

Realtime Ethernet - an analysis of its potential -

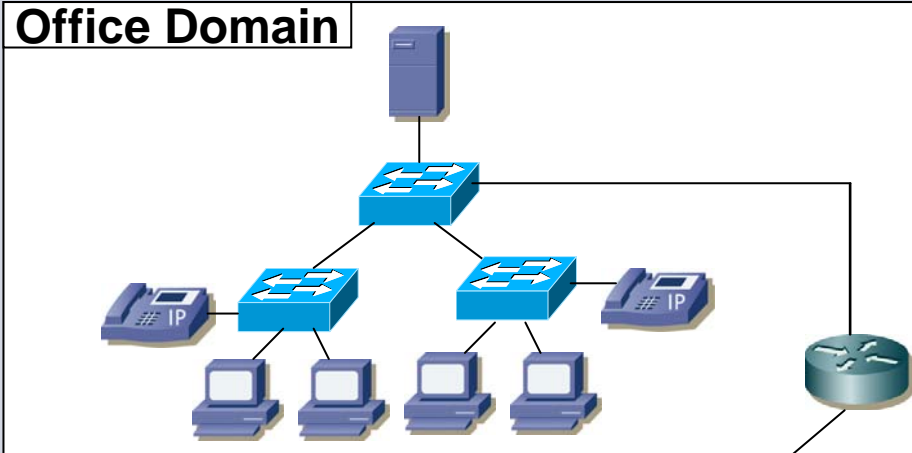
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Introduction

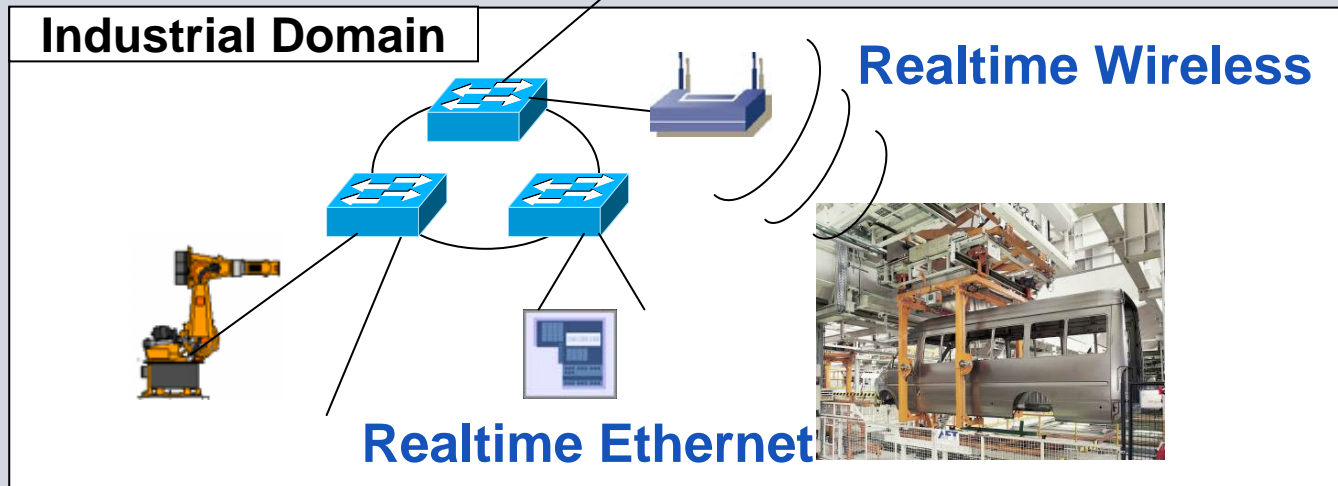
- Interim report on **analysis of potential** of the BMBF (German Federal Ministry of Education and Research) project „Real-Time Ethernet in the Sensor/Actor Networking (ESANA)“ FKZ 1742X06
 - **Performance** and simplicity
- Associated Partners:
 - Phoenix Contact, Blomberg
 - Siemens, Erlangen
 - MAZeT, Jena
 - TU Berlin
 - inIT –Institute Industrial IT, Lemgo
- Project Time Period: 10/2006 - 4/2008

