Global Information Grid Evaluation Facilities

. . . Building tomorrows scalable Transformational Communications Architecture (TCA) today!

Provides inter-network demonstration and validation

TSAT, GIGBE, JTRS, Teleports, ARMY, Navy-Marines, Air Force, NASA, Intelligence Community … *IPV6/MPLS*

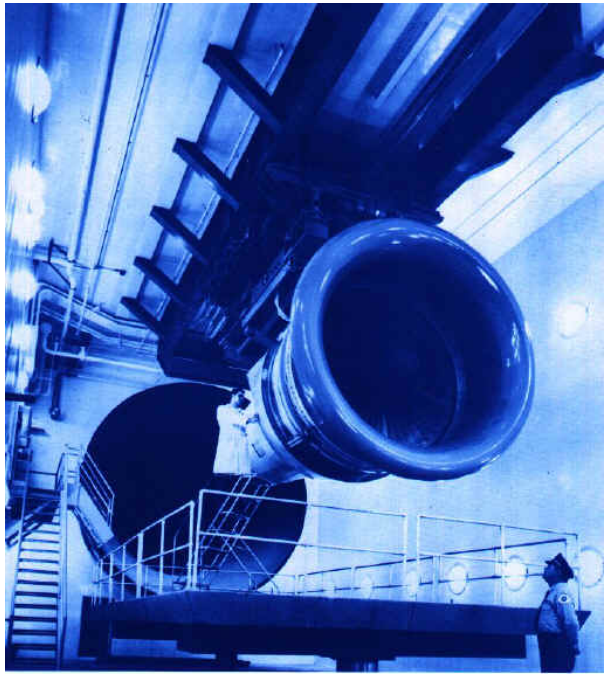

GIGEF
Global Information Grid
Evaluation Facilities

GIG-EF Philosophy …

- ***Interconnect*** **Architects, Developers, Users and Testers of the GIG**
- **Guided by Acquisition Components yet remain** ***Objective***
- ***Stress-Test/Evaluate*** **GIG Components in Collaborative Environment**

ANALOGY: ***Like the Jet Engine Test Stand…***

- ***Provide support to systems, but not the systems themselves***
- ***The "Test Stand"must be a strong framework and not budge when the systems are "run up to 120% of full thrust"***
- ***Connect the "parts" under test and provide the "fuel" (data flows)***
- ***Instrument all components to reveal the performance of the "parts" and their failure modes***



Next Generation DoD Operational IP Networks . . .

Seamless satcom, terrestrial, mobile tactical integration with flexible access, data capture, visualization, collaboration and security end-to-end.

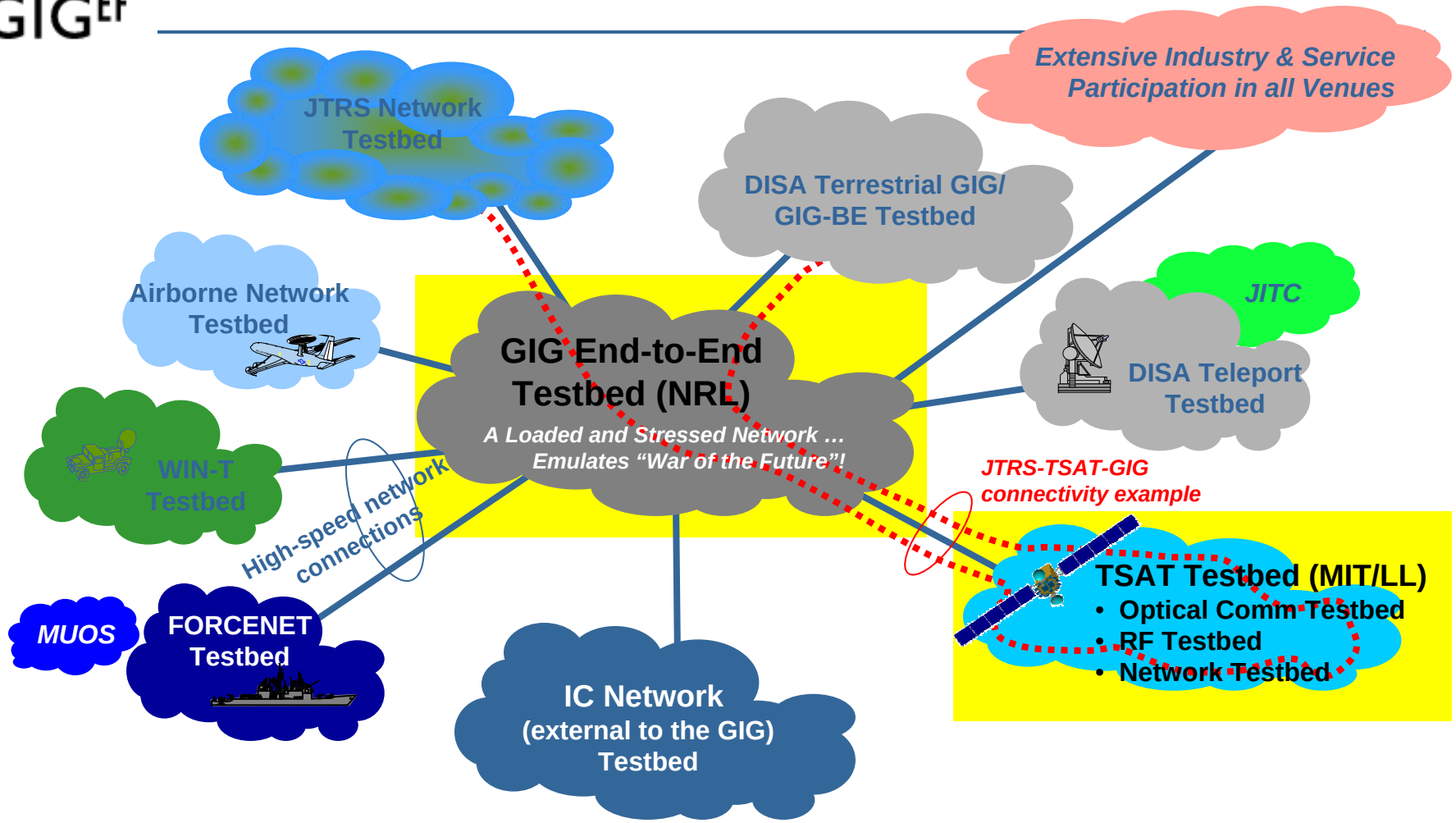
"Expose interfaces early and often"

- Provides scalable, E2E net-centric operation
- Integrated standards-based services
- Robust, adaptable, dynamic and flexible operation
- Interoperable data capture; integrated ops centers
- Accommodates multiple levels of security E2E
- "Black Core" source encryption
- Enables new information exploitation processes
- Transformational, global ISR

$$Bandwidth \times Low\ Latency^{-1} = Professionalism$$

. . . VAdm (Ret) J Cebrowski

IPV6/MPLS End-to-End Testbed



Provides inter-network demonstration and validation

. . . A Place to Test Early and to Test Often ! ! !

IPV6/MPLS End-to-End Testbed

GOAL: Provide users Secure Stable Global Data Access

- IPV6/MPLS Latest Commercial Features
- Efficient Routing … ISIS, BGP+, OSPF, GMPLS
  - Satellite/Fiber/Wireless/Mobile Services
  - RF or Optical Transport
- Full Range of Quality-of-Service Features E2E
  - Priority, Pre-emption, Policy, Authorization, Audit
  - Voice, Video, Data w/ SIP Control Plane
- Scalable Speeds: Bits/sec to 10Gbps initially, 40Gbps, 160Gbps
  - Data is doubling every year
- Network Test and Measurement Capabilities
  - Know the "State of the Network" Dynamically
  - Complete Passive Monitoring with Accurate Time-stamping
  - Stress to "Future Military Operational Levels"
- Conduct "R&D" to Help Resolve Problems/Issues

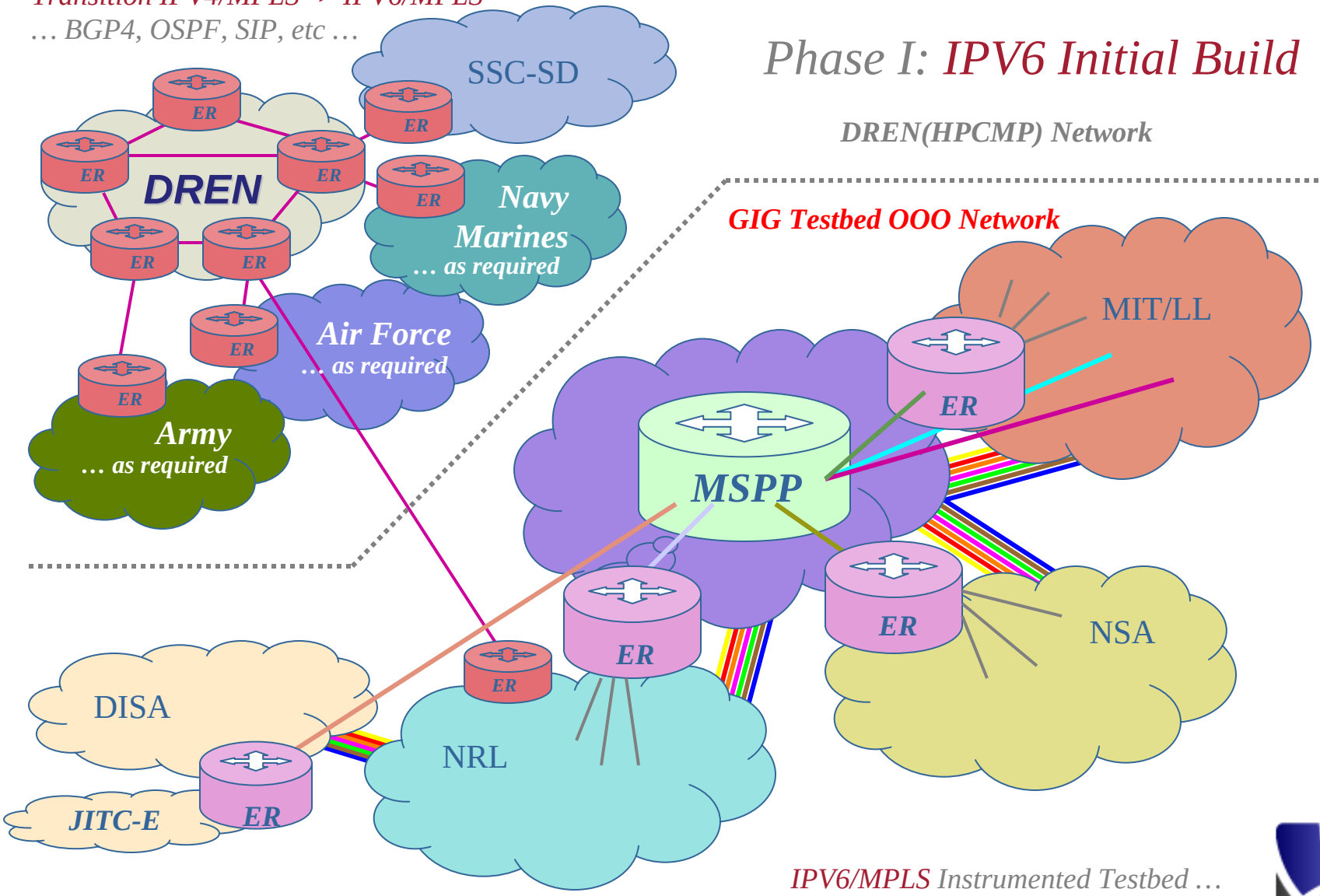
Scaling to 100,000's Users Supporting TPPU & TPED

