CAIRN/DARTnet Collaboration

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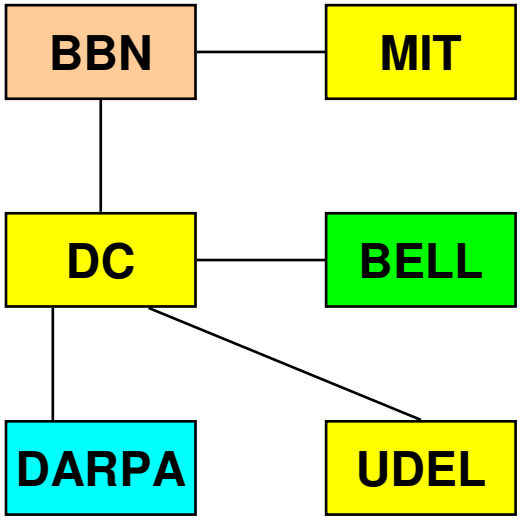
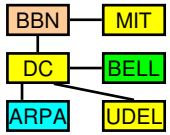
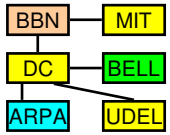


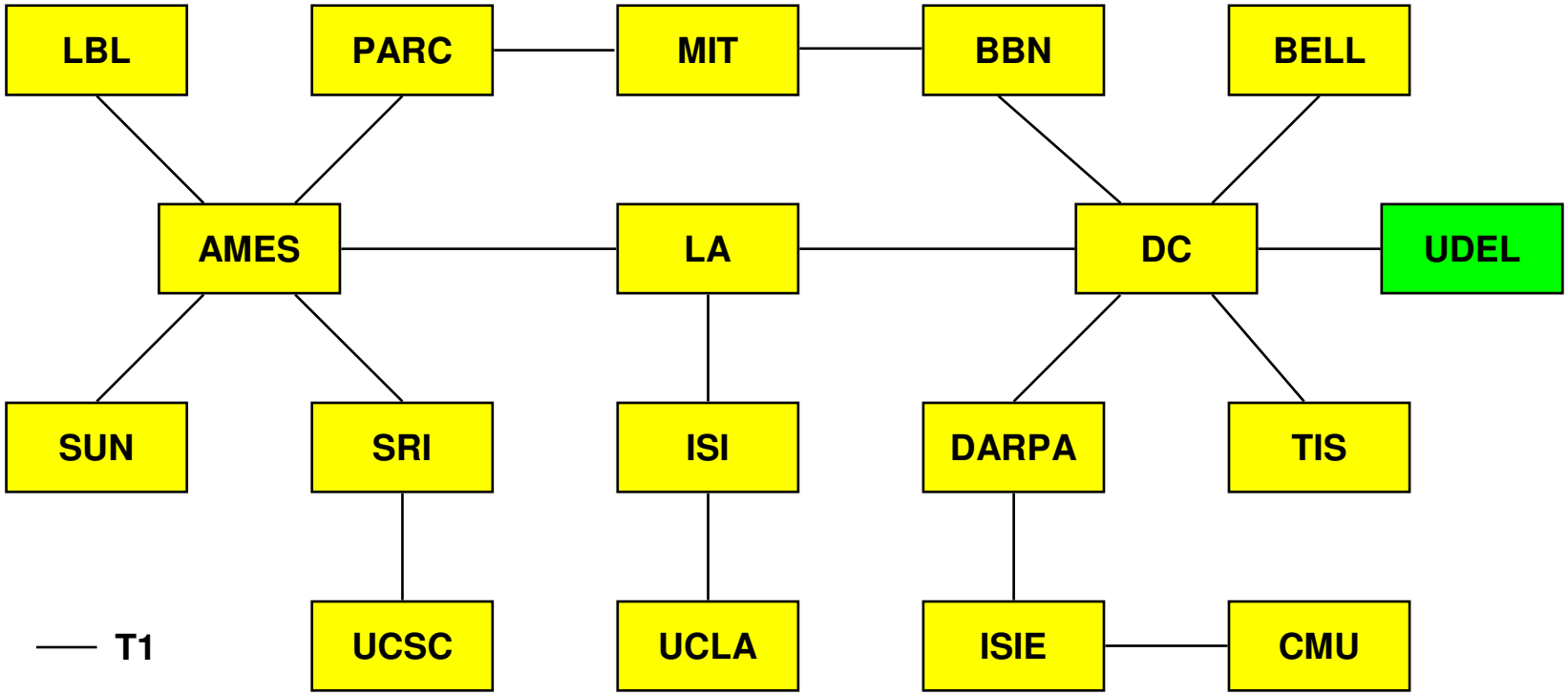
Introduction



- CAIRN and DARTnet research networks
  - DARTnet and later CAIRN span the country from Boston, Washington, Los Angeles and San Francisco
  - Used for protocol development (multicast) and multimedia services (audio, video, whiteboard)
