MOBILITY IN IP NETWORKS

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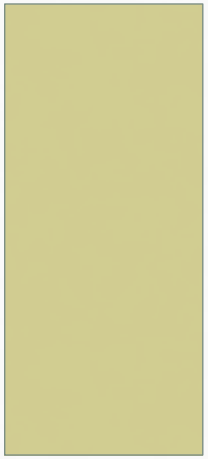
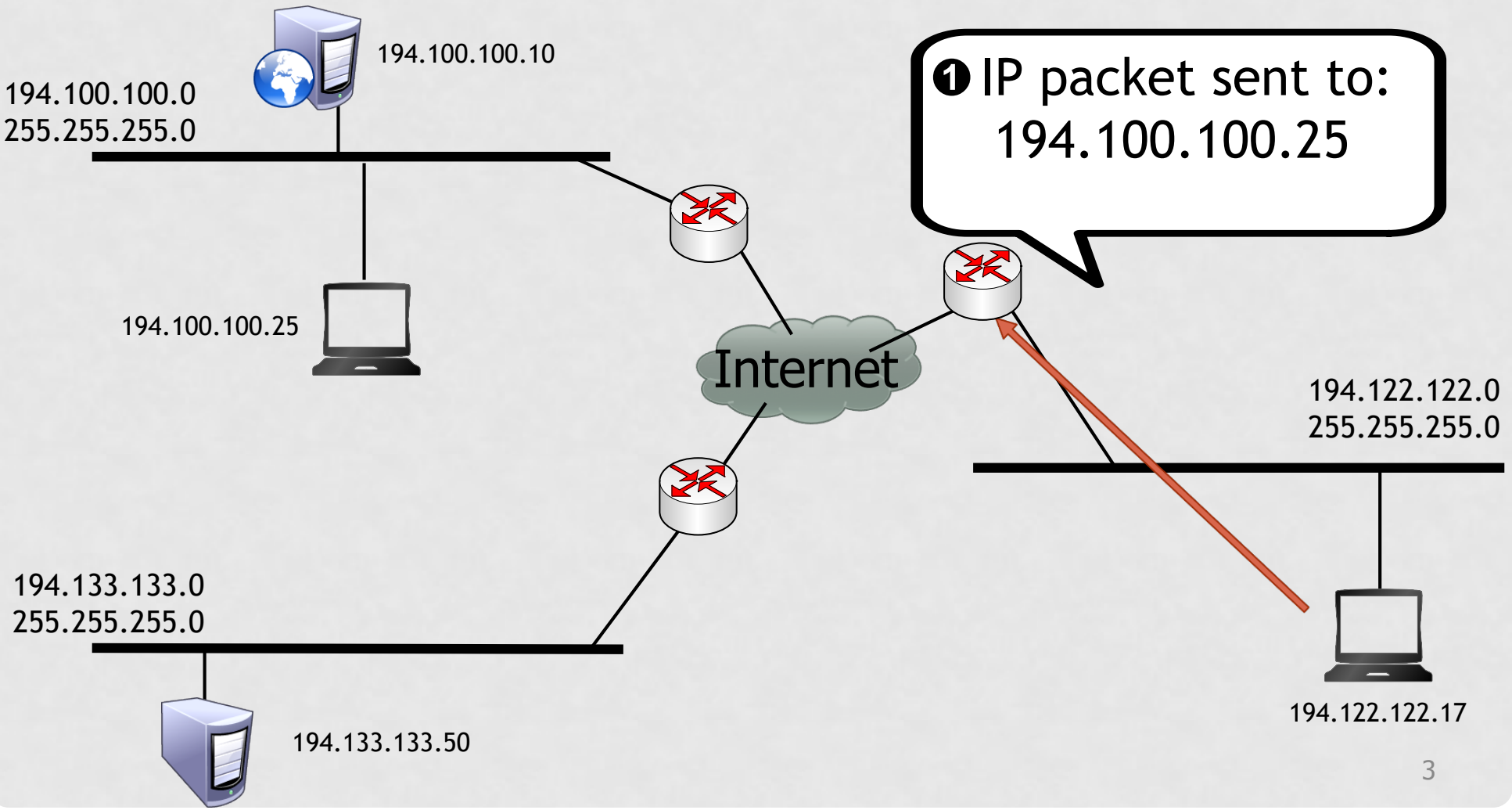


PROBLEM STATEMENT: ADDRESSING SCHEME IN IP NETWORKS

- The IP address:
  - Identifies a system (router or end-host) in an IP network:
    - Transport protocols such as TCP or UDP operate based on pairs (IP address + port number) for identification of source and destination communication endpoints.
  - Allows to route traffic between final systems
    - Routing is based on prefixes: hierarchical (classful), CIDR
    - The IP address has to be topologically correct
- Movement of an end-host in IP networks:
  - We would like to keep the original IP address to maintain identification of the host.
  - We would like to change the IP address in order to make it 'topologically correct', i.e. To reflect new point of attachment to the network

PROBLEM STATEMENT



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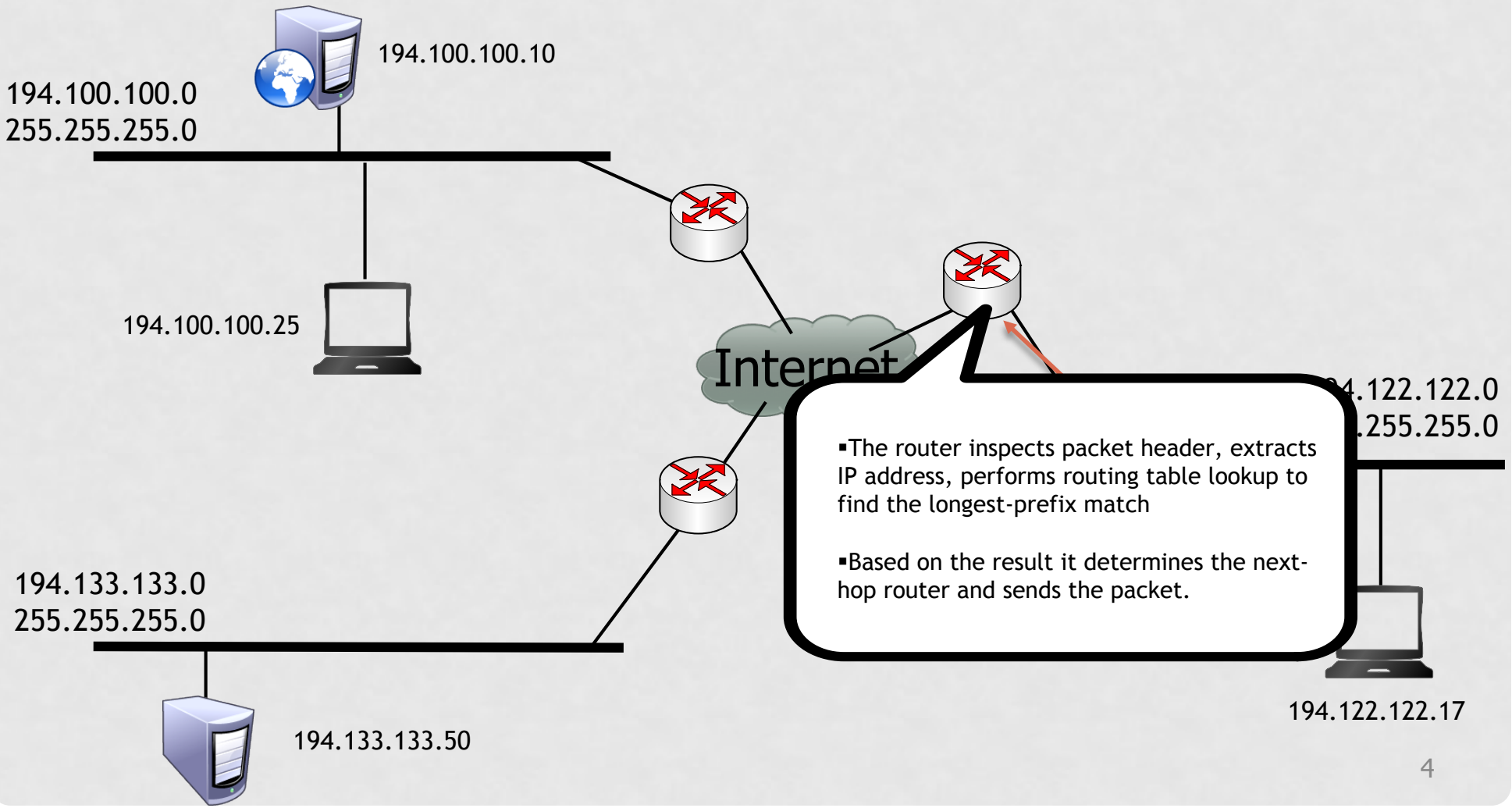

