Mentorium 3

Business Informatics 2 (PWIN)

Communication Systems I & II

SS 2021

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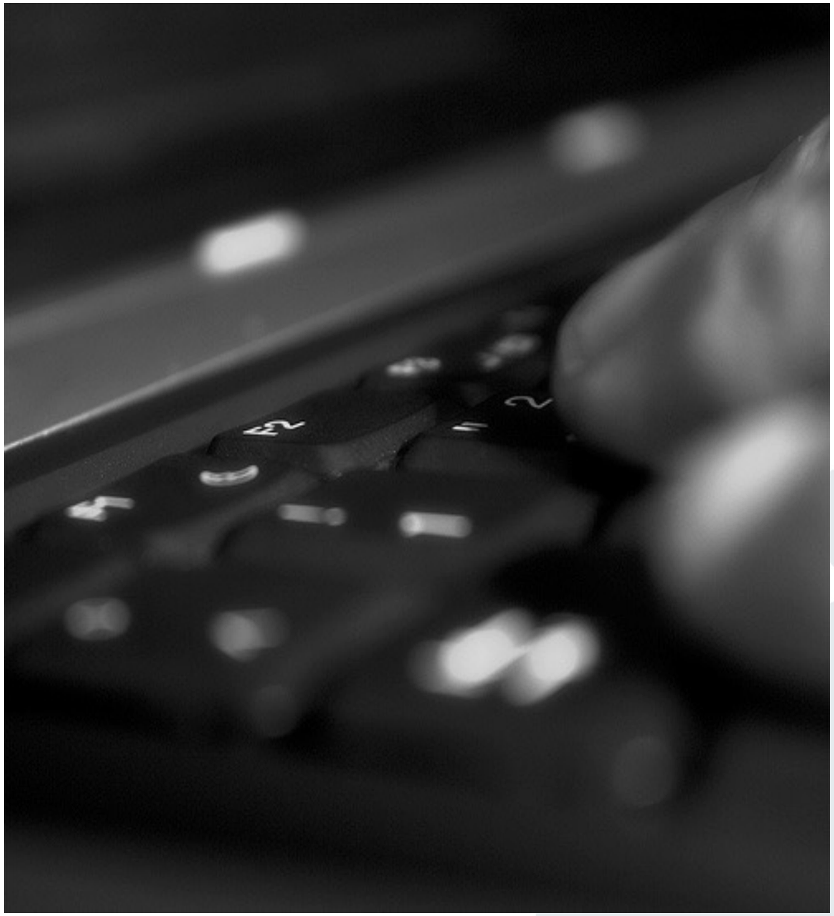
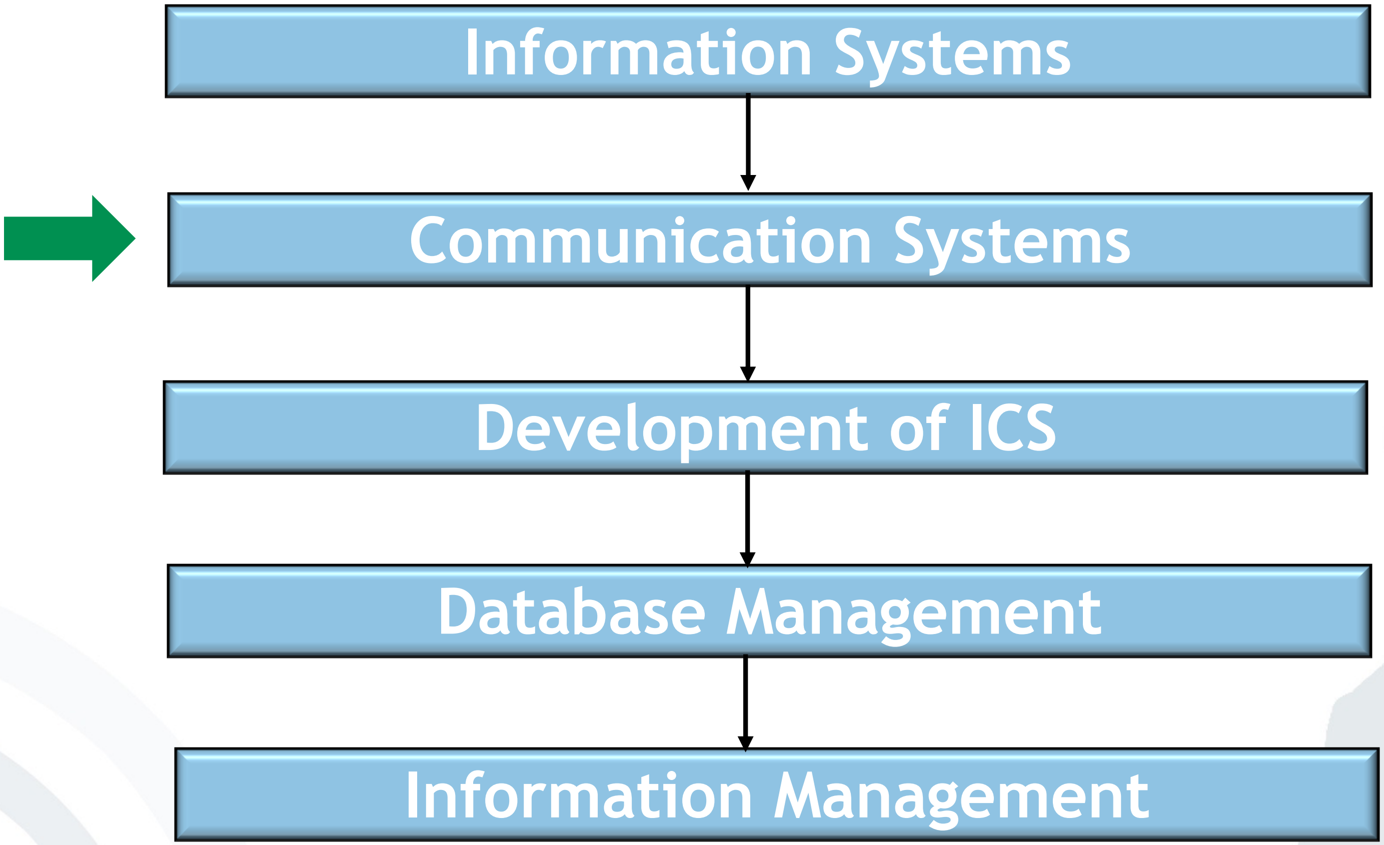


Jenser (Flickr.com)

Components of the Course Business Informatics II (PWIN)



Information Systems

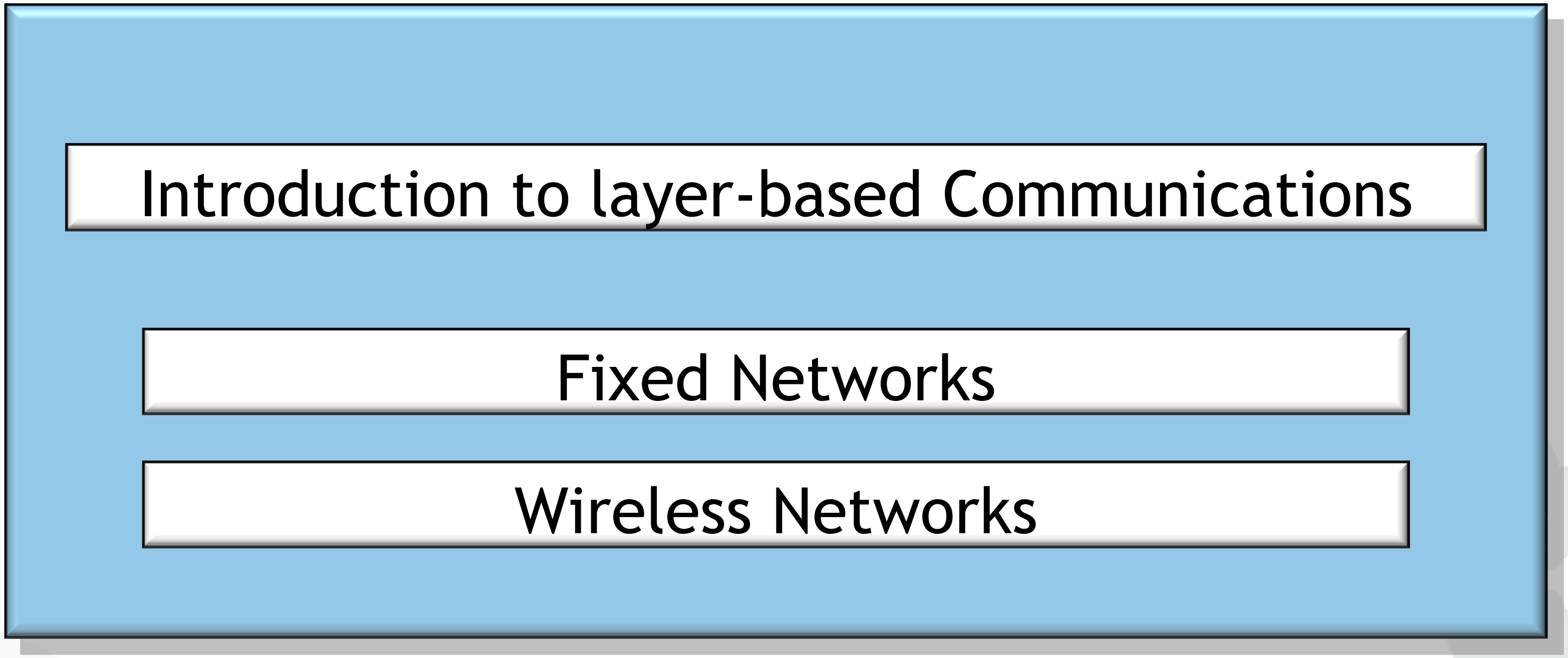
Communication Systems

Development of ICS

Database Management

Information Management

Components of the Course



Introduction to layer-based Communications

Fixed Networks

Wireless Networks

Agenda

- Exercise 1: OSI reference model
- Exercise 2: Fixed Networks
- Exercise 3: Wireless Local Area Networks
- Exercise 4: Bluetooth and NFC

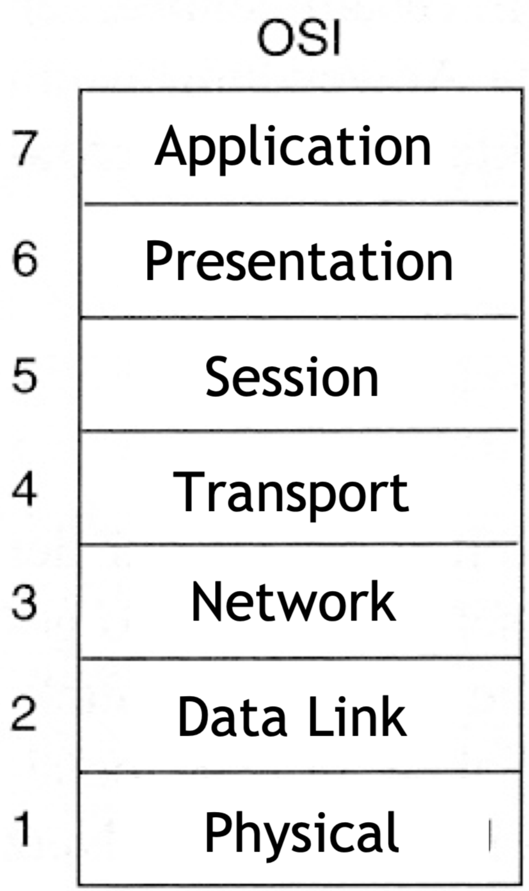
Exercise: TCP vs. UDP

- In which layer are TCP and UDP used? What is the main difference between them?

- Please describe the three way handshake (TCP).

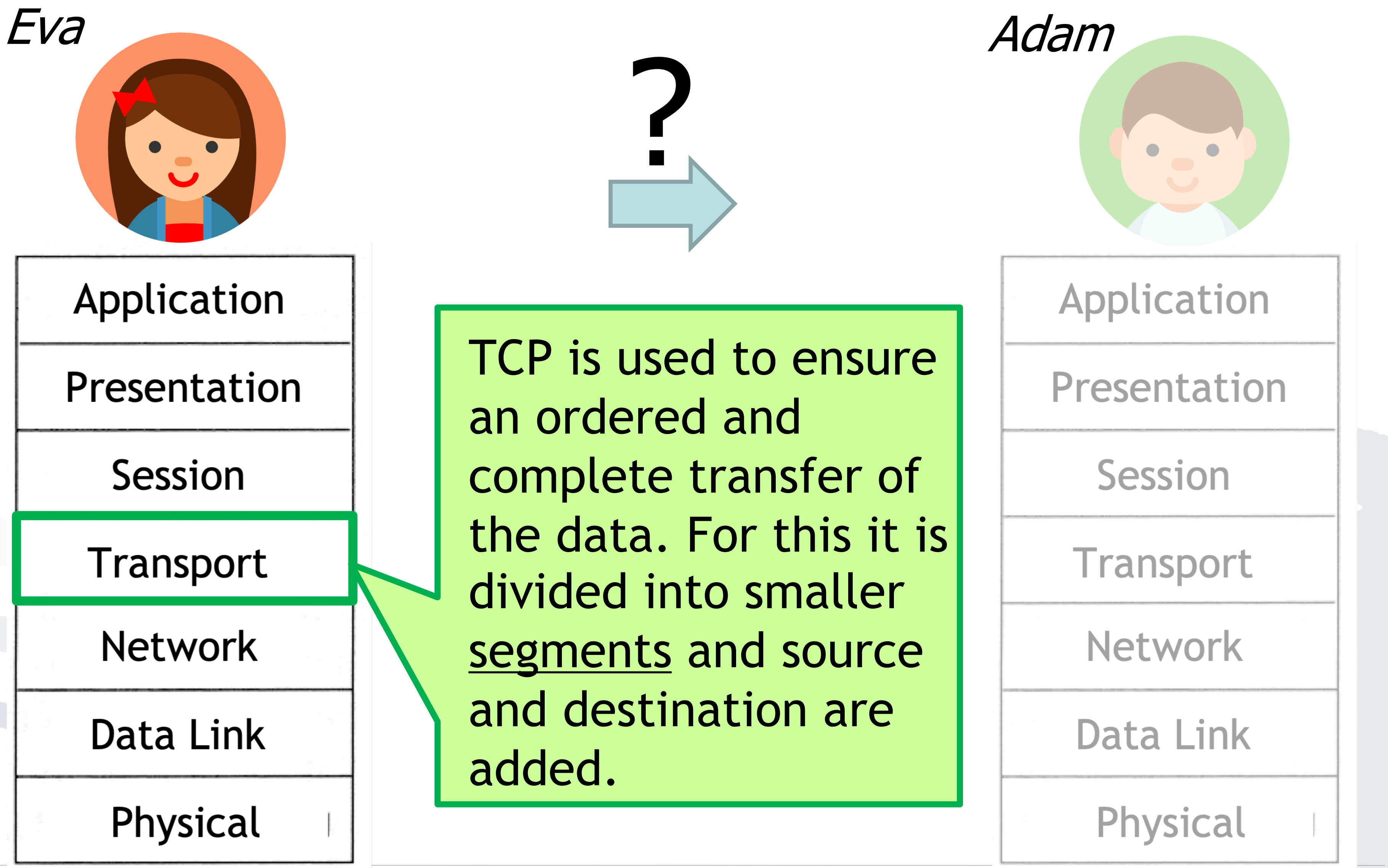
- Should myPlace use TCP or UDP? Why?

Keywords for OSI reference model layers



	OSI	
7	Application	Data in/output – DNS, http, email
6	Presentation	Binary
5	Session	Check-point
4	Transport	TCP (3 way handshake), UDP
3	Network	Routing, IP address
2	Data Link	MAC
1	Physical	LAN cable, optical fibre, air, etc.

