Chaos Practice in TiDB

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About Me

- Chief Engineer of PingCAP
- Open sources: go-mysql, go-mysql-elasticsearch, LedisDB, etc.

Agenda

- Why Chaos
- Fault Injection
- Schrodinger
- Miscellaneous

PingCAP

Why?

Error can happen anywhere, at anytime!!!

- Unit test is not enough
- Integration test is not enough
- Performance test is not enough

OnCall

```
[root@10-180-0-22 data]# ls -lt snap/* | grep 16986
-rw-r--r-- 1 ops ops         58 Jul 18 23:42 snap/rev_1129386_18_16986.meta
-rw-r--r-- 1 ops ops          0 Jul 18 23:42 snap/rev_1129386_18_16986_write.sst
-rw-r--r-- 1 ops ops          0 Jul 18 23:42 snap/rev_1129386_18_16986_lock.sst
-rw-r--r-- 1 ops ops    8499200 Jul 18 23:42 snap/rev_1129386_18_16986_default.sst
```

OnCall

```
[17988717.953807] 0 pages in swap cache
[17988717.953808] Swap cache stats: add 0, delete 0, find 0/0
[17988717.953809] Free swap  = 0kB
[17988717.953810] Total swap = 0kB
[17988717.953811] SLUB: Unable to allocate memory on node -1 (gfp=0x20)
[17988717.953813]   cache: kmalloc-8192, object size: 8192, buffer size: 8192, default order: 3, min orde
[17988717.953815]   node 0: slabs: 78, objs: 312, free: 21
[17988717.953816]   node 1: slabs: 37, objs: 148, free: 0
[10253.332261] snapshot worker: page allocation failure: order:1, mode:0x204020
[18010253.332267] CPU: 15 PID: 32283 Comm: snapshot worker Not tainted 3.10.0-327.el7.x86_64 #1
[18010253.332268] Hardware name: Huawei RH1288 V3/BC11HGSC0, BIOS 3.35 10/20/2016
[18010253.332270]  0000000000204020 000000008bc746cd ffff882604e8b768 ffffffff816351f1
[18010253.332277]  ffff882604e8b7f8 ffffffff8116ef80 0000000000000010 0000000000000000
[18010253.332281]  ffff88407ffd7000 00000001ffffffe 0000000000000003 000000008bc746cd
[18010253.332285] Call Trace:
[18010253.332295]  [<ffffffff816351f1>] dump_stack+0x19/0x1b
[18010253.332300]  [<ffffffff8116ef80>] warn_alloc_failed+0x110/0x180
[18010253.332304]  [<ffffffff81173708>] __alloc_pages_nodemask+0x9a8/0xb90
[18010253.332309]  [<ffffffff811b43f9>] alloc_pages_current+0xa9/0x170
```

Chaos Engineering

1. Study the **stable status** of the system, usually through Monitor and Statistics
2. Inject a fault to disturb the system
3. Study the **unstable status** of the system and analyze the results
4. Repeat step 1 to 3
5. Automate

