

Networking Basics

01 - Networks, Packets, and Protocols

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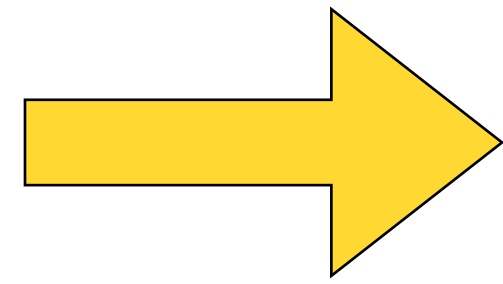
Where networks meet

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Networking Basics

DE-CIX Academy



01 - Networks, Packets, and Protocols

02 - Ethernet, 02a - VLANs

03 - IP, 03a - Routing, 03b - Global routing

04a - UDP, 04b - TCP, 04c - ICMP, 04d - Traceroute

05 - Uni-, Broad-, Multi-, and Anycast

06a - Domain Name System (DNS)

07a - Simple Mail Transfer Protocol (SMTP)

07b - Hypertext Transfer Protocol (HTTP)

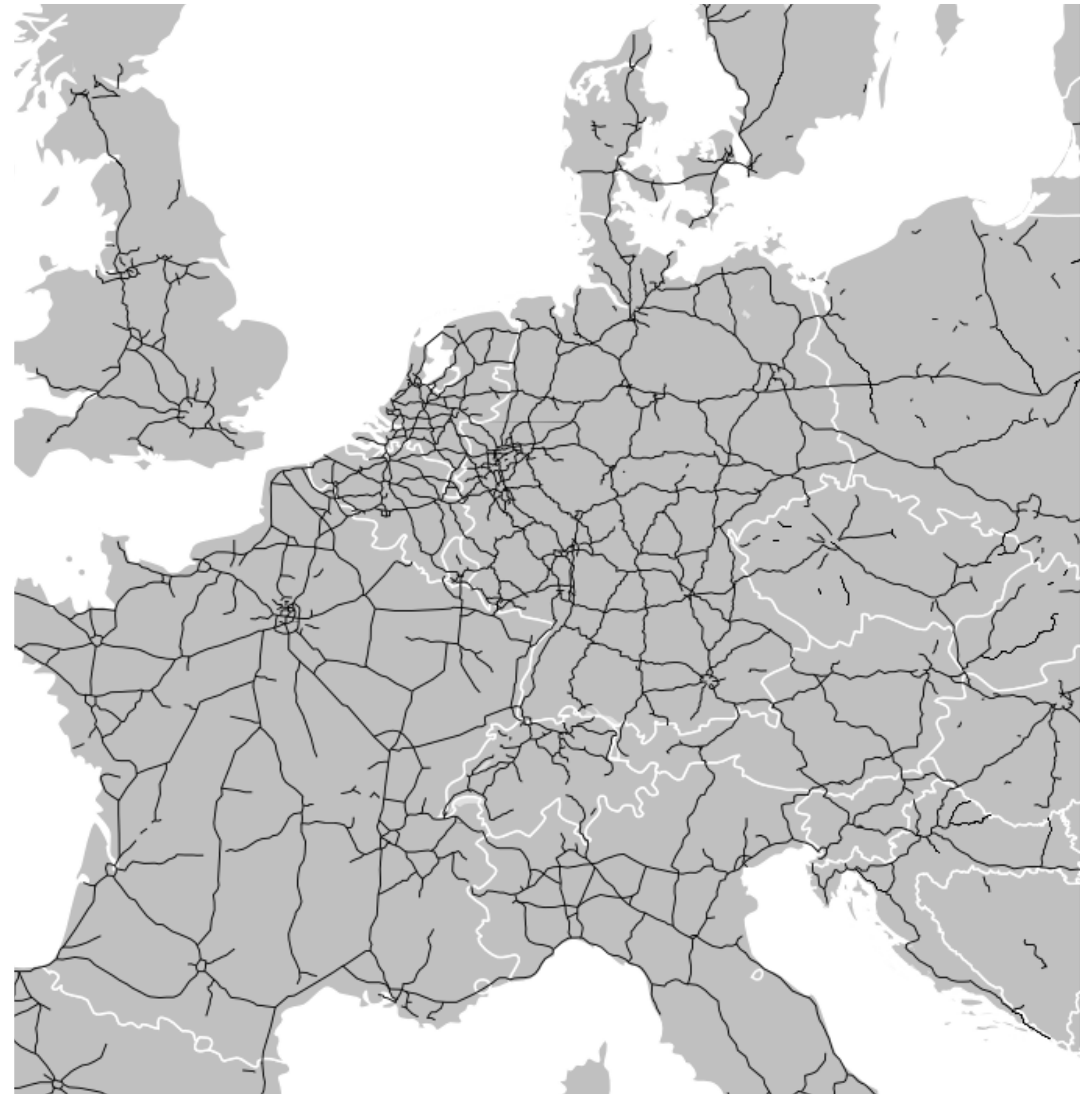


Networks

Networks

Networks are everywhere

- You all know and use networks
- I am not talking about the Internet
- Networks are everywhere
- Example: The **road network**
- It connects cities, using roads and cars



