UNIVERSITY OF OSLO

From Theory to Practice

IN2140
Plenum 6

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13/2-2025

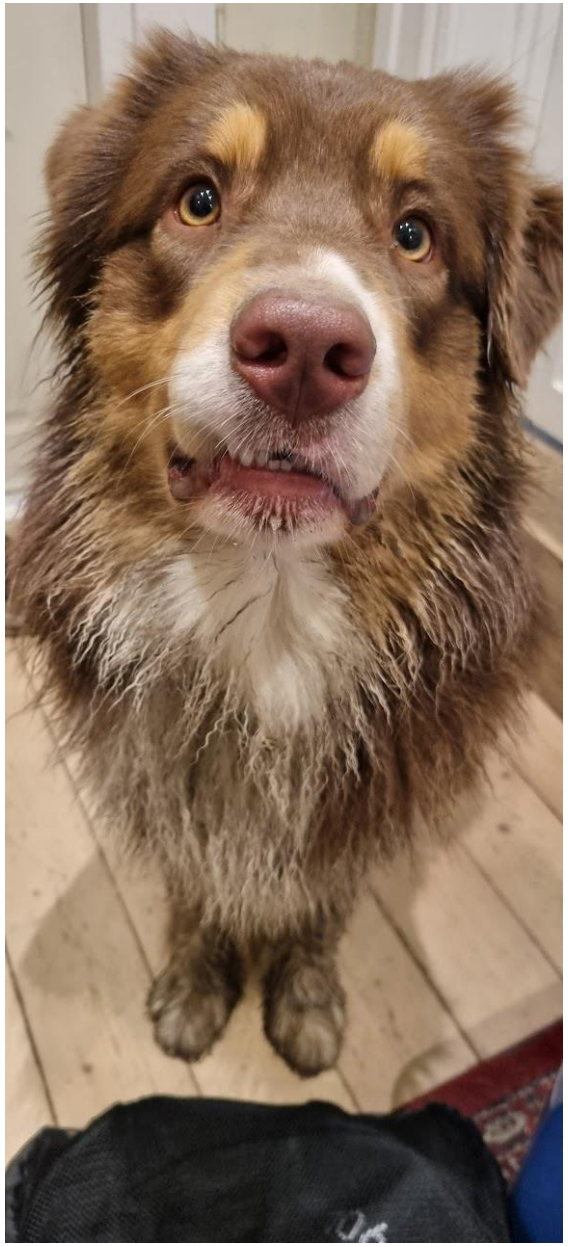


Plenum 6

- I heard you needed some slack after the mandatory assignment

- How was file systems?
  - Heard about FUSE?

- Today
  - OSI layers
  - Simple networking example
  - Test wifi and ethernet
  - Transmit a file
  - Real world example: why OSI layer is helpful



If you’re in the back..

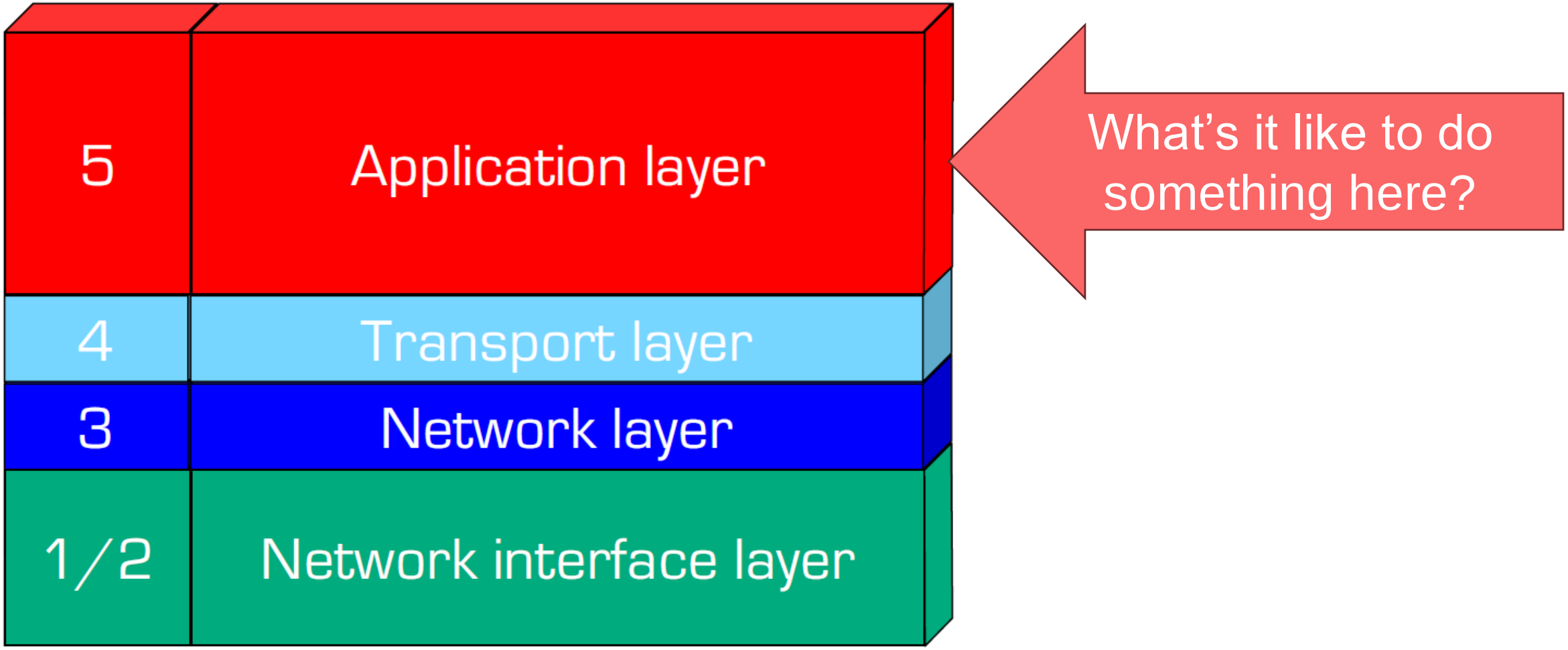
- I’ll share my screen on google meet

- **Please – no video**
- **Please – no audio**

- Don’t know if it will work, but we can have a go

https://meet.google.com/cks-gmfx-sup

The (Simplified) OSI Model



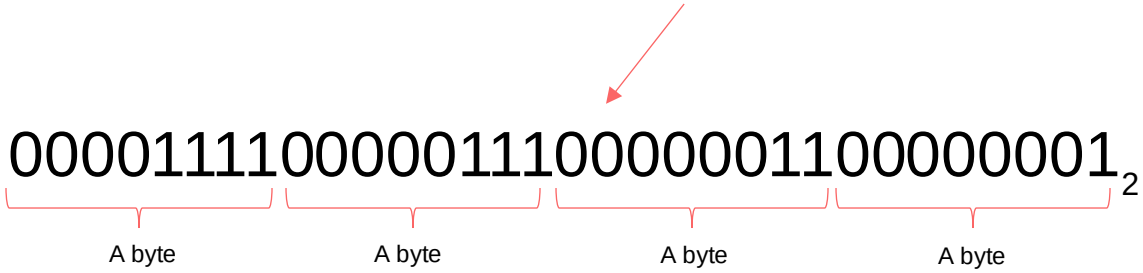
But first..



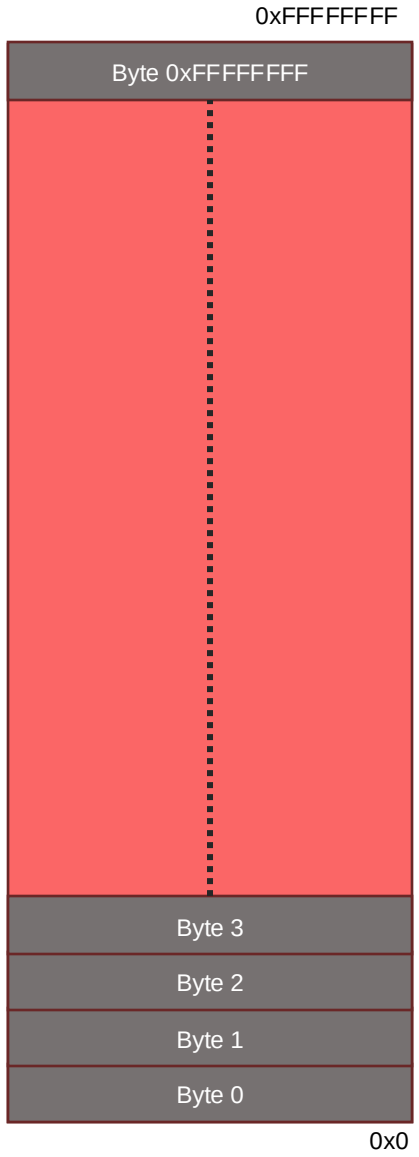
- Let’s talk about how numbers are stored in a computer

Consider the integer.

