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Link Aggregation Reference Model

By Paul A. Bottorff

For March 1998 IEEE Meeting

Definition for Link Group

- **The aggregation of a group of links is a “trunk”**
- **Each Link Aggregation Multiplexer instance along with all link segments and associated entities who’s MACs are bound to the Link Aggregation Multiplexer instance are part of the same Link Segment Group.**
- **Link Segment Group or Link Group for short**
- **Once called a trunk group**
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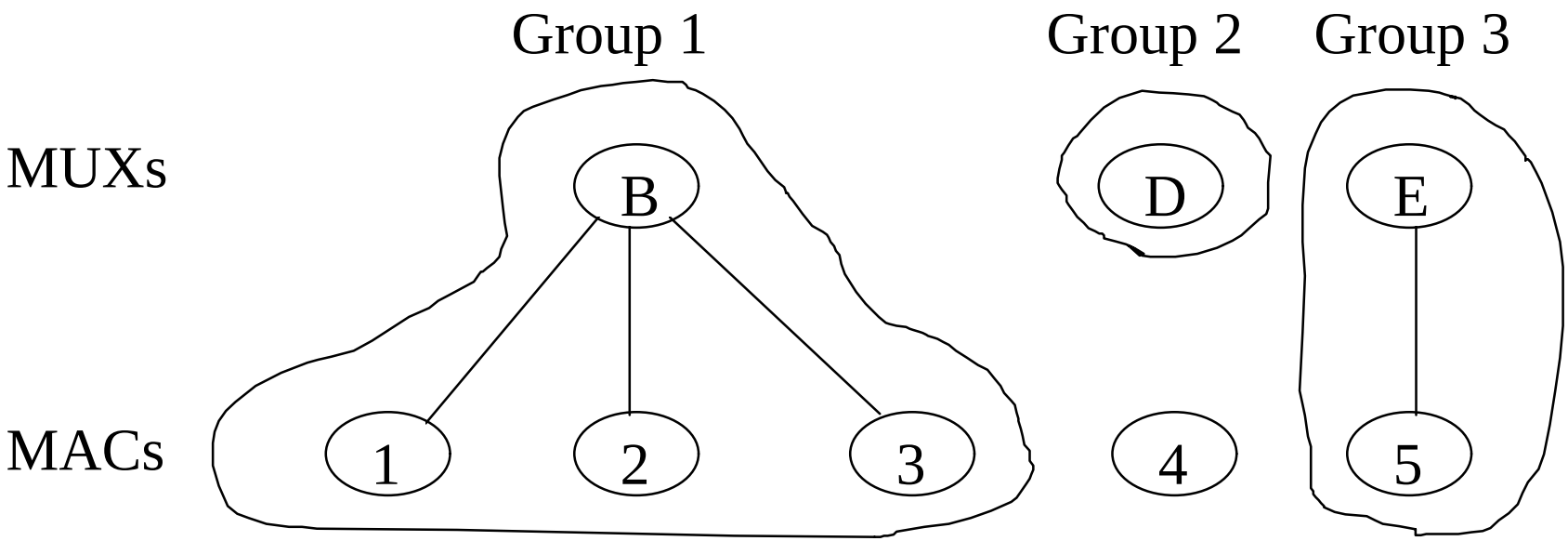
Link Groups



Group 1: Active Link Group
Group 2: Inactive Link Group
Group 3: Active Link Group with Null Mux

