BlkKin: A Low-overhead tracing infrastructure for software-defined storage systems

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Outline

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3. Background

Thesis Background

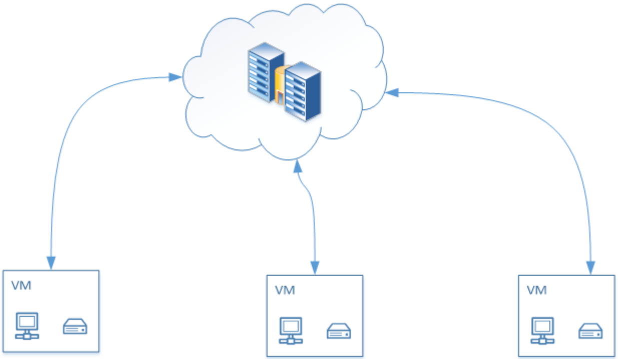
synnefo

Open source, production-ready, cloud software.
Designed since 2010 by GRNET.

okeanos

- IaaS service
- Targeted at the Greek Academic and Research Community
- Designed by GRNET
- In production since 2011

VM Volume storage

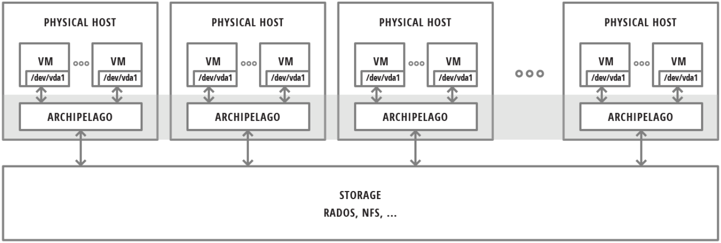


Archipelago I

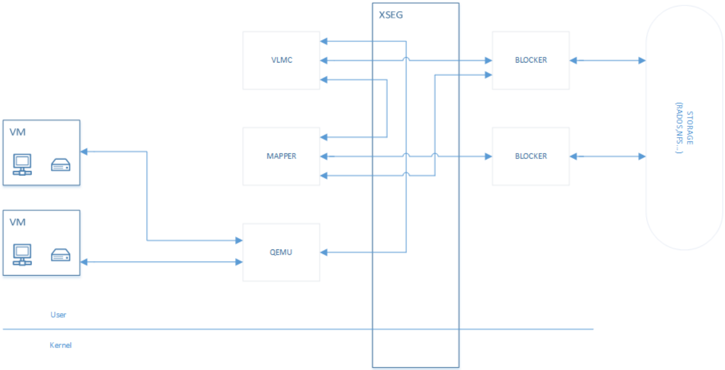
A thin distributed storage layer aiming to:

- Decouple storage logic from the actual data store
- Provide logic for thin cloning and snapshotting
- Provide logic for deduplication
- Provide different endpoint drivers to access Volumes and Files
- Provide backend drivers for different storage technologies

Archipelago II



Archipelago III



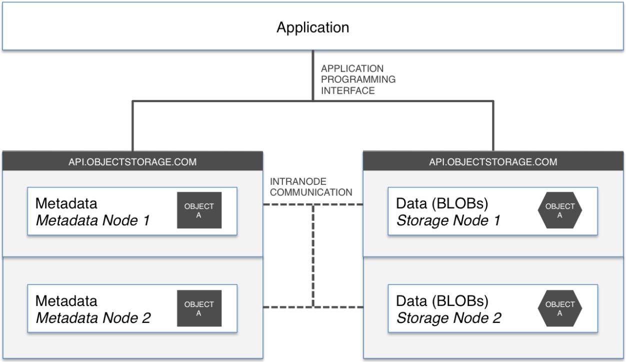
RADOS

is the storage component of Ceph

RADOS basic characteristics are:

- *Replication*
- *Fault tolerance*
- *Self-management*
- *Scalability*

Storage Abstraction



The Problem

- Complex service oriented architectures
- Difficult debugging
- Difficult monitoring
- Non-deterministic execution
- Context-bound faults

Solution

Distributed end-to-end tracing

&

Central data collection

BlkKin

A distributed tracing infrastructure to track the IO request from Qemu until RADOS

BlkKin main characteristics:

- low-overhead tracing
- live-tracing
- End-to-end tracing of causal relationships
- User interface

Main Challenges

- Meaningful and easily correlated tracing data
- Low overhead tracing backend

Schools of thought

black-box schemes
: They assume there is no additional information other than the message record described above and use statistical regression techniques to infer that association.

annotation-based schemes
: They rely on applications or middleware to explicitly tag every record with a global identifier that links these message records back to the originating request.

