Satellite Networking

EPSCoR
San Diego - July 2000

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Israel InterUniversity

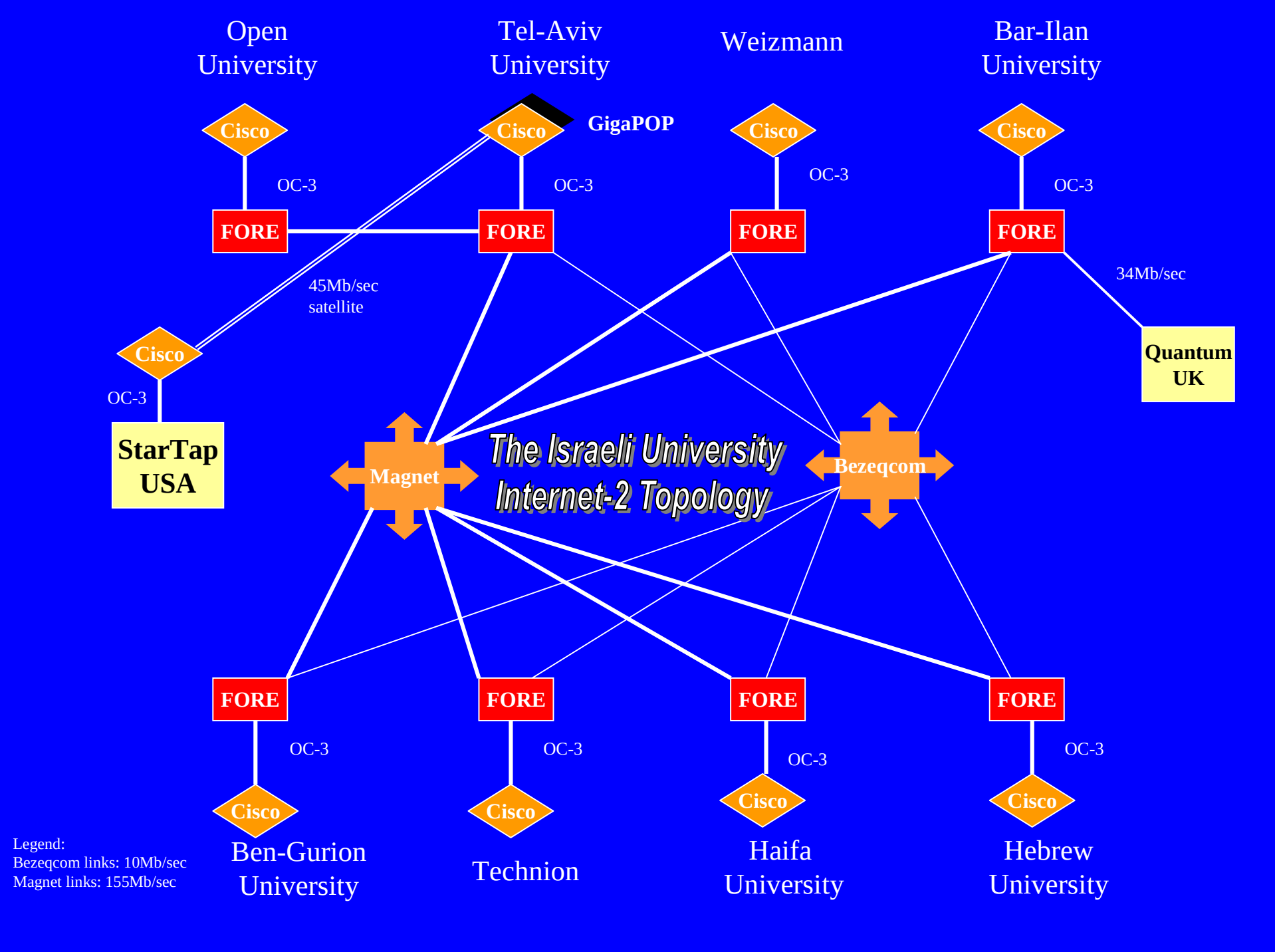
Computation Center

Agenda

- **Where am I coming from?**
- **Mentat**
- **Cidera**
- **iBeam**
- **IPplanet**

Where am I coming from?

