Fast IP Handover between Satellite Networks and Wireless LAN Networks for high-speed Trains

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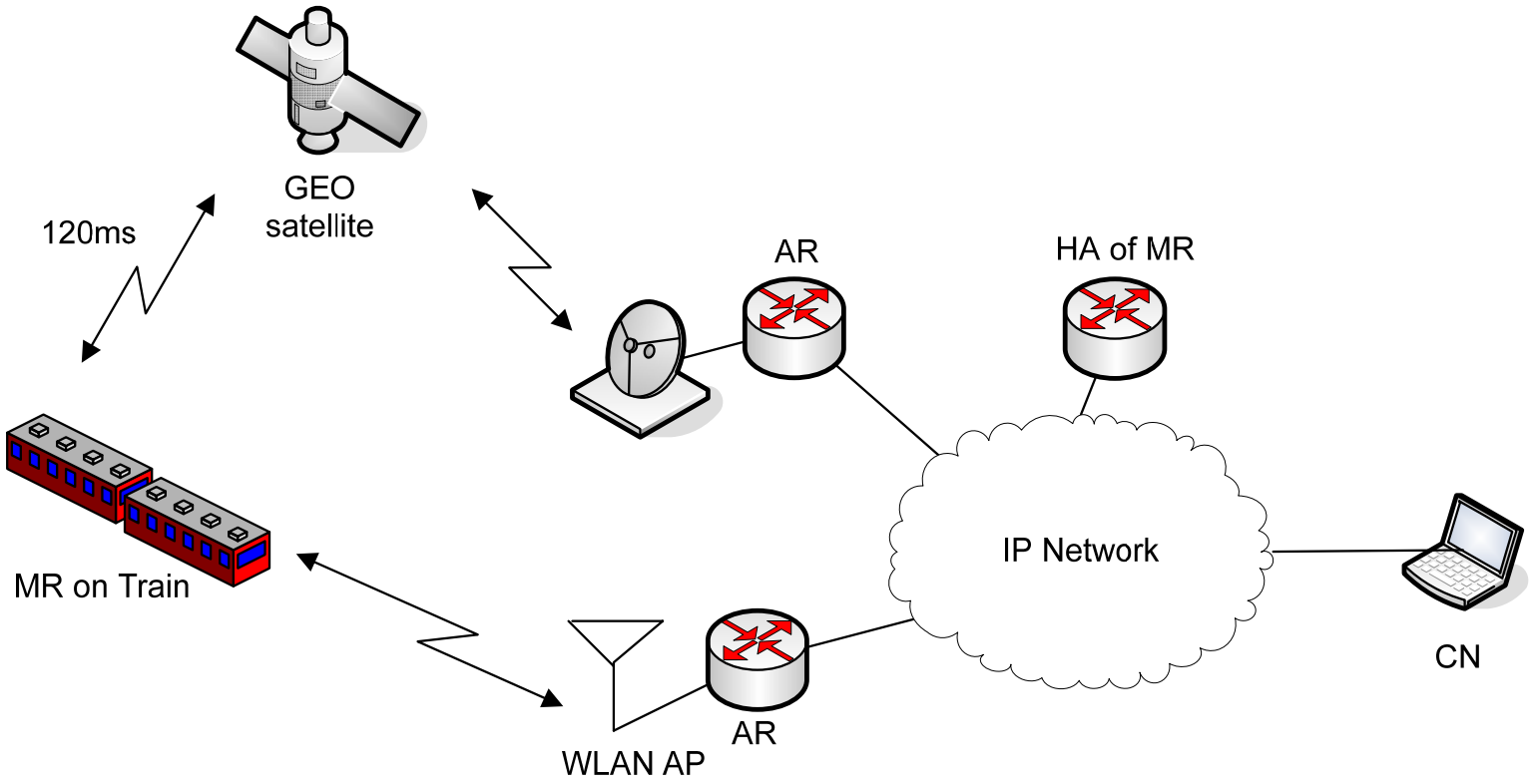
Contents

Introduction

- Introduction
  - Internet services for high-speed train
  - DVBS (Digital Video Broadcasting via Satellite), DVB-RCS (DVB and Return Channel via Satellite) interactive broadband internet services using satellites.
  - Handover to terrestrial wireless network in the stations or shadow zone
  - Propose new IP handover scheme for high-speed trains between satellite network and terrestrial wireless LAN network
  - Simulation environments and results for the proposed handover scheme