Transition IPV4/MPLS -> IPV6/MPLS
… BGP4, OSPF, SIP, etc …

Phase I: IPV6 Initial Build

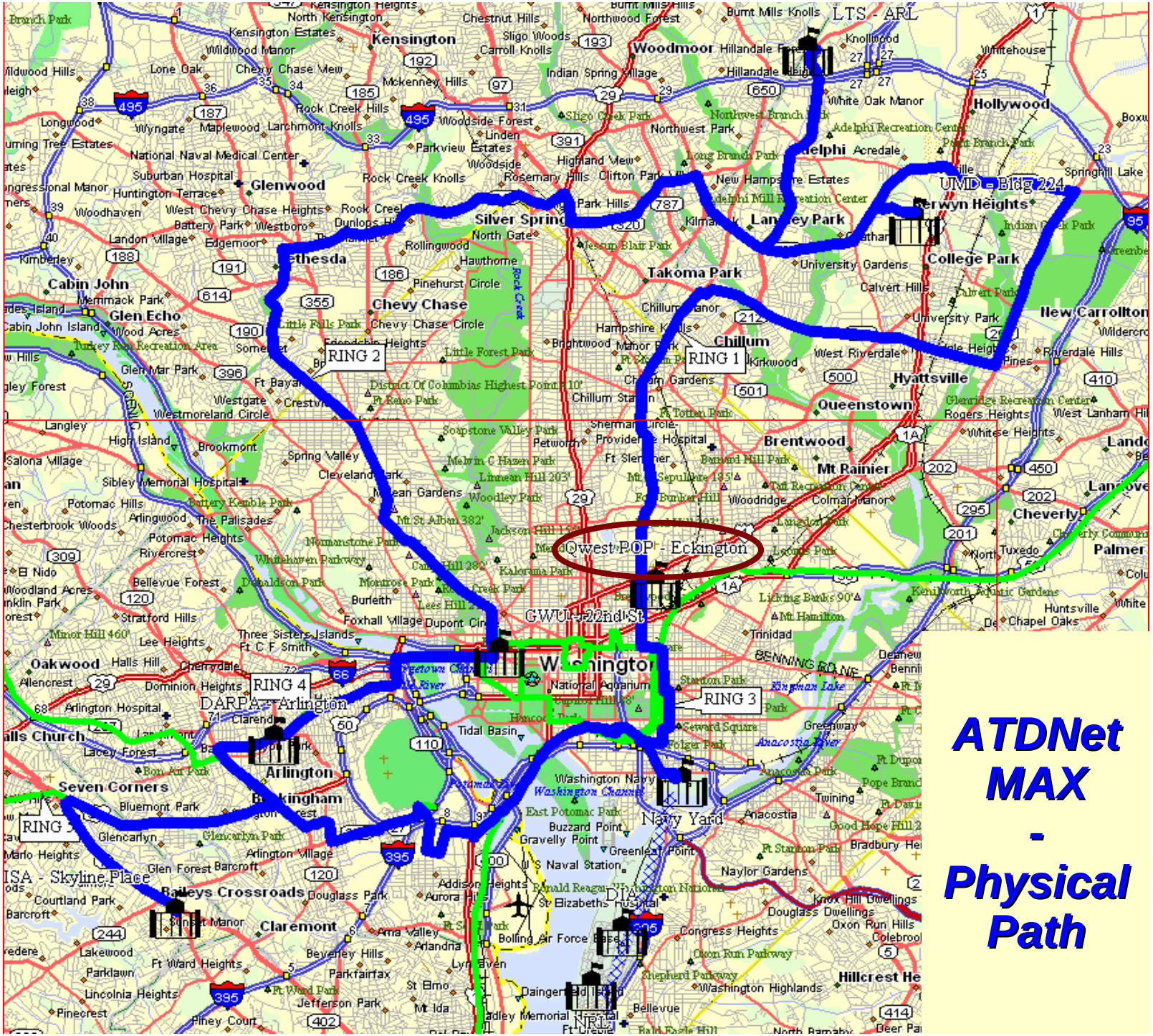
DREN(HPCMP) Network

GIG Testbed OOO Network

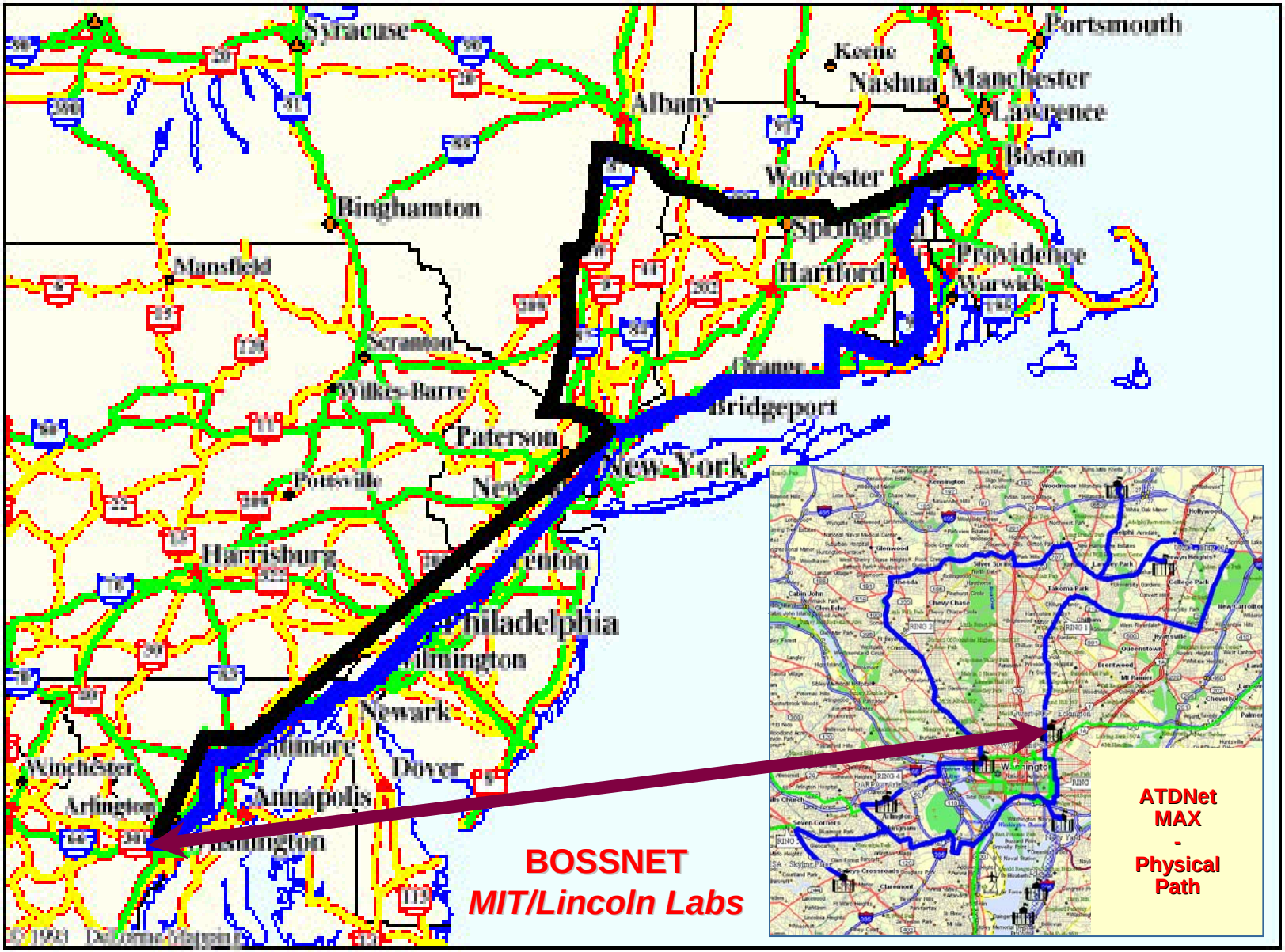


IPV6/MPLS Instrumented Testbed …
RIPng, IS-IS, BGP+
Dual Stack: IPV4 w/ BGP4, OSPF
Research platform for 10-40G

GIG[EF]



ATDNet MAX - Physical Path


Syracuse
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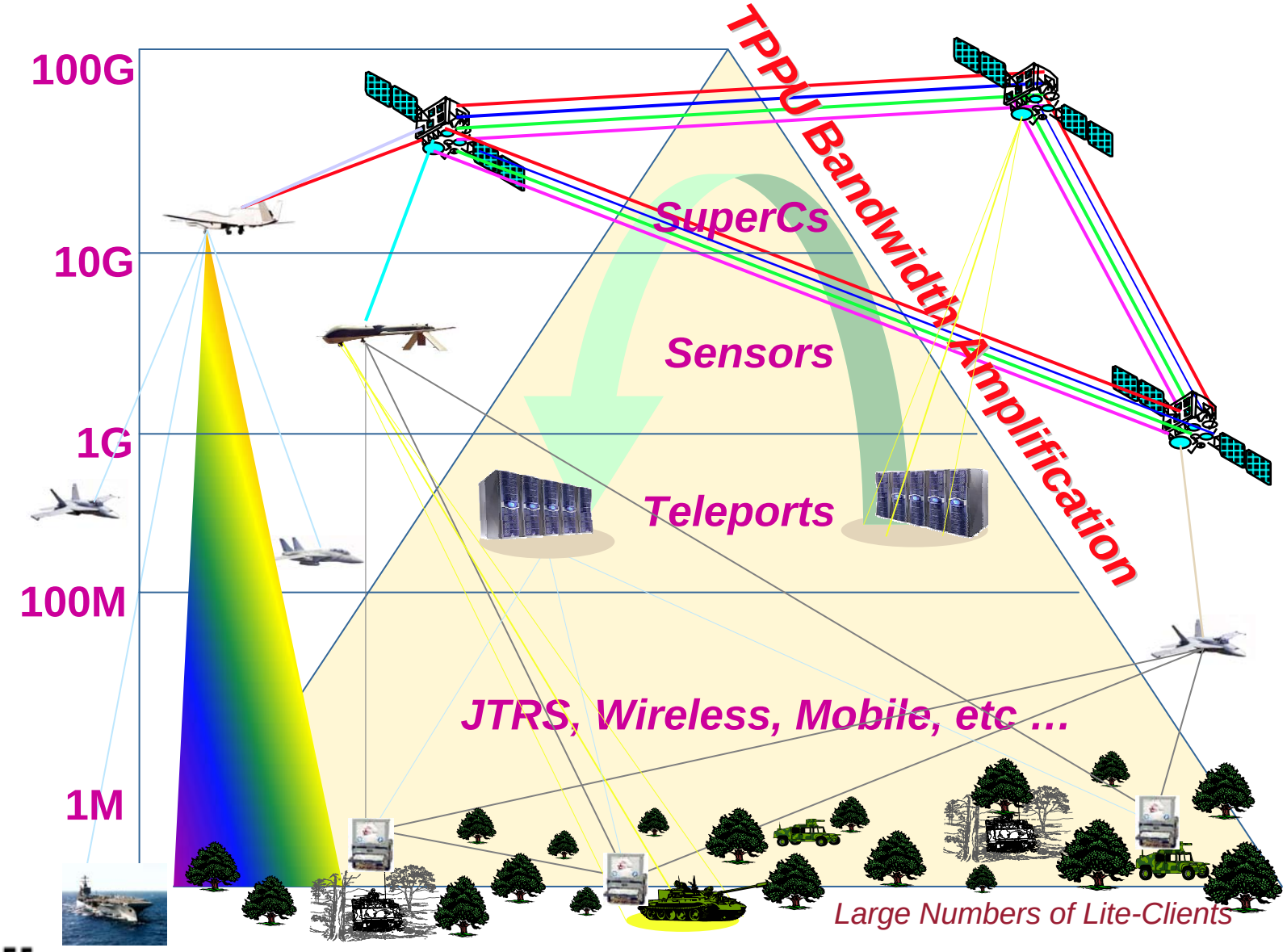
Warwick
Mansfield
Scranton
Wilkes-Barre
Bridgeport
Paterson
New York
Pottsville
Harrisburg
Philadelphia
Wilmington
Newark
Winchester
Dover
Annapolis
Arlington
BOSSNET
MIT/Lincoln Labs
ATDNet
MAX
-
Physical
Path