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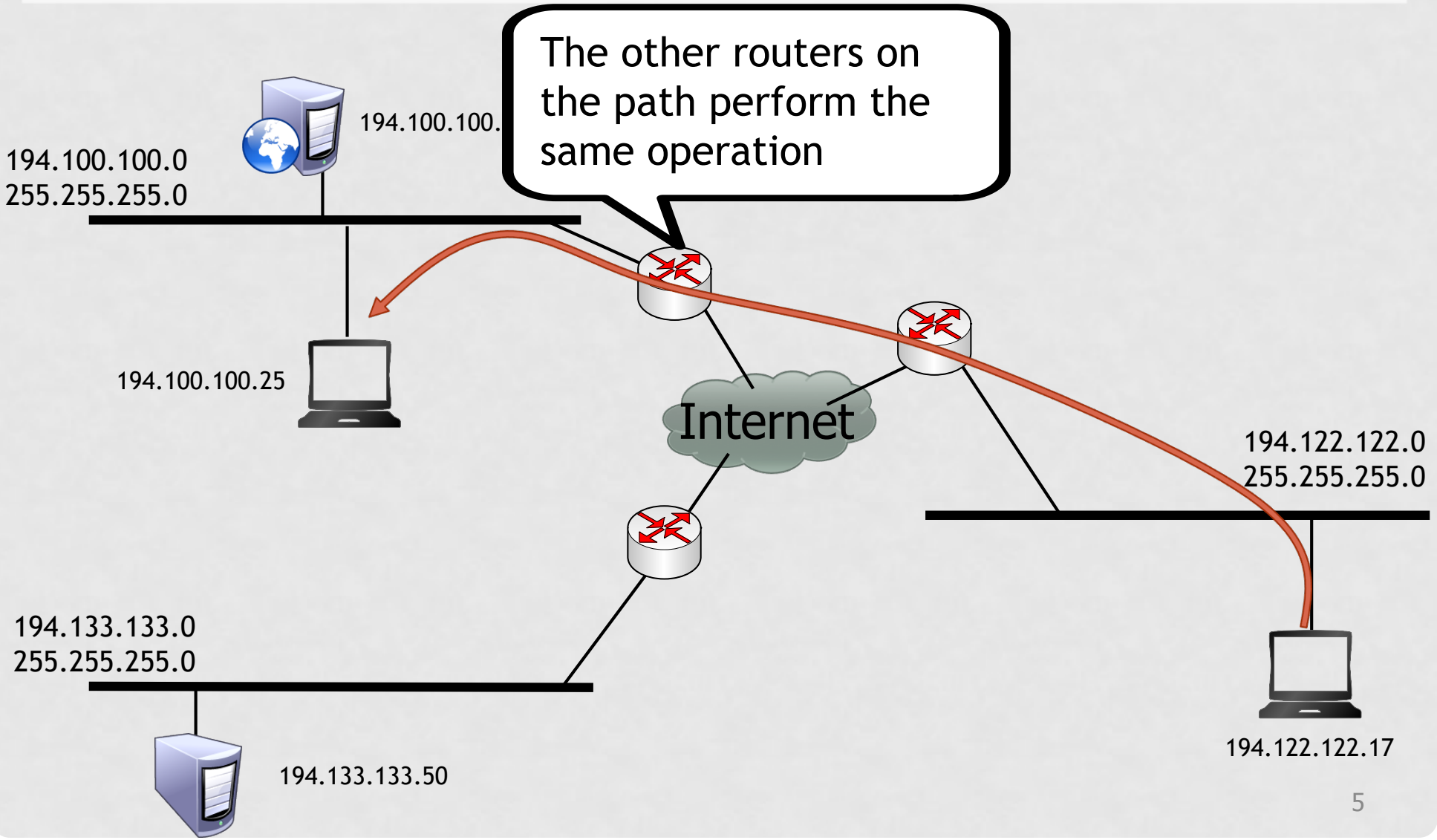

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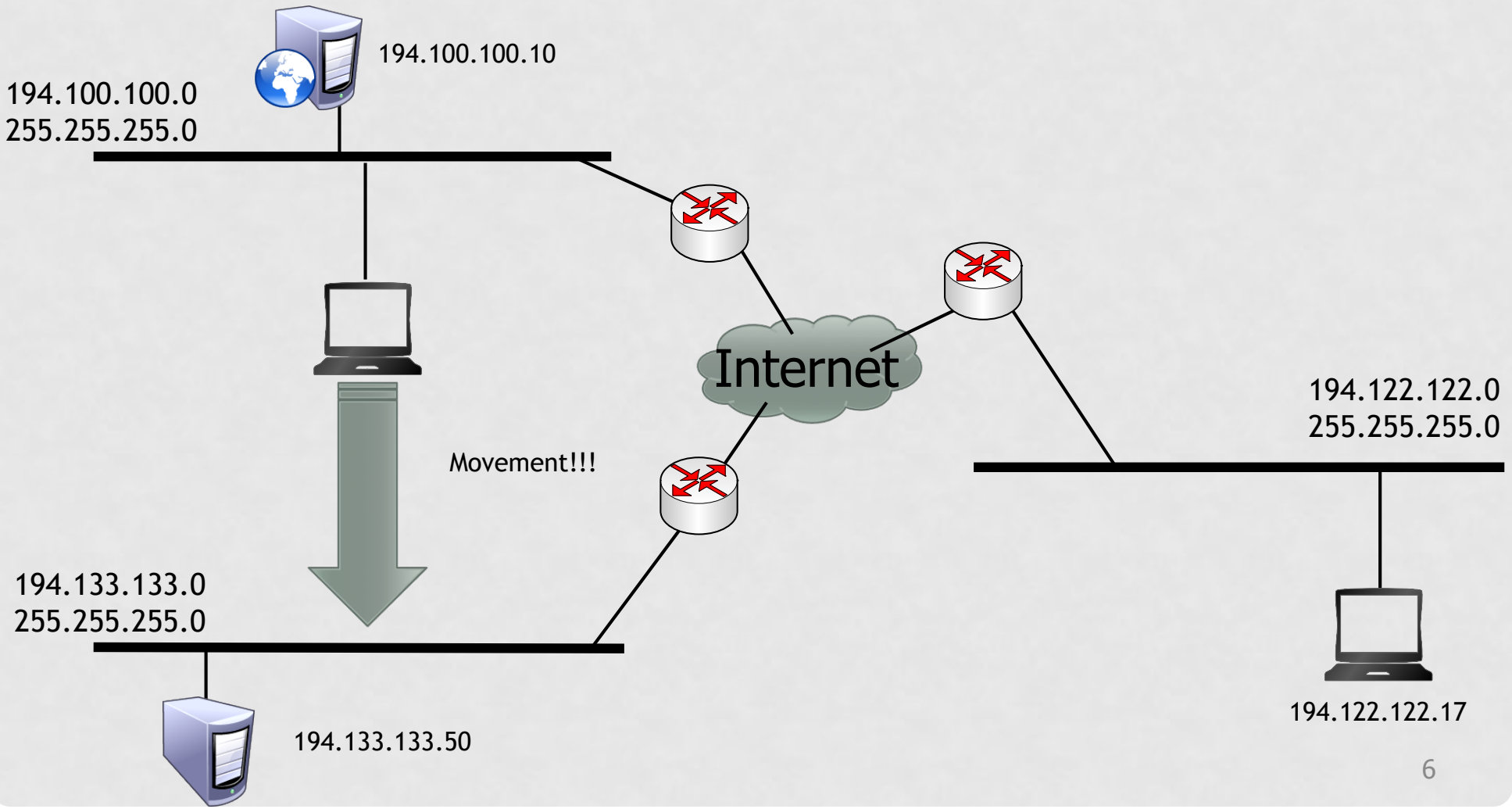

