Optimization of Multicast Distribution Trees

Fachgruppe 5.2.1
Dipl.-Ing. Samer Sulaiman
Lehrstuhl IfN-TK
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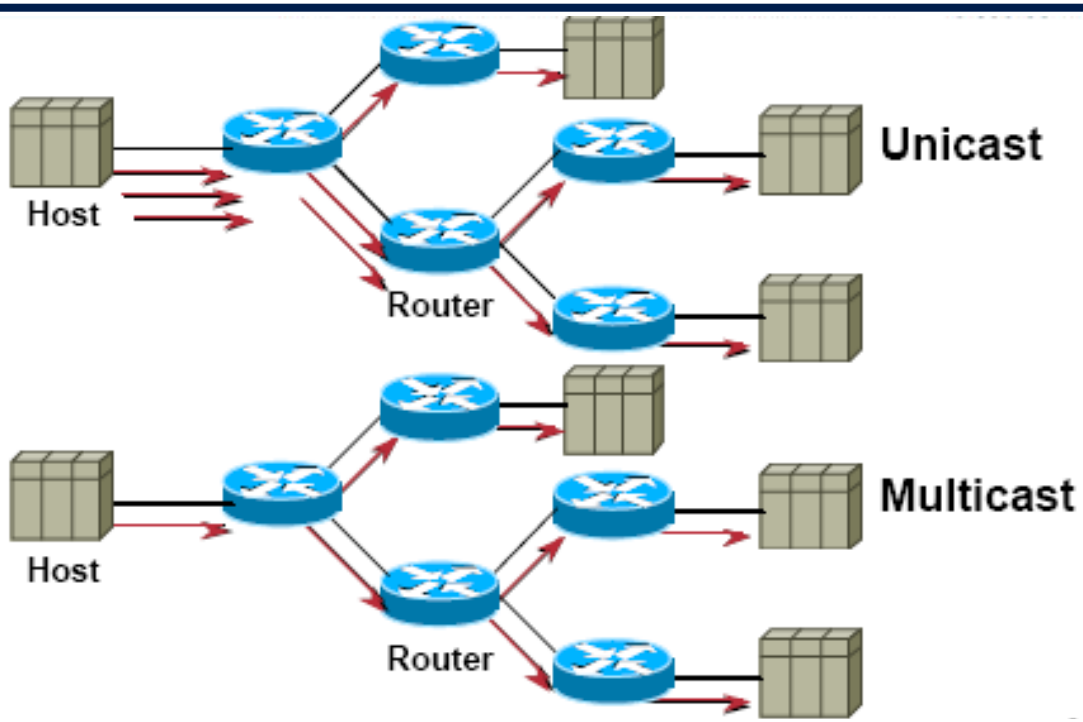
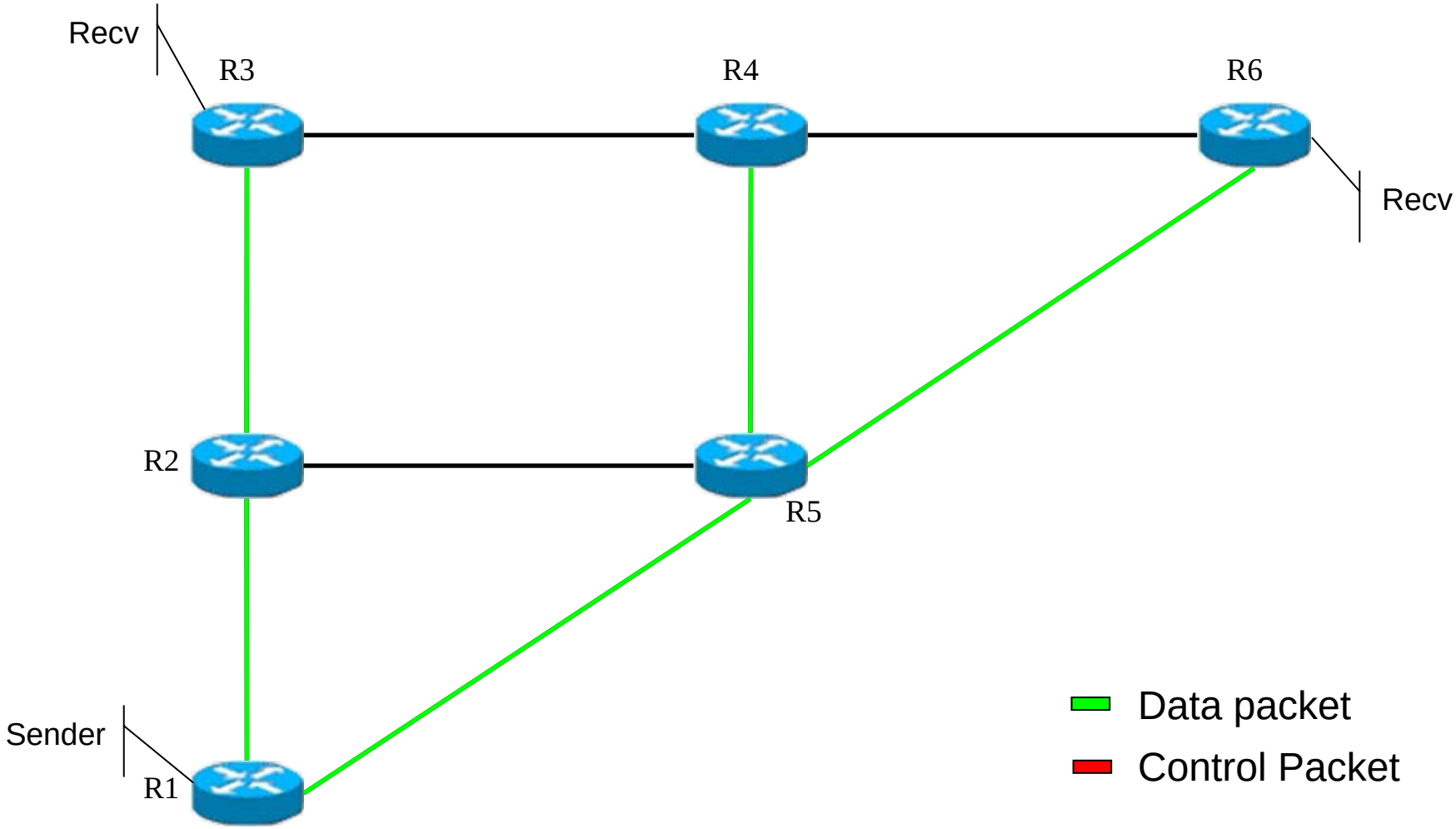
Overview & Motivation