- **Israel InterUniversity Computation Center**
- **Dual ATM network**
  - **OC-3 primary, E3 backup**
- **Fiber E3 (34Mb/sec) to Europe**
  - **$157K/month**
- **Satellite T3 to StarTap in Chicago**
  - **$198K/month**


Open University
Tel-Aviv University
Weizmann
Bar-Ilan University
Cisco
GigaPOP
OC-3
FORE
45Mb/sec satellite
34Mb/sec
Quantum UK
StarTap USA
Magnet
Bezeqcom
The Israeli University Internet-2 Topology
Ben-Gurion University
Technion
Haifa University
Hebrew University
Legend:
Bezeqcom links: 10Mb/sec
Magnet links: 155Mb/sec

Satellite issues and QoS

- **TCP streams are limited to 936kb/sec**
  - **Internet-2 applications affected**
  - **RFC2488 - Enhancing TCP Over Satellite Channels using Standard Mechanisms**
    - **Path MTU - RFC1191**
    - **Large windows - RFC1323 (default is 64KB)**
    - **Large socket buffers - bandwidth*delay = 45Mb*600ms = 3.3Mbytes**
    - **TCP Selective Ack (SACK) - RFC2018**
- **UDP unaffected**

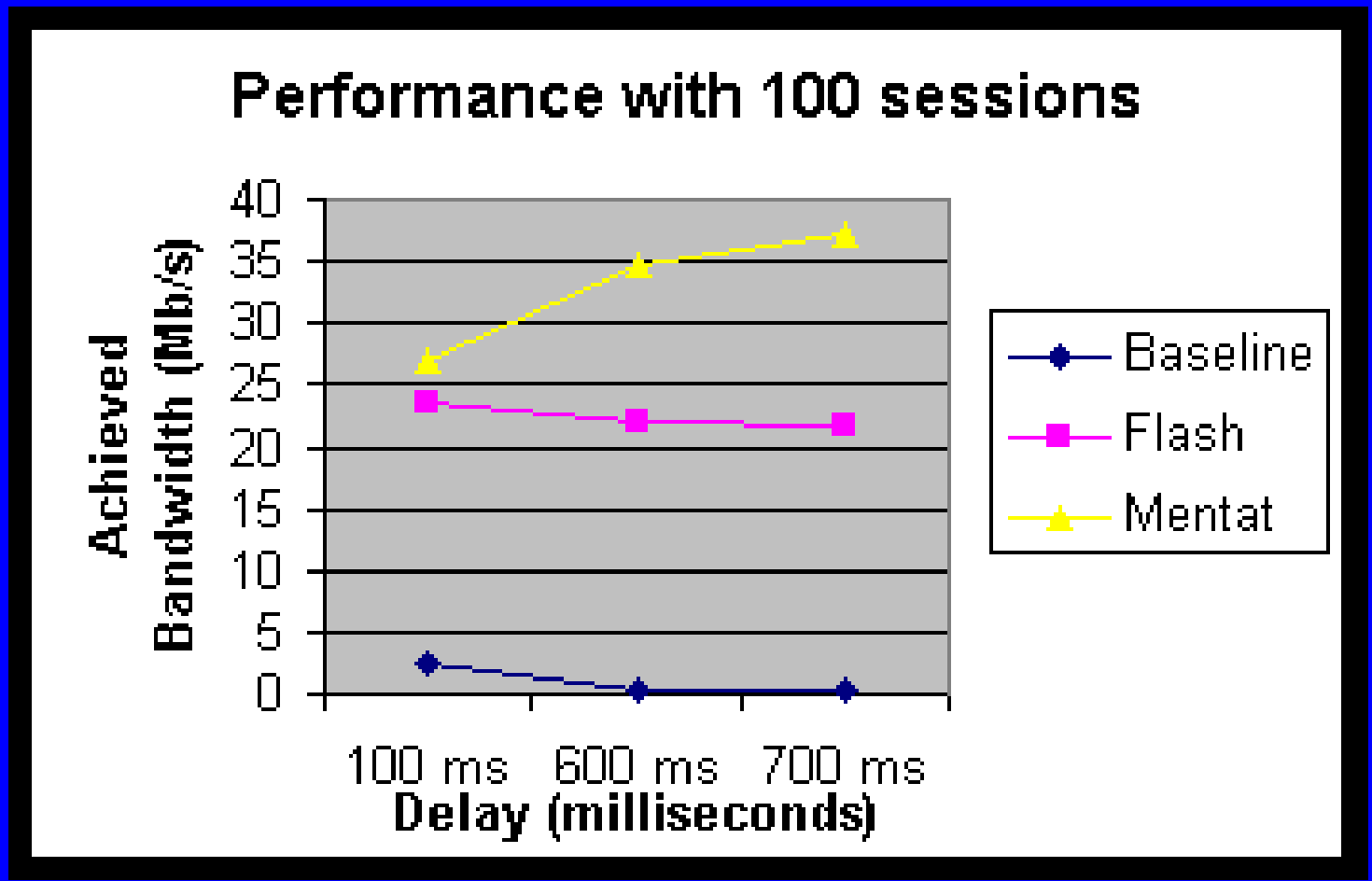
Satellite issues and QoS

- **Thruput = window size / RTT**
  - **64K / 560ms = 117,027 bytes/sec (936kb/sec)**
    - **64K is maximum default - W98 is 8K**
  - **1M / 30ms = 33Mb/sec (Abilene TCP limit?)**
- **Enabling High Performance Data Transfers**
  - **http://www.psc.edu/networking/perf_tune.html**
  - **unable to get researchers to tune their TCP stacks**

