The University of Sydney

Structured Communication Cabling System Specification

GENERAL REQUIREMENTS

The intent of this document is to provide a standard specification that will be used for all the communications cabling including data, voice, video conferencing and security at the University of Sydney. This specification is based on Balanced Twisted Pair Technology and Optical Fibre Cabling Technology.

This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate the University of Sydney's requirements in excess of ten years.

Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types for a specific University of Sydney's facility will be provided as an attachment to this document. If the RFT documents are in conflict, the written specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cabling system described in this document.

The University of Sydney's Structured Cabling Infrastructure Project specifies a single-manufacturer solution. The transmission performance of the cabling system shall comply with the link and channel performance requirements of AS/NZS 3080:2003, ISO/IEC 11801 2nd Ed. The cabling system shall be backed by the manufacturer's long term (minimum 25-Year) System Warranty. The system warranty shall be facilitated by the Contractor and be established between the Sydney University and the cabling system manufacturer.

The successful contractor is required to furnish all labour, supervision, tooling, materials, labels and miscellaneous mounting hardware and consumables for each cabling system installed.

Contractor Qualifications and Training

The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice, imaging, security, lighting controls and other communications network systems. The Contractor shall at a minimum possess the following qualifications:

- Staff trained and certified in the design and installation of the MANUFACTURER Cabling System® including copper and optical fibre systems
- The Designer and Installer shall show current certification of the MANUFACTURER Cabling System® having attended the relevant Design Course and Installation Course within the last twenty four (24) months, prior to undertaking work at the University of Sydney.
- The contractor shall maintain current trained status with the warranting manufacturer, including all training requirements, for the duration of the Project.

The Contractor shall staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the 25-Year System Warranty requirements.

- Provide references of the type of installation provide in this specification for the last 3 years.
- The Contractor's staff shall be registered and possess current valid Cabling Provider Rules (CPR) registration to perform copper and optical fibre design and installations.
- After installation, the Contractor shall submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, and to apply for said warranty on behalf of the University of Sydney. The warranty will cover the components and labour, associated with the repair/replacement of any failed link, within the warranty period, following a valid warranty claim.
- All work shall comply with the latest revision of the codes or regulations. The contracting company shall have been trading for a minimum of five (5) years. The contractor shall possess current liability insurance certificates.

Ownership

All permanently installed data and voice cabling inside building's and between buildings is part of the University of Sydney's communications cabling infrastructure and as such belongs to the Information and Communications Technology(ICT), of the University of Sydney. Any proposed alteration to the cabling shall be reported to the University of Sydney ICT department for approval.

Scope of Works

The scope of this document includes the installations, extensions and modifications of existing cabling within the campus. The scope of works includes the installation of the relevant class of balanced pair cabling system as called up in the request for tender (RFT) and, where appropriate the relevant optical fibre cabling system and related works in the relevant building. The contractor is required to provide detailed design information in the response to be submitted for approval to the University of Sydney's delegated IT Project Manager before installation can commence.

The successful contractor shall carry out the installation in accordance with the timetable supplied and managed by the IT Project Manager and shall accept direction with respect to site installation time frames. Completion dates are fixed and no extensions of time will be permitted. The project completion and staging will be specified within the RFT. Contractors are to include the following information appropriate to carrying out the works in accordance with the construction program:

- The cost of the cable plant installation, including all components, travel and subsistence for the installers must be included for in the overall cost.
- A full bill of materials including the manufacturer's part numbers and the USTEL/ACMA approval number (as applicable) is required.

Specification of Structured Communication Cabling System

This specification includes the requirements for design, installation and termination of:

1. Horizontal, Work Area and Backbone Cabling Systems,
2. Floor Distributors, Building / Campus Distributors,
3. Pathways, Telecommunications Rooms, Equipment Rooms and Entrance Facilities Administration of the cabling system
4. Balanced Pair and Optical fibre Testing
5. Firestop Systems
6. Earthing and Bonding

Referenced Standards

The cabling system is based on industry standard documents incorporated by reference. The following Standards apply:

- The University of Sydney's Communication Cabling Special Requirements and Recommendations
- The Technical Structured Communication Cabling System Specification and Associated Drawings

Australian Standards

AS/NZS 3000: 2007	SAA Wiring Rules
AS/NZS 3080:2003	Telecommunications Installations-Integrated Telecommunications Cabling Systems for Commercial Premises
AS/NZS 3084:2003	Telecommunications installations-Telecommunications Pathways and Spaces for commercial buildings
AS/NZS 3085.1 2003	Telecommunications installations- Administration of communications cabling systems Part 1: Basic requirements
AS/NZS 4703: 2007	Electrical wiring in furniture
AS/NZS 61935.1:2003	Telecommunications installations – Generic cabling systems – Specification for the testing of balanced communication cabling
ISO 14763-3:2007	Telecommunications installations – Generic cabling systems – Specification for the testing of optical fibre communication cabling

Building Code of Australia

Cabling Manufacturer	Design and Installation Training Manual (current)
ACIF S008 2006	Requirements for authorized cabling products
ACIF S009 2006	Installation requirements for University of Sydney cabling (wiring rules).
ACA TCPR 2000	Communications Cabling Provider Rules 2000
ACA CRCPR 2000	Competency Requirements for Cabling Provider Rules 2000

International Standards

ISO/IEC 11801	Telecommunications installations-Integrated Telecommunications Cabling Systems for Commercial Premise

If a conflict exists between applicable documents, then the order in the list above shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity.

All documents listed are believed to be the most current releases of the documents; the contractor is responsible to determine and adhere to the most recent release when submitting their RFT for the project.

Applications Supported by the Cabling System

The applications supported by the cabling system shall be those nominated in AS/NZS 3080:2003 Appendix F.

Installation Requirements

Cable and Pathway Installation

All cabling installation and termination shall comply with AS/ACIF S009, AS/NZS 3084, AS/NZS 3000 and the solution vendor requirements.

- Cable pathways shall be independent of any other service and/or support.
- Cable supports such as cable tray and catenaries shall be supported in accordance with manufacturer's instructions using recommended accessories.
- Cable on wire baskets and cable trays/ladders should only be tied to these supports at intervals of 2m or more, using Velcro type ties.
- The maximum fill of a cable tray/wire basket shall not exceed 50%.
- Minimum clearance between the top of cable trays/wire basket and other objects / surfaces should be 300mm.
- The minimum bending radius of the pathway should not be less than the width of the tray or diameter of the conduit.
- Cable placed on non-continuous cable supports such as catenary wires shall be supported at intervals not exceeding 1000mm, using Velcro type ties.
- The maximum number of cables in a bundle on a catenary wire shall not exceed 24 x 4 pair cables.
- Perimeter pathways and modular furniture pathways fill shall not exceed 40% fill at the initial install, up to a maximum of 60% fill after new additions.
- All pathways shall have sharp edges removed.
- Minimum separation between communication cable (pathways) and non-electrical hazardous services shall not be less than 100mm.
- Metallic pathways may be connected to the CES.
- Minimum clearance between pathways and other objects is 300mm.
- In access / raised floor installations, pathways shall be clearly defined. It is strongly recommended to use cable tray/wire basket/J-hooks to support communication cables.
- Minimum cable run shall be greater than 15m.
- Maximum balanced pair cable run shall not exceed 90m.
- When consolidation points are used, the minimum distance between consolidation points and patch panel shall be 15m or more.
- Minimum recommended distance between consolidation point and telecommunications outlets is 5m.
- Splices are not permitted in a copper cabling installation.
- Bridged taps shall not be used.
- No cable stapling is permitted.
- Communication cables shall not be attached to any other service support.

- Backbone cables shall be installed separately from horizontal distribution cables.
- Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate inner ducts within conduits
- Where cables are installed in an air return plenum (access floor, etc.), the cable should be installed in conduit, or LSZH cable shall be installed in a plenum inner duct to provide protection to the cable
- Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and separated from the horizontal distribution cables.

.

The minimum bending radius during installation and after termination shall not be less than the following:

- 4 pair cable < 6mm outside diameter: 25mm
- 4 pair cable >= 6mm outside diameter: 50mm

Work Area Installation and termination

All outlets shall be installed in the following manner:

- Minimum copper connecting hardware category used shall be Category 5e.
- There shall be no copper cable slack at the outlet. Any copper cable slack (not exceeding 300mm) shall be provided in the ceiling or raised floor in the form of a goose neck.
- For optical fibre, a minimum of 1m of slack is recommended.
- Minimum untwist at termination shall not exceed 13mm.
- Cable jacket stripping is recommended to be the minimum possible and shall not exceed 75mm after termination.
- Work area outlets are recommended to be terminated at the same level as power outlets (typically 300 mm above finished floor height).
- All work area outlets shall be labelled with a unique and acceptable identification label.

Floor Distributor Installation

Copper termination and management hardware shall be installed in the following manner:

- Cables shall be dressed and terminated in accordance with the recommendations made in the AS/NZS 3080:2003 document, manufacturer's recommendations and/or best industry practices.
- Pair untwist at the termination shall not exceed 13mm for Category 5, 6mm for Category 6 and Category 6A connecting hardware.
- The cable jacket shall be maintained as close as possible to the termination point.
- Each cable shall be clearly labelled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties.

Optical Fibre termination hardware shall be installed in the following manner:

- Dust caps shall be installed on the connectors and couplings at all times unless physically connected.
- Cables shall be neatly bundled and dressed to their respective panels or fobots.
- Unjacketed fibre slack shall be neatly coiled within the fibre termination panel. No slack loops shall be allowed external to the fibre panel(s).
- Each cable shall be individually attached to the respective termination panel by mechanical means. The cables strength member(s) shall be securely attached the cable strain relief bracket in the panel.
- Each fibre cable shall be stripped upon entering the termination panel and the individual fibres routed in the termination panel.
- Each cable shall be clearly labeled at the entrance to the termination panel
- No cable stapling is permitted.
- Each fibre optic cable shall be terminated in the Data CD, BD and FDs in 24 port rack mount enclosures providing protection to the terminated fibres.
- The optical fibre patch panel(s) shall each be capable of containing 24 ST connectors in a 1U enclosure.
- The connectors shall be field-installable, requiring no epoxy, or polishing

All optical fibre links shall not exceed the link loss budget for the installed layout.

- Indoor optical fibre cable 10 x cable O/D after install, 15 x cable O/D during install.
- Outdoor optical fibre cable 20 x cable O/D after install, 20 x cable O/D during install.

.

Floor Distributor Interconnect / Cross-Connect Termination Hardware

- The floor distributor for data circuits shall consist of patch cords from the horizontal Category 5/6/6A termination panels to the network equipment within the same or adjacent racks.
- The distributor shall be contained in 2.1m high, 600mm wide and 800mm deep or as required to permit the installation and termination of field cables.
- All passive equipment cabinets / lab racks shall incorporate horizontal and vertical management hardware, both front and rear, to properly dress horizontal cables and patch cords.
- Patch panels shall be 1 RU high and provide 24 modular jack ports, wired to T568A.

- Lab Racks / Cabinets shall be securely attached to the concrete floor using appropriate hardware. All cabinets / racks shall be connected to the Communication earth System (CES) in accordance with AS/ACIF S009.
- Network Equipment cabinets shall be a minimum of 800mm wide and deep enough to protect the equipment from the rear. The space between the equipment

cabinet and the nearest cabinet or wall shall not be less than the depth of the cabinet housing the equipment.