- DARTnet II consists of 18 sites interconnected with T1 circuits (1.5 Mb/s)
  - IP Routers and most test/buddy hosts use Sun SPARC architecture
  - Some routers located at telco PoPs
- CAIRN consists of 27 sites interconnected with T1, T3 and SONET circuits (1.5, 45 and 155 Mb/s)
  - Some circuits provisioned by ATM PVCs
  - Most IP routers use PC architecture running FreeBSD

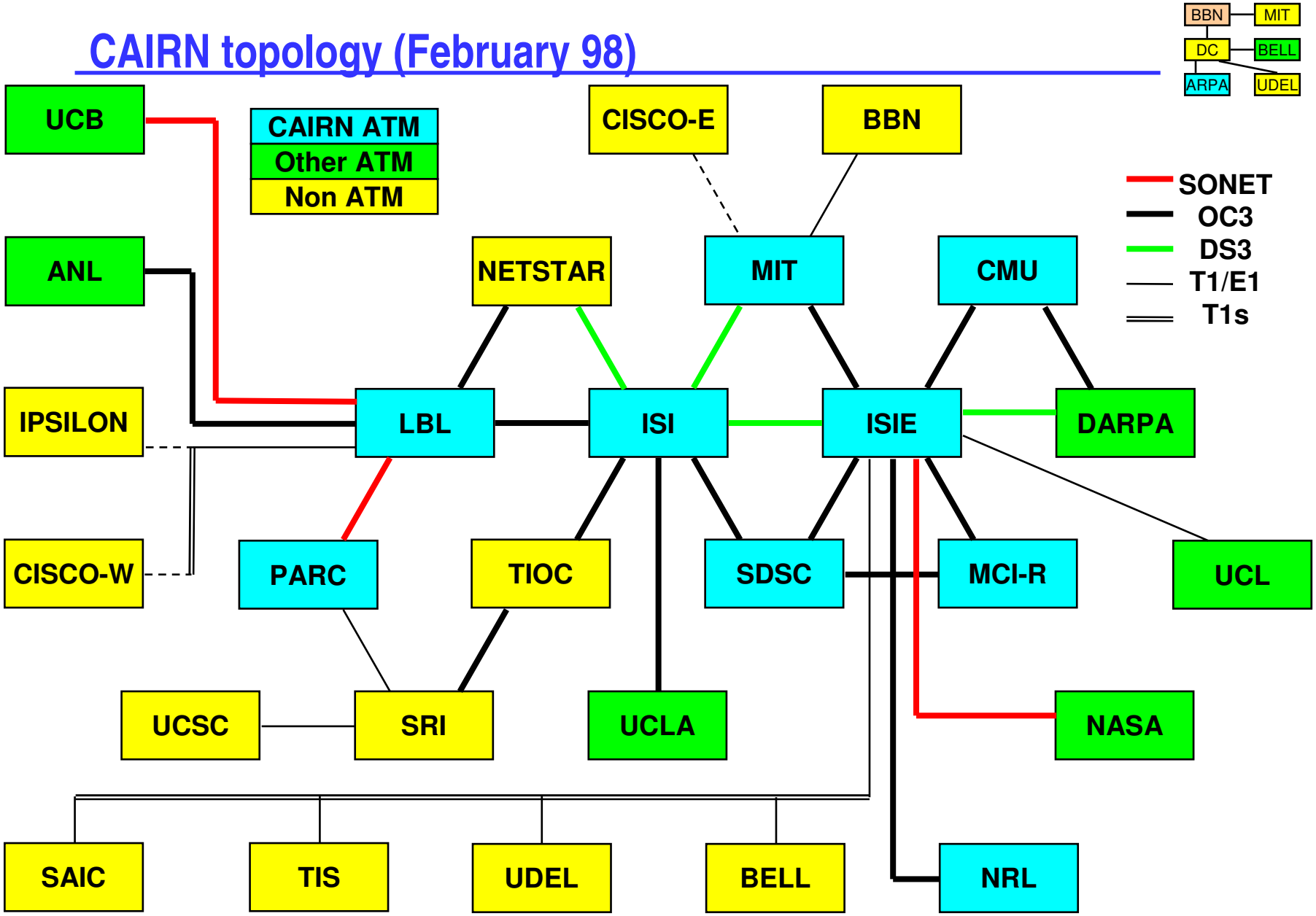
DARTnet II Research Network (1997)



