Riak Tutorial

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Basho Technologies

What is Riak?

- Key-Value store (plus extras)

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- Distributed, horizontally scalable

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- Fault-tolerant

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- Built for the Web

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- Inspired by Amazon's Dynamo

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  - MapReduce
  - Links
  - Full-text search (new, optional)

Key-Value

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- Value is mostly opaque (some metadata)
- Extras
  - MapReduce
  - Links
  - Full-text search (new, optional)
  - Secondary Indexes

Distributed & Horizontally Scalable

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- Load and data are spread evenly
- Add more nodes to get more X

Fault-Tolerant

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  - network partitions

Fault-Tolerant

- All nodes participate equally - no SPOF
- All data is replicated
- Cluster transparently survives...
  - node failure
  - network partitions
- Built on Erlang/OTP (designed for FT)

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- Always accepts read and write requests
- Per-request quorums

Built for the Web

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- Does HTTP/REST well (see Webmachine)
- Plays well with HTTP infrastructure - reverse proxy caches, load balancers, web servers
- Suitable to many web applications

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- Masterless, peer-coordinated replication

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- Consistent hashing

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- Masterless, peer-coordinated replication
- Consistent hashing
- Eventually consistent
- Quorum reads and writes
- Anti-entropy: read repair, hinted handoff

Lab: Riak Basics

Installing Riak

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- Download from our local server

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- Download a package: http://downloads.basho.com/riak/CURRENT

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- Download from our local server
- Download a package: http://downloads.basho.com/riak/CURRENT
- Clone & build (need git and Erlang) :

```
$ git clone git://github.com/basho/riak.git
$ make all devrel
```

You need `curl`

```
apt-get install curl
yum install curl
```

Start the Cluster

Start the Cluster

```
$ surge-start.sh
```

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```
$ surge-start.sh
dev1/bin/riak start
dev2/bin/riak start
dev3/bin/riak start
dev4/bin/riak start
```

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```
$ surge-start.sh
dev1/bin/riak start
dev2/bin/riak start
dev3/bin/riak start
dev4/bin/riak start
dev2/bin/riak-admin join dev1
Sent join request to dev1
dev3/bin/riak-admin join dev1
Sent join request to dev1
dev4/bin/riak-admin join dev1
Sent join request to dev1
```

Check its status

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```
$ dev1/bin/riak-admin member_status

$ dev1/bin/riak-admin ring_status

$ dev1/bin/riak-admin status
```

PUT

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```
$ surge-put.sh
```

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```
$ surge-put.sh
Enter a key: your-key
```

PUT

```
$ surge-put.sh
Enter a key: your-key
Enter a value: your-value
```

PUT

```
$ surge-put.sh
Enter a key: your-key
Enter a value: your-value
Enter a write quorum value:
```

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$ surge-put.sh
Enter a key: your-key
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* About to connect() to 127.0.0.1 port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> PUT /riak/surge/your-key?returnbody=true&w=quorum HTTP/1.1
> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
> Content-Type: text/plain
> Content-Length: 10
>
```

PUT

```
$ surge-put.sh
Enter a key: your-key
Enter a value: your-value
Enter a write quorum value:

* About to connect() to 127.0.0.1 port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
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> Host: 127.0.0.1:8091
> Accept: */*
> Content-Type: text/plain
> Content-Length: 10
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1qb3LYEpkzGNleL/k23G+LAA=
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Date: Tue, 27 Sep 2011 19:21:08 GMT
< Content-Type: text/plain
< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```

GET

GET

```
$ surge-get.sh
```

GET

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$ surge-get.sh
Enter a key: your-key
```

GET

```
$ surge-get.sh
Enter a key: your-key
Enter a read quorum value (default: quorum):
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< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Last-Modified: Tue, 27 Sep 2011 19:01:45 GMT
< ETag: "51h3q7RjTNaHWYpO4P0MJj"
< Date: Tue, 27 Sep 2011 19:31:01 GMT
< Content-Type: text/plain
< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```

GET

```
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Enter a key: your-key
Enter a read quorum value (default: quorum):

* About to connect() to 127.0.0.1 port 8091 (#0)
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* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> GET /riak/surge/your-key?r=quorum HTTP/1.1
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< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```

vector clock

GET

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Enter a key: your-key
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> Accept: */*
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1qb3LYEpkzGNleL/k23G+LAA=
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Last-Modified: Tue, 27 Sep 2011 19:01:45 GMT
< ETag: "51h3q7RjTNaHWYpO4P0MJj"
< Date: Tue, 27 Sep 2011 19:31:01 GMT
< Content-Type: text/plain
< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```

caching headers

GET

```
$ surge-get.sh
Enter a key: your-key
Enter a read quorum value (default: quorum):

* About to connect() to 127.0.0.1 port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> GET /riak/surge/your-key?r=quorum HTTP/1.1
> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1qb3LYEpkzGNleL/k23G+LAA=
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Last-Modified: Tue, 27 Sep 2011 19:01:45 GMT
< ETag: "51h3q7RjTNaHWYpO4P0MJj"
< Date: Tue, 27 Sep 2011 19:31:01 GMT
< Content-Type: text/plain
< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```

content-type

DELETE

DELETE

```
$ surge-delete.sh
```

DELETE

```
$ surge-delete.sh
Type a key: your-key
```

DELETE

```
$ surge-delete.sh
Type a key: your-key

* About to connect() to 127.0.0.1 port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> DELETE /riak/surge/your-key HTTP/1.1
> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
>
```

DELETE

```
$ surge-delete.sh
Type a key: your-key

* About to connect() to 127.0.0.1 port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> DELETE /riak/surge/your-key HTTP/1.1
> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r 
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
>
< HTTP/1.1 204 No Content
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Date: Tue, 27 Sep 2011 19:33:59 GMT
< Content-Type: text/plain
< Content-Length: 0
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
```

Kill two nodes

Kill two nodes

```
$ dev4/bin/riak stop
```

Kill two nodes

```
$ dev4/bin/riak stop
ok
```

Kill two nodes

```
$ dev4/bin/riak stop
ok

$ dev3/bin/riak stop
```

Kill two nodes

```
$ dev4/bin/riak stop
ok

$ dev3/bin/riak stop
ok
```

Try GETting your key

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```
$ . ~/Desktop/surge/surge-get.sh
```

Try GETting your key

```
$ . ~/Desktop/surge/surge-get.sh
Enter a key: your-key
```

Try GETting your key

```
$ . ~/Desktop/surge/surge-get.sh
Enter a key: your-key
Enter a read quorum value (default: quorum):
```

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* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
> GET /riak/surge/your-key?r=quorum HTTP/1.1
> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
>
```

Try GETting your key

```
$ . ~/Desktop/surge/surge-get.sh
Enter a key: your-key
Enter a read quorum value (default: quorum):