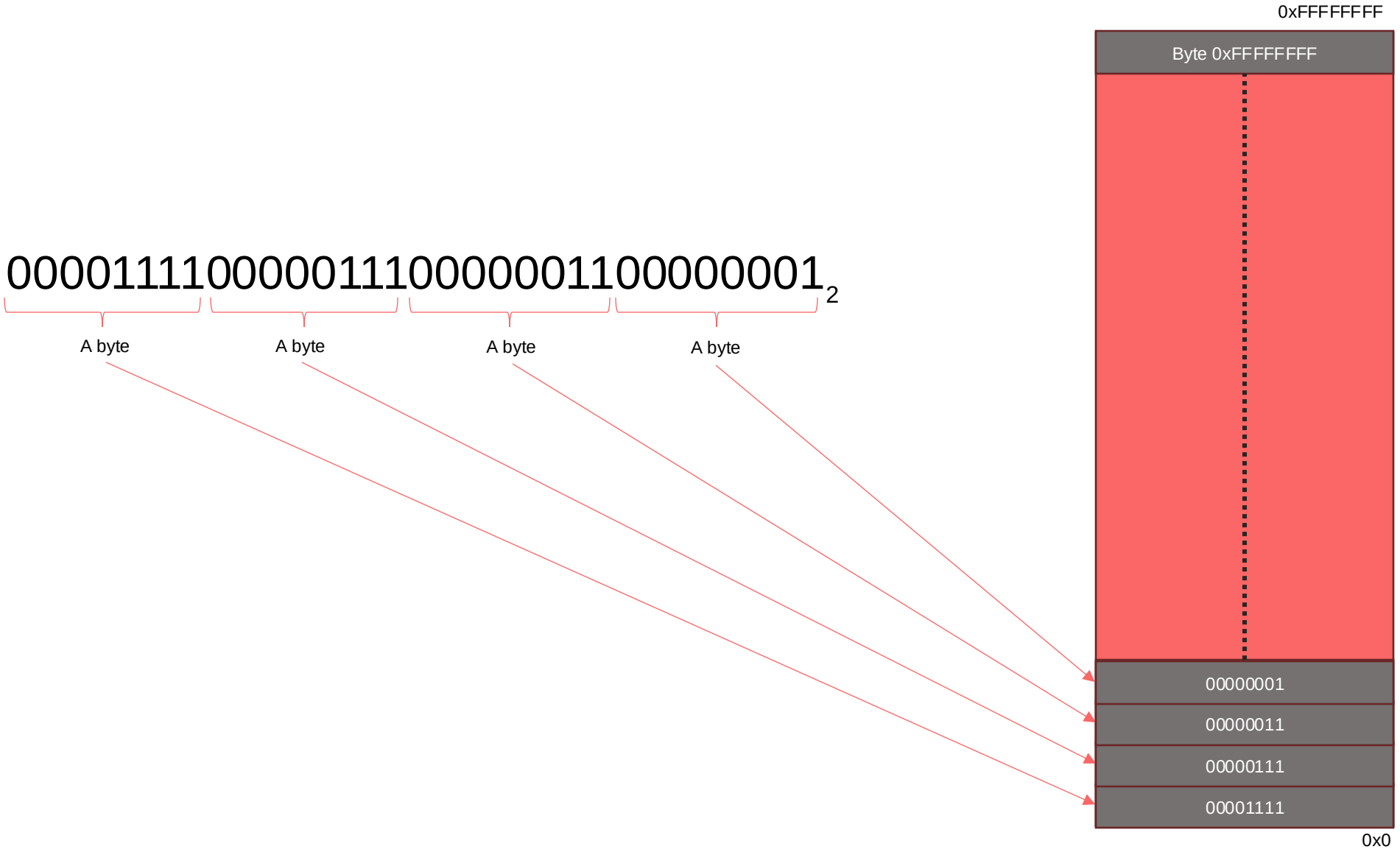
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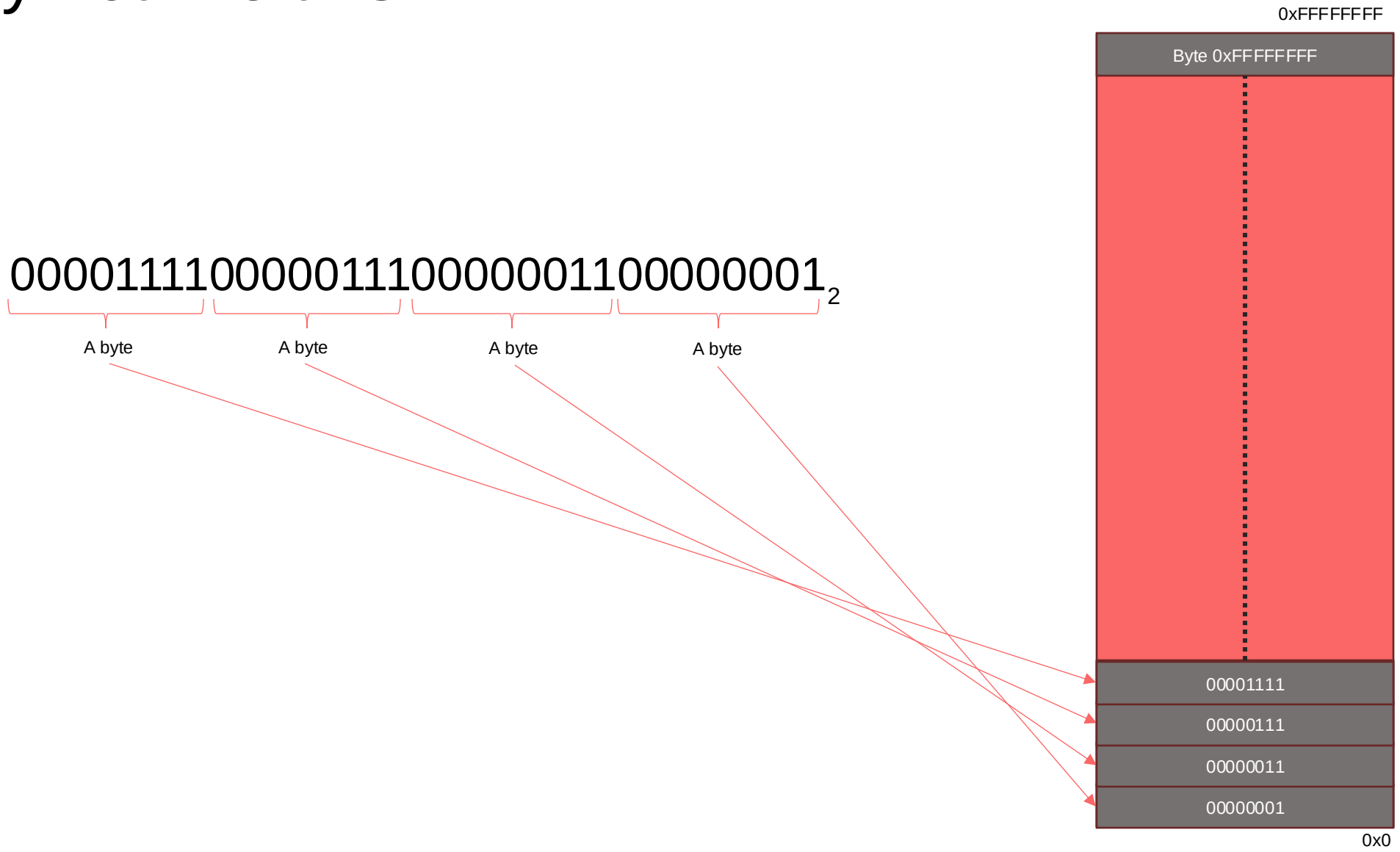
How to store it in the computer?



Like this?


0xFFFFFFFF
Byte 0xFFFFFFFF
00000111100000111000000110000000 1 2
A byte
A byte
A byte
A byte
00000001
00000011
00000111
00001111
0x0

Why not like this?



Endianness

Little endian

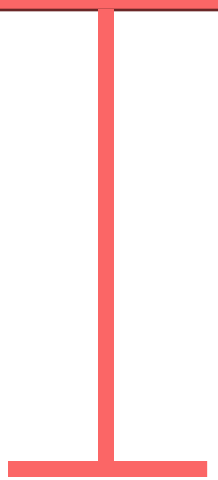
Least significant byte first.

Big endian

Most significant byte first.

«First» means the lower address.

- x86 is little endian
- ARM can be both
- Other architectures exist that are big endian



Other Useless (Computer Science) Discussions

- Spaces or tabs?

  Whatever style you need to submit patches to the Linux kernel.

- Line feed or carriage return?

  
  Depends
  

- Vim or Emacs?

  neovim
  

- What build system is best?

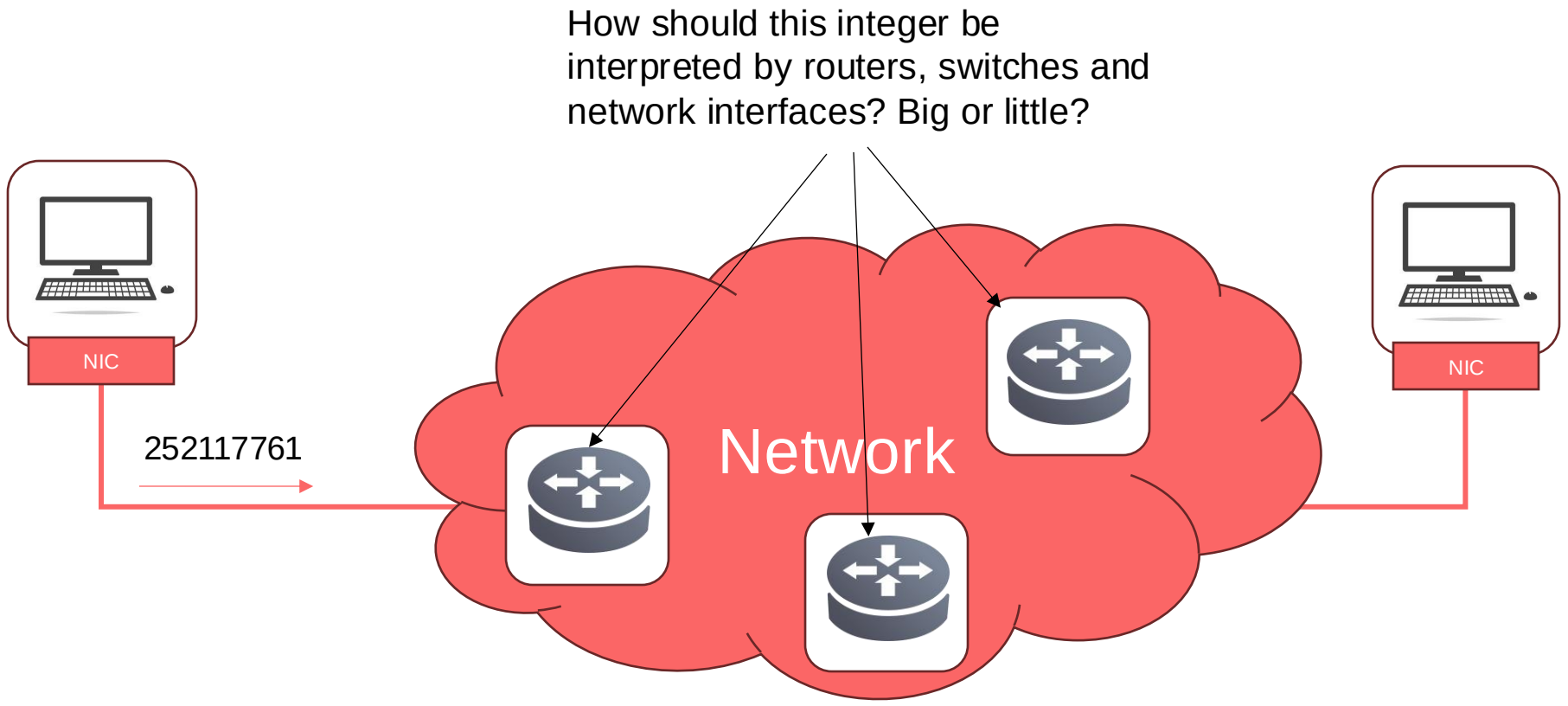
  CMake

- Which Star Wars movie is first?

