ATDnet Experiences
DARPA Workshop on Wide-Area ATM Performance

19-20 June 1996

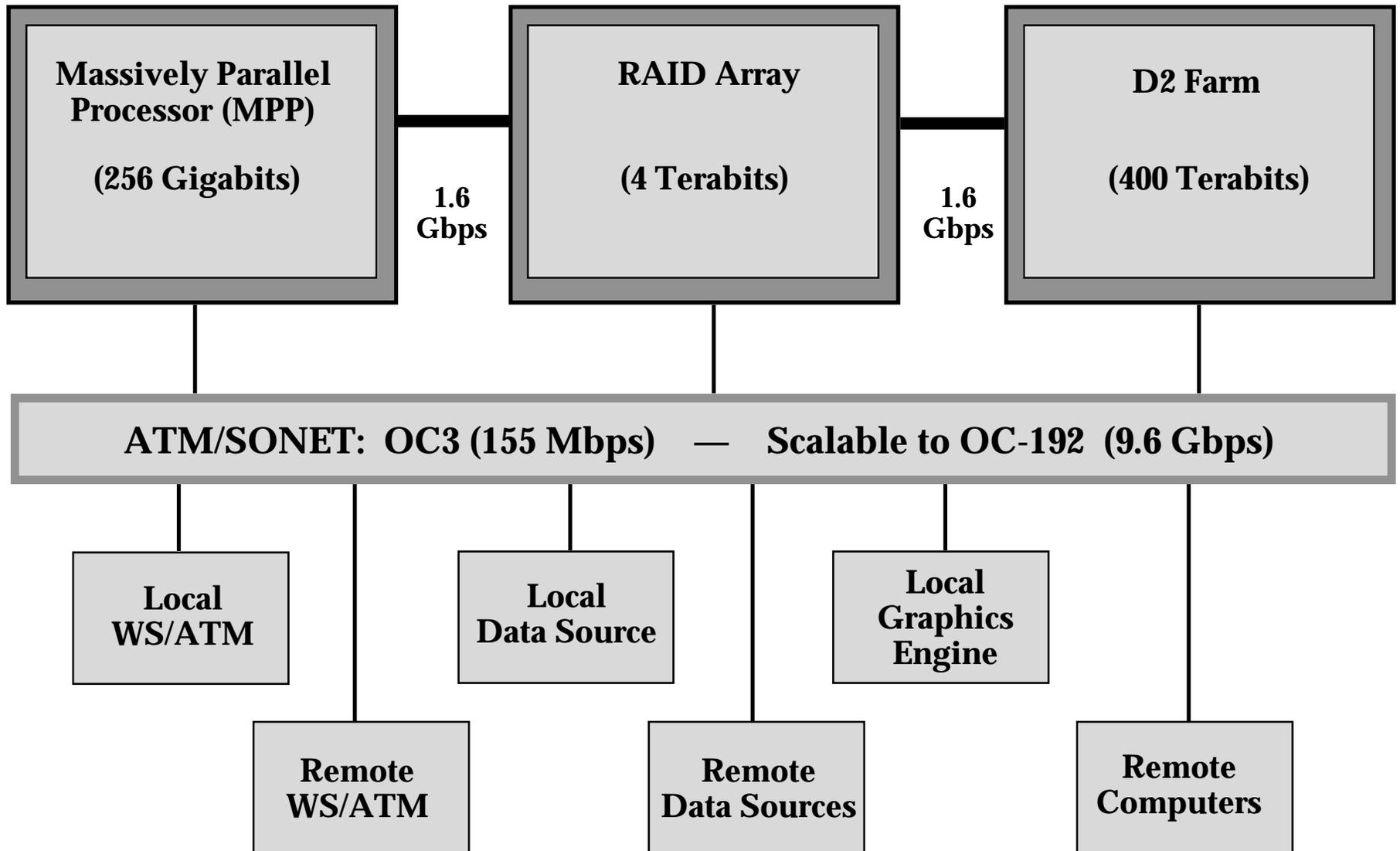**Basil A. Decina**

Naval Research Laboratory
Information Technology Division
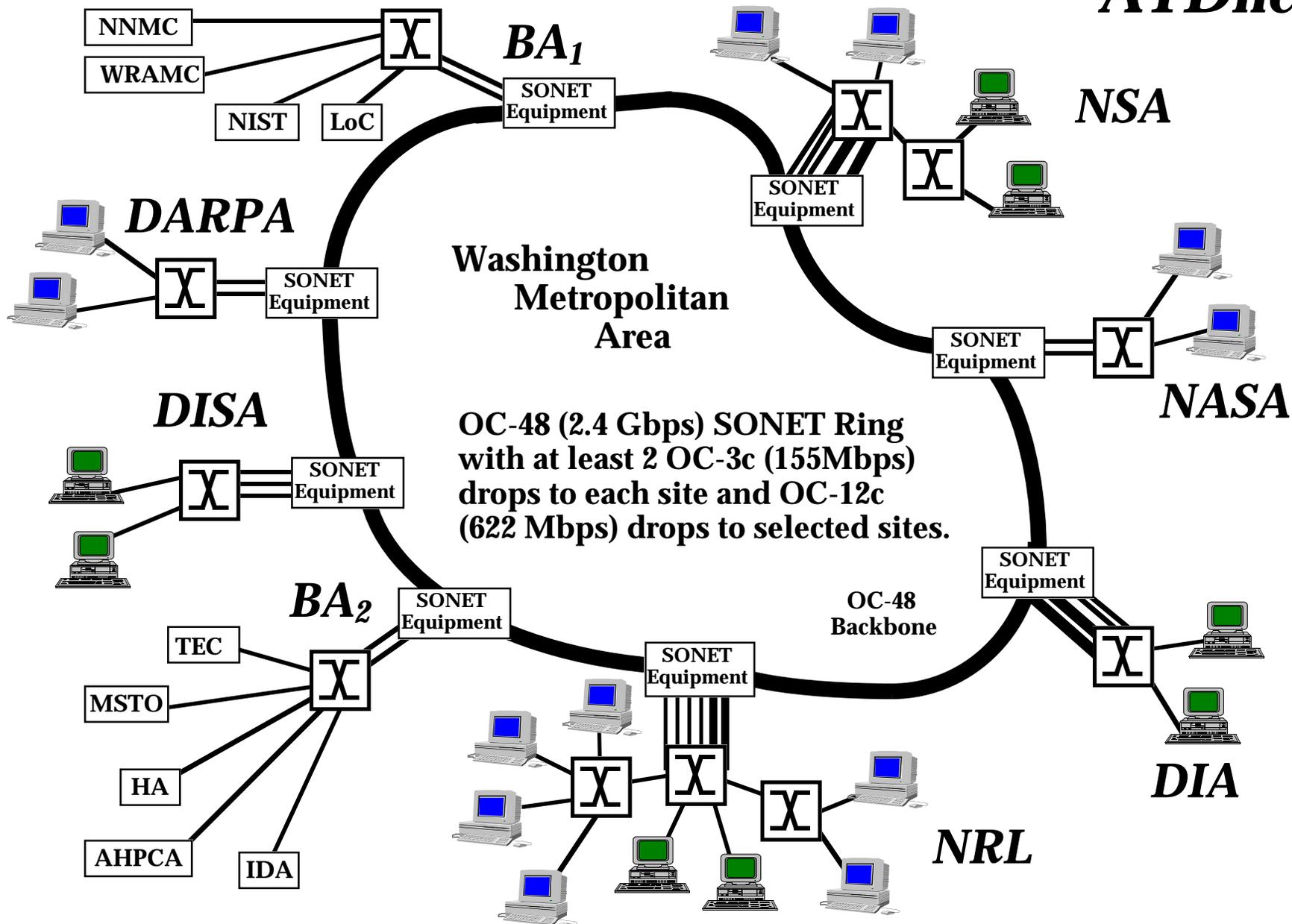**Center for Computational Science, Code 5590**

Prototyping the
Defense Information Infrastructure

Prototyping a "*network-centric*" Information Infrastructure for transparent, ubiquitous access to "*globally remote*" resources as if "*local*"

