Self Healing in Streaming Systems

#UW Database Day
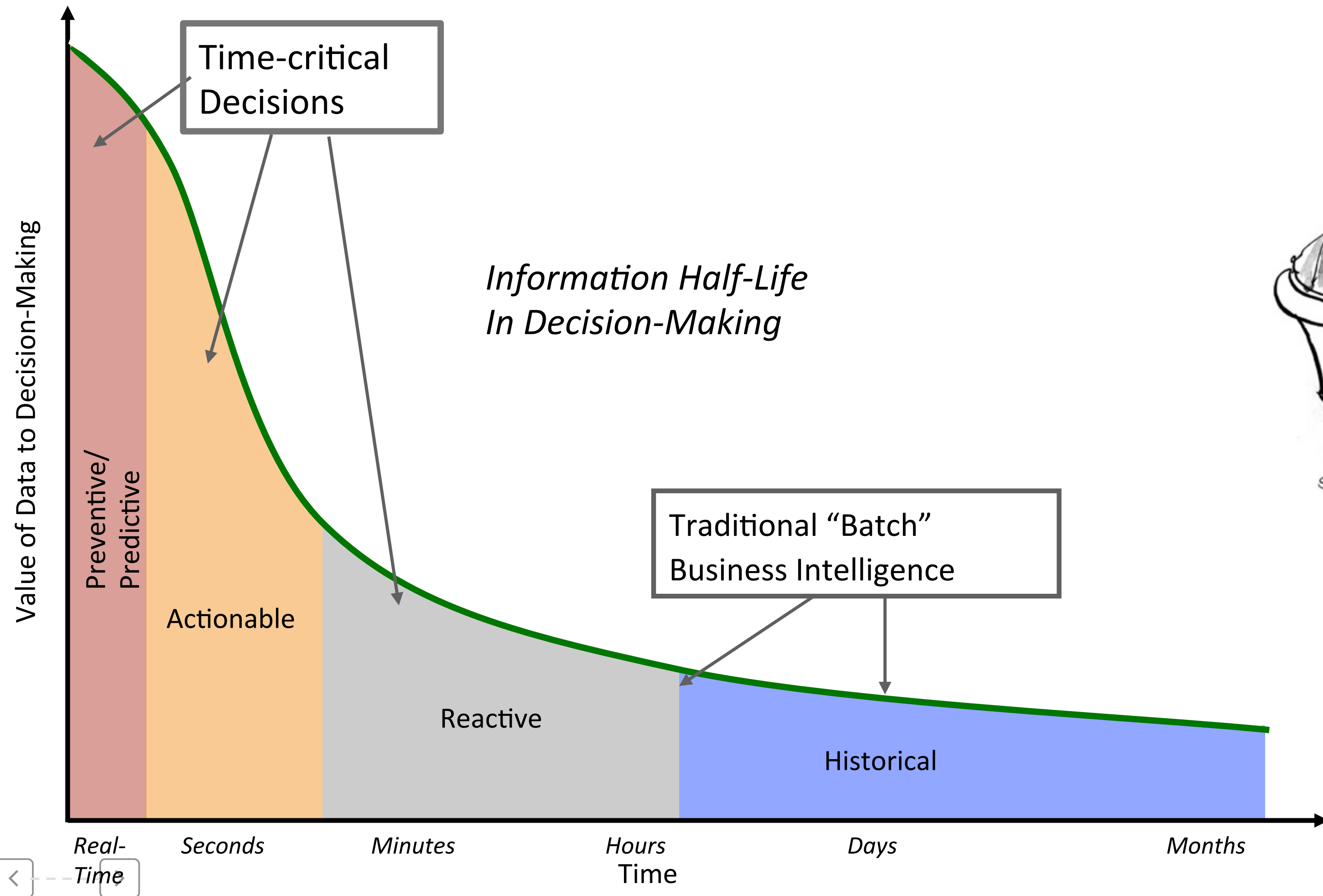## Dec 2nd, 2016

Karthik Ramasamy

Twitter

@karthikz

What is self healing?

A self healing system adapts itself as their environmental conditions change and continue to produce results

Why?

Value of Data to Decision-Making

Preventive/Predictive

Actionable

Reactive

Historical

Time-critical Decisions

Information Half-Life
In Decision-Making

Traditional "Batch"
Business Intelligence

Real-Time   Seconds   Minutes   Hours   Days   Months

Time

"Hold on, shoppers, while I bring that request to management."

Why?

LOSS OF REVENUE

Impact of downtime popular event such as Super Bowl Oscars, etc

SLA VIOLATIONS

Impact of not honoring an SLA leading to penalty payments

QUALITY OF LIFE

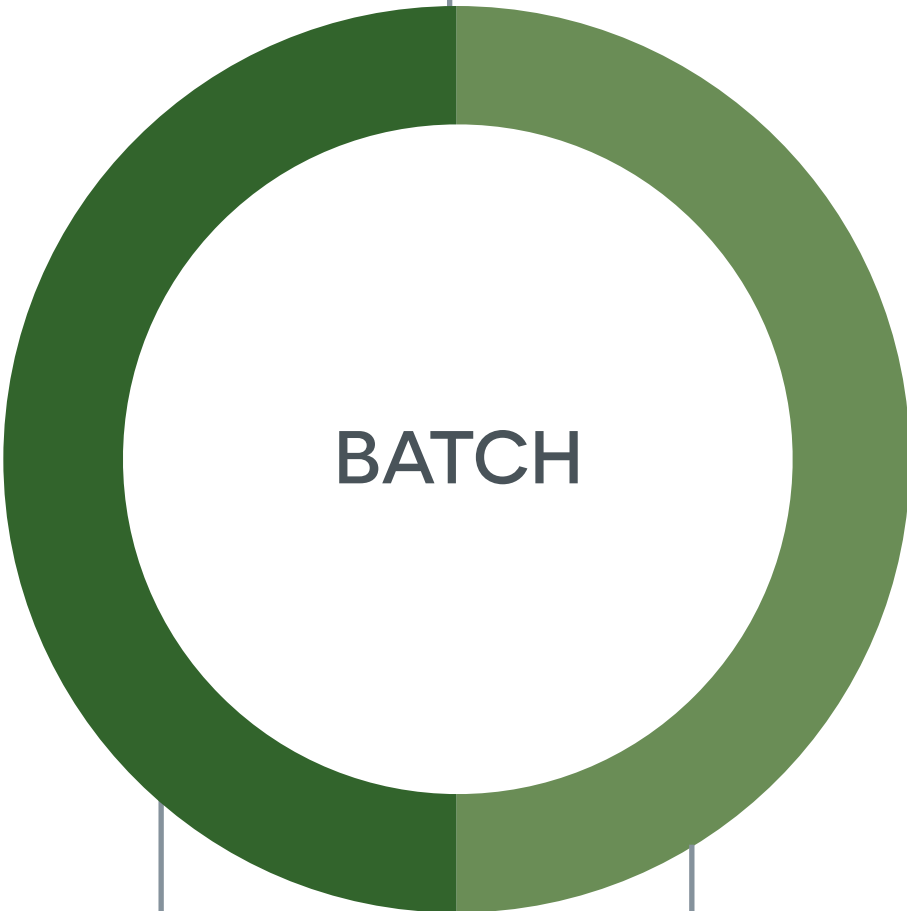Engineers & SRE burnt out attending to incidents

