Optimal Filter Assignment Policy Against Transit-link Distributed Denial-of-Service Attack

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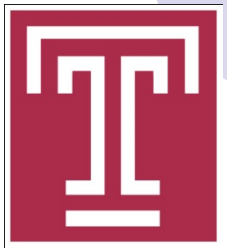
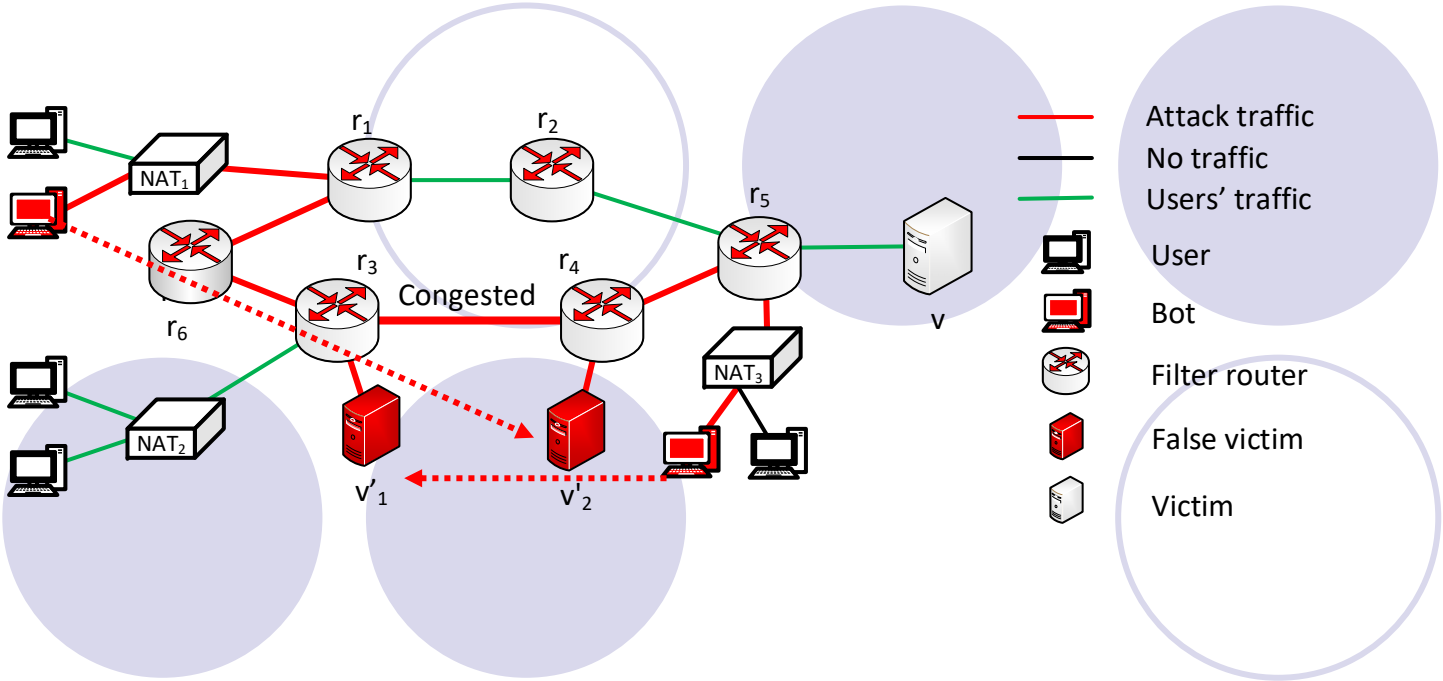
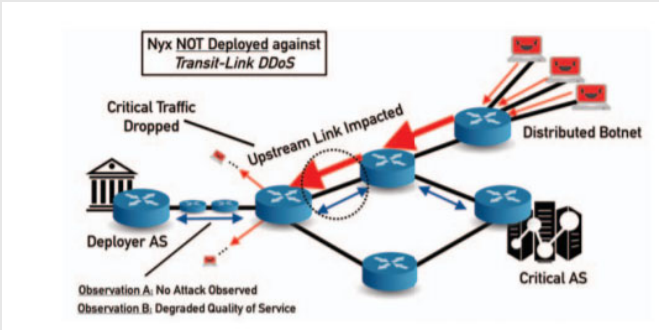


Transit-Link DDoS Attack



- Attackers generated traffic to the false victim.
- Attack traffic congest some links on the way to victim from users.
- Also known as Link-flooding attack.

Previous work

Systems	Limitations
SPIFFY (router level attack packet)  SPIFFY: Inducing Cost Detectability Tradeoffs for Persistent Link-Flooding Attacks (M. Suk Kang et al. NDSS, 2016)	• Increased router overhead.
Routing Around Congestion (BGP-based)  Routing Around Congestion: Defeating DDoS Attacks and Adverse Network Conditions via Reactive BGP Routing (J. M. Smith et al. S&P 2018)	• Victim far from the congested link is tough without additional access. • Hard to detect whether the congestion is created by attacker or user.

