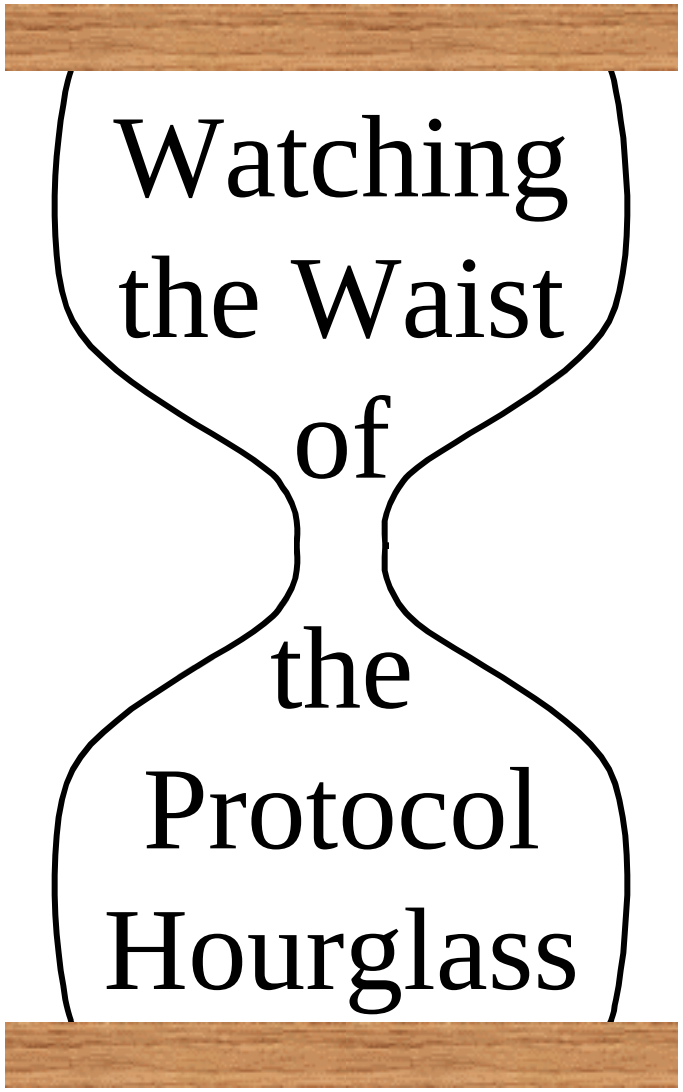
Watching the Waist of the Protocol Hourglass



