COSBench User Guide

Version 2.6.2

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This document describes how to install, configure, and run COSBench (a cloud storage benchmark tool) step by step, explains how to define workloads using configuration files, and provides reference examples.

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Contents

Revision History

Revision	Date	Description
0.5	July 14, 2012	Initial version
0.6	July 18, 2012	Add “init” and “dispose” stages in AmpliStor* example and description for special stages
0.7	July 20, 2012	Add “nsroot” to storage parameter list to access AmpliStor v2.5 namespace; by default, it’s “/namespace”, set to “/manage/namespace” for v2.5
0.8	July 24, 2012	Change default listening ports: • 8088->18088 • 8089->18089 • 9088->19088 • 9089->19089
0.9	August 1, 2012	Change example port numbers to 19088 and 18088 to avoid confusion
1.0	August 9, 2012	Add one section to describe data results and one section for FAQs
1.1	August 13, 2012	• Add one paragraph in result to explain metrics • Modify AmpliStor sample to reflect v2.5 needs • Add parameter list
1.2	August 24, 2012	Enhance content based on internal and external user feedback
1.3	August 30, 2012	• Add Red Hat screenshot • Change runtime from 60 to 300 for AmpliStor example to avoid confusion • Remove internal link for package downloading • Fix one bug in “cleanup” stage of Swift sample
1.4	September 14, 2012	Fix inconsistencies
1.5	September 17, 2012	Change default OS to Ubuntu* 12.04.1 LTS desktop

Revision	Date	Description
1.6	November 2, 2012	Major modifications: • Transfer all scripts to Ubuntu 12.04.1 compatible • Add OS installation steps • Add object integrity check parameter • Add details about selector description • Add details about directory structure • Move workload configuration section from Appendix A to main body
1.7	November 13, 2012	Minor modifications: • Correct batch script names • Add one item in FAQ for handling “OOM” error
1.8	November 20, 2012	Change parameter “url” to “auth_url” for swauth and keystone to avoid confusion
1.9	January 14, 2013	• Add parameter “tenant_name” for keystone • Add items in FAQ to explain testing with large objects
2.0	January 25, 2013	• Correct two minor typographic errors • Add explanation about histogram data • Reword FAQ #12
2.1	February 19, 2013	• Constrain supported AmpliStor versions to v2.3 and v2.5 • Minor formatting modifications

Revision	Date	Description
2.2	March 7, 2013	• Fix one typo from “apt-get” to “apt-get install” • Correct one word from “turn-around point” to “tipping point” • Add section 6.1.14 for how to split read/write • Enhance section 6.1.6 for how to reuse data • Minor rewording from “policy” to “policy UID” in section 6.3.1 • Enhance section 6.1.7 for configuring multiple same stages • Add section 6.3.3 for how to simplify policy UID setting
2.3	March 8, 2013	• Add explanation about using “ps” in section 3.7 • Add explanation about how to do pre-test in section 6.2.2 • Reword section 6.1.12 to explain conditions for using only one worker • Replace “Excel” with “spreadsheet program” in section 5.2.2 • Add case for multiple client daemons in AmpliStor section of Appendix A • Add explanation for what commands do in section 2.2.2 • Add example controller configuration to show multiple drivers supporting in section 3.2.1 • Correct one typographic error in section 6.1.9
2.4	March 13, 2013	• Change “enlarging” to “expanding” and add example
2.5	March 29, 2013	• Change “127.0.0.1” to “192.168.250.36” in text and screen captures of sections 2.4.3, 3.5, 3.6, 4.4.3, and Appendix A • Add AmpliStor v3.1 in section 1.1 • Remove mention of licensing in section 2.3.1

Revision	Date	Description
2.6	April 7, 2013	• Add package list information in section 2.1 and provide one separate pkg.lst • Add “retry” parameter for auth to overcome failures at high concurrent requests for authentication. • Change “mandatory” to “required” in section 3.2.1

1 Introduction

COSBench is a distributed benchmark tool to test cloud object storage systems. It supports OpenStack* Swift and Amplidata AmpliStor* v2.3, v2.5, and 3.1. COSBench also allows users to create adaptors for additional storage systems. Please refer to the “COSBench Adaptor Development Guide” for details.

COSbench consists of two key components:

- Driver (also referred to as COSBench Driver or Load Generator):
  - Responsible for workload generation, issuing operations to target cloud object storage, and collecting performance statistics.
  - Can be accessed via http://<driver-host>:18088/driver/index.html.
- Controller (also referred to as COSBench Controller):
  - Responsible for coordinating drivers to collectively execute a workload, collecting and aggregating runtime status or benchmark results from driver instances, and accepting workload submissions.
  - Can be accessed via http://<controller-host>:19088/controller/index.html.

The controller and driver can be deployed on the same node or different nodes, and the node can be a physical machine or virtual machine (VM) instance.

Intel source code for COSBench is being released under the Apache 2.0 license.

A Google Groups mailing list has been established for COSBench at the following location: https://groups.google.com/forum/?fromgroups=#!forum/cosbench.

1.1 Reference Hardware Configuration

The hardware configurations used for validation purposes in Intel labs are given below. This information is provided for reference only, as the appropriate systems for various implementations are highly dependent upon individual usage scenarios. Also note that network resources play a vital role in COSBench implementations.

Hardware	Configuration
Controller	
Processor	Two Intel® Xeon® processors X5570 @ 2.93 GHz
RAM	12 GB RAM
Storage	1x 120 GB+ disk drive
Network	Intel® 82574 Gigabit Ethernet Controller

Driver	
Processor	Two Intel Xeon processors X5570 @ 2.93 GHz
RAM	12 GB RAM
Storage	1x 50 GB+ disk drive
Network	Intel® 82599 10 Gigabit Ethernet Controller

1.2System Requirements

NOTE: The current release of COSBench features Ubuntu* 12.04.1 LTS Desktop, but the COSBench development team assumes that organizations will install using various OSs and contribute related feedback to the community.

