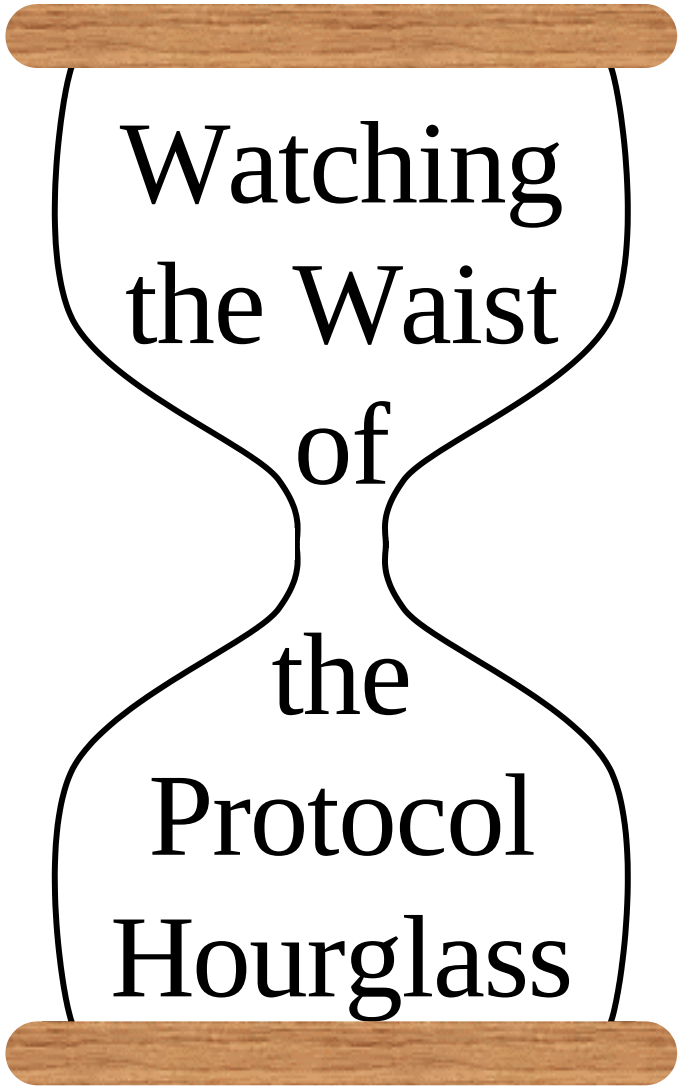
Watching the Waist of the Protocol Hourglass



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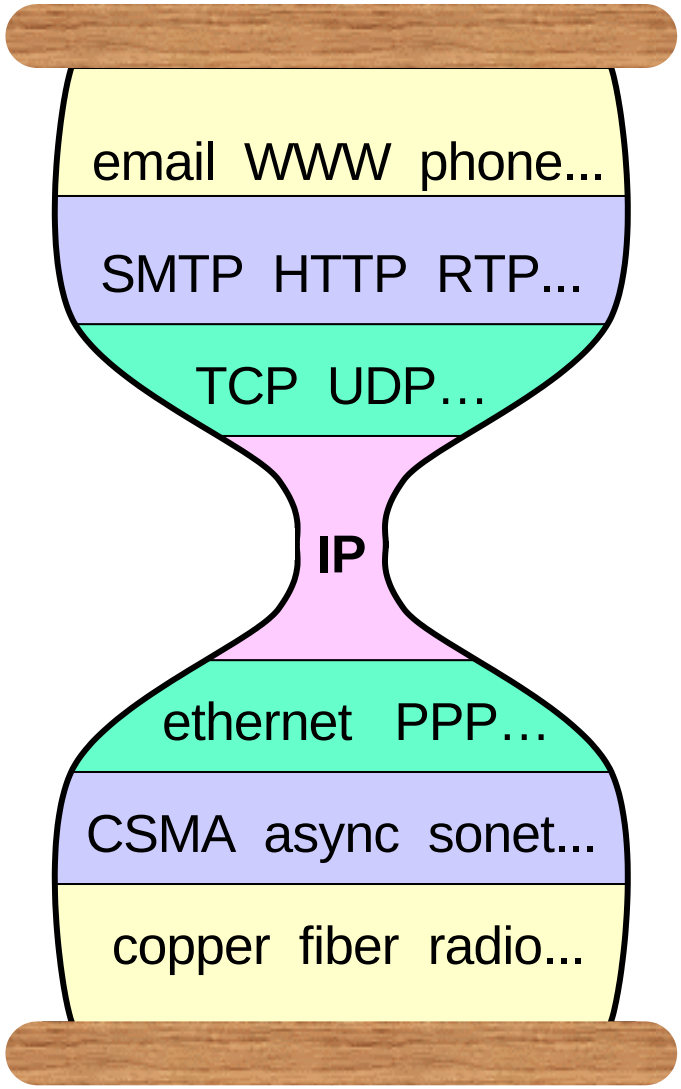
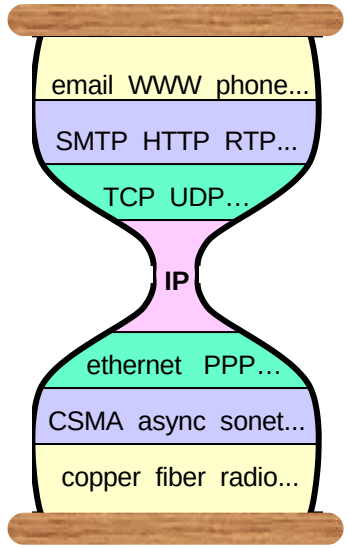

