Computer Networks (Redes de Computadores - RCOMP) – 2022/2023

Project Description - Sprint 2

1. Sprint 2

The goal in this second sprint is creating a network simulation for the developed structured cabling project of the first sprint. In this sprint the focus is on the layer two infrastructure, and the layer three fundamentals (IPv4 addressing, and static routing).

For such purposes, the **Cisco Packet Tracer** is the tool that will be used.

1.1. Teamwork organization

Each team member will keep working over the same building, the task is now creating a Packet Tracer simulation of the networks within the building.

Each of these simulations will encompass a single building, however, **they must include the campus backbone**. As we will see ahead, this means each simulation must include a switch representing the main cross-connect, and switches representing each other building intermediate cross-connect.

The team member assigned with **building A** has one additional final task: putting together into a single Packet Tracer simulation all simulations created by each team member. If there is a good coordination between team members work, this is just a simple copy and paste operation between Packet Tracer instances. The best option for cutting points is the connection of each building to the backbone network, each building's main switch should be kept and the backbone connections between those switches rebuilt. Bear in mind connections between those switches must be in trunk-mode.

1.2. Packet Tracer version

To avoid any issues when putting together all team members' work into a single Packet Tracer simulation, all team members must use the same Packet Tracer version. They all should use the version suggested in the laboratory classes.

1.3. Devices naming

When a new device is added to the Packet Tracer simulation, a display name is automatically assigned, but then it should be changed to a meaningful name. During the planning meeting, the team should establish some rules regarding this, it will facilitate the teamwork, and this should be included in the **planning.md** document.

The display name is just for Packet Tracer to display, at the OS level, each device has a hostname (DNS name), that can be settled by using the **hostname** command, though in DNS names no spaces are allowed.

2. Layer two configuration

The goal is creating a logical and not a physical network layout, the layout should nevertheless be representative of the structured cabling project from the preceding sprint.

Namely:

- Every cross-connect (distributor), including consolidation points (CP), in the structured cabling project is to be represented in the simulation by a layer two network switch. You may use **PT-empty** switch models and add to them modules with the required port types.
- Cable types interconnecting different cross-connects (switches in the simulation) must match the cable types (copper of fibre) settled in the structured cabling project, and the same goes for horizontal cabling subsystems.
- Path redundancy cable links between cross-connects of the same level (e.g., between two intermediate cross-connects), present in the structured cabling project should as well be present in the simulation. Nevertheless, multiple cable links (link aggregation) between two cross-connects of different levels (e.g., between an intermediate cross-connect and the main cross-connect) can be represented as a single connection between two switches in the simulation.

2.1. Virtual LANs

In each building, the following globally unique five VLANs must be defined:

- A VLAN for all end-user outlets at the ground floor.
- A VLAN for all end-user outlets at floor one.
- A VLAN for the Wi-Fi network (for all access-points' outlets within the building).
- A VLAN for the building DMZ (for servers, administration workstations, and infrastructure network devices).
- A VLAN for VoIP (for all IP-phones within the building).

Despite being associated to a specific building, these VLANs must be available on every switch, and thus on every building, meaning all and every switch should have all buildings' VLANs it the local VLAN database and all switches' interconnections must be configured in trunk-mode with all VLANs.

In addition to those, **a VLAN for the campus backbone** is also required, unlike the others, this is the same VLAN for all buildings, likewise this VLAN must be available on every switch, of every building, and be present on every switch's VLAN database.

So, **to summarize and clarify,** for a project including the five buildings, there will be a total of:

(5 x 5) + 1 = 26 VLANs (this is the case for a team with five members).

If the team decides not to use any of those as the default VLAN, there will be also the **default VLAN**, teams may keep the use of VLANID 1 for the default VLAN.

Again, all these VLANs must be available at every switch of every building. This does not mean they are going to be used (have end devices connected to them), on each building only the VLANs belonging to that building will be used. Nevertheless, being available means the administrator may at any time connect a device anywhere in the infrastructure to any VLAN, is just a matter of assigning the corresponding switch port to the desired VLAN.

2.2. Spanning tree protocol

If your layout encompasses redundant cable links between switches, then STP is essential. Switches have STP enabled by default, so there is nothing to do here, simply **do not disable STP on any switch**.

