Automated Analysis with Broker

Matthias Vallentin, CEO
Dominik Charousset, CTO

BroCon '18

Automated Analysis with Zeeker?

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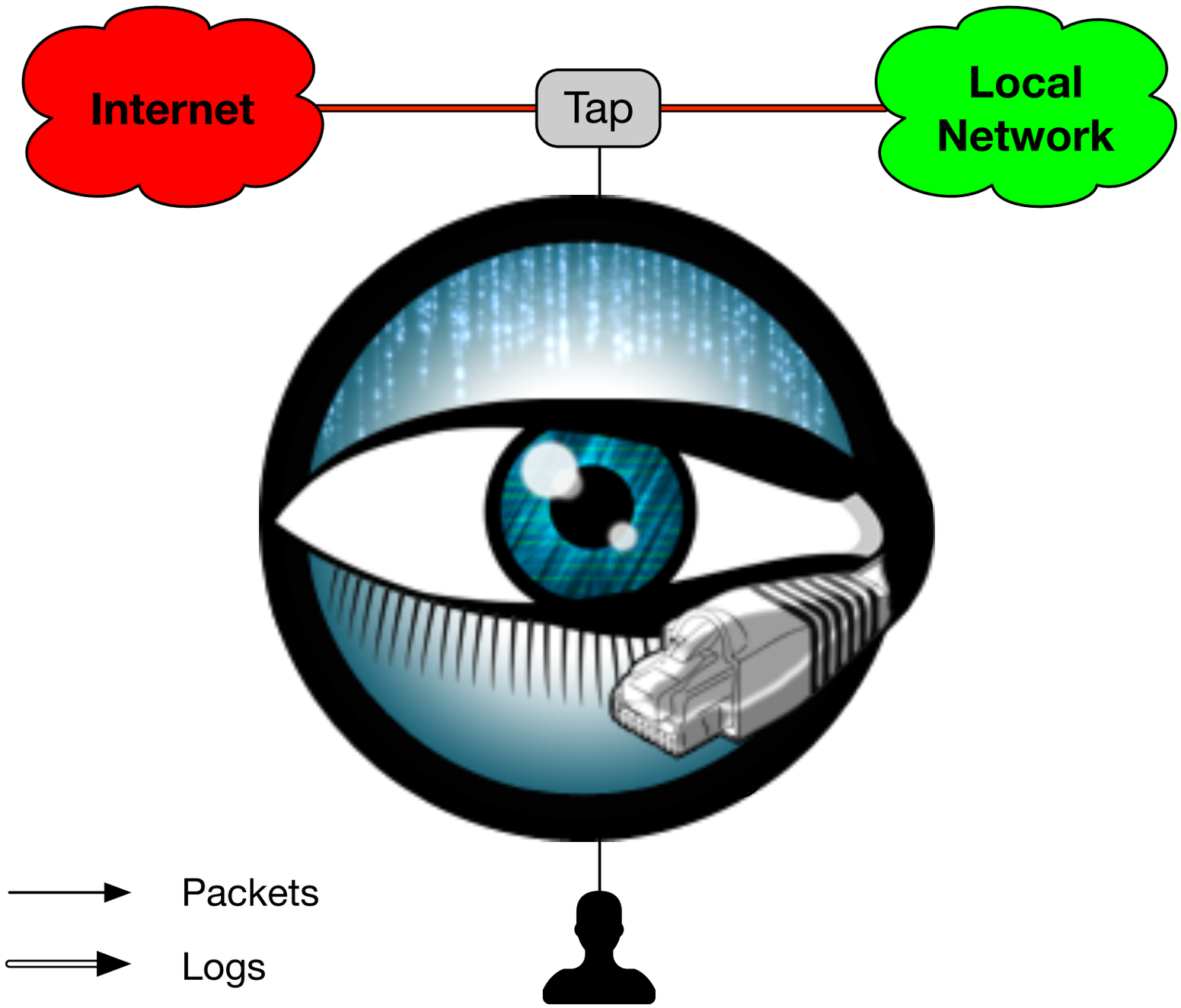
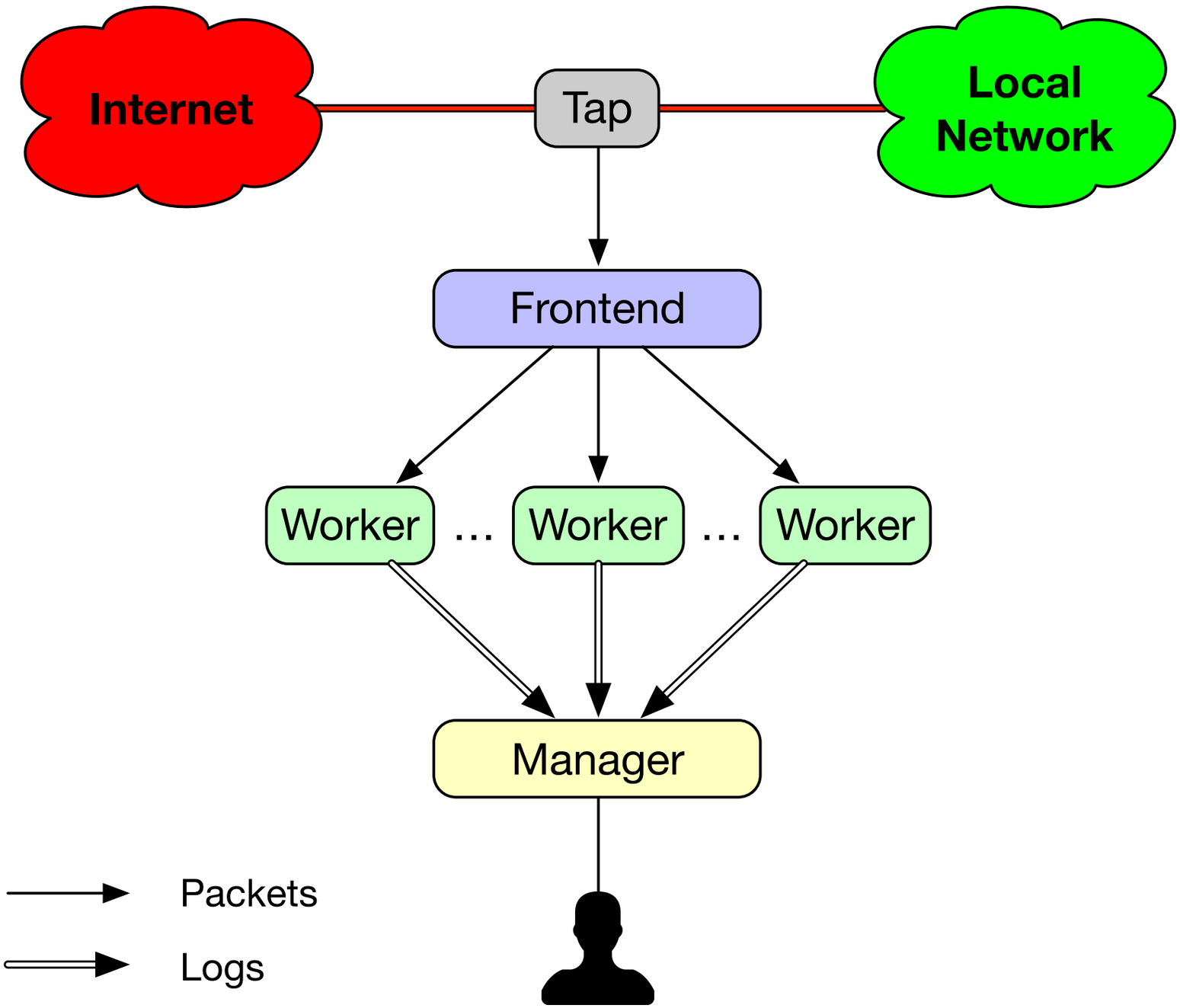
What is Broker again?

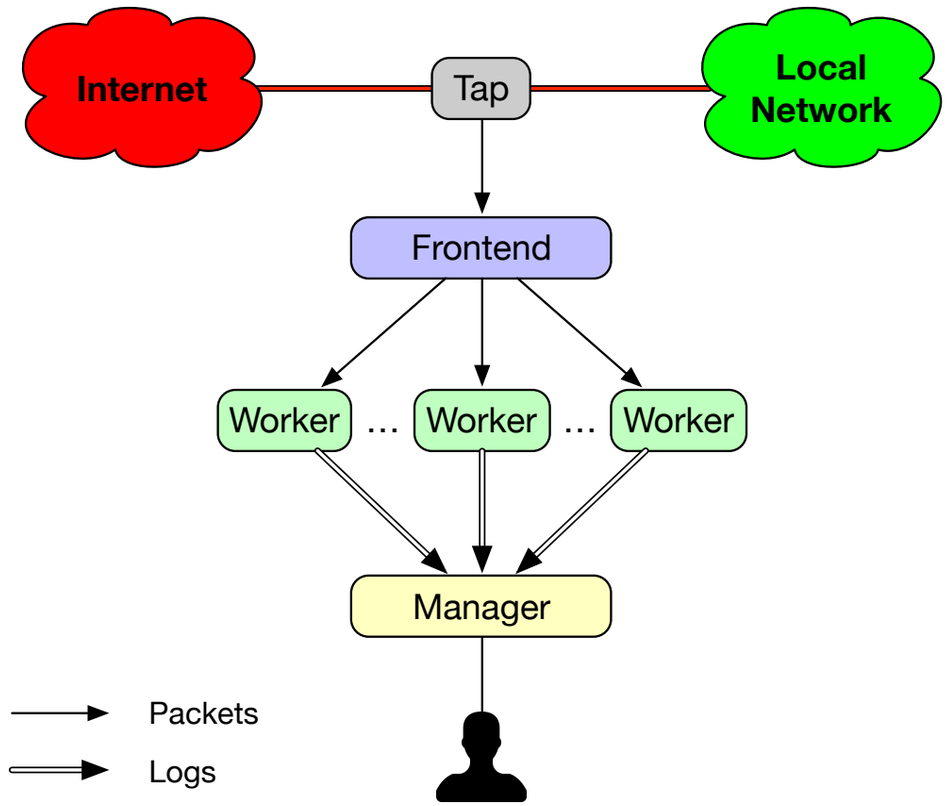
Zeek Communication



Zeek Communication

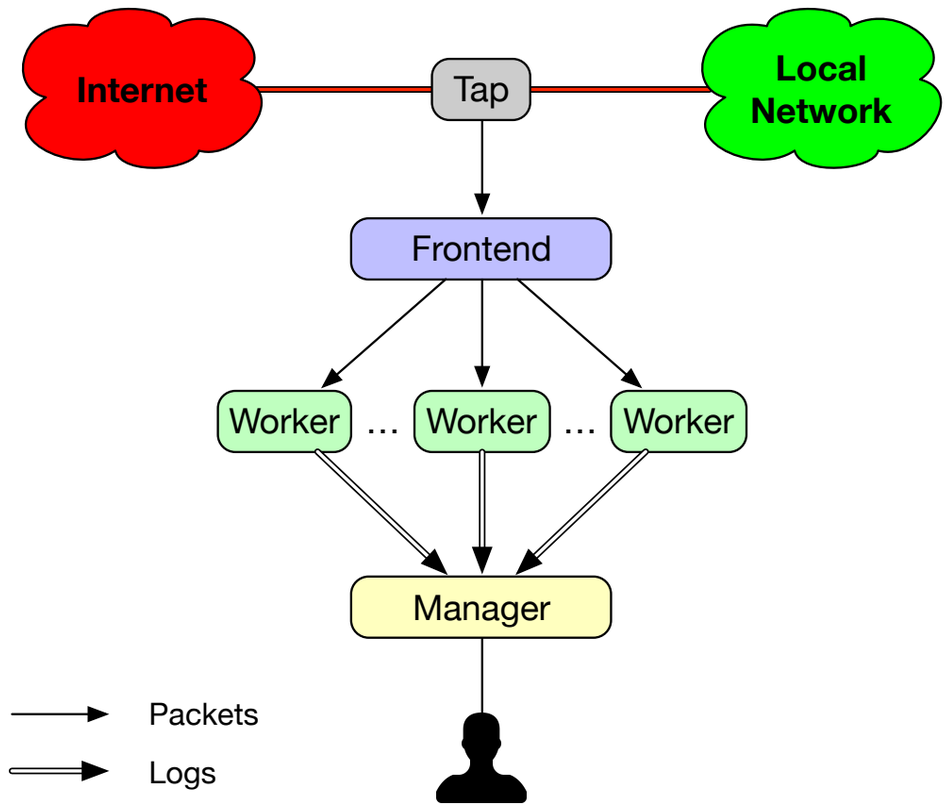


Zeek Communication



- **Manager and workers** exchange valuable insights

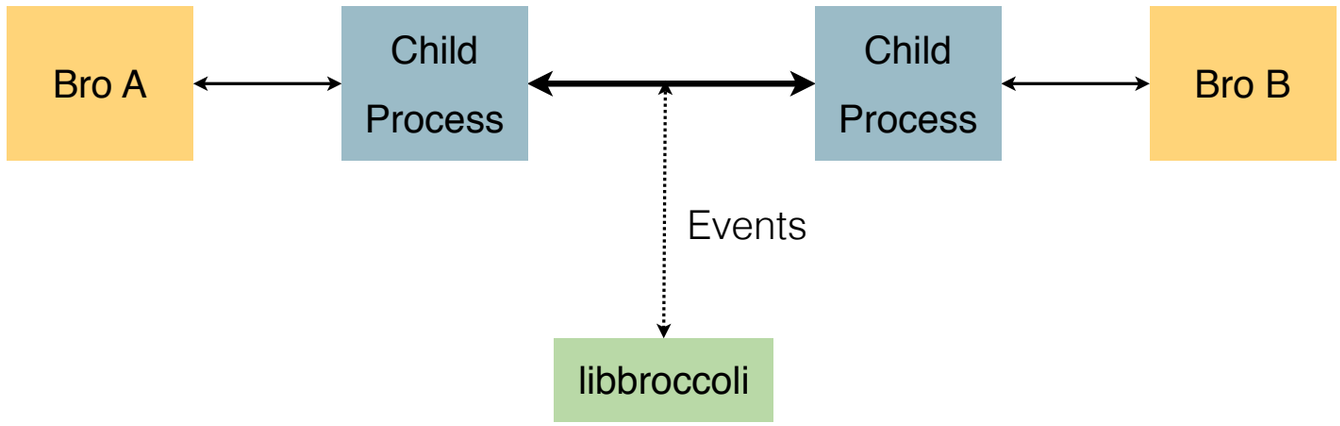
Zeek Communication



- **Manager and workers** exchange valuable insights
- Tapping into this **resource** enables powerful analytics

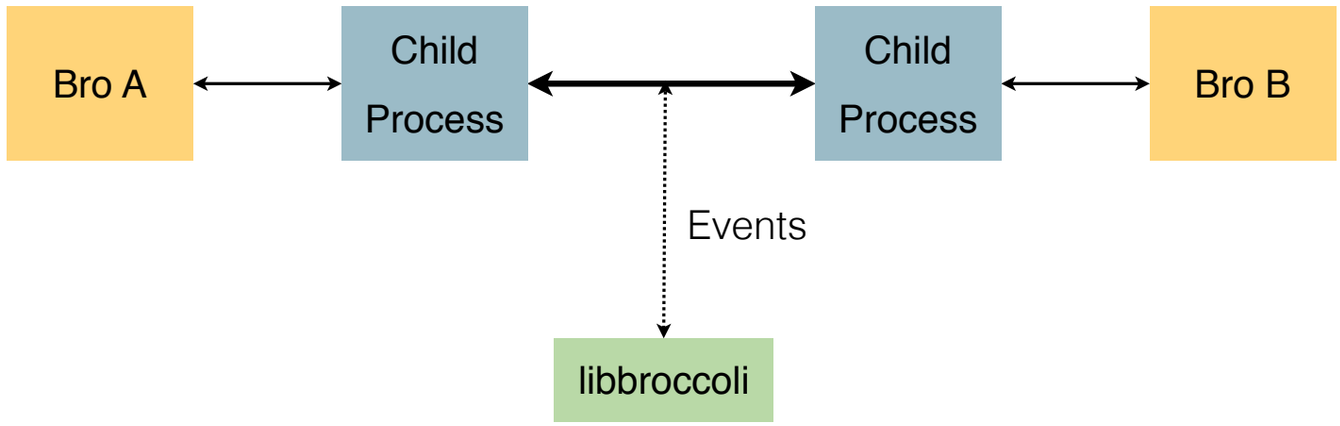
Historic Perspective

Historic Perspective



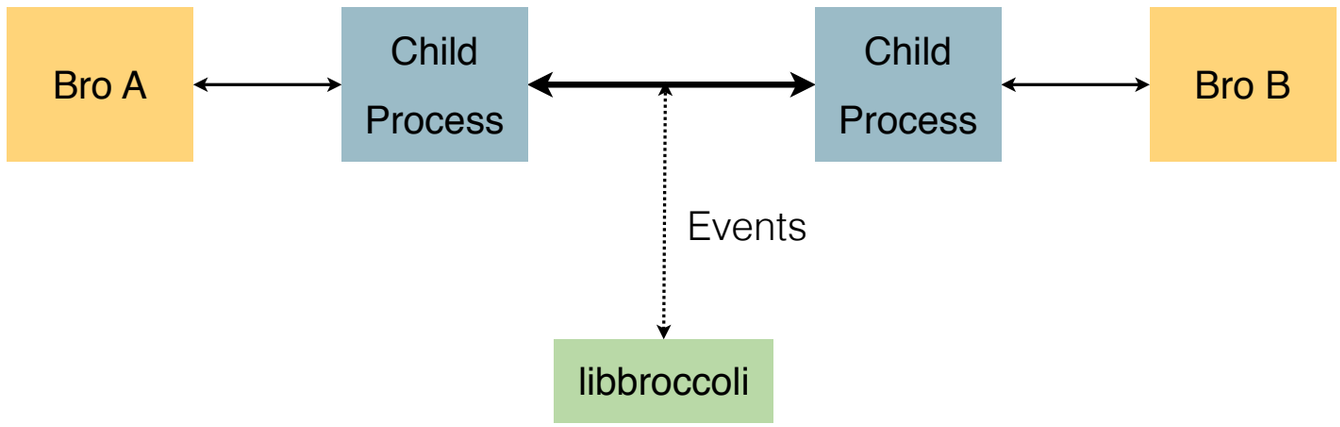
- **Second Bro process** for communication

Historic Perspective



- **Second Bro process** for communication
- Broccoli: **re-implementation** of Bro's protocol

Historic Perspective



- **Second Bro process** for communication
- Broccoli: **re-implementation** of Bro's protocol
- **No persistent state** and limited control over data flow

Introducing Broker

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- Unify **event access** (C++, Python, Zeek Scripts)

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Introducing Broker

- Unify **event access** (C++, Python, Zeek Scripts)
- Provide **persistent key/value stores**
- Leverage **flexible publish/subscribe** communication
- Enable **cross-correlation** and automated analysis

Broker in a Nutshell

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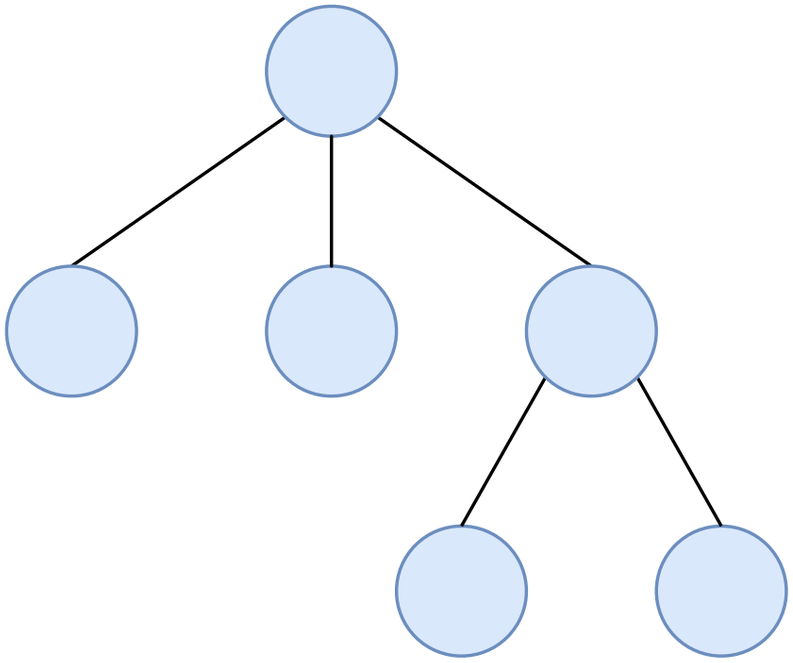
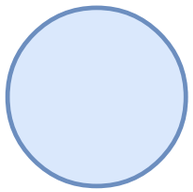
- **Endpoints peer** with each other (tree topology without loops)

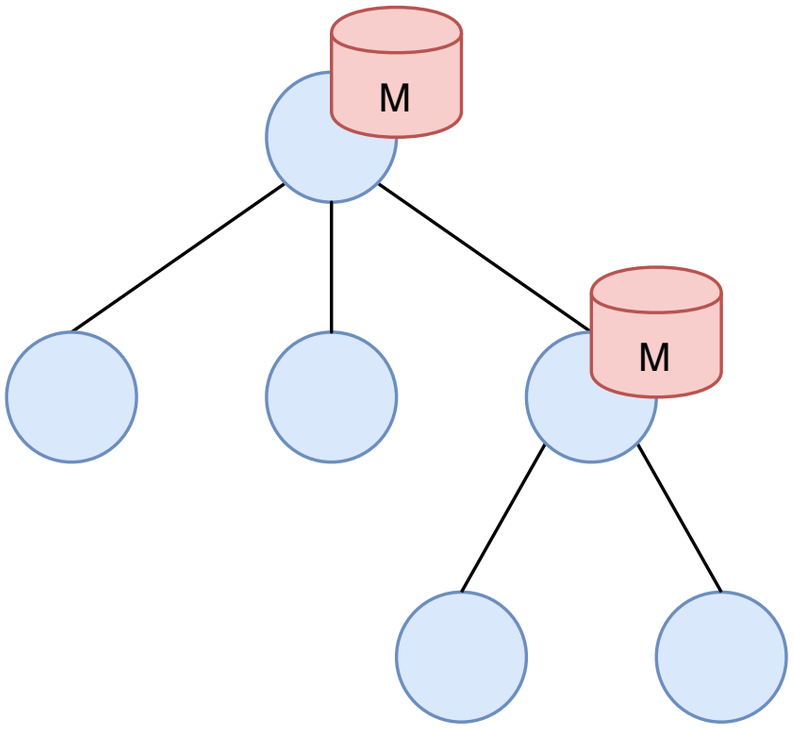


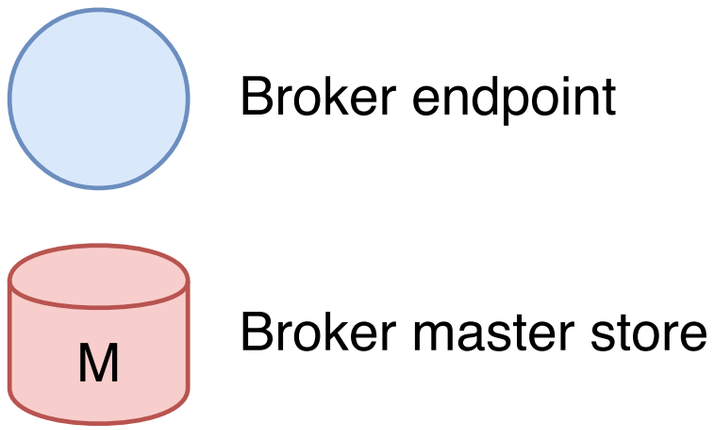


Broker endpoint

Broker in a Nutshell

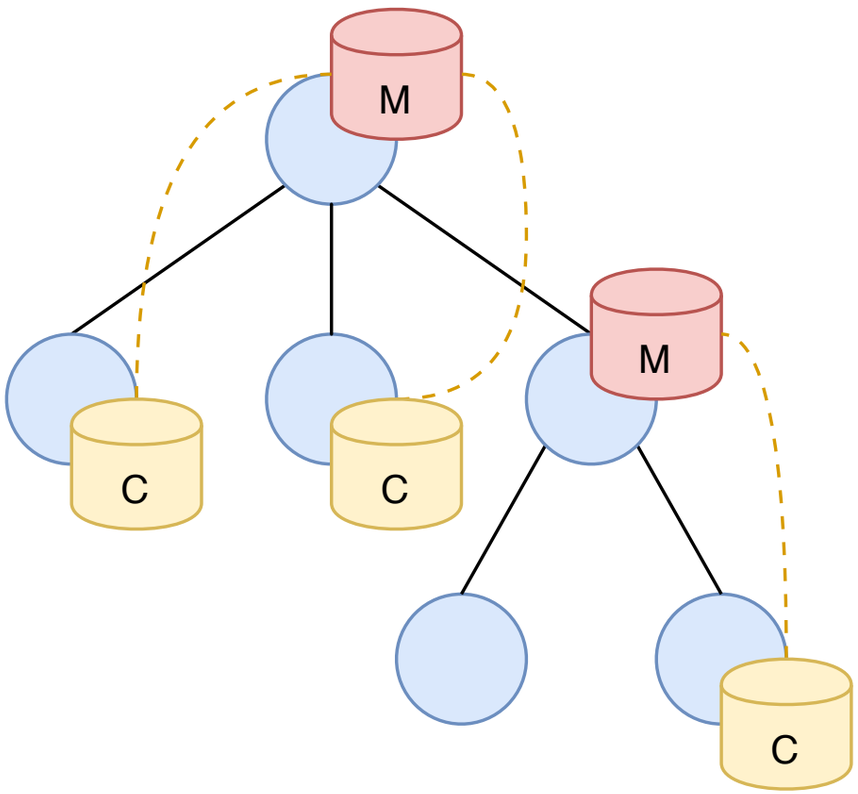
- **Endpoints peer** with each other (tree topology without loops)
- Users can attach **key-value data stores** to endpoints

