

L83 - The Way to IP Switching

The Way to IP Switching

Scalability Issues and Comparison of Traditional Solutions
Ipsilon's IP Switching, Cisco's Tag Switching

Agenda

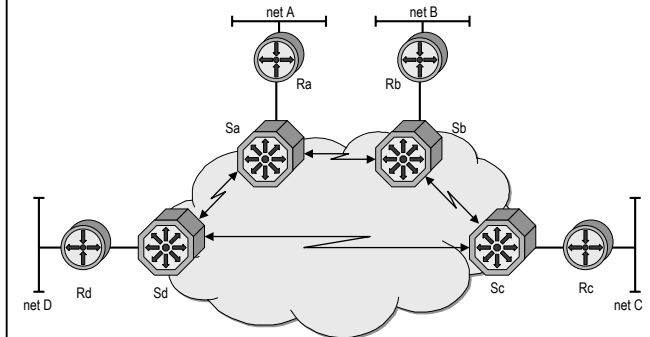
- **Comparison of IP over ATM methods**
 - static address resolution
 - ARP server
 - MARS and MCS
 - LANE
 - NHRP
- **IP Switching**
- **Tag Switching**

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IP over ATM

- **IP routers connected to ATM switches**
 - virtual circuits of the ATM network are used as point-to-point links for IP transport
 - overlay technique of IP
- **ATM network is not a broadcast medium**
 - LAN-like address resolution is not possible
 - LAN-like routing updates are not possible
 - Non Broadcast Multiple Access (NBMA) network
 - for IP a NBMA situation is given if the physical ATM interfaces or the logical ATM sub-interfaces of all routers are in the same IP subnet
 - if all logical ATM sub-interface pairs are in different IP subnets then the ATM network appears as a number of conventional point-to-point interfaces to IP

Physical Topology for Comparison



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Possible Solutions for IP Transport

- **several ways to solve address resolution and routing aspects:**
 - full-mesh VC's
 - with static address mapping/static routing on PVC's or SVC's
 - full-mesh VC's
 - with static address mapping/dynamic routing on PVC's
 - partial-mesh VC's
 - with static address mapping/static routing on PVC's or SVC's
 - partial-mesh VC's
 - with static address mapping/dynamic routing on PVC's
 - on demand VC's (ARP server)
 - with dynamic address resolution/static routing on SVC's

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Solutions (cont.)

- on demand VC's (MARS and MCS)
 - with dynamic address resolution/dynamic routing on point-to-multipoint distribution circuits
- LANE emulation
- on demand VC's (NHRP)
 - with dynamic routing hop by hop and establishing of a cut-through circuits on demand
- MPOA

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IP Connectivity through Full-mesh VC's

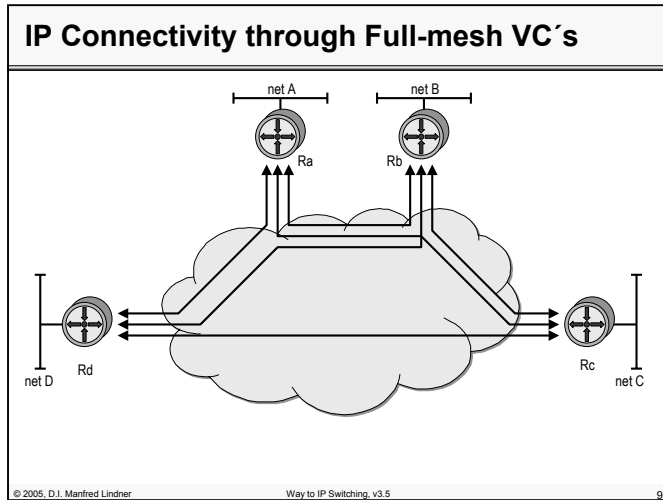
- **one way to achieve full connectivity between all IP networks**
 - full mesh of ATM virtual circuits
- **address resolution**
 - static mapping ⇒ administrative overhead
 - does not scale well
- **routing**
 - static routing ⇒ administrative overhead
 - dynamic routing ⇒ bandwidth problem
 - duplicates of broadcasts are sent out by a router on every VC
 - dynamic routing ⇒ discovery of neighbors problem
 - broadcasts can be sent on PVC's only

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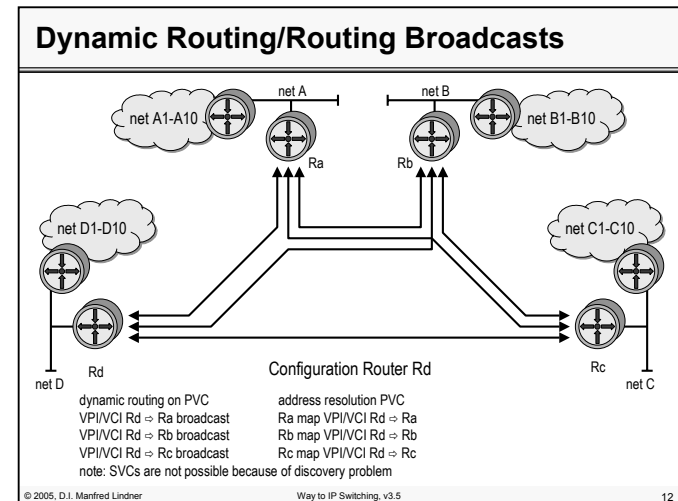
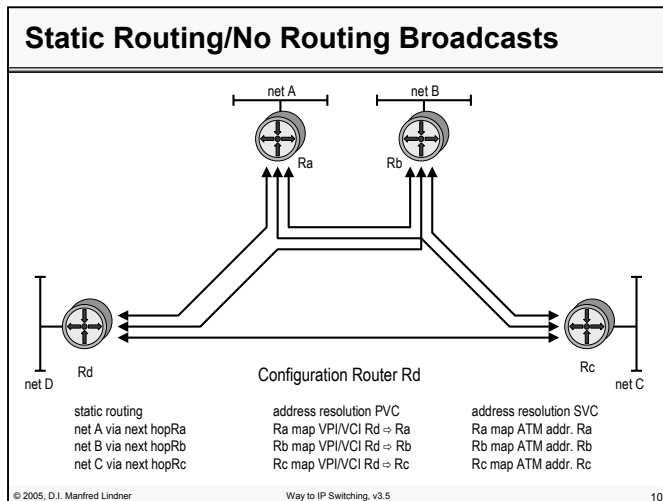
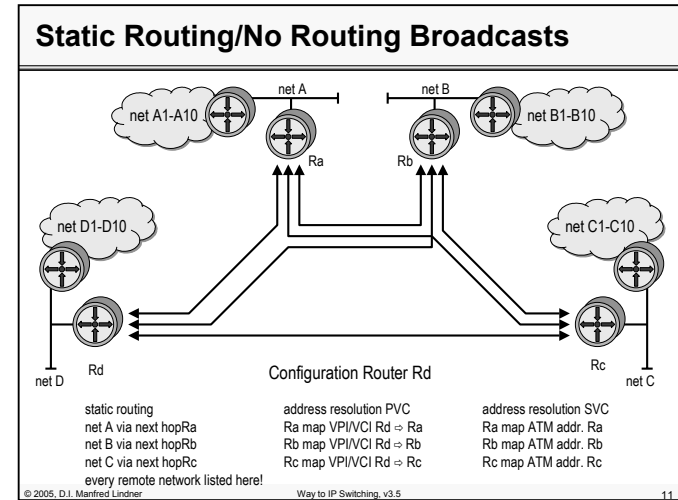
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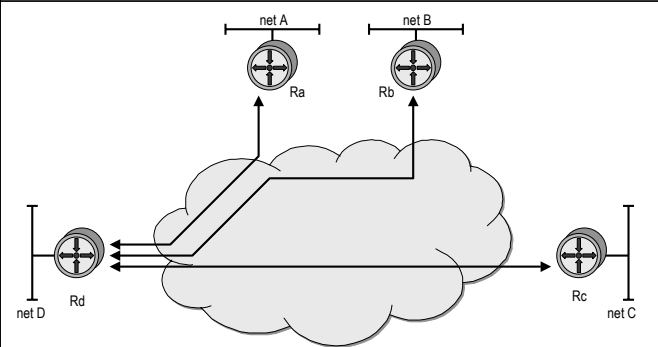


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IP Connectivity through Partial-mesh VC's

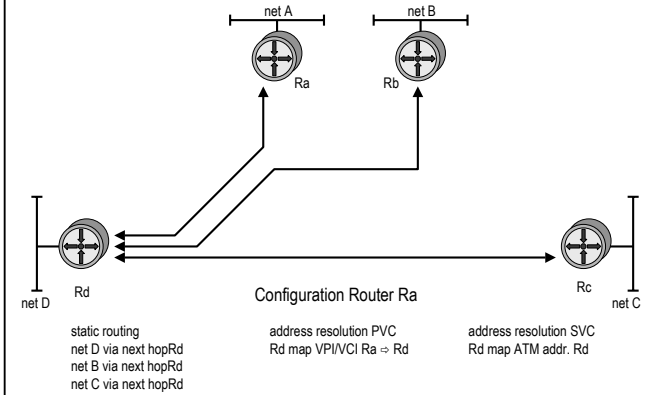
- **another way to achieve full connectivity between all IP networks**
 - partial mesh of ATM virtual circuits
 - hop by hop routing
 - means additional delay and SAR overhead on intermediate router
- **address resolution**
 - same problems as for full mesh VC's
- **routing**
 - same problems as for full mesh VC's
 - dynamic routing ⇒ additional split horizon problem
 - in case of NBMA and Distance Vector routing split horizon must be disabled

