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The Role of Packet Tracer in Learning Wireless Networks and Managing IoT Devices☆

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A R T I C L E   I N F O.

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Abstract

Wireless networks, Internet of Things (IoT), Internet of Everything (IoE), and smart homes have become extremely important terms in our present-day life. Most of the buildings, companies, institutions, and even homes depend on these technologies for interaction, communication, automation, and everything surrounding humans. To understand the advanced topics in wireless networks and IoT devices, it is necessary to use one of the practical learning tools, called Packet Tracer. This wireless network simulator is freely available by Cisco Networking Academy. In this paper, we will use Packet Tracer to design a smart home based on wireless and IoT devices and illustrate how to create different networking scenarios to make our homes more comfortable and convenient.

1 Introduction

Nowadays, there are many simulators for learning wireless technologies and offering different functionalities to configure, model, design, study, test, and analyze wireless networks. Examples of these simulators are NS-2, TOSSIM, OMNeT++, J-Sim, Avrora, and the common one Packet Tracer [1]. Packet Tracer is a powerful software program developed by Cisco and considered to become the common and most straightforward software for simulating virtual networks, especially, wireless networks and Internet of Things (IoT) devices [2].

In the Cisco Packet Tracer, the devices appear as they are in reality, and users can monitor and interact with various wireless and IoT devices. It is important for users, especially students, to work with a virtual environment before working in real time [3]. They can learn, understand, and recognize how to solve networks problems safely [4]. Moreover, users will have a lot of self-confidence and sufficiency. Packet Tracer is developed not only for simulating wireless networks but also for wired networks that have different hardware ranges, mobility, and reliability [5].

Packet Tracer is a multi-task network simulation software that model different network actions like topology implementation, choice of the best path based on several routing algorithms, server configuration, IP sub-netting, and investigation of network troubleshooting [6]. To establish the communication between end user devices inside a network, it is important to select the suitable core networking devices like routers, switches, hubs and create a physical connection by connecting the appropriate cables to the ports from the tool list of packet tracer [7].

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In this paper, we will present how to design a smart home simulation using IoT and IoE devices; it is familiar that with the new era of technology; the devices in our home will be more intelligent. It makes our life comfortable and convenient.

The remainder of this paper is organized as follows. In Section 2, smart home using packet tracer with different wireless devices are discussed. Then, we conclude the paper and suggest future work in this area in Section 3.
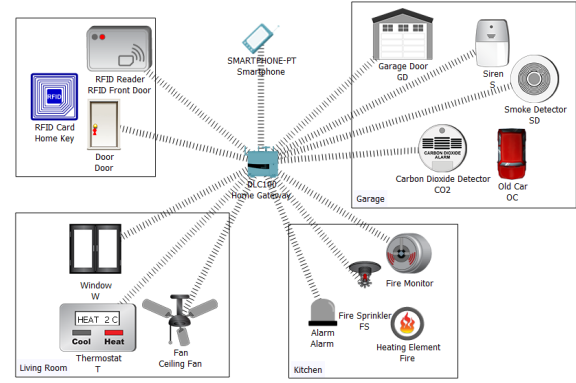
2   Smart Home Using Packet Tracer

The packet tracer software [8] has a simple interface that allows users to create and perform the topology by dragging and dropping the components easily. In addition, entering the device parameters, network configurations, and IoT devices interfaces for the desired components can be simply referenced [2].

Different wireless devices are available in the Packet Tracer software with their explanations and all the desired parameters, such as wireless Access Point (AP), wireless Network Interface Card (NIC), wireless antenna, and wireless topologies [9]. In addition, IoT and IoE devices used in a smart home like home gateways, Microcontroller Units (MCU), smoke detector, fire monitor, thermostat, Radio-Frequency Identification (RFID) reader with their cards, and Carbone Dioxide (CO_2) detector [10].

