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Expires: November 30, 2002 University of Helsinki
May 31, 2002

Mobility Related Terminology

<draft-manner-seamoby-terms-04.txt>

Status of this Memo

Abstract

There is a need for common definitions of terminology in the work to be done around IP mobility. This memo defines terms for mobility related terminology. It is intended as a living document for use by the Seamoby working group, and especially for use in Seamoby drafts and in WG discussions. Other working groups dealing with mobility may also take advantage of this terminology.

Changes from -03

- Added CAR Discovery terminology

- Added placeholder for security terminology

- Edited the introduction and the figure in the network nodes section

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1. Introduction

This document presents terminology to be used for documents and discussions within the Seamoby Working Group, and other mobility related working groups that would like to take advantage of this terminology, in order to create a common terminology for the area of mobility.

Some terms and their definitions that are not directly related to the IP world are included for the purpose of harmonizing the terminology, for example, 'Access Point' and 'base station' refer to the same component, from the point of view of IP, but 'Access Router' has a very different meaning. The presented terminology may also, it is hoped, be adequate to cover mobile ad-hoc networks.

The proposed terminology is not meant to assert any new terminology.

Rather the authors would welcome discussion on more exact definitions as well as missing or unnecessary terms. This work is a collaborative enterprise between people from many different engineering backgrounds and so already presents a first step in harmonizing the terminology.

The terminology in this draft is divided into several sections. First, there is a list of terms for general use, followed by some terms related to handovers, and finally some terms used within the MANET working group.

2. General Terms

Bandwidth

The total capacity of a link to carry information (typically bits).

Bandwidth Utilization

The actual amount of information delivered over a link, expressed as a percent of the available bandwidth on that link.

Beacon

A control message broadcast by a node (especially, a base station) informing all the other nodes in its neighborhood of the continuing presence of the broadcasting node, possibly along with additional status or configuration information.

Channel

A subdivision of the physical medium allowing possibly shared independent uses of the medium. Channels may be made available by subdividing the medium into distinct time slots, or distinct spectral bands, or decorrelated coding sequences.

Channel Access Protocol

A protocol for mediating access to, and possibly allocation of, the various channels available within the physical communications medium. Nodes participating in the channel access protocol can communicate only when they have uncontested access to the medium, so that there will be no interference.

Control Message

Information passed between two or more network nodes for maintaining protocol state, which may be unrelated to any specific application.

Distance Vector

A style of routing protocol in which, for each desired destination, a node maintains information about the distance to that destination, and a vector (next hop) towards that destination.

Fairness

A property of channel access protocols whereby a medium is made fairly equal to all eligible nodes on the link. Fairness does not strictly imply equality, especially in cases where nodes are given link access according to unequal priority or classification.

Flooding

The process of delivering data or control messages to every node within the network under consideration.

Forwarding node

A node which performs the function of forwarding datagrams from one of its neighbors to another.

Home Address

An IP address that is assigned for an extended period of time to a mobile node. It remains unchanged regardless of where the node is attached to the Internet [10].

Interface

A node's attachment to a link.

IP access address

An IP address (often dynamically allocated) which a node uses to designate its current point of attachment to the access network. The IP access address is typically to be distinguished from the mobile node's home address; in fact, the former may be considered unsuitable for use by any but the most short-lived applications.

Link

A communication facility or physical medium that can sustain data communications between multiple network nodes, such as an Ethernet (simple or bridged). A link is the layer immediately below IP.

Asymmetric Link

A link with transmission characteristics which are different depending upon the relative position or design characteristics of the transmitter and the receiver of data on the link. For instance, the range of one transmitter may be much higher than the range of another transmitter on the same medium.

Link Establishment

The process of establishing a link between the mobile node and the access network. This may involve allocating a channel, or other local wireless resources, possibly including a minimum level of service or bandwidth.

Link State

A style of routing protocol in which every node within the network is expected to maintain information about every link within the network topology.

Link-level Acknowledgement

A protocol strategy, typically employed over wireless media, requiring neighbors to acknowledge receipt of packets (typically unicast only) from the transmitter. Such strategies aim to avoid packet loss or delay resulting from lack of, or unwanted characteristics of, higher level protocols.