IP Connectivity through Partial-mesh VC's

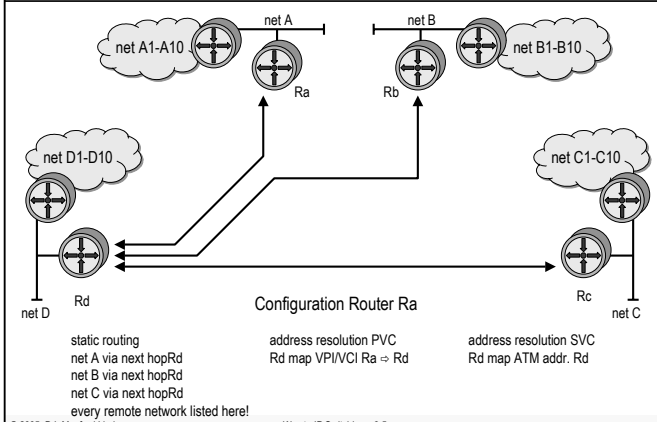


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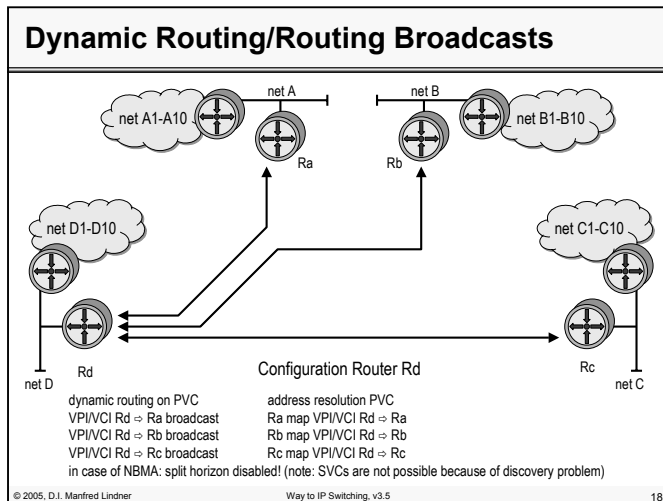
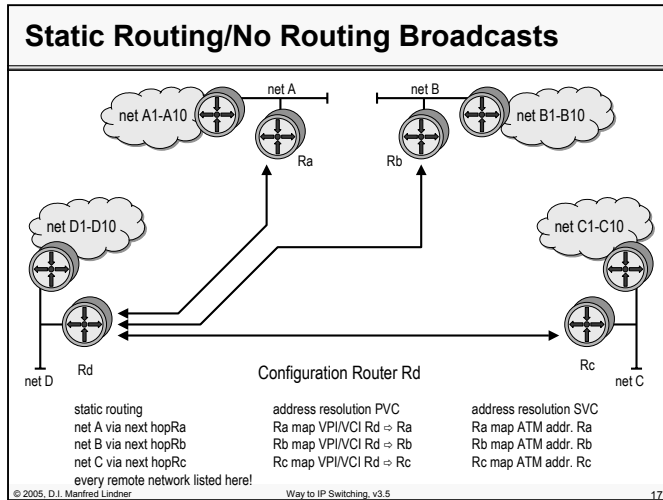
Static Routing/No Routing Broadcasts



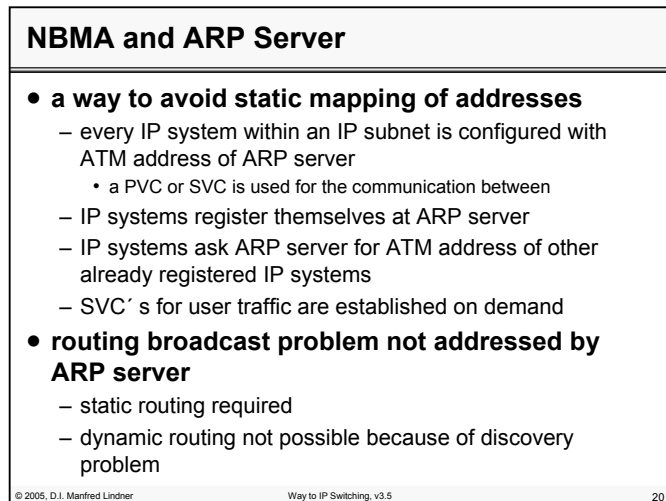
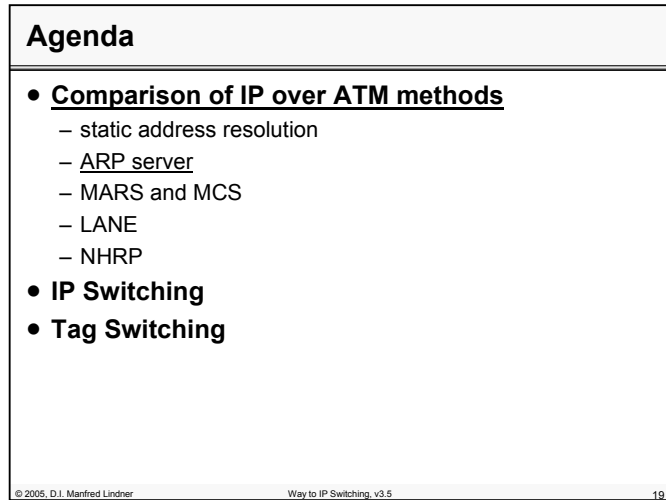
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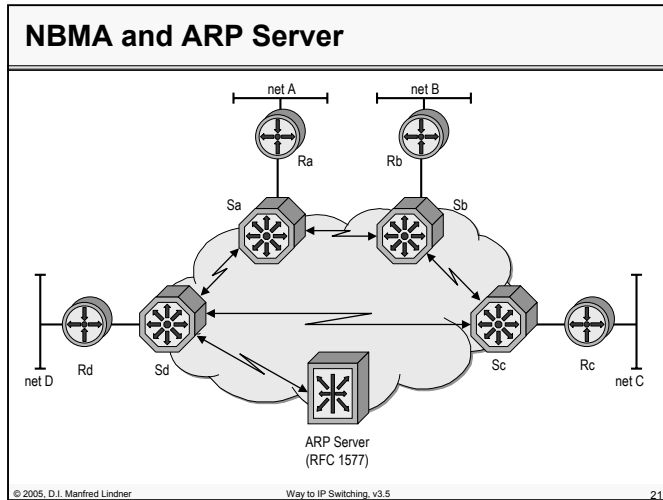
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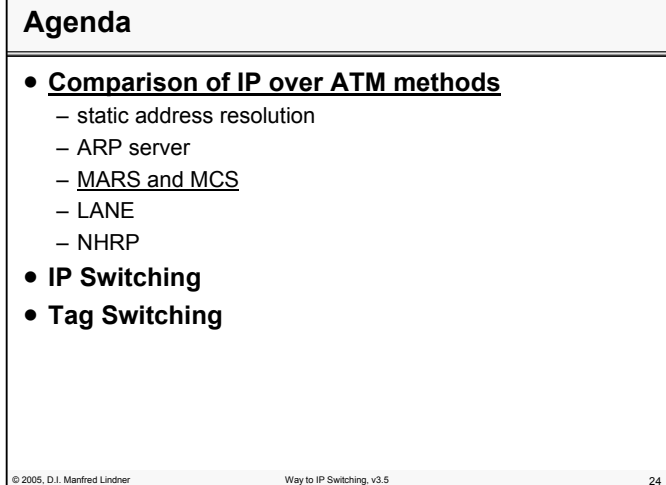
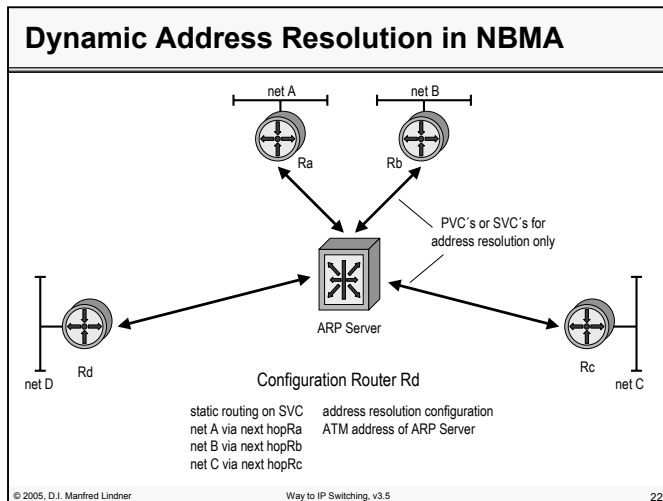
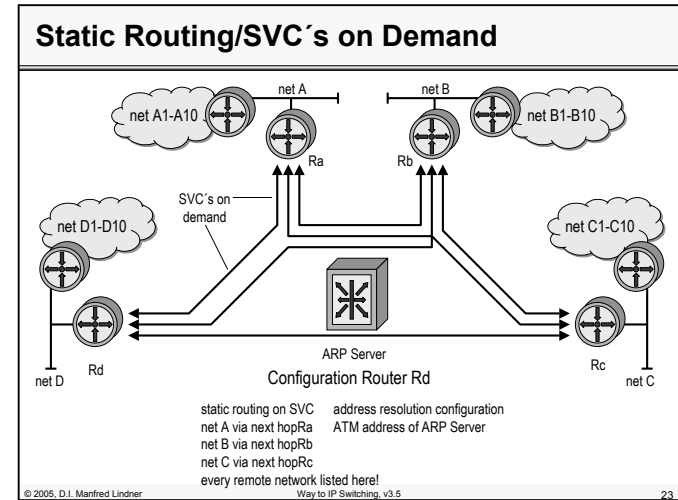
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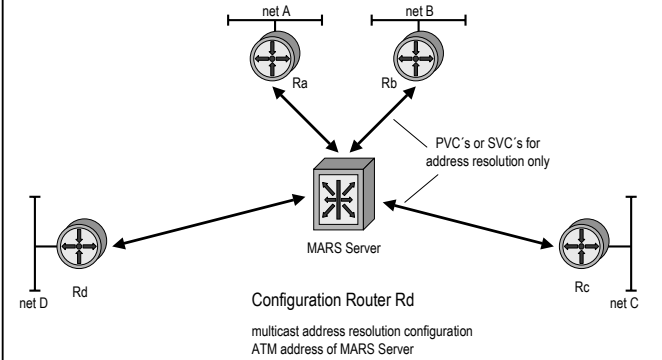
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MARS/MCS

