DCnet Research Network

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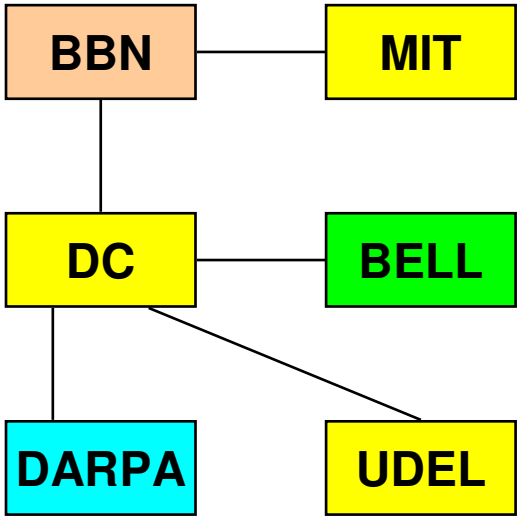
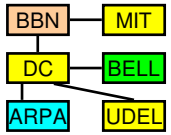
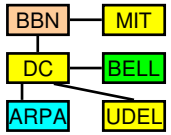


DCnet research network at UDel



- DCnet (128.4. subnets 1-9) is dedicated to network research at UDel
  - Several subnets dedicated to various network research projects in electrical engineering and computer science
  - Entire network or each subnet separately can be logically and electrically isolated from campus networks and routers
  - Uses 10/100-Mb/s Ethernet and ISDN
- Workstations used for program development and experiments
  - Workstations are stand-alone, but can share files with NFS
  - Experiment workstations can be used by outside investigators
- File, web and time servers
  - Files are automatically backed up by EECIS department archive servers
  - Sun Solaris standard software automatically updated from master site
  - Several primary (stratum 1) time servers available for dedicated DCnet, and public access

DCnet research network (May 2004)



WWVB (2)

GPS (2)

WWVB and GPS receivers connect to multiple computers via ASCII, PPS and IRIG

2x64 kb ISDN 128.4.2 Backroom

rackety *malarky* *pogo* *bunnylou* *cowbird* *others (3)* *boombah*

128.4.1 10/100 Mb

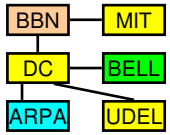
barnstable *churchy* *roogey* *hepzibah* *baldwin* *bridgeport* *evans-gw* *mudge-gw*

IPv6 Tunnel to Viagenie

IP Router
ISDN Router
Workstation
Server
Radio Clock

100 Mb
UDELnet 128.175
Abilene 155 Mb

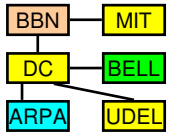
DCnet campus munchkins



128.4.1	DCnet campus			
128.4.1.1	rackety	Sun IPC	SunOS 4.1.3	time server
128.4.1.2	mizbeaver	TrueTime NTS-200	proprietary	time server
128.4.1.3	hepzibah	Intel Pentium II 200MHz	FreeBSD 4.3	program development
128.4.1.4	barnstable	Intel Pentium II 200MHz	FreeBSD 3.4	CAIRN router
128.4.1.5	churchy	Compaq Alpha 433au	Tru64 5.1	David Mills
128.4.1.7	alf	Intel Pentium 4 1.9GHz	Windows XP	David Mills
128.4.1.8	bridgeport	Sun Ultra 5_10	Solaris 2.9	grad student
128.4.1.11	snavely	HP 9000/735	HP-UX 10.02	program development
128.4.1.20	pogo	Sun Ultra 5_10	Solaris 2.9	file/time server
128.4.1.21	boombah	Cisco 736	proprietary	ISDN router
128.4.1.22	malarky	Sun Ultra 5_10	Solaris 2.9	David Mills
128.4.1.24	baldwin	Sun Ultra 5_10	Solaris 2.9	grad student
128.4.1.25	albert	Intel Pentium II 200	Linux	program development
128.4.1.26	seminole	Sun Blade 1500	Solaris 2.8	grad student
128.4.1.28	cowbird	Digital Alpha 3000/300	Digital Unix 4.0	program development
128.4.1.29	porkypine	Digital RISC 5000/240	Ultrix 4.4	program development
128.4.1.30	crazycat	Intel 386 25MHz	DOS	LORAN-C receiver
128.4.1.31	bunnylou	Digital Alpha 3000/400	Digital Unix 4.0	program development
128.4.1.32	roogey	Intel Pentium 4 1GHz	Windows XP	office shared
128.4.1.50	cockatoo	HP JetDirect	proprietary	printer server
128.4.1.64	mudge-gw	Torrent router	proprietary	department router
128.4.1.100	evans-gw	Cisco router	proprietary	department router

