# IPv6 @ Microsoft

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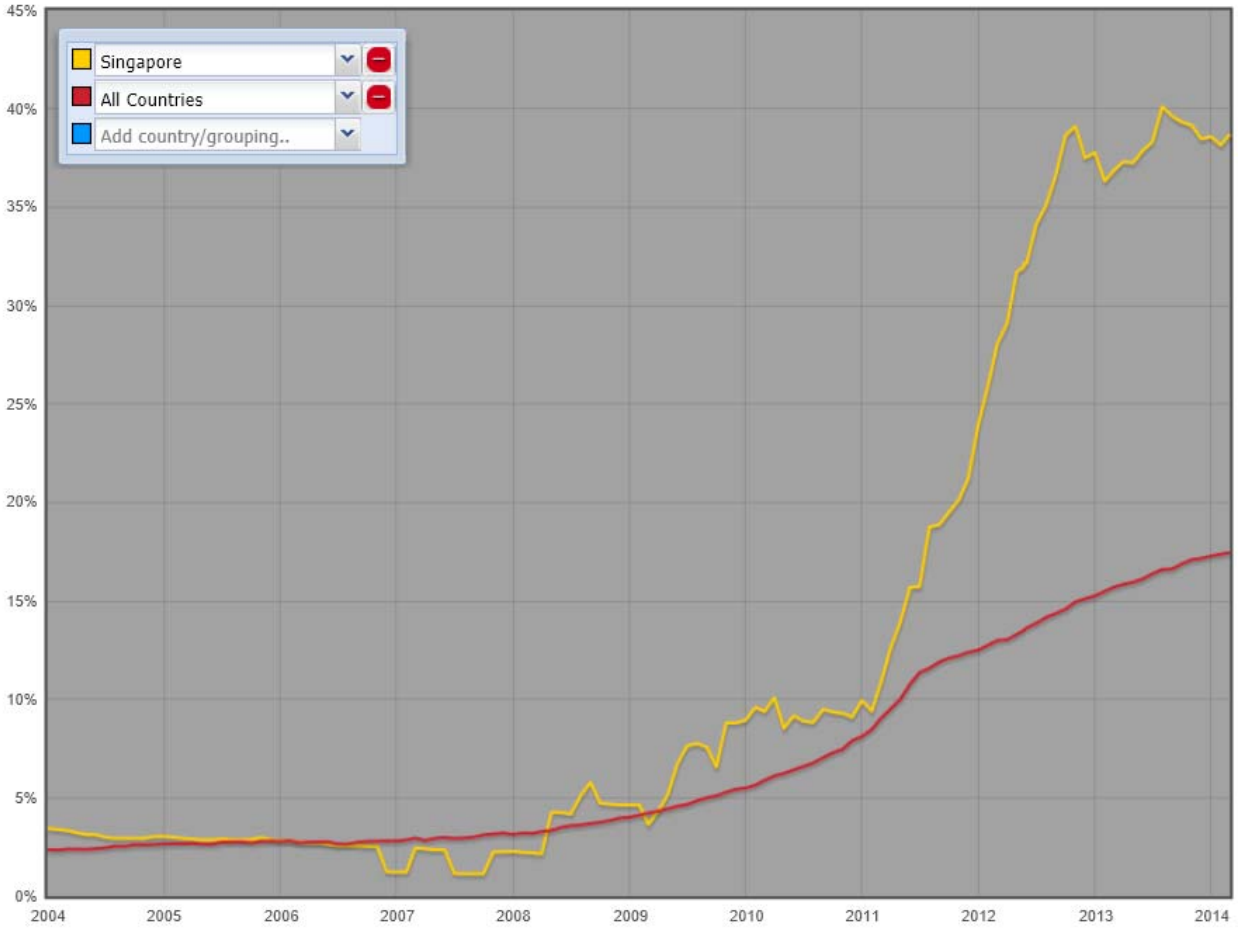
## IPv6 Enabled Networks

permalink: http://v6asns.ripe.net/v/6?s=SG;s=_ALL

This graph shows the percentage of networks (ASes) that announce an IPv6 prefix for a specified list of countries or groups of countries



# Agenda

How did this all start?
What is available?

IPv6 WW @ MSFT
Challenges
How did we get there?

OS Support
Technical stuff
Supported RFCs
Azure and Cloud

Customer Experiences
What is the Future?