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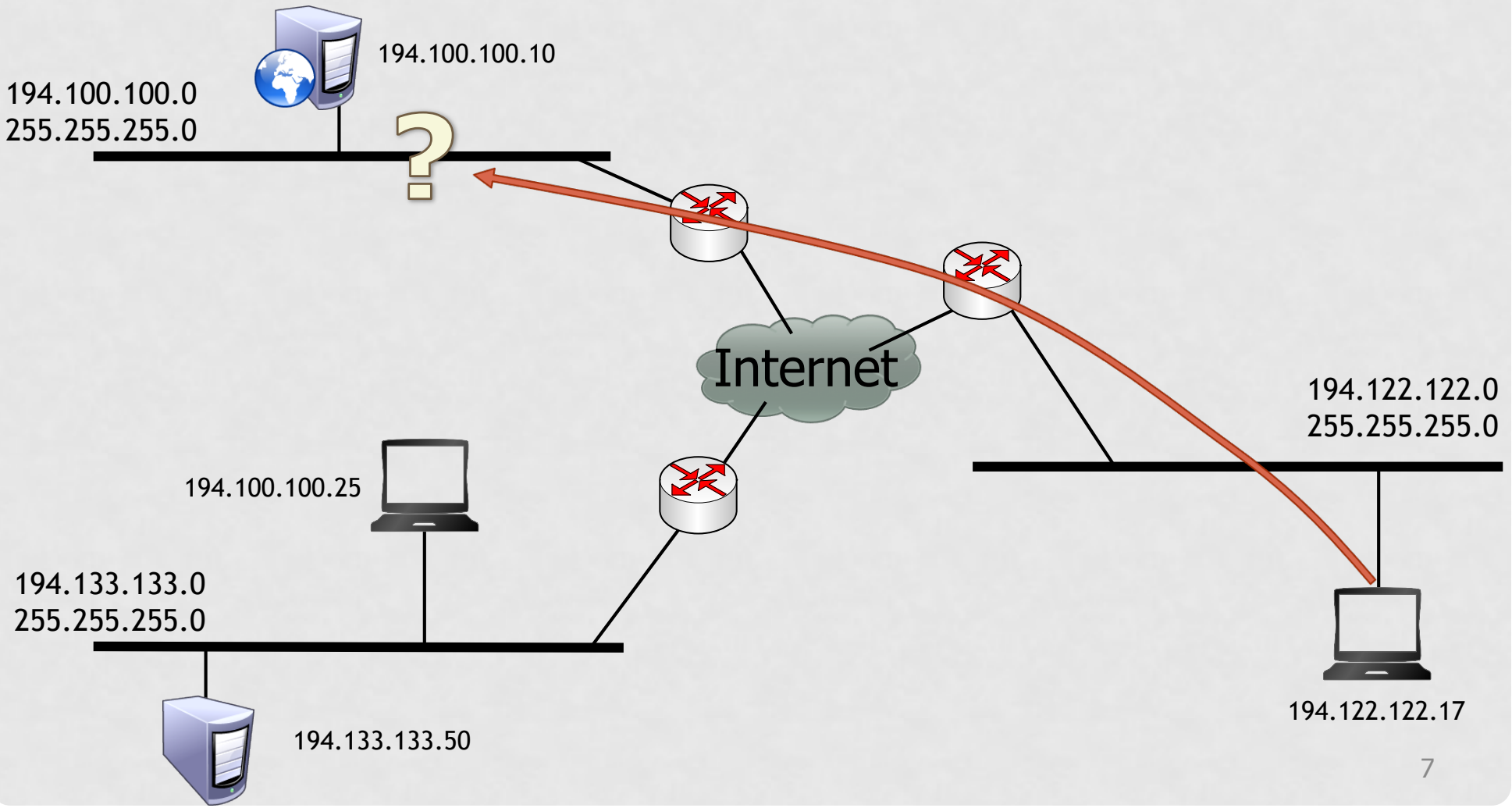


PROBLEM STATEMENT

- There are two IP-based alternatives to maintain reachability of hosts that move:
  - Advertise per-host routes in the Internet to announce their current point-of-attachment to all routers
    - Requires update in routing tables of all routers
      - Not scalable
      - No support for security (e.g. DoS attacks)
    - Has high latency
  - Change the IP address and use the new one
    - Mobility versus portability

MOBILE IP (IPV4)

- Supports continuous connectivity(mobility)
  - Mobility implies that the running sessions (open connections) are maintained after the movement and the system is still identified by its IP address.
- Defined by IETF in RFC 2002 (October 1996). Revised in RFC 3344 (August 2002)
- Extends the IP protocol to preserve identification of a mobile when it is moved and allows the node to receive packets independent of its current point of attachment to the network.
- Introduces control messages to allow mobile nodes to manage their internal routing tables in a secure way.
- Several commercial and open source implementations exist.
- Fully independent of the underlying technology: Ethernet, IEEE 802.11, cellular, …

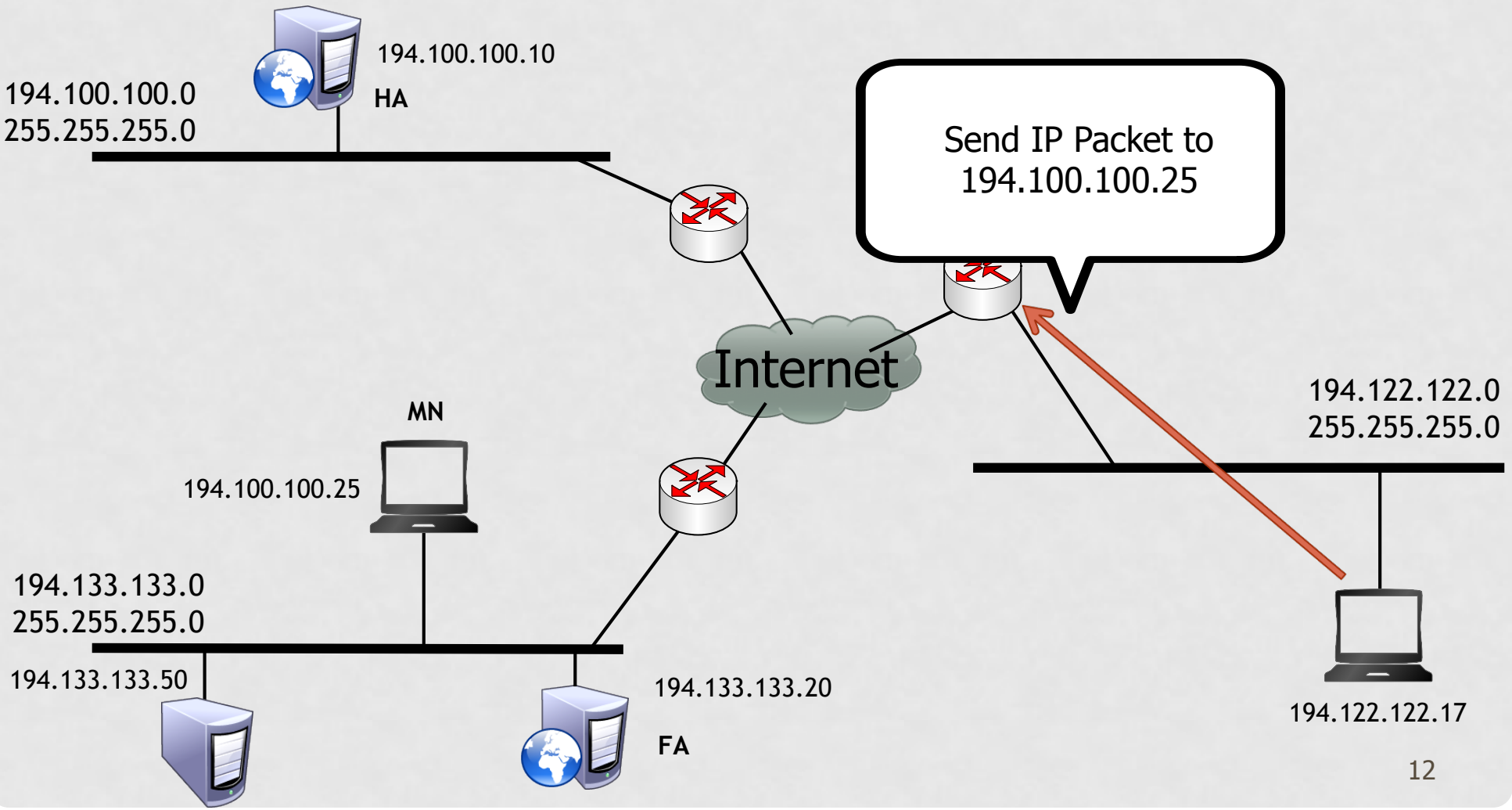
WHY WE USE IP LAYER FOR MOBILITY ?

