Reducing Inconsistent Context Problem on Providing Internet Connectivity for Mobile Ad Hoc Networks

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Review IP Mobility Management [MIPv4] (1/4)

Internet

Domain_3

Router/FA

Correspondent Node

(CN)


Foreign Agent Care-of Address

Mobile Node

Foreign Agent

Link-layer Connectivity

Agent Discovery

Registration

MN

Router/HA

DHCP Server

(1): MN moves to a new domain

(2): MN gets & registers its new CoA with its HA

(3): MN registers its CoA with CN

(4): MN & CN communicates directly each other

(5): MN’s HA tunnels data to MN’s FA

(6): MN’s FA delivers data to MN

Co-Located Care-of Address

C. Perkins, "IP Mobility Support for IPv4," Internet Draft draft-ietf-mip4-rfc3344bis-03.txt, Mar. 2007


Review IP Mobility Management [MIPv6] (2/4)

Internet

Domain_3

Router/FA

Correspondent Node

(CN)


Review IP Mobility Management [FMIPv6] (3/4)

Internet (IPv6)

Domain_1

RouterHA

F-Back

F-BAck

F-NA

F-NA

Packet Re-Routing

Mobile Node (MN)

Previous Access Router (pAR)

New Access Router (nAR)

Domain_2

Domain_3

Mobility

Binding Update (BU)/ Binding Acknowledgement (BA)

F-BU

F-BAck

F-NA


Review IP Mobility Management over WLAN (4/4)

IP Mobility Management over WLAN

Proactive or Pre-Registration or Make-Before-Break

Reducing Re-authentication/Re-Association phase

Using Frequency Handoff Region

Using Proactive Neighbor Caching

Using Selective Neighbor Caching

Detection discovery phase

Selecting observed scanning

Interleaving data probe intervals

Refining Min-Max Channel Time

Combination

S02.11 Packet Sequence

New AP

Old AP

Probe Delay

A. Probe Request (Broadcast)

B. Probe Response

C. Probe Request (Broadcast)

D. Probe Response

802.11 Packet Sequence

Authentication

E. Authentication

F. Authentication

Re-Association

G. Re-Association Request

Send Security Block

Ask Security Block

More Notify

More Response

H. Re-Association Response

LAPP Packet Sequence
Needing functions on Internet connectivity for MANETs (1/5)

- MANET node location determination
- Internet gateway discovery
- The metrics for Internet gateway selection
- Establishing and maintaining Internet gateway forwarding strategies
- Addressing configuration scheme for MANET node
- Handoff style

Needing functions on Internet connectivity for MANETs (2/5)

- MANET node location determination
  - Using network prefix
    - MANET node must be assigned a global unicast IP address
    - MANET node address is topologically correct
  - Using routing table
    - for only MANETs using proactive ad-hoc routing protocols
  - Using flooding route request (RREQ) & route reply (RREP)
    - for only MANETs using reactive ad-hoc routing protocols
  - Using Internet gateway
    - In response to a RREQ, sending a proxy RREP to signal it can route to a requested destination
      - Keeping a list of currently known active nodes (visitor list)
      - Pinging destination on the IGW network interface attaching to the Internet
      - Flooding the MANET with a new RREQ
Needing functions on Internet connectivity for MANETs (3/5)

- Internet gateway discovery
  - Proactive [IGW broadcasting agent/router advertisement]
  - Reactive [MANET node sending agent/router solicitation]
  - Hybrid (fixed or adaptive broadcast radius)

- The metrics for Internet gateway selection
  - Shortest hop-count to the nearest IGW
  - Load-balancing for intra-MANET traffic
    - Via different immediate MANET nodes
  - Load-balancing for inter-MANET traffic
    - Via different Internet gateways
  - Service class: depend on the service classes provided and supported by each IGW
  - Euclidean distance: distance (space or hop-count) between the MANET node and the IGW
  - Hybrid: a combination of some of above metrics

Needing functions on Internet connectivity for MANETs (4/5)

- Establishing and maintaining Internet gateway forwarding strategies
  - For inter-MANET/Internet traffic/routing/forwarding
    - Using default routes
    - Using tunnelling (encapsulation)
    - Using half-tunnelling
    - Using source routing
    - Spanning tree rooted at the IGW
  - For intra-MANET traffic/routing/forwarding
    - Proactive (or table-driven)
    - Reactive (or on-demand)
    - Hybrid/Hierarchical (clustering)
Needing functions on Internet connectivity for MANETs (5/5)

