UNIT 7 · SESSION 8

Computer Networks

Your page has been live for six weeks. Today you find out what actually carries it from a machine in a rack to the phone in your hand.

2ND SEMESTER · SCHOOL YEAR 2026-2027

Introduction to Computing · Prof. Ryan V. Labrador

Saturday, 3 October 2026 · 2-hour lecture

TODAY

Two hours, five parts

Part 1	**Why networks exist**	The problem they solve, before any of the vocabulary
Part 2	**How big**	PAN, LAN, MAN, WAN — and where free public Wi-Fi sits
Part 3	**Topologies**	Bus, star, ring, mesh, and the honest trade-offs
Part 4	**The boxes and the media**	NIC, switch, router, access point, modem, firewall
Part 5	**Bandwidth vs latency**	Two different things. Satellite is where the difference bites.
After	**Laboratory**	You map this campus, crimp a cable, and publish the diagram

LEARNING OBJECTIVES

By the end of today you will be able to…

1. Say what a computer network is and name three problems it solves.
2. Tell PAN, LAN, MAN and WAN apart by scale, ownership and who pays.
3. Describe bus, star, ring and mesh topologies and one trade-off of each.
4. Name what a NIC, switch, router, access point, modem and firewall each do.
5. Explain the difference between wired and wireless honestly, both ways.
6. Define bandwidth and latency separately, and say which one satellite hurts.

PART 1

Why networks exist

Nobody built the first network because it was interesting. They built it because carrying a tape across a car park was worse.

THE DEFINITION

Two or more devices that can exchange data



Share resources

One printer for a whole office. One server holding the files. One internet connection for a barangay hall. Buying a copy of everything for everybody has never been affordable.



Communicate

Message, call, email, video. All of it is data moving between two machines that have agreed in advance how to talk to each other.



Centralise and protect

Data kept in one managed place can be backed up, controlled and recovered. Data scattered across forty desktops cannot be.

A network is not the internet. The internet is one enormous network built out of millions of smaller ones that agreed to interconnect.

ANATOMY

Every connection needs the same four things

Sender and receiver	**Two endpoints**	Your phone and a server. Somebody has to speak and somebody has to be listening.
A medium	**Something to carry it**	Copper cable, glass fibre, radio through the air, or a radio link through space.
An address	**Who it is for**	Every device on a network has one. Without it the data has nowhere to go.
A protocol	**The agreed rules**	How to start, how to take turns, how to say 'repeat that, it arrived broken'.

Change any one of these four and everything else can stay the same. That is why a message can start on fibre and finish on radio without anybody noticing.

PART 2

How big is it?

PAN, LAN, MAN, WAN. Four words, one idea: networks are classified by how far they reach and who owns them.

From your pocket to the planet



Each ring sits inside the next. Your earbuds are on a PAN, inside a campus LAN, reached across a WAN.

The dividing line is not really distance. It is this: on a LAN you can walk to every cable. On a WAN you are renting somebody else's.

THE TWO THAT MATTER

LAN and WAN, side by side

LAN — local

- One site. One owner. Your cables, your switches.
- Fast and cheap inside the building.
- You fix your own faults. Nobody to phone.
- Typical speeds in the hundreds of megabits or gigabits.
- Latency is under a millisecond. It feels instant.

WAN — wide area

- Many sites, many owners, leased links.
- You pay monthly, forever, per site.
- When it breaks you raise a ticket and wait.
- Speed is whatever you paid for and the weather allows.
- Latency is measured in tens or hundreds of milliseconds.

Every fault you will ever troubleshoot starts with one question: is this inside my LAN, or out on somebody's WAN?

