WalB: A Fast and Low Latency Backup System for Block Devices

Open Source Summit Japan 2017

Kota Uchida

June 1, 2017

About me

- Kota Uchida
- SRE team at Cybozu, Inc.
- A WalB developer

About Cybozu

- A **large** cloud service vendor in Japan.
- Largest market shares
  in field of collaborative software.

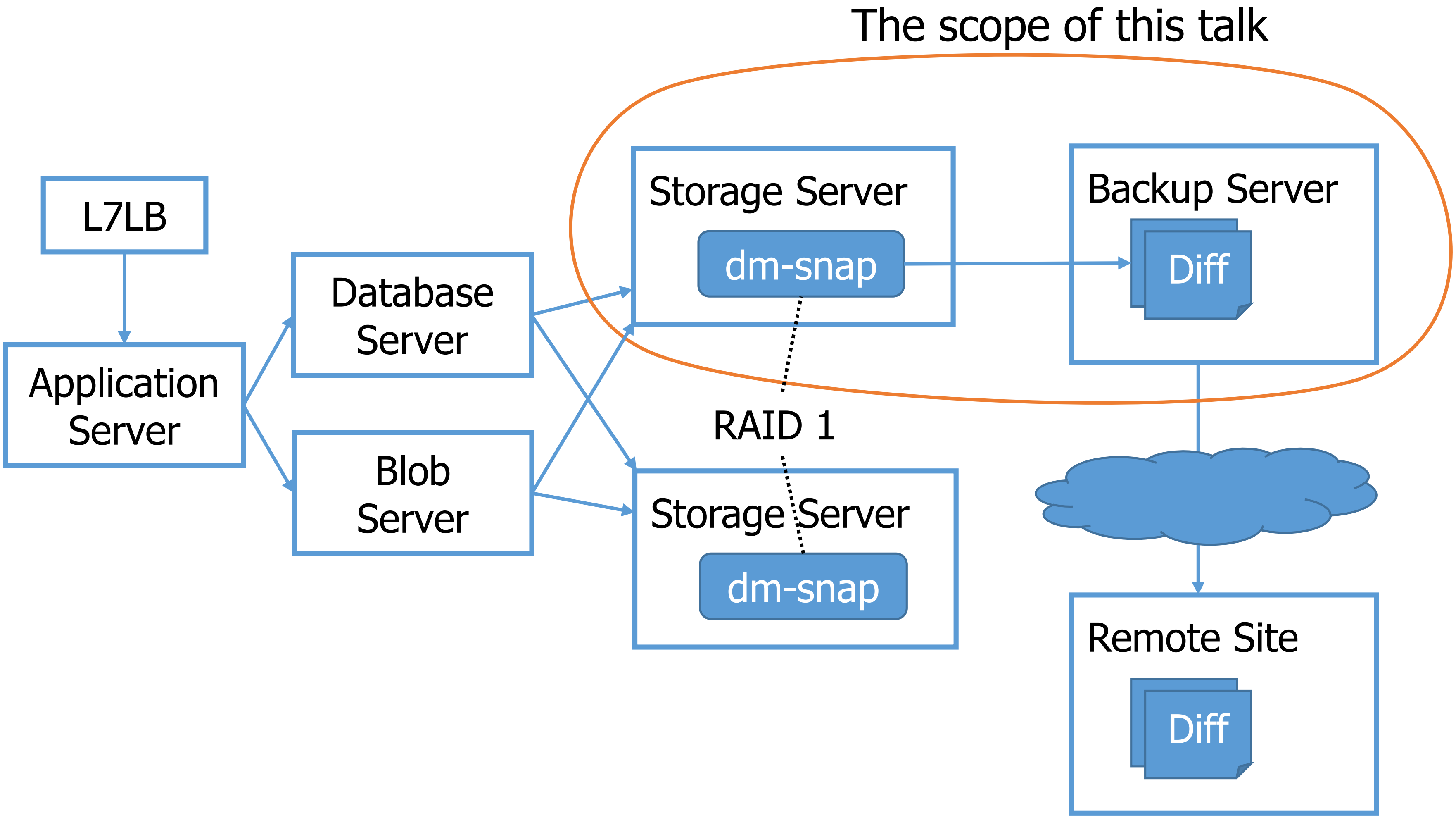
- We serve web applications on our own cloud platform.
  - kintone: a low-code business app platform
  - and more

#customer companies :	**19,000+**
#accesses / day :	**190 millions**
write IOs / day :	**24.5 TiB**

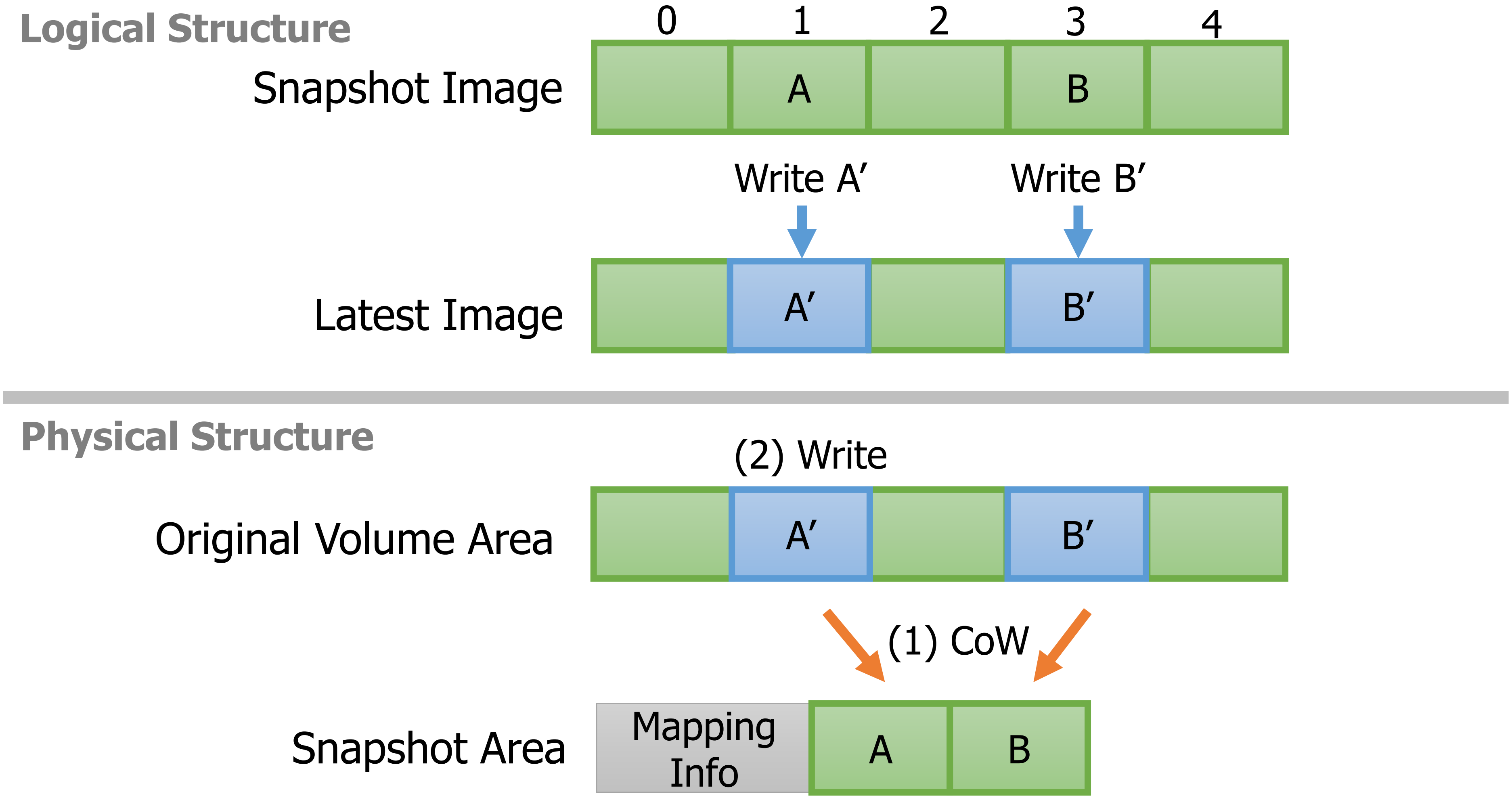
Service Level Objective

- **24/7** nonstop service
- **99.99%** availability (4 min / month)
- Daily backup (retention period is **14 days**)
- Disaster recover: copy data to a remote site **once a day**

