Project Report

IoT project using Cisco PT

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1.0 PROJECT DESCRIPTION

Detailed description about the project and the network:

[Features & Functionality]

- The entire system is a typical smart office that utilizes "smart" things, also called IoT devices, which allow the office to have the smart functionality. The smart office consists of six departments, each having their own mini-smart things network. All the departments link up to one major network and communicate back and forth with the IoT registration server.

- The IoT registration server handles all the connected IoT devices and also handles all the automation/behavior of these smart things.

- The major network consists of seven Cisco 2950 switches and three Cisco 2911 routers. Each of the six departments have their own Cisco 2950 switch. The three Cisco 2911 routers serve as gateways for all the departments/subnets. Every single device can see one another in the major network.

- The current status of the smart office can be viewed by accessing any of the PCs found in all the departments. To do so, the user accesses the IoT registration server's webpage by entering the "myiotserver.com" URL in the PC's browser. The login credentials are:

  username: **Leonardo** | password: **cisco**

- The smart office has many features and performs many things. The table on the next page outlines all the features and behaviors of the smart office.

- All the conditions can be found by viewing the IoT registration server's IoT webpage as mentioned above (too big to be shown here).

  *Note: to scroll through the list, hold down the **tab** key on your keyboard.

Department	Feature & Functionality
All	• Able to detect the presence of a burglar. • Able to detect the presence of smoke. • Motion sensors are used to detect a possible burglar and a solar panel is used to differ between daytime and nighttime. • CO detectors are used to detect any significant amount of smoke. • Sirens are used as alarm in the event of any of the mentioned situations becomes true.
Sales	• Able to run a fan only when a person is present in the department. • A motion sensor detects when a person is present, and a smart door is used to ensure that the fan can only run if the door is closed.
Human Resources	• Able to unlock a door if a person has the correct RFID card. • An RFID card reader is used to detect if the correct RFID card is used to unlock a door. When the correct card is used, a door becomes unlocked, otherwise the door stays locked.
Purchasing	• Able to record video if someone opens a door. • A smart door and a motion sensor are used to detect the presence of a person. • The camera records when the presence of a person has been asserted by either the smart door or the motion sensor.
Marketing	• A light turns on when it is nighttime and that someone has opened a door. • A smart solar panel is used to differ between daytime and nighttime. • A smart door is used to detect when someone opens the door.
Production	• An AC turns on when someone is in the department, when a door is closed and when the temperature is above 15 degrees. • A motion sensor and a door are used to detect the presence of someone. • A smart temperature monitor detects when the temperature is above 15 degrees.
Accounting	• A fan turns on when the humidity is over 74%, when a door is closed and when someone is in the department. • A motion sensor and a door are used to detect the presence of someone. • A smart humidity monitor detects when the humidity is over 74%.

[Equipment list]

- (3x) Cisco 2911 routers with HWIC-2T card installed.
- (7x) Cisco 2950 switches.
- (3x) Cisco smart serial cables (CAB-SS-2626X).
- (47x) Cat5E straight-through UTP cables.
- (6x) host computers.
- (1x) server.
- (6x) CO detectors.
- (6x) Motion detectors.
- (6x) Sirens.
- (6x) Doors.
- (2x) Fans.
- (1x) RFID reader.
- (1x) Webcam.
- (1x) Light.
- (1x) Solar panel.
- (1x) Air Conditioner.
- (1x) Temperature monitor.
- (1x) Humidity monitor.
- (1x) Old car.
- (1x) RFID tag.

[Physical Network Topology]

