Handoff Support for Mobility with IP over Bluetooth

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Outline

- ☐ Introduction
- ☐ Bluetooth & BLUEPAC
- ☐ Handoff support
- ☐ Prototyping
- ☐ Conclusons

Introduction

☐ To overcome the Bluetooth short range wireless communication.

☐ In a BLUEPAC, mobile Bluetooth devices can move between different APs while still being addressable via the same IP address.
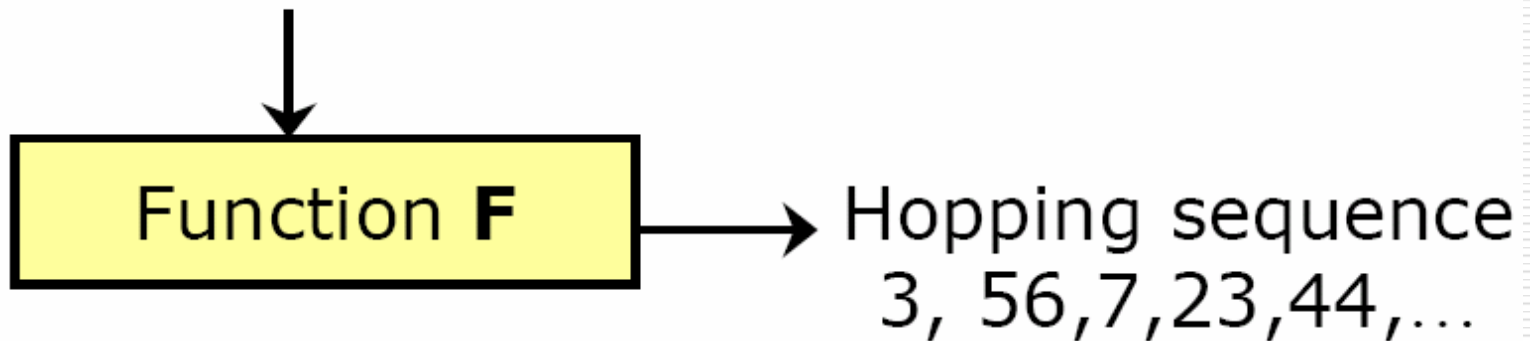
Bluetooth & BLUEPAC

- ☐ Bluetooth is a low-cost, low-power

- ☐ A slotted protocol with a FHSS (Frequency Hopping Spread Spectrum) in 2.4 GHz.

- ☐ The hop frequency is 1600 hops per second, the frequency spectrum is divided into 79 channels of **1** MHz bandwidth each.

