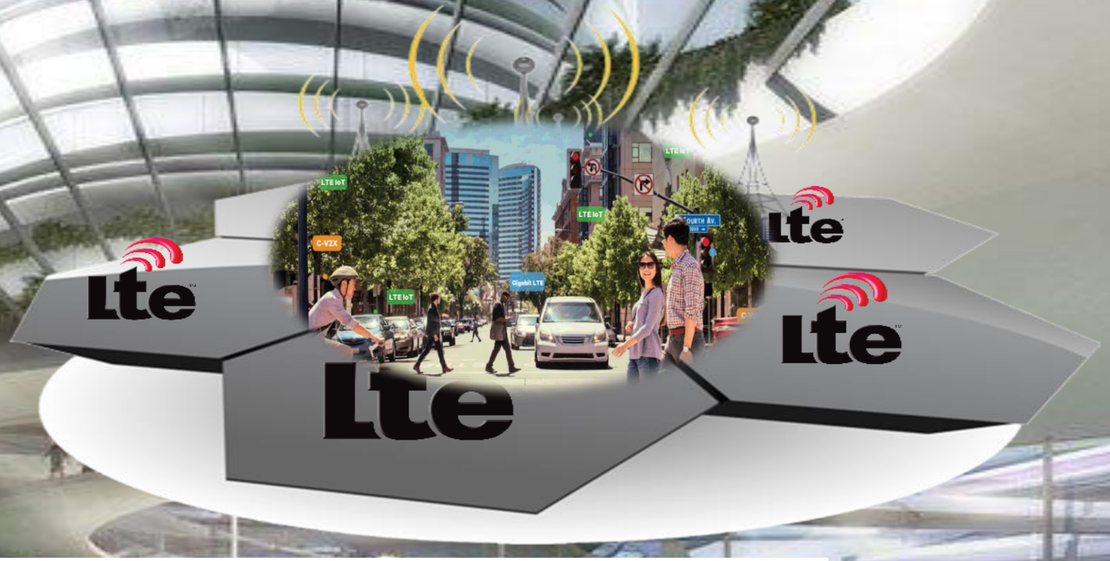
TIP KEBERKESANAN KURSUS

Signal Network Yang Stabil

Pengurusan Masa

Catat Nota Jika Perlu & Bertanya Bila Perlu

Fokus & Elak Gangguan Luar Kursus



Kursus Asas Rekabentuk Sistem ICT & Telefon

SESI KENALI DIRI…

- Nama Sebenar:
- Nama Panggilan:
- Pengalaman bekerja di JKR: berapa tahun & di pejabat mana
- Pengalaman dalam Rekabentuk @ Pemasangan Sistem ICT:
- Pandangan bagi Rekabentuk @ Pemasangan Sistem ICT: Susah @ Senang @ Pening @Konfius
- Harapan di akhir kursus:

MAKLUMAT PENCERAMAH

ROSLIANA BINTI MAT SENAPI (YANA)
JURUTERA ELEKTRIK
UNIT PERUNDING ICT, CKE
Email: roslianams@jkr.gov.my
Tel. Office: 03-26189933

PENGALAMAN BEKERJA:

- UNIT PERUNDING ICT, CAW. KEJURUTERAAN ELEKTRIK
  - 20 OGOS 2009 ~ 18 FEBRUARI 2018
- BAHAGIAN PENGURUSAN PROJEK 2, CAW. KERJA KESELAMATAN
  - 19 FEBRUARI 2018 ~ 30 SEPTEMBER 2018
- UNIT PERUNDING ICT, CAW. KEJURUTERAAN ELEKTRIK
  - 01 OKTOBER 2018 ~ KINI

MEMPEROLEHI SIJIL:

- IJAZAH SARJANA MUDA KEJURUTERAAN ELEKTRIK
  - 2008, UNIVERSITI TEKNOLOGI MARA
- PENSIJILAN JKR
  - TAHAP 2 NETWORK SYSTEM (2017)
  - TAHAP 2 TELEKOMUNIKASI (2019)

MUHAMMAD IZWAN BIN OTHAMAN
JURUTERA ELEKTRIK
UNIT PERUNDING ICT, CKE
Email: izwan@jkr.gov.my
Tel. Office: 03-26189935

PENGALAMAN BEKERJA:

- UNIT PERUNDING ICT, CAW. KEJURUTERAAN ELEKTRIK
  - 02 DISEMBER 2015 ~ 31 MEI 2018
- UNIT PERUNDING REKABENTUK KESIHATAN, CAW. KEJURUTERAAN ELEKTRIK
  - 01 JUN 2018 ~ 30 APRIL 2019
- UNIT PERUNDING ICT, CAW. KEJURUTERAAN ELEKTRIK
  - 01 MEI 2019 ~ KINI

MEMPEROLEHI SIJIL:

- IJAZAH SARJANA MUDA KEJURUTERAAN ELEKTRIK
  - 2011, UNIVERSITI TUN HUSSEIN ONN MALAYSIA

Kursus Asas Rekabentuk Sistem ICT & Telefon

- Kursus ini dilaksanakan bagi memberi **pengetahuan terhadap asas rekabentuk** berkaitan sistem ICT dan Telefon
- **Di akhir kursus, peserta akan dapat:**

1. Menyelesaikan pengesahan skop dengan mengenali dan mengenalpasti personel yang tepat mengurus dan mentadbir Sistem ICT dan Telefon
2. Mengaplikasi asas rekabentuk sistem ICT dan Telefon dalam penyediaan rekabentuk
3. Menerangkan kepentingan ruang dalam pemasangan sistem ICT dan telefon
4. Mengklasifikasikan jenis talian masuk dari pembekal pekhidmatan dalam rekabentuk sistem ICT dan telefon

Peserta kursus boleh merekabentuk Infrastruktur ICT dan Telefon serta dapat meningkatkan kompetensi peserta dalam menjalankan tugas-tugas mengikut Akta, Piawaian dan Garis Panduan yang berkaitan.

KANDUNGAN KURSUS

HARI/MASA	8.00 pagi	8.30 Pagi – 10.30 Pagi	10.30-11.00 Pagi	11.00 Pagi - 1.00 T/hari	1.00 - 2.30 Petang	2.30 Petang - 4.30 Petang	4.30 - 5.00 Petang
ISNIN 29/3/2021	SARAPAN PAGI DAN PENDAFTARAN PESERTA	KURSUS REKABENTUK SISTEM ICT & TELEFON **PRE-TEST** **Pengenalan & Perancangan Projek** a. Objektif Kursus b. Kandungan Kursus c. Pengenalan Sistem d. Keperluan Rekabentuk e. Standard & Garis Panduan	MINUM PAGI	KURSUS REKABENTUK SISTEM ICT & TELEFON **Perancangan Projek** a. Terminologi	MAKAN TENGAHARI	KURSUS REKABENTUK SISTEM ICT & TELEFON **Perancangan Projek** a. Terminologi (sambungan) b. Kajian Tapak c. Rekabentuk Konsep d. Penyediaan Anggaran Awalan	MINUM PETANG
		Penceramah: Pn. Rosliana Mat Senapi		Penceramah: Muhammad Izwan Othaman		Penceramah: Muhammad Izwan Othaman	
SELASA 30/3/2021		KURSUS REKABENTUK SISTEM ICT **Perancangan Projek** a. Keperluan Ruang ICT dan Telefon b. Rekabentuk External Infrastructure **Rekabentuk** – Schematic & Layout ICT		KURSUS REKABENTUK SISTEM ICT **Rekabentuk –** Schematic & Layout ICT		KURSUS REKABENTUK SISTEM ICT **Rekabentuk –** Schematic & Layout ICT	
		Penceramah: Pn. Rosliana Mat Senapi		Penceramah: Pn. Rosliana Mat Senapi		Penceramah: Pn. Rosliana Mat Senapi	
RABU 31/3/2021		KURSUS REKABENTUK SISTEM TELEFON **Rekabentuk –** Schematic & Layout		KURSUS REKABENTUK SISTEM TELEFON **Rekabentuk –** Schematic & Layout		KURSUS REKABENTUK SISTEM ict & TELEFON **Pembinaan** **Pengujian &Pentauliahan** **POST-TEST**	
		Penceramah: Pn. Rosliana Mat Senapi		Penceramah: Pn. Rosliana Mat Senapi		Penceramah: Muhammad Izwan Othaman	

Pengenalan

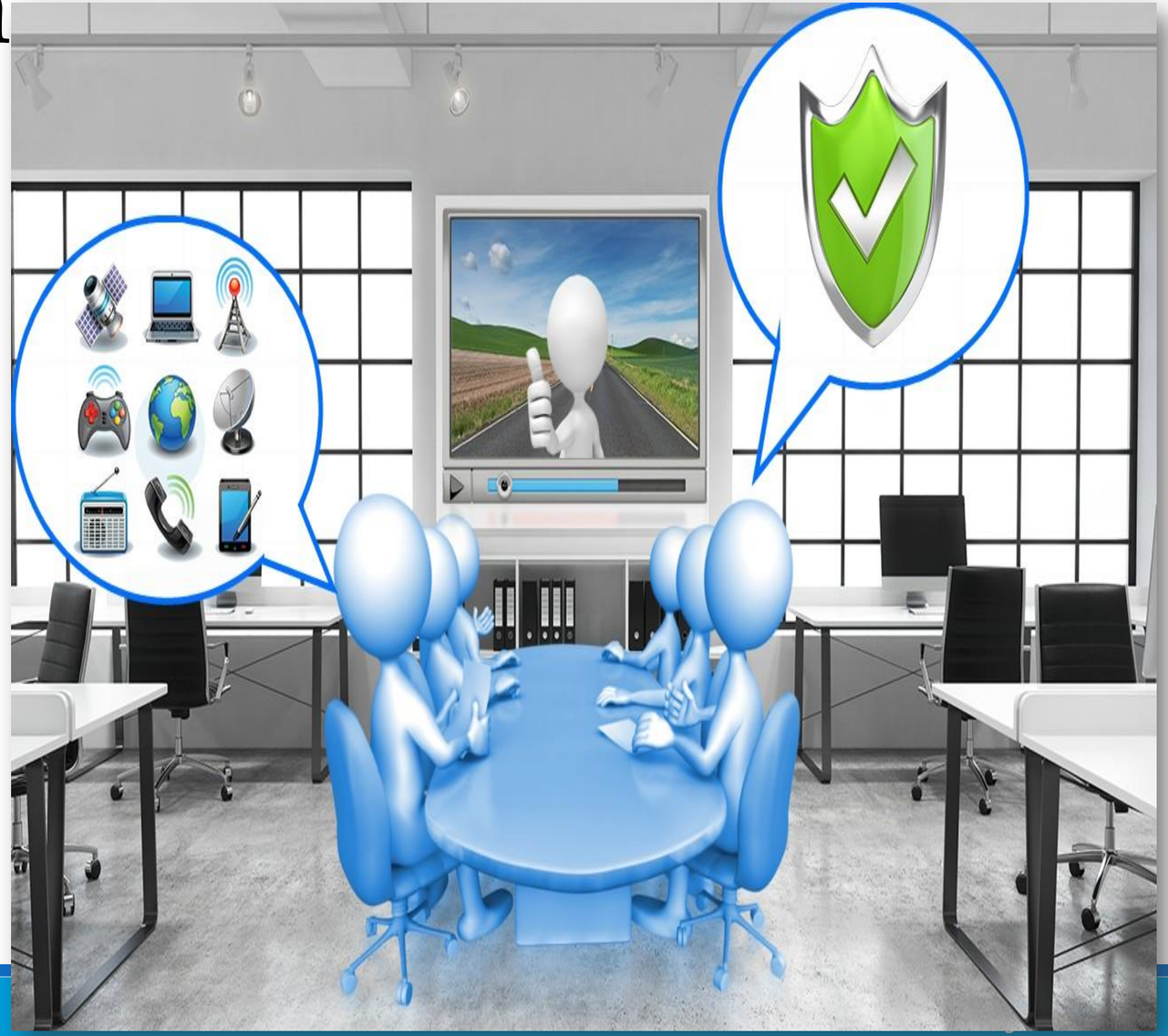
Definisi Infrastructure ICT & Telefon

Infrastruktur rangkaian *Information & Communication Technology* (ICT) dan Telefon yang terdiri daripada **pendawaian, perkakasan dan perisian** yang berkaitan.

Tujuan Pemasangan

Memenuhi keperluan pengguna di dalam premis untuk **berkomunikasi, akses kepada Internet dan capaian kepada aplikasi-aplikasi di dalam talian** yang berkaitan dengan pantas berkualiti dan selamat.

Aplikasi : email 1govuc, HRMIS, laman sesawang agensi kerajaan dll)



Perancangan Projek

KEPERLUAN REKABENTUK

Standard & Garis Panduan

Kajian Tapak

Keperluan Pelanggan & Objektif

Rekabentuk Konsep

Penyediaan Anggaran Awalan

SPACE FACTOR

Keperluan Ruang ICT & Telefon

Standard & Garis Panduan

❑ Institute of Electrical and Electronics Engineers

- ✓ IEEE 802.3xx Ethernet Network
- ✓ IEEE 802.11xx Wireless Local Area Networks

❑ American Standard National Institute / Insulated Cable Engineers Association

- ✓ ANSI/ICEA s-87-640 Optical Fibre Outside Plant Communications Cable Standard

Standard & Garis Panduan

❑ Malaysia Standard

- ✓ MS IEC 60038 IEC Standard Voltages
- ✓ MS IEC 60364 Electrical Installations for Building
- ✓ MS IEC 61537 Cable Management –Cable Tray Systems and Cable Ladder Systems
- ✓ MS 2121:2012 Telecommunication Cable : Plastic twin pair, triple and unit types, internal cable.
- ✓ MS 2122:2012 Telecommunication Cable : Jumper Cable
- ✓ MS 2123:2012 Telecommunication Cable : Self-supporting drop wire
- ✓ MS 2124:2012 Telecommunication Cable : Fully filled, unit twin moisture barrier polyethylene sheathed cable (FF PEUT)
- ✓ MS 2125:2012 Telecommunication Cable: Integral bearer - Moisture barrier polyethylene sheathed cable (IB PEUT)

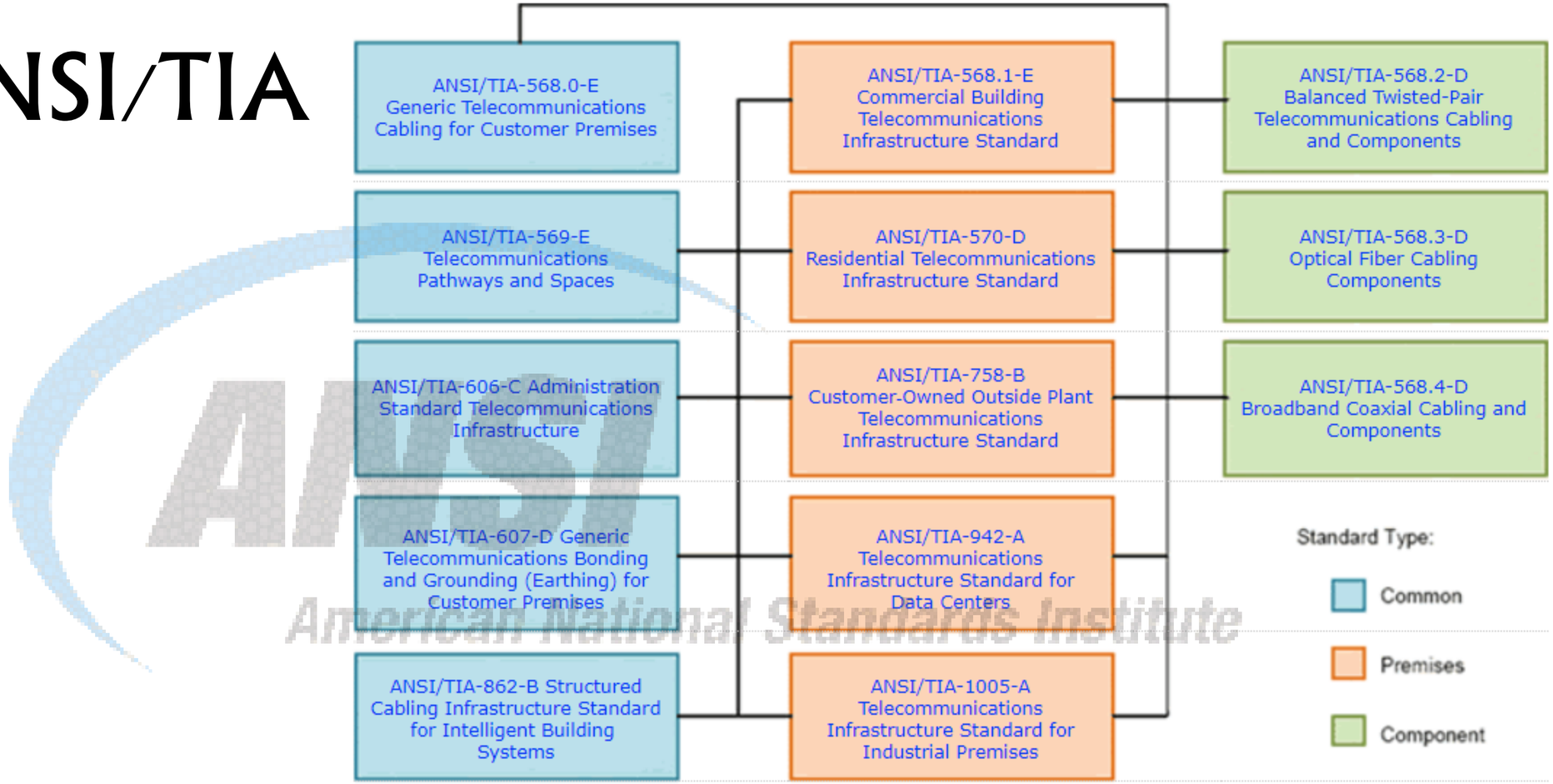
Standard & Garis Panduan

❑ International Standard

- ✓ IEC 61000 Electromagnetic Compatibility
- ✓ CISPR 22 Electromagnetic Compatibility within Europe for Information Technology Equipment
- ✓ IEC 60332-3 Tests on Electric and Optical Fibre Cables under Fire Conditions - Test for Vertical Flame Spread of Vertically-Mounted Bunched Wires or Cables
- ✓ IEC 60754-2 Test on Gases Evolved During Combustion of Materials from Cables - Determination of Acidity (by pH measurement) and Conductivity
- ✓ IEC 61034-2 Measurement of Smoke Density of Cables Burning under Defined Conditions - Test Procedure and Requirements
- ✓ IEC 60603-7 Connectors for Electronic Equipment - Detail Specification for 8-way, Unshielded, Free and Fixed Connectors
- ✓ IEC 60512 Connectors for Electrical and Electronic Equipment - Tests and Measurements
- ✓ IEC 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
- ✓ IEC 61557-1 Electrical Safety in Low Voltage Distribution Systems up to 1 000 V AC and 1 500 V DC - Equipment for Testing, Measuring or Monitoring of Protective Measures

Standard & Garis Panduan

❑ ANSI/TIA



ANSI/TIA 598	Optical Fibre Cable Color Coding
ANSI/TIA 1096-A	Telecommunications Telephone Terminal Equipment Connector Requirements for Connection of Terminal Equipment to the Telephone Network

Standard & Garis Panduan

❑ ISO/IEC

- ✓ ISO/IEC 30129:2015 Information Technology - Telecommunications Bonding Networks for Buildings and Other Structures
- ✓ ISO/IEC 14763-2 Information Technology - Implementation and Operation of Customer Premises Cabling - Planning and Installation
- ✓ ISO/IEC 11801-1 Generic Cabling for Customer Premises
- ✓ ISO/IEC 11801-5 Generic Cabling for Customer Premises : Data Centres
- ✓ ISO/IEC 18598 Information Technology - Automated Infrastructure Management (AIM) systems - Requirements, Data Exchange and Applications
- ✓ ISO/IEC 14763-3 Information technology - Implementation and Operation of Customer Premises Cabling - Testing of Optical Fibre Cabling

Standard & Garis Panduan

❑ International Telecommunications Union Standard

- ✓ ITU-T H.323 (12/2009) Packet-based multimedia communications systems
- ✓ ITU-T T.38 (11/2015) International Telecommunications Union Standard
- ✓ ITU-T G.652 (11/2016) Characteristics of a single-mode optical fibre and cable.
- ✓ ITU-T G.657 (11/2016) Characteristics of a bending-loss insensitive single-mode optical fibre and cable.
- ✓ ITU-T G.711 (11/1988) Pulse code modulation (PCM) of voice frequencies
- ✓ ITU-T G.722 (11/1988) 7 kHz audio-coding within 64 kbit/s
- ✓ ITU-T G.726 (12/1990) 40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)
- ✓ ITU-T G.729A/B (10/2017) Reduced complexity 8 kbit/s CS-ACELP codec
- ✓ ITU-T G.984 (03/2008) Gigabit-capable passiveoptical networks (GPON): General Characteristics

Standard & Garis Panduan

❑ SKMM

- ✓SKMM MTSFB TC G024:2020 Fixed Network Facilities In Building And External.
- ✓SKMM MTSFB TC T001:2013 Specification For Terminal Equipment Connecting To The Public Switched Telephone Network (PSTN).
- ✓SKMM MTSFB TC T002:2013 Specification For Analogue Calling Line Identity Presentation (A-Clip) Facility For Connection To Public Switched Telephone Network (PSTN).

Standard & Garis Panduan

❑ JKR Specification

- ✓ L-S1 Low Voltage Internal Electrical Installation
- ✓ L-S16 Specification For Telephone System
- ✓ L-S38 Specification For ICT Networking System

❑ Garis Panduan JKR

- ✓ Panduan Teknik Rekabentuk Elektrik Edisi 4
- ✓ Electrical System Design & Installation Guidelines for Architects & Engineers

ULANGKAJI PEMAHAMAN…

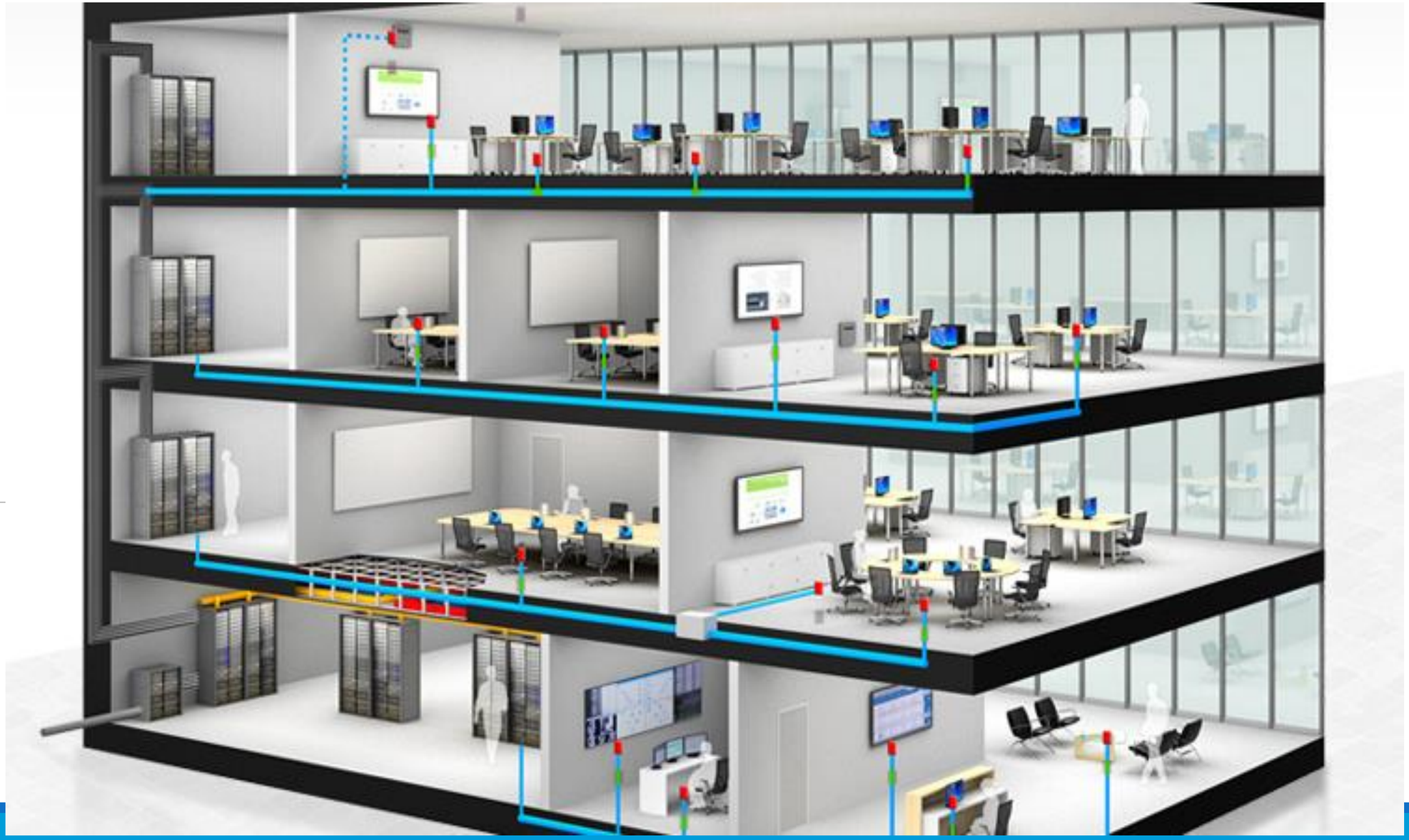
https://prod.classflow.co.uk/join/Q6ZQ4


Chris
balancing
Thank
even
questions
network
Jason
Best
people
well
two
good
guys
live
staff
load
excellent
great
session
attended
helpful
mics
coffee
deployment
time
thought
one
longer
sessions

Continue...

Terminologi

- Horizontal Cable
- Backbone Cable



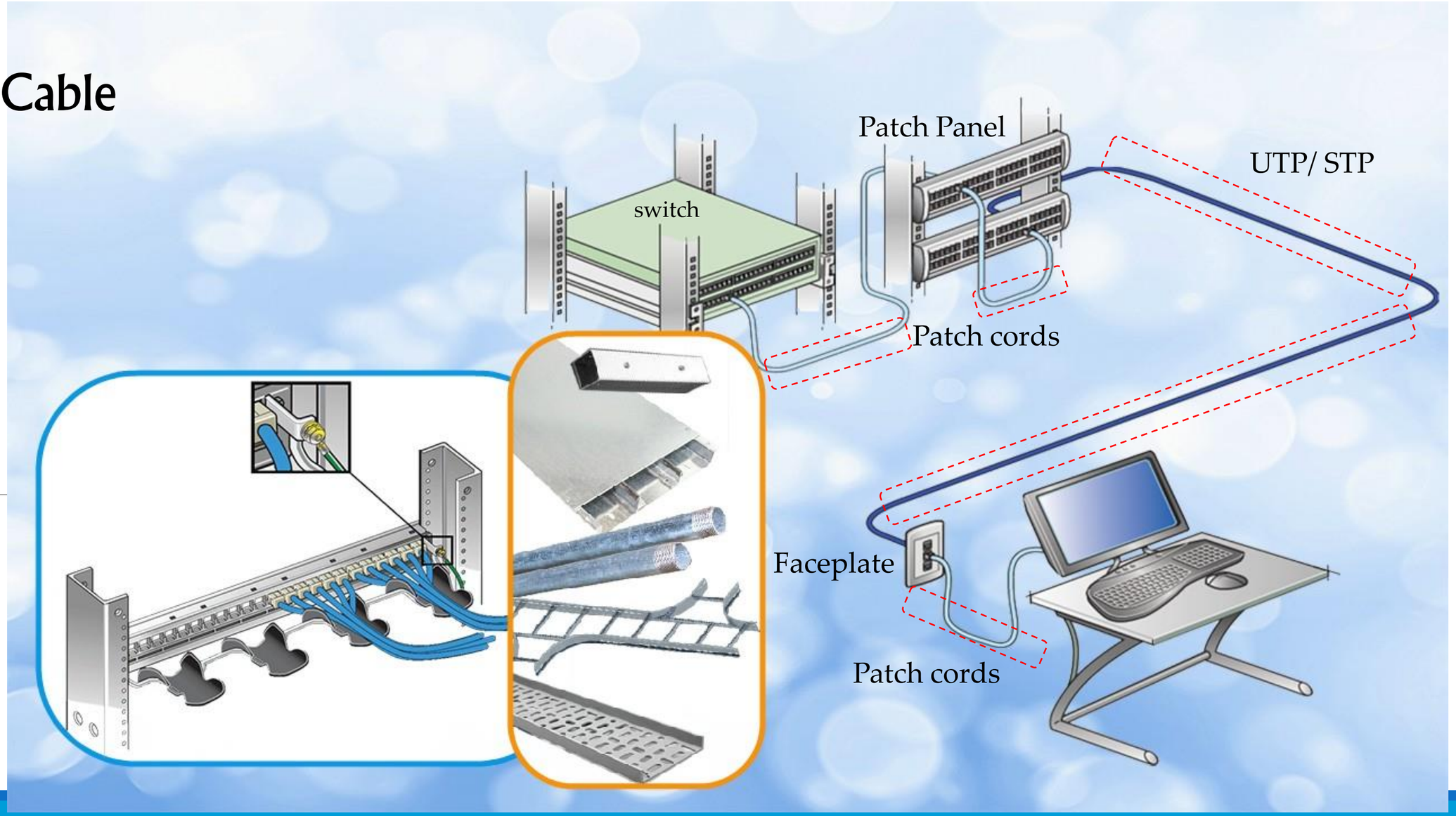
Terminologi

❑ Horizontal Cable

Cabling from the switch to the faceplate / data point (work area)

Consist of :

- ✓ Patch cords
- ✓ Patch Panel
- ✓ Twisted Pair (UTP/STP) cable
- ✓ RJ45 modular jack
- ✓ Faceplate



Terminologi

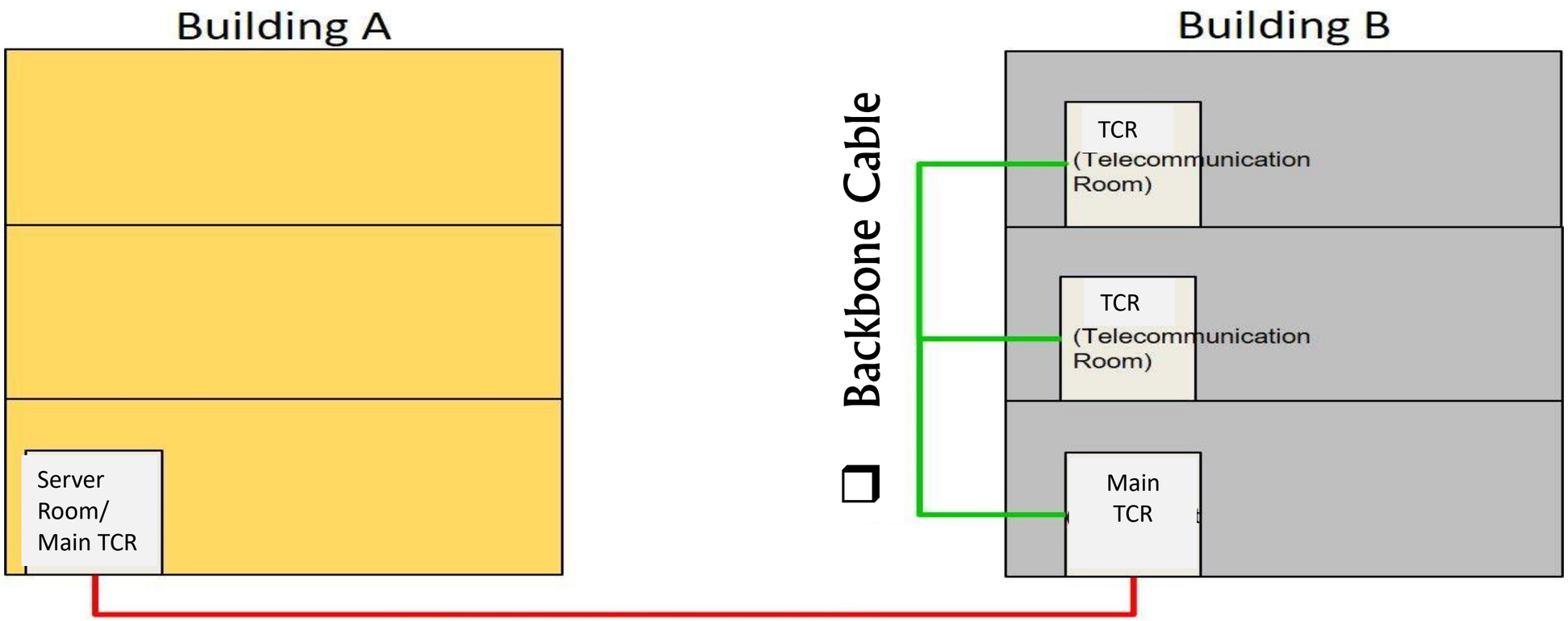
❑ Backbone Cable

Cabling between **switch (core/distribution)** to another in the different building.

Cabling between **one switch** to another in the same building which can be in different or in the same floors.

Consist of :

- ✓ Patch cords
- ✓ Fiber optic cable (SM/MM)
- ✓ Splicing Cassette
- ✓ Patch Panel
- ✓ SC/LC connector



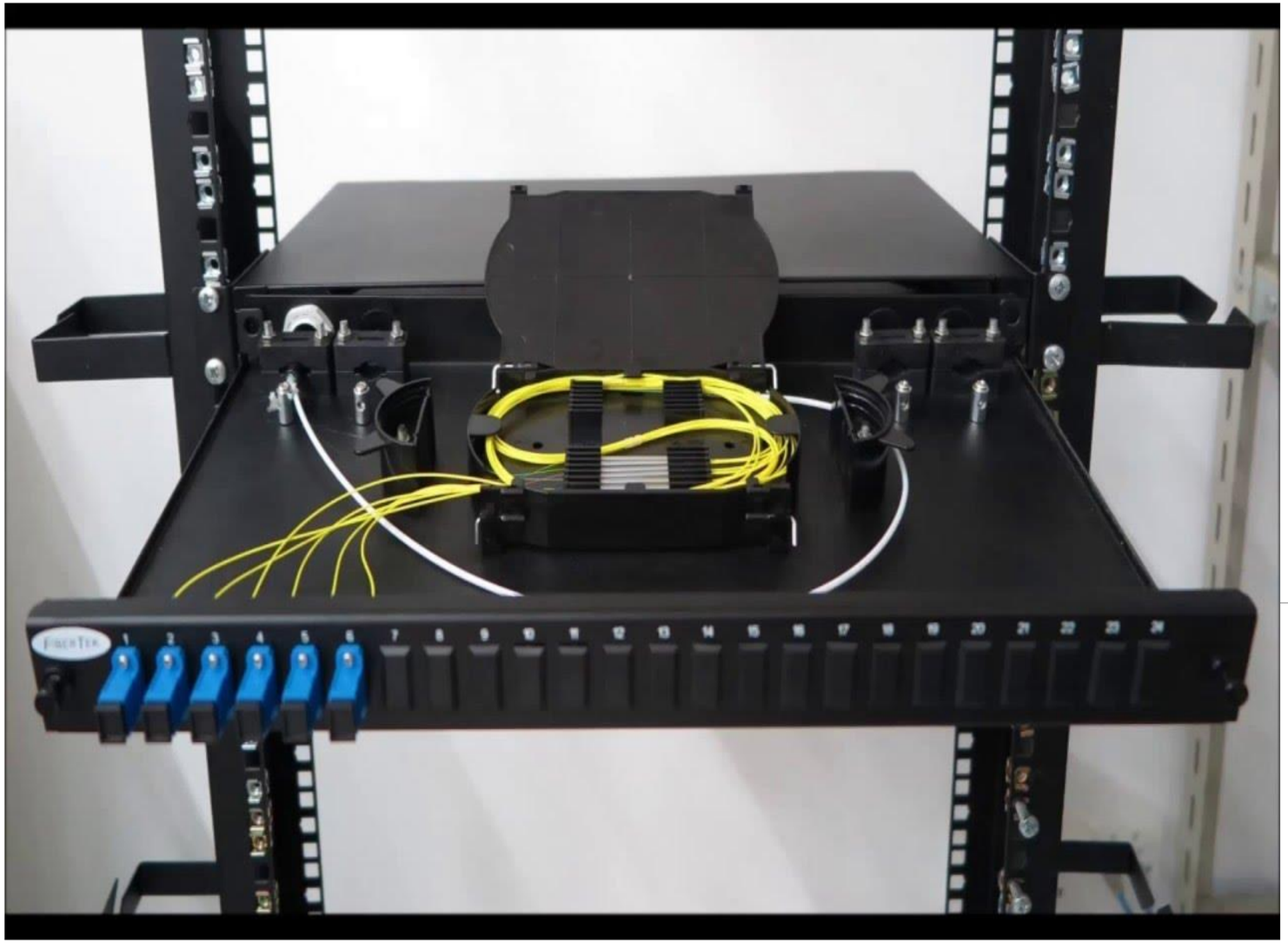
❑ Backbone Cable

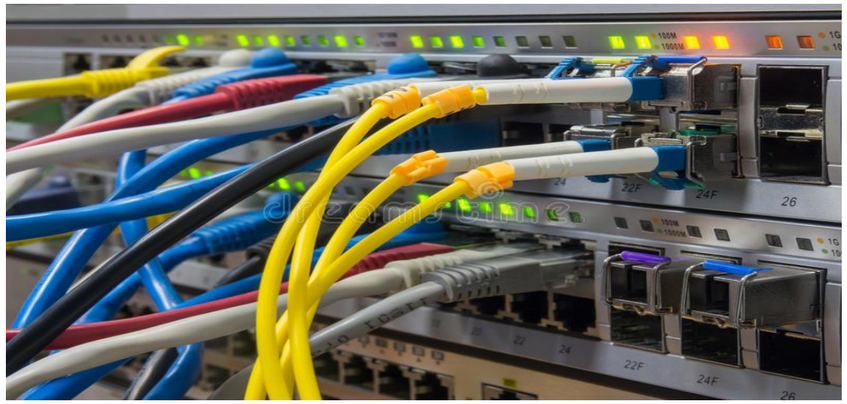
Equipment Rack – top access/ entry

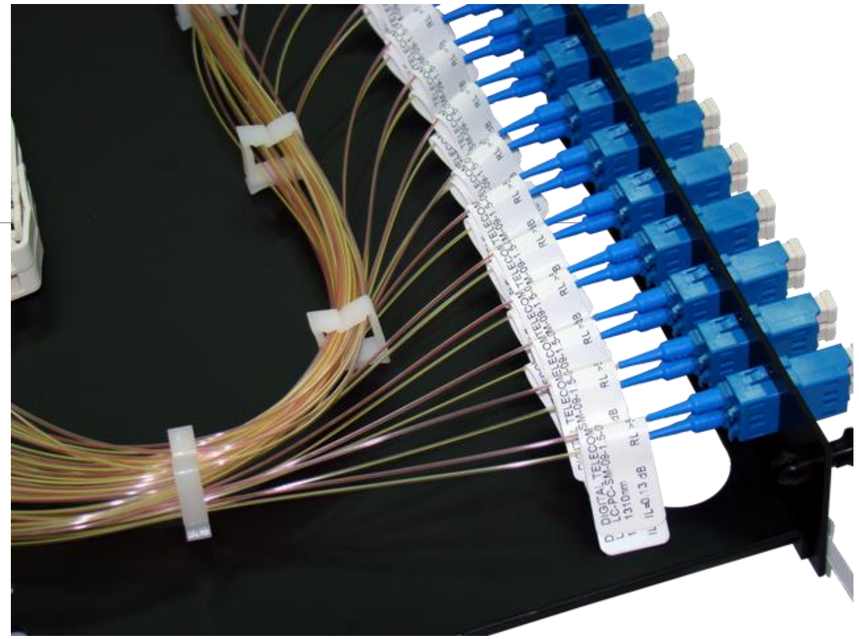
Equipment Rack – top access/ entry

- ✓ Holes contain brushes to control airflow
- ✓ Allow cable pass through to adjacent rack

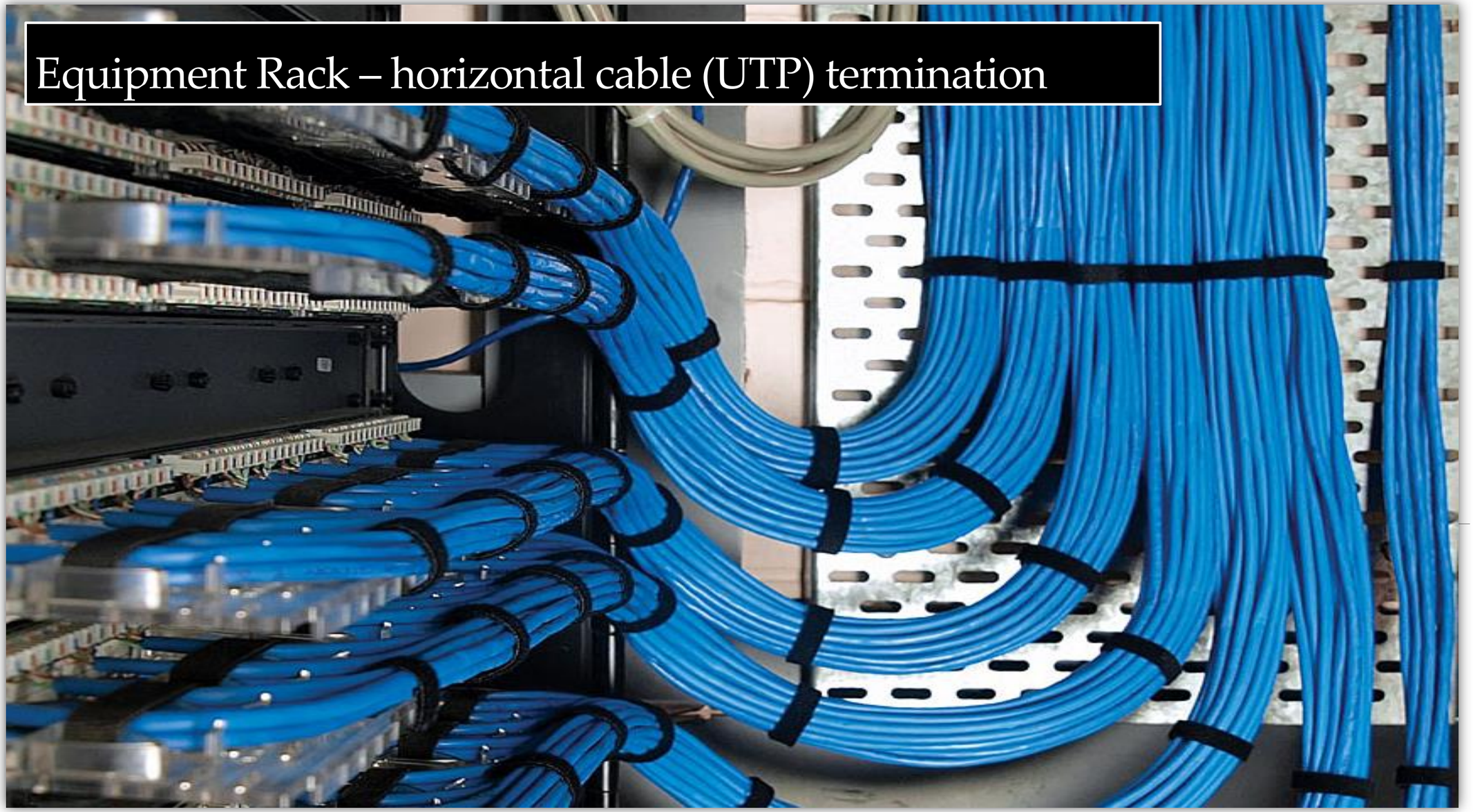
Equipment Rack – fiber patch panel, pigtails & fiber patch cord





