RPR MAC Data Transport & Buffering

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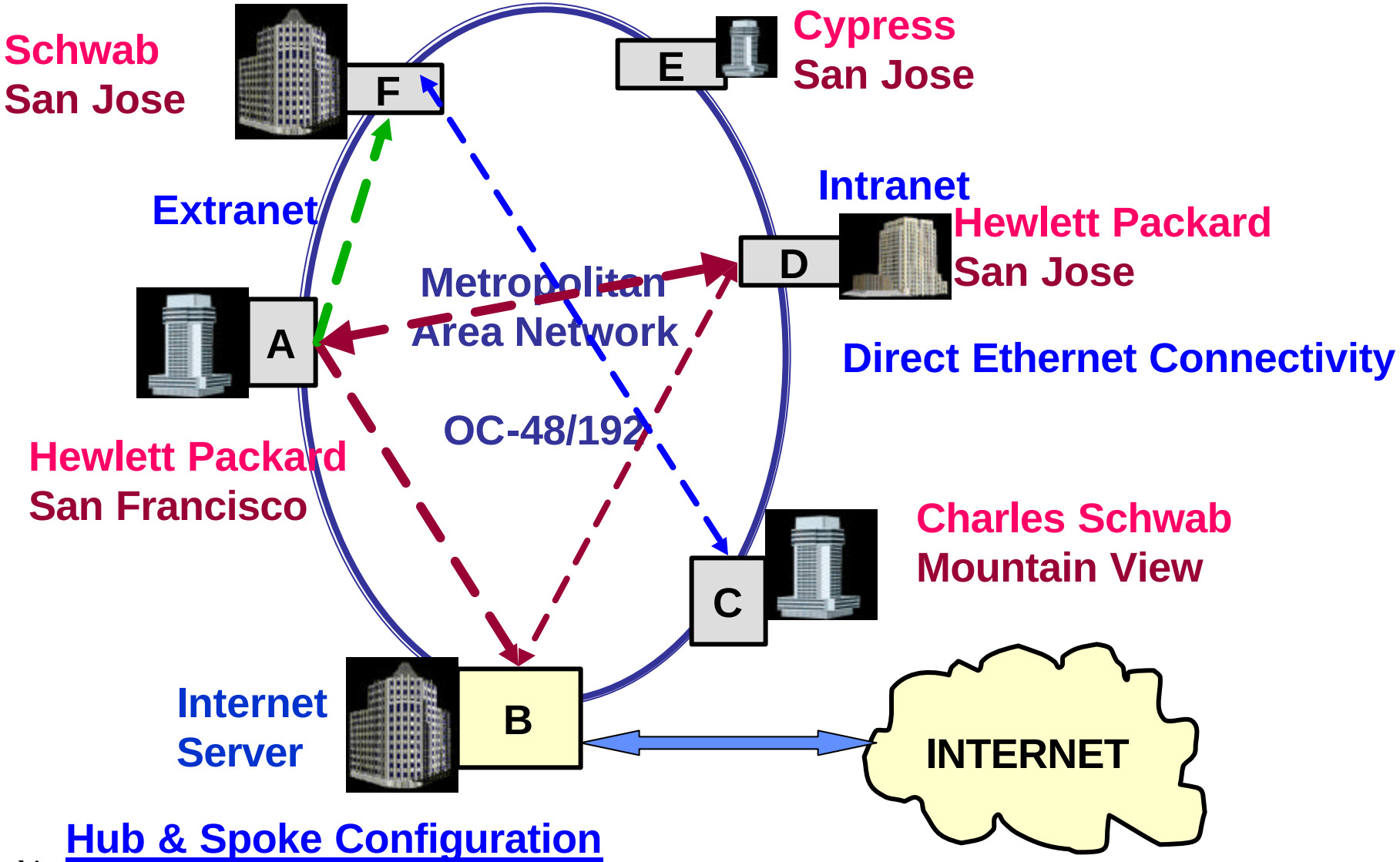
RPR MAC Issues

- **Dissimilar Bandwidth Allocation**
  - Allocate Bandwidth for different flows at different nodes
- **Upstream packet bursting when guaranteed bandwidth flows are not present (on a packet-by-packet basis).**
- **Provide a way for guaranteeing bandwidth so RSVP and other L3 Models work**
- **Per-node Traffic Policing and Shaping**
- **Support for same CoS Levels as Diff-serv and MPLS.**
- **Security in RPR Networks**

