Fundamentals of Fiber To The Office (FTTO)

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Agenda

- **Introduction of FTTO**
- **Design Guidelines**
- **Installation Practices – Hardware & Configuration**
- **Management of FTTO's**
- **Q&A**

Introduction

- History

  FTTO Technology emerged in Germany at the start of the 1980s when fiber based connectivity was extensively explored and meet the following,

  - Ethernet based
  - Long Life Cycle
  - Redundancy
  - Security
  - Improved energy efficiency
  - Low maintenance
  - Less network hierarchy

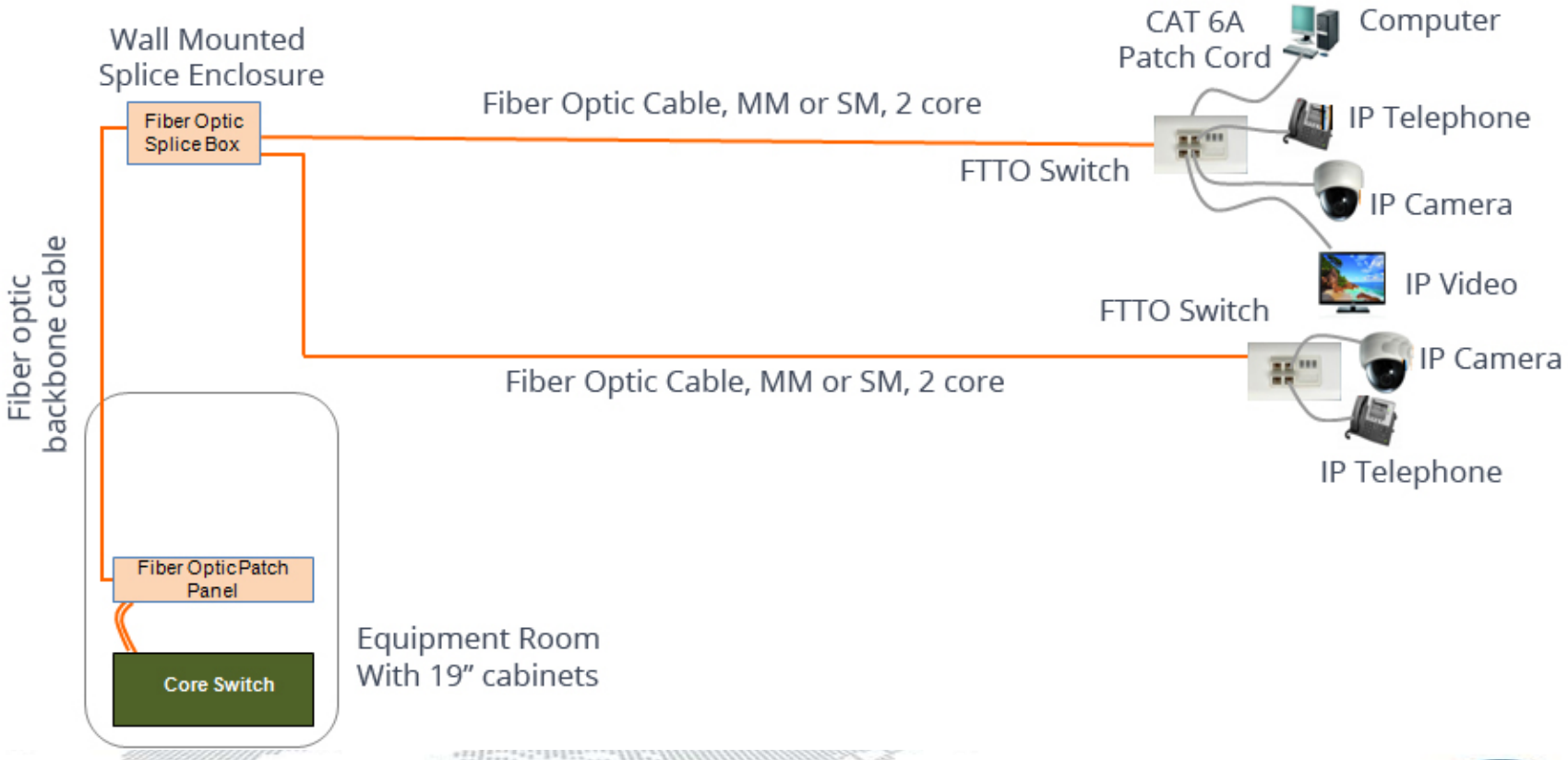
Introduction

- FTTO (Fiber To The Office) is a future-proof networking infrastructure for modern office environments
- A cost effective cabling infrastructure for modern office environments
- FTTO is a standards compliant and decentralized cabling concept

Introduction

- Highly efficient fiber optic technology with the flexibility of twisted pair cabling
- Networking infrastructure that offers flexibility, protects investments and reduces life cycle costs.

Basic Schematic



Fiber Optic Technology

- Fiber optic technology being the most future-proof cabling technology currently available, its economic benefits are widely accepted, and used particularly in generic office environments, such as commercially-used buildings.

Current Scenario

- In Local Area Networks (LANs), optical fiber is normally used for backbone cabling.
- Multi-fiber multimode (OM3/OM4) or single-mode fiber cables are used in backbone.
- For horizontal cabling for the individual floors, fiber optic cabling is quite rare, only copper cabling is used.
- Following a short boom at the end of the 90s, things have become very quiet again around Fiber to the Office (FTTO) and Fiber to the Desk (FTTD) solutions.

Advantages of Fiber Optics

- Long distances possible > 100 km
- Almost unlimited bandwidth
- Low space requirements
- Longer Life time
- No EMC issues and grounding problems
- Higher Security (tapping)
- Fiber optic cable less expensive than copper
- Environmental friendly (green building)

Physical Conditions Demand Fiber

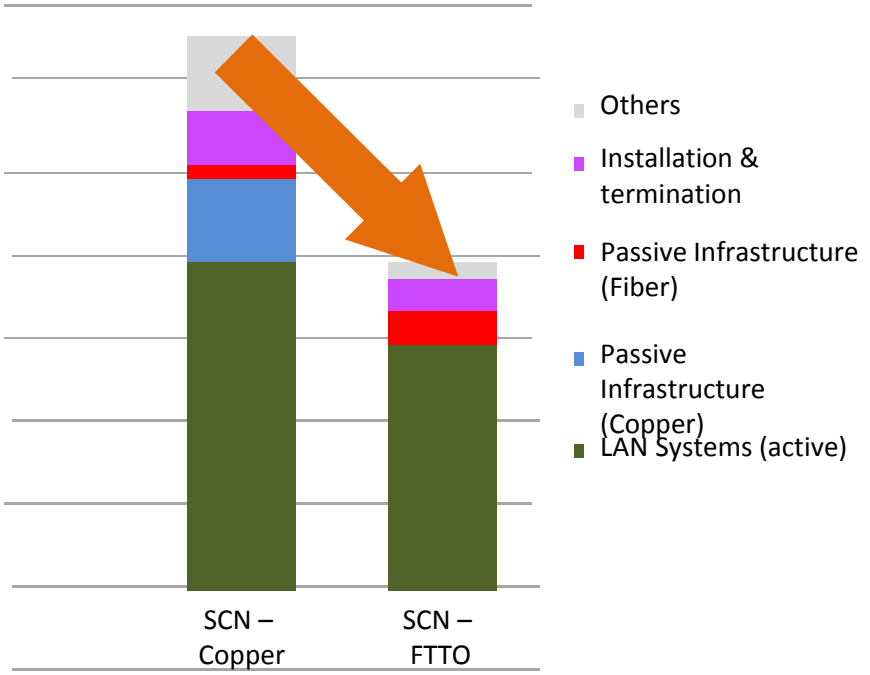
For a large number of applications copper cabling cannot be used

- Physical restrictions
  - airports with extremely long cable routes
  - historically protected buildings need thinner cables and smaller pathways
- Electro-magnetic considerations
  - e.g. industrial, hospitals

FTTO Reduces Cost

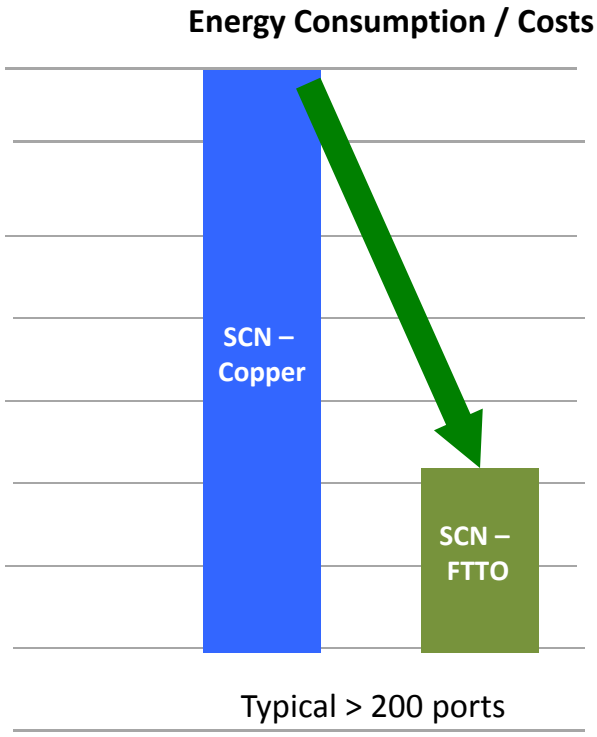
FTTO Makes Gigabit Ethernet Cost-Effective for medium to large IT-Infrastructures

- CAPEX (Capital expenditure)
- OPEX (Operational expenditure)
- Flexibility



FTTO Green and Sustainable

- FTTO saves up to 70% in energy costs
- FTTO is the greenest network solution
- No need for energy hungry floor distribution rooms
  - Less power consumed
  - Less active equipment also means less CO_2-Footprint and less impact on the environment
  - Less technical rooms also means more useable area



Fiber Requires Less Energy

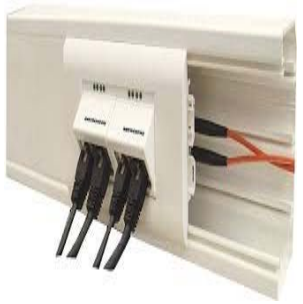
Due to fibre physics, less energy is required to transport data over fibre.

- Fibre transmission can halve energy requirements in comparison with traditional copper cabling solutions.
- Fibre optic cables can carry signals with much **less energy loss** than copper cable as copper wires lose signal energy as heat ($P=I^2R$) due to their resistance.

FTTO Consumes Low Power

Micro FTTO switch consumes low power, i.e. 0.5 – 1 W per port for data transmission

- as against 3-4 W per port for traditional rack mounted switches



0.5-1 W/port

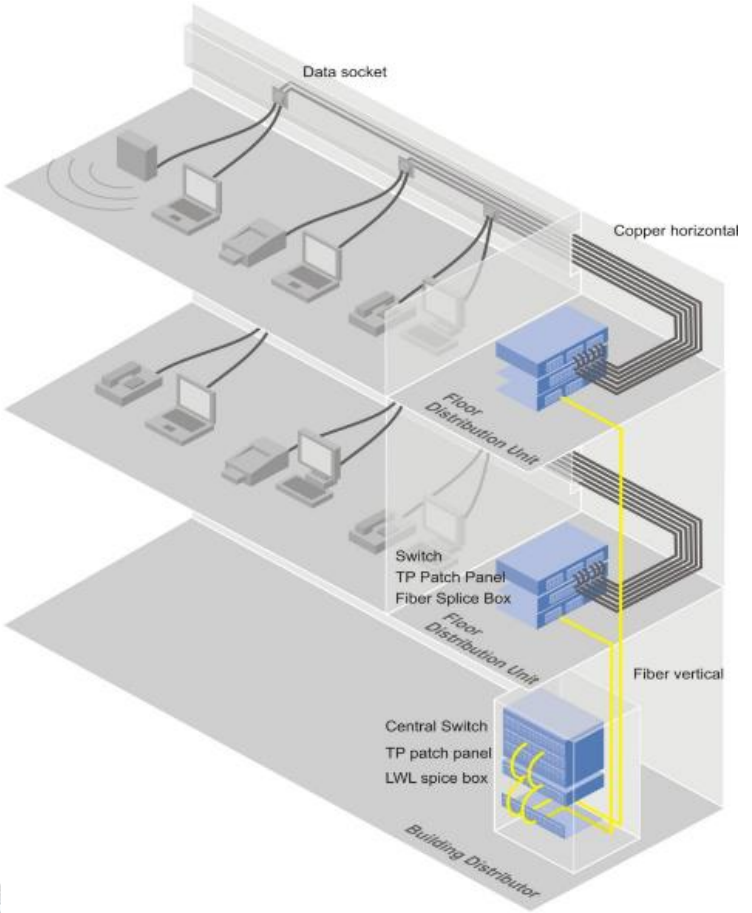
3-4 W/port

FTTO is Energy Efficient

FTTO micro-switches support “Eco-Mode” and Energy Efficient Ethernet (IEEE 802.3az)

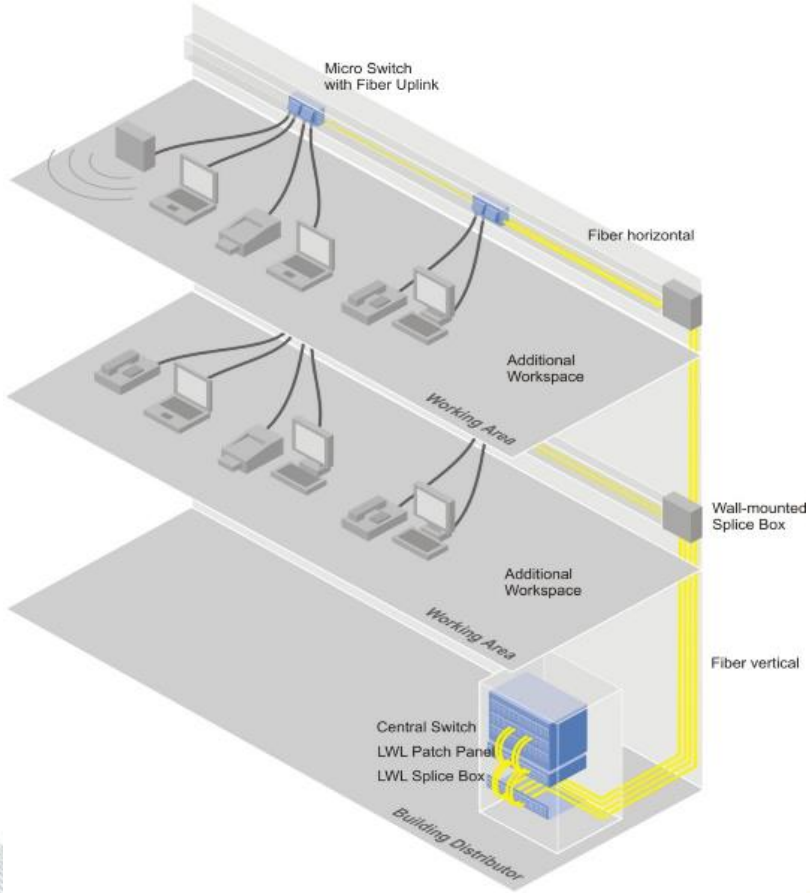
Copper Structured Cabling Network

- Strict length limitation (max. 90 m)
- Floor distribution required
- Additional energy consumption for air conditioning / UPS
- For each end device one central switch port is required
- Huge bundles of cabling (fire load / EMC)
- Technology change requires complete change of horizontal cabling



Fiber To The Office

- No length limitation
- Gain more usable space – no floor distribution required
- 4 end devices share one central switch port
- Up to 75% reduced cabling volume
- At technology change the cabling can remain unchanged
- Technical advantages of fibre



Cost Effectiveness

“Cost comparison of the FTTO-concept with a standard structured cabling with floor distribution“

•WIK = Wissenschaftliches Institut für Kommunikationsdienste

•Founded by the ministry of economy and technology (BMWi)

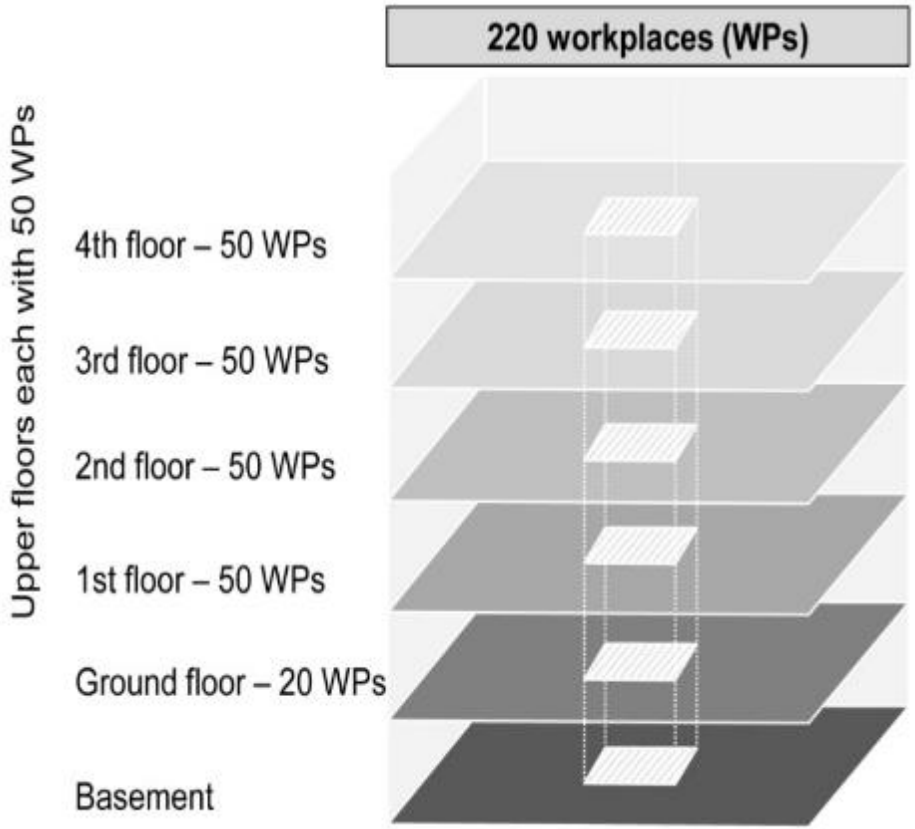
•Analyses and evaluates the concept in terms of business and political economical aspects

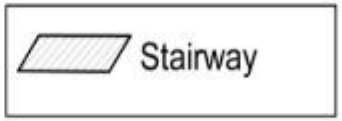
•Main competence is the development of detailed cost models for different network architectures.

The comparison shows clearly the advantages of the FTTO concept. Both, technology and economical wise fiber networks are the better choice. WIK-Consults proves this with an expertise and recommends clearly the use of fiber networks.

Cost Effectiveness

Sample: Small Building





Representation floor on the ground floor with 20 WPs (reception, conference rooms, showrooms, social room).

Basement with central telecommunication room (für both architectures with identical costs).

Cost Effectiveness

Sample: Tall Building

10th floor – 50 WPs
•
•
•
5th floor – 50 WPs

4th floor – 50 WPs

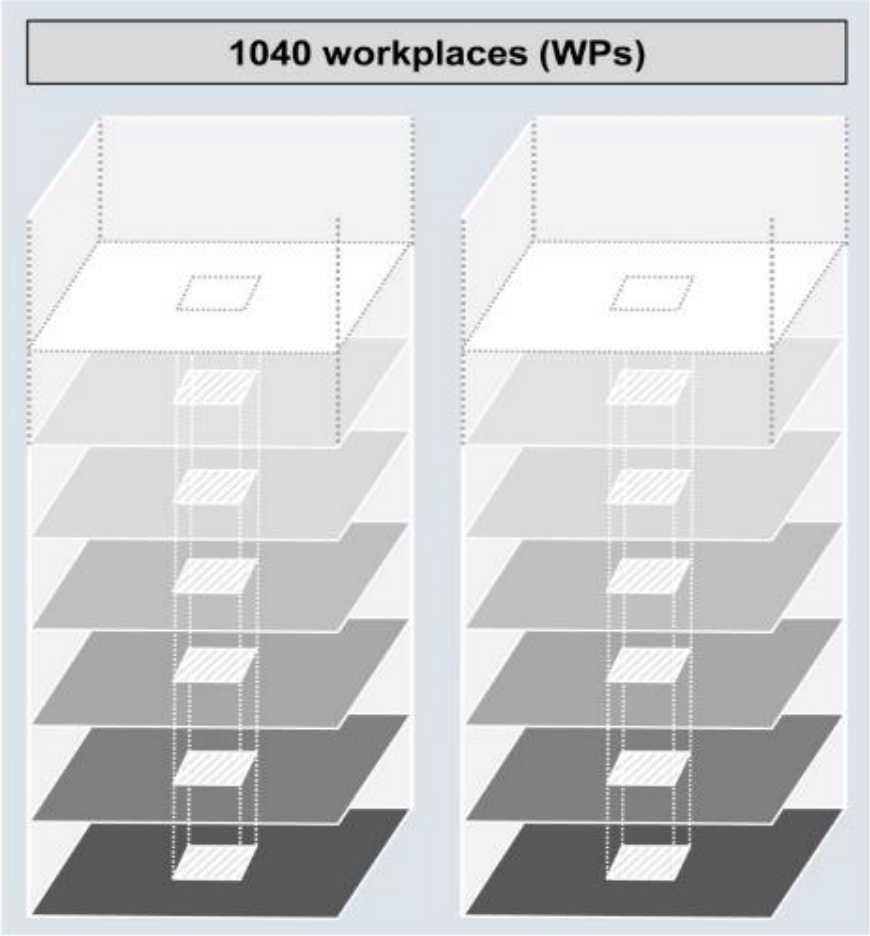
3rd floor – 50 WPs

2nd floor – 50 WPs

1st floor – 50 WPs

Ground floor – 20 WPs

Basement



Cost Effectiveness

Number of workplaces	220	220		1040	1040
	New building	Old building		New building	Old building
Costs of installation and operation after 10 years					
Copper	429,860 €	437,294 €		1,668,005 €	1,731,980 €
FTTO	309,129 €	309,129 €		1,106,685 €	1,106,685 €
Related difference	28%	29%		34%	36%
Yearly costs per work place					
Copper	265 €	270 €		218 €	226 €
FTTO	191 €	191 €		145 €	145 €
Related difference	28%	29%		34%	36%

– The total costs (first installation, operation, planned replacements) of the copper architecture are in all scenarios higher than the FTTO solution and the cost advantage increases if you increase the distances, the number of floors or the number of workspaces.

