

Introduction to Computer Networks

Computer Networks: a HW/SW Perspective

<https://pages.cs.wisc.edu/~mgliu/CS640/F22/>

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Today

Last lecture

- What are compute networks?
- What are the requirements of computer networks?

Today

- Computer networks: hardware infrastructure
- Computer networks: software component

Announcements

- Lab1 will be released today

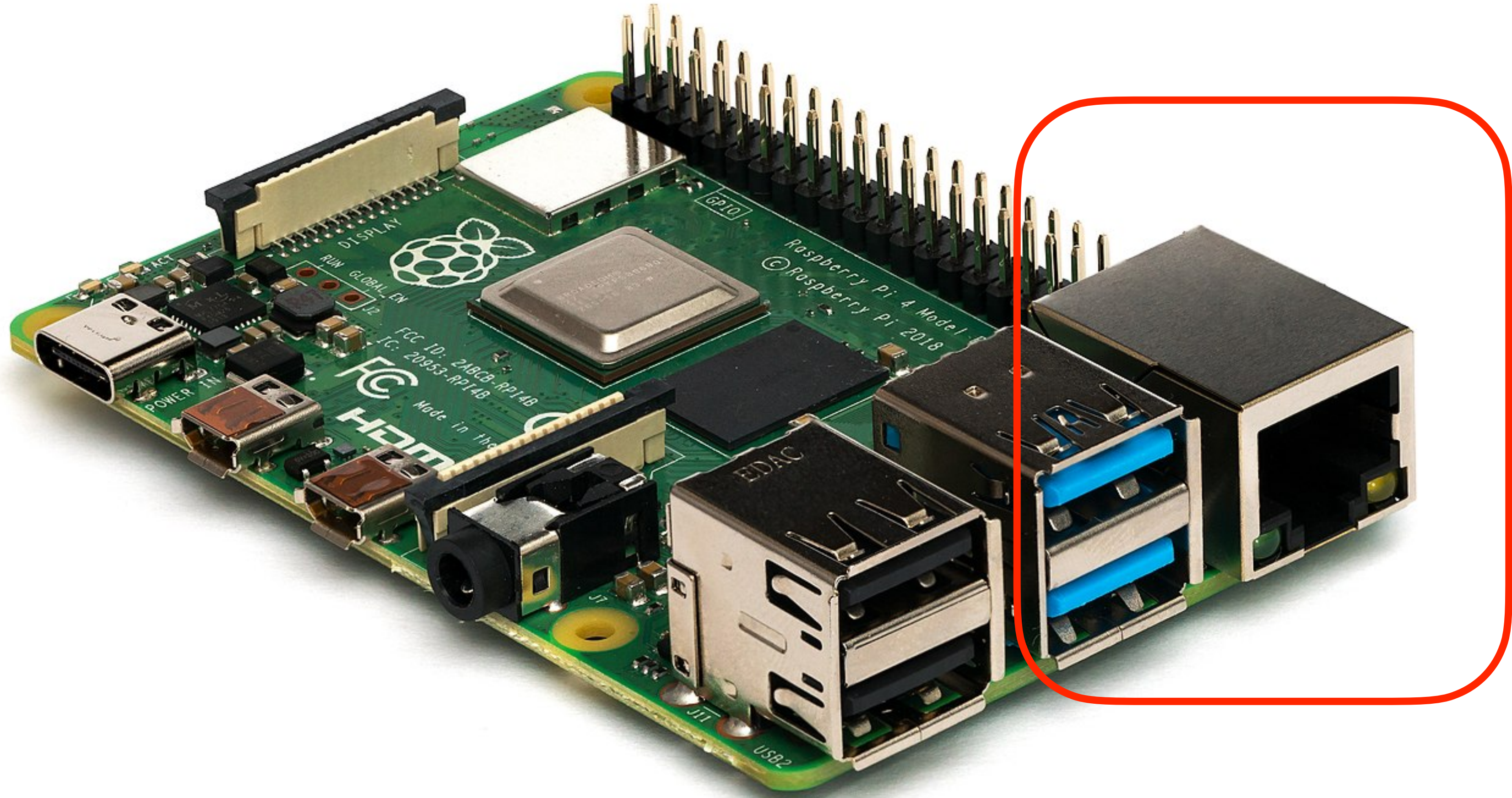
Q: What hardware elements are used to build computer networks?

