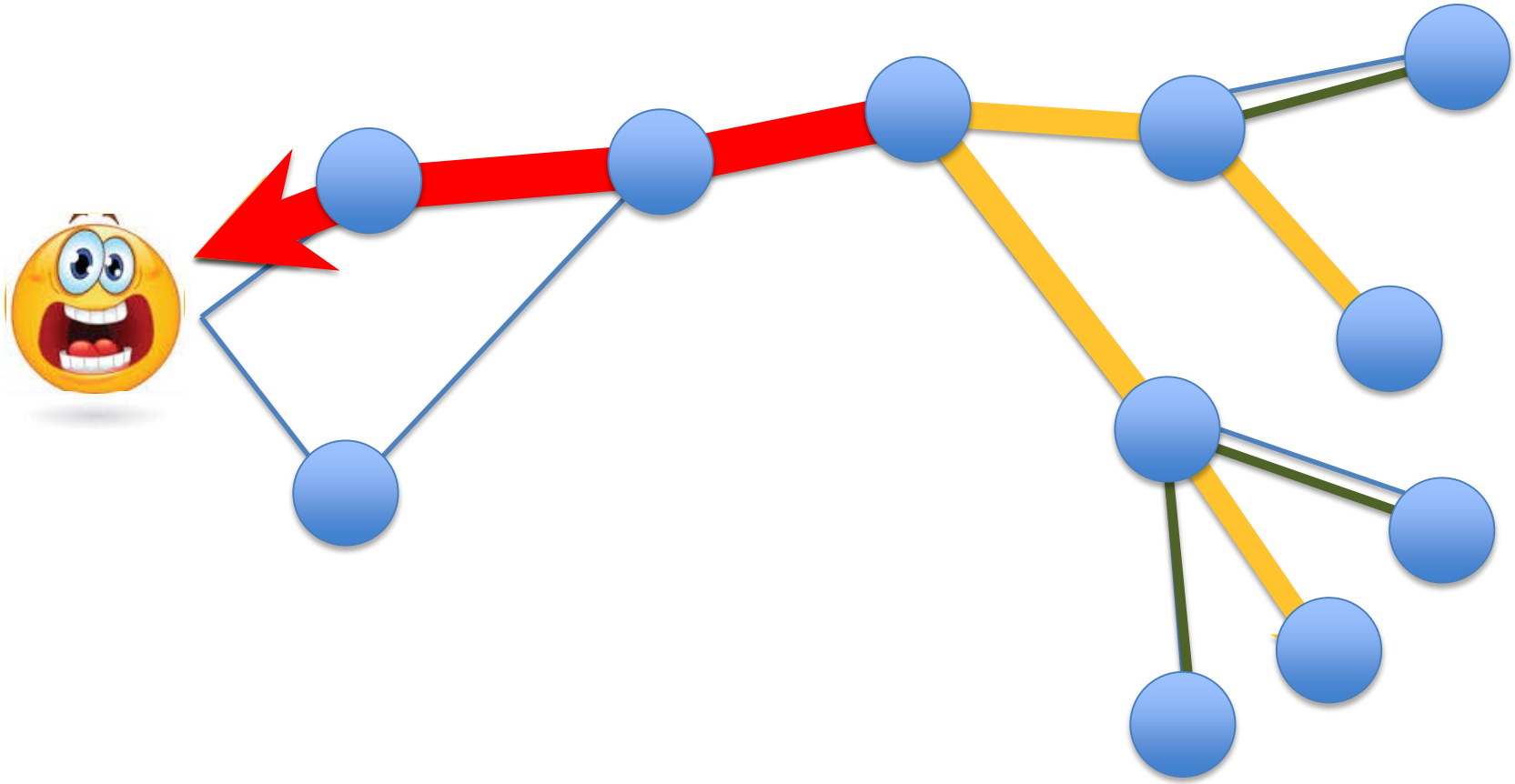
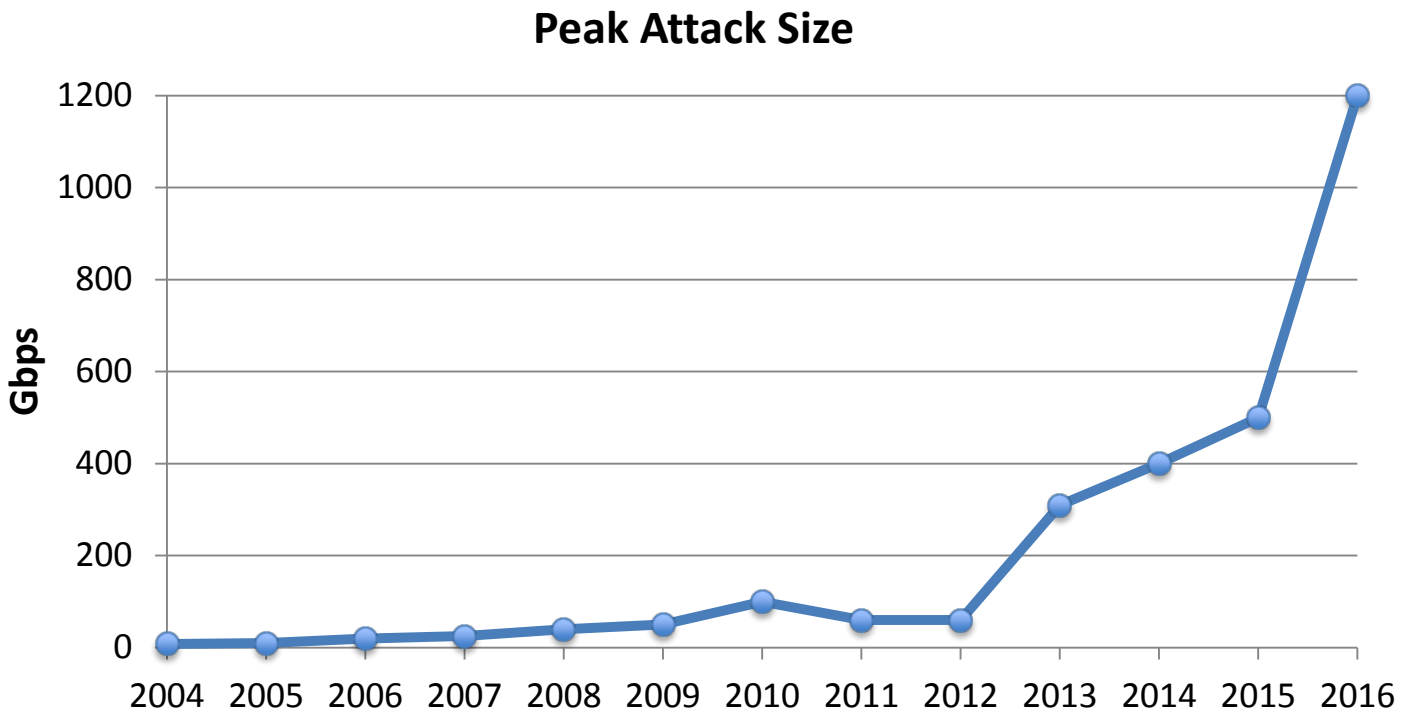
DDoS Defense for a Community of Peers

Jem Berkes (Project PI) and Adam Wick (Transition Lead)

