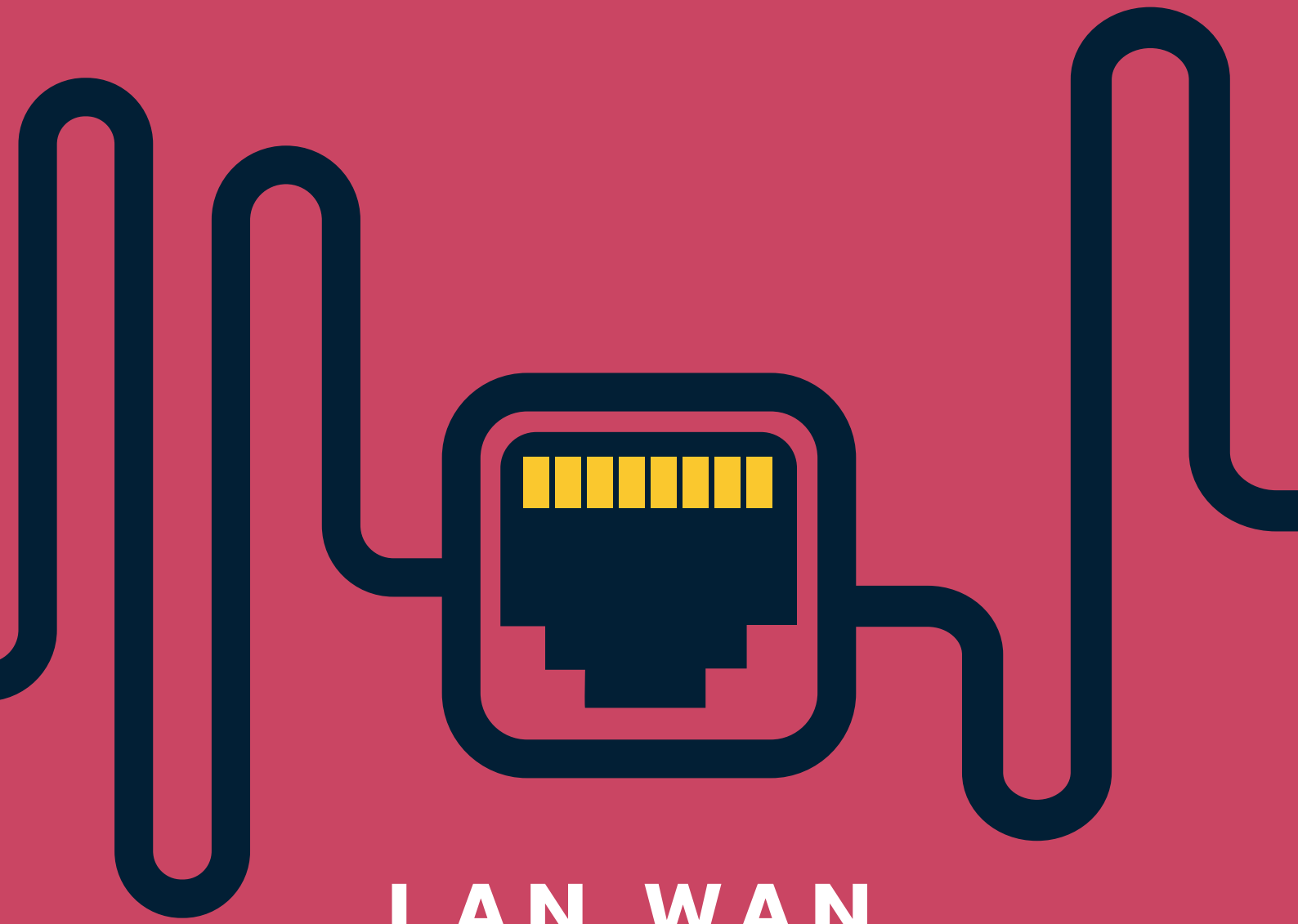

# LAN WAN
## STANDARD

NITA
National Information Technology Agency
GHANA

# Contents



**Figures**



**Tables**

# 1.0 Introduction

The National Information Technology Agency (NITA) is a semi-autonomous corporate body established under the Acts 772 and 771, to coordinate and regulate Information Technology services in both Government and the nation at large.

One of the core functions of NITA is to set, monitor and regulate standards for Information Technology planning, acquisition, implementation, delivery, support, organization, sustenance, disposal, risk management, data protection, security, contingency planning among many others.

In light of the above function, NITA embarked on the development of the following Guidelines and Standards for Structured Cabling to support IT Rationalization programme in the Government Institutions

The Guidelines and standards herein have been developed with reference to International best practices and shall be utilized to provide guidance in the process of implementing structured cabling to enhance the delivery of voice, data and video conferencing services across Government Institutions

## 1.1 Purpose

This standard provides mandatory requirements, recommended best practices, background information and guidance to assist with the implementation of the ICT cabling infrastructure across the different Government Institutions.

## 1.2 Audience

This document is primarily intended for Government Institutions IT staff involved in activities associated with cabling infrastructure. These activities include management, planning, system design, purchasing, implementation, testing, documentation, compliance audits, and operational support.

## 1.3 Scope

### 1.3.1 In Scope

This standard contains mandatory requirements, recommended best practice and guidance applicable to all Government Institutions. It is applicable to general building cabling infrastructure and is reliant on each department having a more detailed cabling standard in place.

a) Structured Cabling System (SCS) comprised of balanced copper cabling and optical fiber for use in various Governmental Institutions in Ghana.

b) Cable pathways and equipment spaces including equipment rooms, telecommunications distribution spaces and equipment mounting

c) Cabling for wireless networking systems.

### 1.3.2 Out of Scope

The following are considered to be out of the scope of this standard:

1.Temporary cabling requirements where appropriate temporary cabling is required (trade shows, exhibitions, conferences, emergency repairs)

2. Temporary buildings such as site offices, classrooms, exhibition buildings, short term accommodation arrangements (12 months or less) where these buildings will be removed following use.

3. Specialized applications/services which have specific non-standard cabling requirements

4. Overseas sites which would be subject to the legislation and regulations of that country.

NOTE: Cabling work undertaken under these conditions, must still comply with the mandatory safety requirements.

## 1.4 Interpretation

This technical standard contains mandatory requirements as well as recommendations for best practice. The use of the words **'shall'**, or **'must'** defines a mandatory requirement. The use of the words **'shall not'** or **'must not'** defines a prohibited activity.

*"Acts 771 and 772 mandates NITA to refuse connection or to disconnect unsatisfactory cabling/ connection of any sort and components from the Government Network.*

*For cablings connected to the Government Network, compliance with NITA's specifications is a contractual requirement."*

## 1.5 Requests For Exception

This standard details specific requirement intended to specify the technical requirements for Government Institution's IT cabling infrastructure. Where a proposed implementation is not consistent with the requirements in this standard, this shall require prior approval for exception from NITA.

## 1.6 Life Of This Standard

This Standard is a living document. The principles contained in this Standard are subject to revisions and updating as warranted by advances in building construction techniques and Information technology.

# 2.0 Definition /Abbreviations / Units of Measure

## 2.1 Definitions

Adapter: A device that enables different sizes or types of plugs to mate with one another or to fit into a telecommunications outlet or rearrangement of leads.

Administration: The method for labeling, identification, documentation and usage needed to implement moves, additions and changes of the IT cabling infrastructure.

Attenuation: The decrease in magnitude of transmission signal strength between points, expressed in dB as the ratio of output to input signal level

Backbone: A facility (e.g., pathway, cable or conductors) between telecommunications rooms, or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings

Cable: An assembly of one or more insulated conductors or optical fibers, within an enveloping sheath

Cabling: A combination of all cables, jumpers, cords, and connecting hardware.

Cable run: A length of installed media, which may include other components along its path

Cable sheath: A covering over the optical fiber or conductor assembly that may include one or more metallic members, strength members, or jackets.

Channel: The end-to-end transmission path between two points at which application-specific equipment is connected.

Connecting hardware: A device providing mechanical cable terminations

Connector, small form factor: An optical fiber duplex connector with a size approximating that of an 8- position modular outlet/ connector typically used for terminating 4-pair copper cable.

Cord (telecommunications): A cable using stranded conductors for flexibility, as in distribution cords or line cords.

Cross-connect: A facility enabling the termination of cable elements and their interconnection or cross- connection.

Cross-connection: A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

Data: Electronically encoded information

Electromagnetic interference: Radiated or conducted electromagnetic energy that has an undesirable effect on electronic equipment or signal transmissions.

End user: The owner or user of the premises cabling system

Entrance facility: An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space.

Entrance point: The point of emergence for telecommunications cabling through an exterior wall, a floor, or from a conduit.

Equipment room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect or a room dedicated to housing distributors and application specific equipment.

Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables.
Media (telecommunications): Wire, cable, or conductors used for telecommunications.

Mode: A path of light in an optical fiber

Multimode optical fiber: An optical fiber that carries many paths of light.

Multipair cable: A cable having more than four pairs
Optical fiber: Any filament made of dielectric materials that guide light.

Optical fiber cable: An assembly consisting of one or more optical fibers.

Outlet/Connector (telecommunications): A connecting device in the work area on which horizontal cable or outlet cable terminates.

Patch cord: A length of cable with a plug on one or both ends

Patch panel: A connecting hardware system that facilitates cable termination and cabling administration using patch cords

Pathway: A facility for the placement of telecommunications cable.

Power sum equal level far-end crosstalk: A computation of the unwanted signal coupling from multiple transmitters at the near-end into a pair measured at the far-end, and normalized to the received signal level.

Power sum near-end crosstalk loss: A computation of the unwanted signal coupling from multiple transmitters at the near-end into a pair measured at the near-end.

Room, telecommunications: An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling, that is the recognized location of the horizontal cross-connect.

Screen: An element of a cable formed by a shield.

Shield: A metallic layer placed around a conductor or group of conductors

Single mode optical fiber: An optical fiber that carries only one path of light.

Splice: A joining of conductors in a splice closure, meant to be permanent.

Splice closure: A device used to protect a splice

Work area (work station): A building space where the occupants interact with telecommunications terminal equipment.

Work area cable (cord): A cable connecting the telecommunications outlet/connector to the terminal equipment.