* About to connect() to 127.0.0.1 port 8091 (#0)
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* Connected to 127.0.0.1 (127.0.0.1) port 8091 (#0)
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> User-Agent: curl/7.21.4 (universal-apple-darwin11.0) libcurl/7.21.4 OpenSSL/0.9.8r
zlib/1.2.5
> Host: 127.0.0.1:8091
> Accept: */*
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1qb3LYEpkzGNleL/k23G+LAA=
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Last-Modified: Tue, 27 Sep 2011 19:50:07 GMT
< ETag: "51h3q7RjTNaHWYpO4P0MJj"
< Date: Tue, 27 Sep 2011 19:51:10 GMT
< Content-Type: text/plain
< Content-Length: 10
<
* Connection #0 to host 127.0.0.1 left intact
* Closing connection #0
your-value
```
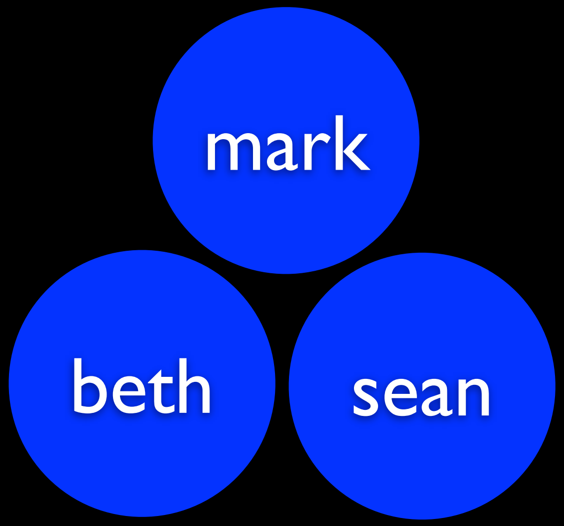

Riak Architecture

Key-Value Data Model

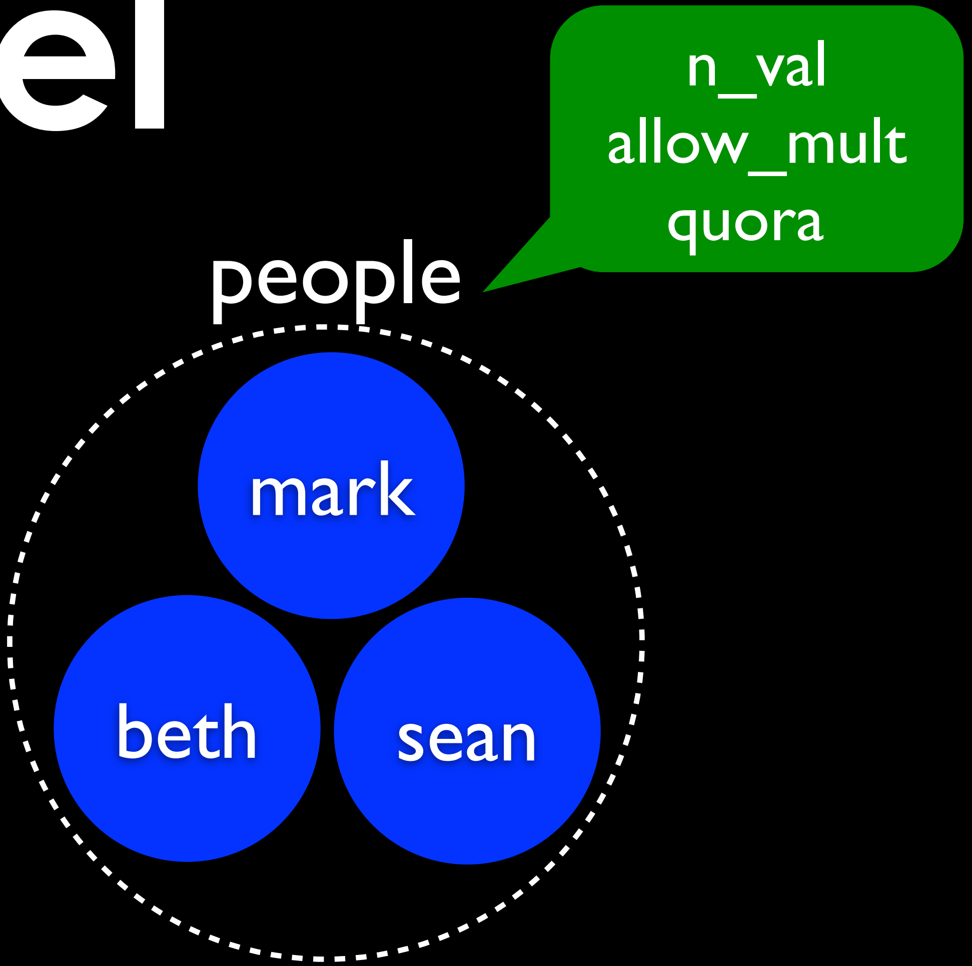
Key-Value Data Model

- All data (objects) are referenced by keys



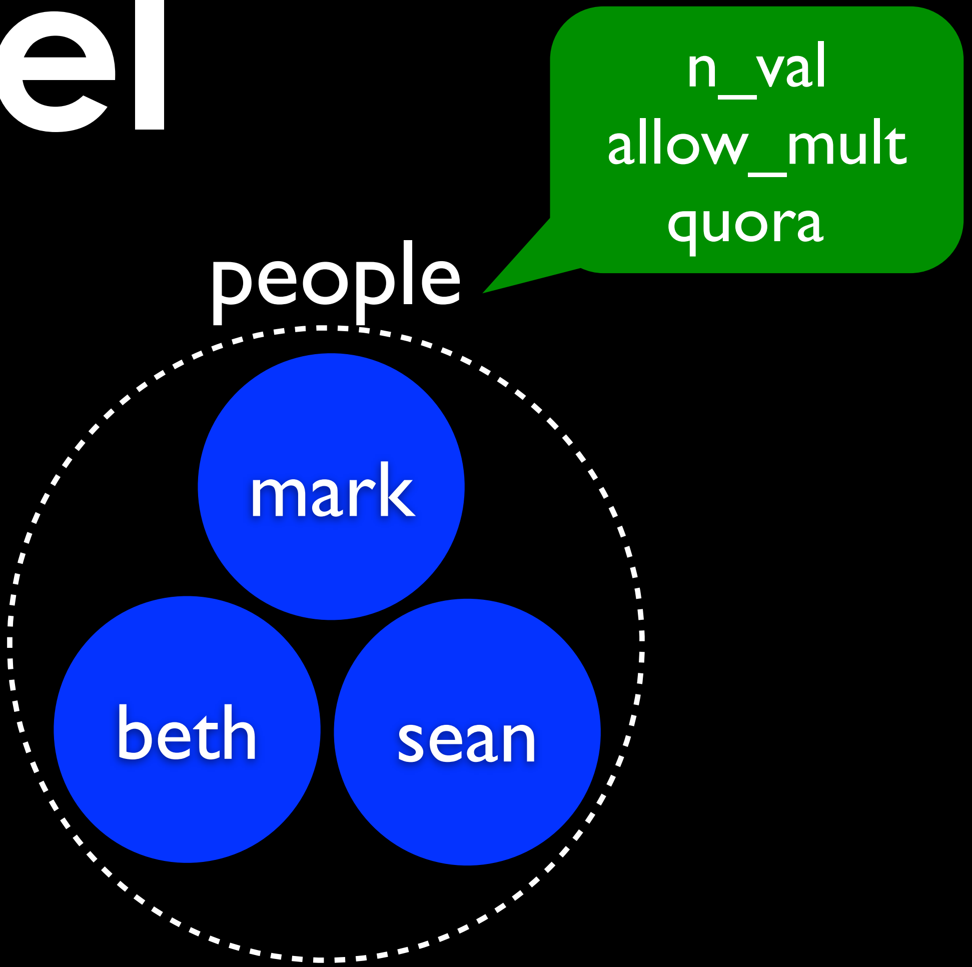
Key-Value Data Model

- All data (objects) are referenced by keys
- Keys are grouped into buckets



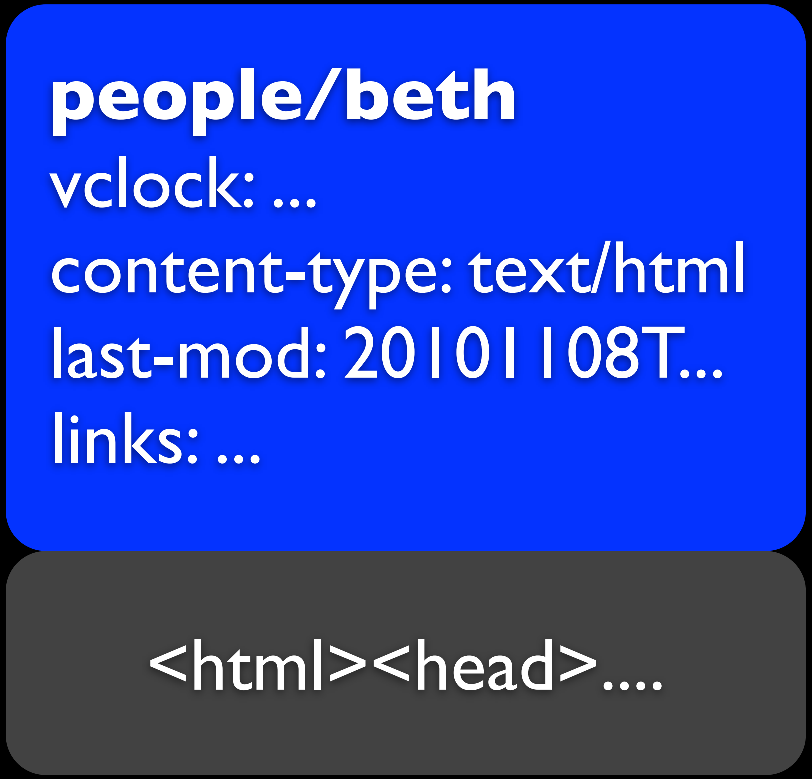
Key-Value Data Model

- All data (objects) are referenced by keys
- Keys are grouped into buckets
- Simple operations: get, put, delete



Key-Value Data Model

- All data (objects) are referenced by keys
- Keys are grouped into buckets
- Simple operations: get, put, delete
- Object is composed of metadata and value



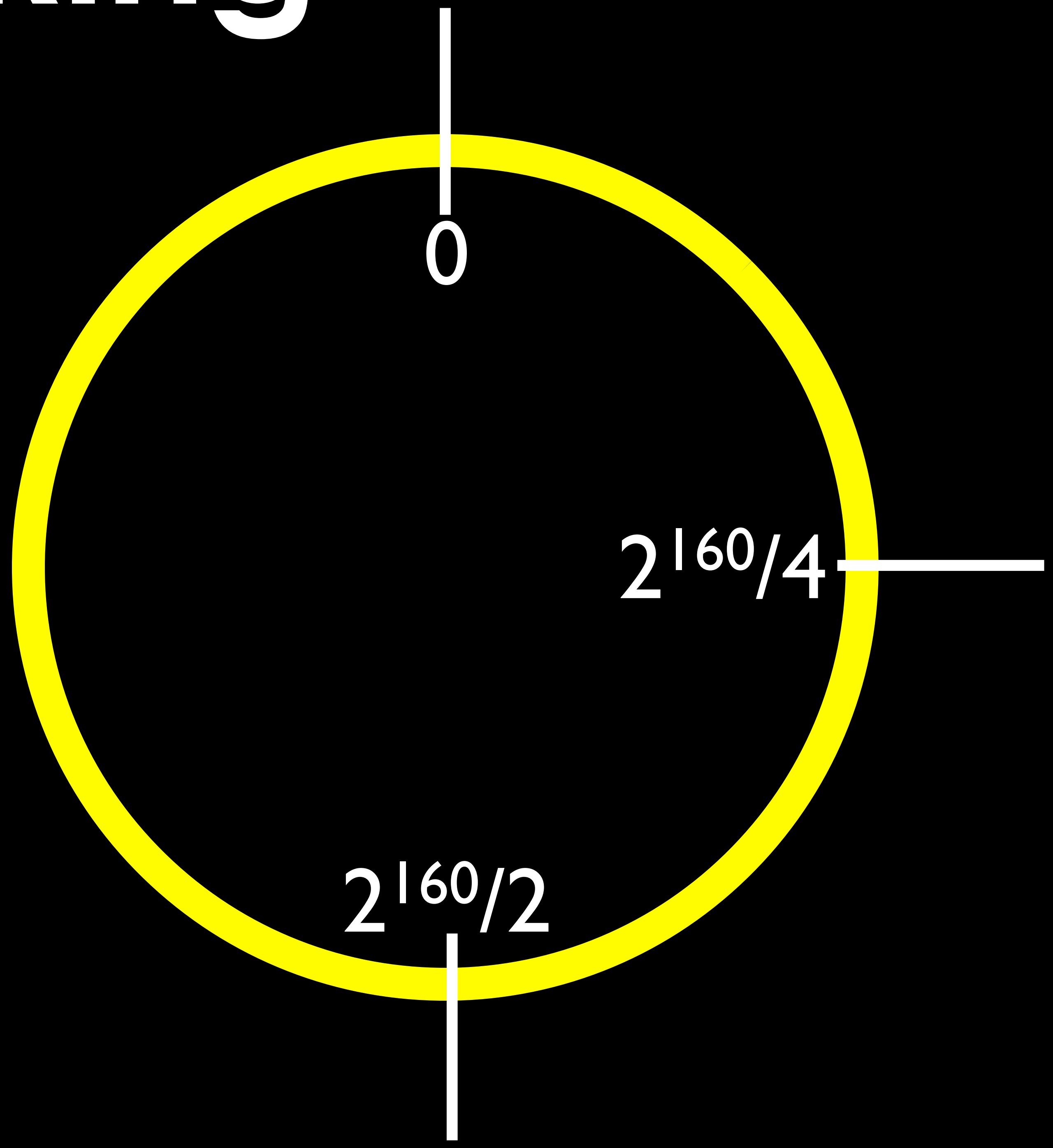
people/beth
vclock: ...
content-type: text/html
last-mod: 20101108T...
links: ...

<html><head>....

Consistent Hashing & The Ring

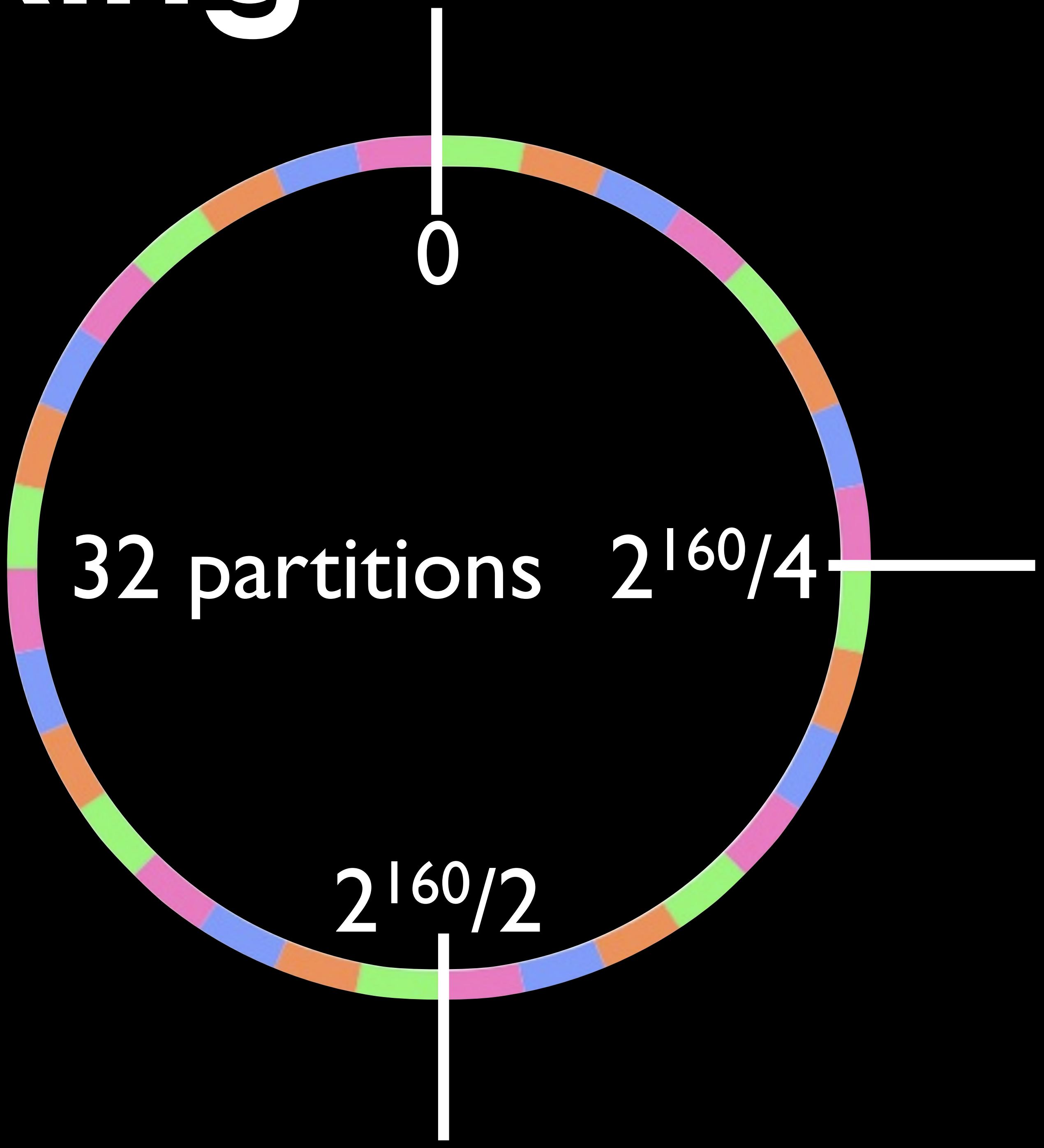
Consistent Hashing & The Ring

- 160-bit integer keyspace



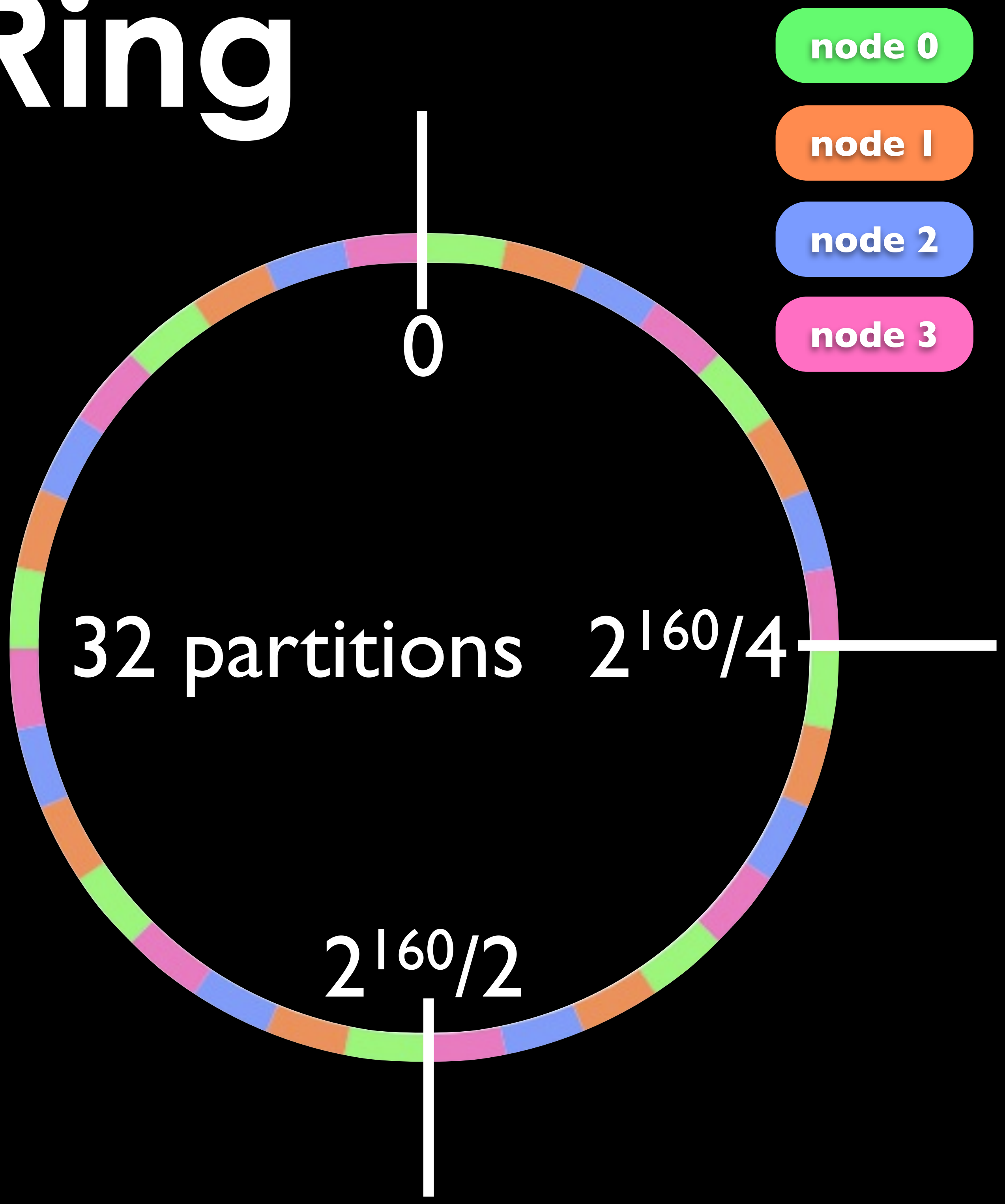
Consistent Hashing & The Ring

- 160-bit integer keyspace
- Divided into fixed number of evenly-sized partitions



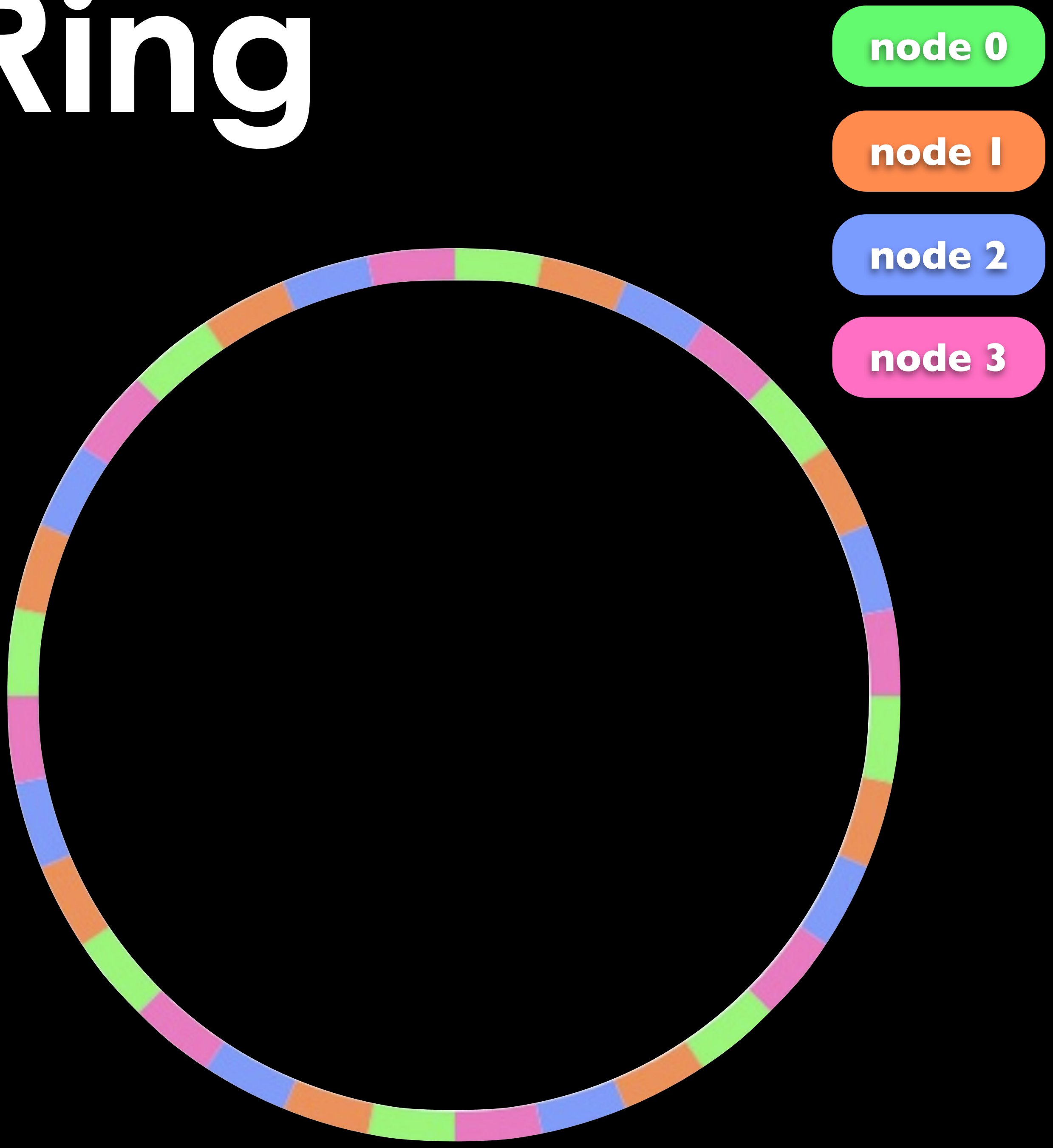
Consistent Hashing & The Ring

