facebook

Massive Schema Changes in Facebook

Junyi Lu / 卢钧轶
Production Engineer

Agenda

1. How OnlineSchemaChange works
2. How OSC Scheduler works

Online Schema Change

https://github.com/facebookincubator/OnlineSchemaChange

Online Schema Change

Why

Why not MySQL's native online DDL?

- no resource control
- causing replication lag on slaves
- cannot cover all our use cases.
  - ie: ALTER TABLE WHERE COL1 = 2

Online Schema Change

Existing approach

- pt-online-schema-change 2011
- Large Hadron Migrator(LHM) 2011
- Github's Online Schema Change (gh-ost)? 2016

Online Schema Change

OSC.php (2009-2016)

Core logic is written in PHP

First open sourced in Sep 2010

A wrapper is required

Hard to test

https://www.facebook.com/notes/mysql-at-facebook/online-schema-change-for-mysql/430801045932/

Online Schema Change

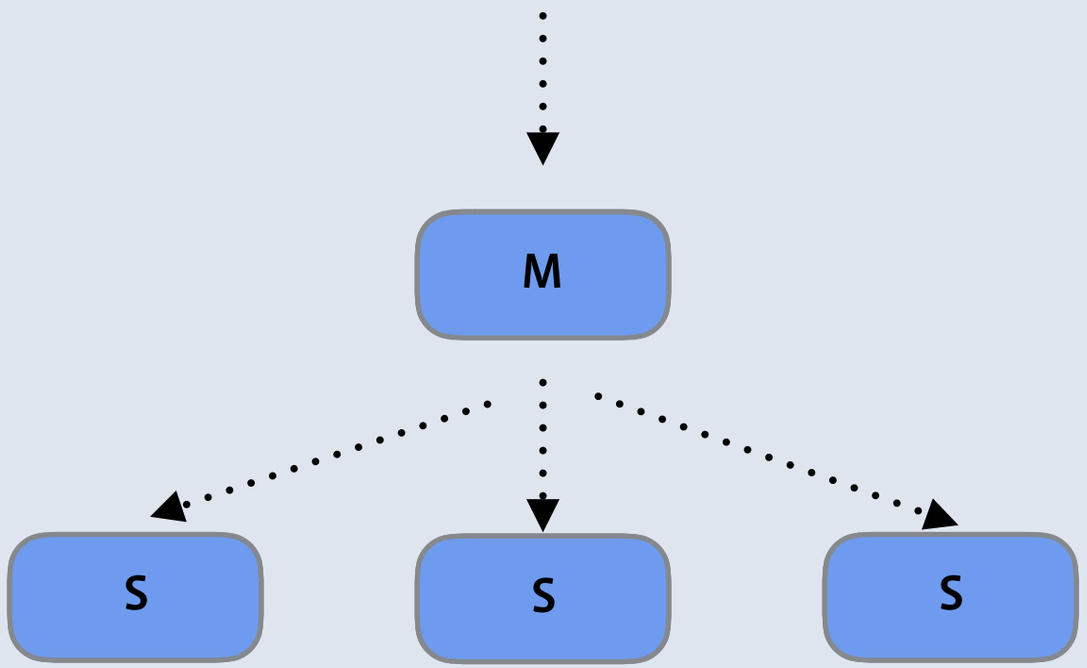
OSC.py (2016 - ?)

- Well tested (unittest/integration test) & bug fix
- Faster catchup
- Checksum
- Hook system
- Unicode CREATE TABLE `(ノ≧∇≦)ノミ┻━━┻` ...

Online Schema Change

What is OSC?

- Out of replication
- Async dump & load
- Trigger based



Online Schema Change

How to use

Cats		
ID	int	PRIMARY
Name	varchar(10)	

Cats		
ID	int	PRIMARY
Name	varchar(10)	
PictureURL	**varchar(30)**	

Online Schema Change

How to use

```
ALTER TABLE Cats ADD COLUMN
PictureURL VARCHAR(30)
```

```
CREATE TABLE Cats (
    ID  INT NOT NULL,
    Name VARCHAR(10),
    PictureURL VARCHAR(30),
    PRIMARY (ID)
) ENGINE=INNODB
```

>> osc --database cats_db --ddl-file-list /path/to/a.sql

OnlineSchemaChange

OnlineSchemaChange

Sanity check:

- Primary key/Unique key (required on new schema)
- Foreign key (not supported)
- Table existence
- Accidentally drop column
- Primary key coverage on new schema

OnlineSchemaChange

Cats		
CatID	int	PRIMARY
Name	varchar(10)	

__osc_new_Cats		
CatID	int	PRIMARY
Name	varchar(10)	
PictureURL	varchar(20)	

__osc_chg_Cats		
ID	int	PRIMARY
DML_TYPE	ENUM	
CatID	int	
Name	varchar(10)	

OnlineSchemaChange

OnlineSchemaChange

INSERT INTO Cats VALUES (1, 'foo')

ID	DML_TYPE	CatID	Name
1	DML_TYPE_INSERT	1	foo

OnlineSchemaChange

DELETE FROM Cats

WHERE CatID = 1

ID	DML_TYPE	CatID	Name
2	DML_TYPE_DELETE	1	

OnlineSchemaChange

UPDATE Cats set Name = 'bar'

WHERE CatID = 2

ID	DML_TYPE	CatID	Name
3	DML_TYPE_UPDATE	2	bar

OnlineSchemaChange

UPDATE Cats set CatID = 4, Name = 'foobar'

WHERE CatID = 3

ID	DML_TYPE	CatID	Name
4	DML_TYPE_DELETE	3	
5	DML_TYPE_INSERT	4	foobar

OnlineSchemaChange

INSERT INTO Cats VALUES (1, 'foo')

DELETE FROM Cats WHERE CatID = 1

UPDATE Cats set Name = 'new_foo' WHERE CatID = 3

UPDATE Cats set CatID = 4, Name = 'foobar'
WHERE CatID = 3

ID	CHANGE_TYPE	CatID	Name
1	DML_TYPE_INSERT	1	foo
2	DML_TYPE_DELETE	1	
3	DML_TYPE_UPDATE	3	bar
4	DML_TYPE_DELETE	3	
5	DML_TYPE_INSERT	4	foobar

OnlineSchemaChange

_osc_chg_Cats

start: chg_id = 5

START TRANSACTION

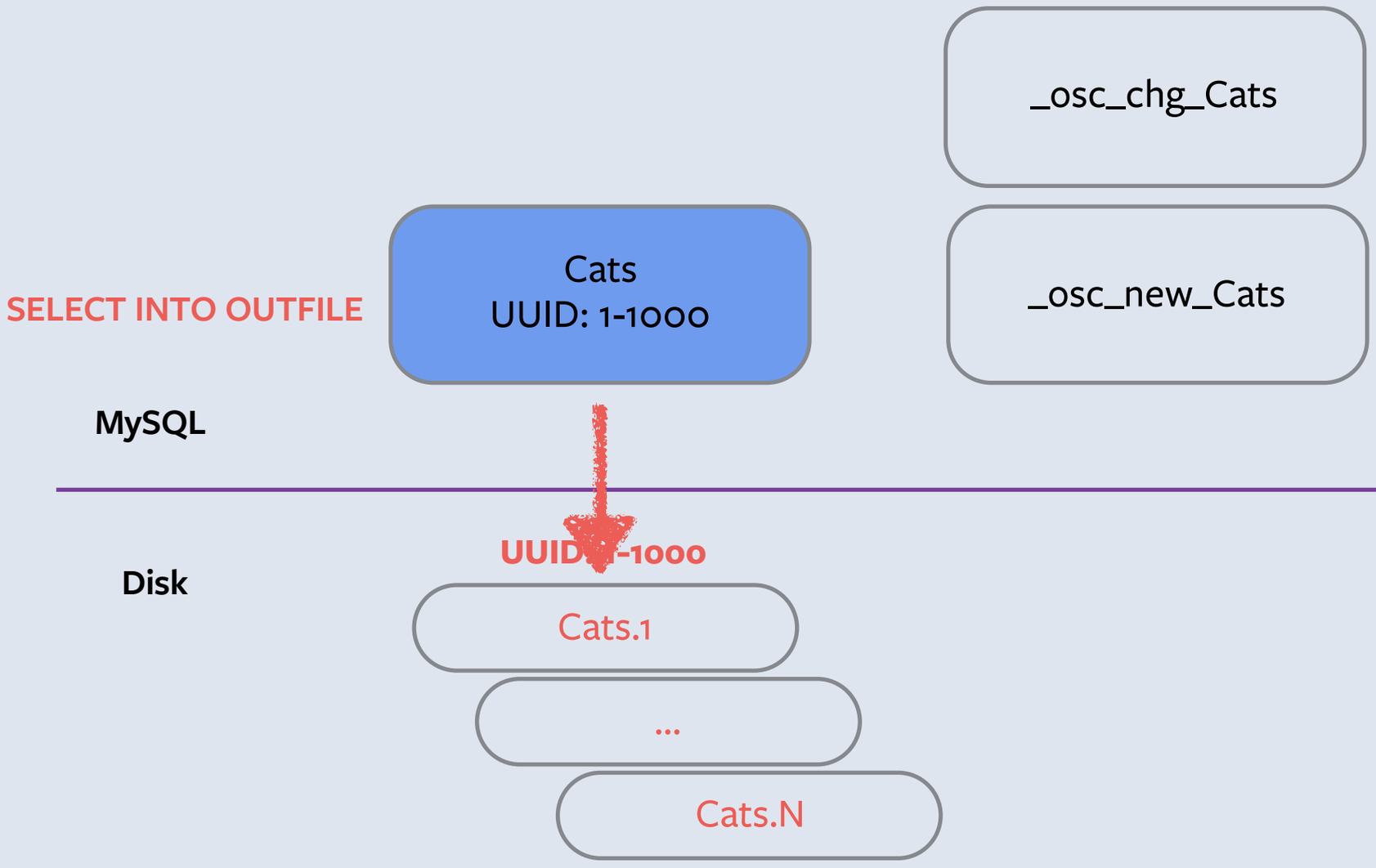
Cats
UUID: 1-1000

_osc_new_Cats

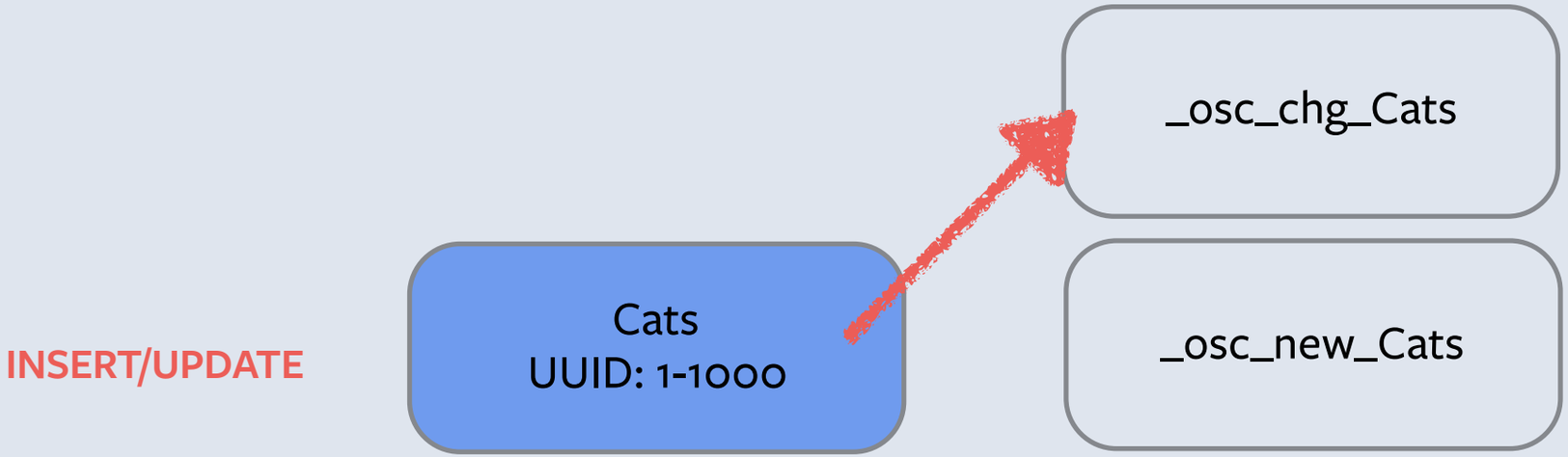
MySQL

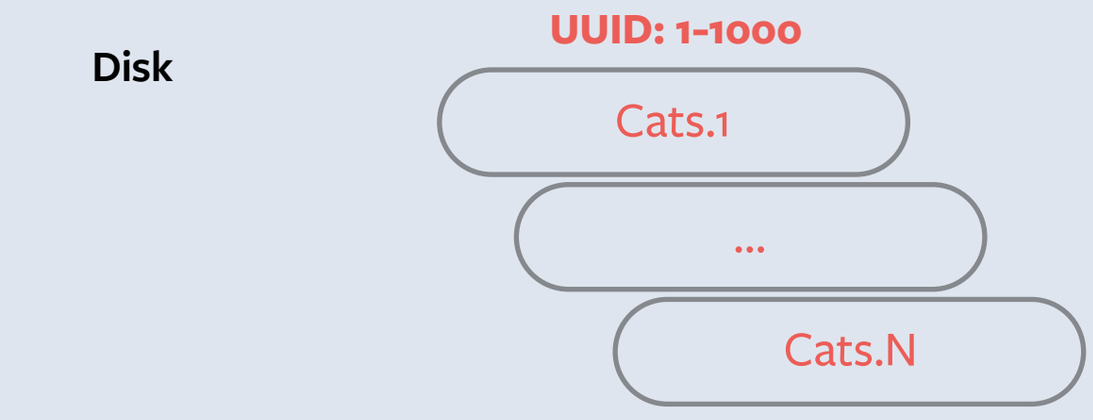
Disk

OnlineSchemaChange

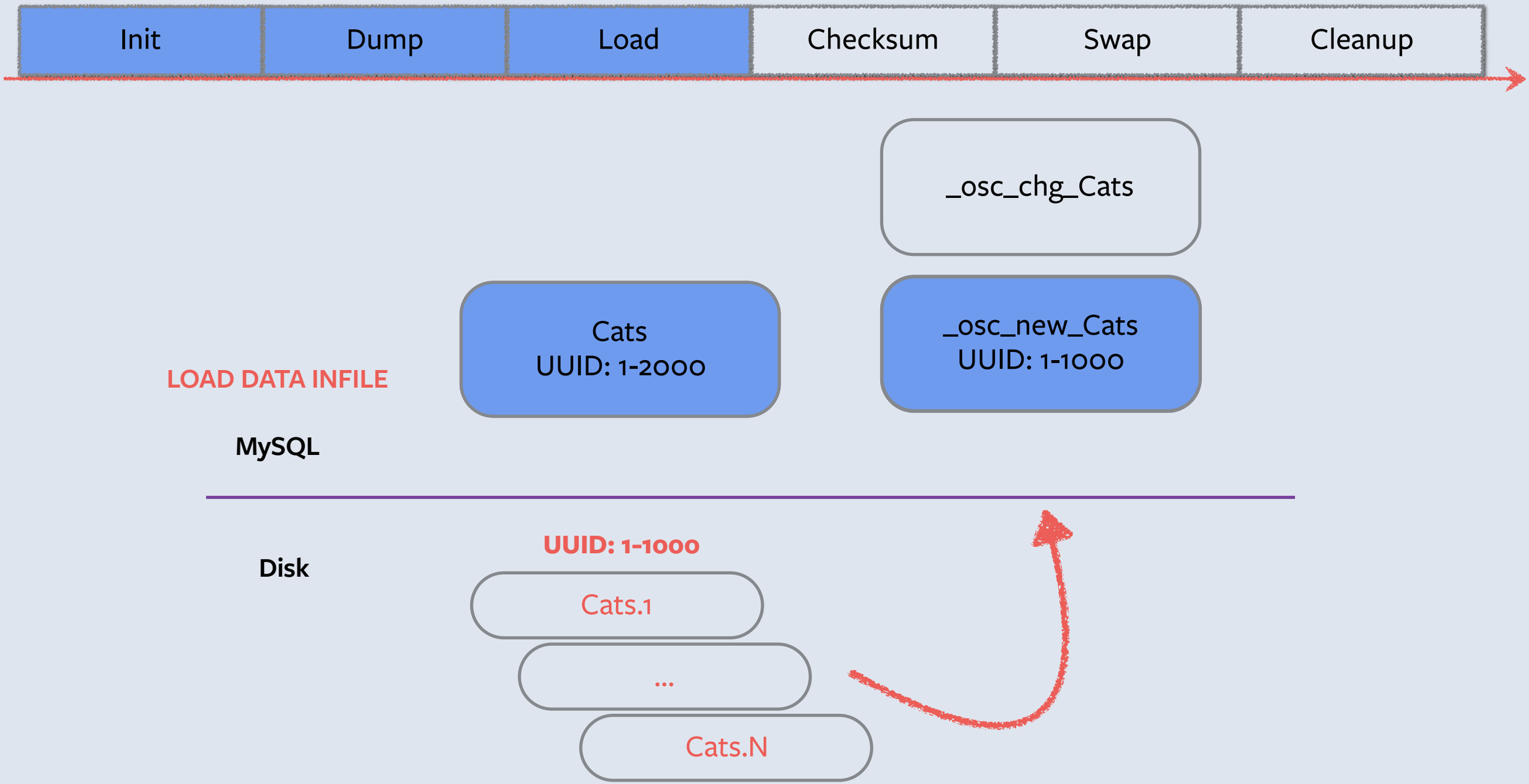


OnlineSchemaChange



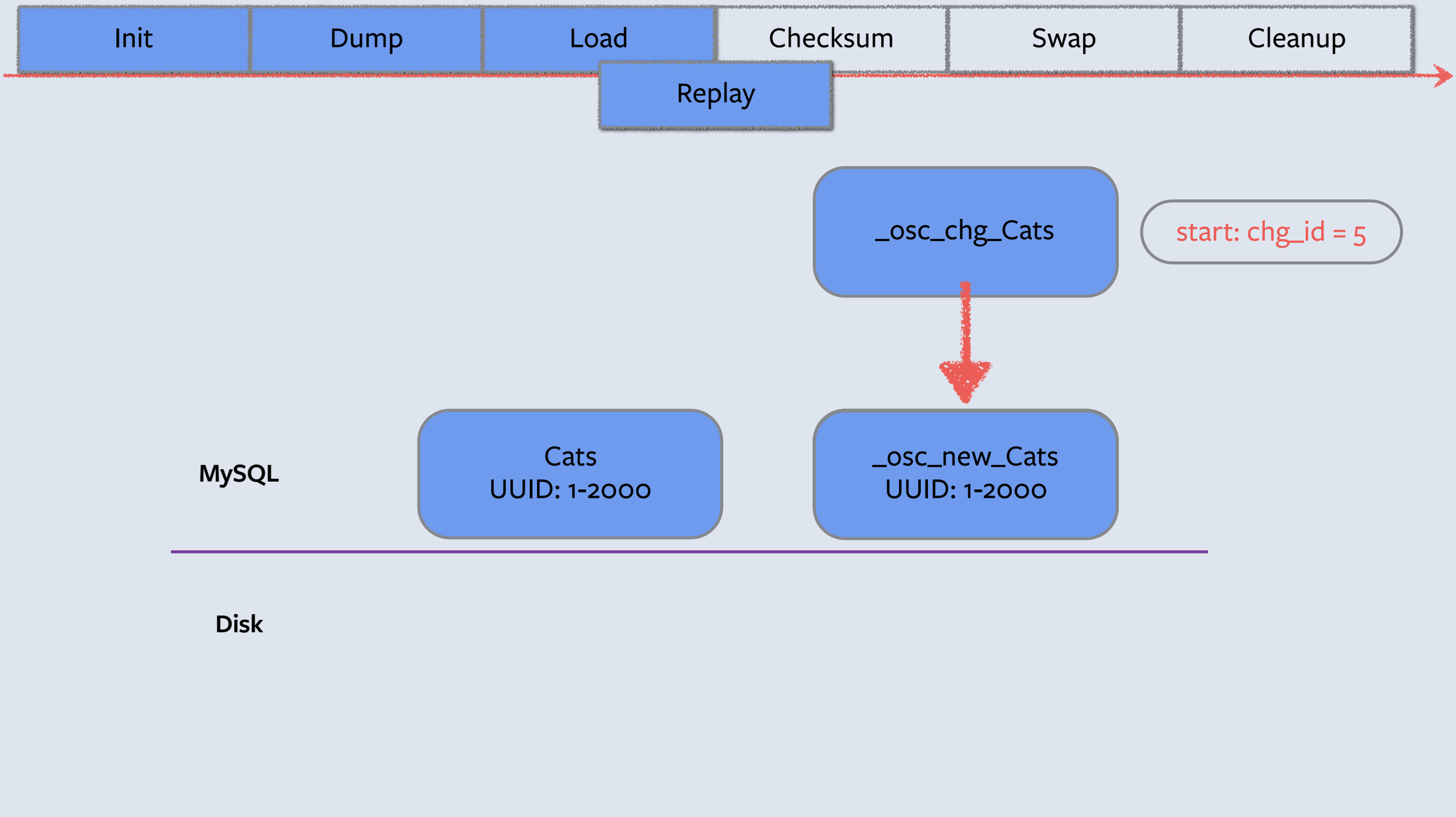


OnlineSchemaChange

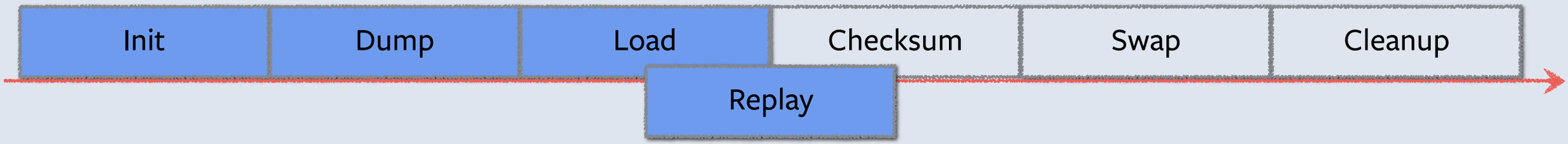


Replay

OnlineSchemaChange



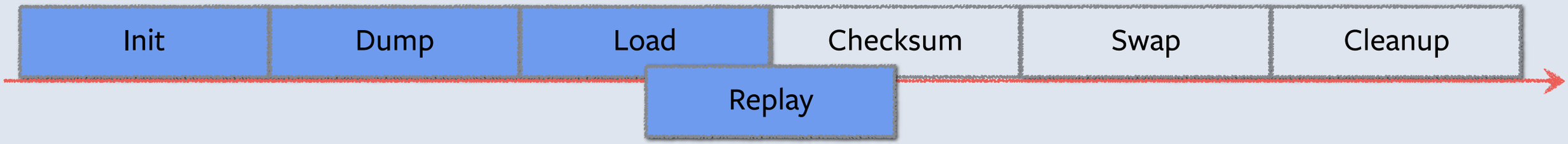
OnlineSchemaChange



ID	DML_TYPE	CatID(PK)	Name
1	DML_TYPE_INSERT	1	foo

```
INSERT INTO __osc_new_Cats (CatID, Name)
SELECT CatID, Name
FROM __osc_chg_Cats WHERE ID = 1;
```

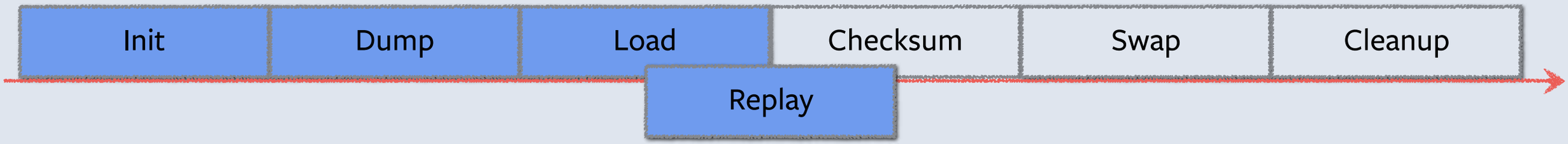
OnlineSchemaChange



ID	DML_TYPE	CatID(PRIMARY)	Name
2	DML_TYPE_DELETE	2	

```
DELETE __osc_new_Cats
FROM __osc_chg_Cats, __osc_new_Cats
WHERE
__osc_chg_Cats.CatID = __osc_new_Cats.CatID
AND ID = 2
```

