NATSPEC// Construction Information

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# Selection and design of Building IT systems

This TECHreport outlines how NATSPEC can be used to document Building IT (information technology) systems. It provides an overview of the selection and design of Building IT systems and components, and presents a range of approaches for preparing the specification.

# CONTENTS



**Abbreviations**
For the purposes of this TECHreport the following abbreviations apply:

- BMS: Building Management System.
- EMI: Electromagnetic interference
- IP: Internet Protocol.
- IT: Information Technology.
- LAN: Local Area Network.
- PABX: Private Automatic Branch Exchange.
- PLC: Programmable Logic Controller.
- PoE: Power over Ethernet.
- VoIP: Voice over Internet Protocol.
- WAN: Wide Area Network.

**Definitions**
For the purposes of this TECHreport the following definitions apply:

- Cat 6A F/UTP: A foil screen/unshielded twisted pairs (F/UTP) cable where there is an outer foil shield with all four twisted pairs unshielded. It is designed to reliably carry data for 10GBASE-T (10 Gigabits per second) with a possible band width of 500 MHz. It minimises crosstalk and improves EMI performance while not requiring a centre spline that results in a flexible cable that has a smaller overall diameter for installations.
- Ethernet: A protocol for a LAN, covering both software and hardware.
- Horizontal cabling system: A cable system connecting telecommunications rooms to individual outlets, plantrooms or work areas on a floor or area of a building.
- Insulation displacement termination frames: Commercial wiring frame for the termination of copper communications cables. It is the adopted standard used by the Australian telecommunications industry for the termination of voice communications cables.
- Patch panel: A panel where incoming and outgoing communications cables are terminated on communications jacks or plugs. Patch or interconnecting leads (cables) are used to connect incoming to outgoing cables via the jacks/plugs to simplify the interconnection of these cables.
- RJ45 plugs and sockets: A connector plug or socket for the connection of telephone and computer network (Ethernet) cables.
- VoIP: A communication protocol used for the delivery of voice and computer communications.

# 1 INTRODUCTION

## 1.1 Intended users

This TECHreport can be used by clients, project managers, architects and building services engineers to determine the extent and procurement of building information technology (IT) facilities and equipment to be used in a project. It provides guidance on how the component parts can be configured and how a satisfactory overall IT installation can be achieved by using the following NATSPEC worksections as appropriate:

- *0771 Automatic controls*.
- *0772 Automatic controls – minor*.
- *0773 Building management systems*. (BMS)
- *0961 Information and communications technology (ICT) systems*.
- *0981 Electronic security*.

## 1.2 Overview of a Building IT system

A Building IT system manages the use of computer and telecommunications technology throughout a building. It includes the distribution and transmission of digital and analogue data over copper, optical fibre cables and wireless networks. IT systems used in buildings and by building users include the following:

- Computer software.
- Information systems.
- Computer hardware such as PCs, printers, scanners.
- Telecommunications.
- Engineering system control, including BMS, fire safety systems and security systems.
- Client management systems.
- Building access systems.
- CCTV, entertainment video and radio systems, free-to-air TV systems.

The Building IT system is managed by Ethernet systems over LAN networks using file servers, routers and patch panels, and is constructed using multiple inputs from the following:

- Building contractors.
- Client's IT personnel or dedicated IT component specialists.
- Software suppliers and installers.
- Specialist telecommunications installers.
- Specialist system providers.

# 2 BUILDING IT COMPONENT STRUCTURES

## 2.1 Components

A Building IT system comprises many individual subsystems. It is important to understand the role of the individual subsystems and how these are organised to form the total Building IT system. The subsystem components include:

- Basic structured cable system:
  - Structured (backbone) cable system.
  - Equipment racks.
  - Power outlets.
  - Telecommunications and data outlets
- Network hardware.
- Computer hardware.