Free public Wi-Fi, from the top down

At the site	**A LAN**	An access point, a small router, a switch, a power supply. This part fits on one wall.
The backhaul	**The hard part**	Fibre where fibre exists. Radio or satellite where it does not. This is the expensive decision.
Aggregation	**A WAN**	Hundreds of sites joined into one managed network with central authentication and monitoring.
Governance	**Policy and law**	Public internet access in public places is national policy, enacted by law. The engineering follows the mandate.
The user	**One SSID**	A student in a plaza sees a network name and a splash page. Everything above is invisible, and should be.

The site is trivial. The backhaul is the project. That is true of every network you will ever be asked to build.

PART 3

Topologies

The shape of the wiring. Four classic patterns, and the trade-off each one makes.

THE OLD TWO

Bus and ring

Bus

- One shared cable. Every device taps into it.
- Cheap, and almost no equipment needed.
- Only one device can talk at a time.
- One break in the cable kills the whole segment.
- Historical. You will meet it in an exam, not a rack.

Ring

- Each device connects to the next, in a loop.
- Orderly — a token decides whose turn it is.
- No collisions, so it behaves predictably under load.
- One break splits the ring unless it is a double ring.
- Survives today mostly in carrier and industrial networks.

Both fail the same way: they share one path, so one fault or one talkative device affects everybody.

THE MODERN TWO

Star and mesh

Star

- Every device has its own cable to a central switch.
- One bad cable affects exactly one device.
- Easy to add, remove and trace. Faults are obvious.
- More cable, and the switch is a single point of failure.
- This is what your campus is. This is what everything is.

Mesh

- Devices connect to several others. Many possible routes.
- A break is routed around automatically.
- Expensive in links, complex to configure.
- Full mesh is rare; partial mesh is common in cores.
- The internet itself is a partial mesh, at planet scale.

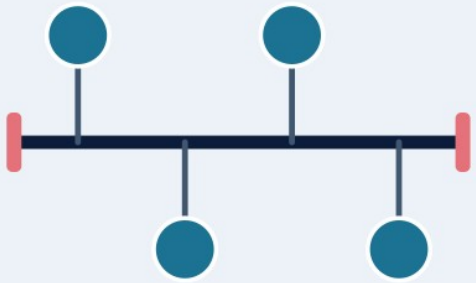
Star inside a building. Mesh between buildings. That combination is roughly every serious network on earth.

ALL FOUR

The shapes, drawn

BUS

the shared backbone



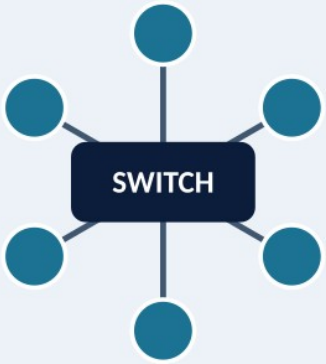
terminator at each end

One shared cable

One break kills the whole segment

STAR

one cable per device



Own cable to a central switch

The switch is the single weak point

RING

each device joins the next

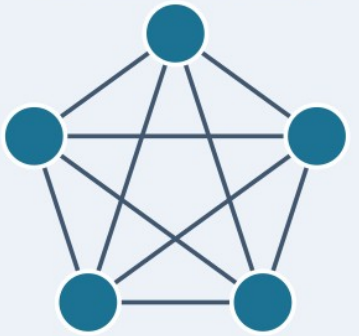


A loop; a token takes turns

One break splits the ring

MESH

every node to every node



Many links, many routes

Most expensive to cable and configure

= one device (PC, printer, phone) = a cable or radio link

Star inside the building, partial mesh between buildings. That combination is roughly every serious network on earth.

HONEST COMPARISON

What each shape costs you

TOPOLOGY	CABLE COST	ONE CABLE BREAKS	CENTRAL DEVICE FAILS	WHERE YOU MEET IT
Bus	Lowest	**Whole segment down**	No central device	Exams; very old sites
Ring	Low	**Ring splits**	No central device	Carrier and industrial rings
Star	Higher	One device down	**Everything down**	Every office and campus
Mesh	**Highest**	Routed around	No single centre	Network cores; the internet

There is no best topology. There is a budget, a building, and how much downtime the organisation can survive.

