Preferred Path Routing

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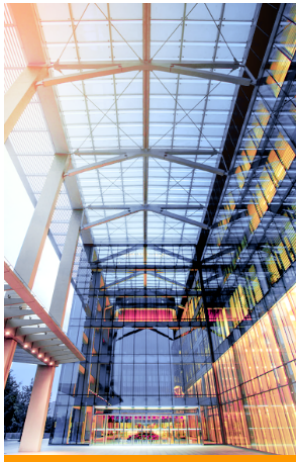
AFIN 2018

Huawei at a Glance

180,000
Employees

80,000
R&D employees

170+
Countries



15
R&D institute and centers

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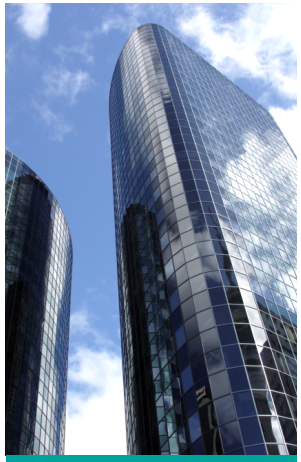
Interbrand's Top 100 Best Global Brands



No. 72
Fortune Global 500

Research at Huawei's

- Huawei has consistently invested over 10% of its revenue in R&D every year.
- The Huawei Innovation Research Program (HIRP)
  - An Open program that offers funding opportunities leading universities and research institutes
  - Conducting innovative research in the field of communication technologies and computer science
  - http://innovationresearch.huawei.com/IPD/hirp/portal/index.html
- Active Collaboration with many universities in the US

University Of Maryland | Harvard | Winlab @Rutgers | MIT | University Of California Riverside | University Of California Berkley | Stanford

Agenda

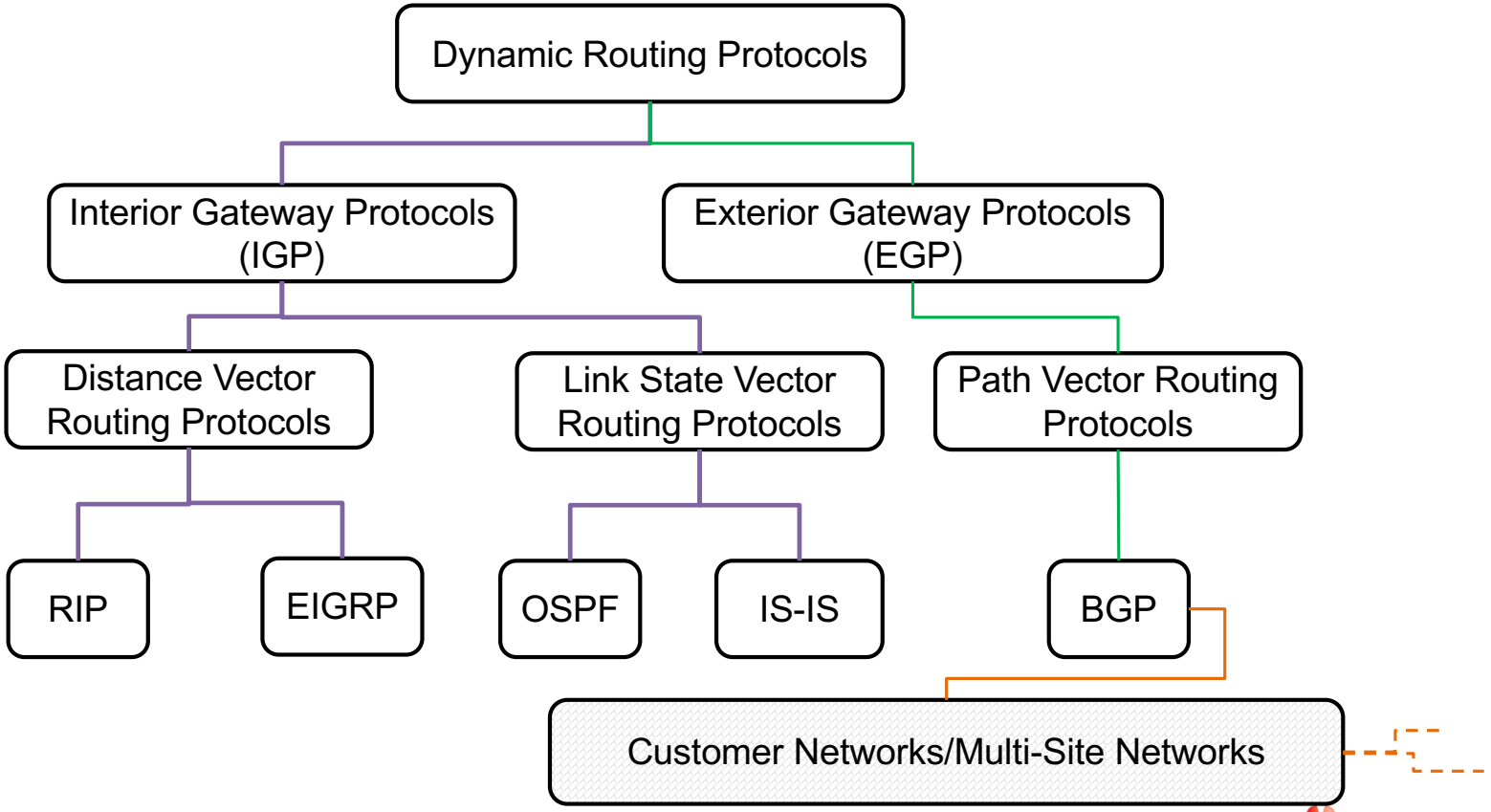
- Routing Review
- Segment Routing
- Preferred Path Routing
- Summary