Building / Campus Backbone Links / Channels

- Minimum copper cable category used shall be Category 5 (Category 5e).
- Minimum cable run (shall be greater than 15m).
- Maximum copper cable run (shall not exceed 90m).
- Maximum optical fibre cable length shall not exceed 2000m for total backbone.

Notes:

- 1000 Base SX <=275m for OM1 fibre, 500m for OM2, OM3 fibre.
- 1000 Base LX, <=2000m using only OS1
- For XG SR, <=300m using only OM3 (Laser B/W 2000 MHz.km)
- For XG LX, <=300m using only OM3
- For XG LX, <=2000m using only OS1

Backbone Connecting Hardware.

Appendix B provides details for the installation, termination and testing of the voice and other low bandwidth applications. Appendix B specifies a stand-alone cabling system, independent of the normal structured cabling system.

Separation between parallel runs of Communication Cables and Power Cables

- Separation between copper communications cable and low voltage power cables (not exceeding 240 volts) shall not be less than 50mm unless separated by a solid barrier of durable (metallic or non-metallic) material.
- Separation between copper communications cable and low voltage power cables (greater than 240 volts and less than 1000 volts) shall not be less than 300mm.
- When copper communications cable (UTP) is enclosed in metal pathways, the separation from low voltage power cables (greater than 240 volts and less than 1000 volts) can be reduced to 100mm.
- Shielded copper communications cable (ie FTP or STP) enclosed in metal pathways may be separated from low voltage power cables (greater than 240 volts and less than 1000 volts) by 50mm or more.

Separation from EMI Sources

Separation between shielded copper communications cable and fluorescent light fixtures shall not be less than 300mm. This minimum separation shall also be maintained from other EMI sources.

Telecommunications Rooms

Telecommunication Rooms (TR) are located within the building(s).

- Each TR shall be at least 10 square metres in size, excluding riser pathways. Only services associated with the telecommunications function are permitted within the TR(s).
- Each TR shall provide space for at least three (600mm wide 800mm deep, 39/45 RU high) cabinets or racks.
- Backbone cable access / reticulation into these cabinets / racks shall be through the top on the specified optical fibre pathway. Redundant backbone should enter the TR from the opposite end of the primary backbone.

Cabinets / Racks LAB RACKS

Cabinets / Lab Racks shall consist of the following:

- 39/45 RU x 600mm x 800mm (19" wide rack), c/w levelling feet.
- Frames are to be of welded steel construction, powder coated, with three adjustable vertical mounting rails to mount accessories.
- Glass front door and metal rear door, with lock. Doors shall close with all patch leads/ cables housed within the cabinet, without being crushed or bent.
- Be provided with removal side panels. The top and side panels shall be solid metal. The two side panels shall be lockable.
- Integrated power rails shall be provided as defined in appendix A (University Requirements Specification).
- Comply with ACMA standards and regulations.
- Be electrically earthed in accordance with AS/NZS 3000 and AS/ACIF S009.
- Contain cable entries, sized to suit the cables specified and positioned to suit site conditions (i.e., cable tray positioning).
- Provide at least 150mm vertical cable management space on any side to suit the size of cables entering and leaving the cabinets or racks.
- Be provided with internal cable trays for the entire height, 200 mm wide on each side.

Firestop Systems

A firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and pressurized water stream.

All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure.

Product Specifications

Firestop systems shall meet the requirements of the BCA of Australia and shall be approved by a qualified Professional Engineer (PE).

Firestop System Installation

All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cabling system acceptance.

Earthing and Bonding

The basic purposes of earthing and bonding are applicable to both unscreened and screened cabling systems:

- Safety: touch voltage limitation and earth fault return path;
- EMC: zero potential reference and voltage equalisation, screening effect.

As long as the currents flow in the earthing system and not in the electronic circuits, they do not have any harmful effects.

Earth System Installation

The Earthing system shall be designed and/or approved by a qualified PE. The earthing system shall adhere to the requirements of the AS/NZS 3000:2000 and AS/ACIF S009:2006 and shall be installed in accordance with best industry practices.

- Installation and termination of the main bonding conductor to the building service entrance earth, at a minimum, shall be performed by a licensed electrical contractor.
- The installation shall be equipped with an appropriate earthing system (such as CES and/or building electrical earth).
- This earthing system shall be used to earth all telecommunications cable shields, equipment, racks, cabinets, pathways, and other associated hardware that has the potential for acting as a current carrying conductor.
- The earthing system shall be designed in accordance with the requirements contained in the AS/NZS 3000:2000 and AS/ACIF S009:2006.

Earthing and bonding all metalwork

In all cases, the electrical installation shall be provided with a main equipotential bonding which connects:

- the main earthing terminal;
- any installed earth electrode or earth electrode network;
- metallic water pipes and other extraneous conductive parts (e.g. metallic construction elements of the building);
- the (main) protective earthing conductors.

All other bondings including the examples listed below should be electrically connected to the main equipotential bonding network to form a mesh network:

- down conductors of lightning protection systems of the building;
- functional earthing conductors (such as TRC);
- interconnecting earthing conductors (e.g. from a nearby building).

For best results the earthing system should be bonded in three dimensions, in particular for multi-storey buildings having a networked data system. The preferred mesh size for a vertical bond is about 3 m to 4 m, particularly in areas with a high concentration of electronic equipment.

Each item of equipment is connected to the earth terminal by its own protective earth conductor (PE).

Earthing and Bonding networks

For most electrical disturbances a mesh of about 3 m per square is sufficient. This forms a mesh bonding network. The minimum structure comprises a conductor (e.g. copper strip or cable) surrounding the room.

The length of the connection between a structural item and the bonding network should not be more than 500 mm, and an additional connection should be added in parallel at another point some distance away.

Bonding straps

For bonding straps, suitable conductors include metal strips, metal mesh straps or round cables. For high frequency systems, metal strips or braided straps are better (skin effect). A round conductor has, at high frequencies, a higher impedance than a flat conductor with the same material cross section. Wide and short bonding straps up to 0.5m are also suitable.

Bonding techniques

Welding or soldering are the best solutions to ensure a very low impedance connection between two parts of a conduit, with a good stability with time. Spot welding, riveting, screwing or bolting are suitable to provide the necessary contact pressure to obtain reliable and durable connections. Nevertheless, these methods require the contact of clean metal surfaces (paint and other non-conducting protective coatings should be removed from the contact areas) and due precautions to avoid corrosion. This arrangement requires periodic maintenance in industrial installations environment.

Earthing at Building Entrance Facility

The Building Entrance Facility/Equipment Room in each building shall be equipped with a telecommunications main Earth electrode. Each telecommunications room shall be provided with a Communications Earth Terminal (CET). The intent of this earthing system is to provide a protective and functional earthing system defined in AS/ACIF S009, as the Communications Earth System (CES) that connects to the building electrical earthing system. This system reduces earth loop current potential between the telecommunications equipment and the electrical system to which it is attached.

Telecommunications Room equipment earthing

All cabinets / racks, metallic back mounts, cable sheaths, metallic strength members, metallic optical fibre enclosures, cable trays, etc. entering or residing in the TR or ER shall be earthed to the respective telecommunications earth terminal (CET) using a minimum 2.5mm^2 stranded copper earthing conductor and compression connectors.

The earthing copper conductor size shall be upgraded based on the largest power conductor feeding any cabinet/rack mount active equipment to handle any potential earth-fault currents.

All wires used for Communications Earthing System purposes shall be identified with a yellow/green insulation. All cables and earth link-bars shall be identified and labeled in accordance with AS/ACIF S009:2006.

Each cabinet or rack shall have a suitable connection point to which the rack framework earthing conductor can be bonded.

Cabinet/Rack connection to the CES shall be accomplished by a dedicated copper earth bar/stud attached to the cabinet/rack. A bond between the earth bar or stud and the rack should exist. The mounting screws for the bar should be of the thread-forming type, not self-tapping or sheet metal screws.

Every structural member of the cabinet or rack shall be earthed. There shall be electrical continuity throughout its structural members, as described below:

1. Welded racks: the welded construction serves as the method of bonding the structural members of the rack together.

2. Bolt together racks: special consideration shall be taken while assembling bolted racks. Earth continuity cannot be assumed through the use of normal frame bolts used to build or stabilize equipment cabinets. Most power is routed over the top or bottom of the rack. Without a reliable bond of all four sides of the rack, a safety hazard in case of contact with live feeds exists. Any paint at the point of contact with assembly hardware shall be removed for an acceptable method of bonding.

3. An alternate method is the use of internal-external spring (tooth) lock washers. Two washers are necessary to accomplish this; one under the bolt head contacting and cutting paint and one under the nut.

Cabinet/rack-mounted equipment should be bonded and earthed via the chassis, in accordance with the manufacturer's instructions. Provided the rack is bonded and earthed as detailed in the previous section, the equipment chassis should be bonded to the rack using the following method:

The cabinet/rack shall be equipped with a separate earthing stud. This should be used with a conductor of proper size to handle any fault currents up to the limit of the circuit protection device feeding power to the equipment unit

Although ac powered equipment typically has a power cord that contains an earth wire, the integrity of this path to earth cannot be easily verified. Rather than relying on the ac power cord earth wire, the equipment shall be earthed in a verifiable manner as described above.

Structured Communication Cabling System Testing

All cabling links / channels shall be 100% tested to verify performance under installed conditions to AS/NZS 3080:2003 and the Manufacturer's certified installer agreement.

UTP/STP/FTP Cabling

If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of the project team for clarification and/or resolution.

- All links / channels covered by the Manufacturer's warranty shall be 100% tested for all parameters, using the test method specified in AS/NZS 61935-1, with a Level 3 test device or better:
- The test device shall carry a calibration certificate not exceeding 12 months. This calibration certificate shall form part of the test documentation.
- All test cords/ personality modules used on the project shall be brand new at the start of the project and presented to the project manager.
- These test cords/personality modules shall only be used on the project and the number of tests performed by these devices shall be documented.
- Any defect in the cabling system installation including but not limited to cable, connectors, feed-through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- Test results shall be downloaded to a database file using an application from the test equipment manufacturer.
- No Marginal Passes / Fails or failed test results are acceptable for a MANUFACTURER warranty.
- Only test results saved in the scanner database are acceptable. These include*lkw, *.dat, *.sdf.
- No text files or hard copies are acceptable.

Parameters tested are to include:

Wire Map, Continuity, Length, Pair-to-Pair Near End Crosstalk (NEXT), Power Sum Near End Crosstalk (PSNEXT), Insertion Loss, Return Loss, Attenuation-to-Crosstalk Ratio Far End (ACR-Far End), Power Sum Attenuation-to-Crosstalk Ratio Far End (PSACR-Far End), Near End Attenuation-to-Crosstalk Ratio (ACR Near End), Power Sum Near End Attenuation-to-Crosstalk Ratio (PSACR Near End) and where applicable, Alien Cross-talk .

The test devices accepted to test the MANUFACTURER warranted balanced cabling system includes the following brands:

- Fluke Networks DSP 4xxx, Fluke DTX1200/1800 using PM06. MicroTest OMNI Scanner I / II.

- Agilent WireScope 350, WSPro
- Lantek 7/7G

For best performance, all test devices should be field calibrated to an accuracy of +/- 1dB from 50MHz to 500 MHz.

Optical Fibre Testing

For optical fibre links / channels, only properly calibrated power meter and light source test equipment is acceptable.