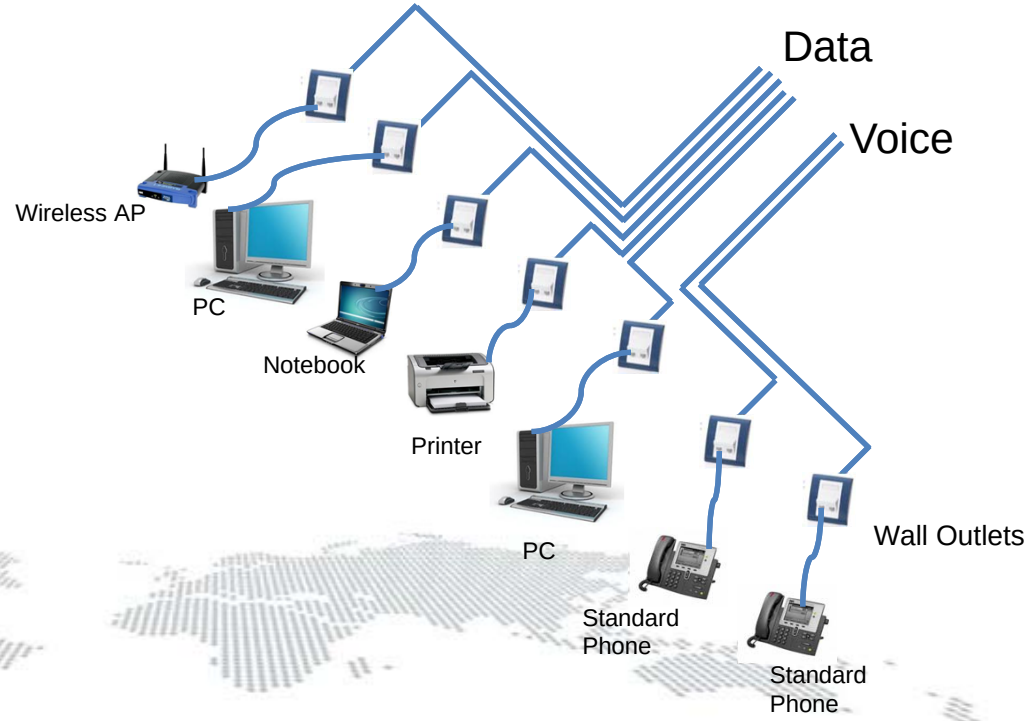
Design Guidelines

FTTO Concept

- Standards-compliant, decentralized networking concept
- Combination of the advantages of fiber optics and copper cabling in an intelligent way
- Standard interfaces (TP) at the workplace
- One central building wiring closet for better scalability, migration, and redundancy
- Investment protection and reliable planning due to long-term periods of use
- Low cable volume, no floor distribution units, reduction of investment and operational costs

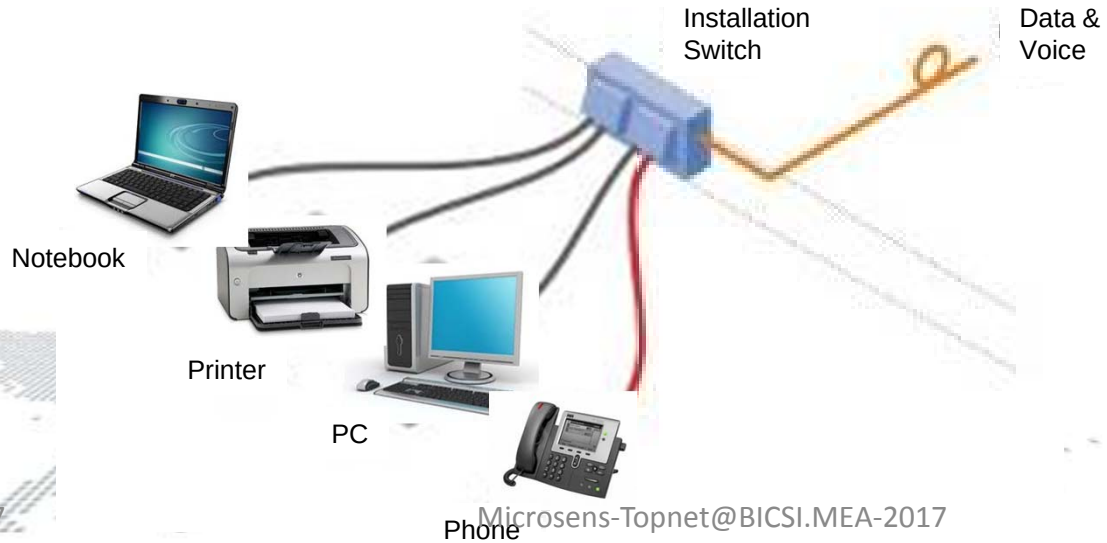
Copper Structured Cabling System

- In classic structured cabling system, the horizontal cabling on each floor consists of copper cables linking the data ports in the offices to decentralised Ethernet switches located on each floor



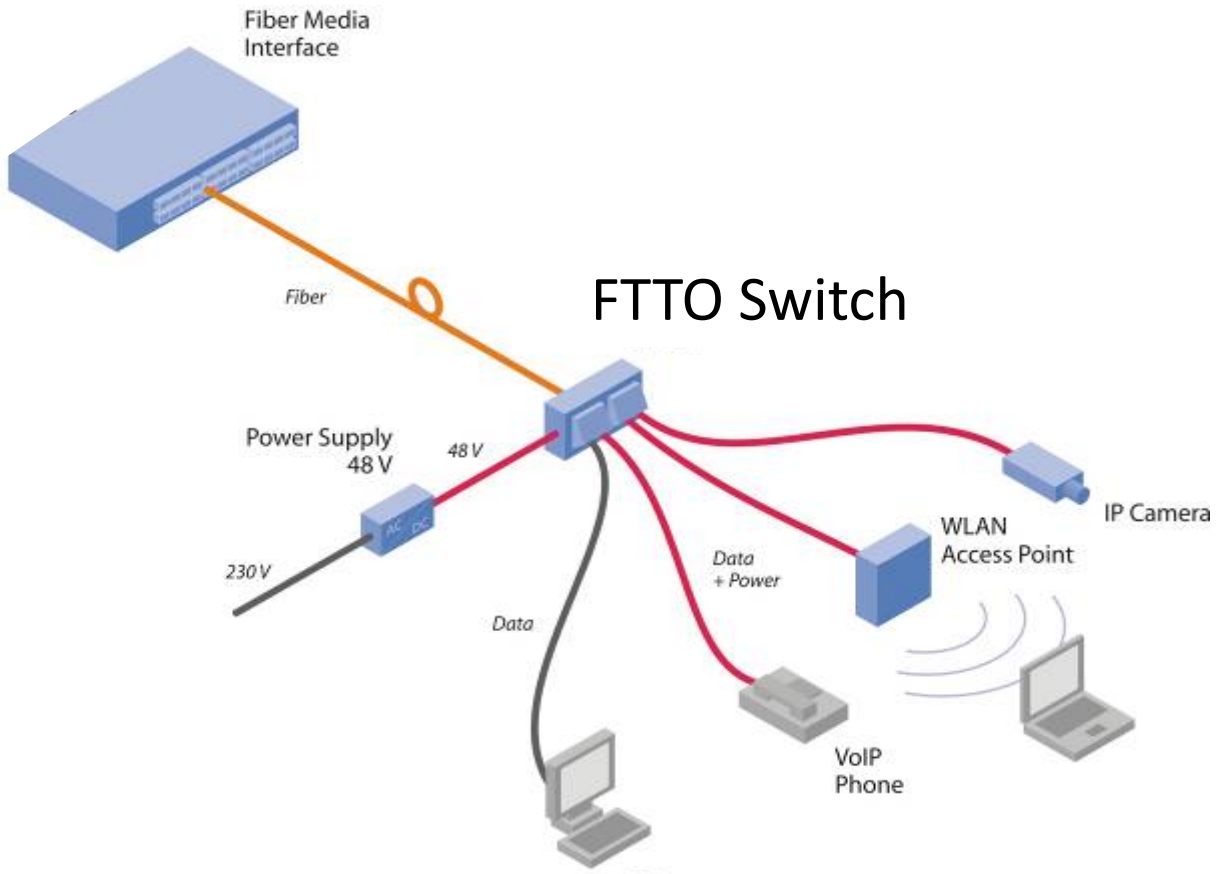
FTTO Concept

- The FTTO Concept implements fiber optic cables for the horizontal floor cabling, allowing the end users to connect their equipment directly up to copper Ethernet ports via 4-port fiber micro switches / installation switches (Fast Ethernet or 1 Gb) located in the work areas.

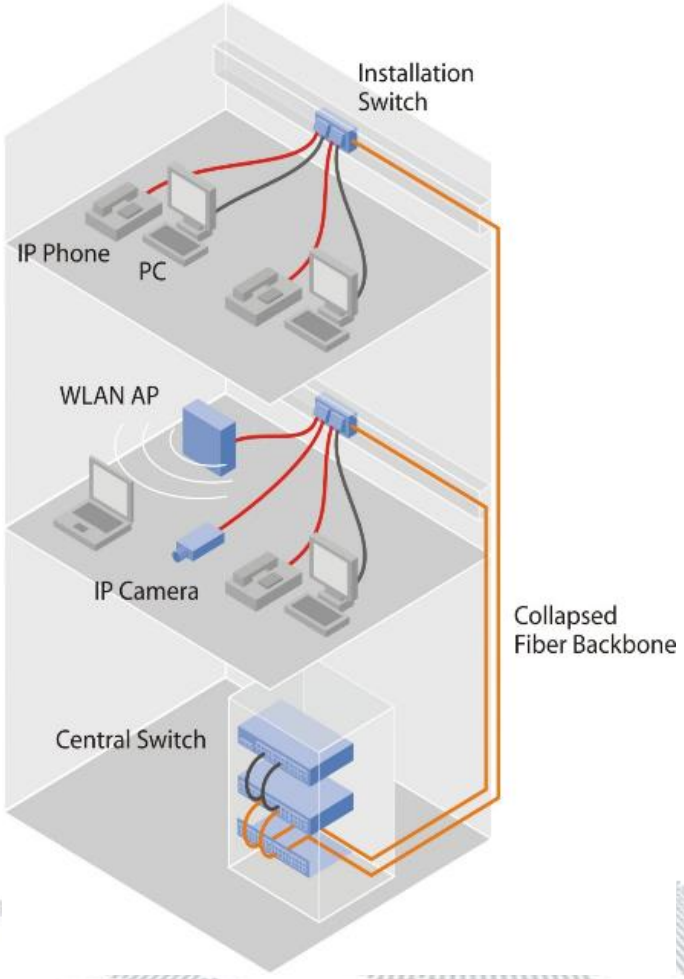


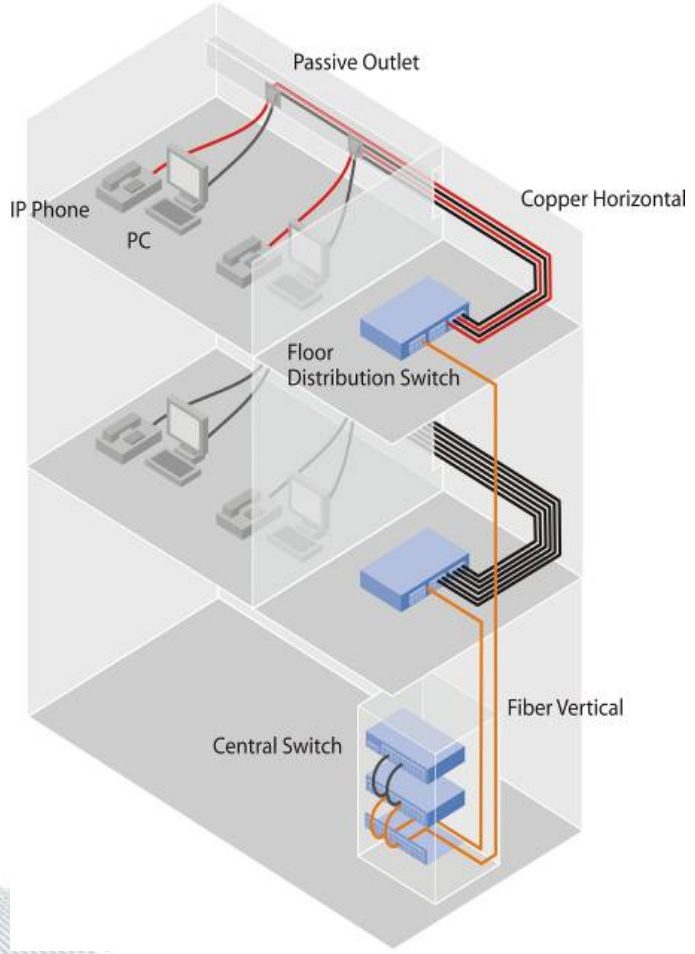
FTTO Concept

Central Switch



FTTO Versus Copper SCS





FTTO Sub Systems

Work Area

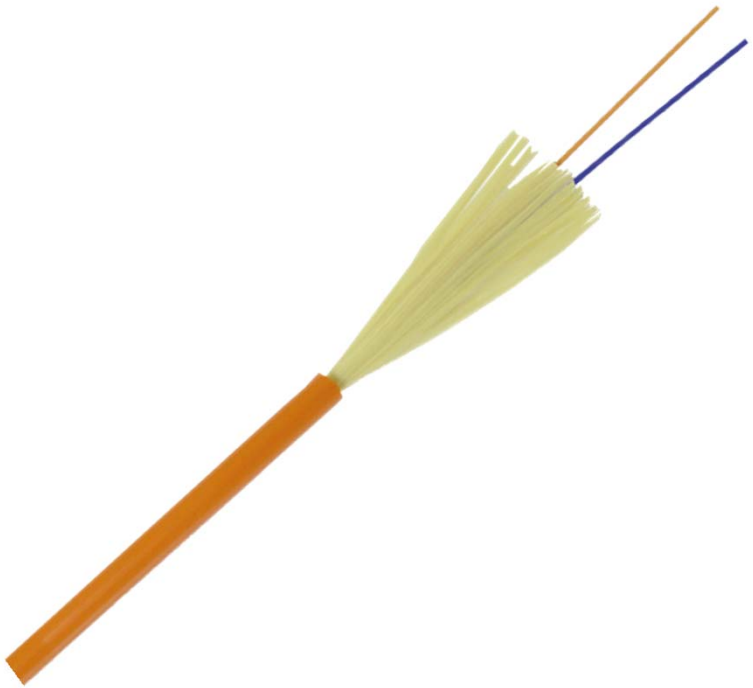
- **The horizontal cable can be terminated with a splice on connector or field connectors**

SC Type Splice-on Connector

FTTO Sub Systems

Horizontal Cables

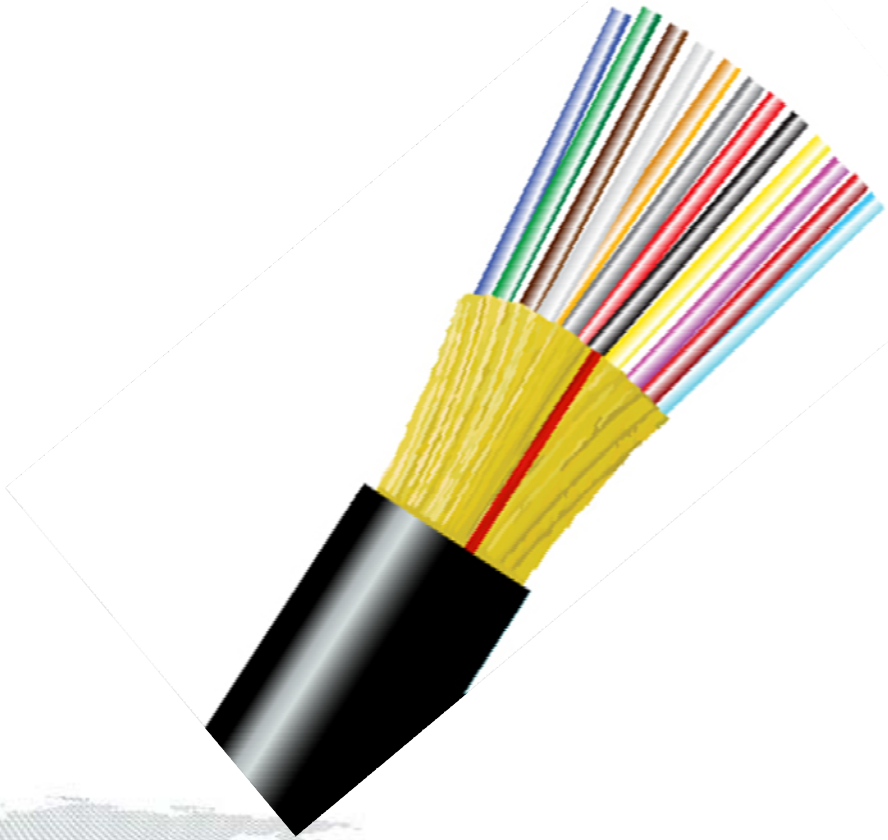
- **For the horizontal links either Single Mode or Multi Mode cables can be used.**
- **Preferably 2 core**



FTTO Sub Systems

Backbone Cables

- **For the backbone links, use higher count tight buffered cables**
- **Strands depends on the number of FTTO switches**



FTTO Sub Systems

Backbone Hardware

Wall mount splice enclosures are used to join the backbone and horizontal cables.

Micro Switch / Installation Switch

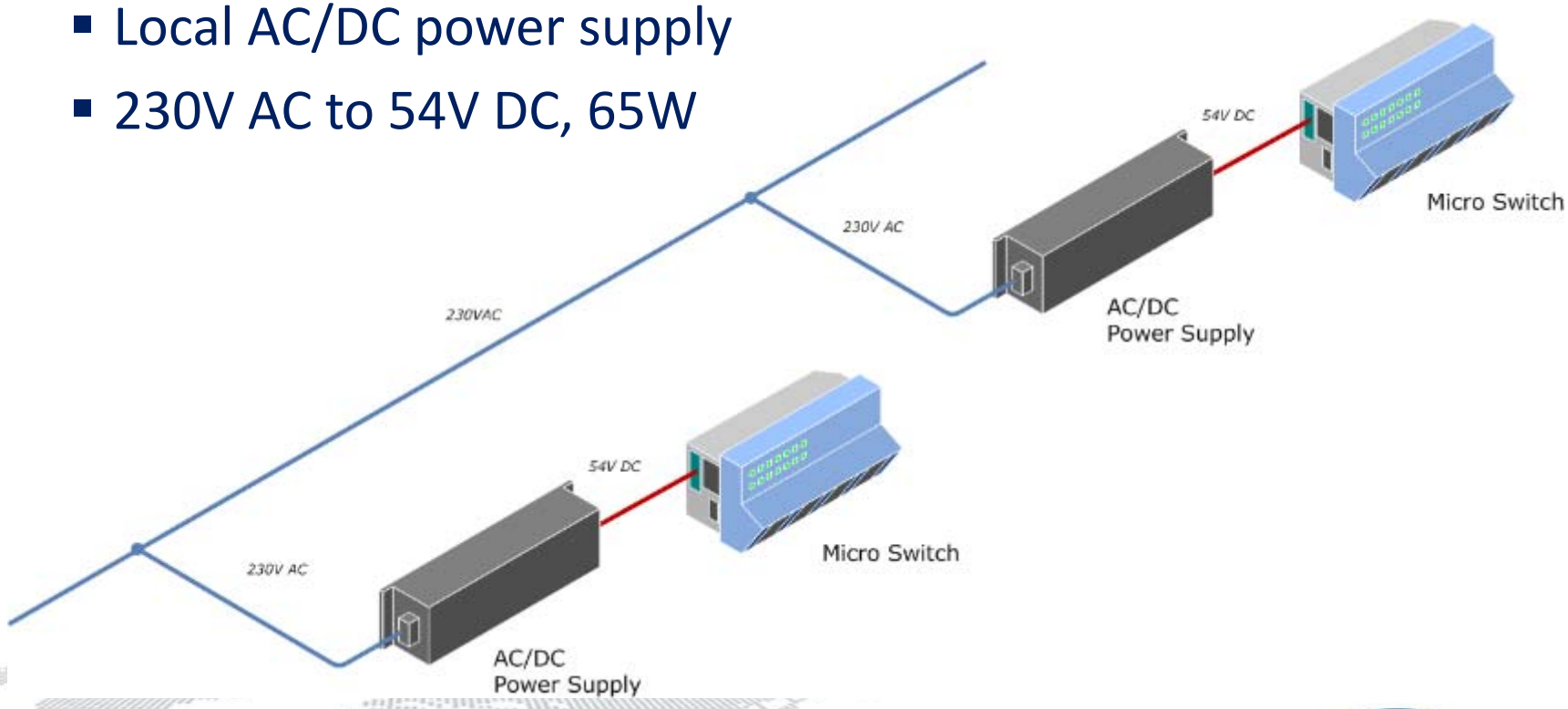
- Easy installation and operation
- Compact dimensions, Universal 45x45 Design
- Universal Snap-In mounting into
  - Cable trunks, sub-floor boxes, wall boxes
  - In wall
  - Desktop (Desktop box, laboratory unit)
  - Distribution racks (DIN-rails)
- Simple configuration and monitoring via network management

FTTO Switch

- Optimised compact and fanless design
- Full Gigabit Ethernet Performance on all ports
  - 1x 1000Base-X fiber uplink
  - 4x 10/100/1000Base-T Twisted Pair RJ-45 ports
  - 1x 10/100/1000Base-T Twisted Pair RJ-45 downlink (optional)
- Power-over-Ethernet functionality on all RJ-45 ports
- Integrated network management

Power Supply

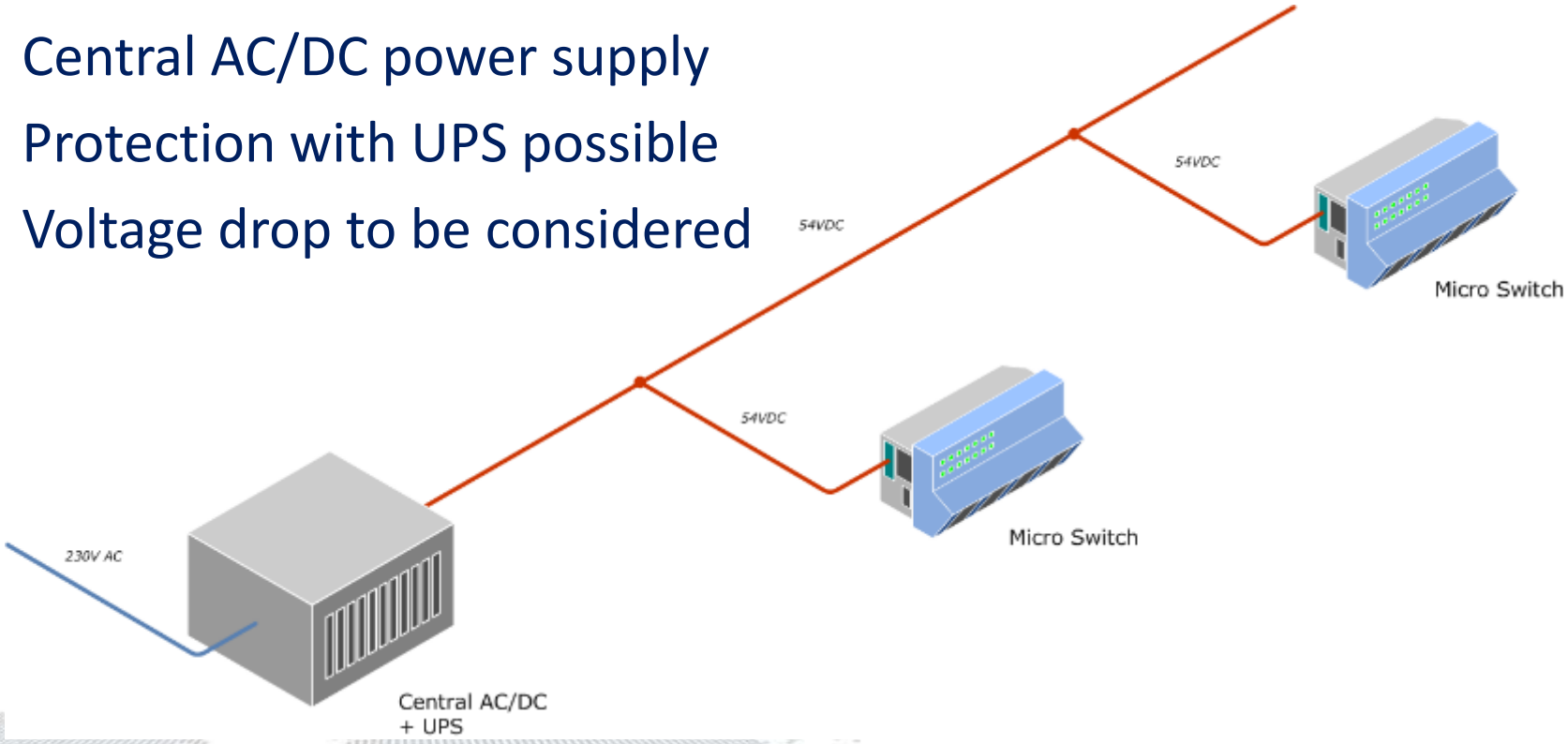
- **AC power supply (decentral)**
  - Local AC/DC power supply
  - 230V AC to 54V DC, 65W



Power Supply

DC Power Supply (central)