## 2.2 Acronyms And Abbreviations

**ANSI:** American National Standards Institute AWG: American Wire Gauge

**EIA:** Electronic Industries Alliance

**ELFEXT:** Equal-Level Far-End Crosstalk GHz: Giga-Hertz

**GPO:** General Purpose (230Vac power) Outlet

**ICT:** Information Communication Technology

**IDC:** Insulation Distribution Connector

**IDF:** Intermediate Distribution Frame

**IEC:** International Electro technical Commission

**IEEE:** Institute of Electrical and Electronics Engineers

**IT:** Information Technology

**ISO:** International Organization for Standardization

**Km:** Kilometer

**MDF:** Main Distribution Frame

**MHz:** Mega Hertz

**NEXT:** Near End Cross Talk

**NITA:** National Information Technology Agency-Ghana

**OM:** Prefix for Multimode Optic Fiber

**OS1:** Prefix for Single Optic Mode fiber

**PSNEXT:** Power Sum Near End Cross Talk

**PVC:** Polyvinyl Chloride

**RJ45:** Registered Jack 45

**SCS:** Structured Cabling System

**STP:** Shielded Twisted Pair

**TIA:** Telecommunications Industry Association

**TO:** Telecommunications Outlet

**UTP:** Unshielded Twisted Pair

## 3.0 Cabling Standards

### 3.1 ICT Cabling Background

The Information and Communications Technology (ICT) cabling system plays a critical role in telecommunications systems, providing the physical link between sources and destinations of information. Data, voice, video and control signals are transmitted over this infrastructure linking devices across the hall, throughout a building or across several buildings.

Cabling systems range in size from small and simple, linking just a few nodes, to large and complex, linking several buildings with tens of thousands of nodes.

The cabling system provides the physical link between active network equipment such as routers and switches, and the terminal equipment such as computers and telephones. Structured cabling systems (SCS) are typically comprised of unshielded twisted pair (UTP) copper cable and optical fiber cable.

To facilitate the day-to-day operations of an institution, a cabling system must enable the user to make additions, moves and changes, wherever and whenever necessary. Furthermore, the SCS must also be flexible and provide the capability to carry a wide variety of applications – from high-speed local area network (LAN) applications to voice and low speed data.

As data throughput and transmission speeds continue to grow, greater demands are being placed on the UTP and optical fiber cabling plant. Gigabit Ethernet, and other high bandwidth services, use "parallel transmission schemes" to transmit signals simultaneously over multiple copper pairs instead of one pair. Delivery of these new services requires increased performance from cabling plant.

### 3.2 General Cabling Requirements

All works that include either new or upgraded ICT cabling shall:

a) Be installed to comply with this Standard
b) Have a minimum of twenty (20) year performance warranty
c) Have a minimum of two (2) year installation warranty
d) Be installed by a NITA approved ICT contractor
e) Be installed using a NITA approved manufacturer product
f) Have all relevant documentation submitted to NITA

### 3.3 Structured Cabling System (SCS)

An SCS is a set of cabling and connectivity products that are constructed according to standardized rules to facilitate integration of voice, data, video, and other signals.

Cabling infrastructure must be based on structured cabling systems for copper and optical fiber cabling. For the purpose of this document an SCS is defined as the cabling, connecting hardware, terminations, patch cords and work area cords. In addition to providing network services, the use of structured cabling for other services is recommended where this is technically feasible. (Examples of these services include control systems, security systems, paging and call systems).

Equipment enclosures and associated pathways and spaces are considered as ancillary items.

#### 3.3.1 Associated systems and components

The following systems and peripheral components should be considered in conjunction with the design and implementation of the cabling system:

A. False floor in server/communications rooms to facilitate cable routing to floor mounted racks and cabinets
B. Temperature control by forced ventilation or air conditioning in server and communications rooms
C. Alternatives to fire sprinklers in server and communications rooms

D. Smoke detection in server and communications rooms
E. UPS system capacity requirements, accommodation, battery maintenance and life span
F. Wireless access points
G. IP telephone systems
H. Video conferencing
I. IP cameras using existing switching (not on separate security network)
J. Network for Learning (N4L) terminations and associated equipment.

### 3.4 Specifications For Copper Cabling

The minimum balanced cabling performance class for copper cabling shall be ISO/IEC class E balanced cabling performance with category 6 components (in line with ISO/IEC 11801) which is guaranteed to transport Gigabit Ethernet (GbE) and allow for emerging technologies as they develop.

The cabling system shall be based on a four pair Unshielded Twisted Pair (UTP) cable that meets or exceeds the transmission performance requirements for a Category 6 (Cat-6) cable. Where cable performance exceeds Cat-6 full details of the cable specification shall be documented including the operational and technical benefits.

The use of a lower balanced cabling performance class (e.g. category 6) is not recommended unless compelling reasons exist. The cable sheath shall be of Low Smoke Zero Halogen (LSOH) type.

#### 3.4.1 Copper Cabling Guidelines;

**A. Exposed cabling**

The designer is expected to minimize the use of exposed conduit and capping and overhead connections. Where possible all cabling and cable pathways, including pits and external conduits, should be placed as unobtrusively as possible so as to be hidden from view and not attract attention.

**B. Electromagnetic compatibility**

There are presently no EMC regulations governing cabling installations and systems. However, the following cabling installation practices are recommended to limit the risk of interference to other services and the risk of interference from unwanted external emissions.

For unscreened cabling, the EMC performance of the installed cabling is controlled by its 'balance'. Balance is a measure of the control exercised over the physical relationship of individual conductors inside the cable or connecting hardware and is, therefore, a critical parameter during the manufacture of the high-performance cables and connecting hardware used in generic cabling.

### 3.5 Specifications for Multi-Mode Optical Fiber Cabling

The minimum cabled optical fiber category for multi-mode fiber shall be OM2, compliant with ISO/IEC 11801. The use of OM3 cabled optical fiber category or its superior, compliant with ISO/IEC 11801 is recommended. The use of a lower performance cabled optical fiber category (e.g. OM1) is not recommended unless compelling reasons exist.

Multimode optic fiber patch cord shall be color coded Orange

**Table 1 Comparison of Multimode Optic Fiber Types**

| No. | Fiber Type | Core/Cladding Diameter (µm) | Minimum Bandwidth (MHz/Km) | Distance at 850nm | Distance at 1310nm | 1000BASE-SX | 10GBASE-S |
|---|---|---|---|---|---|---|---|
| | OM1 | 62.5/125 | 160/500 | 220m | 500 | 275m | 33m |
| | OM2 | 50 or 62.5/ 125 | 500/500 | 500m | 500 | 550m | 82m |
| | OM3 | 50/125 | 1500/500 | | | 300m | 100m |

OM : Prefix for Multimode Fiber

### 3.6 Specification For Single Mode Optical Fiber Cabling

The minimum cabled optical fiber category for single mode optical fiber cabling shall be OS1, compliant with ISO/IEC 11801 with a minimum core diameter 8microns and a cladding diameter of 125microns.The use of cabled optical fiber category OS2, compliant with ISO/IEC 11801 is recommended. Single mode optic fiber patch cord shall be color coded Yellow

### 3.7 Cabling System Architecture

The conceptual arrangement of a generic cabling system is illustrated below:

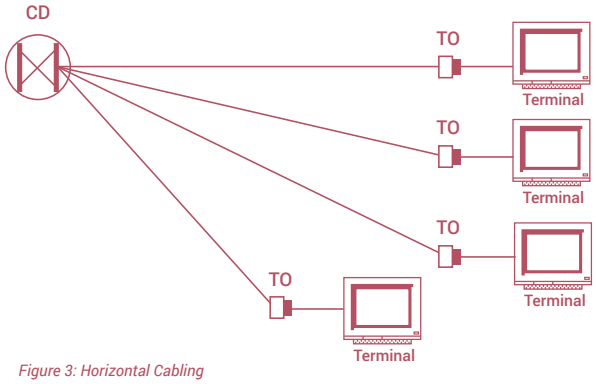


*Figure 3: Horizontal Cabling*

Horizontal cabling at Institutions shall consist of a minimum Enhance Category 6 from a local wiring closet to the room sockets. These cables are presented at both ends with RJ-45 type sockets. Telephone circuits shall also be delivered over the Category-6 cable as a minimum cable with a convertor plugged in at the client end to allow the connection of a normal telephone plug.

### 3.8 Maximum Cabling Channel Lengths

The Maximum channel lengths below shall be utilized as specified by ISO/IEC 11801;

A. 100m for the horizontal cabling channels (Copper).

B. 2000m for the campus backbone + building backbone + horizontal cabling channel (Fiber).

C. The length of work area cords/ Patch Cords shall not exceed 5m.

D. On occasions, UTP cables used as link cables will need to be run between two cabinets. This is only permissible where it can be established that the cabinets involved are in the same earth potential zone. These runs must not be more than 90 meters.

### 3.9 Wireless LAN (WLAN) Location

The planning and deployment of WLAN access points will solely be carried out by LAN/WAN/TEL team of NITA and is not considered to be a part of the Structured Cabling System.

The SCS installer will be responsible for the installation of the SCS required to support the Access Points.

A site survey will be undertaken by the LAN/WAN/TEL team to determine the optimum mounting locations for the wireless access points to ensure total coverage and seamless connectivity at the premise.
All wireless systems shall be selected and installed to suit the Institution's requirement.

#### 3.9.1 Wireless Access Points/ Access Points

The Network Point that connect to the Wireless Access Points (WAP's) should be fixed to structural members of the building where possible, alternatively the use of manufacturer approved mounting fixtures can be used subject to approval.

The TO shall be permanently and clearly identified and labelled. It shall be installed in a readily accessible location.

Final placement of the WAP shall be achieved by the use of patch-cables. Patch- cables shall not be longer than 5m.

When a WAP is fitted on a ceiling tile, the TO may be installed above the ceiling tile as long as it can be readily accessed to allow the patch cables to be fitted.

## 4.0 Cable Termination

### 4.1 Copper Cable Termination Requirement

The means of terminating balanced copper cabling shall be the modular 8-pin sockets (commonly known as RJ45) and plugs using the EIA/TIA-568B standard. The method of termination at the RJ45 sockets will be by Insulation Displacement Connection (IDC).

#### 4.1.0 Pin Terminations

Termination of the cable pins shall be guided by the following:

a) All four pairs of the UTP cable shall be terminated at either end by Insulation Displacement Connection (IDC) techniques.

b) To ensure the transmission performance of a Category 6 system, the amount of untwisting in a cable pair to achieve a termination shall be no greater than 13 mm. In addition, the stripping back of the outer sheath shall be limited to the minimum amount required to achieve successful termination.

c) The cables shall be terminated as per the EIA/TIA 568B wiring scheme so that the presentation of the pairs on the RJ45 socket is as shown in the figure 4 below:

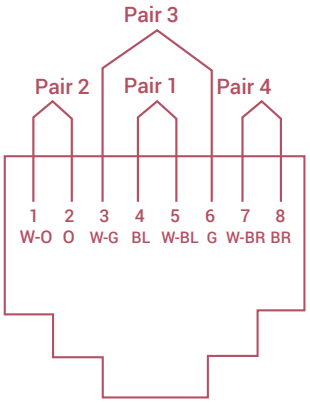


*Figure 4: Eight-Position jack pin/ pair assignment (T568B)*

**Table 2 Summary of the Pin numbers and Color Codes**

| No. | Wire Pair and Color Codes | Pin Numbers |
|---|---|---|
| 1 | Pair 1 Blue | Pin 4 and Pin 5 |
| 2 | Pair 2 Orange | Pin 1 and Pin 2 |
| 3 | Pair 3 Green | Pin 3 and Pin 6 |
| 4 | Pair 4 Brown | Pin 7 and Pin 8 |

#### 4.1.1 Creating a Loopback Plug for an RJ-45 Ethernet Interface

This exercise is for troubleshooting purposes. This is to ensure that the Ethernet interface is fully functional and helps one identify network and network interface card (NIC) issues i.e. TX and RX functionalities are fully operational on that port/ interface.