Exercise 2b): Solution



Eva

Adam

?

Application

Presentation

Session

Transport

Network

Data Link

Physical

TCP is used to ensure an ordered and complete transfer of the data. For this it is divided into smaller segments and source and destination are added.

Application

Presentation

Session

Transport

Network

Data Link

Physical

Layer 4: Transport Layer
Transmission Control Protocol (TCP)

- The Transmission Control Protocol (TCP) was especially designed in order to provide a reliable and connection-oriented transportation of a byte-stream (from endpoint to endpoint) through unreliable networks.
- TCP is defined in RFC 793 (September 1981).

- Functions:
  - Data Segmentation
  - Connection Establishment and Termination
  - (Error Detection)
  - (Flow Control)

Source: Tanenbaum (2006), p. 573

Layer 4: Transport Layer
Transmission Control Protocol (TCP)

- Properties of TCP
  - Reliable
    - Data communication is repeated until the remote station acknowledges the receipt.
  - Connection-oriented
    - Before the actual data transfer begins, during setup of a TCP connection by 3-way handshake, a logical end-to-end connection between sender and receiver is established.
  - Makes it possible to send information directly to an application (ports).

Source: Tanenbaum (2006), p. 573

Layer 4: Transport Layer User Data Protocol (UDP)

- User Data Protocol (UDP) is a connectionless, insecure transport protocol without assurance whether a data packet has been received by the remote party or not.
- UDP has the advantage of a reduced protocol overhead compared to the Transmission Control Protocol (TCP).
- UDP is used e.g. for the Domain Name System (DNS, sometimes also known as Domain Name Service).

Memory aid: "unreliable" data protocol

Source: Tanenbaum (2006) p. 573, Holtkamp (2002) p. 40-41

Exercise: TCP vs. UDP

- Please describe the three way handshake (TCP).

- Should myPlace use TCP or UDP? Why?

Exercise: Layer 4: Transport Layer 3-Way Handshake (TCP)

- Example from everyday life – making an appointment via correspondence

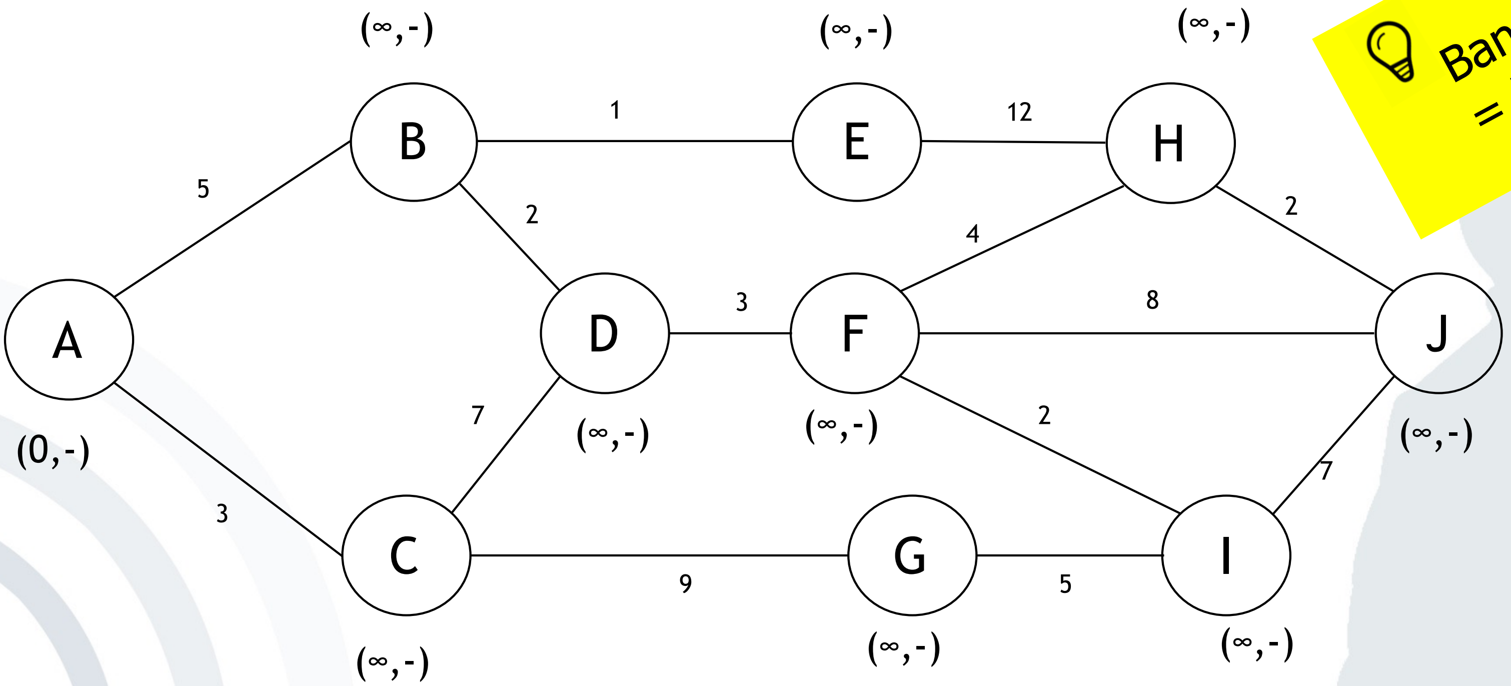
Prof. Rannenberg wants to make an appointment with Prof. König via correspondence.

1. Prof. Rannenberg sends a message to Prof. König to suggest an appointment date.
2. Prof. König confirms the appointment date by sending a message back to Prof. Rannenberg.
3. Prof. Rannenberg sends a message to Prof. König to let him know that he received the confirmation message.

Step 3 is necessary in order for Prof. König to know that Prof. Rannenberg has received the confirmation. Message No. 2 could have gotten lost and then Prof. König would show up alone for the meeting.

Exercise: Dijkstra Algorithm

- The following graphs shows the various systems a message from a place of interest needs to pass to get to the end user. Please calculate the fastest track. Note that lower case letters denote *system vertices* and the numbers the *bandwidth* of a connection.



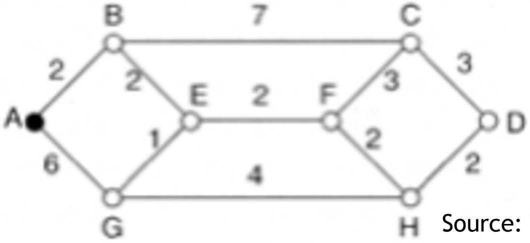
Bandwidth: = longest path

Solution: Layer 3: Network Layer Using Dijkstra Algorithm

Dijkstra Algorithm

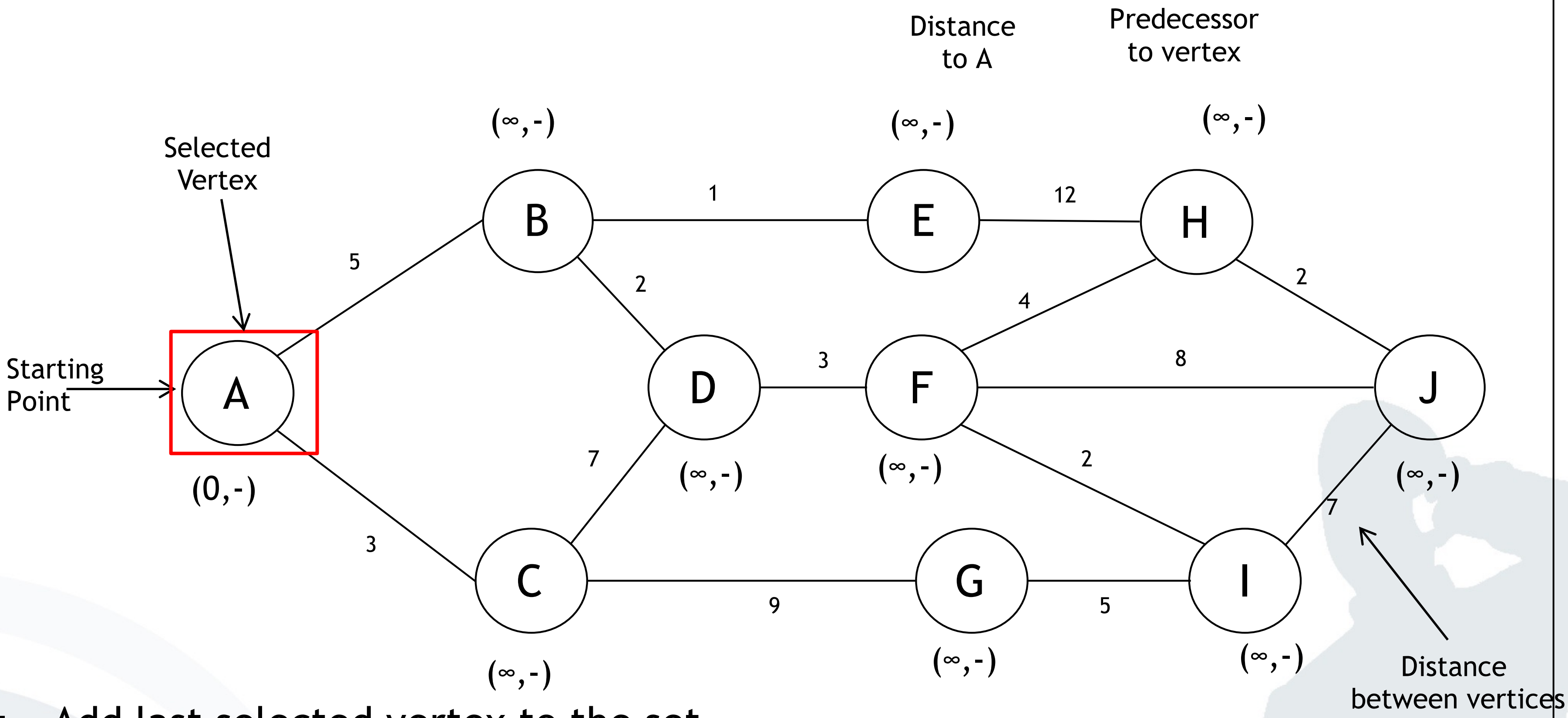
Vertex = Knoten
Edge = Kante

- The algorithm was developed 1959 by Edsger Wybe Dijkstra.
- It solves the problem of finding the shortest path between two vertices *(singular: vertex)* in a graph.
- For this concept, a graph is created in which every router is represented by a **vertex** and every transmission line by an **edge**.
- The algorithm computes the shortest path between a selected pair of (two) routers with the help of this graph.
- The labels of the **edges** can e.g. be distance, bandwidth, average traffic, transmission costs, average queue length, average transmission time measured or other factors.
- Every **weighted edge** has an impact on the shortest path.



