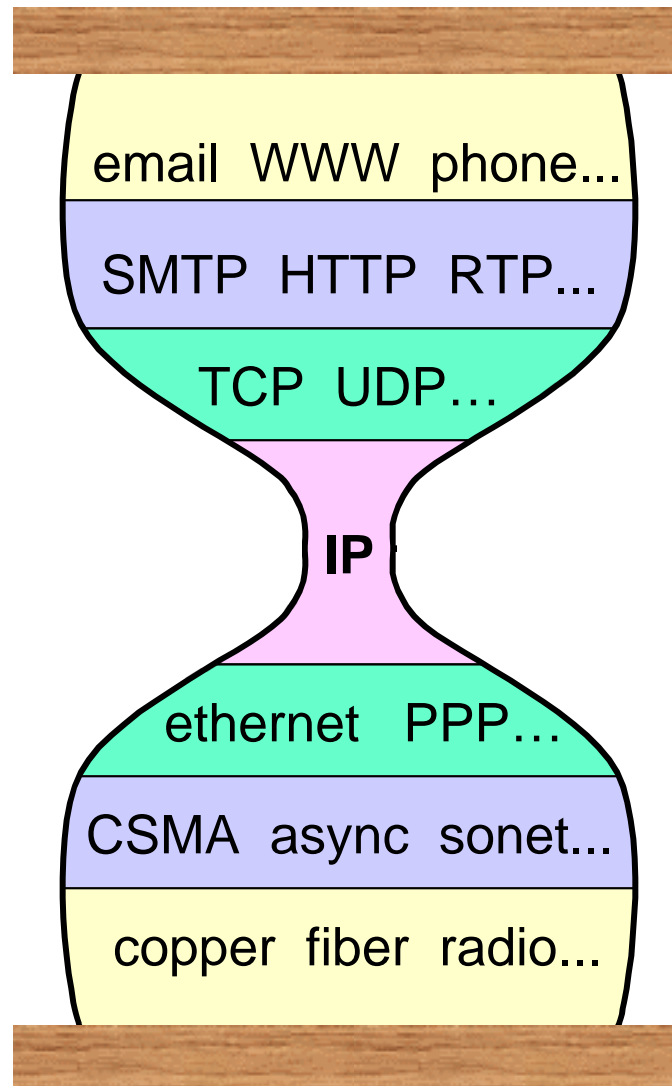
An hourglass graphic with a wooden-texture top and bottom bar. The text is centered within the hourglass shape.

Watching
the Waist
of
the
Protocol
Hourglass

IETF 51
London
August
2001

Steve
Deering
deering@
cisco.com



Why the Hourglass Architecture?

⌚ Why an internet layer?

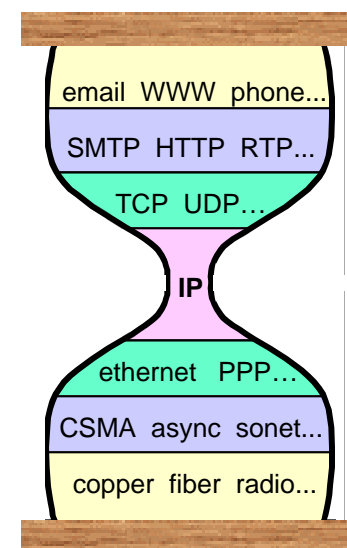
- make a bigger network
- global addressing
- virtualize network to isolate end-to-end protocols from network details/changes

⌚ Why a *single* internet protocol?

- maximize interoperability
- minimize number of service interfaces

⌚ Why a *narrow* internet protocol?

