A PROFINET IO application implemented on Wireless LAN

Giorgio Santandrea
Siemens SpA – Automation & Drives AS/PT/SE

SIEMENS

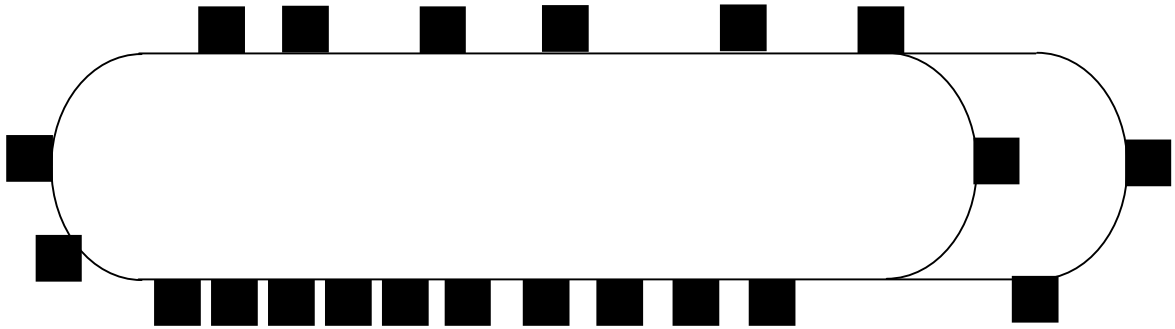
Customer's information

- Customer's name:
-
- The application:

Example of a plant from website

Customer needs

- The plant is made by a ring (80m long) along which there are 21 trolleys
- Each trolley has 2 Control Technique drives (DP slaves) and should move independently from the others
- Two trolleys cannot be closer then 5 cm.
- The complete system should be controlled by a single CPU, without any kind of intelligence on trolleys

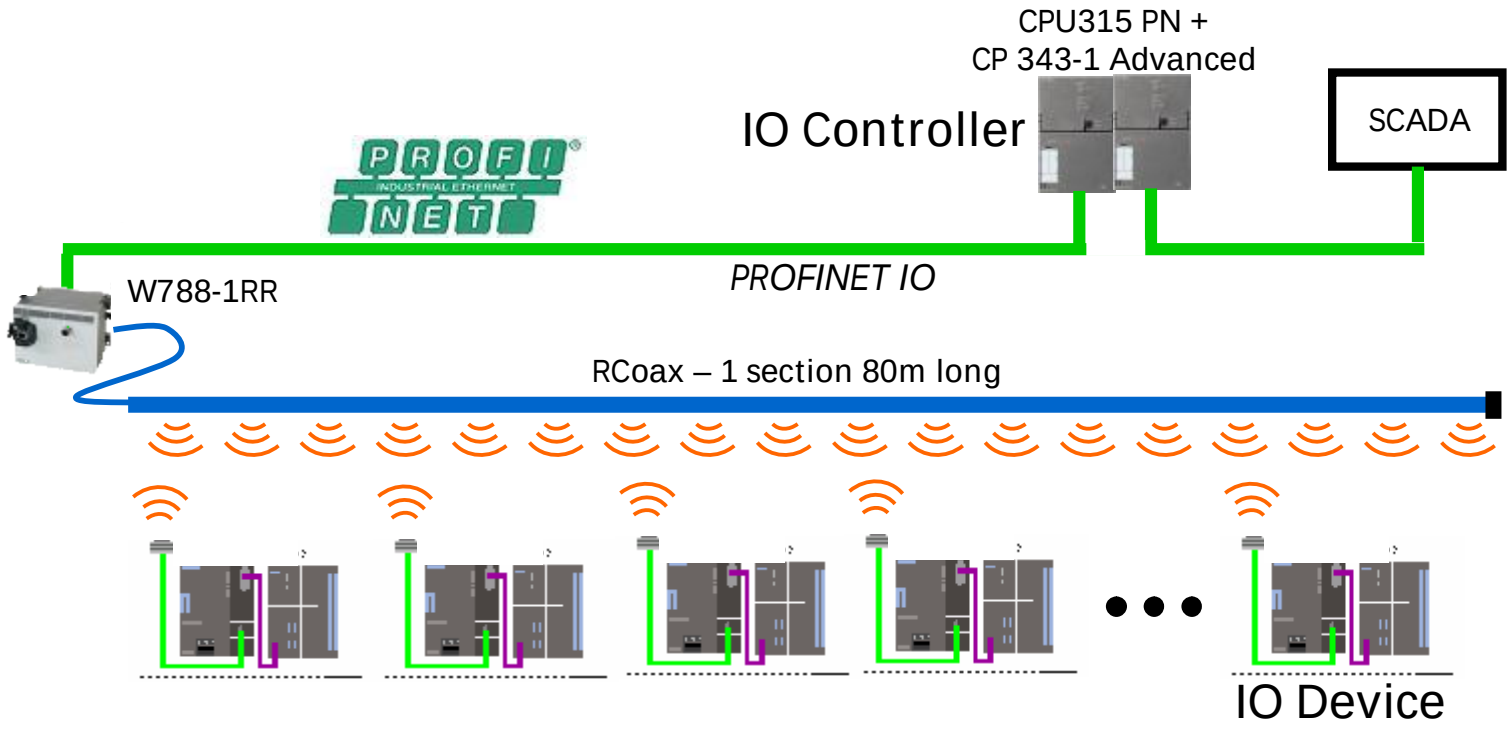


Customer needs (2)

- In the past the customer has used a PROFIBUS solution based on sliding contacts
- System performance were enough only for a little number of trolley
- Customer want to have at least:
  - IO Update rate <= 64ms
  - Quantity of date to exchange with each trolley: 128 bytes

Solution:
PROFINET IO implemented on a Wireless LAN network

Solution system architecture



- SCALANCE W788 RR as access point with iPCF function
- Rcoax cable as antenna all around the ring
- 21 trolleys, each one with:
  - IWLAN/PB Link PN IO as proxy between PROFINET IO and PROFIBUS DP
  - 2 non Siemens PROFIBUS DP slave

Detail of the trolley configuration

WFCS 2006

- Customer needs
- WLAN vs. determinism
- Roaming in industrial application
- RCoax cable
- Practical implementation
- Results