email WWW phone...
SMTP HTTP RTP...
TCP UDP…
IP
ethernet PPP…
CSMA async sonet...
copper fiber radio...

Why the Hourglass Architecture?

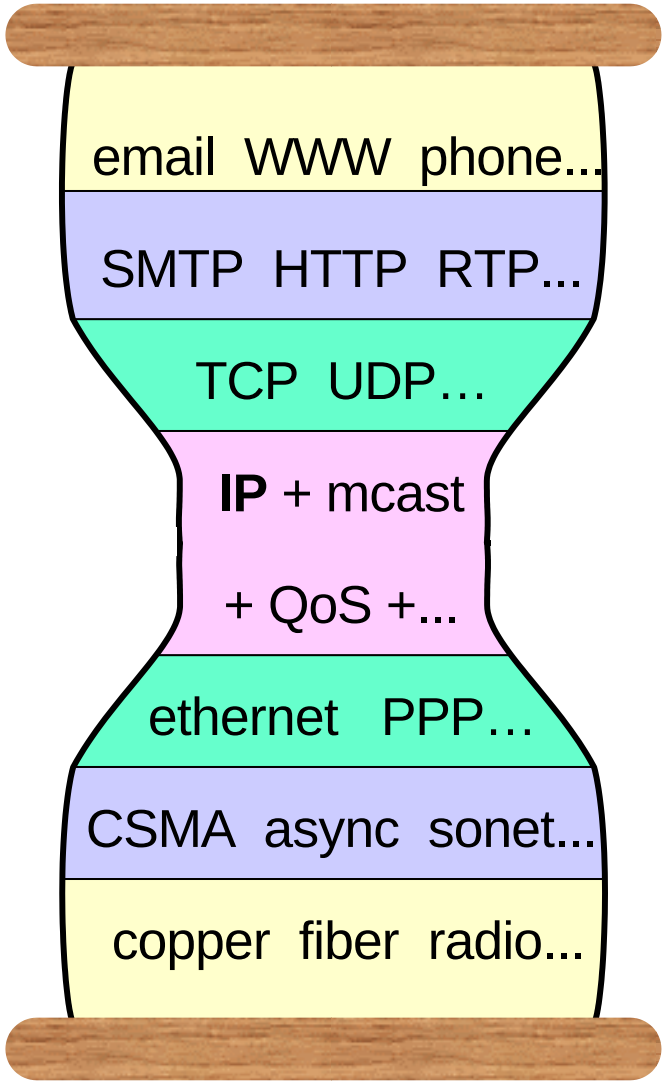
- Why an internet layer?
  - make a bigger network
  - global addressing
  - virtualize network to isolate end-to-end protocols from network details/changes
- Why a *single* internet protocol?
  - maximize interoperability
  - minimize number of service interfaces
- Why a *narrow* internet protocol?
  - assumes least common network functionality to maximize number of usable networks



Why Am I Talking About Watching the Waist?

