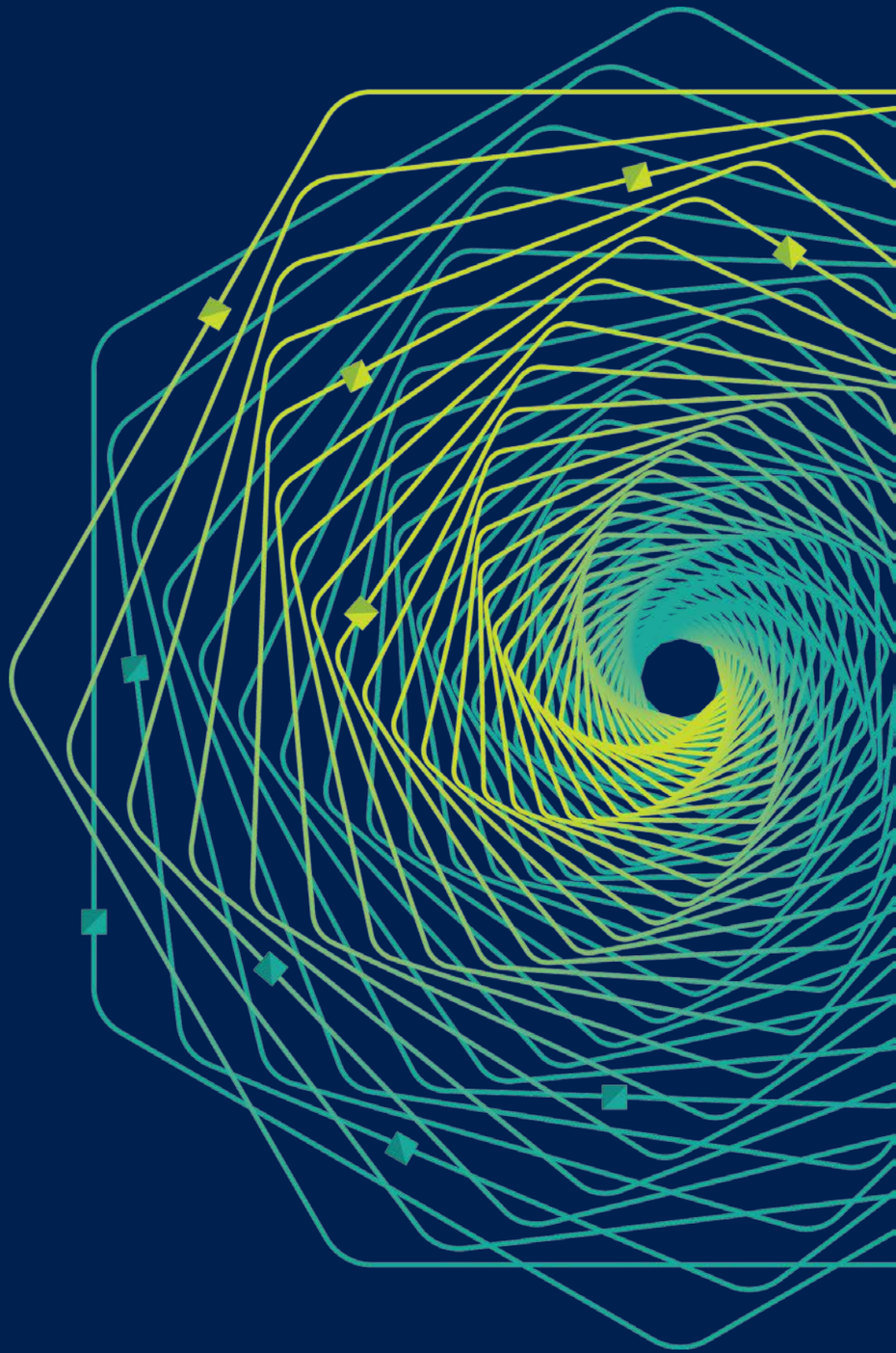
Microsoft

Research Faculty Summit 2018

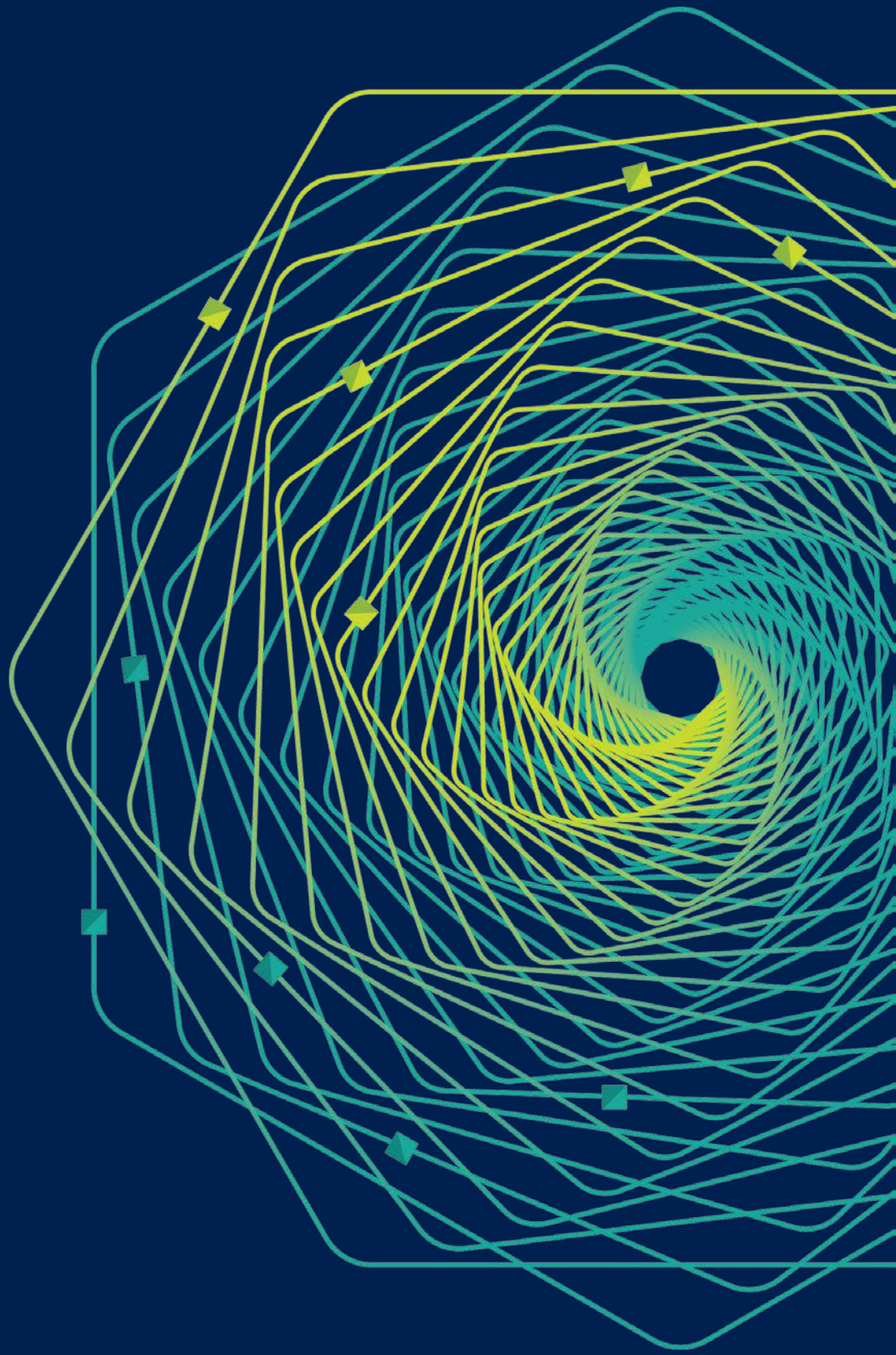
Systems | Fueling future disruptions



Microsoft

Towards Self-managing Networks

Behnaz Arzani
Post doctoral researcher at Microsoft

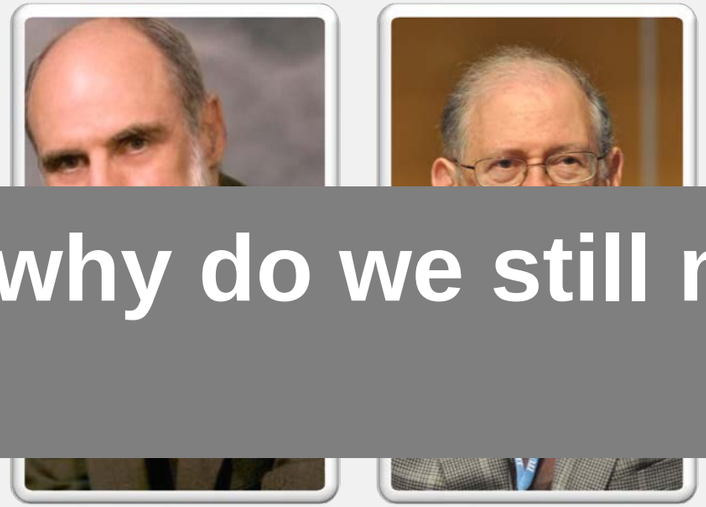


Today, managing networks is expensive

Albert Greenberg
Head of Azure Networking

- 1096 reports