Channel 1 Channel 2 ... Channel 79

2402M   2403M   2404M   2480M

2.4G ISM band
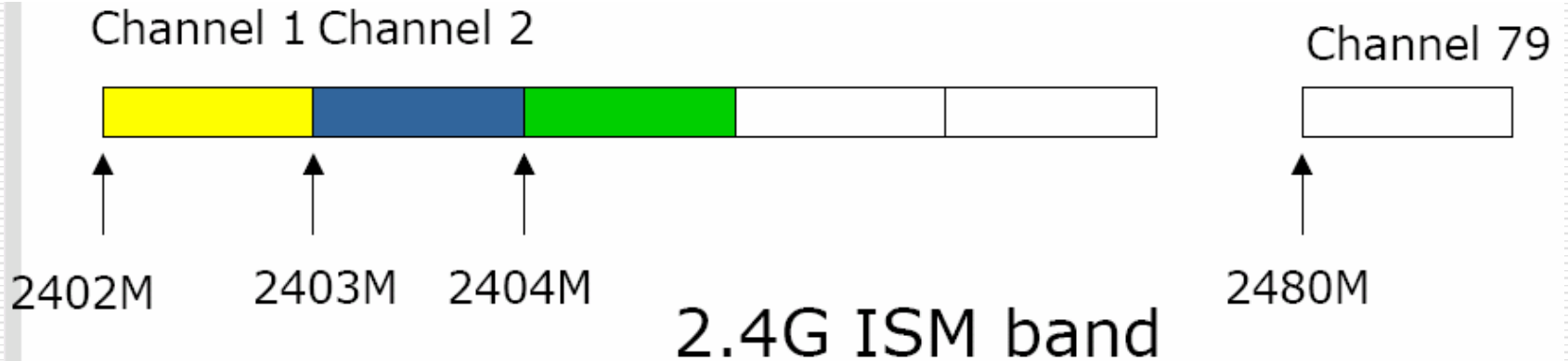
Bluetooth & BLUEPAC

☐ Each Bluetooth device has 48-bit address

48-bit Bluetooth address

↓

| Function **F** | → Hopping sequence 3, 56,7,23,44,...

Bluetooth & BLUEPAC

- A strict master-slave scheme.

- A device acting as master can have up to 7 active slaves connected.

- Master and slaves form a so-called *piconet,*
  - Master defines the timing and the hop pattern.
  - Slaves have to stay synchronized to the master

Bluetooth & BLUEPAC

☐ Link support

■ Synchronous Connection Oriented (SCO) links (typically used for voice)

■ and an Asynchronous Connectionless link (ACL)

☐ Time Division Duplex (TDD)
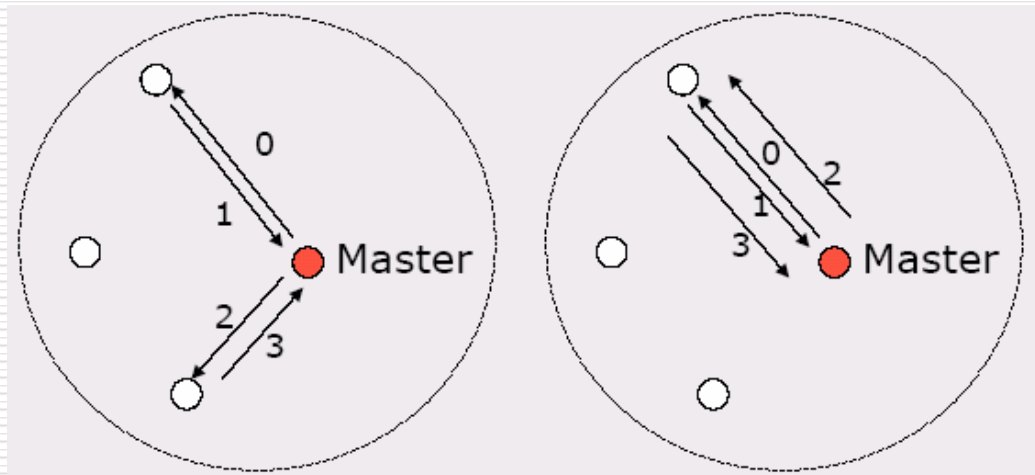
Bluetooth & BLUEPAC

- ☐ Master/slave establish connection
  - ■ Master enters inquiry state
    - ☐ Master send inquiry command two times in one time slot
    - ☐ Slave in inquiry scan state, will send its 48 bits bluetooth address to master.

