IPv6: A carrier's perspective

ARIN XI Meeting

April 2003

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Agenda

- Background about Qwest
- Overview of Qwest's IPv6 network
- Carrier Adoption Challenges
- Future Deployment Strategies
  - Tunneling
  - IPv6 2547 MPLS VPNs
  - 6PE
  - Native IPv6
- Conclusions
- Questions

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Qwest North American Fiber Network

United States: 23,890

Canada: 6,303

Mexico: 1,832

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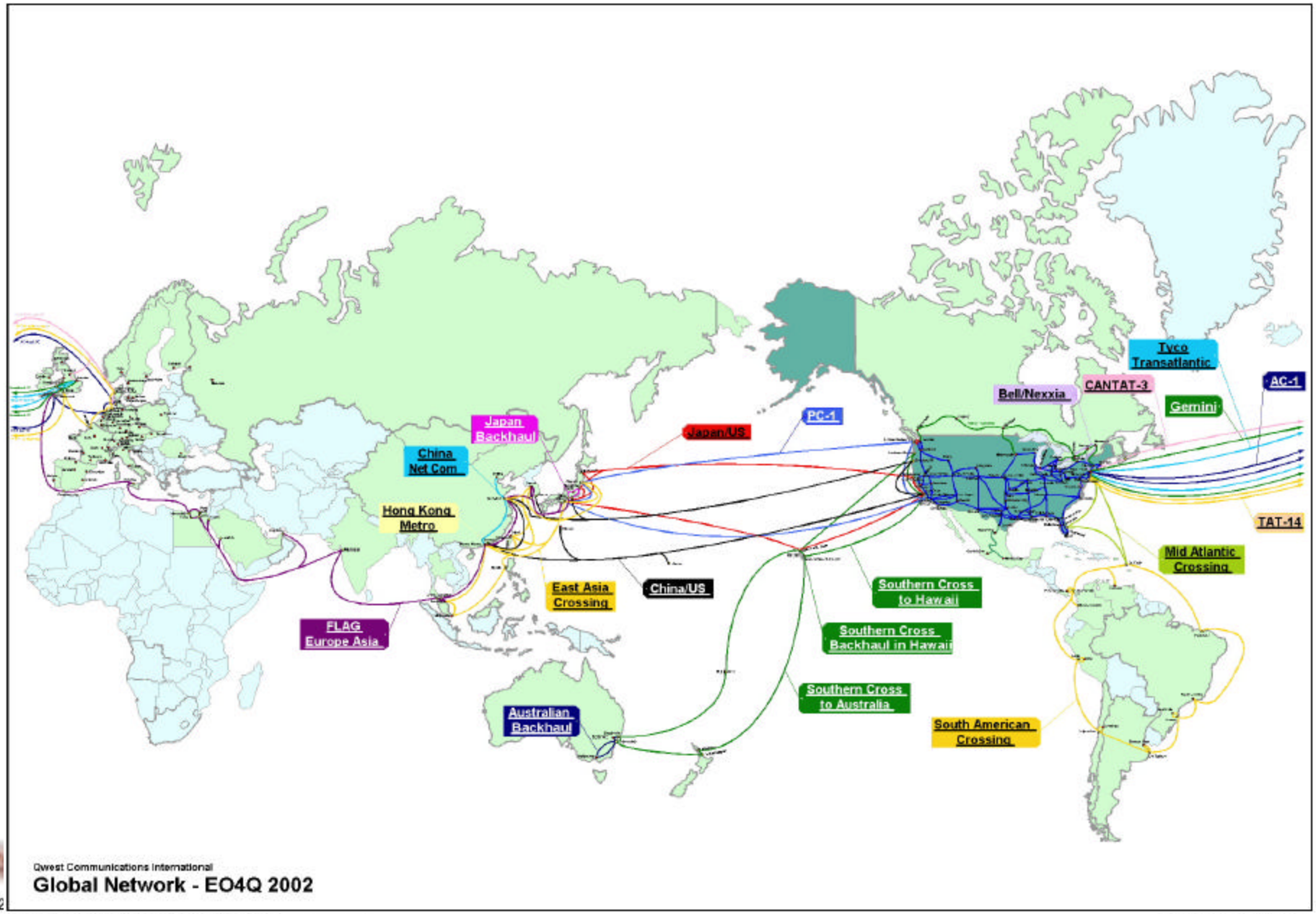
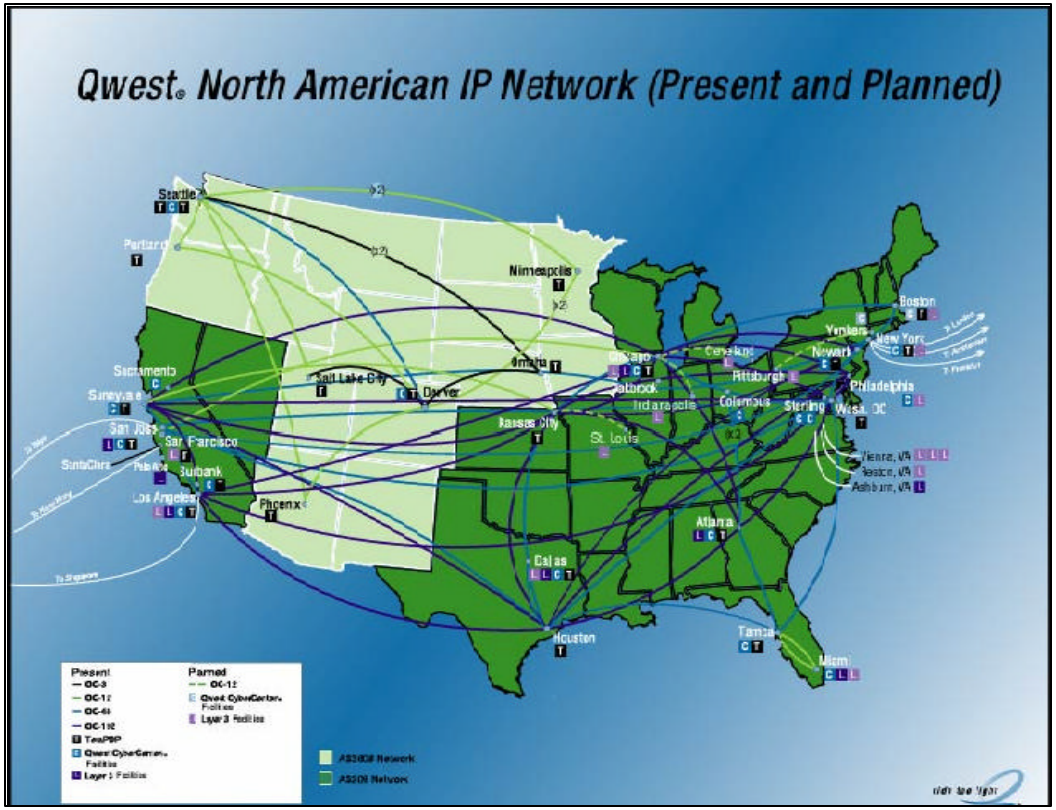
Qwest Global Network – EO4Q 2002