Satellite black box testing

- **Initial benchmark testing performed in April 1999 at Intelsat lab**
  - **Flash Networks (Israeli) and Mentat (USA)**
    - **results located at: www.internet-2.org.il/satellite-testing.html**

Satellite results



Mentat SkyX

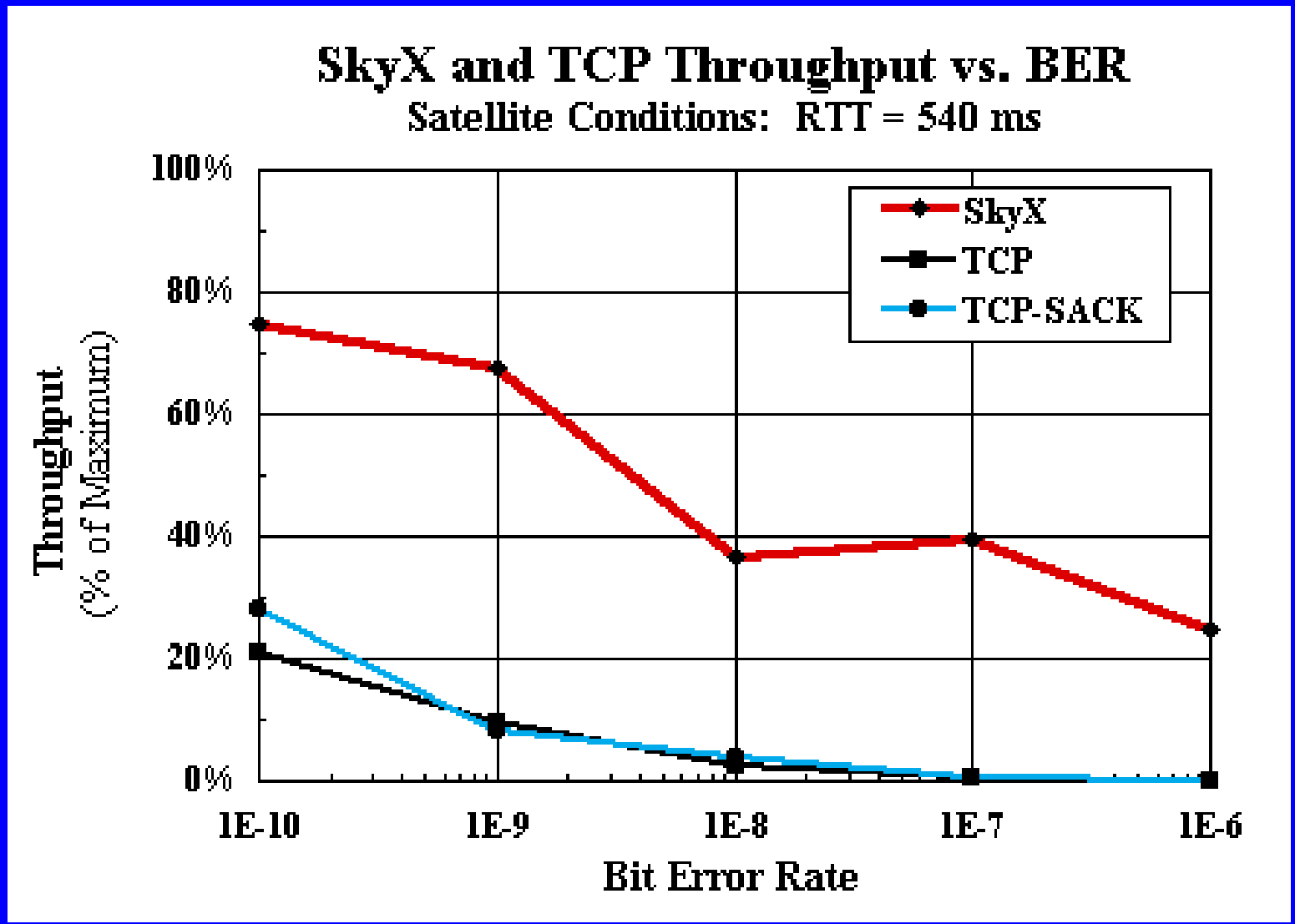
- **Only affects TCP - UDP and ICMP is bypassed (as well as Ipsec)**
  - **requires symmetric routing**
- **Intercepts TCP connections and replaces it over satellite with “SkyX protocol”**
  - **uses NACKS to request again lost data packets**
  - **unlimited window size**
  - **no slow start over satellite link**
  - **streamlined TCP handshake on initial connection**
  - **TCP rate control over satellite link**