- Mobility is supported at the Network Layer
  - Fully independent of the lower-layers which are technology specific
- Provides a uniform solution for upper layers.
  - Transparent to upper layers
- Why not at the Tranport Layer ?
  - Transport layer identifies connection endpoints with IP addresses. A change of IP address would change the identifier. Applications would get confused.
    → difficult to manage the sessions while their identifiers change
  - Need a generic solution for all higher-layer protocols (e.g. TCP, UDP, null transport layer)

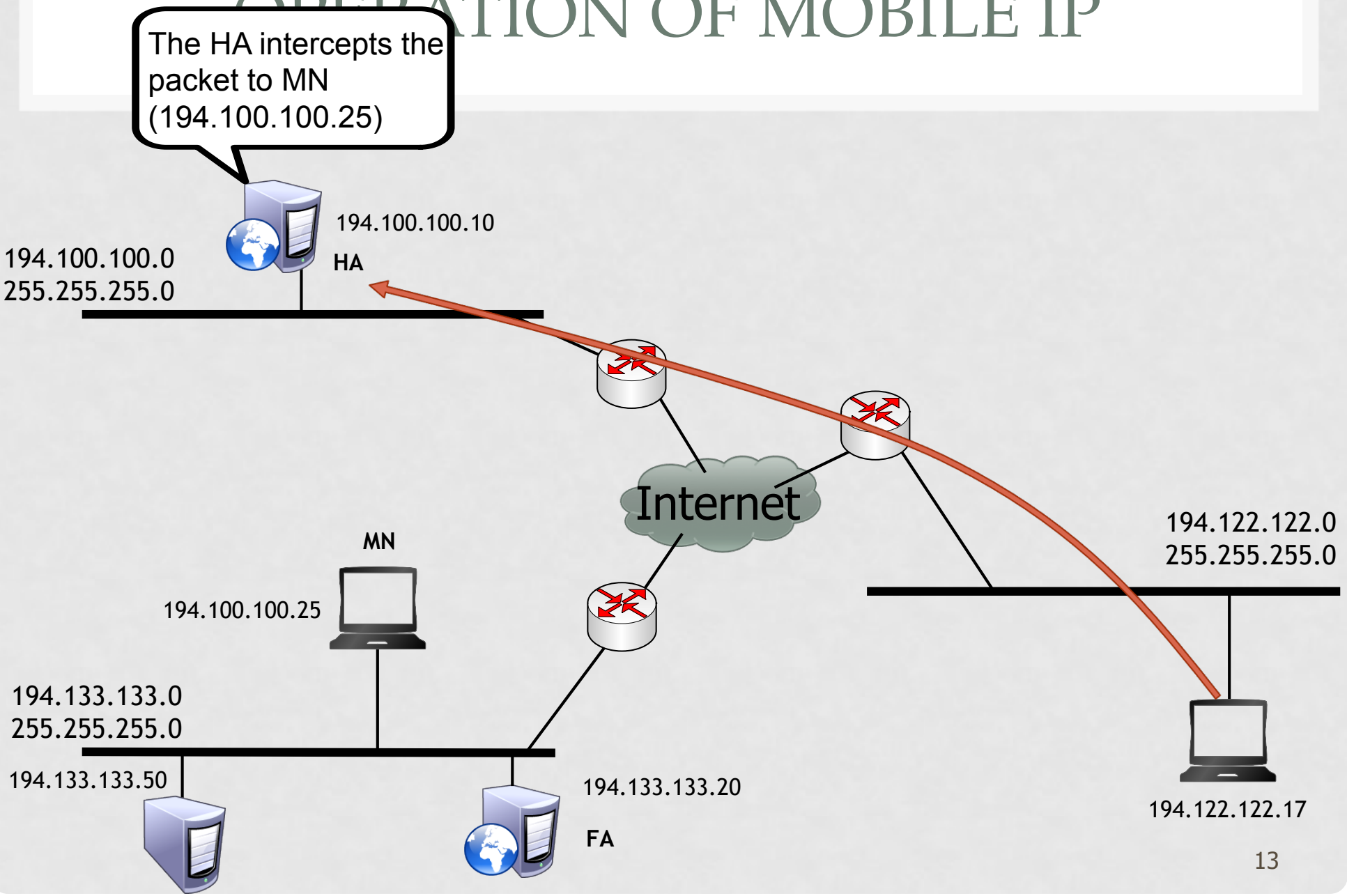
MOBILE NODES IN MOBILE IP

- **Mobile Node (MN):** A system that changes its point of attachment without changing its IP address
  - HoA (Home Address): Permanent Address
  - CoA (Care-of Address): Temporary Address
- **Local Agent (HA, Home Agent):** is a "router" located in the home network of the mobile node. Re-sends, using tunnels, the traffic destined to the mobile node while the node is not at his home network. Implements location registry functions to know the current point of attachment of a mobile. The registry (the table) binds home address (HoA), care-of-address (CoA) and control data, such as e.g. time-stamp.
- **Foreign Agent (FA):** is a "router" in the visited network which provides routing functions for all registered mobile nodes visiting the foreign network. Acts as a 'proxy' between the home agent and the MN. The mobile node uses that router as the default router for traffic.

