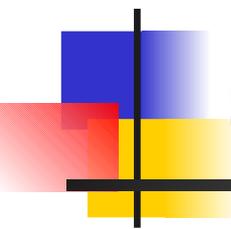


# LC-PCN – The Load Control

PCN solution: (current + updates to support HOSE model)

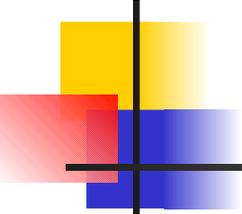


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draft-westberg-pcn-load-control-04.txt

Authors: Lars Westberg, Anurag Bhargava, Attila Bader, Georgios Karagiannis, Hein Mekkes

# Main updates since IETF-71



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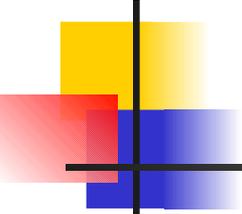
- Supports both trunk model (ingress-egress-aggregate) and HOSE model (ingress + egress do not support aggregates)
- The sliding window is moved to the egress
- When PCN\_Affected\_Marking is used then flow termination is triggered at the egress when an PCN\_Affected\_Marking packet is received

# Main updates since IETF-71

- Calculation of configured\_termination\_rate\_egress (ctre):
  - If  $N * PCN\_Marked\ rate > link\ bandwidth$ ,  $ctre = (U-1) * (total\_load)$
  - If  $N * PCN\_Marked\ rate < link\ bandwidth$ ,  $ctre = (U-1) * (unmarked\ rate - ((N-1) * PCN\_marked\ rate))$

Note when PCN\_Affected\_Marking used then rate of unmarked = rate PCN\_Affected\_Marking

# Main updates since IETF-71

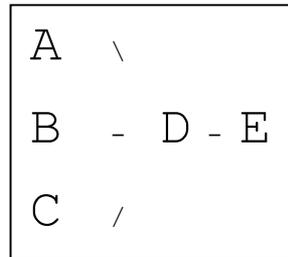


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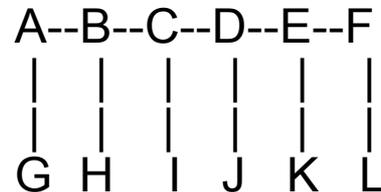
- Description of flow termination experiments included
- Admission control experiments not performed since functionality is identical to SM admission control functionality
- Trunk (IE-aggregate) and HOSE-model used
  - Hose model can be seen as a solution to a worst-case ECMP routing situation
- In draft no results shown, but they are shown in this presentation

# Description of experiments (Topologies used, SM draft based)

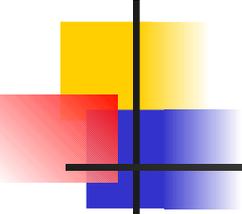
## Multi-link network: Single bottleneck



## Multi-bottleneck network: Parking Lot Topology



# Description of experiments (Traffic parameters, SM draft based: Voice based codecs)

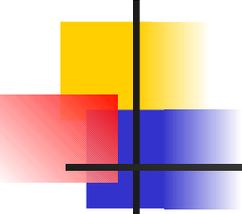


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Name/Codecs	Packet Size (Bytes)	Inter-Arrival Time (ms)	On/Off Period Ratio	Average Rate (kbps)
"CBR"	160	20	1	64
"VBR"	160	20	0.34	21.75

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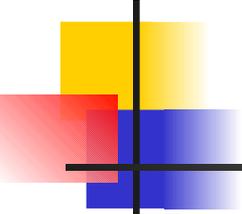
- VBR-experiments not completed and therefore not included due to time constraints.



## Description of experiments (Parameter metrics)

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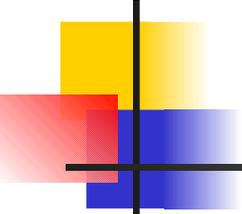
- Over-termination, same as in SM draft:
  - $(\text{actual termination} - \text{optimal termination}) / \text{optimal termination} * 100\%$
- Reaction time:
  - duration of time that a bottleneck node remains in flow termination state



## Description of experiments (Parameter settings)

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- Propagation time of each link: 1ms
- Capacity of each link: T3 (45mbps)
- Configured-Admissible-Rate =  $0.5 * \text{capacity of link}$
- EWMA weight: 0.5
- CLE threshold = 0.001
- $U = 1.2$
- $N = 1$