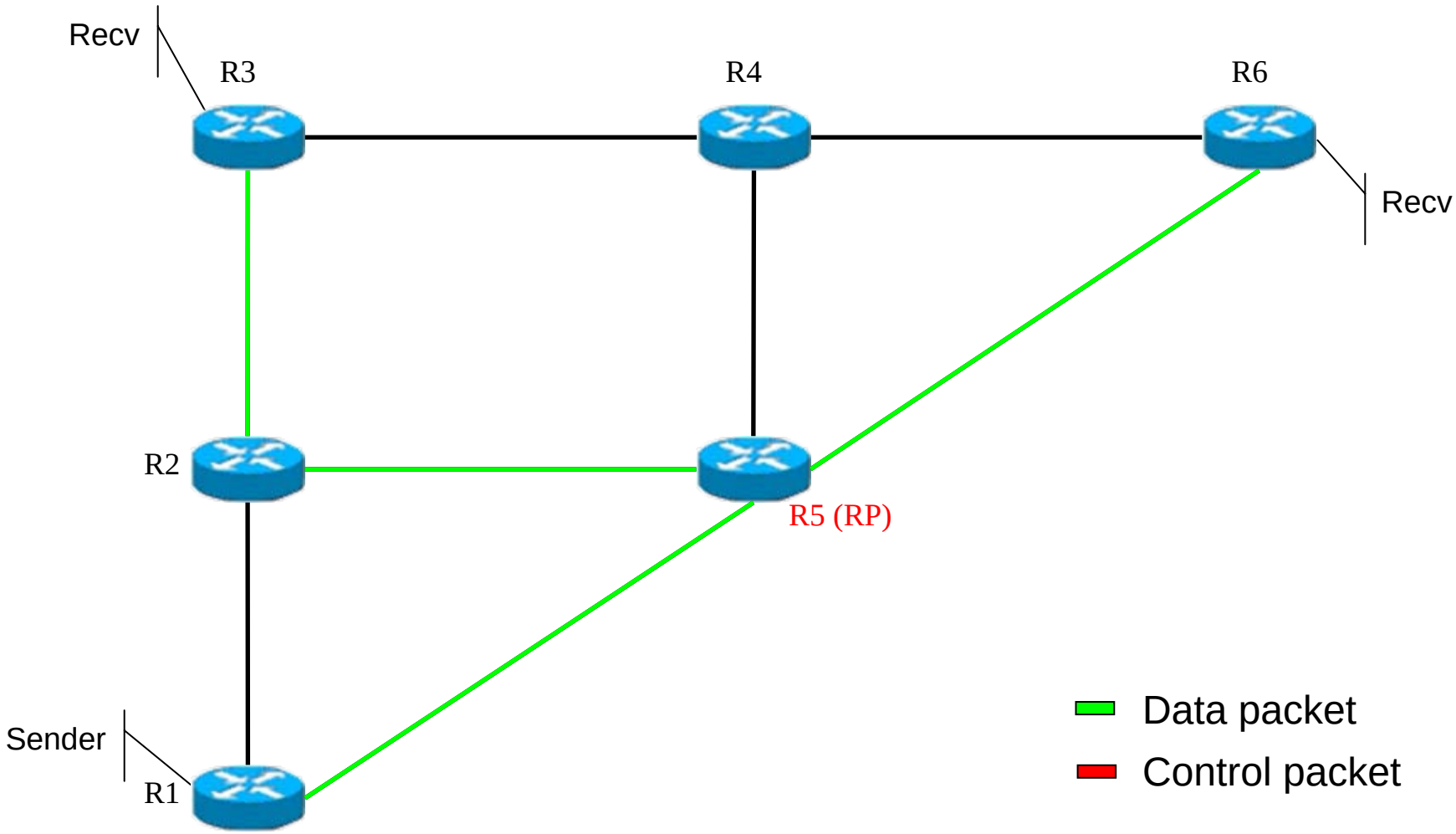


- Unicast
  - Multiple copies of data (one copy for each receiver)
  - Point to Point
- Multicast
  - Single copy of data
  - Point to Multipoint (Group of multicast membership)
  - Efficient network utility
  - Optimized performance
  - Make multipoint applications efficient

