Computer Networks

and Communication Protocols

It takes two to communicate

- Alice: “Hey, Bob”

. . .

- Alice: “Hey, Bob”
- Bob: “Hey, Alice. How’re doing? <crackle> <buzz>”
- Alice: “Sorry, Bob, I didn’t quite catch that.”
- Bob: “I said, ‘How’re doing?’”
- Alice: “I’m good, thanks. I was just wondering …”

Communication is Unreliable

Just like humans, computers sometimes have trouble talking to each other. A question might not get an answer or a message might get garbled.

No communication technology is 100% perfect.

But, just like humans, computers know how to cope with unreliable communication channels.

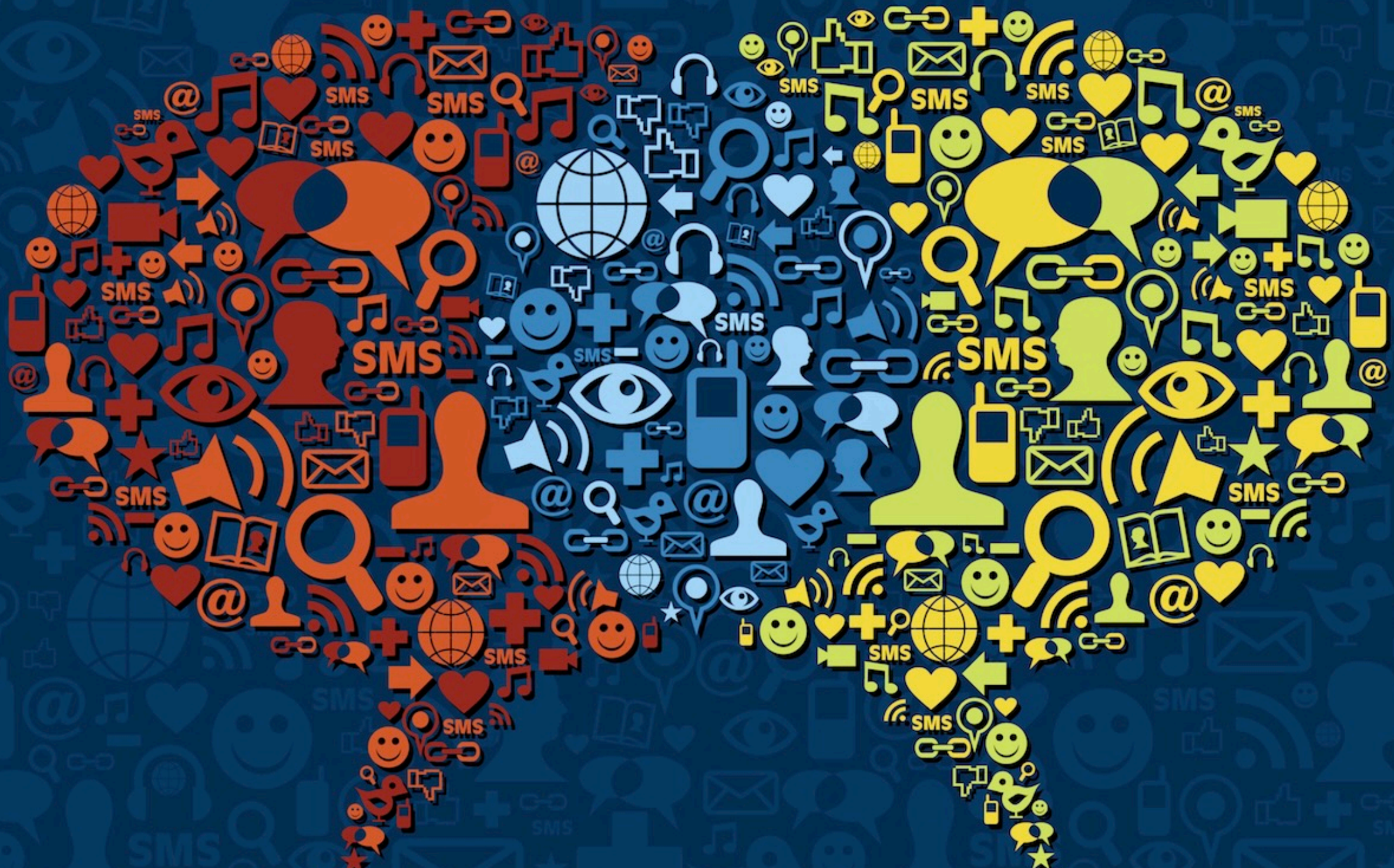
If Alice's computer doesn't get a reply, it will send the question again. And, if Bob's computer doesn't understand the message, it will ask for clarification.

Communication Protocols

The rules governing how one computer talks to another are known as a communication protocol.

There are a number of communication protocols, each designed for a specific type of communication technology.