Attribution: <https://commons.wikimedia.org/wiki/User:Scoter20>

https://commons.wikimedia.org/wiki/File:Europe_Completed_Motorways_Dec_2012.png



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Networks

Networks are everywhere

- You all know and use networks
- I am not talking about the Internet
- Networks are everywhere
- Example: The **railway network**
- It connects railway stations, using rails and trains



Attribution: [Hbf878](#), OpenStreetMap contributors

https://commons.wikimedia.org/wiki/File:Bahnstrecken_Deutschland_Karte.svg



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Networks

Networks are everywhere

- You all know and use networks
- I am not talking about the Internet
- Networks are everywhere
- Example: The **electrical grid**
- It connects producers and consumers of electricity

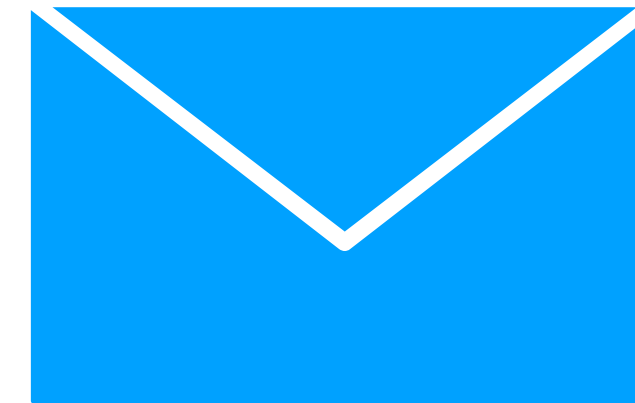
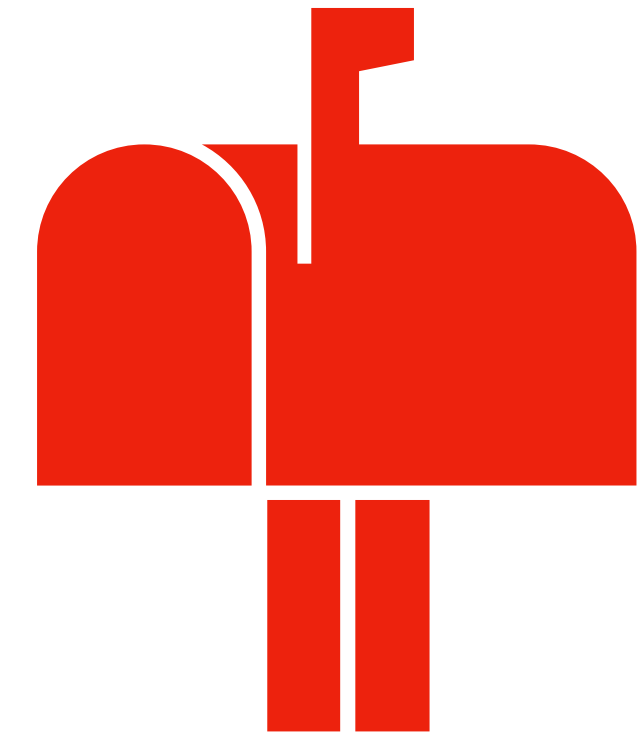


