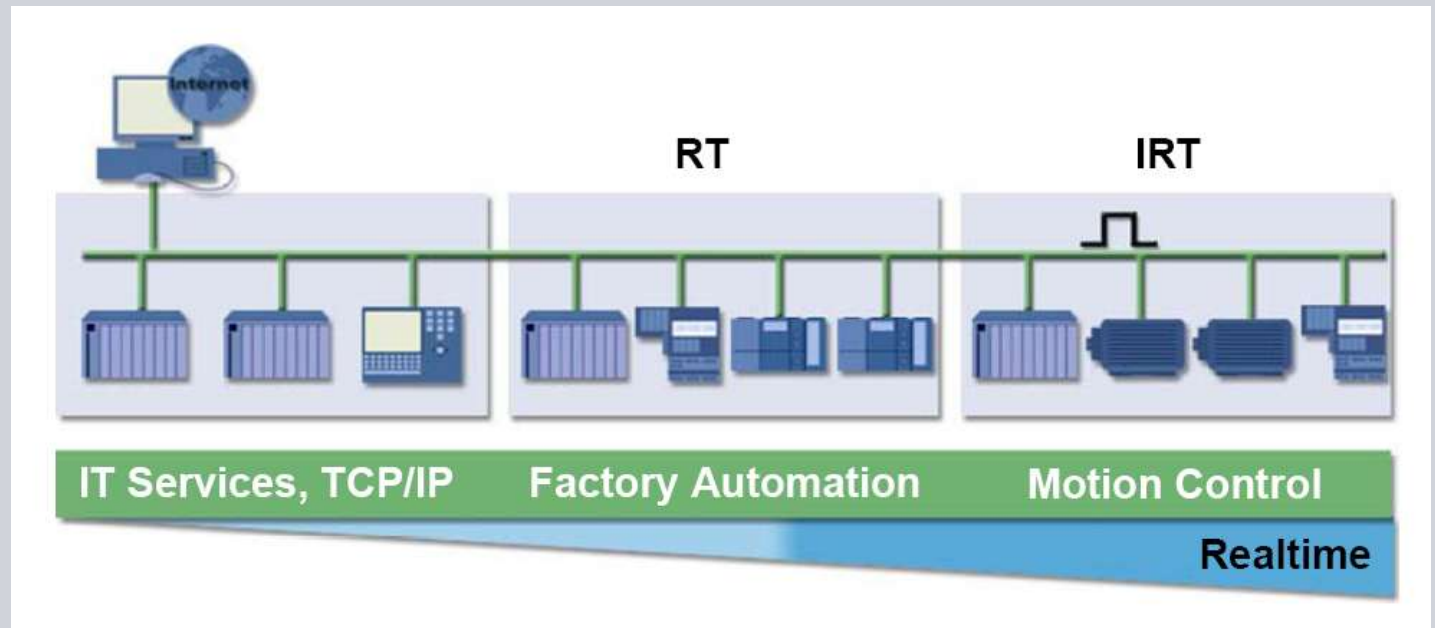


# Using Industrial Ethernet Networks for PROFINet



Can I use ordinary  
Ethernet Switches  
for PROFINet?