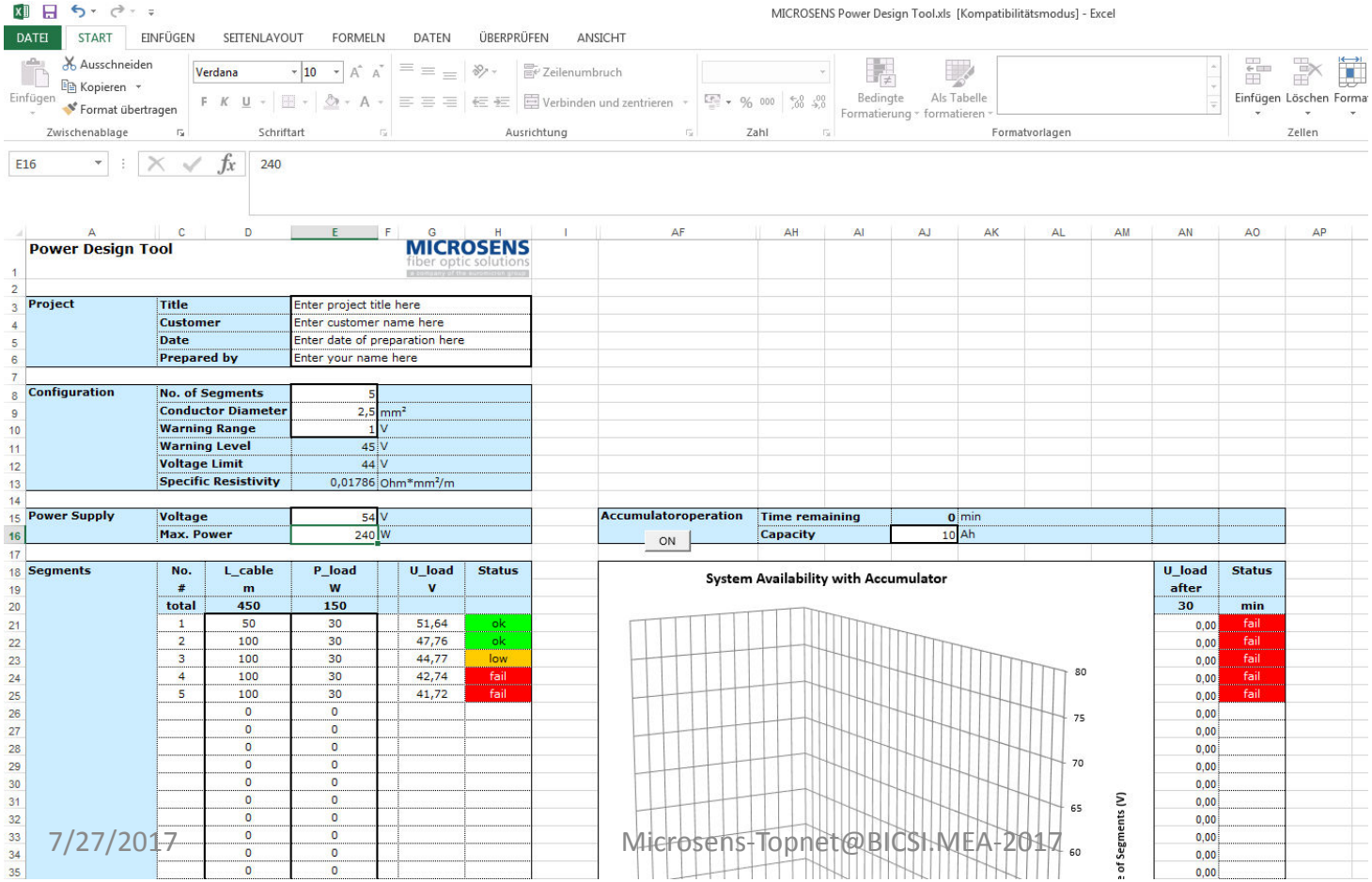
- Central AC/DC power supply
- Protection with UPS possible
- Voltage drop to be considered



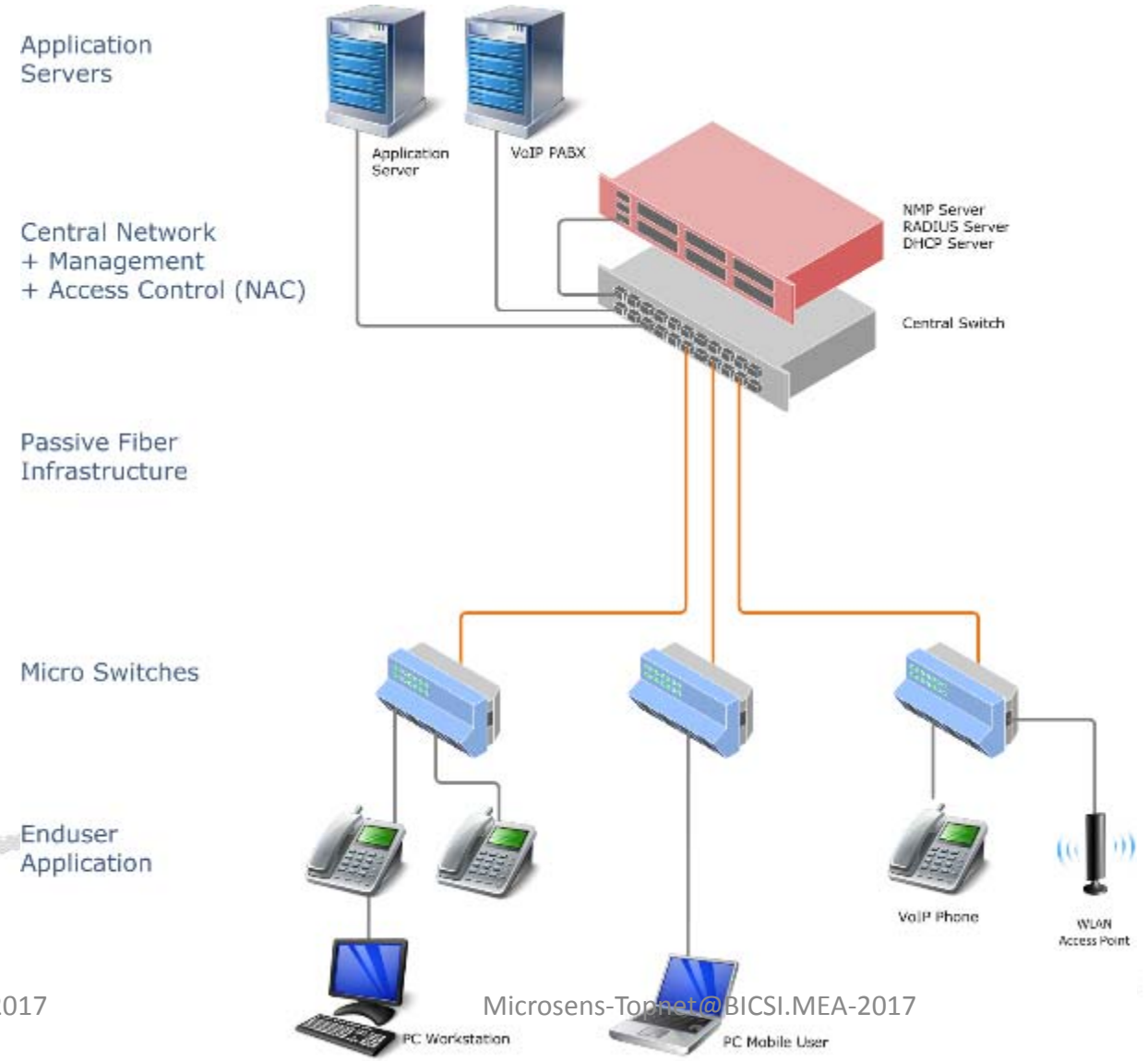
Power Supply

Power Design Tool

- Calculating cable length and diameter



FTTO Structure



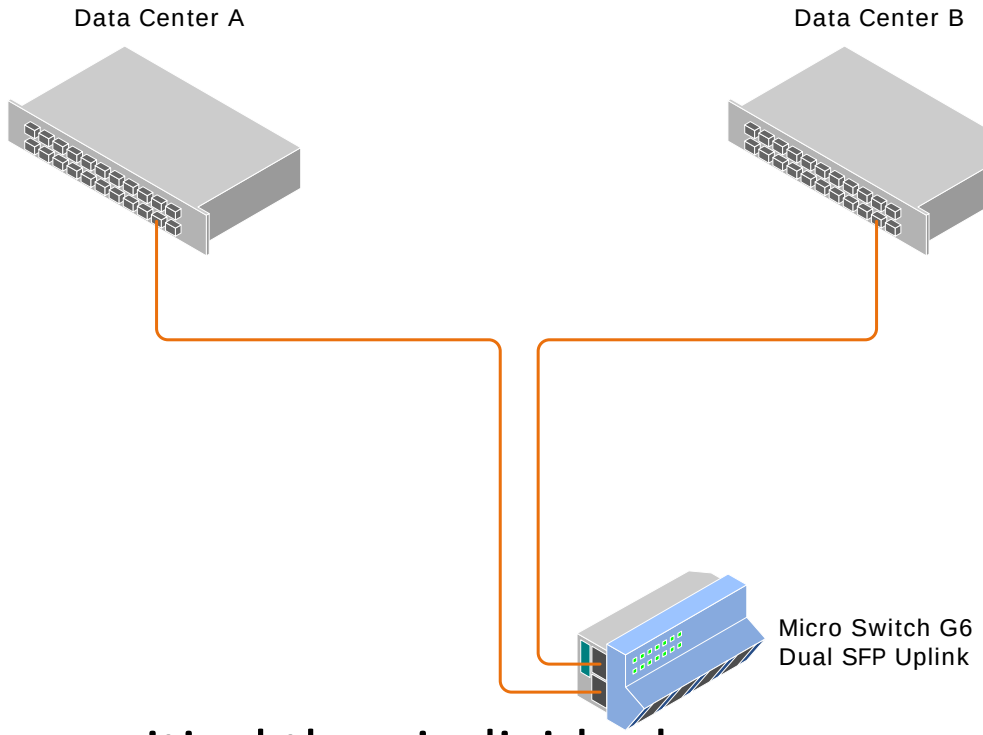
Redunduncy

Dual SFP Uplink

- Provides 2 slots for fiber uplink
- Downlink is removed
- Former Downlink port is used as Expansion Port (Terminal)

FTTO – Dual SFP

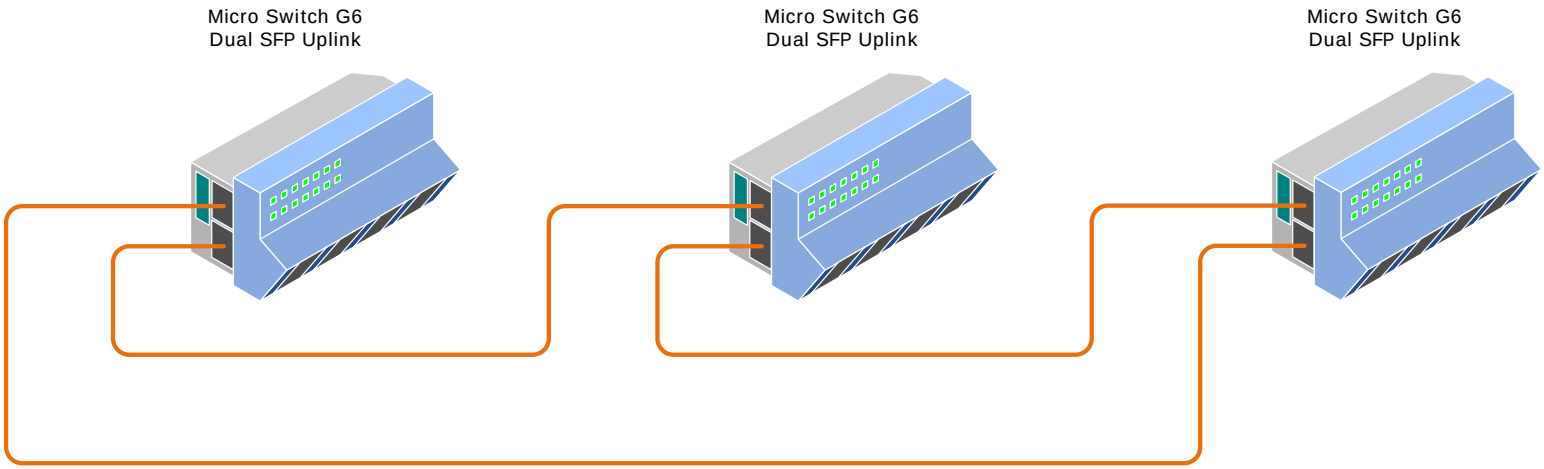
Dual SFP Uplink - Redundant Data Center



- Service is more critical than individual user
- Maximum network service availability
- Minimized downtime

FTTO – Dual SFP

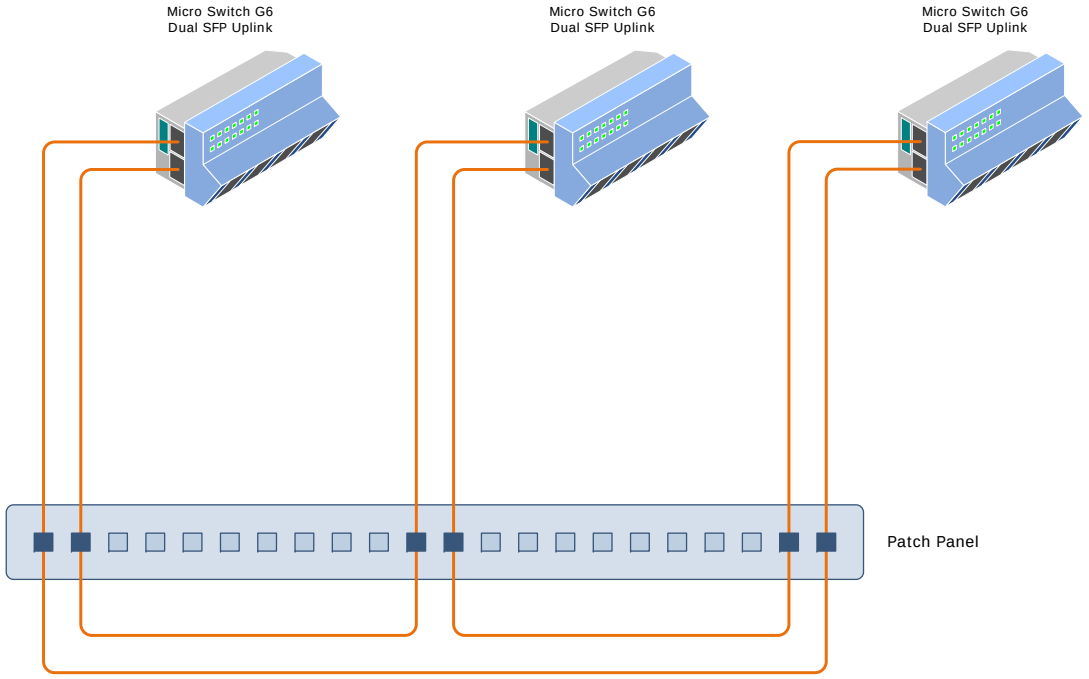
Dual SFP Uplink – Redundant Ring Structure



- Simplified network topology
- Easy to install, easy to expand
- Ring provides failure tolerance

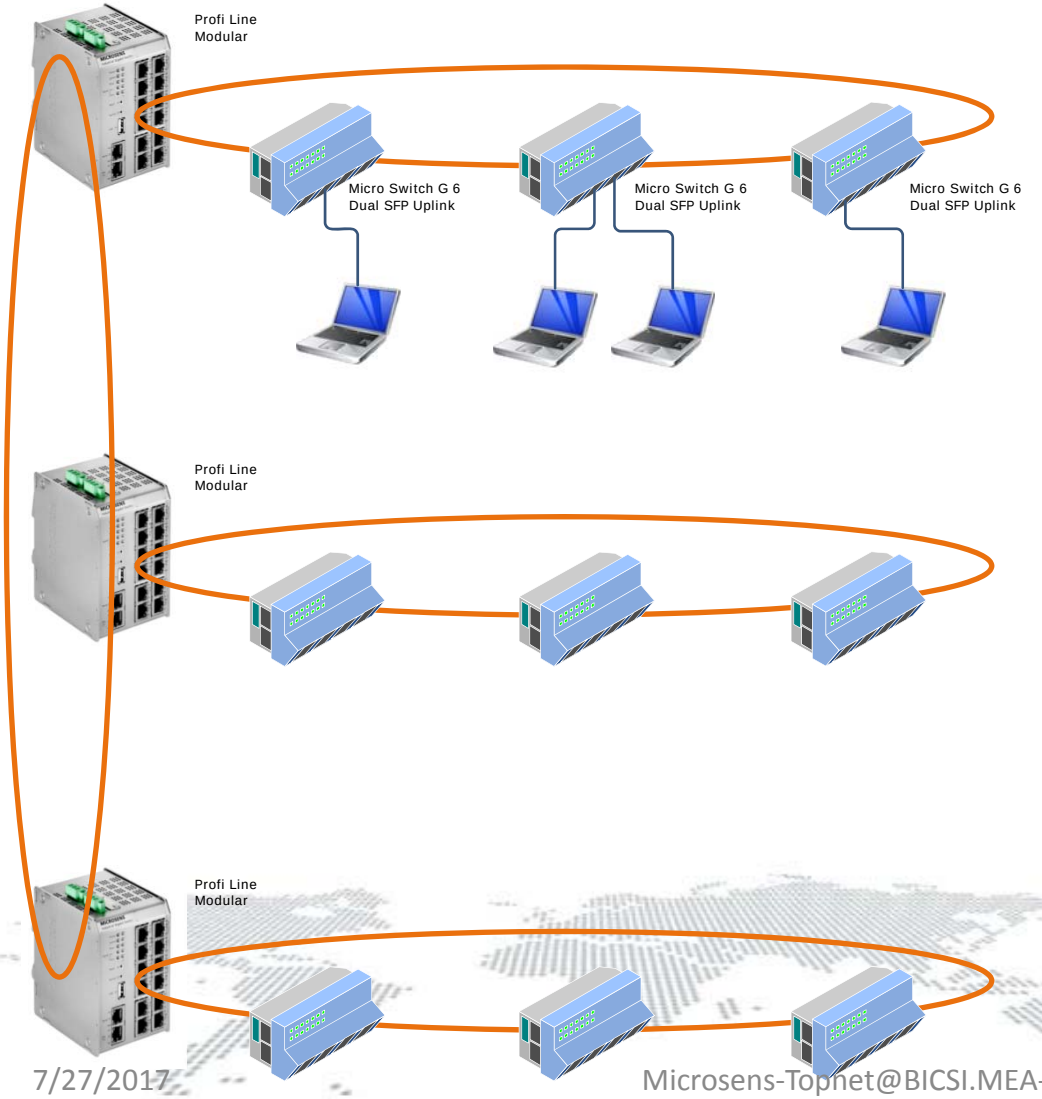
FTTO – Dual SFP

Dual SFP Uplink –Ring structure with star topology



- Star cabling topology, patched for ring structure
- Utilization of existing cabling
- Ring provides failure tolerance

FTTO – Ring Cabling



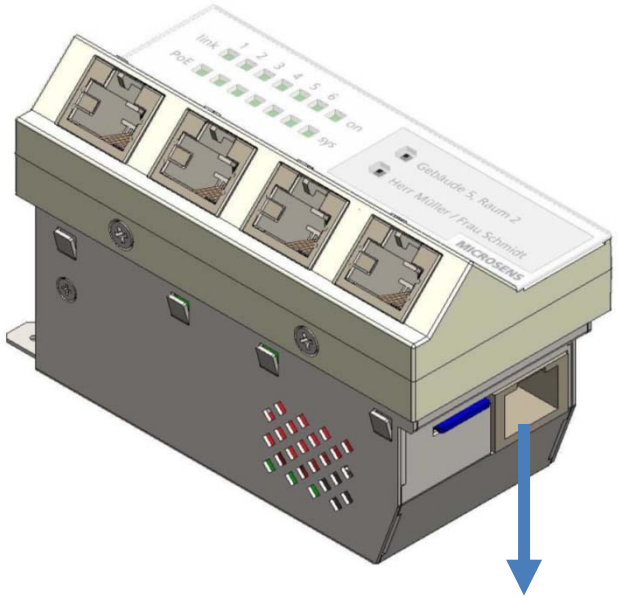
FTTO Topology
Ring Structure

- Ring structure for horizontal cabling
- Ring structure for vertical cabling
- Combination of PLM and Micro Switches
- Simplified installation and expansion
- Minimized cabling efforts

FTTO Expansion

Downlink Port

- **For cascading up to 3 FTTO switches**
- **For locations where more than 4 ports are required**



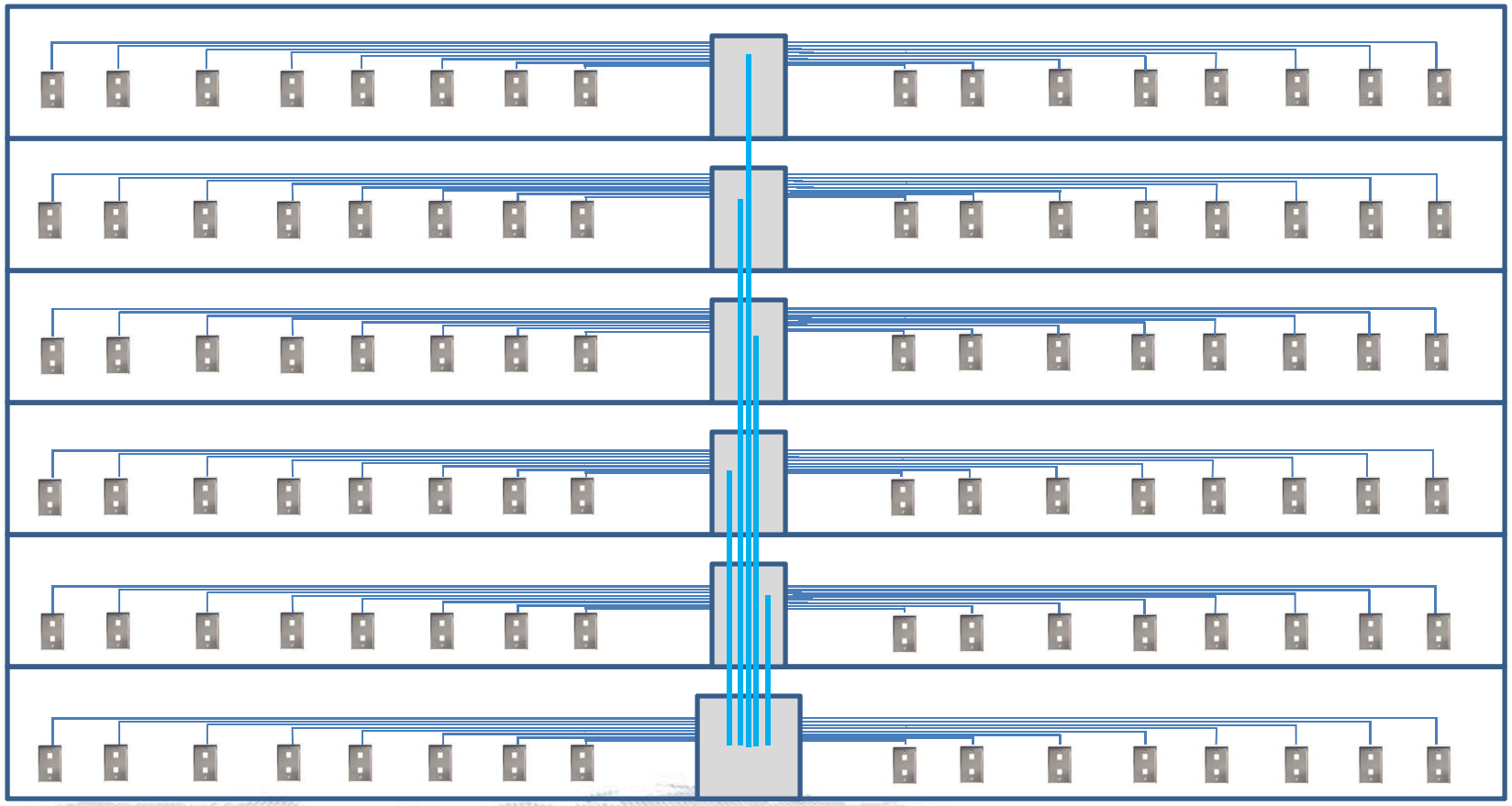
DownlinkPorts
EnergyEfficientEthernet
PoE+ (max. 30 W)

Typical Commercial Building

Cabling Requirement

- Usable space / floor - 1,200 m^2
- Number of floors - 6
- Total usable space - 7,200 m^2
- Number of work areas - 720
- Work areas / floor - 120
- I/O per floor - 120 dual