  - ■ Master enters Page state
    - ☐ Master sends to slave 48-bit Address and clk (for computing hopping sequence).
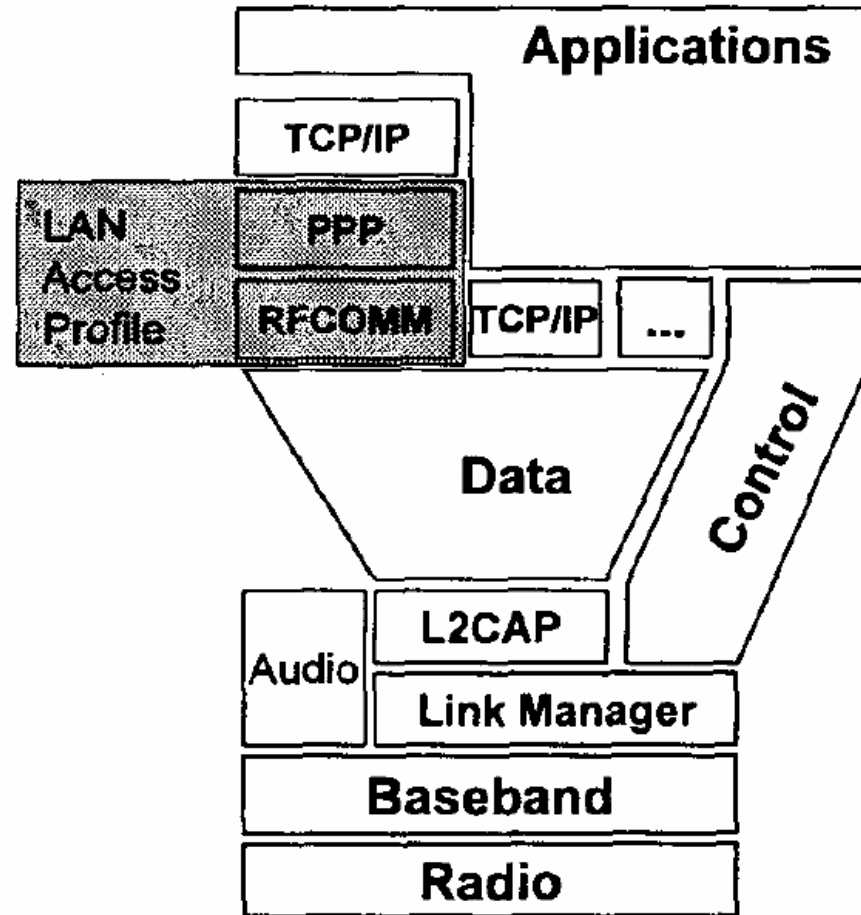
Bluetooth & BLUEPAC

Figure 2: Bluetooth protocol stack
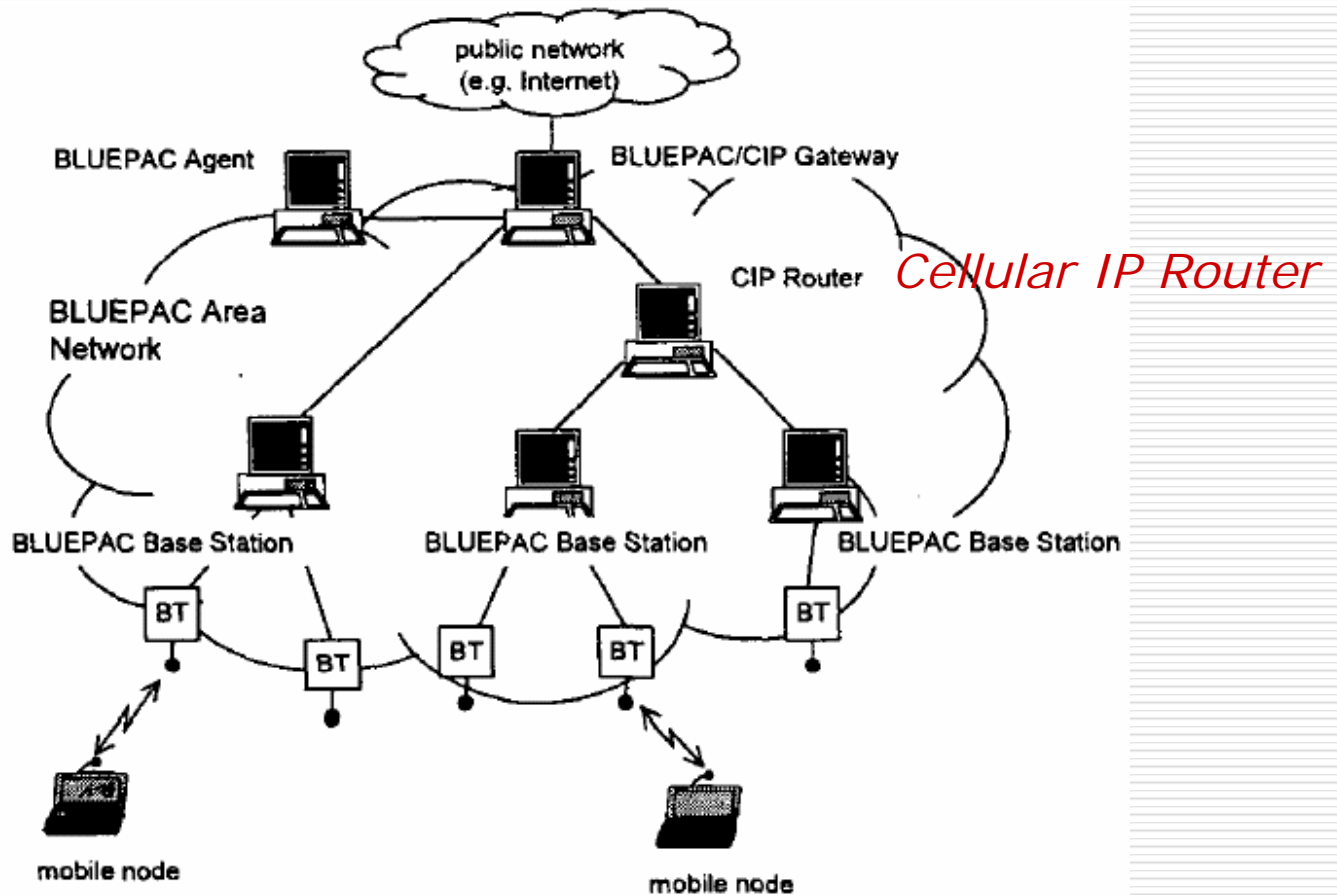
Bluetooth & BLUEPAC