Simple Queries Trigger Extensive Bandwidth Utilization



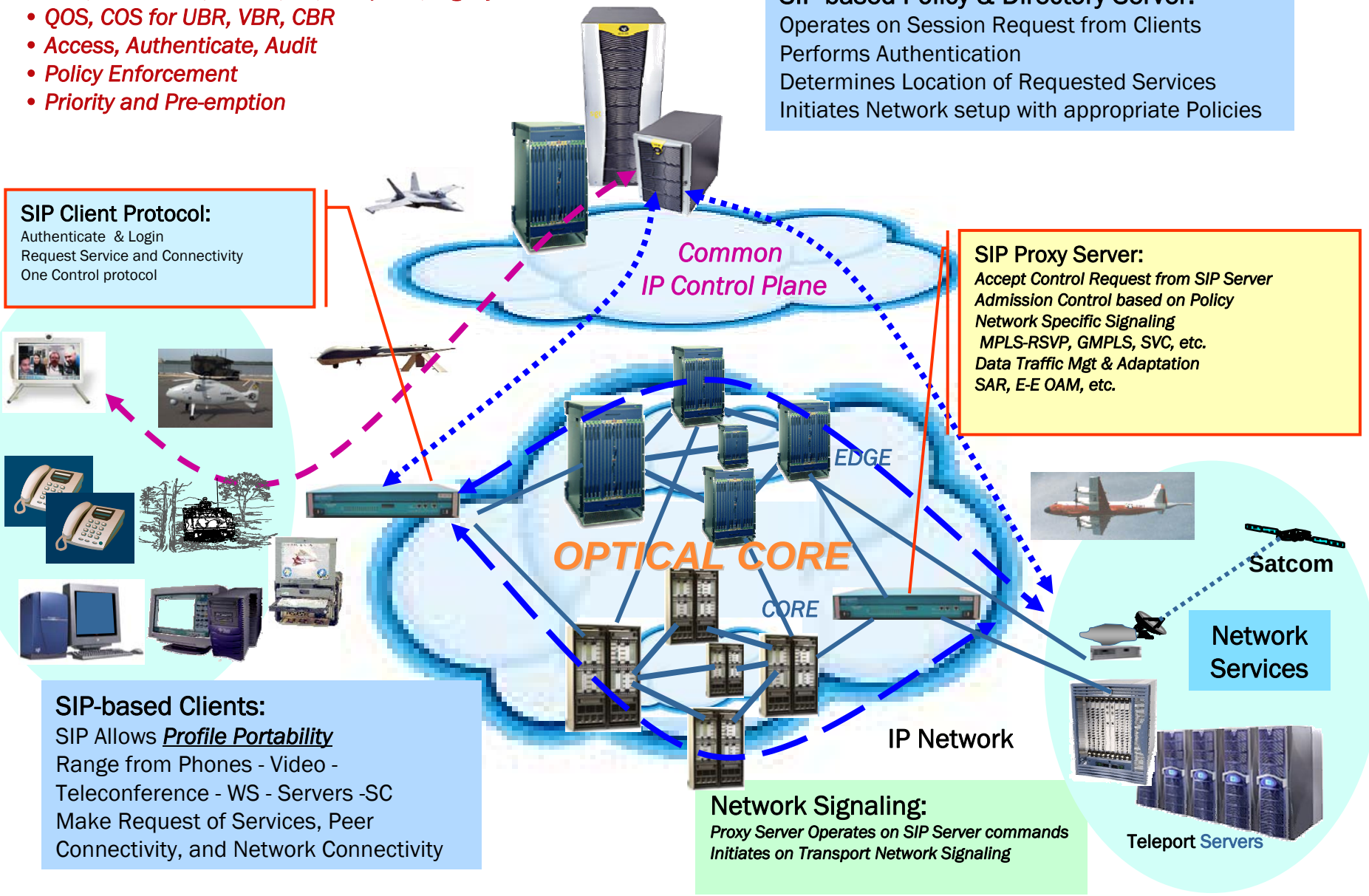
GIG[EF]

E2E IP User Services . . .

- *IPv6, XML: JTRS, GIGBE, TC, Teleports, legacy*
- *QOS, COS for UBR, VBR, CBR*
- *Access, Authenticate, Audit*
- *Policy Enforcement*
- *Priority and Pre-emption*

SIP-based Policy & Directory Server:
Operates on Session Request from Clients
Performs Authentication
Determines Location of Requested Services
Initiates Network setup with appropriate Policies

SIP Client Protocol:
Authenticate & Login
Request Service and Connectivity
One Control protocol

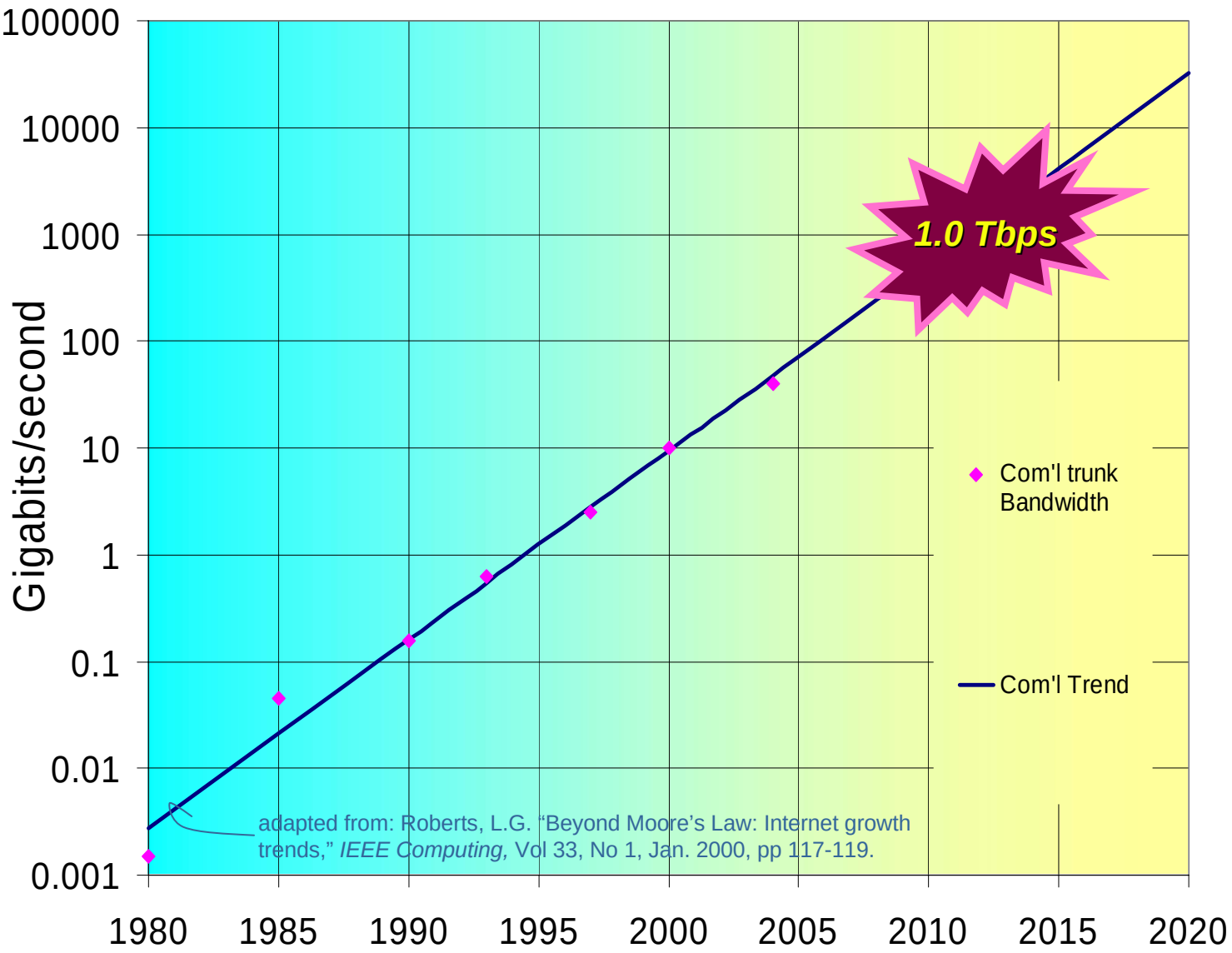


SIP Proxy Server:
Accept Control Request from SIP Server
Admission Control based on Policy
Network Specific Signaling
MPLS-RSVP, GMPLS, SVC, etc.
Data Traffic Mgt & Adaptation
SAR, E-E OAM, etc.

SIP-based Clients:
SIP Allows ***Profile Portability***
Range from Phones - Video - Teleconference - WS - Servers -SC
Make Request of Services, Peer Connectivity, and Network Connectivity

Network Signaling:
Proxy Server Operates on SIP Server commands
Initiates on Transport Network Signaling

Network Growth Trend . . .



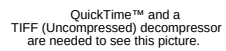
Network Research Agenda . . .