Architecture of our platform



Snapshot Management with dm-snap



Logical Structure

0 1 2 3 4

Snapshot Image: A, B

Write A′ Write B′

Latest Image: A′, B′

Physical Structure

(2) Write

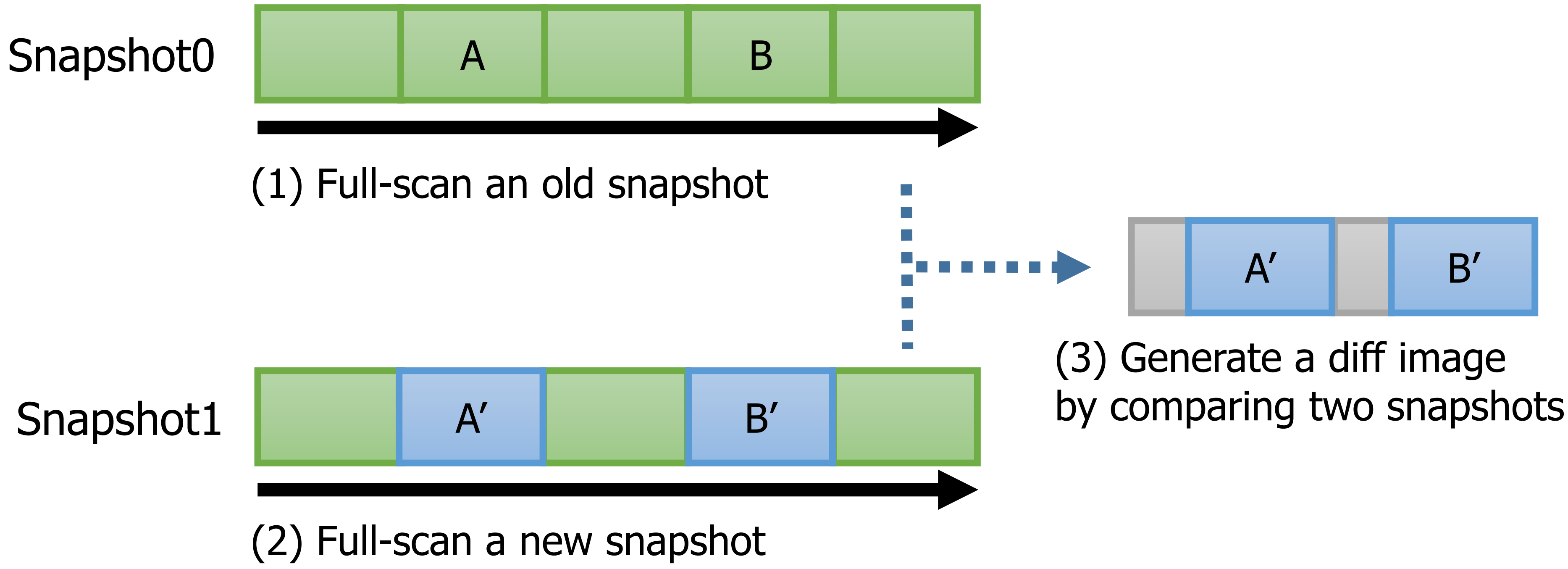
Original Volume Area: A′, B′

(1) CoW

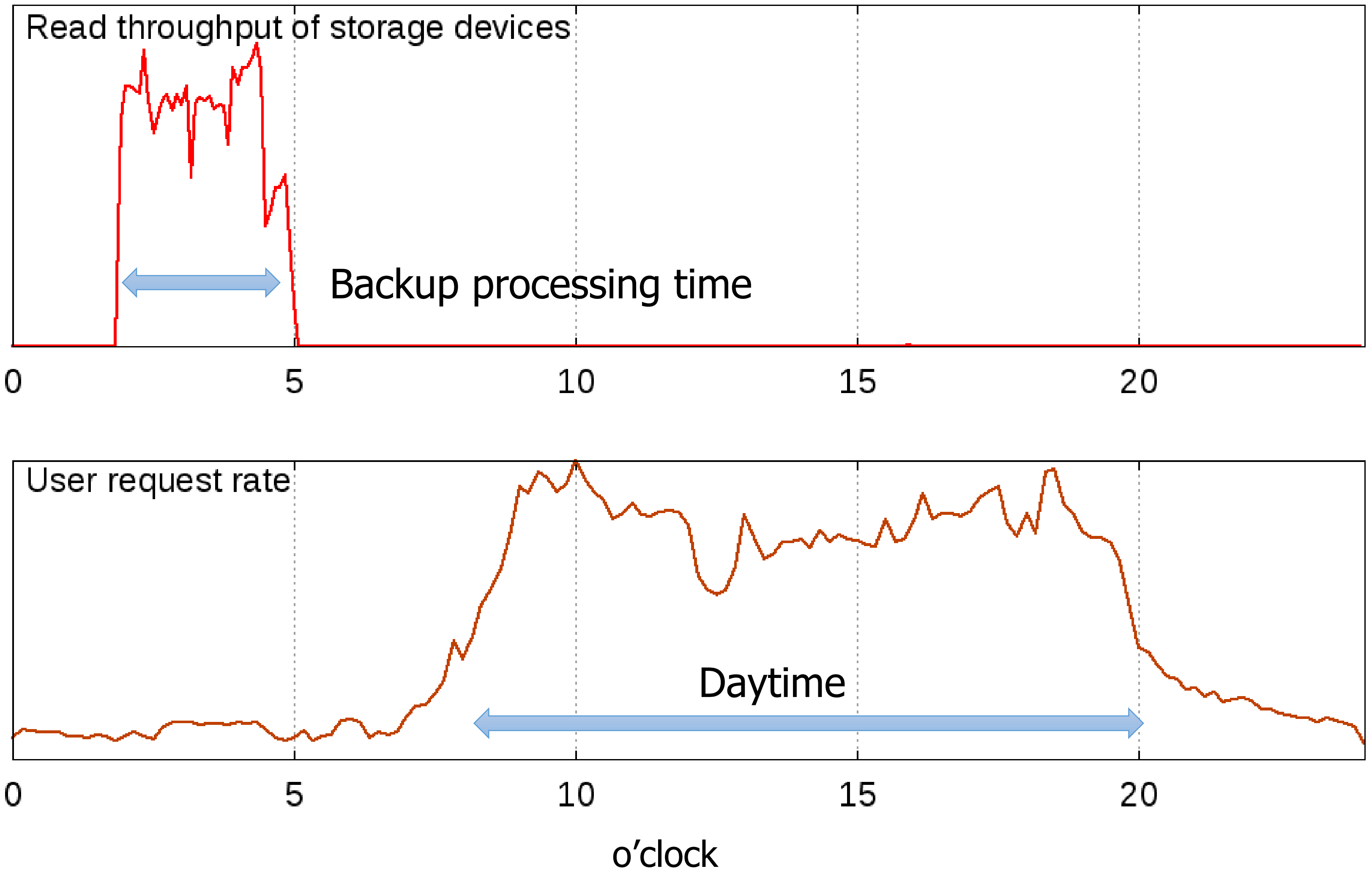
Snapshot Area: Mapping Info, A, B

Backup using dm-snap

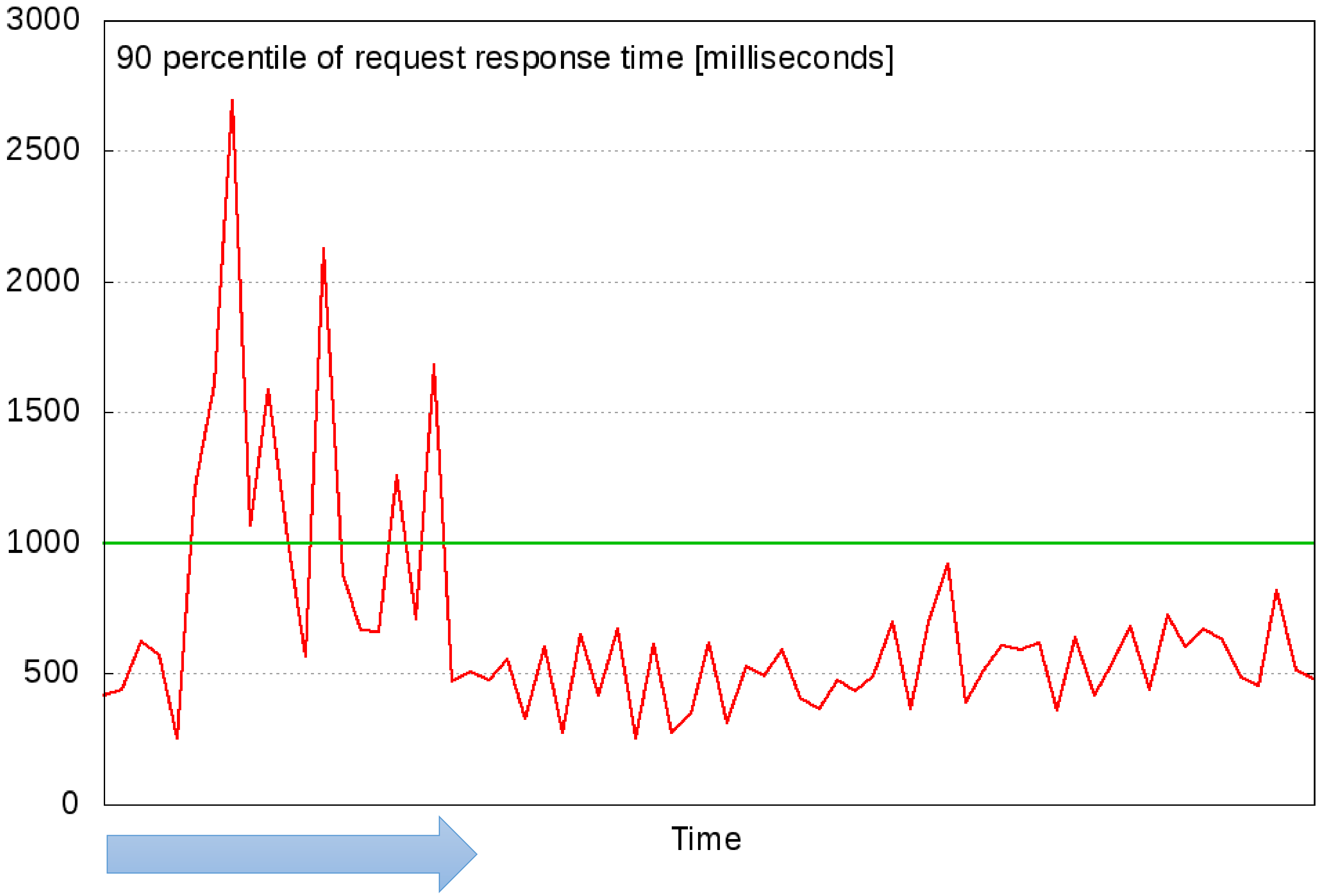
Logical Structure


Snapshot0
A
B
(1) Full-scan an old snapshot
A′
B′
(3) Generate a diff image by comparing two snapshots
Snapshot1
A′
B′
(2) Full-scan a new snapshot

Full-scan at night



UX degradation during a full-scan



Full-scanning

We have no more “nights”