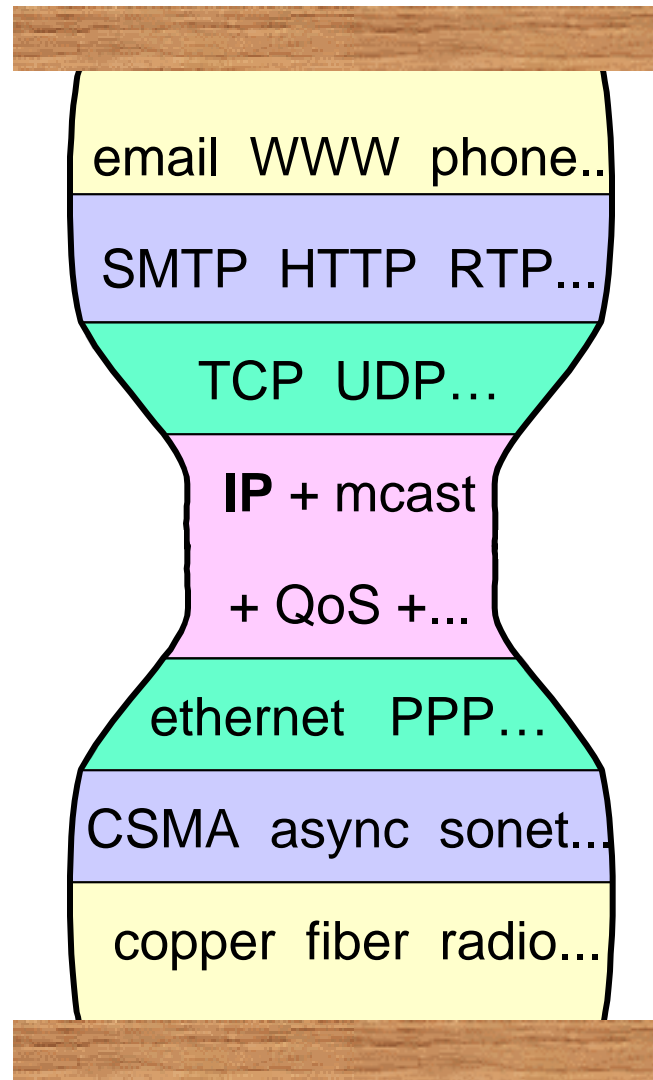
- assumes least common network functionality to maximize number of usable networks



Why Am I Talking About Watching the Waist?

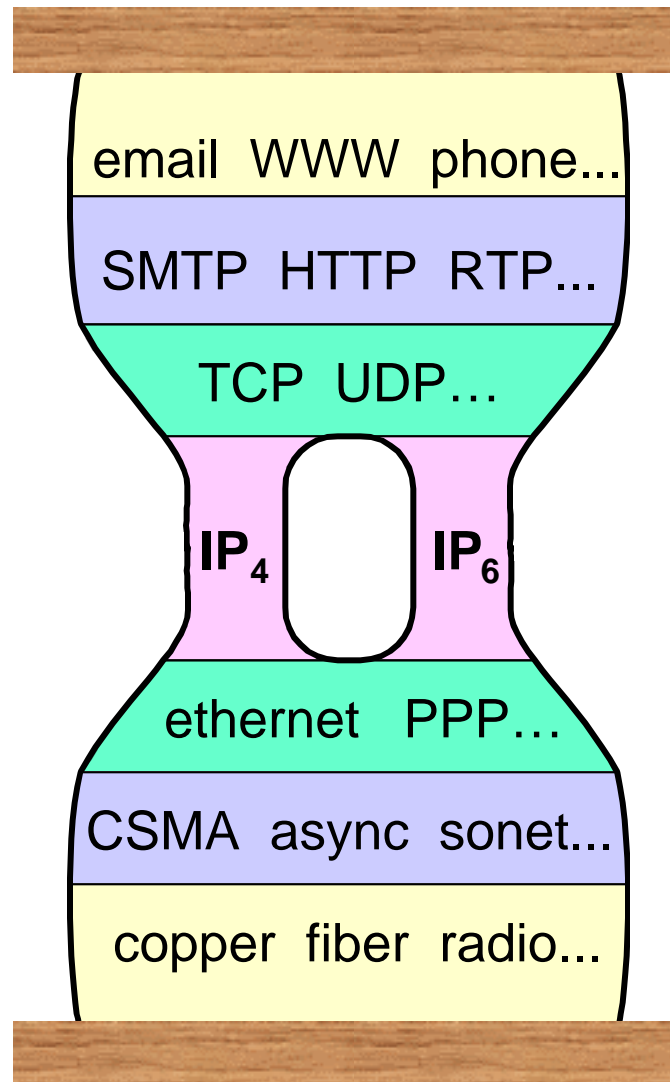
- ⌚ Plenary talk is an opportunity for navel gazing
- ⌚ It happens on reaching middle age (me & IP)
- ⌚ The IP layer is the only layer small enough for me to get my arms around
- ⌚ I am worried about how the architecture is being damaged: the waste of the hourglass
- ⌚ The hourglass theme offers many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

