

EMnify

# How our Cloudy Mindsets Approached Physical Routers

*SNMP was not an option*

Steffen Gebert

DENOG12, 09.11.2020





# | Abstract

After the latest project, EMnify became a 99% only cloud company. To meet growing scalability and reliability requirements of the interconnection between our AWS-based deployments and multiple carriers, BGP peerings had to be moved out of AWS. Therefore, a pair of Juniper routers were put into place. For a company fully relying on cloud services so far, this alien technology resulted in several challenges.

We want to share, how we solved the integration puzzle of this physical equipment into our existing workflows and tools. The use of CI/CD systems for applying changes, AWS CloudWatch, Prometheus and Grafana for monitoring as well as the reluctance to run applications that require a lot of shepherding lead our research to find the right glue - the glue between these pieces of iron and our cloud infrastructure.

Being used to CI/CD processes backed by automated tests, we wanted to adapt these practices here as well. As a result, configuration changes are rolled out by an automated pipeline using Ansible. Efforts for automated testing were made, where we failed. We explain why and what we did instead as well as what we envision for the future.

As every other part of our system, we want its monitoring data accessible via Grafana.

With the help of pmacct and fluentbit, we can treat IPFIX flow records as they were logs. With the help of jtimon, Prometheus stores the routers' metrics as we are used to do, in doubt tickled out through few custom YANG models.

In summary, the integration worked very well, while we still have several learnings and pain points to share.

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**EXARING AG**



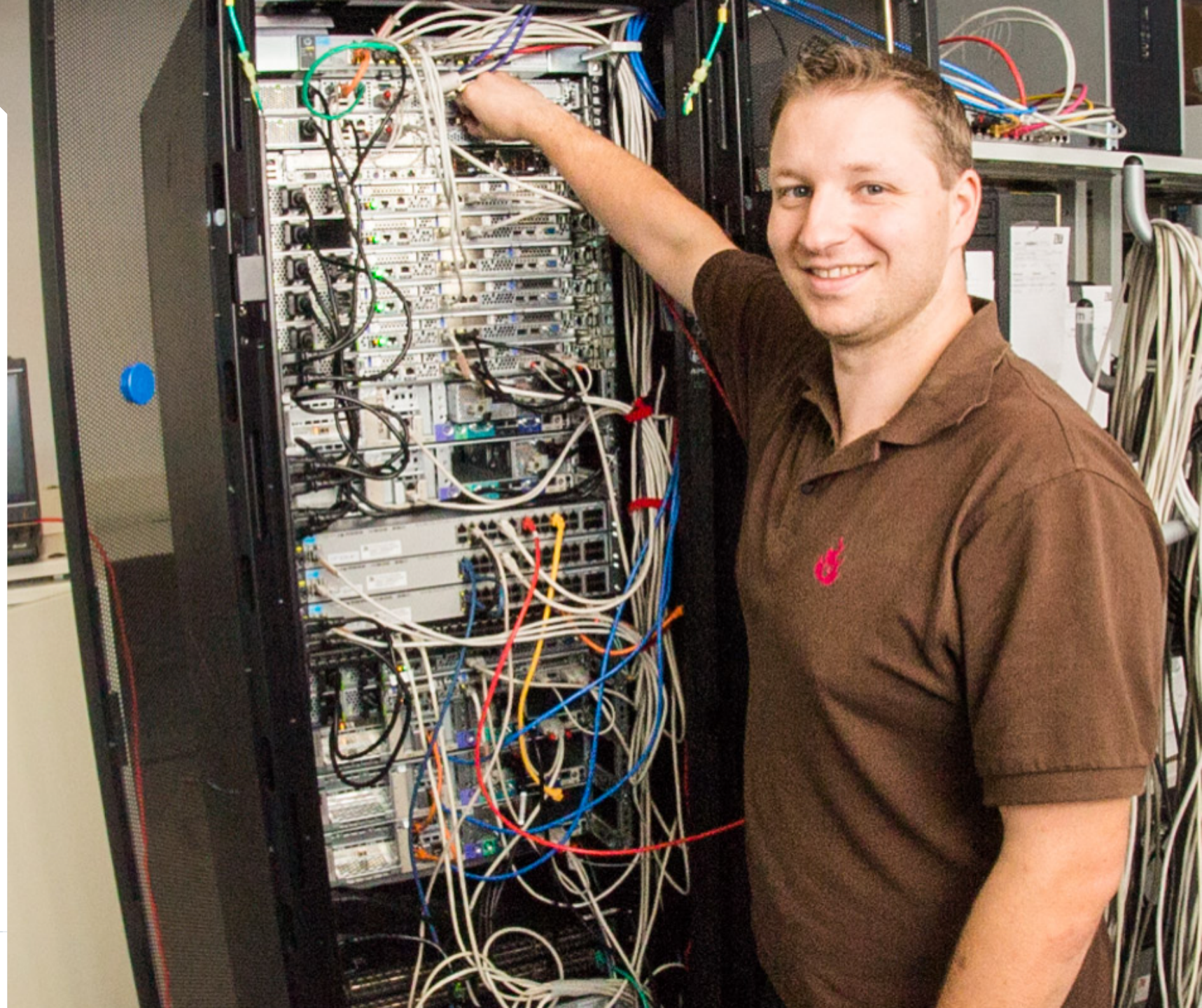
# Cloudy Mindset?



| 5 years ago



EMnify



I 3-10 years ago



# I Since 2017

# EM*nify*





# Is This a Better World?



# Focus on Business Value



# Prefer Managed Services



And Suddenly... Hardware?

