

# D4 Project

Open and collaborative network monitoring

Team CIRCL

<https://www.d4-project.org/>

2019/05/22

TEAM CIRCL



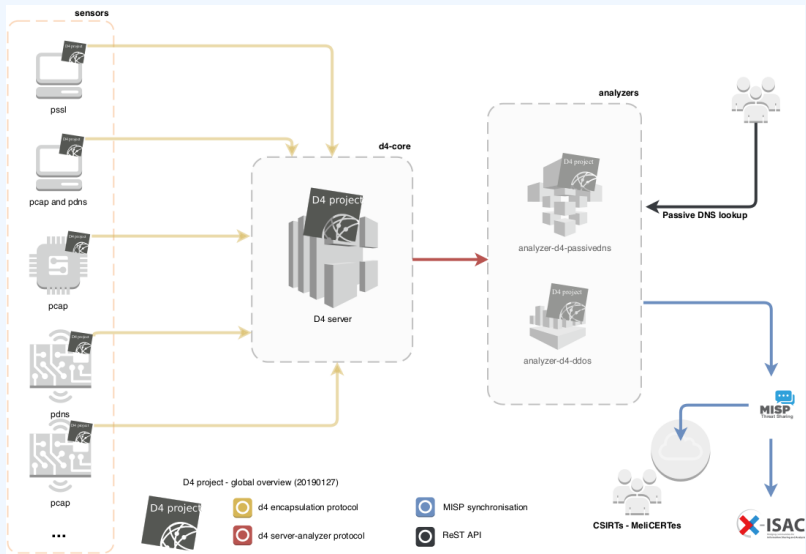
- CSIRTs (or private organisations) build their **own honeypot, honeynet or blackhole monitoring network**
- Designing, managing and operating such infrastructure is a tedious and resource intensive task
- **Automatic sharing** between monitoring networks from different organisations is missing
- Sensors and processing are often seen as blackbox or difficult to audit

- Based on our experience with MISP<sup>1</sup> where sharing played an important role, we transpose the model in D4 project
- Keeping the protocol and code base **simple and minimal**
- Allowing every organisation to **control and audit their own sensor network**
- Extending D4 or **encapsulating legacy monitoring protocols** must be as simple as possible
- Ensuring that the sensor server has **no control on the sensor** (unidirectional streaming)
- Don't force users to use dedicated sensors and allow **flexibility of sensor support** (software, hardware, virtual)

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<sup>1</sup><https://github.com/MISP/MISP>

# D4 OVERVIEW



- D4 Project (co-funded under INEA CEF EU program) started - **1st November 2018**
- D4 encapsulation protocol version 1 published - **1st December 2018**
- vo.1 release of the D4 core<sup>2</sup> including a server and simple D4 C client - **21st January 2019**
- First version of a golang D4 client<sup>3</sup> running on ARM, MIPS, PPC and x86 - **14th February 2019**

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<sup>2</sup><https://www.github.com/D4-project/d4-core>

<sup>3</sup><https://www.github.com/D4-project/d4-goclient/>

## (SHORT) HISTORY

Release	Date
analyzer-d4-passivedns-vo.1	Apr. 5, 2019
analyzer-d4-passivessl-0.1	Apr. 25, 2019
analyzer-d4-pibs-vo.1	Apr. 8, 2019
BGP-Ranking-1.0	Apr. 25, 2019
d4-core-vo.1	Jan. 25, 2019
d4-core-vo.2	Feb. 14, 2019
d4-core-vo.3	Apr. 8, 2019
d4-goclient-vo.1	Feb. 14, 2019
d4-goclient-vo.2	Apr. 8, 2019
d4-server-packer-0.1	Apr. 25, 2019
IPASN-History-1.0	Apr. 25, 2019
sensor-d4-tls-fingerprinting-0.1	Apr. 25, 2019

see <https://github.com/D4-Project>

CIRCL will host a server instance for organisations willing to contribute to a public dataset without running their own D4 server:

- ✓ Blackhole DDoS
- ✓ Passive DNS
- ✓ Passive SSL
  - BGP mapping
  - egress filtering mapping
  - Radio-Spectrum monitoring: 802.11, BLE, etc.
  - ...