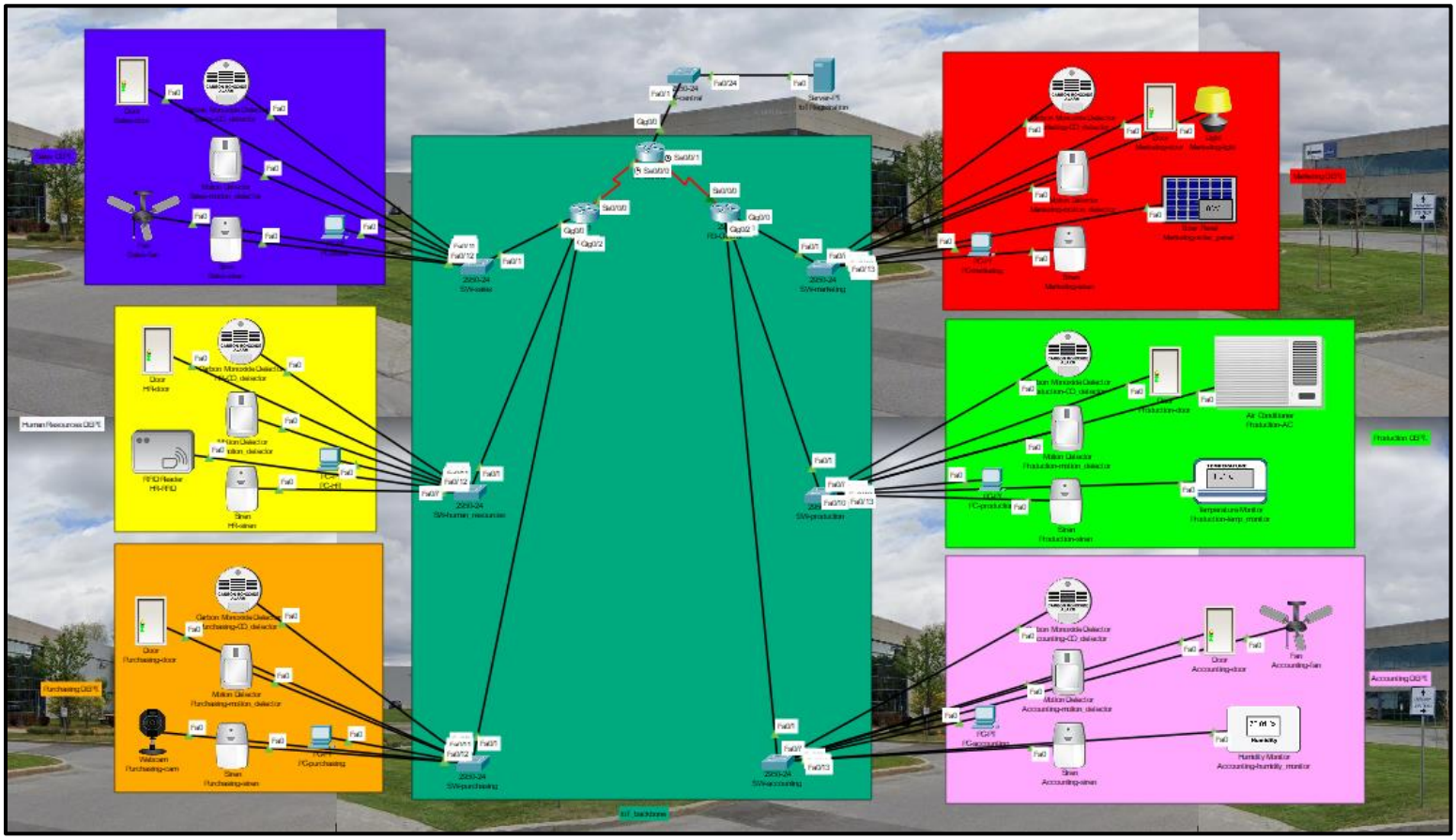


Figure 1. Complete physical network topology of the smart office. The green area is the major network backbone, and the other colors are the multiple departments found in the smart office.

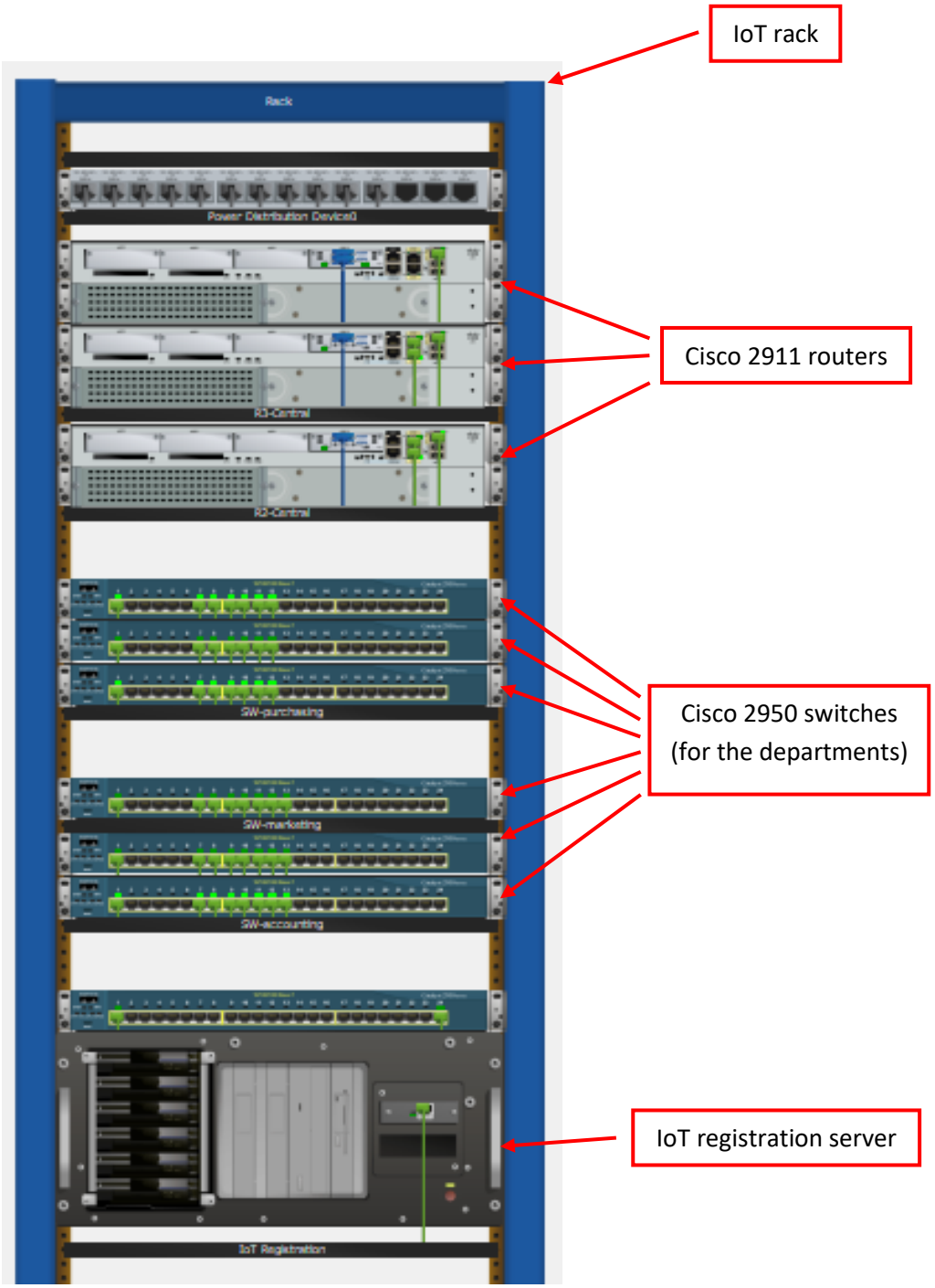


Figure 2. Smart office IoT rack that contains part of the major network hardware.

