# TIES529 Mobile Systems Laboratory Work, 1–12 ECTS cr.

Mobile IPv6 laboratory work

## Presentation

This laboratory work aims at familiarizing the students with mobility in IPv6 networks through its Mobile IPv6 extension. Mobile IPv6 is an extension to the IPv6 protocol which is meant to replace in the future the current IPv4 protocol. With Mobile IPv6, mobile nodes have the possibility to roam through multiple IPv6 networks without interruption of the connection.

The topology of the network used in this work is illustrated in figure 1. The network is composed of a mobile node (MN), a home agent (HA), a corresponding node (CN) and an access router (AR).

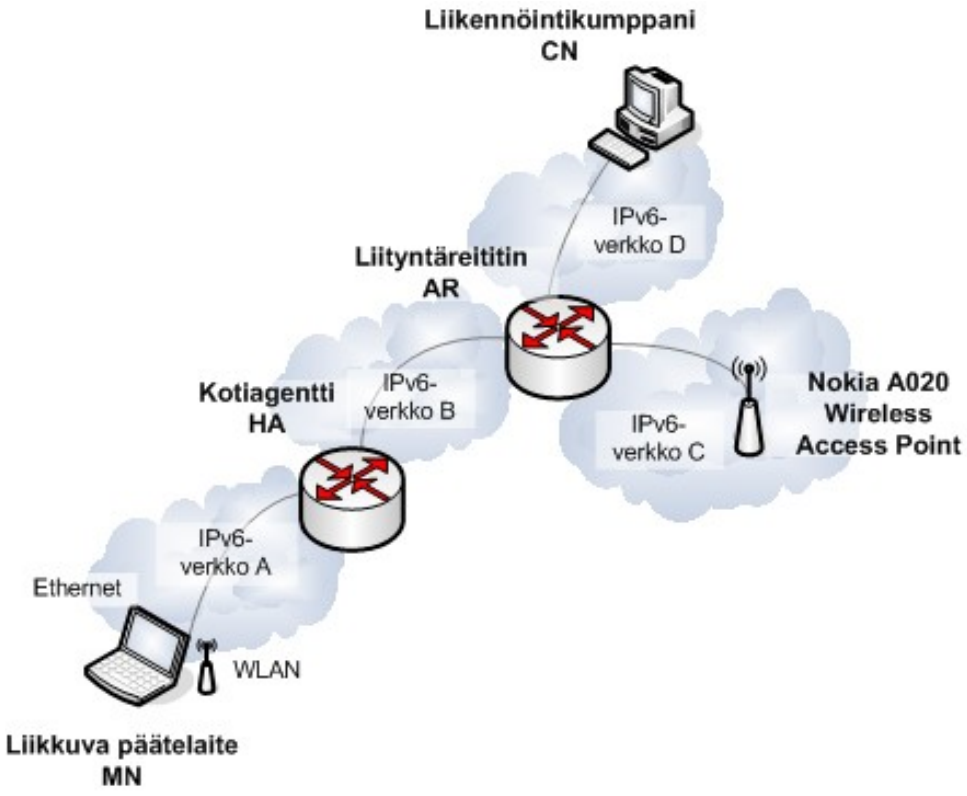



Figure 1: Mobile IPv6 Network

The network is Ethernet-based, but the mobile node has also a WLAN connection and a WLAN base-station (acting as a bridge) plays the role of the IPv6 network's C interface. All the elements of the network are running Linux (Debian 4.0 Etch) and the MIPv6 protocol is provided through the MIPL 2.0.2 software.

In this work you will familiarize yourself first with the IPv6 protocol and with using Linux as a router. After that you will move to the Mobile IPv6 extension and to the installation of the necessary tools in Linux. Finally, you will run some tests with the working Mobile IPv6 network and study how it works in practice.

The devices use the following usernames and passwords: root:user and user:user.

The WLAN base station's network ID (ESSID) is wlanap (no encryption).