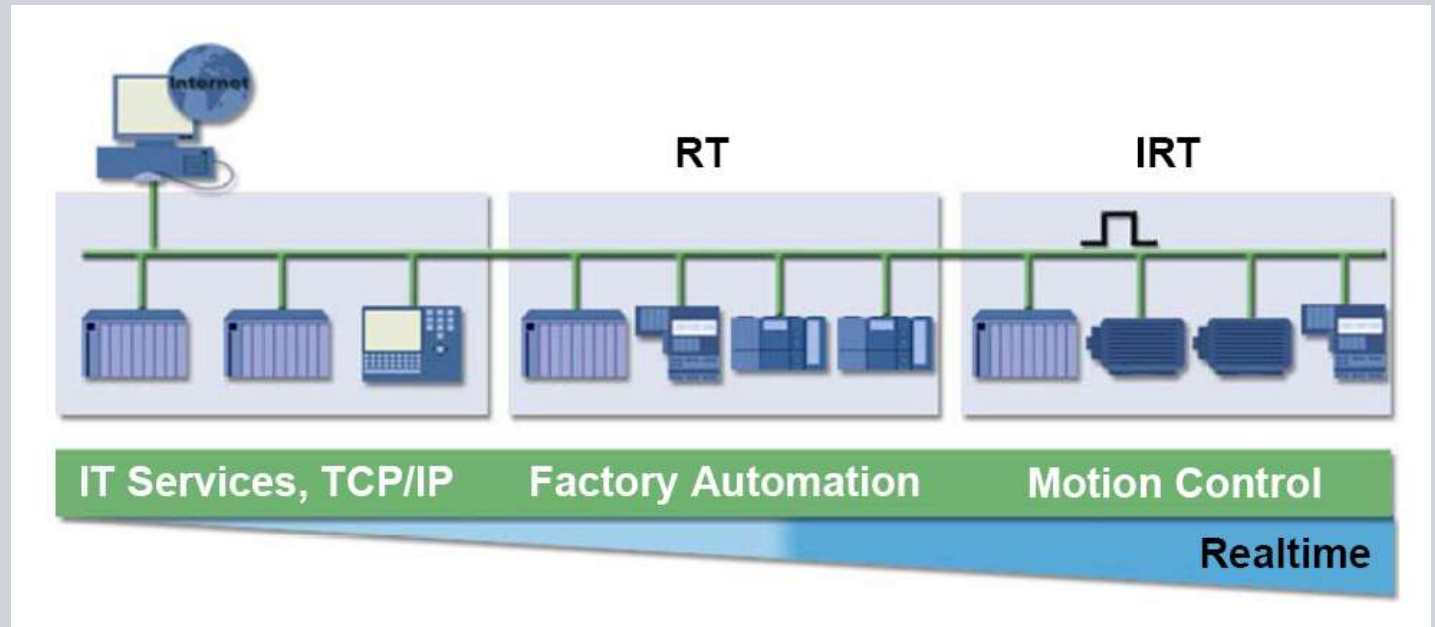
## Switches and PROFINet



Profinet communications use IEEE 802.3 Ethernet packets  
 Profinet can be used for many different applications