- 160-bit integer keyspace
- Divided into fixed number of evenly-sized partitions
- Partitions are claimed by nodes in the cluster



Consistent Hashing & The Ring

- 160-bit integer keyspace
- Divided into fixed number of evenly-sized partitions
- Partitions are claimed by nodes in the cluster
- Replicas go to the N partitions following the key



Consistent Hashing & The Ring

- 160-bit integer keyspace
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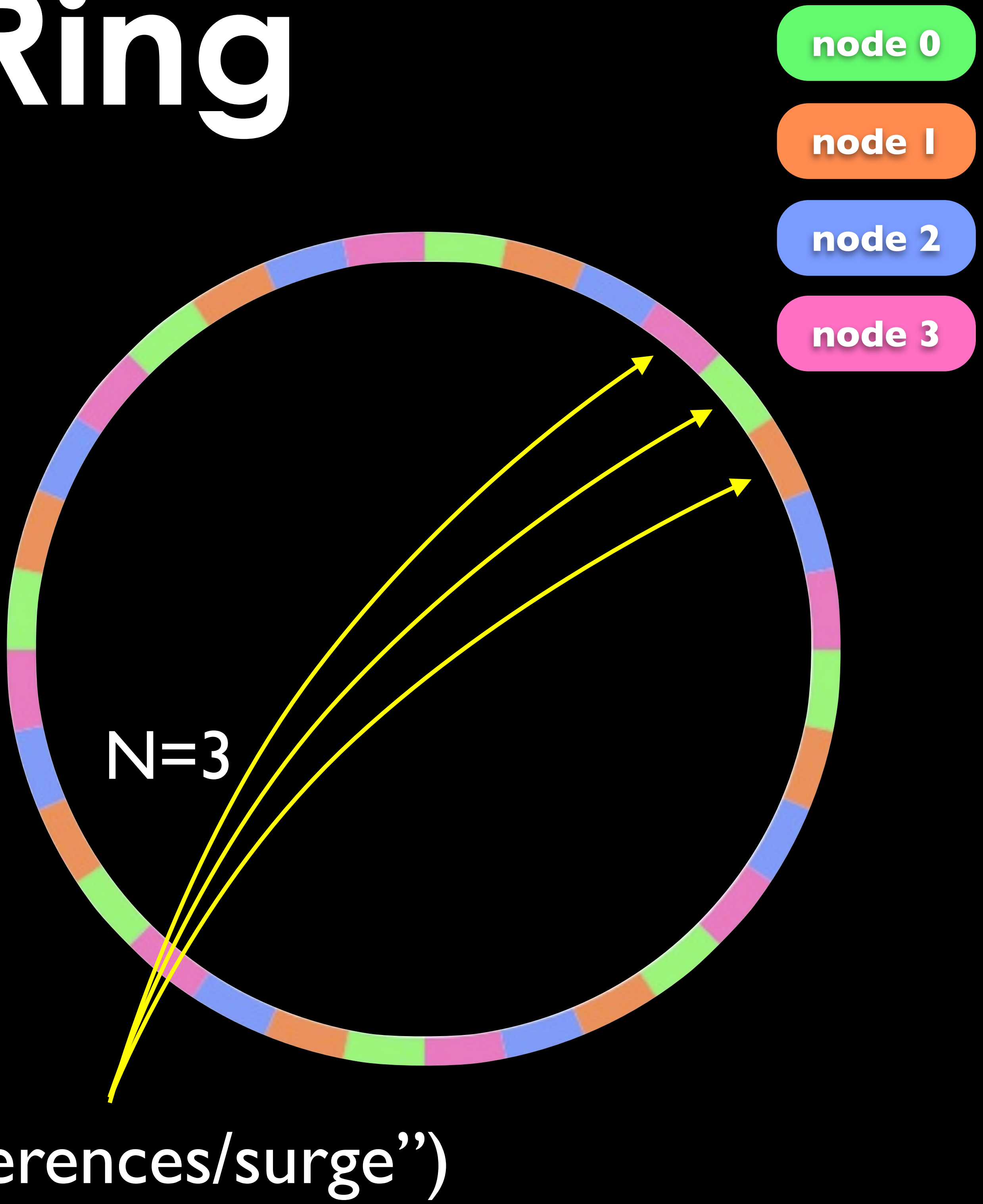

Request Quorums

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- Every request contacts all replicas of key

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- N - number of replicas (default 3)

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Request Quorums

- Every request contacts all replicas of key
- N - number of replicas (default 3)
- R - read quorum
- W - write quorum

Vector Clocks

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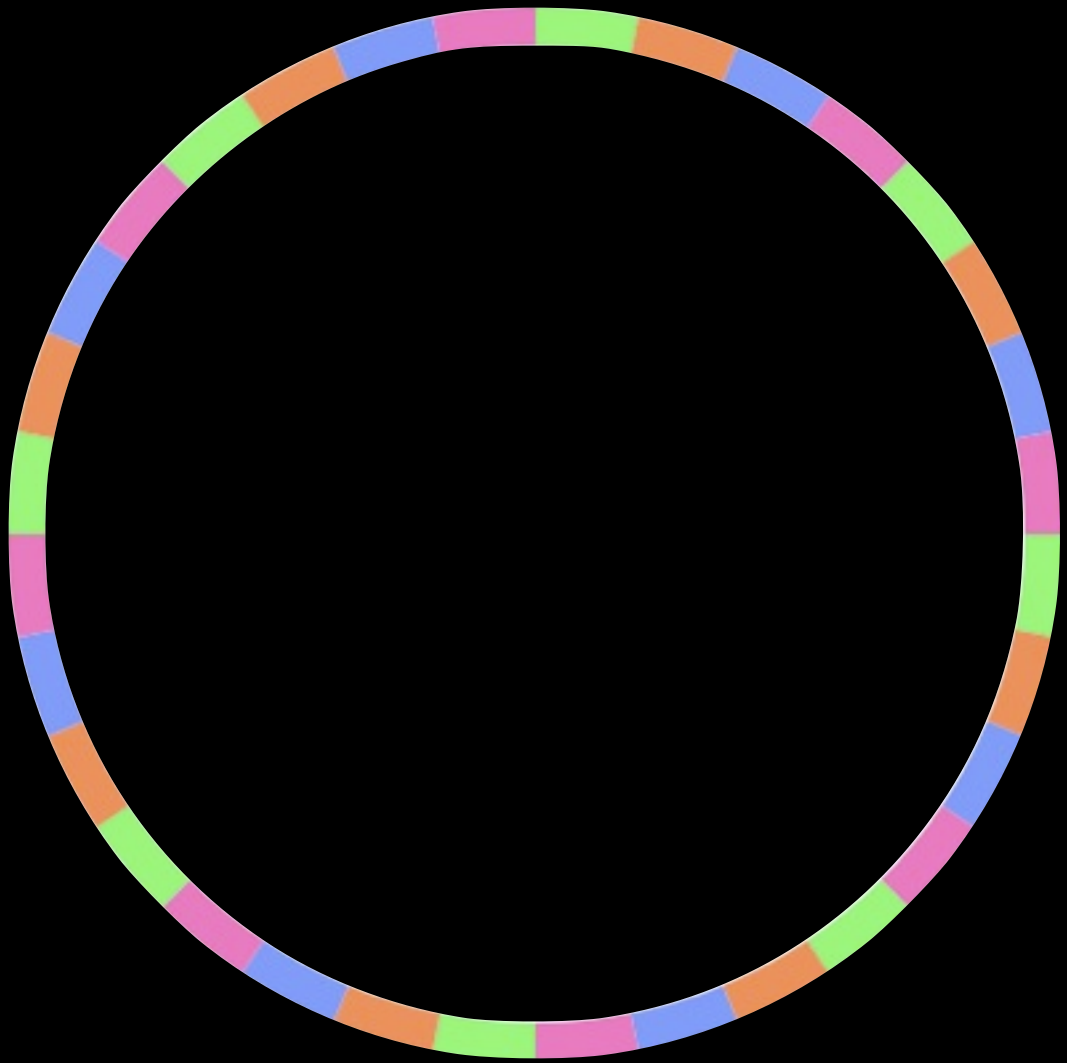
- Riak tracks history of updates
  - Auto-resolves stale versions
  - Lets you decide conflicts

Vector Clocks

http://blog.basho.com/2010/01/29/why-vector-clocks-are-easy/

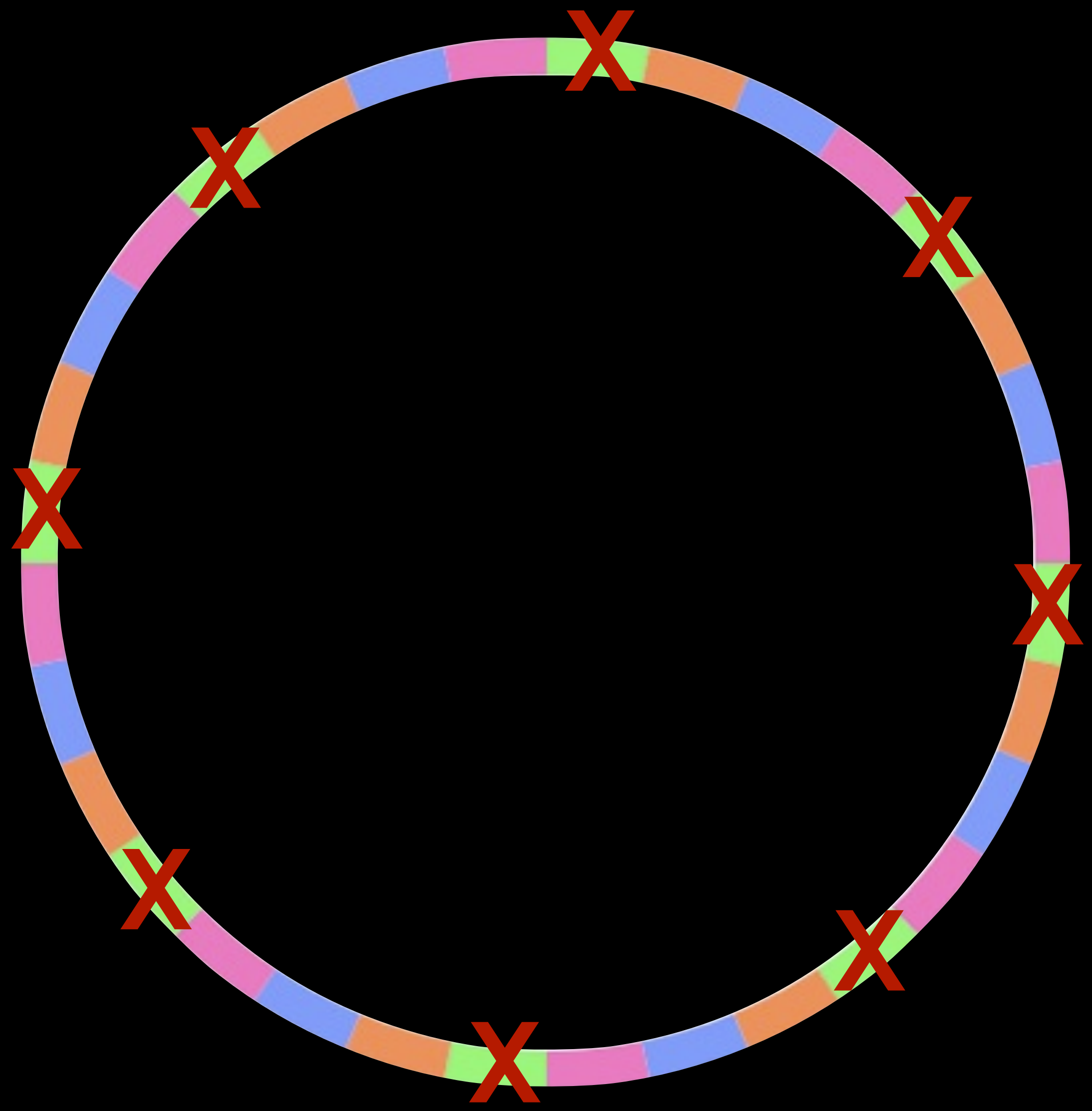
- Every node has an ID *(changed in 1.0)*
- Send last-seen vector clock in every "put" or "delete" request
- Riak tracks history of updates
  - Auto-resolves stale versions
  - Lets you decide conflicts

Hinted Handoff



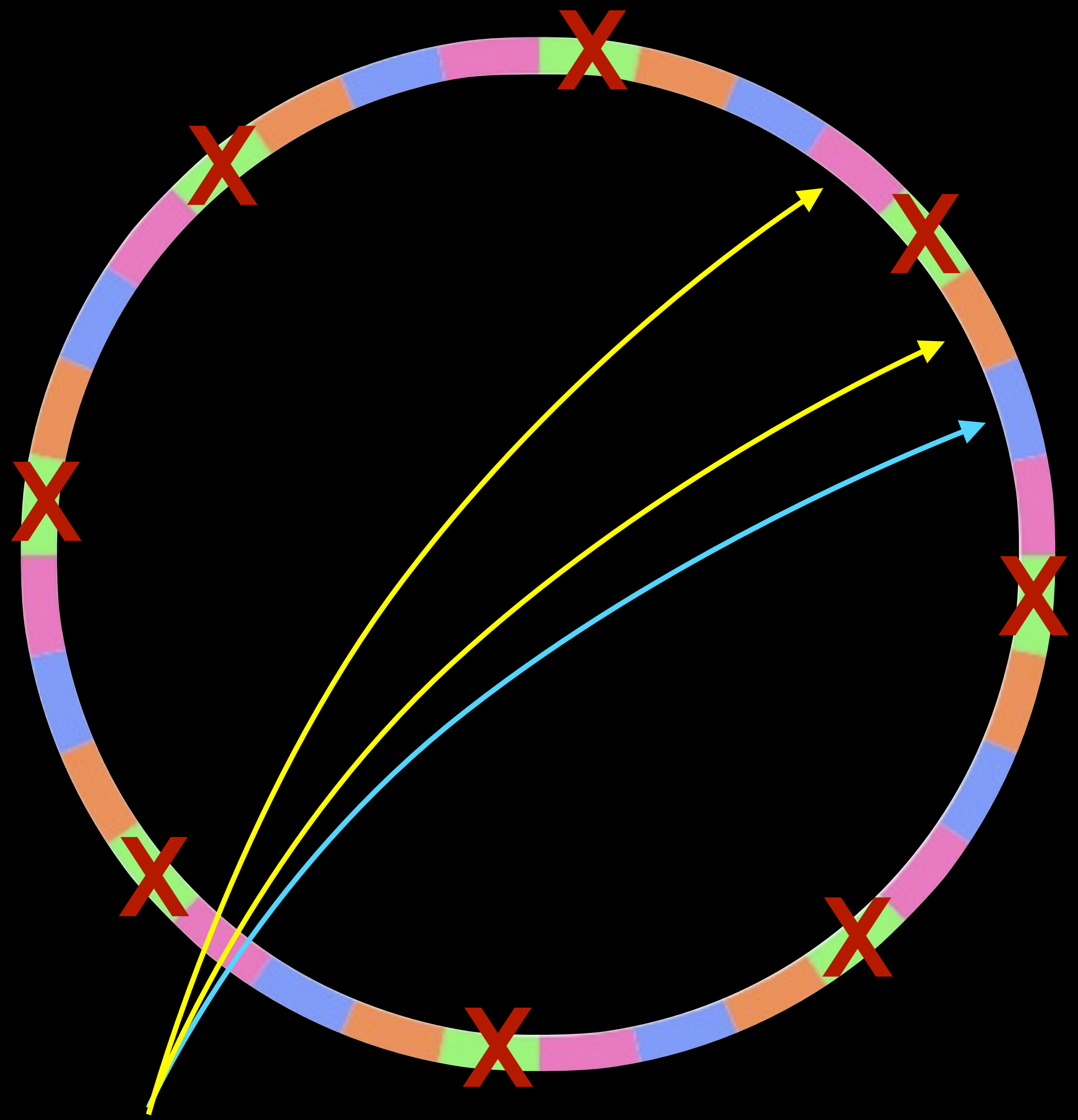
Hinted Handoff

- Node fails



Hinted Handoff

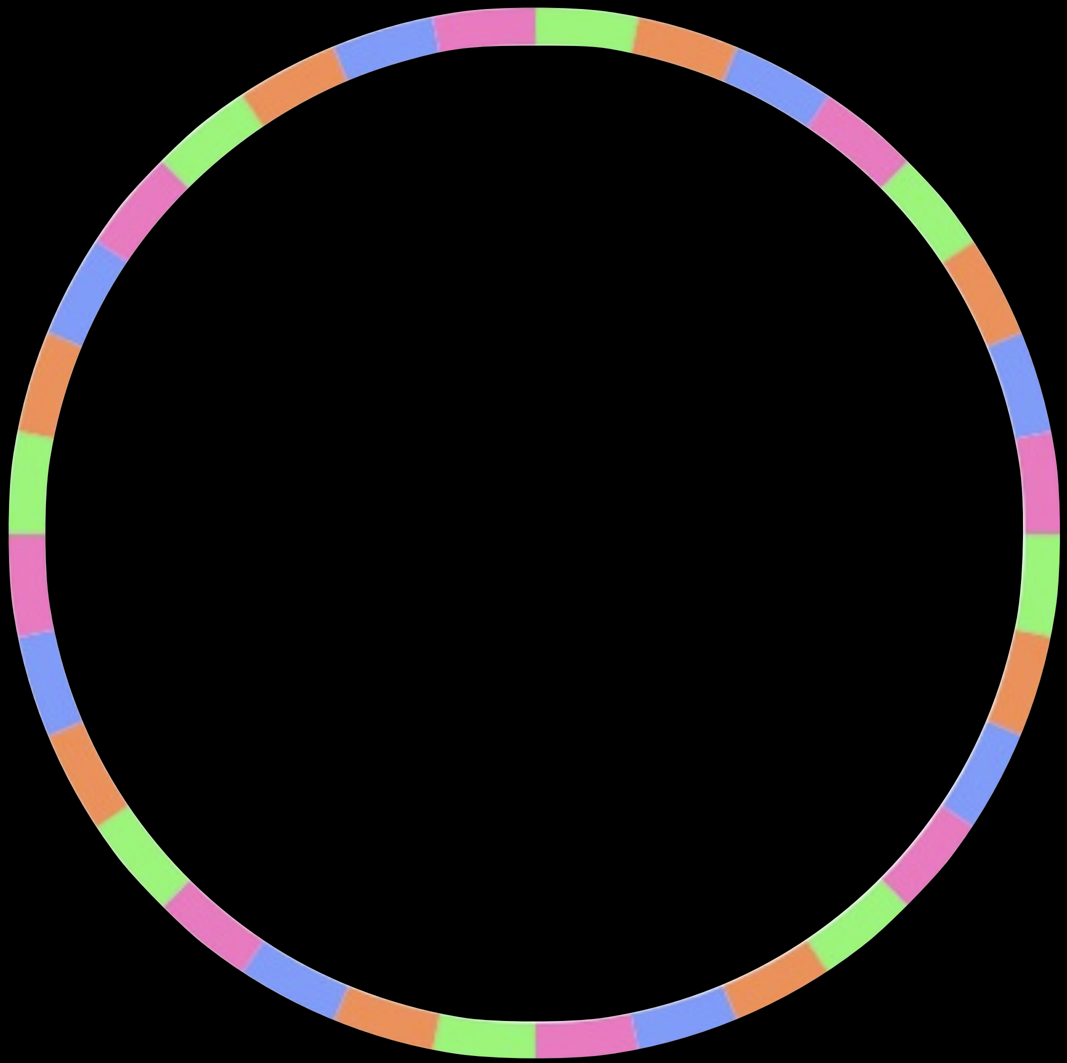
- Node fails
- Requests go to fallback



hash("conferences/surge")

Hinted Handoff

- Node fails
- Requests go to fallback
- Node comes back



hash("conferences/surge")

Hinted Handoff

- Node fails
- Requests go to fallback
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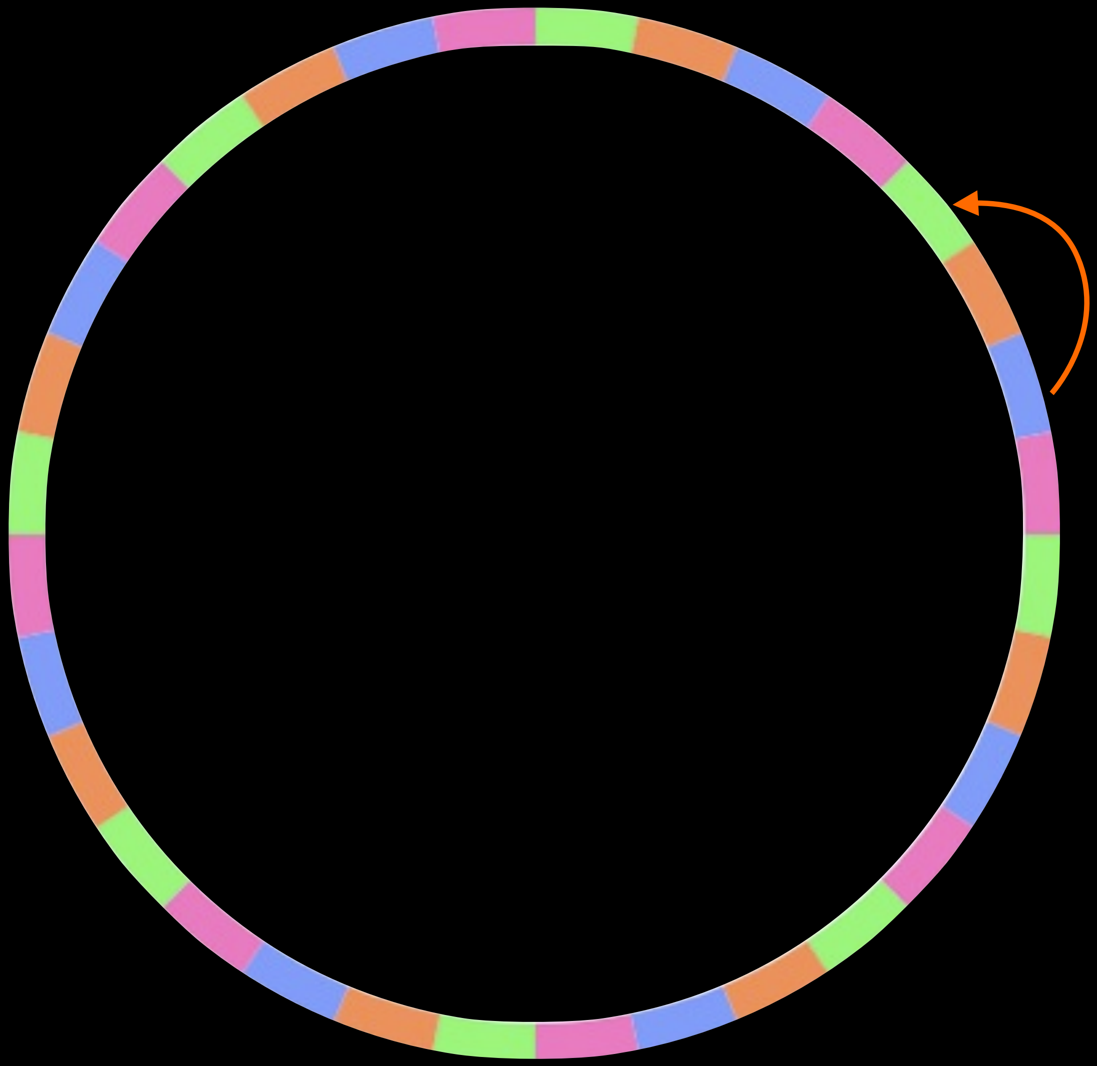
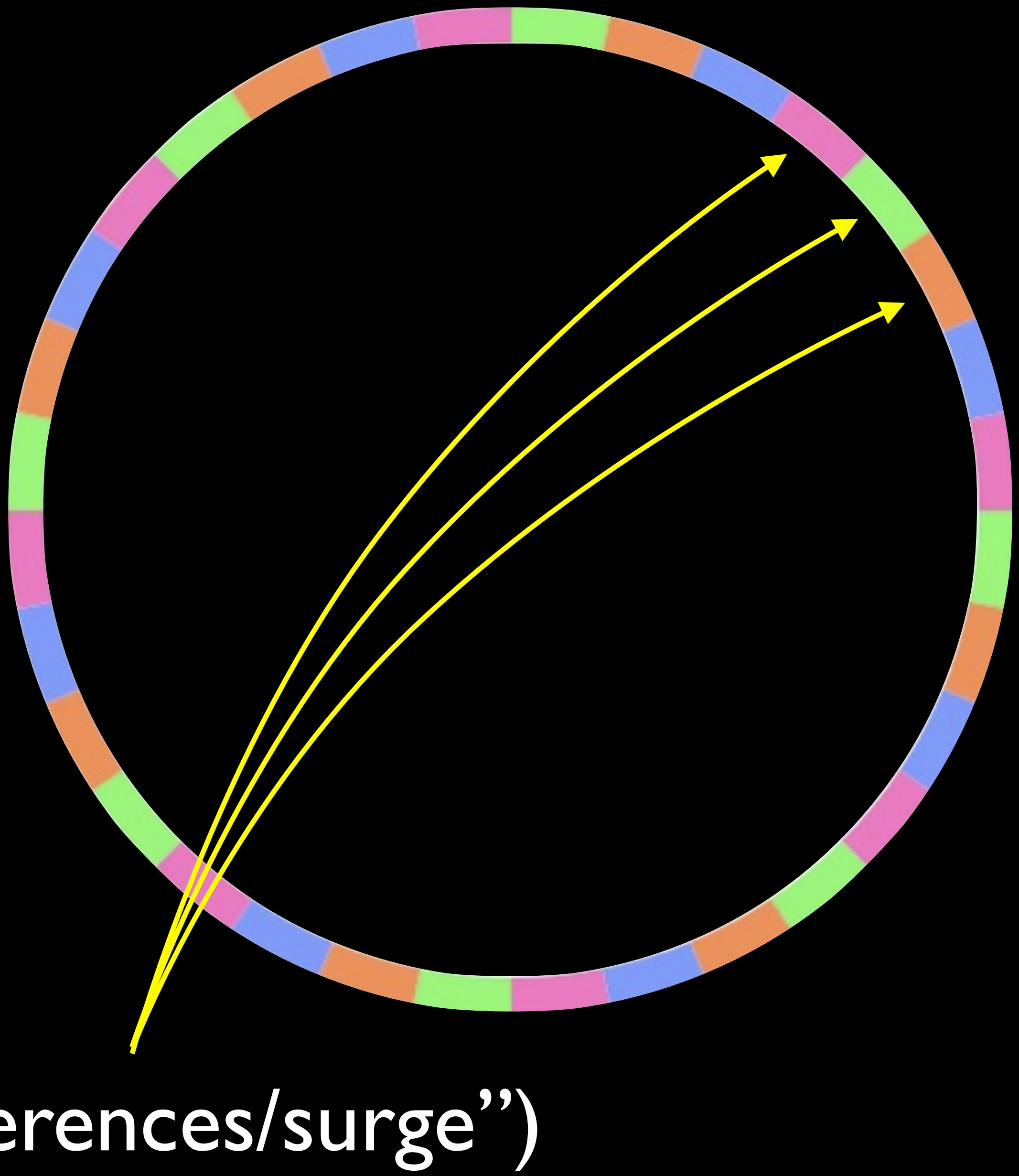