PROXY PROFINET

PROFIBUS DP

PROFI PROCESS FIELD BUS BUS

Slave DP non Siemens

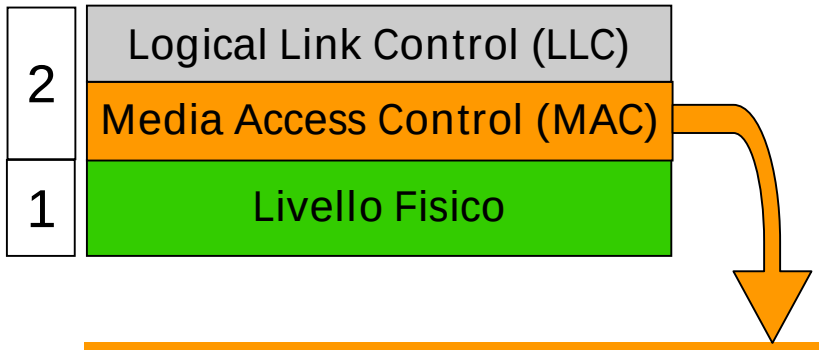
Slave DP non Siemens

SIEMENS

SIEMENS

WLAN vs. determinism

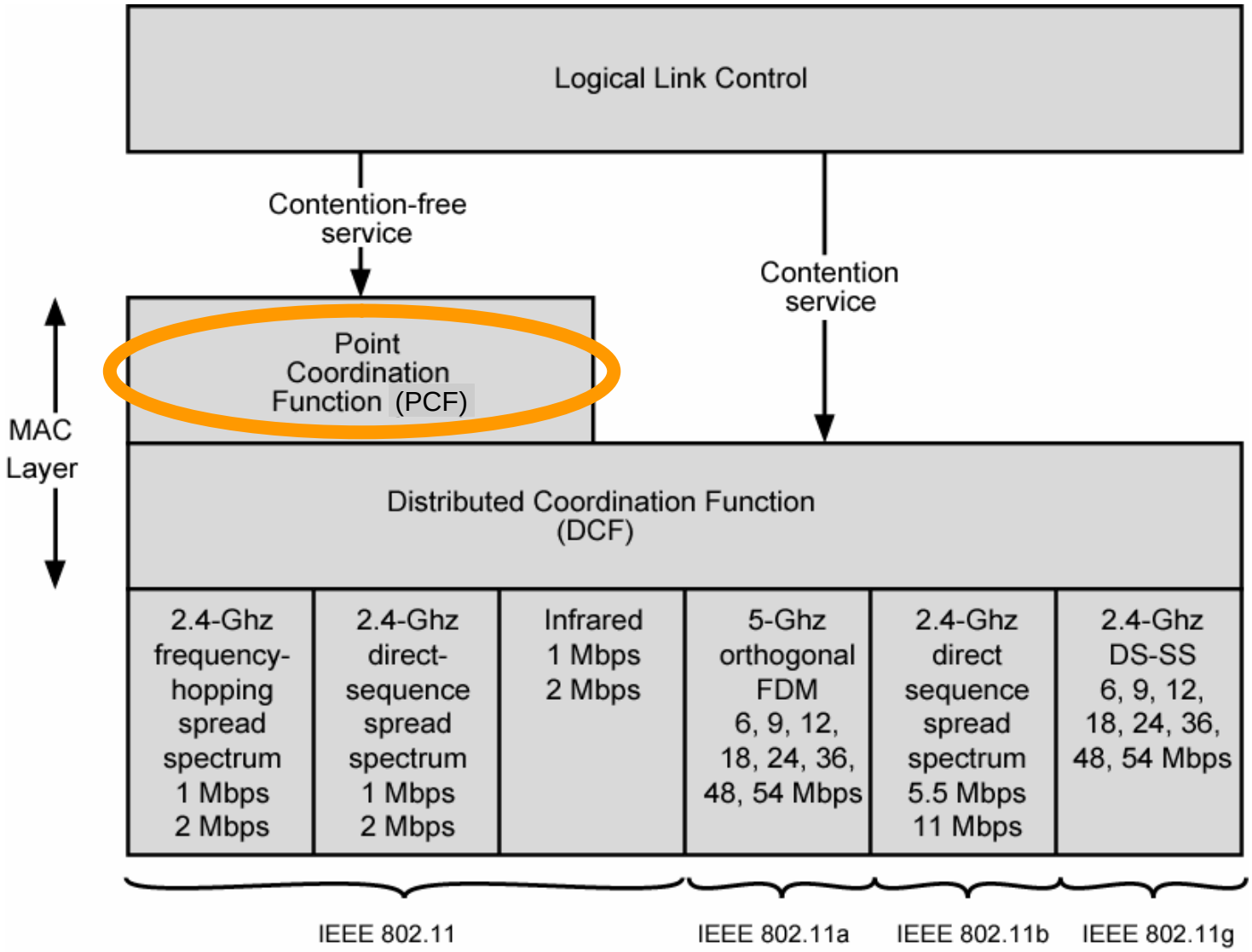
- WLAN is based on a shared and poor medium
- The access control is typically based on CSMA; in a certain time only one client can transmit
- When a high number of collision happened the network performance could be very low



DCF (Distributed Coordinated Function) **à** CSMA/CA

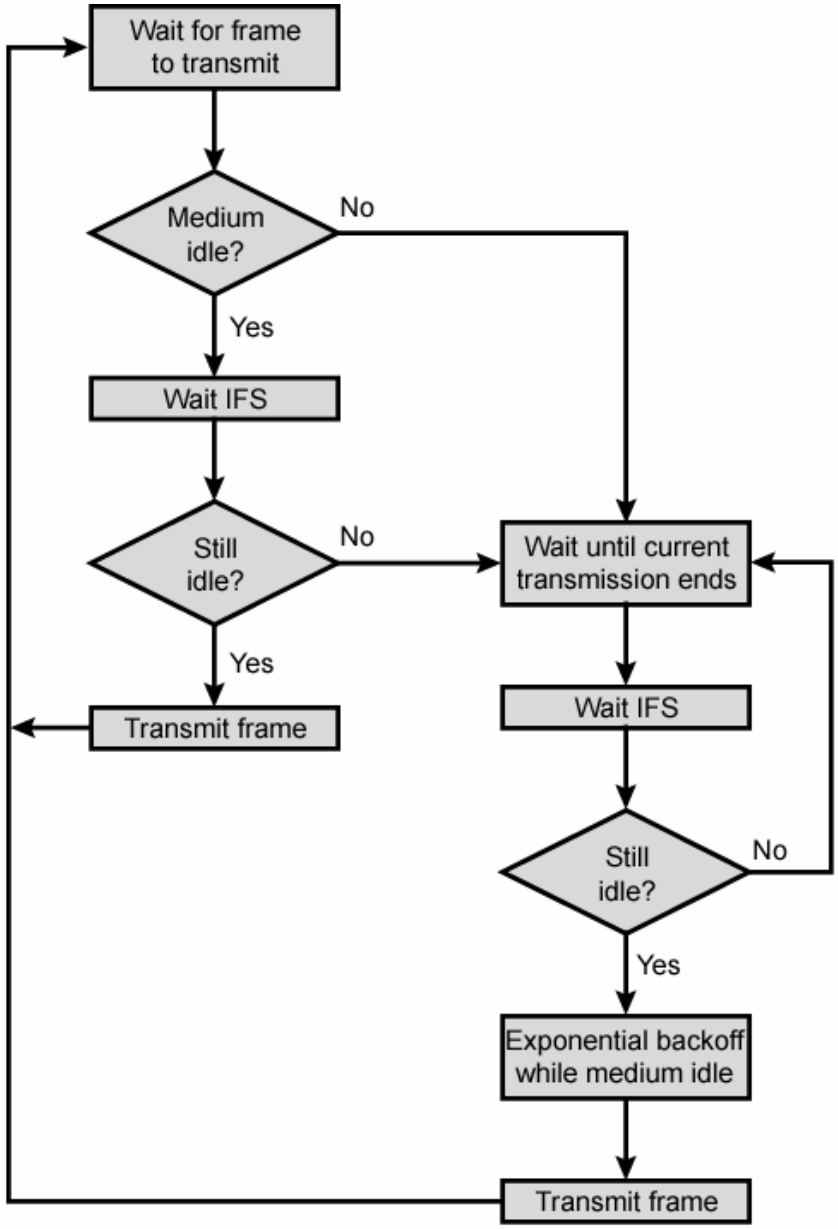
PCF (Point Coordinated Function) **à** Polling