NASA testing

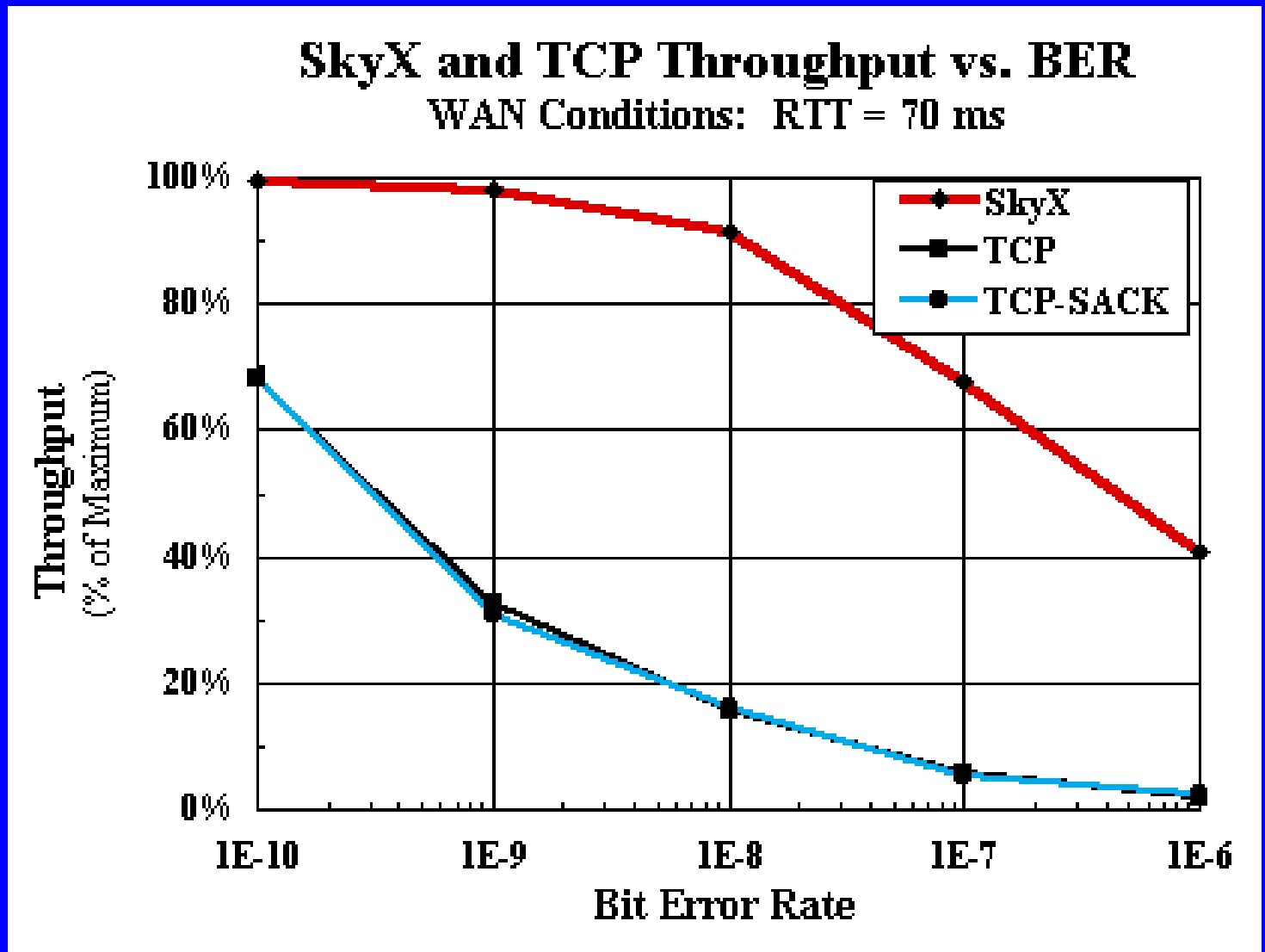
- **OC-3 testing in a lab**
- **Details located at:**