Background: Filter Router and Filter

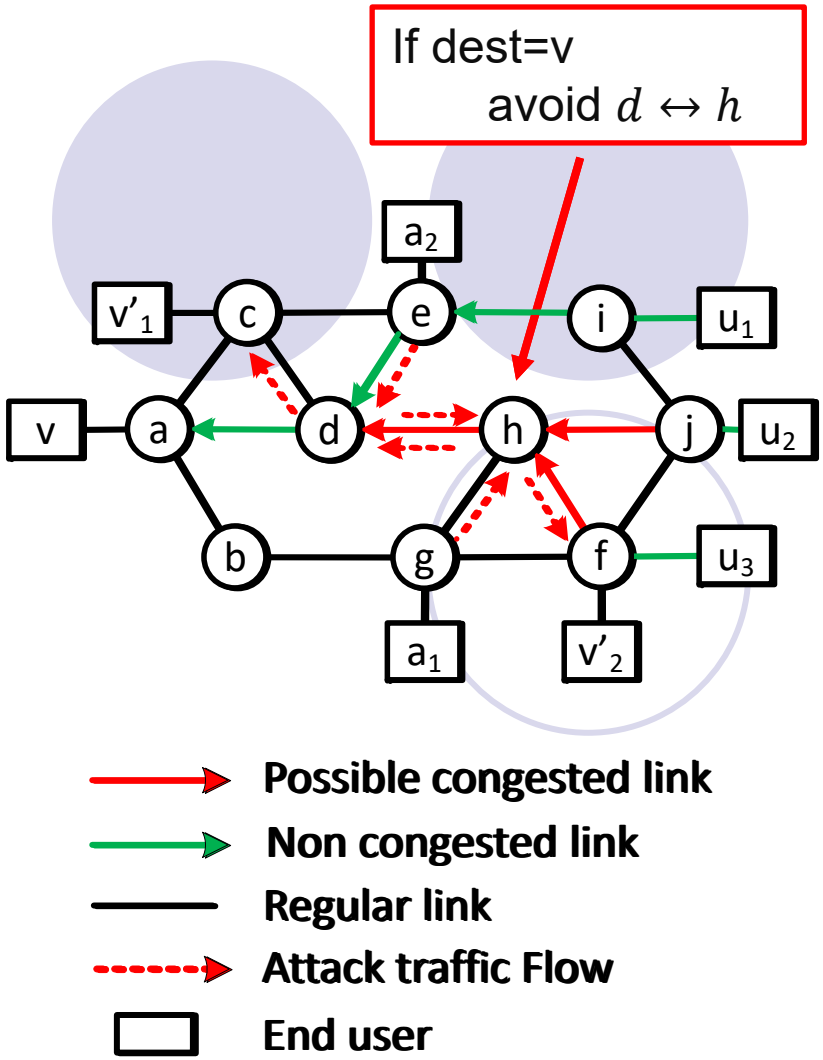
- Assumption: Victim knows the topology.
  - (ISP, packet marking)
- Finds possible congested links.
  - Based on User traffic rate.
- Send filter to Filter router to change route.

Filter Router:

Accepts filter and apply that to block links based on destination.

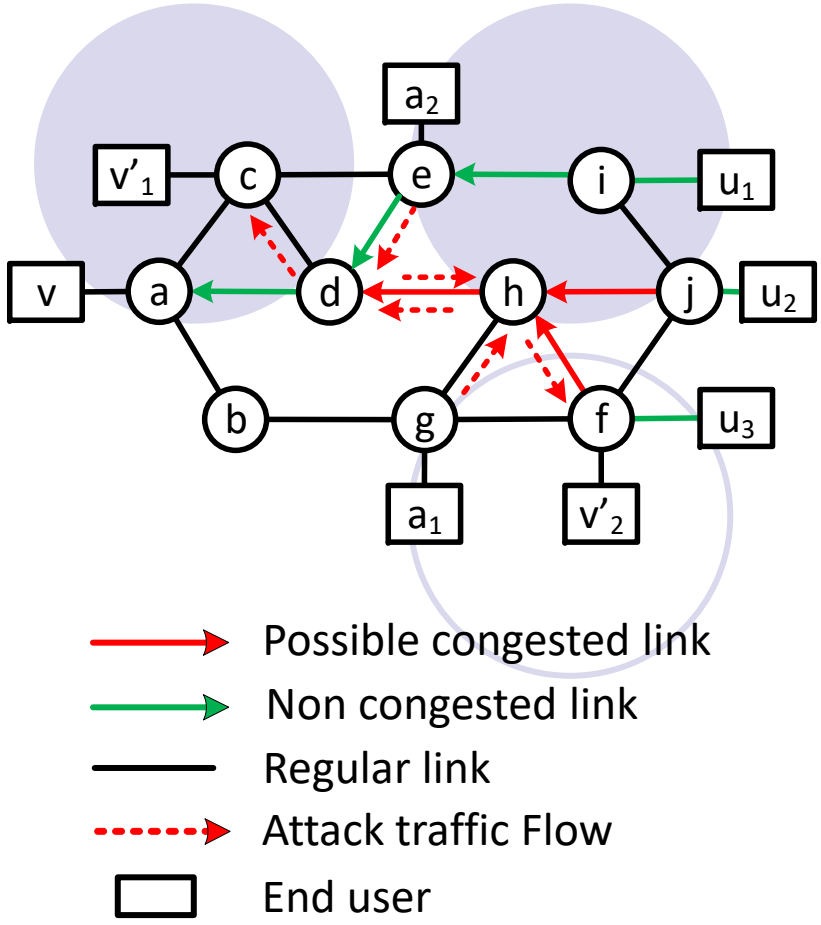
Filter:

Link blocking rule.



Protecting User by Sending Filter

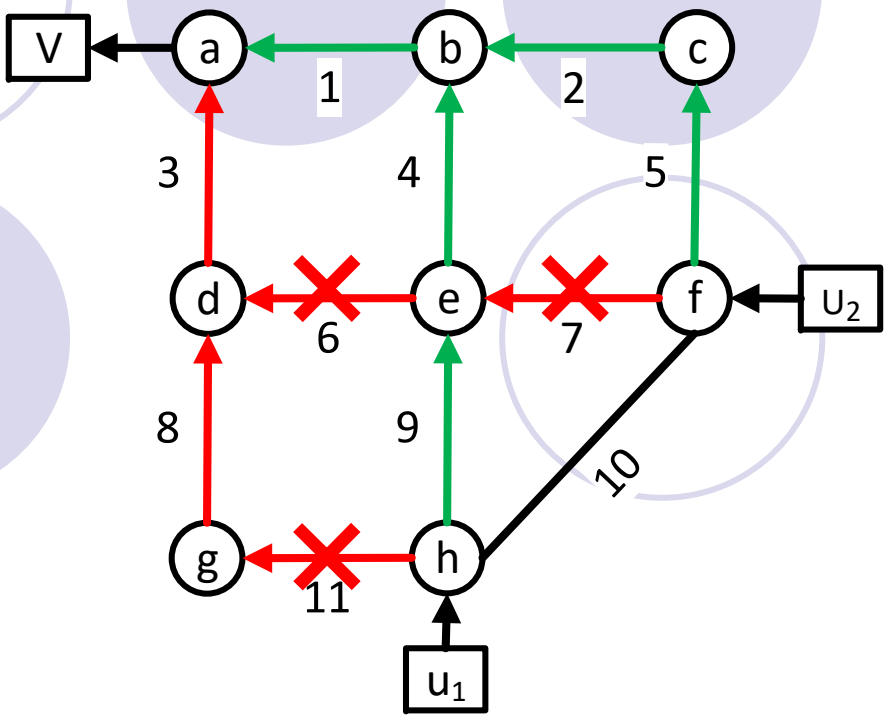
- Assumption:
  - There exist a non congested path from each user.
  - Shortest path routing is used.
- Send filter to block all possible congested links
  - Owner of the FR changes money for applying filter.
- Need to block links wisely.