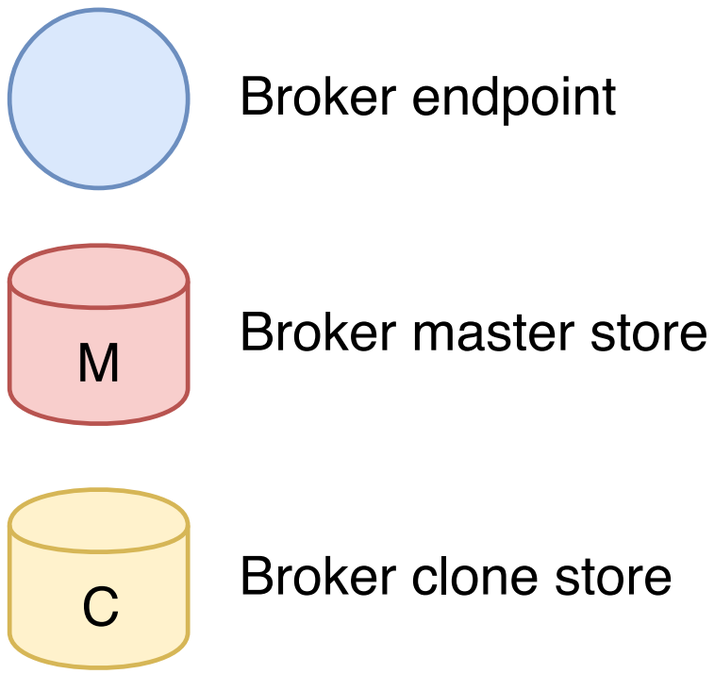




Broker in a Nutshell

- **Endpoints peer** with each other (tree topology without loops)
- Users can attach **key-value data stores** to endpoints
- **Clones act as caches** for faster access





Flexible Zeek Messaging

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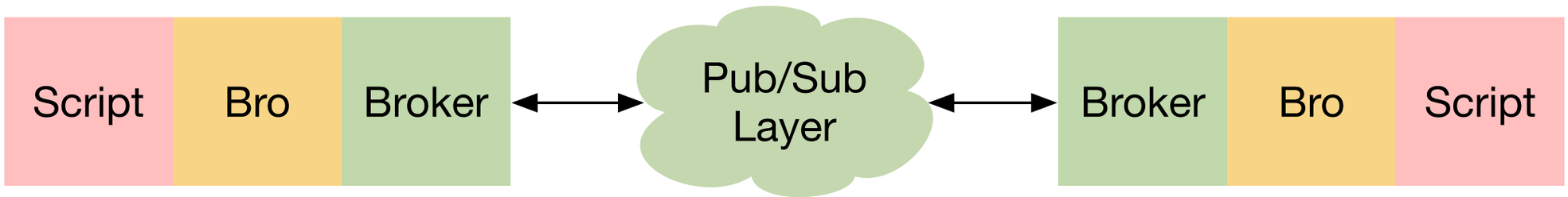
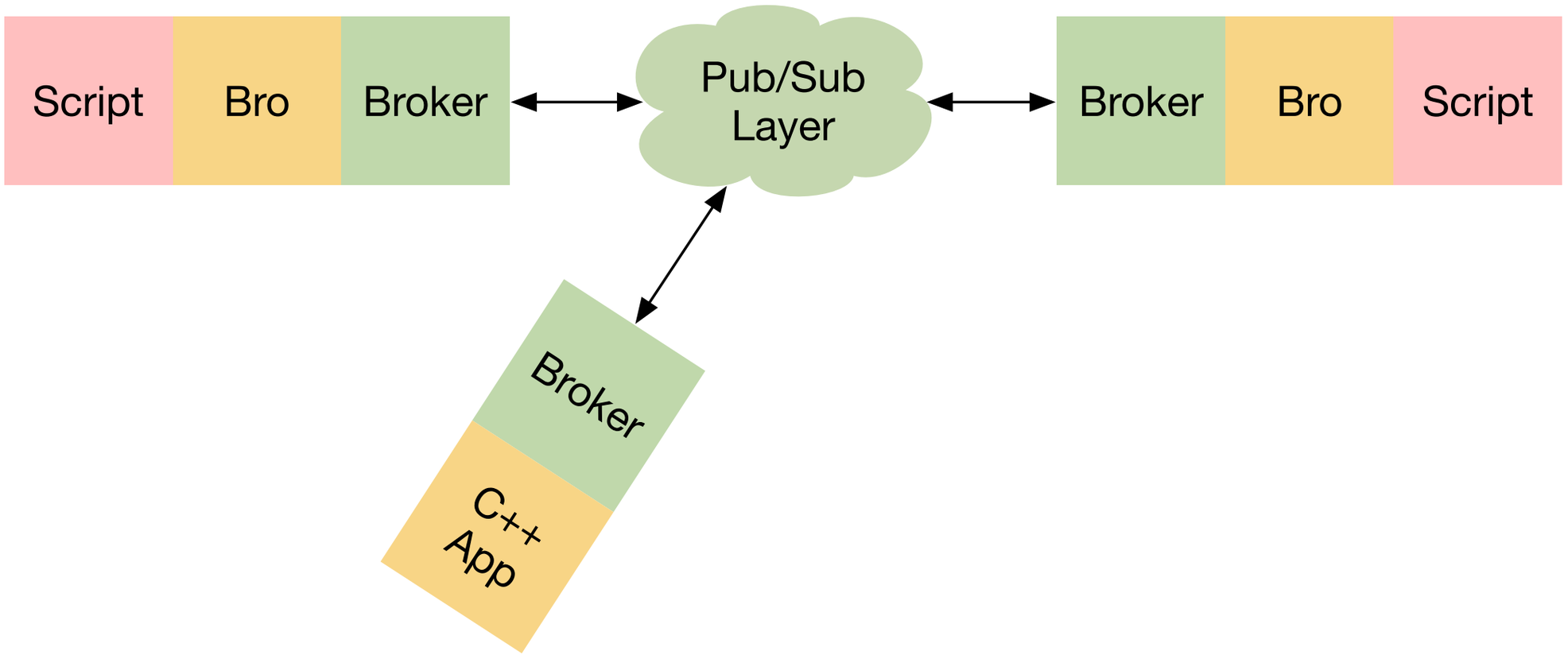
Zeek 2.6

Flexible Zeek Messaging



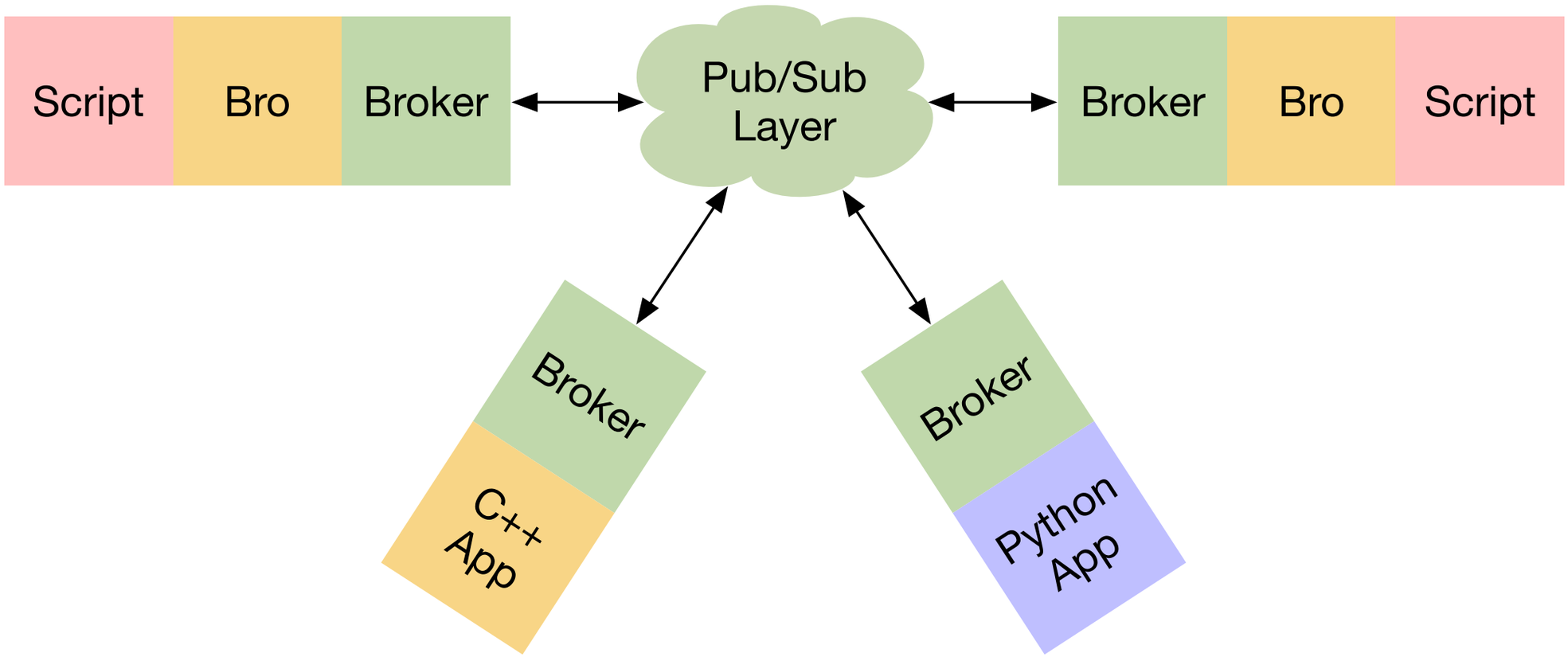
Zeek 2.6

Flexible Zeek Messaging



Zeek 2.6

Flexible Zeek Messaging



Zeek 2.6

Broker Timeline

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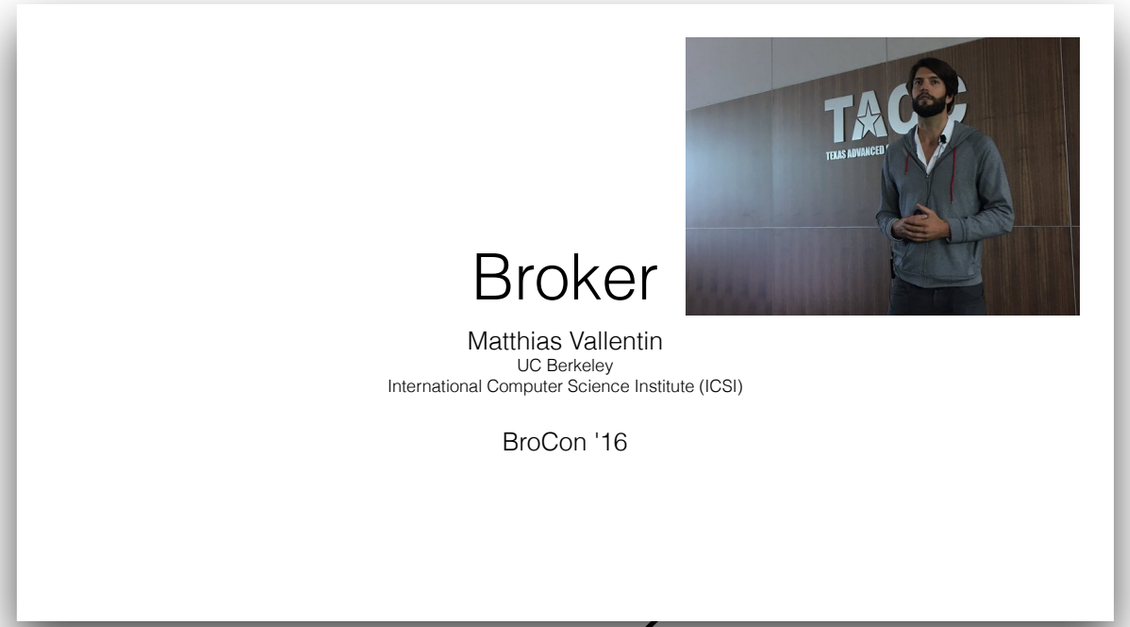
First Prototype

2015

Broker Timeline

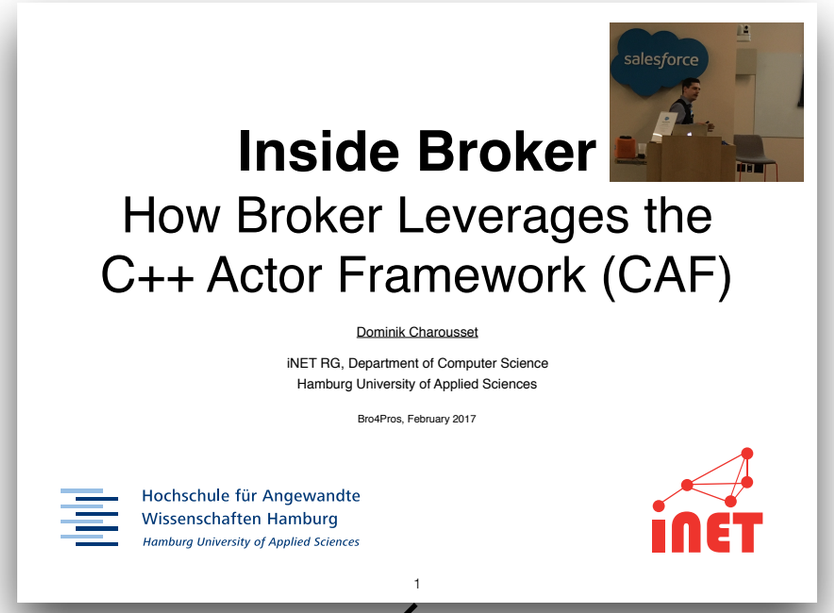


First Prototype

Nonblocking API

2015 **2016**

Broker Timeline

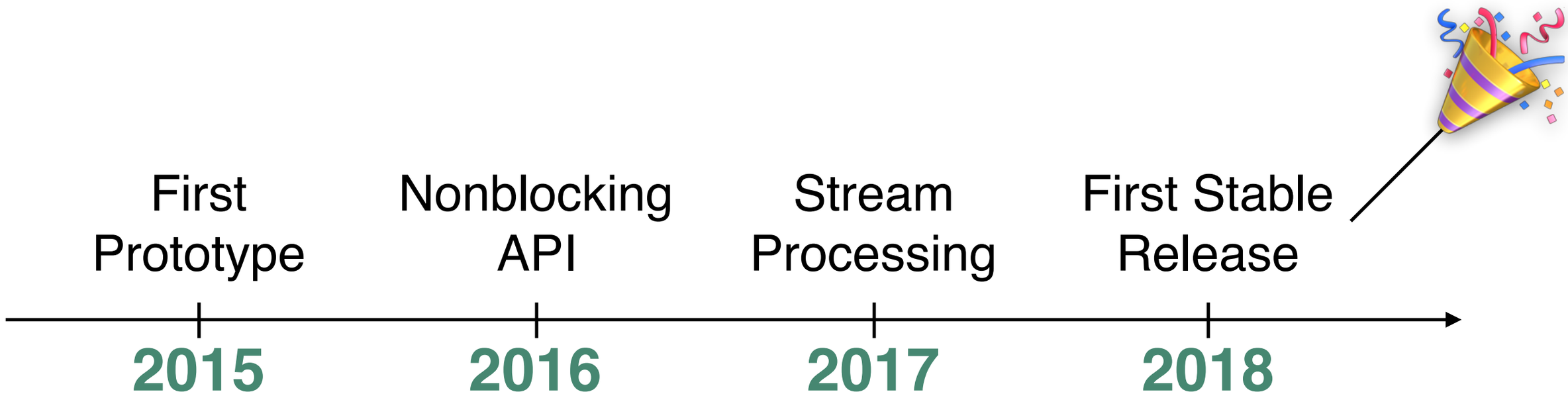


First Prototype — 2015

Nonblocking API — 2016

Stream Processing — 2017

Broker Timeline



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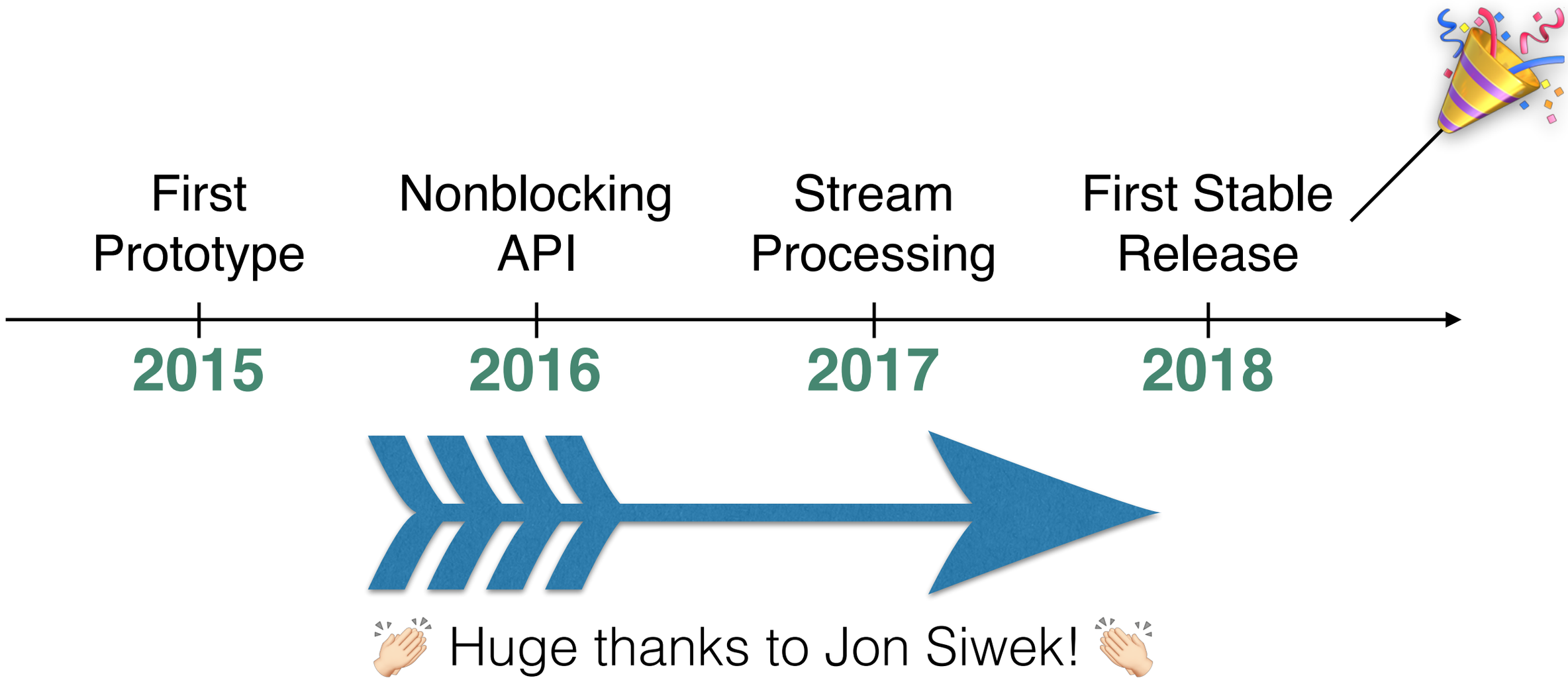

👏 Huge thanks to Jon Siwek! 👏

State of Broker

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✅ Stable: tested and merged to master

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- ✅ Native C++ API and Python bindings

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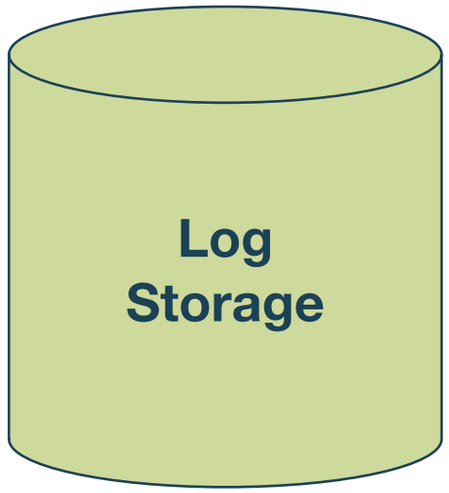
- 🚫 No access to Zeek logs (yet)

What can I do with Broker?