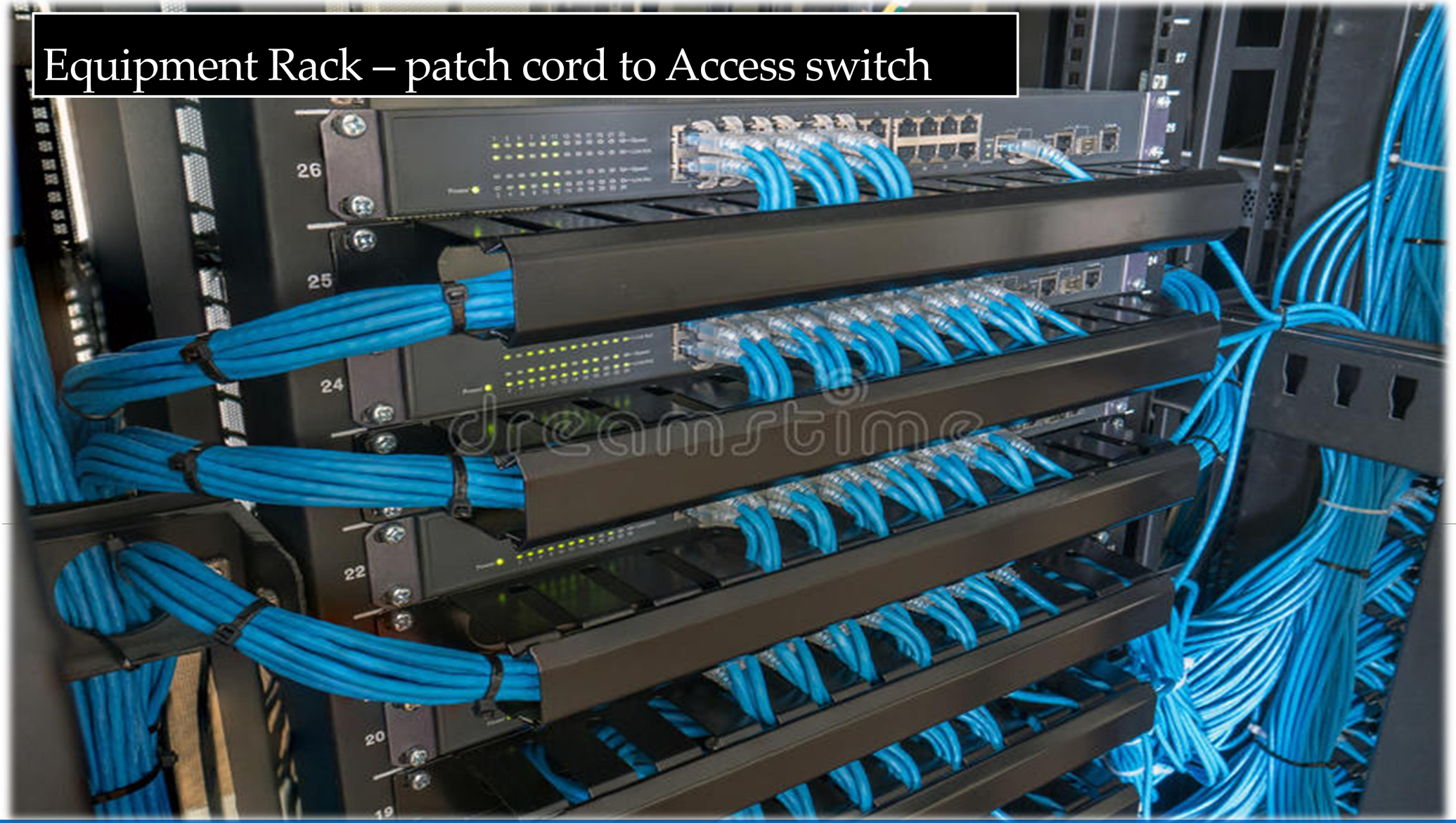


Equipment Rack – horizontal cable (UTP) termination



Equipment Rack – patch cord, patch panel & cable management

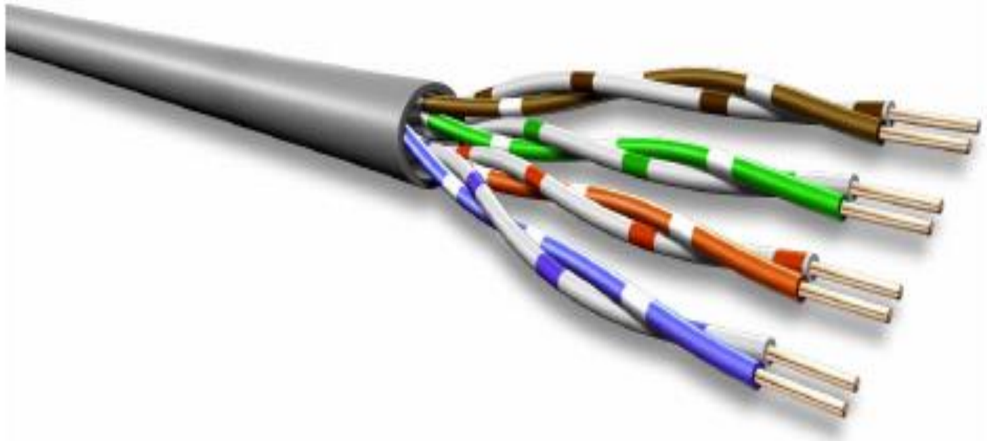
Equipment Rack – patch cord to Access switch



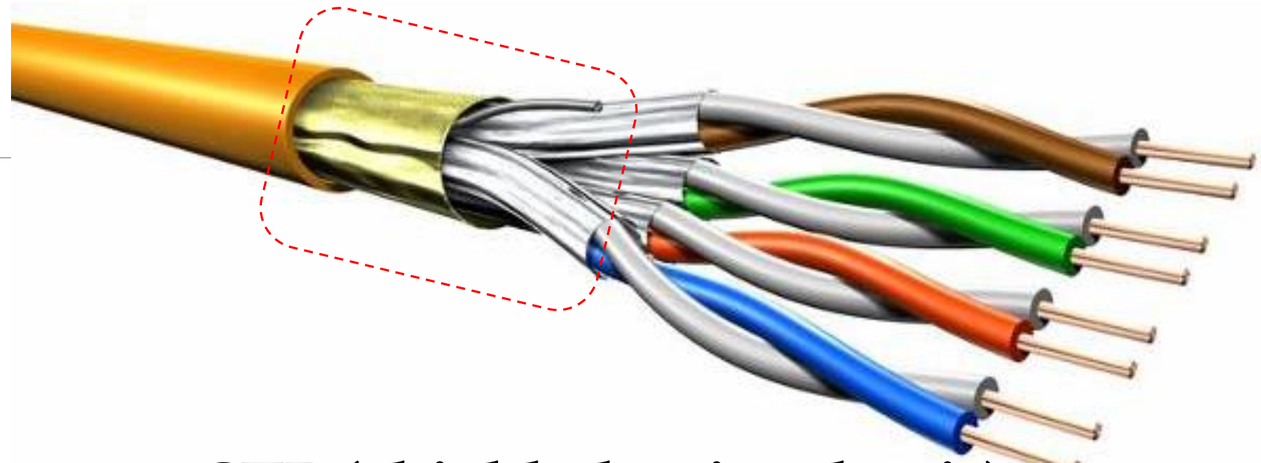
Rangkaian Pasif

❑ Twisted pair cable

- ✓ Pairs of conductor **arranged in a twisted pattern to eliminate the electromagnetic** interference between adjacent pairs
- ✓ The cable has **<u>four pairs</u>** of wires inside the jacket
- ✓ Two types : UTP & STP

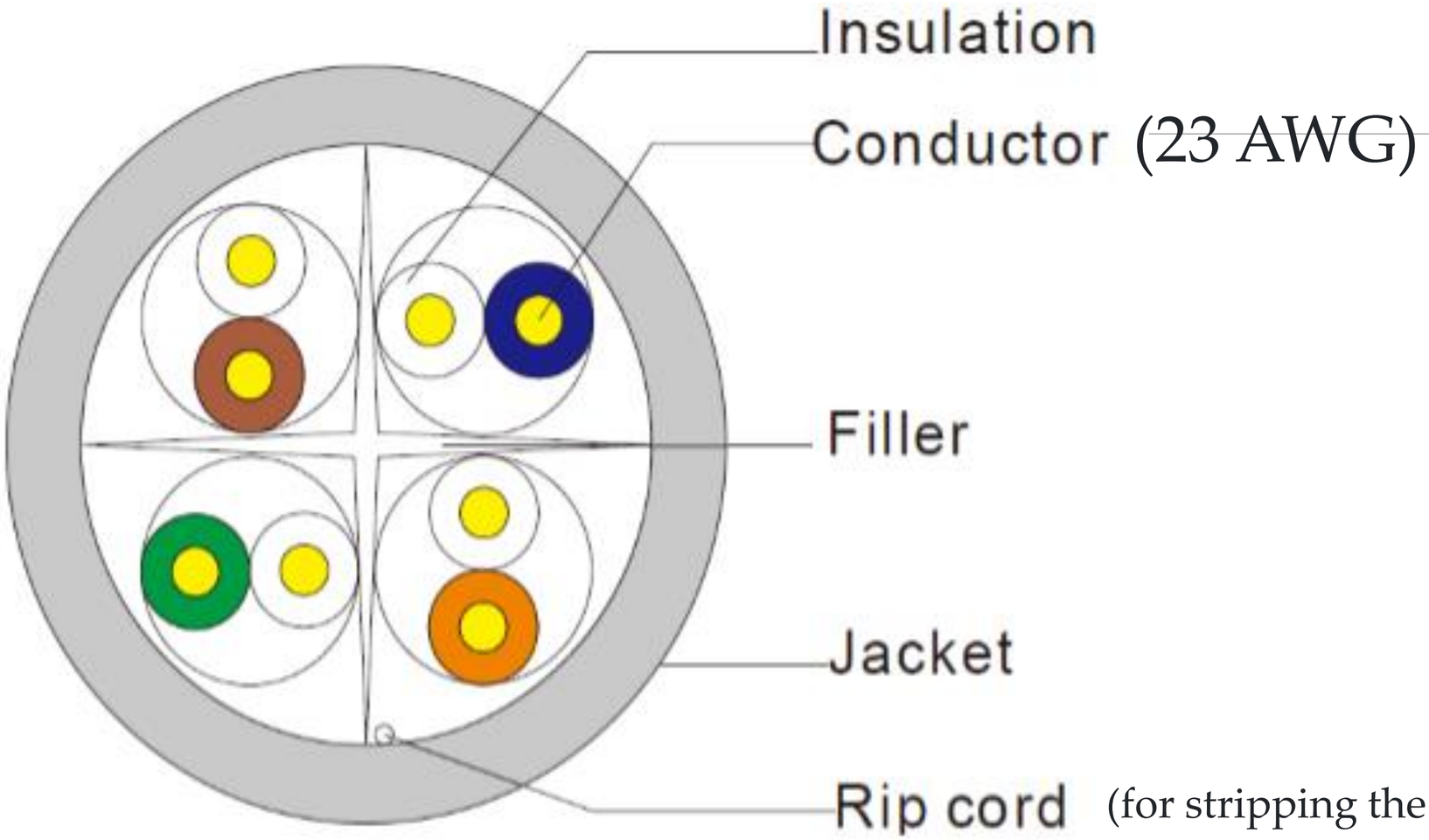


UTP (Unshielded twisted pair)

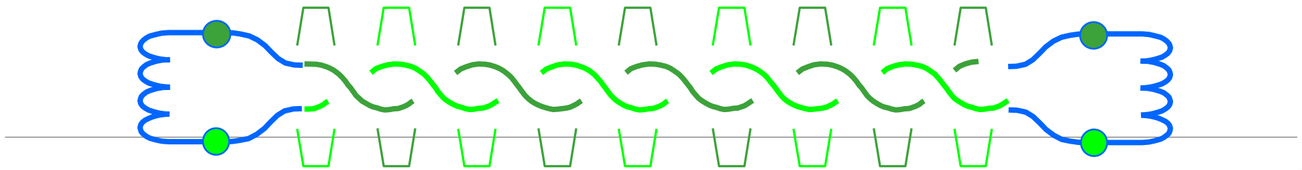


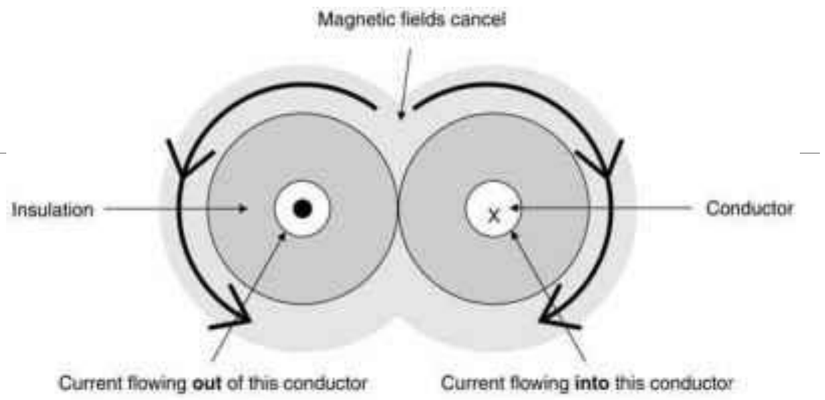
STP (shielded twisted pair)

❑ Cross section

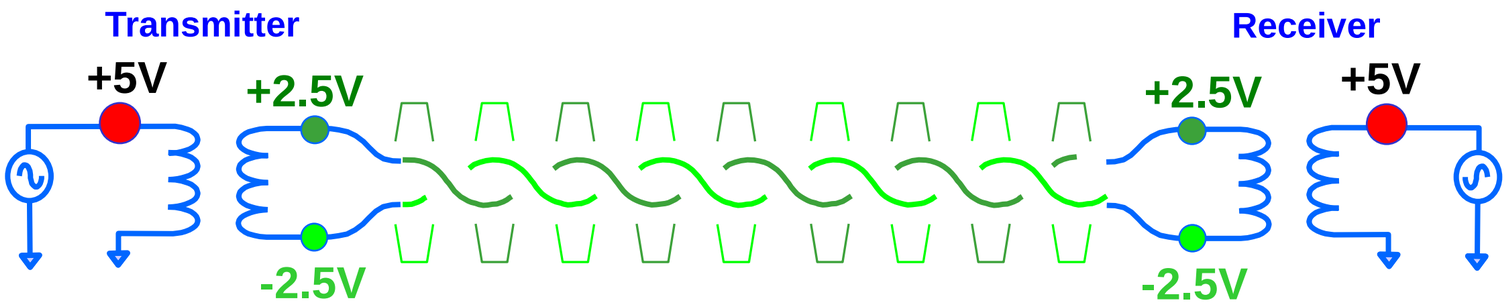


❑ Signal transmission





The twists create coupling between the two wires in the pair such that opposing electromagnetic fields are canceled.



The two conductors of a pair carry the opposite transmitted signal:

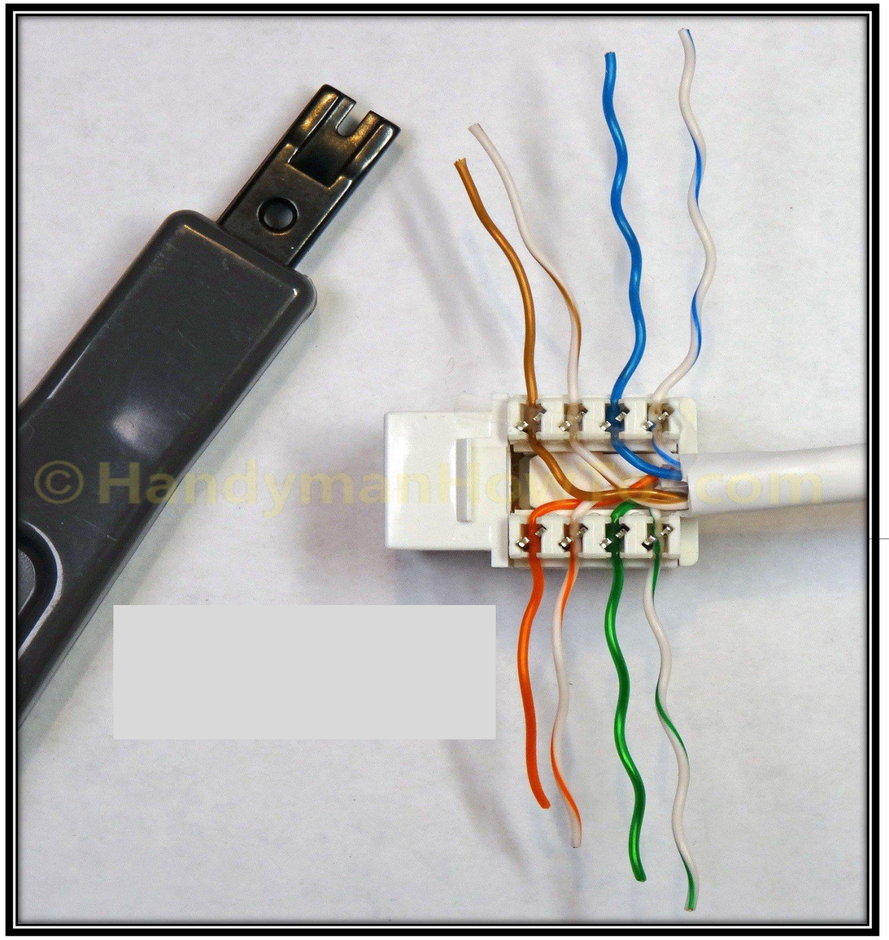
The difference of the signals resulting 5V

$+2.5V_1 - (-2.5V_2) = +5.0\ V$

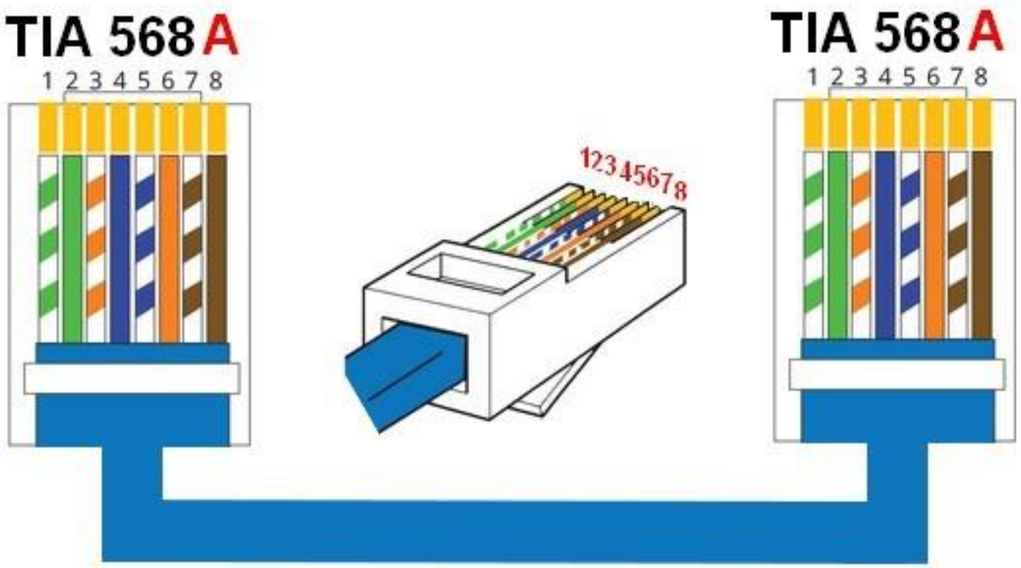
The sum of the signals is ideally zero resulting 0V

$+2.5V_1 + (-2.5V_2) = 0\ V$

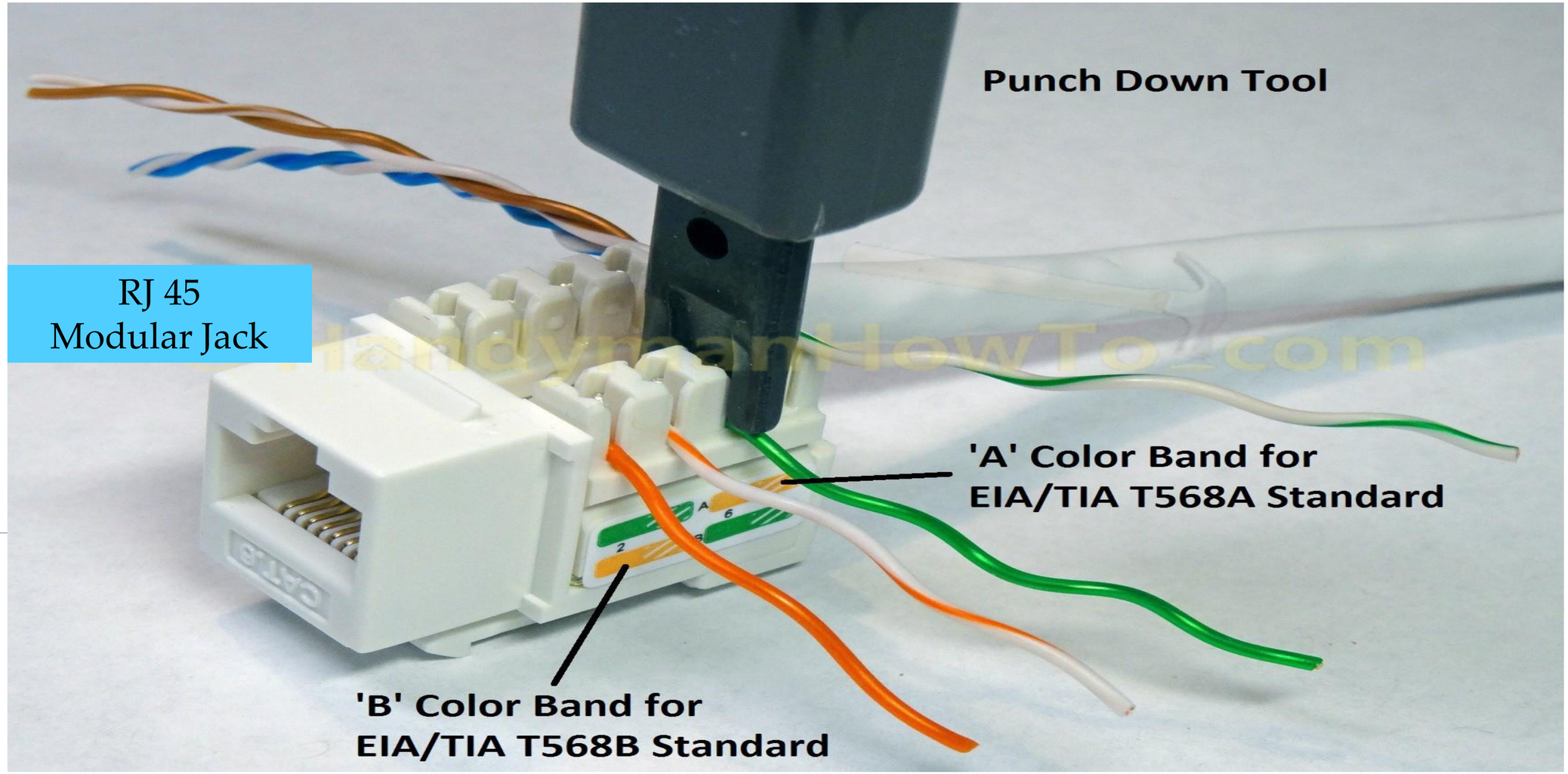
- Which standard specified termination of twisted pair cable



✓ According to ANSI/TIA 568 A

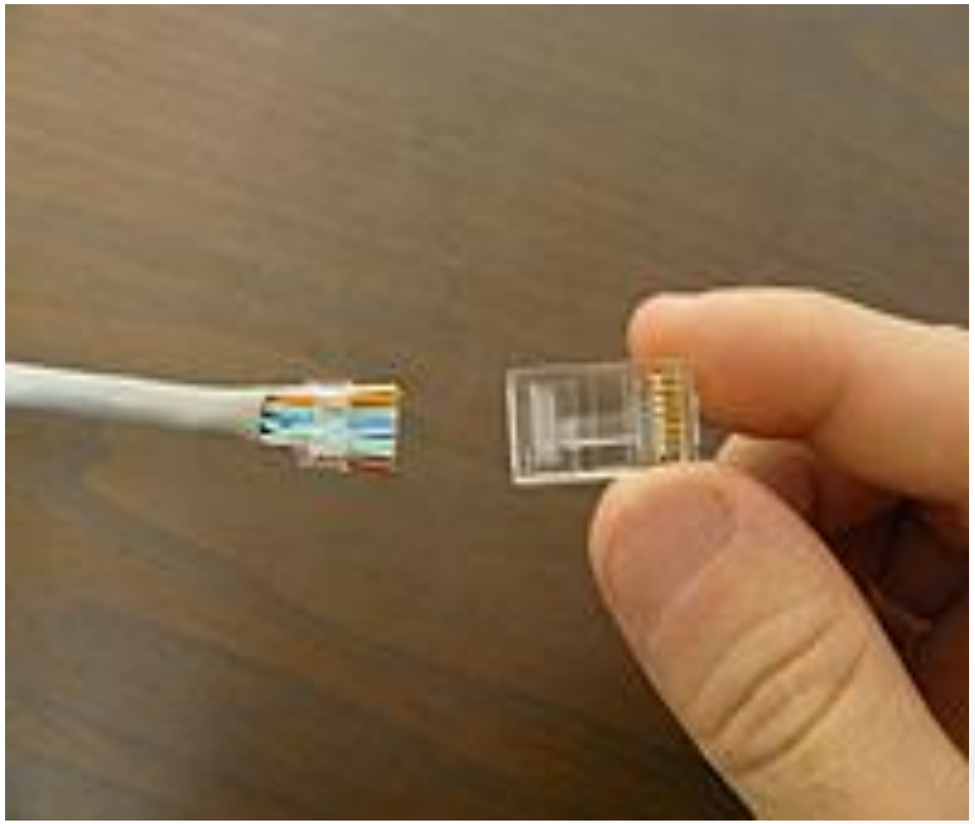


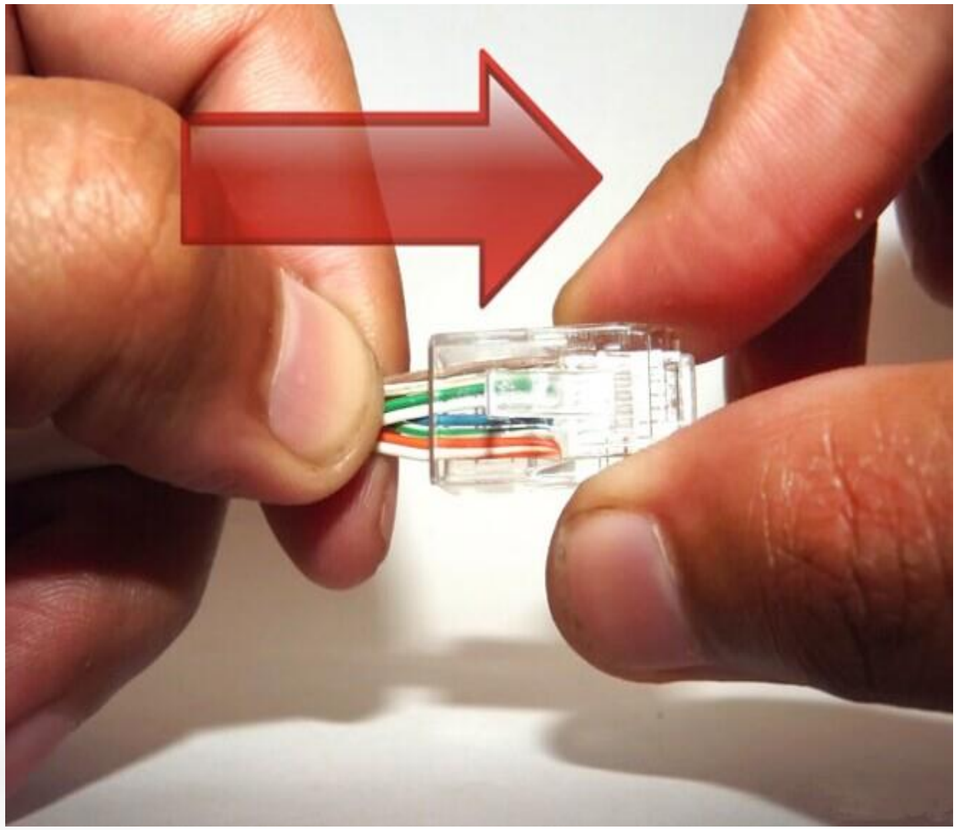
❑ How to terminate twisted pair cable



Termination UTP cable into **<u>RJ 45 modular jack</u>** using punch down tool

Why?





Self termination of twisted pair cable into **RJ45 connector** is not permitted

Direct connection to equipment is not allowed : Wi-Fi, CCTV, Medical Equipment etc.

❑ Factory terminated UTP patch cord c/w RJ45 connector

CORRECT

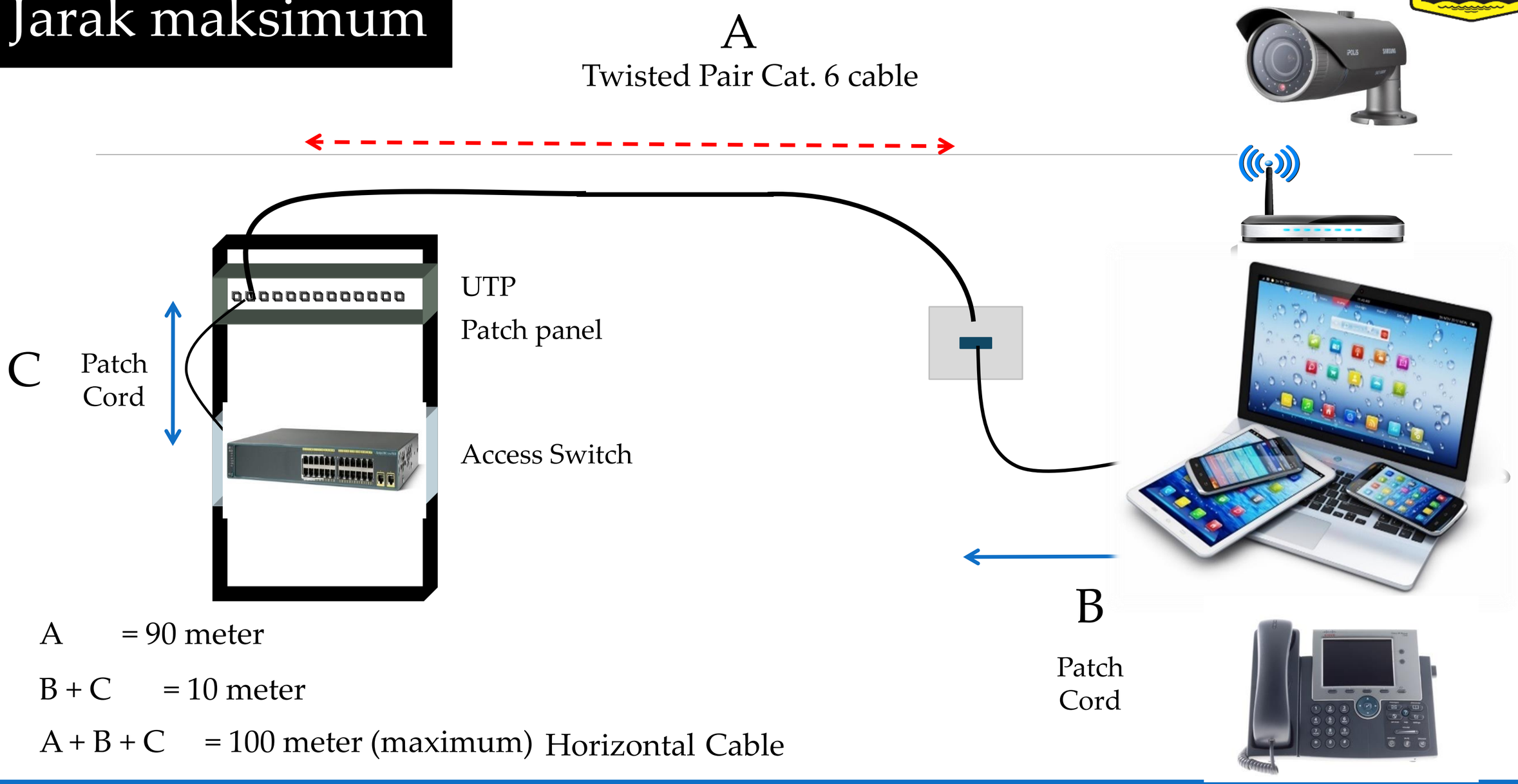
Faceplate to patch panel

Faceplate with UTP patch cord connected to RJ 45 modular jack at one side and PC on the other side

Faceplate with RJ 45 modular jack (termination of UTP Cat.6 cable at the User side)

Patch Panel with RJ 45 modular jack (termination of UTP Cat.6 cable at the Equipment Rack side)

Jarak maksimum

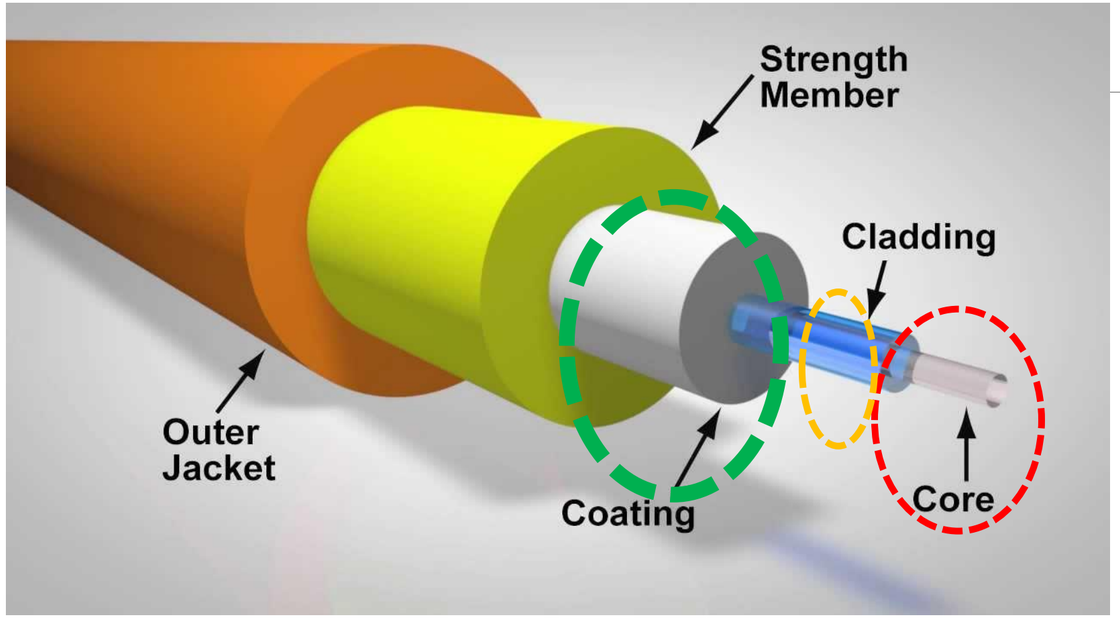


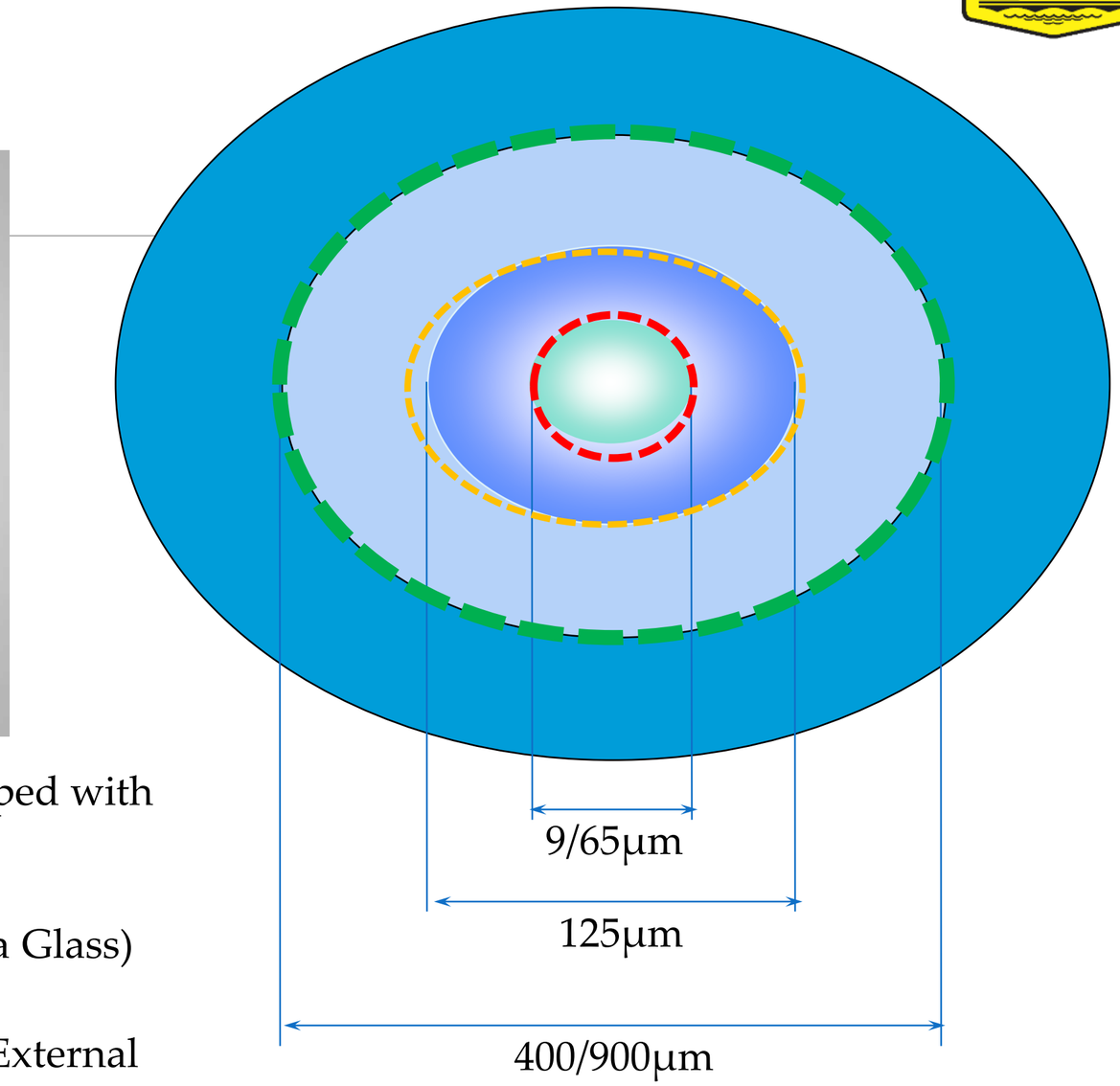
A = 90 meter

B + C = 10 meter

A + B + C = 100 meter (maximum) Horizontal Cable

Fiber Optic cable



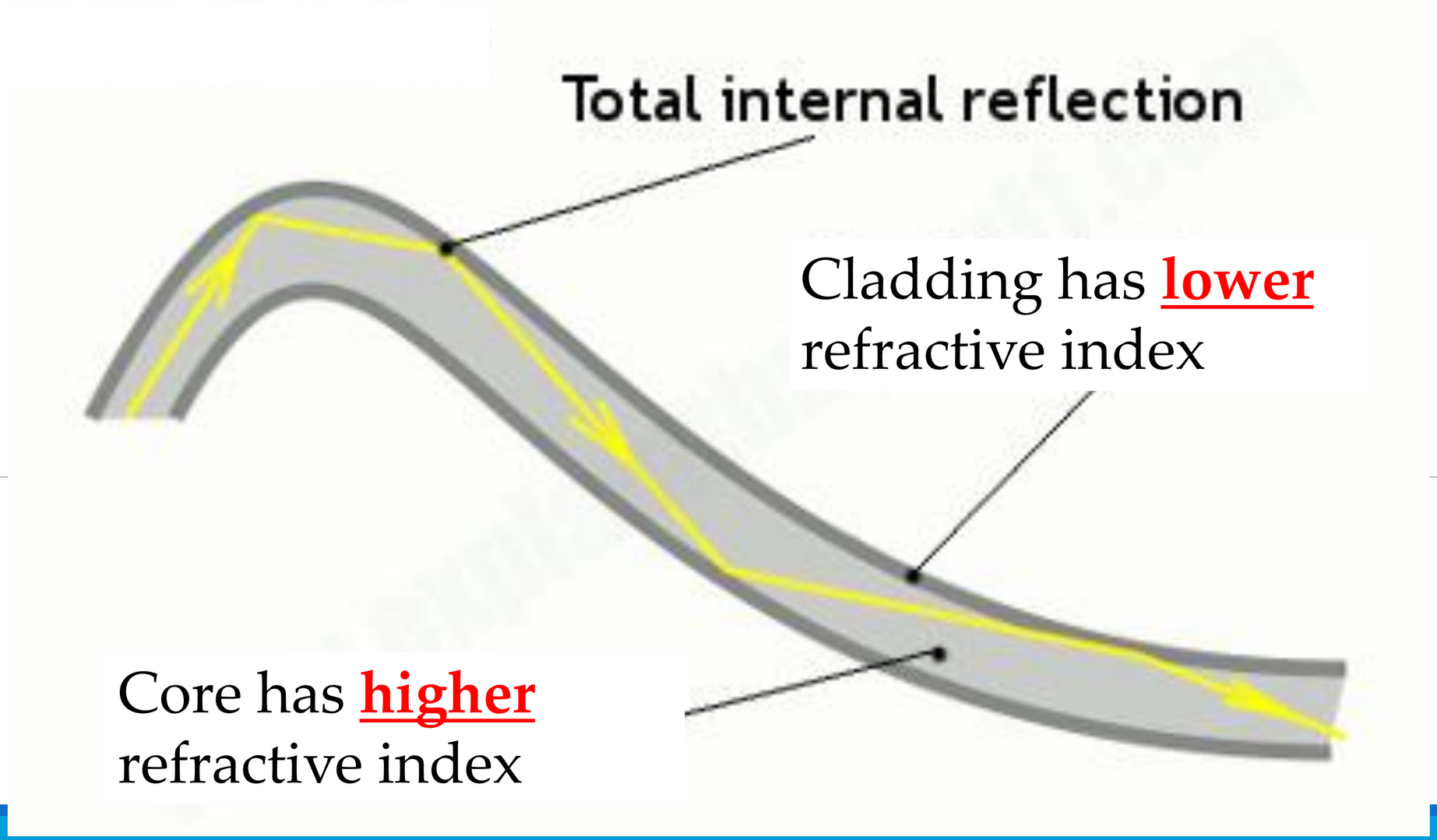


CORE : Carries the light signal (pure silica glass and doped with germanium

CLADDING : Keeps light signal within core (Pure Silica Glass)

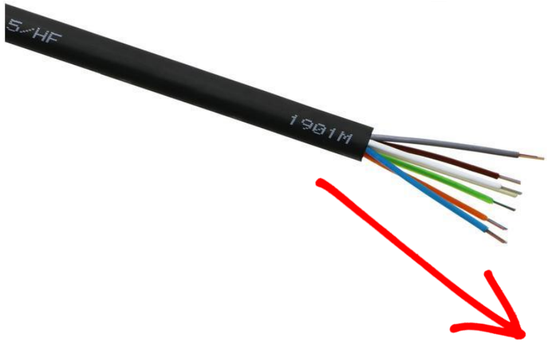
COATING : Protects Optical Fiber From Abrasion and External Pressures (UV Cured Acrylate/Acrolyte)