## 2.2 Basic structured cable system

**Structured (or backbone) cable system**

A structured cable system consists of the cable networks and equipment required to form the LAN and to support and power the equipment which allows the Building IT system to function. **APPENDIX A**: **BUILDING IT SYSTEM DIAGRAM** and **APPENDIX B**: **CAMPUS SYSTEM IT DIAGRAM** give an overview of a Building's IT system and its components.

A campus and building structured cable system distributes IT information throughout the client's site and buildings. Structured cable systems are installed between the campus, building and floor distributors.

Several different cable topologies can be used to form a structured cable system, three general types include:

- Ring.
- Star (also known as hub-and-spoke).
- Mesh (multiple communications paths connected to each node).

In large networks, ring and mesh topologies have the advantage of allowing multiple communications paths to be connected to communications nodes, allowing the system to continue operating if a single path failure occurs.

A structured cable system generally comprises a mix of copper cables, single mode and multimode optical fibre cables of sufficient capacity, and in quantities to meet the carrying capacity required for the site's IT system. The structured cabling system design will also consider the provision for remote powered equipment (PoE) and its impact on the conductor pair's current loading, the number of cables that form a cable bunch and the spacing between cable bunches for derating purposes. The default IT cable installation designation is Category RP1.

Refer *0961 Information and communications technology (ICT) systems* worksection for further details.

The structured cable system can include the following:

- Termination frames for copper and optical fibre cables.
- Equipment and router racks.
- Patch panels.
- Patch leads to allow termination and interconnection of the cable systems, usually in dedicated communications rooms or cupboards.

Patch leads connect the incoming reticulated structured cables to the outgoing horizontal cabling to floor outlets throughout the building. They allow outlet configurations to be changed easily and are either of copper or optical fibre cables.

Cat 6A F/UTP copper cables, forming the horizontal cable distribution, generally run to telecommunications or computer data outlets throughout the building, and are serviced by each floor distributor or communications room.

RJ45 socket outlets, wired with 4 twisted pair cable cores (8 core cable), are generally used at floor outlet locations. The RJ45 plug (8 core cable) combination allows for interchangeability between voice and data applications.

Fibre optical horizontal cables may be used in areas served from floor distributors to floor outlets to meet high data rates or specialised equipment requirements.

**Equipment racks**

Standard industry-type equipment racks are provided in campus, building and floor distributors for mounting file servers, routers and patch panels, allowing free access to the back and front for cable termination to the equipment.

**Power outlets**

A generous allowance is required for power outlets providing power to equipment mounted on racks. Power outlets are mounted on equipment racks and are usually powered from an uninterruptible power supply (UPS) source.

**Specifying the basic structured cable system**

A basic structured cable system for a Building IT system is usually provided under the building contract within the electrical services package. It can be documented in the NATSPEC *0961 Information and communications technology (ICT) systems* worksection.

## 2.3 Wireless network hardware

**Components**

The wireless network hardware comprises hardware necessary for the building IT system network to function wirelessly. This generally includes the following equipment operating over an ethernet managed LAN network:

- Incoming internet provider wired and wireless modems, either operating from wired or wireless incoming services.
- Wireless access points.

Note:

In small building IT systems, an internet provider wired and wireless modem, connected to wired and wireless LAN routers, would generally provide a satisfactory network for providing internet and general IT communication to wireless connected hardware, i.e. portable laptop computers.

In larger buildings, or a multiple building campus, wired internet provided modems would generally be required to distribute internet services over the site. These modems would connect into the site wide structured cable system to carry IT information over the site. Wireless access point hardware or routers and file servers with wireless transmission facilities, are required to distribute wireless functions over the site, to allow connection of portable or wireless connected devices for IT function. Specialised data systems require gateways into the structured cable system to allow connectivity to portable devices.

### 2.4 Network hardware

**Components**

The network hardware comprises hardware necessary for the Building IT system network to function. This generally includes the following equipment operating over an Ethernet managed LAN network:

- Network fileservers.
- Network routers.
- Network switches.

Network hardware can be procured by several methods, including the following:

- Installation under the building contract within the electrical services package.
- Procurement and installation by the client's IT personnel or by dedicated IT component specialists.
- Lease or purchase by the client from specialist hardware system providers.