- Ubuntu 12.04.1 LTS Desktop
- Java* Runtime Environment 1.7 or later
- Curl 7.22.0 or later
- Free TCP port (ensure these ports are accessible non-locally):
  - On COSBench controller machine: 19088
  - On COSBench driver machines: 18088

NOTE: Throughout this document, command line is **bolded** and *italicized;* yellow text is used for emphasis, to draw attention to specific information.

1.3What's in the Rest of This Guide

This document describes how to install, configure, and use COSBench, a cloud storage benchmarking tool.

- Section 2 covers the initial installation and testing of COSBench.
- Section 3 explains how to configure and run the tool.
- Section 4 instructs the user about how to define workloads.
- Section 5 explains the results provided by COSBench and how to interpret them.
- Section 6 answers frequently asked questions.
- Appendix A provides sample configurations for different storage systems.

2 Installing COSBench

2.1 Installing the Operating System

1. Download Ubuntu Desktop 12.04.1 LTS.
2. Follow the instructions in the Ubuntu installation guide.
3. Below are screenshots from major steps during installation, which include the creation of one user named "cosbench"; all other settings may be left at their defaults or modified at the user's discretion.

4. The final package list after installation can be found in the file "pkg.lst" on the github site.

2.1.1 Installing the Java Runtime Environment (JRE)

- OpenJDK is the default JRE; Oracle JRE should also work.
- If an Internet connection is available, the package can be installed through apt-get as follows:

```
cosbench@cosbox:~$ sudo apt-get update
cosbench@cosbox:~$ sudo apt-get install openjdk-7-jre
```

- If no Internet connection is available, the JRE can be installed using Debian* software packages; two packages are essential: JRE-LIB and JRE-HEADLESS.
- Those packages can be installed as follows (this procedure uses "/tmp" as an example; a different folder may be used at the user's discretion):

```
cosbench@cosbox:/tmp$ sudo dpkg –i –force depends openjdk-7-jre-lib_7u7-2.3.2a-0ubuntu0.12.04.1_all.deb
(Reading database ...


cosbench@cosbox:/tmp$ sudo dpkg –i –force depends openjdk-7-jre-headless_7u7-2.3.2a-0ubuntu0.12.04.1_amd64.deb
Selecting previously unselected package openjdk-7-jre-headless ...


cosbench@cosbox:/tmp$ java –showversion
java version "1.7.0_07"
...
```

2.1.2Installing Curl

- If an Internet connection is available, Curl can be installed as follows:

```
cosbench@cosbox:~$ sudo apt-get update
cosbench@cosbox:~$ sudo apt-get install curl
```

- If no Internet connection is available, install Curl using Debian software packages:

```
cosbench@cosbox:/tmp$ sudo dpkg –i curl_7.22.0-3ubuntu4_amd64.deb


cosbench@cosbox:/tmp$ curl –V
curl 7.22.0 (x86_64-pc-linux-gnu) ...
```

2.2Installing COSBench

2.2.1Preparation

In the current release, the COSBench controller and driver are combined; they do not each have a separate package.

Obtain the installation package **<version>.zip** (e.g., 2.1.0.GA.zip) from https://github.com/intel-cloud/cosbench and place it at COSBench package under the home directory on the controller node.

2.2.2Installation

Follow the commands below to finish the installation, which unpacks the COSBench package into one folder, create one symbolic link called “cos” to it, and make all bash scripts executable:

```
cosbench@cosbox:/tmp$ cd ~
cosbench@cosbox:~$ unzip 2.1.0.GA.zip
cosbench@cosbox:~$ rm cos
cosbench@cosbox:~$ ln –s 2.1.0.GA/ cos
cosbench@cosbox:~$ cd cos
cosbench@cosbox:~$ chmod +x *.sh
```

2.3Directory Structure

2.3.1Scripts

Script	Description

start-all.sh stop-all.sh	Start/stop both controller and driver on current node
start-controller.sh stop-controller.sh	Start/stop controller only on current node
start-driver.sh stop-driver.sh	Start/stop driver only on current node
cosbench-start.sh cosbench-stop.sh	Internal scripts called by above scripts
cli.sh	Manipulate workload through command line

A few Windows* batch scripts are also included, for demonstration purposes only.

Script	Description
start-all.bat	Start both controller and driver on current node
start-controller.bat	Start controller only on current node
start-driver.bat	Start driver only on current node
Web.bat	Open controller web console through locally installed browser

2.3.2Sub-directories

Sub-directory	Description
archive	Stores all generated results; see the Results section of this document
conf	Configuration files, including COSBench configurations and workload configurations
log	Runtime log files; the important one is system.log
osgi	Contains COSBench libraries and third-party libraries
main	Contains the OSGi launcher

2.4Verifying Install

The following steps launch the controller and driver on the current node and test to ensure that the installation is correct.

2.4.1Launching COSBench

HTTP proxy breaks the interaction between controller and driver. To avoid HTTP requests routing, you need to **bypass** the proxy setting:

```
cosbench@cosbox:~$ unset http_proxy
```

Start up the COSBench driver and controller on the current node. By default, the COSBench driver listens on port 18088, and the COSBench controller listens on port 19088.

```
cosbench@cosbox:~$ sh start-all.sh
```

2.4.2Checking Controllers and Drivers

```
cosbench@cosbox:~$ netstat –an |grep LISTEN |grep 19088 # check controller.
tcp        0      0 :::19088                :::*        LISTEN

Cosbench@cosbox:~$ netstat –an |grep LISTEN |grep 18088 # check driver
tcp        0      0 :::18088                :::*        LISTEN
```

2.4.3Testing the Install

```
Cosbench@cosbox:~$ sh cli.sh submit conf/workload-config.xml # run mock test.
Accepted with ID: w1

cosbench@cosbox:~$ sh cli.sh info
Drivers:
driver1 http://127.0.0.1:18088/driver
Total: 1 drivers

Active Workloads:
W1      Thu Jul 12 04:37:31 MST 2012    PROCESSING
```

Open http://127.0.0.1:19088/controller/index.html in a browser to monitor status. In the example below, one “processing” workload is listed in the “active workloads” section.