Putting on Weight



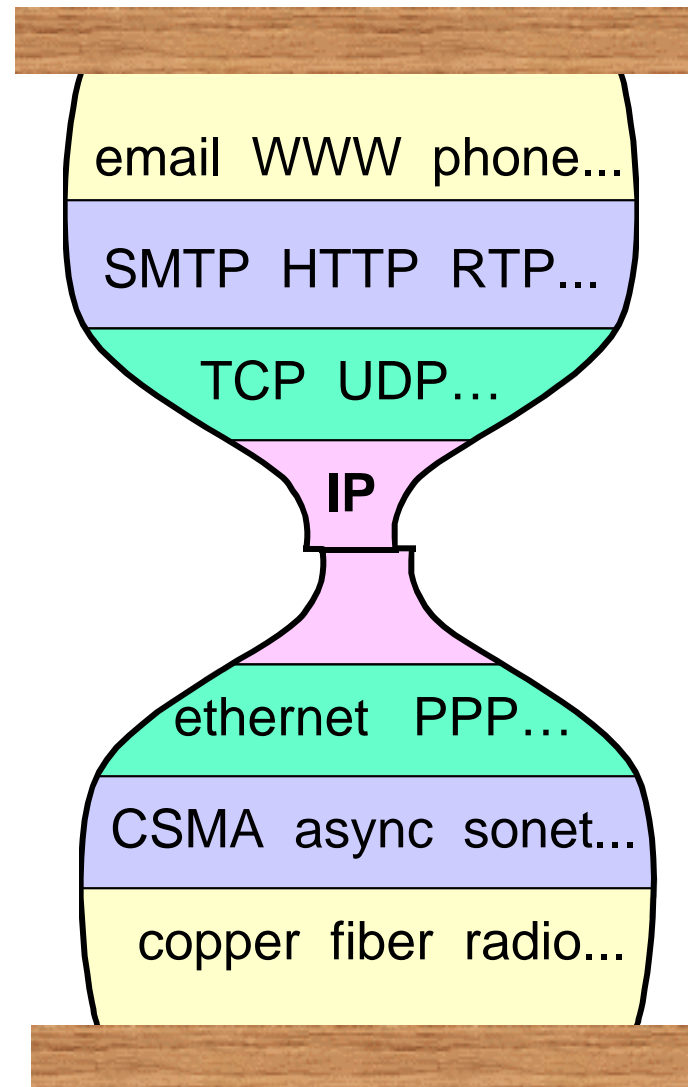
- requires more functionality from underlying networks