Introduction



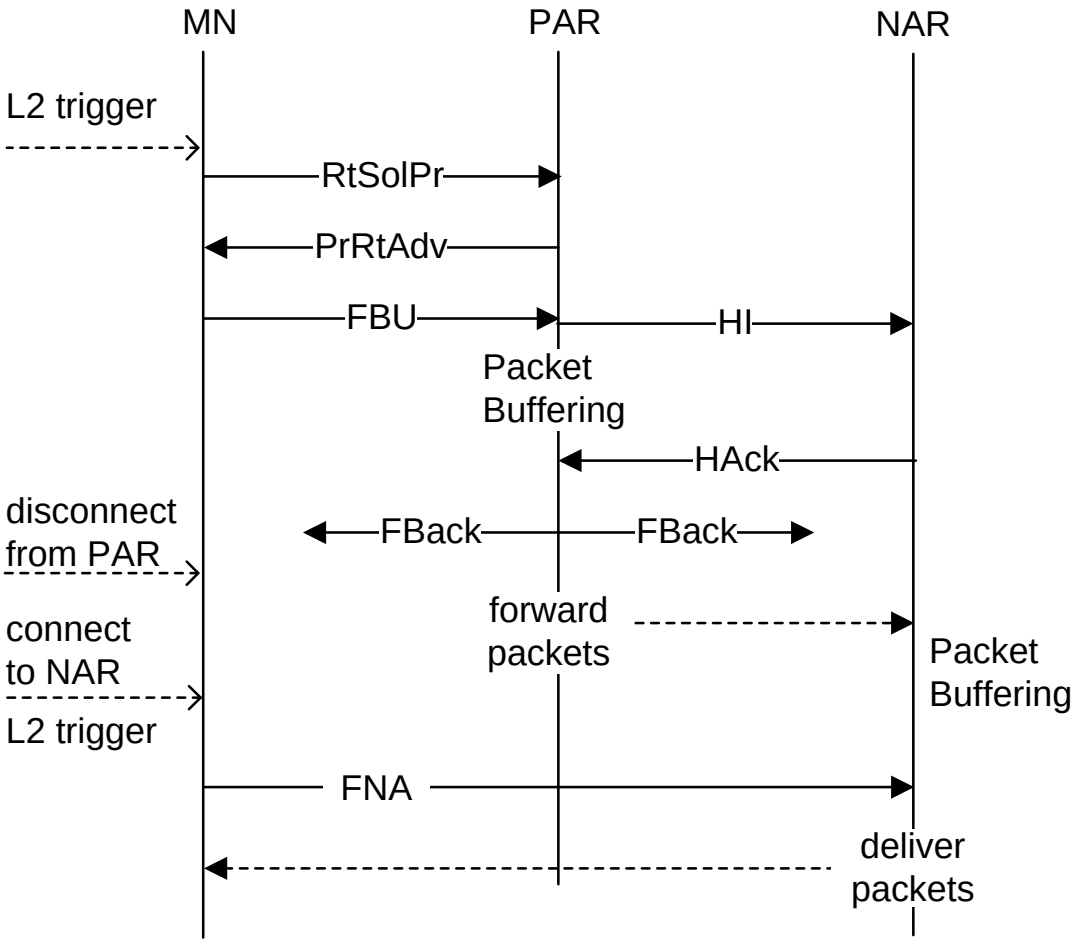
Fast Handover for Mobile IPv6

- Fast Handover for Mobile IPv6
  - Extension of Mobile IPv6 (RFC 4068)
  - Anticipates the layer 3 handover based on layer 2 triggers
  - Because trains move in fixed paths, we can easily anticipate its movements. Therefore Fast Handover is applicable effectively

