

ntt.net



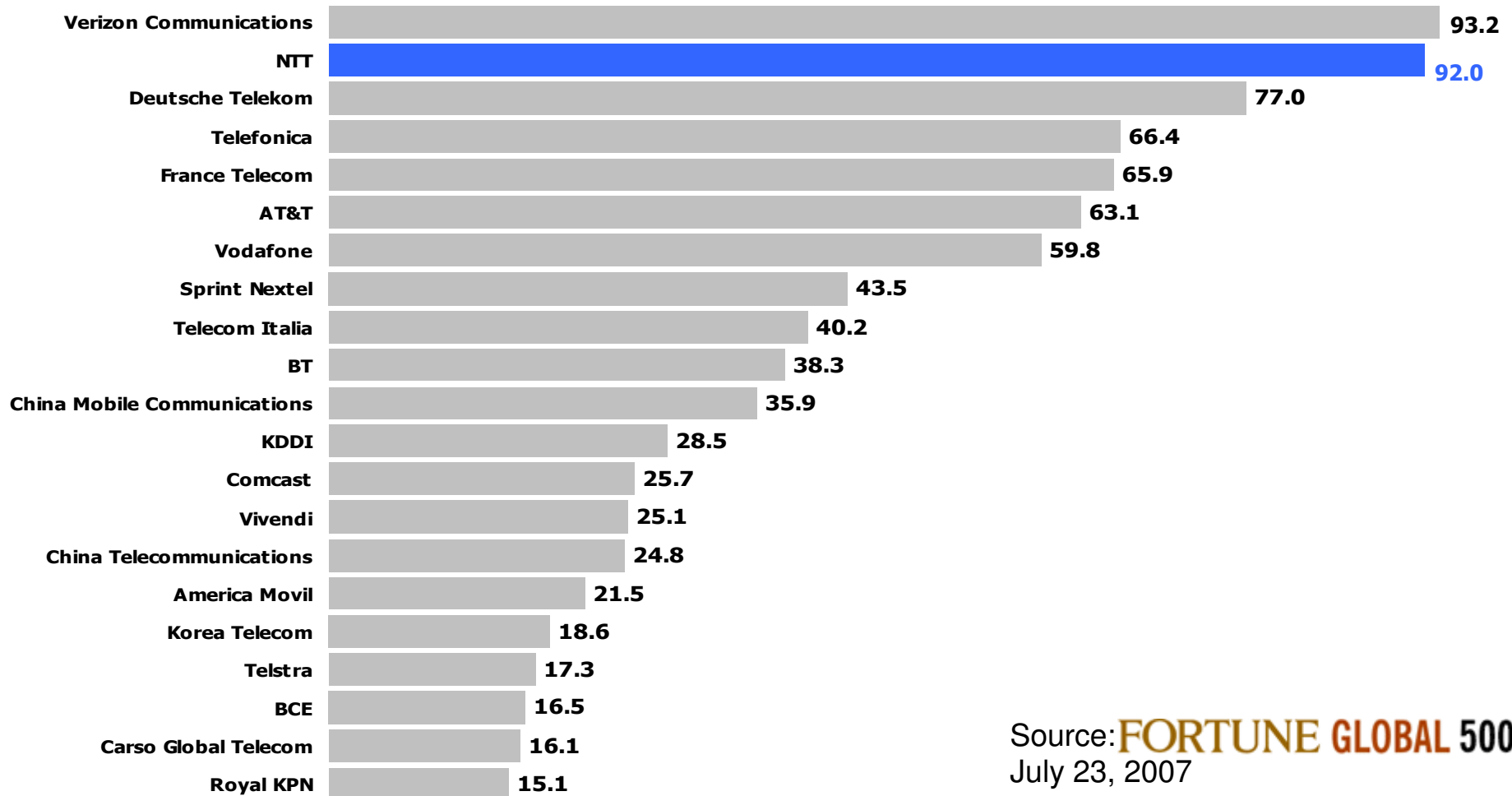
# Introduction to Mobile IPv6

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# Who is NTT?

