ADA LOGICS

CubeFS Security Audit

In collaboration with the CubeFS project maintainers, The Linux Foundation and the Open Source Technology Improvement Fund

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Executive summary

In the fall of 2023, Ada Logics conducted a security audit of CubeFS in a coordinated collaboration between Ada Logics, CubeFS, OSTIF and the CNCF. The CNCF funded the work. The security audit was a holistic security audit with the following goals:

1. Assess and formalize a threat model for CubeFS highlighting entrypoints, risks and at-risk components.
2. Review the CubeFS codebase for security vulnerabilities of any severity.
3. Review CubeFS's supply-chain maturity against SLSA.

To formalize the threat model, Ada Logics relied on three sources of information: 1) CubeFS's official documentation, 2) the CubeFS source tree and 3) feedback from the CubeFS maintainers. The manual review was performed against the threat model to allow the auditors to consider trust levels and threat actors as they were reviewing the code.

The report contains all issues found from both the threat modelling and manual code audit exercises. Five of these issues were exploitable by threat actors identified during the threat modelling, and these issues were assigned the following CVE's:

Issue	CVE	CVE severitiy
Authenticated users can crash the CubeFS servers with maliciously crafted requests	CVE-2023-46738	Moderate
Timing attack can leak user passwords	CVE-2023-46739	Moderate
Insecure random string generator used for sensitive data	CVE-2023-46740	Moderate
CubeFS leaks magic secret key when starting Blobstore access service	CVE-2023-46741	Moderate
CubeFS leaks users key in logs	CVE-2023-46742	Moderate

Ada Logics disclosed these findings responsibly to CubeFS through CubeFS's public Github Security Advisory disclosure channels. The CubeFS security response team responded to the disclosures with fixes in a timely manner and before the audit had been completed.

The SLSA review found that CubeFS scores low because it does not include provenance for releases. Ada Logics included practical steps for achieving SLSA Level 3 compliance.

Strategic recommendations

In this section, we include our strategic recommendations for CubeFS to maintain a secure project moving forward. Several points in this section are reflected in "Found Issues" or other parts of the report, whereas some are only included here.

Supply-Chain Security

CubeFS has undoubtedly included supply-chain security in its ongoing work. For example, CubeFS has adopted Scorecard, which considers several different aspects of supply-chain security risks in an automated manner. Nonetheless, Supply-chain Security is an area where CubeFS can improve its ongoing work. The audit found that releases are not signed and do not include provenance, which makes consumers vulnerable to known supply-chain risks. We have included practical steps to take to add this to releases. While CubeFS has integrated the Scorecard Github Action, CubeFS currently scores a 6,5 Scorecard score, which leaves room for improvement. Open and closed-sourced software ecosystems are seeing an increase in supply-chain attacks and their sophistication, with major recent attacks having had their first compromise in the software development lifecycle rather than after deployment.

Static analysis

CubeFS uses automated SAST in its development pipeline however limited to only CodeQL for security tooling. During the audit, Ada Logics tested CubeFS with other SAST tools, which found true positives in the CubeFS code base. We recommend adding the GoSec and Semgrep tools as wellm and add `ignore` directives for false positives.

Security-relevant documentation

CubeFS has good documentation but lacks a dedicated security-best-practices section to help users deploy a security-hardened CubeFS instance. We recommend adding and maintaining this to ensure users can consume CubeFS in a secure manner and avoid security issues arising from misconfiguration.

During the security audit, the CubeFS team added a security-best-practices section to the official CubeFS documentation which is available here:
https://cubefs.io/docs/master/maintenance/security_practice.html

Project Scope

The following Ada Logics auditors carried out the audit and prepared the report.

Name	Title	Email
Adam Korczynski	Security Engineer, Ada Logics	Adam@adalogics.com
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The following CubeFS team members were part of the audit.

Name	Title	Email
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The following OSTIF members were part of the audit.

Name	Title	Email
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Threat model

In this part, we look at CubeFS's threat model. We have used open-source materials to formalize the threat model including mainly from documentation produced by the CubeFS ecosystem, recorded talks, presentations and third-party documentation.

CubeFS is a cloud-native data storage infrastructure often used on top of databases, machine-learning platforms and applications deployed on top of Kubernetes. It supports multiple access protocols like S3, POSIX and HDFS with flexibility for consumers using multiple protocols in the same deployment.

CubeFS has four main components: 1) A metadata subsystem, 2) a data subsystem, 3) a resource management node also called "Master" and 4) an Object Subsystem. Below, we enumerate the components.

Metadata subsystem

The Metadata subsystem runs the `MetaNode` which stores all file metadata in the cluster. In Kubernetes, this is deployed as a `DaemonSet` K8s resource.

Data subsystem

The data subsystem is known internally in CubeFS as `DataNode` and handles the actual storing of file data. It mounts a large amount of disk space to store file data. When using CubeFS with Kubernetes, `DataNode` is deployed as a `DaemonSet`.

Resource management

The resource management component is called `Master` and is responsible for managing resources and maintaining the metadata of the whole cluster. When deploying CubeFS on Kubernetes, the Master Node is deployed as a StatefulSet K8s resource.

Object Subsystem

This component runs ObjectNodes and acts as an interface between different protocols - HDFS, POSIX and S3 - such that CubeFS works as the underlying data store, and the user can operate CubeFS by way of either or several of these protocols. The Object Subsystem is also called the Object Gateway internally in the CubeFS ecosystem.

In addition to the four core components, CubeFS implements an `AuthNode` which handles authentication and authorization in a CubeFS deployment.

CubeFS is meant to be deployed in such a manner that it is available to users of varying permission levels. This means that at a high level, CubeFS must be resistant to malicious cluster users who have been granted access. For example, if an organization grants access to an employee who gets convinced by a competitor to steal or corrupt data, the CubeFS devops team must know the impact this employee has for risk mitigation and impact remediation purposes. User permissions in CubeFS should start at the lowest and increase with the permissions that CubeFS admins intend to add to the user.

There are at least two security-relevant implications for CubeFS's architectural and permission design:

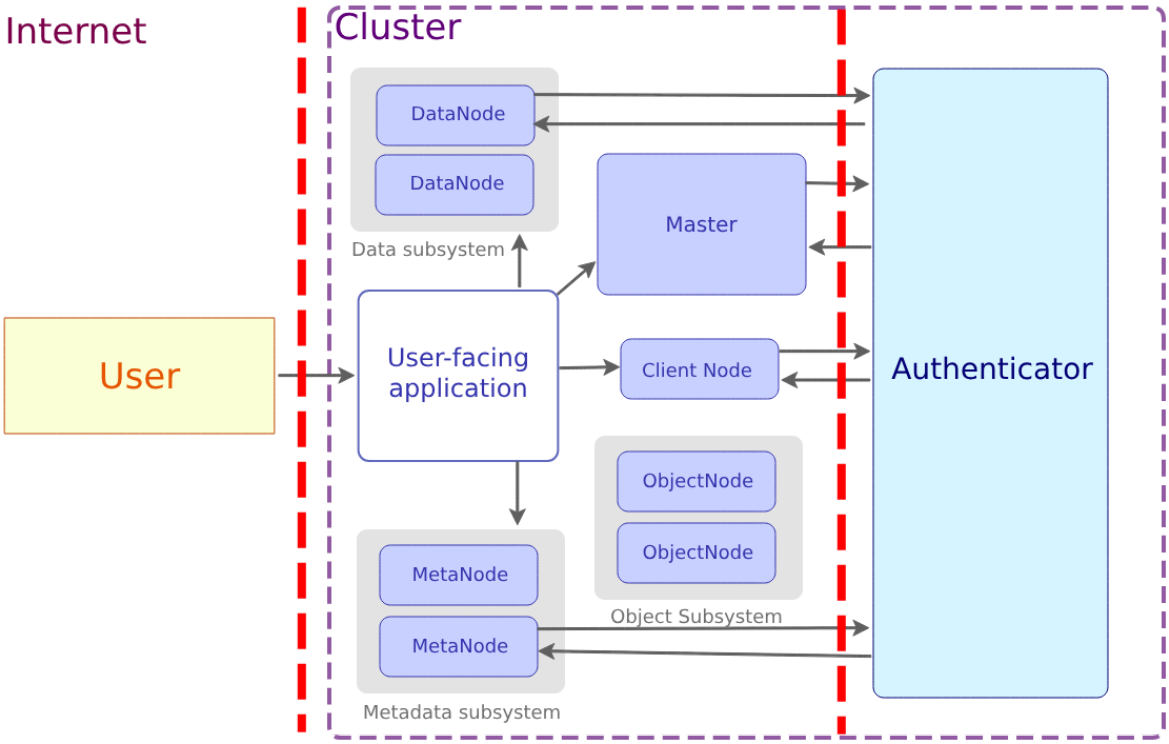
1. Users should not be able to achieve permissions they have not been granted. A permission should not imply another permission, whether intended or not. At this level, we are considering defined permissions that are not assigned to a user. This part of CubeFS's security model distinguishes between privileges at a granular level.

2. The second implication is the distinction between root and non-root permissions. CubeFS should accept a full cluster deletion by the cluster admin; it is not a security breach if the cluster admin or CubeFS admin can take down the entire cluster or cause any other harm to any part of CubeFS. There is an implied list of non-permitted actions that users should not be allowed to perform. These are general security risks that pertain to other software applications, such as Denial-of-Service attacks, stealing data, remote code execution, corruption of data and other general threats.

Most commonly, CubeFS is not exposed directly to the internet but will be available to services inside the cluster to which it is deployed. A CubeFS deployment will have multiple client nodes that include a client container, which is intended to communicate with the remaining CubeFS components. Communication between components happens via HTTP(S); Each component exposes a web server to the cluster. As such, threats are likely to come from users who already have a position in the cluster. This position can be through a legitimate use cage - a user that should have access and has been granted so by the CubeFS admin, or it could be through a threat actor who has already escalated privileges and who seeks to further advance their position inside the cluster. In the former scenario, we have covered the expectations above, which we can sum up as such: If a legitimate user turns malicious, the CubeFS admin should know what their impact is and should be in control of reducing any permissions that the user has. In other words, what the CubeFS admin expects the user can do represents the user's privileges pricisely. For the latter, CubeFS should reduce the ease with which an attacker can further escalate privileges inside the cluster.

Trust boundaries

In this section, we identify the trust boundaries of a CubeFS deployment. Below, we include a trust-flow diagram of an out-of-the-box CubeFS deployment:



Typically, a CubeFS deployment will be deployed alongside an internet-facing application in the cluster with which users communicate. When traffic enters the cluster, it crosses a trust boundary and flows low to high in the direction from the internet to the cluster. This trust boundary could also exist between the user-facing application and the CubeFS client nodes, depending on the specific use case. The reason for this is that the user-facing application could do its own validation and sanitization. From the user-facing application, traffic flows to the CubeFS client nodes. These authenticate the request before processing it, and the traffic crosses another trust boundary when being authenticated. At this point, trust flows low to high in the direction from the CubeFS client nodes to the authenticator. Trust remains high until CubeFS responds to the user external to the cluster.

Threat actors

A threat actor is an individual or group that intentionally attempts to exploit vulnerabilities, deploy malicious code, or compromise or disrupt a CubeFS deployment, often for financial gain, espionage, or sabotage. A threat actor is the personification of a possible attacker of security issues. Each threat actor has a level of trust tied to them, and matching one or several threat actors with CubeFS's threat model helps identify the high-level security risk. We identify the following threat actors for CubeFS. A threat actor can assume multiple profiles from the table below; for example, a fully untrusted user can also be a contributor to a 3rd-party library used by CubeFS.

Threat Actor	Description	Level of trust
Code contributor to CubeFS	Person or group of people that contribute code to CubeFS's upstream repository	None
Code contributor to CubeFS's 3rd-party dependencies	Person or group of people that contribute code to CubeFS's 3rd-party dependencies	None
External users of ingress cluster entrypoints	Users that interact with internet-facing applications in the cluster. The purpose of these entrypoints will for the most part be to enable use of CubeFS.	None
Outside actor with position in cluster	A person or group of people with no granted privileges that have escalated privileges by using a weakness in CubeFS, its underlying platform or a 3rd-party dependency.	None
Cluster user	Cluster users with non-root privileges. These are users of the CubeFS deployment.	Low to high
Infrastructure contributors	These are users that maintain applications and infrastructure running on the cluster. This threat actor is not a user of CubeFS themselves, but they facilitate access for other users.	Low
Cluster admin	Users with sudo permissions over the cluster and CubeFS.	Full

SLSA review

ADA Logics carried out a SLSA review of CubeFS. SLSA (https://github.com/slsa.dev) is a framework for assessing the security practices of a given software project with a focus on mitigating supply-chain risk. SLSA emphasises tamper resistance of artifacts as well as ephemerality of the build and release cycle.

SLSA mitigates a series of attack vectors in the software development life cycle (SDLC), all of which have seen real-world examples of successful attacks against open-source and proprietary software.

Below, we include a diagram made by the SLSA illustrating the attack surface of the SDLC.

Each of the red markers demonstrate different areas of possible compromise that could allow attackers to tamper with the artifact that the consumer invokes at the end of the SDLC.

SLSA splits its assessment criteria into 4 increasingly demanding levels. The higher the level of compliance, the higher tamper-resistance the project ensures its consumers.

An essential part of ensuring tamper resistance is to include a verifiable provenance statement with releases. SLSA provides a framework for creating this automatically when building release artifacts (https://github.com/slsa-framework/slsa-github-generator) which we recommend CubeFS adopts. Building artifacts by way of the slsa-github-generator will produce SLSA level 3 compliant provenance. CubeFS can adopt the slsa-github-generator by adding a Github workflow that invokes the SLSA builder.

Complying with SLSA level 3 reflects a high standard of supply-chain mitigation, and CubeFS consumers should not be discouraged from a low level of compliance. We recommend that the CubeFS community tracks ongoing work for adopting the slsa-github-generator project and working on this in the open. It is far from all open-source projects that have achieved level 3 compliance at this part of SLSA open-source lifetime.

CubeFS currently is at Level 0 by the SLSA specification.

Issues found

Ada Logics found 12 issues during the audit. The list includes all issues found by way of manual auditing and fuzzing. Ada Logics uses a scoring system that considers impact and ease of exploitation. This is different from the CVSS scoring system, and there may be discrepancies between the severity assigned by Ada Logics and the severity resulting from a CVSS calculation.