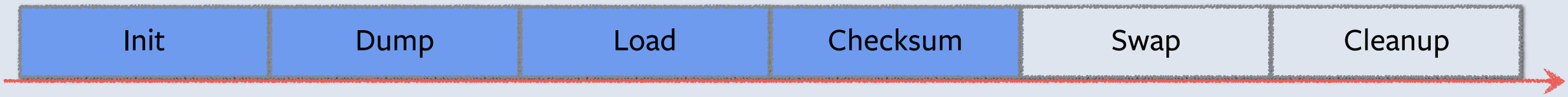
OnlineSchemaChange



ID	DML_TYPE	CatID(PRIMARY)	Name
3	DML_TYPE_UPDATE	3	bar

```
UPDATE __osc_new_Cats, __osc_chg_Cats
SET  __osc_new_Cats.Name = __osc_chg_Cats.Name
WHERE __osc_new_Cats.CatID = __osc_chg_Cats.CatID
AND ID=3
```

OnlineSchemaChange



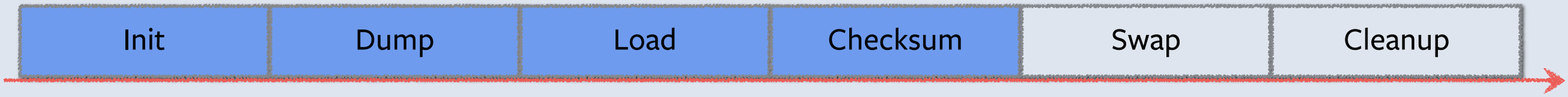
START TRANSACTION

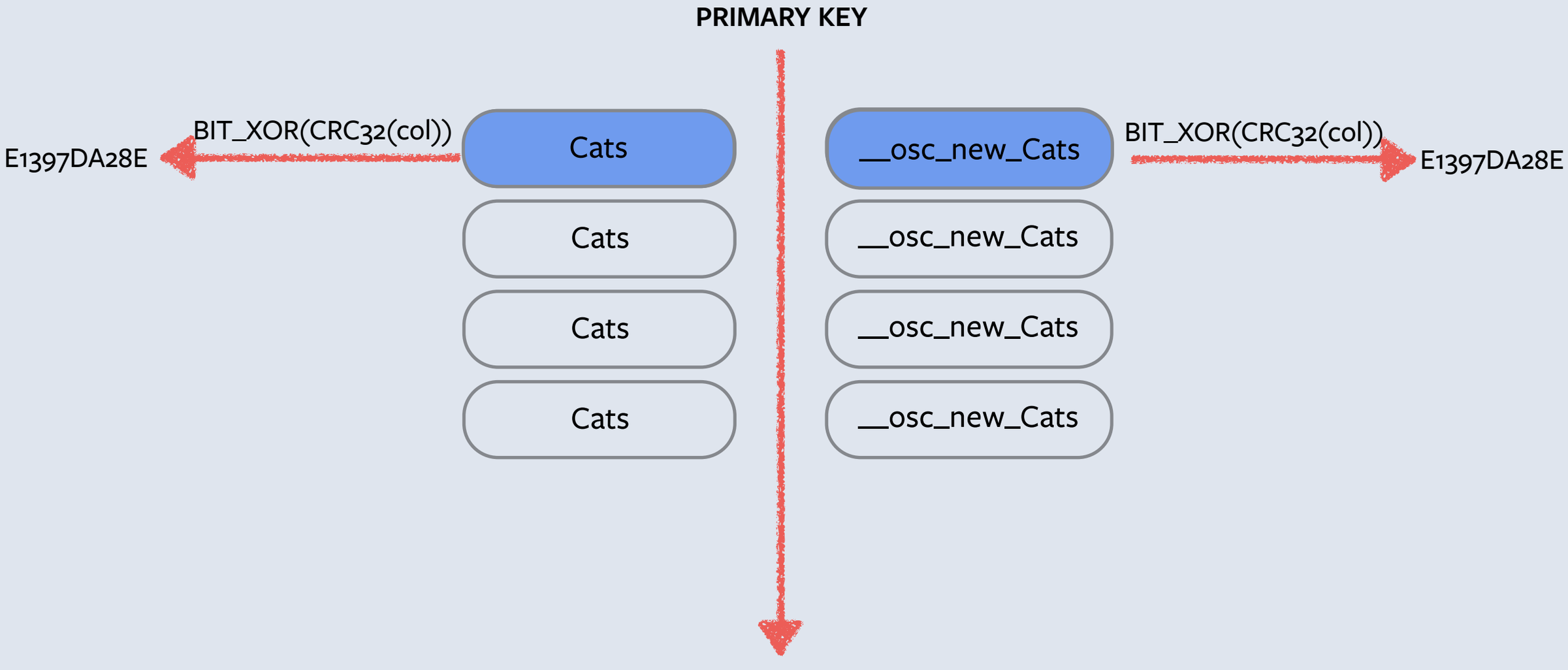
Cats
UUID: 1-2500

__osc_chg_Cats

_osc_new_Cats
UUID: 1-2500

OnlineSchemaChange





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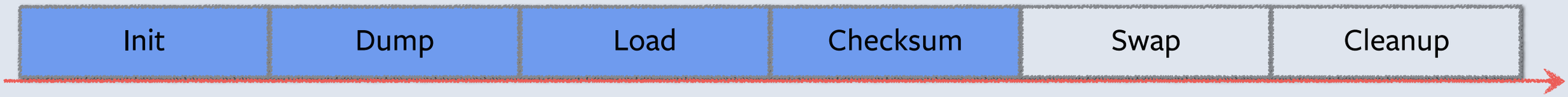
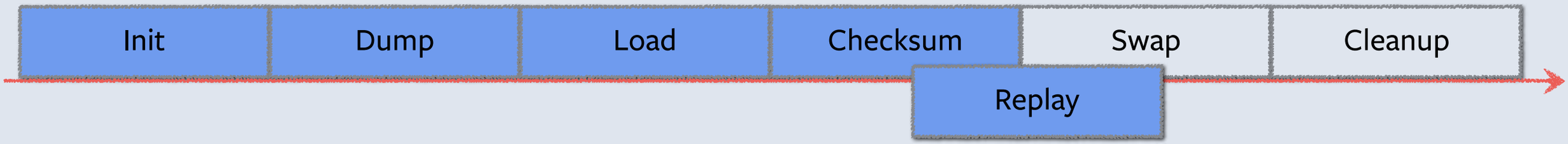


Q: Is checksum useful?

A: Absolutely!!! Any code written by human can have bugs:

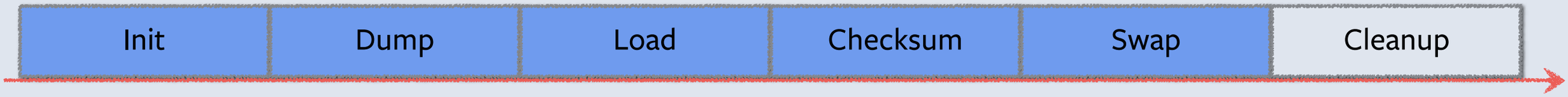
- ID recorded by triggers are not always monotonic with commit order
- transaction visibility when using unique_checks=0 on MyRocks

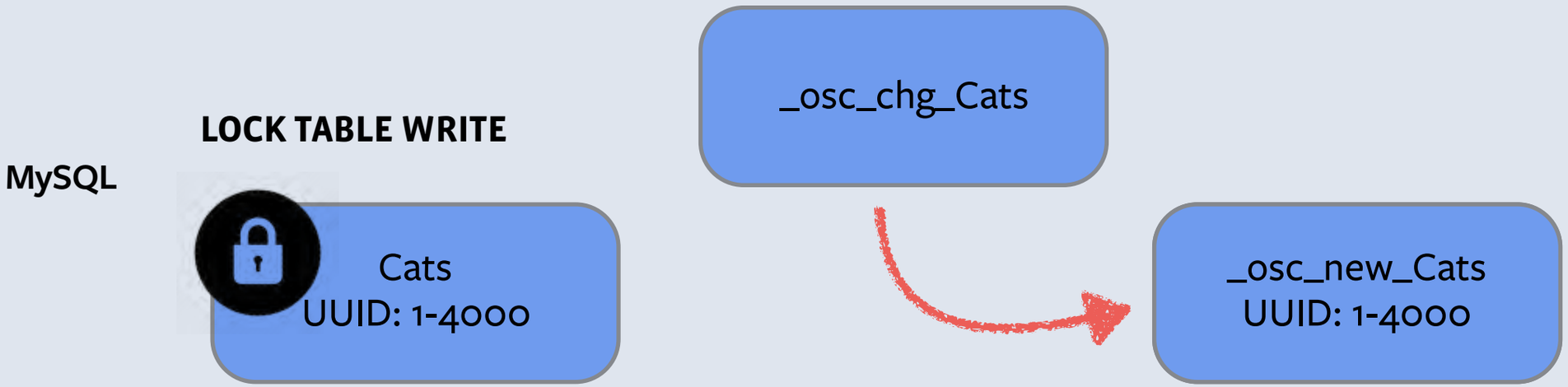
OnlineSchemaChange



Stage	Changes Stacked	Time Spent in Replay
Dump	10000 rows	
Load	20000 rows	
Replay	5000 rows	500 Seconds
Checksum	10000 rows	
Replay Round 1	2000 rows	200 Seconds
Replay Round 2	1000 rows	50 Seconds
Replay Round 3	100 rows	5 Seconds
Replay Round 4	1 rows	0.1 Seconds

OnlineSchemaChange





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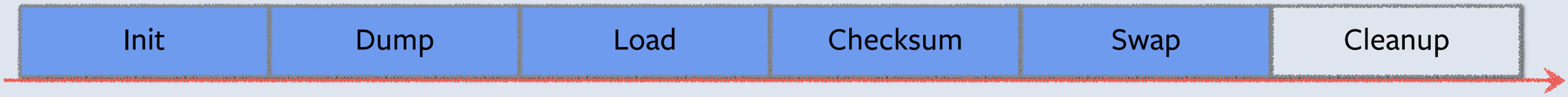

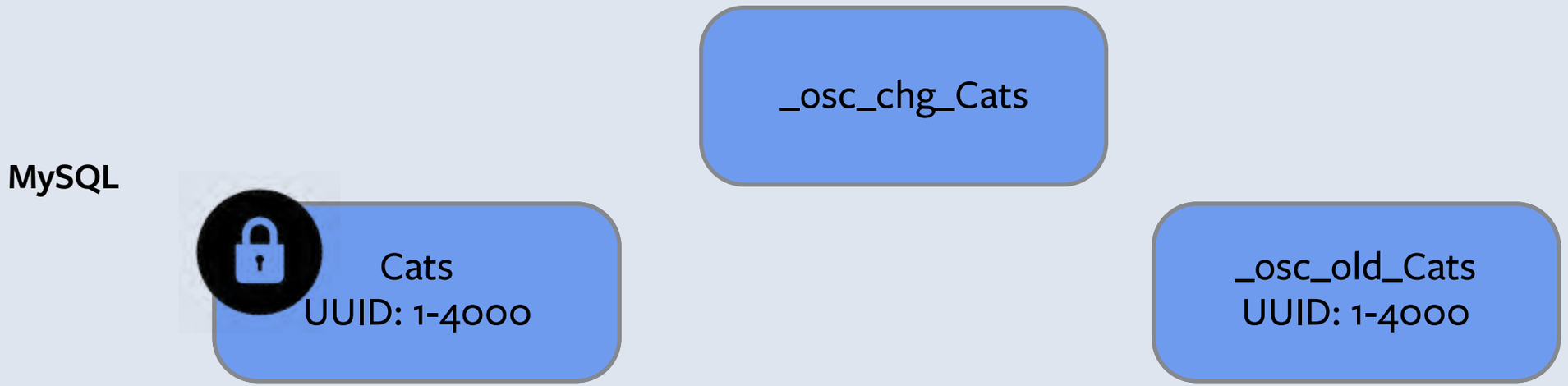

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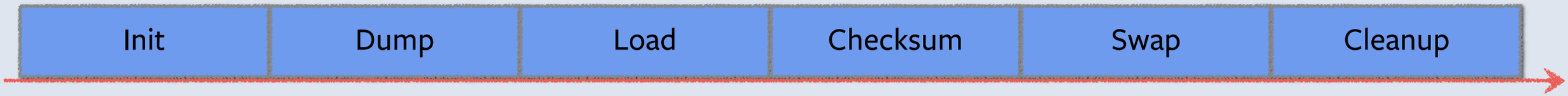


MySQL

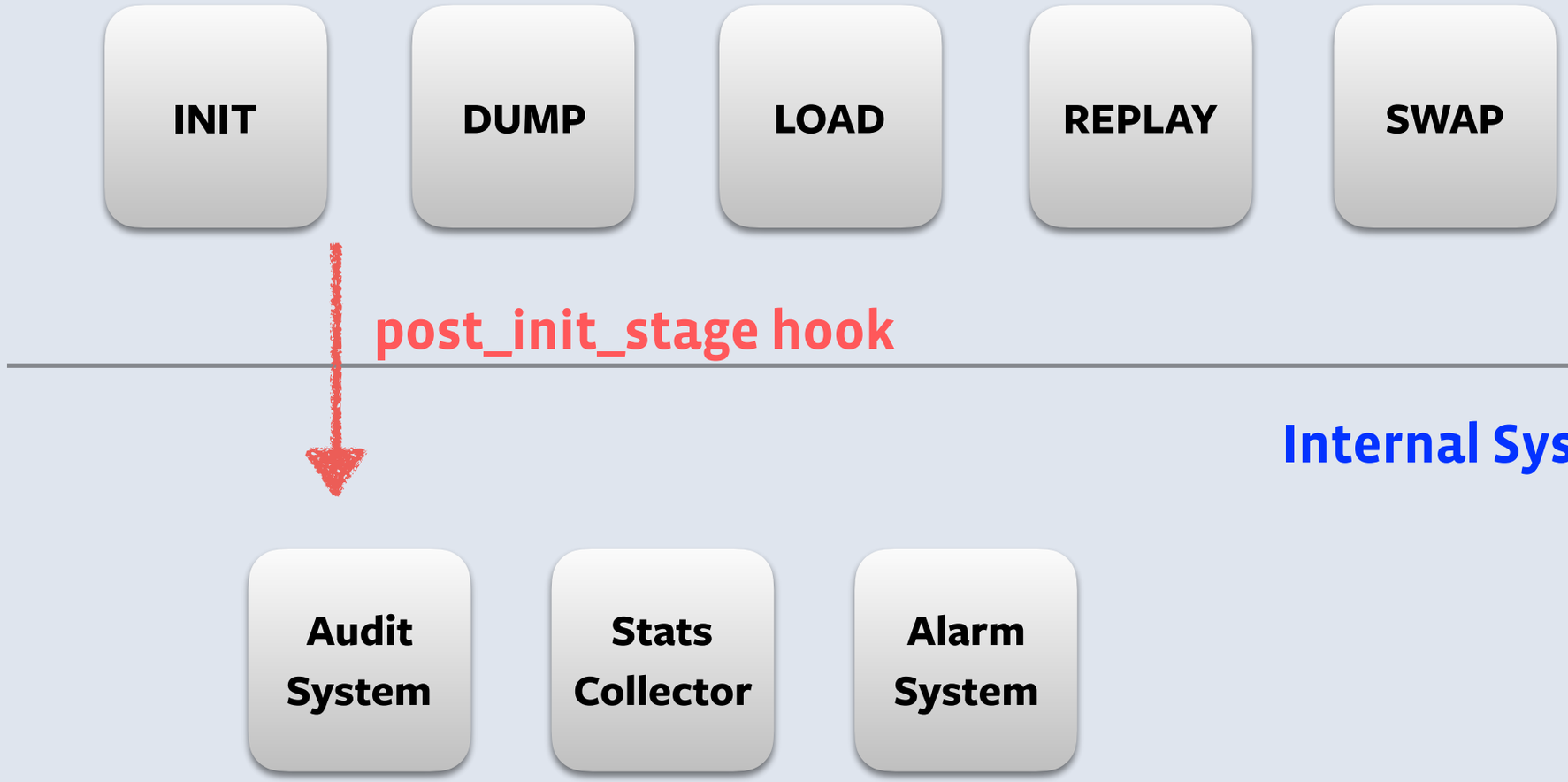
Cats

ID	int	PRIMARY
Name	varchar(10)	
PictureURL	varchar(30)	

Hooks

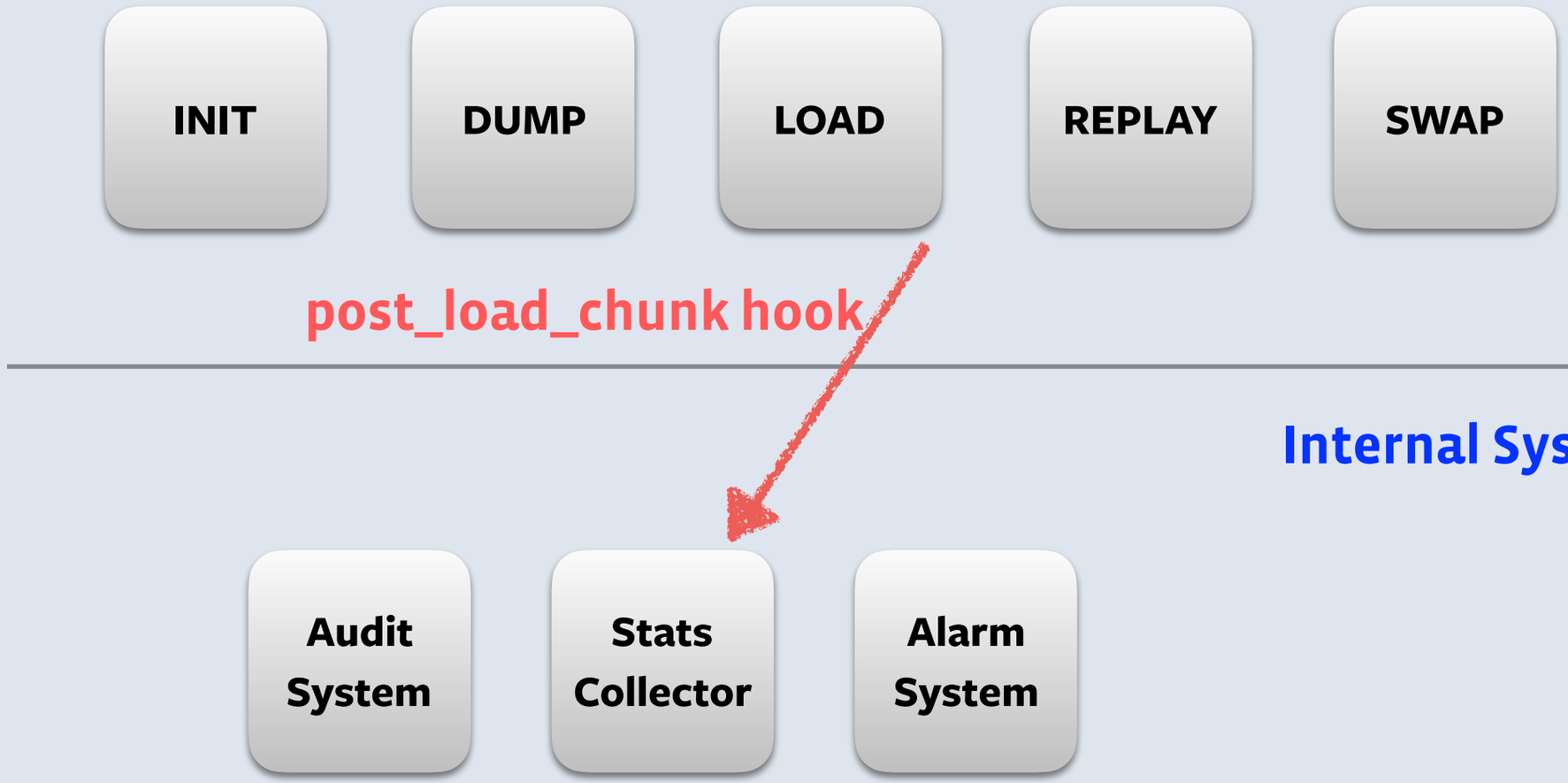
OnlineSchemaChange

Hook



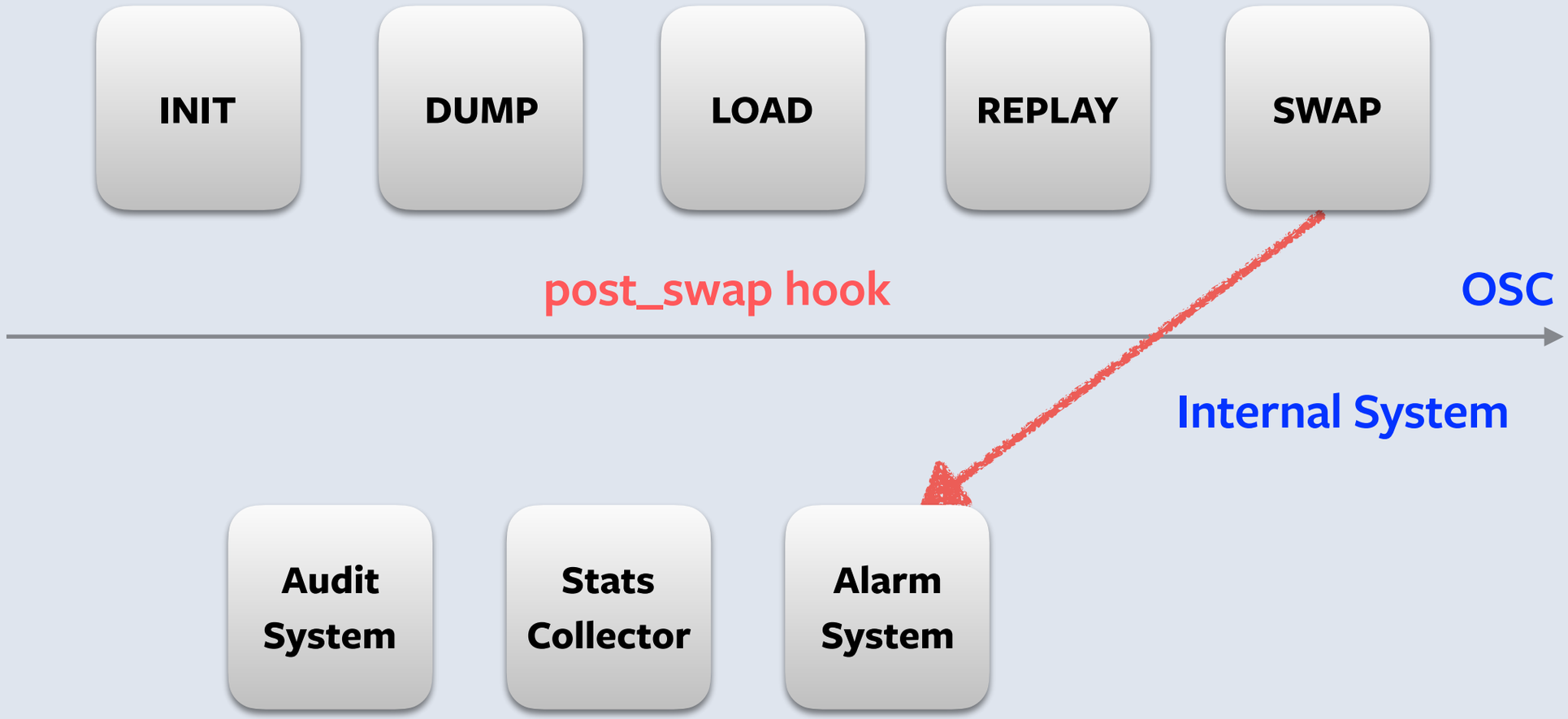
OnlineSchemaChange

Hook



OnlineSchemaChange

Hook



OnlineSchemaChange

What's the difference

	fb-osc	pt-osc	gh-ost
resource control	NO	static threshold	interactive threshold
consistency check	YES	NO	NO
replay speed	Fast	ON THE FLY	Slow
binlog_format	SBR & RBR + FBMYSQL	RBR MASTER + SBR	1+ RBR
MyRocks ready	YES	NO	NO
charset support	=MySQL	=MySQL	=Go