Hardware Prerequisites

A. Cat5 or Cat6 Cable
B. Crimping tool
C. Cutter
D. RJ-45 Connector

Step 1

Remove the jacket of CAT5/6 Cable and cut out one pair (2 Wires) of approx. 4-5 inch length from the total of the 4 pairs.

Step 2

Follow below pin connectivity –Pin 1 <-> Pin 3 Pin 2 <-> Pin 6

Step 3

Crimp the wires in RJ-45 connector through Crimping Tool.

Upon completion of these steps, one can insert the terminated plug into the Ethernet port and confirm the status of the port; i.e. if the port is not faulty it would begin to blink if otherwise faulty.

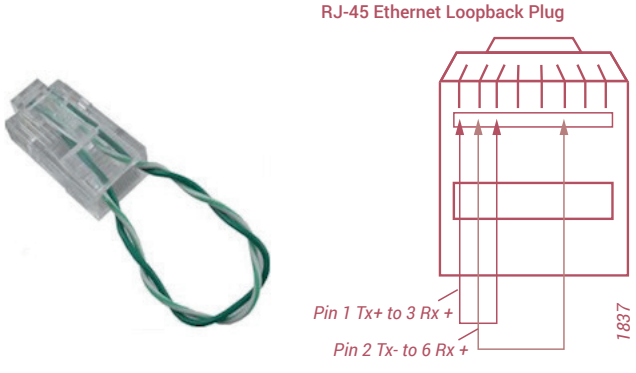


*Figure 5*

### 4.2 Optical fiber cable terminations

#### 4.2.1 Optic Fiber Termination

A. Optical fiber cable shall be terminated with a particular fiber connector depending on the application.
B. The fiber connector module shall be from the same manufacturer as the surface mount box. In addition, the fiber connector shall be from the same manufacturer as the fiber optic cable to ensure manufacture compatibility, performance and warranty.
C. Multimode optical fiber cores shall be either directly terminated by the use of multimode ceramic tipped connectors or spliced with a different fiber connector type terminated pig-tails. Any mechanical and fusion splicing method must be specifically approved and warranted by the cable manufacturer
D. Single mode optical fiber terminations shall be achieved by splicing pigtails to optical fiber cores using the manufacturer's approved splicing techniques.
E. The cables shall terminate in fully enclosed 1-RU 12 port (24 fiber) or 24 port (48 fibers) duplex patch panels in the communications cabinets. All fiber cores specified shall be terminated at each end and connected to duplex clip or screw couplers inserted into the patch panel.
F. Optical fiber cables shall be terminated within purpose provided patch panels mounted within the Communications cabinets.
G. Splicing shall be conducted within the termination and Joint boxes only unless compelling reasons exists.
H. Termination points shall be in existing or new wiring closets and assigned a wiring center number. Fiber splice box shall be considered as a 'wiring center' and assigned a wiring center number.

#### 4.2.2 Optical Fiber Cable Re-terminations

Where re-termination is required the installer shall ensure that:

A. Enough slack is left to enable at least two re-terminations to be achieved.
B. The amount of slack is sufficient for a first termination or splice and then at least two subsequent terminations or splices for un-terminated cable.
C. Re-termination or splicing of individual fibers is carried out without disrupting services on other fiber cores.

#### 4.2.3 Optical Fiber Patch Panels

A. Optical fiber termination equipment shall provide cross-connect, interconnect or splicing capabilities.
B. Optical fiber patch panels shall be combination type 1RU 12 or 24 port fitted with duplex connector type couplers and cover plate. Patch panels shall be equipped with cable management facilities including splice trays.

c). Patch panels shall be rack mountable, hinged or sliding, with eye safe front (including laser warning symbol) and integrated patch cord management. All new fibers installed shall be terminated within this enclosure using manufacturer-approved fusion splice pigtails with either screw or clip connectors to maintain warranty (unless specified on the network upgrade design)

D. Terminated fibers shall be connected to either Screw or Clip type connectors through couplers mounted on the faceplate of the optical fiber termination panels.

E. Hardware shall minimize potential eye hazards from optical sources.

## 4.3 Distributors and patch panels

### 4.3.1 General Requirement

Distributors and patch panels shall be designed for 19" rack mounting in accordance with IEC-60297

### 4.3.2 Insulation Displacement Termination Blocks

Insulation displacement (IDC) termination blocks may be used for termination of outdoor balanced copper cabling.
The IDC termination blocks shall be matched to the performance of Category 6 and be compatible with the cable conductor type (solid or stranded).

### 4.3.3 Balanced Cabling Patch Panels

A. Patch panels for balanced cabling shall be a 1U high 24 way or 2U high 48-way modular socket (RJ45) with a port density of 24 ports per 1RU.

B. The connecting hardware of the patch panels shall be as a minimum rated to the performance of Category 6.

C. Cable Management bars will be installed in all cabinets. For every 1RU of patch panel, 1RU of cable management will be provided and vertical cable management shall be installed to manage vertical cable ways.

D. New cable management shall be from the same manufacturer providing the performance warranty.

### 4.3.3 Telecommunication Outlets

A. Each telecommunication outlet (TO) shall incorporate two or more modular RJ45 sockets designed for IDC termination and compliant with the performance of Category 6 as the minimum required.

B. Balanced copper cables shall be terminated at the TO using the "T568B" pin assignments and color codes.

C. All Insulation Displacement Connector (IDC) blocks shall be permanently fixed to the faceplate.

D. Telecommunication outlets shall be equipped with un-shuttered faceplates. Where the TO is positioned on existing trunking, modular type mounting enclosures shall be used.

E. Blanking plugs shall be fitted where the apertures of the mounting enclosure is not filled with a RJ45 jack (unused faceplate apertures shall be provided with blanking plates).

F. Faceplates shall match power outlets in appearance and manufacture.

G. All outlets shall be provided with shutters that automatically close when device leads are removed

H. The outlets shall be provided with RJ45 sockets for voice and data on a single faceplate.

I. Unless otherwise indicated, dual outlets shall be co-located with two dual power outlets. Two compartment PVC trunking may provide a cost effective solution to this requirement.

J. Outlets shall be located to avoid being obscured and work area cords being damaged by furniture and office equipment and feet.

K. All cable pairs at the telecommunication outlets and at the distribution panels shall be terminated

L. For Cat 6 cable, a bend radius of at least 25mm (4 times the cable diameter) should be provided

M. All Telecommunications outlets shall be clearly labeled for voice and data services.

### 4.3.4 Balanced Cabling Patch and Work Area Cords

A. Patch cords and work area cords shall be constructed of an 8 wire, stranded Category 6 cable terminated with RJ45 connectors at both ends as a minimum.

B. Patch cords and work area cords shall be from the same manufacturer as the horizontal cable and matched to the performance of Category 6 of the cabling system in which they are used.

C. Pin assignments and color codes shall conform to the "T568B" arrangement.

D. All patch cords and work area cords shall be factory assembled, terminated and certified.

E. It is desirable that where spare capacity exists on existing patch panels that this is used first before providing additional patch panels.

F. The length of work area cords shall not exceed 5m

G. The length of the patch cord shall not exceed 1.0m

### 4.3.5 Optical Fiber Patch Cables

A. Optical fiber patch cords shall be provided as duplex clip to clip or screw to screw except where used to interface equipment using Small Form Factor (SFF) connectors to optical patch panels screw to clip type connectors may be used.

B. Patch cords shall be from the same manufacturer as the backbone cable and matched to the optical fiber cable

type of the cabling system in which they are used.

C. Patch cords shall be provided in standard pre-manufactured lengths (e.g. 1m, 2m, etc.) sufficient to interconnect the optical fiber termination unit and switch/router hardware while minimizing the need to manage excess cable.
D. Mixing of optical fiber patch cords and cabling, e.g. 50/125µm cabling with 62.5/125µm patch cords and vice versa shall be strictly avoided.
E. Optical fiber patch cords shall be provided as standard manufactured items of standard length and shall be as short as is practicable to minimize excess cable management requirements.
F. The total number of patch cords per distributor shall equal the number of optical fiber ports.
G. Multimode optic fiber patch cord shall be color coded Orange
H. Single mode optic fiber patch cord shall be color coded Yellow

## 5.0 Structured Cable Wiring System

Governmental Institutions shall use a structured wiring system based on a number of Wiring Centers (MDFs and IDFs) interconnected by a backbone consisting of fiber-optic cabling carrying network data and multi pair copper cabling carrying telephone circuits.

Distribution from the Wiring Centers to the desktops or work station and other end user devices shall be provided as a Category-6 (Cat-6) cabling terminated at both ends with RJ-45 sockets.

### 5.1 Wiring Centers or Cabinet

A Wiring Centre/cabinet is the location where the cabling from the desktop sockets and the Backbone cabling meet. This will consist of one or more cabinets containing active data equipment (such as switches, Routers and Firewalls) and patch cables connecting these and the phone circuits to the desktop circuits. Cabinet shall comply with the following general guidelines:

A. Cabinets and wall frames shall comply with the relevant requirements of IEC-60297
B. The enclosure(s) within the main equipment room containing core switching equipment shall provide 45RU equipment mounting space.
C. Cabinets/racks shall not be more than 60% occupied at installation
D. All enclosures at a site shall be fitted with keyed-alike doors
E. Enclosures shall provide facilities for ventilation in the form of vented panels.
F. Metal surfaces of the enclosure and accessories shall be powder coated, painted or otherwise protected against corrosion.
G. Enclosures and open frame racks shall be bonded to the protective earth system using a minimum 2.5mm2 green/yellow conductor
H. All Cabinets shall be tested for electrical safety in accordance with the IEEE 16th Edition Wiring Regulations
I. Transparent front lockable door with a key;
J. A means of being secured to the walls, floor, ceiling or overhead racking as appropriate.
K. Cabinet shall have top and bottom grommeted cable entries
L. Cable management in the front of the cabinet for routing of patch cords both horizontally and vertically
M. Cabinet shall be fitted with Documentation wallet.