Fault Injection

Common

- kill
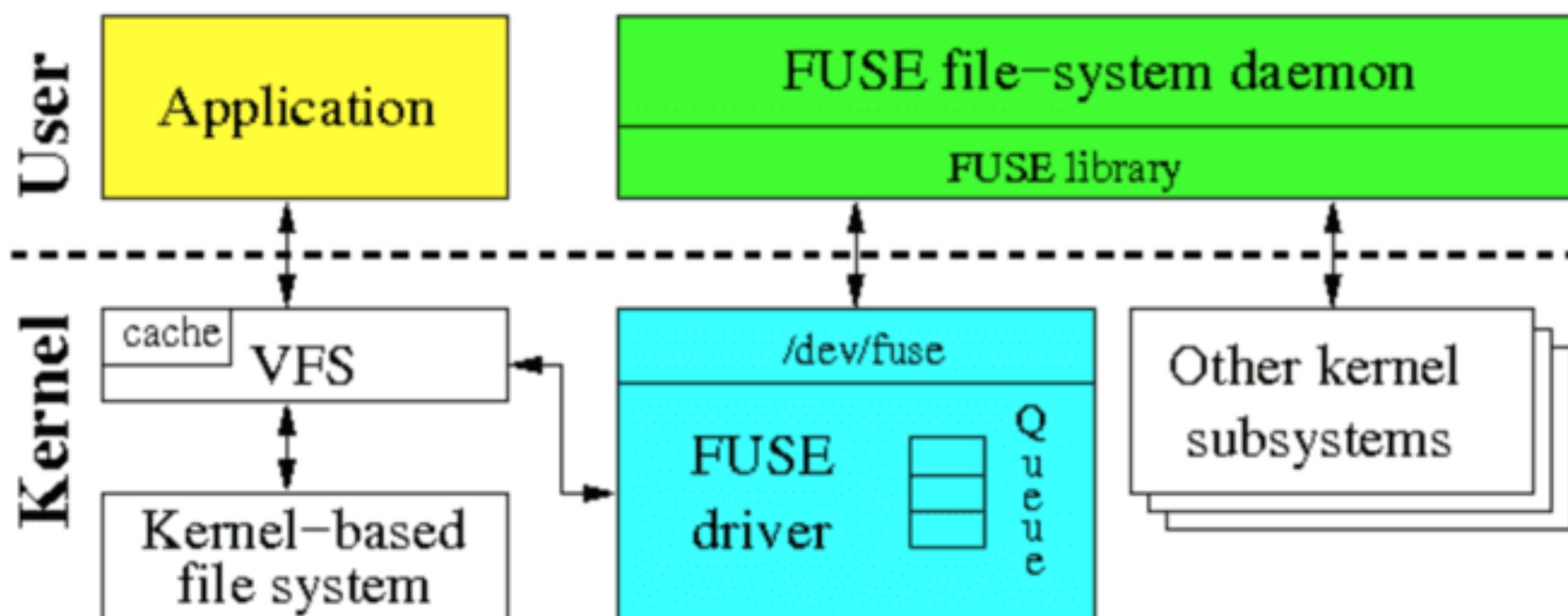- kill -9
- SIGSTOP, SIGCONT
- renice
- Maxing out CPU
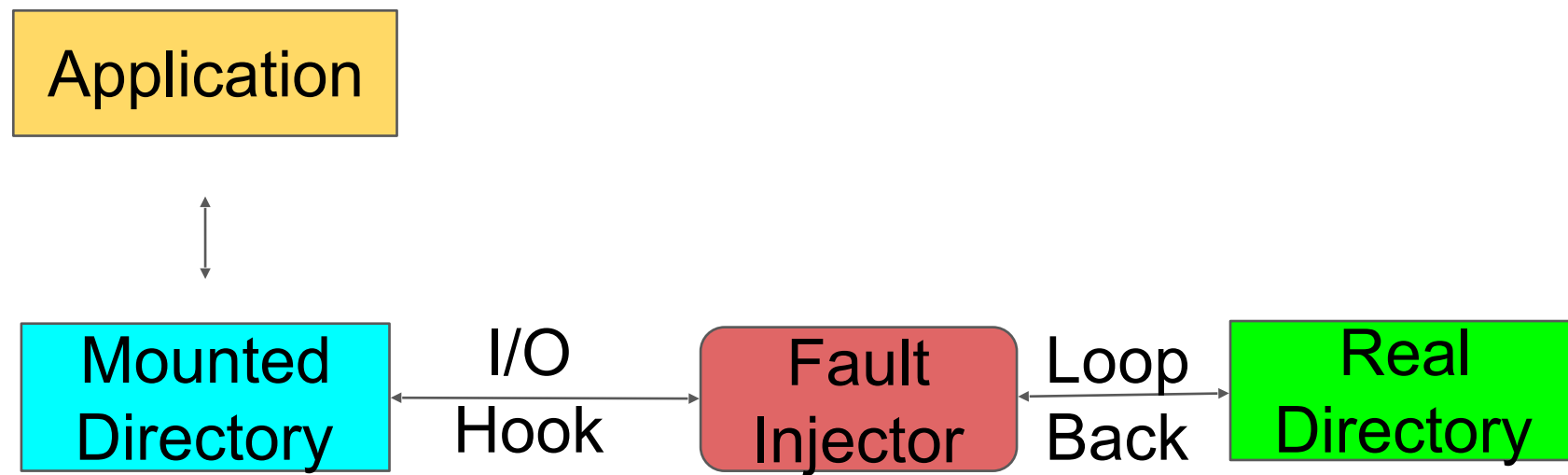- Cgroups