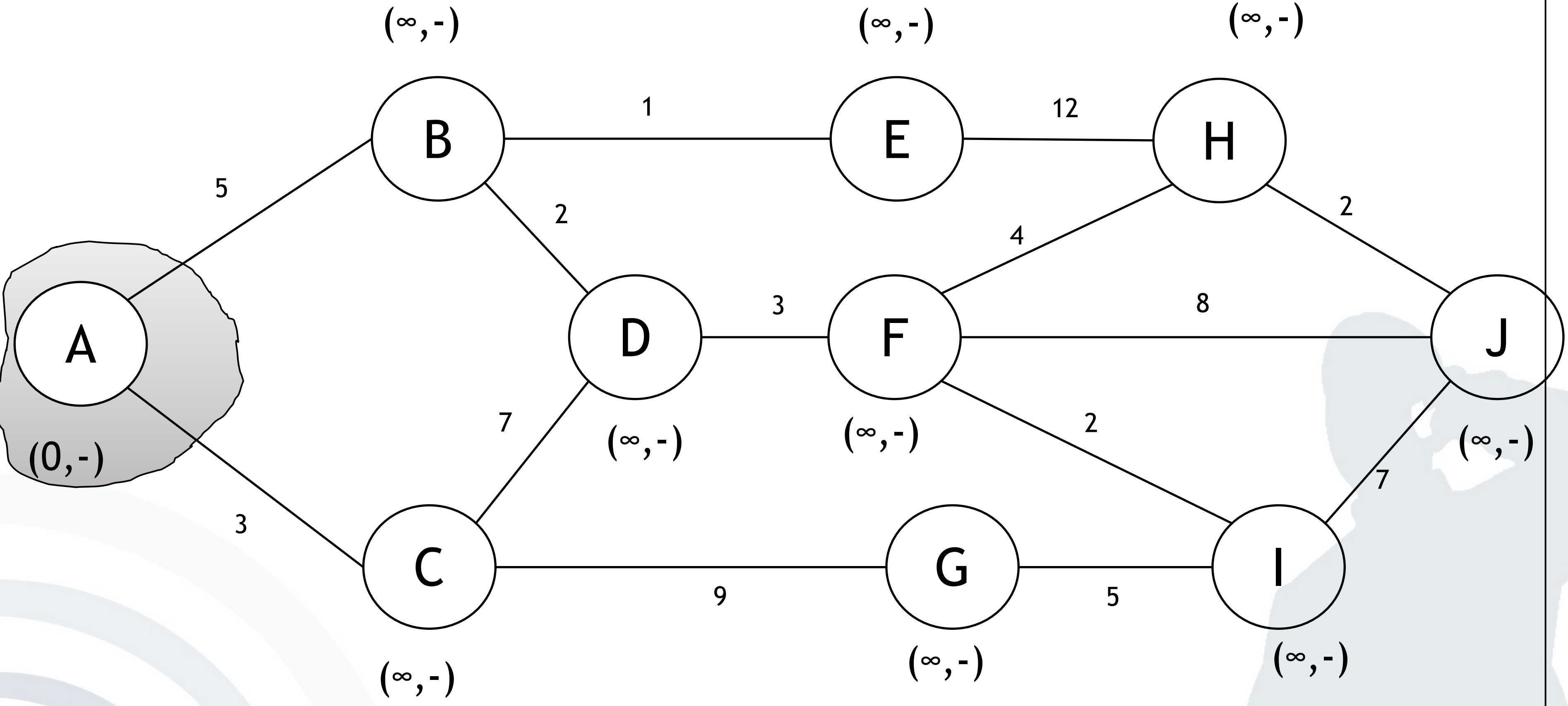
Source: Tanenbaum (2006), p. 391-393

Solution: Layer 3: Network Layer Using Dijkstra Algorithm

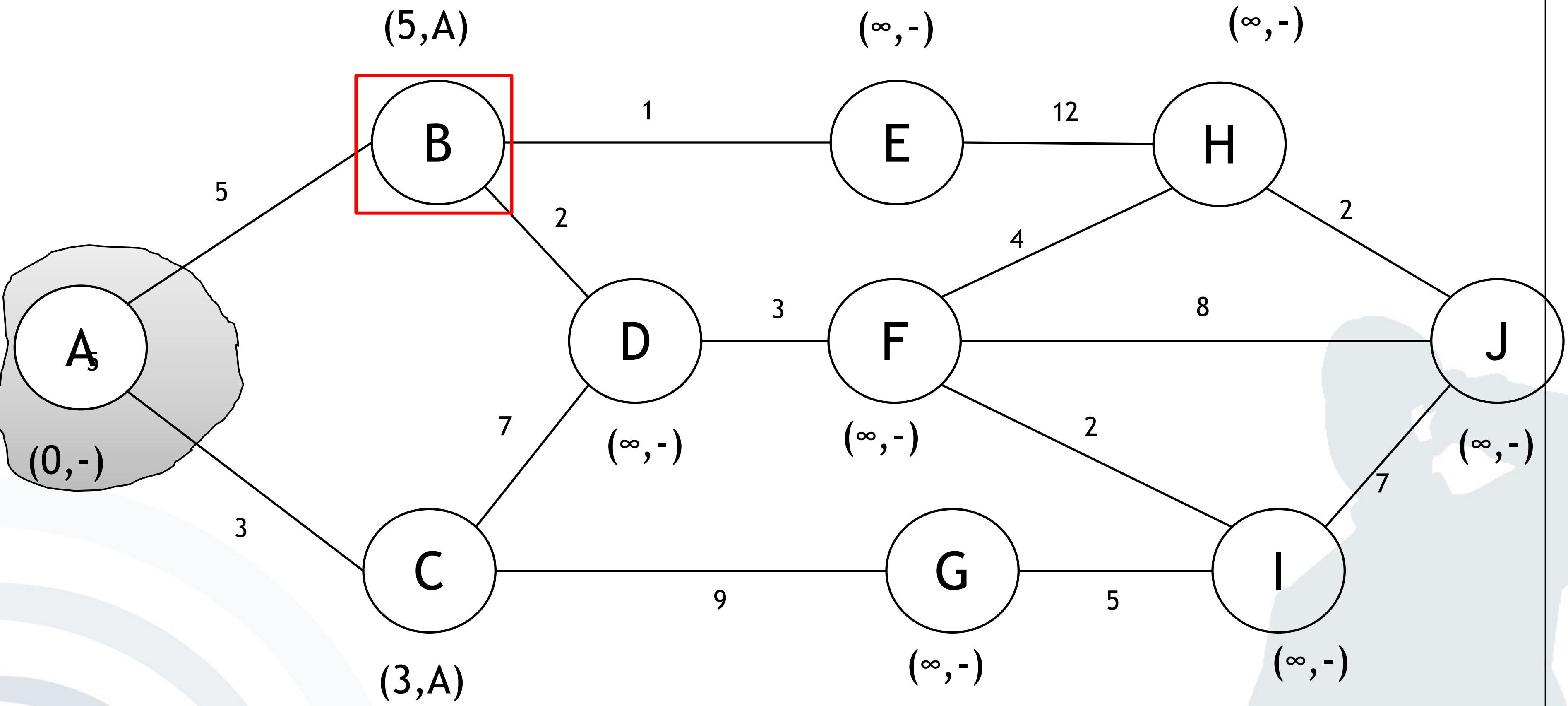


- Add last selected vertex to the set
- If shorter (longer), update distance and predecessor values of the neighbours of the last selected vertex
- Select the vertex, which is not in the set and has the minimum (maximum) value

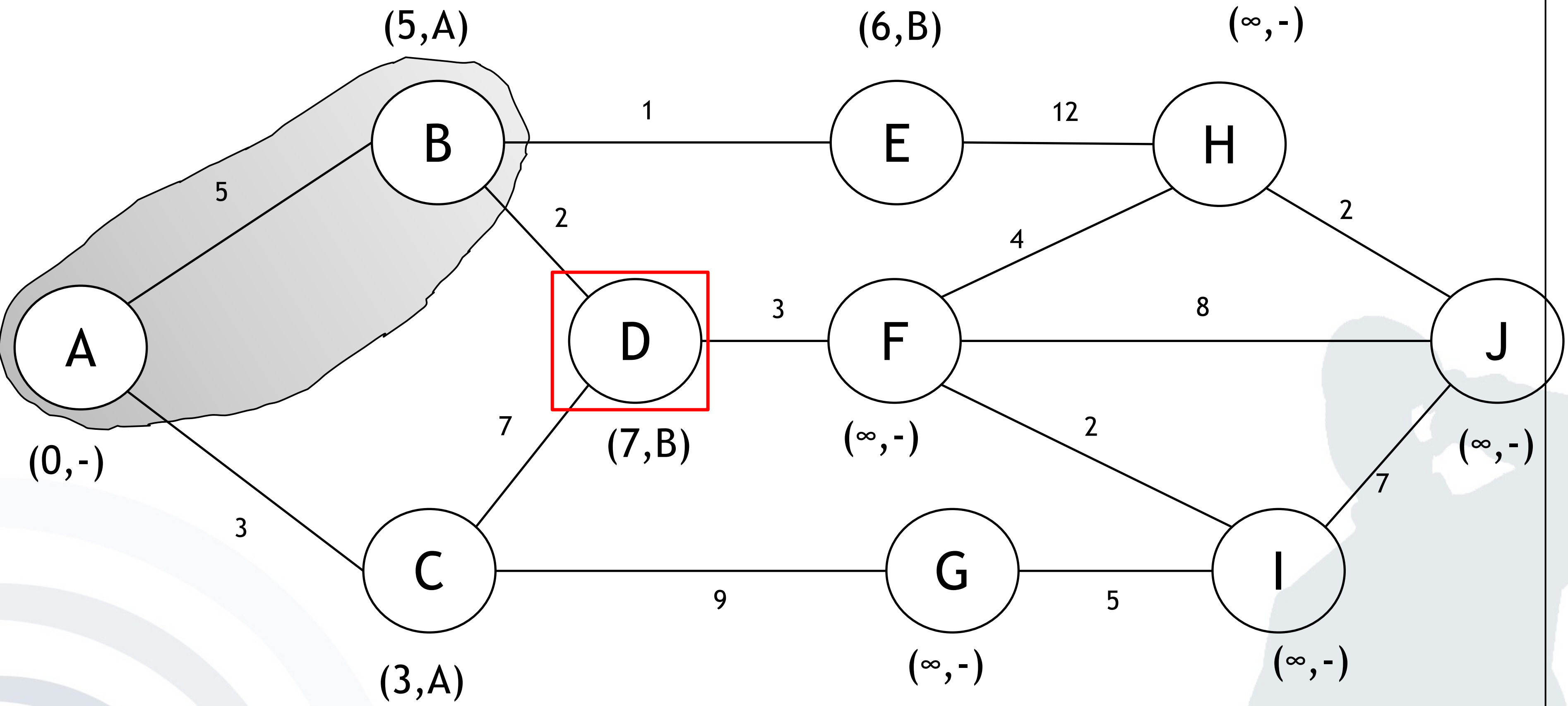
Solution – longest path: Dijkstra Algorithm