The 802.11 protocol



SIEMENS

Contention service: Distributed Coordinated Function (CSMA)

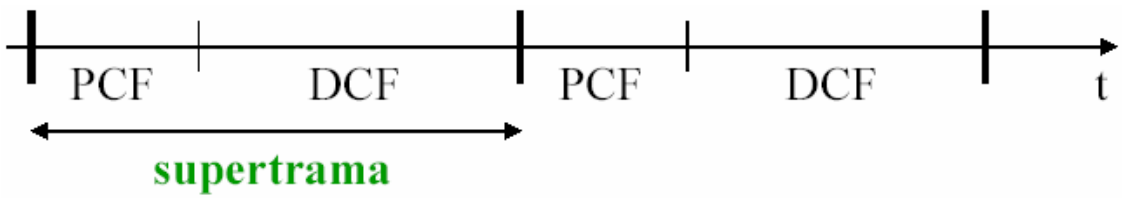


- Each client waits the medium idle for at least a time = IFS
- If the medium is still idle, the client waits until the current transmission ends and, after IFS, start an exponential backoff
- Collisions could be avoid by RTS/CTS technique (Collision Avoidance)

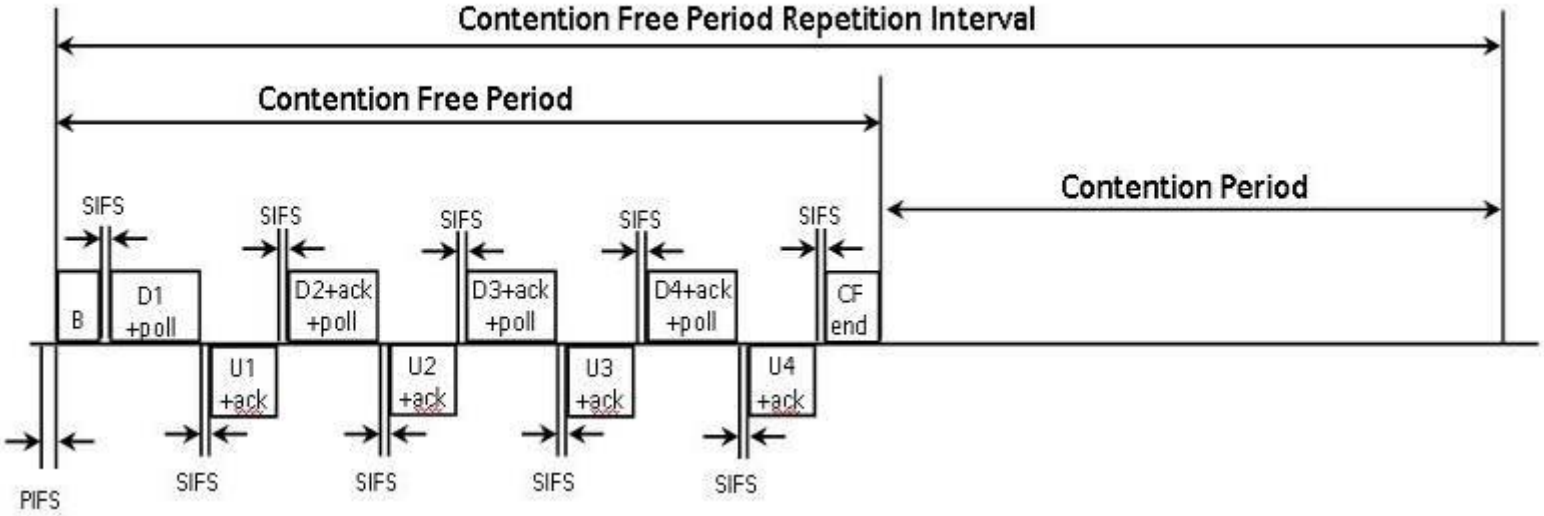
IFS: Inter Frame Space

Contention free services: Point Coordination Function (PCF)

- PCF is implemented above the DCF
- The critical traffic is managed by the access point simply using a polling technique scheduled by a round robin algorithm
- The rest of the traffic share the medium with CSMA/CA
- Each time slot is divided into 2 periods; the first in which PCF is applied and the second one in which DCF is used



PCF implementation

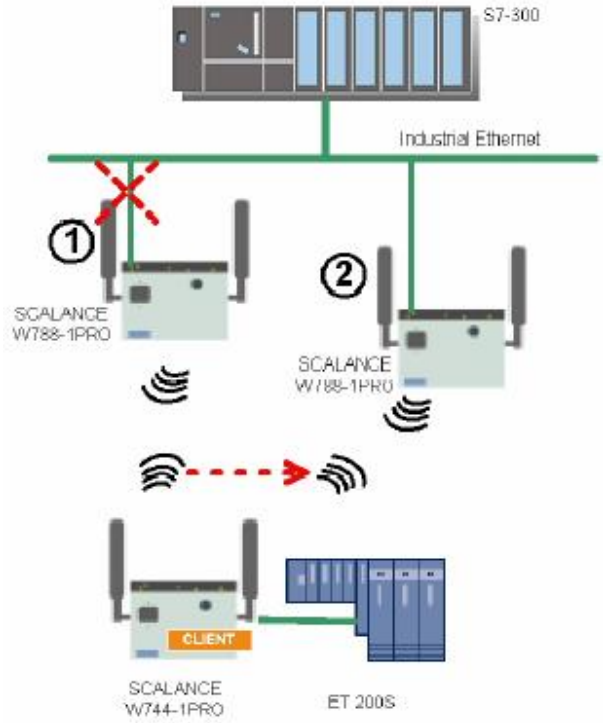


- The use of a mixed solution (PCF and DCF) can lead to a high jitter between a Contention Free Period Repetition Interval and the next one
- In order to have controlled jitter it could be used a solution based on a pure PCF

