IPng Mobility Considerations

Status of this Memo

   This memo provides information for the Internet community. This memo
   does not specify an Internet standard of any kind. Distribution of
   this memo is unlimited.

Abstract

   This document was submitted to the IPng Area in response to RFC 1550.
   Publication of this document does not imply acceptance by the IPng
   Area of any ideas expressed within. Comments should be submitted to
   the big-internet@munnari.oz.au mailing list. This RFC specifies
   criteria related to mobility for consideration in design and
   selection of the Next Generation of IP.

Table of Contents

1. Introduction

   Current versions of the Internet Protocol make an implicit assumption
   that a node's point of attachment remains fixed. Datagrams are sent
   to a node based on the location information contained in the node's
   IP address.

   If a node moves while keeping its IP address unchanged, its IP
   network number will not reflect its new point of attachment. The
   routing protocols will not be able to route datagrams to it
   correctly.

   A number of considerations arise for routing these datagrams to a
   Mobile Node.

2. Addressing

   Each Mobile Node must have at least one Home-Address which identifies
   it to other nodes. This Home-Address must be globally unique.

2.1. Ownership

   The presence of ownership information in the Home-Address would be
   beneficial. A Mobile Node will be assigned a Home-Address by the
   organization that owns the machine, and will be able to use that
   Home-Address regardless of the current point of attachment.

   The ownership information must be organized in such a fashion to
   facilitate "inverse" lookup in the Domain Name Service, and other
   future services.

   Ownership information could be used by other nodes to ascertain the
   current topological location of the Mobile Node.

   Ownership information could also be used for generation of accounting
   records.

2.2. Topology

   There is no requirement that the Home-Address contain topological
   information. Indeed, by the very nature of mobility, any such
   topological information is irrelevant.

   Topological information in the Home-Address must not hinder mobility,
   whether by prevention of relocation, or by wasting bandwidth or
   processing efficiency.

2.3. Manufacturer

   There is no requirement that the Home-Address contain manufacturer
   information.

   Manufacturer information in the Home-Address must not hinder
   mobility, whether by prevention of relocation, or by wasting
   bandwidth or processing efficiency.

2.4. Numbering

   The number of mobile nodes is expected to be constrained by the
   population of users within the lifetime of the IPng protocol. The
   maximum world-wide sustainable population is estimated as 16e9,
   although during the lifetime of IPng the population is not expected
   to exceed 8e9.

   Each user is assumed to be mobile, and to have a maximum combined
   personal mobile and home network(s) on the order of 4e3 nodes.

   The expectation is that only 46 bits will be needed to densely number
   all mobile and home nodes.

   The size of addressing elements is also constrained by bandwidth
   efficiency and processing efficiency, as described later.

2.5. Configuration

   Since the typical user would be unlikely to be aware of or willing
   and able to maintain 4e3 nodes, the assignment of Home-Addresses must
   be automatically configurable. Registration of the nodes must be
   dynamic and transparent to the user, both at home and away from home.

3. Communication

   A Mobile Node must continue to be capable of communicating directly
   with other nodes which do not implement mobility functions.

No protocol enhancements are required in hosts or routers that are
not serving any of the mobility functions. Similarly, no additional
protocols are needed by a router (that is not acting as a Home Agent
or a Foreign Agent) to route datagrams to or from a Mobile Node.

A Mobile Node using its Home-Address must be able to communicate with
other nodes after having been disconnected from the Internet, and
then reconnected at a different point of attachment.

A Mobile Node using its Home-Address must be able to communicate with
other nodes while roaming between different points of attachment,
without loss of transport connections.

3.1. Topological Changes

In order that transport connections be maintained while roaming,
topological changes must not affect transport connections.

For correspondent nodes which do not implement mobility functions,
topological changes should not be communicated to the correspondent.

For correspondent nodes which implement mobility functions, the
correspondent should be capable of determining topological changes.

Topological change information must be capable of insertion and
removal by routers in the datagram path, as well as by the
correspondent and Mobile Node.

