

# SCTP for Vertical Handover

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# SCTP



- **Stream Control Transmission Protocol**
  - ❖ RFC 2960 (October 2000)
- **Two Major Extensions**
  - ❖ PR-SCTP (Partial Reliable SCTP): RFC 3758
  - ❖ Dynamic Address Reconfiguration (ADD-IP): I-D
- **IETF Transport Area (TSV) WG**
  - ❖ Sockets API extensions for (SCTP)
  - ❖ SCTP Implementer's Guide

# Related Links

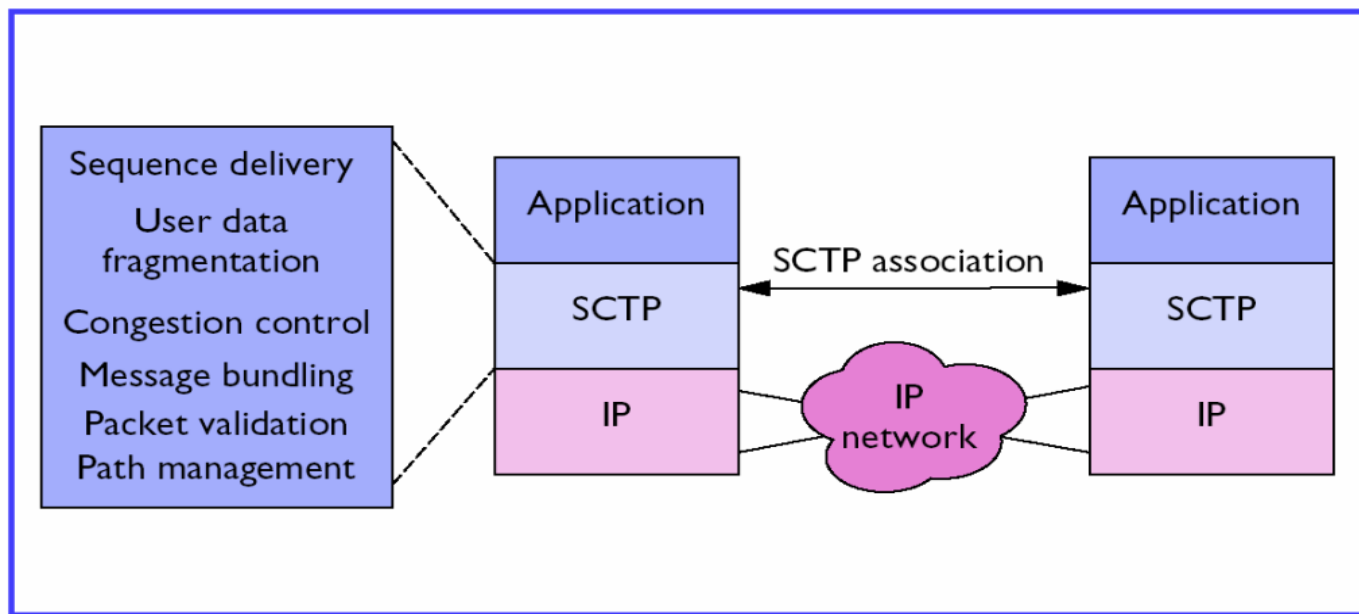


## ❑ SCTP Implementations

- ❖ Linux (since Kernel 2.6.0)
  - <http://www.kernel.org/>
- ❖ LK-SCTP
  - <http://sourceforge.net/projects/lksctp>
- ❖ SCTPLIB: User Space Implementation
  - <http://www.sctp.de/sctp.html>
- ❖ ns-2 for SCTP
  - <http://www.cis.udel.edu/~iyengar/research/>

# SCTP Architecture

- The 3<sup>rd</sup> Transport Protocol (next to TCP and UDP)
  - ❖ Protocol ID = 132
    - (cf.) TCP = 6, UDP = 17



# SCTP Features



## □ Similarly to TCP

- ❖ Connection-Oriented Unicast protocol
- ❖ Reliable and Full duplex transmission
- ❖ TCP-friendly flow and congestion control