COSBench is now successfully installed on the current node. Optionally, the workload may be cancelled and COSBench may be stopped as follows:

```
cosbench@cosbox:~$ sh cli.sh cancel w1
W1      Thu Jul 12 23:34:14 MST 2012    CANCELLED

cosbench@cosbox:~$ sh stop-all.sh
Stopping cosbench controller ...
Successfully stopped cosbench controller.

=================================================
Stopping cosbench driver ...
Successfully stopped cosbench driver.
```

2.5 Deploying COSBench

- Copy <version>.zip to the remaining COSBench nodes by means such as scp or shared folder.
- Repeat the procedures listed above for installing COSBench and verifying the installation on each node.

3 Configuring and Running

3.1 General

The COSBench controller and driver depend on different system configuration files to start up, and those configuration files are only for COSBench itself, as opposed to workload configuration.

The following table gives an overview of all the configurations COSBench expects.

Configuration	Description	File Path
controller	Configuration for a controller; read by the controller during its initialization	conf/controller.conf
driver	Configuration for a driver; read by the driver during its initialization	conf/driver.conf
workload	Configuration for a workload being submitted	Submitted via controller's web interface

3.2 Configuring the Controller

3.2.1 Conf/controller.conf

An INI format file is *required* for configuration of the COSBench controller, as in the following example:

```
[controller]
concurrency=1
drivers=3
log_level = INFO
log_file = log/system.log

[driver1]
name=driver1
url=http://192.168.10.1:18088/driver

[driver2]
name=driver2
url=http://192.168.10.2:18088/driver
```

```
[driver3]
name=driver3
url=http://192.168.10.3:18088/driver
```

[controller]

Parameter	Type	Default	Comment
drivers	Integer	1	Number of drivers controlled by this controller
concurrency	Integer	1	Number of workloads that can be executed simultaneously
log_level	String	“INFO”	“TRACE”, “DEBUG”, “INFO”, “WARN”, “ERROR”
log_file	String	“log/system.log”	Where the log file is stored

The driver section for the nth driver should be named **driver<n>** in order to be recognized.

[driver<n>]

Parameter	Type	Default	Comment
name	String		Label used to identify the driver node. Note that driver name is not necessarily the node’s hostname
url	String		Address to access the driver node

3.3Configuring the Driver

3.3.1Conf/driver.conf

This file is optional; the COSBench driver can start up without this configuration file, although the web console can’t correctly label the driver node. Configuration is an INI format file, as in the following example:

```
[driver]
name=driver1
url=http://192.168.0.11:18088/driver
```

[driver]

Parameter	Type	Default	Comment
name	String		Label used to identify the driver node; note that driver name is not necessarily the node's hostname
url	String		Address to access the driver node

3.4Starting Drivers

- Edit conf/driver.conf on driver nodes, if desired.
- By default, COSBench driver listens on port 18088.
- Launch driver on all driver nodes.

```
sh start-driver.sh
```

- Ensure that all drivers are accessible from the controller using an HTTP connection.
    - By connecting with Curl, one valid HTML file is expected in the console:

```
curl http://<driver-host>:18088/driver/index.html
```

    - When http://<driver-host>:18088/driver/index.html is opened in a web browser, the following web page displays:

NOTE: If any errors or unexpected results occur, please check system configurations; common issues include firewall filtering or http proxy routing.

3.5Starting Controllers

- Edit conf/controller.conf on the COSBench controller machine.
- By default, the COSBench controller listens on port 19088.
- Launch Controller on the controller node.

```
sh start-controller.sh
```

- Ensure that the controller is started successfully.

- By connecting with Curl, one valid HTML file is expected in the console:

```
curl http://<controller-host>:19088/controller/index.html
```

- When http://<controller-host>:19088/controller/index.html is opened in a web browser, the following web page displays (note that the <controller-host> IP address 192.168.250.36 shown in the screen capture below is replaced with the actual IP address of the controller node):

3.6Submitting Workloads

A few templates are provided for reference in the conf/ directory:

- **workload-config.xml** is a template with comments to describe how to configure for different storage types. It will access mock storage to help with verification.
- **swift-config-sample.xml** is a template for the OpenStack Swift storage system.
- **ampli-config-sample.xml** is a template for the Amplidata AmpliStor v2.3 and v2.5 storage systems. See Appendix A for version-specific configuration information.

3.6.1Defining Workloads

For details of how to create a workload config file for user-defined workloads, please see the **Workload Configuration** section of this document.

Basic workload configuration options are also available from the config editing page on the controller web console; please refer to the **Workload Configuration** section of this document to customize the XML file for maximum flexibility. (Note that the <controller-host> IP address 192.168.250.36 shown in the screen capture below should be replaced with the actual IP address of the controller node.)

3.6.2Submitting Workloads

There are two ways to submit workloads to COSBench.

- Using the command-line interface:

```
sh cli.sh submit conf/config.xml
```

- Using the web console:

Open http://<controller-host>:19088/controller/index.html in a browser to monitor running status. (Note that the <controller-host> IP address 192.168.250.36 shown in the screen capture below should be replaced with the actual IP address of the controller node.)

3.6.3 Checking Workload Status

There are also two ways to check workload status.