2.3. VLAN Trucking Protocol (VTP)

This is one very convenient way to ensure all switches have the same complete VLAN database. To achieve that:

- All switches must use the same VTP domain name (**vtp domain …**).
- At least one switch must be in server mode (**vtp mode server**). These are the switches where the VLAN database may be manually defined (**vlan**) and changed whenever needed.

As far as switches interconnection ports are in trunk mode (**switchport mode trunk**), and the VTP domain name is the same, VTP will ensure the VLAN database established by the servers is propagated to every switch of the domain operating in either VTP server mode or VTP client mode (**vtp mode client**).

2.4. The VLAN database

Within the team, all Packet Tracer simulations must use the same VLAN database (manually established on VTP server switches). As result from the planning meeting, there should be a table or list of VLANs to be used by all team members, this must be included in the **planning.md** document.

Each VLAN should have a unique meaningful name, and of course a unique VLANID. In Cisco devices VLANIDs between 2 and 1000 can be used without interfering with other features. **For this project, each team is required to use a specific range of values for VLANIDs,** please check the last chapter, **"Per team specific data - mandatory use by teams"**.

2.5. VTP domain

VTP only propagates the VLAN database between switches belonging to the same VTP domain, thus, so that later all simulations may be putted together easily, all team members must use the same VTP domain name on every switch. The VTP domain name can be 1 to 32 characters long, spaces are not supported. The VTP domain name for each team is established at the **"Per team specific data - mandatory use by teams"** chapter in the last pages of this document. The adopted VTP domain name should be also registered in the **planning.md** document.

3. Layer three configuration

Over the established layer two infrastructure, IPv4 networks will then be defined, more precisely **one IPv4 network for each VLAN**.

The IPv4 traffic forwarding between VLANs is implemented by **a router in each building**. In each building, the corresponding router is connected to the backbone VLAN and provides access to every VLAN/IPv4 network in the building.

3.1. IPv4 networks

The IPv4 network address assigned to each VLAN must meet the following requirements regarding the maximum number of IPv4 nodes it will be able to support.

3.1.1. Building A and backbone

- End user outlets on the ground floor: 40 nodes
- End user outlets on floor one: 70 nodes
- Wi-Fi network: 100 nodes
- DMZ (Servers, administration workstations, and network infrastructure devices): 90 nodes
- VoIP (IP-phones): 35 nodes

- **Backbone: 100 nodes**

3.1.2. Building B

- End user outlets on the ground floor: 25 nodes
- End user outlets on floor one: 60 nodes
- Wi-Fi network: 110 nodes
- DMZ (Servers, administration workstations, and network infrastructure devices): 10 nodes
- VoIP (IP-phones): 13 nodes

3.1.3. Building C

- End user outlets on the ground floor: 40 nodes
- End user outlets on floor one: 50 nodes
- Wi-Fi network: 55 nodes
- DMZ (Servers, administration workstations, and network infrastructure devices): 20 nodes
- VoIP (IP-phones): 25 nodes

3.1.4. Building D

- End user outlets on the ground floor: 25 nodes
- End user outlets on floor one: 60 nodes
- Wi-Fi network: 80 nodes
- DMZ (Servers, administration workstations, and network infrastructure devices): 10 nodes
- VoIP (IP-phones): 13 nodes

3.1.5. Building E

- End user outlets on the ground floor: 45 nodes
- End user outlets on floor one: 60 nodes
- Wi-Fi network: 70 nodes
- DMZ (Servers, administration workstations, and network infrastructure devices): 20 nodes
- VoIP (IP-phones): 25 nodes

Each team is assigned with a **block of addresses to be used**. Such information is found at the **"Per team specific data - mandatory use by teams"**, the last chapter of this document.

For each team, all used IPv4 network addresses must be non-overlapping, and they are required to belong to the provided block of addresses.

In the sprint planning, the team will establish:

- The IPv4 network address assigned to the backbone network.
- The IPv4 node address each router will use in the backbone network connection.
- The block of addresses each team member will use within its building. During the sprint, the team member in charge of each building will use this block of addresses to assign IPv4 addresses to every network within the building.

Important: addresses blocks assigned to each team member can´t overlap each other's, and they cannot overlap either with the IPv4 network address assigned to the backbone network.