INCREASED PRODUCTIVITY

With reduced incidents, engineers can focus on actual development

Real-Time Budget

> 1 HOUR

high throughput

BATCH

adhoc
queries

monthly active users
relevance for ads

10 MS – 1 SEC

approximate

Near Real Time

ad impressions count
hash tag trends

< 500 MS

latency sensitive

OLTP

deterministic
workflows

fanout Tweets
search for Tweets

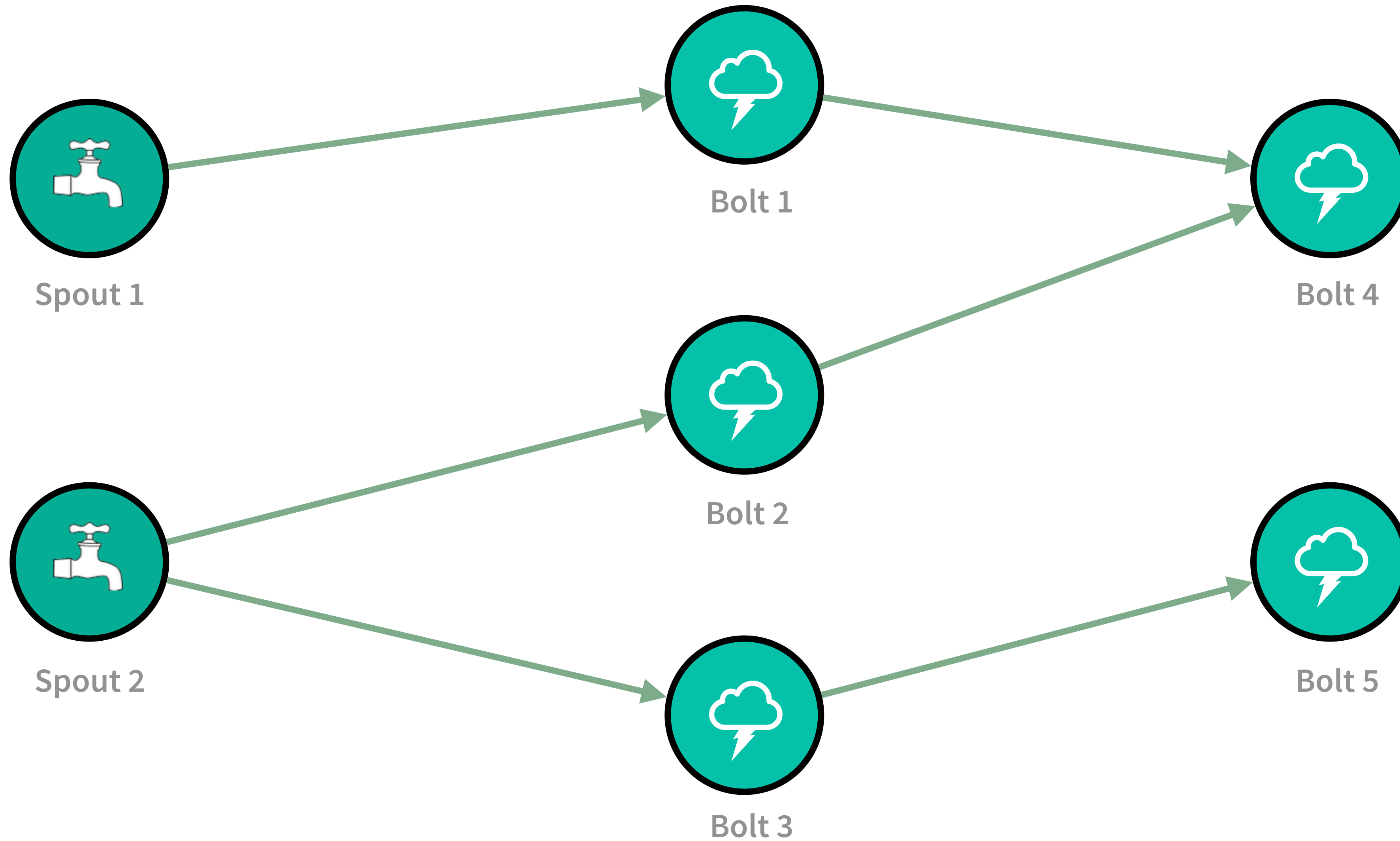**< 1 MS**

low latency

REAL TIME

Financial
Trading

Streaming Variants

STREAM WORKFLOWS

Continuous process of events for a deterministic workflow

Analyze and act on data with continuous queries

STREAM PROCESSING

Continuously analyze data using mathematical & statistical techinques

STREAM ANALYTICS

Heron Topology

Spout 1

Bolt 1

Bolt 4

Bolt 2

Spout 2

Bolt 5

Bolt 3
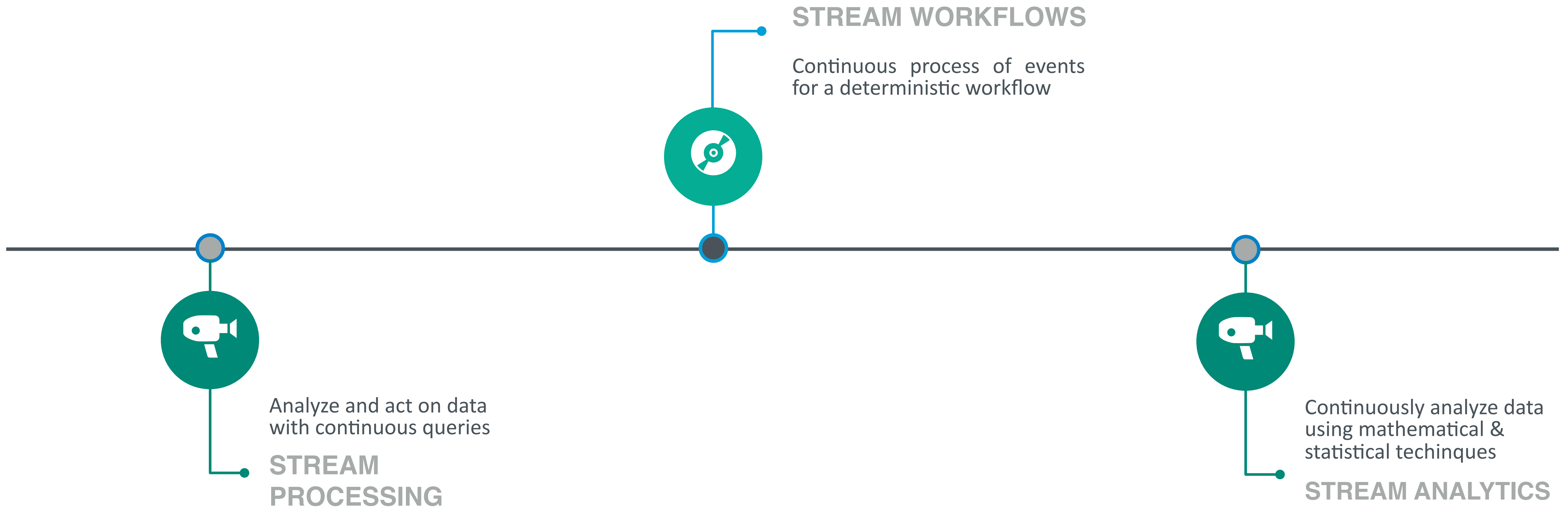
Heron Topology - Physical Execution

Spout 1

Spout 2

Bolt 1

Bolt 2

Bolt 3

Bolt 4

Bolt 5
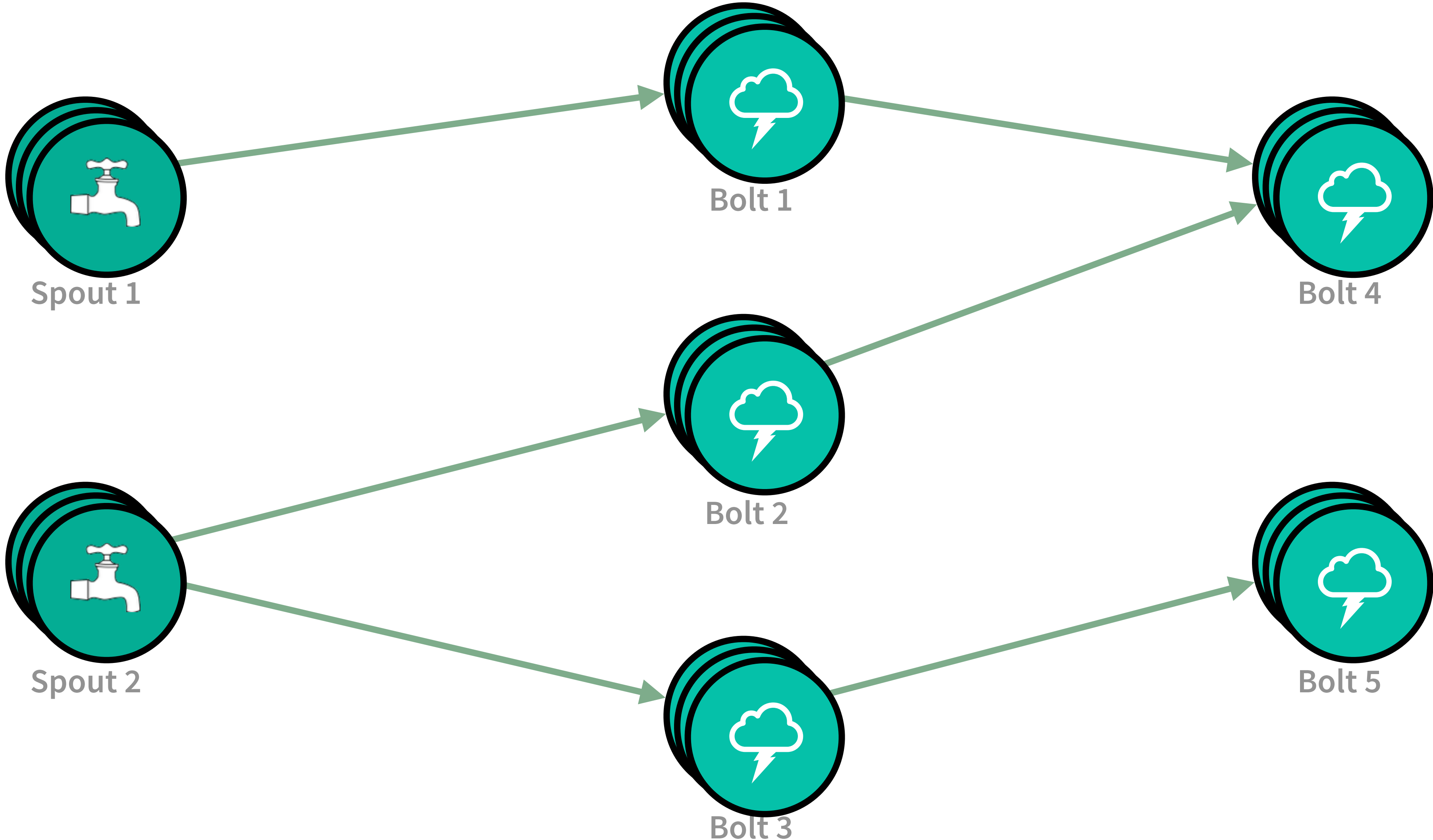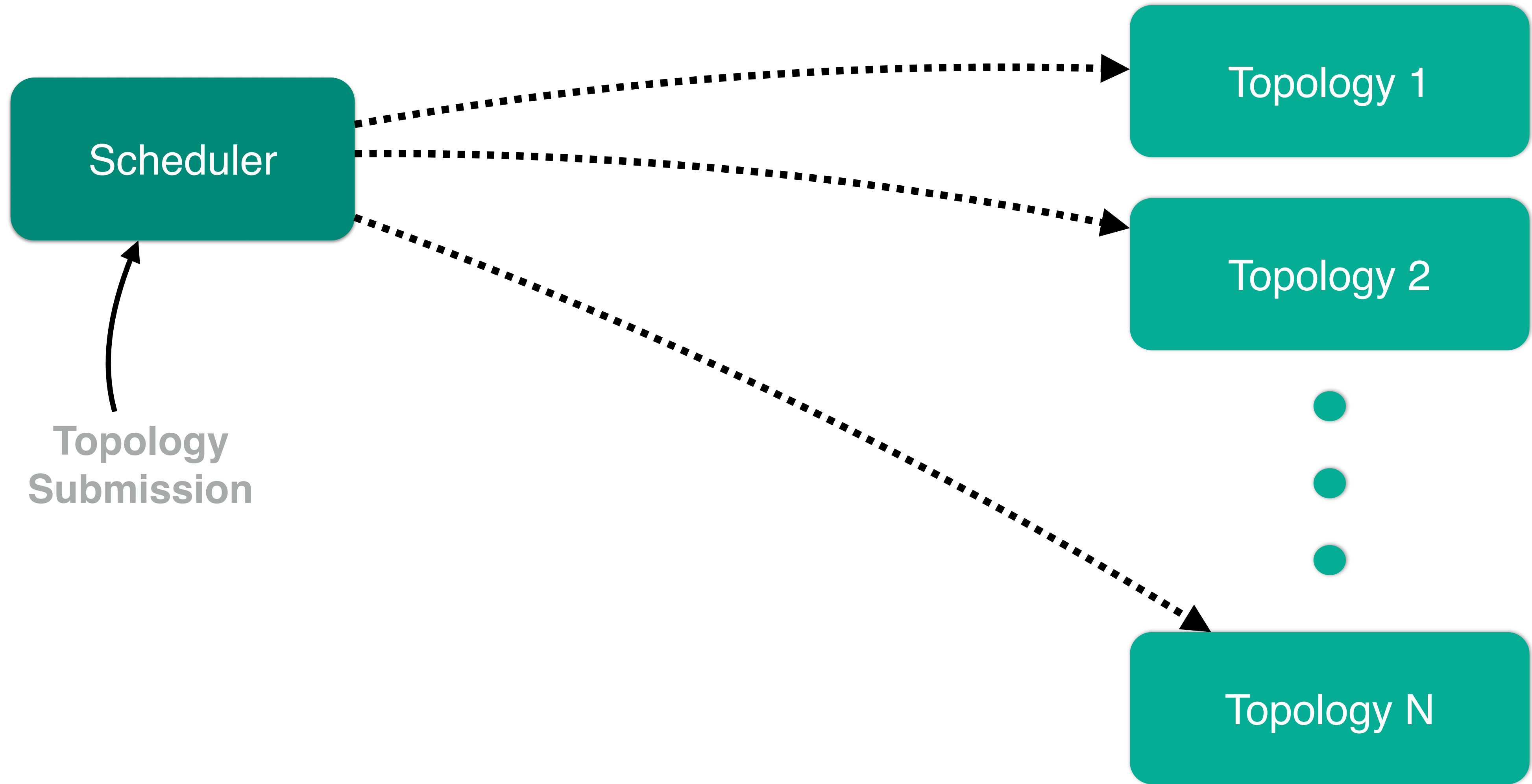
Heron