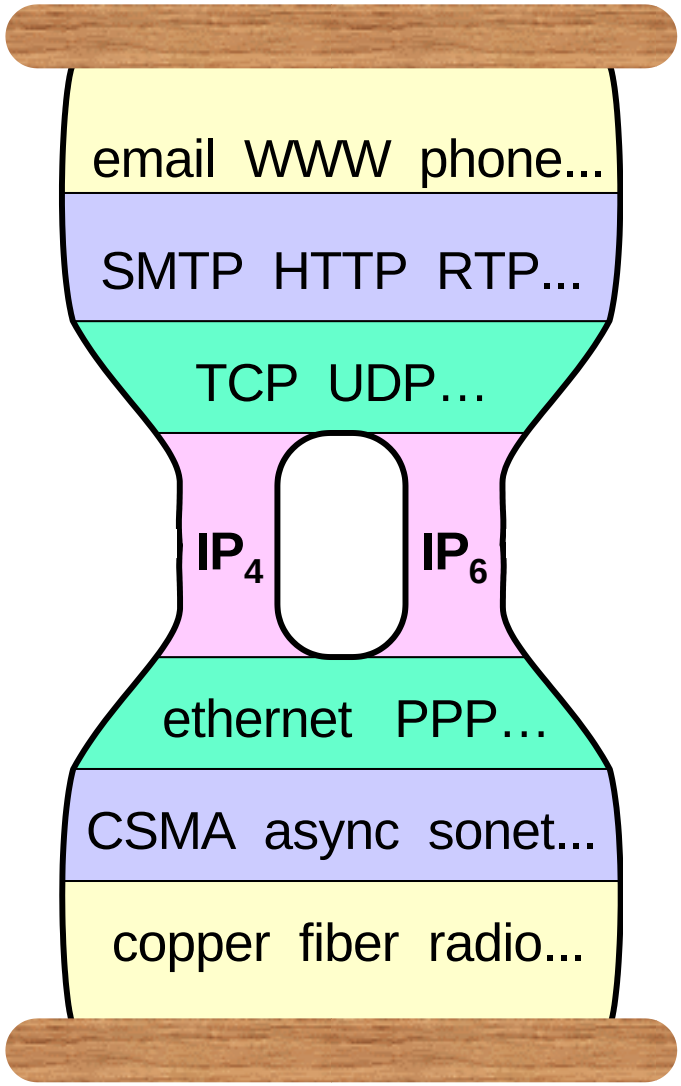
- Invited talk is an opportunity for navel gazing
- It happens on reaching middle age (me & IP)
- The IP layer is the only layer small enough for me to get my arms around
- I am worried about how the architecture is being damaged: the waste of the hourglass
- The hourglass theme offers many bad puns

Putting on Weight



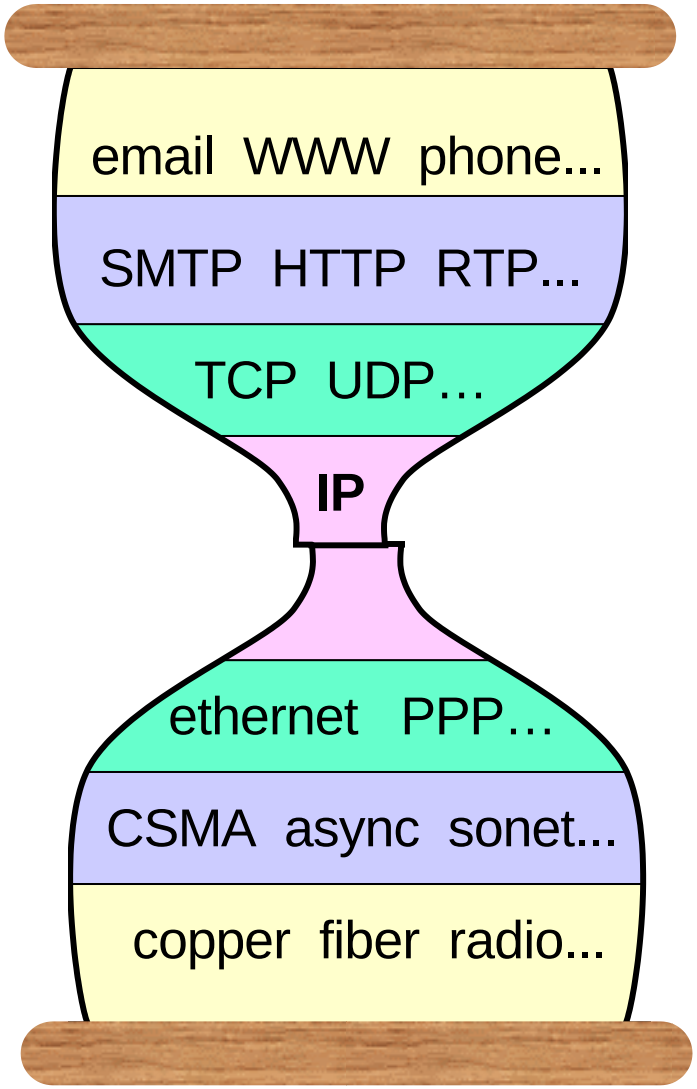
- requires more functionality from underlying networks

