# BGP Convergence in much less than a second

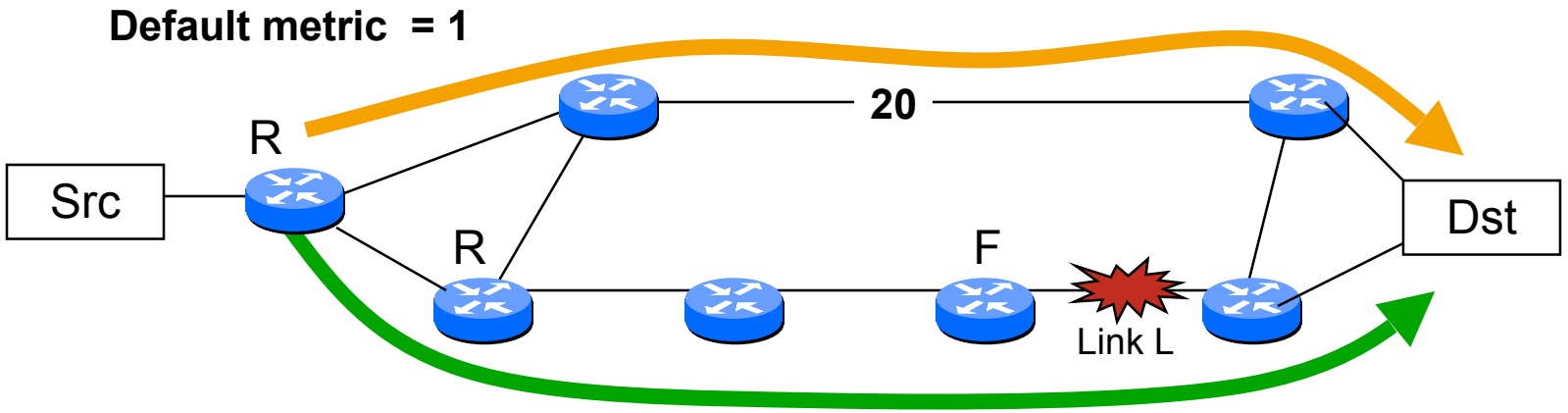
**Clarence Filsfils - cf@cisco.com**

**Presented by**

**Martin Winter - mwinter@cisco.com**

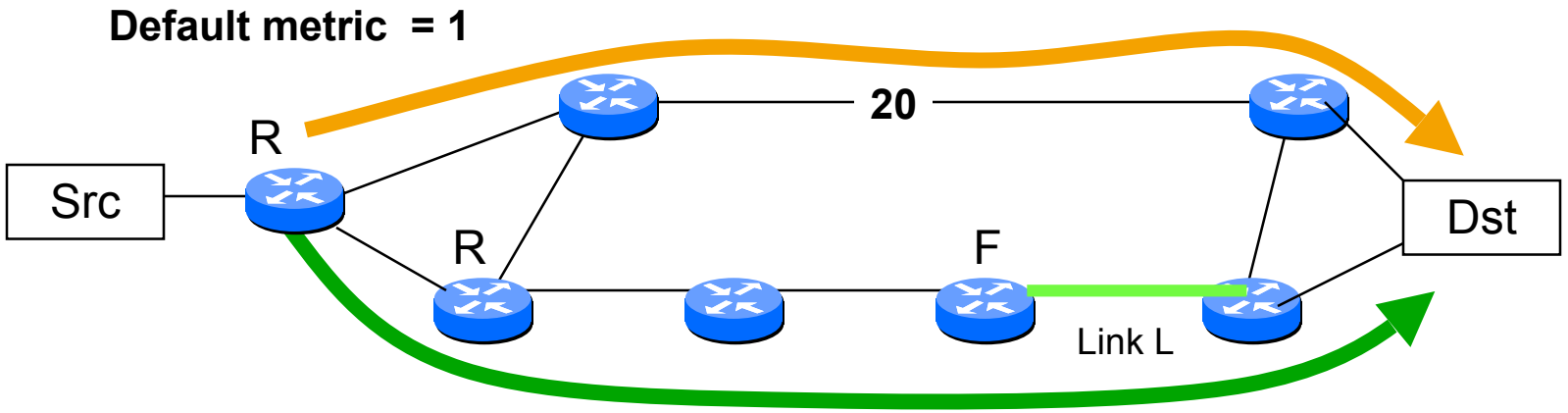
  

# Down Convergence


- Assume a flow from Src to Dest
- T1: when L dies, the best path is impacted
  - loss of traffic
- T2: when the network converges, a next best path is computed
  - traffic reaches the destination again
- Loss of Connectivity: T2 – T1, called “Down convergence” hereafter
- Analyzed for streams going to IGP and BGP learned prefixes

# Up Convergence

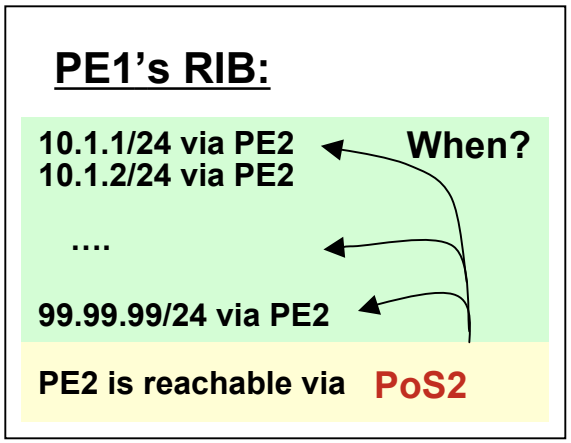