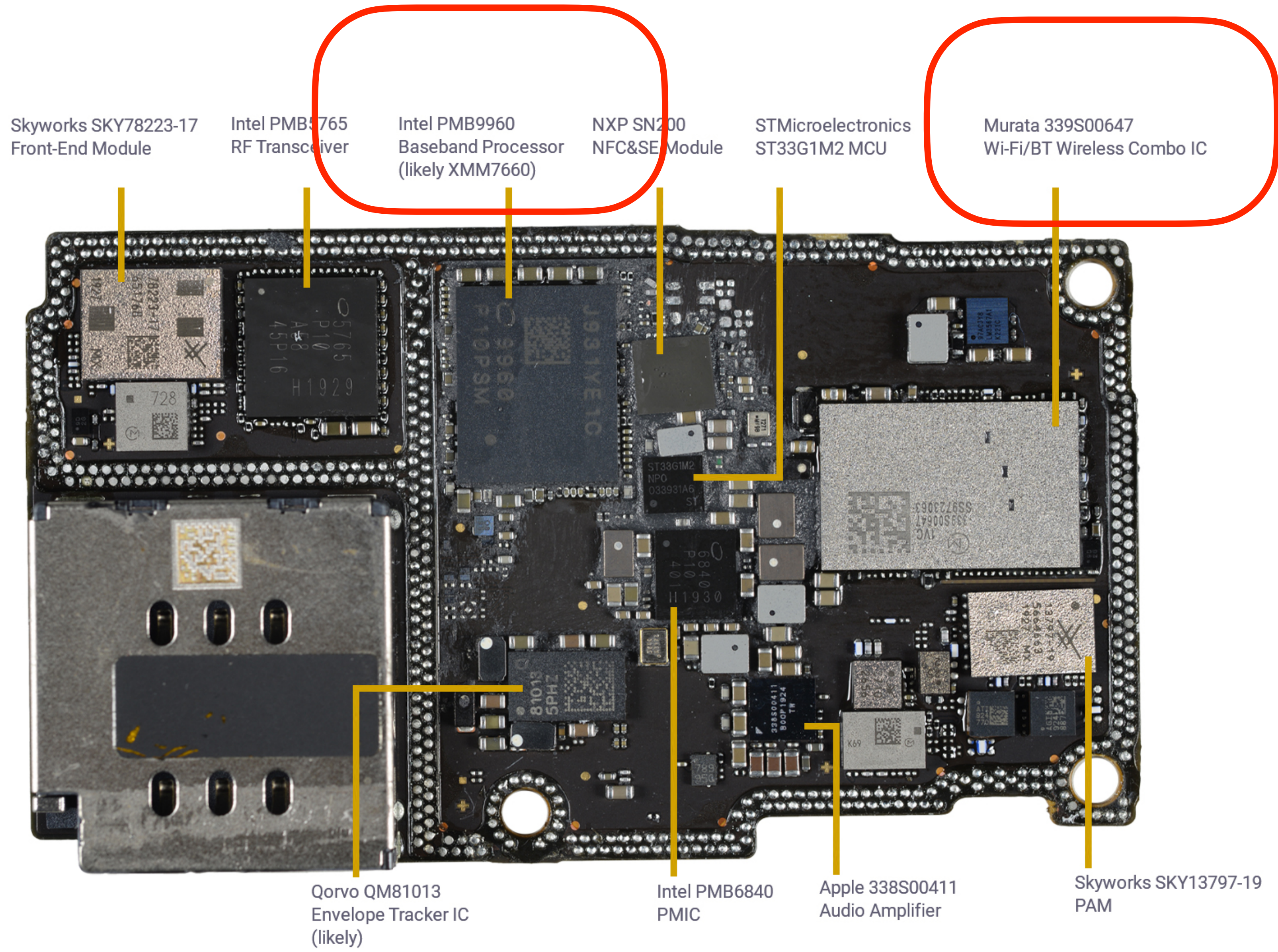
Q: What hardware elements are used to build computer networks?

A: There are specialized I/O devices:

#1: Network interface card (NIC)

A networking hardware, attached to the end host, provides network accessing point





Q: What hardware elements are used to build computer networks?