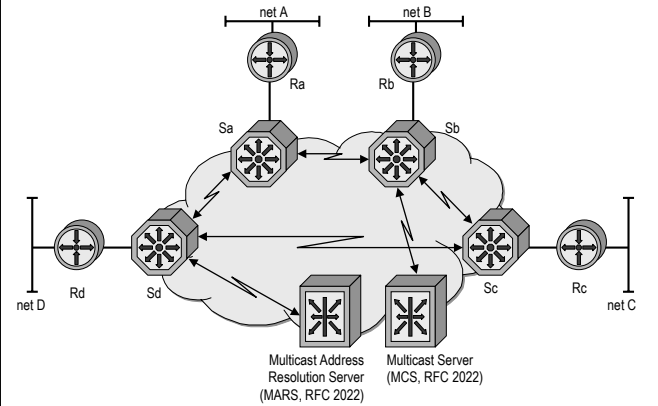
- **to enable multicasting and hence dynamic routing based on multicasts**
 - a multicast address resolution server (MARS) is used
 - resolving ATM destination addresses for a given layer 3 multicast group (broadcast)
 - a multicast server (MCS) is used
 - direct distribution using a mesh of ATM point-to-multipoint circuits
 - see details in corresponding RFC's
- **SVC's for user traffic are established on demand**

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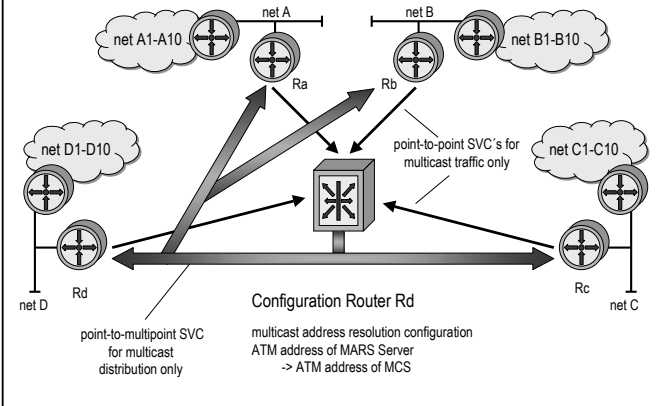
MARS



MARS/MCS Server

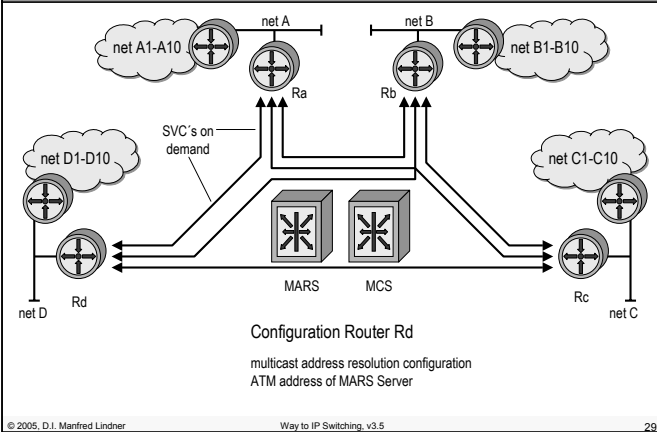


MCS



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Dynamic Routing/SVC's on Demand



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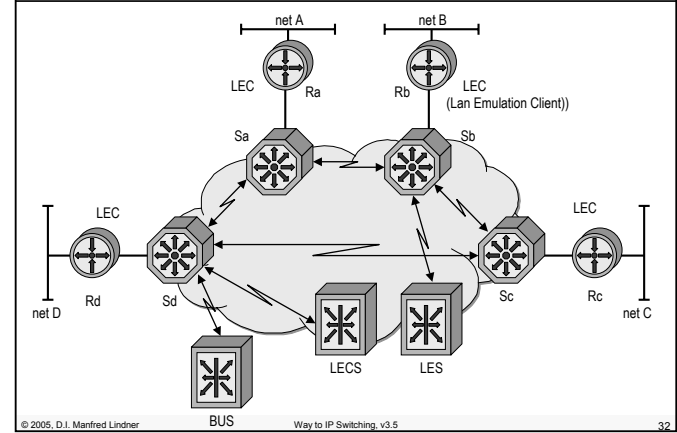
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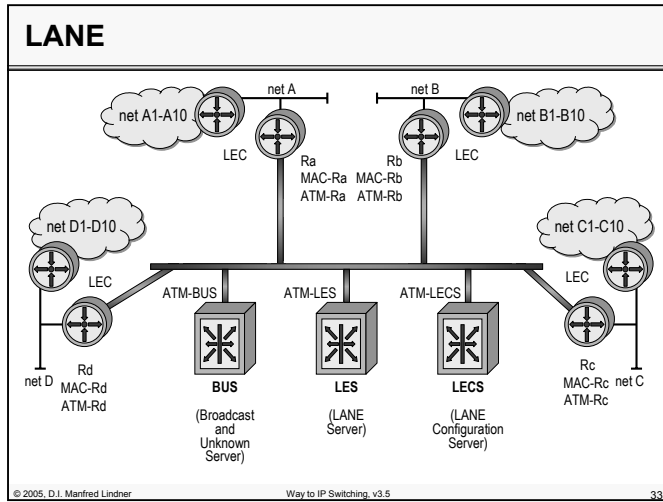
LANE

- **ATM looks like a LAN using MAC addresses for communication**
 - address resolution between MAC address and ATM address is done by LES
 - LEC is configured with ATM address of LECS in order to connect to a certain virtual LAN
 - Broadcasts (routing messages) are sent to BUS which distribute them using point-to-multipoint ATM circuits
 - IP-ARP used to resolve MAC-address
 - LANE-ARP used to resolve ATM-address
- **SVC's for user traffic are established on demand**

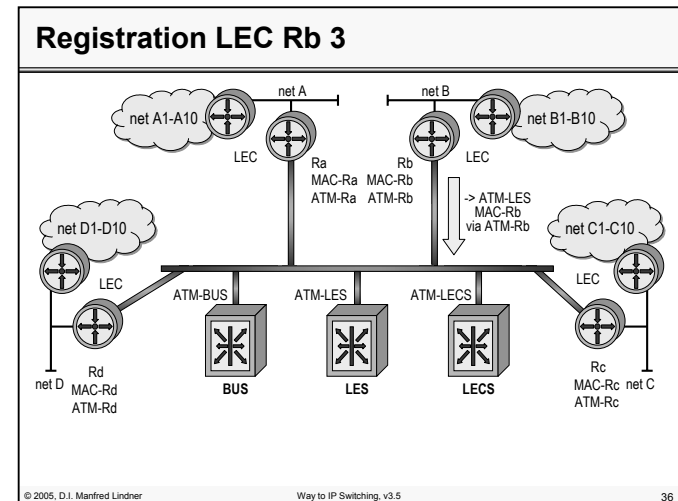
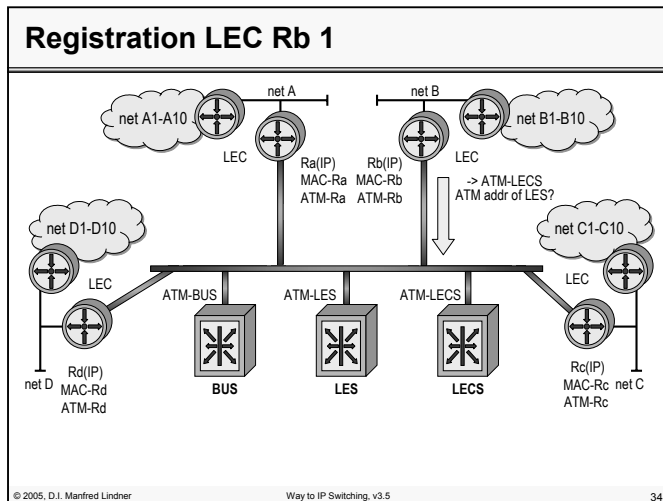
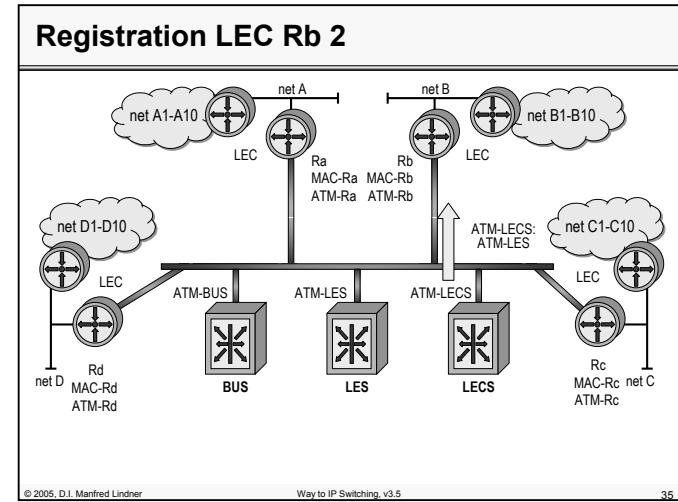
ATM LAN Emulation



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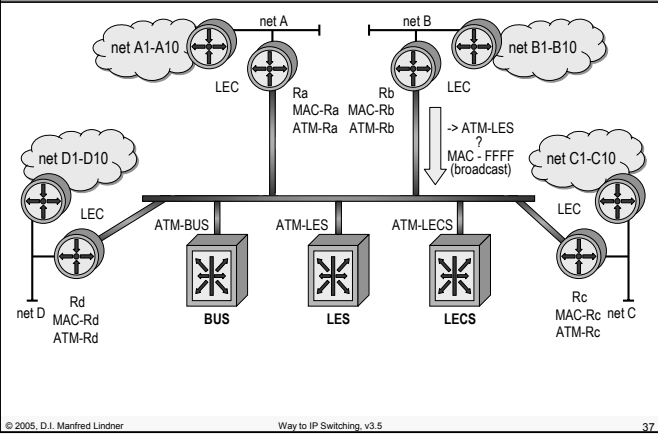


