oueees-201806 talks Part 1/3: Packet Switching

Kenji Rikitake

26-JUN-2018
School of Engineering Science
Osaka University
Toyonaka, Osaka, Japan
@jj1bdx

Lecture notes

- https://github.com/jj1bdx/oueees-201806-public/
- Check out the README.md file and the issues!

Reporting

- Keyword at the end of the talk
- URL for submitting the report at the end of the talk

Before starting the today's talk: the risk of being a professional and exposure to the public

- You might be harassed, harmed, and attacked at any time
- The attackers are *anonymous* while you are *well-identified*
- *Anyone can be a target*
- Stay low profile when you can
- Stay vigilant

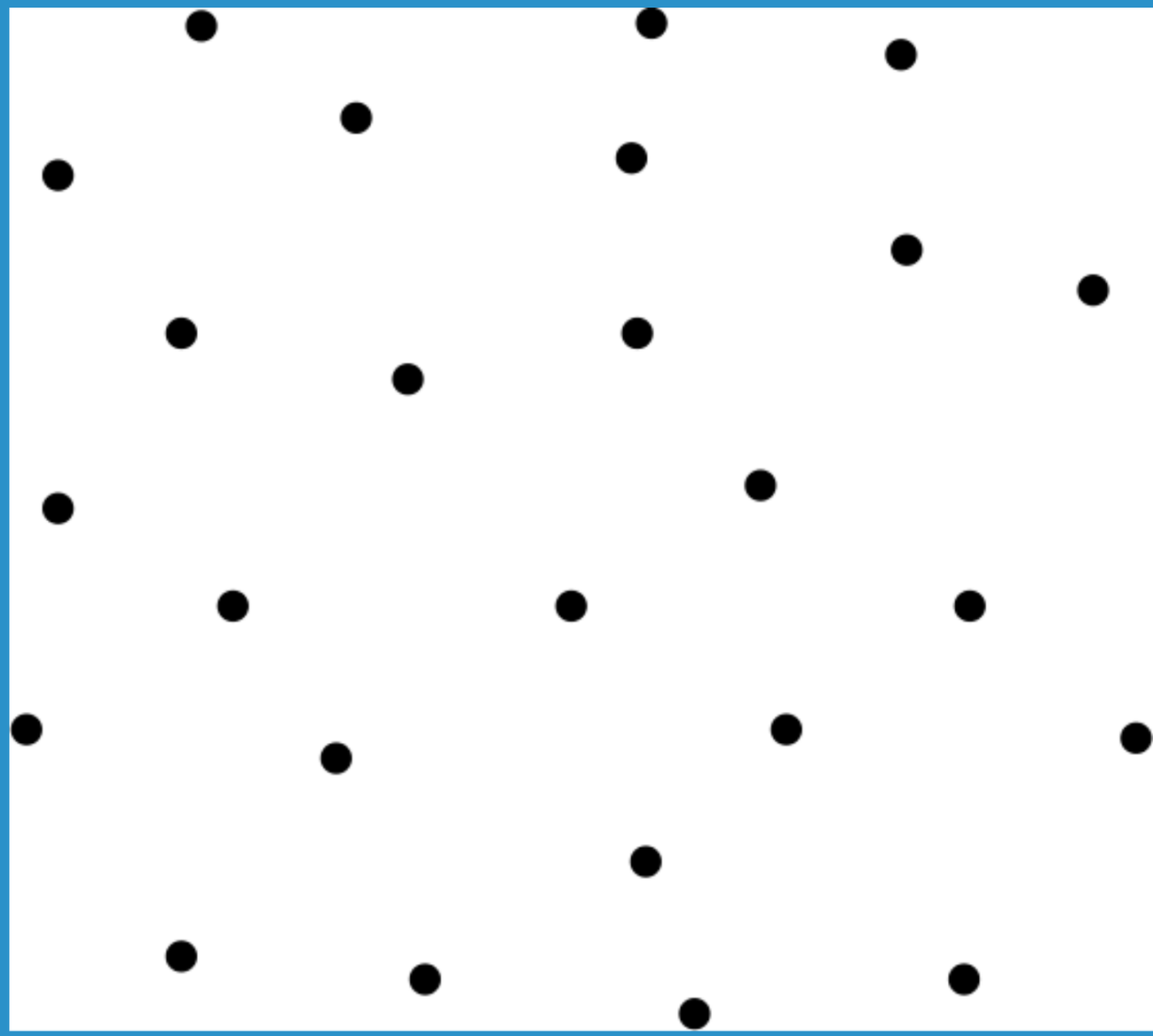
Today's topic: communication fundamentals of the packet switching networks