OPERATION OF MOBILE IP

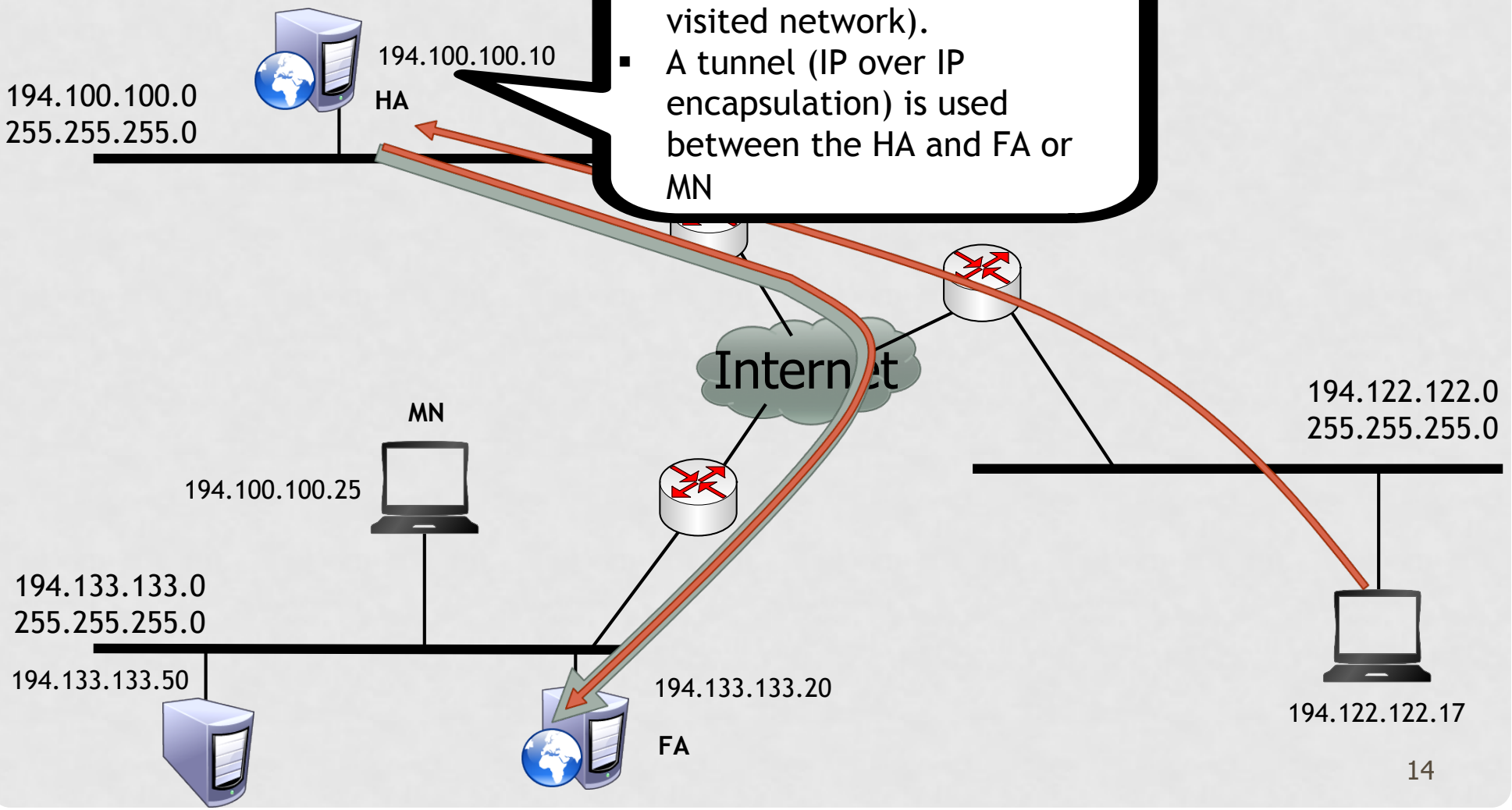


OPERATION OF MOBILE IP



OPERATION OF MOBILE IP

- The HA re-sends these packets to the network where the mobile node is currently attached (the visited network).
- A tunnel (IP over IP encapsulation) is used between the HA and FA or MN



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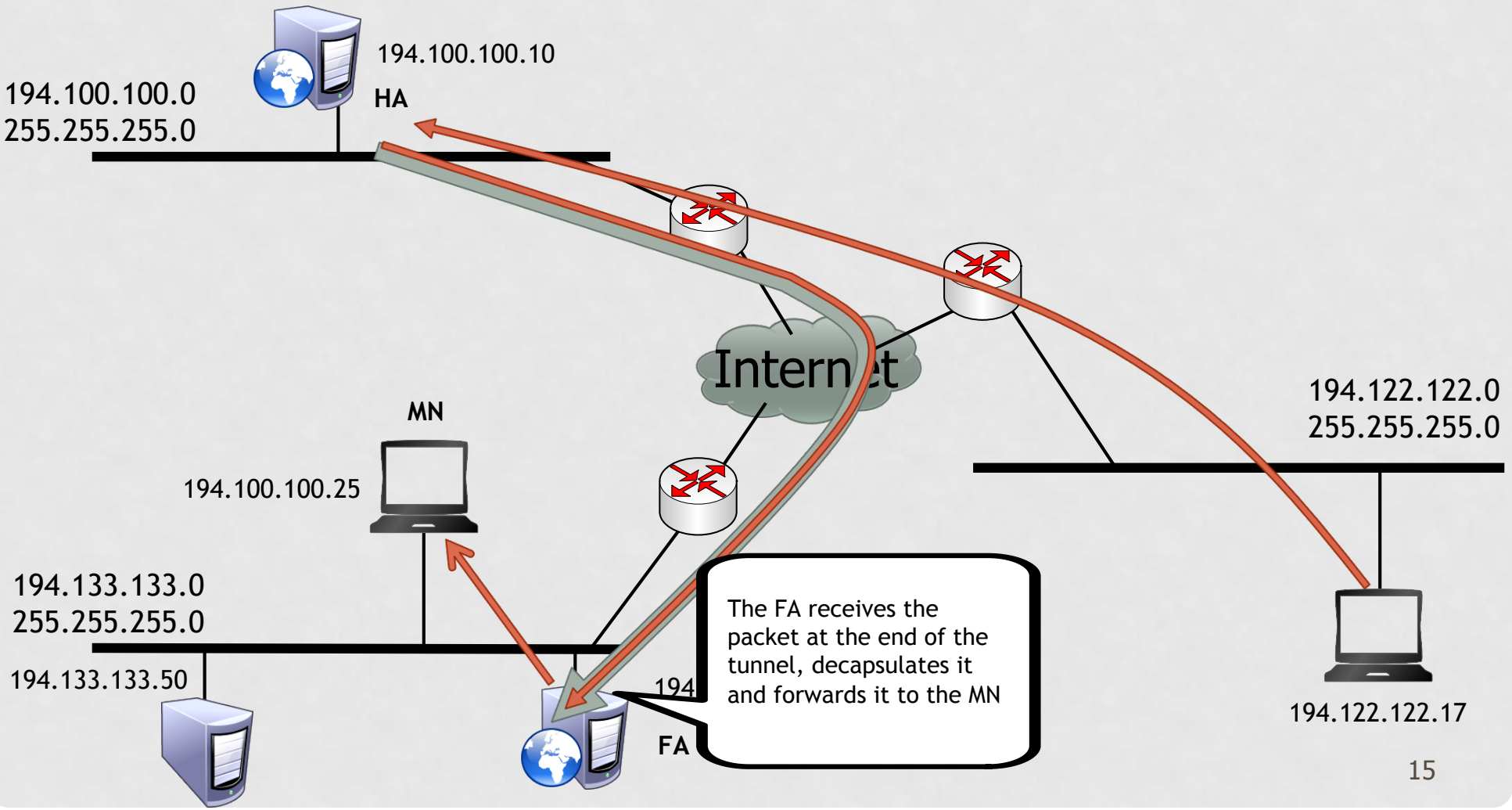


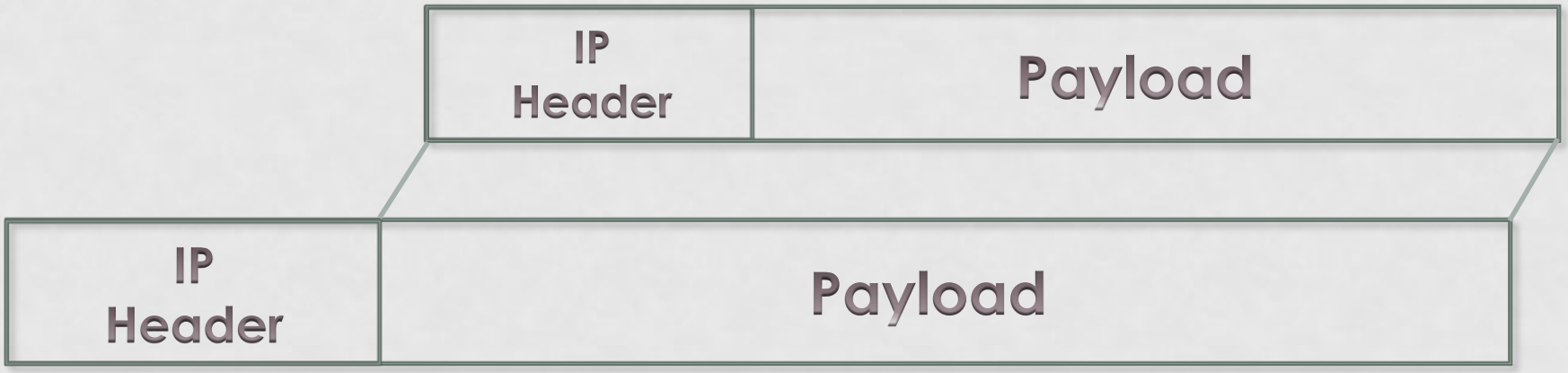
OPERATION OF MOBILE IP:TUNNELS IN IP

Outer header:

- Src/dst = tunnel end-points
- Protocol type = 4
- TTL high enough for the packet to get through the tunnel
- Packet length and checksum are recomputed

Internal header= Original header:

- The tunnel appears as transparent direct connection (virtual link).
- The TTL of the interior header is decreased only at the tunnel entry and at the tunnel exit.