	TODAY 2005	*0-2 YEARS*	*3-5 YEARS*	*5-15 YEARS*
OPTICAL STREAMS	1-10 Gbps	10-40 Gbps	100-640 Gbps	1-10 Tbps
OPTICAL CNTL Plane	STATIC Provisioned	DYNAMIC (GMPLS)	JIT Just-in-time	
IP CNTL Plane	STATIC Tunneled	DYNAMIC SIP	SIP	
LAN Technology	IPV4: 1GE, OC12c, 4xInfbnd	IPV6: 4x/12x DDR Infbnd, 10GE	IPV6: 12x QDR Infbnd, 100GE	
SECURITY Devices	1.0G IPV4 Firewalls, CBs, KGs	10G KGs, HAIPEs, FEON, NTAM	40G HAIPE, GFP Encptr	640G HAIPE, GFP Encptr
SPECIAL TOPICS	*Quantum Key Distribution (QKD), Dynamic PMD Comp, Peering, OOO(2R) Optical Regeneration*			

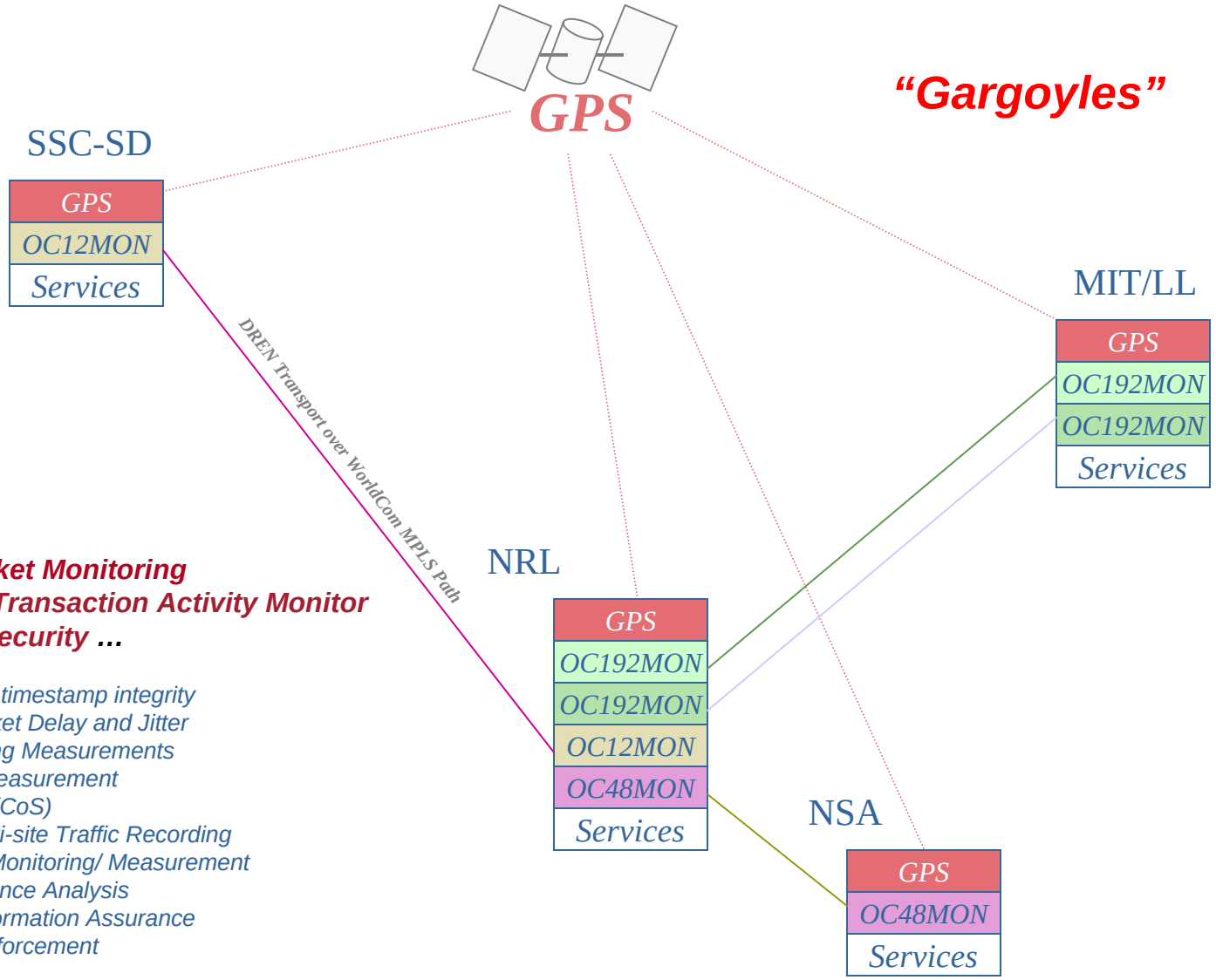
ViPr: Video Presence Flexible Audio/Video Teleconferencing

… IPV6 based, SIP Control Plane, 14+1 Participants, "White Board" enabled, clear progressive HD video, echo-cancelled audio, touch controlled

TRUE BROADBAND CONFERENCING



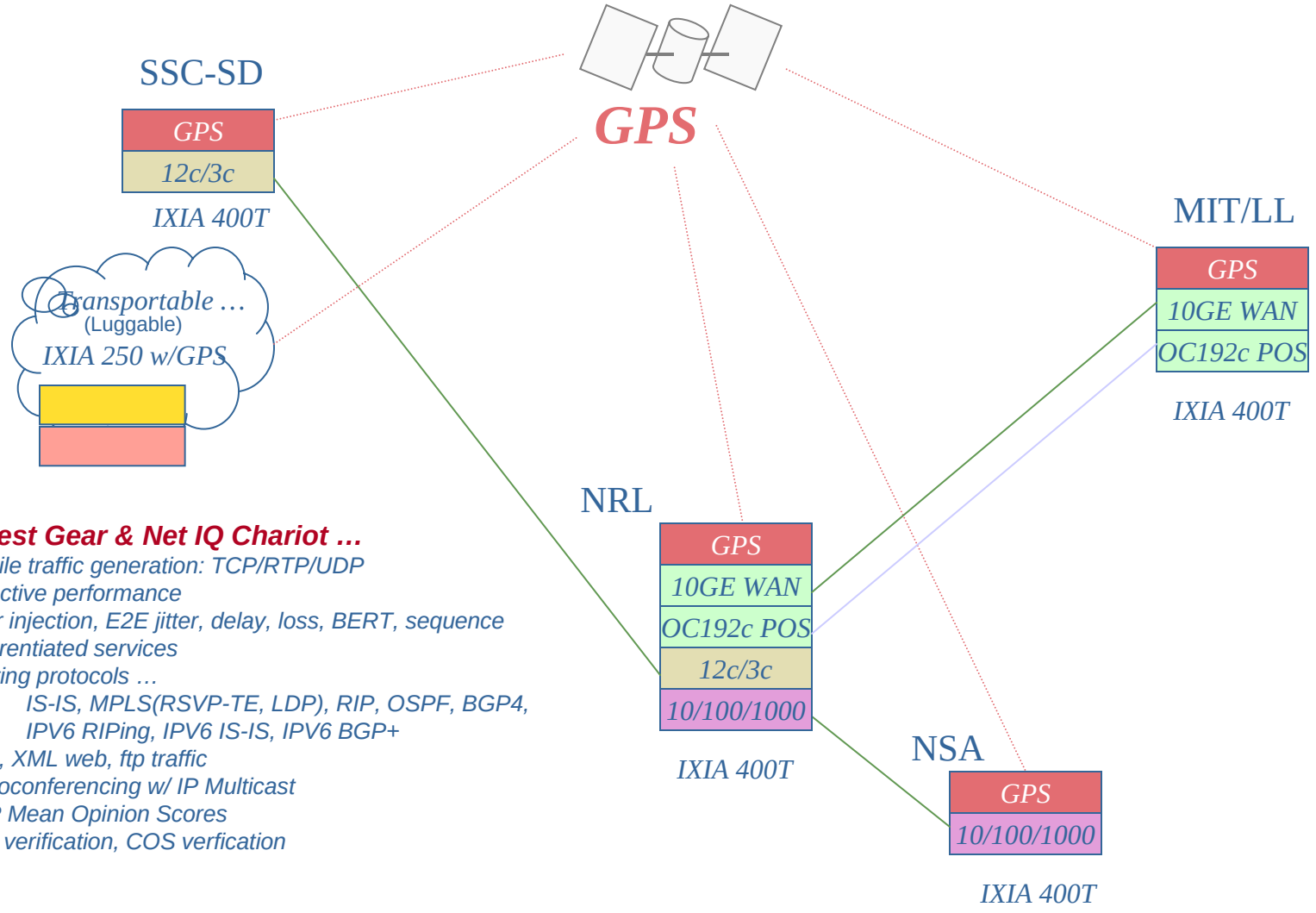
Passive Monitoring Strategy …



DAGMON IP Packet Monitoring
NTAM: Network Transaction Activity Monitor
Authentication/Security …

- *Non-obtrusive*
- *GPS sync … PPS timestamp integrity*
- *E2E Network Packet Delay and Jitter*
- *Bandwidth & Timing Measurements*
- *QoS Monitoring/Measurement*
- *SLA Verifications (CoS)*
- *Synchronized Multi-site Traffic Recording*
- *NTAM E2E Flow Monitoring/ Measurement*
  - *E2E Performance Analysis*
  - *Enhanced Information Assurance*
- *Security Policy Enforcement*

Active Loading/Stress Testing …



IXAI Test Gear & Net IQ Chariot …

- *Hostile traffic generation: TCP/RTP/UDP*
- *Proactive performance*
- *Error injection, E2E jitter, delay, loss, BERT, sequence*
- *Differentiated services*
- *Routing protocols …*
  IS-IS, MPLS(RSVP-TE, LDP), RIP, OSPF, BGP4,
  IPV6 RIPing, IPV6 IS-IS, IPV6 BGP+
- *ERP, XML web, ftp traffic*
- *Videoconferencing w/ IP Multicast*
- *VoIP Mean Opinion Scores*
- *QoS verification, COS verfication*

A User Services Net-Centric Perspective

- ***Volume of Information Increasing Exponentially***
- ***Demand for Net-Centric Services Increasing Exponentially***

PROBLEM: DELIVERY TIME INCREASING FROM HOURS TO DAYS

LARGE DATA: SIGNIFICANT INCREASE IN BANDWIDTH WITH HIGH END-TO-END QUALITY OF SERVICE (QoS/QoP) - REDUCE DELIVERY TIME TO SECONDS OR MINUTES: ***…REACHBACK!***

"THE TIMELY DELIVERY OF IMAGERY, VIDEO, AND LARGE DATA FILES IS A HIGH VOLUME INFORMATION DISSEMINATION REQUIREMENT THAT DEMANDS A SOLUTION"

AIR FORCE SPACE COMMAND

Sources: Advanced Media Networks Technology Briefing, And DTIC Website

IMAGERY EXAMPLE: Geospatial Knowledge Base (GKB) and Very Large Data Base (VLDB)

… Organize all Geospatial Knowledge to support Analysts, Warfighters, and other Consumers