Qwest North American OC-192 IP/MPLS Network

- First NSP to deploy a fully meshed OC-192 IPv4 backbone
- Design goal: 100 percent packet delivery
- Multiple Protocol Label Switching (MPLS) Fast Re-route for redundancy in the network
- Over 400 access POPs to bring IP traffic onto the network
- On-Net & Off-Net Service Level Agreements



Qwest is in the process of requesting regulatory authorization in AZ, CO, ID, IA, MN, MT, NE, NM, ND, OR, SD, UT, WA, and WY to provide interLATA long-distance service originating; interLATA 8XX service terminating; or interLATA private line or data circuits with either end in these states, and Internet services without a required Global Service Provider (GSP). These services will not be available until regulatory authorization is received relating to each state.

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Qwest's current IPv6 Implementation

- Qwest today operates a native IPv6 network separate from IPv4 network
  - Native OC-3 Backbone
  - 5 routers directly connected to backbone
  - 7 additional routers tunneled through IPv4 network to IPv6 Backbone
    - Currently peering at Public and private locations with approximately 12 peer relationships
    - Actively engaged with vendors to evolve to a native IPv6 network integrated with the current IPv4 network
- Primary objective of network is to offer IPv6 transit service

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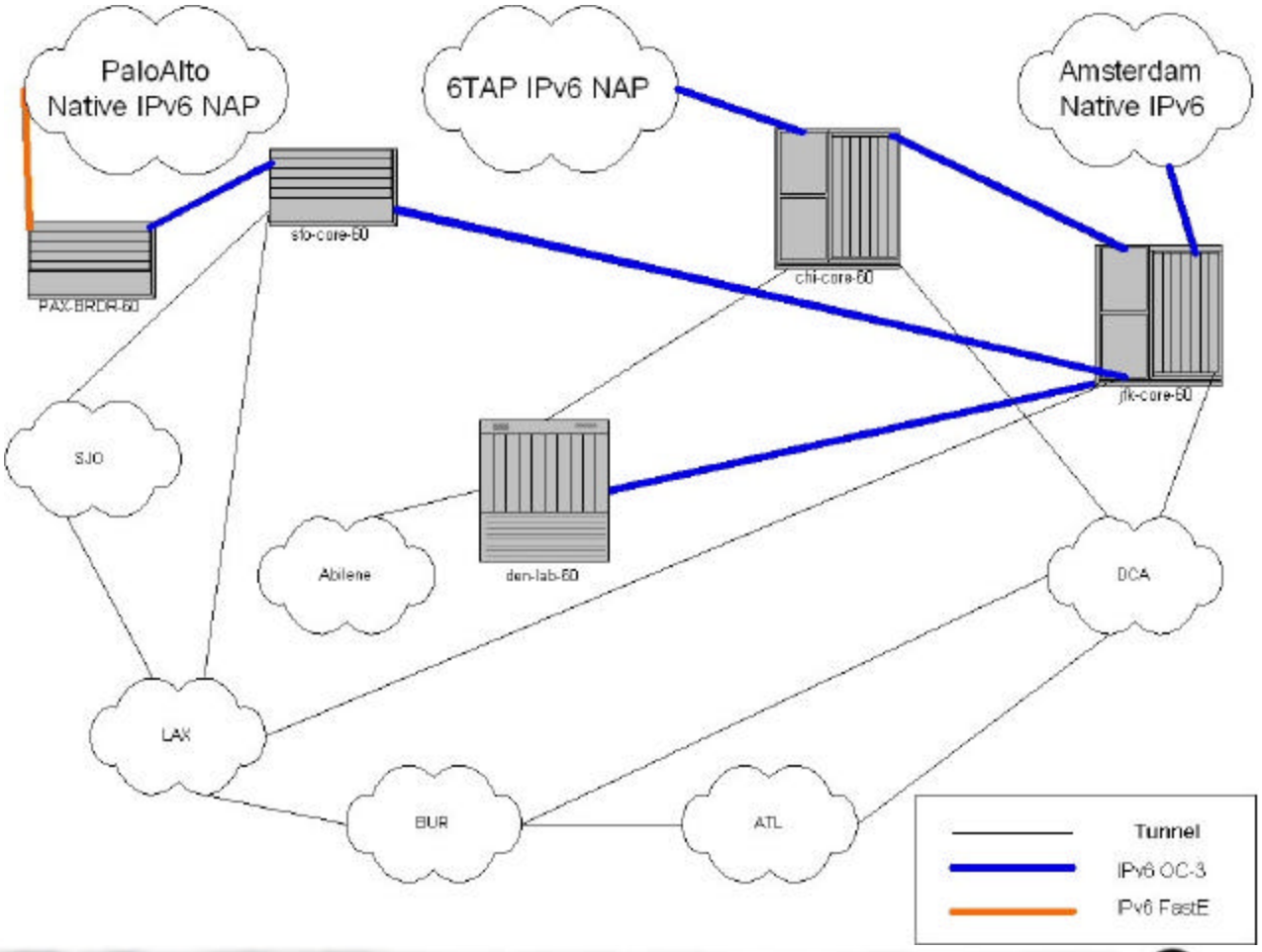
Current Qwest IPv6 Backbone



