Lab 4: Internet of Things (IoT) in Smart Campus

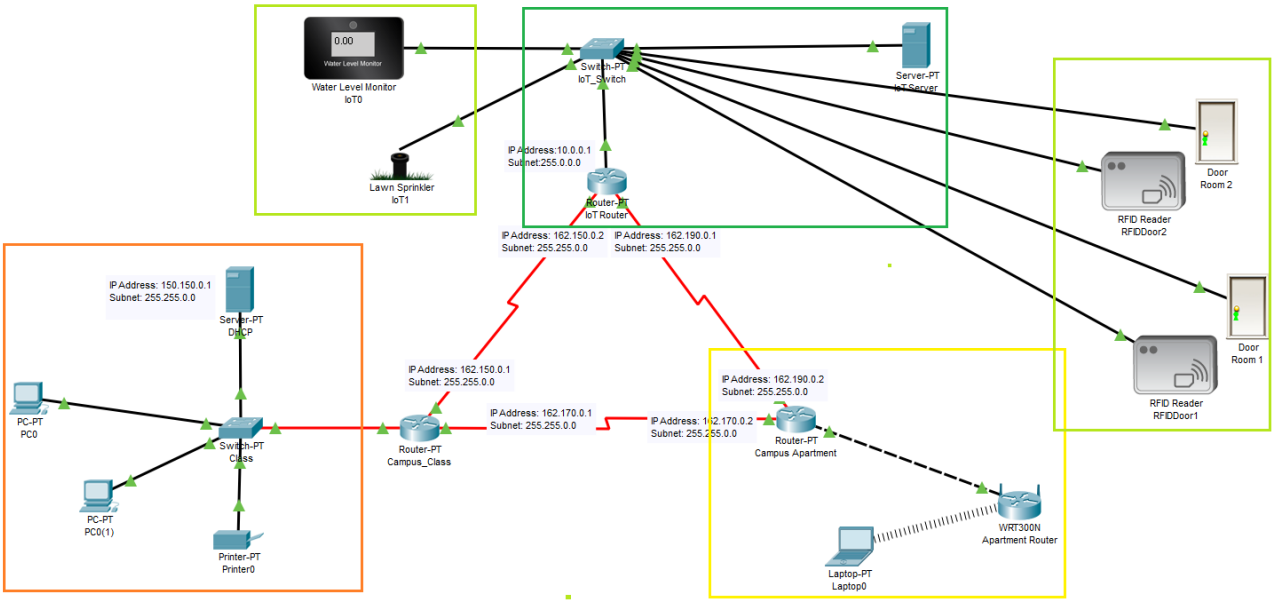
Internet of Things (IoT)

The **Internet of Things** is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of Things.

Smart Campus

Smart campus was a more comprehensive IoT simulation compared to the previous two smart home exercises, both network and IoT layout, were in fact more complex in order to show a deeper interaction between the IoT devices but also to give more options to the students for future exercise expansion. Smart-Campus simulated a university campus where, along with traditional school and apartment networks, an IoT network allowed to connect different IoT devices spread across the campus premises. Examples of RFID access control management and intelligent sport field watering solution were included in the simulation.

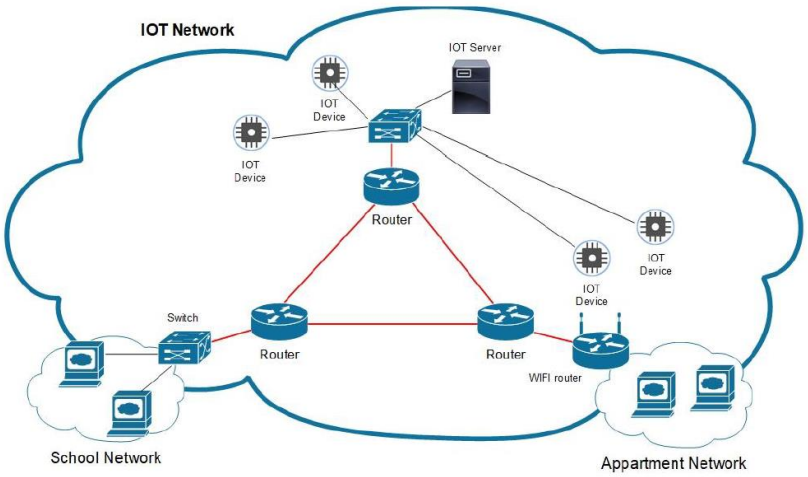
Smart Campus Topology



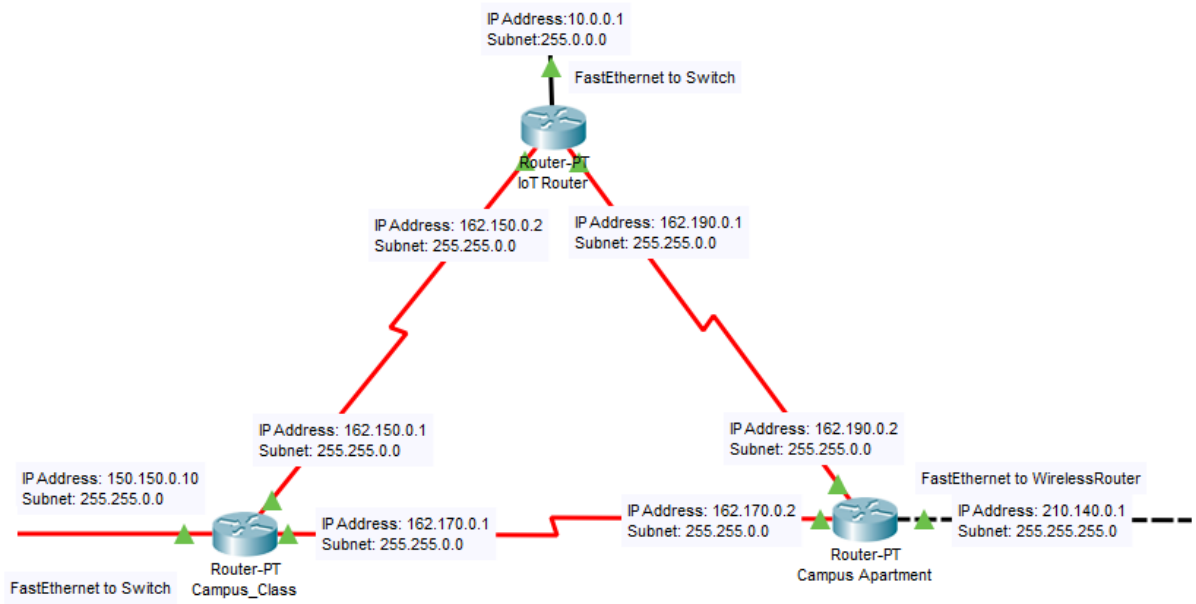
Network Layout

The network layout in this exercise is more complex compared to previous lab exercises. This network topology includes

- Backbone router network
- Traditional switch-based classroom wired network
- Wireless LAN for the apartment buildings
- Dedicated IoT network based also on switch



