



IPv6: The Air Force Perspective

Air Force Network Integration Center

Douglas Fry

October 5, 2012



UNCLASSIFIED

- **AF IPv6 Transition Management Office**
- **The Need for IPv6**
- **IPv4 Address Pool Status**
- **Technology Evolution**
- **Industry Applications**
- **Air Force Applications**
- **Mutual Challenges**
- **Air Force Unique Challenges**
- **Air Force Approach**
- **Recent Activities/Progress**
- **Case Studies**
- **Lessons Learned**
- **Road Ahead**
- **Conclusion**
- **Contact Information**

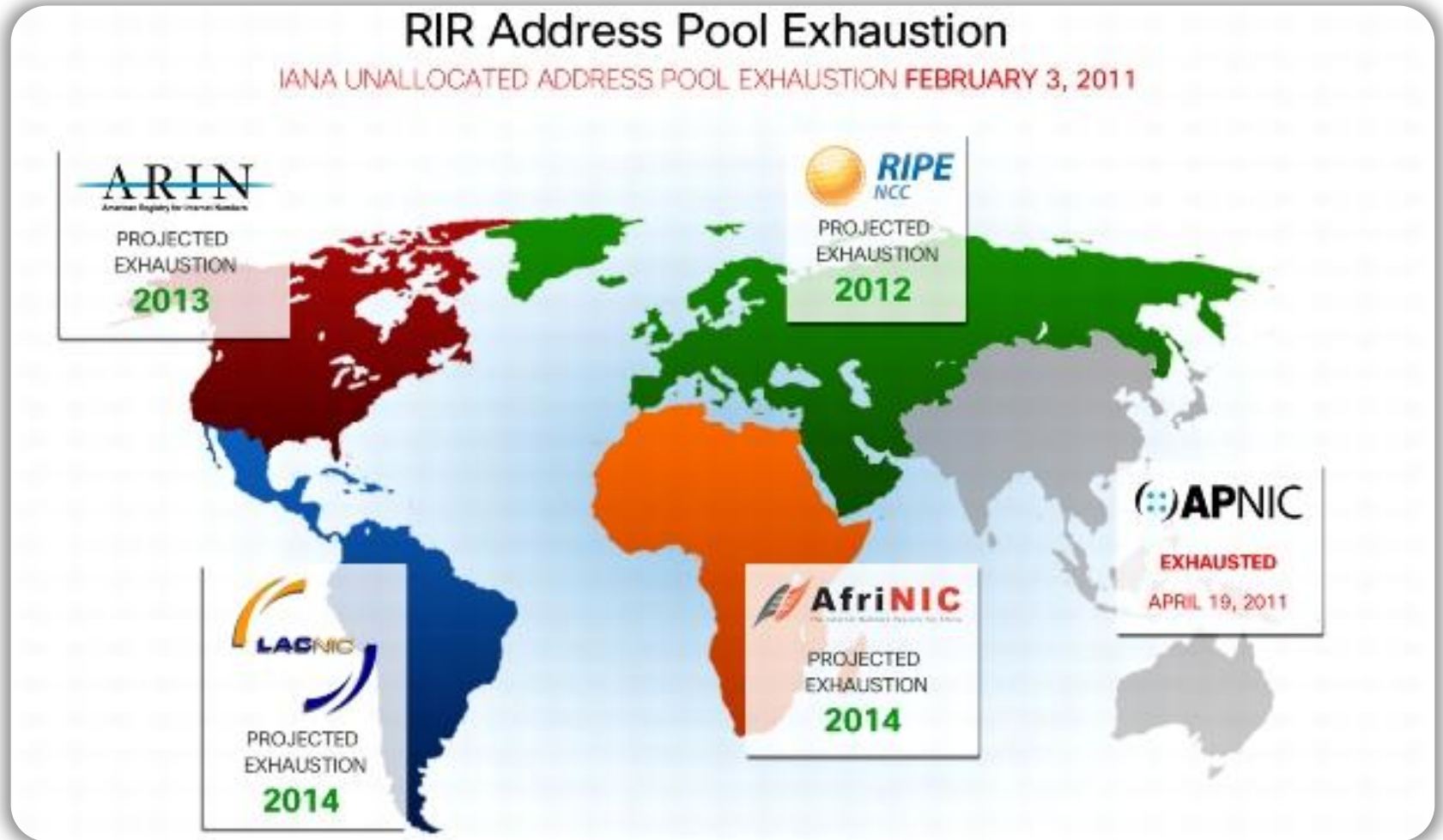
- **Established in July 2003**
- **Guide AF transition as the link between SAF (AF CIO) and operations (AFSPC)**
- **Develop, regulate, and control AF transition to IPv6**
- **Develop and publish AF IPv6 transition guidance**
- **Assist AF organizations with transition efforts**
- **Monitor all IPv6 activities and IT investments and report status quarterly to SAF CIO**
- **Represents the AF at DoD and other service IPv6 working groups (Army, Navy, and VA)**