Link-layer acknowledgements are often used as part of ARQ algorithms for increasing link reliability.

Local Broadcast

The delivery of data to every node within range of the transmitter.

Loop-free

A property of routing protocols whereby the path taken by a data packet from source to destination never transits the same intermediate node twice before arrival at the destination.

Medium-Access Protocol (MAC)

A protocol for mediating access to, and possibly allocation of, the physical communications medium. Nodes participating in the medium access protocol can communicate only when they have uncontested access to the medium, so that there will be no interference. When the physical medium is a radio channel, the MAC is the same as the Channel Access Protocol.

Mobility Factor

The relative frequency of node movement, compared to the frequency of application initiation.

Mobility Security Association

A collection of security contexts, between a pair IP nodes, each of which is configured to be applied to mobility-related protocol messages exchanged between them. Mobility security associations MAY be stored separately from the node's IPsec Security Policy Database (SPD).

Neighbor

A "neighbor" is any other node to which data may be propagated directly over the communications medium without relying the assistance of any other forwarding node

Neighborhood

All the nodes which can receive data on the same link from one node whenever it transmits data.

Next Hop

A neighbor which has been selected to forward packets along the way to a particular destination.

Payload

The actual data within a packet, not including network protocol headers which were not inserted by an application.

DISCUSSION: How shall we say that payloads are different between layers: user data is the payload of TCP, which are the payload of IP, which three are the payload of link layer protocols etc.

Prefix

A bit string that consists of some number of initial bits of an address.

Route Table

The table where forwarding nodes keep information (including next hop) for various destinations.

Route Entry

An entry for a specific destination (unicast or multicast) in the route table.

Route Establishment

The process of determining a route between a source and a destination.

Route Activation

The process of putting a route into use after it has been determined.

Security Context

A security context between two routers defines the manner in which two routers choose to mutually authentication each other, and indicates an authentication algorithm and mode.

Security Parameter Index (SPI)

An index identifying a security context between a pair of routers among the contexts possible in the mobility security association.

Signal Strength

The detectable power of the signal carrying the data bits, as seen by the receiver of the signal.

Source Route

A source route from node A to node B is an ordered list of IP addresses, starting with the IP address of node A and ending with the IP address of the node B. Between A and B, the source route includes an ordered list of all the intermediate hops between A and B, as well as the interface index of the interface through which the packet should be transmitted to reach the next hop.

Spatial re-use

Simultaneous use of channels with identical or close physical characteristics, but located spatially far enough apart to avoid interference (i.e., co-channel interference)

System-wide Broadcast

Same as flooding, but used in contrast to local broadcast.

Topology

A network can be viewed abstractly as a "graph" whose "topology" at any point in time is defined by set of "points" connected by (possibly directed) "edges."

Triggered Update

An unsolicited route update transmitted by an router along a path to a destination.

3. Network Components

Figure 1 presents a reference architecture which illustrates an IP network with components defined in this section. The figure presents two examples of access network (AN) topologies.

We intend to define the concept of the Access Network (AN) which supports enhanced mobility.It is possible that to support routing and QoS for mobile nodes, existing routing protocols (i.e., OSPF or other standard IGPs) may not be appropriate to maintain forwarding information for these mobile nodes as they change their points of attachment to the Access Network. These new functions are implemented in routers with additional capability. We can distinguish three types of Access Network components: Access Routers (AR) which handle the last hop to the mobile; Access Network Gateways (ANG) which form the boundary on the fixed network side and shield the fixed network from the specialized routing protocols; and (optionally) other internal Access Network Routers which may also be needed in some cases to support the protocols. The Access Network consists of the equipment needed to support this specialized routing, i.e. AR/ANG/ANR.

Note: this reference architecture is not well suited for people dealing with MANETs. We need to refine this section in the future.

Mobile Node (MN)

An IP node capable of changing its point of attachment to the network. A Mobile Node may have routing functionality.

Mobile Host (MH)

A mobile node that is an end host and not a router.

Access Link (AL)

A last-hop link between a Mobile Node and an Access Router. That is, a facility or medium over which an Access Point and the Mobile Node can communicate at the link layer, i.e., the layer immediately below IP.

