Extensions to PCEP for handling Link Bandwidth Utilization

draft-wu-pce-pcep-link-bw-utilization-02

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Introduction

Allows **real-time traffic** flow into consideration while computing new paths.

Bandwidth

- Maximum bandwidth, Maximum reservable bandwidth and Unreserved bandwidth. [RFC3630][RFC3784]
- Residual bandwidth, Available bandwidth and Utilized bandwidth. [OSPF-TE-EXT] and [ISIS-TE-EXT]

A new object "BU (Bandwidth Utilization) Object" has been defined to indicate the upper limit of the acceptable link bandwidth utilization percentage.

New objective functions, namely MUP (Maximum Under-Utilized Path) and MRUP (Maximum Reserved Under-Utilized Path) are defined.

Link Utilization

Link Bandwidth Utilization (LBU)

- It is the bandwidth utilization on a link, forwarding adjacency, or bundled link.
- For a link or forwarding adjacency, bandwidth utilization represent the actual utilization of the link. (i.e. as measured in the router) for forwarding all traffic (RSVP and Non-RSVP).
- LBU Percentage is described as: (LBU / Maximum bandwidth) * 100

Link Reserved Bandwidth Utilization (LRBU)

- It is the reserved bandwidth utilization on a link, forwarding adjacency, or bundled link.
- This includes traffic for only RSVP-TE LSPs.
- LRBU Percentage is described as: (LRBU / (Maximum Reservable bandwidth)) * 100

Objective Functions

Maximum Under-Utilized Path (MUP)

- Find a path P such that
  (Min {(M(Lpi)- u(Lpi)) / M(Lpi), i=1…K }) is maximized.

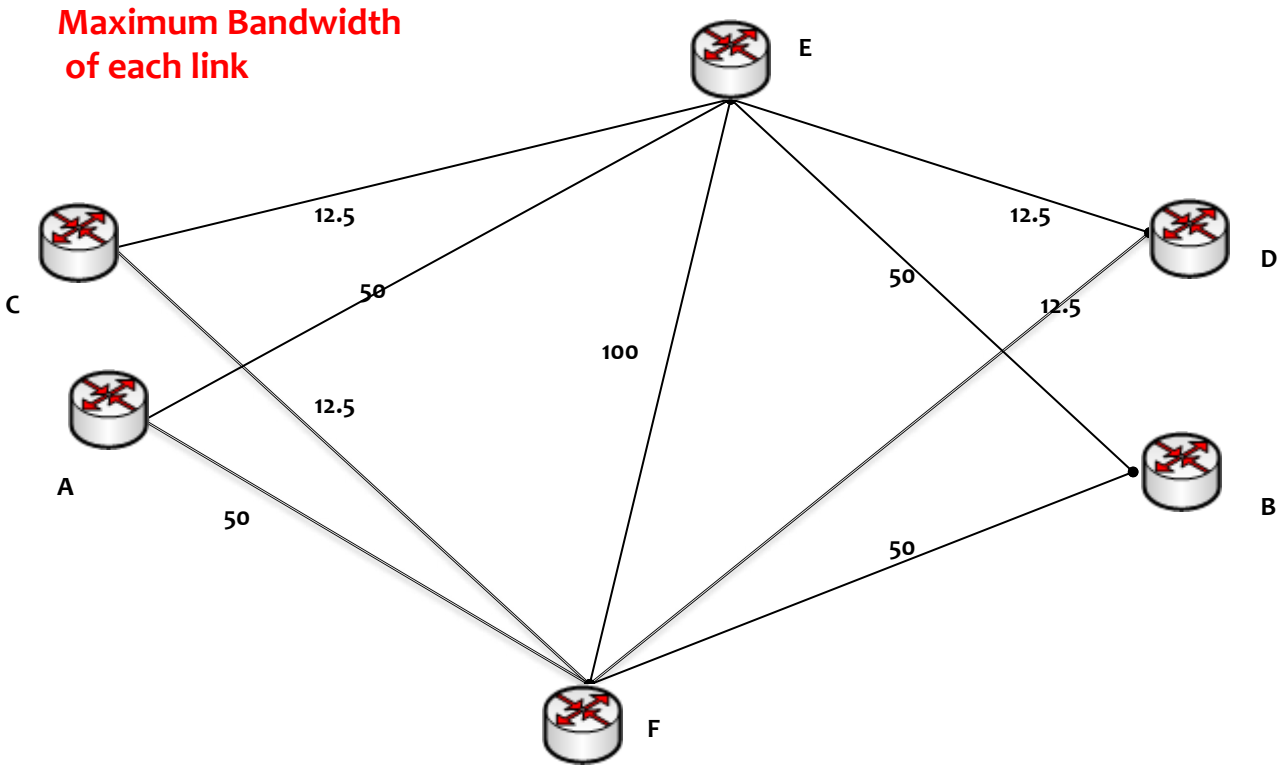
Maximum Reserved Under-Utilized Path (MRUP)