Network

- Drop
- Reject
- Delay
- Reorder
- Full

Disk

- libfuse
- libfiu
- rm -rf
- echo 0 > file
- NoSpace

Fuse

Fuse

Kernel Fault Injection

Need rebuild kernel with fault injection support

```
echo 1 > /sys/block/vdb/vdb1/make-it-fail
mount debugfs /debug -t debugfs
cd /debug/fail_make_request
echo 10 > interval # interval
echo 100 > probability # 100% probability
echo -1 > times # how many times: -1 means no limit


> Buffer I/O error on device vdb1, logical block 32538624
> lost page write due to I/O error on vdb1
```

Kernel Fault Injection

```
echo 1 > cache-filter
echo 1 > /sys/kernel/slab/ext4_inode_cache/
failslab
echo N > ignore-gfp-wait
echo -1 > times
echo 100 > probability

> cp linux-3.10.1.tar.xz linux-3.10.1.tar.xz.6
> cp: cannot create regular file 'linux-
3.10.1.tar.xz.6': Cannot allocate memory
```

Systemtap

```
probe vfs.read.return {
    if (target() != pid()) next
    udelay(300)

}


probe vfs.write.return {
    if (target() != pid()) next
    udelay(300)

}
```

Systemtap

```
probe vfs.read.return {
    if (target() != pid()) next
    // Interrupted by a signal
    $return = -4
}


probe vfs.write.return {
    if (target() != pid()) next
    // No space
    $return = -28
}
```
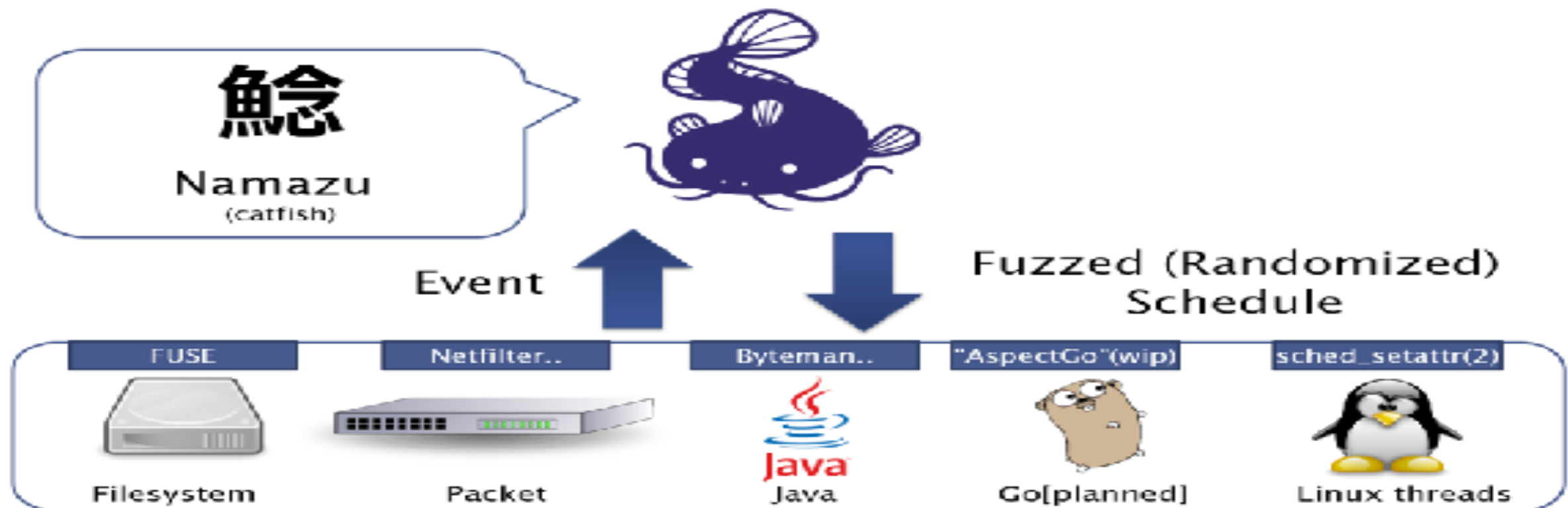
Fail