MAN Configuration



Hub & Spoke Configuration

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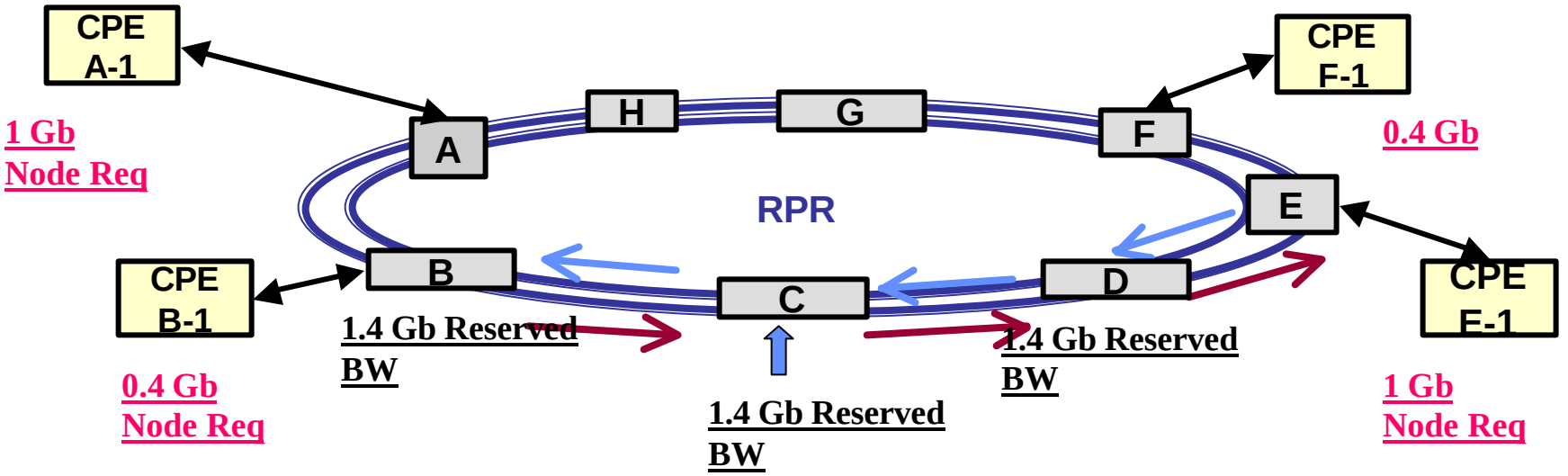
RPR Network Requirements

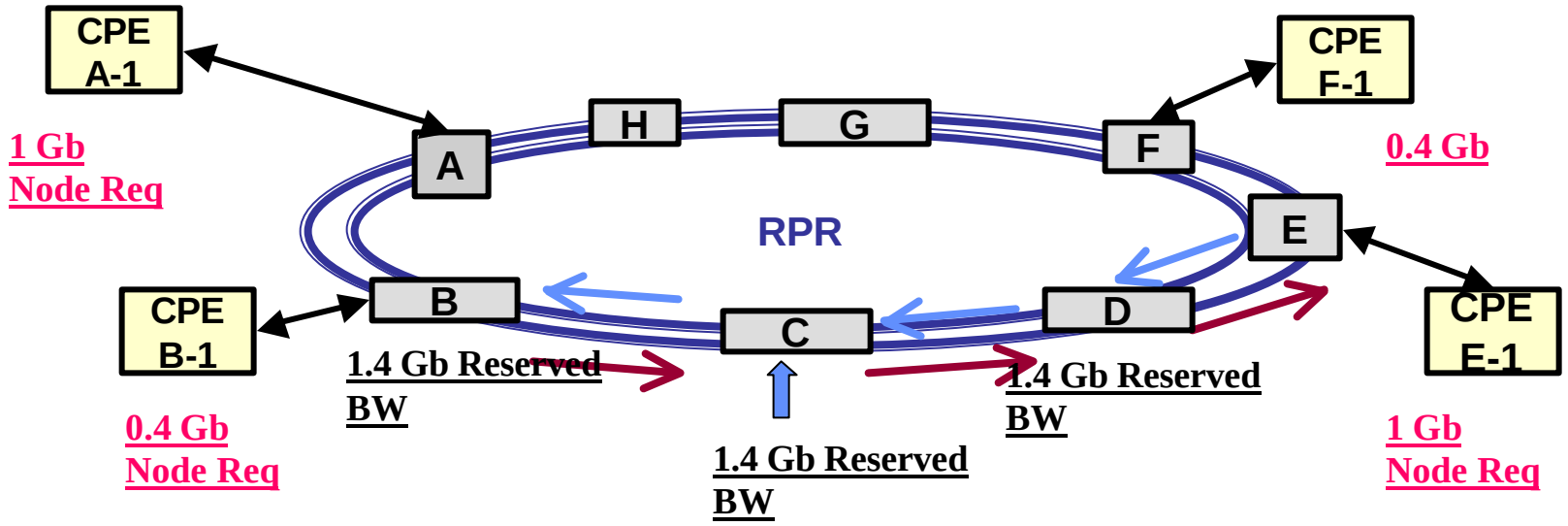
- **Different Customers need different Bandwidth Sizes & Guarantees**
  - **Corporate clients:** guaranteed high-bandwidth IP usage during day
  - **Local ISP**: web traffic, high/guaranteed bandwidth, best effort
  - **Campus**: best effort, some guaranteed high bandwidth for videoconferencing, etc.
  - **Financial institutions**: guaranteed high-bandwidth IP usage
- **RPR must provide a way for guaranteeing bandwidth**
- **RSVP, Diff-serv, and other L2/L3 models for QoS/CoS should not be broken/voided by RPR MAC, else RPR MAC will not succeed**
- **Any RPR MAC with less than 8 priority levels (true for Diff-serv, MPLS, etc.) will fail this compliance.**
- **Intranets must be secure, and Extranets should be authenticated**