Attribution: Wolfgang Tremmel

Networks

Networks are everywhere

- You all know and use networks
- I am not talking about the Internet
- Networks are everywhere
- Example: The **postal network**
- It connects senders and receivers of letters and **Packets**



Packets

Just imagine...

Using the postal network

- Lets say you have seen this garden shed in a catalog
- And want to mail order it
- It does not fit into one package
- So the sender dismantles it



Attribution: Concord

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Just imagine...

Using the postal network

- So the sender dismantles it
- Packs it into several packages
- And sends them to you
- You unpack the packages
- And put the garden shed together again



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Using a computer network

Data is sent in packets

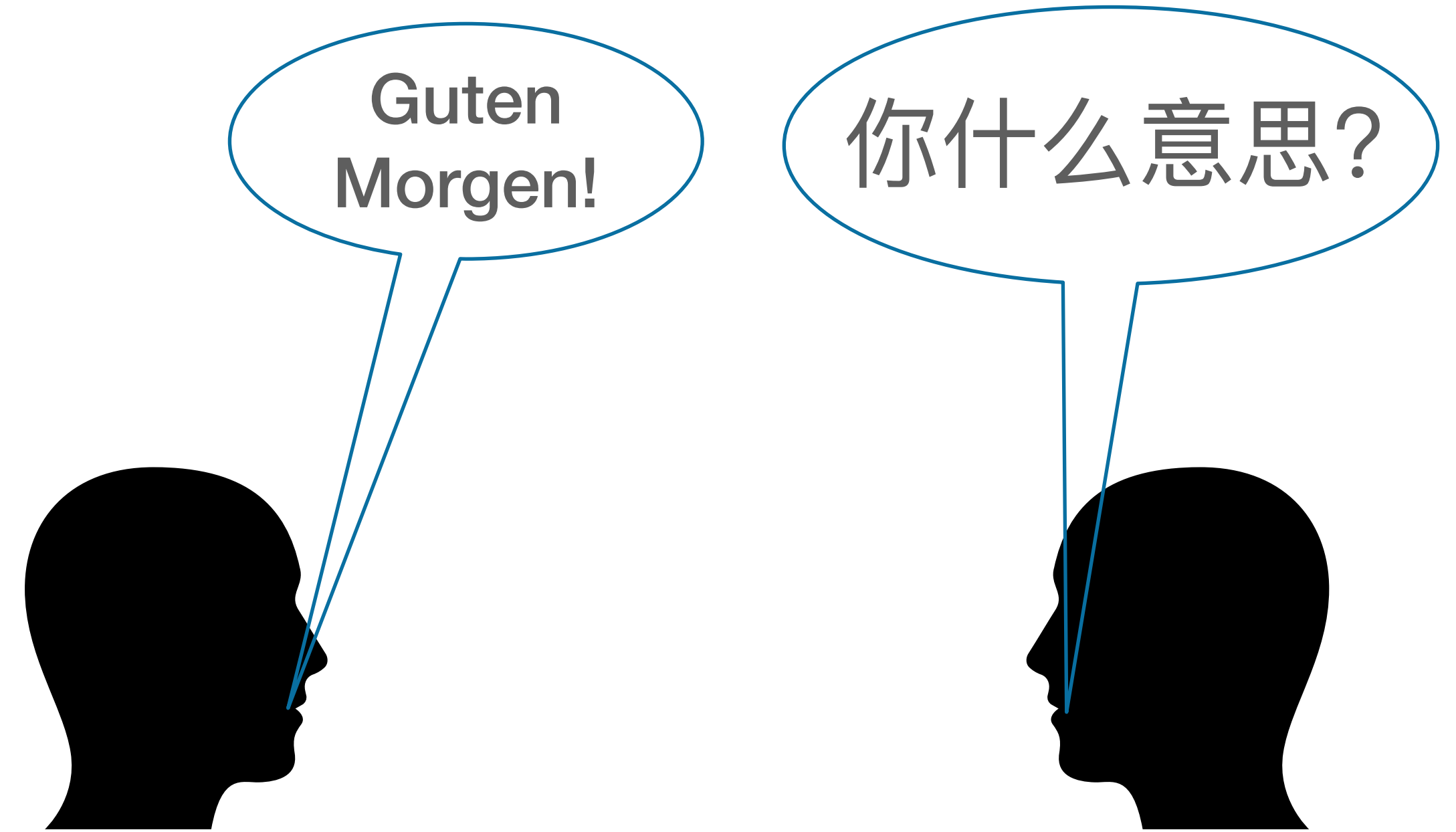
- Computer networks (and the Internet) work in the same way
- Data is most of the time too big to sent as a whole
- So it is cut into packets by the sender
- And put together by the receiver
- Network Protocols take care that the transmission is successful