## Switches and PROFINet



IT Communications

RT – Real Time

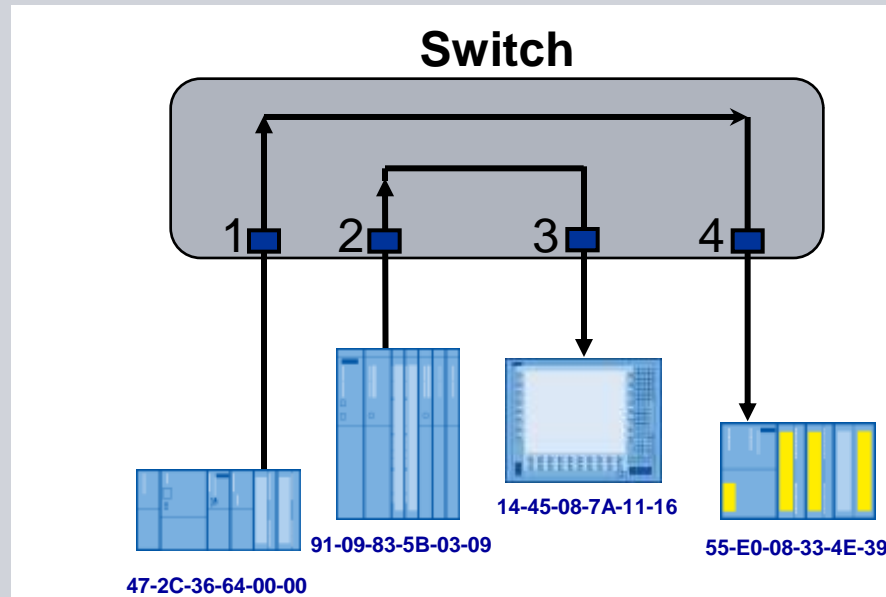
IRT – Isochronous Real Time

<100ms cycle → Standard Switches

<10ms cycle, low jitter → **Standard Switches**

<1ms, less <1uS jitter → Special Switches

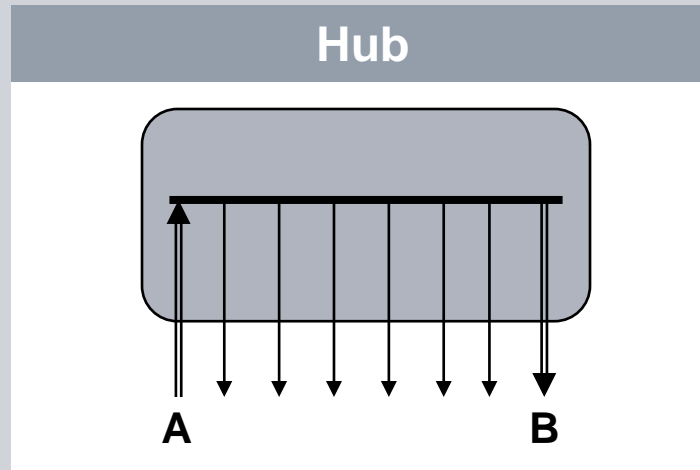
# Switches and PROFINet



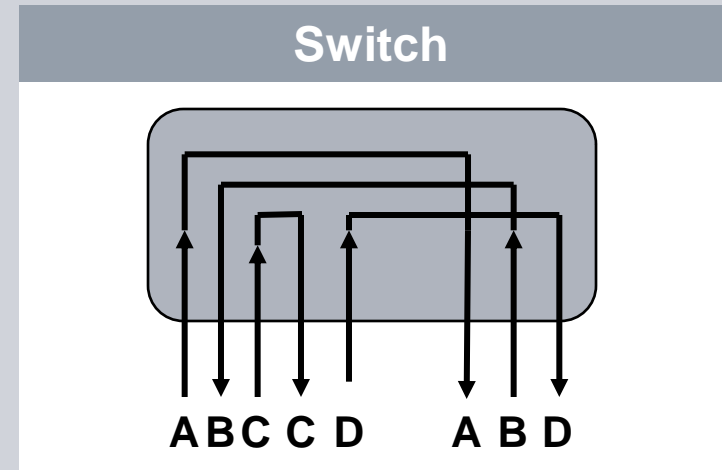
Data exchange between ports 1 – 4 and ports 2 – 3 is private and simultaneous.

- Associates each port with physical addresses connected through it
- Sends frame out the port associated with the physical address
- Improves the performance of the network
- Two most common types...
  - Cut-through
  - Store and forward