#	Title	Status	Severity
1	Authenticated users can crash the CubeFS servers with maliciously crafted requests	Fixed	Moderate
2	CubeFS leaks magic secret key when starting Blobstore access service	Fixed	Moderate
3	CubeFS leaks users key in logs	Fixed	Moderate
4	Insecure cryptographic primitive used for sensitive data	Fixed	Moderate
5	Insecure random string generator used for sensitive data	Fixed	Moderate
6	Lack of security-best-practices documentation	Fixed	Moderate
7	Possible deadlocks	Fixed	Moderate
8	Possible nil-dereference from unmarshalling double pointer	Fixed	Low
9	Potential Slowloris attacks	Fixed	Low
10	Releases are not signed	Fixed	Moderate
11	Security Disclosure Email Does Not Work	Fixed	Low
12	Timing attack can leak user passwords	Fixed	Moderate

Authenticated users can crash the CubeFS servers with maliciously crafted requests

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-NKbh4NJK
Component:	ObjectNode

The root cause is that when CubeFS reads the body of incoming requests, it reads it entirely into memory and without an upper boundary. As such, an attacker can craft an HTTP that contains a large body and exhausts memory of the machine, which results in crashing the server.

Details

The issue exists across multiple CubeFS components. We have not made an exhaustive list and will follow up with that. For now, we exemplify the issue with the `deleteObjectsHandler` of the objectnode component. This handler reads the body of the incoming request entirely into memory on line 561 below:

https://github.com/cubefs/cubefs/blob/45442918591d25e7ab555469df384df468df5dbc/objectnode/api_handler_object.go#L532C22-L567

```
532 func (o *ObjectNode) deleteObjectsHandler(w http.ResponseWriter, r *http.Request) {
533         var (
534                 err       error
535                 errorCode *ErrorCode
536         )
537         defer func() {
538                 o.errorResponse(w, r, err, errorCode)
539         }()
540
541         var param = ParseRequestParam(r)
542         if param.Bucket() == "" {
543                 errorCode = InvalidBucketName
544                 return
545         }
546
547         var vol *Volume
548         if vol, err = o.getVol(param.Bucket()); err != nil {
549                 log.LogErrorf("deleteObjectsHandler: load volume fail: requestID(%v)
    volume(%v) err(%v)",
550                         GetRequestID(r), param.Bucket(), err)
551                 return
552         }
553
554         requestMD5 := r.Header.Get(ContentMD5)
555         if requestMD5 == "" {
556                 errorCode = MissingContentMD5
557                 return
558         }
559
560         var bytes []byte
561         bytes, err = ioutil.ReadAll(r.Body)
562         if err != nil {
563                 log.LogErrorf("deleteObjectsHandler: read request body fail:
    requestID(%v) volume(%v) err(%v)",
564                         GetRequestID(r), param.Bucket(), err)
565                 errorCode = UnexpectedContent
566                 return
567         }
```

In this case, a user does not require permission to delete objects since the ACL check is done after reading the request body.

PoC

We include two programs to reproduce this issue. Warning: save all work before running this PoC, including work in browser tabs.

The first program is a server that represents the `deleteObjectsHandler`. We have stripped unrelated parts of the function body that the HTTP request can easily pass legitimately. Start up this server by creating the following go module and run it with `go run main.go`:

```
package main

import (
        "fmt"
        "io/ioutil"
        "net/http"
)

func main() {
         http.HandleFunc("/deleteObjects", func(w http.ResponseWriter, r *http.Request) {
                 // Here CubeFS gets the params. We skip that since an authenticated user can get past that.

                 // Here CubeFS gets the volume. The user can pass a Bucket identifier that will not return an error to get past that.

                 // Here CubeFS gets the requestMD5. The user can include any value in the header to get past that.

                 // At this point, the handler invokes the vulnerable line
                 fmt.Println("Got request")
                 _, err := ioutil.ReadAll(r.Body)
                 if err != nil {
                         return
                 }
                 fmt.Println("Finished reading body")
         })

         fmt.Printf("Starting server at port 8080\n")
         if err := http.ListenAndServe(":8080", nil); err != nil {
                 panic(err)
         }
}
```

You should see `Starting server at port 8080` in the terminal when starting this program.

The next program is the client. This program represents the malicious user who crafts a request with a large body and sends it to the server. Depending on the system used when running this program, it may be necessary to reduce or increase the size of the body. Create the following `main.go` in another module and run it with `go run main.go`

```
package main

import (
        "io"
        "strings"
        "net/http"
)

func main() {
         req := maliciousRequest()

         _, err := http.DefaultClient.Do(req)
         if err != nil{
                 panic(err)
         }
}

func maliciousRequest() *http.Request {
         s := strings.Repeat("malicious string", 100000000)
         r1 := strings.NewReader(s)
         r2 := strings.NewReader(s)
         r3 := strings.NewReader(s)
         r4 := strings.NewReader(s)
         r5 := strings.NewReader(s)
         r6 := strings.NewReader(s)
         r7 := strings.NewReader(s)
         r8 := strings.NewReader(s)
         r := io.MultiReader(r1, r2, r3, r4, r5, r6, r7, r8)
```

```
29          req, err := http.NewRequest("POST", "http://localhost:8080/deleteObjects", r)
30          if err != nil {
31                  panic(err)
32          }
33          return req
34  }
```

This request should exhaust memory temporarily and then crash the server.

Impact

All CubeFS users are impacted by this issue.

CubeFS leaks magic secret key when starting Blobstore access service

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-MNJHBrv3
Component:	BlobStore

CubeFS leaks secret configuration keys during initialization of the blobstore access service controller, more specifically here:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/blobstore/access/server.go#L76-L86

```
76 func initWithRegionMagic(regionMagic string) {
77         if regionMagic == "" {
78                 log.Warn("no region magic setting, using default secret keys for
   checksum")
79                 return
80         }
81
82         log.Info("using magic secret keys for checksum with:", regionMagic)
83         b := sha1.Sum([]byte(regionMagic))
84         initTokenSecret(b[:8])
85         initLocationSecret(b[:8])
86 }
```

Users with access to the logs can retrieve the secret key and escalate privileges to carry out operations on blobs that they otherwise don't have the necessary permissions for. For example, a threat actor who has successfully retrieved a magic secret key from the logs can delete blobs from the blob store by validating their requests in this step:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/blobstore/access/server.go#L546-L569

```
546 func (s *Service) DeleteBlob(c *rpc.Context) {
547         args := new(access.DeleteBlobArgs)
548         if err := c.ParseArgs(args); err != nil {
549                 c.RespondError(err)
550                 return
551         }
552
553         ctx := c.Request.Context()
554         span := trace.SpanFromContextSafe(ctx)
555
556         span.Debugf("accept /deleteblob request args:%+v", args)
557         if !args.IsValid() {
558                 c.RespondError(errcode.ErrIllegalArguments)
559                 return
560         }
561
562         valid := false
563         for _, secretKey := range tokenSecretKeys {
564                 token := uptoken.DecodeToken(args.Token)
565                 if token.IsValid(args.ClusterID, args.Vid, args.BlobID,
    uint32(args.Size), secretKey[:]) {
566                         valid = true
567                         break
568                 }
569         }
```

To exploit this security issue, the attacker needs to have privileges to read the logs. They could have obtained these privileges legitimately, or they could have obtained them by already having escalated privileges.

CubeFS leaks users key in logs

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-vc34CGVVJB
Component:	Master

CubeFS leaks secret user keys and access keys in the logs in multiple components. When CubeCS creates new users, it leaks the user's secret key. This could allow a lower-privileged user with access to the logs to retrieve sensitive information and impersonate other users with higher privileges than themselves.