Fast Handover for Mobile IPv6

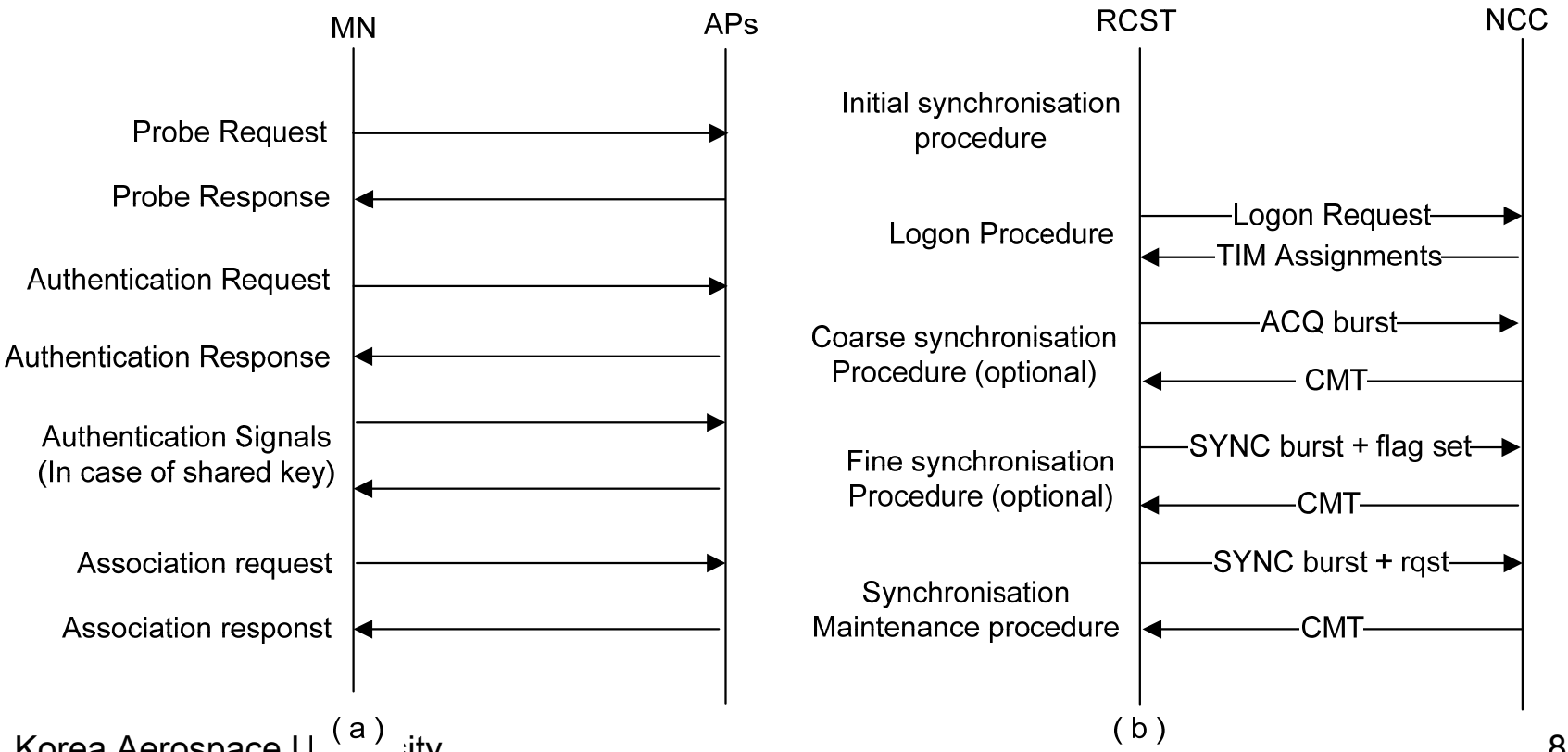
- Signal Messages
  - Proxy solicitation / advertisement
    - Contain one or more AP-ID, AR-Info
    - MN formulates a prospective NCoA with this message.
  - FBU (Fast Binding Update) / FBack
    - Authorize PAR to bind PCoA (Previous Care of Address) to NCoA, so that newly coming packets can be forwarded to the current location of the MN.
  - HI (Handover Initiation) / HAck
    - After receiving Hack the PAR tunnels buffered and arriving packets to the NAR (New Access Router).
  - FNA (Fast Neighbor Advertisement)
    - MN sends this message to the NAR to inform its existence.
    - Until NAR receives FNA, it buffers arriving packets from PAR.