# Preliminary Tasks

## Preliminary Task 1. IPv6

Study the IPv6 protocol. Tell about IPv6 and compare it to IPv4. What are the most important differences and innovations compared to IPv4?

## Preliminary Task 2. IPv6 Addressing

IPv6 addresses differ from IPv4 addresses. Explain how and describe their form.

What are the different IPv6 address types and how do they differ from each other?

Which address can be used with the mobile node and the router?

Based on the network in Figure 1, plan the addressing of the devices and the routing table. Add the device ID (MN, HA, CN and AR) to the table and the necessary information about the IP adresses, default routes and other routes if the device requires such.

Hint: be careful with the masks!

| Device | Interface | IPv6 address/Mask | Default route | Other routes |
|---|---|---|---|---|
| | | | | |

Which settings are required by the routers for the routing to succeed?

## Preliminary Task 3.

Study the MIPv6 protocol. Explain what are the different devices in the MIPv6 network and what are their roles.

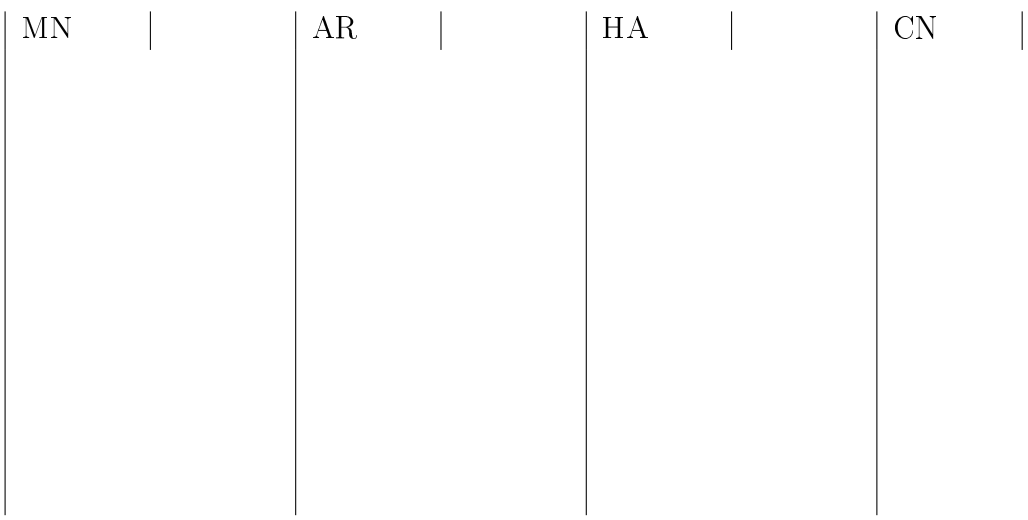
What IPv6 addresses does MN need in the Mobile IPv6 network?

Tell also about the most important messages and data structures used by MIPv6.

What kind of operation models exist in a Mobile IPv6 environment and in which cases do they apply (or can be applied)? What is the Return routability process, what does it relate to and when is it needed?

Handover is a process that happens when the MN moves from its home network to a visiting network, between visiting networks or from a visiting network to its home network. Study and explain how the handover process works. Draw onto the chart below the exchange of messages happening during a handover.

You will find the necessary information on the Internet (check the Sources) or on the CD.




# Tasks

The following tasks will allow to familiarize yourself with the operation of MIPv6.

## Task 1. IPv6 Network and Routing

The network is setup according to Figure 1. In order to prevent unnecessary repetitive work, Linux (Debian 4.0) has been installed on each device except the access router. You must threrefore install Linux on the access router. (You can find guidance on the laboratory work's CD and in the Sources).

Network setup:

1. Install Linux on the access router (for example Debian 4.0. Ask the supervisor for the installation CD).
2. Meanwhile, cable the whole network.
3. Define the IPv6 routes to your liking and assign the address to the devices.
4. Setup the IPv6 routing.
5. Test that the connections are working (go through the whole network using the ping command). Test also the WLAN connection. See "Troubleshooting" near the end of these instructions.