- Wide area communications and computing via a GLOBAL GRID; SVC signalling

- Based on client/server and peer-to-peer paradigms

- Policy-based dynamic routing with authentication

- Information caching and hiding inherent in system

- Scalable multicast support

- Global efficient network management

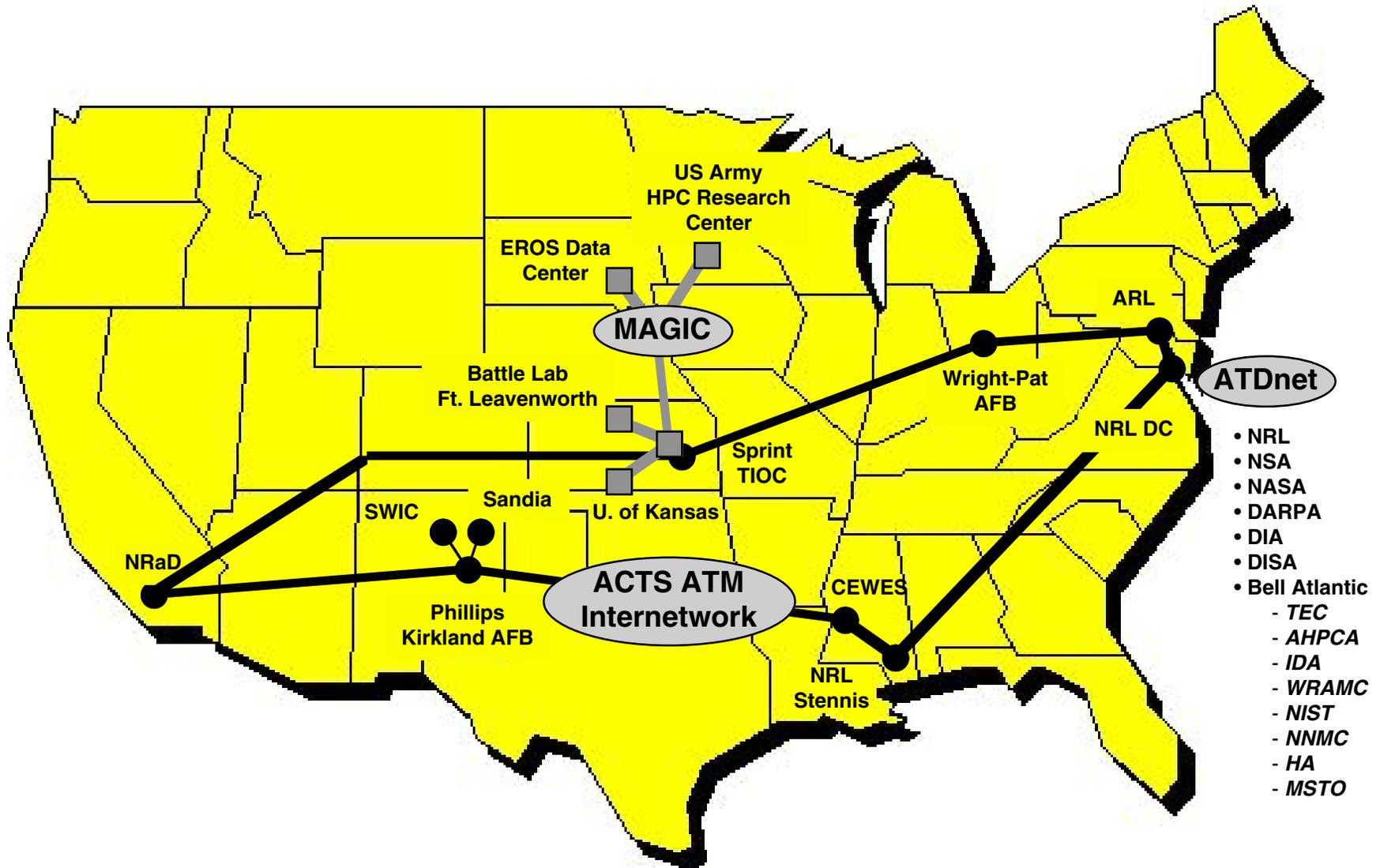- Wide-area, on-time information retrieval (QoS)

The Backplane Moves to the Network

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┌────────────────────┐      ┌────────────────────┐      ┌────────────────────┐
│ Massively Parallel │      │     RAID Array     │      │      D2 Farm       │
│  Processor (MPP)   │──────│                    │──────│                    │
│                    │ 1.6  │   (4 Terabits)     │ 1.6  │   (400 Terabits)   │
│  (256 Gigabits)    │ Gbps │                    │ Gbps │                    │
└────────────────────┘      └────────────────────┘      └────────────────────┘
         │                           │                           │
┌────────────────────────────────────────────────────────────────────────────┐
│  ATM/SONET:  OC3 (155 Mbps)   —   Scalable to OC-192  (9.6 Gbps)             │
└────────────────────────────────────────────────────────────────────────────┘
     │          │          │              │            │              │
 ┌───────┐  ┌───────┐  ┌───────┐     ┌─────────┐  ┌─────────┐    ┌─────────┐
 │ Local │  │Remote │  │ Local │     │ Remote  │  │  Local  │    │ Remote  │
 │WS/ATM │  │WS/ATM │  │ Data  │     │  Data   │  │Graphics │    │Computers│
 │       │  │       │  │Source │     │ Sources │  │ Engine  │    │         │
 └───────┘  └───────┘  └───────┘     └─────────┘  └─────────┘    └─────────┘
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NNMC

WRAMC

NIST LoC

BA₁

SONET Equipment

NSA

DARPA

SONET Equipment

SONET Equipment

SONET Equipment

Washington Metropolitan Area

OC-48 (2.4 Gbps) SONET Ring with at least 2 OC-3c (155Mbps) drops to each site and OC-12c (622 Mbps) drops to selected sites.

