Defense Research and Engineering Network IPv6 Pilot Introduction

– 2003 to 2008 –

IPv6-team

@hpcmo.hpc.mil

Topics

- DREN in the HPCMP
- DREN History of IPv6
- Review of DREN Pilot
  - Initial Planning Efforts
  - How Goals were achieved
- Local preparation for IPv6 deployment

HPC Modernization Program

Air Force HPC Centers
ASC MSRC
AEDC, AFRL/IF, AFWA, SIMAF,
& MHPCC DC Projects
1,204 Users/54 Locations
19 DREN Sites
7 Challenge Projects
11 Institutes/Portfolios
3 CTA Leaders & 3 Porfolio Leaders

Army HPC Centers
ARL & ERDC MSRCs
AHPCRC, ATC, RTTC, SMDC
& WSMR DC Projects
1,324 Users/35 Locations
38 DREN Sites
13 Challenge Projects
10 Institutes/Portfolios
5 CTA Leaders & 5 Porfolio Leaders

Navy HPC Centers
NAVO MSRC
FNMOC, SSCSD, NAWCAD
& WSMR DC Projects
1,627 Users/57 Locations
25 DREN Sites
11 Challenge Projects
10 Institutes/Portfolios
2 CTA Leaders & 2 Porfolio Leader

Defense Agencies
DARPA, DTRA, JNIC, JFCOM,
MDA, & OTE
431 Users/13 Locations
8 DREN Sites
1 Challenge Project

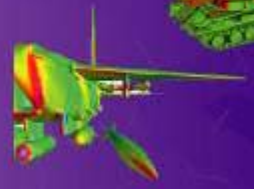
DoD Challenge Projects
2 Joint Challenge Projects
1 Army, Navy, & DTRA
1 Army, Navy

HPC Centers

Networking

Resource Mgmt

DoD Challenge Projects

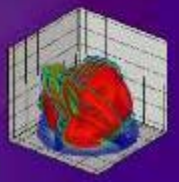


Requirements & Allocations

Software Applications Support

PET

HPC-SAI



S/W Portfolios

DREN in the HPCMP (continued)

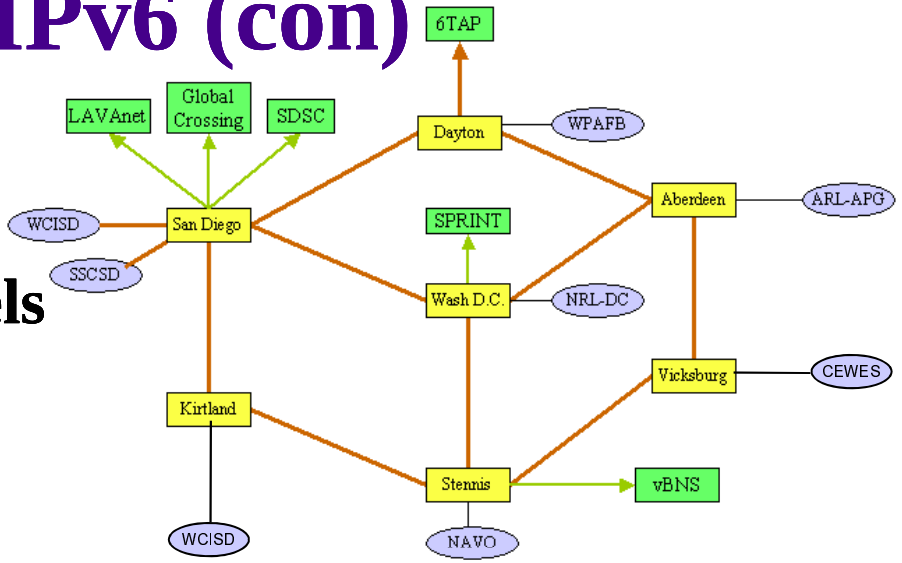
- A DoD network supporting the Research, Engineering, Modeling & Simulation, Test & Evaluation, and related communities.
- Protocol-rich, high performance secure network environment with support of new technologies.
- High capacity, low latency, predominately unclassified.
- Peers with the Internet, numerous commercial, and other DoD and Federal networks.
- Verizon Business service over the vBNS backbone.