ICNP ’98
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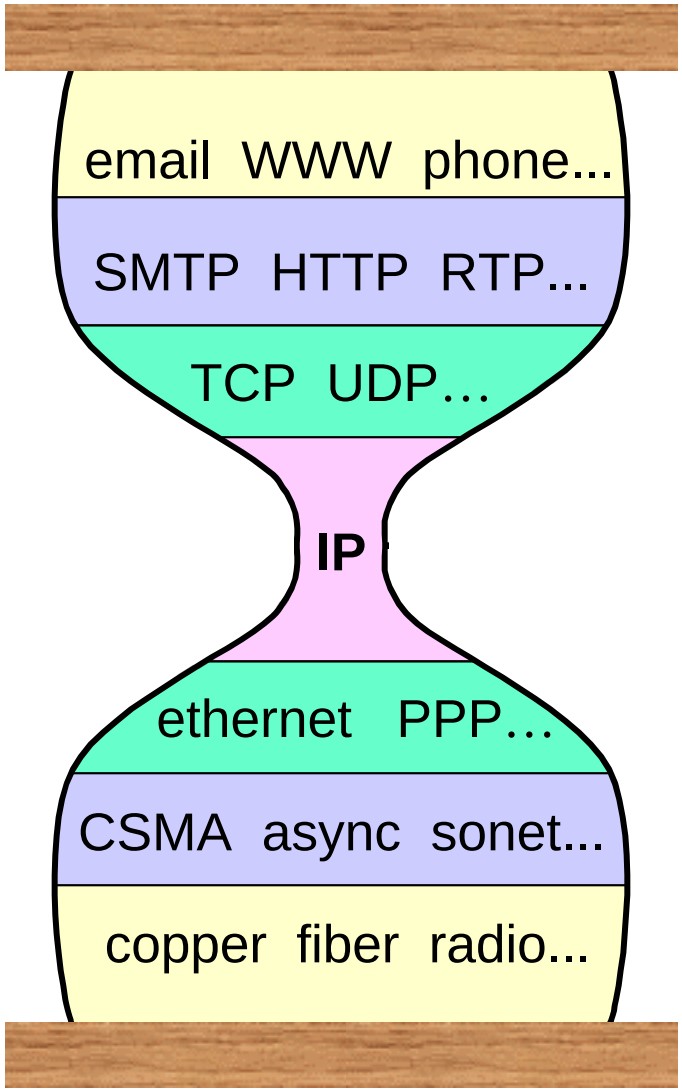
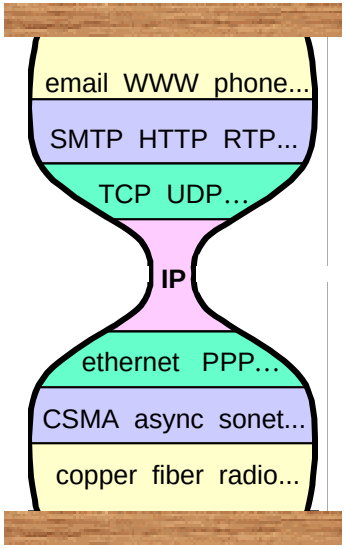

email WWW phone...
SMTP HTTP RTP...
TCP UDP…
IP
ethernet PPP…
CSMA async sonet...
copper fiber radio...

Why the Hourglass Architecture?

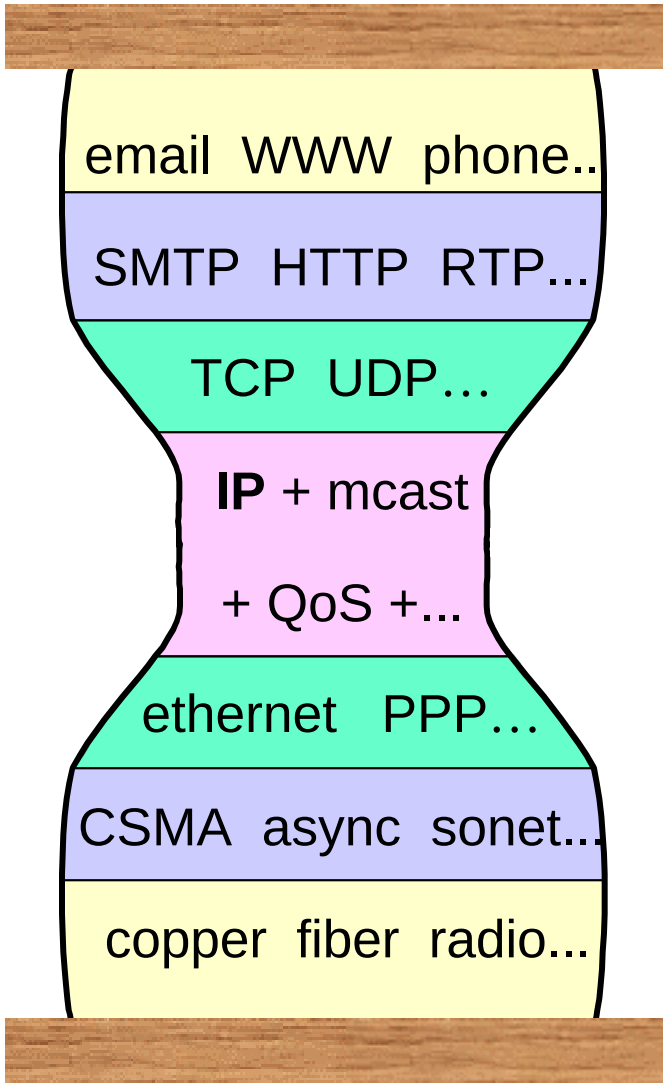
- Why an internet layer?
  - make a bigger network
  - global addressing
  - virtualize network to isolate end-to-end protocols from network details/changes
- Why a *single* internet protocol?
  - maximize interoperability
  - minimize number of service interfaces
- Why a *narrow* internet protocol?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



Why Am I Talking About Watching the Waist?