OnlineSchemaChange

What's coming

- No more triggers by using RBR
- Real time resource control
- Parallel mode
- Heuristic decision
- Support more versions

https://github.com/github/gh-ost/blob/master/doc/why-triggerless.md

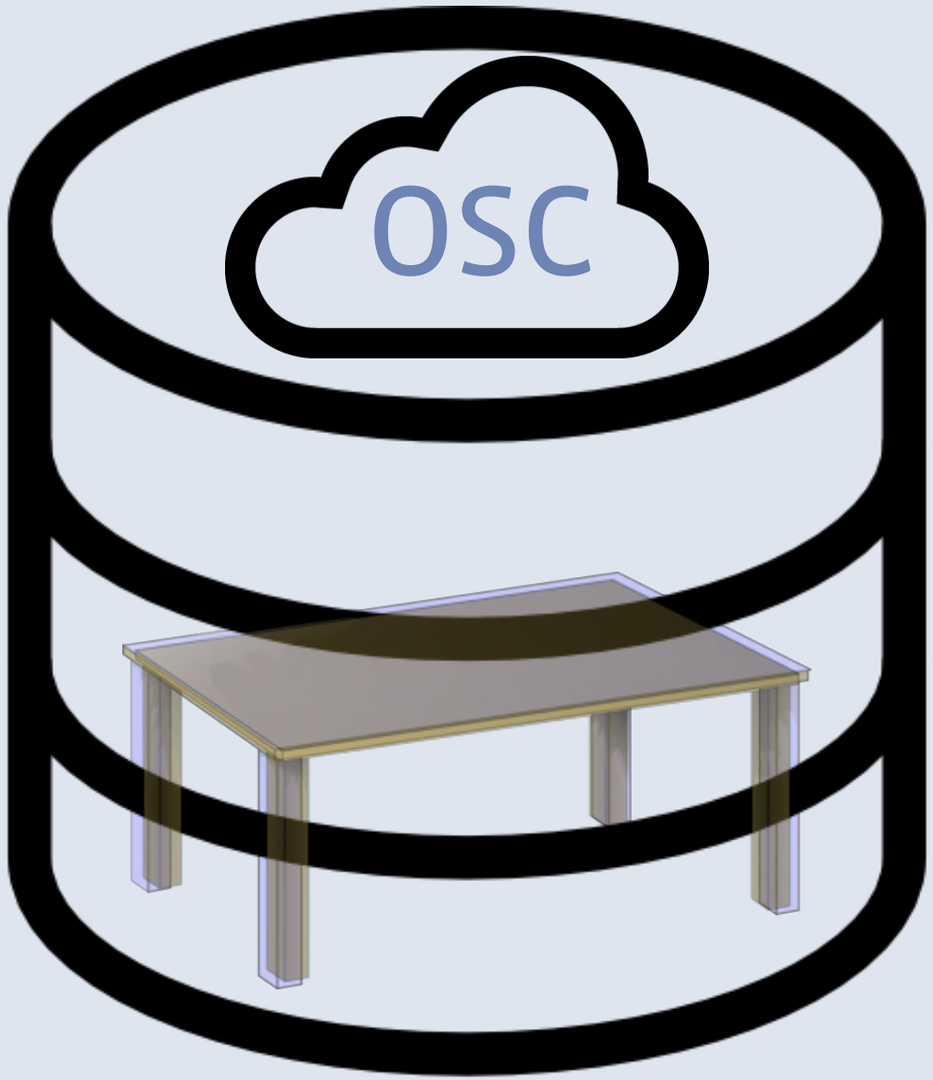
Automatic Online Schema Change

Schema Changes at Scale

Problem

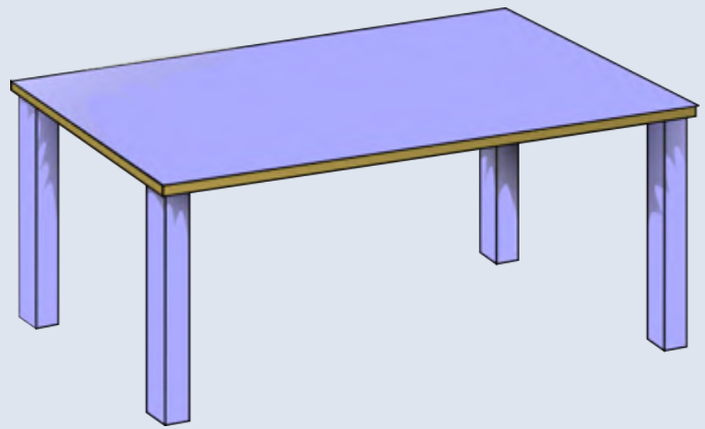
Schema Changes at Scale

Problem



Schema Changes at Scale

Problem



Schema Changes at Scale

Problem

Schema Changes at Scale

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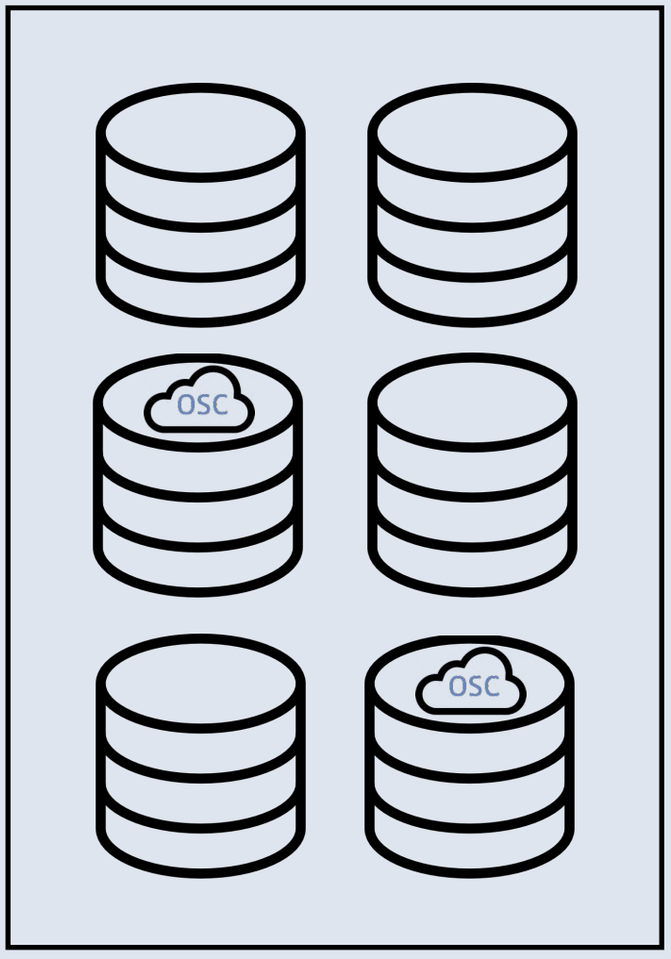
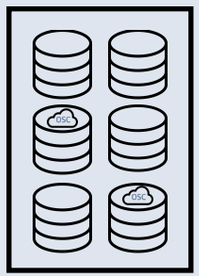


Schema Changes at Scale

Problem



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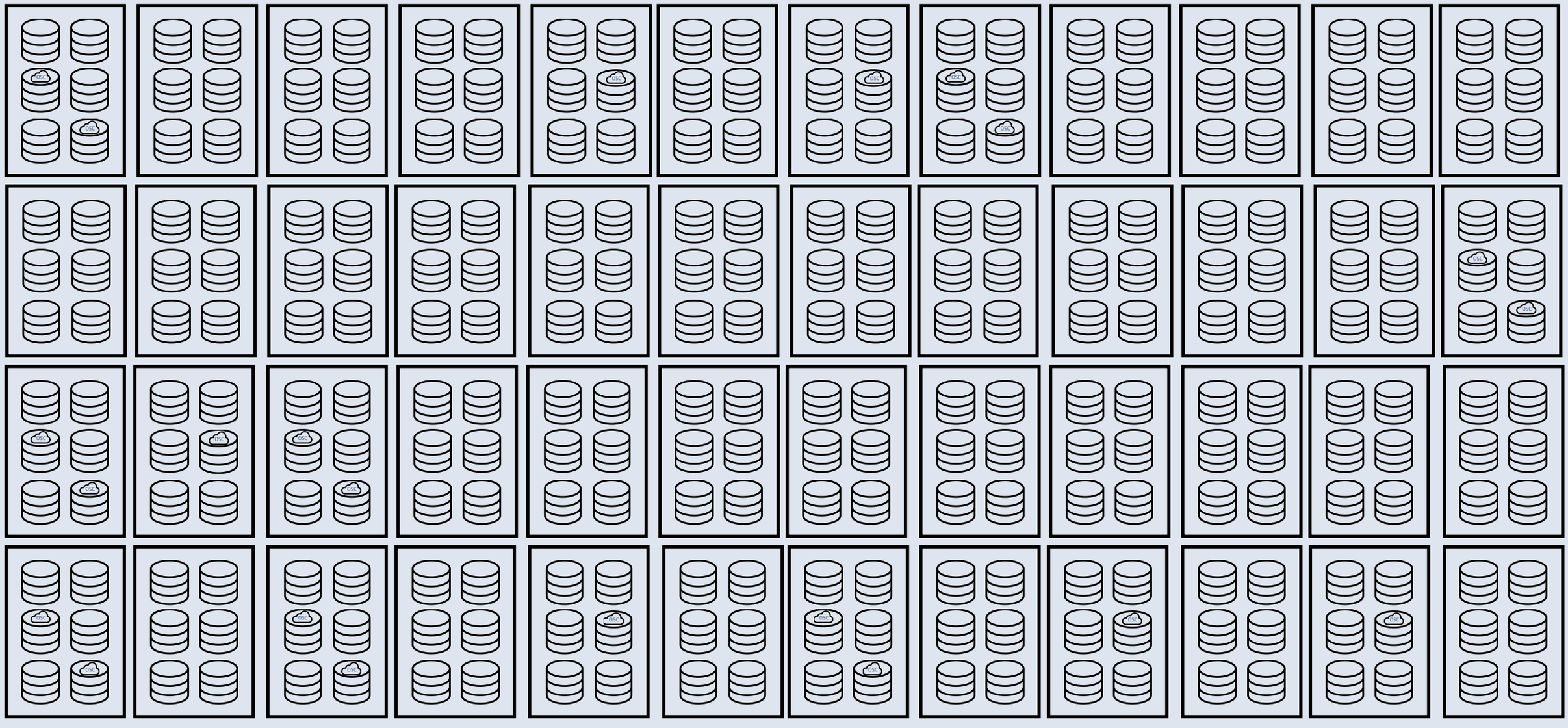

Schema Changes at Scale

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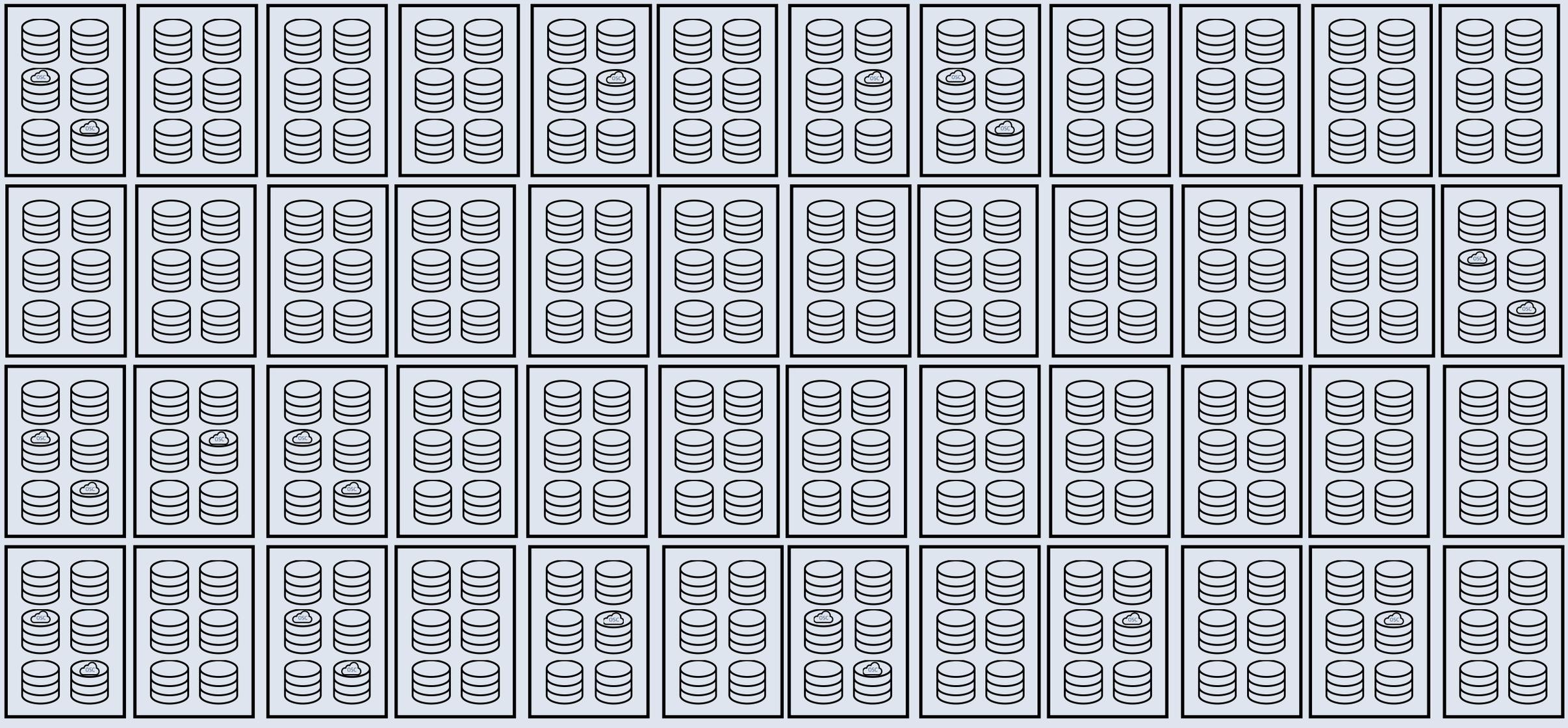

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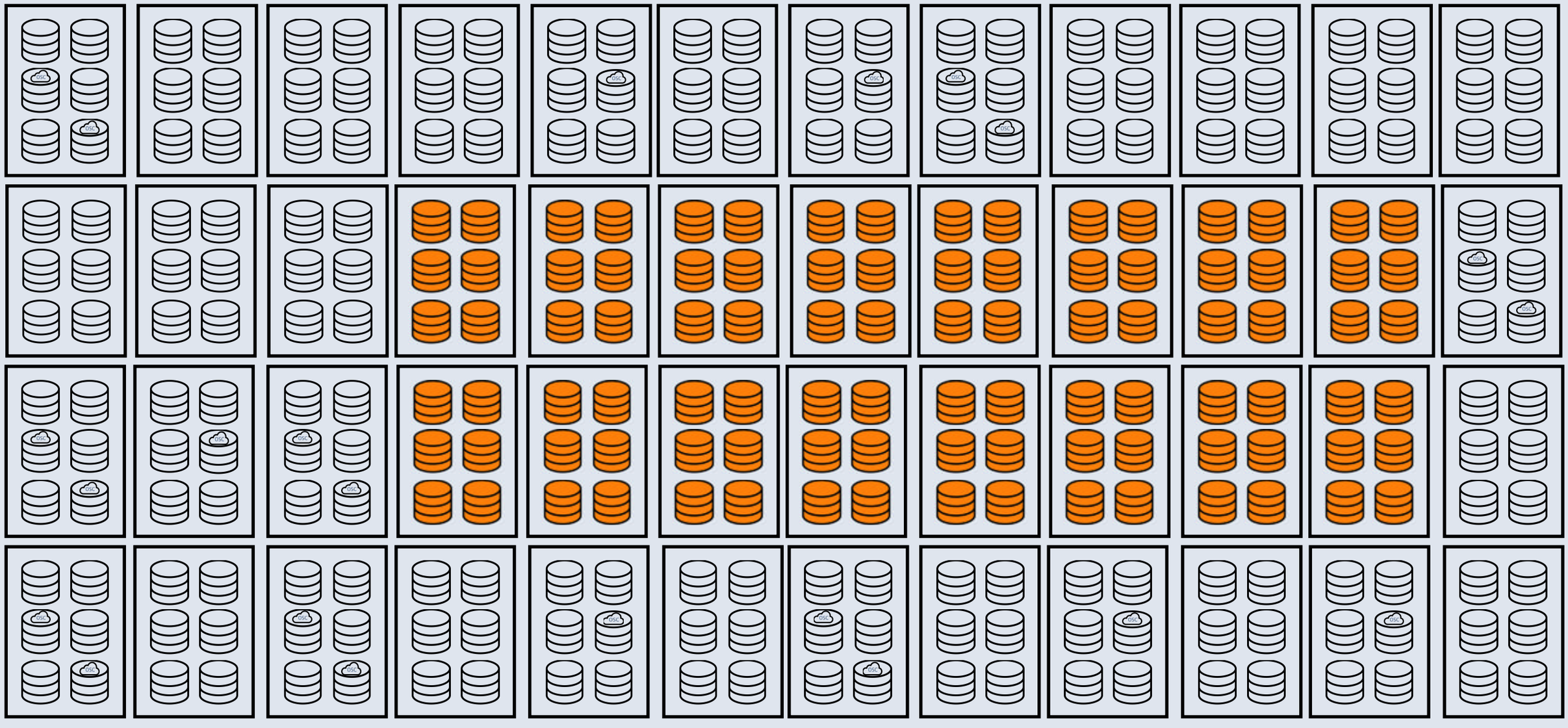

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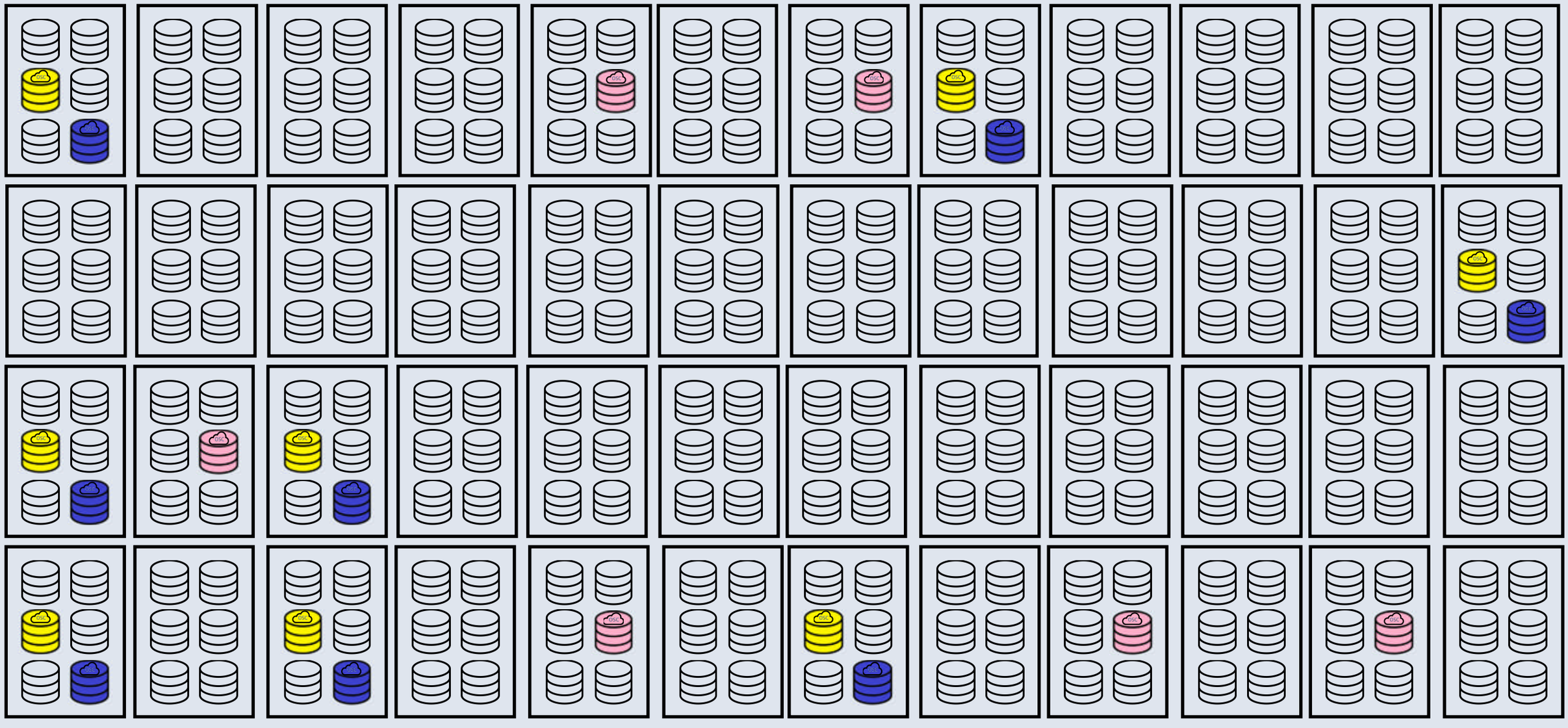

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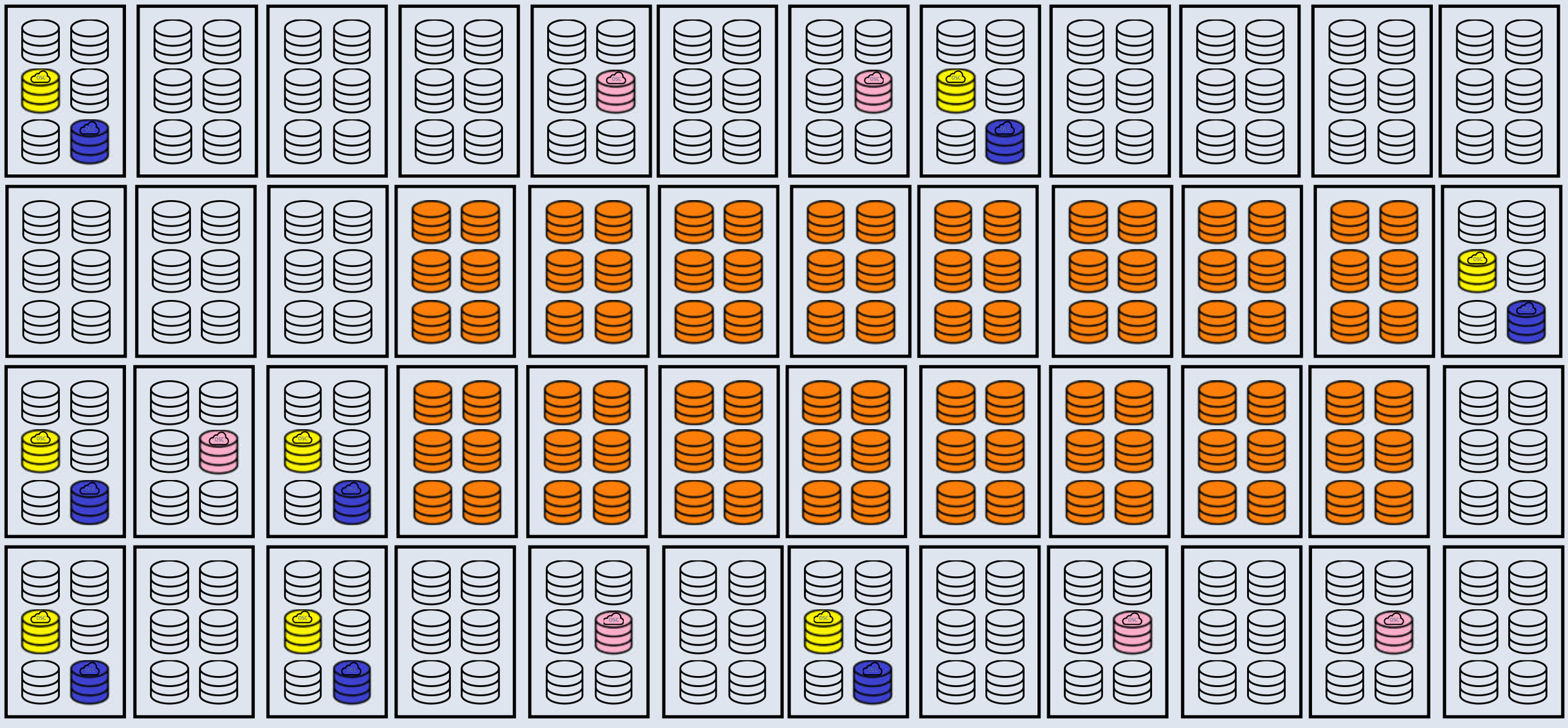