A Review Of Routing Technologies

Goals Of Routing Protocols

Reachability	• How to transmit from source to destination
Optimal Path	• Shortest of the best paths to reach destination
Rapid Convergence	• When path changes occur, how fast a new path is discovered
Respond to Resource Changes	• Mechanisms to configure link resources – bandwidth, delay, queue sizes and policies.

Routing Protocol Classification



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Source Routing

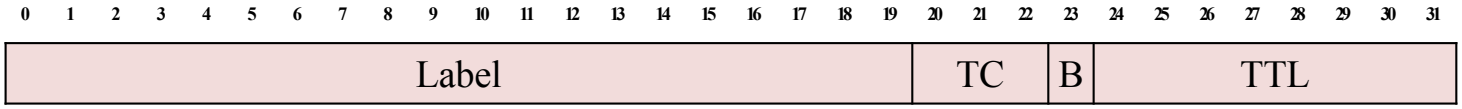
- Source routing allows the sender of a packet to determine how the packet is routed through the network towards the destination.
- Loose Source Routing (LSR)
- Strict Source Routing (SSR)

Policy-based Routing

- PBR uses policies for routing decisions at each hop instead of using the destination as the primary routing decision factor.

MPLS Traffic Engineering

- **Multi Protocol Layer Switching (MPLS)**



TC: Traffic Class, B: Bottom-of-Stack flag, TTL: Time-to-Live

- **Label Distribution Protocol (LDP)**

  Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) enables peer label switch routers (LSRs) in an MPLS network to exchange label binding information for supporting hop-by-hop forwarding in an MPLS network.

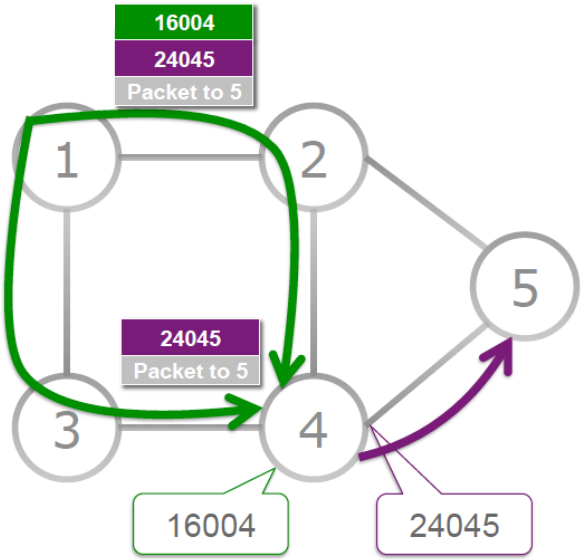
- **Resource Reservation Protocol for Traffic Engineering (RSVP-TE)**

