Boosting Campus Network Design Using Cisco Packet Tracer

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Abstract:-Campus Network (CN) is a set of Virtual Local Area network (VLAN), which covers the entire university. It provide difference service such as connect user to internet, data sharing among user, accessing different web service for different functionalities. As Campus Network (CN) provides students, teachers, and different university member for different application, to sustain different activities in the university, so it need to design in advance. To sophisticate the campus network service, this paper proposed Smart Campus Network Design(SCND) by integrating internet of thing device with classically network device in campus network and each smart device for different application must be registered to IOE server and controlled by legitimate user. To design the proposed campus network design, I used cisco packet tracer simulator software.

Keyword:-Campus Network (CN), Smart Device, Virtual Local Rea Network (VLAN), Internet of Things.

I. INTRODUCTION

Local area network (LAN) is a network that is controlled by single authority (e.g. CN). Campus network (CN) is set of virtual local area networks (VLAN), which are virtual divided for increasing the performance of network and increases campus network management with security.

While the term “Internet of Things” (IoT) was first announced, the primary question might be what is considered as “Things”. Till current years, groups of scholars and organizations tried to make clear the definition of IoT. Haller et al. [1] proposed a definition of IoT with “A world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business process.” To spread the coverage of IoT definition, Sarma et al. [2] defines the “Things” from physical objects to virtual objects which represents as the identities with Internet connectivity. Although IEEE IoT Initiative is proceeding to draft a white paper [3] for the formal definition of IoT there are still no common agreements for the definition of IoT.

In this paper, I define a “Smart Thing” on Internet of Things that indicates a physical object that registered on IOT server or Home Gateway and controlled through web from remote/local network by legitimate user [4].

Smart Campus Network Design (SCND) is the proposed method to design campus network by integrate IoT device with networking device, to facilitate different activities in campus network. This design includes Hierarchical Network Design as a hierarchical design is used to cluster devices into multiple networks layers [5]. The networks are structured in a layered approach, those are Core layer, distribution layer and access layer. Each layer have their own functionalities that are Core layer: connect distribution layer to the internet Distribution layer: Interconnects the smaller local networks, Access layer: Provides connectivity for network hosts, smart things and end devices. To design Smart Campus Network Design (SCND) I used cisco packet tracer simulator software.
Cisco packet tracer is simulation software used to design, configure, troubleshoot different Cisco device [6] [7] and currently included IOT device in Cisco packet tracer version 7.

II. MOTIVATION

Cisco currently release new version of Cisco packet tracer that include IOE device with classically networking device.

III. METHODOLOGY

In order to design campus network I used Cisco packet tracer. Cisco Packet Tracer is a networking simulator used for teaching and learning by offering a unique combination of realistic[7][8].

Benefits of Packet Tracer are:

- Offers a realistic simulation and visualization
- Permits users to design, build, configure, and troubleshoot complex networks
- Allows students to explore concepts, conduct experiments,

Currently released Cisco packet tracer included new feature like new device, sensor, and Programming Languages with classically networking device, those device stated below [4].

Things and Components available in Packet Tracer 7.0

- **Smart Things** are smart object attached to the Registration Server or Home Gateway through a network interface. They are divided into 4 subcategories: Smart City, Home, Industrial, and Power Grid.
- **Components** are smart objects that link to microcontroller (MCU-PT) or single boarded computers (SBC-PT). Not have a network interface and rely on the MCU-PT or SBC-PT for network access. This smart object can communicate through analog or digital slots.

A. New Future of Cisco Packet Tracer 7.0

- Registration server for IoT devices
- IOE devices and sensors in a new IoE devices category: solar panel, power meter, car, wireless home gateway, power meter, motion detector, temperature sensor, conveyor sensor,
- Programming languages for IoE.
- Single board Computer (SBC)
- Microcontroller Unit (MCU)
- Wireless IOE RFID sensor.
- Wireless IOE RFID items.

