Protected Inter-Ring Connection

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PIRC High Level Goals

- **Built on top of 802.17b MAC**
  - **Assumption is an L2 switched network**
    - **L3 systems already have mechanisms to deal with failover and were handled by 802.17-2004 informing the client of topology changes.**
  - **PIRC has to provide loop-free dual connectivity**
  - **PIRC should be compatible with STP but allow customers to use a network without STP**
- **Compatible with non-PIRC stations**
  - **ideally no MAC or operational changes needed for other nodes**
  - **usable with existing standard product chips**

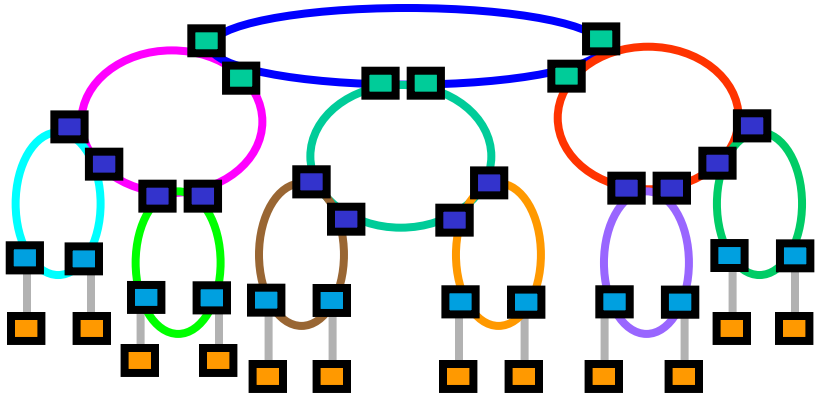
Positioning PIRC

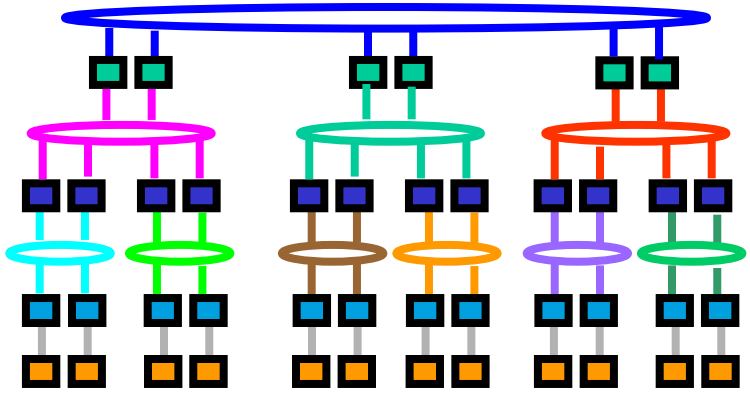
- **Need to avoid intrusion into 802.1 territory**
  - **Limit scope of PIRC so that it doesn't try to solve all problems for all networks hence it belongs in 802.17**

- **Must decide whether PIRC can work with un-changed STP or decide to push back on the 5C requirement for compatibility with the 802 architecture**
  - **PIRC *can* work with spanning tree but there are tweaks required to the STP stack**
  - **PIRC can work better without spanning tree**
    - **more options for load balancing**

Topology Considerations

- **Restricted Topology for rapid fail-over (50ms) with no single point of failure**
- **Each ring is connected to the higher level ring through a pair of matched nodes**
- **The rings form a tree hierarchy with no loops allowed between branches of the tree**
  - **Frame forwarding rules are restricted to insure that loops do not occur between hierarchical rings**
  - **No need to run STP if topology restrictions are met**





If a single path exists from a child level to a parent level then the network is loop free
PIRC can insure that loops don't exist