Bandwidth Allocation at a Node



- Nodes need guaranteed bandwidth for different traffic flows
- L3 requests & reserves Bandwidth (using RVSP, etc.) at different nodes for different flows
- A node, or other upstream node may still send over-provisioned High & Low Priority Data.
- RPR MAC cannot always allow Upstream Transit High Priority Data to go through
- RSVP & other L3 models break down if if High Priority Upstream Transit Data is always given Priority

Transit & Transmit Operations



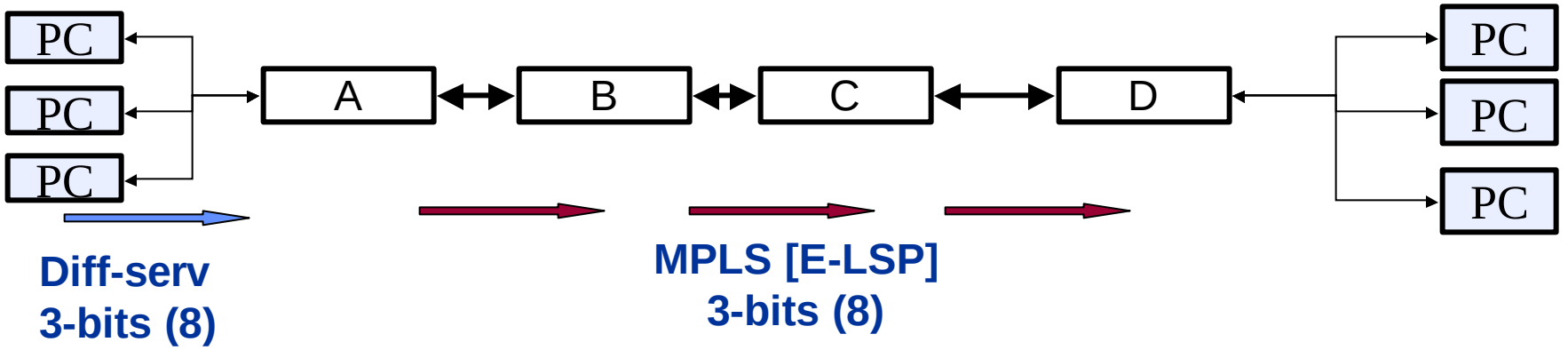
At Node C

- Incoming packets are received by RPR MAC
- Traffic policing & shaping logic for Node Traffic as well as Transit Traffic
- Node Reserved Bandwidth Traffic + Incoming Reserved Transit Traffic given Priority over other Packets.
- Bandwidth at a Node: $A_b = T_b - R_b$ (A: Available, T: Total, R: Reserved)