Details

The vulnerable API that leaks secret keys is `createKey`:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/master/user.go#L43-L111

```
43 func (u *User) createKey(param *proto.UserCreateParam) (userInfo *proto.UserInfo, err
   error) {
44         var (
45                 AKUser     *proto.AKUser
46                 userPolicy *proto.UserPolicy
47                 exist      bool
48         )
49         if param.ID == "" {
50                 err = proto.ErrInvalidUserID
51                 return
52         }
53         if !param.Type.Valid() {
54                 err = proto.ErrInvalidUserType
55                 return
56         }
57
58         var userID = param.ID
59         var password = param.Password
60         if password == "" {
61                 password = DefaultUserPassword
62         }
63         var accessKey = param.AccessKey
64         if accessKey == "" {
65                 accessKey = util.RandomString(accessKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
66         } else {
67                 if !proto.IsValidAK(accessKey) {
68                         err = proto.ErrInvalidAccessKey
69                         return
70                 }
71         }
72         var secretKey = param.SecretKey
73         if secretKey == "" {
74                 secretKey = util.RandomString(secretKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
75         } else {
76                 if !proto.IsValidSK(secretKey) {
77                         err = proto.ErrInvalidSecretKey
78                         return
79                 }
80         }
81         var userType = param.Type
82         var description = param.Description
83         u.userStoreMutex.Lock()
84         defer u.userStoreMutex.Unlock()
85         u.AKStoreMutex.Lock()
86         defer u.AKStoreMutex.Unlock()
87         //check duplicate
88         if _, exist = u.userStore.Load(userID); exist {
89                 err = proto.ErrDuplicateUserID
90                 return
91         }
92         _, exist = u.AKStore.Load(accessKey)
93         for exist {
```

```
94                accessKey = util.RandomString(accessKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
95                _, exist = u.AKStore.Load(accessKey)
96        }
97        userPolicy = proto.NewUserPolicy()
98        userInfo = &proto.UserInfo{UserID: userID, AccessKey: accessKey, SecretKey:
   secretKey, Policy: userPolicy,
99                UserType: userType, CreateTime: time.Unix(time.Now().Unix(),
   0).Format(proto.TimeFormat), Description: description}
100         AKUser = &proto.AKUser{AccessKey: accessKey, UserID: userID, Password:
    encodingPassword(password)}
101         if err = u.syncAddUserInfo(userInfo); err != nil {
102                 return
103         }
104         if err = u.syncAddAKUser(AKUser); err != nil {
105                 return
106         }
107         u.userStore.Store(userID, userInfo)
108         u.AKStore.Store(accessKey, AKUser)
109         log.LogInfof("action[createUser], userID: %v, accesskey[%v], secretkey[%v]",
    userID, accessKey, secretKey)
110         return
111 }
```

`createKey` creates a `UserInfo`, an access key and a secret key and stores it in the respective stores. If `createKey` successfully creates all three pieces of information and successfully stores them, it will log the created pieces of information on this line:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/master/user.go#L109

```
109         log.LogInfof("action[createUser], userID: %v, accesskey[%v], secretkey[%v]",
    userID, accessKey, secretKey)
```

Impact

An attacker who has access to the logs can see the secret key in plain text and impersonate the user. The attacker can either be an internal user with limited privileges to read the log, or it can be an external user who has escalated privileges sufficiently to access the logs.

To find the places where CubeFS logs the users `accessKey`, we refer to the following grep call: `grep -r "log\." . --exclude=*test.go | grep accessKey`. Not all occurrences of this constitute a vulnerability: Only cases of logging after authorization represent a security issue.

Insecure cryptographic primitive used for sensitive data

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-VGvgh234hb2
Component:	Master

Cubefs Master uses an insecure cryptographic primitive for encoding user passwords. Cubefs uses SHA1 to encode the password. Researchers have identified theoretical collision attacks of SHA1 for the first time in 2004 but have only demonstrated it in practice in 2017 (Marc Stevens, Elie Bursztein, Pierre Karpman, Ange Albertini, and Yarik Markov. "The first collision for full SHA-1"). NIST recommends that existing usage of SHA1 for security-sensitve information should be upgraded to SHA2 or SHA3 (https://www.nist.gov/news-events/news/2022/12/nist-retires-sha-1-cryptographic-algorithm). The issue exists in the `encodingPassword` helper:

https://github.com/cubefs/cubefs/blob/45442918591d25e7ab555469df384df468df5dbc/master/user.go#L547-L551

```
547 func encodingPassword(s string) string {
548         t := sha1.New()
549         io.WriteString(t, s)
550         return hex.EncodeToString(t.Sum(nil))
551 }
```

Cubefs uses this helper when creating a user below on line 100:

https://github.com/cubefs/cubefs/blob/45442918591d25e7ab555469df384df468df5dbc/master/user.go#L43-L111

```
43 func (u *User) createKey(param *proto.UserCreateParam) (userInfo *proto.UserInfo, err
   error) {
44         var (
45                 AKUser     *proto.AKUser
46                 userPolicy *proto.UserPolicy
47                 exist      bool
48         )
49         if param.ID == "" {
50                 err = proto.ErrInvalidUserID
51                 return
52         }
53         if !param.Type.Valid() {
54                 err = proto.ErrInvalidUserType
55                 return
56         }
57
58         var userID = param.ID
59         var password = param.Password
60         if password == "" {
61                 password = DefaultUserPassword
62         }
63         var accessKey = param.AccessKey
64         if accessKey == "" {
65                 accessKey = util.RandomString(accessKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
66         } else {
67                 if !proto.IsValidAK(accessKey) {
68                         err = proto.ErrInvalidAccessKey
69                         return
70                 }
71         }
72         var secretKey = param.SecretKey
73         if secretKey == "" {
74                 secretKey = util.RandomString(secretKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
75         } else {
76                 if !proto.IsValidSK(secretKey) {
77                         err = proto.ErrInvalidSecretKey
78                         return
79                 }
80         }
```

```
81          var userType = param.Type
82          var description = param.Description
83          u.userStoreMutex.Lock()
84          defer u.userStoreMutex.Unlock()
85          u.AKStoreMutex.Lock()
86          defer u.AKStoreMutex.Unlock()
87          //check duplicate
88          if _, exist = u.userStore.Load(userID); exist {
89                  err = proto.ErrDuplicateUserID
90                  return
91          }
92          _, exist = u.AKStore.Load(accessKey)
93          for exist {
94                  accessKey = util.RandomString(accessKeyLength,
    util.Numeric|util.LowerLetter|util.UpperLetter)
95                  _, exist = u.AKStore.Load(accessKey)
96          }
97          userPolicy = proto.NewUserPolicy()
98          userInfo = &proto.UserInfo{UserID: userID, AccessKey: accessKey, SecretKey:
    secretKey, Policy: userPolicy,
99                  UserType: userType, CreateTime: time.Unix(time.Now().Unix(),
    0).Format(proto.TimeFormat), Description: description}
100          AKUser = &proto.AKUser{AccessKey: accessKey, UserID: userID, Password:
     encodingPassword(password)}
101          if err = u.syncAddUserInfo(userInfo); err != nil {
102                  return
103          }
104          if err = u.syncAddAKUser(AKUser); err != nil {
105                  return
106          }
107          u.userStore.Store(userID, userInfo)
108          u.AKStore.Store(accessKey, AKUser)
109          log.LogInfof("action[createUser], userID: %v, accesskey[%v], secretkey[%v]",
     userID, accessKey, secretKey)
110          return
111  }
```

An attacker who can retrieve the database records of users has a lower barrier for getting the actual passwords of users than if Cubefs used a secure primitive such as SHA2 or SHA3. To exploit this weakness, an attacker would already need to escalate privileges or gain access to database records from misconfiguration of a Cubefs deployment. Even so, an attacker has the potential for further escalating privileges by exploiting this weakness depending on the user credentials they can steal.