4 Components of Link Aggregation

- **Link Aggregation Collector (AC)**
- **Link Aggregation Distributor (AD)**
- **Link Aggregation Load Balancer (AB)**
- **Link Aggregation Controller (ACTRL)**
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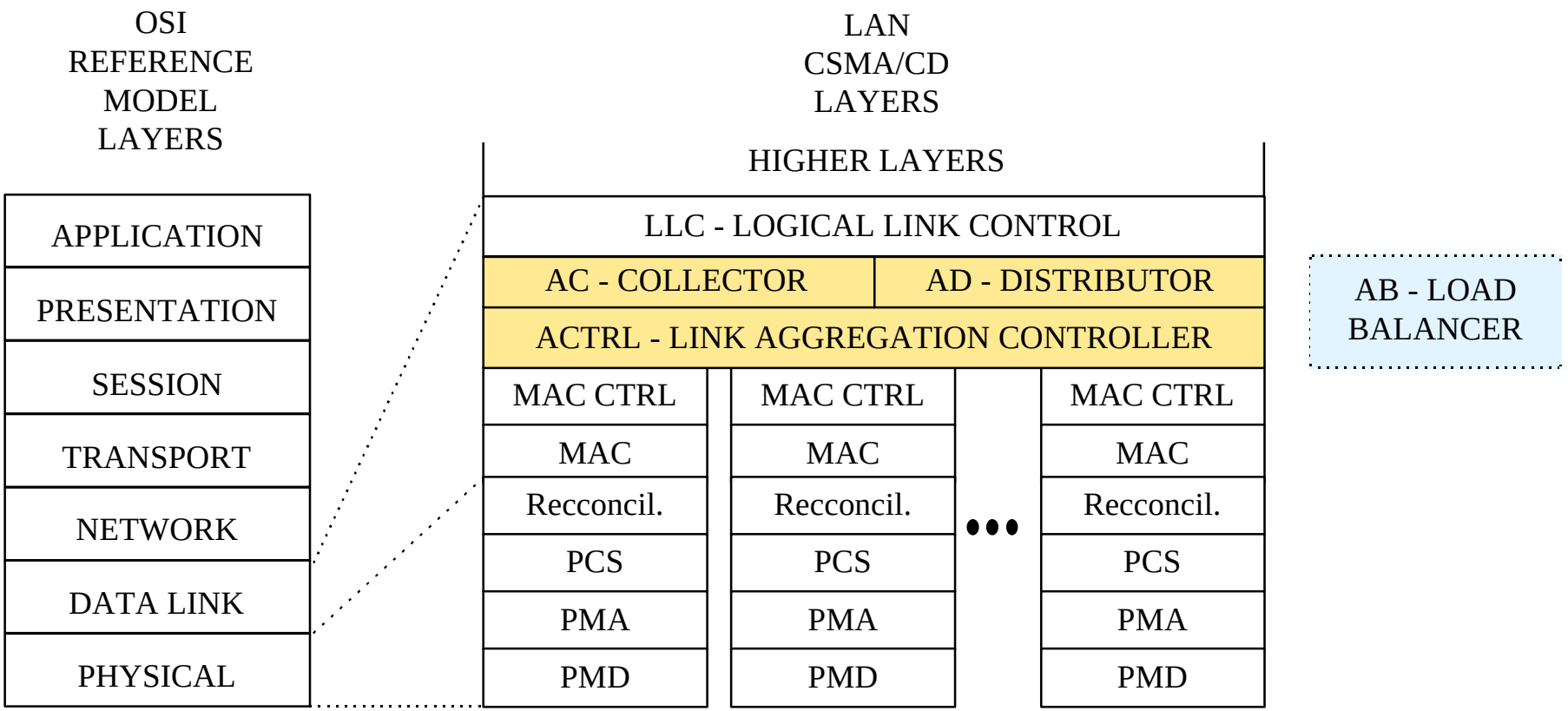
- **The combination of the Collector, Distributor, and Load Balancer is a Link Aggregation Multiplexer or MUX**

Link Aggregation Reference Model



Collector Functions

- **Provides a client interface for end-station, bridge, or router entities conforming to 802.3 or 802.1d MAC interface**
- **Binds with all 802.3 MACs of the Link Group**
- **Merges frame from all MACs of the Link Group into a single receive stream**
- **Registers Multicast Addresses with the Controller**
-

Distributor Functions

- **Provides a client interface for end-station, bridge, or router entities conforming to 802.3 or 802.1d MAC interface**
- **Binds with all 802.3 MACs of the Link Group**
- **Distribute frames from the client to the MACs**

Controller Functions

- **Initializes each Mux**
- **Initializes each MAC**
- **Determines which MACs are active**
- **Assigns MACs to Link Groups**
- **Informs MACs what unicast MAC address to use**
- **Informs each Mux of the MACs in its Link Group**