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                        ---        ------                    -------  |
           ---  | <-->  | | -------| AR | -------------------|     |  |
           | |--[]      ---        /------          \       /| ANG |--|
           ---            AP      /                  \     / |     |  |
            MN                   /                    \   /  -------  |
        (+wireless       ___    /                    -------          |
           device)       | |----                     | ANR |          |
                         ---                         -------          |
                          AP                          /   \           |
                                                     /     \ -------  |
                        ---       ------            /       \|     |  |
                        | |-------| AR |---------------------| ANG |--|
                        ---       ------                     |     |  |
                         AP                                  -------  |
                                                                      |
                             Access Network (AN) 1                    |
        - - - - - - - - - - - - - - - - - - - - - - - - - - - - -   -|
                             Access Network (AN) 2                    |
                                                                      |
                                                                      |
                        ---        ------                    -------  |
          ---   |<-->   | | -------| AR | -------------------|     |  |
          | |--[]       ---       /------                   /| ANG |--|
          ---            AP      /                         / |     |  |
           MN                   /                         /  -------  |
       (+wireless       ___    /                         /            |
          device)       | |----                         /             |
                        ---                            /              |
                         AP                           /               |
                                                     /                |
                        ---       ------         -------              |
                        | |-------| AR |---------| ANR |              |
                        ---  \    ------         -------              |
                          AP  \                  /                    |
                               \                /                     |
                        ---     \ ------       /                      |
                        | |-------| AR |-------                       |
                        ---       ------                              |
                         AP                                           |
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Figure 1: Reference Network Architecture

Access Point (AP)

An Access Point is a layer 2 device which is connected to one or more Access Routers and offers the wireless link connection to the Mobile Node. Access Points are sometimes called base stations or access point transceivers. An Access Point may be a separate entity or co-located with an Access Router.

Radio Cell

The geographical area within which an Access Point provides radio coverage, i.e. where radio communication between a Mobile Node and the specific Access Point is possible.

Access Network Router (ANR)

An IP router in the Access Network. An Access Network Router may include Access Network specific functionalities, for example, related to mobility and/or QoS. This is to distinguish between ordinary routers and routers that have Access Network-related special functionality.

Access Router (AR)

An Access Network Router residing on the edge of an Access Network and connected to one or more Access Points. The Access Points may be of different technology. An Access Router offers IP connectivity to Mobile Nodes, acting as a default router to the Mobile Nodes it is currently serving. The Access Router may include intelligence beyond a simple forwarding service offered by ordinary IP routers.

Access Network Gateway (ANG)

An Access Network Router that separates an Access Network from other IP networks, much in the same way as an ordinary gateway router. An Access Router and an Access Network Gateway may be the same physical node. The Access Network Gateway looks to the other IP networks like a standard IP router.

Access Network (AN)

An IP network which includes one or more Access Network Routers.

Administrative Domain (AD)

A collection of networks under the same administrative control and grouped together for administrative purposes. [5]

Serving Access Router (SAR)

The Access Router currently offering the connectivity to the Mobile Host. This is usually the point of departure for the Mobile Node as it makes its way towards a new Access Router (then Serving Access Router takes the role of the Old Access Router). There may be several Serving Access Routers serving the Mobile Node at the same time.

Old Access Router (OAR)

An Access Router that offered connectivity to the Mobile Node prior to a handover. This is the Serving Access Router that will cease or has ceased to offer connectivity to the Mobile Node.

New Access Router (NAR)

The Access Router that offers connectivity to the Mobile Node after a handover.

Previous Access Router (PAR)

An Access Router that offered connectivity to the Mobile Node prior to a handover. This is the Serving Access Router that will cease or has ceased to offer connectivity to the Mobile Node. Same as OAR.

Candidate Access Router (CAR)

An Access Router to which the Mobile Node may do a handoff.

4. Handover Terminology

These terms refer to different perspectives and approaches to supporting different aspects of mobility. Distinctions can be made according to the scope, range overlap, performance characteristics, diversity characteristics, state transitions, mobility types, and control modes of handover techniques.