## Switches and PROFINet

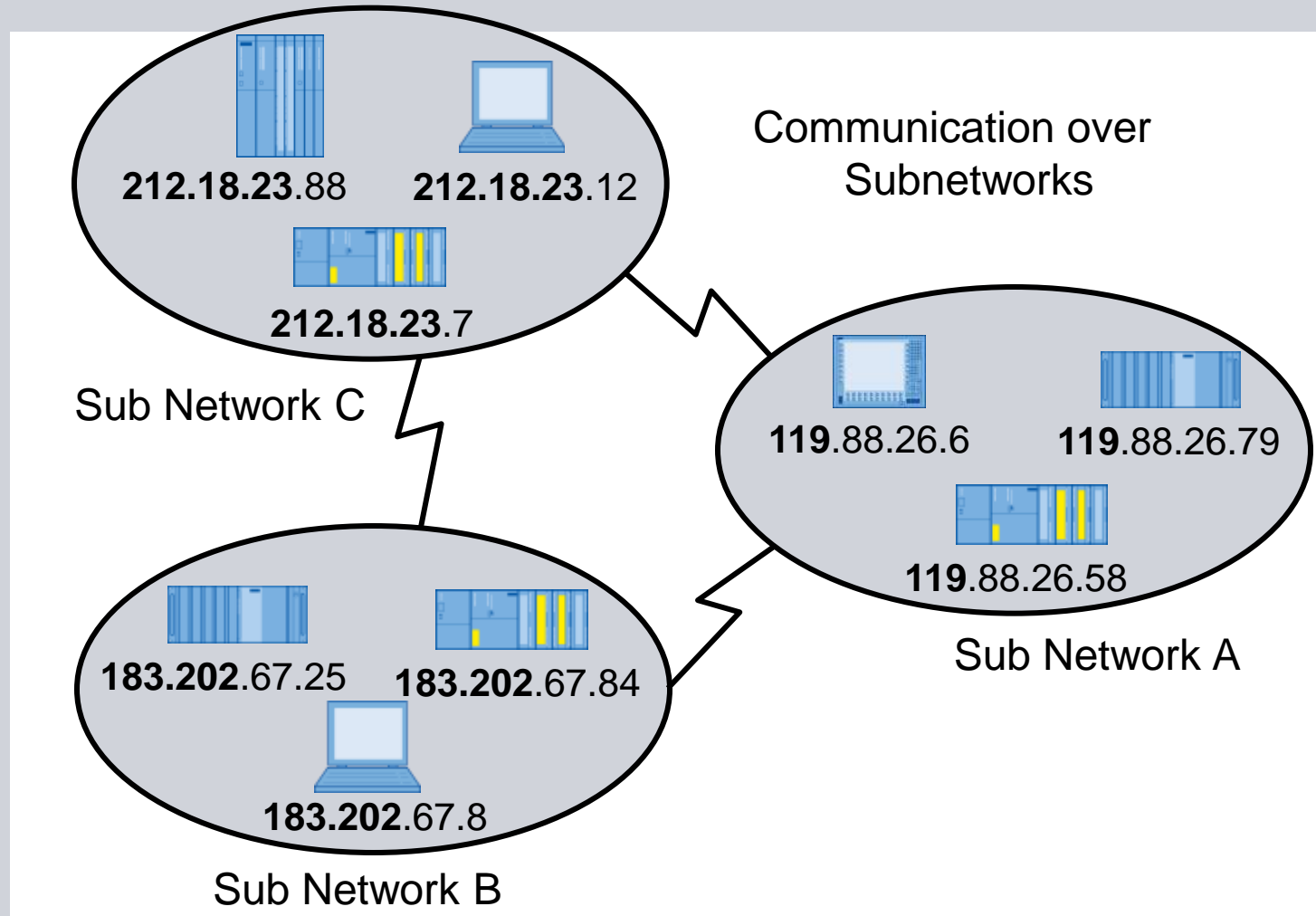


- If „A“ transfers Data to „B“, the data will be sent to every station which is connected with the Hub.
- The 10Mbps Ethernet Bandwidth needs