Problem: Minimizing Blocked Links

- Given topology and possible congested links.
- Block minimum number of links so that all user traffic follow non congested paths.

- Option 1: block 11, 6, 7
  - Three blocks (not minimum)
- Option 2: Block 3,7
  - Two blocks (not minimum)



No traffic travels through possible congested links

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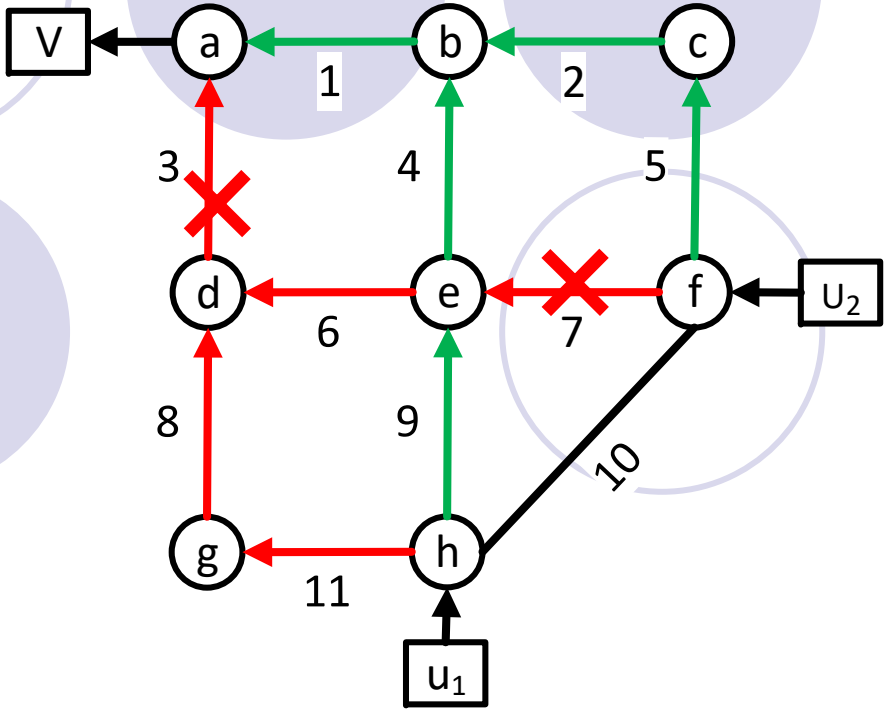
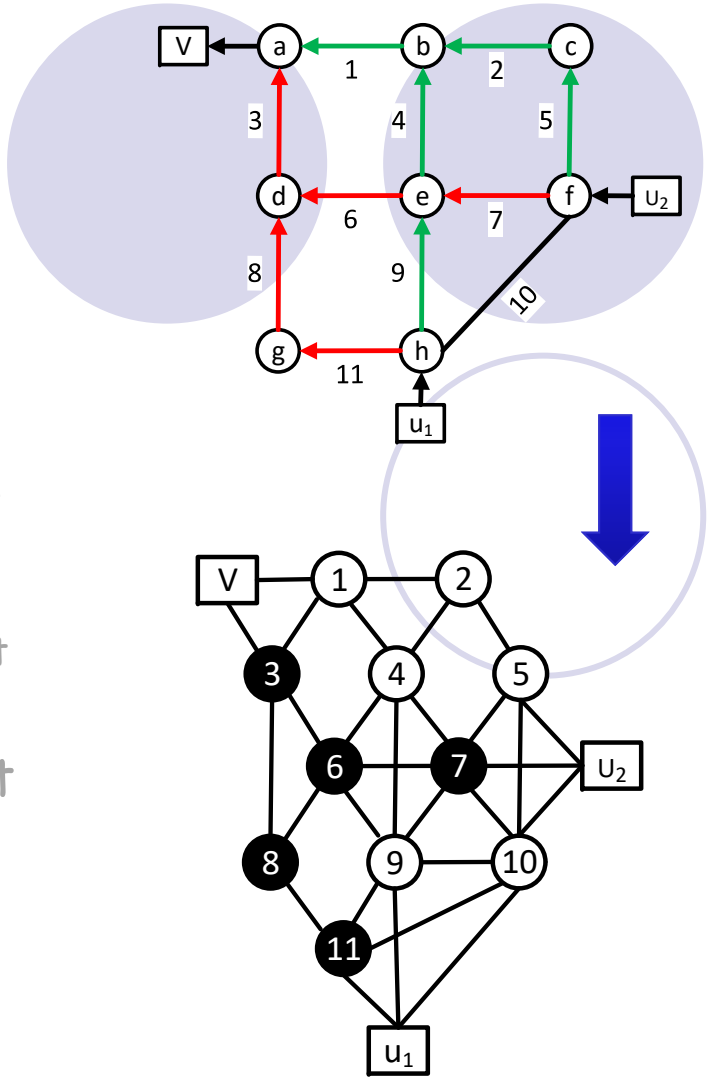