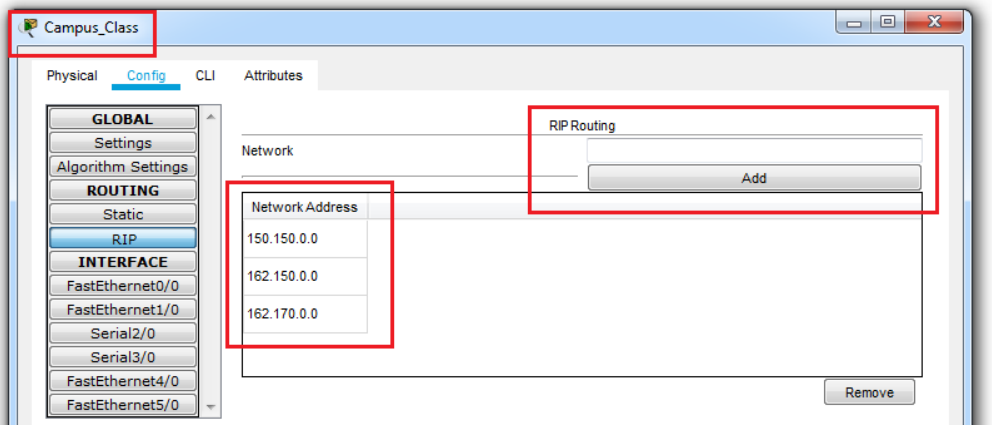
Part 1: Backbone Router Network

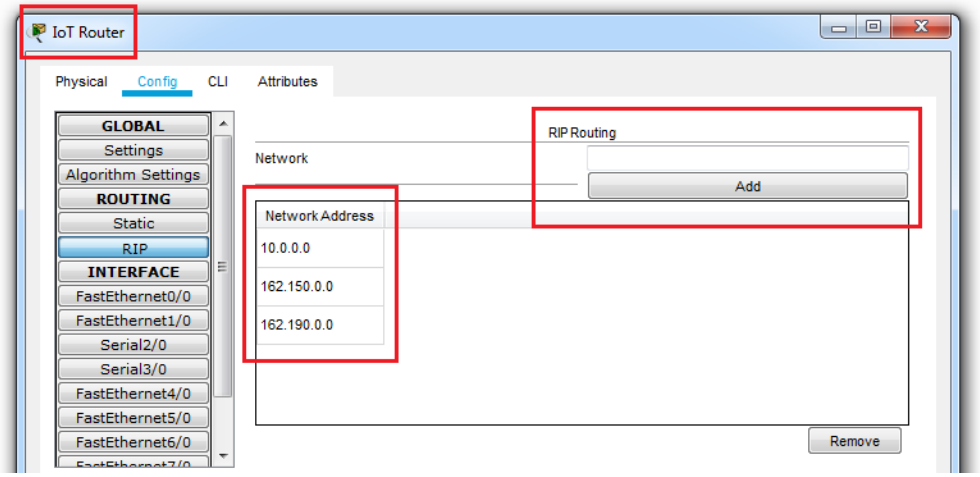


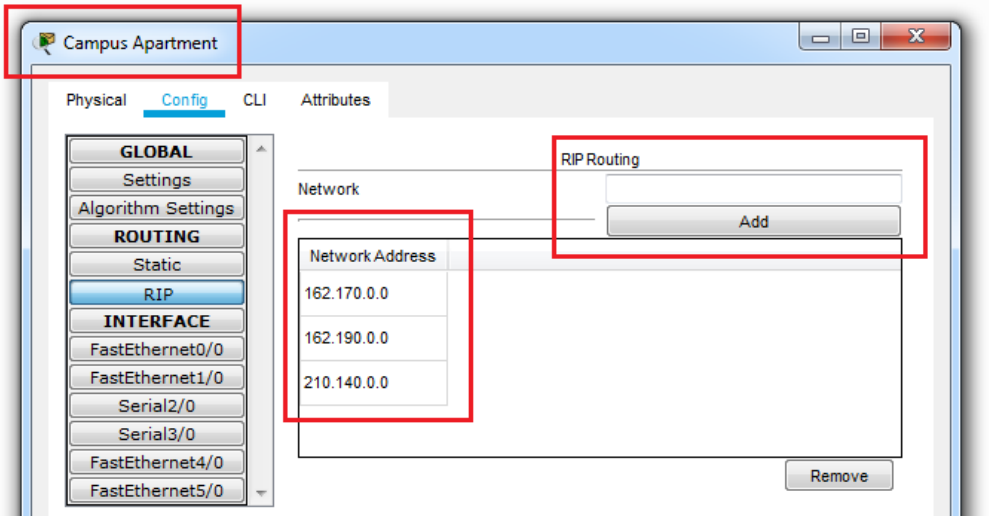
1. Set the router interface IP addresses as follows

Router Name	Interface	IP Address	Subnet
Campus Class	FastEthernet to Switch	150.150.0.10	255.255.0.0
	Serial 2/0	162.150.0.1	255.255.0.0
	Serial 3/0	162.170.0.1	255.255.0.0
Campus Apartment	FastEthernet to Wireless Router	210.140.0.1	255.255.0.0
	Serial 2/0	162.190.0.2	255.255.0.0
	Serial 3/0	162.170.0.2	255.255.0.0
IoT Router	FastEthernet to Switch	10.0.0.1	
	Serial 2/0	162.150.0.2	255.255.0.0
	Serial 3/0	162.190.0.1	255.255.0.0

2. Implement **RIP Protocol** on all the three routers as shown below.

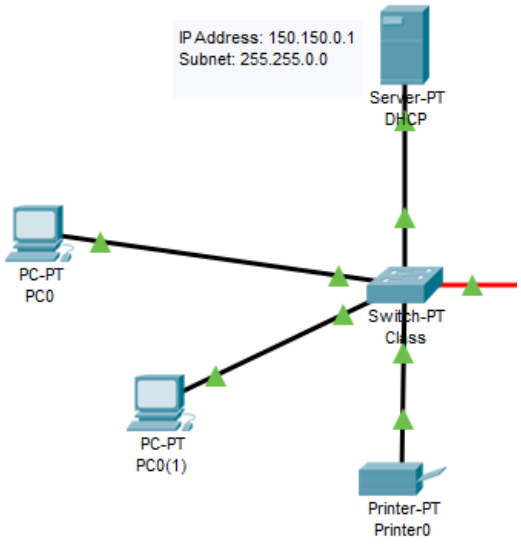



IoT Router
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
FastEthernet6/0
Network
RIP Routing
Add
Network Address
10.0.0.0
162.150.0.0
162.190.0.0
Remove

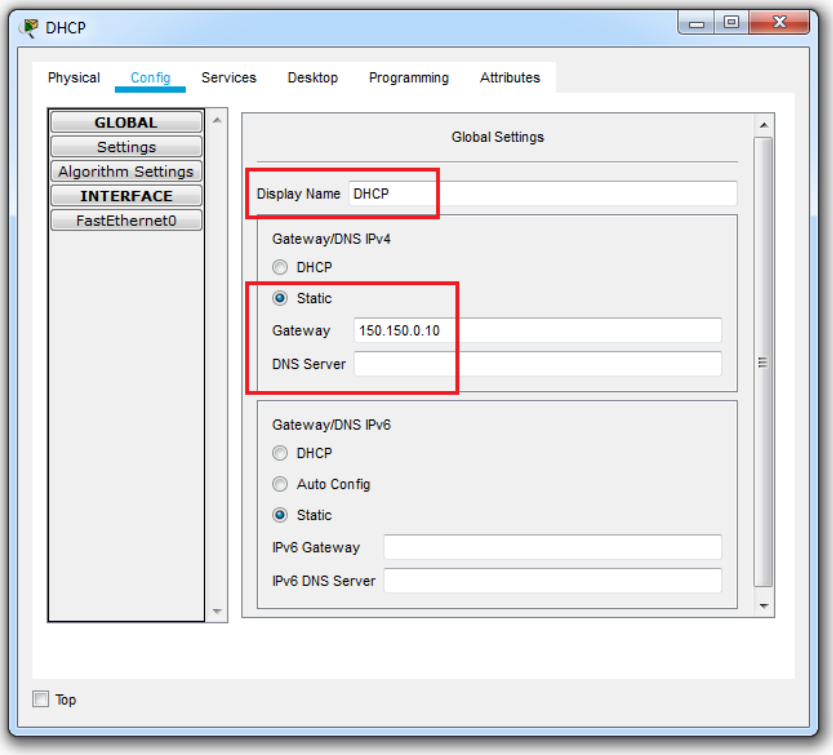

Campus Apartment
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Network
RIP Routing
Add
Network Address
162.170.0.0
162.190.0.0
210.140.0.0
Remove

