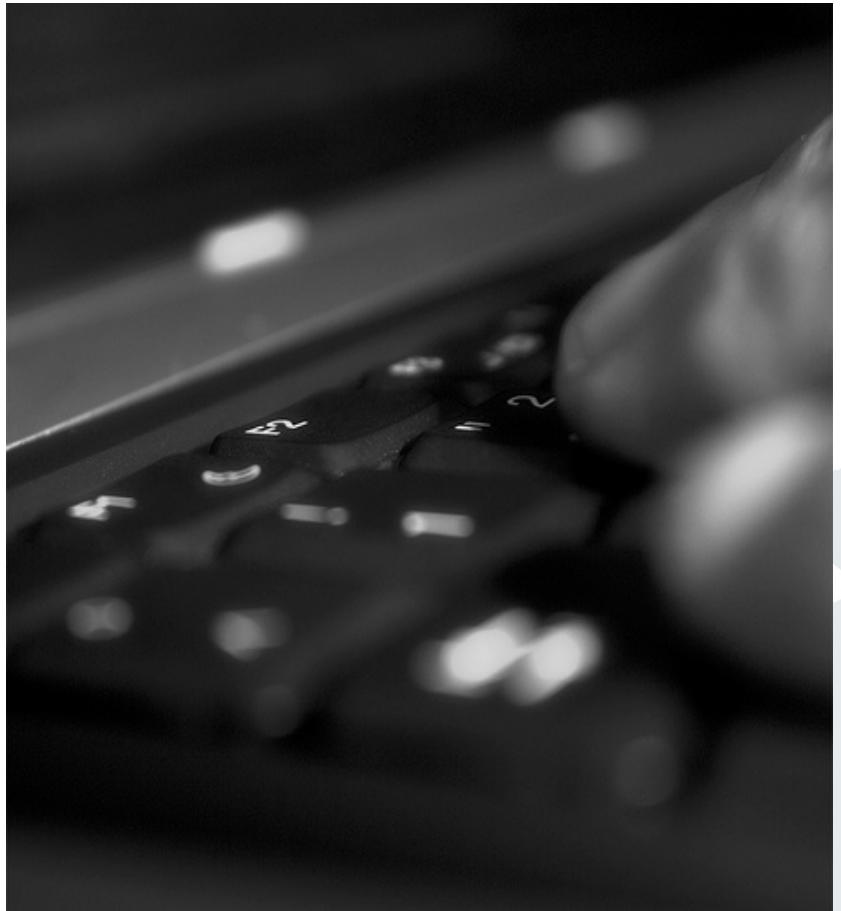


Mentorium 3  
Business Informatics 2 (PWIN)

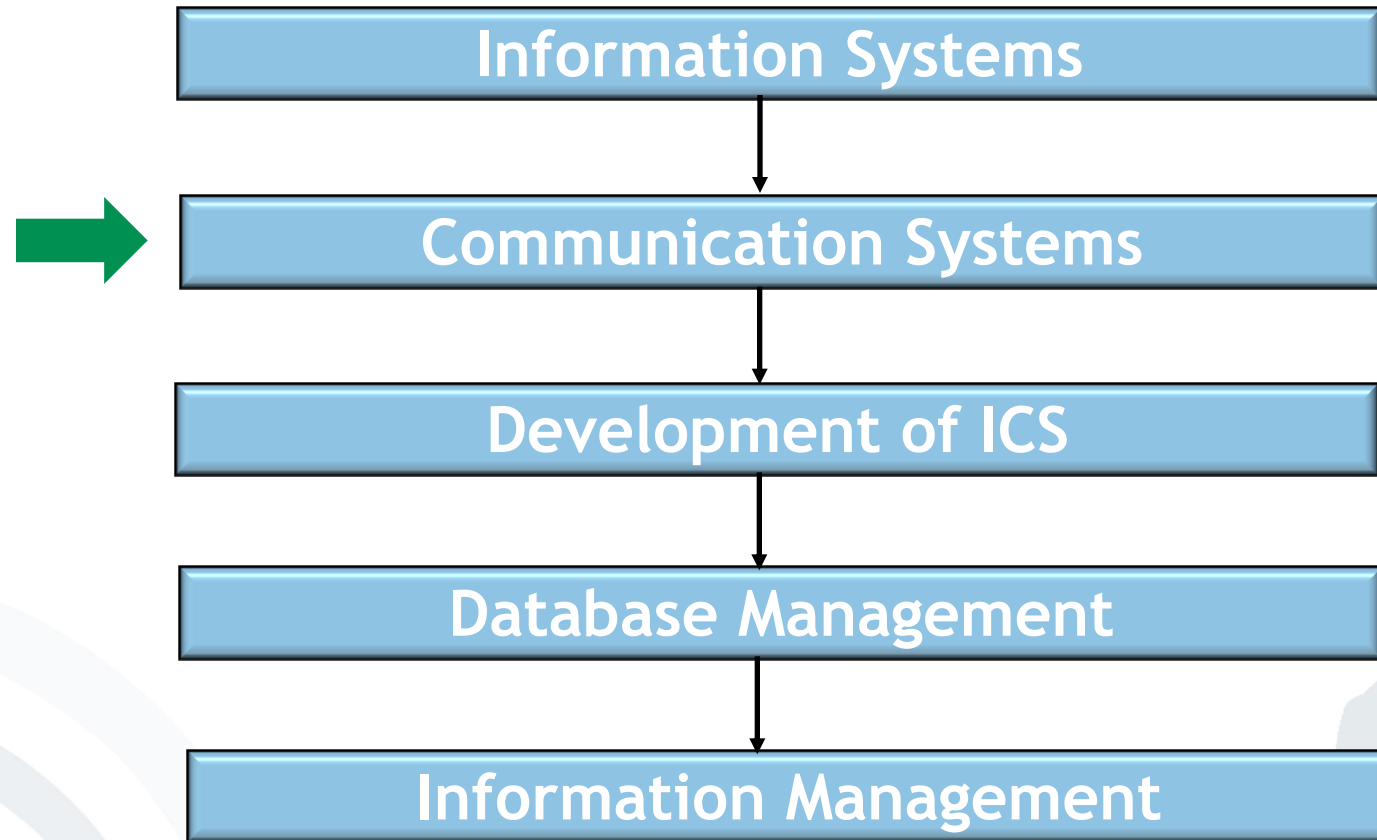
Communication Systems I & II

WS 2019

Frédéric Tronnier  
[www.m-chair.de](http://www.m-chair.de)



Jenser (Flickr.com)



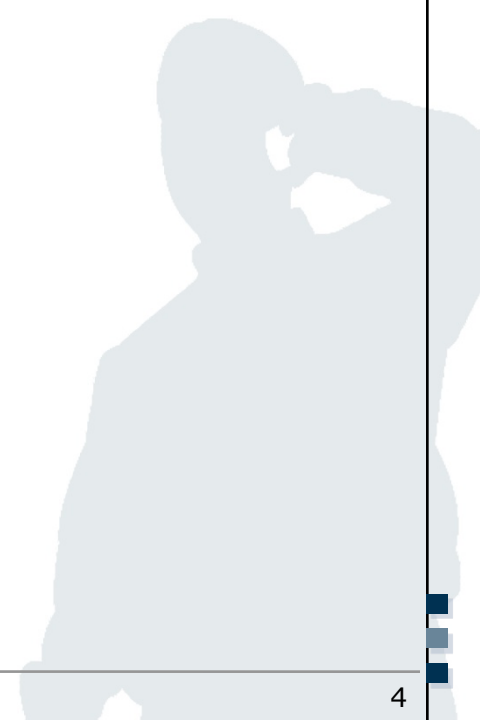
# Components of the Course

Introduction to layer-based Communications

Fixed Networks

Wireless Networks

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





- 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?

## OSI

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

Data in/output - DNS, http, email

Binary

Check-point

TCP (3 way handshake), UDP

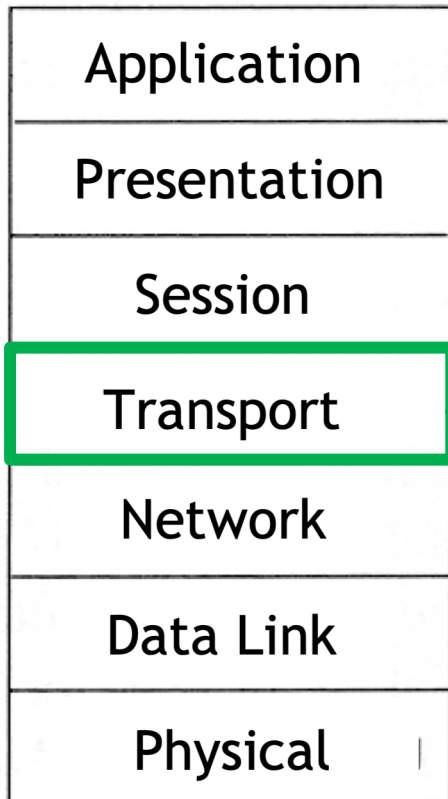
Routing, IP address

MAC

LAN cable, optical fibre, air, etc.

## Exercise 2b): Solution

*Eva*



*Adam*



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.

- 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

## ■ Properties of TCP

### ■ Reliable

- Data communication is repeated until the remote station acknowledges the receipt.

### ■ Connection-oriented

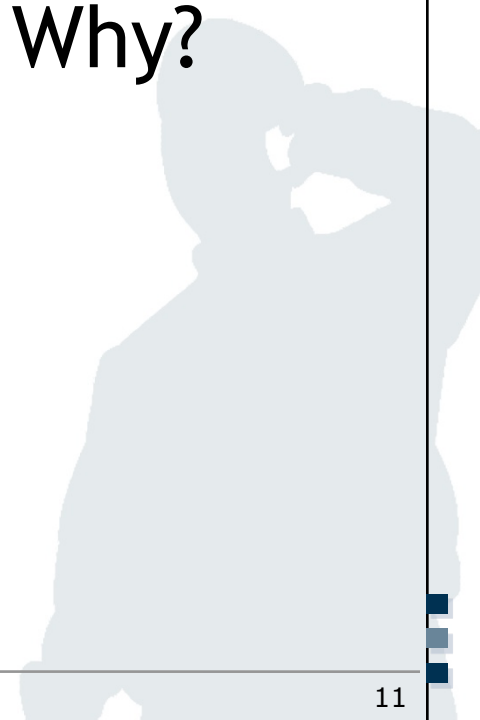
- Before the actual data transfer begins, during setup of a TCP connection by 3-way handshake, a logical end-to-end connection between sender and receiver is established.

### ■ Makes it possible to send information directly to an application (ports).

- 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

- 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.

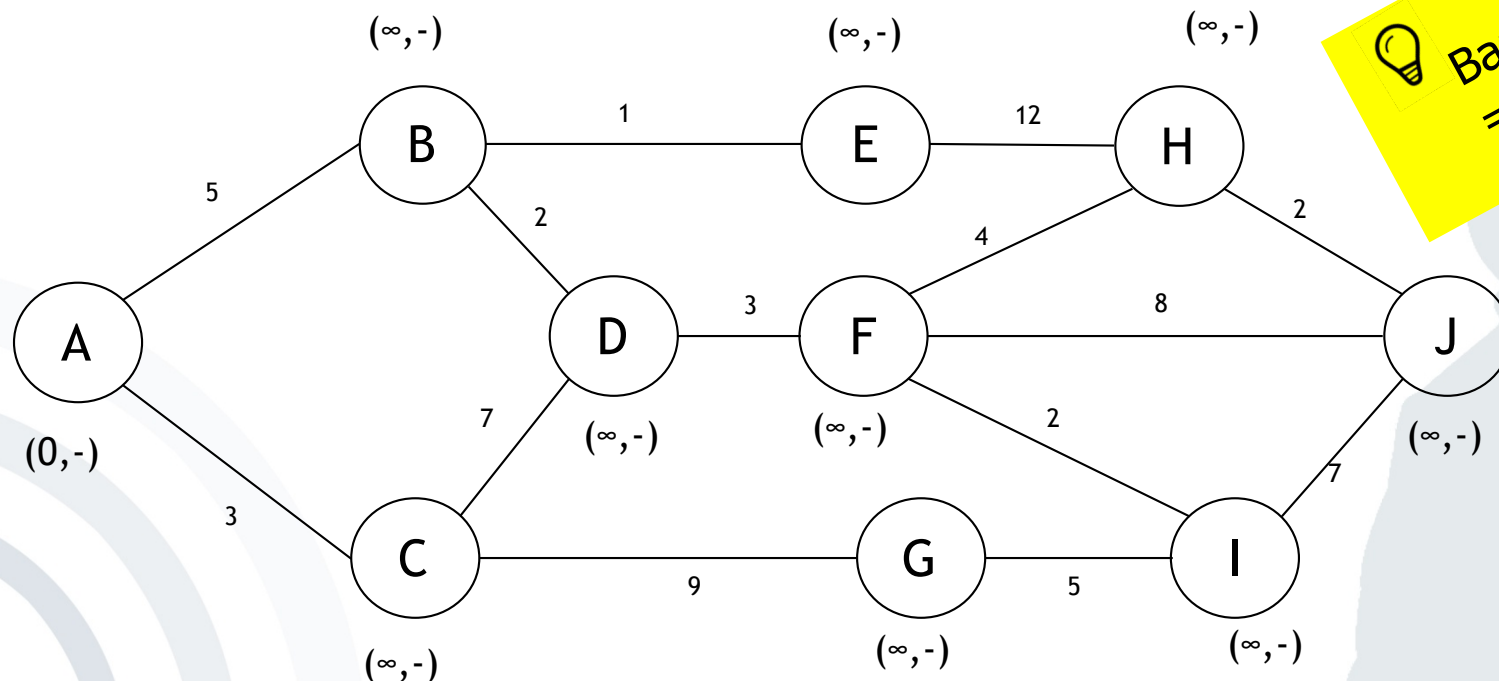
1. Prof. Rannenberg sends a message to Prof. König to suggest an appointment date.
2. Prof. König confirms the appointment date by sending a message back to Prof. Rannenberg.
3. Prof. Rannenberg sends a message to Prof. König to let him know that he received the confirmation message.