A: There are specialized I/O devices:

#1: Network interface card (NIC)

#2: Cable



A networking hardware provides NIC-to-NIC connections through communication media

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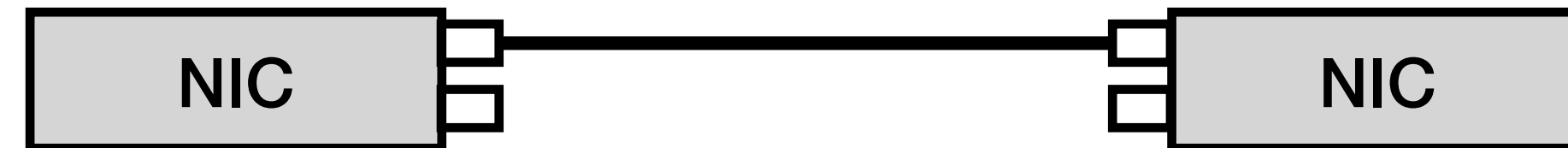
#2: Cable

#3: Multi-port I/O bridge

A networking hardware, with multiple input/output ports, enables scalable communications. Examples include hubs, switches, and routers.

Three building blocks

#1: NIC-Cable-NIC



#2: NIC-Cable-Bridge



#3: Bridge-Cable-Bridge



More discussion

There is no perfect hardware

- Limitations: #ports, length, bandwidth, ...

More discussion

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Q: Suppose we are building a network for 16 hosts using NICs, cables, and bridges. If (1) the NIC has 1 port; (2) the bridge has 8 ports. How many bridges do we need at least to make all hosts fully connected (i.e., there is a connection between any two hosts)?

More discussion

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A: 3

More discussion

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- The fabric is build and maintained by network providers

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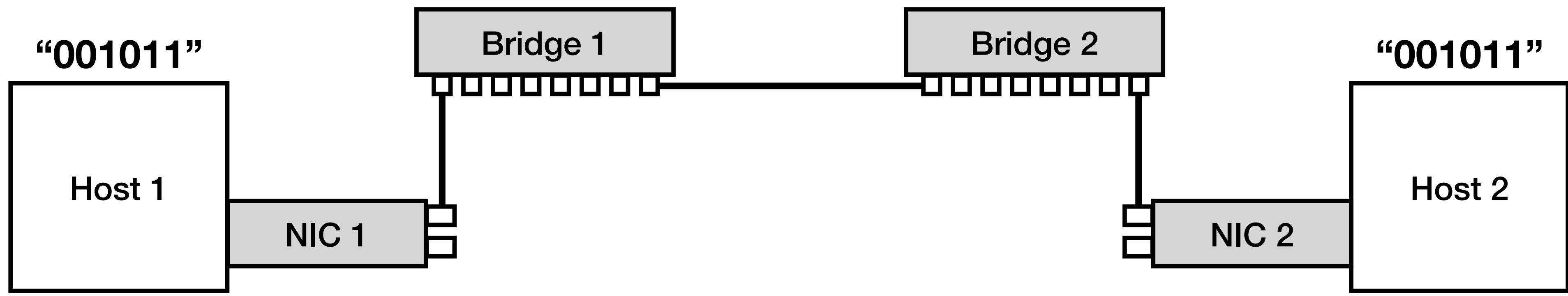
Three audiences of computer networks:

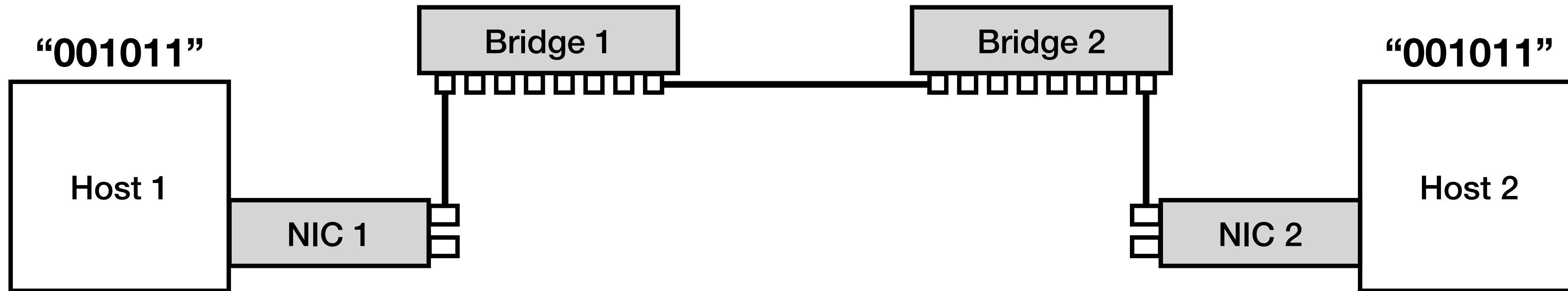
#1: Network designer

#2: Network provider

#3: Network user

Q: What software components are needed to build computer networks?

