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Smart Networking of Company

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Abstract: ***This paper simulate IoT based smart companies and make our networking infrastructure effective, efficient and most importantly accurate with security. The simulator used is Cisco Packet Tracer, this tool has been used form many years in networking. Main strength of the tool is the offering of a variety of network components that simulate a real network, devices would then need to be interconnected and configured in order to create a network. Technology plays a critical role in all daily activities of the present day.***

One of these needs is to create a smart office that controls operation and turns off electronic devices via a smartphone. This implementation can be implemented effectively using package tracking software that includes IoT functions to control and simulate a smart office. The latest version of the tool Cisco introduced IoT functionalities, and now it is possible to add to the network smart devices, components, sensors, actuators and also devices that simulate microcontrollers such as Arudino or Raspberry Pi.

All the IoT devices can be run on standard programs or can be customized by programming them with Java, Phyton or Blockly. This makes Cisco Packet Tracer an ideal tool for building IoT practical simulations. Smart-Industrial smart-company office offer simulation of a power plant that produces and stores electricity via solar panels and wind turbines. All the electricity is produced by smart devices, then stored and utilized to power a production chain filled with smart sensor and actuators. IoT security features are also introduced in the simulations.

Keywords: Internet of things (IOT), Campus Network (CN), networking, wide area network (WAN).

I. INTRODUCTION

In the 21st century are becoming more and even more automated and self-controlled because of the comfort they provide, especially when they are installed inside an offices, home or companies. A house/company/industry automation system provides us with resources that would let customers to access and be in charge of for electric appliances of various kinds. A lot of the active as well as well-established automated systems have been based on interaction through wires. This will not be a difficulty until and unless the system has been designed properly in advance and has been installed at the time of the production of our building. Also in case of the already existing buildings, implementation costs can go pretty high. On the contrary, Wireless systems have been of a large help for the automation systems. In recent times due to the improvement that has been shown by wireless technologies like cloud networks, Wi-Fi in quite near past, these wireless system have been in use almost everywhere every day.

A worldwide, immersive, imperceptible, ambient networked computing setting built throughout the sustained creation of smart sensors, smart cameras, database, soft wares, and enormous data centers in a world-spanning foundation of information which is known as Internet of Things.

These paper simulated an industrial application where electricity was generated via solar panel and wind turbines, temporary stored in batteries, and then spent by an industrial production line made by actuators and component. Same electricity was also utilized for power accessory items like cooling units and lights. Network topology was divided in five main sub-networks: two where IoT devices producing and storing electricity were connected, one for the corporate office building, one where IoT device that utilized electricity were located and last one for overall IoT control. All these networks were interconnected to each other by a central core router located in the IoT control network.

The simplest network was the corporate office building LAN. Network consisted in a main router connected to the central router and a local office switch. PCs and office DHCP server were also connected to the local switch. By network design, none of the office PCs were able to reach the IoT homepage or any of the IoT devices. Intention in fact was to isolate and restrict the access to control IoT device for only authorized user physically connected to the IoT control network. Sea and Land were the two networks where IoT device producing electricity were connected, both of these LANs were connected to the central core router.

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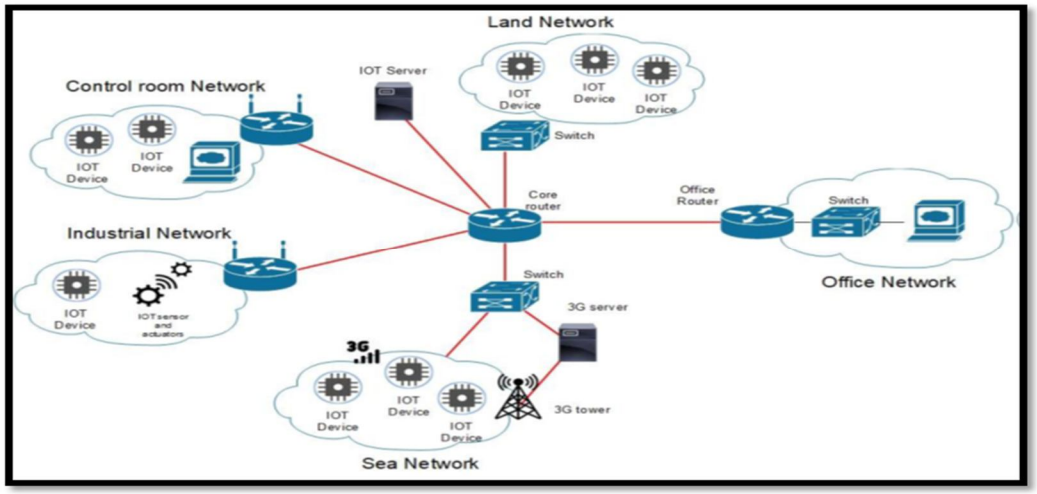