Controller Functions

- **Adds and removes MACs from Link Groups**
- **Responds to manual Link Groups controls**
- **Performs automatic Link Group protocols**
- **Provides status for the Link Group**
- **Maintains the list of multicast addresses for each Link Group**
- **Updates the multicast addresses for each MAC of each Link Group**
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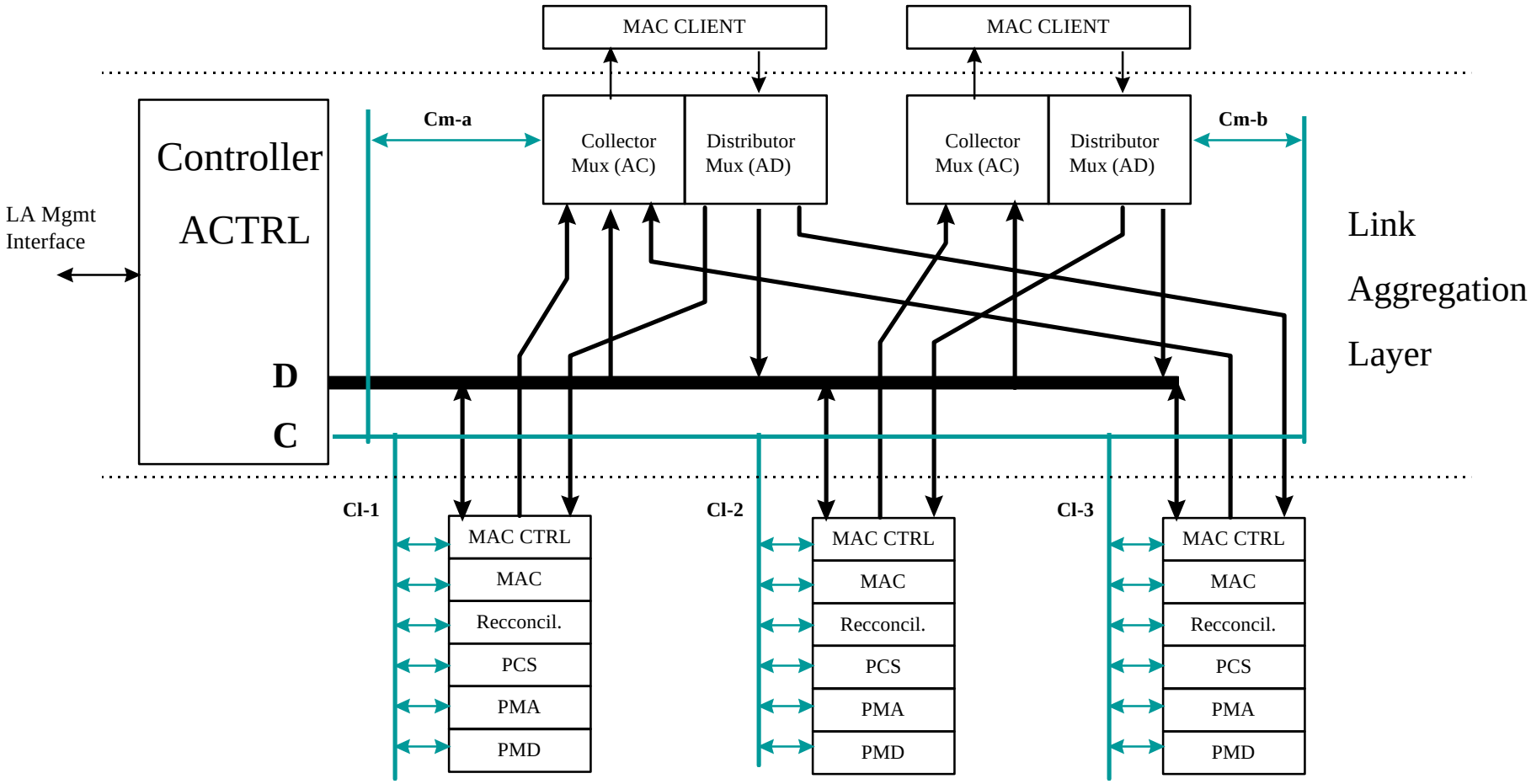
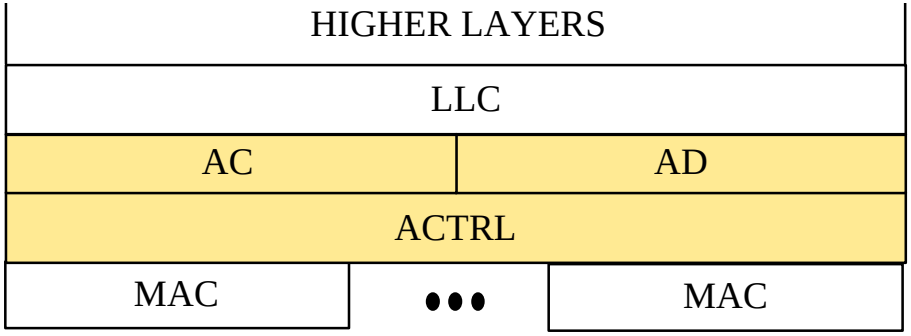
A Switch Design Example