**Specifying the network hardware**

If installed under the building contract, the network hardware requirements can be documented through additional text in *0961 Information and communications technology (ICT) systems*.

### 2.5 Computer hardware

**Components**

The computer hardware comprises the items of computer or digital equipment necessary for conducting the client's business using the Building IT system. Hardwired equipment is connected to the building LAN via RJ45 outlets. Portable/mobile equipment may be connected via the building wireless network (if provided) or by a carrier network, if coverage is adequate within the proposed building. Hardware includes the following:

- Main frame computers.
- PC computers.
- Printers.
- Scanners.
- Other specialised digital equipment required as defined by the client.

**Specifying the computer hardware**

This equipment is usually installed by the client or building tenant's IT personnel when occupying the building and is generally not part of the building contract.

## 3 TELECOMMUNICATION VOICE SYSTEM

### 3.1 Components

Generally known as the voice or telephone system, the telecommunication voice system comprises vital equipment needed for the Building IT system including:

- Connection to the telecommunications carriers.
- Telecommunications lead-in cables.
- Campus distributor, building and floor distributor requirements.
- Telecommunications voice cabling network and horizontal wiring to outlets.
- PABX equipment or Voice over Internet Protocol (VoIP) service.
- Telephone handsets.

The complexity of the voice system is determined by the size of the client's business. It can vary from a small, simple business model to a very large business complex of several buildings over a common site to building complexes over several different sites integrated together forming a common WAN operating system.

The telecommunications facility can be procured in various ways, including purchase or installation by the following:

- Telecommunications carriers.

- Building contractor.
- Specialist telecommunications installers.
- The building owner or tenant.

In each instance the Building Contract and the specification should include provisions for access, coordination and Work-by-Others.

## 3.2 Requirements for connection to the telecommunications carriers and lead-in cables

The National Broadband Network (NBN) was charged with providing a broadband network connection to all premises in Australia using optical fibre supplemented by radio technologies in remote locations. Metropolitan areas can convert to the NBN or 5G broadband. Regional areas have choices including satellite or fixed wireless, mobile broadband, private wireless or ADSL.

www.nbnco.com.au

At locations that have been cabled by the NBN, telecommunications carriers that have signed up to the NBN may use the NBN cable to deliver services to the customer.

For those locations not connected to the NBN, carriers such as the following are available to provide lead in cable services:

- Telstra.
- Optus.
- National Broadband Network (NBN) provider.
- TPG Telecom Ltd.
- State and Federal Government owned communications networks (for government projects).

Designers need to determine the best procurement method for the services. They will need to liaise with the individual carriers to define the extent of services to be provided and how these services will be connected to the building facilities, including spatial requirements within the property and the building.

When liaising with each provider, define the following requirements:

- Volume of voice communications required for the site.
- Number of incoming copper and optical fibre cable facilities. The carrier's lead-in cables may comprise both copper and optical fibre cables, but large, modern building complexes may only require optical fibre cable lead-in facilities.
- Route of the carrier's services external to the site.
- Point of entry to the site and boundary connection points.
- Size and type of cable pits and conduits connecting the boundary connection points to the campus distributor.
- Extent of share facilities between different carriers at the site boundary connection point for the cable connection infrastructure, i.e. shared or separate cable pits.
- Lead-in cable termination requirements. It is usual to provide separate conduits for each carrier's lead-in cable.

When finalising these requirements, the building owner or tenant requiring the service will generally be required to enter into a formal agreement with each telecommunications carrier.

**Specifying the computer telecommunication voice system**

The basic requirements for connecting to telecommunications carriers are covered in *0961 Information and communications technology (ICT) systems*.

## 3.3 Campus, building and floor distributor requirements

**Campus distributor**

Provision of the site telecommunications facilities requires siting and establishment of a campus distributor, and building and floor distributors. Refer to AS 11801.2 Section 5 for a description of these facilities. Refer also to AS 11801.1 for general requirements for cabling.