Scenario

Scenario



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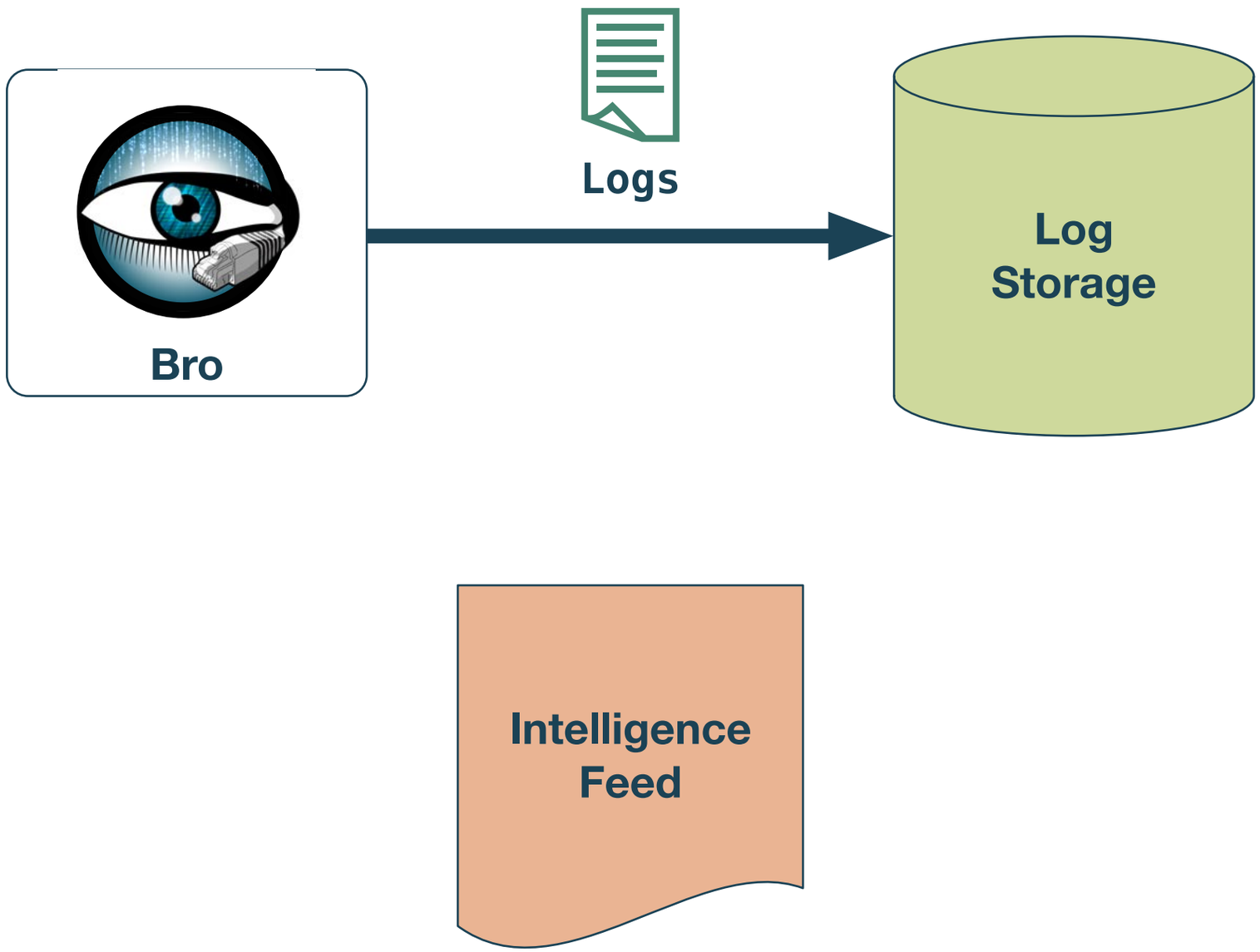

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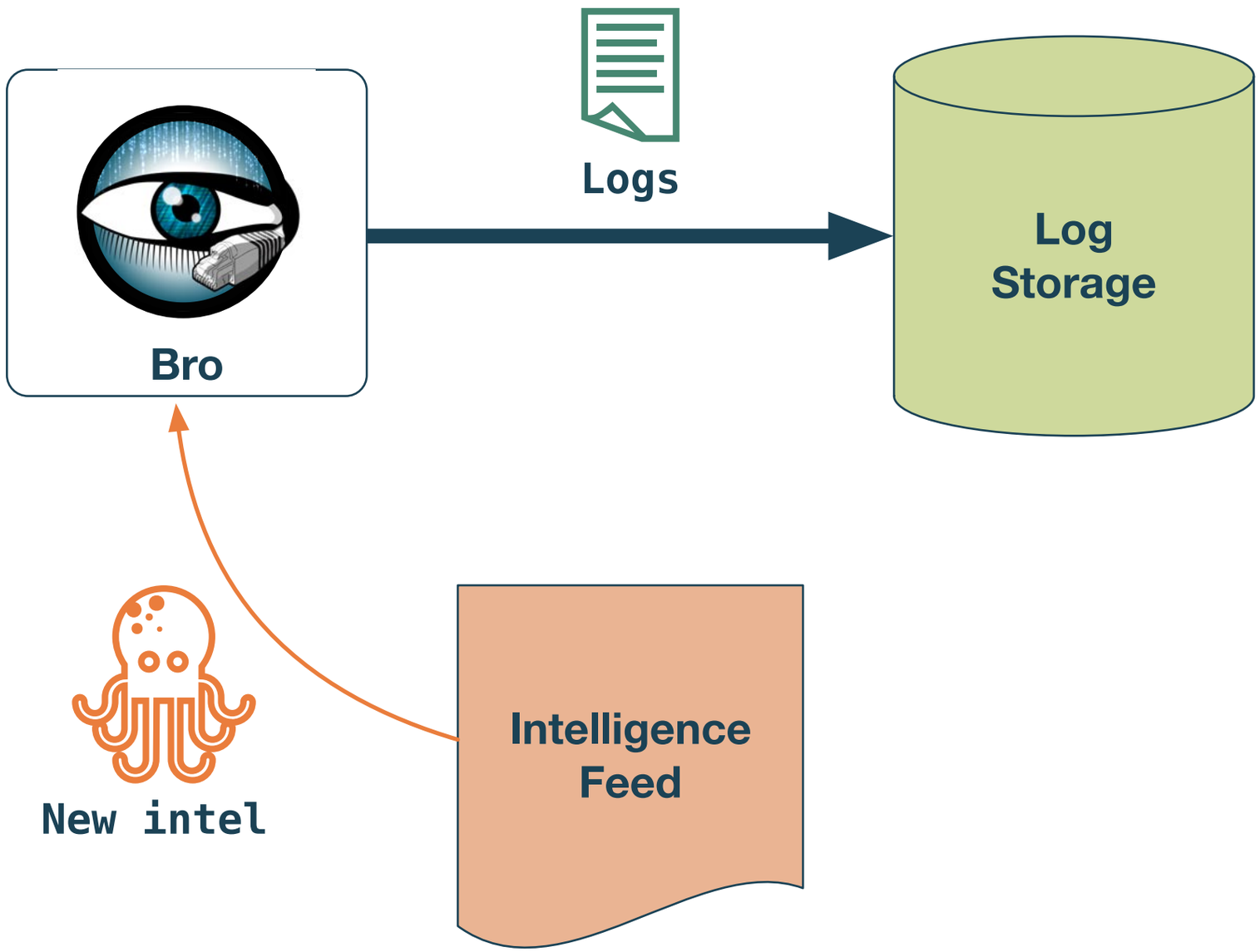

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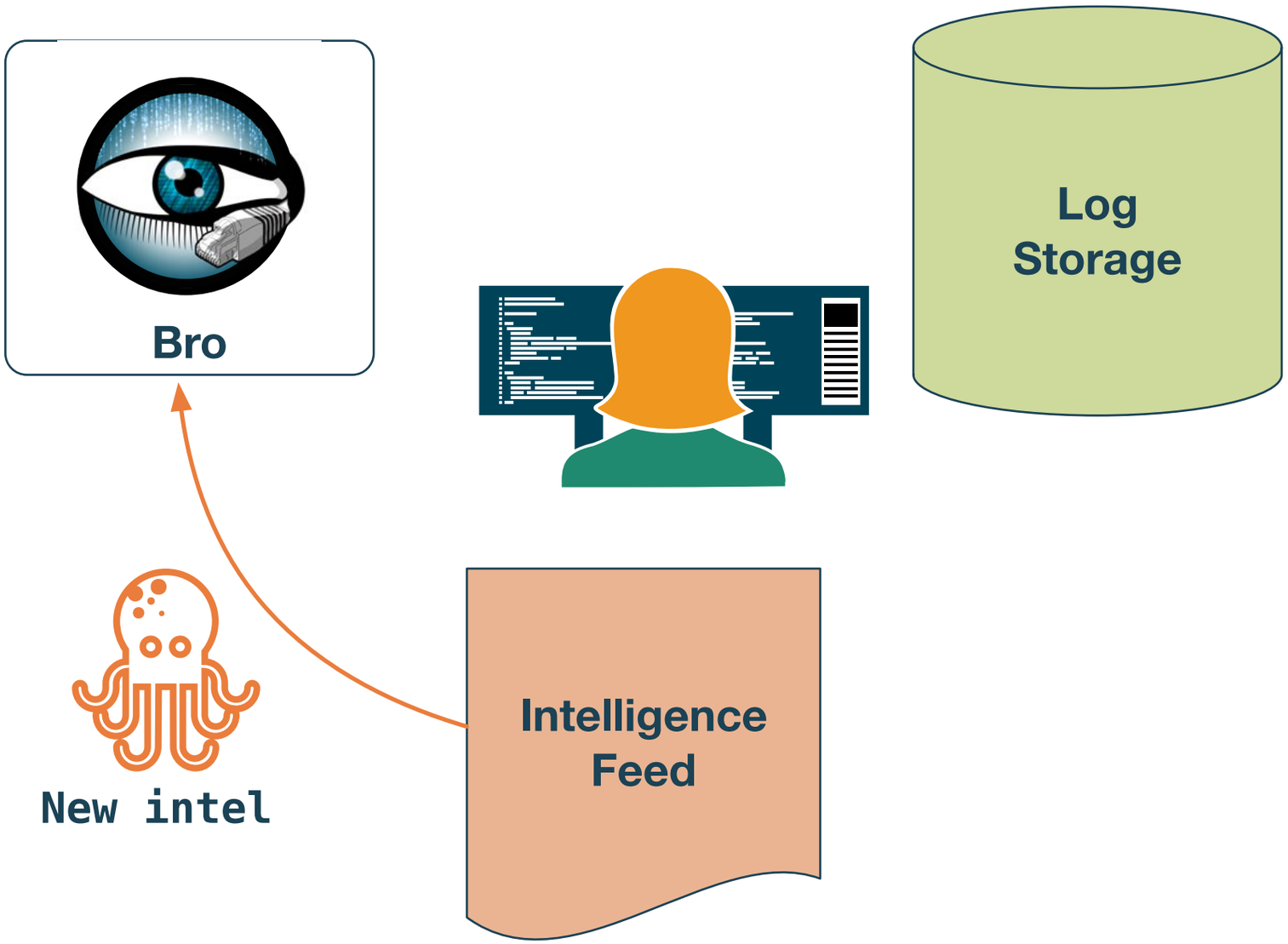

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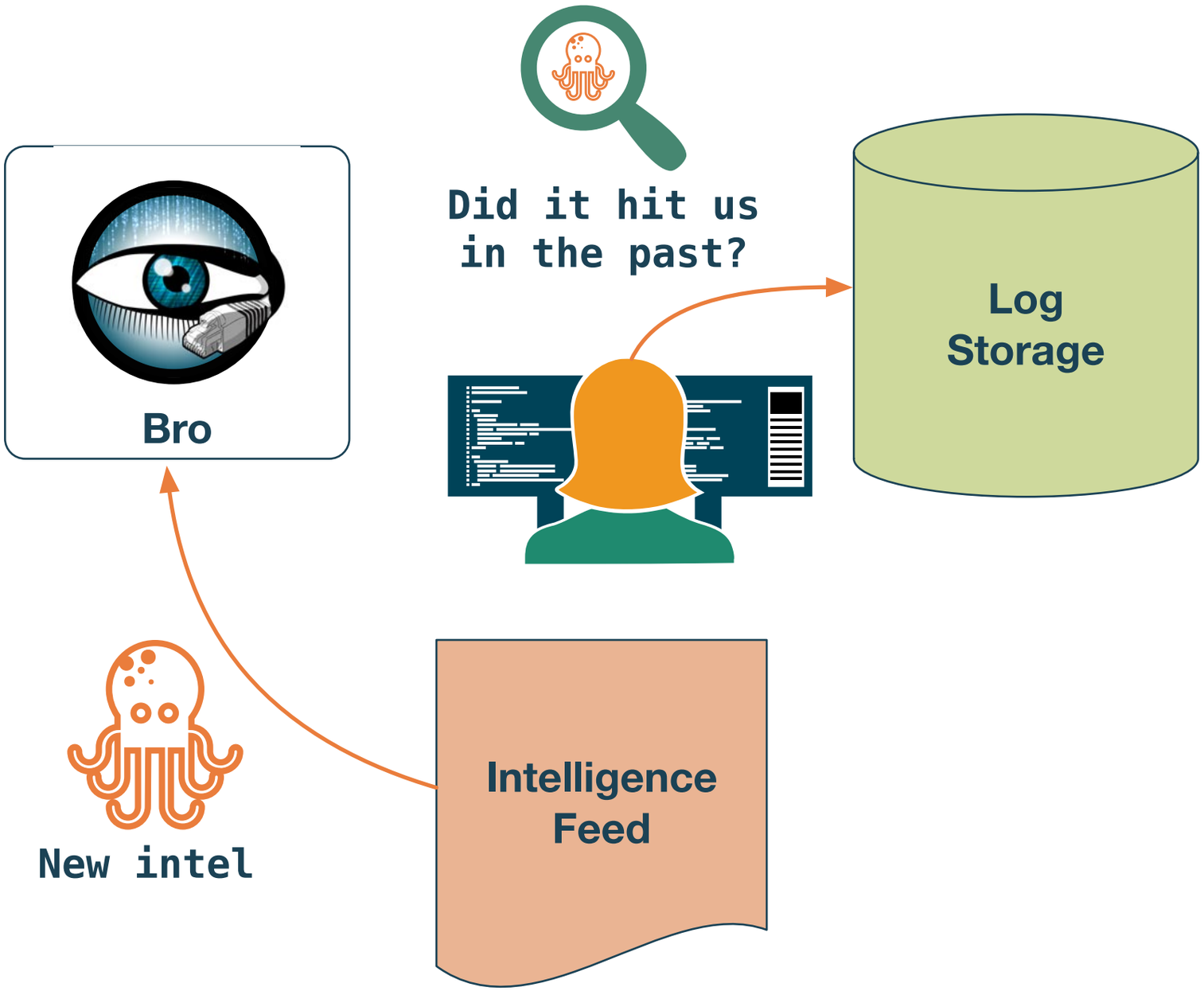
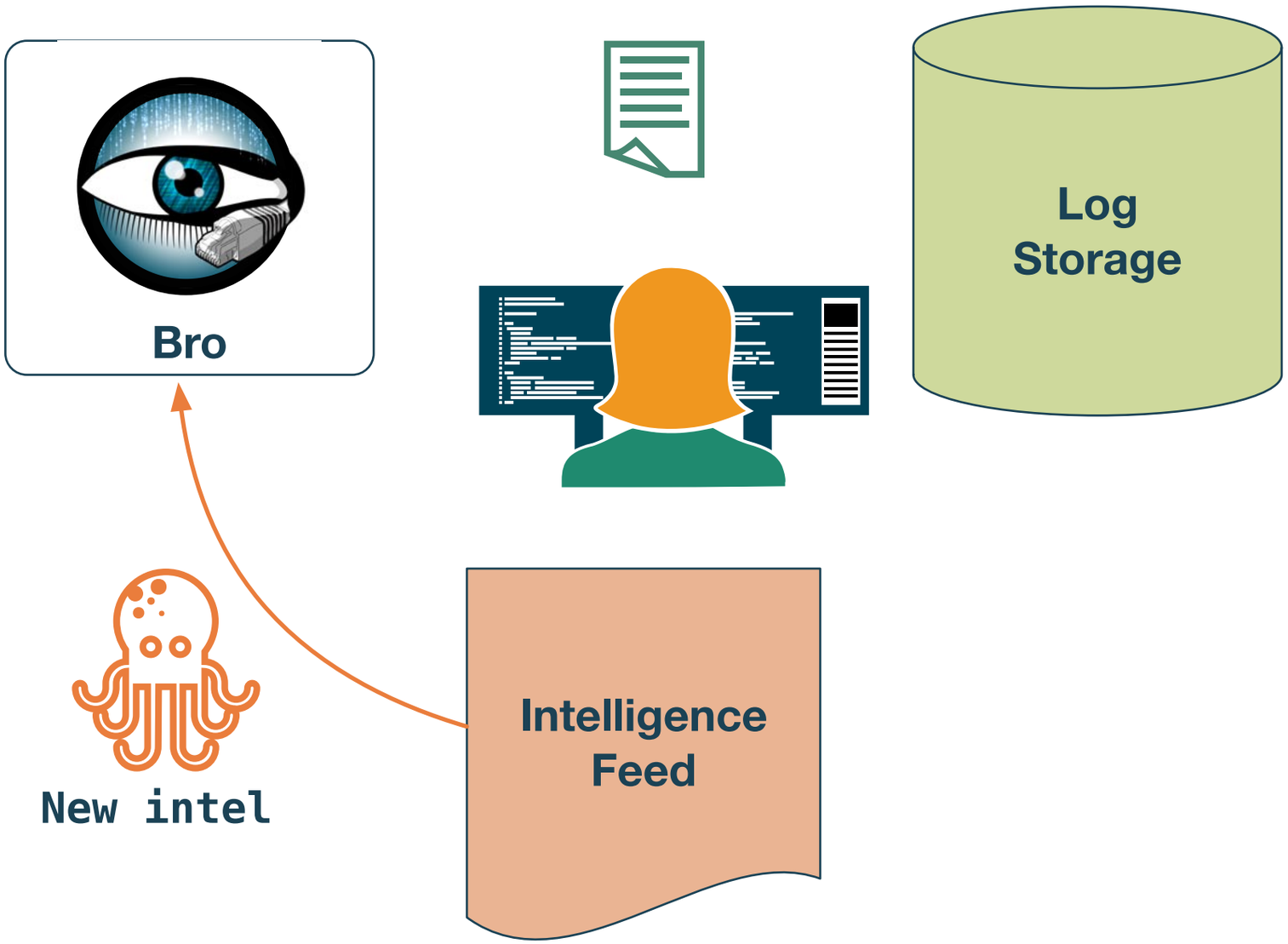

Bro
Did it hit us
in the past?
Log
Storage
Intelligence
Feed
New intel

Scenario


Already
6 weeks ago!
Bro
Log
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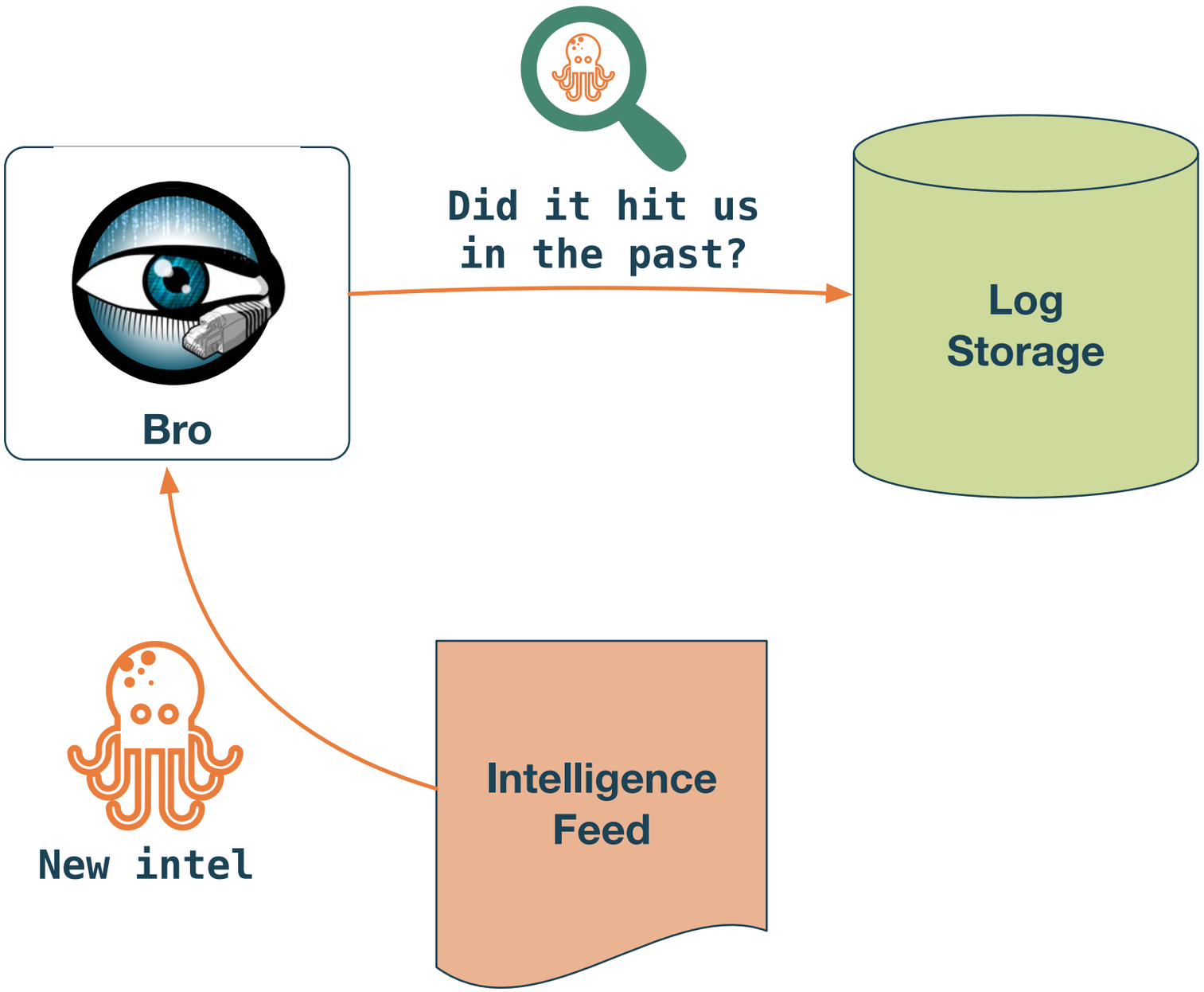
Scenario