Simplified Reference Model

LAN
CSMA/CD
LAYERS



AC - Link Aggregation Collector

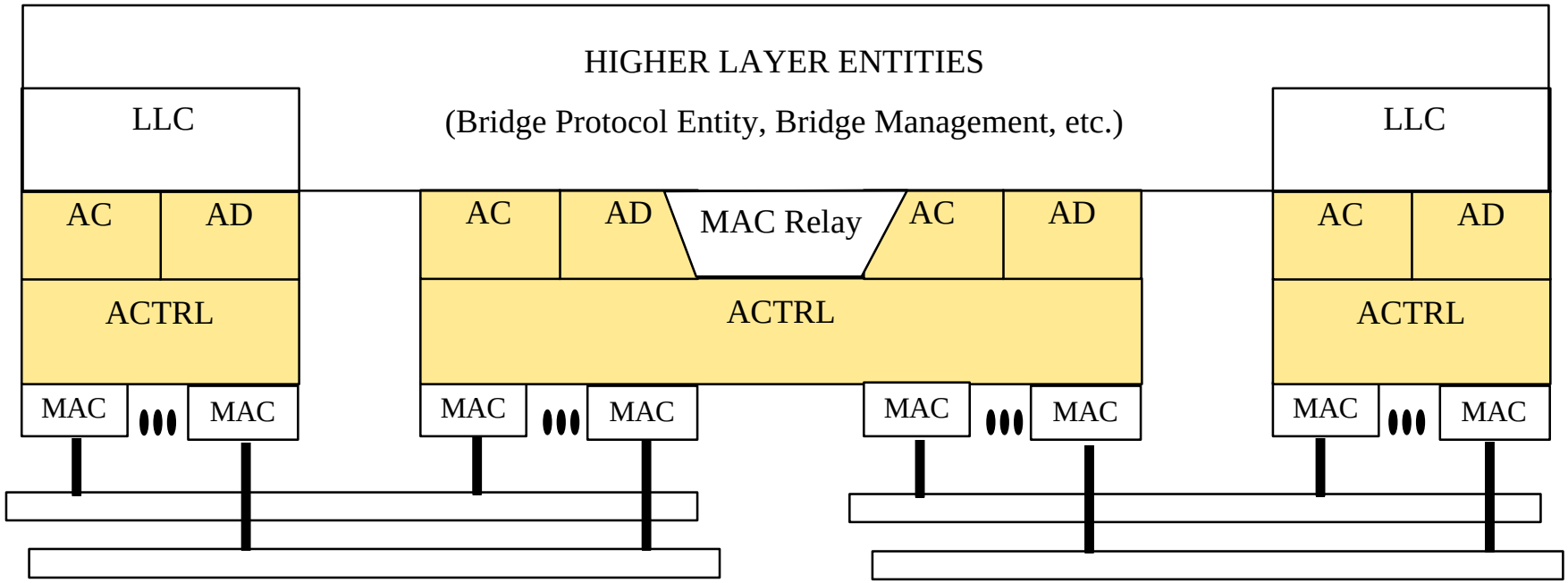
AD - Link Aggregation Distributor

ACTRL - Link Aggregation Controller

MAC - Media Access Control

LLC - Logical Link Control

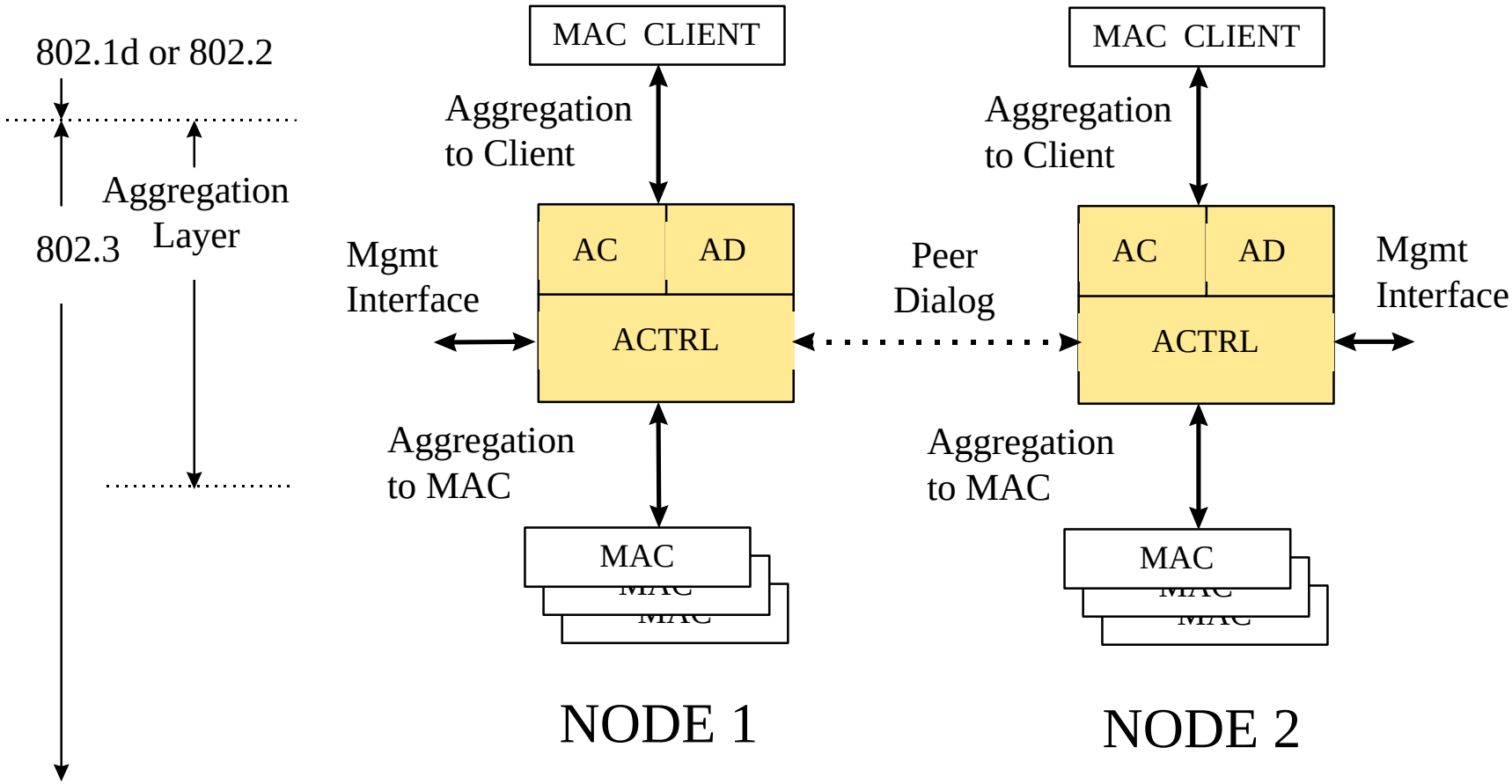
Switch Reference Model



The Standard Needs To Cover 4 Interfaces

- **Aggregation Layer to Client Interface**
  - — Identical to 802.3 and 802.1 MAC interface
- **802.3 or 802.1 MAC to Aggregation Layer Interface**
  - — Already specified by 802.3 and 802.1 MAC interface
- **Aggregation Layer Management Interface**
  - — MIB and service primitives need specification
- **Aggregation Layer Peer Dialog Interface**
  - — Frame based protocols for auto-configuration and error detection

Interfaces For Standardization



Recommedations

- **Adopt the term Link Group to replace “trunk group”**
- **Adopt the Link Aggregation Reference Model**
- **Standardize Link Aggregation behavior at the 4 interfaces:**
  - **— Link Aggregation to Client**
  - **— MAC to Link Aggregation**
  - **— Link Aggregation Layer Management Interface**
  - **— Link Aggregation Peer Dialog Interface**

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Addressing for Link Aggregation

By Paul A. Bottorff

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So What Are the Issues?