A campus distributor is the central point where the incoming carrier services are terminated and from which the telecommunications services are distributed over the site. It consists of the following:

- Incoming insulation displacement type termination frames, such as the ADC Krone type, for copper and termination frames for optical fibre cables. (Separate termination frames are required for each telecommunications carrier engaged on the site.)
- PABX equipment and any backup battery power supply.
- Patch panels for interconnecting internal cable facilities within the campus distributor.

- Outgoing insulation displacement type cable frames for copper cabling and outgoing frames for optical fibre cabling.
- Workstation for maintenance staff.
- Facilities for other equipment required to interconnect with the telecommunications equipment, such as paging equipment.

**Building distributors**

These are the central connection points in each building on the site, where the campus structured cable system from the campus distributor is connected. It consists of equipment similar to that installed in the campus distributor. If the project has only one building, the campus and building distributors are the same.

**Floor distributors**

Floor distributors or communications rooms form a connection point between the building structured cable system and the horizontal cabling system. They generally house the following:

- Incoming and outgoing insulation displacement termination frames, such as the ADC Krone range, for copper cabling and termination frames for optical fibre cabling.
- Patch panels for copper and optical fibre cabling.
- Equipment and patch panel racks.
- Local power supplies as required.

**Specifying the campus, building and floor distributor equipment**

The basic requirements for distributors are covered in *0961 Information and communications technology (ICT) systems*.

## 3.4 Site telecommunications cabling network and telephone outlets

The telecommunications cabling system is part of the LAN, see **Structured (or backbone) cable system**.

Cabling to telephone outlets for basic telephone handsets requires CAT 6A F/UTP copper cable because of the variety and flexibility of equipment likely to be connected to the outlet and the LAN. RJ45 outlets are generally used for the connection of equipment.

## 3.5 PABX equipment or VoIP services

It has been normal practice to size PABX equipment to meet the requirements of the building complex. However, VoIP phone systems are increasingly being used for large Building IT systems.

PABX equipment is usually procured outside of the building contract, and is often installed in the latter stages of building completion for new buildings. Procurement may be by the building owner, tenant or by a building manager overseeing the building construction.

If the voice system is to function as a VoIP system, no PABX is required and the system operates as part of the Building IT Computer System, using the Internet facilities. Each telephone handset functions as a separate device, connected to the Building IT Ethernet system. The telecommunication carrier's optical fibre lead-in cable facilities connect the external communications services to the site's IT LAN network. No copper lead-in services are required. The telecommunications campus distributor requirements are usually integrated into the central computer centre facilities.

**Specifying PABX equipment or VoIP services**

NATSPEC currently has no worksections covering the purchase of PABX equipment or VoIP systems.

If required, PABX equipment could be documented in *0961 Information and communications technology (ICT) systems*.

## 3.6 Telephone handsets

Telephone handsets vary in complexity and cost, and designers need to consider the type required for each application in the building, based on the level of complexity required by the end user. More complex handsets can require a 230V AC external power source.

Telephone handsets used in VoIP systems require an individual power supply to function. Individual power outlets are required at each handset location (plug packs) or, power is more commonly provided from the Building IT system Ethernet cabling (PoE).

**Specifying telephone handsets**

NATSPEC currently has no worksections covering the purchase of telephone handsets.

# 4 BUILDING CONSIDERATIONS

In planning building facilities for the campus distributor, central computer facilities and communications rooms, designers should consider the use of access flooring or under floor pits to facilitate the routing of the large number of communications cables involved.

Computer flooring also facilitates efficient air flow from air conditioning systems used to cool the communications equipment and racks.

## 4.1 Specifying access floors

Access floor requirements are covered in *0541 Access floors*.

# 5 ENGINEERING SYSTEMS

## 5.1 Types of systems

In modern buildings, computer-based or intelligent building operating systems are generally used to control and operate engineering systems. These systems include the following:

- Building management systems (BMS) for the automatic control and monitoring of mechanical (HVAC), electrical and hydraulic services.
- Security systems.
- Fire service.