Heron Topology Components
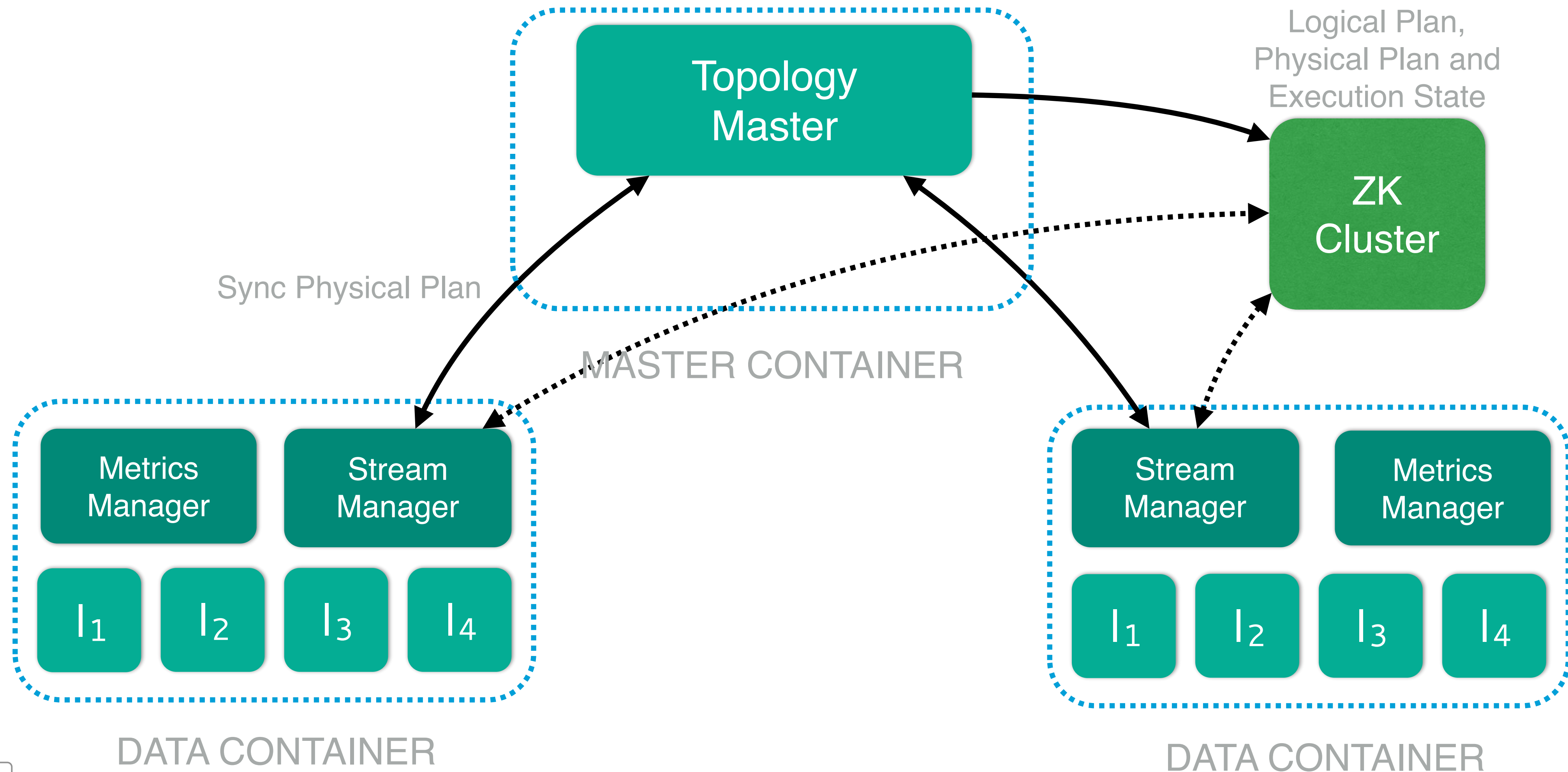
Heron @Twitter

> 500 Real Time Jobs

500 Billions Events/Day PROCESSED

25-200 MS latency

Common Operational Issues
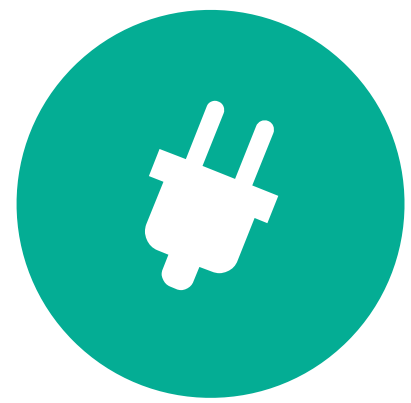
01

02

03

Slow Hosts

Network Issues
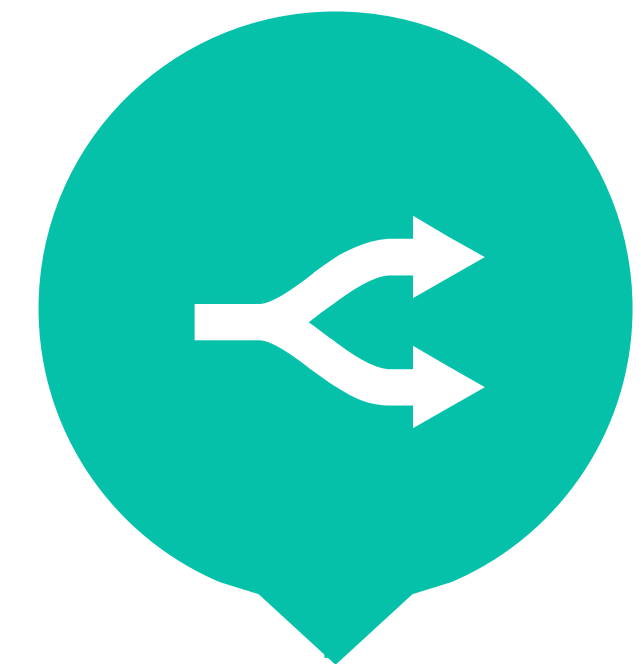
Data Skew

Slow Hosts
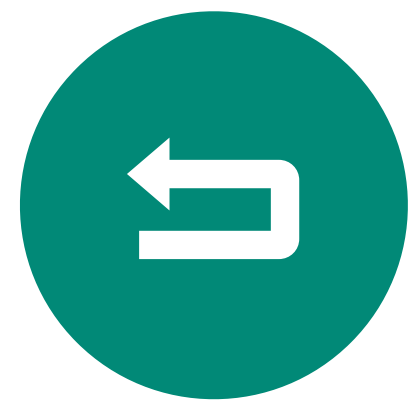
Memory Parity Errors

Impeding Disk Failures

Lower GHZ

Heron Backpressure

S1   B2   B3   B4

Stream Manager
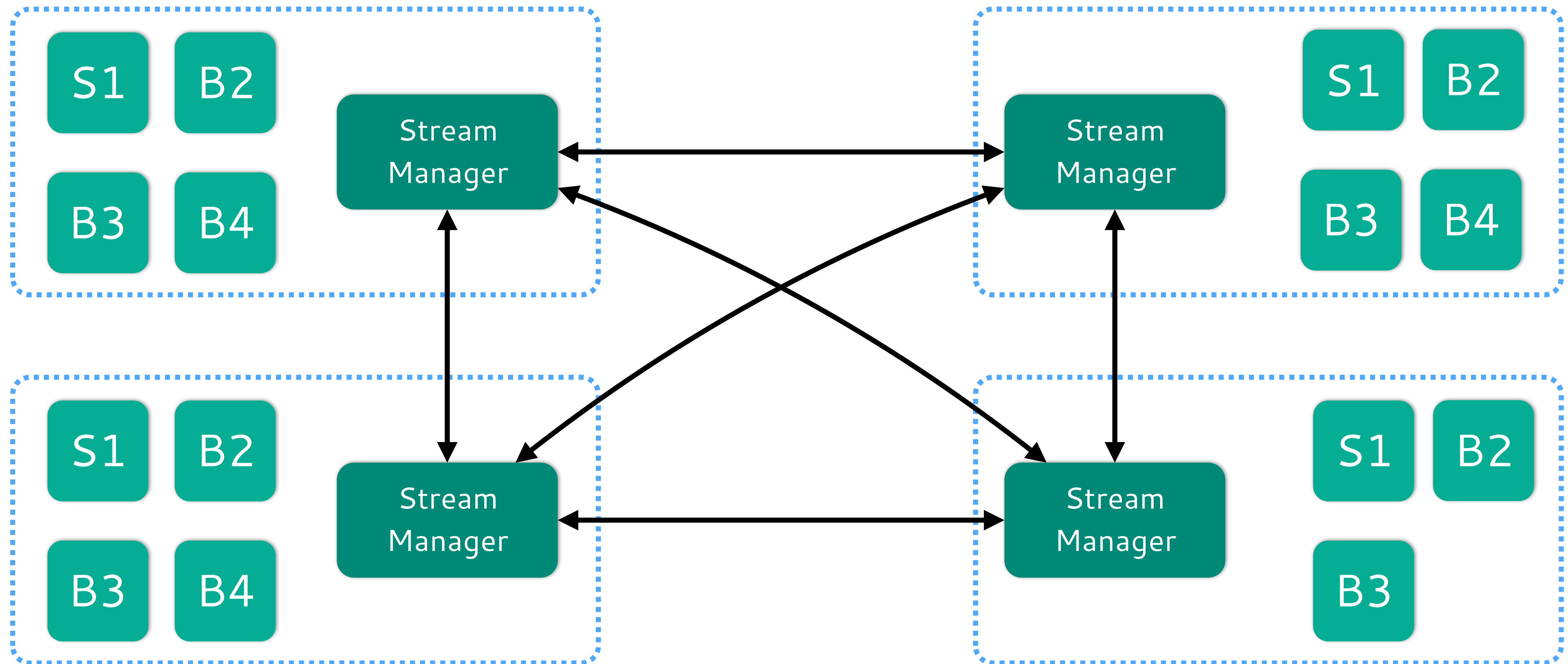
Spout Backpressure
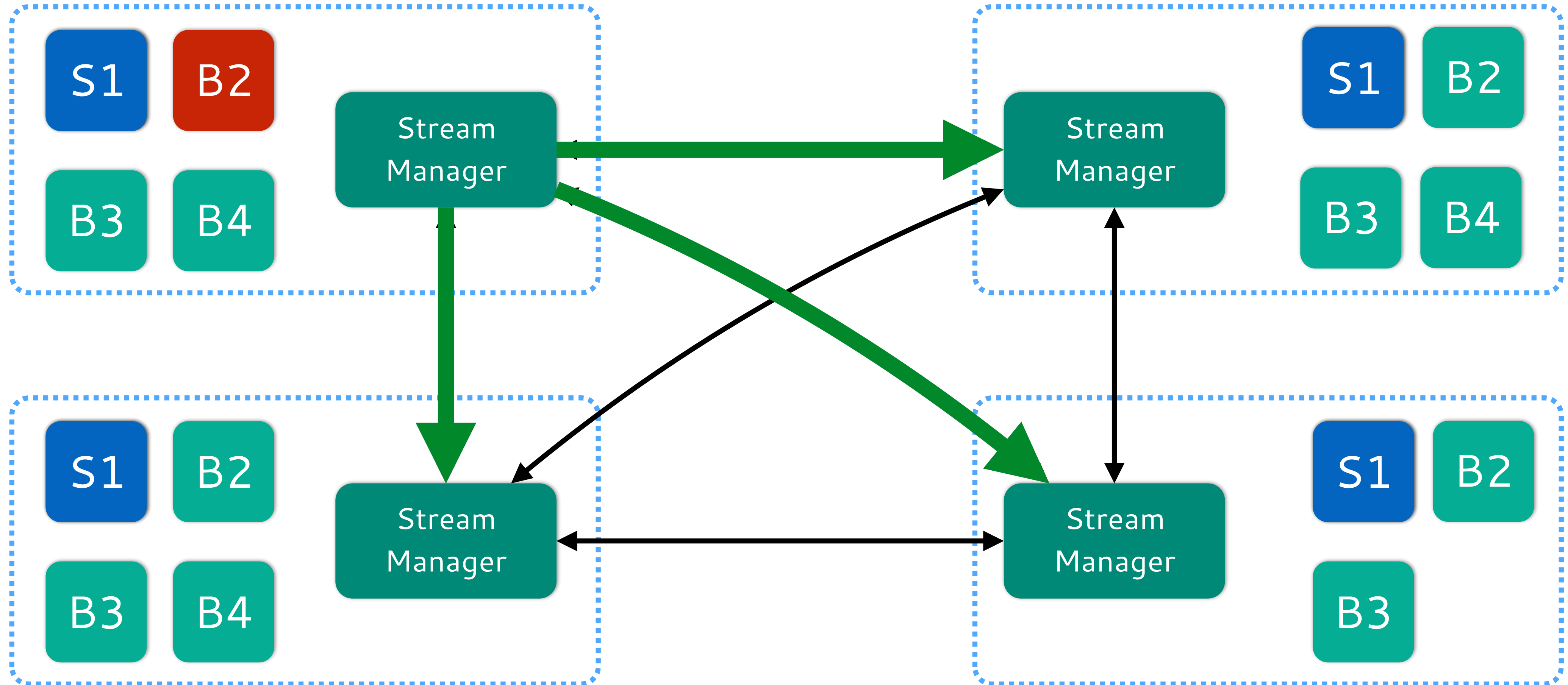
Can we do better?