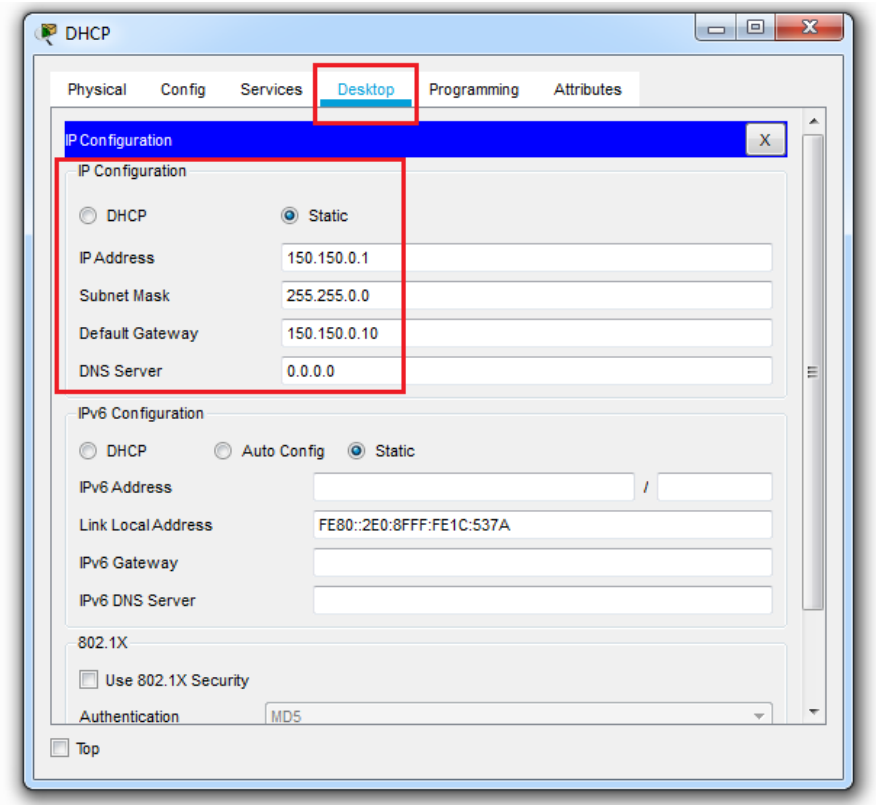
(Part 2 Below)

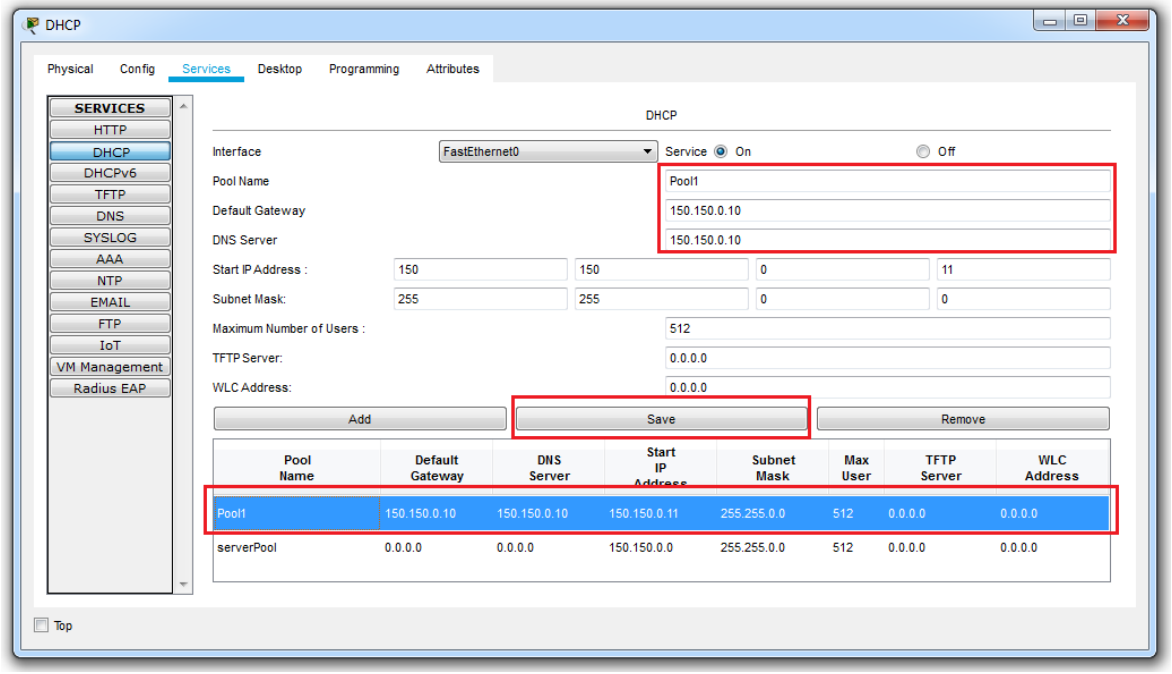
Part 2: Setting up Campus Class Network



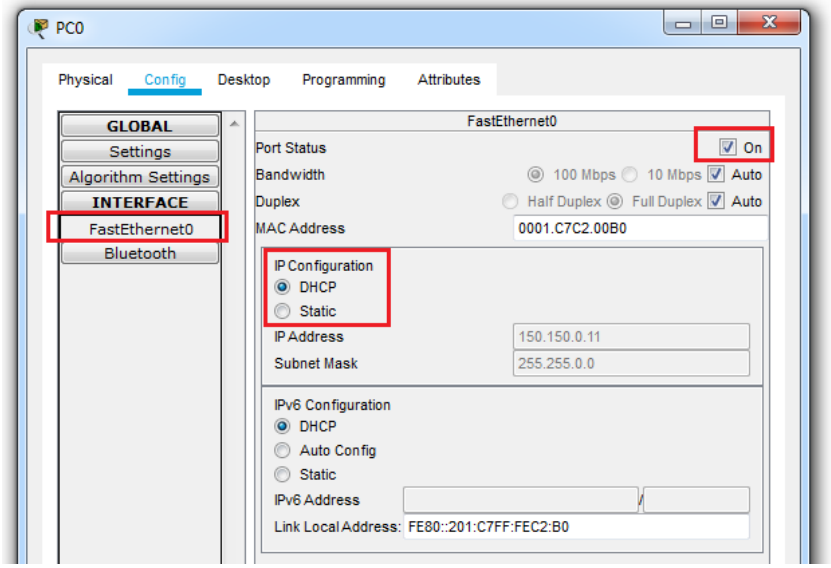
1. Add devices as shown in the above diagram.
2. Setup a **DHCP** server. A DHCP Server is a network server that automatically provides and assigns IP addresses, default gateways and other network parameters to client devices. Therefore one a DHCP server is configured, there is no need to add IP Addresses to the remaining client devices.