  IV
  

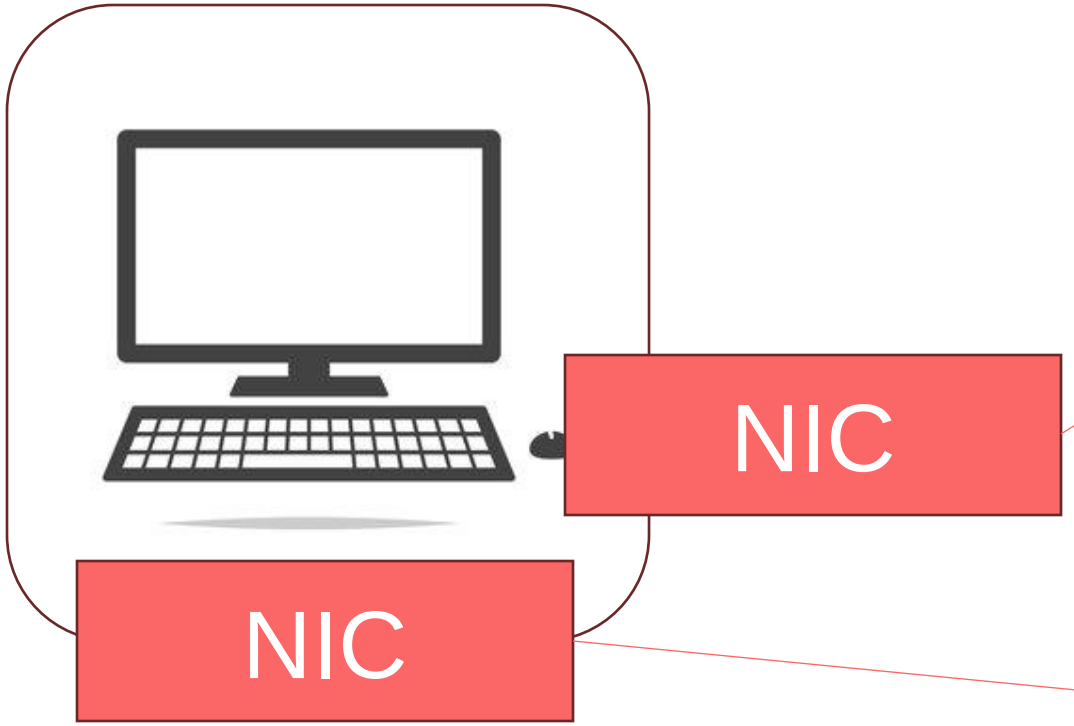
So how is this relevant?

Integers also cross the network.