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.



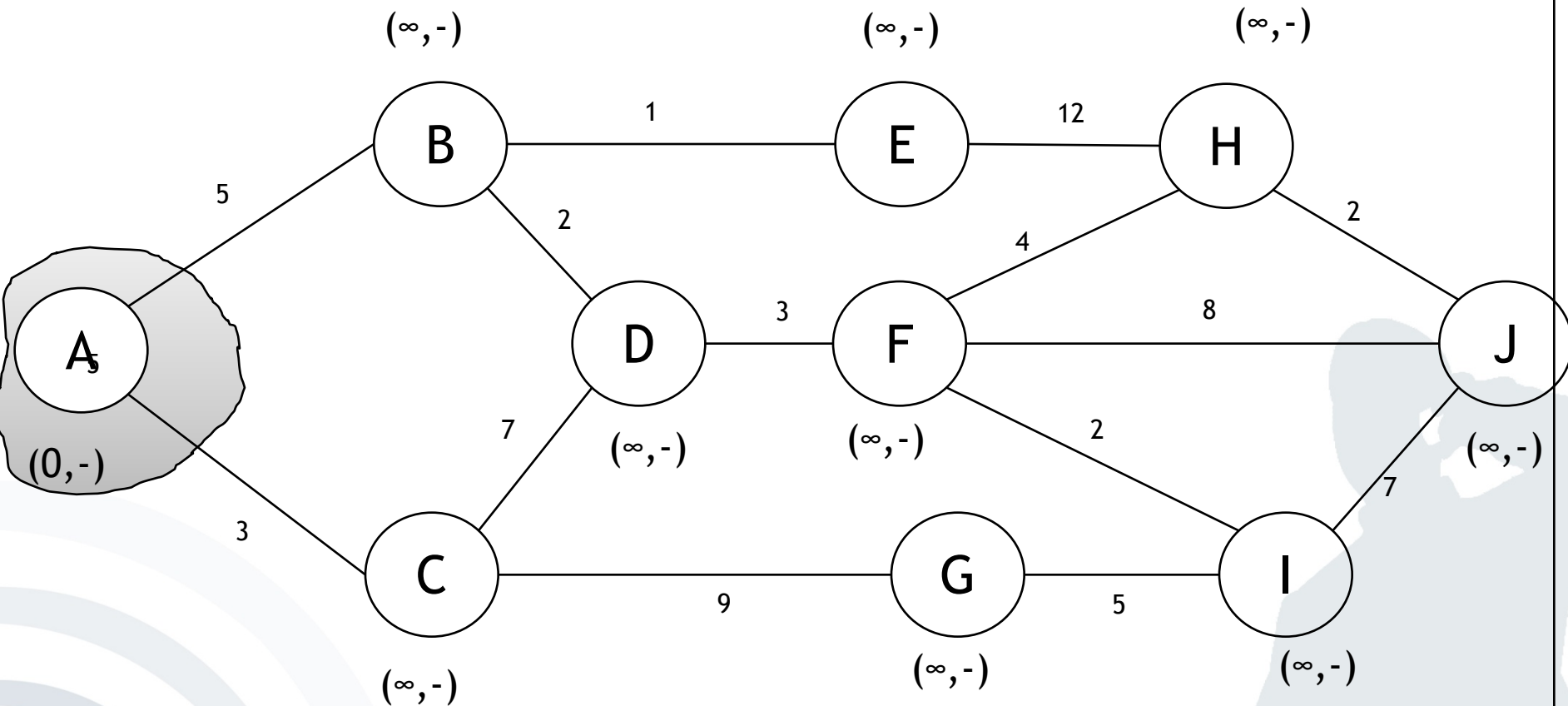
# Exercise: Dijkstra Algorithm

- 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.