Mitigation

We recommend using a secure primitive for user passwords. This would mitigate risk even if an attacker has access to the encrypted user passwords.

Insecure random string generator used for sensitive data

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-BH£Rj2432jk
Component:	Master

CubeFS uses an insecure random string generator to generate user-specific, sensitive keys used to authenticate users in a CubeFS deployment. This could allow an attacker to predict and/or guess the generated string and impersonate a user, thereby obtaining higher privileges.

When CubeFS creates new users, it creates a piece of sensitive information for the user called the “accessKey”. To create the `accesKey`, CubeFS uses an insecure string generator which makes it easy to guess and thereby impersonate the created user. The API that generates access keys is `RandomString`:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/util/string.go#L58-L67

```
58 func RandomString(length int, seed RandomSeed) string {
59         runs := seed.Runes()
60         result := ""
61         for i := 0; i < length; i++ {
62                 rand.Seed(time.Now().UnixNano())
63                 randNumber := rand.Intn(len(runs))
64                 result += string(runs[randNumber])
65         }
66         return result
67 }
```

`RandomString` uses `math/rand` seeded with `UnixNano()` to generate the string, which is predictable. `math/rand` is not suited for sensitive information, as stated in the documentation: https://pkg.go.dev/math/rand#pkg-overview.

CubeFS uses `RandomString()` to generate user access keys in the following places:

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/master/user.go#L63-L66

```
63         var accessKey = param.AccessKey
64         if accessKey == "" {
65                 accessKey = util.RandomString(accessKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
66         } else {
```

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/master/user.go#L92-L96

```
92         _, exist = u.AKStore.Load(accessKey)
93         for exist {
94                 accessKey = util.RandomString(accessKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
95                 _, exist = u.AKStore.Load(accessKey)
96         }
```

https://github.com/cubefs/cubefs/blob/26da9925a3db98ff9a1e9a12cca2c457f736b831/master/user.go#L72-L75

```
72         var secretKey = param.SecretKey
73         if secretKey == "" {
74                 secretKey = util.RandomString(secretKeyLength,
   util.Numeric|util.LowerLetter|util.UpperLetter)
75         } else {
```

Impact

An attacker could exploit the predictable random string generator and guess a users access key to impersonate the user and obtain higher privileges.

Lack of security-best-practices documentation

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-vc34CGVVJB
Component:	CubeFS

CubeFS maintain documentation on how to easily get started with CubeFS, which is positive; however, CubeFS lacks a section or dedicated page on deploying and using CubeFS in a secure, production-ready manner.

We recommend setting up a dedicated page to accommodate this. See the Istio security-best-practices page for reference: https://istio.io/latest/docs/ops/best-practices/security/.

Without an officially maintained security-best-practices page, users may deploy CubeFS in ways that are known by the community to be insecure and obviously necessary for secure but also easy to overlook. Users should not be expected to read through the entire documentation to dissect the critical parts for deployment. Instead, we recommend a dedicated page for this purpose.

The work to maintain secure-best-practices documentation should be considered an ongoing process. Adding this to the documentation, maintaining it and developing it over time is good practice.

Possible deadlocks

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-LK432hu
Component:	Multiple

Cubefs is susceptible to a number of deadlocks across multiple components. This is an umbrella issue for all identified possible deadlocks. Deadlocks happen when two threads or programs are waiting for each other to finish, where one of them does not finish. This has security implications if an attacker is able to cause the deadlock. The attacker will steer the execution of the program into a path where the program invokes a lock but does not unlock it.

Below we enumerate the places across the Cubefs source tree where this can happen.

Rate limiter

Below, Cubefs locks the mutex on line 60 and unlocks it on line 72. Between the mutex lock and unlock, the method can exit in two places: line 63 and line 67.

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/util/ratelimit/keyratelimit.go#L58-L73

```
58 func (k *KeyRateLimit) Release(key string) {
59
60         k.mutex.Lock()
61         limit, ok := k.current[key]
62         if !ok {
63                 panic("key not in map. Possible reason: Release without Acquire.")
64         }
65         limit.refCount--
66         if limit.refCount < 0 {
67                 panic("internal error: refs < 0")
68         }
69         if limit.refCount == 0 {
70                 delete(k.current, key)
71         }
72         k.mutex.Unlock()
73 }
```

flowctrl

A similar case to the Rate limiter exists in the `flowctrl` package:

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/util/flowctrl/keycontroller.go#L55-L71

```
55 func (k *KeyFlowCtrl) Release(key string) {
56
57         k.mutex.Lock()
58         ctrl, ok := k.current[key]
59         if !ok {
60                 panic("key not in map. Possible reason: Release without Acquire.")
61         }
62         ctrl.refCount--
63         if ctrl.refCount < 0 {
64                 panic("internal error: refs < 0")
65         }
66         if ctrl.refCount == 0 {
67                 ctrl.c.Close() // avoid goroutine leak
68                 delete(k.current, key)
69         }
70         k.mutex.Unlock()
71 }
```

Cubefs locks the mutex on line 57 and unlocks it on line 70. The method can exit on lines 60 and 64 without unlocking.

Metanode

Metanodes method for marshalling a value to bytes has a potential deadlock if the call to `binary.Write` fails with an error, which will cause the method to panic without releasing the lock.

Below, `MarshalValue()` locks on line 703 and unlocks on line 719. On line 709, the method panics without releasing the lock:

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/metanode/inode.go#L698-L721

```
698 func (i *Inode) MarshalValue() (val []byte) {
699         var err error
700         buff := bytes.NewBuffer(make([]byte, 0, 128))
701         buff.Grow(64)
702
703         i.RLock()
704         i.MarshalInodeValue(buff)
705         if i.getLayerLen() > 0 && i.getVer() == 0 {
706                 log.LogFatalf("action[MarshalValue] inode %v current verseq %v, hist
    len (%v) stack(%v)", i.Inode, i.getVer(), i.getLayerLen(), string(debug.Stack()))
707         }
708         if err = binary.Write(buff, binary.BigEndian, int32(i.getLayerLen())); err
    != nil {
709                 panic(err)
710         }
711
712         if i.multiSnap != nil {
713                 for _, ino := range i.multiSnap.multiVersions {
714                         ino.MarshalInodeValue(buff)
715                 }
716         }
717
718         val = buff.Bytes()
719         i.RUnlock()
720         return
721 }
```

An attacker who can trigger the panic in a controlled manner has the potential to exploit this by locking a lot or all resources on the machine and thereby cause denial of service.