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Allocation/Transit/Peering Policy

- Qwest currently has a /35 sTLA from ARIN
  - Addressing plan for network in place
  - NLA and SLA fields are used within the Network to follow topology and allocation to customers
  - Customers typically receive a /48 from Qwest
  - Tier 2 providers can justify /40 of addresses if proper need is demonstrated
- Peering/transit policy is very open
  - Will peer with other networks with an sTLA
  - Transit service today “free” for non-commercial applications for existing customers

Current challenges

- Separation of the IPv4 and IPv6 networks has helped test early implementations. However…..
- Maintaining two separate, disjoint networks has hindered ability to fully operationalize IPv6 network – the IPv6 network is perceived to be less “production-quality” than the IPv4 network. Additionally,
- Maintaining two networks is less feasible than before
  - Must integrate these systems on a single network for cost and effort synergies
  - Operation of two diverse networks is costly
  - Operational teams need proven solutions that induce little uncertainly into day-to-day operations

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Integration of v6 and v4 networks

- Therefore, we believe that by collapsing both the IPv6 and IPv4 networks on a common infrastructure will benefit IPv6 by leveraging operational maturity that the IPv4 network has developed
- Challenges surround the integration of two diverse networks
  - Must mitigate risk to current IPv4 infrastructure from operational instability with the IPv6 introduction
  - We give up the “experimental” nature of current implementation

Integration Goals

- Leverage existing technology to implement IPv6 on current IPv4 backbone
  - Drive wider adoption and denser connectivity for the IPv6 network
  - Reduce risk of instability in Routing, Software and Architectures
  - Provide line rate performance
  - Provide customers native IPv6 access
  - Minimize cost to IPv4 infrastructure
  - Reduce costs of maintaining disjoint networks

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Integration Strategies: GRE

- Multiple approaches possible
  - GRE tunnel
    - IPv6 packets tunneled through an IPv4 network via a mesh of point-to-point GRE tunnels
    - Effective solution with many drawbacks
      - Tunnels don't always go down when connectivity is lost
      - Mesh of tunnels becomes difficult to manage
      - Scaling properties of tunnels not ideal
      - May require additional "tunneling" hardware (capital outlay)

Integration Strategies: 6PE

- 6oMPLS, aka – 6PE
  - Enables public IPv6 over an IPv4/MPLS network
  - Only selected PE routers are dual-stack
  - Solution incorporates the use of an MPLS core
    - IPv6 packet is encapsulated in 2 MPLS labels stacked on top of the header
    - Packet is switched through the network to end-point
    - Tunnels are dynamically configured and maintained by already deployed MPLS control plane mechanisms
    - Allows for same treatment of IPv4 packets and IPv6 packets on the network
    - draft-ietf-ngtrans-bgp-tunnel-04.txt

