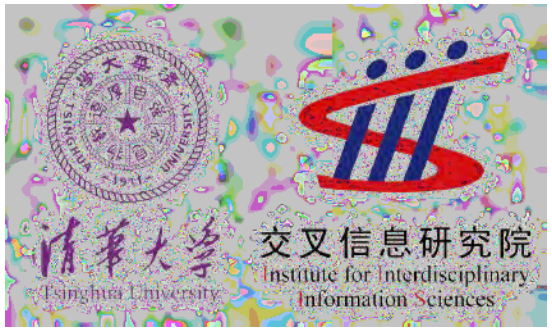

Debugging Openstack Problems Using A State Graph Approach

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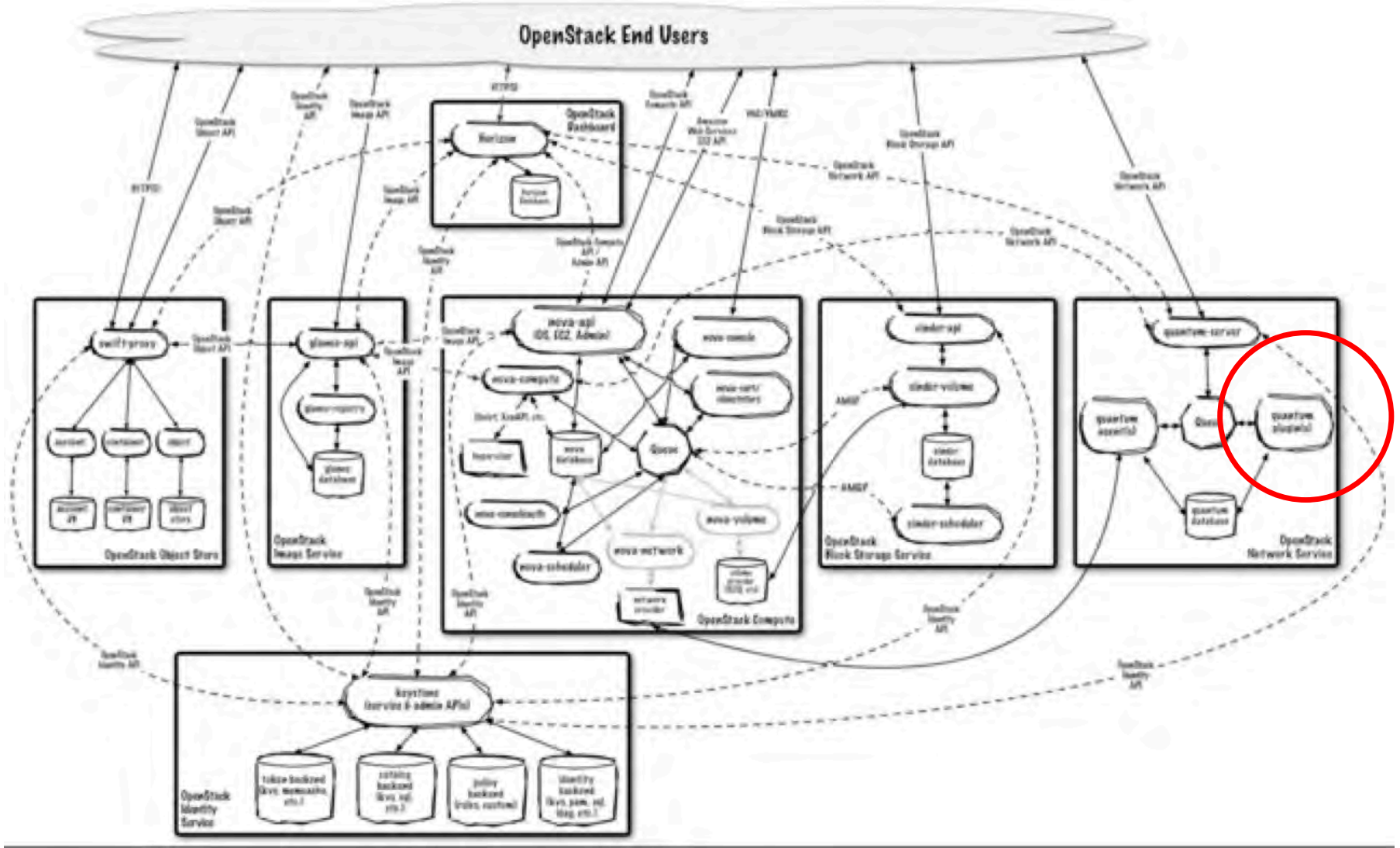
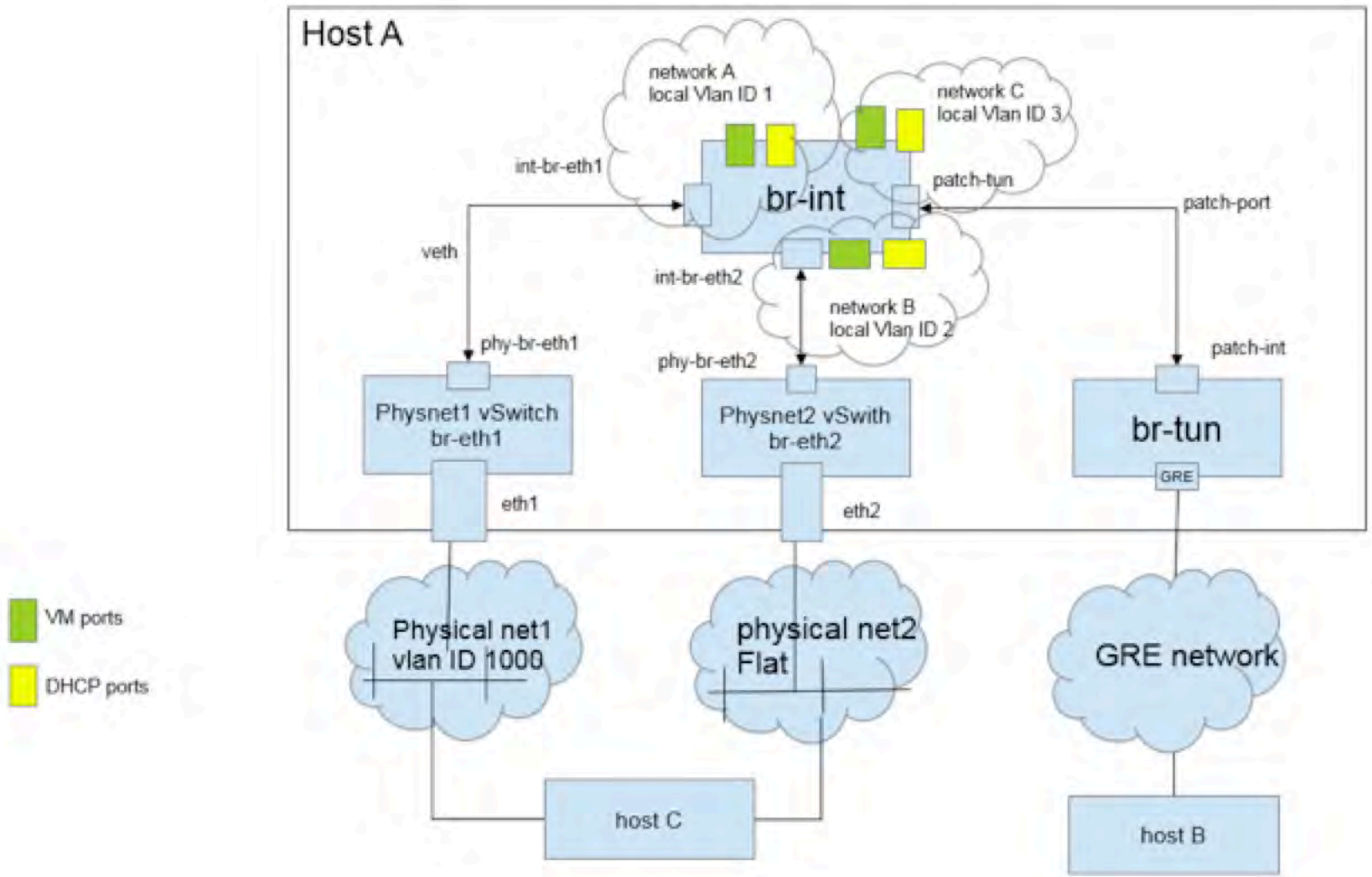
Modern systems are complicated