Fast Handover for Mobile IPv6



Handover Delays

- Layer 2 signal flows (a) joining a network at IEEE 802.11 MAC layer (b) example of RCST (Return Channel Satellite Terminals) network entry signalling flow for DVB-RCS



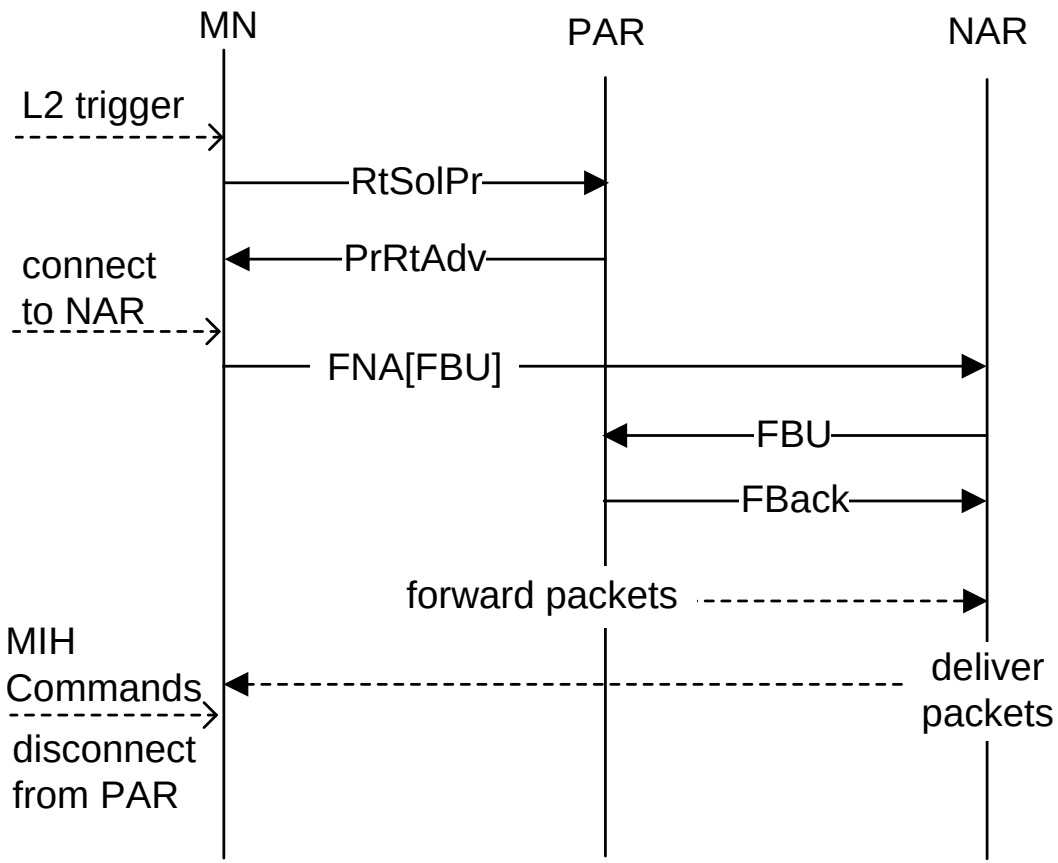
Disconnection Time

- Disconnection Time
  - layer 2 & layer3 delays are included in disconnection time
  - $T_D = N_{SIG} * T_{MR\text{-}NAR} + T_{FNA} + T_P$
  - N_{SIG} is number of layer 2 access signals (entry signals),
  - $T_{MR\text{-}NAR}$ is the propagation delay between MR and NAR
  - T_{FNA} is the propagation delay for FNA from MR to NAR
  - T_P is processing delay including scheduling delays at NCC (Network Control Centre) or APs (Access Points).
  - propagation delays on WLAN and geo-satellite network are 35ms and 240ms respectively. In consequence, disconnection time are at least 245ms and 1200ms respectively
  - Proposed handover scheme can eliminate disconnection time

