Realtime Networking and Packet-Voice

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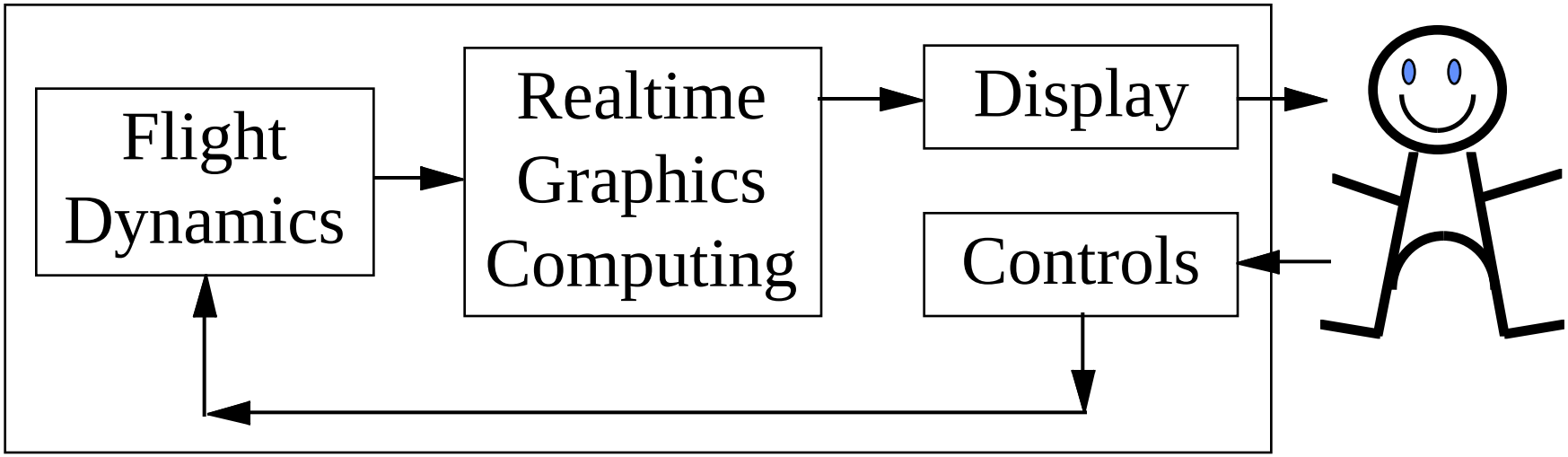
Realtime Networking

ARPA told us that the purpose of the network was resource sharing (Illiac-IV...).

We believed it...

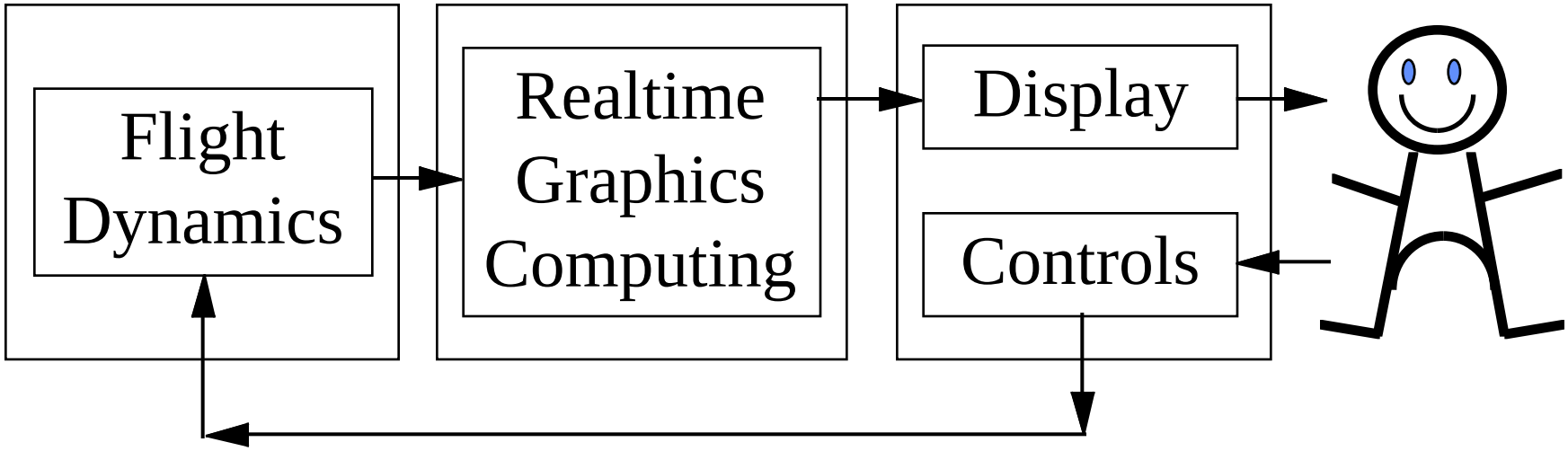
We had a perfect application for it, and wanted to try it.