- "Handoff" - data returns to recovered node



hash("conferences/surge")

Hinted Handoff

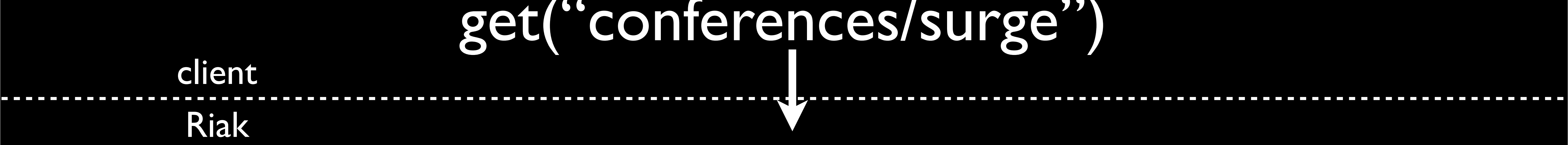
- Node fails
- Requests go to fallback
- Node comes back
- "Handoff" - data returns to recovered node
- Normal operations resume



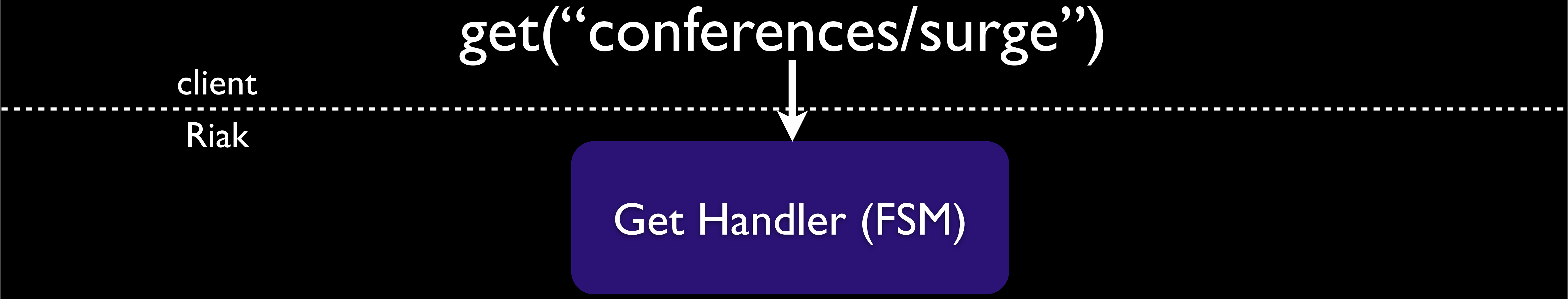
Anatomy of a Request

get(“conferences/surge”)

Anatomy of a Request



Anatomy of a Request



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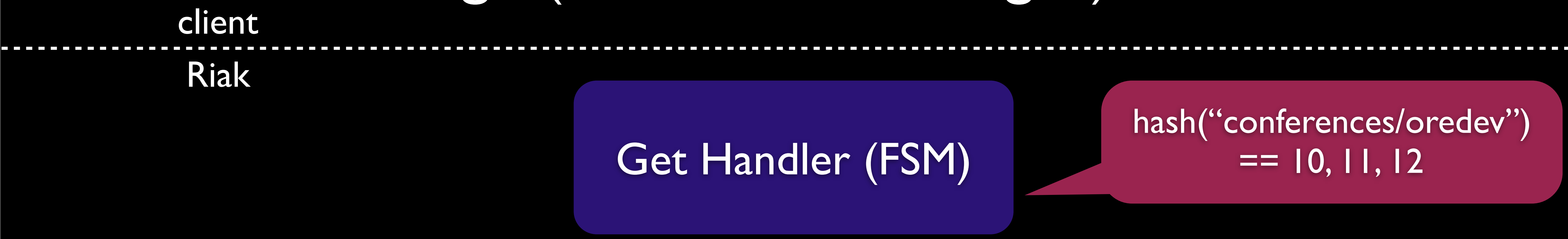

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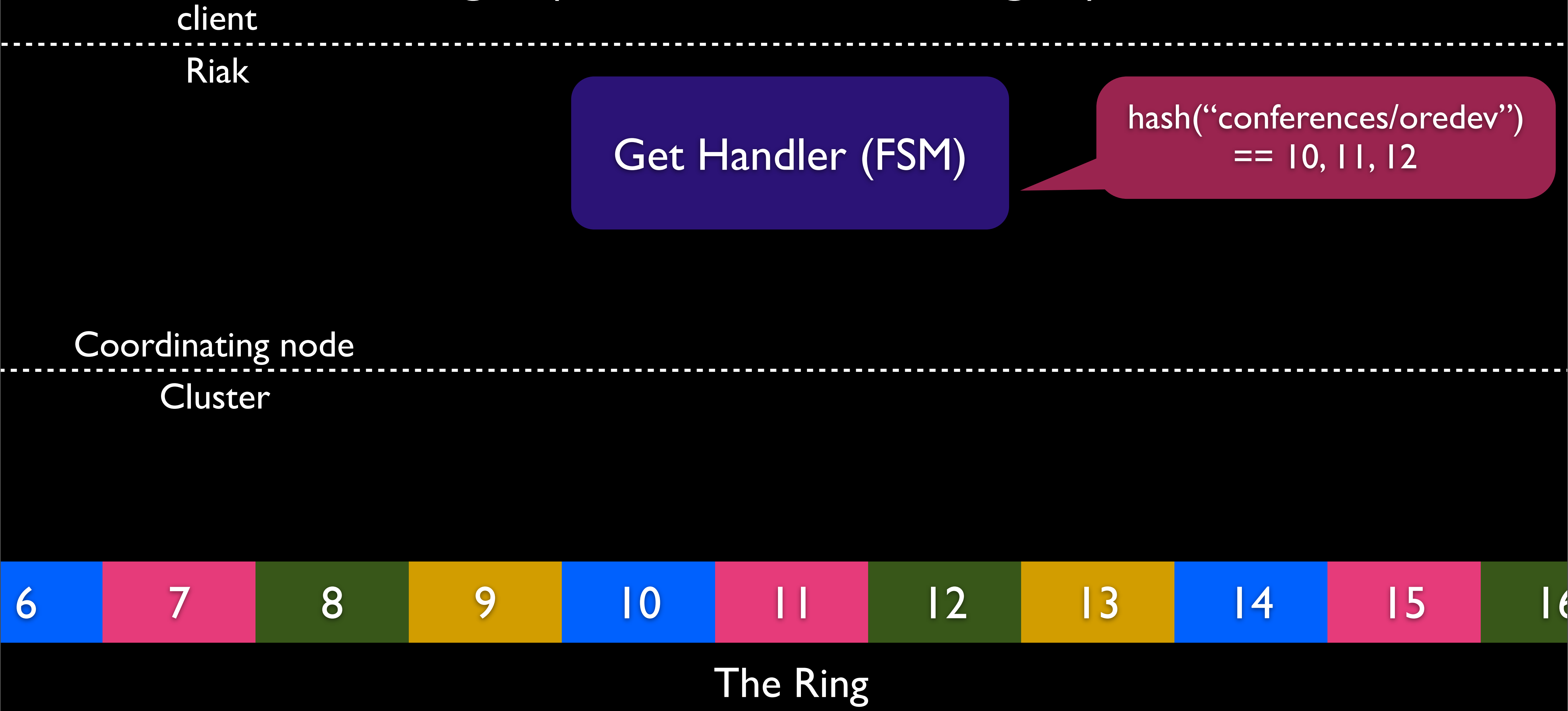

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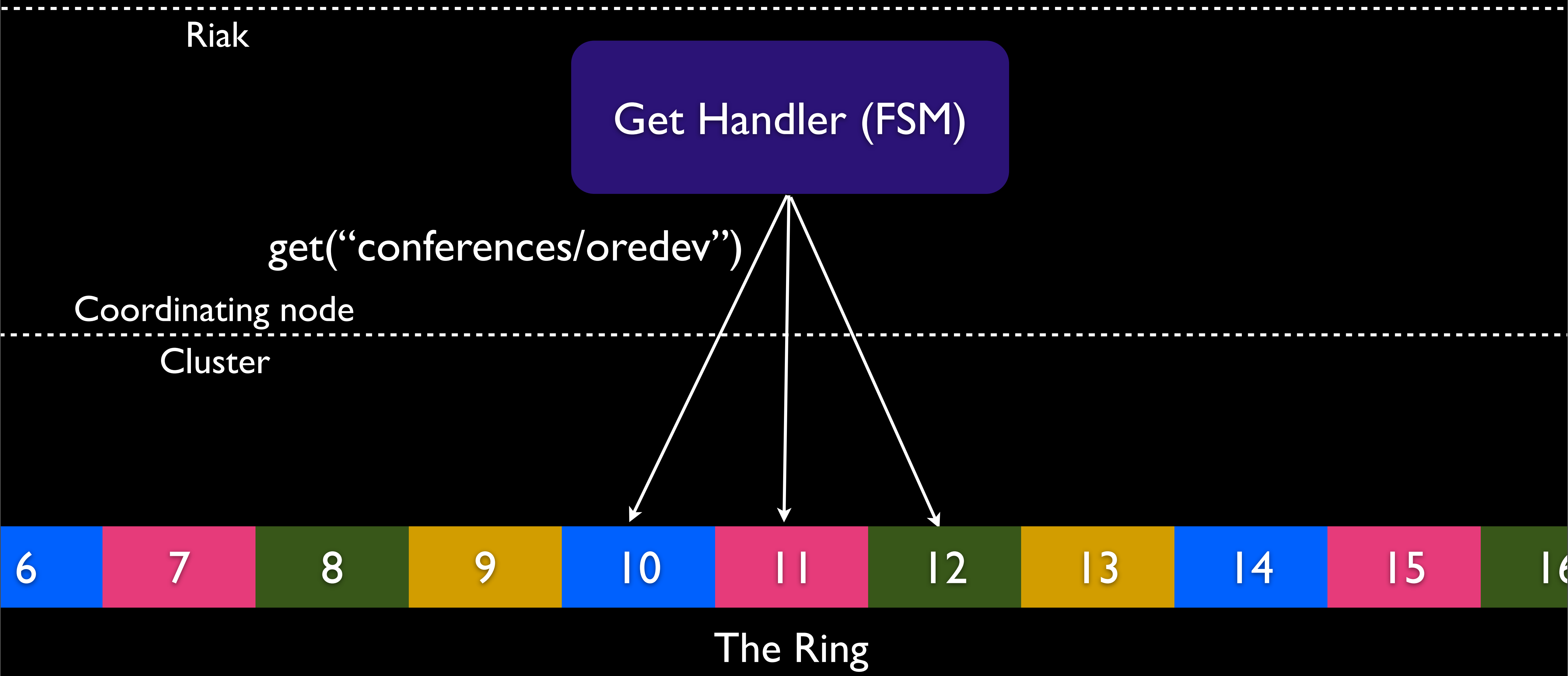

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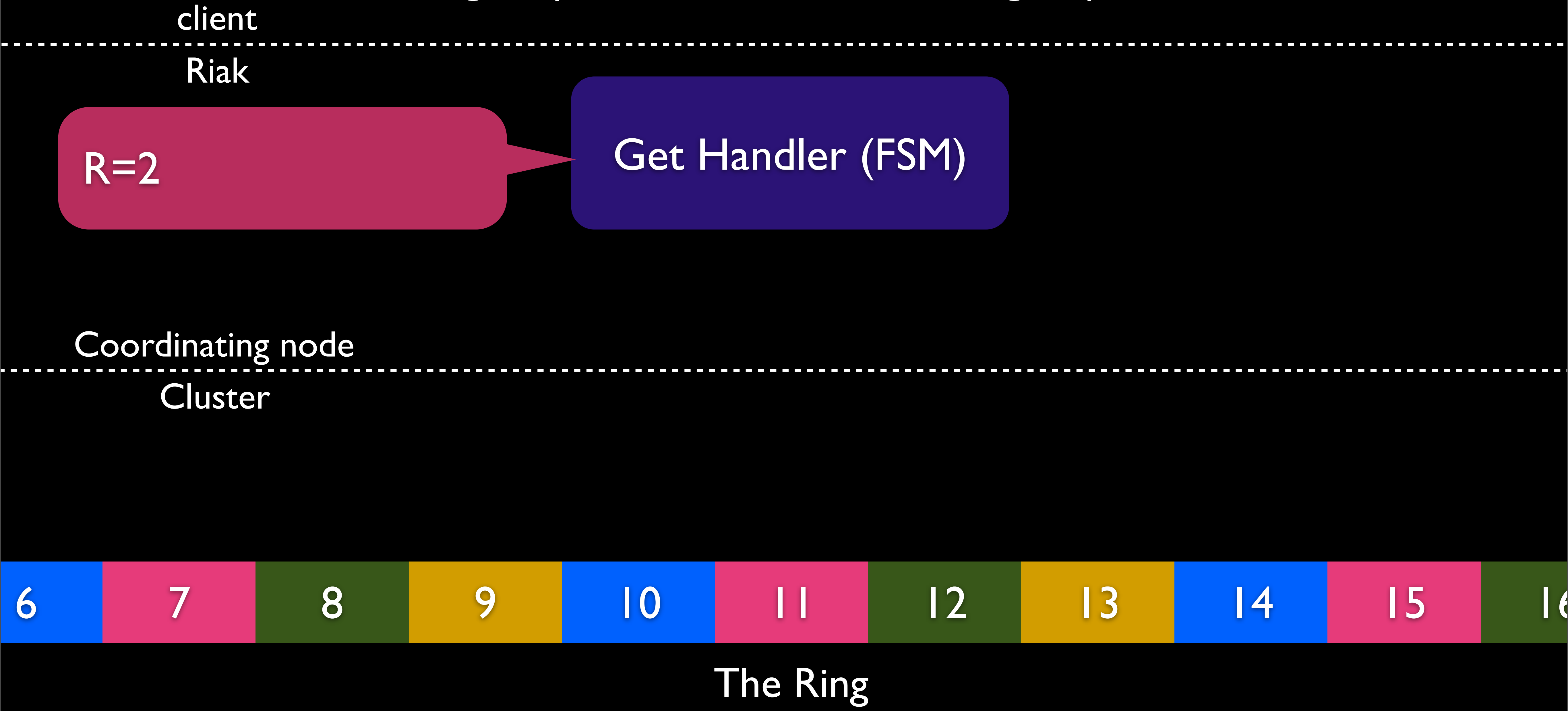

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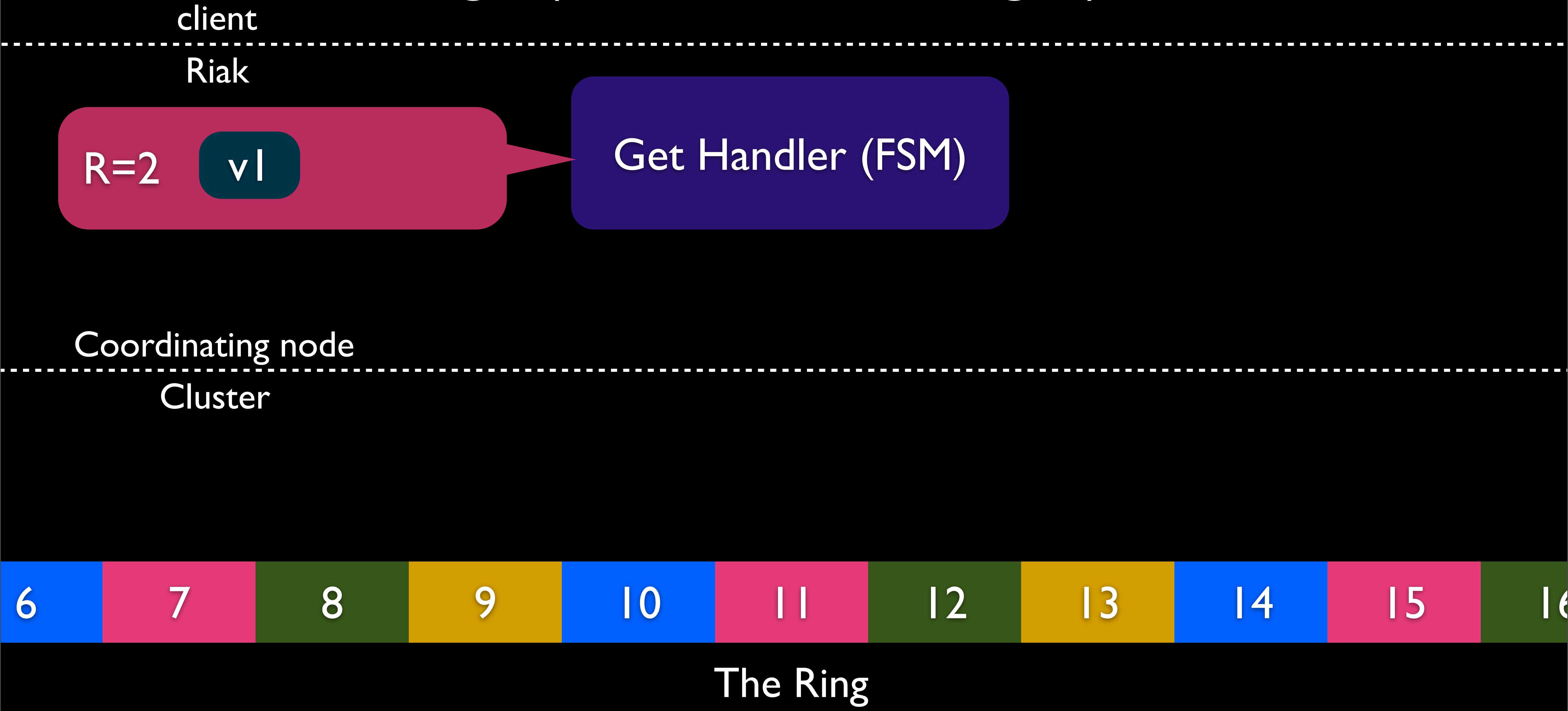

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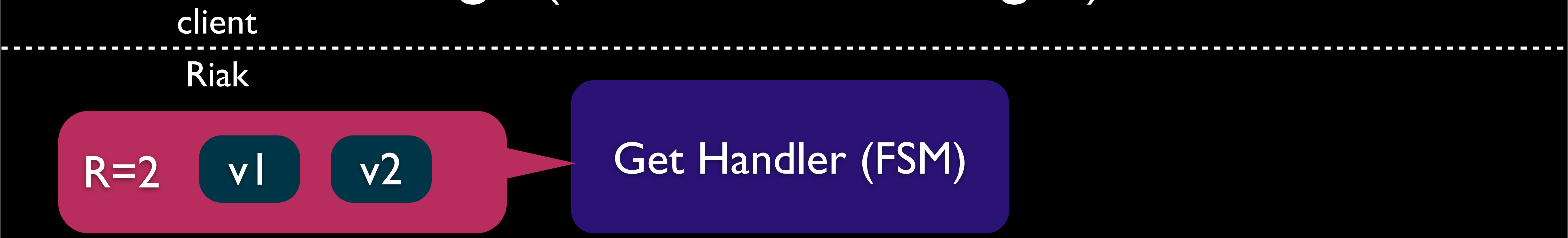

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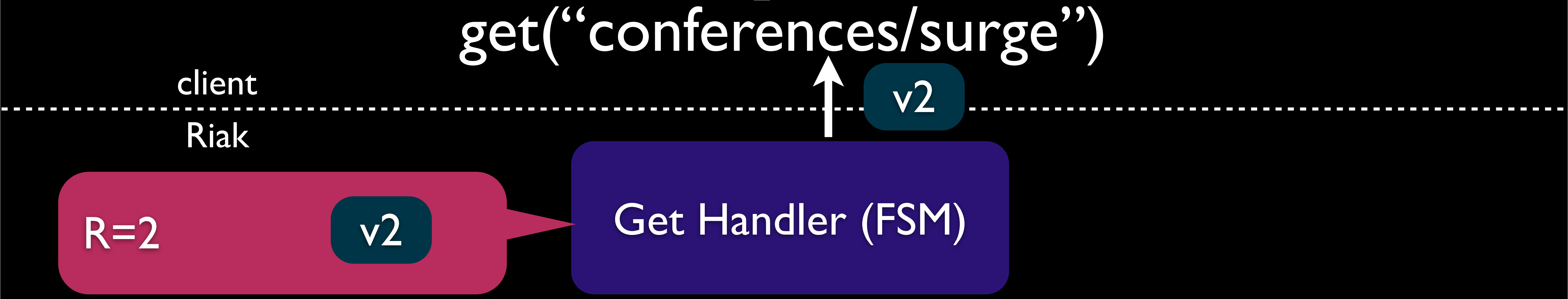
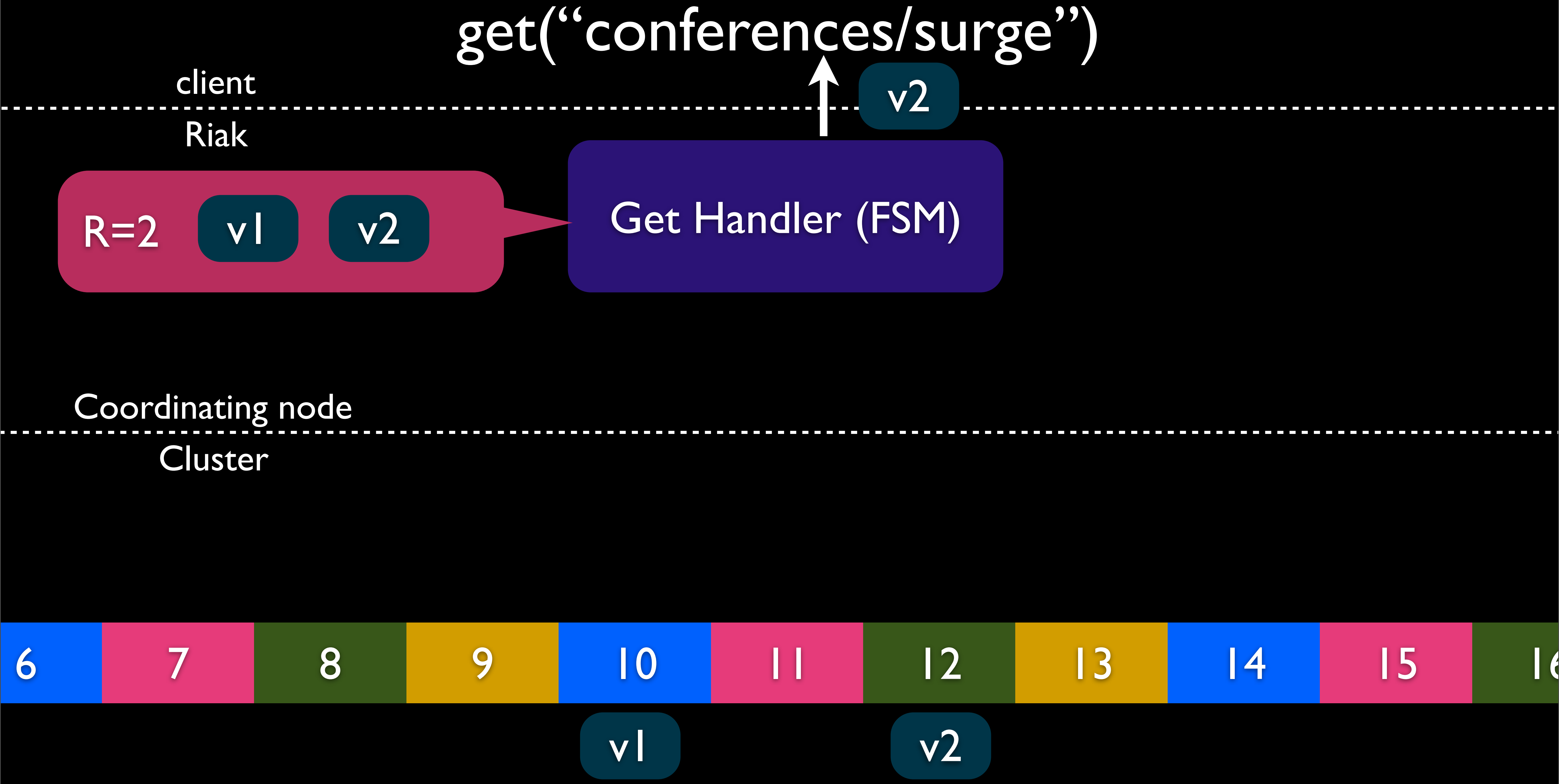


Anatomy of a Request

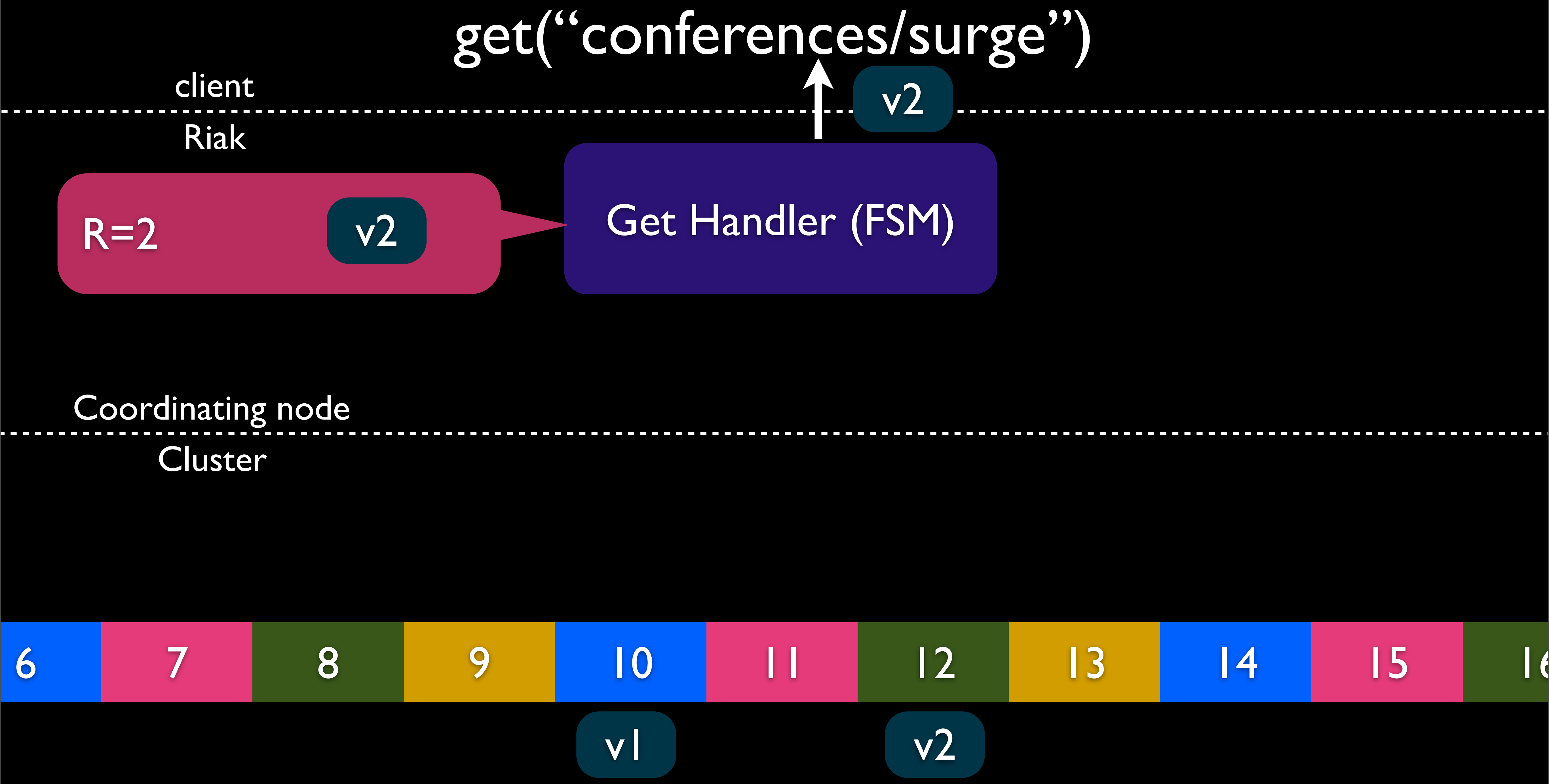
get("conferences/surge")

v2

Read Repair


get("conferences/surge")
client
Riak
v2
R=2
v1
v2
Get Handler (FSM)
Coordinating node
Cluster
6
7
8
9
10
11
12
13
14
15
16
v1
v2

Read Repair


get("conferences/surge")
client
Riak
v2
R=2
v2
Get Handler (FSM)
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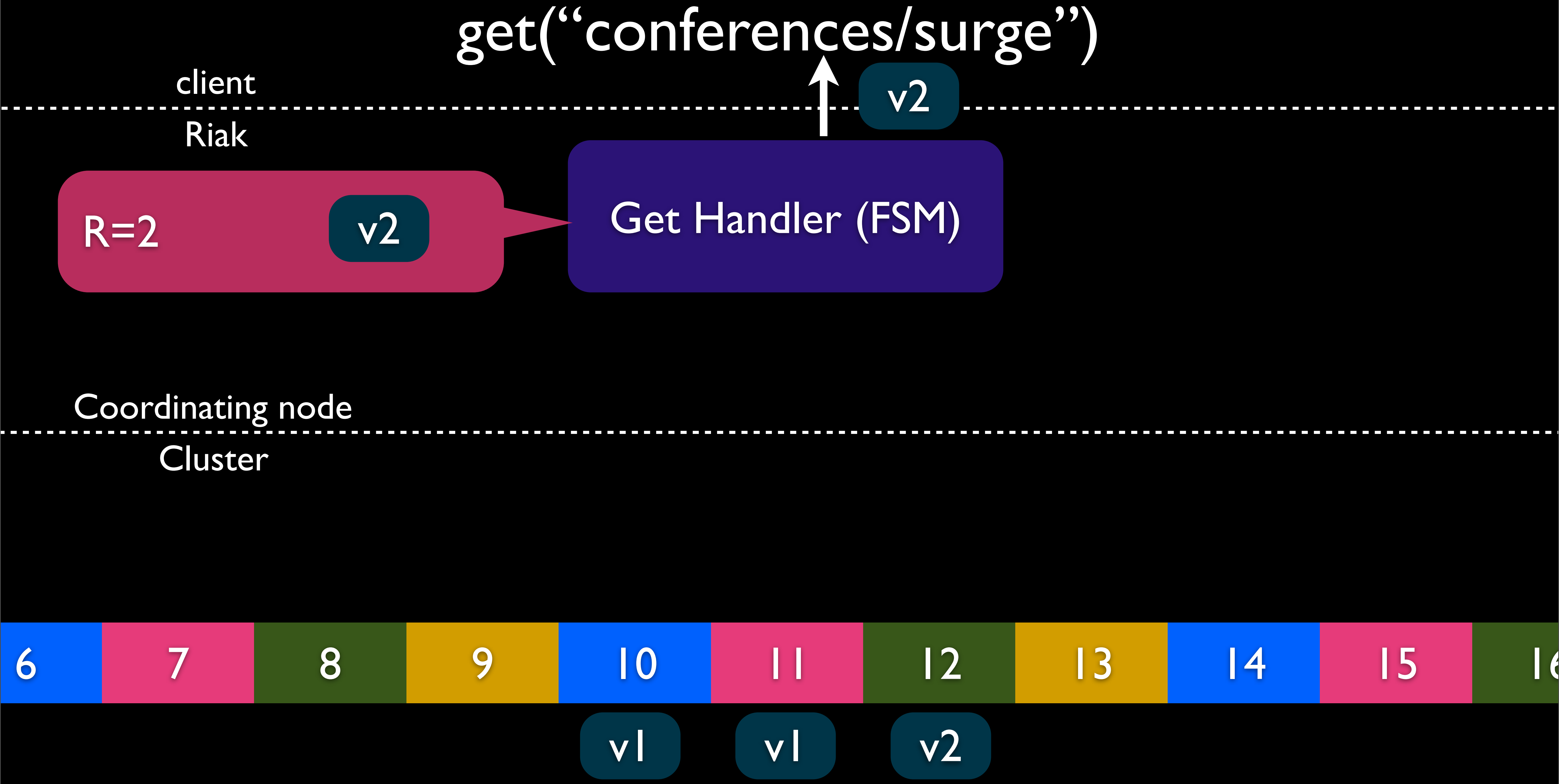
Cluster
6
7
8
9
10
11
12
13
14
15
16
v1
v2

Read Repair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v2
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12
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v1
v1
v2

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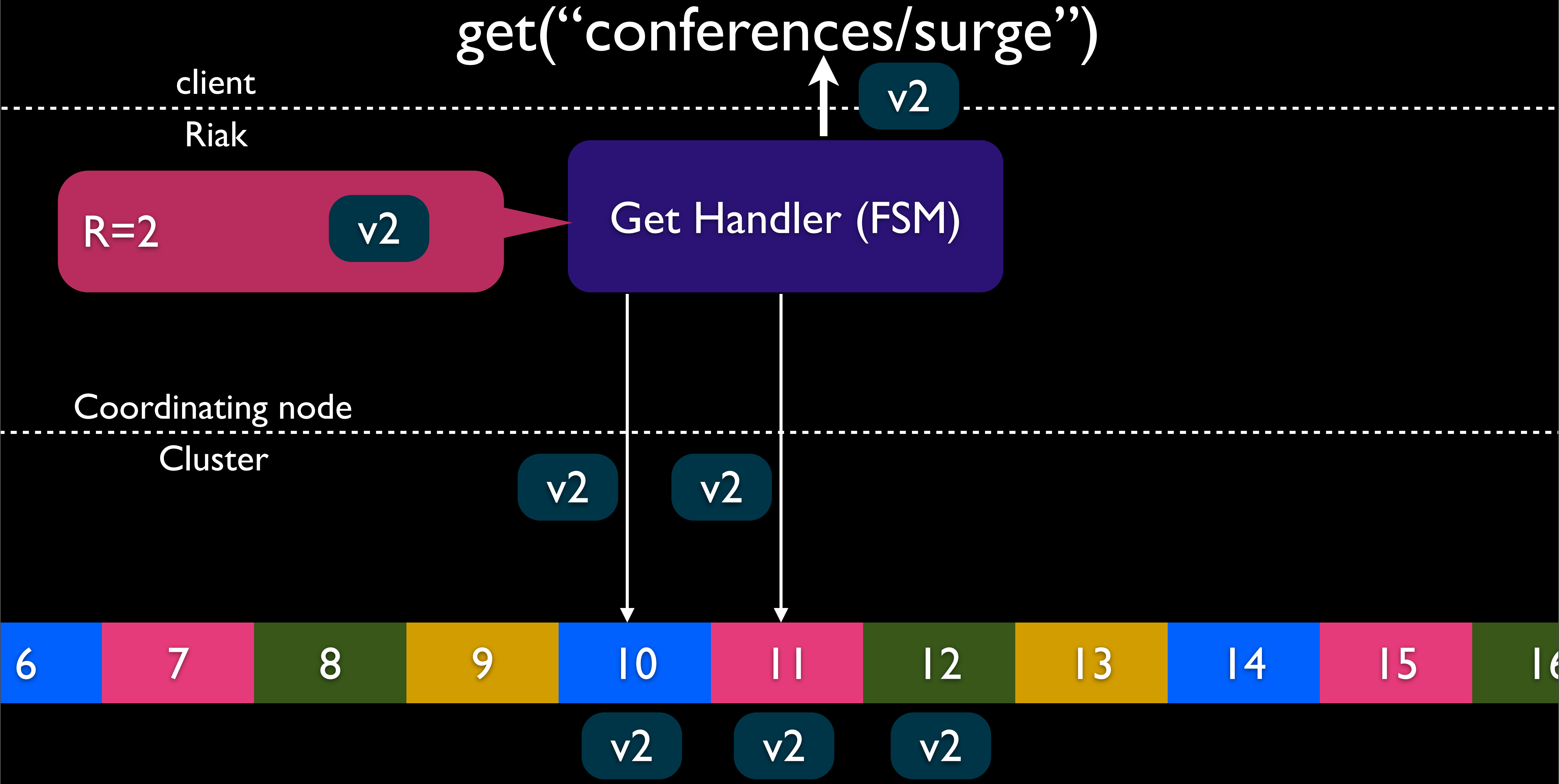
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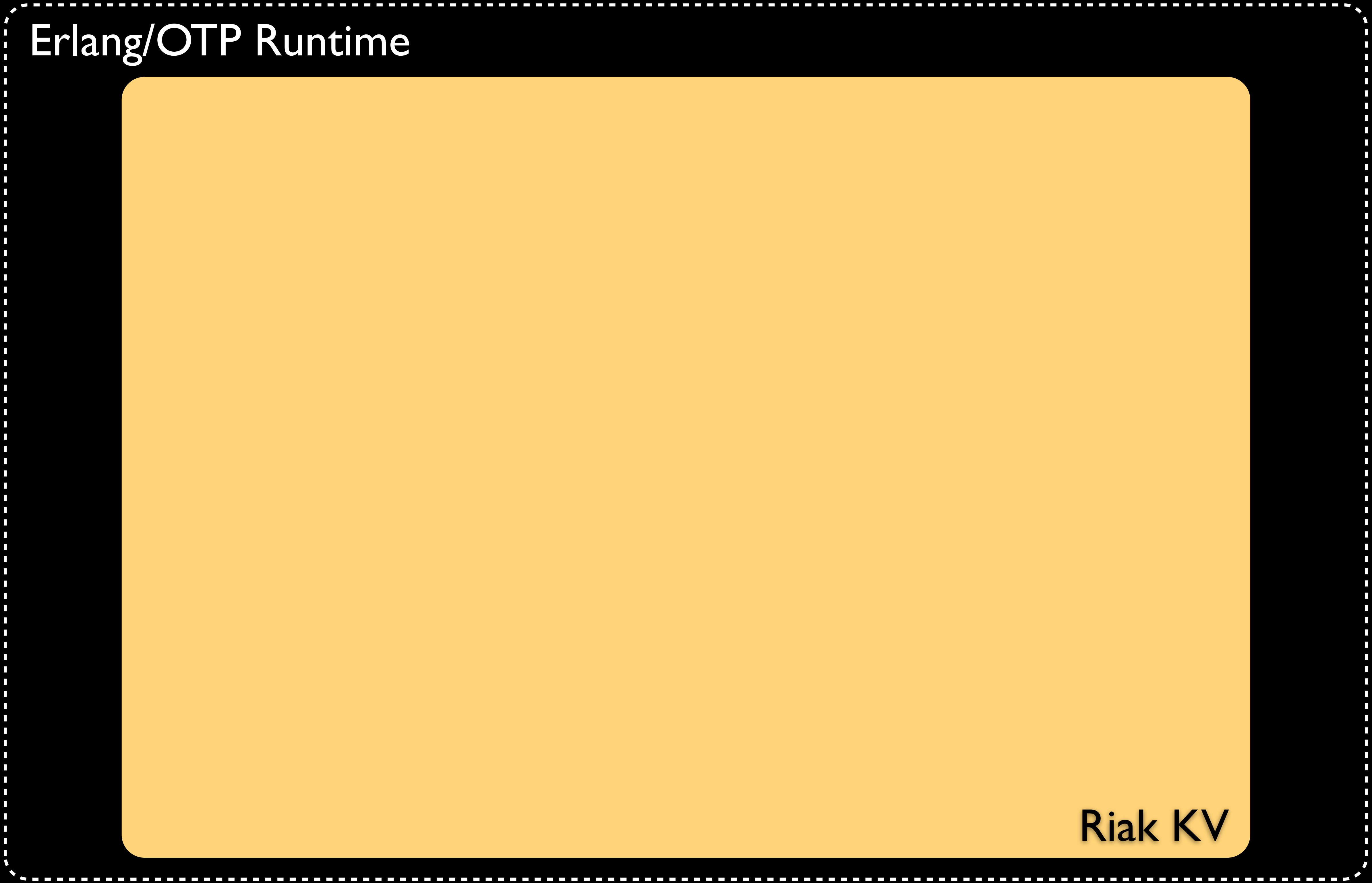