Communication: sharing a medium

- Sharing a physical link between two or multiple parties
- *The physical layer*
- A medium could be: electric wires, optic fibers, radio airwaves, sound, flying birds like pigeons

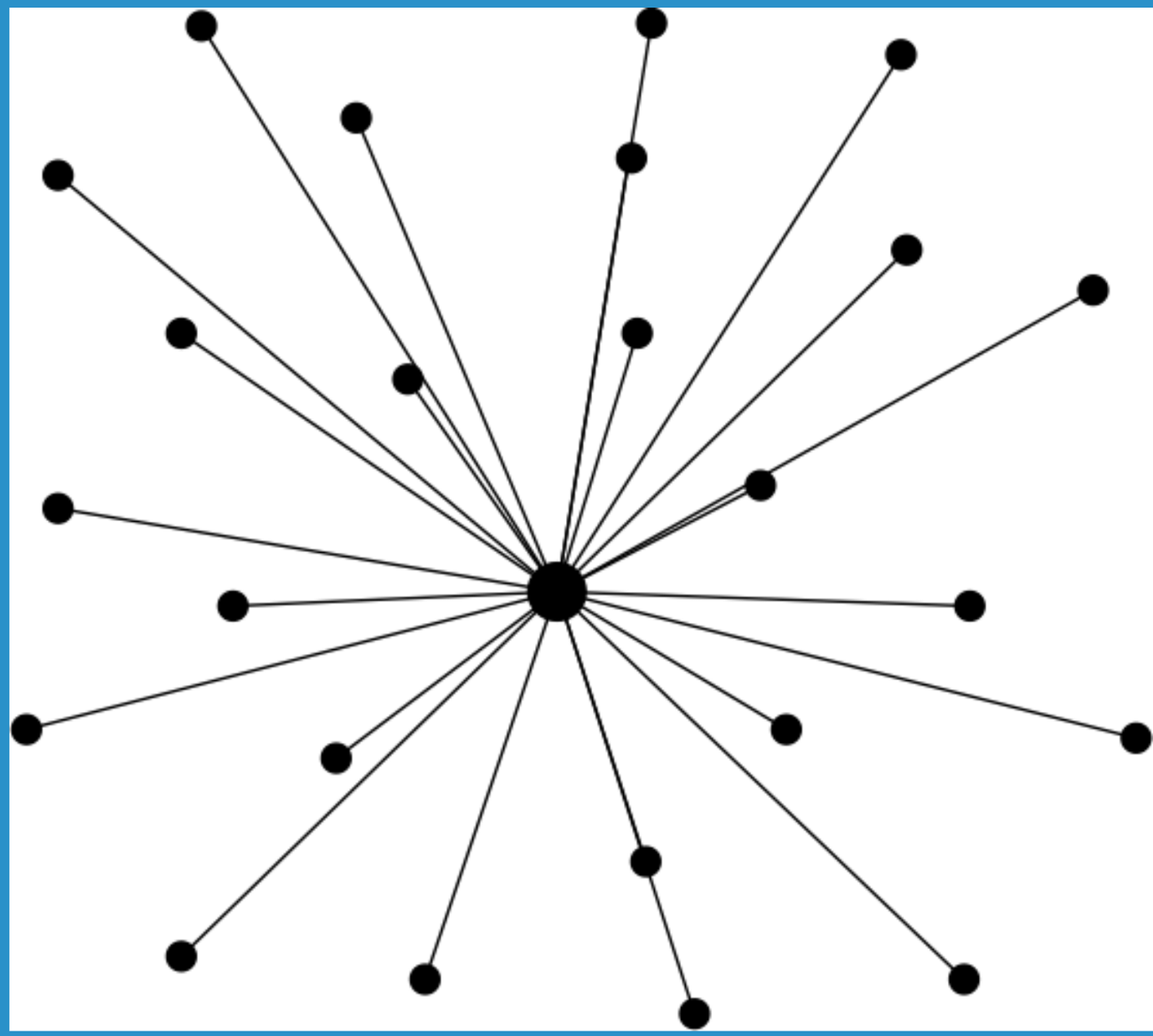
Connecting unconnected nodes

There are many ways to connect the dots in this picture



Simplest way: star/ centralized connection

- Centralized connection was the easiest way to connect the nodes
- Very much susceptible to network link failures
- Links should stay connected during the connection



