Cybersecurity of Urban Critical Infrastructure by Intelligent Big Data Analytics...

Konstantinos Demertzis

[~] Cybersecurity of Urban Critical Infrastructure by Intelligent Big Data Analytics…

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- brainchip
- prospects
- in progress

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Stuxnet
infected

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

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Cyber Security of Critical Infrastructures, "**Development of intelligent models and respective big data analytics platform for cyberdefense of urban critical infrastructure**"
Supervisor Professor **Lazaros Iliadis**

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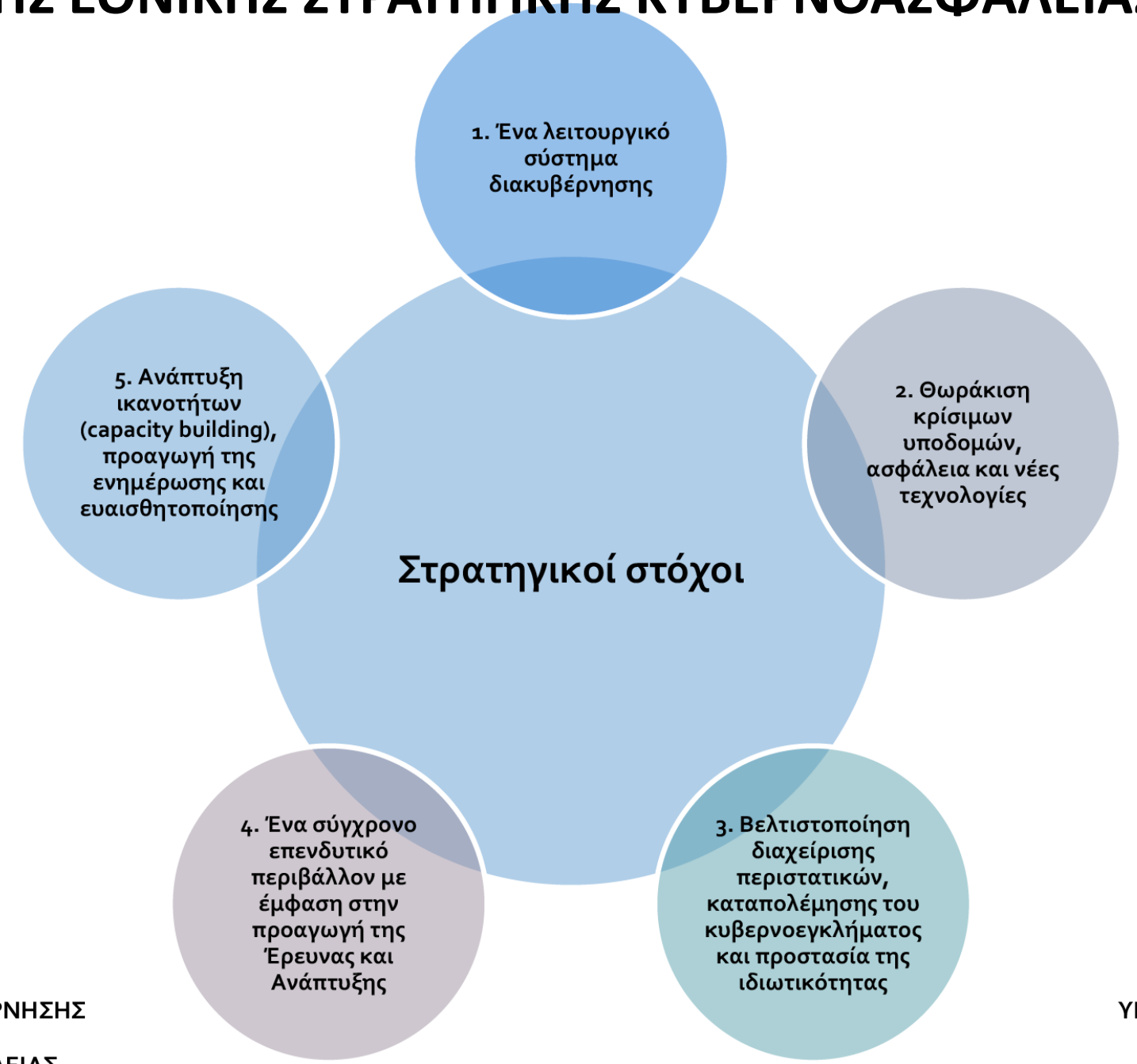
Α Φάση

Εναρμονισμός με τα θεσμικά κείμενα για την ψηφιακή ασφάλεια των κρίσιμων υποδομών

- Τομέας Ενέργειας
- Τομέας ΤΠΕ
- Τομέας Μεταφορών
- Τομέας Εθνικής Άμυνας
- Βιομηχανικός Τομέας

ΣΤΟΧΟΙ ΤΗΣ ΕΘΝΙΚΗΣ ΣΤΡΑΤΗΓΙΚΗΣ ΚΥΒΕΡΝΟΑΣΦΑΛΕΙΑΣ 2020-2025



ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ

ΥΠΟΥΡΓΕΙΟ ΨΗΦΙΑΚΗΣ ΔΙΑΚΥΒΕΡΝΗΣΗΣ

ΕΘΝΙΚΗ ΑΡΧΗ ΚΥΒΕΡΝΟΑΣΦΑΛΕΙΑΣ

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ΕΘΝΙΚΗ ΑΡΧΗ ΚΥΒΕΡΝΟΑΣΦΑΛΕΙΑΣ


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Critical Infrastructures and Services

Recent deliberate disruptions of critical automation systems prove that cyber-attacks have a significant impact on critical infrastructures and services. Disruption of these ICT capabilities may have disastrous consequences for the EU Member States' governments and social wellbeing. The need to ensure ICT robustness against cyber-attacks is thus a key challenge at national and pan-European level.

Critical infrastructures, such as electricity generation plants, transportation systems, manufacturing facilities are controlled and monitored by Industrial Control Systems (ICS), including SCADA (Supervisory Control and Data Acquisition) systems. Today ICS products are mostly based on standard embedded systems platforms and they often use commercial off-the-shelf software. This results in the reduction of costs and improved ease of use but at the same time increases the exposure to computer network-based attacks.

Smart Grids will substantially improve control over electricity consumption and distribution to the benefit of consumers, electricity suppliers and grid operators. Nevertheless, improved operations and services will come at the cost of exposing the entire electricity network to new challenges, in particular in the field of security of communication networks and information systems. Vulnerabilities of communication networks and information systems may be exploited for financial or political motivation to shut off power to large areas or directing cyber-attacks against power generation plants.

The maritime sector is critical for the European society. Statistics show the augmenting trend of maritime transport share in the overall goods traffic, which in 2010 reached 52%. This continuous increase in dependency upon the maritime transport underlines its vital importance to our society

Recommended publications

Railway Cybersecurity

This ENISA study regards the level of implementation of cybersecurity measures in the railway sector, within the context of the enforcement of the...

Published on November 13, 2020

Power Sector Dependency on Time Service: attacks against...

Published on May 12, 2020

Encrypted Traffic Analysis

Published on April 23, 2020

Procurement Guidelines for Cybersecurity in Hospitals

Published on February 24, 2020

Recommended news

Healthcare's Cybersecurity Incident Response Spotlighted...

The EU Agency for Cybersecurity and the Danish Health Data Authority are joining forces again this

Communication network interdependencies in smart grids


73%

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Good practices for cybersecurity in the maritime sector

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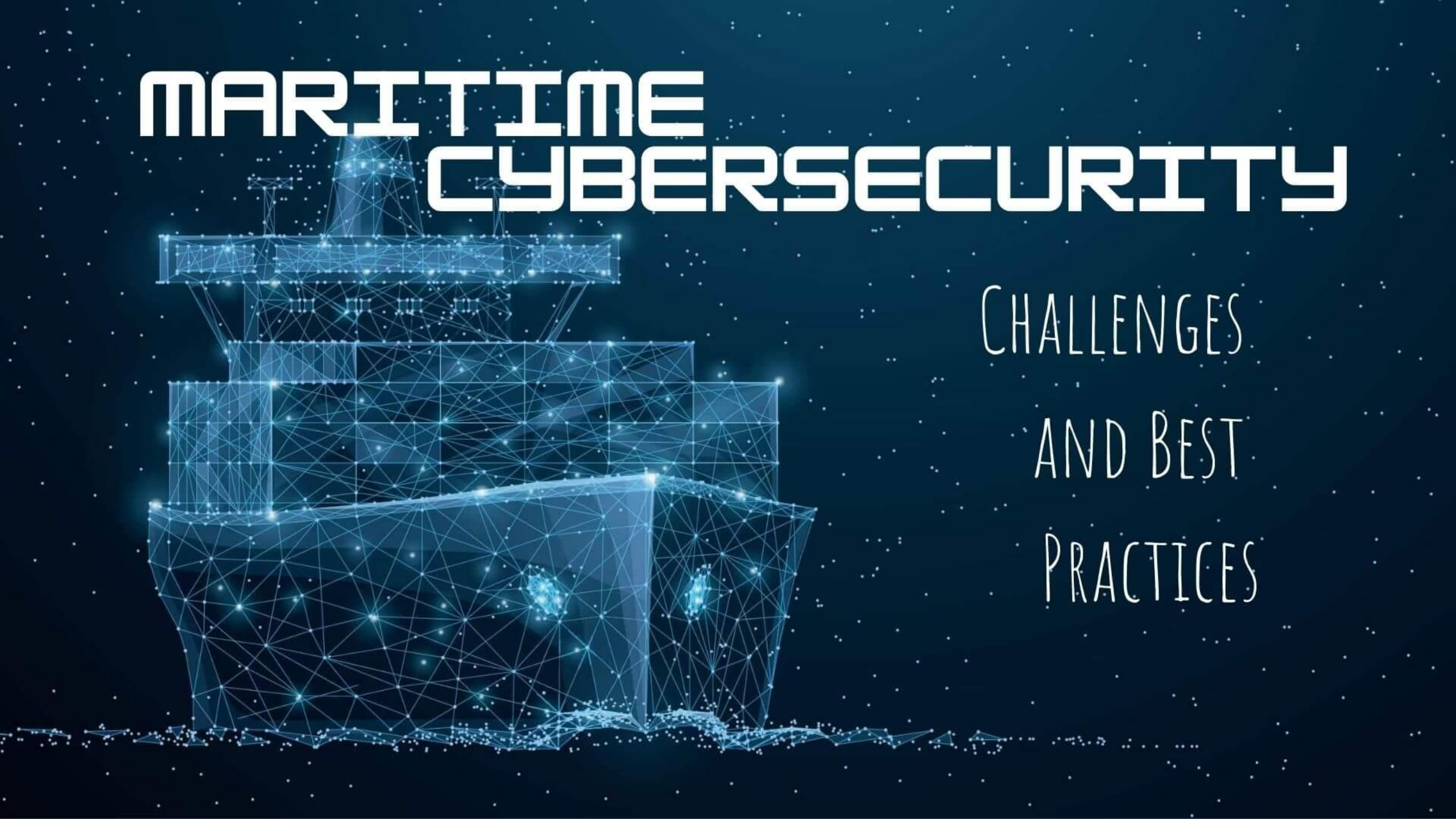
MARITIME CYBERSECURITY



Challenges and Best Practices

Securing Smart Airports

DECEMBER 2016

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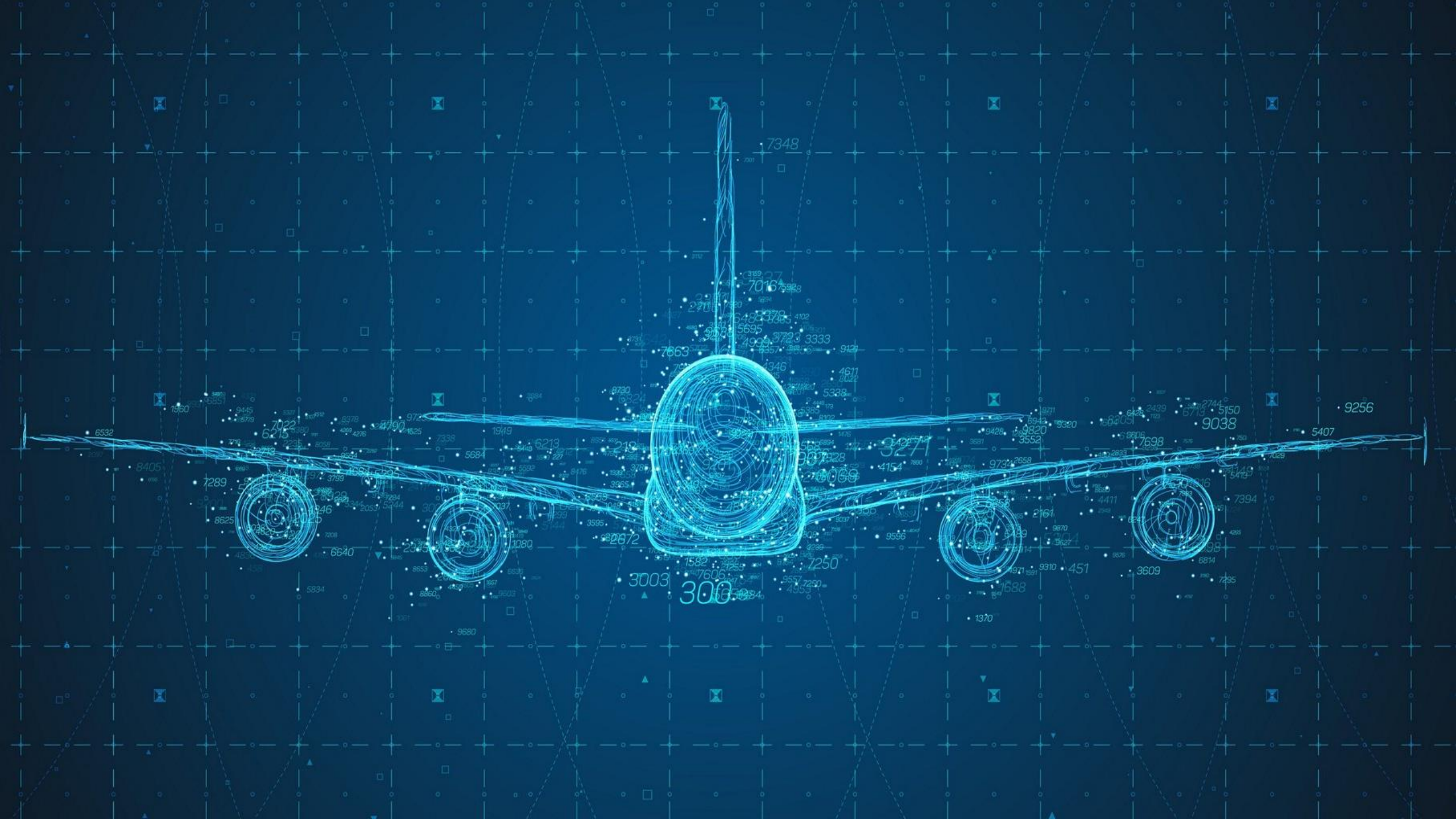