- Go fail - https://github.com/coreos/gofail
- Rust fail - https://github.com/pingcap/fail-rs

```rust
// Ingest a failure
fn save_snapshot() {
    save_data();
    fail_point!("snapshot");
    save_meta();
}
// Run and Trigger the failure panic
FAILPOINTS=snapshot=panic(msg) cargo run
```

Namazu

- Filesystem Inspector - Use Fuse to delay or inject faults
- Ethernet Inspector - Use iptables to drop or delay

鮎 Namazu (catfish)

Event

Fuzzed (Randomized) Schedule

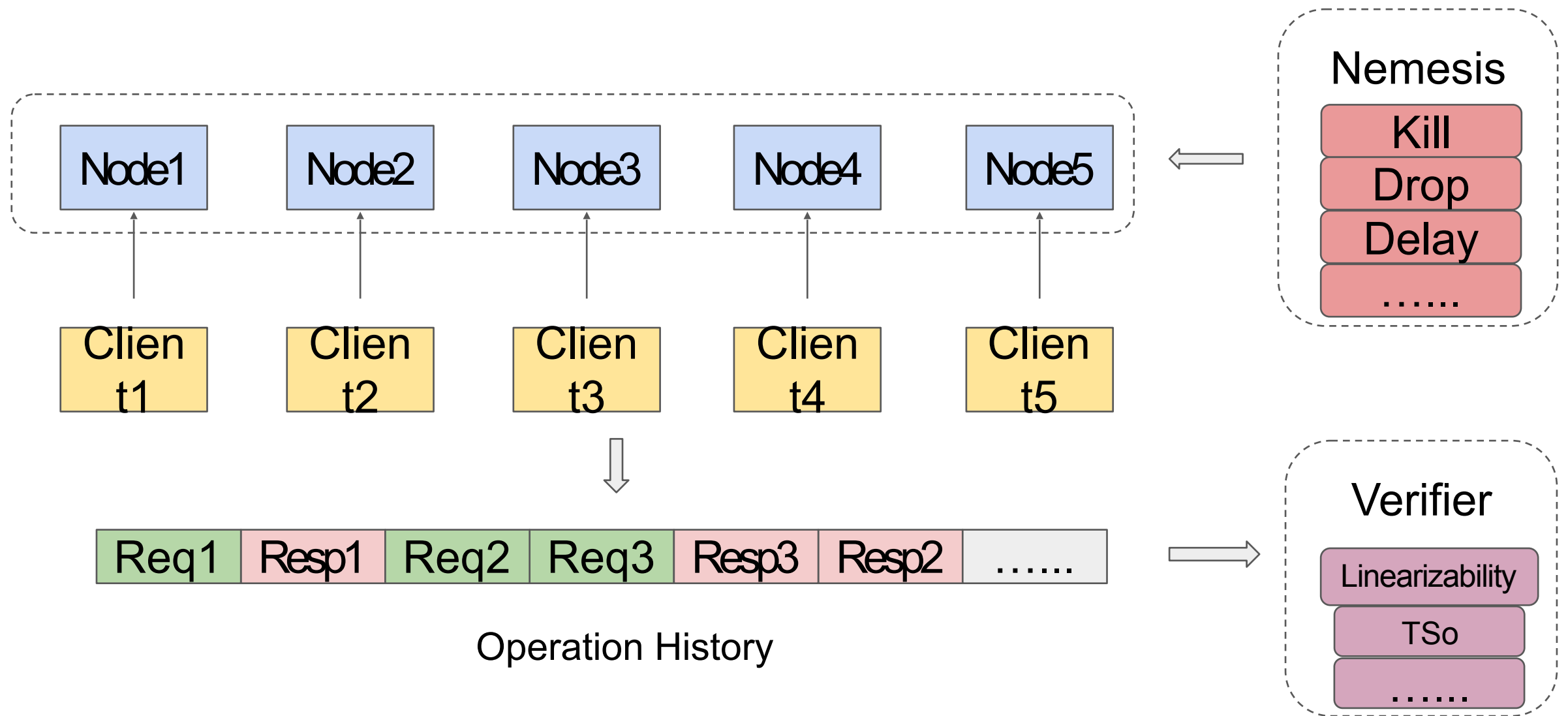| FUSE	Netfilter..	Byteman..	"AspectGo"(wip)	sched_setattr(2)
Filesystem	Packet	Java	Go[planned]	Linux threads