## Description of experiments (Parameter settings)

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- Buffer = 2.625 Mbytes
- Marked and unmarked (PCN\_Affected\_Marking) are randomly dropped
- Sliding window size at egress is equal to 1
- Measurement period (interior and egress) set to 100ms

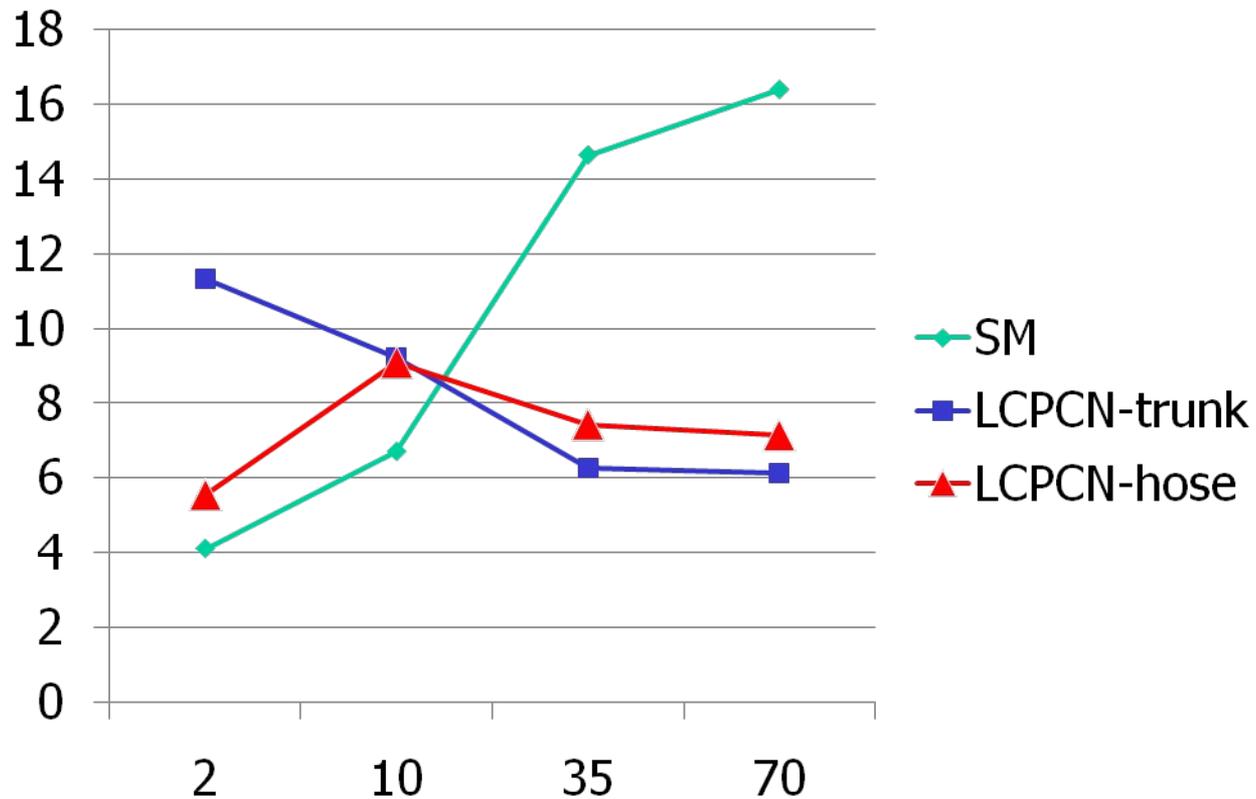
# Description of experiments (Experiment 1: Sensitivity to aggregation)

- Goal: study sensitivity of over-termination and reaction time to level of aggregation