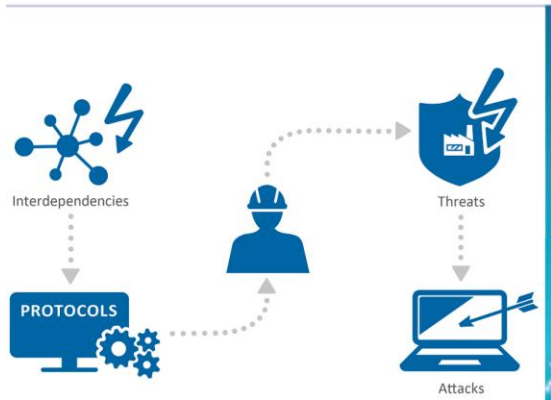

Communication network dependencies for ICS/SCADA Systems

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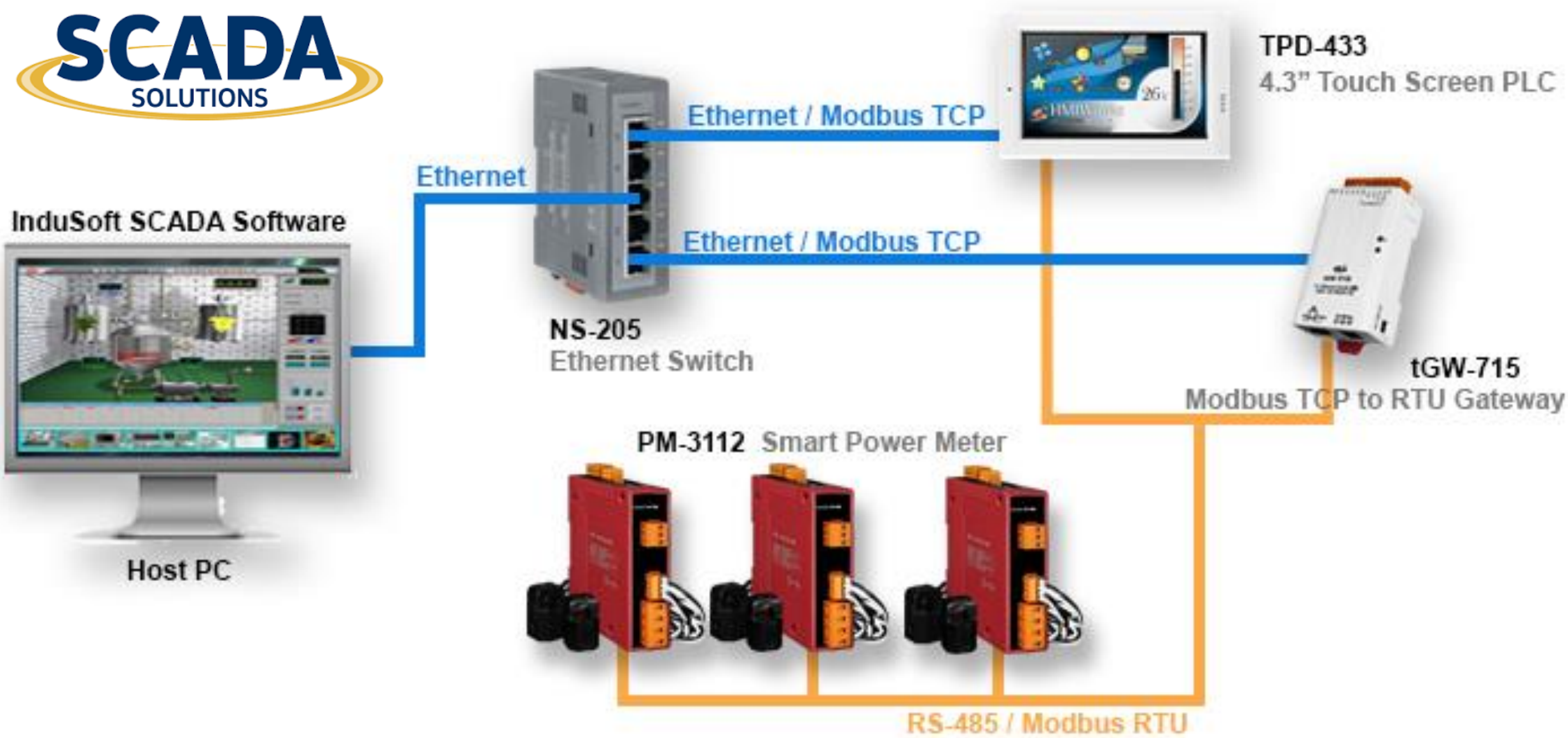
SCADA
SOLUTIONS
InduSoft SCADA Software
Host PC
Ethernet
NS-205
Ethernet Switch
Ethernet / Modbus TCP
Ethernet / Modbus TCP
TPD-433
4.3" Touch Screen PLC
tGW-715
Modbus TCP to RTU Gateway
PM-3112 Smart Power Meter
RS-485 / Modbus RTU


Container ports


Oil refineries


Manufacturing


Construction


Mines


Warehouses


Wind farms


Oil rigs


INDUSTRY 4.0
DIGITALIZATION OF MANUFACTURING

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ENCRYPTED TRAFFIC ANALYSIS

Use Cases & Security Challenges

NOVEMBER 2019

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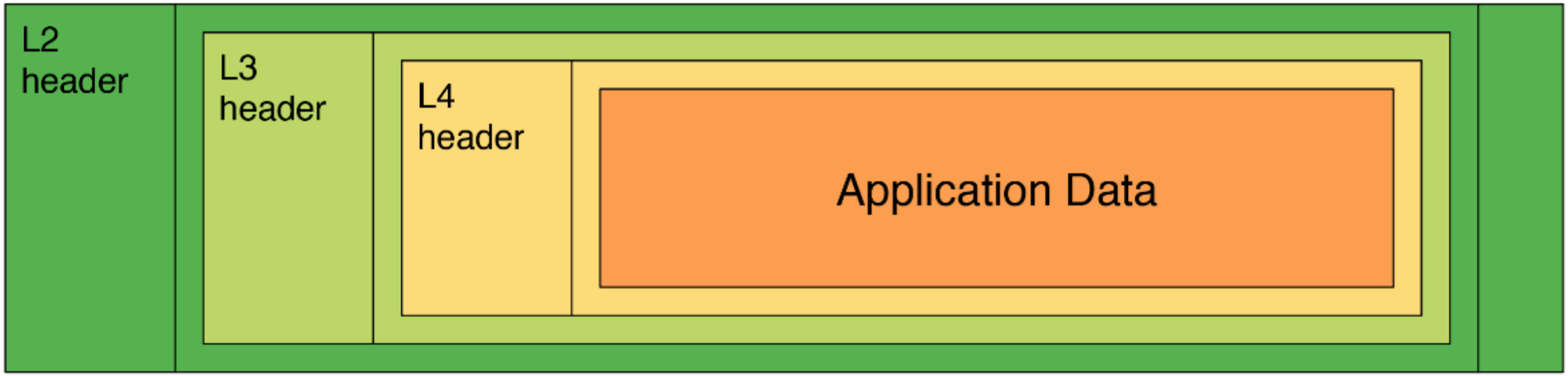
Β Φάση

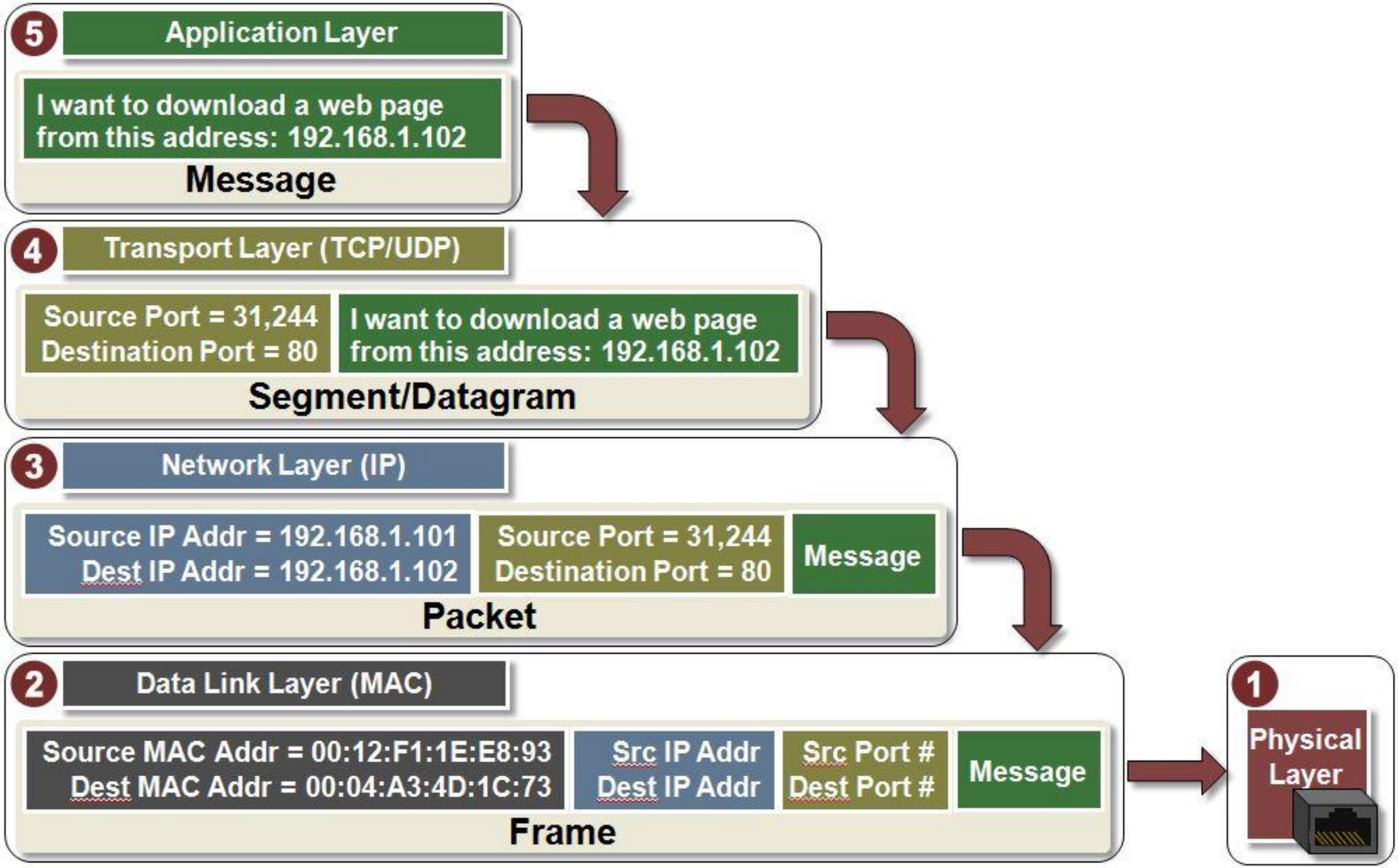
Μελέτη του τρόπου ανάλυσης της δικτυακής κίνησης ως μέθοδο εντοπισμού σύγχρονων ψηφιακών απειλών

- Network Traffic Analysis
- IDS/IPS
- Demystification Malware Traffic
- Encrypted Traffic Identification

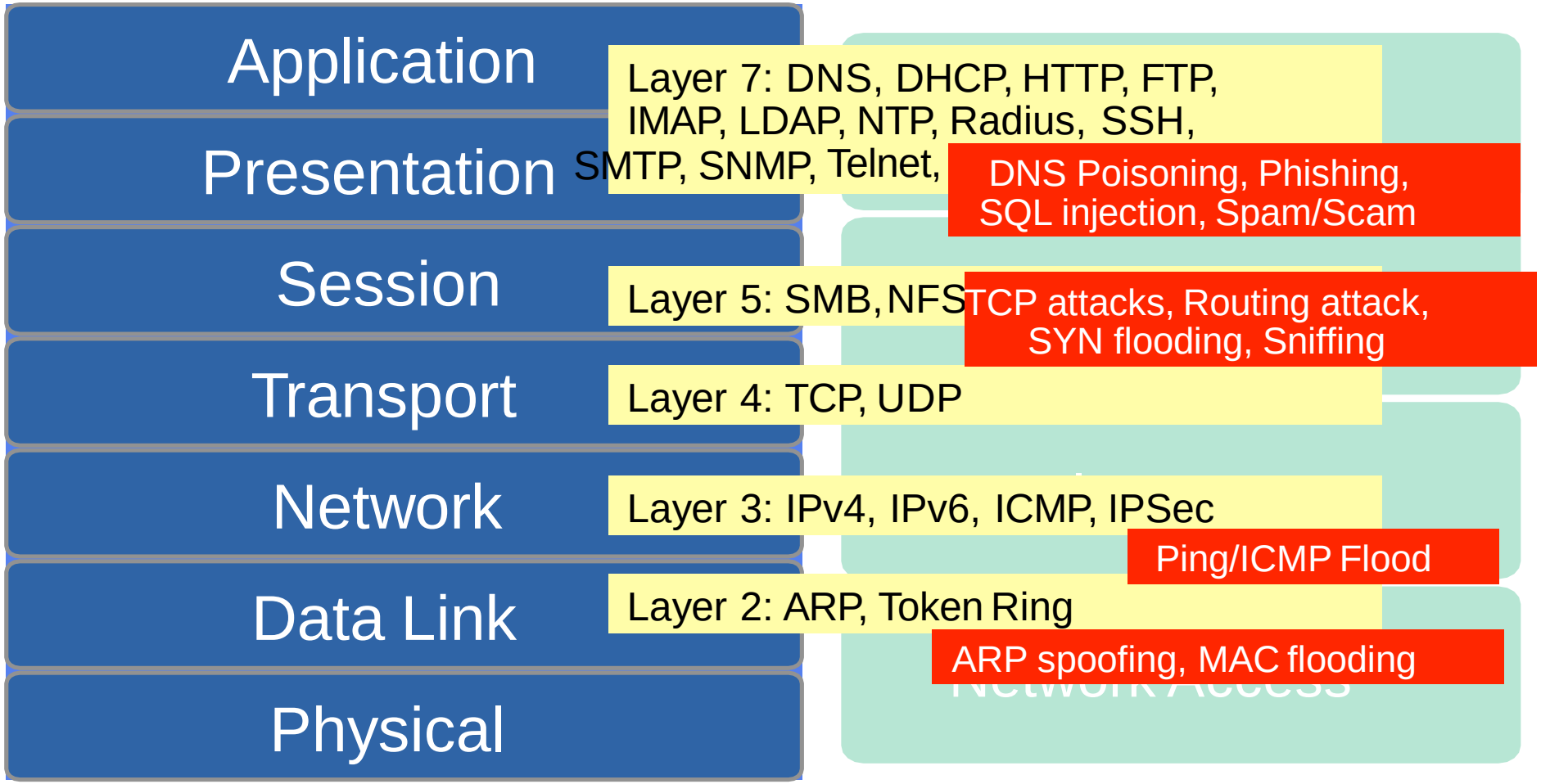
Encapsulation in Action



- L4 segment contains part of stream of application protocol
- L3 datagram contains L4 segment
- L2 frame has L3 datagram in data portion


5
Application Layer
I want to download a web page from this address: 192.168.1.102
Message
4
Transport Layer (TCP/UDP)
Source Port = 31,244
Destination Port = 80
I want to download a web page from this address: 192.168.1.102
Segment/Datagram
3
Network Layer (IP)
Source IP Addr = 192.168.1.101
Dest IP Addr = 192.168.1.102
Source Port = 31,244
Destination Port = 80
Message
Packet
2
Data Link Layer (MAC)
Source MAC Addr = 00:12:F1:1E:E8:93
Dest MAC Addr = 00:04:A3:4D:1C:73
Src IP Addr
Dest IP Addr
Src Port #
Dest Port #
Message
Frame
1
Physical Layer

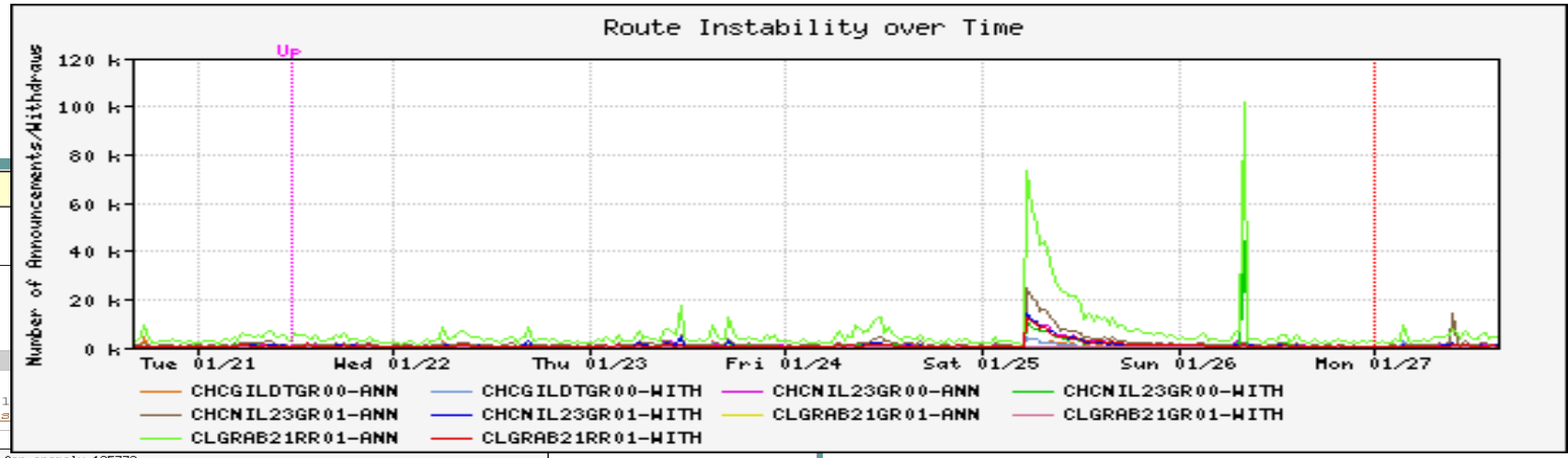
Attacks on Different Layers



Flow-based Detection

- **Once baselines are built anomalous activity can be detected**
  - Pure **rate-based** (pps or bps) anomalies may be legitimate or malicious
  - Many **misuse** attacks can be immediately recognized, even **without** baselines (e.g., TCP SYN or RST floods)
  - **Signatures** can also be defined to identify “interesting” transactional data (e.g., proto udp and port 1434 and 404 octets (376 payload) == slammer!)
  - Temporal compound signatures can be defined to detect with higher precision