Jepsen

- Run Nemesis to disturb a cluster
- Record the request and response
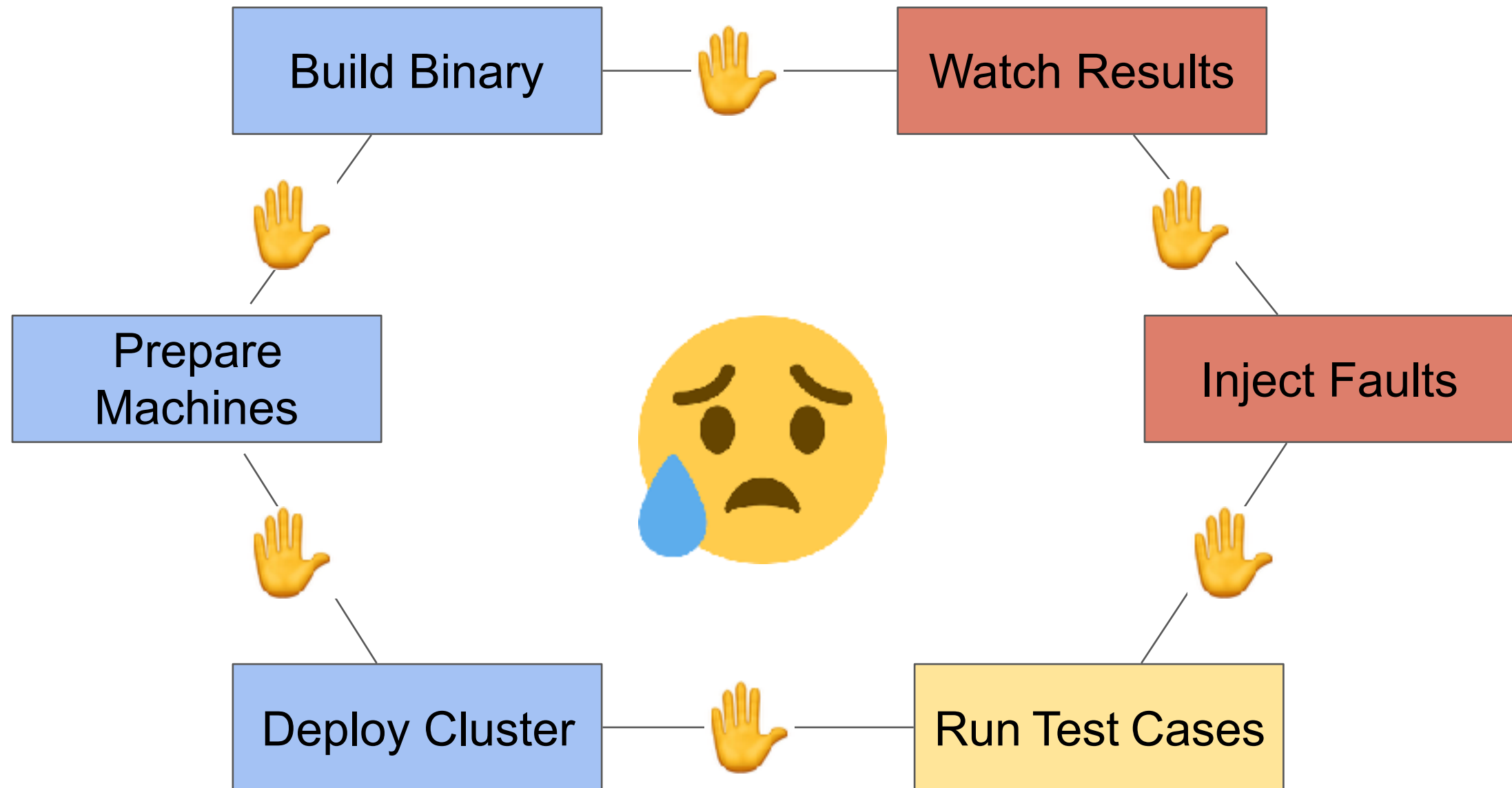- Verify the linearizability of history