- The engineer’s time is largely spent on debugging/configuring the network
- This time could be spent on improving the network itself
  - Designing new protocols
  - Adding new functionality
  - Upgrading to new technology: e.g. P4.

There has been a lot of networking research



So why do we still need people to manage/configure our networks?

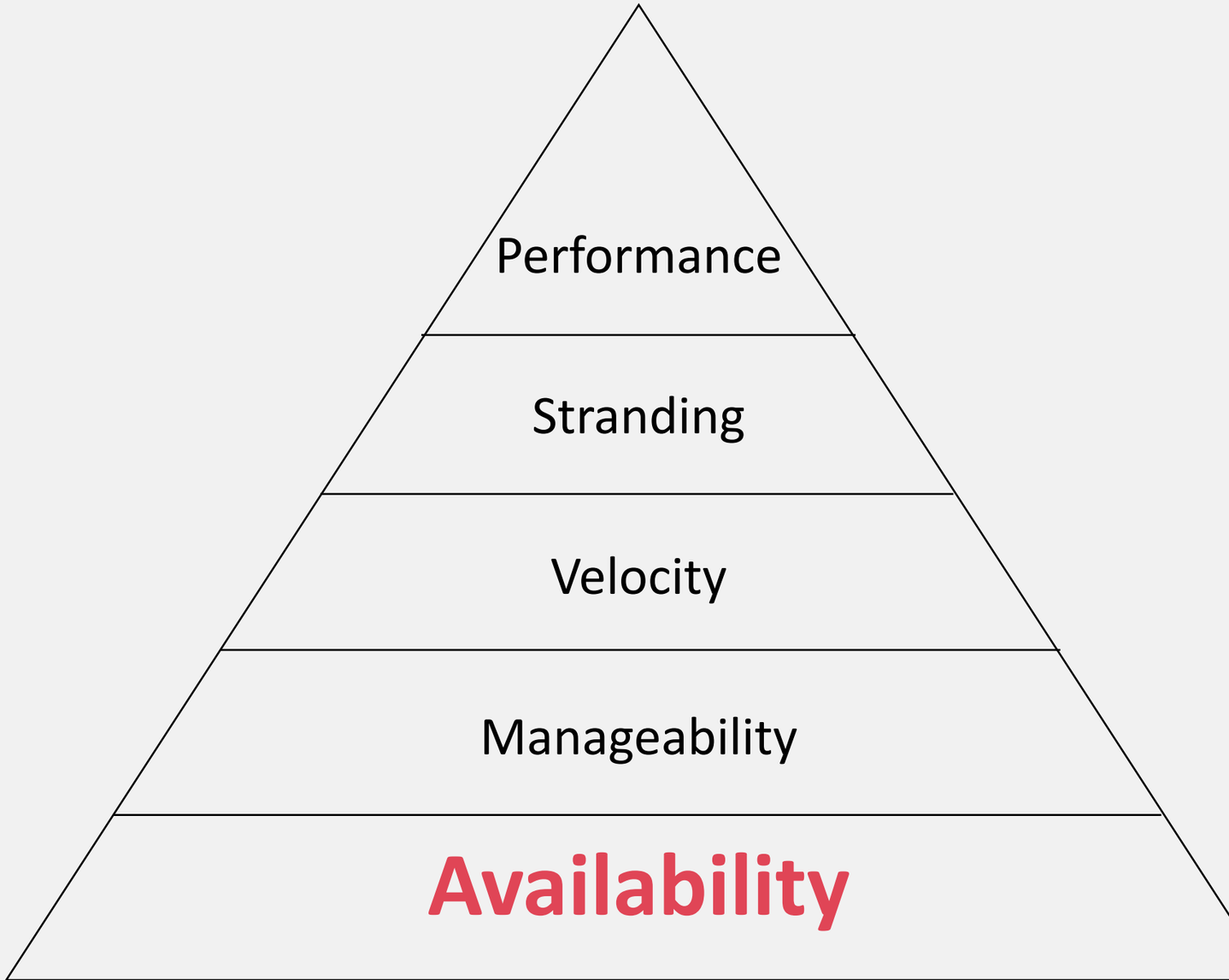
Vint Cerf and Bob Kahn
Publish first TCP/IP paper in 1973