- Assume a flow from Src to Dest
- T1: when L comes up, a better best path is available
  - there is no traffic loss
- T2: the new bestpath is applied
  - there is no traffic loss
- “T2-T1” is called “UP convergence”. This does not imply any loss of connectivity

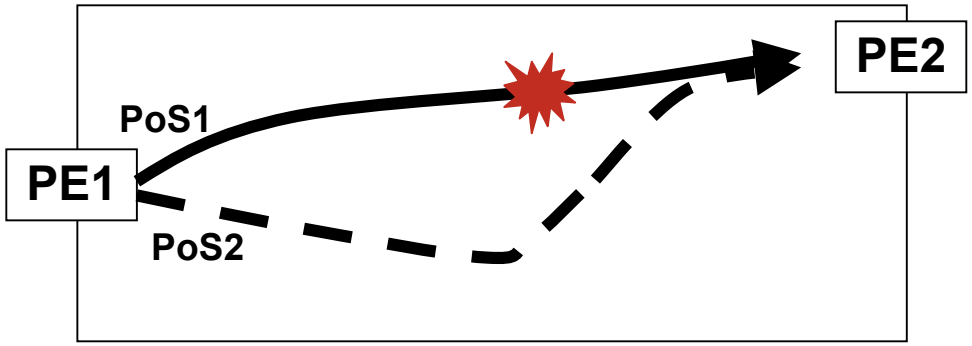
# Convergence – Down versus UP

- Down convergence
  - impacts customer service (there is loss between T2 and T1)
- UP Convergence
  - does not impact customer service (there is no loss between T2 and T1 because modern router implementation supports lossless switch-over from valid to valid path)
- **This paper focuses on "BGP Convergence upon Down transition"**