# IPv6 @ MSFT – a history

## Early days … 2001 - 2004

2001 First Deployments supporting research and Dev

- Limited support from vendors
- Deployed using experimental "6bone" address space
- Deployed on dedicated devices due to poor performance on routing platforms

2002-2004 Native expansion and ISATAP

- A single ISATAP instance deployed in each region (Redmond, Silicon Valley, Dublin, Singapore)
- Pockets of native v6 deployed across enterprise
- Limited to Dev and Research groups with a documented business need
- "Stitched" together across the enterprise network on a link by link basis

# IPv6 @ MSFT – a history

## Getting more mature … 2005 - 2010

2005-2006 Enable enterprise backbone

- Obtained new v6 address space from ARIN and RIPE
- Entire network readdressed into new address blocks
- Requests for native v6 enabled networks grow
- Network hardware capable of routing at performance parity is introduced during hardware refresh
- Native v6 enabled across all backbone and tail site WAN links to resolve issues
- End user networks still require justification for v6 due lack of security and performance visibility
- Operational issues in connecting disparate v6 clouds become commonplace

2007-2010 Dealing with growth

- Client and Server OS platforms become v6 capable
- ISATAP usage grows concurrently, causing scaling/performance issues
- Redesigned ISATAP infrastructure to distribute service across the backbone
- IDS infrastructure becomes v6 aware

# IPv6 @ MSFT – recent past

## IPv4 Address Depletion

Current public and RFC 1918 (address allocation for private networks) space should be sufficient for addressing needs for the next  2 years

- 25 /16's Address ranges left for enterprise connectivity

ISATAP supports all other networks

MSIT will migrate majority of internal networks to RFC1918 space

- To provide online services with sufficient public IPv4 space to meet future requirements

Providing public v4 addresses for external facing properties is the correct use of remaining IPv4 space

Ongoing effort started in FY10

# IPv6 @ MSFT – today

## IPv6 is enabled across the majority of the MSFT network

Backbone is on IPv6 since 5 years
Native host connectivity is getting more prevalent
ISATAP supports will be reduced due to scaling issues, preferred is native v6

## Leveraging dual stack and network transition technologies

Dual Stack Hosts
Transition Technologies
- ISATAP : Provides connectivity between dual-stack hosts across a v4 network
- NAT64 : Direct Access

# IPv6 @ MSFT – today

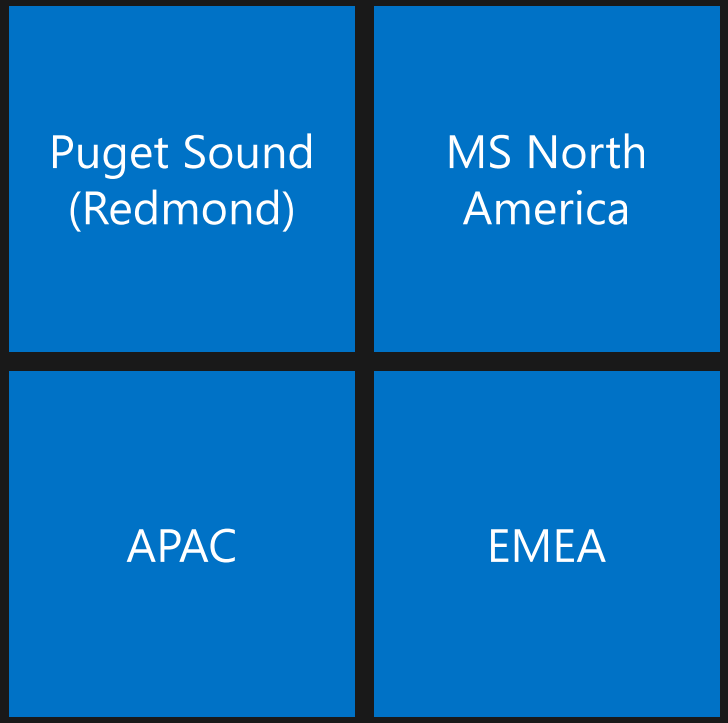
## Network Overview

### By the Numbers

550+ Sites
1.4M machines (excl. Azure)