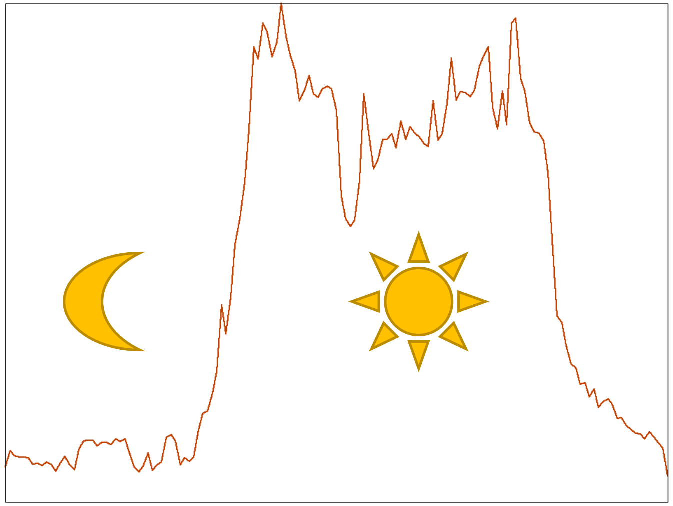
- Until now:

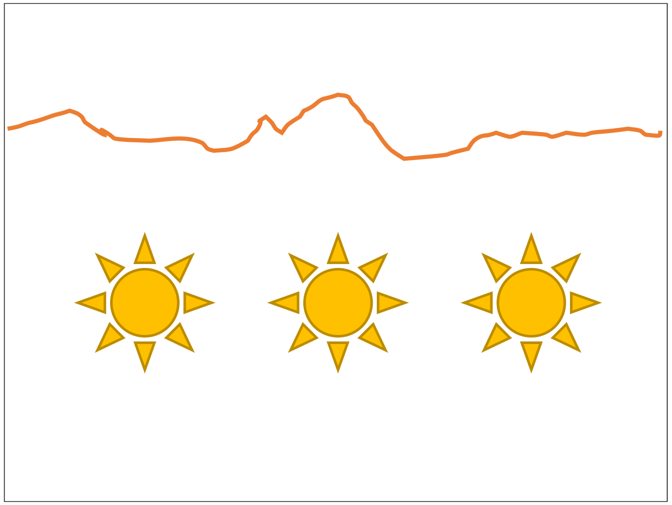
  Full scan is allowed only when access rate is low, i.e., at night.

- From now on:

  We have to handle accesses from multiple timezones.

- We must be able to backup any time without UX degradation.





New Solution

- We need a new solution with:
  - No IO spikes
  - Short backup time

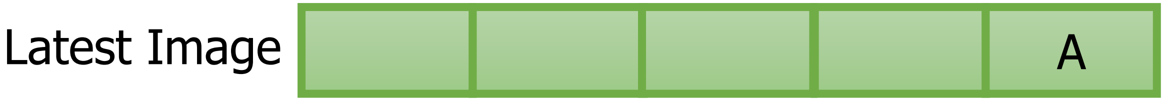
- We compared dm-thin with WalB

What is dm-thin?

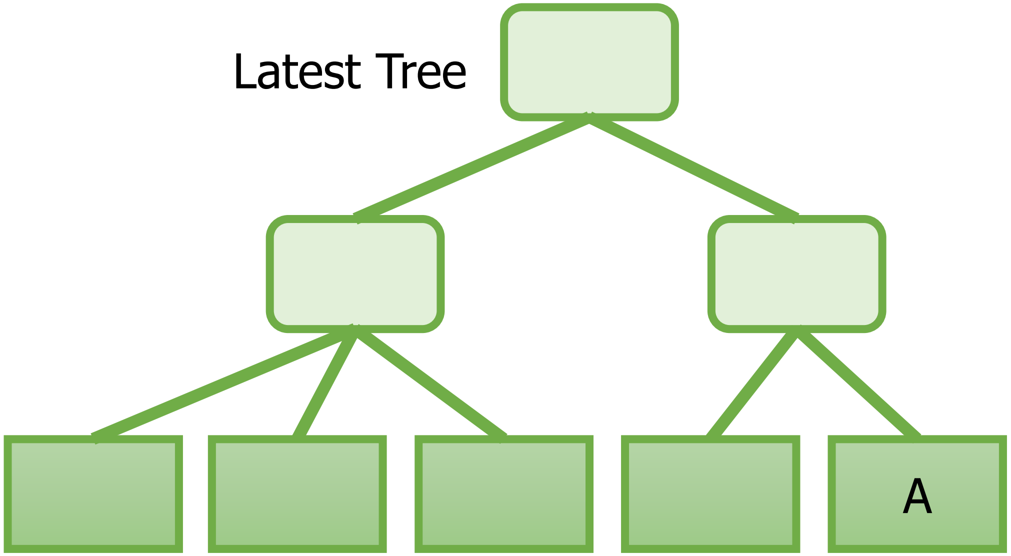
- dm-thin provides thin-provisioning volume management to
  - share same data among volumes
  - reduce disk usage using snapshots
- In the mainline Linux kernel