# BGP PIC Core

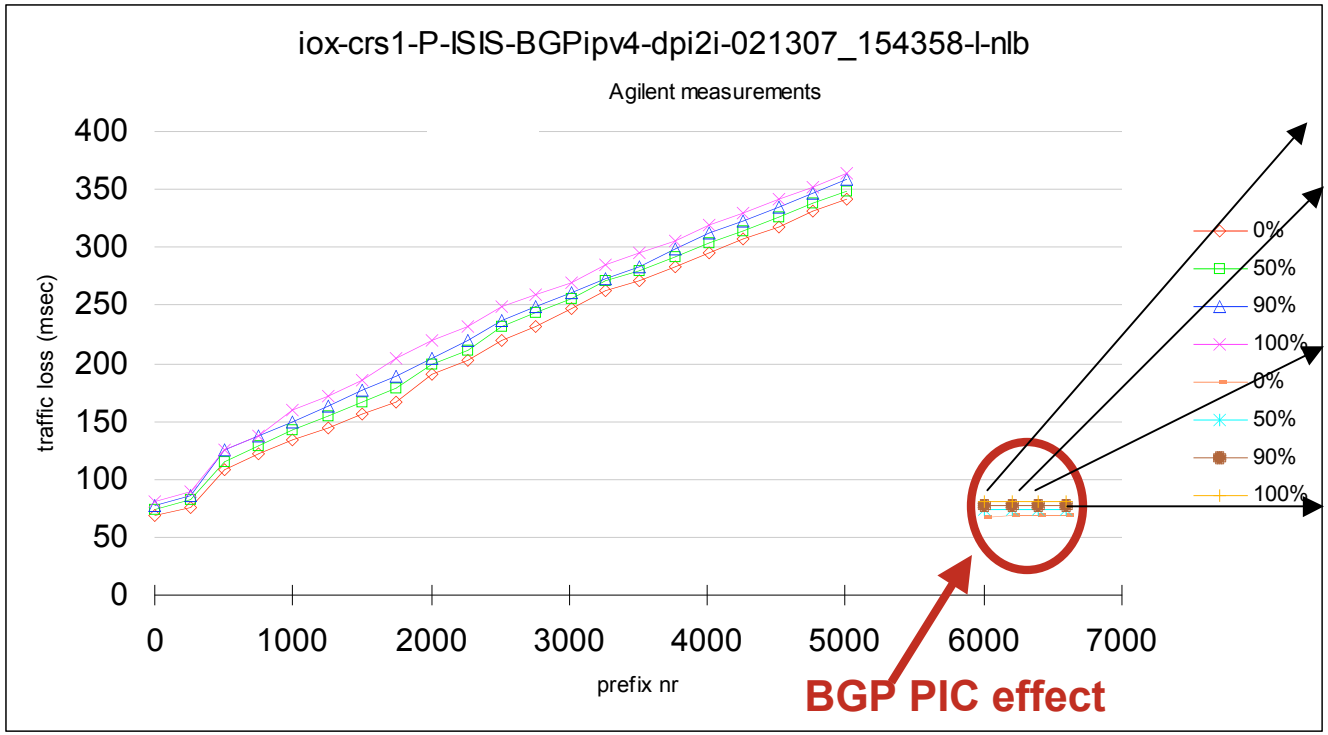
# BGP Prefix-Independent Convergence Core failure




- Upon a core failure, the IGP finds an alternate path to the BGP next-hop PE2 in a few 100's of msec
- Requirement: the BGP prefixes depending on reachability to PE2 must leverage the new ISIS path as soon as it is updated in the FIB