The old Stockholm telephone tower in 1890

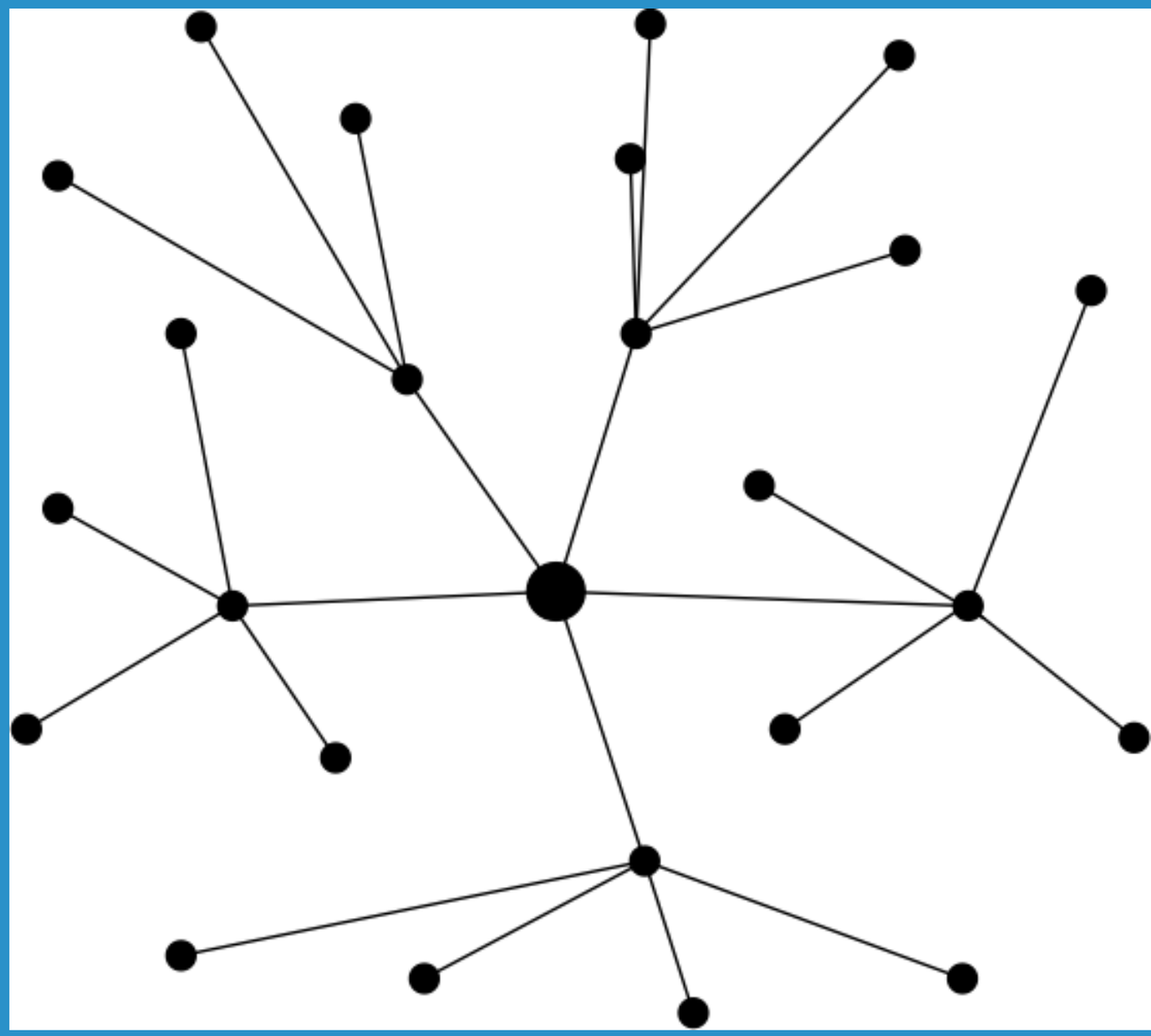
Fallen telephone lines by frost at Jönköping, Sweden, 1929

Tekniska museet in Stockholm (June 2018)

Multiplexing: sharing the same link by multiple nodes and communication devices

Multiplexing enables decentralization

— Some links carry shared traffics for many different nodes



How to multiplex different types of information, and put them together for sharing a same medium?