… *Semantic Web Based .geo*

PROBLEM: REQUIRES ADVANCED STORAGE (RAIN) and A NET-CENTRIC HIGH PERFORMANCE, LOW LATENCY ARCHITECTURE

LARGE DATA ACTD: TECHNOLOGIES THAT PROVIDE DISTRIBUTED, SYNCHRONIZED, HUGE DATA STORES SCALABLE TO EXABYTES (over 10^{18} bytes): **TRACEBACK**

MUST BE ABLE TO FULLY ARCHIVE ALL DATA AND HAVE ON-LINE ACCESS TO ARCHIVES FOR REAL-TIME PLANNING AND ANALYSIS

LARGE DATA ACTD SOLVES A DOD WIDE PROBLEM

FEDERATED, DISTRIBUTED

NET-CENTRIC INFRASTRUCTURE

A KEY ENABLING TECHNOLOGY

"LARGE DATA" APPLICATION CHALLENGE:

Reduce Latency to Post, Access and Analyze Very Large Data Sets: Imagery, Video, MASint, SIGint, etc…

- Current operational systems … 2-3+ days may be required to Access, Transfer, Process, and Analyze "BiG Data" sets (TPED)

Problems that use Big Data:

Example PACOM problem: BGen Cone "OIF" Lessons Learned --- "latency" is the issue, … (Currently hard to deal with Big Data across; local, distributed and archive storage/processing, distributed analysts… synchronization issues) … 5K x 5K clips

- Problem becomes increasingly difficult as data volumes increase significantly … solution requires move to "Network Centric" (TPPU)

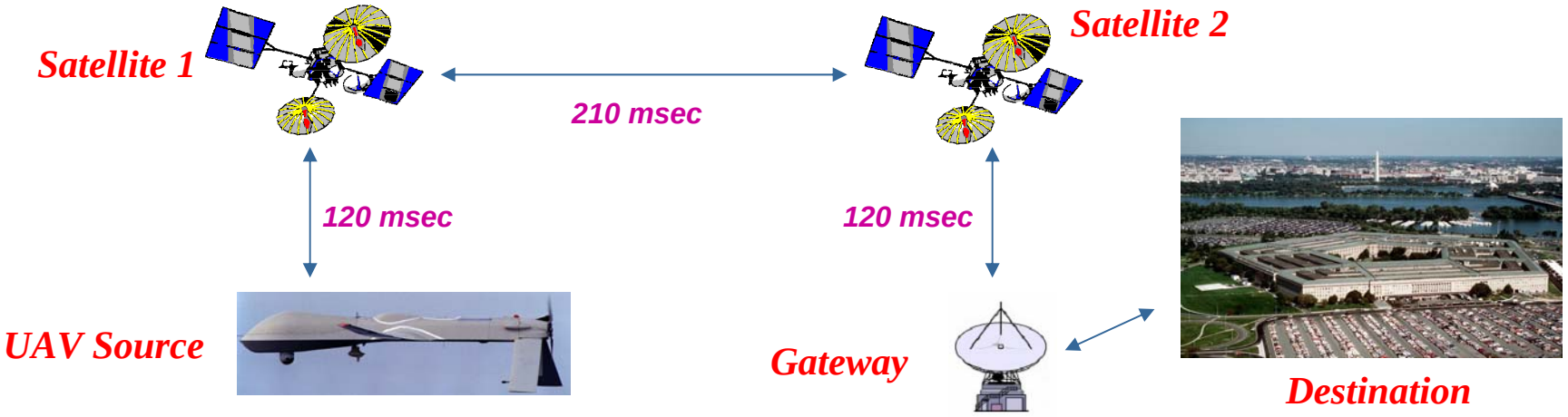
Future Imagery Architectures, Higher Resolution Video (HDTV NGA mandate), 100x UAV's, More MASINT Products, Multiple Distributed Analysts both in/out theater, realtime response… 40K x 40K clips

“Large Data” Challenge

… Transforming WWW for spatial-temporal post, access --- .geo

- Performance driven, wide area cache-coherent distributed SAN
- Realtime ingest of live data sources
- Multiple levels of resolution seamlessly manipulated (ZUI)
- Multiple collaborators … Situation Awareness … Big Picture
- Multi-INT data fusion
- Multiple levels of security
- Authenticated access to large amounts of distributed data
- Peer-peer interaction, spatial-temporal intelligent agents
- Analyst and Senior decision-maker … joint participation
- Akamai-on-steroids with RAIN(RAID)
- Online/Nearline disk archive, self-healing … 100’s TB per site
- No single point(s) failure, embedded data manager
- Data encrypted “at-rest”
- SIP control plane for MLPP

Possible TSAT Reference Scenario . . .



- *Space-borne high-speed backbone using OBS-capable satellites*
- *Free-space DWDM ISLs with JIT signaling; no 3R regeneration required*
- *Real-time imaging UAV/Sensor; bursty due to changing coverage*
- *Two GEOs with 120^{o} separation and 10 Gbit/sec transmission path*

- *~ 210 msec ISL propagation delay*
- *~ 120 msec UAV-to-satellite, satellite-to-ground propagation delay*
- *~ 1 msec switching delay, < 1 msec processing delay*

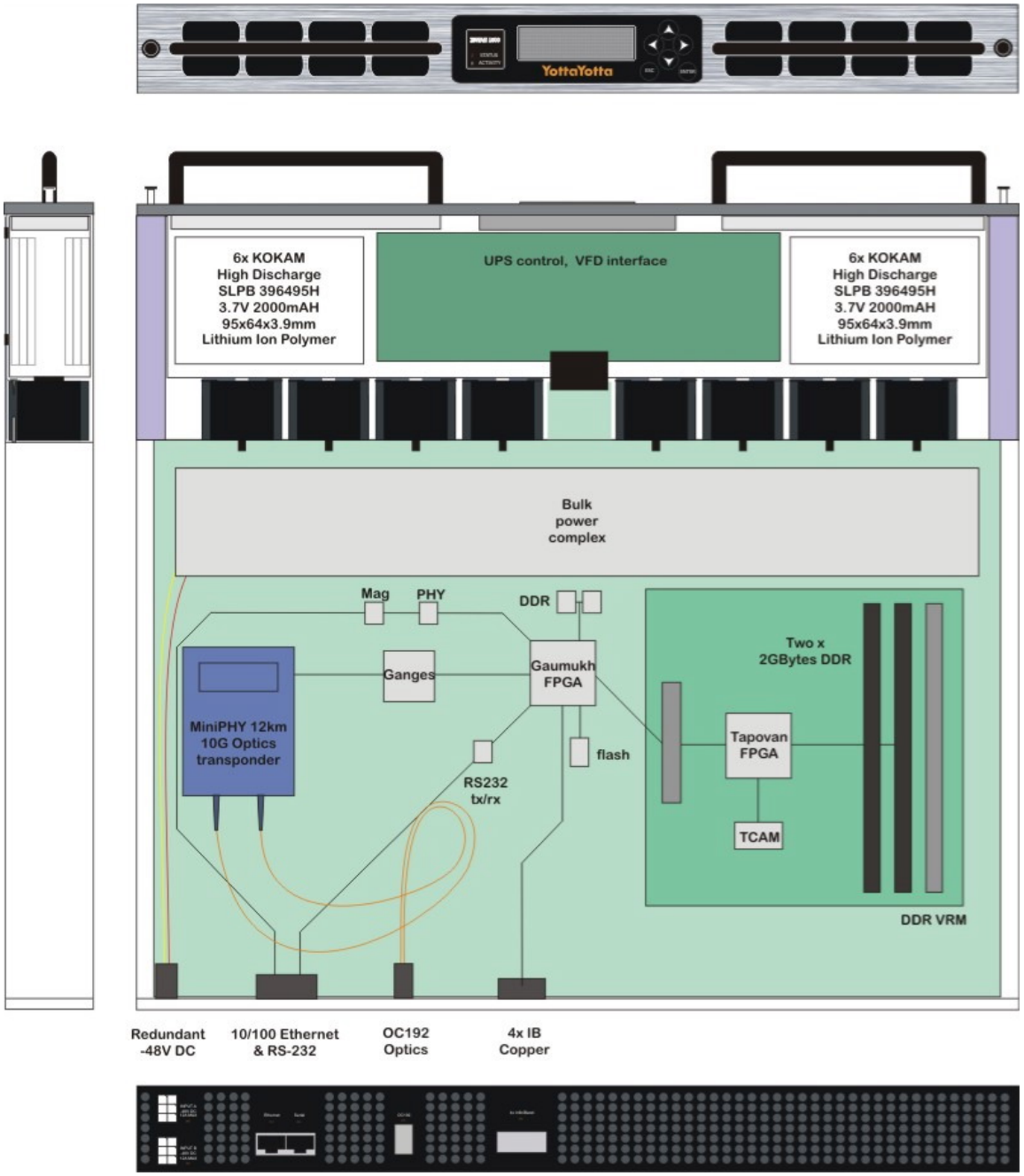
SC2004:

IBWAN

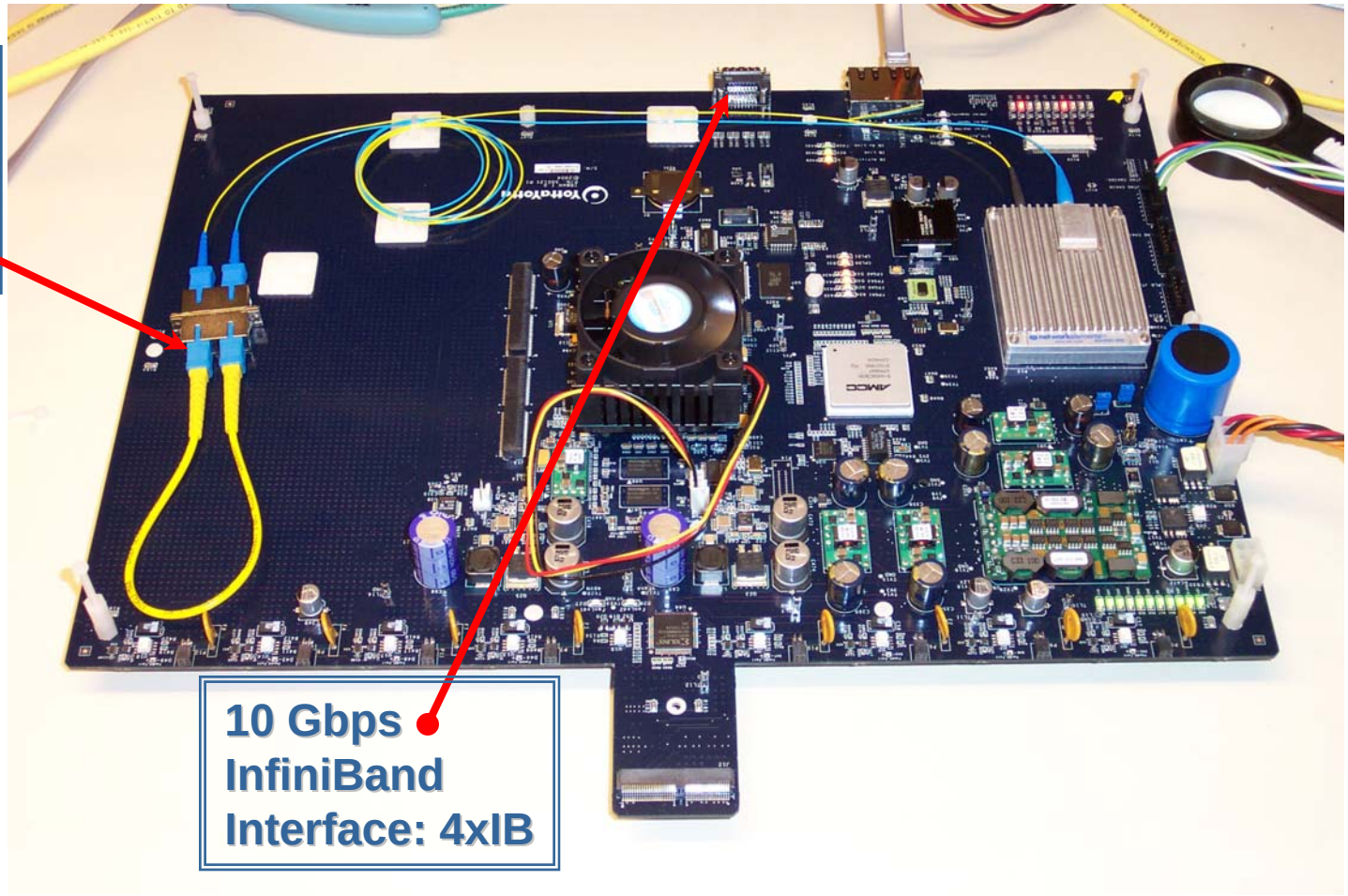
A Fresh Start

OC192c <-> 4xIB

Infiniband RDMA

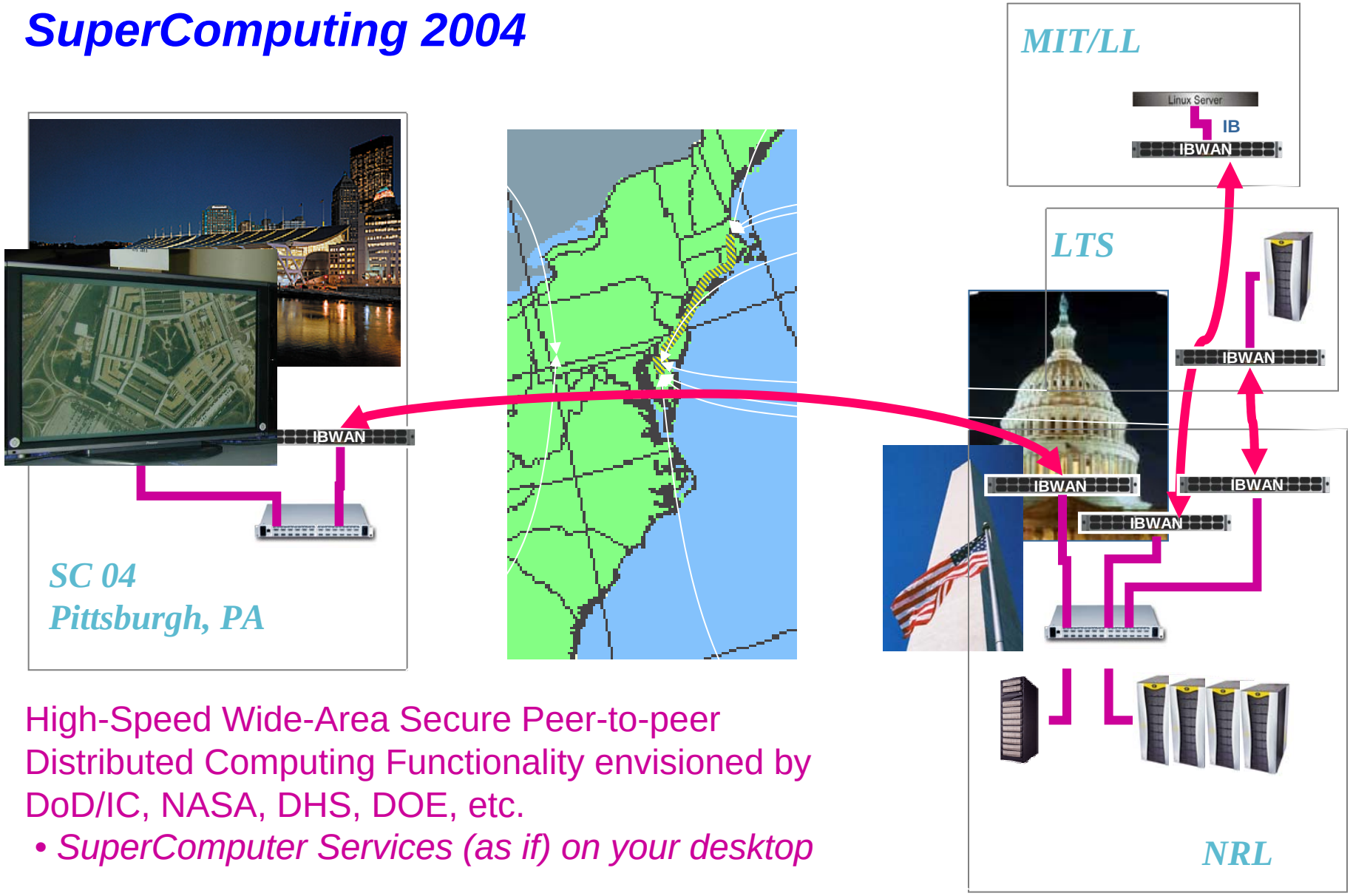


IBWAN Concept Board …



InfiniBand (IB) Wide Area Networking

SuperComputing 2004



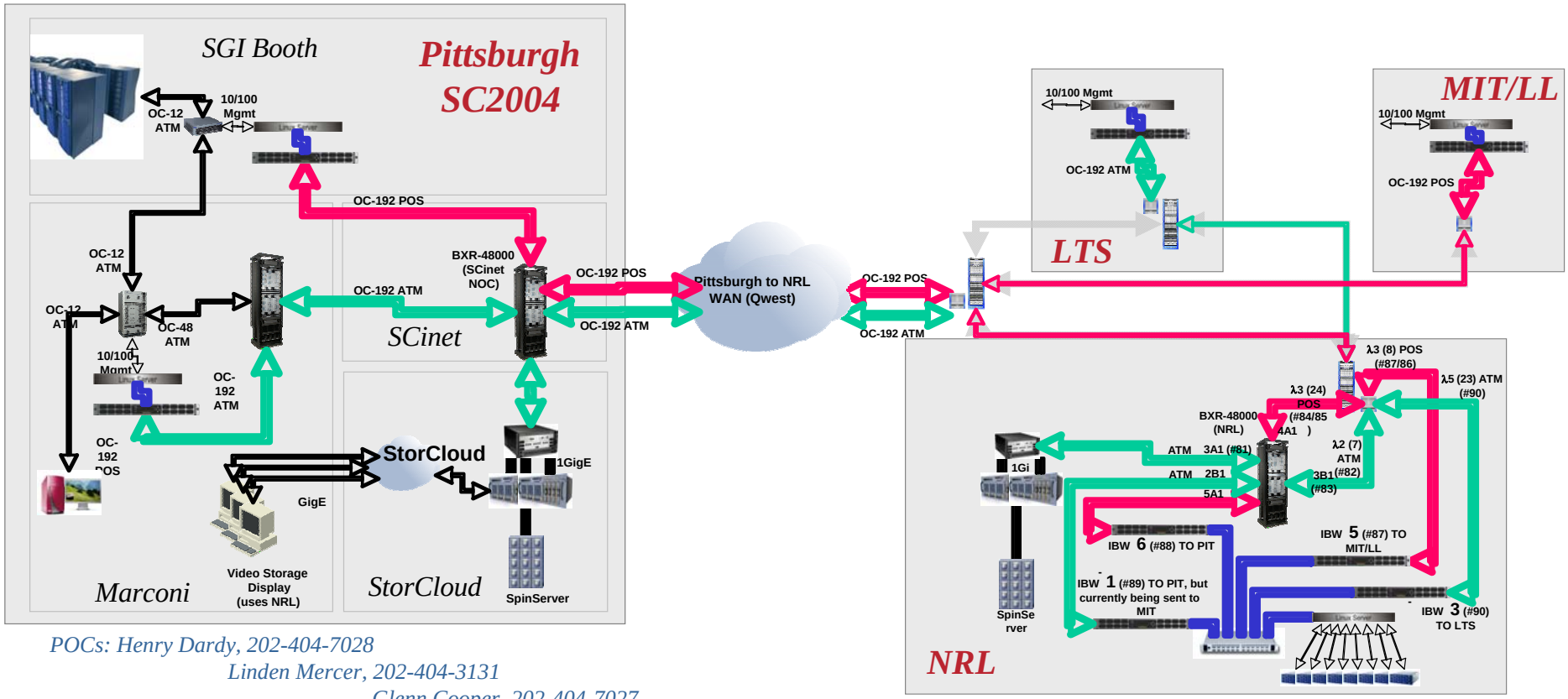
High-Speed Wide-Area Secure Peer-to-peer Distributed Computing Functionality envisioned by DoD/IC, NASA, DHS, DOE, etc.