- Find a path P such that
  (Min {(R(Lpi)- ru(Lpi)) / R(Lpi), i=1…K }) is maximized.

Where…

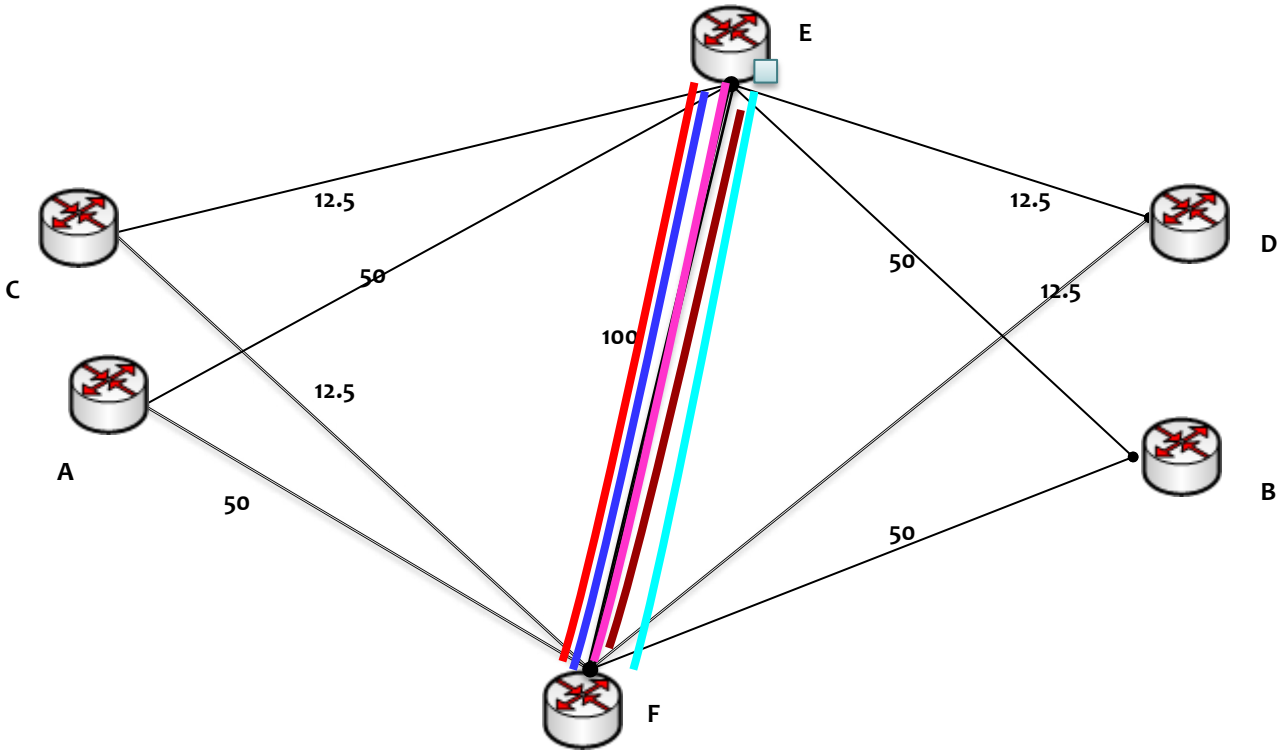
- A network comprises a set of N links {Li, (i=1…N)}.
- A path P is a list of K links {Lpi,(i=1…K)}.
- Bandwidth Utilization on link L is denoted u(L).
- Reserved Bandwidth Utilization on link L is denoted ru(L).
- Maximum bandwidth on link L is denoted M(L).
- Maximum Reserved bandwidth on link L is denoted R(L).