Roaming

An operator-based term involving formal agreements between operators that allows a mobile to get connectivity from a foreign network. Roaming (a particular aspect of user mobility) includes, for example, the functionality by which users can communicate their identity to the local AN so that inter-AN agreements can be activated and service and applications in the MN's home network can be made available to the user locally.

Handover

(also known as handoff) the process by which an active MN (in the Active State, see section 4.6) changes its point of attachment to the network, or when such a change is attempted. The access network may provide features to minimize the interruption to sessions in progress.

There are different types of handover classified according to different aspects involved in the handover. Some of this terminology follows the description of [4].

4.1. Scope of Handover

Note: the definitions of horizontal and vertical handover are different than the ones commonly used today. These definitions try to look at the handover from the IP layer's point of view; the IP layer works with network interfaces, rather than specific technologies used by those interfaces.

Layer 2 Handover

When a MN changes APs (or some other aspect of the radio channel) connected to the same AR's interface then a layer 2 handover occurs. This type of handover is transparent to the routing at the IP layer (or it appears simply as a link layer reconfiguration without any mobility implications).

Intra-AR Handover

A handover which changes the AR's network interface to the mobile. That is, the Serving AR remains the same but routing changes internal to the AR take place.

Intra-AN Handover

When the MN changes ARs inside the same AN then this handover occurs. Such a handover is not necessarily visible outside the AN. In case the ANG serving the MN changes, this handover is seen outside the AN due to a change in the routing paths. Note that the ANG may change for only some of the MN's data flows.

Inter-AN Handover

When the MN moves to a new AN then this handover occurs. This requires some sort of host mobility across ANs, which typically is be provided by the external IP core. Note that this would have to involve the assignment of a new IP access address (e.g., a new care-of address [9]) to the MN.

Intra-technology Handover

A handover between equipment of the same technology.

Inter-technology Handover

A handover between equipment of different technologies.

Horizontal Handover

A handover in which the mobile node's network interface does not change (from the IP point of view); the MN communicates with the access network via the same network interface before and after the handover. A horizontal handover is typically also an intra-technology handover but it can be an inter-technology handover if the MN can do a layer 2 handover between two different technologies without changing the network interface seen by the IP layer.

Vertical Handover

In a vertical handover the mobile node's network interface to the Access Network changes. A vertical handover is typically an inter-technology handover but it may also be an intra- technology handover if the MN has several network interfaces of the same type. That is, after the handover, the IP layer communicates with the Access Network through a different network interface.

The different handover types defined in this section and in section 4.1 have no direct relationship. In particular, a MN can do an intra-AN handover of any of the types defined above.

Note that the horizontal and vertical handovers are not tied to a change in the link layer technology. They define whether, after a handover, the IP packet flow goes through the same (horizontal handover) or a different (vertical handover) network interface. These two handovers do not define whether the AR changes as a result of a handover.

4.2. Handover Control

A handover must be one of the following two types (a):

Mobile-initiated Handover

the MN is the one that makes the initial decision to initiate the handover.

Network-initiated Handover

the network makes the initial decision to initiate the handover.

A handover is also one of the following two types (b):

Mobile-controlled Handover (MCHO)

the MN has the primary control over the handover process.

Network-controlled Handover (NCHO)

the network has the primary control over the handover process.

A handover may also be either of these three types (c):

Mobile-assisted handover

information and measurement from the MN are used by the AR to decide on the execution of a handover.

Network-assisted handover

a handover where the AN collects information that can be used by the MN in a handover decision.

Unassisted handover

a handover where no assistance is provided by the MN or the AR to each other.

A handover is also one of the following two types (d):

Backward handover

a handover either initiated by the OAR, or where the MN initiates a handover via the OAR.

Forward handover

a handover either initiated by the NAR, or where the MN initiates a handover via the NAR.

The handover is also either proactive or reactive (e):

Planned handover

a proactive (expected) handover where some signalling can be done in advance of the MN getting connected to the new AR, e.g. building a temporary tunnel from the old AR to the new AR.

Unplanned handover

a reactive (unexpected) handover, where no signalling is done in advance of the MN's move of the OAR to the new AR.