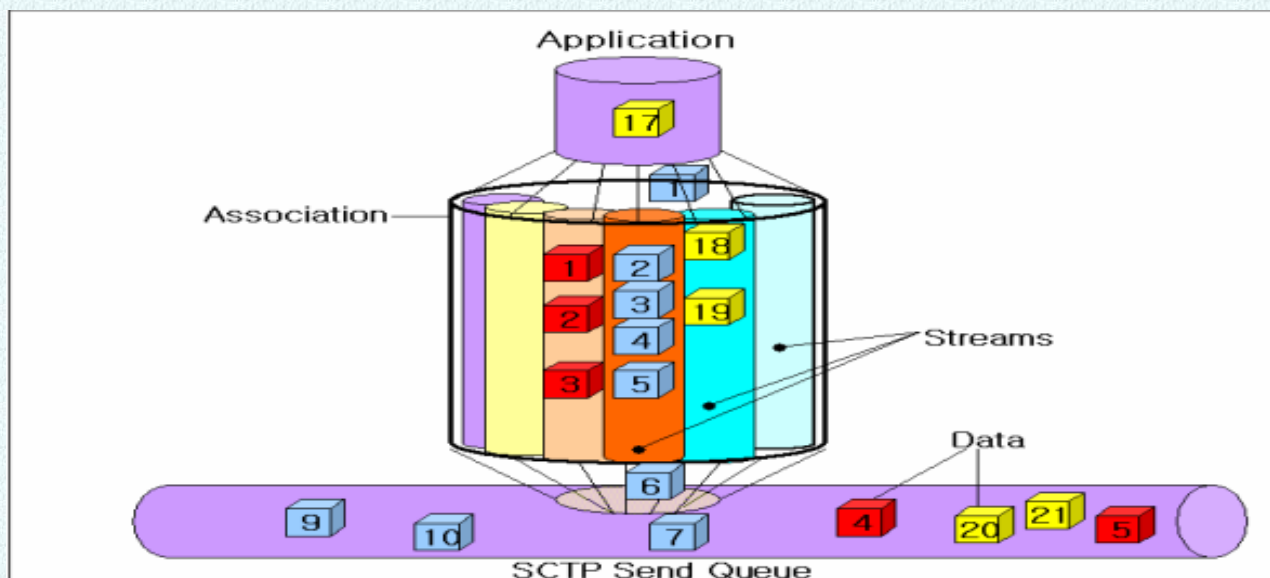
## □ Differently from TCP

- ❖ Message-Oriented (data chunks)
- ❖ Multi-Streaming
- ❖ Multi-Homing
- ❖ 4-Way Connection Setup
- ❖ 3-Way Connection Shutdown

# SCTP Multi-Streaming

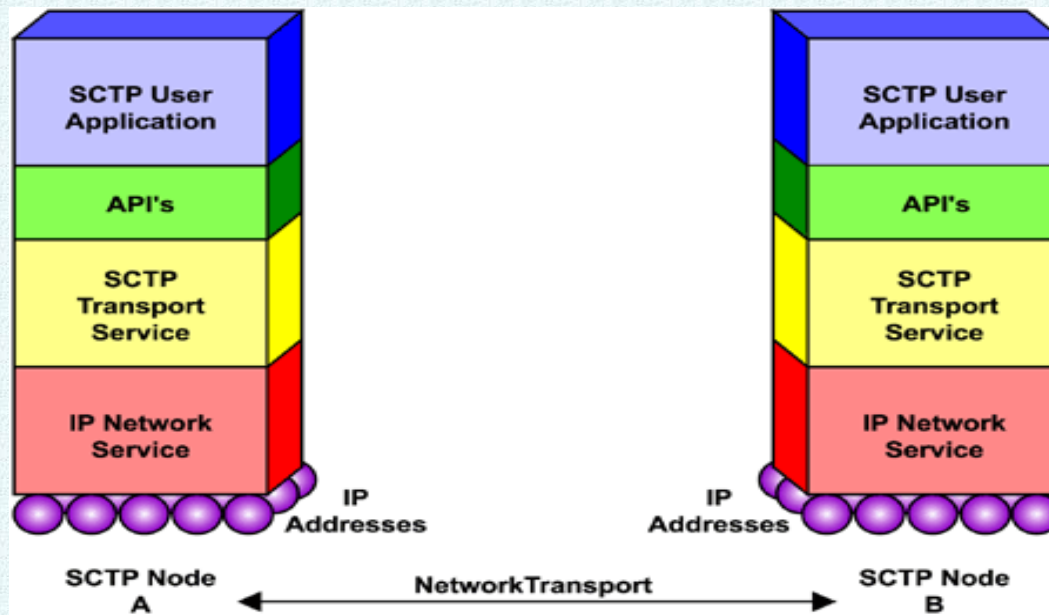
## □ Multi-Streaming per Association

- ❖ Stream ID
- ❖ Stream Sequence Number (SSN)