Network
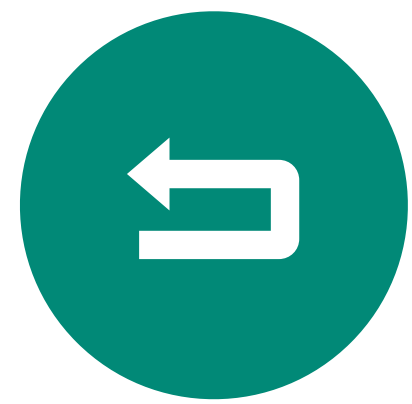
Network Slowness
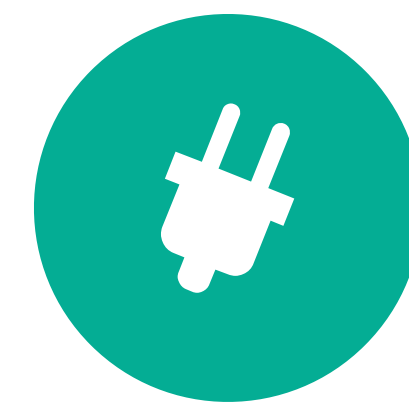
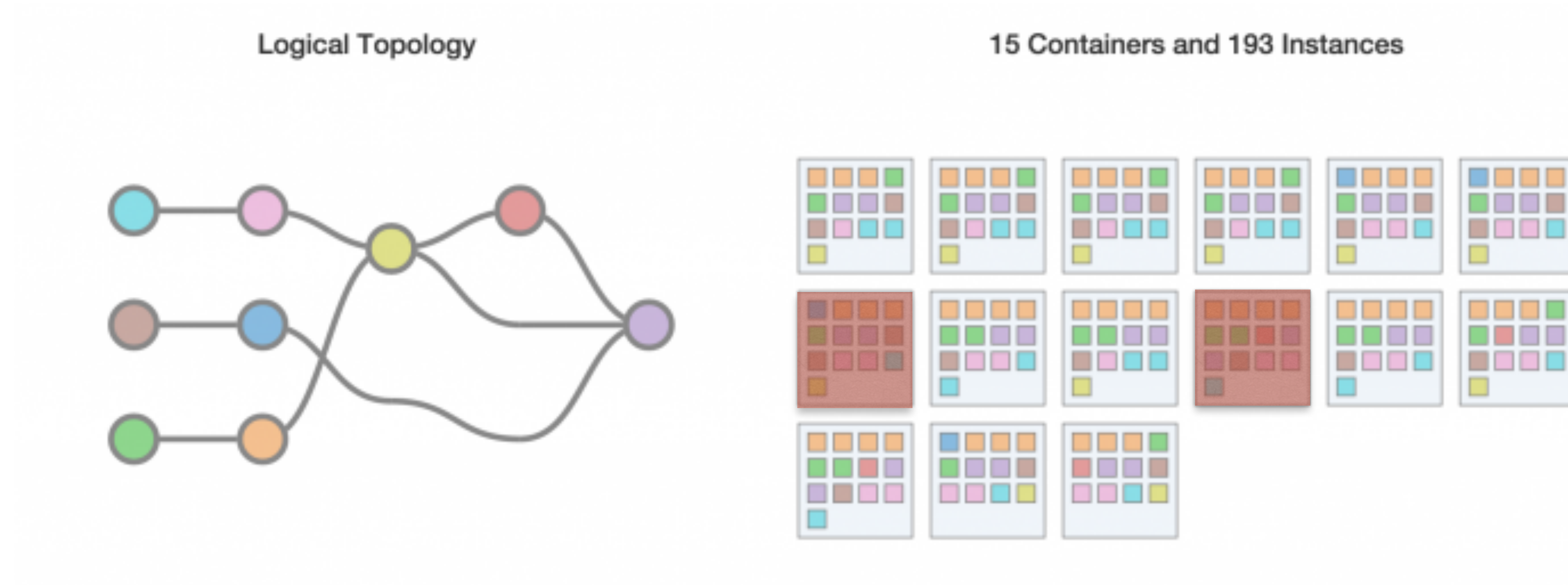Network Partitioning

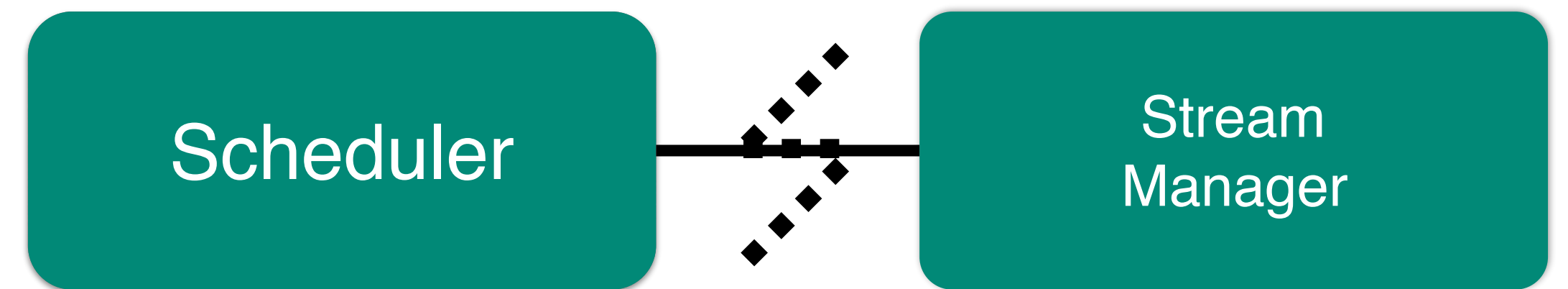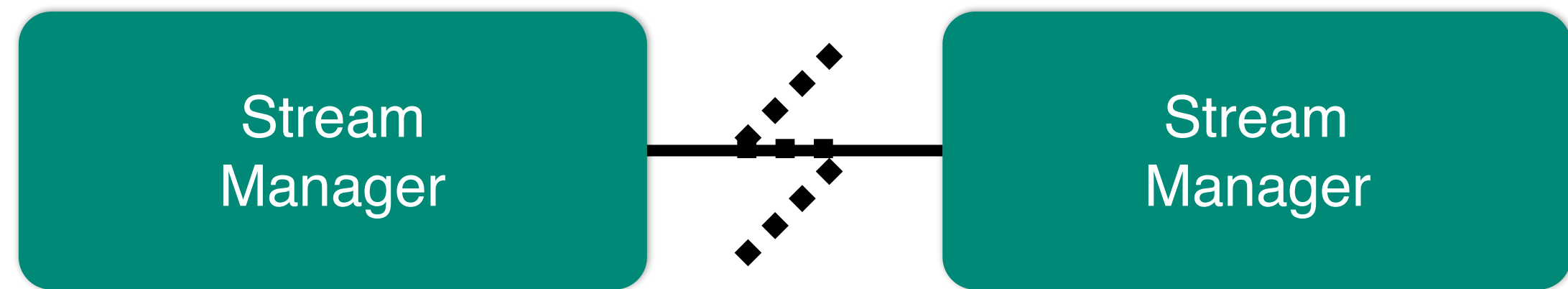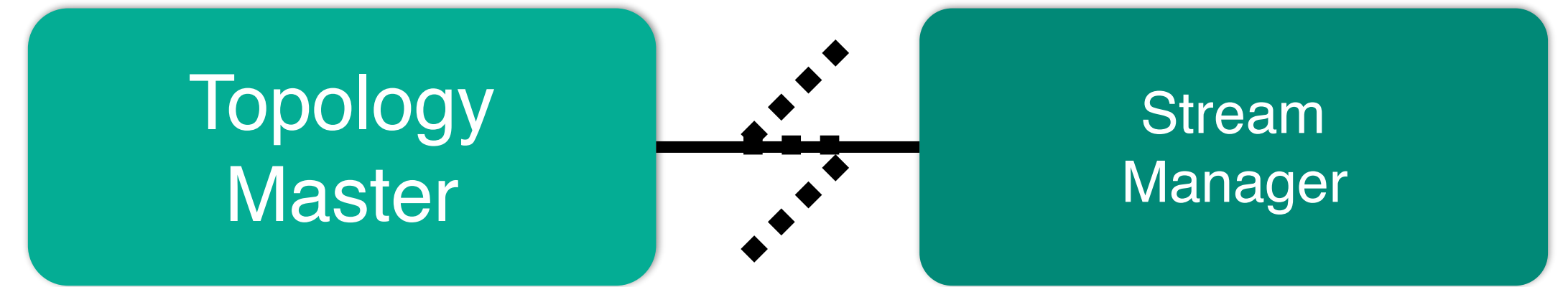# Network Slowness

Delays processing

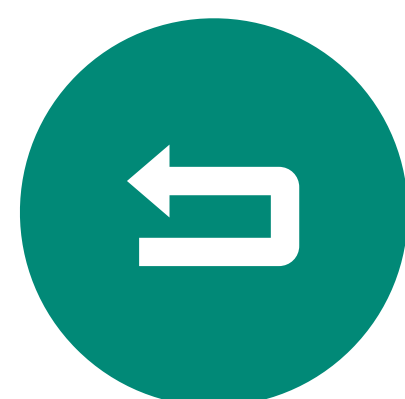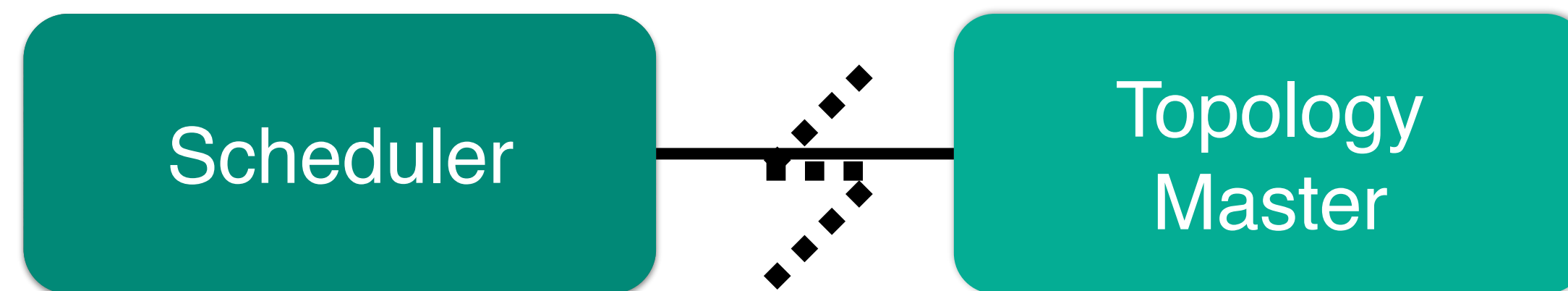**Data is accumulating**

Timeliness of results is affected

Network Slowness

Logical Topology

15 Containers and 193 Instances

Can we do better?