❑ How light can propagates throughout the core

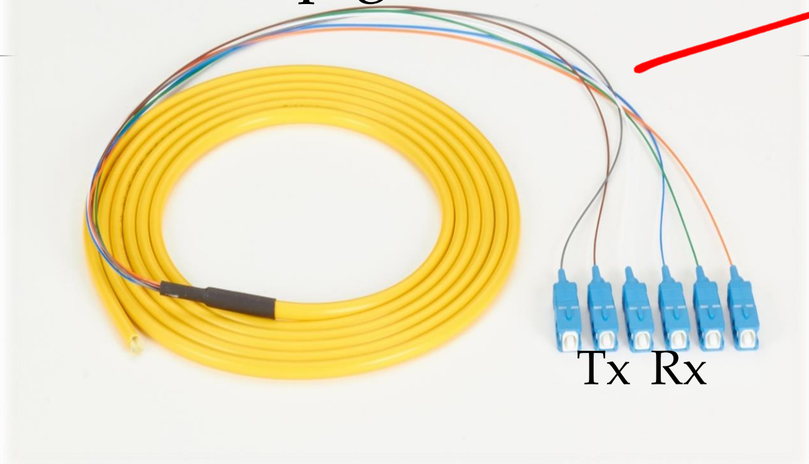


❑ Termination cable (splicing)

6 - core fiber optic cable



pigtails



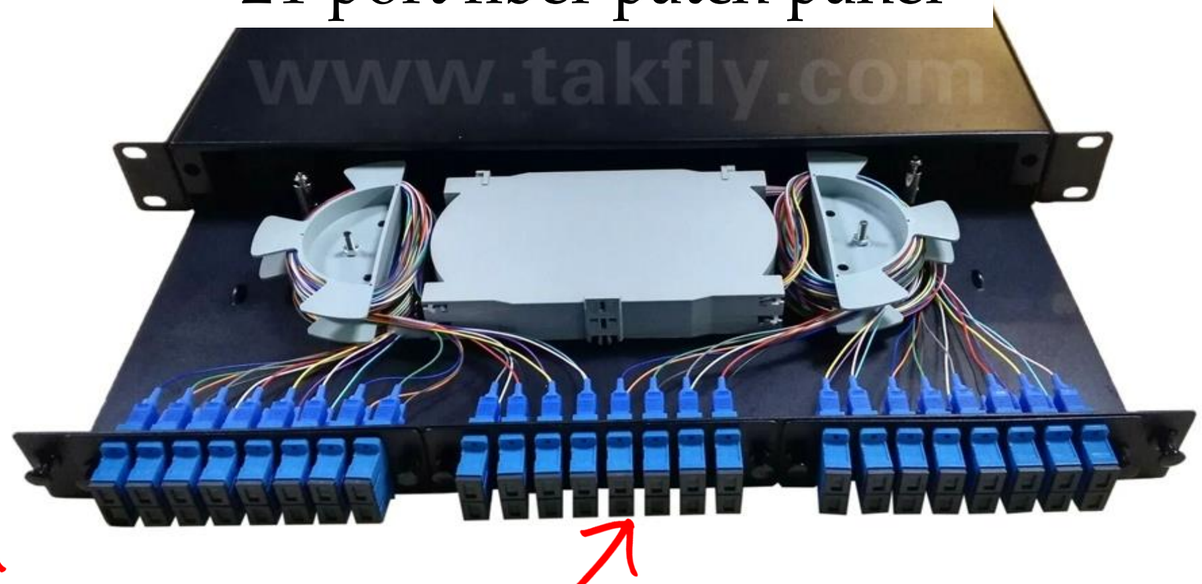
❑ Fiber optic cable entrance to the Splicing cassette

❑ 24 port fiber patch panel c/w splicing cassette

24-port fiber patch panel

SC-LC duplex fiber patch cord

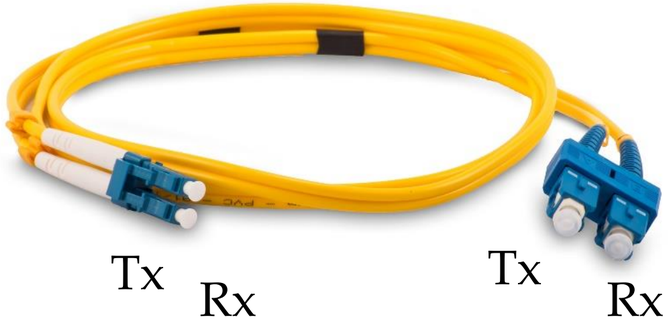
LC connector

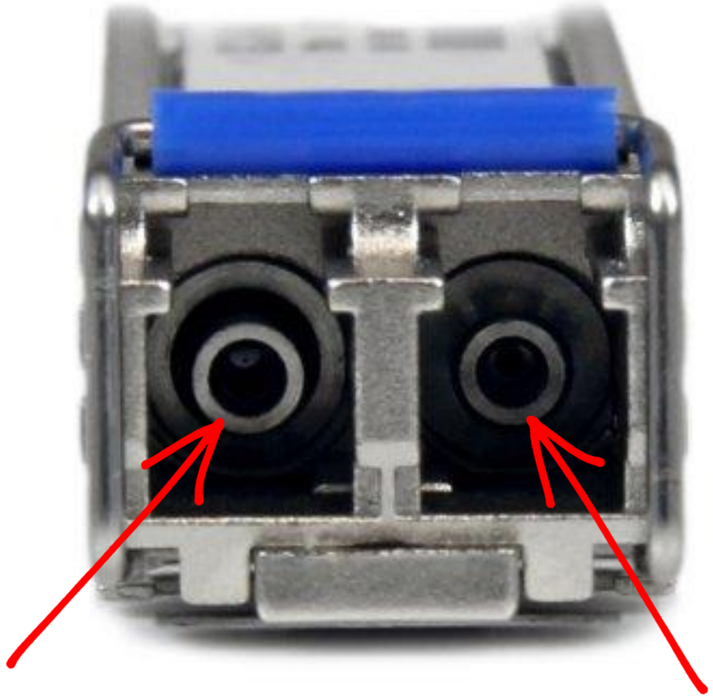


To connect to Core/Access Switches

SC connector (male)

SC connector (female)





Transmit - Tx
(LED/ Laser)

Receive - Rx
(Photo diode)

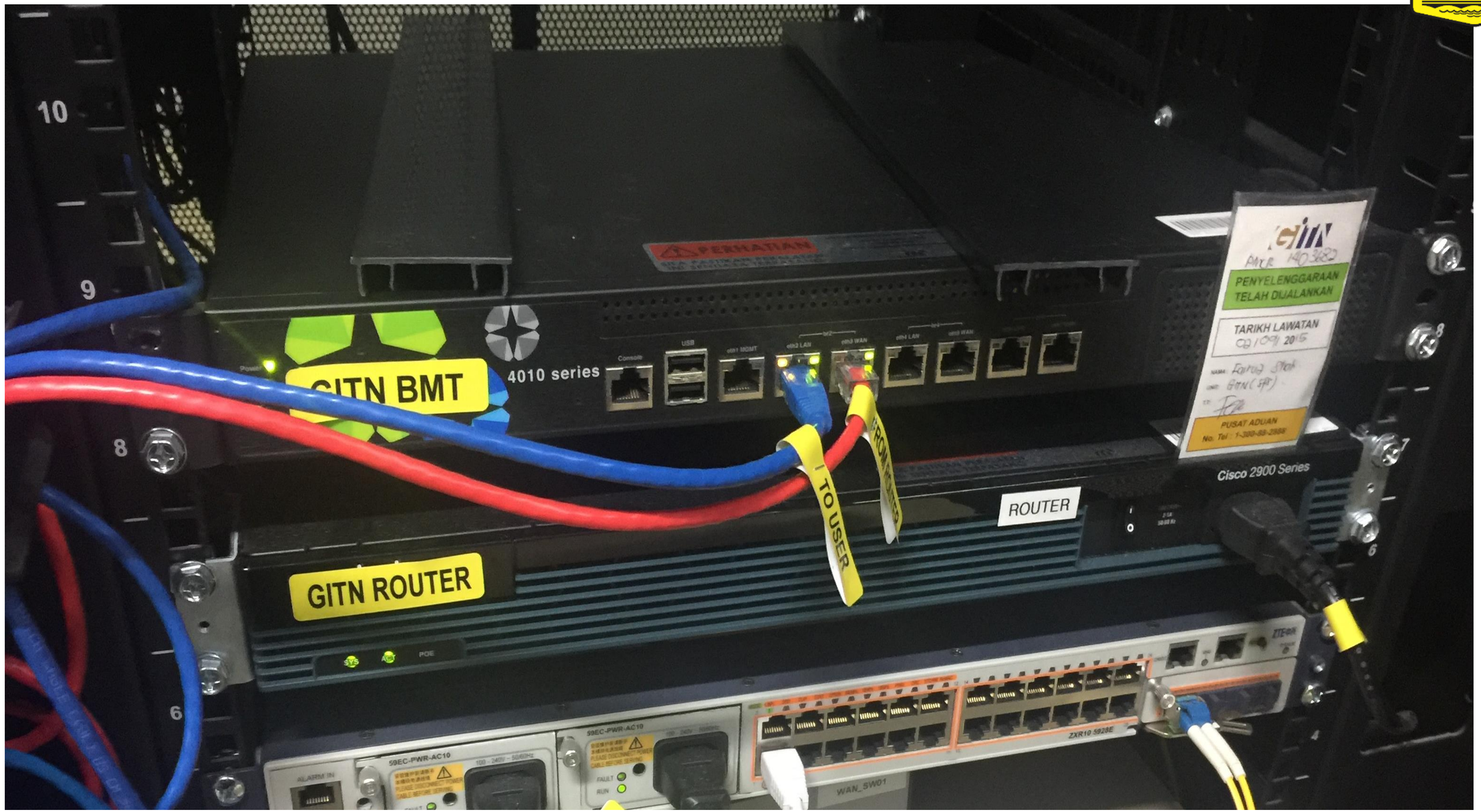
LED = multimode

Laser = singlemode

TO BE CONTINUE....

Next .....

Rangkaian Aktif


GITN BMT
4010 series
PERHATIAN
PENYELENGGARAAN
TELAH DIJALANKAN
TARIKH LAWATAN
PUSAT ADUAN
Cisco 2900 Series
ROUTER
TO USER
GITN ROUTER
59EC-PWR-AC10
ZXR10 5928E
WAN_SW01

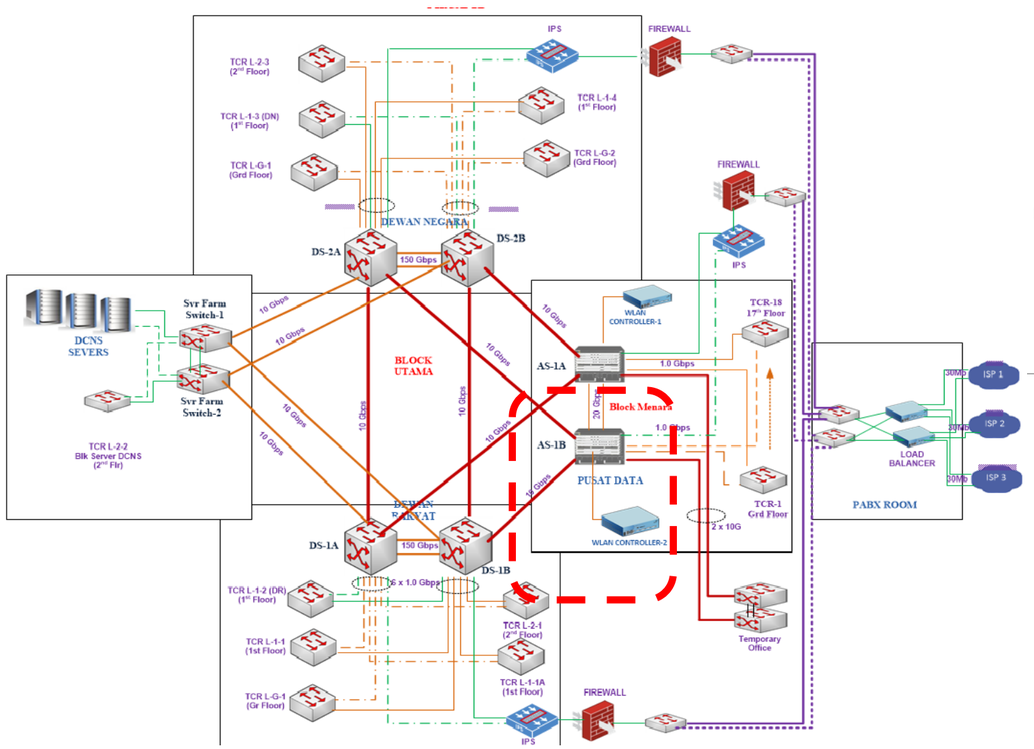
Core Switch

Chassis type

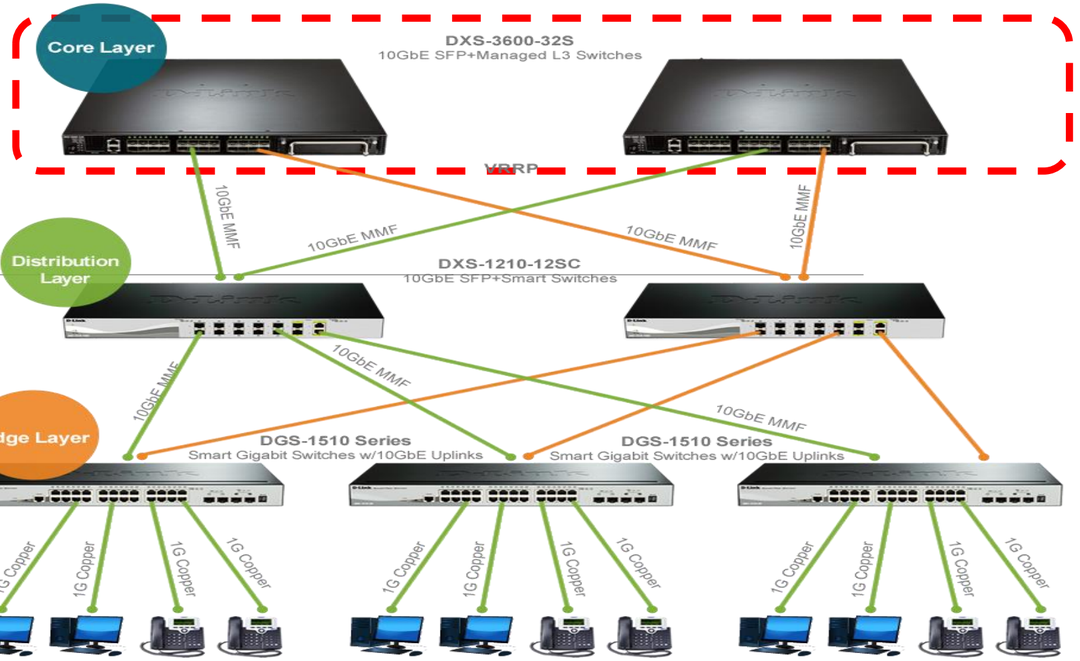
Modular type

❑ What does Core Switch mean?

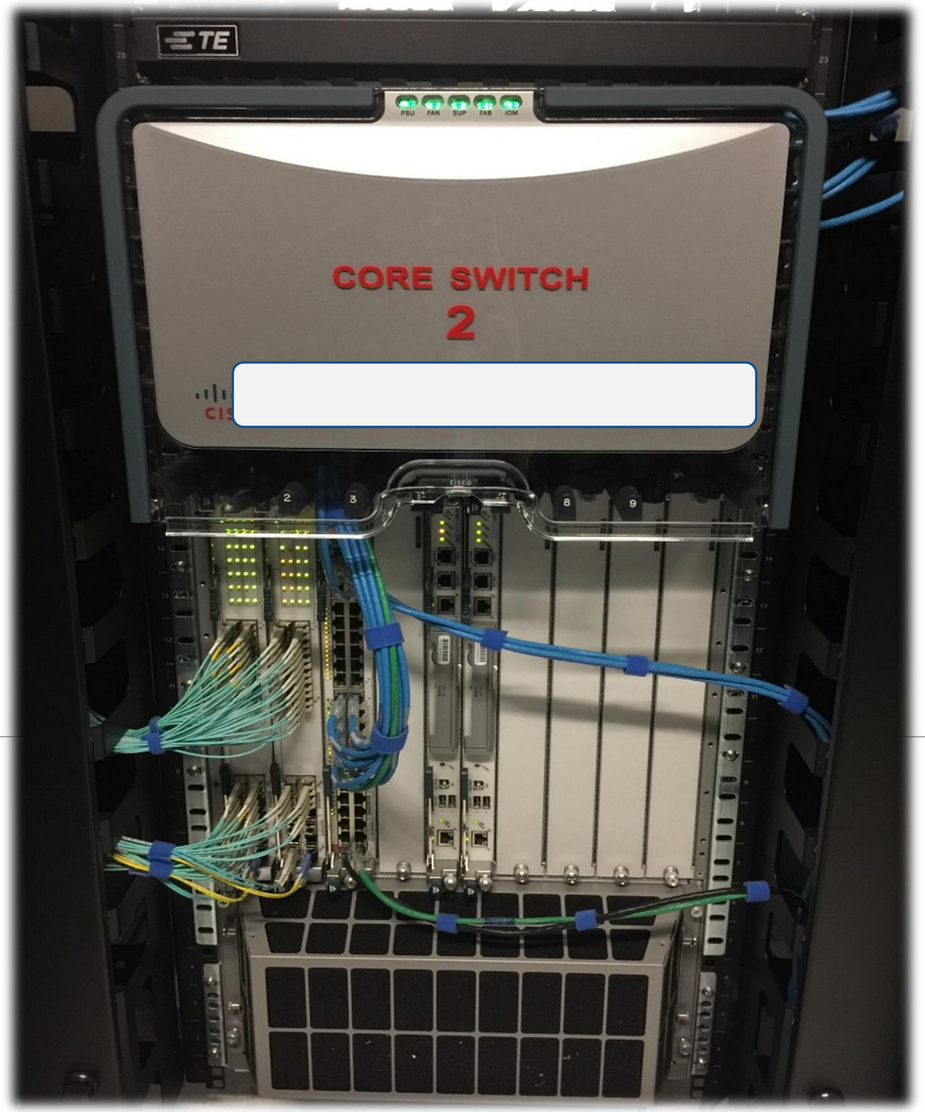
A core switch is a high-capacity switch serve as a gateway to a wide area network (WAN) or the Internet - they interconnects group of access switches



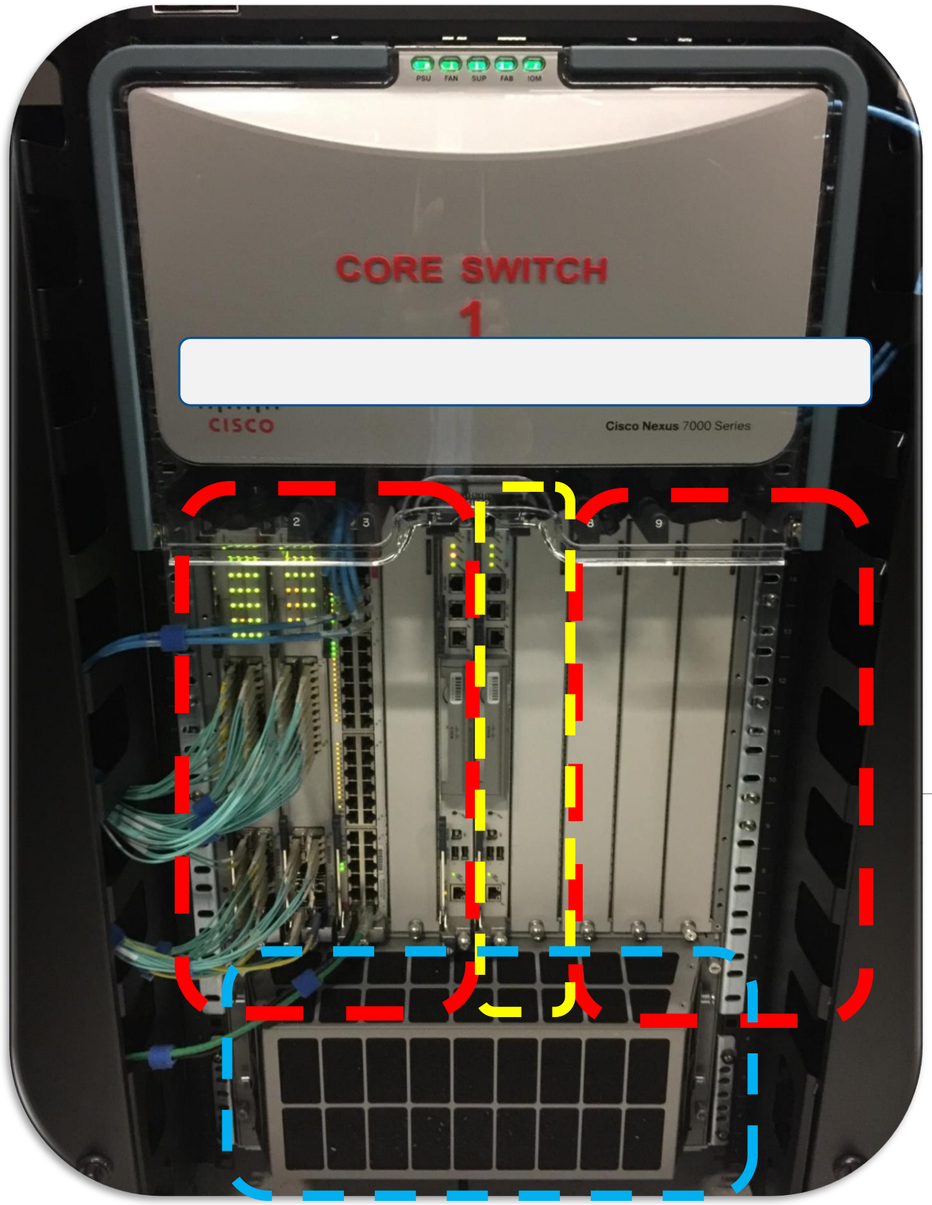
Core Switch




CORE SWITCH
1


TE
CORE SWITCH
2

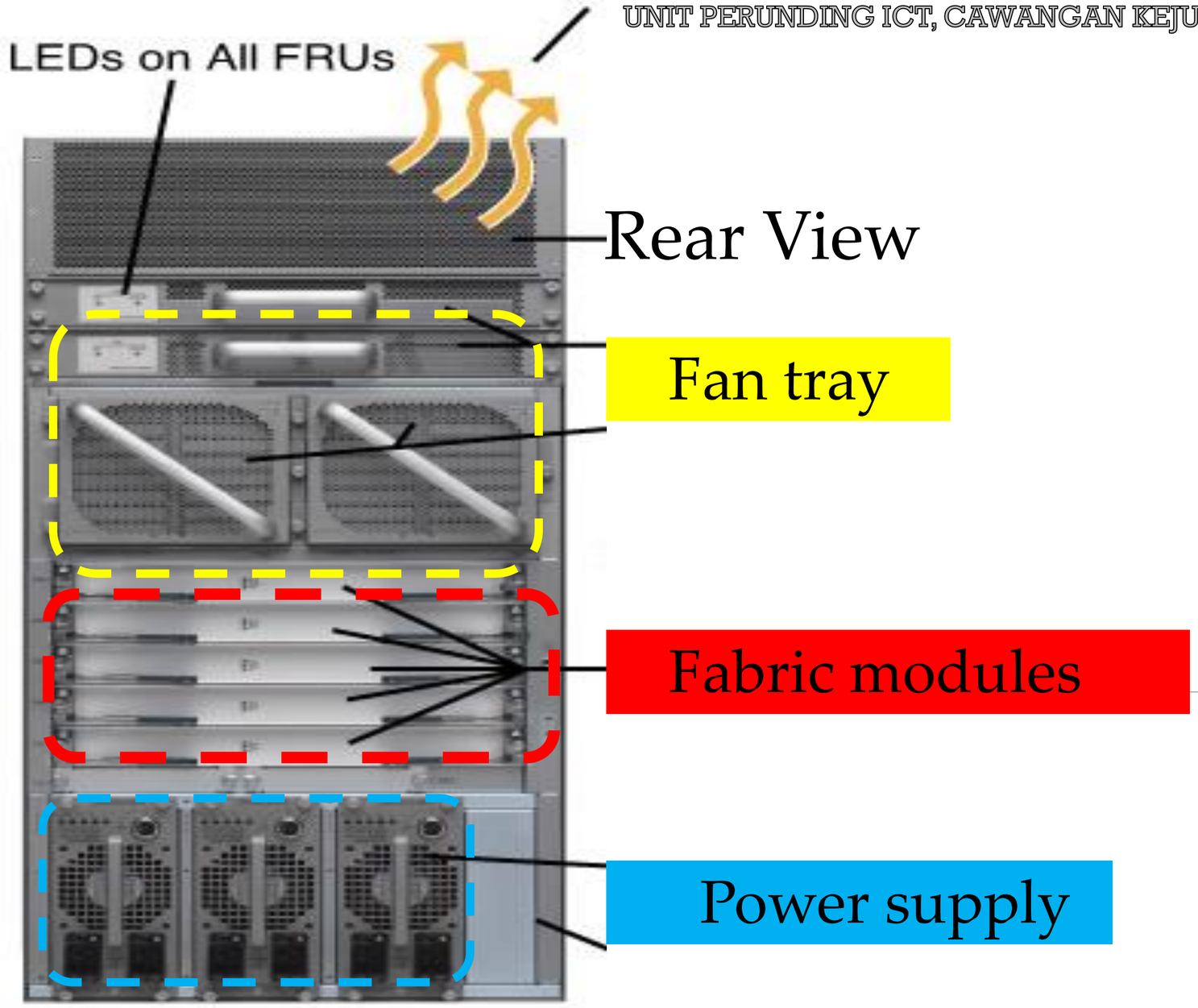
10 slots Chassis CORE SWITCH



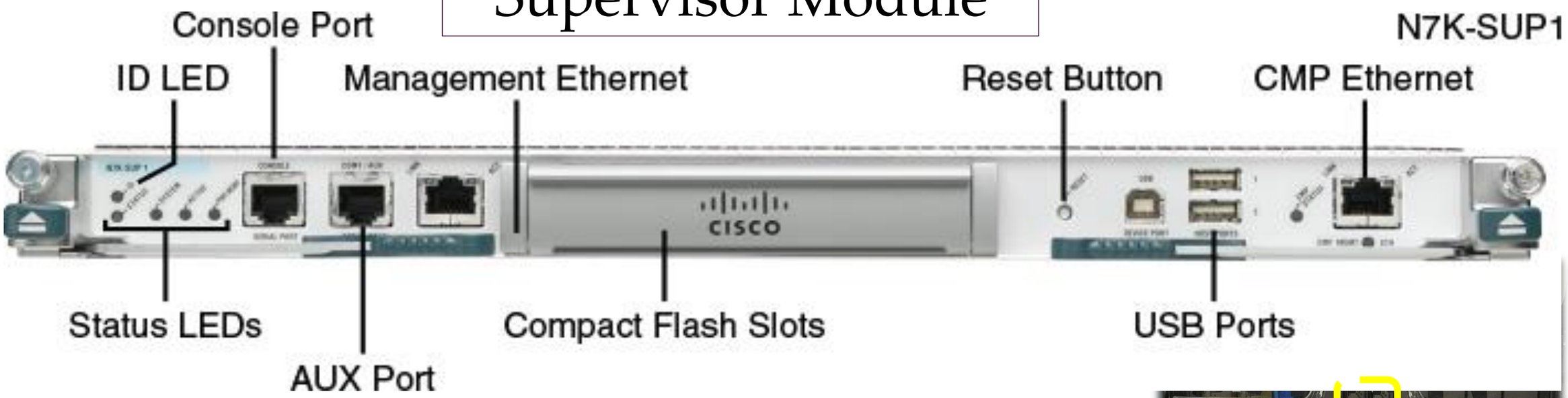
Supervisor module: 2 slots

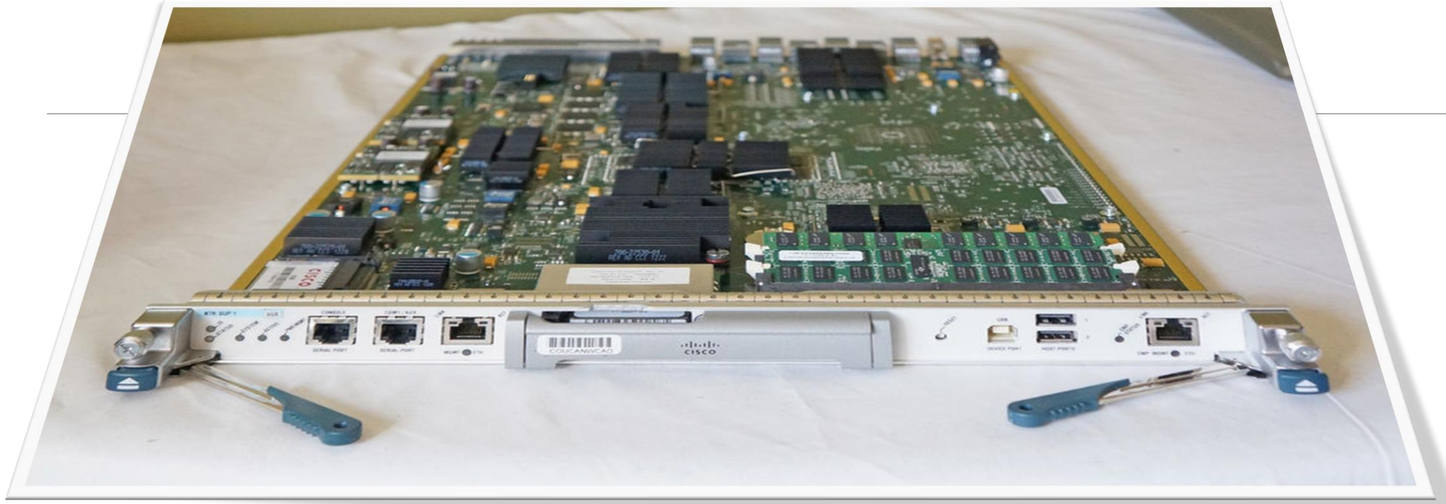
I/O module: 8 slots

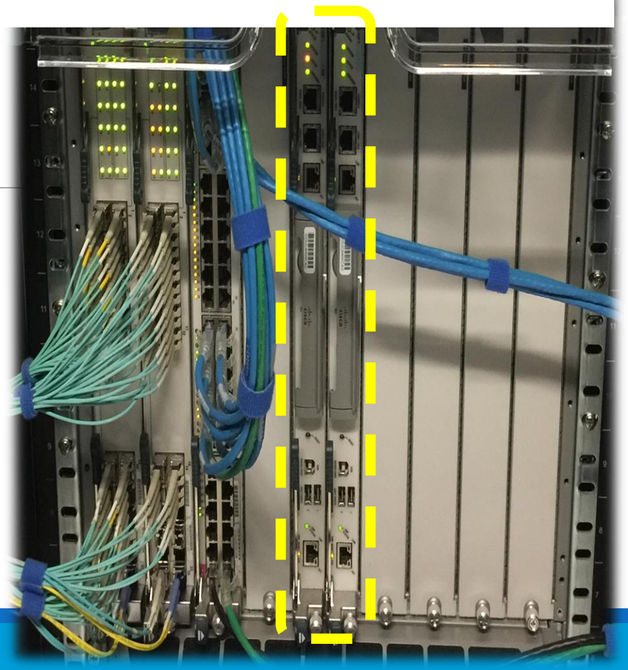
Fan & Intake filter


LEDs on All FRUs
Rear View
Fan tray
Fabric modules
Power supply

Supervisor Module





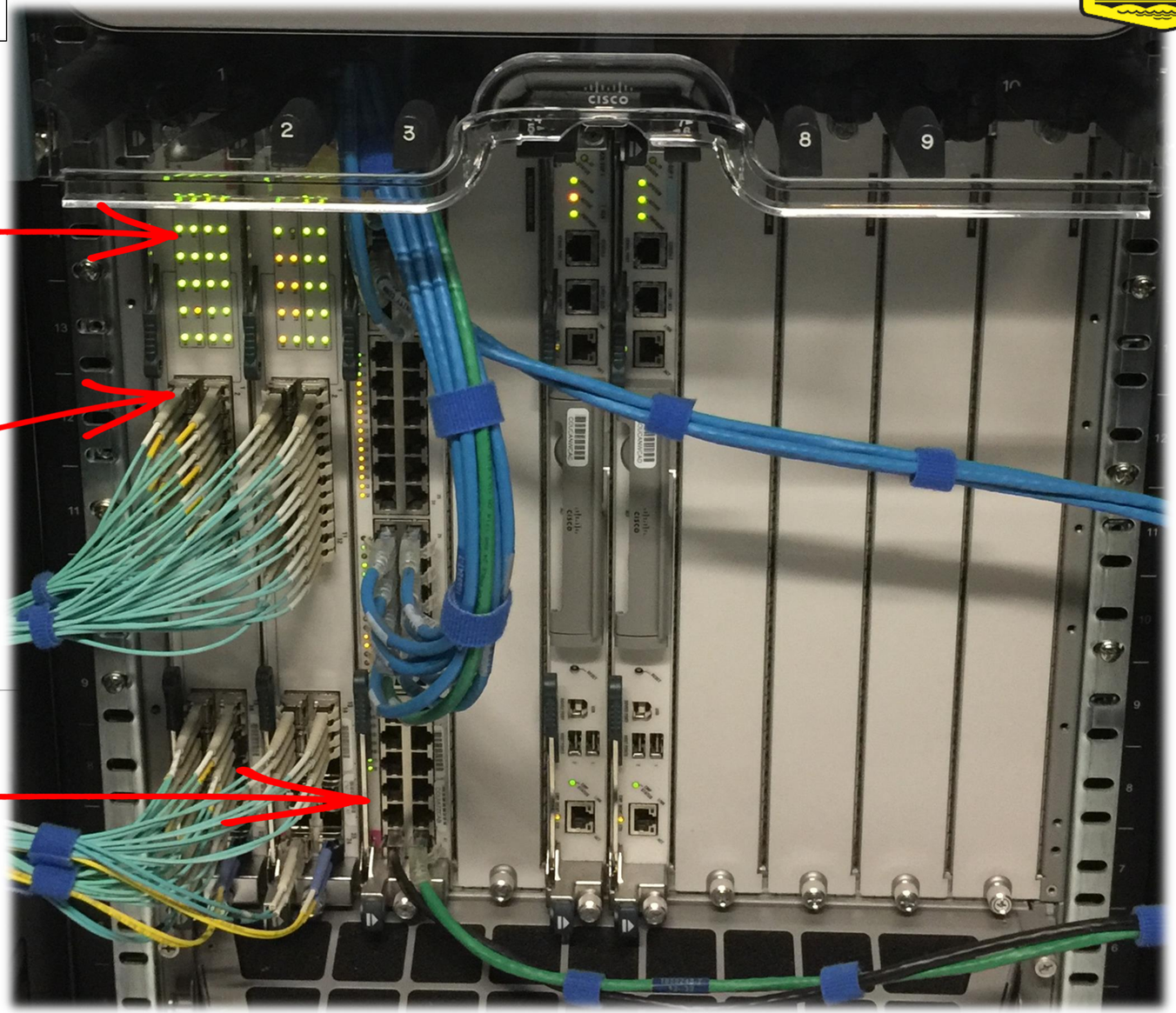


Input/ Output module

Slot for 10 gigabit Ethernet (10 GbE) port

Multimode transceiver (10Gb SFP+/ 10G BASE SR)

1GbE / 1000 BASE T



❑ What does 1000BASE X mean?

- ✓ is **a term** describing technologies for transmitting Ethernet frames at a rate of a gigabit per second (1,000,000,000 bits per second)
- ✓ transmit over **fiber optic cable** or **twisted pair cable**.

- ✓ as defined by the **IEEE 802.3ab** standards for Ethernet physical layer.

The 1,000 refers to the **transmission speed** of 1,000 Mbps

"BASE" refers to **baseband signaling**, which means that only The Ethernet signals are being carried on this medium.

1000BASE X SFP

"X" refers to the technology of cables uses

T= twisted pair cable,
SX = multimode fiber
LX = single mode fiber)

Small Form Pluggable

1000 mega bit per second (Mbps) = 1 Gbps

The 10G = 10,000 refers to the **transmission speed** of 10,000 Mbps

"BASE" refers to **baseband signaling**, which means that only The Ethernet signals are being carried on this medium.

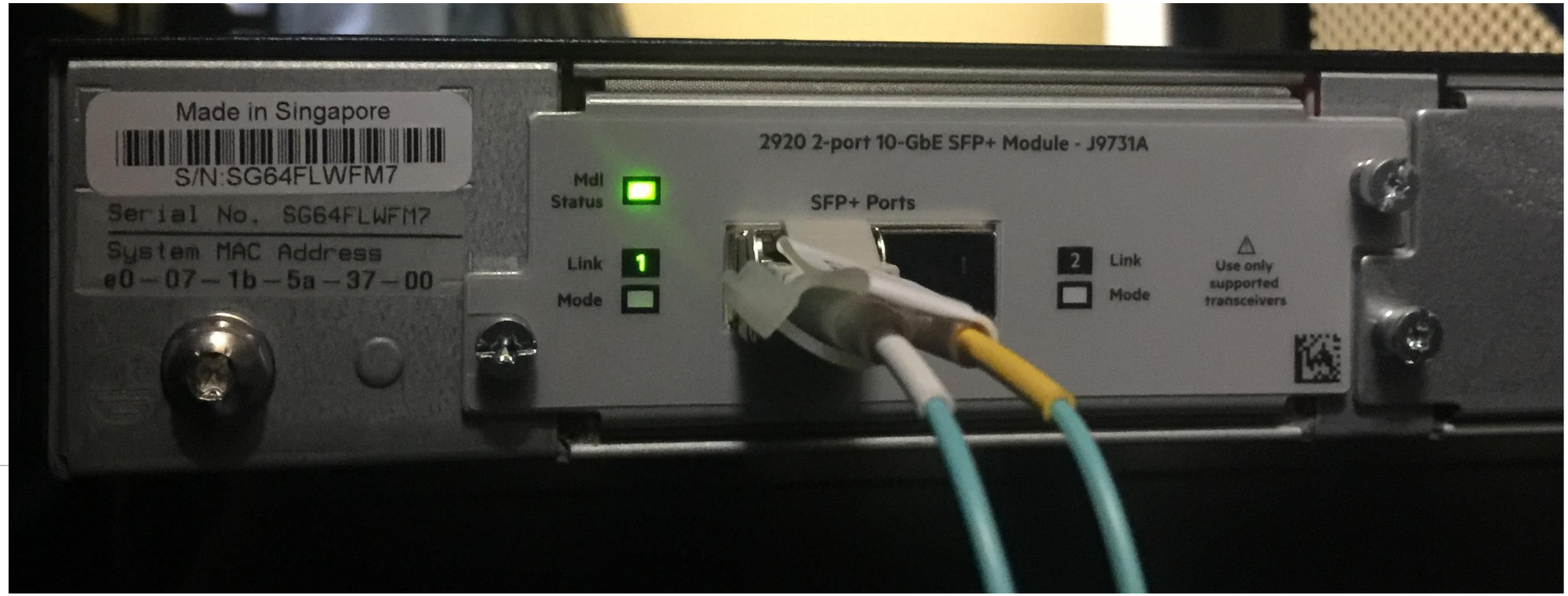
10G BASE LR/SR SFP+

"LR/SR (long range/ short range)" refers to the technology of cables uses

SR = multimode fiber (850 @ 1300nm)
LR = single mode fiber (1310 @ 1500nm)

Small Form Pluggable + used for 10GbE port

10G BASE = 10GbE = 10GE
10,000 mega bit per second (Mbps) = 10 Gbps


Made in Singapore
S/N:SG64FLWFM7
Serial No. SG64FLWFM7
System MAC Address
e0-07-1b-5a-37-00
2920 2-port 10-GbE SFP+ Module - J9731A
Mdl Status
SFP+ Ports
Link
1
Mode
2
Link
Mode
Use only supported transceivers

❑ How to consider and select Core Switch?

1) Determine the number of **10Gb port (SFP +) required** including spares and future expansion

2) No of **1Gb port required** if any

3) **20Gb/ 40Gb (QSFP +) port** availability

4) Survey & Select model from all manufacturers that provides **optimum specification** (switching capacity, throughput, reliability etc)

5) Cost

❑ Core Switch specifications

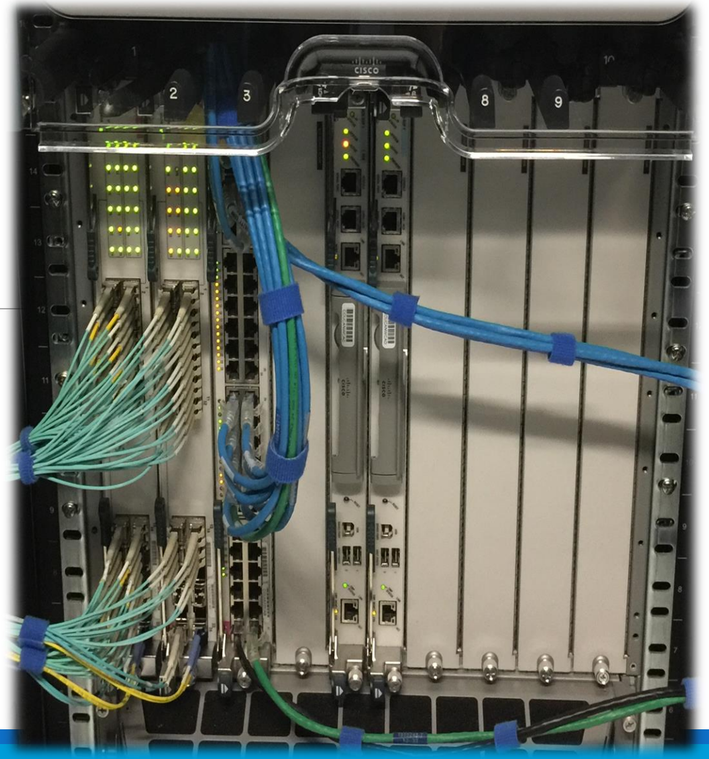
Physical specifications

- Usable rack space: 21RU
- 10-slot chassis: 2 dedicated supervisor modules and 8 I/O modules
- 5 fabric module slots
- 3 power supply slots
- Dimensions (H x W x D): 36.5 x 17.3 x 33.1 in. (92.7 x 43.9 x 84.1 cm)
- Chassis depth including cable management and chassis doors is 38 in. (96.5 cm)
- Unit is rack mountable in a standard 19-inch (482.6-mm) EIA rack
- Weight
  - Chassis only: 200 lb. (90 kg)
  - Fabric Module: 4 lb (1.8 kg)
  - System Fan Tray: 20 lb (9.1 kg)
  - Fabric Fan Tray: 5 lb (2.3 kg)
- Supports 6-kW and 7.5-kW AC and DC power supplies

Cisco Nexus 7000 10-Slot Switch Chassis

- The Cisco Nexus 7000 10-Slot chassis with up to eight I/O module slots supports up to 384 x 1 and 10 Gigabit Ethernet ports, 48 x 40 Gigabit Ethernet ports, and 16 x 100 Gigabit Ethernet ports, meeting the demands of large data center deployments. It has two dedicated supervisor slots to provide full redundancy.
- Front-to-back airflow helps ensure that use of the Cisco Nexus 7000 10-Slot chassis addresses the requirement for hot-aisle and cold-aisle deployments without additional complexity.