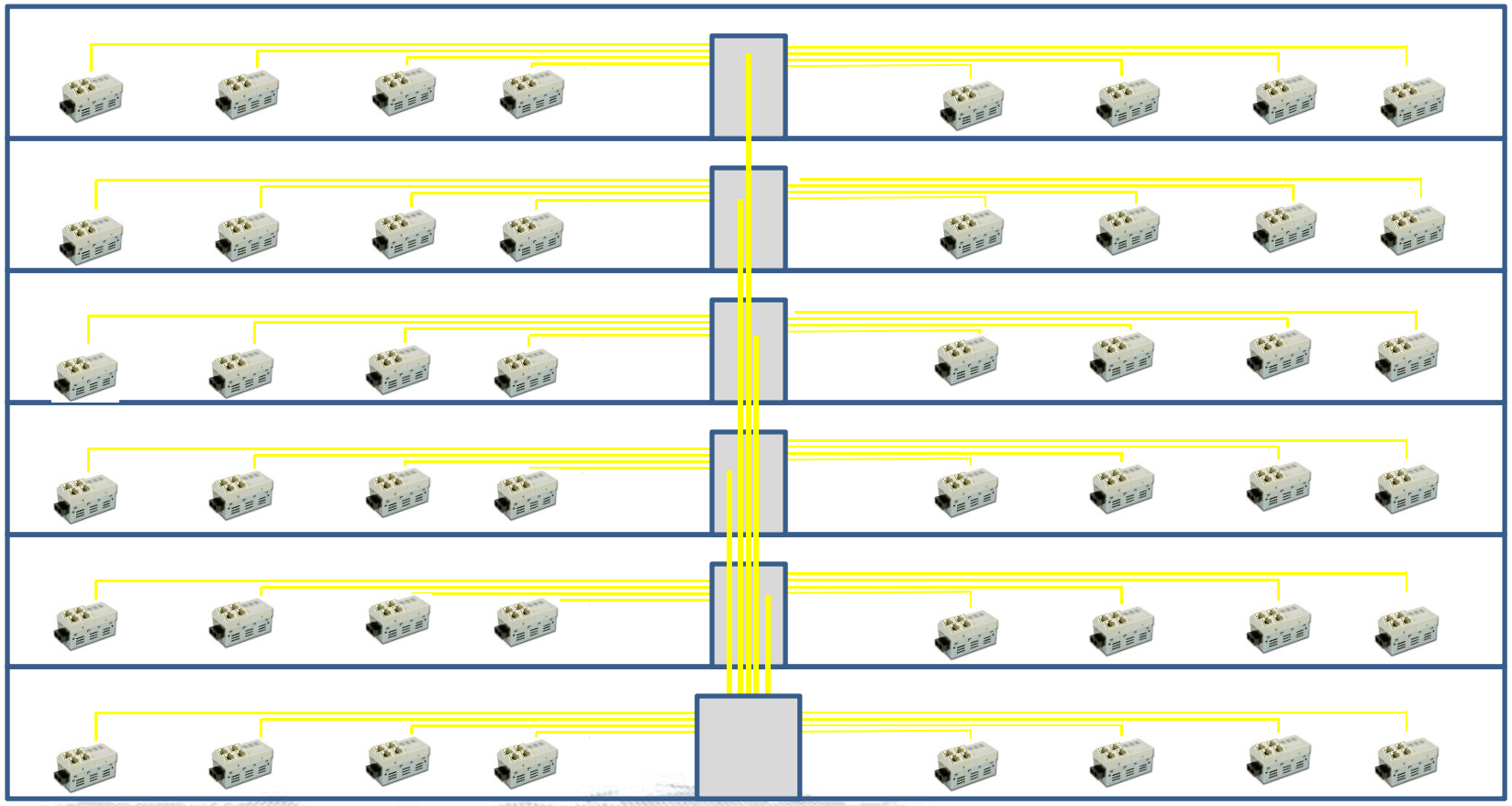
Copper Structured Cabling



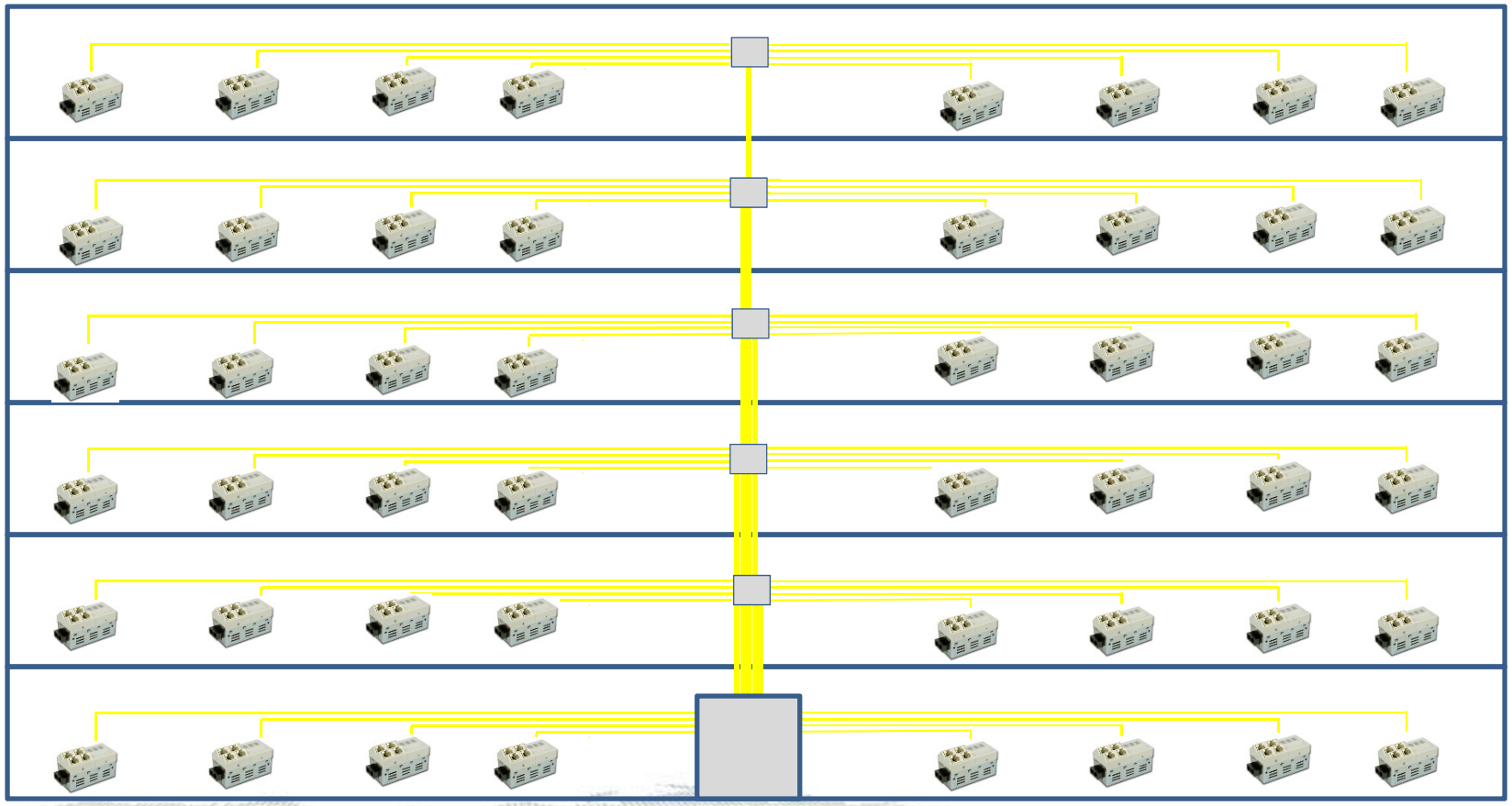
Copper Structured Cabling

Information Outlets	1,440
Cat6 Patch Cords - I/O	1,440
Cat6 Horizontal Cable (m)	72,000
Cat6 Patch Panel (24 port)	60
Cat6 Patch Cords - TR	1,440
24-port access switch	60
FO Patch Panel (6-fiber)	5
FO Patch Panel (48-fiber)	1
FO Patch Cords	12
6-core FO cable (m)	150
42U Racks for Telecom Rooms	5
42U Racks for Equipment Room	4
Telecom Rooms	5
Equipment Room	1
Core Switch ports	60

FTTO and Fiber Optic Cabling



FTTO and Fiber Optic Cabling



FTTO Bill of Material

FTTO switch (4-port)	360
Cat6 Patch Cords - I/O	1,440
2-core FO cable Horizontal (m)	18,000
FO termination box	360
FO Patch Cords (FTTO)	360
Splice enclosures	6
FO Patch Cords (ER)	360
FO Patch Panel (72-fiber)	12
72-core FO cable (m)	300
42U Racks for Equipment Room	4
Equipment Room	1
Core Switch ports	360

Copper and FTTO Bill of Material

Item	Copper	FTTO
Information Outlets	1,440	
FTTO switch (4-port)		360
Cat6 Patch Cords - I/O	1,440	1,440
Cat6 Horizontal Cable (m)	72,000	
2-core FO cable Horizontal		18,000
FO termination		360
Cat6 Patch Panel (24 port)	60	
Cat6 Patch Cords - TR	1,440	
24-port access switch	60	
FO Patch Panel (6-port)	5	
FO Patch Panel (48-port)	1	
FO Patch Panel (72-fiber)		12
6-core FO cable (m)	150	
72-core FO cable (m)		300
FO Patch Cords	12	360
42U Racks for Telecom Rooms	5	
Splice enclosures		6
42U Racks for Equipment Room	4	4
Telecom Rooms	5	
Equipment Room	1	1
Core Switch ports	60	360

Design Advantages of FTTO Solution

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Saving Space on Telecom Rooms

FTTO

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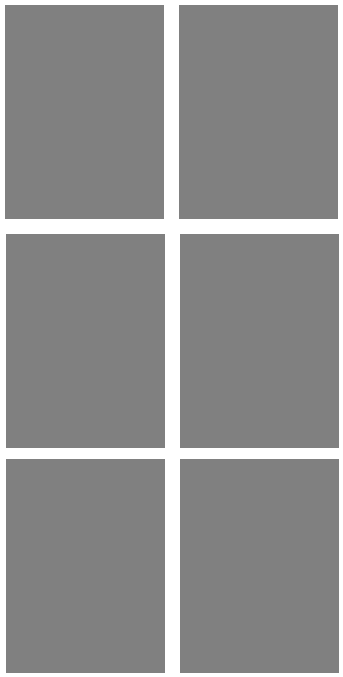
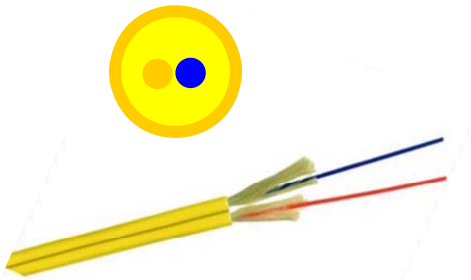


- **Saving on premium space**
- **Reduced operations cost**

(Cooling, Power, maintenance, access control, fire safety)

Cable Trunking and Laying

FTTO



2 core FO cable is only 4 mm dia and one cable for 4 users

- **Saving on cable trunking**
- **Reduced installation cost**

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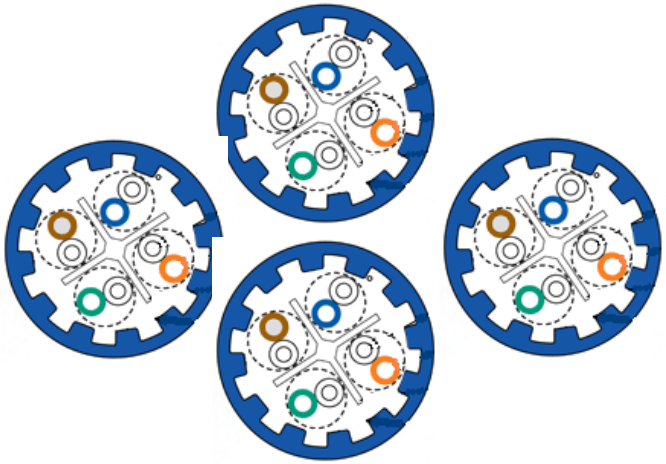

Cat6A or Cat7 cable is 7 – 8 mm dia and 4 cables for 4 users

Core and Access Switches

FTTO

Only 3 core switches

- **Saving on hardware, space, power and cooling**
- **Reduced maintenance and troubleshooting**
- **Higher reliability and availability**

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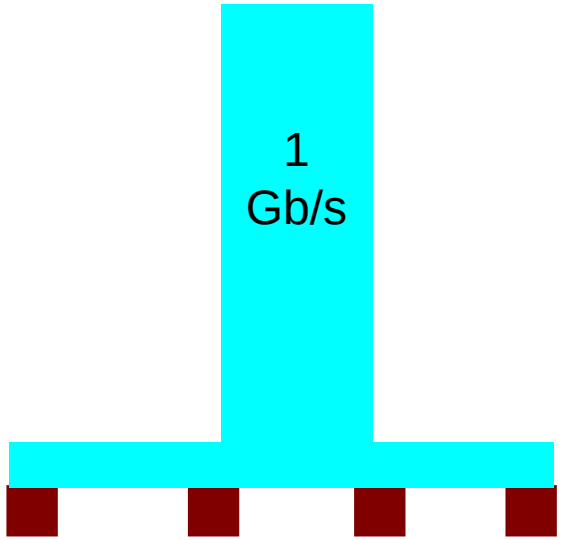
60 nos. 24-port Gigabit switches with PoE and 1 Core switch

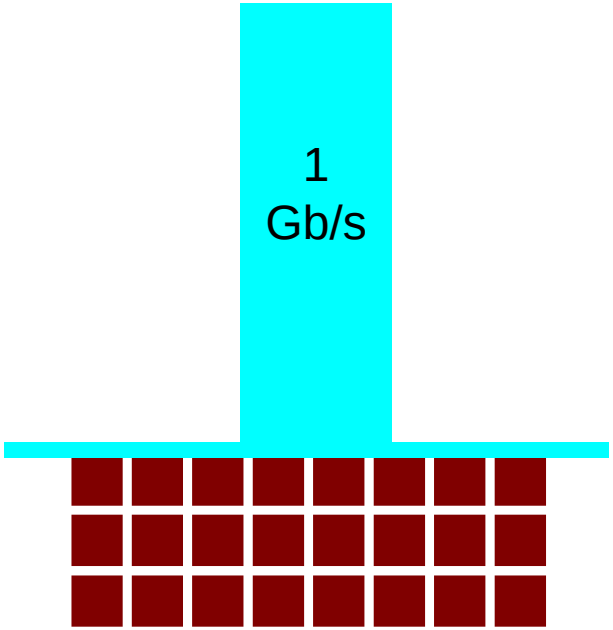
Bandwidth per User

FTTO



4 users share 1 GbE link

COPPER



24 users share 1 GbE link

FTTO offers higher bandwidth per user

Future Proof

FTTO	COPPER
1 10 40 100 ++ Gb/s	1 10 ?? Gb/s

> 1 THz

All present and future data transfer speeds will be supported

500 MHz

Copper can not support more than today's 10 Gb/s

FTTO is future proofed

Life Cycle Cost

FTTO	COPPER
Fiber networks have a longer useable lifetime because fiber networks can be upgraded without pulling new cable: increased data rates are implemented by changing the electronics.	In a copper cabling network, increased data rates have historically required that users change cables, connectors and electronics [Cat5e, Cat6, Cat6A].

FTTO offers lowest TCO

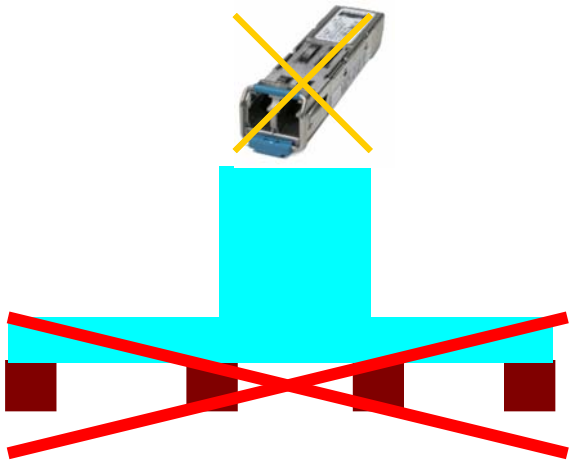
Costs

FTTO	COPPER
• Initial cost slightly less than copper • Much less cost of space for only a few TRs • Low operation cost • Low maintenance cost	• High initial cost for huge cabling, trunking and large quantity of hardware • Huge cost for large number of TRs • High operation cost • High maintenance cost

FTTO offers the least total cost of ownership

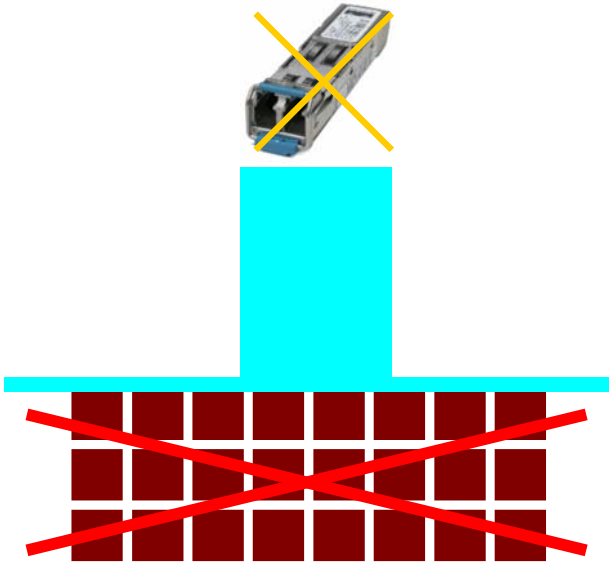
Availability

FTTO



When an SFP or fiber uplink fails only 4 users will be affected

COPPER



When an SFP or fiber uplink fails all 24 users will be affected

FTTO offers high availability

Reliability

FTTO	COPPER
FTTO is inherently more reliable because of its resistance to electro magnetic interference (EMI), radio frequency interference (RFI) and crosstalk.	Copper cabling is highly susceptible to EMI, RFI, crosstalk and return loss failures.

FTTO is highly reliable, provides error-free transfer

Weight and Pulling Tension

FTTO	COPPER
• Weighs only 21 kg/km • Max pulling loading 660 N	• Weighs 75 kg/km • Max pulling loading 100 N

Fiber is lighter and stronger

Cable Testing

FTTO	COPPER
Simplified testing, only a few parameters to be tested : attenuation, polarity , length and OTDR trace, On a much less number of links → 75% less than copper	Many parameters have to be tested: length, wire map, return loss, Insertion loss, NEXT, PSELFEXT, delay skew. Even if one of them fails, the link will not work

FTTO is simpler to test and troubleshoot

Safety

FTTO	COPPER
Fiber is dielectric (non-metallic), so completely safe and presents no spark or fire hazard.	Copper conducts electricity, can cause damages to equipment if carries unwanted currents.

Fiber provides maximum safety

Security

FTTO	COPPER
Fiber does not radiate any energy, so it is extremely difficult to tap into it	Copper cable can be tapped since it radiates EMI

FTTO provides maximum security

Environmental

FTTO	COPPER
Due to its size and weight, fiber optic cable uses **less than one fifth** of jacket material used by copper cables.	Large volume of copper cables used have large amount of jacket and Insulation material, which poses an environmental hazard.

FTTO is environmental friendly

FTTO is Standard Compliant

- TIA/EIA 568C
  - Standardised as Fiber-to-the-Enclosure (FTTE)
  - Centralized cabling
  - Singlemode cable can now be used in horizontal
- EN 50173
  - Recognized as collapsed backbone cabling
- ISO 11801
  - Recognized as FTTD and centralized optical architecture (COA)

Association for FTTO

- A non-profit organization
- Composed of ICT professionals, consultants, manufacturers, distributors, systems integrators, and users of ICT infrastructure who are actively involved in applications of fiber optic for ICT network infrastructure
- To support the growth and education of FTTO for its use in the industry
- Members are focussed on promoting the adoption of FTTO for modern data network infrastructure in premise applications
- www.ftto.us, www.ftto.me, www.ftto.in

Why FTTO?

- Fiber optic technology is the most future-proof cabling technology currently available
  - maximum achievable bandwidth
  - a range of other obvious advantages.
- Copper cabling is much less future-proof from a long-term perspective.
- Copper performance has its physical limitations and is clearly inferior to fiber optic networks.

Why FTTO?

- FTTO concept offers cost benefits for large projects, such as airports or hospitals
- FTTO can also achieve obvious cost savings for smaller projects
- For some buildings, FTTO may be the only solution

Installation Options

Floor Tank

Cable Trunk

Distribution Rack

In Wall

Desktop Box

Pillar

Wall Box

TeLi-Tank

Installation Accessories

Micro Switch in cable duct
with 45 mm track

Adapter plate + E2 Socket
in OBO BETTERMANN GEK BR-Duct

Installation Accessories

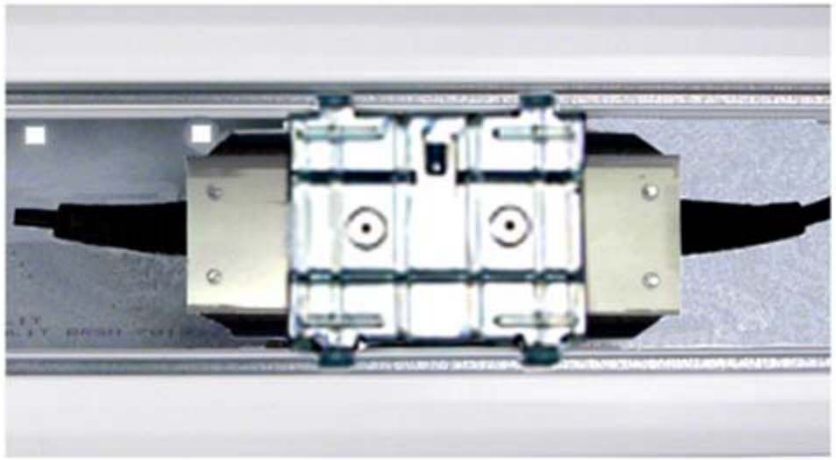
Insert switch

Apply cover frame

Installation Accessories

Power supply installed with C-rail

Power supply installed with front-locking mounting in duct



Installation Accessories

Power supply installed in a standard socket

Installation Accessories

- **Floor service box installation**

Installation Accessories

- **Floor service box installation**

Installation Accessories

- **Switch with cover installed in an hollow wall socket**

References

AIRPORTS

Dubai International Airport, UAE
Concourse A

Dubai International Airport, UAE
Concourse D

References

UNIVERSITIES

Munich University, Germany

College de l'oise, France

References

HOSPITALS

Det Nye Universitetshospital, Denmark

Cannes Hospital, France

Installation Practices
Hardware and Configuration

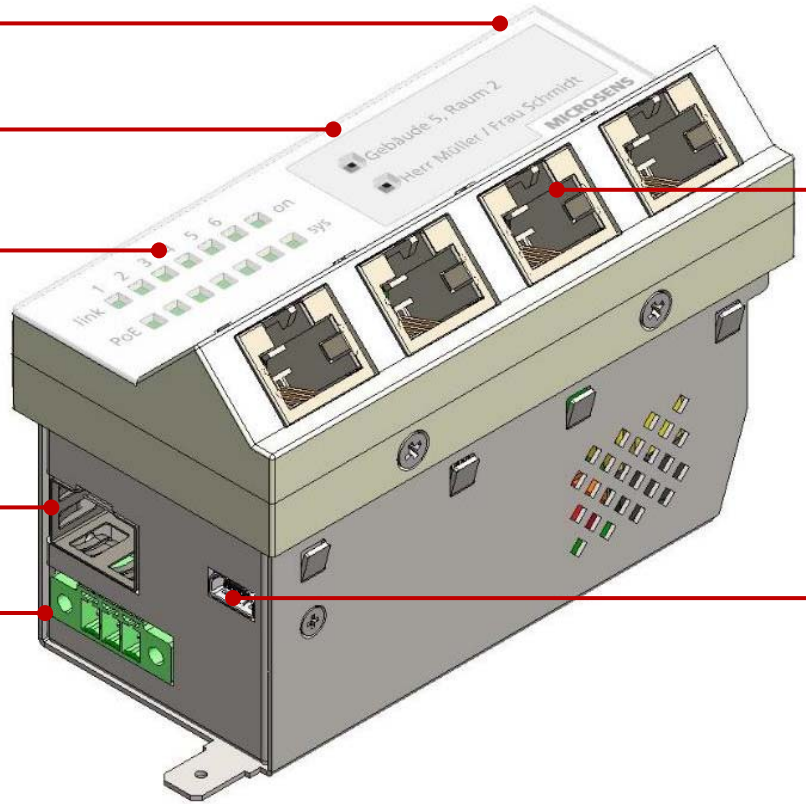
FTTO Switch

Hardware Platform

- Latest Ethernet switch technology
  - Energy Efficient Ethernet (energy savings for copper ports)
  - QoS – 4 Hardware Queues pro Port
  - 256 VLANs
- Power-over-Ethernet Plus (802.3at) on all copper ports (max. 30W per end device)
- Memory card for firmware and configuration (optional)
- Solid, shielded metal housing, clear structure of ports and displays
- Mounting in standard 45mm double frame
- Horizontal and vertical versions for cable ducts, columns and sub-floor boxes

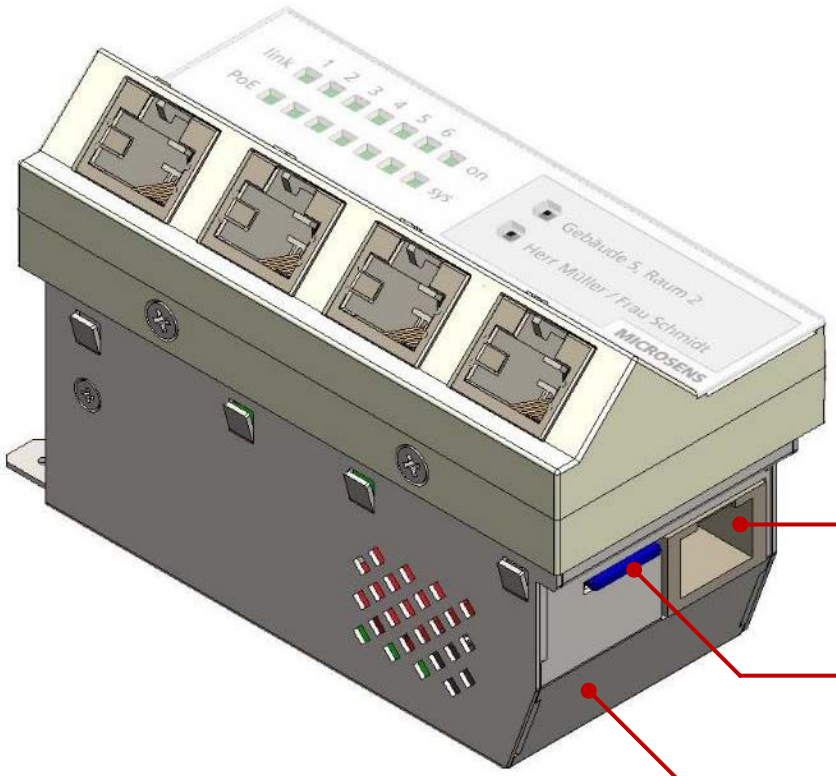
Switch Features

GENERATION 6



Switch Features(Contd.)