  RSVP-TE is an extension of the Resource Reservation Protocol (RSVP) for traffic engineering. It supports the reservation of resources across an IP network. Applications running on IP end systems can use RSVP to indicate to other nodes the nature (bandwidth, jitter, maximum burst, and so forth) of the packet streams they want to receive. RSVP runs on both IPv4 and IPv6.

Segment Routing

Segment Routing - MPLS

- The source chooses a path and encodes it in the packet header as an ordered list of segments.
- The rest of the network executes the encoded instructions.
- In MPLS data plane: an ordered list of segments is presented as a stack of labels. (reuse MPLS data plane, no hardware change)
- Use ISIS or OSPF to distribute segments.



In this example, for a packet to be routed from 1 to 5, the shortest path will be 1->2->5.
Segment routing changes this routing behavior by saying from 1 to 5, now the path is 1->4->5 using label stack 16004 and 24045. so the packet will be routed to 4 first, then 5.

Segment Routing – SRv6 Network Programming

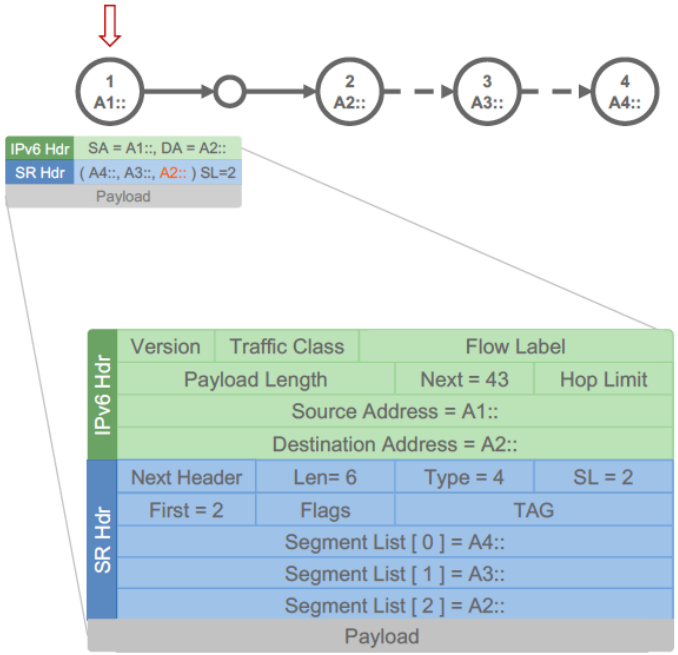
- IPv6 data plane: an ordered list of segments is encoded in a routing extension header (new hardware required).
- Network instruction

Locator	Function(arg)

128-bit SRv6 SID (IPv6 Destination Address)

- Locator: routed to the node performing the function
- Function: any possible function (optional argument)
- Flexible bit-length selection

- SR Header (SRH) is created with a list for segments
- Non-SR transit node only needs to do plain IPv6 forwarding
- SR Segment endpoint inspect the SRH:
  - if segments left > 0, it decrements the segments left, update the DA and forward according to the new IP DA.
  - If segments left = 0, remove the IP and SR header, process the payload.