Signal characteristics used for multiplexing

- Space division (multiple lines or multiple beam-formed antennas)
- Time division
- Frequency/wavelength division
- Polarization division
- Code division (multiple codes of very small cross-correlation)

Packet switching

What if you can split a stream into the *packets* and let them be delivered through *different links* for each packet?

How to form a packet (1/2)

- **Split a stream into multiple pieces of data**

```
ABCDEFHIJ -> ABC DEF HIJ
```

- **Put a header on each piece**

```
ABC DEF HIJ -> P1-ABC P2-DEF P3-HIJ
```

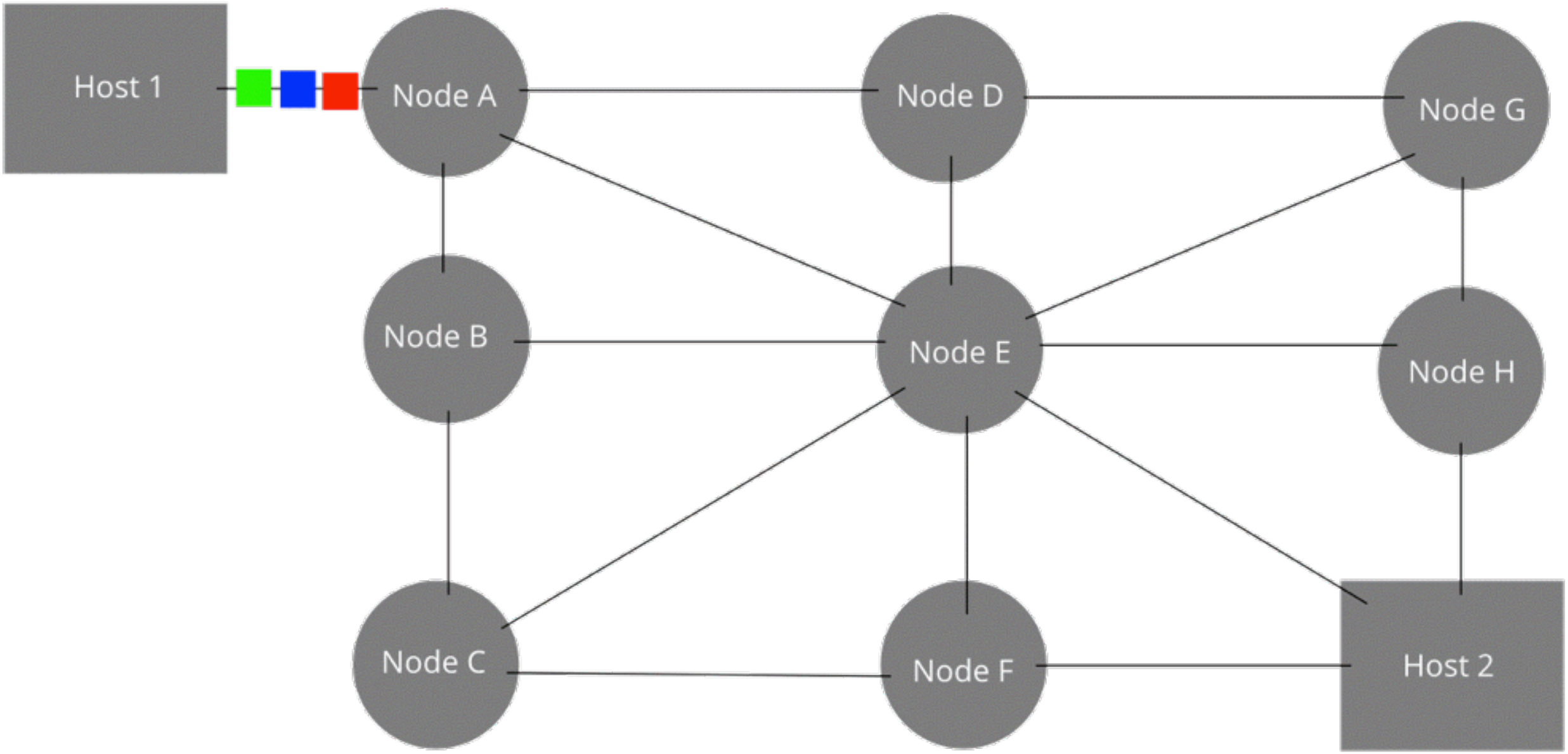
How to form a packet (2/2)

- Add source and destination addresses to each packet

```
P1-ABC P2-DEF P3-HIJ
->   FromXtoY-P1-ABC
     FromXtoY-P2-DEF
     FromXtoY-P3-HIJ
```

- Then send them on the network!