GENERATION
6

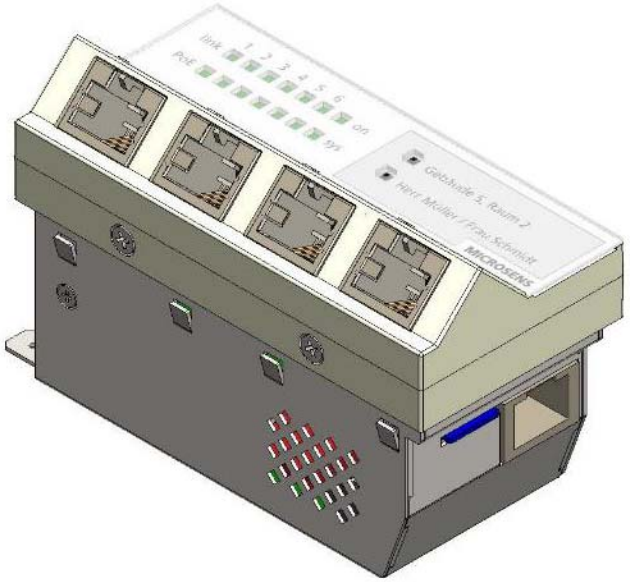


Downlink Ports
Energy Efficient Ethernet
PoE+ (max. 30 W)

Memory Card
Configuration Storage
(optional with G6+)

Chamfer Edge
Simplified Installation

Versions



Horizontal Mounting (Reference)

- *Cable ducts*
- *Floor-boxes*

Vertical Mounting

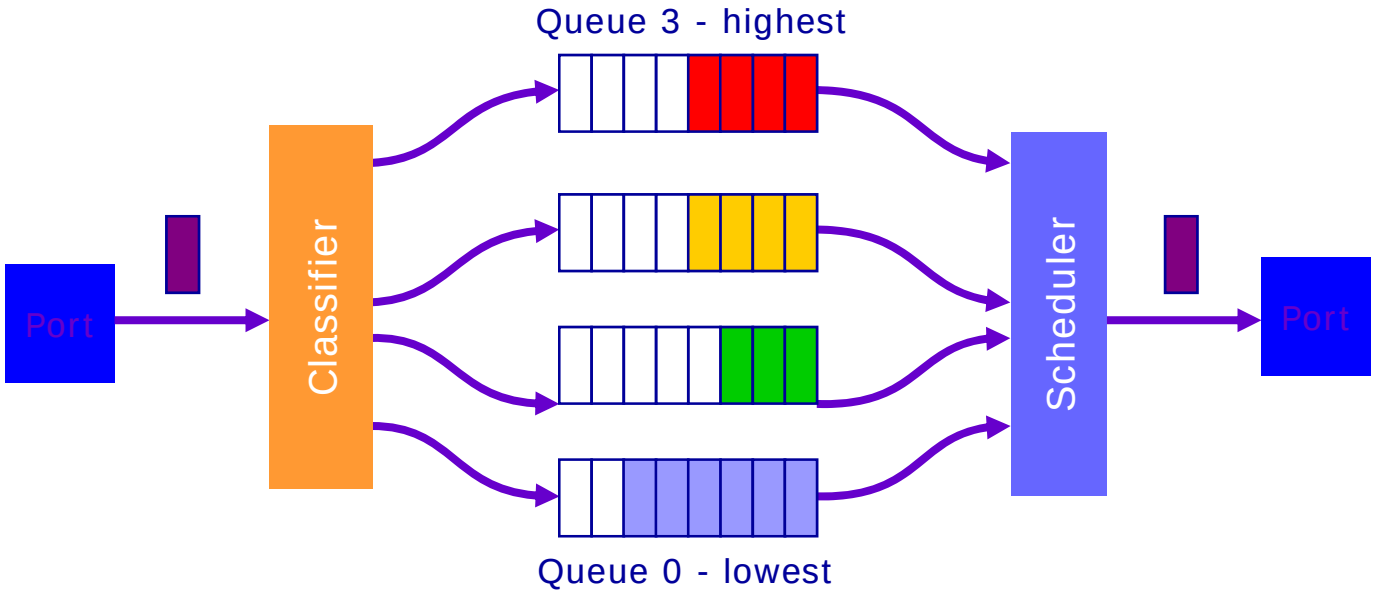
- *Cable ducts*
- *Columns*
- *Floor-boxes*

Intelligent Office

- From Product to Application

Quality of Service

Prioritization



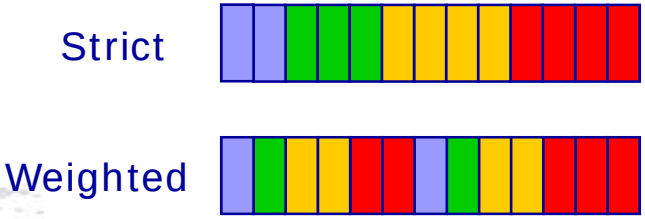
4 Priority levels

4 queues per port

2 Weightings

Strict = Higher priority first

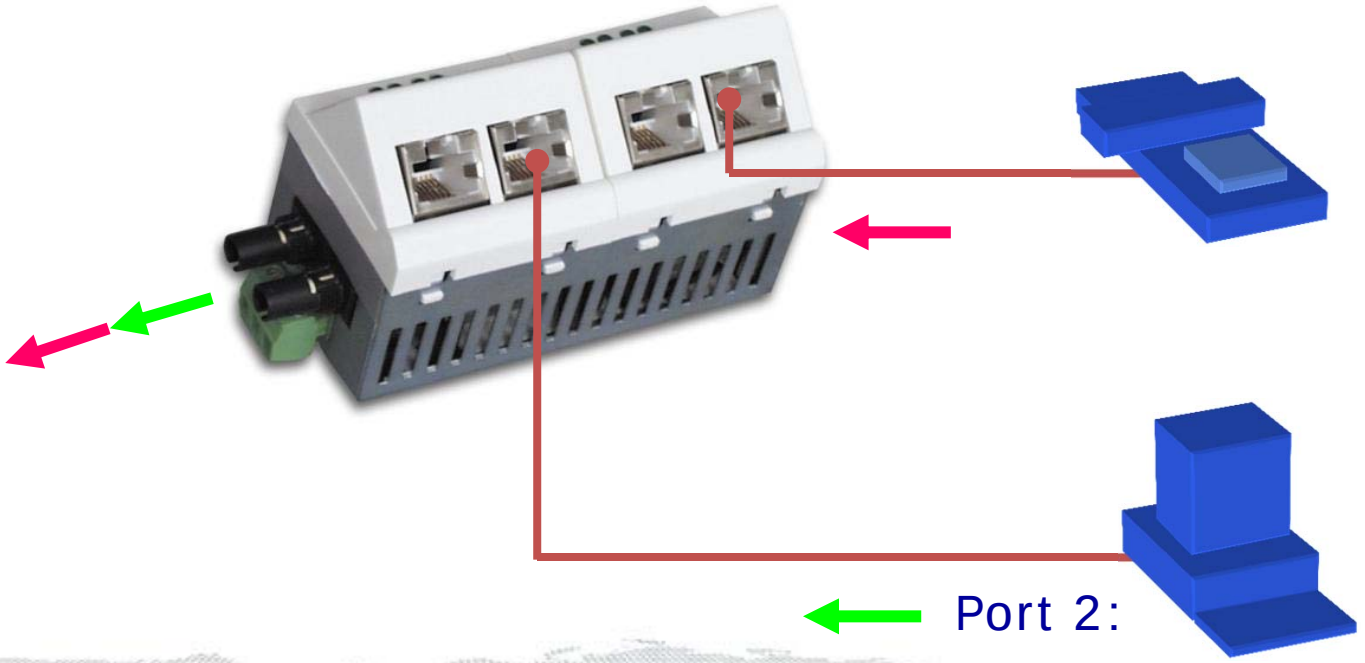
Weighted = queues weighted 8:4:2:1



Quality of Service

Port based prioritization

Layer 1: Hardware

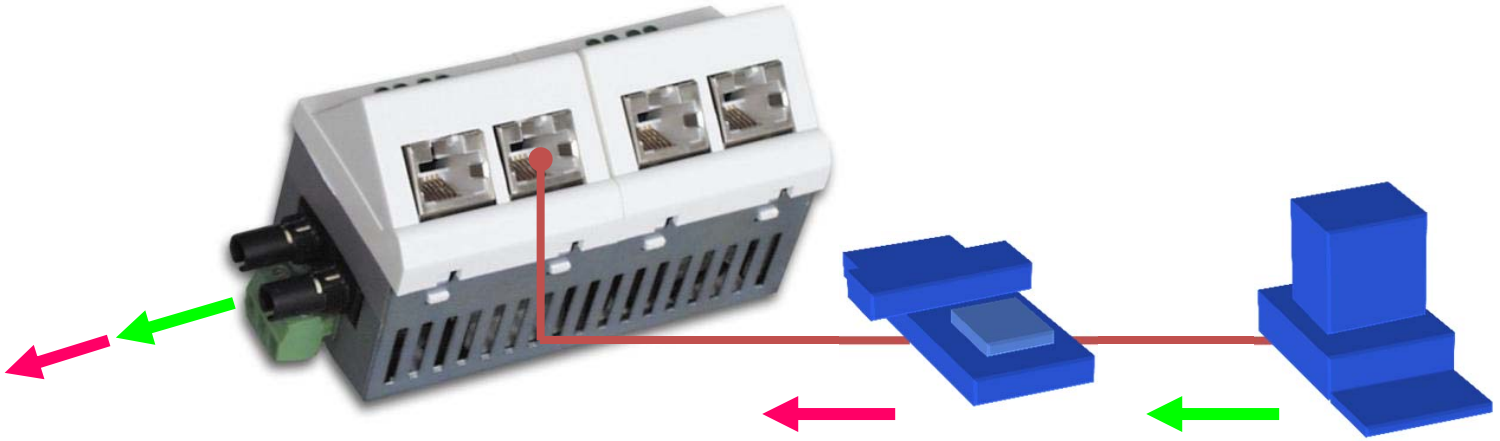


Quality of Service

Protocol based prioritization

Layer 2: IEEE 802.1p/Q (VLAN Tag)

Layer 3: DiffServ Codepoint (IP Header)