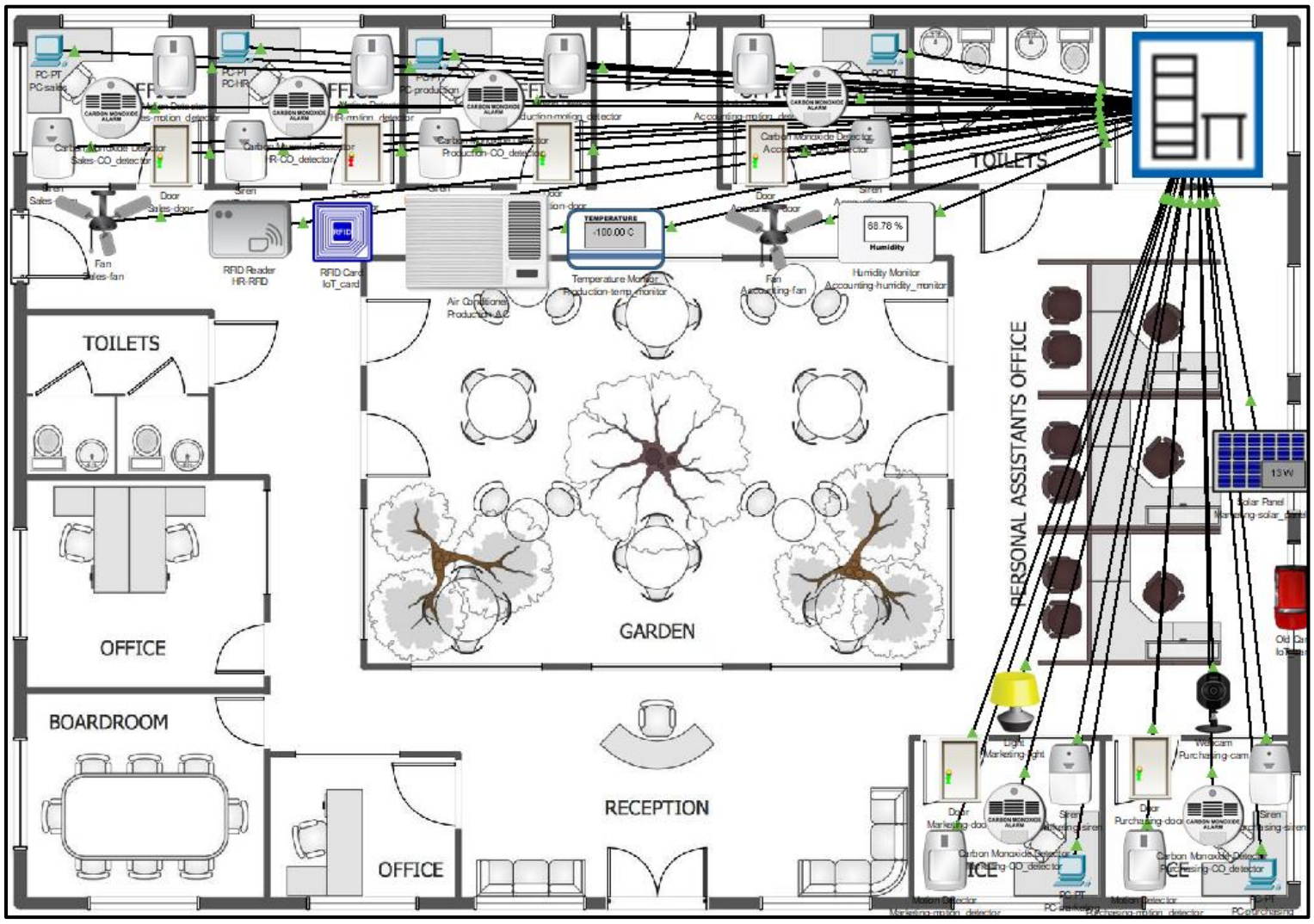


Figure 3. Smart office layout and all the smart things found around it.

[IoT Network Addressing]

Given constraints:

- 7 subnets are desired (not counting WAN links).
  - Accounting subnet: 18 hosts needed.
  - Production subnet: 16 hosts needed.
  - Marketing subnet: 14 hosts needed.
  - Purchasing subnet: 12 hosts needed.
  - Human Resources subnet: 10 hosts needed.
  - Sales subnet: 8 hosts needed.
  - IoT-Servers subnet: 5 hosts needed.

Subnet	Needed Size	Required number of host bits	Allocated size
Accounting	18	5 ($\log_2 18 = 5$)	32 ($2^5 = 32$)
Production	16	5 ($\log_2 16 = 5$)	32 ($2^5 = 32$)
Marketing	14	4 ($\log_2 14 = 4$)	16 ($2^4 = 16$)
Purchasing	12	4 ($\log_2 12 = 4$)	16 ($2^4 = 16$)
Human Resources	10	4 ($\log_2 10 = 4$)	16 ($2^4 = 16$)
Sales	8	4 ($\log_2 8 = 4$)	16 ($2^4 = 16$)
IoT-Servers	5	3 ($\log_2 5 = 3$)	8 ($2^3 = 8$)
WAN#1	2	2 ($\log_2 2 = 2$)	4 ($2^2 = 4$)
WAN#2	2	2 ($\log_2 2 = 2$)	4 ($2^2 = 4$)
TOTAL	**87**	**8** ($\log_2 144 = 8$)	**144**

Major IP: 192.168.10.0

Subnet mask: 255.255.255.0

Complete subnetting table for 192.168.10.0 /24 network:

Subnets	Subnet Address	Usable Range	Broadcast Address	Prefix (mask)
Accounting: 18 hosts	192.168.10.0	.1 to .30	192.168.10.31	255.255.255.224
Production: 16 hosts	192.168.10.32	.33 to .62	192.168.10.63	255.255.255.224
Marketing: 14 hosts	192.168.10.64	.65 to .78	192.168.10.79	255.255.255.240
Purchasing: 12 hosts	192.168.10.80	.81 to .94	192.168.10.95	255.255.255.240
Human Resources: 10 hosts	192.168.10.96	.97 to .110	192.168.10.111	255.255.255.240
Sales: 8 hosts	192.168.10.112	.113 to .126	192.168.10.127	255.255.255.240
IoT-Servers: 5 hosts	192.168.10.128	.129 to .134	192.168.10.135	255.255.255.248
WAN#1: 2 hosts	192.168.10.136	.137 to .138	192.168.10.139	255.255.255.252
WAN#2: 2 hosts	192.168.10.140	.141 to .142	192.168.10.143	255.255.255.252

IP assignment table for 192.168.10.0 /24 network:

Device	Interface	Subnet	IP Address	Default Gateway	Prefix	DNS	IoT Registration
Sales-CO_detector	NIC	Sales	.114	.126	/28	192.168.10.130	192.168.10.130
HR-CO_detector		HR	.98	.110			
Purchasing-CO_detector		Purchasing	.82	.94			
Marketing-CO_detector		Marketing	.66	.78			
Production-CO_detector		Production	.34	.62	/27		
Accounting-CO_detector		Accounting	.2	.30			
Sales-motion_detector		Sales	.119	.126	/28		
HR-motion_detector		HR	.99	.110			
Purchasing-motion_detector		Purchasing	.83	.94			
Marketing-motion_detector		Marketing	.67	.78			
Production-motion_detector		Production	.35	.62	/27		
Accounting-motion_detector		Accounting	.3	.30			
Sales-siren		Sales	.116	.126	/28		
HR-siren		HR	.100	.110			
Purchasing-siren		Purchasing	.84	.94			
Marketing-siren		Marketing	.68	.78			
Production-siren		Production	.36	.62	/27		
Accounting-siren		Accounting	.4	.30			
Sales-door		Sales	.117	.126	/28		
HR-door		HR	.101	.110			
Purchasing-door		Purchasing	.85	.94			
Marketing-door		Marketing	.69	.78			
Production-door		Production	.37	.62	/27		
Accounting-door		Accounting	.5	.30			
Sales-fan		Sales	.118	.126	/28		
HR-RFID		HR	.102	.110			
Purchasing-cam		Purchasing	.86	.94			
Marketing-light		Marketing	.70	.78			
Marketing-solar_panel		Marketing	.71	.78			
Production-AC		Production	.38	.62	/27		
Production-temp_monitor		Production	.39	.62			
Accounting-fan		Accounting	.6	.30			
Accounting-humidity_monitor		Accounting	.7	.30			
PC-sales		Sales	.119	.126	/28		
PC-HR		HR	.103	.110			
PC-purchasing		Purchasing	.87	.94			
PC-marketing		Marketing	.72	.78			
PC-production		Production	.40	.62	/27		
PC-accounting		Accounting	.8	.30			
IoT Registration		IoT-Servers	.130	.134	/29		
R1-Central	Gi0/0		.134	N/A		N/A	N/A
	S0/0/0 (DCE)	WAN#1	.137		/30		
	S0/0/1 (DCE)	WAN#2	.141		/30		
R2-Central	Gi0/0	Sales	.126		/28		
	Gi0/1	HR	.110		/28		
	Gi0/2	Purchasing	.94		/28		
	S0/0/0 (DTE)	WAN#1	.138		/30		
R3-Central	Gi0/0	Marketing	.78		/28		
	Gi0/1	Production	.62		/27		
	Gi0/2	Accounting	.30		/27		
	S0/0/0 (DTE)	WAN#2	.142		/30		

2.0 ADMINISTRATOR GUIDE

Configuration guide for future use:

[Configuring the system]

- Before changing the existing configuration on the Cisco 2911 routers or Cisco 2950 switches, ensure that all necessary planning was done beforehand, such as functional requirements, in order to mitigate any issues during the configuration phase.

- Once all planning has been sorted out, you may proceed with modifying the existing configuration on any of the three Cisco 2911 routers or Cisco 2950 switches. At the time of writing this document, the only way this can be done is through the console port on any of the three Cisco 2911 routers or Cisco 2950 switches. Refer to the "maintaining" section under "maintenance guide" to view how to connect a PC to any of the three Cisco 2911 routers or 2950 switches (to see how to access the CLI of any of these three devices). Also, **only authorized personnel are allowed to access the CLI on any of these three devices**.

- Once you gain access to the CLI on any of the three Cisco 2911 routers or Cisco 2950 switches, there are many options as to what you can configure on the Cisco 2911 routers or Cisco 2950 switches. For simplistic reasons, following on the next few pages are a few common tasks that can be configured on any of the three Cisco 2911 routers (the Cisco 2950 switches have a default configuration, so any configuration tasks for them are not shown):

  (Refer to next few pages)

  ***Note**: the following snippets assume that the router has default settings applied, meaning that there are no passwords, hostnames, etc., that are configured/applied onto the router.

  At the time of writing this document, the login password for the Cisco 2911 routers is "cisco" and the password for user EXEC mode is "Leonardo" (assuming there has been no modification done to these passwords).

[Configuring a login banner]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#banner motd %
Enter TEXT message. End with the character '%'.
<enter your text and once your done enter the '%' key>
Router(config)#end
...
Router#copy run start
...
```

[Configuring a login password]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#line console 0
Router(config-line)#password <your password>
Router(config-line)#login
Router(config)#end
...
Router#copy run start
...
```

[Configuring a user EXEC password]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#enable secret <your password>
Router(config)#end
...
Router#copy run start
...
```

[Configuring a hostname]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#hostname <your hostname>
X(config)#end
...
X#copy run start
...
```

***Note**: "X" refers to the new hostname that is applied onto the router.

[Configuring the Gi0/x interface]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#int Gi0/X
Router(config-if)#ip address <ip address> <subnet mask>
Router(config-if)#description <your description>
Router(config-if)#no shut
...
Router(config-if)#end
...
Router#copy run start
...
```

[Configuring the S0/0/X interface (as DCE)]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#int S0/0/X
Router(config-if)#ip address <ip address> <subnet mask>
Router(config-if)#clock rate <desired clock rate>
Router(config-if)#description <your description>
Router(config-if)#no shut
...
Router(config-if)#end
...
Router#copy run start
...
```