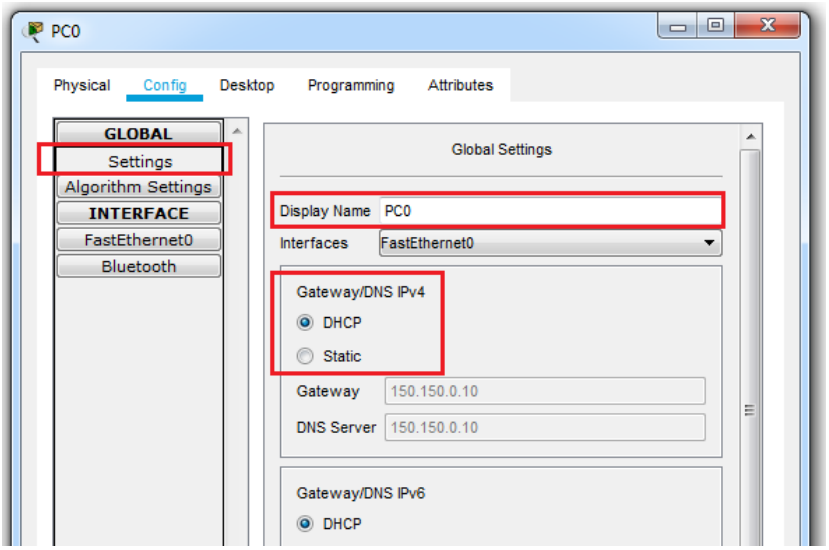

DHCP
Physical
Config
Services
Desktop
Programming
Attributes
IP Configuration
X
IP Configuration
DHCP
Static
IP Address
150.150.0.1
Subnet Mask
255.255.0.0
Default Gateway
150.150.0.10
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
Link Local Address
FE80::2E0:8FFF:FE1C:537A
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Top


DHCP
Physical
Config
Services
Desktop
Programming
Attributes
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
IoT
VM Management
Radius EAP
DHCP
Interface
FastEthernet0
Service
On
Off
Pool Name
Pool1
Default Gateway
150.150.0.10
DNS Server
150.150.0.10
Start IP Address :
150
150
0
11
Subnet Mask:
255
255
0
0
Maximum Number of Users :
512
TFTP Server:
0.0.0.0
WLC Address:
0.0.0.0
Add
Save
Remove
Pool Name
Default Gateway
DNS Server
Start IP Address
Subnet Mask
Max User
TFTP Server
WLC Address
Pool1
150.150.0.10
150.150.0.10
150.150.0.11
255.255.0.0
512
0.0.0.0
0.0.0.0
serverPool
0.0.0.0
0.0.0.0
150.150.0.0
255.255.0.0
512
0.0.0.0
0.0.0.0
Top

3. For all the devices, turn on the connected port and refresh the DHCP option. The port is allocated an IP address by the server.

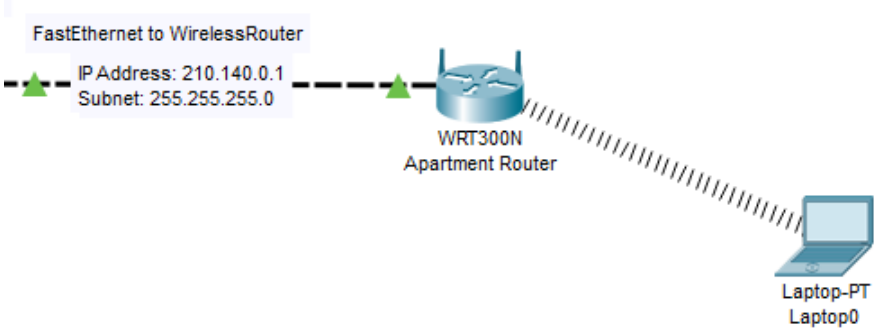


4. For all the devices, refresh the DHCP option in the Settings. The Gateway and DNS IP Address configured in the DHCP server will appear.

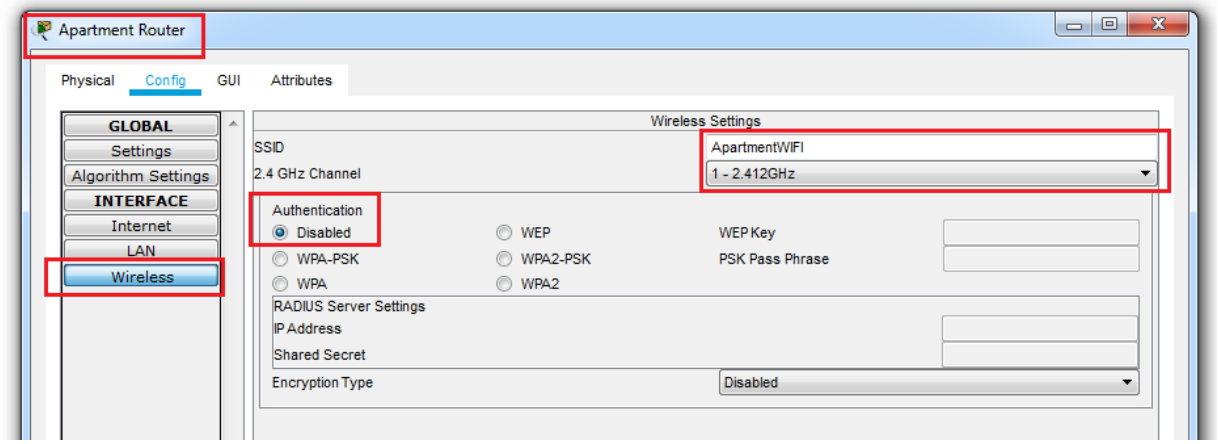


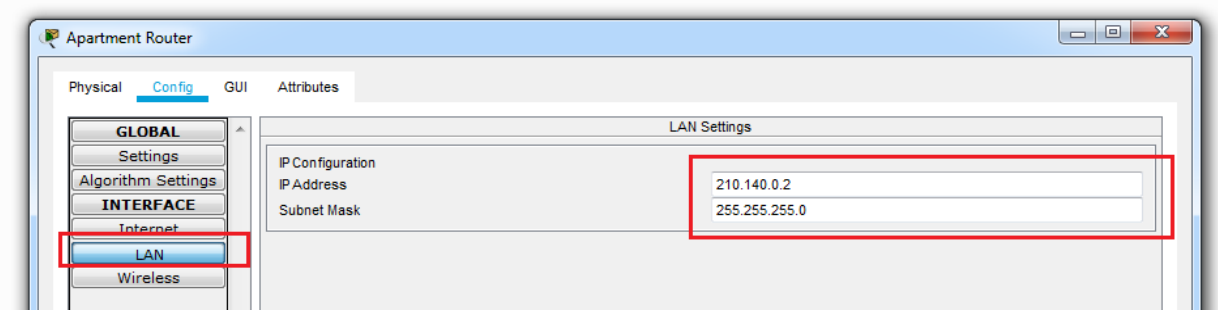
(Part 3 Below)

Part 3: Setting up Campus Apartment Network



1. Setup the wireless router WRT300N as shown below. We setup a wireless network through which various devices can connect.