Node Bandwidth Management

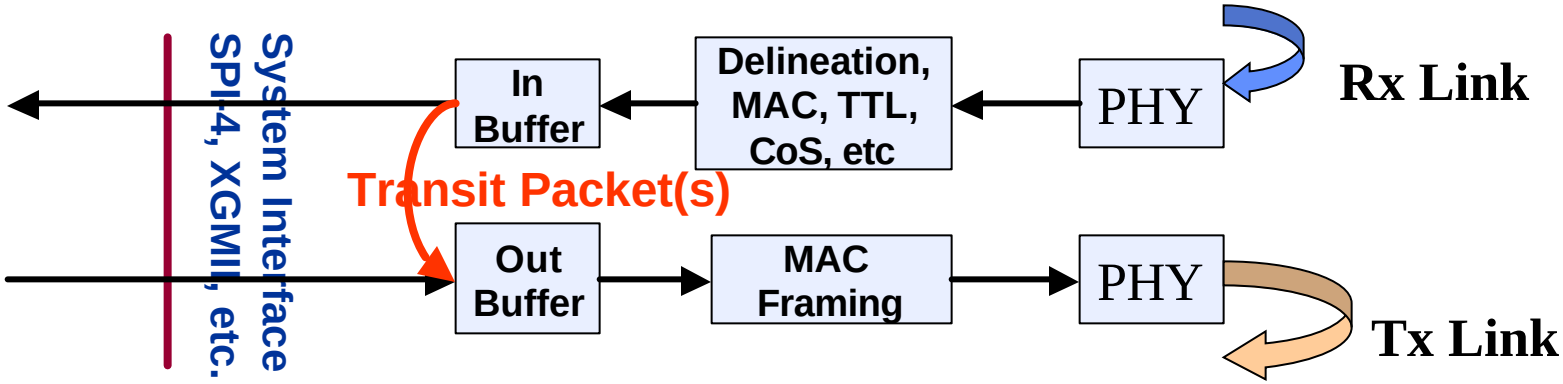
- Different Nodes have different Bandwidth needs
- “Fair and Equal Allocation” to all Nodes is not desirable
- Node’s own reserved bandwidth needs to hold valid
- Incoming High/Low Transit Traffic must give way to any Reserved Traffic
- Policing & Shaping at every Node
- For a Node MAC, “complaining” to Upstream Node about Congestion is not enough
- At the same time, Usage Notification to Upstream Node prevents Bursting by Upstream Nodes