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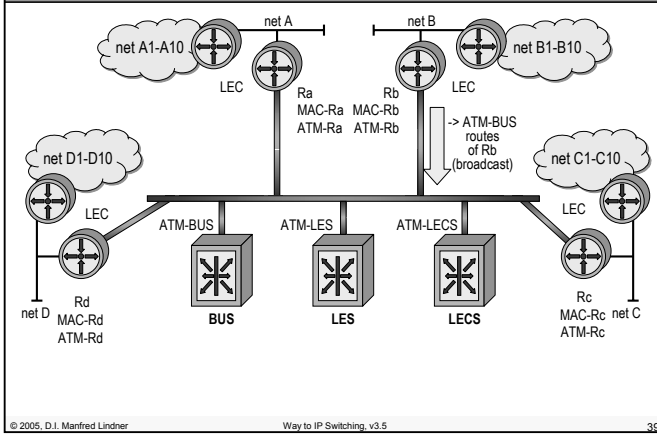
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Registration LEC Rb 4

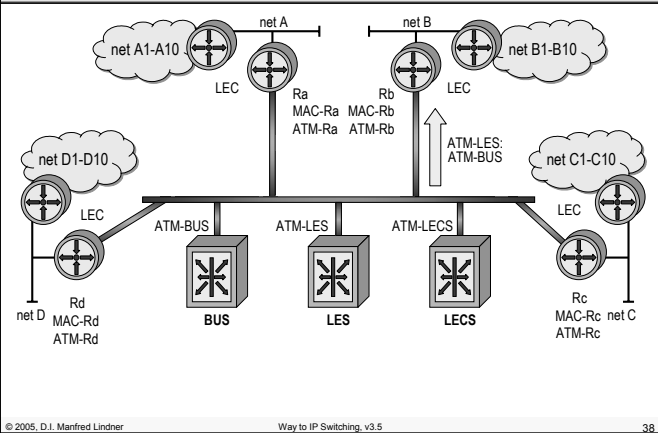


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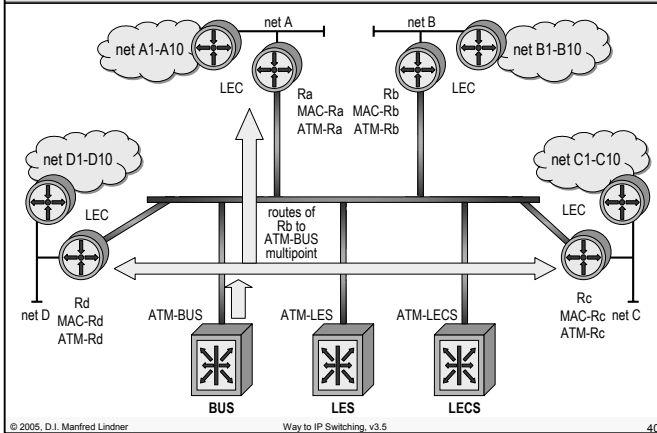
Routing Broadcast Rb



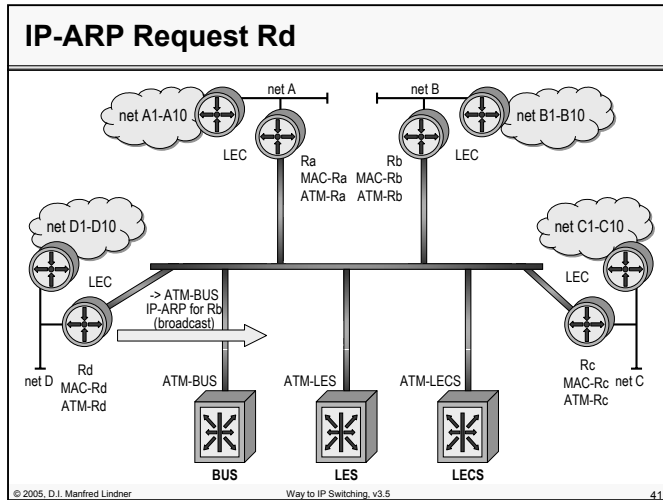
Registration LEC Rb 5



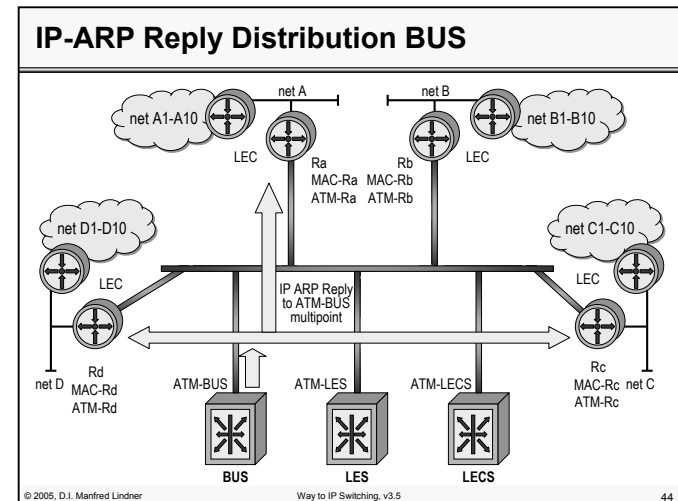
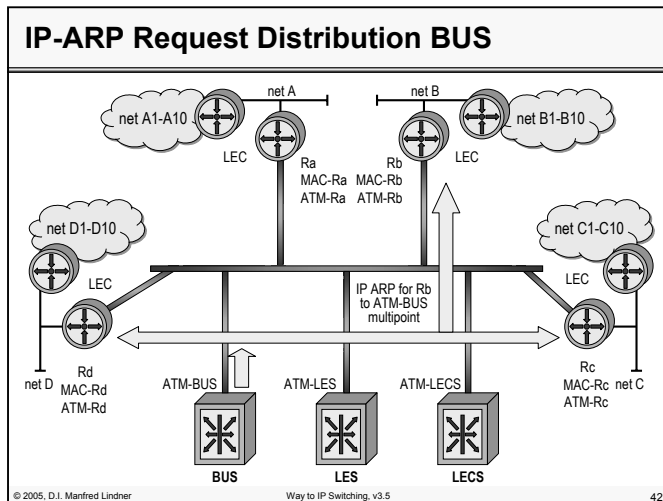
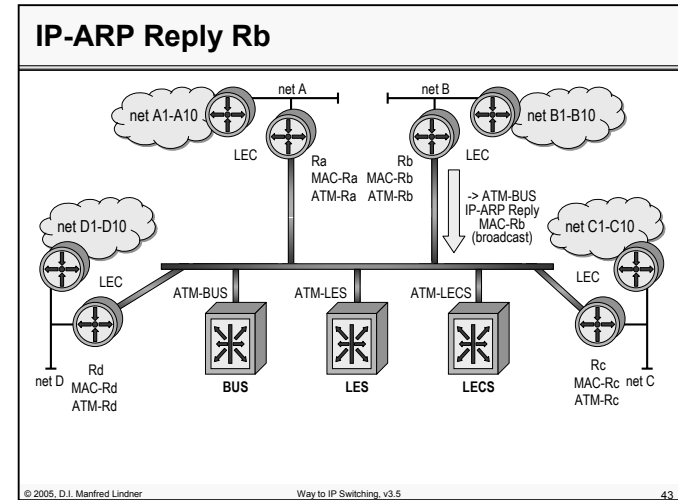
Routing Broadcast Distribution BUS



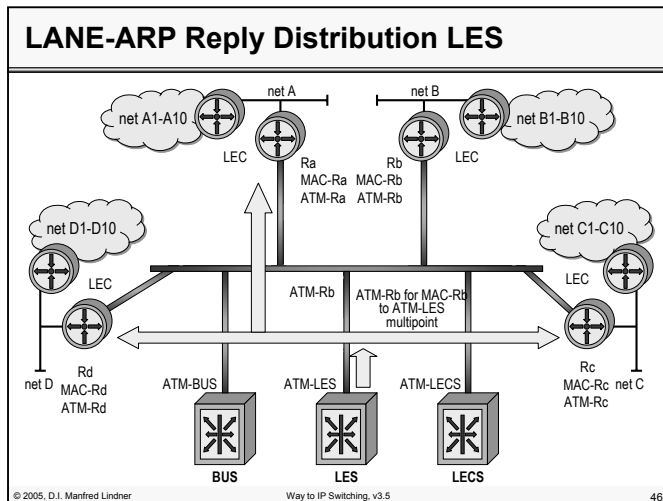
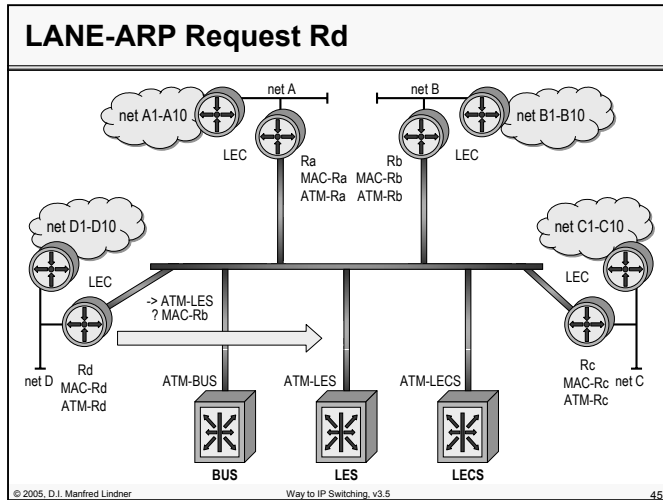
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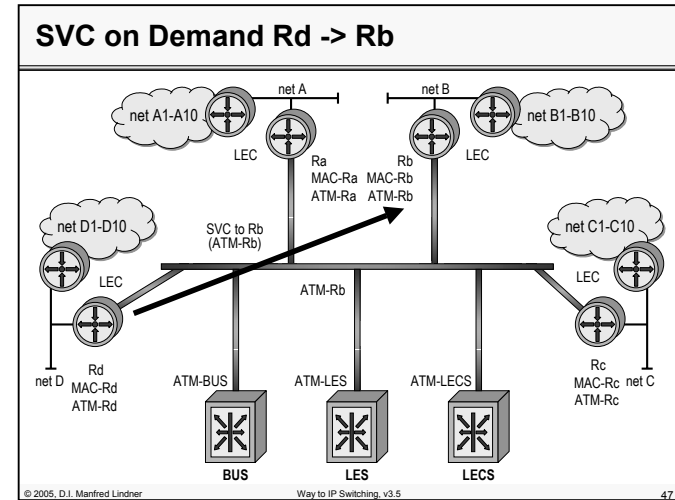
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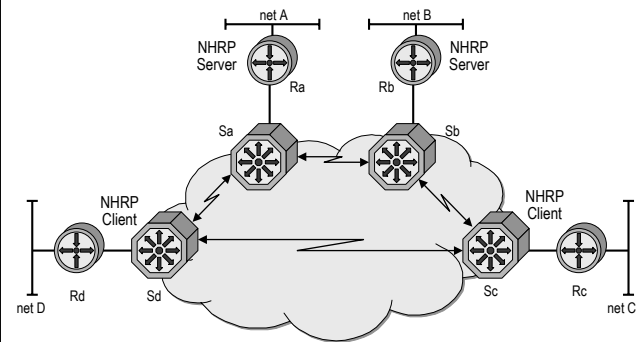
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NHRP Server