Proposed Handover Scheme

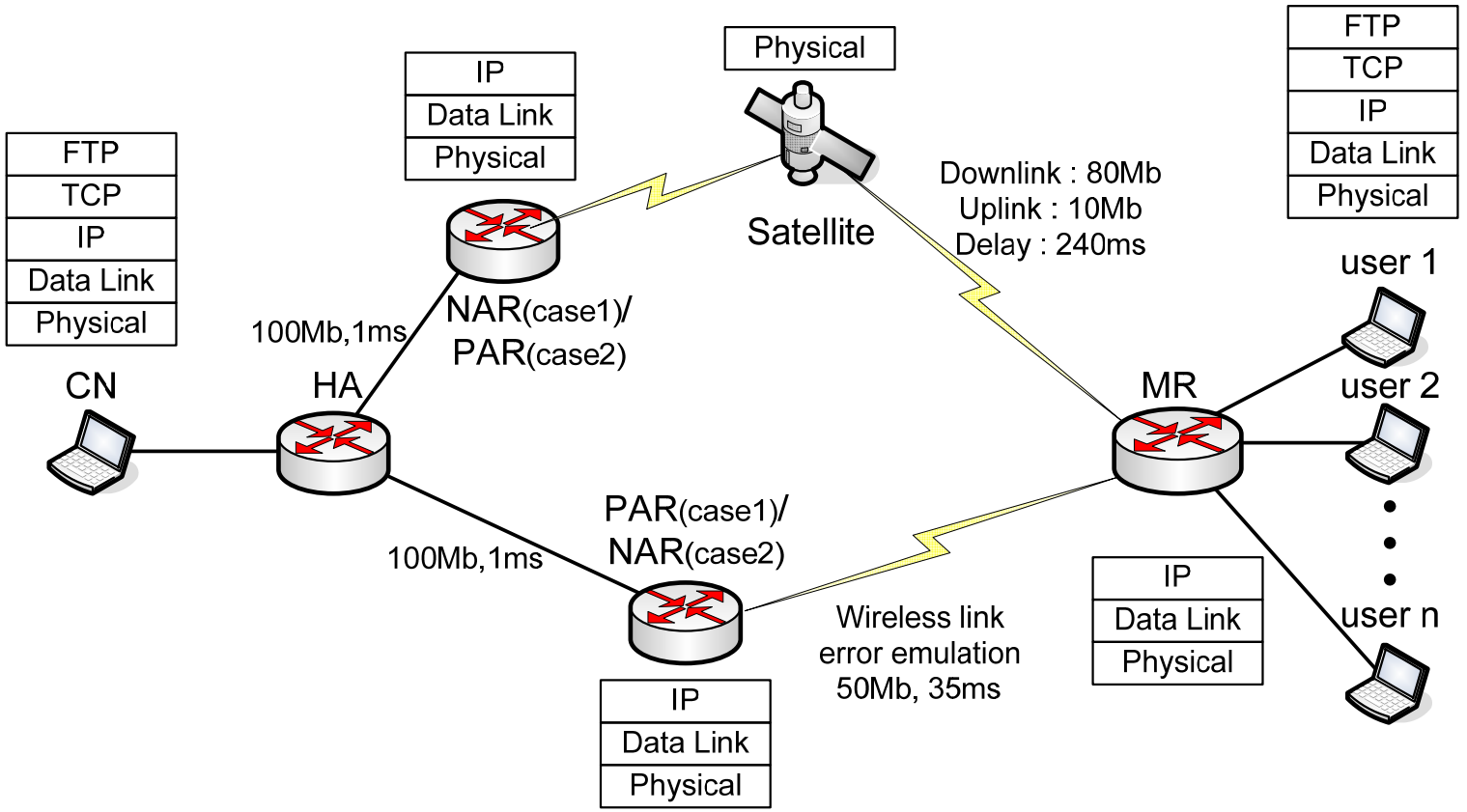
- Proposed Handover Scheme Between Satellite Network and Wireless LAN Network For High-Speed Trains
  - In this case
    - Train length is long so that antennas at its head and tail can be connected to different networks respectively.
    - In IPv6, the MR can be assigned several IP care-of addresses.
  - While an MR is connected to PAR, it completes layer 2 connection to new network and sends FBU to PAR via NAR.
  - After receiving the FBU, the PAR stops sending packets to the previous network and start sending packets to the MR via NAR.
  - The MR cuts off the connection with PAR, after it receives a packet from NAR.
  - L3 trigger is to inform layer 2 that layer 3 handover is completed and it can disconnect with the previous network.