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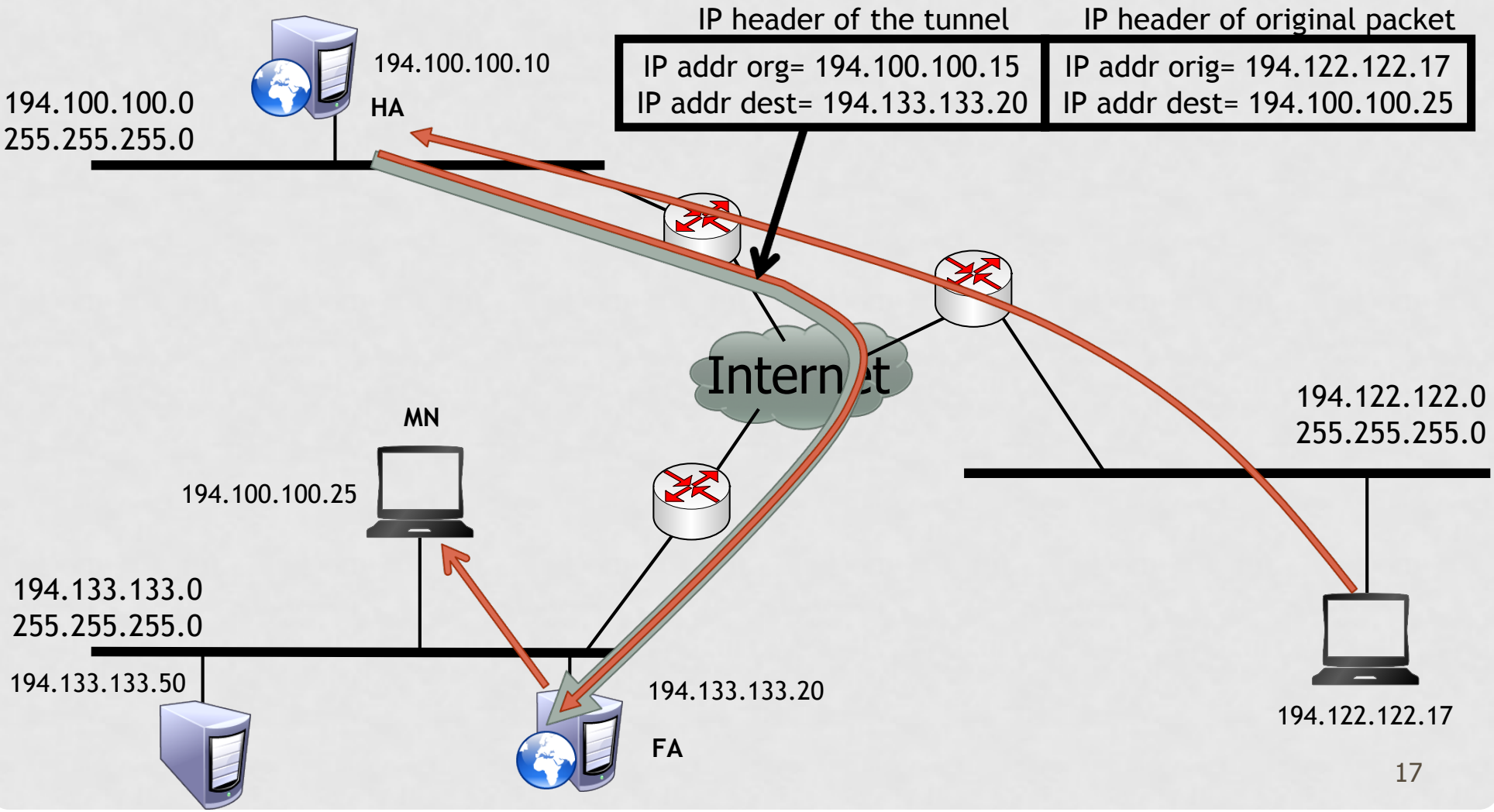
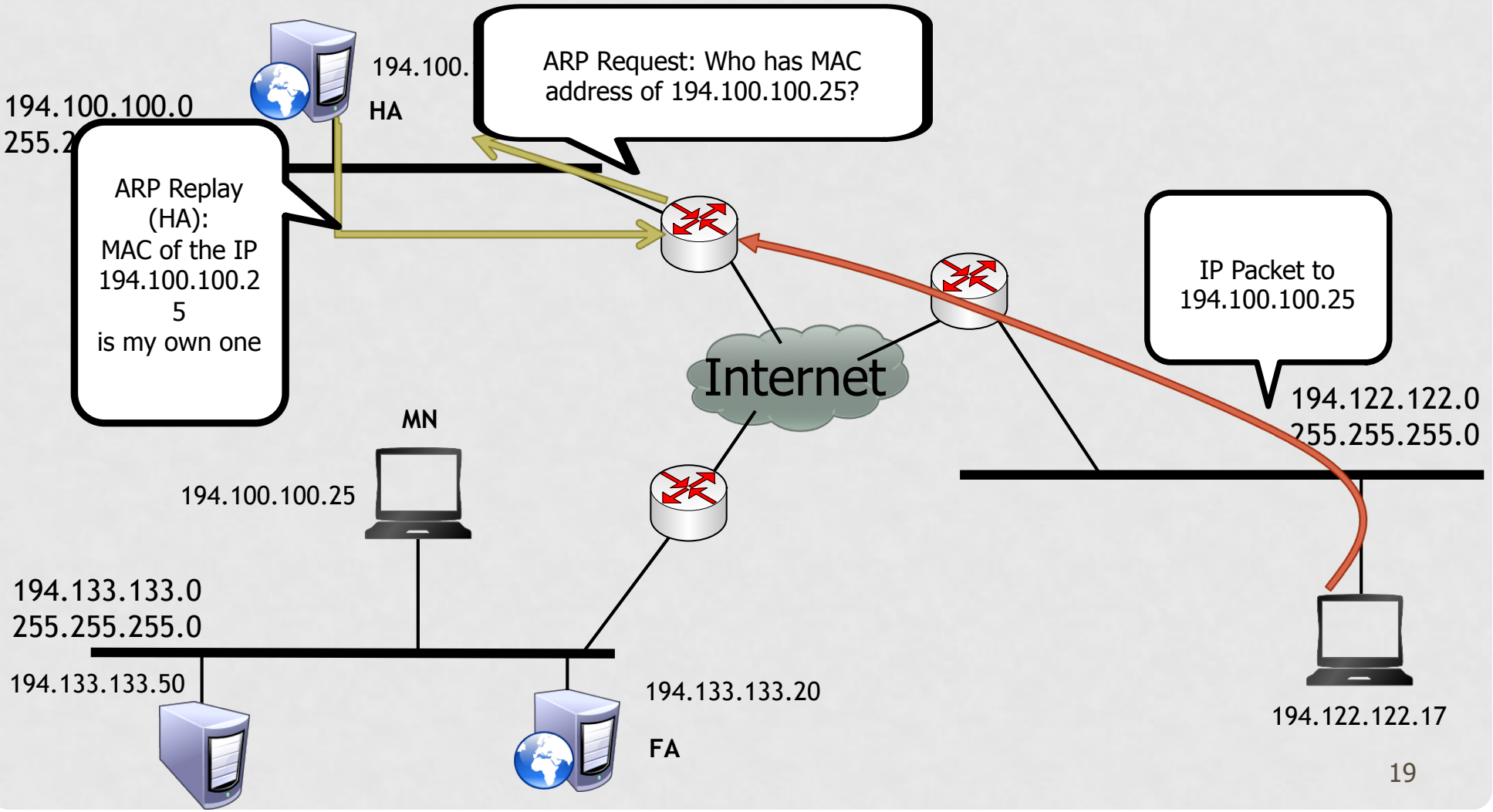


DATA TRANSMISSION CONSIDERATIONS

- After registration, the HA has to receive packets destined for the MN. For this:
  - Implements proxy ARP
  - Initially also sends *gratuitous ARPs* to populate ARP cache in other hosts within the home network
- The packets for the MN are sent over the tunnel to the FA or, optionally directly to the MN
- If the FA is the endpoint of the tunnel, it de-encapsulates the packets and forwards them to the MN
- If the MN is the endpoint of the tunnel, it decapsulates the packets itself