- **End-Station and Router Aggregates must use a single “logical” address so higher layer protocols view the Aggregate as a single MAC.**
- **Single MAC address for IP ARP**
  - **— Single MAC address for IPX network layers**
  - **— Single MAC address for management and policy systems**
  - **—**
- **Bridges don’t require a MAC address for data transfer**
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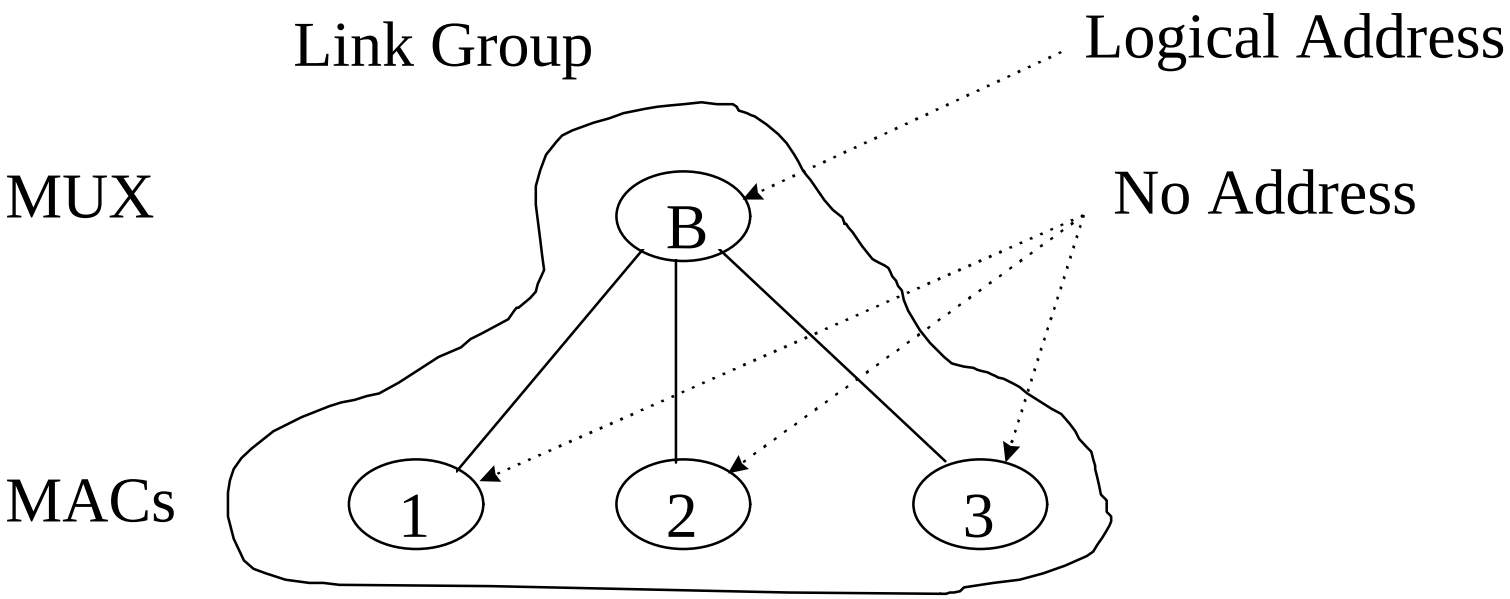
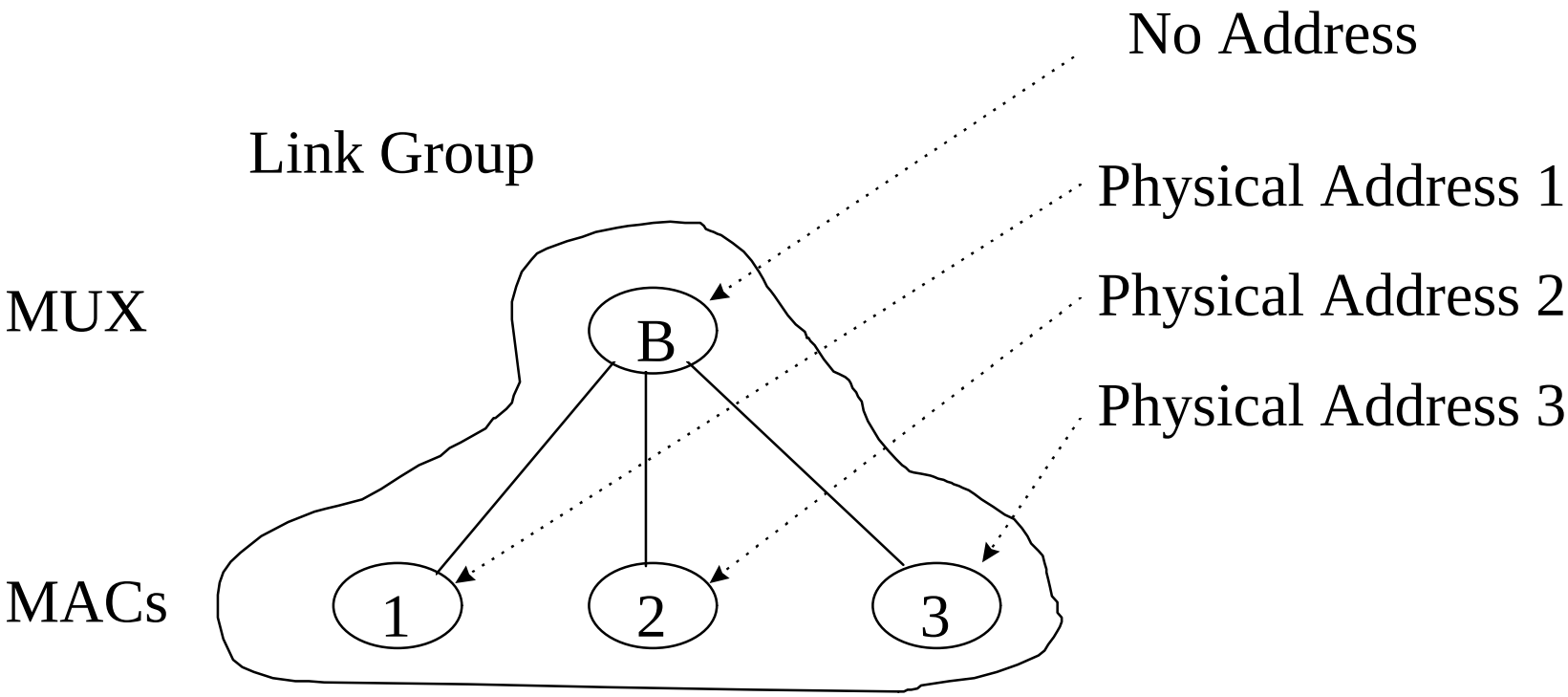
End-Stations Use Single Address



