Riak Core

An Erlang Distributed Systems Toolkit

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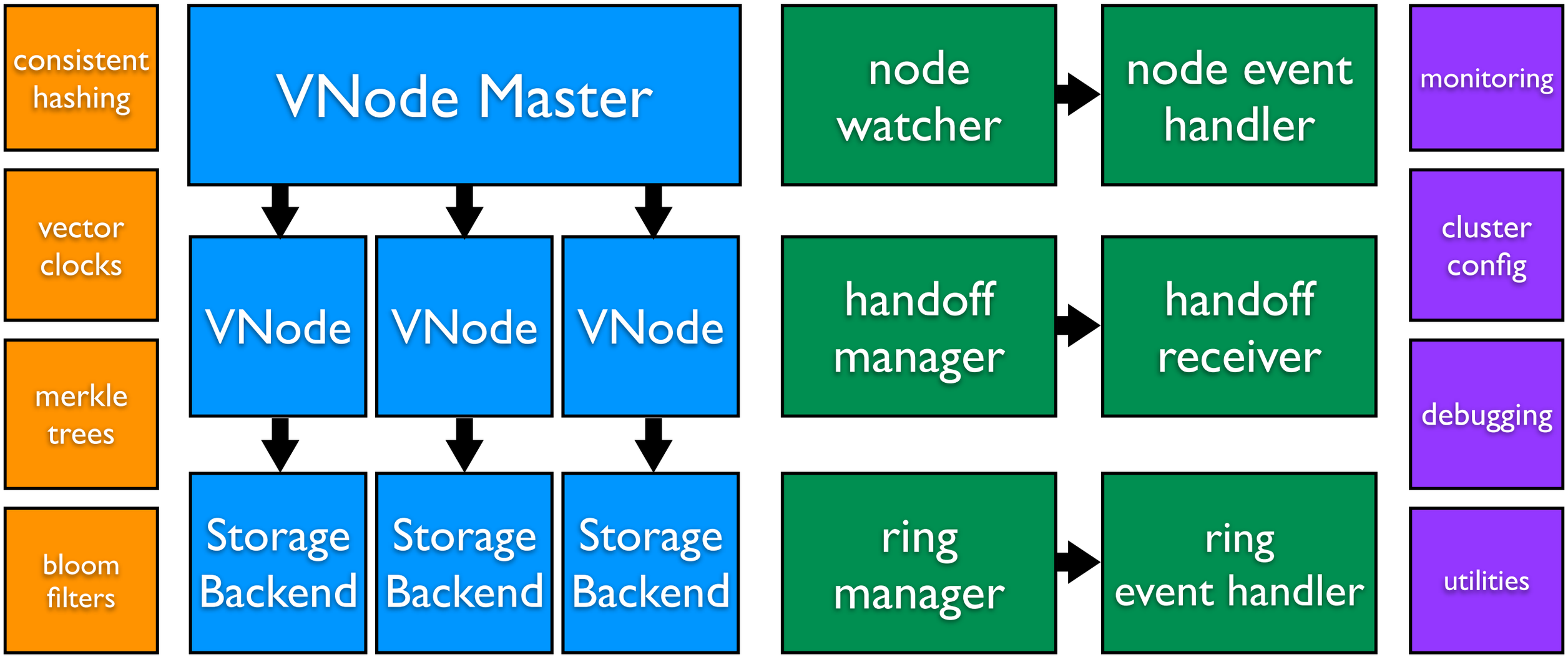
SF Bay Erlang Factory 2011

Déjà vu

- 1999, Akamai: Large-scale log aggregation: consistent hashing, cluster membership, node monitoring
- 2005, Apple: Distributed filesystem: consistent hashing, cluster membership, node monitoring
- 2007, Mochi Media: Various apps: cluster membership, node monitoring

