- Packets may be in transit during the switchover in networks. How many packets are lost?
- Notation:
  - $t_{MN \rightarrow FAi}$ = delay from mobile node to i-th FA
  - $t_{HA \rightarrow FAi}$ = delay from HA to i-th FA
  - $t_{CN \rightarrow HA}$ = delay from CN to HA
  - d_{DATA} = duration of data packet
- Assumptions: control packets have negligible duration; no delay for computation; no errors.
- Based on the figure, the total delay between the link breaking and being re-established is

(Eq. 1)

- Two options: retransmit or buffer
  - Retransmit: all lost packets are dropped and retransmitted by the CN. Advantage: simple; disadvantages: wastes bandwidth, larger latency.
  - Buffer: a required number of packets are retained by the HA in a buffer in case the foreign network changes. Advantages: low latency; disadvantages: complexity at the HA.
- (Example.)
- Aside from packet loss, out-of-order packet delivery is a problem, whether you buffer or retransmit (though it is better with buffering)
- Soft handover: Maintain simultaneous links to two foreign networks during the handover process to ensure that packets are not lost – also helps with out-of-order delivery
- Disadvantage: Wasteful of bandwidth, though usually for only a short time

(Fig. 1)

Micro-mobility

- Say you are designing a cell network. As a result of the above analysis, you want to minimize packet losses.
- Travelling between adjacent cells, owned by the same company, it seems excessive to rebuild a link from scratch after every handoff
- Cellular IP:
    - Group several base stations into a cluster, and assign a common FA to the entire cluster
    - This common FA is called the Cellular IP gateway
    - Downstream of the CIP gw is a router to redirect packets in case of handoff within the cluster
- Thus, packet losses only occur when travelling between clusters, which is less frequent than travelling between base stations

(Fig. 2)

- packets are essentially never lost, and the smaller delay among the localized nodes means that fewer out-of-order packets arrive

Mobility support in IPv6

- First cellular phones: 1973 (prototypes), 1978 (first commercial network in Chicago)
- First portable computers: Osborne 1 (1981), Compaq Portable (1983 – 28 lb)
- Internet Protocol: 1973 (proposal), 1981 (IPv4)

- So it’s reasonable that no mobility support would be built in to IPv4. However, IPv6 (1998) is designed with device mobility in mind.
- Fundamentally, mobility in IPv6 is similar to Mobile IP as an extension of IPv4. However … changes in IPv6:
    - All IPv6 nodes must do address autoconfiguration – so it’s easy for nodes to acquire a COA.
    - All IPv6 nodes can send address bindings to any other node – so the MN can send its new COA directly to the HA.
    - As a result of the above two facts, FAs are no longer needed.
    - Soft handover support: the MN can now send address bindings directly to the router handling old versions of the COA (as a result packet loss is minimized)
    - Address space massively increased, so it is not “wasteful” for every mobile device to keep two IP addresses