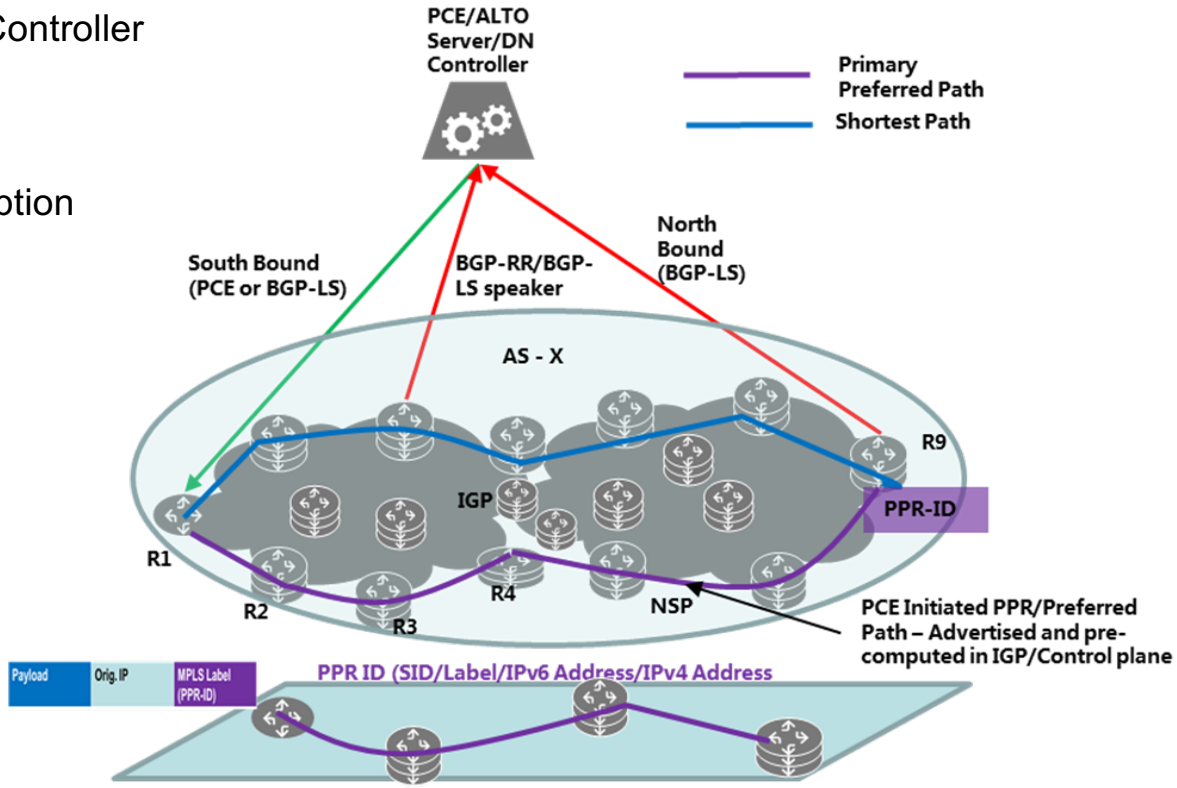
Preferred Path Routing

Preferred Path Routing (PPR) - Basic Concept

- **Compute** Path out-of-band: e.g. PCE/Controller
- **Abstract** To path id = PPR ID
- **Distribute** Crafted path in IGP
- **Program** Hardware as per path description
  - Different data plane capabilities
  - IPV6, IPV4, Label etc.

Features:

- Lean data plane
- Extends source routing to native IP
- Lean network programmability
- Unique FRR with identical QoS aware backups



