Performance Analysis of Handoff Techniques Based on Mobile IP, TCP-Migrate, and SIP

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Outline

- Introduction
- Mobility management
- Classification of applications
- Qualitative handoff performance analysis of existing mobility management protocols
- Analytical modeling
- Handoff performance comparison
- Summary and conclusion
Introduction

- Next-generation wireless systems (NGWS) integrate different wireless networks to provide ubiquitous "always best connection" to mobile users.
- In NGWN, mobile users are connected to the best available networks that suit their service requirements and switch between different networks based on their service needs.
Introduction

- Efficient mobility management protocols are required to support mobility across heterogeneous access networks.
- To answer the question “What is the suitable mobility management protocol for a particular application class?”
Mobility management

- Location management
  - Enabling the system to track the locations of mobile users between consecutive communications.

- Handoff management
  - The process by which users keep their connections active when they move from one base station (BS) to another.
Classification of applications

- **Class A Applications:**
  - TCP or UDP applications that are short lived and originated by a mobile node (MN).
  - Therefore, these applications do not require location or handoff support.

- **Class B Applications:**
  - TCP applications that are long lived and originated by an MN such as Web browsing and telnet sessions.
  - These applications do not require location support but require handoff support.

- **Class C Applications:**
  - TCP applications that are long lived and terminated at an MN such as telnet sessions.
  - Location and handoff support are required.
Classification of applications

- **Class D Applications:**
  - UDP applications that are long lived and originated by an MN such as mobile telephony where MN is the calling party.
  - These applications require only handoff support.

- **Class E Applications:**
  - UDP applications that are long lived and terminated at an MN such as mobile telephony where MN is the called party.
  - These applications require both location and handoff support.
Classification of applications

The results of our analysis advocate:

- The use of transport layer mobility management for Class B and Class C applications.
- Mobile IP for non-real-time Class D and Class E applications.
- Session Initiation Protocol-based mobility management for real-time Class D and Class E applications.
Qualitative handoff performance analysis of existing mobility management protocols

- Parameters:
  - Handoff latency
  - Packet loss during handoff
  - Throughput degradation time
  - End-to-end delay
  - Transport-layer transparency
Network Layer (Layer 3) Mobility Management Protocols

- Mobile IP registration introduces a significant amount of latency during handoff.
- Mobile IP triangular routing increases the end-to-end delay.
- Mobile IP handoff is transparent to the applications and the transport layer connections are kept intact during a handoff.
Transport Layer (Layer 4) Mobility Management Protocols

- The communicating end points are involved in the handoff process, the latency is often lower than that of Mobile IP.
- The packets that are lost during the handoff can be recovered because of TCP retransmission.
- As a transport layer connection is reactivated upon handoff, the applications remain transparent to mobility.
Application Layer (Layer 5) Mobility Management Protocols

- Because redirecting agents are used during handoff, the handoff latency of SIP is comparable to that of Mobile IP but is higher than the transport layer mobility protocols.
- The packets during the handoff signaling procedures are lost, making handoff packet loss comparable to that of Mobile IP handoff.
- SIP mobility is not transparent to TCP protocol.
<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>Layer 2</th>
<th>Layer 3</th>
<th>Layer 4</th>
<th>Layer 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handoff latency</td>
<td>Worst</td>
<td>Worse</td>
<td>Weak</td>
<td>Worse</td>
</tr>
<tr>
<td>Handoff packet loss</td>
<td>Worst</td>
<td>Worse</td>
<td>Weak</td>
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<tr>
<td>End-to-end delay</td>
<td>Good</td>
<td>Weak</td>
<td>Good</td>
<td>Good</td>
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<tr>
<td>Transport-layer transparency</td>
<td>Weak</td>
<td>Good</td>
<td>Good</td>
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<tr>
<td>Security</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>
D: the link-layer access delay
Analytical modeling

- End-to-End Packet Loss Probability
  - with Radio Link Protocol (RLP) and without RLP
- End-to-End Packet Transportation Delay
- Average Signaling Packet Transportation Delay Using UDP
- TCP Retransmission Timeout Duration
- Time for TCP Slow Start
Handoff Performance Comparison of Mobile IP and TCP-Migrate for a TCP Connection

FER : link layer error rate

$t_{whn}$ : delay between the home agent and new base station

no RLP (Radio Link Protocol)
Handoff Performance Comparison of Mobile IP and TCP-Migrate for a TCP Connection

RLP enabled
Handoff Performance Comparison of Mobile IP and SIP for a UDP Connection

![Graph showing handoff delay with varying FER for different t_wnh values for MIP and SIP. The graph indicates that SIP has lower handoff delay compared to MIP with no RLP.]
Handoff Performance Comparison of Mobile IP and SIP for a UDP Connection

RLP enabled
Summary and conclusion

- Our analysis shows that the handoff performance of a mobility management protocol depends on the following factors:
  - Type of application
  - Link layer frame error probability
  - Signaling delay
  - Link layer access technologies

- The use of application-adaptive mobility itself is not enough to support seamless mobility management.

- Information sharing between different layers to enhance the performance of mobility management.