- Using the command-line interface:

```
sh cli.sh info
```

- Using the web console:

Open http://<controller-host>:19088/controller/index.html in a browser to monitor running status. (Note that the <controller-host> IP address 192.168.250.36 shown in the screen capture below should be replaced with the actual IP address of the controller node.)

Clicking **view details** in the Active Workload section of that interface screen displays runtime performance data, as shown below:

3.7 Stopping Drivers and Controllers

```
ps |grep java # you should see java here.
sh stop-driver.sh
ps |grep java # should be no java running.

ps |grep java
sh stop-controller.sh
ps |grep java
```

The “ps” command is used to help confirm whether the driver or controller process is stopped. If the Java process doesn’t stop as expected, the user may forcibly stop it by killing the process.

4 Configuring Workloads

4.1 Introduction

```
workload
    auth
    storage
    workflow
        workstage
            auth
            storage
            work
                auth
                storage
                operation
```

A workload is represented as an XML file with the following structure:

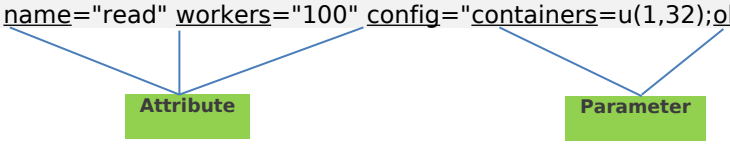
- Workload → work stage → work → operation
- If necessary, one workload can define one or more work stages.
- Execution of multiple work stages is sequential, while execution of work in the same work stage is parallel.
- For each piece of work, “workers” is used to tune the load.
- Authentication definition (auth) and storage definition (storage) can be defined at multiple levels, and lower-level definitions overwrite upper-level ones. For example, operations use the definitions for auth and storage at its work instead of those at workload level.

4.2 Selection Expression (also referred to as Selector)

4.2.1 Overview

- In workload configuration, the elements below support one “config” attribute (**auth**, **storage**, **work**, **operation**); the attribute contains an optional parameter list with key-value pairs that use the format “a=a_val;b=b_val”.

```
<work name="read" workers="100" config="containers=u(1,32);objects=u(1,100)" />
```



- In the parameter list, commonly used keys include “**containers**”, “**objects**”, and “**sizes**”, which are used to specify how to select container, object, and size. One expression is used to help define selection.
- The number in an expression has a different meaning for object size versus object or container. For object size, the number represents a quantity, while for object or container, the number represents a numbering or label.

4.2.2Selector

Expression	Format	Comments
constant	c(number)	Only use specified number For example, c(1) means the element numbering will be fixed in one fixed number
uniform	u(min, max)	Select from [min, max] evenly For example, u(1,100) means the element numbering is evenly selected from the 100 elements; the selection is random, and some numbers may be selected more than once, while some may never be selected
range	r(min,max)	Select from [min,max] incrementally For example, r(1,100) means the element numbering incrementally increases from min to max, and each number is selected only once; this is only used in special stages (init, prepare, cleanup, dispose)

4.2.3Allowable Combinations

There are additional constraints for selectors based on the element type and work type; the following two tables list allowable combinations.

Selector versus Element:

	Selector		
Key	constant (c(num))	uniform (u(min,max))	range (r(min,max))
containers	✓	✓	✓
objects	✓	✓	✓
sizes	✓	✓	

Selector versus Work:

Key	init	prepare	normal (read)	normal (write)	normal (delete)	cleanup	dispose
containers	r()	r()	c(), u(), r()	c(), u(), r()	c(), u(), r()	r()	r()
objects		r()	c(), u(), r()	c(), u(), r()	c(), u(), r()	r()	
sizes		c(), u()		c(), u()			

4.3Workload

4.3.1General Format

```
<workload name=”demo” description=”demo benchmark with mock storage” />
```

4.3.2Attributes

Parameter	Type	Default	Comment
name	String		One name for the workload
description	String		Some additional information

4.4Auth

4.4.1General Format

```
<auth type="none|mock|swauth|keystone"
config="<key>=<value>;<key>=<value>" />
```

4.4.2Attributes

Attribute	Type	Default	Comment
type	String	none	Authentication type
config	String		Parameter list [optional]

4.4.3Authentication Mechanisms

none (do nothing, default)

```
<auth type="none" config="" />
```

Parameter list:

Parameter	Type	Default	Comment
logging	Boolean	false	Print information to log
retry	Int	0	Specifies number of retry attempts if authentication fails

mock (delay specified time)

```
<auth type="mock" config="" />
```

Parameter list:

Parameter	Type	Default	Comment
token	String	“token”	Token string
delay	Long	20	Delay time in milliseconds
retry	Int	0	Specifies number of retry attempts if authentication fails

swauth (for OpenStack Swift)

```
<auth type="swauth"
config="username=test:tester;password=testing;url=http://192.168.250.36:8080/auth/v1.0" />
```

Note that the IP address 192.168.250.36 should be replaced with the actual IP address of the controller node.

Parameter list:

Parameter	Type	Default	Comment
auth_url	String	“http:/192.168.250.36:8080/auth/v1.0”	URL for auth node

username	String		Username for authentication . Syntax h account:user
password	String		Password for authentication
timeout	Integer	30,000	Connection timeout value in milliseconds
retry	Int	0	Specifies number of retry attempts if authentication fails

keystone (for OpenStack Swift)

```
<auth type="keystone"
config="username=tester;password=testing;tenant_name=test;url=http://192.168.250.36:5000/v2.0;service=swift" />
```

Note that the IP address 192.168.250.36 should be replaced with the actual IP address of the controller node.