Traditional CoS & QoS



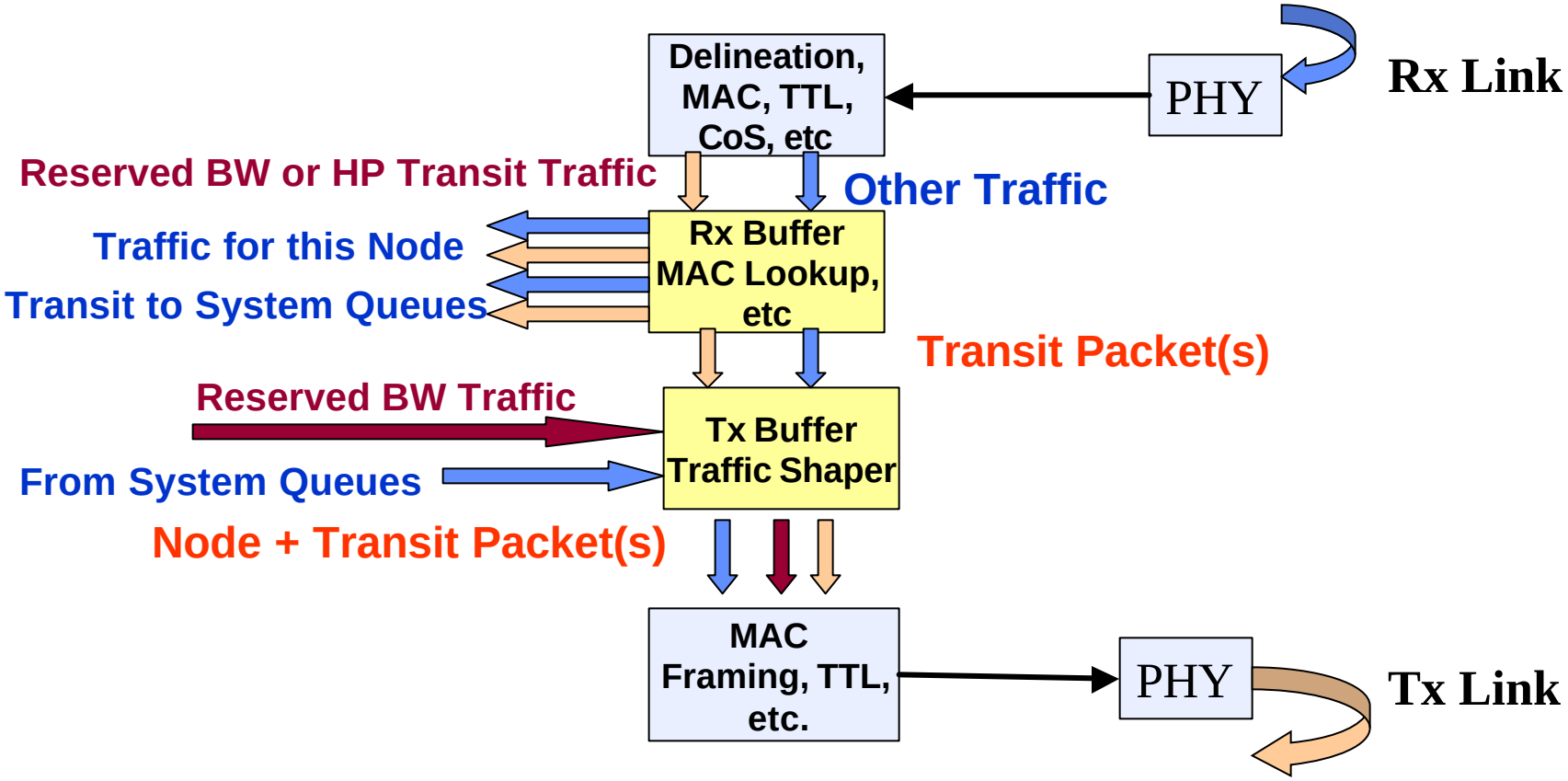
- **Ethernet MAC doesn't force any CoS - leaves it to L2/L3**
  - Ethernet, therefore, doesn't preclude Diff-serv, MPLS, Int-serv/RSVP, etc.
- **RPR MAC must have built-in CoS to coordinate Transit/Transmit Traffic**
  - Must decide extent of CoS for RPR MAC.
  - Just two levels for CoS will break all Diff-serv & MPLS CoS Assignments
- **RPR MAC should support 8 CoS Levels.**
- **RPR MAC doesn't need to have built-in processing for all CoS**
  - Leave Scheduling optionally to System so newer Scheduling Techniques can be used in Future.

Data Flow in RPR MAC (High-level)



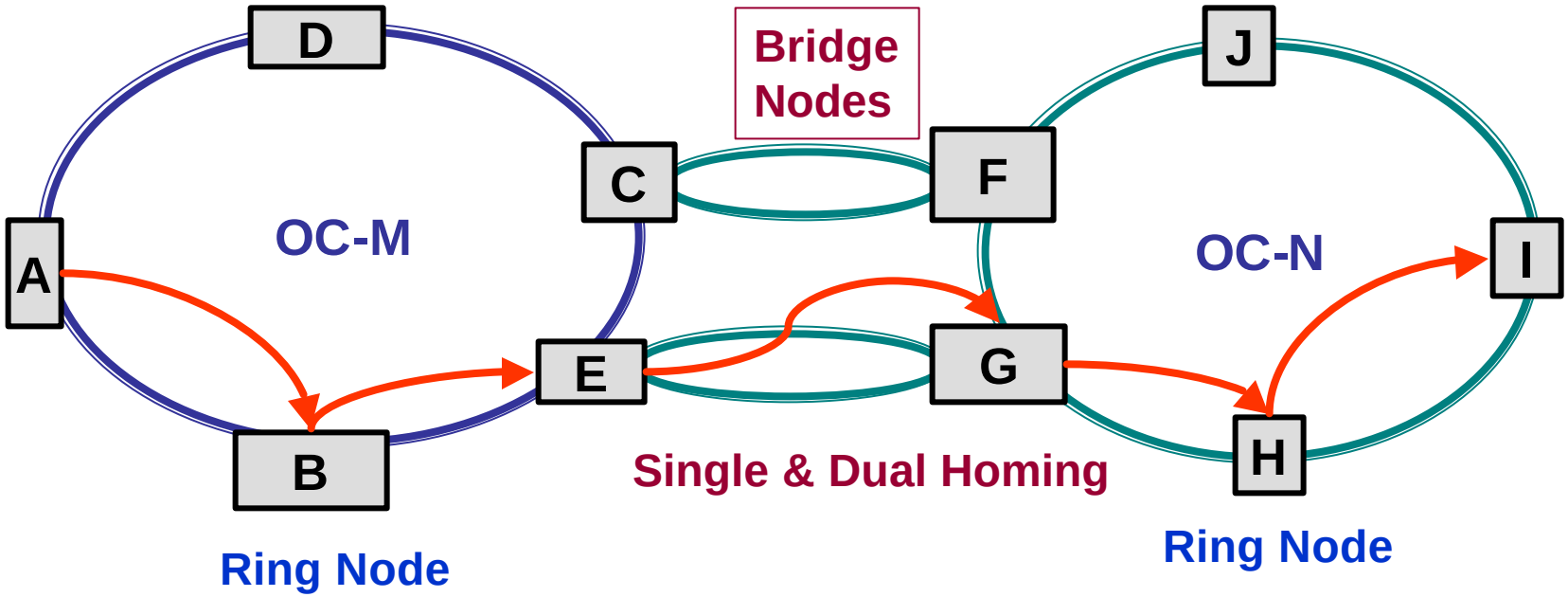
- **Even with Transit Buffer operations, Transit Data travels most of RPR MAC blocks**
  - System Interfaces are Full-duplex at Full Speed
  - Little Penalty in sending Data across & have system analyze & send it back
  - Leave flexibility in QoS and Traffic Engineering for Future Developments.
  - Have Minimal Transit Buffer in MAC
- **Option to send ALL packets to System, if a user wants to do all Traffic Management with his Queuing/scheduling Logic.**
  - Doesn't Inhibit Future Developments in Traffic Management
  - At RPR, we should design MAC protocol, not a Chip Architecture