#### 5.1.1 Free-standing Cabinet

A. Free-standing enclosures shall be provided as 18RU, 24RU, 38RU or 45RU and may be installed on a plinth to facilitate cable entry from beneath.
B. Enclosures shall be 600mm wide and 800mm deep, or 600mm deep when installed in a telecommunications closet/cupboard
C. The dimensions of the required equipment cabinets should be 42U, 800mm x 800mm.
D. Free-standing cabinets /racks shall not be more than 60% occupied at installation
E. Free-standing enclosures shall be fitted with:
   i. Front and rear 19" mounting rails
   ii. Horizontal and vertical cable tidy panels and/or loops
   iii. Vertical cable tray or cable management troughs fitted to both sides of the enclosure
   iv. A minimum of two supporting shelves
   v. Power rail providing not less than 5 outlets for 18RU and 24RU enclosures and not less than 9 outlets for 38RU and 45RU enclosures incorporating a 10A miniature circuit breaker
   vi. Removable rear and side panels
   vii. Keyed, lockable, front door
   viii. Keyed, lockable, steel rear door or removable panel in cases where insufficient clearance is available to accommodate a door
   ix. Leveling adjustment
   x. Consideration shall be given to load bearing capacity of the floor when selecting or specifying floor mounted enclosures

xi. All active network components, including switches, server, monitor with keyboard, and the UPS must be properly mounted in the rack, and all associated wiring must be properly dressed to meet all building and telecommunications codes.

xii. No equipment should be located on the rack any closer than 8in. from the floor to avoid dust and dirt intake through the fan and air vents located on any piece of equipment.

xiii. Cabinet shall have transparent front lockable door with a key;

xiv. A means of being secured to the floor, ceiling or overhead racking as appropriate.

xv. Cabinet shall have top and bottom grommeted cable entries

xvi. Front and rear adjustable rails for equipment, providing standard 19" rack mounting. (The front rails must be recessed by 100mm);

xvii. Cable management in the front of the cabinet for routing of patch cords both horizontally and vertically

xviii. A four way fan tray to be located within the roof of the equipment cabinet

xix. Cabinet shall be fitted with Documentation wallet

xx. A four way fan tray to be located within the roof of the equipment cabinet. The fan tray must fit within the equipment cabinet after the front rails have been recessed by 100mm and a cable tray has been installed within the rear of the cabinet.

xxi. Equipment cabinet shall be provided with a 1U blanking plate to be located at the top of the cabinet and engraved with an identification code.

### 5.1.2 Wall-Mount Cabinets

A. Wall mounting enclosures shall be of swing frame design where possible to facilitate rear access. The wall shall be structurally adequate to support the enclosure.

B. Wall mounting enclosures shall be provided as 12RU, 18RU or 24RU.

C. Enclosures shall be 600mm wide with a minimum internal depth of 450mm - 600mm is preferred. Enclosures shall have no sharp edges or protrusions that could cause injury to persons.

D. Wall mounting enclosures shall be fitted with:

i. Front 19" mounting rails

ii. Horizontal and vertical cable tidy panels and/or loops

iii. Power rail providing not less than 5 outlets

iv. Keyed, lockable, Perspex or toughened glass front door

v. Earth bar or stud

vi. Transparent front lockable door with a key;

vii. A means of being secured to the wall, ceiling or overhead racking as appropriate

viii. Cabinet shall be fitted with Documentation wallet

### 5.1.3 Open Frame Racks

A. Open frame racks shall be mechanically secure and supported at the base and top.

B. Open frame racks shall be provided as 38RU or 45RU

C. Racks shall be fitted with:

i. Horizontal and vertical cable tidy panels and/or loops

ii. Vertical cable tray

iii. Power panel

iv. Open frame racks shall not be used to support heavy equipment – free-standing (4-post) enclosures shall be used for such equipment.

v. A means of being secured to the floor, ceiling or overhead racking as appropriate.

vi. Cable management in the front of the cabinet for routing of patch cords both horizontally and vertically

vii. Cabinet shall be fitted with Documentation wallet

viii. The dimensions of the required equipment cabinets should be 42U, 800mm x 800mm

D. A four way fan tray to be located within the roof of the equipment cabinet. The fan tray must fit within the equipment cabinet after the front rails have been recessed by 100mm and a cable tray has been installed within the rear of the cabinet.

E. Each equipment cabinet shall be provided with a 1U blanking plate to be located at the top of the cabinet and engraved with an identification code.

## 5.2 Cabinet Layouts

A typical cabinet layout is as shown figure 5 below. The fiber optic circuits are presented at the top of the cabinet, the active equipment below that, then the desktop circuits and finally the telephone circuits at the bottom.

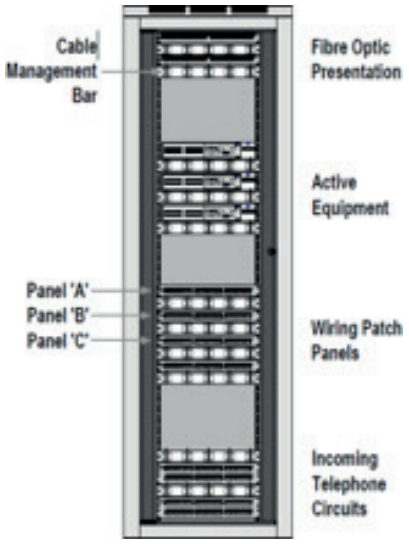


*Figure 6 Generic Layout of a Cabinet*

### 5.3 Cable Management

A. Racks shall be supplied with cable management panels to facilitate the support and organization of patch cords between patch panels. For each 2RU of equipment in the rack there shall be a corresponding 1RU cable management panel which is deep enough to support 48 patch cords.

B. Rear cable support systems are also required to offer strain relief for cables entering the rear of the rack and patch panels.

C. Cable management in the front of the cabinet for routing of patch cords both horizontally and vertically

D. Cabinet shall have top and bottom grommeted cable entries

### 5.4 Patch Cables Color Codes

In order to avoid confusion and mix-up as to the function of patches within the cabinet, the following colors have been adopted for patch leads/cords.

**Table 3 Patch Cable Color Codes**

| No. | Color Codes | Usage |
|---|---|---|
| 1. | Green | Telephone (Generally analogue Circuits) |
| 2. | Yellow | Telephone (Generally digital Circuits) |
| 3. | Blue<br>Red<br>Orange<br>Purple | Data, generally with one Color per Subnet |
| 4. | Black<br>Grey with Green boots | Crossover Cables-only used between two (2) items of active equipment with Cabinet |
| 5. | White, Grey | Do Not Use |

*Governmental Institutions shall ensure that Patch leads should meet Category-6. It is preferred that they have integral strain relief and no boots*

### 5.5 Circuit Numbering

A numbering system shall be implemented to ensure that each circuit from a Wiring Centre to a desktop outlet is unique. The circuit identifier shall consist of three parts:

A. The wiring cabinet/center ID – a number allocated to the wiring center by the Network Administrator.

B. The patch panel ID – a letter identifying the patch panel within a wiring center. This will run from 'A' through to 'Z'.

C. The circuit on the patch panel – a number running from '1' at the beginning of a patch panel to the last socket number on the patch panel (typically 24 or 48).This number re-starts at '1' on each patch panel within the Wiring Centre.

For example, Cabinet 100, patch panel A, circuit 10 will be labeled: 100/A/10. NB: The characters 'I' and 'O' should be avoided.

### 5.6 Cable Pathways and Enclosures

#### 5.6.1 Scope

This section provides mechanisms for protecting cable installations including ways in which the cables may be run across the buildings to and from the wiring closets.

### 5.6.2 General guidelines

While running or installing cables it is important that the following general guidelines are adhered to;

A. All UTP cables are to be run internally to the building and must not run between buildings.

B. No UTP cable is to be run on the exterior of any building.

C. No cabling is to be run in lift shafts or airflow areas.

D. A comprehensive survey or an assessment of the cable routes shall be agreed upon prior to installation of the cable.

E. All vertical cables shall be secured to installed trays at intervals as recommended by the cabling manufacturer.

F. Care must be taken to avoid close proximity of cabling to water pipe work.

### 5.6.3 Walls and Floors

The following guidelines shall apply to cable runs made through walls and floors;

A. Holes drilled through walls and floors for the routing of cables shall be suitably covered to prevent damage to the installed cables. Where cables pass through floors, such protection shall be extended to at least skirting height.

B. Where cables, trunking, tray-work or conduit pass through floors or walls, suitable fire sealing shall be provided.

### 5.6.4 Cable Containment

Below are the general guidelines to be followed in ensuring that cables are contained within a confinement.

A. Cables shall be contained within containment, which may take the form of PVC Trunking, Cable Tray, Basketwork, Steel Trunking or Steel Conduit.

B. New containment shall be of sufficient capacity, such that the total of the cross sectional areas of the cables contained will not exceed 45% of the internal cross-sectional area of the containment.

C. Cables within a room must be contained within white PVC trunking. Cables need not be contained in the ceiling of the room in which they are terminating if there are four or less cables and they are adequately supported and not resting on any false ceiling.

D. Cables in corridors ceiling spaces must be contained. This should be in white PVC trunking where it is visible. Otherwise, cable tray or basket may be used. Cables must not be left lying on the top surface of suspended ceilings, nor should they be in contact with any water pipes located above the ceiling.

### 5.6.6 Use of PVC Trunking

The selection and use of PVC trunking shall comply with the following;

A. All PVC trunking to be used shall be manufactured in accordance with BS 4678 where applicable;

B. All necessary trunking fittings, i.e. Tees, bends, end-caps shall be used. Such fittings shall be of proprietary manufacture and installed to manufacturer's instructions;

C. In corridors where installed PVC trunking is visible, every effort shall be made to conceal individual cable exit points by making such exit points through the rear of the trunking;

D. Horizontal trunking runs in decorated areas shall be located at ceiling level where fixed ceilings exist

E. PVC trunking (including mini-trunking) shall be securely fixed with screws as per the manufacturer's instructions.

F. The of use self-adhesive trunking is not recommended unless compelling reasons exist

G. New PVC pathways shall not be more than 50% occupied at installation.

H. Newly installed PVC trunk should be selected to have 50% spare capacity after completion of the works.

### 5.6.7 Use of Steel Conduit

While using steel conduits ensure that:

A. All bends, tees, etc. shall be radius or gusset type suitable to allow the installation of the cables without exceeding the cable bending radii.

B. All lengths of Conduit shall be earth bonded to meet the 16th Edition IEE wiring Regulations.

C. New steel conduits are able to accommodate a 50% increase in occupancy at installation.

D. Newly installed conduits should be selected to have 50% spare capacity after completion of the works.

### 5.6.8 Use of Steel Trunking

While using steel trunking it is important to ensure that:

A. All trunking is free from sharp edges and projections likely to cause damage to the cables contained.

B. All bends, tees, etc. is of radius or gusset type suitable to allow the installation of the cables without exceeding the cable bending radii.

C. Fixings are spaced according to the manufacturer's recommendations.

D. All lengths of Steel Trunking are earth bonded to meet the 16th Edition IEE Regulations.

E. New steel conduits should be able to accommodate a 50% increase in occupancy at installation.

F. Newly installed steel trunking shall be selected to have 50% spare capacity after completion of the works.

### 5.6.9 Use of Cable Trays

In using cable trays the following should be considered;

A. All bends, tees, etc. shall be radius or gusset type suitable to allow the installation of the cables without exceeding the cable bending radii.