Cellular IP Router

Figure 3: BLUEPAC reference network with functional elements

Bluetooth & BLUEPAC
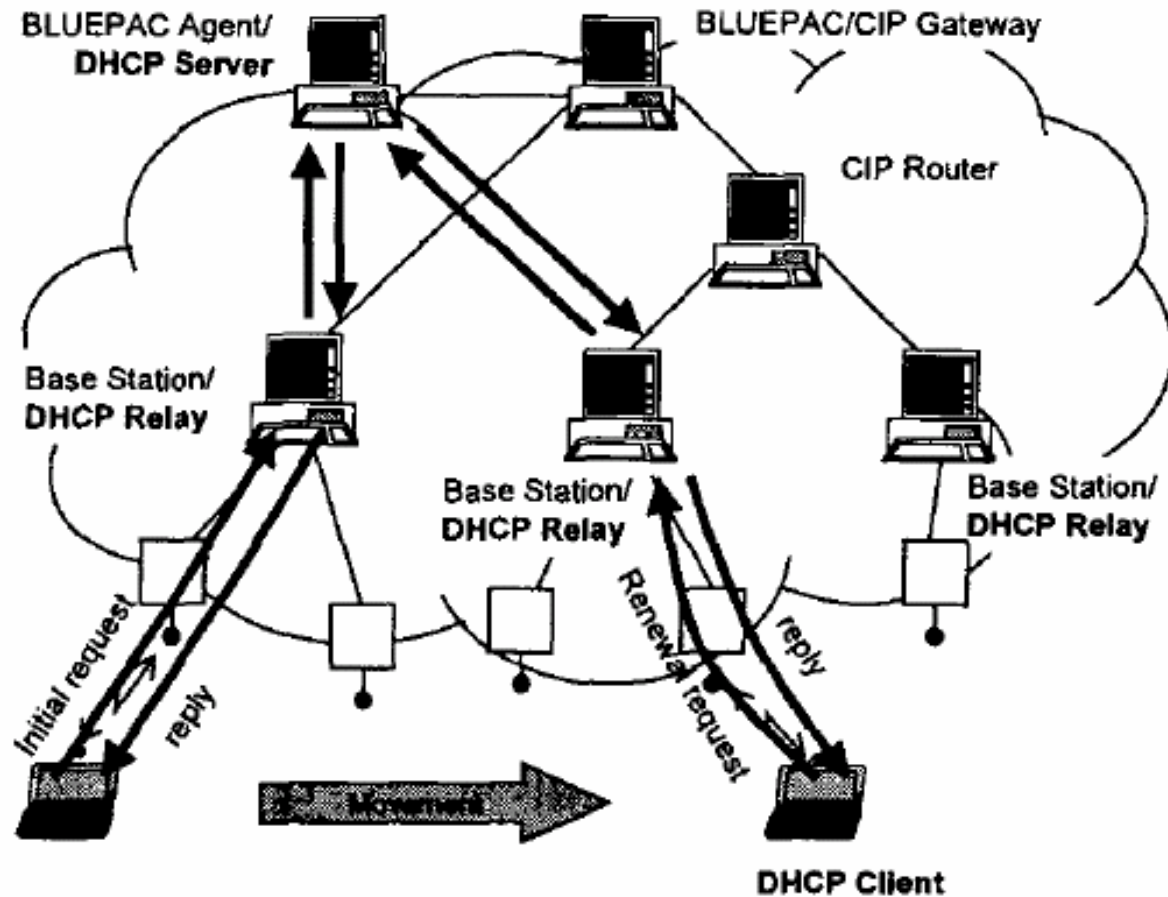

Figure 4: DHCP lease renewal

Handoff support