# | Agenda



Context



Deploy-  
ment



Moni-  
toring



# | EMnify's IoT Connectivity Platform

Cellular connectivity  
in 500+ networks in  
185 countries

RESTful APIs

Pay as you go  
pricing

SMS/USSD to REST  
bridge

Secure connectivity  
via VPN and AWS  
natively

Implemented using  
own virtualized  
mobile core network

# | Supporting Global IoT Deployments

## Traditional Operators



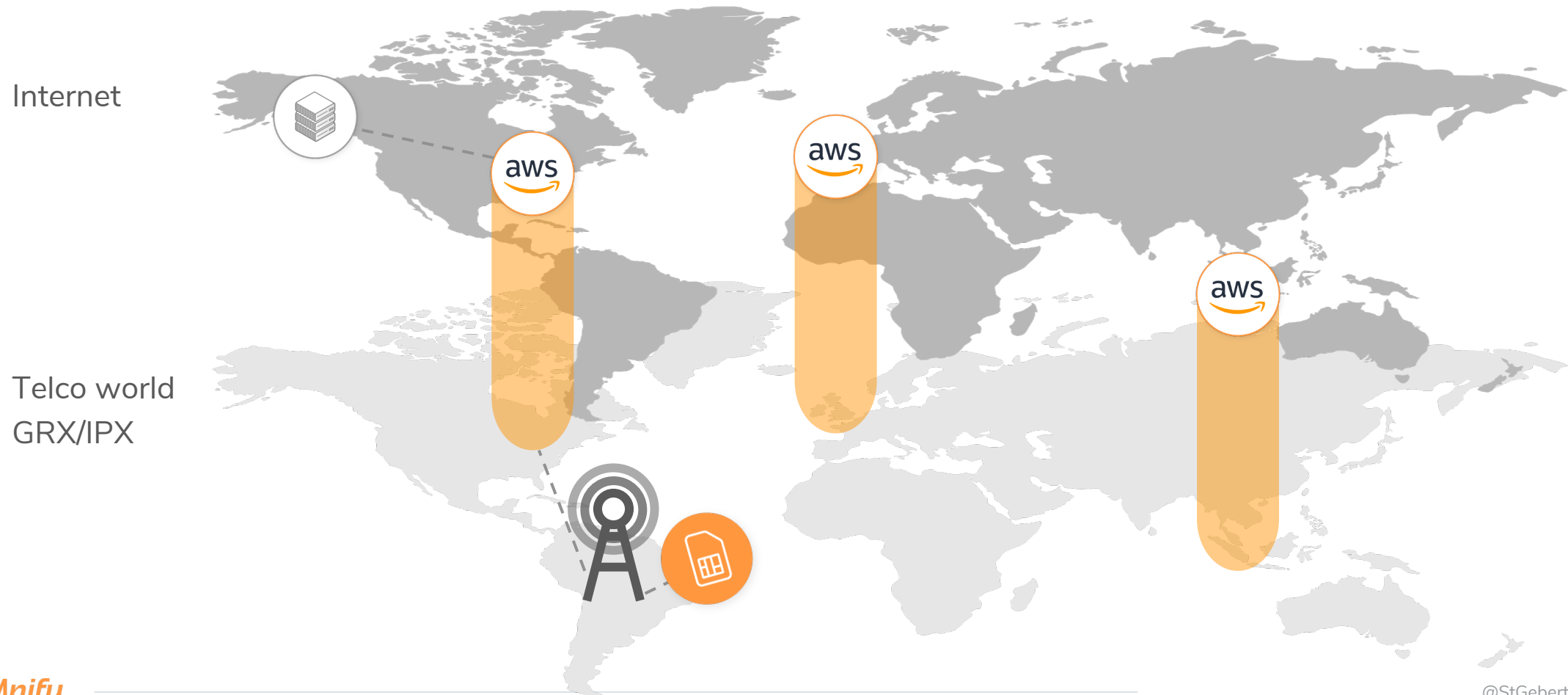
Home-routing of roaming SIM data prevents distributed architecture

## EMnify Connectivity



EMnify's mobile core network is deployed in multiple AWS regions – keeping data local