Motivation

Office Domain

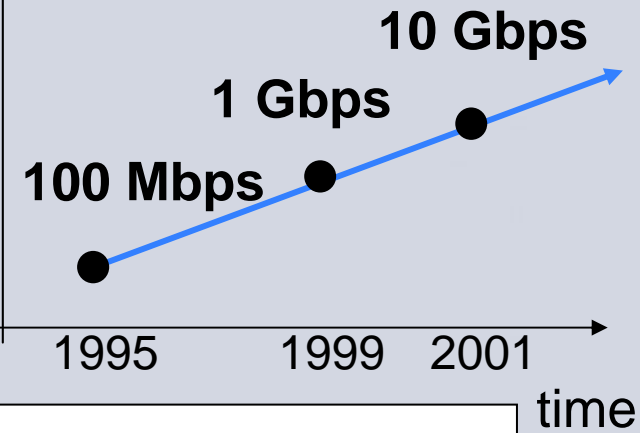


Industrial Domain

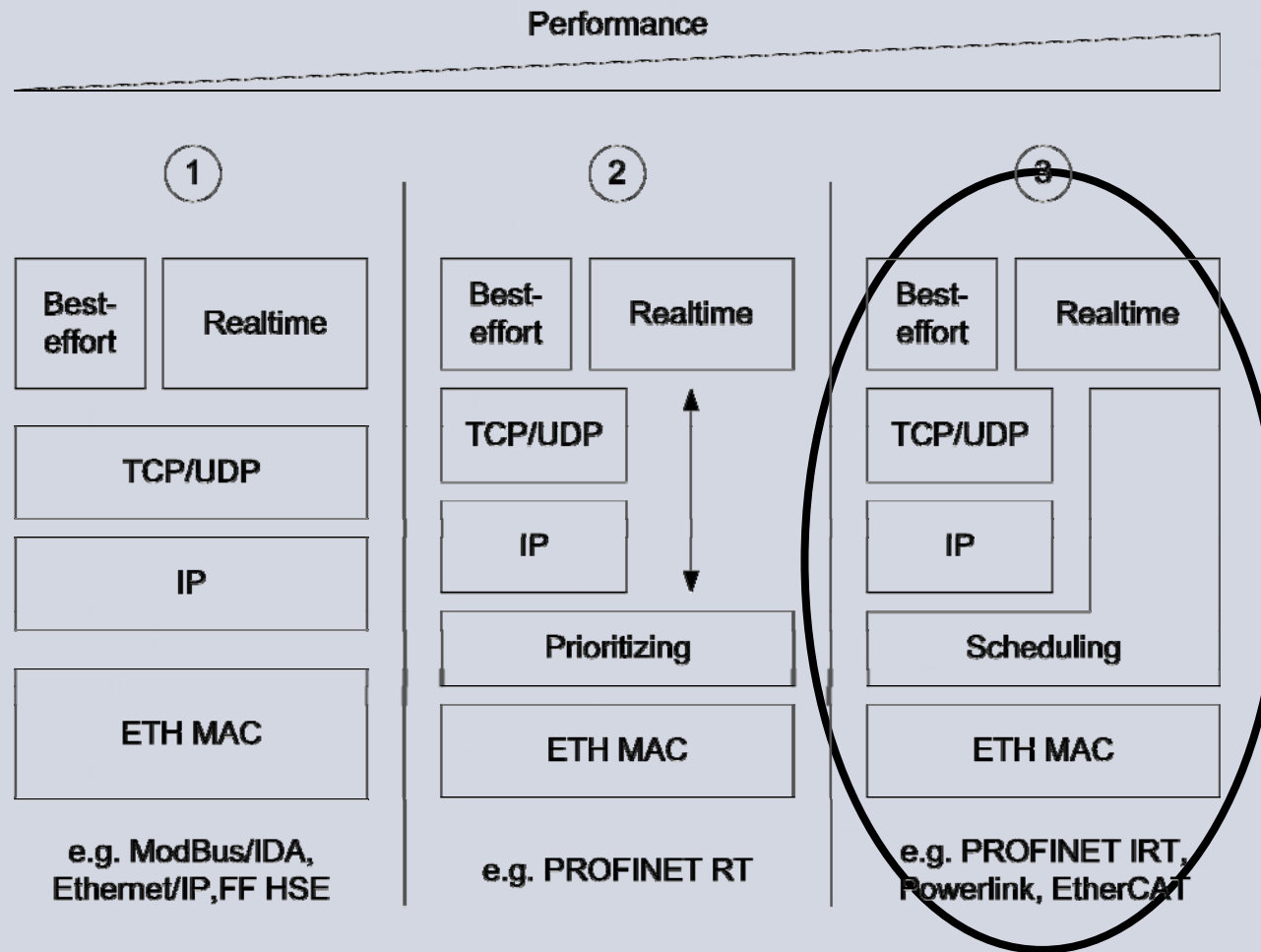


bit rate ↑

IEEE802.3 evolution

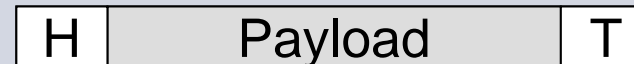


Taxonomy Realtime Ethernet (RTE)