Topology Considerations

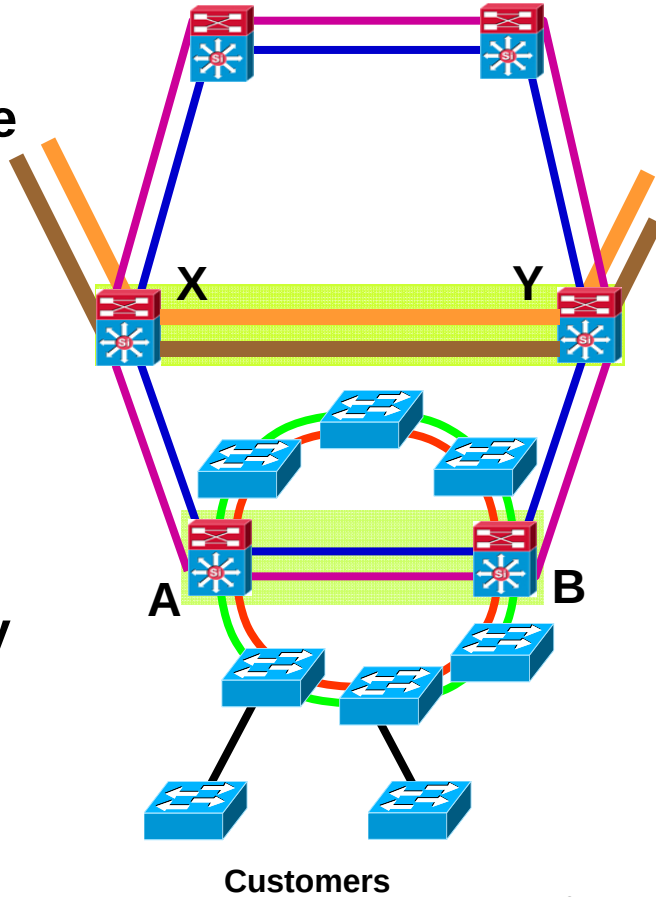
- **The hierarchical tree is in fact a common network**
  - **some SPs don't run STP but need a mechanism to insure basic L2 forwarding doesn't cause the loops, therefore:**
- **PIRC requires a method (or methods) to insure loops don't exist from a forwarding perspective**
- **PIRC requires a method (or methods) to keep STP happy iff STP is running**

PIRC - Nomenclature

- **SONET/SDH concept of Matched-Nodes**
  - **matched-nodes provide redundant interconnection between 2 rings**

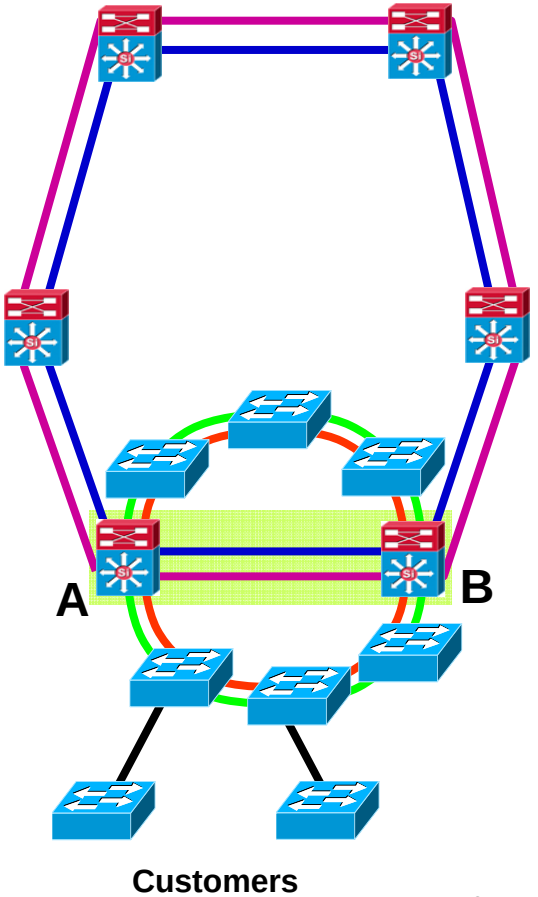
New Terminology:

- **Head-end nodes: the matched nodes that connect a ring to a ring one level higher in the hierarchy**
- **Tail-end nodes: the matched nodes that connect a ring to a ring one level lower in the hierarchy**
- **Note: a pair of matched nodes will be tail-end nodes on one ring and head-end nodes on another (A / B)**
- **If two rings are "equal", one should arbitrarily be made the "parent"**