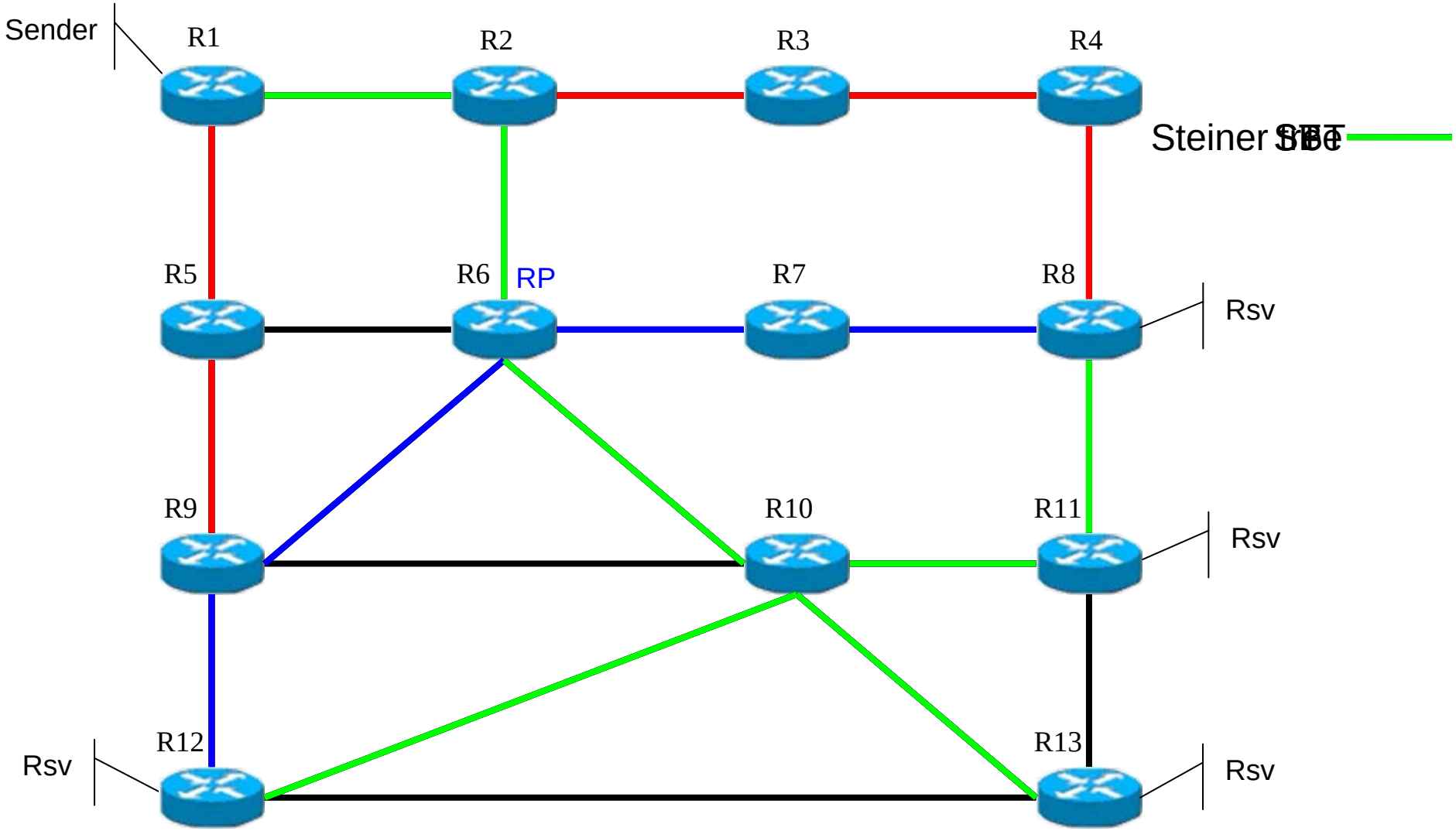
Source based tree (SBT)



Shared tree (ST)



Steiner tree



Optimization approaches

- Distribution tree
  - Switching mechanism (ST→SBT)
    - Packet counter
    - QoS-aware
  - Steiner tree (minimum spanning tree)
- RP-relocation
  - Decentralized (Distributed) calculation (receiver list)
    - All nodes in network are candidate-RP (AN)
    - All receivers are candidate-RP
    - Hill-Climbing algorithm
    - All nodes of distribution tree are candidate-RP (AP)
    - All nodes of longest path are candidate-RP (LP)
  - Centralized calculation (routing-table of receivers)
    - Each receiver sends its own routing-table to RP when joins (All Member “AM”)

Objective function

- Minimum resources (actual cost)
  - Goal → Minimizing the number of links in the distribution tree
  - Calculation methods
    - Real cost: Number of links in the distribution tree
    - Estimated cost (regarding only to distance) :

$$Cost_{Est} = \frac{Cost_{Min} + Cost_{Max}}{2}$$,where

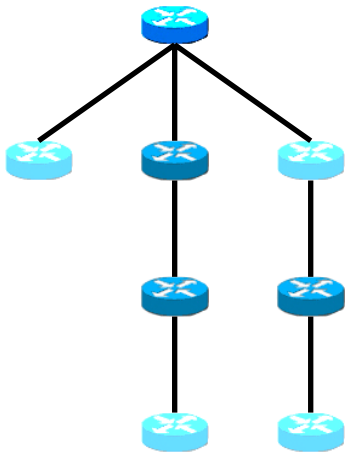
      - $Cost_{Min}$: Best distribution tree
      - $Cost_{Max}$: Worst distribution tree
    - Enhanced estimated cost (regarding to distance and next hop):

$$Cost_{E-Est} = \frac{Cost_{Min} + Cost_{Max}}{2}$$

- Min Max distance:
  - Goal → Minimizing the maximal distance (RP→ RSV)
- Avrg distance
  - Goal → Minimizing the mean distance (RP→ RSVs)
- New function
  - Goal → Minimizing the combination of minimum resources and maximum distance

