Redes de Computadores (RCOMP) – 2017/2018

Laboratory Class Script - PL02

• Structured cabling systems • Mounting copper CAT6 patch panels • Project 1 start - objectives and guidelines	• 4 x RJ45 crimping plier • 4 x Cooper patch panel punch down tool • 2 x CAT6 copper patch panel • 2 x CAT6 copper RJ45 sockets • 4 x CAT6 cables

1. Introduction about structured cabling

Unlike active devices, cabling systems replacement is an overwhelming and costly task, therefore, cabling systems are intended to be usable during a reasonable time.

The cabling system design can't merely meet the current requirements for present usage and network devices, it must also be able to support technological upgrades and future usage requirements.

To achieve these goals two principles must be applied:

- Respect the structured cabling standards (new technologies are developed for present cabling standards).

- Over dimensioning in key points, like backbones.

A structured cabling system is a hierarchical set of cables interconnection points known as cross-connects or distributors.

The structured cabling system is made of **passive equipment only**: cables, connectors and suitable mechanical supports.

Each cable termination is provided with the appropriate connector, in the case of copper cables, RJ45 (ISO8877) sockets. Active equipment can later be connected to the cabling system through **patch cords**.

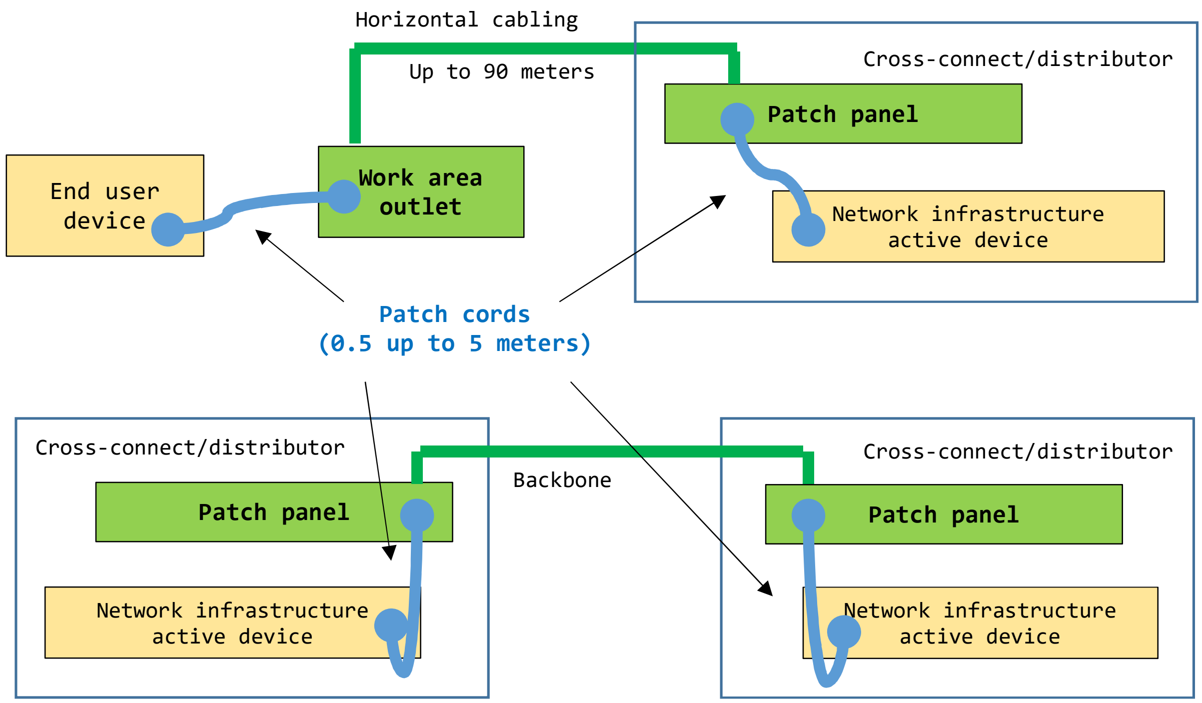
Backbone cable termination points (cross-connects/distributors) are housed in telecommunication enclosures.

Telecommunication enclosures or cabinets use a standard mechanical format known as **19-inch rack**. Mechanical specifications of most hardware meet this format and can be stored inside these cabinets (image on the right).