Past approaches to specifying intelligent building systems have tended to produce isolated systems, for example, one to control mechanical services and another to control lighting, and others for fire detection and security. The advent of open protocols has meant that it is possible to combine these into a common, interoperable system where hardware and systems from different vendors can communicate with each other.

## 5.2 The NATSPEC strategy for specifying BMS

NATSPEC services worksections are based on the use of BACnet™, a non-proprietary, open communications standard. Refer to ANSI/ASHRAE 135.

To facilitate its use in a range of services, NATSPEC uses a modular approach so that central monitoring (BMS), information technology (IT), hardware (computers, printers, etc) and cabling are dealt with in separate worksections that can be combined in various ways to meet project requirements while still achieving interoperability, if required.

Although NATSPEC is based on BACnet™, non-BACnet™ systems (proprietary systems such as LonWorks) can be accommodated by modifying individual worksections where indicated by the *Guidance* text.

Designers must also add project-specific functional descriptions and/or control diagrams.

The following suggested approaches to some common situations should be adapted to suit the requirements of individual projects.

**Large mechanical system with central monitoring**

To produce a specification for a comprehensive centralised system, the following worksections can be used together:

- *0771 Automatic controls.*
- *0773 Building management systems.*
- *0961 Information and communications technology (ICT) systems*.

**Small-to-medium sized mechanical system with no central monitoring**

If central control and monitoring is not required, *0771 Automatic controls* can be used to provide a comprehensive specification for hardware with an optional BACnet™ digital controller interface clause. This worksection covers a wide range of systems and component types and, like all NATSPEC worksections, should be edited to suit the project by deleting redundant material.

**Very small or simple systems with no central monitoring**

For very simple systems, *0772 Automatic controls – minor* may be suitable. Typical applications include projects with a simple packaged air conditioning plant, simple ventilation controls or connection of a fan coil unit to an existing chilled water system.

## 5.3 The NATSPEC strategy for specifying other engineering systems

To produce a specification for other engineering systems, the following worksections can be used in combination:

- *0961 Information and communications technology (ICT) systems.*
- *0981 Electronic security*.
- Other relevant NATSPEC worksections.

### 5.4 Engineering local area network (LAN) systems

Engineered computer based or intelligent systems use the same cable topology as the Building IT system, i.e. copper and optical fibre cables.

Designers should consider whether to use separate cable systems or the structured cable systems employed in the Building IT system LAN. The engineering systems will always interconnect to the Building IT system LAN to share information and to share access facilities.

Often each engineering system is designed to have an independent cable system. This decision is based on the following:

- System independence in the installation, operation and maintenance of the systems.
- Location of engineering plant in different areas of the building.
- Contractual cost sharing and independence.

Designers should consider these issues and the potential cost savings in sharing the common Building IT system backbone cabling system.

## 6 WIDE AREA NETWORKS (WAN)

Large client infrastructures can involve the operation and control of systems over several sites, where WANs are employed. These networks will use the following communications networks:

- Leased or owned optical fibre cables interconnecting different sites.
- Microwave links between sites.
- Carrier services.
- Other carriage facilities for carrying the communications information, e.g. HV Transmission lines, railway communications networks.

WAN networks are often used to manage:

- Telephone voice systems over several sites using a single location for operator interfaces.
- Engineering plant (BMS) at different sites from a common operator interface.
- Security systems at different sites from a common operator interface.
- Client management and information systems over multiple sites.

The WAN system will generally interconnect with the Building IT system LAN and it is important that all systems using the WAN facilities have interconnecting facilities to the Building IT system LAN.

Procurement of the WAN equipment can be part of the building contract or by a separate contract, either by the building owner, tenant or by a building manager overseeing the building construction. In each instance the Building Contract and the specification should include provisions for access, coordination and Work-by-Others.

**Specifying WAN networks**

If required as part of the building contract, specification requirements may be included in *0961 Information and communications technology (ICT) systems*.