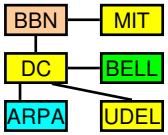
- This is a dedicated, 10/100 Mb/s Ethernet network intended for faculty and students of networking research

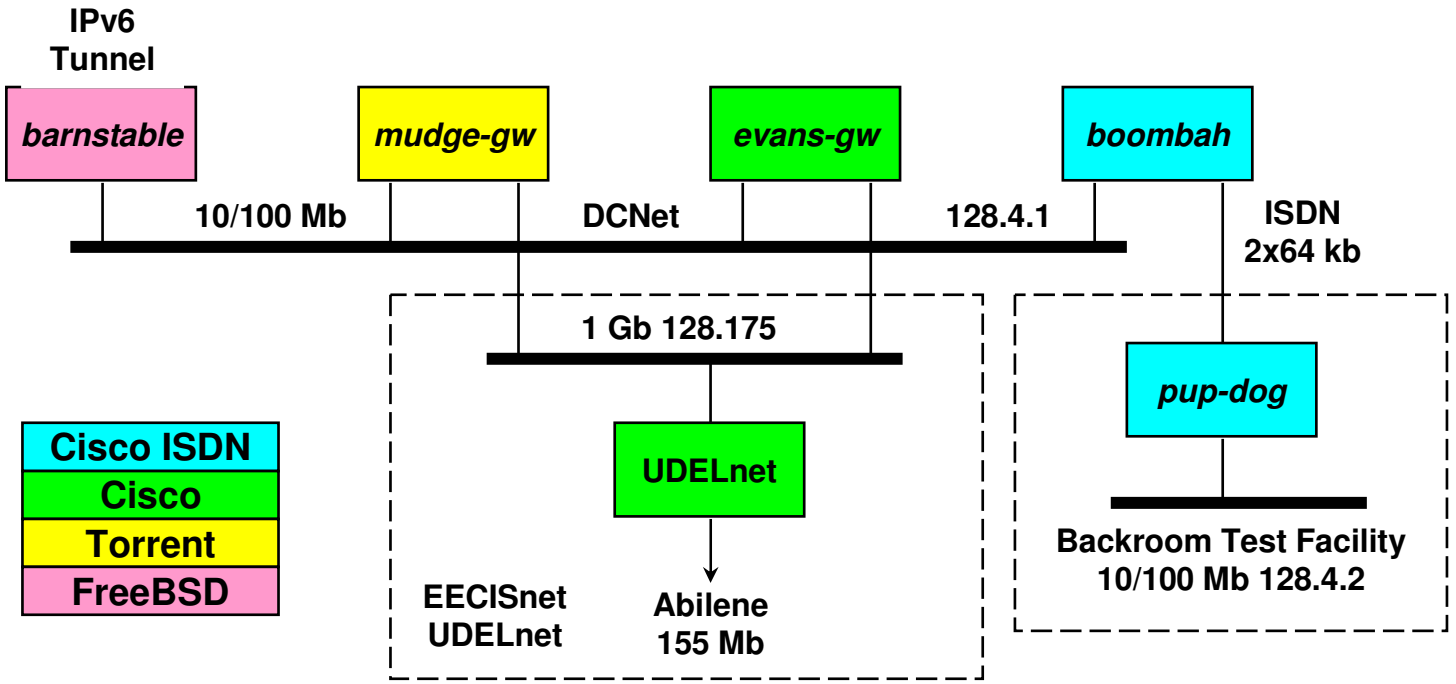
DCnet campus servers



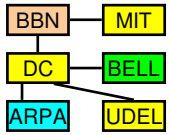
- Primary NFS servers *pogo* and *huey*
  - *pogo* is primary DCnet shared file and time server
  - *huey* is primary EECIS department shared file, ftp and web server
- Dual-redundant NIS servers *pogo* and *malarky*
  - Automatically updated from EECIS master maps
  - Secondary web server for camera and radio controls
- Dual-redundant NTP servers *pogo* and *rackety*
  - Synchronized by dual-redundant GPS receivers via PPS and IRIG
  - Backup synchronization dual-redundant WWVB receivers
  - Monitored relative to dual-redundant frequency standards
- Dual redundant IP routers *evans-gw* and *mudge-gw*
  - Support full 100-Mb access to Abilene and vBNS