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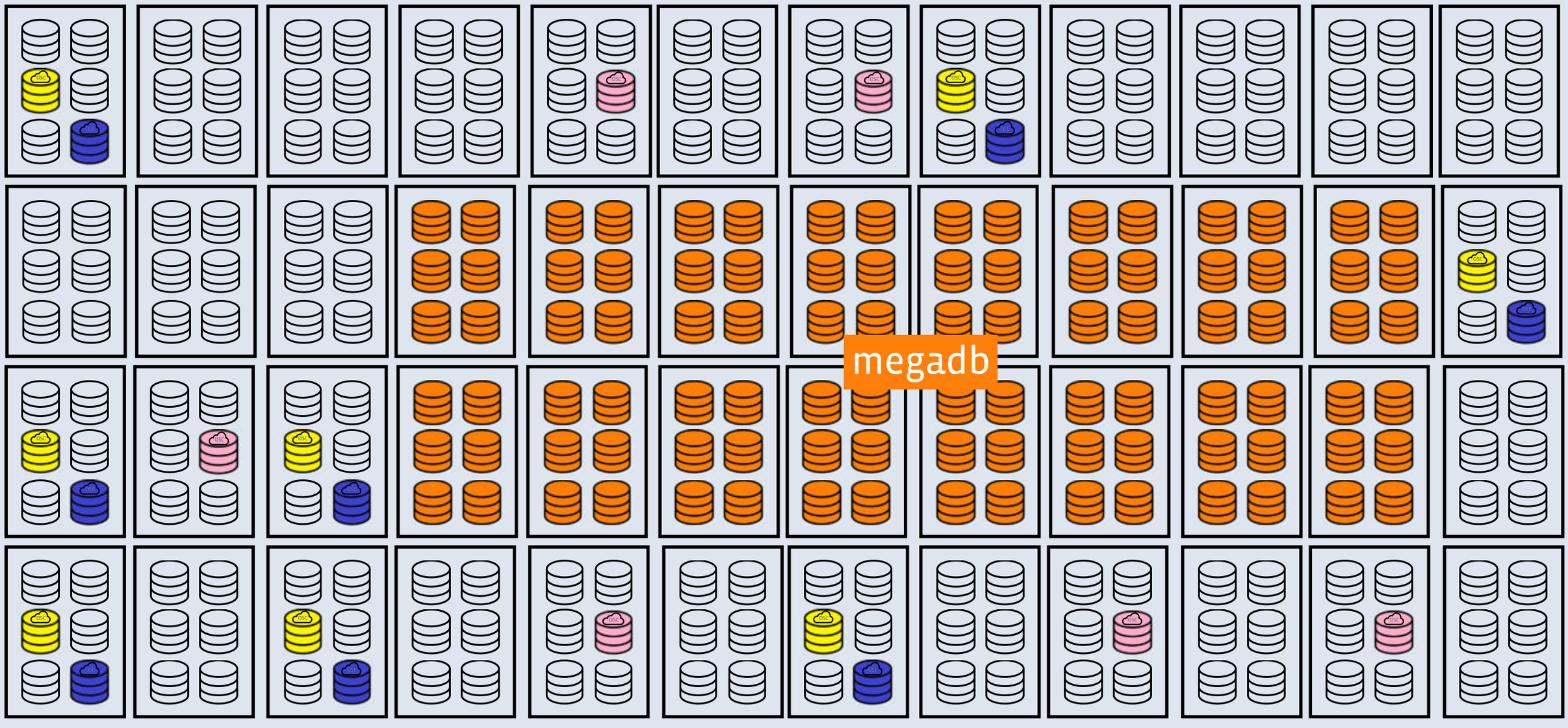
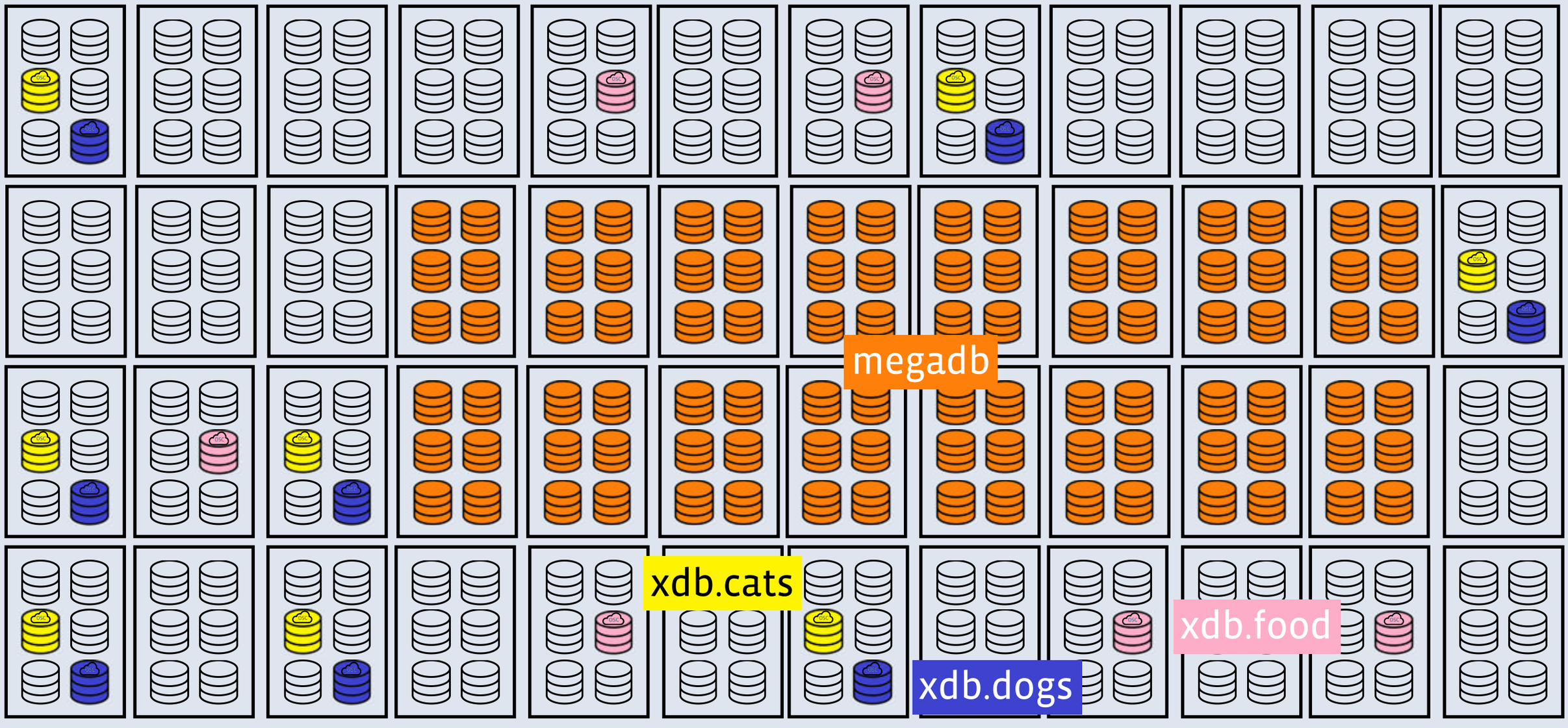


Schema Changes at Scale

Problem



Schema Changes at Scale

Goal

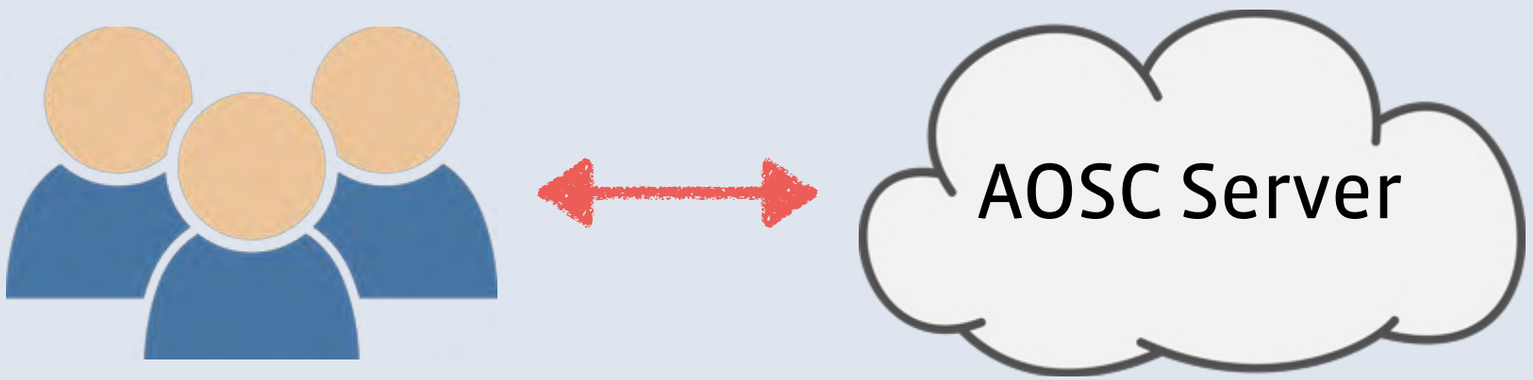
- A given table on a given tier should have an eventually consistent schema across all relevant databases
- Self-service
- Fast
- Safe

Automatic OSC

Solution

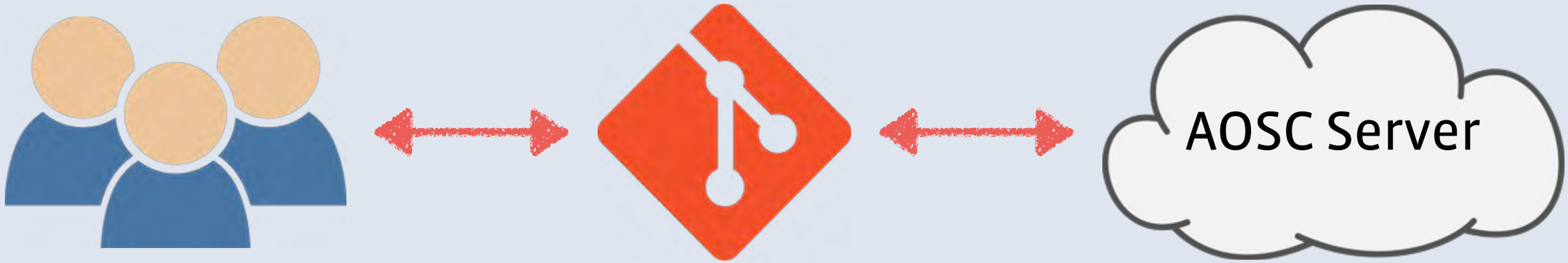
Automatic OSC

Solution



Automatic OSC

Git Repository



Automatic OSC

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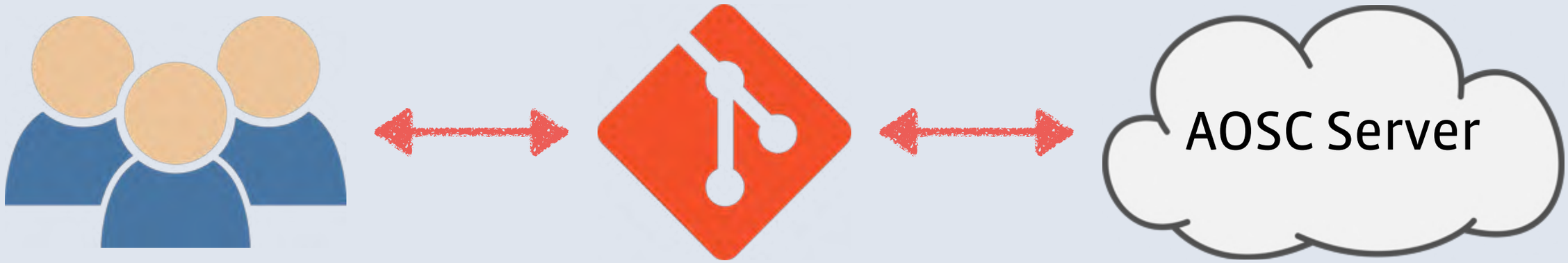


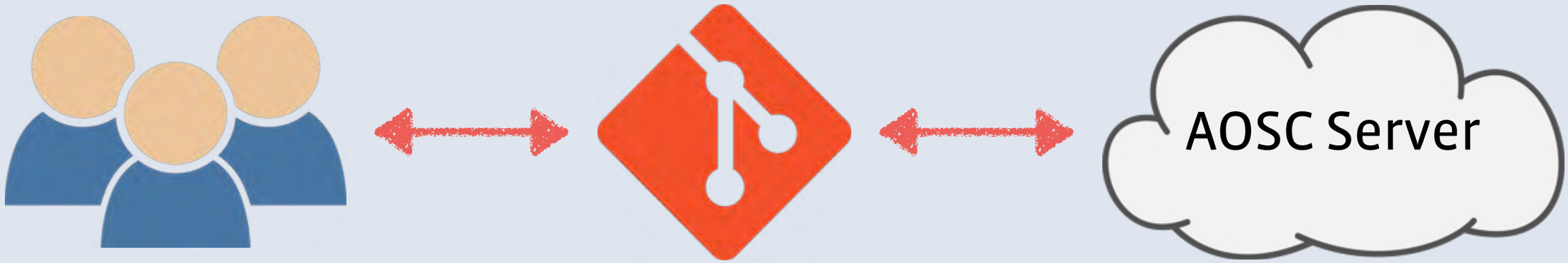

```
~/mysql-schemas $ ls
megadb
xdb.cats
xdb.dogs
xdb.food

~/mysql-schemas $ ls xdb.food
apple
banana
pear
```

```
~/mysql-schemas $ cat xdb.food/apple
CREATE TABLE `apple` (
  `id` int(11) AUTO_INCREMENT,
  `name` varchar(32),
  `quantity` int(11),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

Automatic OSC

Git Repository

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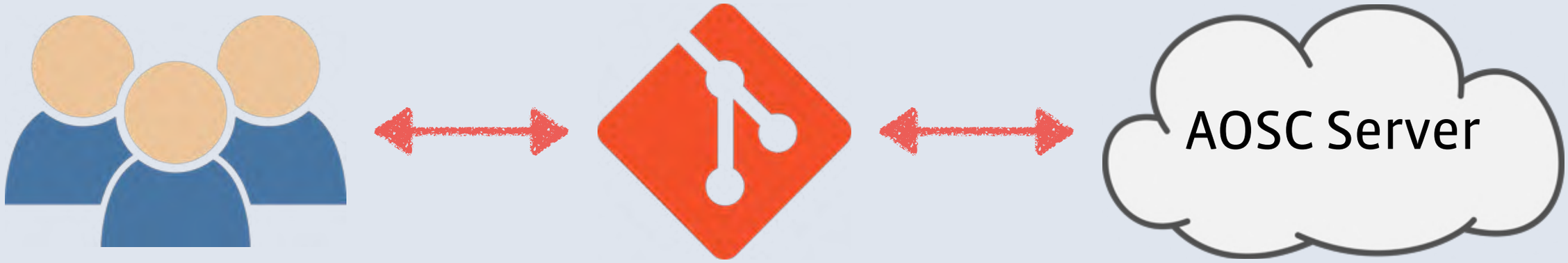
  `name` varchar(32),
  `quantity` int(11),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

```
~/mysql-schemas $ ...

~/mysql-schemas $ git diff
CREATE TABLE `apple` (
  `id` int(11) AUTO_INCREMENT,
  `name` varchar(32),
  `quantity` int(11),
+ `color` enum('red','green'),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

Automatic OSC

Git Repository




```
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  `name` varchar(32),
  `quantity` int(11),
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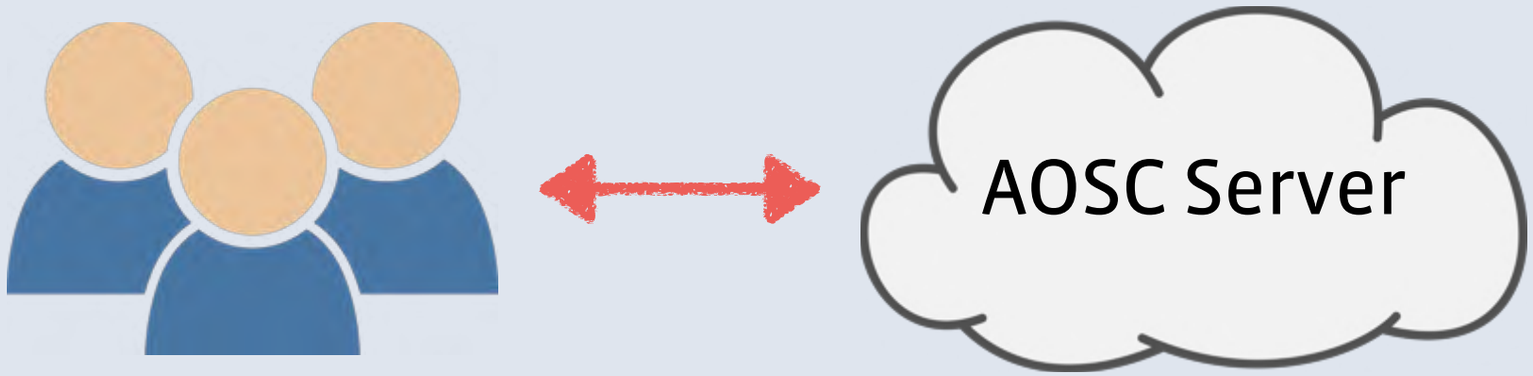
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

- Versioning
- Code review /Auto linter
- Commit hook

Automatic OSC

User Interface




```
~/mysql-schemas $ ...

~/mysql-schemas $ git diff
CREATE TABLE `apple` (
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  `name` varchar(32),
  `quantity` int(11),
+ `color` enum('red','green'),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

```
~ $ aosc allow xdb.food apple
...

~ $ aosc cancel xdb.food apple
...

~ $ aosc hold xdb.food apple
...

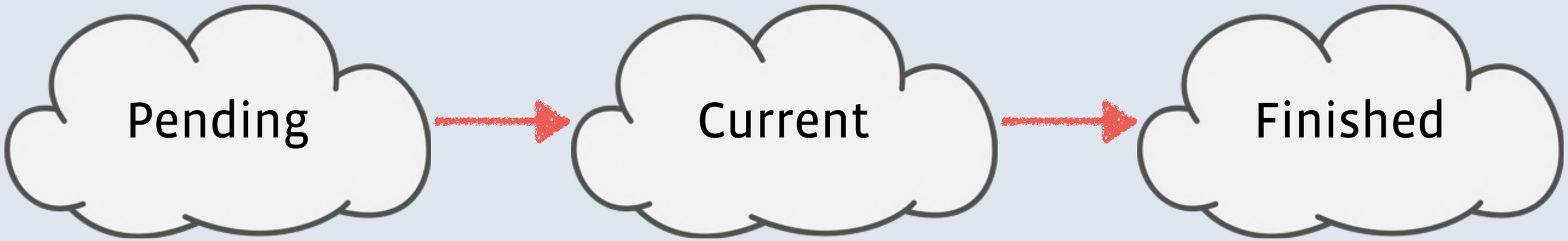
~ $ aosc continue xdb.food apple
...
```