Proposed Handover Scheme



Simulation Environments

- Simulation configuration implemented using NS-2

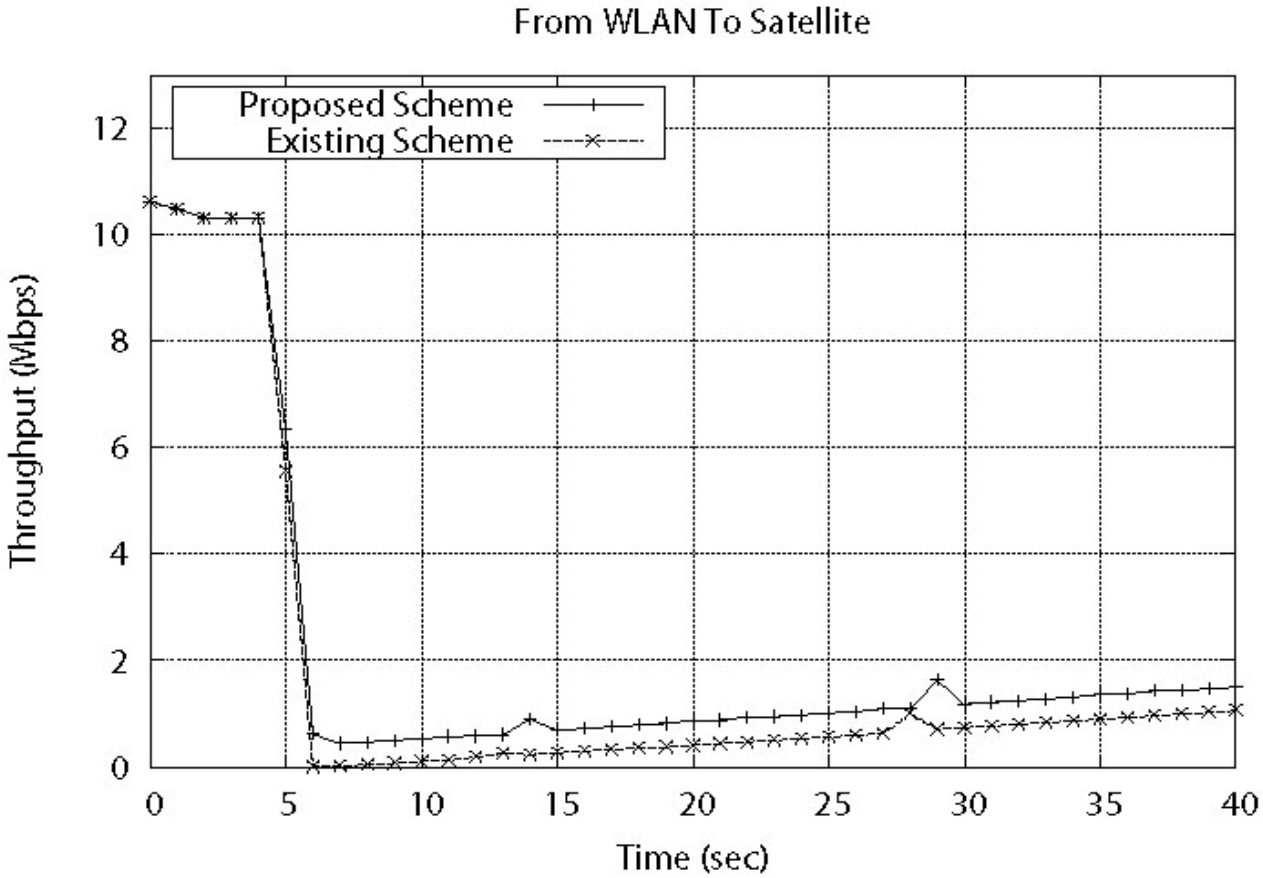


Simulation Environments

- Simulation configuration implemented using NS-2
  - WLAN
    - Propagation delay is 35ms. In consequence, disconnection time are at least 245ms by equation at page 12.
    - Bandwidth is 50Mbps
  - Geo-satellite
    - Propagation delay is 240ms. In consequence, disconnection time are at least 1200ms by equation at page 12.
    - Bandwidths are 80Mbps downlink and 10Mbps uplink
  - TCP
    - TCP-Reno & TCPSink embodied by NS-2
    - TCP segment size is 1040byte
    - Window size is 100
  - MIPAgent (added to NS-2)
    - Decide routing path and exchange handover signals