## World's Top 21 Telecom Companies by Revenue (\$US Billion)



Source: **FORTUNE GLOBAL 500**  
July 23, 2007



# NTT's History and IPv6

## NTT Communications IPv6 Service History

**1996:** NTT Labs started one of the world's largest global IPv6 research networks

**1998:** Verio begins participation in PAIX native IPv6 IX

**1999:** NTT Com begins IPv6 tunneling trial for Japanese customers

**2000:** Verio obtains IPv6 sTLA from ARIN

**2001:** NTT Com pioneers world's first IPv6 connectivity services on a commercial basis

**2002:** World Communications Awards (WCA) awards NTT Communications with "Best Technology Foresight" for its IPv6 Global products

**2003:** NTT/VERIO launches IPv6 Native, Tunneling, and Dual Stack commercial service in North America

**2003:** Communications Solutions magazine names NTT/VERIO IPv6 Gateway Services "Product of the Year"

**2004:** NTT IPv6 Native and Dual Stack services available around the globe

**2004:** NTT Com wins the World Communications Awards "Best New Service" award for IPv6/IPv4 Global Dual Service

**2005:** Dual stack Virtual Private Server released. First ISP to offer an IPv6 managed firewall service

**10/2006 –** Launched the NTT Communications IPv6 Transition Consultancy

**2/2007 –** Awarded GSA Schedule 70 contract for IPv6 IP transit





# Why IP Mobility?

- Both ends of a TCP session (connection) need to keep the same IP address for the life of the session
  - This is the Mobile Node's (MN) *home address*, used for end-to-end communication
- The MN's IP needs to change its IP address when it moves to another link (subnet) in the network
  - This is the *care-of address (CoA)*, used for routing
- Mobile IP considers the mobility problem as a *routing* problem
  - Managing a *binding* – that is, a dynamic tunnel between a care-of address and a home agent address
  - Data link layer needs to hand-off also, separate from the IP layer