# D4 ENCAPSULATION PROTOCOL

stream of information  
(text or binary)

```
010111010100
100010101101
010100101011
010100100100
011010100101

01011101010010
10001010110101
01010010101111
01010010010100
01101010010101

01011101010010
10001010110101
01010010101111
01010010010100
01101010010101
```



D4 encapsulation protocol version 1



*version* (8) - Version of the header  
*type* (8) - Data encapsulated type  
*uuid* (128) - Sensor UUID  
*timestamp* (64) - Encapsulation time  
*hmac* (256) - Header authentication  
(HMAC-SHA256-128)  
*size* (32) - Payload size



<https://www.d4-project.org>



Name	bit size	Description
version	uint 8	Version of the header
type	uint 8	Data encapsulated type
uuid	uint 128	Sensor UUID
timestamp	uint 64	Encapsulation time
hmac	uint 256	Authentication header (HMAC-SHA-256-128)
size	uint 32	Payload size

Type	Description
0	Reserved
1	pcap (libpcap 2.4)
2	meta header (JSON)
3	generic log line
4	dnscap output
5	pcapng (diagnostic)
6	generic NDJSON or JSON Lines
7	generic YAF (Yet Another Flowmeter)
8	passivedns CSV stream
254	type defined by meta header (type 2)

D4 header includes an easy way to **extend the protocol** (via type 2) without altering the format. Within a D4 session, the initial D4 packet(s) type 2 defines the custom headers and then the following packets with type 254 is the custom data encapsulated.

```
{
  "type": "ja3-jl",
  "encoding": "utf-8",
  "tags": [
    "tlp:white"
  ],
  "misp:org": "5b642239-4db4-4580-adf4-4ebd950d210f"
}
```

- D4 core server<sup>4</sup> is a complete server to handle clients (sensors) including the decapsulation of the D4 protocol, control of sensor registrations, management of decoding protocols and dispatching to adequate decoders/analysers.
- D4 server is written in Python 3.6 and runs on standard GNU/Linux distribution.

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<sup>4</sup><https://github.com/D4-project/d4-core>

D4 server reconstructs the encapsulated stream from the D4 sensor and saves it in a Redis stream.

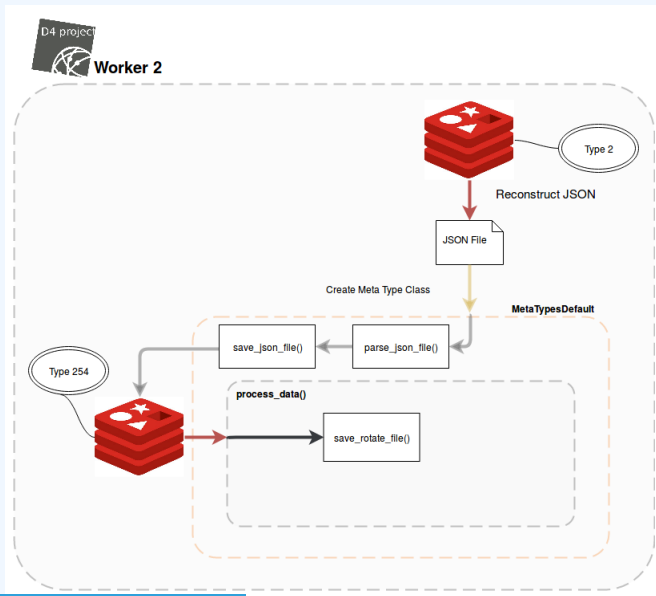
- Support TLS connection
- Unpack D4 header
- Verify client secret key (HMAC)
- check blacklist
- Filter by types (Only accept one connection by type-UUID - except: type 254)
- Discard incorrect data
- Save data in a Redis Stream (unique for each session)

After the stream is processed depending of the type using dedicated worker.

- Worker Manager (one by type)
  - ▶ Check if a new session is created and valid data are saved in a Redis stream
  - ▶ Launch a new Worker for each session
- Worker
  - ▶ Get data from a stream
  - ▶ Reconstruct data
  - ▶ Save data on disk (with file rotation)
  - ▶ Save data in Redis. Create a queue for D4 Analyzer(s)

- Worker custom type (called Worker 2)
  - ▶ Get type 2 data from a stream
  - ▶ Reconstruct Json
  - ▶ Extract extended type name
  - ▶ Use default type or special extended handler
  - ▶ Save Json on disk
  - ▶ Get type 254 data from a stream
  - ▶ Reconstruct type 254
  - ▶ Save data in Redis. Create a queue for D4 Analyzer(s)

# D4 SERVER - TYPE 254 - IMPLEMENTATION





The D4 server provides a **web interface** to manage D4 sensors, sessions and analyzer.

