Computer Networks (SWE3022): Homework 1

Instructor: Jaehoon (Paul) Jeong
Date: September 17th, 2025
Due: October 1st 15:00, 2025

Total Credits: 100 points
Note: Write your answers in English

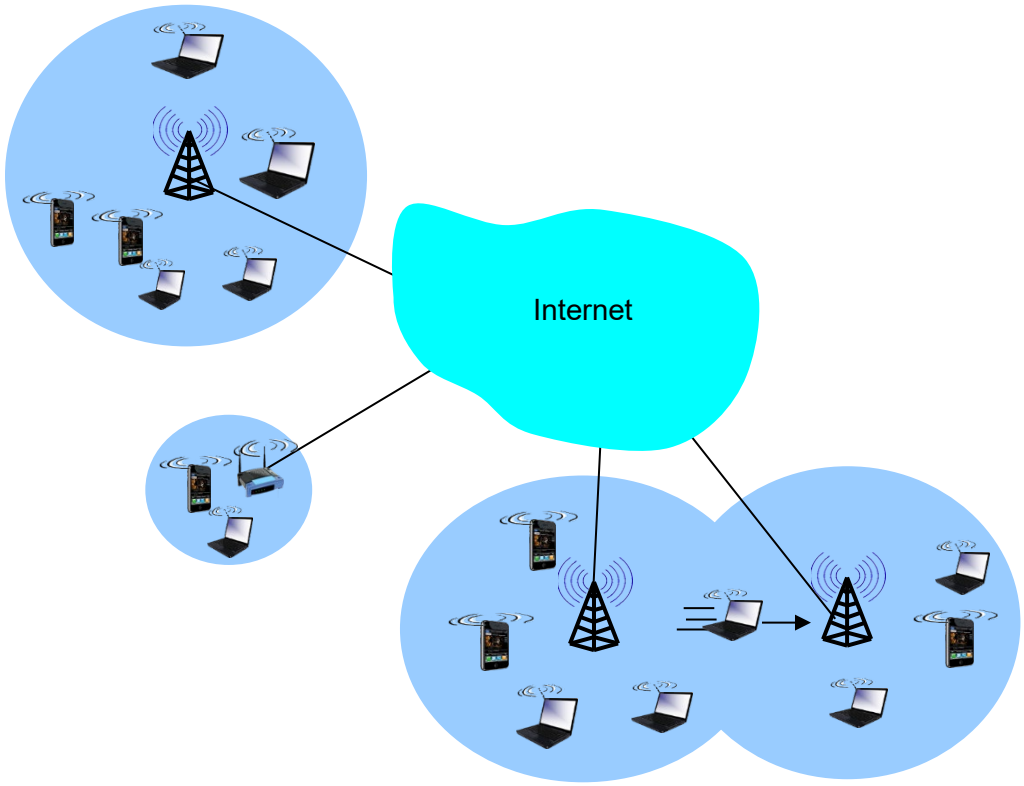

Figure 1. Wireless Networks in the Internet

1. What does it mean for a wireless network to be operating in "infrastructure mode"? If the network is not in infrastructure mode, what mode of operation is it in, and what are the differences between that mode of operation and infrastructure mode? (10 points)

2. Cookies (15 points)
(a) What are the main purpose and usage of the Cookies? (5 points)
(b) Consider an e-commerce site that wants to keep a purchase record for each of its customers. Describe how this can be done with cookies step by step. (10 points)

3. When your computer (denoted X) accesses a server computer (denoted Y) running a website called "www.google.com" by a web browser, explain the procedure until you see the website page in terms of DNS resolution, HTTP, transport layer (i.e., TCP), network layer (i.e., IP), and link layer. Assume that your computer is located at your home network via a cable modem connected to an Internet Service Provider, and the web server for "www.google.com" is multi-hop away from your home network. (20 points)

4. This is a problem about Domain Name System (DNS). (15 points)
(a) Explain the DNS, and the three classes of DNS servers (i.e., Root, Top-Level Domain (TLD), and Authoritative DNS Servers). (5 points)
(b) Explain two DNS name resolutions such as iterative resolution and recursive resolution along with figures for a given target DNS name (e.g., gaia.cs.umass.edu). (10 points)

5. In Wireless Networks, there are two famous problems such as Hidden Terminal Problem and Exposed Terminal Problem. (20 points)
(a) Explain the Hidden Terminal Problem and its solution. (10 points)
(b) Explain the Exposed Terminal Problem and its solution. (10 points)