→ iPCF = Industrial + PCF

The roaming time in industrial applications

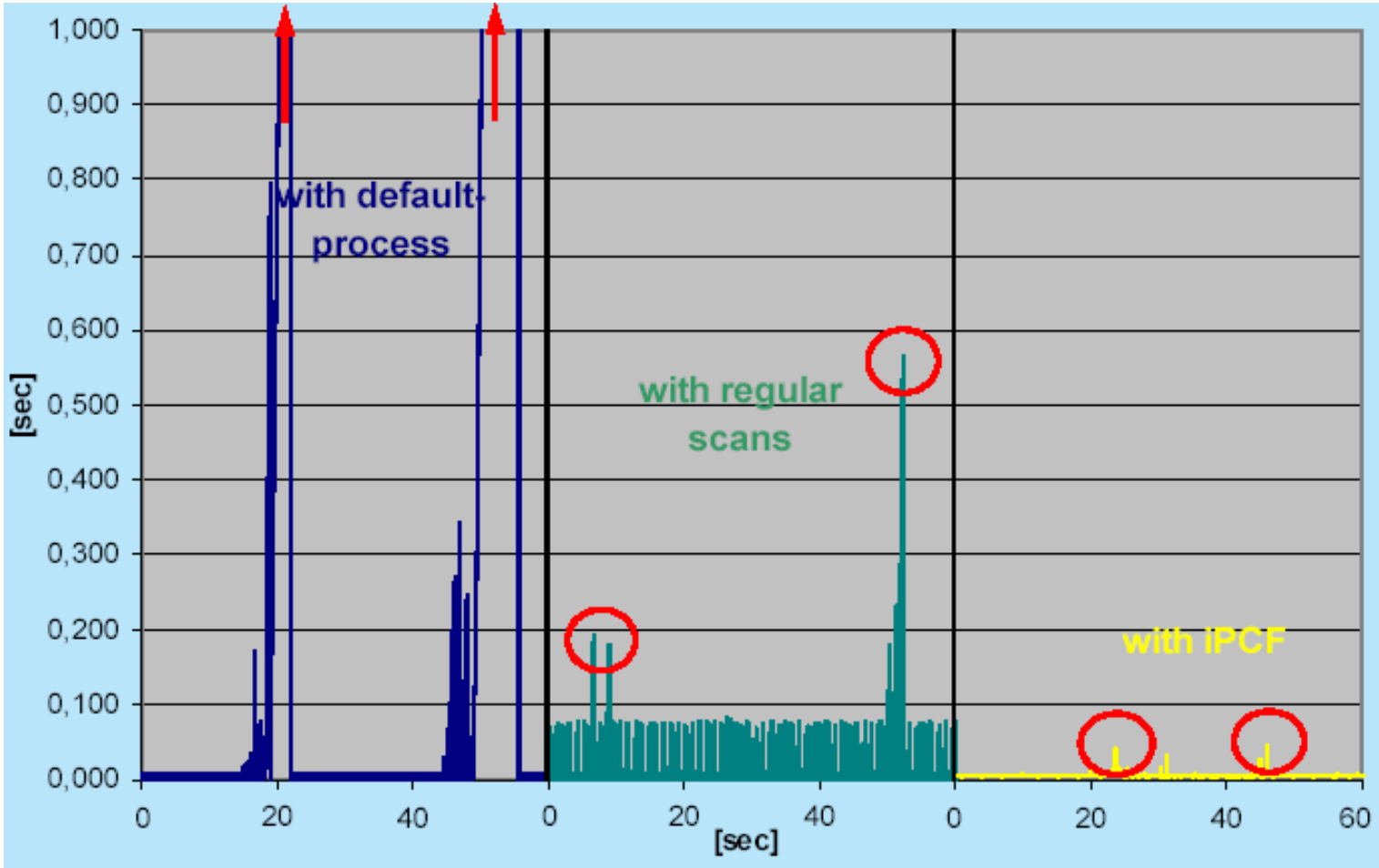
- The roaming mechanism is not defined into the 802.11 standard
- Inside the standard are explained some topics related to roaming:
  - Scanning (active / passive)
  - Association
  - Authentication
- Roaming time is obtained by adding this 3 times and it's not easy to estimate
- Some of these times could be reduced:
  - Scanning on fixed and specified channels
  - Use simple security techniques (such as WEP) in order to reduce authentication time



Roaming times: some examples

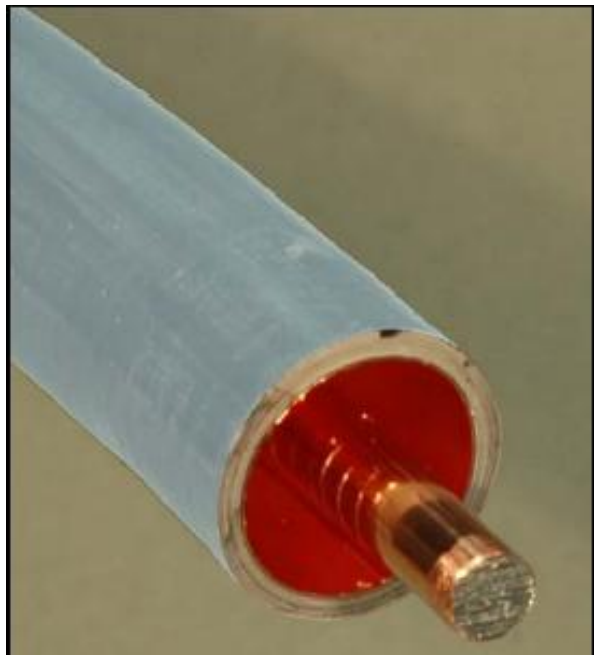
- Scan on defined channels
- iPCF functionality
- Security based only on WEP