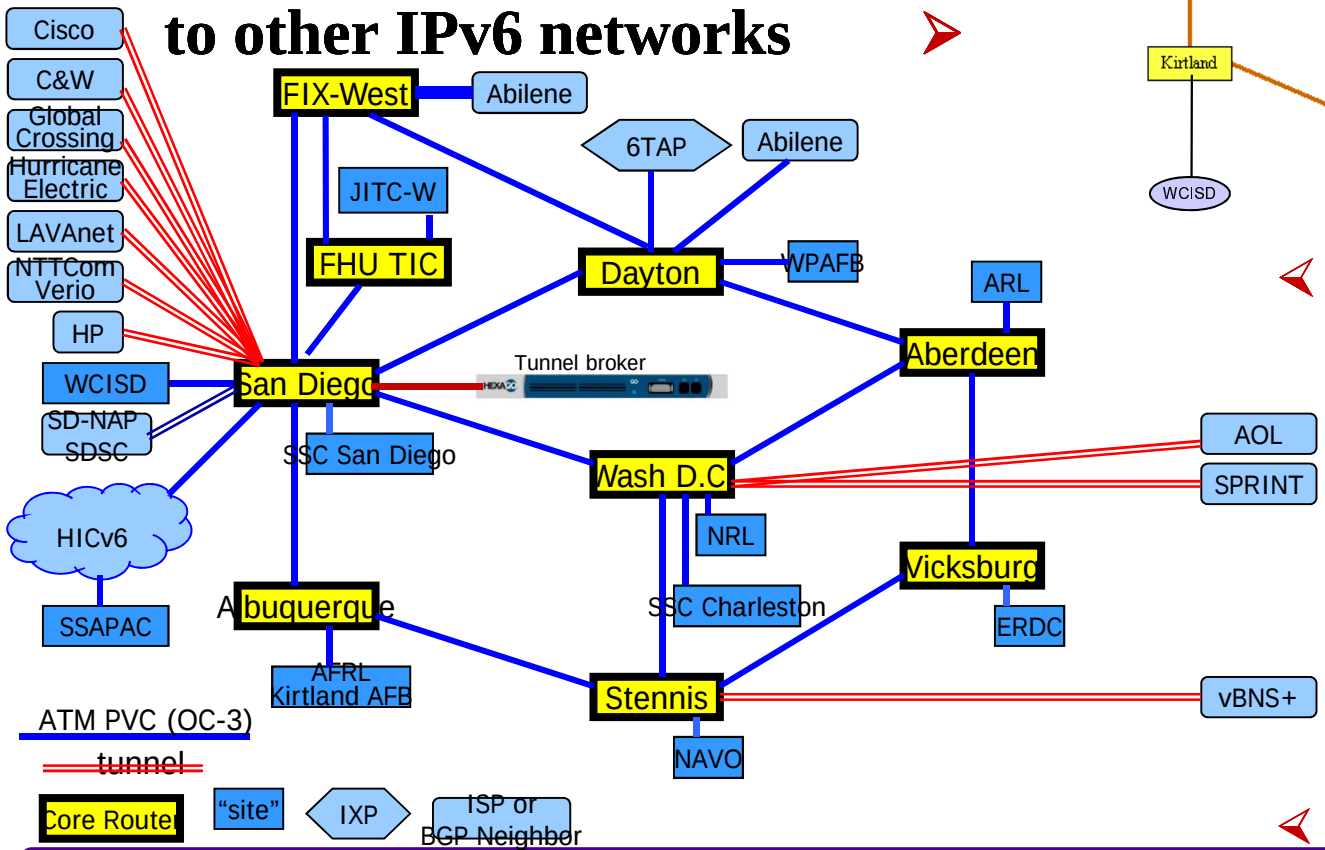
DREN History of IPv6

- 1995-2000
  - Ad-hoc tunnels, playing on 6bone.
  - Presentation at conferences
- Jan 2001
  - DRENv6 “test bed”
    - Native IPv6 (no tunnels)
    - Logically separate from DREN IPv4 backbone
    - 8 core nodes (Cisco routers – dedicated to IPv6)
    - Sites connect via PVCs (native IPv6), or tunnels.
  - New DREN2 backbone contract (MCI) includes IPv6
- Jul 2003
  - Selected as DoD IPv6 “pilot”
- Oct 2003
  - Added DRENv6 node at Ft Huachuca (TIC, JITC) for Moonv6 interconnect between DoD and Abilene (UNH), “pilot” nodes at Indian Head, MD (JITC East), Quantico, VA (MCNOSC)

DREN History of IPv6 (con)

- 2001 – Test bed started with 7 native ATM nodes tunneled across DREN and a few tunnels to other IPv6 networks





- 2003 – Test bed connected to and peered with many IPv6 networks. FIX-West and FHU TIC nodes added for MoonV6

Review of DREN IPv6 Pilot

- In June 2003, DoD CIO said DoD will do IPv6
- In June 2003, DDR&E said DREN will do IPv6
- In August 2003, HPCMP Director said HPCMP sites and DREN will do IPv6
- In late 2003 the DREN IPv6 pilot team (TAP members & HPCMP personnel) made plans for IPv6
- In October 2003, DREN WAN was IPv6 enabled
- In late 2003-mid 2004 many on-site visits were made
  - Various briefings were presented to site personnel
    - 01 Overview – briefing for executives
    - 02 Introduction – briefing for managers
    - 03 Implementation Details – briefing for technical personnel
  - Interactions between IPv6 pilot team and site personnel continued, and sites enabled IPv6 across their LAN

Review of DREN IPv6 Pilot

DREN IPv6 Pilot Goals in 2003:

1. IPv6 enabled Wide Area Network: all 120+ Service Delivery Points (since grown to 170+), the backbone core, and the Network Operations Center (NOC). Complete
2. Performance and Security as good as pre-existing IPv4-only network. Complete
3. Facilitate IPv6 deployment into HPCMP sites and HPC Computer Emergency Response Team (CERT). Complete
4. IPv6 enable:
   - HPCMP funded sites' infrastructures. Mostly complete
   - HPCMP provided applications. Complete
5. Furnish feedback, lessons learned across DoD and to wider Federal Agency community, via web and briefings. On-going
   - Published via web site https://kb.v6.dren.net