- *SuperComputer Services (as if) on your desktop*

World's Largest Spatial INFINIBAND Network …

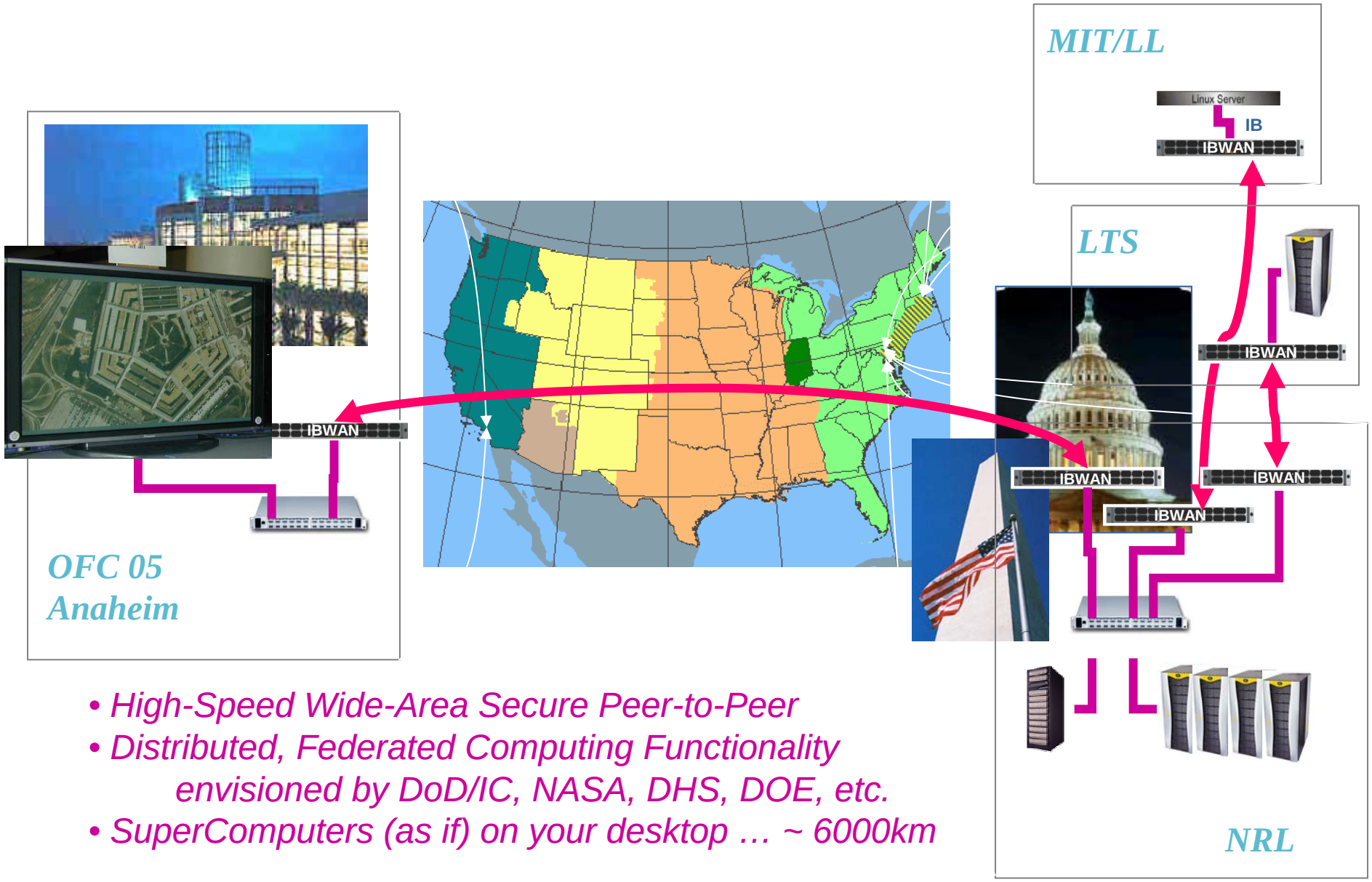
Demonstration of key Large Data ACTD high-speed wide-area features under NGA FY04 and NRL support
A low-cost leveraging of extensive industry to support demonstrating:

- Initial proof of principle for High-Bandwidth IP Networks -- OC-192c (10Gbps)
- Simultaneous IPv6 (POS) and ATM *(UNCLASS, but supports Type 1 Encryption)*
- Long haul connectivity between Boston (MIT/LL), Baltimore (NSA LTS), Washington DC (NRL) and Pittsburgh (SC2004) *(~1200km Boston to DC to Pittsburgh)*
- Instant accessibility to large data no matter where it may be stored–just as if stored on your desktop
- Shows secure cache coherency and image-rich data from storage cluster



POCs: Henry Dardy, 202-404-7028
Linden Mercer, 202-404-3131
Glenn Cooper, 202-404-7027

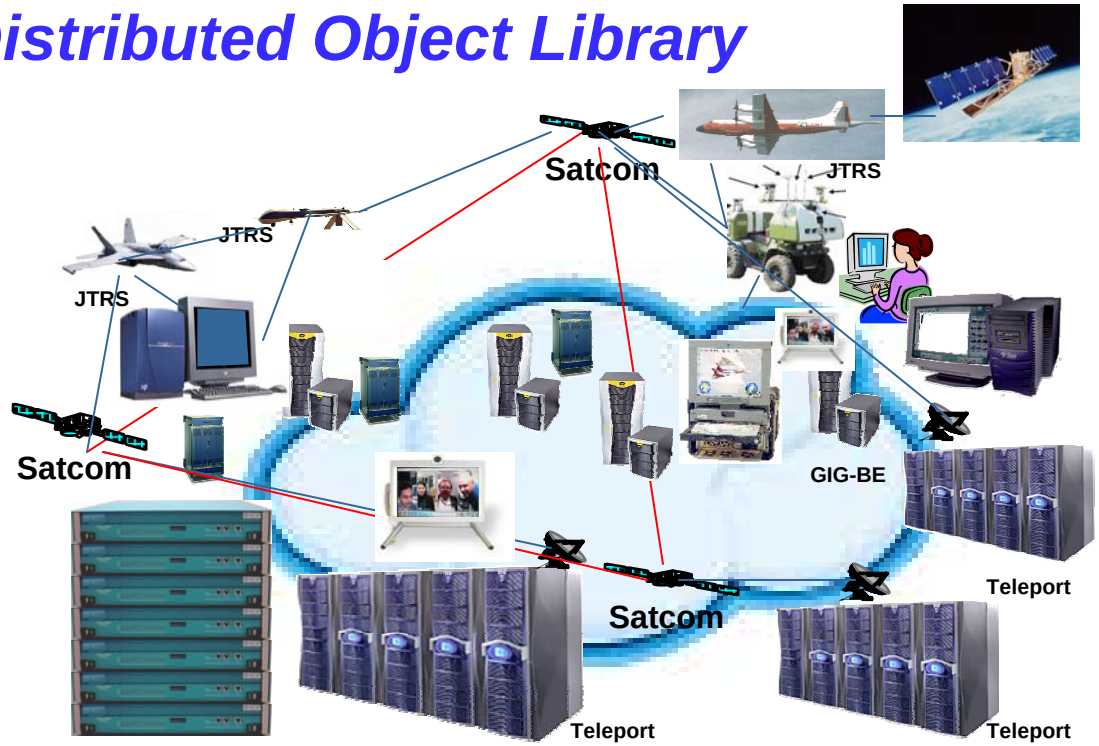
InfiniBand(IB) Wide Area Networking OFC/NFOEC 2005



- *High-Speed Wide-Area Secure Peer-to-Peer*
- *Distributed, Federated Computing Functionality envisioned by DoD/IC, NASA, DHS, DOE, etc.*
- *SuperComputers (as if) on your desktop … ~ 6000km*

MOADB: Interactive Distributed Object Library

❖Virtual network of Active Information Producers & Consumers
… i.e., Grid core w/ P2P edges
❖Vertical fusion - aggregation, delegation
… i.e., level of detail
❖ Horizontal fusion - peer group metadata search & discovery
… e.g., DoD Discovery Metadata Standard
❖Agile data - type support for spatiotemporal indexing
❖Pluggable transport architecture including IPV6, native ATM & hardware QoS, DWDM
❖Intelligent caching hierarchy for multi-terabyte/petabyte datasets (BIG DATA …)

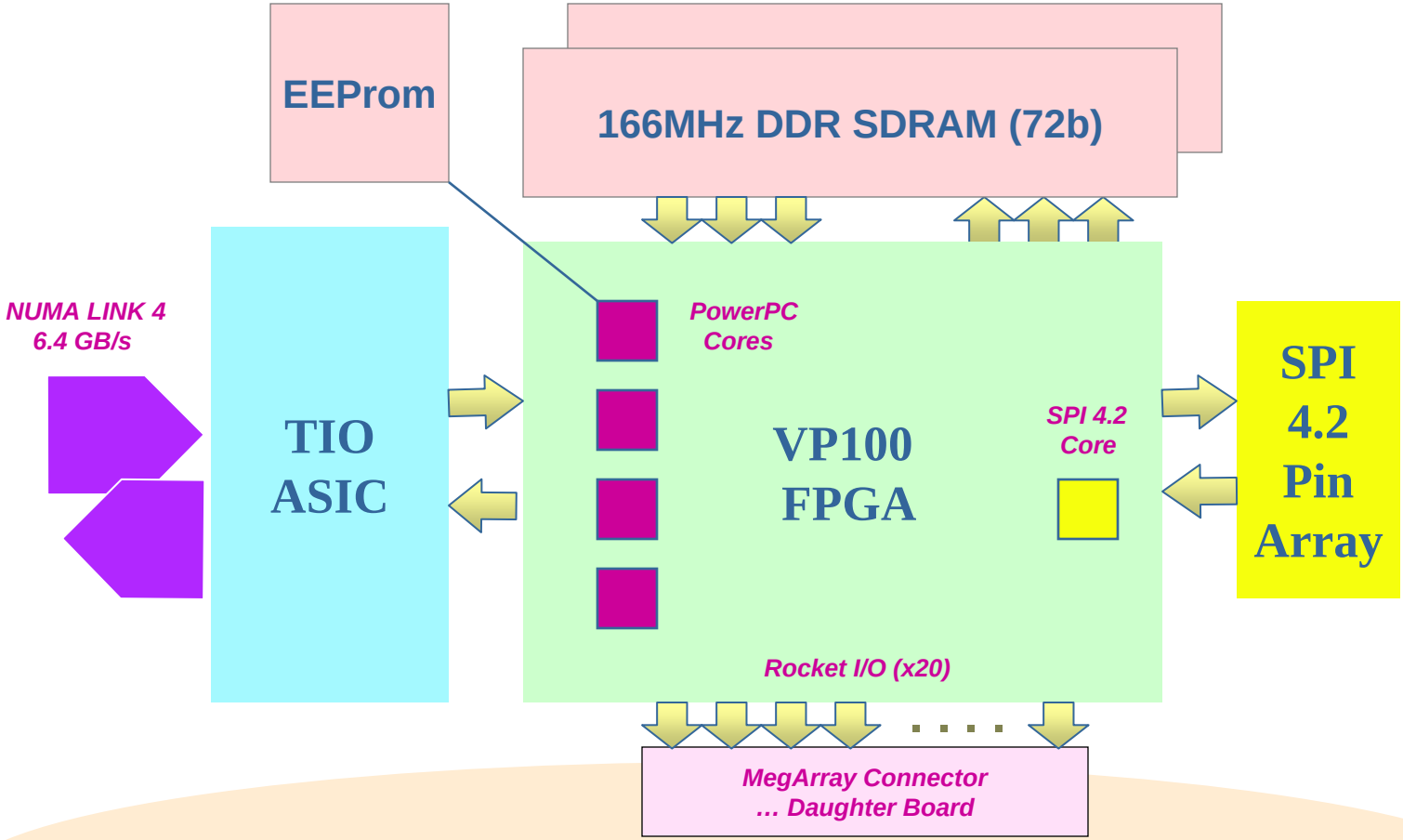


Distributed Database Backend

❖ Immersive Zoomable User Interface (ZUI)
❖ Filter and layer definition, selection, and presentation support
❖ Flexible, intuitive manipulation
❖ Platform support ranging from PDA to workstation to distributed grid to HPCS supercomputer
… High performance: SGI InfiniteReality & UltimateVision systems … well defined API
… Ubiquitous: Desktop PC/Mac/Linux, open source
… Pervasive: iPAQ handheld