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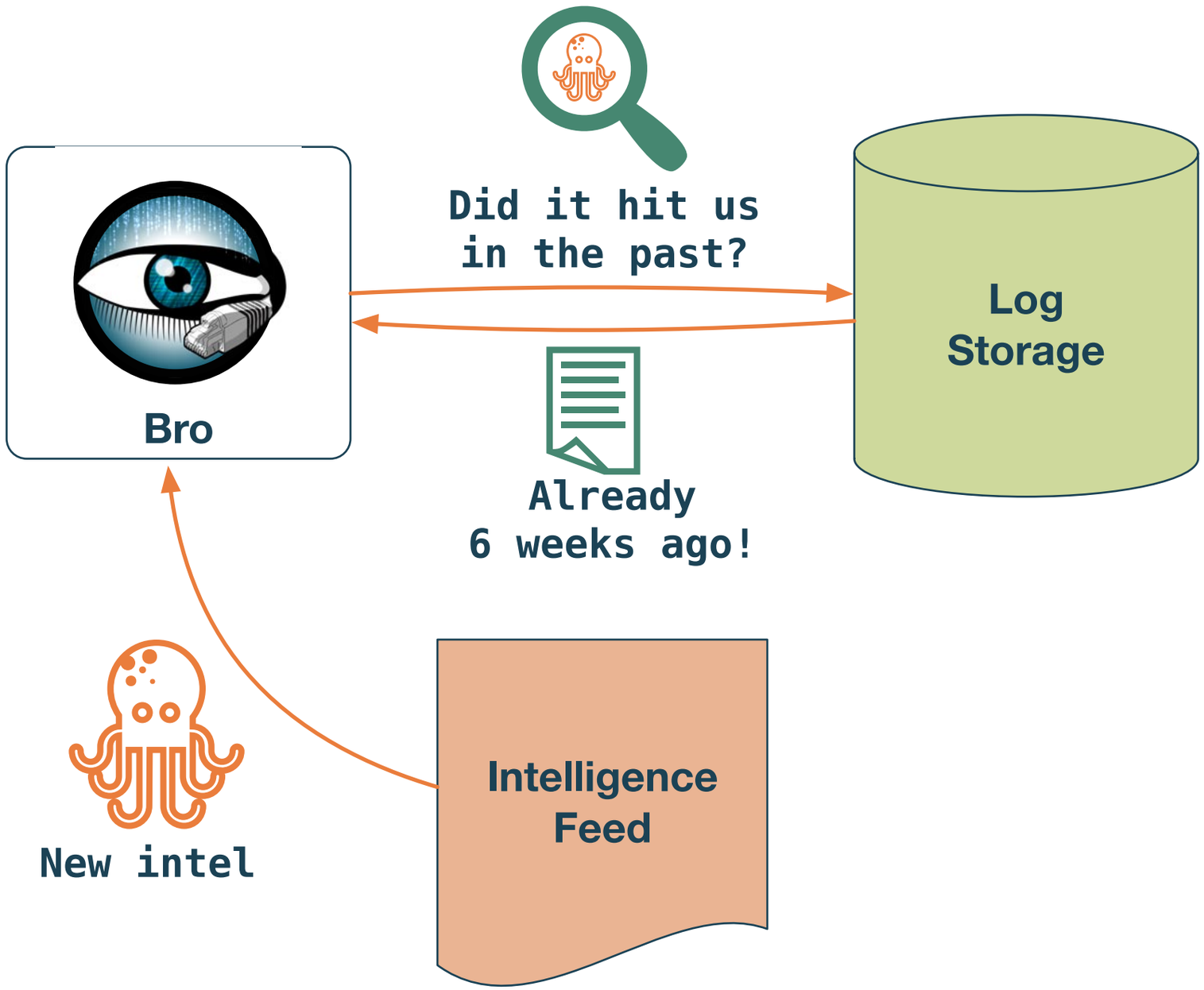
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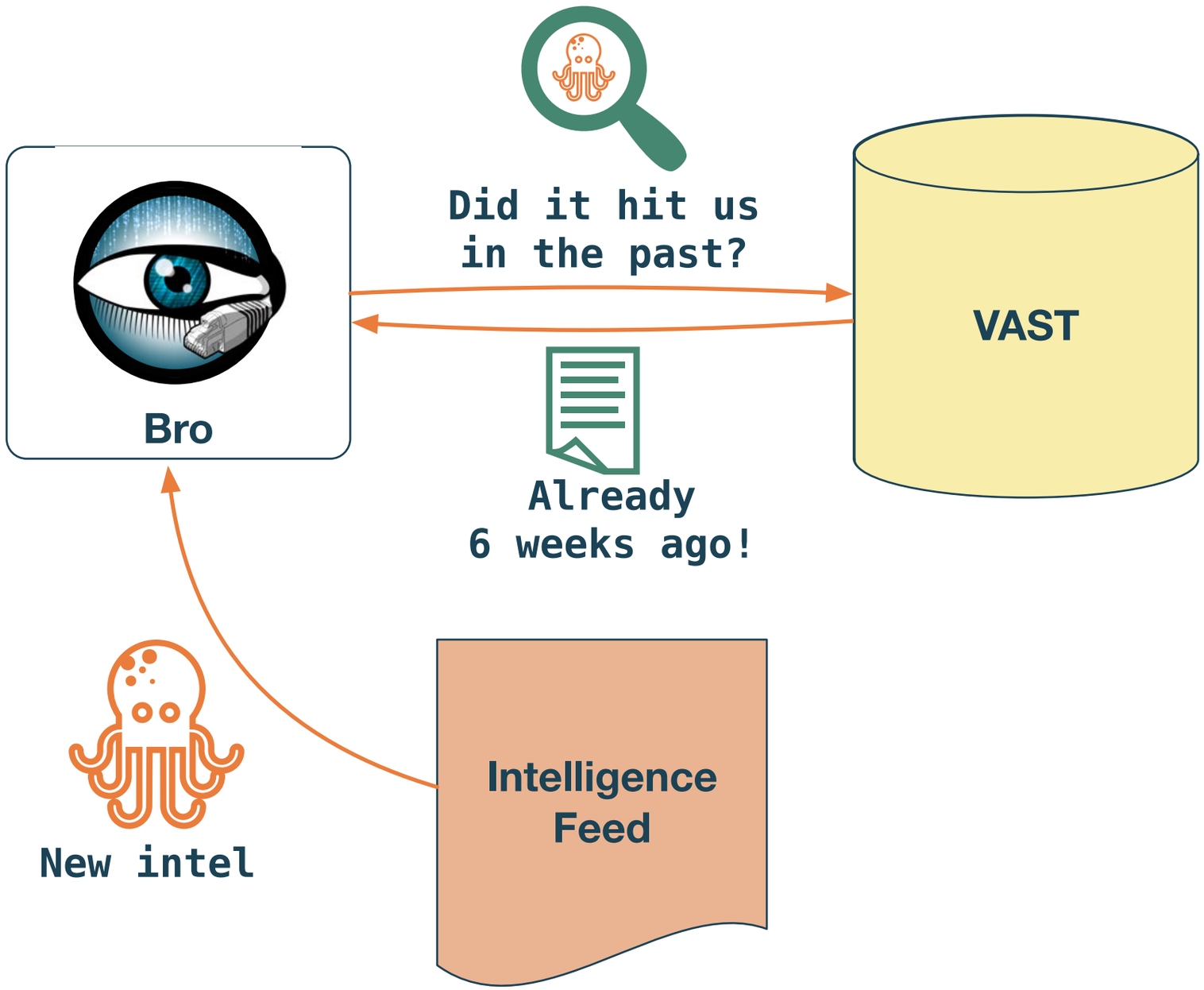
Did it hit us
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VAST
Bro
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Intelligence
Feed

VAST

Visibility Across Space and Time

VAST

*under development

VAST

- Scalable open-source **data plane** for network forensics

*under development

VAST

- Scalable open-source **data plane** for network forensics
- Features
  - **Interactive search** in typed language
  - **Native support for Zeek** & PCAP import and export
  - Integration with **R, Python/Pandas, Spark***

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VAST

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- We are zeeking for alpha testers. Come talk to us!

*under development

VAST

developed by

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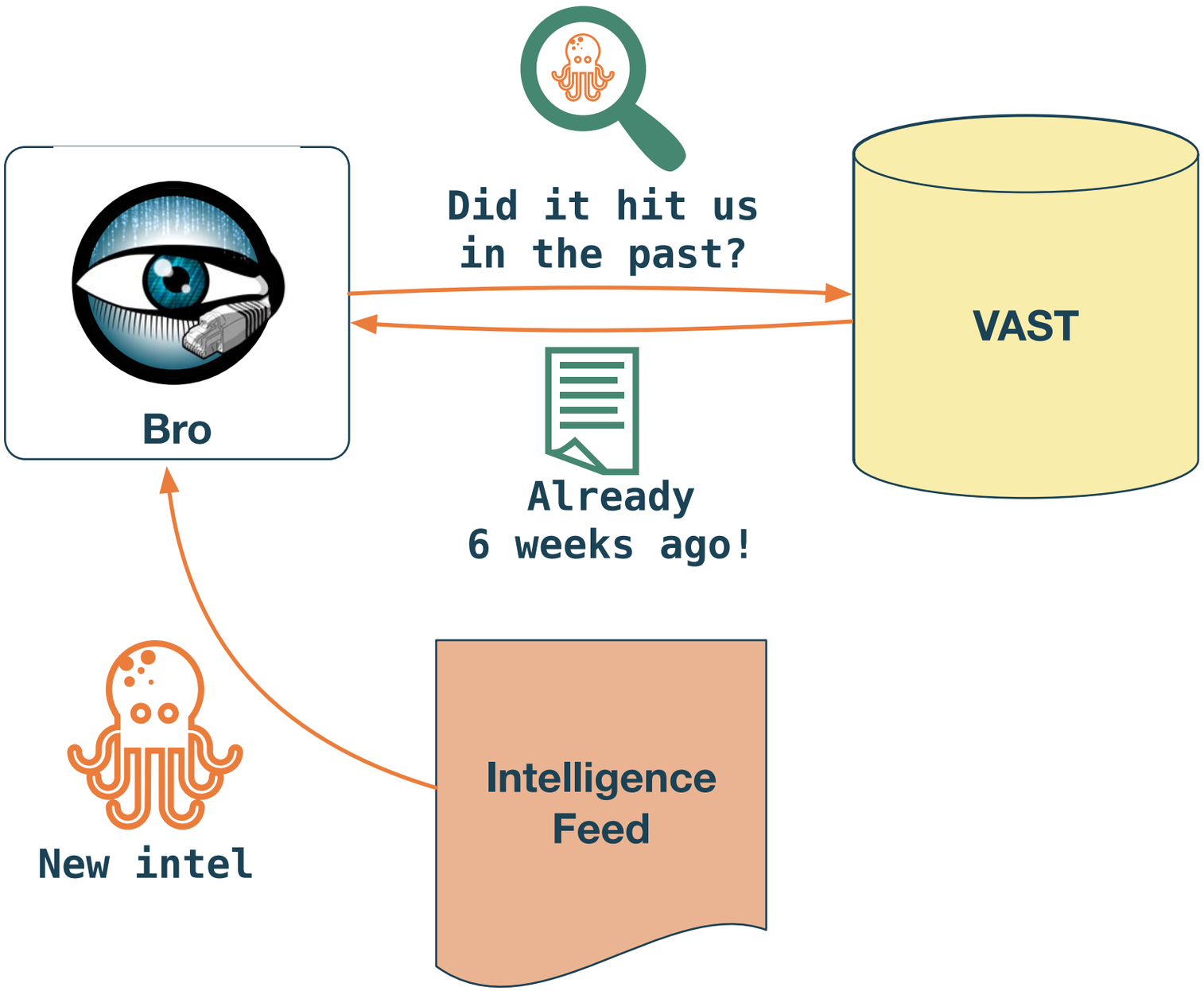
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Scenario

Let’s build this!

(with Broker)

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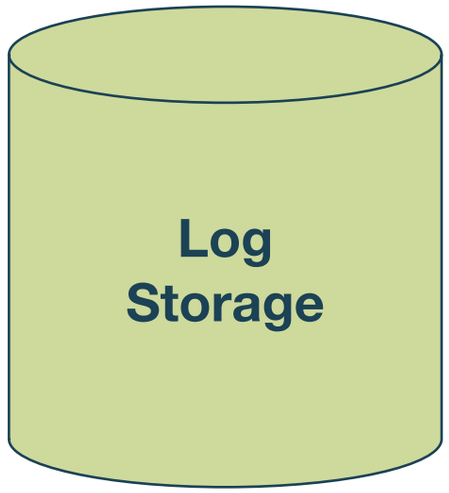
(with Broker)

tenzir/events

Version 1:
Stub →|| Stub

Version 1:
Stub →|← Stub



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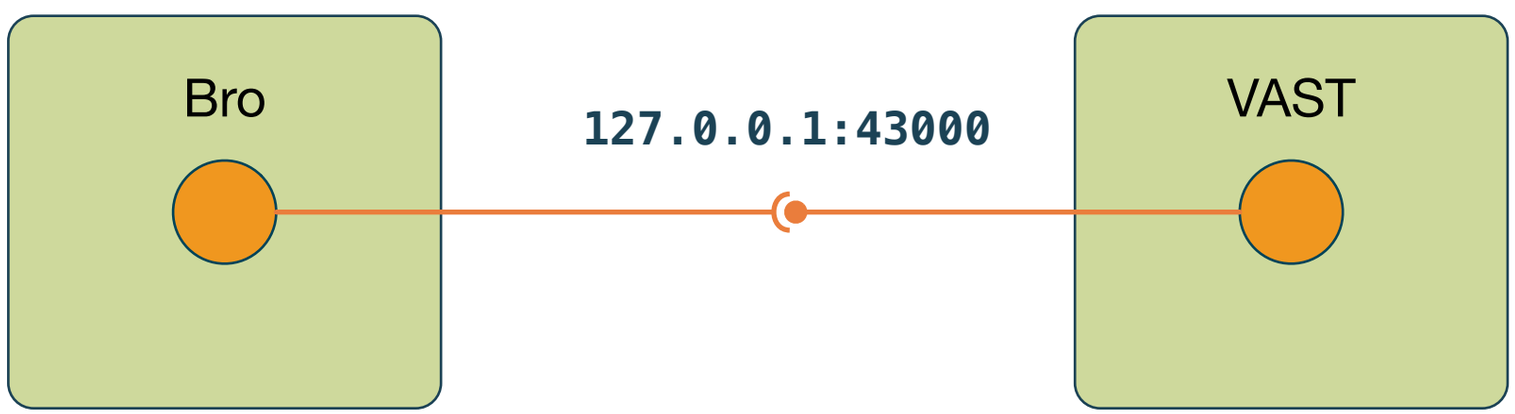


Version 1:
Stub →|← Stub

Version 1:
Stub →|← Stub

/vast/control

Version 1:
Stub →|← Stub

`/vast/data` `/vast/control`

Version 1:
Stub →|← Stub

/vast/control **/vast/data**

Version 1:
Stub →|← Stub

`/vast/control`

`/vast/data -> Bro`

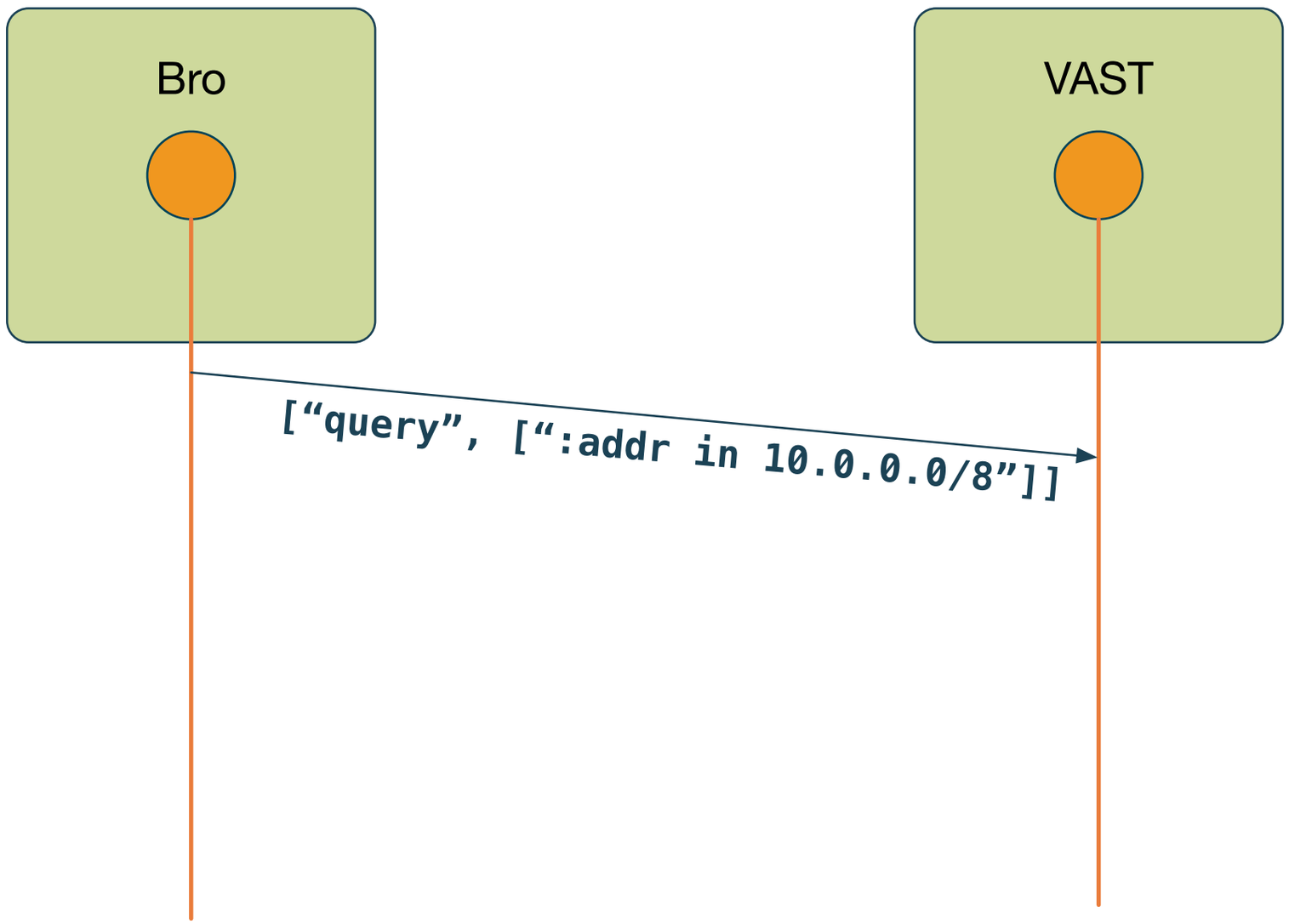
Version 1:
Stub →|← Stub

`/vast/control -> VAST`

`/vast/data -> Bro`

Version 1:
Stub →|← Stub

Version 1:
Stub →|← Stub



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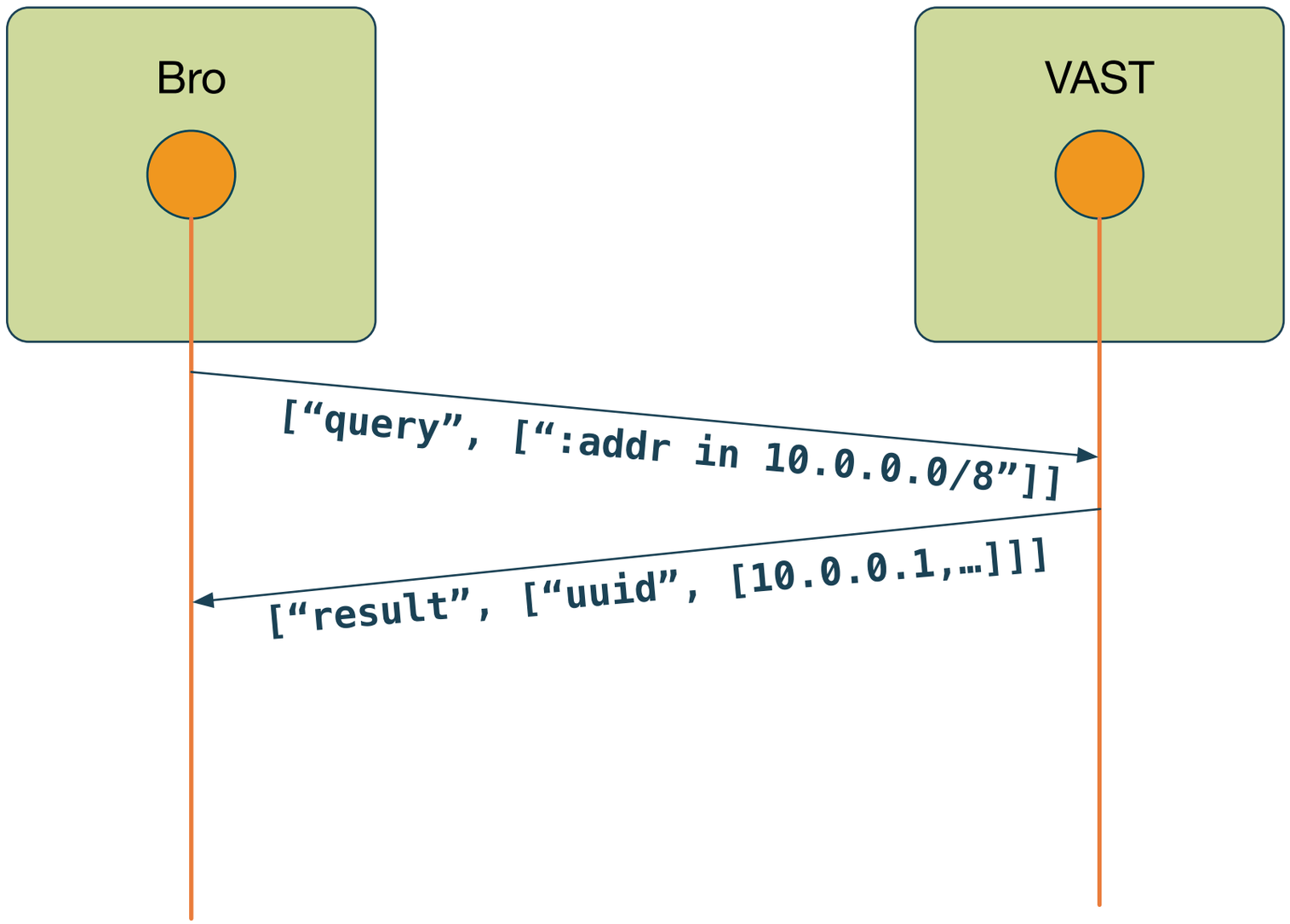

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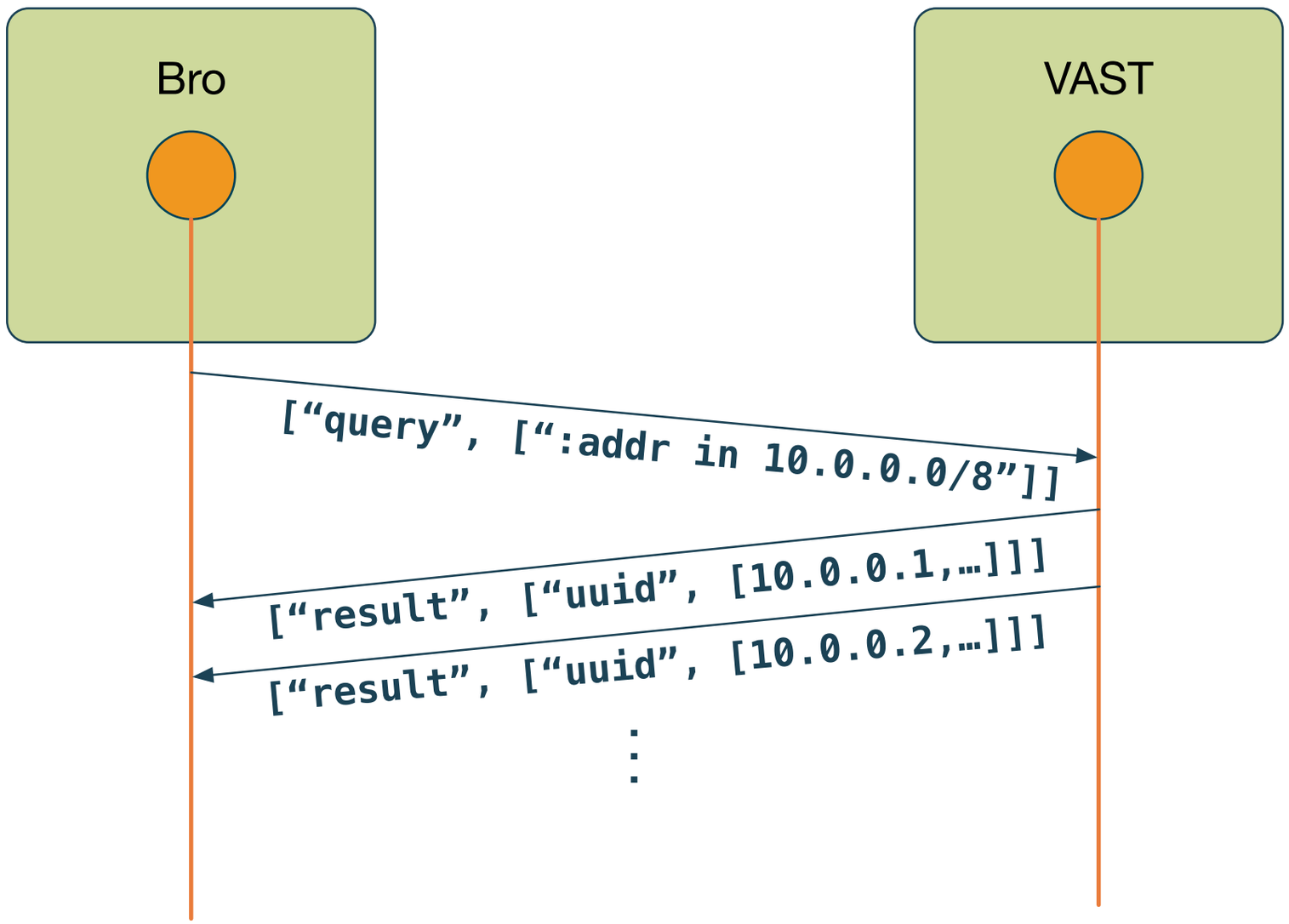