Protocols

What is a "Protocol"?

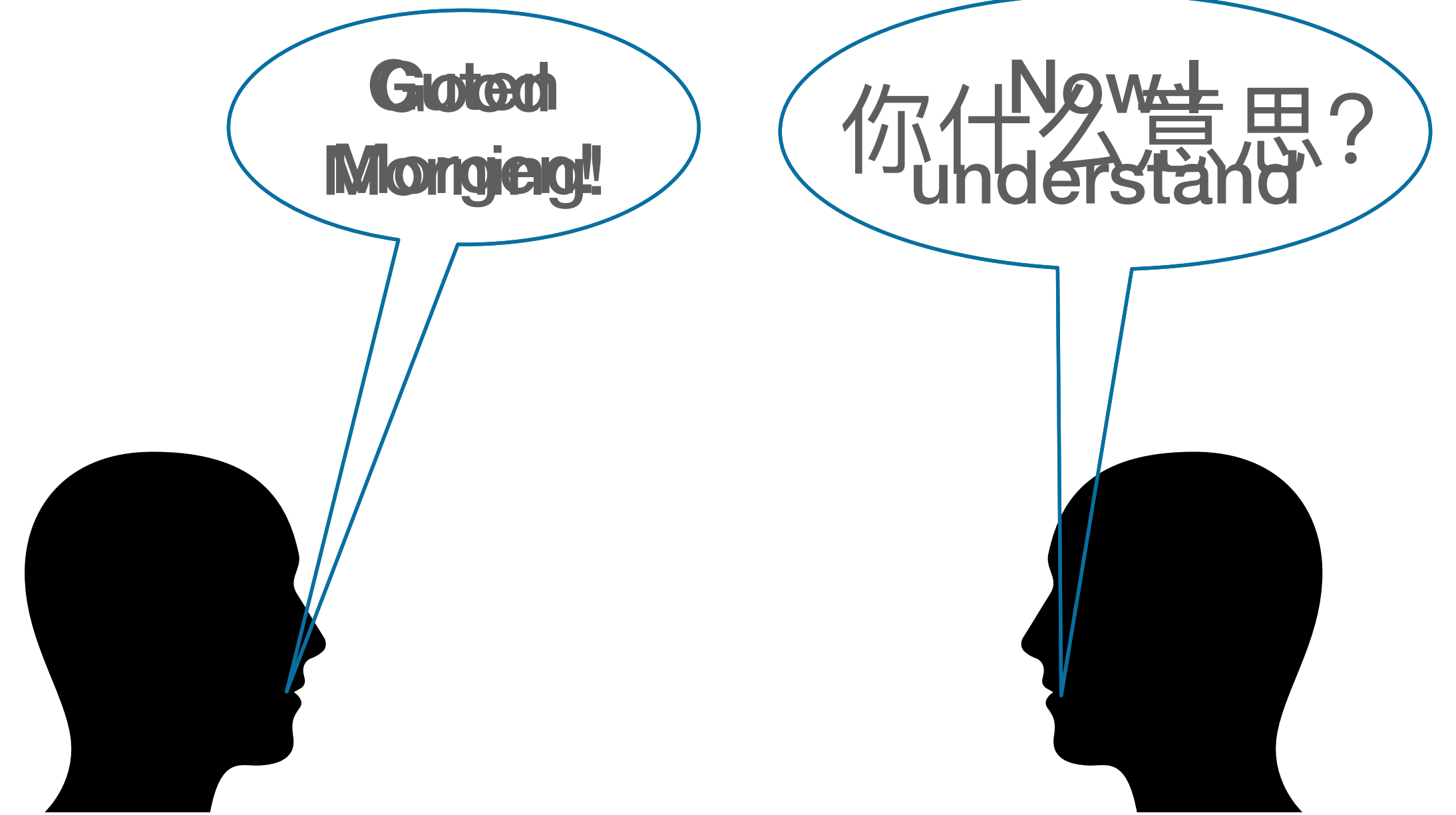
- If you want to communicate, you need to speak a common language
- Otherwise you will not understand each other