Objective function

Real



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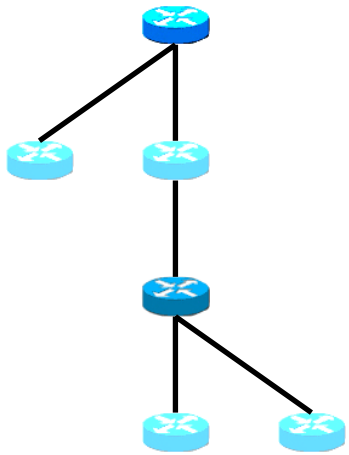
Min



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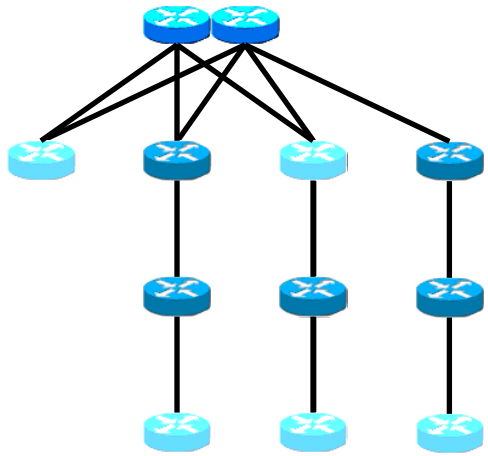
Max



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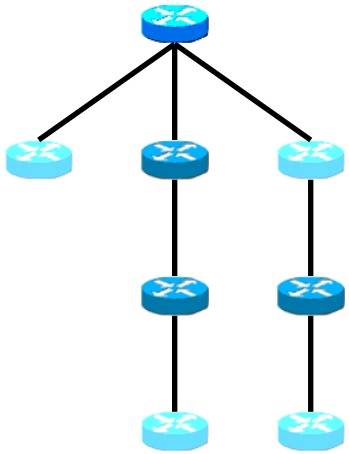

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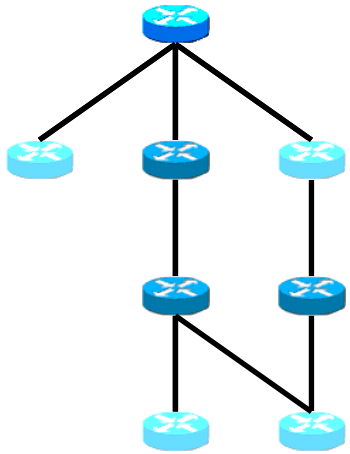