In each case, they define which messages should be sent and received, the format of those messages, and how they should be processed.


SMS

Connecting Computers

There are two ways to connect computers together:

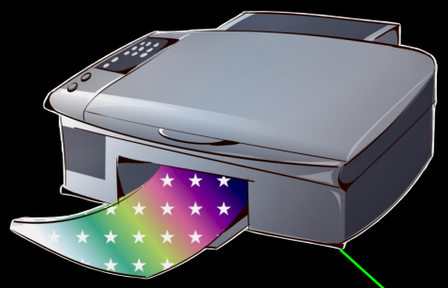
- with wires (copper cable, optical fibre)
- wirelessly (mobile phones, wi-fi, bluetooth, …)

In general, wired connections are faster, more reliable and work over longer distances than wireless.

The protocols for wired connections are quite different from those for wireless communications. And there are multiple protocols in each of those categories.

Some Common Protocols

ADSL	To connect your router to your Internet Service Provider over copper phone lines.
GPON	To connect your router to your Internet Service Provider over optical fibre.
TCP/IP	To connect a computer to the Internet.
3G,4G,5G	To connect a phone/tablet to the mobile phone network.
Wi-Fi	To connect your mobile devices to your wi-fi router.
Bluetooth	To connect keyboard, mouse, earphones to a computer.



Printer

Wi-Fi

The Internet

ADSL

GPON

Router

Wi-Fi

Wi-Fi

3G,4G,5G

Basestation

Computer

Bluetooth

Earphones

Bluetooth

Smartphone

Speed vs Distance

As a rule of thumb:

- Bluetooth connects across a room
- Wi-Fi connects across a building
- 3G,4G,5G connect across a village or city suburb

Higher frequencies mean faster transmission but over shorter distances.

So, you may find wi-fi at 5GHz works in the house but you need to use 2.4GHz at the far end of the garden.

Routing Protocols

You might have noticed that one of the protocols in the table a few slides ago doesn't appear on my picture slide.

The missing one is TCP/IP (Transmission Control Protocol/Internet Protocol). It is this that defines the addresses of computers on the Internet and how to route messages from one machine to another.

The protocols shown in the earlier diagram enable a machine to talk to its neighbour. They can be thought of as 1-hop communication rules. TCP/IP governs how messages are routed through the whole of the Internet. It is a multi-hop protocol.

But, computers on the Internet also offer multiple services such as email or websites. And those services have their own application-specific addresses and communication protocols.

Protocol Layers

The protocols form layers. The higher-level protocols use the lower-level protocols to route and deliver their messages.

Texting apps use the SMS protocol, which uses the underlying 3G, 4G or 5G cellular network protocols.

Email apps and web browsers use TCP/IP to send their messages. TCP/IP uses ADSL or GPON to send its messages.

Protocol Layers (simplified)

Layer	Protocols
Application	SMS, SMTP, POP, IMAP, HTTP, FTP, SSH, …
Transport	TCP, UDP, SCTP
Link	Bluetooth, Wi-Fi, 3G, 4G, 5G, ADSL, GPON

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Email

When you compose an email, you tell your computer who you want to send it to and type in your message.

You can also, if you wish:

- add other recipients in the Cc or Bcc fields
- select a From address (if you have more than one)
- use Reply To to have replies go to a different email address
- attach images and documents

Email Protocols

To make this work, there are communication protocols specifically for conversations between email apps and email servers.

- SMTP for sending emails
- POP or IMAP for receiving emails

(POP has been largely superseded by IMAP)

These rely on TCP/IP to connect sender and receiver.

The World Wide Web

When you visit a website, your web browser contacts a web server and asks for a web page to display. There are communication protocols for this, too.

- HTTP - Hypertext Transfer Protocol
- HTTPS - the secure version of HTTP
- FTP, SFTP (file transfer), SSH (remote terminal), etc.

These also rely on TCP/IP to connect browser and server.

Glossary - Data Layers

ADSL	Asymmetric Digital Subscriber Line
GPON	Gigabit Passive Optical Network
TCP/IP	Transmission Control Protocol/Internet Protocol
3G,4G,5G	Third, fourth and fifth generation phone protocols.
Wi-Fi	Medium range wireless protocols.
Bluetooth	Short range, low power wireless protocol.

Glossary - Application Layer

SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
POP	Post Office Protocol (for single device access)
IMAP	Internet Message Access Protocol (multiple devices)
HTTP	Hypertext Transfer Protocol
FTP	File Transfer Protocol

In Summary

- All communication is inherently unreliable …
- … but protocols create reliable connections.
- A protocol defines the messages a computer can send and receive.
- Computers can be connected by wires or wirelessly.
- Higher frequencies mean faster speed over shorter distances.
- Protocols are organised in layers, higher levels building on the lower ones.


thank
you!