Fig.1: smart-company network topology

Purpose of the networks was to be the main connection point between other WLANs and LAN, but also to conceptually work as main control room for the IoT devices. All IoT devices were in fact remotely connected to the IoT server hosted in the IoT control LAN. Heart of this grid was the core routers. As device was the central connection point additional NIC cards were needed in order to be able to connect all the other sub-networks.

II. LITERATURE SURVEY

Literature review is an important section in the thesis through which we can decide what all innovations we can added in this project to reach the level with today's technologies. So, here we have reviewed a number of research papers and has gone through those papers and from that we analyze systems and implemented here in this network. Literature review covers the related work and the technologies used in the previous papers. There are different systems reported in literature out of that few important systems are reviewed. Some of them are:

Table 1: literature review analysis

Sr. No	Author	Technology	Discussions
1	Aqeel-ur-Rahman (2008)	RFID	This concept gives unique identification number to every object to differentiate from the other
2	Kevin Ashton (2009)	RFID	gives objects to their unique identification number to a reader through wireless sensor networks
3	Miluzzo Choudhury (2010)	smart Sensor	Mainly used for controlling access data and controlling smart devices by different sensors.
4	Dlodlo (2012)	smart Sensor	used to create objects of quickly identifiable and addressable objects that can communicate with each other
5	Mohamed Masud (2013)	smart Sensor	It has features which are used for transferring and processing sensor data
6	Alexandria Aloisi (2014)	smart Sensor COAP	Provides compatibility between the network of things and the remote sensing system.
7	Marian cata (2015)	IOT	Questionnaire-based survey on mobile phone sensor.
8	Mrs.Chaira HK (2016)	IOT	easy to adopt the concept in a larger scale and Making the younger generation familiar with the application
9	Ahmed Abdi (2018)	IOT	IoT gateways provide the link between the smart office and internet through cloud.

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A. Gap in Research

The Networking Industry is evolving day by day. Every day is a New Invention Day. But there are some technologies in the Networking domain which are and will transform the picture of the Network Industry. These are the Latest Network Technologies which will rule the Industry from several years. Let us have a look at them below,