RPR MAC Model



- Up to 8 Priority Levels. All Need Not Be Processed by MAC
- MAC Allows Merging of Priority Levels
- MAC Passes Remaining Packets to System

Multi-ring Configurations



- All Network Operations should be able to go across Rings
- Bandwidth reservations are made by L3 across rings
- L3 protocols aren't necessarily aware of Ring Structure(s)
- RPR MAC shouldn't preclude reservations across rings
- Each Node (ring or bridge) manages Bandwidth Allocation

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Bandwidth & Priority Management

- Total Bandwidth of a Tx Link = T_b
- Node Bandwidth Reserved (through RSVP, etc.) = RN_b
- Upstream Traffic Bandwidth reserved (through RSVP, etc.) = RU_b
- Available Bandwidth $A_b = T_b - RN_b - Ru_b$
- Node Reservations get highest Priority, followed by Transit
- 8 Priority Levels supported. RPR MAC doesn't need to have on-chip Logic for all these Levels within the device
- Priority Merging. A Few Priority Levels can be merged into one.
- Bursting (over-provisioned cases): If no Packet from Upstream/Node for Reserved Bandwidth present, Node may use unused bandwidth for other Packets
- Non-conforming Packets are sent to System

Bursting & Overprovisioning

- Usage Notification in advance not a Method for per-Packet Traffic Allowance from Upstream Node
- Node tells Upstream Neighbor about any Reservations.
- Upstream may burst at Full Speed, if it chooses.
- At the time of Upstream Data Arrival, if Node doesn't have Reserved Bandwidth Packet, the Burst Succeeds
- MAC sends non-conforming Packets to System Buffers for Later Delivery
- Congestion Notifications sent later by System on Buffer Overflow, etc.
- Larger Buffers and Longer Timeouts Help in Delaying Congestion Notification Triggers

Security in RPR Networks

- Each Intranet must be Secure
- Security within MAC would allow Native Packets Transport without any Encryption
- Service Provider (SP) Equipment may Provide Security
- No Mixing of Intranet Data
- VLAN Field (16 bits): VLAN ID (12-bit) and Priority (3-bit) within MAC
- Broadcast and Multicast Packets only affect Controlled Networks, not entire MAN/WAN.
- Access to a VLAN through Proven VLAN Registration Protocols

Summary

- Different Nodes have different Bandwidth needs
- “Fair and Equal Allocation” to all Nodes is not Desirable
- Support for 8 priority levels to Match Diff-serv and MPLS
- Policing & Shaping at every Node
- Congestion Notification not a Method for Traffic Allowance from Upstream Node
- Instead, Upstream Node bursts at Full Speed.
- System Buffers non-conforming Packets for Later Delivery
- Security through Integrated VLAN ID