Ad Hoc Multihop Wireless Networking for Mobile Devices

Name: Alex Song
Supervisor: Dr Mark Schulz
Seminar Outline

- Describe the thesis and the need for it.
- Compare the features of current commercial products and my thesis.
- Technical details of my thesis.
- Current status of the thesis project.
Thesis description

To implement an ad hoc multihop routing protocol for IPv4 which will allow a dynamic network of mobile and handheld devices to be self-organizing and self-configuring.
Thesis description
Applications for thesis project

- Search and rescue missions.
- Conferences and meetings.
- Any application where there is no pre-existing networking infrastructure.
- Can also form a wireless extension to existing networks.
Commercial Products

- IEEE 802.11 – Wireless LAN
- Bluetooth (version 1.1)
- Both technologies can only single hop in ad hoc mode.
Piconet II features

- Provide multihop capabilities to existing hardware and software platforms e.g. Linux/x86 and Linux/arm/iPAQ.
- Compatibility with standard IP networks.
- Transparent to existing TCP/IP applications.
## TCP/IP Network Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Telnet, FTP, DNS</td>
</tr>
<tr>
<td>Transport</td>
<td>TCP, UDP</td>
</tr>
<tr>
<td>Internet</td>
<td>IP</td>
</tr>
<tr>
<td>Host-to-network</td>
<td>802.11, Bluetooth</td>
</tr>
</tbody>
</table>
Routing Protocol

- Dynamic Source Routing Protocol (DSR)
- Internet draft: draft-ietf-manet-dsr-05.txt
- Current draft does not support packet fragmentation.
- Plan to extend draft and add support for packet fragmentation.
Why Dynamic Source Routing?

- Not a complex protocol.
- Low packet overhead.
- Routes efficiently.
- Does not require promiscuous mode and supports uni-directional links.
Dynamic Source Routing

- Route Discovery.
- Packet Forwarding.
- Route Maintenance.
Route Discovery
Packet Forwarding
Route Maintenance

A -> C -> D
CDE, n=3

B

C

D

E

F

CDE, n=2

CDE, n=2
DSR on IPv4

- IP options field (40 bytes) too small.
- DSR protocol uses a special header which can be included in any IP packet.
- The DSR header format is similar to the options format of IPv6.
DSR Header Format

Standard IP packet

| IP Header | Transport Layer Data |

Standard IP packet with DSR options

| IP Header | DSR Header | DSR Options | Transport Layer Data |
# DSR Header Format

## IPv4 Header

<table>
<thead>
<tr>
<th>Version</th>
<th>IHL</th>
<th>Type of Service</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Identification</th>
<th>DF</th>
<th>MF</th>
<th>Fragment Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time To Live</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol</td>
<td></td>
<td></td>
<td>Header Checksum</td>
</tr>
<tr>
<td>Source Address</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destination Address</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## DSR Header

<table>
<thead>
<tr>
<th>Next Header</th>
<th>Reserved</th>
<th>Payload Length</th>
</tr>
</thead>
</table>
DSR Options

- Route Request Option.
- Route Reply Option.
- Route Error Option.
- Acknowledgement Request Option.
- Acknowledgement Reply Option.
- Source Route Option.
- Pad1 and PadN Options.
## DSR Options Format

### Route Request Option

<table>
<thead>
<tr>
<th>Option Type</th>
<th>Opt Data Len</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address[1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address[n]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Why Implement on Linux?

- Open Source
  - access to existing TCP/IP code.
- Available on multiple platforms
  - x86, arm, sparc, powerpc etc.
- Allows kernel code to be written as modules, which can be inserted and removed at anytime.
Linux TCP/IP Network Layers

Network Applications

User Space

Kernel Space

Socket Interface

BSD Sockets

INET Sockets

TCP

UDP

IP

ARP

Ethernet, PPP, 802.11 Bluetooth.

Protocol Layers

Network Devices
Linux Netfilter

- A framework that allows kernel modules to observe and modify packets as they pass through the IP stack.
- New architecture, available in Linux 2.4
- Used for packet filtering, packet mangling and network address translation (NAT).
Netfilter Architecture

- 5 Hooks defined for IPv4.
- functions register to listen at specific hooks.
- functions are called in order of priority when a packet arrives at a hook.
Current Progress

- Written a kernel module.
- Packet forwarding implemented with static routes.
- Can forward ICMP and all transport protocols like TCP and UDP.
- The DSR network can access standard IP networks via a PC gateway running NAT.
Current Progress

- CSEE IP Network
- NAT Gateway
- PC
- iPAQ1
- DSR Network
- iPAQ2
Features to be implemented

- Route discovery.
- Route maintenance.
- Packet fragmentation.
- Performance and packet statistics.
Any Questions ?