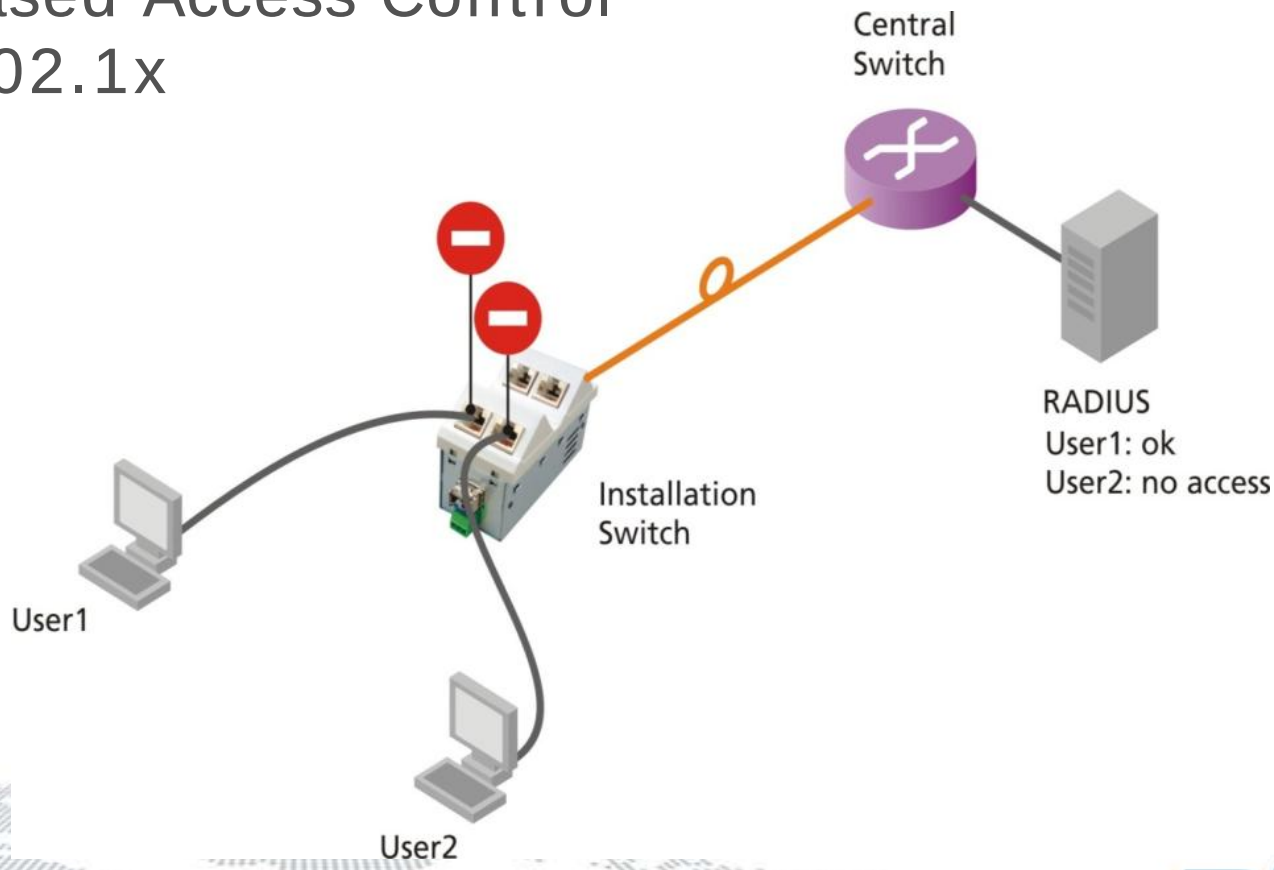


VoIP application *high priority*

Data application *low priority*

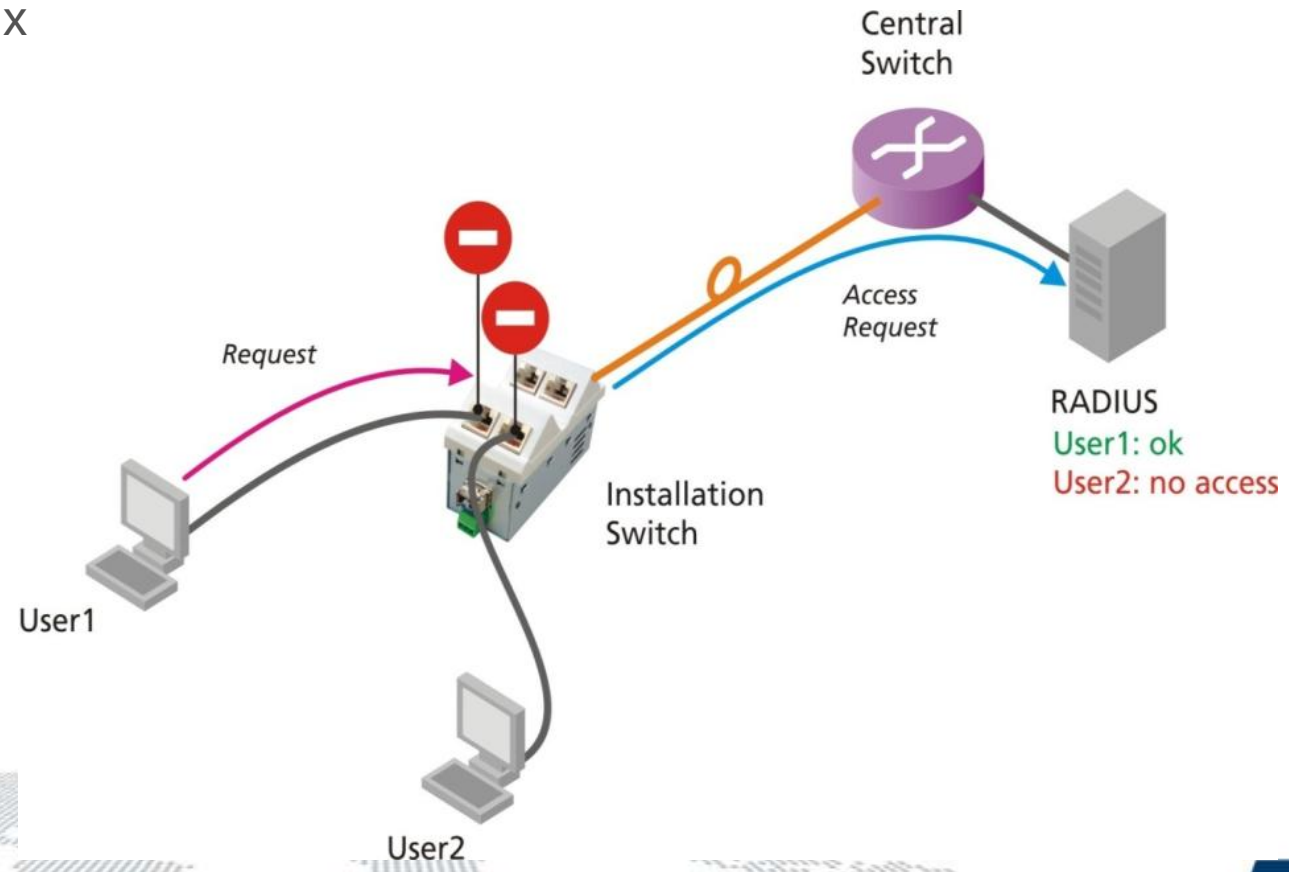
Authentication

Port Based Access Control
IEEE 802.1x



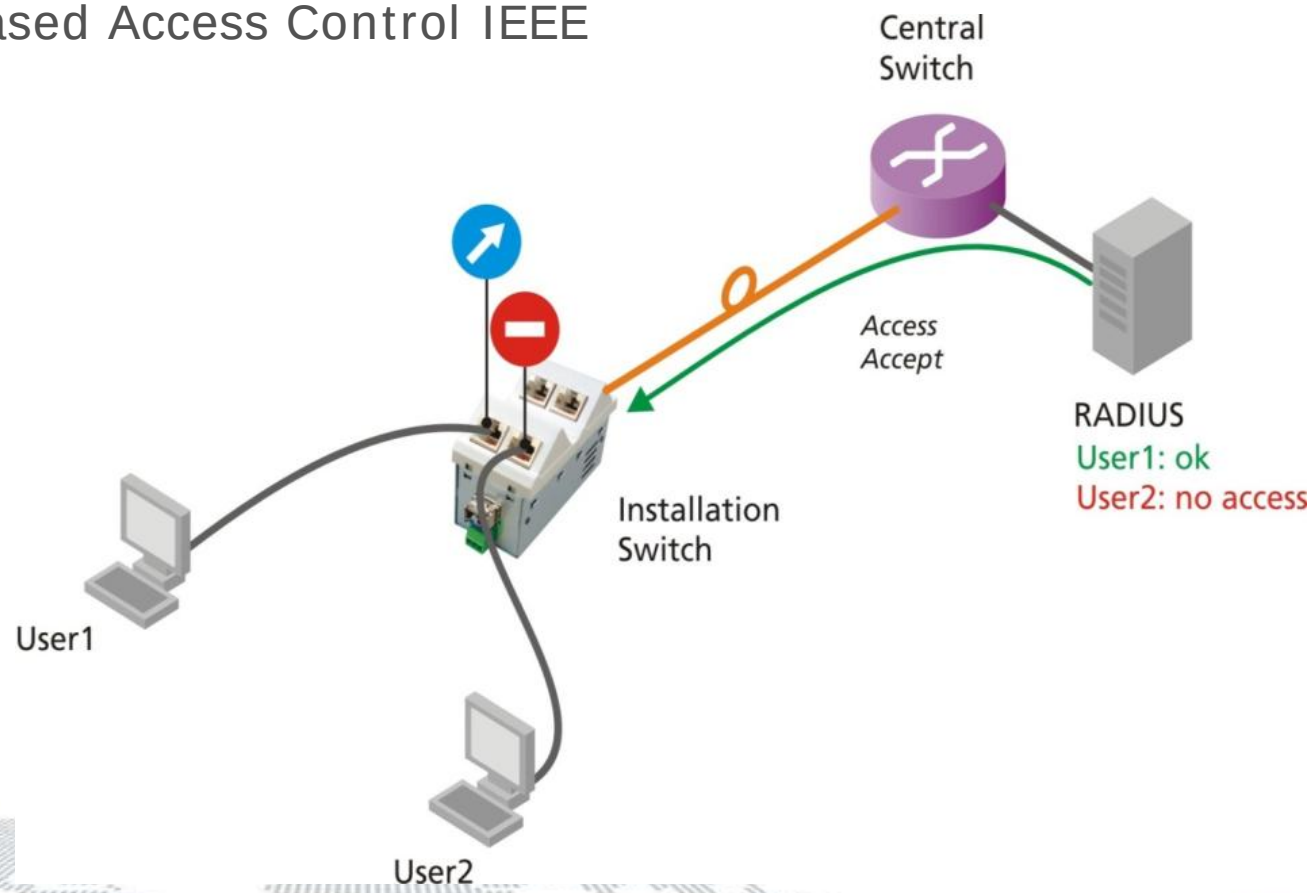
Authentication

Port Based Access Control IEEE 802.1x



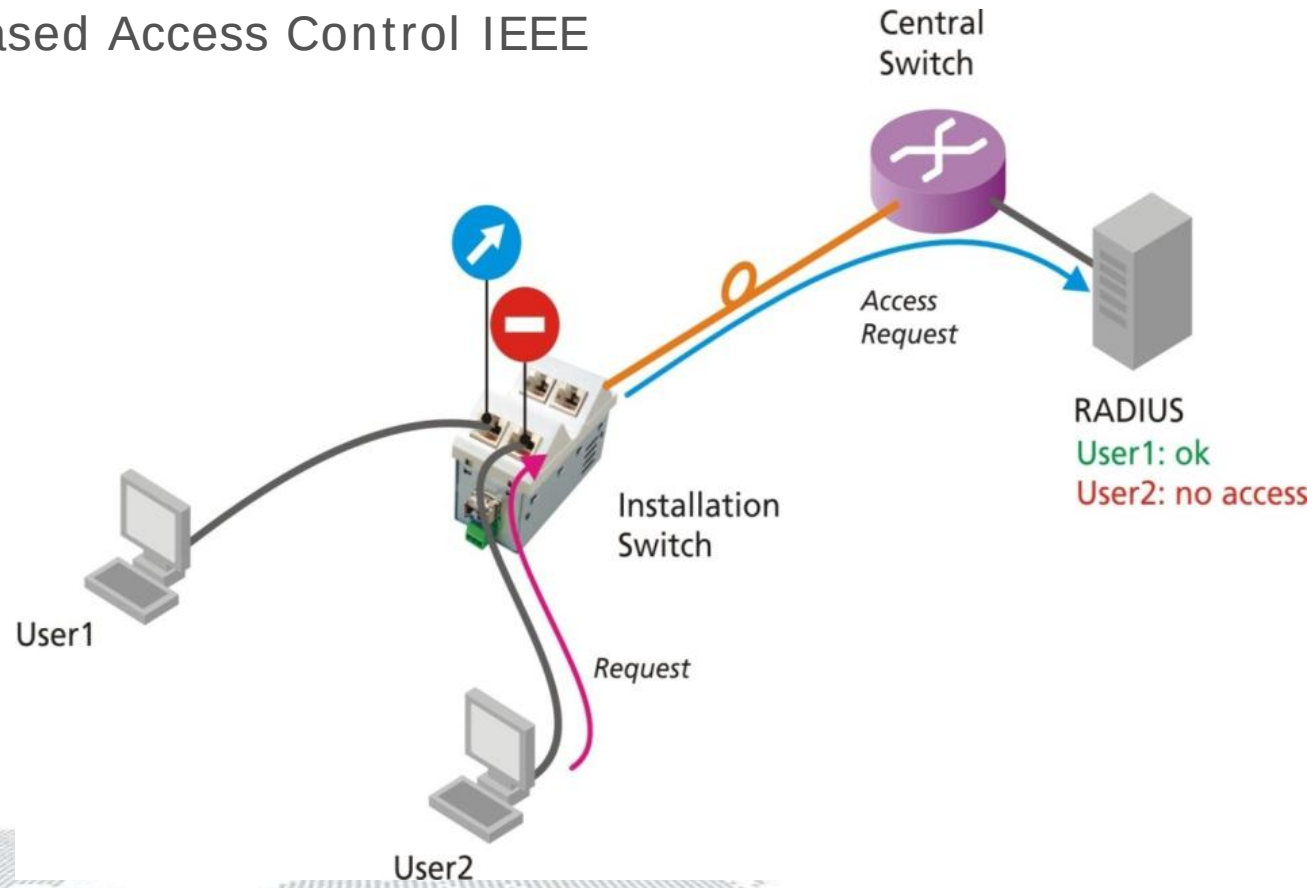
Authentication

Port Based Access Control IEEE 802.1x



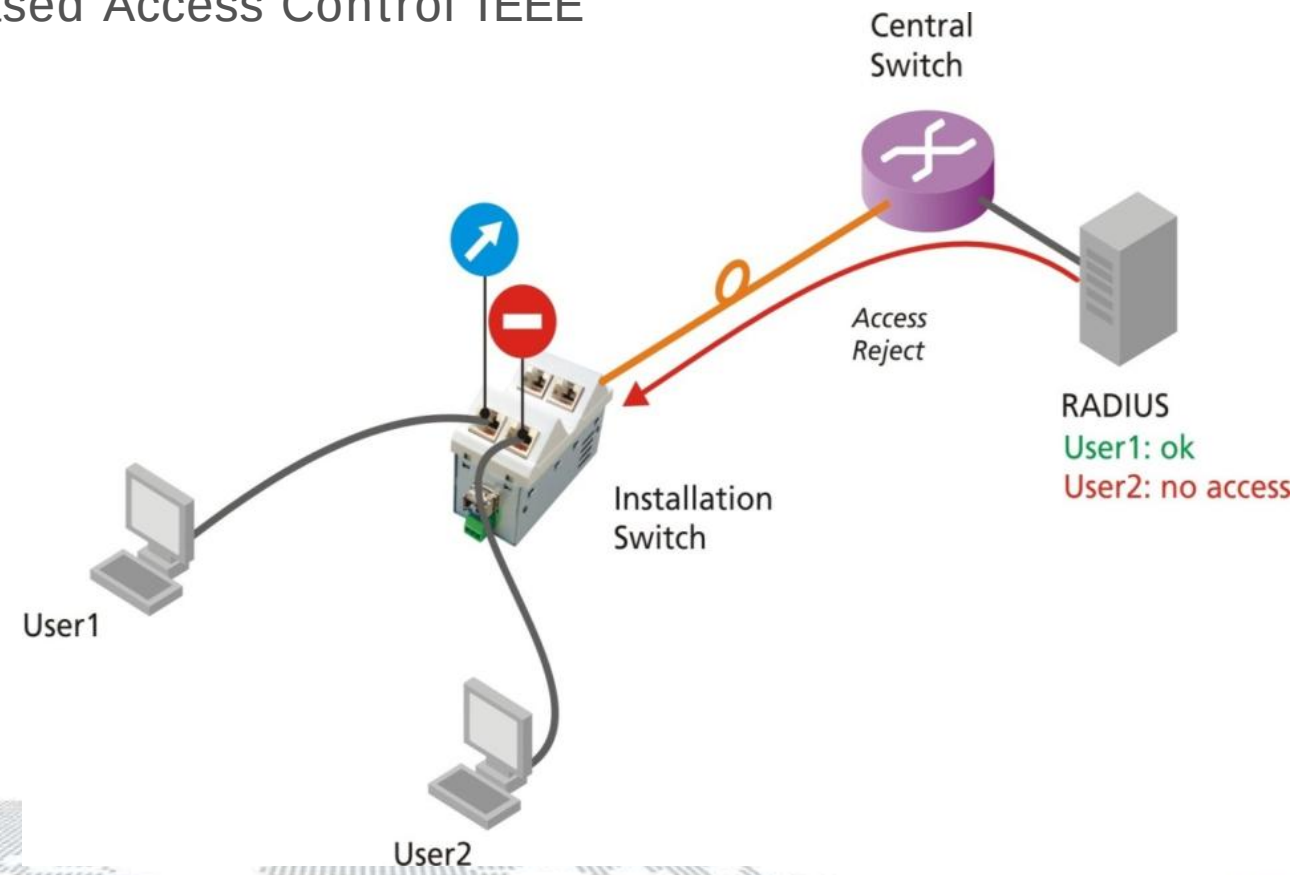
Authentication

Port Based Access Control IEEE 802.1x



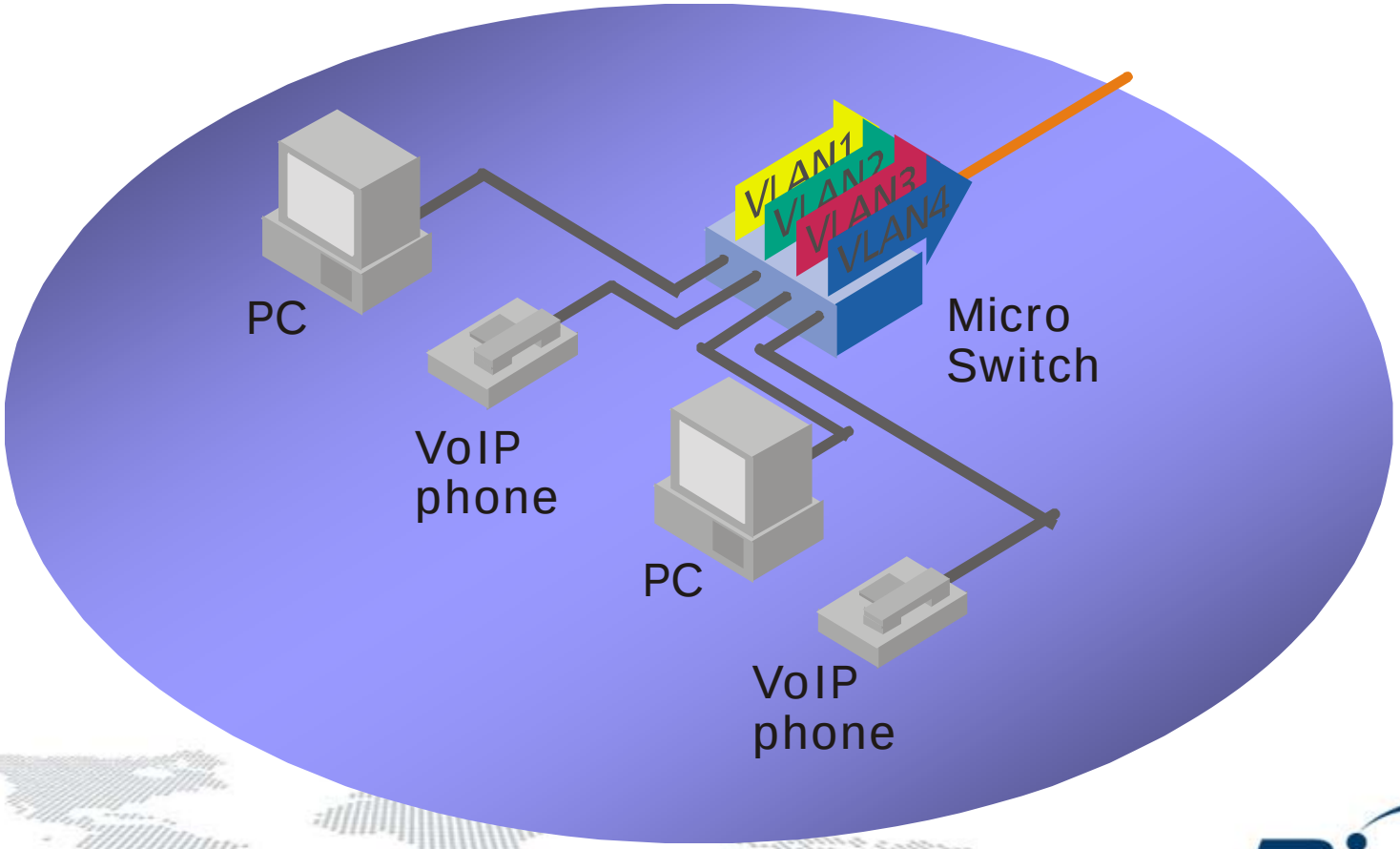
Authentication

Port Based Access Control IEEE 802.1x



Enterprise Networks

VLAN Filtering (IEEE 802.1p/Q)



VLAN Modes

Access

Outgoing frames are sent untagged. Incoming frames receive the port's default VLAN ID (PVID). This port mode is normally used for connecting end devices.

Hybrid

Outgoing frames are sent tagged, except the frames of the default VLAN port. Incoming frames from the default port VLAN are expected to be untagged, frames from other VLANs are always expected to be tagged. This mode is normally used to connect a VoIP phone and a PC to share one port. In this setup the phone communicates tagged and the PC untagged.

Trunk

Outgoing frames are always sent tagged. Incoming frames are expected to be received tagged. Incoming frames without a VLAN tag are processed using the port's default VLAN ID (PVID). This mode is normally used as an inter-switch connection.

Enterprise Networks

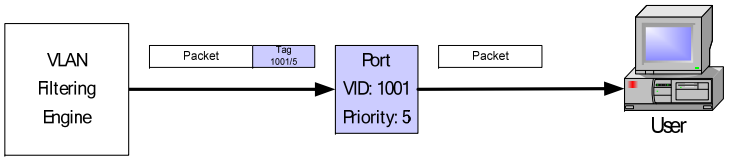
Port VLANs

Insert/removal of port VLAN ID/priority

Processing of tagged/untagged packets (hybrid ports)

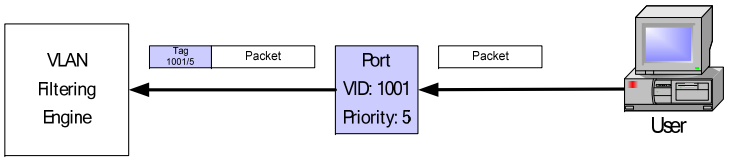
Egress packets

VLAN Tag is removed



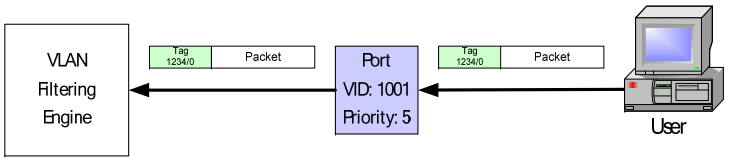
Ingress packets without tag

Port VLAN tag is inserted



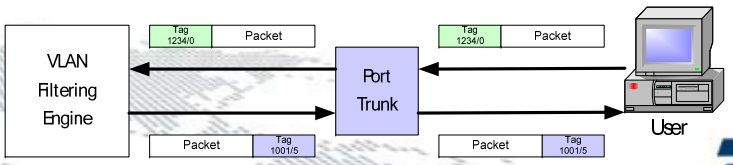
Ingress packets with tag

VLAN tag remains unchanged



Trunk port

VLAN tag remains unchanged



Enabling the Internet of Things

Smart Lighting

Bicsi

Smart Lighting/Office

Smart Lighting

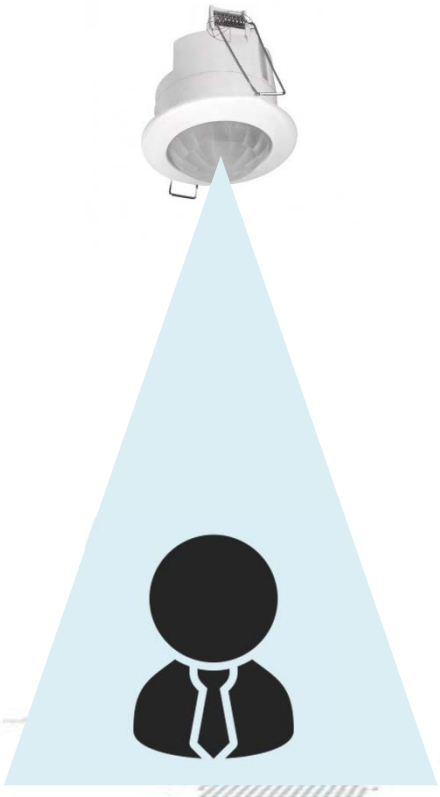
- Light
- GUI
- Light switch

Smart Office

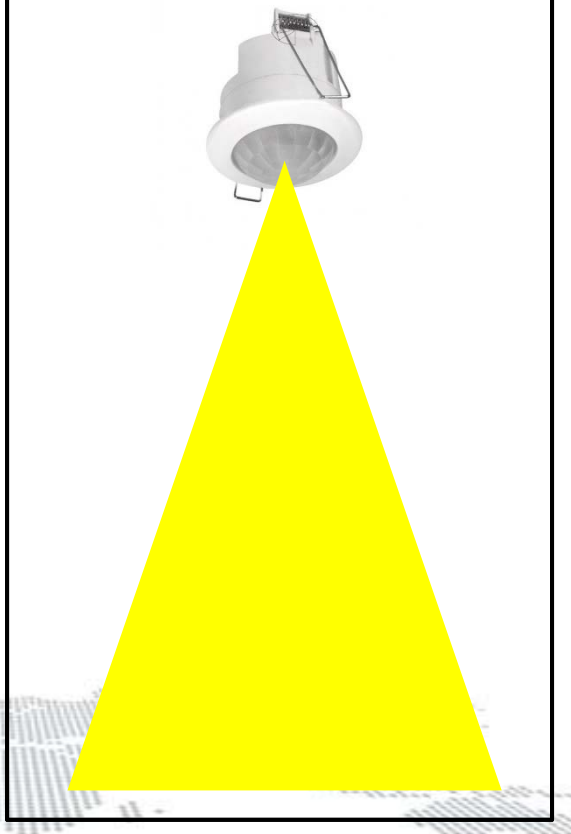
- Public address
- Intercom
- Window blinds
- Heating control
- Wall thermostat
- Air conditioning

Smart Sensor

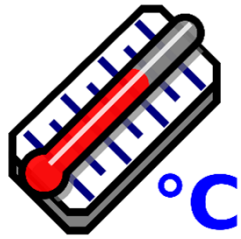
Presence



Intensity



Temperature



Smart Lighting Controller

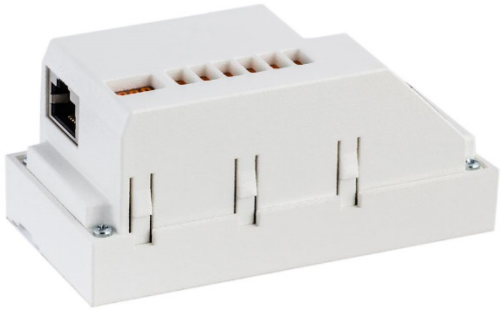
1 Controller for each light

- Powered via PoE+
- Input RJ-45 (Ethernet)
- Sensor input RJ-45

- Output to light Phoenix contacts on the device back side
- Power output approx. 25 W

Extension Module

for the Micro Switch G6

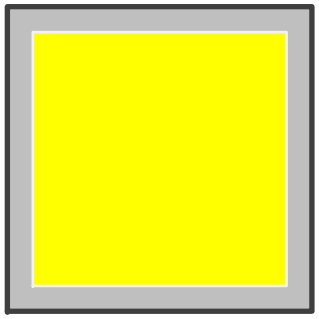


3 functions in one device:

- **WLAN Access Point** (802.11b/g/n)
- **Smart I/O** (2x In Optokop./2x Out 230 VAC)
- **Wireless Gateway** (868 MHz)

- Own Firmware based on OpenWRT (Linux)
- Integrated **FHEM Server** as EQ3 Gateway
- PoE power supply via Micro Switch
- Configuration via Micro Switch firmware

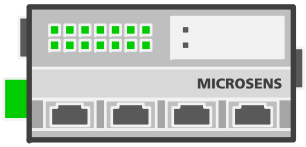
LED Lights



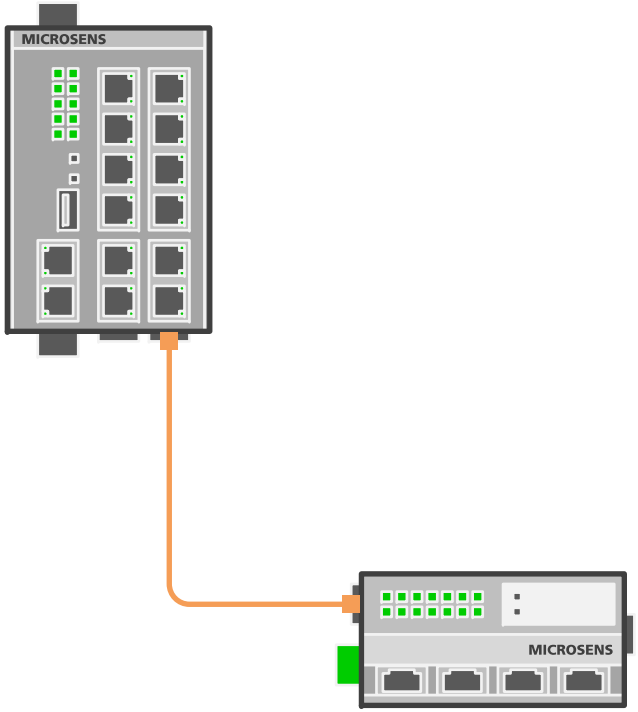
Requirements for LED lights:

- max. 54 V DC
- Power consumption approx. 30 W

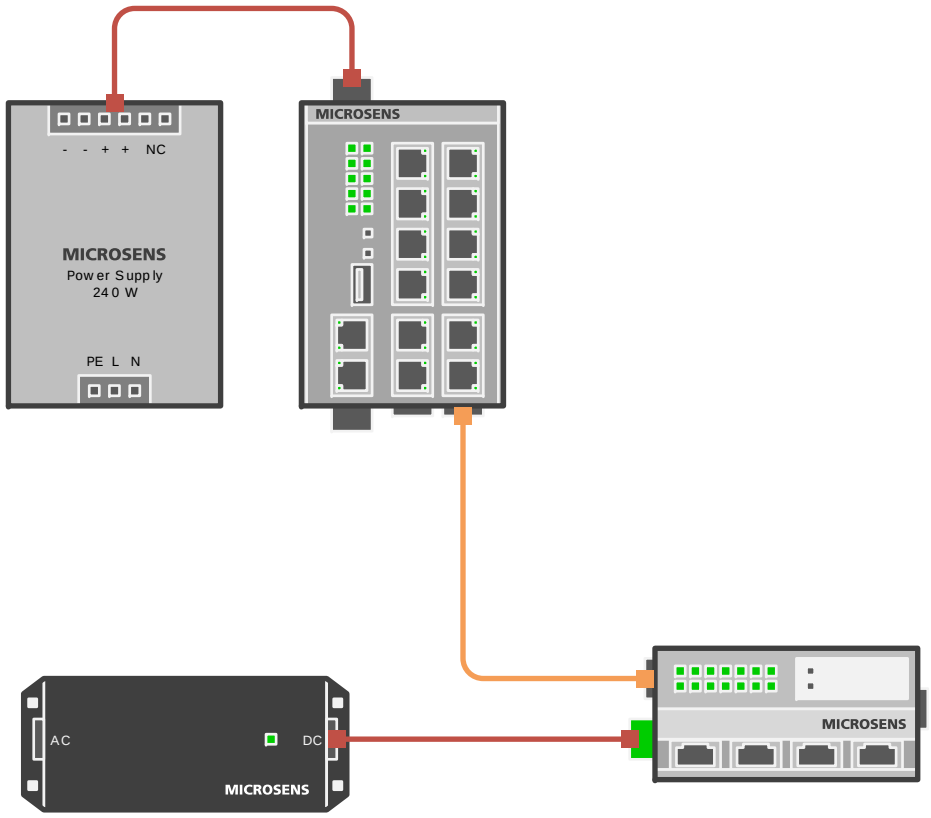
Construction



Construction



Construction



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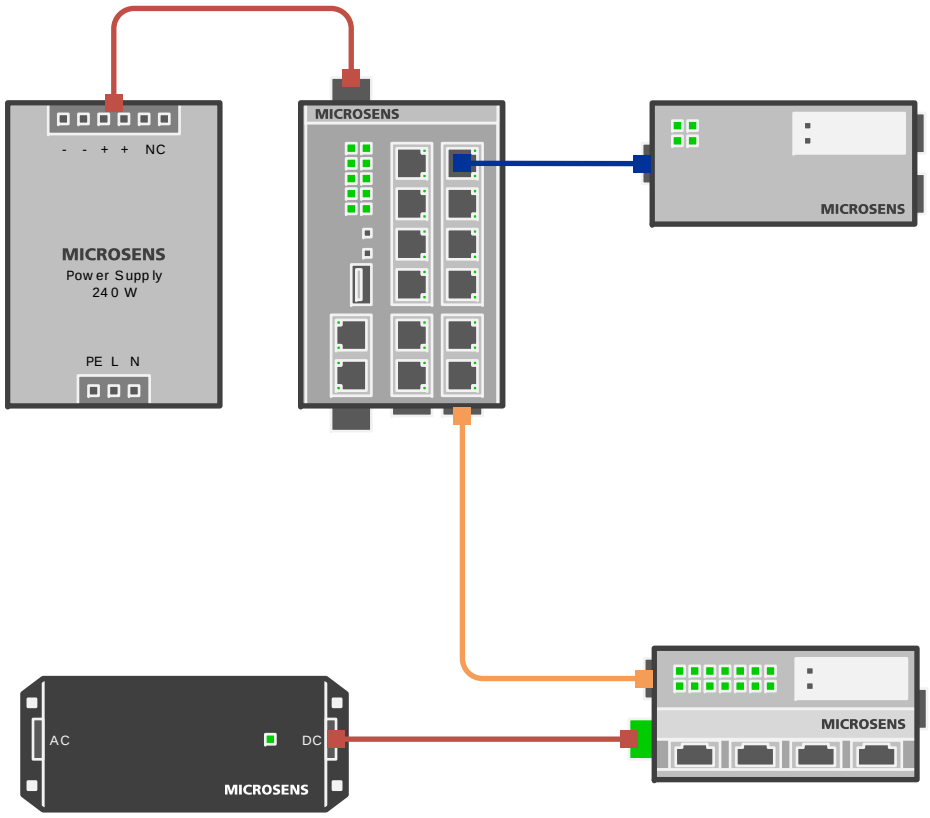

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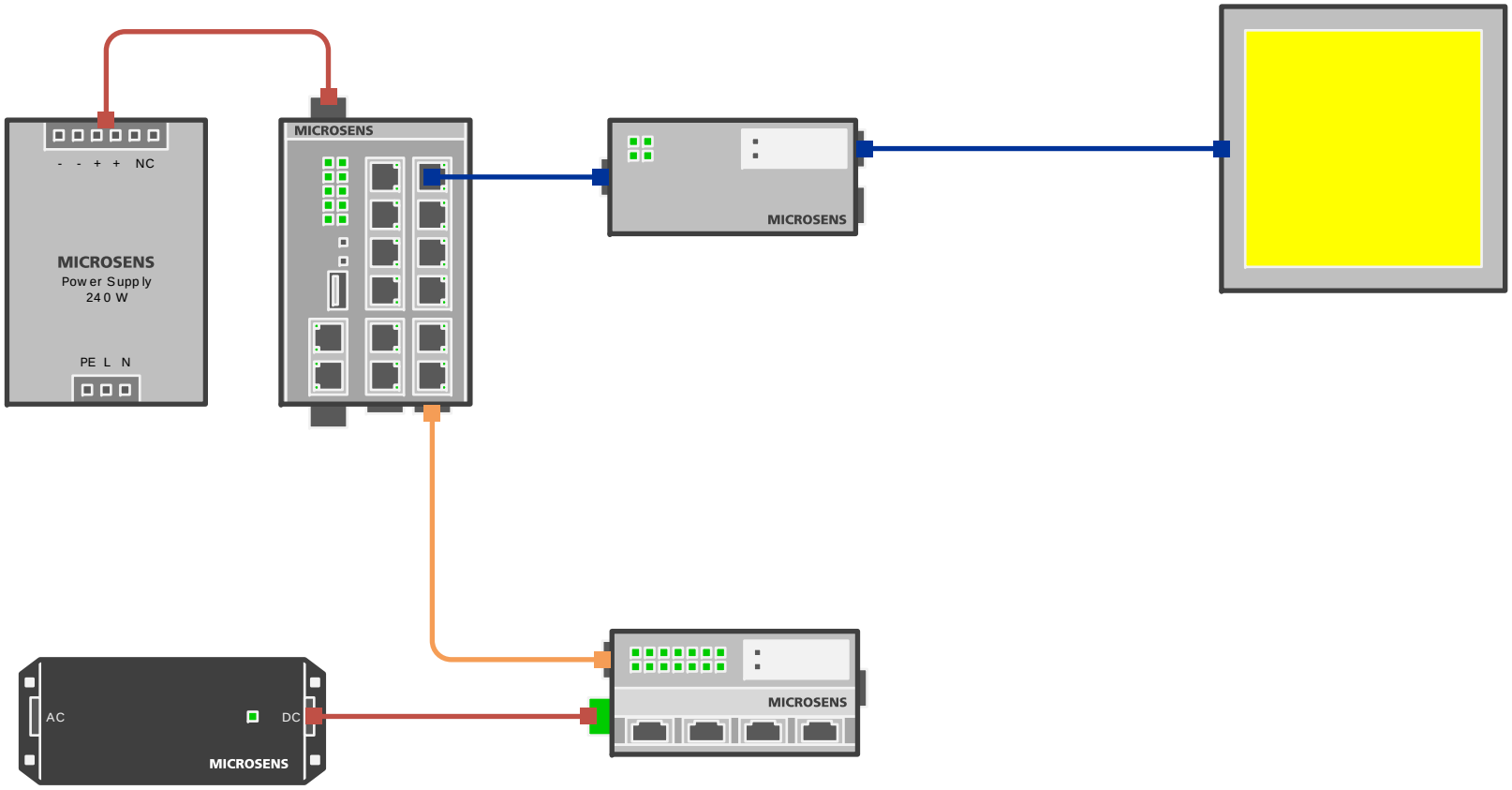