to be shared on every host which is connected.

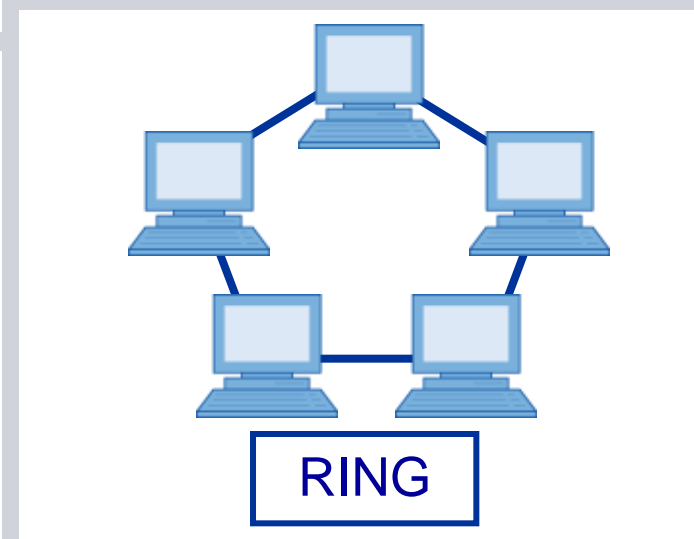
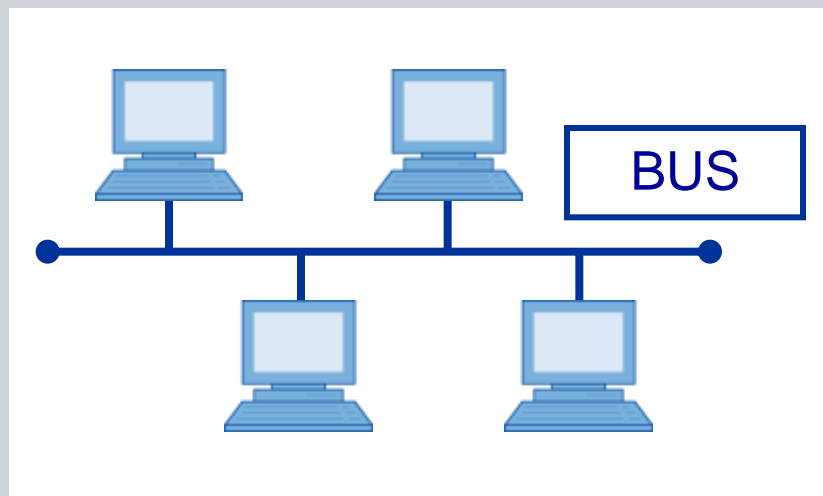
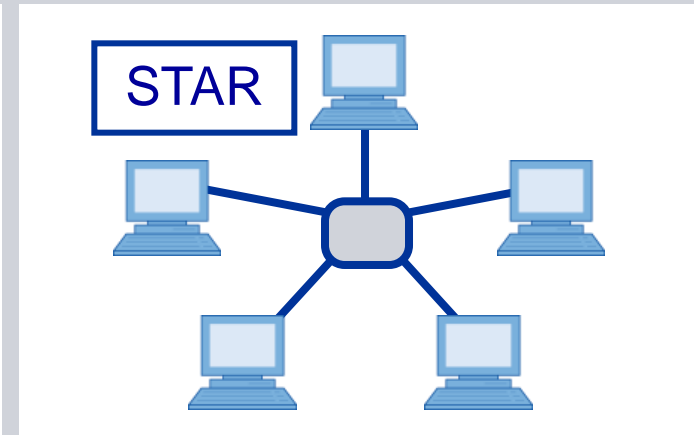
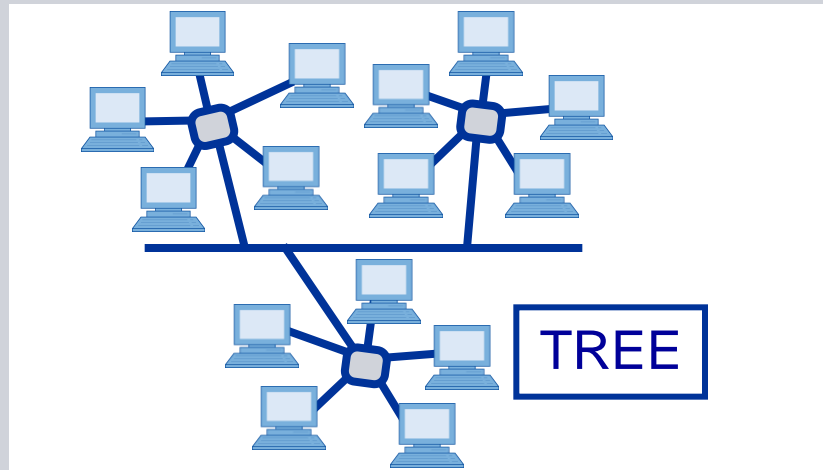