Network Partitioning

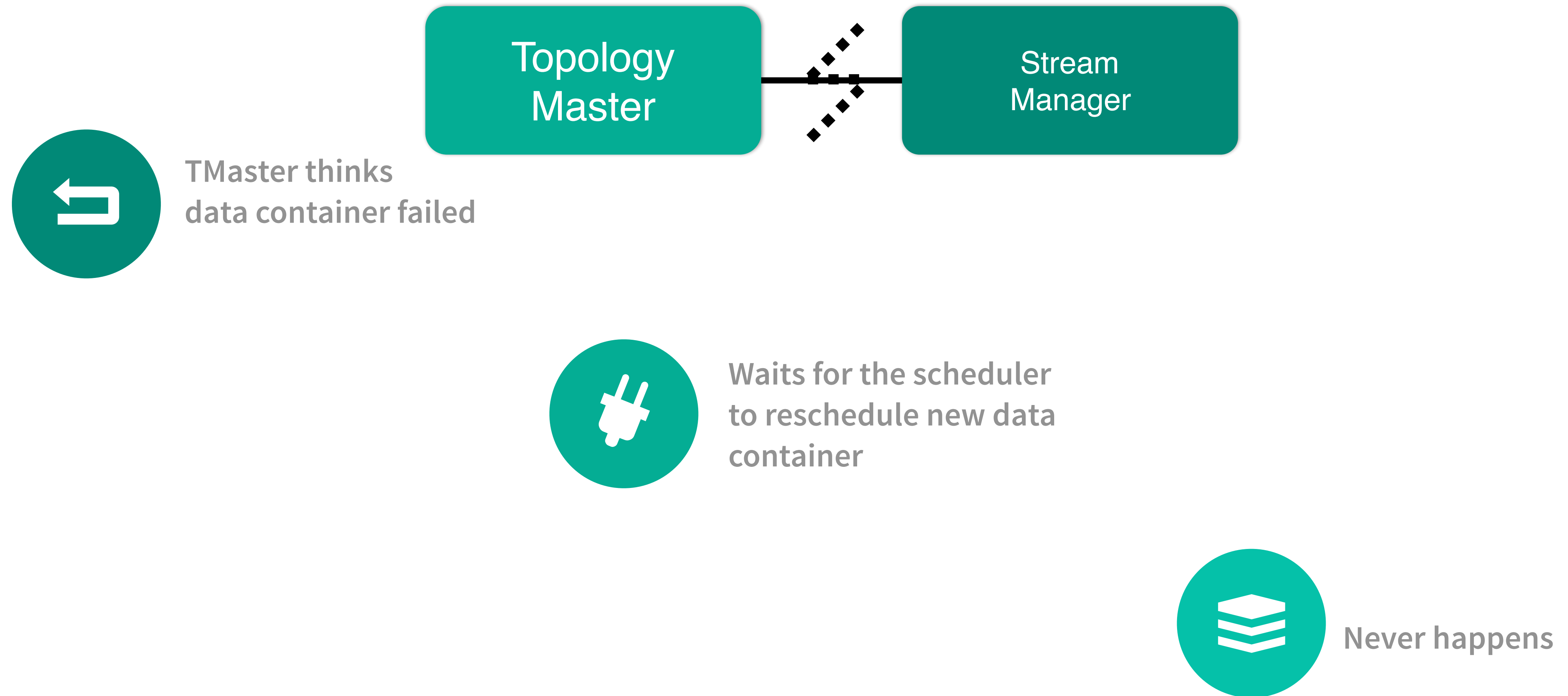# Network Partitioning

Scheduler

Topology Master
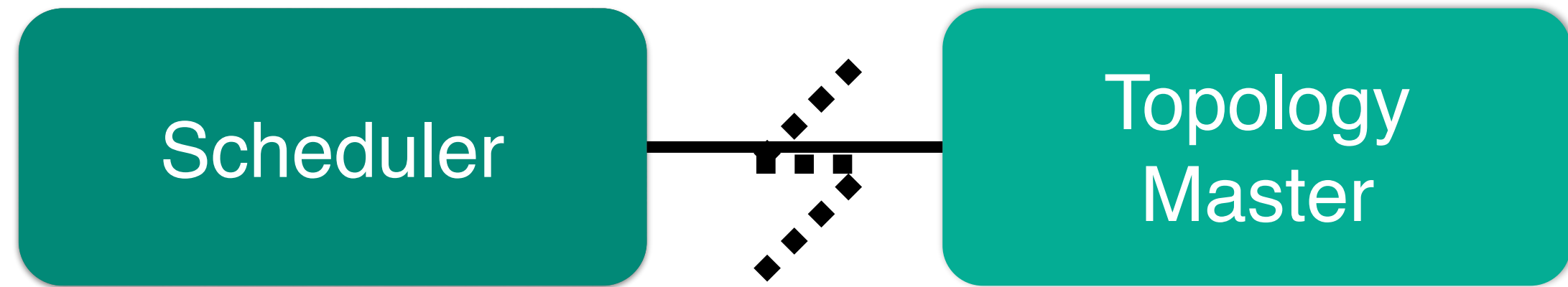
New Master Container
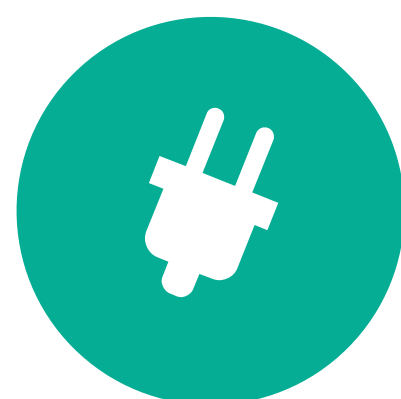
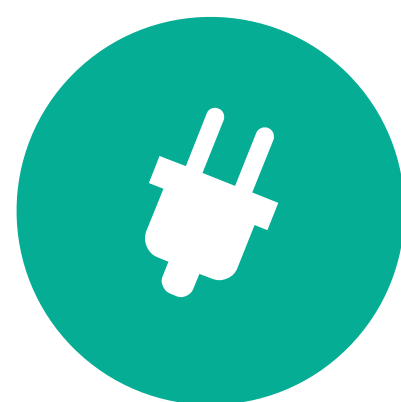Acquiring Mastership in ZooKeeper fails

Master Container Dies

Network Partitioning

Topology Master

Stream Manager

TMaster thinks data container failed

Waits for the scheduler to reschedule new data container

Never happens

Network Partitioning

Stream Manager   **Stream Manager**
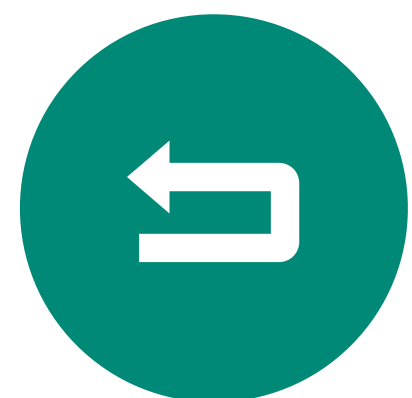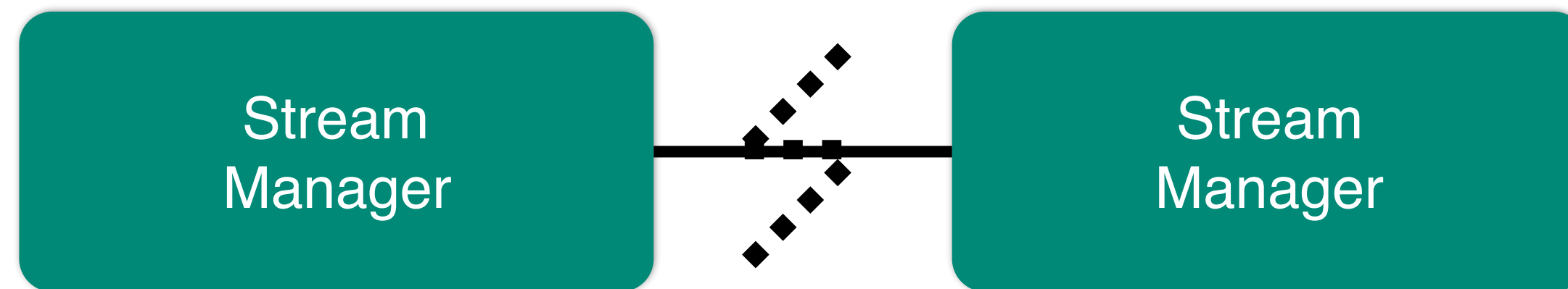
Cannot exchange data

Data accumulates

Chaos ensues!

Can we do better?