Focus on network and linearizability testing
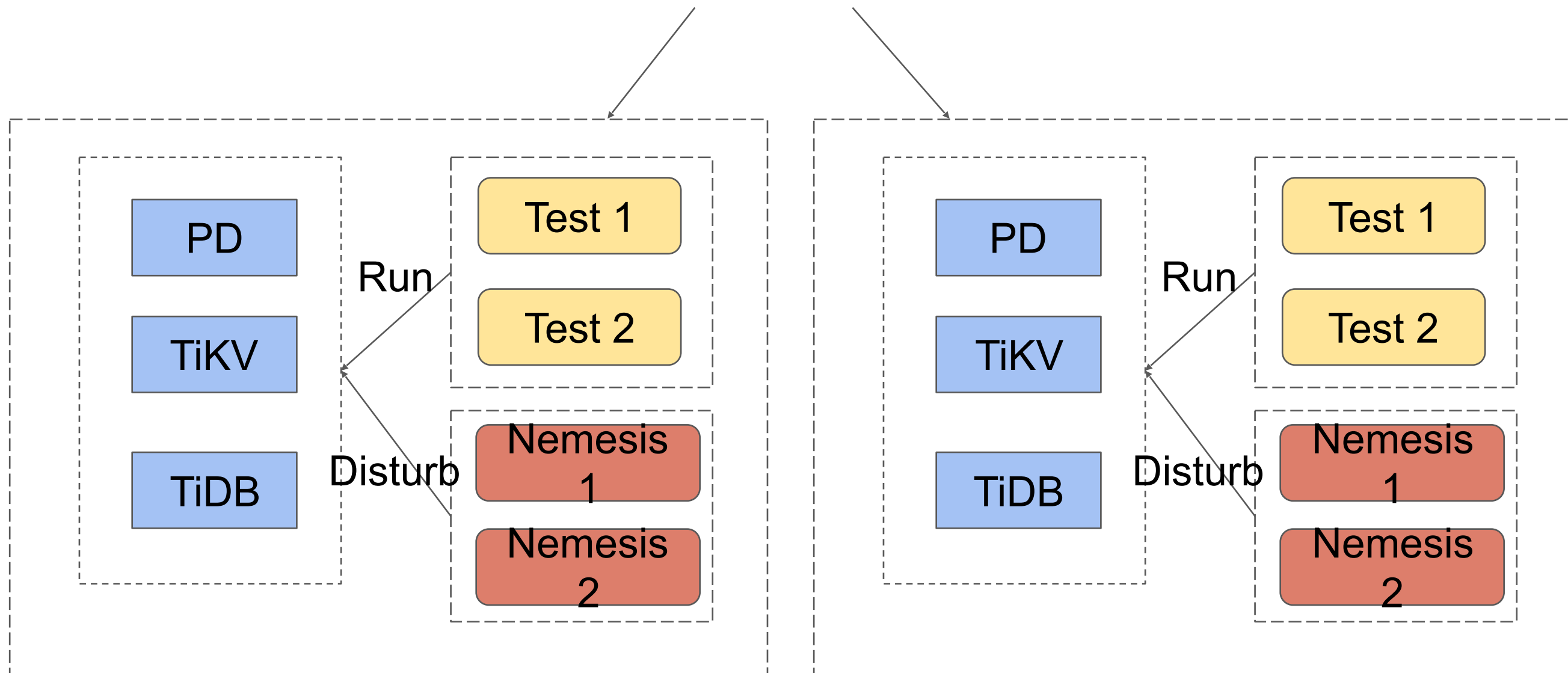