You can perform the installation using for example the command line or shell scripts.

What steps are required for routing to work in the router?

What kind of address do the devices have? Check using e.g., ifconfig.

Write down the devices' addressing and routing schemes.

## Task 2. Mobile IPv6 Devices

Mobile IPv6 is handled through the MIPL 2.0.2 application, which requires patching the Linux kernel and recompiling. In order to save time, all the devices except the HA have an Mobile IPv6-compliant kernel. Patch and recompile the Home Agent's kernel. (Guidance can be found e.g., in appendix 1, on the CD, or in [4, under Others] in Sources).

1. Copy the kernel package (linux-2.6.16.tar.bz2) from the CD and unpack it.
2. Patch it with the patch found on the CD (mipv6-2.0.2-linux-2.6.16.patch)
3. Configure the necessary features in the kernel (look at the material [4, under Others] on the CD. Note: Ensure that you have enabled ("y") all the MIPv6 features in order to prevent problems.)
4. Compile the kernel.

While the compilation is taking place, you can start to study the Mobile IPv6 material.

Do you need to enable specific services in order to support the routing (on HA and AR)? If yes, which one(s)?

## Task 3. MIPL Setup

When the kernel compilation from the previous task is over, install the MIPL 2.0.2 software that is need of supporting MIPv6. In order to save time, it has already been installed on all the devices except the HA. Install the mip6d software on the Home Agent. (Instructions can be found on the CD or in [4, under Others]).

1. On the HA: copy the source code (mipv6-2.0.2.tar.gz) from the CD to the /usr/local/src folder and unpack it.
2. Go the the unpacked directory.
3. Follow the installation instructions ([4, under Others], /usr/local/src/mipv6-2.0.2/README)

After the installation, check how the MIPv6 devices need to be configured. Configure MN, HA and CN.

Test next that the MIPv6 network is working. Make sure that both Ethernet and WLAN are enabled in MN, check the mobility e.g., by pinging CN to MN and unplugging the Ethernet cable. (See the "Troubleshooting" section in case of WLAN problems.)

When the Mobile IPv6 network is working, move the the next task.