Parameter list:

Parameter	Type	Default	Comment
auth_url	String	“http://192.168.250.36:8080/auth/v2.0”	URL for auth node
username	String		Username for authentication . Syntax account:user
password	String		Password for authentication
tenant_name	String		Name of tenant to which the user belongs
service	String	“swift”	Service requested
timeout	Integer	30,000	Connection timeout value in milliseconds

retry	Int	0	Specifies number of retry attempts if authentication fails

4.5Storage

4.5.1General Format

```
<storage type="none|mock|swift|ampli" config="<key>=<value>;<key>=<value>" />
```

4.5.2Attributes

Attribute	Type	Default	Comment
type	String	“none”	Storage type
config	String		Parameter list [optional]

4.5.3Storage Systems

none (do nothing, default)

```
<storage type="none" config="" />
```

Parameter list:

Parameter	Type	Default	Comment
logging	Boolean	false	Print information to log

mock (delay specified time)

```
<storage type="mock" config="" />
```

Parameter list:

Parameter	Type	Default	Comment
logging	Boolean	false	Print information to log
size	Integer	1024	Object size in bytes

delay	Integer	10	Delay time in milliseconds
errors	Integer	0	Set error limit to emulate failure
printing	Boolean	False	Print out data content

Swift (OpenStack Swift)

```
<storage type="swift" config="" />
```

Parameter list:

Parameter	Type	Default	Comment
timeout	Integer	30,000	Connection timeout value in milliseconds

Ampli (Amplidata)

```
<storage
type="ampli"config="host=192.168.10.1;port=8080;nsroot=/namespace;policy=141
95ca863764fd48c281cb95c9bd555" />
```

Parameter list:

Parameter	Type	Default	Comment
timeout	Integer	30,000	Connection timeout value in milliseconds
host	String		Controller node IP to connect
port	Integer		Port
nsroot	String	“/namespace”	Namespace root
policy	String		Policy ID the namespace will access

4.6Work Stage

4.6.1General Format

```
<workstage name="<name>" >
</workstage>
```

4.6.2Attributes

Attribute	Type	Default	Comment
name	String		One name for the stage
closuredelay	Integer	0	It is in seconds

4.7Work

4.7.1General Format

```
<work name="main" type="normal" workers="128" interval="5" division="none" runtime="60"
rampup="0" rampdown="0" totalOps="0" totalBytes="0" config="" > . . . </work>
```

There is one normal and four special types of work (init, prepare, cleanup, and dispose). Section 4.7 focuses on normal work, while Section 4.8 covers the special types of work. The form given above is for a full set—different work types will have different valid forms. General rules are given below:

- *workers* is a key attribute, normally used to control load.
- *runtime* (including *rampup* and *rampdown*), *totalOps* and *totalBytes* are attributes that control how to end the work, called ending options. Only one can be set in a work.

4.7.2Attributes

Attribute	Type	Default	Comment
name	String		One name for the work
type	String	“normal”	Type of work
workers	Integer		Number of workers to conduct the work in parallel
interval	Integer	5	Interval between performance snapshots
division	String	“none”	[“none”| “container”| “object”], controls how work is divided between workers

runtime	Integer	0	How many seconds the work will execute
rampup	Integer	0	How many seconds to ramp up workload; this time is excluded from runtime
rampdown	Integer	0	How many seconds to ramp down the workload; this time is excluded from runtime
totalOps	Integer	0	How many operations will execute; it should be a multiple of workers
totalBytes	Integer	0	How many bytes will transfer, it should be a multiple of the product of workers and size.

4.8Special Work

4.8.1General Format

```
<work type="init|prepare|cleanup|dispose" workers="<number>"
config="<key>=<value>;<key>=<value>" />
```

Special work is different from normal work in the following ways:

- It internally adopts and calculates “totalOps”, so *no ending option* need be explicitly included in the configuration.
- It has implicitly defined operations, so *no operation* is needed.

4.8.2Supported Special Work

init (creating specific *containers* in bulk)

```
<work type="init" workers="4" config="containers=r(1,100)" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), r(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix

prepare (inserting specific *objects* in bulk)

```
<work type="prepare" workers="4"
config="containers=r(1,10);objects=r(1,100);sizes=c(64)KB" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), u(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix
objects	String		Object selection expression; for example: c(1), u(1,100)
oprefix	String	myobjects_	Object prefix
osuffix	String	<null>	Object suffix
sizes	String		Size selection expression with unit (B/KB/MB/GB); for example: c(128)KB, u(2,10)MB

chunked	Boolean	False	Upload data in chunked mode (or not)
content	String	“random”(default) ”zero”	Fill object content with random data or all-zeros
createContainer	Boolean	False	Create related container if it does not exist
hashCheck	Boolean	False	Do work related to object-integrity checking

cleanup (removing specific *objects* in bulk)

```
<work type="cleanup" workers="4" config="containers=r(1,10);objects=r(1,100)" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), u(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix
objects	String		Object selection expression; for example: c(1), u(1,100)
oprefix	String	myobjects_	Object prefix
osuffix	String	<null>	Object suffix
deleteContainer	Boolean	False	Delete related container if it exists

dispose (removing specific *containers* in bulk)

```
<work type="dispose" workers="4" config="containers=r(1,100)" />
```

Parameter list:

Parameter	Type	Default	Comment

containers	String		Container selection expression; for example: c(1), u(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix

delay (adding *sleep* between workload run)

```
<workstage name="delay" closuredelay="60">
        <work name="delay" type="delay">
                <operation type="delay"/>
        </work>
</workstage>
```

Parameter list:

Parameter	Type	Default	Comment
closuredelay	Integer	0	It is in seconds

4.9Operation

4.9.1General Format