Mid-Life Crisis



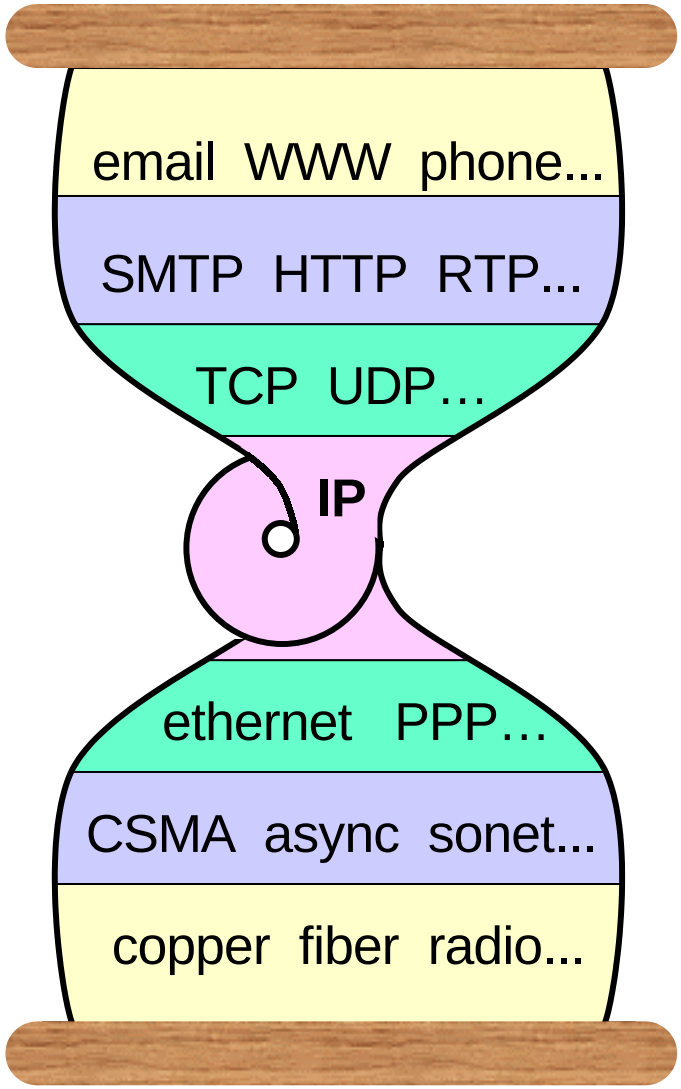
- doubles number of service interfaces
- requires changes above & below
- creates interoper-ability problems

Oops! An Accident



- NATs & ALGs used to glue the broken pieces
- lots of kinds of new glue being invented—ruins predictability
- some apps remain broken, since repairs are incomplete

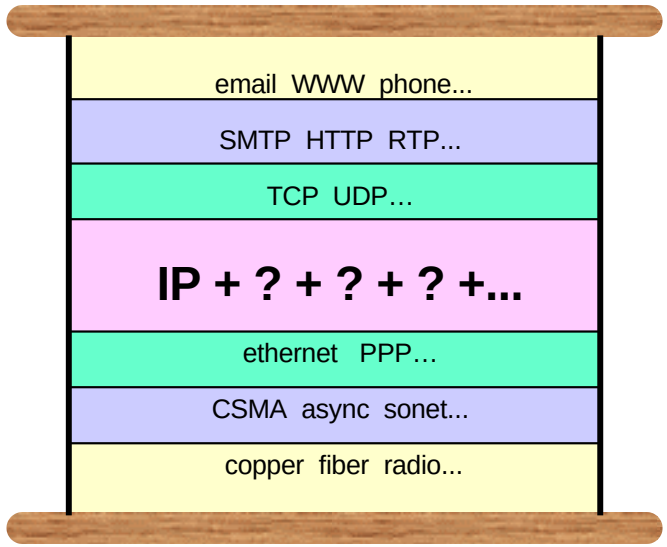
But Still Supple



- IP-over-IP tunneling has become more and more common
- this is not so bad: retains benefits of hourglass model