B. Fixings shall be spaced according to the manufacturer's recommendations.

C. All lengths of Cable Tray shall be earth bonded to meet the 16th Edition IEE regulations.

D. New cable trays shall not be no more than 50% occupied at installation.

E. Cable trays shall be perforated galvanized mild steel sheet.

F. Minimum steel thickness for cable tray shall be;
   i. 1.0mm for trays up to 150mm wide and
   ii. 1.2mm for trays up to 300mm wide

G. Trays shall have folded edges with minimum height of 20mm.

H. Electrical continuity shall be maintained along the full length of cable trays.

### 5.6.10 Use of Cable Basket

The following are considerations for using Cable baskets

A. All bends, tees, etc. shall be radius or gusset type suitable to allow the installation of the cables without exceeding the cable bending radii.

B. Fixings shall be spaced according to the manufacturer's recommendations.

C. All lengths of Cable Basket shall be earth bonded to meet the 16th Edition IEE Regulations.

D. New cable trays shall not be more than 50% occupied at installation.

### 5.6.11 Outside Plant copper cable

A. Filled core (waterproofing compound) cable must be used for underground and direct buried cable installations. Filled cable preserves the integrity of the cable by providing physical protection against moisture penetration and seepage;

B. Direct buried cable requires an armored sheath to resist rodent and penetration type damage;

C. Plastic Insulated Cable (PIC) cables must be marked with cable length, cable code, date and manufacturer.

### 5.7 Aerial pathways

In cases where underground or overhead pathways are not practicable, aerial pathways utilizing catenary suspension systems may be employed.

Aerial pathways shall meet the following networking requirements;

A. Aerial pathways shall be selected to avoid crossing power lines

B. Where aerial pathways are indicated on the site plans, the SCS installer shall install UV resistant, PVC-coated, flexible metal conduit between buildings. In this instance the length of conduit may be greater than 1m

C. The conduit shall be sized such that fill at the time of installation does not exceed 50% rated capacity

D. The catenary wires shall be terminated and sized to support the load of the conduit with 80% fill of cables under extreme weather conditions

E. Catenary wires shall be PVC coated galvanized steel and in no circumstances shall be less than 3.4mm diameter. Catenary wire shall be fixed to the buildings using eyelets and turnbuckles and bonded to the protective earth as required

F. The conduit shall be tied to the catenary with stainless steel cable ties.

### 5.8 Intra-building Pathways

Intra-building pathways shall be constructed to accommodate the cabling within a building or blocks.

In multi-storey installations, cabling between floors shall be routed via an approved communications cabling riser or duct.

All ICT cabling pathway components shall be approved by the SCS manufacturer as suitable and approved within the warranty requirements of the vendor's system.

### 5.9 Horizontal cabling pathway components

All networking cabling pathway components shall be approved by the SCS manufacturer as suitable and approved within the warranty requirements of the vendor's system.

### 5.9.1 Horizontal cabling supports

Horizontal cablings shall be supported by an approved method – for example, cable tray, catenary wire – from the cabinet to within 1m horizontally of the vertical channels used to deliver the ICT cables to their telecommunications outlets. In addition;

A. No more than 24 cables of any type shall be tied to a catenary wire

B. Cables shall be tied to catenary wires at 300mm intervals using a hook and loop tape (minimum of 12mm wide tape)

C. Cables installed on cable trays shall be loosely laid and secured not more than every 1.5m using hook and loop tape

D. Catenary wire shall be supported at a minimum of every 3m.

## 6.0 Labeling And Identification of Cables

### 6.1 Scope

This section provides guidelines to be used for cable labeling to facilitate easy of identifications from one end to another. The section covers both the labeling of the balance copper cable and Optical fiber cables.

### 6.2 General Requirement

The following are the general guidelines for use in the process of labeling cables for ease of identification.

The Governmental Institutions shall have a standard circuit identification system in order to ensure each UTP circuit has a unique identifier. This shall consist of three parts:

A. Each wiring center has a unique three-digit number assigned by the contractor

B. Each patch panel within that wiring center has a unique letter identifier starting at 'A'. Upon reaching 'Z' the next identifier will be 'AA' then 'AB','AC','AD' etc. The characters 'I' and 'O' should be avoided.

C. Each socket in a patch panel is numbered starting at 1.Thus, circuit '092/C/21' would be terminated in wiring center 092, on patch panel C and would be the 21st socket on that patch panel.

NOTE:
This identifier is unique within the wiri ng center rather than an individual cabinet in the wiring center.

The patch panel numbering restarts at 1 on each patch panel.

### 6.3 Labeling of the Telecommunications outlets

A. All RJ45 outlets shall be clearly marked with a securely fixed label showing the circuit number for ease of identification of the services to be accessed (Data and Voice services).

B. The labels shall be clearly printed with a self-adhesive backing.

C. Each telecommunications outlet shall be labeled with the unique enclosure and patch panel port identifier.

### 6.4 Labeling of Patch Panels for Balance Copper Cables

A. Patch panels shall be clearly labeled with a securely attached label showing the patch panel identifier.

B. Each socket on the patch panel should also be labeled with the full circuit identifier as indicated in

C. The labels shall be 100mm x 50mm, self-adhesive multi-layered laminate engraved with 15mm upper case lettering. The labels shall be located on the front center of each rack or enclosure, near the top UTP cables shall be labeled at each end with a wrap-around label clearly printed with the circuit identifier. The label shall be located near the termination point at either end such that the circuit can be identified if the termination is removed.

### 6.4.2 Labeling of the Optical Fiber cables

A. Fiber optic termination housings shall be labeled using the plastic panel provided by the termination housing manufacture. The plastic panel shall be overlaid with a one-piece, self- adhesive, full-size, laser-printer generated label sheet adhered to the inside door of the enclosure. Contractor shall cut sheet to size.

B. Fiber connectors and splices in the termination housings shall be clearly labeled using a standard code. A splicing enclosure will be assigned a wiring center number in the same series as a normal wiring center.

## 7.0 Cable Installation Requirement

### 7.1 General Requirement

A. All cabling shall be installed in full accordance with the manufacturer's recommendations. Cables shall be installed with due skill and care so that:
   I. Maximum permitted hauling tension is not exceeded
   II. Minimum bending radius of the cable is not exceeded
   III. Maximum permitted crush rating is not exceeded

B. Cable bundles shall not obstruct the installation and removal of equipment within equipment enclosures.

C. Jumper wires on wiring frames shall follow clear paths to minimize jumper lengths and avoid obstructing jumper fields.

D. Equipment and patch panels shall be laid out to minimize patch cord length. Patch cords shall follow clear paths to avoid patch field obstruction.

### 7.2 Precautions during Installation of Cables

A. Precautions shall be observed to eliminate cable stress caused by tension in suspended cable runs and tightly strapped bundles.

B. Care shall be taken not to distort the twists by excessive pulling or bending of cables.

C. Cable bundles shall not rub on or be unduly compressed against or by any cable tray, building or enclosure penetrations, equipment racking, or other cable support. Grommets or similar forms of protection shall be provided where cables traverse sharp edges.

D. The weight of vertically installed cabling shall be adequately supported.

E. Category 6 cables shall be securely fixed to cable trays using Velcro or manufacturer recommended cable ties only.

F. Cables shall be neatly grouped together based on their destination and bound at regular intervals.

G. Where cabling is run in cavity walls, surface mounted ducting and similar enclosures, cables shall be installed in areas free from protrusion of screws and similar fasteners.

H. Care shall be taken to avoid tight twisting of the cable, tearing of the outer jacket, cutting or wearing through due to abrasion of the cable.

I. When drawing cable through underground conduit, care must be taken to ensure that the conduit is clear of water and other obstacles and appropriate action taken to protect the cable from water and soil damage. Cable ends must be sealed appropriately when being drawn though underground ducts.

## 7.3 Cabling System Installation Practice

### 7.3.1 Safety Requirement

A. Cabling system installation shall be performed in a safe manner.

B. Personnel undertaking installation works shall be equipped with appropriate personal protection equipment, tools and mechanical aids.

C. Appropriate barriers and warning signs shall be used to restrict access and draw attention to potential hazards such as open trenches and the like.

### 7.3.2 Qualifications of Installer

The Structured Cabling System shall be installed only by accredited firms of the cabling system components and by suitable qualified personnel(s)

### 7.3.3 Manufacturers Recommendations

All equipment and cabling shall be installed in full accordance with manufacturers recommendations and instructions.

### 7.3.4 Cable Lengths

Cable lengths shall be kept to a minimum by taking the most direct and practical route.

### 7.3.5 Segregation

A. Care shall be taken to ensure UTP Cat 6 cables are not routed adjacent to other services where Electro-magnetic emissions may be generated. UTP Data cable must never be run in the same containment as mains voltage cables or fire alarm circuits. Where data cables are run in trunking containing mains cables and outlets the data cable must be segregated in a separate part of the trunking.

B. Minimum segregation distances shall also comply with the standards laid down by the cable manufacturer

C. Category 6 (4 pair UTP) cables shall be kept in separate bundles from the multi-pair voice or fiber cable.

### 7.3.6 Concealment

A. All cables shall be concealed in walls or ducts except where run on cable trays in equipment rooms. Cables shall be run in neat lines.

B. Aesthetics are important. All installed installations are to be unobtrusive and blend in with the existing surroundings.

### 7.3.7 Electrical and Earthing System

A. All equipment racks and cabinets, cable trays, and metal duct systems shall be permanently and effectively earthed to the building protective earth system.

B. A four way fan tray to be located within the roof of the equipment cabinet

C. Building earth systems and electrical earth systems shall be provided as part of the building works.

D. Earthing and related works by the cabling system Contractor shall be limited to the following:

   I. Provision of communications earth system (CES) where specified as part of the works

   II. Provision of telecommunications reference conductor Earthing system (TRC) where specified as part of the works

   III. Bonding of the cabling system equipment, enclosures, components, pathways and the like to the relevant earthing system including provision of earth bars, cabling and connections as required.

E. Power strips on both sides of the rear of the cabinet, providing a minimum of sixteen 13-amp power outlets. Every Circuit outlet shall have a 13-Amp double power socket

### 7.3.8 Fire Protection

Where cables, trunking, tray-work, conduit, pass through floors or walls, suitable fire sealing shall be provided in accordance with IEE 16th Edition Wiring Regulations (BS7671: 1992).

### 7.3.9 Air conditioning and temperature control in Equipment Room

Equipment in the Server rooms and cupboards will generate heat. The heat created in this environment will, unless moderated, cause the air temperature to rise.

Servers and associated equipment operate reliably only within certain temperature and humidity ranges and may fail if operated outside of these specified ranges. The vendor may decline to honor the warranty if it can be established that the equipment was operated outside its specified environmental range. Each equipment space shall be evaluated in regards to potential heat output and environmentally conditioned accordingly.