Review of DREN IPv6 Pilot – Efforts

Functional Areas

FA07: HPC Community involvement through:
- Information availability and technology transfer (via web site)
- Information dissemination (publicity, briefings, conferences, meeting participation)
- HPC Center and Service program/project site participation (education, training, assistance)

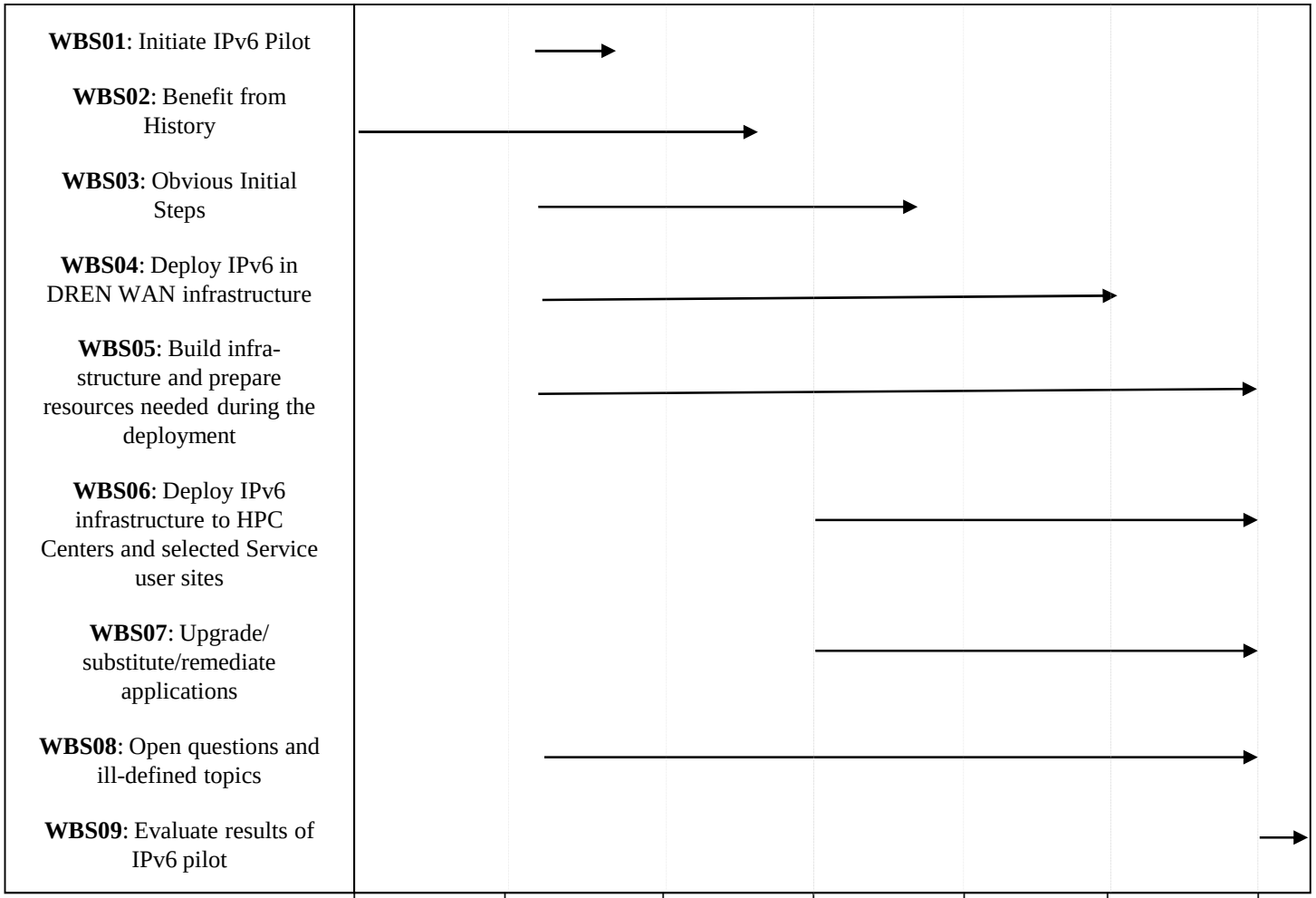
FA06: Future planning
- Identify and provide support for new applications only possible with IPv6
- Plan for continuing support after IPv6 pilot concludes

FA02: Infra-structure services	FA03: Network Management	FA04: Security	FA05: Upgrade/ substitute/ remediate applications
- Protocols and tools to ensure network apps perform	- Protocols and tools for N/W management	- Devices (IDS, firewalls) - Accreditation processes - Access Control Lists - Encryption (H/W&S/W)	

FA01: IP Transport
- DREN WAN connectivity (layers 1 through 4 of the ISO 7 layer model)
- DRENv6 peering with other test beds and production DREN
- SDREN connectivity and performance tuning
- Protocol translation and tunneling

Review of DREN IPv6 Pilot – Efforts

Work Breakdown Structure



Review of DREN IPv6 Pilot – Efforts

- **WBS01 (Initiate IPv6 Pilot)**
  - **Goals, Pilot team formation, FAs, budget, draft plan***
- **WBS02 (Benefit from History)**
  - **DRENv6 test bed and address plan, IDSv6 development**
- **WBS03 (Obvious Initial Steps)**
  - **DREN networkers conf, MoonV6, early sites (HPCMPO, CERT), peering DRENv6 with DREN production network**
- **WBS04 (Enable IPv6 in DREN WAN infrastructure)**
  - **SDPs, MCI infrastructure, NOC, dren.net nameservers**