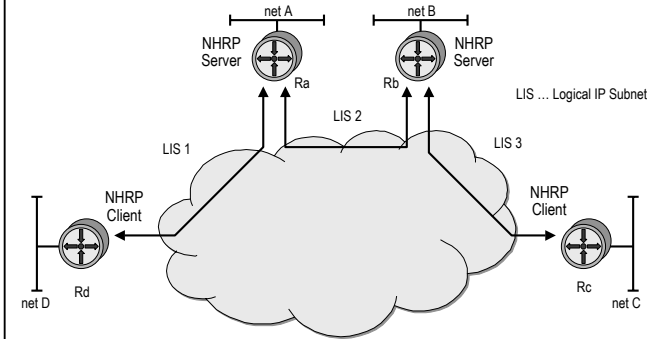
- **a way to establish a cut-through circuit on demand by using NHRP protocol**
 - NHRP server provides address resolution for clients of the same LIS like RFC 1577
 - NHRP client can ask for a direct path for a given network different to its own LIS and may establish an exclusive, direct SVC for that network
 - dynamic routing is supported in fabric mode
 - routing messages and all default traffic will follow sequence of virtual circuits crossing routers hop-by-hop
- **neighbor discovery problem between routers not addressed by NHRP server**
 - must be still done by PVCs

NHRP physical Topology

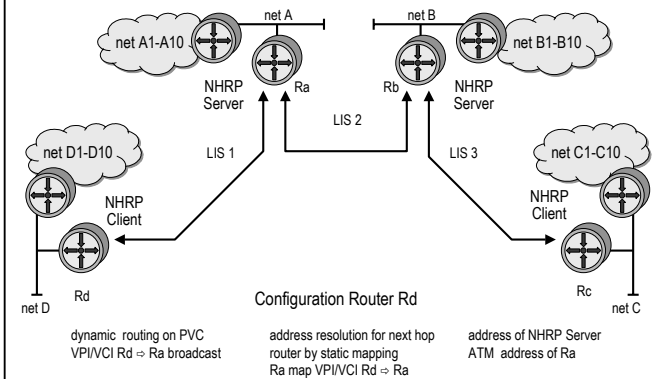


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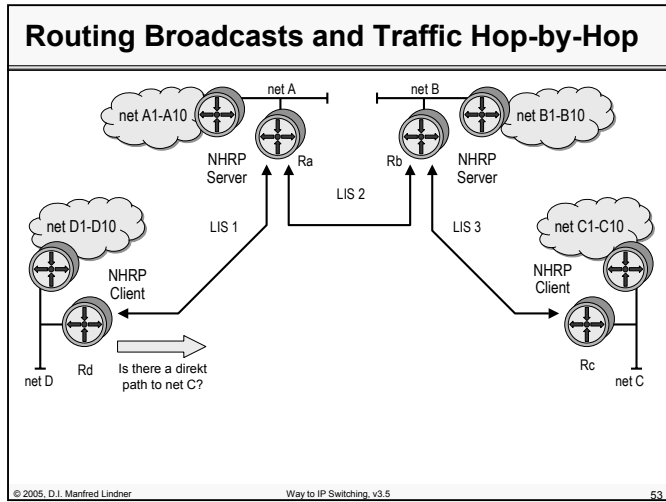
IP Basic Connectivity Hop-by-Hop



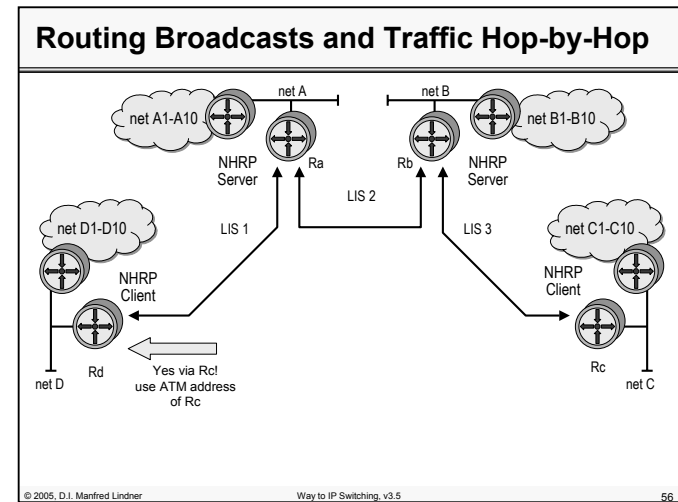
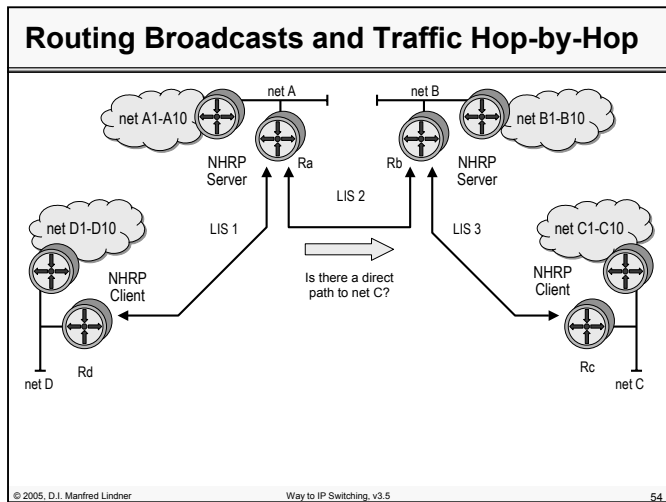
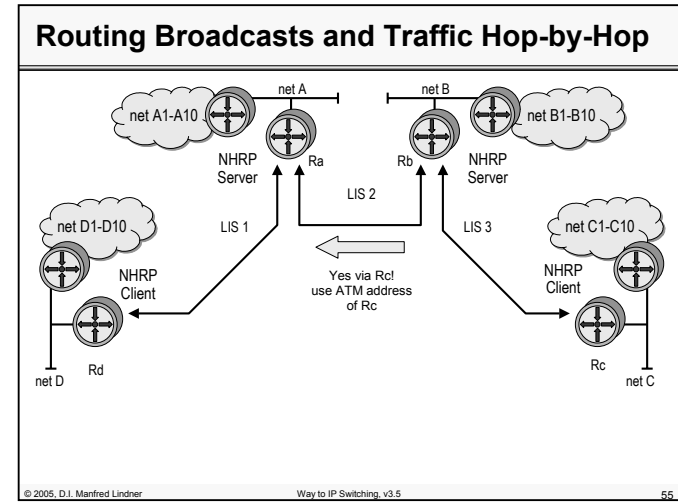
Routing Broadcasts and Traffic Hop-by-Hop



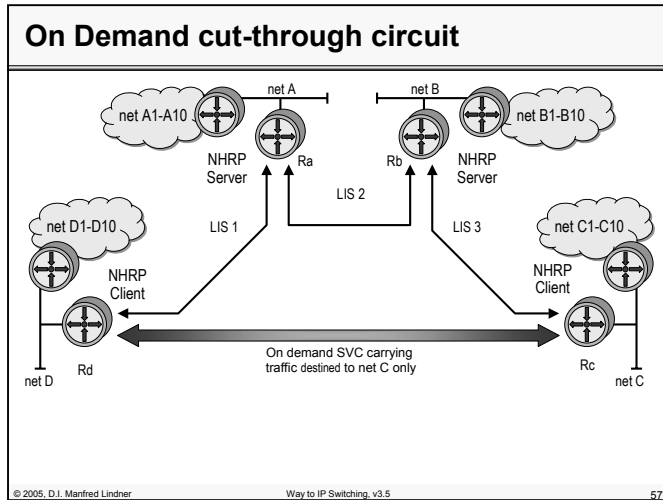
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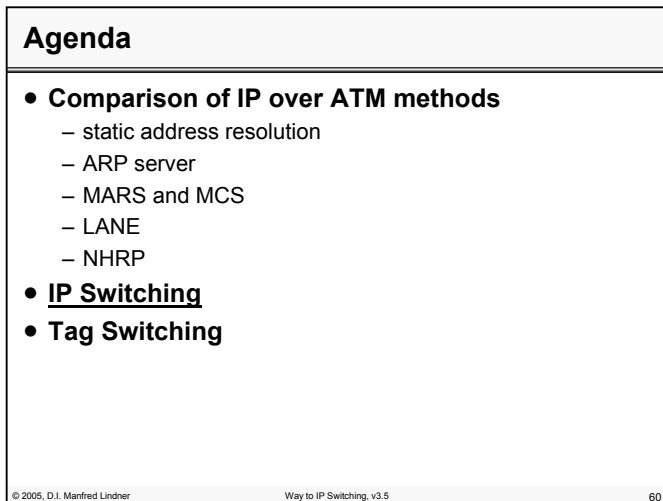
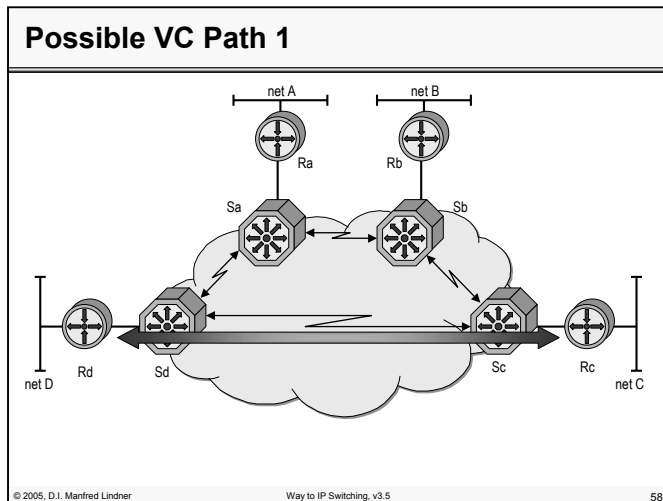
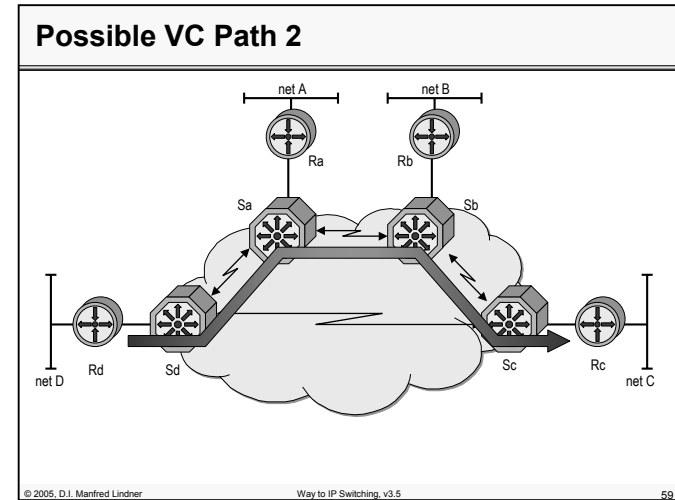
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IP Switching