### WAN/Routing

OSPFv3 moving to ISIS
Partnering with MPLS Carriers to support v6



# IPv6 @ MSFT – today

## Addressing

One /32 block from ARIN: 2001:4898::/32
One /31 (equals two /32s) from RIPE:2a01:0110::/31
/40 for regional block/DC
/48 for sub-region/country
/56 for building
/64 for LAN
/112 for network links
Split into /33 for Internal vs External

## Issues

Influence of regional ISP routing policy
PI /48's

## LAN / Datacenter

DHCPv6 for options/SLAAC for address
RA-Guard
ND tuning
DHCPv6 Address and Option
VLB and Firewall support

Needs update

## Internet/DTAPS

PS peers v6 capable
Firewall support for DTAPS

# IPv6 @ MSFT –Statistics

## Infrastructure

**100%** of WAN/Backbone is IPv6

**40%** of access networks

4170 IPv6 routes

## Client/Server

**98%** of Clients are IPv6

**94%** of Severs are IPv6


# MSIT IPv6 Deployment Philosophy

A normal evolution (rhythm of the business)

## The Drivers

Proper planning is put in place

Specific investment in enabling IPv6 should be exceptions

Infrastructure components are enabled for IPv6
Plan within each upgrade cycle

# IPv6 @ MSFT – Lessons Learned

## Transition Technologies

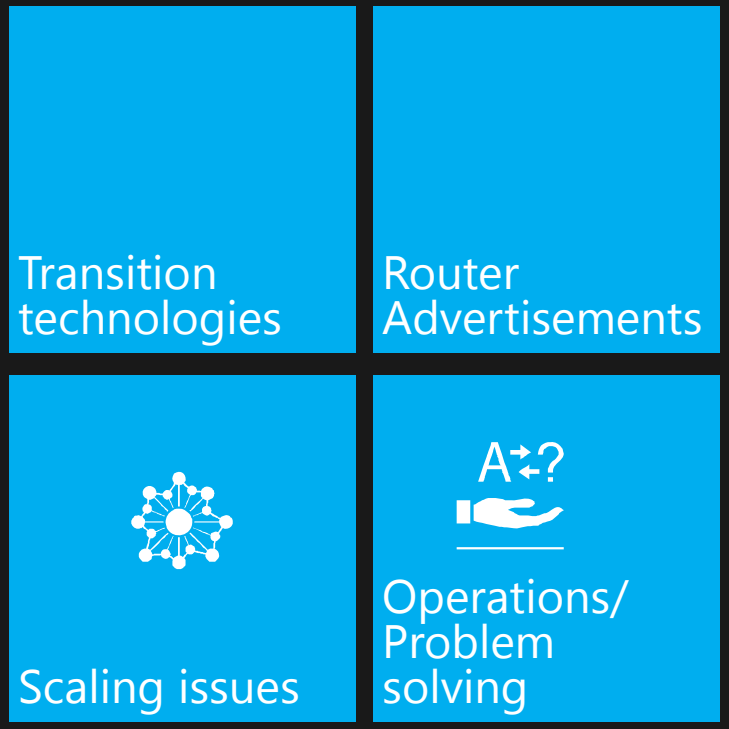
Logical network should map to physical WAN infrastructure
Ensure traffic isn't funneled through ISATAP servers
Deploy a single prefix or static routes

## Scaling Issues

Neighbor Discovery timers
Wireless controller issues
TCAM / Memory usage

## Order of Deployment

All IPv6 services external first
2nd the user facing segments to avoid disruption of business



# IPv6 @ MSFT – Lessons Learned (cont)

## Router Advertisements

Rogue router announcements comprised 80% of issues
Mitigation: RA-Guard / snooping
Limit the number of v6 ICMP error messages
Secure Neighbor Discovery (SeND) not used at MSFT

## Operations / Problem solving

Multiple client  interfaces (ISATAP, NATIVE, v4) complicate troubleshooting issues.
Lack of comfort with new technology leads to poor troubleshooting methodology
Results in immediate escalations to tier 4

# IPv6 @ MSFT – Lessons Learned (cont)

## DHCPv6 vs Stateless Address Auto-Configuration (SLAAC)

Stateful DHCPv6 is recommended for the majority of host LANs
Necessary to meet security requirements for tracking addresses