Realtime Visual Flight Simulation



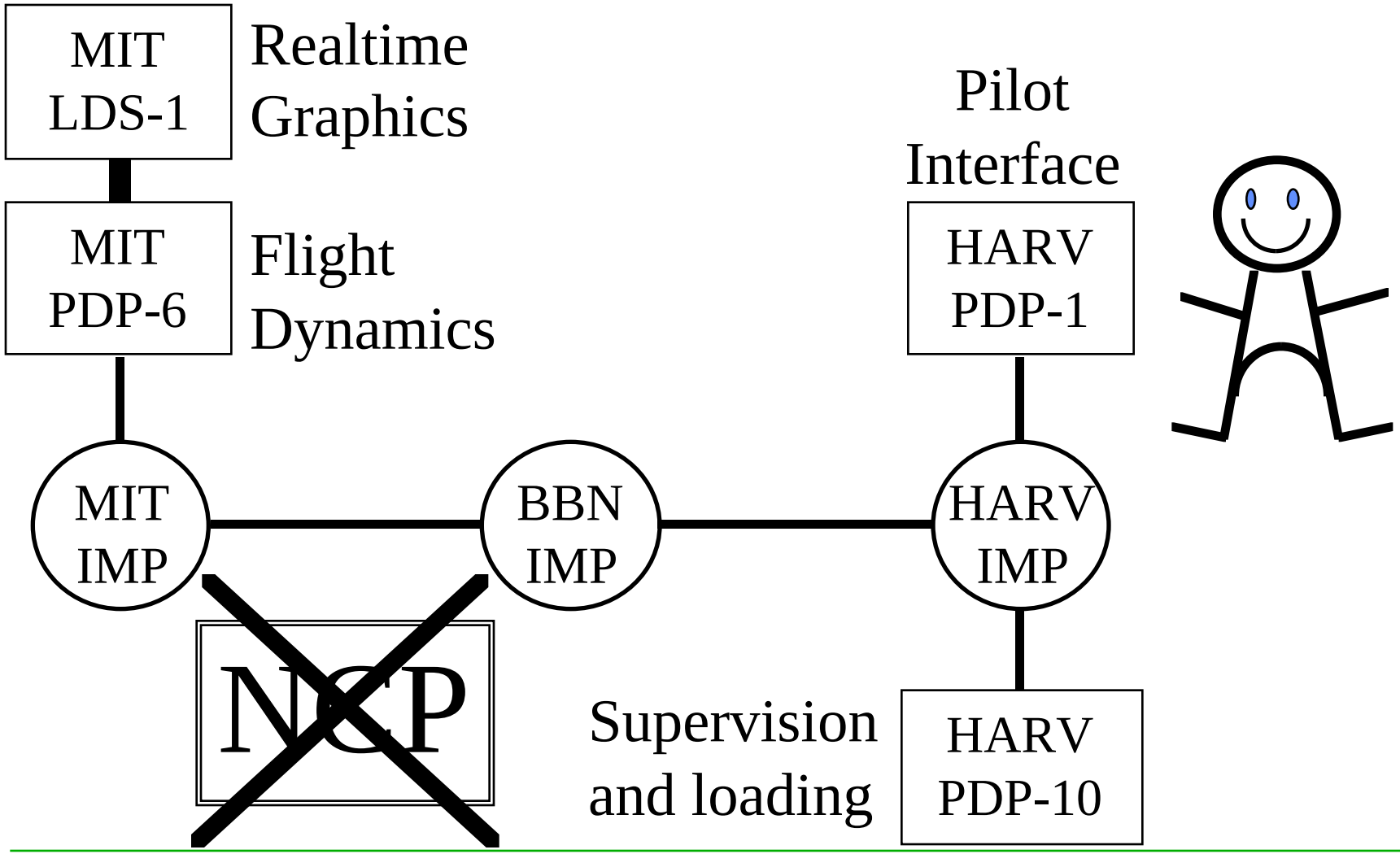
We had it running on the Harvard PDP-1

Distributed Realtime Flight Simulation



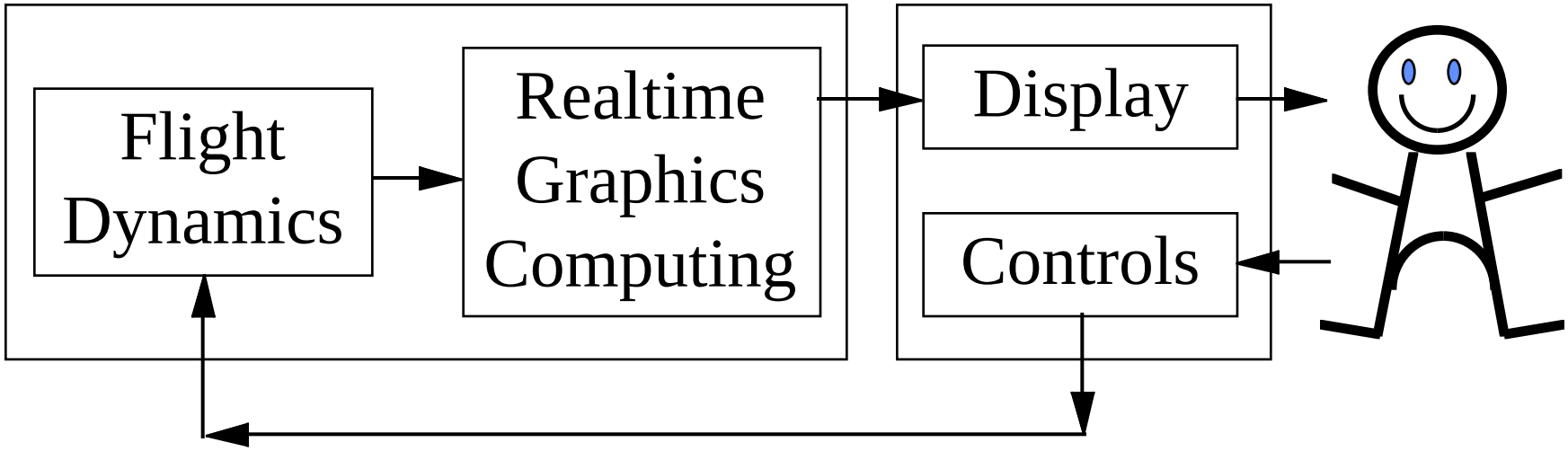
MIT PDP-6 | MIT LDS-1 | Harvard PDP-1

Distributed Computing



More about this application may be found in RFC0089 ("Some Historic Moments in Networking") by Bob Metcalfe Jan-19-1971

Distributed Realtime Flight Simulation



PDP-10 Anywhere (Harv, CMU, ISI)

Harvard PDP-1

NCP

Issues

* Bandwidth
* Latency (average, jitter, ...)
* Coping with lost packets
* Network Protocols
* Technique: TimeStamp, Seq#

Realtime Packet Speech

In 1973 ARPA created the NSC program (Network Secure Communication).
It faced the same realtime issues as the distributed flight simulation.
The biggest problem was the bandwidth.

The ARPAnet had only a total of 168=3*56**K**bps across the country

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Temporary Focus

The initial focus of the program was the speech compression technology, from 56Kbps to 16Kbps (CVSD) and to 2.4Kbps (LPC).

TI's speak-&-spell and many other consumer speech chips, as well as military systems are based on that technology.