- **proposal of Ipsilon Networks**
 - avoids costly cell reassembly for long-term flows
 - each ATM switch should be equipped with routing software
 - based on destination routing
- **requires flow detection**
 - flow-oriented traffic: ftp, telnet, web, multimedia
 - short-lived traffic: DNS query, mail, time sync, management
 - claims: 80% of packets and 90% of bytes are flow-oriented

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IP Switching

- **uses special protocols**
 - Generic Switch Management Protocol (GSMP)
 - Ipsilon Flow Management Protocol (IFMP)
 - RFC1953
- **relatively simple software should be added to the ATM switch**
 - GSMP - 2000 lines
 - IFMP - 10000 lines
- **multicast flows are mapped into point-multipoint VCs**
- **initially IP only, other protocols must be tunneled**

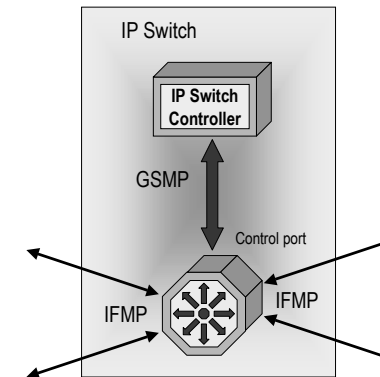
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IP Switching

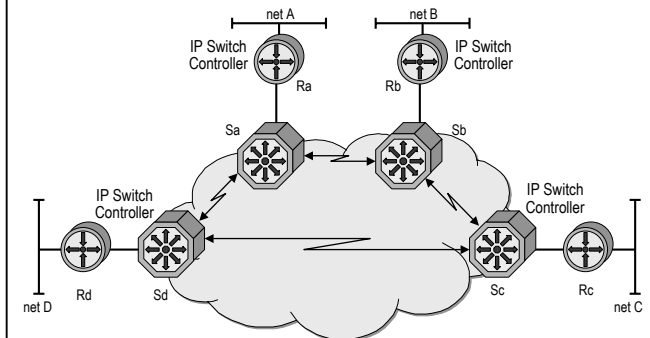


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IP Switching



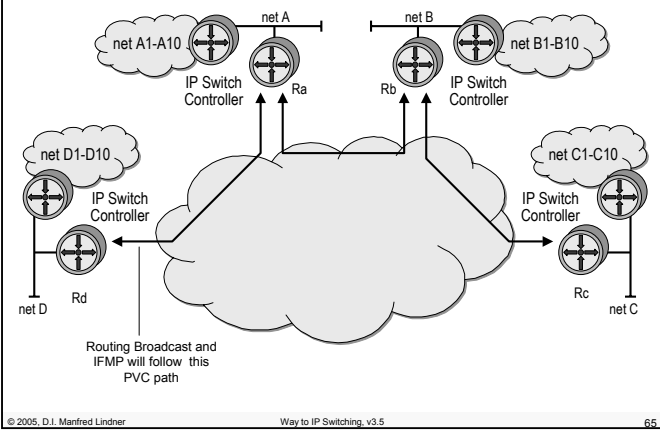
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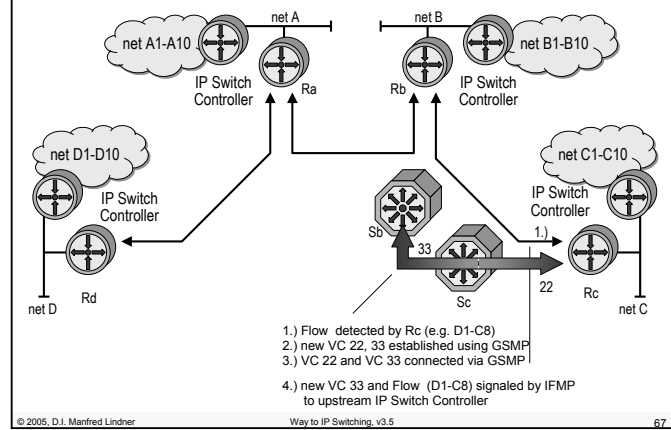
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IP Basic Connectivity via normal VC's

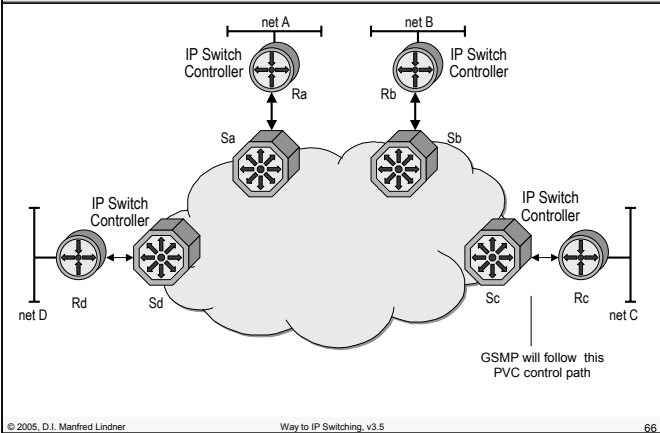


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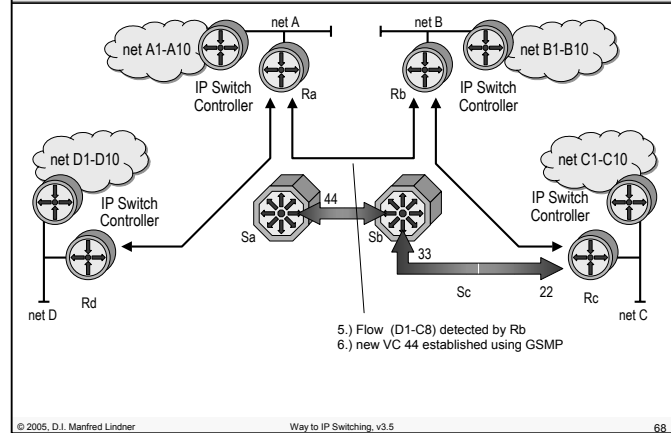
Flow Detection Rc