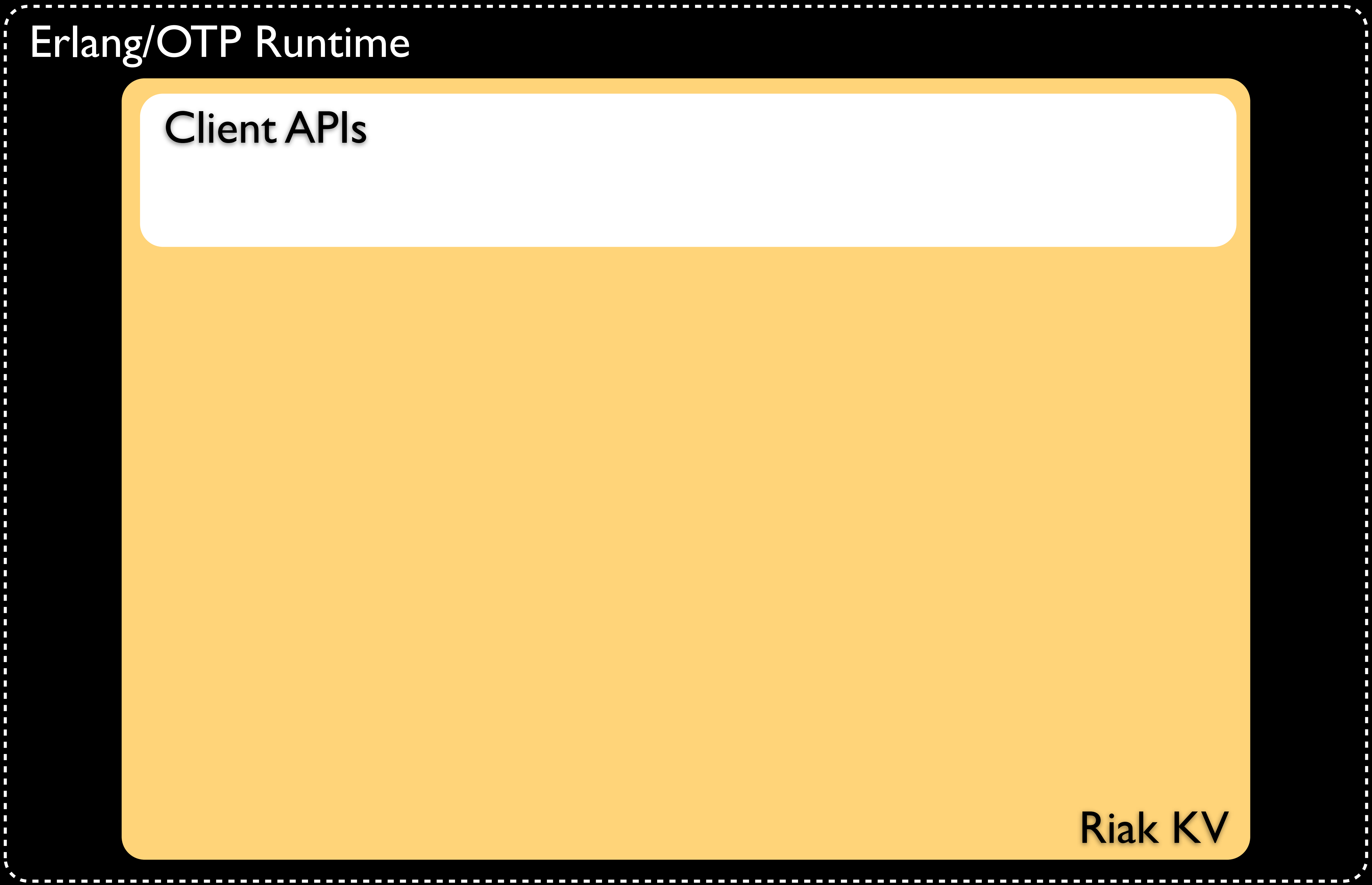
14
15
16
v2
v2
v2

Riak Architecture

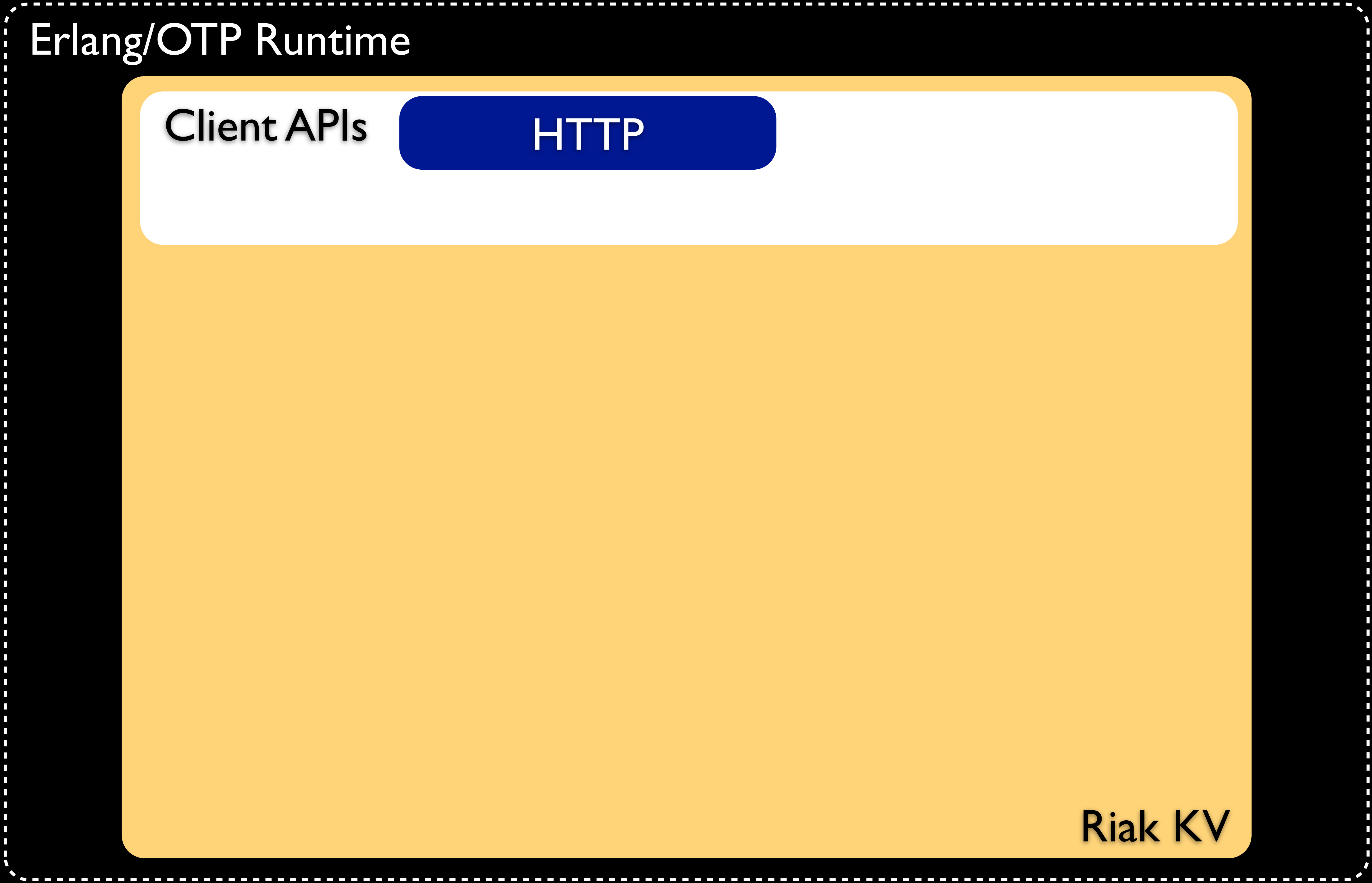
Riak Architecture



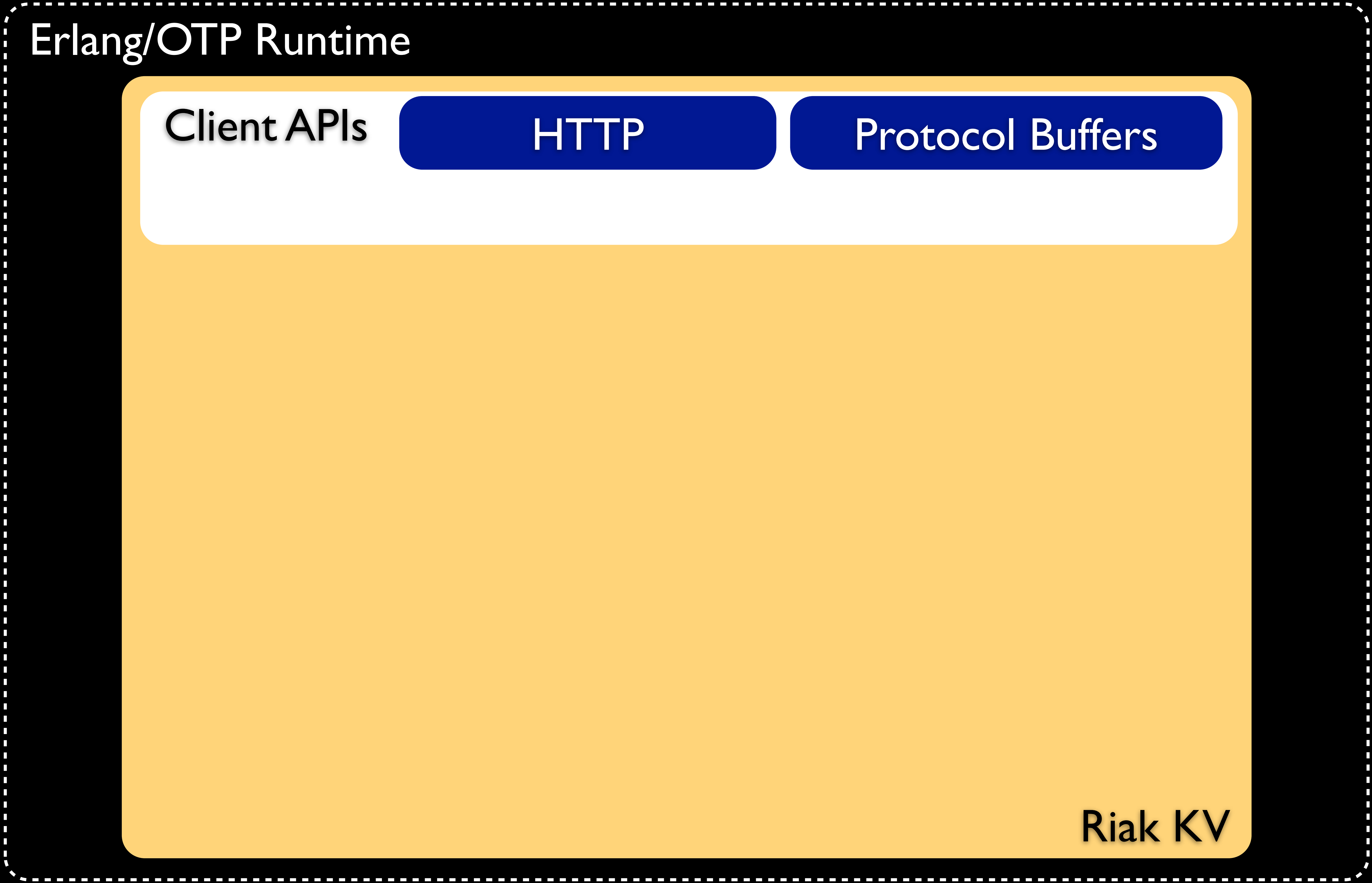
Riak Architecture



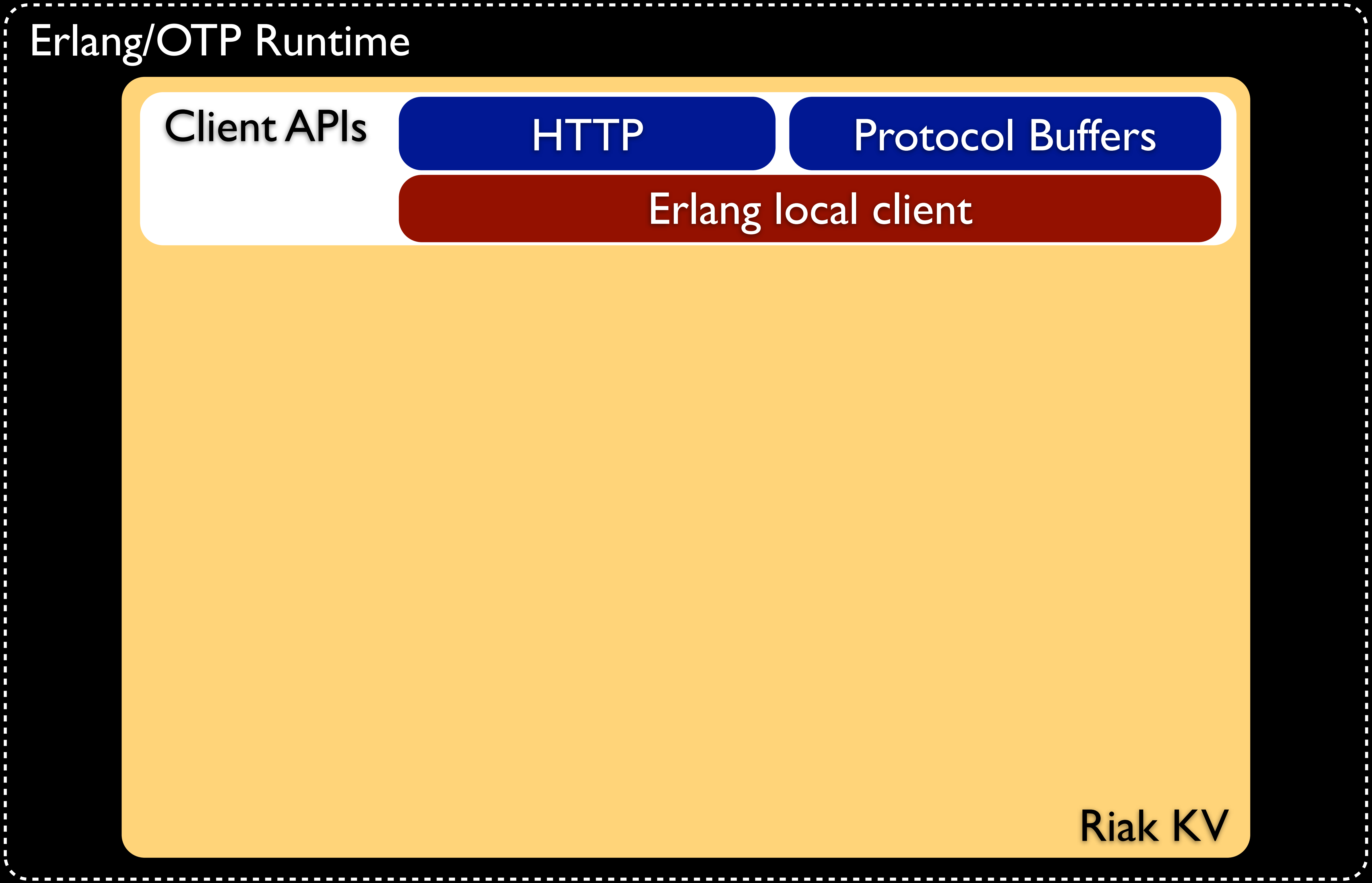
Riak Architecture



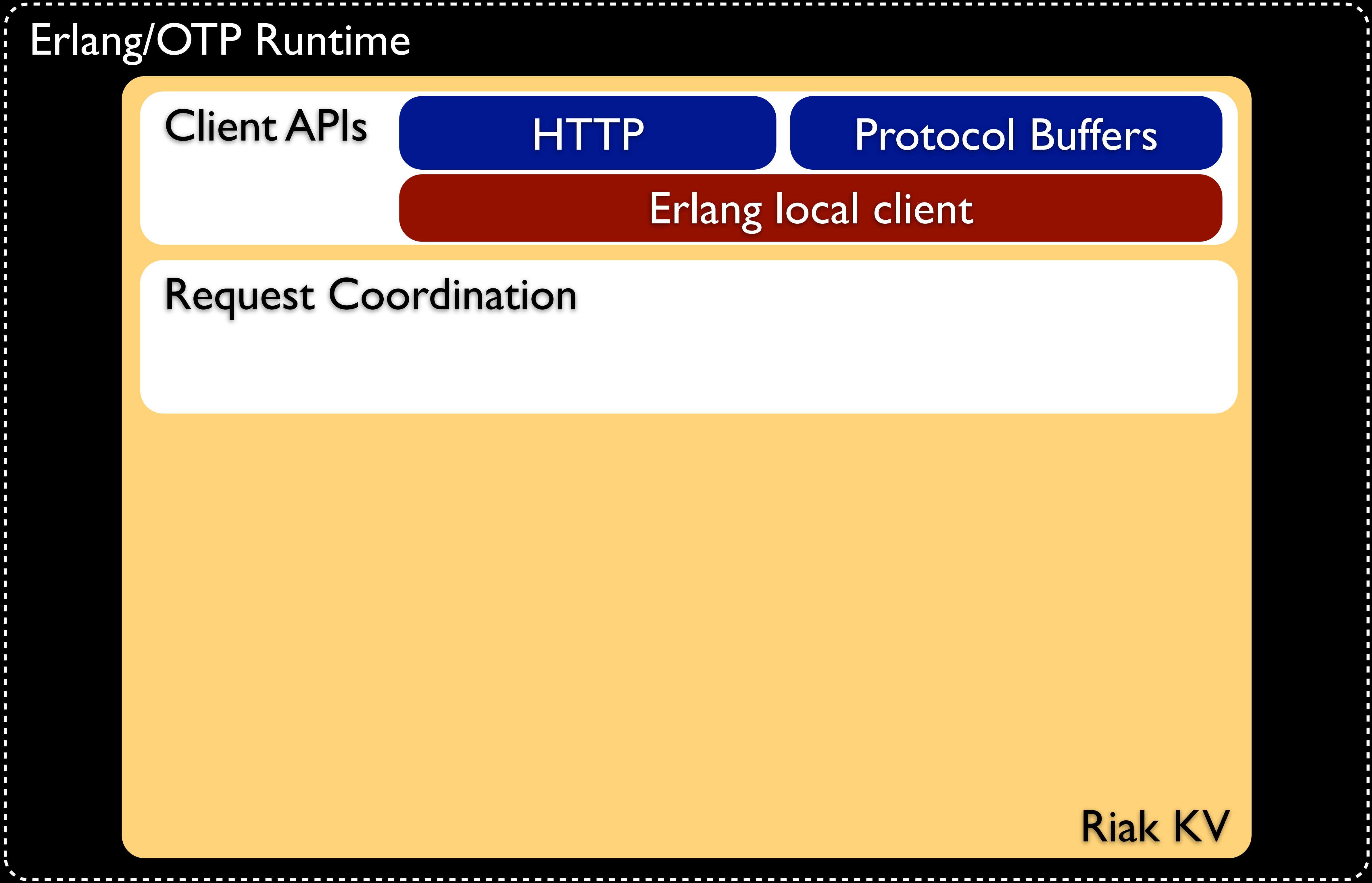
Riak Architecture



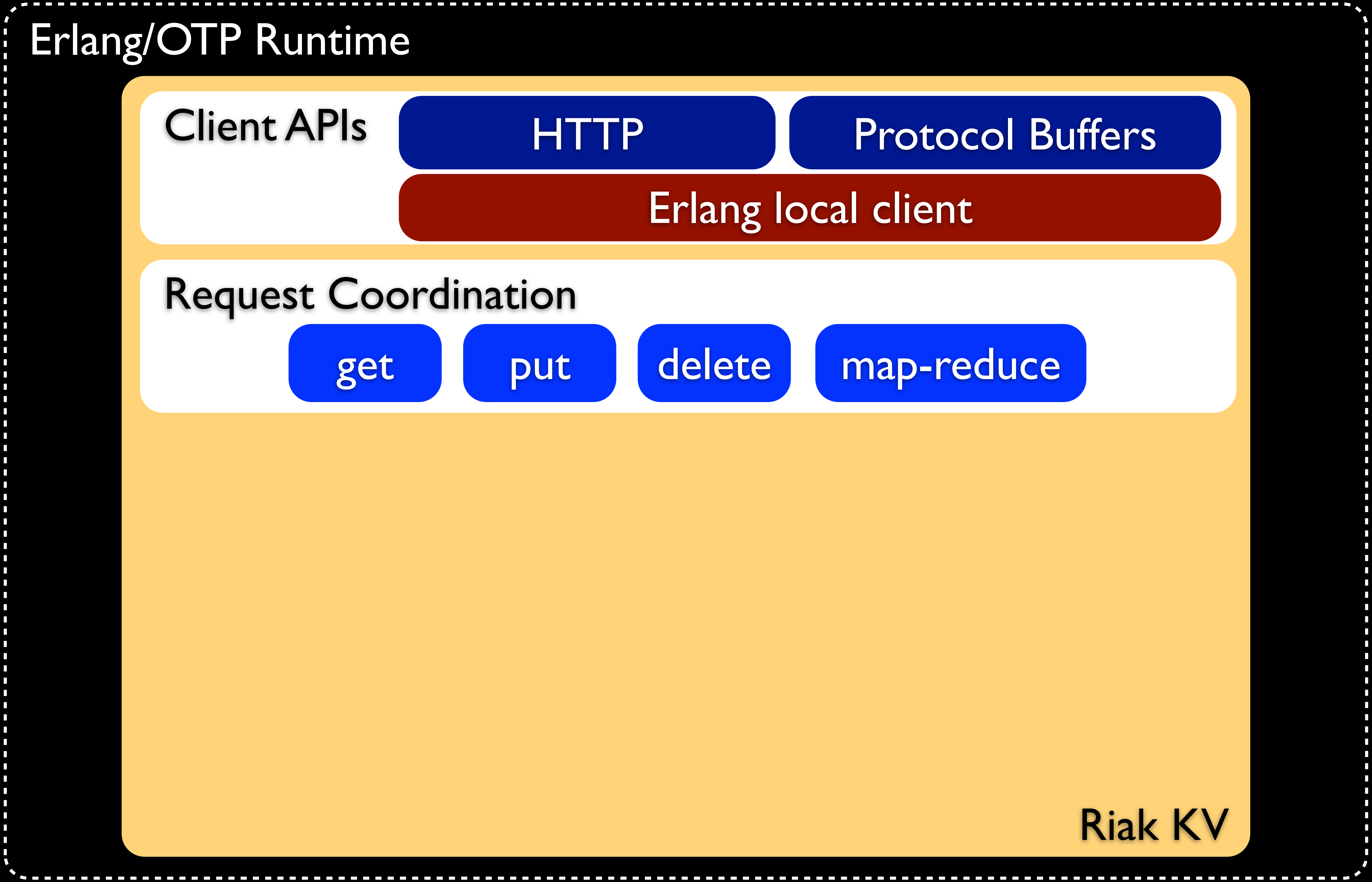
Riak Architecture



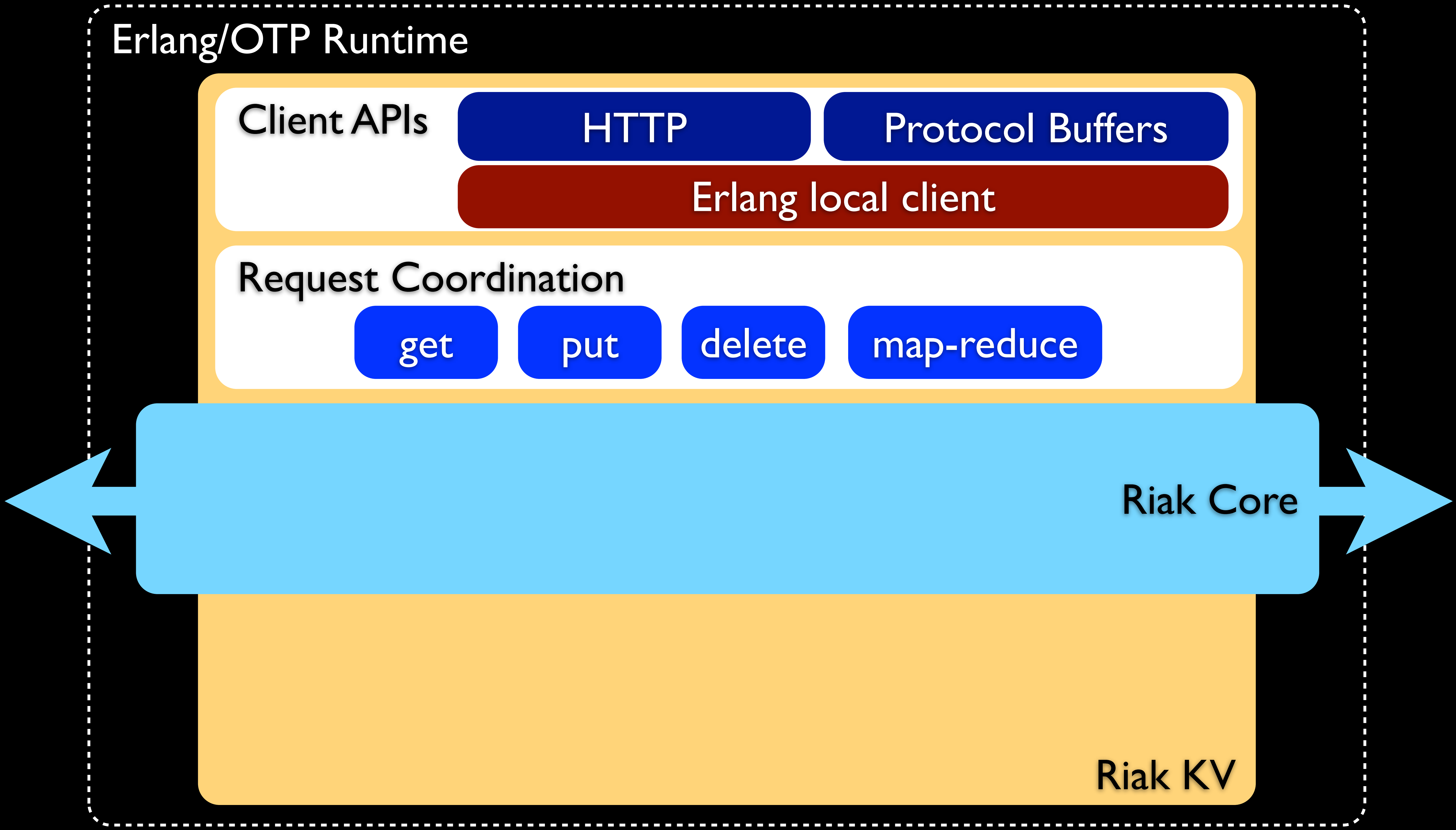
Riak Architecture



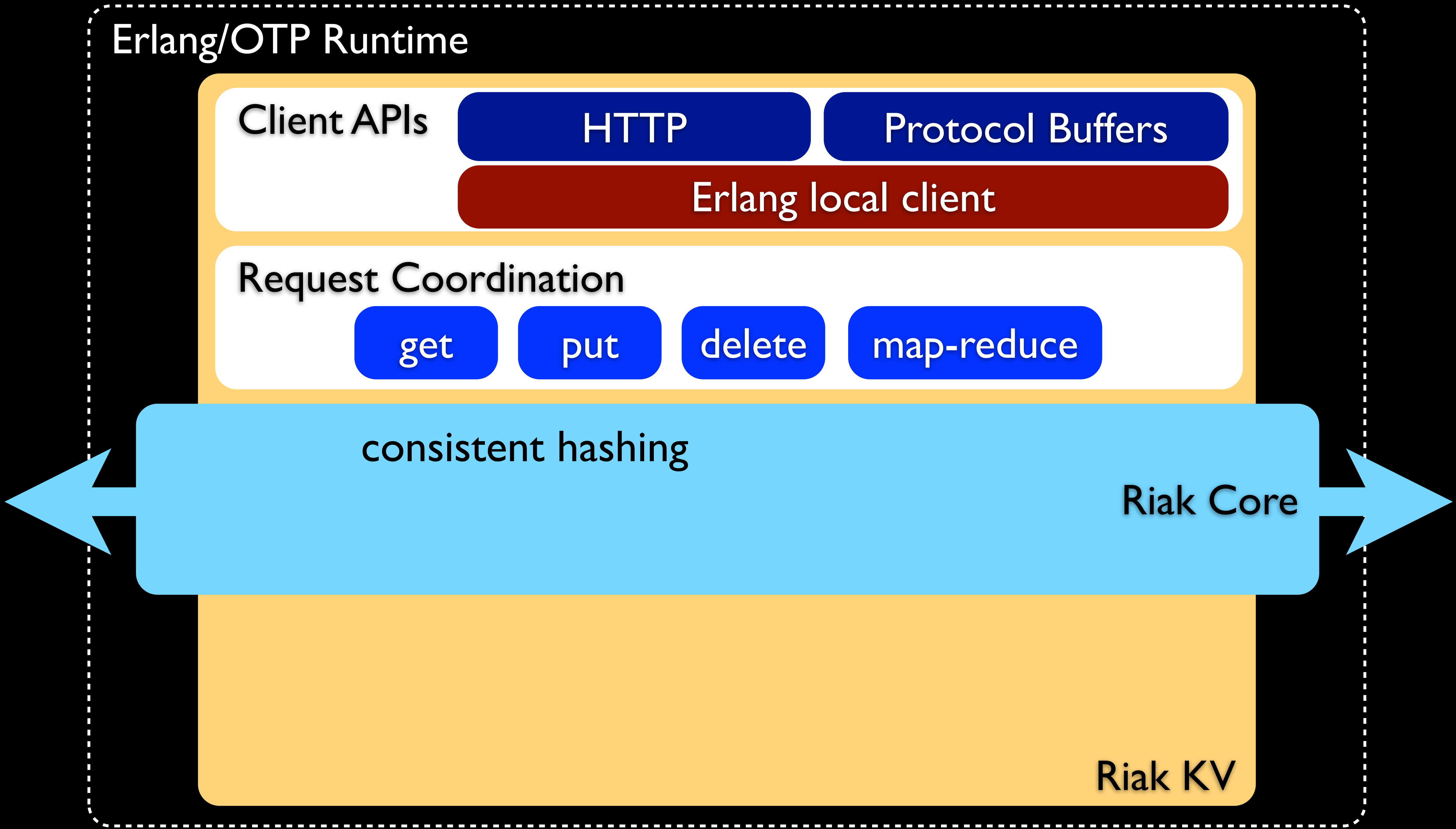
Riak Architecture



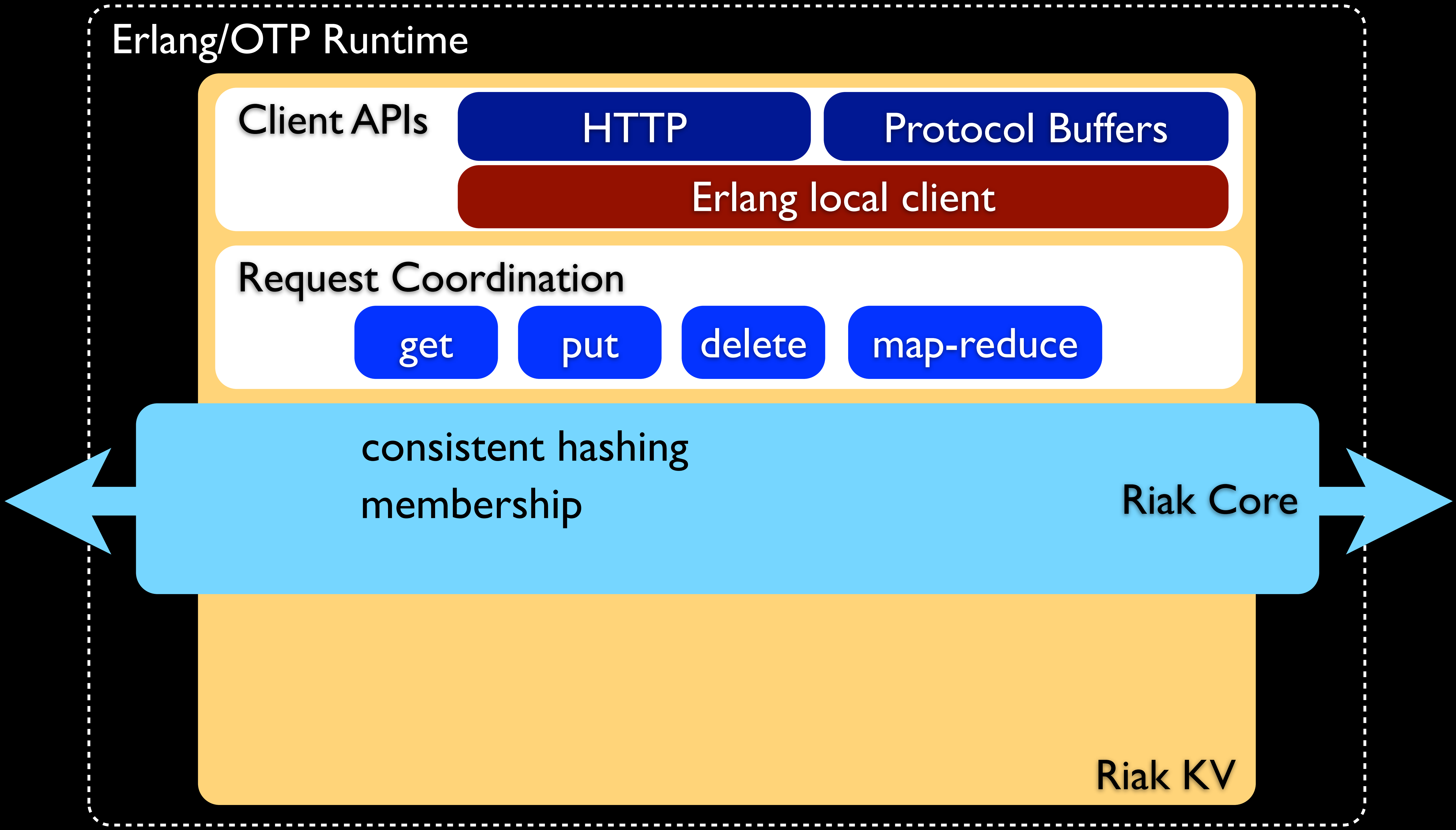
Riak Architecture



Riak Architecture



Riak Architecture



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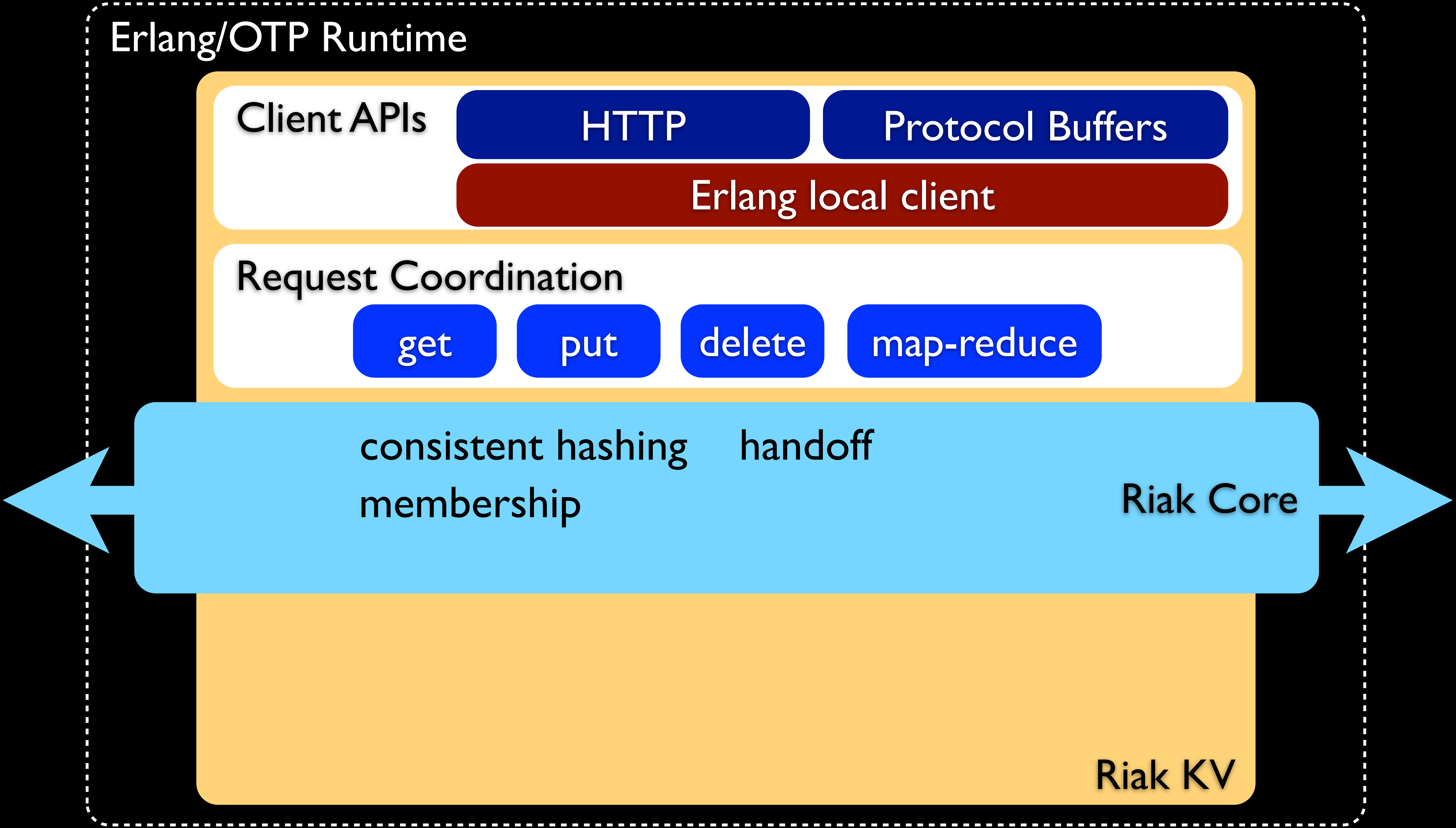
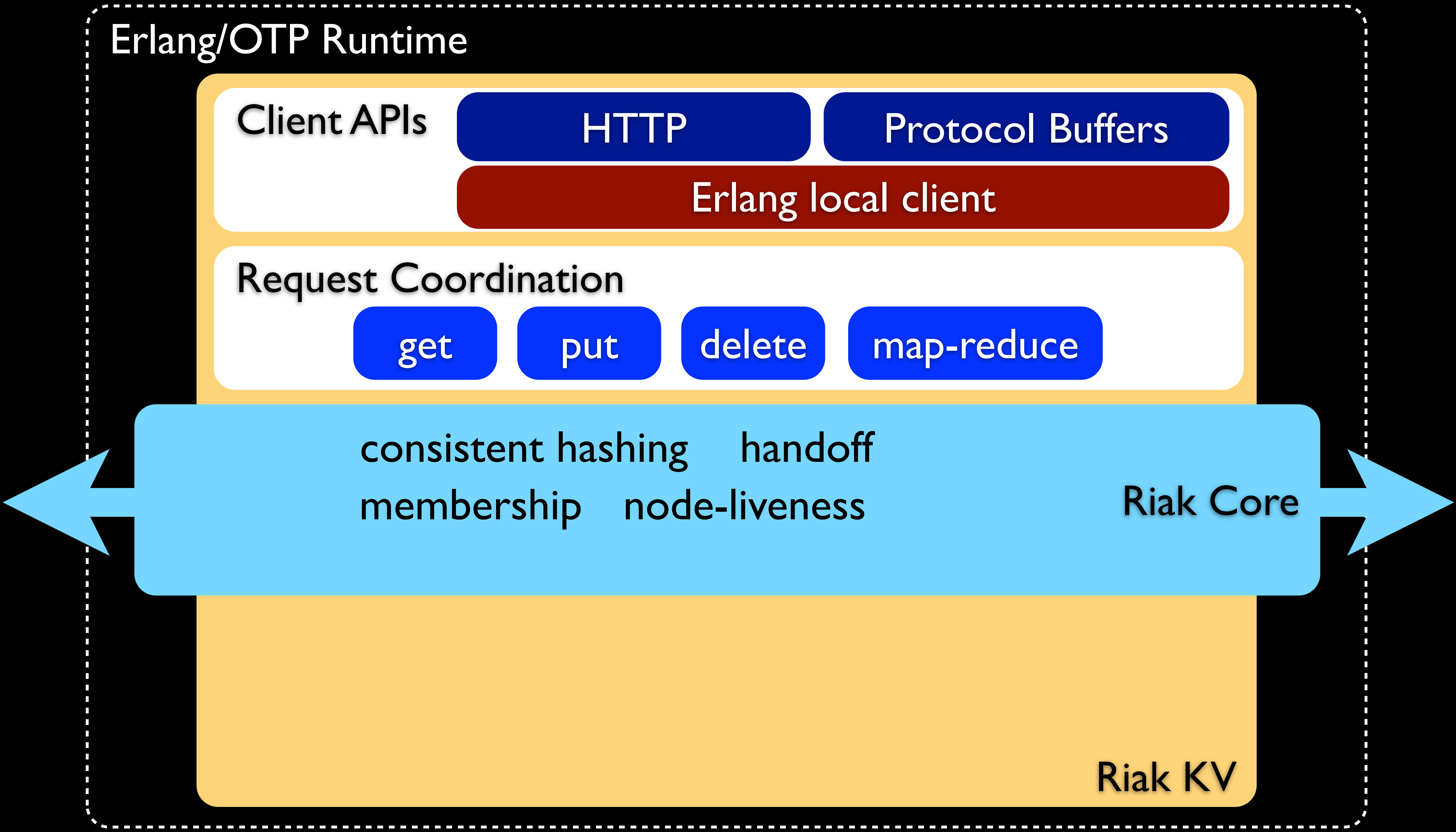
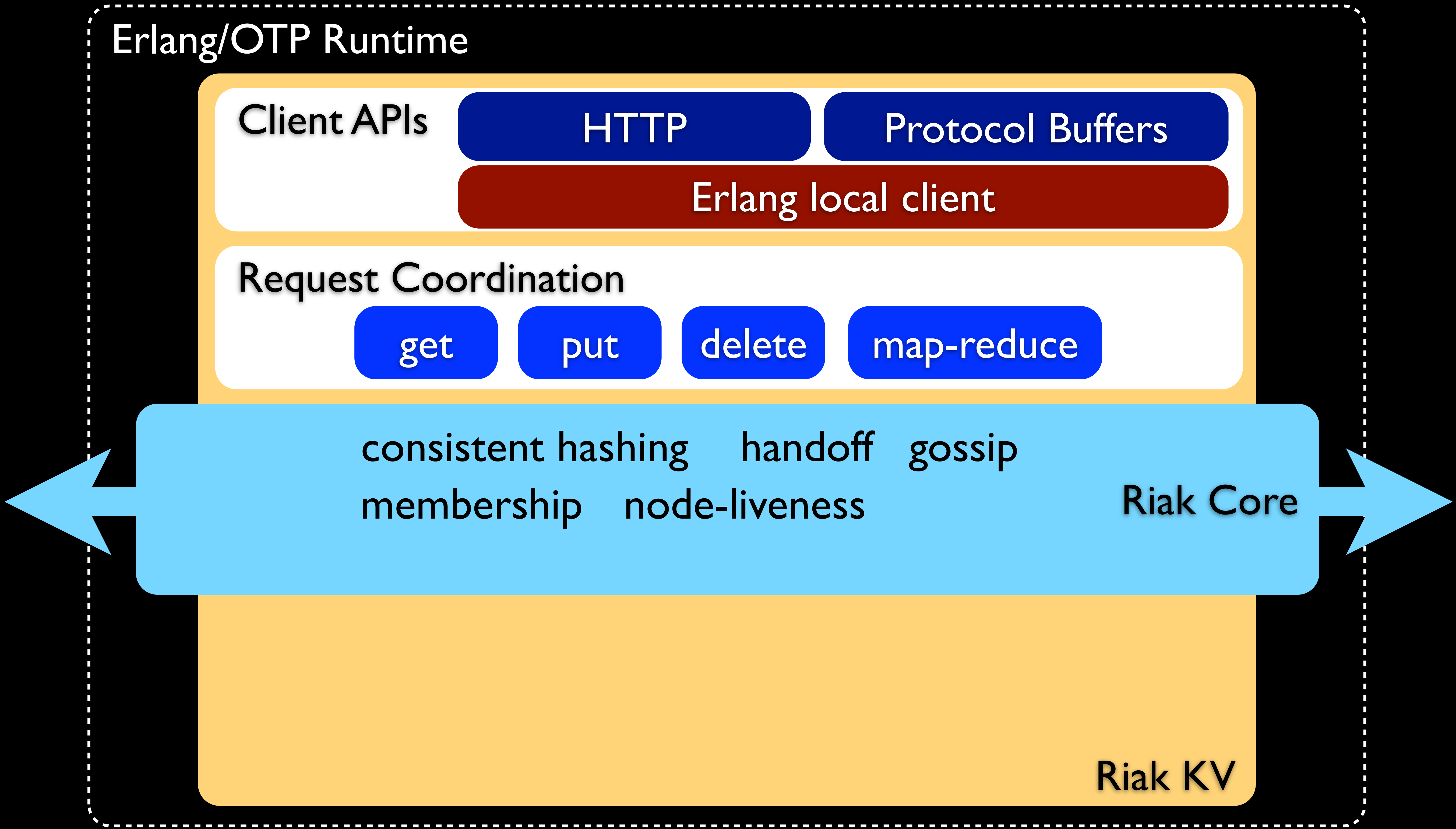


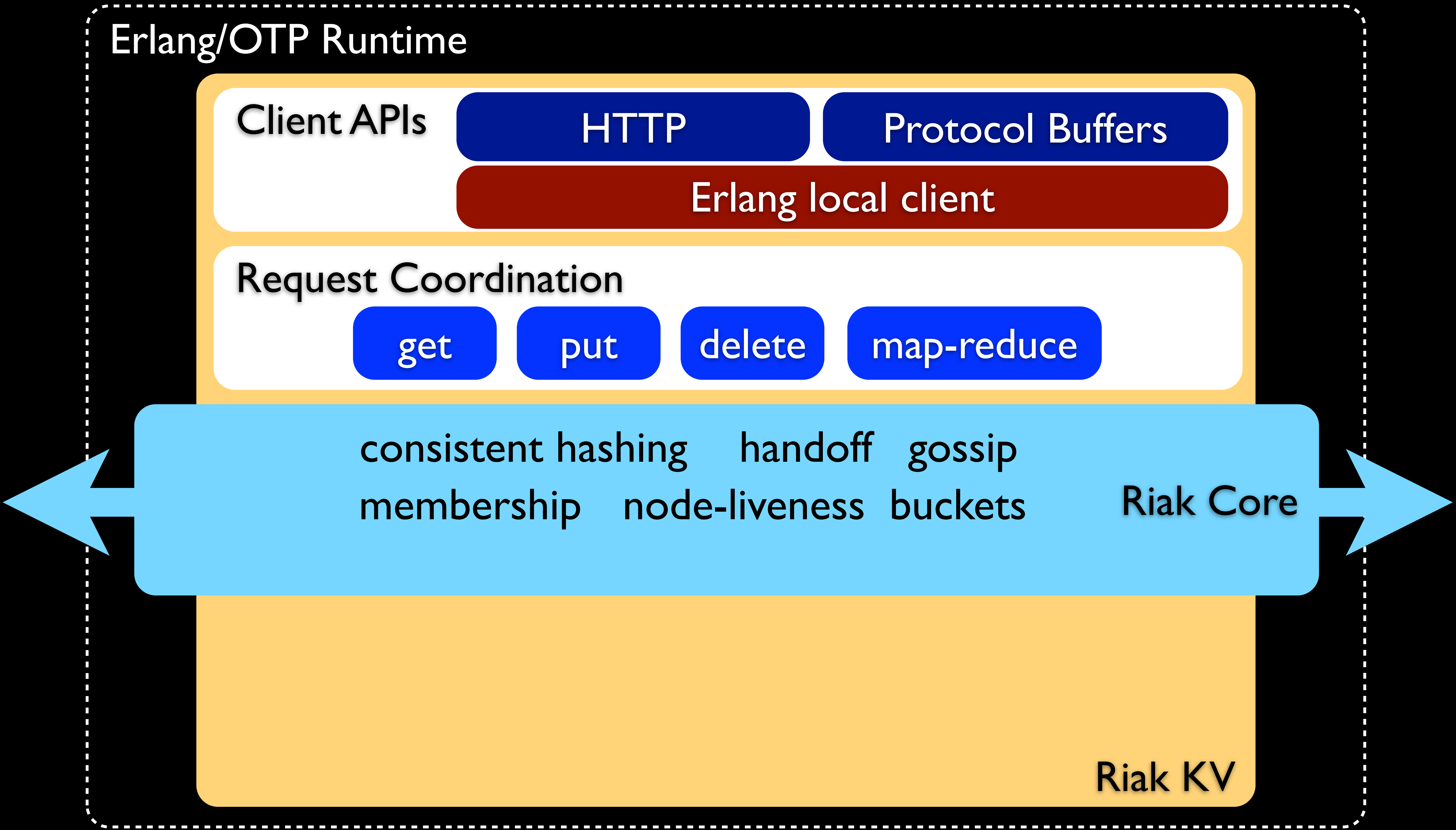
Riak Architecture



Riak Architecture



Riak Architecture



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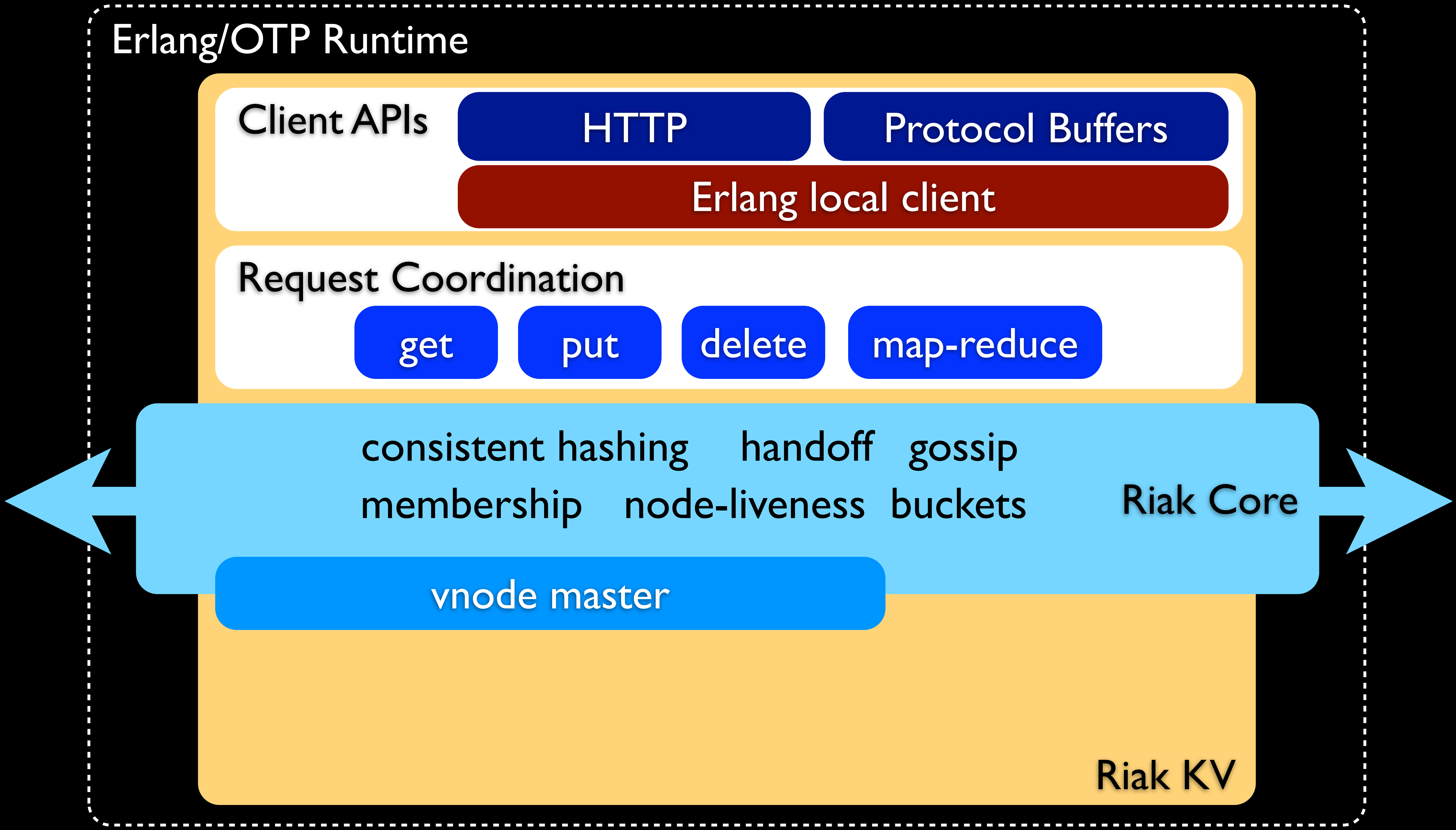

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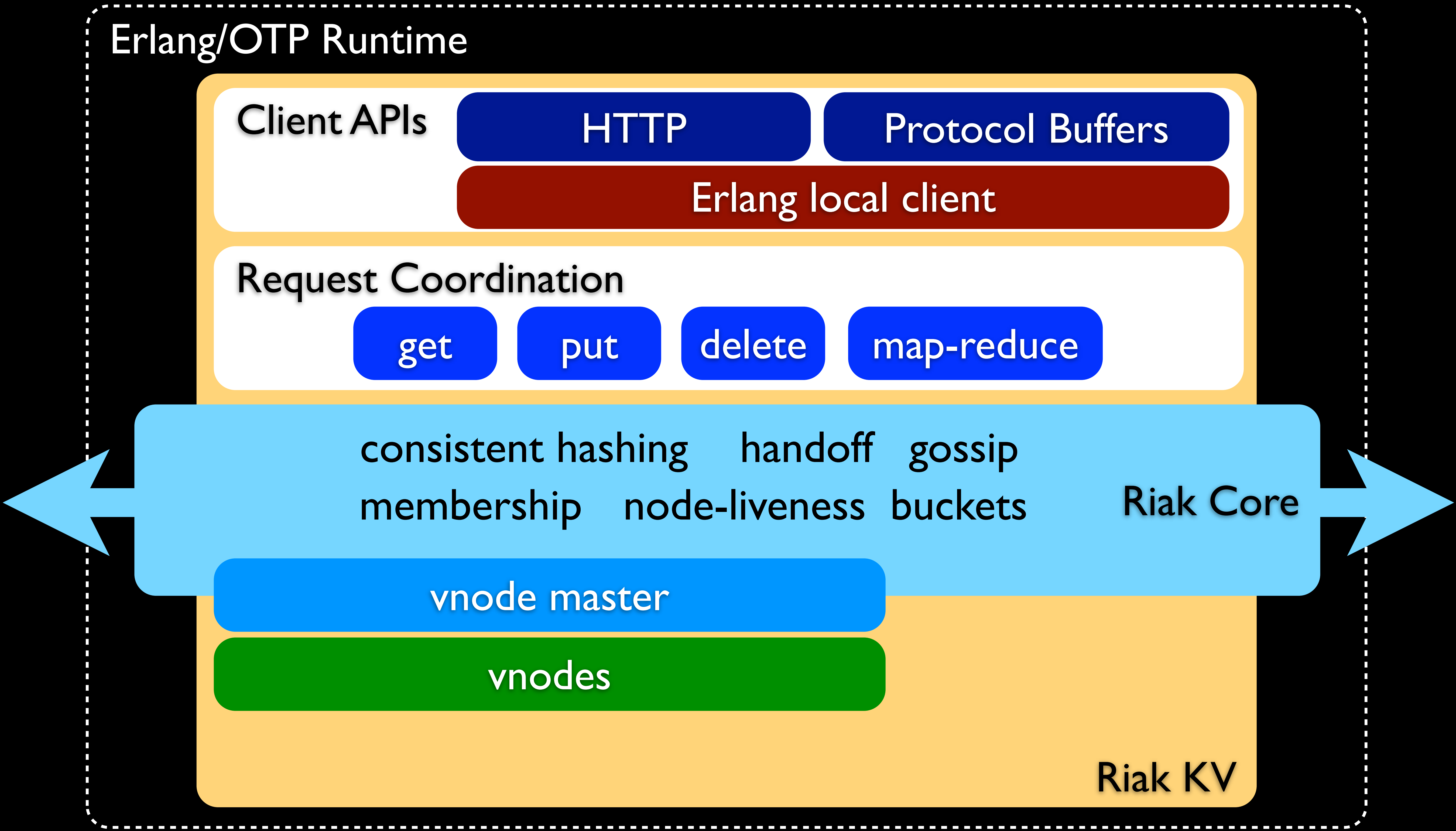

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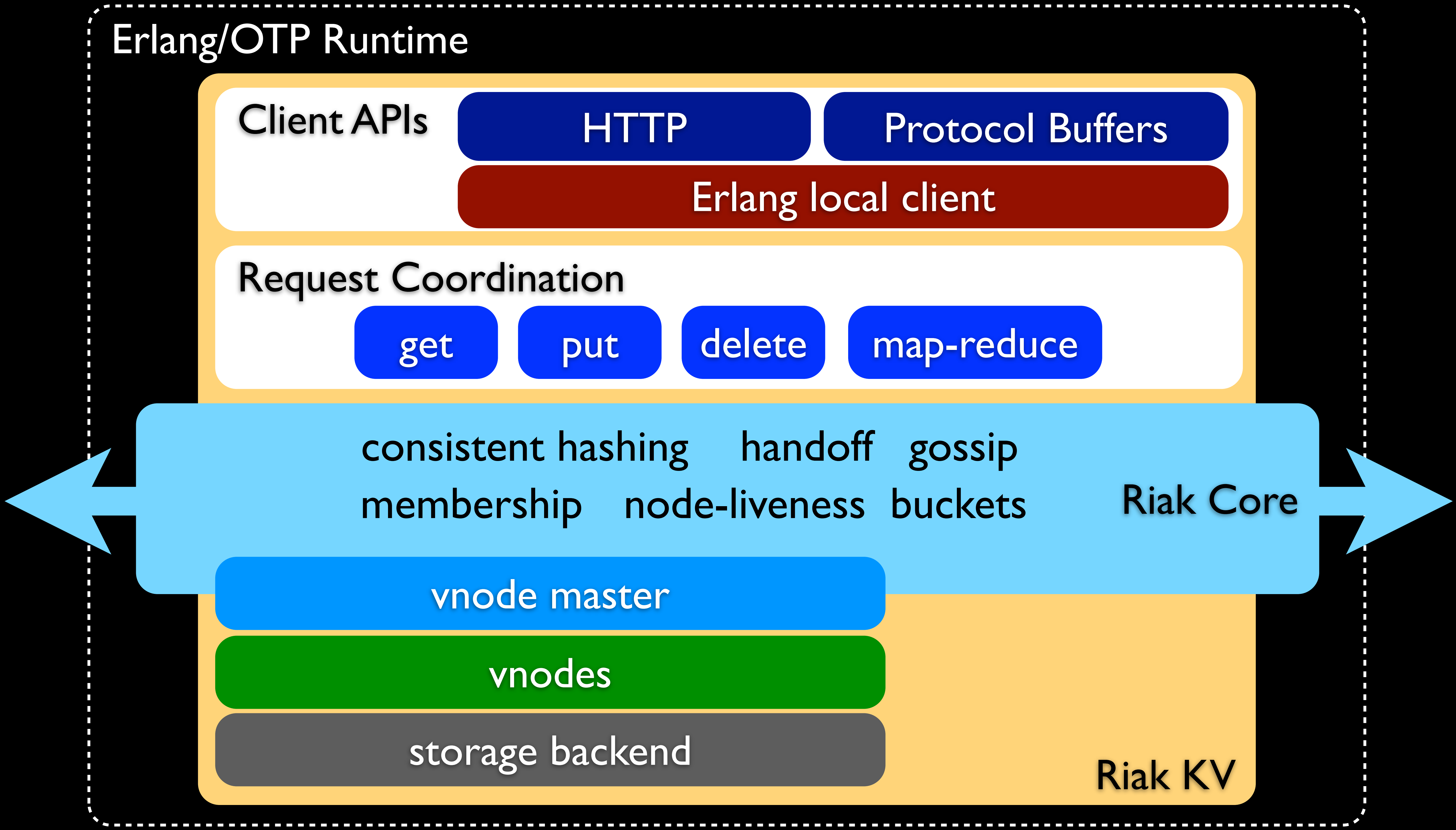

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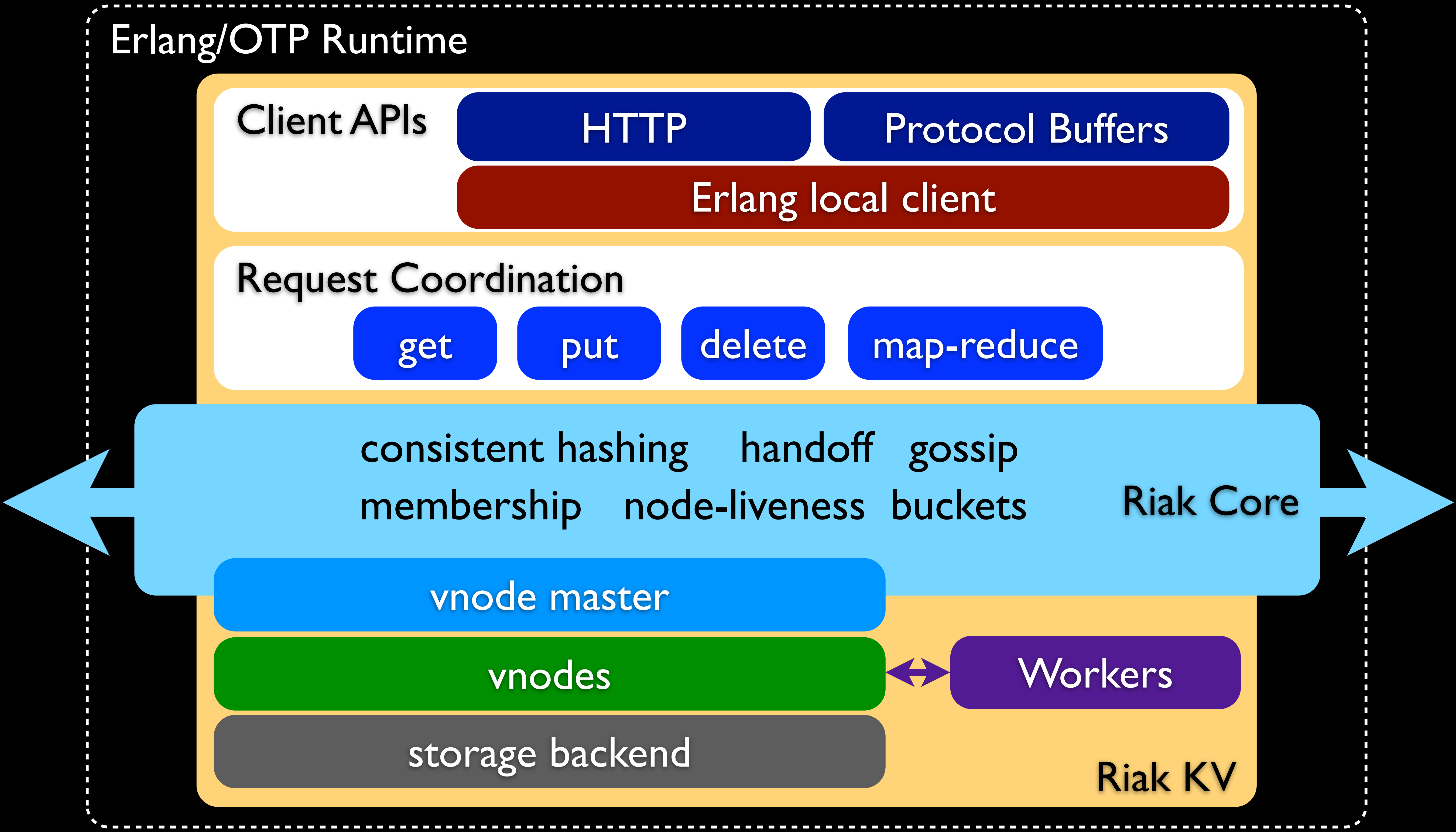

Modeling & Querying

Application Design

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- No intrinsic schema

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- No intrinsic schema
- Your application defines the structure and semantics

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- No intrinsic schema
- Your application defines the structure and semantics
- Your application resolves conflicts (if you care)

Modeling Tools

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- Key-Value

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- Key-Value
- Links