# I GRX/IPX Network (GPRS Roaming Exchange)





Our scale[throughput] bores you



# We're critical to our customers' success



# Increased demands vs. AWS as “General Purpose Cloud”



# Running BGP on AWS?



# We had to move logic out of AWS





**We could not find a fitting  
managed service**



# We had to get hardware



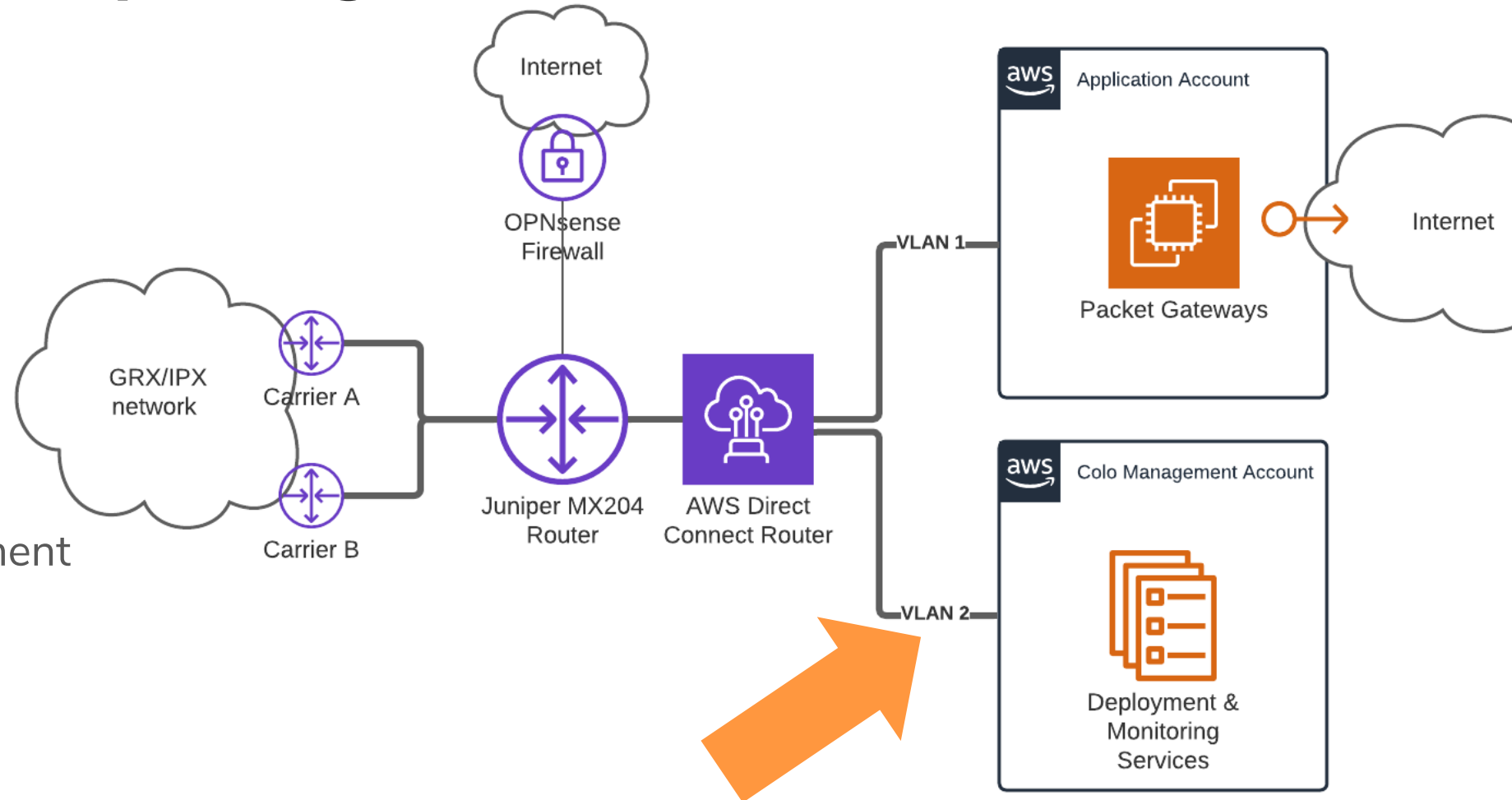
# We chose boring technology



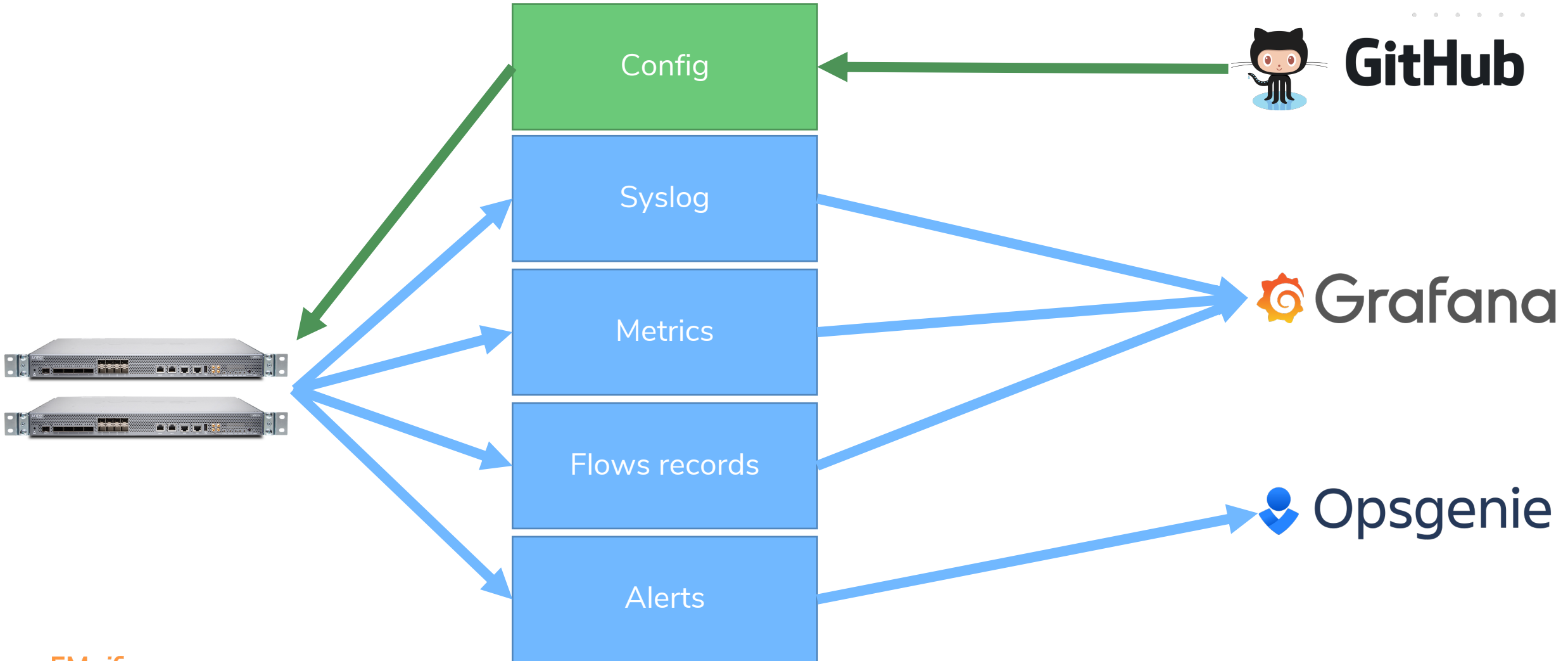
# Greenfield project

# Setup – Twice per region

- Juniper MX204
- Colocation rack space
- Fiber links towards  
2 carriers  
AWS
- Out-of-band management  
access via OPNsense