The test devices accepted to test the MANUFACTURER warranted optical fibre cabling system include the following brands:

- Fluke Networks DSP 4xxx, Fluke DTX1200/1800 using PM06. MicroTest OMNI Scanner I / II.
- Agilent WireScope 350, WSPro
- Lantek 7/7G
- King Fisher

The test method shall be AS/NZS 14763-3:2007, (1 test cord method or 3-test cord method).

For backbone testing, the Pass / Fail criteria shall be determined using the link loss budget calculated for each fibre cable length. The link loss budget shall be made part of the test documentation.

- Backbone multimode optical fibre attenuation shall be measured in both directions at both 850 nanometers (nm) or 1300 nm using an LED light source and power meter.
- Singlemode optical fibre attenuation shall be measured in both directions, at 1310 nm and 1550 nm using a laser light source and power meter. Tests shall be performed at both wavelengths in both directions on each fibre.

Administration

The installed cabling shall meet the administration requirements of ACIF S009, AS/NZS 3085.1 and the colour code requirements of TIA / EIA 606A. The installation is a Class xx type, as defined in AS/NZS 3085.1:2004.

- All cables shall be labeled, one label at each end.
- Earthing and bonding shall be labeled as per AS/ACIF S009.
- Records shall be provided in each TR, ER and EF.
- Floor plans (As-builts) should be provided as part of the MANUFACTURER warranty documentation.

System Documentation

The following section describes the installation, administration, testing, and as-built documentation required to be produced and/or maintained by the contractor during the course of the installation.

Cabling System Labelling

The contractor shall use the labelling system defined in appendix A for the cable installation:

- All labelling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labelling scheme.
- Traffolyte labels may be required on medium to large project works, on small installations the label type may be varied by the University of Sydney IT project manager.
- All data communication outlet ports must be labelled at each end.

As-Built Drawings

The installation contractor will be provided with 2 sets of D or E-size drawings at the start of the project. One set will be designated for the central location to document all as-built information as it occurs throughout the project. The central set will be maintained by the Contractor's Foreman on a daily basis, and will be available to the Technical representative upon request during the course of the project. Anticipated variations from the build-to drawings may be for such things as cable routing and actual outlet placement. No variations will be allowed to the planned termination positions of horizontal and backbone cables, and grounding conductors unless approved in writing by the Project manager.

The Contractor shall provide the central drawing set to the Project Manager at the conclusion of the project. The marked up drawing set will accurately depict the as-built status of the system including termination locations, cable routing, and all administration labelling for the cabling system. For smaller installations the outlet ports are to be

marked up by hand onto drawings provided, where there are no drawings are available, then a marked up drawing of the actual room/ rooms shall be completed on A3 paper and handed in with the test results of the outlet points.

Test Documentation

Test documentation shall be provided in a three ring binder(s) within three weeks after the completion of the project. For smaller installations the test results for the outlet ports shall be handed in on completion of the installation.

Warranty

The contractor shall provide a system and application warranty provided by the cabling solution manufacturer, covering the installed cabling system against defects in workmanship, components, and performance, and follow-on support after project completion.

Installation Warranty

The contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labour and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.

Cabling system Warranty

The contractor shall facilitate a 25-year system performance warranty between the solution provider and the Owner:

- An extended component warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of acceptance.
- The performance warranty shall cover the installed complete cabling system.
- Balanced Pair links and channels shall be warranted against the requirements of AS/NZS 3080:2003and any other standard agreed to.
- Fibre optic links and channels shall be warranted against the requirements of AS/NZS 3080:2003 and any other standard agreed to.

Post Installation Maintenance

The contractor shall furnish an hourly rate with the proposal submitted which shall be valid for a period of one year from the date of acceptance. This rate will be used when

cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall not void the Contractor's nor manufacturer's warranty.

Project Management / General

The contractor shall establish a single point of contact with the University of Sydney who will be responsible for reporting progress and updating the University of Sydney's Technical Representative with issues that the Project Manager shall address to facilitate the cabling system installation:

- The contractor's POC shall provide regular written reports to the University of Sydney's Technical Representative detailing progress.
- The contractor shall maintain the University of Sydney's facility in a neat and orderly manner during the installation of the communications cabling system.
- At the completion of work in each area, the contractor will perform a final cleaning of debris prior to moving the installation crew to the next work area.

Commissioning

Cabling system Acceptance

The University of Sydney's Technical Representative and the solution vendor's representative will make periodic inspection of the project in progress.

- One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling, to inspect the method of cable routing and support, and the fire stopping of penetrations.
- A second inspection will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with Australian standards specifications for jacket removal and pair untwist, compliance with manufacturer's minimum bend radius, and that cable ends are dressed neatly and orderly.
- Upon completion of the project, The University of Sydney's Technical Representative and the solution vendor's representative will perform a final inspection of the installed cabling system with the Contractor's Project Foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package, and that the installation meets the aesthetic expectations of the University of Sydney.

Test Verification

Upon receipt of the test documentation, The University of Sydney reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. University of Sydney testing will use the same method employed by the contractor, and minor variations will be allowed to account for

differences in test equipment. If significant discrepancies are found the Contractor will be notified for resolution.

System Performance

During the period between final inspection and delivery of the test and as-built documentation, The University of Sydney will activate the cabling system. The University of Sydney will validate operation of the cabling system during this period.

Final Acceptance

Completion of: the installation; in-progress and final inspections; receipt of the test and as-built documentation; and successful performance of the system for a two week period will constitute acceptance of the system.

Appendix A

The University of Sydney Communication Cabling Special Requirements and Recommendations

Optical fibre cable, connectors and patch cords

- All installations will use either 62.5/125 micron for multimode and 9/125 micron for singlemode.
- OM3 50/125 micron fibre can only be considered for use in new buildings after consultation with the Data Network Manager of ICT.
- All optical fibre cable shall be consist of a minimum 12 core multimode and 12 core singlemode single sheath cable between any two buildings.
- The existing University Campus infrastructure is installed using ST connectors for both singlemode and multimode terminations. All future installations should follow the existing infrastructure and will terminate on ST connectors.
- The ST connector shall have a metal body and ceramic ferrule. The ST connectors shall comply with the latest version of AS/NZS 3080.
- SC, LC, SC/APC and LC/APC connectors can only be considered for use after consultation with the Data Network Manager of ICT.
- All singlemode patch cords shall be Yellow.
- All multimode patch cords shall be Orange or grey.

Balanced cabling (UTP) and Telecommunications outlets (TOs)

Unless otherwise specified, all cabling (cable, connectors, distributors/patch panels, patch cords) shall be UTP. For moves, adds and changes in existing horizontal and backbone installations, Class D (Category 5) can still be used until further notice.

For new buildings or complete rewiring, Class E (Category 6) must be used.
The cable termination scheme shall be the T568A. (Refer AS/NZS 3080 Appendix ZA).

- In the office space, 3 outlets per work station shall be installed.
- In the laboratory environment, 1 outlet per workspace + 20% shall be installed.
- In the teaching areas, lecture theatres and research laboratories, the number of outlets per work area shall be as indicated in the drawings provided.
- In other spaces, including storage space, circulation spaces and plant room, the minimum number of telecommunications outlets is two, plus one outlet per 6 sqm.

Any variations need to be approved by the Data Network Manager of ICT.

UTP Patch cords

For Ethernet applications, all patch cords shall be blue or grey. Other colours shall be used for special applications as follows:

Red: For Crossover Ethernet & Alarm
Green: For Non-Ethernet data services (RS232, ISDN and special communication cable)
Yellow: For Temporary services (testing use, etc.)

Communication cabinets, racks in Telecommunication Rooms housing BDs, FDs.

Only floor mount communication cabinets/LAB RACKS shall be used where possible. Wall mount cabinets should only be used where it is not possible to use floor mount units.

- These cabinets shall be 600 mm wide by 800mm deep x 39/45 RU high.
- All communication cabinets shall be supplied with front and rear mounting rails.
- The mounting rails shall be installed to provide a minimum of 150 mm spacing between the rails and the doors allowing for transceivers and patch cords etc. to extend from the switches.
- The front of the cabinet shall have a clear (plexiglass) door.
- Both front and back doors should be lockable.
- A minimum of 1m clearance shall be provided in front and rear of cabinets and frames.

Cable management

It is a university requirement that cable management be installed for every two patch panels, ensuring minimum stress on the patch cords. For two cabinets, a vertical cable management system should be used between the two cabinets.

- Samples of proposed cable management systems shall be supplied to ICT for approval prior to installation.
- Vertical cable within a cabinet shall NOT protrude into the active equipment area (between mounting rails).
- Cable slack shall be stored near the rack, in the ceiling or under the floor. All efforts should be made to keep cable slack out of the rack
- No coils are permitted for copper cable. For UTP cable, the minimum slack is 1.0m.
- For Optical fibre cable a minimum of 2 m of slack shall be provided at each end.

Power Rails in cabinets and Racks

A minimum of six power outlets shall be installed in small racks and eighteen power outlets in larger racks. Each rack shall be supplied with a dedicated 15 Amp circuit or greater.

The power rail shall be connected to the power circuit by an industrial type plug-socket arrangement.

Skirting ducts

Unless otherwise stated, use 2 channel duct, providing metallic shielding, approved by the University, and capable of supporting 8-way modular outlets (RJ-45) and faceplates.

Labelling

Self adhesive or Traffolyte labeling shall be used at all work area outlets, cabinets/racks, patch panels and UTP cables. Self laminating wrap around labels shall be used for optical fibre cables.

Telecommunication outlets

All UTP wall outlets shall be labelled with the following two items.

Top of label:

1. Rack located room number,
2. The sequential number of Rack,
3. Vertical number of Patch panel
4. Sequential horizontal port number on Patch panel

Bottom of label:

1. Outlet located room number
2. The sequential number

Example:
Rack located in room 419a, rack 1, and patch panel vertical number 9, Sequential horizontal port number on Patch panel 24.
Outlet located in room 317. Sequential number 2.

Top of label: 419a. 1. 9. 24
Bottom of label: 317. 2

Patch panel in the rack

All UTP outlets in the rack shall be labelled with the following items.

1. Outlet located room number
2. Sequential numbers,

Example: Outlet located in room 317, sequential number 2 should be labelled 317. 2

Patch panel to another patch panel

Each patch panel port shall be labelled the following items of destination.

1. Vertical number of patch panel,
2. Sequential horizontal port number on patch panel.
3. Destination Rack number.

If the patch panels are in different telecommunication rooms then the room's number shall be labelled on the left side of the patch panel

Example: To patch panel vertical number 1 at rack B, sequential horizontal port number on patch panel 24
Labelling on the left side at patch panel of rack A: 1 - 24 Rack B

Rack - Rack rail / Patch panel

Label the sequential number of the patch panel on the left side of the patch panel / vertical rail.
Example: 1, 2, 3, 4

Rack Identification

Label shall be installed in the middle at the top of the rack as per the following:
Rack - Building number – Room number (optional) – rack sequential numbers. If all racks are in the same room in the building, then the room number need not be included.

Example: Rack – H08 – 8

Optical fibre

At the patch panel, the size of the label shall be no less than 3 cm x 2.5 cm.

For building to building connections, label the cable sequential number and building code of destination in the patch panel and on the cable near the patch panel.
Example: Cable sequential number C1 to A14 (at F09): C 1 to A14

If the cable has been spliced, then the destinations shall be labelled at either end of patch panel and cable to show the final termination point. Splice information shall be labelled at patch panel indicating the cable number and cores spliced.