http://www.mentat.com/skyx/skyx-nasa.html

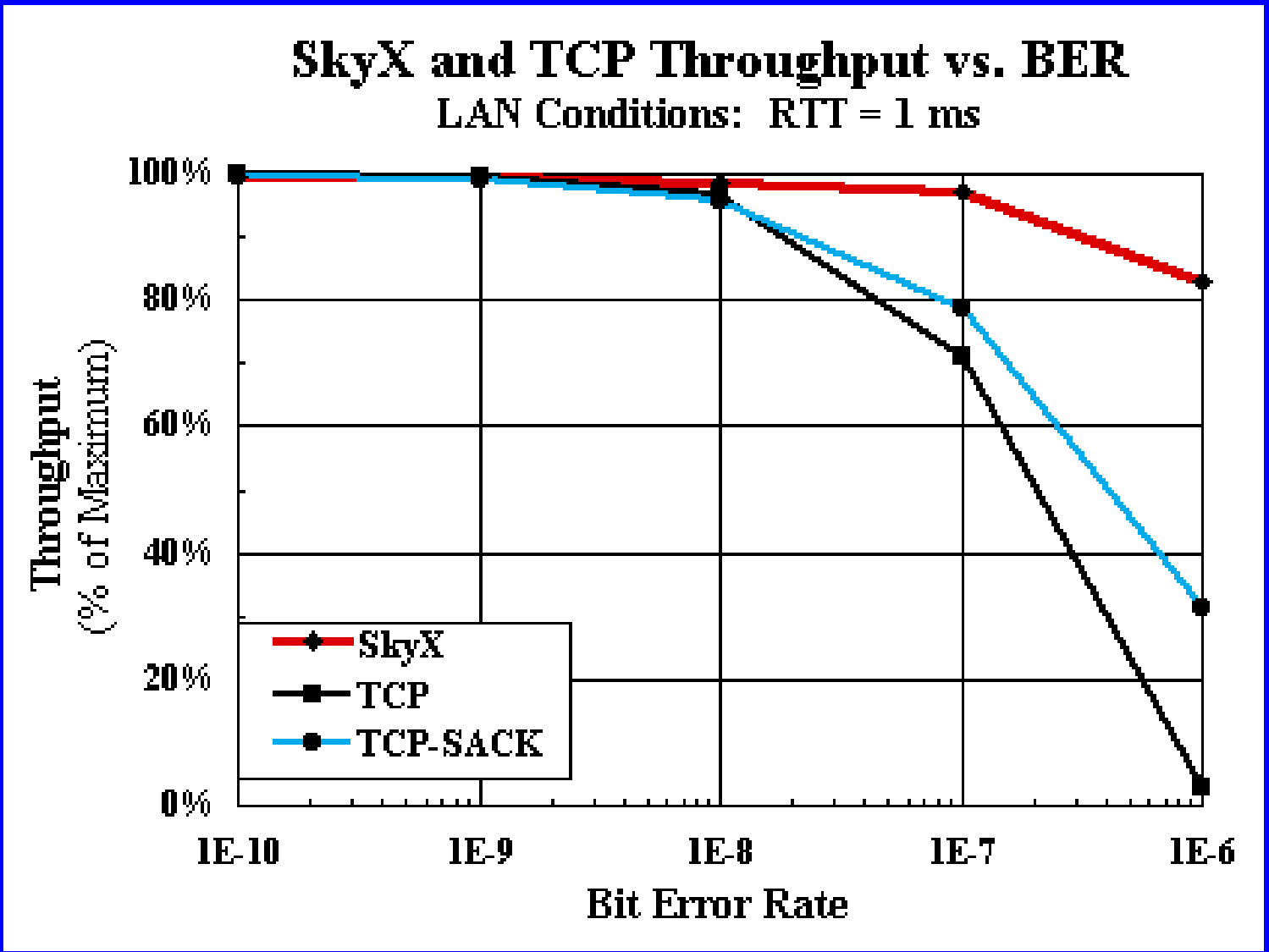
NASA tests of SkyX - #1



NASA tests of SkyX - #2



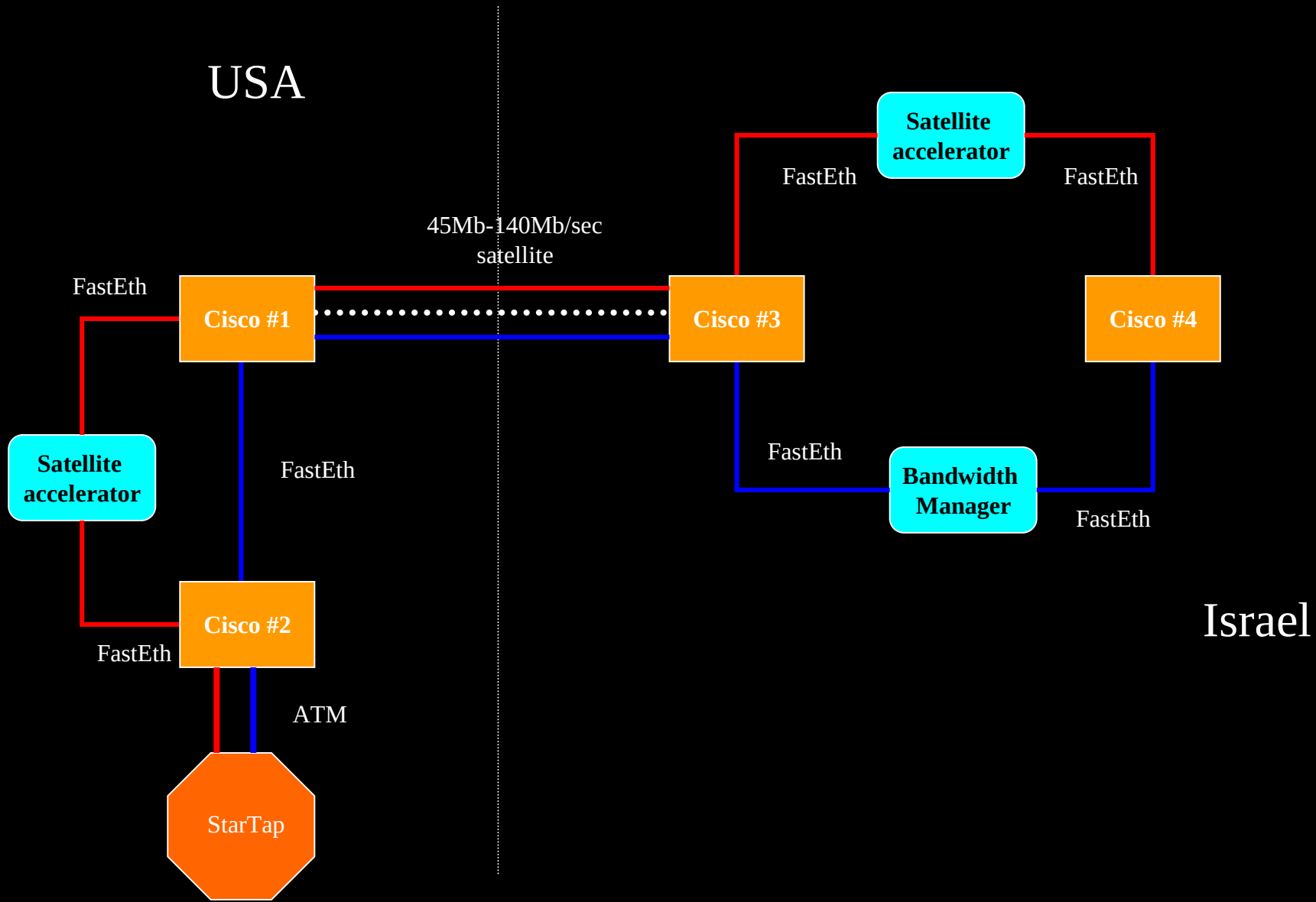
NASA tests of SkyX - #3



Israeli Mentat results (Jan 2000)

- **30Mb/sec pipe, iperf to U of Oregon**
- **No SkyX (560ms RTT)**
  - **8Kbyte TCP window- 118kbit/sec**
  - **64Kbyte TCP window - 646kbit/sec**
  - **500Kbyte TCP window - 2.9Mbit/sec**
- **With SkyX (560ms RTT)**
  - **8Kbyte TCP window - 19.5Mbit/sec**
  - **64Kbyte TCP window - 18.0Mbit/sec**
  - **500Kbyte TCP window - 18.5Mbit/sec**

GigaPOP Design for Differentiated Services



Visible Human project

- **Sharing "Visible Human" data files**
  - **NASA & National Library of Medicine**
  - **Sapporo Medical University in Japan**
- **http://www.nlm.nih.gov/research/visible/getting_data.html**