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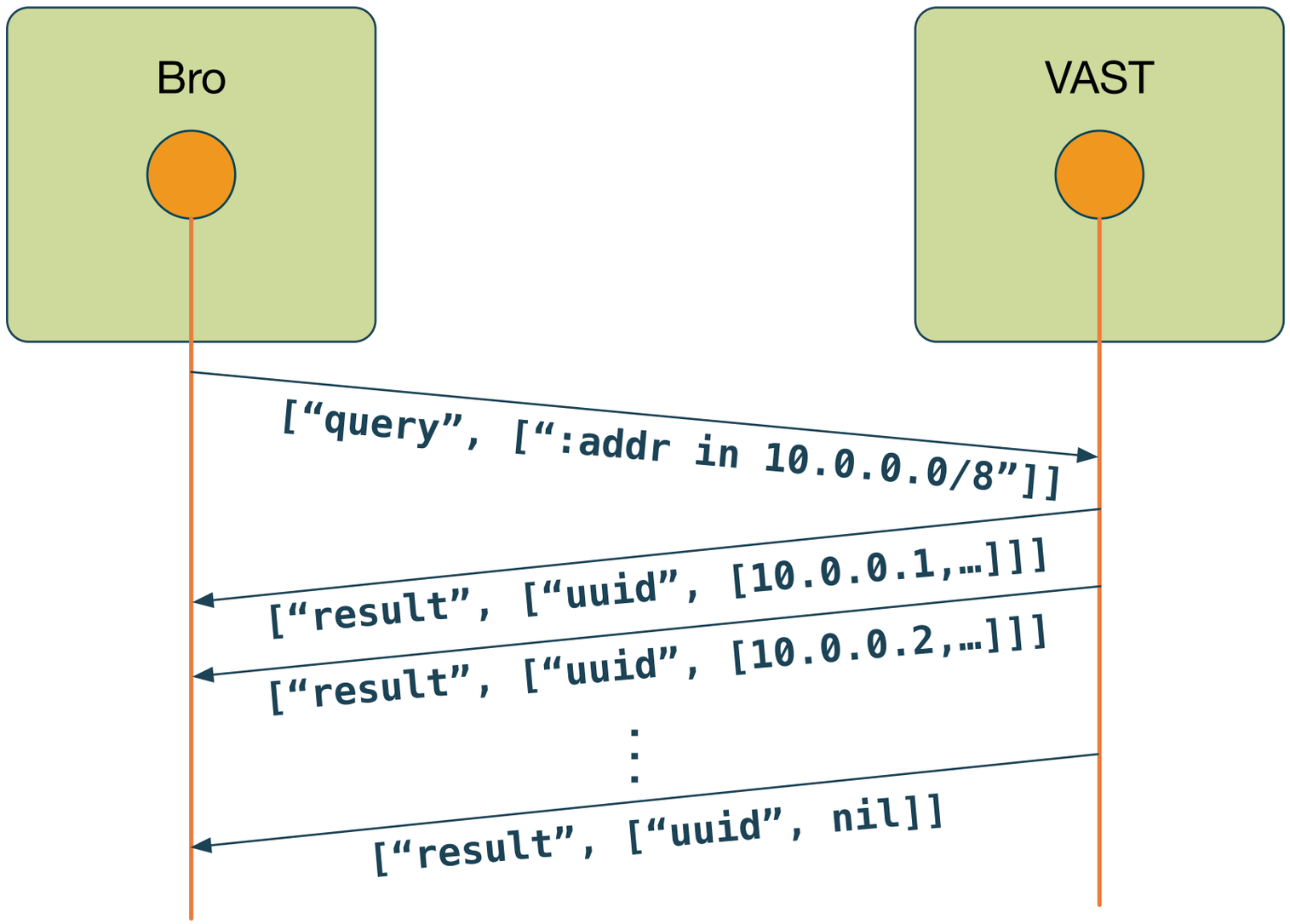

VAST Python Stub

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```
# Create endpoint & subscribers.
endpoint = broker.Endpoint()
subscriber = endpoint.make_subscriber(["/vast/control"])
endpoint.listen("127.0.0.1", 43000)
```

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# Create endpoint & subscribers.
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# Loop until peering established successfully.
while True:
    print("waiting for commands")
    (topic, data) = subscriber.get()
    event = broker.bro.Event(data)
    (qid, expression) = event.args()
```

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while True:
    print("waiting for commands")
    (topic, data) = subscriber.get()
    event = broker.bro.Event(data)
    (qid, expression) = event.args()

    # Answer the query with dummy data
    make_result_event = lambda *xs: broker.bro.Event("VAST::result", qid, *xs)
    generate_data = lambda x: [x, time.ctime(), [IPv4Address("10.0.0.1")]]
    for x in map(generate_data, range(10)):
        endpoint.publish("/vast/data", make_result_event(x))
    endpoint.publish("/vast/data", make_result_event(None))
```

Zeek Python Stub

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endpoint.peer("127.0.0.1", 43000)
```

Zeek Python Stub

```
# Create endpoint & subscribers.
endpoint = broker.Endpoint()
subscriber = endpoint.make_subscriber(["/vast/data"])
endpoint.peer("127.0.0.1", 43000)

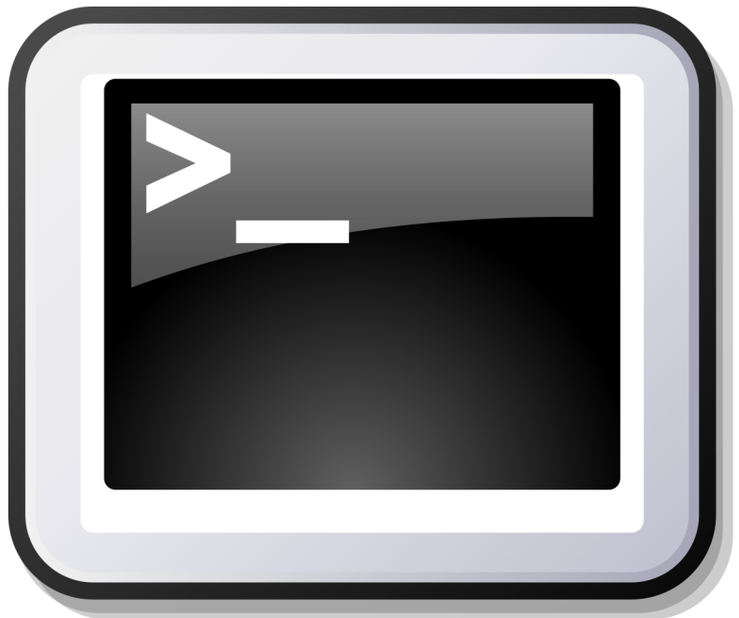
# Create a query event and send it to VAST.
query_id = str(uuid.uuid4()) # random value
event = broker.bro.Event("VAST::query", query_id, ":addr in 10.0.0.0/8")
endpoint.publish("/vast/control", event)
```

Zeek Python Stub

```
# Create endpoint & subscribers.
endpoint = broker.Endpoint()
subscriber = endpoint.make_subscriber(["/vast/data"])
endpoint.peer("127.0.0.1", 43000)

# Create a query event and send it to VAST.
query_id = str(uuid.uuid4()) # random value
event = broker.bro.Event("VAST::query", query_id, ":addr in 10.0.0.0/8")
endpoint.publish("/vast/control", event)

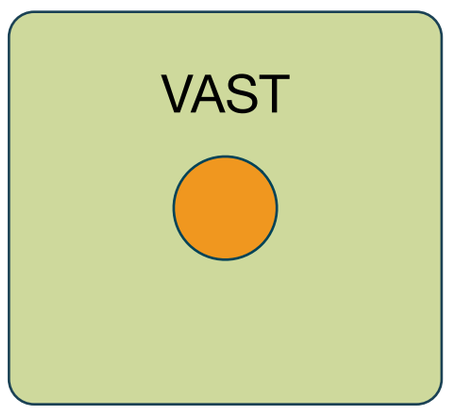
# Loop until we got all results.
while True:
    topic, data = subscriber.get()
    event = broker.bro.Event(data) # parse Broker data as Bro event
    print(topic, event.args())
    (qid, result) = event.args()
    if result is None:
        break; # we're done
```



Demo

Version 2:
Zeek →|| Stub

Version 2:
Zeek →|| ← Stub



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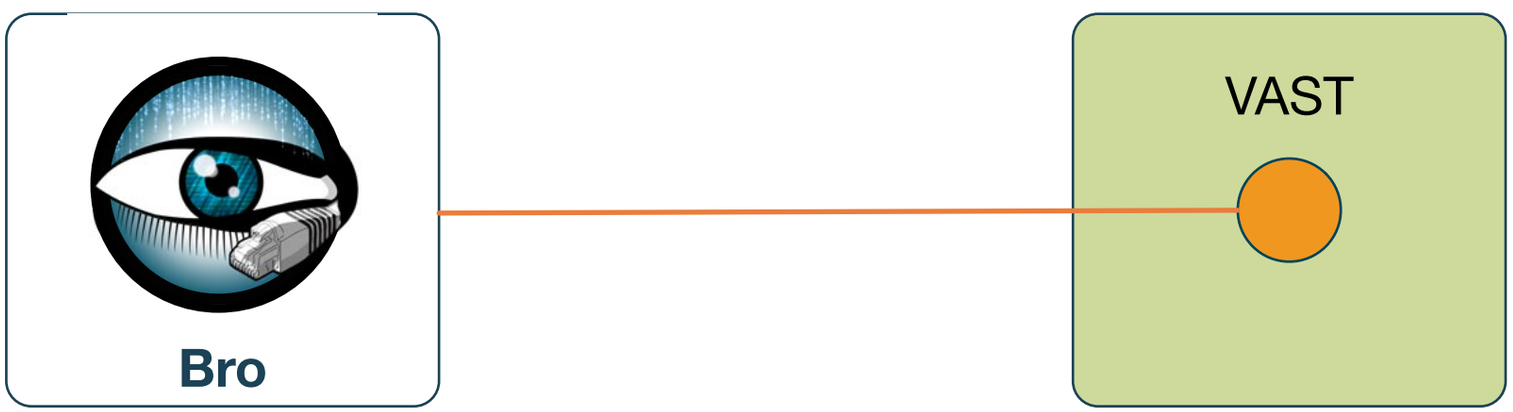

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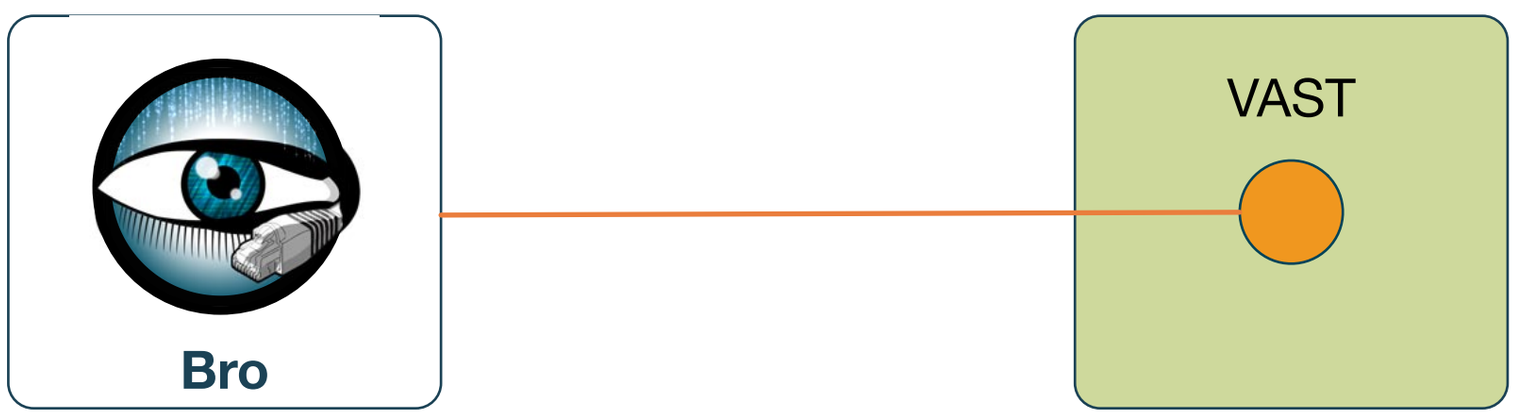


(Protocol same as before)

Zeek Script

Zeek Script

```
event bro_init() {
  Broker::subscribe("/vast/data");
  Broker::peer("127.0.0.1", 43000/tcp);
}
```

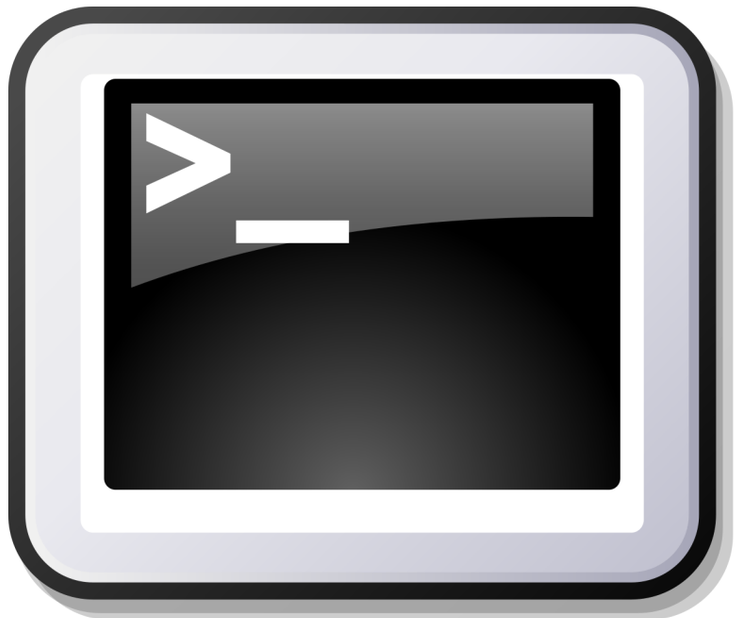
Zeek Script

```
global query: event(id: string, expression: string);

event Broker::peer_added(endpoint: Broker::EndpointInfo, msg: string) {
  local query_id = random_uuid();
  local e = Broker::make_event(query, query_id, expression);
  Broker::publish("/vast/control", e);
}
event bro_init() {
  Broker::subscribe("/vast/data");
  Broker::peer("127.0.0.1", 43000/tcp);
}
```

Zeek Script

```
event result(uuid: string, data: any) {
  switch (data) {
    default:
      terminate(); # harsh way to signal that we're done
      break;
    case type vector of any as xs:
      print xs;
      break;
  }
}
global query: event(id: string, expression: string);
event Broker::peer_added(endpoint: Broker::EndpointInfo, msg: string) {
  local query_id = random_uuid();
  local e = Broker::make_event(query, query_id, expression);
  Broker::publish("/vast/control", e);
}
event bro_init() {
  Broker::subscribe("/vast/data");
  Broker::peer("127.0.0.1", 43000/tcp);
}
```

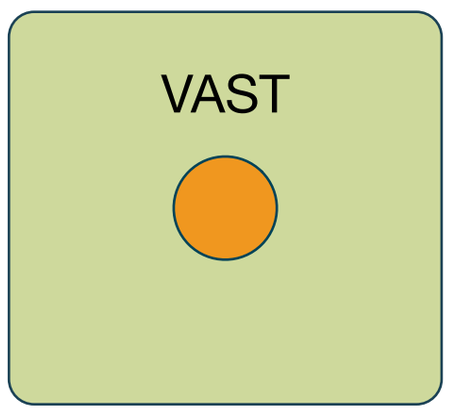


Demo

Version 3:

Zeek →|| VAST

Version 3:
Zeek →|← VAST



Version 3:
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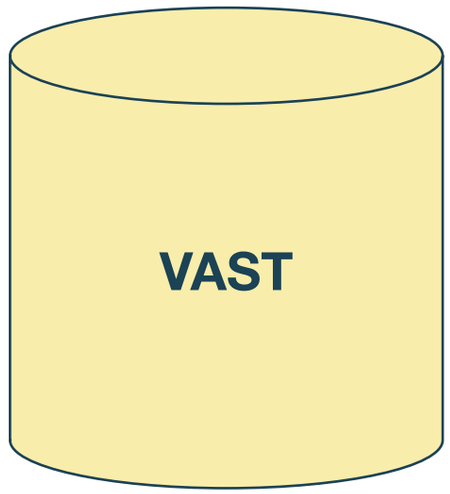

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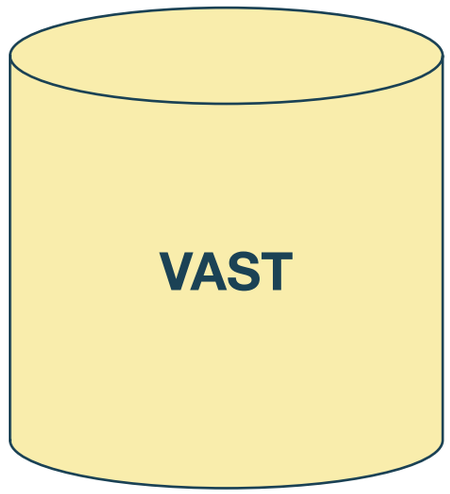

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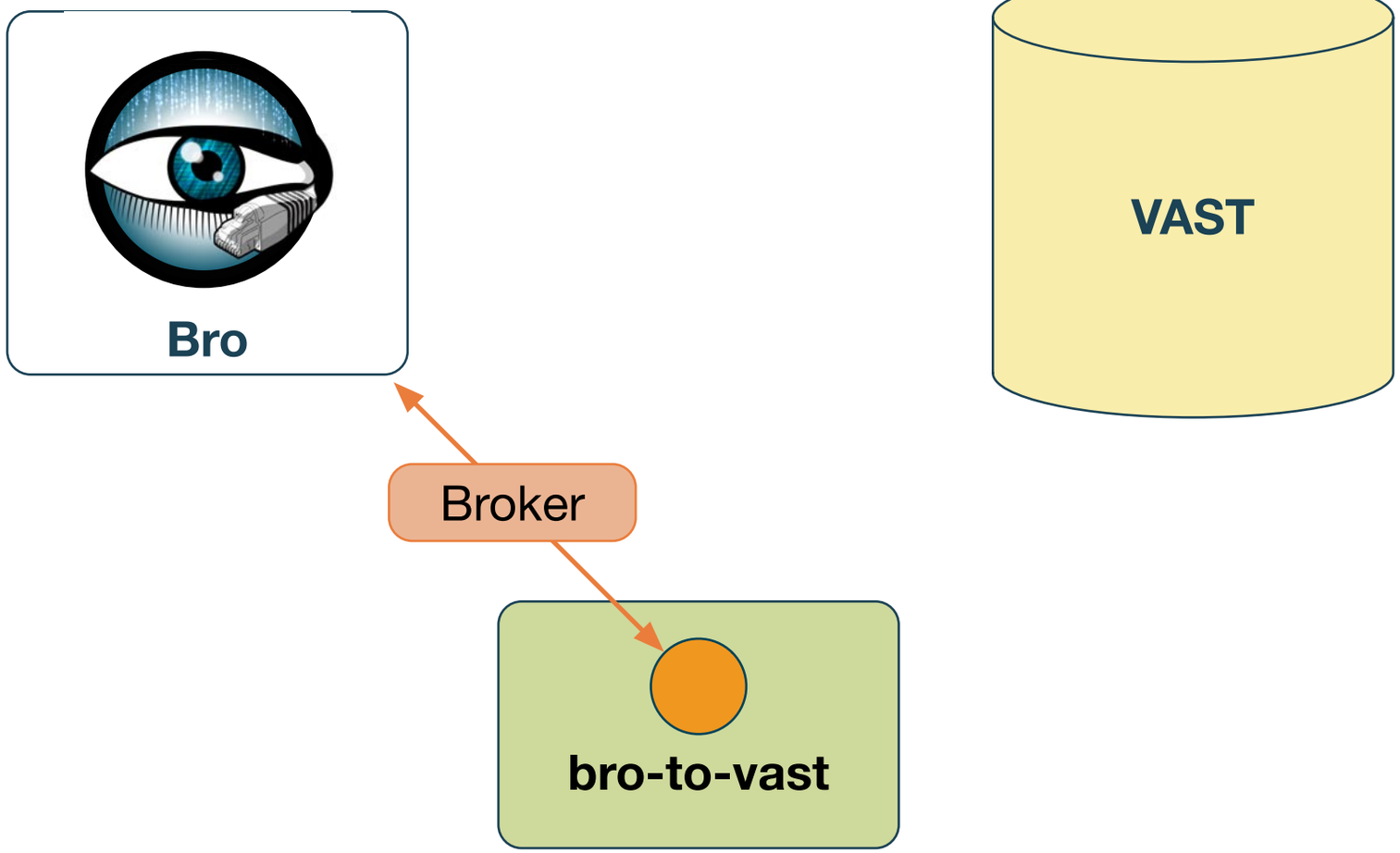

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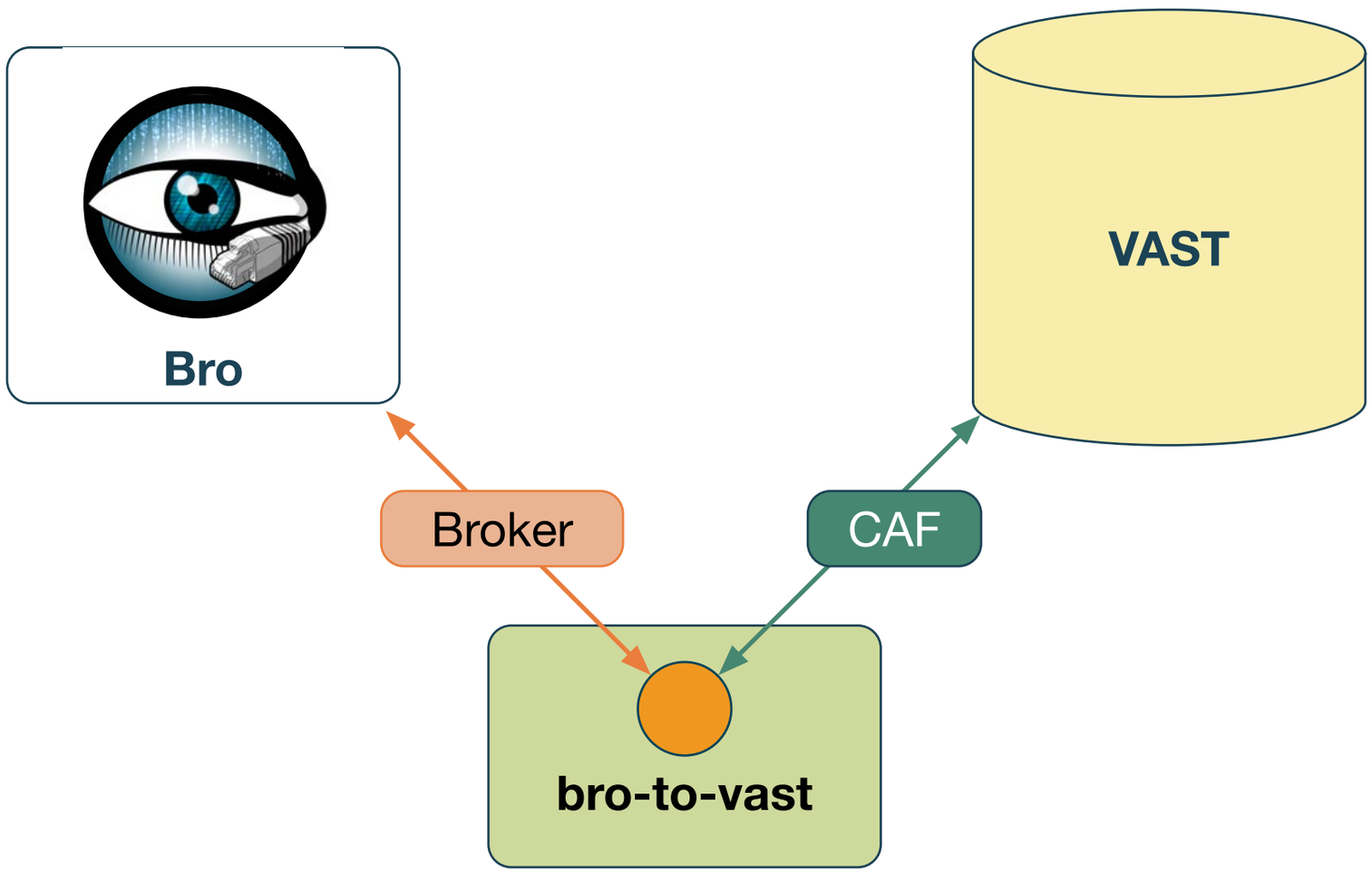