☐ The layer 2 which are supported mobility of Bluetooth devices in a BLUEPAC network.

☐ The IP Adaptation Layer which is inserted between IP and L2CAP to provide a suitable data link layer.
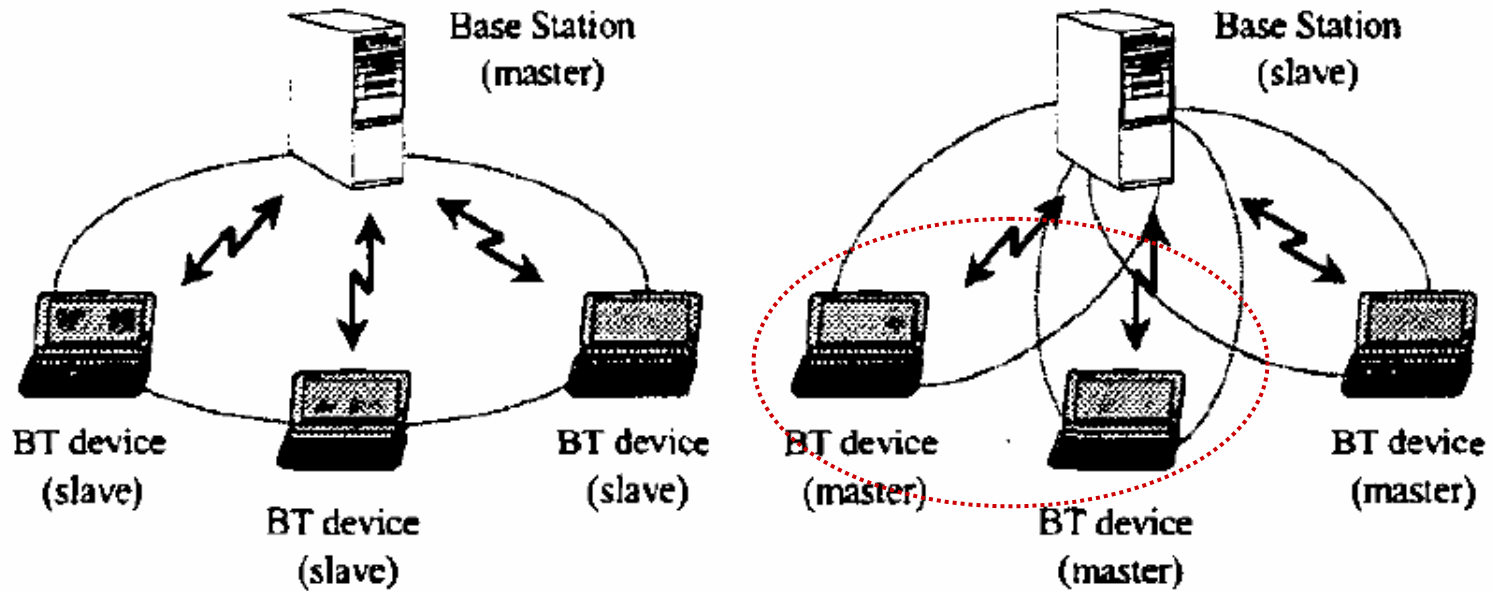
Handoff support