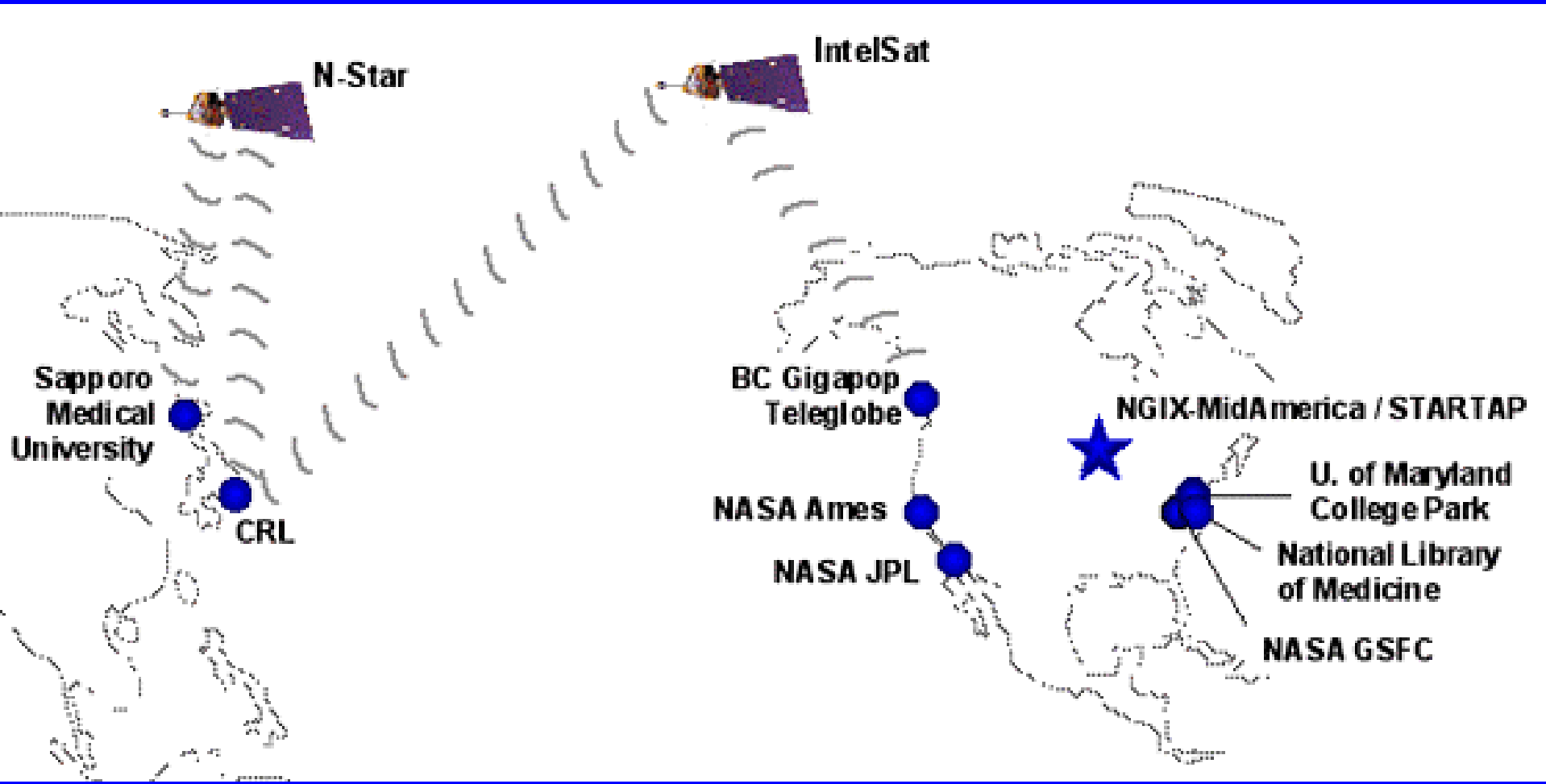
Data size for Visible Human

- **Anatomical and CT databases**
  - **3742 male images @ 7.5MB = 28GB**
    - **done at 1mm intervals**
  - **6871 female images @ 7.5MB = 51GB**
    - **done at .33mm intervals**

Remote Astronomy

- **Mt Wilson 24” telescope**
  - **NASA**
  - **Soka High School in Japan**
  - **Jefferson High School in Maryland**
  - **University of Maryland**

US-Japan topology



Mentat

- **http://www.mentat.com**
- **Email: DC Palter - dc@mentat.com**

How much do you pay for bandwidth?

- **T1 - $1500-$2000/month**
- **T3 - $28,500-$37,500/month**
- **How much of your bandwidth is used by Usenet news?**
  - **500,000 articles/day, 100GB/day, 12Mb/sec 24x7**

What is using your bandwidth?

- **How much of your traffic is standard port=80 web traffic?**
- **56% of my incoming traffic is port=80**

Cidera

- **Used to be known as Skycache**
- **Data broadcasting at 45Mb/sec**
- **Uses GE-4 satellite over North America (ku-band)**
  - **requires 1.2 meter dish**
  - **slightly larger dish needed in Alaska (1.9 meter)**
- **Maintains 3 uplinks via 7.6 meter dishes in Laurel, MD**

GE-4 coverage

Cidera services

- **Usenet news**
- **Web caching**
- **Streaming media**
  - **multicast as well as unicast**
  - **Windows Media Player, RealPlayer or Apple Quicktime**

How much does it cost?

- **For 8Mb/sec web cache: $350/month**
- **For 12Mb/sec Usenet news feed: $500/month**
- **Usenet and caching: $650/month**
- **$1000 install per site**