Network Partitioning
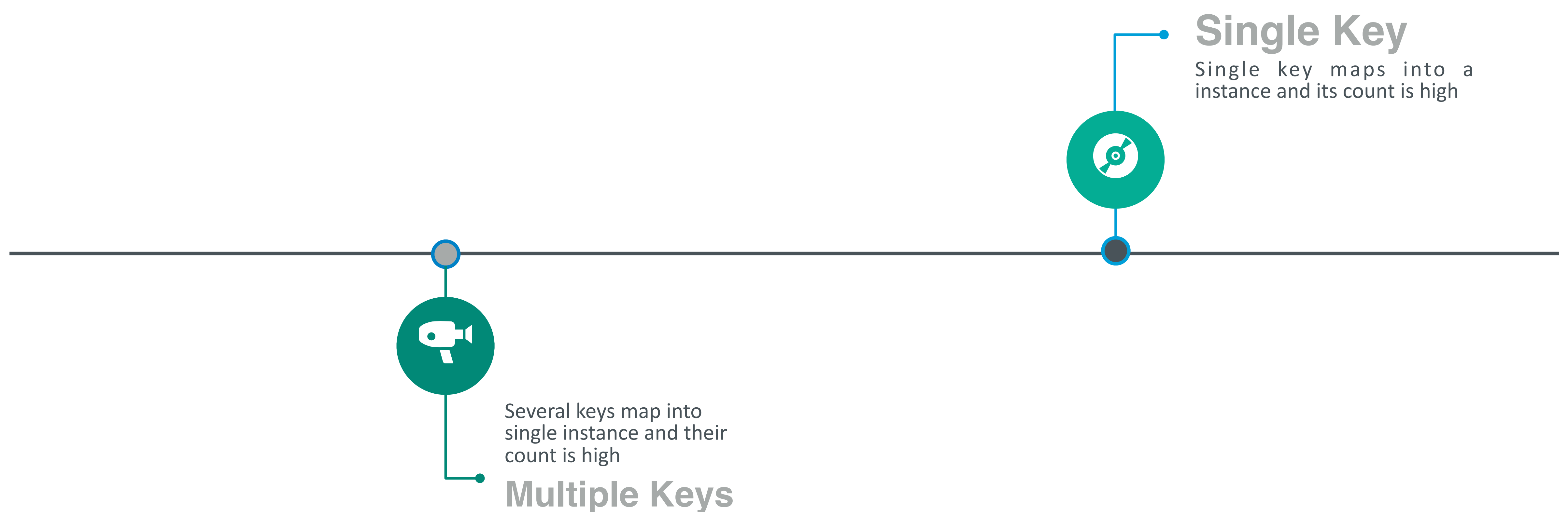
Scheduler

Stream Manager
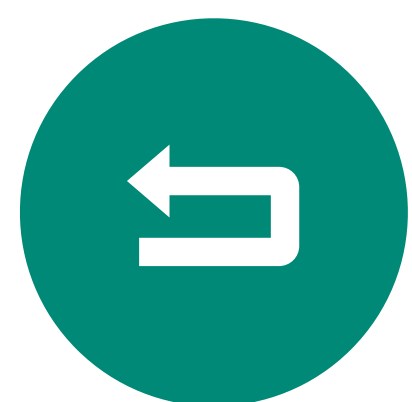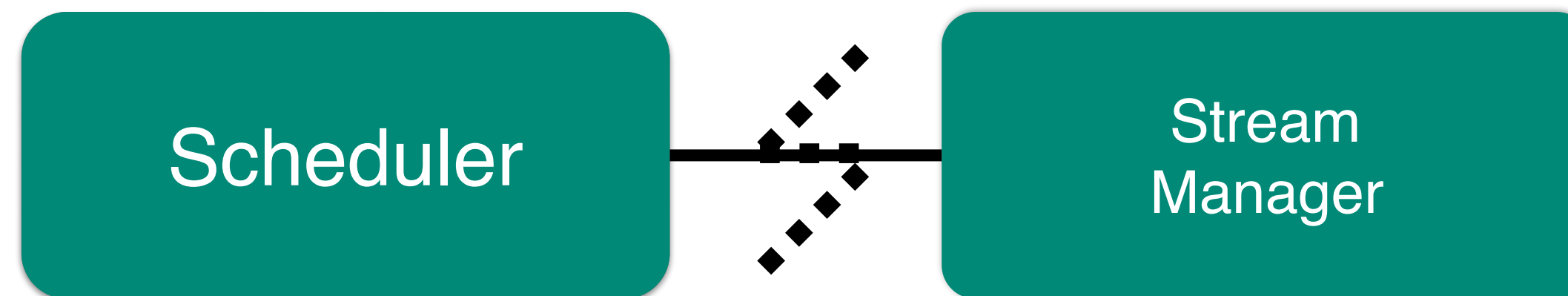
New data container spawned
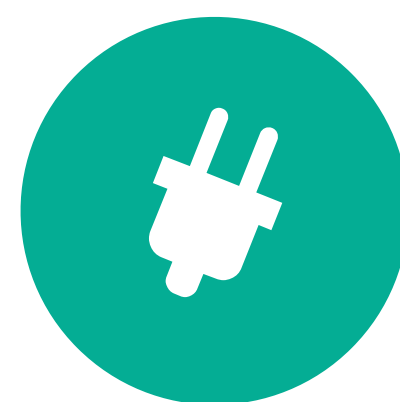
TMaster realizes two data containers report as the same

Does not accept the new one and eventually it dies

Data Skew

Single Key

Single key maps into a instance and its count is high

Several keys map into single instance and their count is high

Multiple Keys

Data Skew - Multiple Keys

Data Skew - Single Key

Spout 1

Bolt 1

Bolt 4

Bolt 2

Spout 2

Bolt 5

Bolt 3

What happens if the skew is temporary?