1) *Software Defined Networking (SDN):* Software Defined Networking Technology is an emerging architecture aimed to make Networks flexible, manageable, cost-effective, and adaptable. Software Defined Networking improves network performance by decoupling the network control and forwarding functions which enable network controls to become directly programmable. Open Flow Protocol is a fundamental for building SDN Solutions. The companies which adapt to SDN will deliver services to the customers depending on their expectations. SDN users would capture business in little time as SDN Speed. The centralized control will streamline processes. It will also help in understanding the network and allowing rapid troubleshoot.
2) *Multi Cloud Technology:* Multi-Cloud Technology is a heterogeneous architecture of multiple cloud computing and storage devices. A Multi-Cloud Technology utilizes two or more public clouds along with n number of private clouds. Hence it is also known as Multi-Cloud Environment. Multi Cloud Technology works as a Service (SaaS) or Platform as a Service (PaaS) but currently referred to as Infrastructure as a Service (IaaS). Hybrid Cloud Technology is a Traditional Technology in comparison with Multi-Cloud Technology.Multi-Cloud Technology allows stakeholders to select solutions which work for their organization hence increasing the ROI. Businesses can thus allocate and maximize resources, and only pay for the ones they use. Multi-Cloud Technology reduces the risk of an attack even when the applications are offline. Multi-Cloud Technologies help reduce the risk of a single point of failure.
3) *Cloud Repatriation*: Technology has evolved due to which enterprises have the freedom to locate applications with maximum performance, cost, and security. Several enterprises are pulling out applications from Cloud to the Traditional Data Centres Cloud Repatriation is gaining popularity these days.
4) *Edge Computing:* Edge Computing is a distributed open architecture which enables Internet of Things and Mobile Computing. The device processes by itself or by a local server. Edge Computing enables data, applications, and computing power to be closer to the users and away from centralized points. Edge Computing targets applications needing to be closer to the source of action. Edge Computing refers to Decentralized Data Processing at the edge of the Network.
5) *Internet of Things (IoT):* Internet of Things is used in physical and everyday devices or appliances. Devices consist of Internet Connectivity and Sensors. These devices can interact with each other and with others all over the internet. Some everyday IoT Examples are Smart Watch, 3D Printers, Hue Bulbs, etc. With IoT, there are sensors around which gather data on our world and help improving it. IoT puts emphasis on the real world as compared to the virtual world. It encourages a balance between virtual and practical experiences.
6) *Artificial Intelligence (AI):* Artificial Intelligence is developing the computer systems to perform tasks which include human intelligence like speech recognition, decision making, visual perception, and translation between languages. This universal network makes decisions based on your activity and location. It will route you to the best system and manage the task without affecting your experience. This combination of AI and SDN will provide evolutions of networks across industries. Artificial Intelligence provides opportunity to revolutionize networks. We need to continually ensure that the infrastructure and systems rely on the growing digital demands. Due to the continuous revolution, Artificial Intelligence will re-think whether current business models could give the best possible user experience.
7) *Intent Based Networking:* Network Administration is a new form of Intent-Based Networking (IBN).It is a combination of Artificial Intelligence (AI), Machine Learning, and Network Orchestration to automate administrative tasks. Intent-Based Networking reduces the complexity to create, manage, and enforce network policies for reducing labour associated with traditional configuration management. Intent-Based Networking is a combination of existing and new technologies. Software Defined Networking, Analytics, and Virtualization belong to Long Term Intent Based Networking. A lot of companies are trying to incorporate Intent Based Networking in their networks. In my work I deal with the proliferation of technology, it becomes difficult to complete tasks manually as it consumes more time. However, to mitigate this issue, the implementation of Internet of Things is primarily done. This is because it allow to run free several opportunities in order to make workspace even smarter. The combination of last three technology as mention above, helps to transform a workplace into an intelligent system where multiple activities can be accomplished using IoT devices. Moreover, these devices are computed with smartphones, beacons and even sensors so that data can be taken as an input and appropriate output can be provided to the user. Such IoT based applications and devices predominantly help to control, manage and monitor business operations effectively.

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B. Problem Formulation

By studying the research gaps reported in literature survey, I decided to formulate research problem around remote monitoring of smart IOT based company's technical parameters with more effective methodology. Here I use software known as Cisco Packet Tracer with different protocol and IoT devices combine with inference tools like computer logic and machine learning language for better performance of system. With the help of this technology our system works in an effective and efficient manner to provide required service to the user.

III. METHODOLOGY

In this thesis, I will cover all the software related part in detail which will show us the exact scenario of the project we have done here. The system architecture will give us the detailed overview of the module. In order to design company's network I used cisco packet tracer .Cisco Packet Tracer is a networking simulator used for teaching and learning program by offering a unique combination of realistic reference [7] and [8]. Benefits of Packet Tracer are: Offers a realistic simulation and visualization, Permits users to design, build, configure, and troubleshoot complex networks.

Currently released cisco packet tracer included new feature like new device, sensor, and Programming Languages with classically networking device, those device stated below in reference [4].Following concerns about the different services provided by the smart campus of company:

1) **Smart campus** is a characteristic application that keeps and work with the standards of the internet of things.
2) **Smart Security** is a smart card with sensors and Technologies that can be used to alert the employees in case of any emergency will add great value to the information of the smart campus.
3) **Smart office** is an intelligent environment in office using the information collected by the sensors, software and other intelligent agents. It has flexible to users, scalability, and reliability and have ability to support many devices.
4) **Smart-industrial** was the most complex IoT simulation created for the IoT. Complexity of the case was mostly because the network layout and also due to logical connections between the IoT devices.

New Future of Cisco Packet Tracer 7.3 are 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.