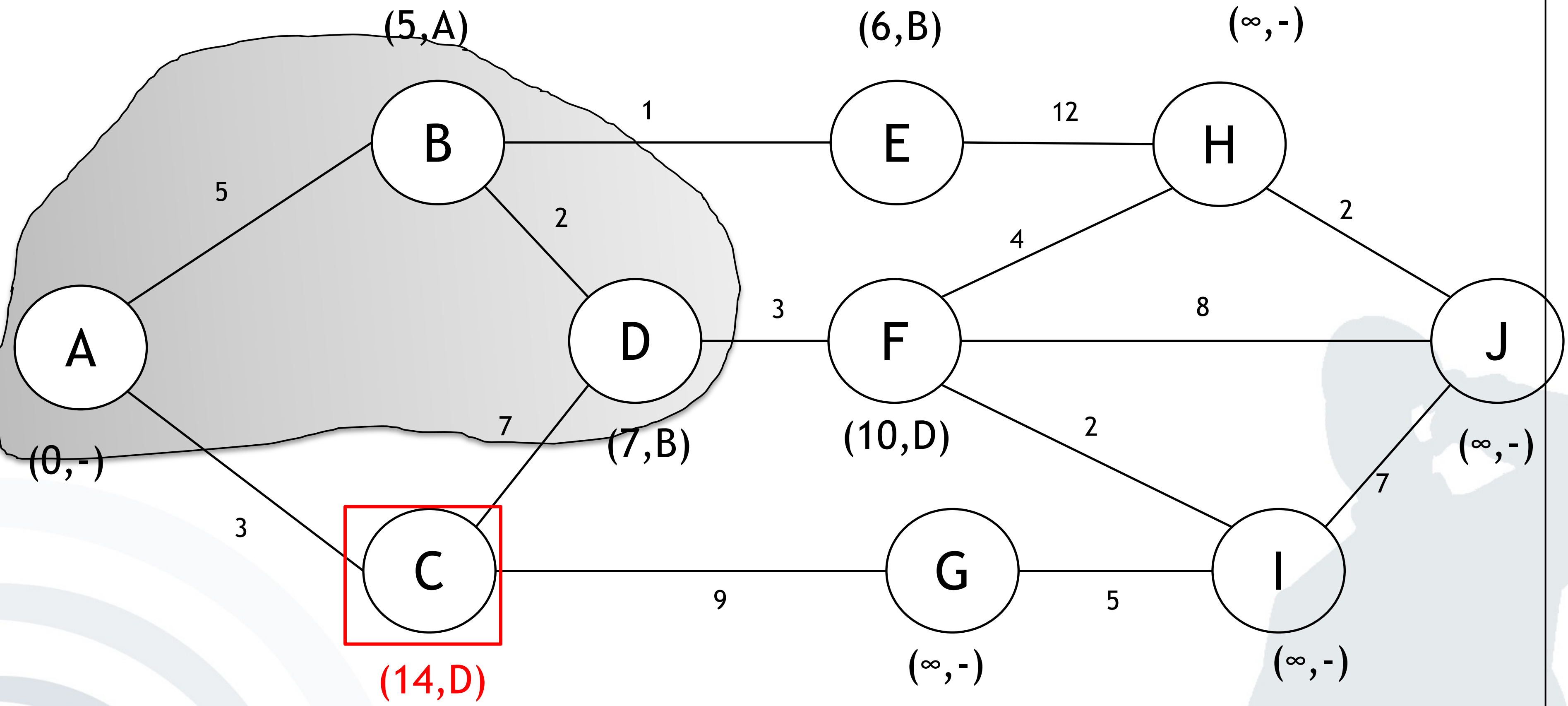
Solution: Dijkstra Algorithm



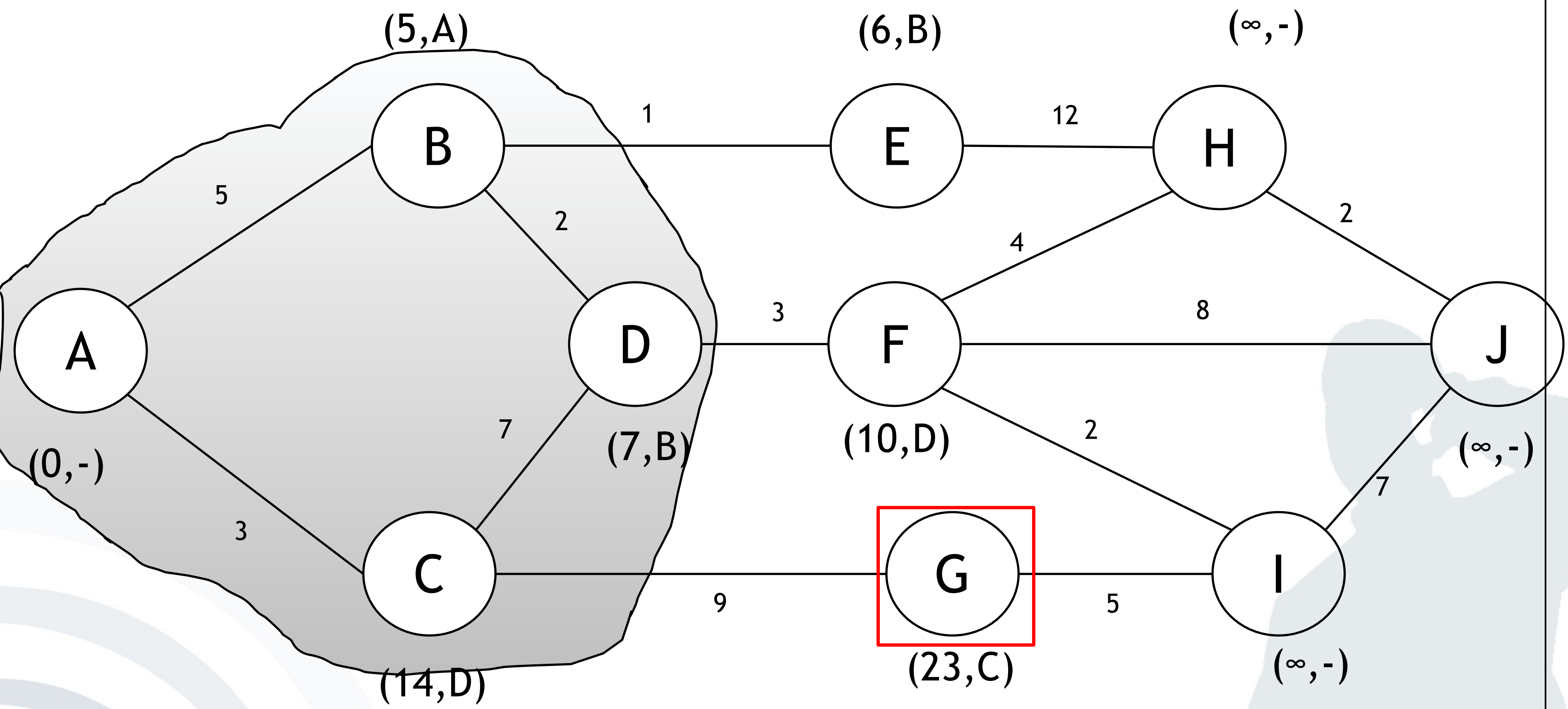
Solution: Dijkstra Algorithm



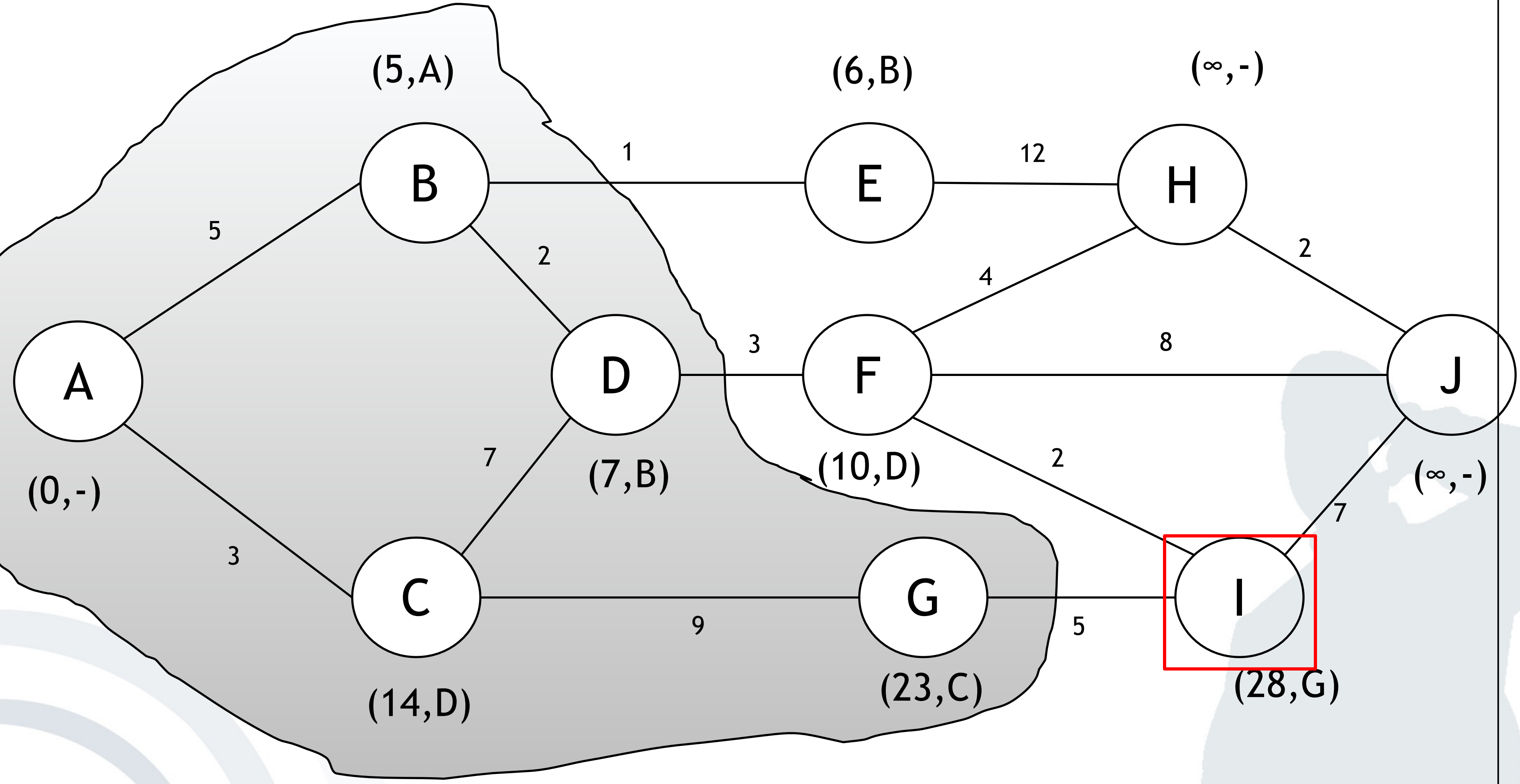
Solution: Dijkstra Algorithm



Solution: Dijkstra Algorithm



Solution: Dijkstra Algorithm



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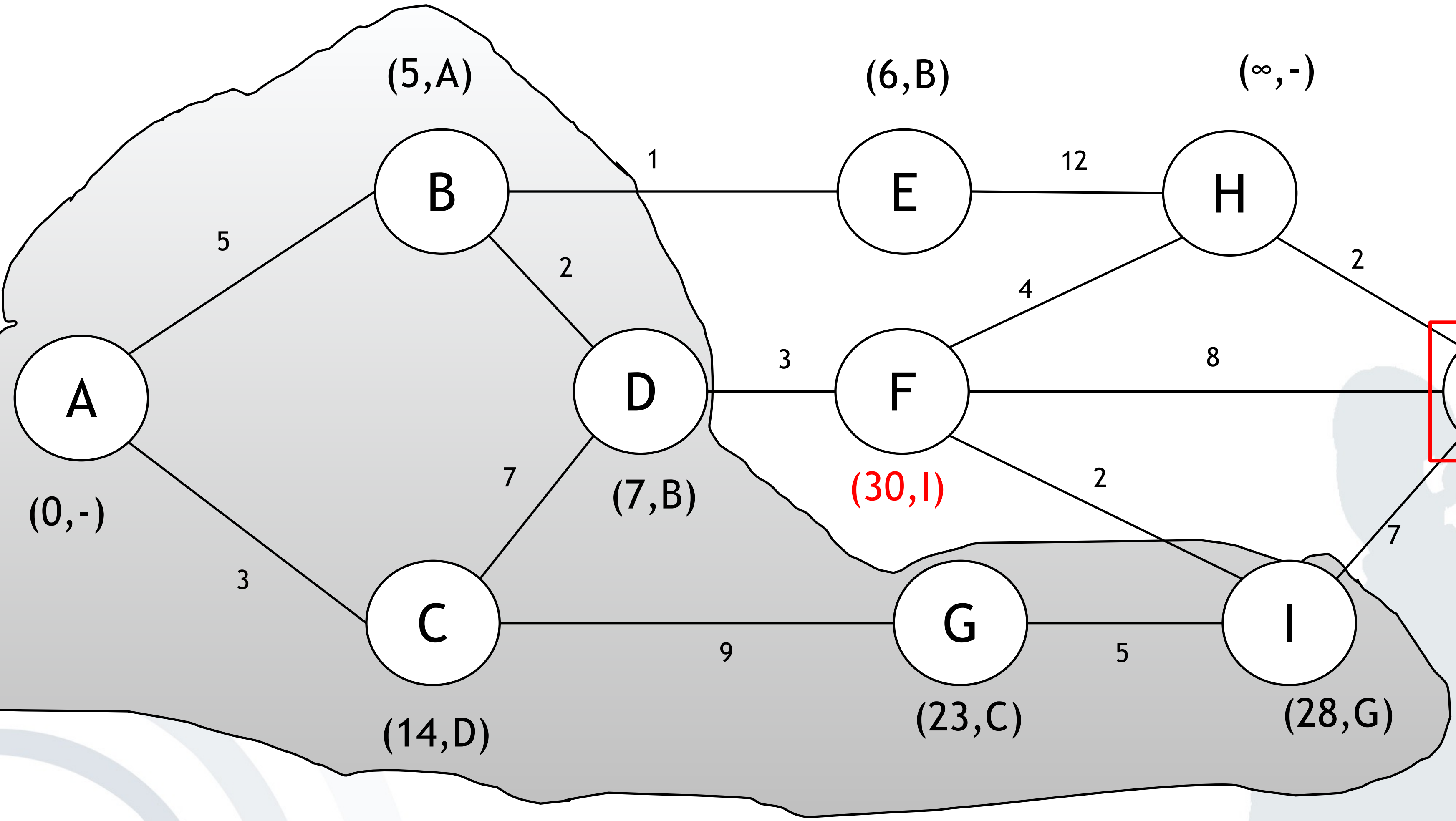

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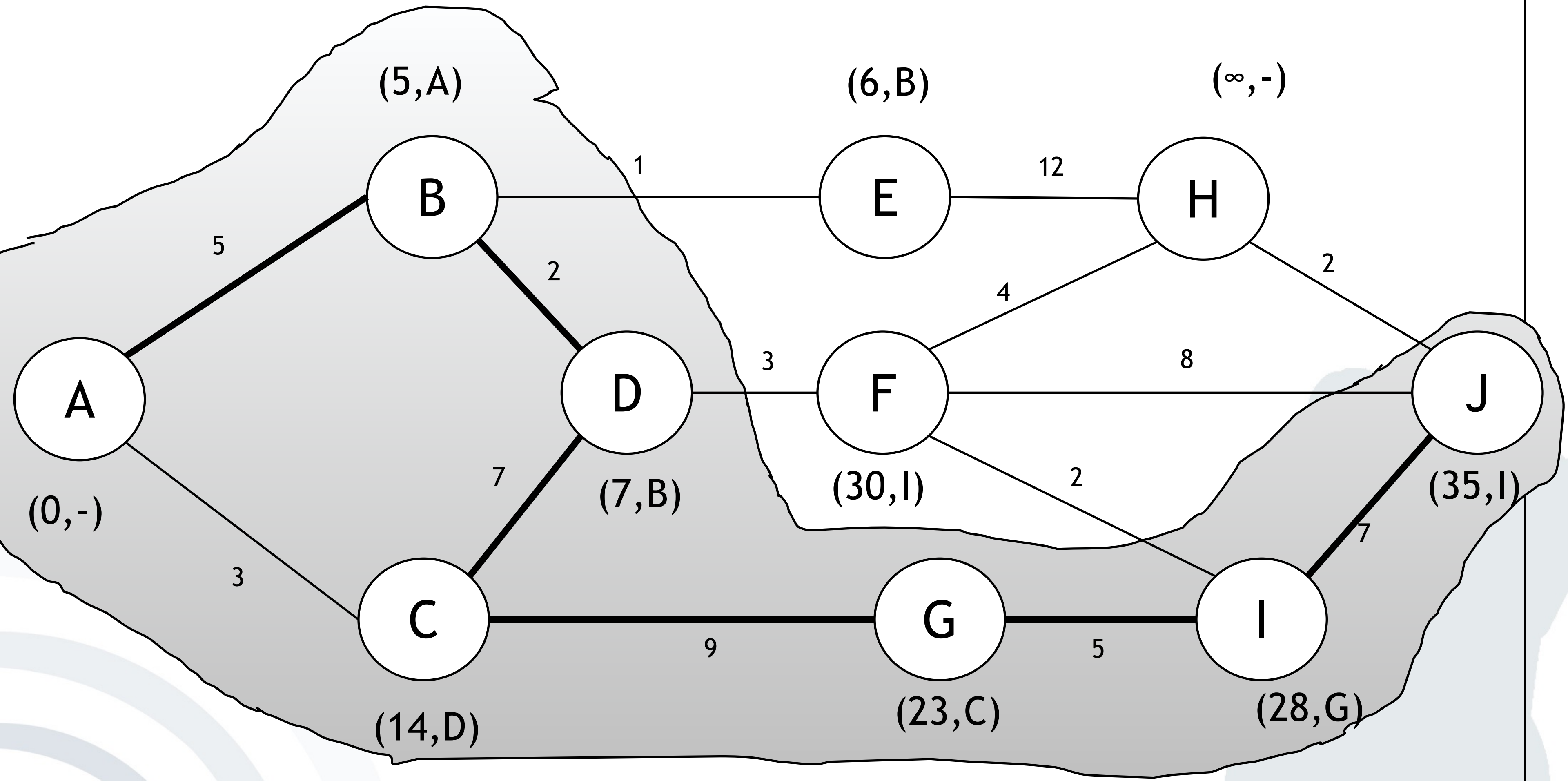


Best (longest?) path: A → B → D → C → G → I → J

Dijkstra Algorithm - Conclusion

→ Dijksta not created to find longest path – Possible that it does not find it

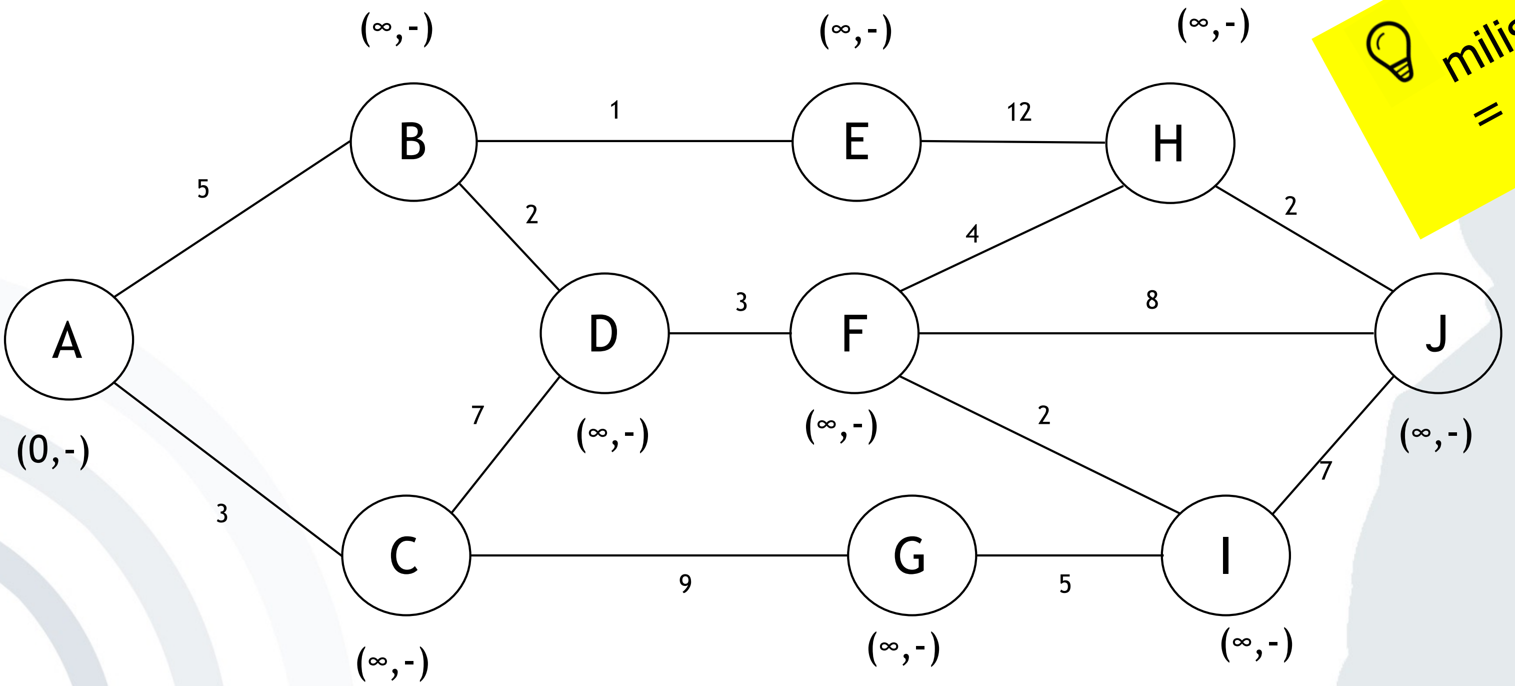
Now try to find the shortest path in the same graph:

Tips:

- Dijkstra only looks at neighbor knots of already visited knots
- Find nearest neighbor and visit it. Recalculate all paths to neighbor knots after each step. Repeat
- Brackets include the total length from starting point and the predecessor knot
- Shortest path can be found by looking at the predecessor knot in brackets, starting from the final knot

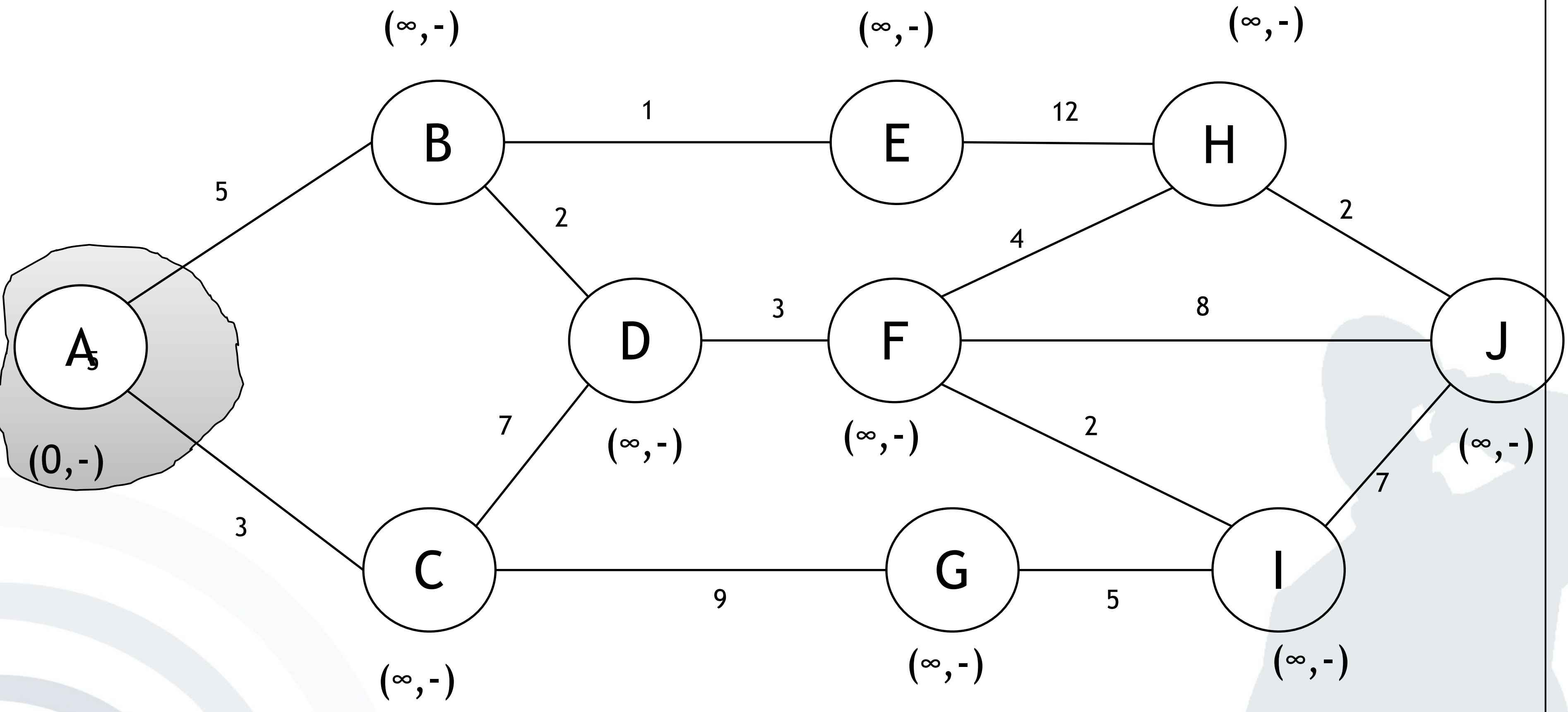
Exercise: Dijkstra Algorithm

- The following graphs shows the various systems a message from a place of interest needs to pass to get to the end user. Please calculate the fastest track. Note that lower case letters denote *system vertices* and the numbers the *miliseconds*.

