Network protocols

Network principles:

* Packet transmission
* Stream transmission

Message:

* Data to be transmitted
  + Text, pictures, video, …
* A sequence of bytes
* Arbitrary length
  + Can be large
  + Possibly infinitely long
    - Example: live stream, sensor measurements, …

Packet transmission:

Definition packet:

* One part of a message
* Is a sequence of bytes
* Has maximum length
  + Example: 65,356bytes
* Logic unit of transmission
* With a source and destination address

Packets are useful because

* Enable sending of unrelated packets over some network link

Stream transmission

* For real time applications
  + Video and audio streaming
    - Video and audio frames need to arrive in time to be useful
  + Remote-control systems
    - Possibly machine, robots, airplane controls
* Set’s up a channel, with reserved resources for packet transmission
* Used in private networks, use on the internet is rare

Packet Switching

* Packets are transmitted by store-and-forward network
  + First stored in memory before it is forwarded
  + Same idea for postal system and how packages are sent
* Node in network decides which links brings packets closer to destination
  + This process is called routing
* Packets may travel along different routes
  + May arrive in different order
* Packets may get lost
  + Receiver may want to re-request lost packets
* Packets may get corrupted along the way
  + Check sums, and error connection code increase packet size but can increase reliability

All governed by protocols

The open Systems Interconnection (OSI) protocol Model

* OSI model is a conceptual model
  + Internet does not fully correspond to it
* Each layer extends properties of inderlying communication system
* Layers:
  + Physical: bits send across a transmission medium
  + Data link: bits combined into blocks for transmission, flow and routing is managed
  + Network: blocks of information, routed across a network of data links, independent of physical medium
  + Transport: enables multiple applications on the same host, and provides services e.g. reliable transmission
  + Session, presentation, application: different services for application program

A diagram of a computer network

Description automatically generated

A screen shot of a computer

Description automatically generated

On sending:

* Message goes down the stack
* Decomposed into [packets
* Representation amended or changed

On receive

* Message goes up the stacks
* Representation restored and reconstituted into a whole message

Encapsulation:

* Layering ensures:
  + Layer N at destination receives exactly what layer N sent at souce
  + Important, because it decouples layers, makes lower layer independent of higher layers
* Layers can be replaced
  + Different physical medium
  + Different application laer
  + Or transport layer
* Can adapt connection for different scenarios
  + Needs to be reliable, e.g. for sending documents
  + Or needs to be fast, can be slightly unreliable: video chat

Internet protocol

* Purpose: deliver packets
  + From sender to receiver, identified by IP address
  + contain datagrams: data from high layers in stack
* IPv4 and IPv6
  + Two versions of Internet Protocol in use
  + IPv4’s address space too small for modern applications (does not have enough unique addresses)

Internet protocol simplified:

A close-up of a computer code

Description automatically generated

Version: distinguishes IPv4 and IPv6

Length: total length of packet (IPv4) or payload (IPv6)

Service code: “priority” of packet

Hop limit: to limit a packet’s existence in network, decreased at every hop, until it reaches 0

Source/destination address: from where a packet was sent, and where it is going

Transmission control protocol:

* Reliable end to end transmission
* Notion of data streams
  + Sequence of multiple packets
* Establishes a connection before transmitting payload
  + Between source and destination

User Datagram protocol:

* Best effort
  + Successful transmission not guaranteed
* Single packets (datagrams)
  + Connectionless
  + No notion of packets belonging together