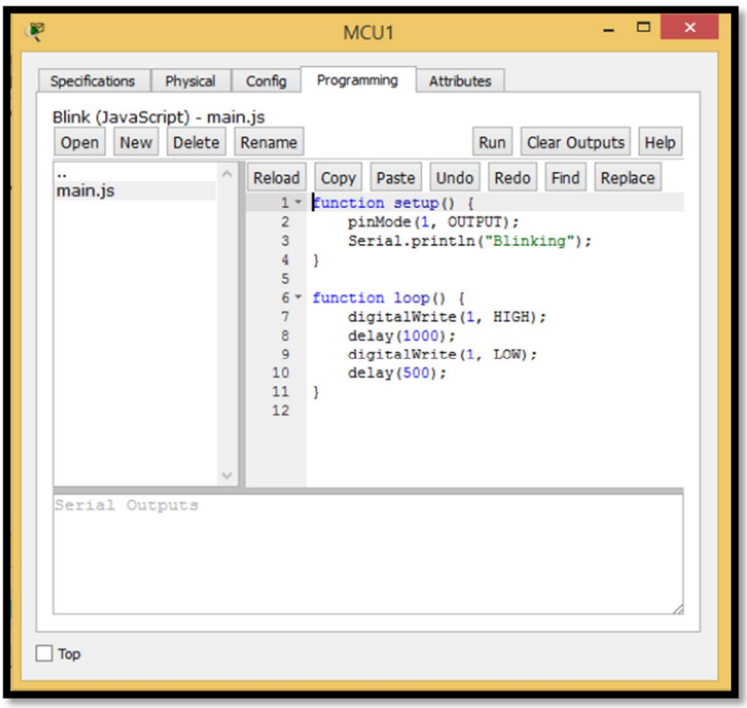


Fig.2: ioe registration server

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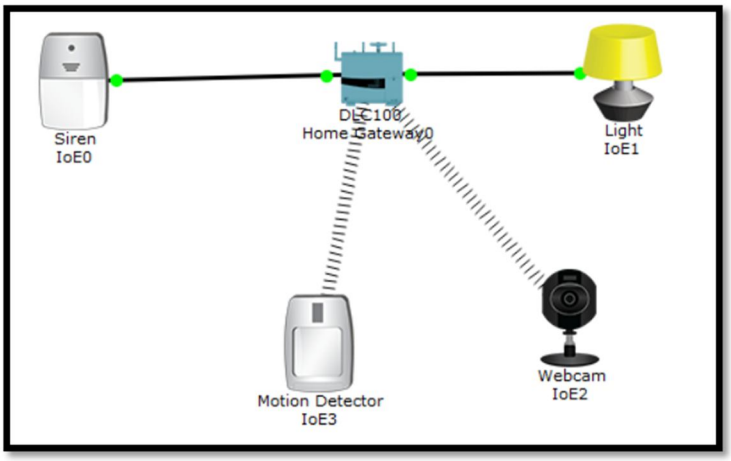


Fig.3: home gateway with four smart things connected to home gateway

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. 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. Smart things can directly register to IOE Server or a 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" 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 MCU programing by using Ethernet cable and wireless. To connect the Home Gateway to the Internet its Internet WAN Ethernet port available on home getaway.