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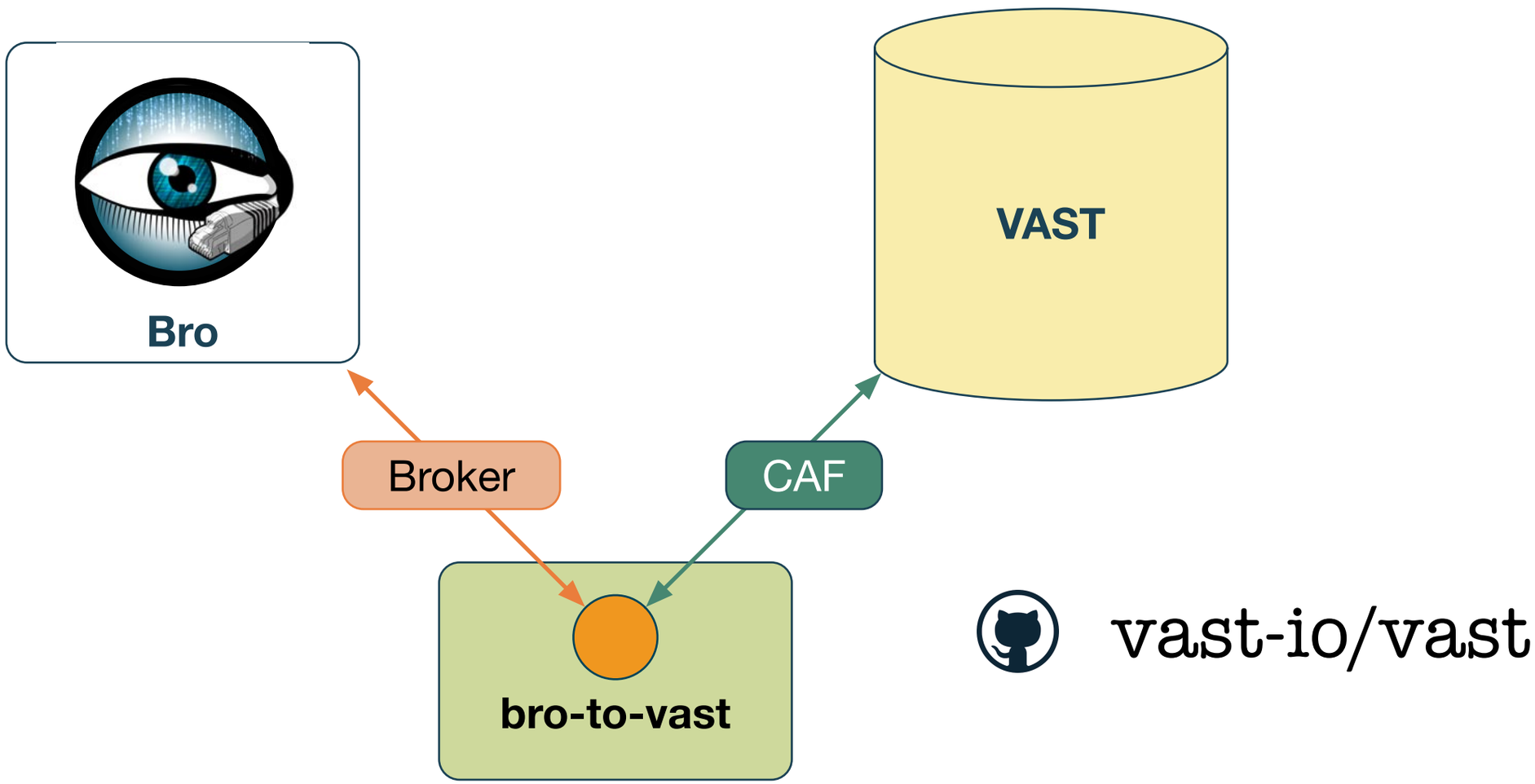
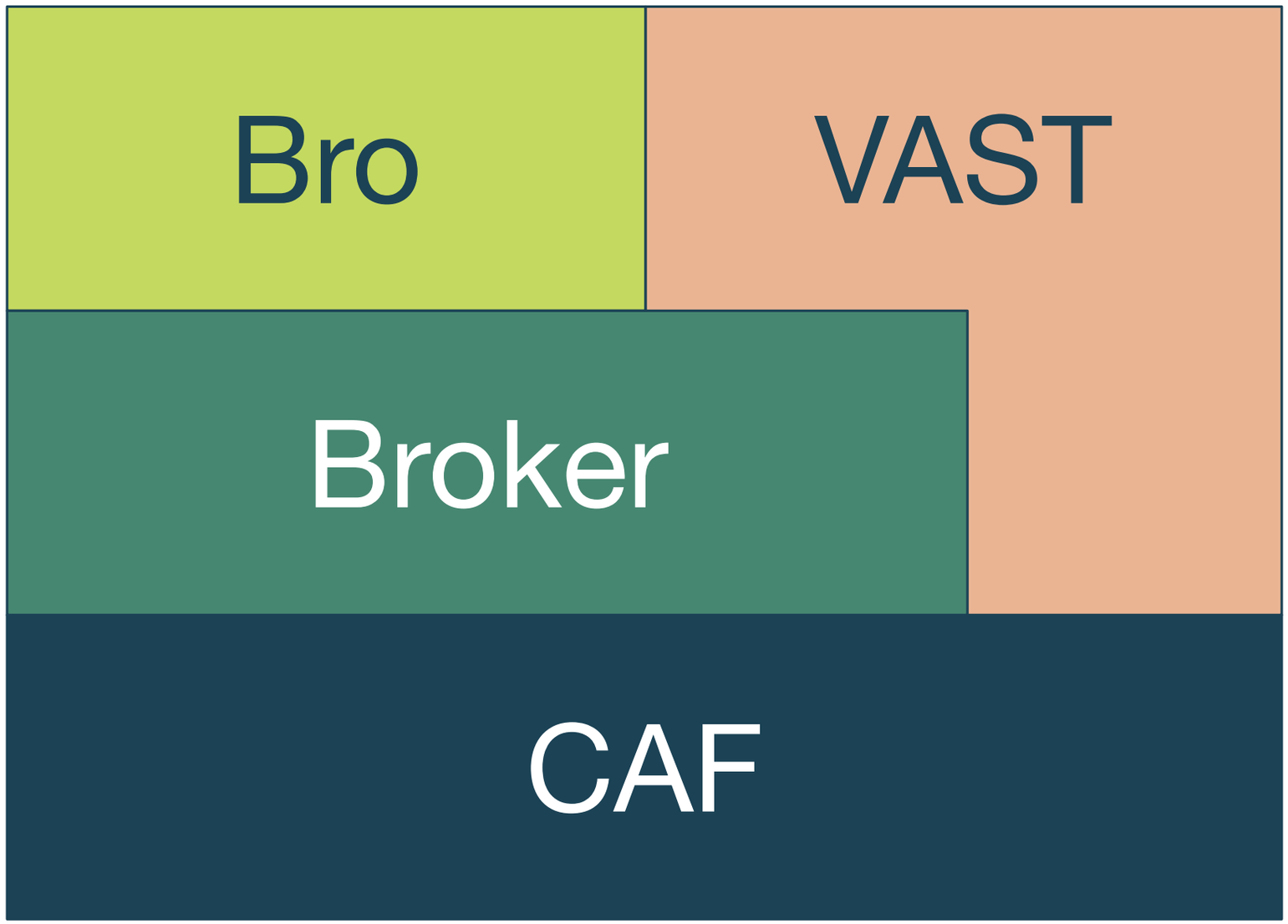
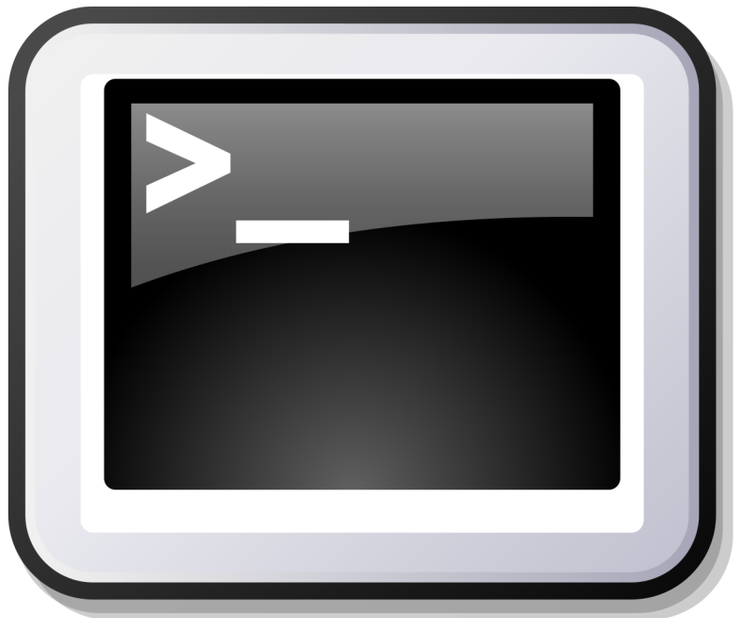


vast-io/vast

Architecture





Demo

Scenario

Scenario

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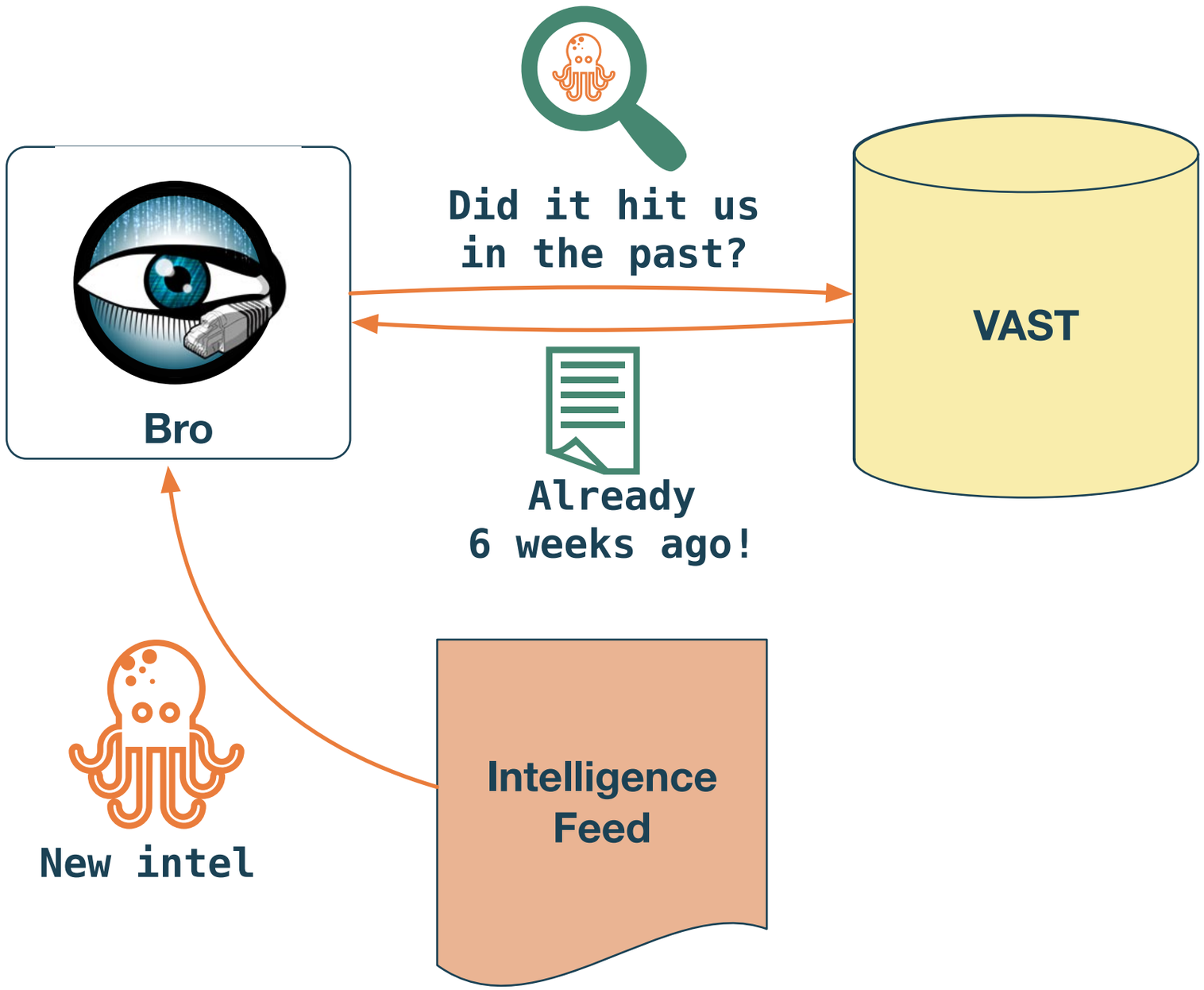
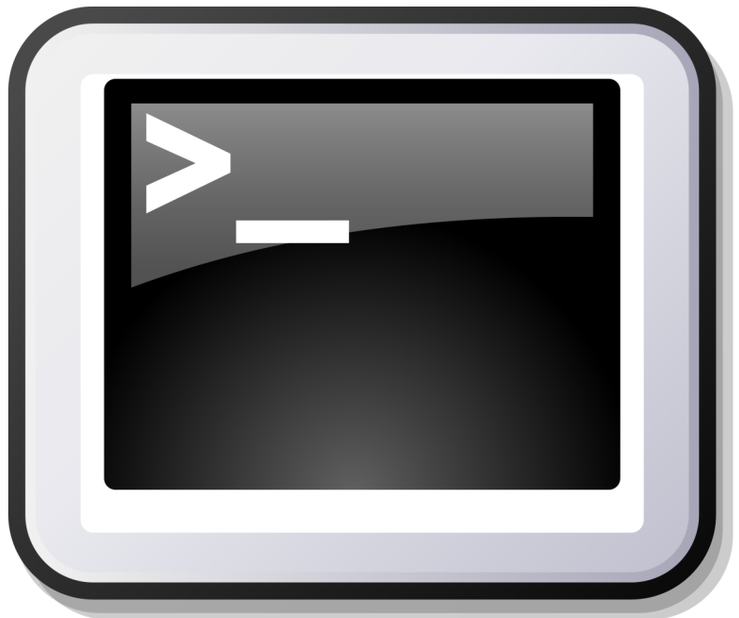

Did it hit us
in the past?
Bro
VAST
Already
6 weeks ago!
New intel
Intelligence
Feed



Demo

Bro Package

tenzir/bro-vast

```
> bro-pkg install bro-vast
```

How does Broker perform?

A Closer Look

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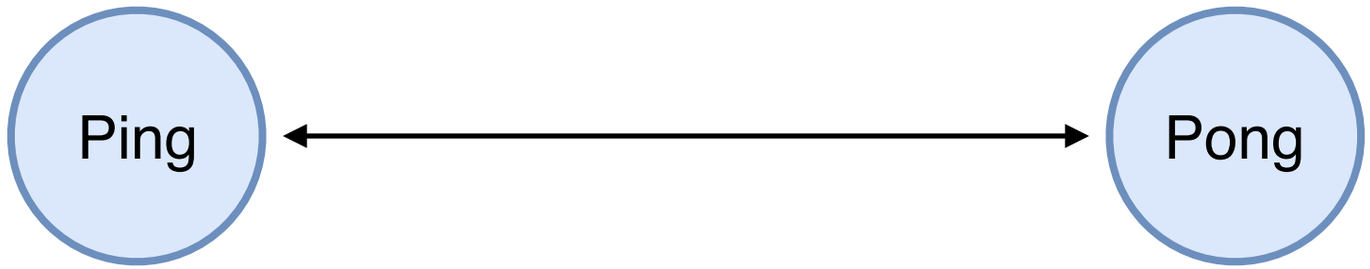
  - **Request-response**: lookup and answer
  - **Streaming results** to the query issuer
- How does Broker perform in **microbenchmarks**?
  - **Latency** between lookup and answer
  - **Throughput** of result stream

Testing Setup

- AMD Opteron 6376, 2.3 GHz, 500GB RAM
- 2 CPUs, 16 cores each
- 64 logical processors (hyper-threading)
- OpenSUSE Leap 42.3
- Localhost communication only (microbenchmarking)

Roundtrip Latency Setup



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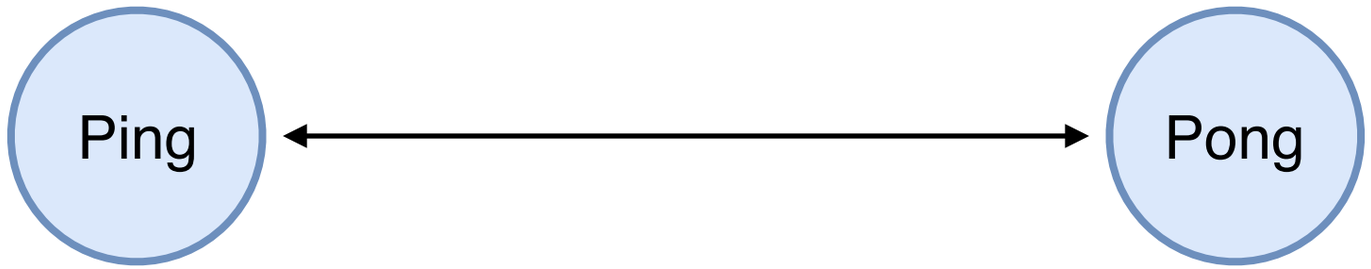

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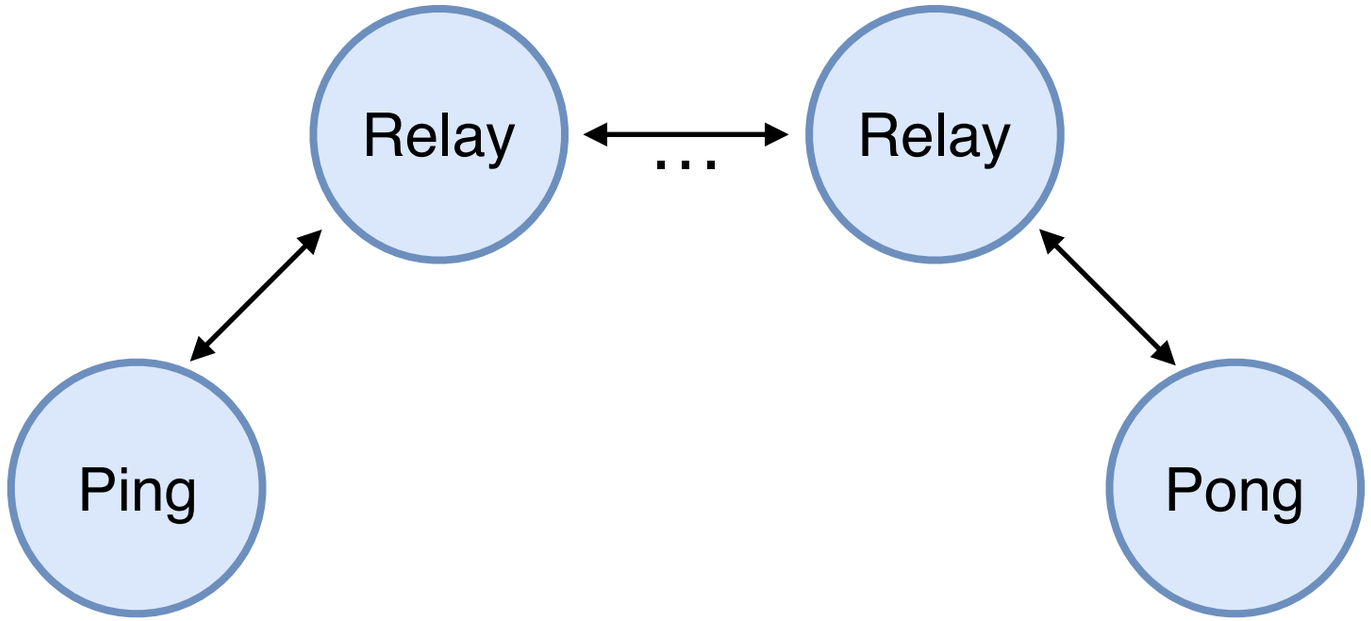

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- Varying **payload sizes** and varying **number of relays**

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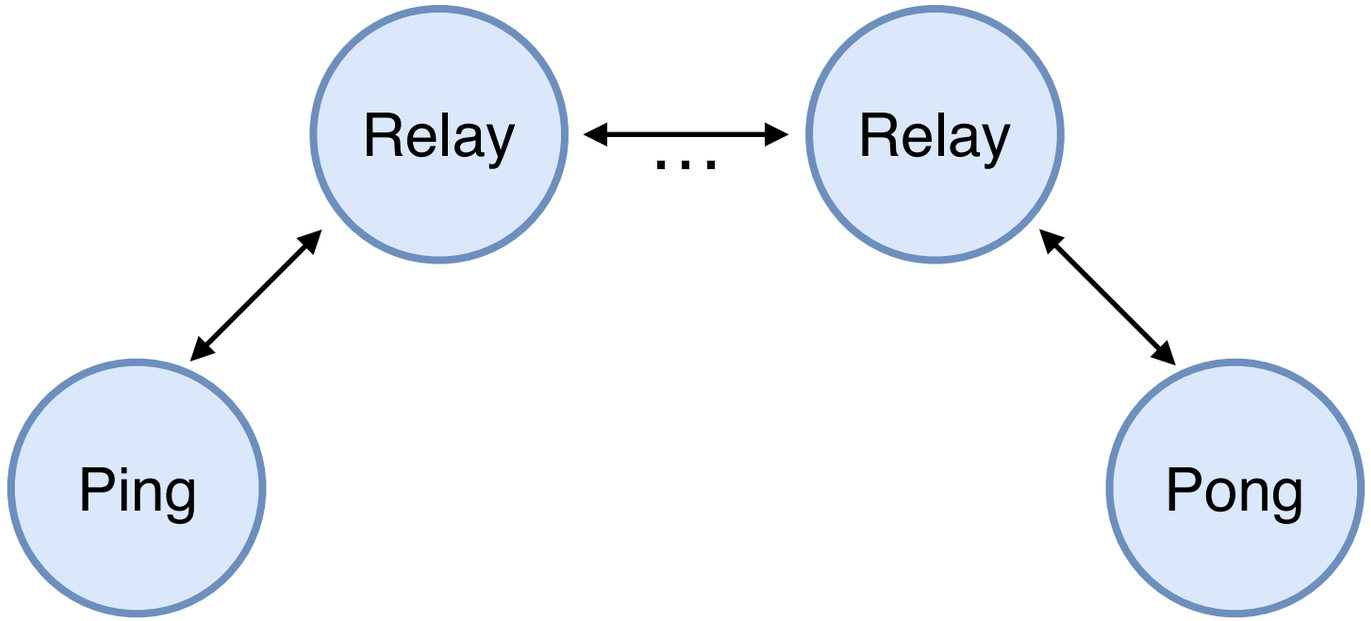
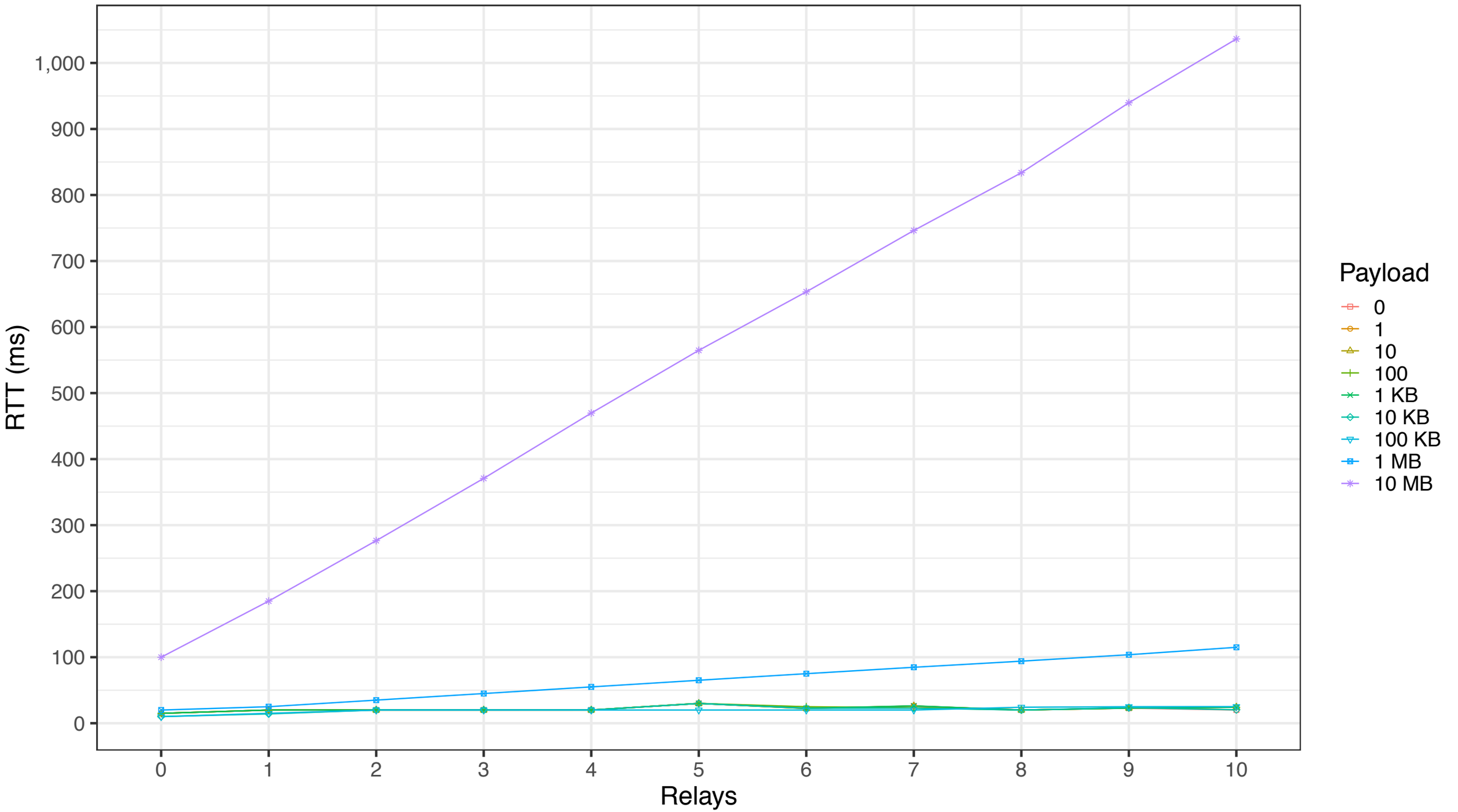