This issue is OBE by now

OBE = Overtaken by Events

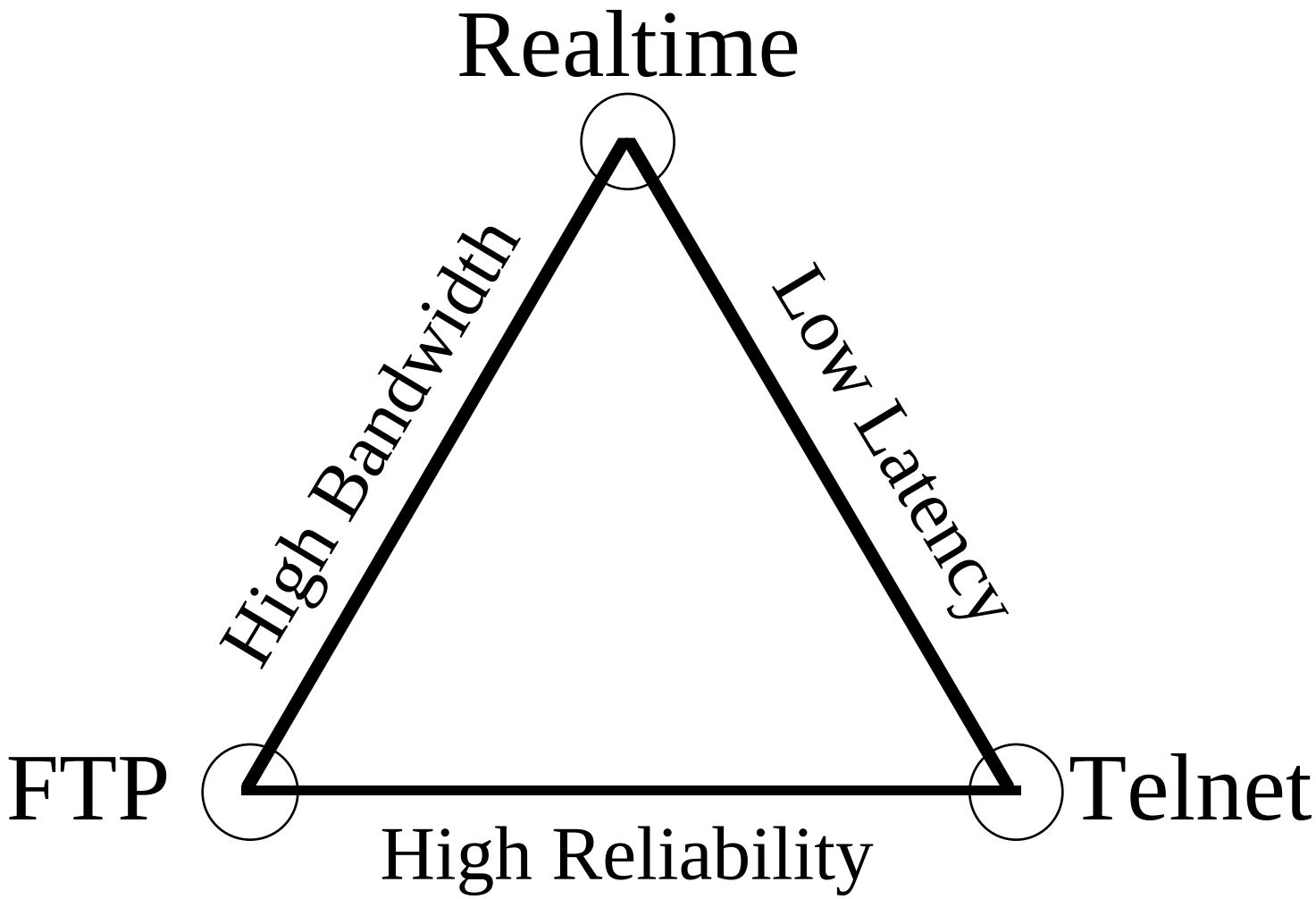
Choose Any Two !

Needed: (1) High Reliability
(2) Low Latency,
(3) High Bandwidth

But we can get only two. Which?
Telnet needs (1)+(2) , FTP needs (1)+(3).

Realtime applications need (2)+(3).
(better to ignore than to retransmit, at 600ms!)

The Eternal Triangle



Built-in Reliability

All the protocols (IMP, NCP,...) had the reliability built into them at the high cost of increased latency and/or reduced bandwidth.

The solution was to ignore the reliability by using “shoot-&-forget”, “best effort”, “datagrams”, a “true connectionless service”.

The Type-3 IMP messages were the solution.

The NVPs

NVP-0 run over 1822 (i.e., talking directly with the IMPs, without NCP) supporting CVSD.

NVP-I also run over 1822 (no NCP) with CVSD, LPC-I, and LPC-II, and also with NVCP for conferencing.

NVP-II was supposed to run on both the ARPAnet, SATnet, and PRnet, using the original TCP.