Figure 5: Comparison of a Base Station acting as master and as slave

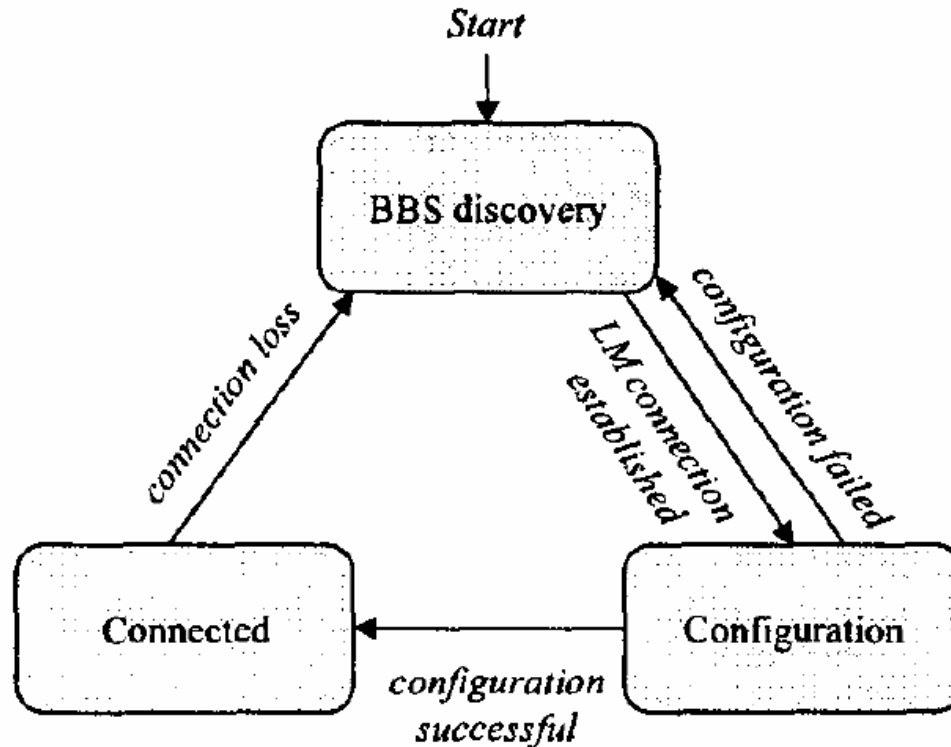# Handoff support-IP Adaptation Layer for mobile devices

Figure 6: State machine for the IP Adaptation Layer for mobile devices

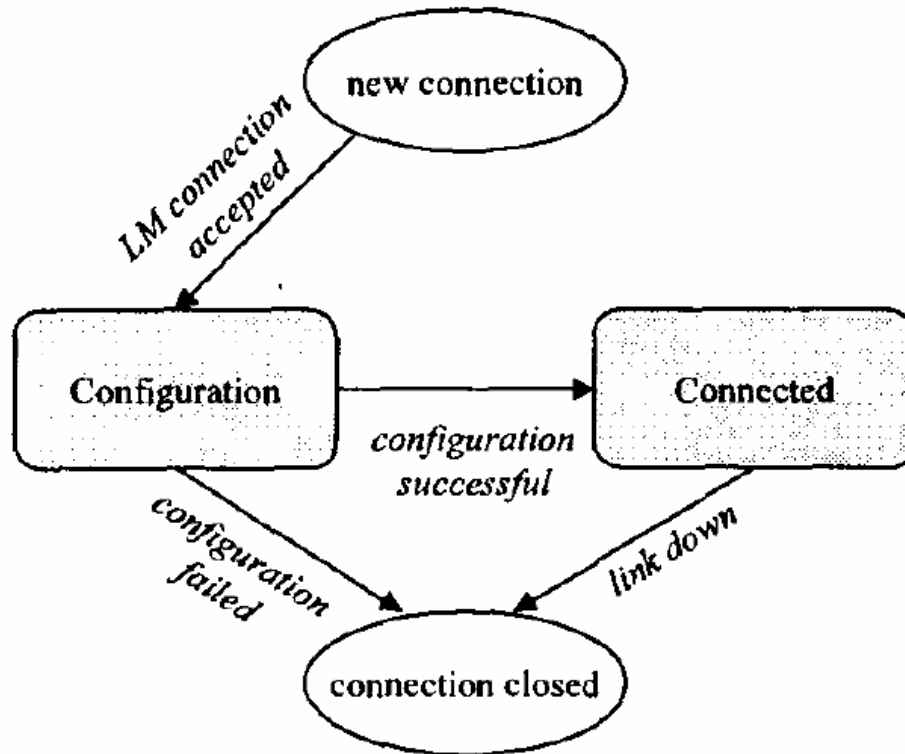# Handoff support-IP Adaptation Layer for Base Station