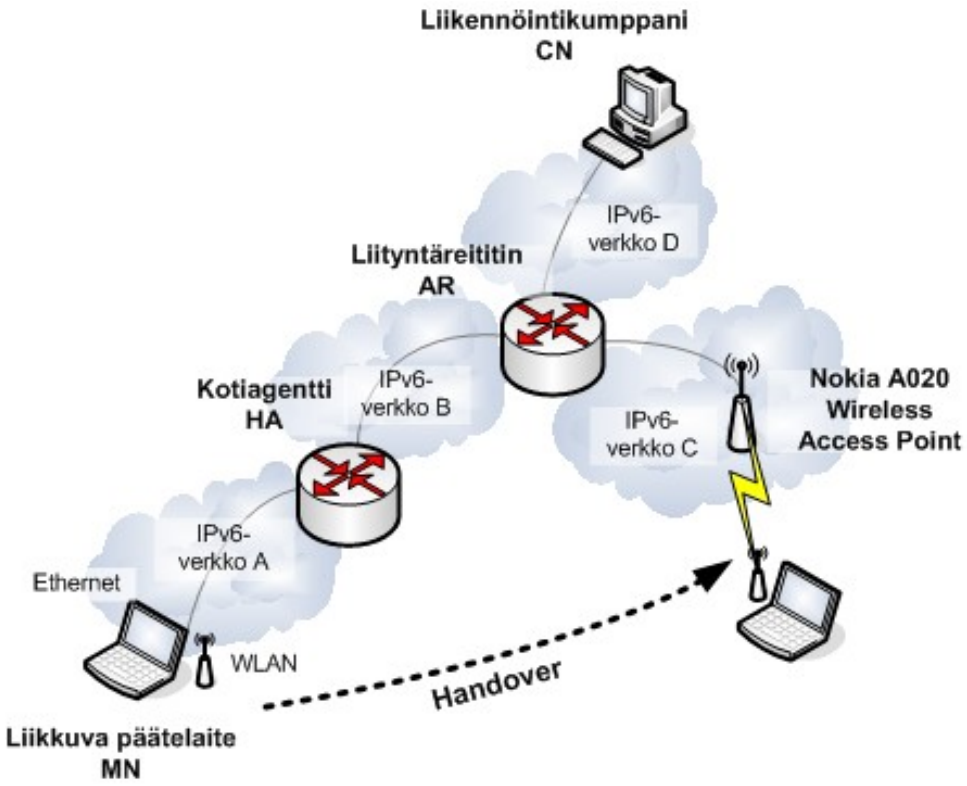



Figure 2: Handover

## Task 4.

Setup the Mobile IPv6 network to work without route optimization and without IPsec. Configure mip6d.conf correctly. (You can find help by using the man mip6d.conf command). Setup first HA, then MN and CN.

Send for example ICMP (ping) or UDP packets from CN to MN (you can use the mgen program located on the CD) and use for example the Wireshark program to follow the traffic. You can also follow mip6d's logfile.

Describe what happens in the Mobile IPv6 network, what happens at the beginning, when MN registers to HA and so on. Perform a handover such as described in Figure 2 (unplug for example the Ethernet cable). Describe also what happens during the handover and what messages are exchanged; do this as well when the MN returns home (when you re-plug the Ethernet cable).

What traffic model is used there and how do the packets move between CN and MN? How are the packets modified?

Use Wireshark (or tshark, or tcpdump) on MN to gather traffic logs during the whole handover process in this task and in the next one. Add the necessary log information to your answer. Describe the exchange of messages onto the following chart (home network to visited network and visited network to home network).

| MN | | AR | | HA | | CN | |
|---|---|---|---|---|---|---|---|

Task 5.

Setup now the Mobile IPv6 network with route optimization and without IPsec. Follow the same steps as in the previous task and use ICMP or UDP traffic between CN and MN. Perform the change to the visited network and back home.

What traffic model is now used? Where do the packets go through? Explain what happens during the handover. What messages are sent, and where to? Tell also about the packets used in that situation and about their headers. Is there a difference between the packets sent by the devices? Describe also the return home.

Experiment also what happens when MN's Lifetime value is too small (See man mip6d.conf and configure mip6d.conf.)

Describe the exchange of messages onto the following chart (home network to visited network and visited network to home network).

| MN | | AR | | HA | | CN | |
|---|---|---|---|---|---|---|---|

Task 6.

Setup the Mobile IPv6 network with both route optimization and IPsec. Follow the same steps as in the previous task and use ICMP or UDP traffic between CN and MN. Perform the change to the visited network and back home.

The difference between this task and the previous one is the IPsec configuration. Study e.g., the /usr/local/src/mipv6-2.0.2/README.IPsec document and use it to configure the necessary devices.

Which devices support at the moment IPsec (between which devices is IPsec used)? What IPsec modes can be used and with what traffic? Tell how IPsec is setup in MIPL.

Perform the change to the visited network like previously and tell what happens.

Describe the exchange of messages onto the following chart (home network to visited network and visited network to home network).

| MN | AR | HA | CN |
|---|---|---|---|
| | | | |

## Troubleshooting

- What could help if no packet goes through the WLAN connection when performing the change of network (when you remove the Ethernet plug)?
  - If the setup has been done properly but the WLAN link doesn't work, you can "wake up" the WLAN connection by using for example tcpdump on the given interface.
- And if the previous doesn't work?
  - Check for example in /var/log/messages that the interface in question is in the "ready" state. If the situation doesn't change, reboot the PC and test that the link is working by e.g., running ifconfig eth1 up (assuming that WLAN is eth1) and check the above-mentionned logfile. After that the interface should work after performing the "wake up" process described above.
  - The used WLAN card has had overheating problems; therefore if the interface refuses to work and the card feels hot, take it out and let it cool down. Try again later.