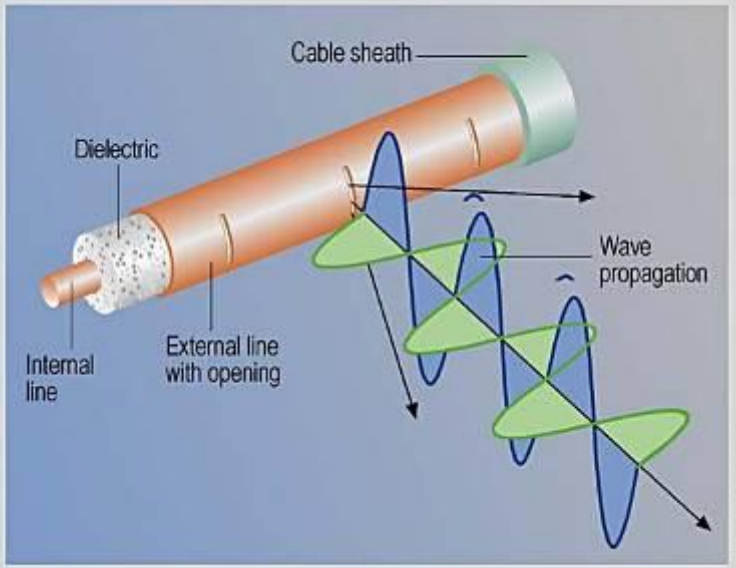
→ Roaming time <= 50ms



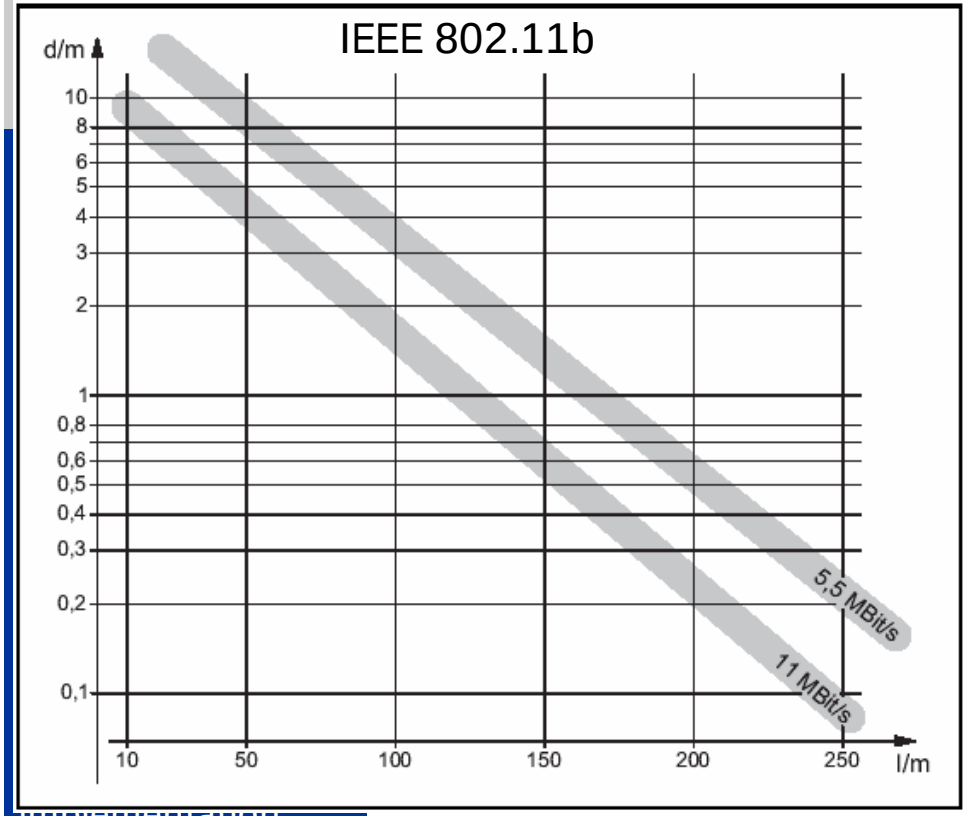
The key of the solution: RCoax cable

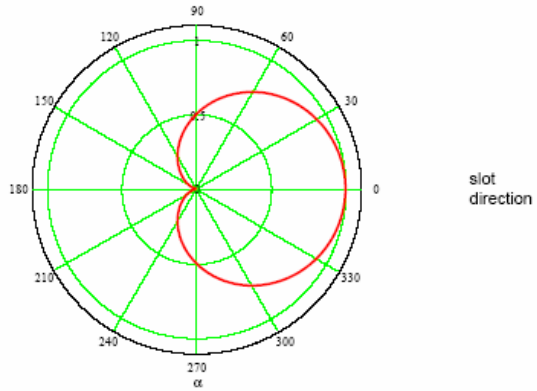
- Used as antenna connected to SCALANCE W
- Optimal and stable coverage in the proximity of the cable
- No interferences to/from other Wi-Fi networks
- Two different versions for 2.4GHz and 5GHz
- Easy to install thanks to his flexibility