Advice should be sought from a suitably qualified person, but, as a guide, room temperature should be maintained between ten (10) and twenty-eight (28) degrees Celsius.

Air conditioning units shall not be placed directly above a cabinet.

### 7.3.10 Communications Overvoltage or Surge Protection

Users and equipment shall be protected from communication system overvoltage that may exist between the operational environment and the communications facilities in that environment. Examples of overvoltage may include the following:

A. Contact with (alternating current) mains power through customer equipment failure or cabling faults
B. Surge currents and induced voltages through power system faults or lightning
C. Power feeding.

### 7.3.11 Surge protection devices (SPD) – Carrier or Voice grade services

Over voltage (lightning) protection modules shall be fitted to all IDC 10 pair modules and frames directly connected to the lead-in cable, on the customer's side of the network boundary, or other external copper cabling (for example, Inter-building tie cabling connections) that have or will have carrier or telephony present.

## 7.4 Balanced Cabling Installation

A. The cable interconnecting distributors or between a telecommunication outlet and a horizontal distribution panel or patch panel shall be one continuous length with no intermediate joints, splices or taps. Mid-run joints of cables are not permitted except for the use of consolidation points.
B. Where two or more cables share a pathway the cables shall be tied together at 1.2m intervals to create a trunk effect.
C. When installing and terminating cable runs, 0.5m of slack shall be provided at a suitable location in the cable pathway. The preferred location is within the ceiling space, under raised floors, or on the side of the cabinet (in a cavity created between the wall and the cabinet).
D. A loop of cable shall be left in the cable trunking on the approach to each telecommunication outlet to facilitate re-termination of the cable in the future, should this be required. The preferred length of this loop is about 0.5m but the final determination as to the required length shall be made by the site representative.
E. For Cat 6 cable, a bend radius of approximately 1 inch (4 times the cable diameter) shall be used when being pulled through conduits, or as specified by the cabling manufacturer. The cables shall be anchored immediately before the start and after the finish of the bend.
F. To preserve the electrical characteristics of the balanced cable, the outer insulation of the cable shall not be stripped back unnecessarily, and shall be left intact up to a point as close as possible to where the individual pairs are terminated to the IDC connector.
G. Sufficient cable slack shall be provided at telecommunications outlets to allow removal of faceplates and associated the RJ45 socket for servicing.

## 7.5 Optical fiber cable installation

### 7.5.1 Scope

This section covers the requirements for the installation of Optical Fiber cables between wiring centers or Main Distribution Facilities (MDFs) within and between buildings.

### 7.5.2 Minimum Requirement

A. The minimum optical fiber category for single mode optical fiber cabling shall be OS1, compliant with ISO/IEC 11801 with a minimum core diameter 8microns and a cladding diameter of 125microns. The use of cabled optical fiber category OS2, compliant with ISO/IEC 11801 is recommended. 8µm/125µm Single-mode fiber shall be used for longer runs between buildings to provide backbone connection.
B. The Optical fiber cable shall be presented on STII type connectors.

### 7.5.3 Optic Fiber Cable Constructions

The following shall be considered in selection of the optic fiber cable for installation;

A. The optical fiber cable shall be of a tight buffer construction suitable for installation in risers. Tight-buffered cables have the buffering material in direct contact with the fiber and tightly wraps around
B. The optical fiber. Tight buffer shall provide a rugged cable structure for better mechanical protection of fibers during handling and installation.
C. The optical fiber cable shall be capable of withstanding temperatures in the range-40°C to +70°C without degradation in performance.

D. Physical characteristics of the cable including overall diameter and minimum bending radius shall be as per the manufacturer specification.
E. The cable shall be of a type suitable for installation in underground ducts and for routing on tray work within buildings. The outer sheath shall meet fire regulations for installation within buildings.

### 7.5.4 Identification of Optical Fiber Cable Routes

The following steps shall be taken to identify the cable routes between new buildings and major building renovations:

A. Obtain a photocopy of the campus layout map
B. Determine where the cable entrance point is for each building
C. Sketch the cable route from the starting point to the terminating point in the buildings to be served on the campus layout map
D. Note any obstacles, existing cable facilities, or other underground utilities on the campus layout map
E. Note if right-of-way permits are required
F. Review proposed cable route to determine if conditions exist that require environmental impact applications. Identify sources of future cable maintenance problems.

### 7.5.5 Optical Fiber Cable Distribution methods

The method may be one or a combination of underground (in conduit), direct buried, directional boring, or aerial. Optical fiber cables shall be installed in enclosed trunking pulled in duct and securely fastened to the trays: The methods for distribution of the cable shall include the following;

A. Underground cable system shall consist of cables placed in buried conduits connected to maintenance holes (MH); hand holes (HH), and pull boxes (PB). Conduits are also installed from the building entrance location to poles, MH's and HH's. Splices shall be located in maintenance holes unless compelling reasons exist.
B. Direct buried cable system shall consist of cables and associated splices directly placed in the earth. The trench shall runs from the building entrance location to a pole, MH or HH. This method is used only in cases where underground or aerial installations cannot be accomplished.
C. Aerial cable system shall consists of cables installed on aerial supporting structures such as poles, sides of buildings, and other above ground structures.

### 7.5.6 Outside Plant Fiber Optic cable

A. Loose Tube, filled core, (waterproofing compound) cable must be used for underground and direct buried fiber optic cable installations. Filled cable preserves the integrity of the cable by providing physical protection against moisture penetration and seepage. Loose tube fiber optic cable is the preferred and recommended cable for Outside Plant applications.
B. Direct buried fiber optic cable requires an armored sheath to resist rodent and penetration type damage

### 7.6 Underground and Direct Buried Cable Requirements

Underground and direct buried cable projects must be designed from engineering drawings approved by the relevant Authority. These drawings shall include the following information;

A. Details of typical trench cross sections showing cable and duct locations in the trench, clearances from final grade, backfill materials and depths, pavement cutting information, and compacting requirements for both paved and unpaved areas.
B. Construction notes applicable to the work being performed.
C. A scale drawing showing location of existing structures, cable, conduit, utility boxes, and any conflicting substructures and profile drawings of congested areas where vertical and horizontal separation from other utilities is critical during cutting and placing operations and any other areas
D. A legend explaining symbols of all relevant structures and work operations.
E. Optical fiber Cable types, counts, and directions of feed.
F. Conduit types, dimensions, and wall-to-wall measurements when used with maintenance holes, hand holes and pull boxes.
G. Maintenance whole drawings shall show cable-racking information, applicable cable counts, conduit assignments, splicing details, point arrows, block or street names.
H. Warning tape must be placed a minimum of 300mm above the underground conduit/duct structure and direct buried cable to minimize any chance of an accidental dig-up.
I. The minimum depth of a trench shall be 1200mm with width 300mm for normal soil, 800mm for soil with gravel and 400mm for rocky soil. For all cases the trench shall allow 600m of cover from the top of the conduit/cable to final grade.
J. Providers for other underground utility services shall be contacted and must be present and on site during any construction, and utilities located before digging to locate all subsurface facilities such as power, gas, water and outdoor lighting.
K. Install a 12-14 AWG copper wire in any unused conduit structures not programmed for immediate fiber or copper cable installation, or where all dielectric fiber optic cable is installed singularly, for the purpose of tracing the conduit/cable route.

L. Maintenance and hand hole covers shall be securable/ lockable with a key to reduce the potential for opportunistic vandalism or sabotage.

M. Sharing of service pits with other services (e.g. gas, power, and water) is not permitted.

### 7.7 Optic Fiber Cable Joints

A. Optical fiber Cables shall be complete between termination points; no cable joints will be permitted

B. Optical fiber cable interconnecting distributors shall be one continuous length with no splices or joins except for pigtails used to terminate single mode optical fiber cores.

C. Optical fiber cable shall only be spliced within termination points unless compelling reasons exist.

### 7.8 Optical Cable Protection

A. Holes drilled through walls or floor for the routing of cables shall be suitably covered or sealed to prevent damage to installed cables

B. Clearly labeled mark posts shall be installed along the optical fiber cable routes for easy of identifications

C. Warning tapes shall be place along the optical fiber trenches and shall be color yellow for ease of identification of cable routes.

### 7.9 Optical fiber Cable Termination Enclosure Capacity

A. Termination and splicing enclosures shall have a minimum of 50% spare capacity after completion of the works.

B. Each optical fiber cable shall be installed with 5m spare length in the communications enclosure at the respective distributors.

C. Optical fiber cable guides, rings and troughs shall be provided to ensure that patching is achieved in a neat and organized manner in line with the manufacturer's specification.

D. Cables shall terminate in fully enclosed 1-RU 12 port (24 fiber) or 24 port (48 fibers) duplex patch panels in the communications cabinets. All fiber cores specified shall be terminated at each end and connected to duplex either screw or clip type couplers inserted into the patch panel.

E. Optical fiber termination enclosures shall be clearly labeled with a durable printed label displaying the assigned fiber number of the cable terminated within.

F. Individual STII connectors should be labeled in accordance with fiber number within that cable.

G. Enclosures shall be bonded to the protective earth system.

H. Equipment mounting rails at the front of the enclosure shall be set back so that doors may be closed without contacting equipment or connectors or distorting cable bends.

I. The labels shall be 100mm x 50mm, self-adhesive multi-layered laminate engraved with 15mm upper case lettering. The labels shall be located on the front center of each rack or enclosure, near the top

## 8.0 Inspection, Testing and Commissioning

### 8.1 General Requirement for Cabling Testing

A. All testing shall comply with ISO/IEC 11801 for copper cabling and ISO/IEC 14763-3 for optical fiber cabling.

B. If recent test results for existing cable are not available and the cable is to be retained, is shall then be tested along with all existing cabling. The cabling system Contractor shall supply all labor, materials and equipment required to fully test and commission all existing and newly installed cabling.

C. All retained cabling shall pass testing and be identified specifically

D. Permanent link copper testing shall be performed in all acceptance testing. Channel testing shall be utilized for fault location only.

E. Testing shall only be performed using calibrated test and simulation equipment following the test guidelines set forth by the tester manufacturer and the structured cabling manufacturer. A minimum Level III tester shall be used for testing of all Class D (Cat 5e) and Class E (Cat 6) cabling.

F. Test equipment approved by the cabling manufacturer should be used for all testing. All test results shall be provided in the native file format of the test equipment.

G. Optical fiber cable shall be tested by light source and power meter in accordance with ISO/IEC 14763-3

H. The test results, for all cables, connectors and outlets shall be fully documented and tabulated, identifying each cable and each outlet or interface port by its label.

I. Testing shall not proceed until all labeling and documentation is complete so that the test results accurately reflect the actual cables and connectors.

J. All test results shall be included in the "as-built" document manual. The Contractor shall include a copy of all relevant specifications and compliance reports for the cables and connecting hardware used in the installation in the "as-built" document manual.