# The right behavior is “BGP PIC/core”




**The measured convergence to the BGP nhop**

**The measured convergence to the first BGP dependent to this BGP nhop**

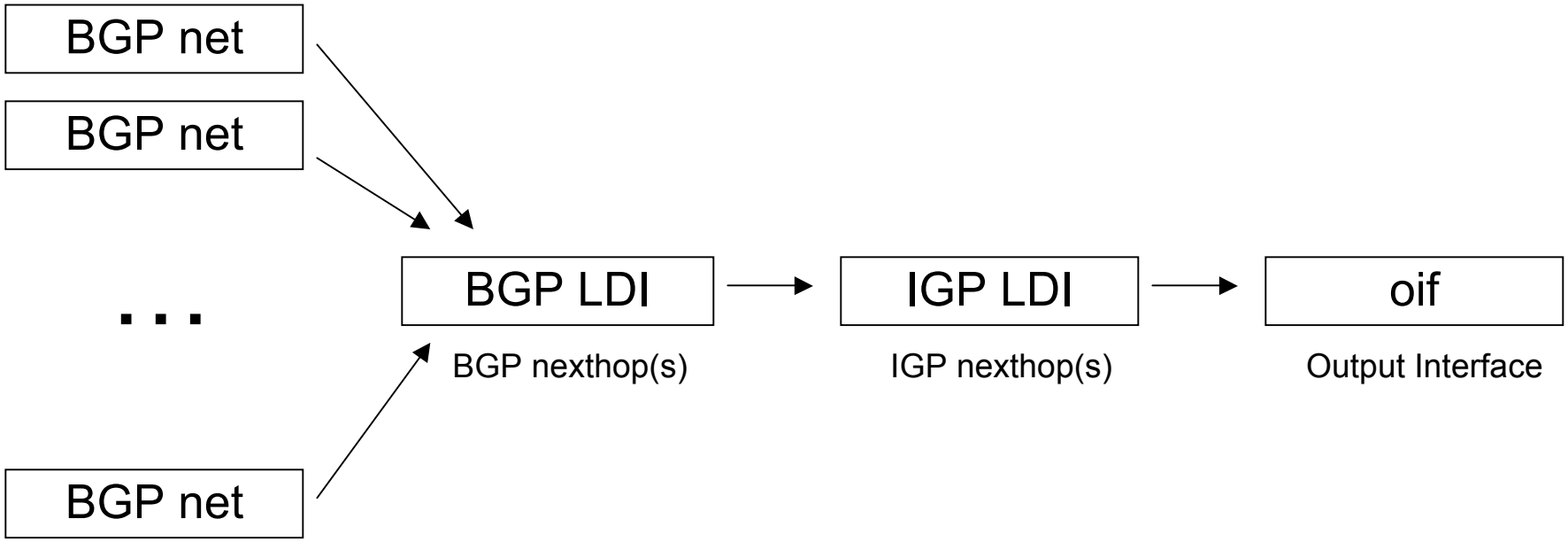
**The measured convergence to the middle (175k) BGP dependent to this BGP nhop**

**The measured convergence to the last (350k) BGP dependent to this BGP nhop**

**Prefix 1 to 5000 are ISIS prefixes. The BGP nhop is an important ISIS prefix and hence is prioritized to the very start of the convergence**

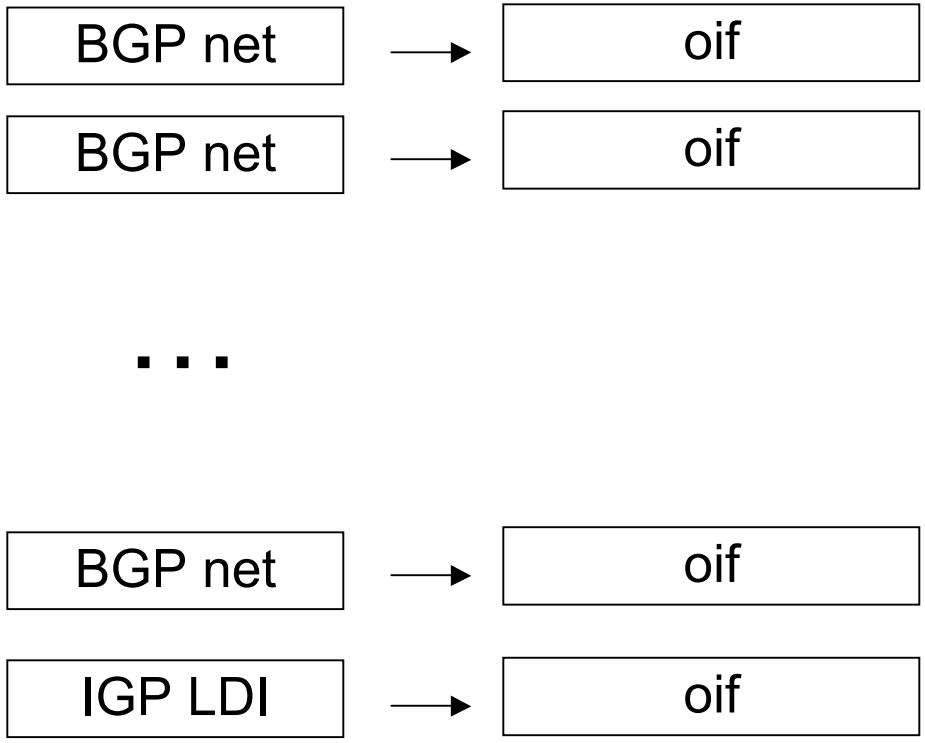
- Testbed: Tier1 ISP topology, CRS1, IOX3.5, 5000 ISIS prefixes, 350k IPv4 BGP dependents to impacted BGP nhop
  - same behavior for VPNv4 as of 3.5
- When ISIS converges, all the BGP dependents immediately leverage the ISIS convergence