# Appendix 1

## Kernel Compilation in Debian or Ubuntu

The following packages are necessary in order to compile the kernel using the described method:

kernel-package, ncurses-dev, fakeroot, wget, bzip2, module-init-tools ja procps. If a package is lacking, you can install it using the command

```
# apt-get install paketti
```

In this exercise, you shouldn't worry about the needed packages because they should already be installed on the computer.

Kernel package unpacking. Move to the /usr/src directory.

```
# cd /usr/src
```

Copy the kernel package linux-2.6.16.tar.bz2 from the CD's MIPL directory to the /usr/src directory.

```
# mount -t iso9660 /dev/hdX /cdrom
```

```
# cp /cdrom/MIPL/linux-2.6.16.tar.bz2
```

Unpack the kernel

```
# tar jxvf linux-2.6.16.tar.bz2
```

Add a symbolic link to the unpacked directory

```
# ln -s linux-2.6.16 linux
```

Change to the linked directory

```
# cd linux
```

If you want to name the compiled kernel, you can change, in the Makefile file located in the directory, the "EXTRAVERSION" statement. E.g., EXTRAVERSION=-mipl-2.0.2-ha

This will show in the kernel image and in the kernel module directory /lib/modules/2.6.16-mipl-2.0.2-ha.

Check and modify the configuration:

```
# make menuconfig
```

When the configuration is fine, run:

```
# make-kpkg clean
```

```
# fakeroot make-kpkg -revision=v.1 kernel_image
```

If the compilation fails (unprobable in this case), run:

```
# make clean
```

and repeat the previous steps:

```
# make menuconfig
```

...

If everything went fine, the new kernel image should be located in the /usr/src directory. E.g., /usr/src/kernel-image-2.6.16_v.1_i386.deb. Move there.

```
# cd ..
```

Install the new kernel with the command:

```
# dpkg -i kernel-image-2.6.16_v.1_i386.deb
```

Next, create a ramdisk for the new kernel:

```
# cd boot
```

```
# mkinitramfs -o initrd.img-2.6.16 2.6.16
```

(The "2.6.16" suffix refers to the /lib/modules/2.6.16 directory.

After that, update /boot/grub/menu.lst and add the initrd-image for the new kernel. Reboot the PC to use the new kernel.

```
# reboot
```

# Sources

## IPv6

### RFC

1. http://ietf.org/html.charters/ipv6-charter.html
2. http://ietf.org/rfc/rfc2460.txt
3. http://ietf.org/rfc/rfc4291.txt
4. http://ietf.org/rfc/rfc2462.txt
5. http://ietf.org/rfc/rfc2461.txt

Others

1. http://fi.wikipedia.org/wiki/IPv6
2. http://www.microsoft.com/technet/network/ipv6/introipv6.mspx
3. http://people.debian.org/~csmall/ipv6/setup.html
4. http://tldp.org/HOWTO/Linux+IPv6-HOWTO

## MIPv6

RFC

1. http://ietf.org/rfc/rfc3775.txt
2. http://ietf.org/rfc/rfc3776.txt

Others

1. http://fi.wikipedia.org/wiki/Mobile_IPv6
2. http://www.mobile-ipv6.org/
3. http://www.microsoft.com/downloads/details.aspx?FamilyID=f85dd3f2-802b-4ea3-8148-6cde835c892
4. http://gnist.org/~lars/doc/Mobile-IPv6-HOWTO/Mobile-IPv6-HOWTO.html
5. http://www.6net.org/publications/deliverables/D4.1.3v2.pdf