Detect Anomalous Events: SQL “Slammer” Worm*



peakflow | DoS

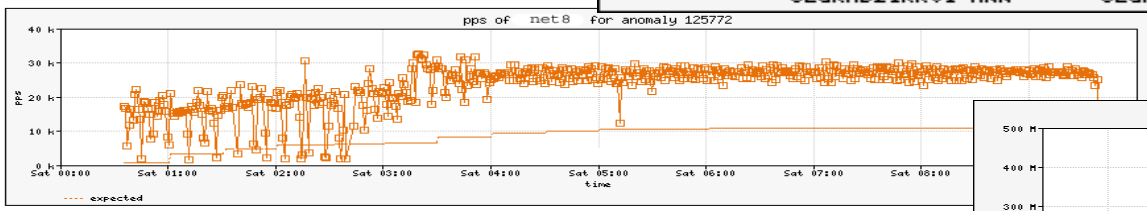
Recent Anomalies : Anomaly 125772 : Detailed Statistics

11:51:49 EST 27 Jan 2003

Status | Topology | Ongoing | Recent | Dark IP | Admin | About

Anomaly 125772 Detailed Statistics

ID	Importance	Severity	Duration	Direction	
125772	High	958.2% of 3.40 Kpps	09h 06m 47s	Outgoing	192.1 members



Affected Network Elements

Router net8 1.2.3.4

	Triggering	Expected	Difference	Maximum
Bitrate	71.69 Mbps	2.34 Mbps	69.35 Mbps	105.26 Mbps @ 03
Packet Rate	**22.20 Kpps**	**712 pps**	**21.49 Kpps**	**32.58 Kpps @ 03:**

Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

Summary of all Data Snapshots Collected:

	Bytes	Packets	Bytes/Pkt	bps	
	308.01 GB	762,849,500	404 B	76.05 Mbps	23.54

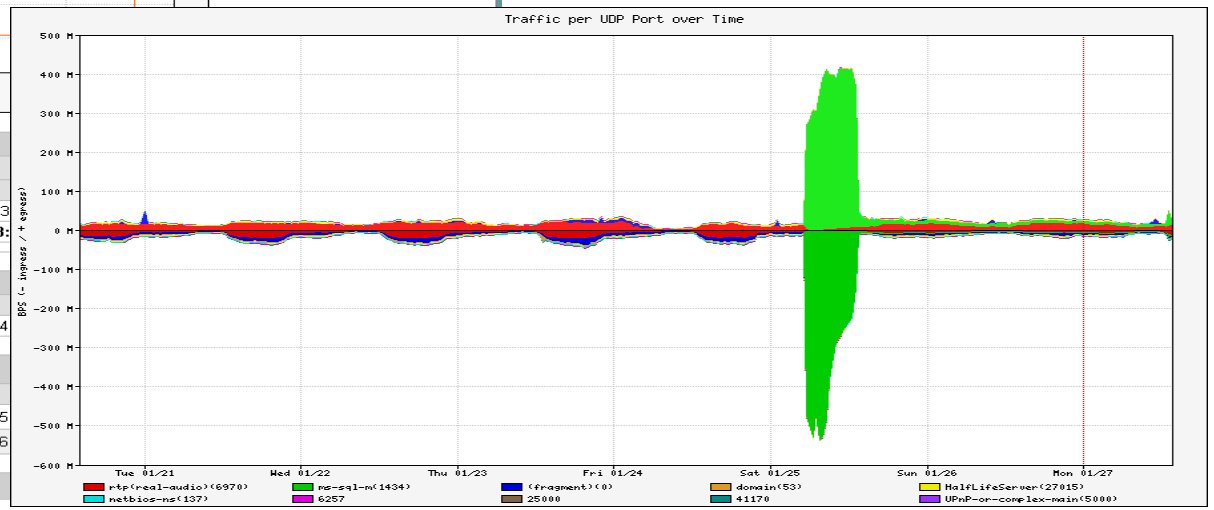
Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

Source Addresses

Network / Mask	Bytes	▼Packets	Bytes/Pkt	bps	
192.168.20.217/32	168.22 GB	416,436,800	404 B	41.54 Mbps	12.85
192.168.18.187/32	139.53 GB	345,372,800	404 B	34.45 Mbps	10.66

Summary | Source Addresses | Destination Addresses | Source Ports | Destination Ports | Protocols | Output Interfaces | Input Interfaces | Generate Filter

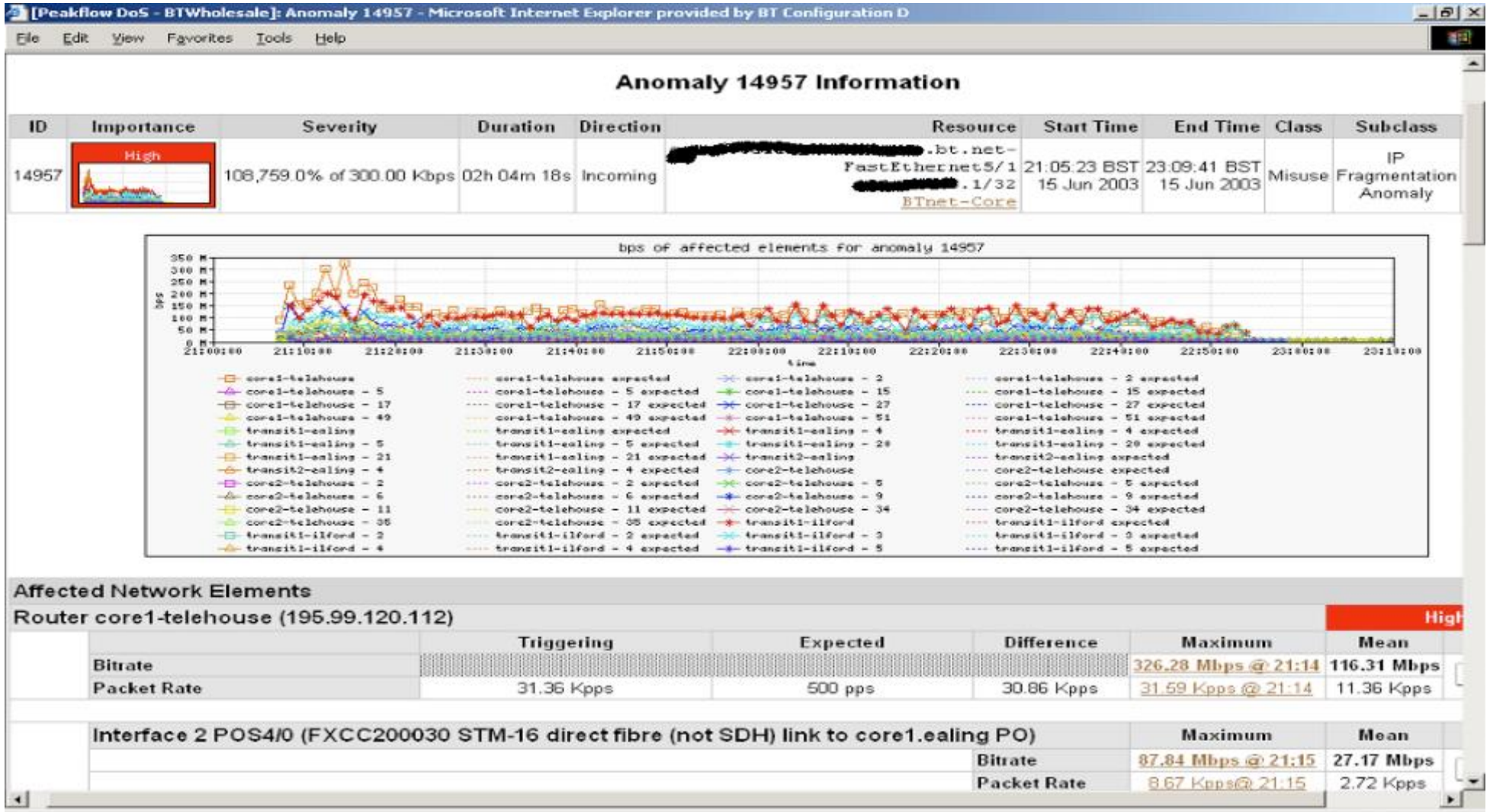
Destination Addresses



How to Identify a Security Attack?

- Suddenly highly-increased overall traffic in the network
- Higher CPU and memory utilization of network devices
- Unexpectedly large amount of traffic generated by individual hosts
- Increased number of accounting records generated
- Multiple accounting records with abnormal content, like one packet per flow record (e.g. TCP SYN flood)
- A changed mix of traffic applications, e.g. a sudden increase of "unknown" applications
- An increase of certain traffic types and messages, e.g. TCP resets or ICMP messages
- An increasing number of ACL violations

A Large Scale DOS attack



What Does a DOS Attack Look Like?

Potential DoS Attack on Router
Estimated: 660 pkt/s 0.2112 Mbps

```
Router# show ip cache flow
…
SrcIf    SrcIPaddress     SrcP   SrcAS     DstIf   DstIPaddress     DstP    DstAS     Pr     Pkts     B/Pk
29       192.1.6.69       77     aaa       49      194.20.2.2       1308    bbb       6      1        40
29       192.1.6.222      1243   aaa       49      194.20.2.2       1774    bbb       6      1        40
29       192.1.6.108      1076   aaa       49      194.20.2.2       1869    bbb       6      1        40
29       192.1.6.159      903    aaa       49      194.20.2.2       1050    bbb       6      1        40
29       192.1.6.54       730    aaa       49      194.20.2.2       2018    bbb       6      1        40
29       192.1.6.136      559    aaa       49      194.20.2.2       1821    bbb       6      1        40
29       192.1.6.216      383    aaa       49      194.20.2.2       1516    bbb       6      1        40
29       192.1.6.111      45     aaa       49      194.20.2.2       1894    bbb       6      1        40
29       192.1.6.29       1209   aaa       49      194.20.2.2       1600    bbb       6      1        40
…        …                …      …         …       …                …       …         …      …        …
```

Typical DoS Attacks Have the Same (or Similar) Flow Entries:

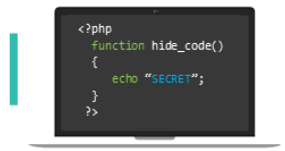
- Input Interface (SrcIf)
- Destination IP (DstIf)
- 1 Packet per flow (Pkts)
- Bytes per packet (B/Pk)

Trends in Malware Evolution

- Botnets:
  - Distributed Management (C&C Servers/anti–network forensics techniques, such as randomized and encrypted packets that made traffic filtering difficult.
  - Full-Featured Control (remote access trojans (RATs), designed to facilitate remote control of individual compromised endpoints.
  - Sophisticated endpoint control with automated propagation techniques, automated self-update mechanisms, and multilayer, hierarchical, and/or peer-to-peer C&C channels.
  - Also legitimate enterprise networks, including internal DNS, web, email, and software update mechanisms.

Encryption and Obfuscation

- Hiding C&C Channels
- Maintaining Control
- Hiding and encrypted IRC
- Peer-to-Peer C&C
- Pool Ips
- Blind Redirection
- Fast-Flux DNS
- DGA domains
- Tor-based C&C



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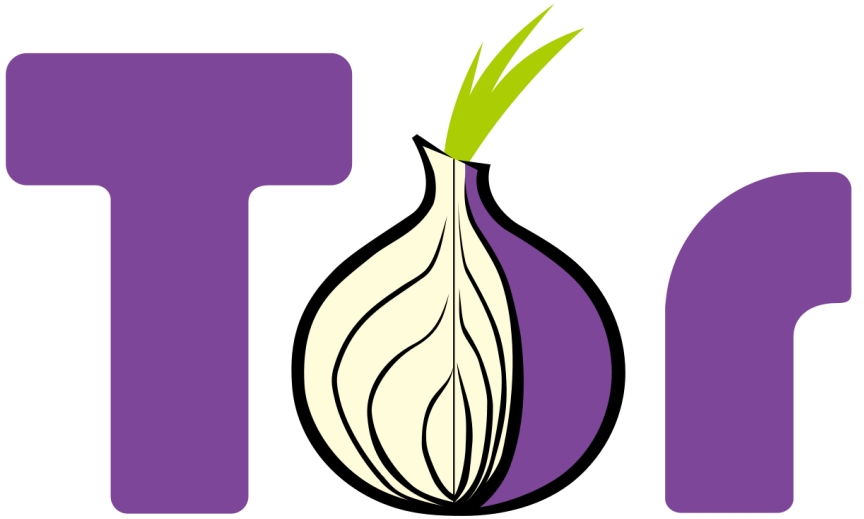
OB{FUS}CATION

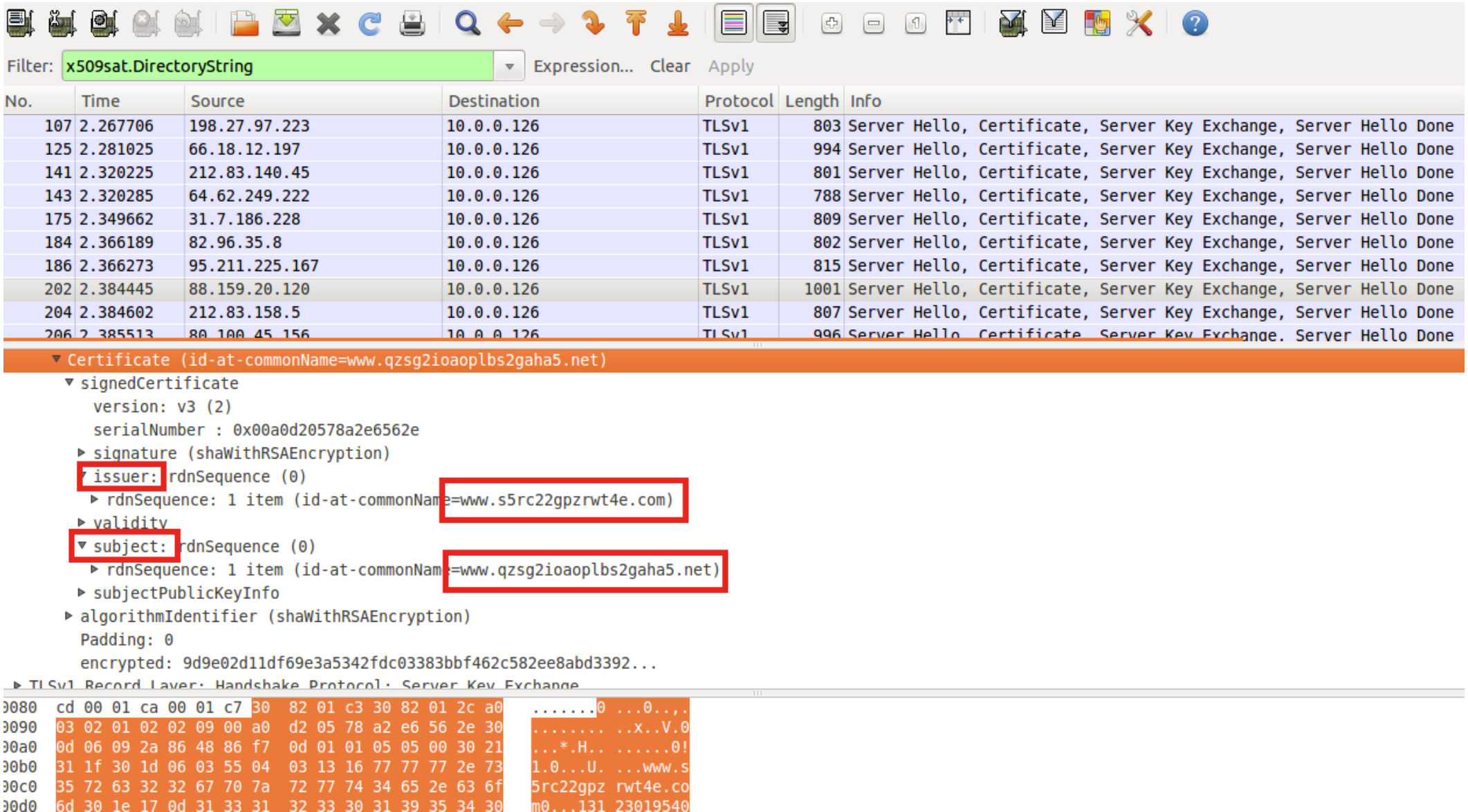
#PART-1

Tor-based Botnets and Tor Traffic Analysis

- The Tor network is operating in the Transport layer of the OSI, the onion proxy software shows customers the Secure Socket interface (SOCKS) which operates in the session layer.
- The Tor network can use the TCP port 443, which is used by the HTTPS, so that the supervision and interpretation of a session exclusively with the determination of the door cannot constitute a reliable method.