In this talk:
I will describe my research and what I've learned about why we still don't have a self-managing network

Talk Outline

- Diagnosis
- Security
- What are the common themes?
- How can AI help?

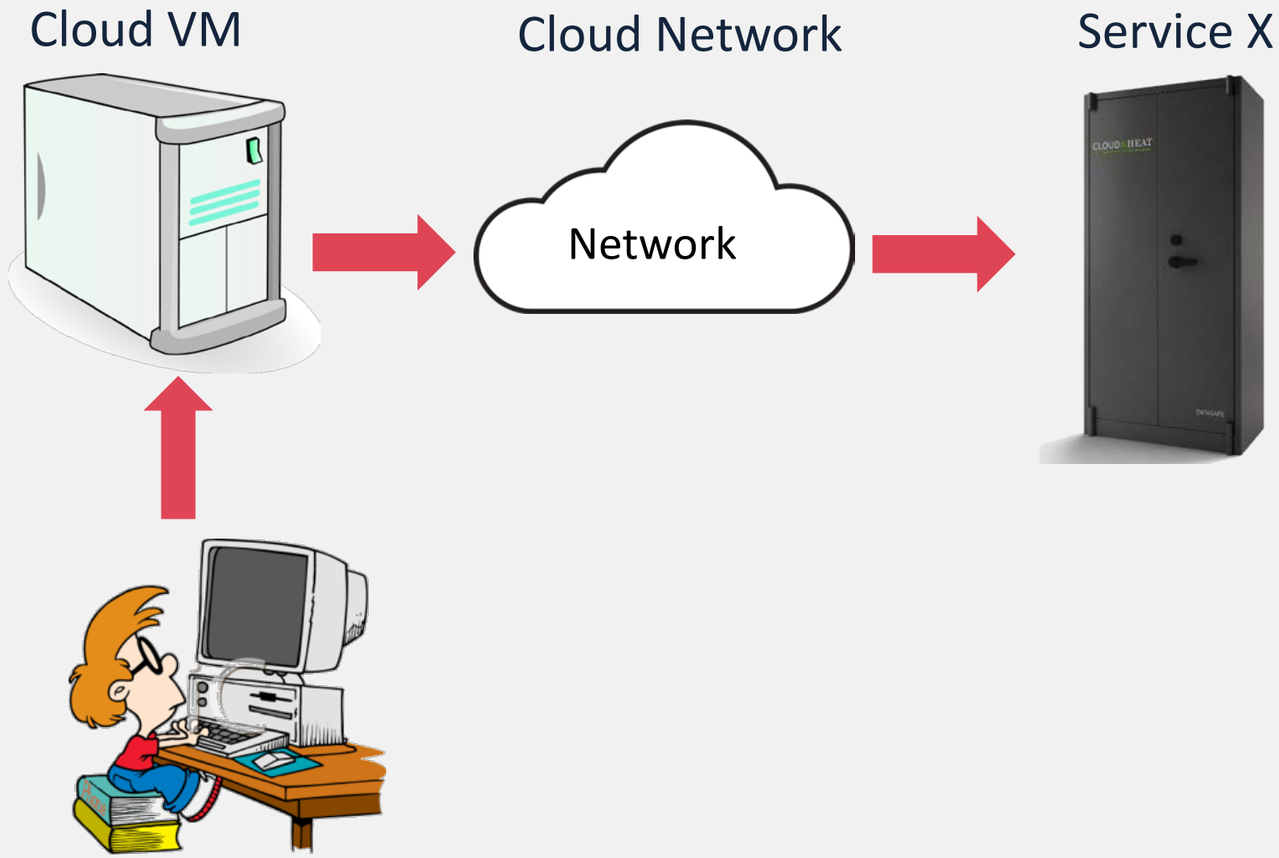
Availability is important!