***Copies available on request (For Official Use Only)**

Review of DREN IPv6 Pilot – Efforts

WBS05 Build Infrastructure and Prepare for Deployment

- In 7 sub-tasks, one for each Functional Area:
  - Queries of what networking infrastructure and additional hardware resources are present,
  - Queries of what software is present on those resources (to be IPv6 enabled),
  - Queries of HPC centers and user sites to identify some of the applications software is present (to be IPv6 enabled),
  - Investigation of vendor IPv6 plans and capabilities
  - Evaluation of possible IPv6 deployments, such as:
    - protocols,
    - tools,
    - upgraded/substituted/remediated software
  - Develop plans and approaches for deployment

Review of DREN IPv6 Pilot – Efforts

WBS06 Deploy IPv6 to Centers and sites

- Facilitate IPv6 deployment into networks and systems at those Centers and program/project sites in the IPv6 pilot:
  - Perform an initial site visit
    - Various briefings presented to site personnel
      - 01 **Overview** – briefing for executive, management, contracting, and legal personnel (general audience)
      - 02 **Introduction** – briefing for management, security, technical, and application support personnel (general audience)
      - 03 **Implementation Details** – briefing about pilot details and deployment process presented to technical personnel
    - Additional materials provided to technical personnel (See backup slides)
      - » Self-assessment kit
      - » Pointers to on-line training and information sources
  - Over an extended period of time – further interactions between IPv6 pilot team and involved site personnel
  - Eventually, site personnel deploy IPv6

Review of DREN IPv6 Pilot – Efforts

WBS07 Upgrade/substitute/remediate applications

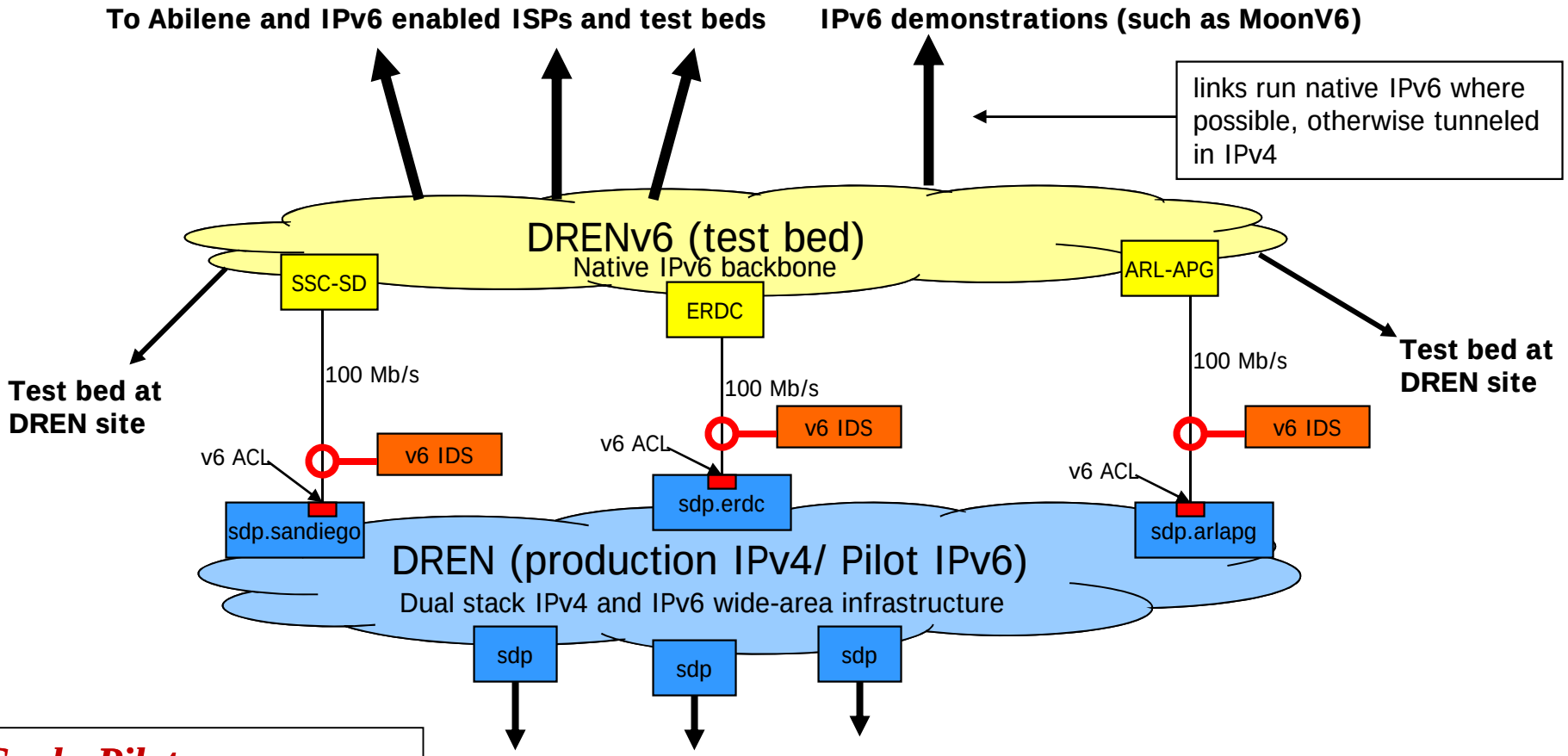
- Facilitate application transition during IPv6 deployment at each site. For each application identified for transition (by either the DREN IPv6 pilot applications team or by the site's deployment team):
  - Transition that application at the site where the application is installed, using a previously prepared plan
  - Each time that application is upgraded/substituted/ remediated, the plan will be refined
  - After an application is upgraded/substituted/remediated at all DREN IPv6 pilot sites, the final revision of the plan will stay on the HPC community web site for later use by the DoD community