K. Any modifications to an already warranted structured cabling system must be retested and warranties revalidated by the manufacturer.

### 8.2 Acceptance Test for Balanced Copper Cabling

A. Compliance testing for class E installations requires a level III tester as defined by ISO/IEC 61935.1.

B. Compliance testing shall be carried out on all balanced communication cabling (U/UTP, F/UTP, S/FTP, SF/UTP) in accordance with IEC 61935.1 and IEC 61935.2, based on testing in accordance with values set out in (ISO/IEC 11801).

C. Test equipment must be calibrated and current calibration certificates must be supplied.

D. The person/s carrying out the compliance and certification testing must have current certification for the test equipment used for this testing. Certificates must be provided.

E. The acceptance testing and certification report section for balanced cabling shall include the test results for each link. The test report shall be provided in the native file format of the test equipment and include as a minimum the following details and tests results for each link:

   I. Cable and outlet/port identification

   II. Test equipment and test configuration details

   III. Tester manufacturer, model, serial number, hardware and software version.

   IV. Wire map testing shall indicate the cabling has no shorts, opens, mis-wires, split, reversed, or crossed pairs

   V. Cable length

   VI. Cabling performance parameters as specified in ISO/IEC 11801:2002

   VII. Date and time of testing

   VIII. Name and signature of testing engineer.

F. The Contractor shall fully test the cabling system for wire map (including pin assignment and color coding), cable length and performance of all cable pairs.

G. Any channel not meeting the required performance standards shall be replaced at the expense of the Contractor

H. The equipment manufacturer shall provide certification in writing indicating full compliance of the balanced cabling connecting hardware (telecommunication outlets and patch panels) with the Class D or Class E cabling system. Certification shall include test results as recorded by the appropriate test laboratory.

I. The cabling system installer shall certify the performance of each channel (horizontal and backbone) to minimum Class E (all frequencies ranging from 200-250 MHz) for all pairs. The overall responsibility for achieving and demonstrating this performance objective shall remain with the Contractor.

J. Test shall be conducted for Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. Information shall be provided for all pairs or pair combinations and in both directions as required by the standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL.

K. Individual test that fails the relevant performance specification in terms of Length (in meters), propagation delay, and delay skew relative to the relevant limit shall be marked as a FAIL.

### 8.3 Acceptance Test for Optical Fiber Cabling

A. Conformance testing of all optical fibers shall be in accordance with ISO/IEC 14763-3 at both wavelengths and in both directions using a Light Source and Power Meter.

B. The acceptance testing and certification report for optical fiber cables shall include as a minimum:

   I. Cable identification (unique identifier of the fiber optic cable and fiber number)

   II. Type and manufacturer of the cable being tested

   III. Test equipment and configuration details including equipment settings

   IV. Length of fiber segment in meters

   V. The end of the cable from which the test is carried out.

   VI. Loss/attenuation over fiber segment at 850nm and 1300nm in dB

   VII. Date and time of testing

   VIII. Name and signature of testing technician

   IX. Bandwidth in MHz/km at 850nm and 1300nm

   X. A copy of the OTDR trace

C. Cable length shall be determined for each core from the meter markings on the cable, OTDR or from the certification testers.

D. Optical loss testing shall be conducted on each core of all installed optical fiber cable runs by way of a Light Source and Power Meter. Actual throughput loss, in decibels (dB) of the fiber link at the wavelength of system operation shall be tabulated from both ends of each fiber link.

E. Testing for multimode optical fibers shall be carried out at the optical wavelengths of 850nm and 1,300nm in both directions.

F. Testing for OS1 optical fibers shall be carried out at the optical wavelengths of 1,310nm and 1,550nm in both directions.

### 8.3.1 Compliance testing of multi-mode optical fiber cabling

I. Compliance testing for multi-mode optical fiber (MMOF) shall be in accordance with ISO/IEC 14763.3 and ISO/IEC 11801. For all OM2 testing, test equipment shall either:

II. Be encircled flux compliant (preferred)

III. Use encircled flux conditioning leads as the source launch lead when encircled flux non- compliant test equipment is used.

IV. The person/s carrying out the compliance and certification testing must have current certification for the test equipment used for this testing. Certificates must be provided.

V. Test equipment must be calibrated and current calibration certificates must be provided.

### 8.3.2 Compliance testing of single mode optical fiber cabling

A. Compliance testing for single mode optical fiber (SMOF) shall be in accordance with ISO/IEC 14763.3 and ISO/IEC 11801.

B. The person/s carrying out the compliance and certification testing must have current certification for the test equipment used for this testing. Certificates must be provided.

C. Test equipment must be calibrated and current calibration certificates must be provided.

**Table 3 Patch Cable Color Codes**

| Type | Fiber Size | Attenuation | Bandwidth at 850 nm | Attenuation at 1300nm | Bandwidth at 1300nm | Splice Loss |
|---|---|---|---|---|---|---|
| Single Mode | 8/125 | <0.38dB/Km | >30GHz/Km | 0.25dB/km | >30GHz/km | <0.2dB |
| Multimode | 62.5/125 | 3.5dB/km | 160MHz/km | 10dB/km | 600Mhz/km | <0.2dB |

### 8.4 Cable Removal

All cabling that does not meet the required Standard should be removed from site prior to any new installation where practical. Consideration should however be given to service continuity and ensuring a minimal service disruption period during installation. This includes associated pathways and the repair of any building structures as a result of the removal

## 9.0 Administration and Documentation

### 9.1 General

Records should be provided in both electronic and hard-copy formats.

### 9.2 Management Requirements for Cabling Infrastructure

Heads of IT in the respective Governmental Institutions shall ensure that their cabling infrastructure is managed on an ongoing basis as best practice. The use of computerized systems to assist with this management function is highly recommended. The management of cabling infrastructure shall include (but not be limited to) these areas:

A. Establish and maintain a single cabling register for the each department within the Institution. The register can be split into sections or regions (based on functionality or structure) to assist with management of the register.

B. Establish and maintain a cabling register for each site. As a minimum, each register shall list the standard of cabling at each site in terms of compliance.

C. Identifying and rectifying non-compliant cabling infrastructure

D. Recording commissioning and test results.

E. Recording site certification details and warranty details.

F. Managing cabling records, as built drawings and diagrams

G. Managing the records for cable pathways, trays, pits, conduits, ducts, pipes, underground cabling, and aerial cabling.

H. Labeling of backbone cables, panels, outlets, patch cables, cross connect cables, associated equipment

I. Recording and tracking defects, faults, claims, and rectifications raised under product warranty, system performance warranty, or applications assurance warranty.

J. Managing cabling infrastructure moves, adds or changes managing cabling infrastructure capacity (capacity planning)

K. Auditing the installed base of cabling infrastructure against documentation records

L. Establishing and maintaining a plan to address the upgrading of cabling infrastructure at sites where that cabling will cost effective service for the Institution due to the introduction of new services that require higher specifications than is available.

### 9.3 Construction Documentation

Installation shall be in accordance with the approved construction/As-built drawings. Construction documentation will typically include:

A. Schematic diagrams detailing the quantity and types of cables linking distributors.

B. Scaled site and building/floor location plans showing the location and size of pathways and the cables to be installed therein, cable routes, pit locations and enclosure/ distributor locations. Drawings will be to a reasonable accuracy.

C. Equipment room layouts

D. Physical enclosure layouts

E. Schematic diagram detailing patch panel layout and port numbering
F. Physical layout drawings of data and power outlet positions and identification numbers
G. Equipment lists detailing the equipment (type/make/model) to be installed including racks, enclosures, patch panels, and outlets
H. Test methods for balanced copper and optical fiber cables
I. As-installed schematics for each equipment cabinet and or cabling frame.

### 9.4 Handover Documentation

A. One bound copy and one electronic copy on USB Drive of the following documentation shall be supplied to the Institution at the completion of the work.
B. As-built site and building/floor location plans showing the location and size of pathways and the cables installed therein, cable routes, pit locations and enclosure/distributor locations. Drawings shall be to a reasonable accuracy.
C. As-built schematic diagrams detailing the quantity and types of cables linking distributors
D. As-built equipment room layouts.
E. As-built physical enclosure layouts
F. As-built schematics of patch panel layout and port numbering
G. As-built physical layout drawings detailing outlet positions (both TOs and GPOs) and identification numbers.
H. Description of the patching system and the labeling system used.
I. Equipment lists detailing the installed equipment (type/make/model) including racks, enclosures, patch panels, and outlets.
J. Test reports detailing procedures, equipment configuration, and test results (in the test equipment native format) for both balanced copper and optical fiber cable.
K. Manufacturer's Warranty Certificate/Certificate of Compliance to performance as specified for the particular cabling system detailing the outlets and backbone channels covered by the warranty.
L. Contractor contact details.
M. Drawing shall be provided in AutoCAD or VISIO as a minimum.

## 10.0 Warranty

### 10.1 General

Two types of warranties apply to Data Communication Cabling Installations:

A. Installation Warranty
B. Manufacturer Warranty

### 10.2 Installation Warranty

The cabling system Contractor shall warrant its own work and workmanship for a minimum period of 12 months. This includes any remedial work done to bring existing cabling up to the required Standard.

### 10.3 Manufacturer's Warranty

A. Manufacturer's performance warranty shall be a minimum of 3 years parts and labor. The warranty shall be supplied directly from the equipment manufacturer to the Governmental Institution.
B. The Structured Cabling System Contractor shall file for a minimum of 3 years performance and applications assurance warranty offered by the structured cabling manufacturer using the manufacturer's process and requirements. If those guidelines exceed the requirements within this document, those excess requirements should be followed to fully comply with the manufacturer's warranty requirements. In the event that the manufacturer's requirements contradicts those within this document, the Contractor is to bring those contradictions to the attention of the Institution immediately.
C. Any additional cabling at the warranted premises must not compromise the existing warranty. Additional cabling shall be installed and tested by a certified and accredited supplier. An updated warranty and system certification shall be provided at the completion of any additions.
D. Retained cabling which has passed testing (Cat 6 cables) and has been installed to the required standards need not be covered under the new warranty.
E. Manufacturer's warranties will be retained and managed by the Governmental Institution.
F. All modifications and additions to already warranted Structured Cabling System must be tested and warranted by the manufacturer.

## 11.0 Security of the IT Infrastructure

The requirement for securing physical IT infrastructure including structured cables & equipment as well as work areas in Institution have been covered in the international standards US ISO/IEC 27002 (Information technology - Security techniques - Code of practice for information security management)

## 12.0 Capacity Building

The dynamic nature of IT requires necessary skills to ensure optimum utilization of the services/systems, keep them running and implementing them demand new and high-level skills.

The implementation of different IT services and systems requires considerable knowledge and skills which have to be developed among the end-users so that they are empowered to;

A. Use IT services and systems effectively and as independently as possible

B. Establish and sustain effective, efficient application and data management and system maintenance

C. Be aware of the shared responsibilities for equipment, software and data and enforce an atmosphere of collective responsibility and system ownership.