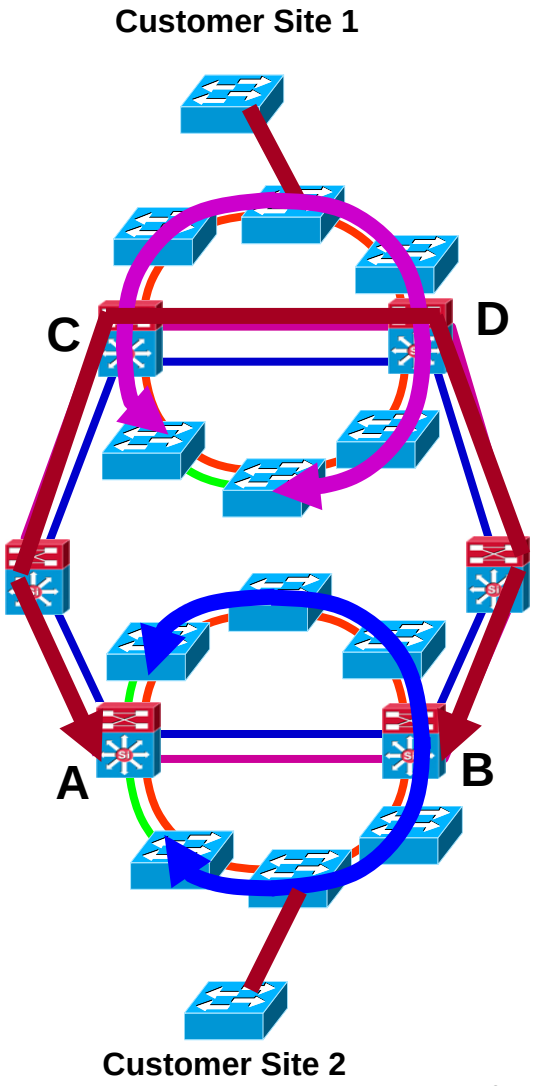
Loop Avoidance / Load Balancing

- A / B are matched nodes on both rings
- Active / Standby
  - only 1 of A or B is active and forwarding
  - similar to what STP does today
    - PIRC can provide rapid notification to update forwarding state
- VLAN Load Balanced
  - A and B are active and forward different VLANs
  - similar to what MSTP does today
    - PIRC can provide rapid notification to update MSTP forwarding state
- Spatial Load Balancing
  - A and B are active and forward frames based on where they came from and use ttl to scope
  - No direct mapping to STP operation