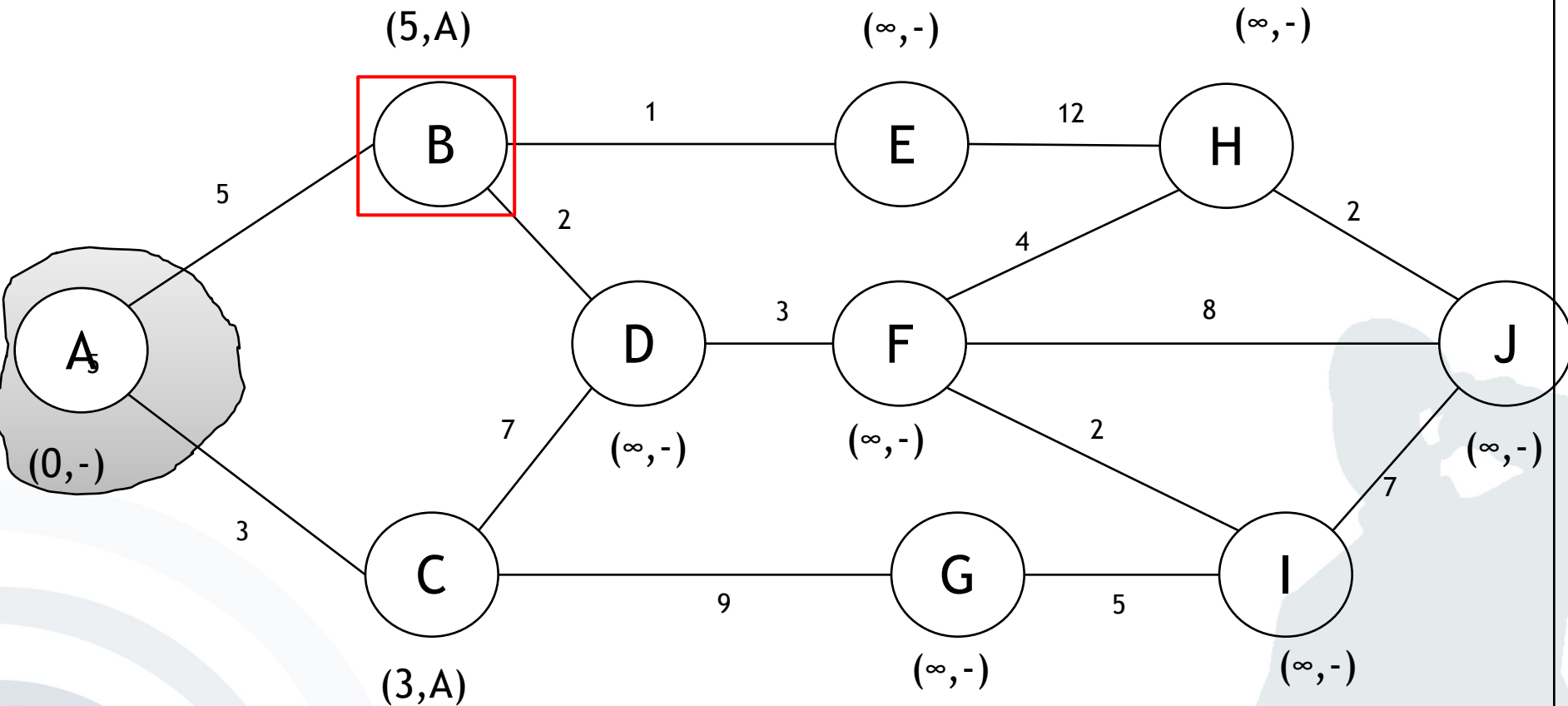


💡 Bandwidth:  
= longest path

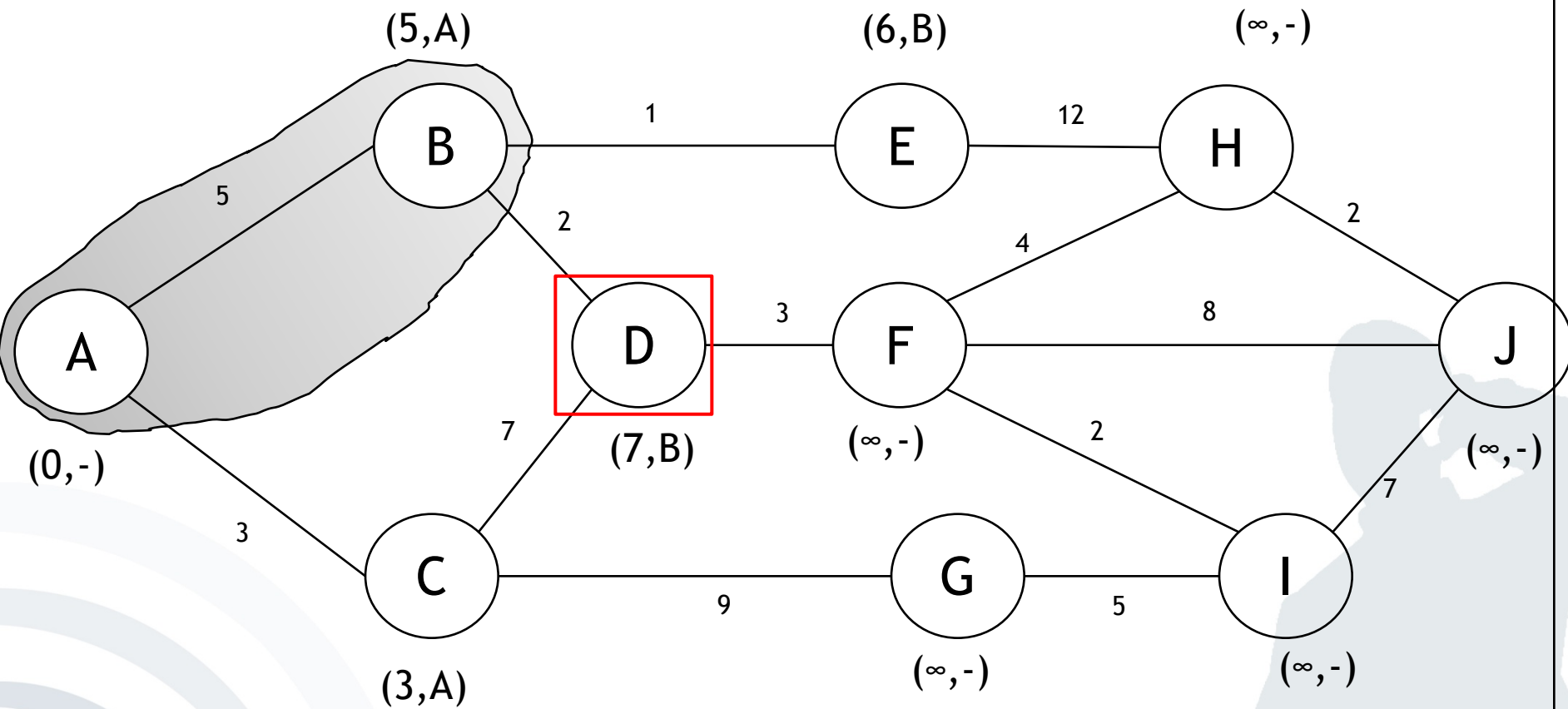
# Dijkstra Algorithm



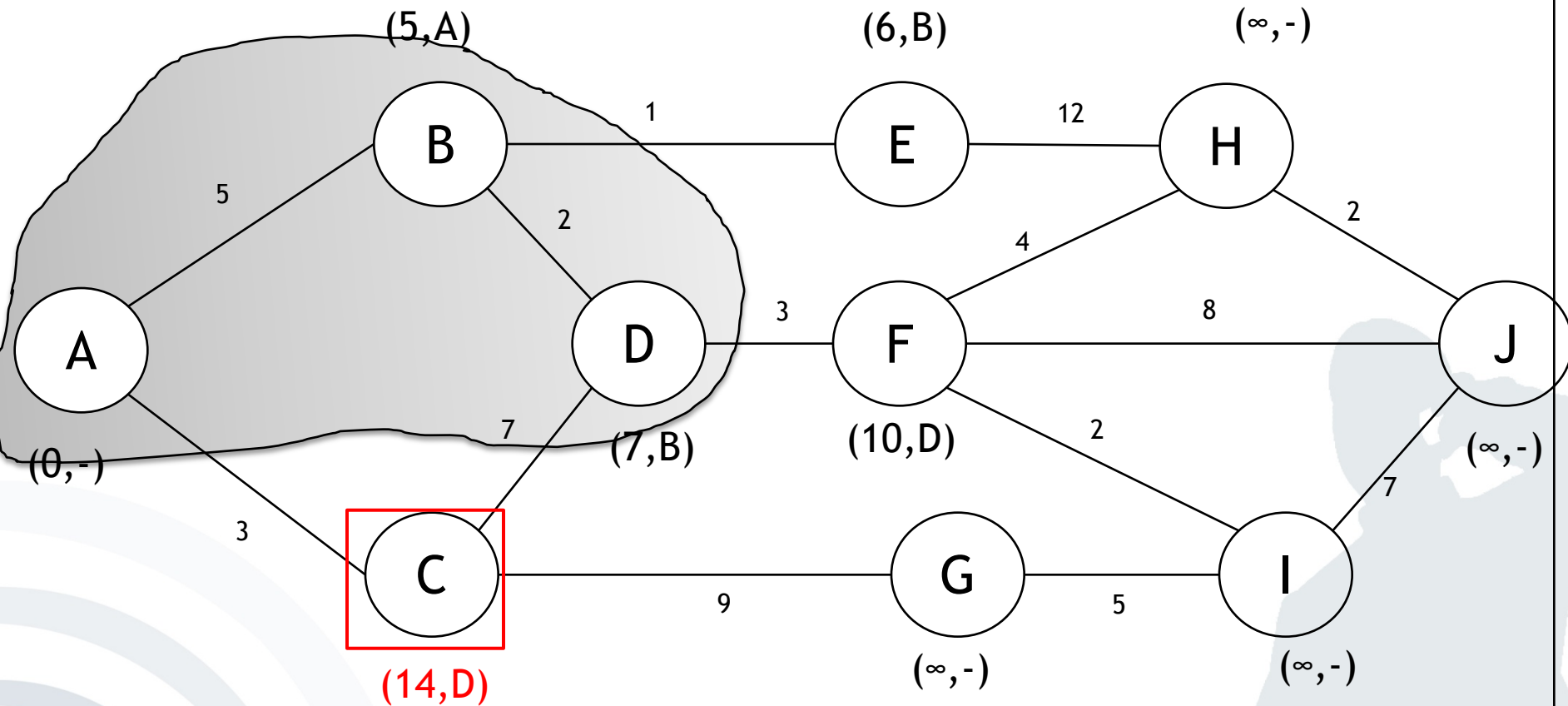
# Dijkstra Algorithm



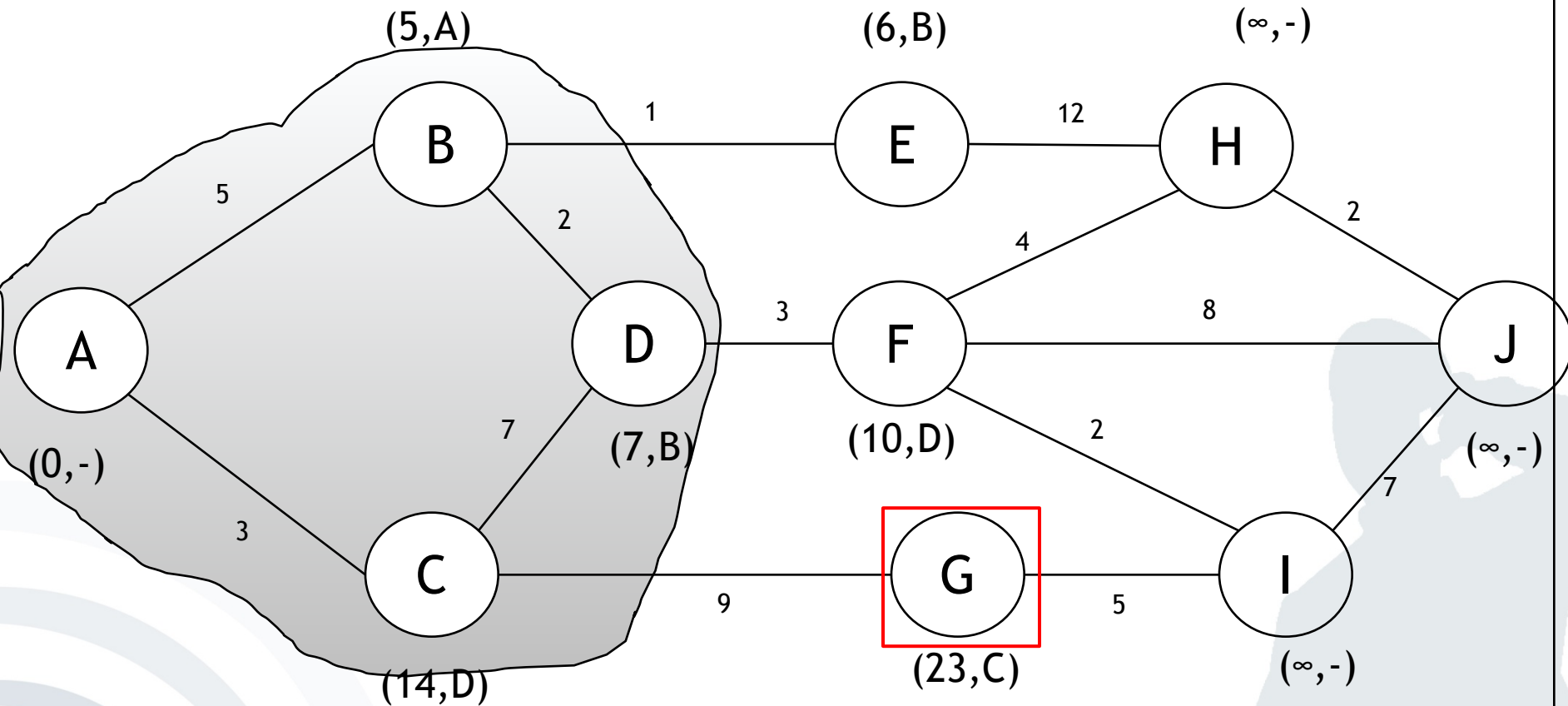
# Dijkstra Algorithm



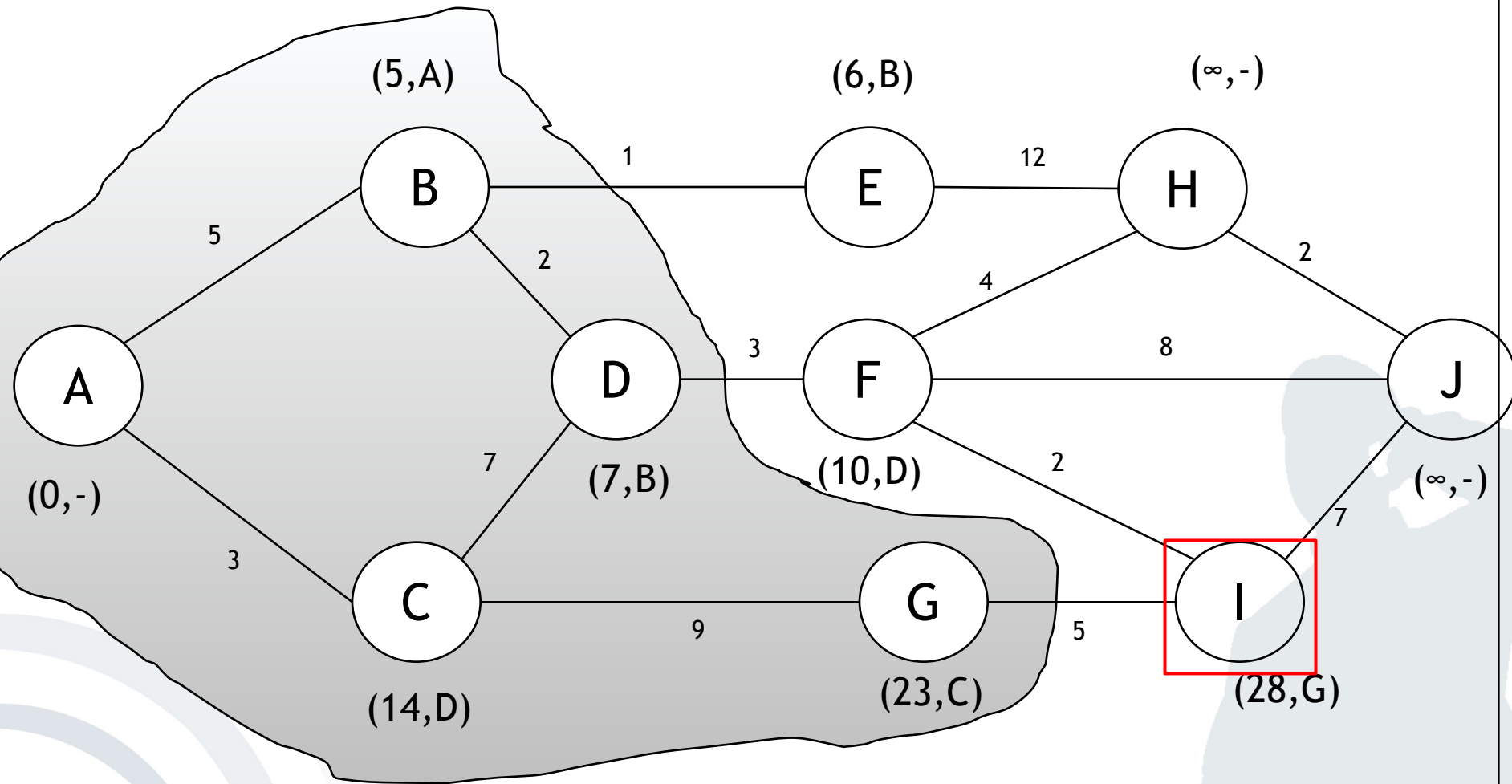
# Dijkstra Algorithm



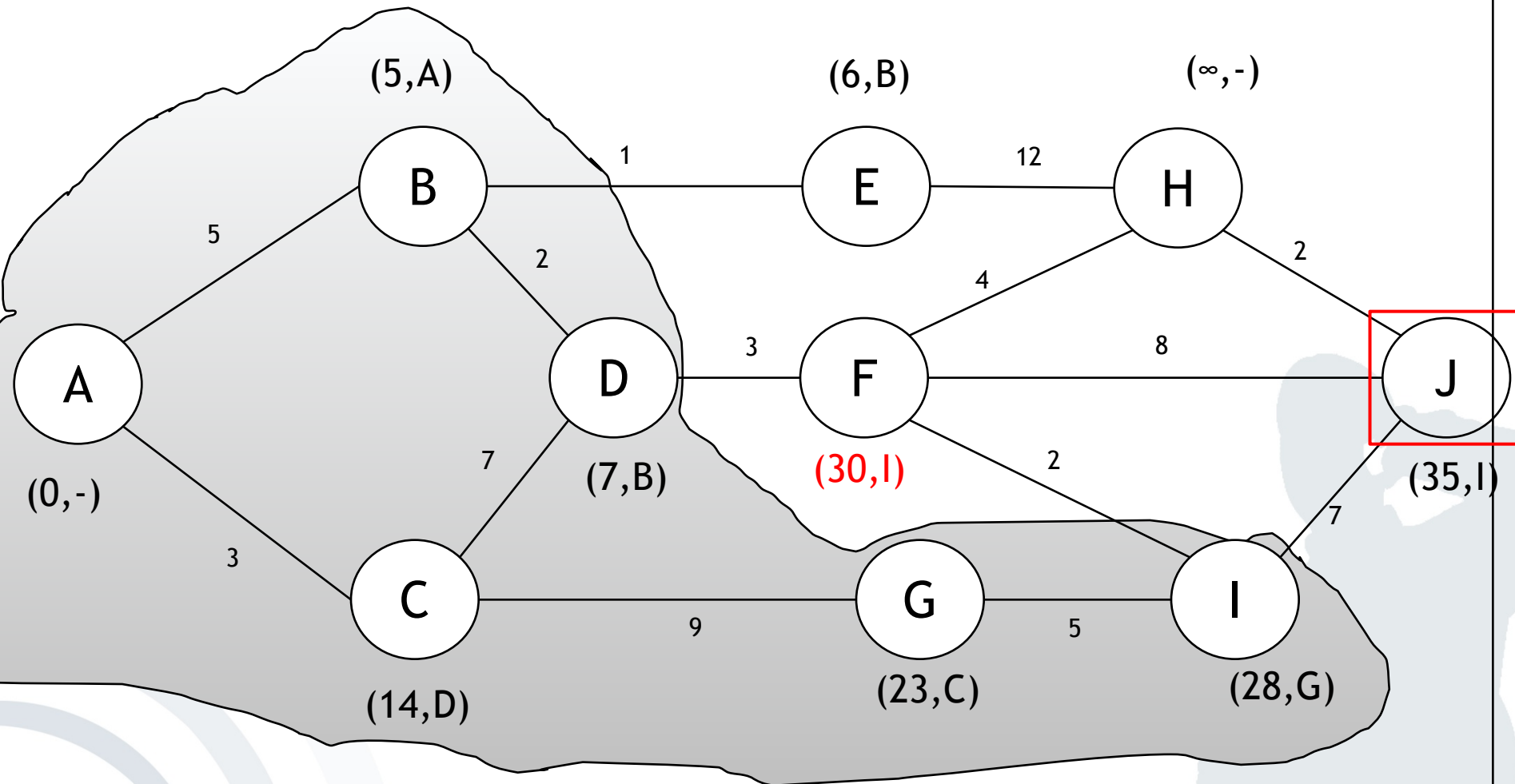
# Dijkstra Algorithm



# Dijkstra Algorithm

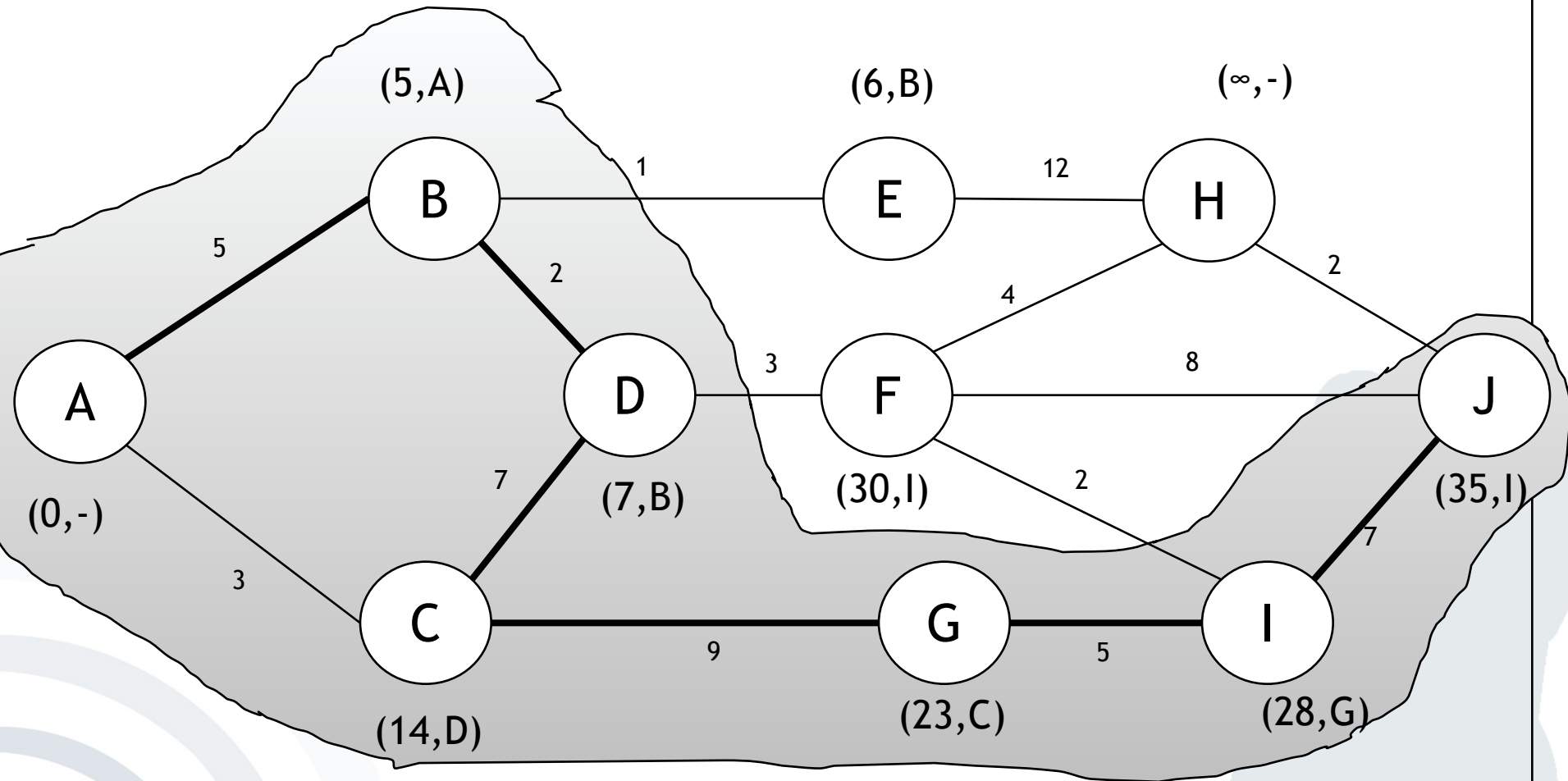