Example Topology



RSVP Utilization	80 % of reserved link bandwidth
Non-RSVP Utilization	5 % of un-reserved link Bandwidth

No Bandwidth Utilization (considered during path computation)

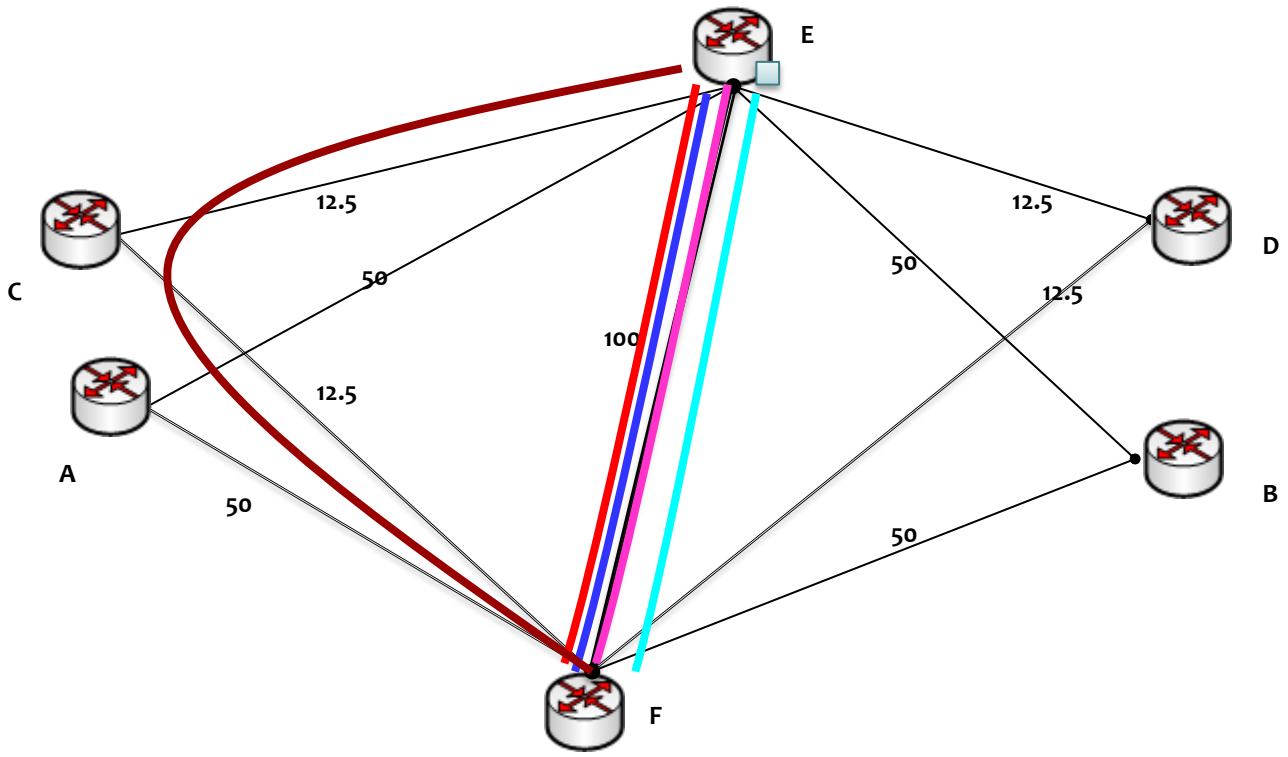


Bandwidth Utilization		
Max	Min	Average
80	0	22.9

LSP	Tunnel ID	B/W (Mbps)
LSP1	1	40
LSP2	2	20
LSP3	3	20
LSP4	4	10
LSP5	5	10

Many links are unused…

Bandwidth Utilization with Limit