About DDoS

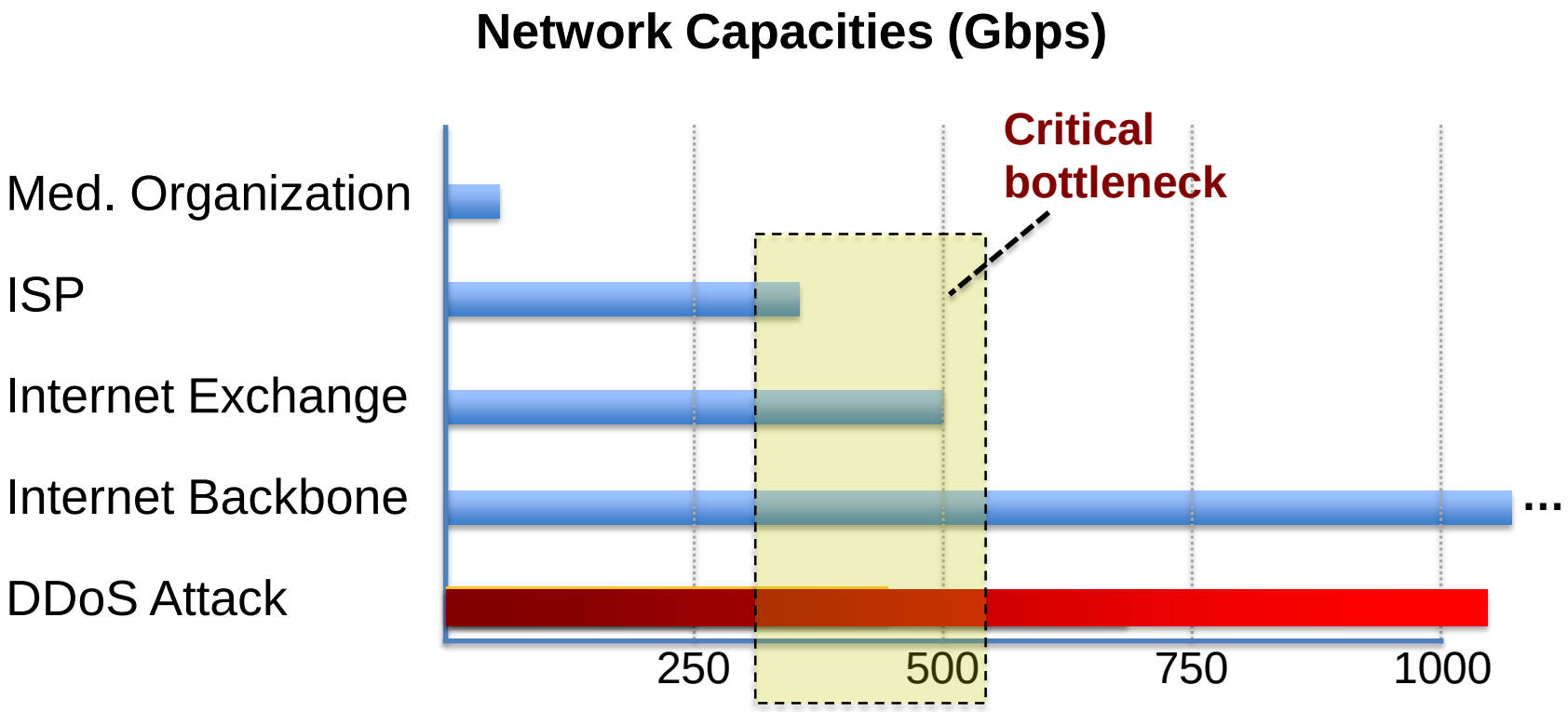
A DDoS Attack





Source data: Arbor Networks Worldwide Infrastructure Security Report, and recent media reports

When DDoS Becomes a Problem ...



Current Attacks Now Exceed Bottlenecks

- **Mirai / IoT botnets**
- **Enormous increase from 500 Gbps to 1,200+ Gbps**
- **Can’t stop this alone**
  - Tier 1 ISPs
  - Cloud providers – not immune
- **Aggregate, world-wide capacity is not the issue**

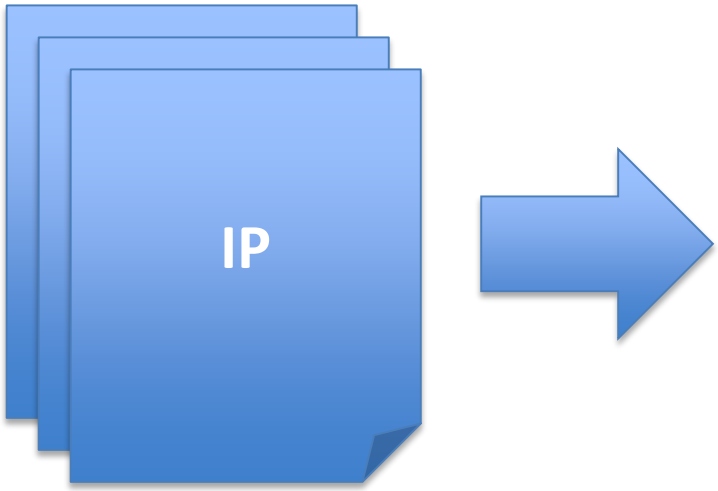
Networks Must Collaborate

- **Effective defense requires collaboration between networks**
- **Must stop traffic closer to sources**
- **Automate response/coordination under attack stress**

We're creating a tool to do this – 3DCoP

Handling DDoS with 3DCoP

Flow representation of traffic



SRCIP	SPORT	DSTIP	DPORT	PROTO	COUNT
…	…	…	…	…	…
…	…	…	…	…	…
…	…	…	…	…	…

- Big
- Packet bodies

- Compact summary
- NetFlow, IPFIX

Our approach

- **Decentralized collaboration between networks**
- **Share flow information (clues) from distributed sensors via P2P**
- **Use clues to compute**
  - Sources of attacks
  - Spoofed traffic
  - Optimal blocking

Decentralized P2P Network

- **Out-of-band P2P**
- **Can operate using cell phone tethering – during attack**
- **IPFS: Kademlia-based DHT swarm**
    - Every node has public key

What is shared?

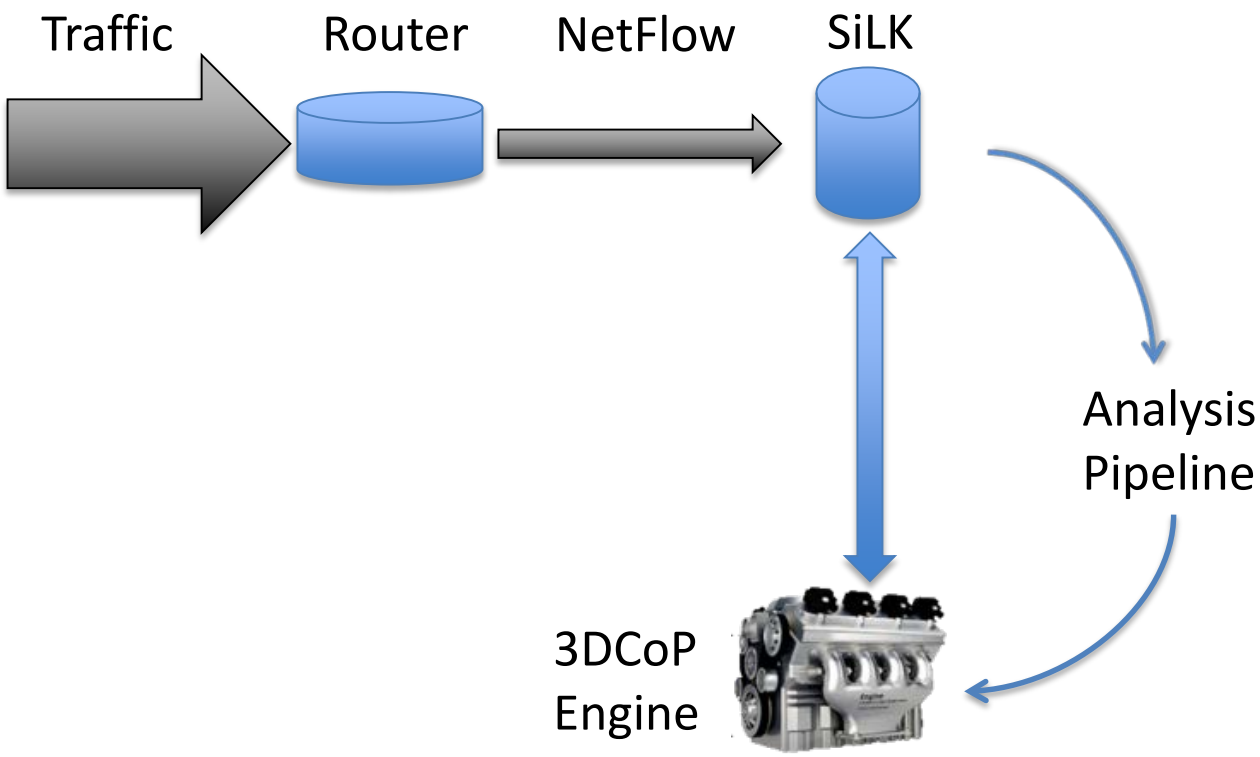
- **Subset of flow data, classified as**
  - Anomalies
  - Undesirable traffic (attacks)
  - Assertions: present or not present
- **Each node pushes data**
  - Decide what you want to share

Who is it shared with?