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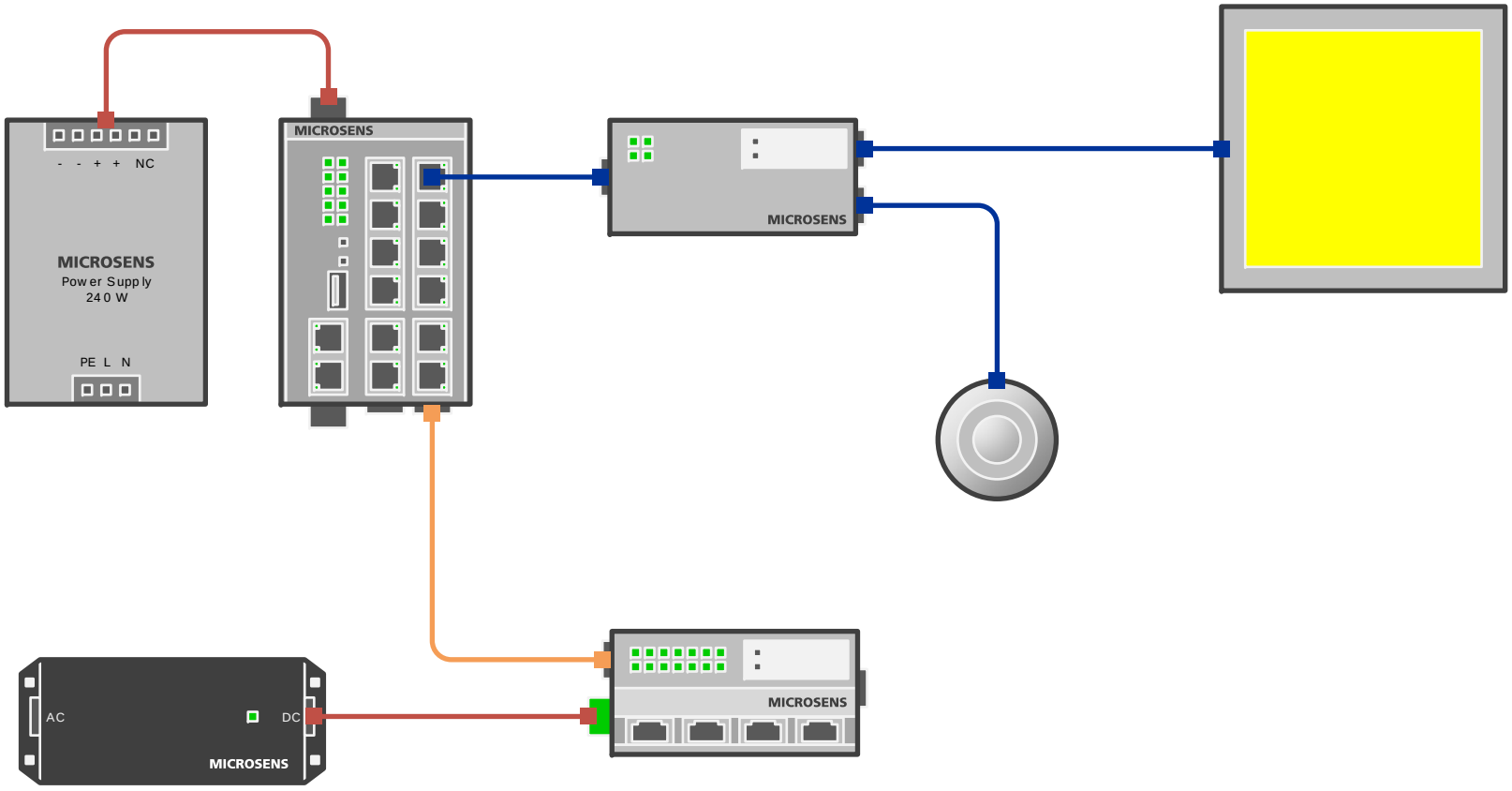

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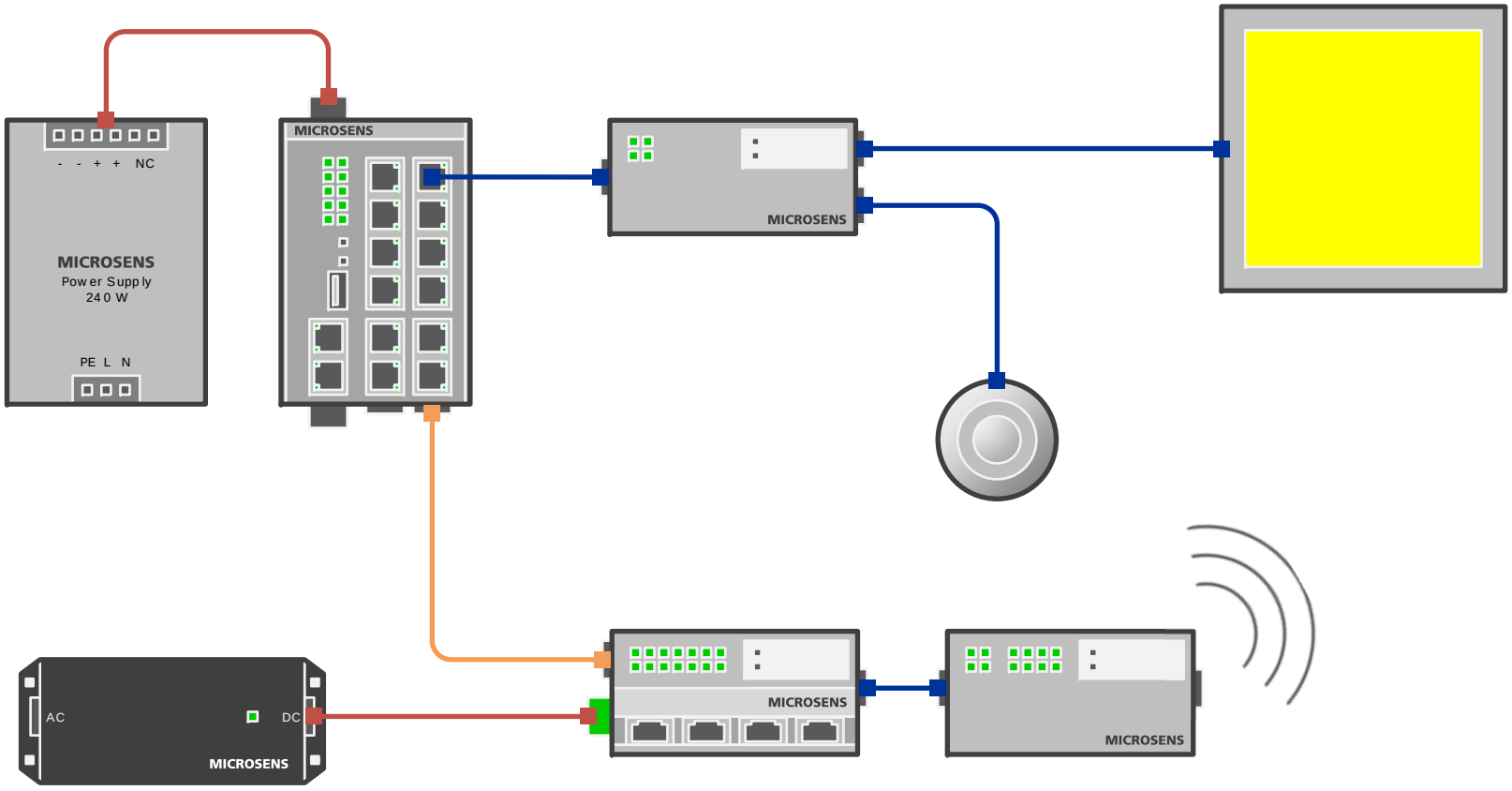
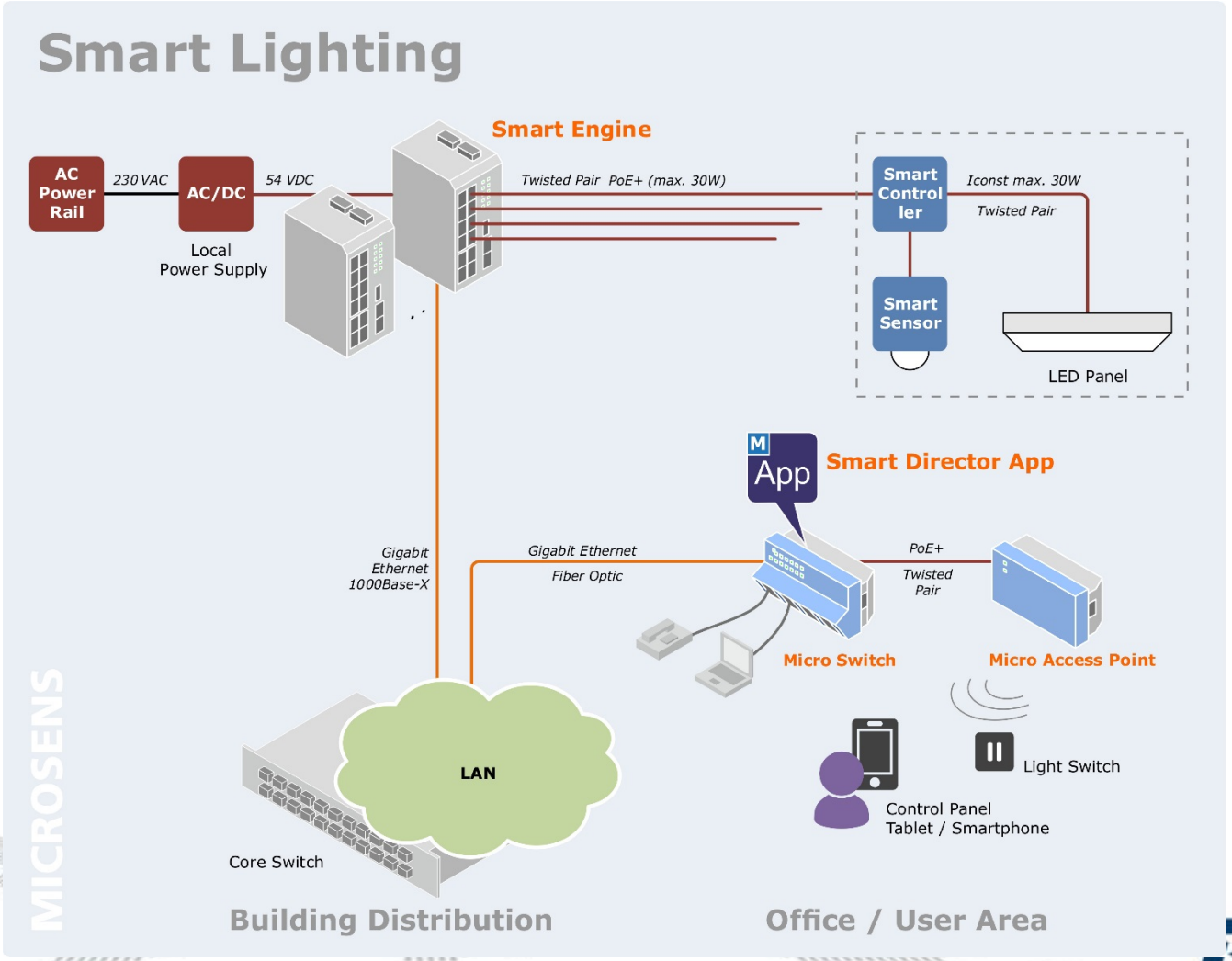
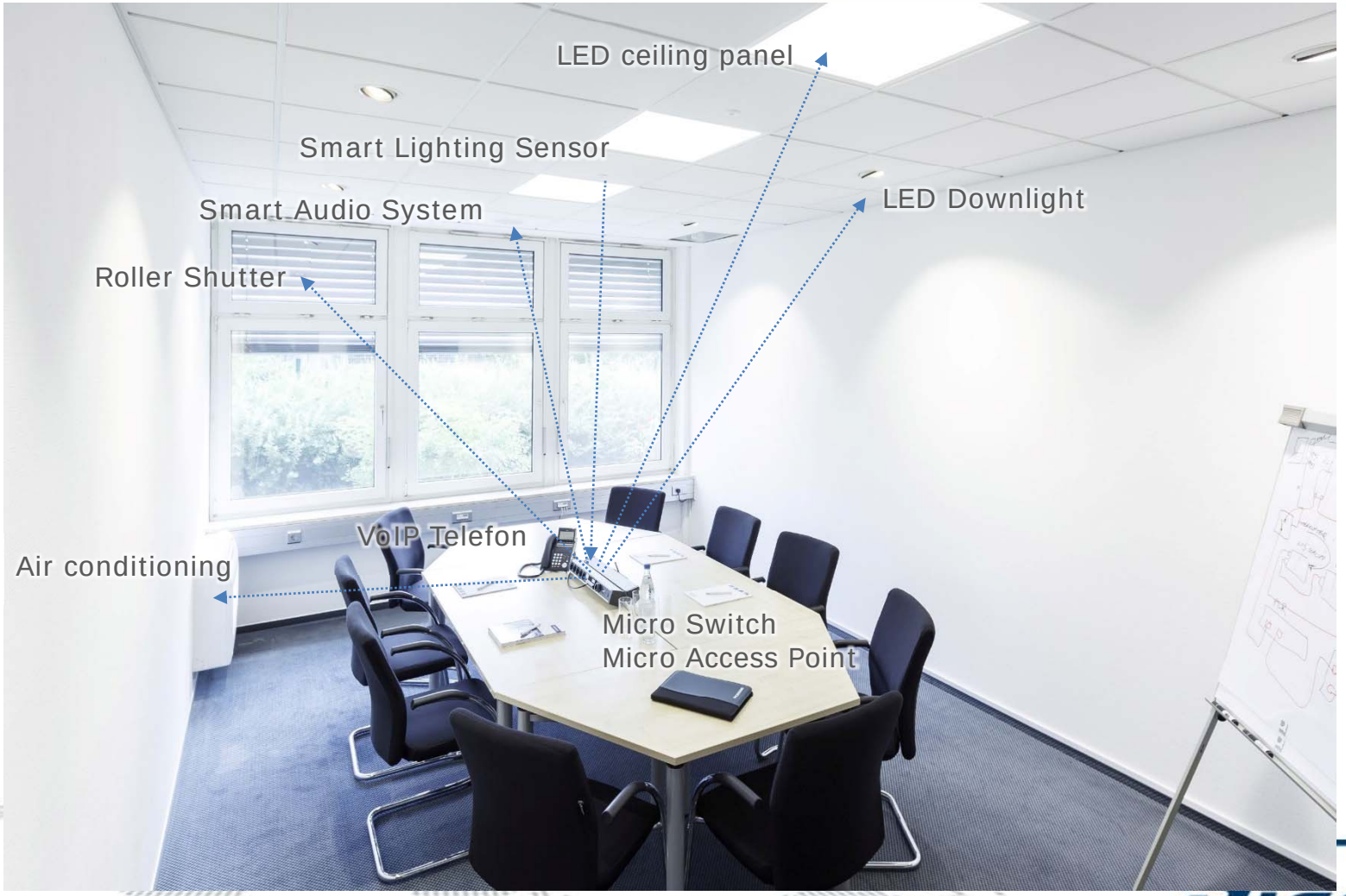


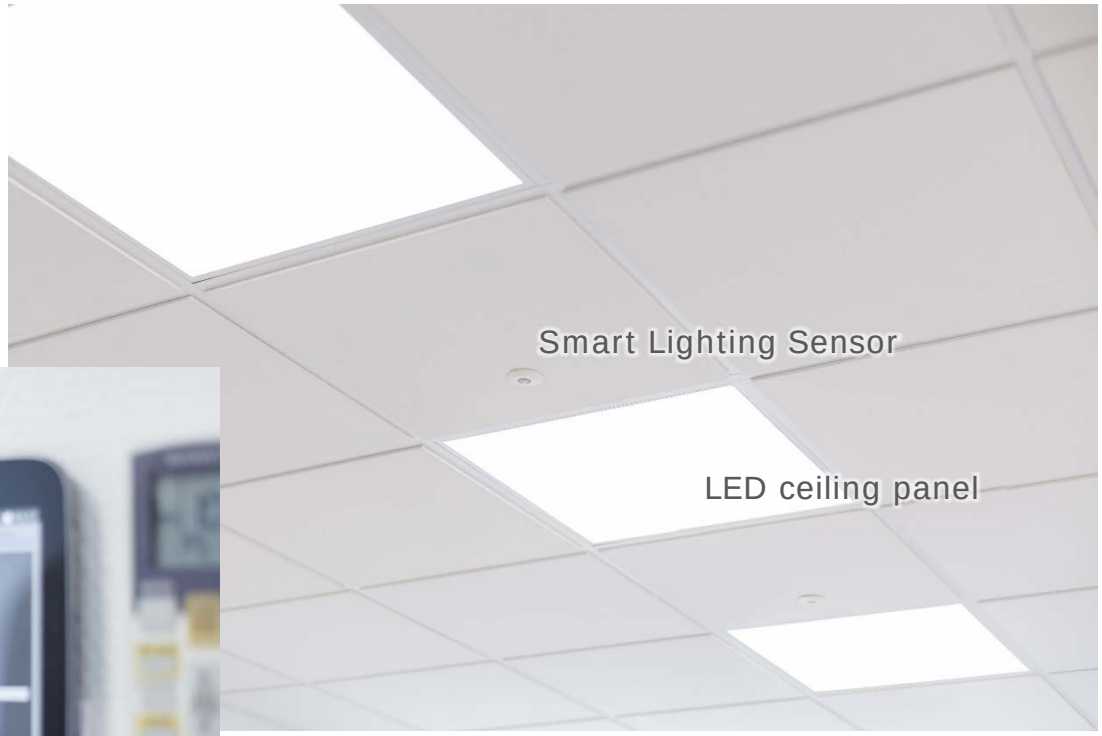
System Overview

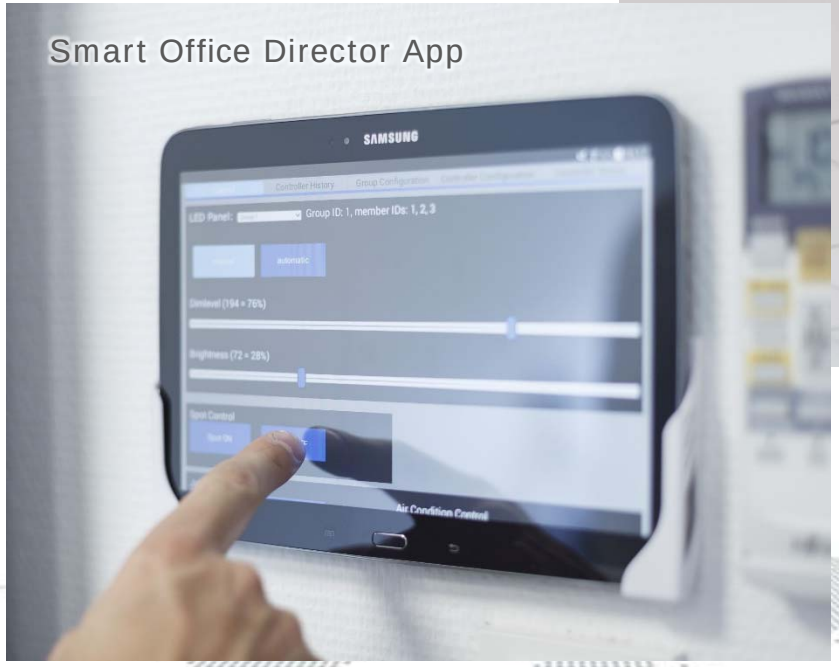


Smart Office Showroom



Smart Lighting Director – Decentral Control from the switch





Benefits Smart Lighting

- Open, decentral and IP based system
- Roll-Out office after office
- Integration into a virtual central control system
- Individual control by user
- Apps on the Smart Director
- High security with SNMP v3, etc. (compared to e.g. KNX)

- Simple planning
- Reduced fire load in the building
- Due to less cable more space in cable ducts
- Reduced installation costs (quicker and less qualified persons)

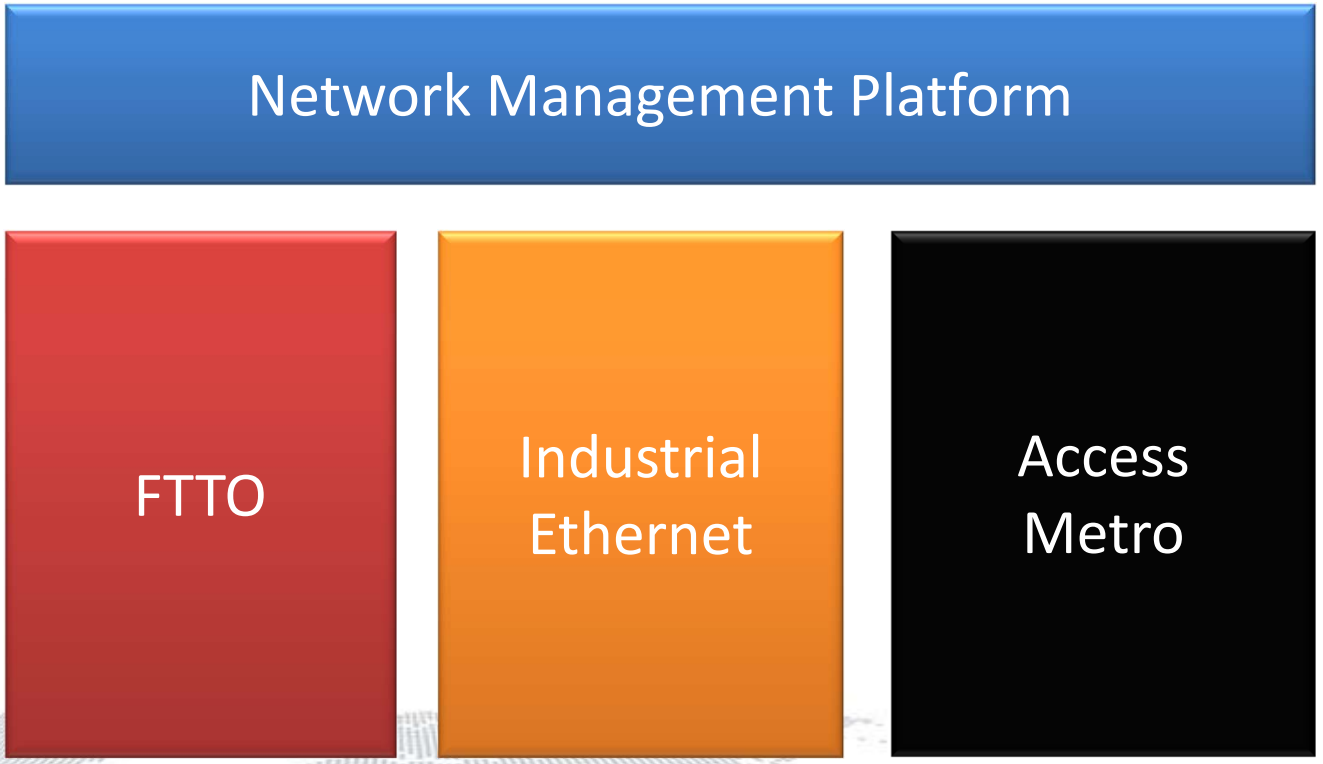
- Energy savings up to 80%
- Monitoring of the real power consumption at each controller
- Extreme reduction of maintenance cycles by use of LEDs > 50000 h
- Possibility for premaintenance
- Detection of faulty lights from central management