- The Switch transfers the Frame based on the Address to a special Port.
- It is also possible to run more connections between the Ports.
- Every Port is capable to work in Full duplex mode and use the entire Bandwidth of the Network.

## Switches and PROFINet

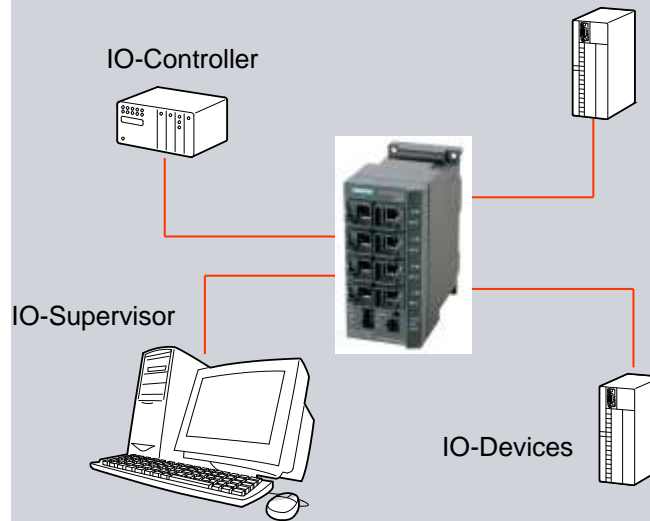


## Switches and PROFINet



## Switches and PROFINET

Any simple unmanaged switch can be used to create a Profinet IO network



Except very old types – Switch must be transparent to large frames

Standard Ethernet Packets have a maximum length on 1518 bytes

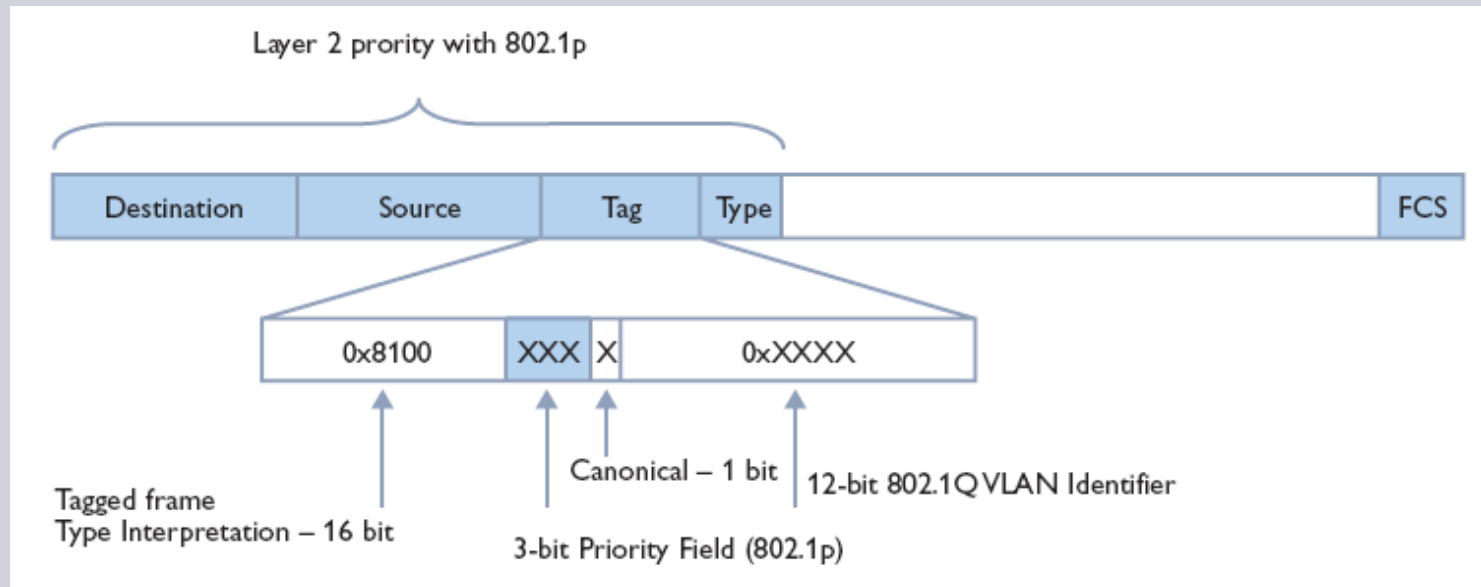


A switch is a store and forward device – all packets received are checked before forwarding

Any packet greater than the maximum length will be rejected

Profinet IO uses the IEEE 802.1Q packet structure

## Switches and PROFINet



Priority field – 0-7 : Profinet uses level 6

Type field for Profinet 0x8892

Packet sizes can now reach 1522 bytes

Priority	Traffic Type
0	Best Effort
1	Background
2	Spare
3	Excellent Effort
4	Controlled Load
5	Video
6	Voice
7	Network Control



## Switches and PROFINet



```

Frame 23 (64 bytes on wire (64 bytes captured)
  Arrival Time: Mar 16, 2006 21:08:09.415475000
  Time delta from previous packet: 0.126966000 seconds
  Time since reference or first frame: 9.698024000 seconds
  Frame Number: 23
  Packet Length: 64 bytes
  Capture Length: 64 bytes
  Protocols in frame: eth:vlan:pn_rt:pn_io
  Ethernet II, Src: 192.168.0.100 (08:00:06:6b:a5:2d), Dst: 192.168.0.101 (08:00:06:6b:f9:81)
  Destination: 192.168.0.101 (08:00:06:6b:f9:81)
  Source: 192.168.0.100 (08:00:06:6b:a5:2d)
  Type: 802.1Q Virtual LAN (0x8100)
  802.1Q Virtual LAN
    110..... = Priority: 6
    ...0..... = CFI: 0
    ....0000 0000 0000 = ID: 0
  Type: PROFINet (0x8892)
  PROFINET cyclic Real-Time, RTC1, ID:0xc000, Len: 40, Cycle:16384 (Valid,Primary,Ok,Stop)
  FrameID: 0xc000 (0xC000-0xFAFF: Real-Time(class=1): Cyclic)
  CycleCounter: 16384
  DataStatus: 0x25 (Frame: Valid and Primary, Provider: Ok and Stop)
    00... = Reserved (should be zero): 0x00
    ...1... = StationProblemIndicator (1:Ok/0:Problem): 0x01
    ...0... = ProviderState (1:Run/0:Stop): 0x00
    ....0... = Reserved (should be zero): 0x00
    ....1... = DataValid (1:Valid/0:Invalid): 0x01
    ....0... = Reserved (should be zero): 0x00
    .......1 = State (1:Primary/0:Backup): 0x01
  TransferStatus: 0x00 (OK)
  PROFINET IO Cyclic Service Data Unit: 40 bytes
  IOxS: 0x00 (bad)
    ....0 = Extension (1:another IOxS follows/0:no IOxS follows): 0x00
    ...0 000... = Reserved (should be zero): 0x00
    ...00... = Instance (only valid, if DataState is bad): detected by subplot (0x00)
    0... = DataState (1:good/0:bad): 0x00
  Data: 39 bytes (including GAP and RTCPadding)
0000 08 00 06 6b f9 81 08 00 06 6b a5 2d 81 00 c0 00  ....k.....k-....
0010 88 92 c0 00 00 00 00 00 00 00 00 00 00 00 00  ....
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ....
0030 00 00 00 00 00 00 00 00 00 00 00 00 40 00 25 00  ....@.%
  
