Chapter 4 Wireless Internet

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Introduction

- **Internet** has caused a revolutionary change in the use of computers and search for information.
- **Wireless Internet** enables the users to access information and data irrespective of their location.
- Some protocols work well in wired network but perform very poor in the wireless networks such as **TCP**.
What is Wireless Internet?

- Wireless Internet refers to the extension of the services offered by the Internet to mobile users.
- The major issues to be considered for wireless internet are the following:
  - Address mobility
  - Inefficiency of transport layer protocols
  - Inefficiency of application layer protocols
802.11/HIPERLAN
Network Layer
(IPv4/IPv6)
802.3/802.4/802.5

Application Layer
(HTTP, TELNET, SMTP, etc.)
Transport Layer
(TCP/UDP)

Internet
Wireless AP
connected to a subnet of the Internet

Mobile node that can be connected to any AP running WLAN protocol

Wireless part of wireless Internet

Traditional wired Internet

Flow of an IP packet from the wired Internet to a mobile node

Transceiver antenna

Figure 4.1.
Address Mobility

- The network layer protocol used in the IP was designed for wired networks with fixed nodes.
- IP employs a hierarchical addressing with a globally unique 32-bit address: network id + host id.
- The addressing scheme was used to reduce the routing table size in the core routers of the Internet.
- This addressing scheme may not work directly in the wireless Internet.
- Mobile IP is a solution for the mobility problem.
(a) IP address format

Subnet A: 10.6.6.x
Wireless AP
Packets addressed to 10.6.6.1
(IP address 10.6.6.1)

Subnet B: 10.6.15.x
Wireless AP

(b)

32 bits

Subnet address
Host address

Figure 4.2.

Network identifier in 10.6.6.1 is different from the subnet address
Inefficiency of Transport Layer Protocols (TCPs)

- TCP is very important in the Internet:
  - maintaining end-to-end connections
  - reliable end-to-end delivery of data packets
  - flow control and congestion control

- Congestion control will reduce the size of the congestion window with every successive packet loss

- Link error or collision may lead to very low throughput in wireless network

- Wireless application protocol (WAP) is used to solve the inefficiency of wireless applications
Mobile IP

- Each computer has a unique IP address
  - Identification the computer
  - Help data routing
- Important issue for Mobile IP
  - Compatibility: compatible to wired Internet
  - Scalability
  - Transparency
Figure 4.3. Routing in MobileIP.
MobileIP Protocol

- **COA: Care of Address**
  - Foreign agent-based COA: address of current FA
    - The FA decapsulates the packet and forwards it to MN
  - Co-located COA: another address of MN
    - MN decapsulates the packet

- **Registration**: MN registers to the HA when it moves to a new location
  - Authorization
  - Authentication
Reverse Tunneling

- Possible problems for reverse tunneling
  - Ingress filtering: some routers may filter the packets going out the network if the source IP is not the subnet’s IP
  - Firewalls
  - Time to live (TTL)
- Solution: the routing of packet from MN to CN via HA
Simultaneous Binding and Route Optimization

- Simultaneous binding: HA allows an MN to register more than one COA at the same time
  - To improve the reliability of data transmission
- Optimization route: (CN to MN bypassing HA)
  - Binding cache: CN can keep the mapping of MN’s IP and COA in a cache
  - Binding request and binding update: find the binding from HA by using a binding request
  - Binding warning (handoff case): old FA sends a binding warning to HA, which in turn informs the CN to use a new binding
MobileIP Variations- The 4 x 4 Approach

- 4 x 4 Approach: There are four strategies for packets from MN to CN (OUT approaches) and four strategies for packets from CN to MN (IN approach).
- S and D represent the inner source and destination of the packet while s and d represent the outer source and destination in the encapsulated packet.
<table>
<thead>
<tr>
<th>IN Strategy</th>
<th>s</th>
<th>d</th>
<th>S</th>
<th>D</th>
<th>Notes</th>
<th>Acceptable Combination</th>
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</table>
| Incoming Indirect Encapsulated (IN-IE)          | IP address of HA  | COA of the MN      | IP address of the CN | Home IP address of the MN | 1. Highest overhead  
2. Guaranteed delivery  
3. Uses tunneling  
4. CN need not be mobility aware | OUT-IE  
OUT-DE  
OUT-DH |
| Incoming Direct Encapsulated (IN-DE)            | IP address of CN  | COA of the MN      | IP address of the CN | Home IP address of the MN | 1. CN is mobility aware  
2. No tunneling | OUT-DE  
OUT-DH |
| Incoming Uses Home Address (IN-DH)             | Not applicable     | Not applicable     | IP address of the CN | Home IP address of the MN | 1. No encapsulation  
2. Usable when no security constrains at routers  
3. MN and CN on same subnet | OUT-DH only |
| Incoming Direct Uses Temporary Address (IN-DT) | Not applicable     | Not applicable     | IP address of the CN | COA of MN            | 1. MN cannot receive packets addressed to its original IP address  
2. Useful for short-term communication | OUT-DT only |
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Handoffs