PART 4

The boxes and the media

Six devices, three media. Learn what each one does and you can read any network diagram.

Getting on, and getting around



NIC

Network Interface Card. The part of your device that actually connects — the Ethernet port or the Wi-Fi radio. It carries the MAC address burned in at the factory.



Switch

Joins devices inside one LAN. Learns which device is on which port and sends each frame only where it needs to go. The workhorse of every building.



Router

Joins different networks together and chooses the path between them. Your home box is a router, a switch, an access point and a modem in one case.

MAC address: twelve hex digits, burned in at manufacture. You met hexadecimal in Unit 5 — this is where it lives.

Radio, translation, and the door policy

Access point

Puts a LAN on the air. Devices join by radio instead of cable. In a plaza or a campus you install several, on planned channels, so they do not shout over each other.

Modem

Translates between your network and the carrier's line — DSL, cable, fibre or radio. Modulate and demodulate. It is a translator, nothing more.

Firewall

Decides which traffic is allowed through, in either direction. Rules, not magic. A firewall with no rules protects nothing at all.

The box on your wall at home is four of these six devices in one plastic case. That is why nobody can agree what to call it.

THE ONE EVERYONE CONFUSES

Switch or router?

Switch

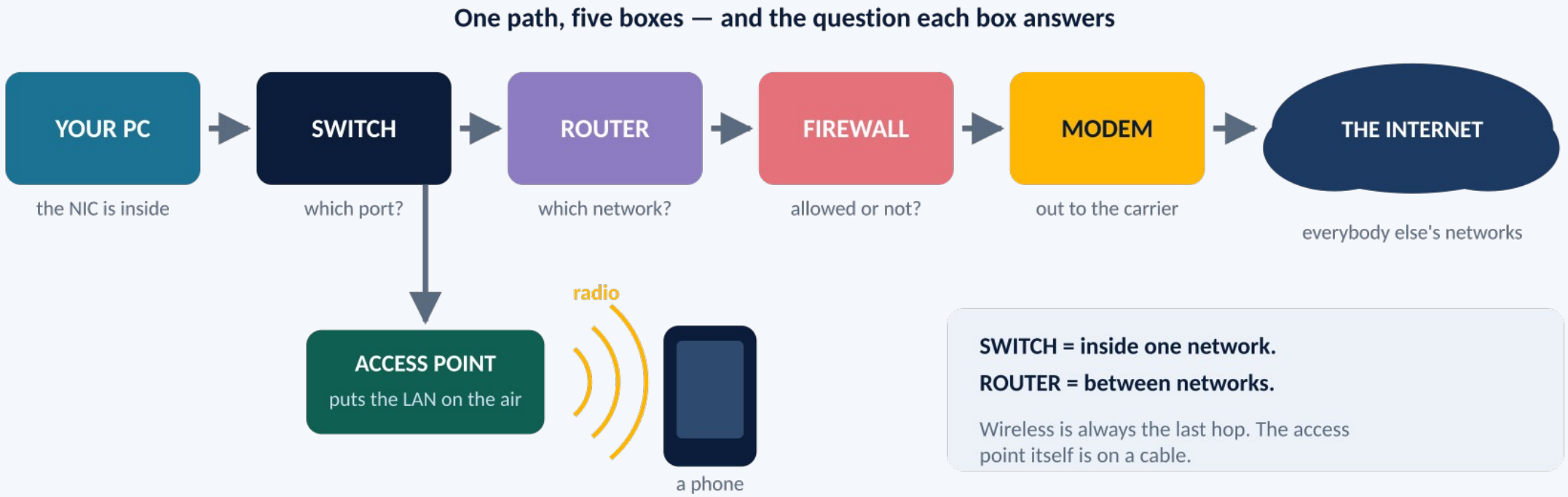
- Works inside ONE network.
- Decides using MAC addresses.
- Question it answers: which port is this device on?
- Does not know or care about the internet.
- Plug in more devices — that is what it is for.