Tor Traffic Analysis



How can an organization detect an attacker who has already entered the network with legitimate credentials?

Detecting Algorithmically Generated Malicious Domains

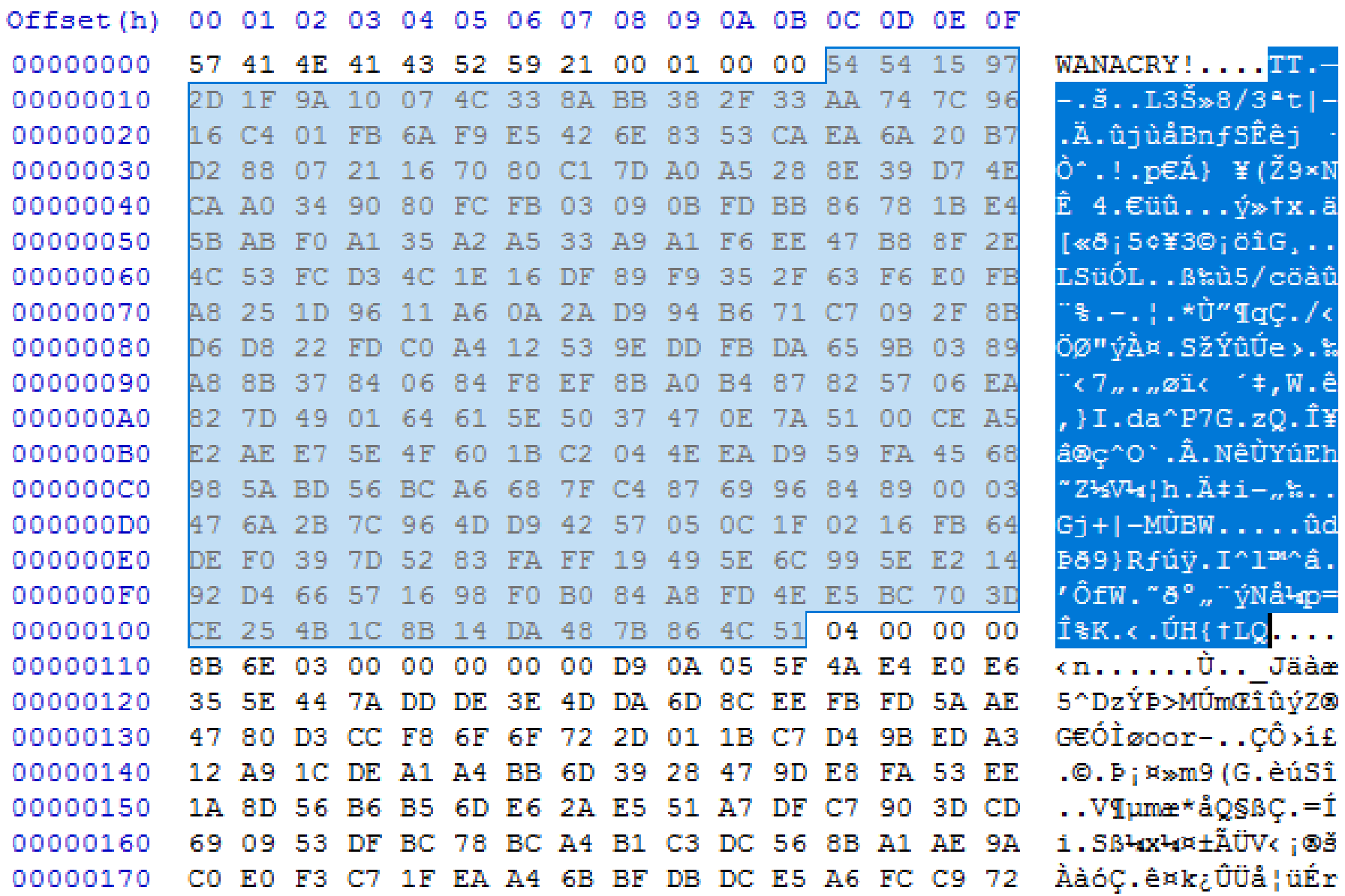
DGA Algorithm: Generates a domain by the current date

```
1. defgenerate_domain(year, month, day):
2.       """Generates a domain by the current date"""
3.       domain = ""
4. for i in range(32):
5.       year = ((year ^ 8 * year) >> 11) ^ ((year &amp;amp; 0xFFFFFFF0) << 17)
6.       month = ((month ^ 4 * month) >> 25) ^ 9 * (month &amp;amp; 0xFFFFFFF8)
7.       day = ((day ^ (day << 13)) >> 19) ^ ((day &amp;amp; 0xFFFFFFFE) << 12)
8.       domain += chr(((year ^ month ^ day) % 25) + 97)
9.       domain += '.com'
10. return domain
```

E.g., on June 18th, 2014, this method would generate the following domain names:

k.com	kafph.com	kafphogvi.com	kafphogvifahu.com
ka.com	kafpho.com	kafphogvif.com	kafphogvifahut.com
kaf.com	kafphog.com	kafphogvifa.com	kafphogvifahutb.com
kafp.com	kafphogv.com	**kafphogvifah.com**	kafphogvifahutbl.com

WCry Ransomware Analysis



Offset(h)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	
00000000	57	41	4E	41	43	52	59	21	00	01	00	00	54	54	15	97	WANACRY!....TT.—
00000010	2D	1F	9A	10	07	4C	33	8A	BB	38	2F	33	AA	74	7C	96	-.š..L3Š»8/3ªt|-
00000020	16	C4	01	FB	6A	F9	E5	42	6E	83	53	CA	EA	6A	20	B7	.Ä.ûjùåBnƒSÊêj ·
00000030	D2	88	07	21	16	70	80	C1	7D	A0	A5	28	8E	39	D7	4E	Ò^.!.p€Á} ¥(Ž9×N
00000040	CA	A0	34	90	80	FC	FB	03	09	0B	FD	BB	86	78	1B	E4	Ê 4.€üû...ý»†x.ä
00000050	5B	AB	F0	A1	35	A2	A5	33	A9	A1	F6	EE	47	B8	8F	2E	[«ð¡5¢¥3©¡öîG¸..
00000060	4C	53	FC	D3	4C	1E	16	DF	89	F9	35	2F	63	F6	E0	FB	LSüÓL..ß‰ù5/cöàû
00000070	A8	25	1D	96	11	A6	0A	2A	D9	94	B6	71	C7	09	2F	8B	¨%.–.¦.*Ù”¶qÇ./‹
00000080	D6	D8	22	FD	C0	A4	12	53	9E	DD	FB	DA	65	9B	03	89	ÖØ"ýÀ¤.SžÝûÚe›.‰
00000090	A8	8B	37	84	06	84	F8	EF	8B	A0	B4	87	82	57	06	EA	¨‹7„.„øï‹ ´‡‚W.ê
000000A0	82	7D	49	01	64	61	5E	50	37	47	0E	7A	51	00	CE	A5	‚}I.da^P7G.zQ.Î¥
000000B0	E2	AE	E7	5E	4F	60	1B	C2	04	4E	EA	D9	59	FA	45	68	â®ç^O`.Â.NêÙYúEh
000000C0	98	5A	BD	56	BC	A6	68	7F	C4	87	69	96	84	89	00	03	˜Z½V¼¦h.Ä‡i–„‰..
000000D0	47	6A	2B	7C	96	4D	D9	42	57	05	0C	1F	02	16	FB	64	Gj+|–MÙBW.....ûd
000000E0	DE	F0	39	7D	52	83	FA	FF	19	49	5E	6C	99	5E	E2	14	Þð9}Rƒúÿ.I^l™^â.
000000F0	92	D4	66	57	16	98	F0	B0	84	A8	FD	4E	E5	BC	70	3D	’ÔfW.˜ð°„¨ýNå¼p=
00000100	CE	25	4B	1C	8B	14	DA	48	7B	86	4C	51	04	00	00	00	Î%K.‹.ÚH{†LQ....
00000110	8B	6E	03	00	00	00	00	00	D9	0A	05	5F	4A	E4	E0	E6	‹n.....Ù.._Jäàæ
00000120	35	5E	44	7A	DD	DE	3E	4D	DA	6D	8C	EE	FB	FD	5A	AE	5^DzÝÞ>MÚmŒîûýZ®
00000130	47	80	D3	CC	F8	6F	6F	72	2D	01	1B	C7	D4	9B	ED	A3	G€ÓÌøoor-..ÇÔ›í£
00000140	12	A9	1C	DE	A1	A4	BB	6D	39	28	47	9D	E8	FA	53	EE	.©.Þ¡¤»m9(G.èúSî
00000150	1A	8D	56	B6	B5	6D	E6	2A	E5	51	A7	DF	C7	90	3D	CD	..V¶µmæ*åQ§ßÇ.=Í
00000160	69	09	53	DF	BC	78	BC	A4	B1	C3	DC	56	8B	A1	AE	9A	i.Sß¼x¼¤±ÃÜV‹¡®š
00000170	C0	E0	F3	C7	1F	EA	A4	6B	BF	DB	DC	E5	A6	FC	C9	72	Ààó Ç.ê¤k¿ÛÜå¦üÉr

What Is PCAP?

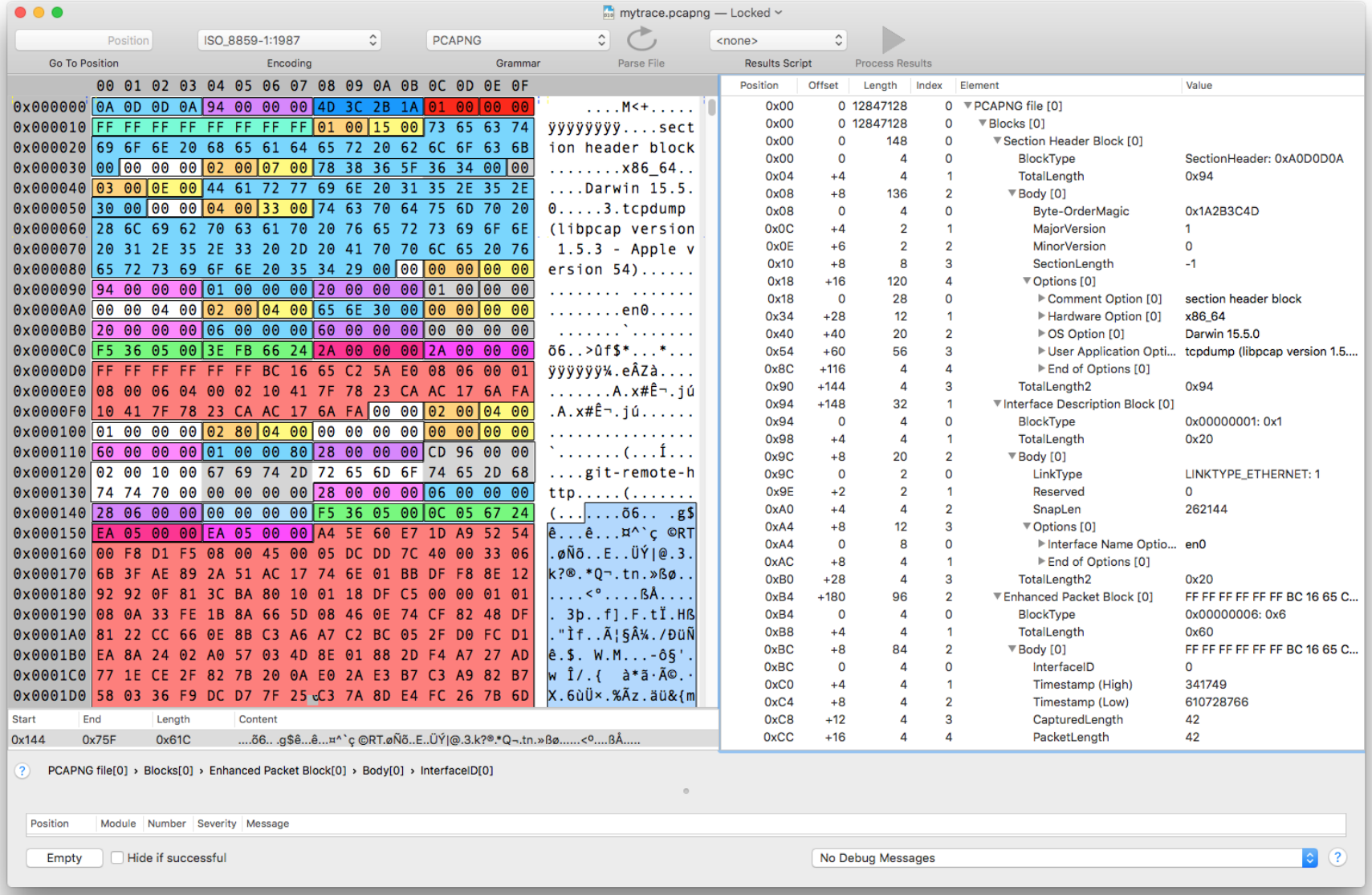
- PCAP == **P**acket **Cap**ture
- PCAP is a straight copy of ALL* network traffic that flows through the pipe for as long as you keep recording. That can be a LOT of data!
- Complete record of network activity
  - Layers 2 – 7
- Most common format is `libpcap`
- `Things to think about`
  - `How long do you need to listen?`
  - `Can your NIC capture it fast enough?`
  - `Can your hard drive store it fast enough?`
  - `How long can you listen before you have  to free up space?`

PCAP data
What does it look like?

zeek

SNORT®

TCPDUMP



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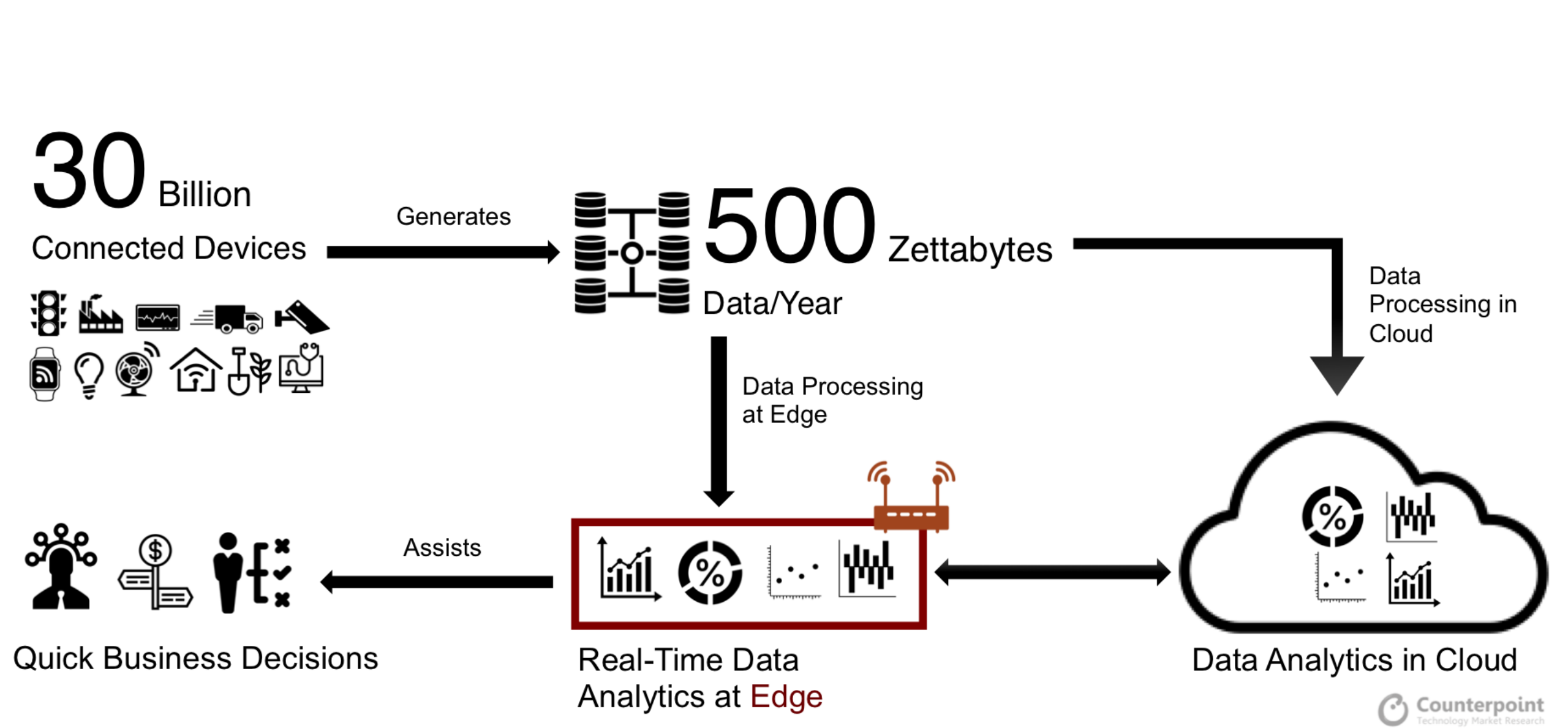
Γ Φάση