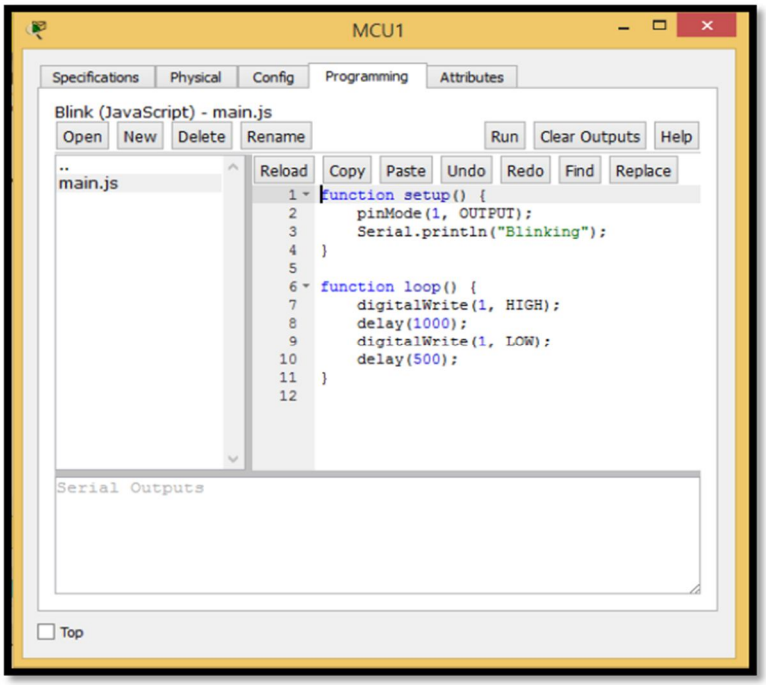


Fig 4: mcu programming

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IV. IMPLEMENTATION

To implement campus network design I proposed Smart company Network Design ,to design this proposed method different networking device are used , those device are cisco router, switch, switch, central office server ,cell tower and some smart thing is also included in this design. Furthermore about the device is elaborated in table 2.

Table 2: devices used for design

Sr. No	Device	Function
1	Router	It connects cellular network and smart office to each other
2	Cable modem	Is used to connect IOT gateway to the cloud and vice versa
3	IOT gateway	It registers smart devices and assigns an ip address to them
4	IOE server	Controls the smart IOE devices registered on it and brings a variety of server functions
5	Central office server	Is used to connect a cell tower to the router and the router to the cell tower for transferring of information.
6	Fan	Used to ventilate the smart office
7	Webcam	Is a smart device used to Control smart Office activities
8	Smart Light	Provides light for the smart office by using smart light devices
9	Smart door	Connects to the IOT gateway and brings some main important functions based events in the smart office.
10	Cell-tower	It is a cellular mechanism that brigs controlling and accessing office services from remote
11	Smart window	It is used to control the window remotely with smart phone connected to a wireless internet This decreases the carbon monoxide, carbon dioxide, hydrogen and helium and it increases oxygen to get fresh air which is good for health.
12	solar panel and wind turbines	It is used to generate electricity power used for different purposes.
13	battery	It is used to store the energy to provide different sector whenever it needed.

A. Device Configuration

1) Main Office

```
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT G0/0
Router(config-if)#IP ADDRESS 10.0.0.1 255.255.255.0
Router(config-if)#NO SHUTDOWN
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT G0/2
Router(config-if)#IP ADDRESS 209.165.201.225 255.255.255.224
Router(config-if)#NO SHOUTDOWN
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to up
```

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```
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT G0/1
Router(config-if)#IP address 209.165.200.225 255.255.255.224
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up
Router(config-if)#exit
Router(config)#ip dhcp excluded-address 209.165.201.225 209.165.201.229
Router(config)#ip dhcp pool cell
Router(dhcp-config)#network 209.165.201.224 255.255.255.224
Router(dhcp-config)#default-router 209.165.201.225
Router(dhcp-config)#dns-server 10.0.0.254
Router(dhcp-config)#exit
Router(config)#ip dhcp excluded-address 209.165.200.225 209.165.200.229
Router(config)#ip dhcp pool wan
Router(dhcp-config)#network 209.165.200.224 255.255.255.224
Router(dhcp-config)#default-router 209.165.200.225
Router(dhcp-config)#dns-server 10.0.0.254
```

2) Industry

```
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname ISP
ISP(config)#ipv6 unicast-routing
ISP(config)#int g0/0/0
ISP(config-if)#ipv6 address 2001:0400:0000:0006::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0/0, changed state to up
ISP(config-if)#int g0/1/0
ISP(config-if)#ipv6 address 2001:0400:0000:0007::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1/0, changed state to up
ISP(config-if)#int g0/2/0
ISP(config-if)#ipv6 address 2001:0400:0000:0008::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2/0, changed state to up
```

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```
ISP(config-if)#int g0/0
ISP(config-if)#ipv6 address 2001:0400:0000:0009::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
ISP(config-if)#int g0/1
ISP(config-if)#ipv6 address 2001:0400:0000:0003::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up
ISP(config-if)#int g0/2
ISP(config-if)#ipv6 address 2001:0400:0000:00010::1/64
ISP(config-if)#ipv6 address fe80::a link-local
ISP(config-if)#no shutdown
ISP(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to up
```