![Cisco Packet Tracer](image)

Fig. 1: First Lookup of Cisco Packet Tracer 7
Fig. 2: Four Categories of Smart Thing

Each category has their own smart thing that is applicable in categories. Example: in home categories different smart things are there such as smart door, co detector, co2 detector, humidifier, home speaker, motion detector, humidity monitor, smoke detector, siren, webcam and smart window.

Fig. 3: MCU and SBC Microcontroller

This microcontroller provide programming environment (fig. 3) in order to control the smart things connected to this two boards.

Fig. 4: Programming Environment Provided By MCU (Microcontroller)
Smart things can directly register to IOE Server or Home Gateway configured with the IoE service. Home Gateway have 4 Ethernet ports in addition to a wireless access point configured with the "Home Gateway" SSID. To secure wireless connection WEP / WPA-PSK / WPA2 enterprise can be configured on home gateway. The figure below shows four internet of Things device connected to a Home Gateway by using Ethernet cable and wireless. To connect the Home Gateway to the Internet its Internet WAN Ethernet port available on home gateway.

**Fig. 5: IOE Registration Server**

**Fig. 6: Home Gateway with Four Smart Things Connected To Home Gateway**

**IV. IMPLEMENTATION**

To implement campus network design I proposed Smart Campus Network Design (SCND), to design this proposed method different networking device are used, those device are cisco 1941 router, 2960 switch, 3560 switch, central office server, cell tower and some smart thing is also included in this design. Furthermore about the device is elaborated in table 1.
**Fig. 7: Proposed Architecture**

### A. Device Used for Design

<table>
<thead>
<tr>
<th>No.</th>
<th>Device</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Router(1941)</td>
<td>Used to connect campus network to the internet</td>
</tr>
<tr>
<td>2</td>
<td>layer two switch (2960)</td>
<td>Used to distribute access to the lower layer</td>
</tr>
<tr>
<td>3</td>
<td>Layer three switch (3560)</td>
<td>Used to perform intra VLAN routing</td>
</tr>
<tr>
<td>4</td>
<td>Server</td>
<td>To control smart thing registered on it and provide server functionalities</td>
</tr>
<tr>
<td>5</td>
<td>Central office server</td>
<td>Used to connect cellular system to the router</td>
</tr>
<tr>
<td>6</td>
<td>MCU</td>
<td>Used to interconnect different smart thing</td>
</tr>
<tr>
<td>7</td>
<td>Pc</td>
<td>Connect to access layer</td>
</tr>
<tr>
<td>8</td>
<td>Fan</td>
<td>Used to ventilate the campus based on some condition</td>
</tr>
<tr>
<td>9</td>
<td>Webcam</td>
<td>Control the campus</td>
</tr>
<tr>
<td>10</td>
<td>Siren</td>
<td>Provide sound for some event in the campus</td>
</tr>
<tr>
<td>11</td>
<td>Light</td>
<td>Provide light</td>
</tr>
<tr>
<td>12</td>
<td>Motion detector</td>
<td>Connect to home gateway and provide Detection of motion</td>
</tr>
<tr>
<td>13</td>
<td>Smart door</td>
<td>Connect to home gateway and provide Function based event</td>
</tr>
<tr>
<td>14</td>
<td>Cell tower</td>
<td>Provide cellular system coverage for different user</td>
</tr>
<tr>
<td>15</td>
<td>Tablet</td>
<td>Used to control the campus from outside</td>
</tr>
<tr>
<td>16</td>
<td>Old car</td>
<td>To detect smoke</td>
</tr>
<tr>
<td>17</td>
<td>LCD</td>
<td>To display text</td>
</tr>
<tr>
<td>18</td>
<td>Motion sensor</td>
<td>To sense motion by mouse movement</td>
</tr>
</tbody>
</table>

Table 1: Device Used for Implementation
B. Device Configuration

To implement the campus network design on cisco packet tracer, I used class A IP address that is 10.10.220.0/24 subnet and this subnet divided into eight subnet from this eight subnet, I used four of them and the rest are reserved for future scalability.