Riak Core

- Toolkit for writing highly-available distributed systems (based on Dynamo)
- Foundation of Riak KV and Riak Search
- ~8000 LOC
- Tested, production ready


consistent hashing
vector clocks
merkle trees
bloom filters
VNode Master
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node watcher
node event handler
handoff manager
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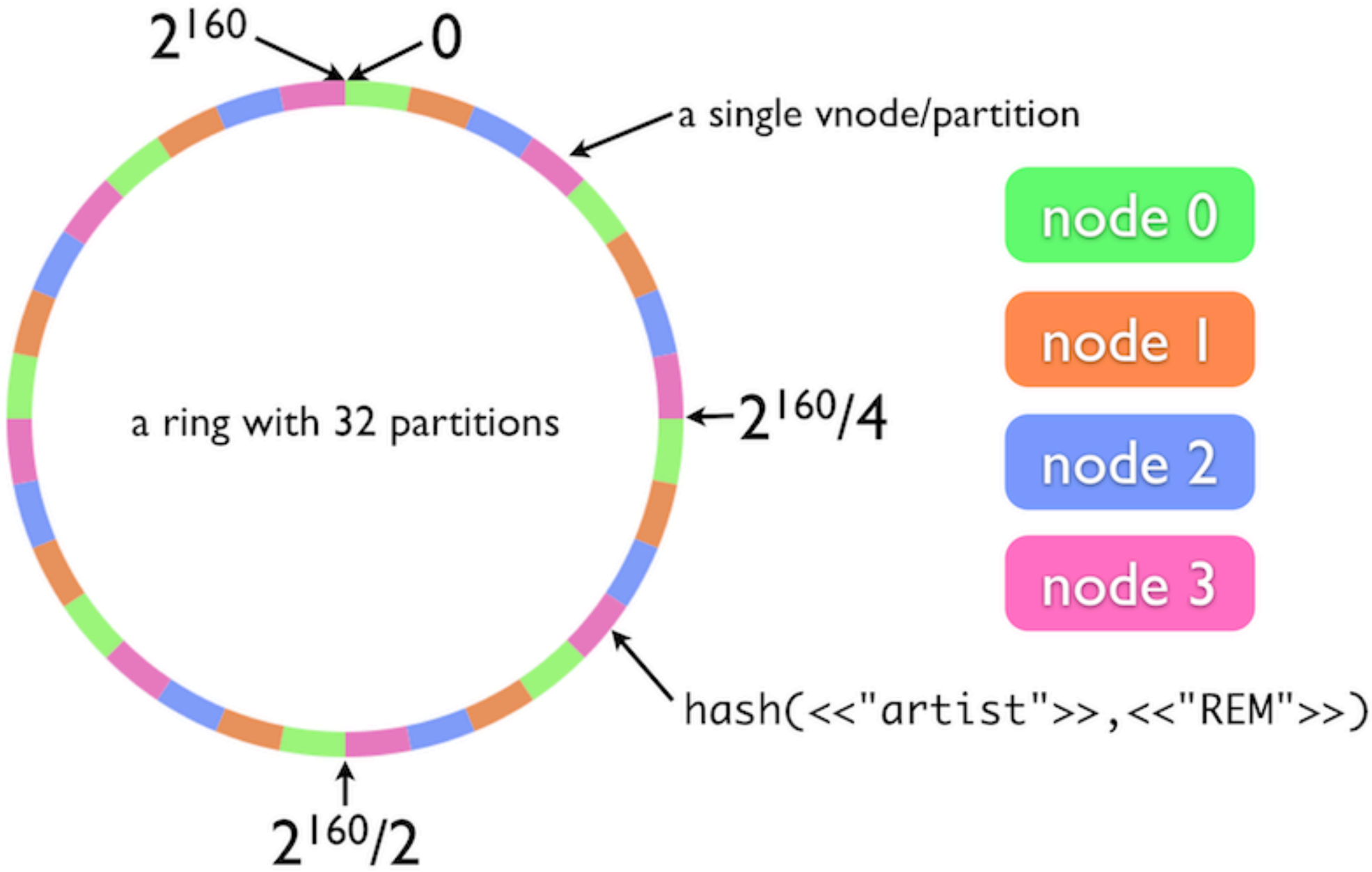
Consistent Hashing

- Hashing technique that suffers minimal reshuffling when # of buckets changes
- Tolerant of divergent client views
- Coordinates both replica selection and replication