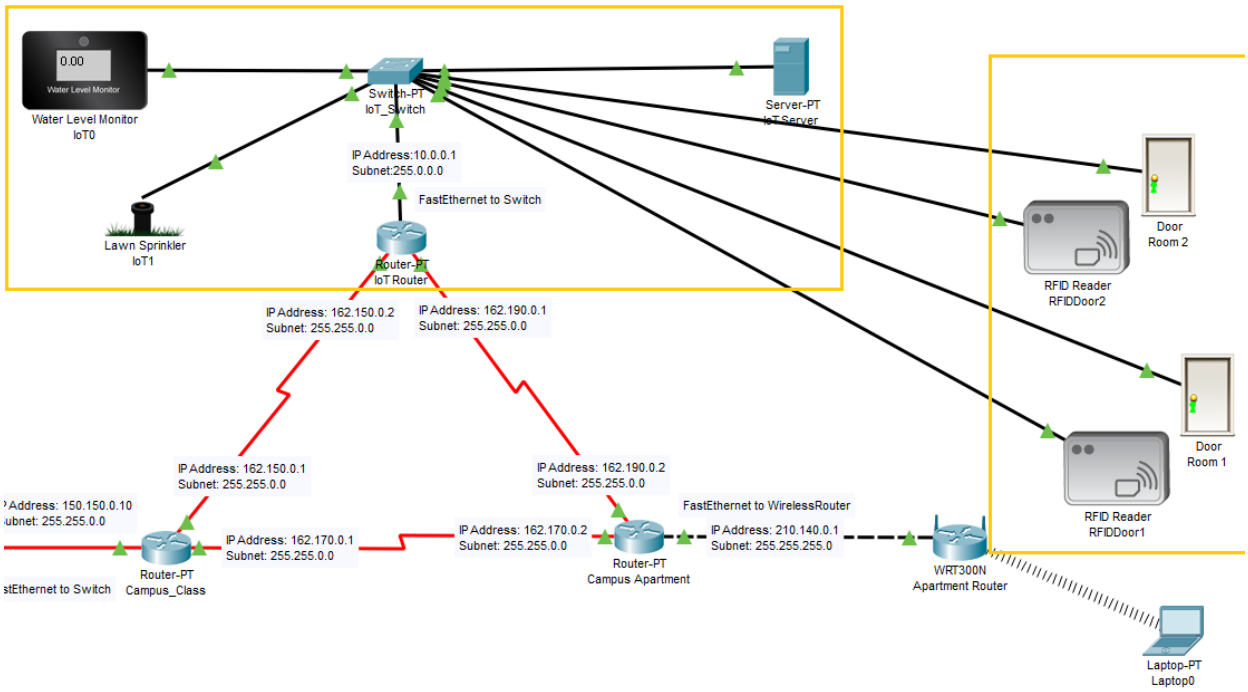




(Part 4 Below)

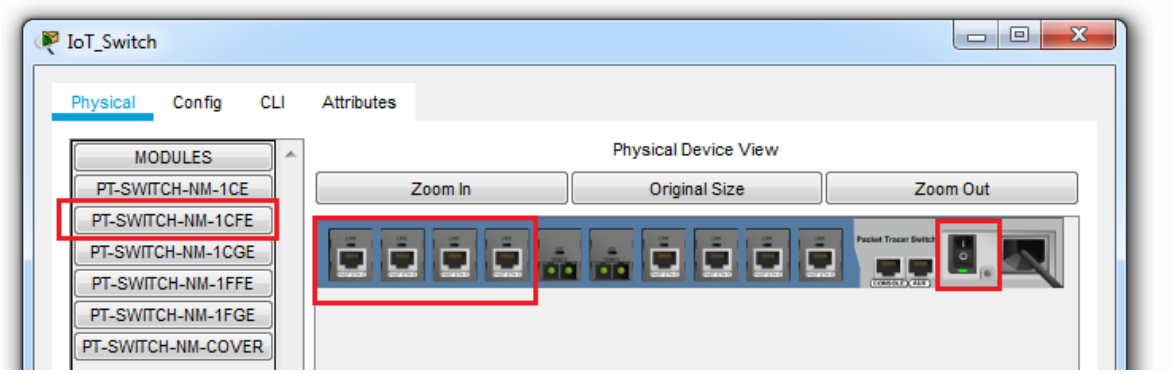
Part 4: Setting up IoT Network

We now setup the IoT network and add IoT devices. Before we add the devices as shown below.

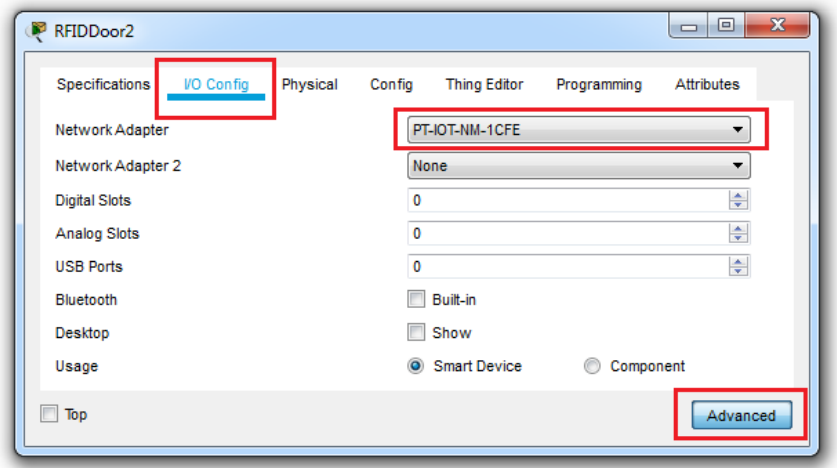


However, you will find that the switch does not have enough FastEthernet port to connect all devices. Therefore we add the ports to the switch as follows

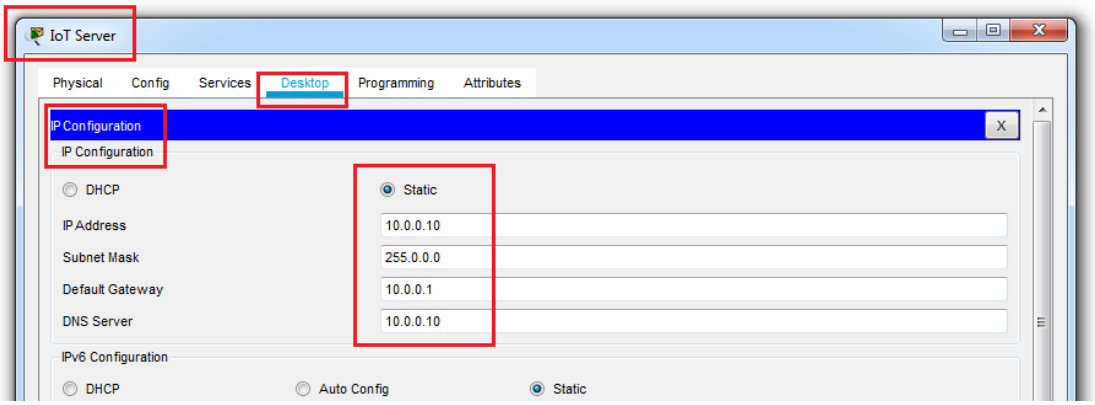
1. Shut down the switch. Drag the PT-SWITCH-NM-1CFE to the empty slots on the right side of diagram.