Snapshot Management with dm-thin

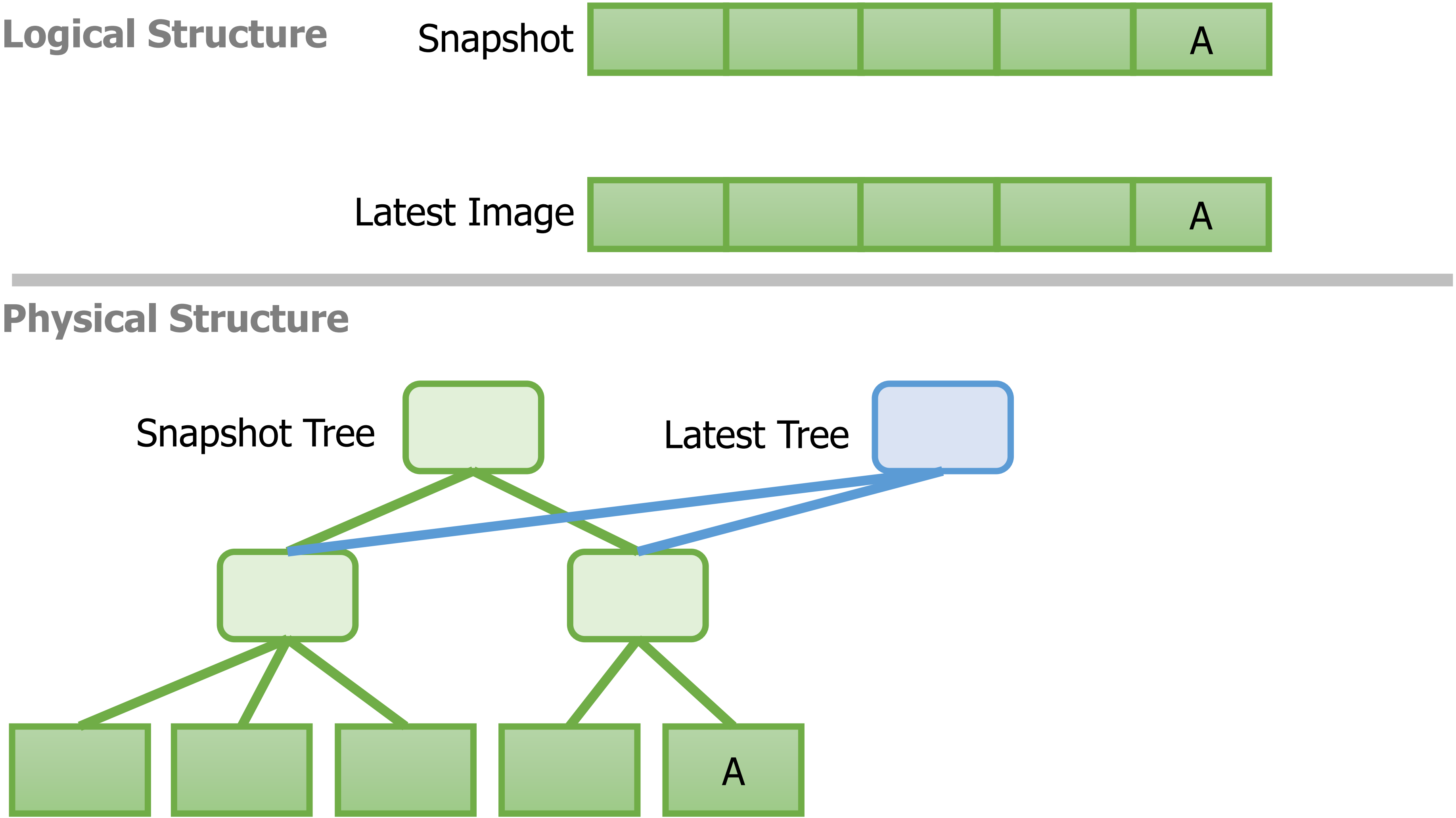
Logical Structure



Physical Structure



Snapshot Management with dm-thin



Logical Structure

Snapshot

Latest Image

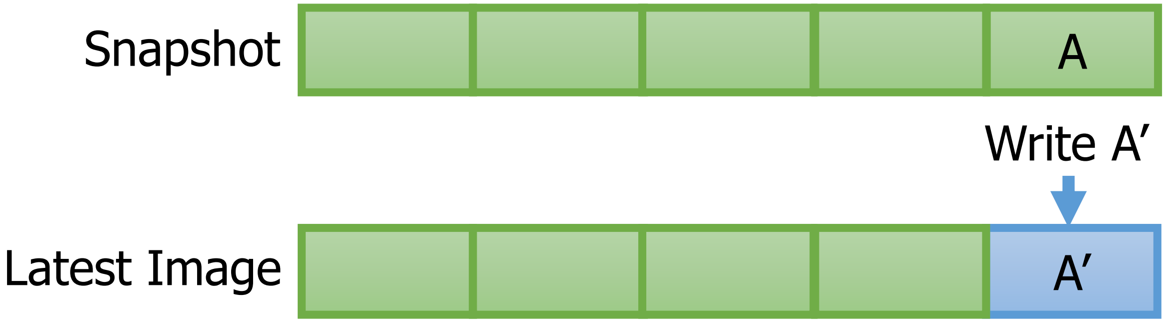
Physical Structure

Snapshot Tree

Latest Tree

Snapshot Management with dm-thin

Logical Structure



Snapshot

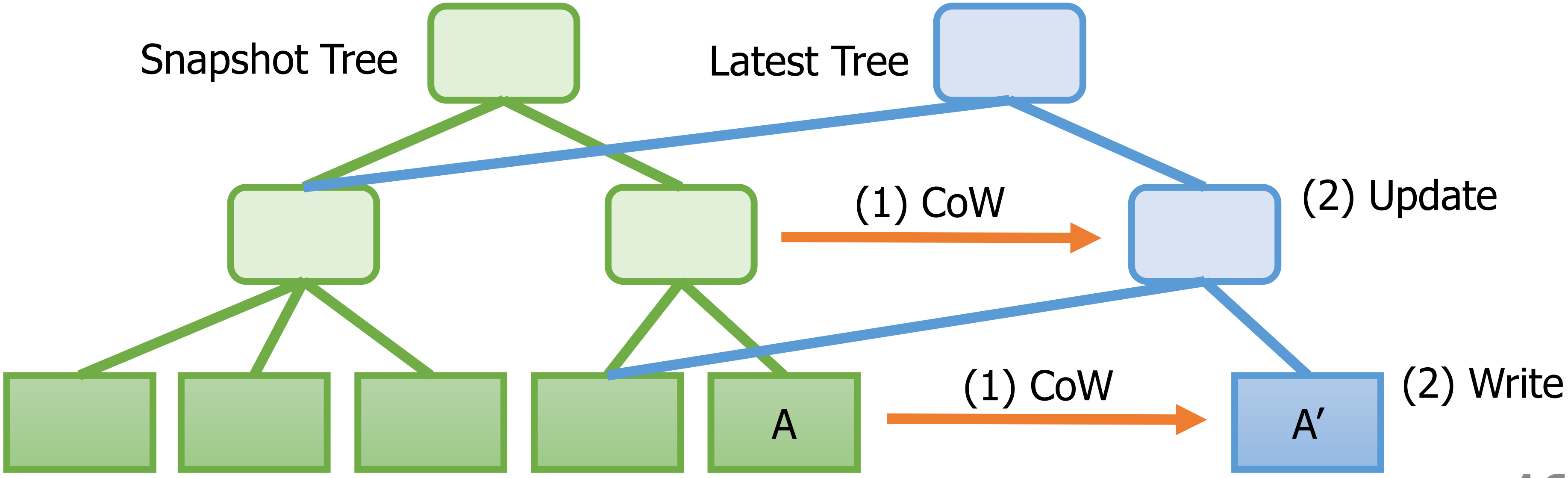