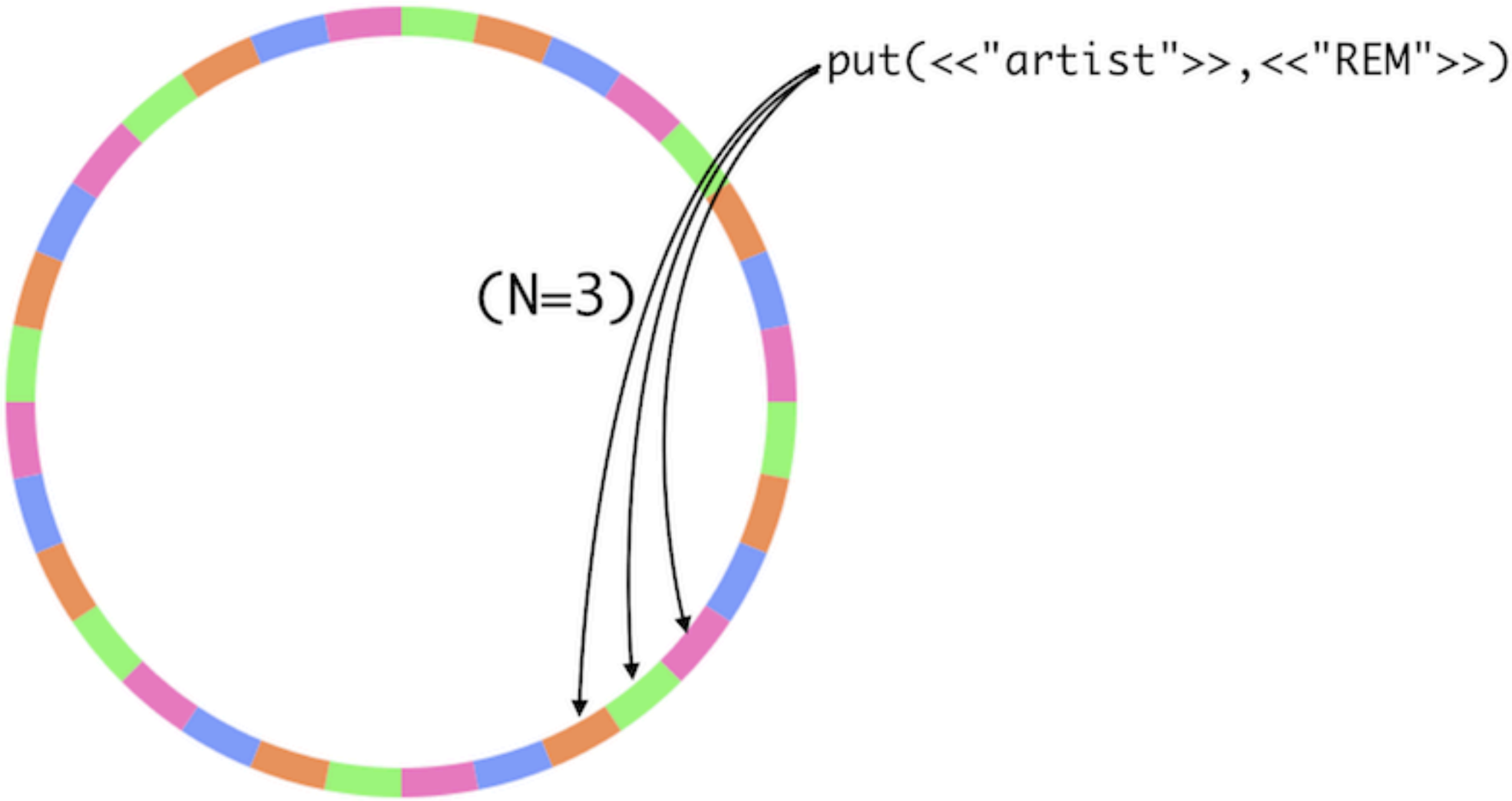
Consistent Hashing



N/R/W Values

- N = number of replicas to store (on distinct nodes)
- R = number of replica responses needed for a successful read (specified per-request)
- W = number of replica responses needed for a successful write (specified per-request)