# SCTP Multi-Homing

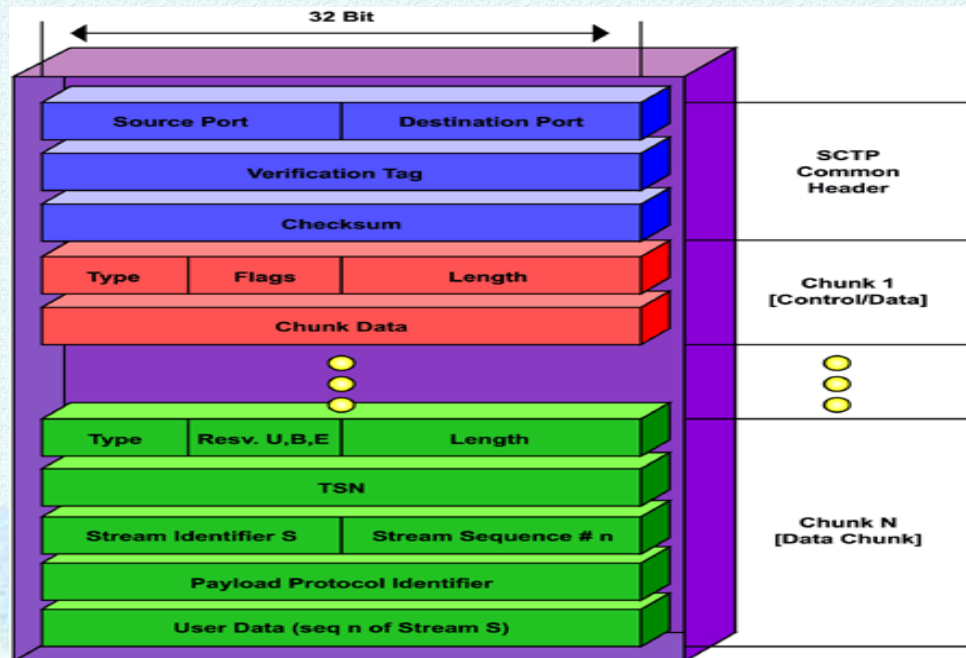
- ❑ Multiple IP addresses per Host
  - ❖ One Primary Path
  - ❖ One or more Backup Paths (against path failure)



# SCTP Packet

## □ Packet Format

- ❖ Common Header (12 bytes)
- ❖ Chunks (Data Chunk, Control Chunks)





# SCTP: Current Use



At present, SCTP is used for “Mission-Critical Reliable Transport” (instead of TCP):

- Signaling transport over IP (for VoIP)
- Transport between AAA servers
- Transport between SIP servers (cf. 3GPP)

These (servers) are using the SCTP “multi-streaming” and “multi-homing” for backup path.

# SCTP: Challenge



**<Question>**

**Could SCTP be used by end users (terminals) ?**

**If yes, one of the promising application areas is  
"mobile SCTP (mSCTP)" ⇔ SCTP handover**

# Mobile SCTP (mSCTP)



## □ mSCTP

- ❖ mSCTP = SCTP with ASCONF(ADD-IP) extension
- ❖ ASCONF extension
  - Dynamic IP Address Reconfiguration
    - ✓ During an association
    - ✓ ASCONF, ASCONF-ACK chunks
  - Three functions
    - ✓ Add a new IP address to the association
    - ✓ Change the primary IP address for the association
    - ✓ Delete the old IP address from the association