The five handover types (a-e) are mostly independent, and every handover should be classiable according to each of these types.

4.3. Simultaneous connectivity to Access Routers

Make-before-break (MBB)

During a MBB handover the MN can communicate simultaneously with the old and new AR. This should not be confused with "soft handover" which relies on macro diversity.

Break-before-make (BBM)

During a BBM handover the MN cannot communicate simultaneously with the old and the new AR.

4.4. Performance and Functional Aspects

Handover Latency

Handover latency is the time difference between when a MN is last able to send and/or receive an IP packet by way of the OAR, until when the MN is able to send and/or receive an IP packet through the NAR. Adapted from [4].

Smooth handover

A handover that aims primarily to minimize packet loss, with no explicit concern for additional delays in packet forwarding.

Fast handover

A handover that aims primarily to minimize delay, with no explicit interest in packet loss.

Seamless handover

A handover in which there is no change in service capability, security, or quality. In practice, some degradation in service is to be expected. The definition of a seamless handover in the practical case should be that other protocols, applications, or end users do not detect any change in service capability, security or quality, which would have a bearing on their (normal) operation. See [7] for more discussion on the topic.

Throughput

The amount of data from a source to a destination processed by the protocol for which throughput is to be measured for instance, IP, TCP, or the MAC protocol. The throughput differs between protocol layers.

Goodput

The total bandwidth used, less the volume of control messages and protocol overhead from the data packets.

Pathloss

A reduction in signal strength caused by traversing the physical medium constituting the link.

Hidden-terminal problem

The problem whereby a transmitting node can fail in its attempt to transmit data because of destructive interference which is only detectable at the receiving node, not the transmitting node.

Exposed terminal problem

The problem whereby a transmitting node prevents another node from transmitting although it could have safely transmitted to anyone else but that node.

4.5. Micro Diversity, Macro Diversity, and IP Diversity

Certain air interfaces (e.g. UTRAN FDD mode) require or at least support macro diversity combining. Essentially, this refers to the fact that a single MN is able to send and receive over two independent radio channels ('diversity branches') at the same time; the information received over different branches is compared and that from the better branch passed to the upper layers. This can be used both to improve overall performance, and to provide a seamless type of handover at layer 2, since a new branch can be added before the old is deleted. See also [6].

It is necessary to differentiate between combining/diversity that occurs at the physical and radio link layers, where the relevant unit of data is the radio frame, and that which occurs at layer 3, the network layer, where what is considered is the IP packet itself.

In the following definitions micro- and macro diversity refer to protocol layers below the network layer, and IP diversity refers to the network layer.

Micro diversity

for example, two antennas on the same transmitter send the same signal to a receiver over a slightly different path to overcome fading.

Macro diversity

Duplicating or combining actions taking place over multiple APs, possibly attached to different ARs. This may require support from the network layer to move the radio frames between the base stations and a central combining point.

IP diversity

the splitting and combining of packets at the IP level.

4.6. Paging, and Mobile Node States and Modes

Mobile systems may employ the use of MN states in order to operate more efficiently without degrading the performance of the system. The term

A MN is always in one of the following three states:

Active State

when the AN knows the MN's SAR and the MN can send and receive IP packets. The AL may not be active, but the radio layer is able to establish one without assistance from the network layer. The MN has an IP address assigned.

Dormant State

A state in which the mobile restricts its ability to receive normal IP traffic by reducing its monitoring of radio channels.

The AN knows the MH's Paging Area, but the MH has no SAR and so packets cannot be delivered to the MH without the AN initiating paging.

Time-slotted Dormant Mode

A dormant mode implementation in which the mobile alternates between periods of not listening for any radio traffic and listening for traffic. Time-slotted dormant mode implementations are typically synchronized with the network so the network can deliver traffic to the mobile during listening periods.

Inactive State

the MH is in neither the Active nor Dormant State. The host is no longer listening for any packets, not even periodically, and not sending packets. The host may be in a powered off state, it may have shut down all interfaces to drastically conserve power, or it may be out of range of a radio access point. The MN does not necessarily have an IP access address from the AN.