N/R/W Values



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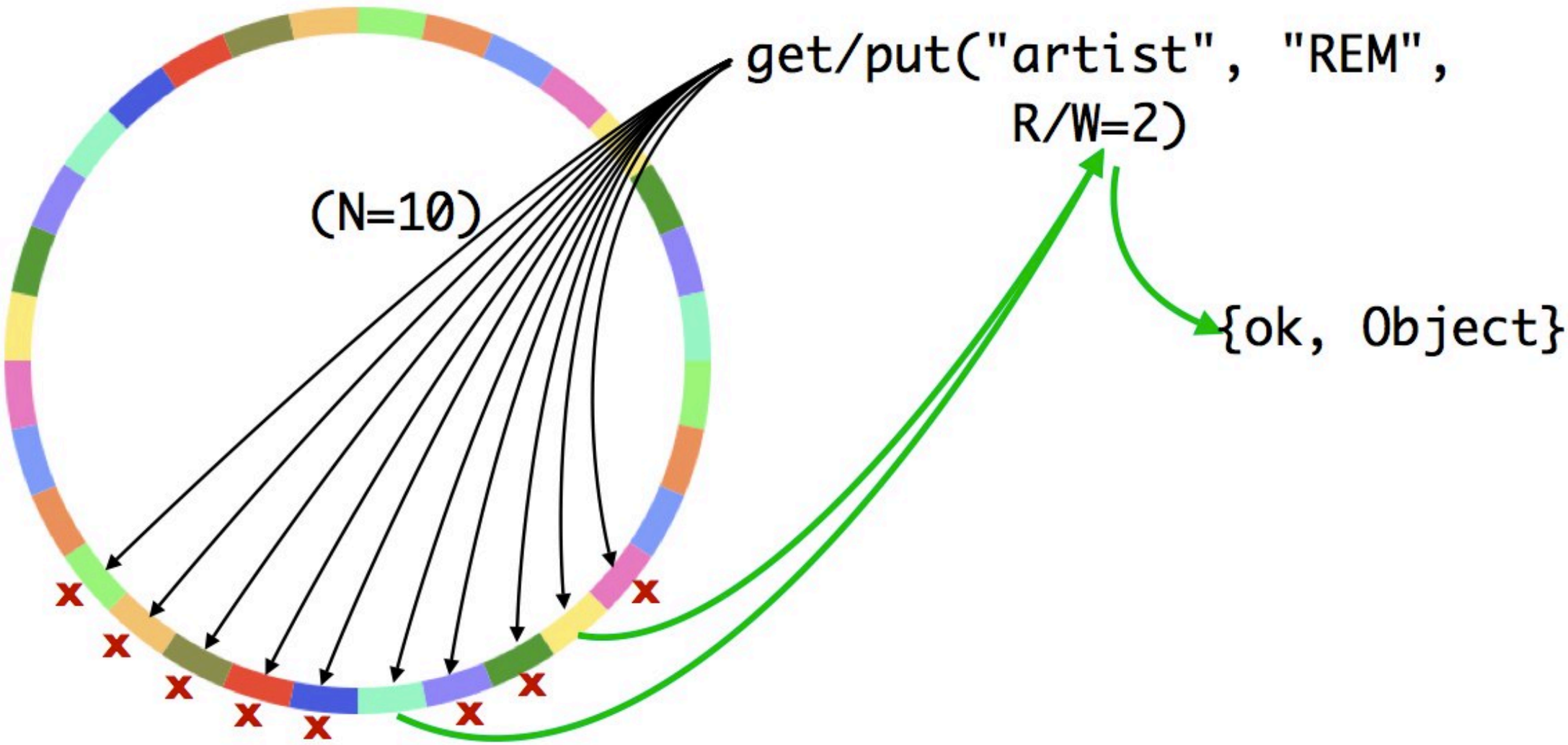
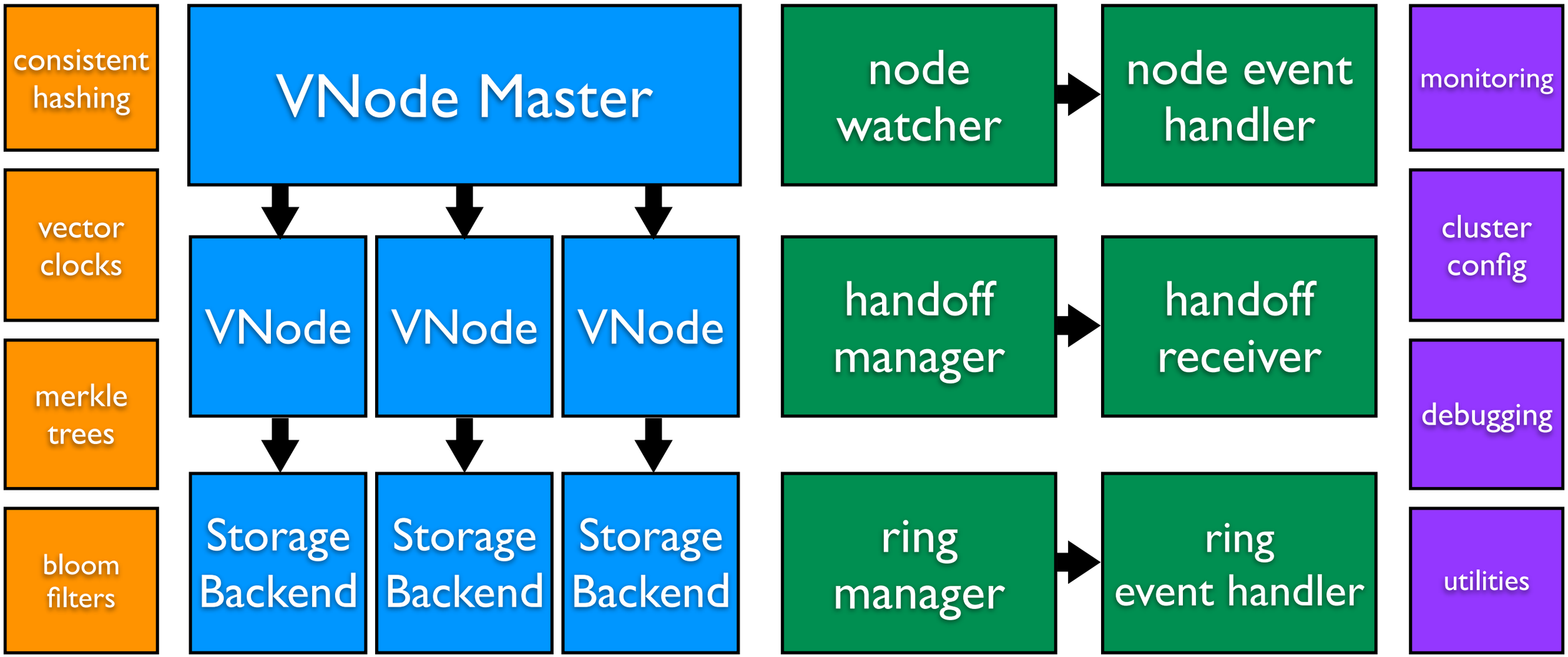