Using TCP

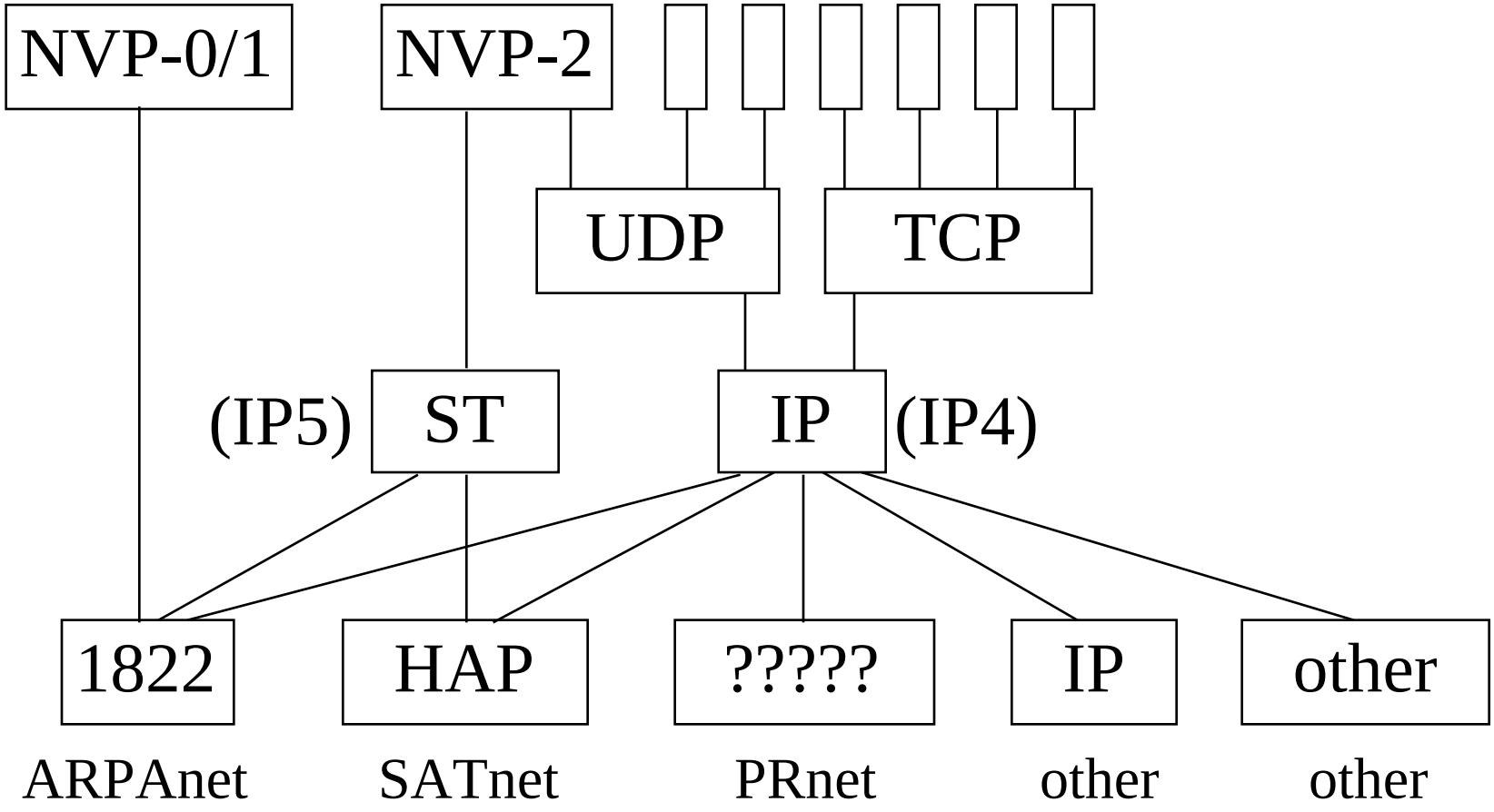
The original TCP assumed that “everyone uses the NCP” and provided reliable transport all the way to the destination process.

NVP-II could not afford this reliability.

To accommodate the NVP, IP was split from TCP, and a TOS field was added to IP, to reflect the “triangle” (bits 3/4/5 of the TOS field).

The NVP’s use of IP became UDP.

Protocol Hierarchy



Lessons

Realtime applications need different protocols than non-RT applications.

The main differences: reliability and flow control (rate based).

Packet communication can support realtime applications.

Historical Milestones

8/74: CVSD/ARPAnet: ISI+LL

12/74: LPC/ARPAnet: LL+CHI

1/76: LPC Conf/ARPAnet: ISI+LL+CHI+SRI

4/77: Flanagan (Bell Labs) applies for a patent for “packet transmission of speech”

7/78: USA Patent 4,100,377 granted

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