# The right architecture: hierarchical FIB




- Pointer Indirection between BGP and IGP entries allow for immediate leveraging of the IGP convergence

# The unoptimal way: flattened FIB



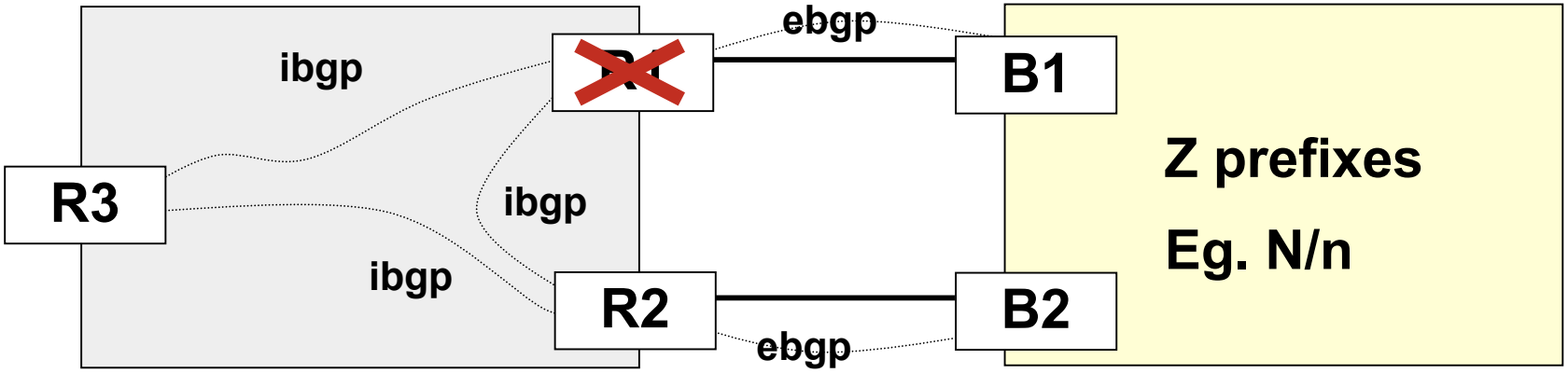

- Control Plane flattens the recursion such that any BGP FIB entry has its own local oif information

# Hierarchical FIB - Advantages

- Routing Convergence: BGP PIC Core
  - the BGP dependents converge at IGP convergence of their nhop
- Scaling and Robustness
  - Smaller FIB Memory (thanks to sharing)
  - Much less CPU requirement (no need to reflatten all BGP prefixes upon IGP change)
- Commercially available – proven