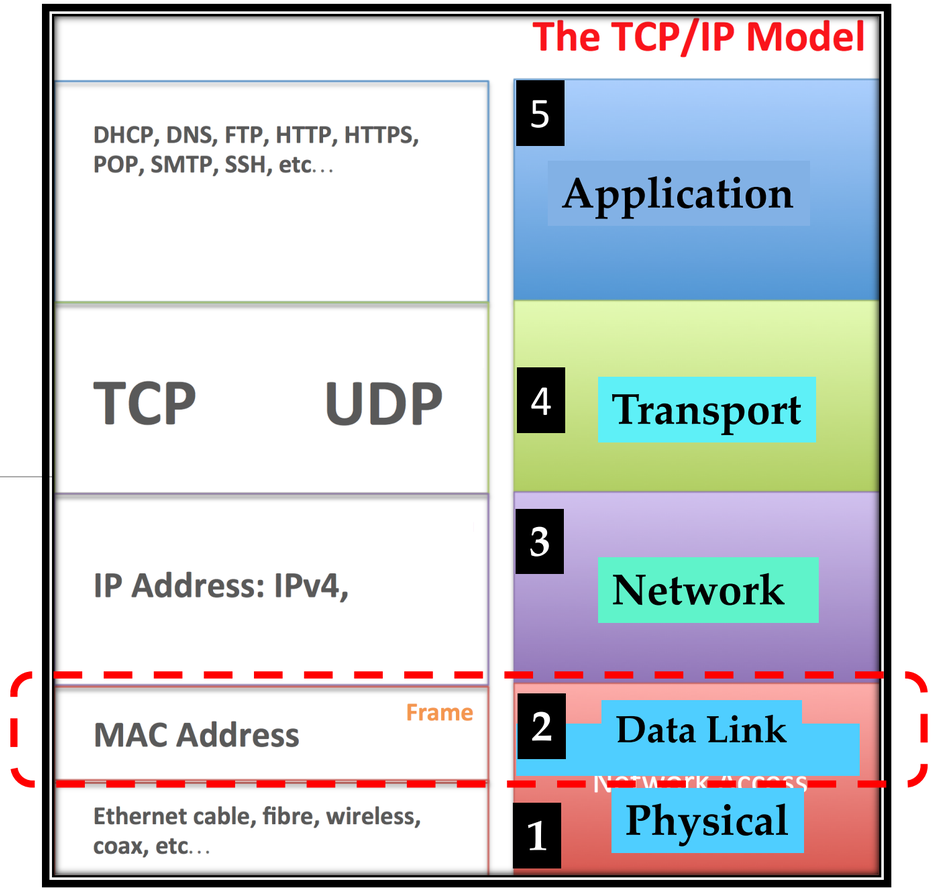
Max local switching capacity	600 Gbps
Performance	5.76 bpps (IPv4 unicast) in combination with supervisor and fabric modules
Reliability and availability	OIR of all redundant components: Supervisor and fabric modules, power supplies, and fan trays
Environmental specifications	• Heat dissipation: Maximum 12,000W per chassis (actual dissipation will be lower, depending on the chassis configuration)



❑ What does Access Switch mean?

Access Switch is also known as Layer 2 switch - **is a device** that works on the data link layer (TCP/IP Layer 2)

It utilizes MAC Address to determine the path where the frames are to be **forwarded** in a local area network (LAN).



❑ Selection of Access Switch?

1) Determine the number of **10Gb port (SFP +) required**
2) Survey & Select model from all manufacturers that provides **optimum specification** (switching capacity, throughput, reliability etc)
3) Cost

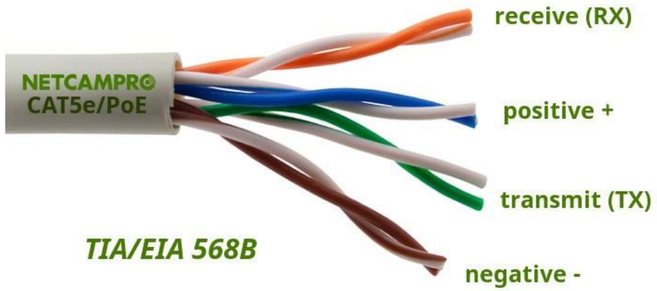
Brand	**Cisco**	**HP**	**Huawei**	**Extreme**
Model	2960x-24PS-LI	HP 1950-24G-2SFP+-2XGT-POE+	S5700-28C-HI-24S	Summit X430-24p
10 GB SFP+ port	4	2	4	4
1 GB port	24	24	24	24
Dual power supply	No	Yes	Yes	Yes
System throughput	71.4 Mpps	95.2 Mpps	96 Mpps	41.6 Mpps
Switching capacity	216 Gbps	128 Gbps	256 Gbps	56 Gbps
AC power rating	0.49 Kva	425 W	< 80 W	425 W
PoE power	370 W	370 W	No	370 W

❑ What is Power Over Ethernet (POE)

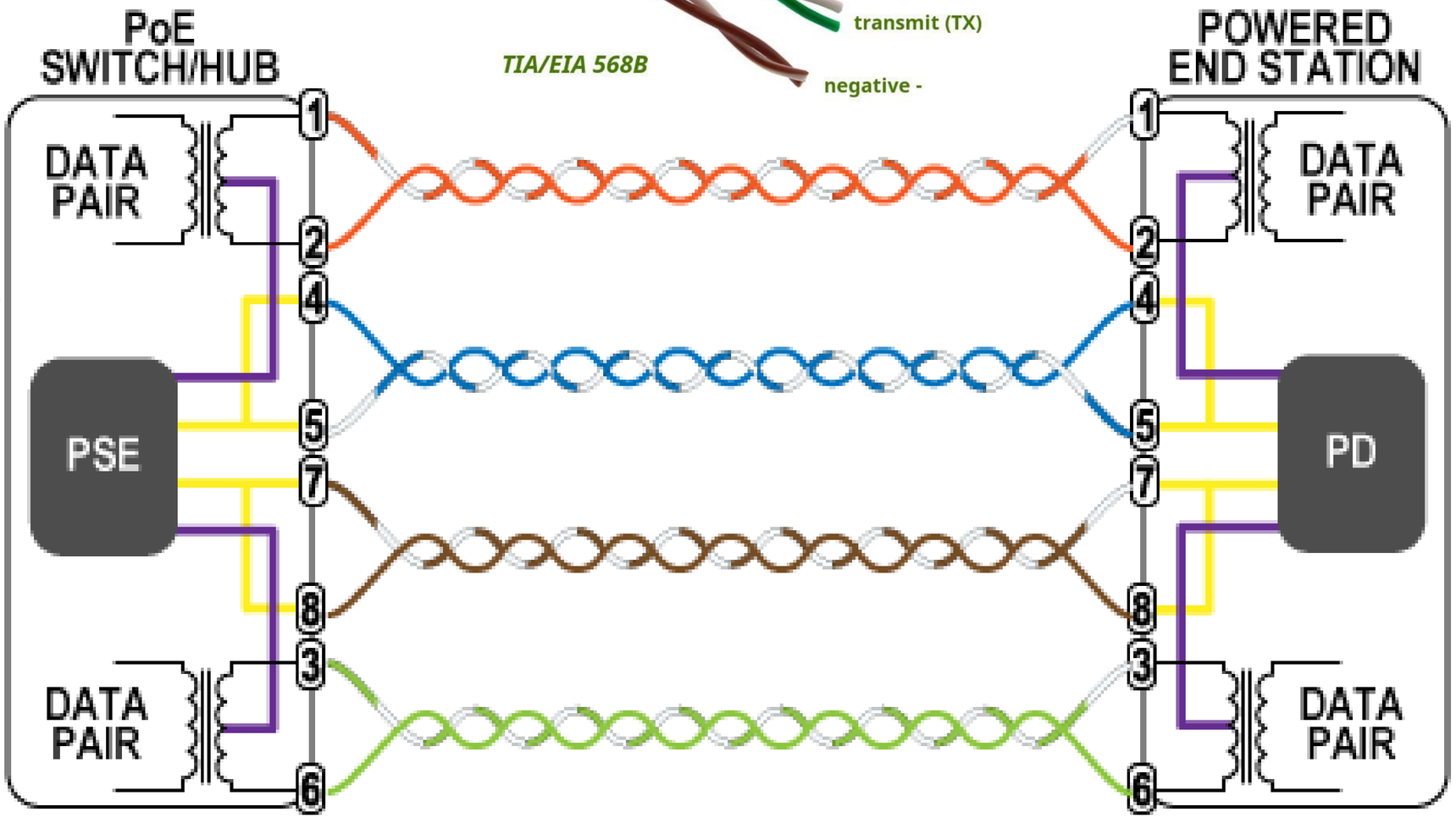
- ✓ Data and Power over a single Ethernet cable
- ✓ Safe & uninterrupted power up to 60W
- ✓ Comply to IEEE 802.3af & at

Cost Savings

Power over Ethernet

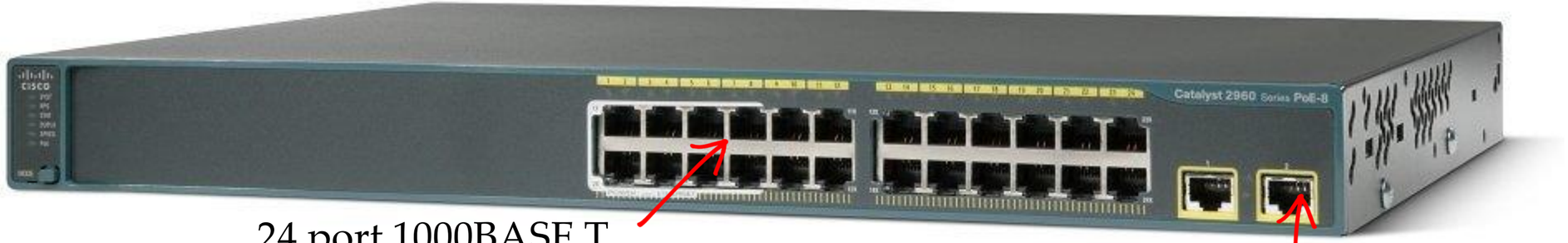


TIA/EIA 568B



Stacking and Uplink method

Front view

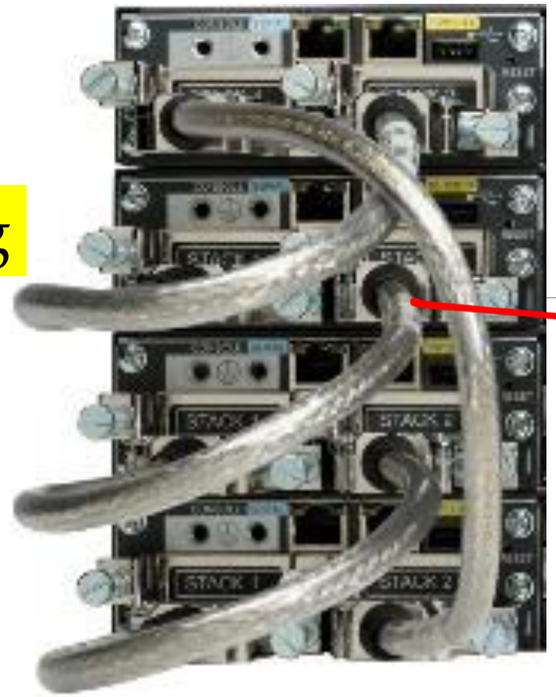


24 port 1000BASE T

Uplink 2 port SFP +

Stacking

Rear view

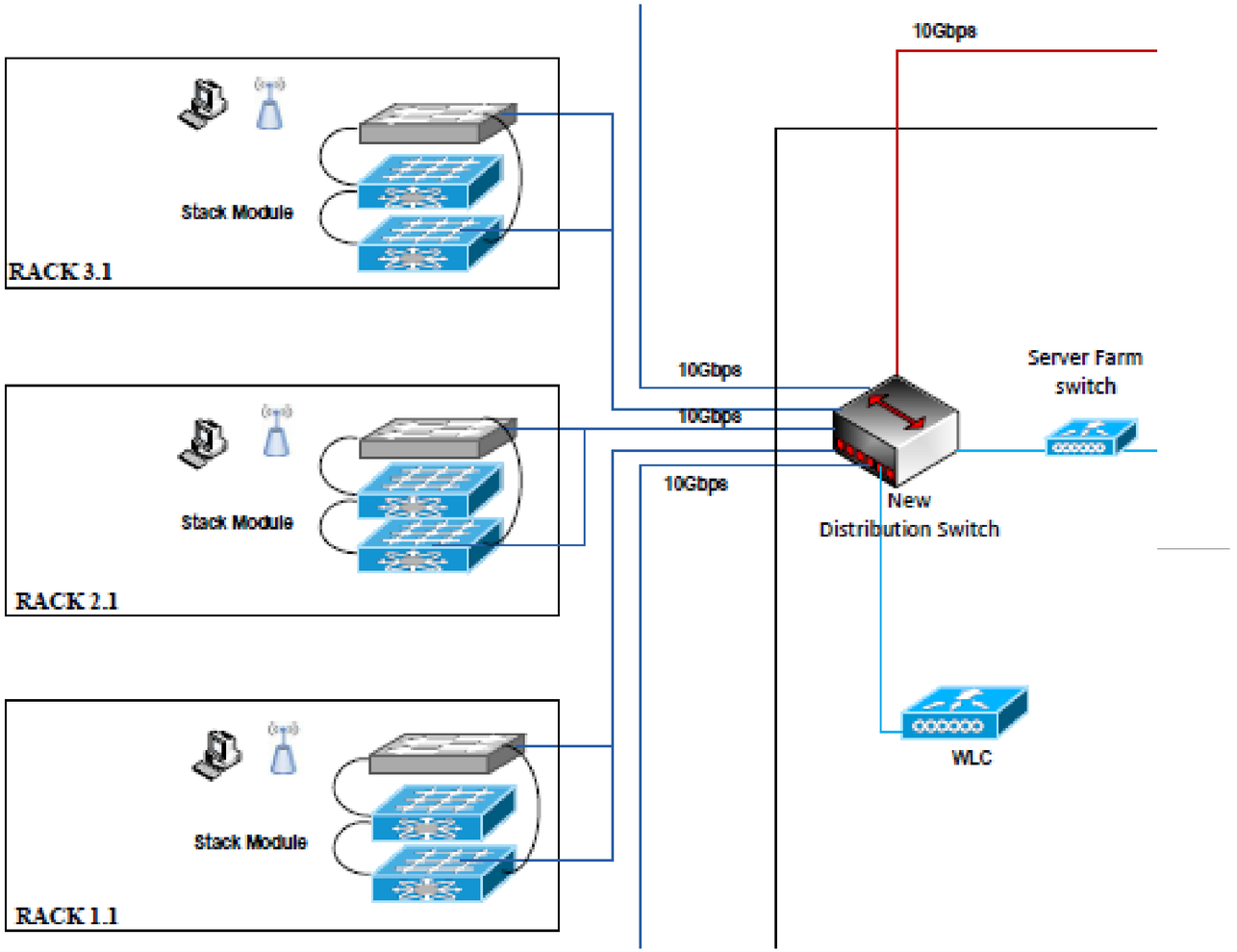


PSU

When to Stack and Uplink?

- ✓ When we use stacking
- ✓ When we use uplink

Stacking module/cable



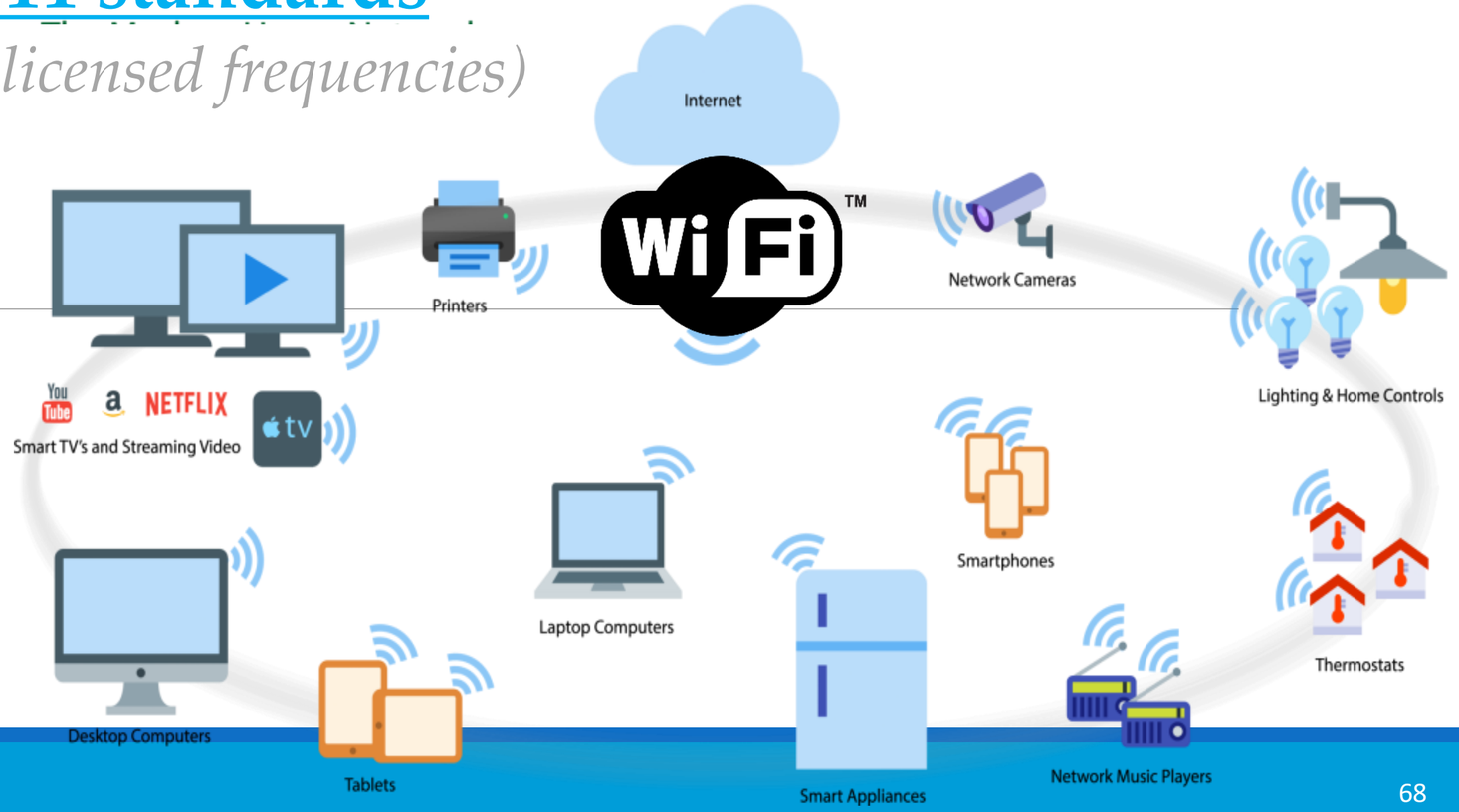
❑ What does Wi Fi™ mean?

- ✓ Wireless Fidelity : Wi-Fi
- ✓ is a technology for radio **<u>wireless local area networking of devices</u>**
- ✓ based on the **IEEE 802.11 standards**
- ✓ use 2.4 GHz/ 5 GHz *(unlicensed frequencies)*

= Wireless Access Point

= Wireless AP

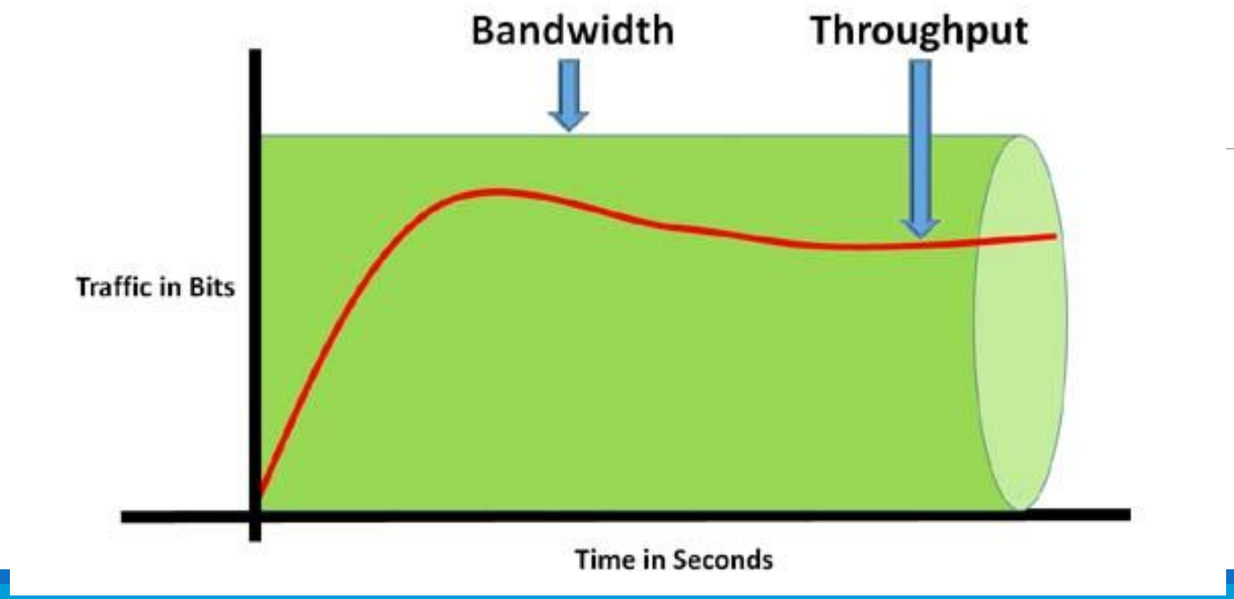
= Wireless LAN



Performance parameter

- Throughput

amount of data moved from one place to another in a given time period



Unit : Mbps/ Gbps

How fast data can be sent or receive in a seconds

- Switching capacity

how much **data** the switch **can be handling** at one time

Unit : Gbps/ Tbps

- Forwarding rate

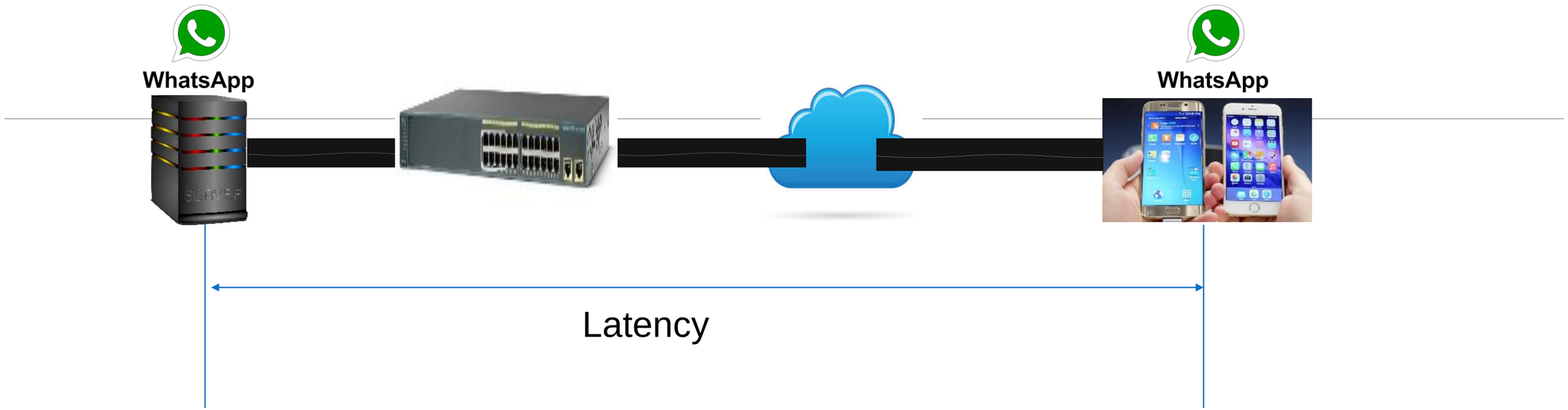
number of **network packets** that **can be processed** by networking equipment

Unit : Mpps

- Latency (delay)

time required to sent packet from sender to receiver

small delays **are called** *low-latency* networks
long delays **are called** *high-latency* networks



Keperluan Pelanggan & Brif Projek

JKR MALAYSIA	PROSEDUR PERANCANGAN PELAKSANAAN PROJEK	No. Dokumen : JKR.PK(O).01-1 No. Keluaran : 06 No. Pindaan : 00 Tarikh : 19 Sept 2019 Muka Surat : 1 / 1

LAMPIRAN 1

SENARAI SEMAKAN BRIF

Tarikh Mula Disediakan: _____

A. Pelanggan: _____

B. Maklumat Projek

1. Nama Projek: _____
2. Kesempurnaan Ringkasan Projek:
   a. Kelulusan peruntukan
      ☐ Sudah Siling: _____ RMK: _____
      ☐ Belum Catatan: _____
   b. Kecukupan skop kerja
      ☐ Ya ☐ Tidak Catatan: _____
   c. Status tapak cadangan
      i. Tanah hakmilik Kerajaan / Pelanggan
      ☐ Ya ☐ Tidak Catatan: _____
      ii. Kebenaran bagi maksud pembangunan
      ☐ Diperolehi ☐ Belum Catatan: _____
      iii. Tapak bebas dari halangan
      ☐ Ya ☐ Tidak Catatan: _____
   d. Kemungkinan tarikh serahguna dicapai
      ☐ Mungkin ☐ Tidak mungkin Tarikh jangkaan: _____
3. Nasihati Pelanggan Mengenai Ringkasan Projek
   ☐ Tidak perlu ☐ Sudah Tarikh: _____
   ☐ Belum Catatan: _____
4. Ringkasan projek dikemukakan semula kepada JKR
   ☐ Tidak berkenaan ☐ Sudah Tarikh diterima: _____
5. Jenis Reka Bentuk
   ☐ Piawai Catatan: _____
   ☐ Baru Catatan: _____
   ☐ PAP Catatan: _____
6. Keperluan Sistem Pengurusan Alam Sekitar, Keselamatan dan Kesihatan Pekerjaan
   ☐ 14001* ☐ ISO 45001# Catatan: _____
   *(Rujuk prosedur JKR.PK(O).04E) #(Rujuk prosedur JKR.PK(O).04B)

.....

Tandatangan HOPT
Nama Pegawai: Senarai Semak Ditutup Pada: _____

DOKUMEN TERKAWAL

BRIEF PROJECT - OLEH EN. AMEERUL ASYRAF BIN AMRAN, CAW ARKITEK JKR

Kos Projek : **RM 54.6 juta (Diluluskan EPU, JPM)**

Lokasi : **Mukim Gua, Daerah Kuala Lemal, Jajahan Pasir Mas**

Keluasan Tapak & Pembangunan : **10.9 Ekar**

Skop Pembangunan :

1) Bangunan Pentadbiran (termasuk Balai, Lokap, Kantin & Stor Transit)
2) Cawangan Kenderaan
3) Stesen PMP (Stor & Pejabat sahaja)
4) Stor Barang Kes & Pound Trafik (20 lot tempat meletak kenderaan)
5) Balai Pengawal
6) Surau (100 Jemaah)
7) Lapang Sasar 6 Lorong (Dalaman)
8) Stor Peluru (Kelas D)
9) Dewan Serbaguna (2 Gelanggang Badminton)
10) Perkep / Tadika & Perumahan Kelas F (~~17~~ Unit)

16 unit ikut VM

Keperluan Pelanggan & Objektif

Objektif keperluan rangkaian

- Maktab – pengajaran & pembelajaran
- Hospital – proses automasi perkhidmatan pesakit

Penentuan keperluan kritikal

- Maktab – Bahan bacaan online
- Hospital – Keputusan ujian darah online

Anggaran bilangan pengguna

Jenis pengguna rangkaian

- Maktab – pelajar
- Hospital – doktor & pekerja
- Gunasama – jabatan-jabatan kerajaan

Lawatan Tapak Projek Bersama Pihak Pelanggan

JKR MALAYSIA	PROSEDUR PERANCANGAN PELAKSANAAN PROJEK	No. Dokumen : JKR.PK(O).01-2 No. Keluaran : 06 No. Pindaan : 00 Tarikh : 19 Sept 2019 Muka Surat : 1 / 1

LAMPIRAN 2

BORANG VERIFIKASI HARTA PELANGGAN

Borang ini digunakan bagi mengenalpasti jenis harta pelanggan dan memastikan bahawa harta pelanggan yang akan diterima adalah dalam keadaan baik/memenuhi keperluan.

Nama Projek: .....

Bil	Perkara	Informasi/Ulasan
1	Jenis Harta Pelanggan:	* Tanah Bagi Tapak Projek/Perabot/ Peralatan Mekanikal/Peralatan Elektrikal/Lain-lain (nyatakan):
2.	Nyatakan *Senarai/No. Siri/Model Bagi * Perabot/Peralatan Mekanikal/Peralatan Elektrikal/Lain-Lain Harta Yang Dibekalkan Oleh Pelanggan. (Jika Berkenaan):	
3.	* Lokasi/Alamat/Lot. No./Tempat Harta Tersebut Berada :	
4.	Tarikh * Pemeriksaan/Pengesahan Dibuat:	
5.	Nama dan Jawatan Wakil Pelanggan/Jabatan Lain Yang Hadir (Jika Berkenaan):	
6.	Keadaan Harta Pelanggan Semasa *Pemeriksaan/Pengesahan:	Baik/Rosak/ Lain-lain (nyatakan) :
7.	Masalah Lain (Jika Ada): (Contoh: Terdapat Halangan di Tapak Projek Seperti Masalah Setinggan, Tempat Pelupusan Sampah Dsbnya)	
8.	Ulasan Lain (Jika Ada) :	

Nota: Sekiranya semasa pemeriksaan/pengesahan harta pelanggan dibuat (pada sebelum/ selepas harta tersebut diserahkan kepada JKR) dan jika didapati hilang, rosak, tidak memenuhi keperluan atau tidak sesuai digunakan hendaklah dilaporkan kepada Pihak Pelanggan dan direkodkan.

** Potong yang tidak berkaitan. Gunakan lampiran jika ruang tidak mencukupi.*

Tandatangan HOPT : .....

Nama : .....

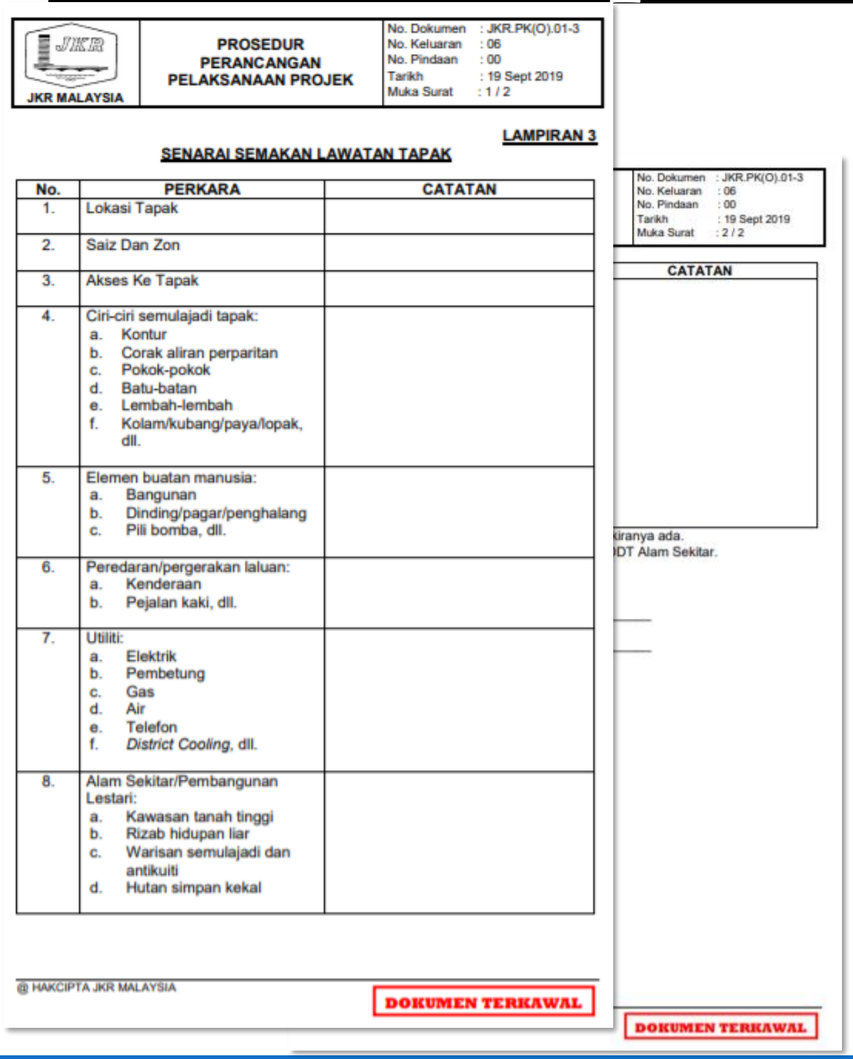
Jawatan : .....

Tarikh : .....

DOKUMEN TERKAWAL

a. Pegawai Yang perlu hadir
   i. Pegawai Pembangunan kementerian / jabatan berkaitan
   ii. Pegawai Bahagian Teknologi Maklumat Pelanggan & pegawai senggara
   iii. Wakil pengguna
   iv. Wakil JKR Elektrik Negeri
b. Tujuan:
   i. Projek baru
      a. Mendapatkan keseluruhan perancangan skop ICT daripada pihak pelanggan
      b. Mengenalpasti keadaan tapak (bentuk muka bumi)
      c. Mengenalpasti keperluan pelanggan
   ii. Naiktaraf & blok tambahan
      a. Mendapatkan keseluruhan perancangan skop ICT daripada pihak pelanggan
      b. Mengenalpasti infrastruktur & lain-lain sistem sedia ada di dalam kawasan premis pelanggan yang berkaitan dengan skop projek
      c. Mengkaji & Mengenalpasti status @ keadaan semasa infrastruktur & sistem sedia ada
      d. <u>Membincangkan tindakan susulan perlu di ambil (mengganti /mengalih / melupus/ menaiktaraf)</u>

Lawatan Tapak Bersama Pihak ISP/Telekom



JKR MALAYSIA

PROSEDUR PERANCANGAN PELAKSANAAN PROJEK

No. Dokumen : JKR.PK(O).01-3
No. Keluaran : 06
No. Pindaan : 00
Tarikh : 19 Sept 2019
Muka Surat : 1 / 2

LAMPIRAN 3

SENARAI SEMAKAN LAWATAN TAPAK

No.	PERKARA	CATATAN
1.	Lokasi Tapak	
2.	Saiz Dan Zon	
3.	Akses Ke Tapak	
4.	Ciri-ciri semulajadi tapak: a. Kontur b. Corak aliran perparitan c. Pokok-pokok d. Batu-batan e. Lembah-lembah f. Kolam/kubang/paya/lopak, dll.	
5.	Elemen buatan manusia: a. Bangunan b. Dinding/pagar/penghalang c. Pili bomba, dll.	
6.	Peredaran/pergerakan laluan: a. Kenderaan b. Pejalan kaki, dll.	
7.	Utiliti: a. Elektrik b. Pembetung c. Gas d. Air e. Telefon f. *District Cooling*, dll.	
8.	Alam Sekitar/Pembangunan Lestari: a. Kawasan tanah tinggi b. Rizab hidupan liar c. Warisan semulajadi dan antikuiti d. Hutan simpan kekal	

DOKUMEN TERKAWAL

No. Dokumen : JKR.PK(O).01-3
No. Keluaran : 06
No. Pindaan : 00
Tarikh : 19 Sept 2019
Muka Surat : 2 / 2

CATATAN

kiranya ada.
DT Alam Sekitar.

DOKUMEN TERKAWAL

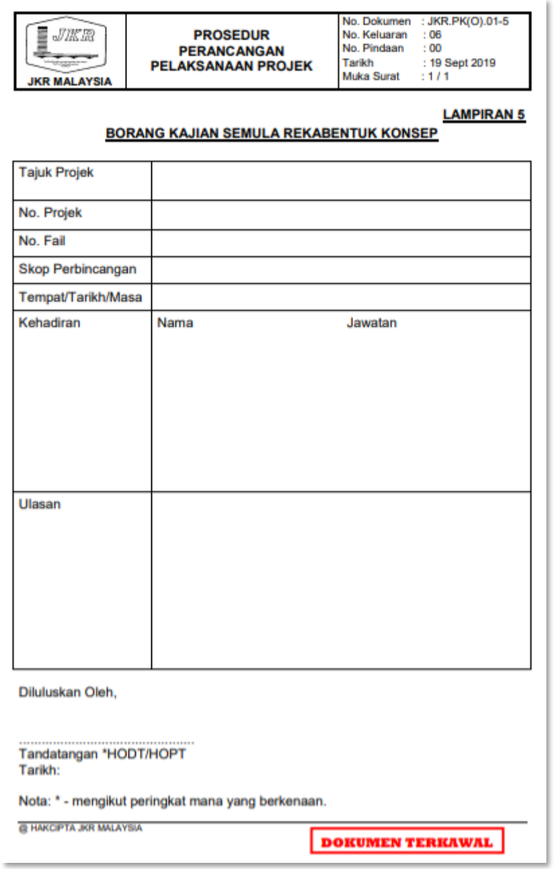
a. Pegawai dari ISP/TELEKOM yang perlu hadir
   i. Pegawai Sales Tempatan
   ii. Wakil Pegawai Access Network Development (TM sahaja)

b. Tujuan lawatan
   i. Mendapatkan kelulusan kebenaran merancang
   ii. Mengenalpasti status infrastruktur sedia ada ditapak @ infrastruktur baru
   iii. Mengenalpasti jenis infrastruktur (jenis talian & rangkaian) ; PRI, HSBB etc
   iv. Mengenalpasti laluan kabel sedia ada (bawah tanah @ overhead)
   v. Mengenalpasti manhole ISP yang terdekat serta laluan yang sesuai
   vi. Mengenalpasti pegawai ISP yang bertanggungjawab kepada kelulusan infrastruktur

c. Dokumen yang perlu disediakan:
   i. Lukisan cadangan laluan manhole & ducting bersama surat Permohonan Kelulusan Pelan Cadangan sebanyak 4 Salinan
      ** Contoh Pelan Cadangan
      ** Contoh surat maklumbalas TM

Nota: Keperluan dokumen tambahan seperti lukisan terperinci tidak boleh dikemukakan kepada pihak ISP kerana belum melalui proses perolehan

Rekabentuk Konsep



JKR MALAYSIA	PROSEDUR PERANCANGAN PELAKSANAAN PROJEK	No. Dokumen : JKR.PK(O).01-5 No. Keluaran : 06 No. Pindaan : 00 Tarikh : 19 Sept 2019 Muka Surat : 1 / 1

LAMPIRAN 5

BORANG KAJIAN SEMULA REKABENTUK KONSEP

Tajuk Projek		
No. Projek		
No. Fail		
Skop Perbincangan		
Tempat/Tarikh/Masa		
Kehadiran	Nama	Jawatan
Ulasan		

Diluluskan Oleh,

.....

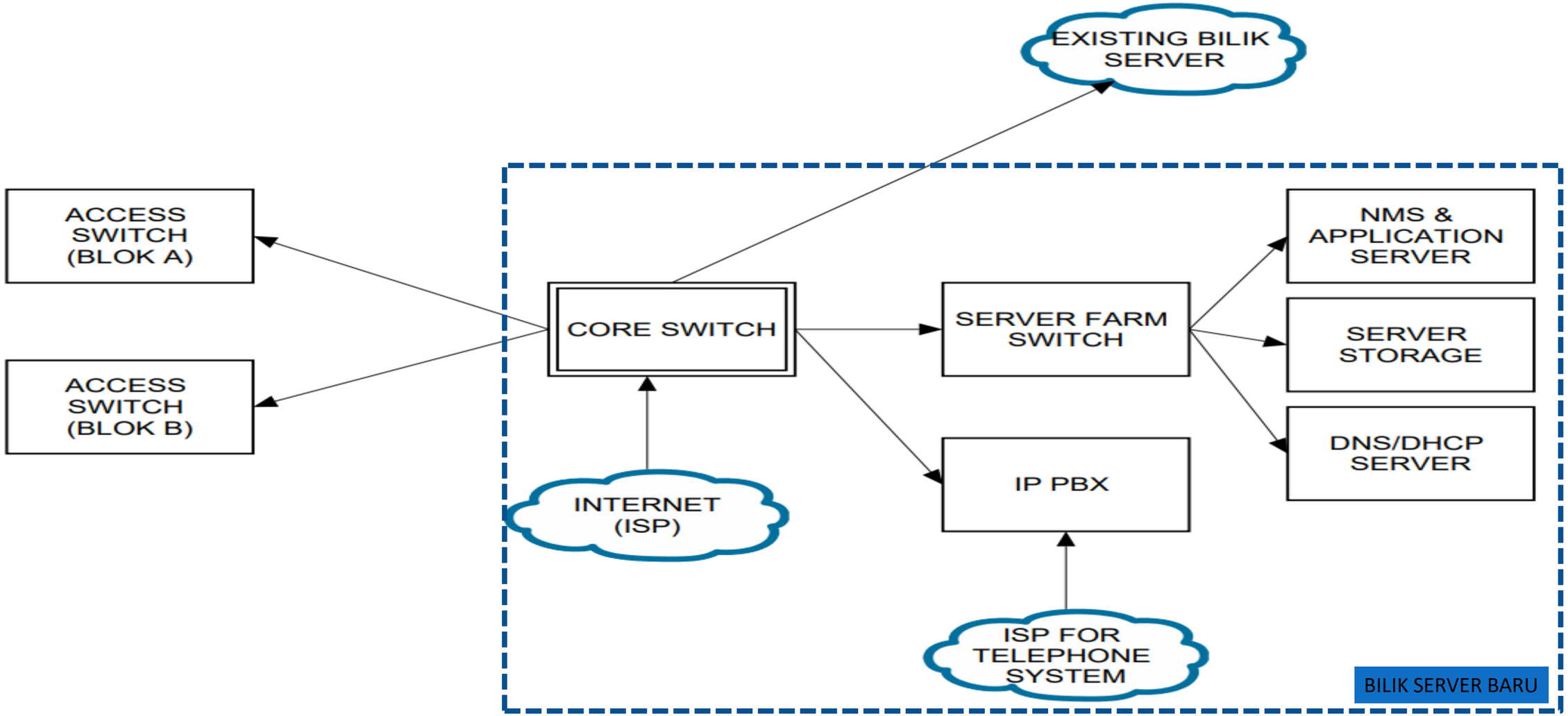
Tandatangan *HODT/HOPT
Tarikh:

Nota: * - mengikut peringkat mana yang berkenaan.

DOKUMEN TERKAWAL

- Jenis infrastruktur secara *campus network* atau *stand alone network*
- Menyediakan *lukisan network topology*
- Mengkaji konsep *network architecture* yang bersesuaian
- Mengkaji, merancang dan menentukan peralatan ICT yang bersesuaian
- Menentukan kedudukan keperluan ruang ICT

Contoh Konsep Rekabentuk



Penyediaan Anggaran awalan

Rules of 👍 : RM5,000.00 per bilangan pengguna (bagi bangunan pejabat) tidak termasuk kos bagi keperluan fasiliti di Bilik Server @ Pusat Data

ATAU

Rules of 👍 untuk Kos ICT : 0.25 x [kos keseluruhan (LV/MV/ELV/ICT)]
: 0.25 x [0.25 x kos bangunan] ≈ Kos ICT

ATAU

Link Excel Sheet: Penyediaan Anggaran awalan terperinci (PDA)
Rujukan Anggaran Jabatan: http://ratol.jkr.gov.my/search

TO BE CONTINUE….

Next ……

Latih Amal:

Penyediaan Konsep Rekabentuk dan Anggaran awalan :

- Berdasarkan Contoh Lukisan Tender Arkitek yang diberikan, sila sediakan Lukisan *Network Topology* dan Anggaran awalan menggunakan formula yang dinyatakan.

Latih Amal – Sila kemaskini maklumat berikut:

1. Nama Kumpulan
2. Ahli kumpulan
3. Projek
4. Objektif rangkaian
5. Keperluan Arkitek
6. Elektrik
7. Mekanikal

Keperluan Ruang ICT dan Telefon

- Memastikan keperluan ruang bagi bilik ICT disediakan menepati spesifikasi dan garis panduan yang telah ditetapkan.
- Mengemukakan cadangan bilik-bilik ICT kepada pihak Arkitek, struktur dan sivil untuk dimasukkan dalam rekabentuk.