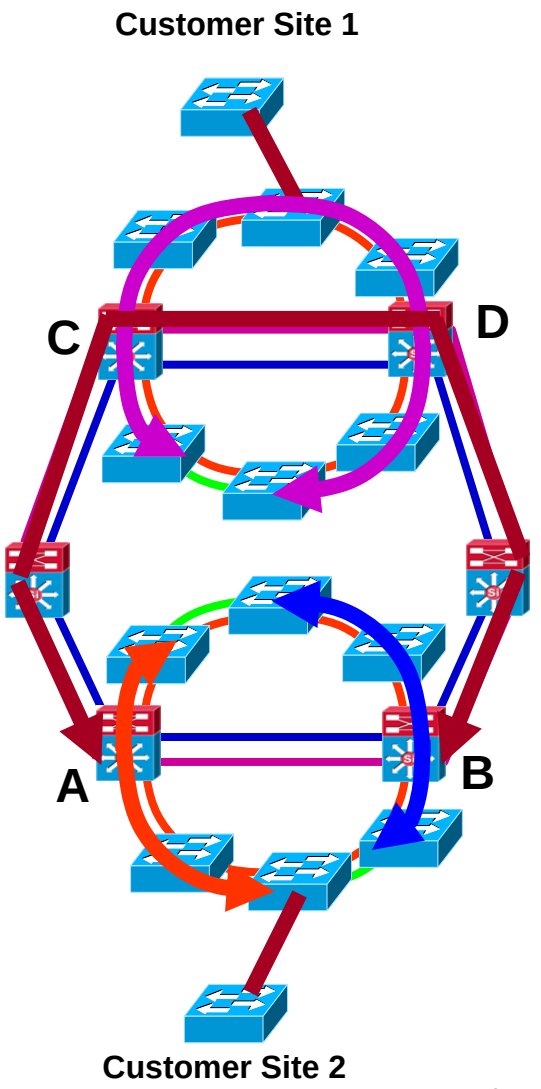
VLAN Balancing Example

- Each matched-node filters frames based on outer VLAN
  - each VLAN is “owned” by one of the nodes
- This provides an ability to load balance across both matched-nodes
  - more configuration is required to set up VLAN filtering rules
- If protection events cause a path to disappear the other node will take over the VLANs and forwarding of all frames to/from the rings



Spatial Balancing Example

- Customer site 1 sends a frame that is destined for site 2
- Assume the frame's destination is unknown for illustration
- As frames move up the hierarchy, a single matched node is responsible for forwarding
  - Closest head-end node forwards
- As frame move down the hierarchy, both matched nodes forward the frame
  - Replication is prevented by flood scoping
  - Bidirectional flooding guarantees shortest path
- If protection events cause a path to disappear the other node will take over forwarding of all frames to/from the rings



PIRC Forwarding Rules

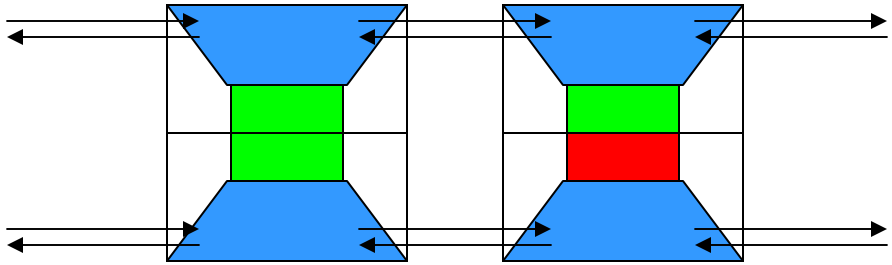
- **Major Rule: Never replicate a frame!**
- **Never forward a data frame sourced by the mate matched node back onto the originating ring**
- **For traffic going to onto a ring either:**
  - **Both matched nodes forward data frames and scope the travel of the frames to insure no replication**
  - **Only 1 matched node forwards the data frame.**
    - **This does not imply that one of the nodes is idle (i.e. a hot standby), although that is a possible network configuration**

Matched Node Position

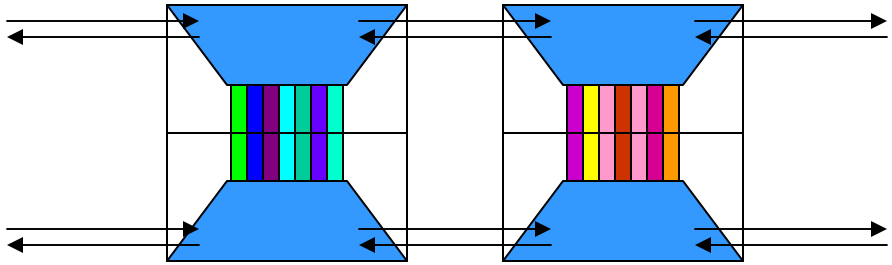
- **Matched nodes can be placed in any position on the ring, but there are “optimal” locations**
- **Opposing for head-end nodes aggregating traffic up to the next level ring gives maximum spatial reuse**
- **Adjacent when all other nodes are on a single fiber loop and nodes are in the same CO**
- **Arbitrary on the highest level ring or in peering scenarios allows location redundancy**

Spanning Tree Models

- **For two nodes connected to both rings, STP will block one of the 4 interfaces (active/standby)**



- **For two nodes connect to both rings, MSTP will block some VLANs going to each of the interfaces**



Spanning Tree Models

- **The spatial balancing approach is trickier**
  - **STP has to be fooled (or changed) into thinking a port is blocked, but in reality it remains active**