The team master is responsible for registering this planning information and make it available to the team (**planning.md**).

3.2. End devices in the Packet Tracer simulation

For each VLAN **in use** at a building, there must be at least one end-device connected to that VLAN. So, in the Packet Tracer simulation, for each building there should be:

- A workstation (PC) connected to the VLAN for end-user outlets on the ground floor.
- A workstation (PC) connected to the VLAN for end-user outlets on the floor one.
- A Wireless laptop, associated with a wireless access-point (not a wireless router) connected to the VLAN of the Wi-Fi network of the building.
- A server connected to the DMZ VLAN of the building.
- A VoIP phone connected to the VoIP VLAN of the building.

End devices must be connected to the correct VLANs by configuring the corresponding switch ports in access mode (**switchport mode access**) and assigning to them the correct VLANs (**switchport access vlan …**).

Except for the VoIP phones, all other end devices are required to have a static and manually defined IPv4 configuration, including the default gateway.

For VoIP phones, the **7960 model** is to be used, the corresponding port on the switch must also be configured in access mode (**switchport mode access**), however, the access VLAN must be disabled (**no switchport access vlan**) and the voice VLAN must be used instead (**switchport voice vlan …**).

The IPv4 configuration of the VoIP phones is out of scope for now and will be addressed on the next sprint.

3.3. Routers and static routing

In each building there must be a router. **Please use a 2811 model, and no other model,** other router models may not support VoIP in Packet Tracer, required in the next sprint.

The router in each building will assure IPv4 traffic forwarding between local IPv4 networks (within the building) and other buildings' IPv4 networks. Traffic to other buildings will be routed through the backbone IPv4 network, to the appropriate router.

IPv4 node addresses being used by every router on the backbone network are established in the planning meeting. Together with the blocks of addresses assigned to each building, they make it possible to build the static routing table on every router.

Each team member is assigned the task of creating the Packet Tracer simulation for one building. Each of these simulations will encompass a single building, however, **they must include the campus backbone**. The main-connect and all intermediate cross-connects must be represented by a switch, and a router (2811 model) must be connected to each.

Because each router is connected to six different IPv4 networks, one might expect a router with six network interfaces would be required. However, the same way a single trunk-mode connection between two switches is able to connect several different VLANs, for a connection to a router the same applies, and on the router side each VLAN appears as different logical network interface (sub interface). **So, in fact, to connect the router to those six networks, a single connection to a trunk-mode port in the switch does it.**

Regarding the configuration of routers outside the scope of the building, it should encompass only the connection to the backbone VLAN and corresponding IP address. The full configuration of each building's router is up to the team member in charge of that building.

3.4. Internet connection

Building A has an internet connection. The member in charge of this building will represent in by a DSL modem connection to an ISP router. The IPv4 node address in use by the ISP router is different for each team, it's provided at the **"Per team specific data - mandatory use by teams"** chapter in the last pages of this document.

The ISP router must have a static routing table such as it will forward the matching traffic into the infrastructure.

4. Sprint 2 backlog

Task	Task description
T.2.1	Development of a layer two and layer three Packet Tracer simulation for building A, encompassing the campus backbone. Integration of every member's Packet Tracer simulation into a single simulation.
T.2.2	Development of a layer two and layer three Packet Tracer simulation for building B, encompassing the campus backbone.
T.2.3	Development of a layer two and layer three Packet Tracer simulation for building C, encompassing the campus backbone.
T.2.4	Development of a layer two and layer three Packet Tracer simulation for building D, encompassing the campus backbone.
T.2.5	Development of a layer two and layer three Packet Tracer simulation for building E, encompassing the campus backbone.

Task T.2.5 is to be ignored by teams with only four members.

5. Sprint 2 outputs/products

For each task on this sprint, the main output is the Packet Tracer simulation file for the corresponding building, it should be named **buildingL.pkt**, with L replaced by the letter identifying the building. Each team member is to commit that file into the personal sprint folder.

A document (in any standard format) detailing how IPv4 network addresses were established and how static routing tables were created.

Each team member must also commit to the personal sprint folder a text file with a configuration dump for every switch and every router within the encompassed building. These configuration text files can be easily exported in Packet Tracer: within the device's window click the **export** button on the **Running Config**, or the **Startup Config** (if the **Running Config** has been saved).

