WHAT ARE THE LIMITATIONS OF IPv4,
WHAT IS IPv6

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INTERNET PROTOCOL (IP)

- Dominant general purpose networking protocol in use today.
- It runs over an astounding number of physical Media.
- Fundamental packet format that many computers Use.
- Routers are the fundamental building blocks of any IP-based network including the Internet.
- IP is a layered protocol, designed to facilitate the exchange of data between two applications on two different computers.
WHAT DOES IP OFFER?

- THE CONVERGENCE LAYER FOR DATA, VOICE AND MULTIMEDIA NETWORKING, AS WELL AS FIXED AND MOBILE APPLICATIONS
- ALLOWS FOR THIRD PARTY DEVELOPERS TO ADD VALUE TO NETWORKS
- SINGLE SYSTEM FOR RESIDENTIAL, OFFICE, CELLULAR ENVIRONMENTS
Addresses Bottleneck for growing Internet

Does not scale to the growth of the fruits and roots
Today:

Internet
400 mio

Mobile Users

Mobile Networks

Fixed Internet

Entities
2010

2 bio
1 mio
1 – 2 bio

gTLDs
today: 30 mio

Physical Addr. Cap.

IPv4 4 Byte = 10^9 Addr. real limit < 1 bio

IPv6 (16 Bytes = 10^{38} Addr. available)

DNS – bottleneck for Mobiles?
The DNS Tree

Root Zone File

TLDs

- jp
- uk
- com
- org
- edu
- icann
- keio
- med
- sfc
- co
- ac
TLD Naming Capacity will be exhausted by

Sample Calculation

Today:  ~ 200 mio host addresses (IPv4) equivalent to 40 mio TLD names used

2010:  2000 – 5000 mio host addresses (IPv6) equivalent to 400 – 500 mio TLD

Conclusion: TLD overload goes up by factor 10!
Running out of Internet addresses
—Limits Internet growth for existing users &
  Hinders use of the Internet for new users
—Internet Routing is inefficient
—Forces users to use translation (NATs)

System Management Costs
—Labour intensive, complex, slow & error prone
—Inconsistent level of DHCP support in clients
—Networks are having to Renumber
  —Caused by address space shortage/ When choosing a more competitive ISP
Optional Security
— Retrofitted and many solutions defined
  — SSL, SHTTP, IPSEC v4 etc.
  — No ONE standard
— Security features are optional
  — CANNOT count on their availability

Difficult to add support for future needs
— Adding it on is very high overhead
— Hinders the ability to connect everything over IP
Will IPv4 last forever?

- How long can we ignore these problems?
  - IPv4 address space will run out
  - There is an engineering limit to the amount of add-on and retrofitting that can be applied to IPv4
    - Ever more complex solutions
    - Each solution causes new problems to solve
      - Limits scalability

- A natural evolution from IPv4 is required
  - Designed with extensibility and scalability in mind
Where are we now?

- IPv6 is here now!
  - Core specifications achieved Draft Standard status
  - Many commercial products available

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Status</th>
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<tbody>
<tr>
<td>1991</td>
<td>Internet Draft</td>
<td>Technically complete</td>
</tr>
<tr>
<td></td>
<td>RFC Proposed Standard</td>
<td>Yes</td>
</tr>
<tr>
<td>1996</td>
<td>RFC Draft Standard</td>
<td>Yes</td>
</tr>
<tr>
<td>1998</td>
<td>RFC Internet Standard</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Timeline:

- 6bone test bed: 1996
- Today: 1998

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NETWORK ADDRESS TRANSLATOR (NAT)

- Limits Multimedia and Interactive Internet
- Extensibility of VPNs, encryption and security
- VoIP simply does not work in many cases with NATs
- NAT inhibits many forms of innovative network use
Peer-to-peer RTP audio example

With NAT:

— Need to know the address “outside the NAT”
— Provide that address to peer
— Need either NAT-aware application, or application-aware NAT
— May need a third party registration server to facilitate finding peers
Peer-to-peer RTP audio example

With IPv6:
— Just use IPv6 address
Transition, with 6to4: No dependency on “core”

Pure “Version 6” Internet

Original “Version 4” Internet

6to4 Site

6to4 Site
IPv6 part of the future

- IPv6 Solves many of the problems caused by the IPv4 success and more...
- Will the whole Internet get upgraded any time soon?
  —No way!
  —Some “green field” sites considering use of IPv6
- IPv6 offer useful features for Today's networks
IPv6 Key Features & Advantages

- Larger Address Space
- Efficient and Extensible IP datagram
- Efficient Route Computation and Aggregation
- Improved Host and Router Discovery
- New Stateless and Stateful Address Autoconfiguration
- Required Security for IP datagrams
- Easy renumbering
IPv6 ADDRESSING

It is more than about addressing.
IPv6 OPPORTUNITIES

- Autoconfiguration of Link-local connections
  - Time limited local addresses given by nearest (inhouse) proxy
- Plug and Play connectivity
  - Link-local or main address accessible
- Mobile use
  - Each station has a main address (Home address pre-fixing) and several time limited sub-addresses (Care-of-Addresses, local host pre-fixing)
  - In mobile use often two addresses active (cell related)
    - at the time to determine the handoff. Movement direction may be determined.
  - Terminal Mobility in form of Mobile IPv6 considered
**IPv6 Flow Labels** provide support for Data Flows
- Allows Packet Prioritizing
- Ensures that high priority traffic is not interrupted by less critical data

**IPv6 Multicast & Anycast**
- Multicast delivers data simultaneously to all hosts that sign up to receive it
  - Makes conferencing more efficient
- Anycast delivers data to one host in the group
  - Could be used to implement fault tolerant client/server applications more efficiently

Enables Next Generation Applications
Available TODAY in commercial products

- Microsoft will offer IPv6 in next Windows XP
- Sun offers it now in Solaris 8
- Cisco
- Telebit has it standardly now in router
- Hitachi
- Fujitsu
- 6WIND
- etc...
Conclusions

IPv6 is ready for deployment;
— all the components are now in place

Most mobile systems need IPv6
— the participants are much more committed to it now than 6 months ago
— Agreed standards are coming

Large-scale trials and experiments
— Needed and happening
Thank you for your attention!!