- **Measured**: time between send and receive on *Ping*
- Varying **payload sizes** and varying **number of relays**
- **Expectation**: linear latency increase with number of relays

Roundtrip Latency



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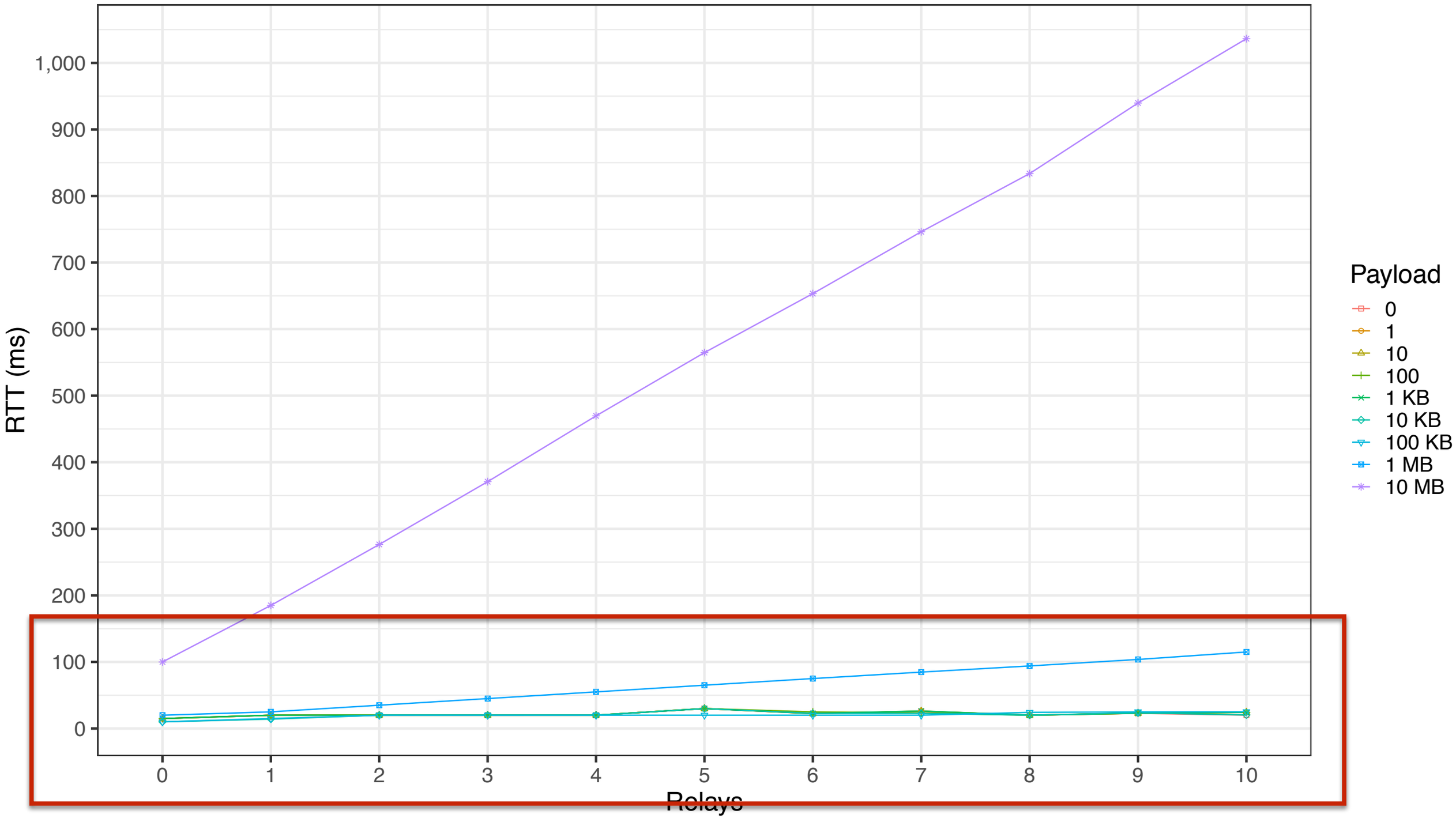

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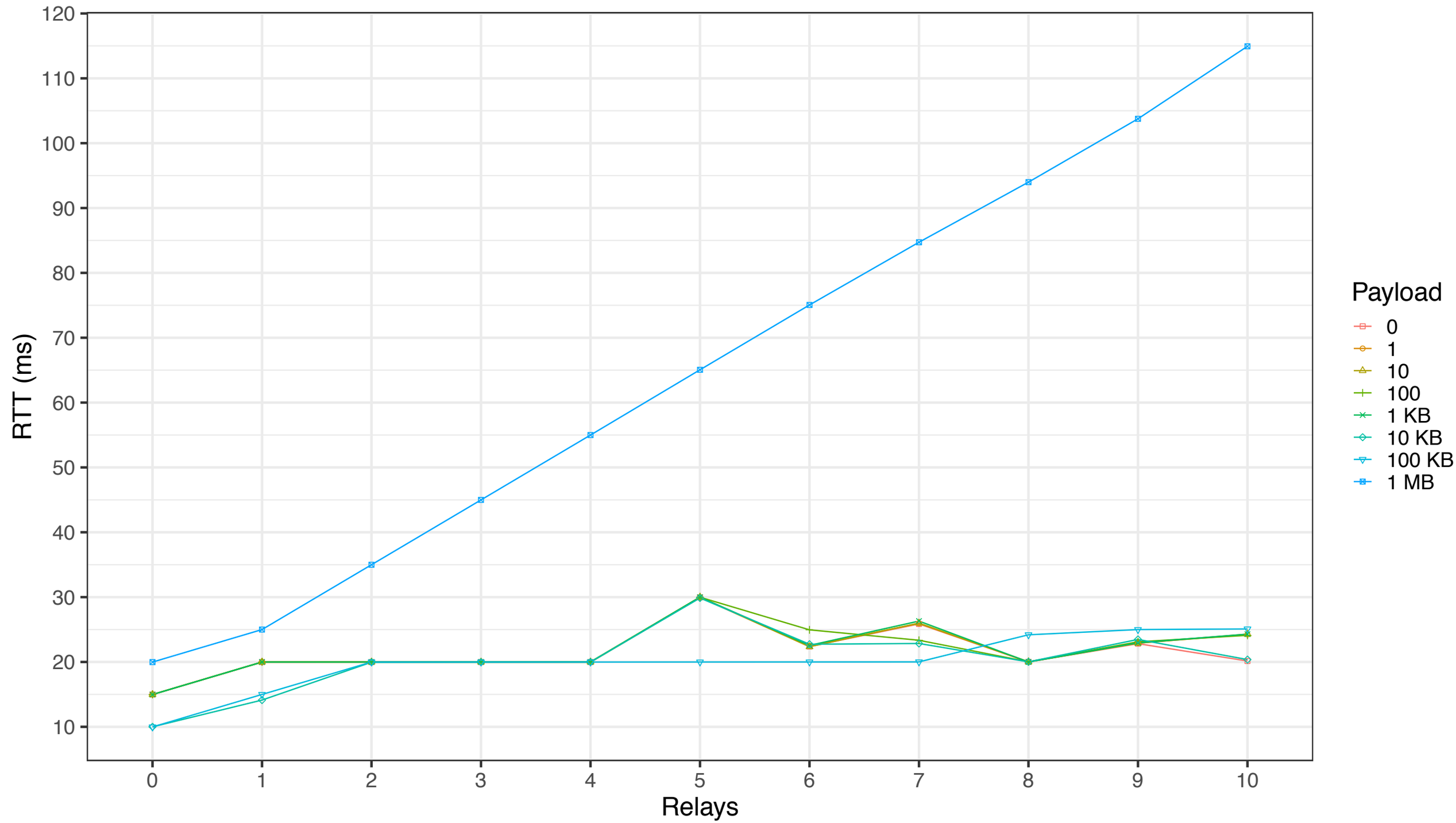

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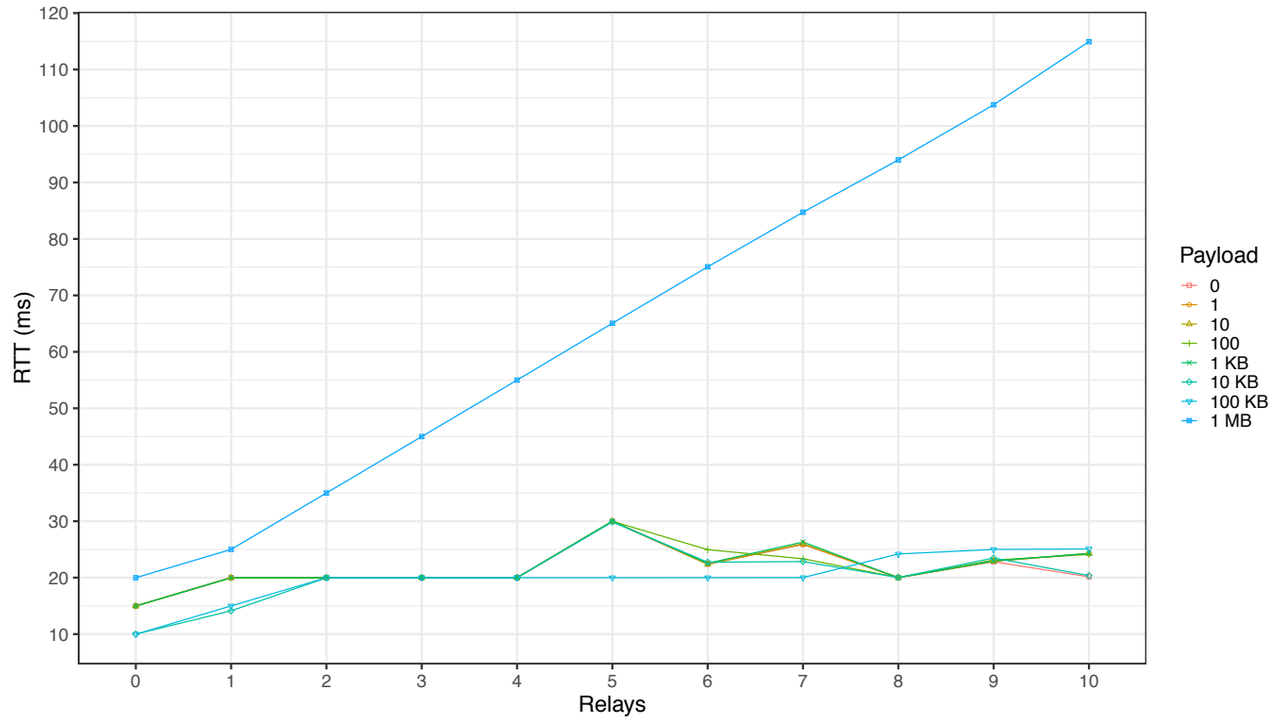

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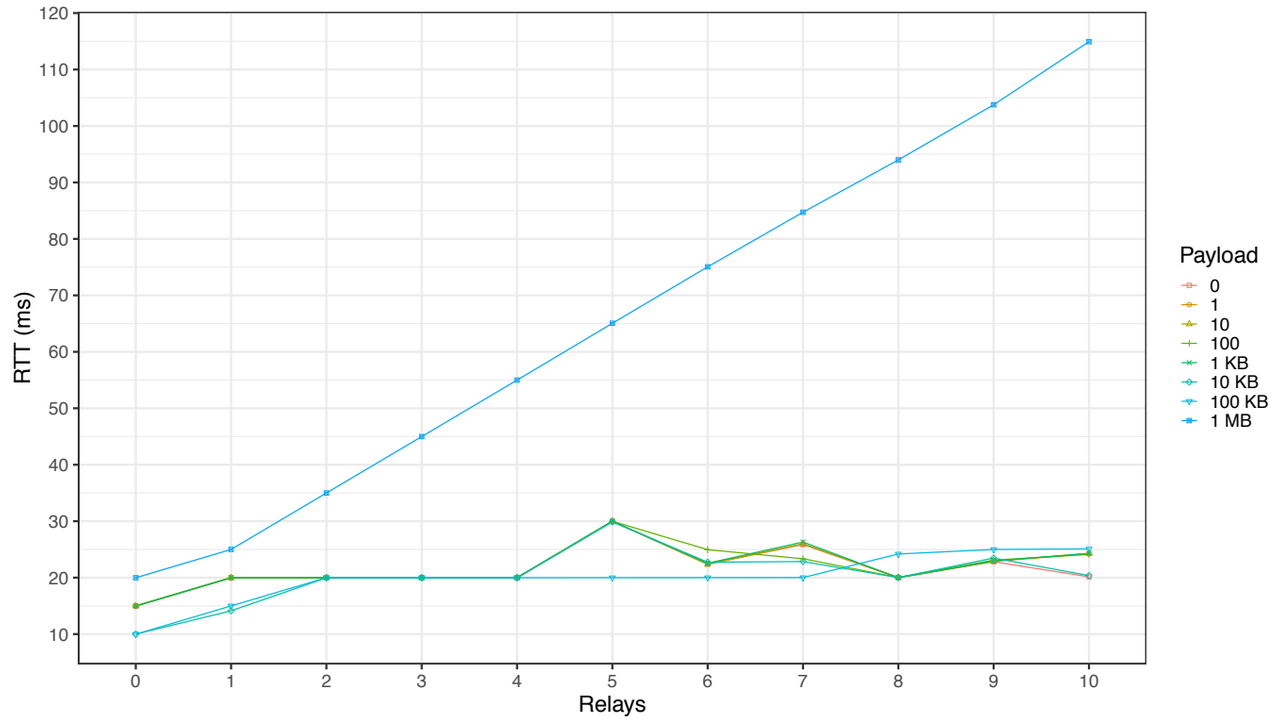

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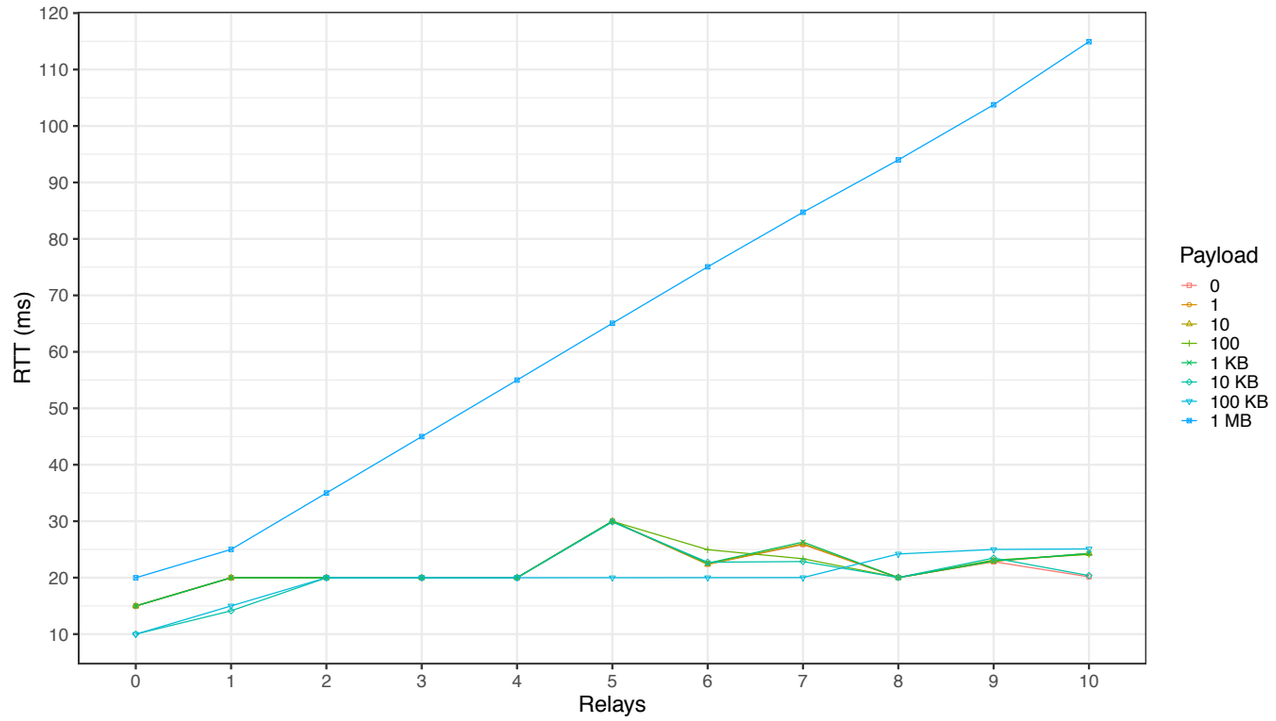

- Payloads **≤ 100 KB** behave similarly
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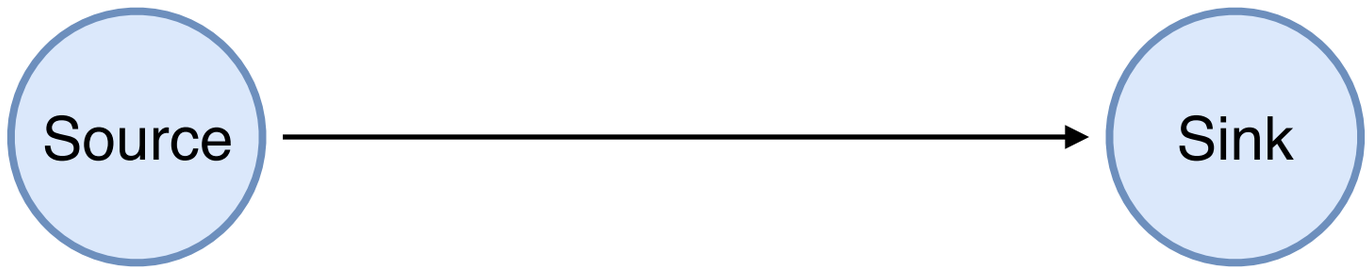
- **Small penalty** for adding additional relays

Throughput Setup



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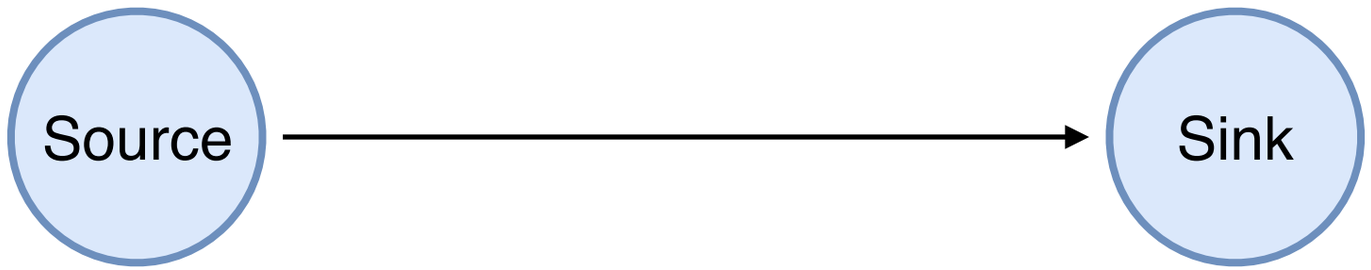
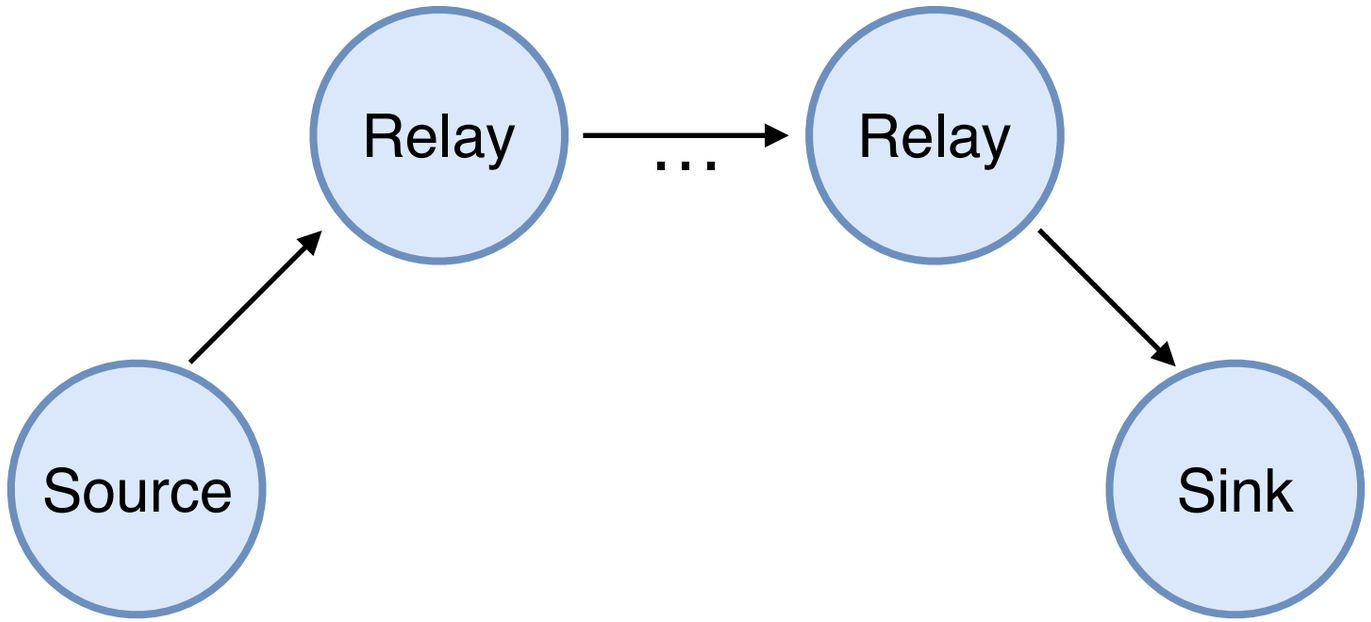