Approaches for frame organisation

- **Summation frame**



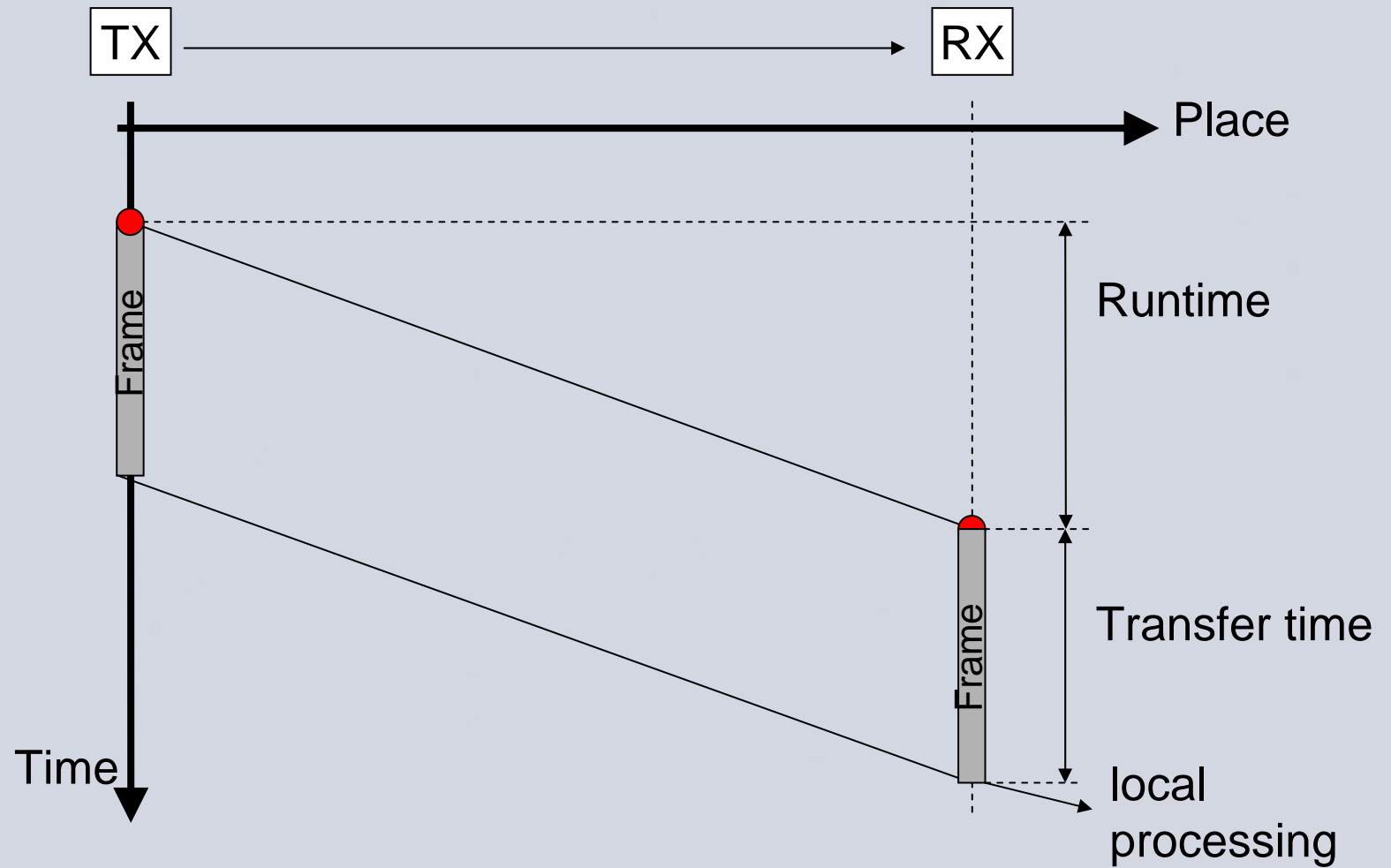
- In a line the most efficient method for nodes with a small payload
- Often used together with ring topology
- e.g. **EtherCAT**

- **Individual Frames**



- Address-based delivery (like IEEE802.3)
- Time Scheduling
- e.g. **PROFINET with IRT**