Note: in fact, as well as the MN being in one of these three states, the AN also stores which state it believes the MN is in. Normally these are consistent; the definitions above assume so.

Here are some additional definitions for paging, taking into account the above state definitions.

Paging

a procedure initiated by the Access Network to move an Idle MN into the Active State. As a result of paging, the MN establishes a SAR and the IP routes are set up.

Location updating

a procedure initiated by the MN, by which it informs the AN that it has moved into a new paging area.

Paging Area

A part of the Access Network, typically containing a number of ARs/APs, which corresponds to some geographical area. The AN keeps and updates a list of all the Idle MNs present in the area. If the MN is within the radio coverage of the area it will be able to receive paging messages sent within that Paging Area.

Paging Area Registrations

Signaling from a dormant mode mobile node to the network, by which it establishes its presence in a new paging area. Paging Area Registrations thus enable the network to maintain a rough idea of where the mobile is located.

Paging Channel

A radio channel dedicated to signaling dormant mode mobiles for paging purposes. By current practice, the protocol used on a paging channel is usually dictated by the radio link protocol, although some paging protocols have provision for carrying arbitrary traffic (and thus could potentially be used to carry IP).

Traffic Channel

The radio channel on which IP traffic to an active mobile is typically sent. This channel is used by a mobile that is actively sending and receiving IP traffic, and is not continuously active in a dormant mode mobile. For some radio link protocols, this may be the only channel available.

4.7. Context Transfer

Context

The information on the current state of a routing-related service required to re-establish the routing-related service on a new subnet without having to perform the entire protocol exchange with the mobile host from scratch.

Feature context

The collection of information representing the context for a given feature. The full context associated with a mobile host is the collection of one or more feature contexts.

Context transfer

The movement of context from one router or other network entity to another as a means of re-establishing routing related services on a new subnet or collection of subnets.

Routing-related service

A modification to the default routing treatment of packets to and from the mobile host. Initially establishing routing-related services usually requires a protocol exchange with the mobile host. An example of a routing-related service is header compression. The service may also be indirectly related to routing, for example, security. Security may not affect the forwarding decision of all intermediate routers, but a packet may be dropped if it fails a security check (can't be encrypted, authentication failed, etc.). Dropping the packet is basically a routing decision.

4.8. Candidate Access Router Discovery

Geographically Adjacent AR (GAAR)

An AR whose coverage area is such that an MN may move from the coverage area of the AR currently serving the MN into the coverage area of this AR. In other words, GAARs have APs whose coverage areas are geographically adjacent or overlap.

Capability of AR

A characteristic of the service offered by an AR that may be of interest to an MN when the AR is being considered as a handoff candidate.

Candidate AR (CAR)

This is an AR that is a candidate for MN's handoff. CAR is necessarily a GAAR of the AR currently serving the MN, and also has the capability set required to serve the MN.

Target AR (TAR)

This is an AR with which the procedures for the MN's IP-level handoff are initiated. TAR is usually selected from the set of CARs.

TAR Selection Algorithm

The algorithm that determines a unique TAR for MN's handoff from the set of CARs. The exact nature and definition of this algorithm is outside the scope of this document.

4.9. User, Personal and Host Mobility

Different sorts of mobility management may be required of a mobile system. We can differentiate between user, personal and host mobility.

User mobility

refers to the ability of a user to access services from different physical hosts. This usually means, the user has an account on these different hosts or that a host does not restrict users from using the host to access services.

Personal mobility

complements user mobility with the ability to track the user's location and provide the user's current location to allow sessions to be initiated by and towards the user by anyone on any other network. Personal mobility is also concerned with enabling associated security, billing and service subscription authorization made between administrative domains.

Host mobility

refers to the function of allowing a mobile host to change its point of attachment to the network, without interrupting IP packet delivery to/from that host. There may be different sub-functions depending on what the current level of service is being provided; in particular, support for host mobility usually implies active and idle modes of operation, depending on whether the host has any current sessions or not. Access Network procedures are required to keep track of the current point of attachment of all the MNs or establish it at will. Accurate location and routing procedures are required in order to maintain the integrity of the communication. Host mobility is often called 'terminal mobility'.