Central Management Software

Network
Management Platform

Software Overview

Strategic Product Groups



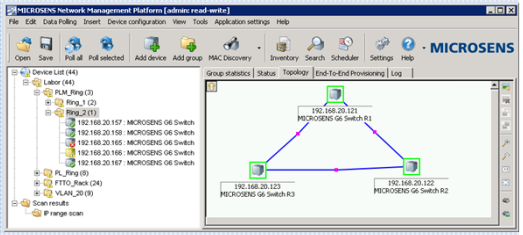
NMP Server

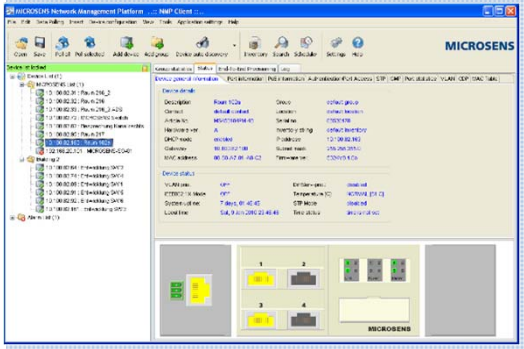
General facts

- Based on Java language
- Available for Windows and Linux
- 32 and 64 Bit versions available
- Three different versions available
  - nmp standard
  - nmp professional
  - nmp server
- License key required
- Unlimited number of devices

Overview of Licensing Models

Unlimited Number of User-Stations per SW-License and Enterprise

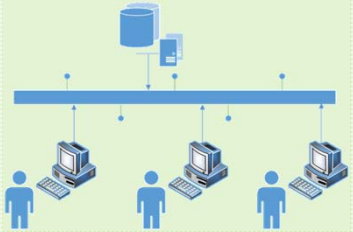




NMP Professional

- Single User/Single Station, Non-Shared Database

1 Redundant Server per License



NMP Server

- Multi User, Shared Database
- Server Redundancy
- Northbound Interface for Data Retrieval

•NMP Standard

- Single User/Single Station, Non-Shared Database

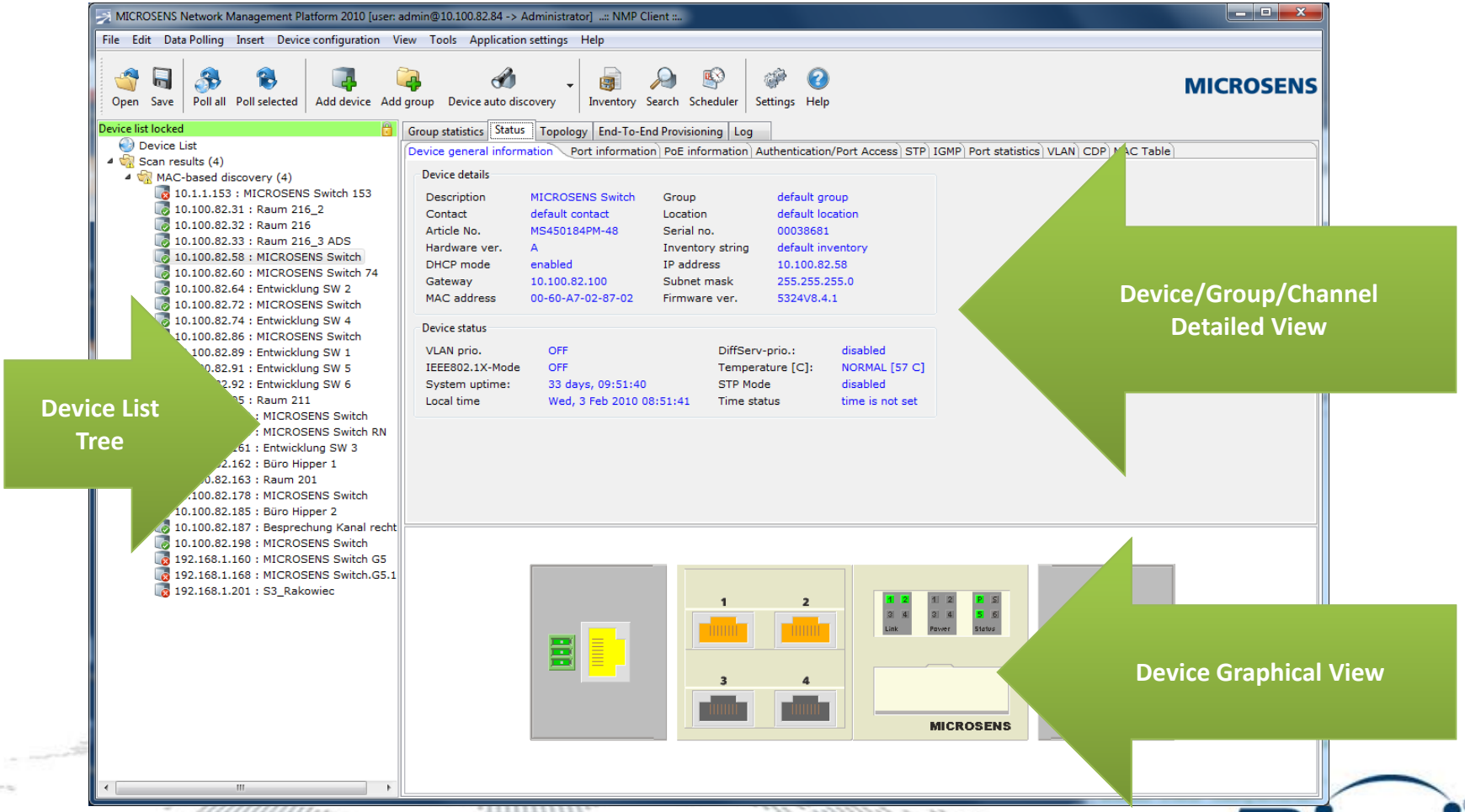
Common Feature Set (Professional, Server)

- Topology Manager
- Inventory List Generator
- Device Search Tool
- VLAN Change Tool
- Link monitoring
- Task Scheduler
- E-Mail notifications
- Automatic alarm list generation
- Switch Password Changer
- RMA Tool

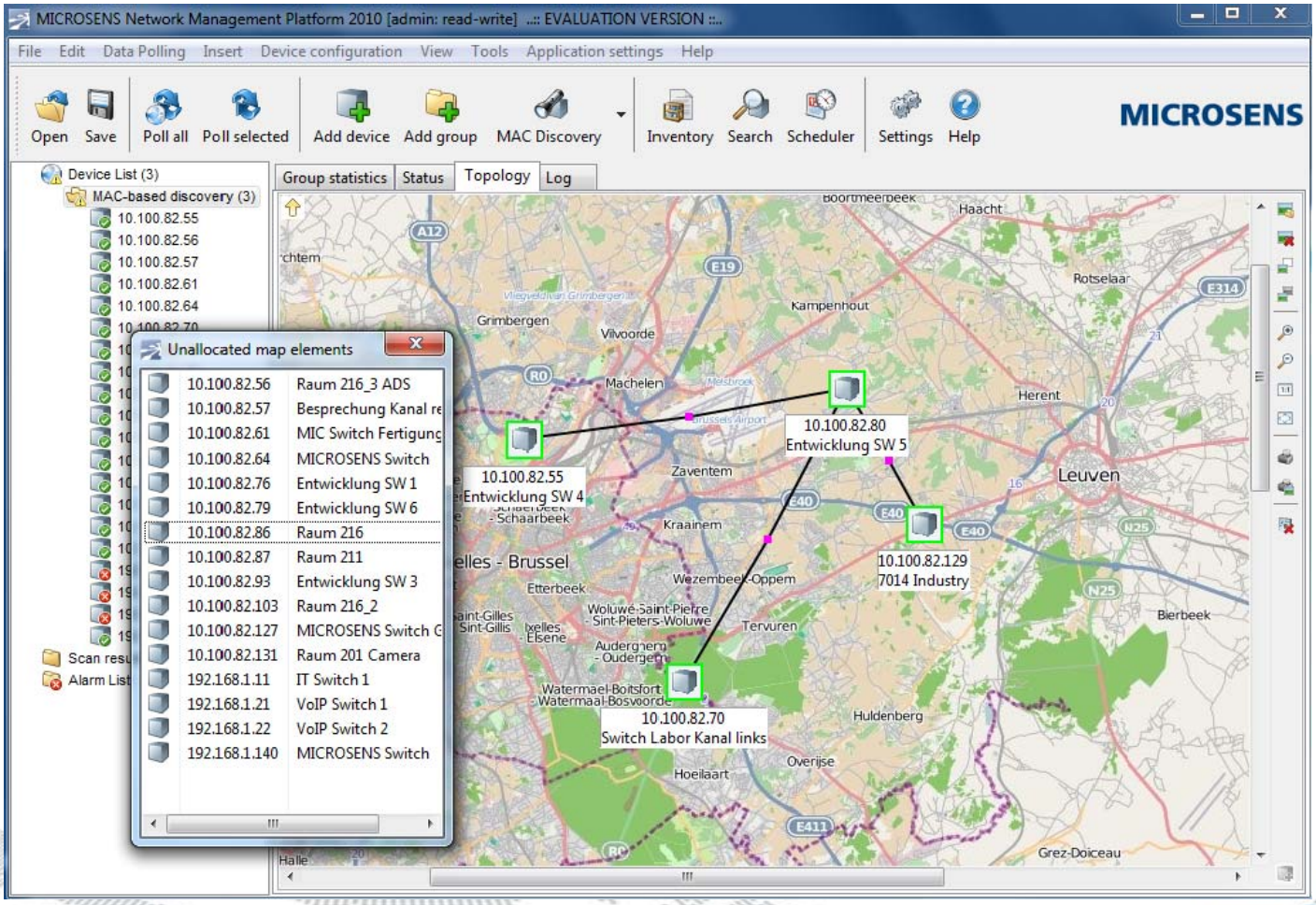
- **Common Feature Set** (Standard, Professional, Server)

Auto Discovery, Element Manager, Flexible Device Tree, Backup/Restore of Switch Configuration

Element Manager



Topology Manager



- Graphical view of network topology

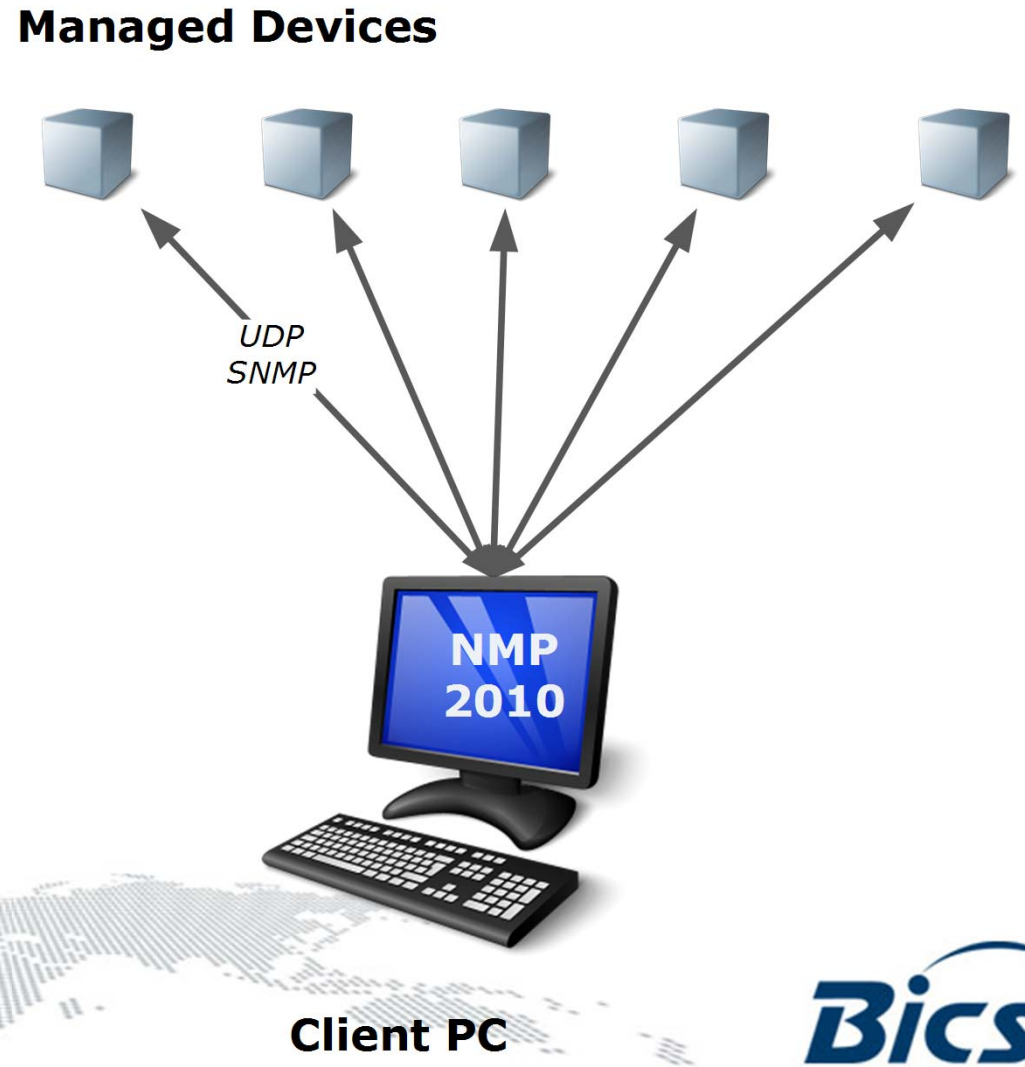
Feature Update

Network Management Platform

Server 2010

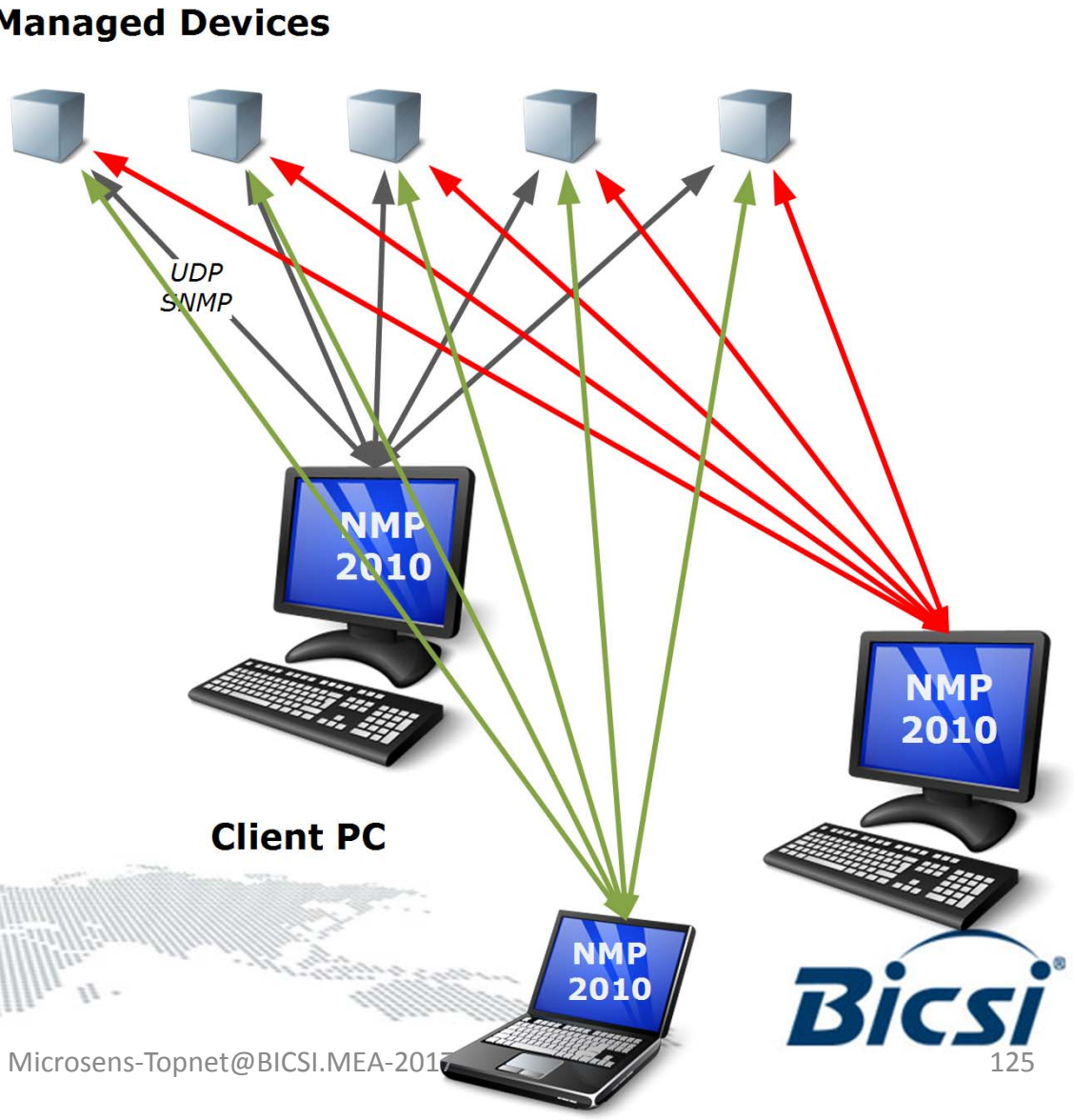
NMP Standard

- Single User
- All data locally stored



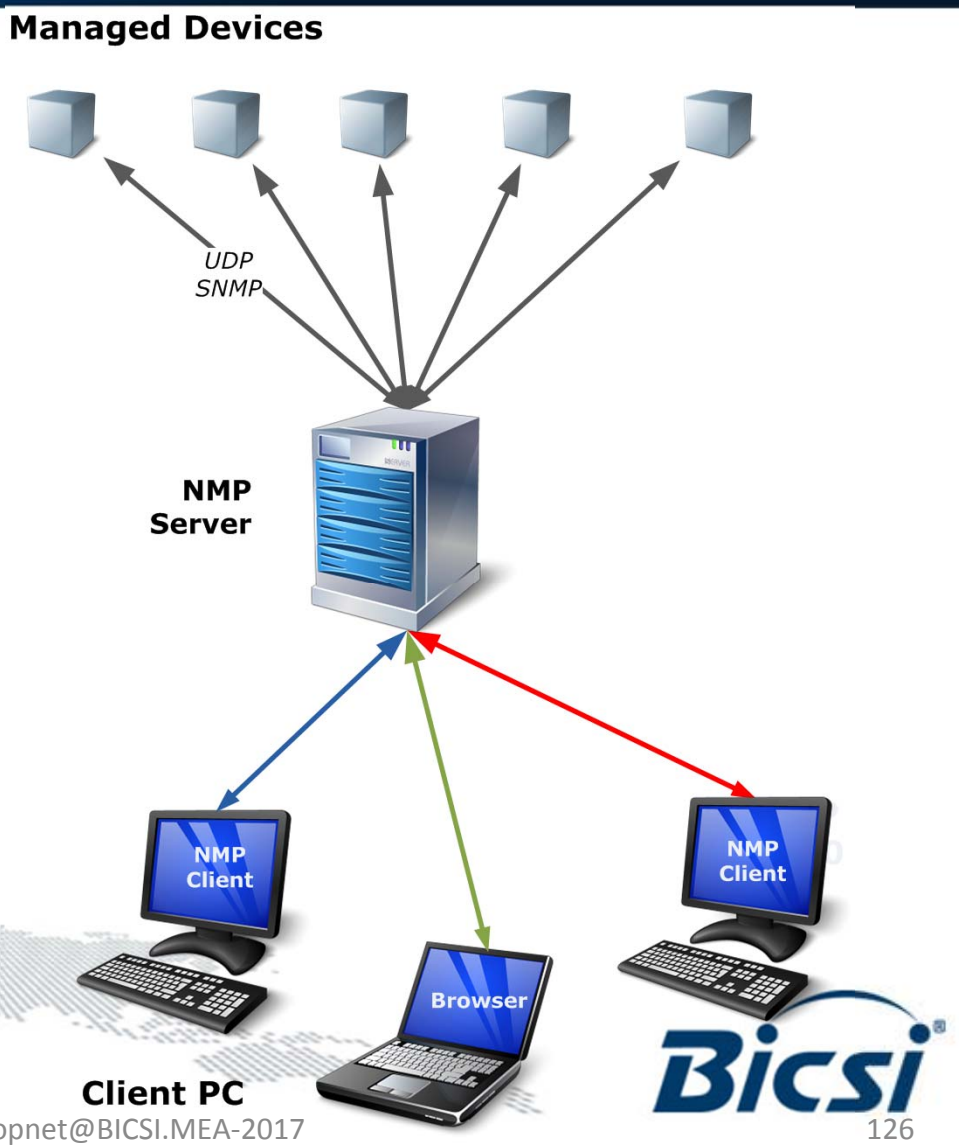
NMP Standard

- Multi User, but
  - Decentralized
  - All data local
- Inconsistency in
  - Data storage
  - Data backup
  - User Management
  - Access Control



NMP Server

- Central Server
  - Data consistence
  - SQL Database
  - Central backup
- User Management
  - Access control
- Client Options
  - Web browser
    - OS independent
    - No local application
  - NMP Client
    - Full functionality
    - Syncronisation to server



NMP Server

Motivation/Benefits

Centralized management platform

+ Single point of administration

- **Dedicated user/access management**

  + Full control over network access

  + Extended logging functionality

- **Central database**

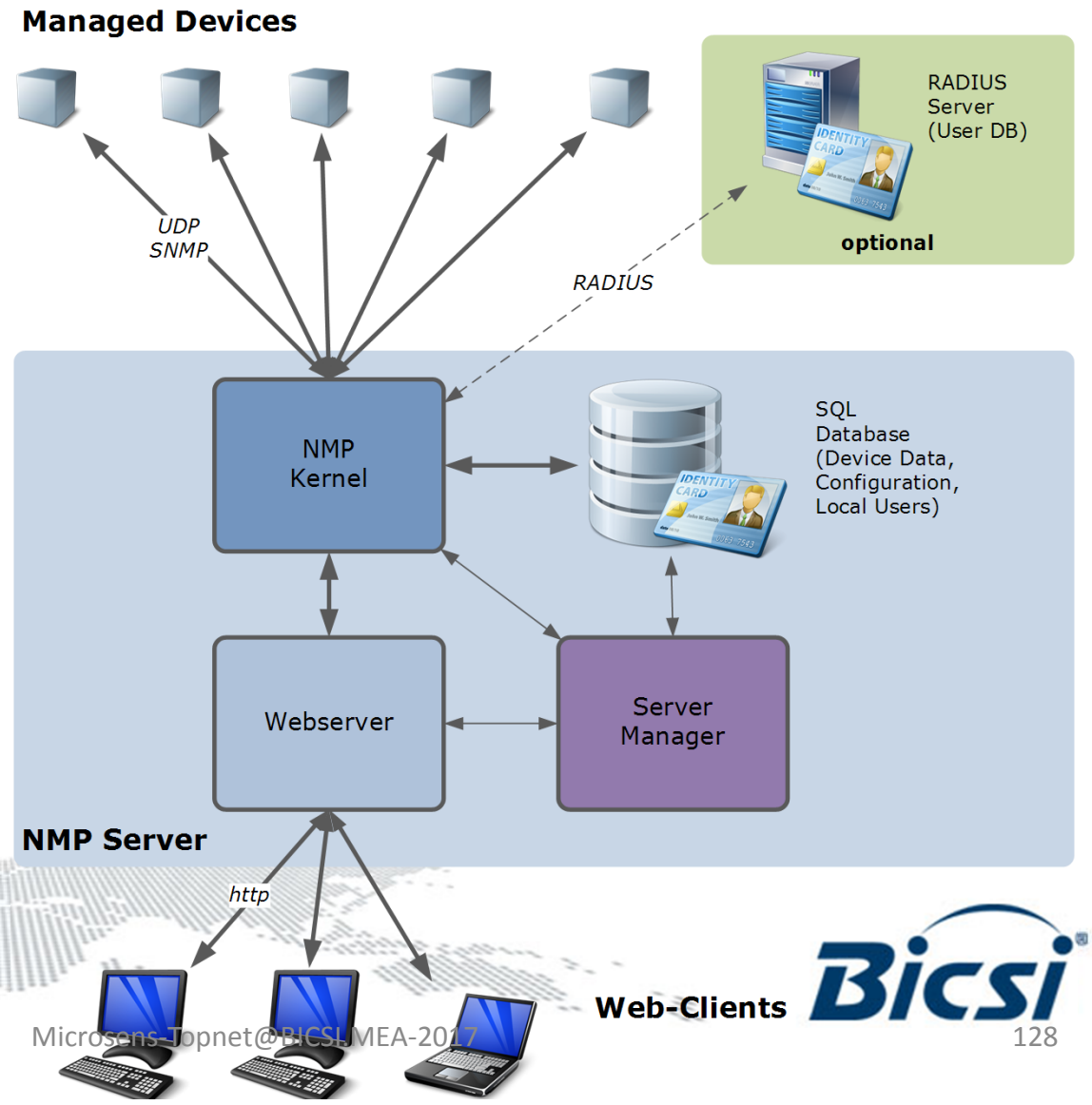
  + Simplified data protection/backup

- **Access with Client or Browser**

  + NMP Client with full function set

  + Web client requires only local browser

Server Architecture



Questions?

Thank you!

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