# Dijkstra Algorithm





# Dijkstra Algorithm



Best path:  $A \rightarrow B \rightarrow D \rightarrow C \rightarrow G \rightarrow I \rightarrow J$

→ Dijkstra not created to find longest path - Possible that it does not find it

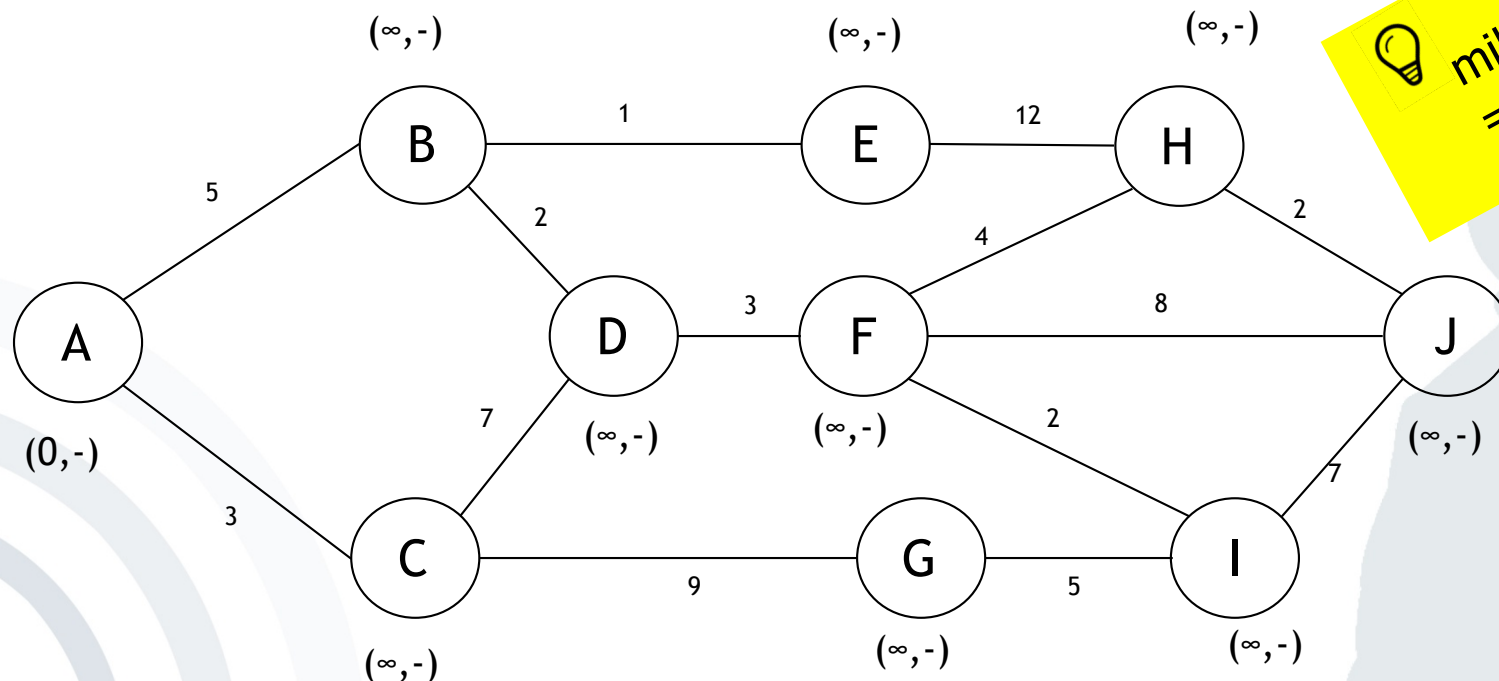
Now try to find the shortest path in the same graph:

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

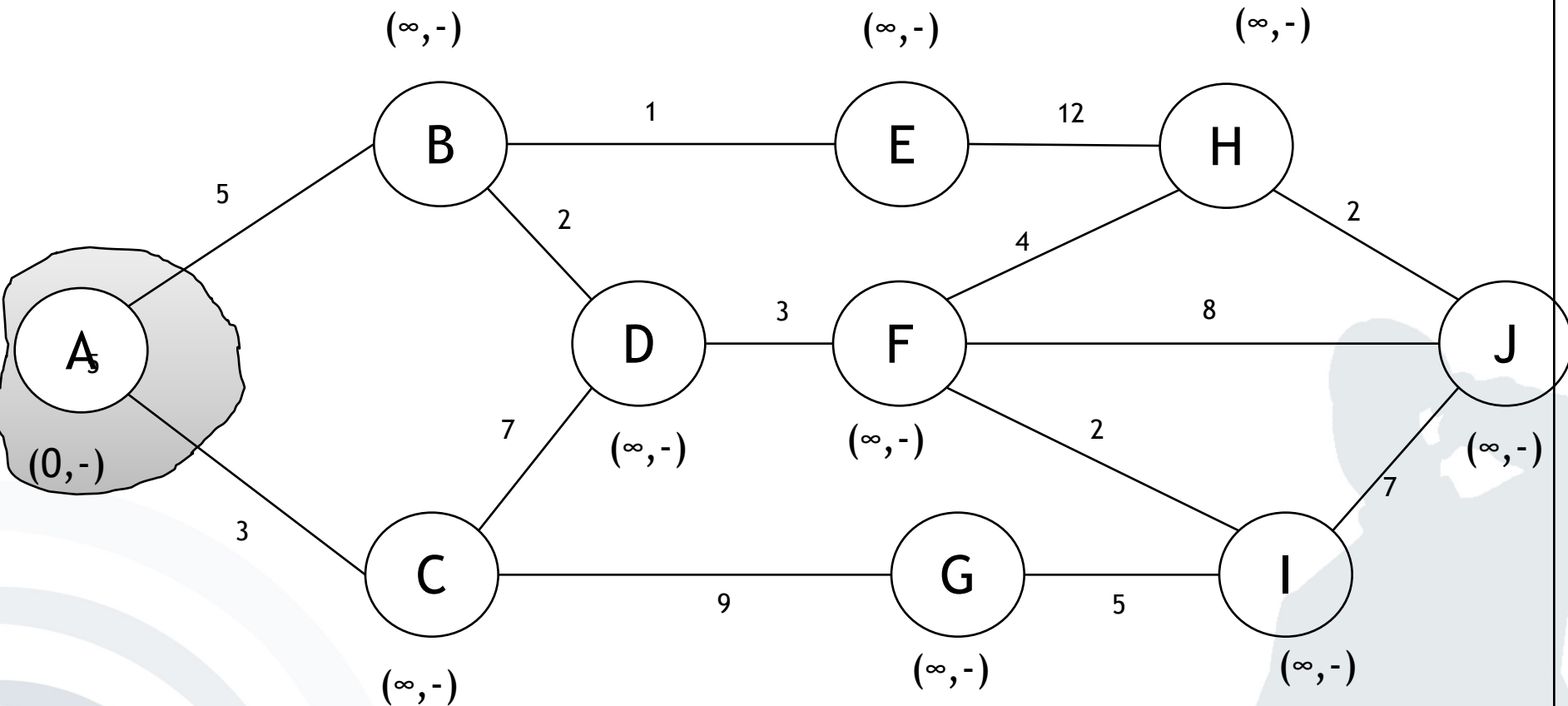
# Exercise: Dijkstra Algorithm

- 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 *milliseconds*.