For connections within a building, label the following information on the patch panel and on the cable near the patch panel.
Example: F05 / rm.110a to rm.419a

If the cable is important then cable sequential number could be mentioned.
Example: C801, F05 / rm.110a to rm.419a

Campus optical fibre cable

Each outdoor optical fibre cable shall be labelled in the pit with the cable number, destination and shall also be labelled “Optical Fibre – Caution” with a contact phone number for ICT, in order to indicate the optical fibre identity.

Example: Cable sequential number and both ends of building cord, c1, F09 to A14.
C 1 - F09 to A14
Optical Fibre – Caution ICT, 9351 5140

In special areas such as corridors, ceiling spaces:
Example: Optical Fibre - Caution, ICT, 93515140:

Testing

Outdoor voice UTP backbone cabling

The test is to be done in accordance with ACA TS 008:

- The insulation resistance is to be tested on a minimum of two randomly picked pairs in every 100 pairs.
- The capacitance is to be tested on a minimum of two randomly picked pairs in every 100 pairs. The maximum value shall not exceed the nominal value by more than 15%.
- The loop resistance of each pair is to be tested with the lowest and highest readings recorded. The difference between the lowest and highest readings not to exceed 10%.

Indoor Riser Voice UTP cabling

The loop resistance of each pair is to be tested with the lowest and highest readings recorded. The difference between the lowest and highest readings is not to exceed 10%.

Pathways

Galvanized steel trays manufactured to AS 1650. Minimum thicknesses are as follows:

For trays up to 150mm wide	1.0mm
For trays from 150mm wide to 300mm wide	1.2mm
For trays over 300mm wide	1.6mm

- The folded edge shall be a minimum height of 20mm radii.
- The slotting on steel trays shall be normal or reverse with no burrs or sharp edges on the side where cables are attached.
- Maintain at least 200mm clearance from hot water pipes and 500mm clearance from boilers or furnaces.

Outdoor and external surface mounted cabling

Underground and external surface mounted cabling shall be reticulated in the existing campus pit and conduit system. Contractors shall contact the Project Officer to determine space availability within existing conduits and appropriate routes. Cables intended for underground use shall be suitable for the purpose.

Heavy duty, white conduits and fittings shall be non-metallic, PVC type. There shall be a minimum of two x 100mm diameter conduits for each run between two buildings. Use cemented joints. Adopt the manufacturer’s recommended procedure for making joints.

Where possible, have conduits preformed by the manufacturer. At site, use correctly sized springs to form sets in UPVC conduit. Bends shall be of large radii and, after setting, shall maintain effective diameter and shape. Reject conduit sets distorted by kinks, wrinkles, flats or heating.

Install flexible couplings where structural expansion joints occur in buildings and in straight runs not embedded in wall chases or floor slabs. Space the flexible couplings in straight runs at intervals of not more than 4m. Install conduit saddles close to the flexible coupling in a manner which allows free movement for expansion and contraction.

In situations where the conduit is exposed to mechanical damage and external to buildings, provide mechanical protection to UPVC conduit at a height of not less than 3m above ground or platform level.

Cable and conduit supports

Bends, connectors, trays, ladders, brackets and other supports necessary to make a complete cable or conduit support system shall be of the same manufacture and sized to adequately support the installed cable.

Cable pits

- Requirement: Provide draw-in pits where shown on drawings. The sizes shown refer to the inside dimensions.
- Construction: Walls and bottom shall be rendered brickwork, 75mm thick concrete moulded or moulded fibre cement. Incorporate an additive to render or concrete to prevent the ingress of water.
- Moulded fibre cement pits: The minimum size of moulded fibre cement pits or telephone plastic pits shall be 600 x 300 x 600mm deep, unless otherwise specified.
- Plastic pits: Plastic pits can be used in grassed and foot pass way areas only. They are not used on roadways.
- The letter “C” or the word “COMMUNICATIONS” shall be moulded into the lid where used for communications. The pits shall be bedded with a minimum of 100mm gravel aggregate.
- Drainage holes: Provide each pit with a drain hole in the base, positioned to drain into a drainage pit.
- Drainage pits: Provide a drainage pit filled with rubble, graded away from each cable pit for 2000mm.The minimum size of the drainage pit shall be 300mm wide by 300mm deep.

Trenching

- Requirement: Excavation plans shall be submitted to the Building and Grounds Manager prior to excavation.

- Roadways: Do not excavate roadways and driveways. These areas are to be underbored. Locate other services before proceeding with trenching. Locations of existing services can be obtained from the Building and Grounds Manager.
- Specification references: Protection of persons and property - preliminaries, service trenches - groundwork and excavation in public areas groundwork.
- Existing surfaces: Saw cut existing concrete or bitumen surfaces in a straight-line to a depth of 75mm before excavation is commenced. Lift and store paving slabs for later reinstatement.
- Excavation: After excavation, clear trenches of sharp projections. Installation depth shall be referred to ICT when rock is encountered in the excavation.
- Excavation commences beyond site: Notify and obtain approval from the University before excavation. Carry out the excavation to the University's requirements.
- Reinstate the surface to the match existing. Approval shall be obtained from appropriate authorities prior to excavations beyond site boundaries.

Cable in trenches

- Draw cords: Provide polypropylene draw cords in all conduits.
- Sand: Provide clean sand around cables and conduits installed underground. The sand is to be flooded with water floors installation to achieve maximum compaction levels.
- Underground roadways: Under roadways and areas subject to traffic movement, install cables in a duct or conduit extending to not less than 1m on either side of the sealed surface or trafficable area and encase in concrete having a minimum cover thickness of 100mm.
- Sealing ducts conduits: Seal the buried entries to ducts and conduits with a pliable AND non-setting waterproof compound. Seal spare ducts or conduits immediately after installation and seal the others after the cable installation.

Backfilling trenches

- Garden areas: Backfill the top 150mm of the trench with topsoil.
- Lawn areas: Re-loam the top 150mm and resow trenches passing through existing lawns.
- Excess soil: Remove from the site unless otherwise directed.
- Existing assets: Reinstate existing surfaces and assets distributed or removed as a result of the excavation of trenching.
- Concrete surfaces: Reinstate concrete surfaces to the original level using approved reinforcing steel, keyed to the existing and laid to prevent reinstalled concrete from subsiding and cracking.
- Bitumen surfaces: For existing bitumen surfaces, camber the reinstated surface so that the edges are flush and the centre is 10mm above the existing pavement. Fill the top 150mm below the bitumen surface with mechanically compacted finely

crushed gravel. Prime coat the existing bitumen edges of the trench with bitumen prior to laying 75mm minimum of hot pre-mix bitumen to the finished cambered surface. If it can be shown that the pre-mix is not available, cold pre-mix will be accepted.

Wall mounted enclosures

Standard size wall mounted enclosures shall be of the same material as the conduit. Where special size boxes are specified and where such boxes are not obtainable in UPVC, prefabricated metal boxes can be used. Use inspection-type fittings in accessible and exposed locations.

Documentation

All communication cabling planning works and requirements shall be fully documented prior to any work commencing. When the work is finished, these documents shall be completed with details required by each specification. The documents are to include test results, cable pathways, space etc.

A hard copy of all final documents shall be provided at the completion of the project in a hardbound folder. Additionally, an electronic copy of all documentation including AutoCAD compatible plans is needed.

Diagrams shall be kept of both indoor and outdoor infrastructure as per AS/NZS 3085.1.

Commission and Acceptance

The contractor shall supply commissioning and preliminary test data to the Project Officer not less than seven (7) days before acceptance tests are scheduled to commence. ONLY PASS test results will be acceptable (No marginal test results will be accepted).

It will NOT be deemed complete until such time as those documents and commissions have been accepted by the Project Manager.

Appendix B

Class D/E/EA System Performance Specification

General Layout

The University of Sydney's buildings / floors vary in function, size and layout. The majority of personnel are/will be situated in an open office / fixed office environment making use of modular office furniture, with some hard wall offices typically around the exterior of the floor.

Telecommunications System Description

The requirement is for a minimum of two communication channels to each user as a standard configuration:

- The two communication channels are provided via two Class D/E/F copper links comprising two, four pair Category 5/6/7 cables, each terminated in 8-way outlets at the work area.
- Horizontal cables are terminated on rack-mounted and/ wall-mounted Category 5/6/7 patch panels.
- All data links are interconnected to LAN electronics within each Floor Distributor.
- Horizontal low bandwidth (e.g. voice) links are cross-connected to backbone riser patch panels within each Floor Distributor. (Note: when VOIP is selected, the latter may not be required.)
- Where applicable OM1/2/3 fibre optic backbone is employed between the data Campus Distributor/Building Distributor and each Floor Distributor for data connectivity, and four pair, Category 5 CMR riser cables are employed between the low bandwidth (e.g. voice) CD/BD and each FD for low bandwidth (e.g. voice) connectivity.
- Within the data CD/BD and the FDs, backbone fibre strands are terminated and housed in rack-mount fibre optic enclosures.
- Within the low bandwidth (e.g. voice) CD/BD and the FDs, backbone copper pairs are terminated on wall-mount 110Connect XC termination frames.

Horizontal Cabling

The Horizontal Cabling Subsystem extends from the work area telecommunications outlet/connector to the floor distributor in the Telecommunications Room.
Horizontal distribution cable for data circuits shall be 4 pair Category 5/6/6A, CMR rated cable as required. Quantities of cables shall be made available in a Bill of Material.

Cable Types

All UTP/FTP/PIMF cables shall conform to AS/NZS 3080:2003 Standard, in accordance with the University of Sydney requirements specification (Appendix A).

- All cables shall be appropriate for the environment in which it is installed.
- Where used, shielded cables shall be earthed at one end, in the Telecommunications Room.
- All cables shall be made by an ISO 9001 and 9002 Certified Manufacturer.

Cable Specifications

Category 5 Cabling – LSZH

Cable shall be 24 AWG, 4-pair UTP, UL CMR or LSZH rated, with an elastomeric jacket. Cable jacketing shall be lead-free. Cable shall be 3rd party verified to AS/NZS 3080:2003 or ISO/IEC 11801 2nd edition. Cable shall be supplied in reel-in-box.

Category 6 Cabling – LSZH

Cable shall be 23 AWG, 4-pair UTP, UL CMR or LSZH rated, with an elastomeric jacket. Individual conductors shall be PE insulated. Cable jacketing shall be lead-free. Cable shall be 3rd party verified to AS/NZS 3080:2003 or ISO/IEC 11801 2nd edition. Cable shall be supplied on wooden reels or in reel-in-box. Cable shall be made by an ISO 9001 and 9002 Certified Manufacturer.

Category 6_A Cabling – LSZH

Cable shall be 22 AWG, 4-pair PiMF, UL LSZH rated, with an elastomeric jacket. Individual conductors shall be PE insulated. Each pair shall be individually screened with a polyester-aluminium laminate, foil on the outside. An overall braid screen shall cover the four screened pairs. Cable jacketing shall be lead-free. Cable shall be 3rd party verified to AS/NZS 3080:2003 or ISO/IEC 11801 2nd edition. Cable shall be supplied on wooden reels or in reel-in-box. Cable shall be made by an ISO 9001 and 9002 Certified Manufacturer.

Work Area Connecting Hardware

Each outlet location, unless otherwise noted, shall be installed with two Category $5/6/6_A$ cables. Each cable shall be terminated on an 8-position, 8-conductor jack to the T568A wiring scheme. The outlet plates, unless otherwise noted, shall be mounted to single gang boxes, surface mount boxes and/or floor monuments (3rd party) as required.