Rack Failures

Single Rack

Outage of a single rack

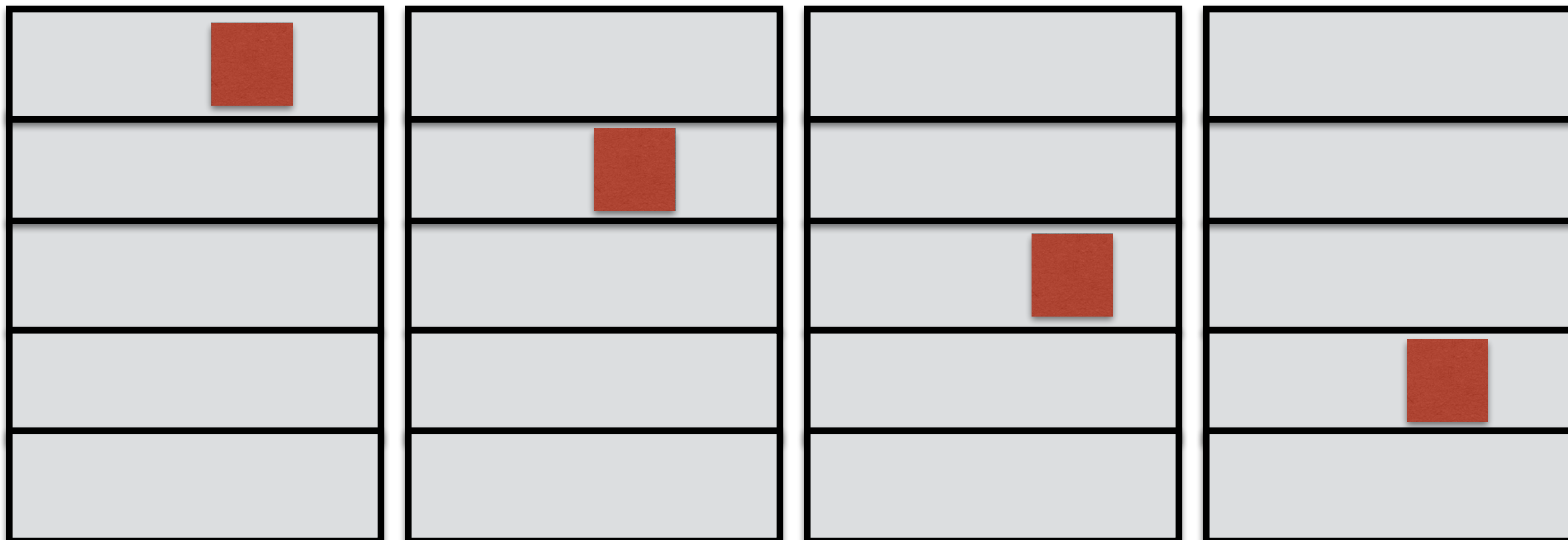Outage of several racks simultaneously

Multiple Rack
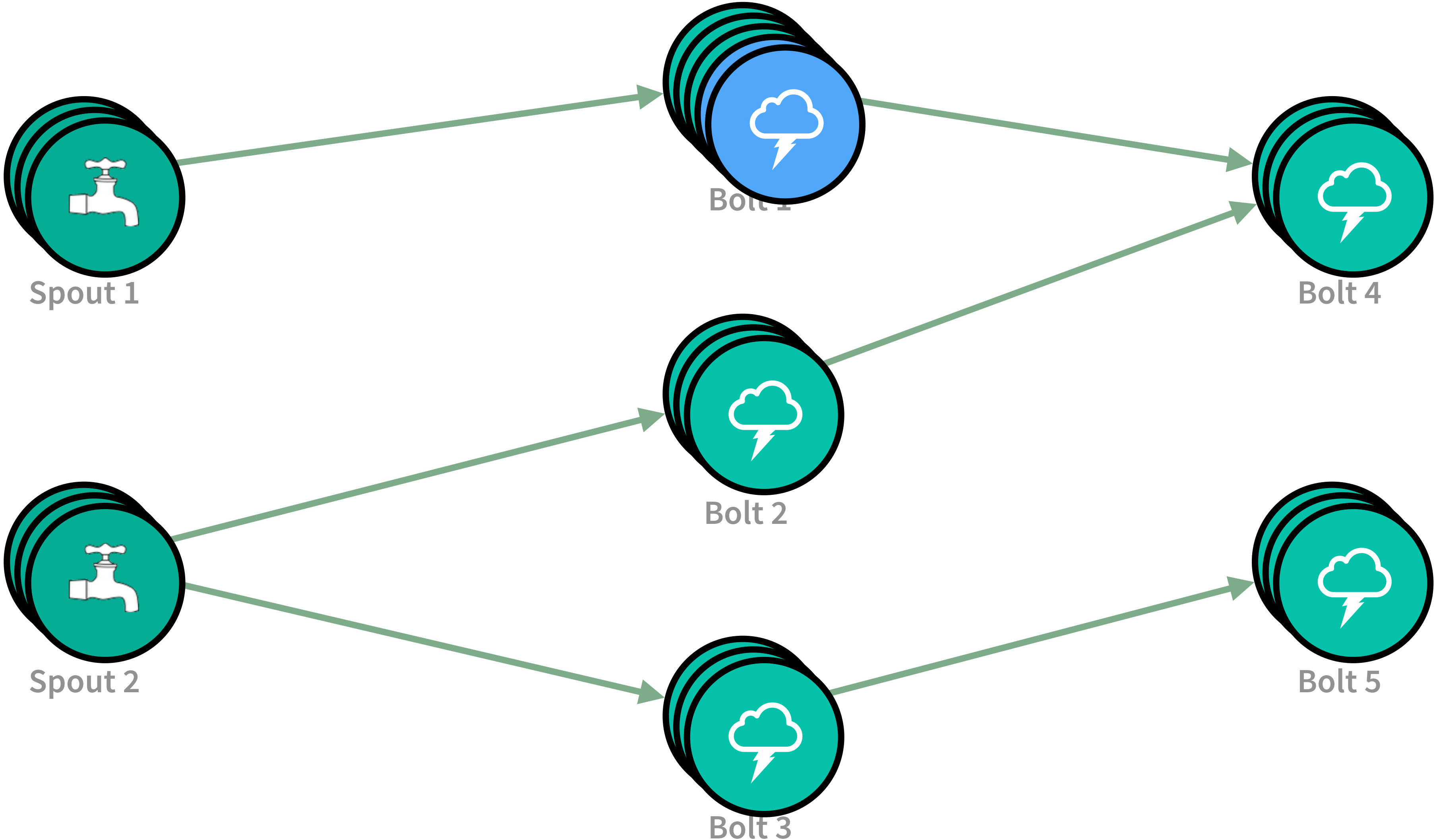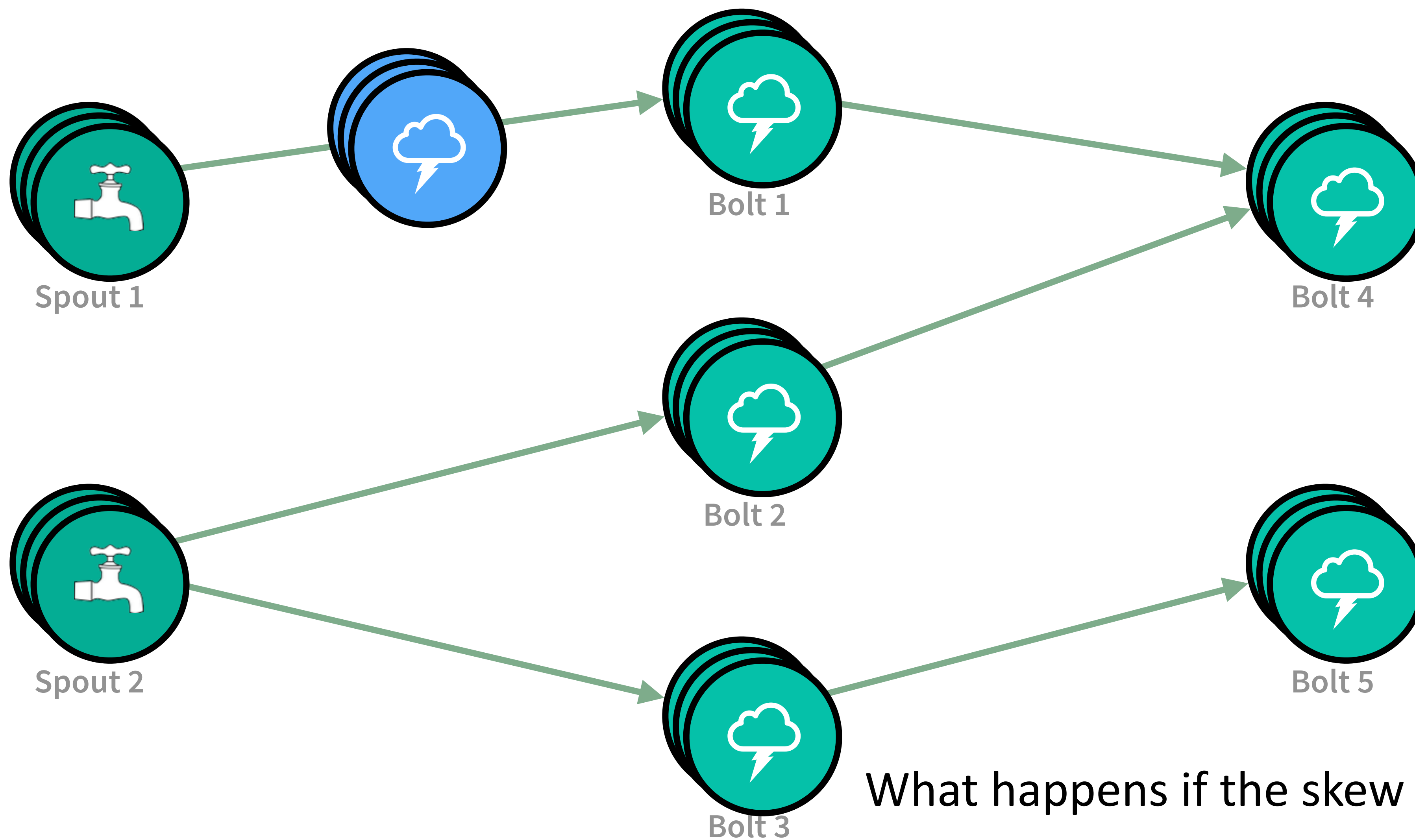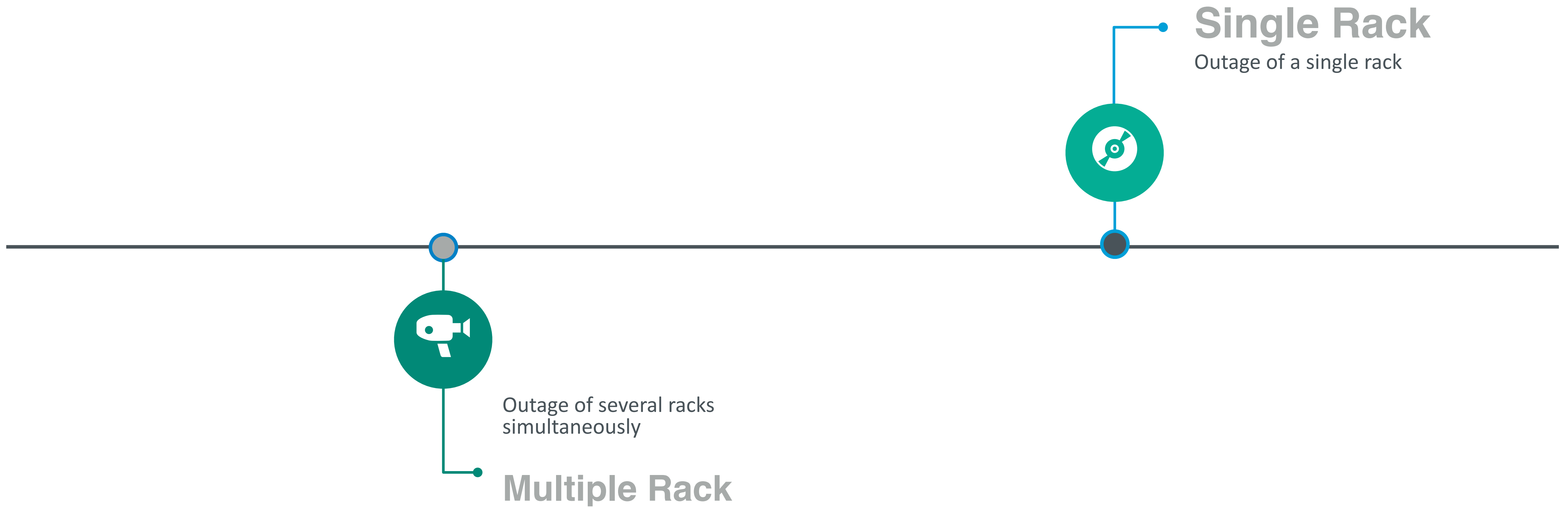
Rack Local vs Rack Diversity