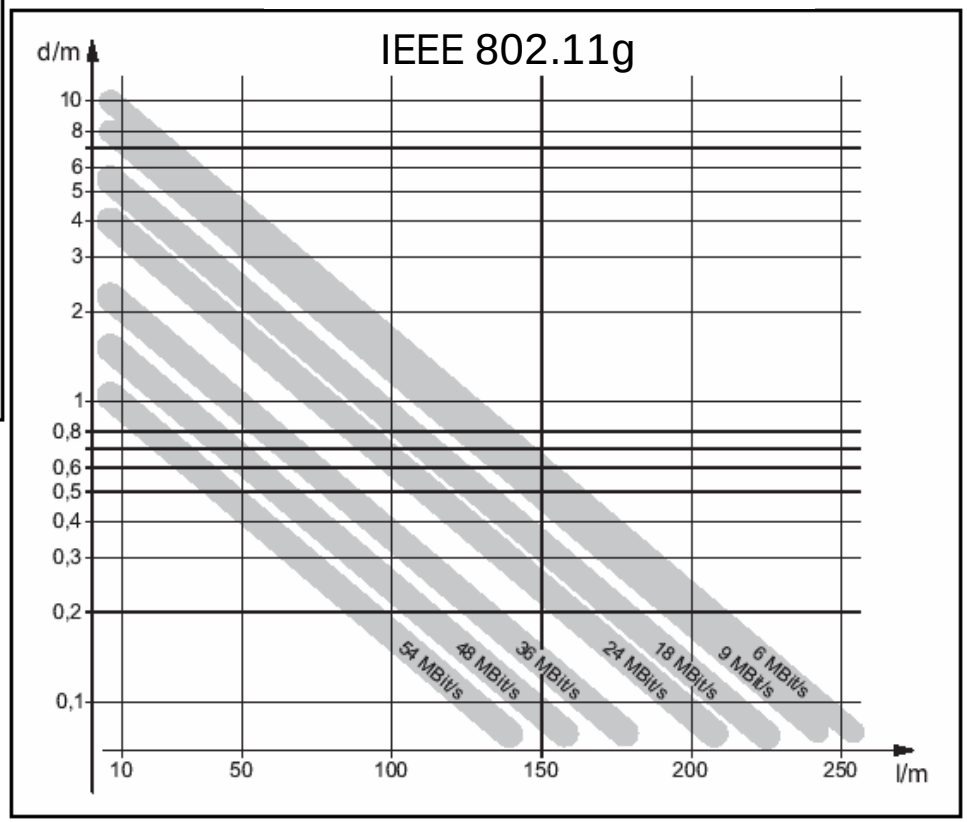




RCoax transmission diagrams







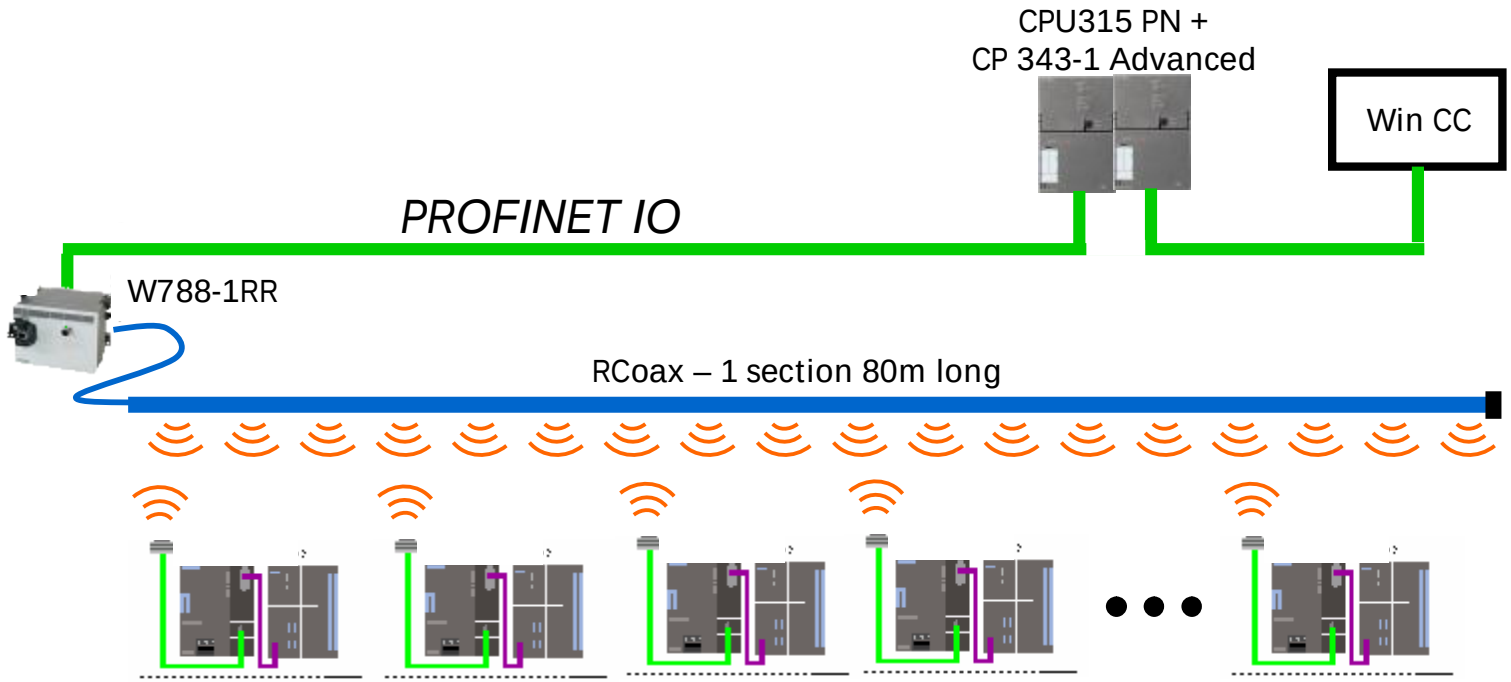
Implementation

Results

SIEMENS

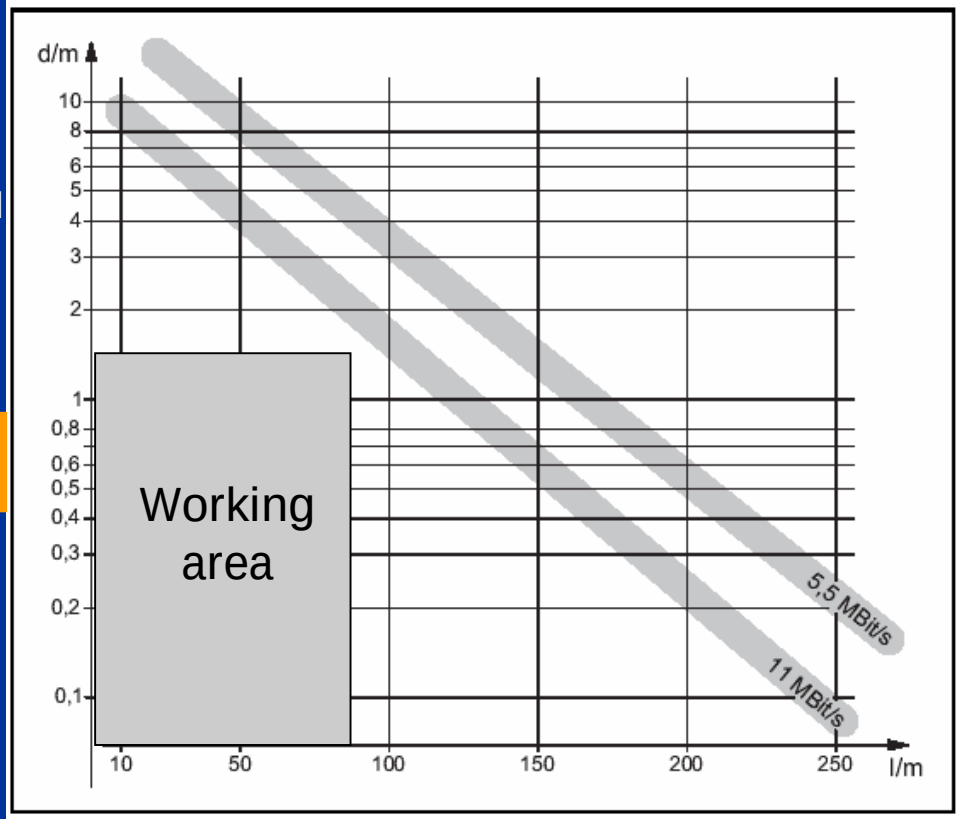
SIEMENS

The solution adopted



- SCALANCE W788 RR as access point with iPCF function
- Rcoax cable as antenna all around the ring
- 21 trolleys, each one with:
  - IWLAN/PB Link PN IO as proxy between PROFINET IO and PROFIBUS DP
  - 2 non Siemens PROFIBUS DP slave

The Rcoax installation



- To have a less obstacles influence we started with 802.11b standard
- The maximum distance between RCoax and client antenna is about 1.5m
- Theoretically the working area should be as in the picture