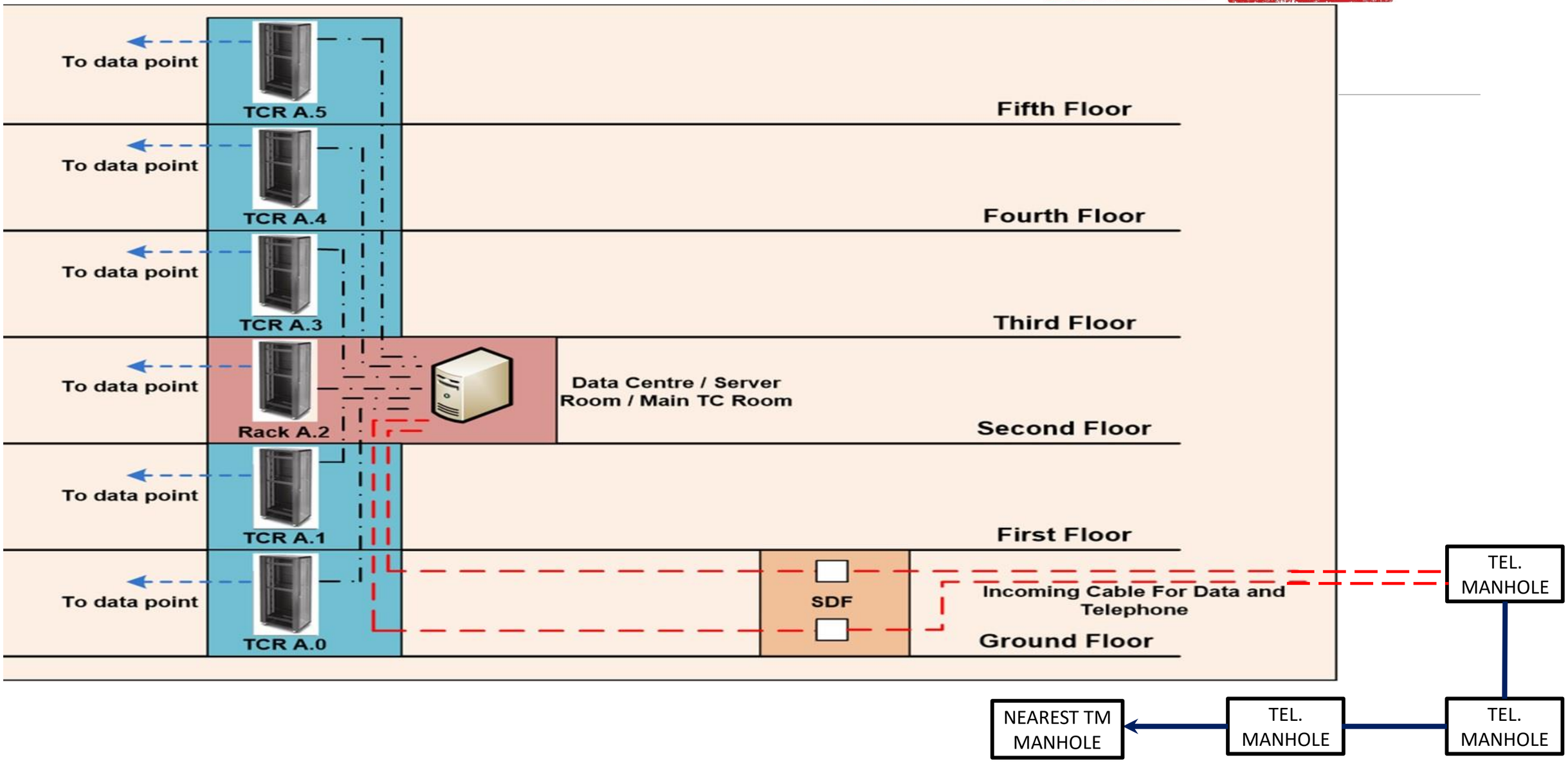
- Kegagalan menyediakan keperluan ini akan menyebabkan:
  - kesukaran pasukan penyelenggaraan melaksanakan tugas
  - perubahan rekabentuk bagi ruang-ruang yang melibatkan BWIC
  - kos pembekalan bahan pembinaan mungkin lebih tinggi

Keperluan Ruang ICT & Telefon

- TCR - Telecomunication Closet Room
- MTCR - Main Telecomunication Closet Room
- SDF - Subscriber Distribution Frame Room
- PABX - Private Branch Exchange Room
- SR - Server Room
- DC - Data Centre
- TR - Telephone Riser
- OR - Operator Room

❑ Spaces and Room requirement

VERY IMPORTANT VERY IMPORTANT VERY IMPORTANT



Subscriber Distribution Frame (SDF)

Fungsi: Untuk laluan kabel masuk ke bangunan oleh pihak TELCO

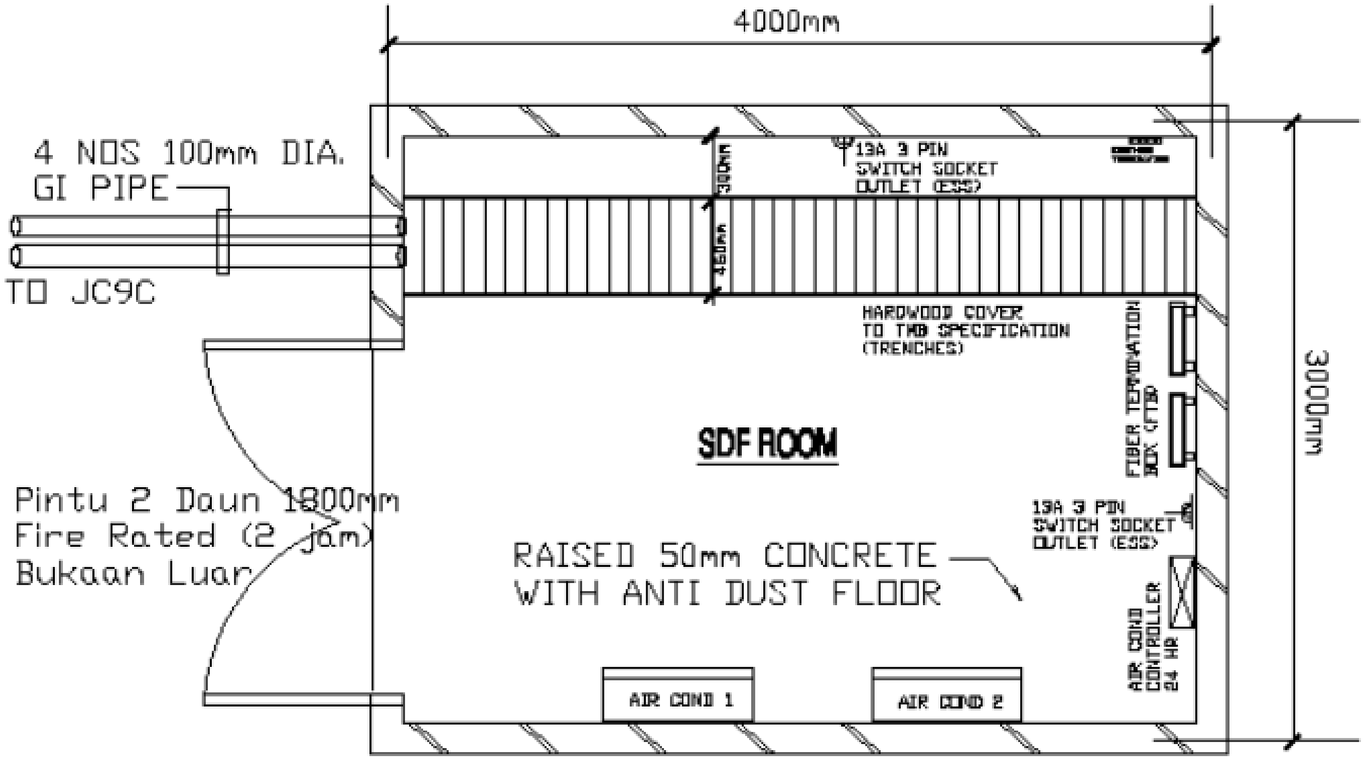
Spesifikasi bilik:

- Pintu rintangan api (2 jam) bukaan keluar 2 daun (2 x 900mm)
- Size bilik minimum: 3000mm x 4000mm
- Trench: 1000mm(L) x 460mm(W) x 760mm(D)
- 2 x 2 nos 100mm GI pipe dari trench ke luar bangunan
- Earthing system (1 ohm)
- Hawa dingin 24 jam
- Anti kondensasi

LOKASI:

- **Tingkat bawah**
- **Berhampiran dengan Man hole TM/Jalan masuk**
- **Di blok Utama**

Subscriber Distribution Frame (SDF)



TYPICAL LAYOUT SDF ROOM

Main Telecommunication Closet Room (MTCR)

Fungsi: Untuk menempatkan Core Switch and Equipment Rack

Spesifikasi bilik:

- Saiz bilik 4000mm(L) x 3000mm(W) x 3700mm(H)
- Hawa dingin 24 jam jenis confort
- Pintu rintangan api (2 jam) bukaan keluar 1000mm
- Lantai anti habuk 50mm lebih tinggi
- Bukaan lantai (riser) 150mm x 300mm
- Anti kondensasi

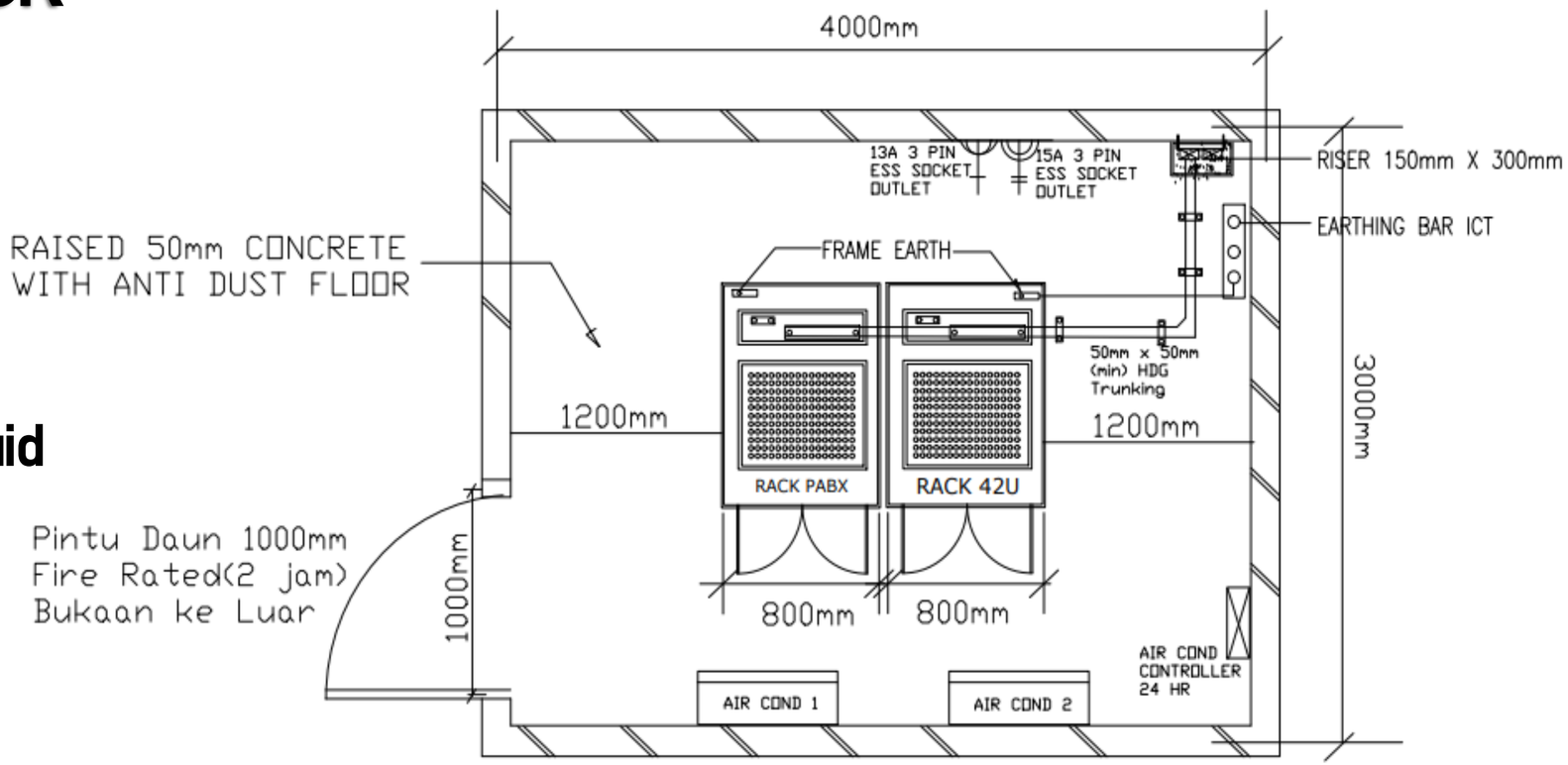
LOKASI:

- Berada kecuali di tingkat bawah/paling atas
- Kedudukan selari dengan TCR untuk setiap tingkat
- Jauh dari laluan air
- Di Blok Utama
- Mudah untuk di akses

Main Telecommunication Closet Room (MTCR)

Keperluan fasiliti bilik MTCR

- 5 Nos 32A 3 Pin Commando Plug
- 24 jam sistem penghawa dingin
- Sistem Keselamatan Pintu (Door Access System)
- CCTV
- Sistem Pencegah Kebakaran (Liquid Gas)
- Water Leak Detector (VESDA)
- DB khas
- UPS
- Generator Set



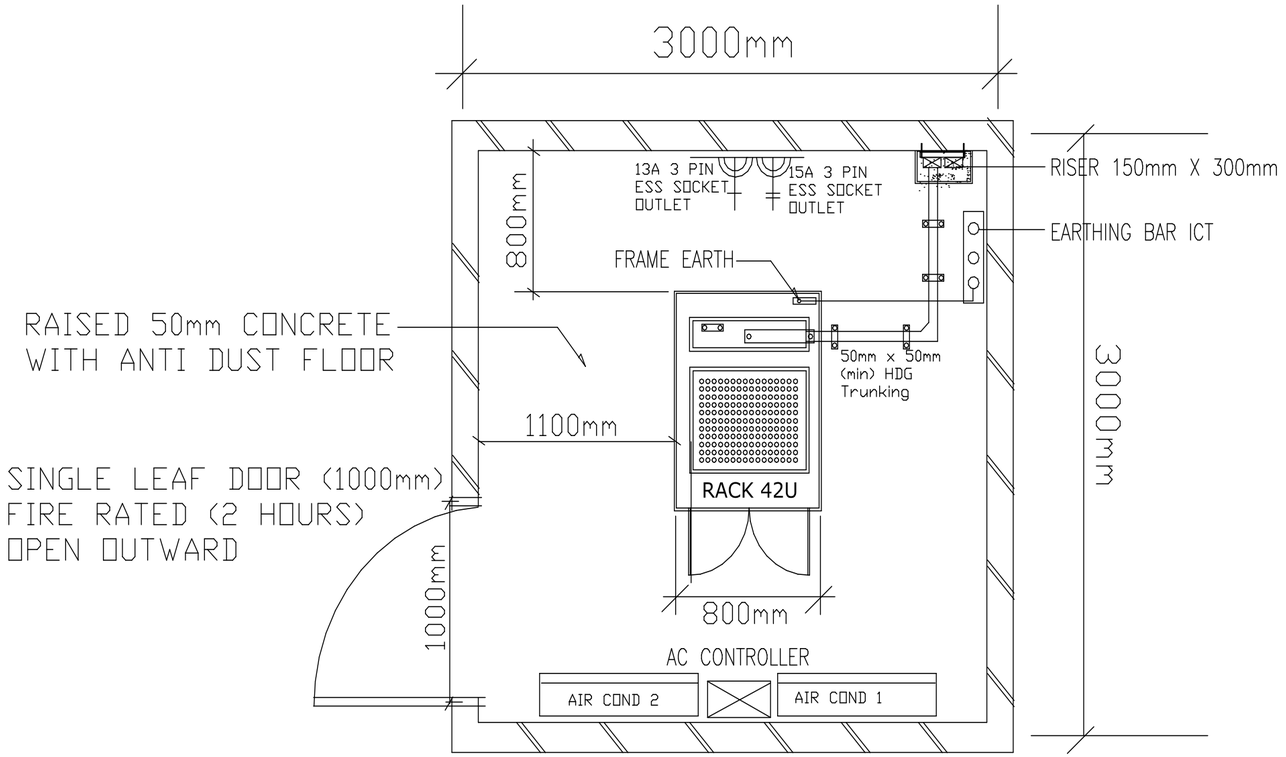
TYPICAL LAYOUT MAIN TC ROOM

Telecommunication Closet Room (TCR)

Fungsi: Untuk menempatkan Equipment Rack

Spesifikasi bilik:

- Saiz bilik 3000mm(L) x 3000mm(W) x 3700mm(H)
- Hawa dingin 12/24 jam
- 1 no. 15A 3pin socket & 1 no. 13A 3 pin socket (ESS)
- Pintu rintangan api (2 jam) bukaan keluar 1000mm
- Lantai anti habuk 50mm lebih tinggi
- Bukaan lantai (riser) 150mm x 300mm
- Anti kondensasi



LOKASI:

- **Berada di bahagian tengah bangunan**
- **Kurang 70m dari network point paling jauh**
- **Kedudukan selari untuk setiap tingkat**

BILIK SERVER

Fungsi: Menempatkan peralatan seperti Server, Storage, Core Switch, Distribution & Workgroup Switch, Router, Firewall, IP PABX, dan peralatan-peralatan network yang lain.

Spesifikasi bilik:

- Saiz Bilik 4000mm(W) X 7000mm(L) X 3700mm(H)
- Cable Basket / HDG Trunking
- Pintu Rintangan Api (2 Jam) Bukaan Keluar 2nos. 900mm(W) X 2400mm(H)
- Lantai Anti Habuk & Anti Statik
- Raised Floor atau raised 50mm concrete
- Bukaan Lantai (RISER) 150mm X 300mm
- Dinding dilengkapi dengan Anti Kondensasi

BILIK SERVER

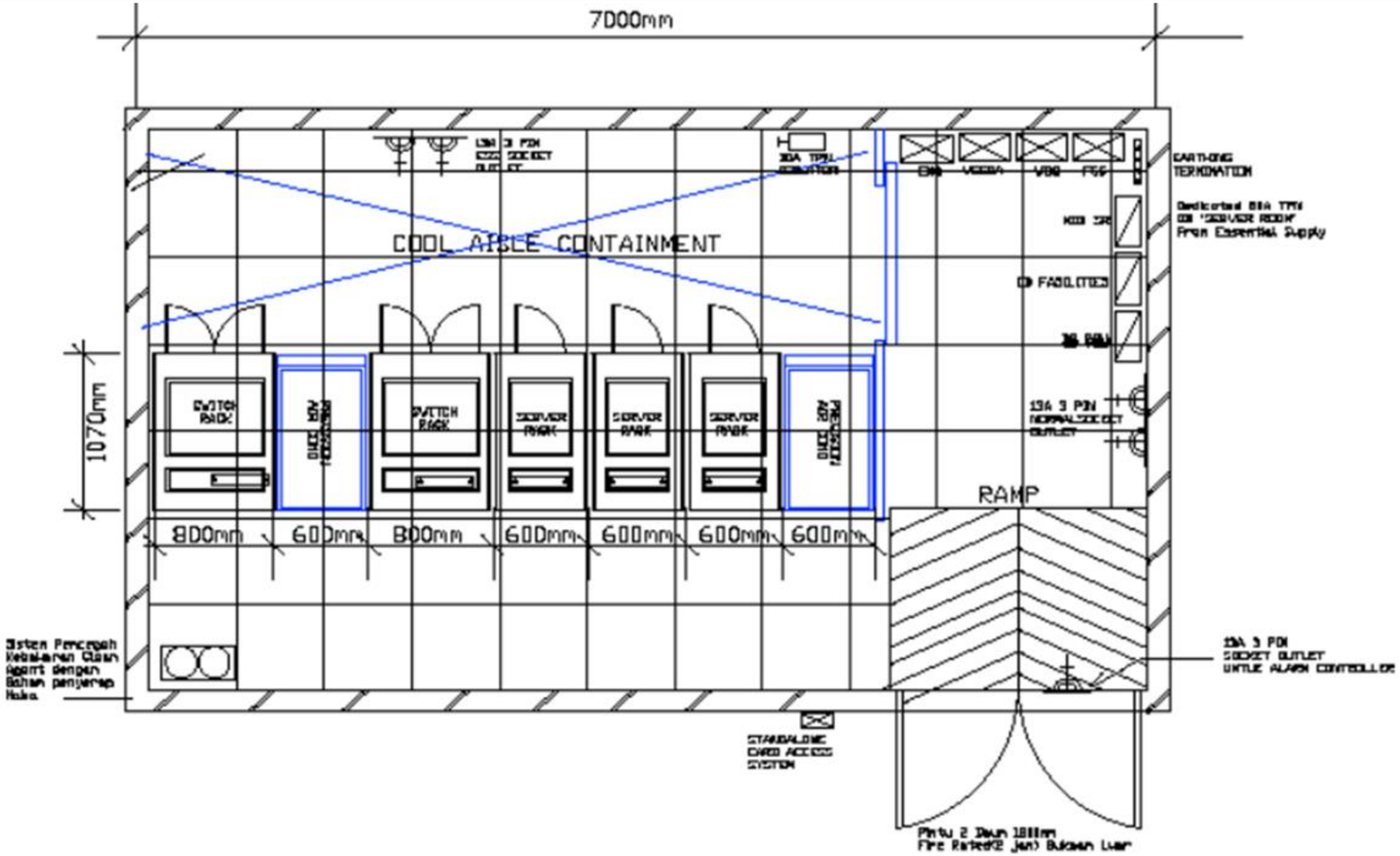
LOKASI:

- Blok ICT/ Blok Utama
- Berhampiran pejabat ICT
- Di aras tengah
- Jauh dari Laluan air
- Elakkan berada di tingkat bawah atau yang paling atas
- Kedudukannya Selari dengan bilik TCR
- Mudah laluan masuk

FASILITI

- 24 jam sistem penghawa dingin
- Sistem Keselamatan Pintu (Door Access System)
- CCTV
- Sistem Pencegah Kebakaran (Liquid Gas)
- Water Leak Detector (VESDA)
- DB khas
- UPS
- Generator Set

BILIK SERVER – LAYOUT PLAN



DATA CENTRE

Fungsi: Menempatkan peralatan seperti Server, Storage, Core Switch, Distribution & Workgroup Switch, Router, Firewall, IP PABX, dan peralatan-peralatan network yang lain.

Spesifikasi bilik:

- Saiz Bilik Minimum 12000mm X 10000mm (dilengkapi dengan Bilik Server, Bilik Mekanikal, Bilik Elektrikal, Bilik Network Operation Centre (NOC), Bilik Staging, dll)
- Pintu Rintangan Api (2jam) bukaan keluar 2 Nos. 900mm(w) X 2400mm(h)
- Lantai Anti Habuk & Anti Statik
- Raised Floor 300mm (bergantung kepada rekabentuk)
- Bukaan Lantai (RISER) 150mm X 300mm
- Anti Kondensasi (double Wall/PU Foam)

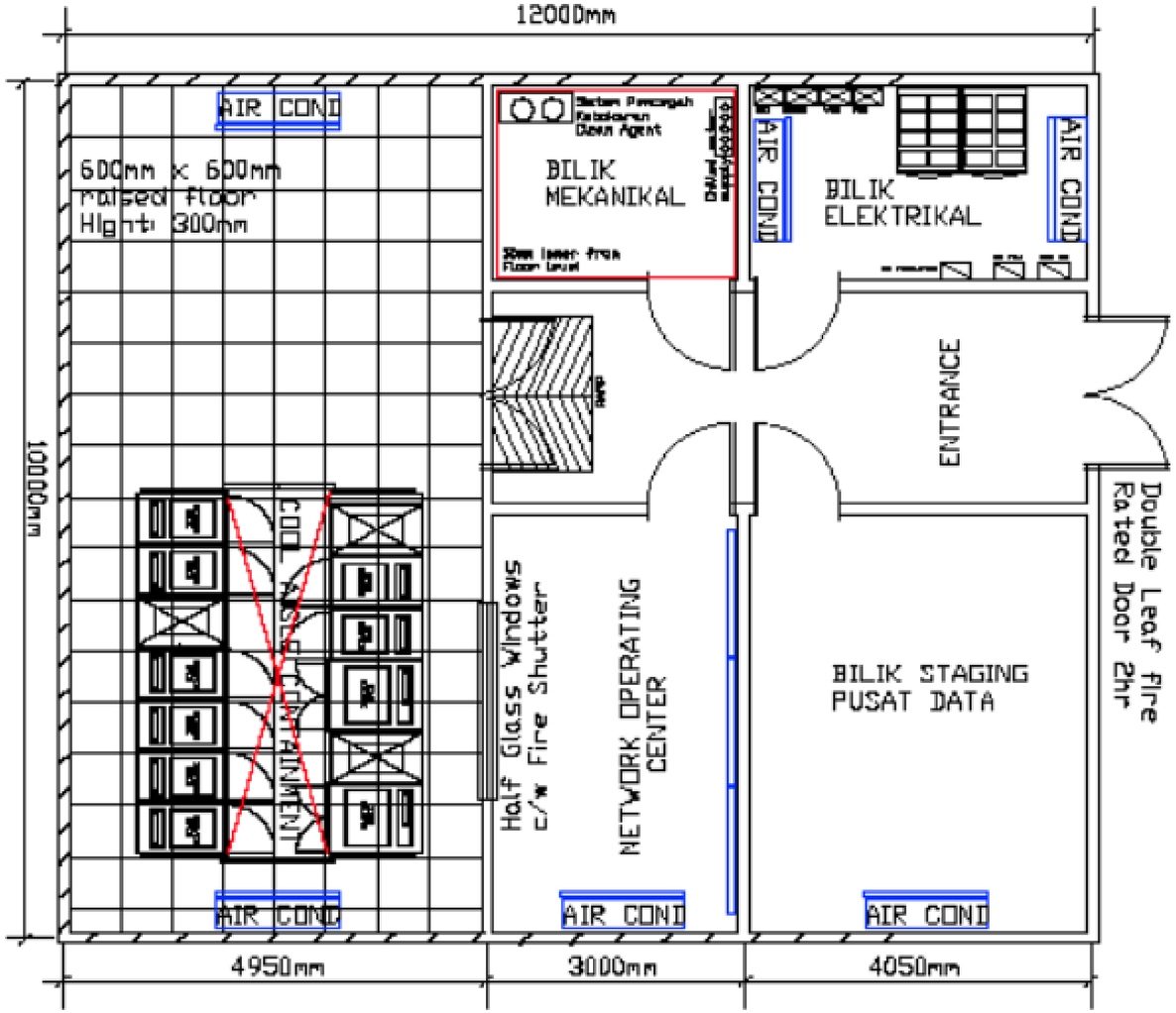
LOKASI:

- Bekalan Elektrik yang stabil
- Elak kawasan banjir
- Mudah laluan masuk

DATA CENTRE

Fasiliti:

- 32A 3 Pin Commando Plug c/w DB'PDU'
- 24 jam sistem penghawa dingin jenis Precision
- Sistem Keselamatan Pintu (Door Access System)
- Close Circuit TV (CCTV)
- Sistem Pencegah Kebakaran (Liquid Gas)
- Water Leak Detector (VESDA)
- Essential supply
- Centralised UPS
- Standby Generator Set
- Earthing system (1 Ohm) for signal Referance Grid



Telephone Riser

Fungsi: sebagai laluan kabel vertical backbone

Spesifikasi:

- Saiz 1200m X 1000mm
- Pintu Bukaan Keluar
- Bukaan Lantai (Riser) 150mm X 300mm

LOKASI:

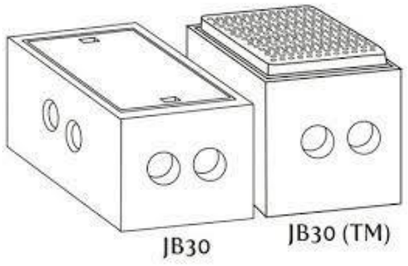
- **Selari dengan Bilik TC /MTCR**
- **Sebaiknya berada di tengah-tengah bangunan**

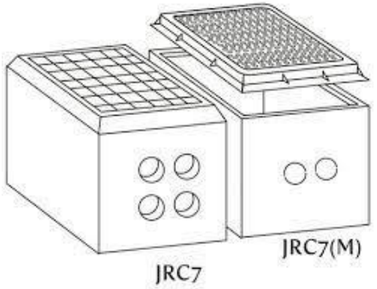
Objektif Kerja Infrastruktur Luaran

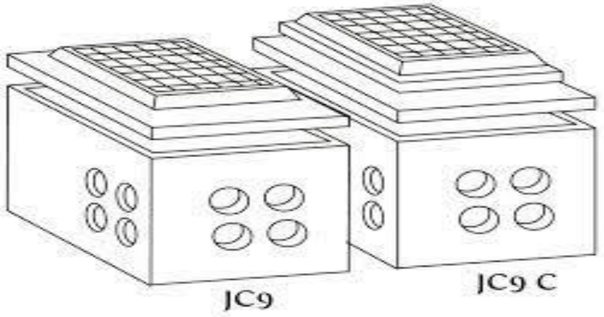
- Menyediakan laluan masuk kabel dari Man-hole terdekat pihak TELCO ke Bilik SDF.
- Menyediakan laluan kabel antara bangunan.
- Memudahkan kerja pemasangan dan penggantian kabel antara bangunan
- Memudahkan kerja selenggaraan kabel.

Telecommunication Manhole

Fungsi: Menamatkan akses sesalur untuk utiliti bawah tanah dan memudahkan kerja-kerja pemeriksaan, penyelenggaraan dan peningkatan system kabel network.







Typical Telecommunication Manhole Specifications

No.	Manhole Type	Recommended Internal Dimension L X W X H (mm)	Total no. of Duct Way Min.100mm G.I pipe /P.V.C /HDPE	Manhole Strength SIRIM Std w/safety Factor x2 (t)
1.	Pit	460 X 460 X 760	2	5.0
2.	JB30	860 x 860 x 760	2	22.5
3.	JRC7	1160 x 855 x 850	2	22.5
4.	JC9	1810 x 890 x 1150	4	22.5
5.	JC9C	1960 x 1260 x 1020	4	22.5
6.	R1B	1980 x 1370 x 1830	6	22.5
7.	R2A	3280 x 1500 x 1830	12	22.5
8.	R2A (M)	3740 x 1640 x 2000	16	22.5

Telecommunication Ducting

Fungsi: Laluan kabel network (fibre optic cable c/w sub-duct) dari server room/ MTCR / bilik TC ke bilik TC di blok yang lain.

Spesifikasi:

Specifications	Description
Material Type	HDPE, PVC-U (Class B), GI (Class C)
Diameter	32mm, 40mm or 110mm
Duct Colour	Black
Stripe Colour (if any-optional)	Yellow
Stripe Width	100mm duct: 5mm – 8mm
Outer Marking Colour	Yellow
Outer Marking Size	Font size 20 pt

Latih Amal:

Penyediaan lukisan cadangan pelan pembangunan infrastruktur ICT

- Berdasarkan Lukisan *Site Plan* yang diberikan, sila sediakan Lukisan cadangan pelan pembangunan infrastruktur ICT.

Proses-proses Rekabentuk

Sistem ICT

Prosedur Rekabentuk _ JKR.PK(O)02-2_19 Sept 2019

JKR MALAYSIA	PROSEDUR REKABENTUK	No. Dokumen : JKR.PK(O).02-2A No. Keluaran : 06 No. Pindaan : 00 Tarikh : 19 Sept 2019 Muka Surat : 2 / 2

LAMPIRAN 2A

REKOD KAWALAN REKABENTUK (KONVENSIONAL DALAMAN)

KAJIAN SEMULA / VERIFIKASI / VALIDASI (*)	
Tajuk Projek	
No. Projek	
No. Fail	
Skop Perbincangan	
Tempat/Tarikh/ Masa	
Kehadiran	Nama Jawatan

DOKUMEN TERKAWAL

SEDUR BENTUK

No. Dokumen : JKR.PK(O).02-2A
No. Keluaran : 06
No. Pindaan : 00
Tarikh : 19 Sept 2019
Muka Surat : 2 / 2

/ VERIFIKASI / VALIDASI (*)

ULASAN

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DOKUMEN TERKAWAL

JKR MALAYSIA	PROSEDUR REKABENTUK	No. Dokumen : JKR.PK(O).02-2B No. Keluaran : 06 No. Pindaan : 00 Tarikh : 19 Sept 2019 Muka Surat : 1 / 2

LAMPIRAN 2B

REKOD KAWALAN REKABENTUK (KONVENSIONAL PERUNDING)

KAJIAN SEMULA / VERIFIKASI / VALIDASI (*)	
Tajuk Projek	
No. Projek	
No. Fail	
Skop Perbincangan	
Tempat/ Tarikh/ Masa	
Kehadiran	Nama Jawatan

DOKUMEN TERKAWAL

SEDUR BENTUK

No. Dokumen : JKR.PK(O).02-2B
No. Keluaran : 06
No. Pindaan : 00
Tarikh : 19 Sept 2019
Muka Surat : 2 / 2

/ VERIFIKASI / VALIDASI (*)

ULASAN

bertanggungjawab dalam memastikan rekabentuk keselamatan rekabentuk, spesifikasi dan garis

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DOKUMEN TERKAWAL

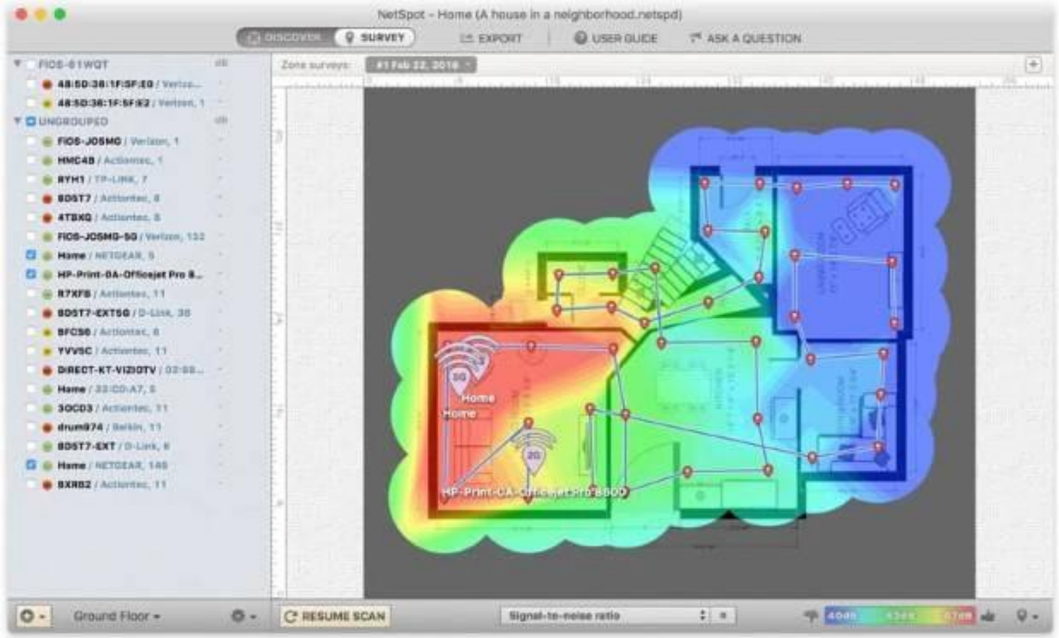
Penentuan Network Point

- Min. 1 No. di setiap ruang kerja/meja pegawai
- Tambahan 1 No. di setiap 8 Nos. ruang kerja – untuk network printer
- 2 Nos di Bilik Mesyuarat
- 2 Nos di Bilik Seminar
- 1 No di setiap meja komputer di makmal komputer
- 4 Nos untuk makmal sains

Penentuan Wireless Access Point (AP)

- Ruang terbuka (1 bagi setiap 15-20m radius)
- Perpustakaan
- Ruang pejabat
- Asrama
- Galeri
- Cafeteria
- Dewan
- Bilik Mesyuarat
- Bilik Seminar
- Nota: Penentuan lokasi AP boleh dibuat melalui simulasi *heat map ;Cth:Ekahau.Pro Tools*

Latest Standard
802.11ax
@
WiFi 6



Penentuan Telephone Point

- Min. 1 No. di setiap ruang kerja/meja pegawai
- 1 Nos di Bilik Mesyuarat
- 1 Nos di Bilik Seminar
- 1 No di makmal komputer
- 1 Nos untuk makmal sains

Pemilihan Kabel

Horizontal Cabling

• UTP Cat 6	< 100 meter
• UTP Cat 6A	< 100 meter

Backbone Vertical Cabling (1Gbps)

• 50um Indoor Multimode Fibre (OM4)	< 500 meter
• 9um Indoor Singlemode Fibre (OS2)	> 10 meter or > 500 meter

Backbone Vertical Cabling (10Gbps)

• 50um Indoor Multimode Fibre (OM4)	< 220 meter (IEEE Standard 802.3aq)
• 9um Indoor Singlemode Fibre (OS2)	> 220 meter

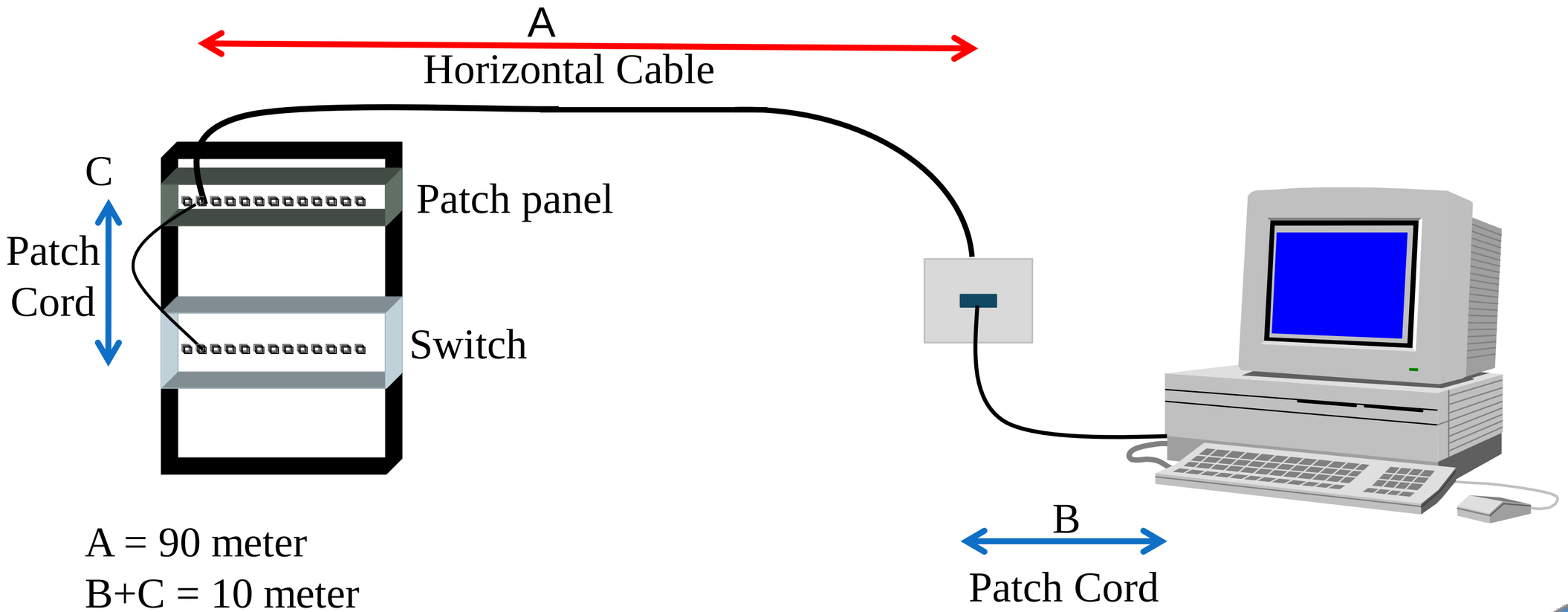
Intra Backbone Cabling (1Gbps)

• 50um Outdoor Multimode Fibre (OM4)	< 500 meter
• 9um Outdoor Singlemode Fibre (OS2)	> 500 meter

Intra Backbone Cabling (10Gbps)

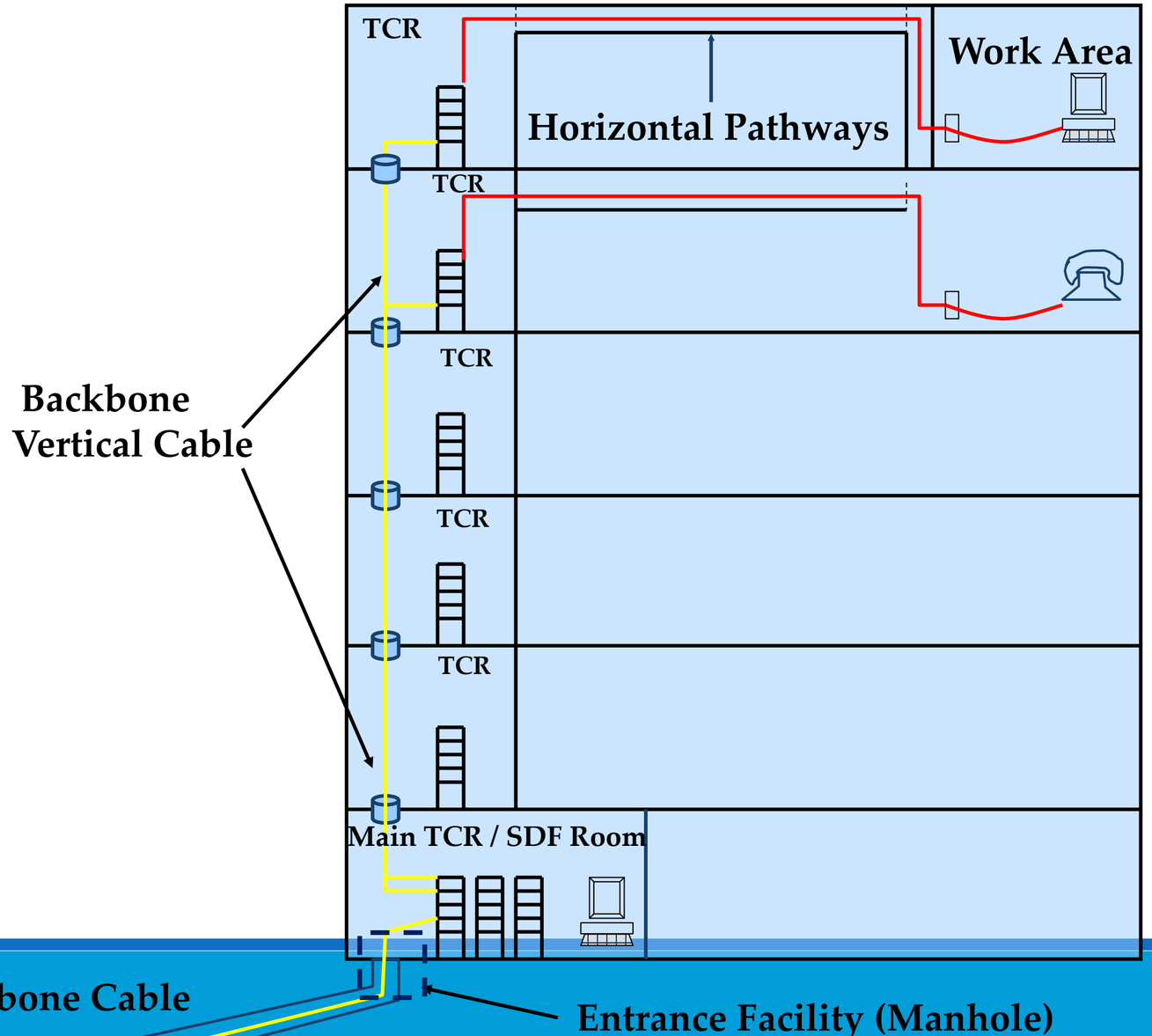
• 50um Indoor Multimode Fibre (OM4)	< 220 meter (IEEE Standard 802.3aq)
• 9um Indoor Singlemode Fibre (OS2)	> 220 meter

Horizontal Cabling

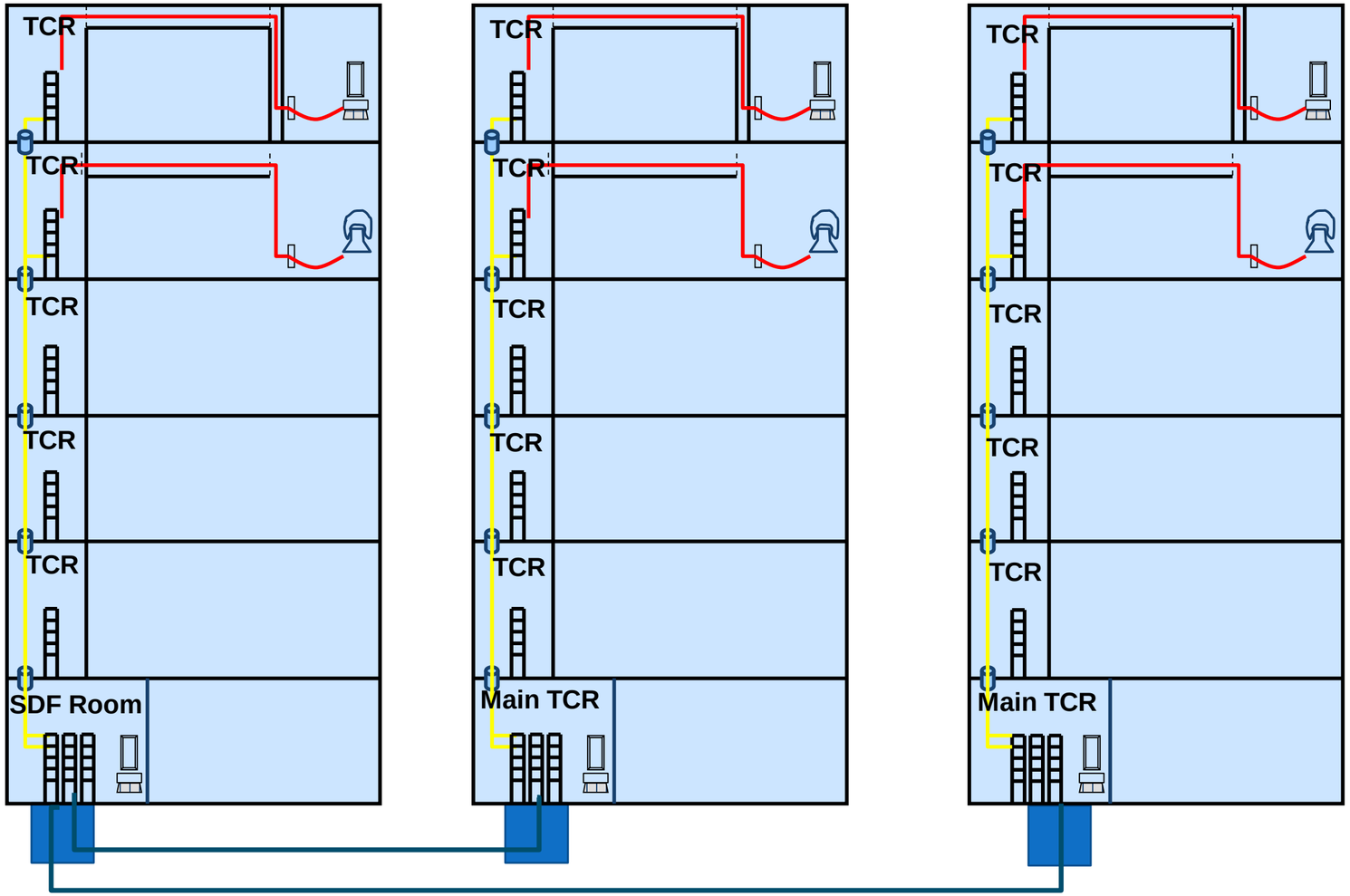


A = 90 meter
B+C = 10 meter
A + B + C = 100 meter

Backbone Vertical Cable



Inter Backbone Cable



Inter Backbone Cable

Contoh Schedule Of Accomodation (SOA)

Bil	Kod Ruang	Ruang	Bil. Bilik	Kapasiti Pengguna	ICT												
					Data Dan Telephone Point			Data Point			Wireless Point	Telephone Type					Saiz
					300 (H)	900 (H)	Floor	300 (H)	900 (H)	Floor	Wireless	Standard	Executive	Fax	Direct Line	FWS	rack
1		KAUNTER TIKET	1	1		1			1								
2		GERAI 1	1	1												1	
3		GERAI 2	1	1												1	
4		GERAI 3	1	1												1	
5		RUANG MENUNGGU	1	20							2						
		TERMINAL BAS & TEKSI	**5**	**24**	**0**	**1**	**0**	**0**	**1**	**0**	**2**			**0**		**3**	

JUMLAH DATA DAN TELEPHONE POINT	**1**
JUMLAH DATA POINT	**1**
JUMLAH WIRELESS POINT	**2**
JUMLAH FWS	**3**

Latih Amal:

Penyediaan SOA:

- Berdasarkan Contoh Lukisan Tender Arkitek yang diberikan, sila sediakan SOA sepertimana contoh yang dipaparkan.