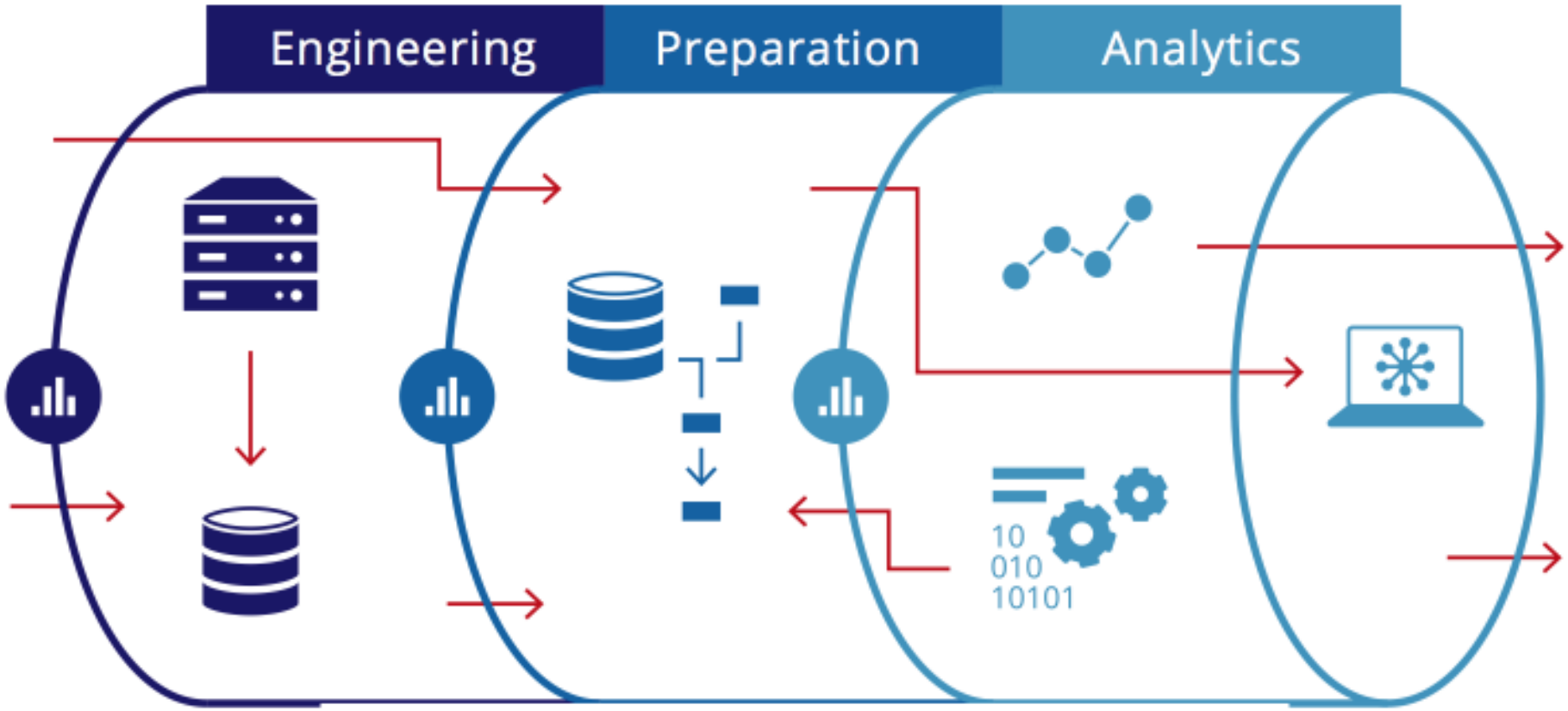
Ανάπτυξη ευφυούς πληροφοριακού συστήματος διαχείρισης και ανάλυσης δεδομένων μεγάλης κλίμακας

- Big Data Tools
- ML Tools
- Cloud IaaS
- Crypto Blockchain
- Visual Analytics


All data originates in real-time!


SLURRY A TRANSFER SECTION
PCI1504
-39.8MMHG
PCI1509
0.08KG
LI11501B
2.83M
XV1531
XV1529
PW
XV1522
XV1501
LA1503
FEED
WASH
HALF
FULL
TI11506
95.7C
FI11520
0.04M3/H
FQI11534
0.13KG
FC1503
PV
1121KG/H
MV
25.3%
XV1530
LS
LA1522
XV1525
XV1526
PI11532
3.92KG
FI11501
31.19T/H
FI11501A
0.02T/H
EI11501
29.88AMP
NO
FA1501B
RECV
XV1504-1
FA1501C
RECV
XV1504-2
GA1501B
EI11502
24.48AMP
GA1501C
FLUSH
DA CONTL
TREND158





Administration	Security	Lifecycle Management	Data Provenance	Dynamic Data Pipeline	Monitoring	Automation

okeanos

CREATE

Create a new Project. Name it, describe its purpose, choose virtual resources to be granted to members, and submit. Your application will be reviewed, and if

JOIN

Request to be a member of an existing Project and instantly gain access to the resources it has to offer you. Search for public Projects, or submit a join

MY PROJECTS

Search:

Name	Status	Application	Expiration	Members	Action
System project	Accepted member	17/11/2014	17/11/2114	1	
biosecurity.fmenr.duth.gr	Denied	23/04/2014	31/12/2016	0	
biosecurity.filab.duth.gr	Denied	16/03/2015	31/03/2017	0	
biosecurity.filab.duth.gr	Denied	23/03/2015	31/01/2016	0	
tartarus.duth.gr	Pending	06/08/2018	31/12/2020	0	

Showing 1 to 5 of 5 entries Pagination 10

< Previous Next >

real-time anomaly detection over big data streams

-AutoAI

-Adaptive

-Scalable

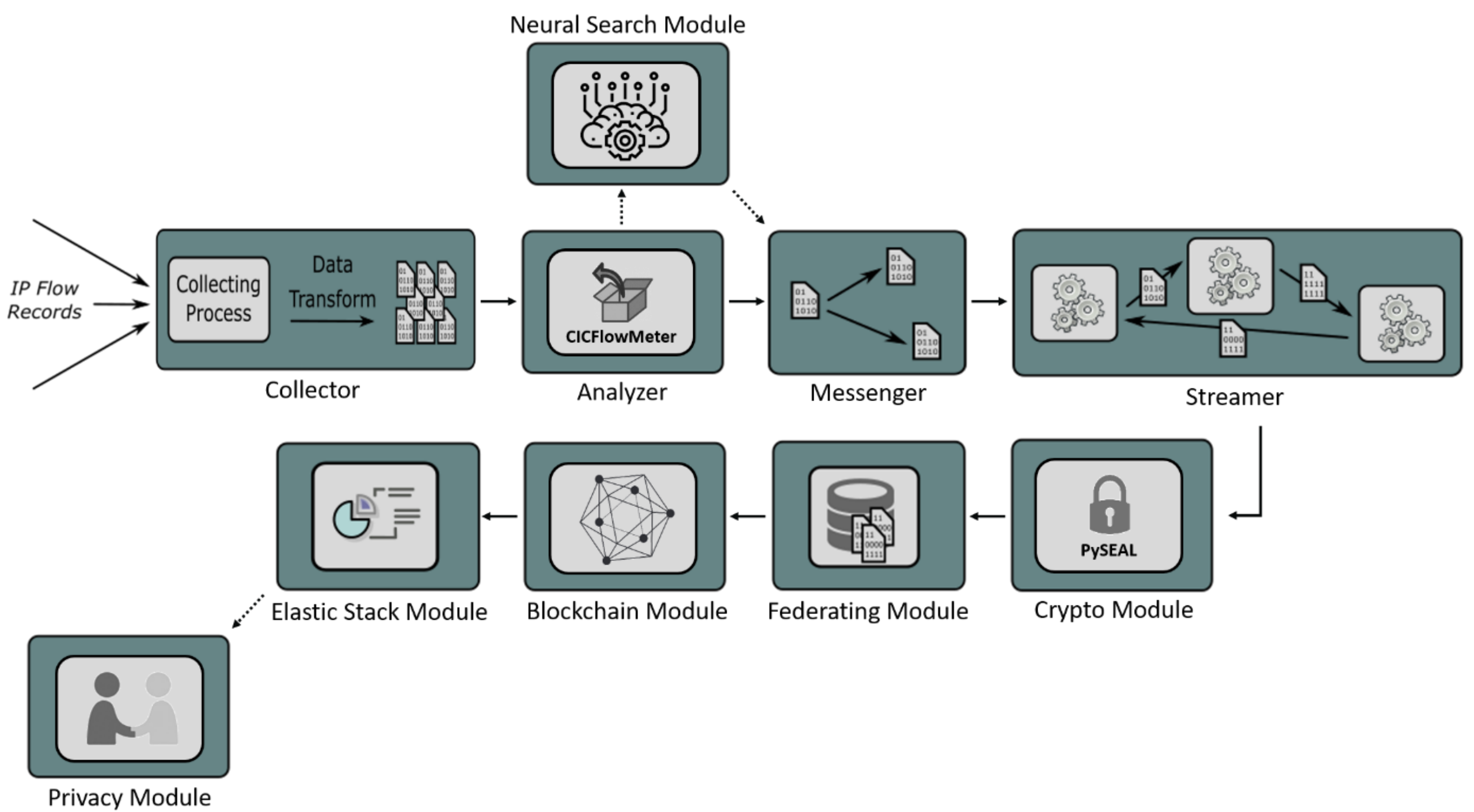
-Portable

-Lightweight

-Secure

-Privacy

-Visual


Neural Search Module
IP Flow Records
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Data Transform
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CICFlowMeter
Analyzer
Messenger
Streamer
PySEAL
Crypto Module
Federating Module
Blockchain Module
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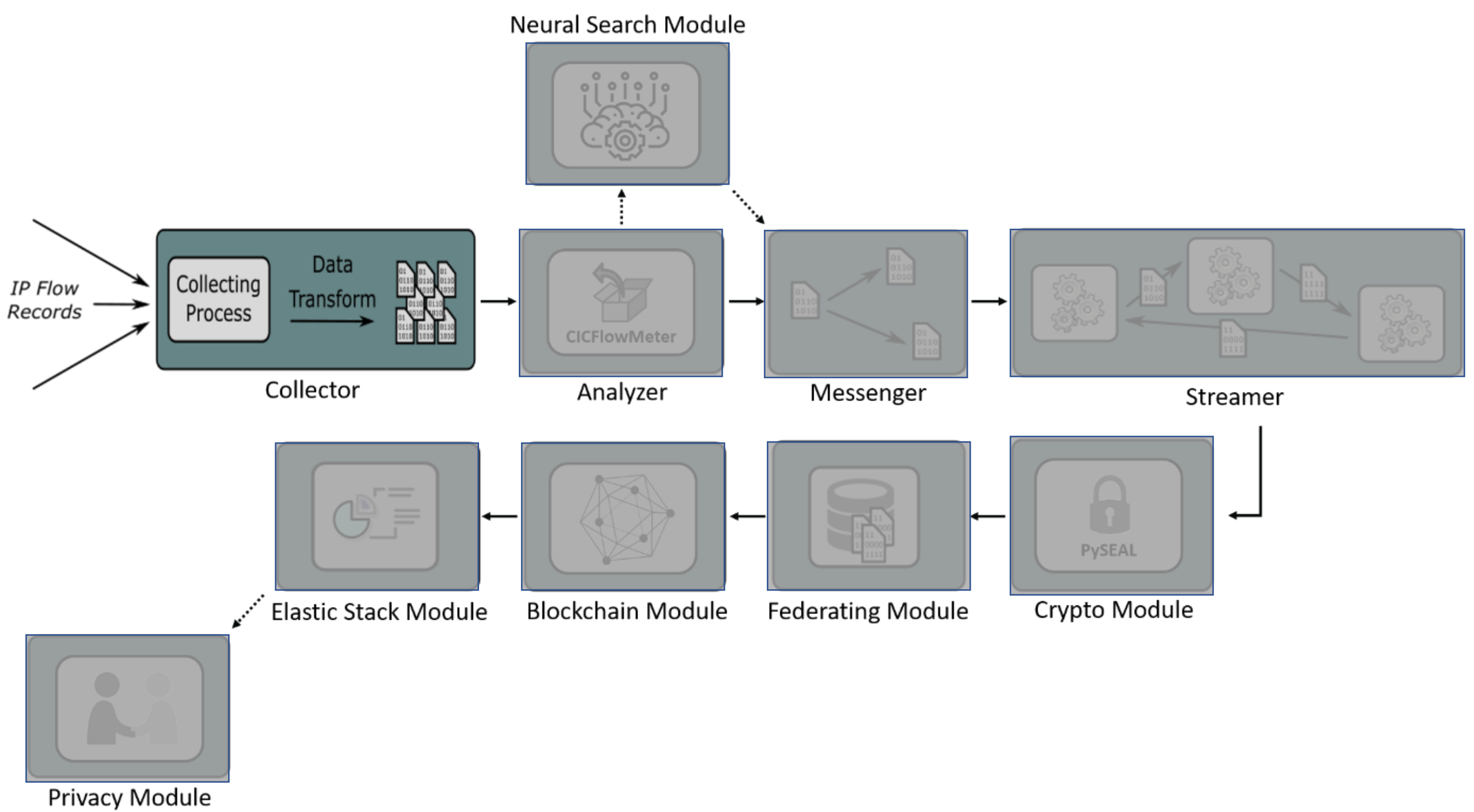
Privacy Module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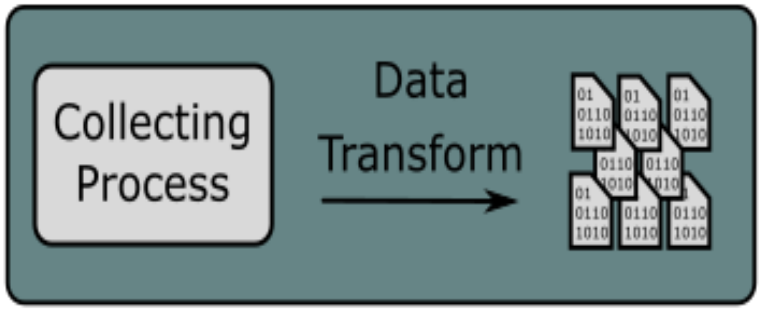
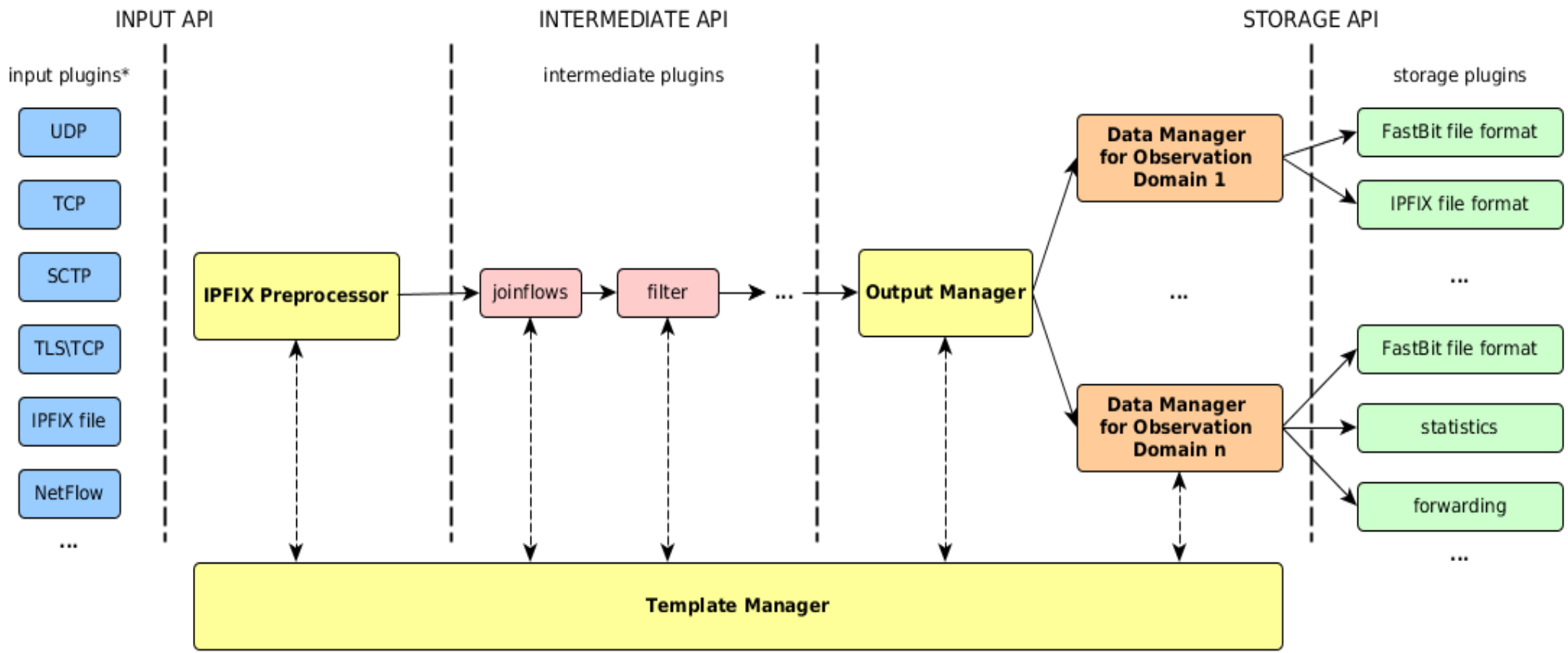
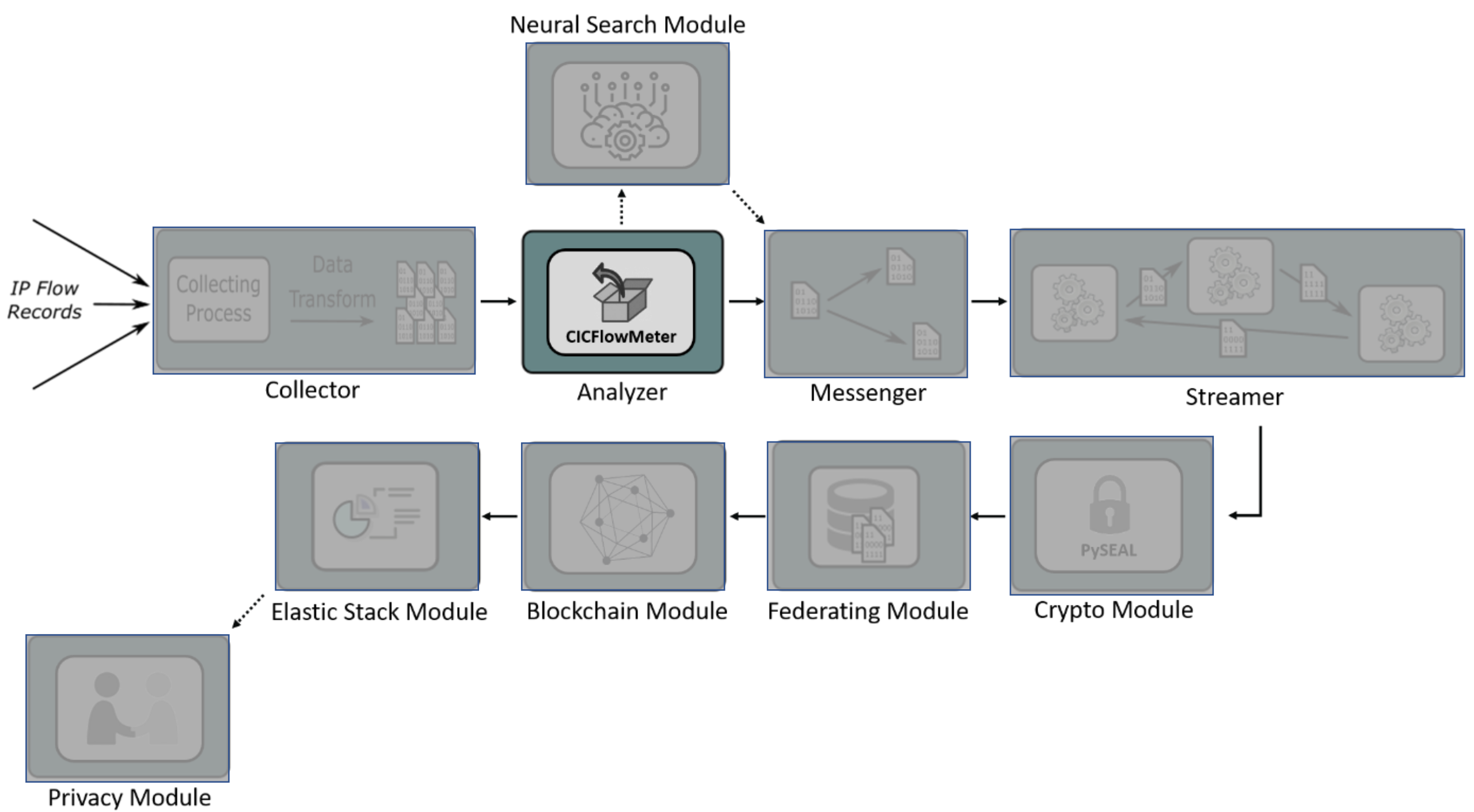