WORLD INTERNET USAGE AND POPULATION STATISTICS December 31, 2011

World Regions	Population (2011 Est.)	Internet Users Dec. 31, 2000	Internet Users Latest Data	Penetration (% Population)	Growth 2000-2011	Users % of Table
Africa	1,037,524,058	4,514,400	139,875,242	13.5 %	2,988.4 %	6.2 %
Asia	3,879,740,877	114,304,000	1,016,799,076	26.2 %	789.6 %	44.8 %
Europe	816,426,346	105,096,093	500,723,686	61.3 %	376.4 %	22.1 %
Middle East	216,258,843	3,284,800	77,020,995	35.6 %	2,244.8 %	3.4 %
North America	347,394,870	108,096,800	273,067,546	78.6 %	152.6 %	12.0 %
Latin America / Carib.	597,283,165	18,068,919	235,819,740	39.5 %	1,205.1 %	10.4 %
Oceania / Australia	35,426,995	7,620,480	23,927,457	67.5 %	214.0 %	1.1 %
WORLD TOTAL	6,930,055,154	360,985,492	2,267,233,742	32.7 %	528.1 %	100.0 %

NOTES: (1) Internet Usage and World Population Statistics are for December 31, 2011. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the [US Census Bureau](#) and local census agencies. (4) Internet usage information comes from data published by [Nielsen Online](#), by the [International Telecommunications Union](#), by [GfK](#), local Regulators and other reliable sources. (5) For definitions, disclaimers, and navigation help, please refer to the [Site Surfing Guide](#). (6) Information in this site may be cited, giving the due credit to [www.internetworldstats.com](#). Copyright © 2001 - 2012, Miniwatts Marketing Group. All rights reserved worldwide.



IPv4 provides 4.3 billion unique addresses
IPv6 provides approximately 3.4×10^{38} addresses
(one trillion addresses/person)

Internal combustion engine

- Enabled: propulsion
- Application: trains, planes, ships, and automobiles

Electric power transmission

- Enabled: distributed power
- Application: industry, refrigeration, light

Telegraph

- Enabled: faster communication
- Application: global trading, near real time global news



Internet (IPv4)

- Enabled: packet switching – robust, survivable networks
- Application: file sharing, World Wide Web, remote access
- Human centric

IPv6

- Enabled: limitless, scalable networks
- Application: end-to-end communication, machine dominant networks

IPV4 VS. IPV6



Fire Alarm



ID Badge



Security System

- Internet Access & Control**
Multiple programs allow you to control and see the status of your home from anywhere via the Internet.
- Motion Detection**
Detect intrusion, automatically turn on lights, and activate automation functions when entering a room.
- Home Theater**
Use an HAI Touchscreen or an iPad to control your theater and home automation functions.
- Irrigation**
Control irrigation solenoid valves for lawn sprinklers, plus inputs for rain sensing.
- Access Control**
Limit admission to designated areas. When you swipe a card or key tag, security arms or disarms and door strikes are activated. Video intercom confirms who has arrived.
- Energy Management**
Be comfortable at home; save energy when away. Control temperatures in greenhouses, humidors, wine cellars, aquariums, & artics. HAI's communicating programmable thermostats for heating and cooling control easily monitors energy use.
- Multi-Room Audio**
Share your favorite music throughout every zone of your home. No expensive proprietary components are required.
- Pool & Spa**
Secure pool areas with access control. Control pumps, filters, timers, heating, temperatures, solar control, and more.
- Lighting**
Set warm and comfortable moods for dining, movies or entertaining. Have lights automatically turn off when leaving your home. Provide architectural quality lighting control and passive security for the "lived-in" look when on vacation.
- Surveillance Cameras**
View and/or record guests arriving at the front door, or check on kids in the pool from any Touchscreen or the Internet.
- Telephones**
Check and adjust security, temperatures, and lights via any phone at home or away. Monitor and control with your Smartphone or iPhone.
- Security**
Professional quality UL Listed security is built-in to HAI's Omni family controllers. If desired, Lumina family controllers can integrate with an existing security system.
- Vehicle Detection**
Announce visitors, turn on lights, and switch on a television to view the driveway or other outdoor area.

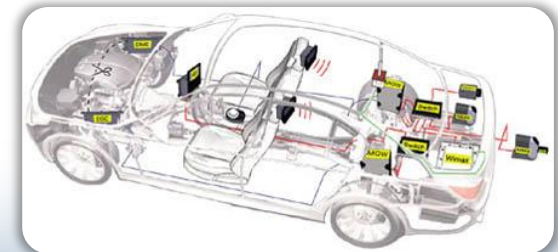
Home



Surfboard



Scale



Car

Ubiquitous, robust and scalable end-to-end networks enable integrated operations.