# BGP PIC Edge

# BGP PIC Edge



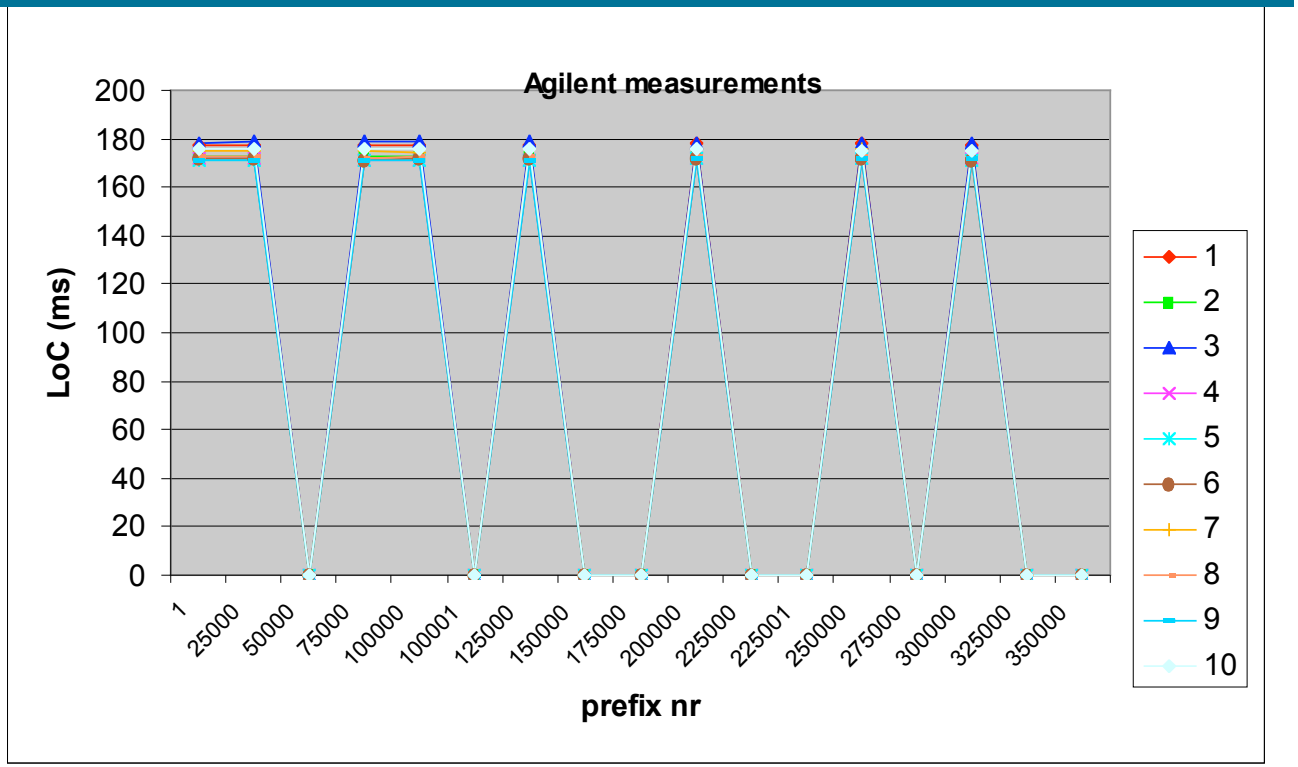

**Two ISP's peer at multiple locations and exchange 350k BGP prefixes.**

**R3, a typical PE within the grey ISP, installs each of these 350k BGP prefixes as multipath pair entries (BGP nhop B1, BGP nhop B2)**

**We send traffic from R3 to each of the 350k IPv4 BGP prefixes of the yellow ISP. We measure the loss of connectivity upon a peering node failure (R1)**

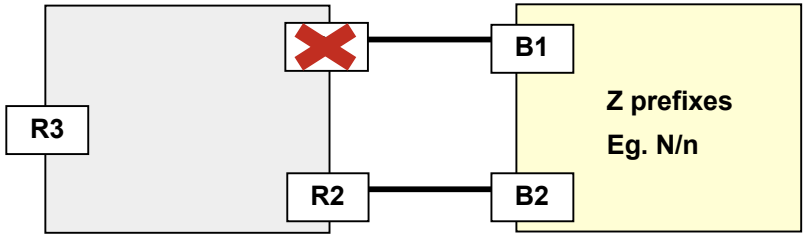
**The UUT (R3) is a 12k running IOX 3.3**