Router

- Works BETWEEN networks.
- Decides using IP addresses.
- Question it answers: which way is that network?
- Is the door out of your LAN to everything else.
- Usually one per site. Sometimes two, for redundancy.

Switch = inside. Router = between. If you remember nothing else from Part 4, remember those four words.

Where each box sits between you and the internet



Trace the path with your finger as you read it. Left to right is your data leaving; right to left is the answer coming back.

Copper, glass, air, space

Twisted pair	**Copper, RJ45**	Cat5e and Cat6. Eight wires in four twisted pairs; the twist is what cancels interference. Roughly 100 m per run, then you need a switch.
Fibre	**Glass, light**	Enormous capacity, immune to electrical interference, runs for kilometres. Costs more to install and needs care when terminating.
Radio	**Wi-Fi, cellular**	No cable to dig. Shared with everyone nearby, blocked by walls and weather, and every user reduces everyone's share.
Satellite	**Radio, upwards**	Reaches places nothing else does. Whether that is usable depends entirely on how high the satellite is — see Part 5.

The 100 metre limit on copper is not a suggestion. It is why network cabinets exist where they do, in every building you will ever work in.

HONESTLY

Wired versus wireless

Wired wins on

- Consistency — the same speed at 2pm and at 2am.
- Latency, and especially latency that does not jump about.
- Security: you have to physically reach the cable.
- Not sharing. Your cable is yours alone.
- Anything that must not drop: servers, payments, CCTV.

Wireless wins on

- Cost of installation — no trenches, no conduits.
- Reaching places a cable cannot go, or is not allowed.
- Moving users. Phones do not have Ethernet ports.
- Speed of deployment: a site up in an afternoon.
- Everything the public actually touches.

Serious networks use both. Wireless for people, wire for the things that must not fail — and the access point itself is always on a cable.

PART 5

Bandwidth is not speed

Two different numbers. Confusing them is the single most expensive mistake in network procurement.

How much fits, per second

Mbps

Megabits per second

small b = bits

MB/s

Megabytes per second

divide Mbps by 8

Shared

Everyone on the link

your share shrinks

Bursty

Advertised vs sustained

'up to' is doing work

The analogy	**Width of the road**	A wider road carries more cars per minute. It does not make any single car faster.
Where it matters	**Volume**	Downloads, video quality, backups, many users at once. Anything where the total mattered.

How long before anything arrives at all

Latency is delay. It is measured in milliseconds, and a large part of it is not an engineering choice — it is distance divided by the speed of light.

WHERE THE DELAY COMES FROM	WHAT IT IS	CAN YOU FIX IT?
Propagation	Distance ÷ speed of the medium	**No. Physics.**
Transmission	Time to push the bits onto the wire	Yes — more bandwidth
Processing	Each router reading and forwarding	Somewhat — better kit
Queuing	Waiting behind other traffic	Yes — capacity and priority

Light travels about 300,000 km per second in vacuum and about 200,000 km per second in glass fibre. No budget changes those two numbers.

THE PICTURE TO KEEP

Bandwidth is width. Latency is length.



Every argument about a slow connection is really an argument about which of these two pictures you meant.

DO THE ARITHMETIC

Why satellite orbit height decides everything

Round trip means up and down, twice — your request goes up and comes down, the answer goes up and comes down again. These are floors set by physics, before any equipment is involved.

PATH	HEIGHT OR DISTANCE	PHYSICS FLOOR, ROUND TRIP	WHAT YOU TYPICALLY MEASURE
Geostationary satellite	35,786 km up	about 480 ms	roughly half a second or more
Low-earth-orbit satellite	around 550 km up	under 10 ms	commonly tens of milliseconds
Fibre, Ilagan to Manila	a few hundred km	a few ms	commonly tens of milliseconds
Cable across this room	10 m	effectively nothing	well under 1 ms

Same technology, same dish, same modem. Change the orbit height and a video call goes from painful to ordinary.