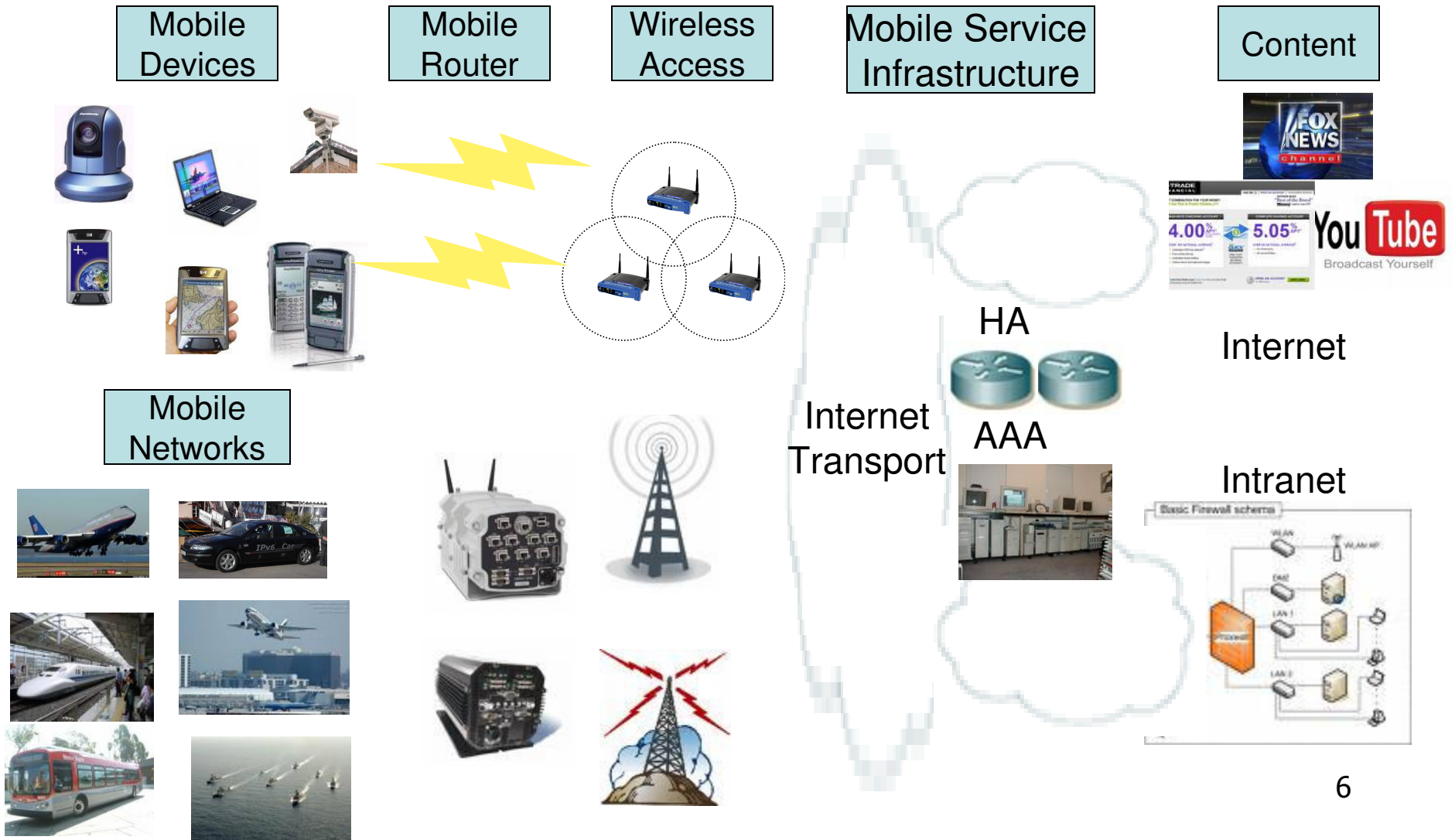


# Building Blocks for Mobility

- **Mobile Node:** A node that can change its point of attachment from one link to another, while still being reachable via its home address
- **Correspondent Node:** A peer node, either mobile or stationary, with which a mobile node is communicating
- **Home Agent:** A router on a mobile node's home link with which the mobile node has registered its current care-of address. While the mobile node is away from home, the home agent intercepts packets on the home link destined to the mobile node's home address, encapsulates them, and tunnels them to the mobile node's registered care-of address.



# Overview – IPv6 Mobility Architecture





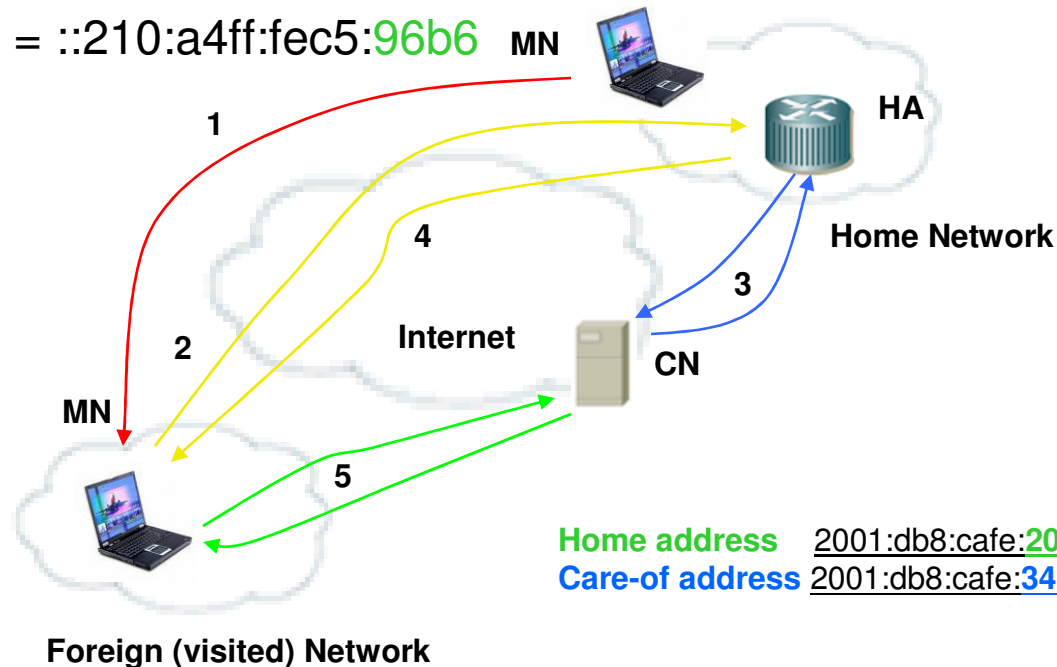
# Available Transport Options

- Layer 2 Mobility Options
  - 802.11 a/b/g Wi-Fi ( City, Muni, Campus, Enterprise)
  - WiMax (SP, Campus)
  - GMRS (MSO)
  - Ethernet (Campus, Enterprise)
  - DOCISS (SP)
  - W-CDMA, EDVO, G2.5/G3, GPRS, GSM UMTS (MSO)