I’ll leave it at that for now

Physical Network Interfaces





Ethernet Interface

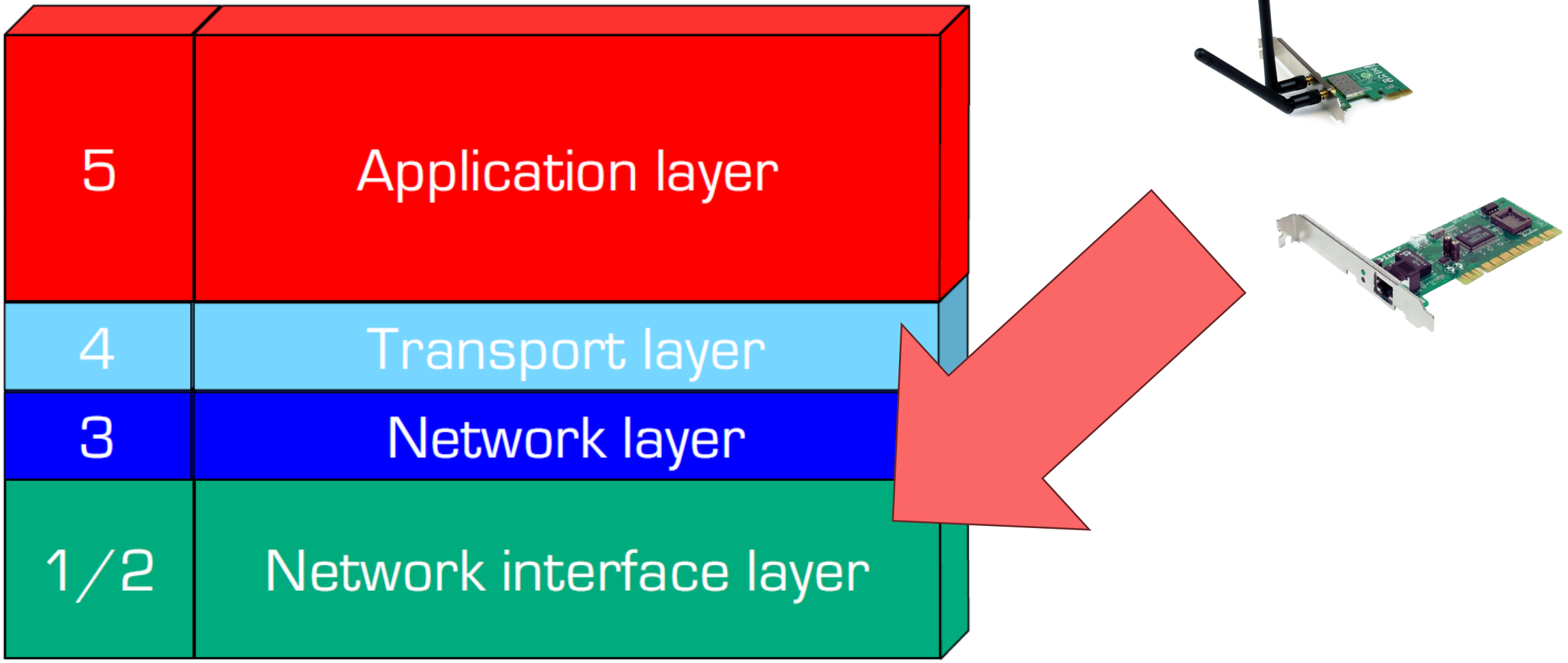


WiFi Interface

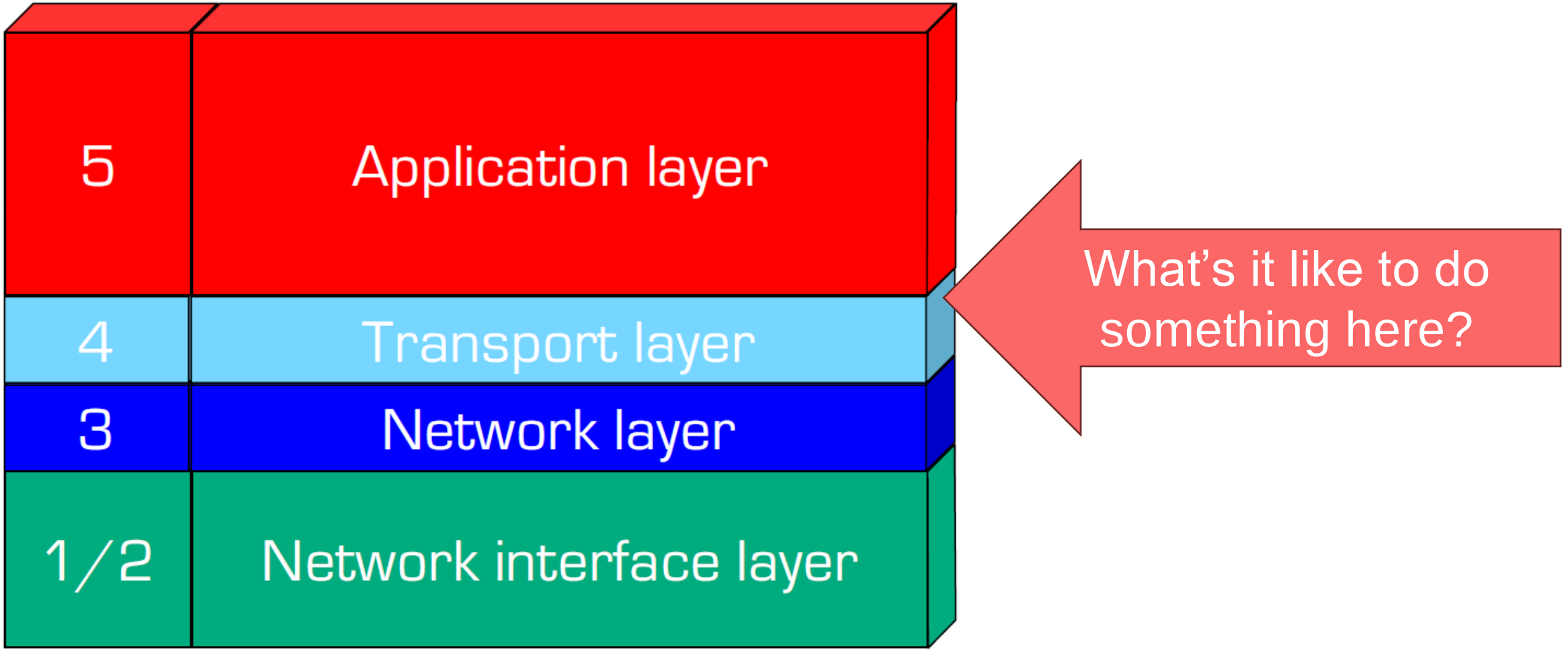
NIC=Network Interface Card

Example:
ifconfig

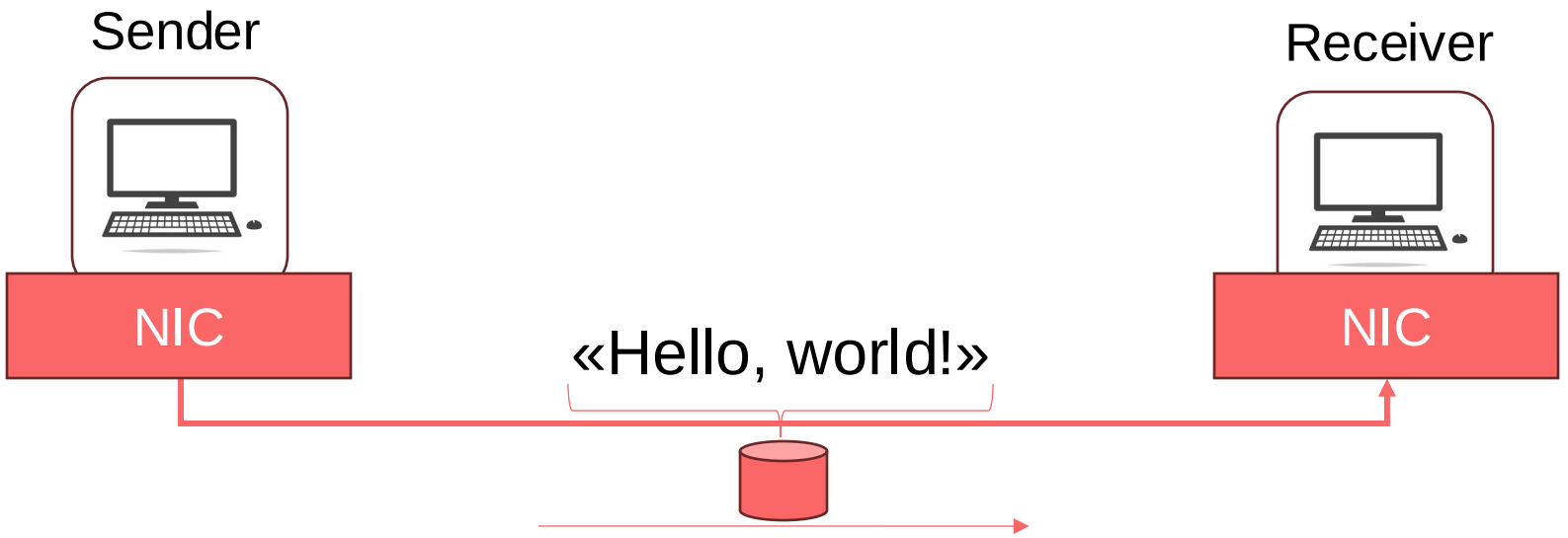
Physical Network Interfaces Live in Layer 1



The (Simplified) OSI Model

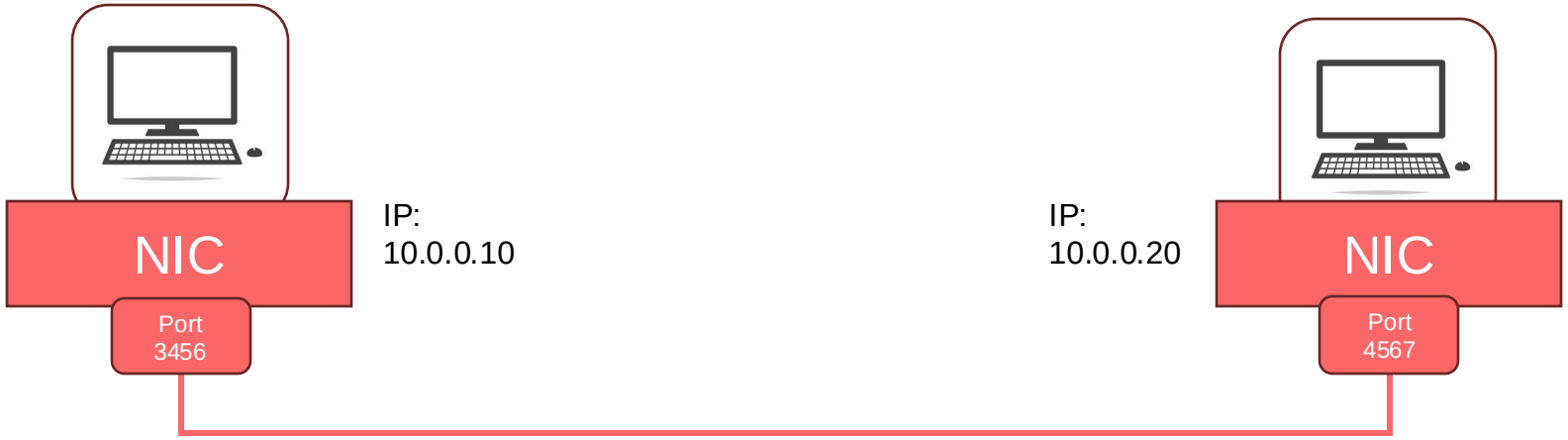


My plan



1. Some simple CLI tools (**ifconfig** and **ping**)
2. A simple example just to send something from one computer to the next.
3. Transmit a file.

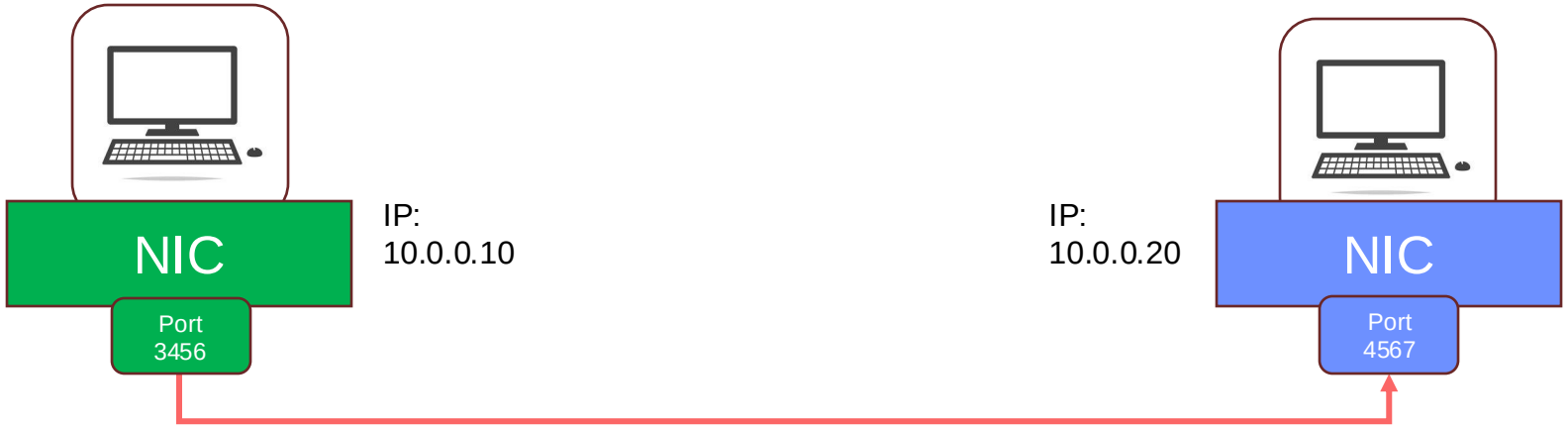
Background Knowledge



- A NIC (network interface card) has:
  1. An IP address.
  2. A range of ports (Port 0 to Port 65535).

Example:
ifconfig and ping

Background Knowledge

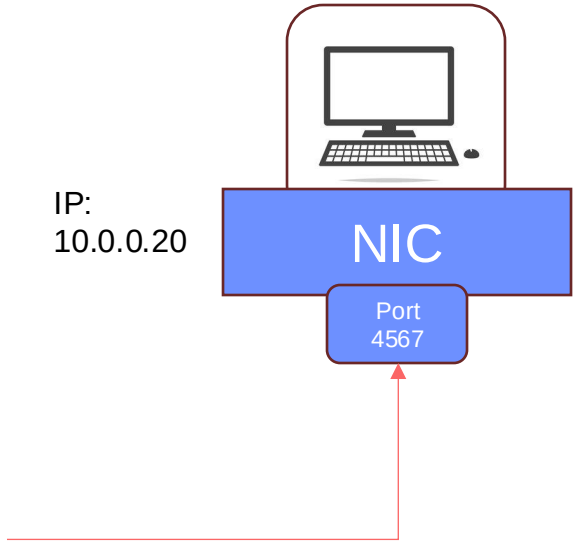


- To send something..
  - The sender must know the destination IP and port
  - The destination must open a port which it can listen for data.

How to open a **port** on an **interface with an IP**?

- **socket** programming!

- Let’s start with the receiver

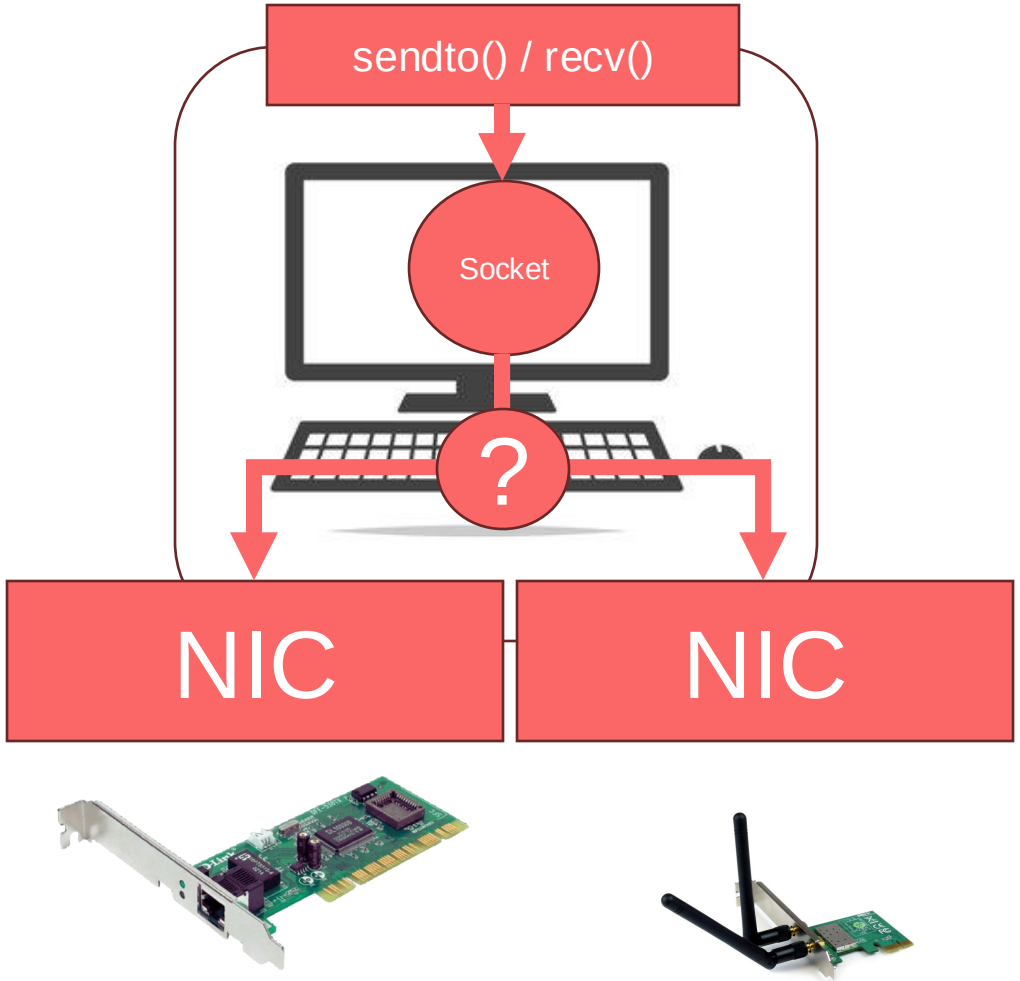


Is it enough with a socked **fd**?