DATA TRANSMISSION



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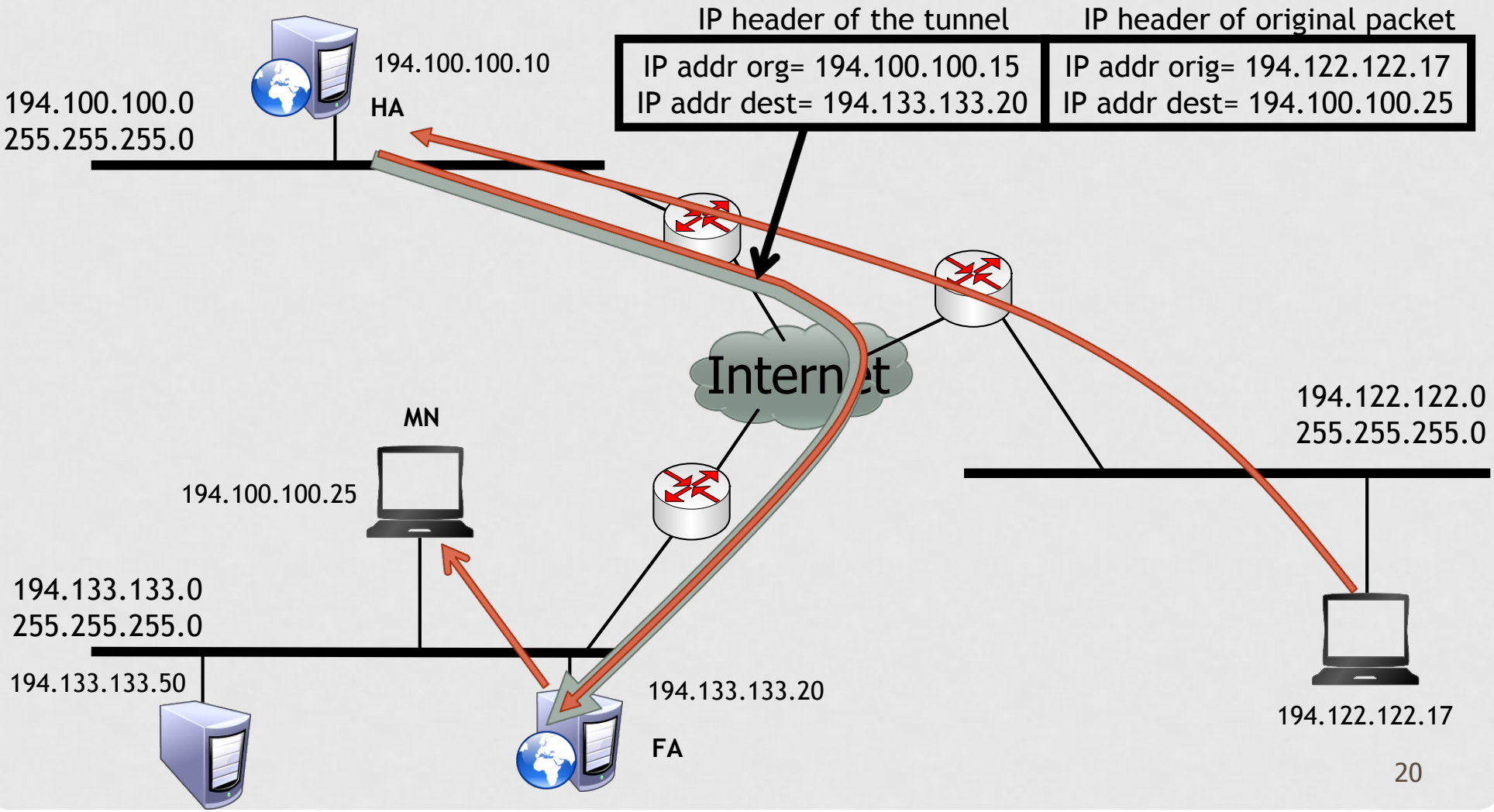