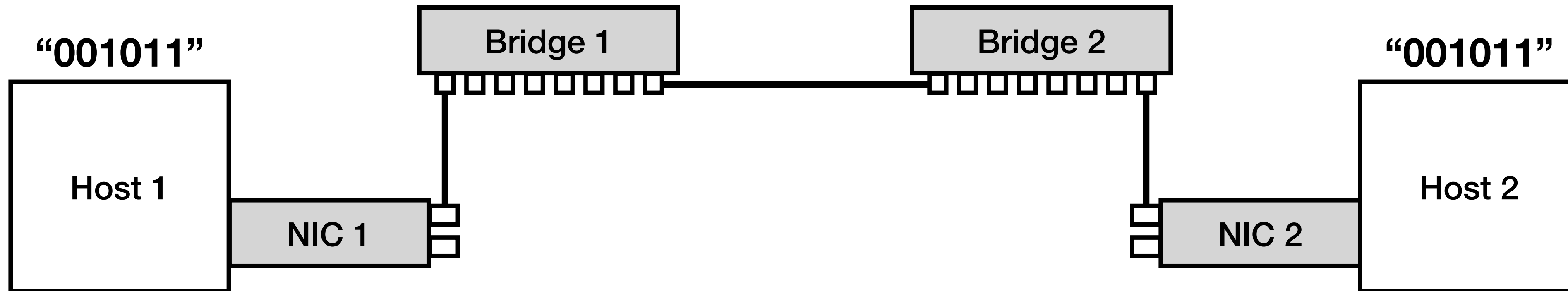




Requirements/Goals

- #1: Anytime and anywhere **connectivity**
- #2: Always-on **correctness**
- #3: Reasonable **performance**
- #4: Low **cost**
- #5: Tolerable **security**

Functionalities?

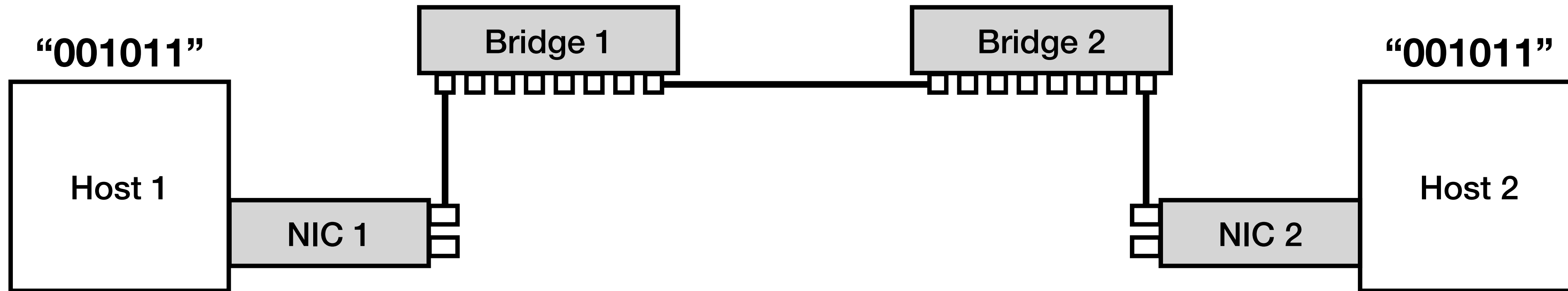


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Functionalities?

What do "Host 1/2", "NIC 1/2",
"Bridge 1/2" refer to?