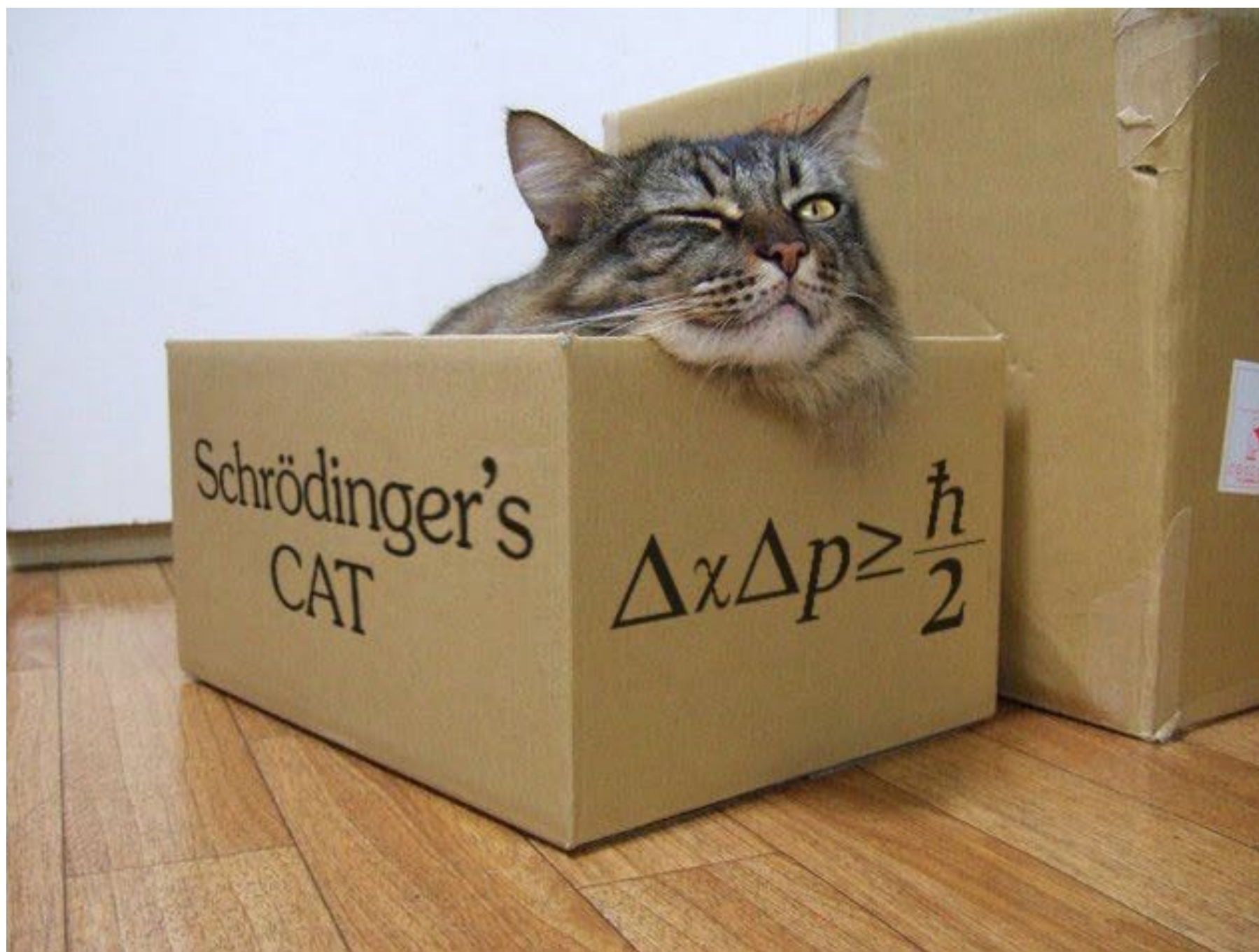
Go Chaos