DCnet IP routers (May 2004)



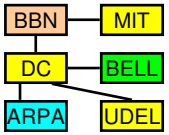


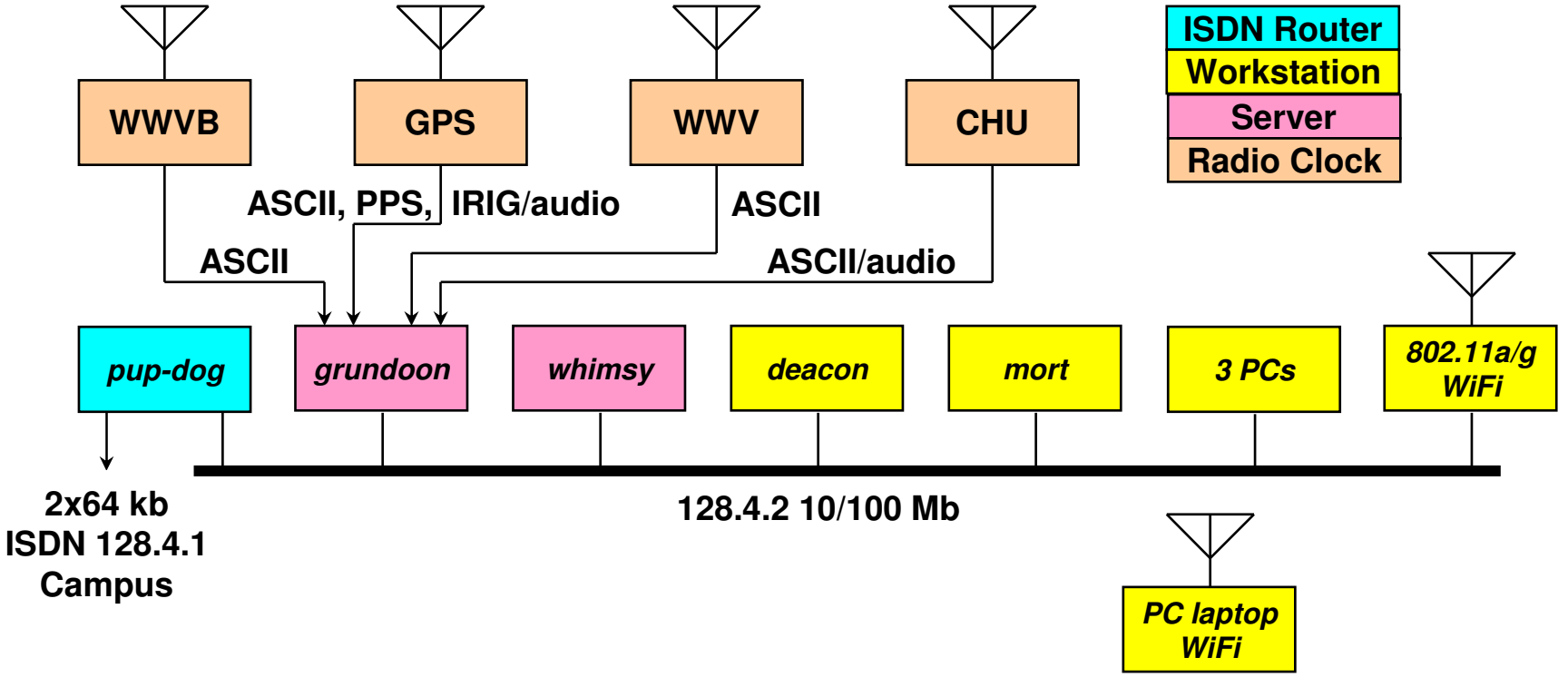
DCnet IP routing (January 2004)



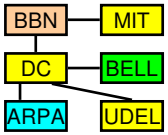
- DCnet IP routers and bridges
  - *barnstable* supports 1.5-Mb direct link to CAIRN PoP near Washington, DC
  - *Evans-gw* and *mudge-gw* are dual-redundant EECIS department routers for 10/100-Mb campus backbone and 1-Gb link to Abilene router
  - *boombah* and *pup-dog* are ISDN routers supporting 2x64 kb/s ISDN line to the Backroom Test Facility (BTF)
- We can run desktop applications at full 100-Mb speeds between DCnet workstations and comparably equipped vBNS networks via Abilene