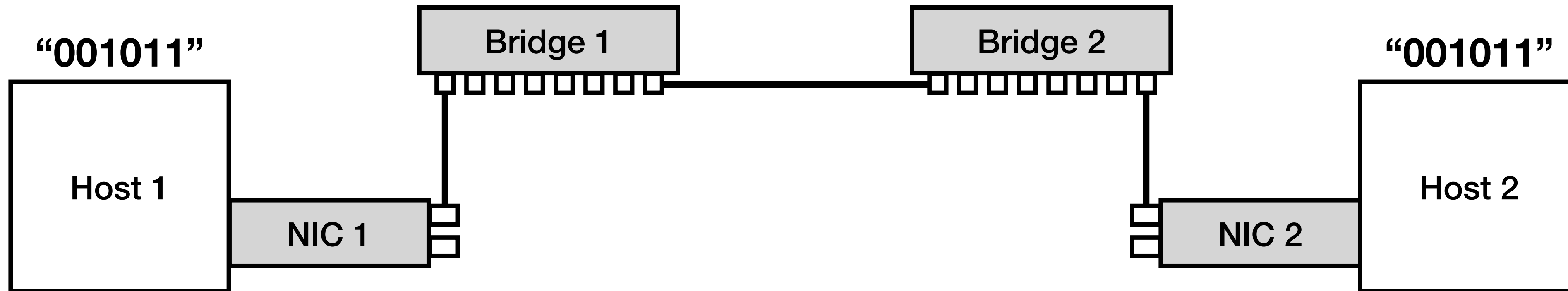


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Functionalities?

How does "Bridge 1" know where is "NIC 2"?

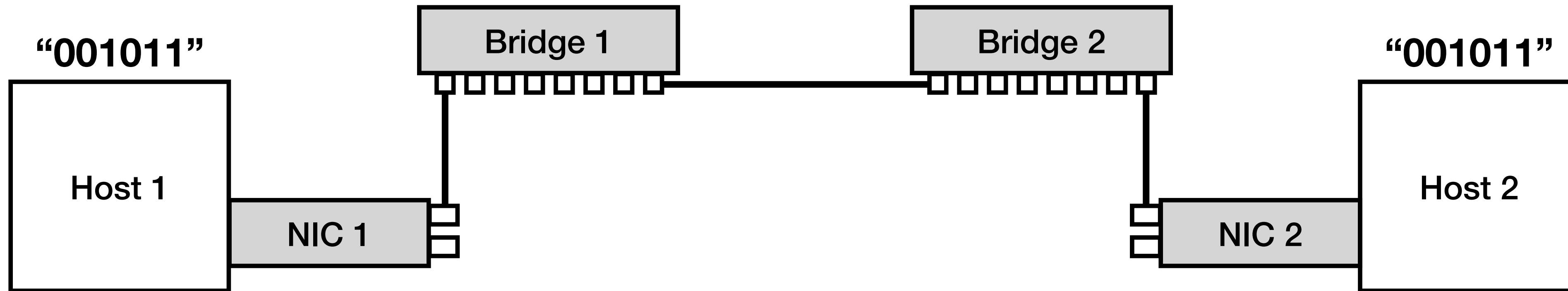


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Functionalities?

What happens if a bit flit happens at NIC1?

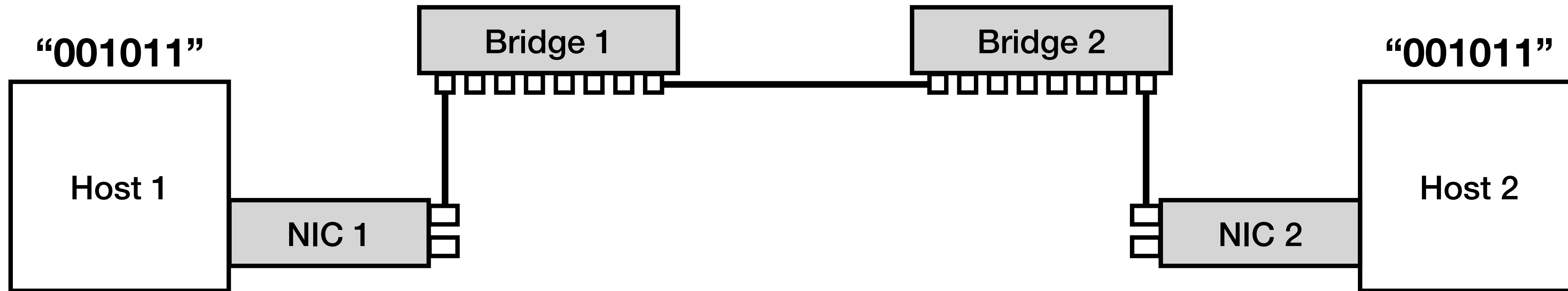


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Functionalities?

What happens if another bit stream wants to send concurrently?