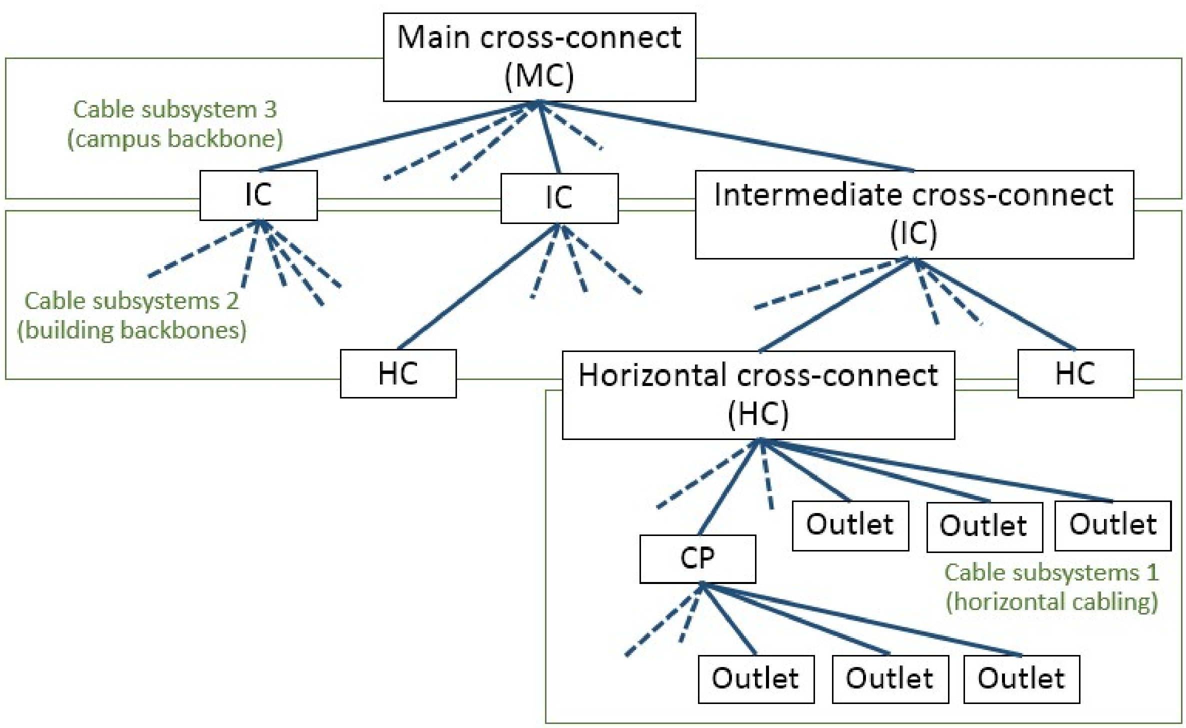
Under the point of view of structured cabling one key component is the patch panel, it's merely a high density set of network connectors, every backbone cable terminates at a patch panel. All patch panels are housed in telecommunication enclosures. The left image shows a copper patch panel made of a set of RJ45 sockets.

At the lower hierarchical level of the structured cabling system (horizontal cabling) each cable ends in a user network socket (outlet). The right image shows a copper network outlet (RJ45).

Every cable is ended by either two patch panels, one on each edge, or, for horizontal cabling a patch panel on one edge and a work area outlet on the other edge. Both scenarios are presented in the images below. Patch cords (0.5 up to 5 meters long) are used to connect active devices to the cabling system. Within the same distributor, active devices can be directly interconnected by a patch cord, elsewhere, they are interconnected as shown below.



The next image represents the general hierarchy of a structured cabling system.



The campus backbone makes sense when there are several buildings to be covered, for each building we will then have an intermediate cross-connect (IC).

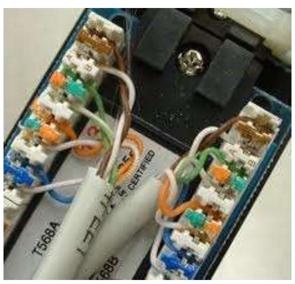
The building backbone connects the intermediate cross-connect to each horizontal cross-connect (usually one per floor). The horizontal cross-connect is the starting point for the horizontal cabling leading to outlets for users. In places with very high outlets density, a Consolidation Point (CP) can be created.

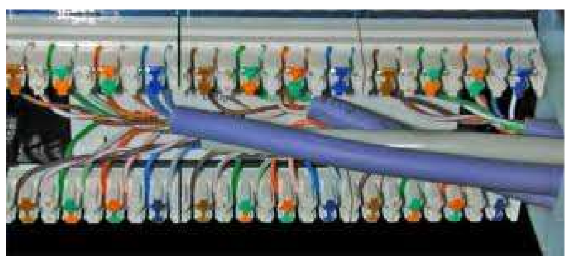
Telecommunication enclosures capacity is measured in U rack units (1U represents 1.75 inches/44.45 mm in height), typical telecommunication enclosures capacity go from 6U up to 42U. A typical patch panel or active device requires 1U or 2U.