D. Contribute to the specification, design and implementation of IT applications.

In ensuring that capacity is built among staff in the Governmental Institution at all levels, the following shall be considered;

1. Governmental Institutions shall take full responsibility to promote the deployment of IT in all programs at all levels in the broadest sense. Governmental Institutions need to ensure that all staff are trained on a continuing basis to equip them with adequate skills to fully exploit the IT environment in their different functions.
2. Governmental Institution shall ensure that end-user skills development includes all efforts to enforce awareness, general knowledge and specific computer skills related to the use of information technology. Staff training on the usage of IT should therefore be given high priority.
3. Governmental Institutions shall ensure that policies are in place that provides for the development and implementation of a consistent set of training programs with different categories of IT users. These include among others management staff, head of departments, program officers, administrative assistants and contract volunteers. Training should be provided to cover, as far as possible all skill levels.
4. While it is not intended to turn all users into experts, it is important that the training plan supports all users of IT at all levels. The short- and medium term goals shall aim at creating, as rapidly as possible, a sizeable proportion of staff that are familiar with and are able to effectively use the IT infrastructure in their daily work.
5. At the end of the training program all staff at all levels should be able to use standard application packages, carry out basic maintenance and take the responsibility to secure their work environments as well as the IT infrastructure allocated to them.

## Referenced Documents

### Standards

The following standards contain provisions, which through reference in this text constitute provisions of these standards for structured Cabling. At the time of drafting and publication of these standards the editions indicated were valid. All standards are subject to revision and, since any reference to standards is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below

| No. | Standards Code | Description of the Standards |
|---|---|---|
| 1. | ANSI/TIA-942-2005 | Telecommunications Infrastructure Standard for Data Centers (April 2005) |
| 2. | ISO/IEC 11801:2002 | Information technology - Generic cabling for customer premises |
| 3. | IEC 61935.1:2006 | Testing of balanced communication cabling in accordance with ISO/IEC 11801 - Installed cabling |
| 4. | ISO/IEC 14763-3 | Information technology – Implementation and operation of customer premises cabling – Part 3:Testing of optical fiber cabling |
| 5. | TIA/EIA-568-B.1 | Commercial Building Telecommunications Cabling Standard (Part 1:General Requirements) |
| 6 | US EAS 372-3:2005 | Telecommunications installations — Specification — Part 3: Generic telecommunications cabling systems for small office/residential premises |
| 7 | US EAS 379-1:2005 | Information technology — Configuration of customer premises cabling for applications — Part 1: Integrated services digital network (ISDN) basic access |
| 8 | US ISO/IEC 27002 | Information technology - Security techniques - Code of practice for information security management |

## Bibliography

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16th Edition (1992)
2. Guidelines for Installation of Fiber Optic Cables
(Cable Plus USA)

## Website References

Belden Optical Fiber Design Guide, Issue 4
http://www.BeldenIBDN.com

## Ethernet Alliance

http://www.ethernetalliance.org

## Fiber Channel Industry Association

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http://www.timbercon.com/om1-om2-om3-and-om4-fiber/

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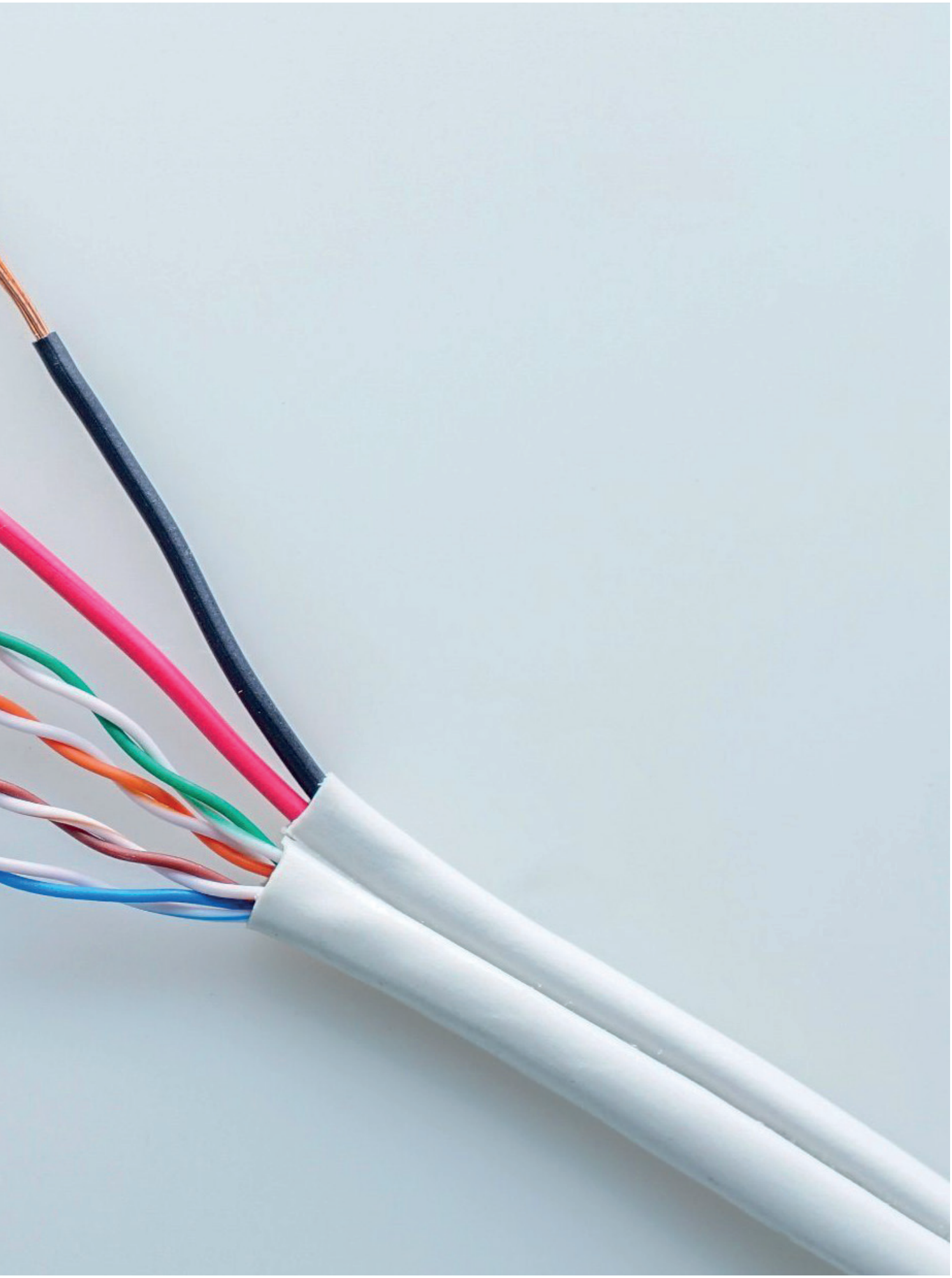

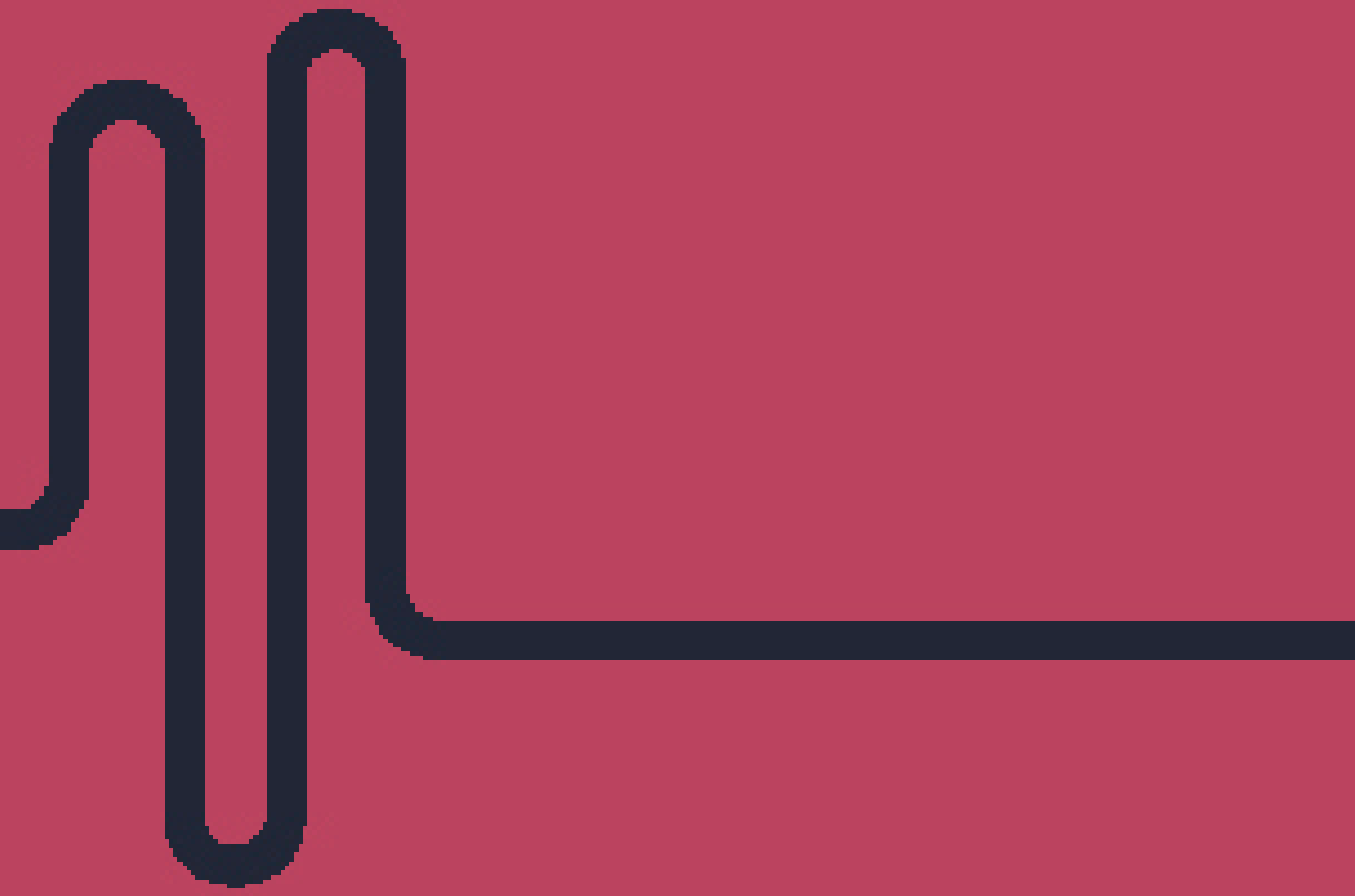

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