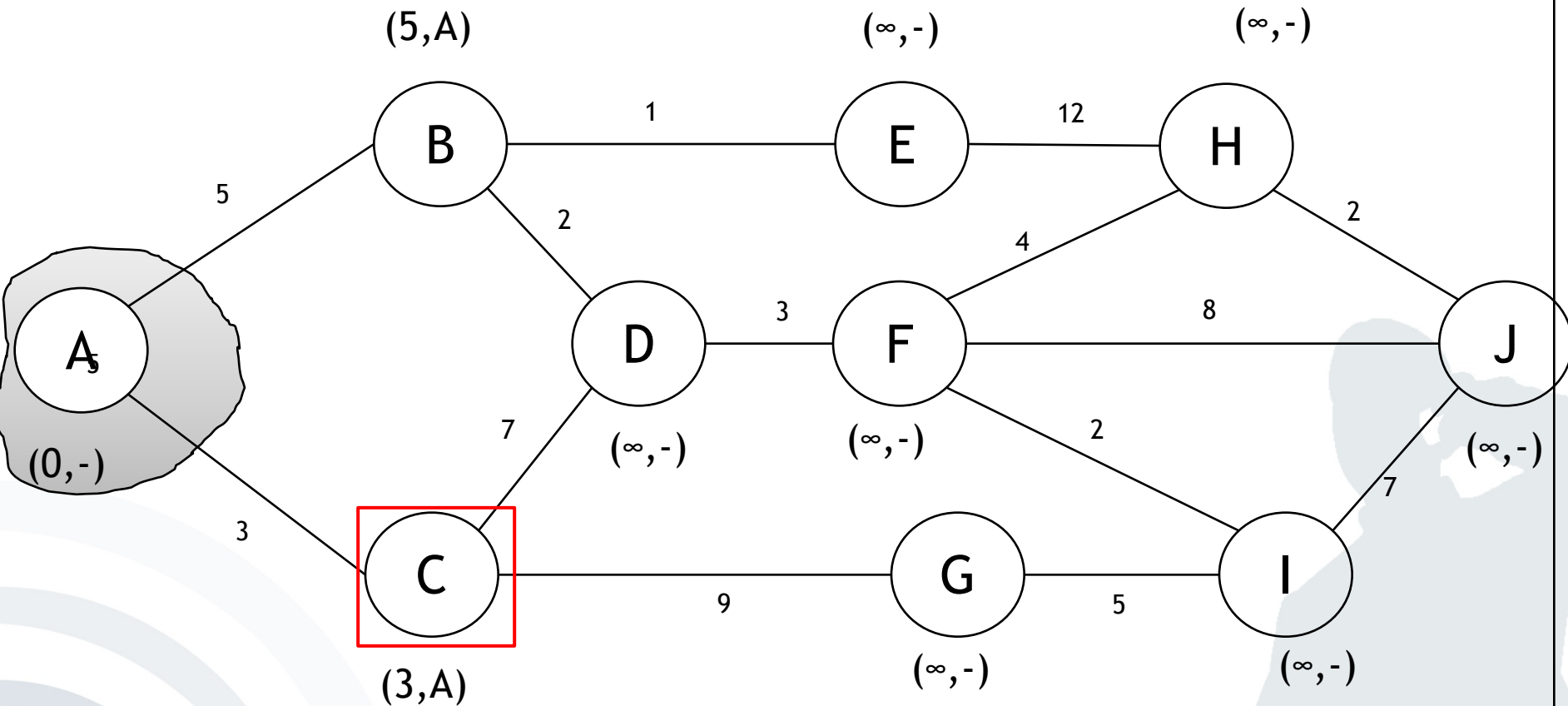


💡 milliseconds:  
= shortest path

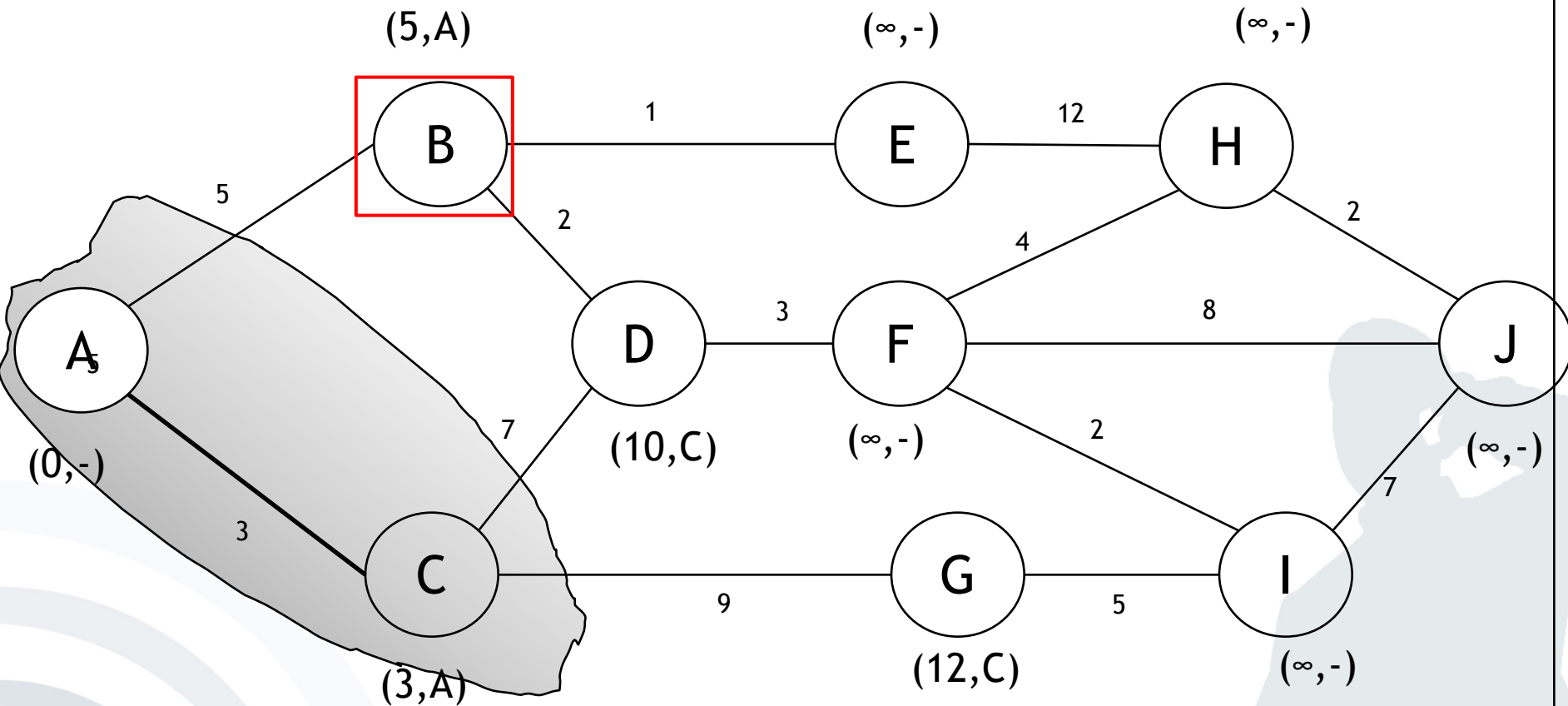
# Dijkstra Algorithm



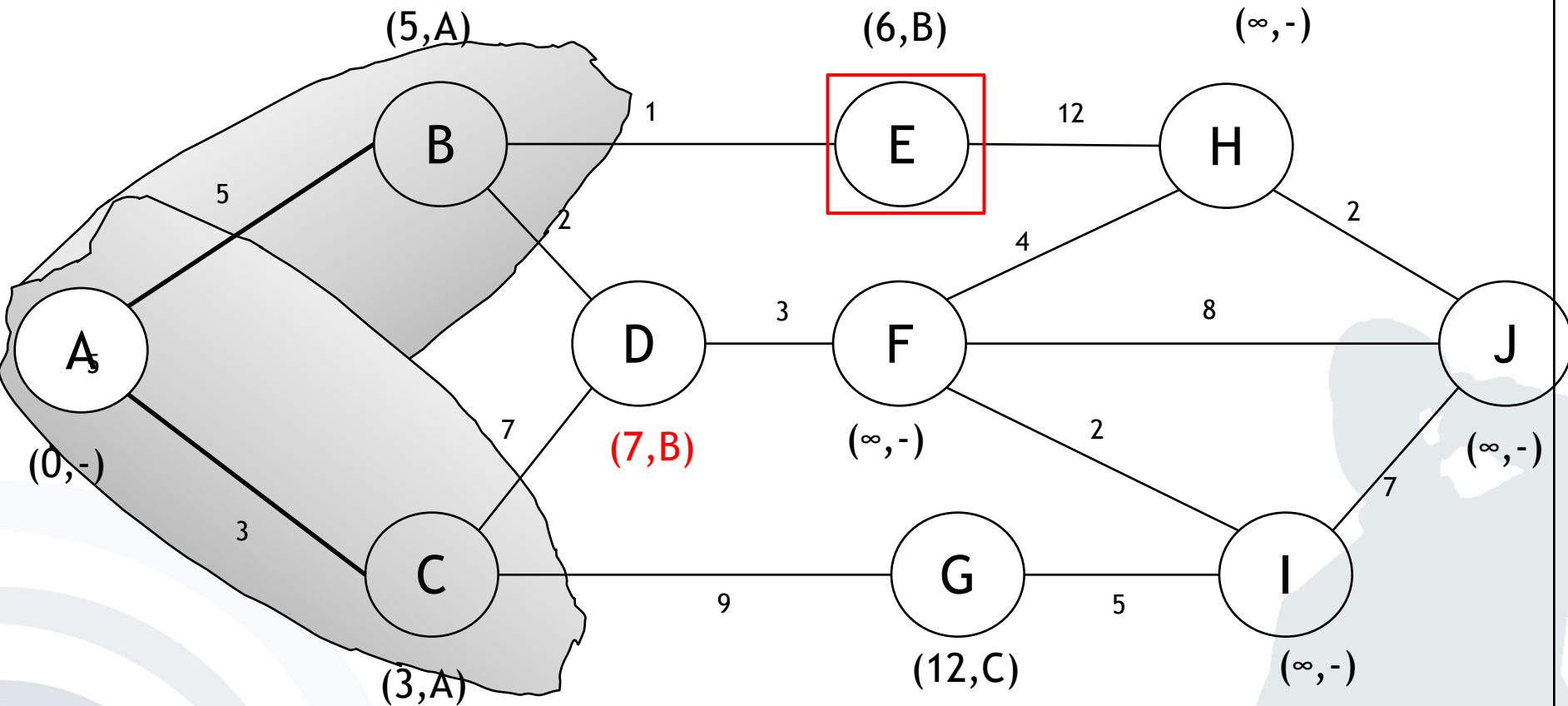
# Dijkstra Algorithm



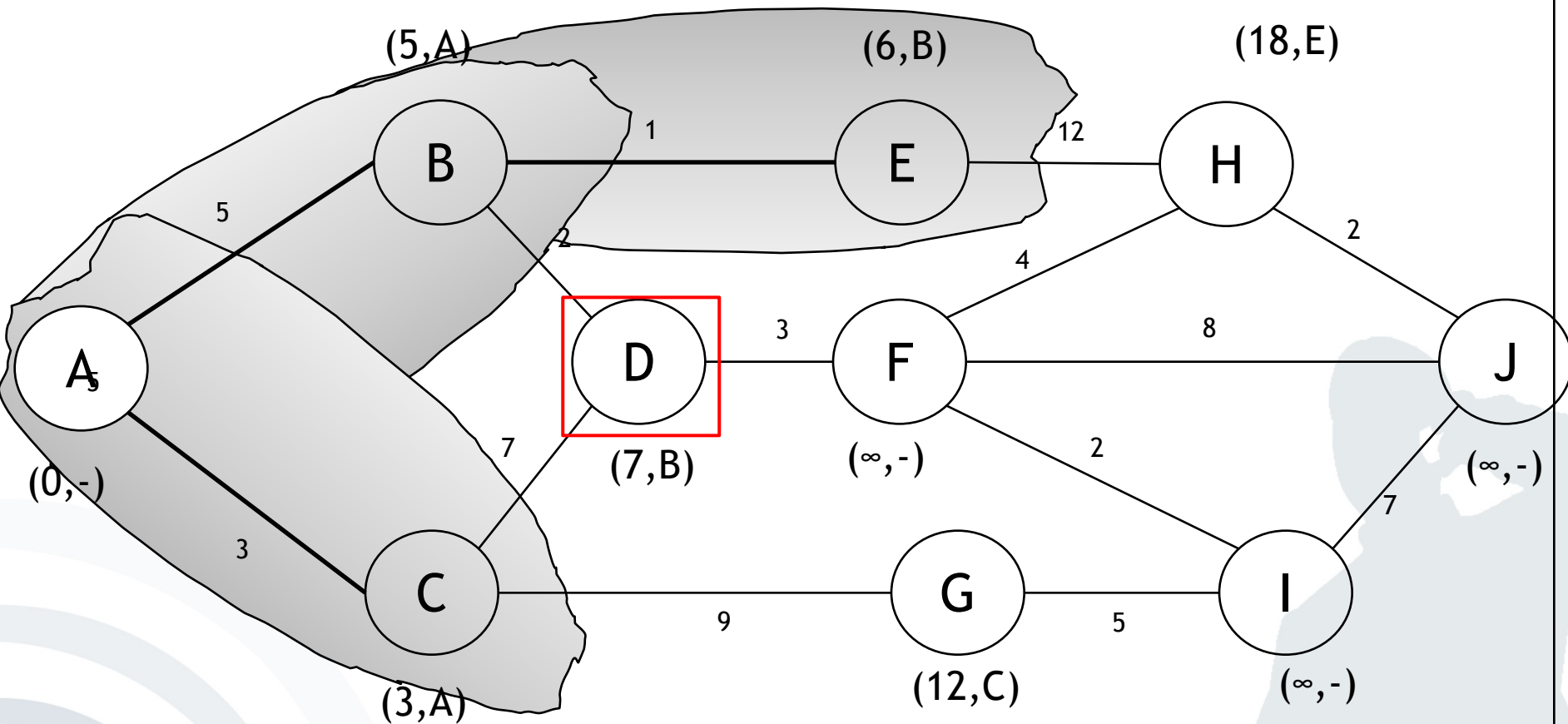
# Dijkstra Algorithm



# Dijkstra Algorithm

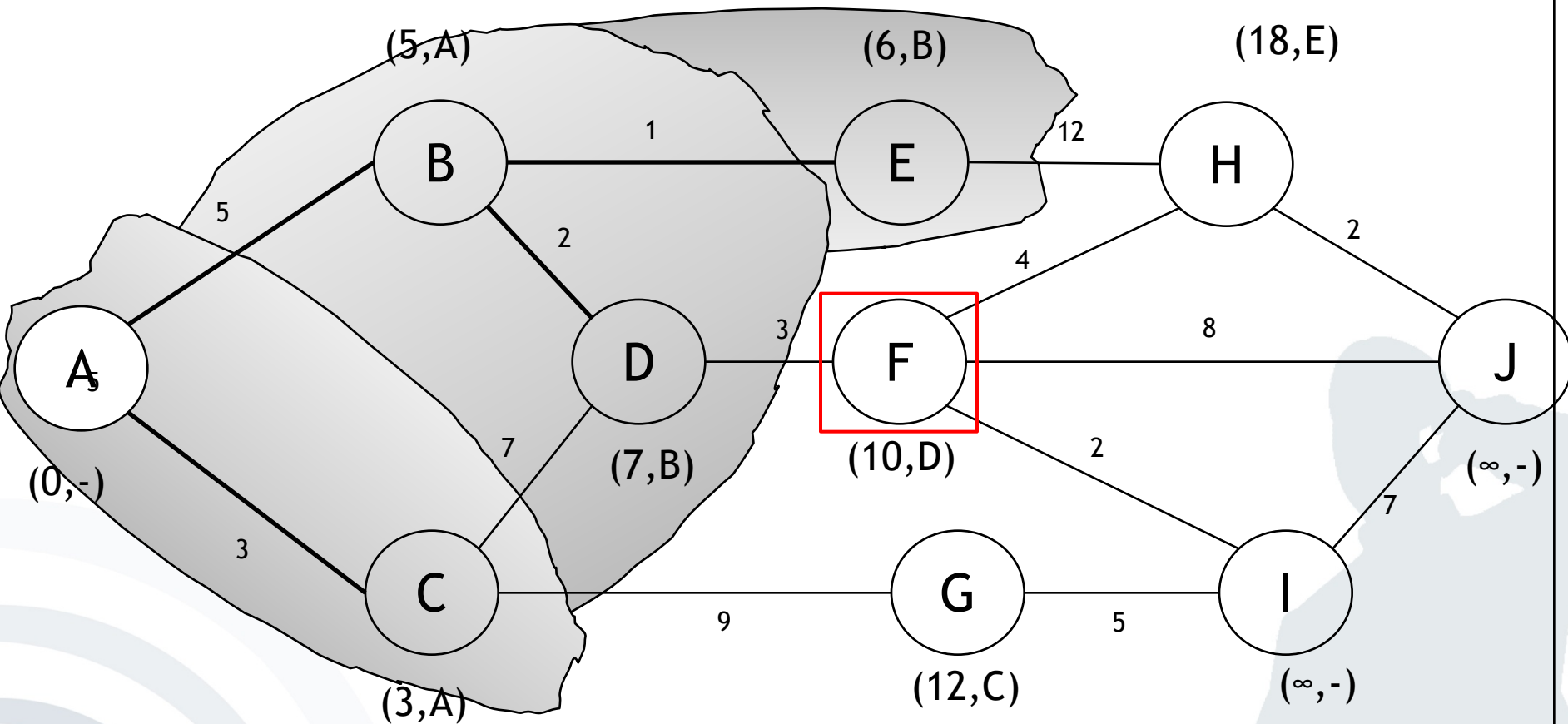


# Dijkstra Algorithm

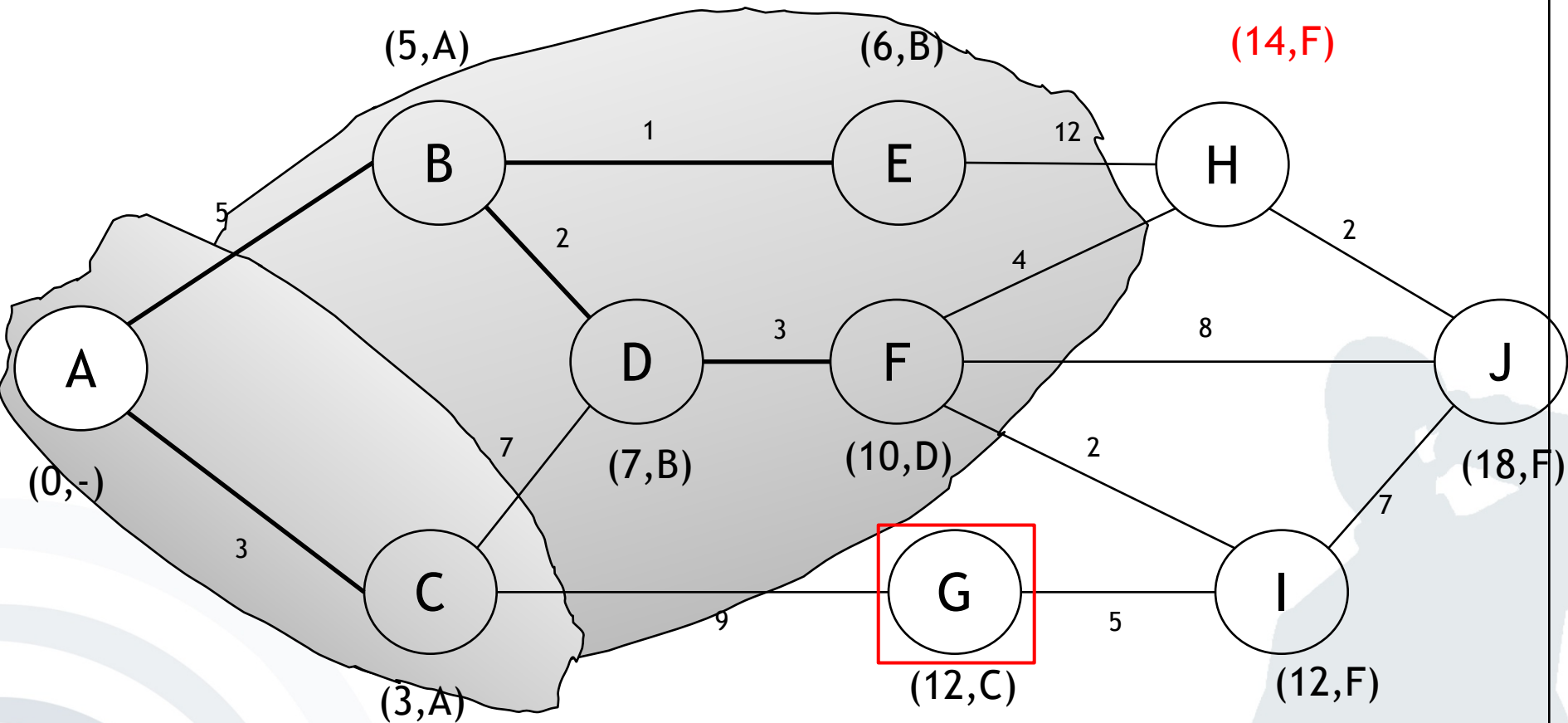




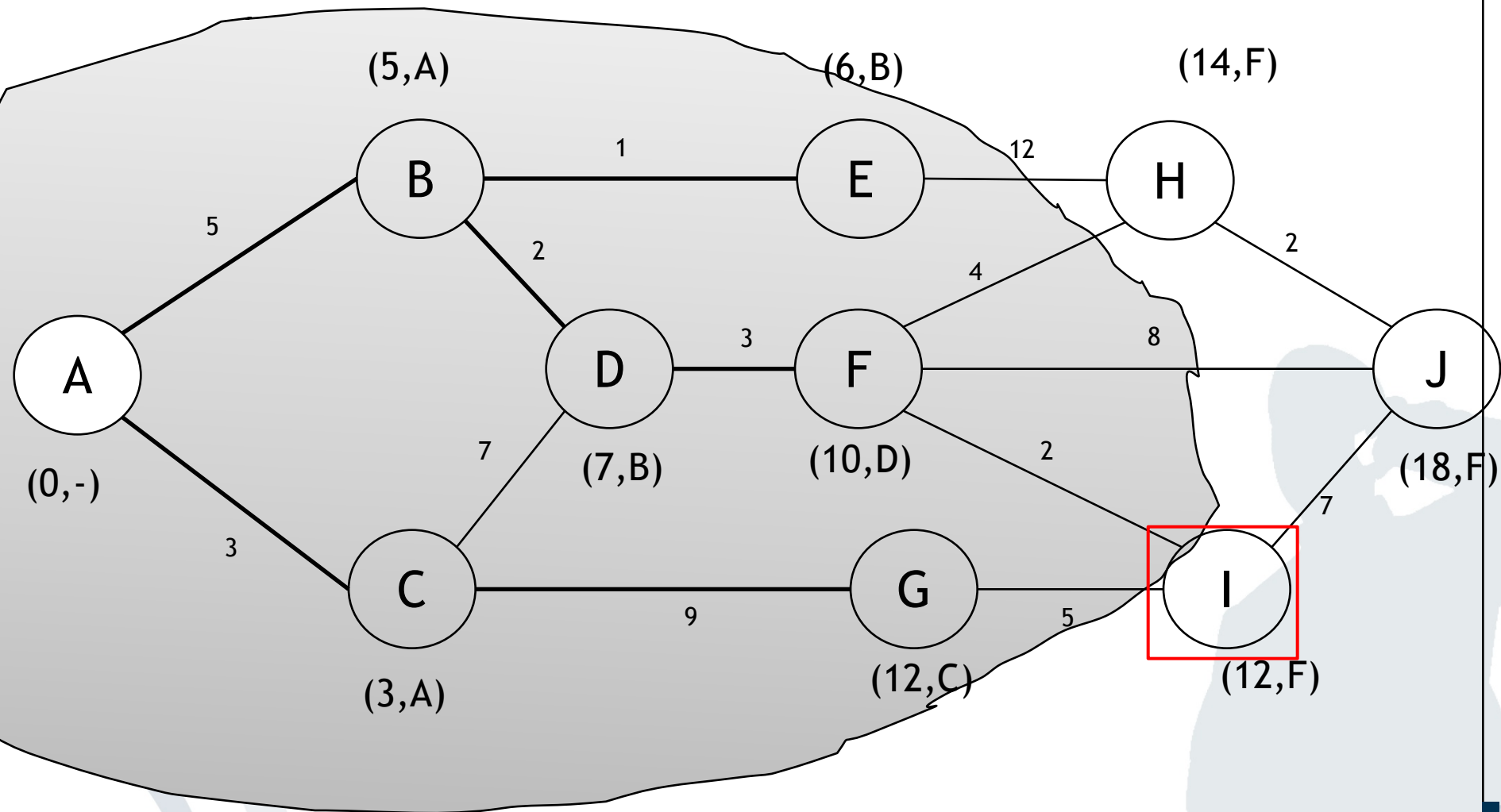
# Dijkstra Algorithm



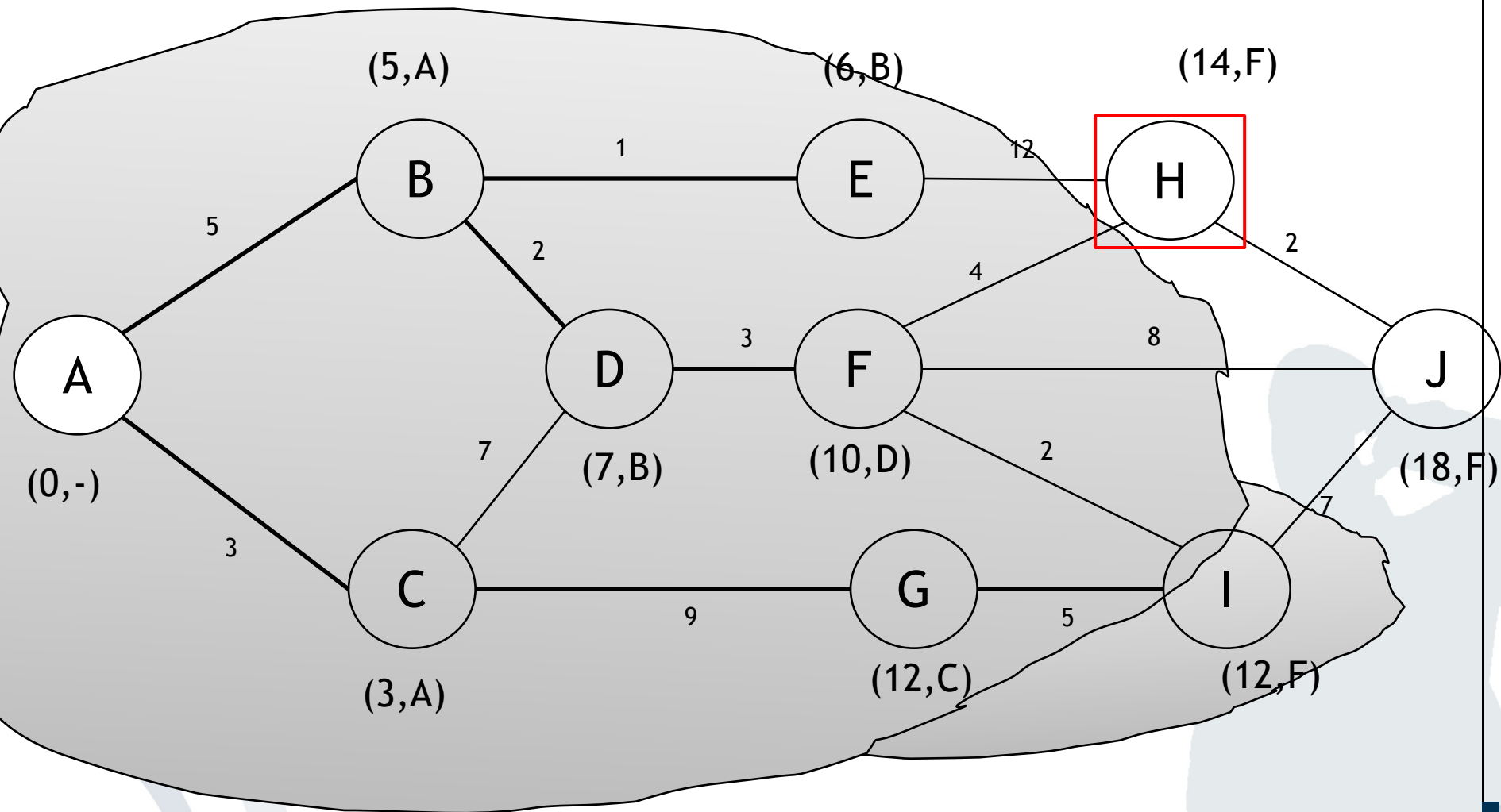
# Dijkstra Algorithm



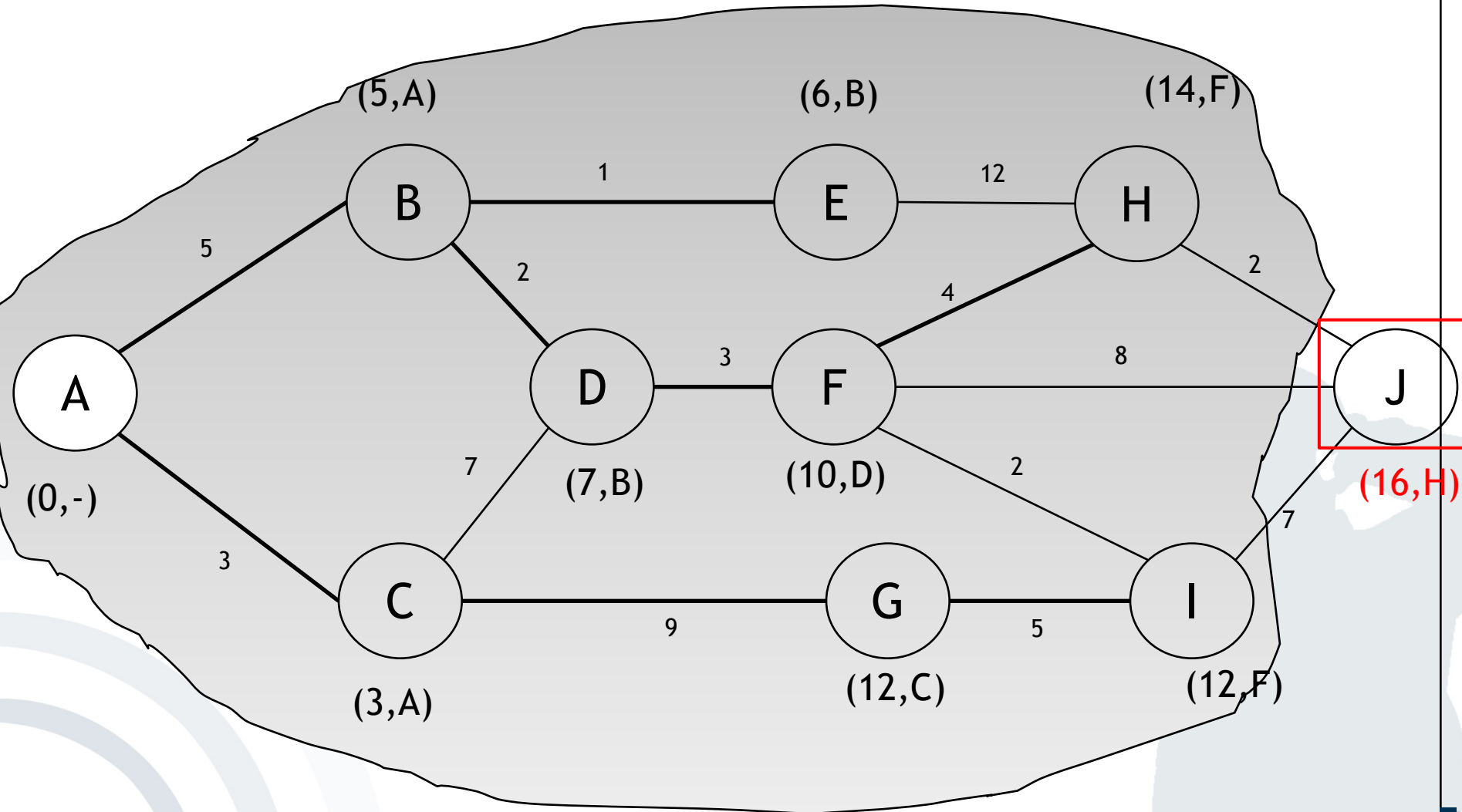
# Dijkstra Algorithm



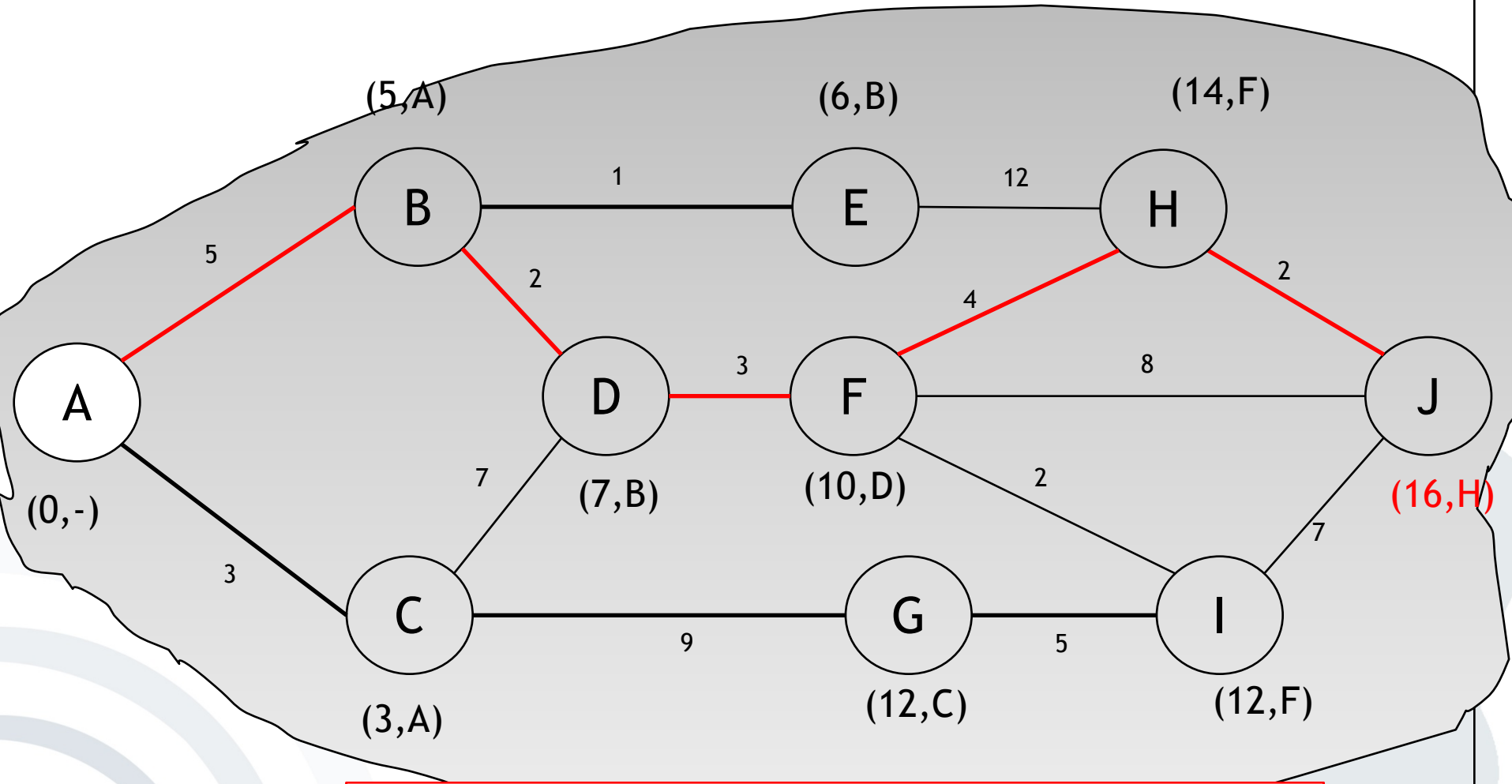
# Dijkstra Algorithm



# Dijkstra Algorithm



# Dijkstra Algorithm



Shortest Path: A → B → D → F → H → J

- 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?

## OSI

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