Mid-Life Crisis



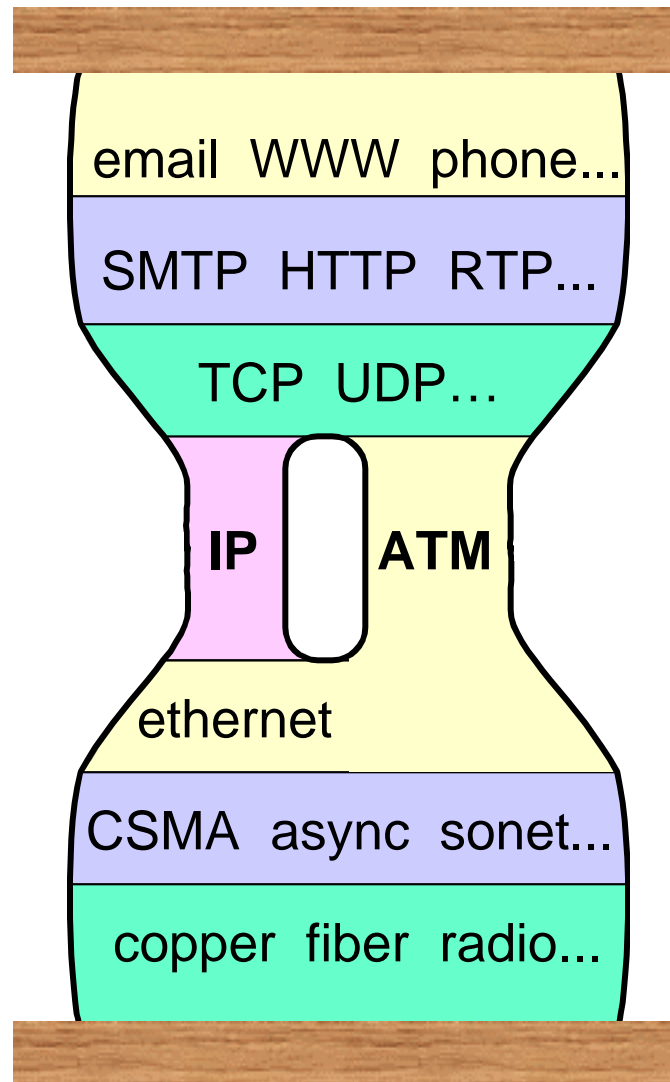
- doubles number of service interfaces
- requires changes above & below
- creates interoperability problems

Oops! An Accident



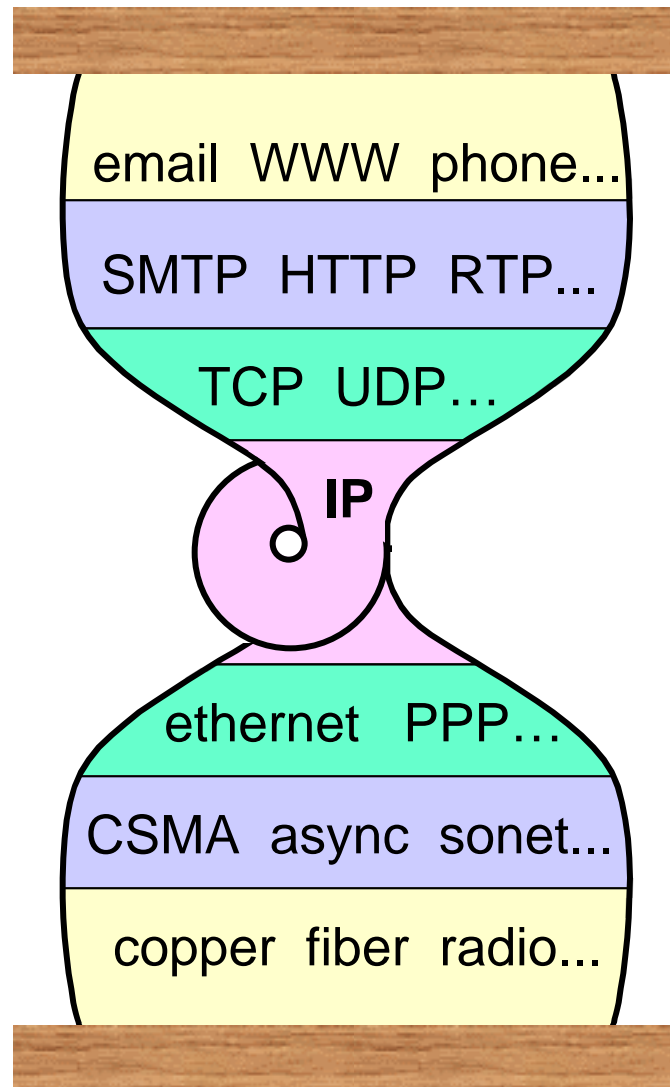
- NATs & ALGs used to glue the broken pieces
- lots of kinds of new glue being invented—ruins predictability
- some apps remain broken, since repairs are incomplete