SONET Equipment

NASA

DISA

SONET Equipment

BA₂

SONET Equipment

SONET Equipment

OC-48 Backbone

SONET Equipment

TEC

MSTO

HA

AHPCA IDA

SONET Equipment

DIA

NRL

ATDnet » AAI » LES

US Army
HPC Research
Center

EROS Data
Center

ARL

MAGIC

Wright-Pat
AFB

ATDnet

Battle Lab
Ft. Leavenworth

NRL DC

Sprint
TIOC

SWIC

Sandia

U. of Kansas

NRaD

**ACTS ATM
Internetwork**

CEWES

Phillips
Kirkland AFB

NRL
Stennis

- **NRL**
- **NSA**
- **NASA**
- **DARPA**
- **DIA**
- **DISA**
- **Bell Atlantic**
  - *TEC*
  - *AHPCA*
  - *IDA*
  - *WRAMC*
  - *NIST*
  - *NNMC*
  - *HA*
  - *MSTO*

Discoveries

High Water Mark

- $\approx$200 Switches: *Largest known SVC ATM Network*

- Problems encountered would not have been readily seen in simple testing but were brought to the forefront by living on the technology.

- Virtual circuit limits reached (100's are not enough – 1000's now, many 1000's soon)

- Major bugs were discovered and corrected as software was upgraded. *(These bugs were not evident on other networks as ours has the most complexity.)* These bug fixes directly helped other ATM networks such as LES.

- Major Areas:
  - Memory Leaks
  - ARP Cache Corruption (with Multicast)
  - Topology

- Isolated ATM networks aren't!

- All are now under control – Major rewrite complete

Current Wide Area Research & Development

- Deploy end-to-end ATM solutions across ATDnet and AAInet so that connectivity between ATM hosts on different subnets is NOT routed

- Deploy Classical IP across the network so that
    - Existing edge routers can be employed
    - Servers are distributed

- Provide for Public-Private Network-Network Interconnect (PNNI)

- Provide for a scalable multicast service

- Provide QoS guarantees for CBR, VBR and ABR traffic

- Migration to UNI 3.1 and ATM Forum compliant PNNI (with FT-PNNI as interim)
  - Migrate from ring to mesh topology
  - Integration of Fastlane key-agile encryption devices
  - Deployment of integrated network management services
  - Rapid research prototyping of ABR, UNI 4.0 and RSVP

- Integrate ATDnet and AAInet signalling, routing and management seamlessly

- Development of Video-on-Demand (VoD) capabilities

- Application thrusts
  - Large file systems for storage and archiving
  - Telemedicine and Medical imagery
  - Simulation support for RITN and STOW
  - ACTS and Joint/Direct Broadcast Satellite (JBS/DBS)

- Transition of AON and MONET technology into ATDnet
  - Deployment of OC-12c and OC-48c streams
  - Improved switches and IP routers

- Continue stress testing through DoD demonstration support

Next Generation Scalable ATM Network

- OC-48c (2.4 Gbps) streams aggregated onto OC-192 (9.6 Gbps) backbones

- Wavelength Division Multiplexing (WDM) cross-connect structure for wide-area transmission; eight wavelengths per fiber for 80 Gbps aggregate bandwidth per fiber
    - 1996 Washington area install between MONET Consortium members NRL, NSA and Bell Atlantic
    - Link in 1997 to New Jersey LATA: AT&T Bell Laboratories (Holmdel & Crawford), Bellcore (Morristown) and Bell Atlantic (Red Bank) over AT&T long lines network based on "C-Net" concept

- Seamless 2.4 Kbps to 2 Mbps LANet ATM-toWarfighter switch fabric for interoperability end-to-end
    - Integrates wireless capabilities; multimedia for voice, video and data
    - Protocol supports error correction and frames sync to BER 10^{-2}
    - Support priority and pre-emption for CBR and ABR traffic
    - API for PBX voice and low-rate video/data interconnect to public telephone network

Issues

- Robust Network Management Mechanisms are not yet available

- Security

- ATM Over Low Data Rate Tactical Circuits

- Multicast

- ATM Signaling and Routing are Not Fully Defined

- Integration of ATM with Multi-Protocol Mixed Technology Infrastructure

- High Rate Connectivity Between Supercomputers and Workstations

- Interoperability

- Priority

- Latency, Call Setup

Summary/Goals

- Seamless Information Architecture
  - Bandwidth on Demand
  - Plugging in to any needed resource regardless of location

- Participate in the enabling of the DoD use of the Global Grid and the National Information Infrastructure (NII)

- Influence and use commercial development to meet DoD requirements

- Demonstrate technical feasibility and Military worth of the Global Grid and ATM related capabilities

- Joint Interoperability

- ATM testbed is a catalyst reflecting World trends, bringing together
  - Applications
  - Communications resources
  - Distributed processing
  - Distributed data