PS: I used Google Translate. Hope it says "I do not understand"

What is a "Protocol"?

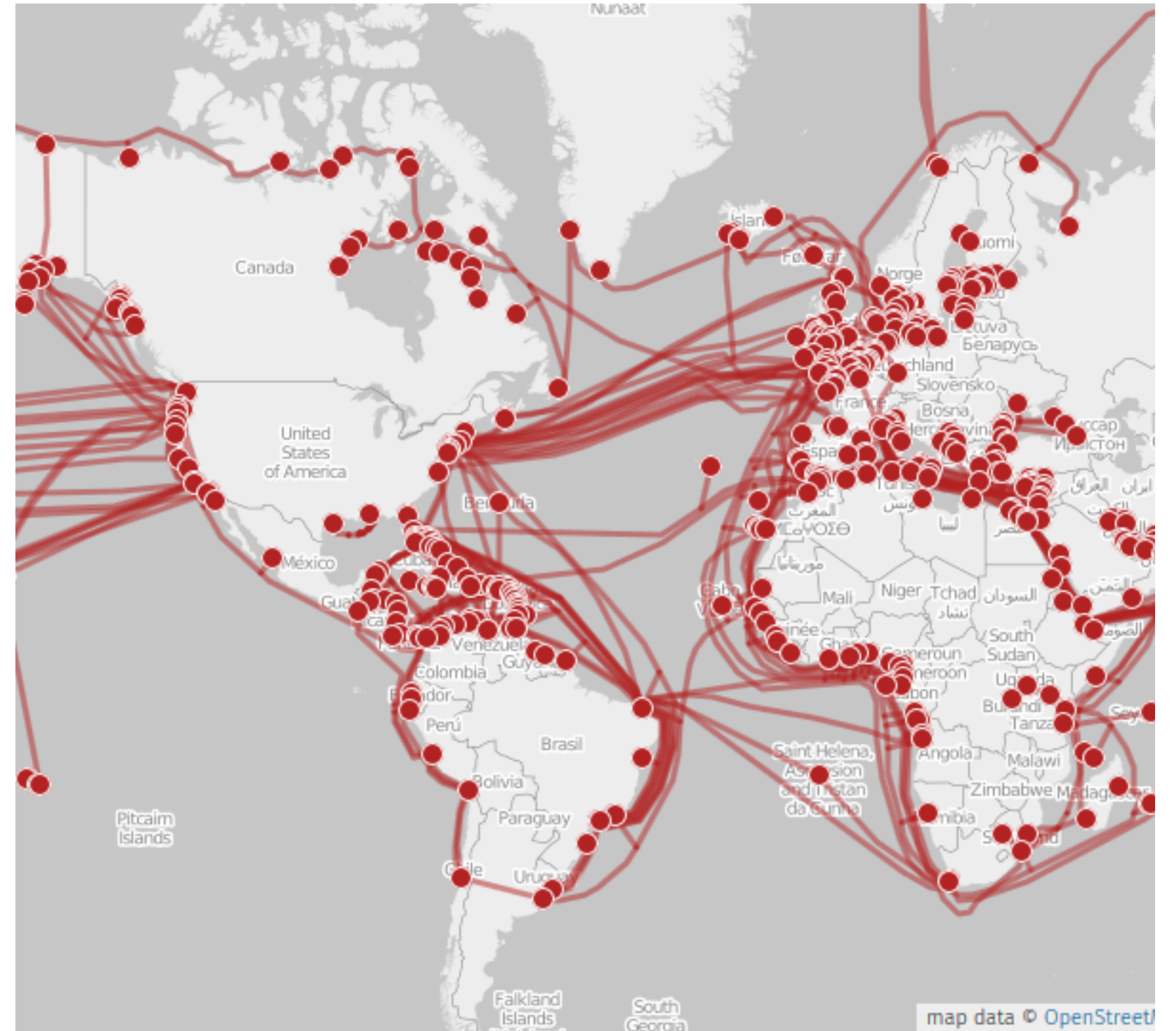
- If you want to communicate, you need to speak a common language
- Otherwise you will not understand each other
- The same is true for computers or other network devices