Modular Jacks (Category 5/ 6)

All modular jacks shall be wired to the T568A wiring pattern. Modular jacks shall be terminated using a 110-style pc board connector , color-coded for both T568A and T568B wiring. The 110 connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of 1.27 mm. The modular jack contacts shall be plated

with a minimum of 50 microinches of gold in the contact area over a 50 microinch minimum nickel underplate. Modular jacks shall be compatible with panel thicknesses of 1.47mm – 1.60mm. Modular jacks shall snap into a 20.1mm X 14.8mm opening. Modular jacks shall be UL Listed.

Modular Jacks (Category 6_A)

All Category 6_A modular jacks shall be terminated to the T568A wiring pattern. The 8-way modular connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of 1.27 mm. The jack contacts shall be plated with a minimum of 50 microinches of gold in the contact area over a 50 microinch minimum nickel underplate. Category 6_A non- modular jacks shall be keyed 4-pair and shall meet the performance requirements specified in IEC 61076-3-104. The jacks shall fit in a 20.1mm X 14.8mm opening. Category 7 non-modular jacks shall be UL Listed. Category 7 non-modular jacks shall be MANUFACTURER part number 336480-X (X indicates color).

Modular Furniture Communication Outlets

Use appropriate modular furniture faceplates determined by modular furniture brand. There shall be two Category $5/6/6_A$ cables terminated as per manufacturers' instructions. The faceplate(s) shall be mounted in the appropriate knockout(s) in the furniture channel.

Flush mounted Communication Outlet Faceplates

These shall be a minimum of 2-port, flush faceplates. Faceplates shall be 115.1m x 70.4mm x 15.24mm in size. Each faceplate shall contain two Category 5/6/6A jacks. There shall be two Category $5/6/6_A$ cables terminated in the back of the jacks. Each port shall be provided with an icon to indicate its function. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Faceplates shall be white in color or as required

Patch Cord Cable Assemblies

Patch cords used at the telecommunication rack and at the workstation shall be Category $5/6/6_A$, 4-pair assemblies. Patch cords shall be factory-assembled by the manufacturer of the cabling system. Each workstation shall require one x 1m Category $5/6/6_A$ patch cord. The telephone cords shall be provided by the owner.

In the FD, 2m-, 3m-, and 5m- patch cords shall be provided to cross-connect between the data patch panels and network equipment. One patch cord per user outlet is provided.

Optical patch cords shall be provided to patch the network equipment to the enclosures and shall be 1 meter in length. Optical fibre patch cords terminated in the appropriate connectors shall be provided depending upon LAN electronic interface.

Backbone Cabling

Copper

Low Bandwidth application backbone cable (such as voice) shall be 24 AWG, 4-pair UTP, UL/ CM rated, with a plastic jacket. The cable shall be third party verified to comply with AS/NZS 3080:2003 Category 5 requirements. The cable shall be supplied on 305m reel-in-a box.

Appendix C

Optical Fibre Backbone Cabling Specification

Cable Types

All optical fibre cables shall conform to AS/NZS 3080:2003 Standard for Customer Premises specifications:

- All cables shall be appropriate for the environment in which they are installed.
- All cables shall be made by an ISO 9001 and 9002 Certified Manufacturer.
- Maximum optical fibre cable length shall not exceed 2000m for total backbone.

Note:

- 1000 Base SX <=275m for OM1 fibre, 500m for OM2, OM3 fibre.
- 1000 Base LX, <=2000m using only OS1 based on the difference in transmitter power and receiver sensitivity if devices are changed.
- For XG SR, <=300m using only OM3 (Laser B/W 2000 MHz.km)
- For XG LX, <=300m using only OM3
- For XG LX, <=2000m using only OS1

Outdoor Loose Tube Gel filled Cable

All multi-loose tube cable constructions consist of (twelve, twenty-four, thirty, thirty-six, forty, forty-eight, sixty, seventy-two] primary coated 250µm [9/125 µm, 50/125µm or 62.5/125µm] fibres. Each construction incorporates colour-coded fibres contained in gel filled loose tubes, stranded around a GRP central strength member, sheathed with LDPe and optionally over-sheathed with nylon material (termite protection) for outdoor applications.

Indoor Multicore Distribution Cable

Twelve core multimode and 12 core singlemode (in one cable sheath) fibre optic cable shall be utilized to provide backbone connectivity between the CD and each TR. The optical fibre cable is all-dielectric and shall consist of (twelve, twelve), 900µm tight-buffered (9/125 µm, 62.5/125µm) fibres surrounded by aramid strength members and a PVC (optionally LSZH) outer jacket.

The cable jacket colour shall be as defined in the University Requirements Specification (appendix A). The cable is UL OFNR rating or ETL listed and complies with AS/ACIF S008:2006.

Connecting Hardware

ST

The optical fibre multicore duplex connector shall be the ST connector.

- It shall be capable of terminating 250 micron (outdoor) or 900 micron (indoor) buffered fibre in a metal housing in accordance with AS/NZS 3080:2003 Premises Cabling Standard.
- The ST connector shall utilise a precision ceramic ferrule and be AS/NZS 3080:2003 and ISO/IEC 11801 Compliant.
- It shall be made by an ISO 9001 and 9002 Certified Manufacturer.

SC

The optical fibre multicore duplex connector shall be the 568SC connector.

- It shall be capable of terminating 250 micron (outdoor) or 900 micron (indoor) buffered fibre in an outer housing colour-coded (blue or green for SM, or beige for MM) in accordance with AS/NZS 3080:2003 Premises Cabling Standard.
- The 568SC connector shall utilise a precision ceramic ferrule and be AS/NZS 3080:2003 and ISO/IEC 11801 Compliant.
- It shall be made by an ISO 9001 and 9002 Certified Manufacturer.

Angled SC (SC/APC)

Optional LC

LC connector shall comply with the specifications for optical fibre connecting hardware specified in AS/NZS 3080:2003 be manufactured by an ISO 9001 and 9002 Certified Manufacturer.

- It shall be capable of terminating 250 micron (outdoor) or 900 micron (indoor) buffered fibre in an outer housing colour-coded (blue or green for SM, or beige for MM) in accordance with AS/NZS 3080:2003 Premises Cabling Standard.
- The LC connector shall utilise a precision ceramic ferrule.
- LC connectors shall be AMPNETCONNECT or equivalent.

Patch Cord Cable Assemblies

- Optical fibre patch cords shall be provided at the telecommunication rack / cabinet.
- Optical patch cords shall be provided to patch the network equipment to the enclosures and shall be at least 1 m in length or as appropriate.
- ST (SC-D/LC-duplex, where specified) terminated optical fibre patch cords shall be provided depending upon the LAN electronic interface.

Optical Fibre Building Backbone Cabling

Indoor type optical fibre cables shall be installed within the customer building(s) as the building backbone medium, connecting between the Building Distributor(s) and all the Floor Distributors within the building(s). The building backbone layout follows the hierarchical Star topology.

- The optical fibre cables shall be shall be terminated in optical fibre enclosures (FOBOTS) mounted the rack / cabinet placed in the relevant communication rooms.
- Fault-tolerant redundant optical fibre backbones shall be installed on redundant (geographically diverse paths) cable pathways between the Building distributor(s) and Floor Distributors. The cable pathways shall be completely enclosed duct or tray system, either metallic or non-metallic as approved by the Customer.
- Provide at least two metres of slack at the distributor adjacent to cabinet /rack mount enclosure. The optical fibre cable(s) shall be terminated on rack mount optical fibre enclosure(s) (1RU or 4RU as per detailed cabinet/rack layout) at the top of the cabinet / rack.
- All single mode optical fibres shall be fusion spliced to the required connecting hardware. Multimode mode optical fibre may be directly terminated (preferred) or fusion spliced.
- All fusion spliced cables shall be spliced to simplex pigtails. The pigtails should be at least 2 metres long to allow for proper management in the cabinet mounted splice tray.
- All pigtails shall be labelled.

Campus Backbone

Campus Optical Fibre Cable

Outdoor type optical fibre cables shall be installed between the customer building(s) as part of the campus backbone cabling system within the campus). The campus backbone layout follows the hierarchical Star topology.

Fault-tolerant redundant optical fibre backbones shall be installed on redundant (geographically diverse paths) cable pathways between the Building distributor(s) and Floor Distributors. The cable pathways shall be completely enclosed duct or tray system, either metallic or non-metallic as approved by the Customer.

The optical fibre cable shall be composite multimode and single mode fibre cable as defined in appendix A University requirements specifications.

- The cable shall be gel filled, polyethylene sheathed, nylon over-sheathed, Optical Fibre cable.
- All underground pathways shall consist of at least two x 100 mm diameter telecommunication conduit and draw rope.
- All underground pathways shall be installed in accordance with AS/ACIF S009, unless otherwise specified.
- Conduit and ducts shall be installed over routes as agreed by the Project Manager.

- Underground pathways shall be constructed to avoid the moisture or fluid traps.
- The lowest point of the underground pathway run shall be drained.
- The underground pathway shall be properly secured by an approved method.
- All telecommunication conduits shall be white.
- All wall, floor and ceiling penetrations shall be as small as practical to accommodate the required conduit.
- All penetrations shall be sealed with approved fireproof packing after installation of wiring through fire rated barriers so that integrity of the fire rating is maintained.
- All penetrations shall be appropriately sealed to prevent vermin entering or passing through the penetration.
- The minimum diameter of external building penetrations shall be sufficient to permit the entry of 100mm conduit.

Pits

- Plastic membrane is to be installed over pit lids to prevent ingress of moisture and vermin.
- Pits shall comply with AS/ACIF S008
- Pits shall be able to withstand vehicular traffic such as is to be expected on road verges or in landscaped areas.
- Cable pits shall be installed at every change in direction, at every building entry, and along straight conduit runs as indicated in the proposed route design drawings.
- Pits shall be installed according to the manufacturer's handling and installation specifications, in accordance with AS/ACIF S008.
- Pits shall be provided with drainage or sealing of ducts to prevent entry of moisture, gas or water through the ducts, into the pit and flooding into the building.

Installation of Campus Optical Fibre Cabling

- External cabling is to be hauled through;
- External optical fibre cable shall, unless otherwise specified, be routed inside the building on cable tray/ladder;
- All splicing external to buildings are to be made in existing or new splice pits;
- The external splice kit shall be loaded with sufficient splice trays for the purpose;
- All splicing equipment internal to buildings shall use Sydney University approved splice cassettes.
- Maximum splice loss shall not exceed 0.1dB at all wavelengths.
- All pigtails used to splice incoming cables shall be terminated in LC/SC/APC connectors.
- Labels shall be fixed to the cable sheath where the cable enters and exists a pit with cable ties;
- Each tube of the loose tube gel-filled cable shall be labelled with a water proof label at the at splice point.

Optical Fibre Cable Testing

The following optical fibre testing requirements shall be followed:

- The Cabling Contractor shall follow the test procedure defined in AS/NZS ISO/IEC 14763.3 and supply in details of the testing devices.
- Reference test cords shall be used for testing.
- all testing shall be bi-directional;
- testing shall be performed using Light Source Power meter test set to measure the length and insertion loss in both directions at 850nm and 1300nm for multimode and 1310 and 1550 nm for singlemode, for each core;
- For backbone testing, the Pass / Fail criteria shall be determined using the link loss budget calculated for each fibre cable length. The link loss budget shall be made part of the test documentation.
- The Cabling Contractor is required to give the Project Manager one week notice of the intention to carry out testing.