[Configuring the S0/0/X interface (as DTE)]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#int S0/0/X
Router(config-if)#ip address <ip address> <subnet mask>
Router(config-if)#description <your description>
Router(config-if)#no shut
...
Router(config-if)#end
...
Router#copy run start
...
```

- If none of the previous snippets don't contain what you are looking for, refer to the following link for more documentation about the Cisco 2911 router:

  https://www.cisco.com/c/en/us/support/routers/2911-integrated-services-router-isr/model.html#~tab-documents

3.0 MAINTENANCE GUIDE

Helpful maintenance, troubleshooting and restore guide for future use:

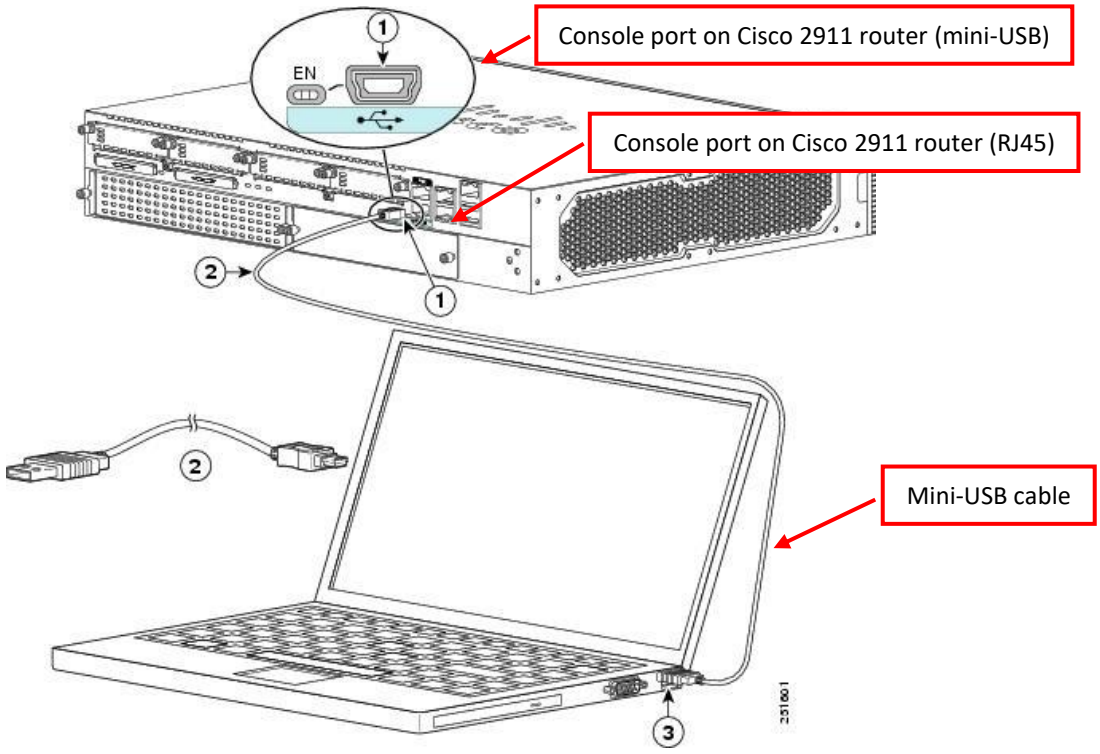
[Maintaining]

- If there is a need, at any point in time, to change or simply maintain the network, you can do so by accessing the CLI of any of the three Cisco 2911 routers or Cisco 2950 switches. There are many ways of accessing the CLI, such as Telnet, SSH, but at the time of writing this document, the only way to do so is via the console port on any of these three devices.

- Before trying to access the CLI on the Cisco 2911 routers or 2950 switches to maintain the network, proper planning, such as functional requirements, should be done beforehand in order to mitigate any issues that may occur during the configuration phase. Also, **only authorized personnel are allowed to access the CLI on any of these three devices**.

- Once all planning has been completed, you may proceed with accessing the CLI of any of the three Cisco 2911 routers or 2950 switches. There is a physical hookup and software configuration that needs to be done. Below is a typical example of how to do so:

[Typical physical hookup]



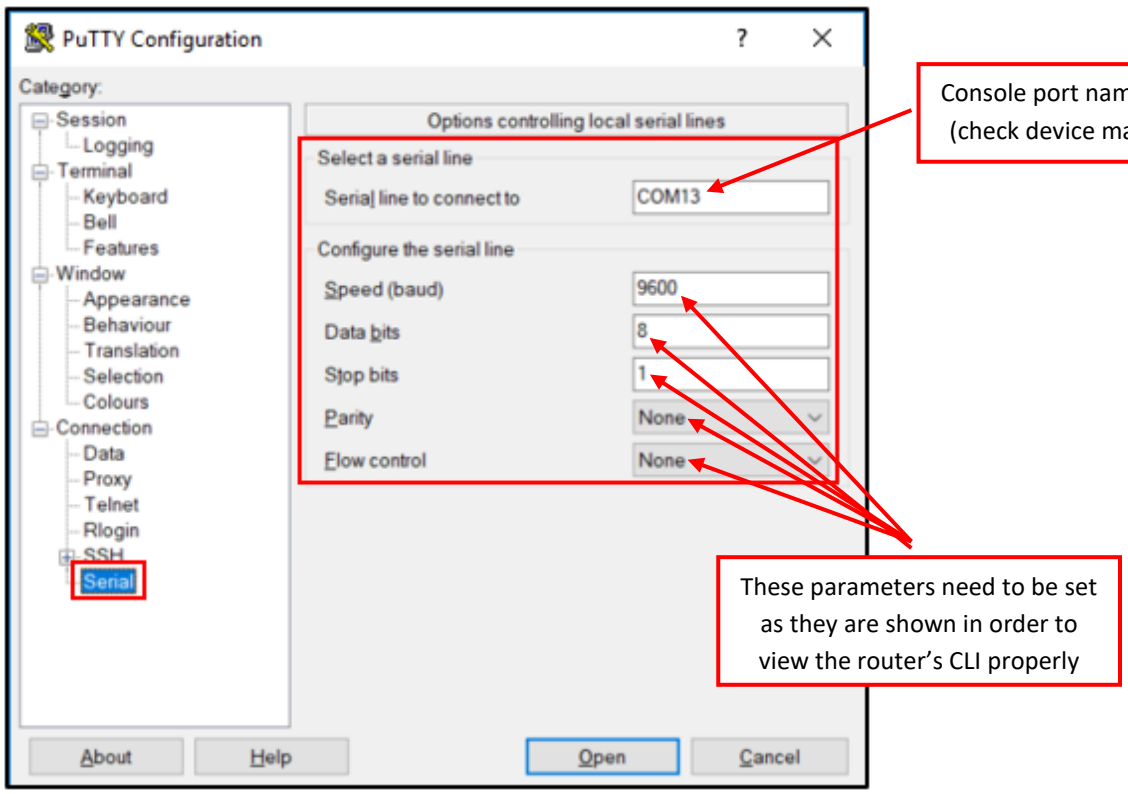
- Note: a traditional aqua Cisco console cable can also be used to access the CLI on the Cisco 2911 router instead of using the mini-USB cable shown above. The procedure is the same on the Cisco 2950 switches, with the only difference that the console port location is different and that there is no mini-USB port (only RJ45).

[Software configuration]

- Once the physical hookup is complete, the next step is to configure your computer to view the CLI on any of the three Cisco 2911 routers or 2950 switches. A terminal emulation software is needed in order to do so. Popular terminal emulation software such as Tera Term or Putty can be used. Refer to the following links for documentation and steps to install the software onto your computer:

  Tera Term: https://ttssh2.osdn.jp/index.html.en
  Putty: https://www.putty.org/

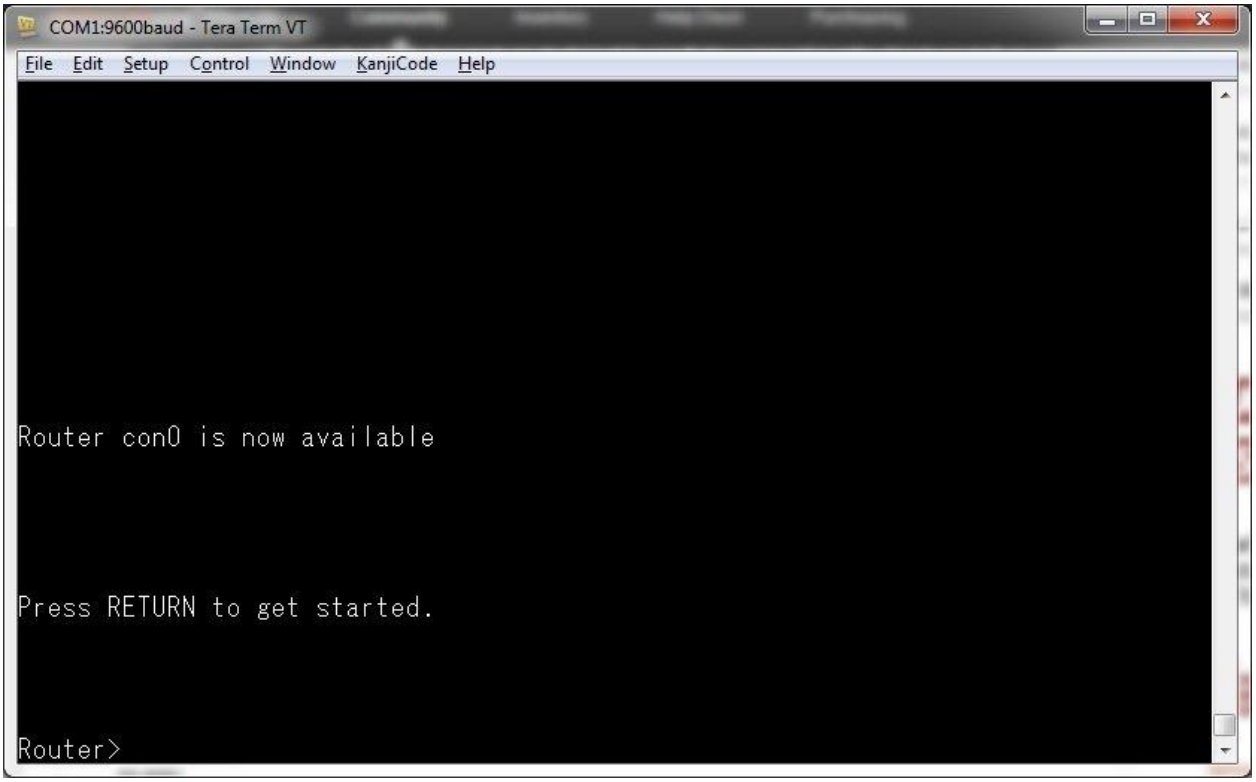
- Once appropriate terminal emulation software has been installed onto your computer, the next step is to launch the software and to configure it for the serial communication between the PC and any of the three Cisco 2911 routers and 2950 switches. Refer to table on next page for exact details. Below is an example how to do so in Putty (refer to terminal emulation software documentation if you are uncertain how to do so):



Parameter	Value
Serial port	COMx (x = console port number)
Speed (baud)	9600
Data bits	8
Stop bits	1
Parity	None
Flow control	None

Serial parameters that need to be set in terminal emulation software

- Once the terminal software serial parameters are set, initiate the serial communication and a black window should show up like the following with the login prompt to the router or switch:



You now have access to the router or switch CLI. As a side note, **you can only access the CLI of any of the three devices one at a time if your computer has only one console port**.

[Troubleshooting]

- If computer networking issues arise while performing any computer networking related tasks, there are some basic troubleshooting steps that can be taken in order to find the source of the problem. Followed on the next few pages are the most common issues with possible solutions:

  [Problem #1: Cisco router does not retain configuration after power cycle]

  - The issue is that the startup-configuration is may be empty besides having the default configuration (or any previously saved configuration). The user needs to copy the running-configuration to the startup-configuration in order to retain all newly added configuration after a power cycle. The user will have to re-enter all proper Cisco IOS commands or obtain a previous configuration from a backup before they can copy the running-configuration to the startup-configuration. Below is an example of how the user can copy the running-configuration to the startup-configuration once all configuration has been completed on the router:

```
...
Press return to get started!

Router>en
Router#copy run start
...
```

  The user can verify if the procedure was successful by observing if the changes were saved to the startup-config. Below is an example how to do so:

```
...
Press return to get started!

Router>en
Router#show startup
...
```

[Problem #2: Cannot ping from one computer to another that is on a different LAN]

- Before proceeding with this issue, ensure that all links are green in the network. If they are not, refer to the "Links are down" troubleshooting on the next page.
- If all links are green, then the issue could be one of two issues:
  - ❖ There might be a route missing in the router's local routing table. Depending on which portion of the network you are trying to access, the router's local routing table will differ. The user has to first analyze the router's local routing table to examine for missing routes and needs to take corrective action if it is the case:

[To view the router's local routing table]

```
...
Press return to get started!

Router>en
Router#show ip route
...
```

[To add a missing route to the router's local routing table]

```
...
Press return to get started!

Router>en
Router#config t
...
RouterX(config)#ip route <network address>
                         <prefix>
                         <next hop or exit
                         interface>
RouterX(config)#end
...
RouterX#copy run start
...
```

  - ❖ If the above issue is not the case for you, then the issue might lie with your computer's firewall. Ensure that your computer's firewall is not blocking any communication that is going on in the network.

[Problem #3: Links are not showing green status (down)]

- The problem can be one of two issues:
  - ❖ The physical interfaces on the routers or on the PCs are not enabled and are in a "shutdown" state. The user has to enable this interfaces in order to see a green status on the physical adapters. On a PC, make sure the physical adapter that is being used to connect to the network is not disabled and that the cable is not unplugged. The same applies for the router. Below is an example how to verify if any of the physical interfaces are disabled and how to enable them if it is the case:

    [To view the status of any of the physical adapters]

```
...
Press return to get started!

Router>en
Router#show ip interface brief
...
```

    [To enable any of the physical adapters]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)#int <interface>
Router(config-if)#no shut
...
Router(config-if)#end
...
Router#copy run start
```

  - ❖ If the above issue is not the case for you, then the cable being used between the router and the PC is not the correct type or it might be damaged. Ensure that a functional copper-crossover cable is being used to connect between the router and the PC.

[Problem #4: Forgotten password on one of the Cisco routers]

- If the issue arises that you are unable to access one of the router's CLI because of a "password incorrect error", then the issue lies with a forgotten password. In the case for a forgotten password, you need to follow the password recovery procedure that is available at the link included below:

  https://www.cisco.com/c/en/us/support/docs/routers/2800-series-integrated-services-routers/112033-c2900-password-recovery-00.html

[Restoring (to factory defaults)]

- If there is a need, at any point in time, to restore the system to a previous working configuration, the user can do so by accessing the CLI on any of the three Cisco 2911 routers or Cisco 2950 switches and copying and pasting a known working configuration file (included on the next few pages) onto the CLI on any of the three devices. If you are uncertain about how to access the CLI, refer to the "maintaining" section shown previously in this section of this document (this is the Maintenance Guide section).

- Before trying to access the CLI on the Cisco 2911 routers or 2950 switches to perform a configuration restore procedure, proper planning, such as down-time, should be done beforehand in order to mitigate any issues that may occur during the restore phase. Also, **only authorized personnel are allowed to access the CLI on any of these three devices**.

- Once all planning has been completed, you may proceed with accessing the CLI of any of the three Cisco 2911 routers or 2950 switches to copy and paste the appropriate configuration file onto the CLI. Below is a typical example of how to do so:

  [To copy and paste a configuration file onto one of the routers]

```
...
Press return to get started!

Router>en
Router#config t
...
Router(config)# <copy and paste the config file here>
...
X#copy run start
```

- Depending on the router you are trying to restore, select the appropriate configuration file that is shown on the next few pages to copy and paste onto the router's CLI as shown in the example above.

[R1-Central configuration file]

```
hostname R1-Central
!
!
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
no ip cef
no ipv6 cef
!
!
!
!
license udi pid CISCO2911/K9 sn FTX1524I68Z-
!
!
!
!
!
!
!
!
!
!
!
spanning-tree mode pvst
!
!
!
!
!
!
```

...continues on next page...

```
interface GigabitEthernet0/0
 description Gateway for "IoT-Servers" network
 ip address 192.168.10.134 255.255.255.248
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface GigabitEthernet0/2
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Serial0/0/0
 description WAN1-Link1
 ip address 192.168.10.137 255.255.255.252
 clock rate 2000000
!
interface Serial0/0/1
 description WAN2-Link1
 ip address 192.168.10.141 255.255.255.252
 clock rate 2000000
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
ip classless
ip route 192.168.10.136 255.255.255.252 Serial0/0/0
ip route 192.168.10.140 255.255.255.252 Serial0/0/1
ip route 192.168.10.112 255.255.255.240 Serial0/0/0
ip route 192.168.10.96 255.255.255.240 Serial0/0/0
ip route 192.168.10.80 255.255.255.240 Serial0/0/0
ip route 192.168.10.64 255.255.255.240 Serial0/0/1
ip route 192.168.10.32 255.255.255.224 Serial0/0/1
ip route 192.168.10.0 255.255.255.224 Serial0/0/1
!
ip flow-export version 9
!
!
!
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: R1-Central                                                     *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                     UNAUTHORIZED ACCESS PROHIBITED                     *
*                          STAY OUTTA MY ROUTER!                         *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
!
!
```

...continues on next page...

```
line con 0
 password cisco
 login
!
line aux 0
!
line vty 0 4
 login
!
!
!
end
```

...END OF R1-Central CONFIG FILE...