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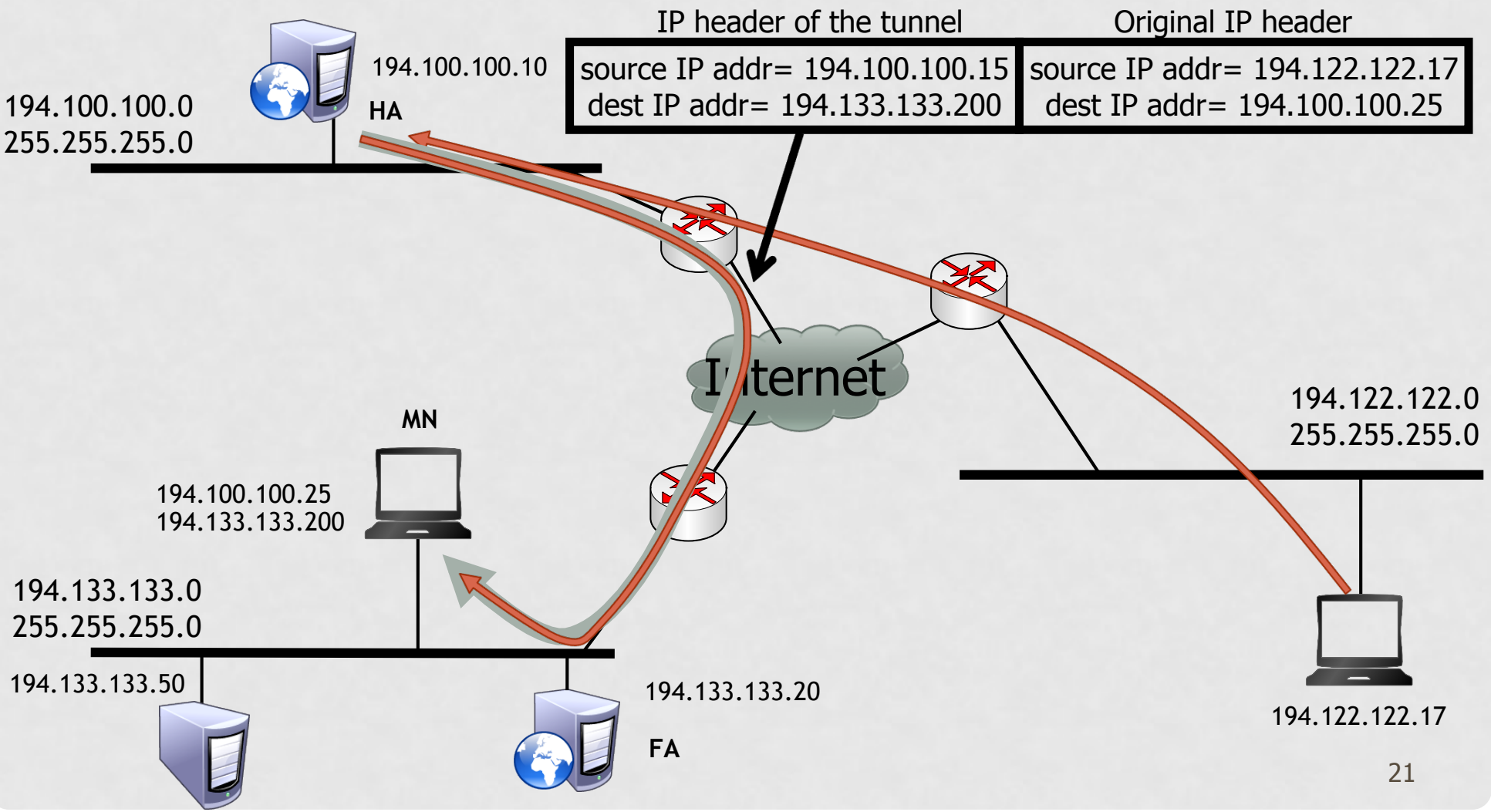
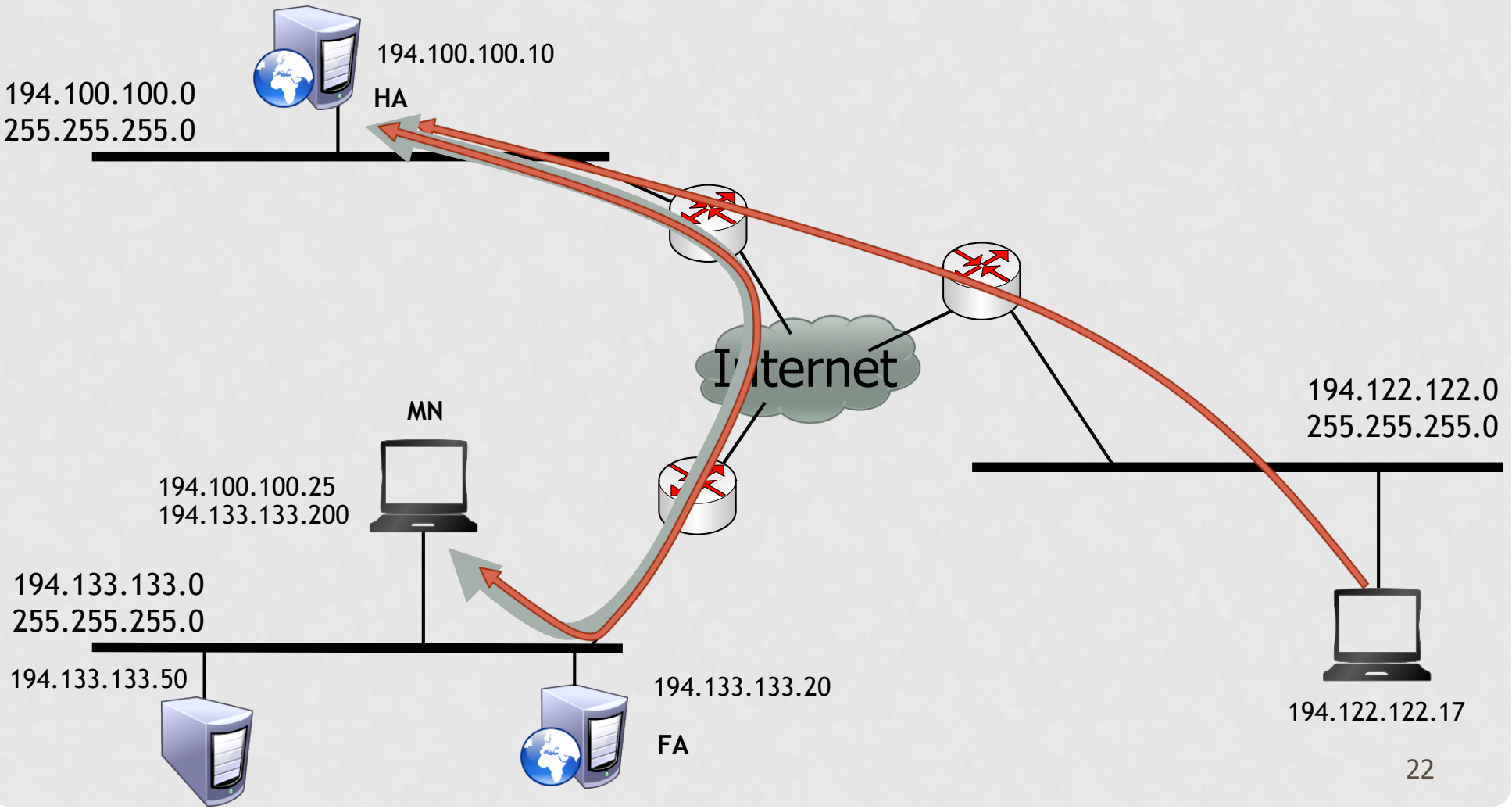
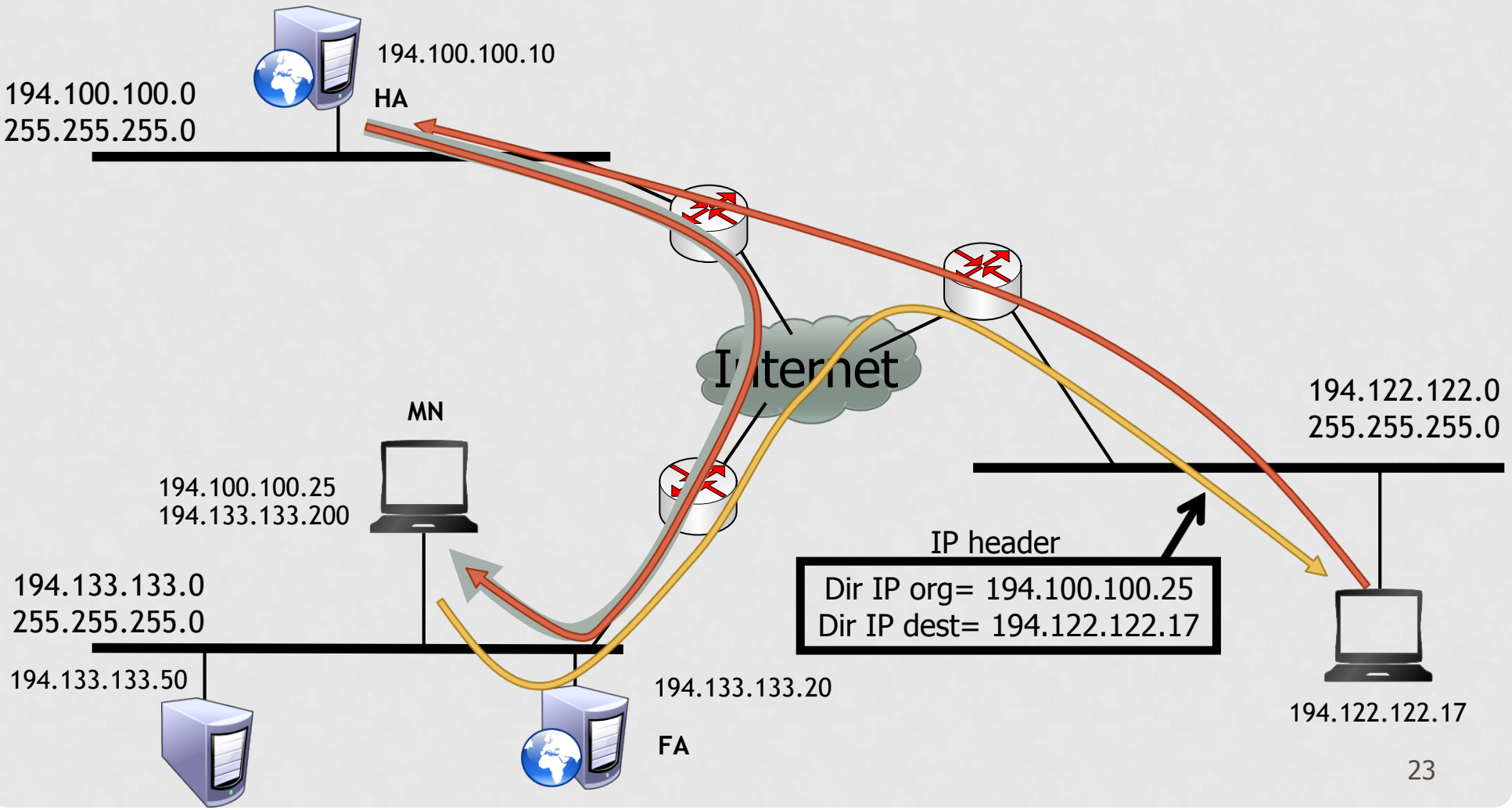


DATA TRANSMISSION: REVERSE PATH BIDIRECTIONAL TUNNEL



DATA TRANSMISSION: REVERSE PATH DIRECT FORWARDING THROUGH FA



PROBLEMS AND LIMITATIONS OF MOBILE IP

- Selected Problems
  - Inefficiency of triangular routing, and reverse tunnel
    - There are some proposed solutions, but do not solve all problems in IPv4 .
- Overhead of control information
- Limitations
  - Mobile IP deals with the macro mobility problem but does not support micro mobility:
    - It will be nice to move between visited networks, potentially far from the home network, and not only maintaining open connections, but also minimizing the effects of change : packet loss and handover delay
    - Some existing proposals/solutions: smooth handoffs, HMIP, Cellular IP, HAWAII.
  - Mobile networks (NEMO)