Automatic OSC

Global Coordination

Automatic OSC

Alter-Level Coordination

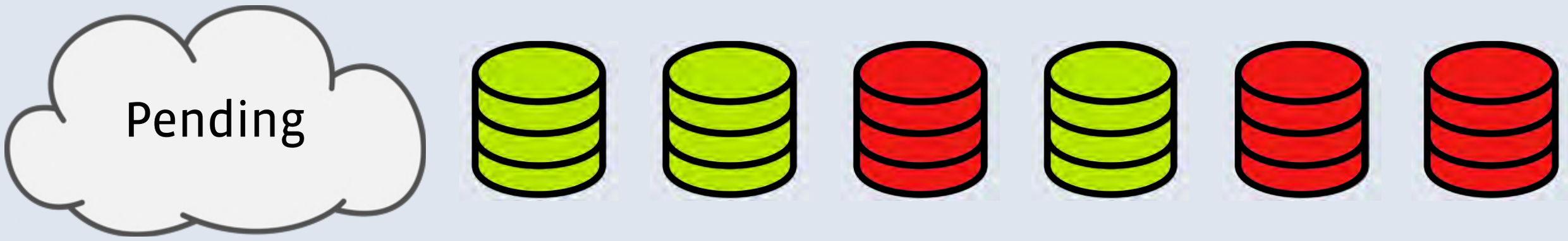


Automatic OSC

Alter-Level Coordination: Pending

Automatic OSC

Alter-Level Coordination: Pending




```
~/mysql-schemas $ git diff
CREATE TABLE `apple` (
  `id` int(11) AUTO_INCREMENT,
  `name` varchar(32),
  `quantity` int(11),
+ `color` enum('red','green'),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

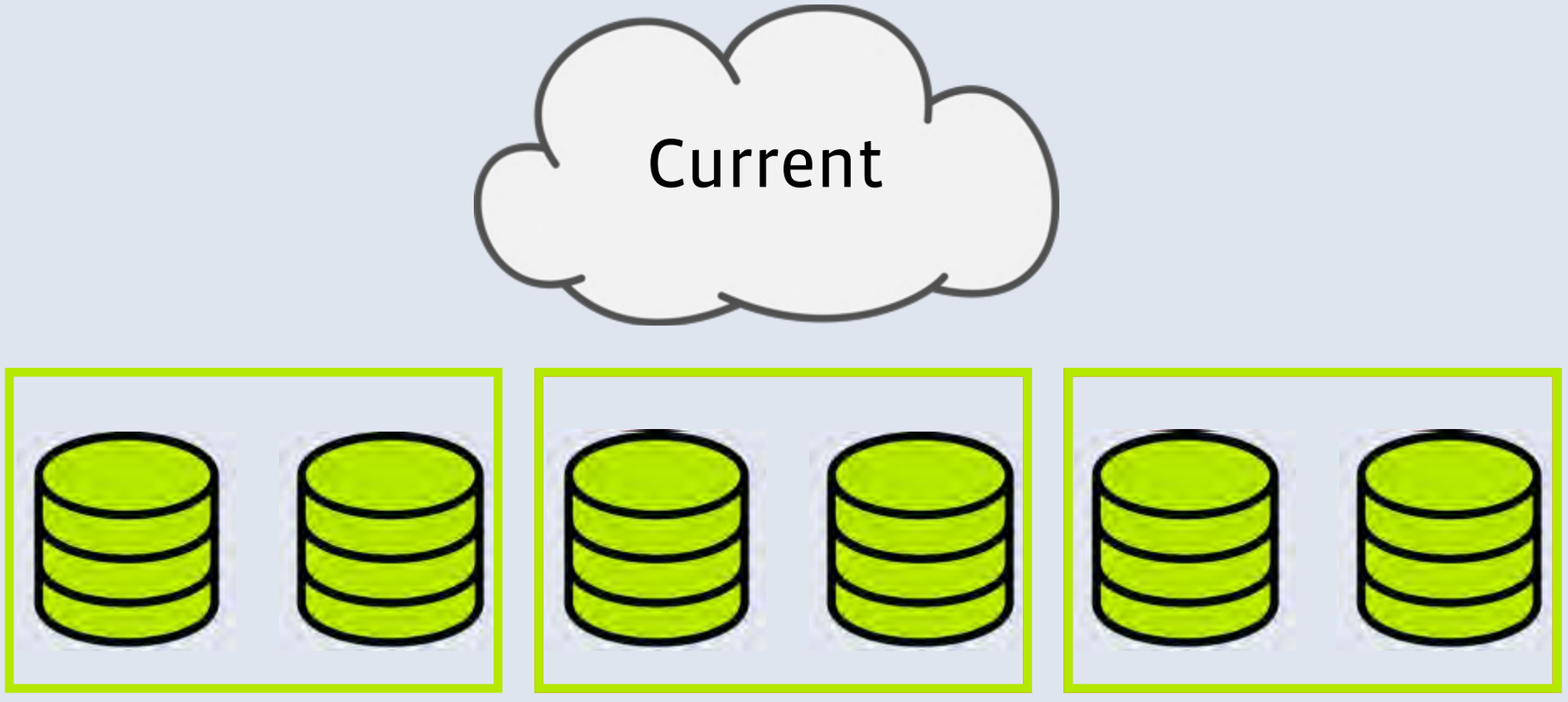
```
db3 > SHOW CREATE TABLE `apple`;
CREATE TABLE `apple` (
  `id` int(11) AUTO_INCREMENT,
  `name` varchar(32),
  `quantity` int(11),
  PRIMARY KEY (`id`)
) ENGINE=RocksDB
```

Automatic OSC

Alter-Level Coordination: Pending

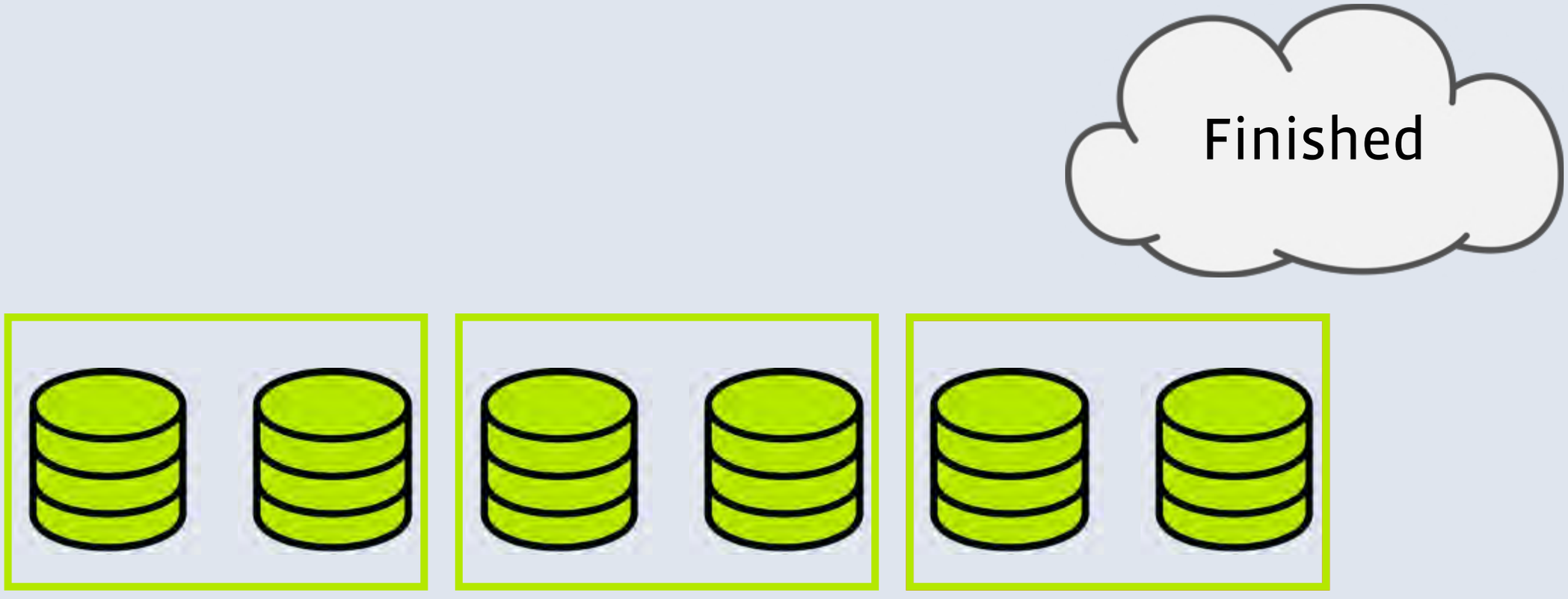
Automatic OSC

Alter-Level Coordination: Current



Automatic OSC

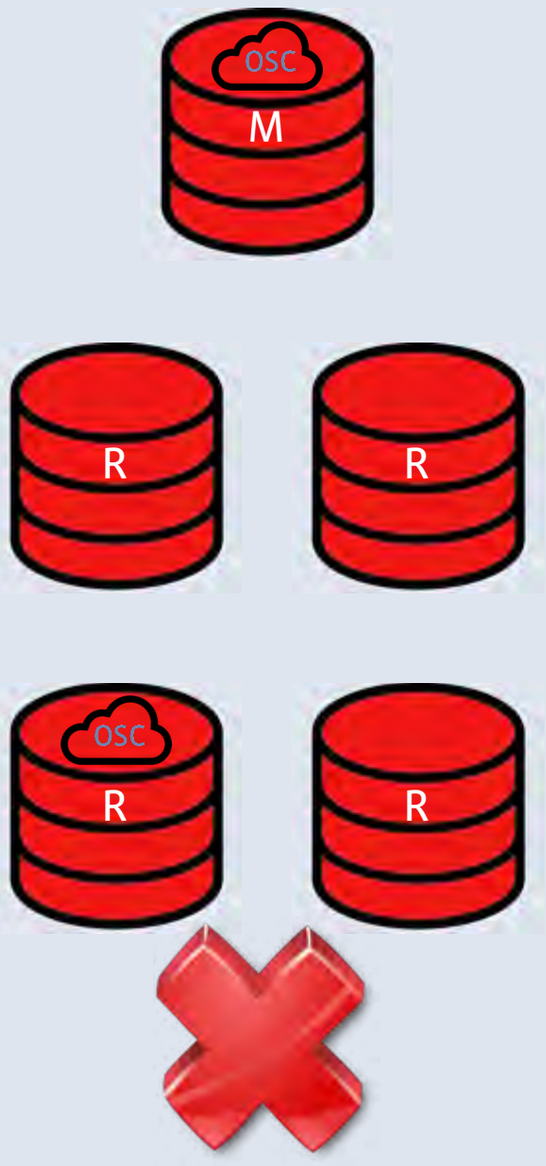
Alter-Level Coordination: Finished



Replicaset-Level Coordination

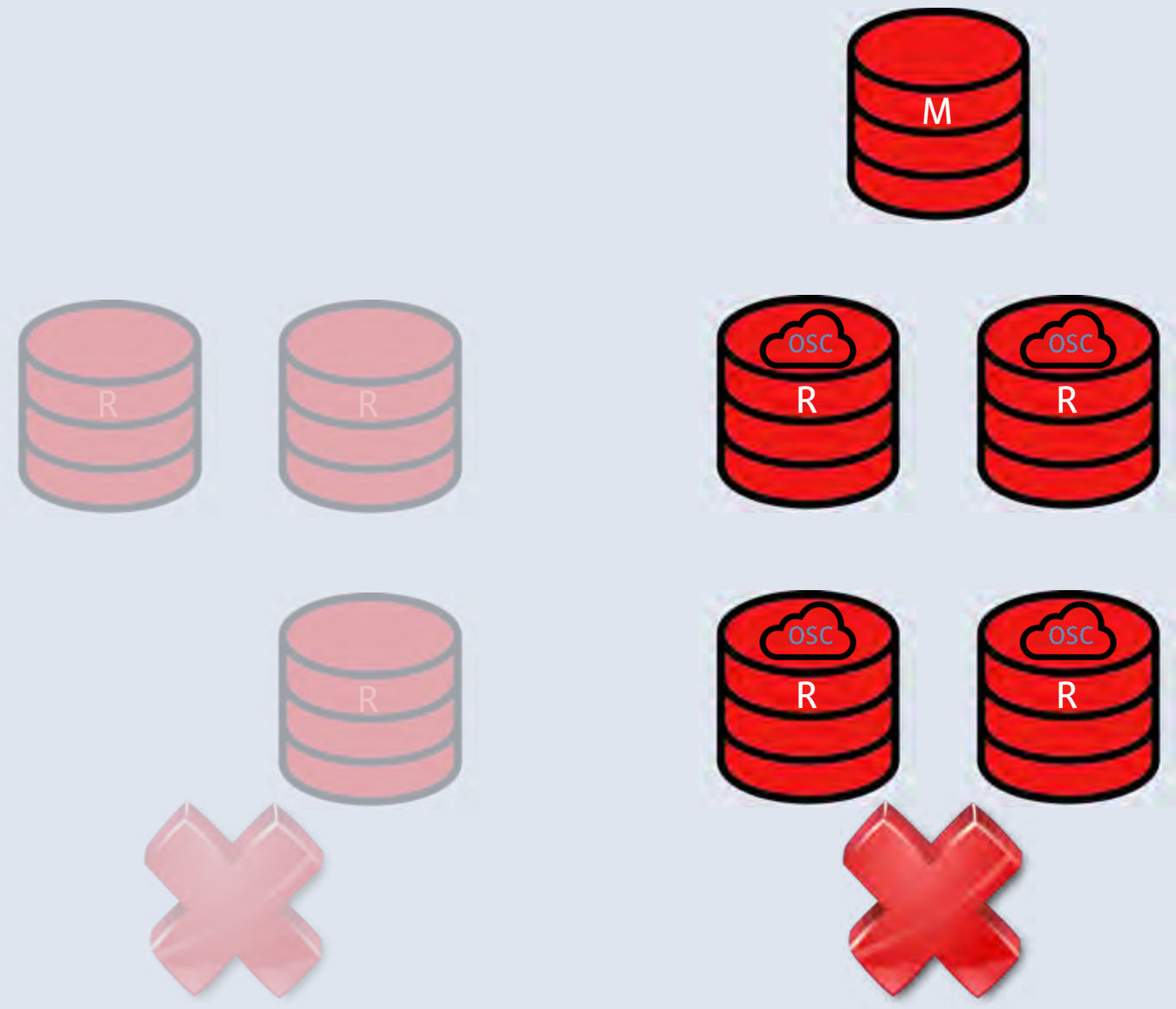
Automatic OSC

Replicaset-Level Coordination



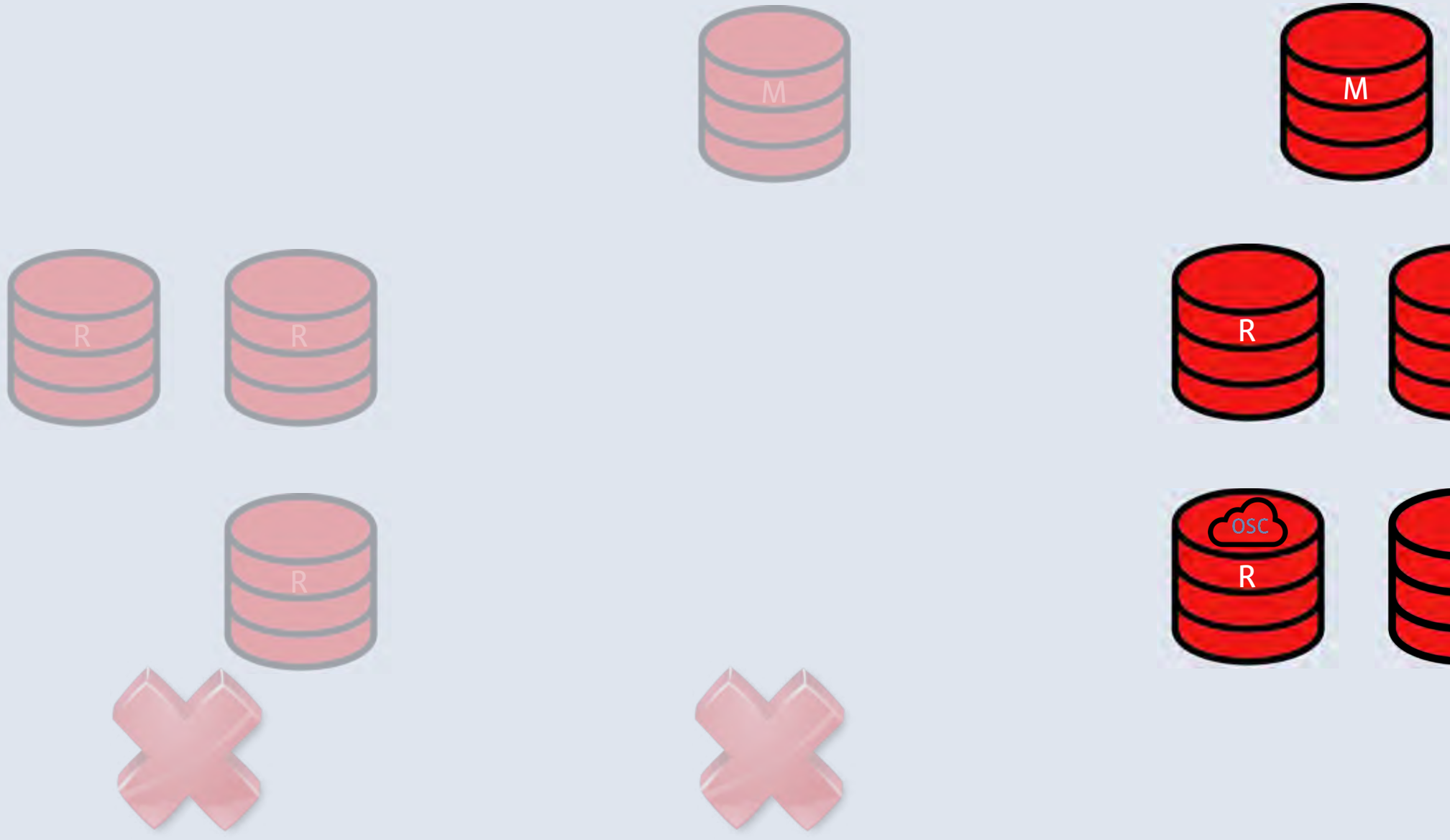
Automatic OSC

Replicaset-Level Coordination



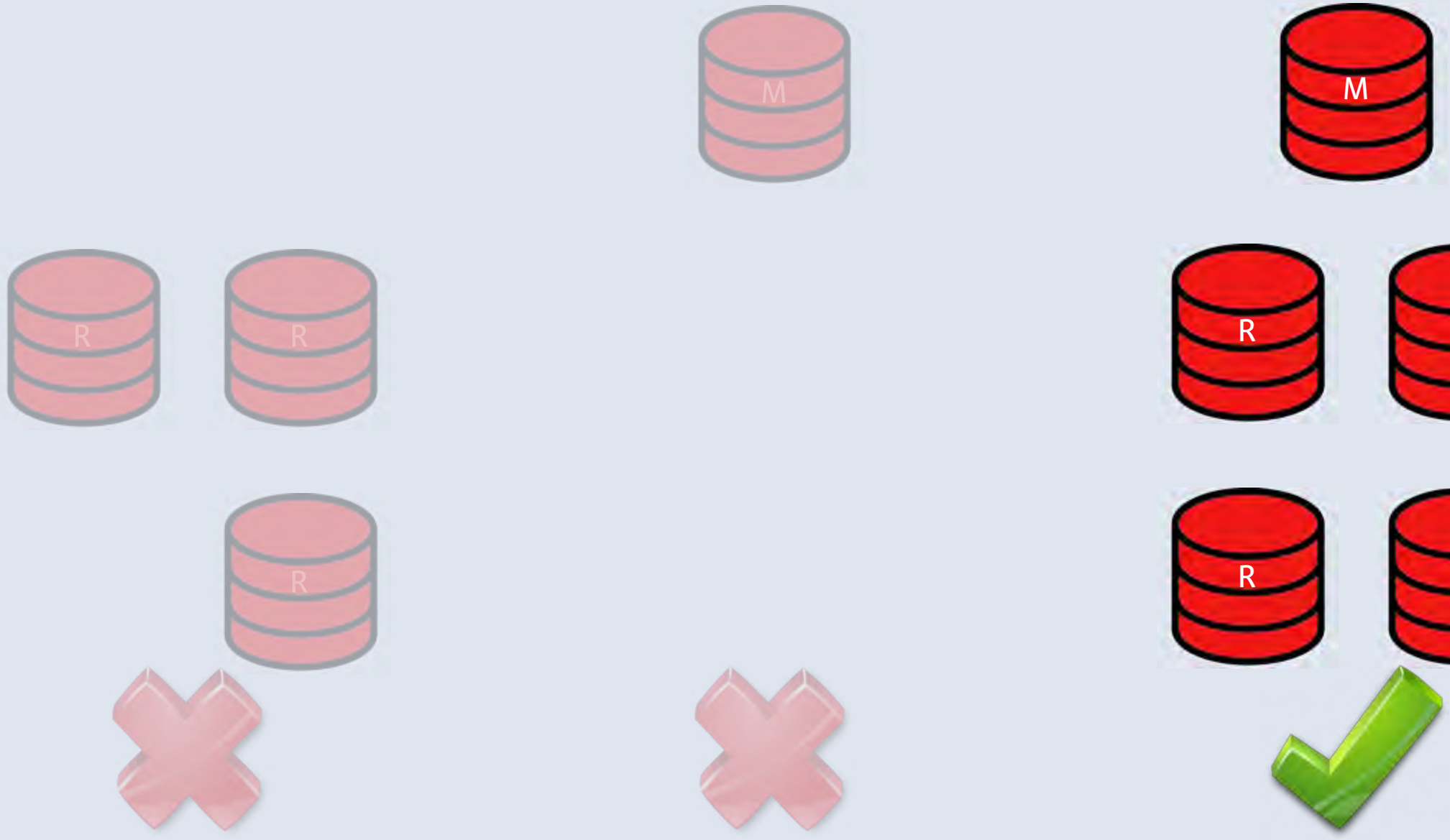
Automatic OSC

Replicaset-Level Coordination



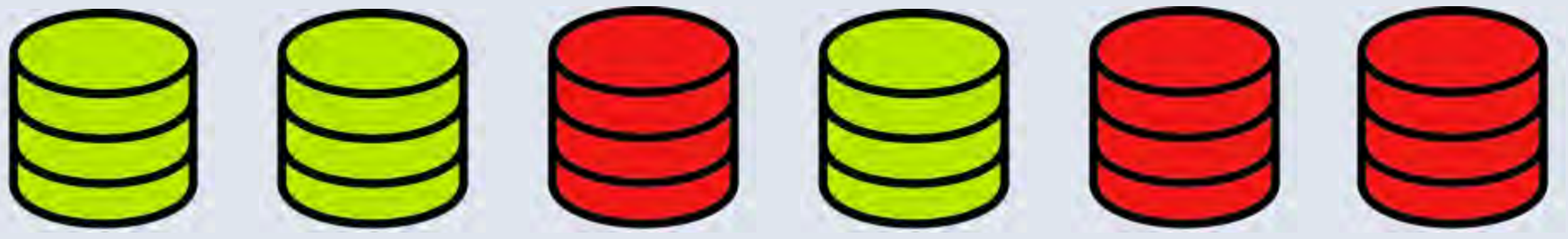
Automatic OSC

Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination

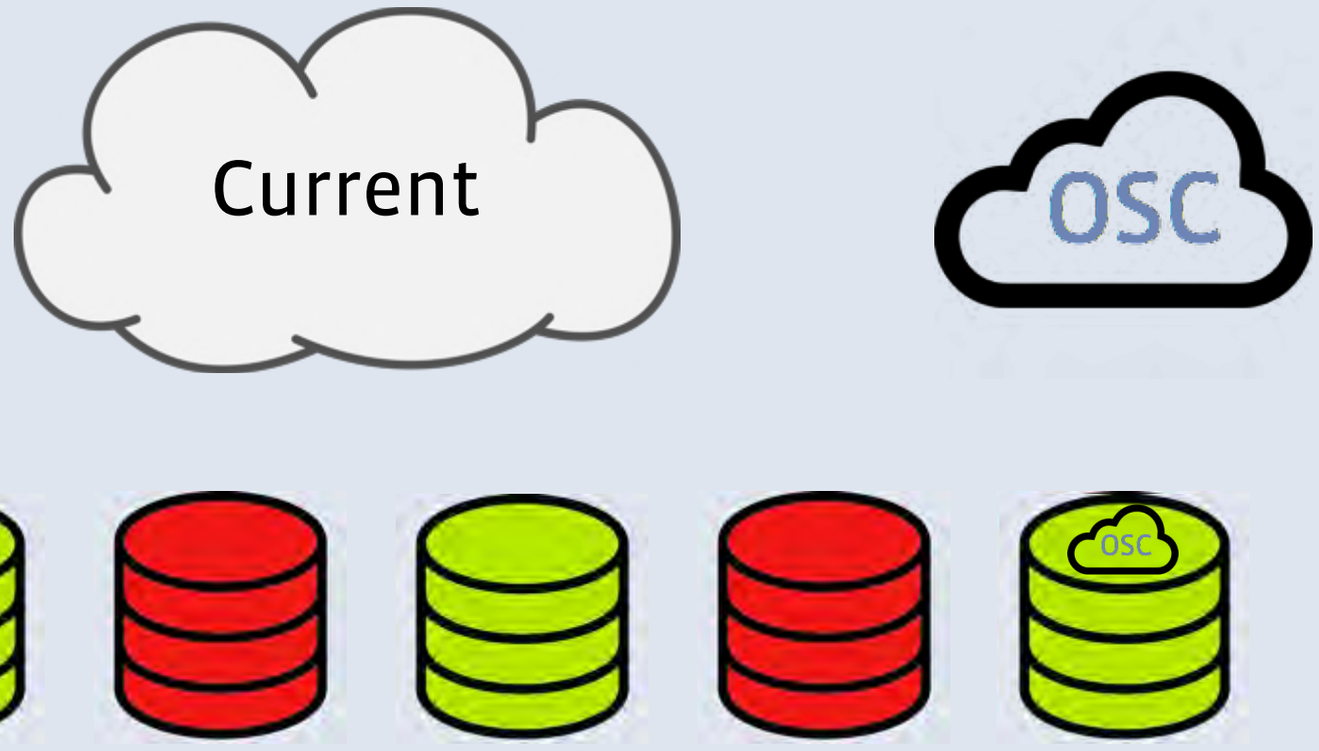


Automatic OSC

Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination

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Replicaset-Level Coordination

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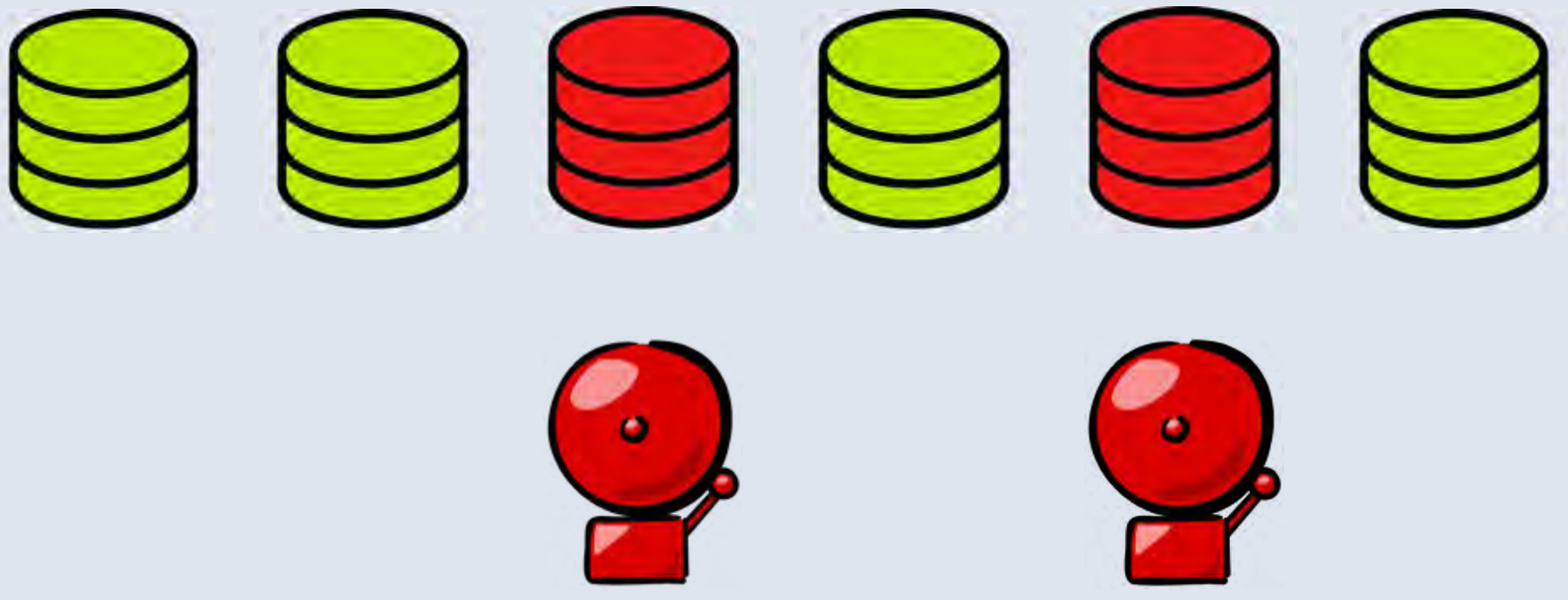
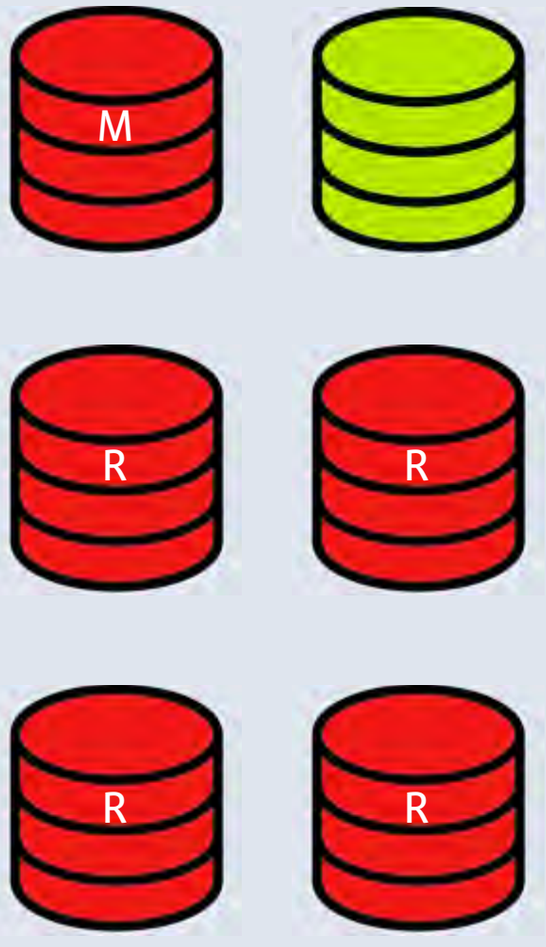
Automatic OSC

Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination

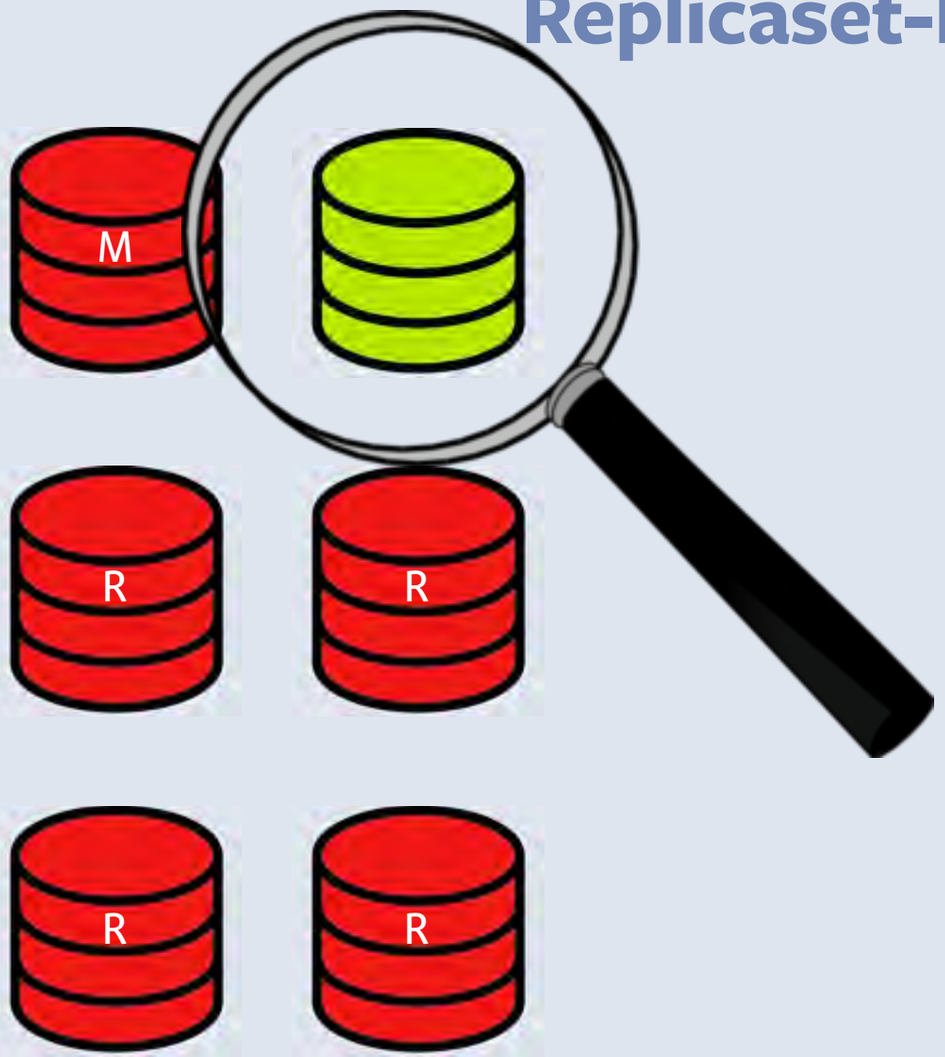


Automatic OSC

Replicaset-Level Coordination

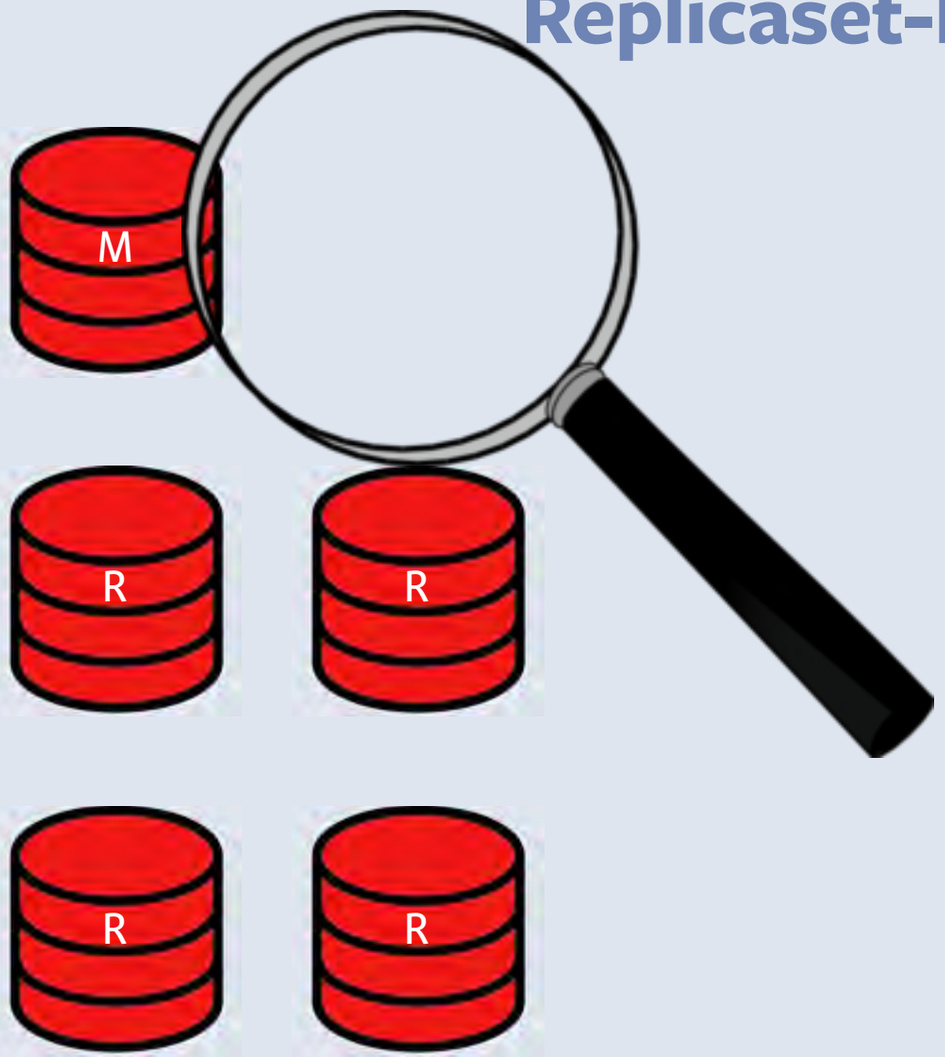
Automatic OSC

Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination

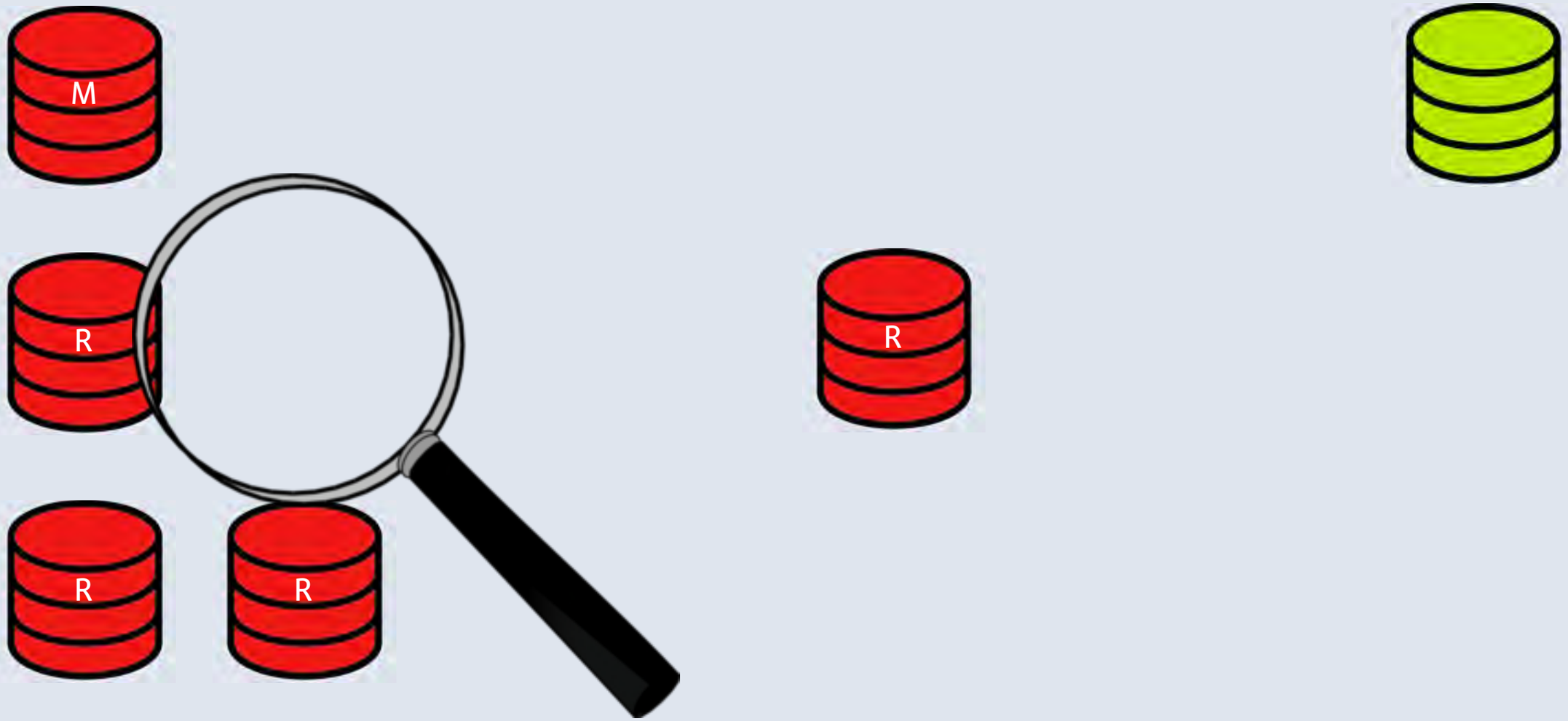


Automatic OSC

Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination



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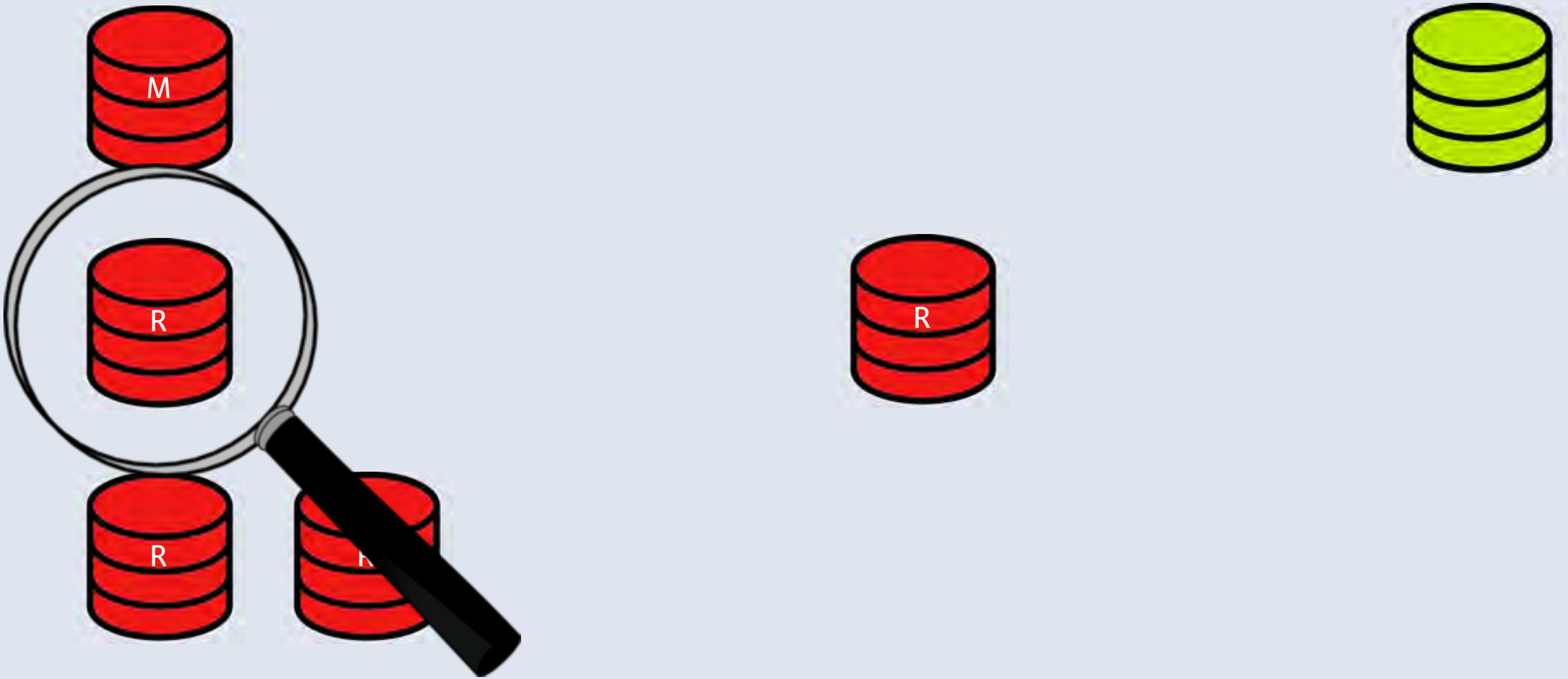
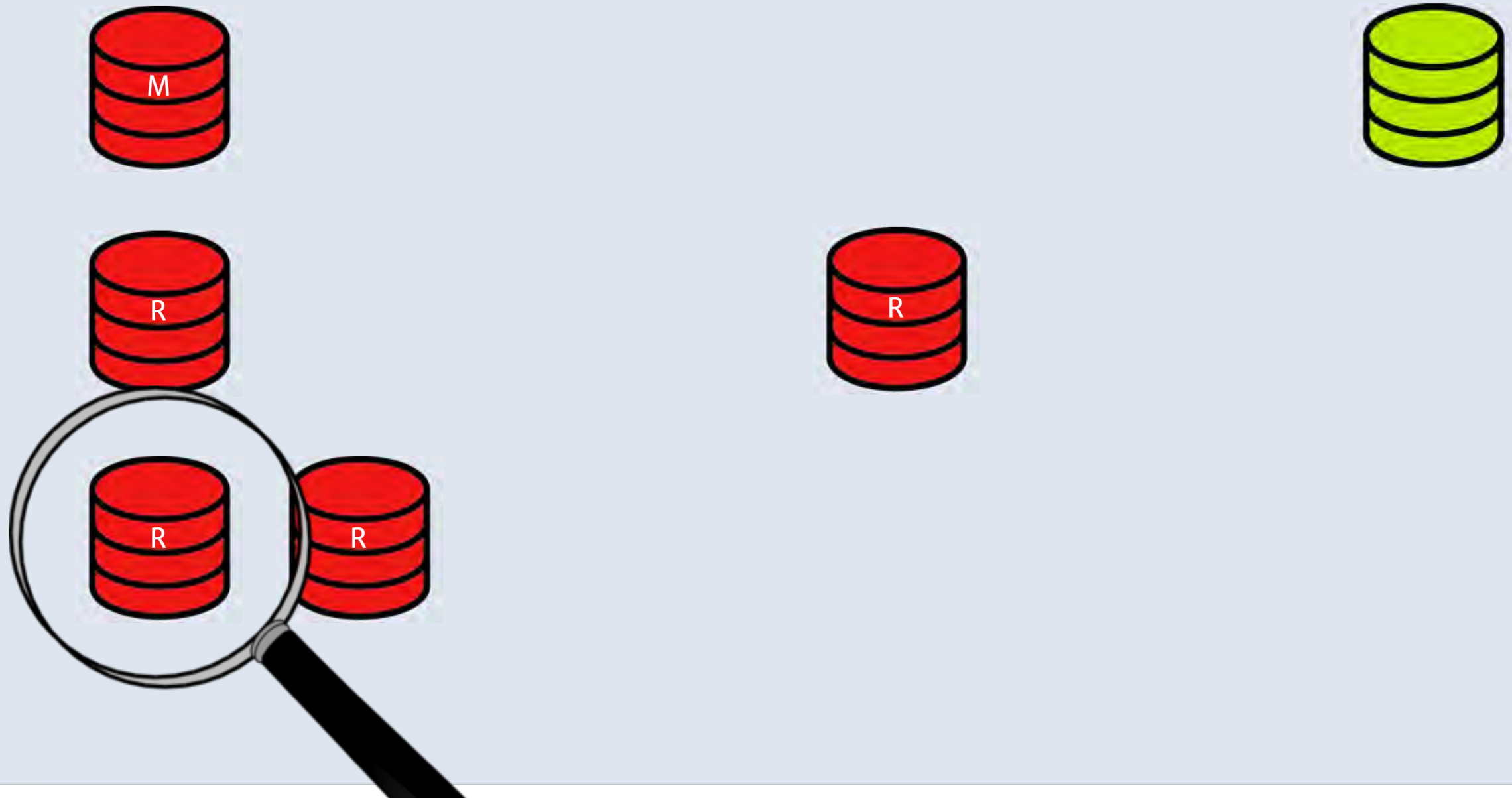
Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination



Automatic OSC

Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination

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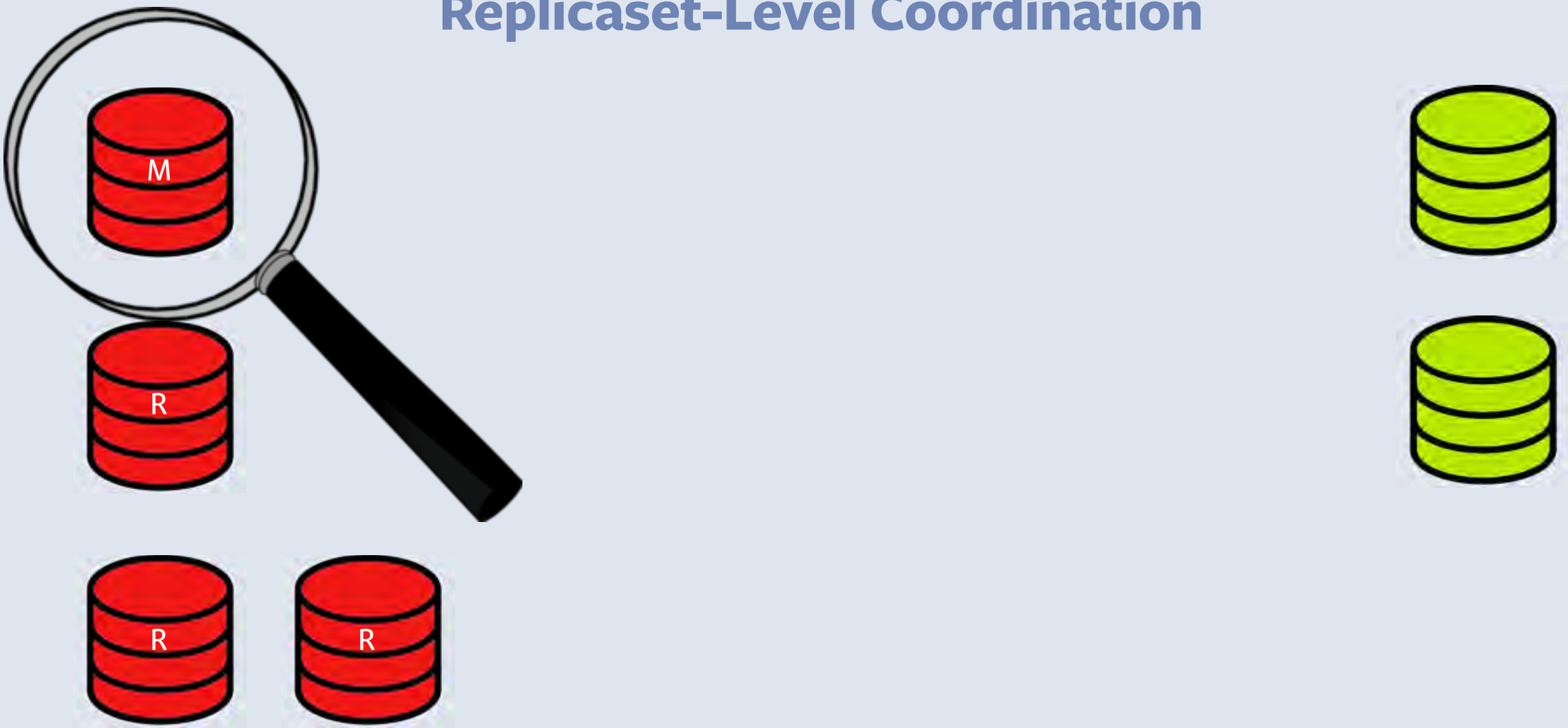
Replicaset-Level Coordination

Automatic OSC

Replicaset-Level Coordination