- When MN is moving away from the FA is connected to
- Decisions regarding where and when to handoff and establish a new connection breaking the old one
Figure 4.4. Entities in wireless Internet handoff scenario
Classification of Handoffs

- Mobile initiated handoff: MN measures the SS, decides the new BS and triggers the handoff
- Mobile evaluated handoff: the decision on handoff lies within the network, such as BS
- Network initiated handoff: the BS decides where the MN should be handed over
- Mobile assisted handoff: MN assists to measure the down link SS that avoids black hole scenario
  - Black hole: Wireless channel is asymmetric
Fast Handoffs

- The handoff delay including:
  - Delay in detection of a need for a handoff
  - Layer 2 handoff: a data link connection need to be established between the new FA and MN
  - Layer 3 handoff or registration with HA
- Pre- and post- registration handoffs are employed to reduce the layer 3 delay
IPv6 Advancement

- IPv6 has a built-in support for mobility
  - Route optimization
  - IPv6 has fields for new COA and home IP so reverse tunneling problem can be avoided
  - Control packet can be piggy-backed onto data packet
  - Detection of black hole
  - IPv6 avoids overheads due to encapsulation
The wireless domain is not only plagued by the mobility problem, but also by high error rates and low BW.

Traditional TCP: provides a connected-oriented, reliable, and byte stream service.

TCP functions: flow-control (controlled by sliding window), congestion-control (congestion window), data segmentation, retransmission, and recovery.

Slow Start: resets the congestion window (CW) size to one and let $threshold$ to half of the current CW size.

- Double the CW on every successful transmission until the CW reach $threshold$ and after that increases the CW by one for each successful transmission.
TCP Over Wireless

- Earliest suggested alternatives: Forward error correction (FEC)
- Link layer solutions: Snoop TCP and TCP-unaware link layer
- Split approach based solutions: ITCP and M-TCP
- End-to-end solutions: ELN, WTCP, TCP SACK and TTCP
Wireless TCPs

- Snoop TCP: buffer the data as close to MN as possible to minimize the time for retransmission
- TCP-Unaware Link Layer: retransmission are triggered by link level ACKs
- Indirect TCP: splits the TCP connection into two distinct connections, one is MN and BS and another is BS and CN
Figure 4.7. Indirect TCP.
Wireless TCPs

- Explicit Loss Notification: the MAC layer can send an (ELN) to sender if packet loss is not caused by congestion

- Using multicast: the MN is required to define a group of BSs that it is likely to visit in the near future
  - Only one BS is in contact with the MN and the others buffer the packets addressed to the multicast address
Wireless Application Protocol

- WAP becomes a standard for providing data and voice services to wireless hand-held devices
- Main objective of WAP is to overcome the shortages of wireless medium and handheld devices such as:
  - Low BW, high latency, low connection stability, and high transmission cost per bit
  - Small display, low memory, limited battery power, and limited CPU
The WAP Model

- WAP adopts a client-server approach: a proxy server acts as an interface between the wireless domain and core wired network.
- The gateway receives WAP request from the hand-held devices, and converted to HTTP request to be sent to the original server.
- The filter between the server and gateway to convert the HTML content into WAP-compatible WML content.
Figure 4.8. The WAP client-server model
The WAP Protocol Stack

- Wireless Application Environment (WAE): provides an addressing model for accessing both the WWW URLs and other resources using uniform resources identifiers
- Wireless Session Protocol (WSP): establishes a reliable session between the client and server
- Wireless Transaction Protocol (WTP): 3 services
  - Class 0: unreliable send with no ACK
  - Class 1: reliable push services (receiver send data as ack)
  - Class 2: request-data-ACK providing a two-way reliable services
Figure 4.9. The WAP protocol stack
Optimizing Web Over Wireless

- Caching: cache data across the browser sessions
- Differencing: only send the different stream
- Protocol reduction: reducing the overhead of repeated setup and tear-down of TCP/IP connection for each Web-object to be transmitted
- Header reduction:
Exercises

- 1, 3, 5, 7, 9, 11, 14