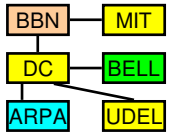


- All routers are Sun SPARCstations running SunOS
- All network links are 1.544 Mb T1 circuits

CAIRN topology (February 98)

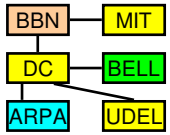


DARTnet II/CAIRN network sites (February 1998)



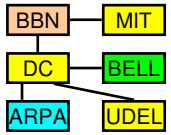
AMES	NASA AMES Reseach Ctr PoP	NASA	Nat Aero and Space Admin
ANL	Argonne Natlonal Labs	NETSTAR	Netstar, Inc
BBN	Bolt Beranek Newman	NRL-V6	Naval Research Labs
BELL	Bellcore	PARC	Xerox Palo Alto Res Ctr
CISCO-E	Cisco Systems - East	SAIC	Science App International
CISCO-W	Cisco Systems - West	SDSC	San Diego Supercomp Ctr
CMU	Carnegie Mellon Univ	SRI	SRI International
DARPA	DARPA Agency of DoD	Sun	Sun Microsystems
DC	Washington PoP	TIOC	Ten Indians Overcome Chaos
IPSILON	Ipsilon, Inc	TIS	Trusted Info Systems
ISI	USC Info Sciences Inst	UCB	UC Berkeley
ISIE	ISI East	UCL	University College London
LA	Los Angeles PoP	UCLA	UC Los Angeles
LBL	Lawrence Berkeley Labs	UCSC	UC Santa Cruz
MCI-R	MCI Reston	UDEL	University of Delaware
MIT	Mass Inst Technology		

Things made possible with DARTnet and CAIRN



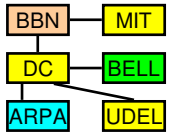
- Development of hybrid unicast/multicast time distribution with low overhead and near-unicast accuracy
- Development and testing of precision-time kernel modifications for SunOS and later porting to FreeBSD, Ultrix, OSF/1 and HP-UX
- Development of Global Positioning System radio clock drivers
- Development of pulse-per-second (PPS) drivers and kernel modifications for nanosecond accuracy
- Collection of performance data under stress and meltdown conditions
- Precision timing for DARTnet/CAIRN real-time applications
- Experiments involving subnet configurations under various failure and fallback scenarios

Timekeeping in DARTnet and CAIRN



- Routine testing of alpha versions of the Network Time Protocol (NTP) in controlled deployments
- Improvement in accuracy from tens of milliseconds to nanoseconds
- Improved reliability with redesigned intersection, clustering and combining algorithms
- Improved accuracy with redesigned phase/frequency-lock loop (PLL/FLL) clock discipline
- Development of user-kernel interfaces and system calls to provide application programs with clock accuracy and stability information
- Development of *autokey* cryptographic authentication
- Development of *autoconfigure* network configuration technology
- Routine logging for long term performance evaluation
- Collaboration with folks at NIST and USNO in common experiments

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*