# Integration Points



# I Design Principles

**80/20 rule  
aka  
MVP**

**Don't get out  
of our comfort  
zone**

**Don't setup  
anythat that  
requires lot of  
handholding**

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# Deployment



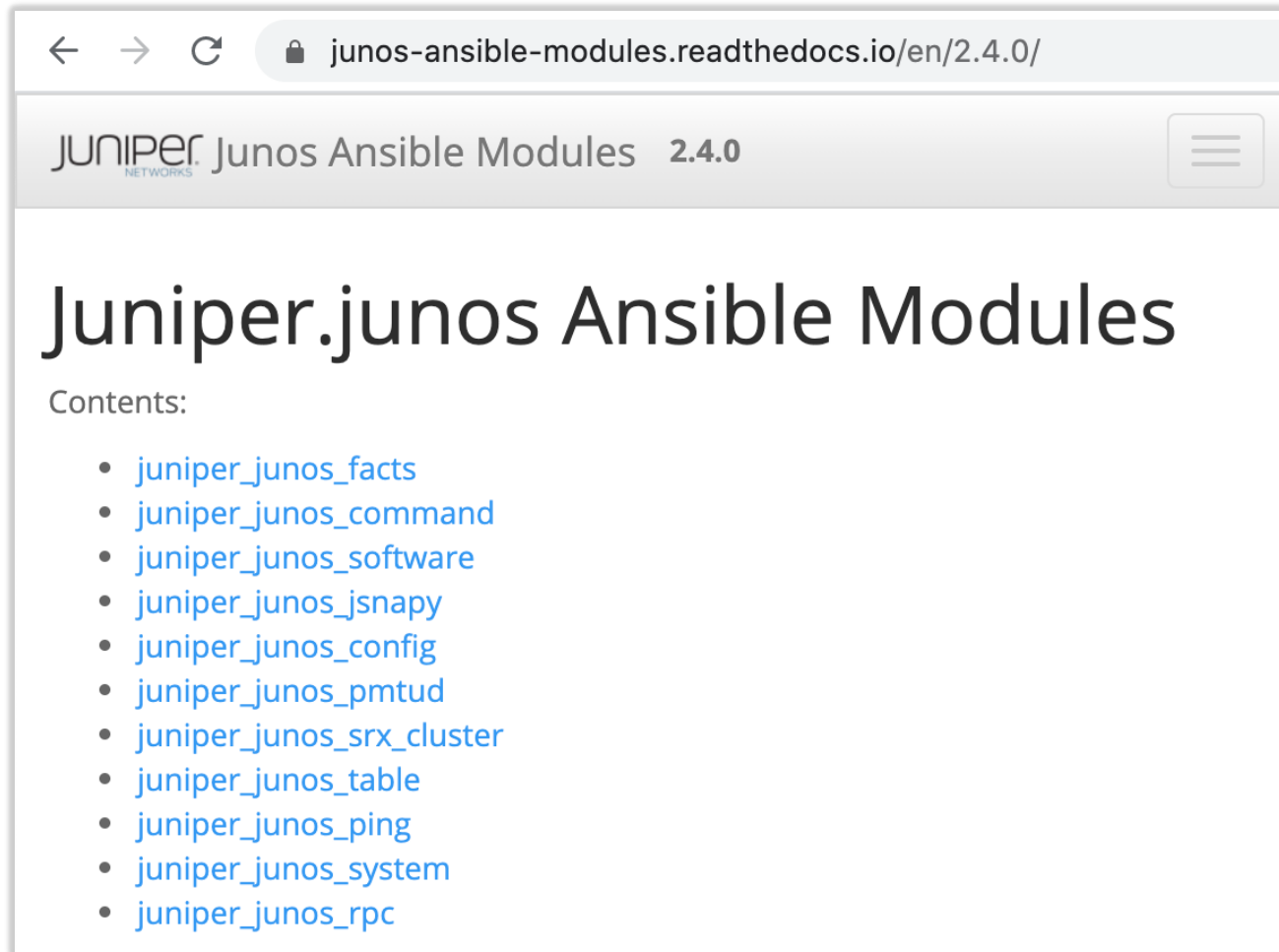




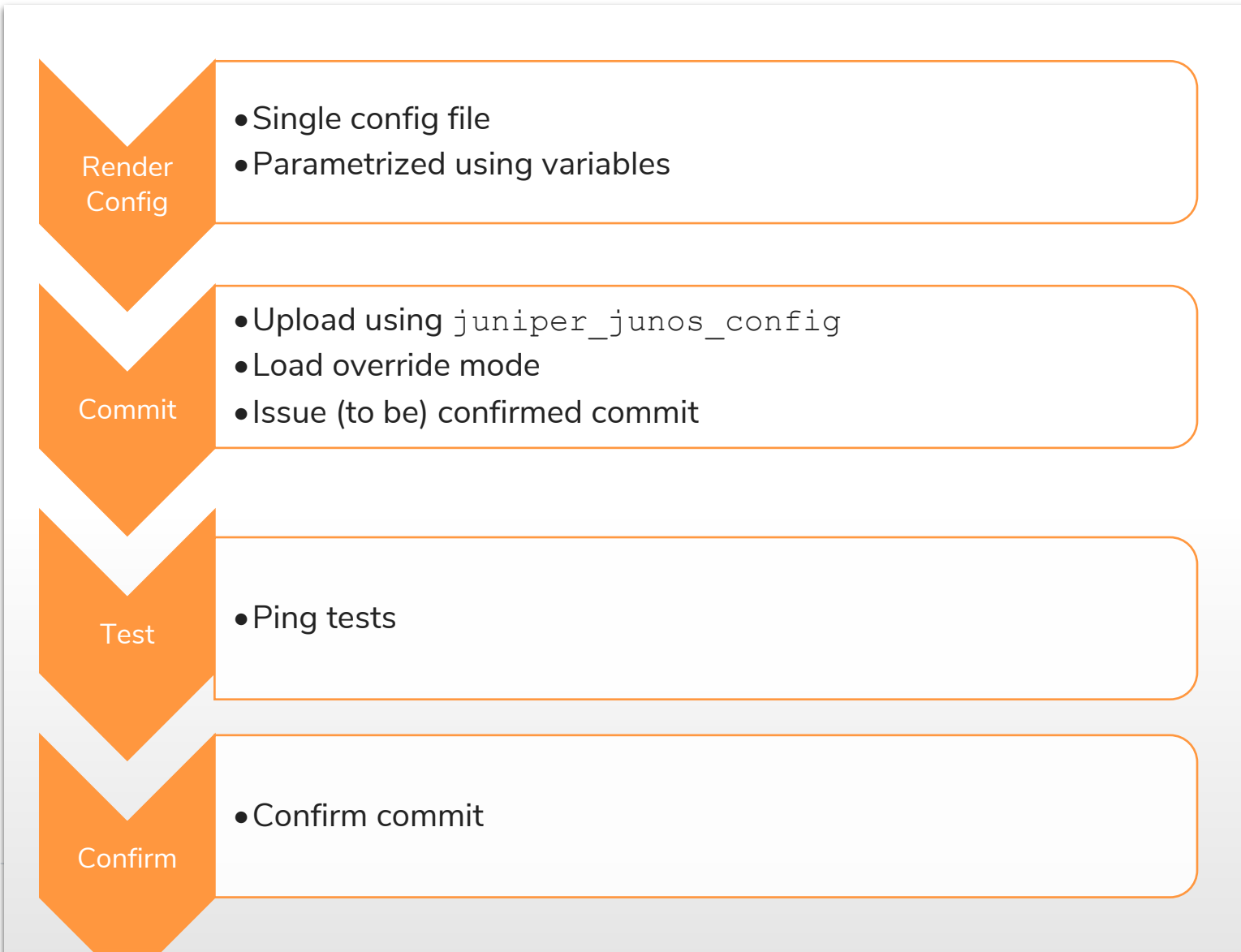
**A human shall not SSH into  
something**

MY INNER SELF

# | juniper\_junos Ansible Modules



# I Configuration Deployment



# I Ansible Playbook - Code Example

```
- name: install generated configuration file onto device
  juniper_junos_config:
    provider: "{{ juniper_connection_settings }}"
    src: "{{ conf_file }}"
    load: override
    comment: "playbook execution, commit confirmed"
    confirmed: 3 # wait X minutes until rollback
    diff: yes
    ignore_warning: yes
    register: config_results
    notify: confirm previous commit
```

# Config Pipeline

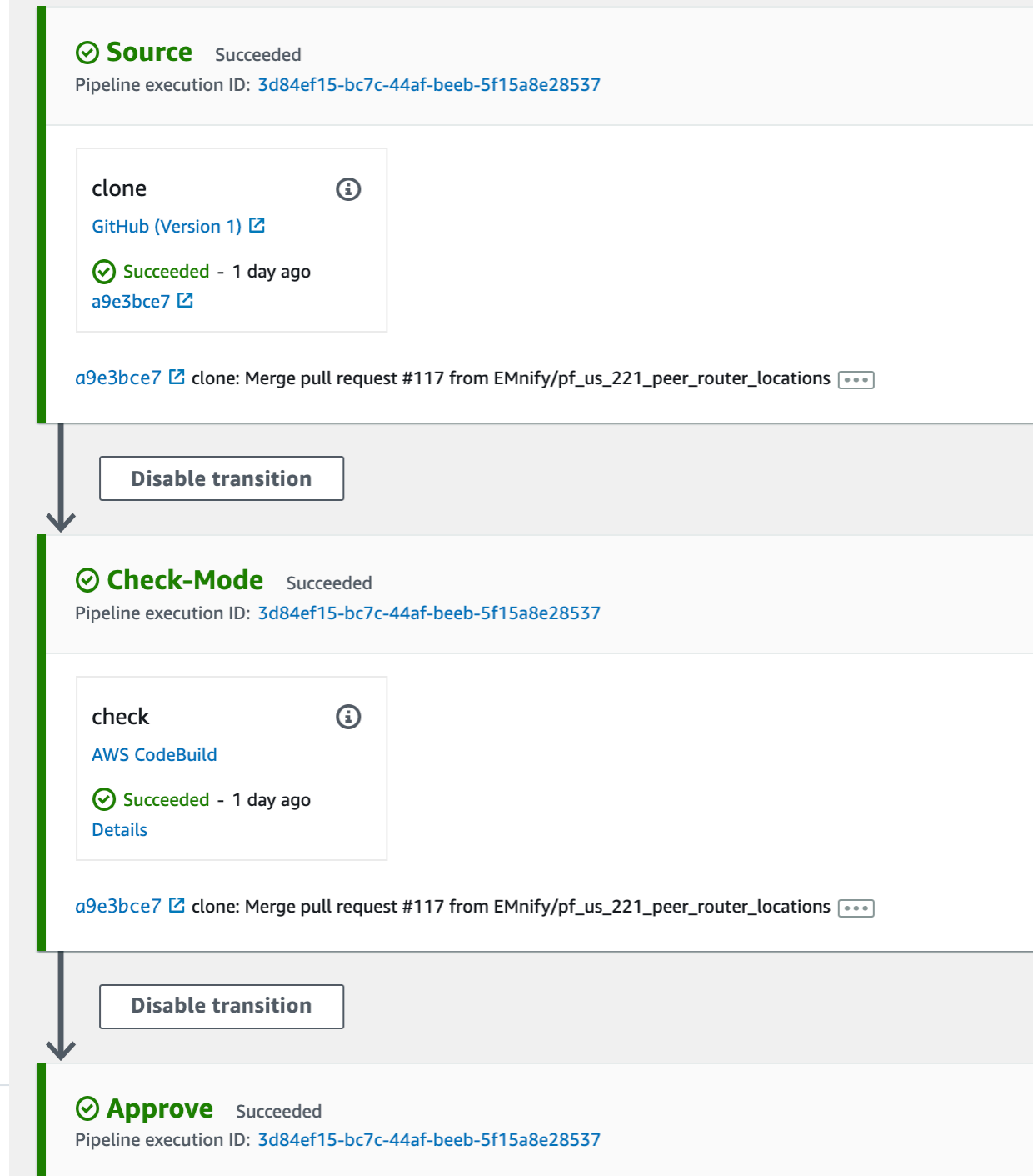
- Separate AWS account
- Isolated connectivity