The default name for the text file maybe kept, as it represents the device's display name. During the sprint, members are to commit changes to these files as change are made to their devices' configurations, this allows the teacher to follow the progresses along the sprint. These files are also a safeguard, if somehow the configuration of a device in Packet Tracer is lost, it may be restored from these files.

For task **T.2.1** there is one additional output to be committed into the personal sprint folder, it is the overall simulation integrating all members work, that file should be named **campus.pkt**. Regarding configuration files, for task T.2.1, they only encompass devices in building A.

6. Sprint 2 planning

- One member takes the role of **sprint master** for sprint 2.

  On each sprint, a different team member takes this role.

  Beyond a technical consultant, the class teacher also assumes the project owner role. Any doubts regarding the provided sprint description and the project in general should be addressed to the class teacher.
  The sprint master will insert a summary of the backlog in file **/doc/sprint2/planning.md**.

- Global technical decisions and team coordination.

  Even though the tasks established in the sprint backlog are rather independent, as they all belong to the same project, a coordination effort in this phase is key. This will most often encompass technical decisions regarding the implementation with a special focus on features that are shared between tasks.
  All taken technical decisions must be registered, by the sprint master, in file **/doc/sprint2/planning.md**.

  For this specific sprint, some decisions that must be settled as soon as possible are:

  - Settle the Packet Tracer version to be used on this sprint (and following sprints). All team members should use the same version. Each team member is assigned a task, and for each task one independent simulation will be created, but later they must all be putted together in a single simulation and that might raise some issues if different Packet Tracer versions are used.

  - VLANIDs and corresponding VLAN names to be used, they must be unique. Don't forget to establish also the native VLAN (untagged) and the default VLAN, probably teams will want to keep the default in Cisco devices (VLANID=1). **For each team there is a range of VLANID values that can be used**.

  - The VTP domain name to be used, when all simulations are putted together all switches belonging to every building will keep the same VLAN database by talking to each other's, so the VTP domain must be the same on every switch. **For each team there is an already assigned VTP domain name**.

  - The IPv4 network address of the backbone network, this network address must belong to the address space provided to the team (addresses block), and yet it cannot overlap any of the blocks of addresses assigned to team members for use within each building.

- The IPv4 block of addresses assigned to each team member. All these blocks must belong to the address space provided to the team. They must be carefully settled, so that they are valid, non-overlapping, and they provide the required number of addresses for each building. Again, these blocks cannot overlap the backbone network address either.

- A unique IPv4 node address in the backbone network for each team member. This IPv4 node address is intended to be used by the building's router connection to the backbone.

- Tasks assignment to team members.

  Every member (sprint master included) is assigned exactly one task from the backlog. The provided backlog has seven tasks, for teams with less than 5 members, the last tasks in the backlog are to be ignored, the first ones are mandatory. The sprint master registers in file **/doc/sprint2/planning.md** the task assigned to each team member.

  - For this sprint, tasks are the follow out of previous sprint's tasks, thus they are already assigned. This means, a team member that was assigned in the previous sprint the structured cabling project of some building is now assigned the task of creating the Packet Tracer layer two and layer 3 simulation for that same building.

  - Tasks that were not assessed as ***Totally implemented with no issues***, should be completed, and have issues fixed by the same team member during this sprint. This must also be registered in the **planning.md** document by the sprint master.