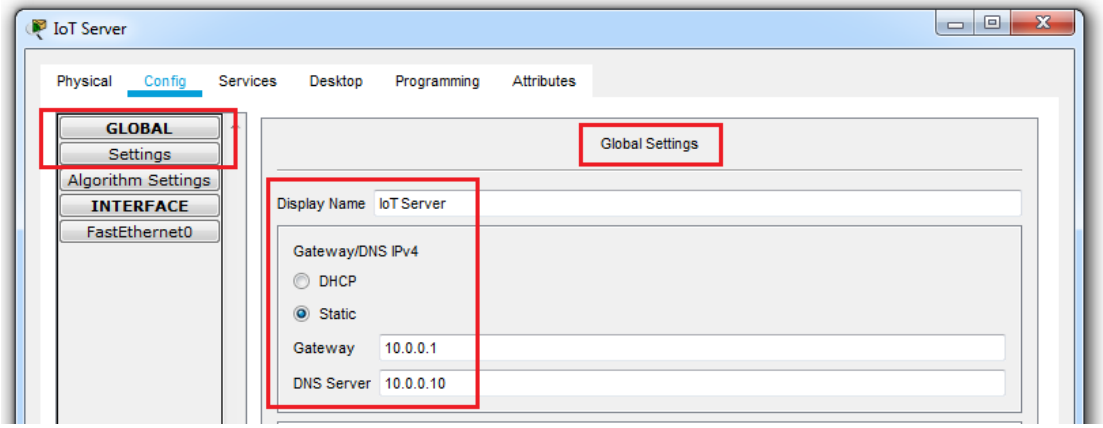
2. Make sure the IoT devices have FastEthernet ports. If not use the Advanced button on every IoT device. That will provide an I/O Config option, where you can change the port connectivity type



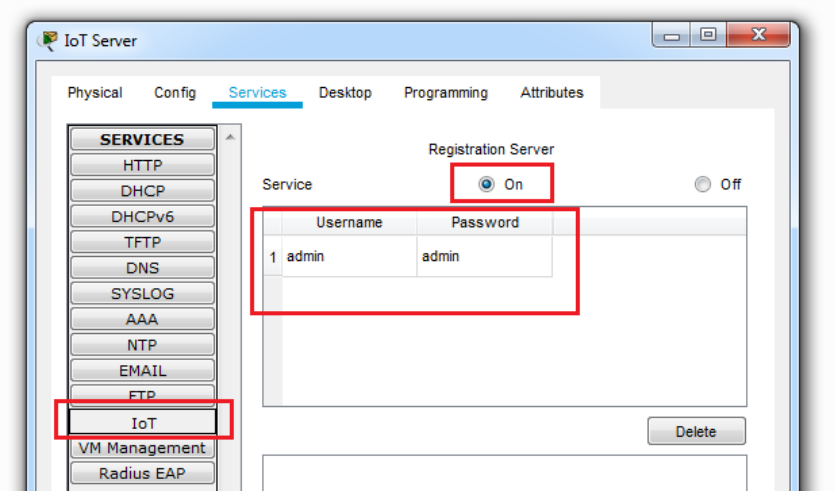
3. After adding all the devices and auto cabling them, we start with configuring the devices.
4. First we configure the IoT Server. Add IP Address to the IoT Server as shown below.



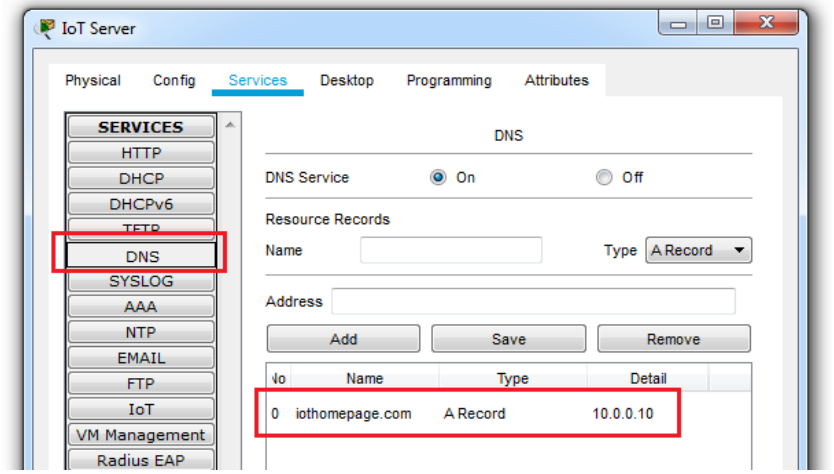
5. In Global Settings, configure the Name, Gateway IP and the DNS IP.



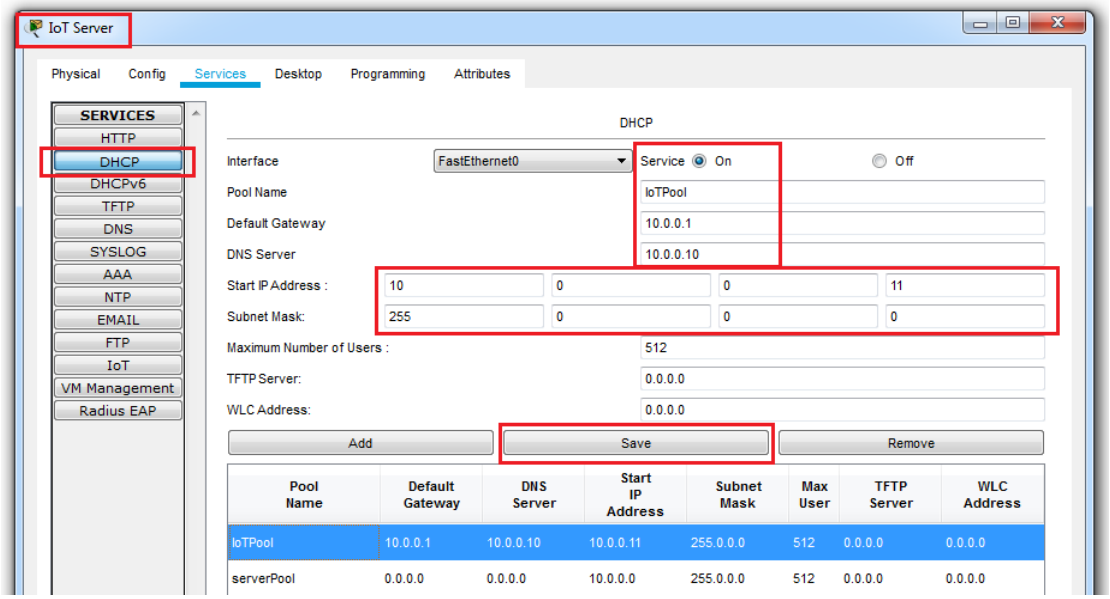
6. Add IoT Registration services as performed in previous labs