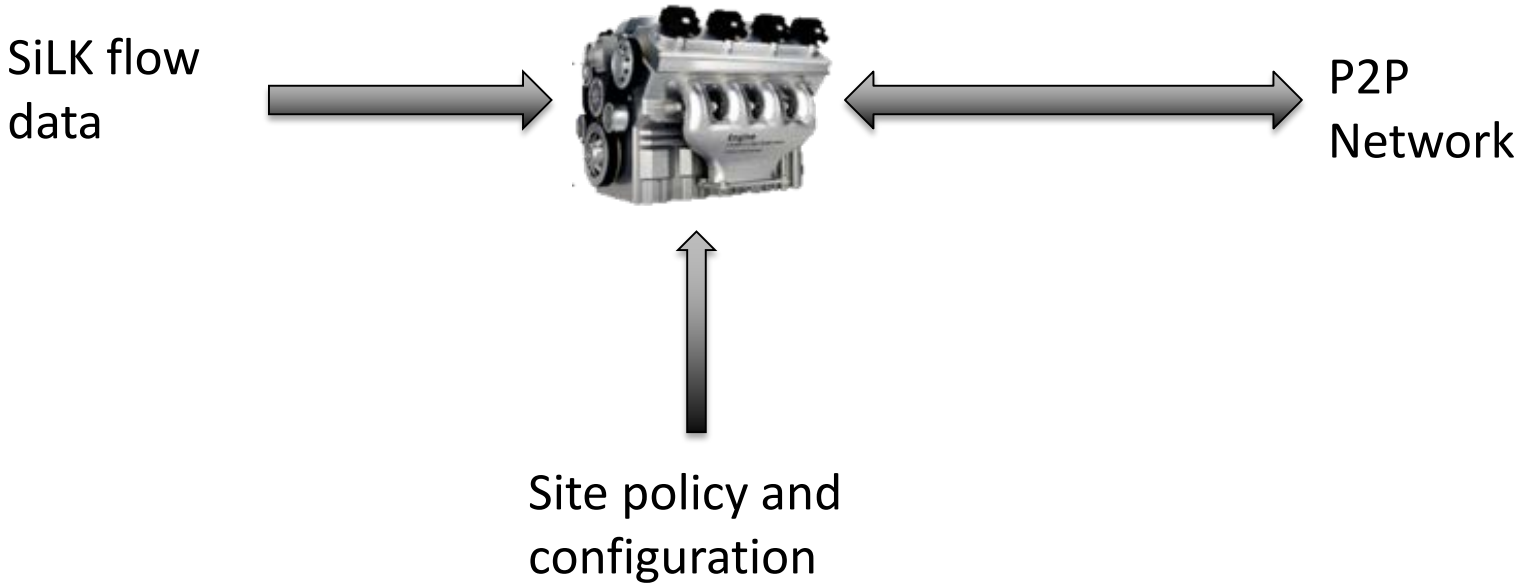
- **Strict/private mode**
  - Flow data only shared with owner of flow endpoint
  - Enforced with public key cryptography
- **Global announcements**
  - For very anomalous traffic, or attacks
- **Groups/associations**

Each site always controls what they share, and with whom

Data Processing



3DCoP Engine



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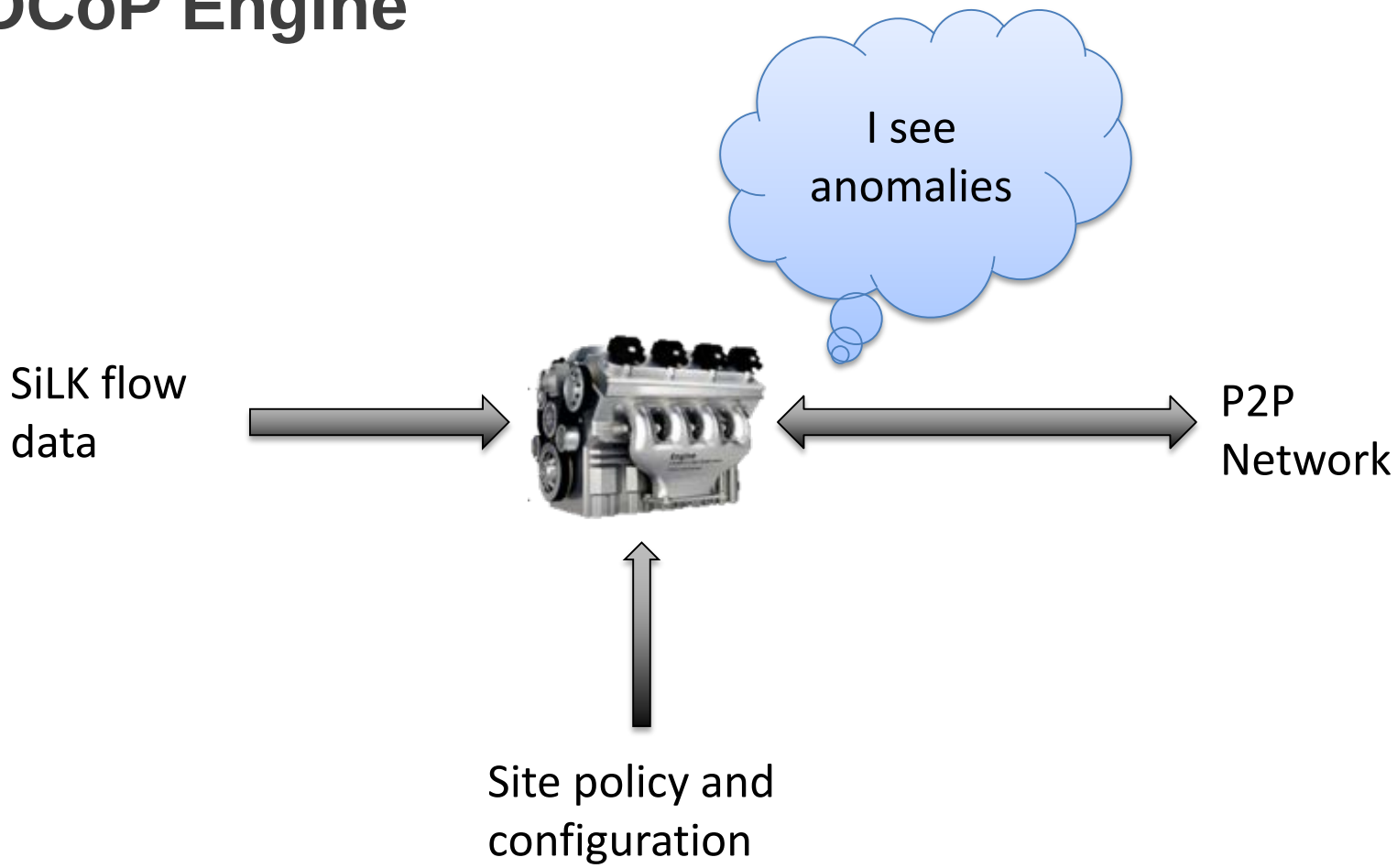

