

Big Idea (Week 11): Networking

We can transmit data between computers over wires, through optical links, or through the air. In modern practice, this is complicated by a number of physical realities:

- multiple applications running on a physical machine sharing a physical network interface
- multiple computers sharing a physical link
- communicating computers that are not directly connected, but can only communicate with the cooperation of a number of intermediate computers
- unreliable data transmission (*e.g.* bits are corrupted, computers along a route crash, packets are lost and reordered)

It is convenient to hide these physical realities from the application and instead provide the abstraction of a reliable, point-to-point datastream connection between applications running on different computers. The abstraction effectively virtualizes the connection between the applications, allowing the physical sharing of resources.

The functionality in this abstraction is provided by a series of layers, each addressing orthogonal sets of issues. The layering provides a form of design and interoperability complexity management. The layers also isolate technology details (*e.g.* wireless vs. wired physical link) from higher layers.

While some elaborated models include more layers (*e.g.* seven in the OSI model), we discuss a basic layering roughly corresponding to the Internet's TCP/IP protocol stack that includes:

- physical layer – communication over the physical transport media (*e.g.* wires, RF, optical fibers)
- link layer – protocols and signaling to send data across one physical link between two directly-connected computers
(sometimes one or more of the directly-connected computers is a special-purpose computer whose job is only to move data; those special-purpose computers get called switches and routers.)
- network layer – end-to-end (source to destination) packet delivery including routing through intermediate computers
- transport layer – reliable delivery of data to the individual application process on the computer
- application layer – sees the abstraction of a reliable link from application to application