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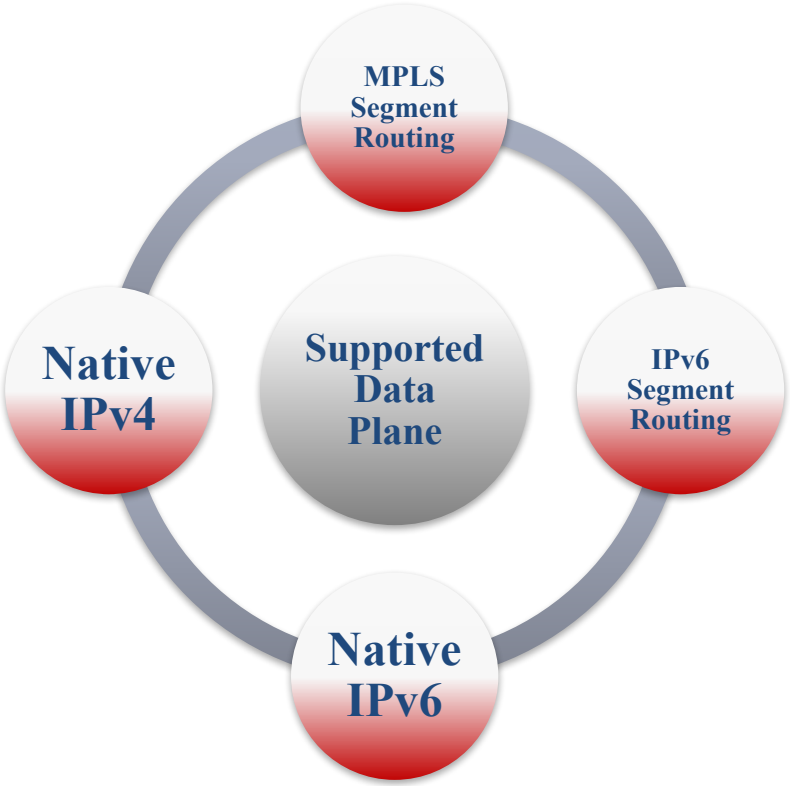
PPR Technology – Data Planes

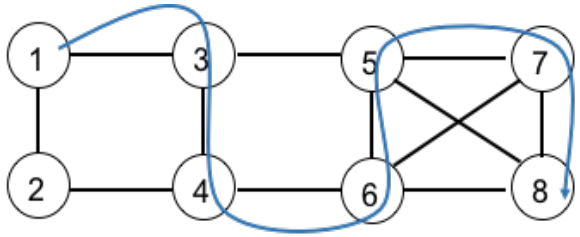
Key idea: Use IGP to populate PPR information and path info to achieve explicit path routing.



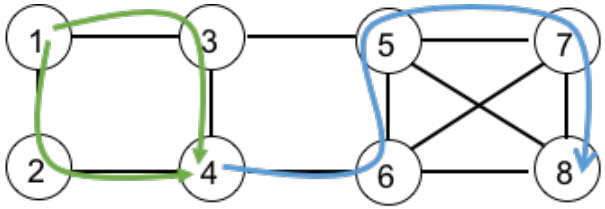
Current Network	Network with PPR
SR MPLS	Reduced label stacks
SRv6 with SRH	Reduced header size, no hardware upgrade
IPv4	IPv4 path routing, no hardware/data plane upgrade
IPv6	IPv6 path routing, no hardware/data plane upgrade

PPR Technology - SR MPLS label Stack Reduction

Strict Explicit Path:
1-3-4-6-5-7-8



Loose Explicit Path:
1-4-6-5-7-8



	1->3	3->4	4->6	6->5	5->7	7->8
SR MPLS Label Stack	16003 16004 16006 16005 16007 16008	16004 16006 16005 16007 16008	16006 16005 16007 16008	16005 16007 16008	16007 16008	16008
PPR label Stack	16088	16088	16088	16088	16088	16088

	1->4	4->6	6->5	5->7	7->8
SR MPLS Label Stack	16004 16006 16005 16007 16008	16006 16005 16007 16008	16005 16007 16008	16007 16008	16008
PPR label Stack	16004 16088	16006 16088	16005 16088	16007 16088	16088