In this Section, we will employ the Packet Tracer tools to build a smart home and applying a connection between smartphone and important and famous IoT devices. The proposed smart home consists of four places: the front door, the living room, the kitchen, and the garage. All these areas contain some wireless and IoT devices, and all of them connected to a home gateway and controlled by a smartphone. The overall smart home design using Packet Tracer software presented in Figure 1. We will show how to use sensors to make IoT devices to react automatically with the condition of the environment. For example, the monitoring server can turn on the fan when the temperature is high.

The important primary step is to set the home gateway parameters like the name in the Service Set Identifier (SSID) property with a suitable passkey [11]. The Dynamic Host Configuration Protocol (DHCP) manages the devices IP addresses [12]. Subsequently, building the other IoT devices distributed in the four areas inside the smart home [13]. The next step is to connect the smartphone to the home gateway; we use the same SSID and the passkey defined before in the home gateway [14]. Finally, the user can access to the smartphone by using the IoE monitor app and write the appropriate rules for managing and

Figure 1. Smart Home design using Packet Tracer

Table 1. Rules for implementing the RFID card and reader

No.	Rule Name	Condition	Actions
$R1$	*Open Door*	*Door Status is Valid*	*Set Door to Unlock*
$R2$	*Lock Door*	*Door Status is Invalid*	*Set Door to Lock*
$R3$	*RFID Key*	*Door Card ID* = 1001	*Set RFID to Valid*

controlling all the connected devices, as shown in the next Subsections.

2.1   Front Door with RFID Card

To connect the door and RFID reader devices to the home gateway; we have to use a wireless connection. In the I/O configuration tab from the advanced mode, we choose the wireless card and the IoE server to become the home gateway. We will use a smart key for the front door instead of the traditional one. This key is an RFID card that can open the door once it is close to it. First, we set up the RFID reader device and connected it with the RFID card key. Some rules must be made in the smartphone for linking between the RFID Card key and the door to open or close the door by moving the RFID key near or far from the RFID reader; In the smartphone IoE monitor tab, we write the rules' conditions as shown in Table 1.

Figure 2 presents the testing step for the RFID card key by moving it close to the RFID reader to open the door. Figure 2 (a) shows the front door area before moving the RFID card key while Figure 2 (b) shows the door opening after moving the RFID card key. This is done by switching the door light from red to green, indicating it is opened.

2.2   Living Room with Thermostat Device

In the living room, we have a ceiling fan, window, and thermostat device. To connect these devices to the home gateway, we use a wireless connection as done in Section 2.1. Then, we can see that the ceiling fan can connect wirelessly to the home gateway; we do the same with the window. Put a thermostat to
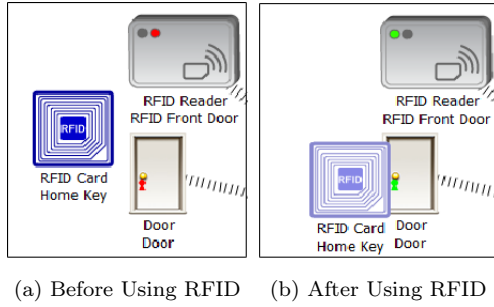
(a) Before Using RFID   (b) After Using RFID

Figure 2. Front Door design Using Packet Tracer

Table 2. Rules for Implementing the Thermostat Usage

No.	Rule Name	Condition	Actions
$R1$	Fan and Window On	Temp. $>= 10C$	Fan and Window On
$R2$	Fan and Window Off	Temp. $>= 10C$	Fan and Window Off

get the temperature on the living room and we apply rules as in Table 2, that if the temperature is more than 10 degree Celsius, the fan will be turned on, and the window will be opened and vice versa, to create the rule with the home gateway first we have to connect the thermostat with it.

