

- 1a
- i. You find yourself in your room, and you can hear loud noises, sirens, and screaming from outside. Instead of getting up, you connect via Bluetooth to your security webcam placed by the window. What type of network did you just use? (*Hint: \_AN*)
  - ii. It is still dark outside, so the situation remains unclear. You try to access the Web to find out what is happening, but it is taking forever to load. You decide to use an ICMP-based command to check if the website is there. Which command was it?
  - iii. You did not receive any useful results, so you clear all your local caches on your machine. As soon as you do this, you start getting the error "*DNS request timed out*". It appears that all the DNS servers are down! The only way to access a website now is by directly entering its \_\_\_\_\_?
  - iv. Since nothing else works, you connect to your home router via its Web interface to check its "port forwarding" settings. Will you find these under: (a) DHCP, (b) NAT, (c) SSID, or (d) DSL?
- b For some reason, even your wired LAN appears to be somewhat slower than usual. You wish to investigate, so you send one full UDP datagram of the maximum possible size within a single RTT, and you find that the network utilisation was 0.26%. Considering that you are using a wired Ethernet 1Gbps network, how much was the RTT in ms? Type out your calculations.
- c Since your LAN is not working properly, you grab your laptop and try to connect to a nearby WiFi network that gives users free access for 1 hour each week. However, you have already used your 1 free hour this week, so it is not letting you in. You use a program to change your MAC address on your laptop, thus tricking the Layer 3 Wireless Access Point into thinking that you are a new device and receiving yet another free hour. Explain why this trick worked, while describing DHCP in the process.
- d Suddenly, the power goes out in your area. You have no reception on your mobile phone, so you grab your battery-operated analogue radio and try to tune into a radio station. You find an active AM station, apparently running on diesel-powered generators, continuously repeating the same warning message: a swarm of armed, autonomous-AI and WiFi-interneted, drones is gradually taking over the country..! The survivors have established a stronghold at a place up north, to fight back against this menace.
- i. You have heard of that place before, but you do not remember how far away it is, and your Maps app is not currently working. Luckily, the message provides a cryptic hint: it is "*one wavelength away at 0.06 MHz*" from where you live. What is your distance in km from the radio station? Type out your calculations.
  - ii. In their recorded message, the radio station also asks survivors to bring their old microwave ovens to enhance the defence of their stronghold. Briefly discuss why they are suggesting this. State any *reasonable* assumptions.
- e You successfully reach the stronghold and join the survivors there. After chatting with them, you find out that the army of drones is using a Wireless Mesh-like topology over IPv4 to communicate with each other. Fortunately, not all drones are weaponised since some are only acting as wireless gateways between subnets. The other survivors understand that IPv4 offers approximately 4 billion unique IP combinations, and they are aware of something called the "subnet mask" dividing groups of IPs into subnets. If you assume that the drones are using the entirety of IPv4 – including the private space, with a subnet mask of /16 in CIDR, how many usable IP addresses are there in total (*i.e., not just for a single subnet*) for all the weaponised drones? Type out your calculations.

*The five parts carry equal marks.*

2a You feel that some time has passed, and the drones have now taken over the entire communication spectrum, thus making the use of any further radio transmissions impossible. Because of this, you need to come up with an agreement on how to remotely (*within hearing distance*) exchange information about the sighting of incoming drone attacks. Because of your computing background, the others have turned to you for help, so you decide to copy the TCP protocol and design your own version using handclapping 🖐️:

- Each interaction starts with a three-way “handshake” to confirm that both parties are listening.
- After a successful “handshake”, one clap is used to indicate approximately 10 incoming drones.
- If the other side does not acknowledge with a single clap, the message is repeated again-and-again.
- If the other side responds with two claps, the message was misheard and needs to be repeated.
- If the other side acknowledges with a single clap, a two-way “handshake” ends the interaction.

“A” successfully initiates an interaction with “B”, and tries to inform them of approximately 40 incoming drones (*four claps*). “B” does not hear it the first time, and mishears it the second time; the third time, “B” confirms reception, and the interaction ends successfully. Complete the missing entries numbered 1-18:

SRC	DST	SYN	ACK	FIN	DATA
<b>1</b>	<b>2</b>	C			
<b>3</b>	<b>4</b>	C	C		
<b>5</b>	<b>6</b>		C		
A	B				CCCC
A	B				<b>7</b>
B	A				<b>8</b>
A	B				CCCC
<b>9</b>	<b>10</b>		C		
<b>11</b>	<b>12</b>			C	
<b>13</b>	<b>14</b>		C		
<b>15</b>	<b>16</b>			C	
<b>17</b>	<b>18</b>		C		

<= *not-heard*

<= *mis-heard*

- b The handclapping 🖐️ protocol that you designed above was a great start, but it had a critical issue with timing. In order to address this, describe TDM and provide Slotted ALOHA as an example.
- c Numerous new survivors join your stronghold on a regular basis, some of whom are wounded, so you build a makeshift hospital to take care of them. With your available resources, you treat approximately 400 patients on an average day. The first patient comes in at 06:00 and the last patient comes in at 21:00; however, today the last patient was quite difficult and finished at 22:00. What was your throughput for this day in patients/minute? Type out your calculations. State any *reasonable* assumptions.
- d The number of survivors in your stronghold keeps increasing, but not everyone can be trusted fully. You have salvaged numerous valuable items essential to your survival, stored in your treasure room, that you need to protect both from external *and* internal malicious individuals. Unfortunately, electricity is *not* guaranteed since you keep running out of diesel for the generators. Suggest and briefly discuss four (4) ways of securing and protecting your treasure room *without* electricity. State any *reasonable* assumptions.
- e You wake up and realise that everything you just experienced was only a dream..! You immediately write down what you remember, in order to analyse and reflect on it later. It involved drones organised in some sort of (i) Mesh Network, communicating over (ii) IPv4, and you had to come up with a (iii) TCP-like protocol, while also using (iv) TDM to fix it. Assign these four items to the appropriate OSI Layers, and briefly discuss whose role in the autonomous-AI drone company would be to identify and forewarn that these are starting to go rogue.

*The five parts carry equal marks.*