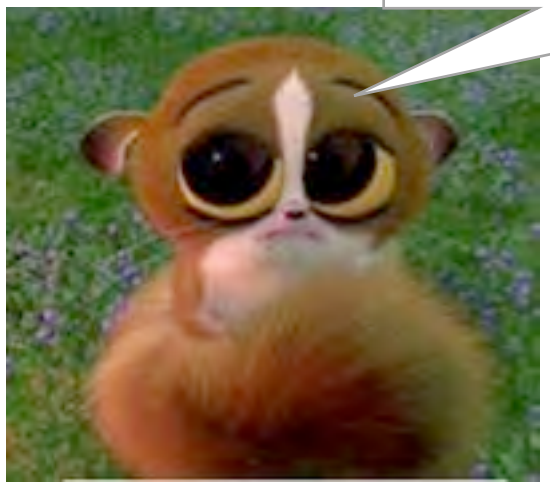


Modern systems are complicated (cont'd)



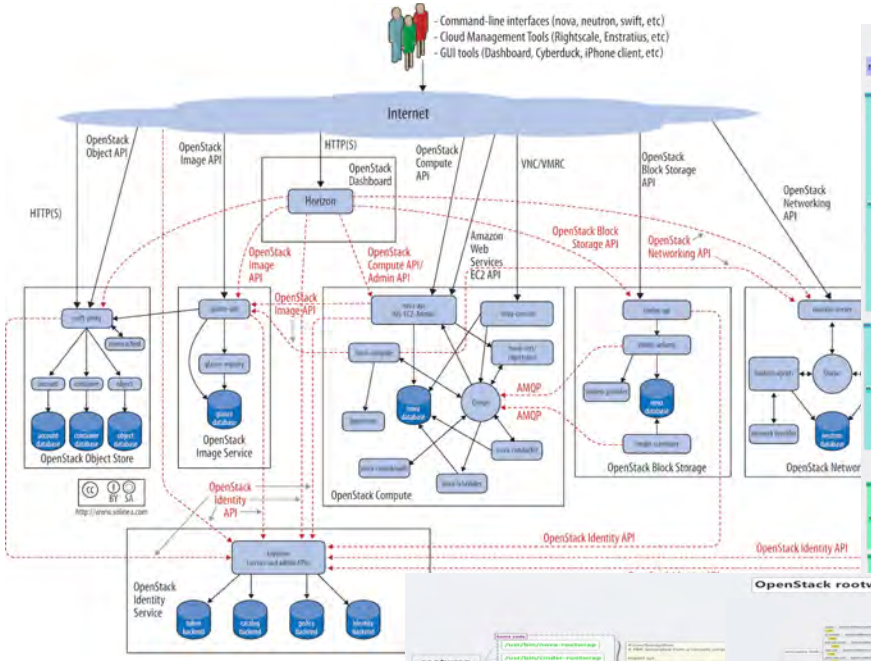
Trouble shooting for clients

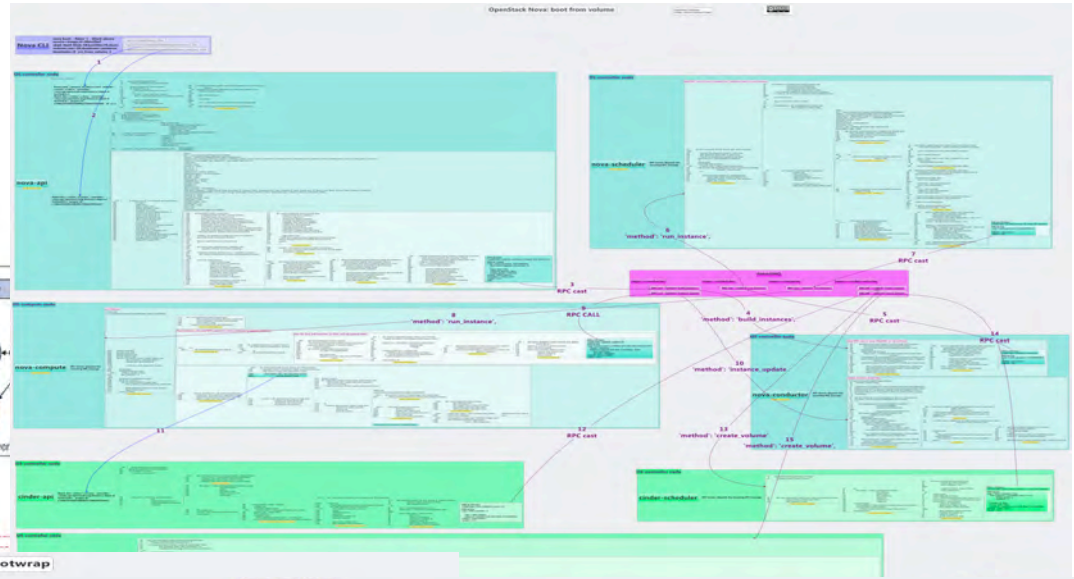
My network is down!

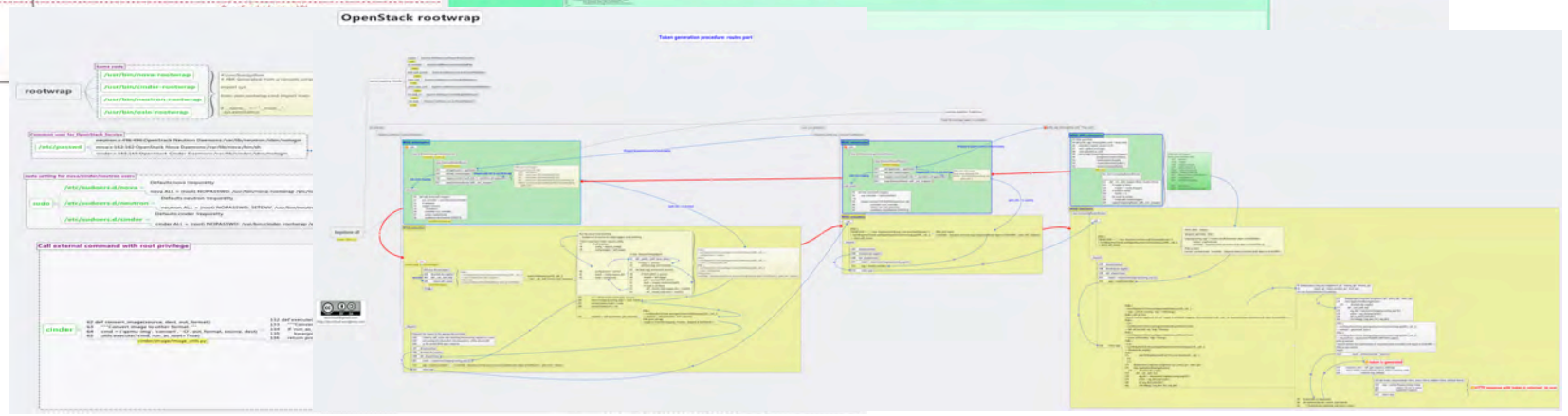


User configuration? (attached NIC?)
Connected the Virtual Network to public?
Physical network down?
OVS down?
OVS agent down?
Network node down?
Floating IP not correctly configured?
Security group rules not set up correctly?
……

How many rules needs to know as a professional openstack operator?