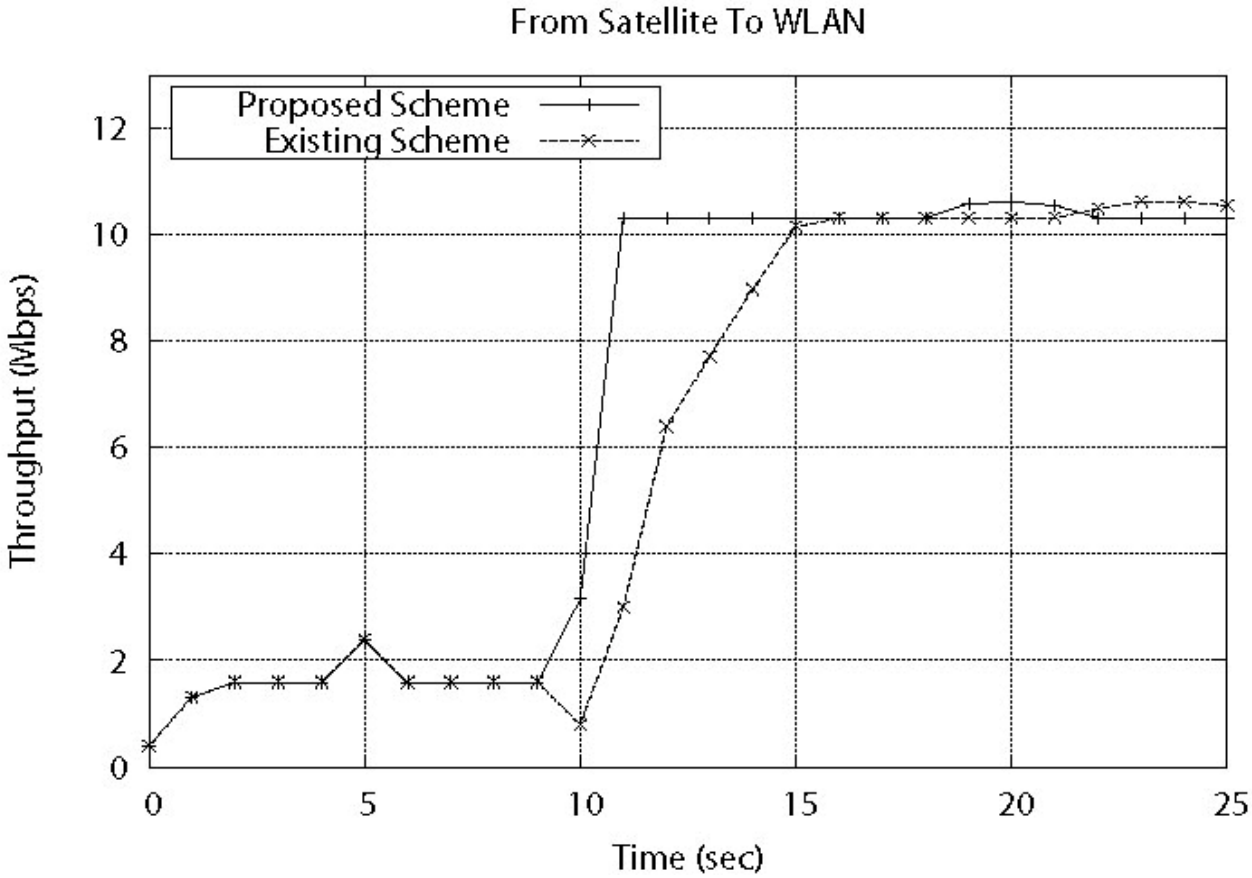
Simulation Results

- TCP throughputs during handover from WLAN to satellite network



Simulation Results

- TCP throughputs during handover from satellite network to WLAN



Simulation Results

- Handover from WLAN to satellite network
  - The throughput of previous scheme goes down to zero during handover due to disconnection time, while the throughput of proposed scheme goes down to 0.5Mbps at the lowest.
  - In the proposed scheme, we could not avoid falling throughput due to increase of RTT (Round-trip Time) because the MR moves to the slower satellite link. However, the restoration of the throughput is advanced by around 15s comparing with existing scheme
- Handover from satellite network to WLAN
  - Proposed scheme takes about 2 seconds till maximum throughput after handover, while the previous scheme takes about 6 seconds.
  - That is because there are no TCP congestion controls caused by disconnection time in case of the proposed scheme.

Further Study

- Further Study
  - To avoid falling throughput due to increase of RTT
  - Apply TCP Performance Enhancing Proxy (RFC 3135)
    - Allow the use of a third connection to optimize for the link
    - It may operate totally transparently to the end systems (transport endpoints or applications)
    - We expect that it may ease the rapid increase of RTT when the MR moves to satellite network

Q & A

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Thank You !