The Dapper System

- Large scale distributed systems tracing infrastructure created by Google
- Annotation-based tracing scheme
- Common libraries instrumentation
    - RPC System
    - Control Flow
- BigTable backend
- Closed-source

Dapper tracing concepts

annotation The actual information being logged. Either *timestamp* or *key-value*

span The basic unit of the process tree. Can represent a subsystem or a function call. To depict causal relationship each span has a parent span or is a *root* span.

trace A different trace id is used to group data related to he same initial request

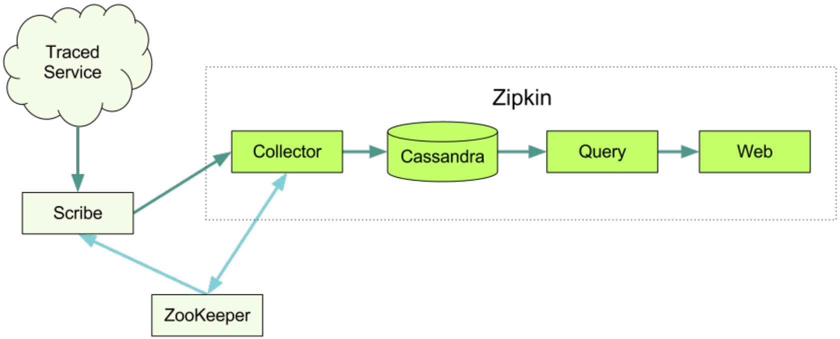
Zipkin

An open-source Scala implementation of the Dapper paper by Twitter

Zipkin services:

- Data collector
- Database service
- Web UI

Zipkin Architecture



Scribe

Scribe is a scalable and reliable logging server created by Facebook

- Written in C++
- Directed graph architecture
- Batch messaging
- HDFS support
- Based on Apache Thrift

Thrift

A software framework for scalable cross-language services development.

Includes a code generation engine to create RPC services across programming languages based on a Thrift file

Sample target languages: C++, Java, Python, PHP, Ruby, Erlang, Perl, Haskell, OCaml

Zipkin sum up

Zipkin is a full stack tracing system using

Scribe as its logging server using

Thrift as its transport protocol

Tracing

> “Tracing is a specialized use of logging to record information about a program’s execution”
>
> Wikipedia

Tracing characteristics:

- Tracing can be low level (eg. kernel tracing, access to preformance counters)
- Tracing has mostly debuggin purposes and performance tuning
- Tracing may produce notoriously bulky output

Tracing Systems

DTrace

Released by Sun Microsystems in 2005

SystemTap

Released by Red Hat in 2005

Advantages:

- Dynamic Instrumentation
- User and kernel tracing

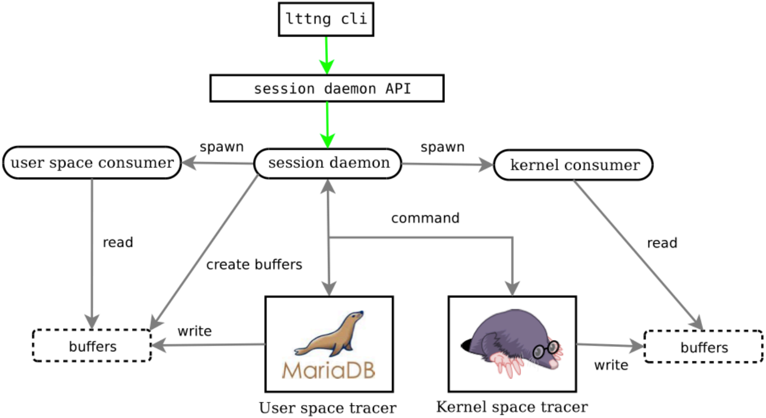
Disadvantages:

- User tracing is based or system calls or breakpoints
- Significant performance overhead
- Inappropriate for live tracing

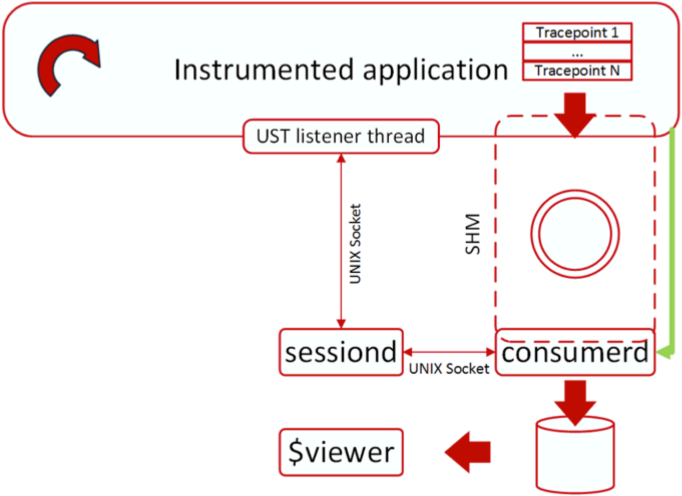
Linux Trace Toolkit - next generation

- successor of Linux Trace Toolkit
- Mathew Desnoyers PhD dissertation in Ecole Polytechnique de Montreal
- maintained by EfficiOS Inc1and the DORSAL lab in Ecole Polytechnique de Montreal.
- Unified user and kernel tracing
- Low overhead tracing based on Tracepoints
- Static instrumentation
- Live tracing

LTTng Architecture



UST architecture



CTF and Babeltrace