# How Does it Work?

Node = ::210:a4ff:fec5:96b6 MN



1. The Mobile Node (MN) travels to a foreign network and gets a new care-of-address.
2. The MN performs a binding update to its Home Agent (HA) (the new care-of-address gets registered at HA). HA sends a binding acknowledgement to MN.
3. A Correspondent Node (CN) wants to contact the MN. The HA intercepts packets destined to the MN.
4. The HA then tunnels all packets to the MN from the CN using MN's care-of-address.
5. When the MN answers the CN, it may use its current care-of-address (and perform a binding to the CN) and communicate with the CN directly (optimized routing) or it can tunnel all its packets through the HA.





# BULE on HA

## Binding Update List Entry (BULE)

```
Wed Dec 12 14:23:28 mn_move: in foreign net
Wed Dec 12 14:23:28 mn_block_rule_add: blackhole is already set.
Wed Dec 12 14:23:28 mn_send_home_bu: 787
Wed Dec 12 14:23:28 mn_get_home_lifetime: CoA lifetime 2591999 s, HoA lifetime 4294967295 s,
    BU lifetime 262140 s
Wed Dec 12 14:23:28 mn_ro_pol_add: Adding default RO triggering policies for all Correspondent
    Nodes
Wed Dec 12 14:23:28 process_first_home_bu: New bule for HA
Wed Dec 12 14:23:28 bul_add: Adding bule
== BUL_ENTRY ==
Home address 2001:db8:cafe:2000:210:a4ff:fec5:96b6
Care-of address 2001:db8:cafe:34:210:a4ff:fec5:96b6
CN address 2001:db8:cafe:2000:216:36ff:fe7b:3bda
lifetime = 262140, delay = 1500
flags: IP6_MH_BU_HOME IP6_MH_BU_ACK IP6_MH_BU_LLOCAL
Wed Dec 12 14:23:28 mn_send_home_bu: New bule for HA
Wed Dec 12 14:23:28 mh_send: sending MH type 5
from 2001:db8:cafe:2000:210:a4ff:fec5:96b6
to 2001:db8:cafe:2000:216:36ff:fe7b:3bda
Wed Dec 12 14:23:28 mh_send: local CoA 2001:db8:cafe:34:210:a4ff:fec5:96b6
Wed Dec 12 14:23:28 bul_update_timer: Updating timer
```



# BULE on MN

```
mip6d> bul
== BUL_ENTRY ==
Home address 2001:418:3f0:2000:210:a4ff:fec5:96b6
Care-of address 2001:418:3f0:34:210:a4ff:fec5:96b6
CN address 2001:418:3f0:2000:216:36ff:fe7b:3bda
lifetime = 900, delay = 855000
flags: IP6_MH_BU_HOME IP6_MH_BU_ACK IP6_MH_BU_LLOCAL
ack ready
dev eth0 last_coa 2001:418:3f0:34:210:a4ff:fec5:96b6
lifetime 162 / 900 seq 21879 resend 0 delay 855(after 118s) expires 162
mps 15460 / 16195
mip6d> stats
Input Statistics:
  2 Mobility Headers
  0 HoTI messages
  0 CoTI messages
  0 HoT messages
  0 CoT messages
  0 BU messages
  1 BA messages
  ...
```



# NEMO – Network MObility

- NEMO - Network Mobility
  - Backwards Compatible with MIPv6
  - More than one Mobile Network Prefix can be advertised in a Mobile Network
  - Reverse routing & route optimization still immature
- Basic mobile router IPv6 (NEMO)
  - Cisco 32xx Mobile Router
- Mobile router feature set on Cisco IOS Release 12.2(4)T and above (NEMO basic support)
- A Mobile Network can be:
  - As small as Personal Area Network (PAN) devices
  - As large as a Navy carrier fleet