DCnet backroom test facility (May 2004)





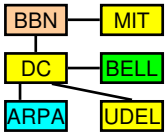
DCnet backroom munchkins

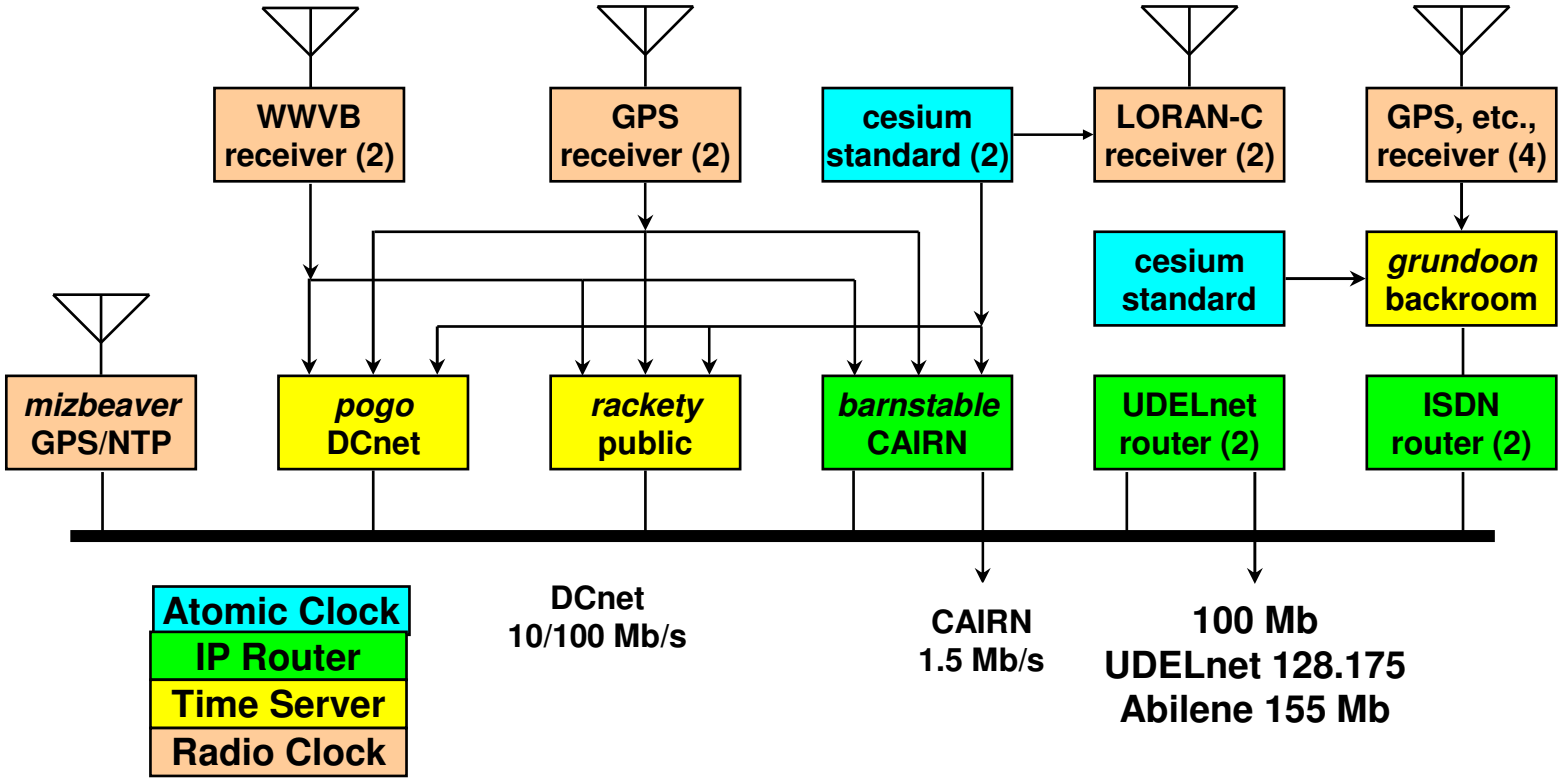


128.4.2	DCnet backroom			
128.4.2.3	whimsy	Sun Ultra 30	Solaris 2.9	file/time server
128.4.2.4	mort	Sun Blade 1000	Solaris 2.9	program development
128.4.2.5	deacon	SUN Blade 1500	Solaris 2.8	David Mills
128.4.2.6	backroom	Intel Pentium 4 2.8GHz	Windows XP	David Mills
128.4.2.7	grundoon	Sun IPC	SunOS 4.1.3	file/time server
128.4.2.8	wifi-gw	Linksys 811.abg	proprietary	WiFi bridge
128.4.2.9	beauregard	Intel 486 40MHz	FreeBSD 4.3	program development
128.4.2.13	fuzzball	DEC LSI-11/73	Fuzzball	historic interest
128.4.2.12	brunce	Intel Pentium 4 1.9GHz	Windows XP	program development
128.4.2.16	howland	Pentium II 233MHz	FreeBSD 4.3	program development
128.4.2.18	macabre	Dell 8200	Windows XP	laptop-to-go
128.4.2.19	pup-dog	Cisco 736	proprietary	ISDN router
128.4.2.20	woodrow	HP JetDirect	proprietary	printer server
128.4.2.21	wiley	Pentium II 450MHz	Windows XP	Beverly Mills

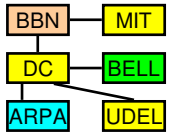
- This is where most of the work gets done
  - A few of these machines are provided at no cost to the Government

DCnet timekeeping facilities (May 2004)