Factors influencing frame transfer

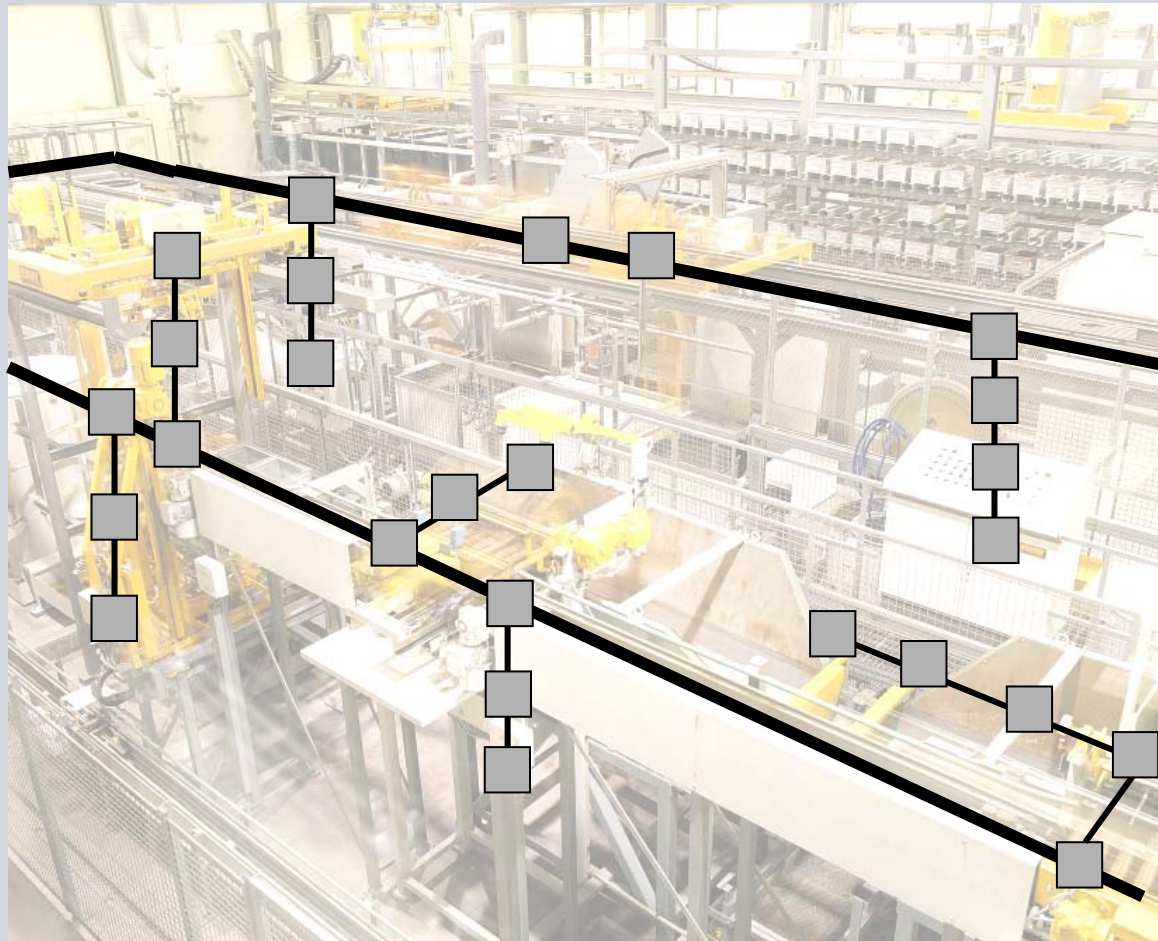


Real plants require flexible structures



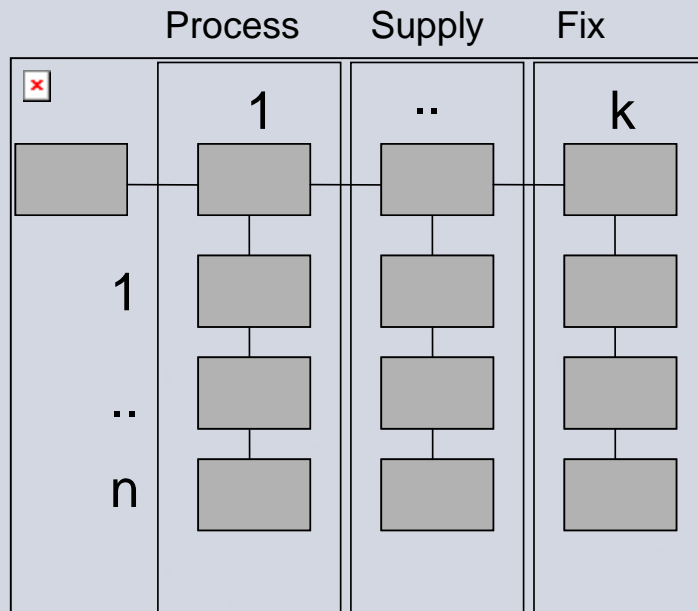
Example of a plant and the resulting network topology

Real plants require flexible structures



Example of a plant and the resulting network topology

.... often leading to lines with branches (= comb structure)



- Modularization
- Different requirements for update times of field devices involved
- Line redundancy