```

Type field indicating 802.1Q

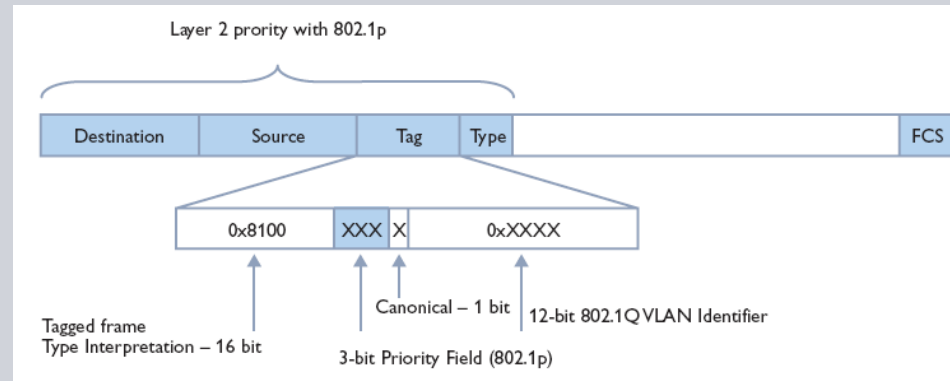
Priority Tag

VLAN ID

Type Field indicating Profinet



# Switches and PROFINet



Because Profinet uses 802.1Q there must be a VLAN identifier

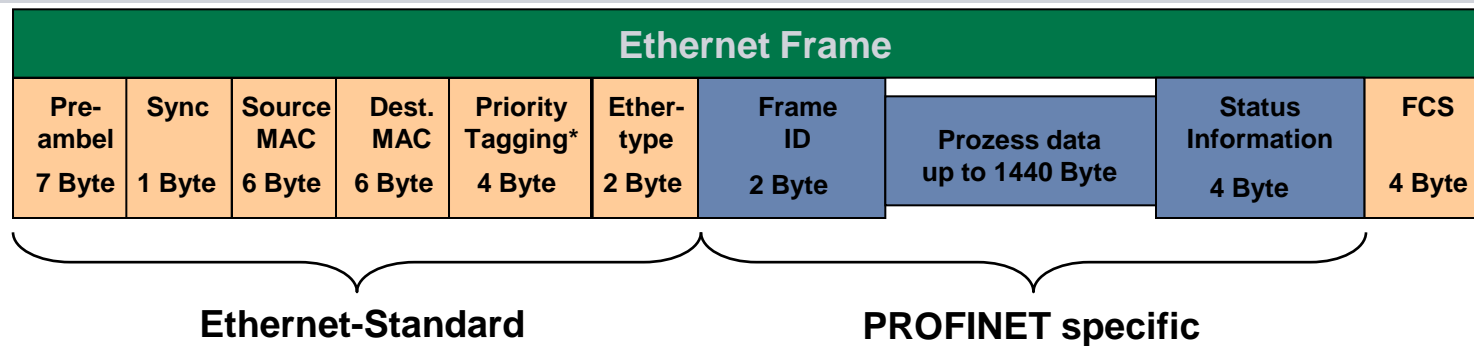
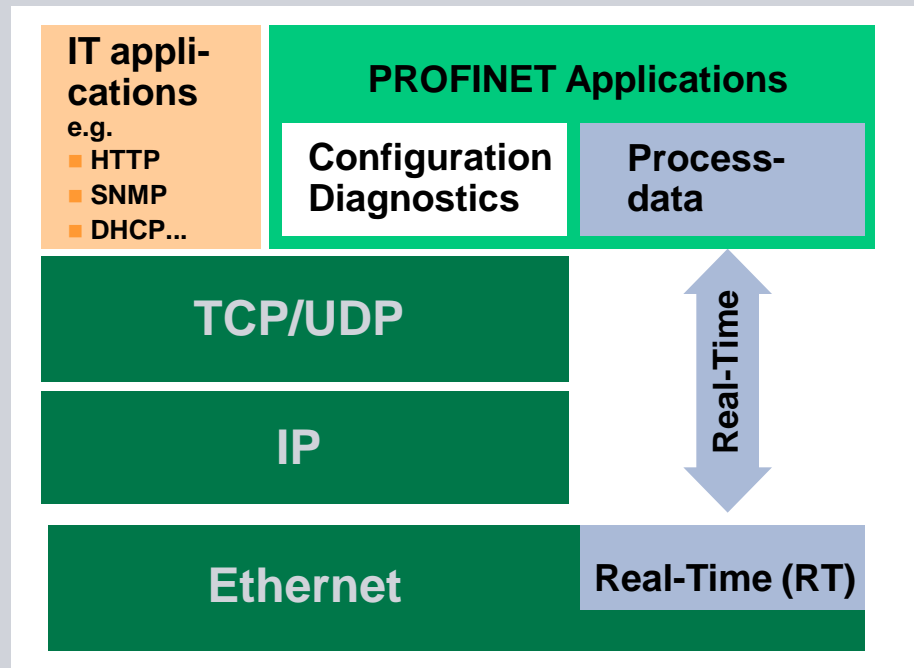
A Virtual LAN allows one physical network to become a number of virtual networks

Virtual LANs are used for security and bandwidth management

If a switch port is set up to support a particular VLAN ID only traffic destined for that VLAN will be passed to that port.