3.2. Routing Updates

Mobile Nodes are expected to be able to change their point of
attachment no more frequently than once per second.

Changes in topology which occur more frequently must be handled at
the link layer transparently to the internetwork layer. It is
further noted that engineering margins may require the link layer to
handle all changes at a frequency in the neighborhood of 10 seconds.

Changes in topology which occur less frequently must be immediately
reflected in the mobility updates. This may preclude the use of the
Domain Name Service as the repository of mobility topological
information.

It must be noted that global routing updates do not operate at this
frequency. As old topological information may be obsoleted faster
than global routing updates, access to the repository of mobility
topological information must be independent of prior topological
information.

   The mobility specific repository should use ownership information in
   the Home-Address for access to the repository.

3.3. Path Optimization

   Optimization of the path from a correspondent to a mobile node is not
   required. However, such optimization is desirable.

   For correspondent nodes which implement mobility functions, the
   correspondent should be capable of determining the optimal path.

   The optimization mechanism is also constrained by security, bandwidth
   efficiency and processing efficiency, as described later.

3.4. At Home

   Mobile Nodes do not require special "virtual" home network addresses.
   The assumption that extra addresses or multiple routers are available
   is unwarranted in small networks.

   Mobile Nodes must operate without special assistance from routers in
   order to communicate directly with other nodes on the home subnetwork
   link.

3.5. Away From Home

   When a router is present, and the correspondent does not implement
   mobility functions, the router must be capable of redirecting the
   correspondent to communicate directly with the Mobile Node.

   When no router is present, Mobile Nodes must be capable of
   communicating directly with other nodes on the same link.

   Mobility must not create an environment which is less secure than the
   current Internet.

   Changes in topology must not affect internode security mechanisms.

4. Security

4.1. Authentication

   Mobility registration messages must be authenticated between the home
   topological repository and Mobile Node.

   When the correspondent implements mobility functions, redirection or
   path optimization must be authenticated between the correspondent and
   Mobile Node.

4.2. Anonymity

   The capability to attach to a foreign administrative domain without
   the awareness of the foreign administration is not prohibited.
   However, any mobility mechanism must provide the ability to prevent
   such attachment.

4.3. Location Privacy

   The capability to attach to a foreign administrative domain without
   the awareness of correspondents is not prohibited. However, any
   mobility mechanism must provide the ability for the home
   administration to trace the current path to the point of attachment.

4.4. Content Privacy

   Security mechanisms which provide content privacy must not obscure or
   have a dependency on the topological location of Mobile Nodes.

5. Bandwidth

   Mobility must operate in the current link environment, and must not
   be dependent on bandwidth improvements. The Mobile Node's directly
   attached link is likely to be bandwidth limited.

   In particular, radio frequency spectrum is already a scarce
   commodity. Higher bandwidth links are likely to continue to be
   scarce in the mobile environment.

   Current applications of mobility using radio links include HF links
   which are subject to serious fading and noise constraints, VHF and
   UHF line of sight radio between ships or field sites, and UHF
   Satellite Communications links.

   The HF radio bandwidth is fixed at 1200 or 2400 bps by international
   treaty, statute, and custom, and is not likely to change.

   The European standard for cellular radio is 2400 bps GSM.

   The most prevalent deployed analog cellular and land-line modulation
   used by mobile nodes is 2400 bps.

   Current digital cellular deployment is 19,200 bps CDPD shared among
   many users. At early installations, under light loads, effective FTP
   throughput has been observed as low as 200 bps.

   Future digital cellular deployment is 9,600 and 14,400 bps CDMA,
   which is shared between voice and data on a per user basis.

Effective FTP throughput has been measured as low as 7,200 bps.

Future Personal Communications Services (PCS) will also have
relatively little bandwidth. In industrialized nations, the
bandwidth available to each user is constrained by the density of
deployment, and is commensurate with planned digital cellular
deployment.