QosCtrlManager

The Cubefs QoS manager's method for assigning QoS to clients, `assignClientsNewQos` is susceptible to a deadlock in case the manager has not enabled QoS. Below, the manager locks on line 692 and unlocks on line 722. On line 694, the manager will return if the QoS is not enabled:

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/master/limiter.go#L691-L735

```
691 func (qosManager *QosCtrlManager) assignClientsNewQos(factorType uint32) {
692         qosManager.RLock()
693         if !qosManager.qosEnable {
694                 return
695         }
696         serverLimit := qosManager.serverFactorLimitMap[factorType]
697         var bufferAllocated uint64
698
699         // recalculate client Assign limit and buffer
700         for _, cliInfoMgr := range qosManager.cliInfoMgrMap {
701                 cliInfo := cliInfoMgr.Cli.FactorMap[factorType]
702                 assignInfo := cliInfoMgr.Assign.FactorMap[factorType]
703
704                 if cliInfo.Used+cliInfoMgr.Cli.FactorMap[factorType].Need == 0 {
705                         assignInfo.UsedLimit = 0
706                         assignInfo.UsedBuffer = 0
707                 } else {
708                         assignInfo.UsedLimit =
    uint64(float64(cliInfo.Used+cliInfo.Need) * float64(1-serverLimit.LimitRate))
709                         if serverLimit.Allocated != 0 {
710                                 assignInfo.UsedBuffer =
    uint64(float64(serverLimit.Buffer) * (float64(assignInfo.UsedLimit) /
    float64(serverLimit.Allocated)) * 0.5)
711                         }
712
```

```
713                         // buffer left may be quit large and we should not use up
    and doesn't mean if buffer large than used limit line
714                         if assignInfo.UsedBuffer > assignInfo.UsedLimit {
715                                 assignInfo.UsedBuffer = assignInfo.UsedLimit
716                         }
717                 }
718
719                 bufferAllocated += assignInfo.UsedBuffer
720         }
721
722         qosManager.RUnlock()
723
724         if serverLimit.Buffer > bufferAllocated {
725                 serverLimit.Buffer -= bufferAllocated
726         } else {
727                 serverLimit.Buffer = 0
728                 log.LogWarnf("action[assignClientsNewQos] vol [%v] type [%v] clients
    buffer [%v] and server buffer used up trigger flow limit overall",
729                         qosManager.vol.Name, proto.QosTypeString(factorType),
    bufferAllocated)
730         }
731
732         log.QosWriteDebugf("action[assignClientsNewQos] vol [%v]  type [%v]
    serverLimit buffer:[%v] used:[%v] need:[%v] total:[%v]",
733                 qosManager.vol.Name, proto.QosTypeString(factorType),
734                 serverLimit.Buffer, serverLimit.Allocated,
    serverLimit.NeedAfterAlloc, serverLimit.Total)
735 }
```

An attacker cannot control whether Cubefs should proceed into this branch and return:

```
1         if !qosManager.qosEnable {
2                 return
3         }
```

For an attacker to return on line 694 and thereby prevent Cubefs from unlocking the manager, they would need to know that the victims Cubefs deployment has disabled QoS and thereby cause Cubefs to invoke `assignClientsNewQos`.

Block cache

The Block cache manager has a method for removing item keys from the cache to free up space, `freeSpace`. This method invokes a loop that ends when a counter, `cnt` reaches `500000`. Each loop iteration performs the following steps: 1) The Block cache manager locks, 2) an item is deleted from the store, 3) the Block cache manager unlocks. This process is susceptible to a deadlock because the `freeSpace` method can exist between step 1 and 3, i.e. it is possible for `freeSpace` to lock the Block cache manager and return without unlocking it.

On line 390 the manager enters the for loop. Inside the loop, the manager locks on line 399 and unlocks on line 415. On line 403, `freeSpace` can return without unlocking the manager.

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/blockcache/bcache/manage.go#L379-L419

```
379 func (bm *bcacheManager) freeSpace(store *DiskStore, free float32, files int64) {
380         var decreaseSpace int64
381         var decreaseCnt int
382
383         if free < store.freeLimit {
384                 decreaseSpace = int64((store.freeLimit - free) *
    (float32(store.capacity)))
385         }
386         if files > int64(store.limit) {
387                 decreaseCnt = int(files - int64(store.limit))
388         }
389
390         cnt := 0
391         for {
392                 if decreaseCnt <= 0 && decreaseSpace <= 0 {
393                         break
394                 }
395                 //avoid dead loop
396                 if cnt > 500000 {
397                         break
398                 }
```

```
399                 bm.Lock()
400
401                 element := bm.lrulist.Front()
402                 if element == nil {
403                         return
404                 }
405                 item := element.Value.(*cacheItem)
406
407                 if err := store.remove(item.key); err == nil {
408                         bm.lrulist.Remove(element)
409                         delete(bm.bcacheKeys, item.key)
410                         decreaseSpace -= int64(item.size)
411                         decreaseCnt--
412                         cnt++
413                 }
414
415                 bm.Unlock()
416                 log.LogDebugf("remove %v from cache", item.key)
417
418         }
419 }
```

Volume manager

When Cubefs's Volume Manager applies an update to a volume unit, it does so with `applyAdminUpdateVolumeUnit`. `applyAdminUpdateVolumeUnit` gets the disk info with a call to the disk managers `GetDiskInfo`. If this call fails, `applyAdminUpdateVolumeUnit` returns the error. Before getting the disk info, `applyAdminUpdateVolumeUnit` puts a lock on the volume that is being modified, and `applyAdminUpdateVolumeUnit` will not release that lock if the call to `GetDiskInfo` fails. In other words, if the call to `GetDiskInfo` fails, the lock will not be released. The parameter to `GetDiskInfo` is passed directly from a parameter to `applyAdminUpdateVolumeUnit`.

`applyAdminUpdateVolumeUnit` locks the volume on line 691 and unlocks it again on line 710. On line 701, `applyAdminUpdateVolumeUnit` returns without unlocking the volume.

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/blobstore/clustermgr/volumemgr/volumemgr.go#L675-L711

```
675 func (v *VolumeMgr) applyAdminUpdateVolumeUnit(ctx context.Context, unitInfo
    *cm.AdminUpdateUnitArgs) error {
676         span := trace.SpanFromContextSafe(ctx)
677         vol := v.all.getVol(unitInfo.Vuid.Vid())
678         if vol == nil {
679                 span.Errorf("apply admin update volume unit,vid %d not exist",
    unitInfo.Vuid.Vid())
680                 return ErrVolumeNotExist
681         }
682         index := unitInfo.Vuid.Index()
683         vol.lock.RLock()
684         if int(index) >= len(vol.vUnits) {
685                 span.Errorf("apply admin update volume unit,index:%d over vuids
    length ", index)
686                 vol.lock.RUnlock()
687                 return ErrVolumeUnitNotExist
688         }
689         vol.lock.RUnlock()
690
691         vol.lock.Lock()
692         if proto.IsValidEpoch(unitInfo.Epoch) {
693                 vol.vUnits[index].epoch = unitInfo.Epoch
694                 vol.vUnits[index].vuInfo.Vuid =
    proto.EncodeVuid(vol.vUnits[index].vuidPrefix, unitInfo.Epoch)
695         }
696         if proto.IsValidEpoch(unitInfo.NextEpoch) {
697                 vol.vUnits[index].nextEpoch = unitInfo.NextEpoch
698         }
699         diskInfo, err := v.diskMgr.GetDiskInfo(ctx, unitInfo.DiskID)
700         if err != nil {
701                 return err
702         }
703         vol.vUnits[index].vuInfo.DiskID = diskInfo.DiskID
704         vol.vUnits[index].vuInfo.Host = diskInfo.Host
705         vol.vUnits[index].vuInfo.Compacting = unitInfo.Compacting
706
707         unitRecord := vol.vUnits[index].ToVolumeUnitRecord()
708         err = v.volumeTbl.PutVolumeUnit(unitInfo.Vuid.VuidPrefix(), unitRecord)
709         vol.lock.Unlock()
710         return err
```

```
711 }
```