More Fattening Temptations

- TCP “helpers”
- reliable multicast assists
- packet-intercepting caches
- “content-based routing”
- active networking



Lost Features of the Internet

- transparency
- robustness through “fate sharing”
- dynamic routing
- unique addresses
- stable addresses
- connectionless service
- always-on service
- peer-to-peer communication model
- application independence

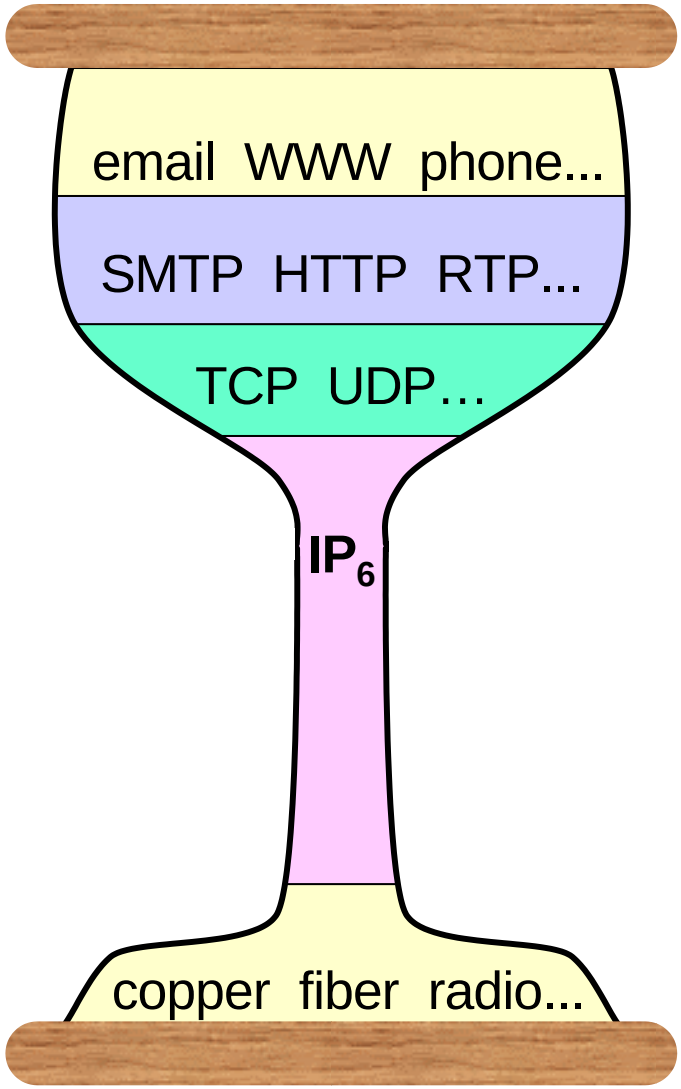
Below-the-Waist Bulge

- mostly reinventing, badly, what IP already does (or could do, or should do):
  - VLANs
  - layer 2 tunneling protocols
  - MPLS, PPPoE,… (“layer 2.5”)
- lower layers mostly seem to just make IP’s job harder
  - cells, circuits, QoS, multicast, large clouds, opaque clouds

What to Do?

- First, acknowledge that this is the normal entropy / decay that besets all large, engineered systems over time
- So, shall we just let nature take its course?
- Or, shall we make the effort to get back into shape?

A Fitness Goal



- perhaps we can trim down from an hourglass to a *wineglass*
- promising signs: IP-over-SONET, IP-over-WDM
- IPv6 to restore simplicity *and* functionality

The Future Architecture

- Who knows?
- Possibilities:
  - the hourglass architecture
    (restoring the old one)
  - the wineglass architecture
    (refining the old one)
  - the non-architecture
    (letting nature take its course)
  - the overlay architecture
    (building on the ruins of the old one)

Only Time Will Tell…