# mSCTP



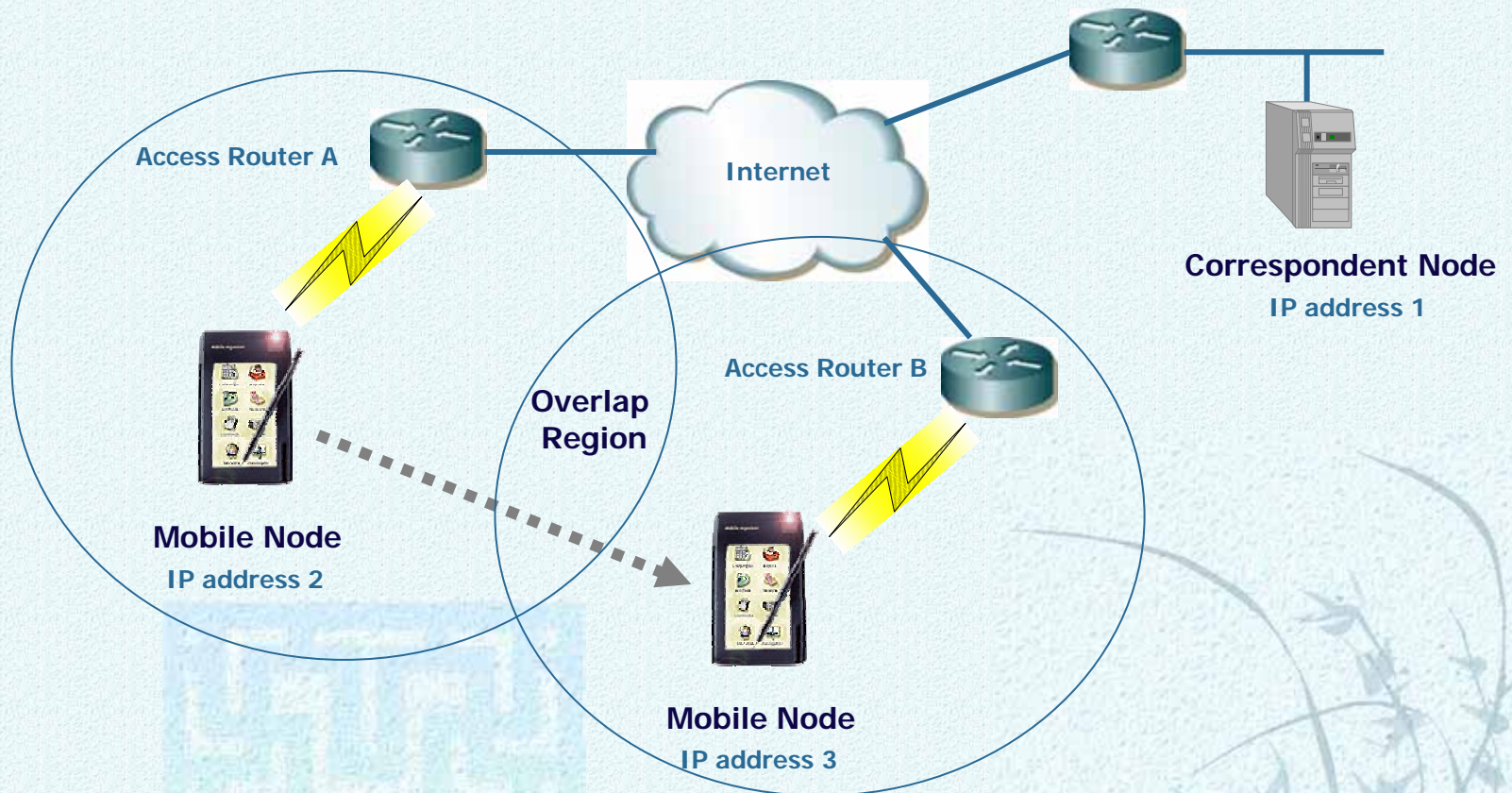
## □ mSCTP ⇔ SCTP handover

- ❖ mSCTP is used to support **soft handover**
  - For a moving terminal
  - Using the SCTP multi-homing feature
  - Using the ASCONF extension
  - In the transport layer
- ❖ mSCTP does not rely on
  - Network Agents for Handover Tunnel (MIP FA)
  - Home address (MIP HoA)