Test results for each fibre link shall be provided in electronic format

Appendix D

Telephone Cabling Specification

The material in this document is a mandatory standard for the University of Sydney. The cabling system defined in this appendix requires compliance to AS/ACIF S009 and AS/NZS 3080:2003. In some un-refurbished areas, the telephone cabling system does not comply with AS/NZS 3080:2003.

Where specifications in this appendix, conflict with specifications in the **The University of Sydney Communication Cabling Special Requirements and Recommendations**, this document will take precedence. Known conflicts are:

- The permissible colours for UTP patch cords
- The required tests for telephone cabling

1.1 Introduction

This appendix details the telephone cabling system specification. The telephone cabling system is a stand-alone system, consisting of voice grade twisted pair cables, reticulated from the campus MDF and PABX equipment to the communications infrastructure in University buildings. This infrastructure supports the following applications:

- analogue PABX
- digital PABX
- security alarm systems
- fire and emergency control systems
- RS-485 telemetry communication systems
- Communications carrier services such as analogue telephone, ISDN and ADSL

1.2 Definitions

TTC "Traditional telephone cable(s)"	voice grade twisted pair cable(s).
Krone frame	A traditional telephone distribution frame with ADC Krone Series 2 disconnection modules.
UBMDF "University Building MDF".	A Krone frame similar to an MDF, except that the lead-in cables may all be customer cables owned by the University and its allied organisations. A UBMDF does not usually have a "carrier side".
Voice Tie cable	A voice-grade cable connecting voice grade twisted pairs on a UBMDF to a modular (RJ-45) distributor of a structured wiring system in a communications room.

Special service	A lift telephone, fire control system, security alarm or telemetry system supported by TTC.

Topology

TTC is used in two different topologies in the University:

- legacy telephone cabling topology
- structured cabling topology with voice tie cables

Legacy telephone cabling topology

In some older buildings, most or all of the space is still served entirely by TTC. In this case, a telephone handset in the work area is patched into a 600 Series wall socket, served by a two pair TTC from an FDP, connected to the UBMDF by a 10 pair or 25 pair TTC system.

While almost every University building has a structured wiring system installed, new horizontal cabling in un-refurbished areas was provisioned to provide data communication services only. The voice cabling and data cabling systems have continued to be maintained separately. There are no cross-connections between the new communications rooms and the UBMDFs.

In these un-refurbished areas, it is routine practice to maintain the legacy telephone cabling system and to add, move or change extensions as required.

Special services shall always be installed to current structured cabling standards, as described in this appendix.

Standard-compliant structured cabling topology cross-connected to voice equipment

All new University buildings and refurbished areas of older buildings are fitted with a standard-compliant structured cabling system, providing enough telecommunications outlets to support both voice and data communications. All voice outlets terminated on the floor distributor (modular (RJ-45) patch panels) in these telecommunications rooms are cross-connected to the voice-grade backbone cable (TTC tie cable) back to the UBMDF.

In this topology, the only "general use" Krone frame is the UBMDF. TTC SHALL not be used to connect normal telephone services in these areas. TTC SHALL only be used for special services as described below.

The most common application is a lift telephone, which will terminate on a small Krone frame at the lift motor room.

Cabling Administration Policy for areas with access to both cabling topologies

Some un-refurbished areas have a full legacy telephone cabling (TTC) topology. These areas may also be cross-connected to a voice tie cable via the structured wiring system installed for data connections.

This situation is normally a side-effect of the refurbishment of an adjacent area. The refurbished area is installed with a full structured cabling system, requiring a voice tie cable to the distributor in the telecommunications room. Older structured wiring which terminates in the same communications room thus gains access to a voice tie cable, even though the older wiring was not installed for telephone use.

In areas of this type, the structured cabling system is **reserved for data connections.** The legacy telephone cabling (TTC) SHALL continue to be used as much as possible. Services supported on TTC may only be connected to the structured wiring with the permission of the Data Network Manager.

Follow these guidelines to protect the University's investment in structured CABLING while minimising future investment in TTC:

- These are temporary situations. The University's refurbishment program will eventually replace the TTC with a standard compliant structured cabling system.
- Use long 600 series extension cords within a room.
- Use the spare pair in an existing two pair cable to provide another socket in the same room. Install TTC within the room when a voice outlet is moved to a new location or a new one added.
- When existing TTC to a room is not available, permission from the Data Network Manager is required to use the structured cabling sparingly. As Class D or Class E cabling can support multiple telephone services on one 4-pair cable, pair splitters and long handset leads can be used to leave as many outlets for data connections as possible.
- DO NOT install new TTC to a room from a Krone frame in another room . New cables to the room SHALL be part of the structured cabling system.

Special Services

TTC **SHALL** be used for **direct** connection to the UBMDF, as shown in Table 1.

Service name	**University contact for service**
Utility Monitoring System (legacy)	Energy and Water Manager
Lift phones	Maintenance Manager

Security systems (legacy)	Security Technical Resources

Table 1. Services with direct TTC connection to University Building MDF

In practice, the only new special services being installed in TTC are lift phones.

The **Fire Alarm Panel** (and sometimes the Sprinkler Pressure Switch) in a building are also cabled directly back to the UBMDF but this cabling is normally red sheath Radox cabling, not TTC.

For the purposes of this standard, it is only necessary to record the fire control communication cabling in the UBMDF record book. Other information is available from the University's Fire Services Co-ordinator.

In Newer buildings, a **Building Management System** is installed instead of a Utility Monitoring System. A BMS consists of Ethernet based devices connected together by a structured cabling system, terminating in the telecommunications room. The BMS is not supported by the TTC.

Cross-connections are not allowed at the UBMDF and FDP for special services. This will prevent accidental disconnections of special services such as lift and security alarms.

The cable for the lift phone SHALL be continuous from the UBMDF to the lift motor room without a break. Special services SHALL be clearly marked in the record book at the UBMDF.

1.4 Minimum capacity of pairs to be installed

Appropriate TTC capacity will be determined by the Telecommunications Manager, taking into account:

- existing spare TTC capacity
- floor space
- structured cabling system capacity
- rack layouts
- 90 m reach to other areas that may later be served from the same distributor
- use of IP phones

Additionally, the Telecommunications Manager will add a minimum of **50% spare capacity for fault redundancy and future expansion,** based on the future needs of the building(s).

TTC Cables between buildings

Each UBMDF shall be connected by a TTC cable to a frame (fan-out point), located (as determined by the Telecommunications Manager) usually close to the nearest PABX Room.

It is recommended that the TTC cable between a UBMDF and the TTC frame (fan-out point) have a **minimum of 50 pairs**.

This should be sufficient for a new building which is to be fitted with IP phones instead of traditional telephones. A building full of traditional telephone handsets will almost certainly need more than 50 pairs.

For areas such as farms, garages, out buildings, less than 50 pairs may be required.

Internal cables to communications rooms

The voice backbone (Voice tie) cable shall have **at least 50% spare capacity** above the estimated future requirements. The voice cross-connect shall be capable of terminating the present and future voice port requirements in that distributor (rack). The voice backbone cable shall have a minimum of **25 pairs**.

This recommended minimum is appropriate for a cross-connect (rack) which will exclusively serve areas with IP phones. A voice backbone (tie) cable is still required so that carrier services to the UBMDF can be connected to the structured cabling system.

In a communications room where structured cabling terminates on more than one rack, a **separate** voice backbone (tie) cable shall be installed from the UBMDF **to each rack.** This provides a tidy patch cord layout. **It is not acceptable to terminate one large pair-count cable across multiple racks.**

Cables for lift phones and other special services

A cable installed to carry a special service shall have **at least 100% spare capacity** above estimated requirements. This results in a spare pair for every lift phone pair that is installed to the lift motor room.

Labelling of traditional telephone cables

The following administration rules apply for all new cables.

Name of telephone cable

- Every new TTC cable containing 10 or more pairs will be uniquely identified by the Telecommunications Manager.
- Every new TTC cable carrying a special service will be uniquely identified by the Telecommunications Manager.
- Every cable shall be labelled by a unique identifier.

- A cable connecting two buildings will be identified by “Tnnn” e.g. "T390". ("T" stands for "Telephone".)
- A cable internal to a single building will be identified by “TQ17-n: e.g. "TQ17-2". ("Q17" is the University building code.)
- Further explanation is given in the section on optical fibre cable labelling section.

Labelling along cable path

TTC shall be clearly labelled. TTC installed on University property or in University-owned ducts, shall be labelled using the methods in Table 2. The labels shall show the name of the cable and the two endpoints.
For example, if the cable name is "T390", the endpoints on the label are the building codes of the two ends. (See example in Figure 1.)

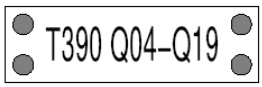

Figure 1. Example of traffolyte label with drilled holes

Figure 2. Example of self-laminating label (before it is stuck on)

If the cable name is "TQ17-2", the endpoints on the label are the room numbers of the two ends. (See example in Figure 2.)

Label location	Label type	Examples of placement
Outdoor	Engraved UV-stable traffolyte, secured to the cable with UV-stable cable ties threaded through drilled holes. Minimum size: 50 mm x 15 mm Hole ø: 4 mm Typeface: 6 mm high Background colour: white Text colour: black	In pits
		Inside enclosures
Indoor	(1) Engraved traffolyte, secured to the cable with cable ties threaded through drilled holes. (details are the same as for outdoor traffolyte labels) or (2) Self-laminating labels, machine printed or neatly printed by hand	Where the cable sheath can be seen leaving a Krone frame or the back of a patch panel
		At each floor level of a riser
		Wherever a cable "disappears" through a wall or ceiling or enters a closed duct
		Inside trunking

Table 2. Labelling methods for TTC

No labelling is required when minor internal extensions to legacy telephone cabling topology are to be installed, such as where there is a new extension in 2 pair TTC from the nearest Krone frame. The record book only needs to be updated.

- Cables for special services (e.g. lift motor room) shall be labelled.
- Labels shall be installed on the day the cable is installed to reduce the need for re-entry in locations, such as road pits, ceiling spaces, and under doors.
- The correct quantity of Traffolyte labels shall be ordered in advance.
- Handwritten self-laminating labels can be used when approved indoors.
- A cable which has a portion split off along its path will require special labelling, as determined by the Telecommunications Manager.
- Cables which are installed on non-University property may have different labelling
- Requirements as determined by the Telecommunications Manager.

Labelling at termination points

Labelling at termination points is described below.

- All TTC shall be Category 3.
- TTC shall follow one of the colour codes defined in Appendix B of AS/ACIF S009:2006.
- All cable pairs shall be terminated in the specified colour sequence.

- The whipping tapes shall be tied around each bundle of pairs at the end of the cable sheath to maintain the bundle identification.
- Internal voice tie cables typically use the code specified in Table B.3 of AS/ACIF S009 S009:2006 (whipping colours are blue, orange, green, brown and grey for each successive bundle of 100 pairs).

Termination hardware

TTC may only be terminated on the following hardware:

- Krone frame
- RJ45 patch panels
- 600 Series socket (as part of a legacy topology)

Cable elements at and near each termination point shall be thoroughly cleaned before installation. All grease, gel, dust or foreign matter shall be removed from the stripped ends of the before termination.