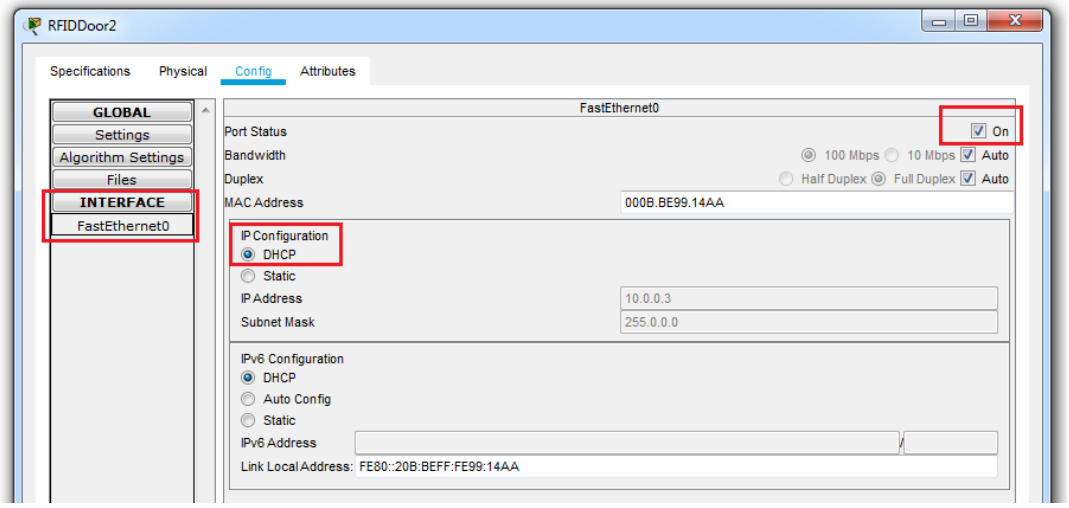
7. Add DNS services on the IoT Server

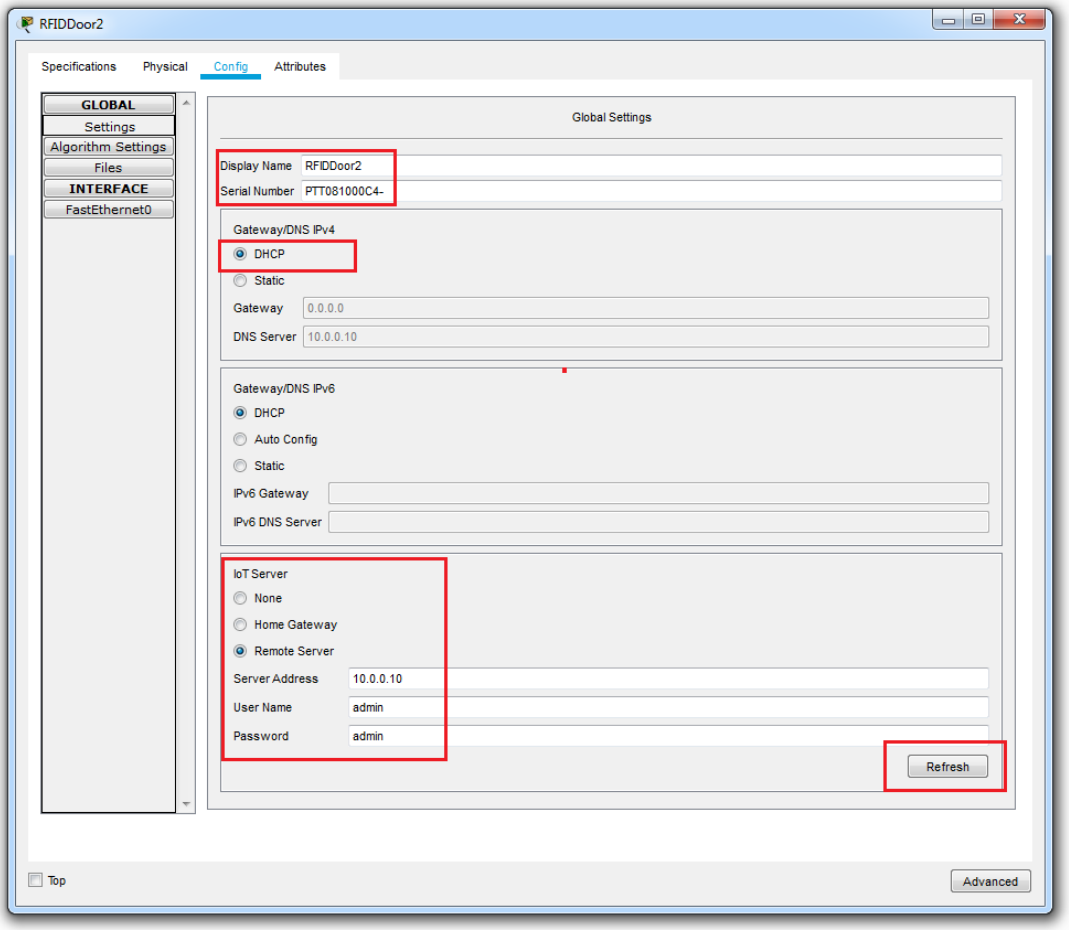


8. Add DHCP service on the IoT Server so it can assign IP addresses to IoT devices

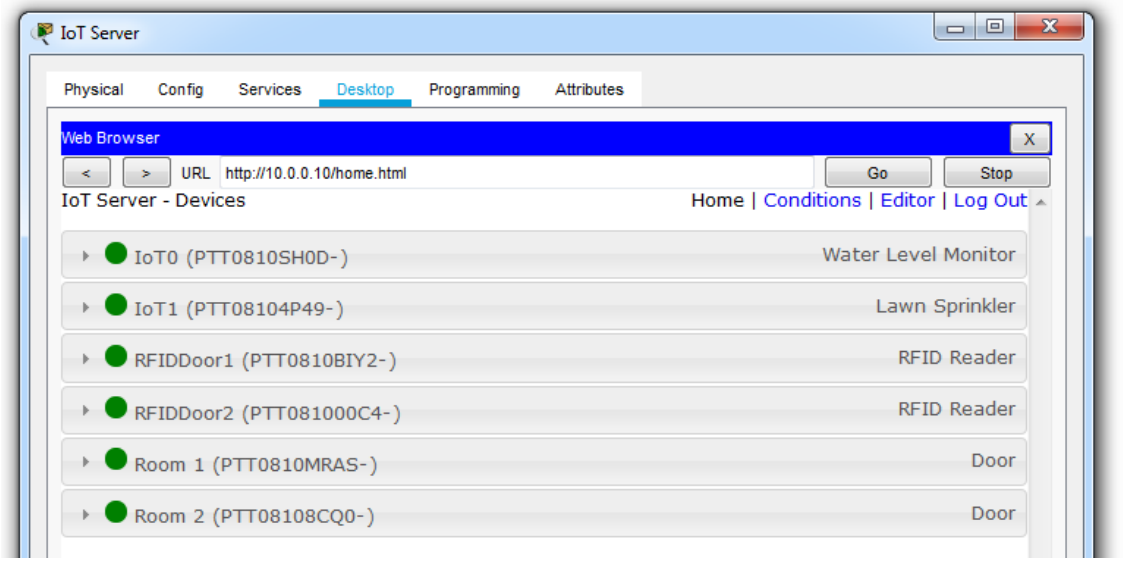


9. Configure all the remaining IoT Devices i.e. Door, RFID Readers, Lawn Sprinkler and Water Level Monitor with the following configurations.





10. When all the devices are properly connected, the devices will show up in the IoT Registration Service. The Registration service can be accessible using the Web Browser and IP address 10.0.0.10



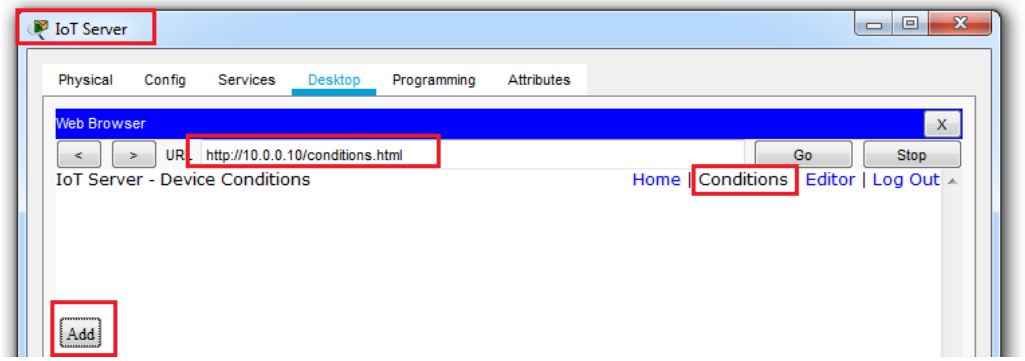
(Part 5 Below)

Part 5: Adding IoT Device Conditions

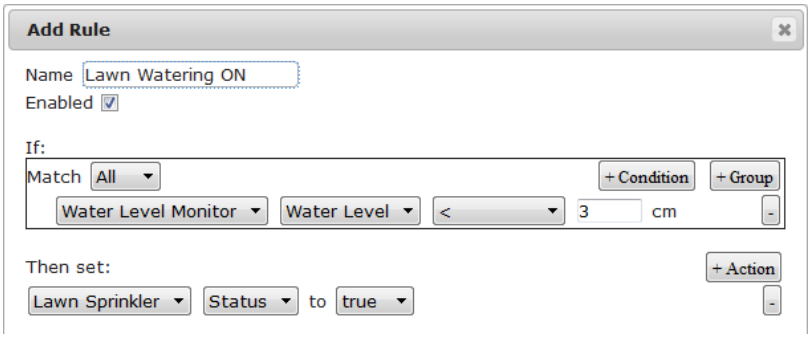
There are 2 ways to add IoT Conditions.