Some pictures from the plant

Customer needs

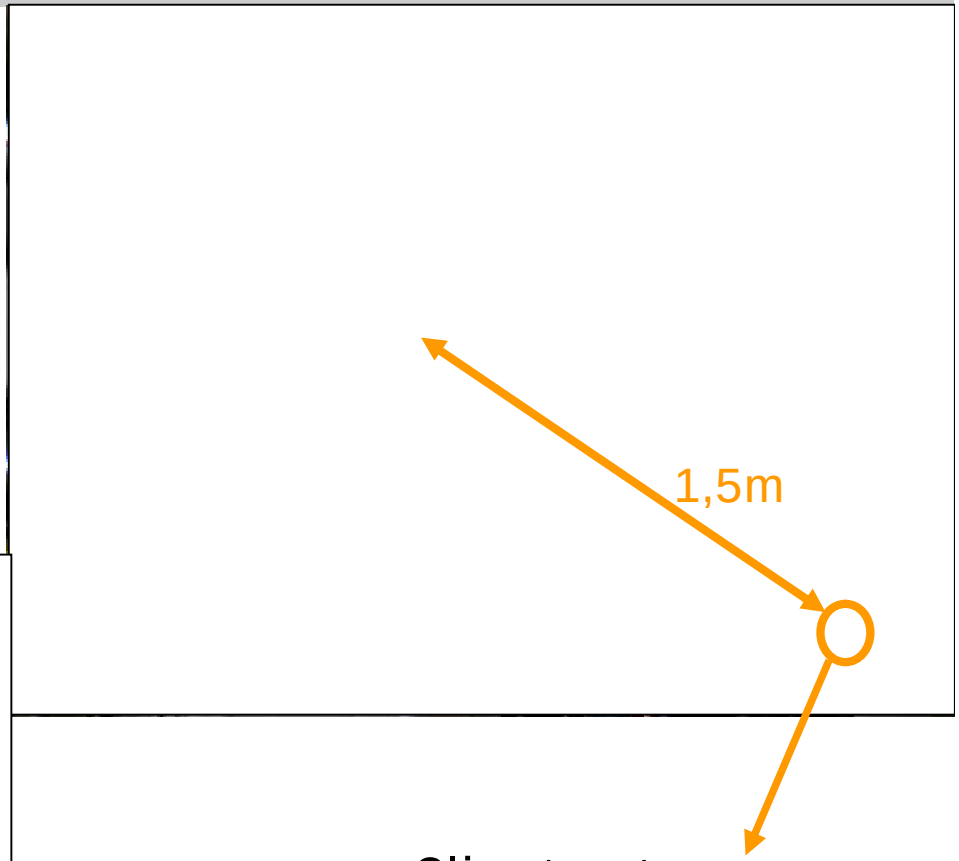
WLAN vs. determinism

Ro
ap

RC

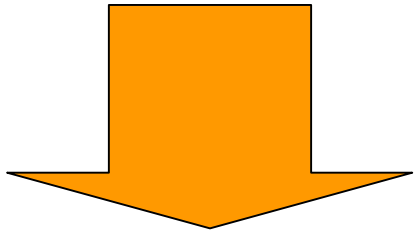
Pr
im

Re



The commissioning phase

- We started with IEEE 802.11b (DCF) because the distance between client antenna and RCoax cable was not too high
- Signal strength on the each client was quite good but very “unstable”, there were a lot of data rate changing
- The high number of clients and this signal situation leaded to a high traffic volume and a lot of transmission errors
- Sometimes some trolleys lost the connection with the PLC IO Controller