Review of DREN IPv6 Pilot – Efforts

- **WBS08 (Open questions and ill-defined topics)**
  - **track open questions and ill-defined topics until closed or well-defined and assigned to one of the functional areas for implementation**
- **WBS09 (Evaluate results of IPv6 pilot)**
  - **lessons learned from DRENv6 test bed for input to MoonV6 (done)**
  - **lessons learned from pilot to use in the DoD Enterprise-wide deployment of IPv6**
  - **work remaining to be done by the HCPMP to finish efforts begun as part of the DREN IPv6 pilot**

Review of DREN IPV6 pilot – Goals

Securely peer with DRENv6 test bed



Goal: Pilot as secure as production IPv4 network

Type "A" (IP) production service to DREN sites
IPv4 and IPv6 provided over the same interface

Review of DREN IPV6 pilot – Goals

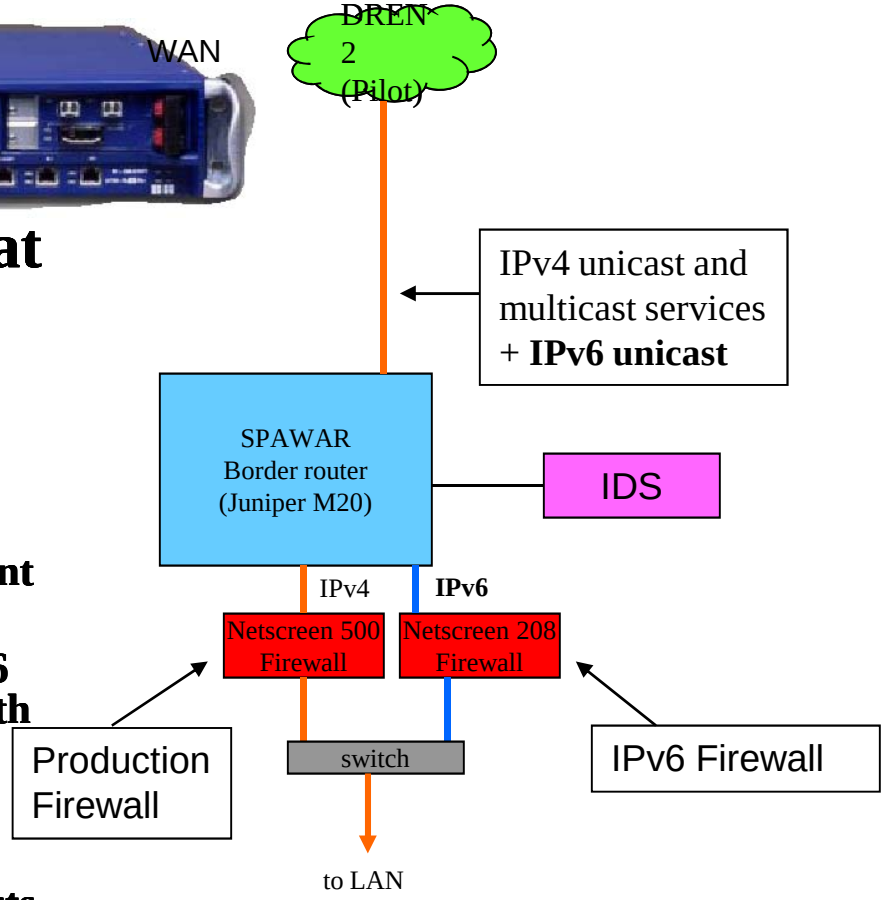
Securely peer with DRENv6 test bed

Continue to operate DRENv6 test bed as an untrusted native IPv6 network that peers with other open IPv6 networks

- **Existing DREN IDS architecture incompatible with IPv6**
  - **Juniper router port mirroring lacks IPv6 support**
    - **So, split the packets out to a separate port**
  - **HPC IDS lacks IPv6 support**
    - **So, upgrade IDS software to handle IPv6 packets**
- **Router ACLs lack necessary IPv6 features**
  - **So, upgrade memory where required and Juniper (pilot) and Cisco (test bed) routers to support IPv6 ACLs**
- **Firewalls didn't support IPv6 (except a few beta units)**
  - **Not a problem, since DREN peering points don't use them**