The original message is Green, Blue, Red.

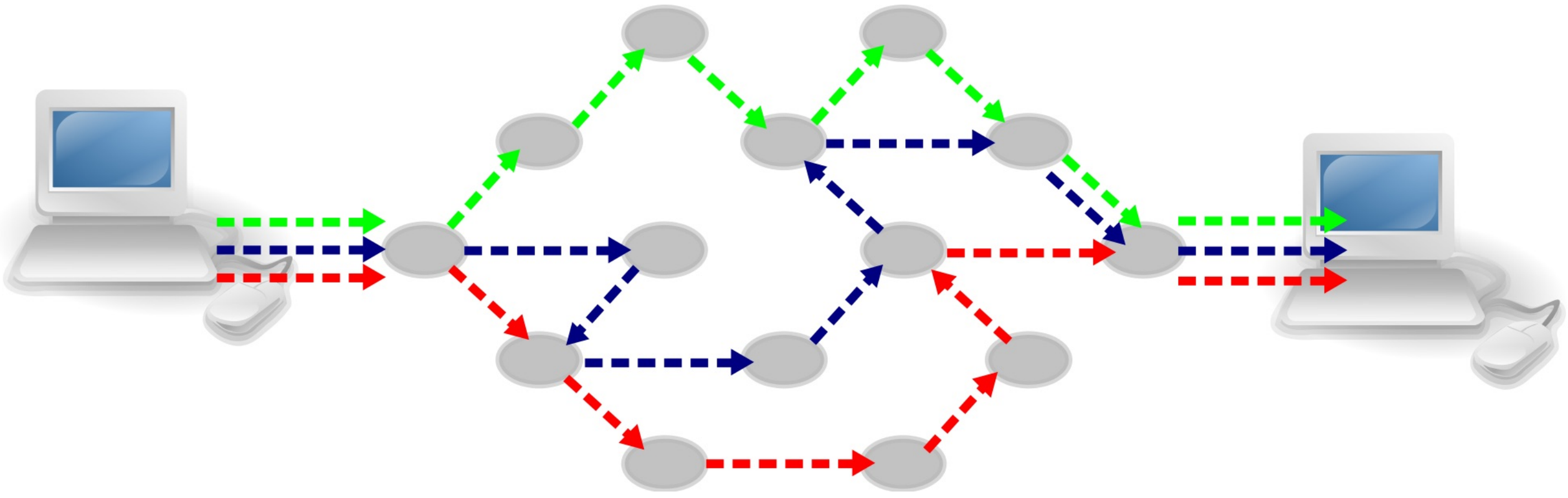


Packet switching and the nodes

- Each communication node must know how to assemble/disassemble information to/from the packets
- Each communication node must know which link should be used to send a packet for the given destination
- Packets can be lost; relaying nodes cannot detect a lost packet

Packet (dis)assembly issues

- The sequence of delivered packets may differ from that of the sender intents; holding the out-of-sequence packets are required
- Retransmission is required to recover a lost packet for a reliable communication