Practice

In Ancient Time...

We need automation

Schrodinger

Schrodinger
TiDB Cluster Stability Test

	Homepage		Create Box		Cat Pool		Create Test Template

Created Test Template Pool

Create Test Template

	ID	Name	Source Type	Create Time	Update Time	Compile Stage ⌄	Operation
>	15324021186	upgrade	git	2018-07-24 11:15:18	2018-07-27 11:41:41	DONE	
>	15325210089	new-test	bin	2018-07-25 20:16:48	2018-07-25 20:16:48	DONE	
>	15324896682	bin	bin	2018-07-25 11:34:26	2018-07-25 19:10:25	DONE	
>	153240761071	merge	git	2018-07-25 11:03:30	2018-07-25 11:19:34	DONE	

Test Template ⓘ

✕

| * Test Name: | Enter test name | Test Creator: | Enter test creator |

Description: Briefly describe the purpose of this test

Source: select an existing binary test file or compile one from git

* Source Type: ● git ○ bin

* Binary Name: Enter name of the binary test

* Git Repo: Enter git repo

* Git Type: ● branch ○ tag ○ hash

* Git Value: master

Docker Image: Enter docker execution image

Args: Execution arguments

Cancel   Reset   **Create**

Schrodinger TiDB Cluster Stability Test

PingCAP

* Box Name: [Enter box name]

CAT

Cat From ● Cat Pool   ○ Create New Cat

* Pick Cat: [Please select cat ▾]

Tests

Execution method ● Serial execution   ○ Parallel execution

* Pick Tests: [Please select test ▾]

Trigger Rules

* Rule Type: ○ Immediately Job ❶   ○ Greaten Job ❶   ○ Git Update ❶

Misc Config

Slack Channel ❶ [   ]

Prepare Callback ❶ [   ]

Stop Callback ❶ [   ]

Type ❶ [   ]

Destory TiDB Cluster ❶   [● Yes]   [○ No]

Schrodinger TiDB Cluster Stability Test

⊕ Create New Box

≡ Box Instance List ⌃

up

⚙ Hide Experiment Config

Config

ID: 15325531914
Name: up
Status: NORMAL
Stage: FINISHED
Create Time: 2018-07-27 11:46:05
Update Time: 2018-07-27 12:13:55
Data:
Destroy TiDB Cluster: true
Prepare:
Slack: #schrodinger-alert
Stop:
Timeout: 604800000000000

Cat

Labels:
PD Version: branch-release-2.0
TiKV Version: branch-master
TiDB Version: branch-master
PD Size: 1
TiDB Size: 1
TiKV Size: 3
Config Map: tidb-cluster-merge-template

Tests

Execution Method: Serial Execution
Tests:

upgrade

All Experiments in Box up > All Tests List in Experiment : up

Test Name	Start Time	Update Time	Status ⌄	Operation
upgrade	2018-07-27 11:46:17	2018-07-27 11:46:17	FINISHED	⤴

Miscellaneous

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TLA+
https://github.com/pingcap/tla-plus

Dr. TLA+ Series - learn an algorithm and protocol, study a specification

Lecture schedule (Time: 10-11:30am PDT)

	Date	Speaker	Topic	Media
	06.22.2016	Andrew Helwer	Paxos	video, slides
	07.21.2016	Jin Li	Raft	video, slides
	08.29.2016	Cheng Huang	Fast Paxos	video, slides
	09.23.2016	Rustan Leino	Global Snapshots	video, slides
	11.09.2016	Heidi Howard	Flexible Paxos	video, slides
	01.20.2017	Shuai Mu	Byzantine Paxos	video, slides
⇒	03.01.2018	Ed Huang	Verifying Distributed Transaction with TLA+ in TiDB	
	TBD	Stephan Merz	Termination Detection	

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Thank you!