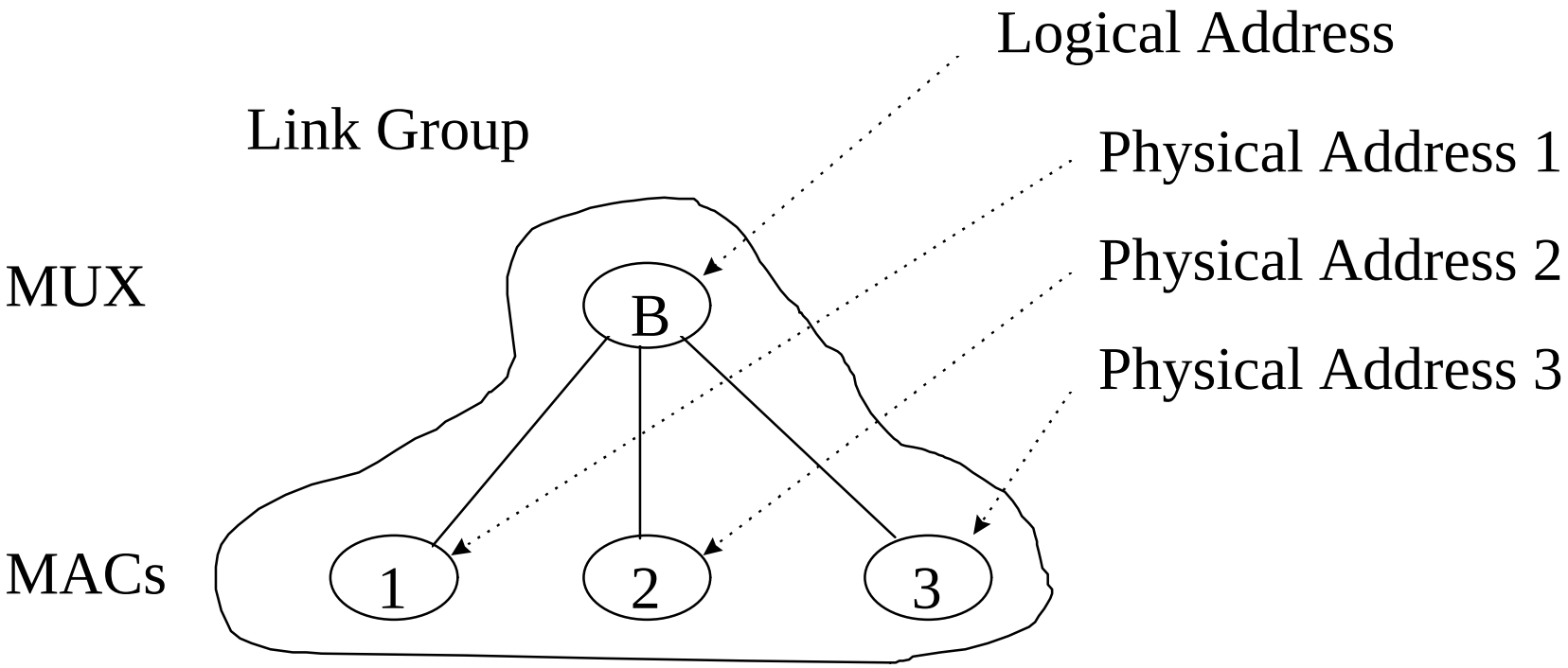
All SA addresses use the Link Group MAC address

Bridges Use An Address Per MAC



Bridge Uses Physical Addresses to source BPDUs etc.