Data in/output - DNS, http, email

Binary

Check-point

TCP (3 way handshake), UDP

Routing, IP address

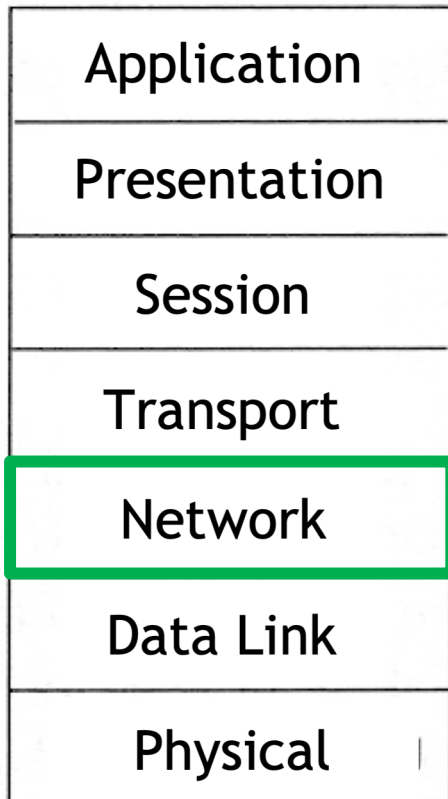
MAC

LAN cable, optical fibre, air, etc.



## Exercise 2b): Solution

*Eva*



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).

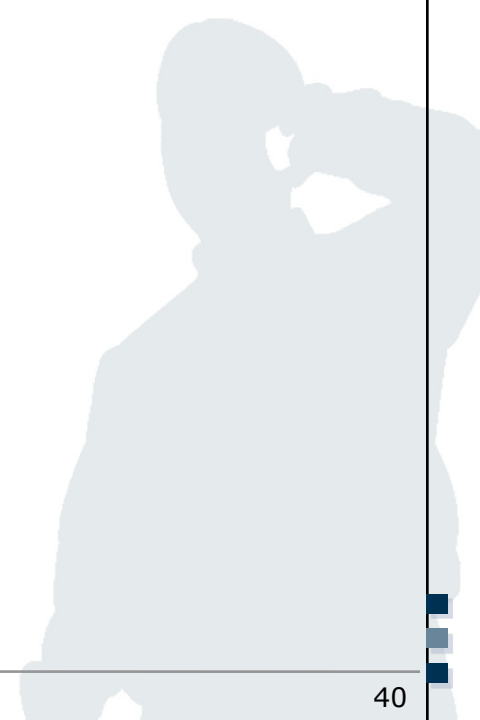
*Adam*



- 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.

- Enhancements in IPv6
  - An IPv6 address consists of 128 bits (instead of 32 bits).
  - IPv6 addresses are not written in decimals (like e.g. 80.130.234.185), 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.

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



## OSI

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

Data in/output - DNS, http, email

Binary

Check-point

TCP (3 way handshake), UDP

Routing, IP address

MAC

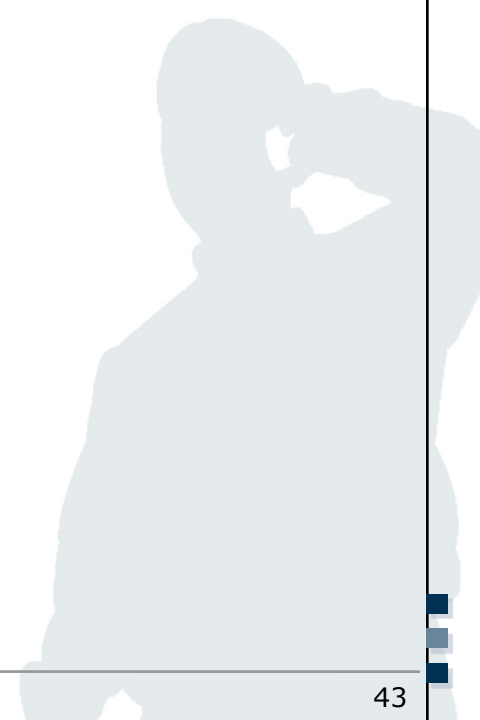