- Core Router

Router(config)#hostname corerouter
corerouter(config)#interface g0/0
corerouter(config)#ip address 10.10.220.1 255.255.255.224
corerouter(config)#no shutdown

corerouter(config)#int g0/1
corerouter(config)#ip address 209.165.20.225 255.255.255.224
corerouter(config)#no shutdown

corerouter(config)#int g0/2

corerouter(config)#int g0/3

corerouter(config)#int g0/4

corerouter(config)#int g0/5

corerouter(config)#int g0/6

corerouter(config)#int g0/7

corerouter(config)#ip dhcp excluded-address 209.165.20.225 209.165.20.229

corerouter(config)#ip dhcp pool tell

corerouter(dhcp-config)#network 209.165.20.224 255.255.255.224

corerouter(dhcp-config)#default-router 209.165.20.225

corerouter(dhcp-config)#dns-server 10.10.220.35

Command for checking running configuration

corerouter#show running-config

Building configuration...

Current configuration : 1072 bytes

version 15.1
no service timestamps log datetimemsec
no service timestamps debug datetimemsec
service password-encryption

hostname corerouter
enable secret 5
$1$mERr$Me19uJMtOy6/CjrWm.7sd1

ip dhcp excluded-address 209.165.20.225 209.165.20.229

ip dhcp pool tell

network 209.165.20.224 255.255.255.224

default-router 209.165.20.225
dns-server 10.10.220.35

no ipcef
no ipv6 cef

license uidipid CISCO1941/K9 sn FTX1524UANM

spanning-tree mode pvst

interface GigabitEthernet0/0
ip address 10.10.220.1 255.255.255.224
duplex auto
speed auto

interface GigabitEthernet0/1
ip address 209.165.20.225 255.255.255.224
duplex auto
speed auto

interface Vlan1
no ip address
shutdown

ip classless
ip route 10.10.220.0 255.255.255.0 10.10.220.2
ip route 10.10.220.0 255.255.255.224 10.10.220.2

ip flow-export version 9

no cdp run

line con 0
password 7 08224D43190C16

line aux 0

line vty 0 4
password 7 08224D43190C16
login

line vty 5 15
password 7 08224D43190C16
login

end
Distribution Layer Device

Switch(config)#hostname multlayerswitch
multlayerswitch(config)#vlan 10
multlayerswitch(config-vlan)#name serverfarm
multlayerswitch(config-vlan)#vlan 20
multlayerswitch(config-vlan)#name admin
multlayerswitch(config-vlan)#vlan 30
multlayerswitch(config-vlan)#name MCUsmartthing
multlayerswitch(config-vlan)#vlan 40
multlayerswitch(config-vlan)#name gatewaysmartthing
multlayerswitch3(config)#ipdhcp excluded-address 10.10.220.96 10.10.220.99
multlayerswitch3(config)#ipdhcp pool mcusmartthing
multlayerswitch3(dhcp-config)#network 10.10.220.96 255.255.255.224
multlayerswitch3(dhcp-config)#default-router 10.10.220.97
multlayerswitch3(dhcp-config)#dns-server 10.10.220.97
multlayerswitch3(config)#ipdhcp excluded-address 10.10.220.128 10.10.220.130
multlayerswitch3(config)#ipdhcp pool getwaysmartthing
multlayerswitch3(dhcp-config)#network 10.10.220.128 255.255.255.224
multlayerswitch3(dhcp-config)#default-router 10.10.220.129
dns-server 10.10.220.129
dns-server 10.10.220.35
dns-server 10.10.220.35
ip dhcp pool serverroom
network 10.10.220.32 255.255.255.224
default-router 10.10.220.33
dns-server 10.10.220.35
ip dhcp pool admin
network 10.10.220.64 255.255.255.224
default-router 10.10.220.65
dns-server 10.10.220.35
ip dhcp pool mcusmartthing
network 10.10.220.32 255.255.255.224
default-router 10.10.220.33
dns-server 10.10.220.35
ip dhcp pool getwaysmartthing
network 10.10.220.128 255.255.255.224
default-router 10.10.220.129
dns-server 10.10.220.129
ip routing
spanning-tree mode pvst
interface FastEthernet0/1
switchport access vlan 10
switchport mode access
interface FastEthernet0/3
switchport access vlan 30
switchport mode access
interface FastEthernet0/4
switchport access vlan 20
switchport mode access
interface Vlan1
no ip address
shutdown
interface Vlan10
mac-address 00e0.f9c0.0001
ip address 10.10.220.33 255.255.255.224
interface Vlan20