This deadlock can be triggered in two ways. One way is to pass a parameter to `applyAdminUpdateVolumeUnit`, which the user knows will result in returning on line 701. The second way is to modify the disk manager such that when another user invokes `GetDiskInfo()` on line 699, it will fail. `GetDiskInfo` returns an error if the `diskInfo` of the passed `DiskID` does not exist:

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/blobstore/clustermgr/diskmgr/diskmgr.go#L274-L285

```
274 func (d *DiskMgr) GetDiskInfo(ctx context.Context, id proto.DiskID)
    (*blobnode.DiskInfo, error) {
275         diskInfo, ok := d.getDisk(id)
276         if !ok {
277                 return nil, apierrors.ErrCMDiskNotFound
278         }
279
280         diskInfo.lock.RLock()
281         defer diskInfo.lock.RUnlock()
282         newDiskInfo := *(diskInfo.info)
283         // need to copy before return, or the higher level may change the disk info
    by the disk info pointer
284         return &(newDiskInfo), nil
285 }
```

An attacker could trigger the deadlock by removing disks that the caller of `applyAdminUpdateVolumeUnit` expects to exist.

Blobnode

The `PutShard` method of the `ShardsBuf` type is susceptible to a deadlock from a missing lock release in case of a wrong size comparison.

`PutShard` performs a size comparison as part of a sanity check and returns an error if the data size does not match the expected size. When doing so, `PutShard` does not unlock the `ShardsBuf`.

On line 293 below, `PutShard` locks the `ShardsBuf` and unlocks it on line 312. On line 309, `PutShard` performs the sanity check `if int64(len(shards.shards[bid].data)) != size {` and returns `errShardSizeNotMatch` on line 310 if it fails. Before returning `errShardSizeNotMatch`, `PutShard` does not unlock the `ShardsBuf`, and it remains locked after returning:

https://github.com/cubefs/cubefs/blob/46cb4d149c45f1ad7b40381b5a2a20bd6d599e25/blobstore/blobnode/work_shard_recover.go#L292-L324

```
292 func (shards *ShardsBuf) PutShard(bid proto.BlobID, input io.Reader) error {
293         shards.mu.Lock()
294
295         if _, ok := shards.shards[bid]; !ok {
296                 shards.mu.Unlock()
297                 return errBidNotFoundInBuf
298         }
299         if shards.shards[bid].size == 0 {
300                 shards.mu.Unlock()
301                 return nil
302         }
303         if shards.shards[bid].ok {
304                 shards.mu.Unlock()
305                 return errBufHasData
306         }
307
308         size := shards.shards[bid].size
309         if int64(len(shards.shards[bid].data)) != size {
310                 return errShardSizeNotMatch
311         }
312         shards.mu.Unlock()
313
314         // read data from remote is slow,so optimize use of lock
315         _, err := io.ReadFull(input, shards.shards[bid].data)
316         if err != nil {
317                 return err
318         }
```

```
319
320         shards.mu.Lock()
321         shards.shards[bid].ok = true
322         shards.mu.Unlock()
323         return nil
324 }
```

Possible nil-dereference from unmarshalling double pointer

Severity:	Low
Status:	Fixed
Id:	ADA-CUBEFS-ASBDVGA
Component:	ObjectNode

Unmarshalling into a double-pointer can result in nil-pointer dereference if the raw bytes are `NULL`.

CubeFS has a case that would trigger a nil-pointer dereference and crash the CubeFS ObjectNode:

https://github.com/cubefs/cubefs/blob/45442918591d25e7ab555469df384df468df5dbc/objectnode/acl_api.go#L186-L201

```
186 func getObjectACL(vol *Volume, path string, needDefault bool) (*AccessControlPolicy,
    error) {
187         xAttr, err := vol.GetXAttr(path, XAttrKeyOSSACL)
188         if err != nil || xAttr == nil {
189                 return nil, err
190         }
191         var acp *AccessControlPolicy
192         data := xAttr.Get(XAttrKeyOSSACL)
193         if len(data) > 0 {
194                 if err = json.Unmarshal(data, &acp); err != nil {
195                         err = xml.Unmarshal(data, &acp)
196                 }
197         } else if needDefault {
198                 acp = CreateDefaultACL(vol.owner)
199         }
200         return acp, err
201 }
```

On line 194, `getObjectACL` unmarshals into a double pointer. `acp` is declared on line 191 as a pointer and is referenced with a pointer on line 194. If `data` on line 194 is the byte sequence equal to `NULL`, `acp` will be `nil` on line 194 and return `nil, nil`.

This behaviour will trigger a nil-pointer dereference on 145 in the below code snippet: https://github.com/cubefs/cubefs/blob/6a0d5fa45a77ff20c752fa9e44738bf5d86c84bd/objectnode/acl_handler.go#L110-L153

```
1  func (o *ObjectNode) getObjectACLHandler(w http.ResponseWriter, r *http.Request) {
2          var (
3                  err error
4                  erc *ErrorCode
5          )
6          defer func() {
7                  o.errorResponse(w, r, err, erc)
8          }()
9
10          param := ParseRequestParam(r)
11          if param.Bucket() == "" {
12                  erc = InvalidBucketName
13                  return
14          }
15          if param.Object() == "" {
16                  erc = InvalidKey
17                  return
18          }
19
20          var vol *Volume
21          if vol, err = o.getVol(param.bucket); err != nil {
22                  log.LogErrorf("getObjectACLHandler: load volume fail: requestID(%v)
    volume(%v) err(%v)",
23                          GetRequestID(r), param.bucket, err)
```

```
24                  return
25          }
26          var acl *AccessControlPolicy
27          if acl, err = getObjectACL(vol, param.object, true); err != nil {
28                  log.LogErrorf("getObjectACLHandler: get acl fail: requestID(%v)
    volume(%v) path(%v) err(%v)",
29                          GetRequestID(r), param.bucket, param.object, err)
30                  if err == syscall.ENOENT {
31                          erc = NoSuchKey
32                  }
33                  return
34          }
35          var data []byte
36          if data, err = acl.XmlMarshal(); err != nil {
37                  log.LogErrorf("getObjectACLHandler: xml marshal fail: requestID(%v)
    volume(%v) path(%v) acl(%+v) err(%v)",
38                          GetRequestID(r), param.bucket, param.object, acl, err)
39                  return
40          }
41
42          writeSuccessResponseXML(w, data)
43          return
44  }
```

On line 136 `getObjectACLHandler` invokes `getObjectACL`. If this returns `nil, nil`, then a nil-pointer dereference will be triggered on line 145.

Mitigation

Unmarshal into a single pointer instead of a double pointer.

Potential Slowloris attacks

Severity:	Low
Status:	Fixed
Id:	ADA-CUBEFS-AMK23ghJVHJ
Component:	AuthNode

Slowloris is a type of attack where an attacker opens a connection between their controlled machine and the victim's server. Once the attacker has opened the connection, they keep it open for as long as possible. They will do the same with a large number of controlled machines to hog the available connections and prevent other users from accessing the service. As such, the victim's server stays up but remains busy from processing the attacker's requests and becomes unavailable to legitimate users.