- **Measured**: messages per second received by *Sink*

Throughput Setup



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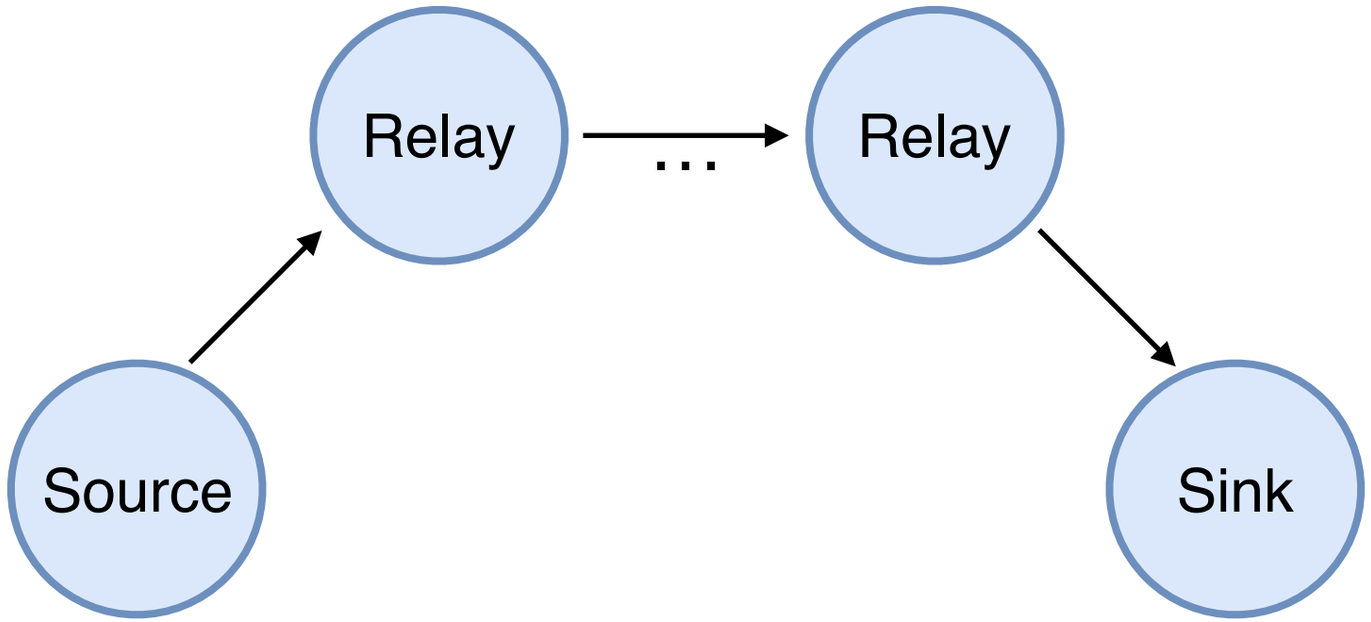

- **Measured**: messages per second received by *Sink*
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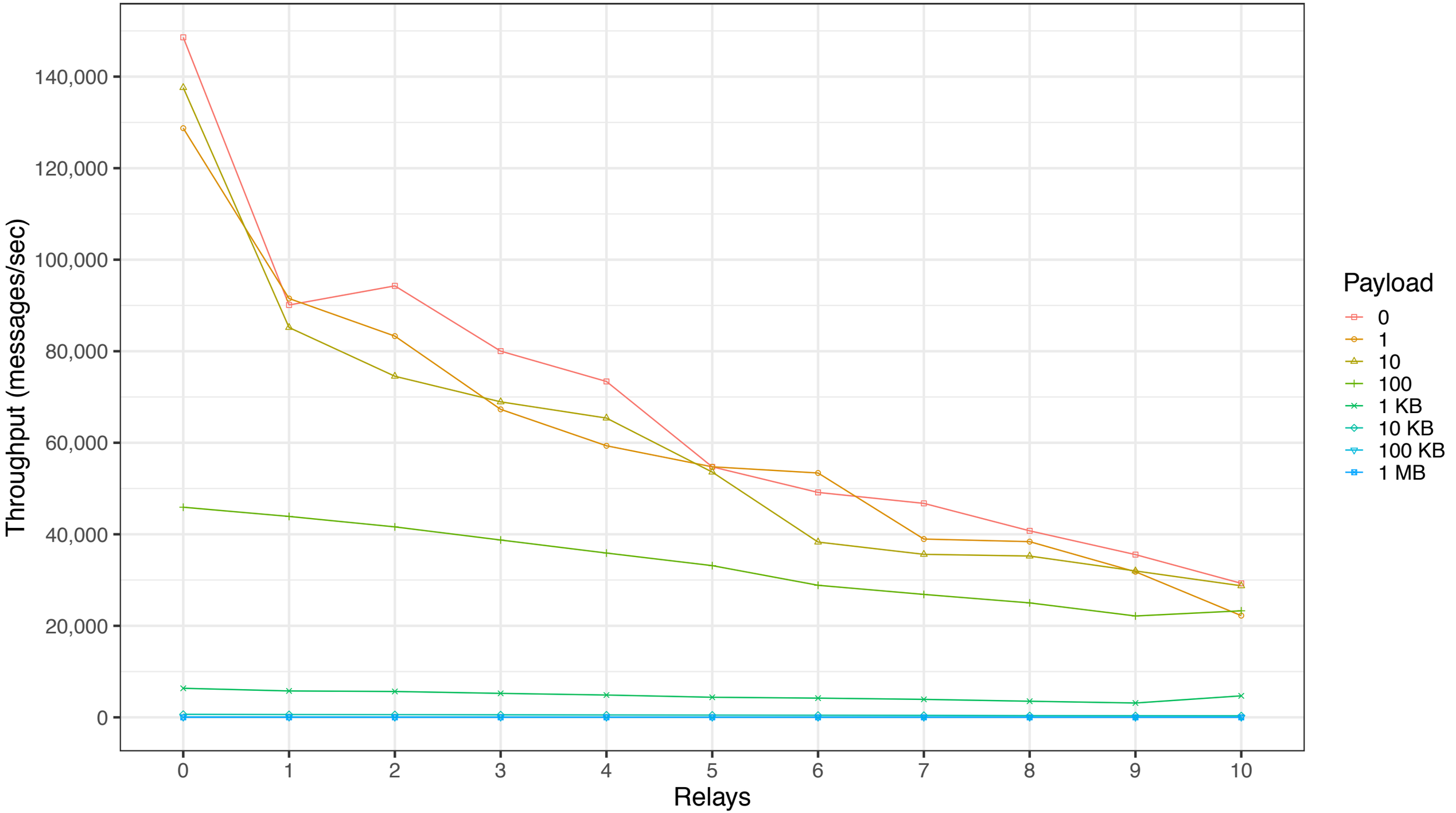
- **Expectation**: throughput should remain constant

Throughput



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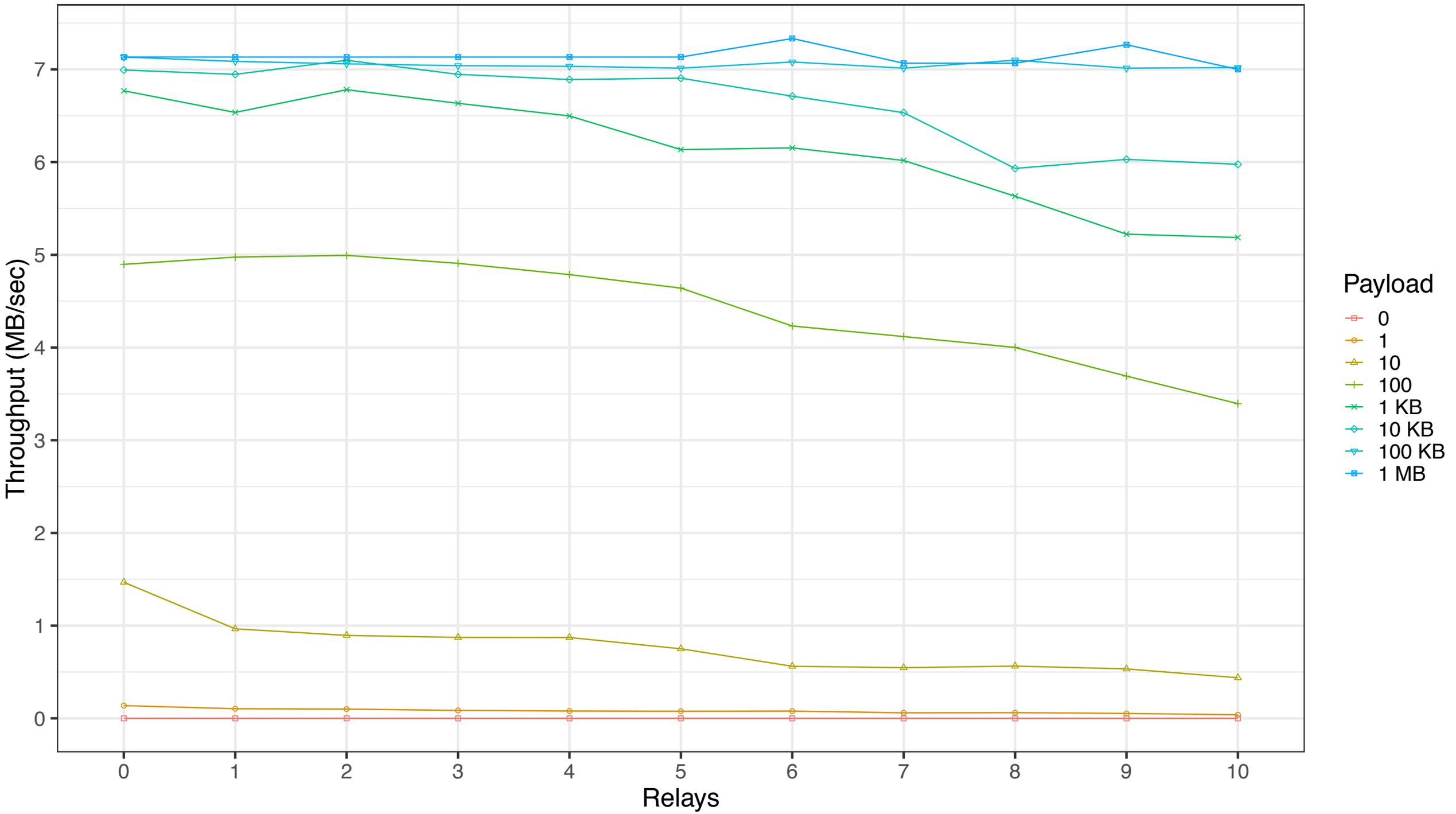

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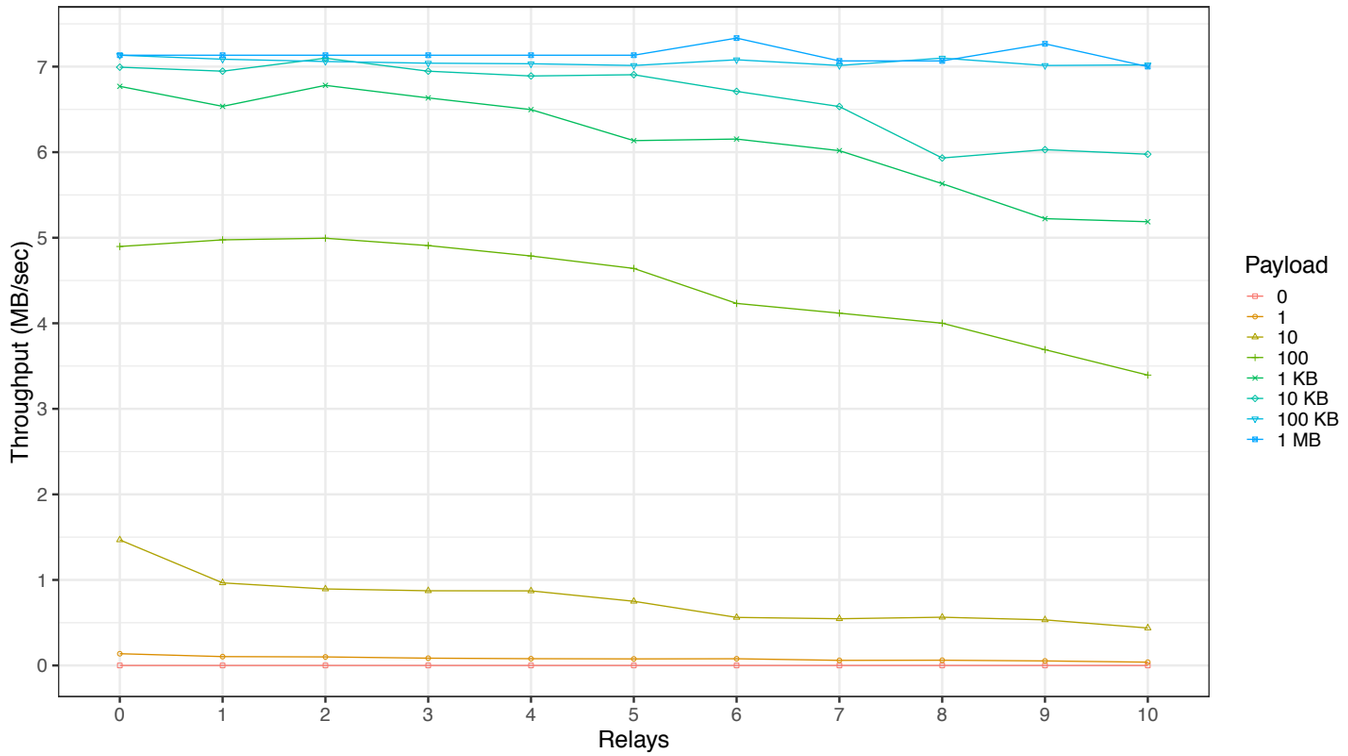

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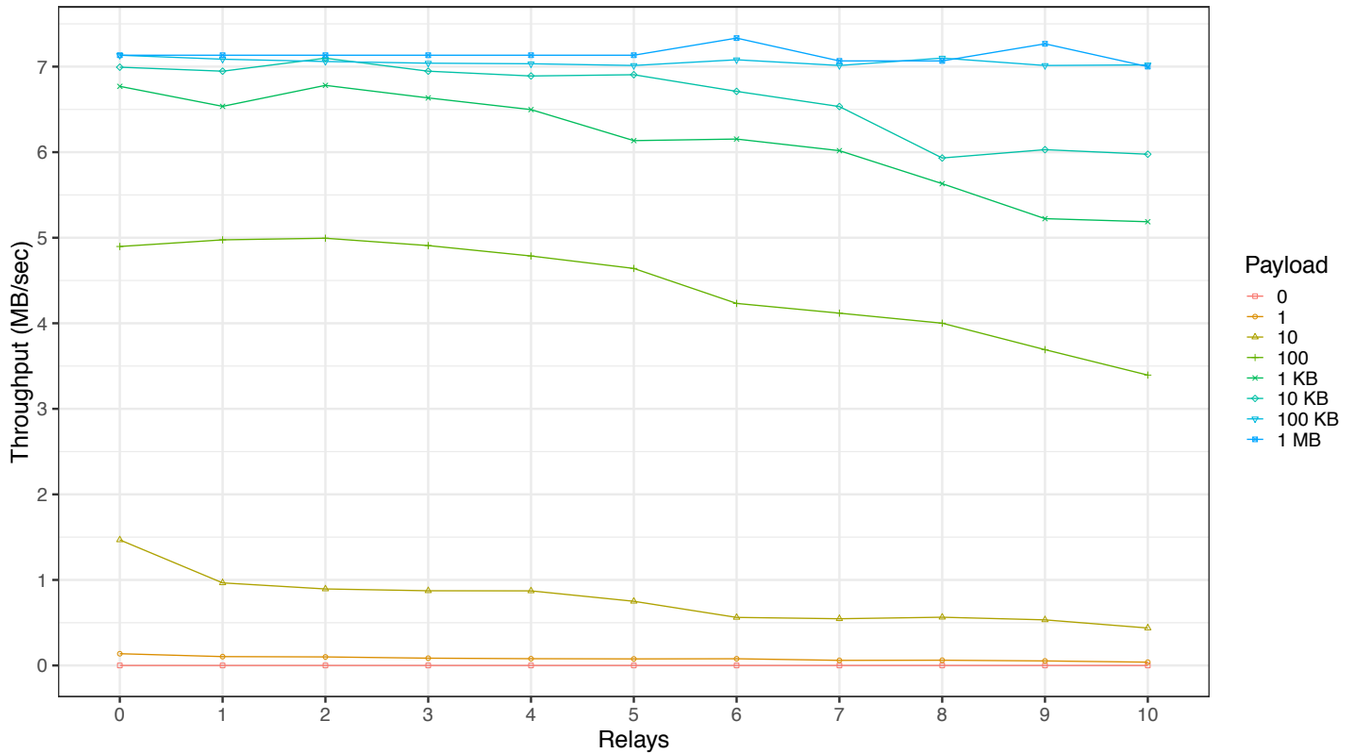

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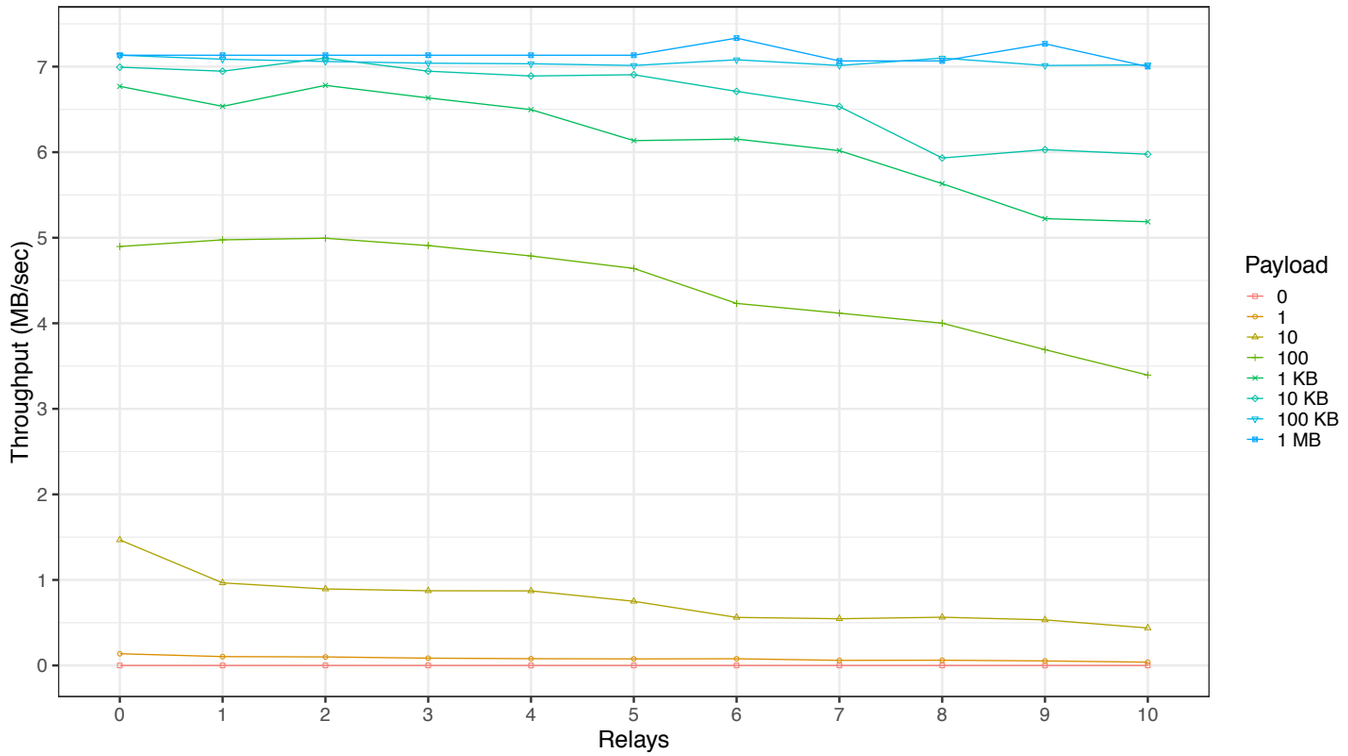

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- System **behavior not ideal** (more relays = less throughput)

Recap

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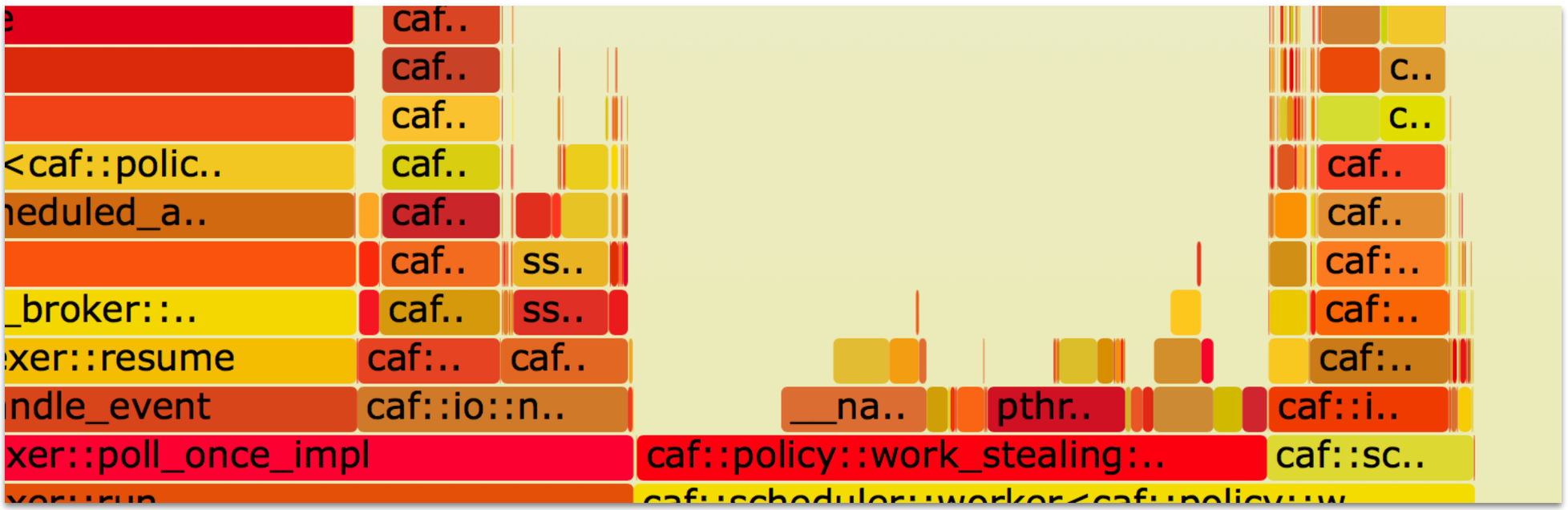
- **Throughput** affected by increasing number of relays 🤔

Inside Broker



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  - Reproduced in mockup, throughput stable with fix ✅
  - No trivial patch, might affect Broker's API 😕

What did we learn?

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- Broker enables **new use cases and integrations**
  - **Automated workflows**, e.g., intel triggers historic query
    - Straightforward integration with tools like VAST
- Easy **rapid prototyping** with Python
- **Latency looks good** in microbenchmarks
- Throughput has **room for improvement**

Thanks for Listening!

bro/broker

tenzir/events

tenzir/bro-vast

vast-io/vast

tenzir_company

tenzir.com