3) Central Control

```
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT G6/0
Router(config-if)#IP ADDRESS 128.16.0.1 255.255.128.0
Router(config-if)#NO SHUTDOWN
%LINK-5-CHANGED: Interface GigabitEthernet6/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet6/0, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT G7/0
Router(config-if)#IP ADDRESS 25.0.0.2  255.255.255.240
Router(config-if)#NO SHOUTDOWN
%LINK-5-CHANGED: Interface GigabitEthernet7/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet7/0, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT FA0/0
Router(config-if)#IP address 10.0.0.2  255.255.255.254
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router>
```

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```
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT Fa1/0
Router(config-if)#IP ADDRESS 20.0.0.2  255.255.255.252
Router(config-if)#NO SHUTDOWN
%LINK-5-CHANGED: Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT Fa4/0
Router(config-if)#IP ADDRESS 30.0.0.2  255.255.255.252
Router(config-if)#NO SHOUTDOWN
%LINK-5-CHANGED: Interface FastEthernet4/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet4/0, changed state to up
Router>
Router>EN
Router#CONF T
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#INT Fa5/0
Router(config-if)#IP address 40.0.0.2  255.0.0.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface FastEthernet5/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet5/0, changed state to up
```

B. Device Setup

After configuration is done the device get IP address dynamically and IOE device registered to IOE server or home getaway

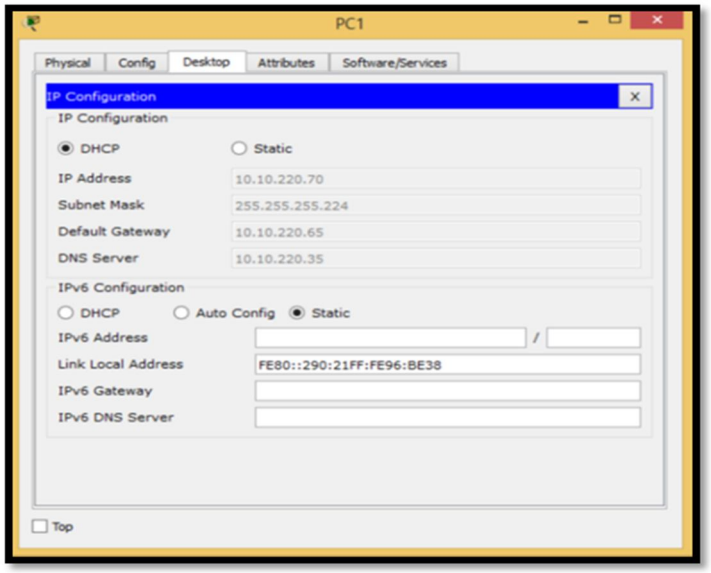


Fig.5: pc gets ip address dynamically

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.

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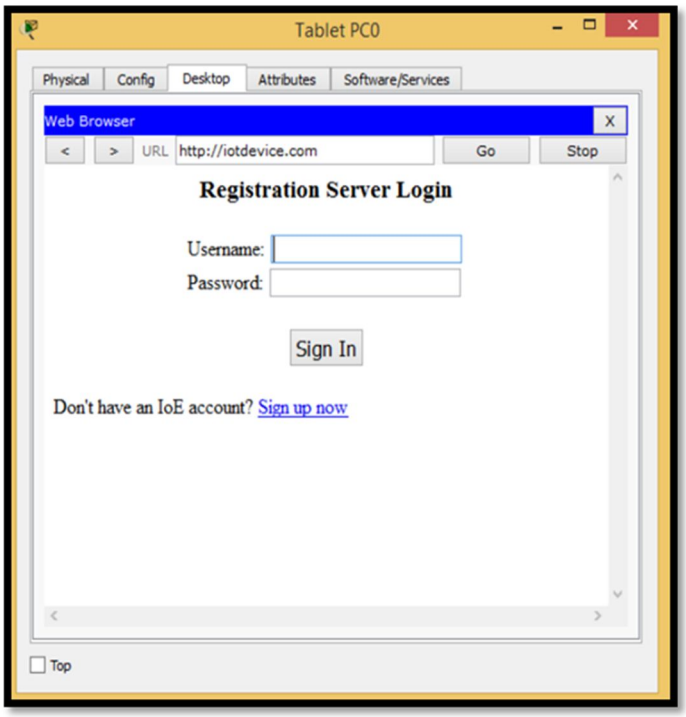


Fig.6: login page for iot register server

V. RESULTS AND DISCUSSION

After registering smart device to home gateway all device are accessed through web by authentic user. Resultant Figure shows there are IOE device registered to Home gateway those all are controlled through web by authentic person. According to user requirement respective changes should be done remotely instated of physical presence for any changes.