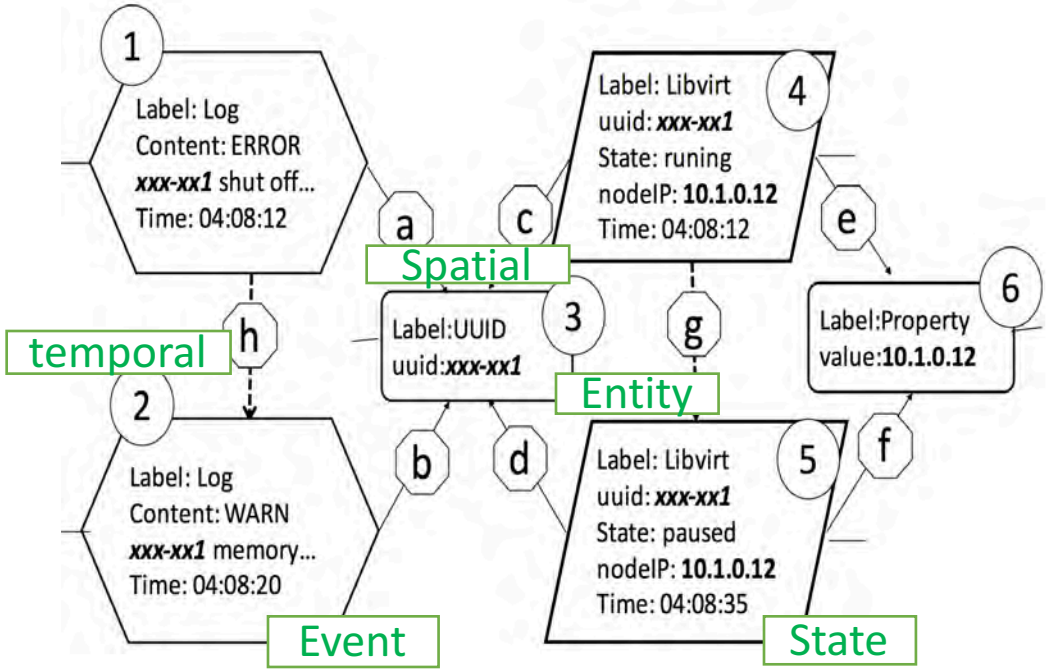


The operational knowledge does not transfer!

Good news for IT consulting business.

Key idea: automatically discover knowledge in systems using most basic rules

- We can capture the knowledge: System Operation State Graph (SOSG)
- Turn ad-hoc system state queries into a uniform graph traversal.
- Anomaly detection to find hidden problems.



