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  <100ms cycle → Standard Switches
RT – Real Time <10ms cycle, low jitter → **Standard Switches**
IRT – Isochronous Real Time <1ms, less <1uS jitter → Special Switches
Switches and PROFI.net

- 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

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

Communication over Subnetworks

Sub Network C
- 212.18.23.88
- 212.18.23.12
- 212.18.23.7

Sub Network B
- 183.202.67.25
- 183.202.67.84
- 183.202.67.8

Sub Network A
- 119.88.26.6
- 119.88.26.79
- 119.88.26.58
Switches and PROFInet

- **TREE**
- **BUS**
- **RING**
- **STAR**
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
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: 0.126660000 seconds
Time since reference or first frame: 9.298024000 seconds
Frame Number: 23
Packet Length: 64 bytes
Capture Length: 64 bytes
Protocols in frame: eth: vlan: pm: rtc: pm: 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: 0x8100 (0x8100)

802.1Q Virtual LAN (0x0100)

802.1Q Virtual LAN

110 0000 0000 0000 = Priority: 6
0 0000 0000 0000 = CFI: 0
0 0000 0000 0000 = ID: 0

Type: PROFINET (0x8092)

PROFINET cyclic Real-Time, RTCl, ID: 0x0000, Len: 40. Cycle: 16384 (Valid, Primary, Ok, Stop)
FrameID: 0x0000 (0x0000-0x0FF): Real-Time(class=1): Cyclic
CycleCounter: 16384

DataStatus: 0x25 (Frame: Valid end Primary, Provider: Ok and Stop)
0000 = Reserved (should be zero): 0x00
01.1.1.1.1 = StationProblemIndicator (1:0x/0:Problem): 0x01
0 0000 = ProviderState (1:Run/0:Stop): 0x00
0 0000 = Reserved (should be zero): 0x00
0 0000 = DataValid (1:Valid/0:Invalid): 0x01
0 0000 = Reserved (should be zero): 0x00
0 0000 = State (1:Primary/0:Backup): 0x01
TransferStatus: 0x00 (OK)

PROFINET IO Cyclic Service Data Unit: 40 bytes
IOx5: 0x0000 (bad)
0000 = Extension (1:another IOx follows/0:no IOx follows): 0x00
0 0000 = Reserved (should be zero): 0x00
0 0000 = Instance (only valid, if DataState is bad): detected by subslot (0x00)
0 0000 = DataState (1:good/0:bad): 0x00

Data: 39 bytes (including GAP and RTCPadding)
0000 00 00 06 6b f9 81 08 00 06 6b a5 2d 81 00 = 00 = k...k...
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

PROFINET Applications
- Configuration Diagnostics
- Process-data

TCP/UDP
IP
Ethernet

Real-Time

Ethernet Frame
- Pre-ambel 7 Byte
- Sync 1 Byte
- Source MAC 6 Byte
- Dest. MAC 6 Byte
- Priority Tagging* 4 Byte
- Ether-type 2 Byte
- Frame ID 2 Byte
- Prozess data up to 1440 Byte
- Status Information 4 Byte
- FCS 4 Byte

Real-Time (RT)
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 >= **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
“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)
“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 point coordination function)
- 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
"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!