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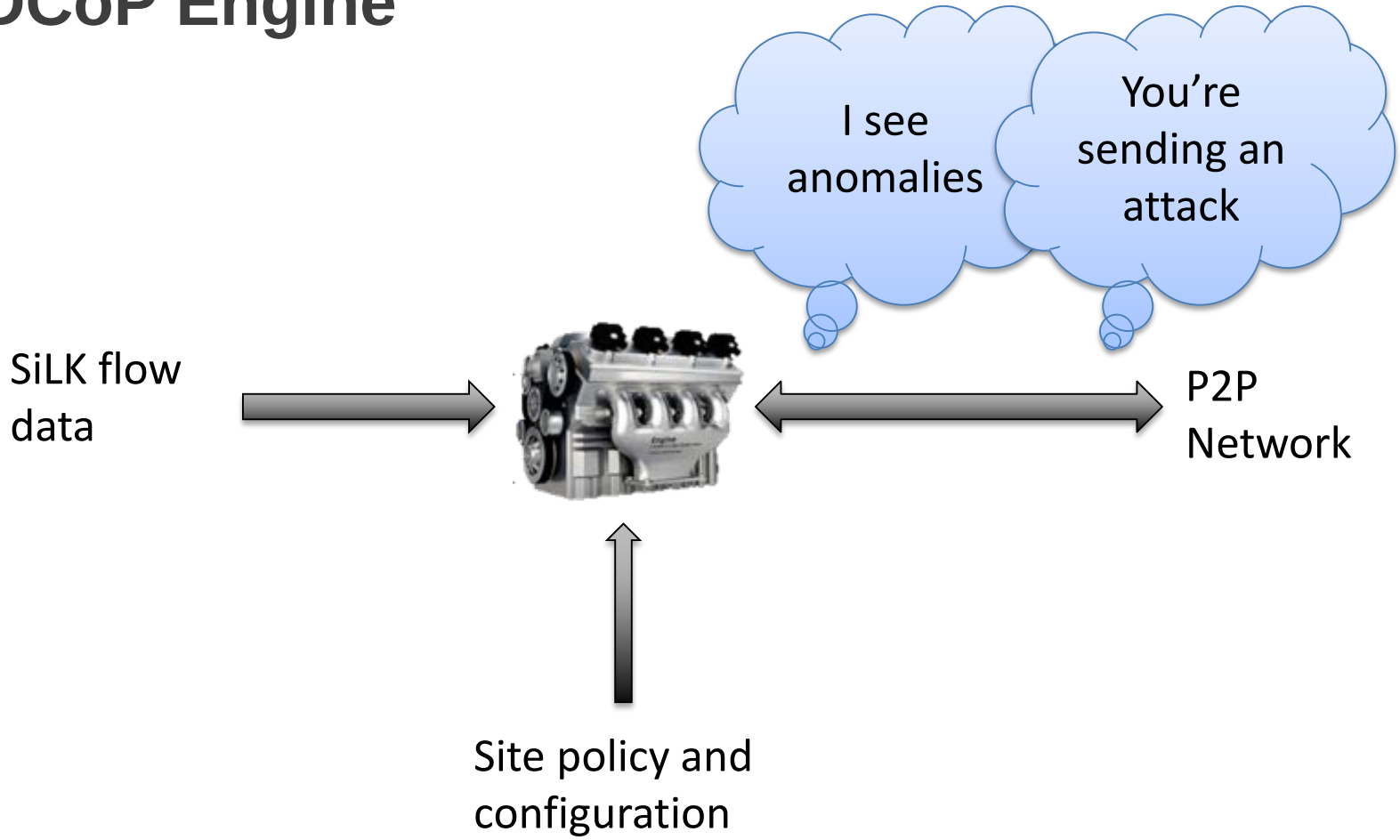


Engine

- **State tables**
  - Local anomalies, peer-reported anomalies, etc.
- **Rules-based algorithm**
- **State iterations with real-time updates**
- **Automatic traffic analysis leading to actions**

Rules in the Engine

```
if I see anomalous outbound flows
   and others report anomalies from me
then

      increase oddness score for flows
```

```
foreach anomalous flow

      if oddness score > THRESHOLD
         and network utilization is high
         and many src_ip are sending to few dst_ip
      then

                promote anomaly to attack
```

More Rules…

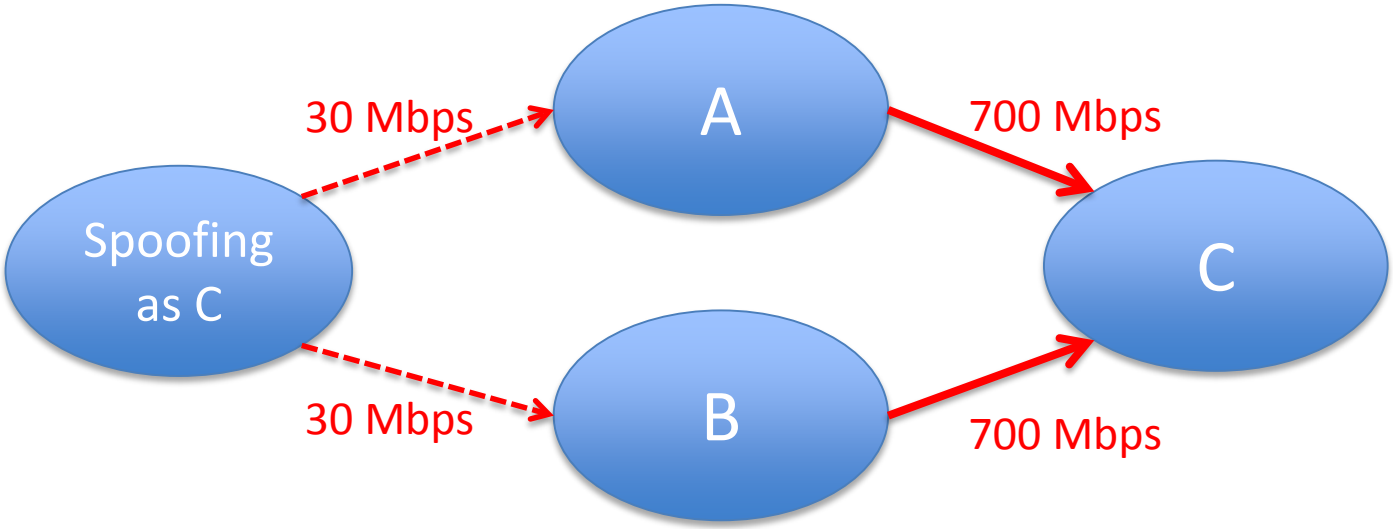
```
foreach peer-reported anomaly

        if local anomaly matches port number
        then
                // might be related attack
                if port is a known amplifier service
                then

                        increase oddness score
                        // we might all be part of
                        // the same DDoS attack
```

Example

Demo scenario



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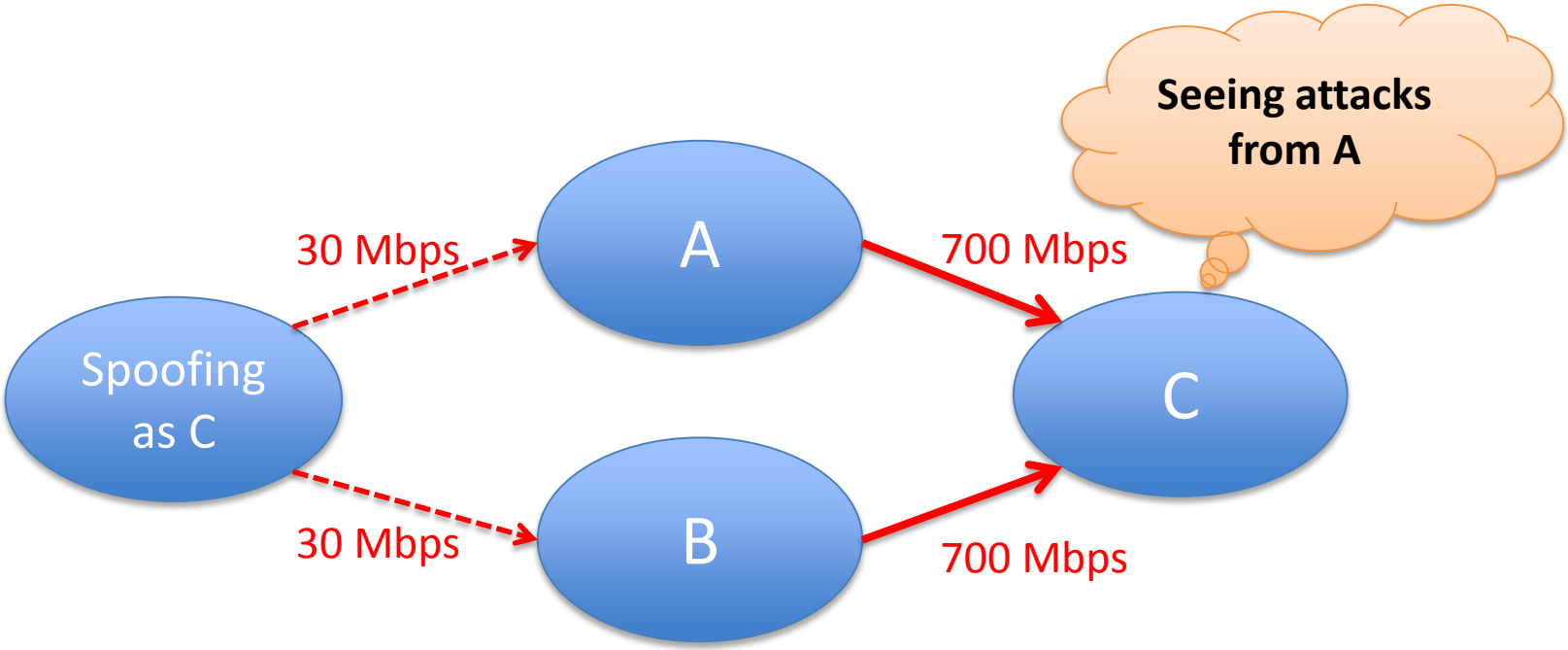