Equipment Rack

Kenapa 19”?

- Saiz-saiz peralatan adalah 19” (lebar)

Saiz Rack

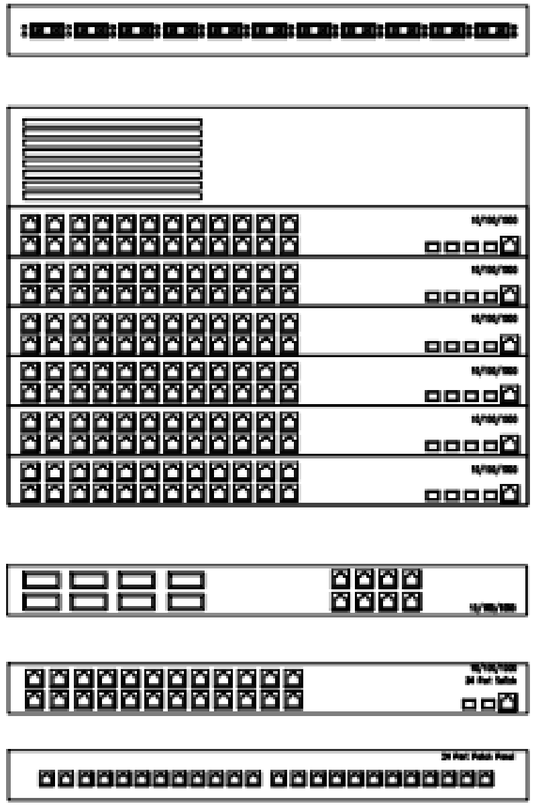
- Wall mounted
  - 9U
  - 12U
  - 15U
- Floor Standing
  - 15U
  - 21U
  - 27U
  - 33U
  - 37U
  - 42U

Equipment Rack

Peralatan-peralatan di dalam rack

- Fibre Termination Unit
- UTP Patch Panel
- Cable Management Unit (Cable Manager)
- Switch
- UPS
- Router

Komponen dalam Equipment Rack



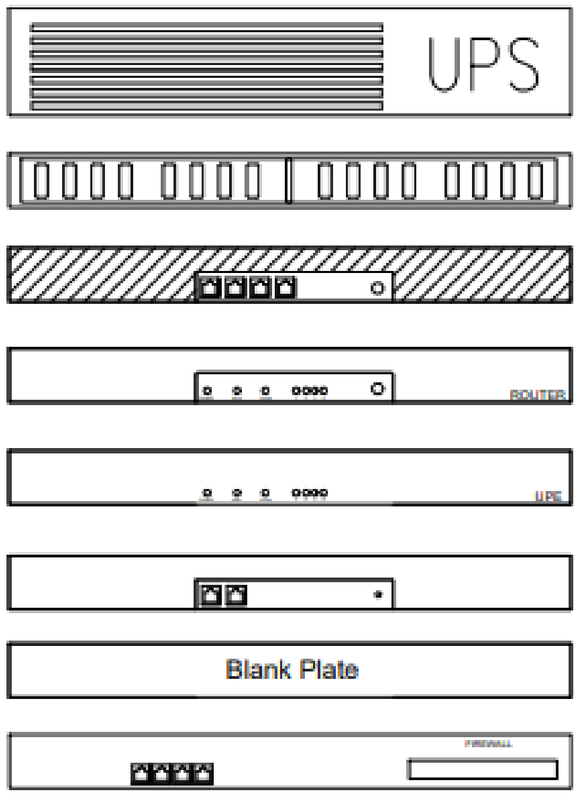
FIBER OPTICAL PANEL

CORE SWITCH CHASIS

CORE SWITCH FIXED

ACCESS SWITCH 24 PORT

UTP PATCH PANEL



UNINTERRUPTIBLE POWER SUPPLY

CABLE MANAGEMENT

BUSINESS GATEWAY

ROUTER

UPE

BANDWIDTH MANAGEMENT TOOL

BLANK PLATE

FIREWALL

Contoh pengiraan saiz Rack

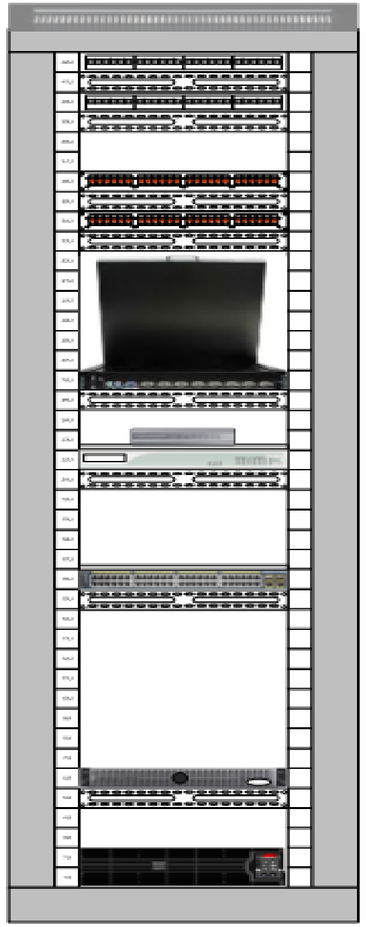
Aras 1 mempunyai 96 bil. network points

Apakah saiz TC diperlukan?

- 96 network points
- Jumlah switch yang diperlukan = 96 ÷ 24 = 4
- 4 unit 24 port switch = 4U
- 4 unit 24 port patch panel = 4U
- 4 x 2 unit cable management = 8U
- 1 unit Fibre Termination Unit = 2U
- 1 unit UPS = 3U
- **JUMLAH = 21U**
- 20-30% Future expansion = 6 U
- **SAIZ RACK = 27 U => sekiranya kiraan saiz rack melebihi 15U, saiz rack yang akan digunapakai ialah 42U**

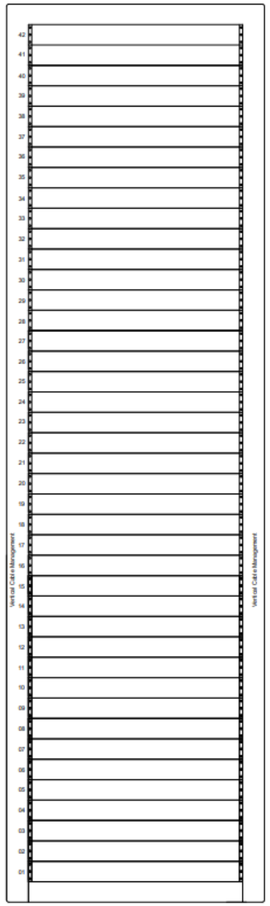
Rack Population Diagram

Server Rack



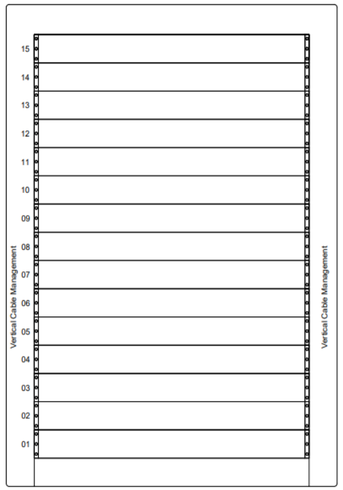
Network Rack

Rack 42u Floor Standing



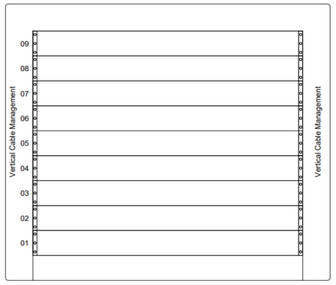
Network Rack

Rack 15u Wall Mounted



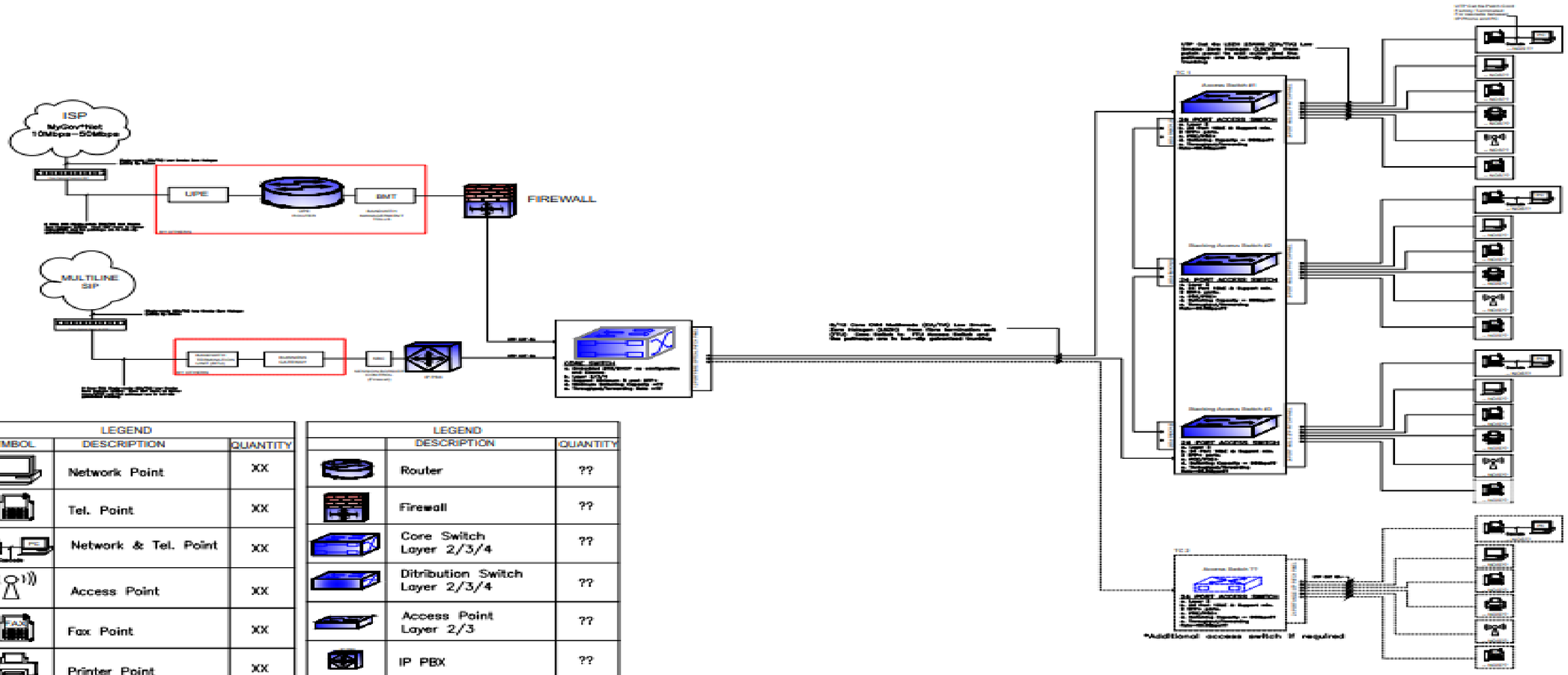
Network Rack

Rack 9u Wall Mounted



Contoh Network & Telephone Schematic

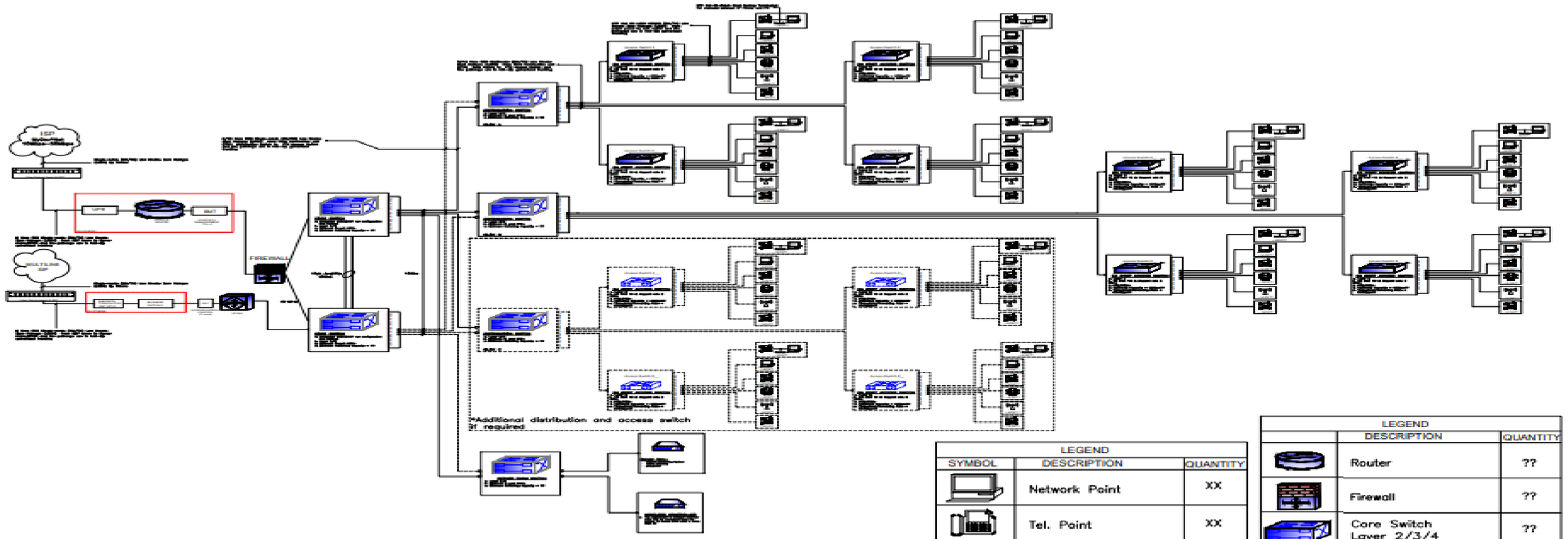
SCHEMATIC DIAGRAM (2 TIER)



LEGEND		
SYMBOL	DESCRIPTION	QUANTITY
	Network Point	XX
	Tel. Point	XX
	Network & Tel. Point	XX
	Access Point	XX
	Fax Point	XX
	Printer Point	XX

LEGEND		
	DESCRIPTION	QUANTITY
	Router	??
	Firewall	??
	Core Switch Layer 2/3/4	??
	Ditribution Switch Layer 2/3/4	??
	Access Point Layer 2/3	??
	IP PBX	??
	Analog Telephone Adapter	??

Contoh Network & Telephone Schematic



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	Router	??
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	Core Switch Layer 2/3/4	??
	Ditribution Switch Layer 2/3/4	??
	Access Point Layer 2/3	??
	IP PBX	??
	Analog Telephone Adapter	??

Latih Amal:

Penyediaan *Network Schematic*:

- Berdasarkan Contoh Lukisan Tender Arkitek yang diberikan, dan maklumat yang telah dikenalpasti, sila sediakan *Network Schematic* sepertimana contoh yang dipaparkan.

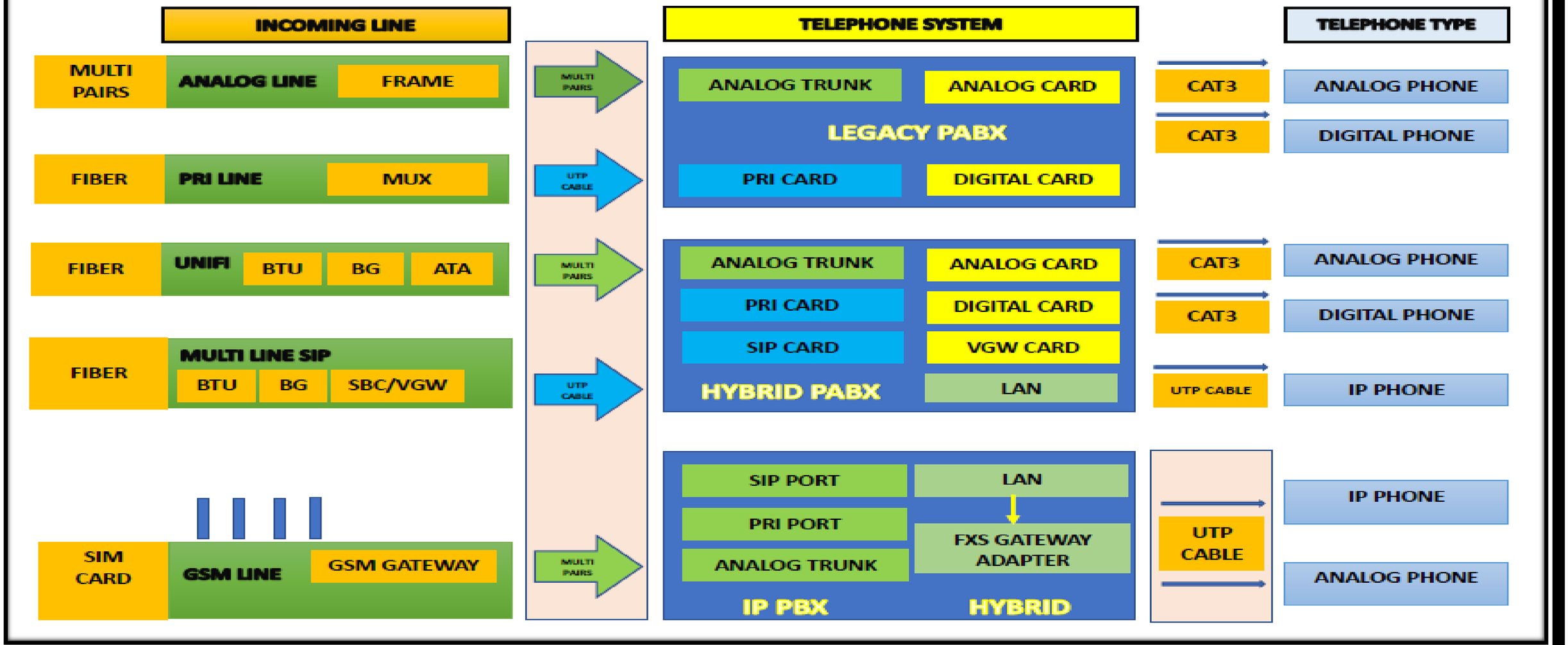
Proses-proses Rekabentuk

Sistem Telefon

TELEPHONE SYSTEM

- ✓ CONVENTIONAL SYSTEM
- ✓ CONVENTIONAL HYBRID SYSTEM
- ✓ IP PBX SYSTEM
- ✓ IP PBX HYBRID SYSTEM

MATRIX TELEPHONE SYSTEM



INCOMING TELEPHONE LINE

Primary Rate Interface

- *PRI is a systems are physical connections over a dedicated line which can only handle voice transmission and require complex setup, maintenance and up-front investment in hardware.*
- *PRI uses a circuit switched model for making voice connections between people*
- *PRI has a guaranteed Quality of Service (QoS)*

PRI Package Offering:-

CHANNEL	➢ **32**
DIRECT IN DAIL	➢ **200 – 300**
SEWA BULANAN	➢ **RM 980.00**

INCOMING TELEPHONE LINE

Session InitiaTiON Protocol

- *SIP Trunking is a virtual connection to the PSTN that can handle both voice and data transmissions. SIP trunks require little or no hardware investment for deployment.*
- *SIP Trunking uses a packet switched model for making voice connections between people*
- *SIP Trunking is typically Best Effort*

TM Multiline SIP Package Offering:-

CHANNEL	4	8	12	16	20	24	28	32	64	128
DIRECT IN DAIL	30	60	90	120	150	180	210	240	480	960
SEWA BULANAN	180	280	400	500	600	680	700	750	1230	2300

INCOMING LINE TELEPHONE

SIP USING IP METRO-E

- Untuk sekala besar TM menyediakan package yang lebih stabil iaitu yang ada SLA dan SLG dari 99.00% hingga 99.90%.
- SIP Trunking yang menggunakan IP Metro-E line kos perlu membayar sewaan bulanan berasingan Metro-E line dan bilangan SIP Channel
- Sesuai untuk jabatan yang kritikal.

TM Multiline SIP IPME:

CHANNEL	32	64	128	256	512
DIRECT IN DIAL	240	480	980	1800	3400
99.0%	750	1280	2300	4600	9200
99.5%	900	1800	3600	7200	14400
99.9%	1000	2000	4000	8000	16000

INCOMING TELEPHONE LINE

IP CENTREX

IP Centrex

The IP Centrex is an application that offers a basic set of voice features for customers who are looking for a cost-effective communications solution using IMS infrastructure. With this, customer will enjoy FREE CALLS within the same Centrex group ID in same HSBB exchange

IP Centrex

Free on net calls within Centrex group in the same HSBB exchange

Flexible Expansion

Unlimited growth, number of lines can easily increase or decrease

Low Set up Cost

Affordable to set up with no up-front capital or initial investment. Customers only need to pay for the monthly subscription and call charges. Lower capital investment cost with no additional equipment, such as PBX

Total Control

IP Centrex can provide control over customer lines. With detailed billings, customers can monitor their usage

No Congestion

All calls are connected via direct lines. No line congestion or missed calls

Package Offering:-

IP Centrex

RM 26 / month / line

- Free 13 Features
- **Extension Calls**
  FREE calls within the same Centrex group ID in the same HSBB exchange
- **Other Calls**
  Published Rates
  *apply Call Plan rates where applicable

Reference: https://unifi.com.my/unifi-en/business/biz/business-voice-ip.page

SISTEM TELEFON

CONVENTIONAL SYSTEM

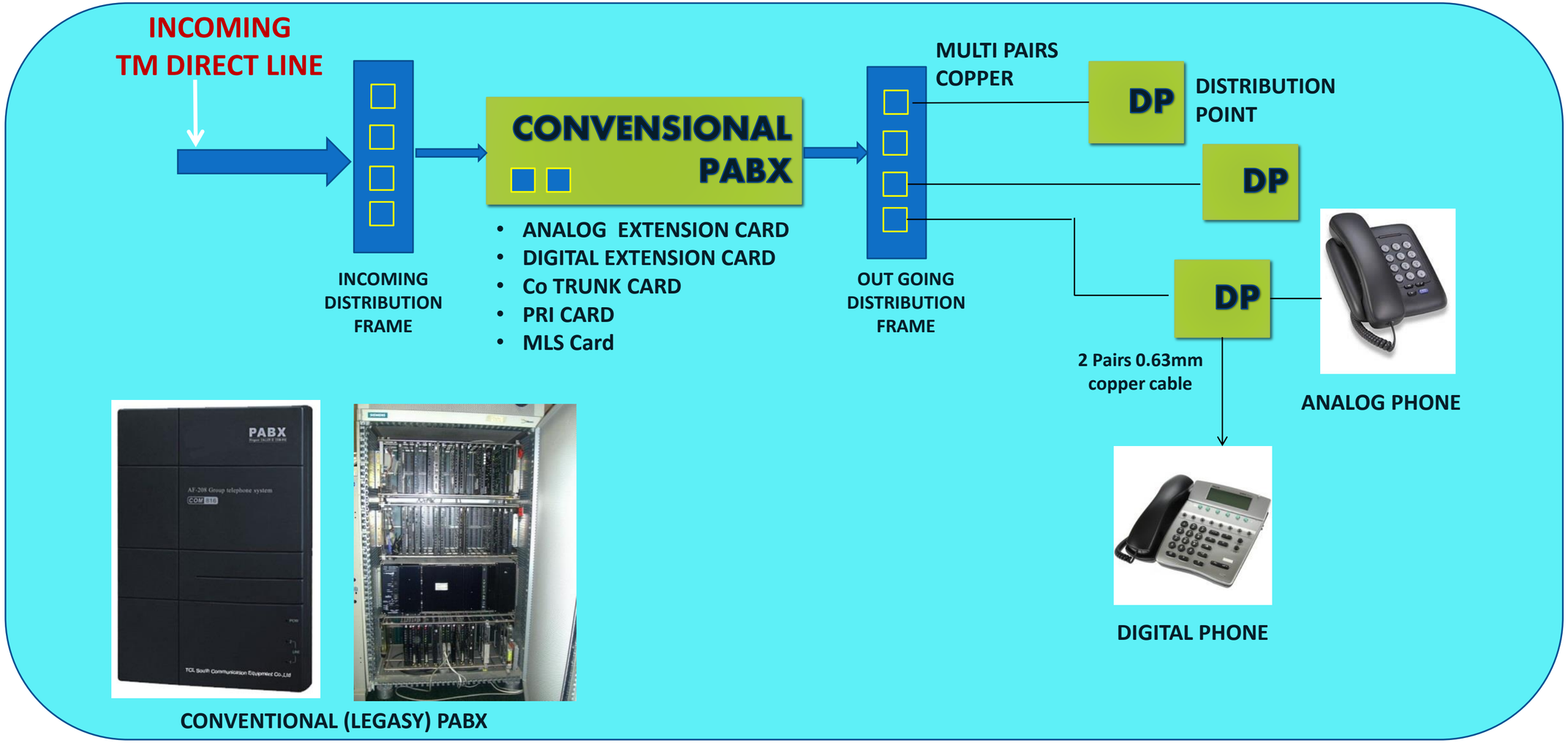
- Keperluan ruang: SDF Room, Riser Tel dan PABX Room
- Jenis Telefon: Analog Phone dan digital Phone
- *Telephone point* menggunakan pendawaian *2 pairs 0.63mm copper cable* dengan RJ11
- *Indoor* menggunakan multipairs *copper 0.63mm cable*
- *Outdoor* menggunakan *copper multipairs copper 0.63 cable*
- *Distribution Frame* dan *Distribution Point*
- Perlu memasang lightning arrestor pada DF/DP untuk setiap out going dan incoming line

SISTEM TELEFON

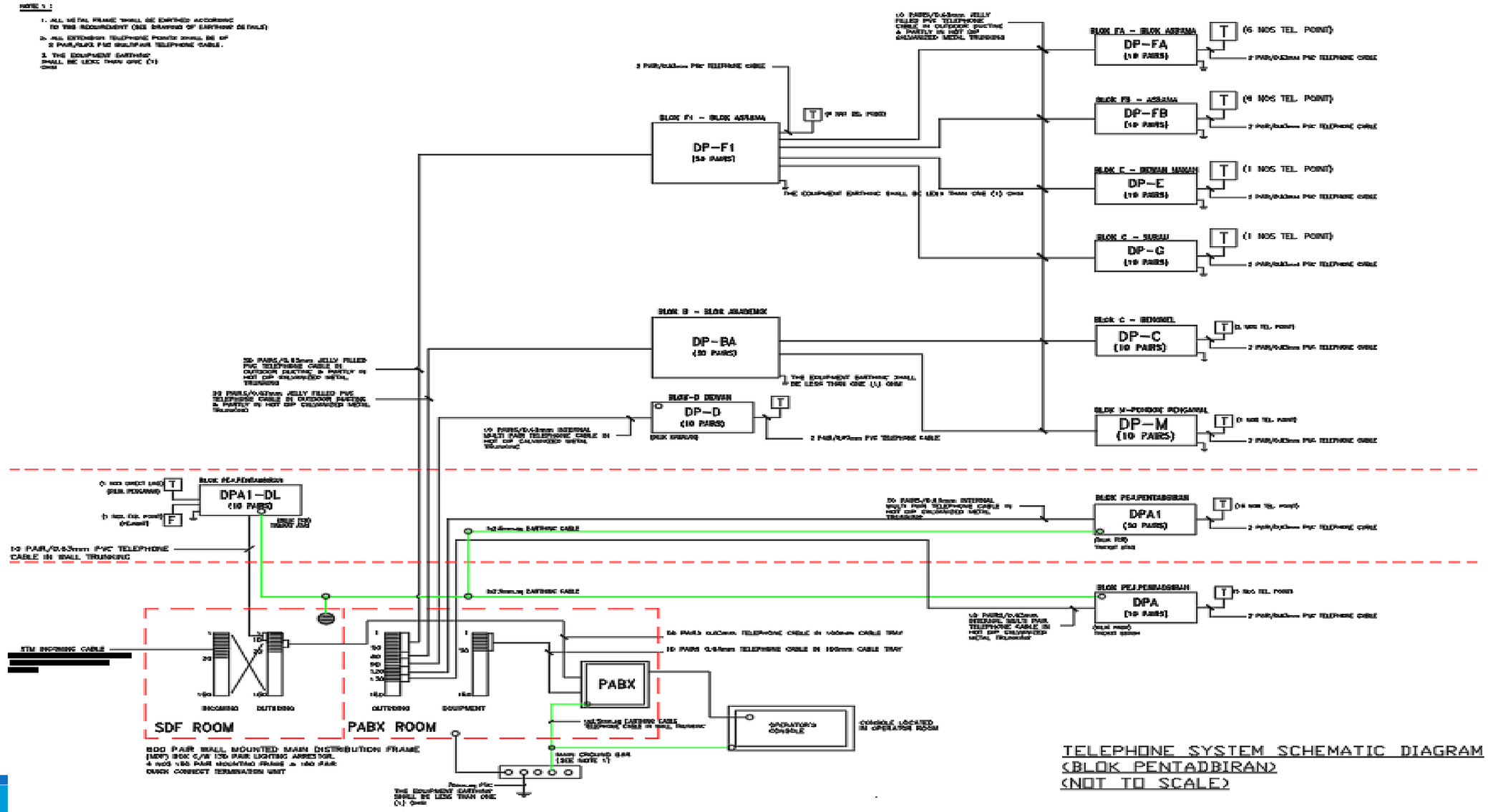
REKABENTUK CONVENTIONAL PABX

- Menentukan bilangan extension yang diperlukan mengikut SOA
- Menentukan bilangan direct line diperlukan
- Menentukan bil jenis Analog Phone dan Digital Phone
- Menentukan Jenis dan bilangan Card diperlukan- Digital Card, Analog Card
- Menentukan bil multipairs indoor dan outdoor cable
- Menentukan saiz Frame, MDP, DP serta kedudukan
- Menentukan jenis incoming line TM: Analog line, PRI Line, dan Multiline SIP.
- Menentukan jenis line Card: CO trunk, PRI Card, Multi Line Card.

CONVENTIONAL TELEPHONE SYSTEM



SCHEMATIC DIAGRAM TEL SYSTEM CONVENTIONAL



SISTEM TELEFON

CONVENTIONAL HYBRID PABX

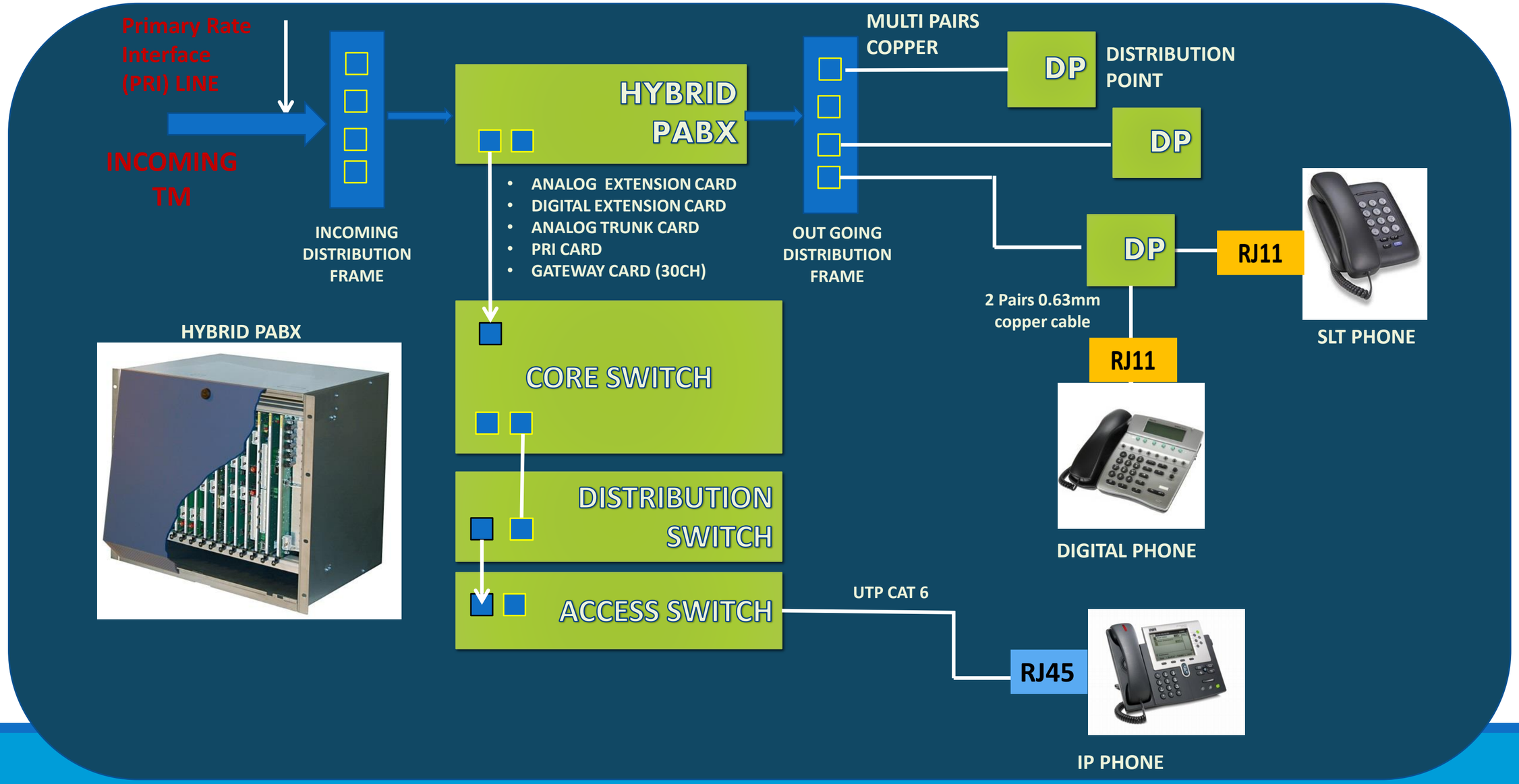
- Menggabungkan dua sistem telefon konvensional dan IP Telefon system.
- Sesuai untuk projek yang mahu mengekalkan dan menggunakan semula telefon analog dan digital sediaada disamping menaiktaraf telefon baharu kepada IP Phone.
- Sistem ini tidak lagi sesuai untuk teknologi masa kini.

SISTEM TELEFON

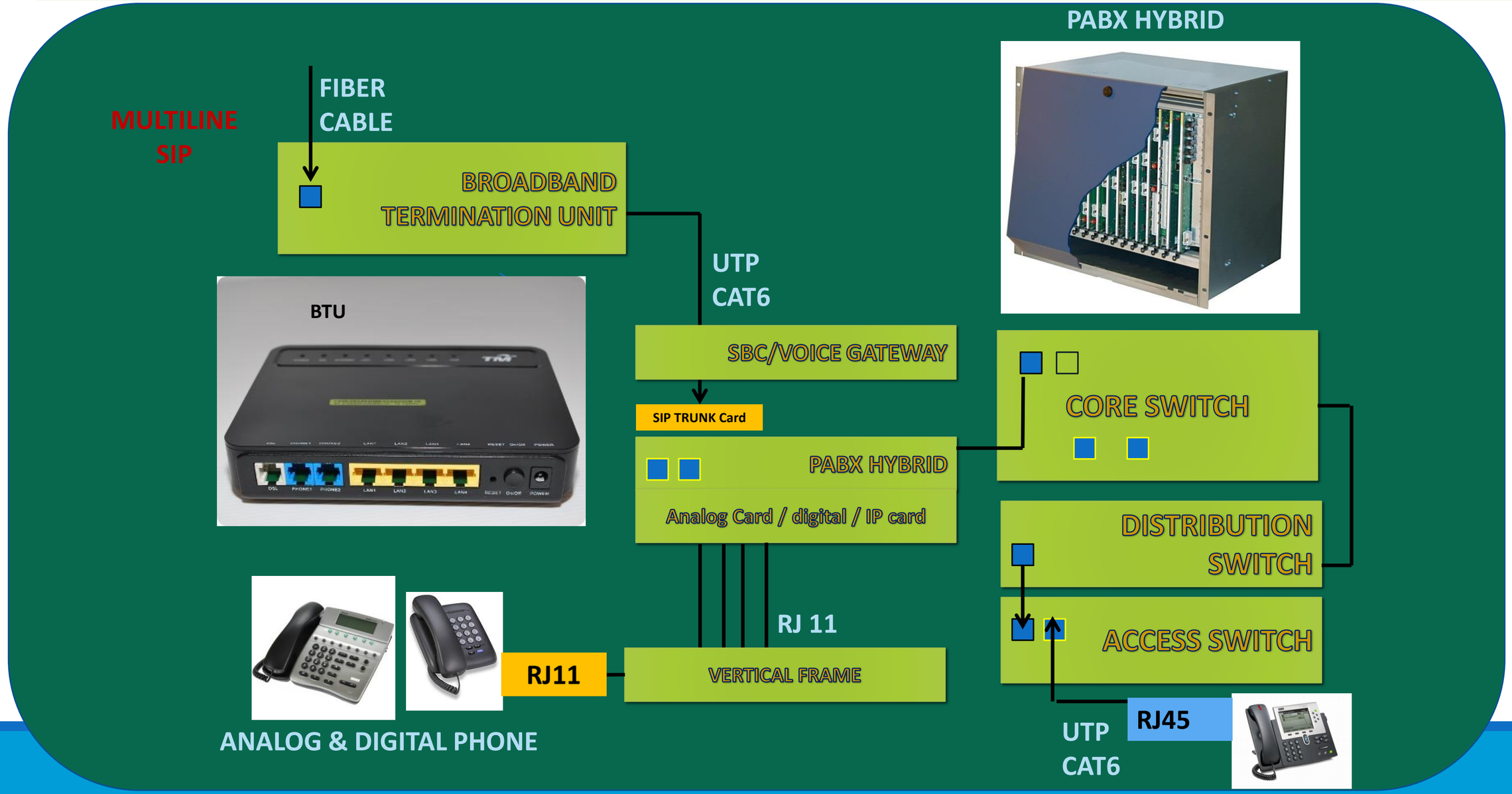
REKABENTUK CONVENTIONAL HYBRID PABX

- Memastikan PABX sediaada mempunyai fungsi IP
- Menentukan bil extension dan jenis IP Phone yang diperlukan mengikut SOA.
- Memastikan point data untuk IP Phone mencukupi atau perlu penambahan
- Menambah bilangan channel Gateway Card yang sesuai dengan bilangan extension IP Phone.
- Membuat konfigurasi IP PABX dan IP Phone.