```
<operation type="read|write|delete" ratio="<1-100>"
config="<key>=<value>;<key>=<value>" />
```

4.9.2Attributes

Attribute	Type	Default	Comment
type	String		Operation type
ratio	Integer		
division	Integer		Division strategy for this operation
config	String		Parameter list

4.9.3Supported operations

container/object naming convention:

- By default, containers are named using the format "**mycontainers_**<n>", and objects are named using the format "**myobjects_**<n>", where <n> is a number defined by one selection expression in the parameter list.
- Container/object naming can be modified through cprefix/csuffix or oprefix/osuffix.

read

```
<operation type="read" ratio="70" config="containers=c(1);objects=u(1,100)" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), u(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix
objects	String		Object selection expression; for example: c(1), u(1,100)
oprefix	String	myobjects_	Object prefix
osuffix	String	<null>	Object suffix
hashCheck	Boolean	False	Do work related to object-integrity checking

write

```
<operation type="write" ratio="20"
config="containers=c(2);objects=u(1,1000);sizes=c(2)MB" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), u(1,100)

cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix
objects	String		Object selection expression; for example: c(1), u(1,100)
oprefix	String	myobjects_	Object prefix
osuffix	String	<null>	Object suffix
sizes	String		Size selection expression with unit (B/KB/MB/GB); for example: c(128)KB, u(2,10)MB
chunked	Boolean	False	Upload data in chunked mode (or not)
content	String	“random”(default) “zero”	Fill object content with random data or all zeros
hashCheck	Boolean	False	Do work related to object-integrity checking

delete

```
<operation type="delete" ratio="10" config="containers=c(2);objects=u(1,1000)" />
```

Parameter list:

Parameter	Type	Default	Comment
containers	String		Container selection expression; for example: c(1), u(1,100)
cprefix	String	mycontainers_	Container prefix
csuffix	String	<null>	Container suffix
objects	String		Object selection expression; for example: c(1), u(1,100)

oprefix	String	myobjects_	Object prefix
osuffix	String	<null>	Object suffix

4.9.4Examples

pure read

```
e.g: 100% read, 16 users, 300 seconds
<work name="100r16c30s" workers="16" runtime="300">
    <operation type="read" ratio="100" config="..." />
</work>
```

pure write

```
e.g.: 100% write, 8 clients, 600 seconds
<work name="100w8c600s" workers="8" runtime="600">
    <operation type="write" ratio="100" config="..." />
</work>
```

mixed operations