It appears likely that satellite-based PCS will be widely deployed
for basic telephony communications in many newly-industrialized and
lesser-developed countries. There is already significant PCS
interest in East and SouthEast Asia, India, and South America.

Van Jacobson header prediction is widely used, and essential to
making the use of such links viable.

5.1. Administrative Messages

The number of administrative mobility messages sent or received by
the Mobile Node must be limited to as few as possible. In order to
meet the frequency requirement of changing point of attachment once
per second, registration of changes must not require more than a
single request and reply.

The size of administrative mobility messages must be kept as short as
possible. In order to meet the frequency requirement of changing
point of attachment once per second, the registration messages must
not total more than 120 bytes for a complete transaction, including
link and internet headers.

5.2. Response Time

For most mobile links in current use, the typical TCP/IPv4 datagram
overhead of 40 bytes is too large to maintain an acceptable typing
response of 200 milliseconds round trip time.

Therefore, the criteria for IPng mobility is that the response time
not be perceptably worse than IPv4.

This allows no more than 6 bytes of additional overhead per datagram
to be added by IPng.

   This was a primary concern in the design of mobility forwarding
   headers. Larger headers were rejected outright, and negotiation
   is provided for smaller headers than the default method.
   Topological headers are removed by the Foreign Agent prior to
   datagram transmission over the slower link to the Mobile Node,
   which also aids header prediction, as described below.

5.3. Header Prediction

   Header prediction can be useful in reducing bandwidth usage on
   multiple related datagrams. It requires a point-to-point peer
   relationship between nodes, so that a header history can be
   maintained between the peers.

   Header prediction is less effective in mobile environments, as the
   header history is lost each time a Mobile Node changes its point of
   attachment. The new Foreign Agent will not have the same history as
   the previous Agent.

   In order for header prediction to operate successfully, changing
   topological information must be removed from datagram overhead prior
   to transmission of the datagram on any final hop's directly attached
   link. This applies to both the Mobile Node peering with a Foreign
   Agent, and also the final link to a Correspondent. Otherwise, header
   prediction cannot be relied upon to improve bandwidth utilization on
   low-speed Mobile and Correspondent links.

   Since the changing topological information cannot be removed in the
   forwarding path of the datagram, header prediction will also be
   affected at any other pair of routers in the datagram path. Each
   time that a Mobile Node moves, the topological portion of the header
   will change, and header history used at those routers will be
   updated. Unless topological information is limited to as few headers
   as possible, this may render header prediction ineffective as more
   Mobile Nodes are deployed.

6. Processing

   Mobility must operate in the current processor environment, and must
   not be dependent on hardware improvements.

   Common hardware implementations of Mobile Nodes include lower speed
   processors, and highly integrated components. These are not readily
   upgradable.

   The most prevalent mobile platform is a low speed i86, i286 or i386.

   The most common ASIC processor is a low speed i186.

6.1. Fixed Location

   The processing limitations require that datagram header fields which
   are frequently examined by Mobile Nodes, or used for datagram
   forwarding to or from Mobile Nodes, are in a fixed location and do
   not require lengths and offsets.

Varied number of fields was explicitly rejected in the design of
mobility registration and forwarding headers.

6.2. Simple Fields

The processing limitations require that datagram header fields which
are frequently examined by Mobile Nodes, or used for datagram
forwarding to or from Mobile Nodes, are simple and fixed size.

Varied length of fields was explicitly rejected in the design of
mobility forwarding headers.

6.3. Simple Tests

Because the most prevalent processors are "little-endian", while
network protocols are in practice "big-endian", the field processing
must primarily use simple equality tests, rather than variable shifts
and prefix matches.

6.4. Type, Length, Value

Fields which are not frequently examined, whether due to infrequent
transmission or content that is not relevant in every message, must
be of the Type, Length, Value format.

Acknowledgements

This compilation is primarily based on the work in progress of the
IETF Mobile IP Working Group.

Security Considerations

Security issues are discussed in section 4.

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