All sorts of required active equipment like hubs, switches, routers, servers and power supplies are also housed inside telecommunication enclosures at cross-connects. Telecommunication enclosures dimensioning must take that into account.

2. Practical activity - copper cable wiring to a patch panel and outlet

Wiring a copper cable to a patch panel is usually a simple operation, and unlike plugs crimping, reversible. However, details are somewhat vendor dependent.
- Usually, wires are forced between two metallic tabs that will drill the plastic insulation cover and establish electrical contact.
- For forced insertion of each wire a specialized **punch down tool** may be required or not.





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One at a time, each students group (desk) will:

- Wire a copper cable to a patch panel in on end.
- Wire the same copper cable to an outlet on the other end.
- Ask the teacher for comments on the job.
- When done, the group should remove the cable from both the patch panel and outlet and cut the cable ends for the next group fresh start.
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3. Project 1 start - objectives and guidelines

Project proposal analysis by students.

3.1. Teacher's briefing - comments and clarifications

3.1.1. Project phases

The project is split into three different successive phases or sprints with one fourth final submission. The first three sprints roughly match the three lower layers of the OSI model:

- Structured cabling design (layer one)

This will include building plans and floors plans representing network outlets, cross-connect telecommunication enclosures and cable pathways.

- Layer two active devices design and configuration.

List of layer two devices with emphasis on network switches location and configurations with planned VLANs. Wireless access-points locations and 2.4 GHz channels are also relevant.

- Layer three active devices design and configuration (IPv4).

List of routers and planned IPv4 networks, including static routing tables and detailed devices configuration.

Each layer design is meant to be independent of other layers but inevitably some dependencies are expected:

- Layer two and layer three active devices are housed in structured cabling cross-connect telecommunication enclosures, therefore, the exact dimension (number of U units) of these telecommunication enclosures must be over-dimensioned to house future layer two and upper devices.

- Wireless access-points are undoubtedly a layer two issue, however, their locations impacts structured cabling design because a network outlet must be available for each. Distribution of access-points over building floors must be, therefore, endorsed during the structured cabling design phase. This same approach will have to be used for other devices requiring specific physical locations, for instance, network cameras and card readers.

3.1.2. Project outcomes

Two products are expected from this project:

- Project reports on all four submissions

This is the main outcome, all topics regarding the structured cabling systems must be addressed including the types of cables to be used, the locations for network outlets and cross-connects. The reason for every option made must be technically explained.

Also layer two and layer three required devices must be addressed, including their locations, layer two configurations (VLANs and access-points 2.4 GHz band channels) and layer three configurations (IPv4 networks and static routing tables).

Inventories for all passive and active hardware must be included.

Global inventory: total cables lengths, the total number of outlets, patch panels, telecommunication enclosures, access-points, switches, routers and so on.

Per telecommunication enclosure inventory: the list of all hardware to be housed by each telecommunication enclosure.

- Network infrastructure simulation (last three submissions)

The Packet Tracer simulation is a complement to the project report, it is not meant to be a physical representation of the infrastructure.

The simulation is supposed to include:

- All routers on the project report.
- A single switch for each project report cross-connect or telecommunication enclosure.
- All access-points on the project report.
- Backbone cable types matching the project report.
- For each building, one workstation on each VLAN.
- VLAN configurations from the project report.
- IPv4 network addresses and static routing tables from the project report.
- Routers DHCP services for workstations automatic configuration.

3.2. Project start - guidelines regarding the structured cabling design

Students should now start developing the project, first sprint submission is due in two weeks' time.

The best structured cabling system design strategy is bottom-up, starting at the delivery point, the network outlets. Under this bottom-up approach, steps will be roughly:

1 – Rooms area measurement and a resulting standard number of network outlets

On this specific project, areas are to be estimated from the in-scale provided plans (accuracy is not a key factor in this project assessment). Specific project requirements (client needs) must be taken into account. Some rooms or locals may require no outlets, others may require an abnormally high number of outlets.

2 – Pinpoint outlets positions over the provided floor plans

Distributing the calculated number of outlets within a room is mostly a common sense issue, they are supposed to cover the whole area. Now is the time to add outlets for specific location hardware like access-points.