Borrowed from Amin Vahdat from Google PhD summit talks 2017

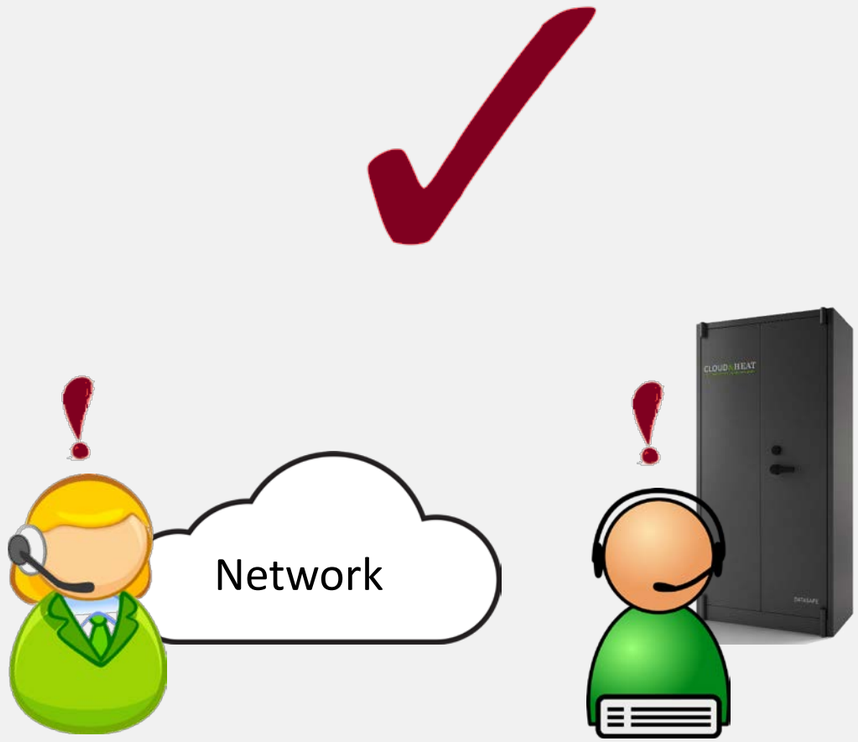
Failures are disruptive

Why is diagnosis hard?

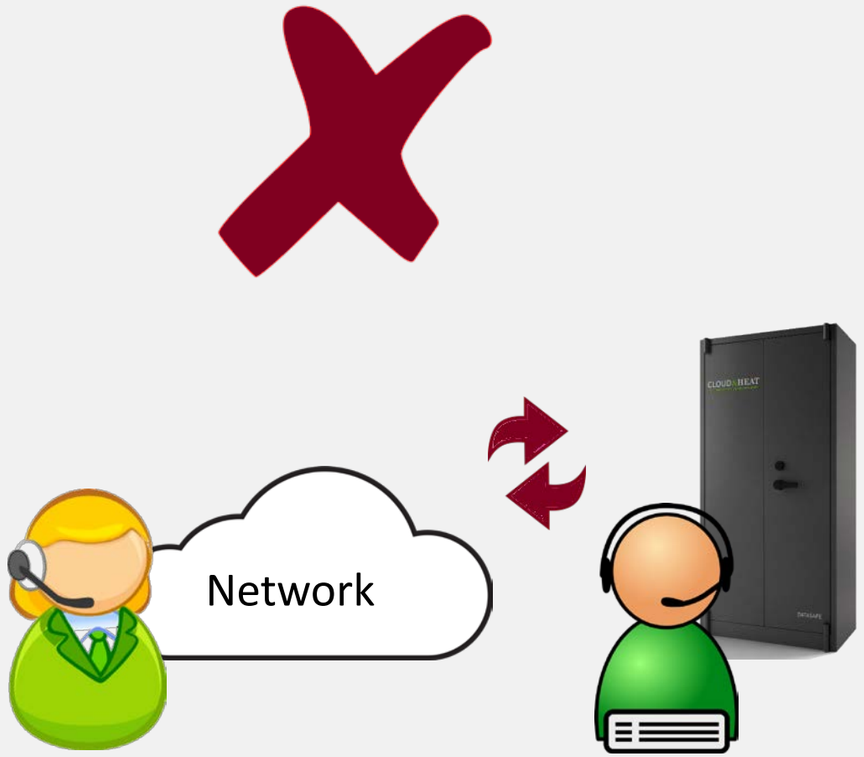


What happens if no one takes responsibility for the failure?

Someone accepts responsibility



Each blames the other



A real example of this happening: Event17

- Azure uses virtual hard drives for storage
  - VMs connect to remote storage for read/write to disk
- Failures often can result in a VM to panic and reboot
- What happened?
  - Storage blames network
  - Network blames storage
  - But who was it?

NetPoirot
(SIGCOMM 2016)