CONVENTIONAL HYBRID PABX TELEPHONE SYSTEM



HYBRID PABX DIAGRAM

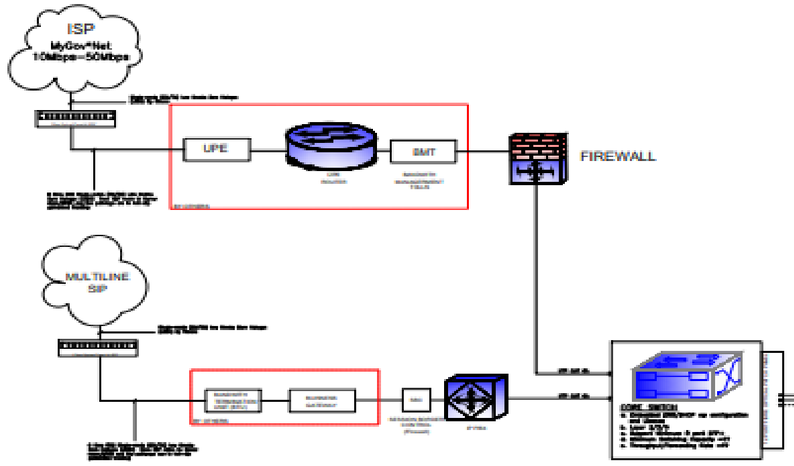


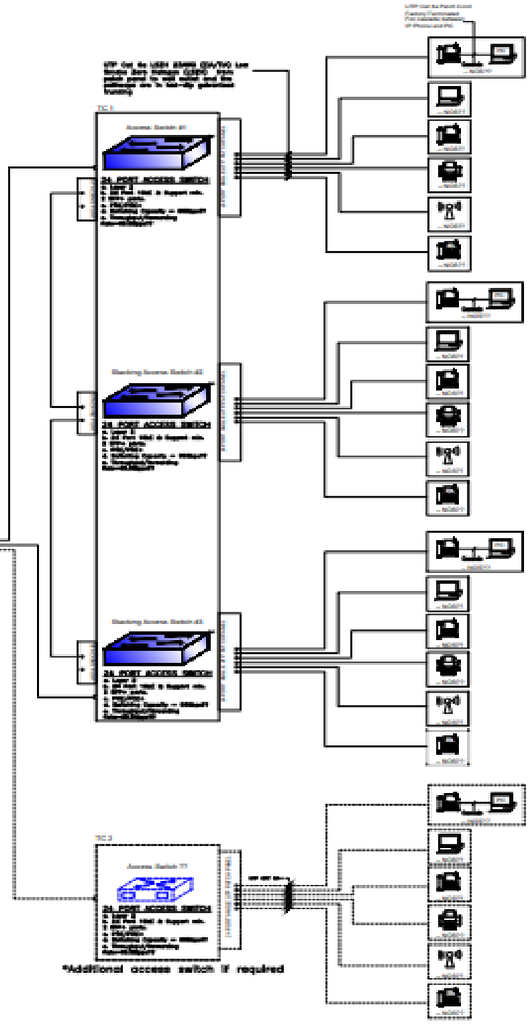
SISTEM TELEFON

REKABENTUK IP PBX

- Menentukan bilangan *IP Telephone* mengikut SOA pelanggan
- Menentukan samada *Network Point* berkongsi dengan *IP Phone* atau berasingan
- Memastikan *Access Switch* jenis POE
- Membuat konfigurasi VLAN untuk *IP Phone*
- Menentukan jenis talian masuk TM: *CO trunk line, PRI Line dan Multiline SIP.*
- Menentukan specifikasi IP PBX yang sesuai dengan bilangan extension berserta lesen
- Menentukan keperluan *Session Border Control*

SCHEMATIC DIAGRAM IP PBX





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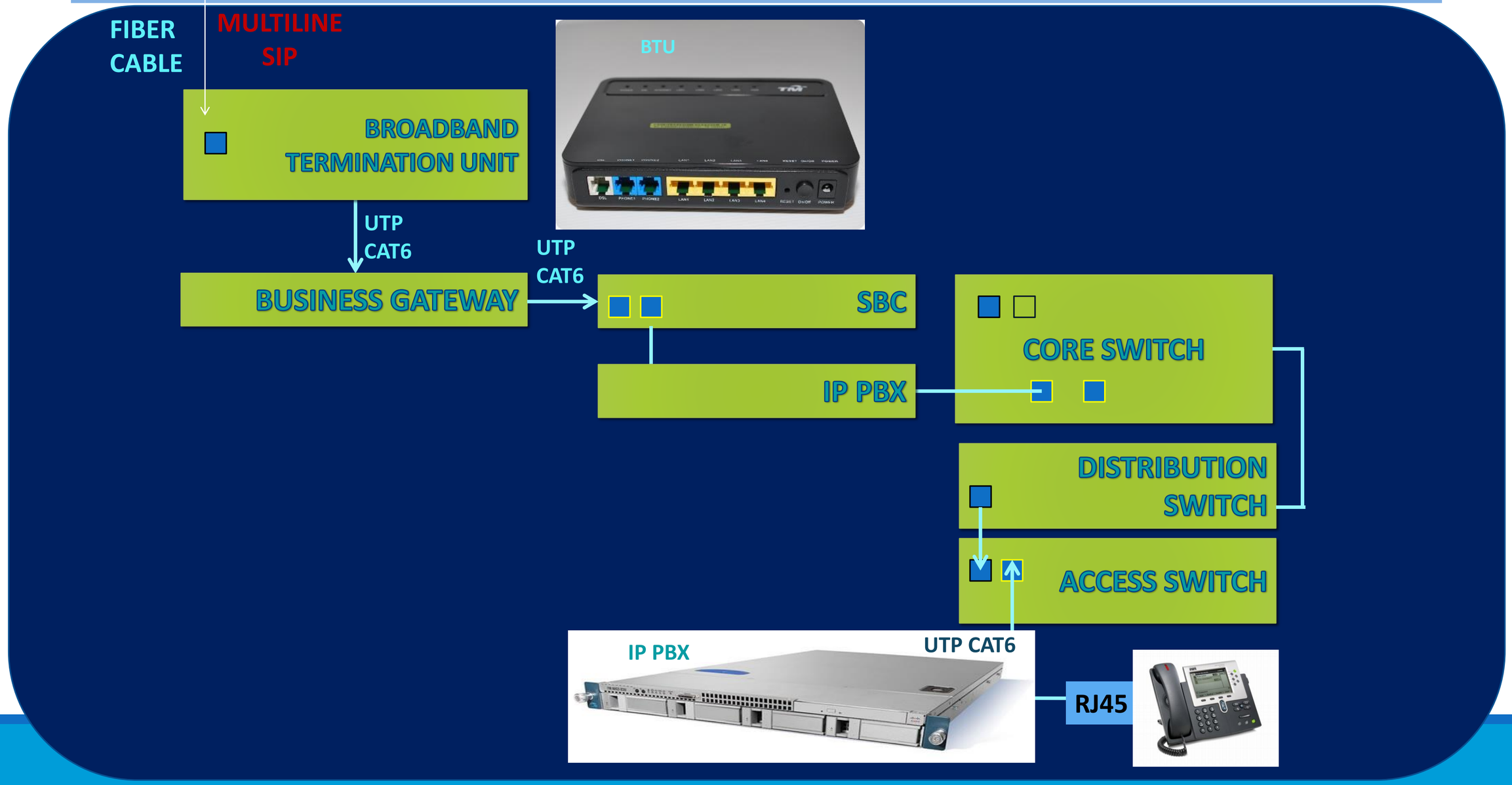
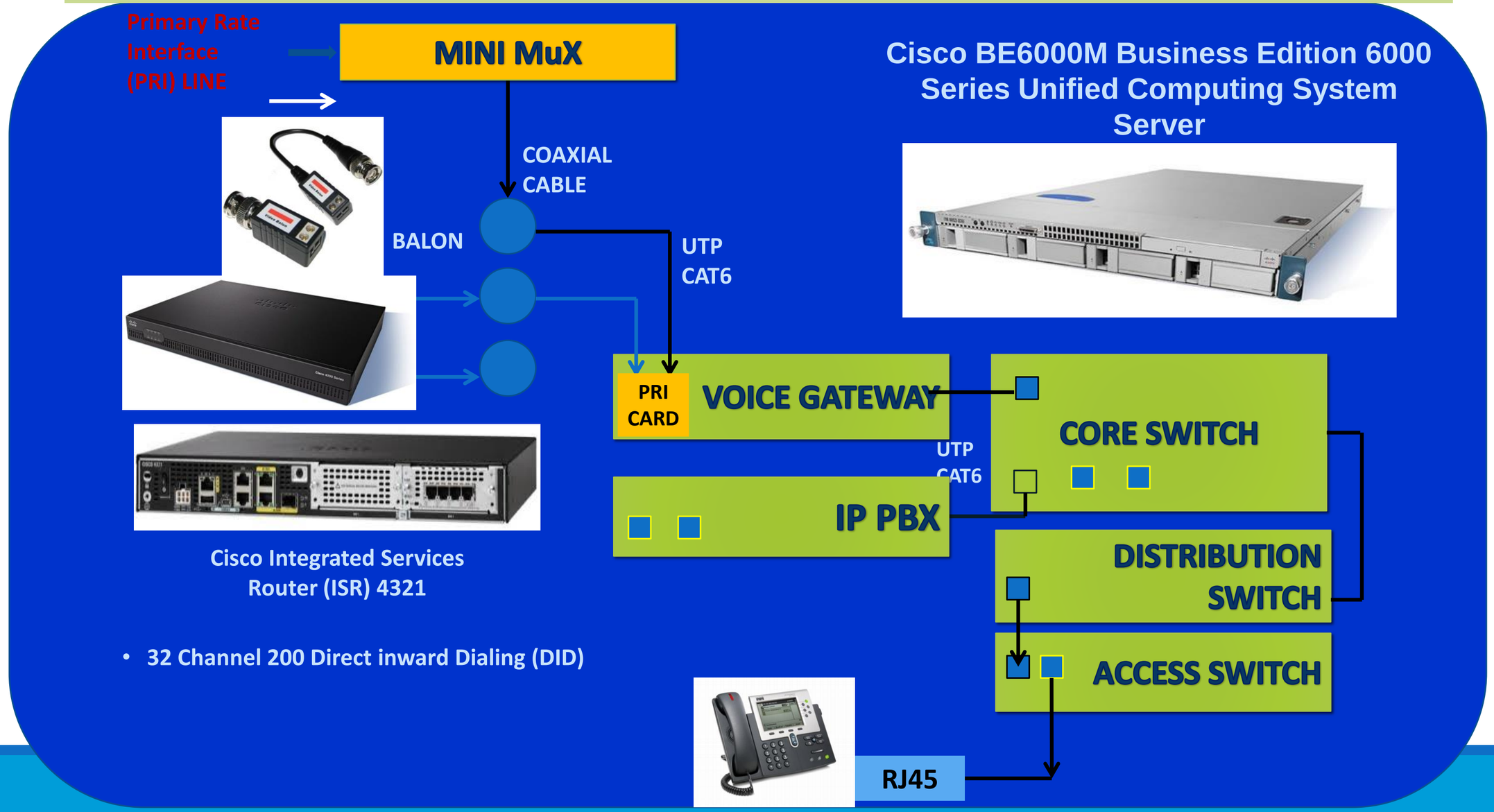
	Access Point Layer 2/3	??
	IP PBX	??
	Analog Telephone Adapter	??

IP PBX SYSTEM DIAGRAM



IP PBX SYSTEM DIAGRAM

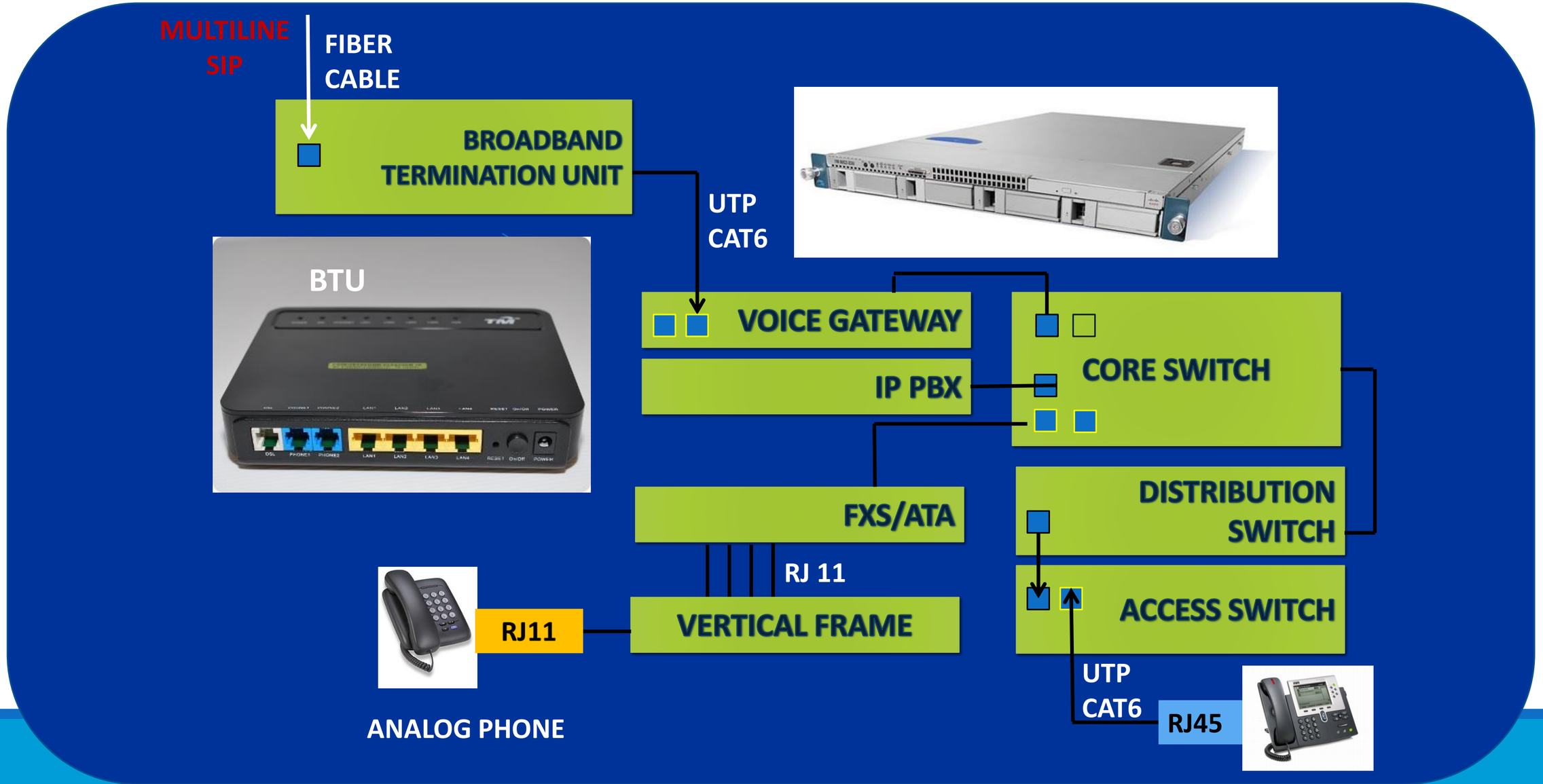


SISTEM TELEFON

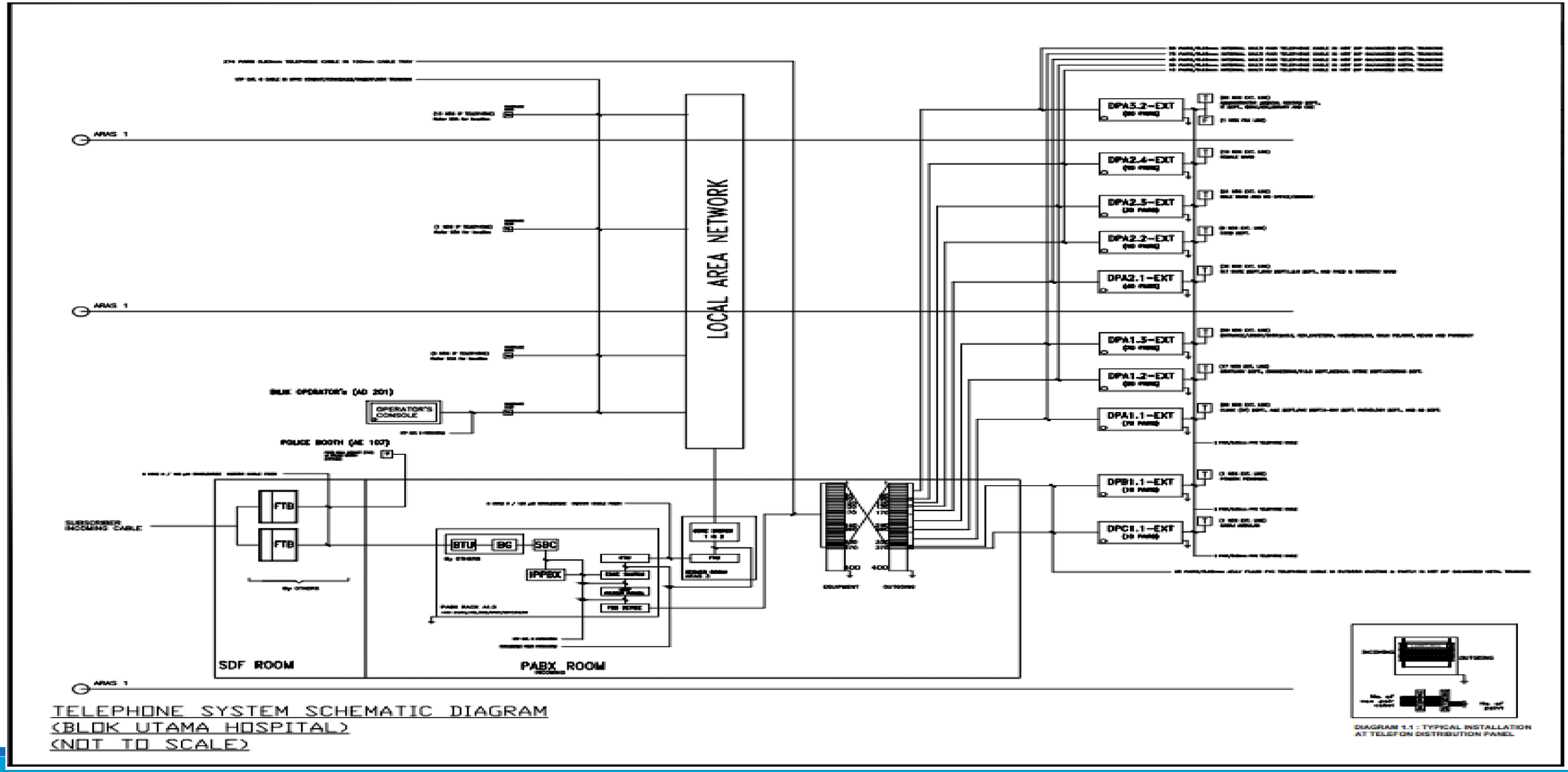
IP PBX HYBRID SYSTEM

- Mengubahsuai IP PBX system kepada Hybrid dengan menambah Foreign Exchange Subscriber (FXS).
- Sesuai untuk projek yang perlu mengekalkan dan menggunakan semula telefon analog sediaada.
- Menggantikan Sistem PABX lama yang tidak boleh diselenggara dengan menggunakan pendawaian telefon sedia ada.

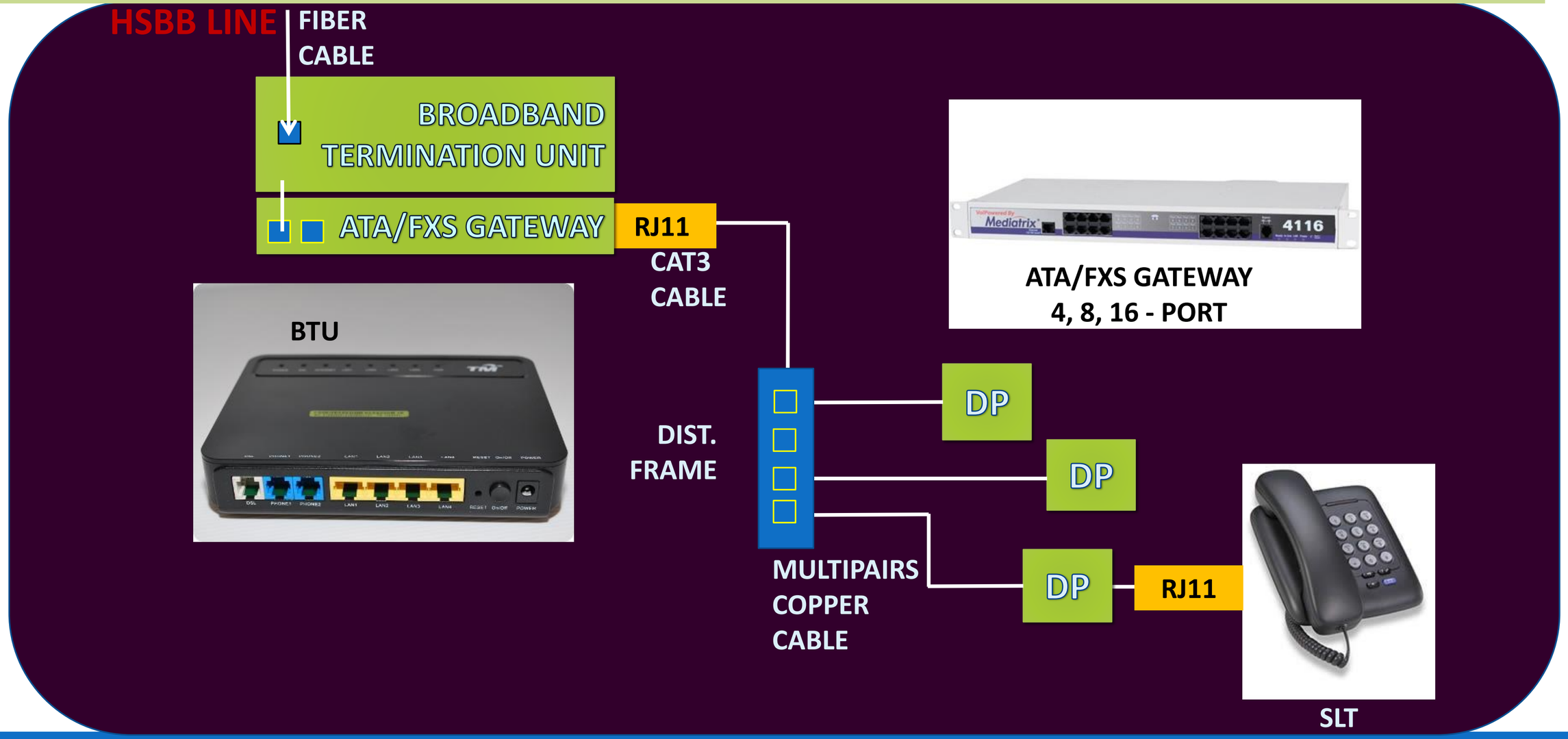
IP PBX HYBRID DIAGRAM



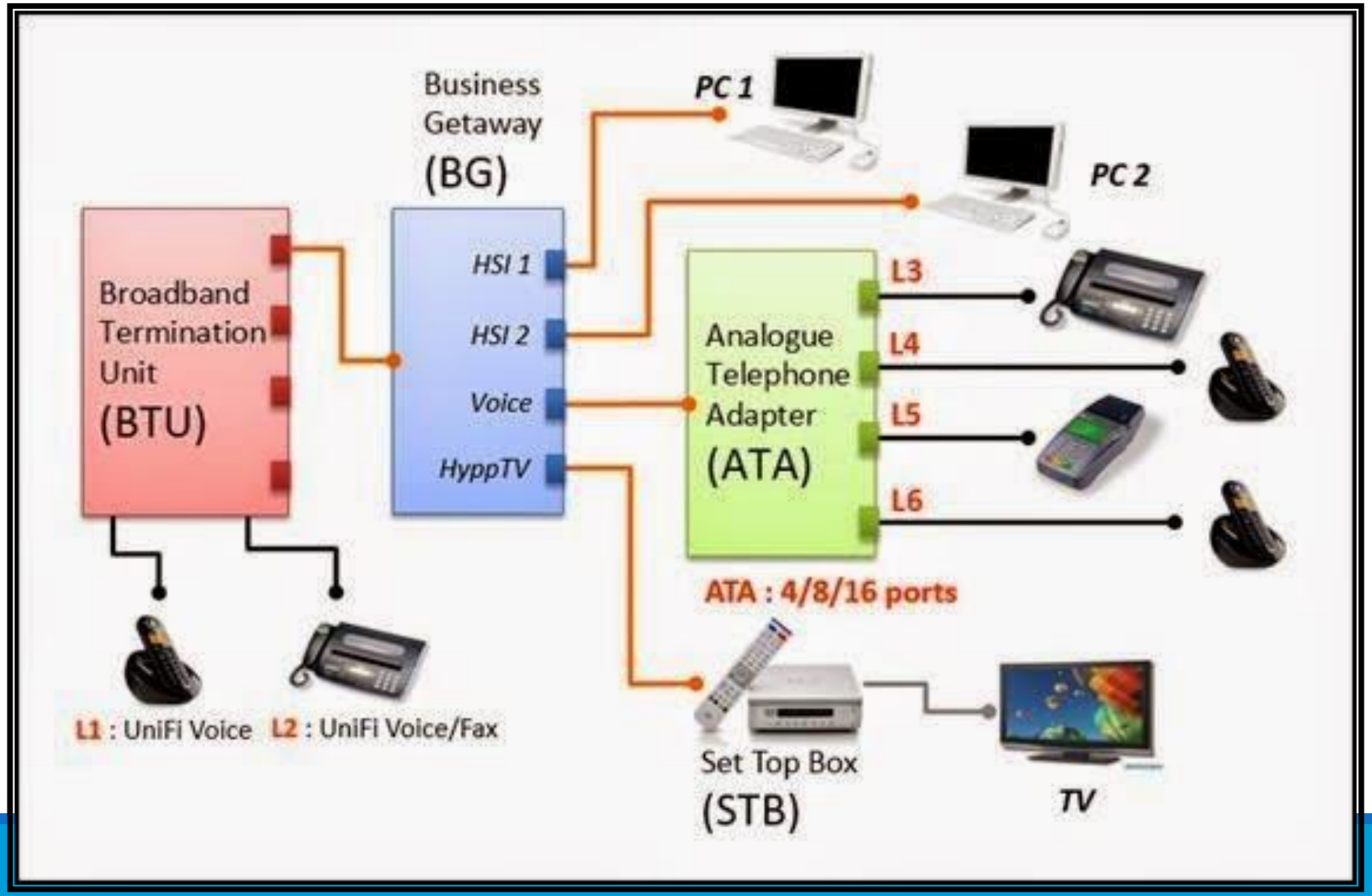
SCHEMATIC DIAGRAM IP PBX-HYBRID



UNIFY BACKUP LINE



IP UNIFY LINE DIAGRAM



- SIP- Session Initiation Protocol
- SBC - Session Border Controller
- POTS – Plain Old Telephone Service
- FXO - Foreign Exchange Office
- FXS - Foreign Exchange Subscriber
- ATA – Analog Telephone Adapter
- SLT – Single Line Telephone
- TDM - Time-division multiplexing
- PSTN- Public Switch Telephone Network
- ISDN - Integrated Services Digital Network

NetBorder SBC

POTS

MEDIA GATEWAY

Pembinaan

Sistem ICT & Telefon

Rujukan Amalan Terbaik

1. Sila rujuk dokumen Do's and Don't ICT :

http://jpedia.jkr.gov.my/images/7/7d/DO_%26_DONT2_%2808_JULAI_2020%29.pdf

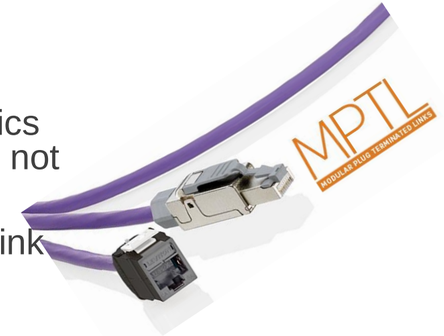
Pengujian & Pentauliahan

Sistem ICT & Telefon

Jenis Pengujian & Pentauliahan

Structured Cabling System Test

❖using a valid version of cable tester or analyzer (i.e. Fluke Field Tester or Softing or Viavi or similar) with the latest updated firmware and software.



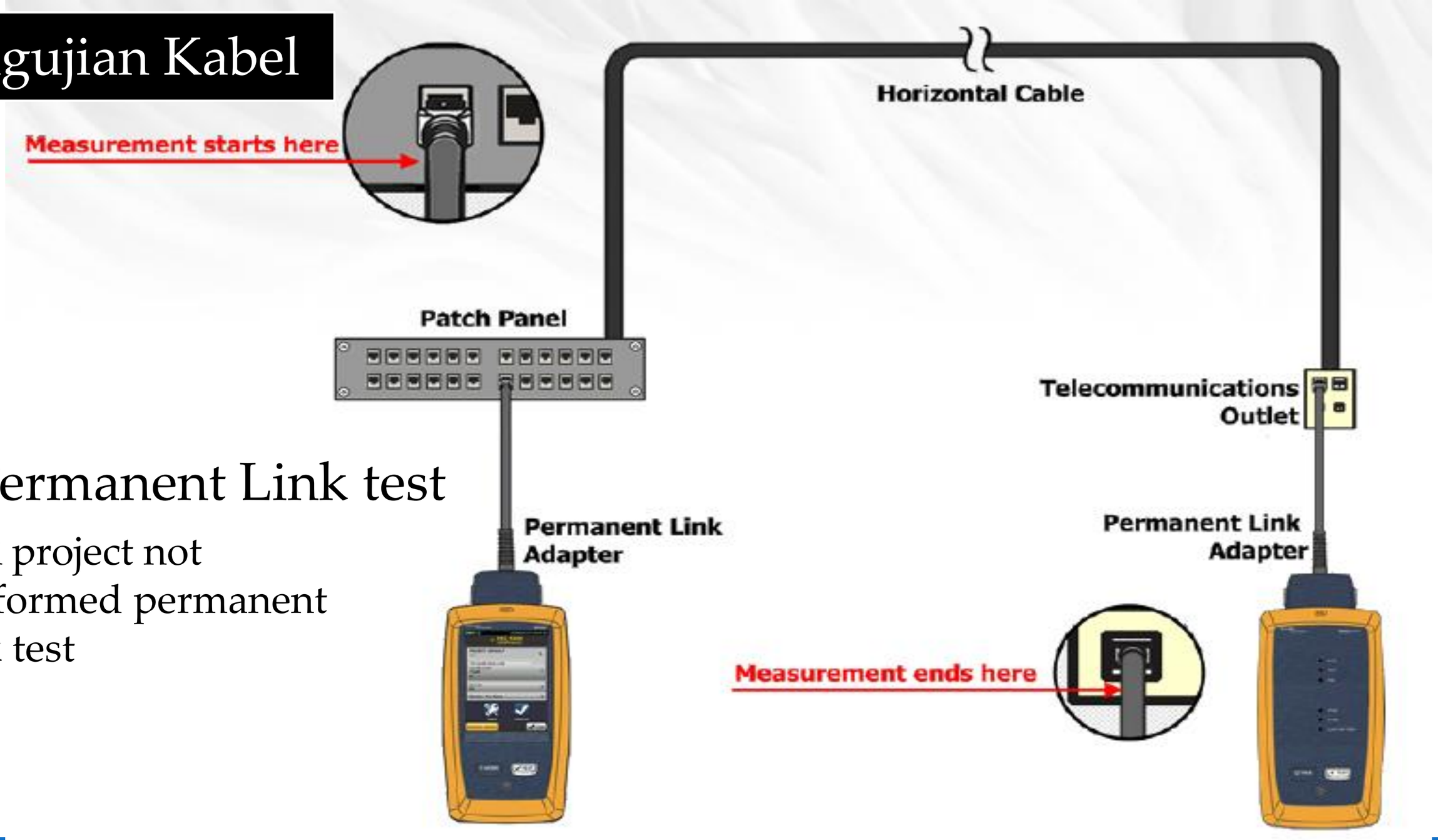
➢Twisted Pair Copper Cable

- **Channel link test** which includes the continuity, presence of electrical parameters and performance characteristics such as return loss, insertion loss (attenuation), pair to pair near end crosstalk (NEXT). Any **marginal pass** shall not be accepted.
- The Modular Plug Terminated Link (MPTL) test shall be conducted with TIA Cat 6A MPTL test limit, Permanent Link Adapter and Patch Cord Adapter for Category 6A testing on the Far End or Remote Test Equipment

➢ Fiber Optic Cable

- Tier 1 test (Optical Loss Test Set) shall include the bi-directional end to end test with 1 jumper reference methods, total link loss attenuation, channel length and polarity of fiber channel.
- The cable shall be tested at both wavelengths 850 nm and 1300 nm for multimode and 1310 nm and 1550 nm for singlemode.
- The insertion loss for each mated optical fiber connection shall not exceed 0.3dB for multimode and 0.5dB for singlemode.

Pengujian Kabel



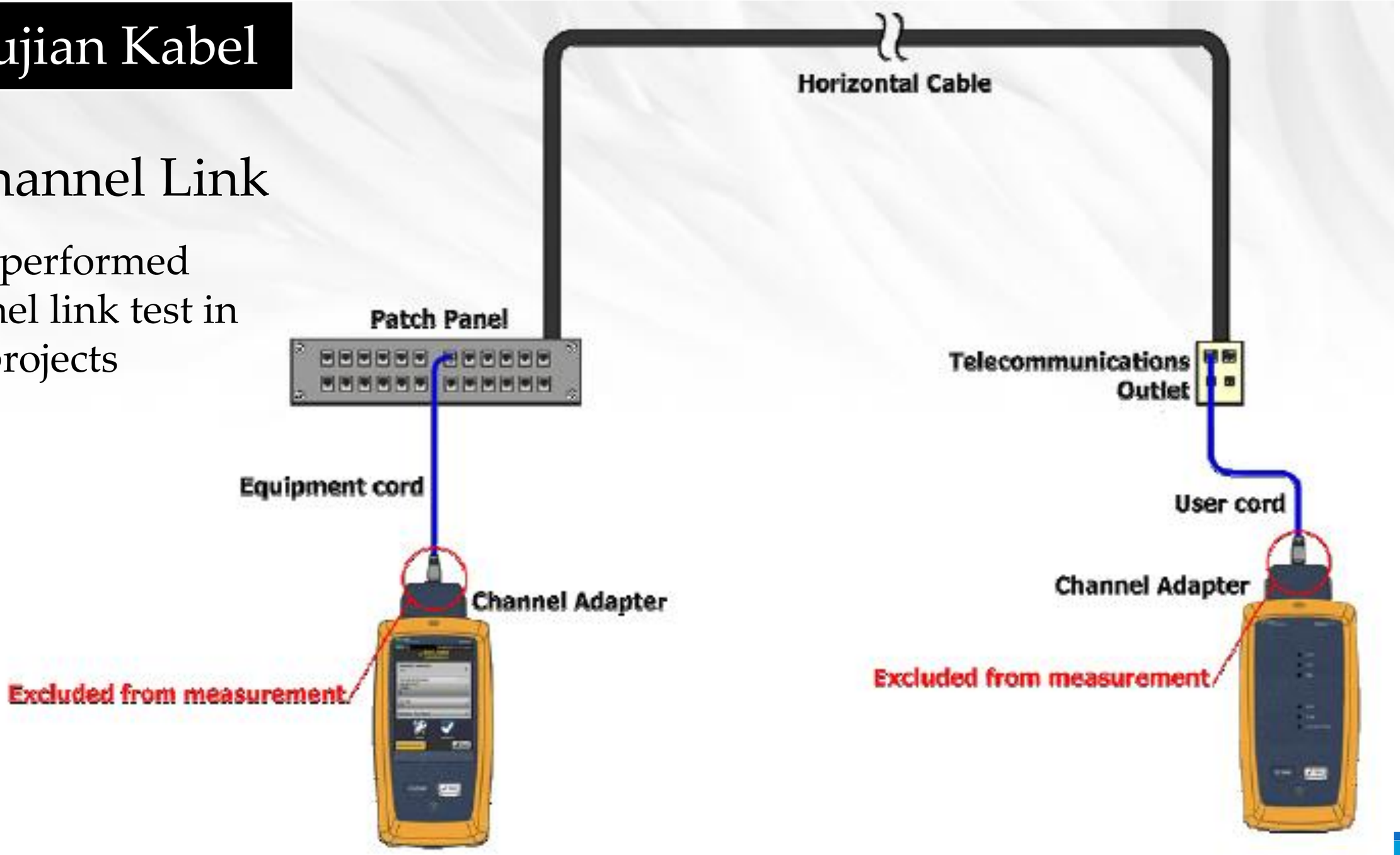
- Permanent Link test

  JKR project not performed permanent link test

Pengujian Kabel

- Channel Link

Only performed channel link test in JKR projects



Pengujian Kabel

- Model : DSX 5000

<u>Use DSX 5000 or latest.</u>

Previous model DTX 1800 no longer supported by manufacturer

Jenis Pengujian & Pentauliahan

Network Equipment Test

- Visual inspection to ensure the network equipment shall be properly mounted/installed according to the manual, free from dust, physically in good condition without any scratch or crack.

- Configuration test to check the administrator able to login into the equipment web browser, IP addresses as per network topology designed, signal strength of the Wi-Fi system, security configuration as per client's policy, the equipment appear in NMS and indicates error-free status.

- Functionality test to ensure the equipment/system meets the functional requirement.
- User Acceptance Test with the present of S.O's Representative and Client's Representative.

Jenis Pengujian & Pentauliahan

Telephone System Test

- ☑ Visual inspection to ensure the telephone equipment shall be properly mounted/installed according to the manual, free from dust, physically in good condition without any scratch or crack.
- ☑ Configuration test to check the basic calls for audio standard quality, caller ID (CLID) and Calling Name (CNAM) Presentation, Call Forward, Dual Tone Multi-Frequency (DTMF) Tests, voicemail, network redundancy if applicable, auto attendant, audio conferencing, call hold, call transfer, session refresh, fax and any applicable test needed.
- ☑ Functionality test to ensure the equipment/system meets the functional requirement.
- ☑ Security Test to ensure the equipment/system meets the security requirement.
- ☑ User Acceptance Test with the present of S.O's Representative and Client's Representative.

Kod-Kod Label Peralatan

Kod Blok

- A, B, C,…….Z, AA, AB..

Kod Aras

- Gnd/Bawah = 1, Tingkat 1 = 2

Kod TC

- A1.1 [KOD BLOK & ARAS.NO TC]

Kod Point

- A1.1.D1 [KOD TC.D POINT]

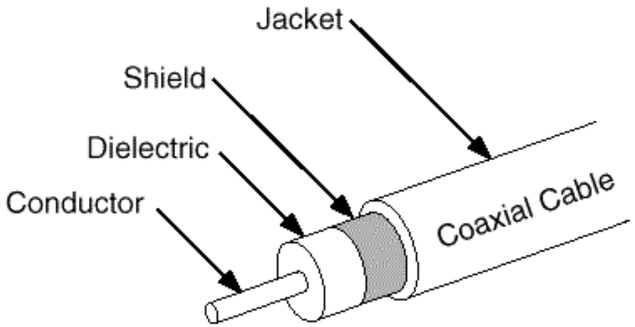
SEKIAN

TERIMA KASIH

NOTA TAMBAHAN

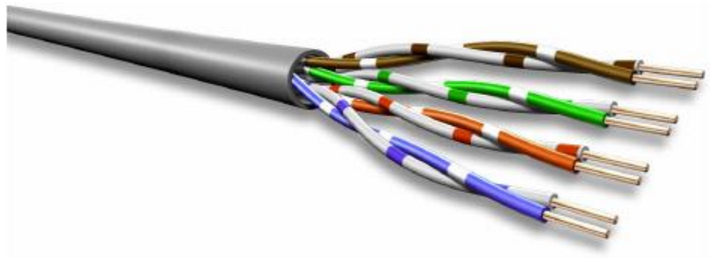
TWISTED PAIR CABLING SYSTEMS

Copper Cables



Coaxial Cable

- Coaxial cabling has a single copper conductor and a plastic layer provides insulation between the center conductor and a braided metal sheath.
- Coaxial cables are network specific cables and are not specified in the standard for generic cabling system applications.

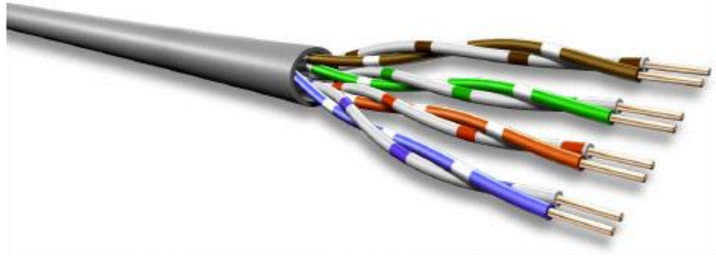


Twisted Pair Cable

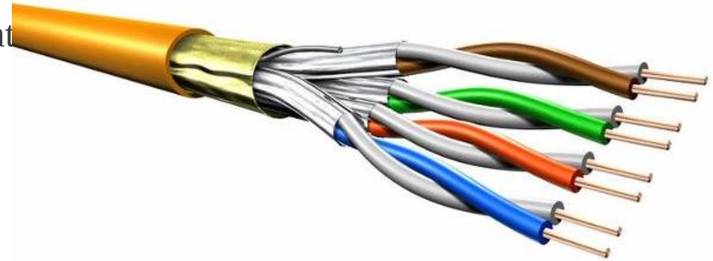
- Twisted Pair cables consist of pairs of conductors with matching pairs “twist wrapped” around each other.
- ISO call this cable Balanced cable, while TIA call this cable Twisted Pair.