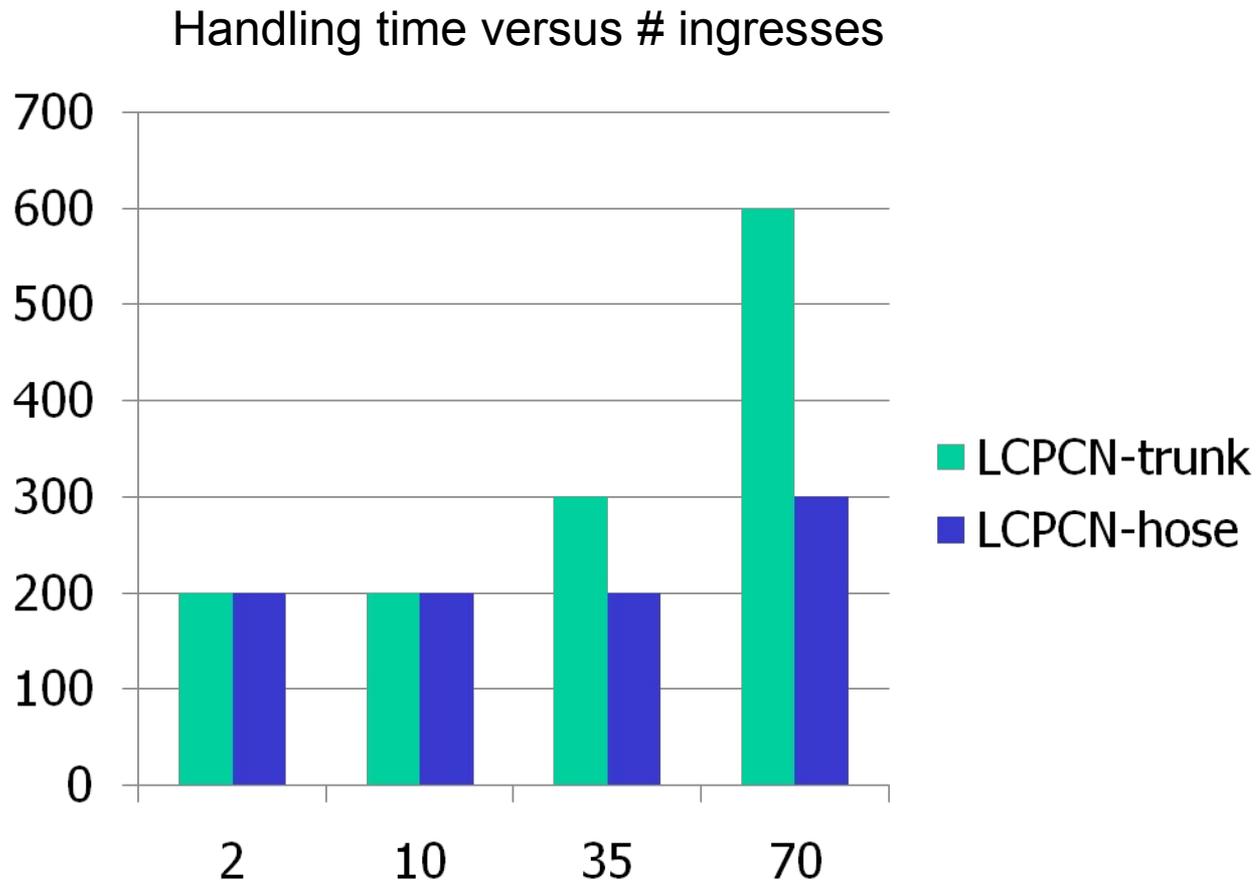
	No.	Flow per
	Ingress	Ingress
	2	289
CBR	10	57
	35	16
	70	8

# Results of experiments (Experiment 1: Sensitivity to aggregation)

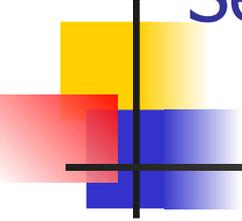
Overtermination % versus # ingress nodes