Protocols used

Internet

- The protocol used for the Internet is called "IP"
- IP stands for "Internet Protocol"
 - actually there are two variants of this protocol used
- IPv4 and IPv6
- There is a video where I explain IP!



Attribution: cable data by Greg Mahlkecht , map by Openstreetmap contributors
https://commons.wikimedia.org/wiki/File:Submarine_cable_map_umap.png

Protocols used

Local networks

- The protocol used for your local network at home is called "Ethernet"
- But you also use IP!
- Confused?
 - *Multiple* protocols are used
 - This is called a Protocol Stack



Protocol Stack

OSI reference model

The Protocol Stack

OSI reference model

- OSI = Open Systems Interconnection
 - Project at ISO (International Organization for Standardization)
- Defined in the 1970s and 1980s
- Intended as a vendor-independent "real" network model
 - But never took off
- Still relevant as reference for teaching

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



OSI Model

Relevance

- It was intended as a working network
- It had some good ideas
 - Like the separation of layers
 - And layers building on each other
- While OSI was writing papers, the Internet guys were already implementing
- Despite all money put into OSI, Internet won

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OSI Model

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

Internet Model

Layer	Name
5	Application
4	Transport
3	Internet
2	Link
1	Physical

Internet Model

Also has layers

- The IP protocols do not exactly fit into the OSI model
- There is also no intention of compliance to OSI
- Internet Protocols care more about architecture and optimization than about layering
- "Running code" most important

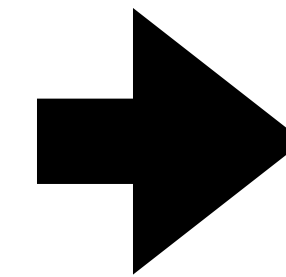
Layer	Name
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1	Physical



Internet Model

Physical Layer

- Data units are bits or symbols
- via a physical medium
- Like light pulses or electrical signals
- Examples:
 - an optical transceiver
 - an electrical Ethernet port

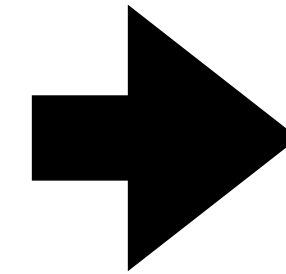


Layer	Name
5	Application
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2	Link
1	Physical

Internet Model

Link Layer

- Data units are called "Frames"
- Provides node-to-node data transfer
- Needs addresses for interfaces
- Examples:
 - Point-to-Point Protocol (PPP)
 - Ethernet

