



## I POWERLINK Worksheet

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### 2 Research Questions for Discussions

#### 2.1 Real-Time Applications

- Why is real-time communication required in dynamic process control?
- Find a definition of the term 'real-time'. What's the difference between 'hard' and 'soft' real-time? What's the difference between 'jitter' and 'latency'?
- Besides real-time capabilities, what other properties are required for industrial networks?
- Think of a practical example for each of the real-time classes from your field of expertise.

#### 2.2 Real-Time Industrial Ethernet

- What are advantages and disadvantages of the three real-time Ethernet implementation methods depending on the ISO/OSI layers?
- Standard (IT) Ethernet uses a mechanism called 'CSMA/CD' on a shared medium: argue why this approach is not valid for real-time communication.
- Compute the theoretical travel time of a standard Ethernet frame in a 100 Mbit/s network according to IEEE 802.3; use the smallest possible frame with 64 Byte as well as the biggest possible frame with 1526 Byte.

#### 2.3 Protocol Architecture

In order to achieve collision-free communication, either single/individual-frame (broadcast) or sum-frame (round-trip) protocols are used. Discuss their potential in following terms:

- Cross-communication for distributed intelligence, e.g. for motion control or safety applications;
- Asynchronous traffic, e.g. for heavy data traffic such as vision data;
- Hot-plugging capabilities, i.e., adding and removing components on-the-fly;
- EMC susceptibility, i.e., what happens if a single frame is destroyed or lost during operation;
- Network components, i.e., are there any special devices required?

#### 2.4 User Organizations and Intellectual Property

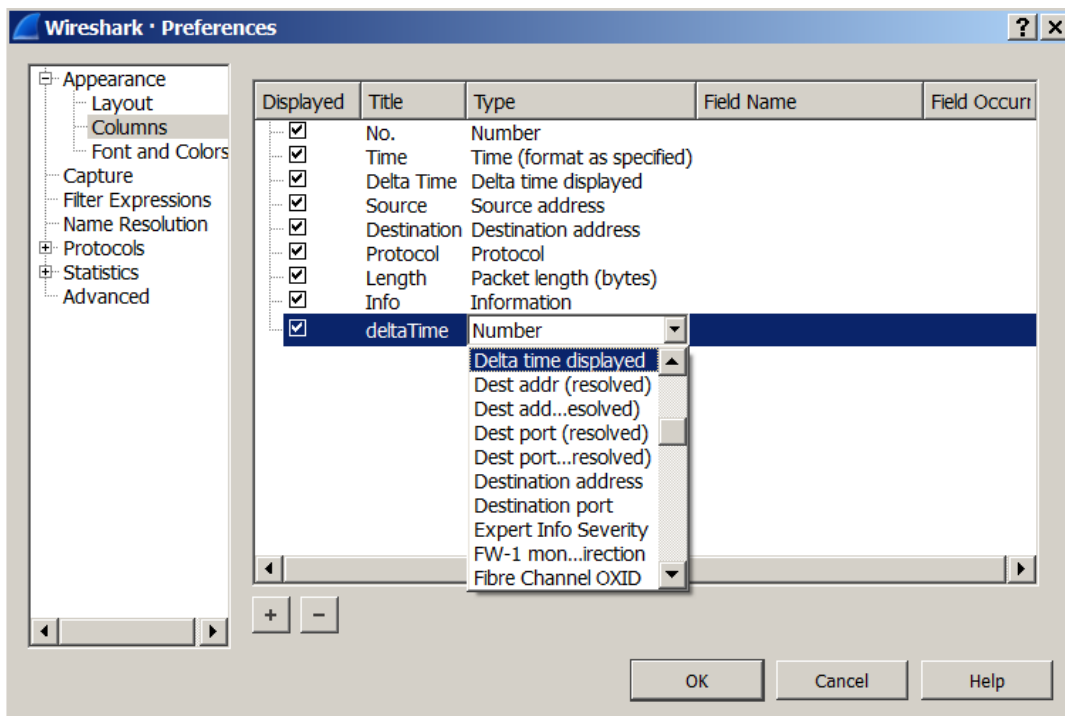
- Why do you think it is important that communication technologies belong to an independent community and not a single company?
- Why is advantageous for the customer to have an open source, patent-free implementation of a protocol stack available? However, which measures must be taken to ensure compatibility with existing solutions?
- Which factors do you have to consider in order to estimate an industrial interface's total cost of ownership?



### 3 Practical Exercises

Use the Wireshark tool and the sample trace provided by the Wireshark wiki (see references). Note: if you want to do actual measures you have to deactivate all protocols on your network adaptor!

- A. Analyze an SoC frame: what's the source and what's the destination?
- B. Find the HEX code which identifies a frame as a POWERLINK package.
- C. Determine the CN's address and its hardware type.
- D. Analyze a full POWERLINK cycle by writing down the communication frames between the MN and the CNs, also take a screenshot.
- E. Only show SoC frames using filtering rules. Use "Edit > Preferences" to add a new column for "Delta time displayed" (see screenshot). Export the data using "File > Export Packet Dissections > As CSV..." and analyze the column to determine the cycle time (mean value) and jitter (standard deviation).



### 4 References

B&R Industrial Automation	<a href="http://www.br-automation.com/">http://www.br-automation.com/</a>
Ethernet POWERLINK Standardization Group (EPSC) > POWERLINK Communication Profile Specification > Industrial Ethernet Facts	<a href="http://www.ethernet-powerlink.org/">http://www.ethernet-powerlink.org/</a> > Downloads > Technical Documents > Downloads > Industrial Ethernet Facts
openPOWERLINK protocol stack > documentation > demo (3 PCs: 1 MN, 1 CN, 1 analyzer and 1 hub)	<a href="http://openpowerlink.sourceforge.net/">http://openpowerlink.sourceforge.net/</a> > openPOWERLINK > Documentation > openPOWERLINK > Download
ALTERA White Paper WP-01249-1.0: "Synchronizing Mechatronic Systems in Real Time Using FPGAs and Industrial Ethernet Communications"	<a href="https://www.altera.com/">https://www.altera.com/</a> > Search > 'POWERLINK'
Raspberry Pi 2 implementation tutorial	<a href="http://www.kalycito.com/index.php/references/119-how-to-powerlink-on-raspberry-pi-2">http://www.kalycito.com/index.php/references/119-how-to-powerlink-on-raspberry-pi-2</a>
Wireshark (network sniffer/analyzer tool)	<a href="https://www.wireshark.org/">https://www.wireshark.org/</a>
sample Wireshark traces	<a href="https://wiki.wireshark.org/SampleCaptures">https://wiki.wireshark.org/SampleCaptures</a> > 61. ETHERNET Powerlink v2