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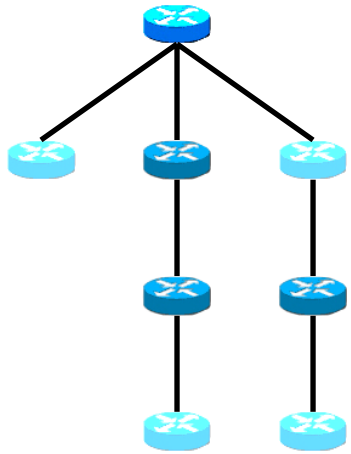
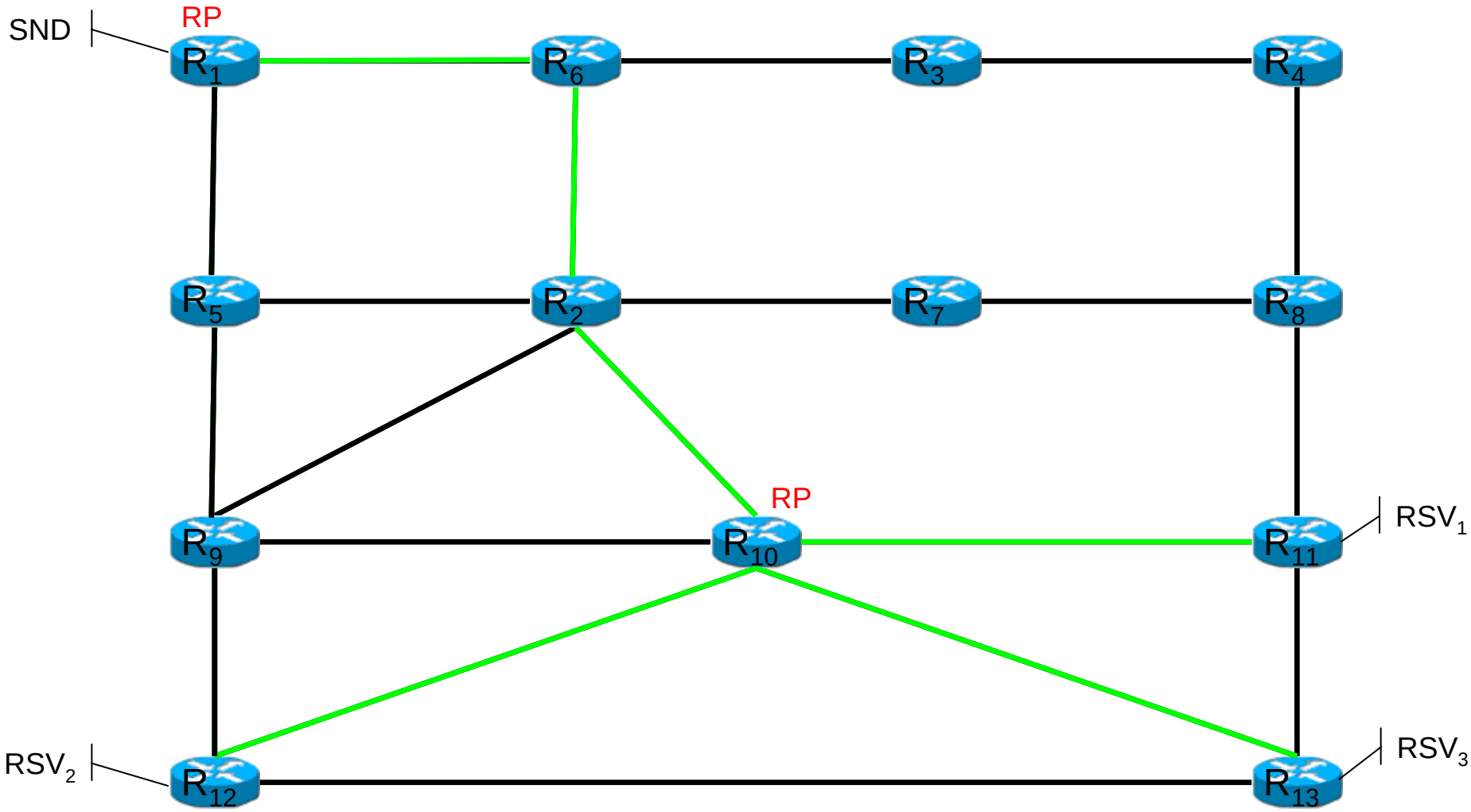
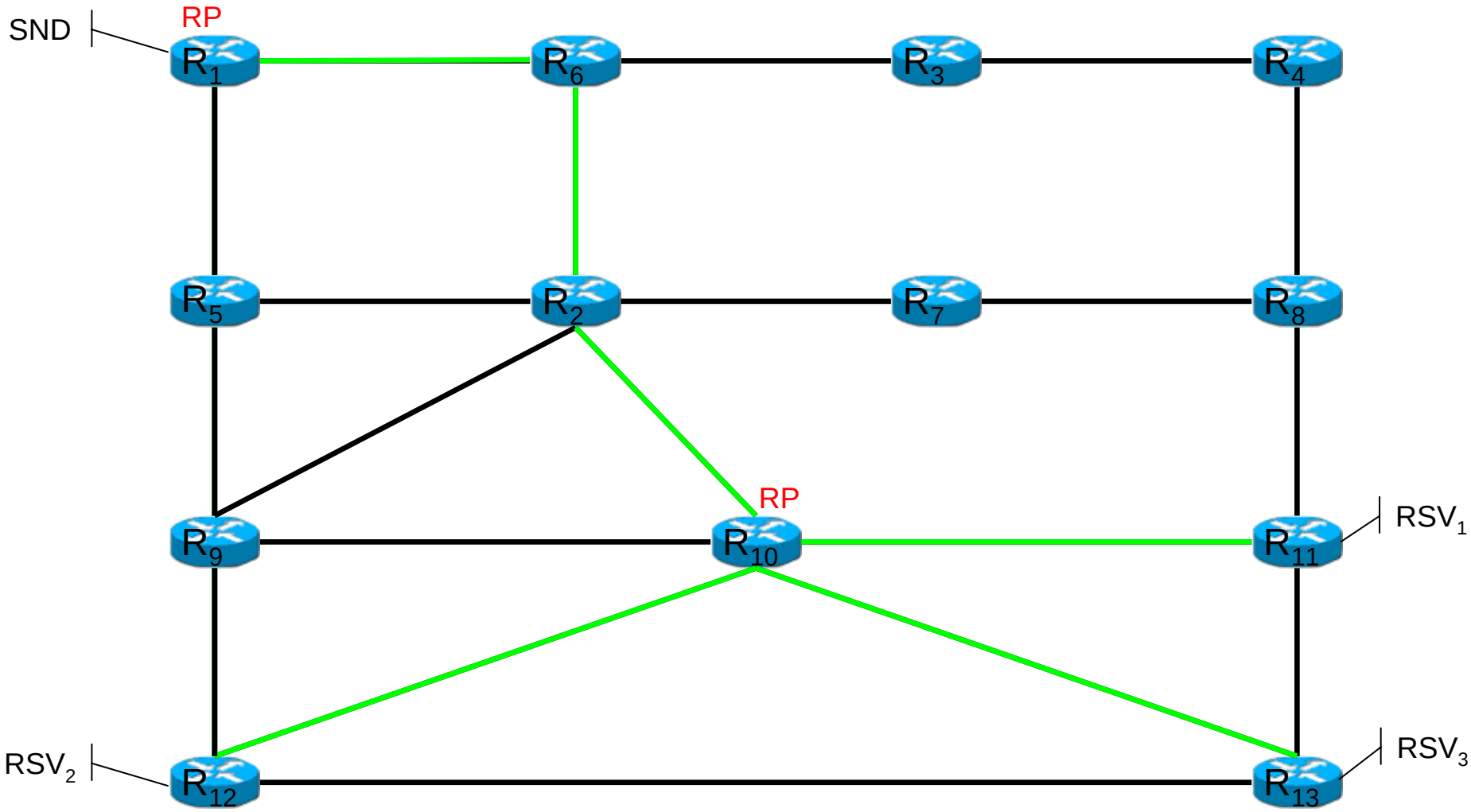


All Paths algorithm (AP)