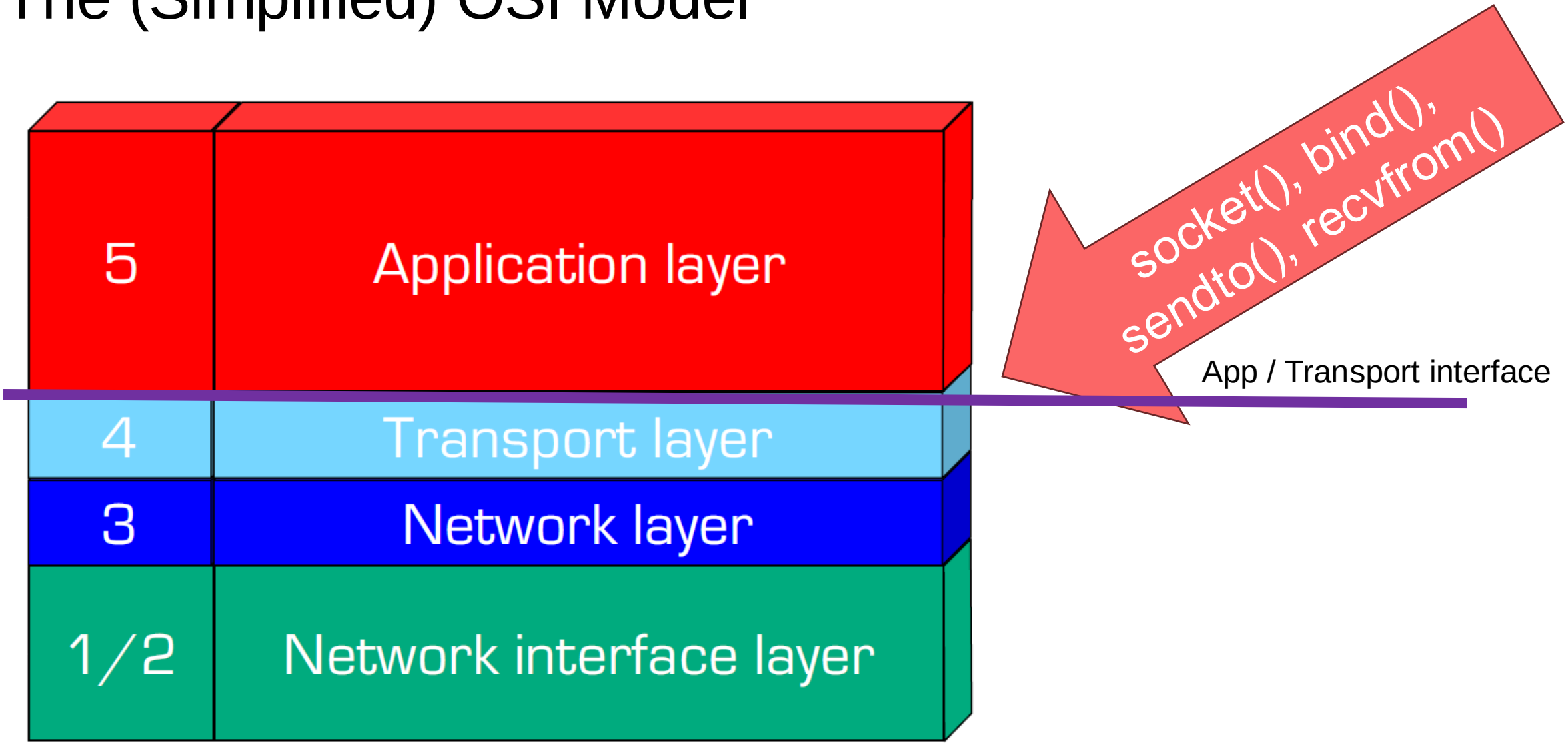
- With a socket **fd** (filedescriptor), we can:
  - recv(fd, ..) ← Read data from the socket
  - sendto(fd, ..) ← Write data to socket

- Is it enough?
  - Imagine that you have **one socket** and **two NICs**
  - Which NIC do you sendto() / recv() from?

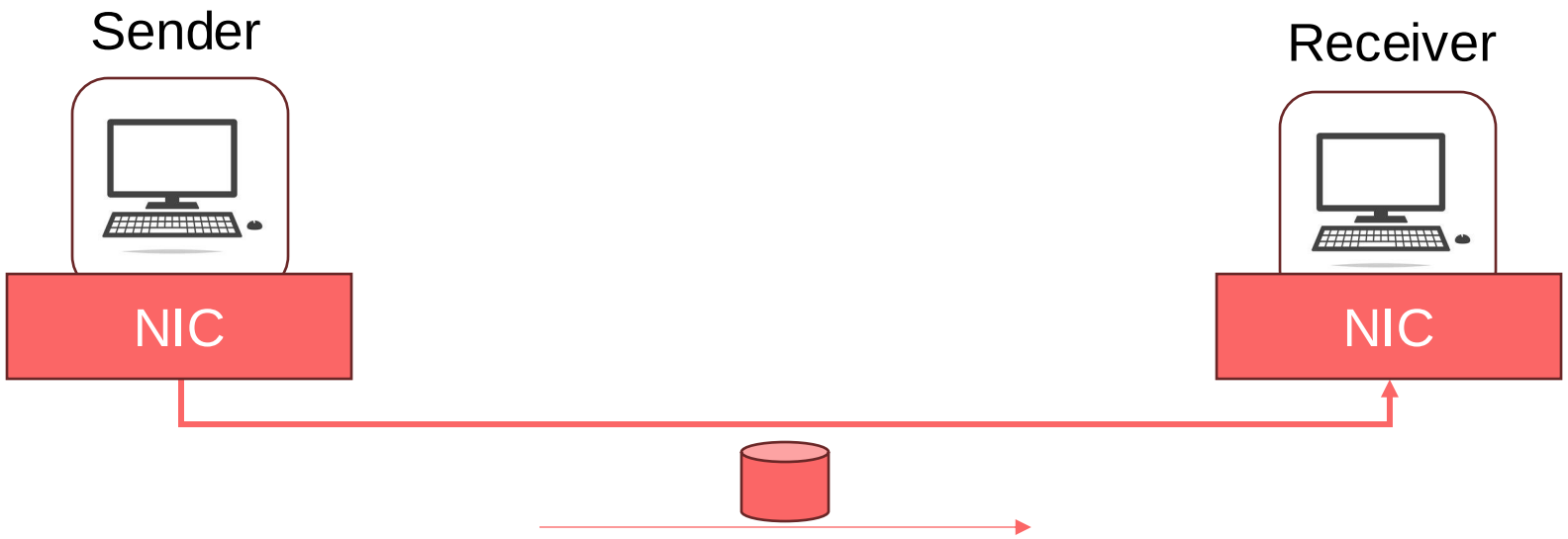
- **man bind**



The (Simplified) OSI Model



Sending a file



Need some volunteers with phones

If everything went as planned...

- You saw that we can **loose packets** in our demo.
  - This is because we send **UDP packets**
  - UDP = unreliable data protocol

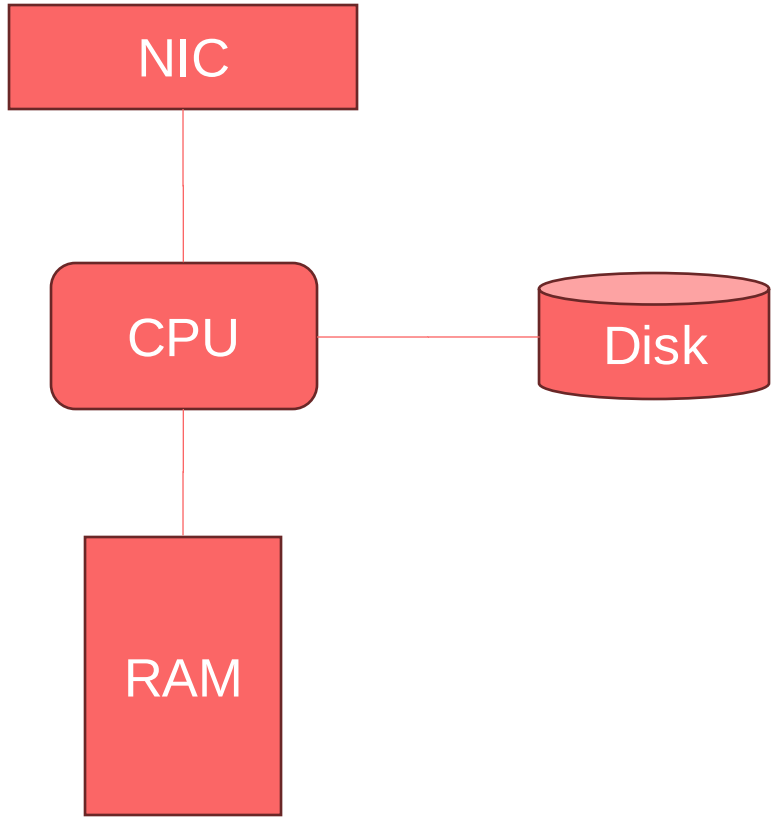
- There is no guarantee that packets will arrive or if they will even arrive in order.

- **TCP** is a widely used transport layer protocol that guarantees orderly delivery of packets.
  - You must implement this on your own if you need that sort of functionality from UDP.