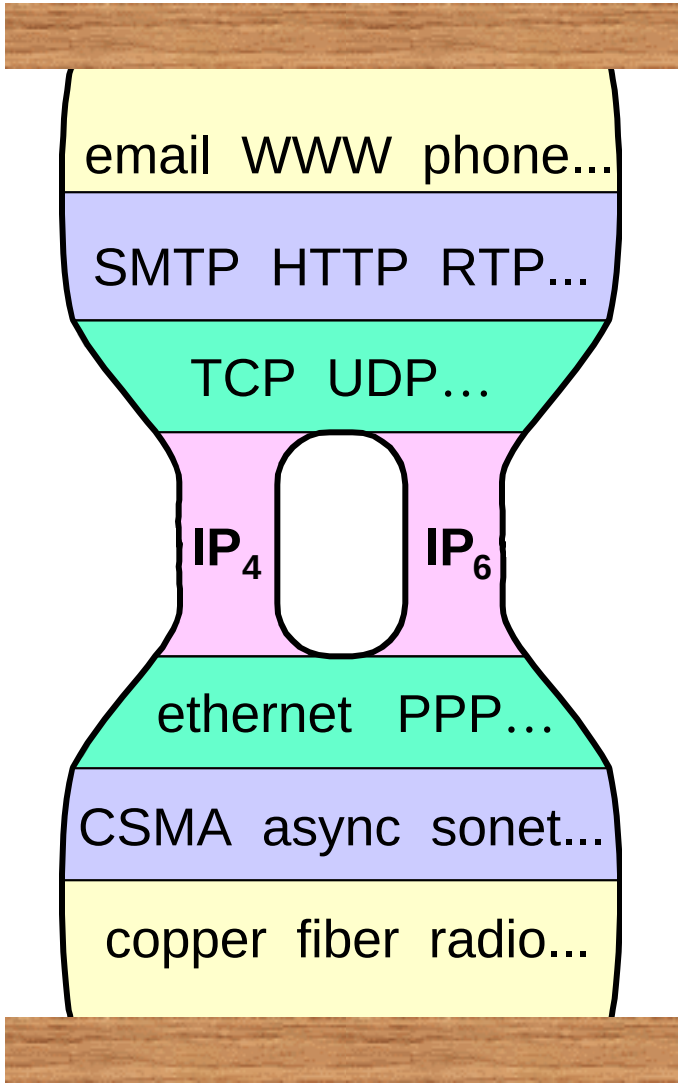
- Keynote is an opportunity for navel gazing
- It happens on reaching middle age (me & IP)
- The IP layer is the only layer small enough for me to get my arms around
- I am worried about how the architecture is now being lost: the waste of the hourglass
- The hourglass theme offers many bad puns