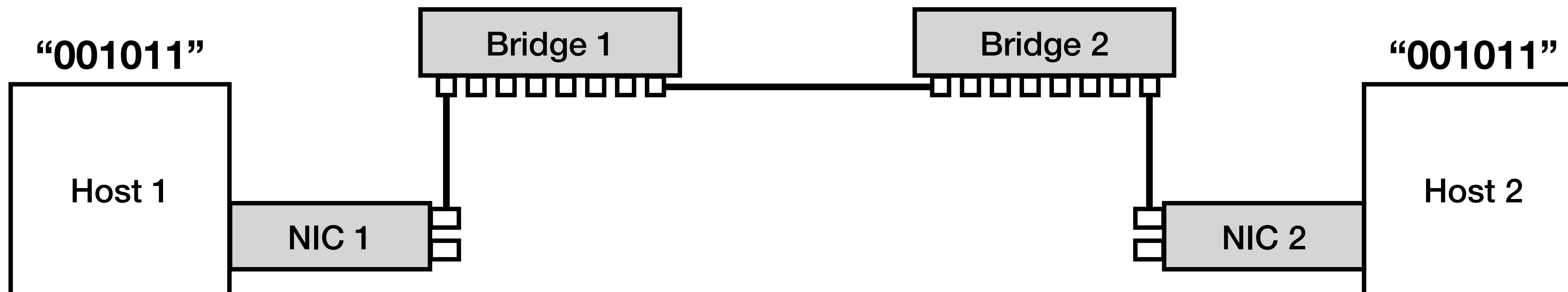


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Functionalities?

What happens if the bridge operates more slowly than others?



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Functionalities?

What happens if "001011" is learned by the network provider?

Q: What software components are needed to build computer networks?

A: A computer network should realize:

#1: Address allocation

#2: Reliable bits delivery

#3: Resource multiplexing

#4: Performance maximization

#5: Access control

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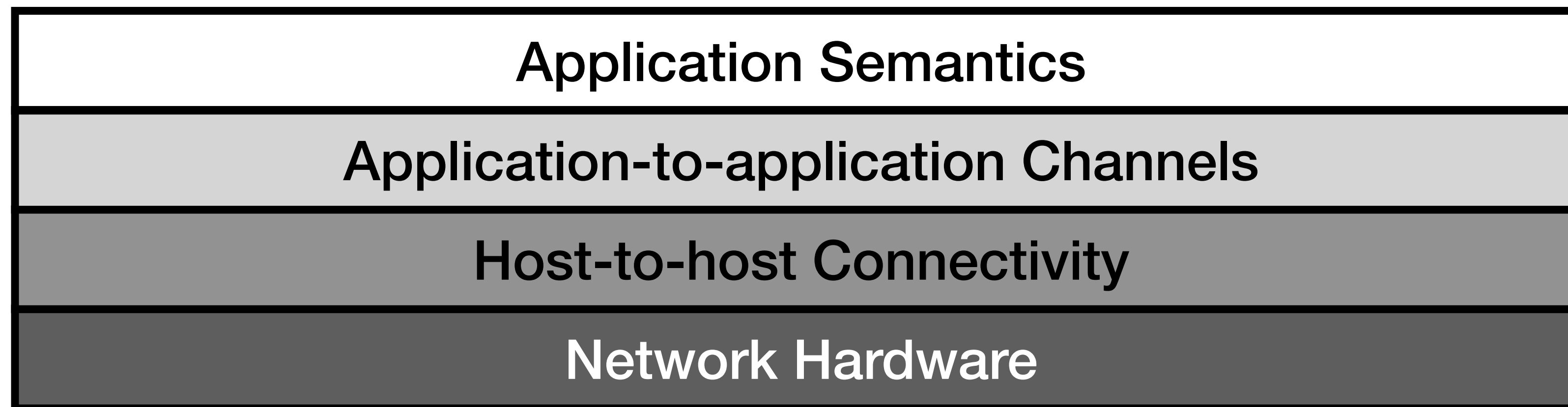
- #1: Address allocation**
- #2: Reliable bits delivery**
- #3: Resource multiplexing**
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- #5: Access control**

} Too complex to implement from the scratch

Solution: layering

Layering: a modular approach to implement new functionalities by introducing abstractions