7. Per team specific data - mandatory use by teams

7.1. VLANID and VTP domain names to be used by each team

Class	Team number (within class)	VTP domain name to be used	VLANIDs range to be used
2DA	1	rc23dag1	340 - 370
	2	rc23dag2	345 - 375
	3	rc23dag3	350 - 380
	4	rc23dag4	355 - 385
	5	rc23dag5	360 - 390
2DB	1	rc23dbg1	365 - 395
	2	rc23dbg2	370 - 400
	3	rc23dbg3	375 - 405
	4	rc23dbg4	380 - 410
	5	rc23dbg5	385 - 415
2DC	1	rc23dcg1	390 - 420
	2	rc23dcg2	395 - 425
	3	rc23dcg3	400 - 430
	4	rc23dcg4	405 - 435
	5	rc23dcg5	410 - 440
2DD	1	rc23ddg1	415 - 445
	2	rc23ddg2	420 - 450
	3	rc23ddg3	425 - 455
	4	rc23ddg4	430 - 460
	5	rc23ddg5	435 - 465
2DE_E	1	rc23deg1	440 - 470
	2	rc23deg2	445 - 475
	3	rc23deg3	450 - 480
	4	rc23deg4	455 - 485
	5	rc23deg5	460 - 490
2DF	1	rc23dfg1	465 - 495
	2	rc23dfg2	470 - 500
	3	rc23dfg3	475 - 505
	4	rc23dfg4	480 - 510
	5	rc23dfg5	485 - 515
2DG	1	rc23dgg1	490 - 520
	2	rc23dgg2	495 - 525
	3	rc23dgg3	500 - 530
	4	rc23dgg4	505 - 535
	5	rc23dgg5	510 - 540
2DH	1	rc23dhg1	515 - 545
	2	rc23dhg2	520 - 550
	3	rc23dhg3	525 - 555
	4	rc23dhg4	530 - 560
	5	rc23dhg5	535 - 565
2DI	1	rc23dig1	540 - 570
	2	rc23dig2	545 - 575
	3	rc23dig3	550 - 580
	4	rc23dig4	555 - 585
	5	rc23dig5	560 - 590
2DJ	1	rc23djg1	565 - 595
	2	rc23djg2	570 - 600
	3	rc23djg3	575 - 605
	4	rc23djg4	580 - 610
	5	rc23djg5	585 - 615

Class	Team number (within class)	VTP domain name to be used	VLANID range to be used
2DK	1	rc23dkg1	590 - 620
	2	rc23dkg2	595 - 625
	3	rc23dkg3	600 - 630
	4	rc23dkg4	605 - 635
	5	rc23dkg5	610 - 640
2DL	1	rc23dlg1	615 - 645
	2	rc23dlg2	620 - 650
	3	rc23dlg3	625 - 655
	4	rc23dlg4	630 - 660
	5	rc23dlg5	635 - 665
2DM	1	rc23dmg1	640 - 670
	2	rc23dmg2	645 - 675
	3	rc23dmg3	650 - 680
	4	rc23dmg4	655 - 685
	5	rc23dmg5	660 - 690
2DN	1	rc23dng1	665 - 695
	2	rc23dng2	670 - 700
	3	rc23dng3	675 - 705
	4	rc23dng4	680 - 710
	5	rc23dng5	685 - 715
2NA	1	rc23nag1	690 - 720
	2	rc23nag2	695 - 725
	3	rc23nag3	700 - 730
	4	rc23nag4	705 - 735
	5	rc23nag5	710 - 740
2NB	1	rc23nbg1	715 - 745
	2	rc23nbg2	720 - 750
	3	rc23nbg3	725 - 755
	4	rc23nbg4	730 - 760
	5	rc23nbg5	735 - 765
2NC	1	rc23ncg1	740 - 770
	2	rc23ncg2	745 - 775
	3	rc23ncg3	750 - 780
	4	rc23ncg4	755 - 785
	5	rc23ncg5	760 - 790