6. Magazine paper analysis (20 points)

IoT Edge-Cloud: An Internet-of-Things Edge-Empowered Cloud System for Device Management in Smart Spaces

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***Abstract*—This paper proposes an Internet-of-Things (IoT) Edge-Empowered Cloud System (called IoT Edge-Cloud) for the visual control of IoT devices in a user's smartphone. This system uses the combination of existing technologies (e.g., DNSNA, SALA, SmartPDR, and PF-IPS), for DNS naming and indoor localization to support the visual control of IoT devices. For the visual control of IoT devices, the IoT devices register their auto-generated DNS names and the corresponding IPv6 addresses with the IoT Edge-Cloud. Each DNS name embeds an IoT device's type (e.g., fire sensor, television, refrigerator, or air conditioner) and its location information, which is obtained through an Indoor Positioning System (IPS). With the DNS name, a user's smartphone can display each IoT device and its location in an indoor place (e.g., home, office, and classroom), so that the IoT device can be located in the smartphone's screen. Through performance evaluation, this paper proposes a localization scheme for a smartphone with average localization error of 1.08 meters. Also, it proposes a localization scheme for IoT devices (especially, at the center area in a testbed) with average localization error of 1.11 meters.**

I. Introduction

THE number of IoT devices has increased from 4.8 billion in 2015 to 25 billion in 2020, showing a rapid expansion. However, about 99.4% of connectable objects in the world are currently not connected to the Internet, and the growth potential of the IoT market is very high [1]. Along with the growth of IoT devices in the market, various IoT communication and management technologies [1], [2], combined with location-based services (LBS), are entering people's lives and smartly changing the living space itself. Due to the continuous research and development on the IoT technologies, people are more willing to use IoT devices in their lives and working spaces. As a result, the number of IoT devices that an individual needs to manage is also exploding. To meet the increasing demands from IoT markets, cloud service providers such as Amazon, Google, Microsoft, and Samsung have introduced different IoT cloud services for other IoT business partners. In the developed IoT cloud services, however, less companies considered integrating visualized LBS into their services, which may greatly increase the usability of those services.

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The number of IoT devices is quickly increasing, so the manual configuration of those IoT devices for management such as monitoring and remote-control is infeasible for the convenience of IoT users. The Domain Name System (DNS) can provide IoT users with the DNS names of the IoT devices for the management of those devices. To efficiently manage the information generated from those IoT devices, the information can be put into their DNS names and registered with a DNS server. Thus, a unified DNS naming for the IoT devices is important since many kinds of IoT devices are produced by the multiple vendors. That is, their DNS names need to be generated by a standardized way. To tackle the problem, DNS Name Autoconfiguration (DNSNA) [3] scheme was proposed to automatically configure DNS names for IoT devices based on certain rules. In this paper, we introduce an integrated system based on DNSNA for the proposed IoT Edge-Cloud system to efficiently manage IoT devices.

The easy use of IoT devices is another pivotal aspect for users using them in smart spaces. A smart space in this paper is defined as a space with different kinds of smart connected IoT devices, where people can live comfortably or work efficiently. A smart space can be a smart home, a smart building, a smart campus, or a smart factory. An LBS in IoT devices may provide users with much convenience for the users to manipulate those devices visually. To provision the LBS in smart spaces, it is necessary to have the location information of both IoT devices and users. This location information can be visualized in a way that the interactions become more efficient and intuitive. Different kinds of indoor localization schemes [4]–[6] can provide LBS for both IoT devices and users. However, those localization approaches have different merits and shortcomings. A pedestrian dead reckoning (PDR)-based localization approach [4] suffers from accumulated localization errors, whereas a particle filter (PF)-based approach [6] has a slow response to the movement of an object. Thus, this paper proposes an integrated localization scheme to improve the localization accuracy by combining the PDR and PF approaches.

When considering the IoT-related tasks together with the issues we have discussed, an IoT management system needs to be capable of continuously monitoring IoT devices and efficiently managing them. In this study, we introduce an IoT Edge-Cloud system based on key functions such as IoT DNS

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Read the attached paper "IoT Edge-Cloud: An Internet-of-Things Edge-Empowered Cloud System for Device Management in Smart Spaces" and analyze this paper in 1 page in terms of summary, advantages, disadvantages, and possible improvements.
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