Visualization Front End

Scalable Systems Port (SSP) Direct Access

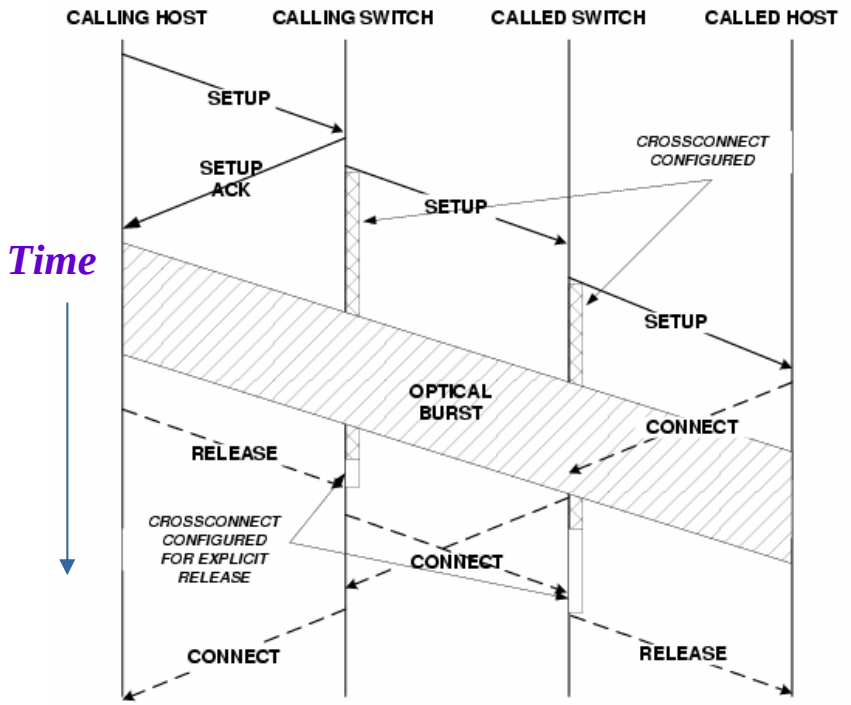


MOACI: High Performance Functional Prototype Platform

Zero-copy Direct Access I/O(RDMA) …i.e.,12x IB, SPI-5, Custom Demux, etc.

Scalable Optical Burst Switching with JIT Signaling

- *No round-trip delay (for 2- or 3-way handshake) required prior to data burst*
- *Out-of-band signaling message precedes data burst*
- *A signaling message's lead time over its data burst shrinks as both propagate through network*
- *Switch resources held only for the duration of burst; no light path required*
- *JIT simplicity - smaller, lighter hardware processing modules*



Single Burst Example

- *Significant improvement in throughput and determinism vs TCP/IP/GMPLS*
- *Out-of-band JIT signaling increases communications security and reliability*

JUMPSTART Message Format

- **Flexible IE (Information Element) based**
- **Separate hardware-parsable part (*Hop-by-Hop* significance) and software-parsable part (*End-to-End* significance)**
- **Will be used in all management protocols inside Jumpstart network (routing, fault management, etc.)**

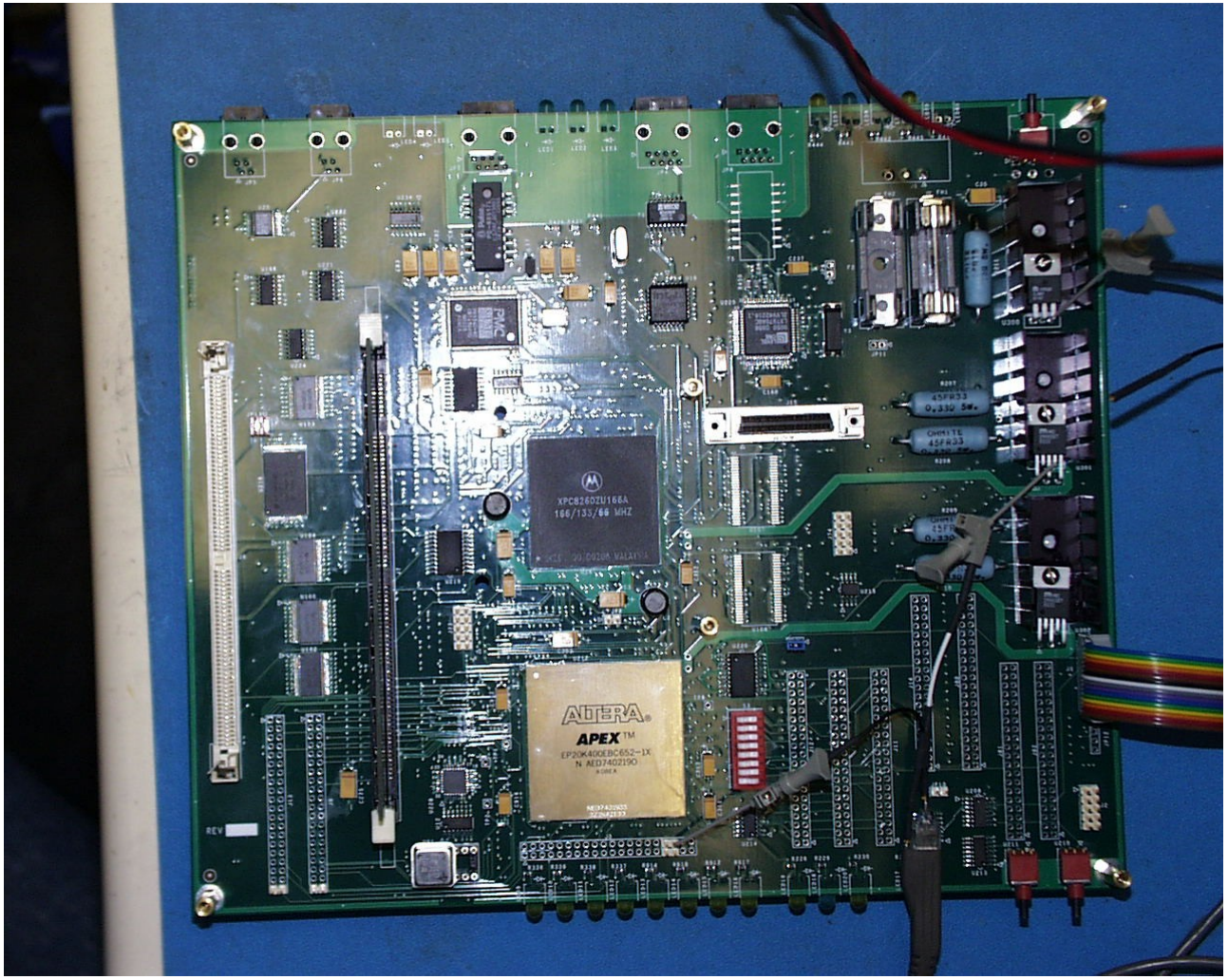
JUMPSTART Addressing

- **Hierarchical**
- **Variable length (up to 2048 bits)**
- **Gives site administrators maximum flexibility in assigning addresses**

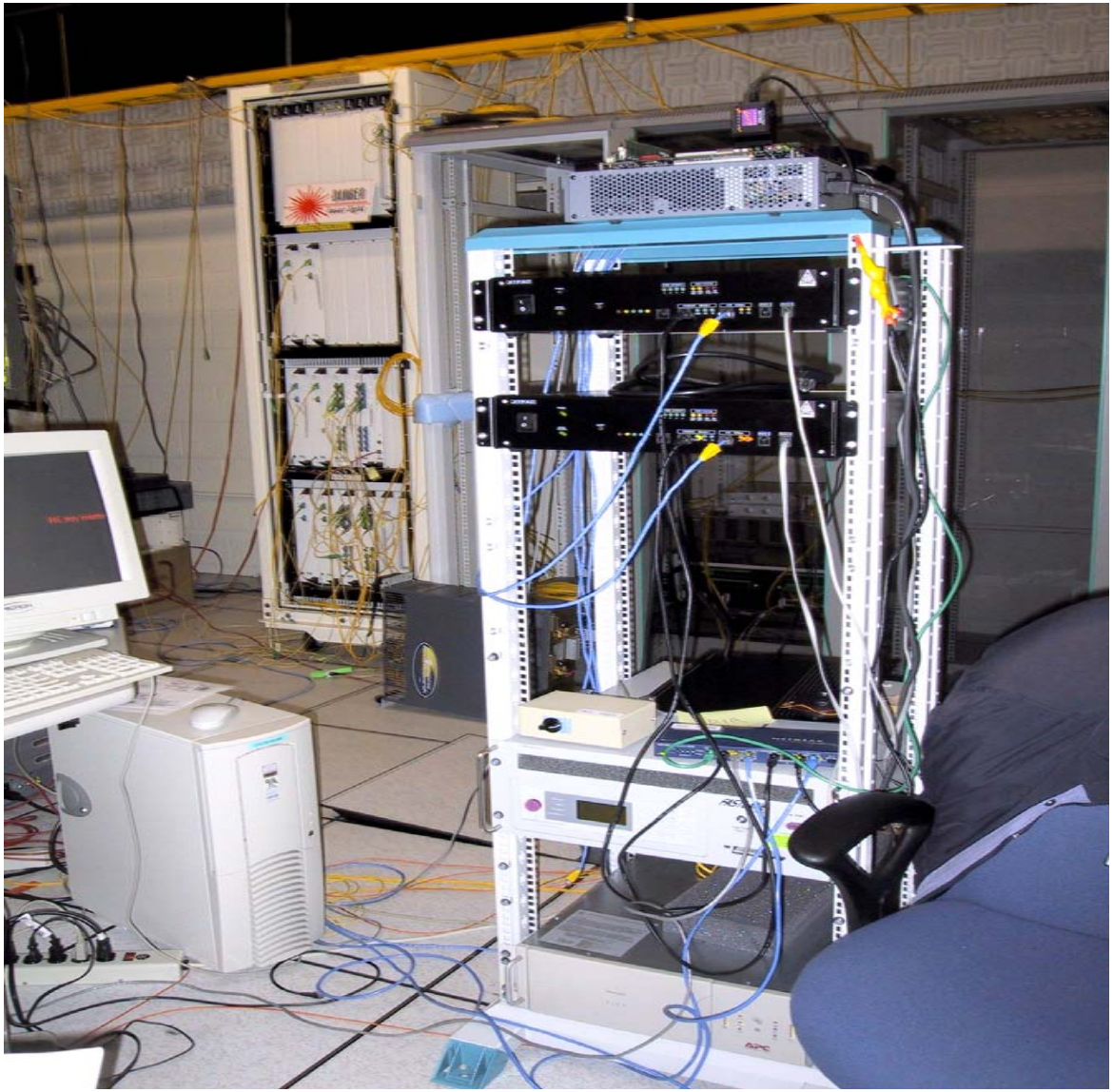
JUMPSTART Forwarding

- **Made easy by the address structure**
- **Each domain level has its own table**
- **A switch forwards a message by taking the longest match between own address and the destination address and using the appropriate table to forward the message**

JITPAC Prototype Hardware . . .



NRL JIT Installation . . .




Let’s Roll !