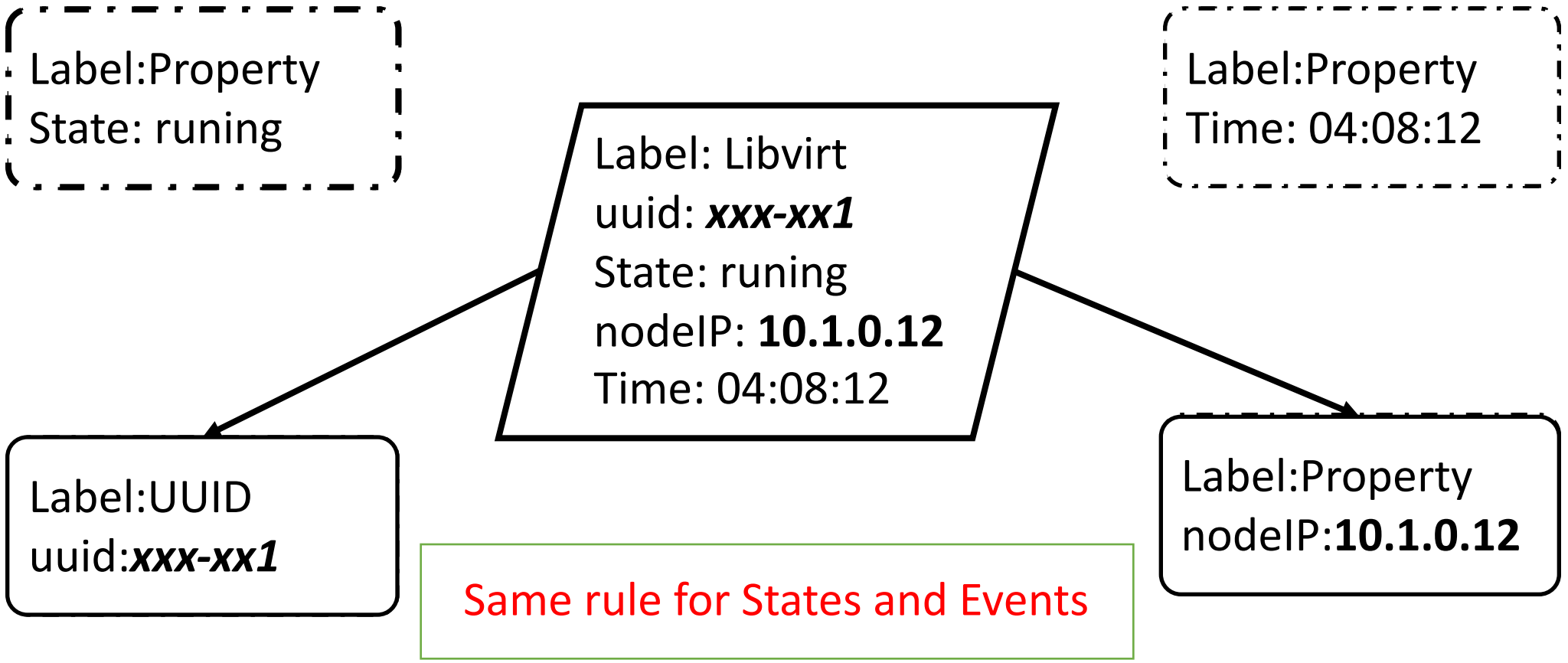
Data source used to construct the graph

- raw data sources, no semantic information

Type	Data source	
DB	OpenStack databases updates (triggers)	States
Libvirt	libvirt status `Python API`	
Ovs	OVS status `ovsdb-client dump`	
Cephimage	Ceph image list `rbd info`	
Cephfile	Ceph block file `ls /ceph/dir/file`	
Cephlog	log files from Ceph	Events
Log	logs from all OpenStack components	

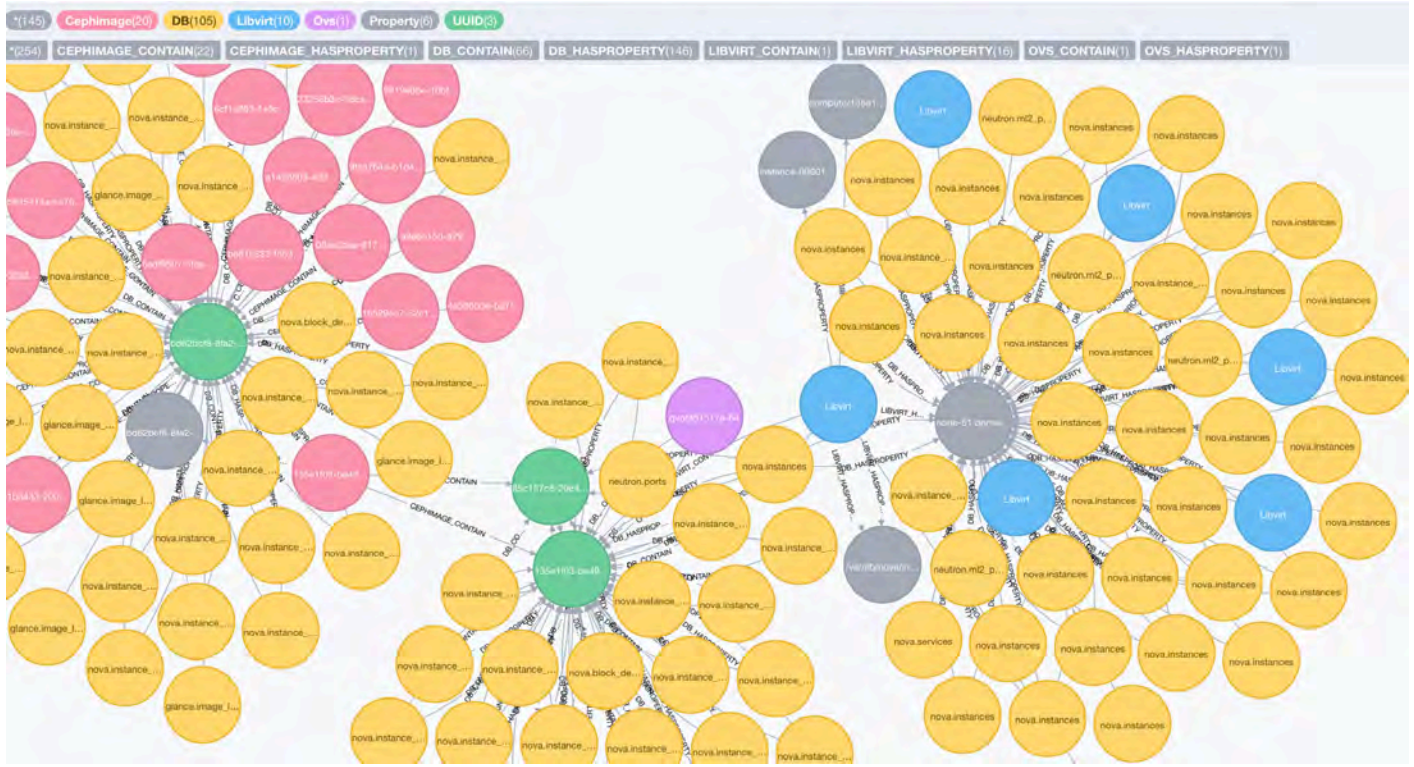
How to construct the graph?

- Simple rule: discovery entity based on syntactic IDs



Can be very a large graph!

- 3-day operation data, about 40 GB
- Graph size: 43.3 million vertices, 56.6 million edges



How can we use the graph?