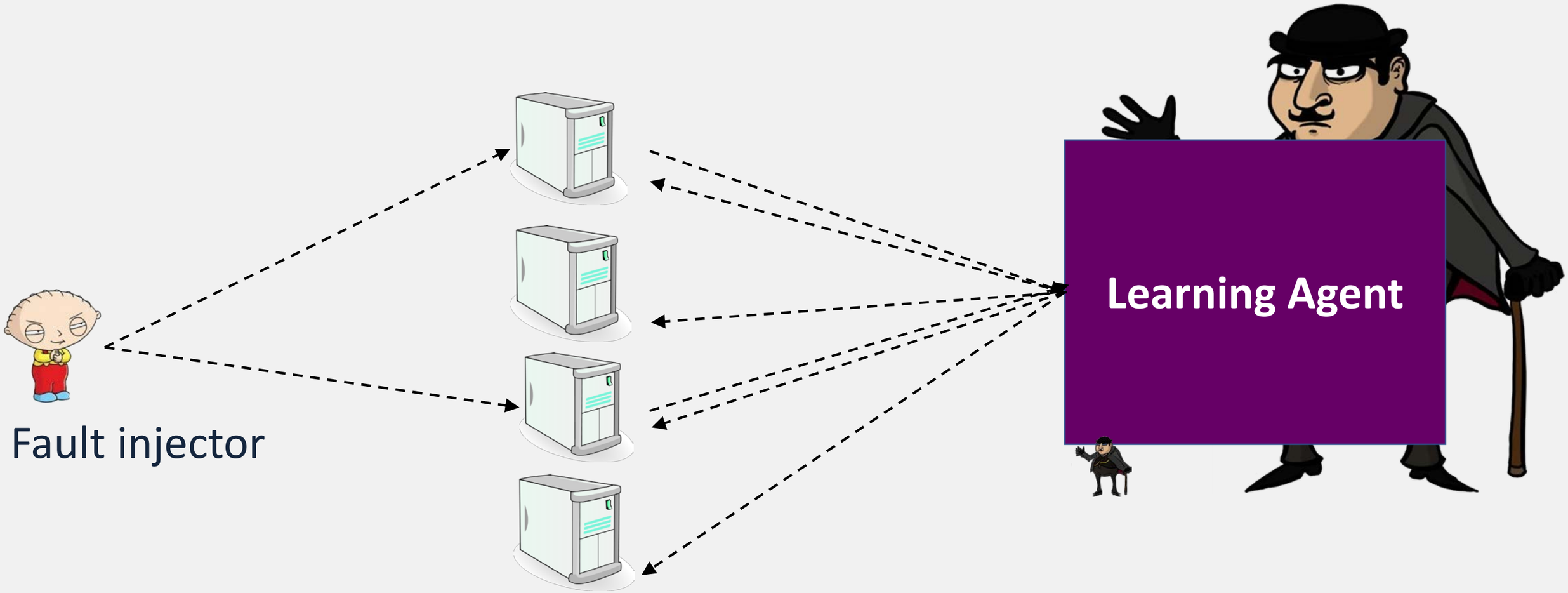
A solution to this problem should

- Allow for monitoring the client, service, and the network

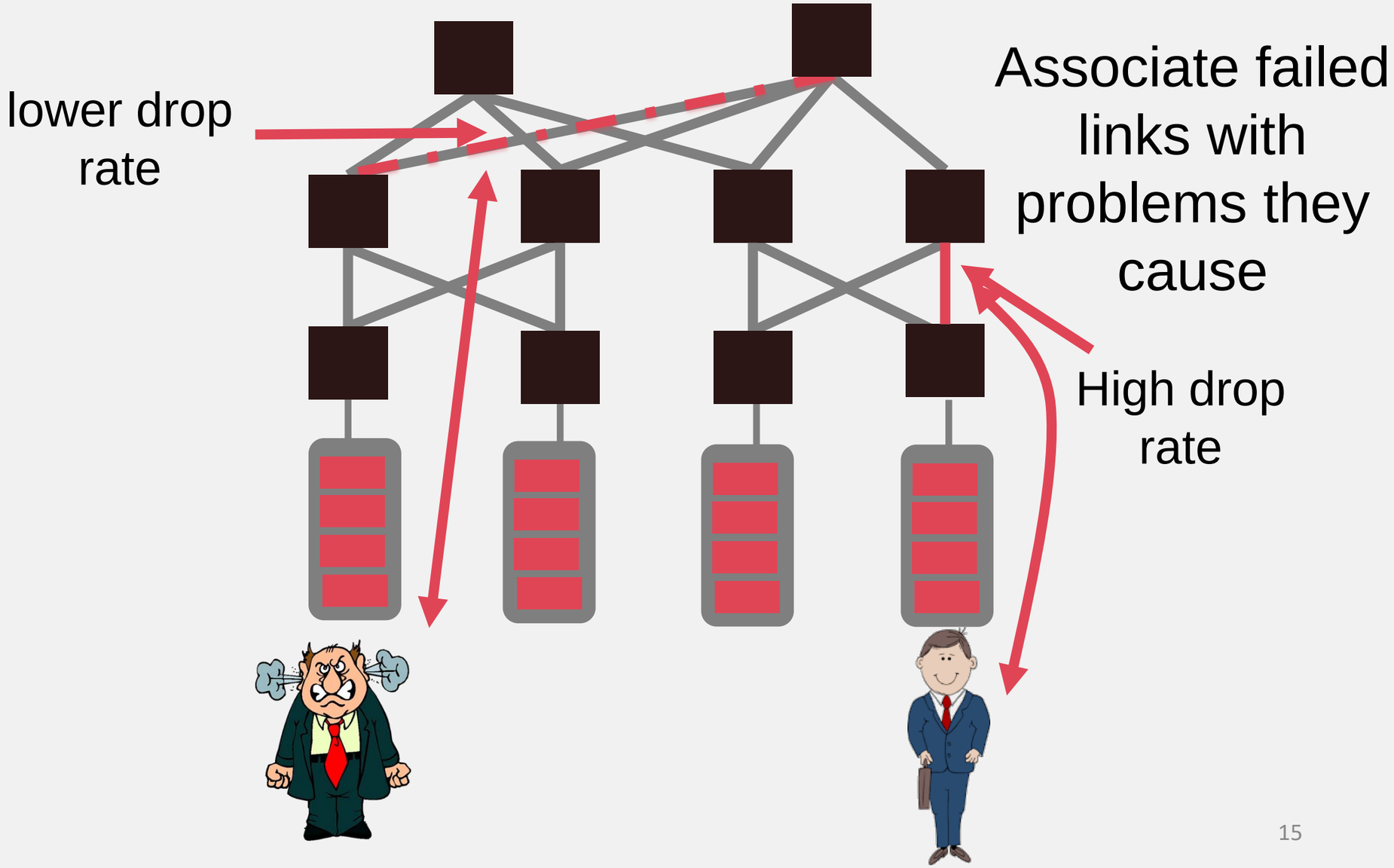
NetPoirot:

Use TCP statistics to identify whether the problem was because of the client, server, or the network