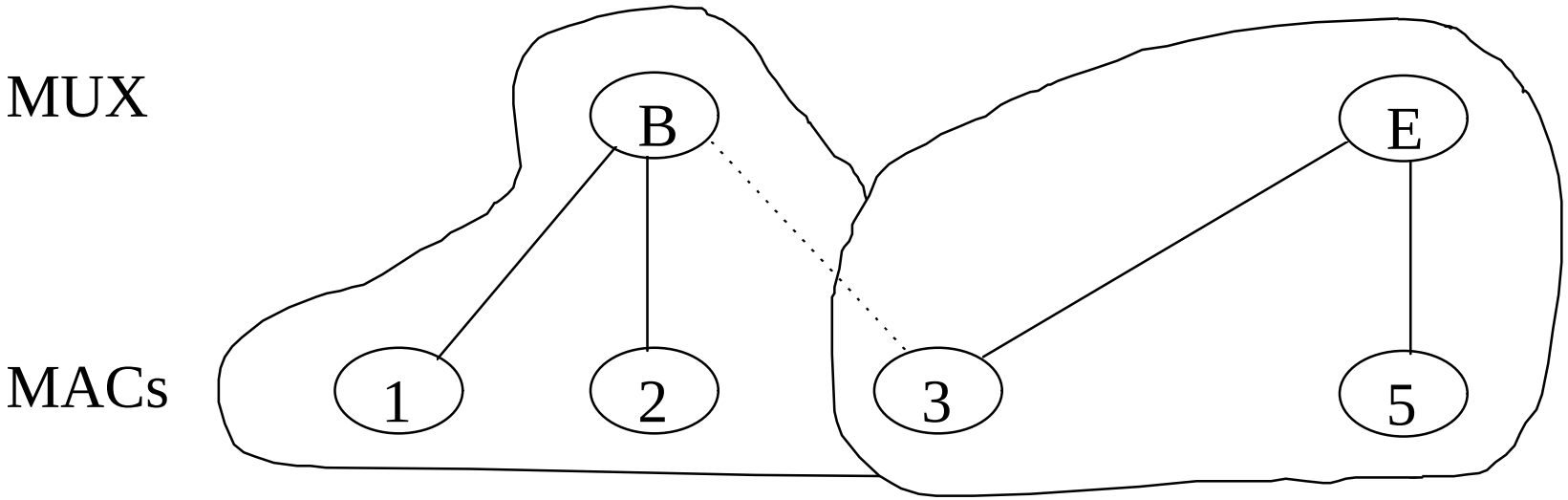
General Case: Bridge/Router/Server



MACs either pass SA from MUX or generate SA with Physical Address

Distinct Logical and Physical Addresses

- **If MUX B is using Physical Address 3, then what happens when 3 is dropped from B and added to E**
- **Dual Homed End-Stations Also Have Problem**



Unique Logical And Physical Addresses

- **For End-Stations and Routers Each Mux must have a unique address**
- **Physical Addresses Do Not Need to Be Unique**
- **Physical Addresses Must Be Distinct From All Logical Addresses**

A Solution Not Requiring a Physical Address

- **A single unique IEEE MAC address is associated with each LA Group**
- **802 MACs which are not yet assigned to a LA Group all use the same well known MAC address called the initialization address**
- **802 MACs in initialization state should only transmit frames with DAs holding the 802.1d reserved addresses**
- **All frames received from a MAC in initialization mode will be directed to the LA Control module**
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Recommendations

- **Allow single address end-stations**
- **Allow bridges without logical addresses**
- **Allow all physical and logical addresses to be unique**
- **Allow combinations where all logical addresses are unique but physical addresses are not unique**

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Link Aggregation Protocols

By Paul A. Bottorff

For Future IEEE Meeting

Initialization Procedure

- **Each MUX powers up in a reset state and with an assigned IEEE MAC address**
- **Each MAC powers up reset and with the init address**
- **Each Controller gets the IEEE MAC address associated with each MUX**
- **Control determines the Link Group for each MAC**
- **The Controller programs each MAC with the Link Group unicast address**
- **The Controller informs MUXs to bind with MACs**
-

Initialization Procedure

- **Each MUX may receive frames in either promiscuous or specifically addressed mode**
- **Each MUX may transmit frames in either passthrough or normal mode**
- **The MUX may register or deregister multicast addresses for the Link Group**
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