If Profinet is required to operate within a VLAN environment the Identifier can be set by the switch

## WLAN and PROFINet



## WLAN and PROFINet

### What special requirements has PN IO for WLAN?

- Profinet IO works with **cyclic data communication**
- **3 retries** (default) = bus fault (BF)
- **→ the WLAN connection must be reliable!**

### “Domestic” WLAN could, however, be used for PN IO – under following conditions:

- No roaming for the Ethernet Client Module (ECM)
- The PN IO update time  $\geq$  **32 ms**
- **max. of four** WLAN Clients for each AP

## WLAN and PROFINet

The ECMs can be set to the following MAC modes:

- **Auto find 'Adopt MAC'**

ECM adopts MAC address from first frame to pass

- **Set 'Adopt MAC' manually**

MAC address can be edited manually

- **Adopt own MAC**

ECM uses its own MAC address

- **Layer 2 Tunnel**

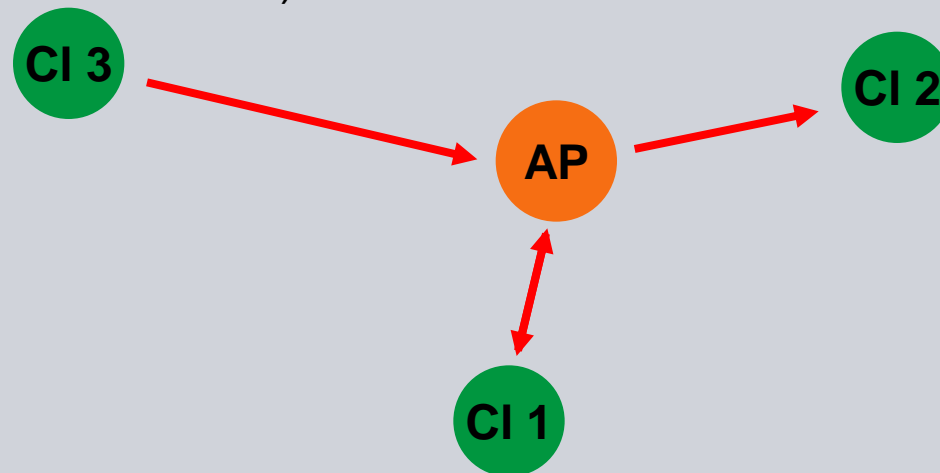
ECM uses its own MAC address **but also the MAC addresses of the end devices** that are connected to the ECM

## WLAN and PROFINet

### “Domestic WLAN” ⇔ Real-time WLAN

“Domestic WLAN” – technical details

- In a “Domestic WLAN”, **each device transmits** (AP and clients) as soon as **data is pending** and the **channel is free** (“distributed coordination”)
- “Domestic WLAN” is therefore also known as **DCF** (distributed coordination function)



## WLAN and PROFINet

### “Real-time WLAN” – technical details

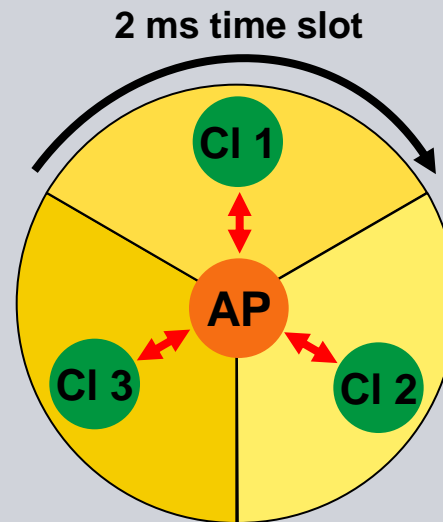
- In real-time WLAN, **the access point coordinates radio traffic**
- Real-time WLAN is therefore also known as **iPCF** (industrial **p**oint **c**oordination **f**unction)
- The AP assigns each client a 2 ms time slot
- Now **the AP transmits data** to client 1
- **Client 1 receives this** and **answers in turn with its data**
- This process is known as “**polling**”

Note: “Real-time” doesn’t mean “immediately” but “at a pre-determinable time” i.e. deterministic



## WLAN and PROFINet

“Real-time WLAN” – what actually happens



The AP determines the polling sequence and it cannot be influenced!

## Summary

Simple PROFINet IO networks can be run using ordinary unmanaged switches.

To ensure real time performance on shared networks the Ethernet switch must support 802.1Q

If IRT is to be used only use specially designed switches

If VLANs are to be used, switches must be set up correctly

Wireless technologies can be used if setup/selected correctly



**Thank you for your attention!**