No traffic travels through possible congested links

Solution Steps

- Step 1: Transformation to line graph
  - Edges-> Nodes, red links-> black nodes
- Step 2: Create traffic flows
  - From all sources, follow all shortest paths.
- Step 3: Remove white nodes
  - Remove white nodes and concatenate red links
- Step 4: Add super user
  - Add links to the black nodes who have incident green links
- Step 5: Find minimum d-separating set
  - Using Acid and Campos's method



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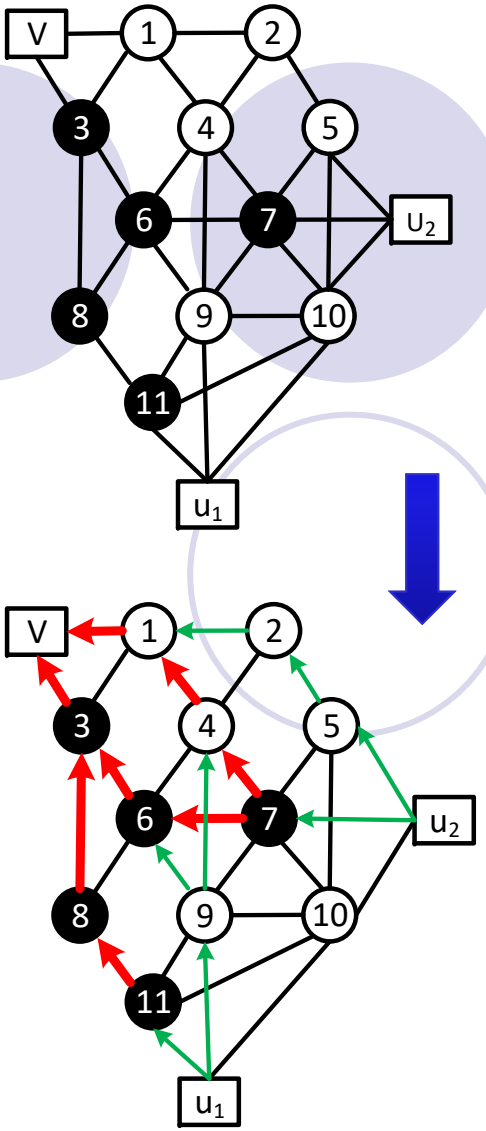

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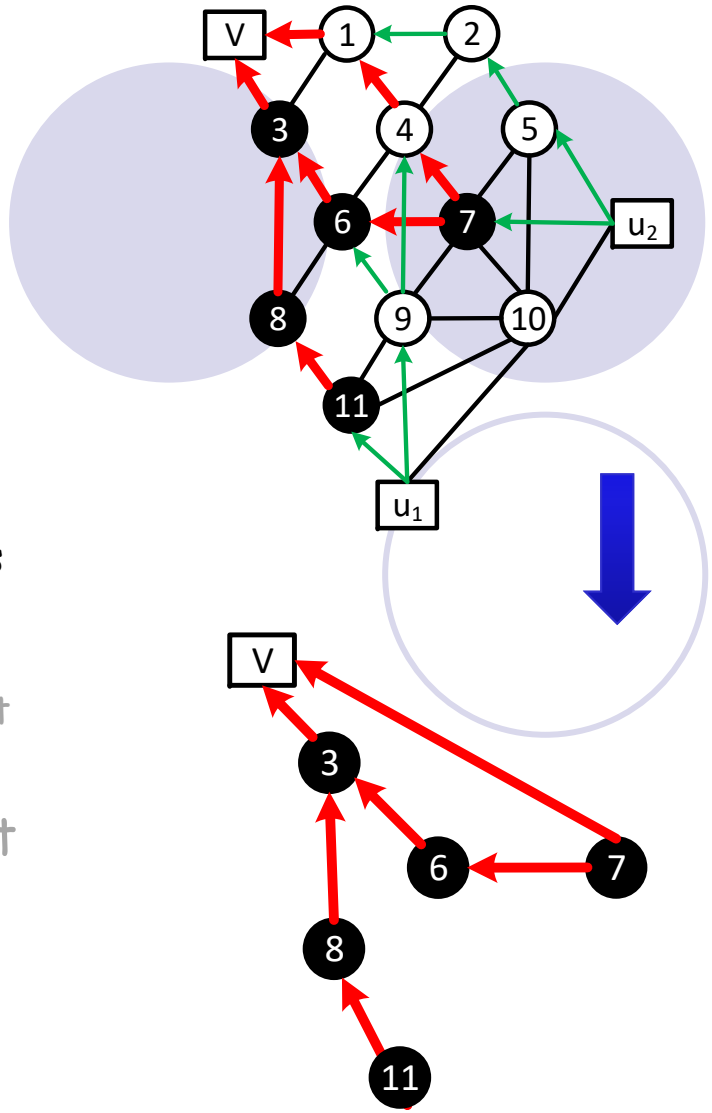