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- Full-text Search

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Modeling Tools

- Key-Value
- Links
- Full-text Search
- Secondary Indexes (2I)
- MapReduce

Key-Value

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- Content-Types

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- Denormalize

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- Meaningful or “guessable” keys

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  - Time-boxing

Key-Value

- Content-Types
- Denormalize
- Meaningful or “guessable” keys
  - Composites
  - Time-boxing
- References (value is a key or list)

Links

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- Lightweight relationships, like <a>

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- Includes a “tag”

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- Includes a “tag”
- Built-in traversal op (“walking”)
  `GET /riak/b/k/[bucket],[tag],[keep]`

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- Includes a "tag"
- Built-in traversal op ("walking")
  `GET /riak/b/k/[bucket],[tag],[keep]`
- Limited in number (part of meta)

Full-text Search

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- Designed for searching prose

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- Lucene/Solr-like query interface

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  - Specify input keys
  - Process data in “map” and “reduce” functions
    - JavaScript or Erlang
- Not tuned for batch processing

Lab: Querying

Lab: Walk Links

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- Store an object with a Link

Lab: Walk Links

- Store an object with a Link
- Store the target of the Link

Lab: Walk Links

- Store an object with a Link
- Store the target of the Link
- Walk from one to the other

Lab: Store Links

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```
$ ./store-linked.sh
```