Putting on Weight



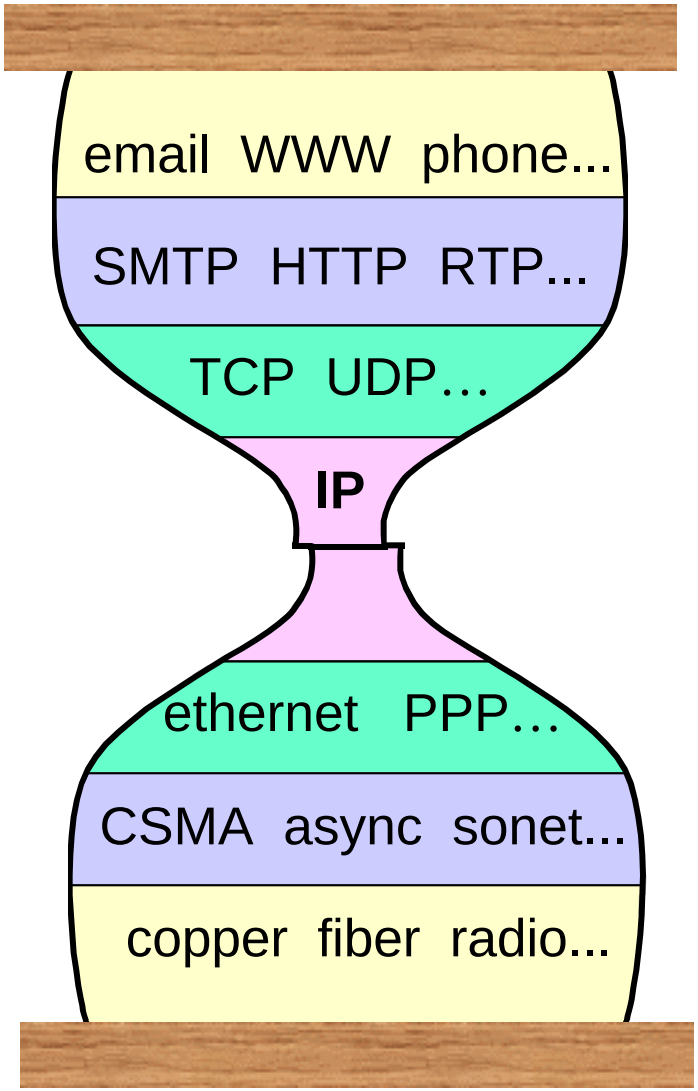
- requires more functionality from underlying networks

Mid-Life Crisis



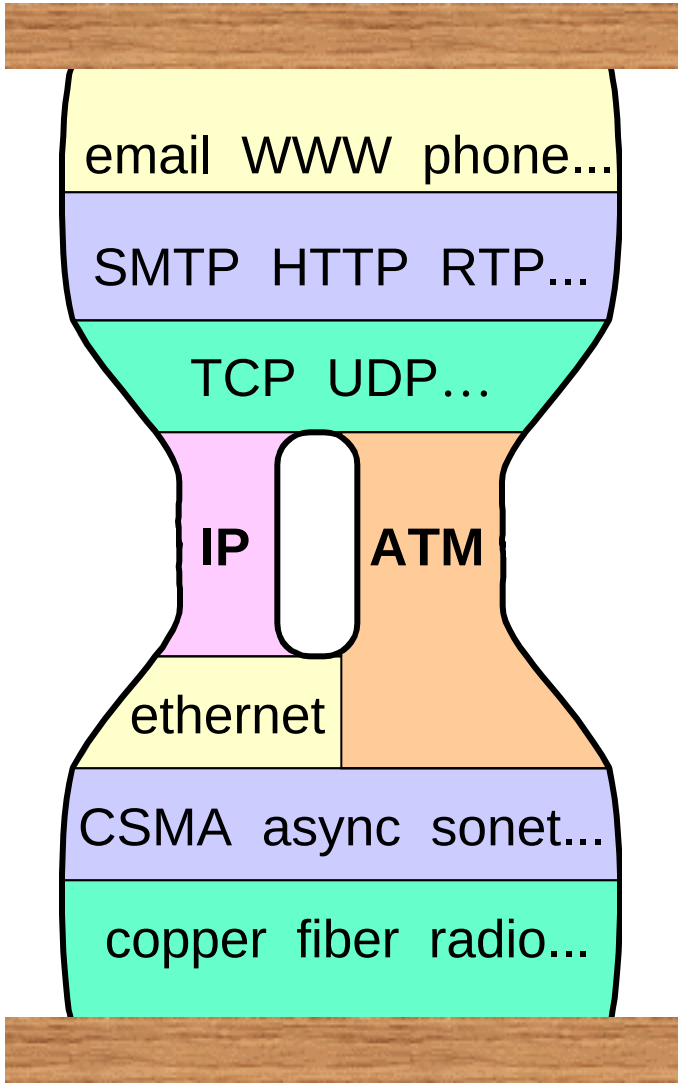
- doubles number of service interfaces
- requires changes above & below
- major interoper-ability issues