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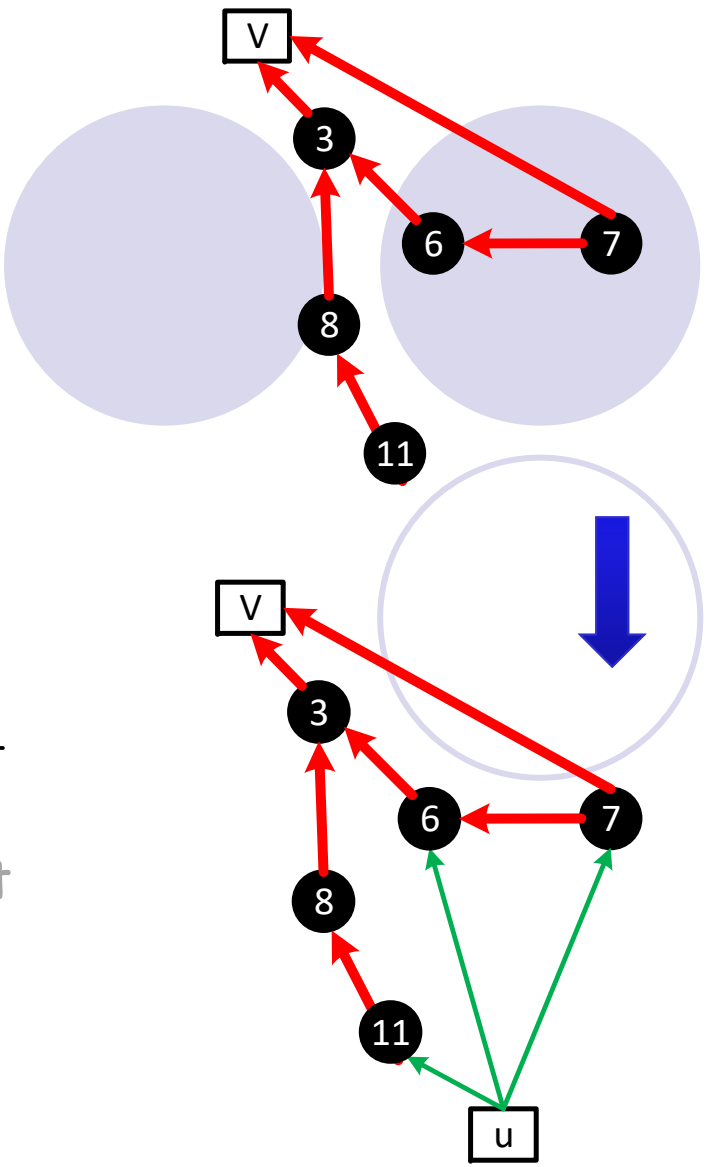

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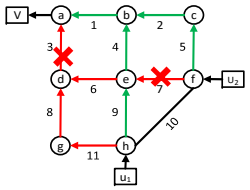
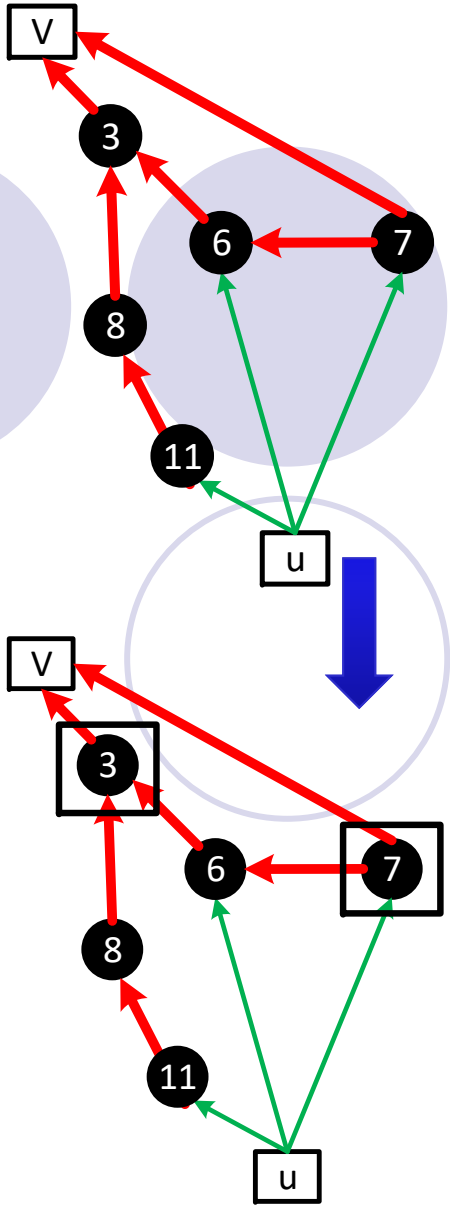
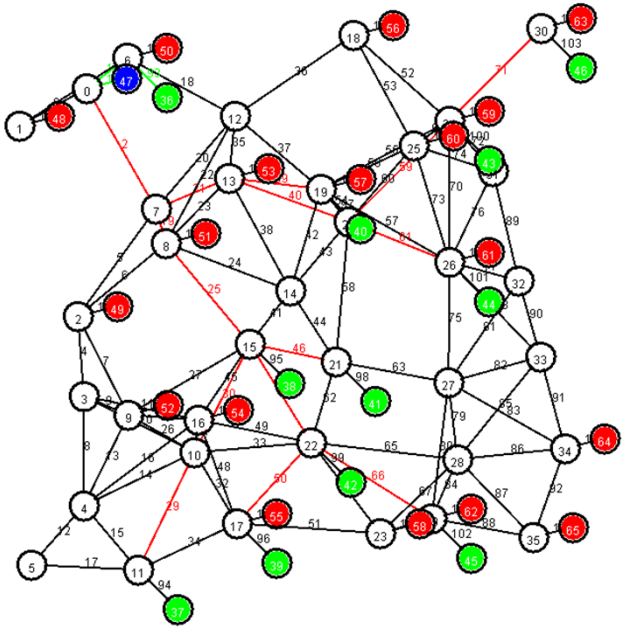