LAN cable, optical fibre, air, etc.

# 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.

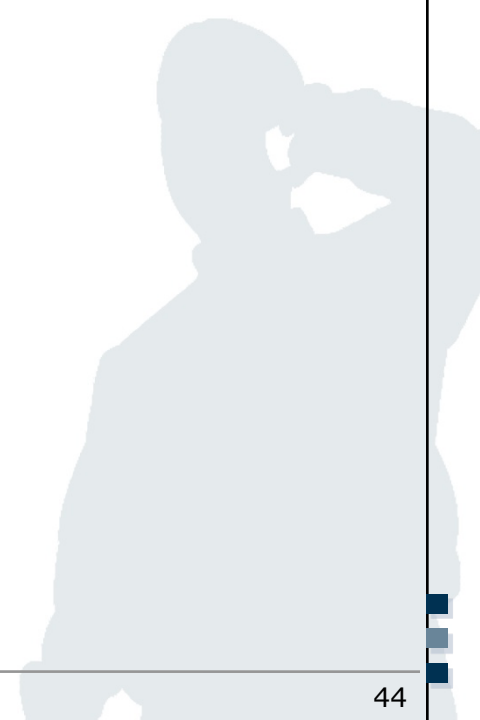
Source: <https://techdifferences.com/difference-between-mac-and-ip-address.html>

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



# Exercise: Wired Communication

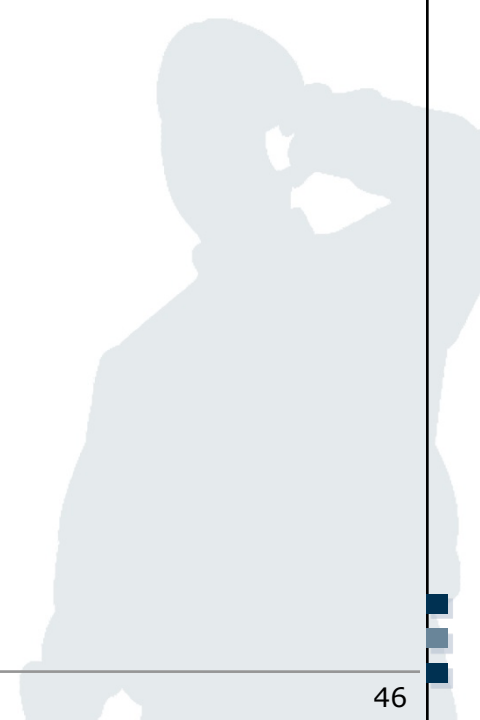
- What are the main challenges in wired communication and why?



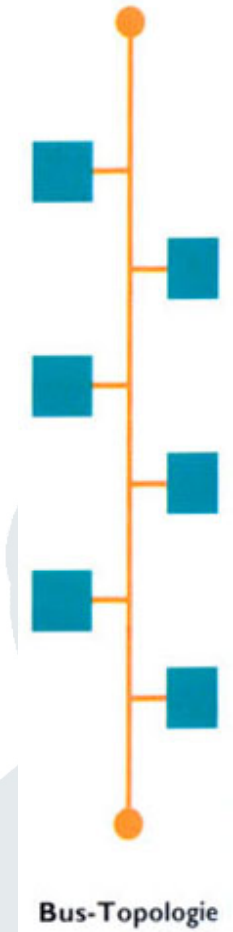


- Wired communication denotes data transmission using physical wires, e.g. for
  - Telephone networks
  - Cable television/Internet access
  - Fiber-optic networks
- Main challenges in wired communication
  - Coping with the distance between two endpoints
  - Provision of the appropriate bandwidth

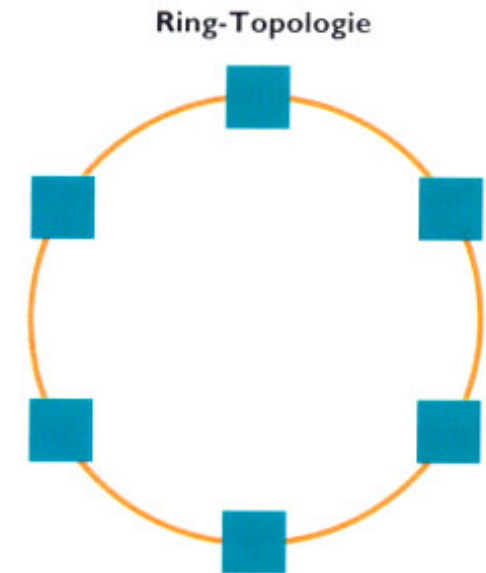
- Name three different types of topologies and expose their advantages and disadvantages.