A

Write A′

Latest Image

A′

Physical Structure



Snapshot Tree

Latest Tree

(1) CoW

(2) Update

(1) CoW

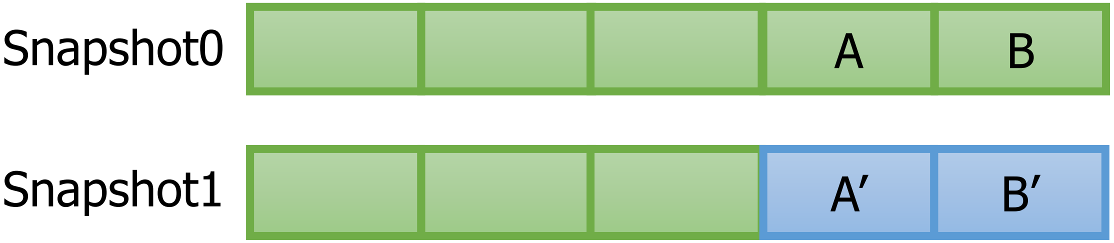
(2) Write

A

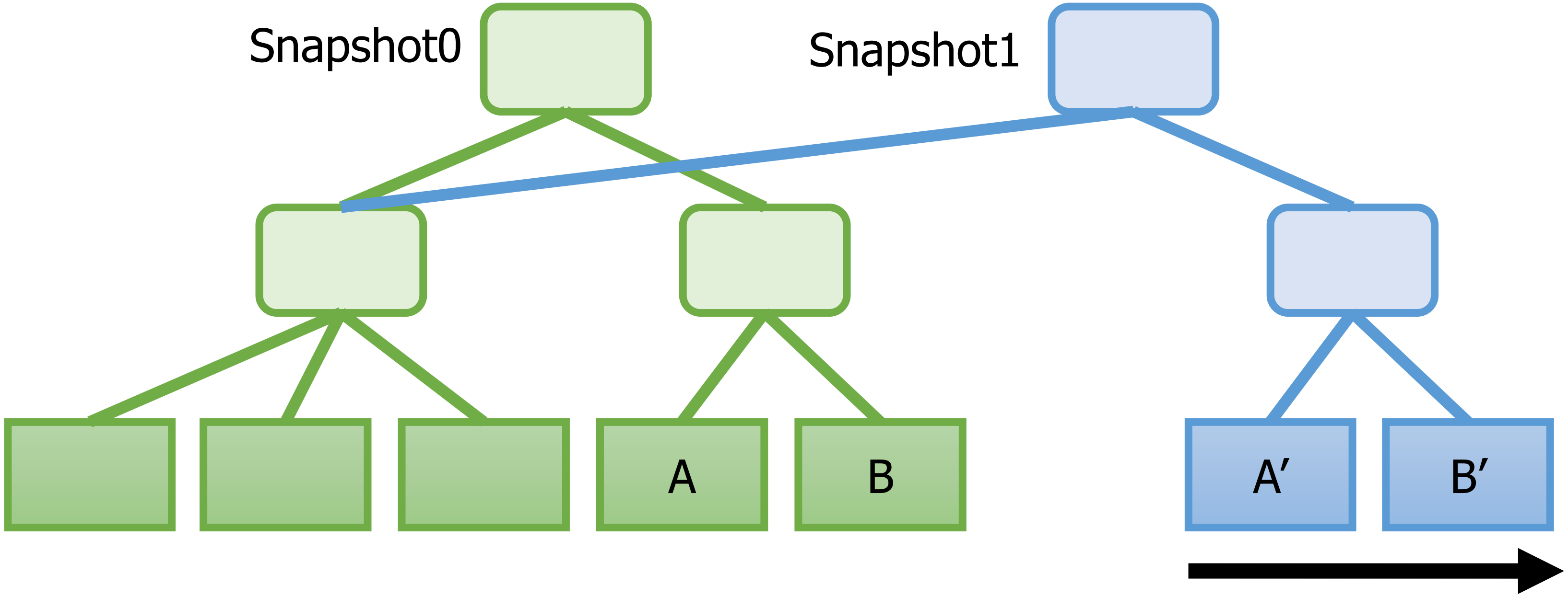
A′

Backup using dm-thin

Logical Structure

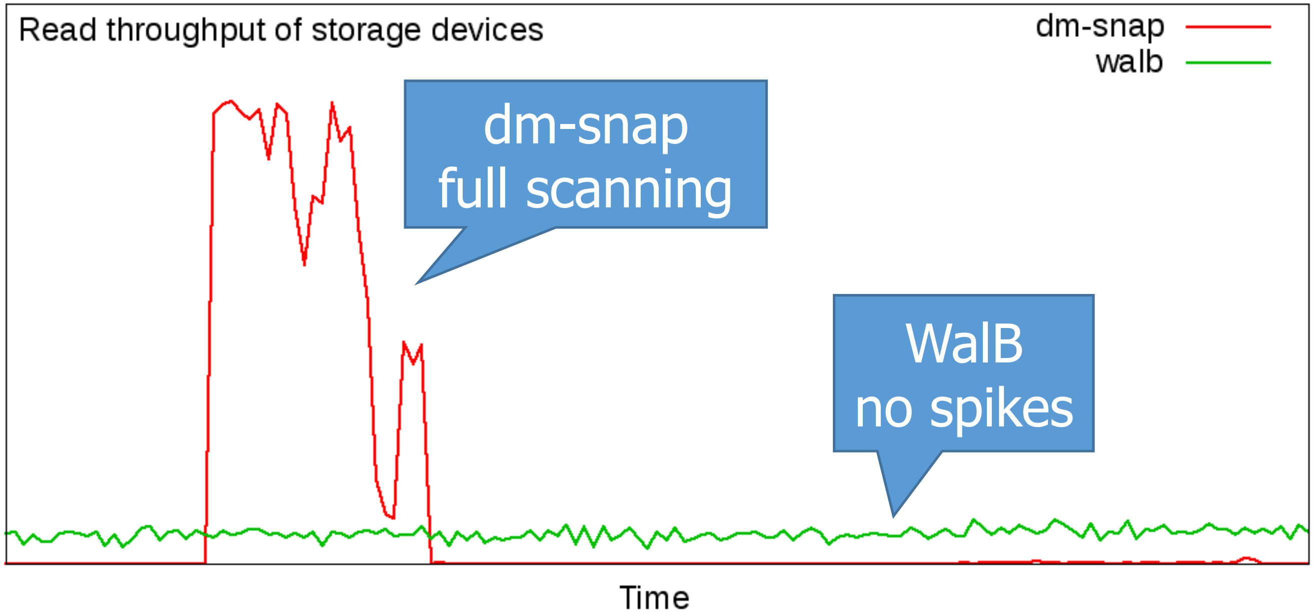


Physical Structure



Generate a diff image using dm-thin metadata

What is WalB?