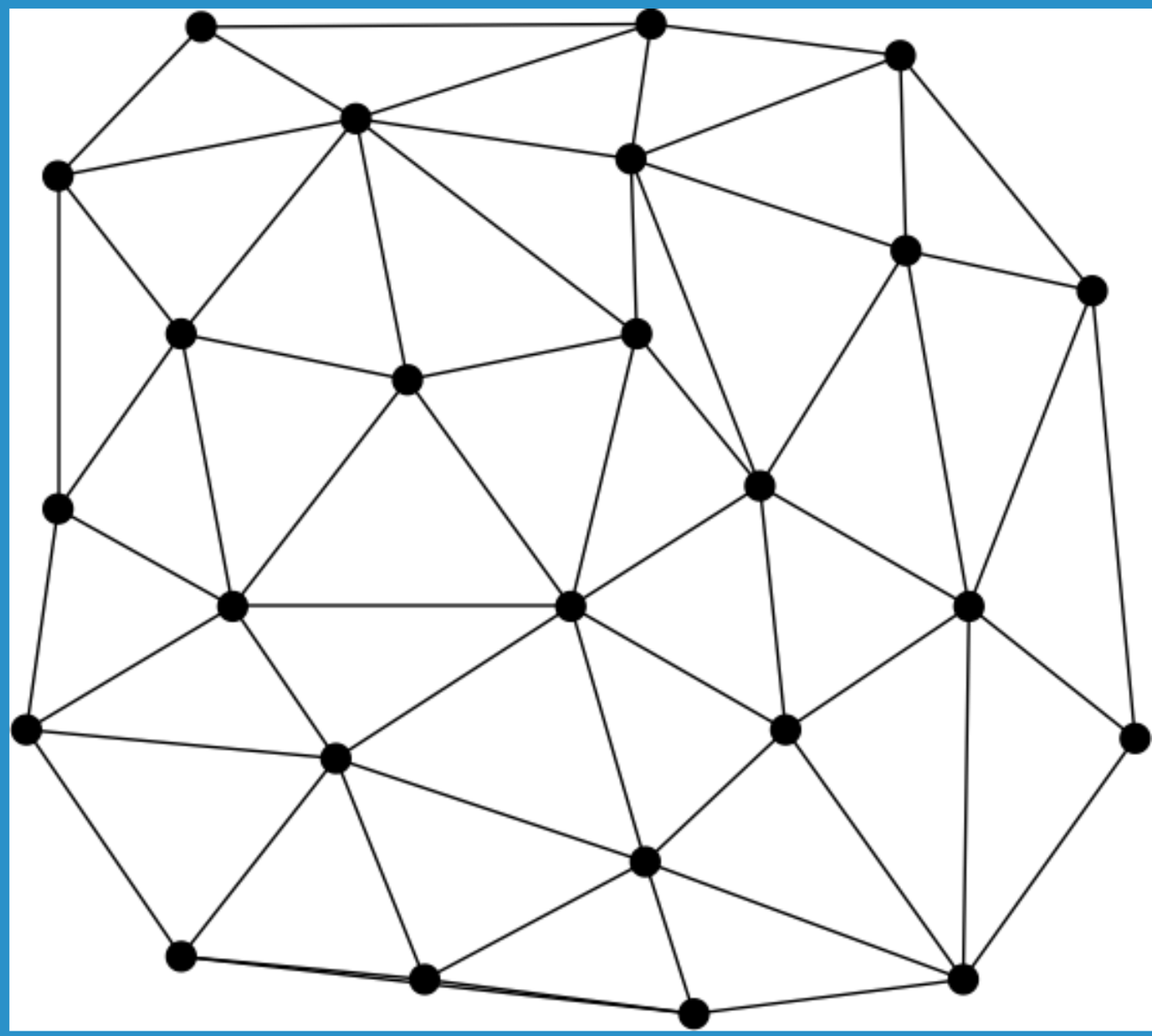


Packet switching enables

- Changing the packet relay routes *during* the communication
- Using multiple routes for a single communication link
- Aggregating multiple communication links into a physical link
- Connectionless *and* connection-oriented communication simultaneously

Truly distributed networks are feasible by packet switching

- No centralized nodes
- Each link can be utilized by all nodes
- A disconnection of the link will not be fatal so long as one link is connected to a node



Disadvantages of packet switching

- Each node must be able to form/ generate and decode/interpret a packet
- Forming and decoding a packet takes time and the computing resources
- Reliability and latency can be a trade-off
- Relay nodes can be neutralized by denial-of-service attacks
- Difficult to manage

Topics on next talk

- IP addresses
- Routing and the information dissemination
- Transport protocols (TCP, UDP, HTTP(/2), QUIC)

Photo credits

- All photos are modified and edited by Kenji Rikitake
- Photos are from Unsplash.com unless otherwise noted
- Title: Shane Rounce
- Stockholm telephone tower: Tekniska museet, from Flickr, CC BY 2.0
- Jönköping telephone lines: Tekniska museet, from Flickr, CC BY 2.0
- Tekniska museet photo: Kenji Rikitake, CC BY 4.0
- Packet Switching animated GIF: By Oddbodz from Wikimedia Commons, CC BY-SA 3.0
- Internet packet switching: By Computer-blue.svg: OpenClipartderivative work: Pluke (Computer-blue.svg), via Wikimedia Commons, CC0 (Public Domain)