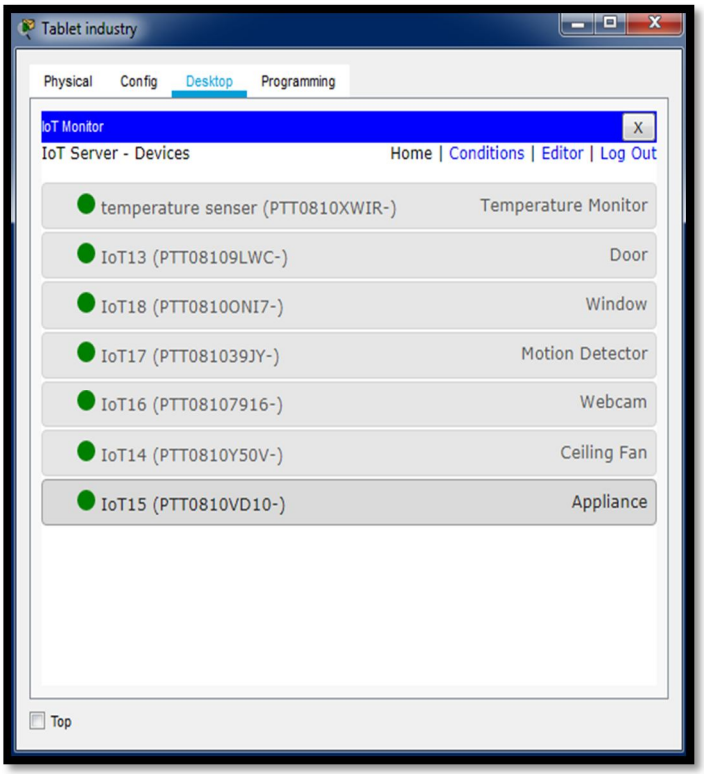


Fig.7: registered ioe device on home gateway

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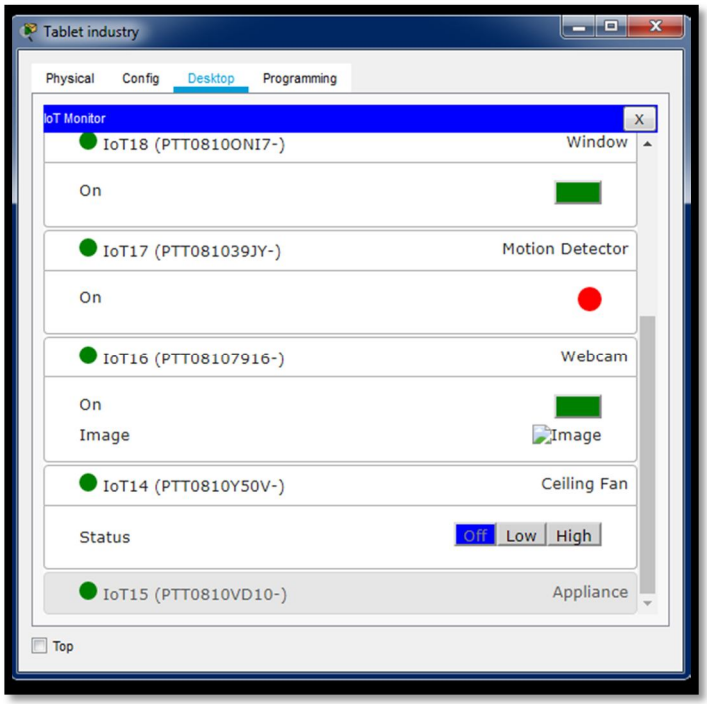


Fig.8: registered ioe device with their status

VI. CONCLUSION

1) Used home Gateway to register smart device on it to control them and Microcontroller (MCU) to interconnect different sensor and IOE device.

2) MCU provide programming environment to manage differenSt device, and used JavaScript and python to control the device

3) Devices combine with inference tools like computer logic and machine learning language help for better performance of system by adopting IOT devices with user defined services.

4) By simulating and analyzing the result, EIGRP and OSPF both efficiently utilize the Bandwidth, accordance with the traffic send (bytes/sec).

5) IOT based infrastructure contributes major role in increasing the production of company, thereby raising the market value of company up to the mark.

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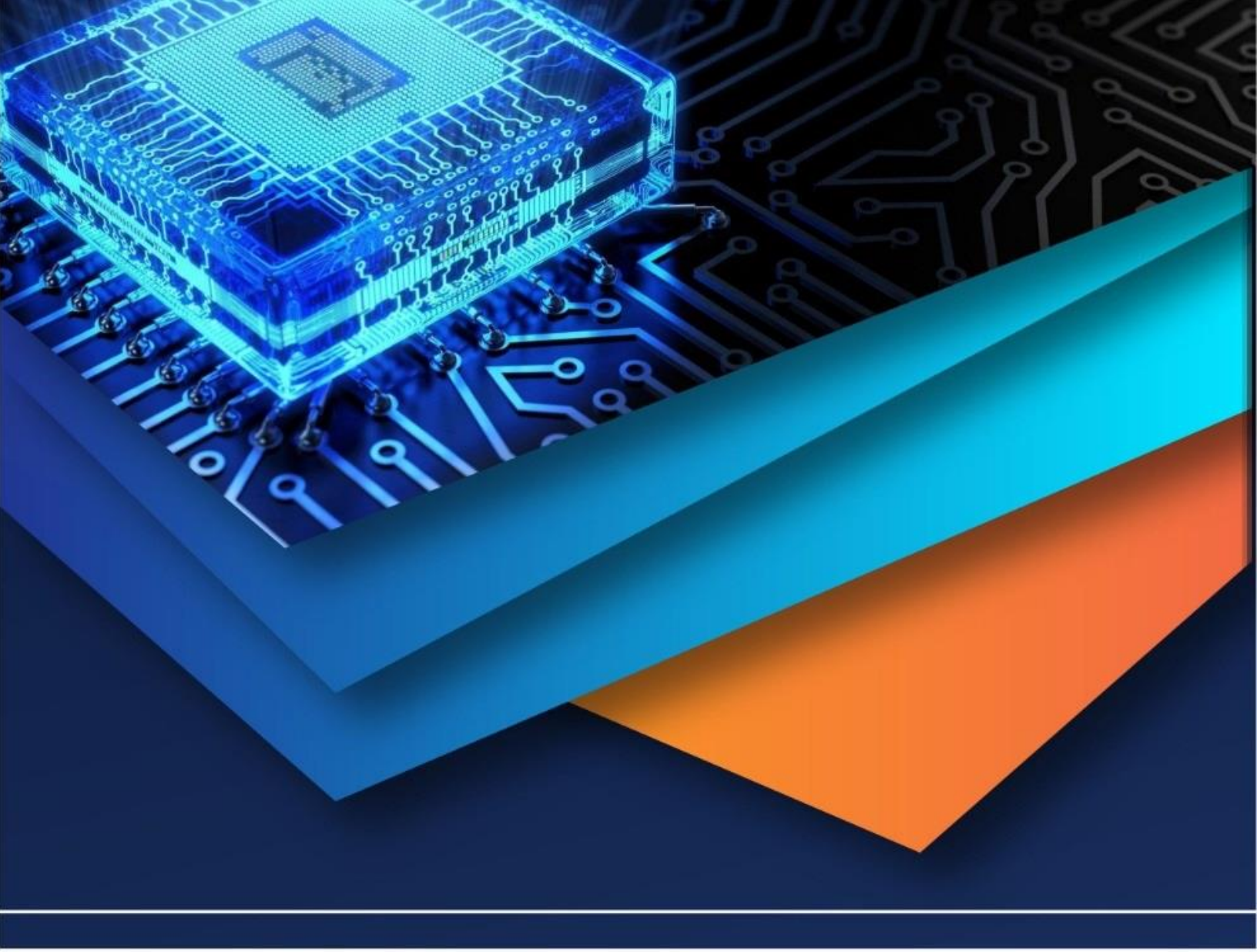
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