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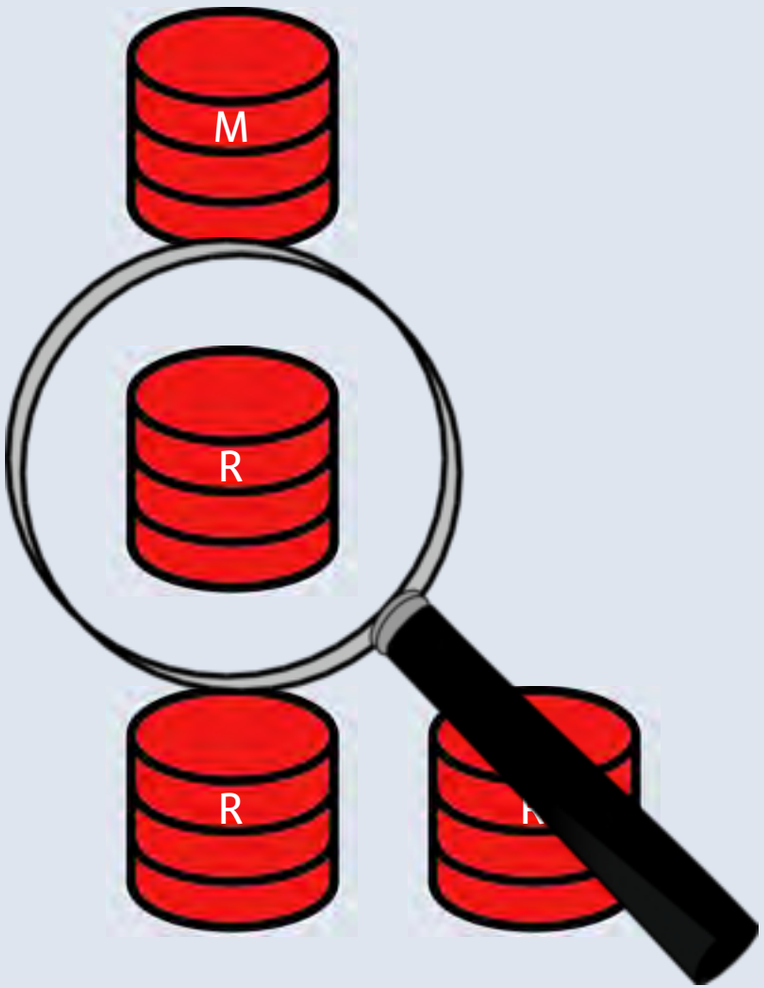

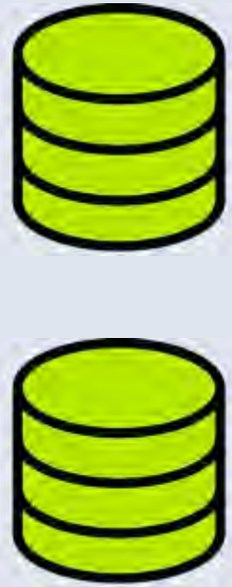

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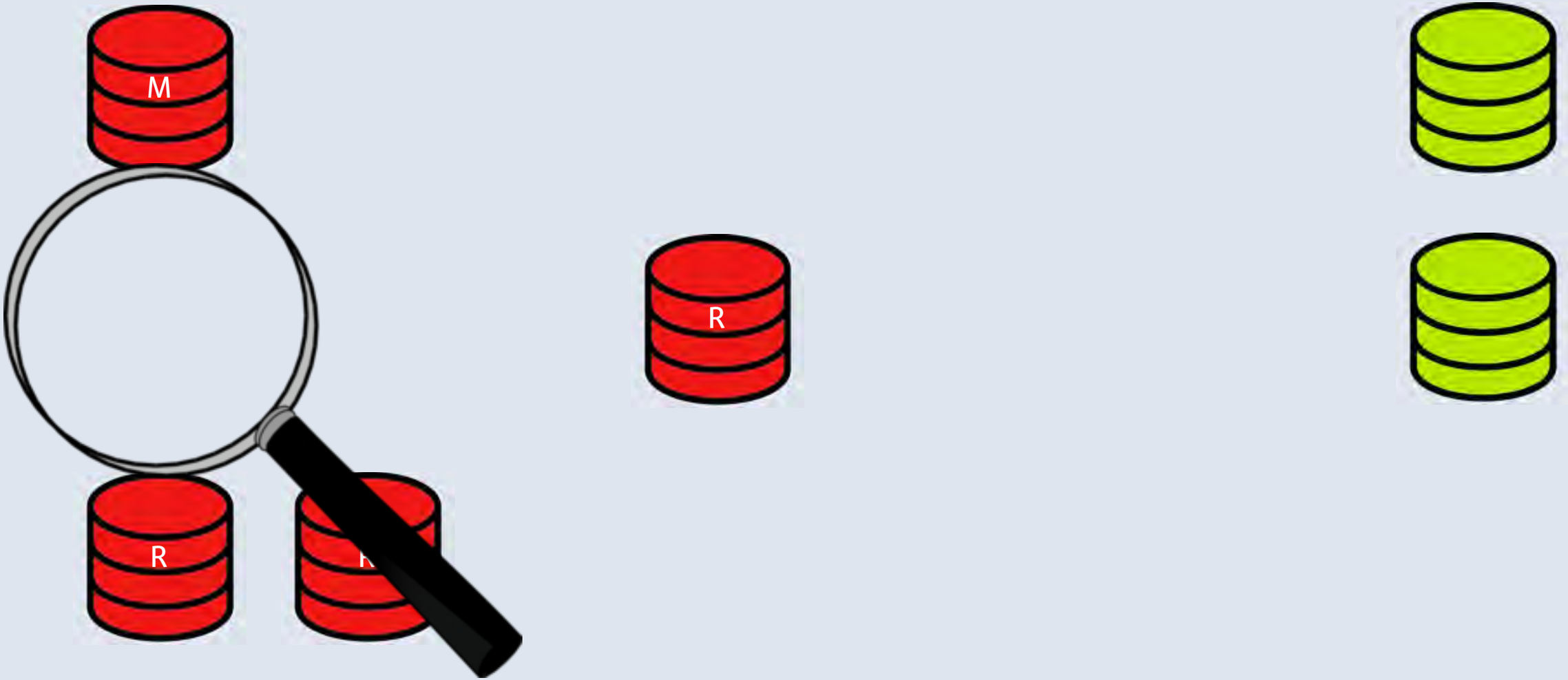

Automatic OSC

Replicaset-Level Coordination

Automatic OSC

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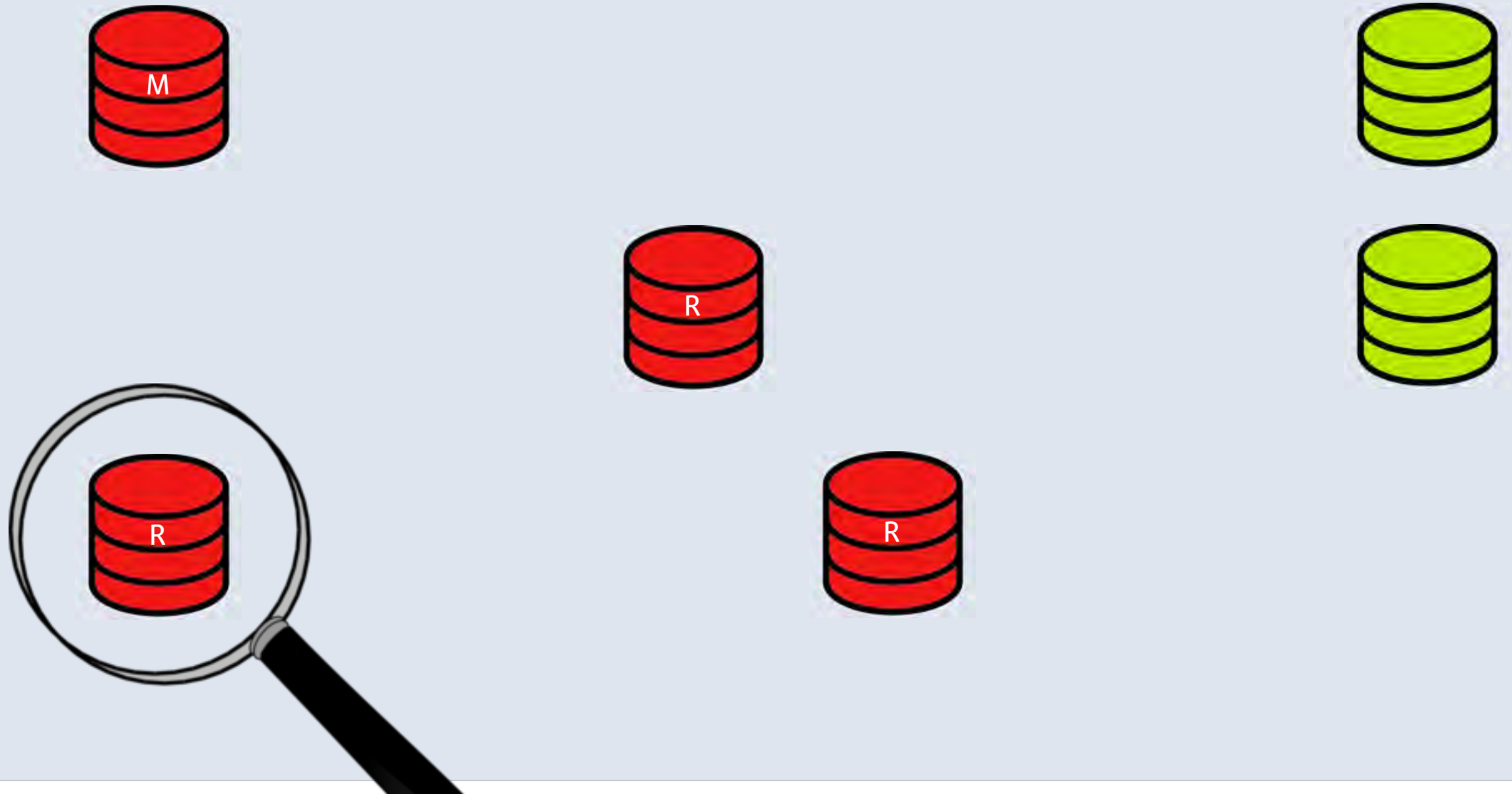

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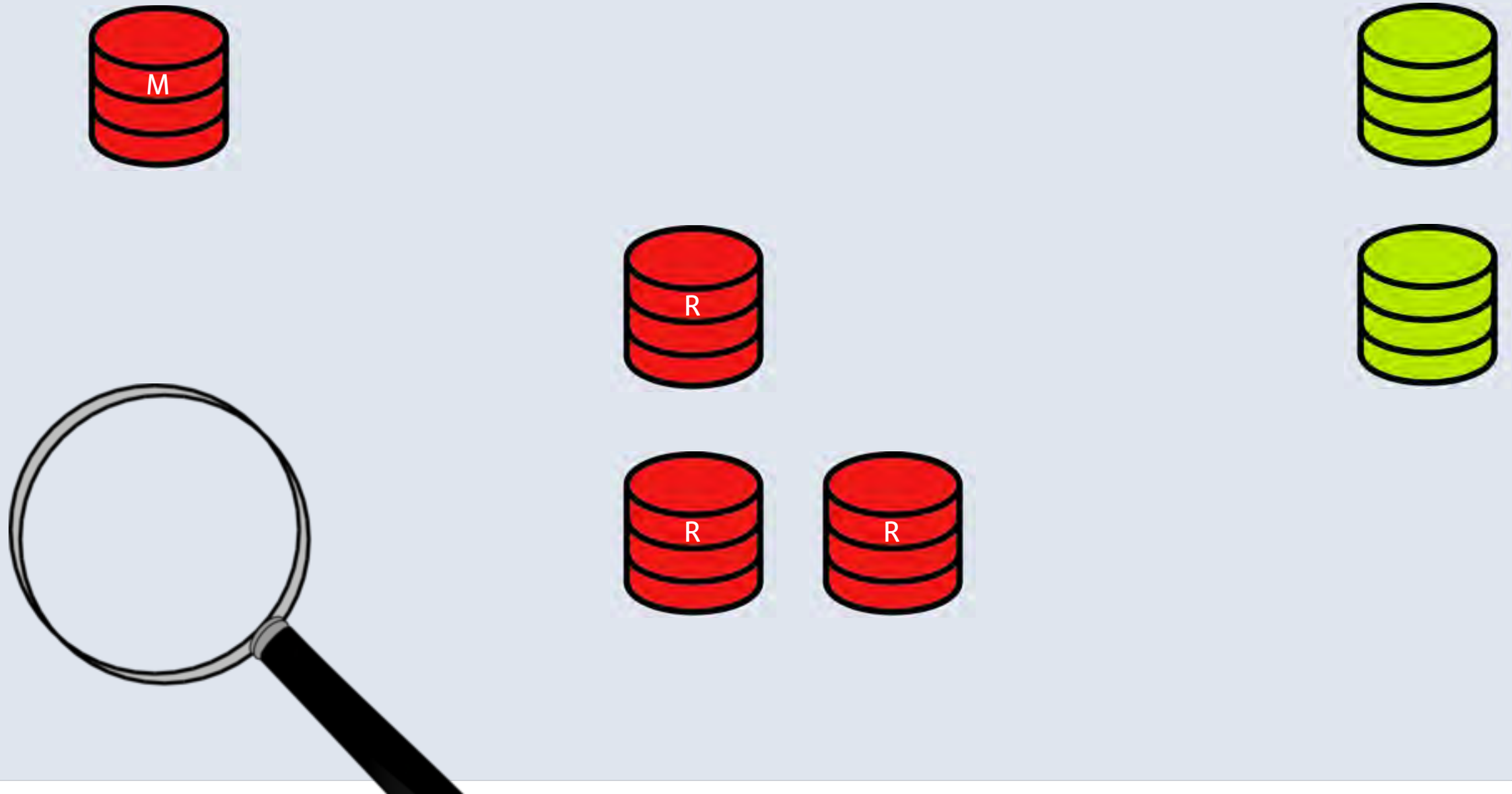

Automatic OSC

Replicaset-Level Coordination

Automatic OSC

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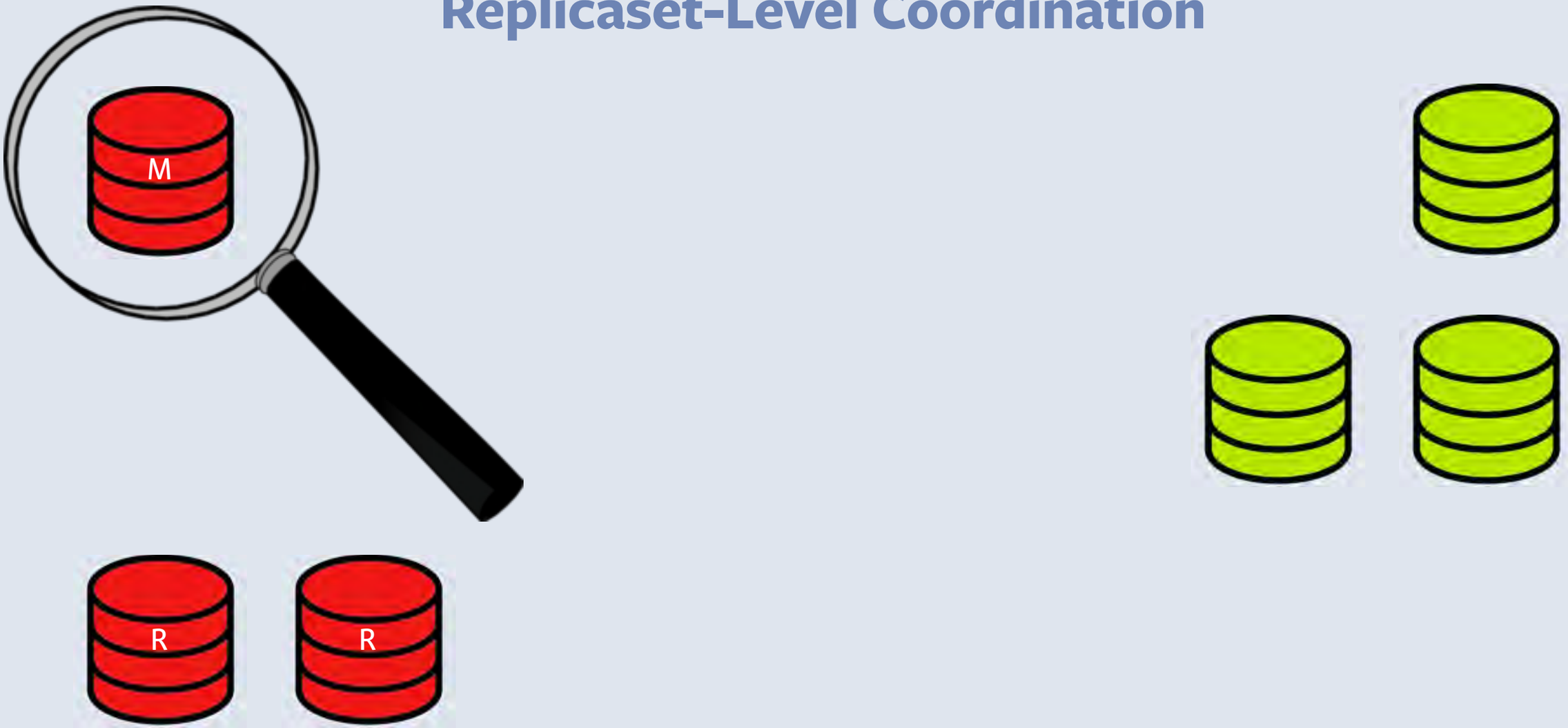
Replicaset-Level Coordination



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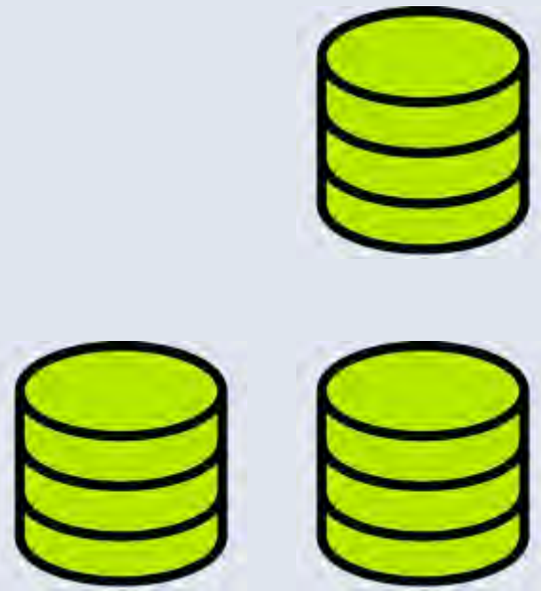

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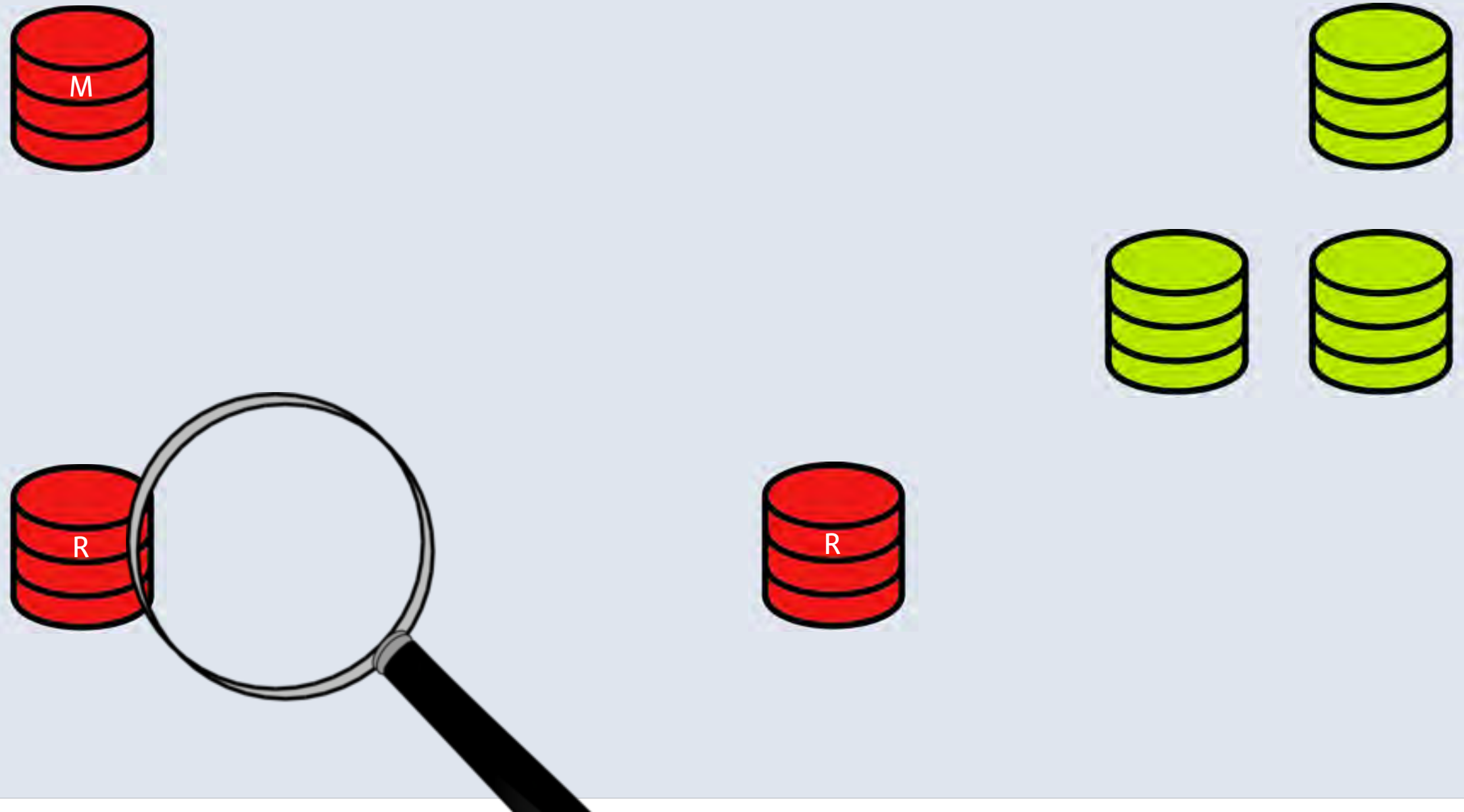

Automatic OSC

Replicaset-Level Coordination

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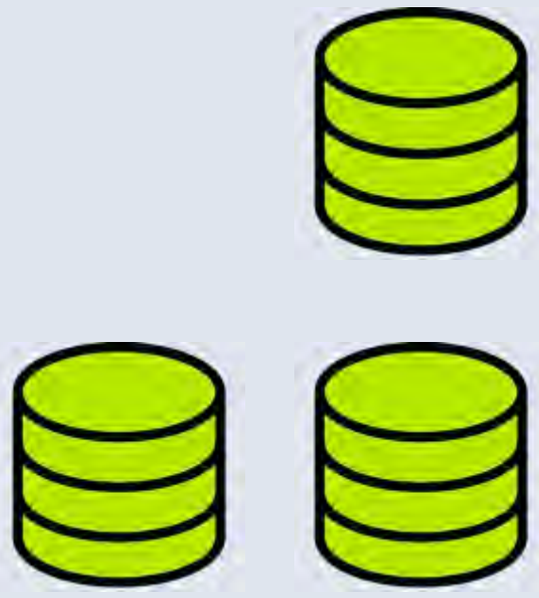


Automatic OSC

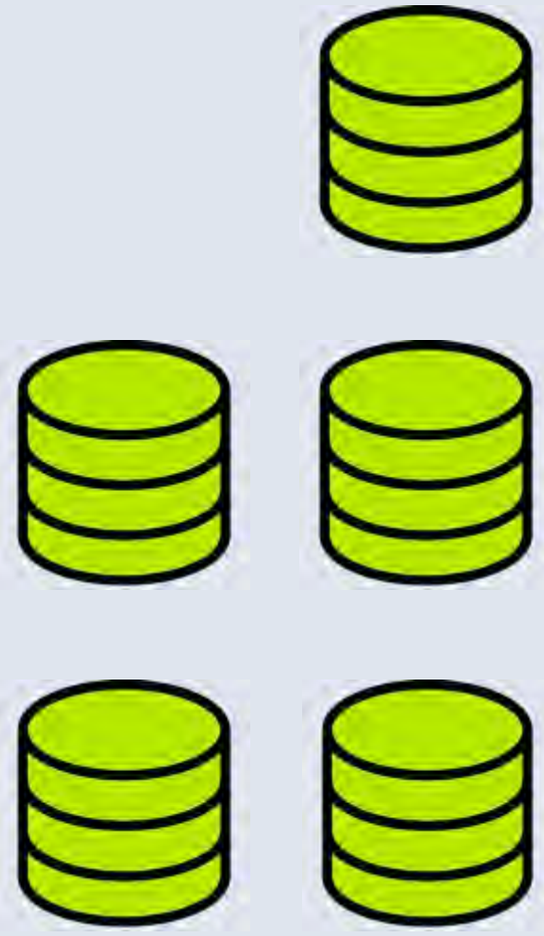
Host-Level Coordination

Automatic OSC

Host-Level Coordination

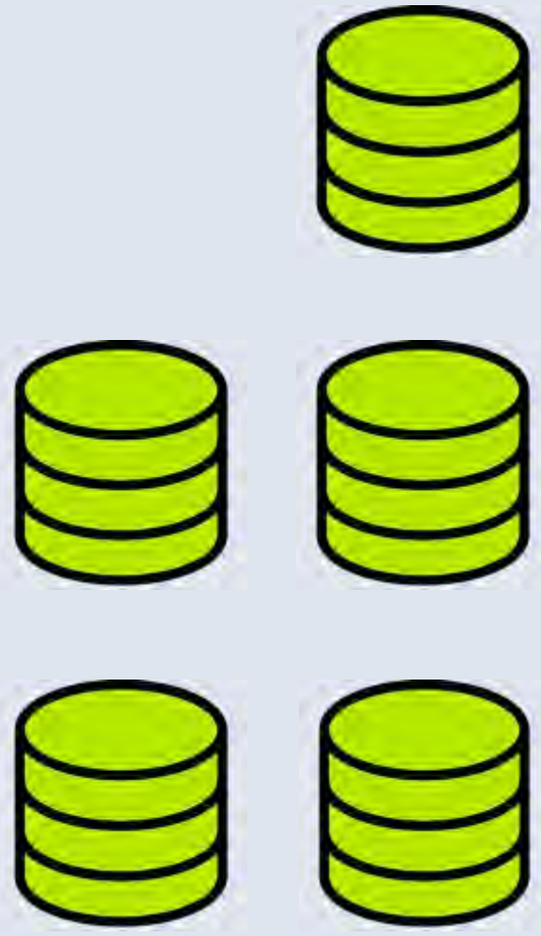
Automatic OSC

Host-Level Coordination



Automatic OSC

Host-Level Coordination



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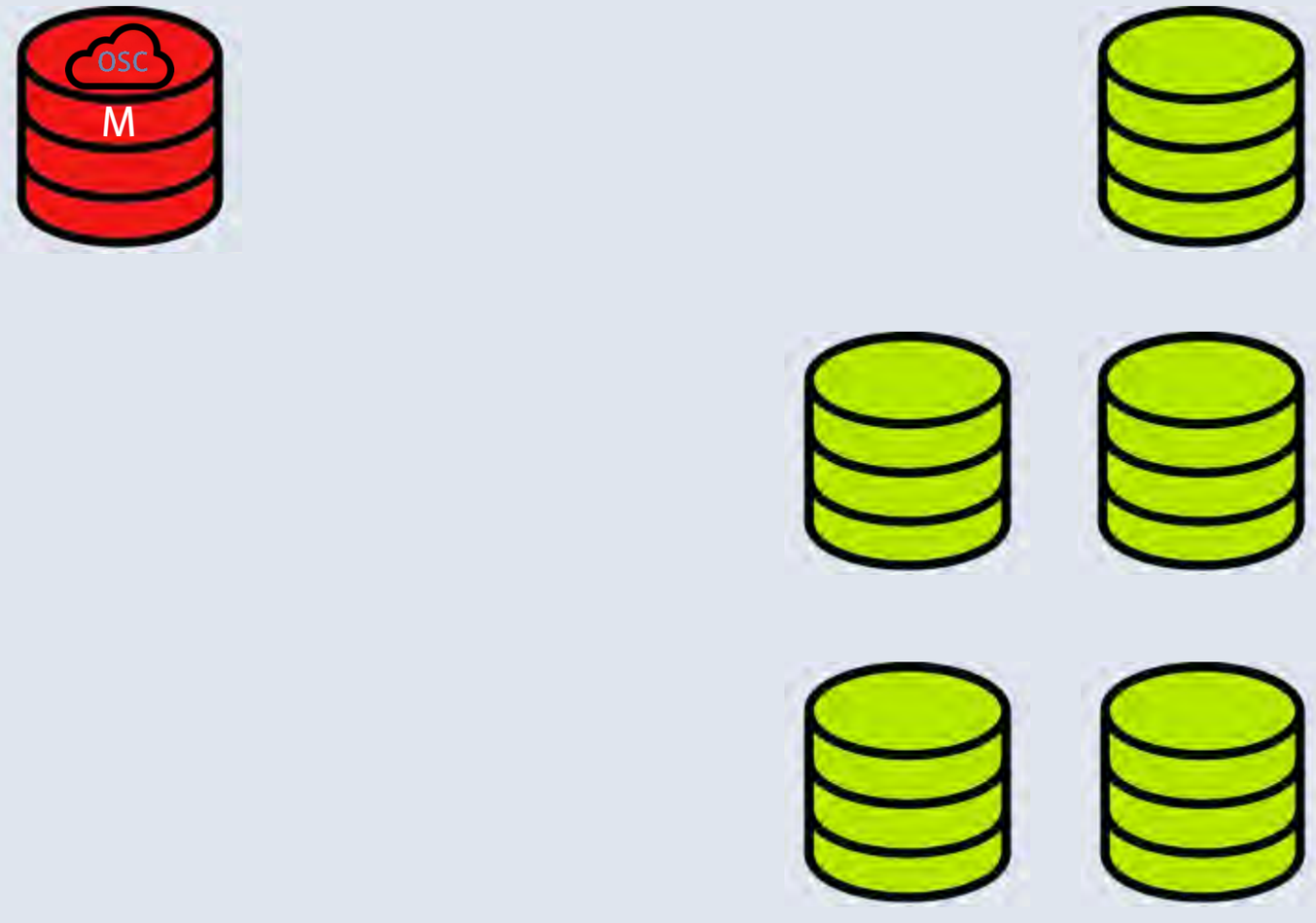