NetPoirot, an overview

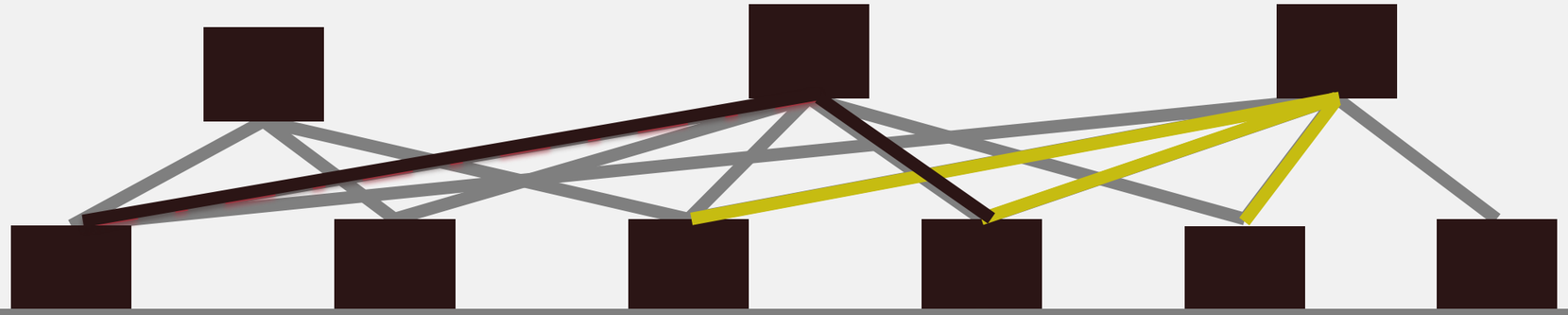


Not all faults are the same

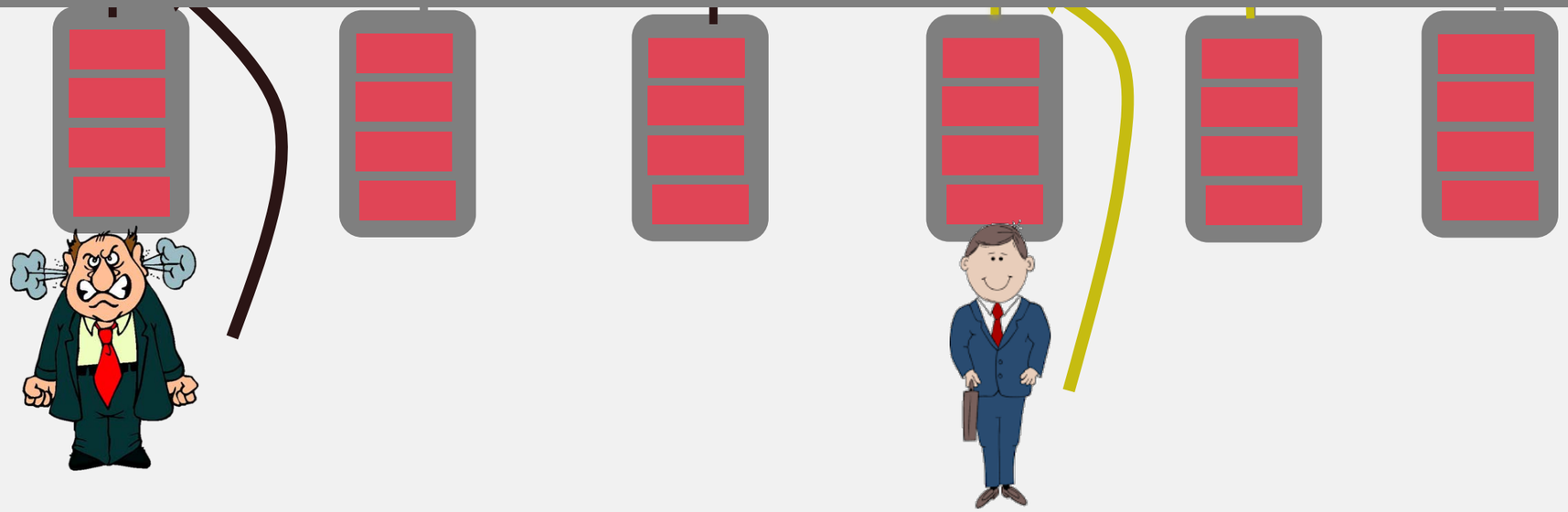


15

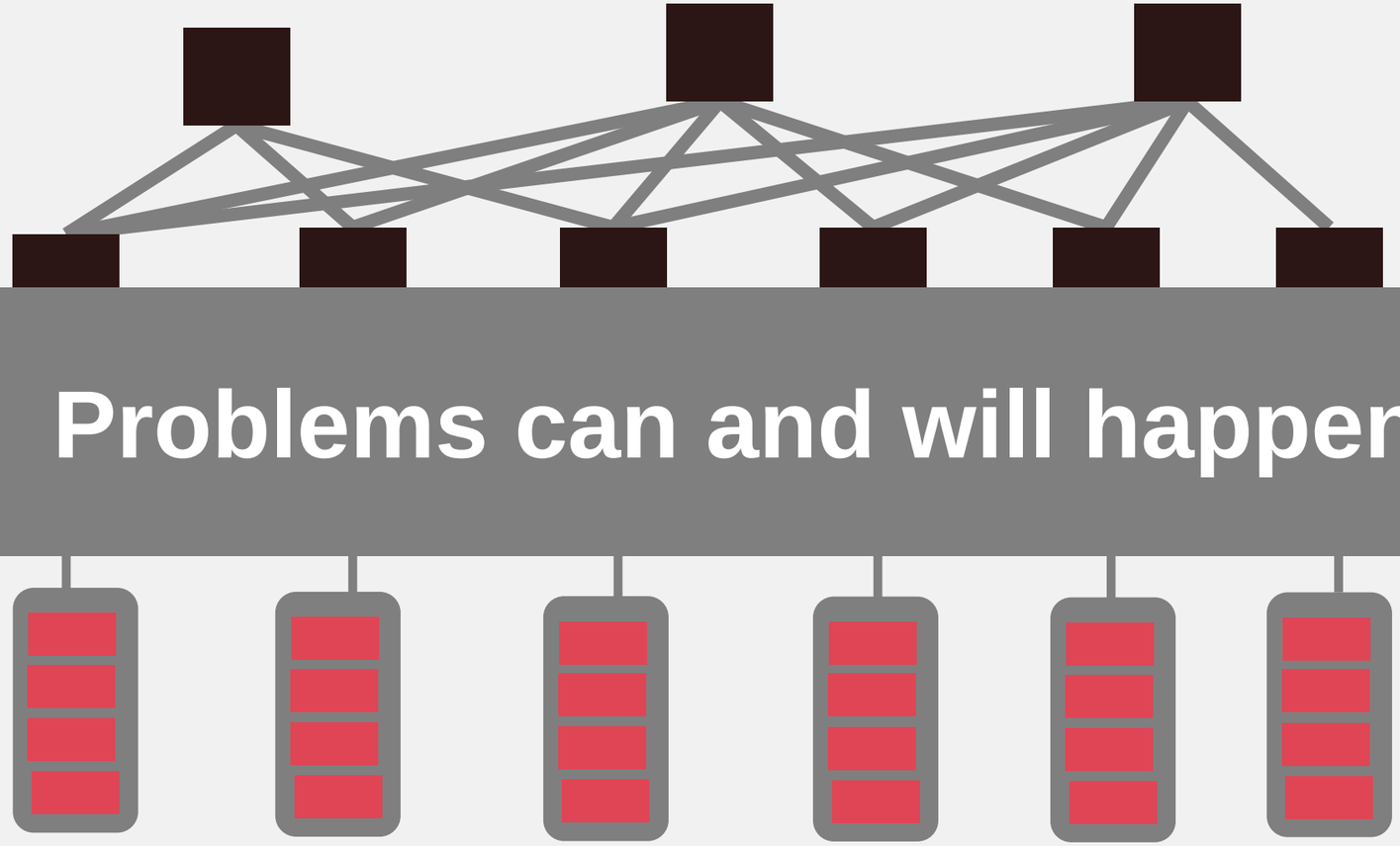
Mapping complaints to faulty links



But operators don’t always know where the failures are either



Clouds operate at massive scales

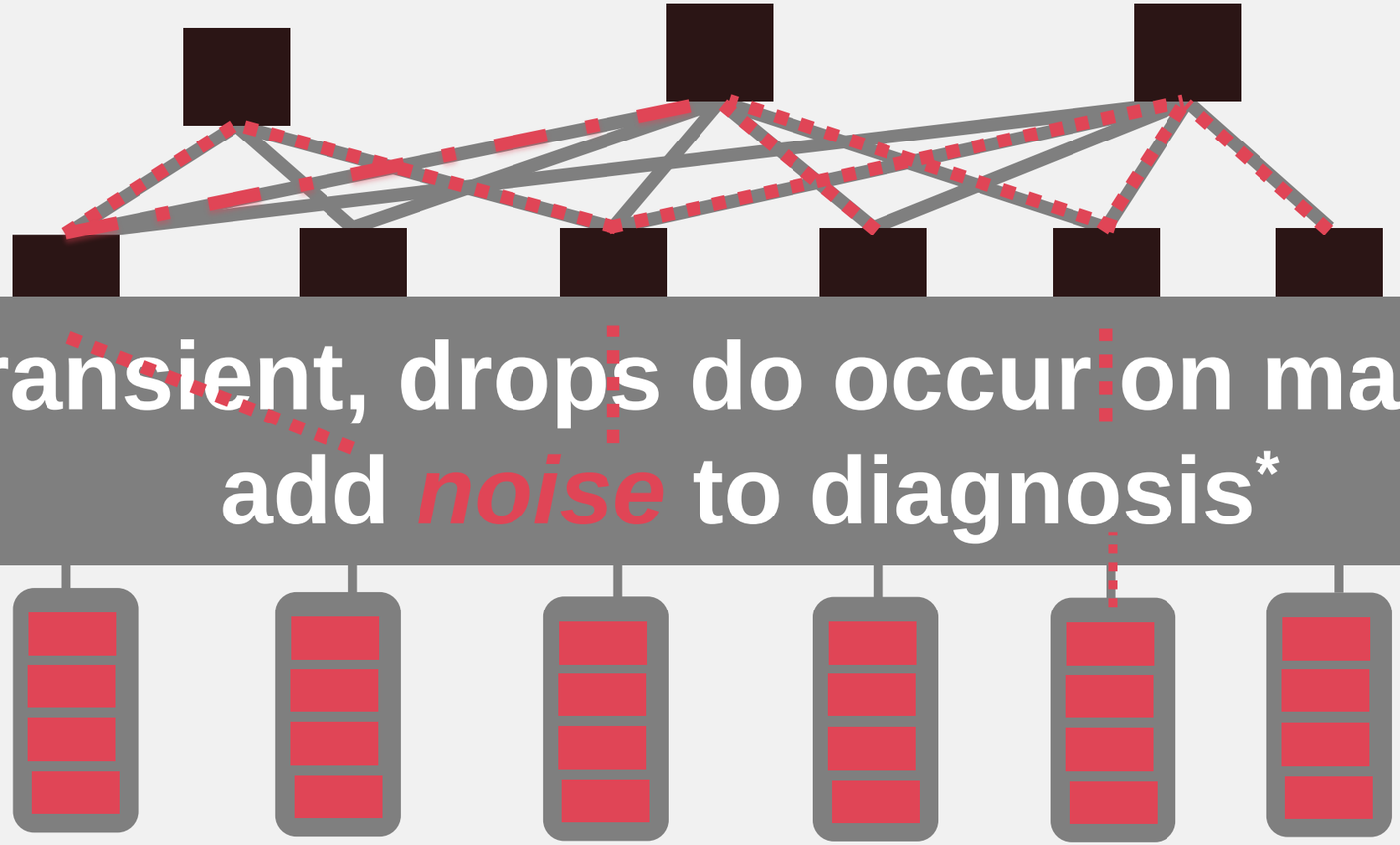


Problems can and will happen*

Each Data center has millions of devices

* Z., Danyang, et al. "Understanding and mitigating packet corruption in data center networks."

Low congestion drop rates add noise



One-off, transient, drops do occur on many links and add *noise* to diagnosis*