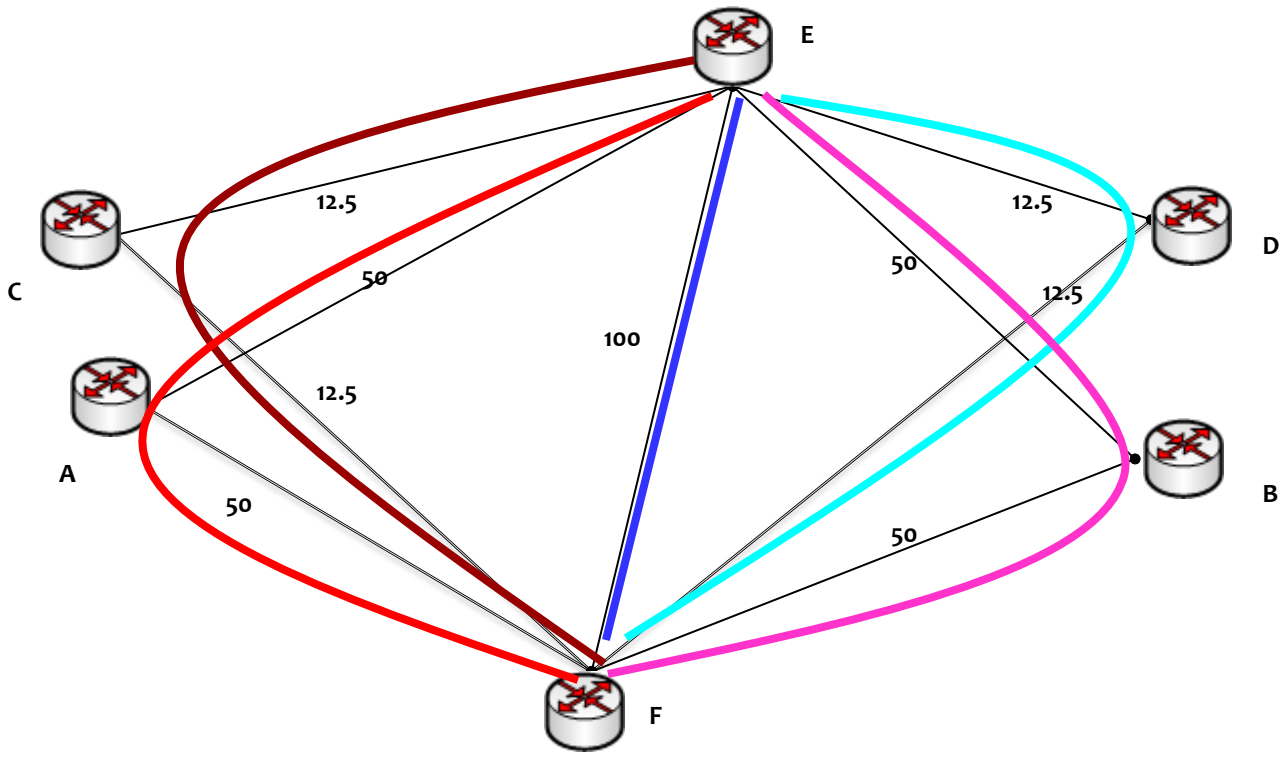
Bandwidth Utilization		
Max	Min	Average
72	0	25.1

LSP	Tunnel ID	B/W (Mbps)
LSP1	1	40
LSP2	2	20
LSP3	3	20
LSP4	4	10
LSP5	5	10

LSPs take same path till the limit constraint is satisfied. So still some links are unutilized and some are used up to 70%!

RSVP Utilization on link F1-E1:
80 % of (40 + 20 + 20 + 10)
= 72 Mbps (out of total 100 Mbps)
So LSP5 takes different path.