```
e.g.: 80% read, 20% write, 32 clients, 300 seconds
<work name="80r20w32c300s" workers="32" runtime="300">
    <operation type="read" ratio="80" config="..." />
   <operation type="write" ratio="20" config="..." />
</work>
```

5 Results

All results are stored in the “archive” directory.

5.1 Structure

- .meta
  - The starting run id
- run-history.csv
  - Record all historical workload runs, including time and major stages
- workload.csv
  - Record overall performance data for all historical workload runs
- Sub-directories
  - Prefixed with “w<runid>-” store data for each workload run

5.2 Per-Run Data

The following is a sample per-run data list:

5.2.1 Overall Performance Data (e.g., w1-demo.csv)

One line per stage:

5.2.2 Timeline Data (e.g., s3-main.csv)

One file per stage; can be imported into a spreadsheet program to draw a timeline chart:

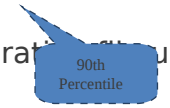
5.2.3 Response-Time Histogram Data (e.g., w1-demo-rt-histogram.csv)

Distribution of response time is a valuable indicator to understand Quality of Service; histogram data is generated for this purpose. The data is grouped from 0 to 500,000 ms with 10 ms stepping.

In a histogram diagram, the bar represents the number of samples in each grouping. The curve is the Cumulative Distribution Function (CDF), which can reveal insights regarding topics such as the response time at the 90th percentile.

5.2.4 Workload-config.xml

- The workload configurat[illegible]used in this run



5.2.5 Workload.log

- The run time log, which is helpful for troubleshooting

5.3 Metrics

5.3.1 Throughput (Operations/s or Op/s)

- The operations completed in one second
- The reported throughput is calculated by dividing total successful requests by total run time

5.3.2 Response Time (in ms)

- The duration between operation initiation and completion
- The reported Response Time is the average of response time for each successful request

5.3.3 Bandwidth (MiB/s)

- The total data in MiB transferred per second
- The reported bandwidth is calculated by dividing total bytes transferred by total run time
- 1 MiB = 1024*1024 bytes

5.3.4 Success Ratio (%)

- The ratio of successful operations

- The reported success ratio is calculated by dividing the number of successful requests by the total number of requests

5.3.5 Other Metrics

- Op-count: total number of operations
- Byte-count: total data transferred

6 FAQs

6.1 General

1. **Is listening on port 19088/18088 configurable, and, if so, how?**

   Yes; conf/controller-tomcat-server.xml specifies the port to be used for the controller, and driver-tomcat-server.xml specifies the port to be used for the driver.

2. **What is the difference between “cancelled” and “terminated”?**

   “Cancelled” means the workload is cancelled by user at runtime, while “terminated” indicates errors during runtime, which typically require user action for resolution.

3. **Can I submit multiple workloads to be run sequentially?**

   Yes; COSBench can accept multiple workloads at one time and run them one by one.

4. **Is it possible to cancel a queued workload?**

   No; cancellation is only for the running workload.

5. **Can COSBench be installed on other Linux* distributions, such as Red Hat Enterprise Linux?**

   Yes; versions prior to v2.1 support Red Hat Enterprise Linux 6 by default, and versions beginning with v2.1 have adopted Ubuntu 12.04.1 LTS as the default OS.

6. **Is it possible to reuse the files from a previous test without removing or cleaning up the old files?**

   Yes; the special stages such as init, prepare, cleanup, and dispose are all optional, and even regarding the main stage, users can choose the stage sequence appropriate to their testing requirements. To reuse data, the user needs to fill all data and perform all tests before the cleanup and dispose stages (for example, in the sequence init, prepare, test1, test2, … cleanup, dispose). A related sample workload configuration file is included in conf/reusedata.xml.

7. **Is it possible to define multiple main or other stages?**

   Yes; to avoid name confusion, they should be named with different labels. For example, users can define multiple init stages to create different container sets, or define multiple main stages to perform different tests in one workload.

8. **If errors occur on running workloads, where can users see more details?**

There is one workload.log under that workload's corresponding folder (archive\<workload id>\workload.log); inspecting this file can help determine the cause of errors.

9. What steps should be taken to resolve a test being stuck at the init stage?

Verify that all COSBench machines are accessible through an HTTP connection using Curl ("curl http://<controller-host>:19088/controller/index.html" or "curl http://<driver-host>:18088/driver/index.html"). If a firewall has blocked the HTTP connection, the user must open the appropriate ports on the firewall. For the controller node, the ports are 19088 and 19089; for driver nodes, the ports are 18088 and 18089.

10. Is there a tool to distribute COSBench on multiple nodes?

Although COSBench itself does not provide a tool for this type of package distribution, many external solutions exist for this purpose, such as scp and shared folder (samba).

11. Why does COSBench show a workload test as "complete," even though there are errors reported in workload.log?

A test may reflect "complete" status although errors are recorded in the log for normal work, as long as special work has completed successfully. COSBench treats "init", "prepare", "cleanup," and "dispose" operations as special work that must be completed without error to result in "completed" status; errors in special work will terminate the test.
On the other hand, normal work associated with performance measurement can tolerate failures, which are tracked by the "success ratio."

12. Are there any recommendations for the number of workers in the "init", "prepare", "cleanup," and "dispose" stages?

Work performed in the "init" and "dispose" stages creates and deletes containers. In our testing with Keystone plus Swift, these tasks can be completed in approximately three minutes with a recommended ratio of one worker for every 32 containers, with 100 objects in each container and a 64 KB object size. Generally, the number of containers should be defined as a multiple of the number of workers.
Work performed in the "prepare" and "cleanup" stages creates or deletes objects, and the time required depends on the number of objects. Generally, the number of objects should be defined as a multiple of the number of workers. Increasing the number of workers can accelerate the process.
Work performed in the "main" identifies bottlenecks, and tuning the workers parameter controls the load to the storage system. The number of workers should be gradually increased until performance decreases.

13. How can "OutOfMemory" errors from the driver be prevented after running COSBench for a long time?

Maximum heap size for the Java process can be specified in the "cosbench-start.sh" script to prevent exhausting memory. For example, the parameter "-Xmx2g" would limit the maximum heap size to 2 GB.

14. **How can read and write be split to different containers?**

    Users can assign containers to be accessed at the operation level, to split reads and writes to different containers; the different container range can be set using the “containers” parameter in “config” as follows:

    *<operation type=”read” ratio=”80” config=”**containers=u(1,2)**;objects=u(1,50)” />*
    *<operation type=”write” ratio=”20” config=”**containers=u(3,4)**;objects=u(51,100);sizes=c(64)KB” />*

    One sample workload configuration file is included in conf/splitrw.xml.

15. **How can different containers be specified for different configurations, such as those with different object sizes?**

    Users can assign different container sets for different configurations using the “cprefix” parameter. For example, users can differentiate between configurations with different sizes by specifying an object size such as “64K” using “cprefix” to avoid confusion and unexpected overwriting as follows:

    *<operation type=”read” ratio=”80” config=”cprefix=100M_;**containers=u(1,32)**;objects=u(1,50)” />*

    In this case, the container name will be prefixed with “100M_” in the target storage system. Users can take advantage of this capability by browsing to the location http://<IP of Amplistor controller node>:8080/namespace as shown below:

16. **When a workload is terminated, where can users obtain the log files to help troubleshoot the issue?**

    Log files are located in two separate places:

    - **In the “log” folder within the COSBench installation folder.** The “system.log” file in this location documents COSBench system activities, including the check for workload configuration file. If a required parameter is missing or mistyped (for example, “sizes” in the “prepare” stage), this file will contain an entry such as “driver report error: no such key defined: sizes” as shown below:

    - **In the “workload” folder in the “archive” folder within the COSBench installation folder.** The “workload.log” file in this location documents workload runtime activities. If failed operations occur while the workload is running, an error (typically HTTP-related) will be logged in this file.

6.2 Swift

1. **How can long prepare times associated with large object sizes (e.g., 1 GB) be avoided?**

   A large number of large objects can saturate network bandwidth, resulting in low performance. If network bandwidth is not saturated, the “workers” parameter can be increased, to better utilize bandwidth.

2. **Are there any special changes for operating with large object sizes (e.g., 1 GB)?**

   Yes; for testing with large object sizes, consider the following:

   - Longer ramp-up time (specified using the parameter “rampup”) can help drive higher performance, while longer run time (specified using the parameter “runtime”) can help drive more consistent results. The optimal combination of settings for these parameters depends on individual usage circumstances. To help determine appropriate settings, run a test case with “runtime” set for a long run time (e.g., 30 minutes) without setting the “rampup” parameter. Consult the resulting timeline curve to determine how many seconds are needed to ramp up in this case; the “runtime” parameter can then be set to 10 times that “rampup” value.
   - As the time for each operation to complete increases, it becomes more likely that timeout errors will occur; this effect can be mitigated using the “timeout” parameter in “config”, which uses milliseconds as units. For Swift, typical syntax is as follows:

   <storage type="swift" config="timeout=100000" />

   - Users should also verify proper setup of the system under test, outside the scope of COSBench itself; for example, errors or performance deficits may occur because of improper setup of back-end storage.

1. **How can the termination of workloads in the authentication phase be overcome when large numbers of workers (e.g., 1024) are configured with Keystone, so that testing can be completed successfully?**

   The new parameter “retry” is introduced for the “auth” section in the workload configuration file to help overcome failures in the authentication phase. Following is a sample configuration:

   ```
   <auth type="keystone"
   config="username=operator;password=intel2012;tenant_name=cosbench;auth_url=
   http://10.10.9.100:5000/v2.0;service=swift;retry=10"/>
   ```

6.3 AmpliStor

1. **Where does the system get the string for the policy in the .xml file?**

   Users can access the Amplidata controller node and manage the available policies by browsing to the location http://<IP of Amplistor controller node>:8080/manage/policy as shown below:

2. **How can object range affect performance?**

Expanding the object range may improve write performance by reducing write conflicts. For example, changing “u(1,100)” to “u(1,10000)” will expand the object range from 100 objects to 10,000 objects.

3. **How can one simplify policy UID settings?**

   Only the “init” stage needs policy UID; other stages such as prepare, main, cleanup, and dispose don’t need to have the policy UID set. If there is no “init” stage in the workload, no policy UID is needed.

7 Appendix A. Sample Configurations

7.1 Swift

The sample workload configuration describes the following test scenario:

- The test includes five stages: init, prepare, main, cleanup, and dispose.
- The test creates 32 containers, each containing 50 objects 64 KB in size.
- The operation requests are issued to three controller nodes.
- The requests include 80 percent GET(read) operations and 20 percent PUT(write) operations; read operations randomly request an object from the 50 objects from #1 to #50, while write operations randomly create objects with object numbering from #51 to #100.
- At completion, the test cleans up all objects and drops all containers.

To use keystone authentication, use the commented keystone authentication line as a sample (note that the IP address 192.168.250.36 should be replaced with the actual IP address of the controller node).