Vector Clocks

- Reasoning about time and causality in distributed systems is hard
- Integer timestamps don't necessarily capture causality
- Vector clocks provide a *happens-before* relationship between two events

Vector Clocks

- Simple data structure: [(ActorID,Counter)]
- All data has an associated vector clock, actors update their entry when making changes
- ClockA happened-before ClockB if all actor-counters in A are less than or equal to those in B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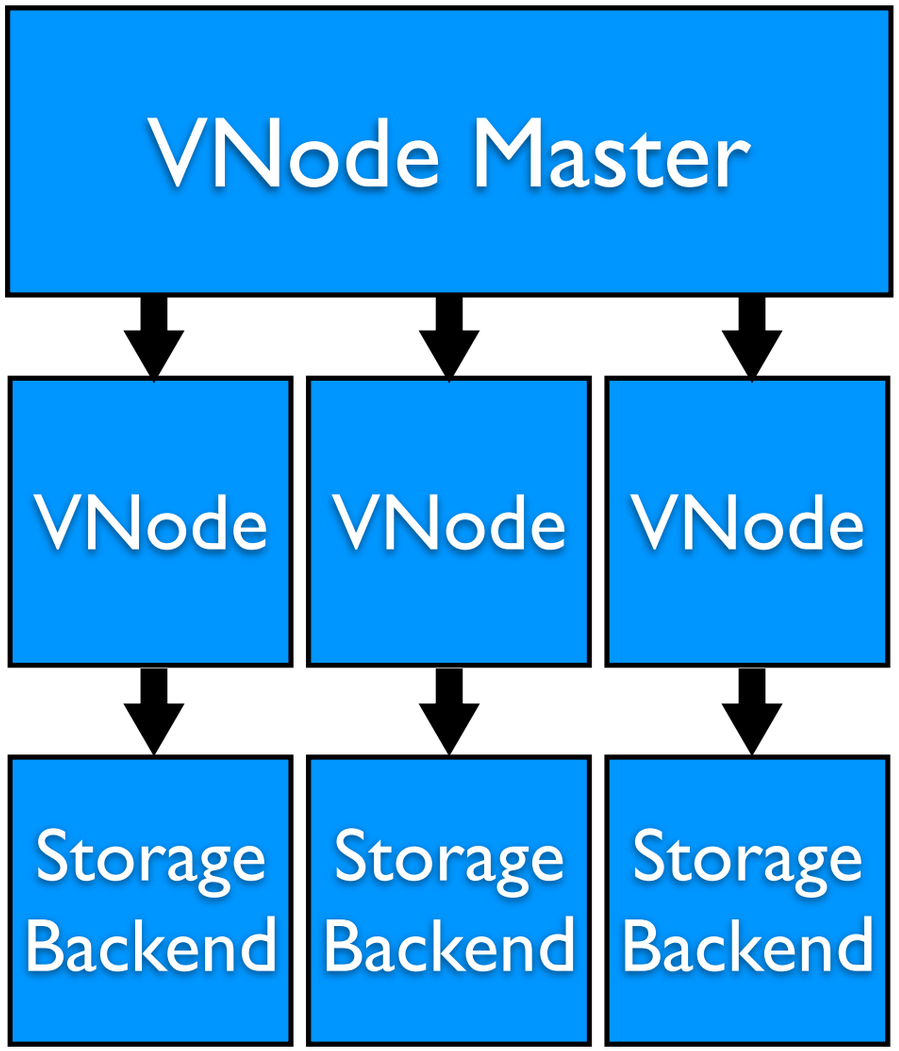

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ring manager → ring event handler

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Virtual Node Master

- Receives messages from coordinating FSMs
- Translates partition numbers to local PIDs and dispatches commands to individual vnodes
- One *vnode_master* per virtual node type (Riak KV, Riak Search)

Virtual Nodes

- One Erlang process per partition in the consistent hashing ring
- Receives work for its portion of the hash space
- Fundamental unit of replication, fault tolerance, concurrency

Virtual Node Behavior

```
-spec behaviour_info(atom()) -> 'undefined' | [{atom(), arity()}].
behaviour_info(callbacks) ->
    [{init,1},
     {handle_command,3},
     {handoff_starting,2},
     {handoff_cancelled,1},
     {handoff_finished,2},
     {handle_handoff_command,3},
     {handle_handoff_data,2},
     {encode_handoff_item,2},
     {is_empty,1},
     {terminate,2},
     {delete,1}];
behaviour_info(_Other) ->
    undefined.
```

Writing VNode Modules

- Define commands and handlers
- Define handoff behavior
- Start a riak_core_vnode_master for the vnode module
- *riak_core:register_vnode_module(VNodeMod)*

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utilities

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Node/Service Watcher

- *gen_event* process for monitoring nodes and local services
- Allows administrative removal of nodes
- Allows distributed applications to define services - service availability info is synchronized among nodes
- Used in the calculation of fallback nodes

Ring Manager

- Stores local copy of gossiped ring data
- Optimized for frequent reads, infrequent writes (using mochiglobal)
- Client applications manipulate ring data, Riak Core handles gossip/conflict resolution

Ring Event Handler

- gen_event that receives notifications on ring changes and broadcasts to subscribers
- Notifications of cluster membership changes
- Notifications of metadata changes

Handoff

- VNodes periodically check to see if they're not on their "home" node and attempt handoff.
- Riak Core manages handoff connection management, your app handles encoding/decoding.
- Handoff is optional.