Bandwidth Utilization with MUP

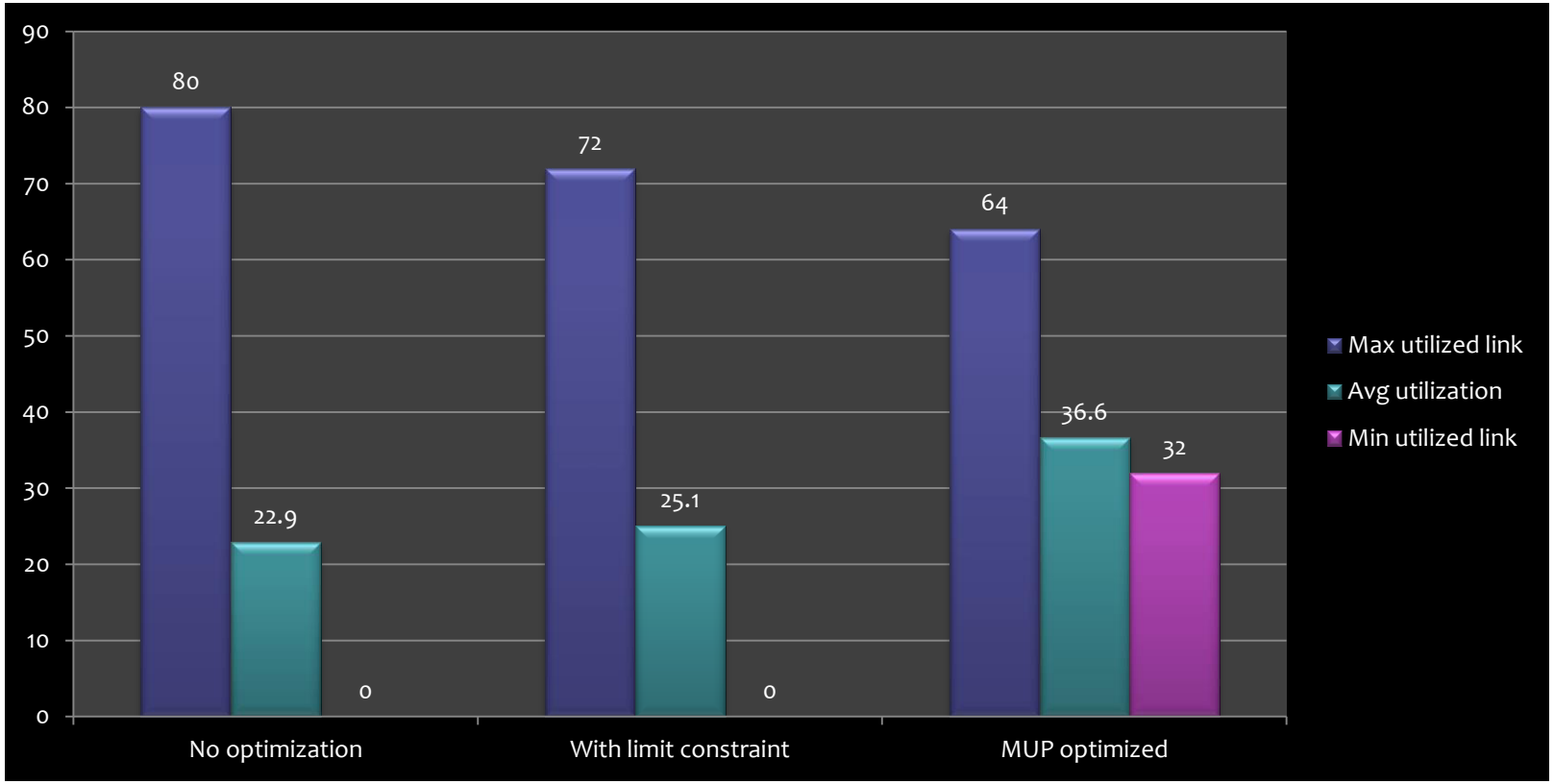


Bandwidth Utilization		
Max	Min	Average
64	32	36.6

LSP	Tunnel ID	B/W (Mbps)
LSP1	1	40
LSP2	2	20
LSP3	3	20
LSP4	4	10
LSP5	5	10

Every LSP takes the most under-utilized path, hence distributing the traffic over the network.

Bandwidth Utilization with different optimization



The network is better utilized without over-loading any particular link.

Other Considerations

BU Object in PCReq and PCRep

Stateful PCE support

Reoptimization

Inter-domain

- Inter-AS Link

P2MP (TBD)

Related utilization metric in –

- draft-ietf-ospf-te-metric-extensions-05
- draft-ietf-isis-te-metric-extensions-01

Companion to –

- draft-ietf-pce-pcep-service-aware-03

WG adoption?

Questions
&
Comments?

Thanks!