• Addressing configuration scheme for MANET node
  – Topological correctly
    • Require each MANET domain (subnet) assigned a global unicast IP subnet
  – Topological incorrectly
    • Either a mobile-specific routing protocol must be used in the MANET domain,
    • Or an address mapping scheme, e.g. network address translation (NAT), is used
  – Architecture
    • Centralized (e.g., stateful auto-configuration like DHCP)
    • Distributed (e.g., stateless IPv6 auto-configuration with DAD)
    • Integrating with ad-hoc routing protocol or separately

• Handoff style
  – Forced handoff
  – Route optimization handoff
Discovered Problems on Internet Gateway Forwarding in MANET (1/2)

- Inconsistent Context
  - Default Routing (Type I)
  - Default Routing (Type II)
  - Default Routing (Type III)
  - MIPv4-FA Triangle Routing
  - MIPv4-FA Ingress Filtering

- Cascading Effect in MANET Node Location Determination

- MIPv4-FA Traversing NAT

Discovered Problems on Internet Gateway Forwarding in MANET (2/2)

- Default Routing Problems (Type III)
  - **Scenario I**: A MANET node updates a shorter route to another IGW without re-registering the new IGW with its home agent (HA), and/or the foreign agent (FA) as well as the network address translation (NAT) device located in the visiting MANET domain.
  - **Scenario II**: A MANET node associated with an IGW (e.g., IGW_1) forwards agent/router advertisement packet for another IGW (e.g., IGW_2). As a result, its downstream nodes can associate to the IGW_2 using it as the next-hop. However, the traffic is actually forwarded through IGW_1.
  - **Scenario III**: A MANET node loses its association to the current IGW (e.g., a detection of link broken) and re-associates to another IGW. As a result, traffic to Internet from its downstream nodes choosing it as the next-hop to the current IGW will be forwarded via another IGW instead.
Solutions to Inconsistent Context Problem on Internet Gateway Forwarding in MANET (1/4)

Solution for SCENARIO I using Default Routes:

- A MANET node is not allowed to update its shorter route to another IGW, unless its current transmissions on any 2-way connections to the Internet hosts are finished, and it has already re-registered this new IGW with its home agent. This re-registration can be prepared in advance, e.g. during the data transmissions on the current connections via the old IGW.

Solutions to Inconsistent Context Problem on Internet Gateway Forwarding in MANET (2/4)

Solution for SCENARIO II using Default Routes:

- On proactive IGW discovery, a MANET node that does not register to any IGW is allowed to re-broadcast the received agent/router advertisement if it decides to register with this IGW. Otherwise, the re-broadcasting of agent/router advertisement is prohibited.

- On re-active IGW discovery, a MANET node is allowed to generate/forward an agent/router advertisement in one of the following three cases:
  - It does not register to any IGW, registering it to the IGW of which the agent/router advertisement it receives, then forwarding the agent/router advertisement to the source MANET node.
  - It has already registered to an IGW, receiving the agent/router advertisement generating by the same IGW, then forwarding this agent/router advertisement to the source MANET node.
  - It has already registered to an IGW, receiving the agent/router solicitation from the source MANET node, generating itself an agent/router advertisement to the source MANET node.

- On hybrid IGW discovery, the above rules are applied whenever an agent/router advertisement or an agent/router solicitation is received.
Solutions to Inconsistent Context Problem on Internet Gateway Forwarding in MANET (3/4)

Solution for Scenario III using Default Routes:
- There should be a mechanism for the MANET node detected the broken link, sending this information to its downstream MANET nodes so that these MANET nodes can re-register their new IGWs with their home agents. This mechanism is usually MANET routing protocol dependent.

Solution for Scenarios I, II, III, removing Inconsistent Context Using Tunneling

• Inconsistent Context [IP-in-IP Tunneling]
  - Default Routing (Type I)
  - Default Routing (Type II)
  - Default Routing (Type III)
  - MIPv4-FA Triangle Routing
  - MIPv4-FA Ingress Filtering

• Cascading Effect in MANET Node Location Determination [Inserting IGW host route]
  - MIPv4-FA Traversing NAT [IP-in MIP UDP-in IP Tunneling]
Contacting Address & References

- **Contacting Address**
  
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