Proliferation of IP addressed Sensors, munitions, logistics tracking, applications, ...will enhance situational assessments and information availability.



Rapid and agile IT infrastructures with the capability to "discover" adjacent network systems and plug-n-play enable quicker, more dynamic responses.



IPv6 Enabled Battlefield of the Future

End-to-end security, authentication and nonrepudiation Will enable new IA strategies that support mission assurance.



Real time collaboration using integrated voice, video and data capabilities enabled by performance and QoS improvements.



Increased OPTEMPO supported by rapid reorg capabilities, shared situational awareness and improved wireless and mobility support. Support for communications on the move.



Stay relevant

- Customers can no longer reach you or can only reach you through a (congested, high latency, geolocation-lossy) translator
- Competitors' products support IPv6 but you don't
- Reputation damaged because you remain in the Internet backwater

Equipment availability

Leadership support

Cost vs. benefit

- You waited too long and can't recover without a significant investment for which you don't have the time or resources

Operational need

Network operations



- **ISP Support**
- **Mandate**
- **End user applications**
- **Approval**

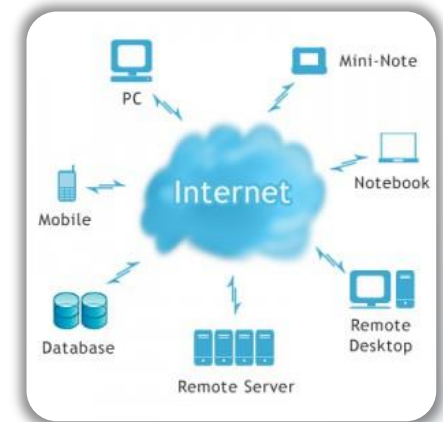


2003

- Initial guidance issued by DoD and Air Force
- Original completion goal 2008
- Purchases required IPv6 capability
- Established the Transition Management Office
- Testing only - no operational IPv6

2005

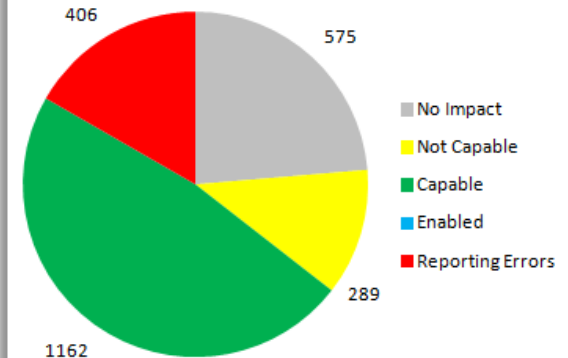
- Second Air Force Transition Plan
- Transition Mechanism Determined
 - Dual-Stack allows for IPv4 or IPv6 compatibility
 - Translation determined to be too expensive and problematic (security)
 - Tunnels do not allow for proper inspection of data
- DoD defined Milestone Objectives 1, 2 and 3
 - MO1: Operational IPv6 in an isolated enclave
 - MO2: Connect two or more MO1 enclaves via tunnel
 - MO3: Native IPv6 packets traversing the network
- OMB direction
- Call for IPv6 Pilot efforts



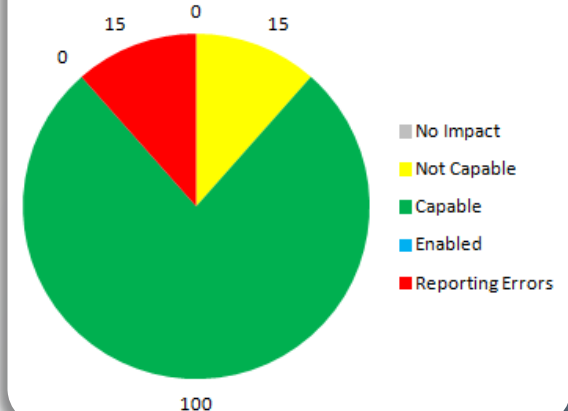
2008

- Operational implementations approved
- DISA passed IPv6 traffic
- Enterprise Information Technology Data Repository (EITDR) is the AF system of record and compliance reporting tool for all AF IT investments
- TMO uses EITDR to report IPv6 readiness to SAF CIO
 - 2487 Investments
 - 62.6% AF IP-based IT investments report IPv6 capable
 - 76.2% of NIPRNet enclaves reported as IPv6 capable

All AF Investments



NIPR Circuit Enclaves



2009

- Federal Acquisition Regulation updated
- First infrastructure implementation

2010

- Two additional infrastructure implementations
- OMB memo
 - Upgrade public/external facing servers and services (e.g. web, email, DNS, ISP services, etc) to operationally use native IPv6 by the end of FY 2012
 - Upgrade internal client applications that communicate with public Internet servers and supporting enterprise networks to operationally use native IPv6 by the end of FY 2014.