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handoff receiver

ring manager

ring event handler

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cluster config

debugging

utilities

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vector clocks

merkle trees

bloom filters

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VNode

VNode

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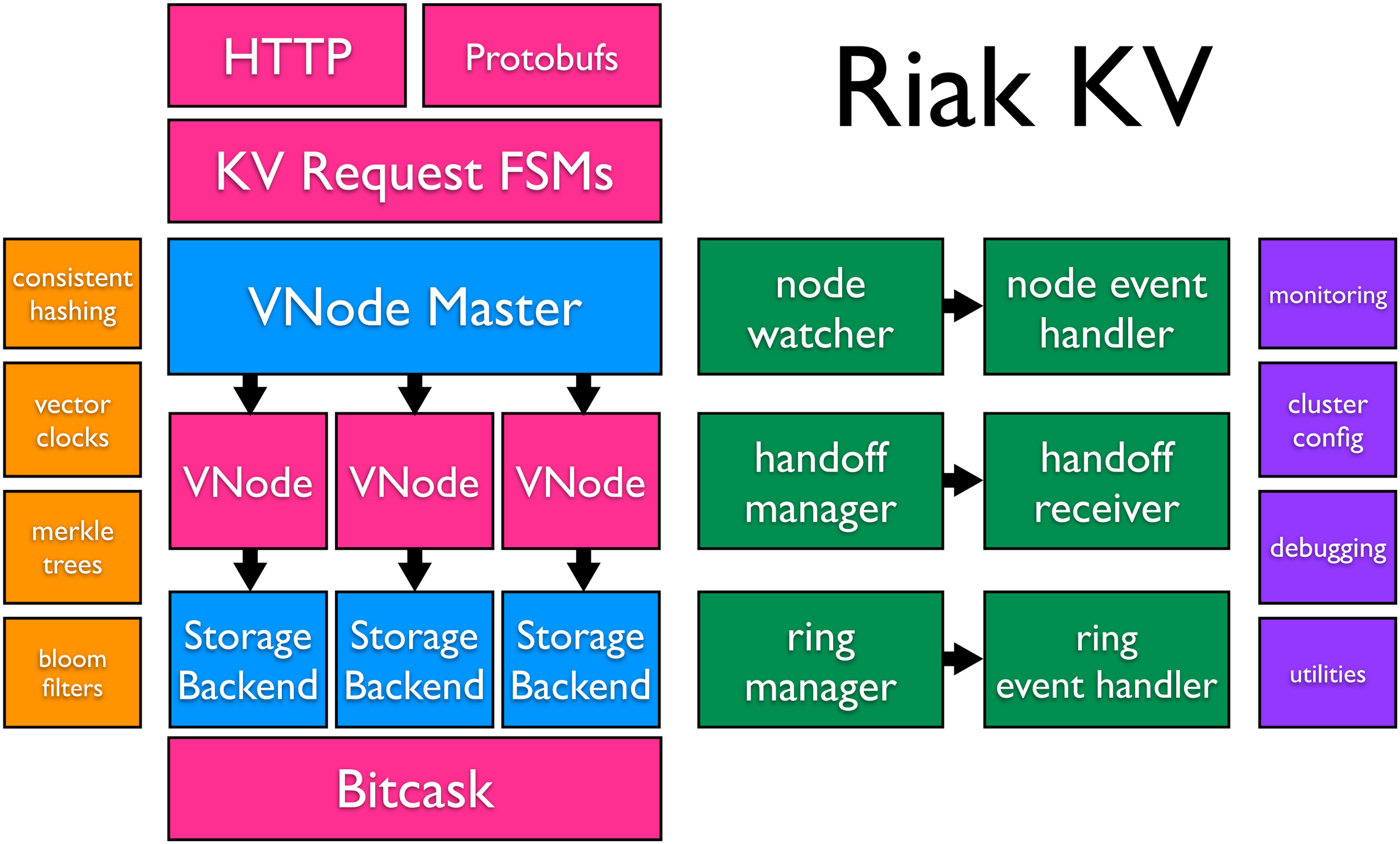
Other Utilities

- System monitoring
- Statistical data structures
- Utilities for
  - inter-node communication
  - tracing/debugging
  - vector clock/preference list manipulating