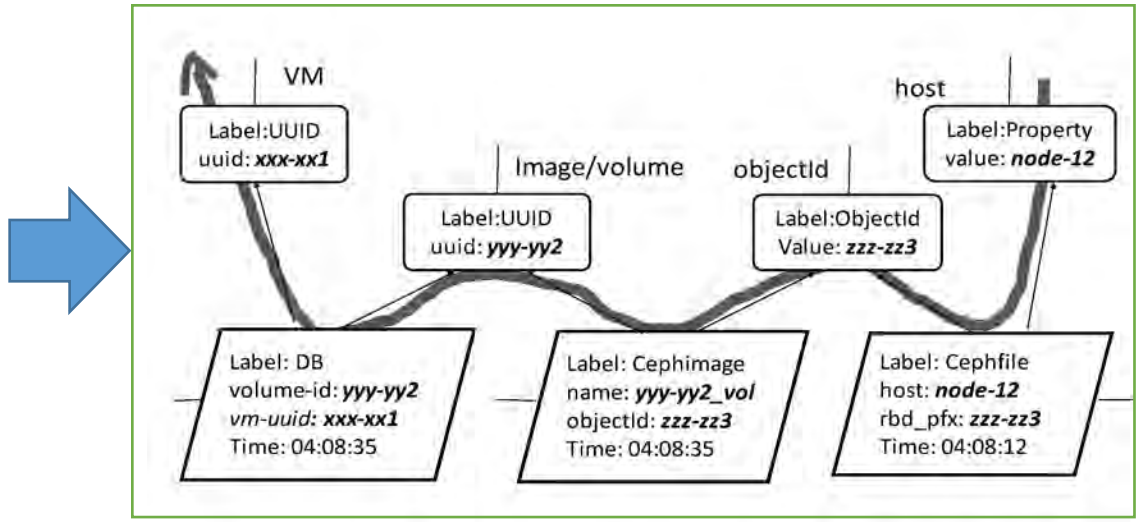
- System query as graph traversal
  - Ad-hoc queries => uniform method
  - No need to memorize tons of system-specific commands

- Anomaly detection
  - Automatically find the hidden problems in system with millions of states

System query as graph traversal

- *If physical server A encounters a hard disk failure, which VMs are affected? (Ceph as the Openstack storage backend)*

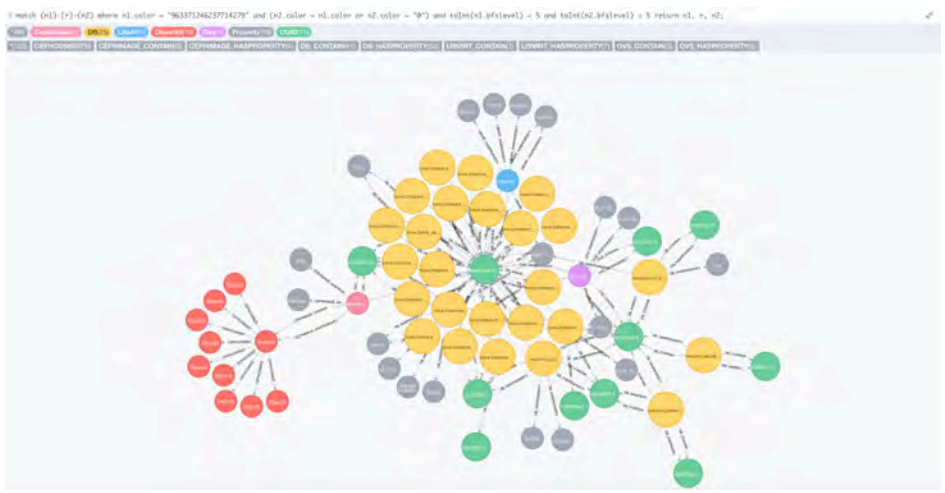
1. Which blocks are stored on the disk (Linux)
   ls /var/lib/ceph/osd/…
2. Which ceph image the block belongs to (Ceph)
   rbd info -p compute(or volumes)
   rbd info -p compute(or volumes) <image>
   grep block-name-prefix filename
3. Where the image is used (Openstack)
   nova show <server>
   nova volume-show <volume>
   cinder show <volume>

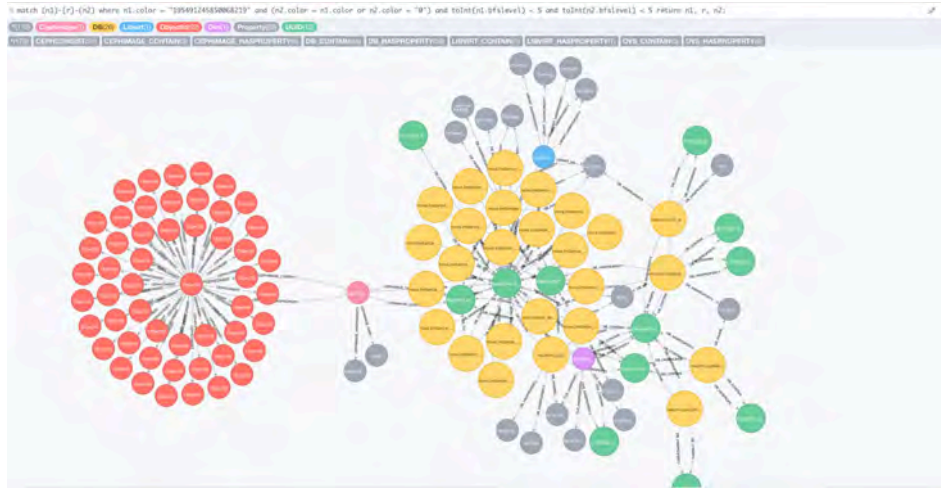


Anomaly detection: ideas

- Based on subgraph describing a single VM
  - find the subgraph that roots at the VM and also includes all its dependencies