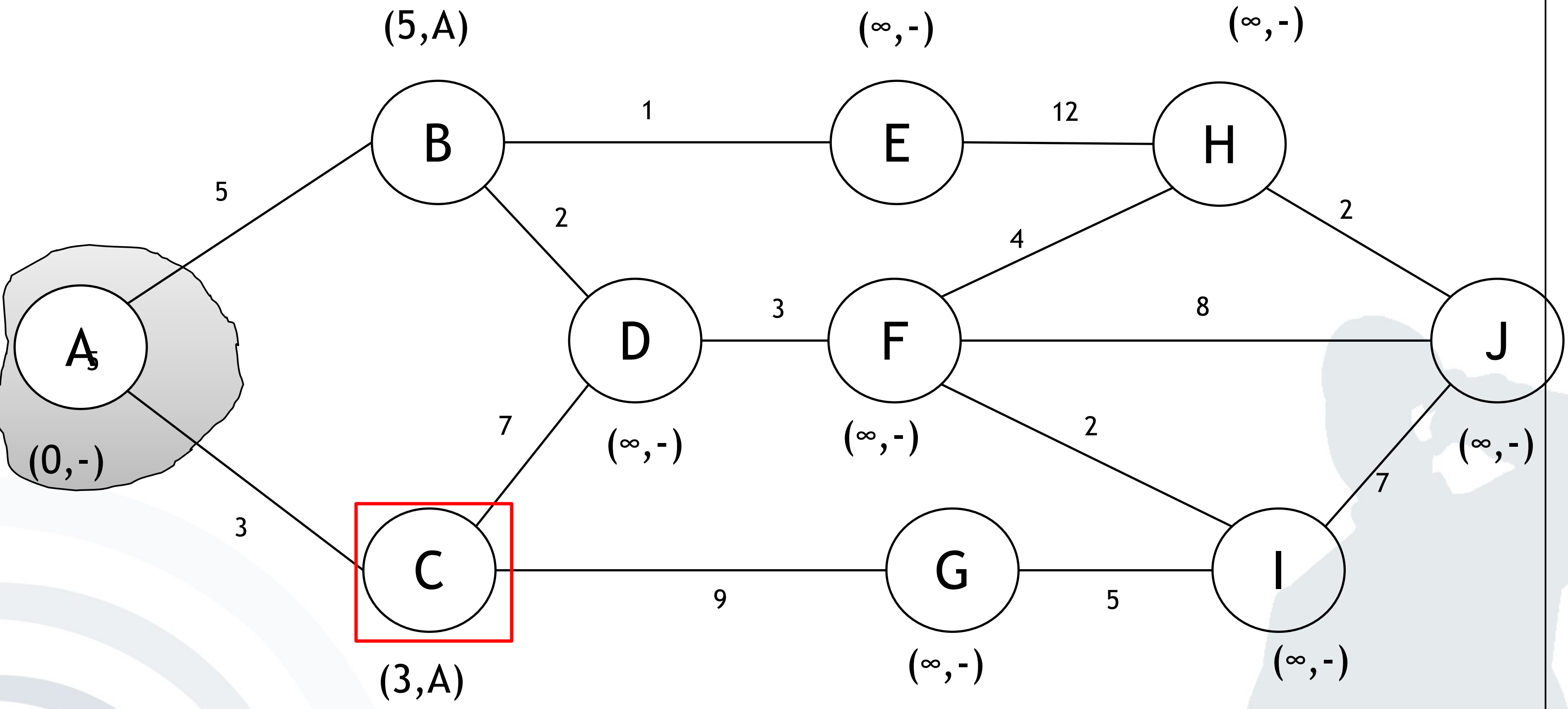


miliseconds: = shortest path

Solution – shortest path: Dijkstra Algorithm



Dijkstra Algorithm



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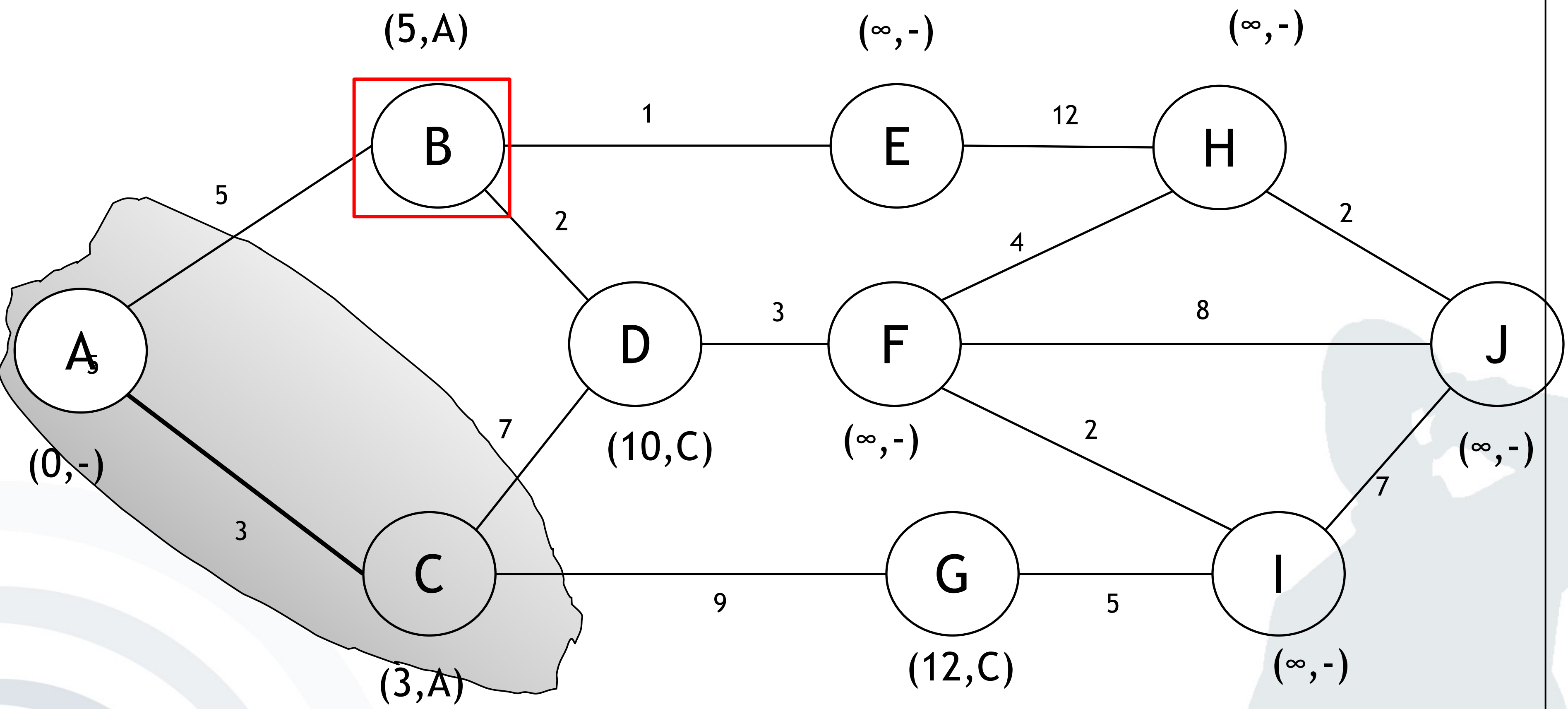

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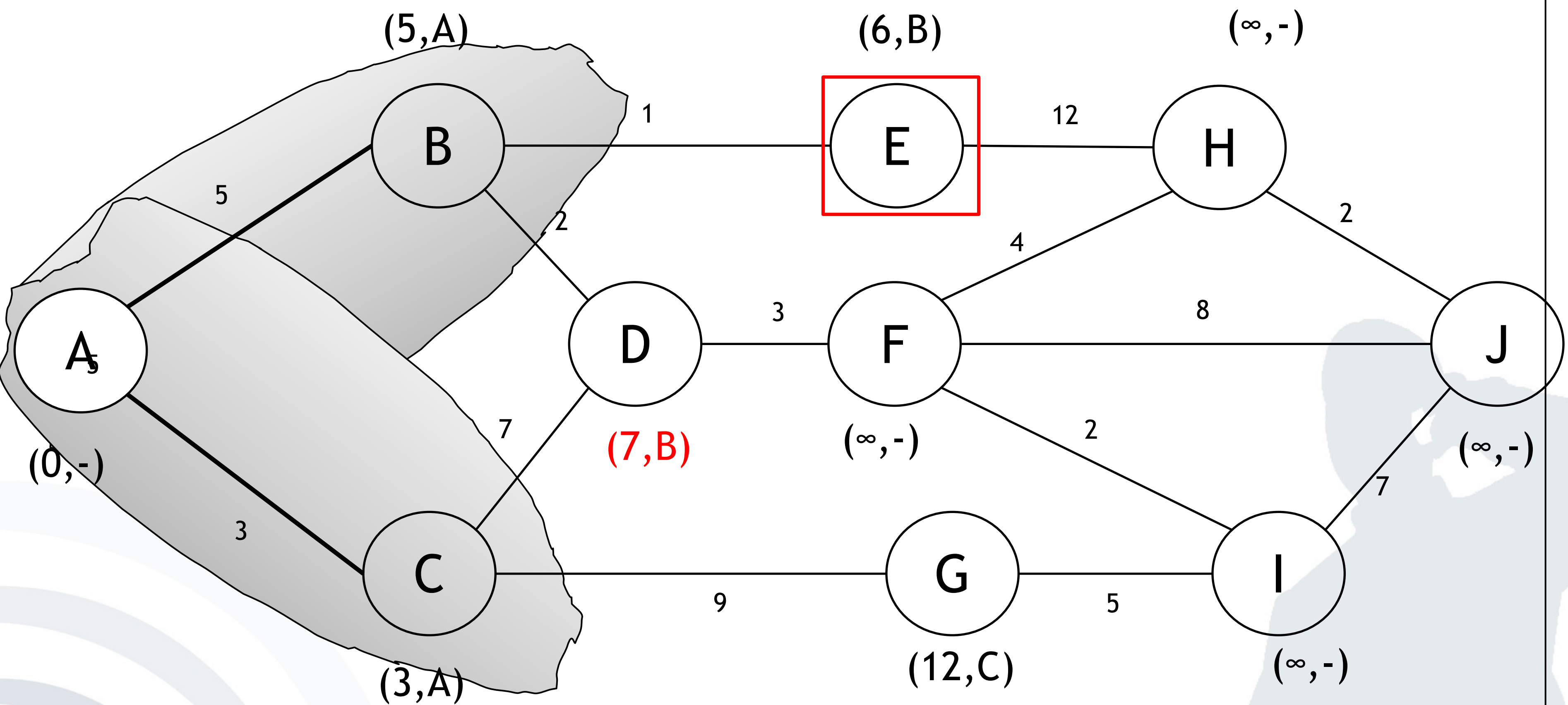

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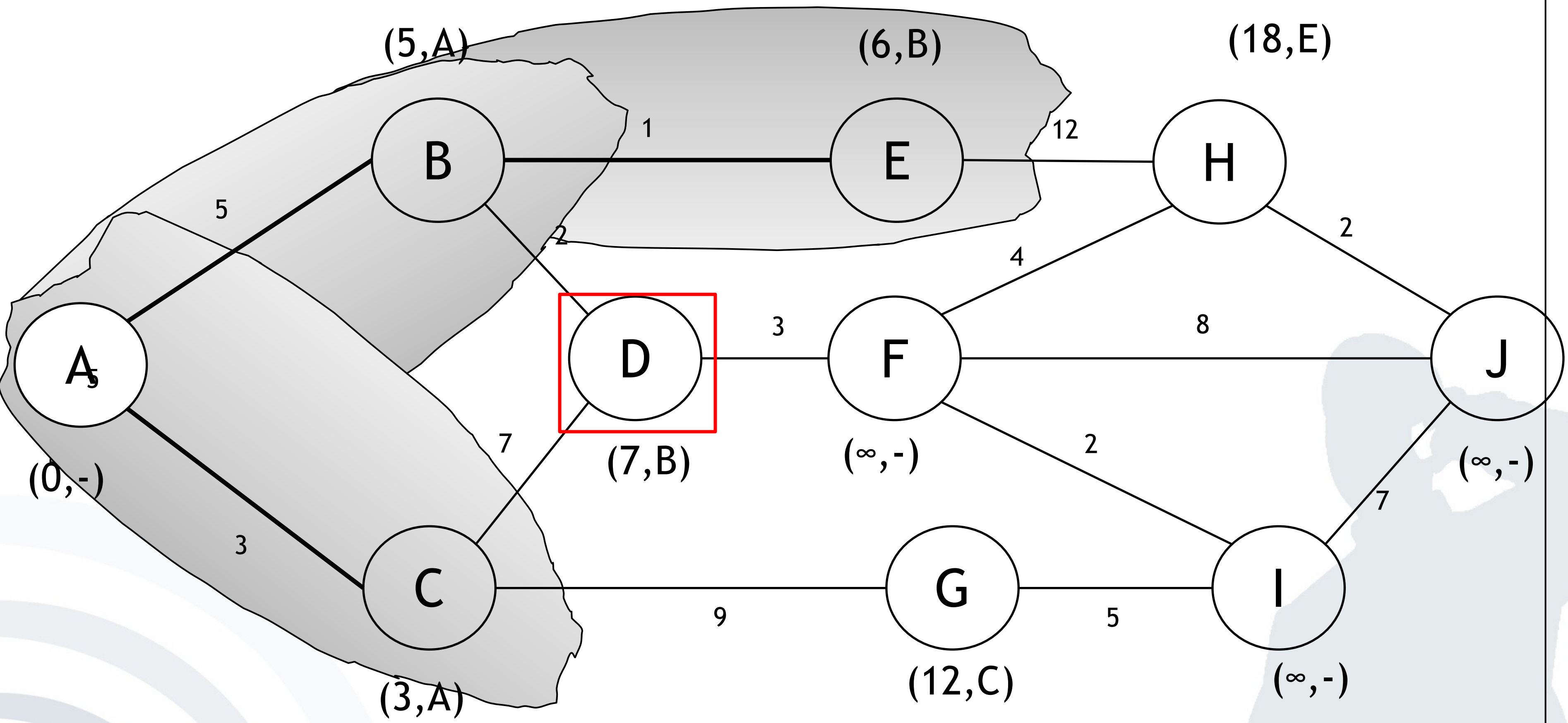