AWS CodePipeline



AWS CodeBuild

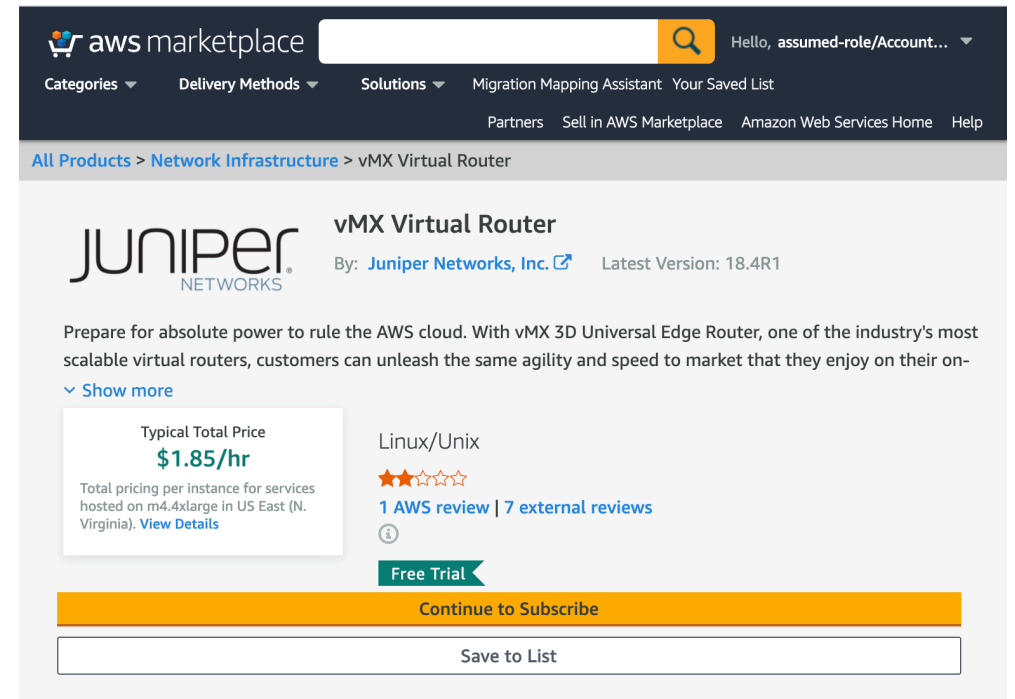




# And where are the tests?

# I In a Perfect World..

- 2-star review could have been mine :D
- Latest version: 18.4R1
- Takes ~30min to be ready
- AWS does not support VLANs!
- Only for manual testing
- Maybe eve-ng or GNS3 could help?



The screenshot shows the AWS Marketplace interface for the Juniper vMX Virtual Router. The header includes the AWS Marketplace logo, a search bar, and user account information. The breadcrumb trail indicates the product is in the Network Infrastructure category. The product page features the Juniper Networks logo, the product name 'vMX Virtual Router', and the provider 'Juniper Networks, Inc.'. It highlights the latest version as 18.4R1. A descriptive paragraph states that the vMX 3D Universal Edge Router is a scalable virtual router for the AWS cloud. A pricing box shows a typical total price of \$1.85/hr for services hosted on m4.xlarge instances in the US East (N. Virginia) region. The page also displays a 1-star AWS review and 7 external reviews, a 'Free Trial' button, and a 'Continue to Subscribe' button. A 'Save to List' button is located at the bottom of the product card.

aws marketplace Hello, assumed-role/Account...

Categories Delivery Methods Solutions Migration Mapping Assistant Your Saved List Partners Sell in AWS Marketplace Amazon Web Services Home Help

All Products > Network Infrastructure > vMX Virtual Router

**JUNIPER** NETWORKS **vMX Virtual Router**  
By: Juniper Networks, Inc. Latest Version: 18.4R1

Prepare for absolute power to rule the AWS cloud. With vMX 3D Universal Edge Router, one of the industry's most scalable virtual routers, customers can unleash the same agility and speed to market that they enjoy on their on-

[Show more](#)

Typical Total Price  
**\$1.85/hr**  
Total pricing per instance for services hosted on m4.xlarge in US East (N. Virginia). [View Details](#)

Linux/Unix  
★★★★★  
[1 AWS review](#) | [7 external reviews](#)

[Free Trial](#)

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# I On My Bucket List



- Start virtualized topology in network emulator
  - Apply configuration pipeline
  - Emulate BGP peers
  - Execute end-to-end connectivity tests
  - Emulate link failures
  - Verify connectivity
- 
- AWS: run on bare metal host (b/c CPU VMX)





# Routine Operations (Runbooks)

# I Firmware Update - Checks

```
/workspace/prod # ansible-playbook upgrade_check.yaml -u steffen.gebert
```

```
...
```

```
TASK [Validate result] *****
```

```
[ mx204-am3 ] Chassis Alarms
```

```
-----
```

```
Expect:
```

```
No alarms currently active
```

```
Actual:
```

```
No alarms currently active
```

```
...
```

```
[ mx204-am3 ] Core Dumps
```

```
-----
```

```
Expect:
```

```
/var/crash/*core*: No such file or directory
```

```
Actual:
```

```
/var/crash/*core*: No such file or directory
```

```
[ mx204-am3 ] ⚠ Proceed? ⚠
```

```
:
```

```
Press 'C' to continue the play or 'A' to abort
```

# I Firmware Update - Draining

- **name:** Drain traffic  
**juniper\_junos\_config:**
  - provider:** "{{ juniper\_connection\_settings }}"
  - load:** 'set'
  - lines:**
    - 'activate policy-options policy-statement OUT-OF-SERVICE-SWITCH term as-path-p
  - comment:** 'Drain traffic to router for upgrade'
- **name:** Traffic drained  
**pause:**
  - prompt:** |
    - [ {{item}} ] Traffic is draining.
    - Verify that traffic is completely drained on the following dashboard before proc
    - [ {{item}} ] ⚠ Proceed with the JunOS upgrade ⚠?
- loop:** "{{ ansible\_play\_hosts }}"

# I Firmware Update – Execute!

- **name:** Install Junos OS package

**juniper\_junos\_software:**

**provider:**

**host:** "{{ ansible\_host }}"

**timeout:** 3600

**remote\_package:** "{{ junos\_vm\_file }}"

**validate:** True

**cleanfs:** False

**vmhost:** True

**reboot:** True

**ignore\_errors:** yes # *rpc times out when upgrading, despite the provider timeout sett*

**register:** output

# | Challenges

Deploy a file  
ㄟ(ツ)ㄟ

Max length  
of file  
copy URLs

Feedback for  
invalid config

Amount of  
boilerplate  
code

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# Monitoring

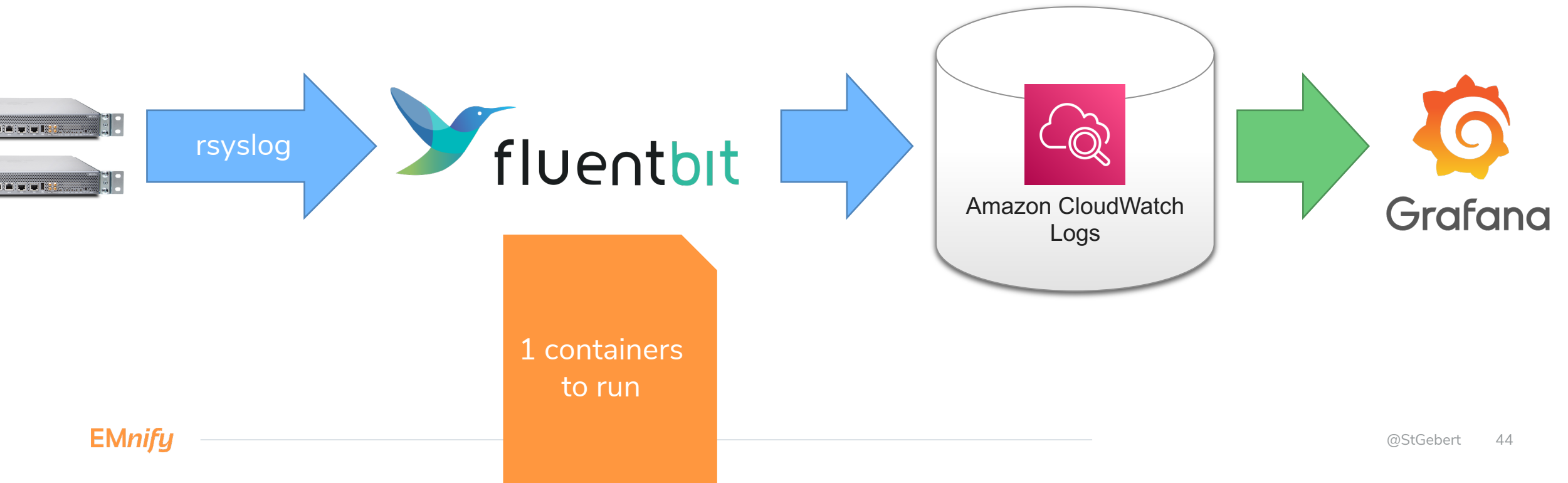




# Syslogs

# I Syslog Implementation

- Who logged into the router?
- What's happening in the router?