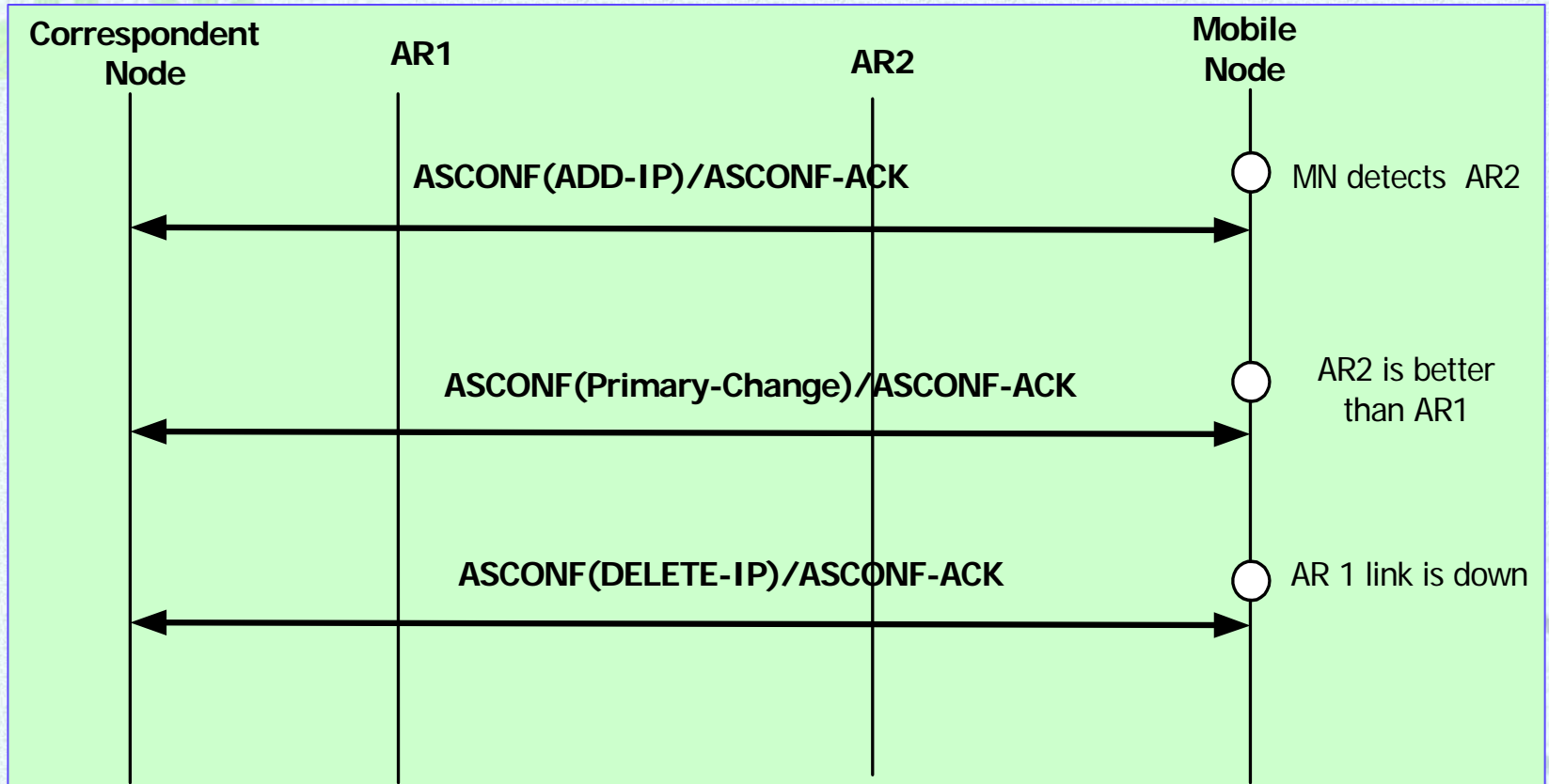
# mSCTP Handover

## □ mSCTP Handover Scenario

- ❖ MN moves from location A to location B during a session



# mSCTP: Control Flow



# Socket APIs for mSCTP (Linux)



## □ API for ADD-IP and DELTE-IP

❖ "sctp\_bindx()"

```
int sctp_bindx(sockfd, sockaddr *addrs, addrcnt, flags);
```