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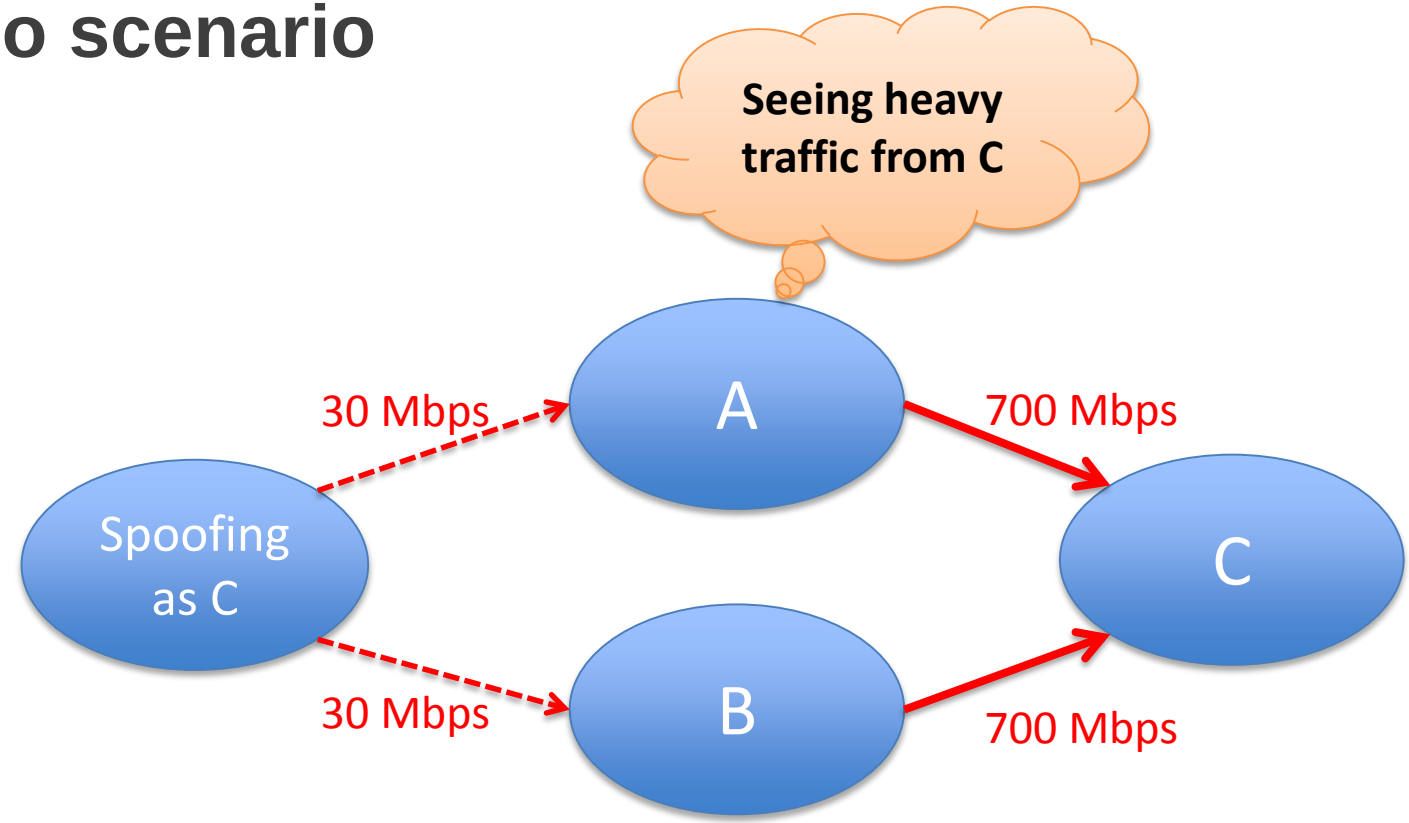

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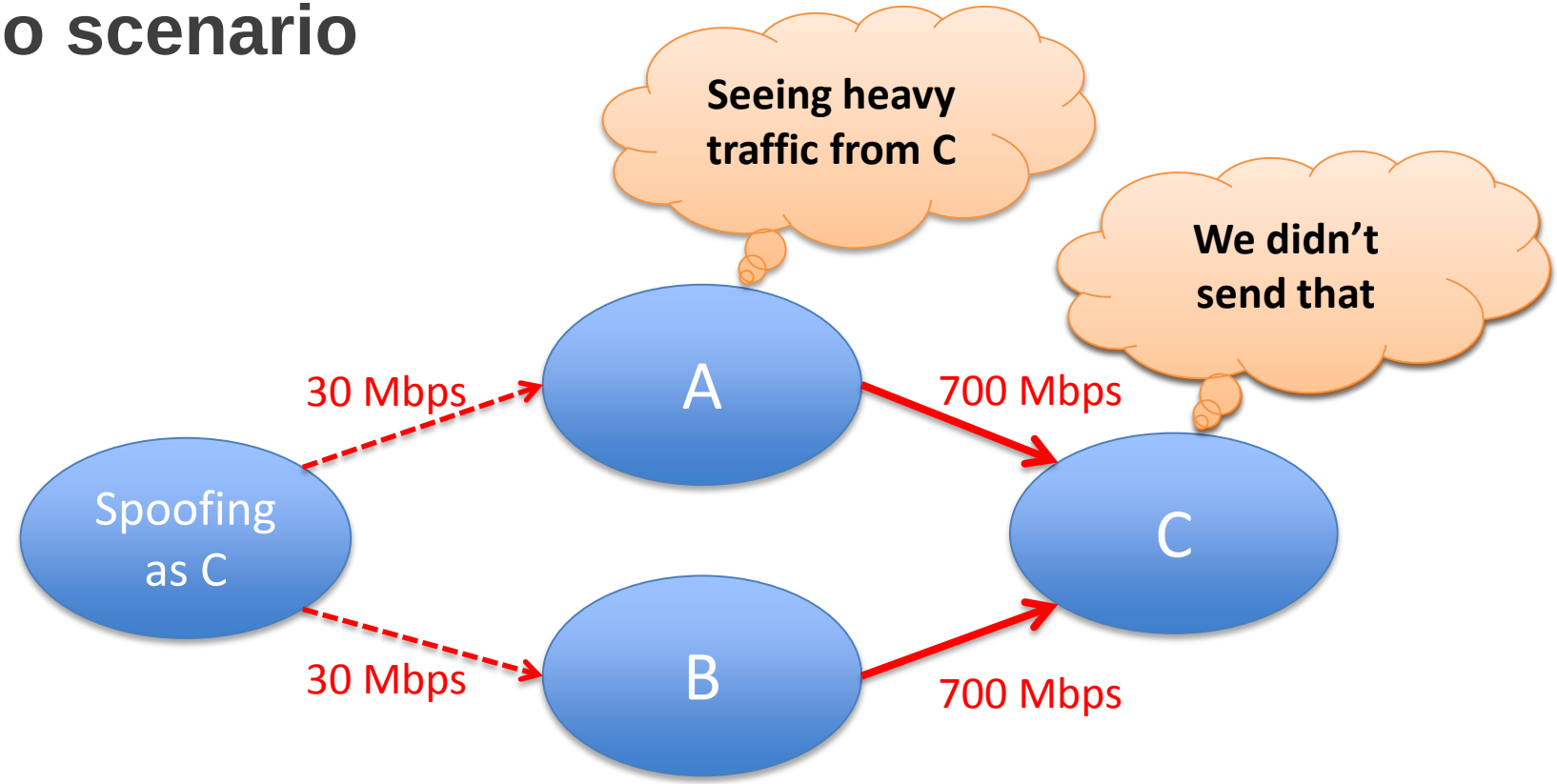