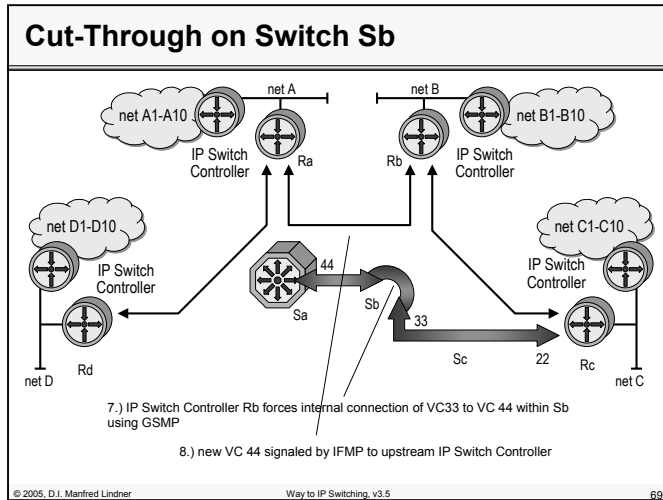
Control Virtual Circuit for GSMP



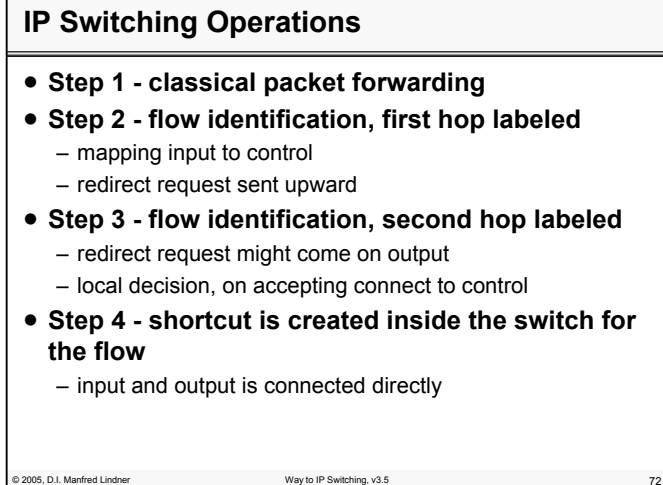
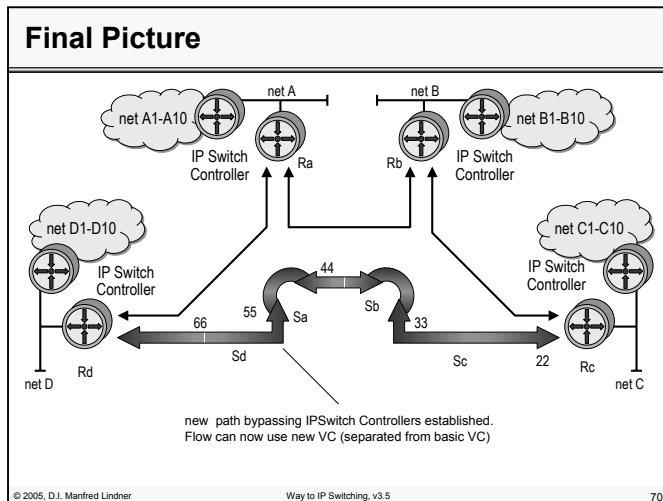
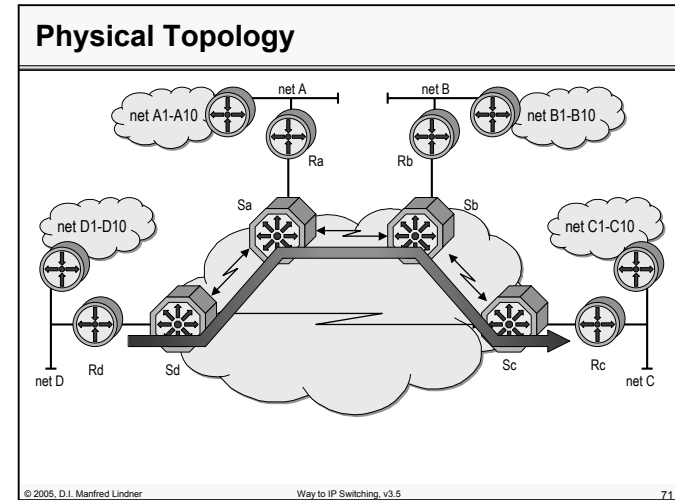
Flow Detection Rb



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IP Switching Operations

- **Flow labeling**
 - VCI field is used
- **Refresh timer**
 - because it is not a real connection-oriented technology
 - if there was no activity the VC is closed
- **Uses a point-to-point model**
- **Quality of service**
 - based on local decisions
 - RSVP can be mapped

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IP Switching Issues

- **only usable over ATM as a transport**
- **connection setup on demand, so first packet is not switched**
- **scalability is limited by VC explosion**
 - number of VC is greater or equal to number of flows

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Tag Switching

- **continuous growth of Internet and emerging multimedia applications**
 - demand higher bandwidth within the Internet Service Provider (ISP)
 - demand improved scaling properties of the Internet routing system
- **demand for higher bandwidth**
 - requires higher forwarding performance for both multicast and unicast traffic
- **the destination-based forwarding paradigm**
 - is not adequate in all situations
 - we would like to have more flexible control over how traffic is routed

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Tag Switching

- **method to combine label-swapping with network layer routing**
 - ingress edge device attaches a label to the packet
 - switches do forwarding decisions based on the labels
 - very quick lookup, lower latency
 - tags have only local significance
 - egress edge device strips off the tag
- **proposed by Cisco**
 - RFC 2105 - "Cisco Systems' Tag Switching Architecture Overview"

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Tag Switching

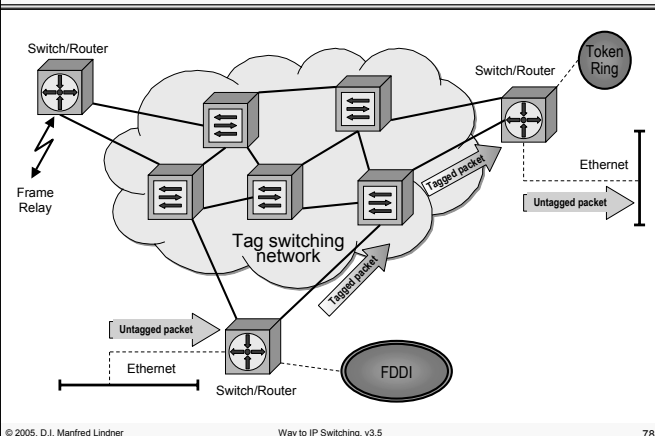
- **Tag switching is a technology that promises**
 - an efficient solution to these challenges
- **Tag switching combines**
 - the flexibility and functionality provided by Network Layer routing
 - with the simplicity provided by the label swapping forwarding paradigm
- **the simplicity of label swapping forwarding paradigm**
 - enable improved forwarding performance

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Tag Switching



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Tag Switching

- **by associating a wide range of forwarding granularities with a tag**
 - the same forwarding paradigm can be used to support a wide variety of routing functions
 - such as destination-based routing, multicast, hierarchy of routing knowledge, and flexible routing control
- **is intended to simplify integration of routers and ATM switches**
 - by employing common addressing, routing, and management procedures
 - in fact, competition to Integrated PNNI
 - intended to be used in large environments, not applicable for workgroups and campus environments
 - independent of network layer

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Tag Switching

- **forwarding component**
 - uses tags carried by packets plus tag information maintained by a tag switch to perform packet forwarding
- **control component**
 - maintains correct tag forwarding information among a group of tag switches
- **tags could be**
 - inserted between MAC layer and Link layer
 - part of the layer 2 header (for example ATM)
 - part of the network layer header (for example flow label in IPv6)

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Way to IP Switching, v3.5

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Tag Switching

- **control component**
 - is responsible for create tag bindings
 - allocation of a tag
 - bind the tag to a route
 - distribute the tag bindings among tag switches
 - use existing routing protocols
 - use tag distribution protocol
- **performance**
 - one VC per routing table entry
 - one memory reference compared to 4-16 in classical router

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Way to IP Switching, v3.5

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L83 - The Way to IP Switching

Tag Switching

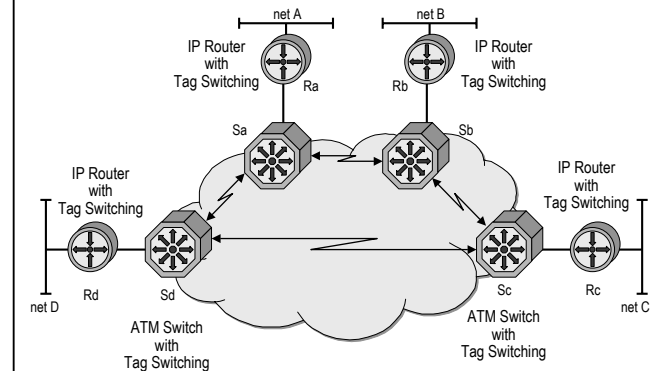
- **Destination based routing**
 - downstream tag allocation (⇒ example follows)
 - downstream tag allocation on demand
 - upstream tag allocation
- **Tag information distribution**
 - piggybacking existing routing protocols
 - Tag Distribution Protocol (TDP)
- **Separate tags for inter-AS and intra-AS switching**
- **Multicast tagging**
- **Policy based routing is supported**
 - manual or external assignment of tags