```
<?xml version="1.0" encoding="UTF-8" ?>
<workload name="swift-sample" description="sample benchmark for swift">


  <storage type="swift" />


  <!-- MODIFY ME -->
  <auth type="swauth"
config="username=test:tester;password=testing;auth_url=http://192.168.10.1:8080/a
uth/v1.0" />


  <!-- Keystone Authentication
  <auth type="keystone"
config="username=tester;password=testing;tenant_name=test;auth_url=http://192.168
.250.36:5000/v2.0;service=swift" />
  -->


  <workflow>


    <workstage name="init">
      <work type="init" workers="1" config="containers=r(1,32)" />
```

```
    </workstage>


    <workstage name="prepare">
      <work type="prepare" workers="1"
config="containers=r(1,32);objects=r(1,50);sizes=c(64)KB" />
    </workstage>


    <workstage name="main">
      <work name="main" workers="8" rampup="100" runtime="300">
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>
    </workstage>


    <workstage name="cleanup">
      <work type="cleanup" workers="1"
config="containers=r(1,32);objects=r(1,100)" />
    </workstage>


    <workstage name="dispose">
      <work type="dispose" workers="1" config="containers=r(1,32)" />
    </workstage>


  </workflow>


</workload>
```

7.2AmpliStor

The workload configuration describes the following test scenario:

- The test includes five stages: init, prepare, main, cleanup, and dispose.
- The test creates 32 containers (namespaces), each containing 50 objects 64 KB in size.
- The operation requests are issued to three controller nodes, and each controller node hosts two client daemons.
- The requests include 80 percent GET(read) operations and 20 percent PUT(write) operations; read operations randomly request objects from the 50 objects numbered #1 to #50, while write operations randomly create objects with object numbering from #51 to #100.
- At completion, the test cleans up all objects and drops all containers (namespaces).

For the AmpliStor v2.5 release, "*nsroot=/manage/namespace*" is necessary for all namespace-related work (init/dispose), for release prior to v2.5, just remove below "nsroot=/manage/namespace" snippets.

```
<?xml version="1.0" encoding="UTF-8" ?>
<workload name="ampli-sample" description="sample benchmark for amplistor">


  <storage type="ampli"
config="host=192.168.10.1;port=8080;policy=14195ca863764fd48c281cb95c9bd555" />


  <workflow>


    <workstage name="init">
        <storage type="ampli"
config="host=192.168.10.1;port=8080;nsroot=/manage/namespace;policy=14195ca863764
fd48c281cb95c9bd555" />
        <work type="init" workers="1" config="containers=r(1,32)" />
    </workstage>


    <workstage name="prepare">
      <work type="prepare" workers="1"
config="containers=r(1,32);objects=r(1,50);sizes=c(64)KB" />
    </workstage>


    <workstage name="main">
      <work name="c1p0" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.1;port=8080" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>
      <work name="c1p1" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.1;port=8081" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>



      <work name="c2p0" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.2;port=8080" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
```

```
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>
      <work name="c2p1" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.2;port=8081" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>


      <work name="c3p0" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.3;port=8080" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>
      <work name="c3p1" workers="16" rampup="100" runtime="300">
        <storage type="ampli" config="host=192.168.10.3;port=8081" />
        <operation type="read" ratio="80"
config="containers=u(1,32);objects=u(1,50)" />
        <operation type="write" ratio="20"
config="containers=u(1,32);objects=u(51,100);sizes=c(64)KB" />
      </work>


    </workstage>


    <workstage name="cleanup">
      <work type="cleanup" workers="1"
config="containers=r(1,32);objects=r(1,100)" />
    </workstage>


    <workstage name="dispose">
       <storage type="ampli"
config="host=192.168.10.1;port=8080;nsroot=/manage/namespace" />
      <work type="dispose" workers="1" config="containers=r(1,32)" />
    </workstage>


  </workflow>


</workload>
```

As mentioned at the beginning of this guide, COSBench also allows users to create adaptors for additional storage systems. Please refer to the “COSBench Adaptor Development Guide” for details.