Two subcategories of "Host mobility" can be identified:

Global mobility

Same as Macro mobility.

Local mobility

Same as Micro mobility.

Macro mobility

Mobility over a large area. This includes mobility support and associated address registration procedures that are needed when a mobile host moves between IP domains. Inter-AN handovers typically involve macro-mobility protocols. Mobile-IP can be seen as a means to provide macro mobility.

Micro mobility

Mobility over a small area. Usually this means mobility within an IP domain with an emphasis on support for active mode using handover, although it may include idle mode procedures also. Micro-mobility protocols exploit the locality of movement by confining movement related changes and signalling to the access network.

5. Specific Terminology for Mobile Ad-Hoc Networking

Cluster

A group of nodes located within close physical proximity, typically all within range of one another, which can be grouped together for the purpose of limiting the production and propogation of routing information.

Cluster head

A cluster head is a node (often elected in the cluster formation process) that has complete knowledge about group membership and link state information in the cluster. Each cluster should have one and only one cluster head.

Cluster member

All nodes within a cluster EXCEPT the cluster head are called members of that cluster.

Convergence

The process of approaching a state of equilibrium in which all nodes in the network agree on a consistent collection of state about the topology of the network, and in which no further control messages are needed to establish the consistency of the network topology.

Convergence time

The time which is required for a network to reach convergence after an event (typically, the movement of a mobile node) which changes the network topology.

Laydown

The relative physical location of the nodes within the ad hoc network.

Pathloss matrix

A matrix of coefficients describing the pathloss between any two nodes in an ad hoc network. When the links are asymmetric, the matrix is also asymmetric.

Scenario

The tuple <laydown, pathloss matrix, mobility factor, traffic> characterizing a class of ad hoc networks.

6. Security-related Terminology

<This section will include terminology commonly used around mobile and wireless networking. Only a subset of the entire security terminology is actually needed.>

7. Security Considerations

There are no security issues in this document.

8. Contributors

This draft was initially based on the work of

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- o Nikos Georganopoulos, King's College London
- o Markku Kojo and Jukka Manner, University of Helsinki, Finland.

Since revision -02, Charles Perkins has given as input terminology related to ad-hoc networks.

9. Acknowledgement

This work has been partially performed in the framework of the IST project IST-2000-28584 MIND, which is partly funded by the European Union. The authors would like to acknowledge the help of their colleagues in preparing this document.

Some definitions of terminology have been adapted from [1], [7], [3], [2], [4], [9], [10] and [11].

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12. Appendix A - Examples

This appendix provides examples for the terminology presented.

A.1. Mobility

Host mobility is logically independent of user mobility, although in real networks, at least the address management functions are often required to initially attach the host to the network. In addition, if the network wishes to determine whether access is authorized (and if so, who to charge for it), then this may be tied to the identity of the user of the terminal.

An example of user mobility would be a campus network, where a student can log into the campus network from several workstations and still retrieve files, emails, and other services automatically.

Personal mobility support typically amounts to the maintenance and update of some sort of address mapping database, such as a SIP server or DNS server; it is also possible for the personal mobility support function to take a part in forwarding control messages between end user and correspondent rather than simply acting as a database. SIP is a protocol for session initiation in IP networks. It includes registration procedures which partially support personal mobility (namely, the ability for the network to route a session towards a user at a local IP address).

Personal mobility has been defined in [8] as "the ability of end users to originate and receive calls and access subscribed telecommunication services on any terminal in any location, and the ability of the network to identify end users as they move. Personal mobility is based on the use of a unique personal identity (i.e., personal number)."

Roaming, in its original (GSM) sense, is the ability of a user to connect to the networks owned by operators other than the one having a direct formal relationship with the user. More recently (e.g., in data networks and UMTS) it also refers providing user-customized services in foreign networks (e.g., QoS profiles for specific applications).

HAWAII, Cellular IP, Regional Registration and EMA are examples of micro mobility schemes, with the assumption that Mobile IP is used for macro mobility.

WLAN technologies such as IEEE 802.11 typically support aspects of user and host mobility in a minimal way. User mobility procedures (for access control and so on) are defined only over the air interface (and the way these are handled within the network is not further defined).