Figure 7: State machine for the IP Adaptation Layer for Base Stations

Handoff support

- ☐ Another important job is to detect a possible handoff.
  - ■ *Link supervision timer*
    - ☐ the default value for the *Link supervision timer* is *20* seconds.
      - ■ Too small value has the effect of tearing down a connection too early and thus wasting time for reconnecting.

      - ■ Too large value has the affect that time is wasted by regarding a link as alive, despite being out of range of the Base Station.
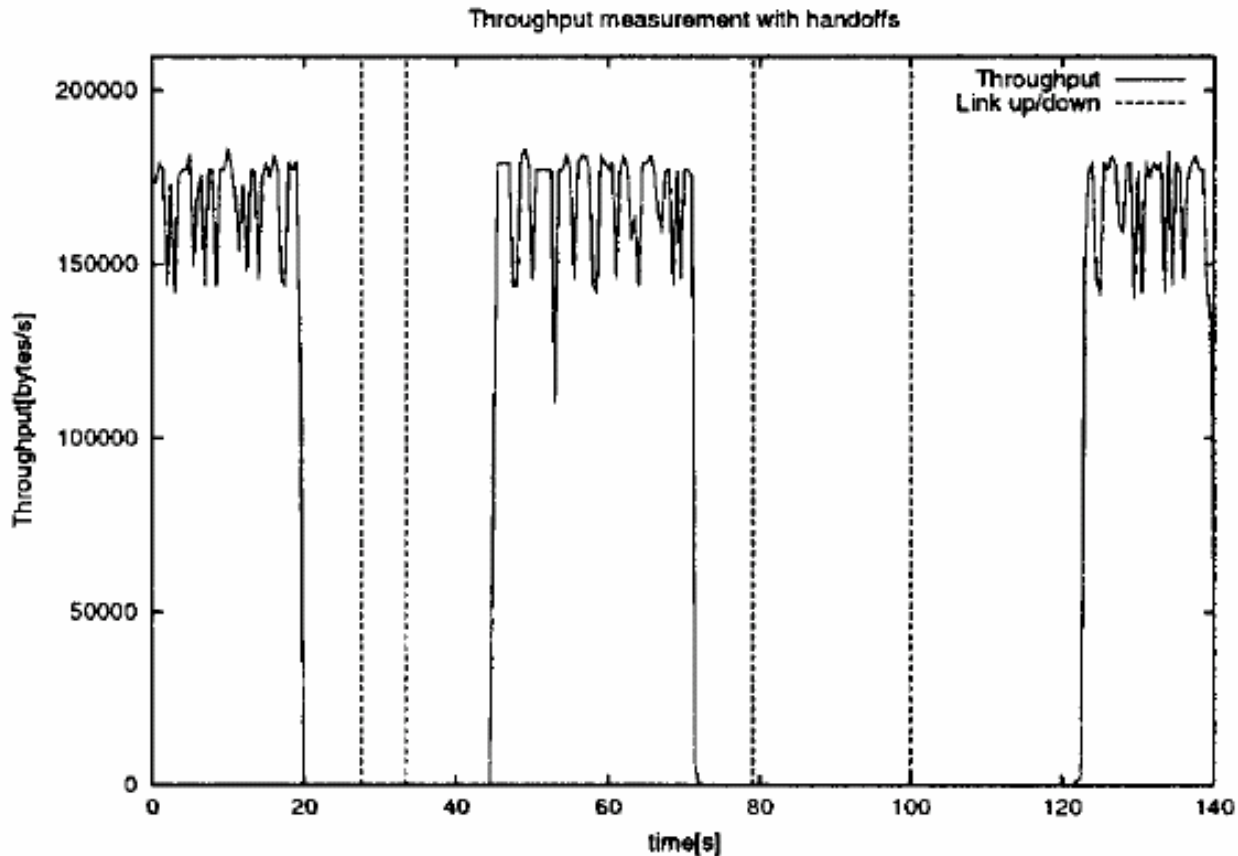
Handoff support