Current configuration : 2742 bytes
!
version 12.2
no service timestamps log datetimemsec	no service timestamps debug datetimemsec
no service password-encryption
!
hostname multlayerswitch
!
ip dhcp excluded-address 10.10.220.128
10.10.220.130
ip dhcp excluded-address 10.10.220.33
10.10.220.35
!
mac-address 00e0.f9c0.0002
ip address 10.10.220.65 255.255.255.224

interface Vlan30
mac-address 00e0.f9c0.0003
ip address 10.10.220.97 255.255.255.224

interface Vlan40
mac-address 00e0.f9c0.0004
ip address 10.10.220.129 255.255.255.224
ip classless
ip route 209.165.20.224 255.255.255.224 10.10.220.1

ip flow-export version 9
no cdp run
line con 0
line aux 0
line vty 0 4
login
!
!
end

C. Device Setup

After configuration is done the device get IP address dynamically and IOE device registered to IOE server or home gateway.
The above Fig shows Registering IOE device to IOE server to control IOE device form remote or local by legitimate person that have username and password.

Above fig shows Controlling ceiling fan by making off/low/high and also control light by making on/dim/off.

Fig. 11: Login page for IOT Register Server

Legitimate user can log the system from remote or local to control smart thing registered on the system.

Fig. 12: Controlling Smart Thing Form Local

Fig. 13: Controlling Smart Thing Form Remote Network

Fig. 14: Condition Making For Smart Thing on Server

The Fig. 14: shows condition made for fire sprinkler and smoke detector. If smoke levels above 10 the fire sprinkler, window, door and siren are on else off.
Fig. 15: Shows Fire Sprinkler and Siren Are on

The above fig shows Fire sprinkler and siren are on when smoke level above 10 to ventilate the place and alarm the surrounding. To detect smoke old car was used. As old car has a lot of problem.

Microcontroller unit (MCU) is a board used to interconnect smart thing and sensor for controlling and provide programming environment to manage the things connected to it. The following python program are written on MCU to control and safe resource used by difference smart things.

from gpio import *
from time import *

def main():
    pinMode(0, OUT)
    pinMode(1, OUT)
    pinMode(2, OUT)
    pinMode(3, IN)
    pinMode(4, OUT)
    print("BLINKING")
    while True:
        customWrite(1, "wel come");
        digitalWrite(2, LOW);
        customWrite(0, 0);
        customWrite(4, 0);  
        if (digitalRead(3)):
            customWrite(3, 0);
            customWrite(0, 1);
            customWrite(1, "Warning");
            digitalWrite(2, HIGH);
            customWrite(4, 1);
            print("ALERT")
            delay(1000)

    if __name__ == "__main__":
        main()
Fig. 16: Shows MCU Control the Smart Thing and Sensor Connected To It.

The above Fig shows if motion is detected in case of security the siren, alarm, webcam are on and LCD display warning text. To control this events the above python program implemented on central MCU.

V. CONCLUSION

To improve the campus network service, this paper proposed Smart Campus Network Design (SCND) by assimilating internet of thing device with classically network device. Each smart device registered to IOT server or home getaway and controlled by legitimate user. This design also include Hierarchical Network Design as a hierarchical design is used to group devices into multiple layers. This paper also present about Microcontroller unit (MCU) that used to interconnect different IOE device and control them by coding. To design the proposed campus network design I used cisco packet tracer simulator software.

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