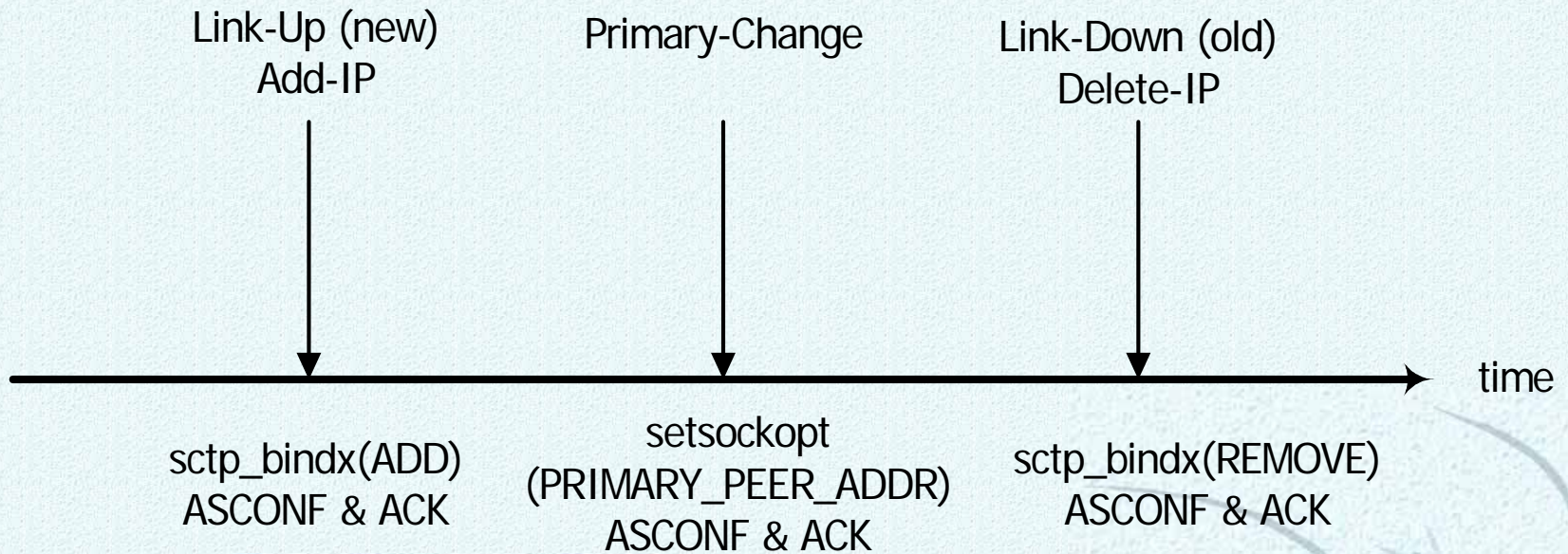
## □ API for Primary-Change

❖ "SCTP\_SET\_PEER\_PRIMARY\_ADDR" Socket option

```
setsockopt(sd, IPPROTO_SCTP, SCTP_SET_PEER_PRIMARY_ADDR,  
*setpeerprim, len)
```