# Flow Records

# | Flow Records

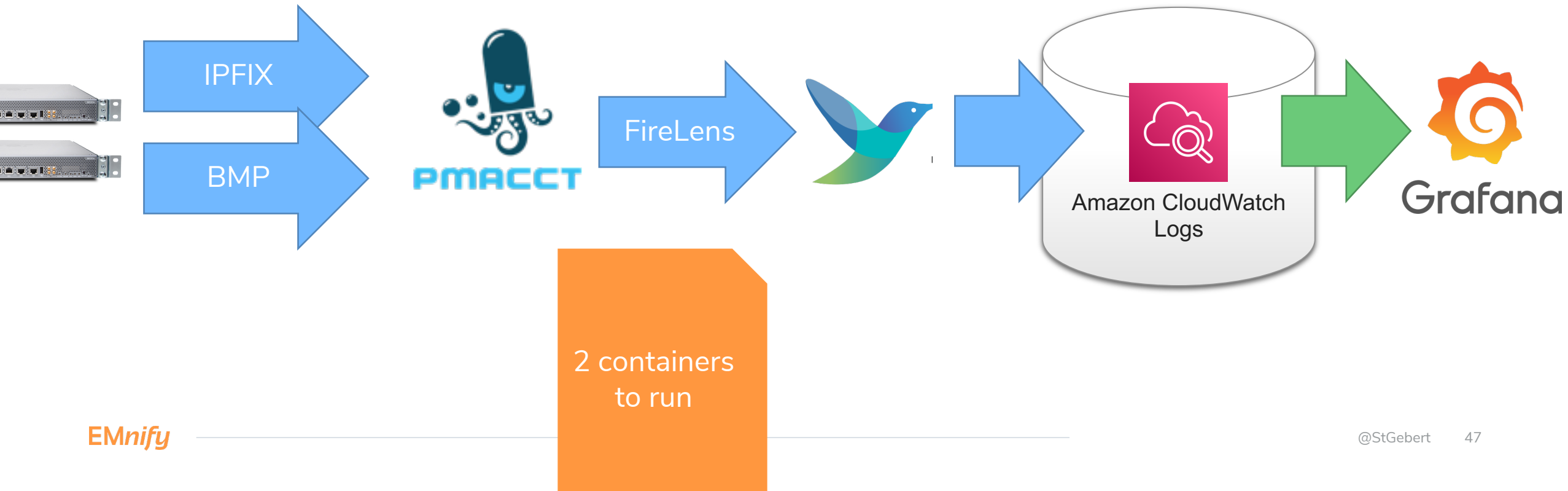
**Network-to-  
Network  
Interface  
(GTP traffic)**

**~20k parallel  
flows**

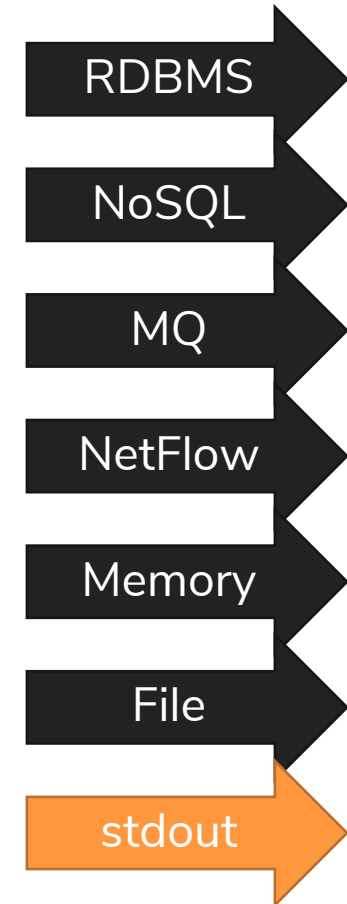
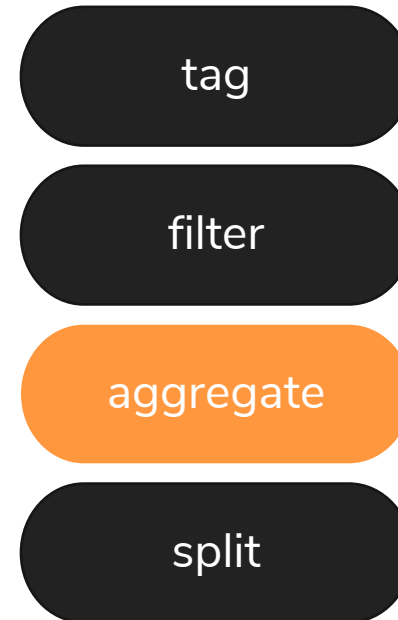
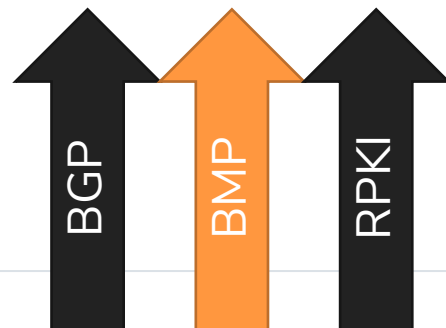
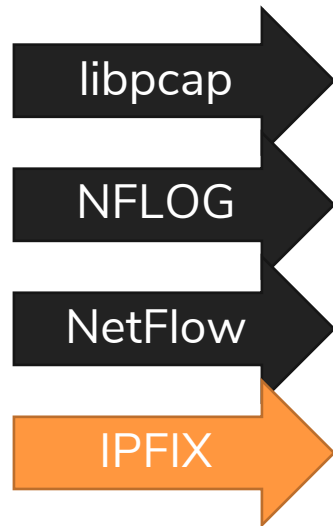
**1 flow =>  
1 log line?!**