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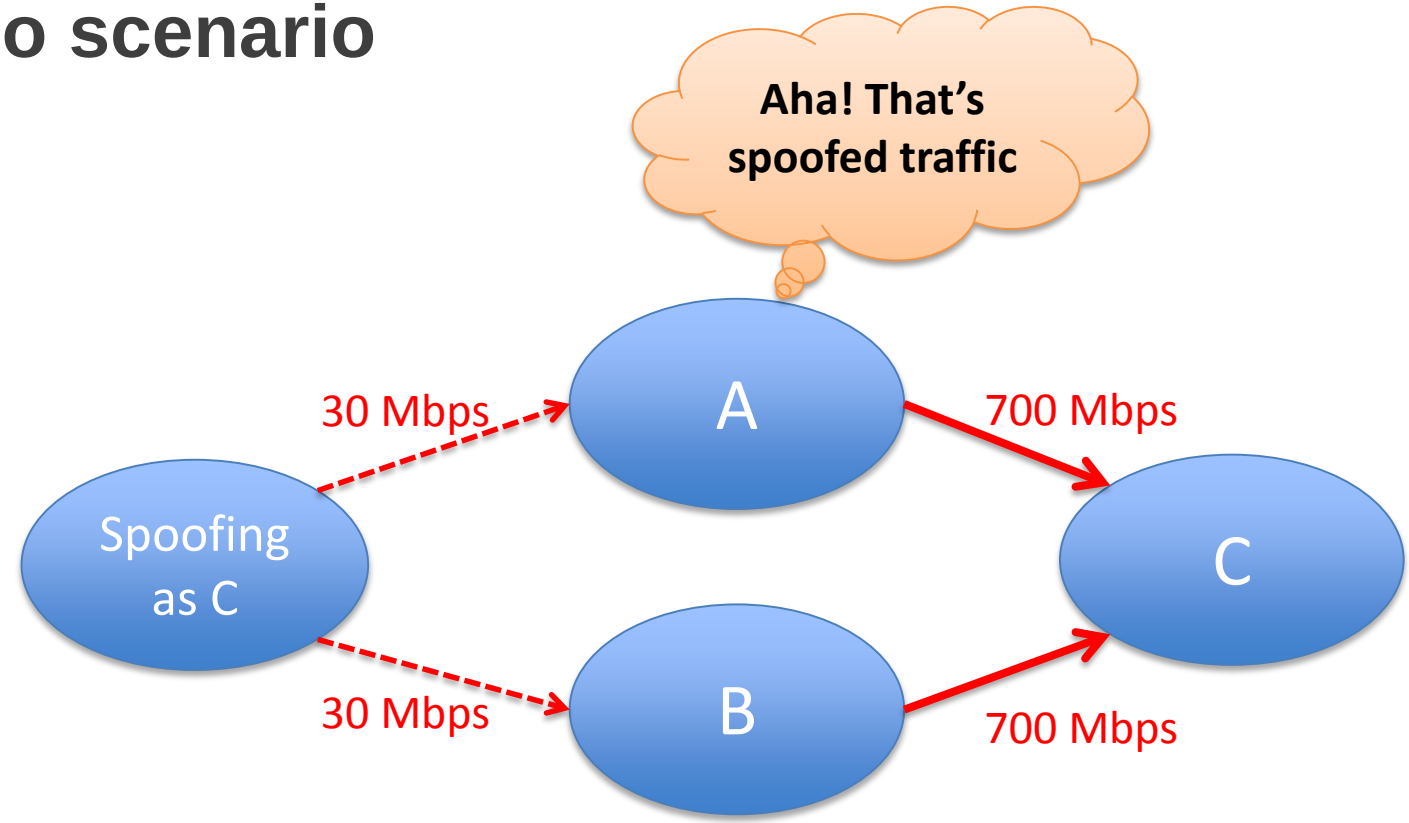

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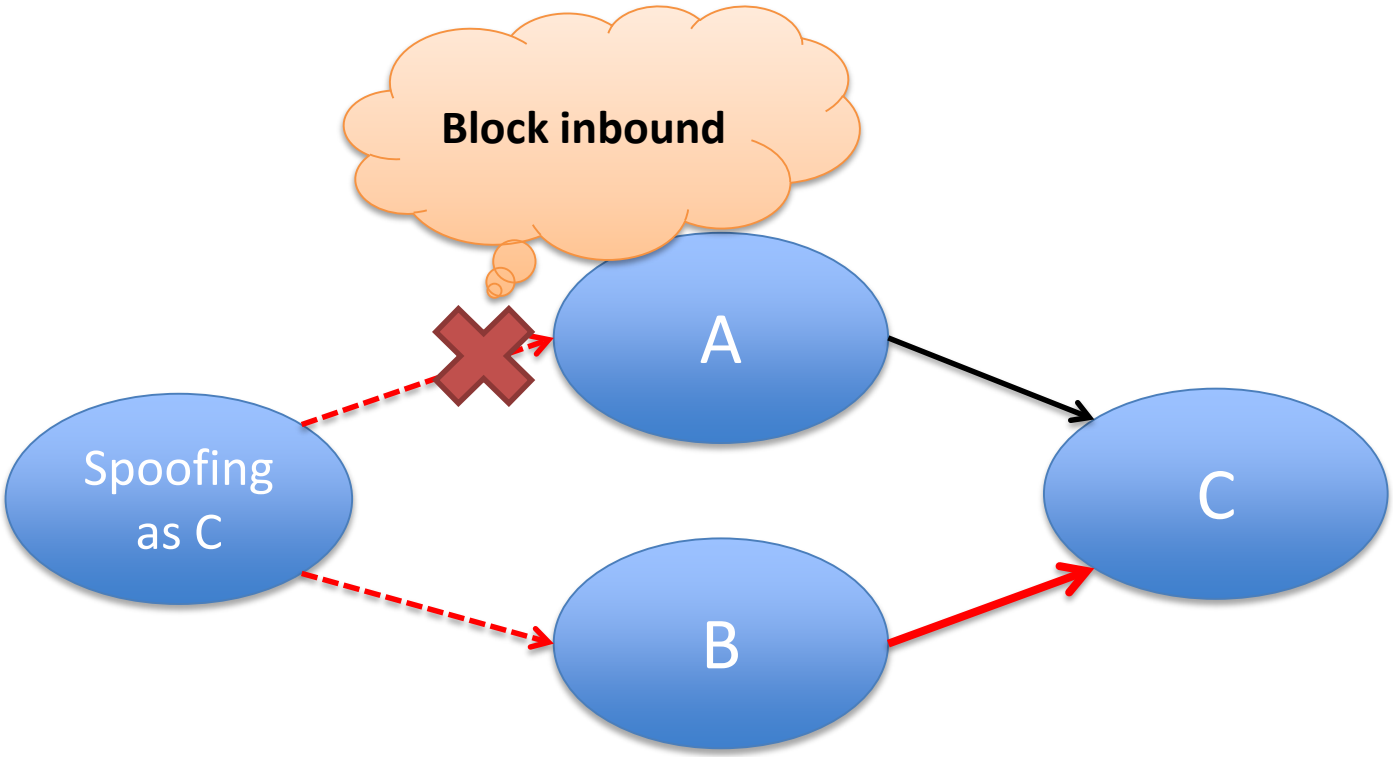