Solution: Block links 3,7



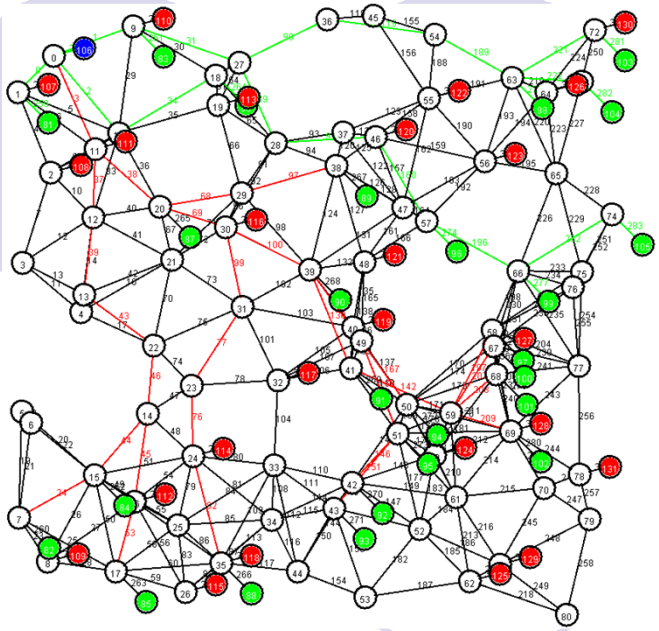
Simulation: Random Topology Generation



Attacker

User

Victim



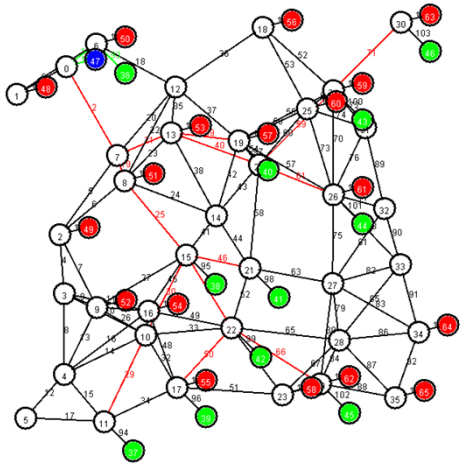
Topology I
Nodes: 65, Links: 123

Topology I
Nodes: 131, Links: 310

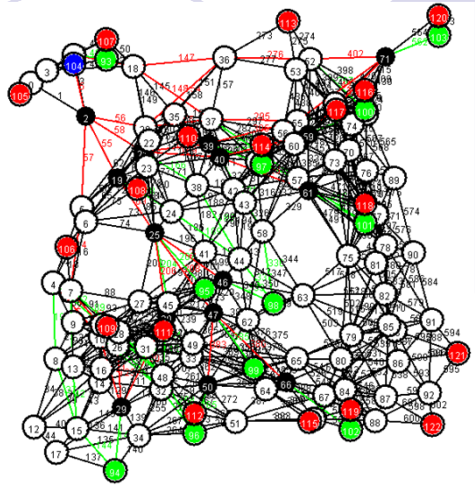
Unite disk graph, Randomly placed nodes (uniform),
Area: 500x500, Neighborhood radius: 70, 50% attackers (chosen randomly)