2011-2012

- Compliance with OMB memo
- World IPv6 Days
- Core services and client implementation



World IPv6 Day: 8 Jun 11

- 400+ websites participated in World IPv6 Day joining together to make it a successful IPv6 global-scale trial
- Military websites: AF.mil, Navy.mil & DoD.gov
- Public websites: Google, Facebook & Yahoo!
- Service providers: Akamai, Limelight Networks & Hurricane Labs
- AFNIC hosted IPv4 & IPv6 workstations allowing user comparison of participating sites
- IPv6 traffic increased, but minimal compared to IPv4

World IPv6 Launch Day: 6 Jun 12

- Global permanent enabling of some IPv6 sites across the Internet
- www.af.mil permanently enabled to support v4/v6

All AF PA sites support v4/v6 as of 30 Sep 12



Details:

- 30,000+ users
- Multiple organizations
- Older network upgraded/maintained by local Comm Squadron

Timeline:

- Started 2008 – Site volunteered for IPv6 upgrade
- Initial phase completed 2009
 - Infrastructure
 - Test traffic across backbone
- Final Phase to be completed late 2012
 - Enable users and core services



Lessons Learned

- Plan early for first implementation
- Red tape is everywhere
- Get buy-in from leadership on down
- Start with small sections to prevent negative feedback

Document the network – equipment details are important

Validate all network equipment is actually IPv6 capable

- Some systems will pass IPv6 but not be manageable

Remove IPv6 from the network prior to implementation

- Analyze network traffic for evidence of IPv6
- Check DNS for AAAA IPv6 entries

Train network staff early in process

Details:

- 15,000+ users
- Multiple organizations
- Recent network upgrade

Timeline:

- Started 2010 – MAJCOM sponsored site
- Initial phase completed 2010
 - Infrastructure
 - Test traffic across backbone
- Final Phase to be completed after AF implementation plan is finalized
 - Enable users and core services



Process Improvements

- Applied lessons learned from Case Study #1
 - Reduced lead time from 9 months to 2 months
 - Reduced red tape issues with implementation approval
 - Implementation timeframe reduced from weeks to days

Lessons Learned

- Red tape still exists
- Early network documentation reduces implementation delays

Develop a complete plan before gaining operational experience

- You will get it wrong the first time
- Things change, especially address plans

Put it off as long as possible

- "We have higher priorities, like security."
- "We lack resources today."
- "We have enough IPv4 addresses."
- "We've got NAT. NATs are good, they provide security."
- "We might break something."

Develop a business case for deploying IPv6 - it is a matter of business survival

Be afraid to break some glass



Develop a corporate culture for IPv6

- Involve all parts of organization, not just the network guys
- Have a local champion
- Include IPv6 in every IT initiative

Take baby steps

- Go for the low hanging fruit
- Get experience along the way

Start now

- If you haven't, you are already quite late to the game

Start by IPv6-enabling your public facing services

- Work from outside in, and from bottom up

Go native

- Avoid translators, tunnels, and other transition schemes

Only choose suppliers that have a good IPv6 story

- **Ensure IPv6 compatible equipment**
- **Monitoring equipment and security**
- **Update entire network documentation**
- **Test lab that simulates your entire network**
- **Understand how things will change**
- **Desktop configuration**
- **Operational assurance/risk**
 - Maintain interoperability/security throughout transition
 - Training
 - Follow changing IPv6 standards
 - Accommodate residual legacy systems

- **Continue with enclave implementation efforts**
- **Enable on public-facing servers, DNS & DHCP (May 13)**
- **Enable IPv6 on Air Force network (end of FY14)**
- **Keep AF strategy aligned w/DoD transition strategy**
- **Ensure each IT program plans for its own IPv6 transition and funding**
 - IPv6 transition primarily occurring via tech refresh
 - Non-infrastructure programs enable IPv6 per own schedules after core infrastructure
- **Acquire necessary tools and ensure training**
- **No sundown date established by DoD for IPv4**



- **IPv6 is critical to achieving DoD's net-centric vision and allows next generation of advanced applications**
- **Challenges/dependencies in DoD IPv6 transition:**
 - Managing/resourcing the transition within existing budgets
 - Maintaining interoperability and security during/after the transition
 - Accommodating residual legacy equipment
- **Requirements for IPv6 capability have been integrated into acquisitions/technology refreshment**
- **Transition strategy: networks first; then systems/applications**
- **We must change the way we perceive our networks**
- **We must implement "killer enablers" before we can implement or even realize "killer applications"**

Douglas Fry
Lead, Air Force IPv6
Transition Management Office

afnic.ipv6@us.af.mil