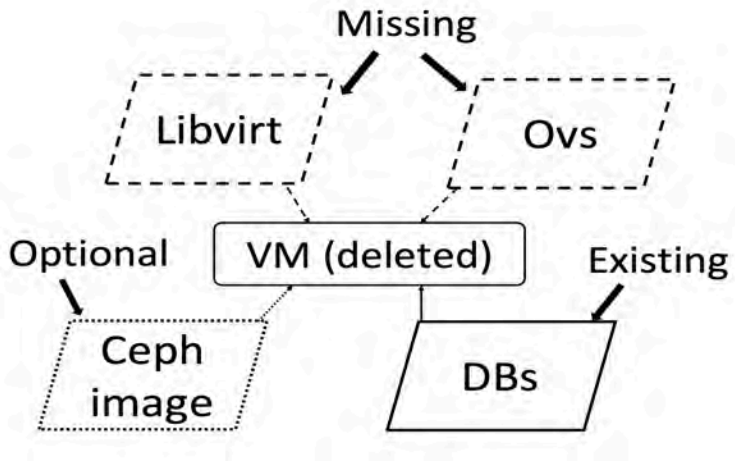
- Distance-based anomaly detection
  - capture the structure information of the subgraphs in the distance metric



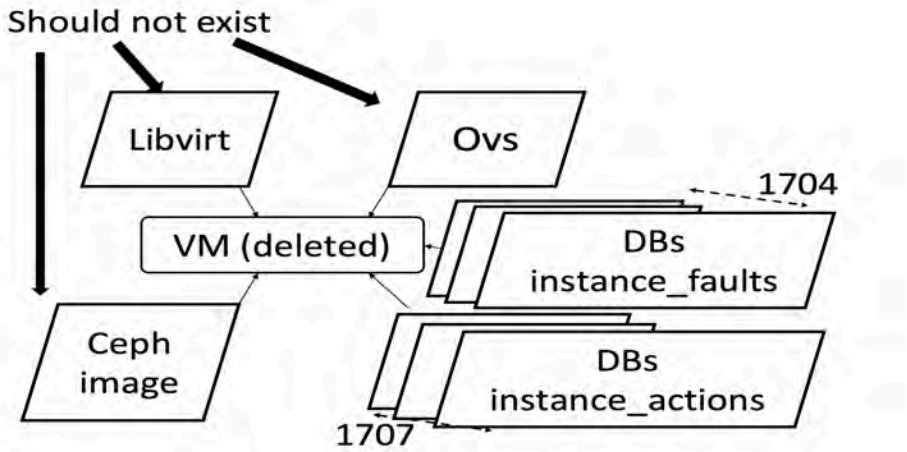


Anomaly case study: database record does not match physical states

- Subgraph: thousands of DB state vertices directly connect to the VM entity vertex
- Inspect: VM has been in deleted state for months, but the libvirt, Cephimage and OVS states still remain.
- Possible bug in retrying / recovery mechanism