Simulation: Graph Transformations

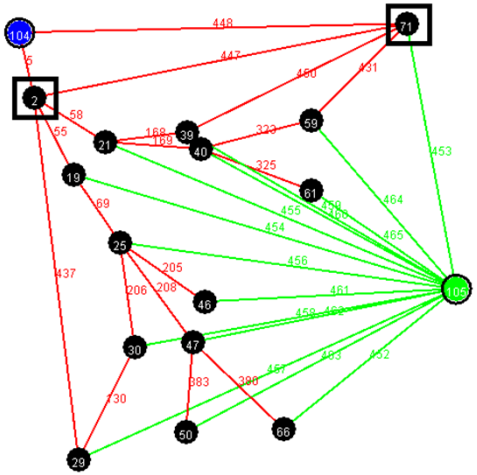
Topology I



Original Topology

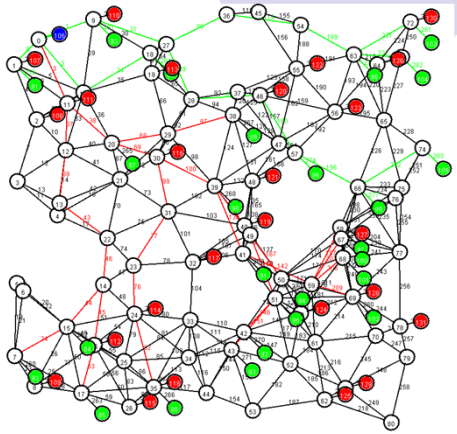


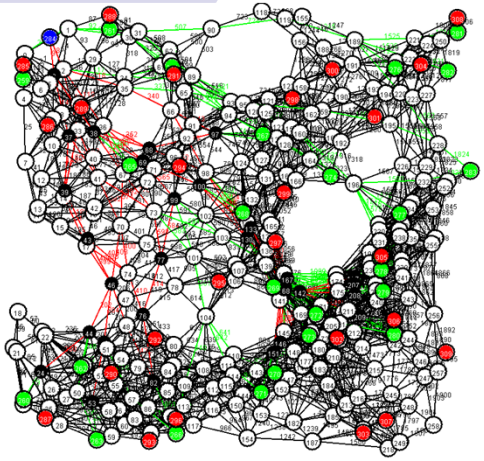
Line graph

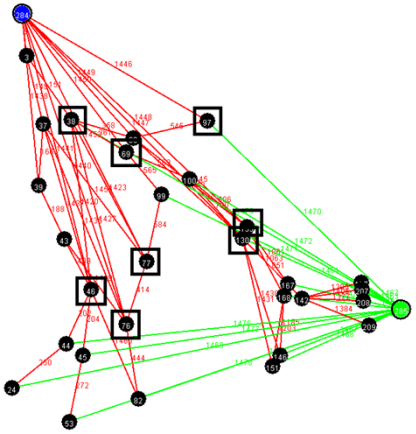


Final Graph

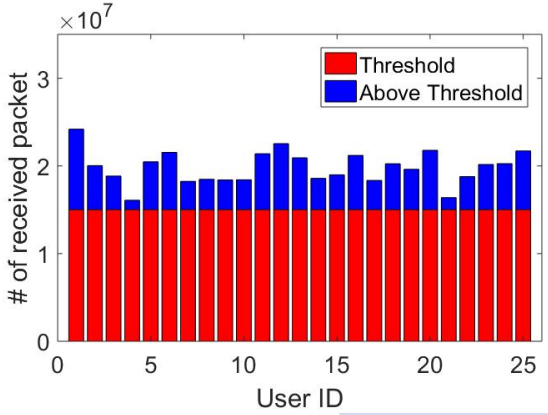
Topology II



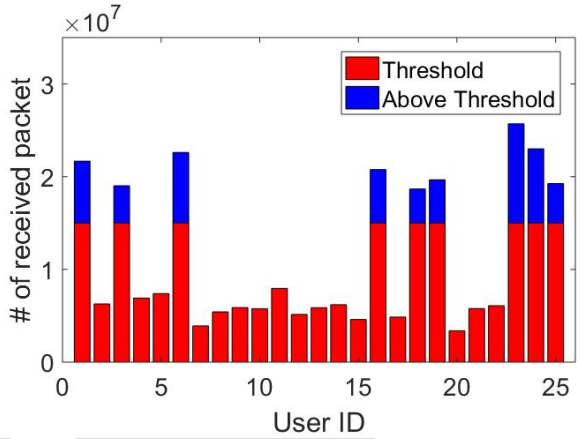




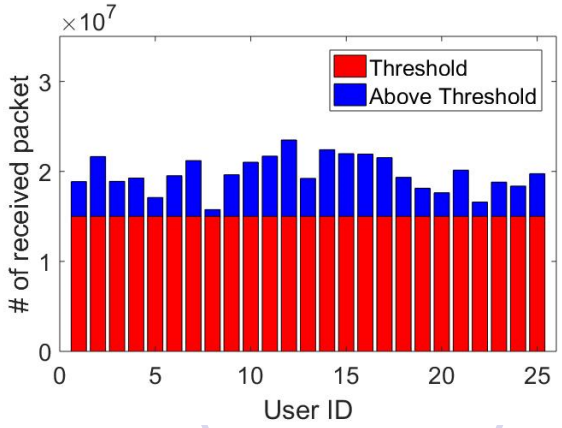
Effect of Filter Deployment



Before attack



After attack



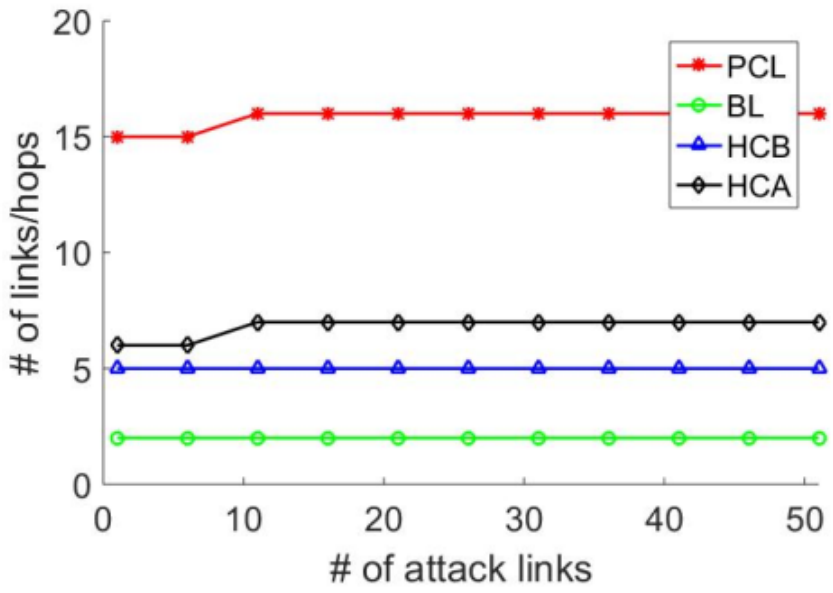
After defense

25 Users, Topology I used

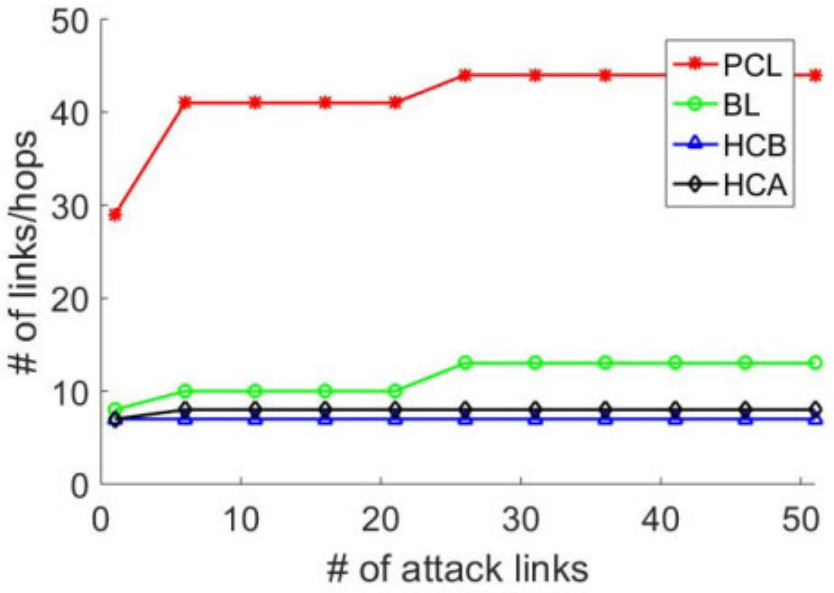
After defense all the users' data rate is above threshold

Effect of Number of Attacked Links

Topology I



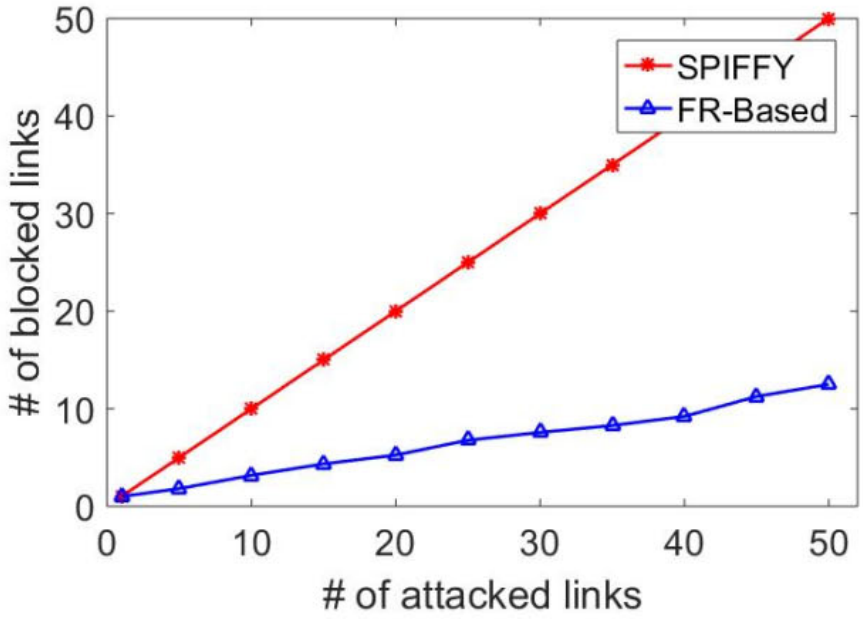
Topology II



Links to block is much greater than possible congested links are much greater than