3 – Decide cross-connects positions

Concerning cross-connects housing rooms, if not described in the project requirements, they should be negotiated and agreed with the client/owner. As far as possible cross-connects housing rooms should be out of public reach, they may be dedicated rooms or shared with other usages like services storage.

Keeping the bottom-up approach, we first handle the horizontal cross-connects. Desirably a horizontal cross-connect location should be central to served outlets, no outlet can distance more than 80 meters in a straight line, also cable length cannot be above 90 meters. If required consolidation points may be created.

A cross-connect for each floor is not mandatory, for a very low number of outlets, a single cross-connect can serve more than one floor.

Once horizontal cross-connects are placed, intermediate cross-connects can be handled, one for each building is required. The housing room and housing telecommunication enclosures for the intermediate cross-connect can be shared with the horizontal cross-connect for a floor.

Finally the main cross-connect is to be housed in some building, likewise, the housing room and housing telecommunication enclosures can be shared with that building intermediate cross-connect.

All cross-connects positioning must also take in account pre-existing cable passing points and pathways.

4 – Define cable pathways and cable types

At this stage, we already have all outlets and cross-connects placed on plans. The next step is setting pathways to interconnect then and connect horizontal cross-connects to outlets. Again, remember each horizontal cable length cannot go beyond 90 meters.

Once defined, pathways must also be represented on plans, either together with outlets and cross-connects or in separate plans.

Redundant backbone cable connections are desirable, they provide fault-tolerance (failover) and can also be used to increase band wide (network load balancing). As far as there are redundant cables, these features can be enabled at layer two (Spanning Tree Protocol and Link Aggregation Control Protocol) or at layer three (Dynamic Routing Protocols).

Under the fault-tolerance point of view, redundant cable connections ought to follow different pathways, this ensures a local disaster is less likely to disturb all cables.

5 – Select cable types

All copper cables should be at least CAT6, they are limited to up to 90 meters long, for longer cables optical fibre must be used.

On horizontal cabling, the use of optical fibre is for now somewhat unpopular because typical end-user devices lack an optical network interface, thus, transceivers would be required to connect optical outlets to most workstations. On backbones cabling, the scenario is different, even if the optical fibre is not imposed due to the cable length, it should always be enforced. Optical fibre grants higher band wide and compatibility with future layer two technologies.

Depending on the selected cable types, different types of patch panels, outlets, and patch cords are required.

6 – Structured cabling hardware inventory

Although inventories will have to be updated later with active equipment, we have now all data required to establish the inventory of all required structured cabling hardware.

We already know the total number of outlets. Achieving a good estimate of total cables lengths required is a heavy task, special for horizontal cabling. Some common sense approximations can be used:

- When a high number of cables share the same segment of a pathway, measure the segment pathway length and multiply by the number of cables.

- When a high number of cables irradiates from the same point, we can estimate the average cable length and multiply by the number of cables. This will be accurate if the cables length distribution is symmetrical. For instance, we can estimate the average cable length based on the two longest cables and two shortest cables.

Each cable reaching a cross-connect it attached to an appropriate type patch panel (copper or fibre), the number of patch panels needed at each cross-connect depends on the number of connections supported by each.

Typical copper patch panels have 24 or 48 connections, taking 1U or 2U respectively, fibre patch panels are more vendor specific. Patch panel models must be selected, and conformingly, the number of patch panels required at each cross-connect is determined.

Also, at each cross-connect, patch panel connections must be matched with the appropriate patch cord and layer two switch port connections. Layer two hardware is not part of structured cabling but impacts on telecommunications enclosures dimensioning.

Roughly, the space required for layer two switching hardware is the same amount required for corresponding patch panels. Because structured cabling infrastructure is supposed to bear future hardware upgrades and additions, an extra 100% over-dimensioning should be applied.

Examples:

- If the telecommunications enclosure is housing a single 1U patch panel, then we add another 1U for the expected corresponding switch, making 2U, and an additional 100% over dimensioning, this will make 4U total. Commercially available telecommunications enclosures start at 6U, so we will assign one.

- If the telecommunications enclosure is housing 2U of patch panels, then we add another 2U for the expected corresponding switches, making 4U, and an additional 100% over dimensioning, this will make 8U. Commercially available size above 6U is usually 12U, so we will use one.

On the other hand, telecommunications enclosure dimensioning is not that critical. If required, as far as there is physical space available, an additional telecommunications enclosure can be mounted side-by-side with existing ones.