[R2-Central configuration file]

```
hostname R2-Central
!
!
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
no ip cef
no ipv6 cef
!
!
!
!
license udi pid CISCO2911/K9 sn FTX152452WQ-
!
!
!
!
!
!
!
!
!
!
!
spanning-tree mode pvst
!
!
!
!
!
!
```

...continues on next page...

```
interface GigabitEthernet0/0
 description Gateway for "Sales" network
 ip address 192.168.10.126 255.255.255.240
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 description Gateway for "Human Resources" network
 ip address 192.168.10.110 255.255.255.240
 duplex auto
 speed auto
!
interface GigabitEthernet0/2
 description Gateway for "Purchasing" network
 ip address 192.168.10.94 255.255.255.240
 duplex auto
 speed auto
!
interface Serial0/0/0
 description WAN1-Link2
 ip address 192.168.10.138 255.255.255.252
!
interface Serial0/0/1
 no ip address
 clock rate 2000000
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
ip classless
ip route 192.168.10.128 255.255.255.248 Serial0/0/0
ip route 192.168.10.64 255.255.255.240 Serial0/0/0
ip route 192.168.10.32 255.255.255.224 Serial0/0/0
ip route 192.168.10.0 255.255.255.224 Serial0/0/0
ip route 0.0.0.0 0.0.0.0 Serial0/0/0
!
```

...continues on next page...

```
ip flow-export version 9
!
!
!
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: R2-Central                                                     *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                     UNAUTHORIZED ACCESS PROHIBITED                     *
*                          STAY OUTTA MY ROUTER!                         *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
!
!
line con 0
 password cisco
 login
!
line aux 0
!
line vty 0 4
 login
!
!
!
end
```

...END OF R2-Central CONFIG FILE...

[R3-Central configuration file]

```
hostname R3-Central
!
!
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
no ip cef
no ipv6 cef
!
!
!
!
license udi pid CISCO2911/K9 sn FTX15246K45-
!
!
!
!
!
!
!
!
!
!
!
spanning-tree mode pvst
!
!
!
!
!
!
```

...continues on next page...

```
interface GigabitEthernet0/0
 description Gateway for "Marketing" network
 ip address 192.168.10.78 255.255.255.240
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 description Gateway for "Production" network
 ip address 192.168.10.62 255.255.255.224
 duplex auto
 speed auto
!
interface GigabitEthernet0/2
 description Gateway for "Accounting" network
 ip address 192.168.10.30 255.255.255.224
 duplex auto
 speed auto
!
interface Serial0/0/0
 description WAN2-Link2
 ip address 192.168.10.142 255.255.255.252
!
interface Serial0/0/1
 no ip address
 clock rate 2000000
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
ip classless
ip route 192.168.10.128 255.255.255.248 Serial0/0/0
ip route 192.168.10.112 255.255.255.240 Serial0/0/0
ip route 192.168.10.96 255.255.255.240 Serial0/0/0
ip route 192.168.10.80 255.255.255.240 Serial0/0/0
ip route 0.0.0.0 0.0.0.0 Serial0/0/0
!
```

...continues on next page...

```
ip flow-export version 9
!
!
!
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: R3-Central                                                     *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                     UNAUTHORIZED ACCESS PROHIBITED                     *
*                          STAY OUTTA MY ROUTER!                         *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
!
!
line con 0
 password cisco
 login
!
line aux 0
!
line vty 0 4
 login
!
!
!
end
```

...END OF R3-Central CONFIG FILE...

[SW-sales configuration file]

```
hostname SW-sales
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-sales                                                       *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                      UNAUTHORIZED ACCESS PROHIBITED                    *
*                           STAY OUTTA MY SWITCH!                        *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-sales CONFIG FILE...

[SW-human_resources configuration file]

```
hostname SW-human_resources
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-human_resources                                             *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                       UNAUTHORIZED ACCESS PROHIBITED                   *
*                            STAY OUTTA MY SWITCH!                       *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-human_resources CONFIG FILE...

[SW-purchasing configuration file]

```
hostname SW-purchasing
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-purchasing                                                  *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                       UNAUTHORIZED ACCESS PROHIBITED                   *
*                            STAY OUTTA MY SWITCH!                       *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-purchasing CONFIG FILE...

[SW-marketing configuration file]

```
hostname SW-marketing
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-marketing                                                   *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                       UNAUTHORIZED ACCESS PROHIBITED                   *
*                            STAY OUTTA MY SWITCH!                       *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-marketing CONFIG FILE...

[SW-production configuration file]

```
hostname SW-production
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-production                                                  *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                      UNAUTHORIZED ACCESS PROHIBITED                    *
*                           STAY OUTTA MY SWITCH!                        *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-production CONFIG FILE...

[SW-accounting configuration file]

```
hostname SW-accounting
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-accounting                                                  *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                       UNAUTHORIZED ACCESS PROHIBITED                   *
*                            STAY OUTTA MY SWITCH!                       *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-accounting CONFIG FILE...

[SW-central configuration file]

```
hostname SW-central
!
enable secret 5 $1$mERr$ds5/MOUitESIkv8XWNoAu/
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
interface FastEthernet0/3
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
```

...continues on next page...

```
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface Vlan1
 no ip address
 shutdown
!
```

...continues on next page...

```
banner motd ^C
**************************************************************************
*                                                                        *
* Leonardo Fusser (1946995) - IoT Project                                *
* Network Embedded Systems (247-609-VA)                                  *
* Day Yann Fong                                                          *
*                                                                        *
*                                                                        *
* Device: SW-central                                                     *
*                                                                        *
*                                                                        *
**************************************************************************
*                                                                        *
*                                                                        *
*                              WARNING!                                  *
*                       UNAUTHORIZED ACCESS PROHIBITED                   *
*                            STAY OUTTA MY SWITCH!                       *
*                                                                        *
*                                                                        *
**************************************************************************
^C
!
!
!
line con 0
 password cisco
 login
!
line vty 0 4
 login
line vty 5 15
 login
!
!
!
!
end
```

...END OF SW-central CONFIG FILE...

4.0 Discussion & Conclusion

Discussion & Conclusion for the project:

[Discussion]

- What was learned:
  - Learned how to build a complete IoT system in Cisco Packet Tracer.
  - Learned how to incorporate IoT devices in existing networks.
  - Learned how to use an IoT registration server to centralize IoT functionality.
  - Learned how to split up networks for various purposes.

- Main challenges:
  - Troubleshooting network communication faults.
  - Testing IoT automation/rules for functionality.
  - Designing the IoT system.
  - Selecting the right hardware for the job.

- Improvements:
  - Organize time better next time.
  - Use of VLANs to consolidate network hardware.
  - Use of more advanced smart things to perform more tasks.
  - Use of more advanced automation tasks with more advanced smart things.

[Conclusion]

- Successfully designed an IoT system using Cisco Packet Tracer.
- Successfully simulated and illustrated the functionality of an IoT system with various things and network components.