7.2. IPv4 addresses to be used, and the ISP router IPv4 address

Class	Team number (within class)	IPv4 address space to be used (Block of IPv4 addresses)	ISP router IPv4 node address
2DA	1	10.80.40.0/21	121.60.202.13/30
	2	10.80.48.0/21	121.60.202.18/30
	3	10.80.56.0/21	121.60.202.21/30
	4	10.80.64.0/21	121.60.202.26/30
	5	10.80.72.0/21	121.60.202.29/30
2DB	1	10.80.80.0/21	121.60.202.34/30
	2	10.80.88.0/21	121.60.202.37/30
	3	10.80.96.0/21	121.60.202.42/30
	4	10.80.104.0/21	121.60.202.45/30
	5	10.80.112.0/21	121.60.202.50/30
2DC	1	10.80.120.0/21	121.60.202.53/30
	2	10.80.128.0/21	121.60.202.58/30
	3	10.80.136.0/21	121.60.202.61/30
	4	10.80.144.0/21	121.60.202.66/30
	5	10.80.152.0/21	121.60.202.69/30
2DD	1	10.80.160.0/21	121.60.202.74/30
	2	10.80.168.0/21	121.60.202.77/30
	3	10.80.176.0/21	121.60.202.82/30
	4	10.80.184.0/21	121.60.202.85/30
	5	10.80.192.0/21	121.60.202.90/30
2DE_E	1	10.80.200.0/21	121.60.202.93/30
	2	10.80.208.0/21	121.60.202.98/30
	3	10.80.216.0/21	121.60.202.101/30
	4	10.80.224.0/21	121.60.202.106/30
	5	10.80.232.0/21	121.60.202.109/30
2DF	1	10.80.240.0/21	121.60.202.114/30
	2	10.80.248.0/21	121.60.202.117/30
	3	10.81.24.0/21	121.60.202.122/30
	4	10.81.32.0/21	121.60.202.125/30
	5	10.81.40.0/21	121.60.202.130/30
2DG	1	10.81.48.0/21	121.60.202.133/30
	2	10.81.56.0/21	121.60.202.138/30
	3	10.81.64.0/21	121.60.202.141/30
	4	10.81.72.0/21	121.60.202.146/30
	5	10.81.80.0/21	121.60.202.149/30
2DH	1	10.81.88.0/21	121.60.202.154/30
	2	10.81.96.0/21	121.60.202.157/30
	3	10.81.104.0/21	121.60.202.162/30
	4	10.81.112.0/21	121.60.202.165/30
	5	10.81.120.0/21	121.60.202.170/30
2DI	1	10.81.128.0/21	121.60.202.173/30
	2	10.81.136.0/21	121.60.202.178/30
	3	10.81.144.0/21	121.60.202.181/30
	4	10.81.152.0/21	121.60.202.186/30
	5	10.81.160.0/21	121.60.203.61/30
2DJ	1	10.81.168.0/21	121.60.203.66/30
	2	10.81.176.0/21	121.60.203.69/30
	3	10.81.184.0/21	121.60.203.74/30
	4	10.81.192.0/21	121.60.203.77/30
	5	10.81.200.0/21	121.60.203.82/30
2DK	1	10.81.208.0/21	121.60.203.85/30
	2	10.81.216.0/21	121.60.203.90/30
	3	10.81.224.0/21	121.60.203.93/30
	4	10.81.232.0/21	121.60.203.98/30
	5	10.81.240.0/21	121.60.203.101/30

Class	Team number (within class)	IPv4 address space to be used (Block of IPv4 addresses)	ISP router IPv4 node address
2DL	1	10.81.248.0/21	121.60.203.106/30
	2	10.82.64.0/21	121.60.203.109/30
	3	10.82.72.0/21	121.60.203.114/30
	4	10.82.80.0/21	121.60.203.117/30
	5	10.82.88.0/21	121.60.203.122/30
2DM	1	10.82.96.0/21	121.60.203.125/30
	2	10.82.104.0/21	121.60.203.130/30
	3	10.82.112.0/21	121.60.203.133/30
	4	10.82.120.0/21	121.60.203.138/30
	5	10.82.128.0/21	121.60.203.141/30
2DN	1	10.82.136.0/21	121.60.203.146/30
	2	10.82.144.0/21	121.60.203.149/30
	3	10.82.152.0/21	121.60.203.154/30
	4	10.82.160.0/21	121.60.203.157/30
	5	10.82.168.0/21	121.60.203.162/30
2NA	1	10.82.176.0/21	121.60.203.165/30
	2	10.82.184.0/21	121.60.203.170/30
	3	10.82.192.0/21	121.60.203.173/30
	4	10.82.200.0/21	121.60.203.178/30
	5	10.82.208.0/21	121.60.203.181/30
2NB	1	10.82.216.0/21	121.60.203.186/30
	2	10.82.224.0/21	121.60.203.189/30
	3	10.82.232.0/21	121.60.203.194/30
	4	10.82.240.0/21	121.60.203.197/30
	5	10.82.248.0/21	121.60.203.202/30
2NC	1	10.83.40.0/21	121.60.203.205/30
	2	10.83.48.0/21	121.60.203.210/30
	3	10.83.56.0/21	121.60.203.213/30
	4	10.83.64.0/21	121.60.203.218/30
	5	10.83.72.0/21	121.60.203.221/30