## 7 COMPUTER HARDWARE AND SOFTWARE

A wide range of computer hardware and software is required for operating a Building IT system and other engineering systems. Generally, these are procured by the client or building tenant's IT personnel and do not form part of the building contract. However, specialist hardware and software for dedicated engineering and other specialised systems procured should be included in the procurement process, and the requirements detailed in the relevant documentation. Windows based software systems are generally preferred for ease of operation.

## 8 REFERENCED DOCUMENTS

The following worksections are referenced in this document:

| | |
|---|---|
| *0541 Access floors* | This worksection *Template* is applicable to pedestal access floor systems. |
| *0771 Automatic controls* | This worksection *Template* is applicable to large automatic control systems for mechanical services and includes hardware, software and cabling material. If used in conjunction with *0773 Building management systems* and related worksections, it can provide a complete building management system (BMS) for building management, monitoring and control. |
| *0772 Automatic controls – minor* | This worksection *Template* is applicable to small stand-alone (e.g. not part of a building management system) automatic control systems for mechanical services. Typical applications are packaged unit air conditioning installations, simple ventilations systems and fan coil unit extensions to existing chilled and heating water systems. |
| *0773 Building management systems* | This worksection *Template* is applicable to Building Management Systems (BMS) which provide the facility to monitor, control and manage building services systems which may include mechanical services, power systems, lighting, fire detection and alarms, electronic security, hydraulic services, lifts and medical gas services. BMS operates through a system of discrete stand-alone controllers which are networked together using a common, open, communications protocol. |
| *0961 Information and communications technology (ICT) systems* | This worksection *Template* is applicable to the provision of a telecommunication cabling network and IT components in commercial (both non-industrial, and industrial) buildings and references several technical standards including AS/CA S008 (2020) and AS/CA S009 (2020). This worksection supplements these standards, and provides a general specification for a complete telecommunications block cabling and facility wiring system, including connection frames. |
| *0981 Electronic security* | This worksection *Template* is applicable to the provision of access control and security alarm systems in buildings. It relies generally on AS 2201, and includes local alarm systems, centrally monitored systems, access control systems and closed circuit television. The worksection is intended to supplement the standard and to cover general commercial grade systems, of the sort likely to be installed in office buildings, residential apartments, hospitals, nursing homes and similar buildings. The worksection can also be used for institutional projects such as schools and technical colleges by the inclusion of appropriate details in the project specification. |