Collector



IPFIXcol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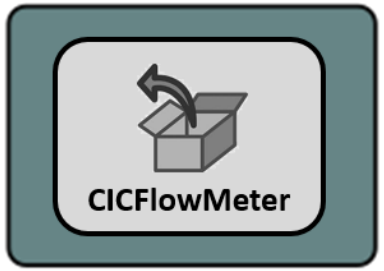
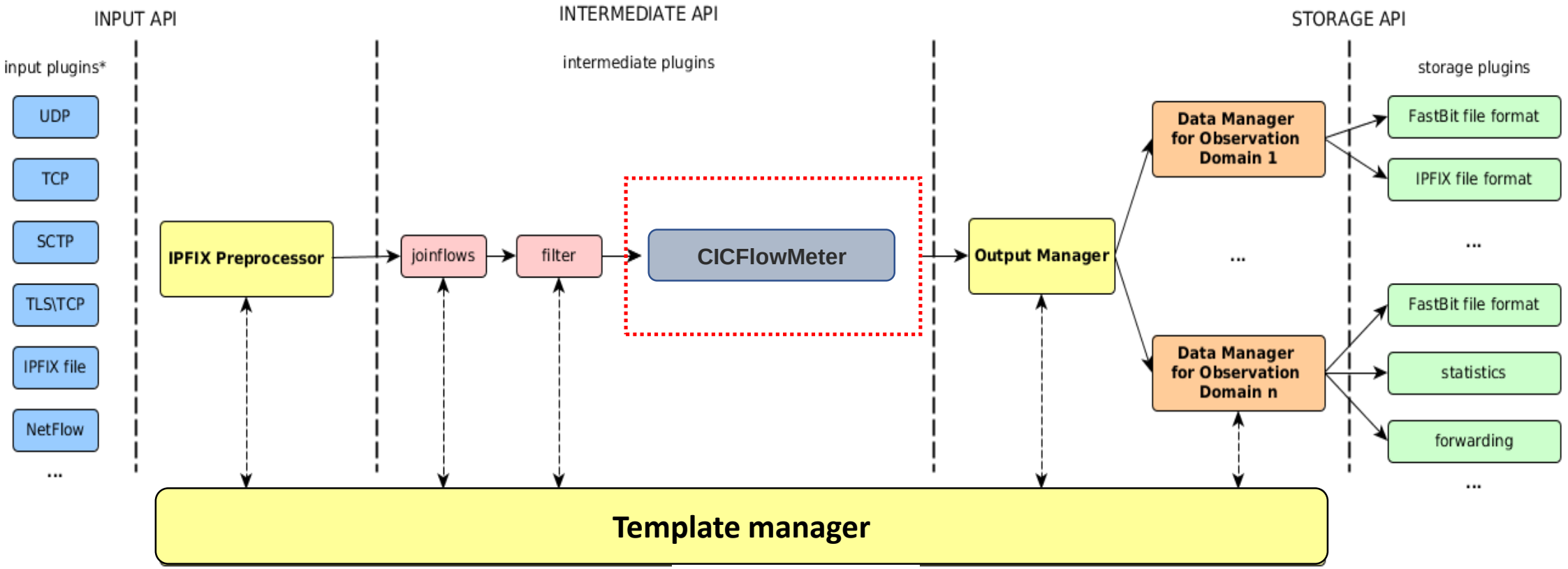


Analyzer



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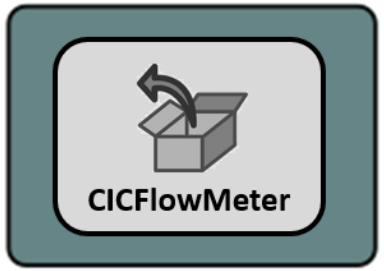
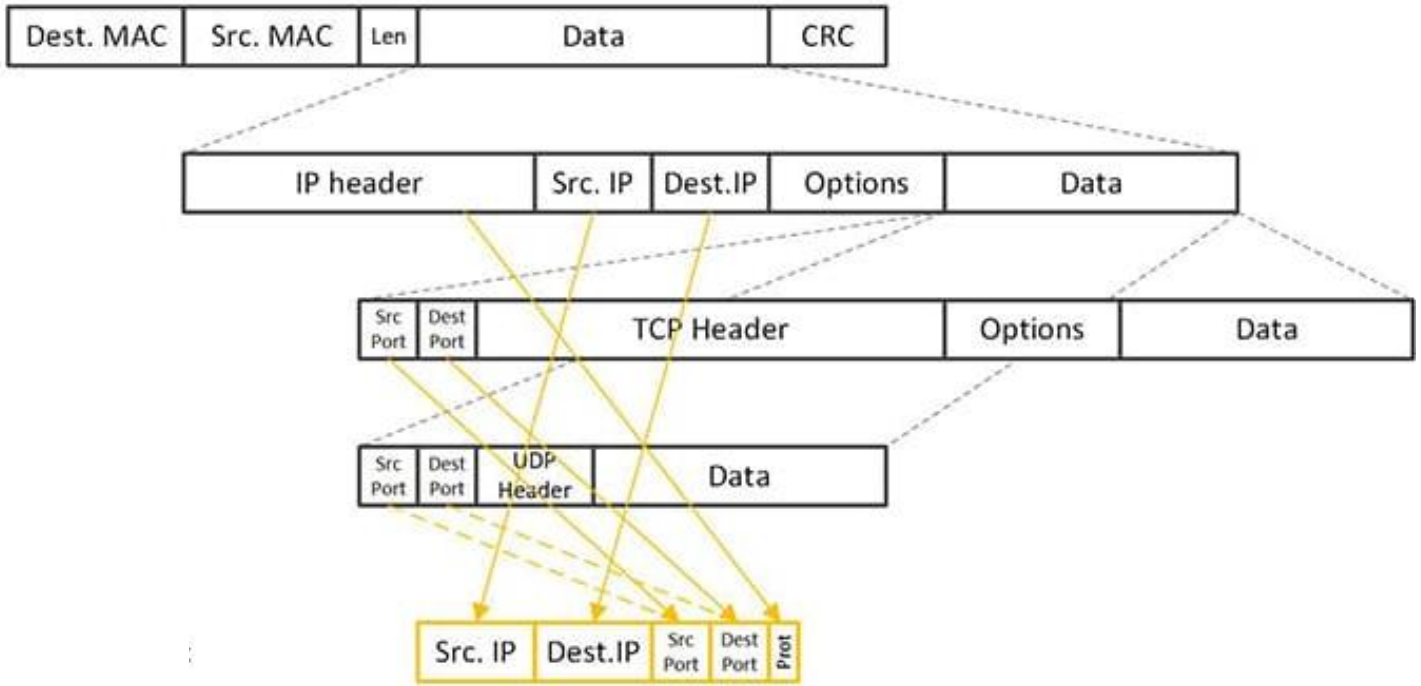
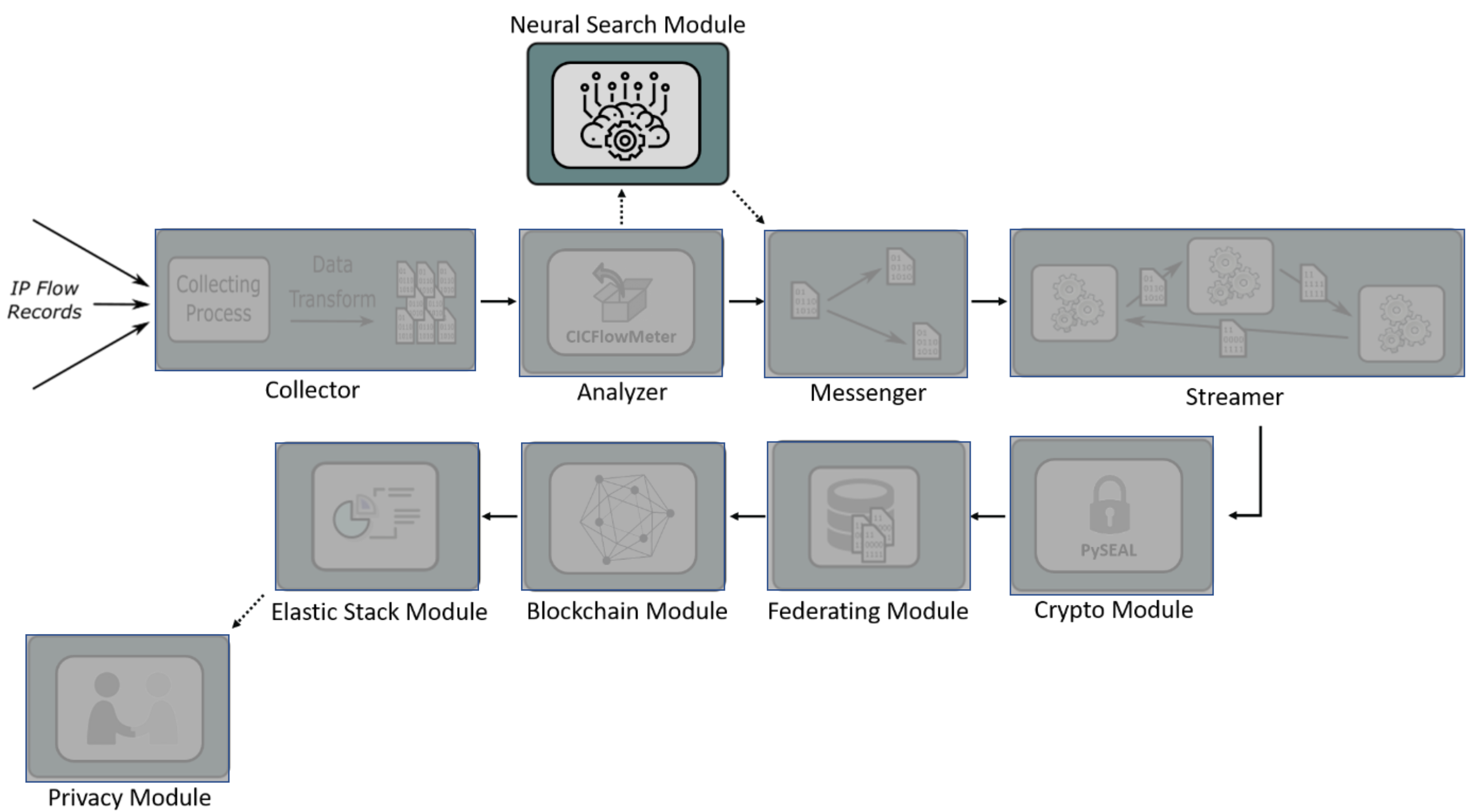