Review of DREN IPV6 pilot – Goals

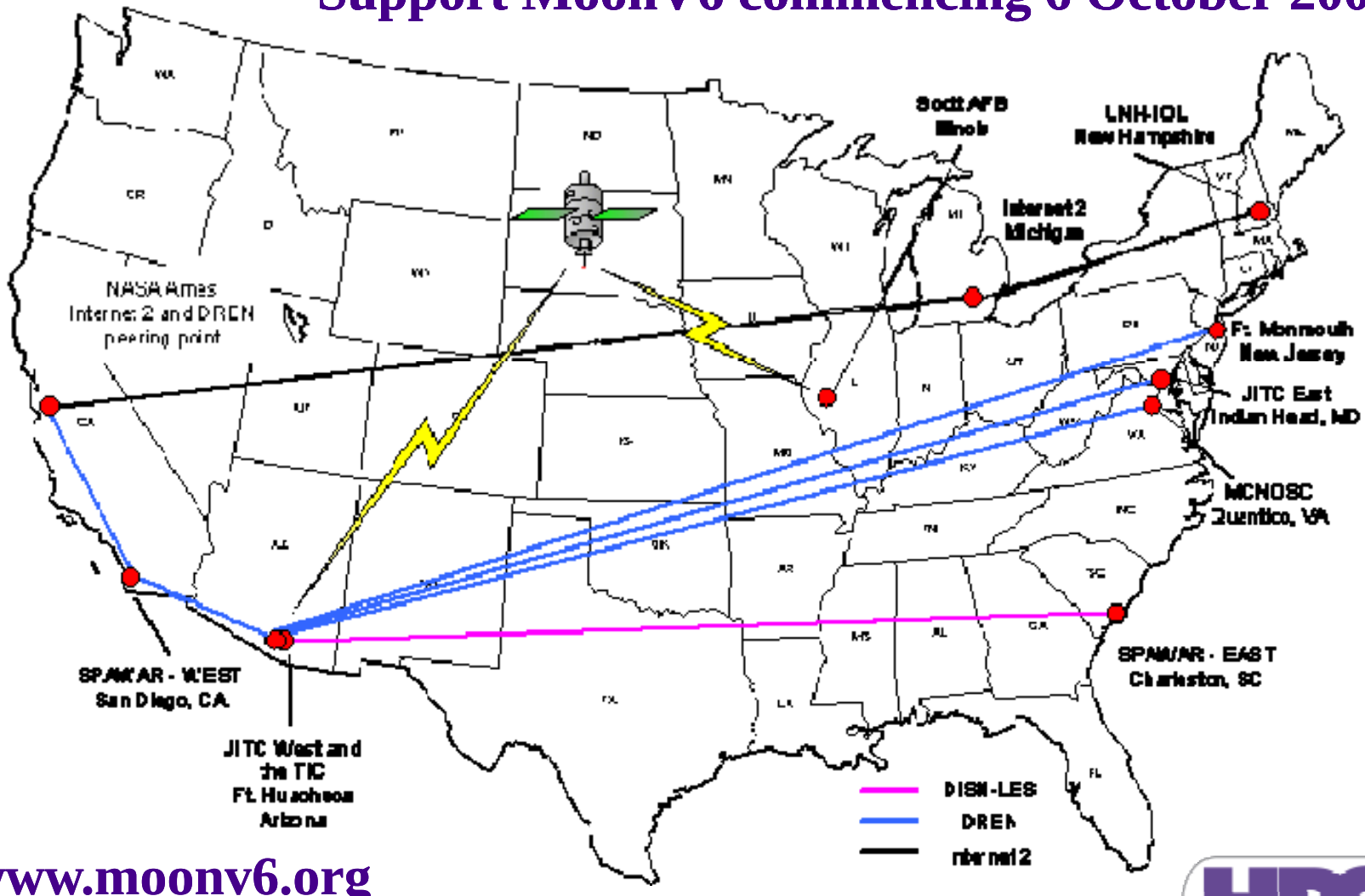
Securely peer with DRENv6 test bed



- **DREN IPv6 pilot recognized that Firewalls are an issue for some sites, so Firewalls were tested:**
  - **Netscreen IPv6 capability early "beta"**
    - **Wanted to test on SSC-SD NS-500 firewall (previously in operation) … but the 500 didn't work in transparent mode**
  - **So NS-208 procured and installed for IPv6 beta … tested it in "routing mode" but with RIP, <u>not</u> OSFPv3 as desired**
  - **Had to install "beta" and production in parallel as shown.**
  - **Status: Both now announced IPv6 products from Juniper (who acquired Netscreen)**
    - **Results favorable, with some minor caveats**