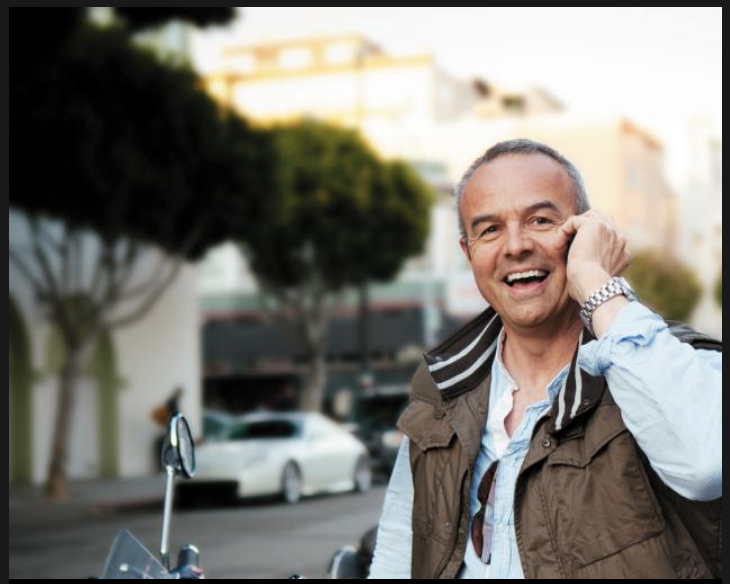
## Firewalls

ICMP plays key role in v6, needed to adjust ACLs (ND, PMTU, etc)
Extension Headers limit only to needed ones

## General

Be conscious of business changes
Very dynamic environment and things will changes as you move on

# IPv6 @ MSFT – Future Tasks



Stabilize/ Eliminate ISATAP

Enable native IPv6 enterprise wide

Datacenter Upgrade

Expand IPv6 peering / edge internationally

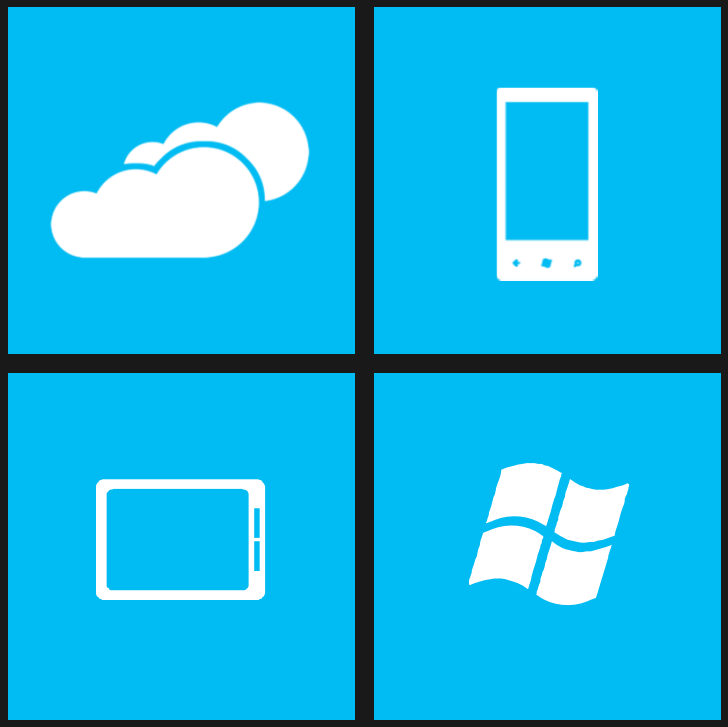
# OS Support

## Windows Server / Client

Support for IPv6 since Windows 2000
Active Dual Stack since Server 2008 / Vista
Default Protocol in Server 2008 R2 / Windows 7
Even better in Server 2012R2 / Windows 8.X

## Mobile / Cloud

Windows Mobile had full support since 4.2
WP 8 has v6 by default
Azure is planned



# OS Support – Technical Details

## IPv6 in Windows XP & 2003

Not installed by default
Only basic support
most system services are not IPv6 aware / capable

## IPv6 in Windows Vista & 2008

Installed, enabled and preferred by default
IPv6 stack enhancements
IPSec integration
Windows Firewall Integration
DNS, LLMNR, PNRP support
Transition Technology support
many more ...