Comparison With Others

Topology I



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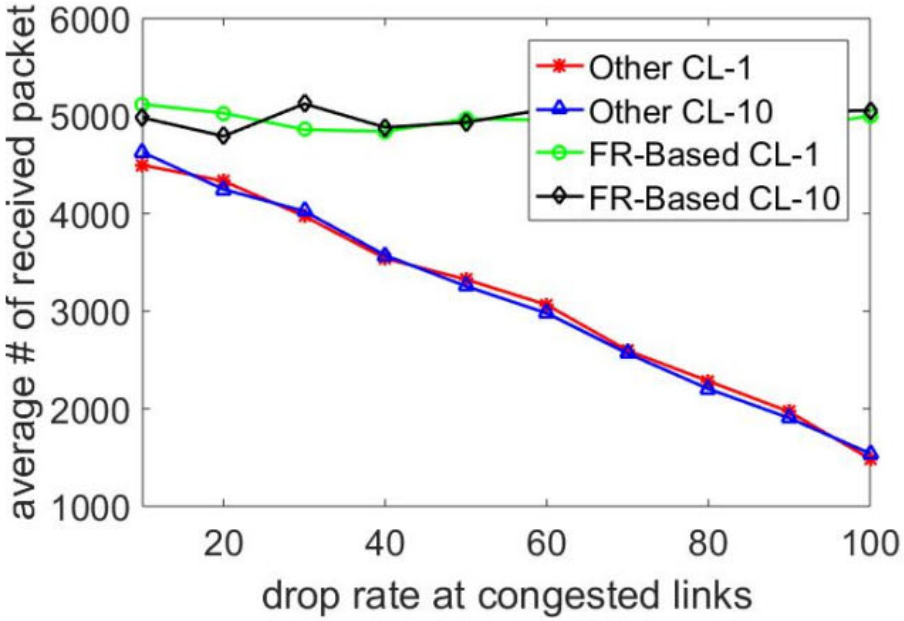
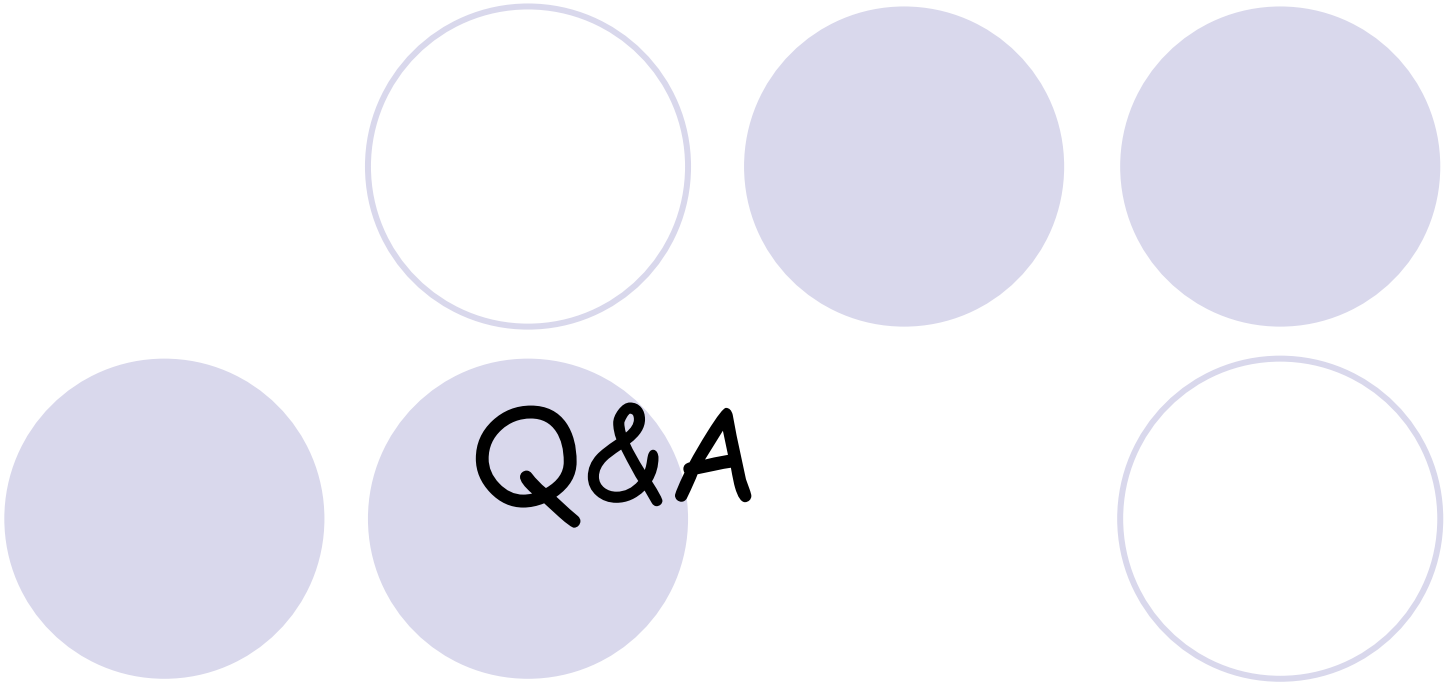


Number of blocked links are always less than SPIFFY

The average number of receied packets is not affected by drop rate at links

Summery

- The filter router-based link blockage can defense against transit-link ddos attack better than other approaches.
- The links needs to block for redirecting the user traffic through non congested way is much less than the possible congested links.


Q&A