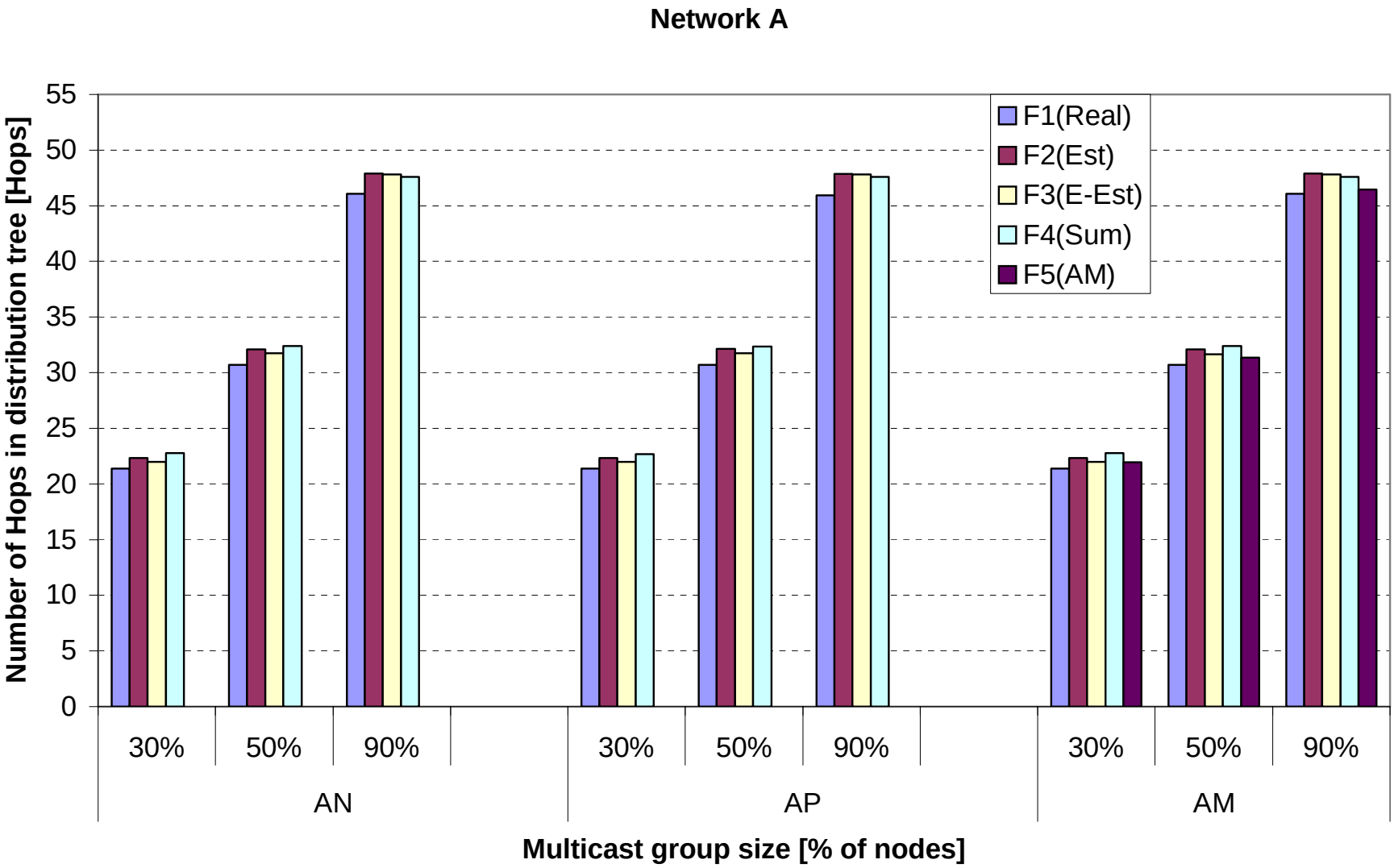
Centralized Calculation (AM)