Throughput measurement with handoffs

Figure 9: TCP throughput measurement in the BLUEPAC emulation system
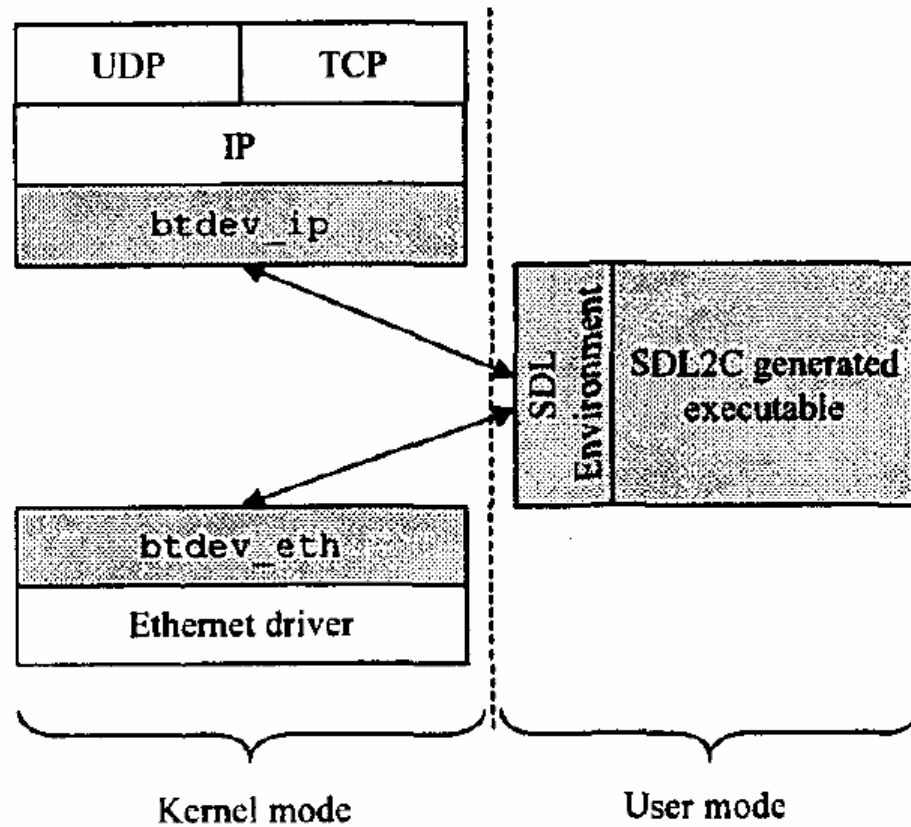
Prototyping

Figure 10 Integration of the emulation system into the TCP/IP protocol stack

Prototyping

- The prototyping system showed that
  - Bluetooth devices are able to successfully move between different Base Stations and

  - keep existing higher layer connections alive.

Conclusons

- ☐ Handoff performance is strongly dependent on the time by the broken link detection

- ☐ An ideal value for the link supervision timer is still an open issue.