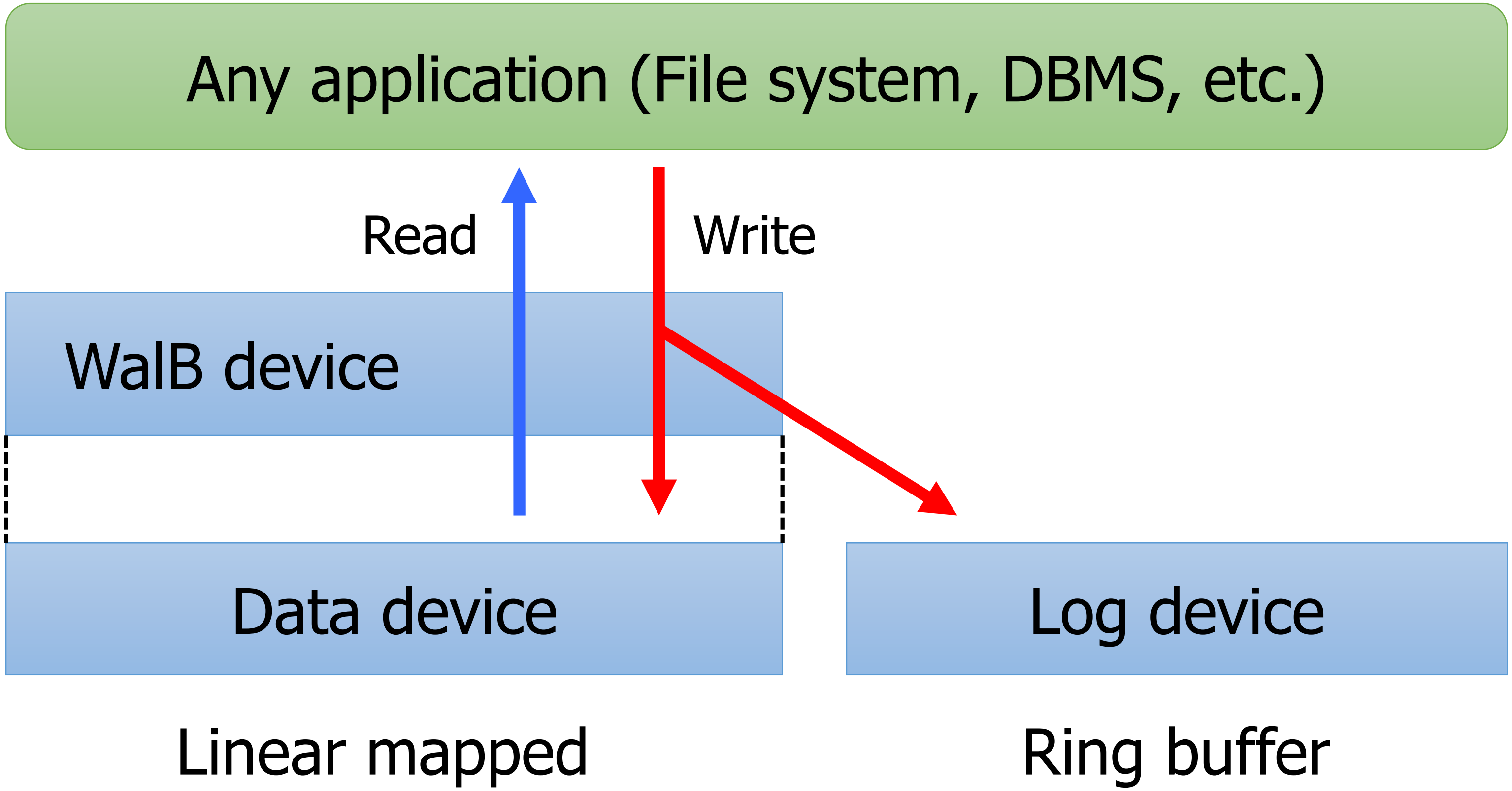


dm-snap
full scanning

WalB
no spikes

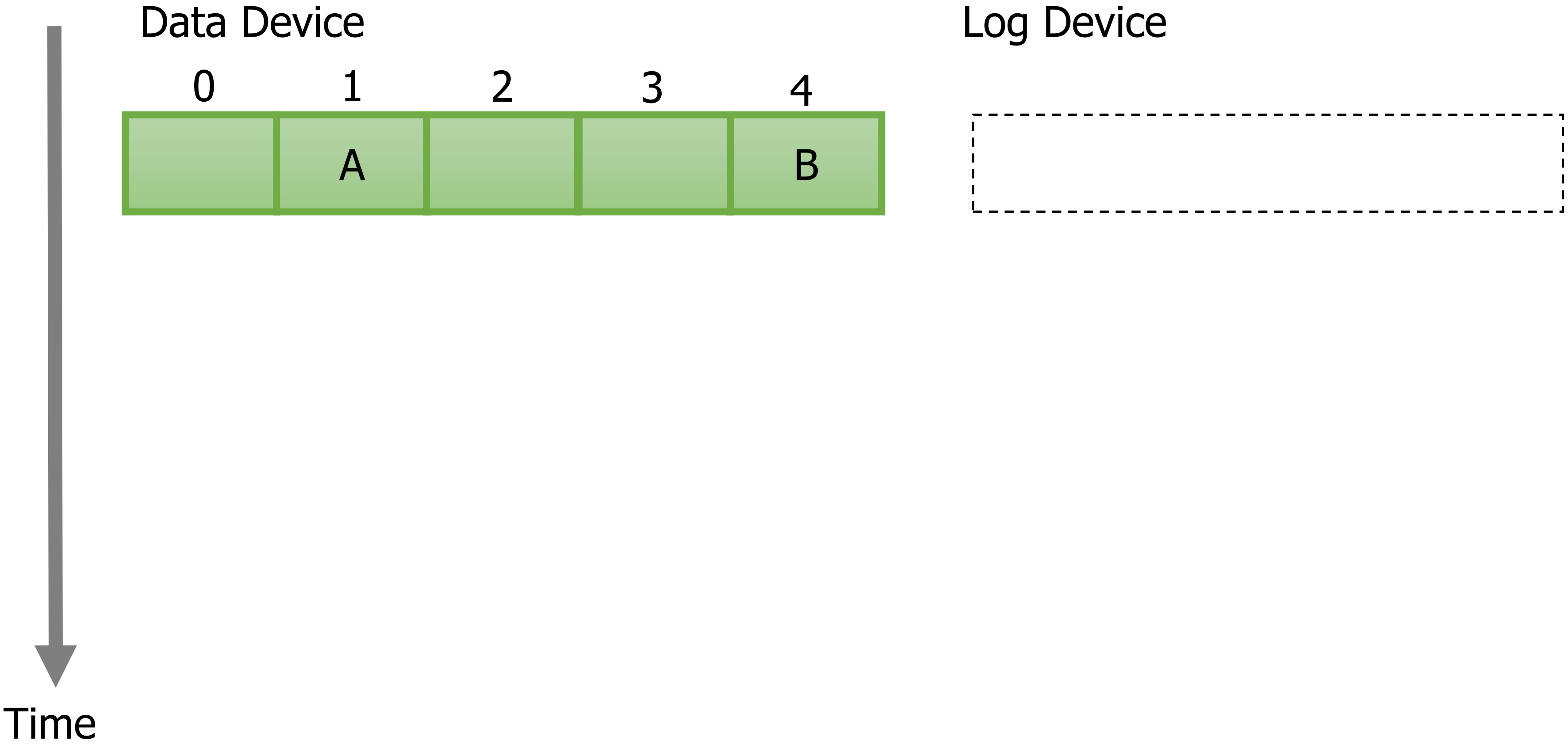
- A real-time and incremental backup system
  - developed at Cybozu Labs
- Can backup block devices without IO spikes