Twisted Pair Wires

- Consists of two insulated copper wires arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs
- Often used at customer facilities and also over distances to carry voice as well as data communications

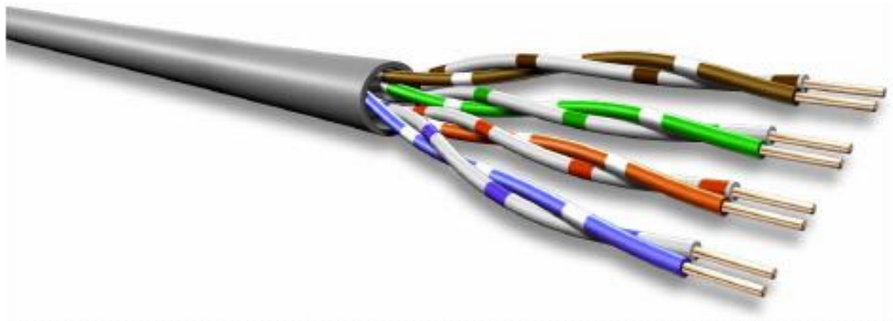


- Low frequency transmission medium
- Two varieties
  - STP (shielded twisted pair)
    - the pair is wrapped with metallic foil or braid to insulate the pair from electromagnetic int
  - UTP (unshielded twisted pair)
    - each wire is insulated with plastic wrap, but the pair is encased in an outer covering

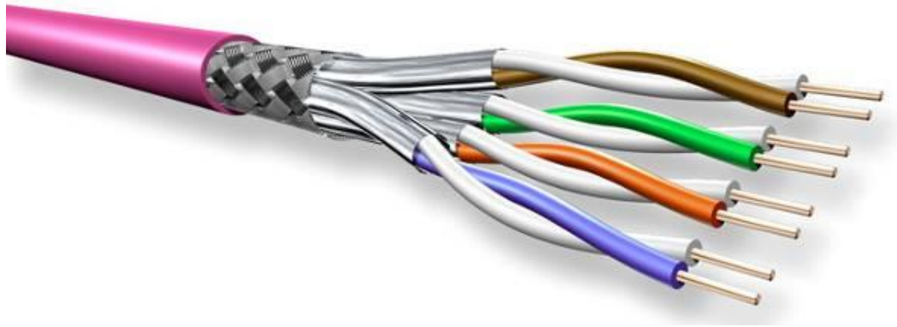


Twisted Pair Cabling

- Has been around for a long time
- Created for voice transmissions
- Most widely used media for networking
  - Lighter
  - More flexible
  - Easier to install
  - Cheaper
  - Greater speeds
- Two types:
  - Unshielded twisted pair (UTP)
  - Screened twisted pair (ScTP)



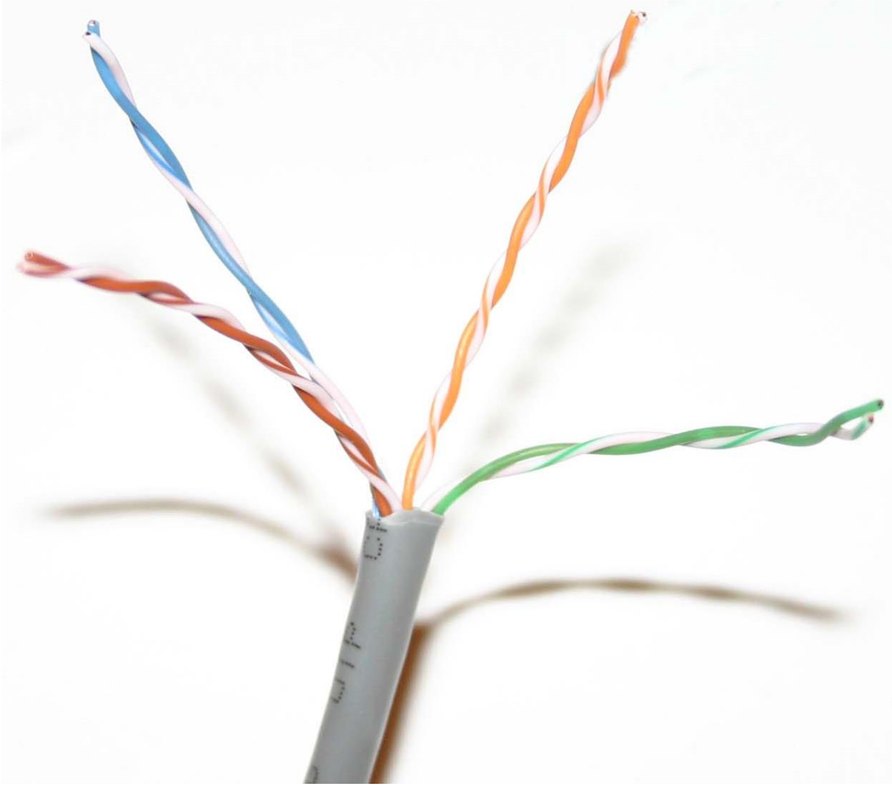
Unshielded twisted Pair



Screened Twisted Pair

Twisted-Pair Cable

- One difference between the different categories of UTP is the tightness of the twisting of the copper pairs.
- The tighter the twisting, the higher the supported transmission rate and the greater the cost per foot.
- The quality of UTP may vary from telephone-grade wire to extremely high-speed cable.
- The cable has four pairs of wires inside the jacket.
- Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices.
- Buy the best cable you can afford.



Unshielded Twisted Pair Types

- Benefits of UTP
  - Inexpensive and readily available
  - Flexible and light weight
  - Easy to work with and install

- Disadvantages of UTP
  - May be susceptible to radio noise and electrical frequency interference (RFI, EFI).
  - Attenuation problem
    - For analog, repeaters needed every 5-6km
    - For digital, repeaters needed every 2-3km
  - Relatively low bandwidth (3000Hz)

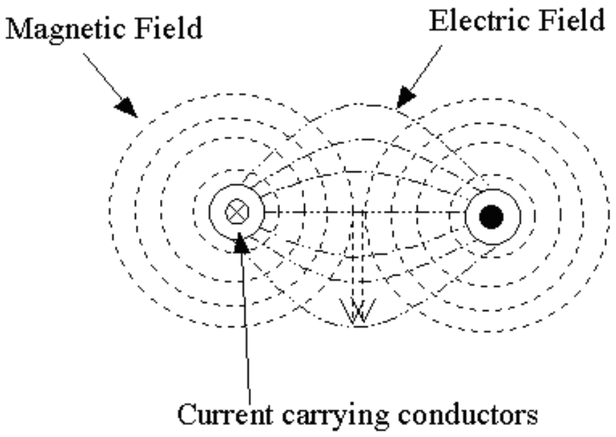
Twisted Pair Cable Applications

Network Platform	Cable Category Min Requirement	T-568-A Wiring (Pair Used)	T-568-B Wiring (Pair Used)	Pin Used
Analog Voice	Cat 3	1	1	4,5
ISDN		1 & 3	1 & 2	3,6 & 4,5
10 Base-T		3 & 2	2 & 3	1,2 & 3,6
Token Ring	Cat 5	1 & 2	1 & 2	4,5 & 3,6
TP-PMD (CDDI)		3 & 4	3 & 4	1,2 & 7,8
ATM				
100Base-TX		3 & 2	2 & 3	1,2 & 3,6
100Base-T4		1 to 4	1 to 4	1,2 & 3,6 & 4,5 & 7,8
100VG-AnyLAN	Cat 3			
1000Base-T	Cat 5e			
10GBase-T	Cat 6a			

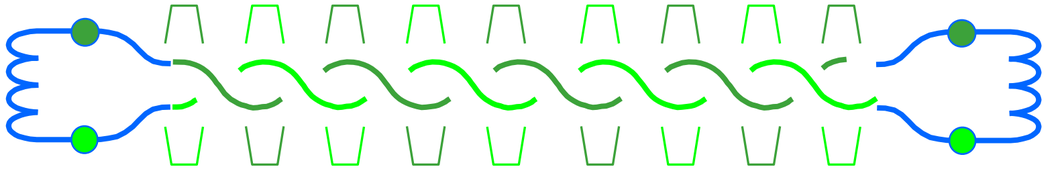
Where Pair 1 = Blue color, Pair 2 = Orange color, Pair 3 = Green color and Pair 4 = Brown color

Signal Transmission

- The main reason for twisting pair of conductors is to minimize crosstalk and noise by decreasing capacitance unbalance and mutual inductance coupling between pairs through electromagnetic field cancellation.
- Each pair is twisted because this allows opposing fields in the wire pair to cancel each other.
- The tighter the twist, the more effective the cancellation and the higher the data rate supported by the cable.



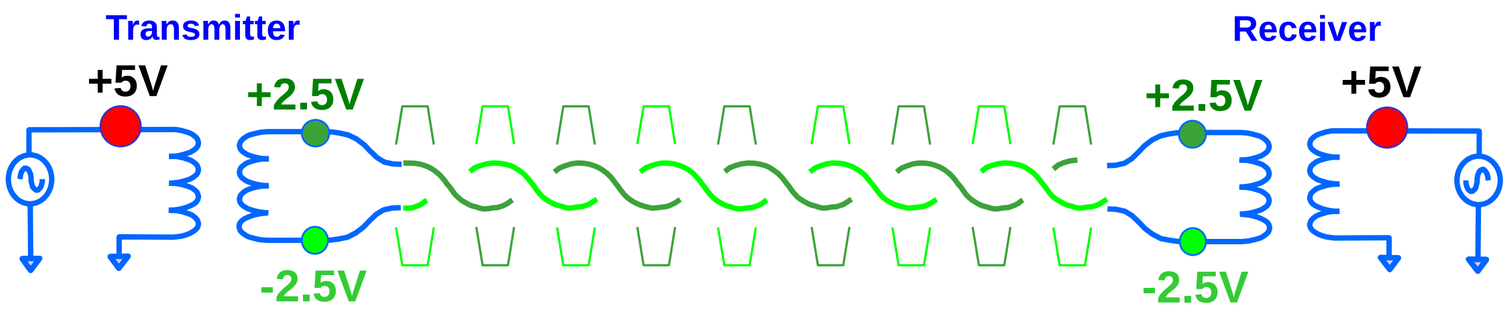
Signal Transmission



- Balanced circuit uses 2 wires (Tip & Ring) to carry the signal.
- Currents flowing through the wires in each pair are equal, but flow in opposite directions. These currents produce electromagnetic fields that could transmit electrical noise to nearby wires.
- However, the fields surrounding the two wires have opposite polarities. Twisting the wires together reduce inductive coupling between pairs.
- Inductive coupling is cause by the expanding and contracting magnetic fields caused by a signal through the wire.
- The twists create coupling between the two wires in the pair such that opposing electromagnetic fields are canceled.

Balanced Mode Transmission Over Twisted Pair

The signal is fed into the wire pair (Tip and Ring) using differential mode transmission scheme



The two conductors of a pair carry the opposite transmitted signal:

- The difference of the signals carries all the data

  $+2.5V_1 - (-2.5V_2) = +5.0V_{Diff}$

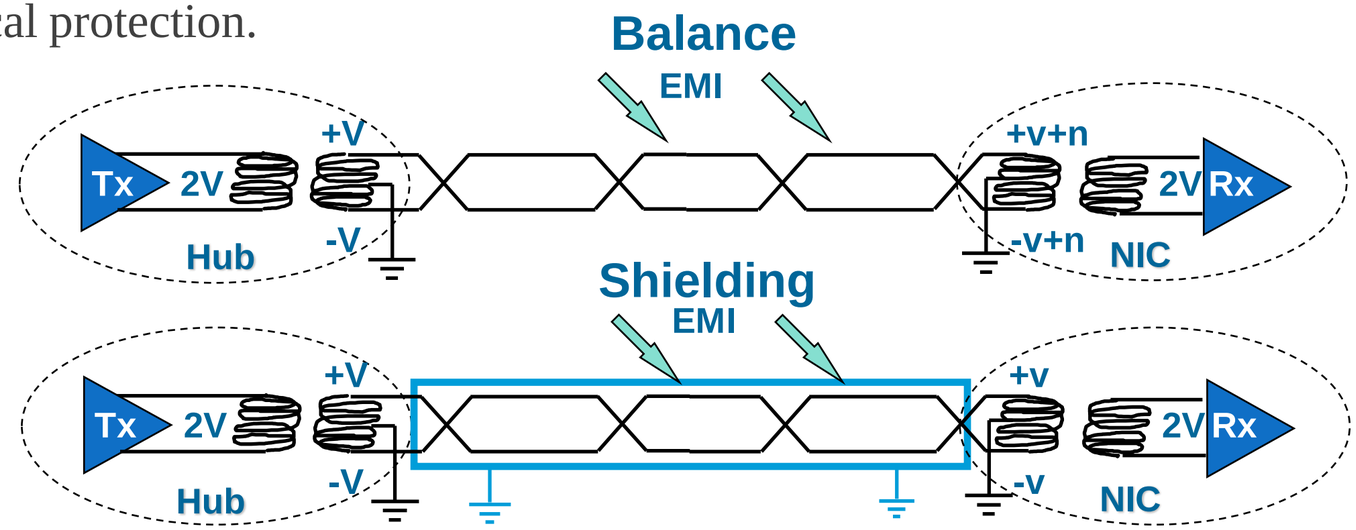
- The sum of the signals is ideally zero resulting in no net emissions

  $+2.5V_1 + (-2.5V_2) = 0V_{Emission}$

Screened Twisted Pair Cables

Shielding Benefits

- Reduce the level of radiated signal from the cable.
- Minimize the effect of external electromagnetic interference (EMI) on the wire pairs.
- Provide electrical hazard protection when properly grounded.
- Provide physical protection.



What is Shielded Cable?

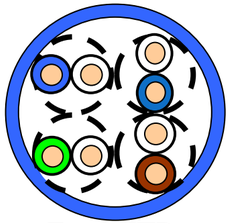
Cable constructions and designations

Current Designations	New Designations	Description
UTP	U/UTP	Unshielded twisted-pair
FTP	F/UTP	Foil over UTP
S-FTP	SF/UTP	Screen and foil over UTP
S-STP	S/FTP	Screen over foil shielded pairs

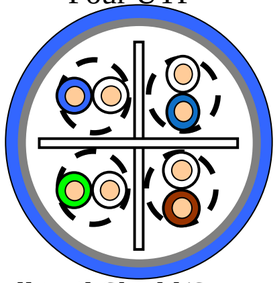
U – Unshielded, F – Foil Shield, S – Braided Shield

First letter designation indicates type of outer shield

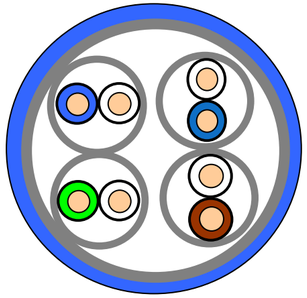
Second letter designation indicates type of shield on each pair



Four UTP



Overall Foil Shield/Screen (F)

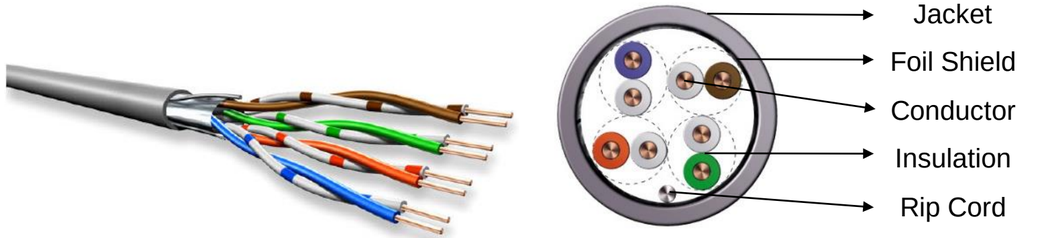


Overall Cable Sheath

Screened Twisted Pair (ScTP) Cables

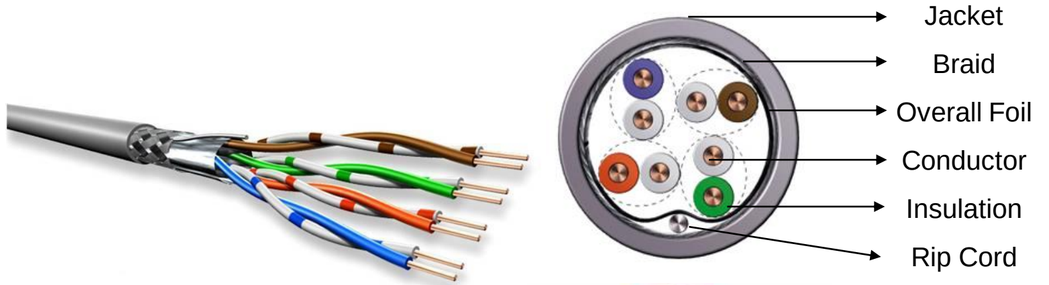
Foiled Twisted Pair (F/UTP)

- Category 5e, 4 pr
- Category 6, 4 pr
- Category 6a, 4pr



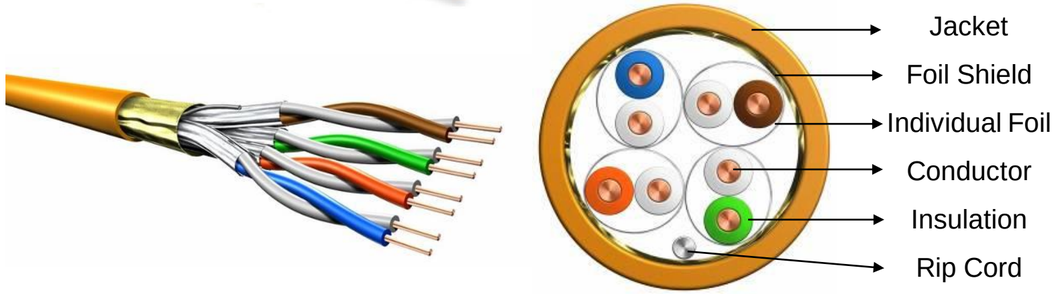
Screened, Foiled Twisted Pair (SF/UTP)

- ScFTP (Old)
- Category 5e, 4 pr



Pair in Metal Foil (F/FTP)

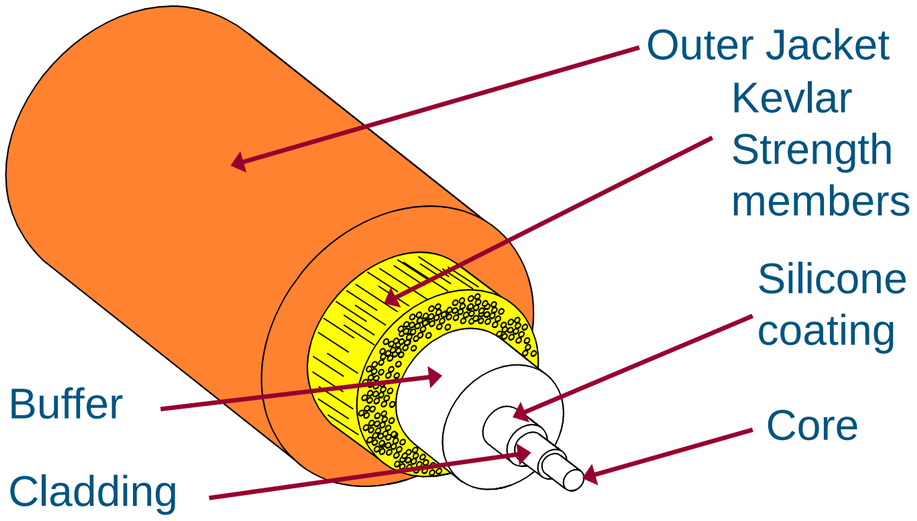
- PiMF
- Category 6, 4 pr
- Category 7, 4 pr
- Category 7a, 4 pr

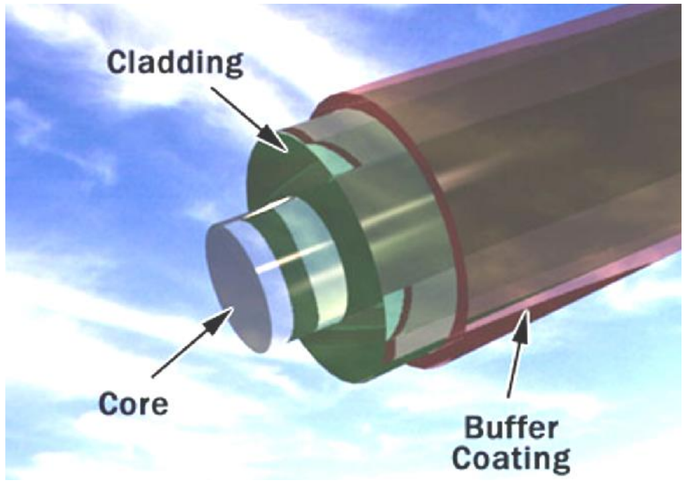


OPTICAL FIBRE CABLING SYSTEMS

Optical Fiber Benefits

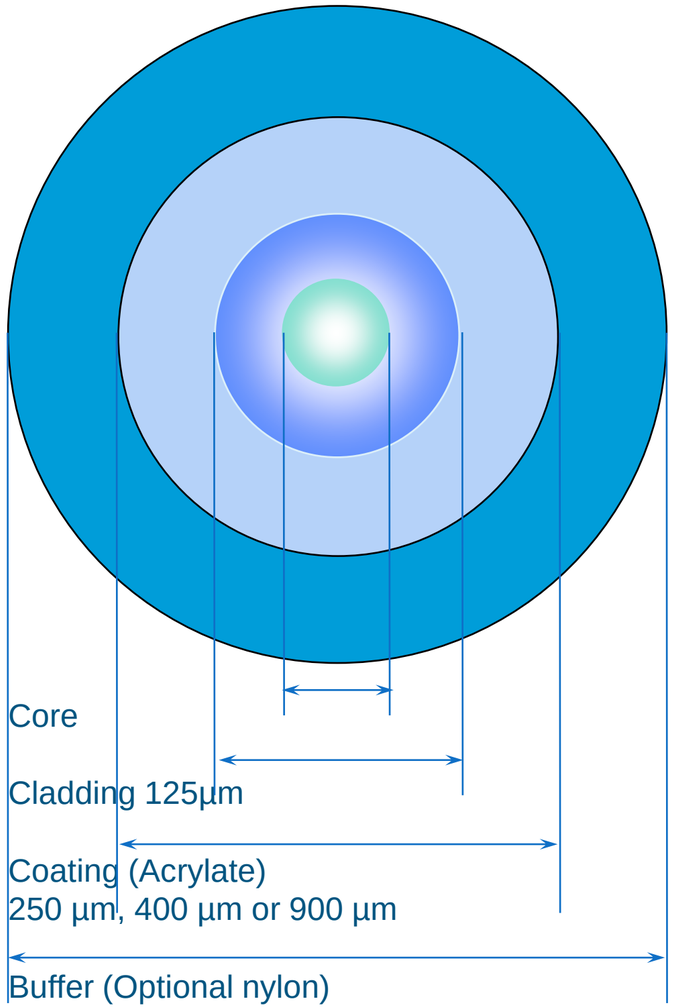
- High Bandwidth
- Low Signal Attenuation
- Increase Transmission Distance
- Easy and Dependable Installation
- Compact and lightweight materials
- EMI/RFI Immunity
- No Crosstalk Problems
- Enhanced Security
- Future proof





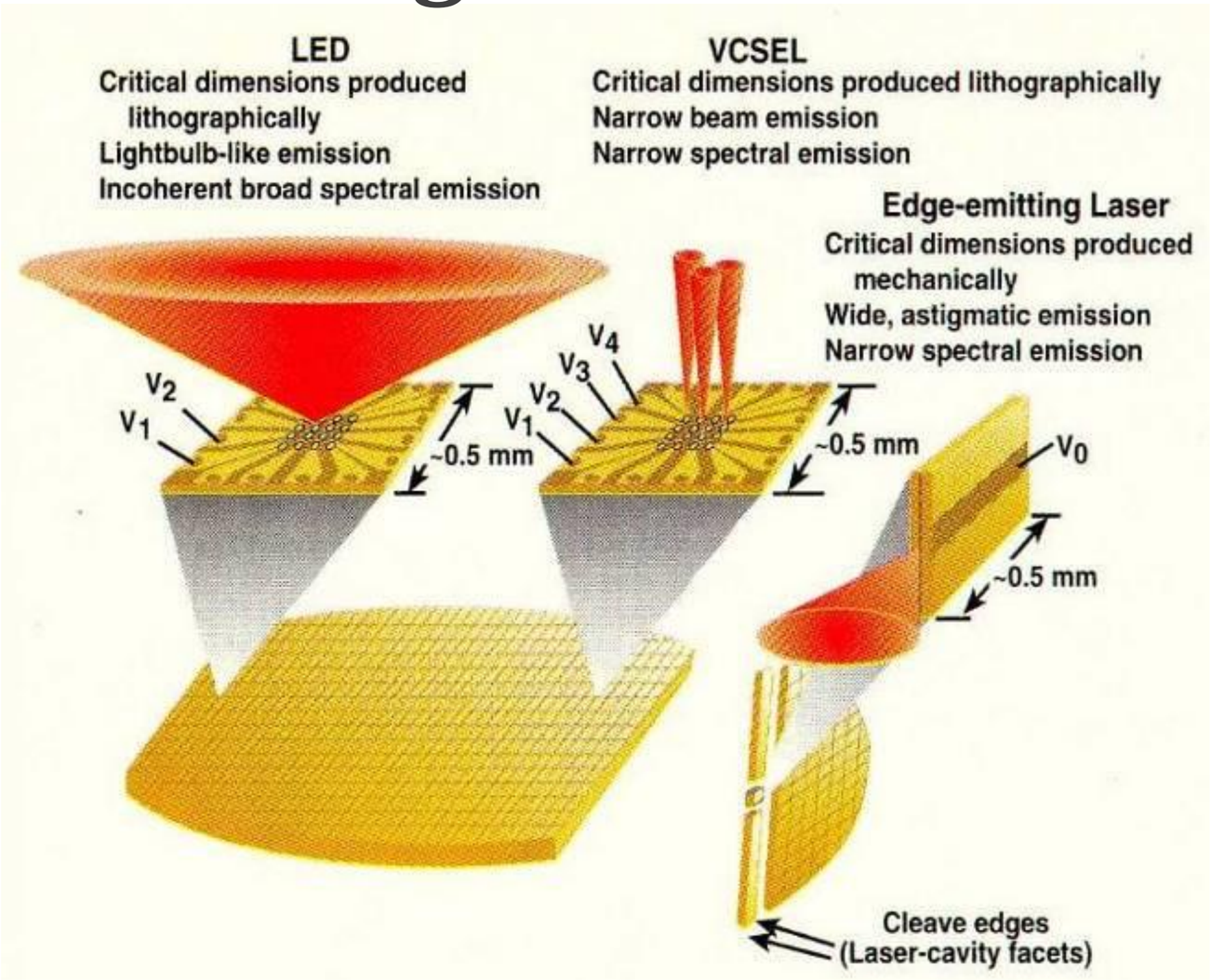
Elements of Optical Fiber

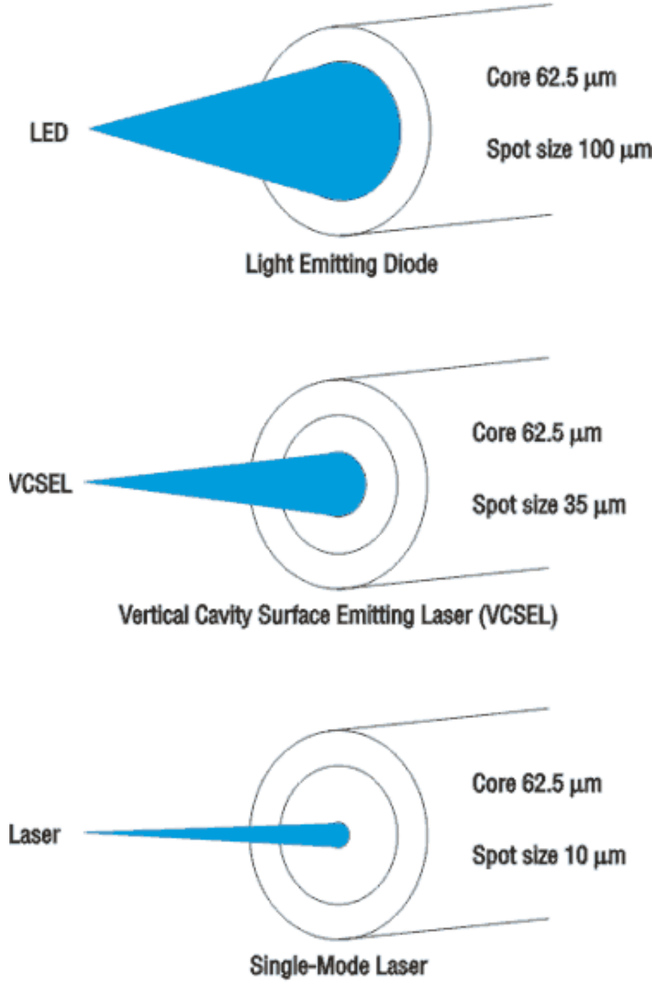
- CORE
  - Carries the light signal (pure silica glass and doped with germanium)
- CLADDING
  - Keeps light signal within core (Pure Silica Glass)
- COATING
  - Protects Optical Fiber From Abrasion and External Pressures (UV Cured Acrylate/Acrolyte)
    - OFN : General use, less than 50´
    - OFNR : Riser rated, Can be used in vertical passages.
    - OFNP : Plenum rated, Can be installed in air plenums without conduit.
    - LSZH : Low Smoke, Zero halogen, No specific flame requirements



1 micron (m) = 1 micrometer/10^{-6} meters

Transmitter Light Sources

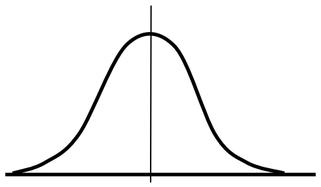


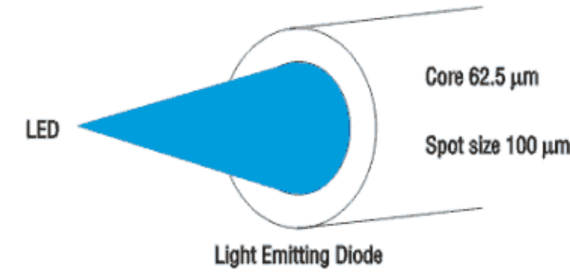


Transmitter Light Sources

Light Emitting Diodes (LED)

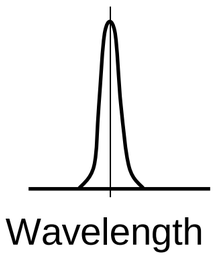
- Used for multimode: 850 nm or 1300 nm
- Wide beam width fills multimode fibers
- Wider spectrum (typically 50 nm)
- Inexpensive

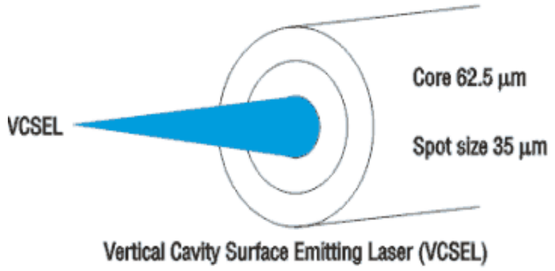




VCSELs

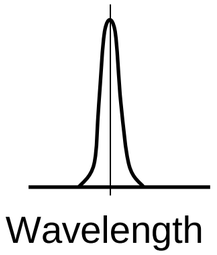
- Vertical Cavity Surface Emitting Laser
- Used for multimode at 850 nm
- Quite narrow spectrum
- Narrow beam width (does not fill multimode fibers)
- Much less expensive than FP or DFB lasers
- Applications: Gigabit Ethernet

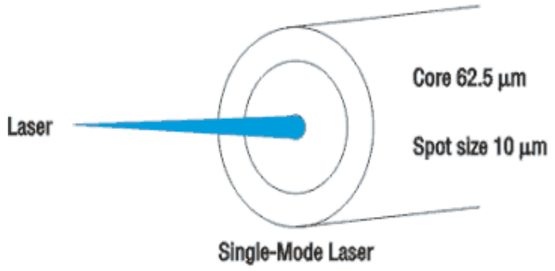




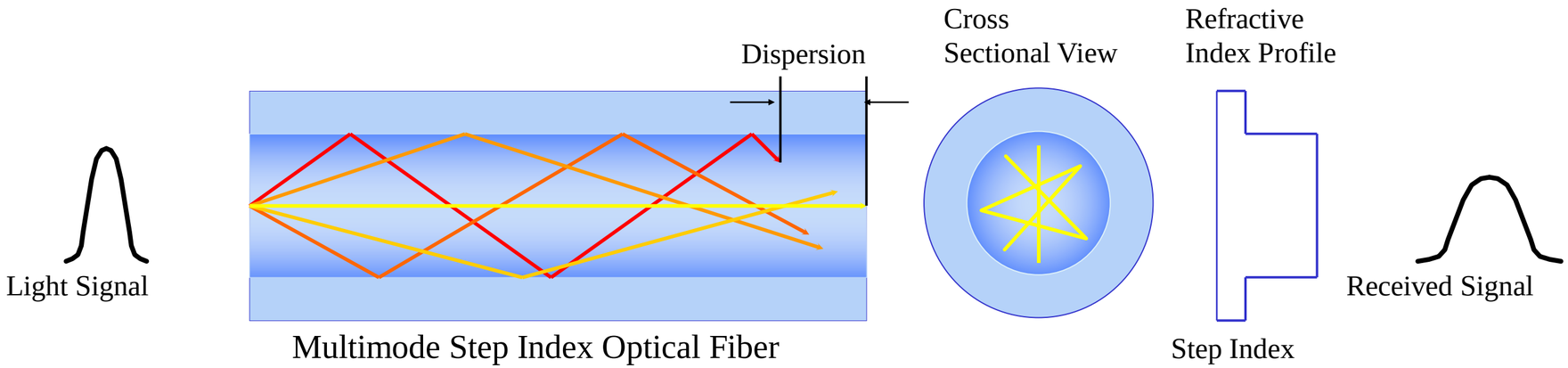
Lasers

- Used for singlemode: 1310 nm or 1550 nm
- Two Common Types: Fabry-Perot (FP) and Distributed Feedback (DFB)
- Narrow spectrum (can be less than 1 nm)
- Narrow beam width (does not fill multimode fibers)
- Highest power and fastest switching
- Most expensive (especially DFB)

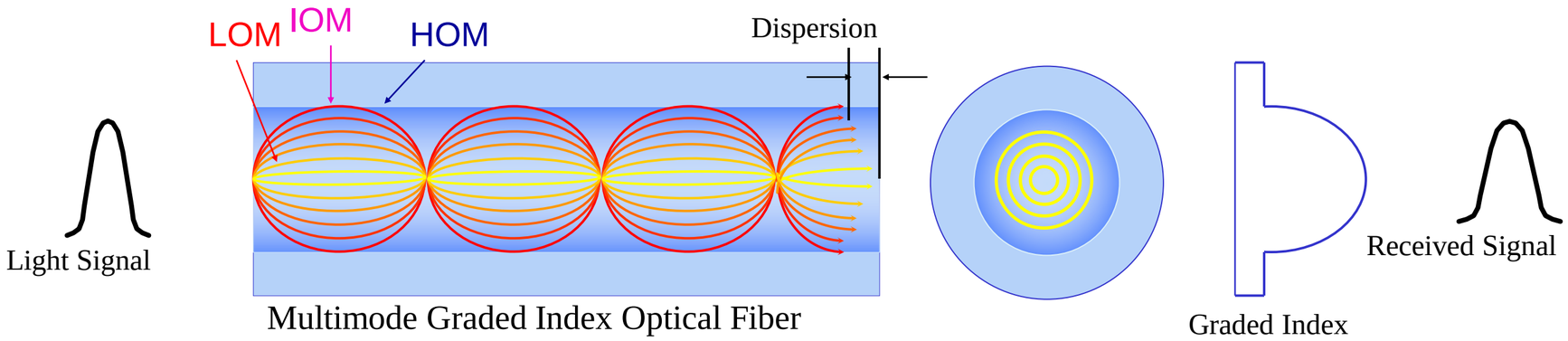




Types of Multimode Optical Fiber



Multimode Step Index Optical Fiber



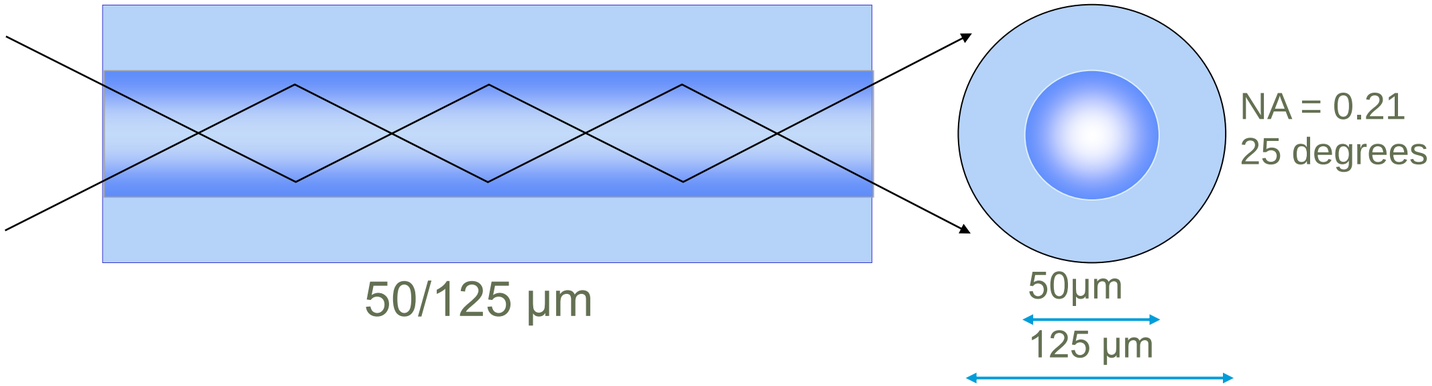
Multimode Graded Index Optical Fiber
Supports 850nm and 1300 nm

Multimode Graded Index Optical Fiber

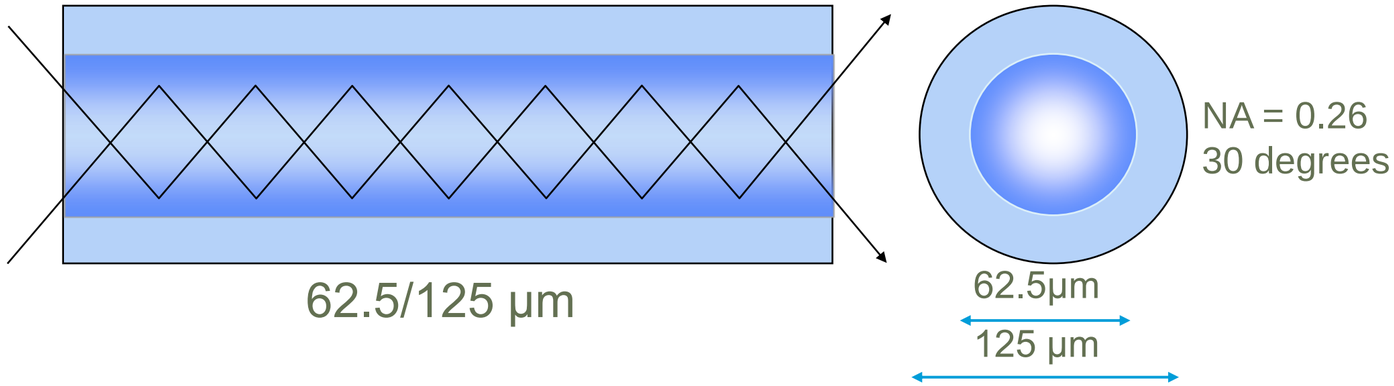
- A larger core size means more modes, or paths of light in the core
- More modes means more modal dispersion, as the light energy takes more paths
- More modal dispersion means more pulse spreading, since the light energy in different modes arrives at different times
- More pulse spreading means less bandwidth because pulses that overlap cannot be distinguished from one another
- Smaller core size means fewer modes and less modal dispersion

Multimode Graded Index Optical Fiber

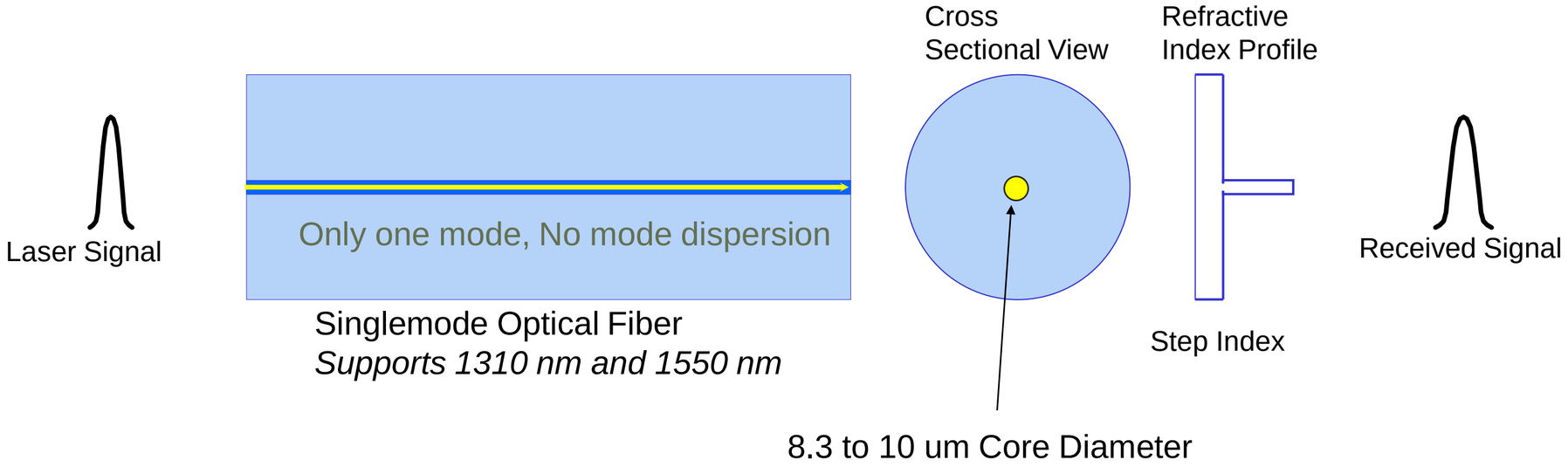
Small Aperture



Large Aperture



Singlemode Optical Fiber



Fiber Selection Table

Description	ISO/IEC Spec.	Bandwidth (MHz.km)		Max. Link length (m)			
		850 nm	1300 nm	850 nm 1000Base-SX Serial VCSEL	1,300 nm 1000Base-LX Serial Laser	850 nm 10GBase-SR/SW Serial VCSEL	1,300 nm 10GBase-LX4 CWDM Laser
62.5/125µm MM	OM1	200	600	300m*	550m*	33m*	360m*
62.5/125µm MM	OM1 Plus	250	800	400m*	1000m*	65m*	450m*
50/125µm MM	OM2	500	500	600m*	600m*	82m*	300m*
50/125µm MM Laser Grade	OM2 Plus	600	1200	750m*	2000m*	100m*	1000m*
50/125µm MM XG (10 Giga)	OM3	1500	500	1000m	600m	300m	300m
50/125µm MM XG (10 Giga)	OM4	3500	500	1040m	600m	550m	300m
9/125µm SM	OS1	Not Specified		-	5000m	-	10000m

Key IEEE Standards and Media for 10 Gigabit Ethernet

- IEEE Ethernet protocol standard 802.3for Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
- IEEE standard 802.3ae for 10 Gigabit Ethernet over Optical Fiber (single-mode and multi-mode).
- IEEE standard 802.3aq for 10 Gigabit Ethernet over installed multimode Optical Fiber up to 220 meters.

Multimode Fiber Selection Table

Standard	Data Rate (Mbps)	Cable Type	IEEE Standard Distance
10Base-FL	10	850nm Multimode OM1, OM2, OM3	2km
100Base-FX	100	1300nm Multimode OM1, OM2, OM3	2km
100Base-BX10	100	1310nm/1550nm Singlemode OS1	10km
1000Base-LX10	1,000	1310nm Multimode/Singlemode	10km
1000Base-BX10	1,000	over single-strand fiber: 1490 nm downstream 1310 nm upstream	10km
1000Base-LH	1,000	1310nm Singlemode OS1	10-70km (6.2-43.4miles)
1000Base-ZX	1,000	1550nm Singlemode OS1	~ 70km
1000Base-EX	1,000	1550nm Singlemode OS1	70-100km (43.4-62miles)
10GBase-LRM	10,000	1300nm Multimode OM1*, OM2*, OM3, OM4	220m
10GBase-LR	10,000	1310nm Singlemode OS1	10-25km
10GBase-ER	10,000	1550nm Singlemode OS1	40km
40GBase-SR-4	40,000	850nm parallel VCSEL Array, OM3	100m
40GBase-SR-4	40,000	850nm parallel VCSEL Array, OM4	150m with 1.0dB connector loss
100GBase-SR10	100,000	850nm parallel VCSEL Array, OM3	100m
100GBase-SR10	100,000	850nm parallel VCSEL Array, OM4	150m with 1.0dB connector loss

* Mode Conditioning Patchcords required
- LRM - Long Range(Reach) Multimode
- LR/ER - Long Range(Reach)/Extended Range; Single Mode

Proposed Physical Medium Dependent (PMD) by IEEE802.3ba Task Force

PMD nomenclature	Media type	Wavelength Window	Minimum reach objective
40GBase-LR4	Singlemode fiber (G.652/021)	1310nm	10km
40GBase-SR4	Multimode fiber OM3	850nm	100m
40GBase-CR4	Copper Cable		7m
40GBase-	Backplane		1m
100GBase-ER4	Singlemode fiber (G.652/021)	1310nm	40km
100GBase-LR4	Singlemode fiber (G.652/021)	1310nm	10km
100GBase-SR10	Multimode fiber OM3	850nm	100m
100GBase-CR10	Copper Cable		7m

LR/ER - Long Range/Extended Range; Single Mode