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Tag Switching

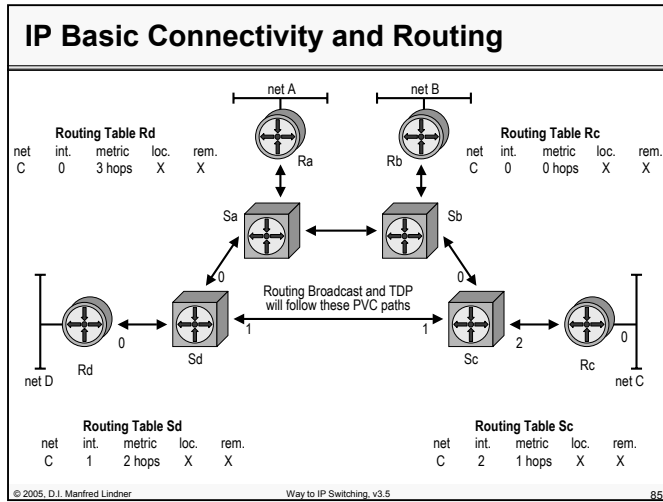


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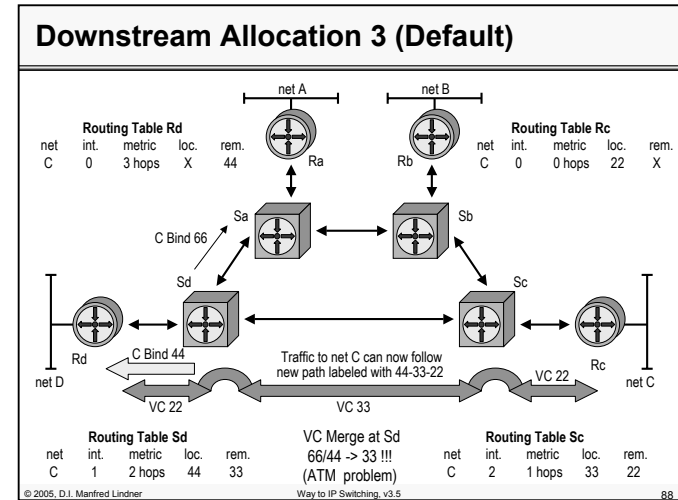
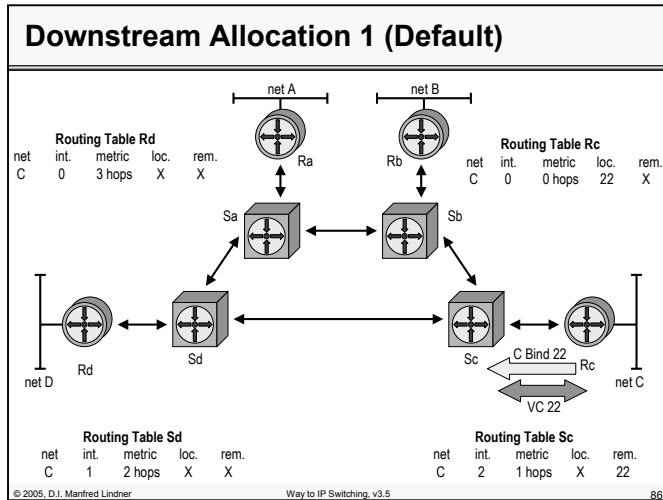
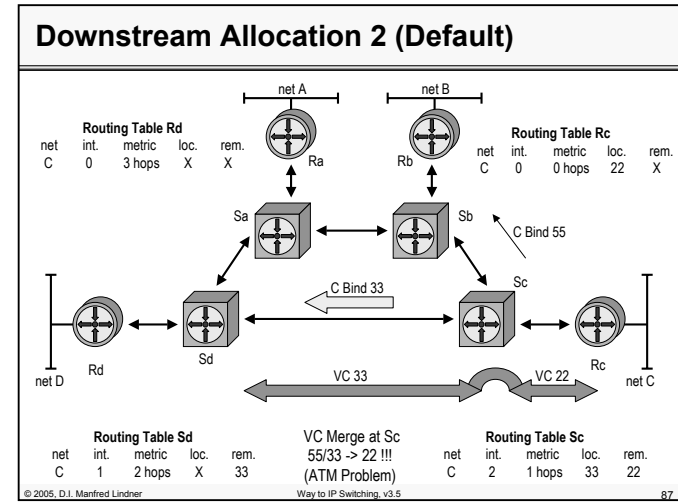
Way to IP Switching, v3.5

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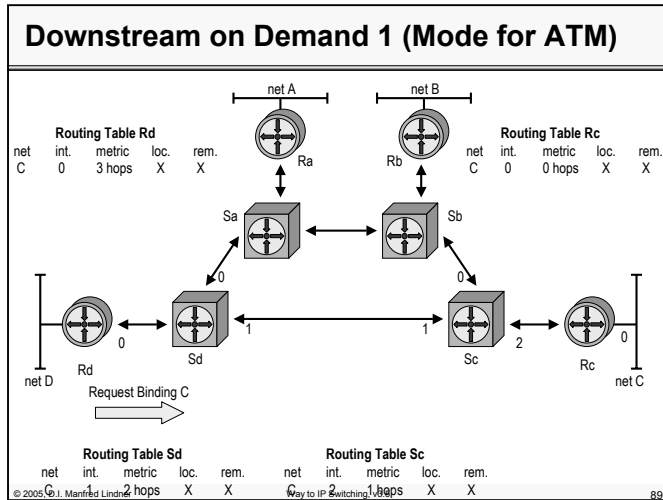
L83 - The Way to IP Switching



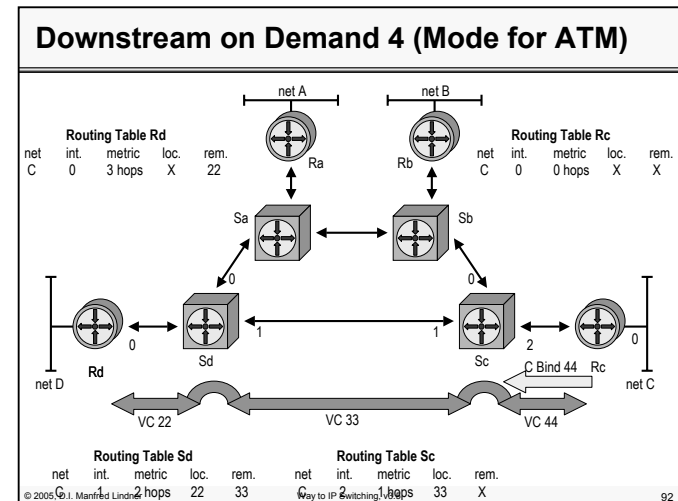
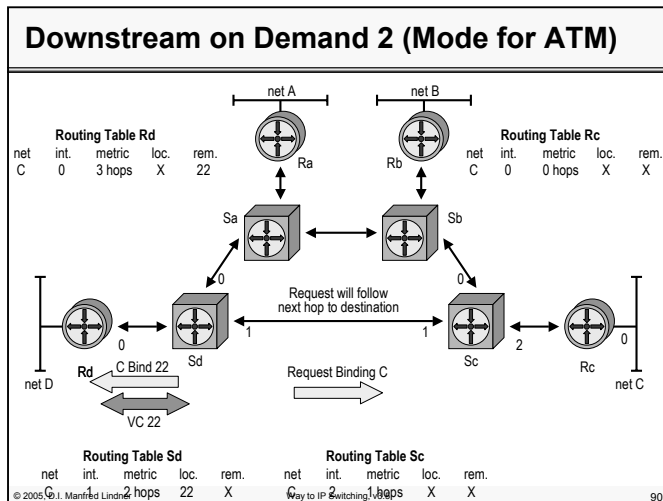
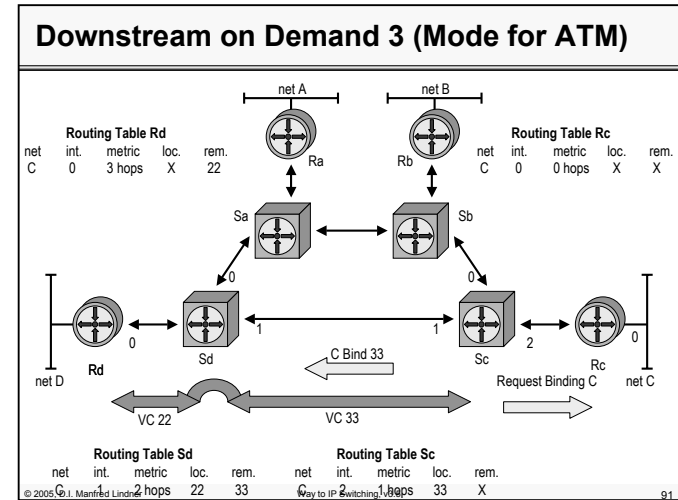
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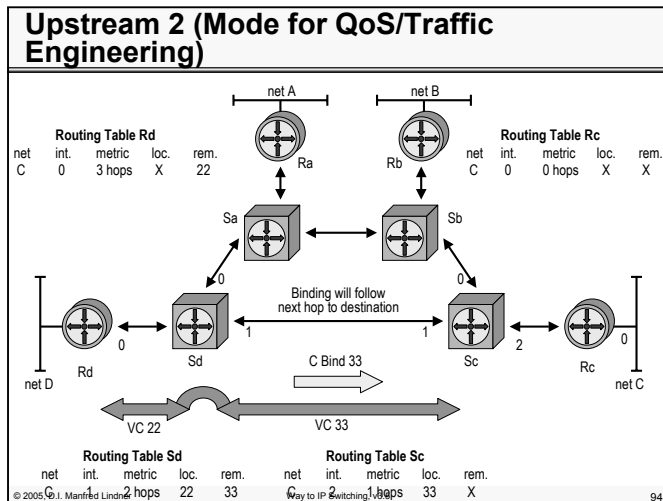
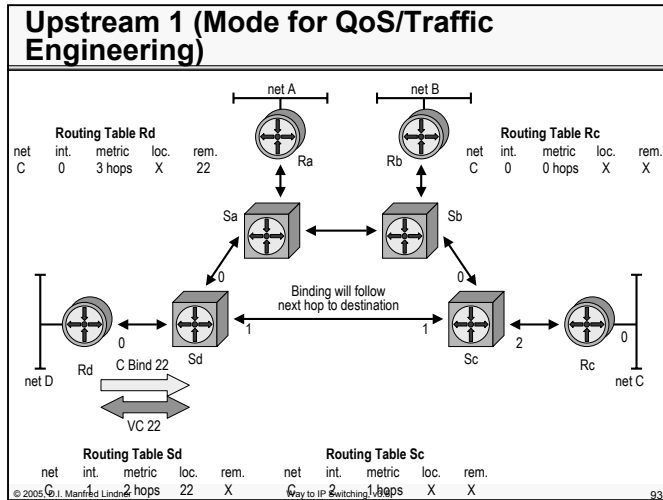
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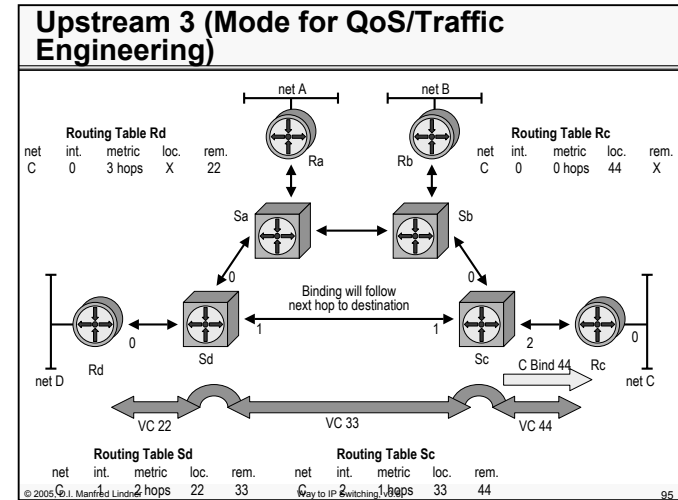
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L83 - The Way to IP Switching



Tag Switching

- **quality of service support**
 - define tags associated with specific quality of service
 - use explicit routes to guarantee the quality of service
 - destination based routing can't guarantee because every router can make it's own decision
- **TAG switching and ATM**
 - can be easily deployed with ATM because ATM uses label swapping
 - VPI/VCI is used for tagging
 - ATM switches needs to implement control component of tag switching
 - ATM attached router peers with ATM switch (TAG switch)
 - exchange tag binding information