Analyzer



CICFlowMeter

Feature Name	Feature Name	Feature Name
fl_dur	fl_byt_s	ece_cnt
tot_fw_pk	fl_pkt_s	down_up_ratio
tot_bw_pk	fl_iat_avg	pkt_size_avg
tot_l_fw_pkt	fl_iat_std	fw_seg_avg
fw_pkt_l_max	fl_iat_max	bw_seg_avg
fw_pkt_l_min	fl_iat_min	fw_byt_blk_avg
fw_pkt_l_avg	fw_iat_tot	fw_pkt_blk_avg
fw_pkt_l_std	fw_iat_avg	fw_blk_rate_avg
Bw_pkt_l_max	fw_iat_std	bw_byt_blk_avg
Bw_pkt_l_min	fw_iat_max	bw_pkt_blk_avg
Bw_pkt_l_avg	fw_iat_min	bw_blk_rate_avg
Bw_pkt_l_std	bw_iat_tot	subfl_fw_pk
fw_urg_flag	bw_iat_avg	subfl_fw_byt
bw_urg_flag	bw_iat_std	subfl_bw_pkt
fw_hdr_len	bw_iat_max	subfl_bw_byt
bw_hdr_len	bw_iat_min	fw_win_byt
fw_pkt_s	fw_psh_flag	bw_win_byt
bw_pkt_s	bw_psh_flag	fw_act_pkt
pkt_len_min	urg_cnt	fin_cnt
pkt_len_max	cwe_cnt	syn_cnt
pkt_len_avg	atv_avg	rst_cnt
pkt_len_std	atv_std	pst_cnt
pkt_len_va	atv_max	ack_cnt
idl_avg	atv_min	idl_max
idl_std	fw_seg_min	idl_min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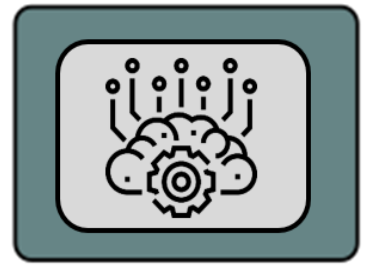
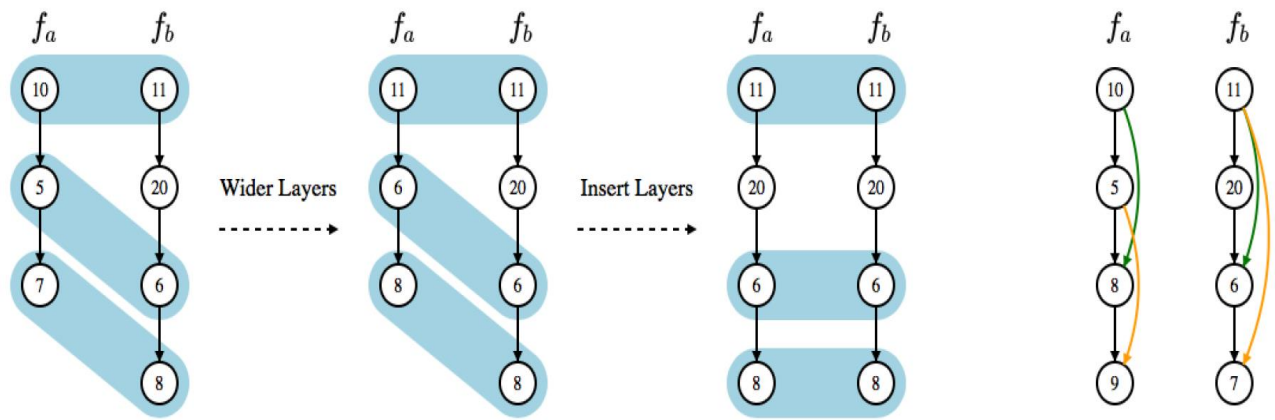
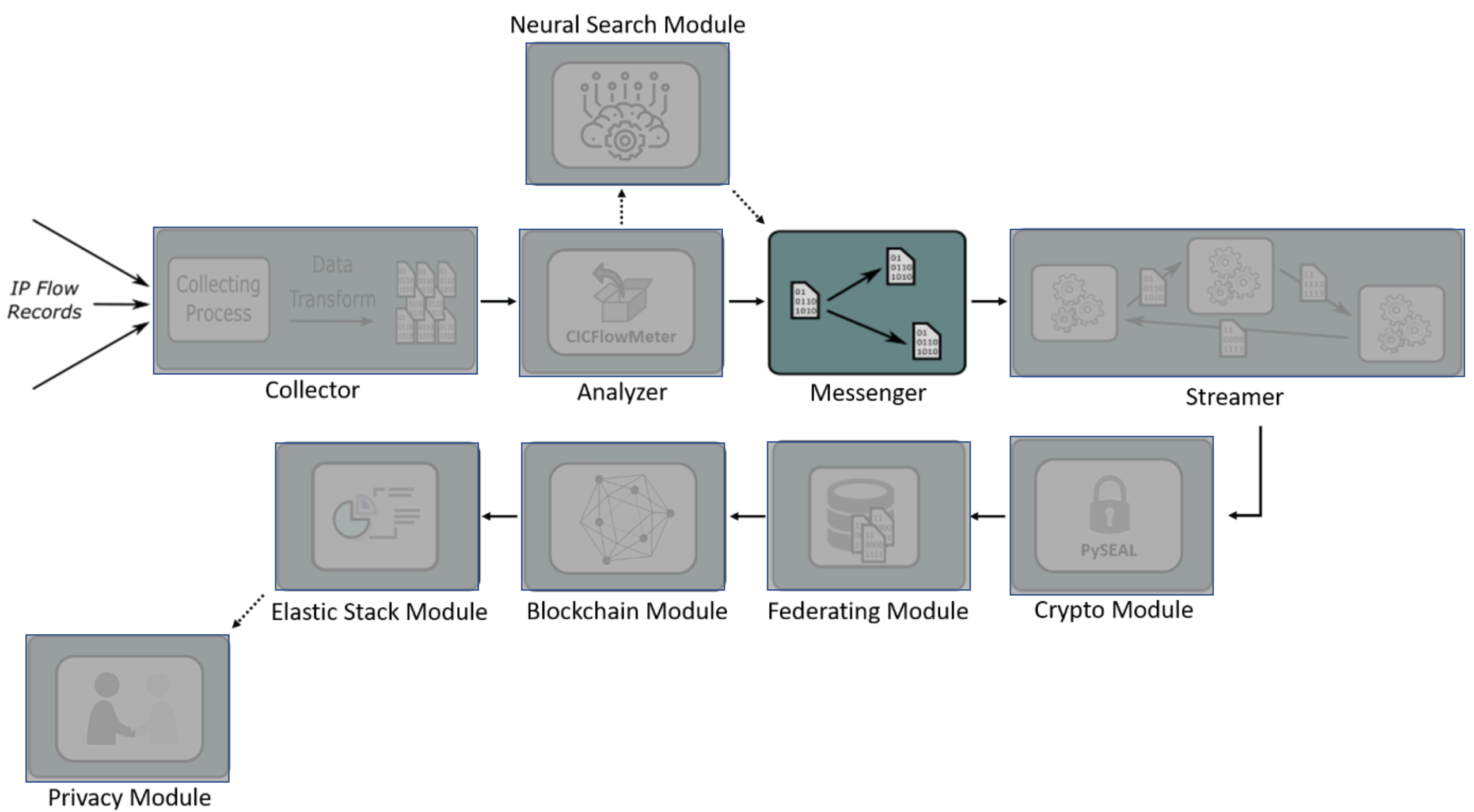


Neural Search Module

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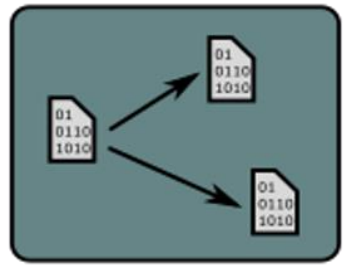
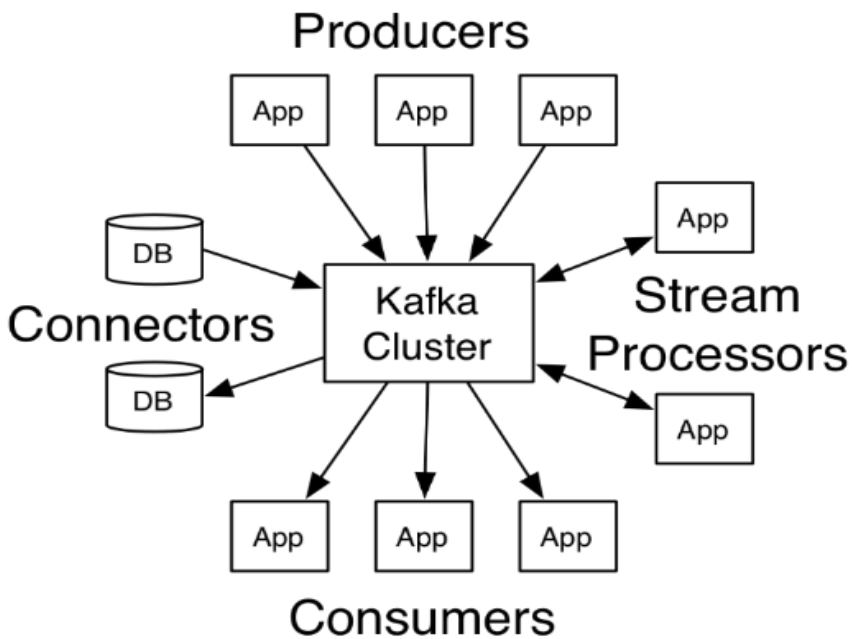
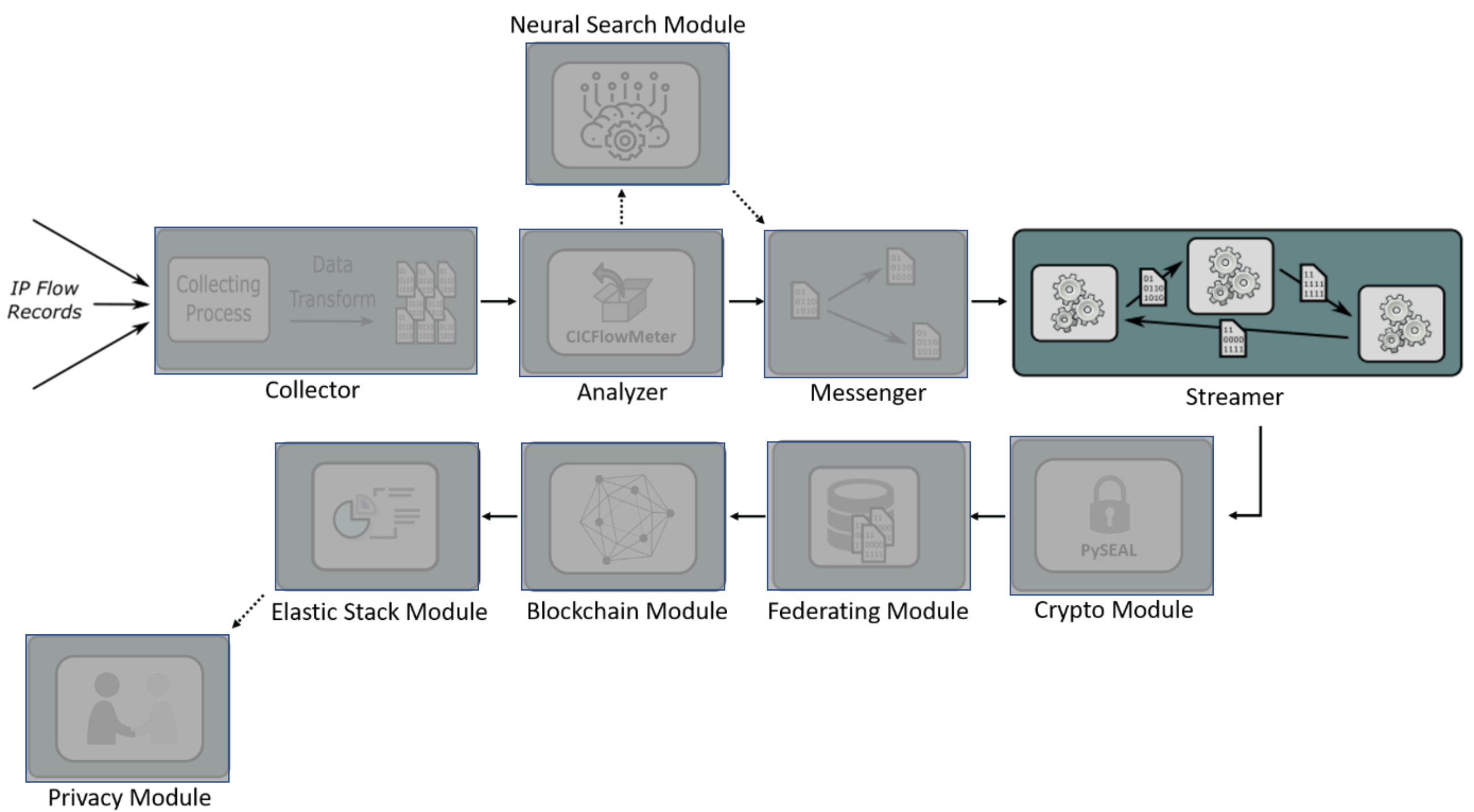


Messenger



APACHE kafka®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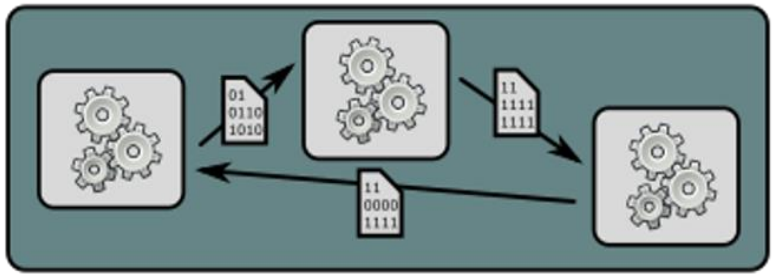
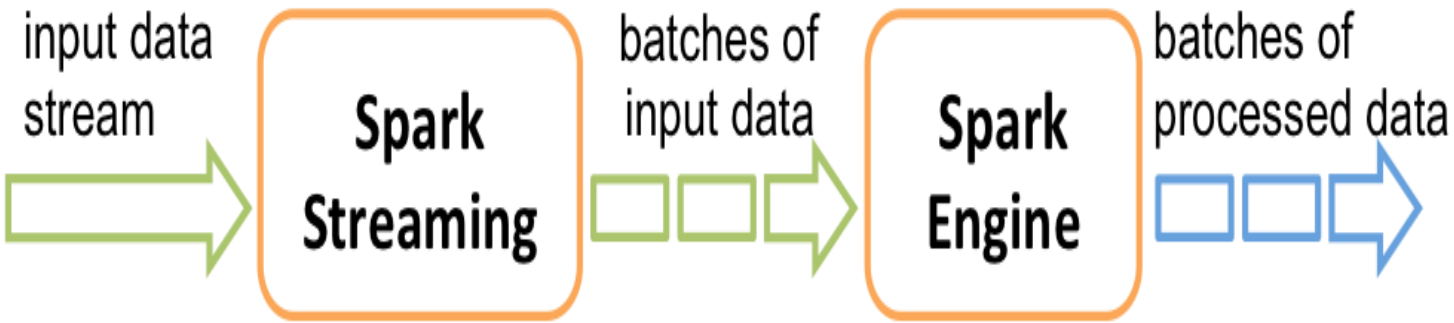
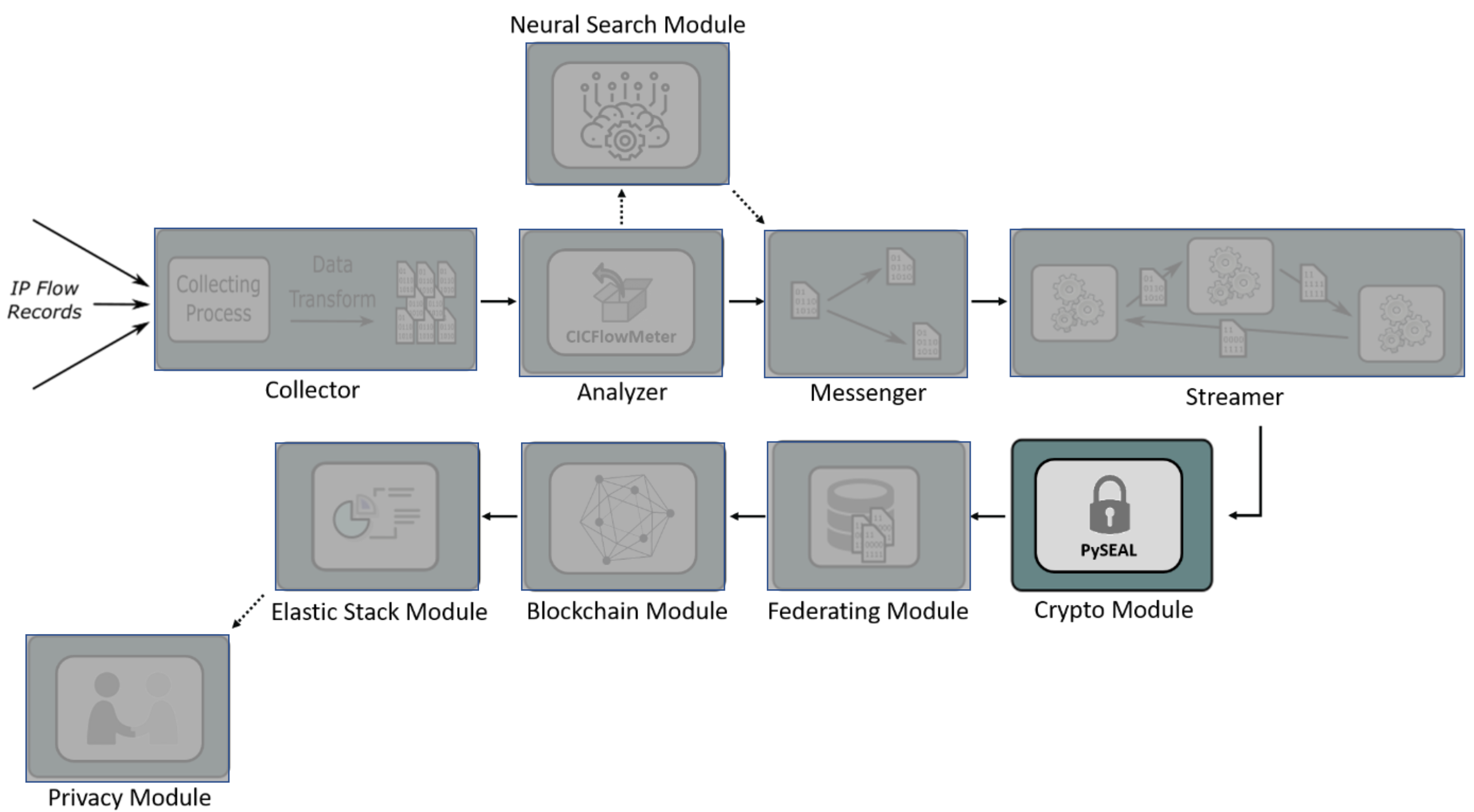