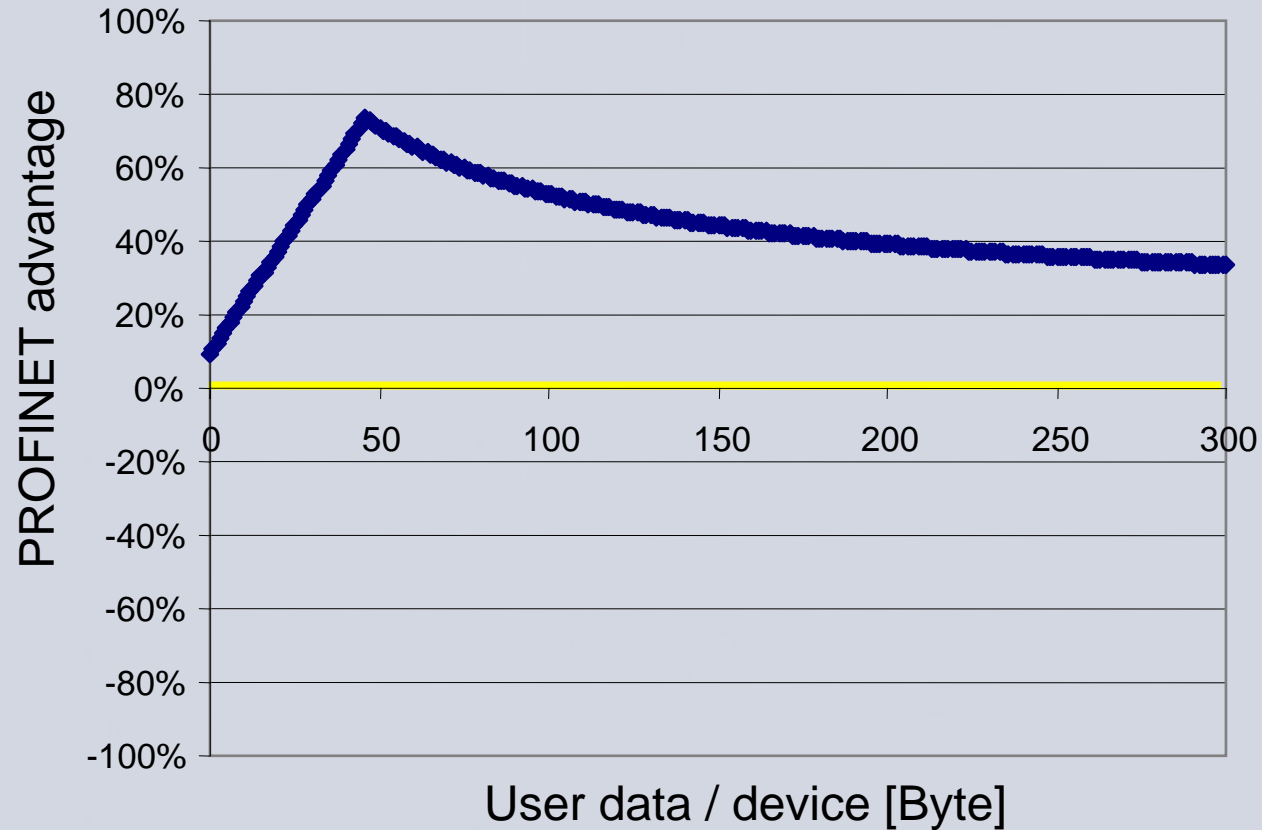
Comb structure scenario:

Main line with $k=8$ stations in every bus cycle

Plant components with $n=10$ users in every 8th cycle

Distance between users 50 metres in each case

Scenario: comb structure with 100 MBit/s



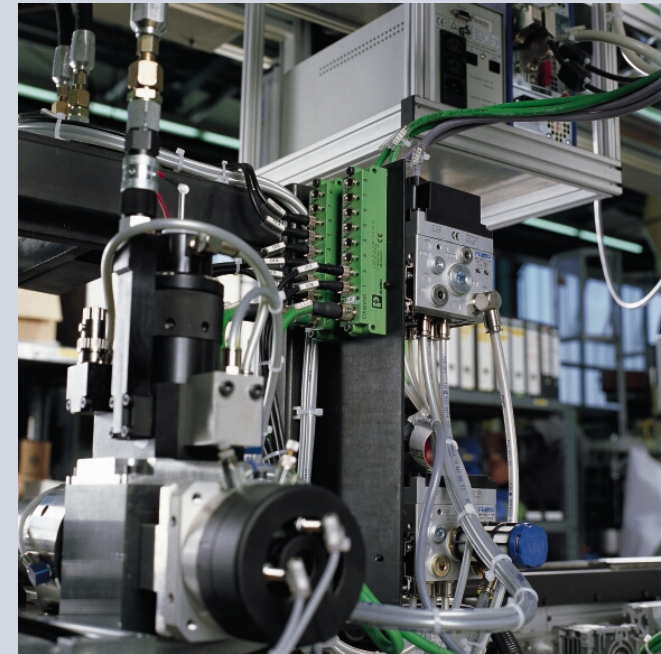
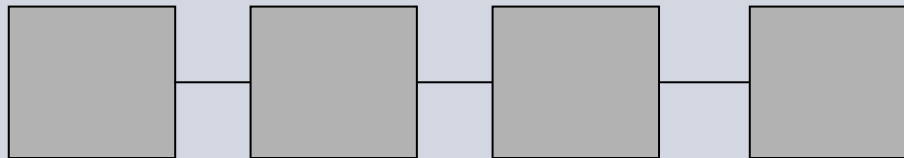
PROFINET advantage = cycle time_EtherCAT/cycle time_PROFINET IRT