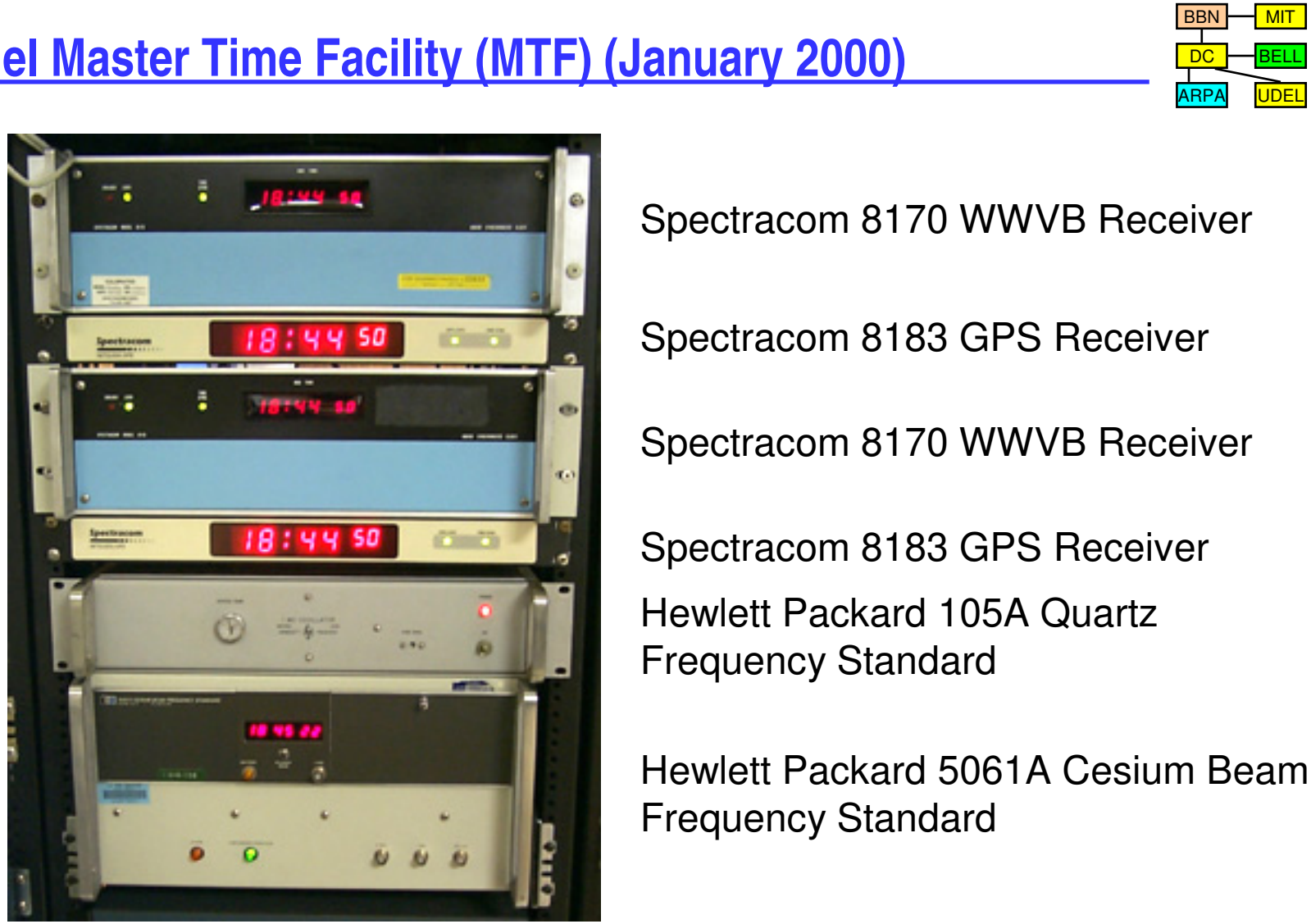


How the clocksprings get wound



- Facility includes dual-redundant servers and reference sources
  - All servers, receivers and frequency standards have UPS backup
  - Dual-redundant Spectracom GPS receivers primary reference sources
  - Dual-redundant Spectracom WWVB receivers secondary reference sources
  - Receivers calibrated by LORAN-C and cesium and quartz standards
- *rackety* is dedicated public primary (stratum 1) time server
  - Has well over 700 regular clients
  - Runs NTP Version 4 and SunOS 4.1.3 with nanokernel modifications
  - Normally accurate relative to GPS PPS signal to within 20-50 μs