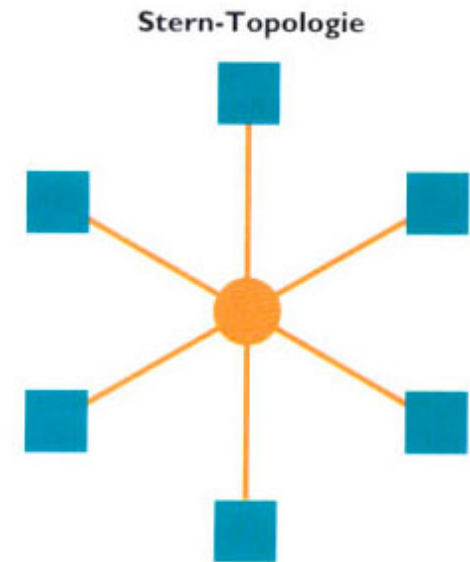
- Bus Topology
  - Low cost
  - Easy and low cost setup and extension
  - Difficult to find errors



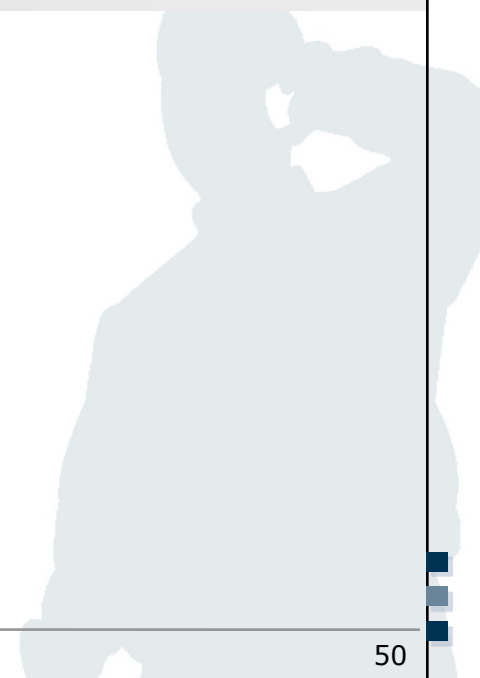
- Ring Topology
  - No single point of failure
  - Slow if one way is broken



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

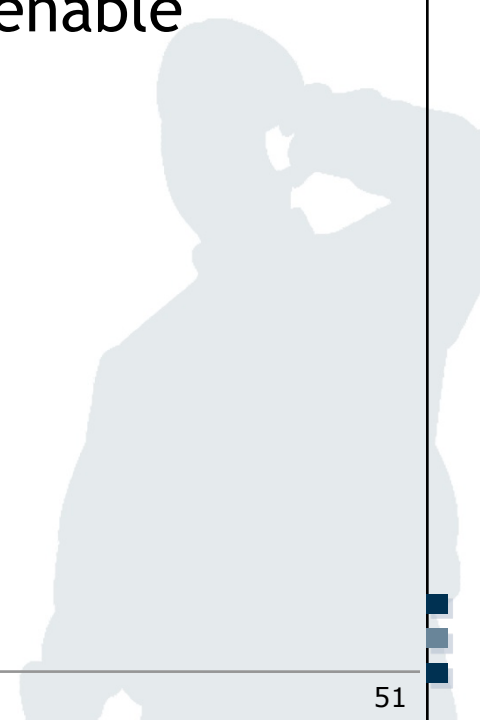


- Exercise 1: OSI reference model
- Exercise 2: Fixed Networks
- Exercise 3: Wireless Local Area Networks
- Exercise 4: Bluetooth and NFC



# 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?

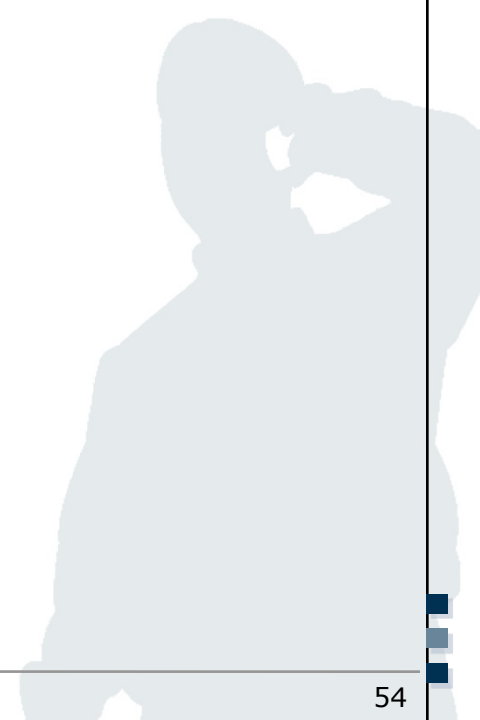


- Wi-Fi Protected Access:
  - WPA is outdated and insecure (e.g. vulnerability to dictionary attacks)
  - WPA2 is secure as it employs the Advanced Encryption Standard (AES)
- Consequences of unsecure Wi-Fi:
  - Data can be extracted
  - Internet access can be used by other for free and illegal activities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



- 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)

- 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.



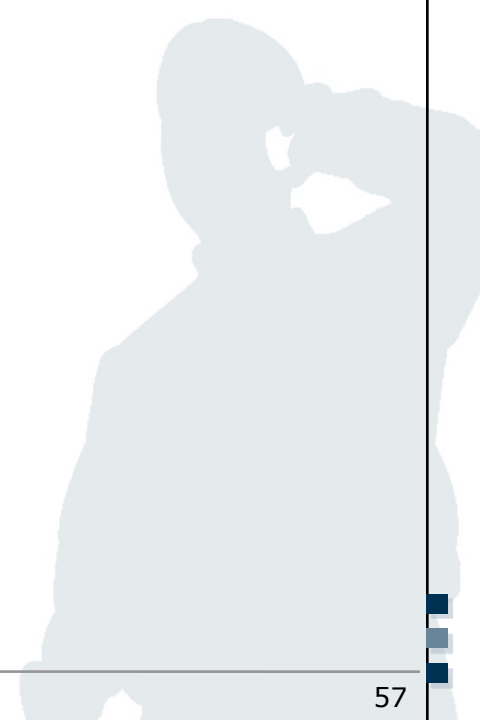
- Eavesdropping on communication
- Redirection to a manipulated service is possible
- Mobile user's perspective:
  - Passwords can be stolen and an attacker can slip into the corresponding identity
- myPlace's perspective
  - Unsecure services results in image loss
  - Suit for violating the legal framework

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



## Exercise: Bluetooth and NFC

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





- 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 ✓

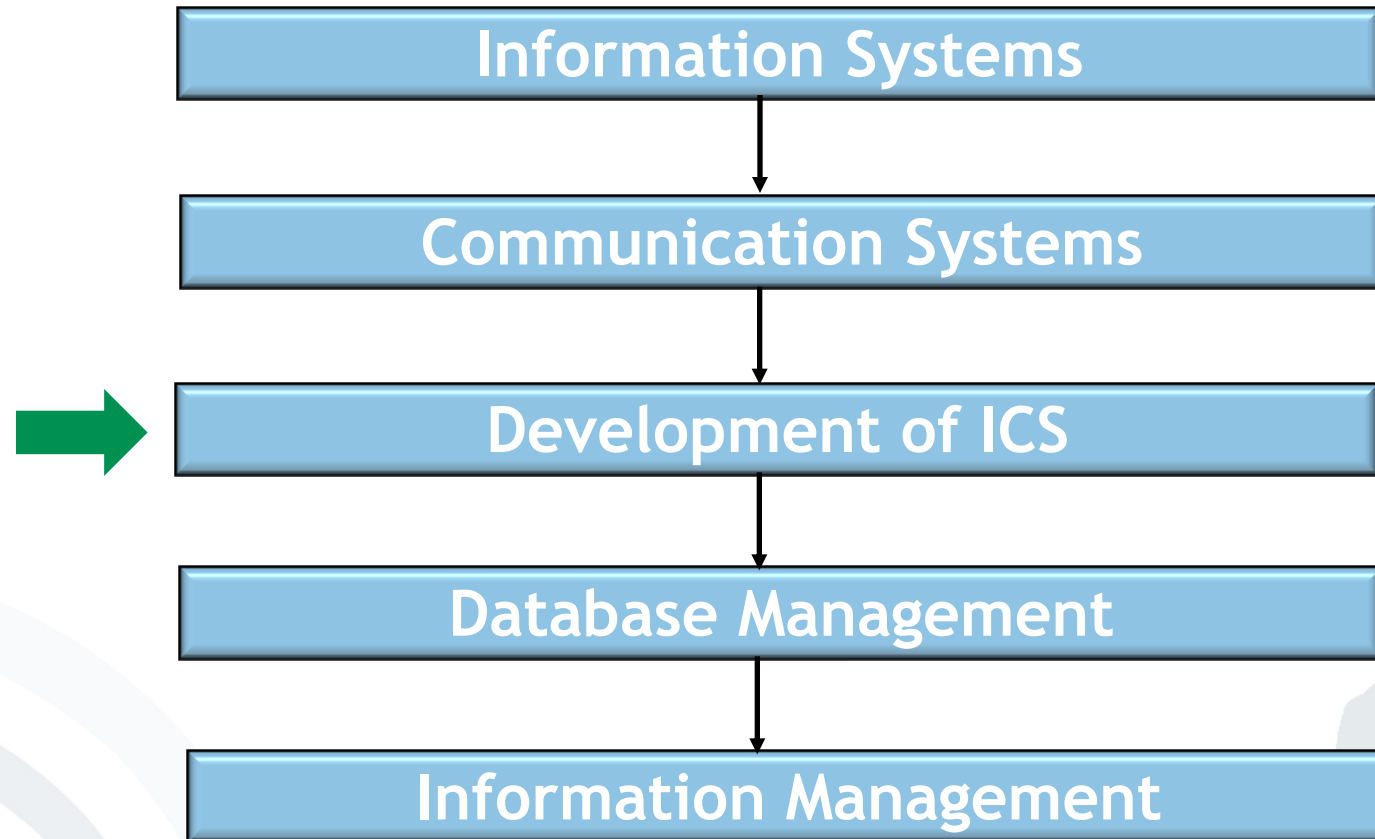


## By now you should:

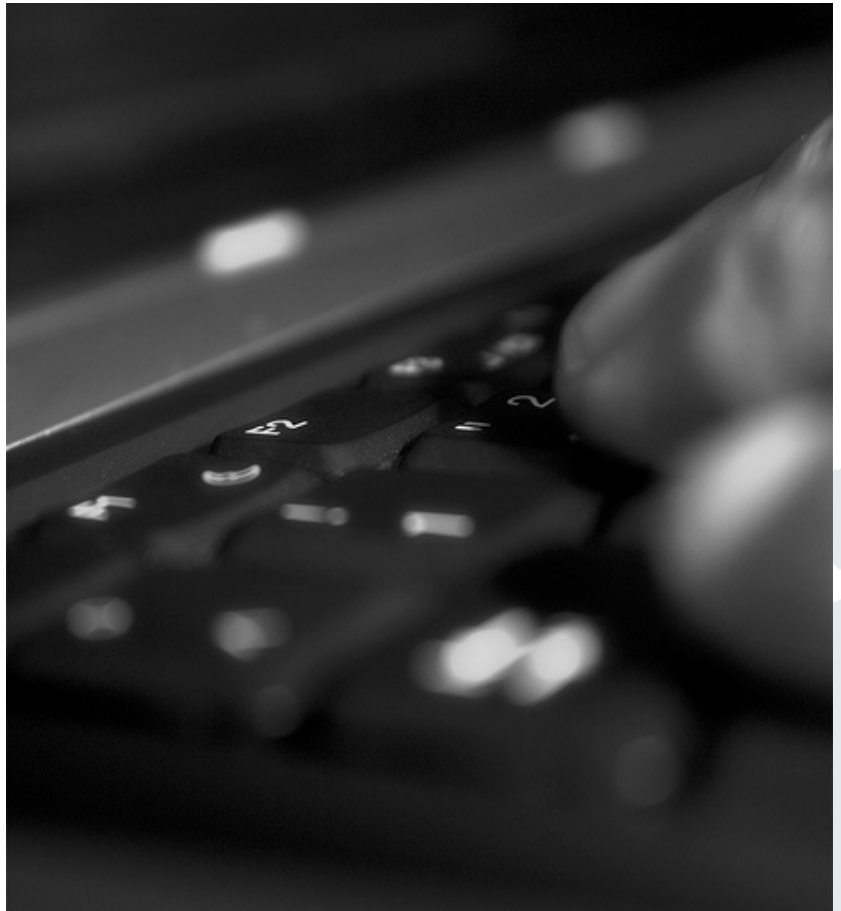
- Know the principles of layer based communication
- Know the layers of the ISO/OSI reference model and their particularities (focus on layer 2, 3, 4 and 7)
- Be able to apply the Dijkstra algorithm
- Understand the principles of fixed Networks
- Understand the principles of wireless communication

→ Apply your knowledge!





Thank you!



Jenser (Flickr.com)