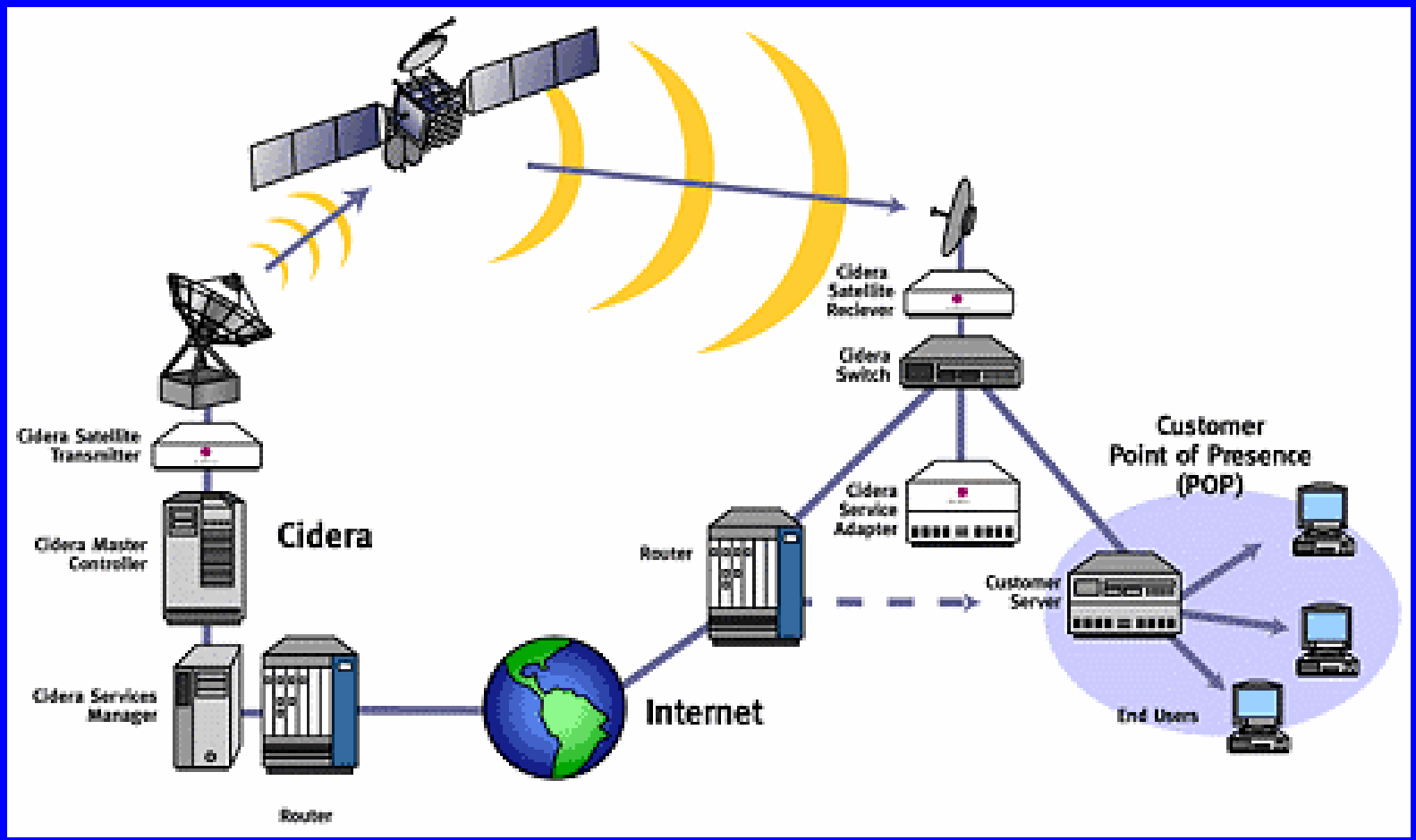
How Cidera caching works

- **Predictive caching**
  - **pre-populating the cache with well known popular sites like Yahoo, CNN, ESPN**
  - **can’t handle things like Mars Pathfinder event**
- **Reactive caching**
  - **analyzing “miss streams”**
  - **3 misses worldwide and Cidera prefetches the page**

How does Cidera news work?

- **Gold ($650/month)**
  - **120GB/day, plus 10 minute delayed terrestrial feed**
    - **picks up lost articles**
- **Silver ($500/month)**
  - **120GB/day, no delayed feed**
  - **slow news servers may drop articles**
- **Bronze ($350/month)**
  - **full text articles**
  - **256KByte limit to objects**

How Cidera works



How much does caching save

- **http://www.intel.com/network/tools/cache_1500_bwcalc.htm**
  - **45 Mb/sec bandwidth**
  - **Bandwidth cost: $577 per Mbps/month**
    - **$26K/month for T3**
  - **50% of traffic is ftp/http**
  - **cache hit rate of 50%**
  - **Savings: $78K/yr or 6.5Mbps**

Cidera

- **http://www.cidera.com**
- **E-mail: Tasha Museles tasha@cidera.com**

Cidera competitors - iBeam

- **iBeam - http://www.ibeam.com**
- **Bucknell University using iBeam to offset Napster use**
  - **using Launch.com service**

IPplanet

- **Uses DVB - Digital Video Broadcast**
  - **originally intended for video and audio broadcasting**
  - **now supports data services**
  - **works over C-band (as well as ku-band)**

Dynamic Bandwidth Allocation

- **Best viewed with an example:**
  - **A total of up to 8Mbps bandwidth available**
  - **Central router has up to 2Mbps**
  - **4 campuses, each has 2Mbps available 8am-8pm, 1Mbps available 8pm-8am**
  - **3 smaller campuses, each has 1Mbps available 8am-8pm, 2Mbps available 8pm-8am**
  - **10 Free Service POPs, all receive "best effort" bandwidth up to 512Kbps each**

IP Multiconnect

IPplanet

- **http://www.ipplanet.net**
- **Email: Yossi Barkan yossi.barkan@ipplanet.net**

Summary

- **Satellite networking is being outpaced by fiber**
  - **OC-12 not available by satellite, let alone OC-48**
  - **pricing not able to compete with fiber over the past 12 months**
- **Satellite networking is excellent for data broadcasting**
  - **very cheap deals available**

Contact info

- **Hank Nussbacher**
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- **I answer all email!**