- *pogo* is DCnet community primary (stratum 1) time server
  - Monitors most national time standards laboratories on the Internet
  - Runs NTP Version 4 and Solaris 2.8 with audio-IRIG driver and GPS PPS
  - Normally accurate relative to GPS PPS signal to within 10-20 μs
- *mizbeaver* is TrueTime NTS-200 integrated GPS/NTP server

Udel Master Time Facility (MTF) (January 2000)



Spectracom 8170 WWVB Receiver

Spectracom 8183 GPS Receiver

Spectracom 8170 WWVB Receiver

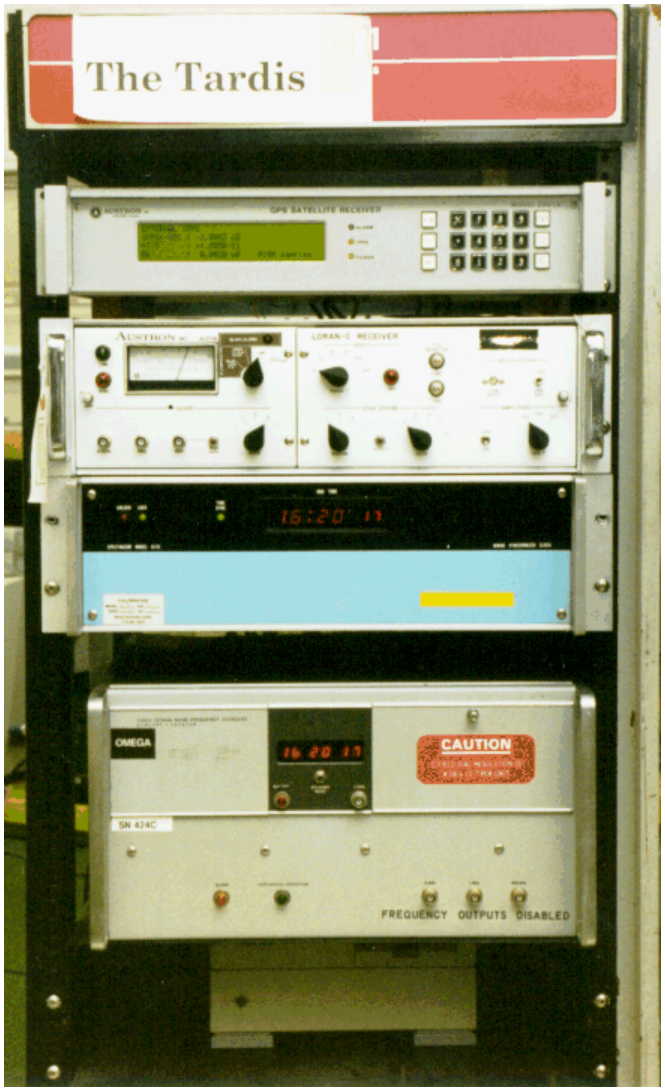
Spectracom 8183 GPS Receiver

Hewlett Packard 105A Quartz Frequency Standard

Hewlett Packard 5061A Cesium Beam Frequency Standard

NTP primary time servers *rackety* and *pogo* (elsewhere)