Special Block Devices for WalB



Write IO Logging and Backup with WalB

Time series of write I/Os



Data Device

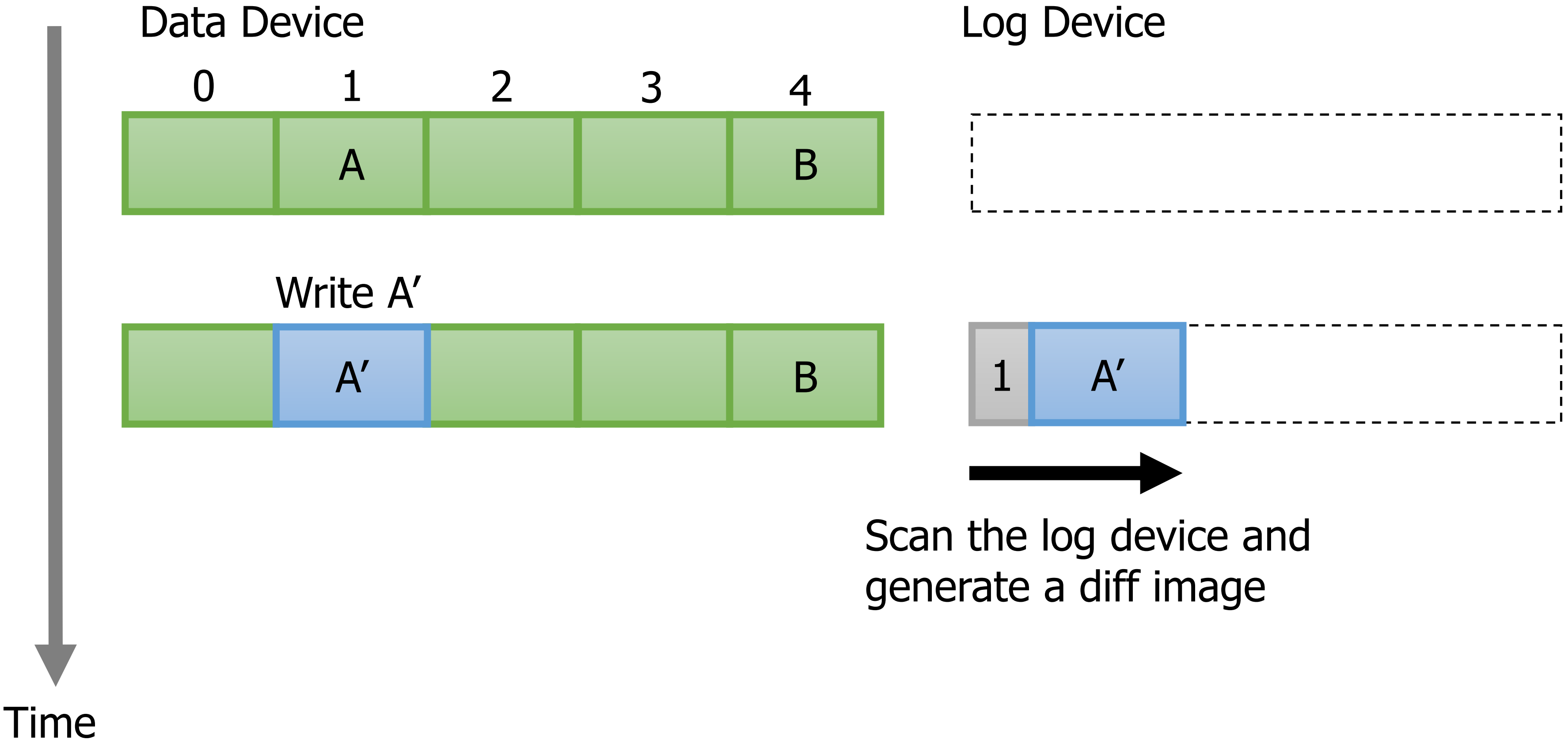
0	1	2	3	4
	A			B

Log Device

Time

Write IO Logging and Backup with WalB

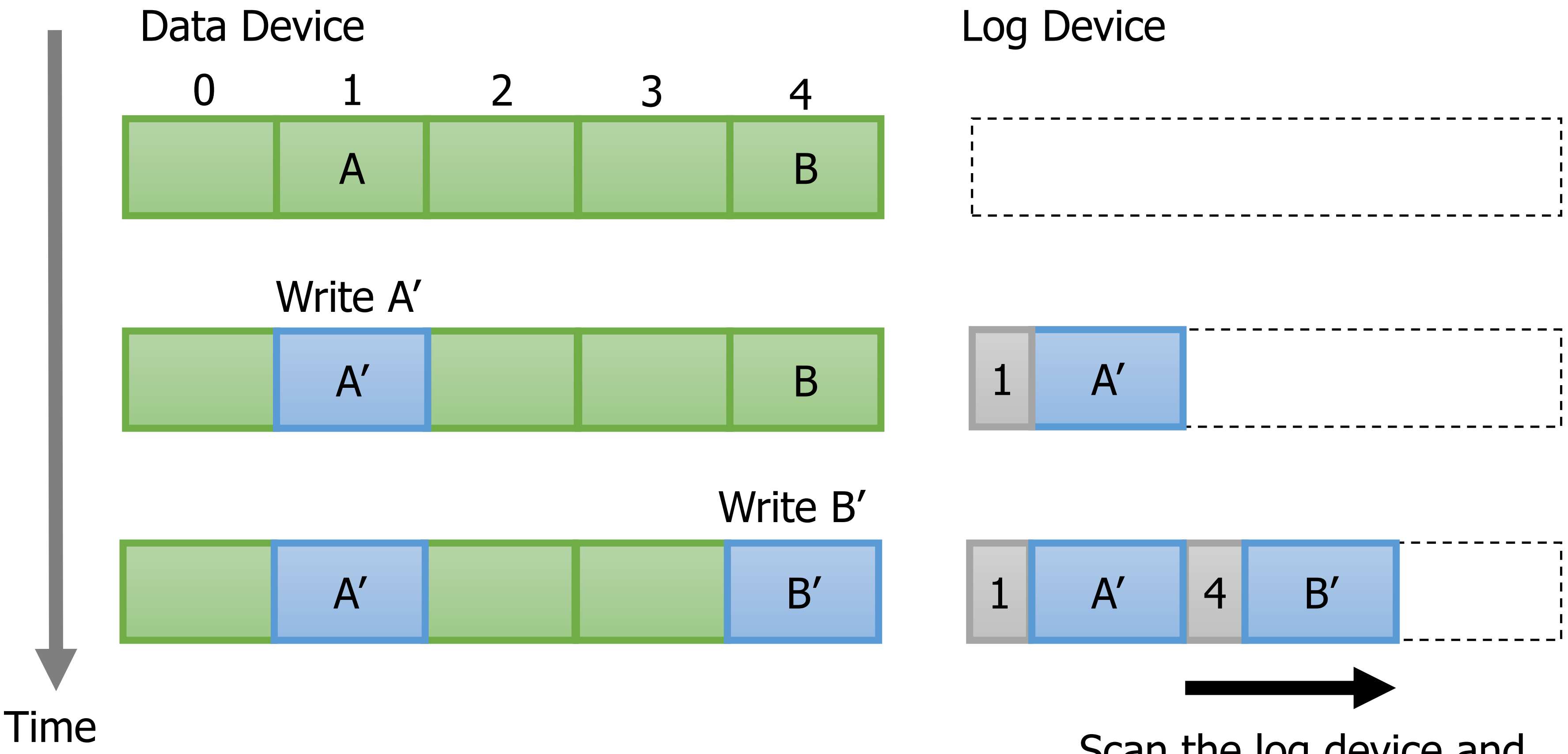
Time series of write I/Os



Scan the log device and generate a diff image

Write IO Logging and Backup with WalB

Time series of write I/Os



Scan the log device and generate a diff image

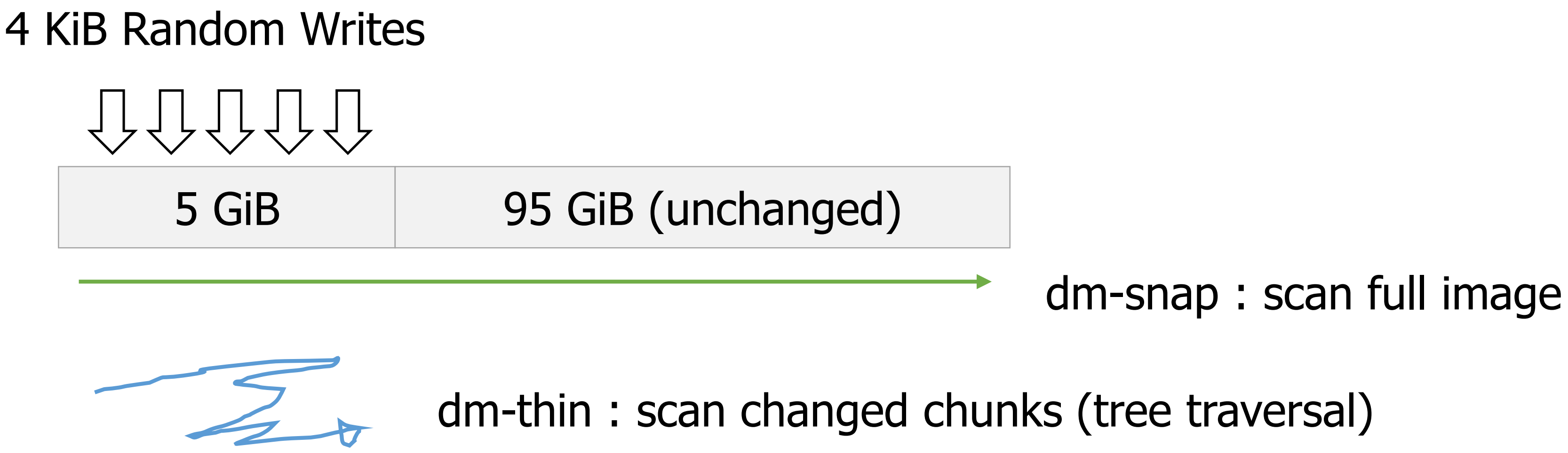
Performance test

- Compared dm-snap, dm-thin, and WalB
- Executed a workload during a backup
  - The workload & the backup will affect each other
- Measured the following metrics:
  - Latencies of the workload
  - Backup time

Environment & Settings

- Test environment:
  - CPU : 2.40 GHz x 12 cores
  - MEM : 192 GiB
  - HDD : 4 TB HDD, RAID 6 (8D2P)
  - NIC : 10 Gbps x 2
  - Kernel : 4.11 (latest upstream)
- Test settings:
  - 100 GiB volumes
  - Workload: 4 KiB Random writes for a 5 GiB range

Measuring the Backup Time (dm-snap, dm-thin)



4 KiB Random Writes

5 GiB

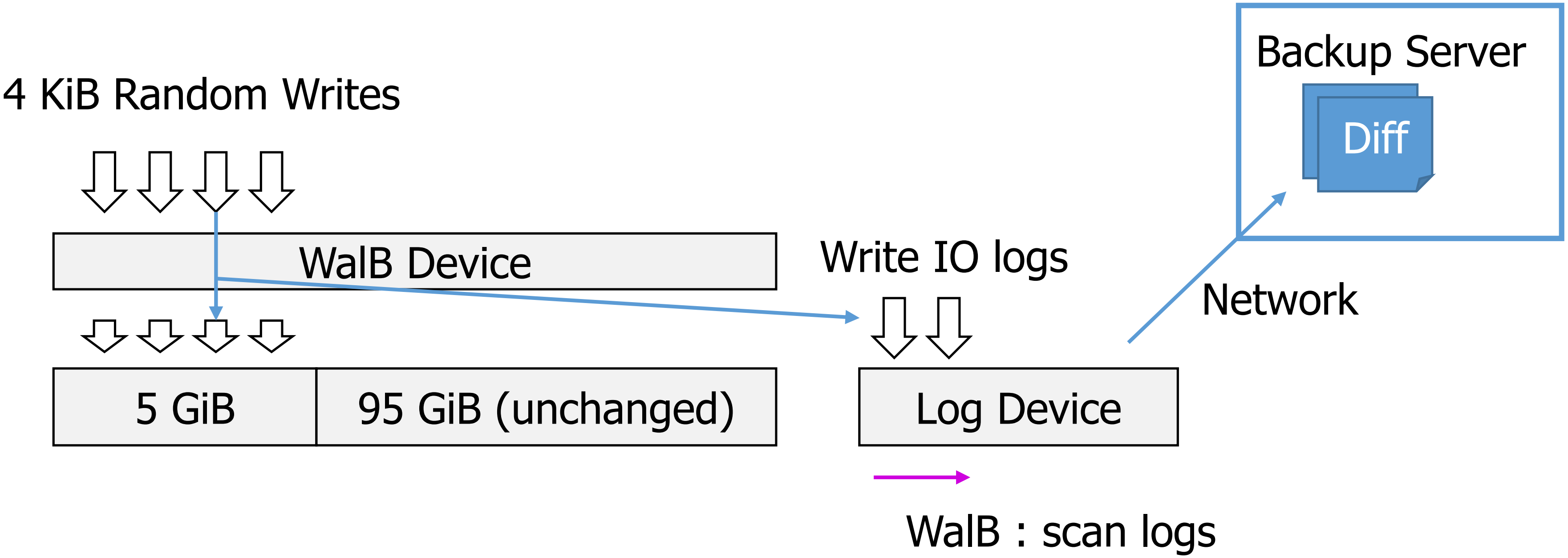
95 GiB (unchanged)

dm-snap : scan full image

dm-thin : scan changed chunks (tree traversal)