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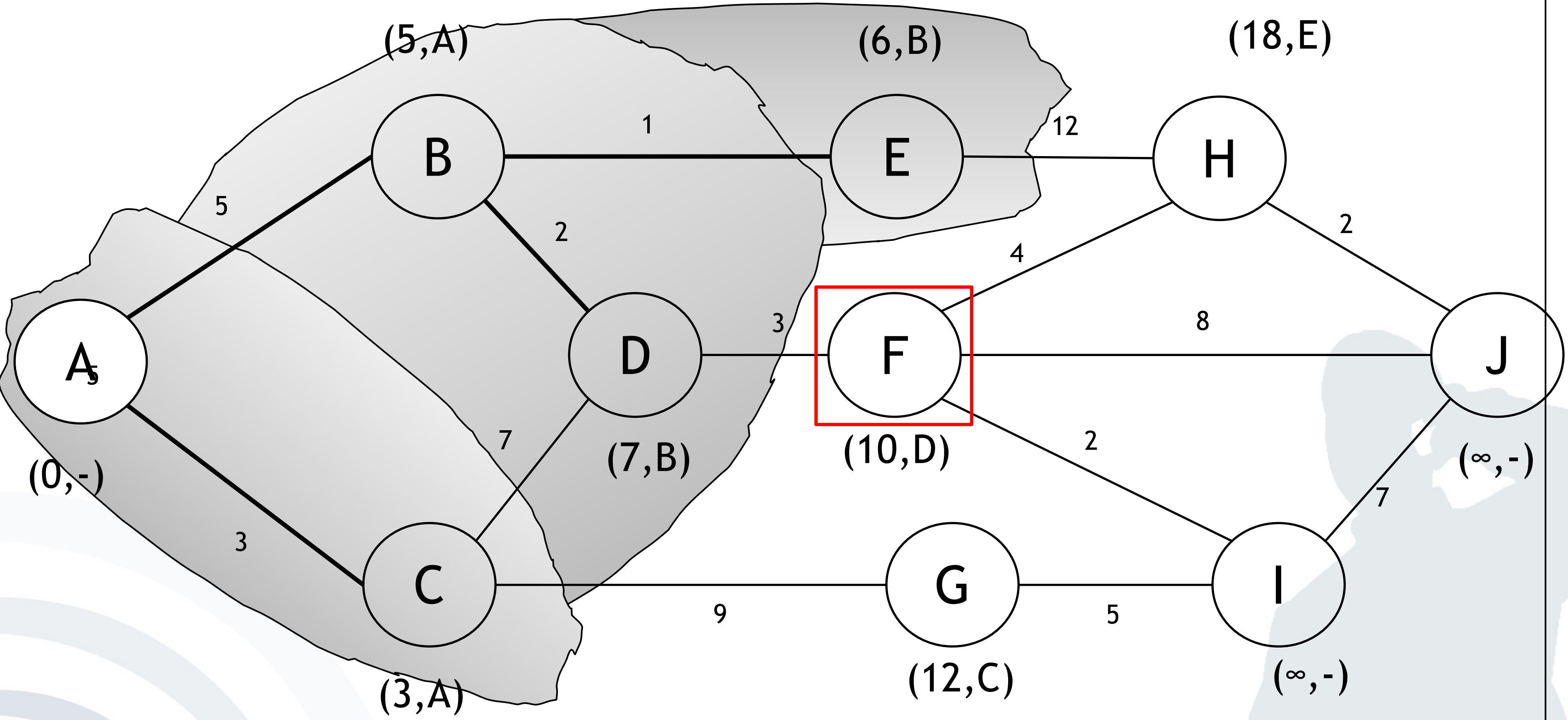

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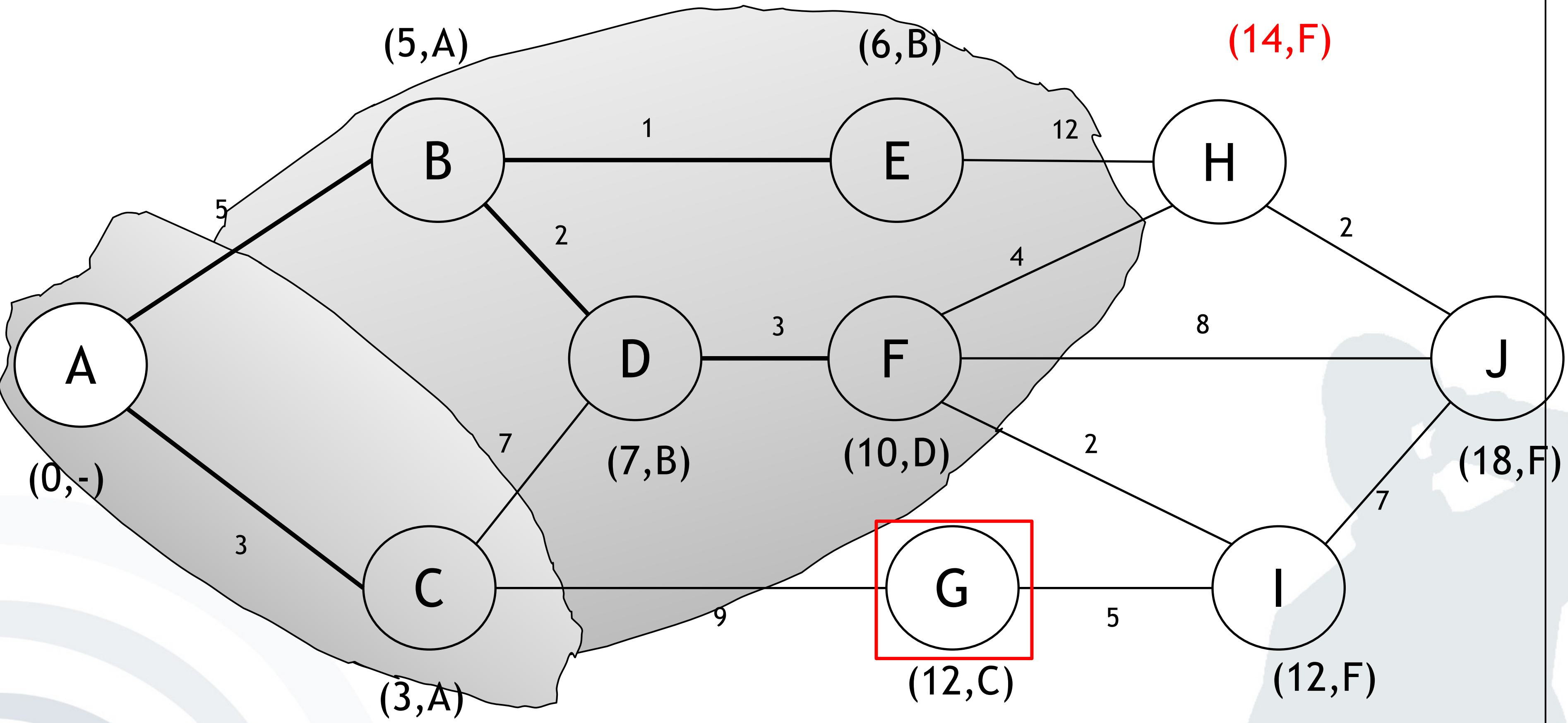

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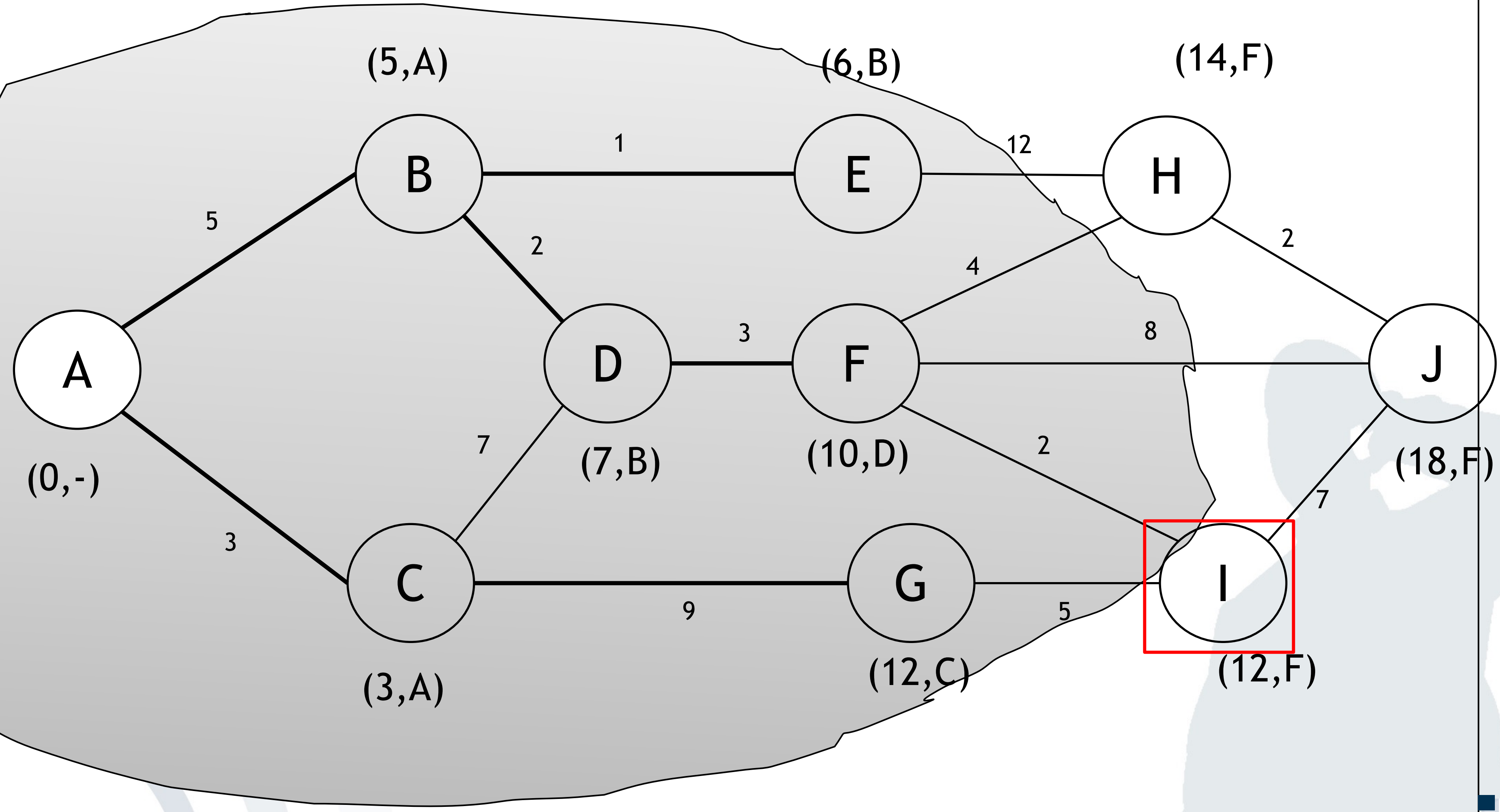

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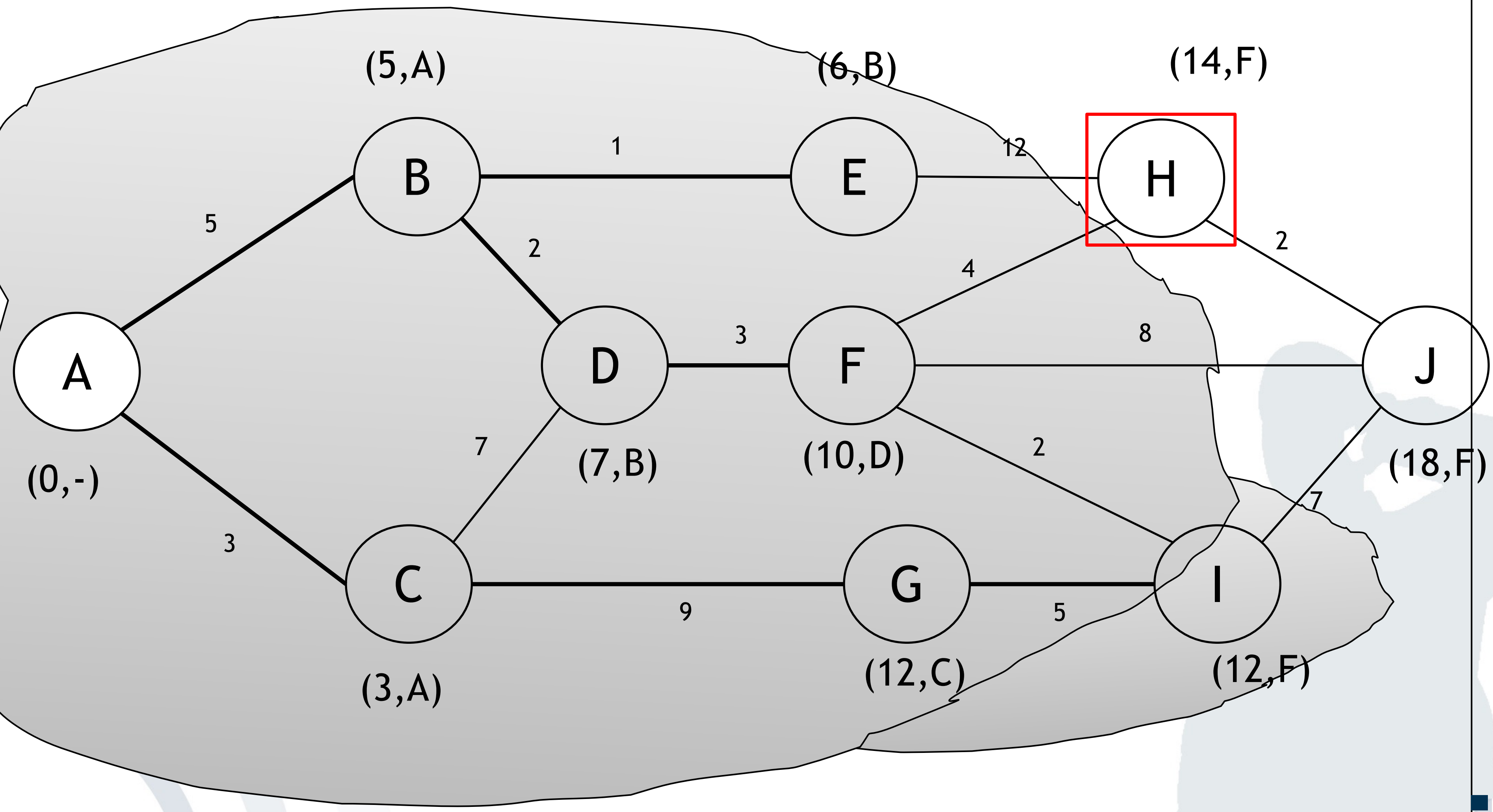