- Hardware Friendly
- Reduce MPLS labels to 1 or 2

Future Work

- IETF drafts
  - https://tools.ietf.org/html/draft-chunduri-lsr-ospf-preferred-path-routing-01
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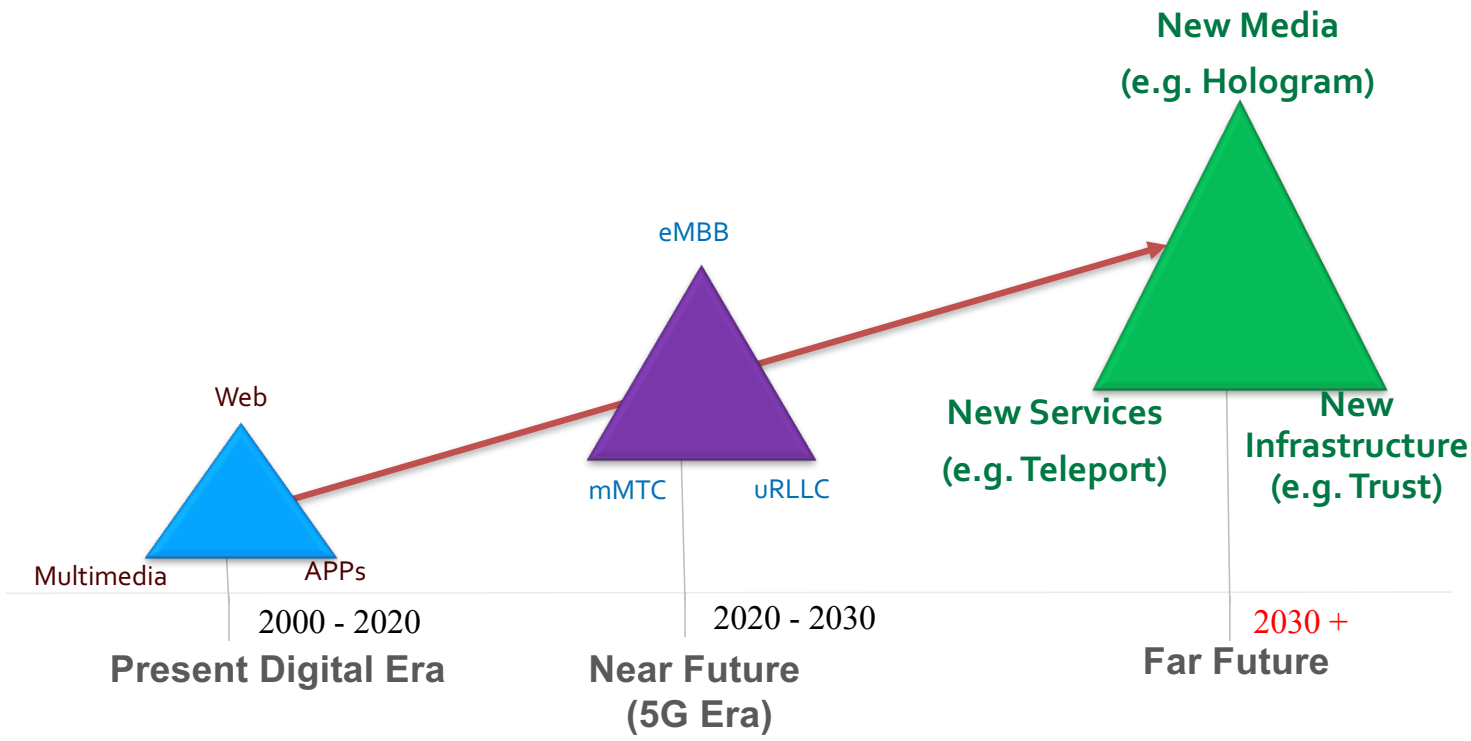
- Academic publications
- PoC

Focus Group on Technologies for Network 2030

Internet: Past, Present, Future



ITU-T Focus Group – Network 2030

WS & FG NET-2030

(New York, USA, 2-4 October 2018)

Call for Presentations and Registration

Focus Group on Technologies for Network 2030

https://www.itu.int/en/ITU-T/focusgroups/net2030/

FG-NET-2030, the ITU-T Focus Group Technologies for Network 2030 was established by ITU-T Study Group 13 at its meeting in Geneva, 16-27 July 2018.

The Focus Group will study the capabilities of networks for the year 2030 and beyond to support forward-looking scenarios, such as ***holographic type communications***, ***extremely fast response in critical situations*** and ***high-precision communication*** **demands** of emerging market verticals.

Thank You