Precision timekeeping equipment (prior to 2000)



Austron 2200A GPS Receiver

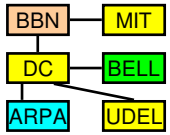
Austron 2000 LORAN-C Receiver

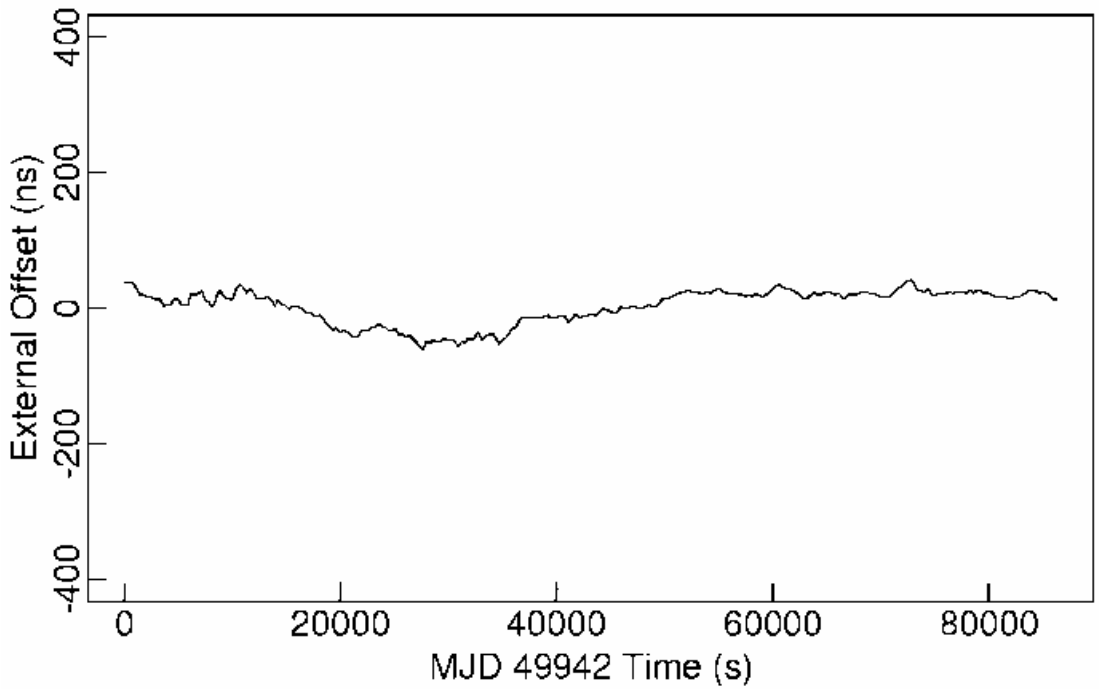
Spectracom 8170 WWVB Reciver

Hewlett Packard 5061A Cesium Beam Frequency Standard

NTP primary time server *rackety*

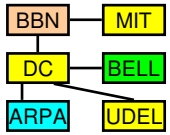
Squeezing the nanoseconds





- This shows the residual error measured between an Austron 2201 GPS receiver and the HP 5061A cesium clock
- The GPS receiver is stabilized using the LORAN-C receiver, which improves its accuracy to about 50 ns, in spite of the intentional degradation introduced in the GPS signal available to the public

Further information



- Network Time Protocol (NTP): *www.ntp.org*
  - Current NTP Version 3 and 4 software and documentation repository
  - FAQ and links to other sources and interesting places
- David L. Mills: *www.eecis.udel.edu/~mills*
  - Papers, reports and memoranda in PostScript and PDF formats
  - Briefings in HTML, PostScript, PowerPoint and PDF formats
  - Collaboration resources hardware, software and documentation
  - Songs, photo galleries and after-dinner speech scripts
- FTP server *ftp.udel.edu* (`pub/ntp` directory)
  - Current NTP Version 3 and 4 software and documentation repository
  - Collaboration resources repository
- Related project descriptions and briefings
  - See “Current Research Project Descriptions and Briefings” at *www.eecis.udel.edu/~mills*