* Z., Danyang, et al. "Understanding and mitigating packet corruption in data center networks."

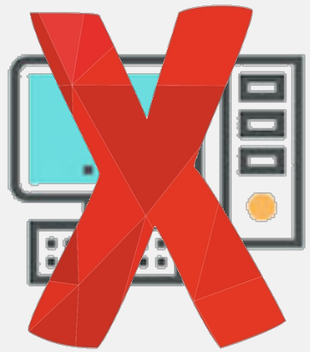
Solution Requirements

- Detect short-lived failures
- Detect concurrent failures

Failure: any systemic cause of packet drop whether transient or not

Want to avoid infrastructure changes

- Costly to implement and maintain
- Sometimes not even an option
  - Example: changes to flow destinations (not in the DC)



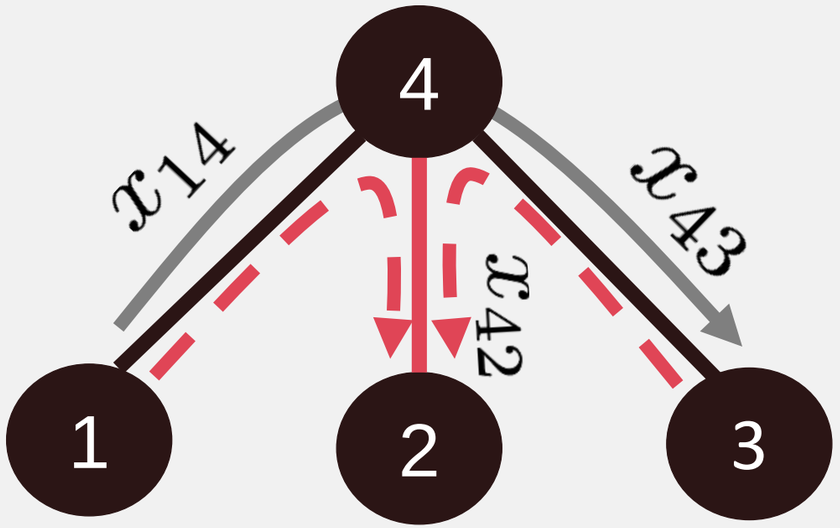
A “strawman” solution

- Suppose
  - we knew the path of all flows
  - we knew of every packet drop
- Tomography can find where failures are