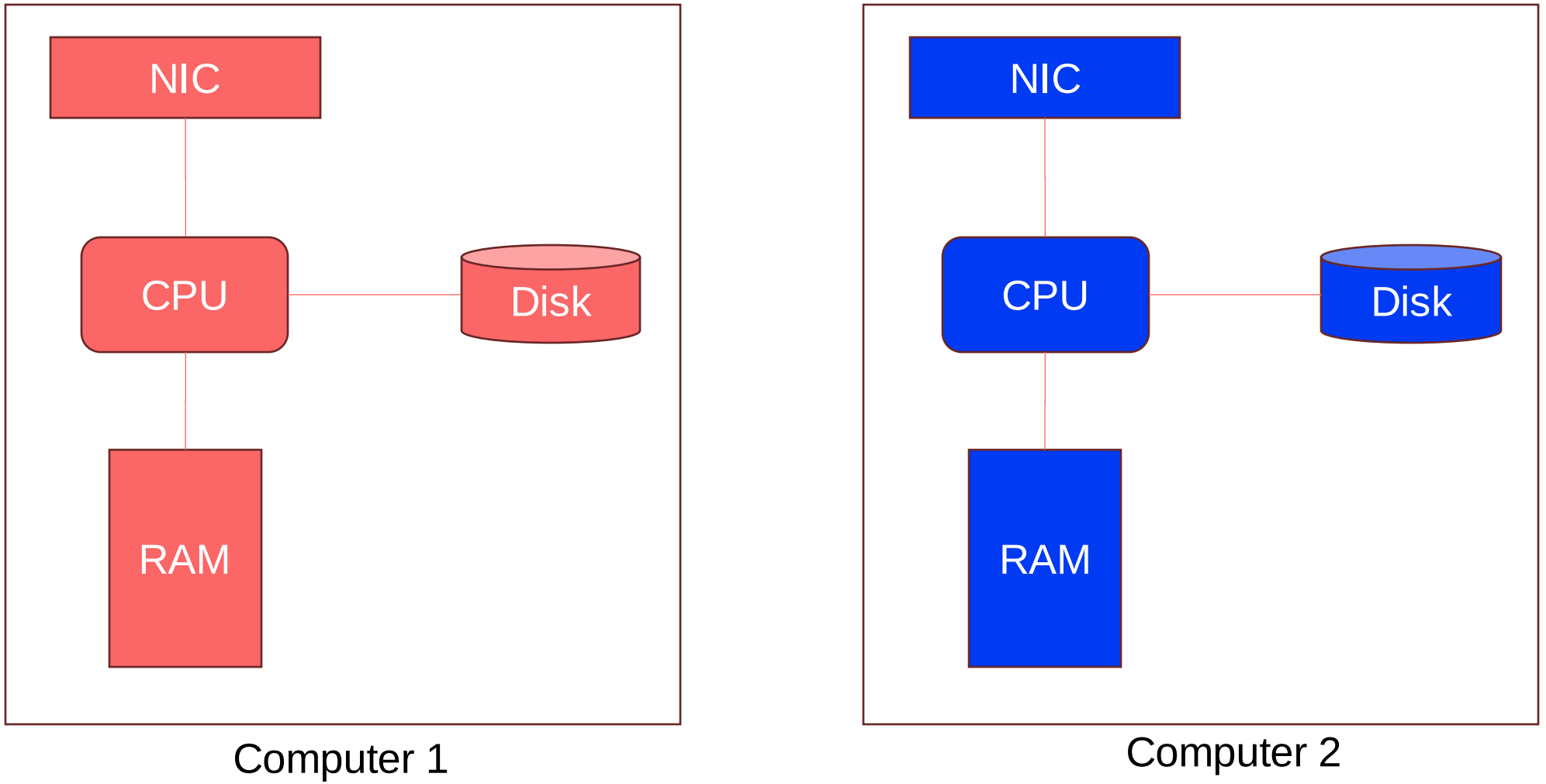
Motivational Example from Huddly

- How to build a computer?
  - **CPU**
  - **Memory**
  - **Disk**
  - **Network**

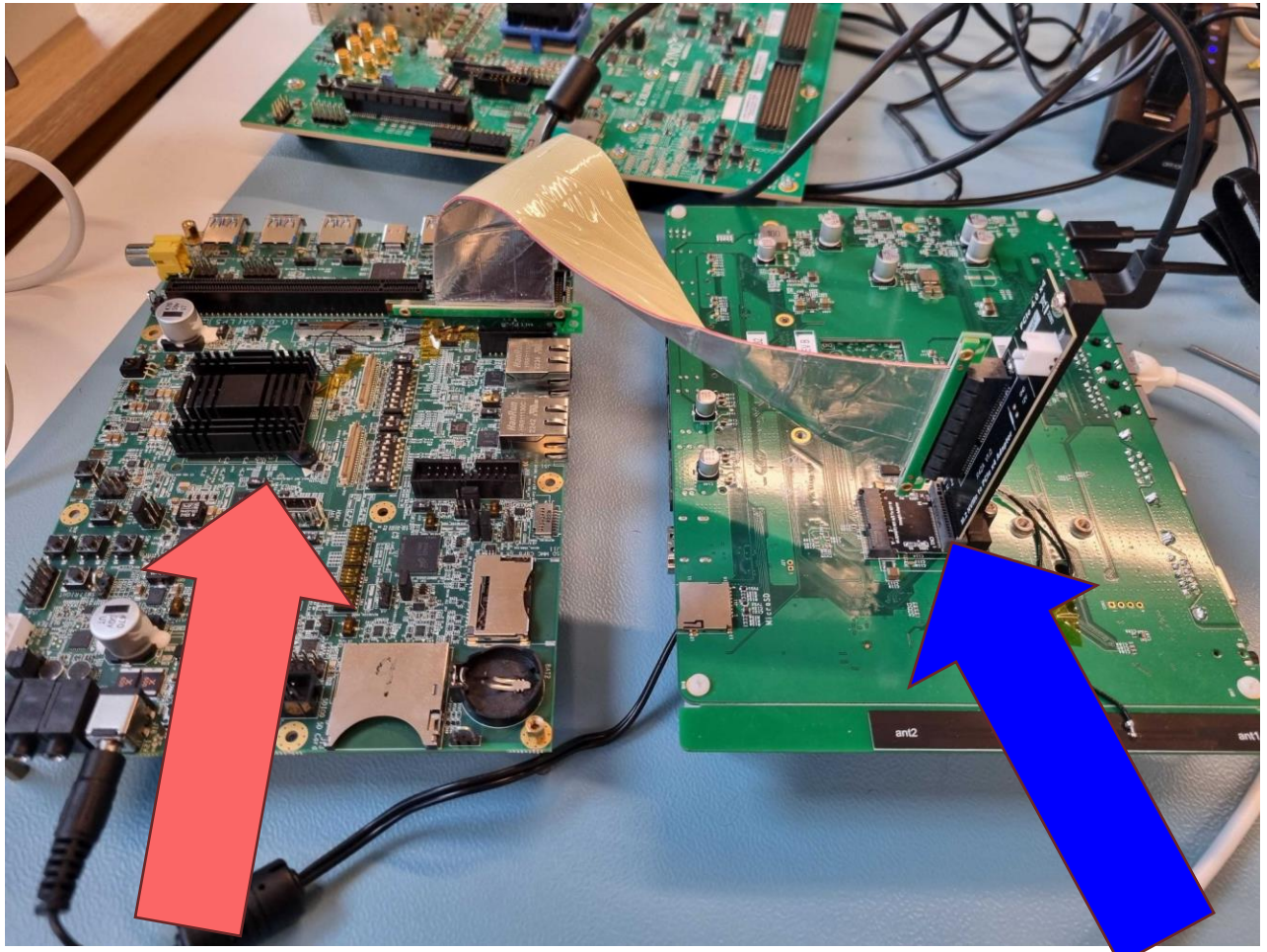
- Pretty expensive!