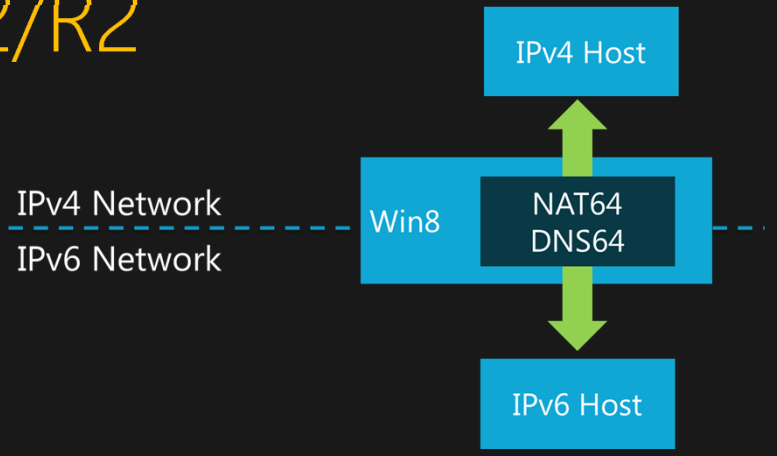
# OS Support – Technical Details

## IPv6 in Windows 7 & Server 2008R2

Installed, enabled and preferred by default
Full integration in multi profile Windows Firewall
More RFCs supported

## IPv6 in Windows 8/8.1 & Server 2012/R2

Updated support with the latest standards for address sorting and reliability
In-box address and DNS translation between IPv4 and IPv6 networks (NAT64 / DNS64)
IP Address Management (IPAM)
Powershell cmdlets added for configuration



Internet Layer

## General

## Applications

Table C-3 IPv6 Applications RFCs

| RFC # | Category | Title |
|---|---|---|
| 1886 | Standards Track | DNS Extensions to support IP version 6 |
| 2428 | Standards Track | FTP Extensions for IPv6 and NATs |
| 2874 | Standards Track | DNS Extensions to Support IPv6 Address Aggregation and Renumbering |
| 3596 | Standards Track | DNS Extensions to Support IP Version 6 |
| 3986 | Standards Track | Uniform Resource Identifier (URI): Generic Syntax |
| 4620 | Experimental | IPv6 Node Information Queries |
| 4795 | Informational | Link-Local Multicast Name Resolution (LLMNR) |

## Sockets API

Table C-4 IPv6 Sockets API RFCs

| RFC # | Category | Title |
|---|---|---|
| 3493 | Informational | Basic Socket Interface Extensions for IPv6 |
| 3542 | Informational | Advanced Sockets Application Program Interface (API) for IPv6 |

| | | |
|---|---|---|
| 3736 | Standards Track | Stateless DHCP Service for IPv6 |
| 3879 | Standards Track | Deprecating Site Local Addresses |
| 4007 | Standards Track | IP version 6 Scoped Address Architecture |

# Windows Azure


## IPv6 support in Windows Azure

Currently limited to Office365 scenarios
Internal projects underway to enable it for remaining scenarios

## Increased demand driven Azure services and more devices to connect

# XBOX and IPv6

Xbox One

## IPv6 in XBOX Services

Uses Teredo to communicate over IPv4 Internet
Focus on peer-to-peer game communication
Teredo implementation on Xbox One behaves similar to that on Windows® 7 and 8.1
IPv6 traffic inside the Teredo tunnel is IPSec protected
Technical guidance available for Hardware vendors and network operators for best peer-to-peer game experience

# IPv6 support in Office 365 services

## Office 365 IPv6 support

Exchange Online

Sharepoint Online

- Office 365 Government G1/G3/G4/K1 – default
- All others – per customer request