PLMNs (GSM/UMTS) typically have extensive support for both user and host mobility. Complete sets of protocols (both over the air and on the network side) are provided for user mobility, including customized service provision. Handover for host mobility is also supported, both within access networks, and also within the GSM/UMTS core network for mobility between access networks of the same operator.

A.2. Handovers

A hard handover is required where a MN is not able to receive or send traffic from/to two APs simultaneously. In order to move the traffic channel from the old to the new access point the MN abruptly changes the frequency/timeslot/code on which it is transmitting and listening to new values associated with a new access point. Thus, the handover is a break-before-make handover.

A good example of hard handover is GSM where the mobile listens for new base stations, reports back to the network the signal strength and identity of the new base station(s) heard. When the old base station decides that a handover is required it instructs the new base station to set up resources and, when confirmed, instructs the mobile to switch to a new frequency and time slot. This sort of hand over is called hard, mobile assisted, network initiated and backward (meaning that the old base station is responsible for handling the change-over).

In a TDMA system, such as GSM, the hard hand over is delayed until the mobile has moved well within the coverage of the new base station. If the handover threshold was set to the point where the new base station signal exceeded the old then there would be a very large number of handovers as the mobile moved through the region between the cells and radio signals fluctuated, this would create a large signalling traffic. To avoid this a large hysteresis is set, i.e. the new base station must be (say) 10dB stronger for handover to occur. If the same was done in W-CDMA then the mobile would be transmitting a powerful signal to the old base station and creating interference for other users, since in CDMA everyone else's transmissions are seen as noise, thus reducing capacity. To avoid this soft handover is used, giving an estimated doubling in capacity. Support for soft handover (in a single mode terminal) is characteristic of radio interfaces which also require macro diversity for interference limitation but the two concepts are logically independent.

A good example of soft handover is the UTRAN FDD mode. W-CDMA is particularly suited to soft handover because of the design of the receivers and transmitters: typically a rake receiver will be used to overcome the multi-path fading of the wide-band channel. Rake receivers have a number of so-called fingers, each effectively separate detectors, that are tuned to the same signal (e.g.

spreading code) but delayed by different times. When the delay times are correctly adjusted and the various components properly combined (this is micro diversity combining) the effect of multi-path fading is removed. The rake receiver can also be used to detect signals from different transmitters by tuning the fingers to different spreading codes. Soft handover is used in UTRAN FDD mode to also increase capacity.

Every handover can be seen as a context-aware Handover. In PLMNs the context to be fulfilled is that the new AP can accommodate the new mobile, for example, the new GSM cell can serve the incoming phone. Lately, the notion of Context-aware Handovers has been enlarged by, for example, QoS-aware handovers, meaning that the handover is governed by the need to support the QoS-context of the moving mobile in order to keep the service level assured to the user of the MN.

A.3. Diversity combining

In the case of UMTS it is radio frames that are duplicated at some point in the network (the serving RNC) and sent to a number of basestations and, possibly via other (drift) RNCs. The combining that takes place at the serving RNC in the uplink direction is typically based on some simple quality comparison of the various received frames, which implies that the various copies of these frames must contain identical upper layer information. The serving RNC also has to do buffering data frames to take account of the differing time of flight from each basestation to the RNC.

A.4. Miscellaneous

In a GPRS/UMTS system the Access Network Gateway node could be the GGSN component. The ANG can provide support for mobility of hosts, admission control, policy enforcement, and Foreign Agent functionality [9].

When presenting a mobile network topology, APs and ARs are usually pictured as separate components (see Figure 1. This is the case with GSM/GPRS/UMTS presentations, for example. From the IP point of view APs are not directly visible. An AP should only be seen from the MN's or AR's IP layer as a link (interface) connecting MNs to the AR.

When the mobile moves through the network, depending on the mobility mechanism, the OAR will forward packets destined to the old MNs address to the SAR which currently serves the MN. At the same time the handover mechanism may be studying CARs to find the best NAR where the MN will be handed next.

13. Appendix B - Index of Terms

<TBA when terminology finalized>