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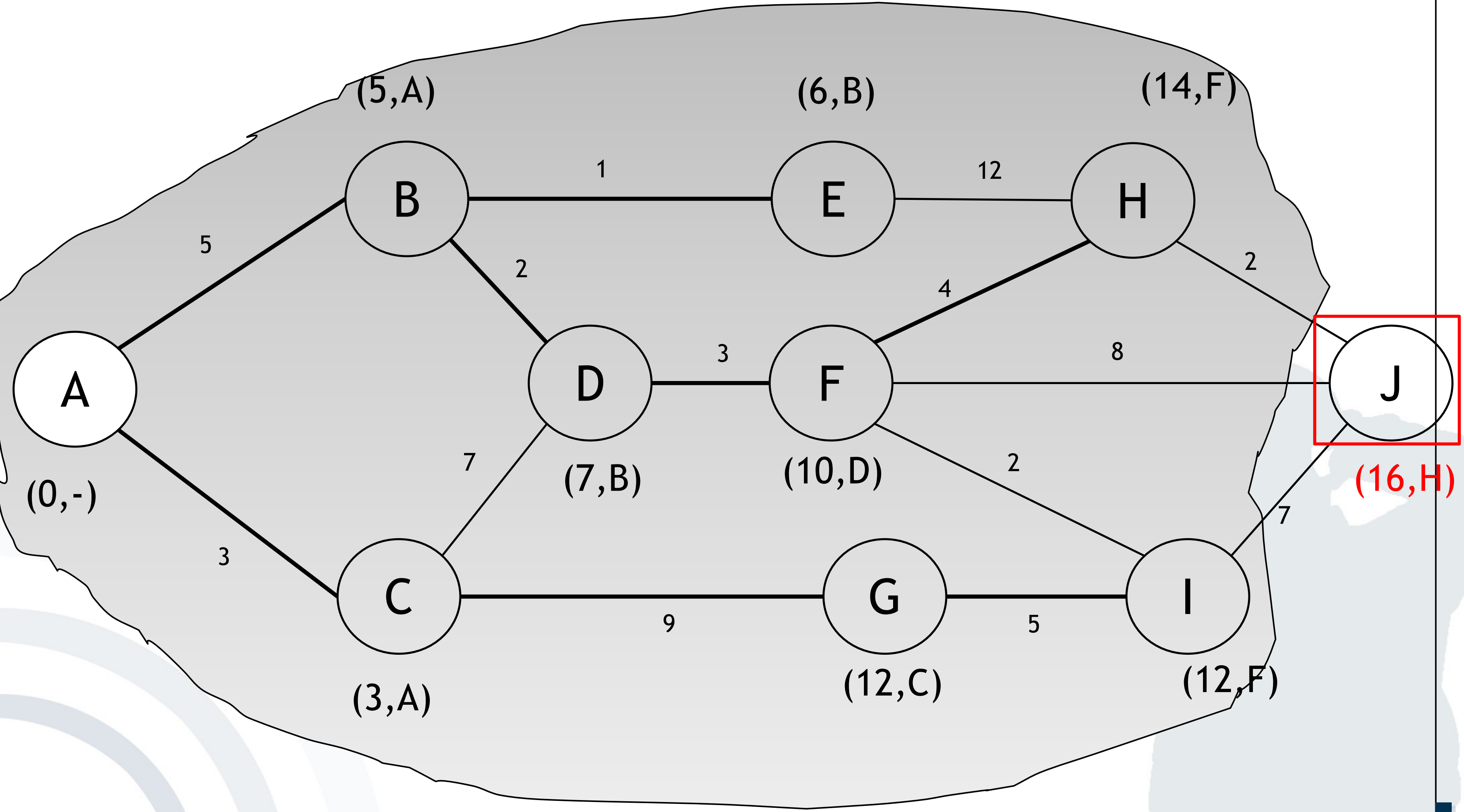

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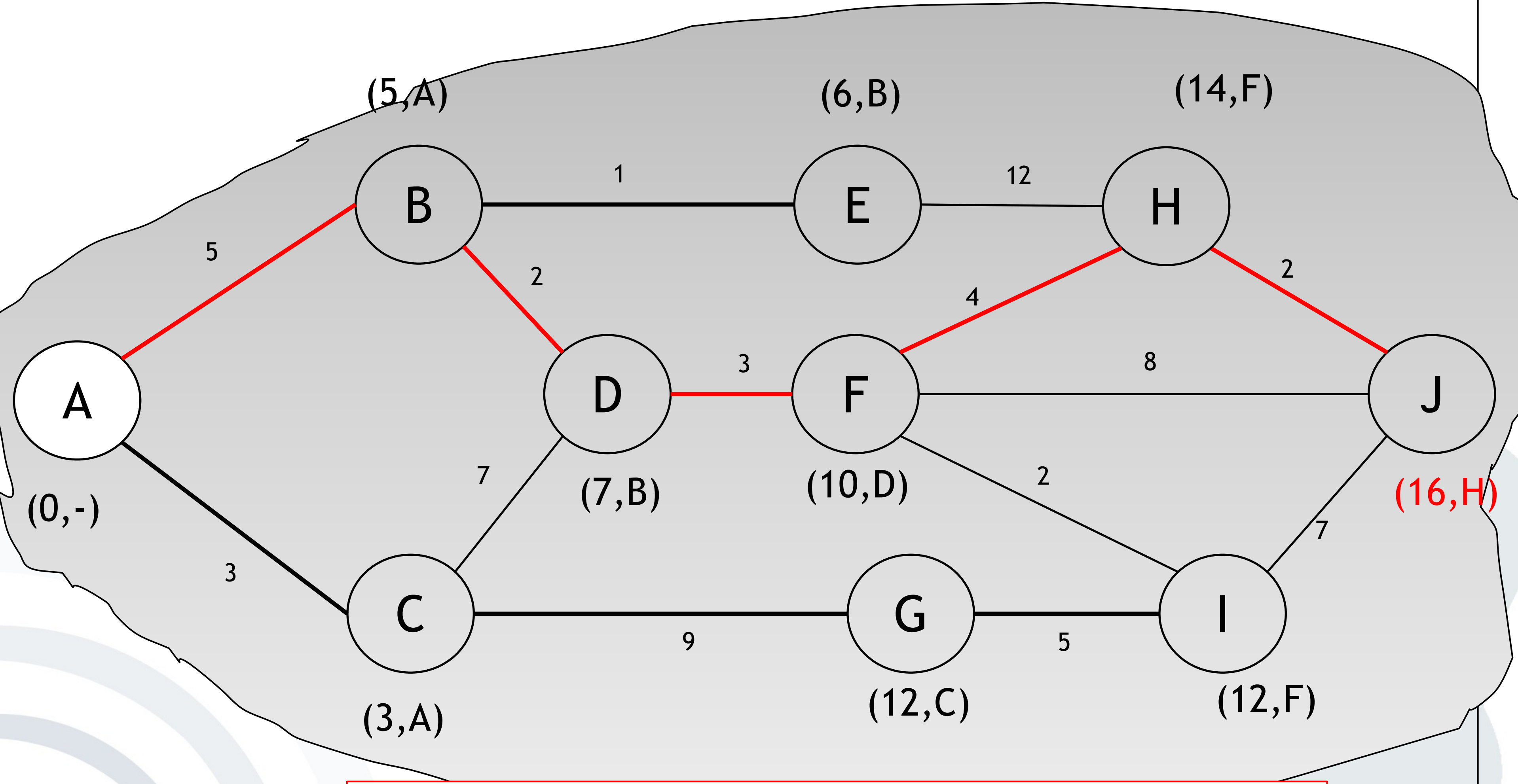


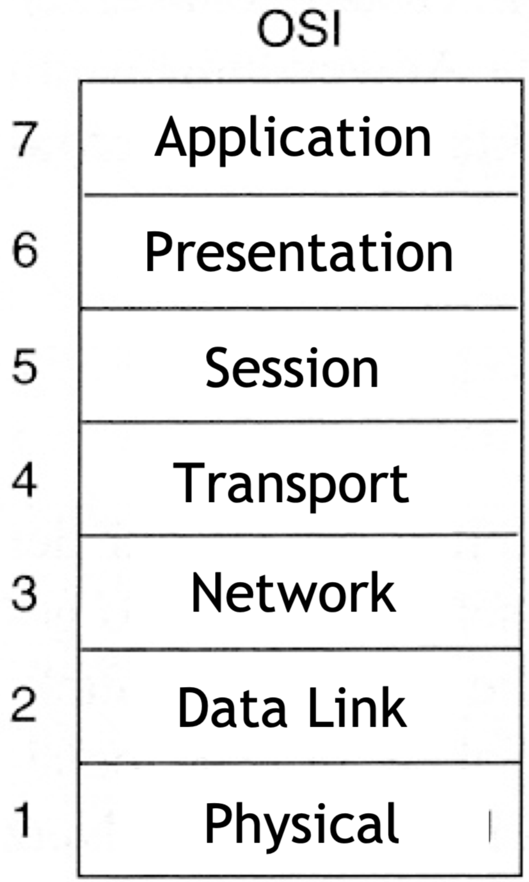
Shortest Path: A → B → D → F → H → J

Exercise: IPv6

- According to the ISO/OSI model, in which layer is the IP protocol?
- What is IPv6 and why do we need it?

- Should myPlace integrate IPv6? Why or why not? What does IPv6 mean with regard to user privacy?

Keywords for OSI reference model layers



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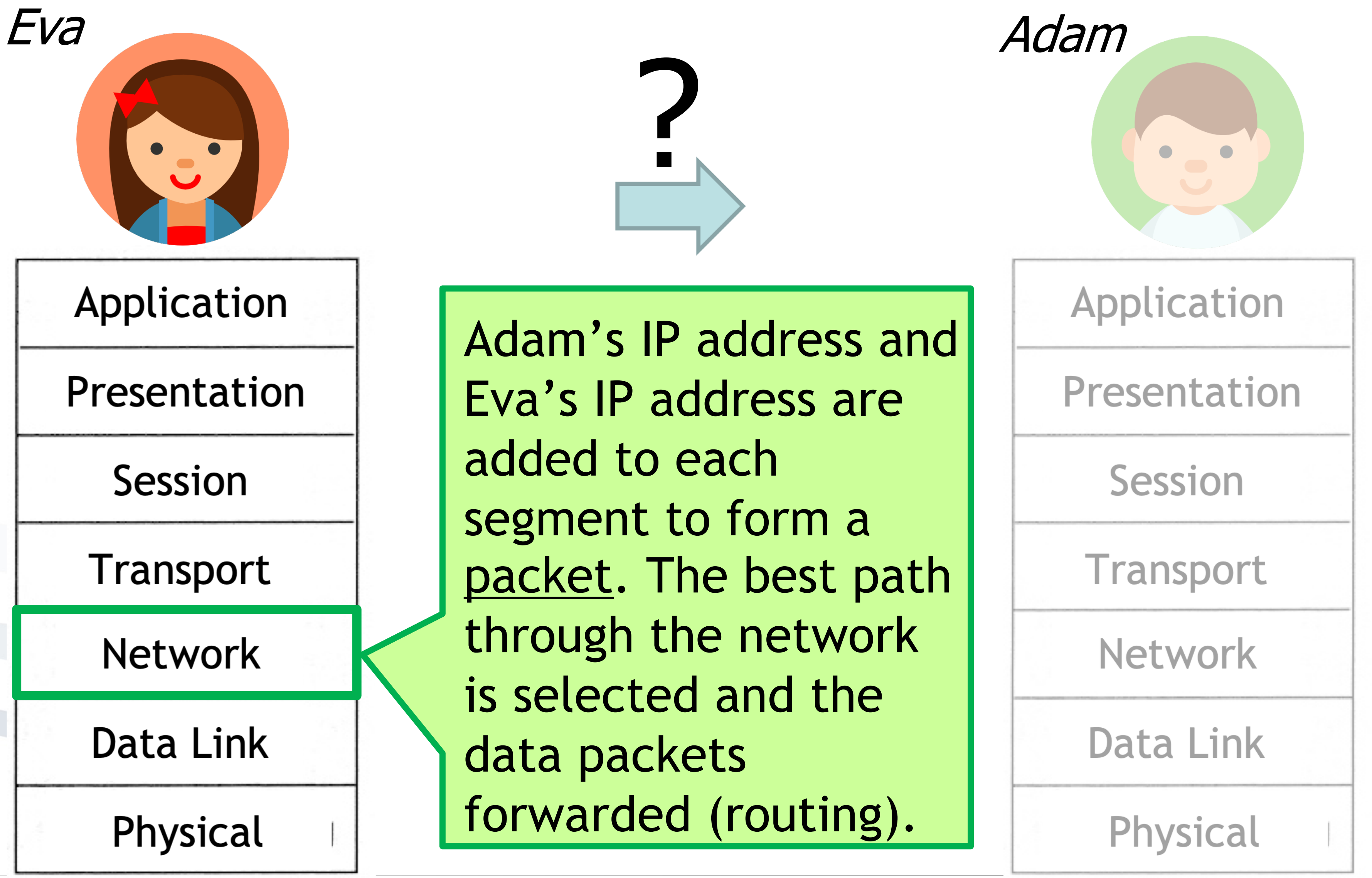
IPv6: Solution



Adam’s IP address and Eva’s IP address are added to each segment to form a packet. The best path through the network is selected and the data packets forwarded (routing).

IPv6: Background

- The task of the Internet Protocol (IP) is (cross-network) transportation of data packets from one sender to one receiver.
- Transmission is 1, packet-oriented 2, connectionless 3, not guaranteed.
- IP addressing
  - Every host and router on the internet has an IP address.
  - An IP address is unambiguous. Two computers cannot use the same (public) IP address at the same time.
- But: There are no more unallocated IPv4 Internet addresses left.

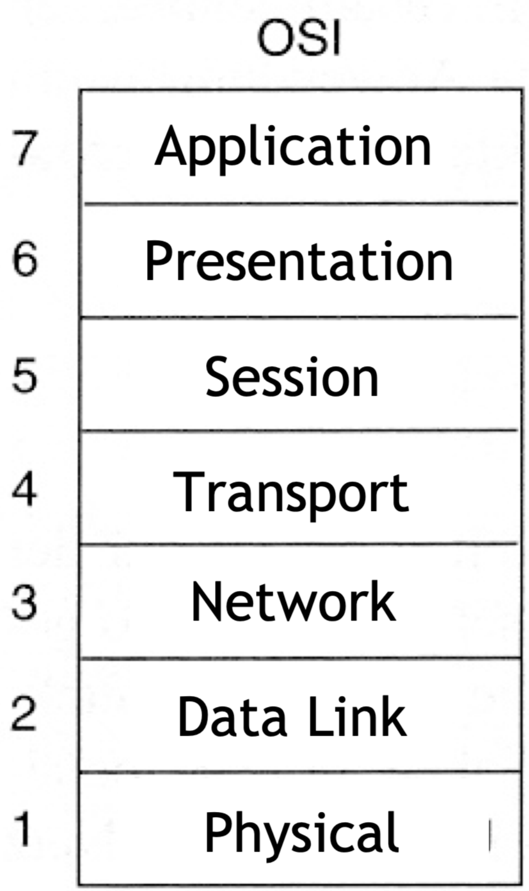
IPv6: Enhancements to IPv4

- Enhancements in IPv6
  - An IPv6 address consists of 128 bits (instead of 32 bits).
  - IPv6 addresses are not written in decimals (like e.g. 157.240.20.35 for facebook), but in **eight groups of four hexadecimal digits**, separated by colons (e.g. 485A:B722:0DEF:3188:CE45:651A:2134:E0F0).
  - The new IPv6 address space supports 2^{128} addresses = 340,282,366,920,938,463,463,374,607,431,768,211,456
  - IPv6 provides enough addresses in order to permanently assign a unique address to any existing internet device – worldwide.

Exercise: IP address vs. MAC address

- What is the difference between an IP and a MAC address?