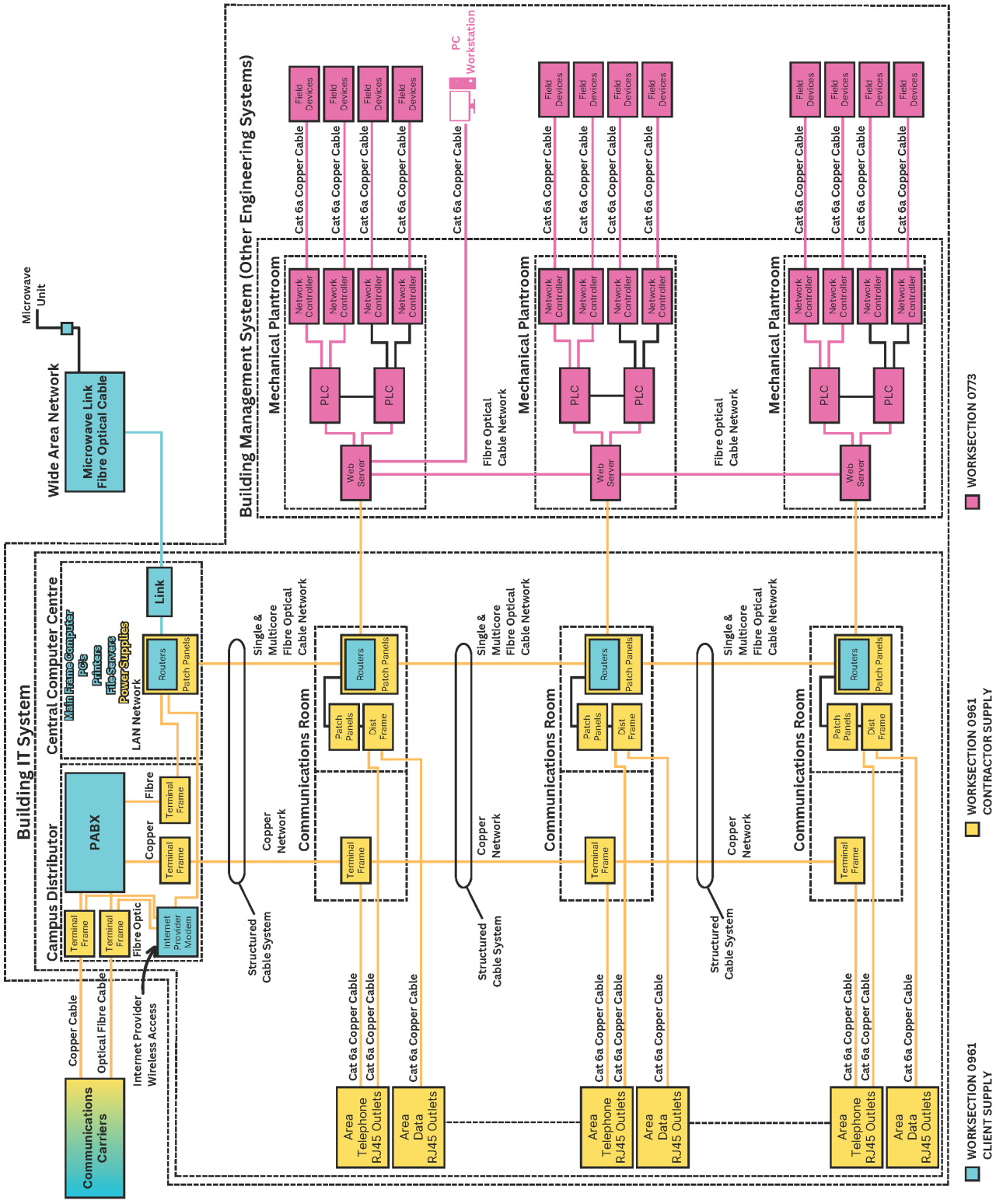
The following standards are referenced in this document:

| | |
|---|---|
| AS 11801.1:2019: Information technology - Generic cabling for customer premises - General requirements (ISO/IEC 11801-1:2017, MOD) | AS 11801.1 specifies requirements that are common to the other parts of the AS/NZS 11801 series or ISO/IEC 11801 series. Cabling specified by this Standard supports a wide range of services including voice, data, and video that may also incorporate the supply of power. |
| AS 11801.2:2019: Information technology - Generic cabling for customer premises - Office premises (ISO/IEC 11801-2:2017, MOD) | AS 11801.2 specifies generic cabling for use within office premises, which may comprise single or multiple buildings on a campus. It covers balanced cabling and optical fibre cabling, and is optimised for premises in which the maximum distance over which telecommunications services can be distributed is 2,000 m. The principles of this document can be applied to larger installations. Cabling specified by this document supports a wide range of services, including voice, data, and video that can also incorporate the supply of power. |
| ANSI/ASHRAE 135: 2020: BACnet™: A data communication protocol for | This standard defines data communication services and protocols for computer equipment used for monitoring and control of HVAC&R and other building systems, and defines information communicated between |

| | |
|---|---|
| building automation and control networks | such equipment, thereby facilitating the application and use of digital control technology in buildings. |

See also www.bacnet.org for the latest information on ANSI/ASHRAE 135. This standard was developed with the support of the American Society of Heating and Refrigerating and Air-Conditioning Engineers (ASHRAE). BACnet™ is an American national standard, a European standard, a national standard in more than 30 countries, and an ISO global standard.

# APPENDIX A: BUILDING IT SYSTEM DIAGRAM



# APPENDIX B: CAMPUS IT SYSTEM DIAGRAM