Threatened by Youths



- danger : creeping dependencies on specific link-layers inhibit flexibility and evolution
- will never fully supplant IP, so end up with complicated hybrid & more address plans

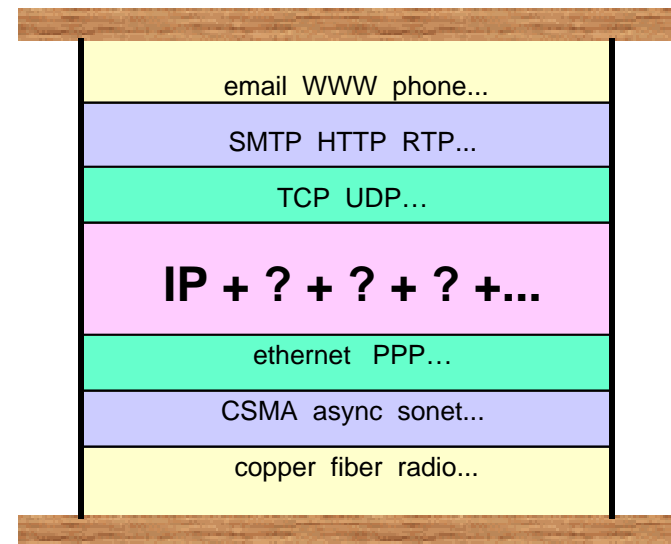
But Still Supple



- 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
- LANE (LAN emulation / “interworking”)
- layer 2 tunneling protocols
- MPLS, PPPoE,... (“layer 2.5”)

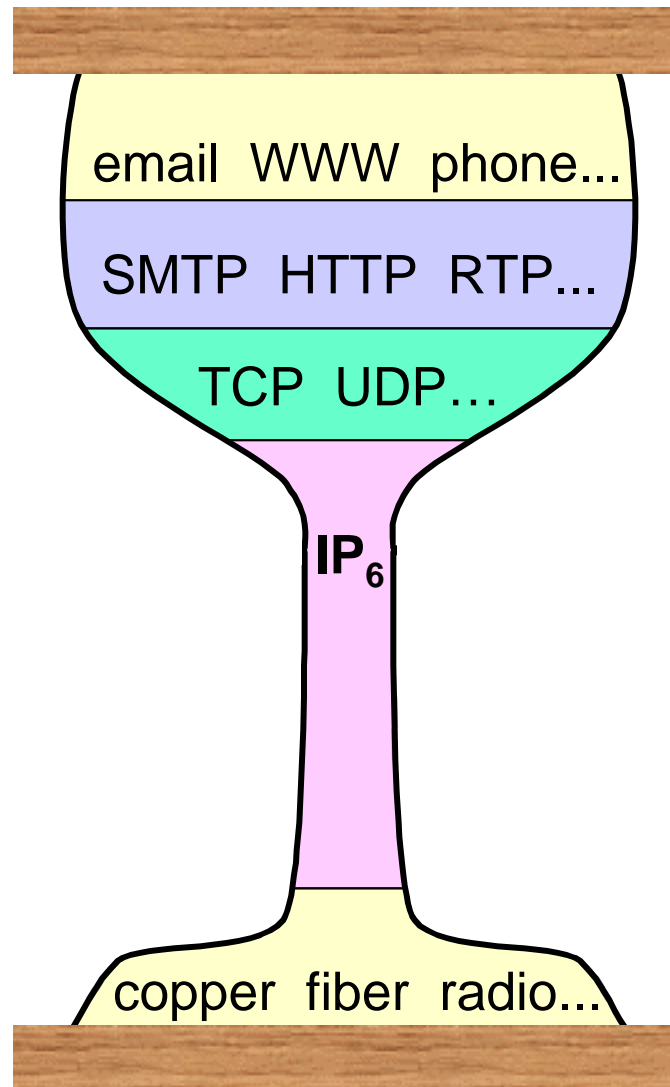
⌚ lower layers mostly seem to just make IP’s job harder

- 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

**Only
Time Will
Tell...**