# | Flow Records Collection

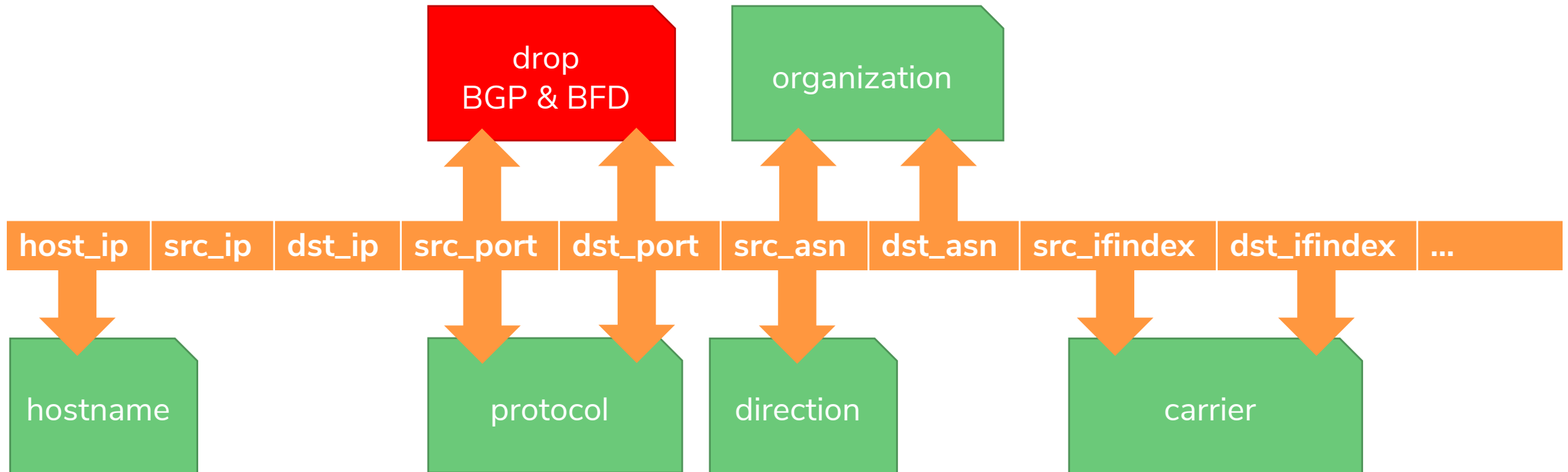
- How much traffic per AS?
- Did we receive any signaling from XYZ and did we really respond?



# | pmacct / nfacct

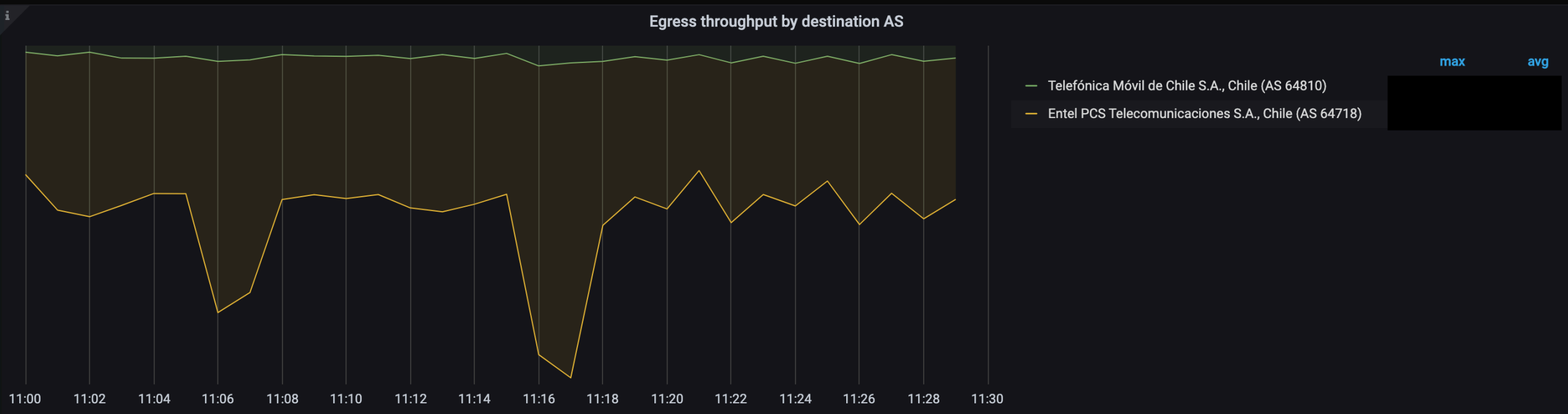
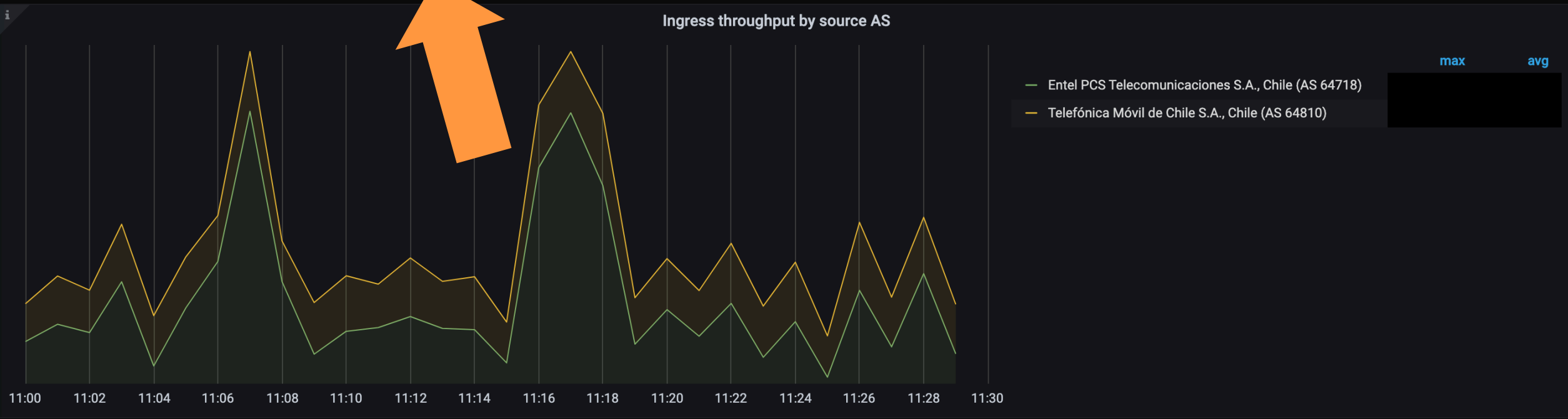


# Enrichment



# I Lua Magic

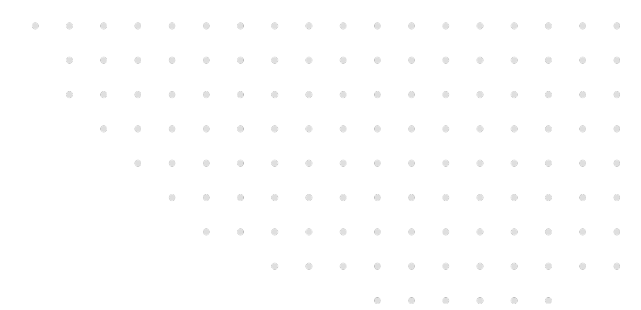
```
-- Sets GTP-c or GTP-u protocol depending on port numbers
function setGTPProtocol(tag, timestamp, record)
    local code = 0
    local gtp_ports = {
        ["GTP-c"] = 2123,
        ["GTP-u"] = 2152,
        ["GTP'"] = 3386,
    }
    local new_record = record
    for protocol, port in pairs(gtp_ports)
    do
        if record["source.port"] == port or record["destination.port"] == port then
            new_record["network.application"] = "GTP"
            new_record["network.protocol"] = protocol
            code = 2
        end
    end
    return code, timestamp, new_record
end
```



Datasource	CloudWatch-colo-mgmt	Operator	Chile	Carrier	All	Host	All	Protocol	GTP-c	Flows Records														
Time	direction	protocol	src.org	src.country	src.asn	dst.org	dst.country	dst.tadig	bytes	packets	src.ip	src.port	dst.ip	dst.port	transport	appli	hostname	dst.carrier	src.carrier	dst.as_path	src.tadig			
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# I Inbound traffic by AS query



```
fields concat(source.as.organization.name, ' ',  
              source.as.organization.country, ' (AS ', source.as.number, ')') as org  
| filter @logStream = "flows"  
| filter host.name like /^$host$/  
| filter concat(source.as.number, ' ', source.as.organization.name, ' ',  
               source.as.organization.country, ' ', source.as.organization.tadig) like /$operator/  
OR concat(destination.as.number, ' ', destination.as.organization.name, ' ',  
          destination.as.organization.country, ' ', destination.as.organization.tadig)  
   like /$operator/  
| filter network.peer.destination.as.organization.name like /^$carrier$/  
| filter network.direction = "inbound"  
| filter network.protocol like /$protocol/  
| filter 10000  
| stats sum(network.bytes)/60*8 as `` by org, bin($time_interval)  
| sort `` desc
```

# | Challenges

CloudWatch  
Read Limits

CloudWatch  
Write Limits

pmacct  
config  
“creativity”



# Metrics

# I Metrics Demand



Temperature, light  
levels, etc.