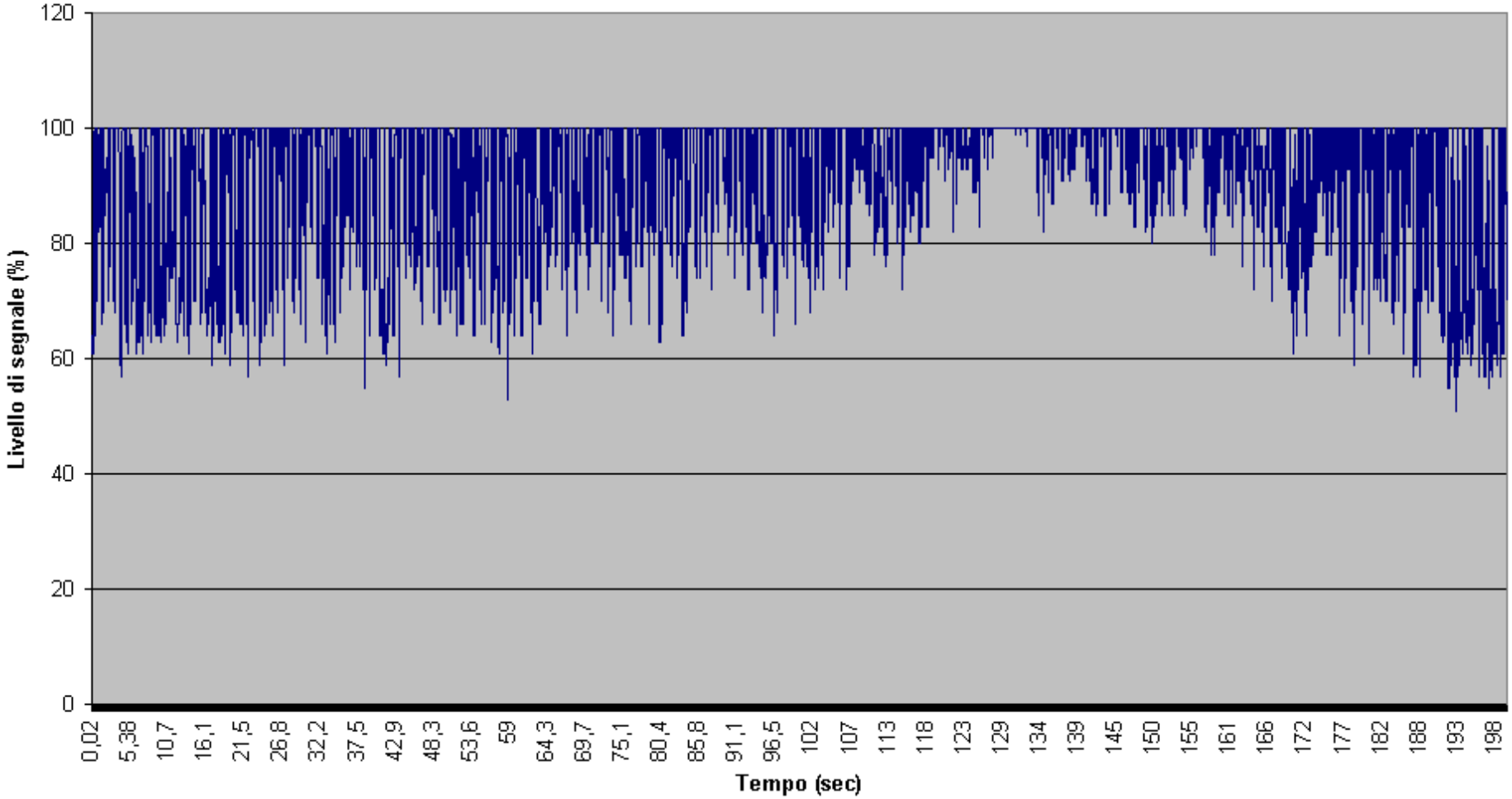


We decided to activate iPCF functionality with a fixed data rate at 5.5 Mbit/s

SIEMENS

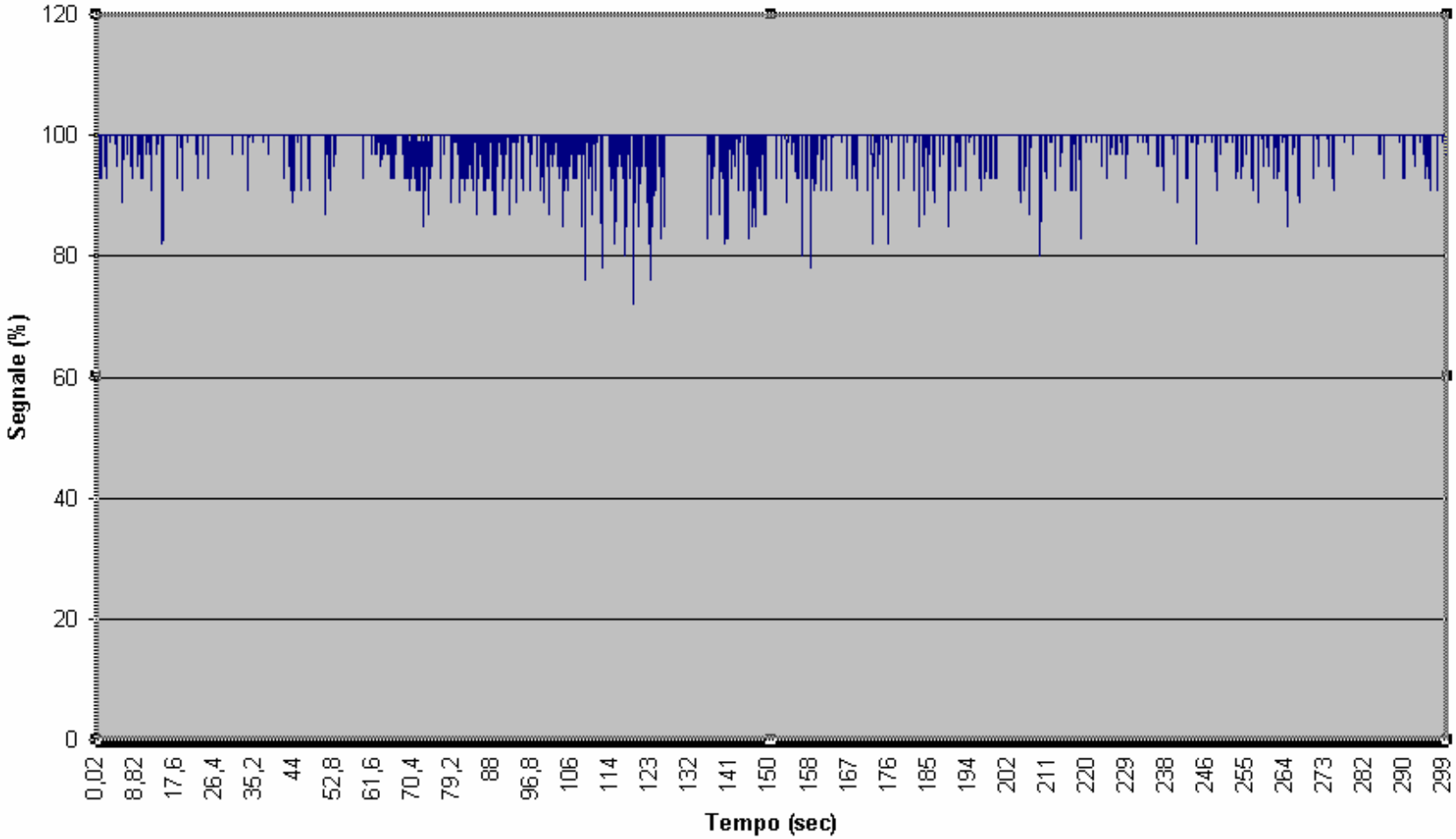
Signal strength on a client

Situation with 802.11b standard, without iPCF



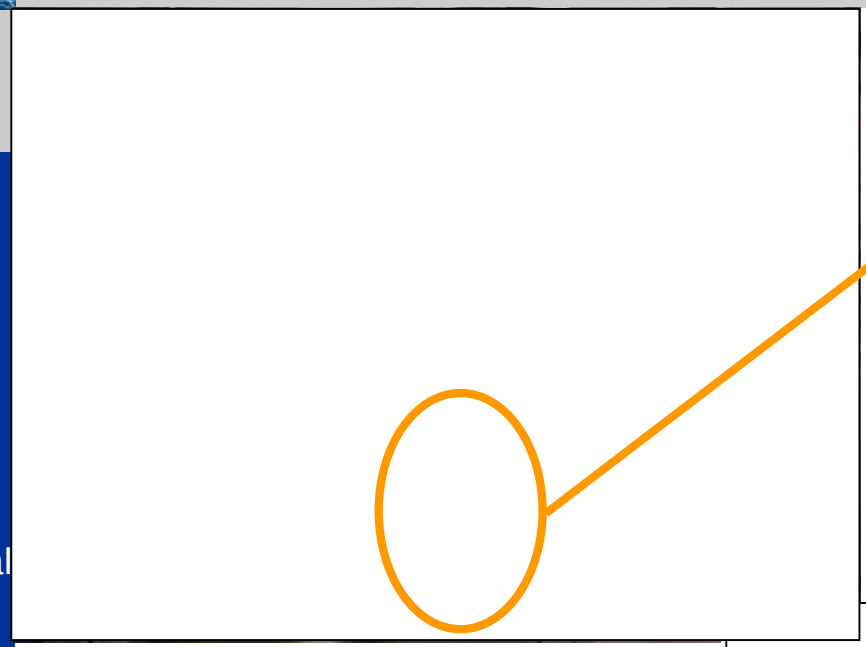
Signal strength on a client

Situation with iPCF activated, at 5.5Mbit/s

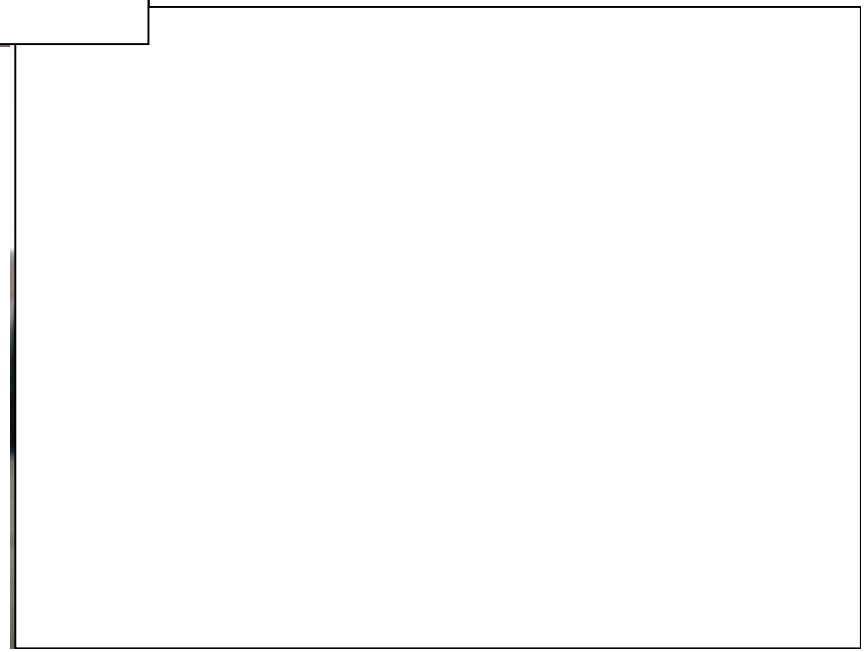


SIEMENS

Some other pictures from the plant…



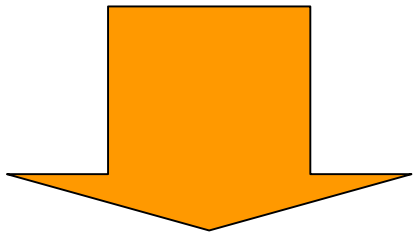
The client cabinet



SIEMENS

Results

- The system has been working properly since last November
- The PROFINET IO update rate is 64ms with 128 bytes exchanged with each trolley on each CPU cycle
- The customer is satisfied with this solution and is going to install a twin plant just beside this one



PROFINET IO could be implemented also on WLAN network with good results!

SIEMENS

Thank you…

WFCS 2006

- Customer needs
- WLAN vs. determinism
- Roaming in industrial application
- RCoax cable
- Practical implementation
- Results

SIEMENS

Questions ?