# mSCTP Handover

## □ API sequences

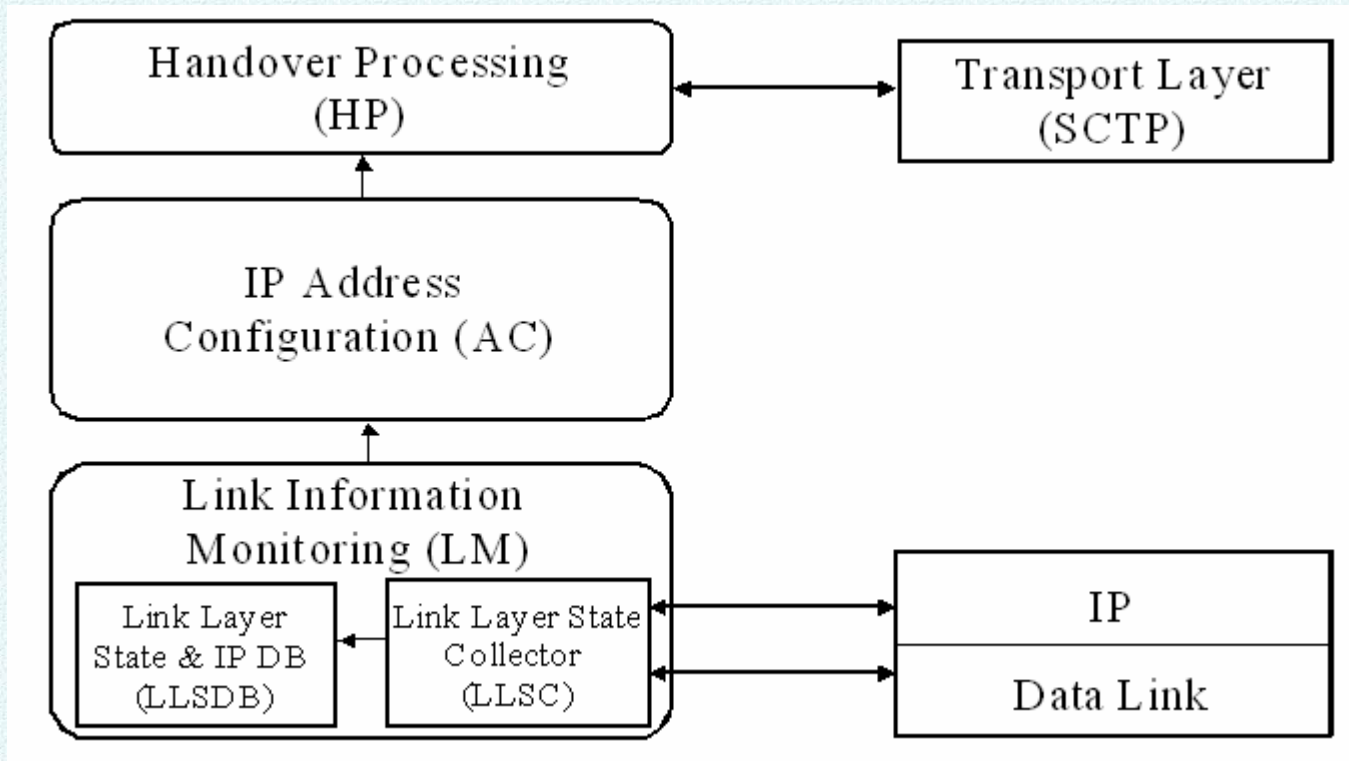




# mSCTP: TODO

## □ Automatic IP Address Configuration for mSCTP

❖ Link (up/down) ⇔ IP address ⇔ mSCTP



# Vertical Handover

## □ Vertical versus Horizontal Handover

### ❖ Vertical Handover

- Between Heterogeneous (Access) Networks
- Multiple Network Interfaces (multi-homing)

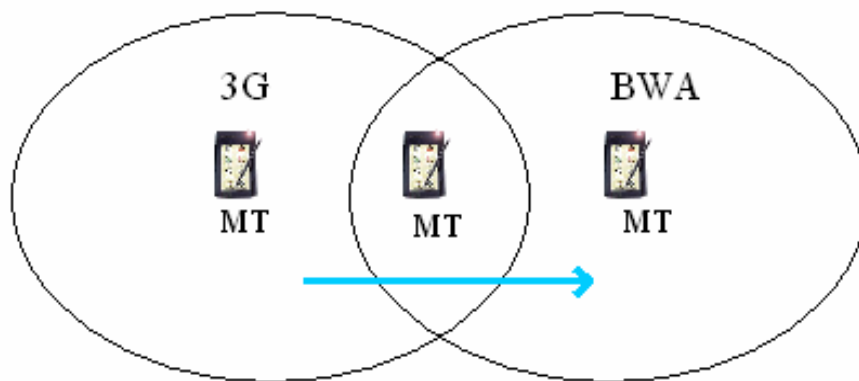
### ❖ Horizontal Handover

- Between Homogeneous (Access) Networks
- Single Network Interface (single-homing)