Riak KV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KV Request FSMs
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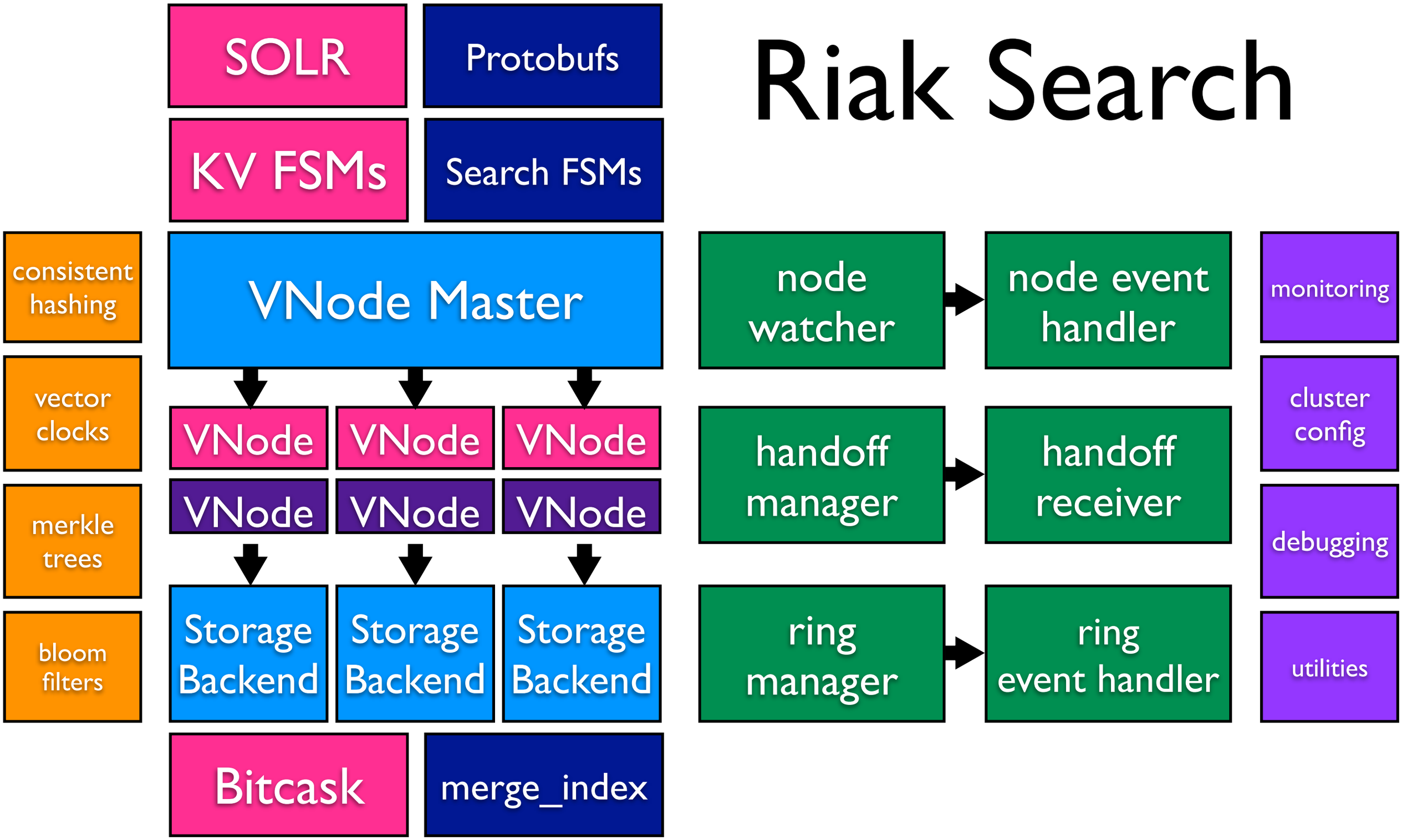
Riak Search


SOLR
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Search FSMs
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VNode Master
node watcher
node event handler
monitoring
vector clocks
VNode
VNode
VNode
cluster config
merkle trees
VNode
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VNode
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Bitcask
merge_index

Future Directions

- Easier creation of new Riak Core based apps
- HTTP APIs for more functionality
- Stronger consistency support?

Greenspun's Tenth Rule

"Any sufficiently complicated C or Fortran program contains an ad hoc, informally-specified, bug-ridden, slow implementation of half of Common Lisp"

Armstrong's Corollary

"Any sufficiently complicated concurrent program in another language contains an ad hoc, informally-specified, bug-ridden, slow implementation of half of Erlang"

Basho's Corollary

"Any sufficiently complicated Erlang distributed system contains an ad hoc, informally-specified, bug-ridden, slow implementation of half of Riak Core"

Thanks!