Review of DREN IPV6 pilot – Goals

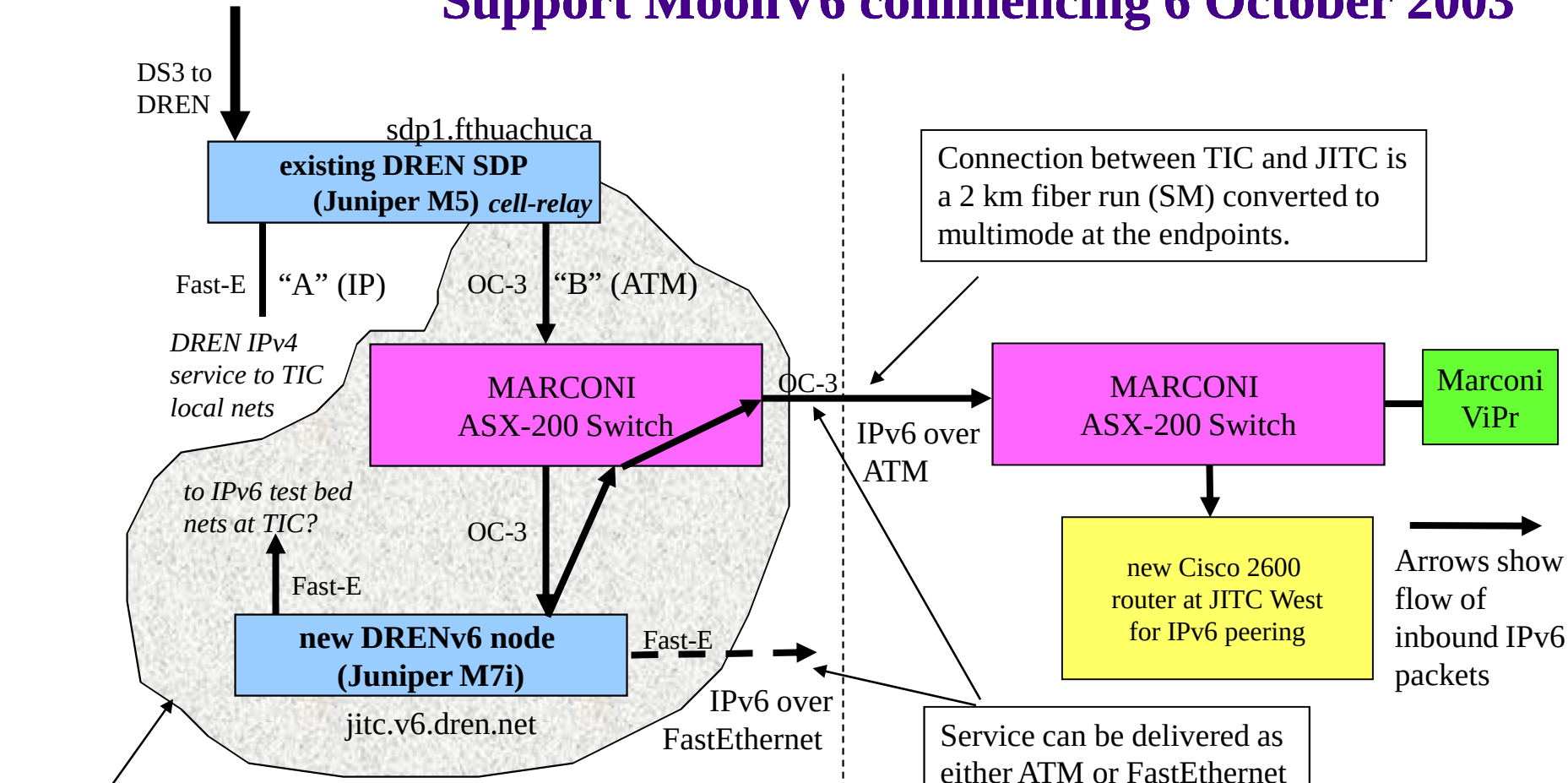
Support MoonV6 commencing 6 October 2003



see www.moonv6.org

Review of DREN IPV6 pilot – Goals

Support MoonV6 commencing 6 October 2003



Review of DREN IPV6 pilot – Goals

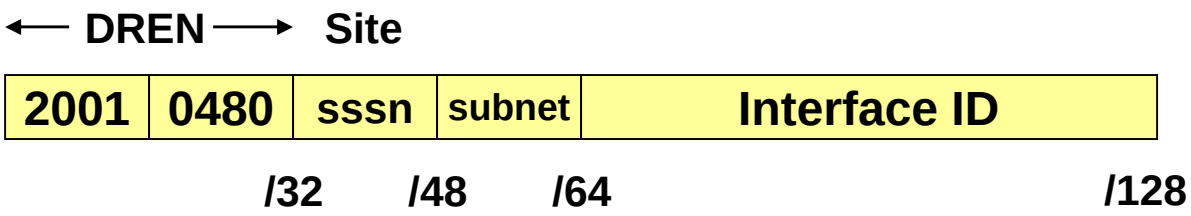
- **FY04 goals for the DREN IPv6 pilot (continued):**
  - **IPv6 deployed on DREN infrastructure**
    - **all SDPs**
    - **the MCI provided Wide-Area Networking infrastructure**
    - **the DREN Network Operations Center**
    - **provide IPv6 dren.net DNS support**
  - **IPv6 deployed on HPCMP funded assets and services**
    - **MSRCs**
    - **ADCs (extent will vary by site)**
    - **Some DDCs volunteered: NRL-DC, SSC-SD, RTTC, WSMR, NAWC-AD**

Review of DREN IPV6 pilot – Goals

- FY04 goals for the DREN IPv6 pilot (continued)
  - Other sites, such as HPC CERT, HPCMPO, SDREN SNOC
  - Various applications enabled
    - HPCMP infrastructure applications, such as Kerberos, Information Environment, On-line Knowledge Center
    - third-party applications (requires vendor cooperation)
      - » COTS, GOTS, CHSSI, and the like
        - at the HPC Centers
      - » used by the program/project user sites
    - Selected HPC user-developed applications
      - » depending on who is interested/willing to convert

Review of DREN IPV6 pilot – Goals

- FY04 goals for the DREN IPv6 pilot (continued)
  - Allocate DREN IPv6 address space (maintaining autonomy)