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Enter the origin key: sean
Enter the target key: ian
Enter the link's tag: coworker
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Enter the origin key: sean
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*** Storing the origin ***
* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> PUT /riak/surge/sean HTTP/1.1
> Link: </riak/surge/ian>;riaktag="coworker"
...
< HTTP/1.1 204 No Content
...
```

Lab: Store Links

```
$ ./store-linked.sh
Enter the origin key: sean
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```

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...
< HTTP/1.1 204 No Content
...
*** Storing the target ***
* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
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```

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* About to connect() to localhost port 8091 (#0)
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* About to connect() to localhost port 8091 (#0)
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```

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...
> GET /riak/surge/sean/_,_,_ HTTP/1.1
...
< HTTP/1.1 200 OK
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Expires: Tue, 27 Sep 2011 20:51:37 GMT
< Date: Tue, 27 Sep 2011 20:41:37 GMT
< Content-Type: multipart/mixed; boundary=J6O2SZfLfSEdAv5dv3mttR7AVOF
< Content-Length: 438
<
```

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Content-Type: multipart/mixed; boundary=C1NUMpwbmSvb7CbqEAy1KdYRiUH

--C1NUMpwbmSvb7CbqEAy1KdYRiUH
X-Riak-Vclock: a85hYGBgzGDKBVIcMRuuc/k1GU/KYEpkymNl0Nzw7ThfFgA=
Location: /riak/surge/ian
Content-Type: text/plain
Link: </riak/surge>; rel="up"
Etag: 51h3q7RjTNaHWYpO4P0MJj
Last-Modified: Tue, 27 Sep 2011 20:38:01 GMT

target
--C1NUMpwbmSvb7CbqEAy1KdYRiUH--

--J6O2SZfLfSEdAv5dv3mttR7AVOF--
```

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--C1NUMpwbmSvb7CbqEAy1KdYRiUH
X-Riak-Vclock: a85hYGBgzGDKBVIcMRuuc/k1GU/KYEpkymNl0Nzw7ThfFgA=
Location: /riak/surge/ian
Content-Type: text/plain
Link: </riak/surge>; rel="up"
Etag: 51h3q7RjTNaHWYpO4P0MJj
Last-Modified: Tue, 27 Sep 2011 20:38:01 GMT

target
--C1NUMpwbmSvb7CbqEAy1KdYRiUH--

--J6O2SZfLfSEdAv5dv3mttR7AVOF--
```

Lab: Walk Links (2/3)

Lab: Walk Links (2/3)

```
Enter the origin key: sean
Enter the link spec (default: _,_,_): surge,_,_
```

Lab: Walk Links (2/3)

```
Enter the origin key: sean
Enter the link spec (default: _,_,_): surge,_,_

> GET /riak/surge/sean/surge,_,_ HTTP/1.1
...
```

Lab: Walk Links (2/3)

```
Enter the origin key: sean
Enter the link spec (default: _,_,_): surge,_,_

> GET /riak/surge/sean/surge,_,_ HTTP/1.1
...
>
< HTTP/1.1 200 OK
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Expires: Tue, 27 Sep 2011 20:52:53 GMT
< Date: Tue, 27 Sep 2011 20:42:53 GMT
< Content-Type: multipart/mixed; boundary=CsxMIsO9tfadrRJ7EQ3XL2ivQ4f
< Content-Length: 438
<

--CsxMIsO9tfadrRJ7EQ3XL2ivQ4f
Content-Type: multipart/mixed; boundary=I3U33LkzkqJi6HtbwsU0qRd4k4y

--I3U33LkzkqJi6HtbwsU0qRd4k4y
X-Riak-Vclock: a85hYGBgzGDKBVIcMRuuc/k1GU/KYEpkymNl0Nzw7ThfFgA=
Location: /riak/surge/ian
Content-Type: text/plain
Link: </riak/surge>; rel="up"
Etag: 51h3q7RjTNaHWYpO4P0MJj
Last-Modified: Tue, 27 Sep 2011 20:38:01 GMT

target
--I3U33LkzkqJi6HtbwsU0qRd4k4y--

--CsxMIsO9tfadrRJ7EQ3XL2ivQ4f--
```

Lab: Walk Links (3/3)

Lab: Walk Links (3/3)

```
Enter the origin key: sean
Enter the link spec (default: _,_,_): foo,_,_
```

Lab: Walk Links (3/3)

```
Enter the origin key: sean
Enter the link spec (default: _,_,_): foo,_,_

...
> GET /riak/surge/sean/foo,_,_ HTTP/1.1
< HTTP/1.1 200 OK
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Expires: Tue, 27 Sep 2011 20:53:08 GMT
< Date: Tue, 27 Sep 2011 20:43:08 GMT
< Content-Type: multipart/mixed; boundary=3AsxaHhVMlDEQCakLSmNqQUTS4Y
< Content-Length: 172
<

--3AsxaHhVMlDEQCakLSmNqQUTS4Y
Content-Type: multipart/mixed; boundary=Ivtq9RgHpydECNEZOnHpiqHcFYl

--Ivtq9RgHpydECNEZOnHpiqHcFYl--

--3AsxaHhVMlDEQCakLSmNqQUTS4Y--
```

Lab: Secondary Indexes

Lab: Secondary Indexes

- Create some objects with indexes

Lab: Secondary Indexes

- Create some objects with indexes
- Query the index for their keys

Lab: Secondary Indexes

- Create some objects with indexes
- Query the index for their keys
- Query input to MapReduce

Lab: Create 2I Objects

Lab: Create 2I Objects

```
$ ./store-indexed.sh
```

Lab: Create 2I Objects

```
$ ./store-indexed.sh
Enter the number of objects to create: 40
```

Lab: Create 2I Objects