Host-Level Coordination

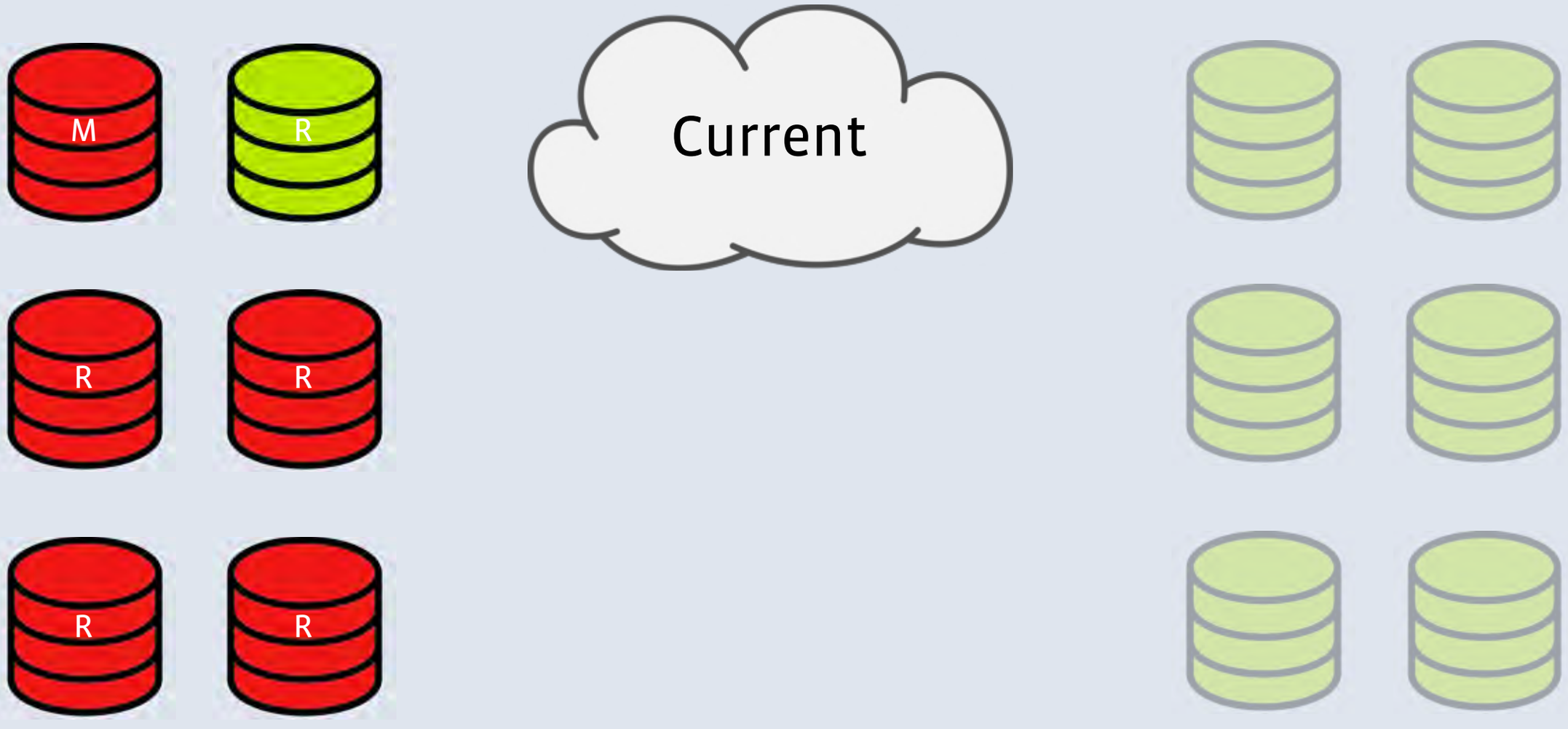


Automatic OSC

Host-Level Coordination

Automatic OSC

Host-Level Coordination



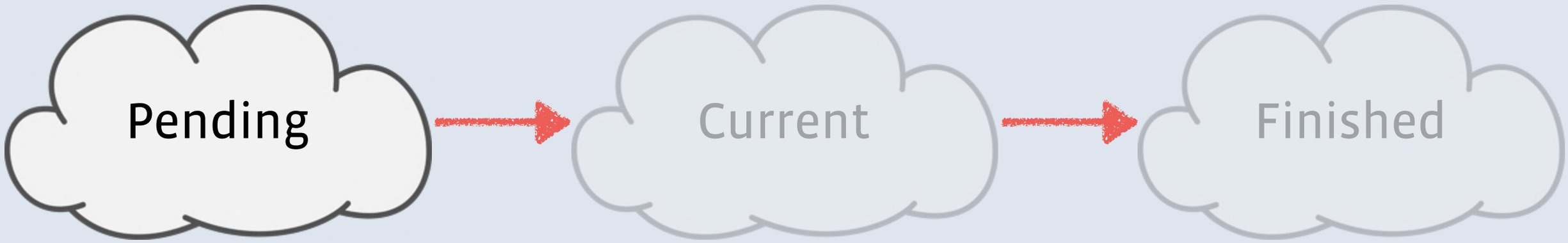
Automatic OSC

Host-Level Coordination

From Current to Finish

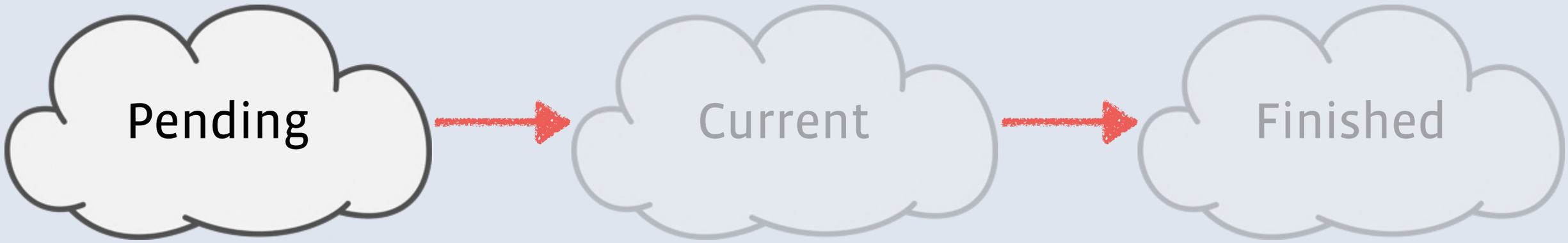
Automatic OSC

Alter-Level Coordination: Finished



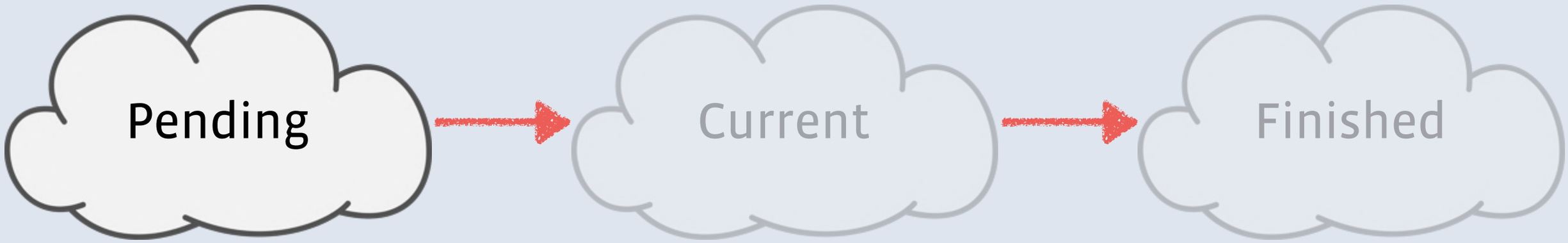
Automatic OSC

Alter-Level Coordination: Finished



Automatic OSC

Alter-Level Coordination: Finished



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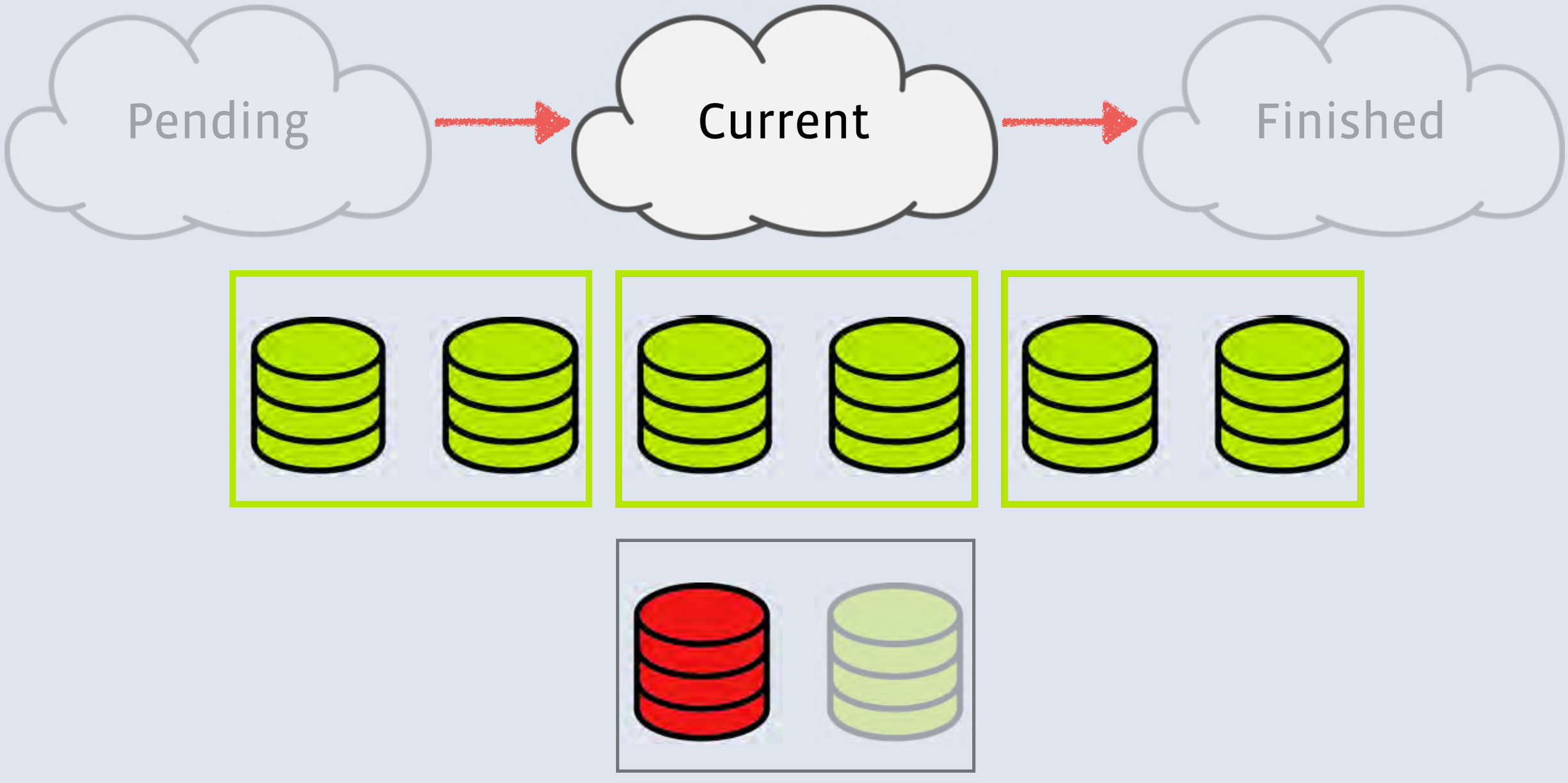
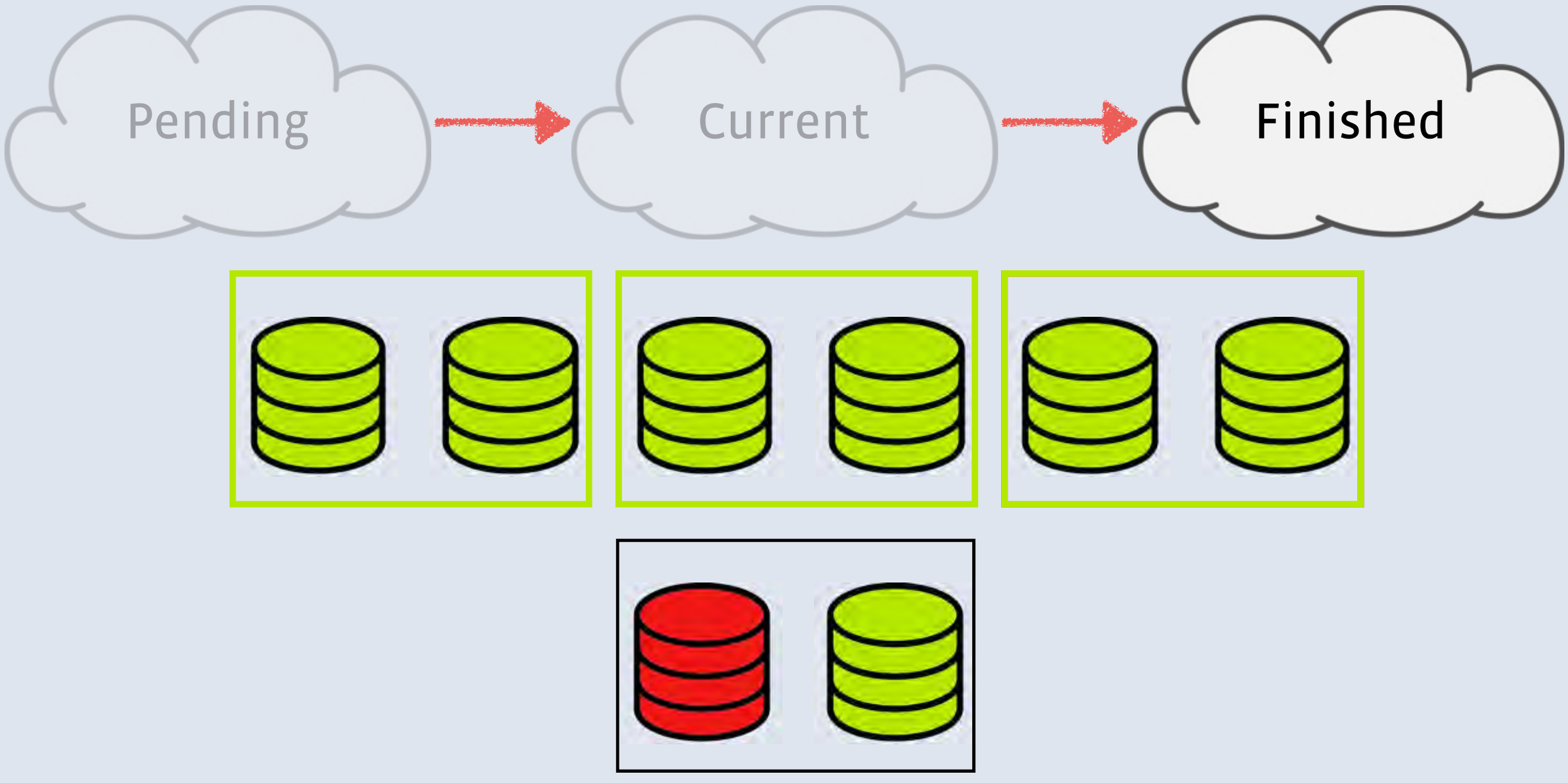
Alter-Level Coordination: Finished



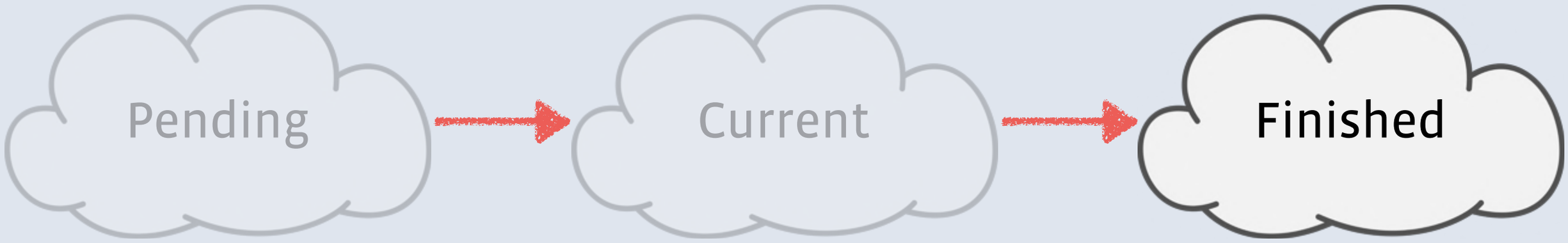
Automatic OSC

Alter-Level Coordination: Finished



Automatic OSC

Alter-Level Coordination: Finished

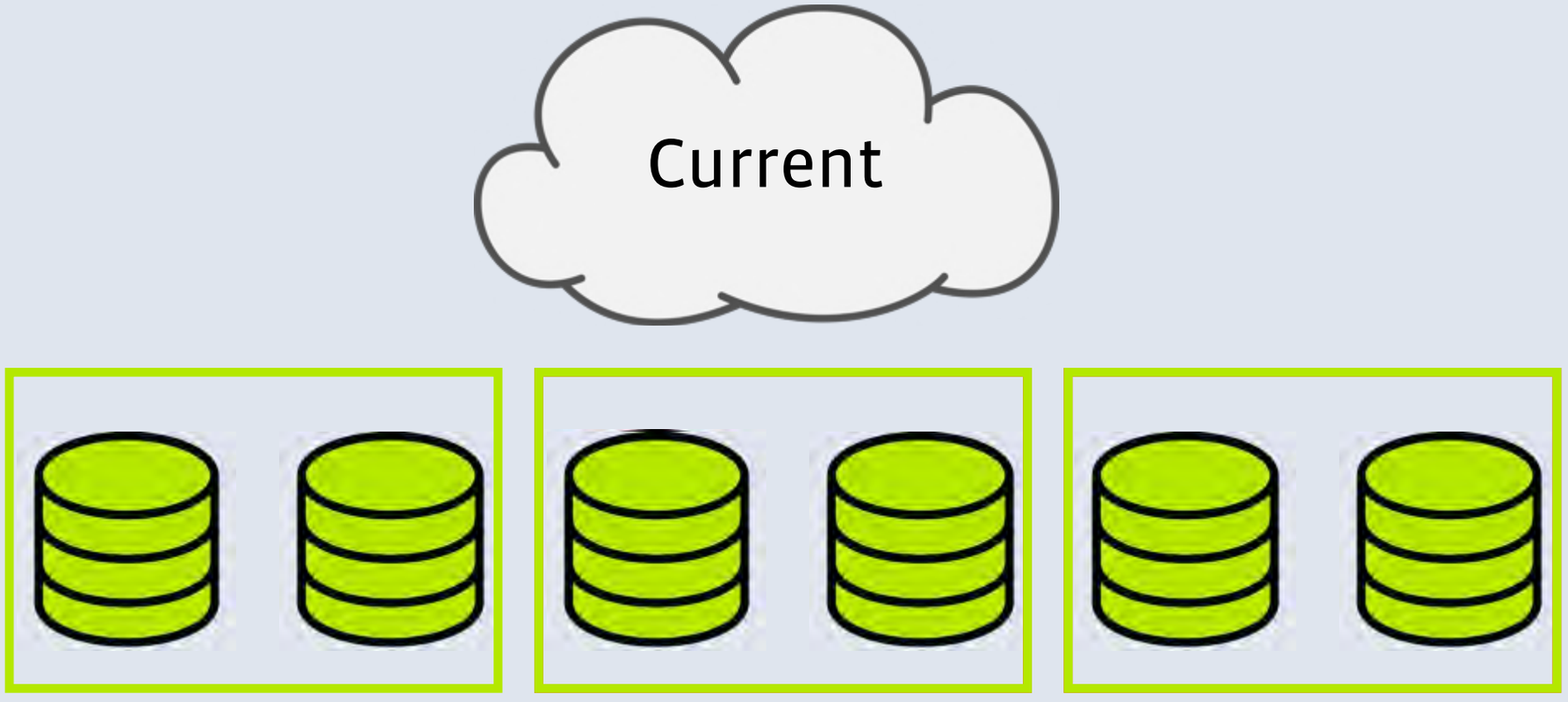


Automatic OSC

Alter-Level Coordination: Finished

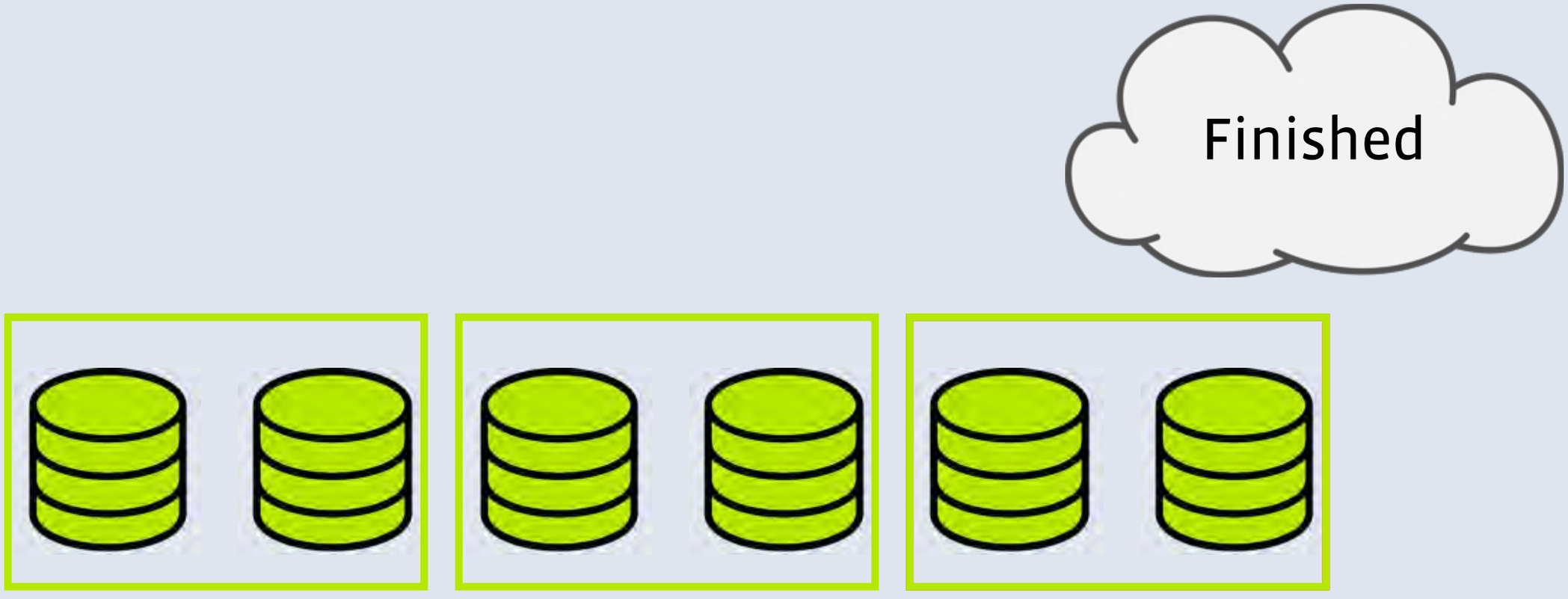
Automatic OSC

Alter-Level Coordination: Current



Automatic OSC

Alter-Level Coordination: Finished



Future Work

- Coordination between AOSC and code release system
- ETA based on regression formula

Q & A

https://github.com/facebookincubator/OnlineSchemaChange

facebook