- Add a micro-controller, connect the devices and program the conditions
- Add the conditions in the IoT Registration Server.

We will use the second approach as we do not need to change the topology

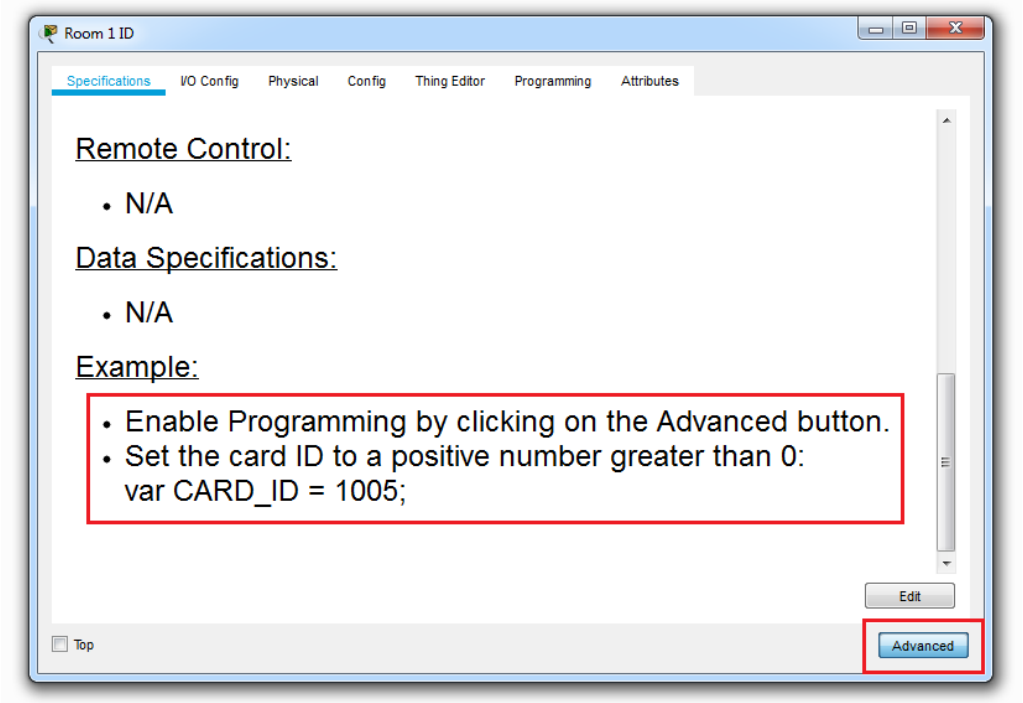


1. Add conditions for Lawn Sprinkler ON and OFF

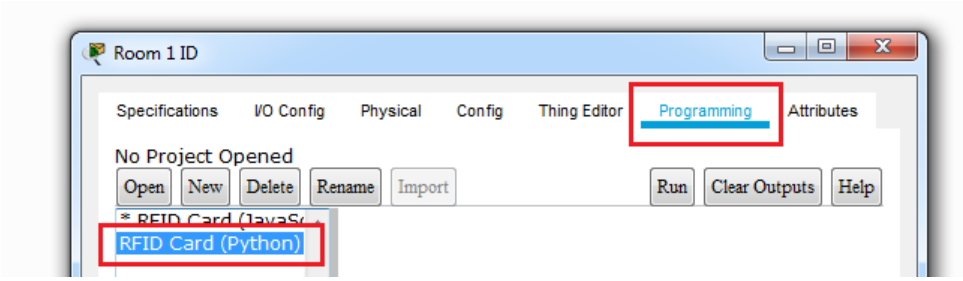


2. We now add RFID cards for the Apartment Doors

3. Configure the above RFID cards as follows



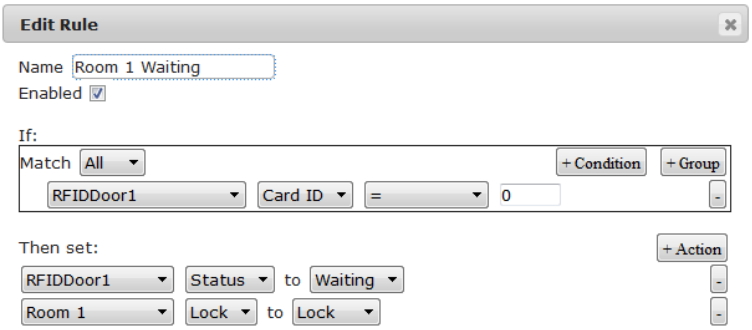
4. Select the Programming option and double click on RFID Card (Python)



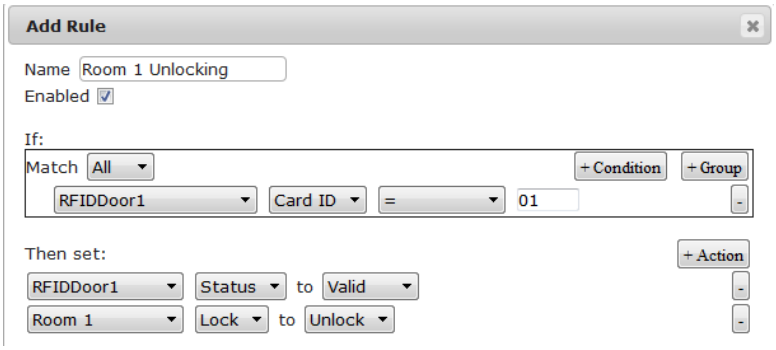
5. Double click on the main.py. And change the value of Card_ID to 01. Click Run. Similarly add 02 and 03 to RFID Card 2 and 3 respectively.

6. We now configure the RFID Reader. Add the following conditions in the Condition section in the IoT Registration Service website. Perform the following for all the RFID readers

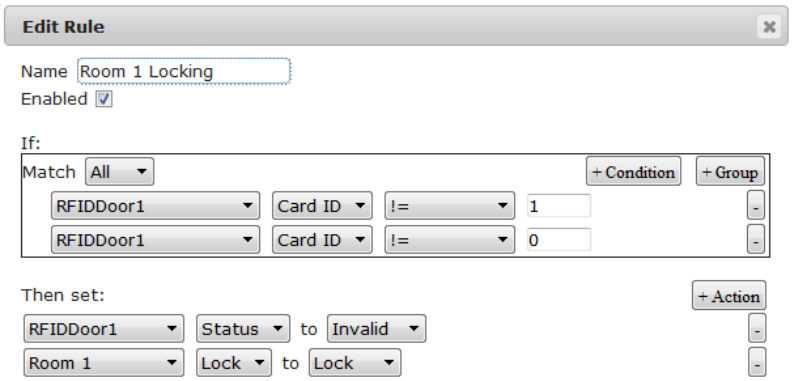
   a. We first set all the RFID into a waiting mode and set room doors to lock status



   b. We set the unlocking conditions for the door



   c. We set the locking conditions for the door



7. The door will unlock with proper RFID Card