Oops! An Accident



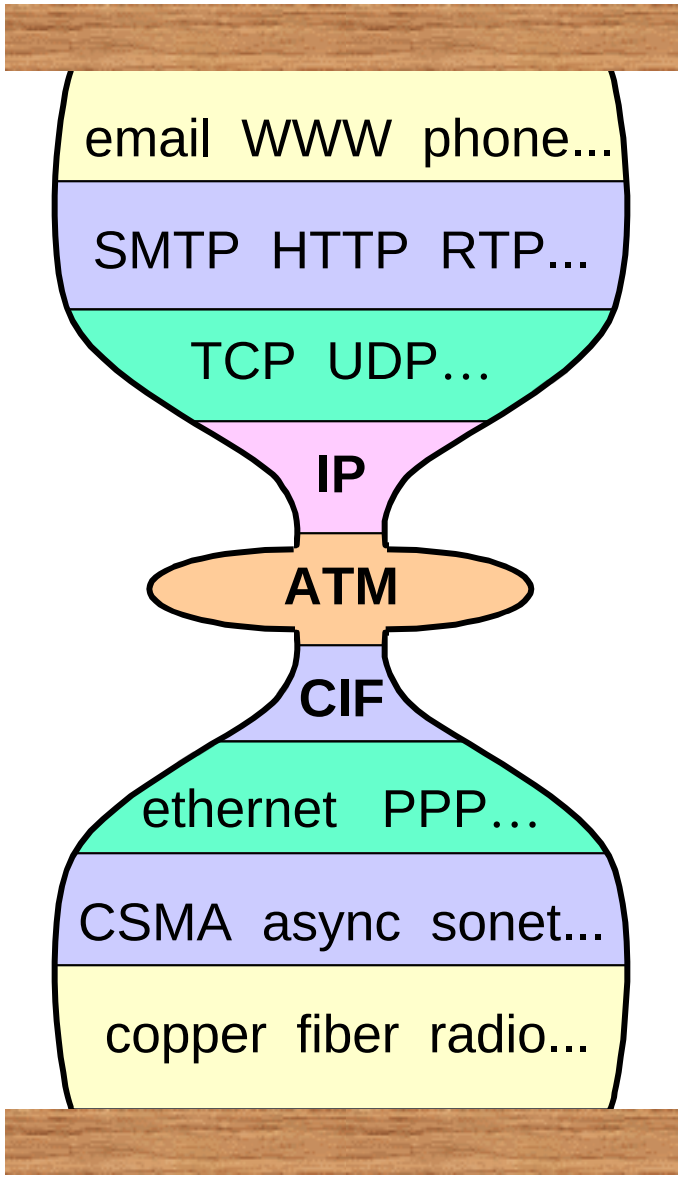
- NATs & ALGs used to glue the broken pieces
- lots of kinds of new glue being invented—ruins predictability
- some apps remain broken, since repairs are incomplete

Threat-ened by Youths



- danger : creeping dependencies on specific link-layers inhibit flexibility and evolution
- doesn't fully supplant IP, so end up with complicated hybrid & two address plans

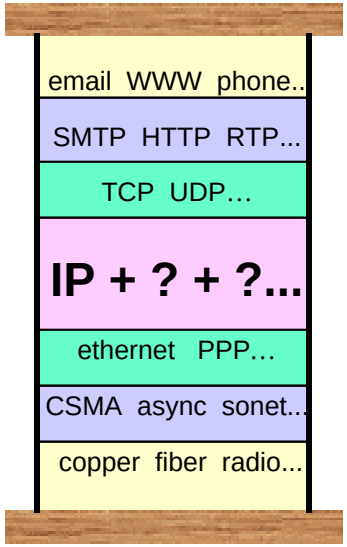
The Youths' Latest Trick



- cells-in-frames (CIF)
- shredded and bundled packets
- hope is that IP and frame-oriented media will fade away
- goal is a fatter waist