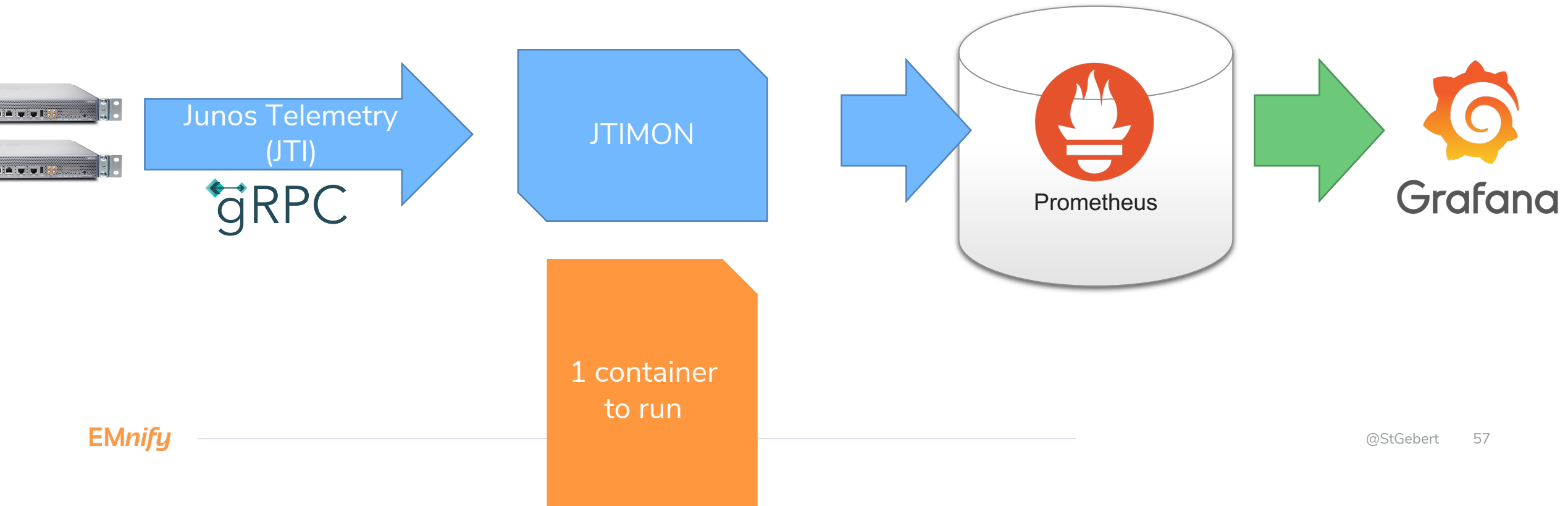
State, throughput,  
errors, etc.



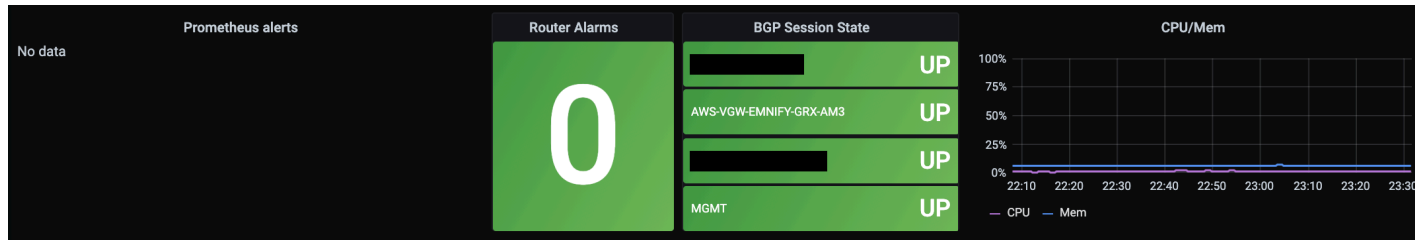
State, prefixes  
received/accepted/installed

# I Metrics Implementation

- High cardinality, high frequency metrics collection



# Metrics Examples



BGP - details									
BGP Information									
Name	Neighbor ↓	device	UP	Established	Transitions	Received Prefixes	Accepted Prefixes	Installed Prefixes	Sent Prefixes
EMNIFY-GRX	172.23.94.33	mx204-am3.c	UP	2020-10-13 16:34:17	8	10853	10853	217	2
EMNIFY-GRX	172.22.94.33	mx204-fr7.col	UP	2020-10-15 21:14:22	10	10853	10853	217	2
EMNIFY-GRX	10.246.176.217	mx204-fr7.col	UP	2020-10-08 18:19:14	5	10736	10733	10733	2
EMNIFY-GRX	10.246.176.17	mx204-am3.c	UP	2020-10-08 18:19:07	5	10736	10733	10733	2
EMNIFY-GRX	10.90.1.13	mx204-fr7.col	UP	2020-10-16 12:36:13	8	3	3	3	4
EMNIFY-GRX	10.90.1.9	mx204-am3.c	UP	2020-10-09 16:01:21	4	3	3	3	4
master	10.90.1.5	mx204-fr7.col	UP	2020-10-16 12:36:12	7	1	1	1	3
master	10.90.1.1	mx204-am3.c	UP	2020-10-09 16:04:38	4	1	1	1	3

# | Challenges

JTI Sensor  
availability

JTIMON  
config file  
duplication

JTIMON ENUM  
support

PKI setup

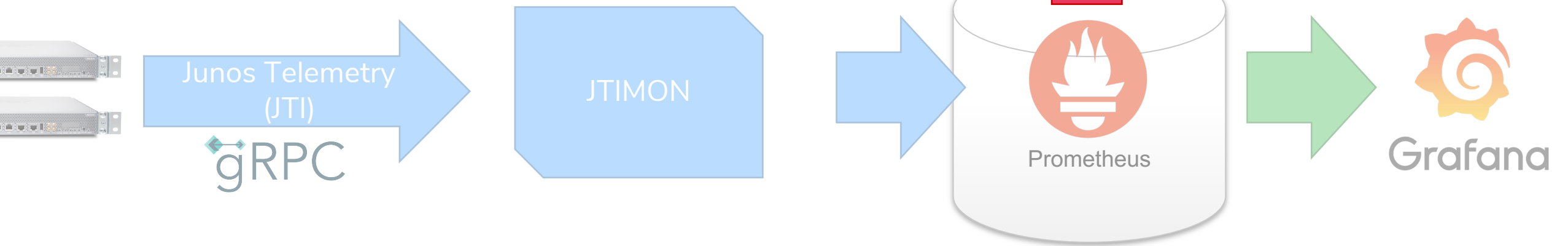


# Alerting



# | Alerting Implementation

- Prometheus-integrated alerting





# I Summary & Conclusion

- Integrated hardware into an otherwise fully cloud-based environment
  - Avoid new processes
  - Avoid new (user-facing) tooling
- Found tooling to bridge gaps to “what we’re comfortable with”
  - 1-2 containers running existing open source tooling
  - No guarantee that this scales to 10s of devices
- Please contact me, if you want details (configs etc.) or have suggestions!



EMnify

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