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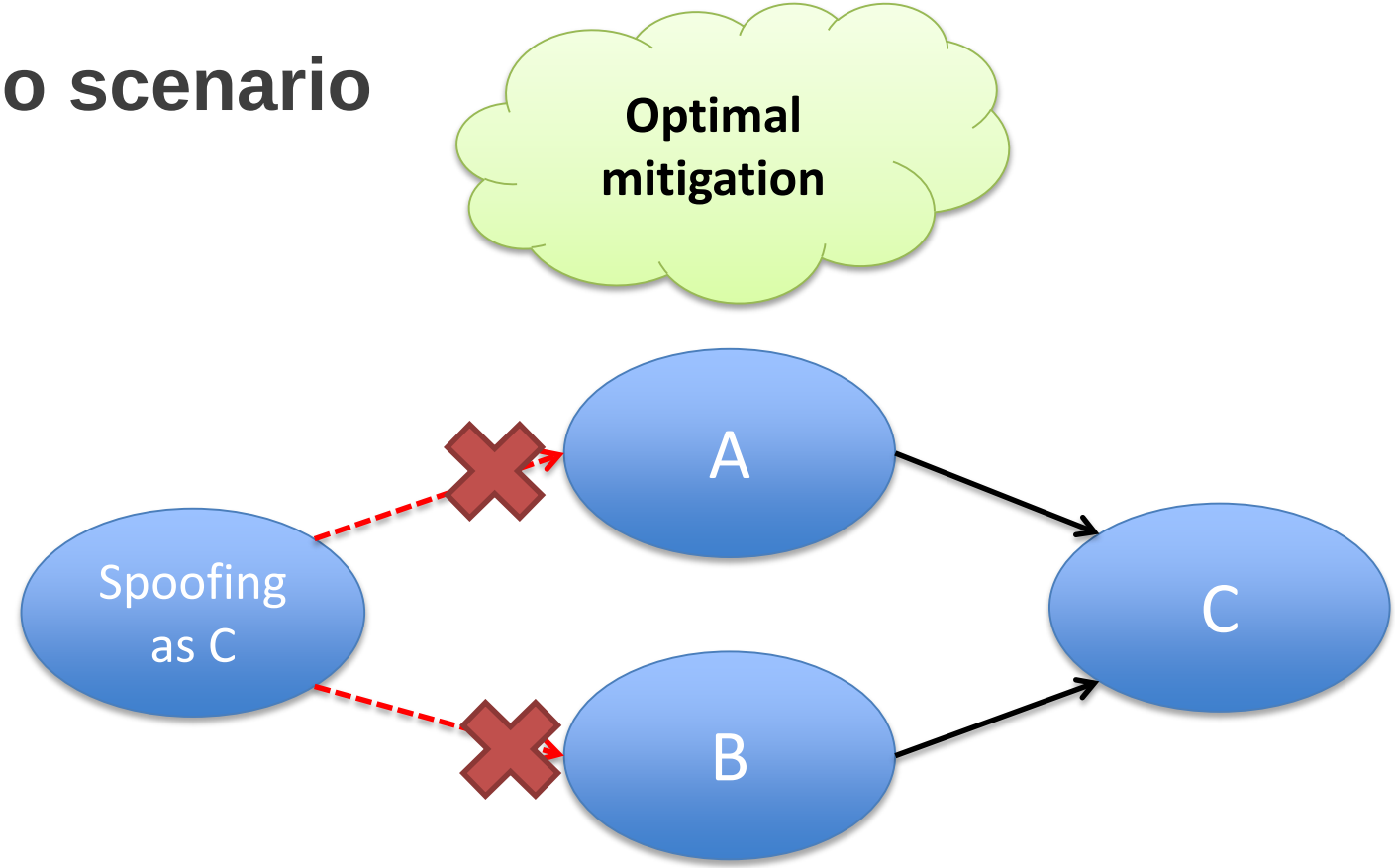

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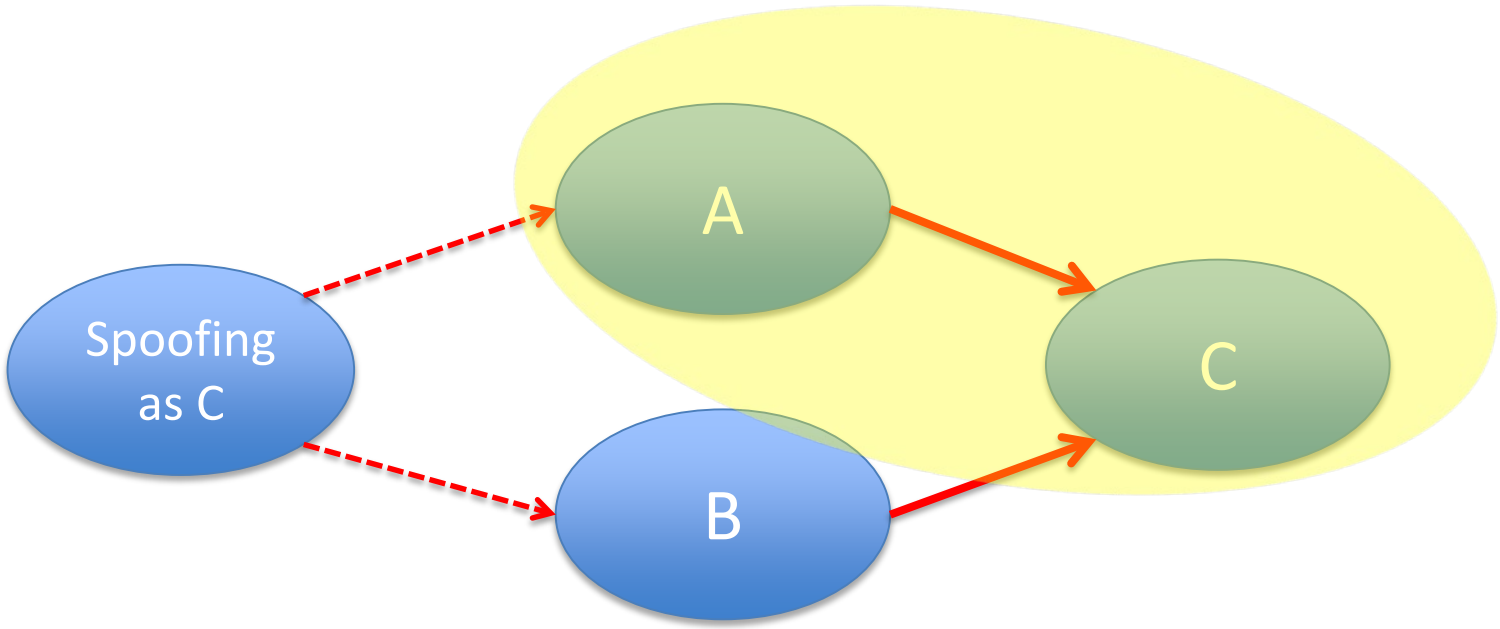
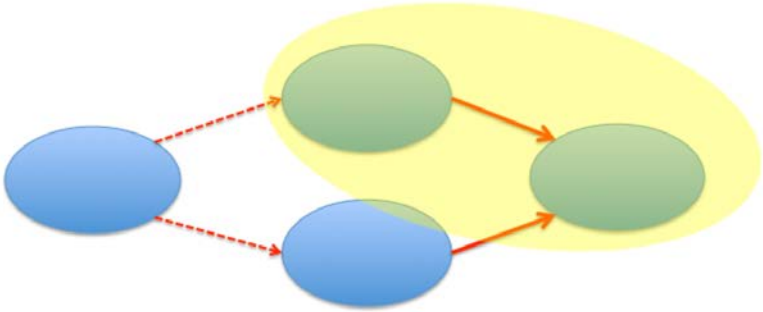
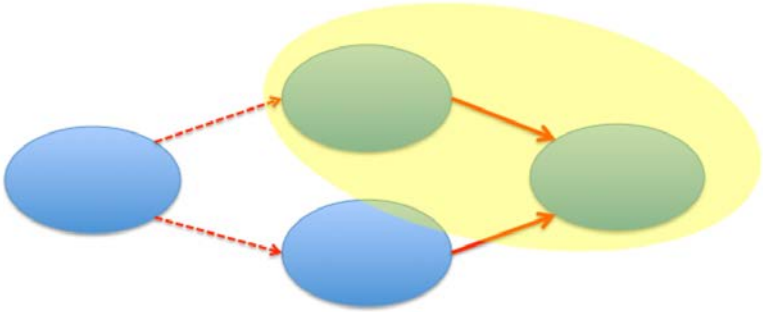