More Fattening Temptations

- layer 2 tunneling protocols
- TCP “helpers”
- reliable multicast assists
- “content-based routing”
- active networking



Below-the-Waist Bulge

- mostly reinventing, badly, what IP already does (or could do):
  - VLANs
  - LANE
  - router bypass / NHRP
  - tag-switching / MPLS (“layer 2.5”)
- lower layers mostly seem to just make IP’s job harder
  - cells, circuits, QoS, multicast, large clouds, opaque clouds

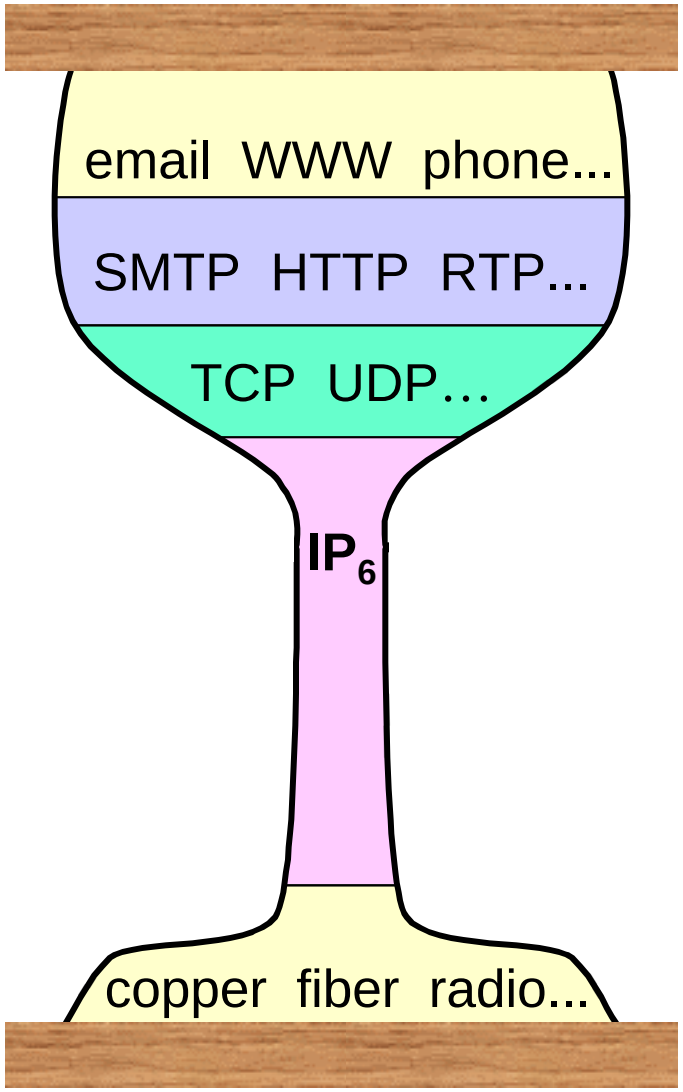
Obfuscation

- In case all this didn't make the network manager's job hard enough…
  - we renamed bridges to switches
  - we renamed routers to switches
  - we now have "multilayer switches" and "layerless switches"

Entropy or Evolution?

- looks like the normal entropy (decay) that besets all large, engineered systems over time
- don't know where/how to reapply energy to fight the entropy
- less worrisome to view as *evolution* instead
  - the Internet as an evolving lifeform or ecosystem?
  - just let nature (the market) take its course
  - though result is undesigned and unpredictable, should not be viewed as decay

Survival of the Fittest?



- may evolve from an hourglass to a wineglass
- early signs: IP-over-SONET, IP-over-WDM
- need IPv6 to restore slim waist

Only Time Will Tell…