If we assume there are enough flows

Example of doing tomography

$$x_{14} + x_{43} = 0$$
$$x_{14} + x_{42} = 1$$
$$x_{34} + x_{42} = 1$$



$$x_{ij} \in \{0, 1\}$$

$x_{ij} = 0$ if link not dropping packets

$x_{ij} = 1$ if link dropping packets

Only solvable if we have N independent equations

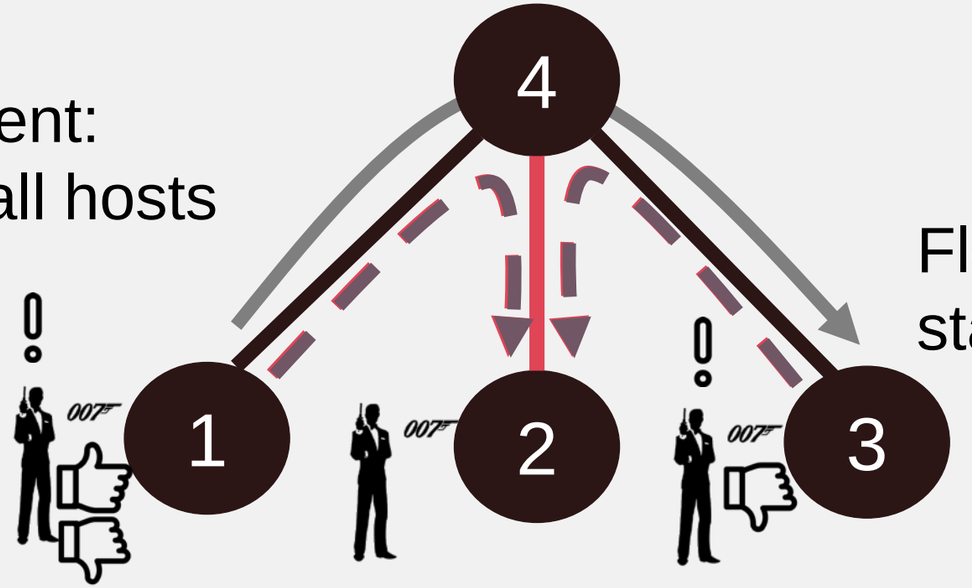
N = number of links in the network

007
(NSDI 2018)

007

How 007 works

Monitoring agent:
Deployed on all hosts

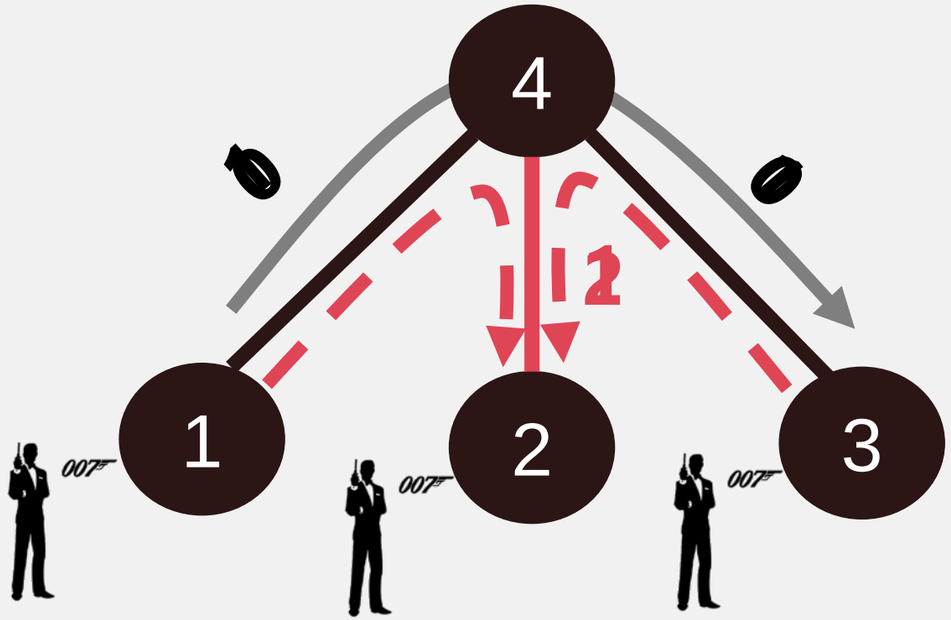


Flows vote on the status of links

Notified of each TCP retransmission (ETW)

Path discovery agent finds the path of the failed flows

How 007 works



Talk Outline

- Diagnosis
- Security
- What are the common themes?
- How can AI help?

Detecting compromised VMs

Ideally…

In practice…

There is a need for agent-less compromise detection systems

The operator needs customer permission to install antimalware

Talk Outline

- Diagnosis
- Security
- What are the common themes?
- How can AI help?

Why do we need operators managing our networks?

- The ideal data needed to solve the problem can be missing
- Gathering the right data can be expensive
- Sometimes its not even clear what the right data is?
- Sometimes, there are datasets that indirectly point to the solution but its hard to derive that such correlation exists

Talk Outline

- Diagnosis
- Security
- What are the common themes?
- How can AI help?

Where can AI help?

- Prediction
  - Monitoring can be expensive
  - Prediction can help turn on expensive monitoring when it is needed
- Identifying (complex) correlations
  - Sometimes there is data that can help solve the problem
  - The relationship between the data and the problem may be unintuitive
  - E.g. NetPoirot – using TCP statistics to find the cause of client/server problems
- Identifying when operator help is really needed
  - Despite our best efforts, sometimes an operator *should* intervene
  - AI can help reduce the noise

Thank you!

Microsoft