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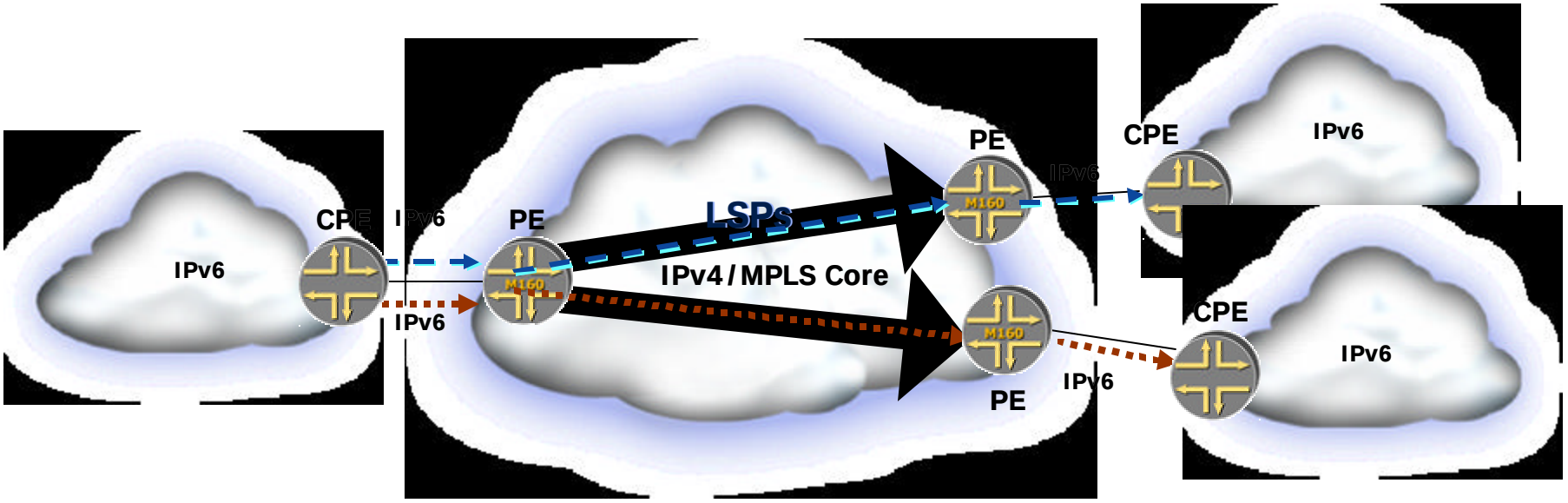
Integration Strategies – 6PE

Similar to BGP/MPLS VPNs, entire IPv6 public network appears like a VPN to existing core



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Integration Strategies: IPv6 2547 MPLS VPNs

- VPN Tunnel (2457 MPLS based VPN)
  - Very similar to BGP/MPLS VPNs
    - Architecture, BGP Configuration, BGP RRs for scaling
    - Customers can buy “IPv6 VPN” service
  - Can leverage operational support that exists for deployed MPLS based VPN products
  - Not truly a native implementation
    - IPv6 traffic looks like a customer on the IPv4 MPLS network
    - Segregation and logical separation of the IPv4 network from the IPv6 network
- Applicability limited to customers who only want IPv6 for use within an enterprise scope

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Integration Strategies: Dual Stack

- IPv4 / IPv6 Dual Stack
  - Routers run 2 stacks on each interface
    - One IPv4 address and one IPv6 address per interface
    - Complete visibility and awareness of IPv6 throughout the network
    - Concerns include;
      - Router memory consumption
      - Throughput (needs hardware support in most cases for line rate support)
      - Operational complexity

Integration Strategies: Native IPv6

- "Pure" IPv6 network infrastructure with tunneled IPv4
  - Clearly the end-goal, but not easy to simply flip the switch and turn on.
    - Needs more application support
    - Needs adoption within customer enterprise deployments, not a chicken and egg problem
      - Customers ask for it and Service Providers will begin to move more quickly to deploy
  - From a carrier standpoint, offering IPv6 access services will result in more benefits than building an IPv6-only network infrastructure

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Conclusions

- Carriers are dependant on demand for IPv6 access/transit services
- Separation of IPv6 and IPv4 network infrastructure may be hindering quicker carrier adoption
- Offering IPv6 access services on existing IP/MPLS infrastructure cheaper, and leverages operational maturity of IPv4 network
- Vendor implementations for such “IPv6 access” services are of interest
- Keeping core network agnostic to IPv6 or IPv4 access may help quicker adoption among carriers

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Thank you

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