

D4 Project

Open and collaborative network monitoring

Team CIRCL

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

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- 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 MISP¹ 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)

¹<https://github.com/MISP/MISP>

- 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 core² including a server and simple D4 C client - **21st January 2019**
- First version of a golang D4 client³ running on ARM, MIPS, PPC and x86 - **14th February 2019**

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

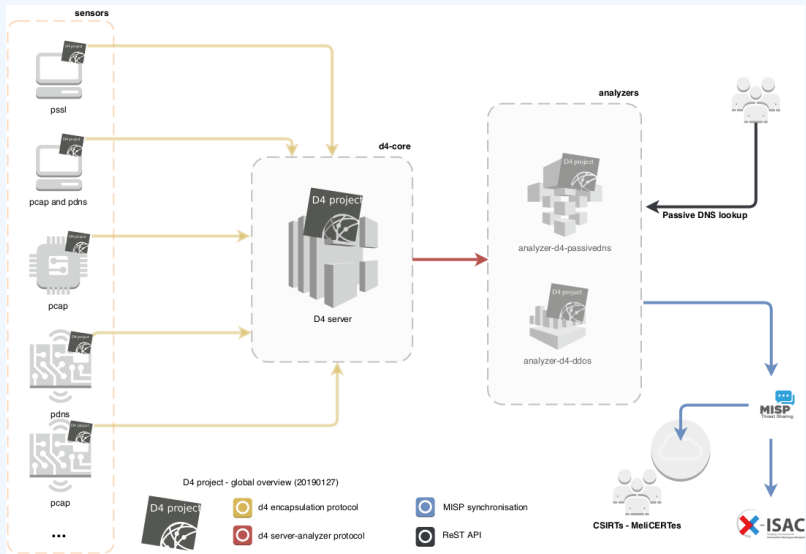
³<https://www.github.com/D4-project/d4-goclient/>

(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>

D4 OVERVIEW



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

- ✓ Passive SSL
- ✓ Passive DNS
- ✓ Blackhole DDoS
 - 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-adf4-4ebd950d21of"
}
```

- D4 core server⁴ 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.

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

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 five entries with their respective UUIDs and associated values. The 'Types' panel shows two entries with their respective IDs and descriptions. The date 2019/05/20 is displayed at the bottom of both panels.


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



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

2019/05/20

2019/05/20

 CIRCL
Computer Incident
Response Center
Luxembourg

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Facility of the European Union

D4 SERVER - SERVER MANAGEMENT

The screenshot displays the 'Server Management' section of the D4 Server interface. It is divided into two main columns: 'Blacklist IP' and 'Blacklist UUID'.

Blacklist IP Section:

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

Blacklist UUID Section:

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

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	dnscap 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:

Add New Types
1
Add New Type

Type Name	Description	Remove Type
ja3-f		Remove Extended Type

Showing 1 to 1 of 1 entries

Previous 1 Next

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	10001
8	4672e072-bfaa-4395-9bb1-ccb3e470d715	2019-05-20 14:14:57	10000 <input type="text"/> Change Max Size	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 passiveOS.</small>	2019-05-14 08:50:31	100000 <input type="text"/> Change Max Size	18036

Showing 1 to 1 of 1 entries

Previous **1** Next

Add New Analyzer Queue

1

Analyzer uuid

Optional Description

[Add New Analyzer](#)

D4 SERVER - SENSOR OVERVIEW

201905 Home Sensors Status Server Management

Active Connection

UID: 0418F038237445277961C7E6A		
First Seen	Last Seen	Status
2019-05-21 13:05 - (150408190)	2019-05-21 13:53 - (150408361)	OK Connected

UID: 10060606176A7F064357320804		
First Seen	Last Seen	Status
2019-04-22 12:24 - (150410402)	2019-05-21 14:09 - (150401340)	OK Connected

UID: 3762749127668204F002947E23		
First Seen	Last Seen	Status
2019-04-21 11:46 - (150411819)	2019-05-21 14:17 - (150401875)	OK Connected

UID: 00077436447461606150207604		
First Seen	Last Seen	Status
2019-04-22 07:14 - (150410402)	2019-05-21 14:17 - (150401875)	OK Connected

UID: 03047610094776482641344900		
First Seen	Last Seen	Status
2019-04-22 13:06 - (150410952)	2019-05-21 14:17 - (150401875)	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 Kick UUID

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:

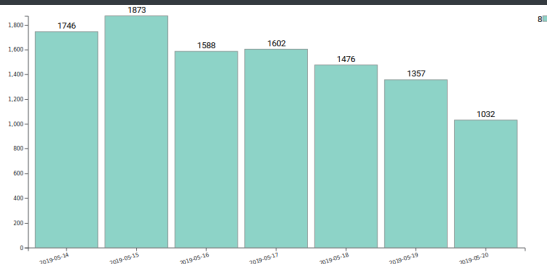
Show 10 entries

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

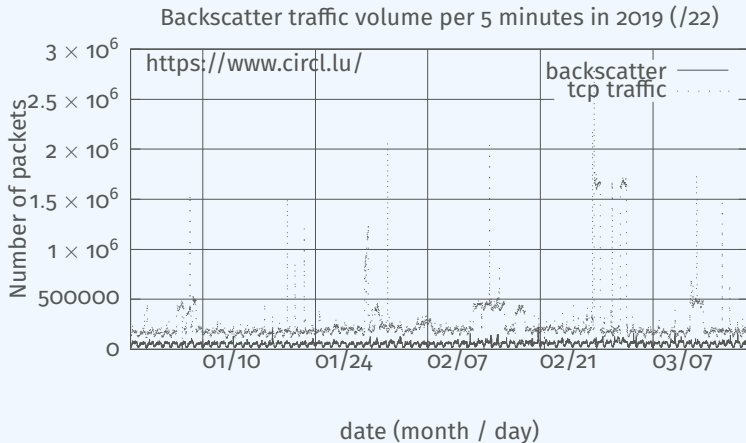
[Previous](#) [1](#) [Next](#)



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.

Passive DNS

- CIRCL (and other CSIRTs) have their own passive DNS⁵ collection mechanisms
- Current **collection models** are affected with DoH⁶ and centralised DNS services
- DNS answers collection is a tedious process
- **Sharing Passive DNS stream** between organisation is challenging due to privacy

⁵<https://www.circl.lu/services/passive-dns/>

⁶DNS 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-passivedns⁷, an analyzer for a D4 network sensor:
 - ▶ **processes** data produced by D4 sensors (in passivedns CSV format⁸),
 - ▶ **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 Format⁹.

⁷<https://github.com/D4-project/analyzer-d4-passivedns>

⁸<https://github.com/gamlinux/passivedns>

⁹<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.”¹⁰

¹⁰<https://github.com/salesforce/ja3>

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

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

Detect broken crypto:

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

- ✓ sensor-d4-tls-fingerprinting ¹¹: **Extracts** and **fingerprints** certificates, and **computes** TLSH fuzzy hash.
- ✓ analyzer-d4-passivessl ¹²: **Stores** Certificates / PK details in a PostgreSQL DB.
- lookup-d4-passivessl ¹³: **Exposes** the DB through a public REST API.

¹¹github.com/D4-project/sensor-d4-tls-fingerprinting

¹²github.com/D4-project/analyzer-d4-passivessl

¹³github.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
- <https://github.com/D4-Project>
- https://twitter.com/d4_project
- <https://d4-project.org>