Lync Online

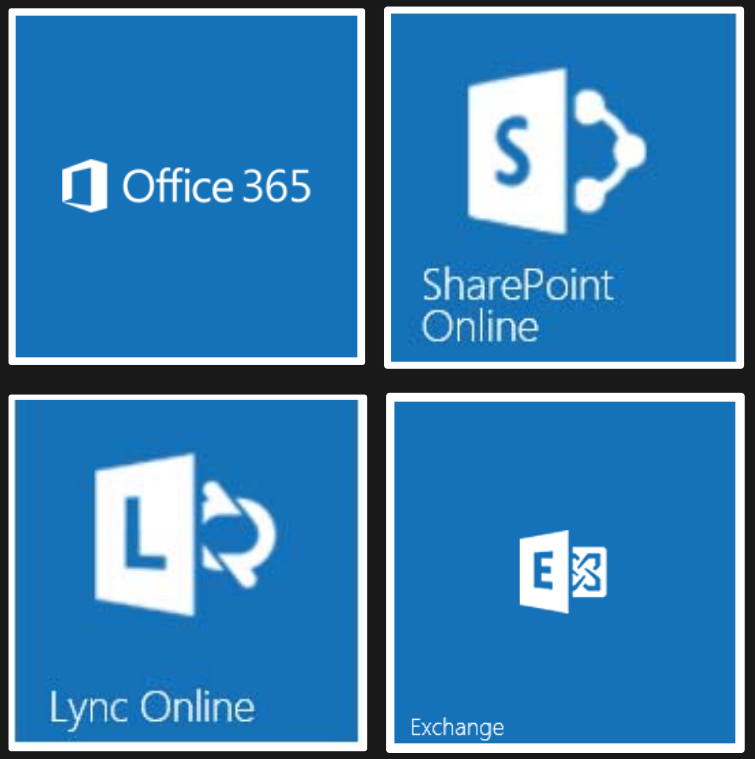
- Same as Sharepoint Online

## Caveats

FOPE does not support IPv6

Some RMS scenarios are limited

BlackBerry® Enterprise Server (BES) doesn't support IPv6



# Application Development Support for v6

## Support for IPv6 for Developers

Fully integrated and tested in winsock2
.NET Frameworks also has full support for IPv6
    Some low level interfaces are only available via un-managed calls (setsockopt())
Checkv4.exe Utility helps to analyze your codebase and identifies potential problems

## Things to watch out for

Avoid using hardcoded addresses in code
UI changes are required – Address format is different
Input validation may needs to be adjusted
Be aware of dual stack implementation
    Mapped v4 addresses can be returned in some cases (e.g. ::FFFF:222.1.41.90)
Aim for writing IP-version agnostic applications

# Future Outlook

## Microsoft Driving to IPv6

Partnerships with vendors to test and drive development of networking and supporting systems that support IPv6

e.g. Office365 worked with Verizon, Comcast, Cisco, Citrix and Level3 to address v6 issues

Pioneering technology such as DirectAccess to employ IPv6 in the enterprise even before it is widely available outside our network

Microsoft is pushing the industry to break down barriers to a robust IPv6 environment

Microsoft is participating actively in IETF, IAB, IANA

## MSIT Goals for IPv6

IPv6 to displace IPv4 by 2015

Begin "Native IPv6 Only" deployments

# Future Outlook

## Common Engineering Criteria

Compliance criteria list (revised annually) for server products

Management Packs, Powershell command lets, IPv6 support

http://www.microsoft.com/cec/en/us/default.aspx

## Services Fundamentals

Compliance criteria list (revised annually) for online services

IPv6 criteria is defined and implementation is underway

# Customer Experiences

"Implementing IPv6 has consumed less than 1 percent of our IT budget, and the IT budget is only a small part of the overall corporate budget. These costs are modest compared to the expected benefits."

Fred Wettling, Bechtel Fellow and Technology Strategy Manager, Bechtel Corporation

# References


ARIN Board Resolution https://www.arin.net/knowledge/about_resources/v6/v6-resolution.html

Planning Guide\Roadmap Toward IPv6 Adoption within the US Government: http://www.ipv6council.de/fileadmin/documents/Planning_GuideRoadmap_Toward_IPv6_Adoptionin_USG_May_2009_final1.pdf

Action Plan for the Deployment of Internet Protocol version 6 (IPv6) in Europe:

http://www.ogf.org/OGF25/materials/1503/action-plan-ipv6.pdf

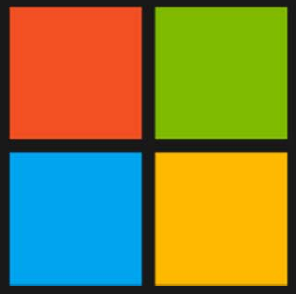
IPv6 Economic Impact Assessment (Report to the US Department of Commerce)

http://www.nist.gov/director/planning/upload/report05-2.pdf

IPv6 Ready Logo Program http://www.ipv6forum.com/dl/white/IPv6_Ready_Logo_White_Paper_Final.pdf

Microsoft 's TechNet IPv6 Site www.microsoft.com/ipv6

IPv6 Support in Microsoft Products and Services http://technet.microsoft.com/en-us/hh994905



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Be what's next