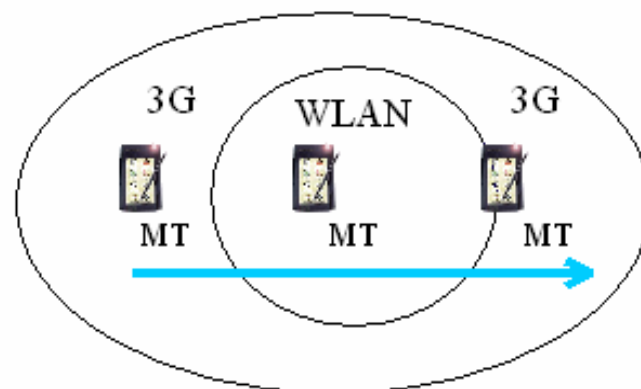
# Vertical Handover

## □ Examples

- ❖ 3G ⇔ BWA(WiBro)
- ❖ 3G ⇔ WLAN



(a) 3G-BWA



(b) 3G-WLAN

# mSCTP for Vertical Handover



## Experimentation over Linux 2.6.10 & LK-SCTP

No. .	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.0.101	192.168.0.100	SCTP	INIT
2	0.000292	192.168.0.100	192.168.0.101	SCTP	INIT_ACK
3	0.000355	192.168.0.101	192.168.0.100	SCTP	COOKIE_ECHO
4	0.000568	192.168.0.100	192.168.0.101	SCTP	COOKIE_ACK
5	0.000769	192.168.0.101	192.168.0.100	SCTP	DATA
6	0.000990	192.168.0.101	192.168.0.100	SCTP	ASCONF
7	0.001020	192.168.0.100	192.168.0.101	SCTP	SACK
8	0.001027	192.168.0.100	192.168.0.101	SCTP	ASCONF_ACK
9	0.001939	192.168.0.100	192.168.0.101	SCTP	DATA
10	0.002052	192.168.0.101	192.168.0.100	SCTP	SACK
11	0.007854	192.168.0.101	192.168.0.100	SCTP	DATA
12	0.008356	192.168.0.100	192.168.0.101	SCTP	SACK DATA
13	0.008457	192.168.0.100	192.168.0.101	SCTP	DATA
14	0.008571	192.168.0.101	192.168.0.100	SCTP	SACK
15	0.008557	192.168.0.100	192.168.0.101	SCTP	DATA
16	0.010567	192.168.0.101	192.168.0.100	SCTP	DATA
17	0.011184	192.168.0.101	192.168.0.100	SCTP	ASCONF
18	0.011353	192.168.0.100	192.168.0.102	SCTP	ASCONF_ACK
19	0.012130	192.168.0.101	192.168.0.100	SCTP	DATA
20	0.012320	192.168.0.100	192.168.0.101	SCTP	SACK
21	0.013416	192.168.0.101	192.168.0.100	SCTP	SACK
22	0.014040	192.168.0.101	192.168.0.100	SCTP	DATA
23	0.030749	192.168.0.100	192.168.0.102	SCTP	DATA
24	0.043514	192.168.0.100	192.168.0.102	SCTP	DATA
25	0.043654	192.168.0.101	192.168.0.100	SCTP	SACK
26	0.056957	192.168.0.100	192.168.0.102	SCTP	DATA
27	0.107983	192.168.0.102	192.168.0.100	SCTP	ASCONF
28	0.108188	192.168.0.100	192.168.0.102	SCTP	ASCONF_ACK
29	0.108299	192.168.0.102	192.168.0.100	SCTP	DATA
30	0.108445	192.168.0.100	192.168.0.102	SCTP	SACK
31	0.108464	192.168.0.102	192.168.0.100	SCTP	DATA
32	0.109175	192.168.0.102	192.168.0.100	SCTP	SACK
33	0.109252	192.168.0.102	192.168.0.100	SCTP	DATA
34	0.109345	192.168.0.100	192.168.0.102	SCTP	SHUTDOWN
35	0.109419	192.168.0.100	192.168.0.102	SCTP	SACK
36	0.109508	192.168.0.102	192.168.0.100	SCTP	SHUTDOWN_ACK
37	0.109449	192.168.0.100	192.168.0.102	SCTP	SHUTDOWN
38	0.109634	192.168.0.100	192.168.0.102	SCTP	SHUTDOWN_COMPLETE

Frame 6 (80 bytes on wire, 80 bytes captured)  
Linux cooked capture  
Internet Protocol, Src Addr: 192.168.0.101 (192.168.0.101), Dst Addr: 192.168.0.100 (192.168.0.100)  
Stream Control Transmission Protocol  
Source port: 6666  
Destination port: 9999

File: cap-1 10670 bytes 00:00:00 P: 38 D: 38 M: 0

# Conclusions



## □ Mobility Management

### ❖ Location Management

➤ MIP, SIP, etc

### ❖ Handover Management

➤ Network-Layer Solution: MIP Fast Handover

➤ End-to-end Solution: mSCTP, SIP

## □ SCTP (mSCTP) can be used

❖ For soft handover (vertical handover)

❖ Using the multi-homing feature

❖ In the “end-to-end” transport layer



**Thank you for your attention !!**

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