# Results



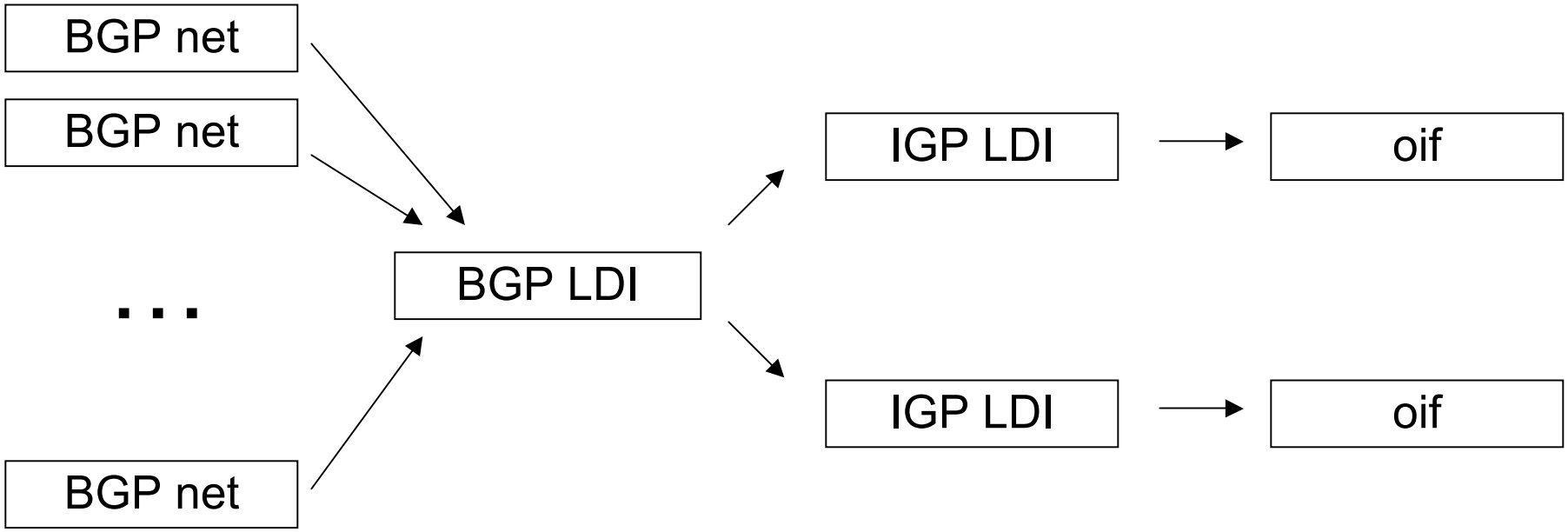

- 180msec !
  - In 180msec, as a consequence of its IGP convergence, R3 has updated its FIB tree such that all the 350k IPv4 BGP prefixes be forwarded via the alternate path through R2
  - The normal BGP convergence will then take place which involves R2 sending 350k of withdraws and R3 running 350k of bestpath's and RIB modifications. This process will likely take multiple tens of seconds but has no impact on the service thanks to the FIB fixup provided by "BGP PIC" at IGP convergence time.

# If Non BGP PIC edge




- R3 receives a NHT/down and trigger on a per-prefix basis
  - bestpath (eg. R2 is now best as R1 is gone)
  - RIB/FIB update
  - peer update
- Results: for Z = 100.000 IPv4 BGP prefixes
  - 12k/Eng3/32S: 30 seconds
  - Other vendors: 30 seconds as well
  - Impossible to perform good here due to the prefix-dependency

# Another advantage of Hierarchical FIB




- Pointer Indirection between BGP and IGP entries allow for immediate update of the multipath BGP LDI at IGP convergence

# Assumption

- The failure must result into an IGP-based deletion of the BGP nhop
  - PE node failure: its IGP neighbors detect the loss of adjacency and trigger a convergence at all remote PE's which concludes with a deletion of this node from the topology and hence a deletion of any BGP nhop "on that node" (its /32) or on peering links "behind" that node.
  - Peering link failure: next-hop-self should not be used (the BGP nhop is on the peering link) and the IGP should run passive on the peering link. Upon peering link failure, the IGP converges and concludes with a deletion of the BGP nhop
- The BGP prefixes impacted by the failure must have alternate paths installed as multipath BGP entries

# Conclusion

- Hierarchical FIB allows for
  - better FIB memory scaling
  - much lower CPU consumption
  - higher robustness
- And especially
  - BGP PIC Core
  - BGP PIC Edge

# Availability

- BGP PIC CORE
  - 12k: IOX 3.3 (ipv4, vpnv4, ipv6)
  - CRS: IOX 3.5 (ipv4, vpnv4, ipv6)
- BGP PIC EDGE - Multipath assumption
  - E3/E5: IPv4 & IPv6 = IOX 3.3, VPNv4 = IOX 3.5
  - CRS: IPv4 & IPv6 & VPNv4 = IOX 3.5