- Get Sensors status, errors and statistics
- Get all connected sensors
- Manage Sensors (stream size limit, secret key, ...)
- Manage Accepted types
- UUID/IP blacklist
- Create Analyzer Queues

# D4 SERVER - MAIN INTERFACE


The screenshot displays the D4 Server Main Interface. At the top, there is a navigation bar with the D4 project logo and links for Home, Sensors Status, and Server Management. The main content is divided into two panels: 'UUID' and 'Types'. The 'UUID' panel shows a list of servers with their IDs and UUIDs. The 'Types' panel shows the types of sensors for each server.


UUID	
4019794	c0bb49e788964718af4dfea4c0ab898c
47820	bbbcf7a43aed47aa84badc50262f5aba
27183	37d2f040fc074aaab2caf49059667525
8401	1b06b4ab8a754ef9ae3dd4d073b38f0e5
1022	de1df62d862b494a830f1f78ec27fca5



2019/05/20

Types	
4046981	1: pcap (libpcap 2.4)
57243	8: passivedns CSV stream

2019/05/20

 CIRCL  
Computer Incident  
Response Center  
Luxembourg

 Co-financed by the Connecting Europe  
Facility of the European Union

# D4 SERVER - SERVER MANAGEMENT

The screenshot displays the D4 Server Management interface. At the top, there is a navigation bar with a logo and links for Home, Sensors Status, and Server Management. Below this, the interface is divided into two main sections: Blacklist IP and Blacklist UUID.

**Blacklist IP Section:**

- Blacklist IP:** A form with an input field for IP Address and a red button labeled "Blacklist IP".
- Manage IP Blacklist:** A button labeled "Show Blacklisted IP".
- Unblacklist IP:** A form with an input field for IP Address and a button labeled "Unblacklist IP".

**Blacklist UUID Section:**

- Blacklist UUID:** A form with an input field for UUID and a red button labeled "Blacklist UUID".
- Manage UUID Blacklist:** A button labeled "Show Blacklisted UUID".
- Unblacklist UUID:** A form with an input field for UUID and a button labeled "Unblacklist UUID".

**Header Accepted Types Section:**

Header Accepted Types

Show 10 entries Search:

Type	Description	Remove Type
1	pcap (libcap 2.4)	Remove Type
2	meta header (JSON)	Remove Type
4	dnsmap output	Remove Type
8	passwdns CSV stream	Remove Type
254	type defined by meta header (type2)	Remove Type

Showing 1 to 5 of 5 entries Previous 1 Next

Show 10 entries Search:

Type Name	Description	Remove Type
ja3-f		Remove Extended Type

Showing 1 to 1 of 1 entries Previous 1 Next

**Add New Types:** A form with an input field containing "1" and a blue button labeled "Add New Type".

# D4 SERVER - SERVER MANAGEMENT

Analyzer Management

Show 10 ▾ entries Search

Type	uuid	last updated	Change max size limit	Analyzer Queue
1	f72ea760-370b-4f99-bb93-b6c6e645a32	2019-05-20 14:14:23	10000 <input type="text"/> Change Max Size	<input type="text" value="10001"/>
8	4072e072-bfaa-4395-9bb1-ccb3e470d715	2019-05-20 14:14:57	10000 <input type="text"/> Change Max Size	<input type="text" value="0"/>

Showing 1 to 2 of 2 entries Previous 1 Next

Show 10 ▾ entries Search

Type Name	uuid	last updated	Change max size limit	Analyzer Queue
jdk-f	8d8b724c71b64d6c942bffc2b6d761ac <small>This analyzer pushes TLS sessions into a postgres database for passiveSSL.</small>	2019-05-14 08:50:31	100000 <input type="text"/> Change Max Size	<input type="text" value="18036"/>

Showing 1 to 1 of 1 entries Previous 1 Next

Add New Analyzer Queue

1

Optional Description

# D4 SERVER - SENSOR OVERVIEW

201905 Home Sensors Status Server Management

Active Connection

UID: 0418F038237445277961C7E6A		
First Seen	Last Seen	Status
2019-05-01 13:05:05 (-155403940)	2019-05-20 13:55:23 (-155040561)	OK Connected

UID: 10562626175A7F0443373235564		
First Seen	Last Seen	Status
2019-04-09 12:27:42 (-155473442)	2019-05-20 14:19:08 (-155004194)	OK Connected