Krone frames

- A UBMDF shall be a Krone frame.
- All special service cables shall terminate on a small Krone frame.
- No other Krone frames shall be installed in a building.
- A Krone frame shall be supplied with adequate jumper rings and horizontal jumper guides.
- All Krone frames shall comply with the regulatory requirements for an MDF as given in AS/ACIF S009:2006 (section 13), except that space will not normally be required for a "carrier side".
- All Krone frames shall be installed in appropriate spaces, with suitable clearances defined for an MDF.
- All disconnection modules supplied shall be **ADC Krone .**
- When expanding a Krone frame, new verticals shall match the existing verticals in height.
- You shall supply jumper rings and horizontal jumper guides to serve the new verticals.

Records at a Krone frame

Every Krone frame in the University shall be provided with a **record book or card.** The records shall be stored out of harm's way. A booklet-type record book should be kept in a record book holder, with no more than two booklets in each holder. The information in the records shall be kept up to date. Records of terminations of a cable shall include:

- the name of the cable
- the size of the cable
- the **exact** destination of the cable, including position on Krone frame or panel numbers on rack.

Examples are given below. These details are normally written sideways on the "cable details" column in the records.

Figure 3. Record book entry for TTC between two buildings

Figure 4. Record book entry for voice tie cable

Figure 5. Record book entry for cable for a special service

Circuits for **special services** and unusual devices, or circuits which terminate in strange locations, shall be clearly described in the records.
All **bad pairs** shall be clearly marked “FAULTY” in the record book.

Labelling on a Krone frame

Krone frames with multiple verticals shall be labelled alphabetically as for an MDF (see AS/ACIF S009:2006 clause 13.12). A vertical capable of terminating more than 100 pairs shall be fitted with **label holders** every 100 pairs and labelled as shown in Figure 6.

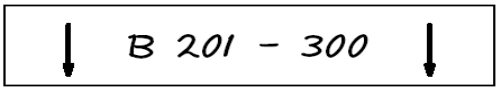

Figure 6. Sample Krone frame label

Dummy plugs and service identification caps

Series 2 dummy plugs and Series 2 coloured service identification caps shall be used to help prevent accidental disconnection of special circuits and emergency telephone services. Any coloured marking cap can be used.

- All jumpered telephone cross-connections shall be protected with a dummy plug at every cross-connection interface.
- The dummy plug is particularly useful for identifying a fire control channel. This prevents a test plug being used which **can set off the fire alarm.**
- Other services that need identification include ISDN, ADSL, security, lift phones, emergency phones, other special telephone and data services.

Modular (RJ45) 24 port patch panels

A voice tie cable from a UBMDF shall be terminated on approved modular 24 port (RJ45) patch panels in the telecommunications room. A parts list of approved types and brands is maintained by the Data Network Manager.

Patch panels for voice tie cables shall be of a type which can accommodate both **upper and lower traffolyte labels**, as shown on the parts list.

Termination pattern

Voice tie cables shall be terminated on patch panels according to the following pattern:

- In each group of 25 pairs, the first 24 pairs are terminated on pins 4 and 5 of the modular (RJ45) jack.
- The 25th pair shall be terminated on pins 3 and 6 of the 24th socket.

Records

The University does not use record books for voice tie terminations on RJ45 patch panels. Records are only kept at Krone frames.

Labelling

Patch panels shall be labelled using **engraved traffolyte**. Each panel shall have two labels: a cable ID label and a label identifying the cable pairs terminated on the jacks.

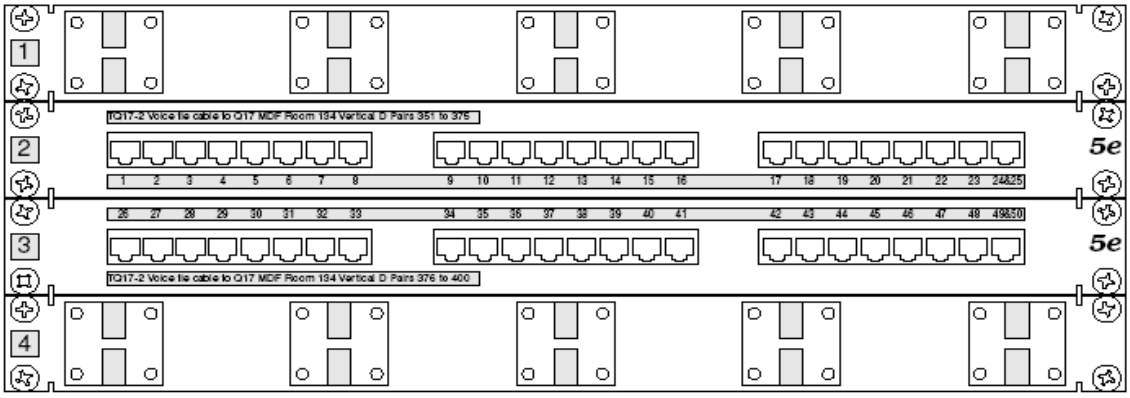

Figure 7. Example of voice tie labelling at patch panel

The cable ID label shows:

- the name of the cable
- the text "Voice tie cable"
- the location of the Krone frame at the other end
- the destination vertical and pair range

Example: Fifty-pair cable terminated on two 24 port patch panels. The upper panel goes to pairs D 351 to 375 and the lower panel goes to pairs D 376 to 400.

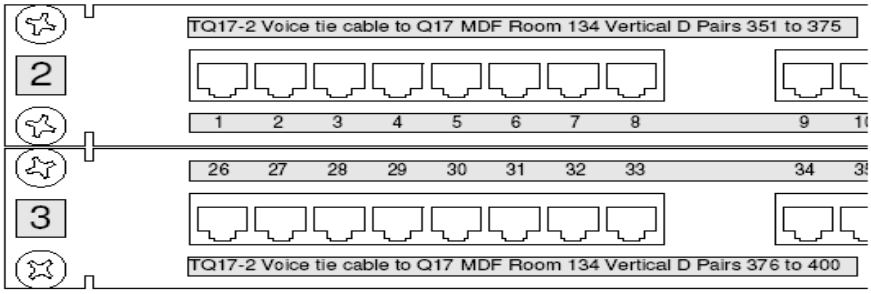

Figure 8. Closer view of cable ID labelling for voice tie

The label shows the pair(s) in the cable terminating on each RJ45 jack. Cable identification starts at "1" for every cable. Note that the **last jack** is labelled with the **two** pairs terminated on it.

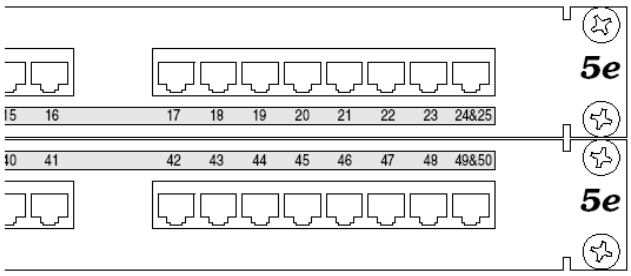

Figure 9. Closer view of numeric labelling for voice tie

600 series jacks

600 series jacks are only installed in areas with a legacy telephone cabling topology.

Terminating hardware for lift phone cables

NOTE: The term "lift motor room" should be interpreted as "lift control area restricted to the lift technician" if the lift is a type without a motor room.

Cables and hardware for lift phones shall be installed, labelled and maintained as detailed in this **specification**.

- TTC for a lift phone shall be terminated on a small Krone frame **just outside** the lift motor room.
- This Krone frame is a management demarcation point between the telecommunications department and the lift department, as the lift motor room itself is a restricted area.
- The Krone frame is to be set up and managed as the network boundary at an MDF.
- The lead-in cable shall terminate on the "telephone technican's side", a dedicated disconnection module.
- The cables entering the lift motor room will be terminated on a separate disconnection module, the "lift technician's side".

- The lift technician shall use the appropriate Krone terminating tool.
- Connections between the two sides will be made with **jumpers**.
- The Krone frame shall be mounted in a dedicated, **lockable metal enclosure** which can be fitted with the University's CCKS **BiLock cylinder**.
- An alternative enclosure is the Madison Technologies "20 Pair Internal FDP", part no. MT27000-020 (B&R Model A20), which can be surface mounted or recessed into a wall. This enclosure provides the requirements for up to five lift phones when fitted with Krone disconnection modules and a record book or card.
- The enclosure shall be **labelled** "Communications" in engraved traffolyte.
- The Krone frame shall have a **record card or book**.
- The records shall be filled in with the same details as the records for any other Krone frame, as shown below in Figure 10. The example shows the completed records for three lift phones jumpered to a 10 pair lead-in cable. Note the full cable details, written sideways on the right.

VERTICAL RECORD CARD

PAIR	SERVICE NUMBER	FROM VERT	FROM PAIR	PAIR	SERVICE NUMBER	FROM VERT	FROM PAIR
10				20			
9				19			
8				18			
7				17			
6				16			
5				15			
4				14			
3	12837		13	13	Lift car 3		3
2	67889		12	12	Lift car 2		2
1	14890		11	11	Lift car 1		1

Cable TQ17-3 PAIRS 1 - 10 TO MDF (Room 134) B 371-380
BOX NO.

Figure 10. Example of record card for Lift Motor Room

Terminating hardware for other special services

TTC for any other special service shall be installed in the same manner as for a cable to the lift motor room, with the following exception:

- The small Krone frame for the special service may be mounted in a non-lockable enclosure with a plastic cover if the frame is located in a secure area.
- University policies will determine where these Krone frames may be located.
- ADC Krone "Final Distribution Point - with Earth 20 pair", part no. 6455 1 016-00, is an example of a suitable plastic enclosure for use in a secure area.

Testing

The University of Sydney requires that TTC be tested after installation. This test follows the procedure in AS/ACIF S008:2006 clause 5.6.11.1, "Conductor composition".

The Telecommunications Manager requires a TTC installation to be tested as follows:

- For a cable containing **ten pairs or more,** loop resistance test.
- For a cable supporting a **special service,** loop resistance test.
- Open Circuit, Short Circuit, Wire Map and high resistance terminations.
- For any cable **100 m long or more,** insulation resistance test.

Loop resistance test

The loop resistance of every pair in the cable is to be tested. The test results shall be supplied to the Telecommunications Manager. The results shall show:

- cable identifier
- type of conductor in he cable (plain annealed copper or plated annealed copper)
- number of strands per conductor in the cable ("1" for solid core cable)
- nominal diameter of a strand
- cable length in metres
- highest and lowest loop resistance results from the test, together with the identifying details of the pairs for which those results were found
- identifying details of any faults that could not be repaired ("bad pairs").

Bad pairs shall also be noted in the record book. The results of the test are acceptable if:

- the difference between the lowest and highest readings does not exceed 10% of the lowest reading; and
- the total number of bad pairs does not exceed 5% of the number of pairs in the cable

University purchasing rules require us to sign a declaration that goods and services have been provided in a satisfactory manner. To do this, we need to check your work. If your test results are not a reasonable match for the results of our own tests, we will not be able to pay you until the matter has been resolved.

Insulation resistance test

This test follows the procedure in AS/ACIF S008:2006 clause 5.6.11.1, "Insulation resistance". The insulation resistance between the conductors of a twisted pair shall be measured at a potential of 500 V d.c. ±50V d.c. This measurement shall be made on one pair from every fifty pairs. The pairs to be tested will be selected by the Telecommunications Manager. The test results shall be provided to the Telecommunications Manager. The results shall show:

- cable identifier
- cable length in metres
- pairs tested
- insulation resistance results for the pairs

Leads, splitters and structured wiring

This section describes how structured wiring components are to be used with TTC.