Twice as expensive with two computers



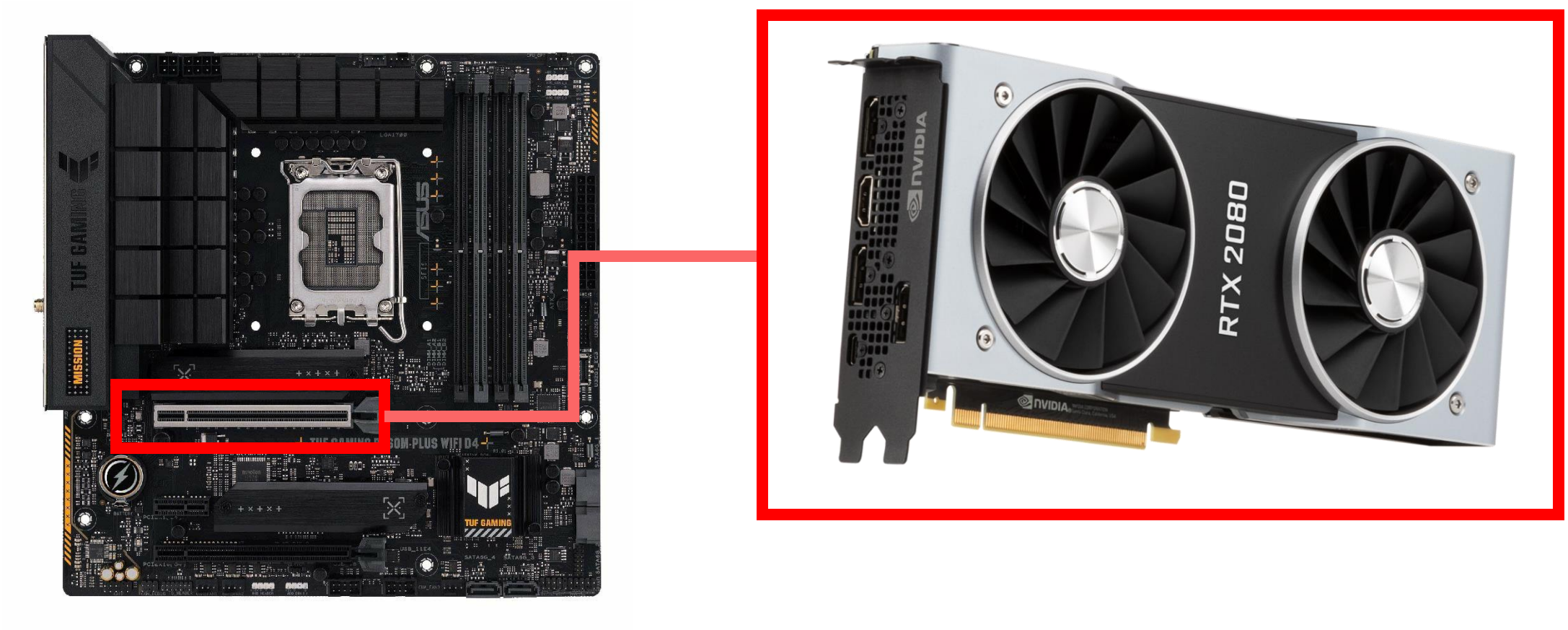
Twice as expensive with two computers



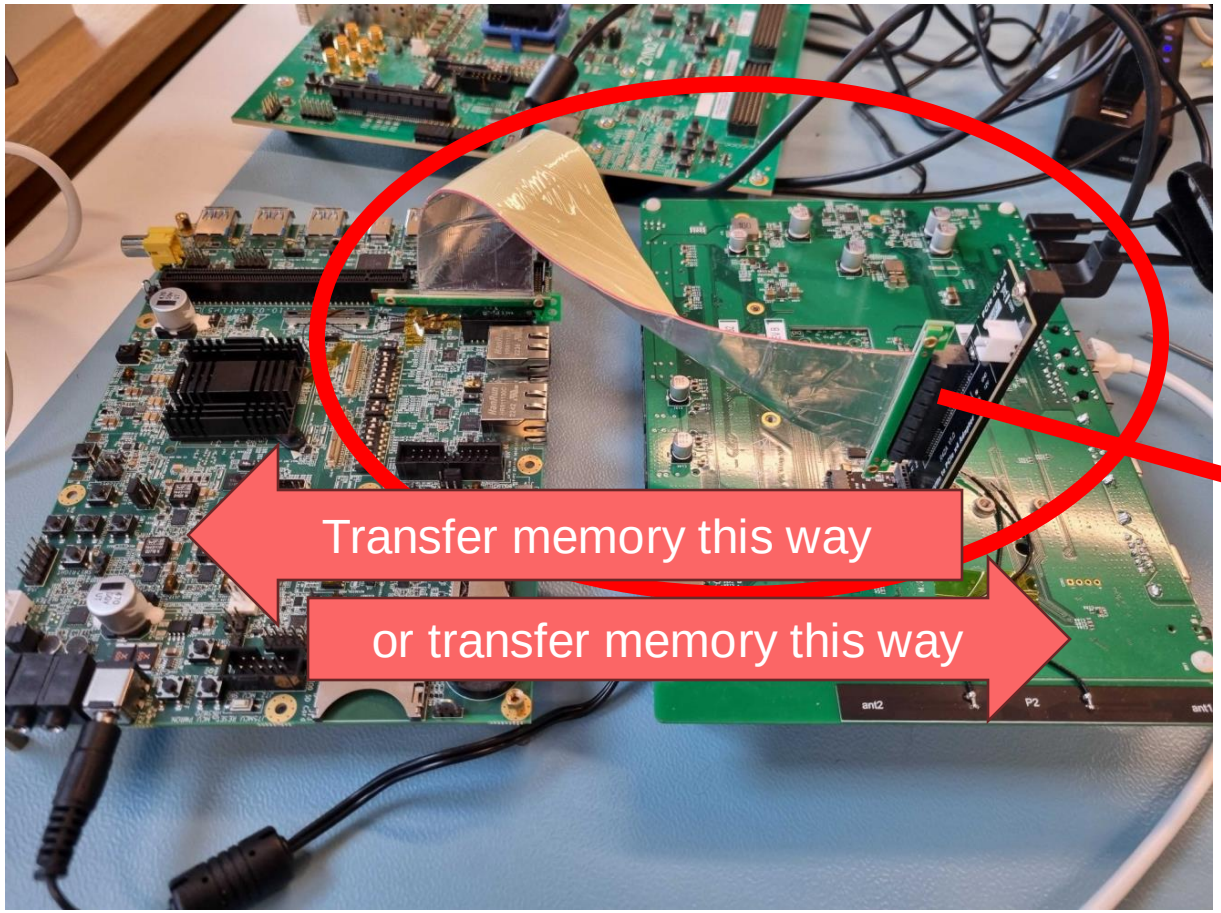
Computer 1

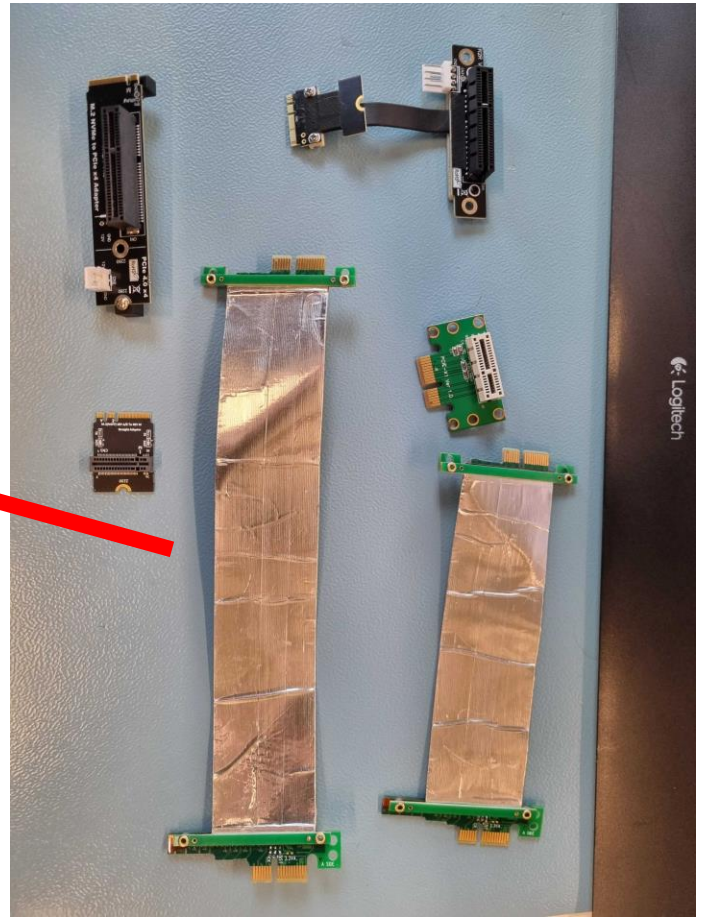
Computer 2

PCI Express

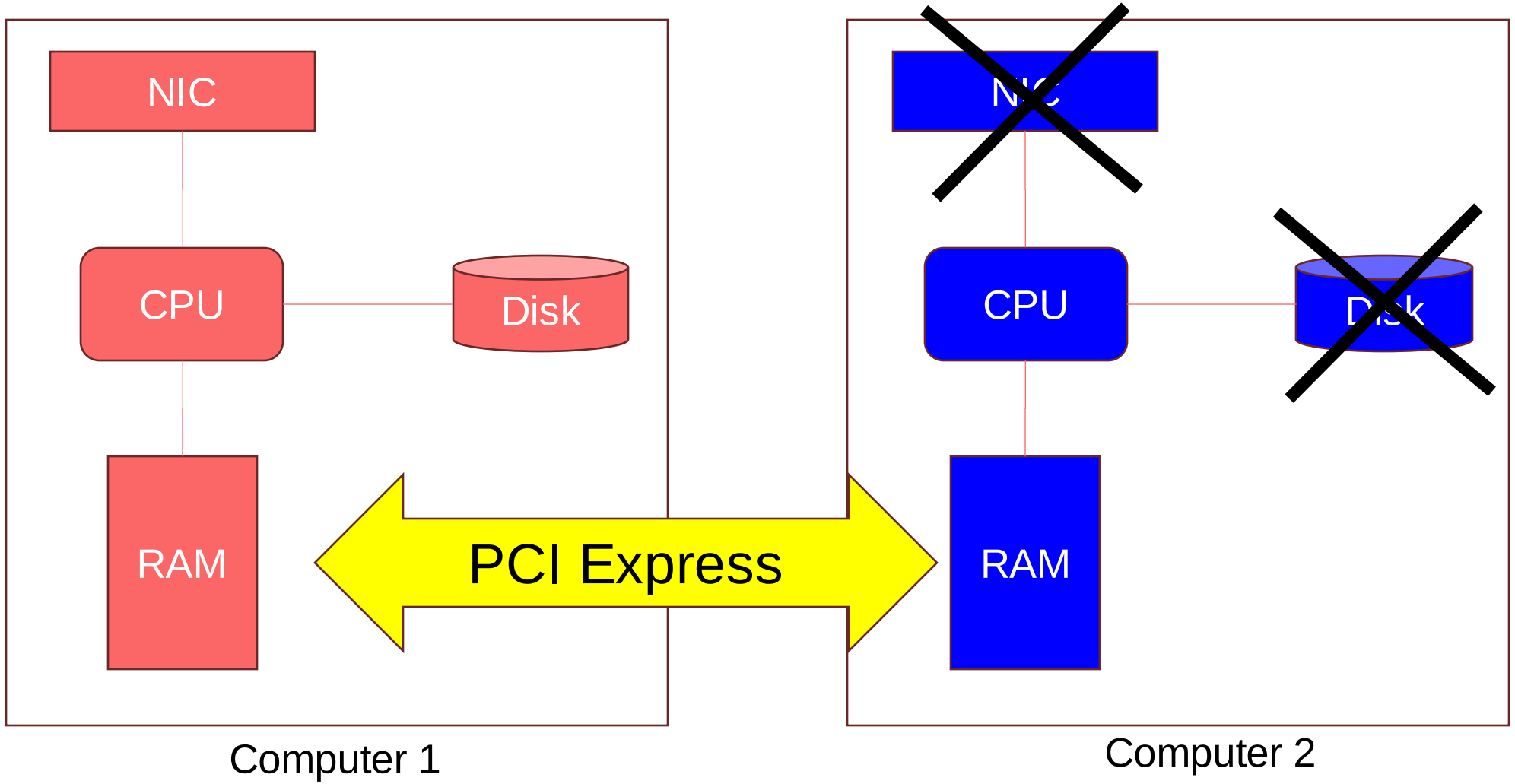


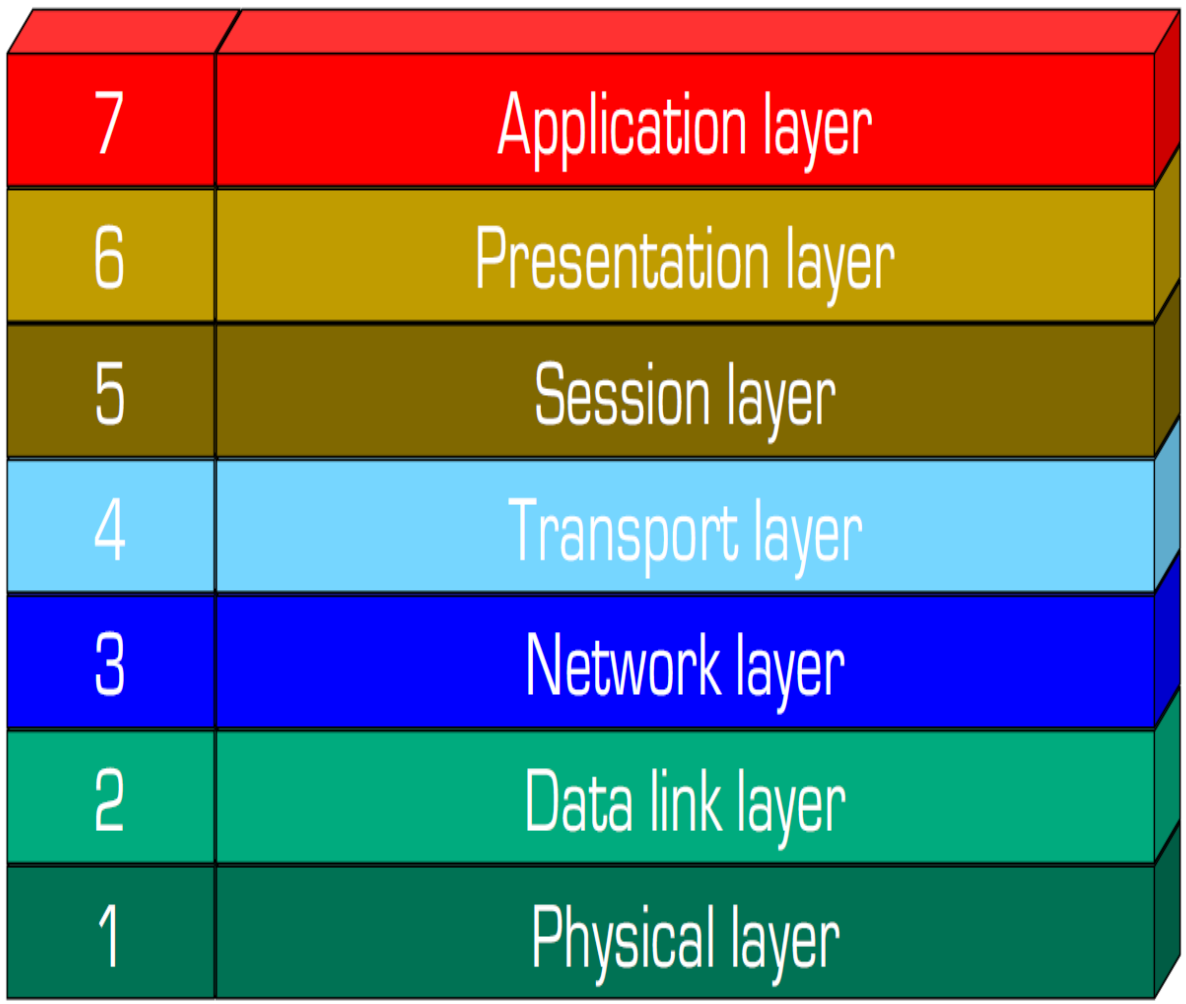
This is also PCI Express





Can we use PCI express to save some money?





This is in your application code