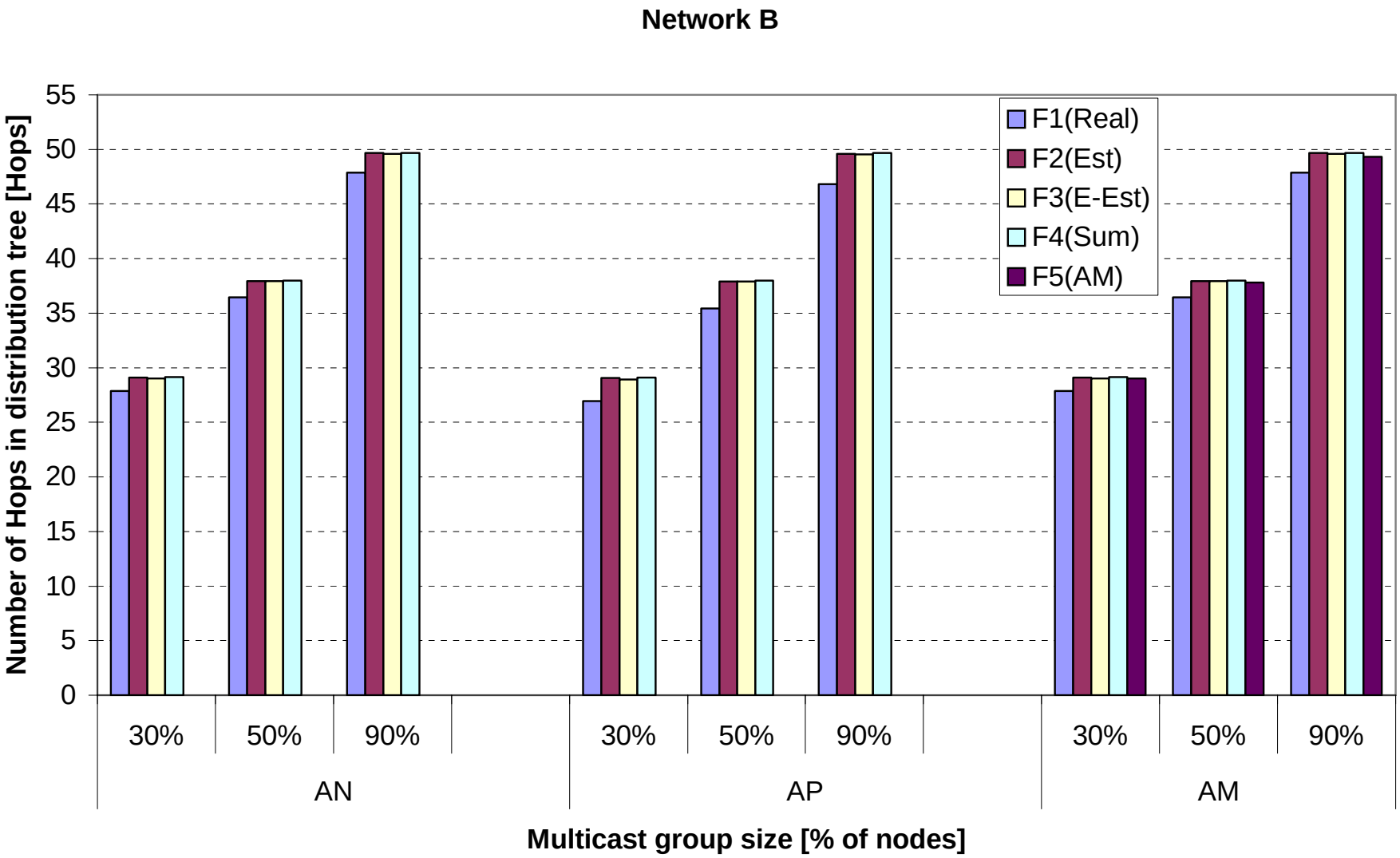
Calculation parameters

- Matlab 7
- Network topology:
  - A (50 nodes; maxhop=5; meanhop=2,74; maxdeg=14; meandeg=4)
  - B (50 nodes; maxhop=12; meanhop=5,02; maxdeg=7; meandeg=2)
- Investigation methods:
  - All Nodes (AN)
  - All Paths (AP)
  - All Members (AM) (Centralized calculation)
- Calculation metrics:
  - Real
  - Estimated
  - Enhanced estimated
  - Sum
- Runs: 100
- Multicast group size: 30%, 50%, 90% of number of nodes
- Number of sender: 1 (each node)