The rules in Table 2, show the step of testing the operation of the ceiling fan and the window when the temperature is increasing, as illustrated in Figure 3 (a,b). Once the thermostat reaches the predefined value 10C, the ceiling fan is running, and the window is opened.
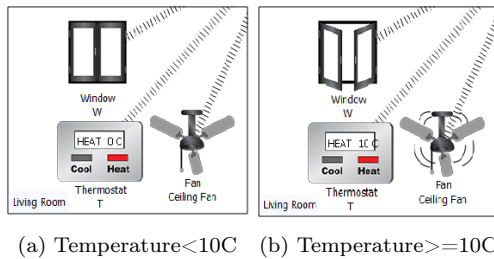

(a) Temperature<10C   (b) Temperature>=10C

Figure 3. Living Room design using Packet Tracer

2.3 Kitchen with Fire Monitor Device

The operation of the fire monitor device is presented to work in the kitchen in case of an emergency. The fire monitor and fire sprinkler are connected to the home gateway, and the rules shown in Table 3 are set in the smartphone IoT monitor. When the fire monitor detects the fire from the heating element, it sends a digital signal to the home gateway. As shown in Figure 4 (a,b), when we turn on the fire, the fire monitor will detect it, then the alarm will set on, and the fire sprinkler will raise the water to put out that fire. Moreover, when the fire goes out, the sprinkler stops spreading the water, and the alarm is set off.

Table 3. Rules for Implementing the Fire Monitor Device

No.	Rule Name	Condition	Actions
$R1$	Alarm on	Fire detected is true	Alarm true
$R2$	FireSprinkler on	Fire detected is true	FireSprinkler true
$R3$	Alarm off	Fire detected is false	Alarm false
$R4$	FireSprinkler off	Fire detected is false	FireSprinkler false

(a) Fire is Off   (b) Fire is On
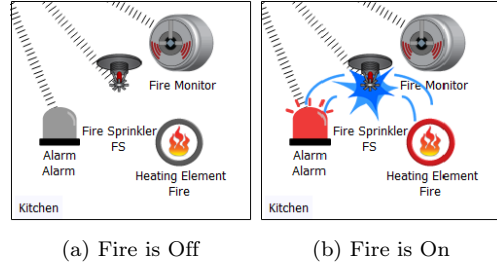
Figure 4. Kitchen design using Packet Tracer

Table 4. Rules for implementing the Garage

No.	Rule Name	Condition	Actions
$R1$	Siren on	Smoke level $>= 1.0$	Siren true
$R2$	Garage open	CO2 level $>= 0.8$	Garage true
$R3$	Siren off	Smoke level $<= 1.0$	Siren true
$R4$	Garage close	CO2 level $<= 0.8$	Garage true

2.4 Garage with Smoke and CO2 Monitor Devices

In the Garage, other IoT devices will be used; set up a smoke detector and Carbon Dioxide detector. Alarm and Garage door used after detecting the CO2 or smoke by implementing the rules introduced in Table 3. If the smoke level is about 1.0, the alarm is activated and if the Carbon dioxide level is about 0.8, the Garage door will automatically be opened, as shown in Figure 5 and using an old car and turning it on to make a smoke and to increase the CO2 level.
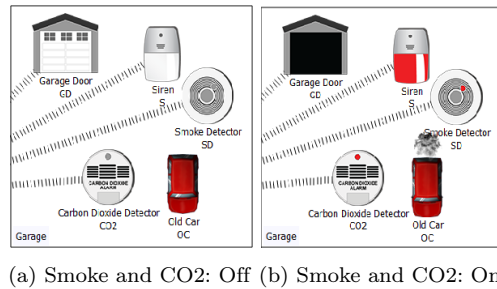

(a) Smoke and CO2: Off (b) Smoke and CO2: On

Figure 5. Garage Design Using Packet Tracer

3 Conclusion

In this paper, we used the Packet Tracer tools to build a smart home and applying a wireless connection between a smartphone and important and famous IoT devices. Our proposed smart home simulation model involved four places, two of them were inside the house (living room and kitchen), one on the incoming door, and the fourth one was a garage. All these areas had

some wireless and IoT devices, and all of them were connected to a home gateway and were controlled by a smartphone. In this research, we concluded that the Packet Tracer simulator is simple, easy, powerful, and great for building smart homes depending on the wireless and IoT technologies. As future work, a comparison between the current model and another one can be established by measuring some metrics like the simulation time and the transmission delay.

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