State Iterations



Network containing A (amplifier)	Network containing C (victim)

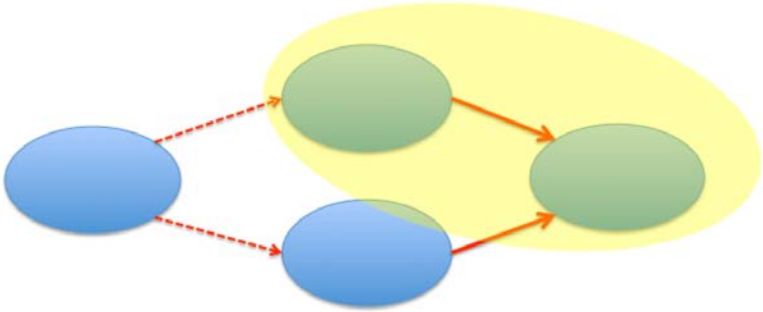
State Iterations



Network containing A (amplifier)
Inbound Anomalies C --> A Outbound Anomalies A --> C

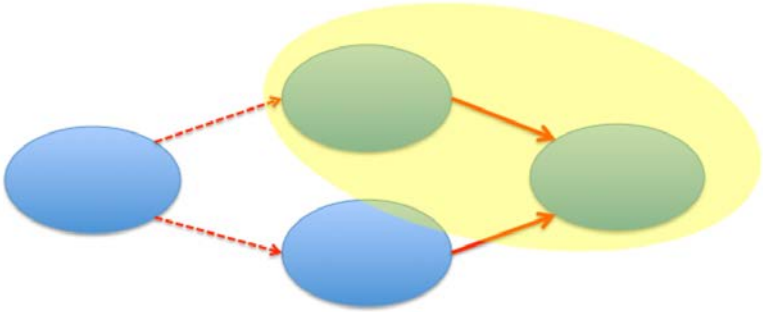
Network containing C (victim)
Inbound Attacks A --> C

State Iterations



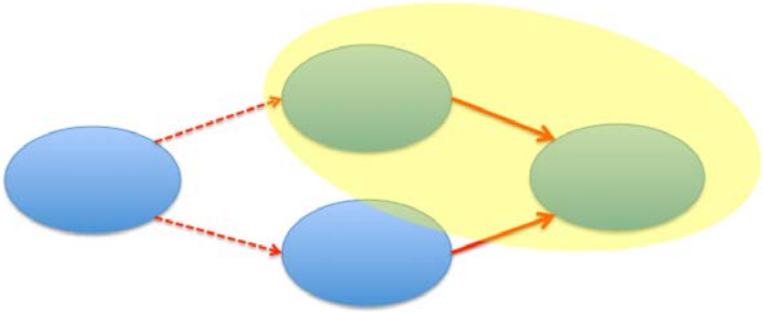
Network containing A (amplifier)	Network containing C (victim)
Inbound Anomalies C --> A Outbound Anomalies **A --> C**	Inbound Attacks **A --> C**

State Iterations



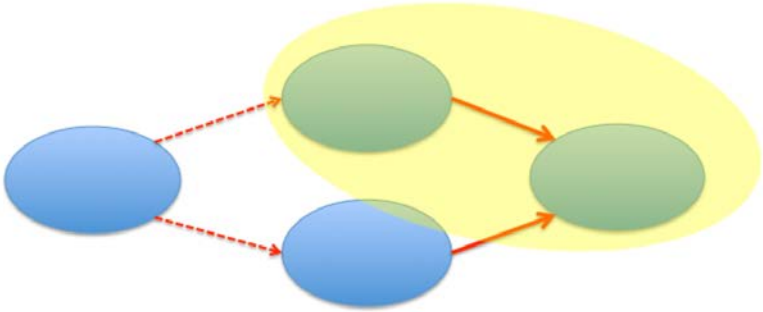
Network containing A (amplifier)	Network containing C (victim)
Inbound Anomalies C --> A Outbound **Attacks, Must Stop** A --> C	Inbound Attacks A --> C

State Iterations



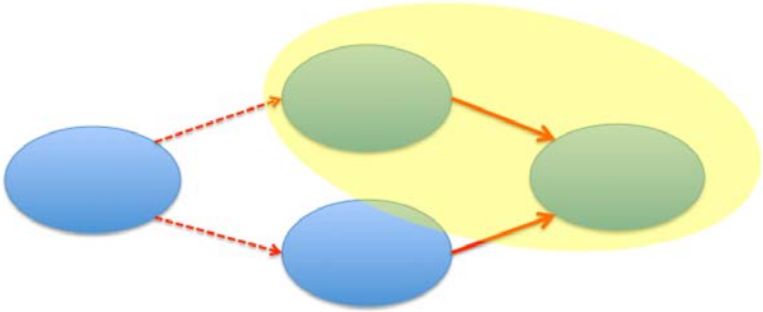
Network containing A (amplifier)	Network containing C (victim)
Inbound Anomalies C --> A Outbound Attacks, Must Stop A --> C	Inbound Attacks A --> C Check flow repository…

State Iterations



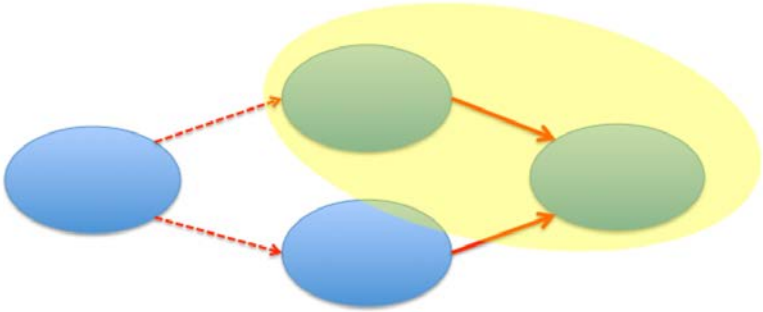
Network containing A (amplifier)	Network containing C (victim)
Inbound Anomalies C --> A Outbound Attacks, Must Stop A --> C **Assertions that Peers Did Not Send** **C --> A**	Inbound Attacks A --> C **Someone is spoofing my IP** **C --> A**

State Iterations



Network containing A (amplifier)	Network containing C (victim)
Inbound Spoofed Attacks C --> A Outbound Attacks, Must Stop A --> C Assertions that Peers Did Not Send C --> A	Inbound Attacks A --> C Someone is spoofing my IP C --> A

We’ve learned a lot!



Network containing A (amplifier)
Inbound Spoofed Attacks C --> A Outbound Attacks, Must Stop A --> C Assertions that Peers Did Not Send C --> A

Network containing C (victim)
Inbound Attacks A --> C Someone is spoofing my IP C --> A

We've learned a lot!

Network containing A (amplifier)
Inbound Spoofed Attacks C --> A Outbound Attacks, Must Stop A --> C Assertions that Peers Did Not Send C --> A

Vital information
learned through
collaboration

What About Mischief and Lies?

- **We have considered this**
- **Peers make statements about their own traffic**
  - “I don’t want this traffic”
- **Public key crypto ties ownership/responsibility**

Status

Status

- **Have an early prototype**
  - ***We are seeking pilot and evaluation partners.***
- **Correctly computes results with a simple attack**
  - Identifies attack sources
  - Identifies spoofed traffic

Next steps

- **Construct larger, more complex attack scenarios**
- **Develop the engine further**
  - Accuracy
  - Better reasoning

Contact Us!

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Galois 3DCoP Team: ddos@galois.com

We are actively seeking evaluation partners for 3DCoP. Please contact us if you'd be interested in trying 3DCoP out in your organization.

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