An attacker can exploit a Slowloris issue by identifying execution paths in their target application that cause it to take longer time to return from, and the attacker can then send requests that force the application into these. The fact that Cubefs's Master server is susceptible to a Slowloris attack does not mean that it is easily exploitable.

AuthNode

https://github.com/cubefs/cubefs/blob/9c9f0bad65fc4a904160ff22cdaba2d9d6becd7c/authnode/http_server.go#L37-L44

```
37              srv := &http.Server{
38                  Addr:      colonSplit + m.port,
39                  TLSConfig: cfg,
40              }
41              if err := srv.ListenAndServeTLS("/app/server.crt", "/app/server.key");
    err != nil {
42                  log.LogErrorf("action[startHTTPService] failed,err[%v]", err)
43                  panic(err)
44              }
```

Master

The root cause of the Master server Slowloris issue is that is does not declare a timeout. On line 50 below, `startHTTPService` declares the HTTP Server with address and handler but does not declare a timeout.

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/master/http_server.go#L37-L64

```
37 func (m *Server) startHTTPService(modulename string, cfg *config.Config) {
38     router := mux.NewRouter().SkipClean(true)
39     m.registerAPIRoutes(router)
40     m.registerAPIMiddleware(router)
41     if m.cluster.authenticate {
42         m.registerAuthenticationMiddleware(router)
43     }
44     exporter.InitWithRouter(modulename, cfg, router, m.port)
45     addr := fmt.Sprintf(":%s", m.port)
46     if m.bindIp {
47         addr = fmt.Sprintf("%s:%s", m.ip, m.port)
48     }
49
50     var server = &http.Server{
51         Addr:    addr,
52         Handler: router,
53     }
54
55     var serveAPI = func() {
56         if err := server.ListenAndServe(); err != nil {
57             log.LogErrorf("serveAPI: serve http server failed: err(%v)", err)
58             return
59         }
60     }
61     go serveAPI()
```

```
62      m.apiServer = server
63      return
64  }
```

The server does not have a timeout at all because the server has specified neither `ReadTimeout` nor `ReadHeaderTimeout`. This grants an attacker ample flexibility and possibilities for getting the server to hang. Note that the server also does not have write timeouts, which adds to an attacker's possibilities of triggering this.

Below, we enumerate all other HTTP servers that do not specify timeouts. We do not include tests and examples.

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/blobstore/cmd/cmd.go#L135-L144

```
135     if mod.graceful {
136         programEntry := func(state *graceful.State) {
137             router, handlers := mod.SetUp()
138 
139             httpServer := &http.Server{
140                 Addr:    cfg.BindAddr,
141                 Handler: reorderMiddleWareHandlers(router, lh, cfg.BindAddr,
    cfg.Auth, handlers),
142             }
143 
144             log.Info("server is running at:", cfg.BindAddr)
```

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/blobstore/cmd/cmd.go#L171-L174

```
171     httpServer := &http.Server{
172         Addr:    cfg.BindAddr,
173         Handler: reorderMiddleWareHandlers(router, lh, cfg.BindAddr, cfg.Auth,
    handlers),
174     }
```

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/blobstore/common/raftserver/transport.go#L70-L73

```
70      tr.httpSvr = &http.Server{
71          Addr:    fmt.Sprintf(":%d", port),
72          Handler: router,
73      }
```

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/blobstore/common/consul/consul.go#L216-L227

```
216     srv = &http.Server{}
217     srv.Addr = ln.Addr().String()
218     port = ln.Addr().(*net.TCPAddr).Port
219     log.Info("start health check server on: ", srv.Addr)
220     http.HandleFunc(patten, healthCheck)
221     go func() {
222         httpError := srv.Serve(ln.(*net.TCPListener))
223         if httpError != nil && httpError != http.ErrServerClosed {
224             log.Fatalf("health server HTTP error: ", httpError)
225         }
226         log.Info("health check server exit")
227     }()
```

https://github.com/cubefs/cubefs/blob/5ab518b3598ee99a74b333d0d2abc80739bbae4d/objectnode/server.go#L463-L473

```
463     var server = &http.Server{
464         Addr:    ":" + o.listen,
465         Handler: router,
466     }
467 
468     go func() {
469         if err = server.ListenAndServe(); err != nil {
470             log.LogErrorf("startMuxRestAPI: start http server fail, err(%v)", err)
471             return
472         }
473     }()
```

Mitigation
Add timeouts when declaring the servers.

Releases are not signed

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-NJb32hjJBN
Component:	CubeFS

CubeFS releases are not signed, with keys available alongside releases. Signing releases and allowing consumers to verify them mitigates supply-chain risks.

A tool like Cosign makes the signing process easy and low-effort and keeps the overhead for consumers low to verify signatures. These signatures should be available with releases.

Mitigation
Release signing by way of Cosign can be adopted by way of the official Cosign Github Action: https://github.com/marketplace/actions/cosign-installer.

Security Disclosure Email Does Not Work

Severity:	Low
Status:	Fixed
Id:	ADA-CUBEFS-vc34CGVVJB
Component:	Security Policy

During the audit, Ada Logics attempted to disclose a finding to the email address listed in CubeFS's security disclosure guidelines: https://github.com/cubefs/cubefs/blob/master/SECURITY.md. The email bounced, and the CubeFS team did not receive the security finding.

This could prevent or discourage community members from contributing to CubeFS's security posture. We recommend regularly ensuring that communication channels for responsible security disclosures are tested.

During the security audit, the CubeFS maintainers enable disclosures through the Github interface.

Timing attack can leak user passwords

Severity:	Moderate
Status:	Fixed
Id:	ADA-CUBEFS-Jh2iu3423b
Component:	Master

Summary

CubeFS uses a string comparison for user passwords that is prone to timing attacks. A timing attack is a side-channel attack whereby an attacker observes the response time from an application and can deduce the number of matching characters in their payload against the control string.

Details

CubeFS password validation routine:

https://github.com/cubefs/cubefs/blob/fdfa176a97e0fbb57c953e2b4a3aebe329e2a631/master/gapi_user.go#L337-L356

```
337 func (s *UserService) validatePassword(ctx context.Context, args struct {
338         UserID   string
339         Password string
340 }) (*proto.UserInfo, error) {
341         ui, err := s.user.getUserInfo(args.UserID)
342         if err != nil {
343                 return nil, err
344         }
345
346         ak, err := s.user.getAKUser(ui.AccessKey)
347         if err != nil {
348                 return nil, err
349         }
350
351         if ak.Password != args.Password {
352                 log.LogWarnf("user:[%s] login pass word has err", args.UserID)
353                 return nil, fmt.Errorf("user or password has err")
354         }
355         return ui, nil
356 }
```

... is prone to a timing/side channel attack due to the way CubeFS compares the two passwords on this line:

https://github.com/cubefs/cubefs/blob/fdfa176a97e0fbb57c953e2b4a3aebe329e2a631/master/gapi_user.go#L351

```
351         if ak.Password != args.Password {
```

For similar issues in the Go ecosystem, which include technical discussions about timing attacks and mitigation, see:

- https://github.com/advisories/GHSA-mq6f-5xh5-hgcf
- https://github.com/gin-gonic/gin/issues/3168

Impact

This vulnerability allows unauthenticated users to escalate privileges to the level corresponding to the highest privileged user in the UserService. If there are users with root permissions being authenticated by `validatePassword`, this is the possible level of privilege escalation.

All CubeFS users using the Master `UserService`s `validatePassword` to validate user passwords are impacted by this.