```
$ ./store-indexed.sh
Enter the number of objects to create: 40
* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> PUT /riak/surge/surgeobj1?returnbody=true HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7 OpenSSL/0.9.8r
zlib/1.2.3
> Host: localhost:8091
> Accept: */*
> Content-Type: application/json
> X-Riak-Index-surgeobj_int: 1
> Content-Length: 14
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1uZVkMCUy5rEyHDn57ThfFgA=
< x-riak-index-surgeobj_int: 1
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Date: Tue, 27 Sep 2011 22:27:16 GMT
< Content-Type: application/json
< Content-Length: 14
<
* Connection #0 to host localhost left intact
* Closing connection #0
{"surgeobj":1} ...
```

Lab: Create 21 Objects

key

```
$ ./store-indexed.sh
Enter the number of objects to create: 40
* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> PUT /riak/surge/surgeobj1?returnbody=true HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7 OpenSSL/0.9.8r
zlib/1.2.3
> Host: localhost:8091
> Accept: */*
> Content-Type: application/json
> X-Riak-Index-surgeobj_int: 1
> Content-Length: 14
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1uZVkMCUy5rEyHDn57ThfFgA=
< x-riak-index-surgeobj_int: 1
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Date: Tue, 27 Sep 2011 22:27:16 GMT
< Content-Type: application/json
< Content-Length: 14
<
* Connection #0 to host localhost left intact
* Closing connection #0
{"surgeobj":1} ...
```

Lab: Create 21 Objects

```
$ ./store-indexed.sh
Enter the number of objects to create: 40
* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> PUT /riak/surge/surgeobj1?returnbody=true HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7 OpenSSL/0.9.8r
zlib/1.2.3
> Host: localhost:8091
> Accept: */*
> Content-Type: application/json
> X-Riak-Index-surgeobj_int: 1
> Content-Length: 14
>
< HTTP/1.1 200 OK
< X-Riak-Vclock: a85hYGBgzGDKBVIcR4M2cvs1uZVkMCUy5rEyHDn57ThfFgA=
< x-riak-index-surgeobj_int: 1
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Link: </riak/surge>; rel="up"
< Date: Tue, 27 Sep 2011 22:27:16 GMT
< Content-Type: application/json
< Content-Length: 14
<
* Connection #0 to host localhost left intact
* Closing connection #0
{"surgeobj":1} ...
```

index header

Lab: Query 2l (1/2)

Lab: Query 2l (1/2)

```
$ ./query-indexed.sh
```

Lab: Query 2I (1/2)

```
$ ./query-indexed.sh
Query on range or equality? (r/e) e
Index value: 10
```

Lab: Query 2I (1/2)

```
$ ./query-indexed.sh
Query on range or equality? (r/e) e
Index value: 10

* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> GET /buckets/surge/index/surgeobj_int/10 HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7
OpenSSL/0.9.8r zlib/1.2.3
> Host: localhost:8091
> Accept: */*
>
< HTTP/1.1 200 OK
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Date: Tue, 27 Sep 2011 22:27:27 GMT
< Content-Type: application/json
< Content-Length: 23
<
* Connection #0 to host localhost left intact
* Closing connection #0
{"keys":["surgeobj10"]}
```

Lab: Query 2I (2/2)

Lab: Query 2l (2/2)

```
Query on range or equality? (r/e) r
Range start: 5
Range end: 15
```

Lab: Query 2I (2/2)

```
Query on range or equality? (r/e) r
Range start: 5
Range end: 15

* About to connect() to localhost port 8091 (#0)
*   Trying 127.0.0.1... connected
* Connected to localhost (127.0.0.1) port 8091 (#0)
> GET /buckets/surge/index/surgeobj_int/5/15 HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7
OpenSSL/0.9.8r zlib/1.2.3
> Host: localhost:8091
> Accept: */*
>
< HTTP/1.1 200 OK
< Vary: Accept-Encoding
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Date: Tue, 27 Sep 2011 22:27:36 GMT
< Content-Type: application/json
< Content-Length: 148
<
* Connection #0 to host localhost left intact
* Closing connection #0
{"keys":
["surgeobj12","surgeobj15","surgeobj6","surgeobj5","surgeobj13","surgeob
j8","surgeobj11","surgeobj14","surgeobj9","surgeobj10","surgeobj7"]}
```

Lab: 2I MapReduce

Lab: 2I MapReduce

```
$ ./mapred-indexed.sh
```

Lab: 2I MapReduce

```
$ ./mapred-indexed.sh
Query on range or equality? (r/e) r
Range start: 35
Range end: 40
```

Lab: 2I MapReduce

```
$ ./mapred-indexed.sh
Query on range or equality? (r/e) r
Range start: 35
Range end: 40

Executing MapReduce:
{ "inputs":{ "bucket":"surge", "index":"surgeobj_int" ,"start":35,"end":40},
"query":[ {"map":
{"name":"Riak.mapValuesJson","language":"javascript","keep":true}} ]}
```

Lab: 2I MapReduce

```
$ ./mapred-indexed.sh
Query on range or equality? (r/e) r
Range start: 35
Range end: 40

Executing MapReduce:
{ "inputs":{ "bucket":"surge", "index":"surgeobj_int" ,"start":35,"end":40},
"query":[ {"map":
{"name":"Riak.mapValuesJson","language":"javascript","keep":true}} ]}

> POST /mapred HTTP/1.1
> User-Agent: curl/7.19.7 (universal-apple-darwin10.0) libcurl/7.19.7 OpenSSL/
0.9.8r zlib/1.2.3
> Host: localhost:8091
> Accept: */*
> Content-Type: application/json
> Content-Length: 164
>
< HTTP/1.1 200 OK
< Server: MochiWeb/1.1 WebMachine/1.9.0 (participate in the frantic)
< Date: Wed, 28 Sep 2011 01:41:53 GMT
< Content-Type: application/json
< Content-Length: 97
<
* Connection #0 to host localhost left intact
* Closing connection #0
[{"surgeobj":35},{"surgeobj":40},{"surgeobj":36},{"surgeobj":37},{"surgeobj":
39},{"surgeobj":38}]
```

Riak Operations

Configuration

File Locations

File Locations

- Configuration

File Locations

- Configuration
  - /etc/riak

File Locations

- Configuration
  - /etc/riak
- Binaries

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs
  - /var/log/riak

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs
  - /var/log/riak
- Data

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs
  - /var/log/riak
- Data
  - /var/lib/riak

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs
  - /var/log/riak
- Data
  - /var/lib/riak
- Handles / Temp Files

File Locations

- Configuration
  - /etc/riak
- Binaries
  - /usr/sbin/riak
  - /usr/sbin/riak-admin
  - /usr/[lib,lib64]/riak
- Logs
  - /var/log/riak
- Data
  - /var/lib/riak
- Handles / Temp Files
  - /tmp/riak

/etc/riak/vm.args

/etc/riak/vm.args

- Overview

/etc/riak/vm.args

- Overview
    - Erlang VM configuration settings.

/etc/riak/vm.args

- Overview
  - Erlang VM configuration settings.
- Important Settings

/etc/riak/vm.args

- Overview
  - Erlang VM configuration settings.
- Important Settings
  - Node name.

/etc/riak/vm.args

- Overview
  - Erlang VM configuration settings.
- Important Settings
  - Node name.
  - Security cookie.

/etc/riak/vm.args

- Overview
  - Erlang VM configuration settings.
- Important Settings
  - Node name.
  - Security cookie.
- Documentation

/etc/riak/vm.args

- Overview
  - Erlang VM configuration settings.
- Important Settings
  - Node name.
  - Security cookie.
- Documentation
  - http://www.erlang.org/doc/man/erl.html

/etc/riak/vm.args

/etc/riak/vm.args

- Node Name & Security Cookie

```
## Name of the riak node
```

/etc/riak/vm.args

- Node Name & Security Cookie

```
## Name of the riak node
-name riak@127.0.0.1
```

/etc/riak/vm.args

- Node Name & Security Cookie

```
## Name of the riak node
-name riak@127.0.0.1
## Cookie for distributed erlang
```

/etc/riak/vm.args

- Node Name & Security Cookie

```
## Name of the riak node
-name riak@127.0.0.1
## Cookie for distributed erlang
-setcookie riak
```

/etc/riak/app.config

/etc/riak/app.config

- Overview

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
    - Ports

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories
  - Number of Partitions

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories
  - Number of Partitions
  - Storage Backend

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories
  - Number of Partitions
  - Storage Backend
- Documentation

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories
  - Number of Partitions
  - Storage Backend
- Documentation
  - http://wiki.basho.com/Configuration-Files.html

/etc/riak/app.config

- Overview
  - Riak (and dependency) configuration settings.
- Important Settings
  - Ports
  - Directories
  - Number of Partitions
  - Storage Backend
- Documentation
  - http://wiki.basho.com/Configuration-Files.html
  - Inline comments

/etc/riak/app.config

/etc/riak/app.config

- Storage Engine

```
%% Storage_backend specifies the Erlang module defining the storage
```

/etc/riak/app.config

- Storage Engine

```
%% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
```

/etc/riak/app.config

- Storage Engine

```
%% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

/etc/riak/app.config

- Storage Engine

```
 %% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

- About Storage Engines

/etc/riak/app.config

- Storage Engine

```
 %% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

- About Storage Engines
  - Riak has pluggable storage engines. (Bitcask, Innostore, LevelDB)

/etc/riak/app.config

- Storage Engine

```
 %% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

- About Storage Engines
  - Riak has pluggable storage engines. (Bitcask, Innostore, LevelDB)
  - Different engines have different tradeoffs.

/etc/riak/app.config

- Storage Engine

```
 %% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

- About Storage Engines
  - Riak has pluggable storage engines. (Bitcask, Innostore, LevelDB)
  - Different engines have different tradeoffs.
  - Engine selection depends on shape of data.

/etc/riak/app.config

- Storage Engine

```
%% Storage_backend specifies the Erlang module defining the storage
%% mechanism that will be used on this node.
{storage_backend, riak_kv_bitcask_backend},
```

- About Storage Engines
  - Riak has pluggable storage engines. (Bitcask, Innostore, LevelDB)
  - Different engines have different tradeoffs.
  - Engine selection depends on shape of data.
  - More on this later.

/etc/riak/app.config

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

- File Locations

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

- File Locations

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

- File Locations

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

- File Locations

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

- File Locations

```
%% Bitcask Config
{bitcask, [
            {data_root, "data/bitcask"}
          ]},

{eleveldb, [
             {data_root, “data/leveldb”}
           ]},
```

/etc/riak/app.config

```
%% http is a list of IP addresses and TCP ports that the
Riak
%% HTTP interface will bind.
{http, [ {"127.0.0.1", 8091 } ]},


%% pb_ip is the IP address that the Riak Protocol Buffers
interface
%% will bind to.  If this is undefined, the interface will
not run.
{pb_ip,   "127.0.0.1" },

%% pb_port is the TCP port that the Riak Protocol Buffers
interface
%% will bind to
{pb_port, 8081 },
```

/etc/riak/app.config

- HTTP & Protocol Buffers

```
%% http is a list of IP addresses and TCP ports that the
Riak
%% HTTP interface will bind.
{http, [ {"127.0.0.1", 8091 } ]},


%% pb_ip is the IP address that the Riak Protocol Buffers
interface
%% will bind to.  If this is undefined, the interface will
not run.
{pb_ip,   "127.0.0.1" },

%% pb_port is the TCP port that the Riak Protocol Buffers
interface
%% will bind to
{pb_port, 8081 },
```

Securing Riak

Securing Riak

- Overview

Securing Riak

- Overview
    - Erlang has a “cookie” for “security.”

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.
  - Riak assumes internal environment is trusted.

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.
  - Riak assumes internal environment is trusted.
- Securing the HTTP Interface

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.
  - Riak assumes internal environment is trusted.
- Securing the HTTP Interface
  - HTTP Auth via Proxy

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.
  - Riak assumes internal environment is trusted.
- Securing the HTTP Interface
  - HTTP Auth via Proxy
  - Does support SSL

Securing Riak

- Overview
  - Erlang has a “cookie” for “security.”
    - Do not rely on it. Plain text.
  - Riak assumes internal environment is trusted.
- Securing the HTTP Interface
  - HTTP Auth via Proxy
  - Does support SSL
- Securing Protocol Buffers

Securing Riak

- Overview
    - Erlang has a “cookie” for “security.”
        - Do not rely on it. Plain text.
    - Riak assumes internal environment is trusted.
- Securing the HTTP Interface
    - HTTP Auth via Proxy
    - Does support SSL
- Securing Protocol Buffers
    - No security.

Load Balancing

Load Balancing

- Overview

Load Balancing

- Overview
  - Any node can handle any request.

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP
  - HAProxy, nginx, etc...

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP
  - HAProxy, nginx, etc...
- Load Balancing Protocol Buffers

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP
  - HAProxy, nginx, etc...
- Load Balancing Protocol Buffers
  - Any TCP Load Balancer

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP
  - HAProxy, nginx, etc...
- Load Balancing Protocol Buffers
  - Any TCP Load Balancer
- In General

Load Balancing

- Overview
  - Any node can handle any request.
  - Makes load balancing easy.
- Load Balancing HTTP
  - HAProxy, nginx, etc...
- Load Balancing Protocol Buffers
  - Any TCP Load Balancer
- In General
  - Use “least connected” strategy.

Storage Backends

There are 5 to choose from

There are 5 to choose from

- Bitcask

There are 5 to choose from

- Bitcask
- Innostore

There are 5 to choose from

- Bitcask
- Innostore
- LevelDB

There are 5 to choose from

- Bitcask
- Innostore
- LevelDB
- Memory

There are 5 to choose from

- Bitcask
- Innostore
- LevelDB
- Memory
- Multi

Bitcask

Bitcask

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Cluster Capacity Planning

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  - All clients support HTTP, some support PB.

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  - http://wiki.basho.com/Benchmarking-with-Basho-Bench.html

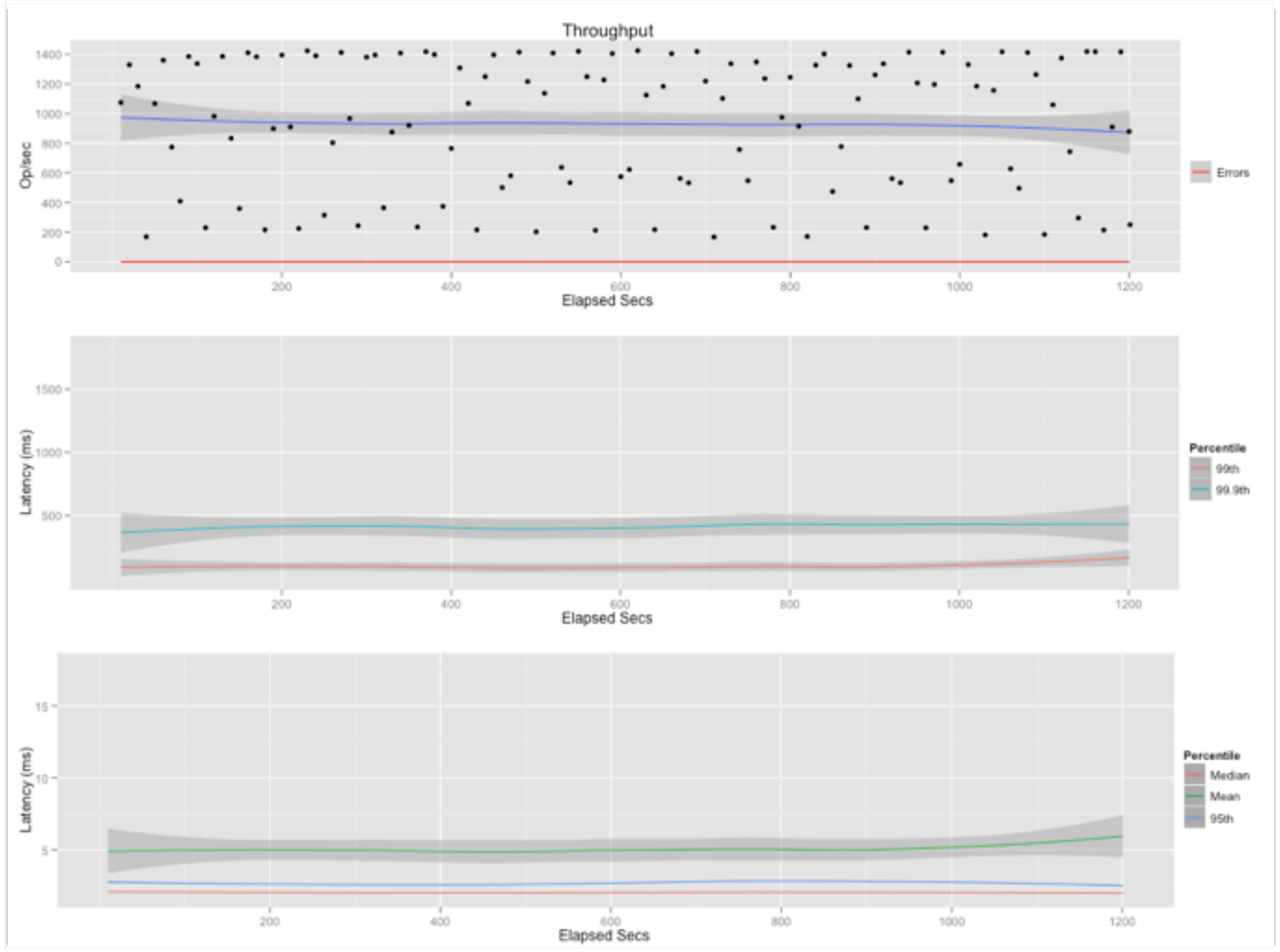
basho_bench: Configuration

```erlang
{mode, max}.
{duration, 20}.
{concurrent, 3}.
{driver, basho_bench_driver_http_raw}.
{code_paths, ["deps/ibrowse"]}.
{key_generator, {int_to_bin,
{uniform_int, 50000000}}}.
{value_generator, {fixed_bin, 5000}}.
{http_raw_port, 8098}.
{operations, [{insert, 1}]}.
{source_dir, "foo"}.
```

basho_bench: Results

```
elapsed, window, total, successful, failed
10, 10, 10747, 10747, 0
20, 10, 13295, 13295, 0
30, 10, 11840, 11840, 0
40, 10, 1688, 1688, 0
50, 10, 10675, 10675, 0
60, 10, 13599, 13599, 0
70, 10, 7747, 7747, 0
80, 10, 4089, 4089, 0
90, 10, 13851, 13851, 0
100, 10, 13374, 13374, 0
110, 10, 2293, 2293, 0
120, 10, 9813, 9813, 0
130, 10, 13860, 13860, 0
140, 10, 8333, 8333, 0
150, 10, 3592, 3592, 0
160, 10, 14104, 14104, 0
170, 10, 13834, 13834, 0
...snip...
```

basho_bench: Results



Monitoring

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Logs

```
{lager, [
            %% What handlers to install with what arguments
            {handlers, [
                {lager_console_backend, info},
                {lager_file_backend, [
                    {"./log/error.log", error},
                    {"./log/console.log", info}
                ]}
            ]},
            %% Whether to write a crash log, and where.
            %% Commented/omitted/undefined means no crash
logger.
            {crash_log, "./log/crash.log"},
            %% Maximum size in bytes of events in the crash log.
            %% Default is 64kb.
            {crash_log_size, 65536},
            %% Whether to redirect error_logger messages into
lager - defaults to true
            {error_logger_redirect, true}
        ]},
```

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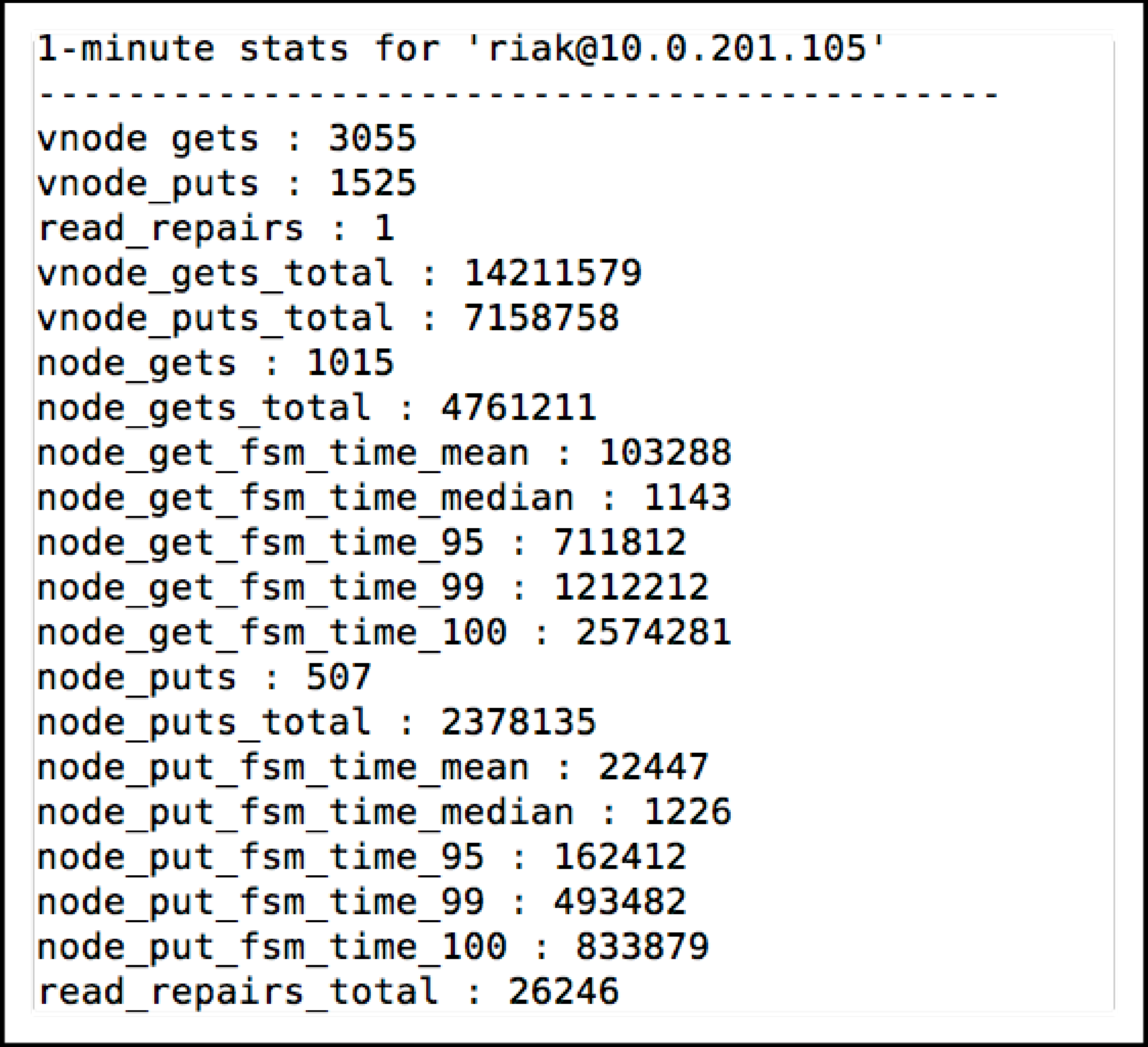

```
1-minute stats for 'riak@10.0.201.105'
-------------------------------------------
vnode_gets : 3055
vnode_puts : 1525
read_repairs : 1
vnode_gets_total : 14211579
vnode_puts_total : 7158758
node_gets : 1015
node_gets_total : 4761211
node_get_fsm_time_mean : 103288
node_get_fsm_time_median : 1143
node_get_fsm_time_95 : 711812
node_get_fsm_time_99 : 1212212
node_get_fsm_time_100 : 2574281
node_puts : 507
node_puts_total : 2378135
node_put_fsm_time_mean : 22447
node_put_fsm_time_median : 1226
node_put_fsm_time_95 : 162412
node_put_fsm_time_99 : 493482
node_put_fsm_time_100 : 833879
read_repairs_total : 26246
```

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Rolling Upgrades

- Overview
  - You can upgrade Riak without taking down cluster.
  - Instead, take down one node at a time. Stay read/write available.
- Steps
  1. Stop node.
  2. Back up configuration and data directories. (If possible.)
  3. Install new package.
  4. Start node.
  5. Do next node.
- Documentation
  - http://wiki.basho.com/Rolling-Upgrades.html

EC2 and EBS

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- There are MANY successful deployments

Troubleshooting

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  - `/var/lib/riak/ring`

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  - http://wiki.basho.com/Recovering-a-failed-node.html