This is Linux kernel code

This is Linux kernel driver code

Physical network interface



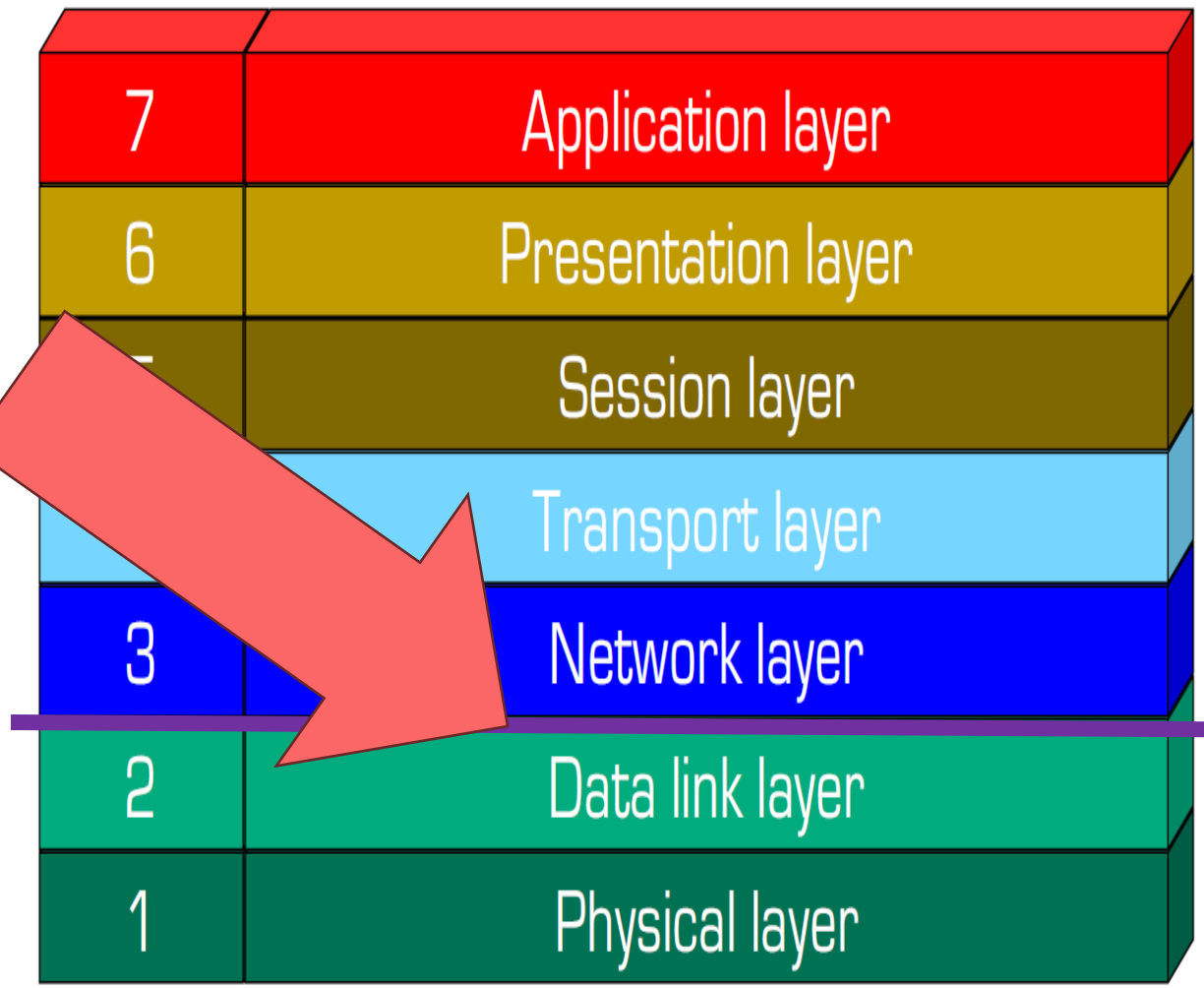
Can PCIe be a physical network interface? Yes!





PCI EXPRESS®

?



This is application code

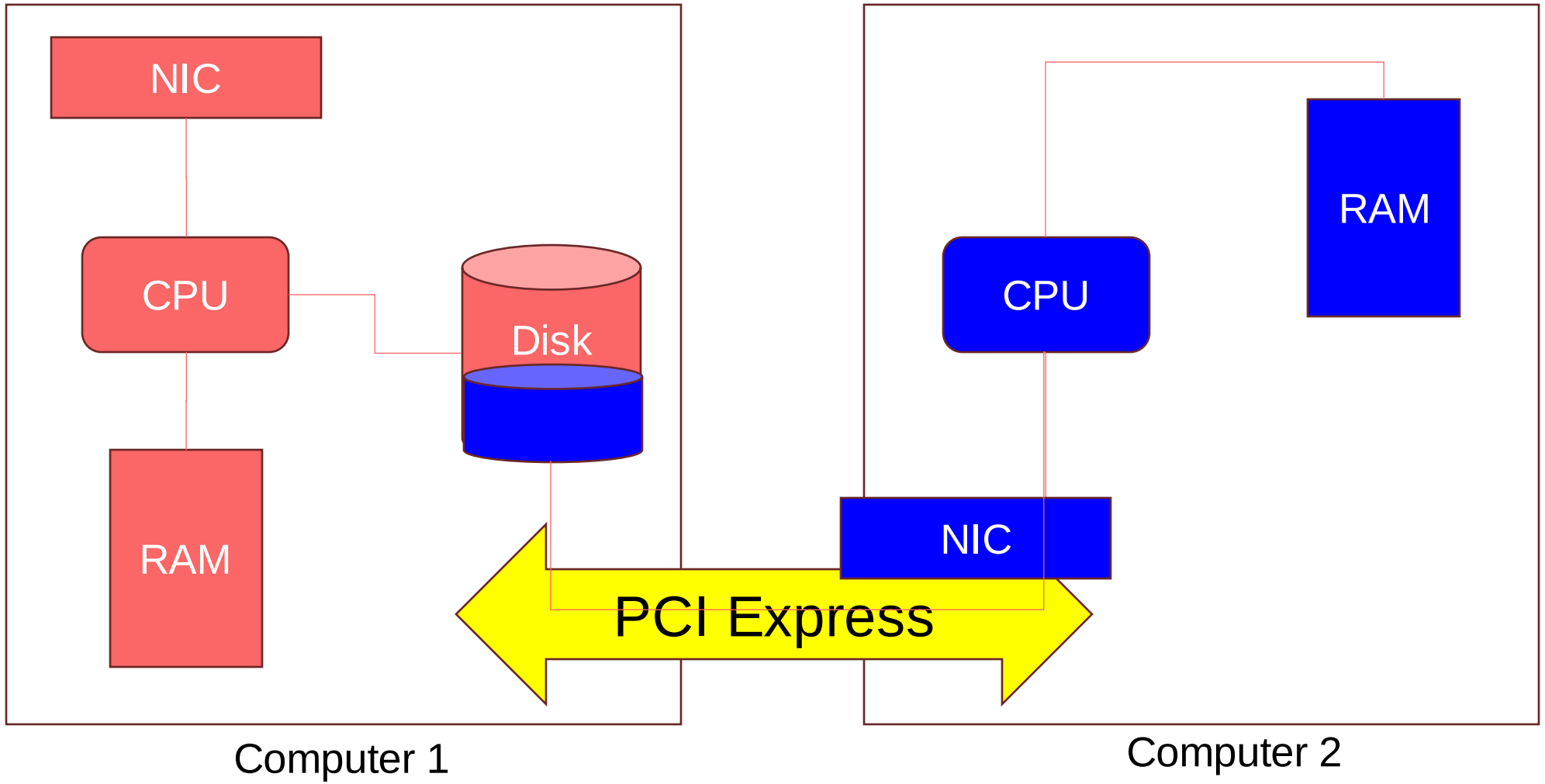
This is Linux kernel code

This is Huddly driver code

PCI EXPRESS®

PCI Express

Disk and network interface over PCIe



Thanks for today!



Have a good weekend tomorrow!