    - sss = 001..299 Each SDP assigned an arbitrary 'decimal' site ID (sss = 000 for DREN NOC and infrastructure, 300..EFF reserved, F00..FFF = DRENv6 and other test beds), NOTE: "s" is a hex digit
    - Allocate a block of sixteen /48 prefixes to each SDP
      - » Each site behind an SDP is allocated its own /48
      - » n = 0..F (for up to 16 sites or enclaves behind each SDP)
    - Smallest subnet is a /64, even point-to-point links!
    - Loopback interfaces are /128 (still)

Review of DREN IPV6 pilot – Goals

- **FY04 goals for the DREN IPv6 pilot (continued):**
  - **facilitate IPv6 deployment into infrastructure at both HPC Centers and selected Service program/project sites**
  - **Eventually, IPv6 deployed locally as part of IPv6 pilot**
  - **Provide product availability, functionality, maturity, standards compliance, other lessons learned to HPC community via the web**

Review of DREN IPV6 pilot – Goals

- Longer term goals for the DREN IPv6 pilot (through FY07):
  - Facilitate DoD test beds and development efforts to deploy IPv6
  - Facilitate DoD transition to IPv6
  - Capture of lessons learned and transfer of experience with IPv6 pilot and DRENv6 test bed to larger DoD community (See Backup Slides)
- Longer term goals for the DREN IPv6 pilot (beyond FY07):
  - Turn off wide-area native IPv4 support for DREN IPv6 pilot resources

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To system developers – They can develop, test, and evaluate future operational systems using the *same* environment that the warfighter will be using
- To programmers (if their programs now use IPv4) – They learn a new protocol and update their program so that it works like it used to
- To computer users – 'Someone' updates the software on their system, and then everything works like it used to
- To system administrators and network managers – They learn to support new protocols, update system software (and possibly some hardware), and then reconfigure, and then everything works like it used to

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To system developers – They can develop, test, and evaluate future operational systems using the *same* environment that the warfighter will be using. Without having access to an IPv4/IPv6 environment:
  - Development must occur in an IPv4 environment
  - Testing would have to be done either:
    - First in an IPv4 environment, and then port the system to an IPv6 environment for regression testing, or
    - After being ported to an IPv6 environment, with any inconsistencies iteratively fixed back on the separate IPv4 development environment
  - Evaluation in either case would take more time/effort/ money

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To programmers (if their programs now use IPv4) – They learn a new protocol and update their program so it works like it used to
  - The source code must be available
  - Reference RFC 3493 Basic Socket Interface Extensions for IPv6, February 2003
  - Fairly simple series of source code changes:
    - Replace IPv4-specific calls “gethostbyname” “getservbyname” to IPv4/6 “getaddrinfo” calls
    - Update socket calls and data structures,
    - Et cetera

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To programmers (continued) – There are some good software tools publicly available that can automatically determine if an IPv4 program contains IP-specific calls, and suggest needed changes. A few are:
  - http://msdn.microsoft.com/library/
    - IPv6 Guide for Windows Sockets Applications
    - Checkv4.exe utility program
  - http://wwws.sun.com/software/solaris/ipv6/
    - IPv6 Socket Scrubber
  - http://wwws.sun.com/software/solaris/ipv6/porting_guide_ipv6.pdf
    - Porting Networking Applications to the IPv6 APIs
  - Linux tools also available

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To programmers (continued) – Suggestions for writing new programs or re-writing old ones:
  - Build application-specific address structure in the code. This would typically be a structure that includes the address type, address data, and optionally address size. This allows a single structure for dealing with multiple address types.
  - Build a small set of functions that deal with the above address structures. Functions may include: setting, comparing, printing, etc., address structures.
  - Hostname lookups: expect multiple addresses to be returned. This should be obvious for hosts with multiple IPv4 addresses, but account for several IP addresses (at least 2) per interface. Also, consider link-local, multicast, and anycast addresses.
  - When replacing IPv4 addresses in code, rename variables or structure members so that the compiler can help you find all instances of the address variable that need to be adjusted
  - Consider the use of "struct sockaddr_storage" and then cast it to the appropriate sockaddr_* for the address family.

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To computer users – 'Someone' updates the software on their system, and then everything works like it used to
  - An IT support organization representative, a local systems administrator, or a knowledgeable computer user:
    - Installs patches or a new version of the O/S (Windows XP with SP2, Mac OS X 10.2 or 10.3, recent Linux or UNIX patches)
    - Installs patches or new versions of the communications, WWW, and distributed applications on the system
    - Installs new Kerberos clients
  - And, the user would notice very little in the way of new or improved functionality

Local preparation for IPv6 deployment

What deployment of IPv6 means to a site

- To system administrators and network managers – They learn to support new protocols, update system software (and possibly some hardware), and then reconfigure, just to keep everything working like it used to. They need to:
  - Learn new terminology and concepts. IPv6 is an expanded protocol with more configuration options
  - Install patches or a new version of the computer O/S (recent Linux or UNIX patches) and router O/S
  - Install patches or new versions of the communications, WWW, DNS, SNMP, and other distributed applications on the systems and routers
  - New Kerberos application servers, KDCs, et cetera
  - All to notice very little in the way of improved functionality, but with lots of new choices