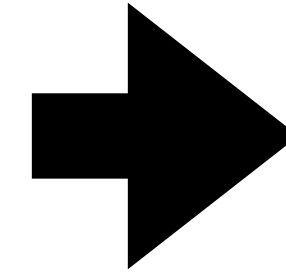


Layer	Name
5	Application
4	Transport
3	Internet
2	Link
1	Physical

Internet Model

IP / Internet Layer

- Data units are called "Packets"
- Provides source to destination transport
- Needs addresses for hosts
- Examples:
 - IPv4
 - IPv6

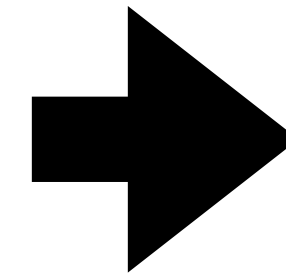


Layer	Name
5	Application
4	Transport
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1	Physical

Internet Model

Transport Layer

- *May* provide flow control, reliability, congestion avoidance
- Not all of them in all protocols
- Also contains information about the next layer up
- Examples:
 - TCP (flow control, reliability, congestion avoidance)
 - UDP (none of the above)



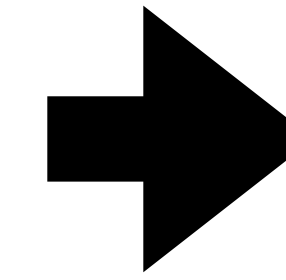
Layer	Name
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Internet Model

Application Layer

- no special name for data units, just "Data"
- Contains all application protocols
- Examples:
 - SMTP, HTTP, SSH and all others



Layer	Name
5	Application
4	Transport
3	Internet
2	Link
1	Physical



Conclusion

Conclusion

This is what you should remember

- Networks are everywhere
- Data is sent in **packets** via a network
- A **protocol** is a common language devices speak so they understand each other
- The OSI model defines a network as a number of **layers**
- The Internet does not exactly fit into the OSI model



Thank you!

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Links and further reading

Links and further reading

- A computer network - https://en.wikipedia.org/wiki/Computer_network
- Other networks
 - Street network - https://en.wikipedia.org/wiki/Street_network
 - Electrical grid - https://en.wikipedia.org/wiki/Electrical_grid
 - Postal service - <https://en.wikipedia.org/wiki/Mail>
- Data is sent in packets
 - Packet switching - https://en.wikipedia.org/wiki/Packet_switching
 - Network packet - https://en.wikipedia.org/wiki/Network_packet
- Protocols
 - Communication protocol - https://en.wikipedia.org/wiki/Communication_protocol
 - Internet protocol - https://en.wikipedia.org/wiki/Internet_Protocol
 - IPv4 - <https://en.wikipedia.org/wiki/IPv4>
 - IPv6 - <https://en.wikipedia.org/wiki/IPv6>
 - Ethernet - <https://en.wikipedia.org/wiki/Ethernet>

Protocol stacks

- Protocol stack - https://en.wikipedia.org/wiki/Protocol_stack
- OSI Network Model: https://en.wikipedia.org/wiki/OSI_model
 - Physical Layer: https://en.wikipedia.org/wiki/Physical_layer
 - Data Link Layer: https://en.wikipedia.org/wiki/Data_link_layer
 - Network Layer: https://en.wikipedia.org/wiki/Network_layer
 - Transport Layer: https://en.wikipedia.org/wiki/Transport_layer
 - Session Layer: https://en.wikipedia.org/wiki/Session_layer
 - Presentation Layer: https://en.wikipedia.org/wiki/Presentation_layer
 - Application Layer: https://en.wikipedia.org/wiki/Application_layer
- IP Network Model: https://en.wikipedia.org/wiki/Internet_protocol_suite

Internet RFCs (Standards)

- [RFC1122](#), [RFC1123](#) - Requirement for Internet Hosts
- [RFC3439](#) - Internet Architectural Guidelines and Philosophy