Calculation results



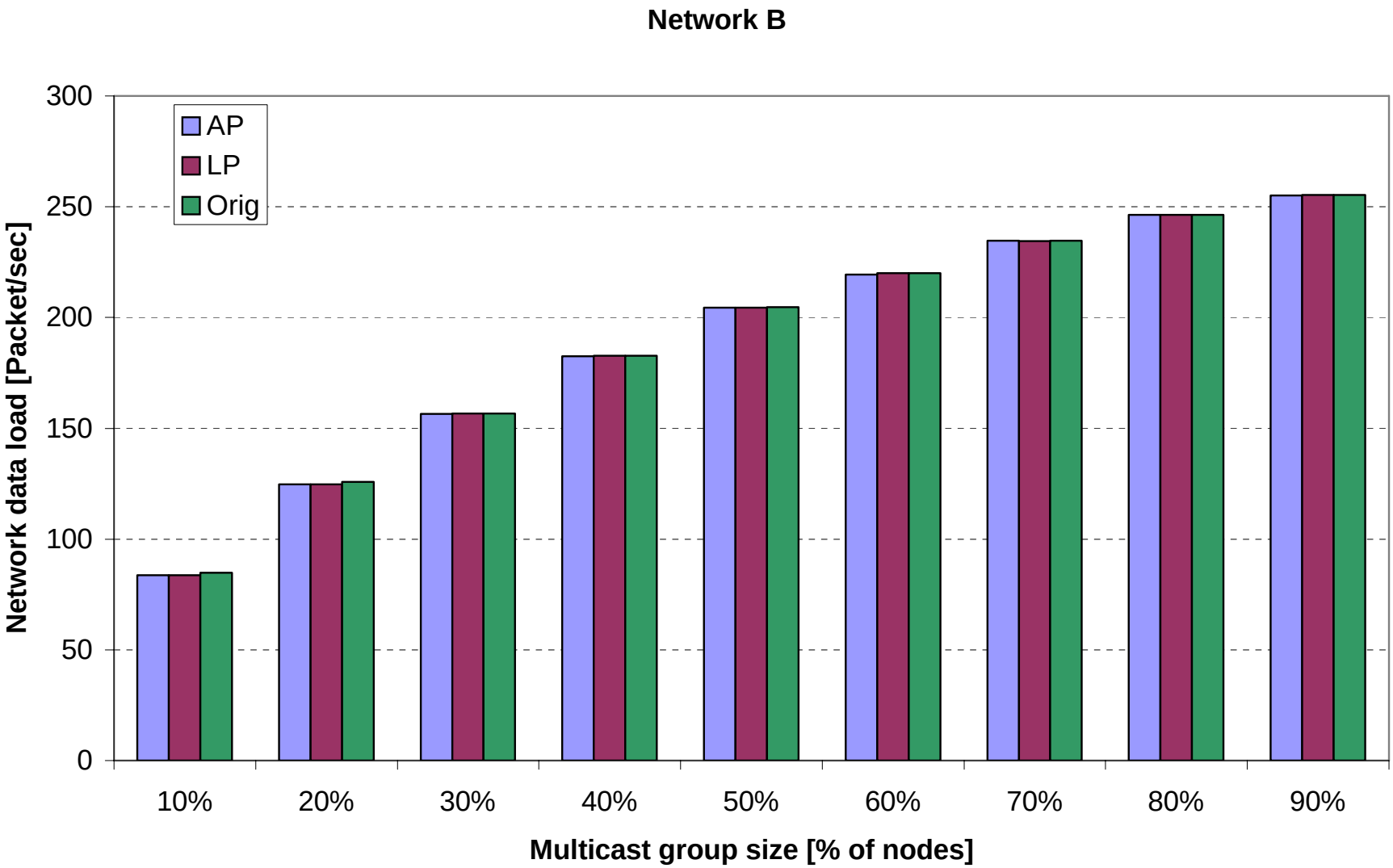
Calculation results



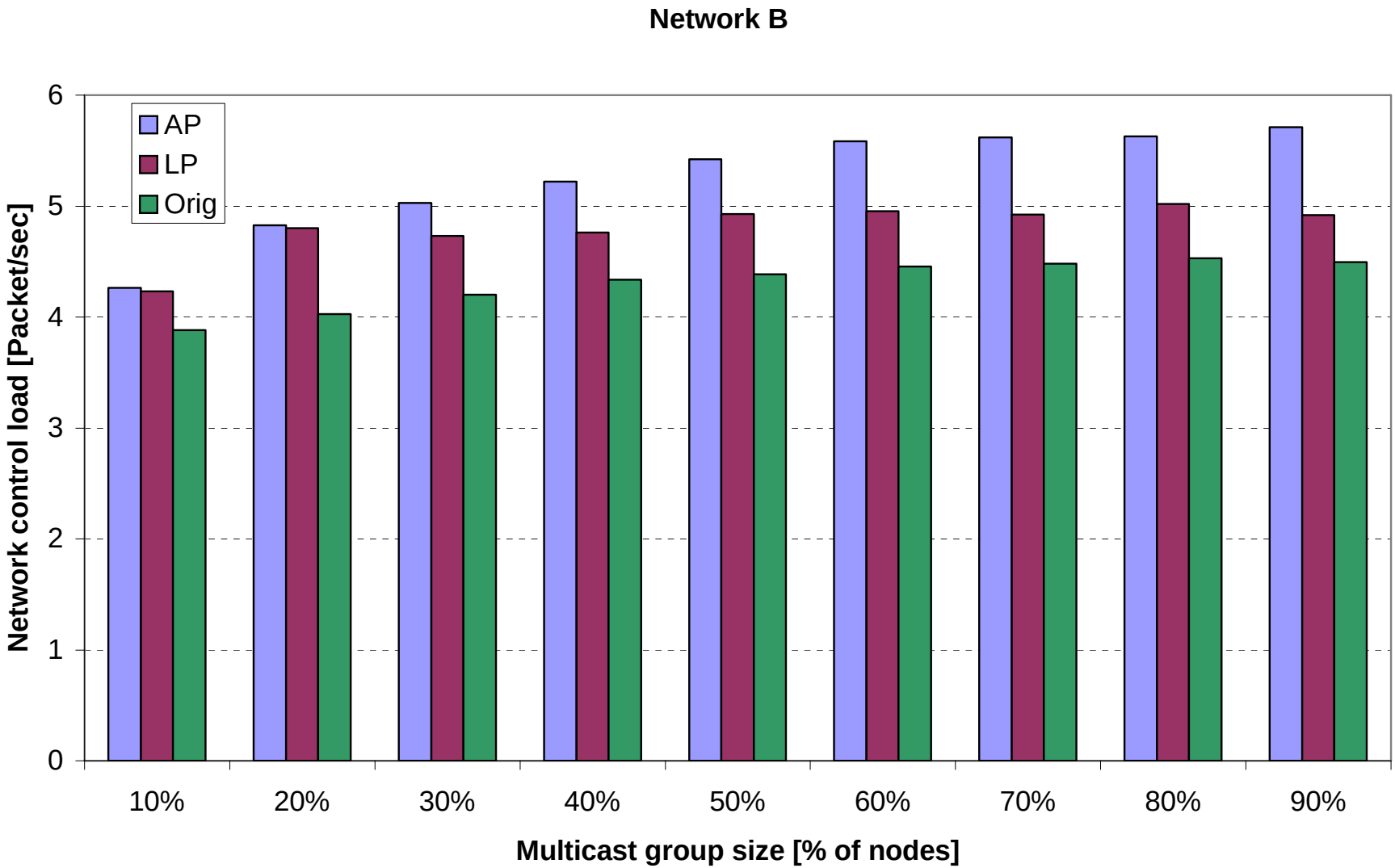
Simulation parameters

- NS2
- Network topology:
  - B (50 nodes; maxhop=12; meanhop=5,02; maxdeg=7; meandeg=2)
- Investigation methods:
  - PIM-Orig
  - All Paths
  - Longest Path
- Calculation metrics:
  - Estimated
- Join/Leave duration: 200 ~ 300 Sec
- Number of Join/Leave: 500 (randomly)
- Runs: 10
- Multicast group size: 10% ~ 90% of number of nodes
- Number of Sender: 1 (each node)

Simulation results



Simulation results



Conclusions

- To obtain an efficient network utility and optimized performance, it is necessary to optimize the distribution tree
- Protocol Independent Multicast Sparse Mode (PIM-SM) builds both the ST and SBT → Switchover Mechanism
- By optimizing the RP the total network load can be reduced. However some optimization approaches increase the needed control load
- Objective function and network topology play a big role in the optimization of RP
- Centralized optimization has the minimum network control load (to be proved through simulation)

Thank you for your Attention

Discussion ?