# Results of experiments (Experiment 1: Sensitivity to aggregation)



# Description of experiments (Experiment 2: Sensitivity to beat down effect in multi-bottleneck)

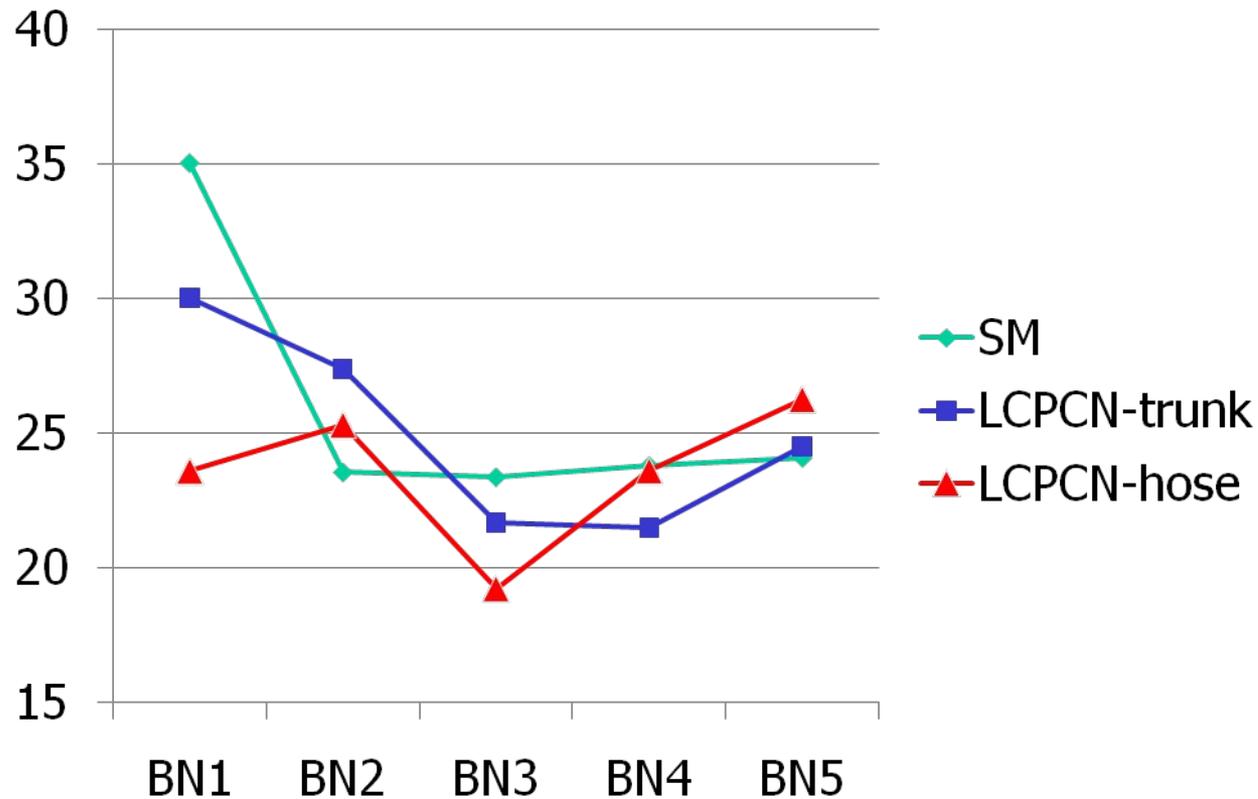


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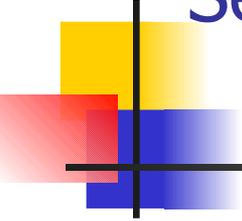
- Goal: study sensitivity of over-termination and reaction time to level beat down effect in a multi-bottleneck scenario
- The Parking Lot Topology (PLT) with 5 bottlenecks is used.

# Description of experiments (Experiment 2: Sensitivity to beat down effect in multi-bottleneck)

Overtermination % versus bottleneck links

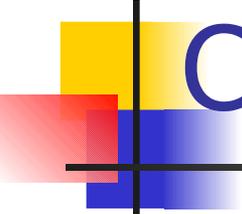


# Description of experiments (Experiment 2: Sensitivity to beat down effect in multi-bottleneck)



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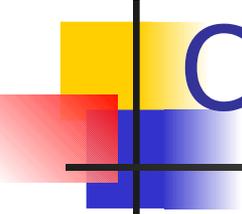
- Reaction time versus number of bottleneck links
  - Reaction time is 200ms on each bottleneck link for trunk as well as HOSE model



# Conclusions and next steps (1)

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- Analysis and comparison of SM and LC-PCN based on experiment 1:
  - *Overtermination is under 11% for all experiments*
  - *LCPCN Trunk and HOSE (ECMP-solution) models are not significantly sensitive to aggregation*
  - *Reaction time varies between 200 and 300ms*



# Conclusions and next steps (2)

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- Analysis and comparison of SM and LC-PCN based on experiment 2:
  - *Overtermination for trunk-model varies between 21 and 30%*
  - *Overtermination for HOSE-model (ECMP-solution) varies between 19 and 26%*
  - *Reaction time is 200ms for all bottleneck links for both the trunk- and HOSE-model*

# Conclusions and next steps (3):

## Next steps

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- Leave open the option to use random dropping of marked and unmarked packets in interior nodes
- Leave open the option to use PCN\_Affected\_Marking encoding since it can solve ECMP problem and provide an efficient solution for the HOSE model
- Leave open the option using the constant  $N$  such that the marked excess rate can represent also high levels of measured excess rate
  - Implemented by marking every  $n$ -th packet (or byte) instead of marking each packet (or byte)