- Only modular eight way (RJ45) plugs may be inserted into modular eight way (RJ45) jacks. Inserting a smaller plug may damage the outer pins.
- Table 3 shows the colours and categories of patch cords that shall be used in telephone installations. These shall be used in the telecommunications room to patch a circuit from a voice tie cable to a structured cabling system.

Circuit type Category Sheath colour

Circuit type	Category	Sheath colour
Analogue phone line (PABX or PSTN)	5e	Yellow
Digital PABX phone line (MD110)		
ISDN	5e	Green
ADSL		
Security line (e.g. Cardax)		
RS-485 telemetry		
Other non-voice services		

Table 3. Patch cords for telephone wiring work

Use the correct patch lead length to follow the correct path through the cable managers.
IP phones are ethernet devices and shall use Category 5e (or Category 6) blue or grey UTP patch leads. The fly leads for IP phone handsets are the same type as the patch cords.
A label or tag should be applied to a **green** patch cord to indicate the type of service supported on the channel. Labels and tags may also be applied to yellow patch cords to distinguish telephone channels of particular significance.

Fl**y leads with boots are not to be used without the written** permission of the IT Telecommunications Manager.

Voice channel Splitters

Splitters shall only be used where there are no dedicated cables available. Where splitters are used, the "last port" on each patch panel, (which has an extra pair terminated on it), should be used. Splitters shall NOT be used for ethernet connections.

Location of Telephone jack at work area faceplate

By convention, a work area telephone cable shall be terminated at the leftmost location on the wall plate.

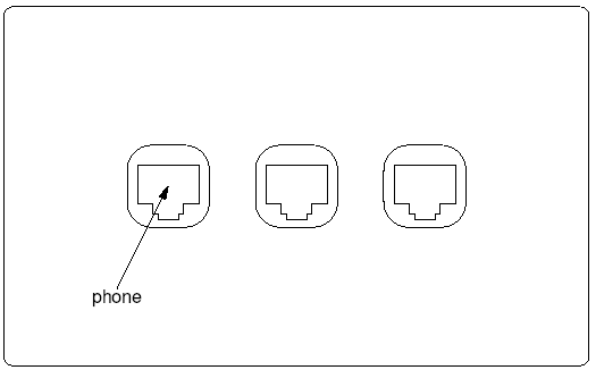

Figure 11. Conventional placement of telephone line at work position

Removal of TTC (traditional telephone cabling)

Obsolete TTC cables and connecting hardware **shall** be completely removed during refurbishment and re-cabling works, as directed by the Telecommunications Manager. These include:

- all redundant TTC, visible or concealed
- all connecting hardware
- redundant Krone frames (except at the UBMDF)
- redundant conduit
- Cabling supporting special services may need to be re-located.
- Ensure all obsolete circuits are identified and disconnected from before removal.
- All relevant **record books** shall be updated to reflect the removal of the obsolete cabling.

Appendix E

Telecommunications Room (TR) Space Requirements

This appendix is intended to provide information to the architect, engineer, builder and installer.

This appendix provides information for determining the space required for housing racks / cabinets in telecommunications rooms. This information includes the computation used by architects to estimate the floor area of the TR. The estimated number of racks / cabinets shall be provided by the engineer.

Installers are required to confirm the computed floor area is suitable for installing the required cabinets / racks before bolting them in the correct position on the floor. Cabinets / racks shall only be fixed to the floor in the presence of the University's Network Group.

Note: the floor area of the TR shall be estimated before cabinets / racks are bolted down and shall be explicitly notified to the builder in the contract.

Telecommunications Room Size: general

Adequate floor space shall be provided for racks and access to them.

Front and rear access to racks and cabinets is required to enable the installation of cables, equipment, maintenance and access for emergency exit.

The clearance requirements between equipment and the TR boundaries have been adapted from the recommended access clearances for a wall mounted MDF, as given in AS/ACIF S009:2006, clause 13.6. Clearance requirements are based on the following principles:

- Space suitable for a person to stand and work at the front and rear of a cabinet / rack.
- Cabinet /rack doors at front and rear, shall have sufficient room to open properly and permit maintenance to be carried out without restrictions.
- Deep equipment shall be able to be brought to the front of the cabinet / rack on a trolley.
- Adequate vertical clearance shall be provided for personnel, cabinets / racks, overhead cable trays and light fittings.
- Horizontal clearances shall be projected to the vertical clearance height.
- Wall-mounted enclosures such as Cardax units shall not obstruct the clearance space.

Telecommunications Room (TR) Space Requirements

The required horizontal clearance for a group of cabinets / racks is shown in Figure 1.

Computation of total floor space for cabinets / racks, including clearance:
the dimensions of the TR space are given by:

$$\text{width} = (n(r + m) + m + 600)\ \text{mm};\ \text{depth} = (p + q + 1800)\ \text{mm}$$

Where:

- n is the number of identical cabinets / racks to be installed, n >0,
- m is the width of the vertical cable manager; r is the width of the rack.;
- p is the depth of B. This is the depth of the rack feet, the depth of the vertical cable manager rings, or150 mm, whichever is the greatest. 150 mm is the protrusion allowance for horizontal cable managers and transceivers.
- B is the forward projection space for the rack.

Typical values for m, r, p and q are:

m = 200 mm, r = 510 mm, p = 150 mm, q = 650 mm

Using these values, the width and depth are given by:

$$\text{width} = (710n + 800)\ \text{mm},\ \text{depth} = 2600\ \text{mm}$$

These dimensions may be used to develop a floor plan for a telecommunications room.

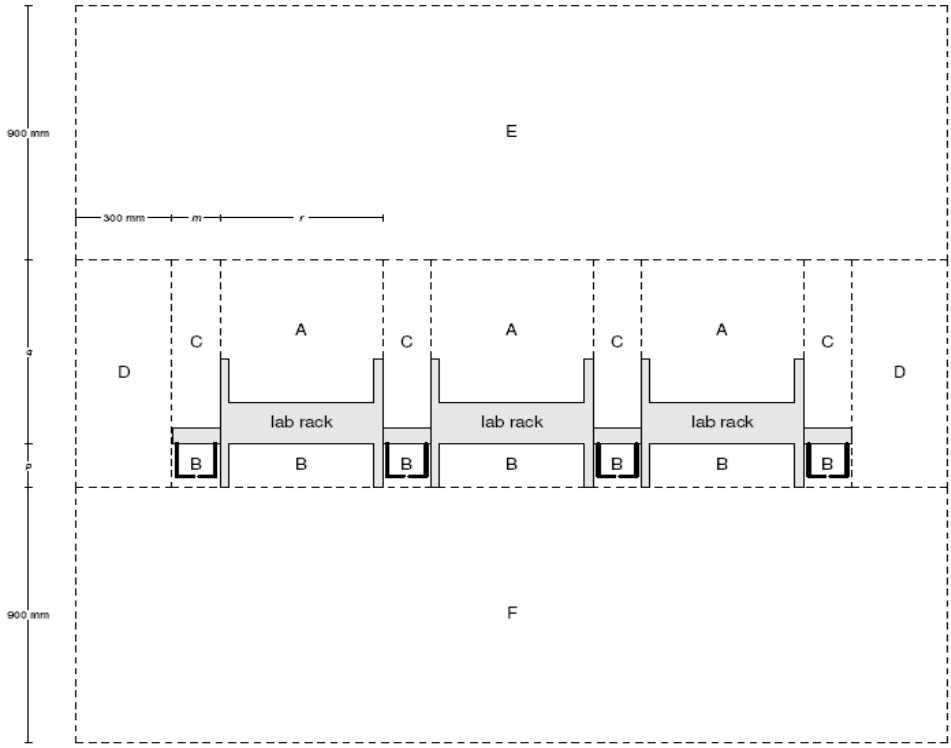

Figure 1. Horizontal clearance for lab racks

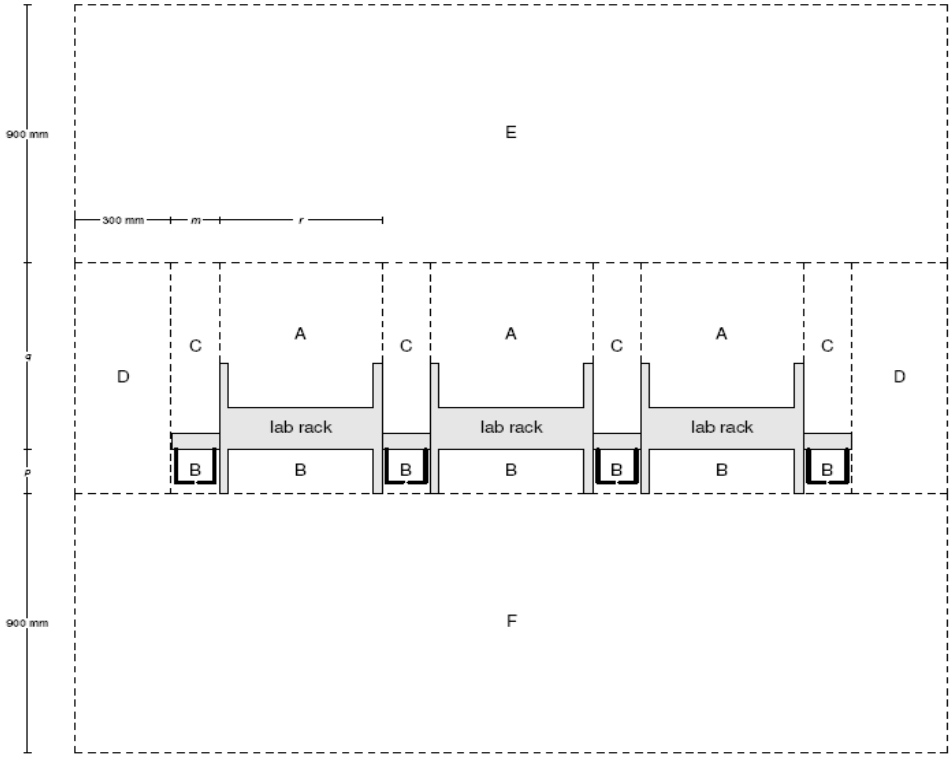

Figure 1. Horizontal clearance for lab racks

A is the rear equipment projection space for the rack.

q is the sum of the cabinet / rack depth plus A. The minimum value for q is 650 mm, which should be sufficient for racks holding communications equipment. If deeper equipment such as deep rack-mounted computers may need to be mounted in the rack, q will need to be increased.

C is the equipment ventilation space behind the vertical cable manager. C may also be partially used for cable reticulation.

D provides the shoulder room when working at the end of the cabinet / rack row. D may be partially filled by cables.

E is the rear clearance area, which allows a person to stand or kneel to work at the back of the rear equipment projection space.

F is the front clearance area, which allows a person to stand or kneel to work at the front of the forward projection space. AS/ACIF S009:2006 recommends a minimum width of 900 mm for the spaces corresponding to E and F.

For architectural purposes, space D should be assumed to be unusable space which cannot form part of an access path.

Space D may be used by an installer to run cables to the cabinet / rack. Without a detailed workshop drawing of proposed cabling installation, it is not possible to determine whether or not space D area will be clear.

Areas A, B, C, D and E shall be on the same level. Area F may be on a lower level than the other areas. This allows the use of a platform-style plinth.