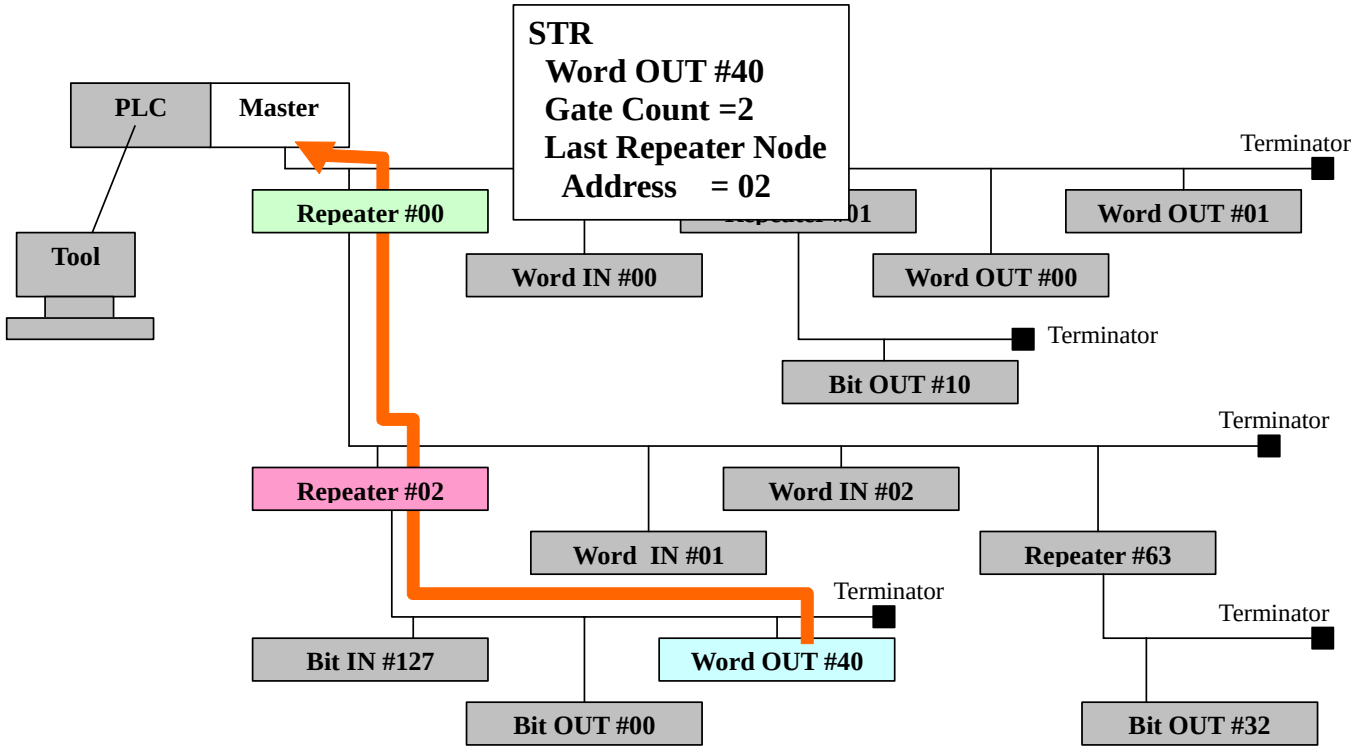
- STR is a part of B_EVENT, and used for special purpose.
- STR stands for STatus Read, and means that ”master can conduct a STatus Read operation to get information from a slave or a repeater.”
- Information masters get from STR follows:

information includes:

- **VendorID:** **CompoNet vendor ID assigned by ODVA**
- **SerialNumber:** **Vendor-managed device-unique number**
- **RepeaterMode:** **True/False to indicate whether it is a repeater or a slave.**
- **InIoModeStatus:** **Status and length of input data**
- **OutIoModeStatus:** **Status and length of output data**
- GateCount: **the number of repeaters between this node and the master.**
- LastRepeaterNodeAddress: **the last repeater address.**

Highly serviceable Protocol(6)

- When requested by the master, a slave or repeater write the gate count and the last repeater node address onto the STR, and send it to the master.
- The STR notifies the master of which layer the requested slave is connected and of under which repeater it locates.



Slaves and Repeaters receive and hold the Gate Count # and the Last Repeater Address.

Conclusion

- To the future

Conclusion

CompoNet is expected to be used as standard network such as EtherNet/IP, DeviceNet in CIP family.