Keywords for OSI reference model layers



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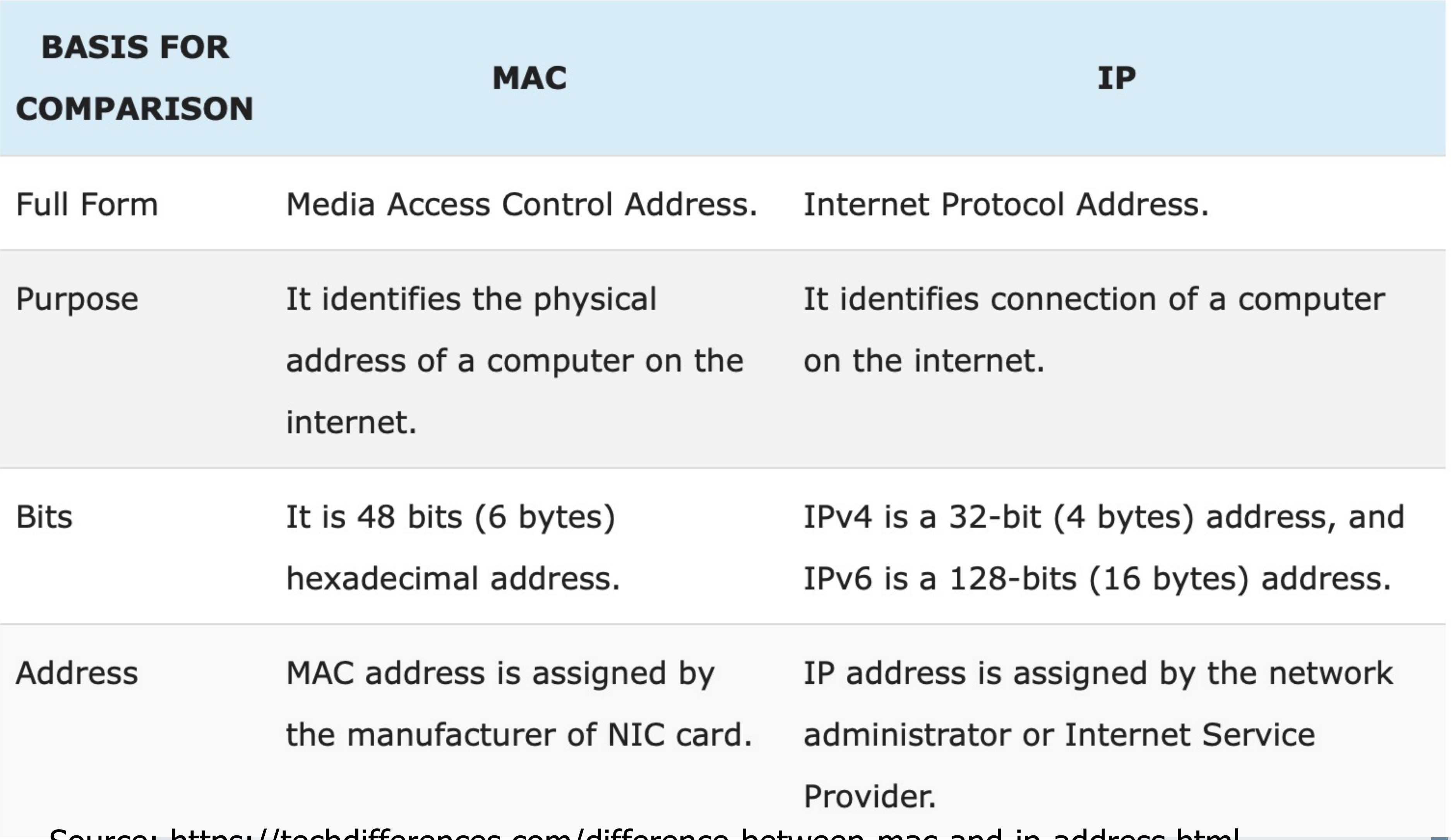
mobile business

IP address vs. MAC address



BASIS FOR COMPARISON	MAC	IP
Full Form	Media Access Control Address.	Internet Protocol Address.
Purpose	It identifies the physical address of a computer on the internet.	It identifies connection of a computer on the internet.
Bits	It is 48 bits (6 bytes) hexadecimal address.	IPv4 is a 32-bit (4 bytes) address, and IPv6 is a 128-bits (16 bytes) address.
Address	MAC address is assigned by the manufacturer of NIC card.	IP address is assigned by the network administrator or Internet Service Provider.

Source: https://techdifferences.com/difference-between-mac-and-ip-address.html

Agenda

- Exercise 1: OSI reference model
- Exercise 2: Fixed Networks
- Exercise 3: Wireless Local Area Networks
- Exercise 4: Bluetooth and NFC

Exercise: Wired Communication

- What are the main challenges in wired communication and why?

Wired Communication

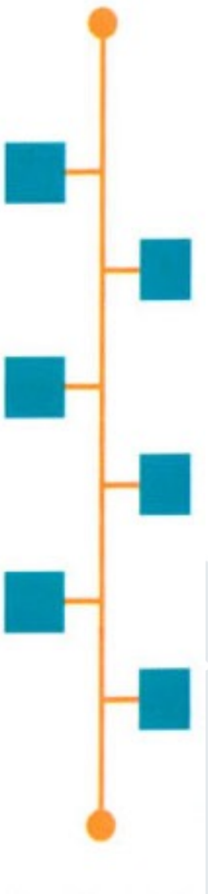
- Wired communication denotes data transmission using physical wires, e.g. for
  - Telephone networks
  - Cable television/Internet access
  - Fiber-optic networks
- Main challenges in wired communication
  - Coping with the distance between two endpoints
  - Provision of the appropriate bandwidth

Exercise :Topologies

- Name three different types of topologies and expose their advantages and disadvantages.

Topologies

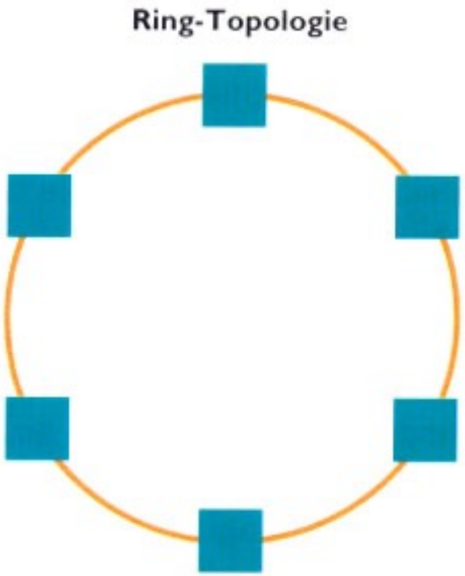
- Bus Topology
  - Low cost
  - Easy and low cost setup and extension
  - Difficult to find errors



Bus-Topologie

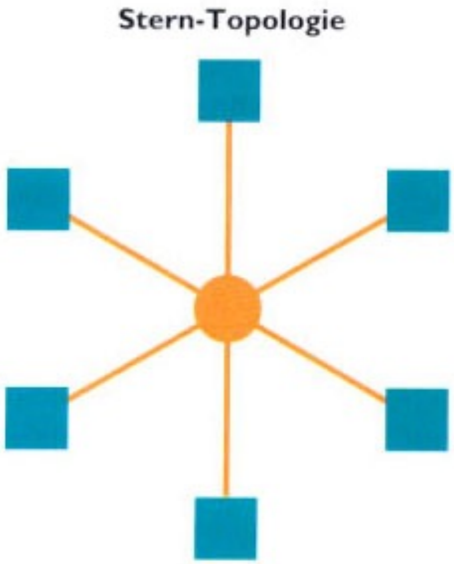
Topologies

- Ring Topology
  - No single point of failure
  - Slow if one way is broken



Topologies

- Star Topology
  - Single point of failure, but only at the central node
  - Easy setup & troubleshooting



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Exercise: Wireless Local Area Networks (Wi-Fi)

- Name a secure method for the encryption of Wireless Local Area Networks (Wi-Fi).
- Why is Wi-Fi encryption important? What could be the potential consequences for users failing to enable encryption for their Wi-Fi network?

Wi-Fi

- Wi-Fi Protected Access (WPA):
  - WPA is outdated and insecure (e.g. vulnerability to dictionary attacks)
  - WPA2/3 is secure as it employs the Advanced Encryption Standard (AES)
- Consequences of unsecure Wi-Fi:
  - Data can be extracted
  - Internet access can be used by other for free and illegal activities like file sharing
  - Phone can be misused
  - …

Wi-Fi

- Man-In-The-Middle Attack
  - Attacker between the communication parties and he has the full control of the data traffic
- Eavesdrop and manipulation of data traffic
  - Passwords, data, personal information
- DNS manipulation, malware
  - E.g. Redirect online banking to a phishing site
- Snarfing (fake wlan access point)

Wireless Local Area Networks (Wi-Fi)

- What could be the potential harm if the data communication of the myPlace service is not encrypted?
- Name at least one consequence respectively for the service and the user.

Wi-Fi (myPlace)

- Eavesdropping on communication
- Redirection to a manipulated service is possible
- Mobile user’s perspective:
  - Passwords can be stolen and an attacker can slip into the corresponding identity
- myPlace’s perspective
  - Unsecure services results in image loss
  - Suit for violating the legal framework

Agenda

- Exercise 1: OSI reference model
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- Exercise 4: Bluetooth and NFC

Exercise: Bluetooth and NFC

- What is Bluetooth and what is NFC? Where is the difference between them?

Bluetooth

- Bluetooth is a wireless technology standard for data exchange using small ad-hoc networks called “personal area networks” (PANs)
  - Devices such as laptops, mobile phones, printers, headsets and other periphery-devices can establish a connection.
  - Simple and cheap possibility to set up ad-hoc networks of limited range (up to 10 meters) for spontaneous data exchange
  - Technical specifications for Bluetooth were developed by the Bluetooth Special Interest Group (SIG).
  - Findings were added to the IEEE 802.15 standard.

Source: Wiegleb, M. (2005)

Near Field Communication (NFC)

- NFC is a short-range (< 4 cm) wireless technology
  - Communication mode of a device can be active or passive
  - Magnetic induction between two loop antennas
  - Application domains
    - Mobile payment / mobile wallet
    - Mobile marketing (e.g. redemption of digital coupons)
    - Mobile ticketing
    - Access control (e.g. e-Key)
    - Mobile data user exchange
    - ...

Source: techtickerblog.com (2011)

Components of the Course

Introduction to layer-based Communications ✓

Fixed Networks ✓

Wireless Networks ✓

mobile business

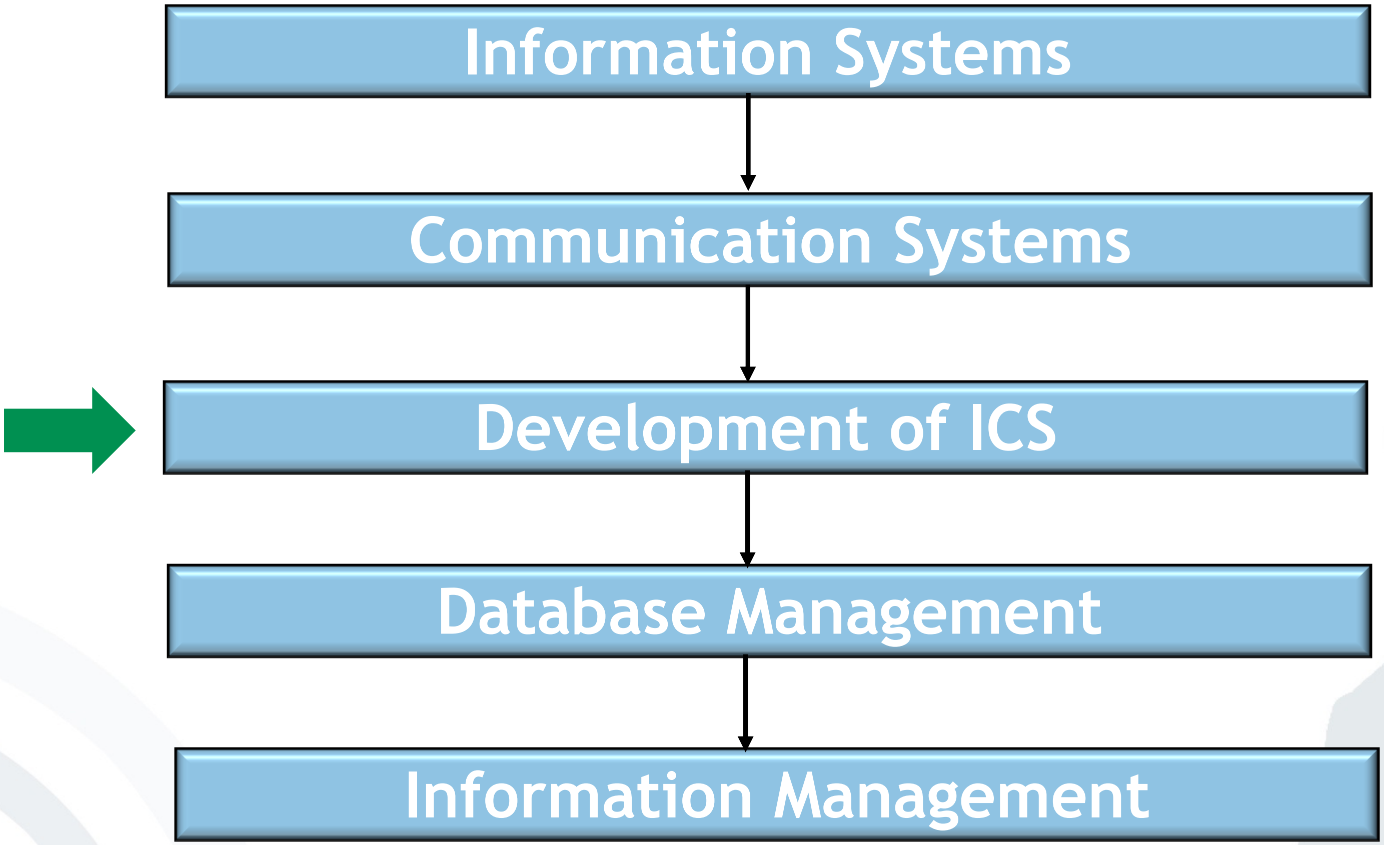
Looking back at Communication Systems I & II

By now you should:

- Know the principles of layer based communication
- Know the layers of the ISO/OSI reference model and their particularities (focus on layer 2, 3, 4 and 7)
- Be able to apply the Dijkstra algorithm
- Understand the principles of fixed Networks
- Understand the principles of wireless communication

→ Apply your knowledge!

Next Mentorium



Information Systems

Communication Systems

Development of ICS

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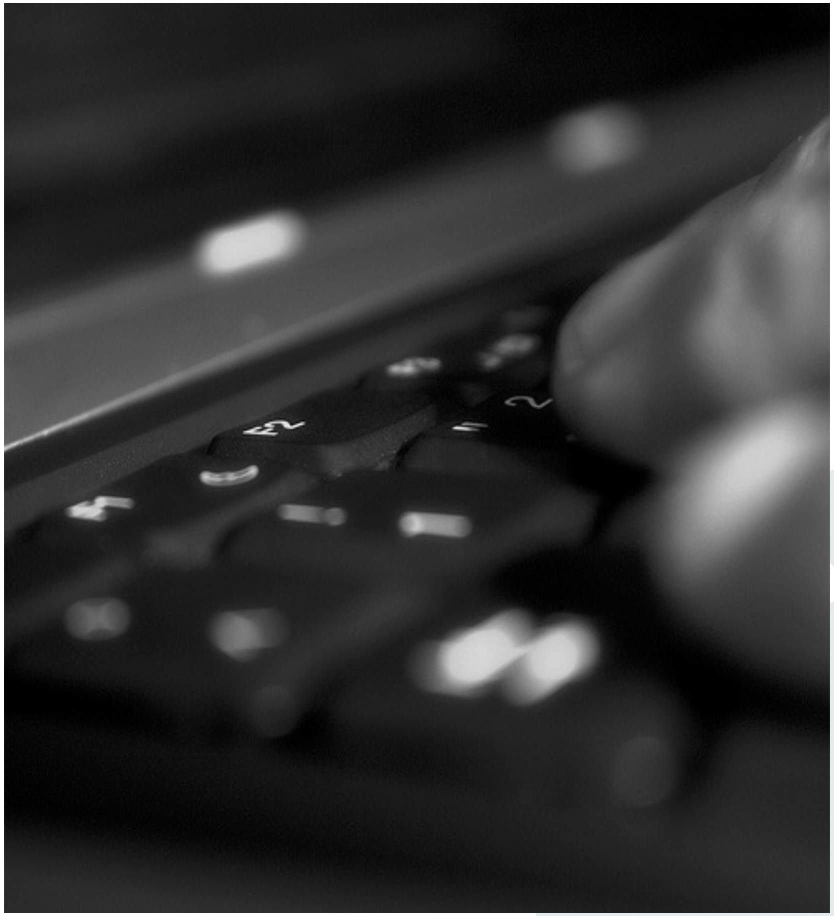
Information Management

Thank you!



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