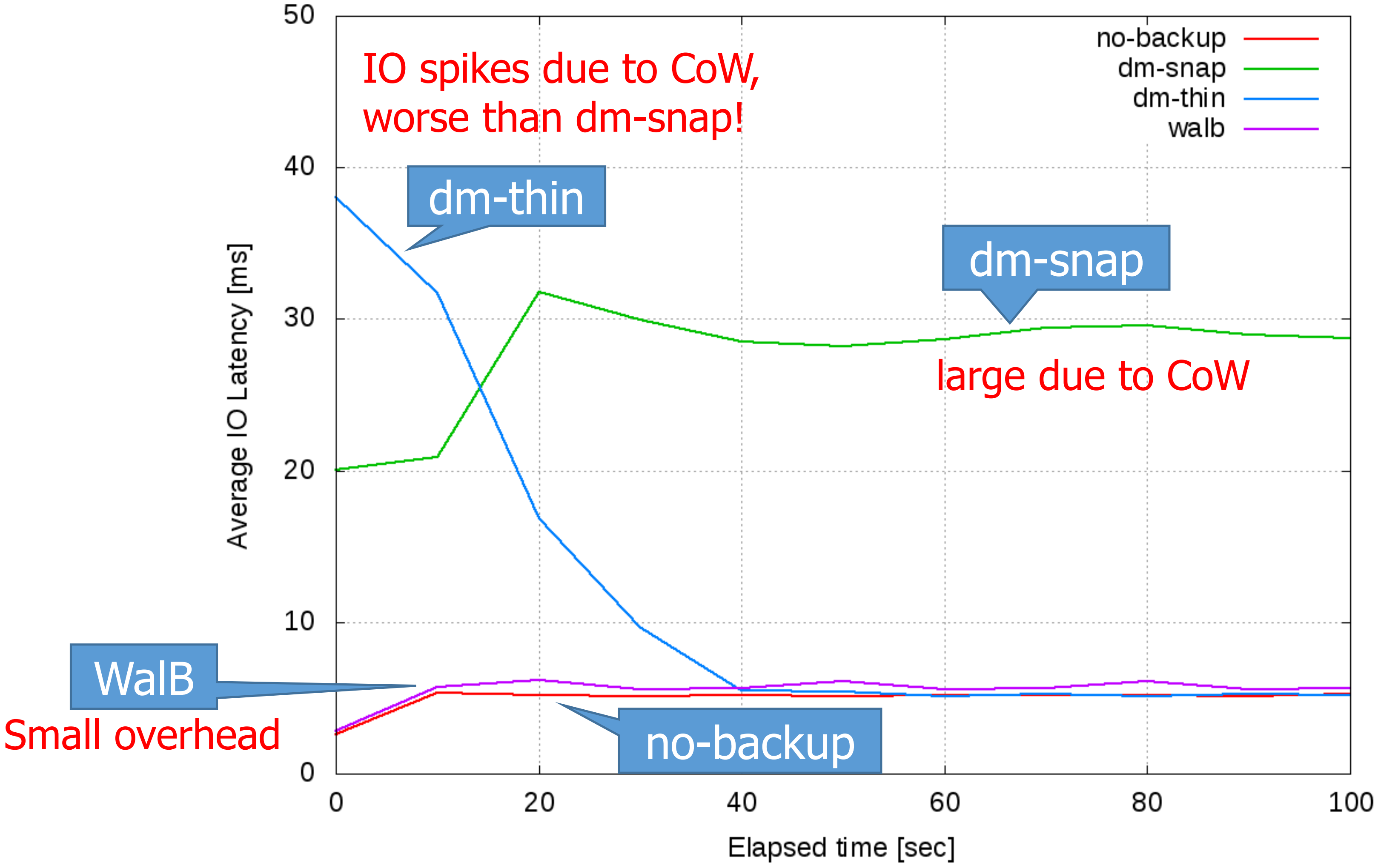
- dm-snap : take a snapshot & scan full image
- dm-thin : get a structure of snapshot trees & find modified blocks & read these blocks

Measuring the Backup Time (WalB)



- WalB : scan logs from a log device & send them to a backup server continuously

Write I/O latency

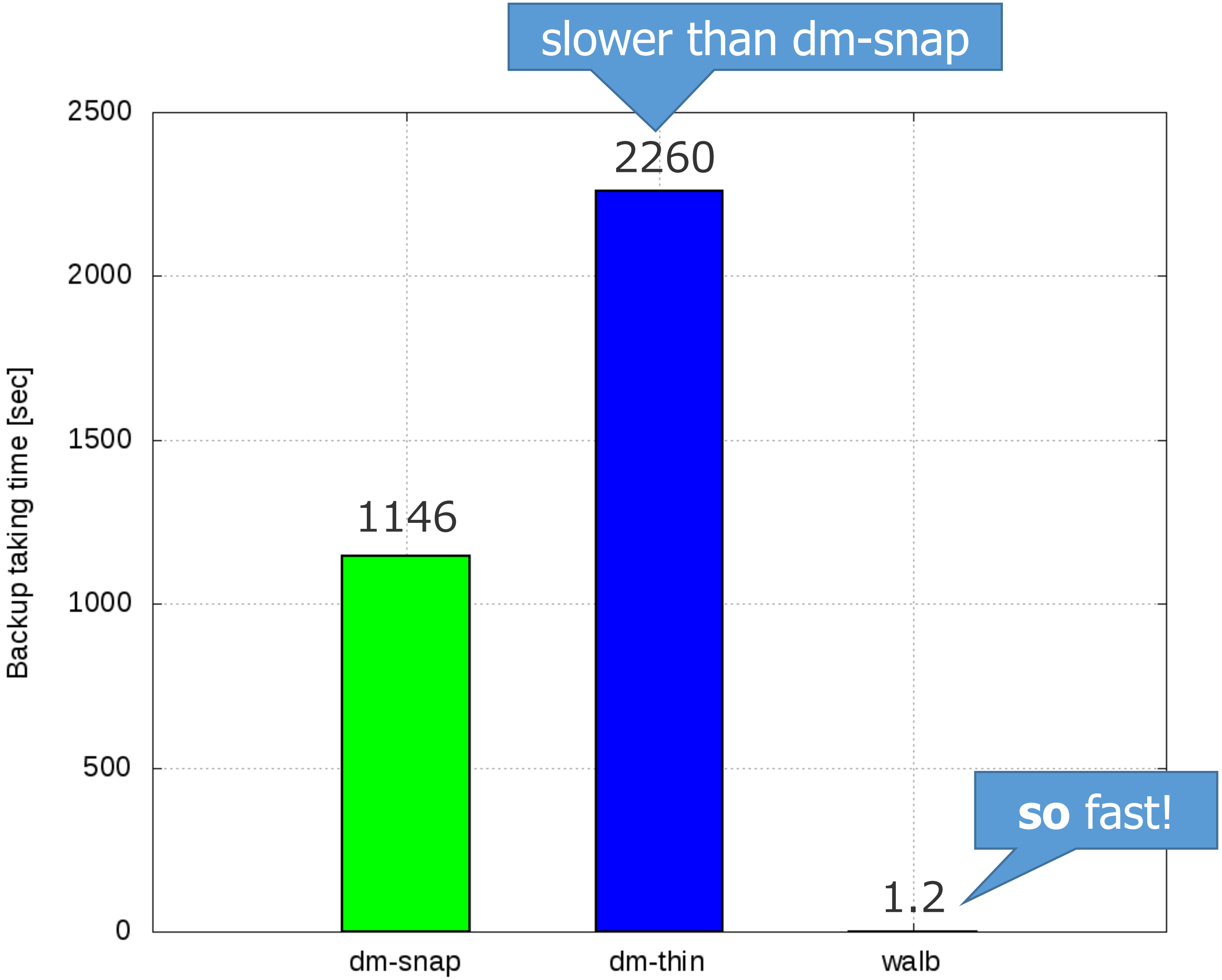


IO spikes due to CoW, worse than dm-snap!

large due to CoW

Small overhead

Backup time



slower than dm-snap

so fast!

Conclusion

- dm-snap & dm-thin
  - High I/O latency during a backup
  - Long backup time
- WalB
  - Stable and low I/O latency (no spikes)
  - Short backup time

WalB satisfies our requirements for production use.

Try WalB!

- Project page
  - https://walb-linux.github.io/
- Tutorial
  - https://github.com/walb-linux/walb-tools/tree/master/misc/vagrant/
  - Vagrantfile for Ubuntu 16.04 and CentOS 7

Q&A

email: kota-uchida@cybozu.co.jp

twitter: @uchan_nos