Which applications care about which number

APPLICATION	NEEDS BANDWIDTH	NEEDS LOW LATENCY	ON A HIGH-ORBIT SATELLITE LINK
Downloading a large file	Very much	Not really	Fine. Slow to start, then fast.
Streaming video	Yes	A little	Usually fine — it buffers ahead.
Video call or online class	Moderate	Very much	Painful. People talk over each other.
Online payment or e-government form	Barely any	Yes	Slow and frustrating per click.
Competitive gaming	Barely any	Critically	Unplayable.

This table is why 'we have internet now' and 'we can hold a class online now' are two different announcements.

HOLD ON TO THIS

Five things from today

	One	Scale plus ownership	LAN means small and yours. WAN means large and rented. That is the real distinction.
	Two	Almost everything is a star	Star inside buildings, partial mesh between them. Bus and ring are history and exams.
	Three	Switch inside, router between	Four words. They answer most networking questions you will be asked.
	Four	Wireless always ends in a cable	The radio is the last hop. Never the whole network.
	Five	Bandwidth and latency are different	One is how much fits. The other is how long you wait. Orbit height decides the second.

Next Saturday: what happens between typing your group address and the page appearing. All of it.

AFTER THE BREAK

In the laboratory today

Observe	**Map this campus**	Walk the building. Find the cabinet, the access points, the cable runs. Draw what is really there.
Build	**/network**	Your map becomes a diagram on your own site — the fifth page, published like the rest.
Hands on	**The cable station**	RJ45, the eight wires, T568B order, straight-through versus crossover. You will hold one.
Measure	**Bandwidth and latency**	Run a speed test and a ping from the same machine and write both numbers down.
AI task	**Ask it about this building**	It will answer confidently about a network it has never seen. Compare that with what you observed.

Observation beats assumption. If you did not see the cable, it does not go on your diagram.

PROGRAMMING LAB ACTIVITY

This afternoon

One list, one function, eight fewer copies

What you are building today

Together	**The group page**	A /network page: the devices you found in this building, as a list, rendered by one function you wrote yourselves.
On your own	**Your own version — this is the marked one**	The devices in your own house — at least five, your own list, your own function, your own columns.
To match	**Your page.html twin**	The same thing again, typed out by hand as HTML.

WHERE IT GOES LIVE

`gNN.cic.rmlsystems.net/network`	`gNN.cic.rmlsystems.net/<yourfolder>/`	`gNN.cic.rmlsystems.net/<yourfolder>/page.html`

Eight identical pages is eight zeros. Your version has to be yours — your data, your words.

NEW THIS WEEK

The Python you have not used before

`devices = ["router", "switch"]`

a list — many things under one name

`devices.append("printer")`

add another one to the end

`for device in devices:`

do this once for each of them

`def row(name):`

your own function, with something handed in

at the shell

```
devices = ["router", "switch"]
devices.append("printer")

def row(name):
    return "<tr><td>" + name + "</td></tr>"

for device in devices:
    print(row(device))
```

It prints: <tr><td>router</td></tr> and two more

TWENTY POINTS

How this is marked

6	**It runs**	Your address loads and there is no traceback on it.
6	**It does this week's thing**	A real list, and your own function called once per device.
4	**It is yours**	The devices in your own house, and columns you chose.
2	**The twin matches**	page.html shows the same thing, by hand.
2	**Worksheet complete**	Including the AI sentence and the twin count.

DUE Sunday 4 October, 11:59pm · the full guide is at labs.cic.rmlsystems.net/guides/

Nobody owns the internet.

It is millions of separately owned networks that agreed on a set of rules and nothing else. No head office. No master switch. Your group's page sits inside it, and this afternoon you go and find the cables.

Questions?