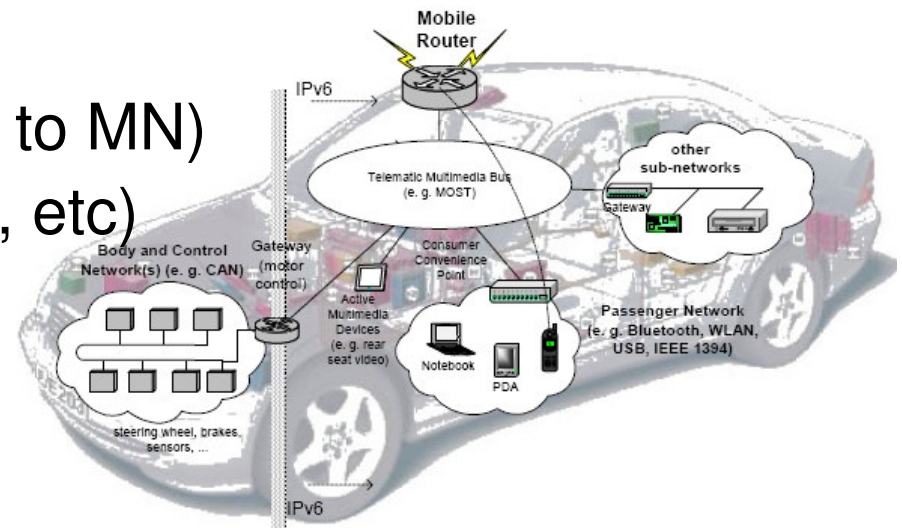
# Features and Options

- Encryption
  - HA to MN signaling - IPSec (recommended)
- Reverse routability
  - Reduces network load by ~50% (traffic model dependent)
  - Reduced latency
  - Better bandwidth utilization
  - Reduced vulnerability to network partition
  - Eliminate any potential Home Agent bottleneck
  - NEMO Extended Support (Not there yet)



# Applications

- Intelligent Transportation System (ITS)
  - Vehicular Communication of road conditions and hazards
  - Recommended diversion routes
- First Responder (i.e. CAV6TF Metronet6)
  - [www.cav6tf.org/html/metronet6.html](http://www.cav6tf.org/html/metronet6.html)
- Telematics (remote vehicle diagnostics, etc.)
- Location Based Services
- Multimedia Entertainment (DVB to MN)
- Public Safety (EAS, earthquake, etc)





# Commercial Vendor Support

- Cisco
  - MIPv6 Home Agent Technology Preview
  - RFC 3775 compliant
  - Available on 12.3(14)T, 12.4/12.4T
- Juniper
  - IPv6 Mobility currently not available in JunOS



# Unix Based Software

- BSD (KAME) [www.kame.net](http://www.kame.net)
- Linux (MIPL)
  - USAGI (Fedora 2.6.23) [www.linux-ipv6.org](http://www.linux-ipv6.org)
  - Nautilus6 (Ubuntu), [www.nautilus6.org](http://www.nautilus6.org)
  - PDAs (Familiar 0.8.4), [www.handhelds.org](http://www.handhelds.org)



# Questions?





# Backup/Reference



# Selected RFC Reference

- 4888 - Network Mobility Route Optimization Problem Statement
- 4885 - Network Mobility Support Terminology
- 4584 - Extension to Sockets API for Mobile IPv6
- 4215 - Analysis on IPv6 Transition in Third Generation Partnership Project (3GPP) Networks
- 4068 – Fast Handovers for Mobile IPv6
- 4060 - Mobile IPv6 Fast Handovers for 802.11 Networks
- 3963 - Network Mobility (NEMO) Basic Support Protocol
- 3776 - Using IPsec to Protect Mobile IPv6 Signaling Between Mobile Nodes and Home Agents
- 3775 - Mobility Support in IPv6



# IPv6 Internet Topology Map

## IPv6 INTERNET TOPOLOGY MAP AS-level INTERNET GRAPH

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