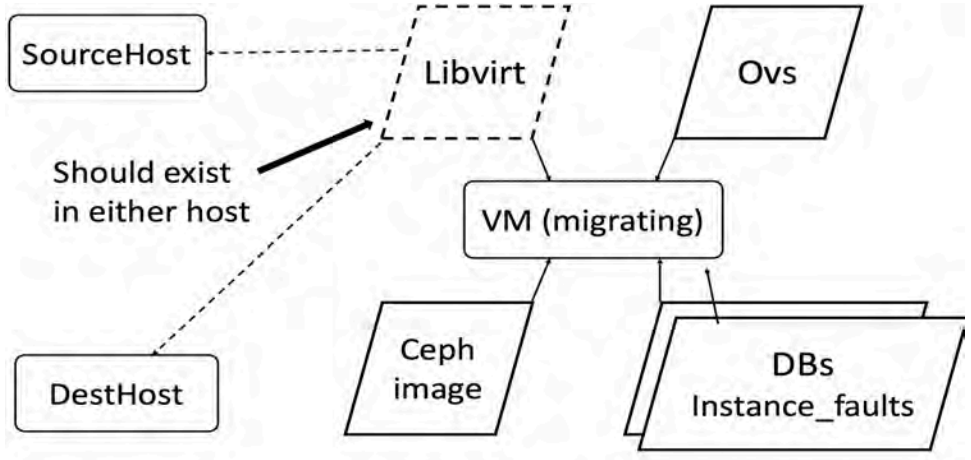
Normal delete case



Database mismatch case

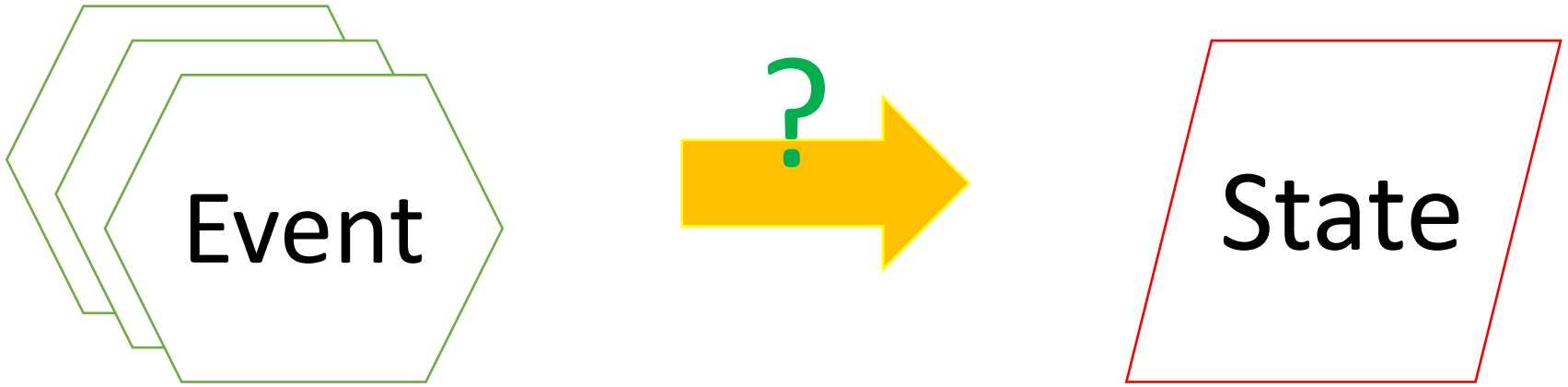
Anomaly case study: failed VM migration

- Subgraph: the migrating VM is missing libvirt state, both from the source host and the destination host
- Inspect:
  - Database: nova.instance_faults shows "*cannot remove config /etc/libvirt/…*" on the source, and "*error removing image*" on the destination
  - Log: "*instance not resizing, skipping migration*" repeated 653 times
- Possible resource management bug



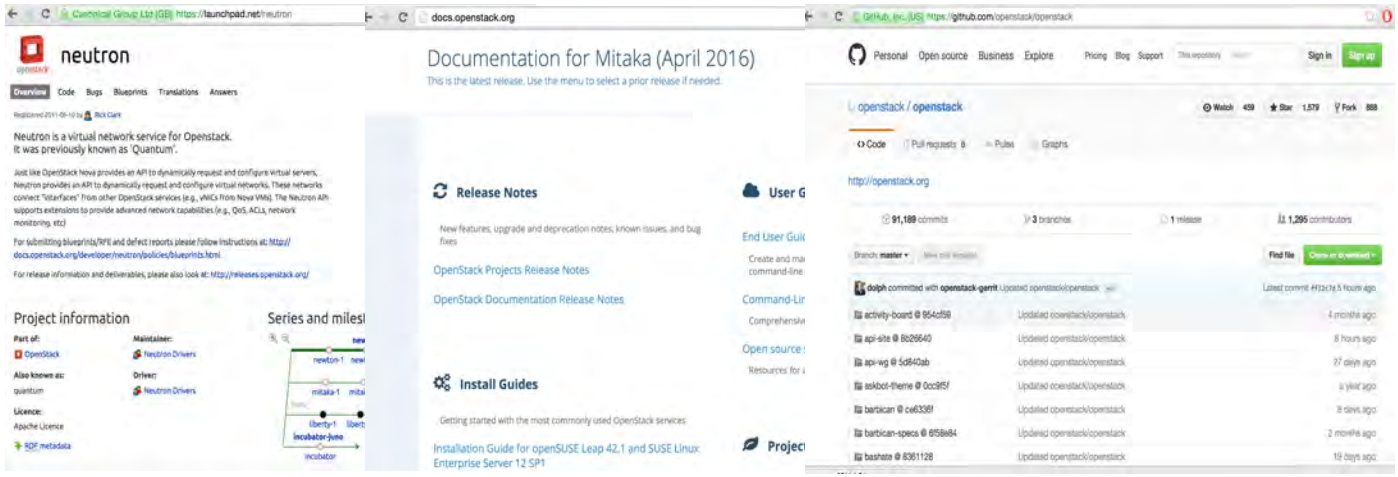
Future work

- Analyzing event and state history
  - Indicate **why** the system end up in an inconsistent state
  - Might predict the failure before actually happens



Future work

- Including other data sources
  - i.e. source code, bug reports and documentations
  - Help further **confirm** the proposed anomalies/bugs
  - Provide insights in how to **fix** the bugs discovered



Future work

- Supporting incremental graph construction
  - Capture the continuous evolving of state and event in a online way
- Applying SOSG to other systems
  - i.e. big data frameworks
  - General applicability

Conclusions

- System operation knowledge can be automatically discovered with simple rules
- Entities and links are important knowledge in systems, and can be captured with a state graph (SOSG)
- Many potential applications
  - System state query as graph traversal
  - Anomaly detection
  - …

Thank You

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