Rack Local
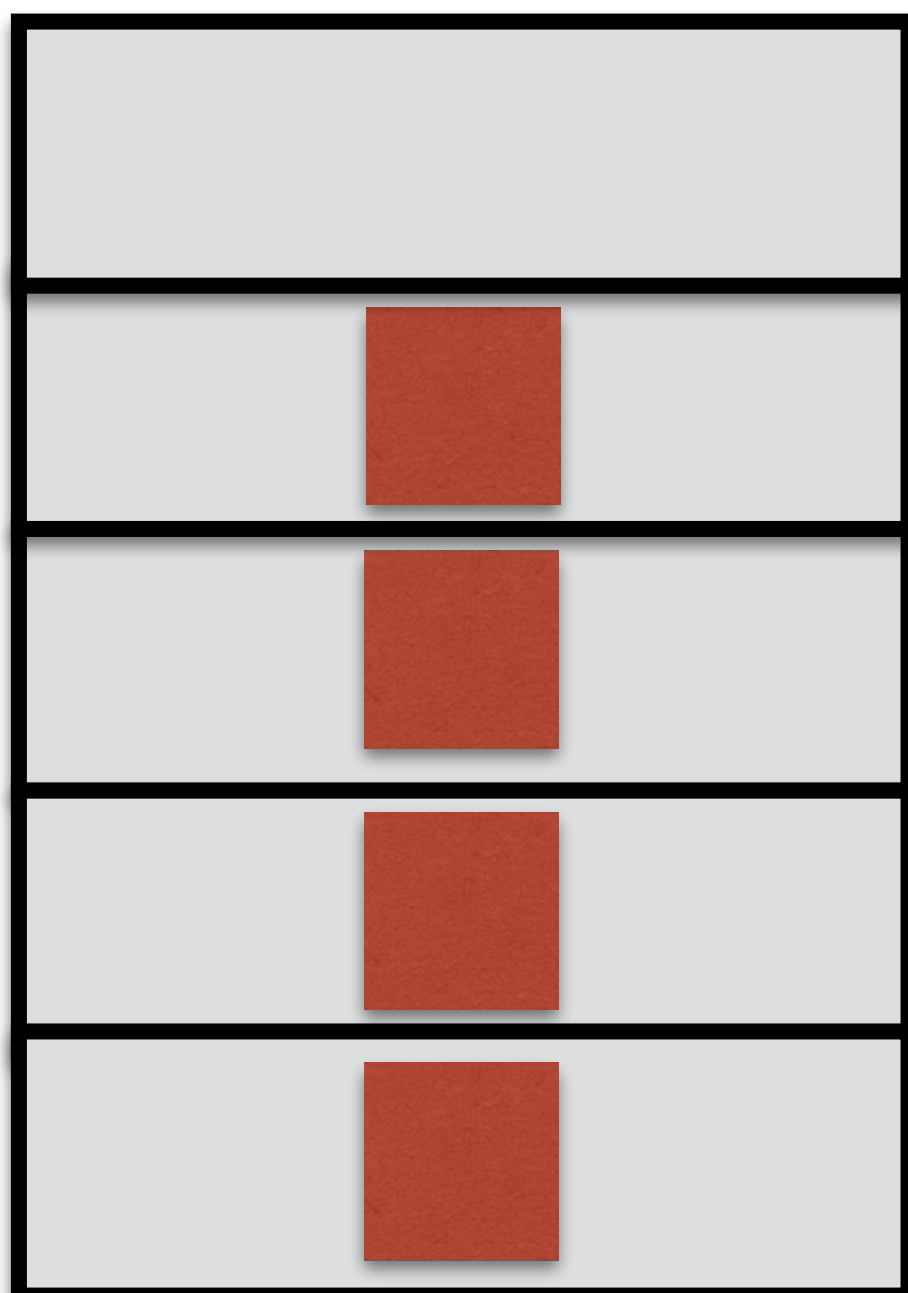
Rack Diversity

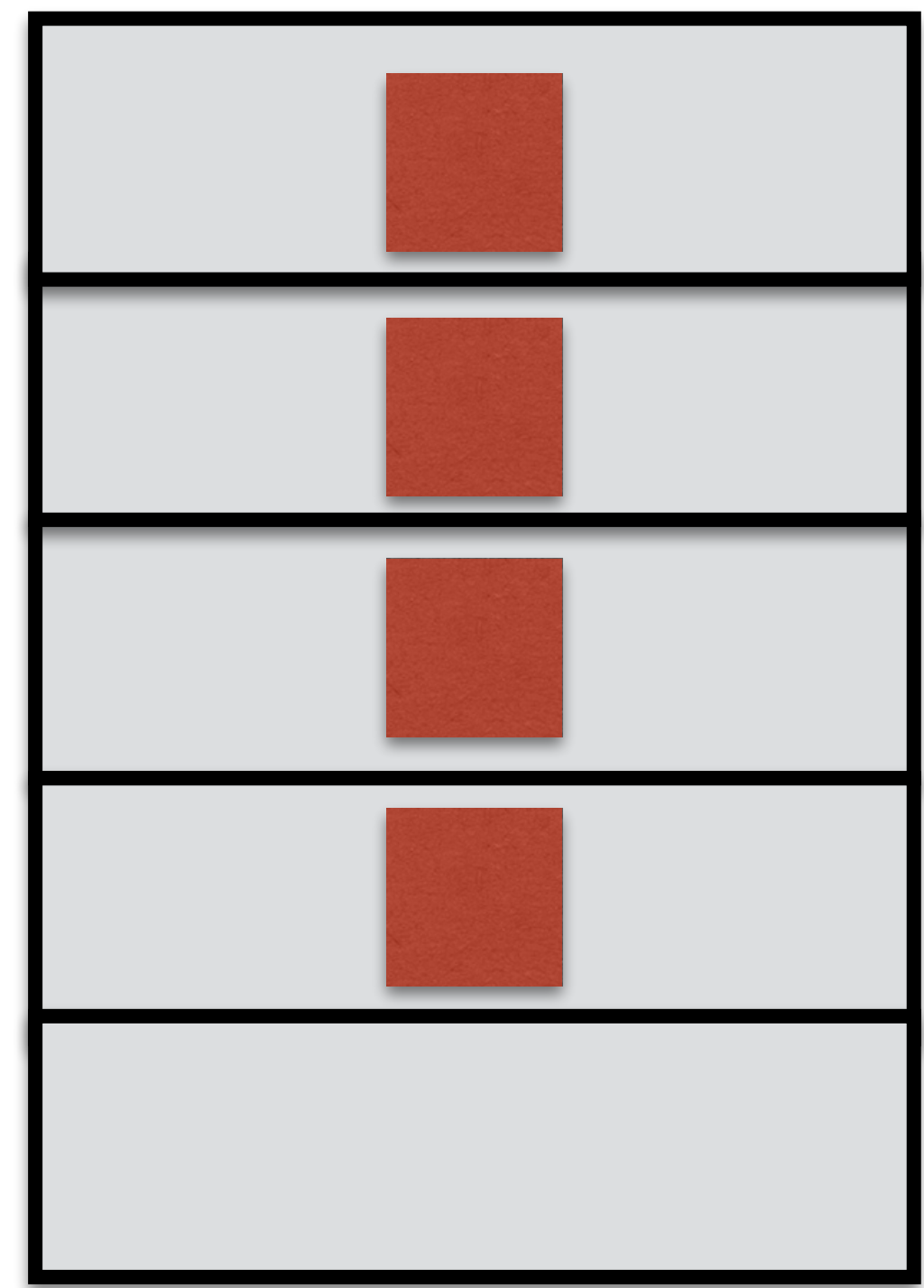Advantage of reduced network latency and high p2p bandwidth
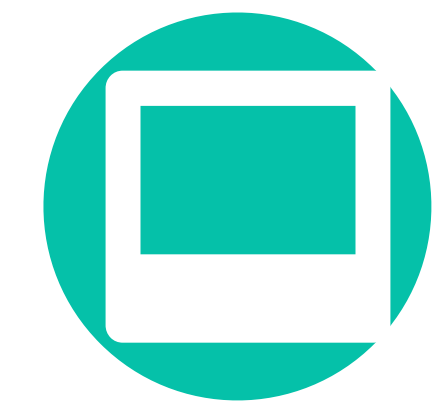
Higher network latency and shared bandwidth

Single Rack Failure
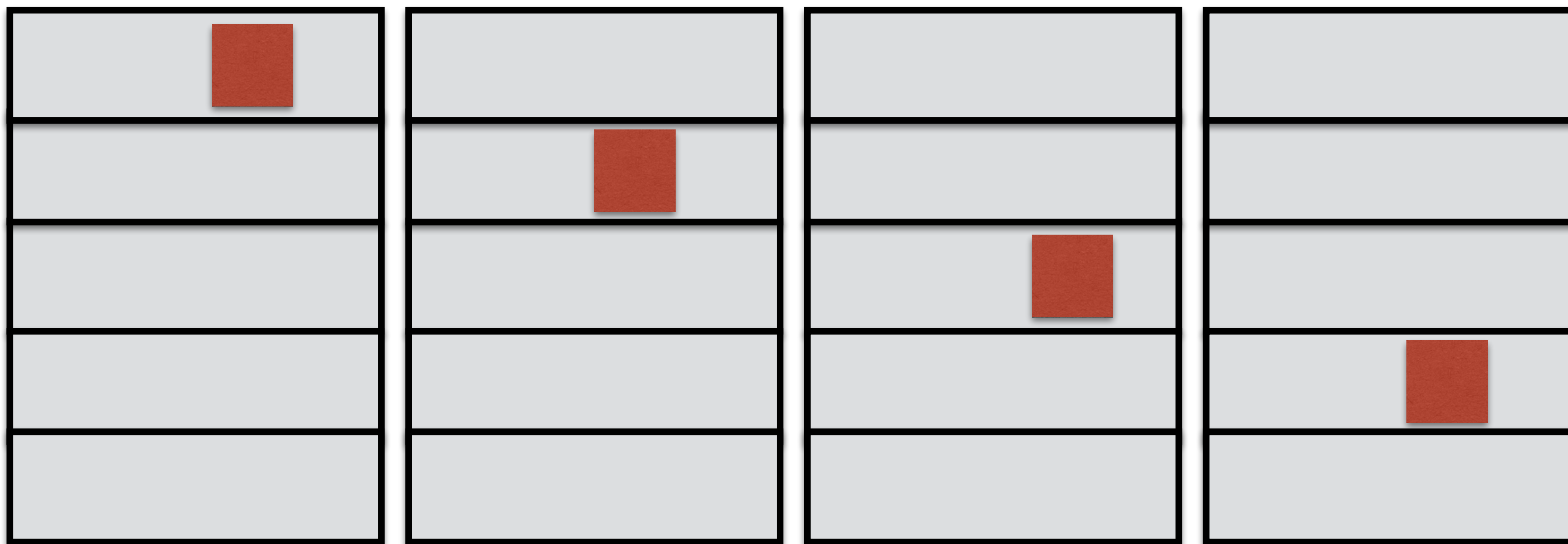
Rack Local

Rack failure
If job is rack local entire job is down and needs to be rescheduled

Impact on real timeliness
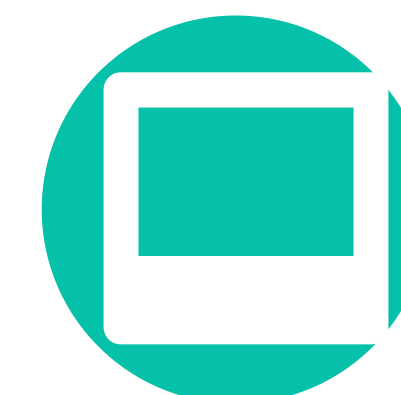Depends on the application

Single Rack Failure

Rack Diversity

Rack failure
If job is rack diverse impact is minimal

Impact on real timeliness
Is affected less - depending on how many containers are running

Conclusion

Self healing is important in Streaming systems

Key operational issues - Slow hosts, network and data skew

These requirements make the streaming systems more complex

Interested in Heron?

HERON IS OPEN SOURCED

CONTRIBUTIONS ARE WELCOME!

https://github.com/twitter/heron

http://heronstreaming.io

FOLLOW US @HERONSTREAMING

Any Questions ???

WHAT **WHY** **WHERE** **WHEN** **WHO** **HOW**
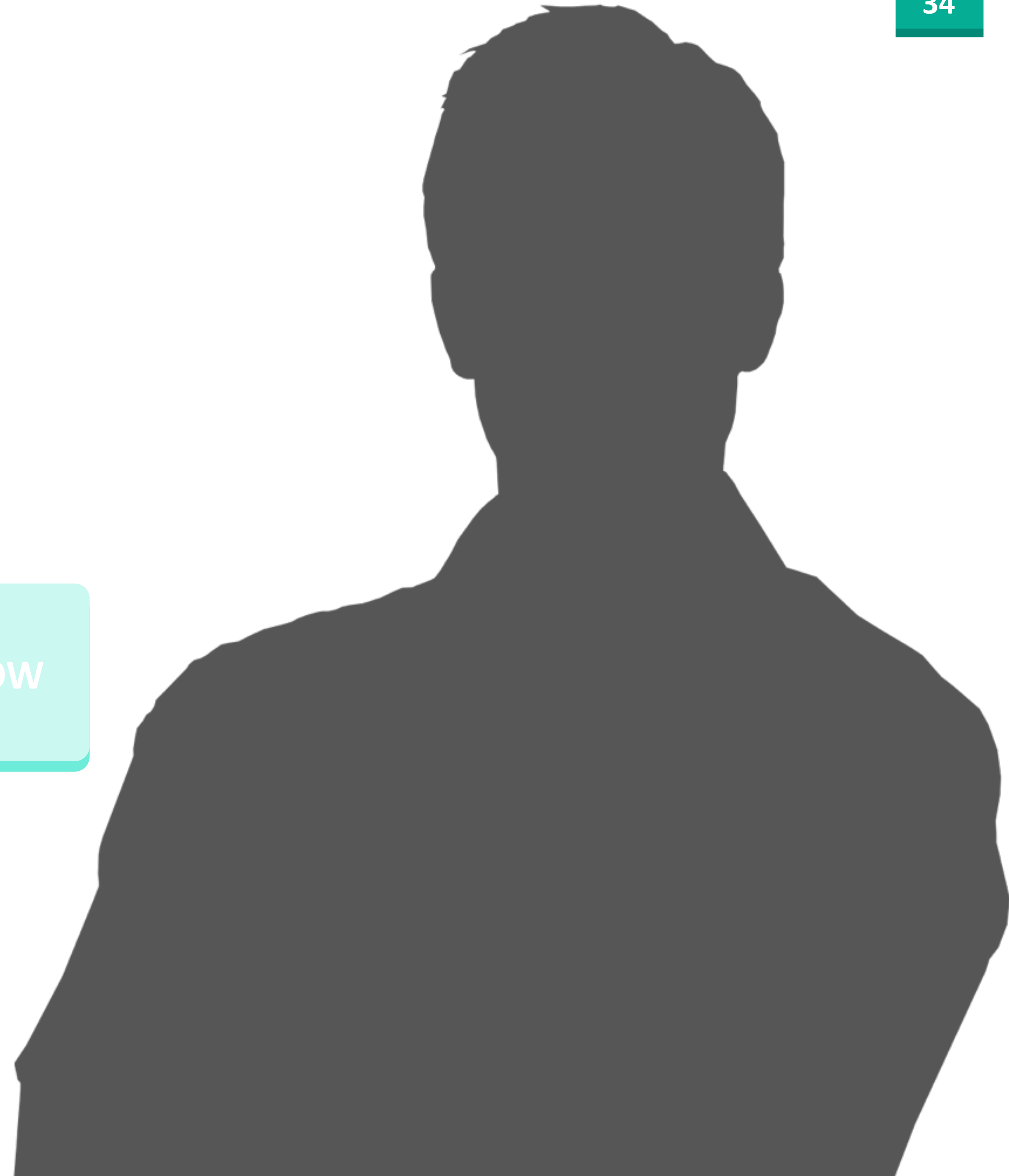
Thanks For Listening

@karthikz

Detections and Resolutions

Detections

	Lazy	Instant
Proactive	Affects real-time (depends on application tolerance)	Keeps up with real-time
Reactive	Full manual intervention	N/A

Resolutions