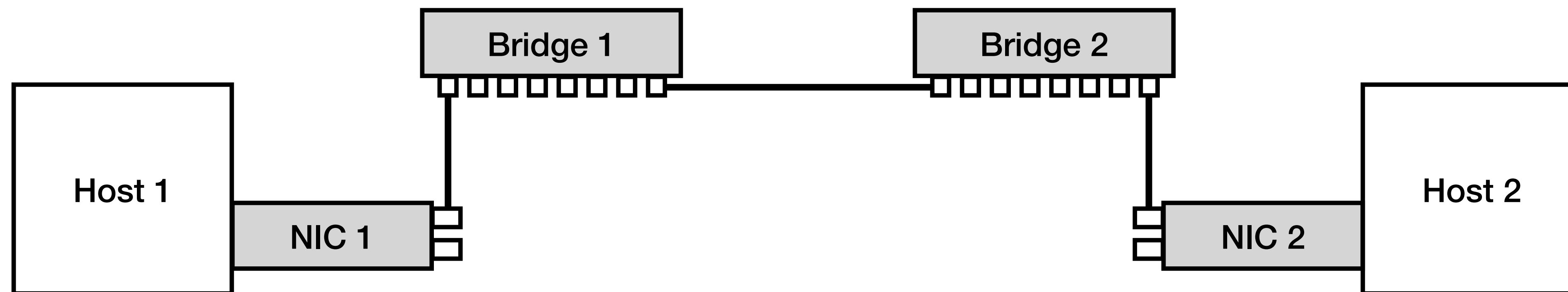
- Build the network with multiple levels of abstractions
- Each layer focuses on different functionalities



Protocol

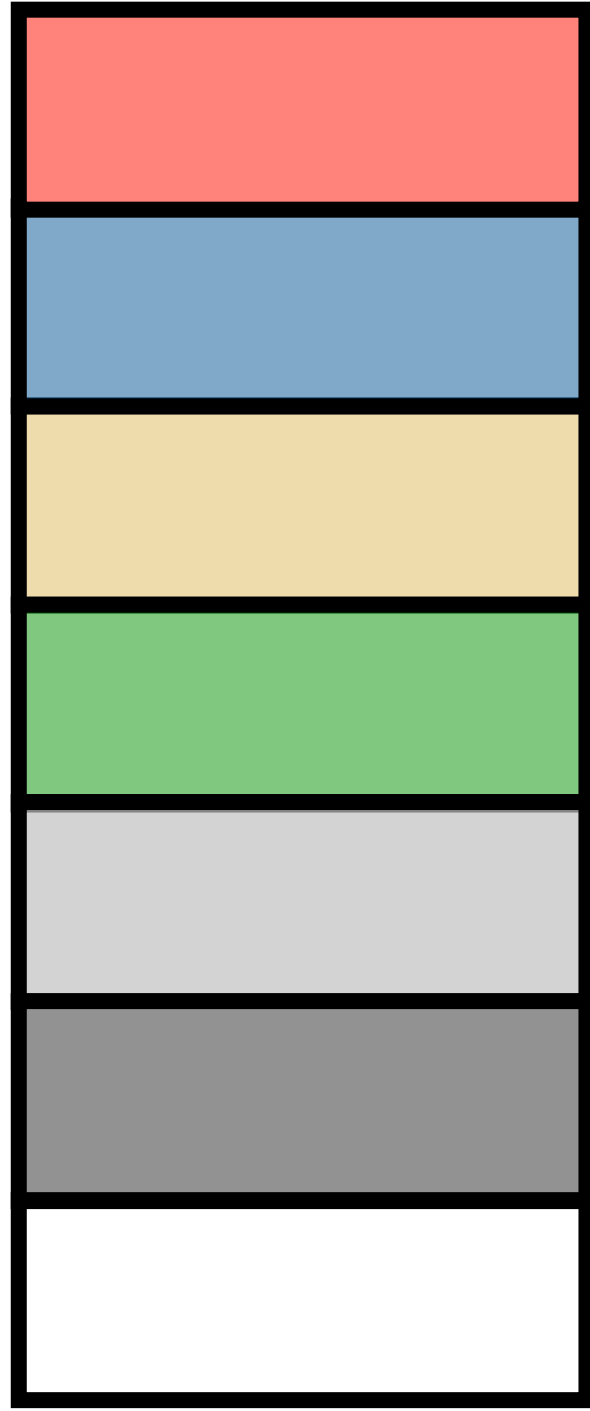
An abstract object or module in a layered structure

- Vertical view: an interface to high-level protocols
- Horizontal view: a peer interface to a counterpart