UID: 37627491E77664624F02947E23		
First Seen	Last Seen	Status
2019-04-01 11:46:31 (-155411919)	2019-05-20 14:17:35 (-155004187)	OK Connected

UID: 80677434e474616646152327646		
First Seen	Last Seen	Status
2019-04-02 07:14:49 (-155439400)	2019-05-20 14:17:35 (-155004187)	OK Connected

UID: 135476139194775491541344990		
First Seen	Last Seen	Status
2019-04-09 13:06:12 (-155472952)	2019-05-20 14:17:35 (-155004187)	OK Connected

# D4 SERVER - SENSOR MANAGEMENT

D4 project



Home

Sensors Status

Server Management

UUID: de1df62d862b494a830f178ec27fca5

First Seen	Last Seen	Status
2019-03-31 11:03:05 - (1554030185)	2019-05-20 13:56:23 - (1558360583)	OK <input checked="" type="checkbox"/> Connected <a href="#">Kick UUID</a>

### Change Stream Max Size

10000

[Change Max Size](#)

### UUID Blacklist

[Blacklist UUID](#)

### Blacklist IP Using This UUID

[Blacklist IP](#)

### Change UUID Key

private key to change

[Change UUID Key](#)

### Types Used:

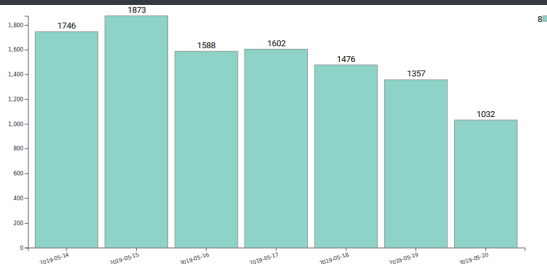
Show 10 entries

Search:

Type	first seen	last seen
8	2019-04-04 12:46:43	2019-05-20 13:56:23

Showing 1 to 1 of 1 entries

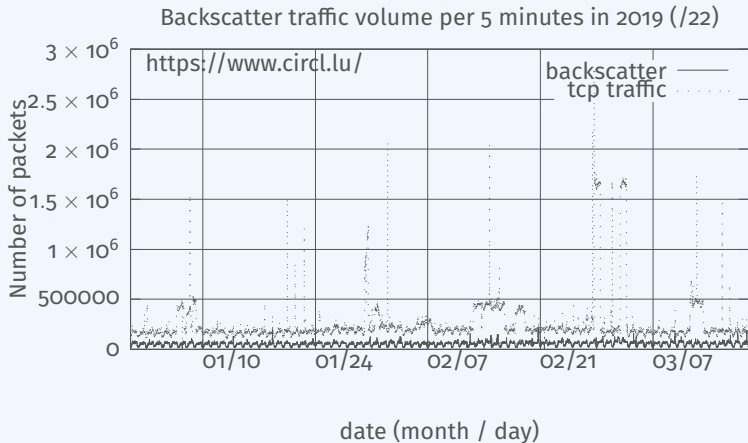
[Previous](#) [1](#) [Next](#)



## A distributed Network telescope to observe DDoS attacks



DDoS Attacks produce an observable side-effect:





- External point of view on ongoing Denial of Service attacks:
  - ▶ **Confirm** if there is a DDoS attack
  - ▶ **Recover** time line of attacked targets
  - ▶ **Confirm** which services (DNS, webserver, ...)
  - ▶ **Observe** Infrastructure changes
- **Assess the state of an infrastructure under denial of service attack**
  - ▶ **Detect** failure/addition of intermediate network equipments, firewalls, proxy servers etc
  - ▶ **Detect** DDoS mitigation devices
- Create models of DoS/DDoS attacks

D4 - for data collection and processing:

- **provide** various points of observation in non contiguous address space,
- **aggregate** and **mix** backscatter traffic collected from D4 sensors,
- **perform** analysis on big amount of data.

D4 - from a end-user perspective:

- **provide** backscatter analysis results,
- **provide** daily updates,
- **provide** additional relevant (or pivotal) information (DNS, BGP, etc.),
- **provide** an API and search capabilities.

- ✓ analyzer-d4-pibs<sup>5</sup>, an analyzer for a D4 network sensor:
  - ▶ **processes** data produced by D4 sensors (pcaps),
  - ▶ **displays** potential backscatter traffic on standard output,
  - ▶ **focuses** on TCP SYN flood in this first release.