1st Interim result

- Real plants often require flexible network topologies and different update times of the users involved.
- In such comb structures, PROFINET is superior.

What about the simple sensor/actor network?

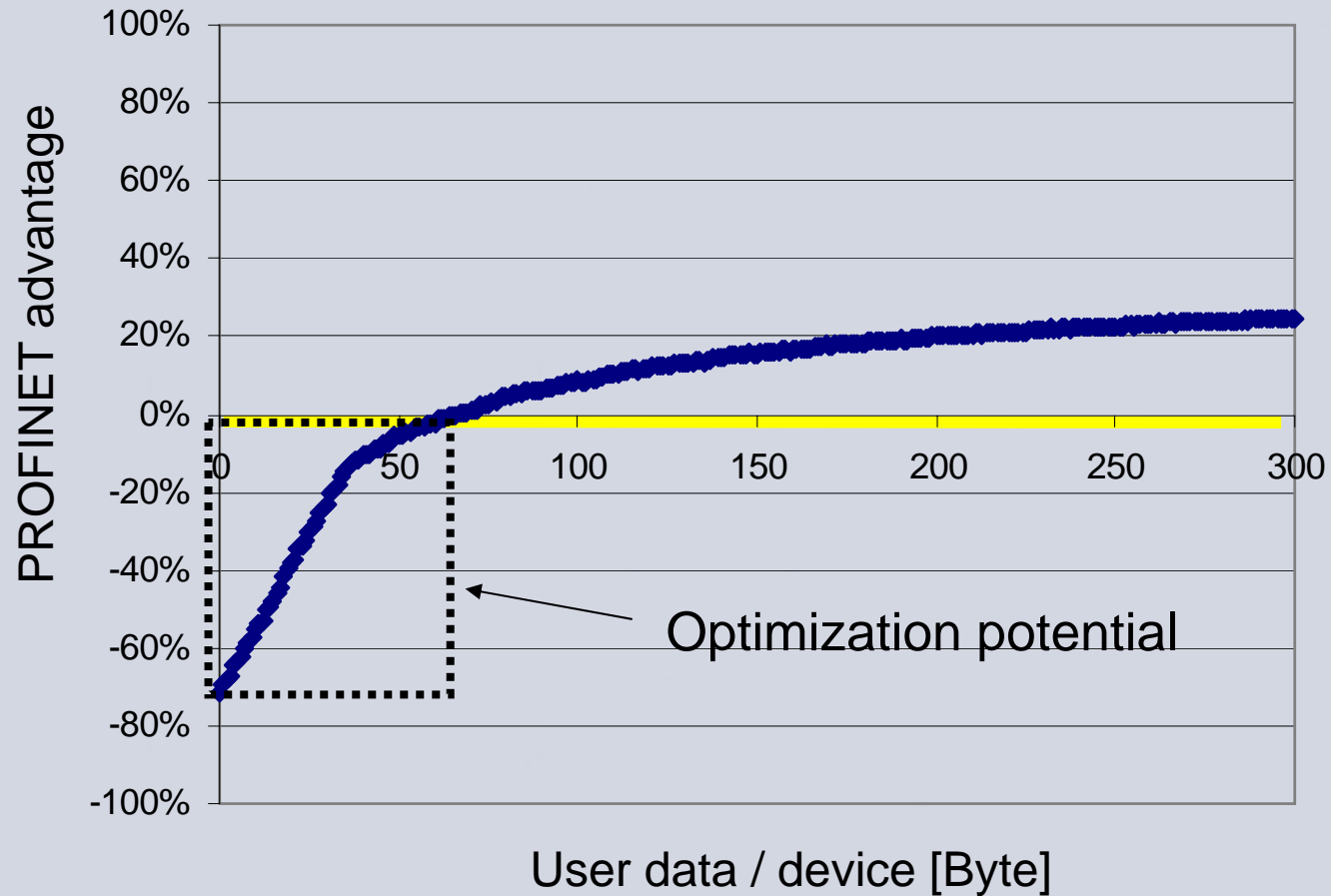
- Often simple linear structures (line)