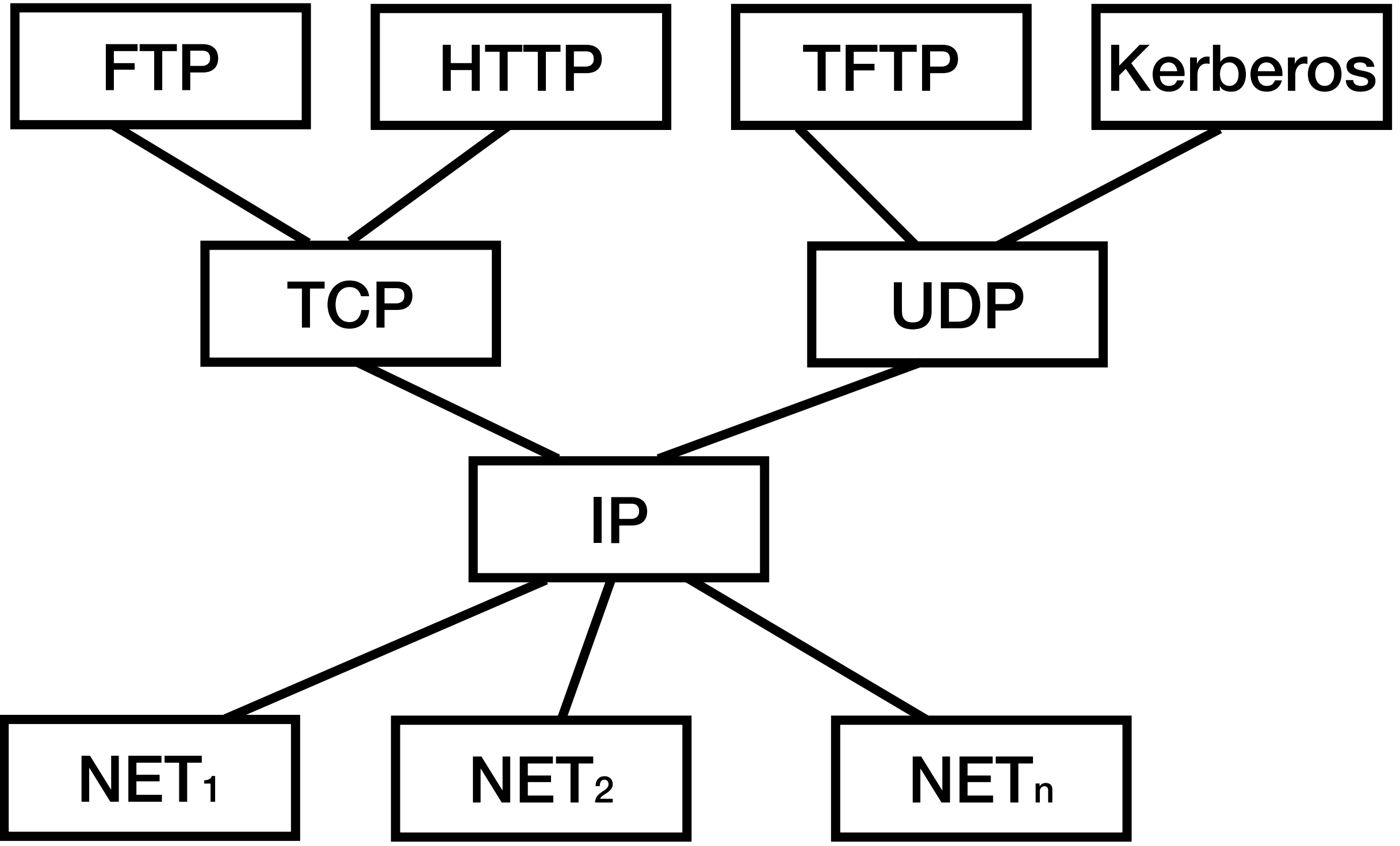


Layering and protocol example

Application
Presentation
Session
Transport
Network
Data Link
Physical



OSI model



TCP/IP

Terminology

1. Host
2. NIC
3. Multi-port I/O bridge
4. Protocol

Principle

1. Layering

Technique

Summary

Today's takeaways

#1: NIC, cable, multi-port I/O bridge

#2: Address allocation, reliable link delivery, resource multiplexing, performance maximization, access control

#3: Layering and protocols

Next lecture

- Network performance analysis