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<sup>5</sup><https://github.com/D4-project/analyzer-d4-pibs>

## Passive DNS

- CIRCL (and other CSIRTs) have their own passive DNS<sup>6</sup> collection mechanisms
- Current **collection models** are affected with DoH<sup>7</sup> and centralised DNS services
- DNS answers collection is a tedious process
- **Sharing Passive DNS stream** between organisation is challenging due to privacy

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<sup>6</sup><https://www.circl.lu/services/passive-dns/>

<sup>7</sup>DNS over HTTPS

- Improve **Passive DNS collection diversity** by being closer to the source and limit impact of DoH (e.g. at the OS resolver level)
- Increasing diversity and **mixing models** before sharing/storing Passive DNS records
- Simplify process and tools to install for **Passive DNS collection by relying on D4 sensors** instead of custom mechanisms
- Provide a distributed infrastructure for mixing streams and filtering out the sharing to the validated partners

- ✓ analyzer-d4-passivedns<sup>8</sup>, an analyzer for a D4 network sensor:
  - ▶ **processes** data produced by D4 sensors (in passivedns CSV format<sup>9</sup>),
  - ▶ **ingests** these into a **Passive DNS server** which can be queried later to search for the Passive DNS records,
  - ▶ **provides** a lookup server (using on redis-compatible backend) that is a Passive DNS REST server compliant to the Common Output Format<sup>10</sup>.

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<sup>8</sup><https://github.com/D4-project/analyzer-d4-passivedns>

<sup>9</sup><https://github.com/gamlinux/passivedns>

<sup>10</sup><https://tools.ietf.org/html/draft-dulaunoy-dnsop-passive-dns-cof-04>

## Passive SSL revamping



CSIRT's rationale for collecting TLS handshakes:

- **pivot** on additional data points,
- **find** owners of IP addresses,
- **detect** usage of CIDR blocks,
- **detect** vulnerable systems,
- **detect** compromised services,
- **detect** key material reuse,
- **detect** weak keys.

**Keeping** a log of links between:

- x509 certificates,
- ports,
- IP address,
- client (ja3),
- server (ja3s),

*“JA3 is a method for creating SSL/TLS client fingerprints that should be easy to produce on any platform and can be easily shared for threat intelligence.”<sup>11</sup>*

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<sup>11</sup><https://github.com/salesforce/ja3>

**Collect** and **store** x509 certificates and TLS sessions:

- Public keys type and size,
- moduli and exponents,
- curves parameters.

**Detect** anti patterns in crypto:

- Shared Public Keys,
- Moduli that share one prime factor,
- Moduli that share both prime factor,
- Small factors,
- Nonces reuse / common preffix or suffix, etc.

- ✓ sensor-d4-tls-fingerprinting <sup>12</sup>: **Extracts** and **fingerprints** certificates, and **computes** TLSH fuzzy hash.
- ✓ analyzer-d4-passivessl <sup>13</sup>: **Stores** Certificates / PK details in a PostgreSQL DB.
- lookup-d4-passivessl <sup>14</sup>: **Exposes** the DB through a public REST API.

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<sup>12</sup>[github.com/D4-project/sensor-d4-tls-fingerprinting](https://github.com/D4-project/sensor-d4-tls-fingerprinting)

<sup>13</sup>[github.com/D4-project/analyzer-d4-passivessl](https://github.com/D4-project/analyzer-d4-passivessl)

<sup>14</sup>[github.com/D4-project/lookup-d4-passivessl](https://github.com/D4-project/lookup-d4-passivessl)

- **Mixing models for passive collection streams** (for privacy) in next version of D4 core server
- **Interconnecting private D4 sensor networks** with other D4 sensor networks (sharing to partners filtered stream)
- **Previewing datasets** collected in D4 sensor network and providing **open data stream** (if contributor agrees to share under specific conditions)
- **Leverage MISP sharing communities** to augment Threat Intelligence, and provide accurate metrology.

# GET IN TOUCH IF YOU WANT TO JOIN THE PROJECT, HOST A SENSOR OR CONTRIBUTE

- Collaboration can include research partnership, sharing of collected streams or improving the software.
- Contact: [info@circl.lu](mailto:info@circl.lu)
- <https://github.com/D4-Project>
- [https://twitter.com/d4\\_project](https://twitter.com/d4_project)
- <https://d4-project.org>