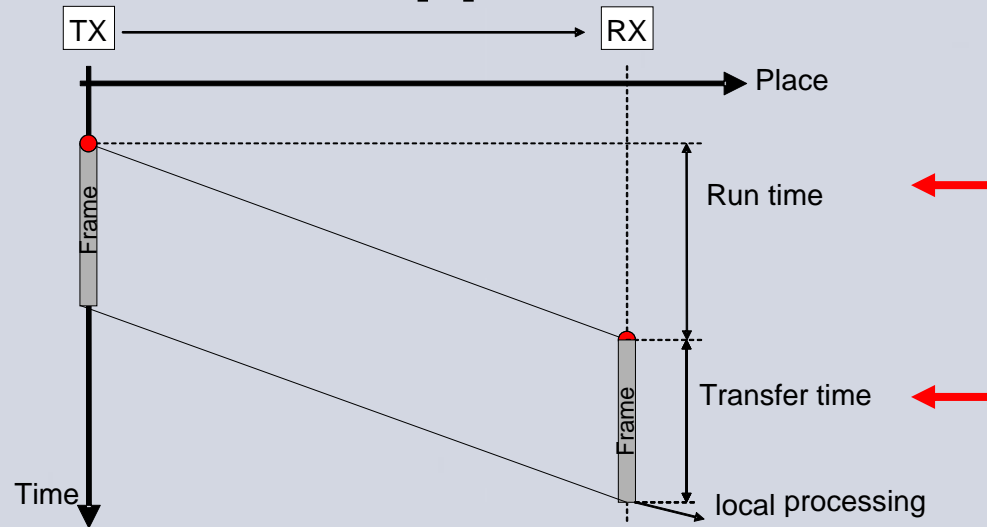
Linear structure scenario:

Line with 50 stations, each 50 metres apart from each other

Scenario: line structure with 100 MBit/s



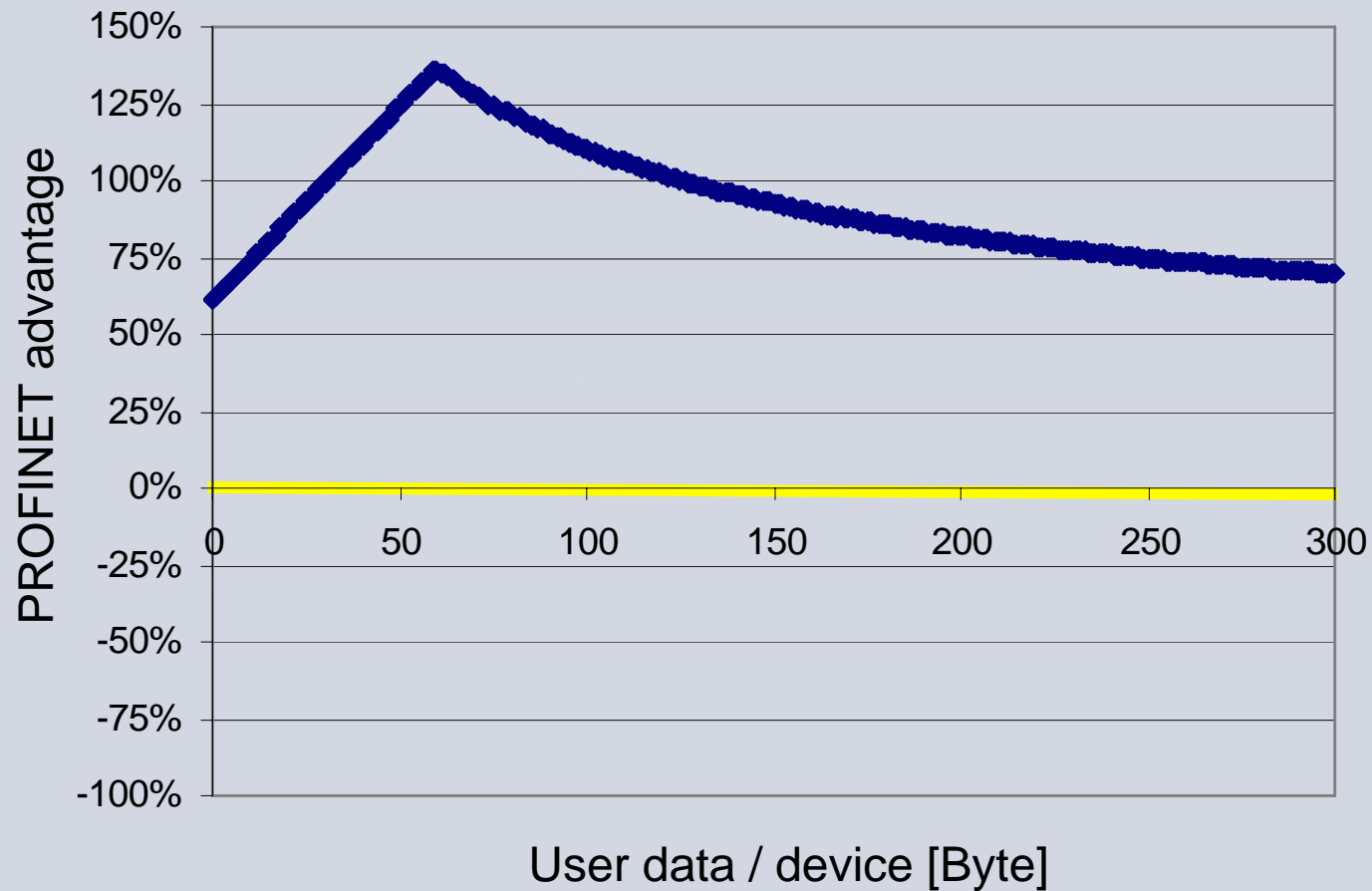
Optimization approaches



Approach: Both time elements have to be reduced

- Cut forwarding delay in the nodes
- Cut telegram overhead
- Use the slipstream effect

Safe choice for the future: linear structure with 1Gbit/s?

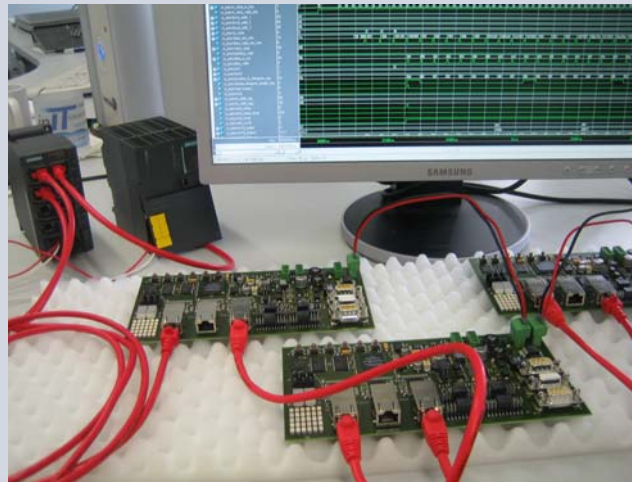


2nd Interim result

- PROFINET benefits from an increase of the bit rate to 1 GBit/s much more than, e.g., EtherCat
- There is room for optimization for PROFINET with 100 MBit/s and small payloads in linear structures
 - By targeted, compatible expansions, PROFINET can also transfer smaller payloads a lot more efficiently than with all other Realtime Ethernet approaches

What next?

- Currently possible compatible expansions are being specified and tested.
- As part of the project, a prototype is being planned for the 2008 Hanover Fair. The prototype will demonstrate the superiority of PROFINET even with smaller frames in the line.



Conclusions

- The performance of PROFINET for complex machine/plant structures is now much better than with any other methods.
- Based on targeted, compatible expansions of PROFINET, a broad field of applications can be supported, even the purely linear structure. This means PROFINET can scale up or down – from simple structures to complex systems.
- PROFINET reaps more benefits than other systems from the Ethernet evolution, making it a safe choice for the future.

More info ...

Limits of Increasing the Performance of Industrial Ethernet Protocols

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Abstract

The evolution of industrial communication inexorably moves to Industrial Ethernet networks. One important reason for using Ethernet at the shop floor is to participate on the continuous advancements of standard Ethernet. Thus it seems to be the logical next step to change the bit rate from Fast Ethernet to Gigabit Ethernet to achieve better performance. The question is, how the cycle time as a relevant performance metrics of industrial automation systems can profit from increasing the bit rate to 1 Gbps. Because of its importance for the industrial automation domain this paper focuses on line topology. The analysis is based on EtherCAT and PROFINET, which are two popular representatives of different architectures for high performance Industrial Ethernet networks.

1. Introduction

formance in realtime transfer. Data transfer times of about 100 milliseconds can be achieved, typically. Industrial communication systems, which use protocols of the second category are perceived as a compromise between native Ethernet standard and achievable performance for realtime data transfer. An example for this category is given by PROFINET RT [4, 12, 9]. These protocols are using the priority scheme at the Ethernet MAC layer according to IEEE802.1D/Q [14, 15]. For an additional optimisation the transport and the network layer has to be bypassed for realtime data. Implementing this optimisation, a data transfer in the range of 10 milliseconds can be achieved.

Further enhancements are only possible by intervening into the scheduling procedure of the MAC layer. Protocols which are changing the original MAC scheme of Ethernet are part of category 3. In order to use those protocols, specific hardware or software is necessary. For example, Ethernet Powerlink [19] uses a Master/Slave support, while EtherCAT [2, 10, 11] organises the whole cyclic realtime

IEEE Conference ETFA in Patras on 25 Sept. 2007