Streamer



Spark Streaming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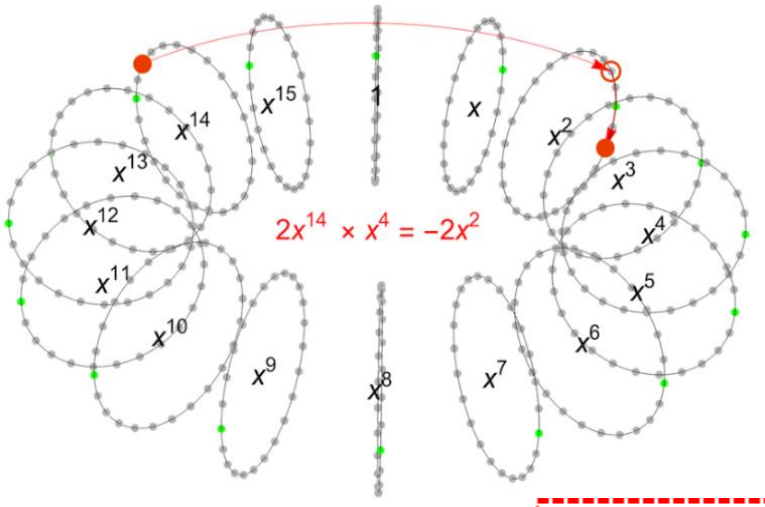
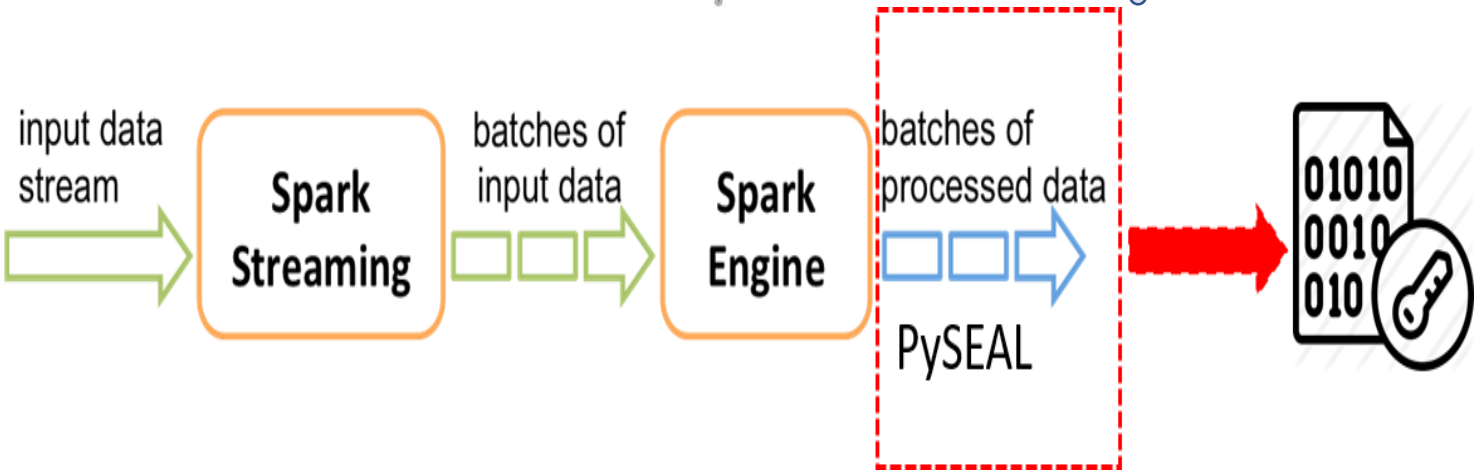
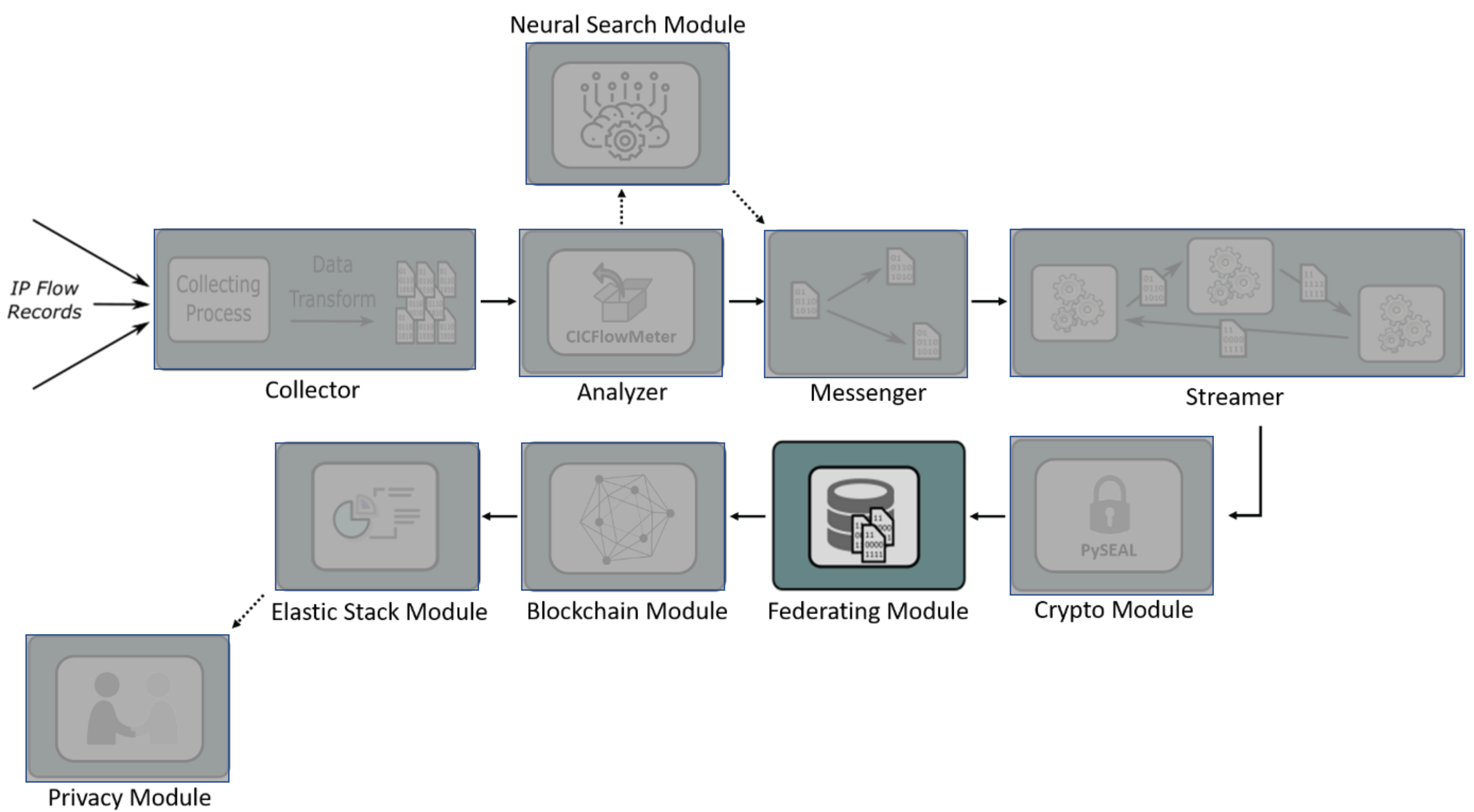


Secure Multi Party Computation

Homomorphic encryption

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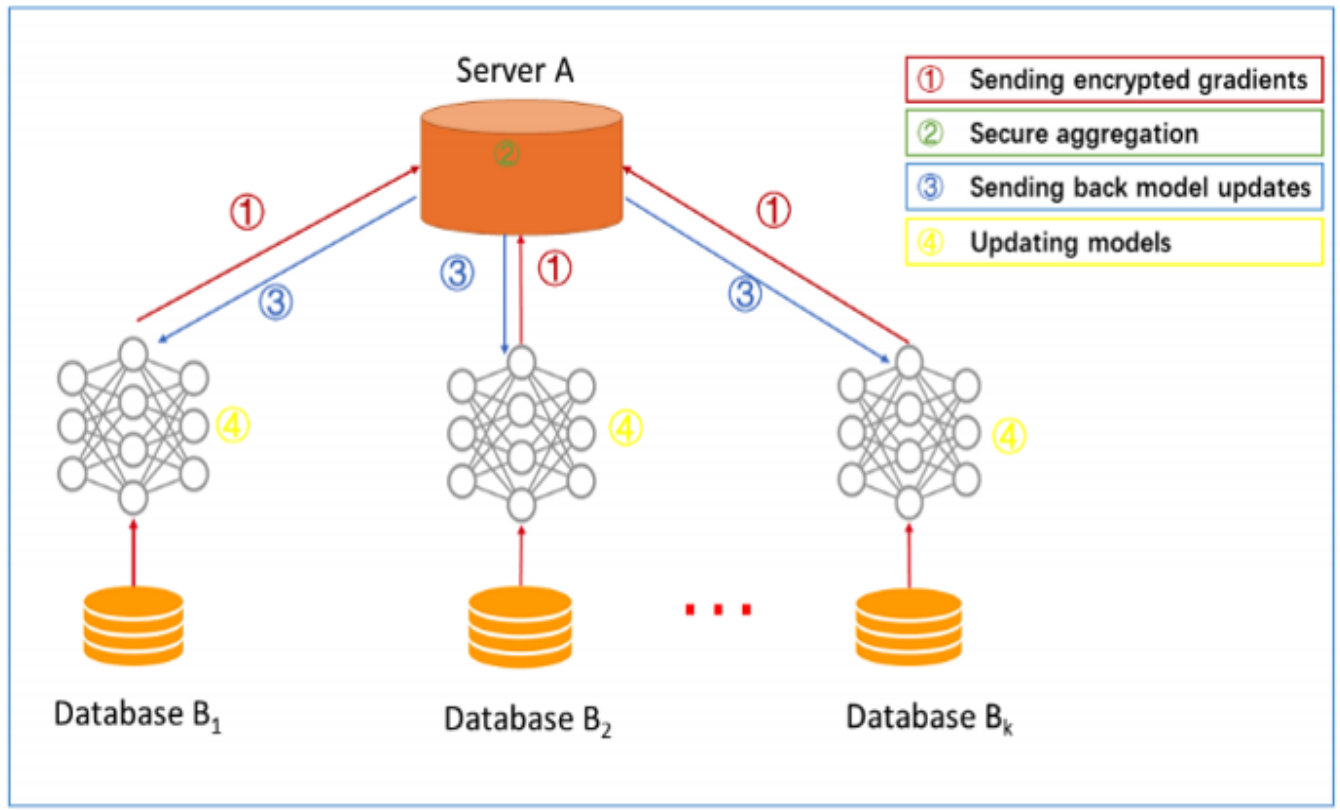
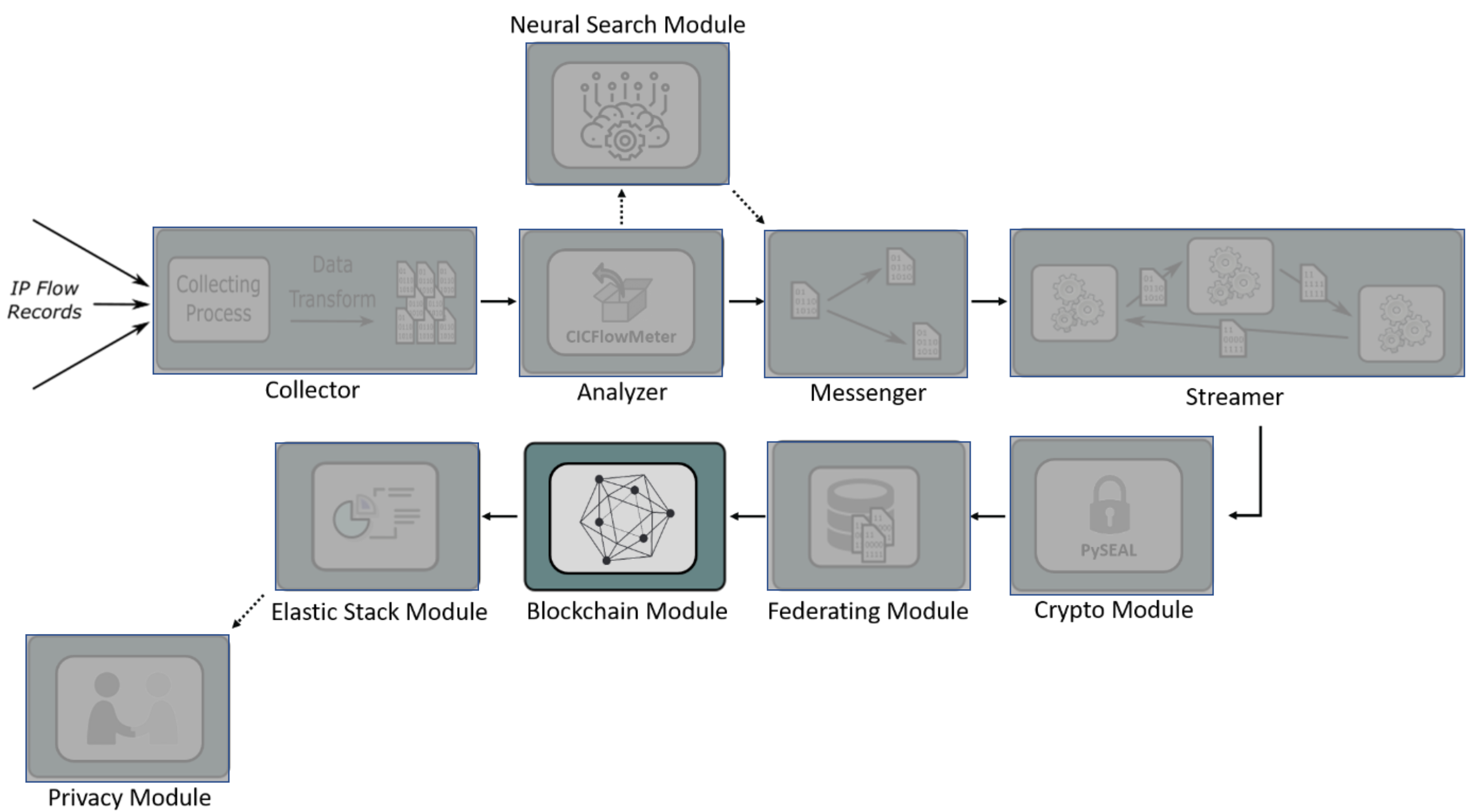
Federating Module

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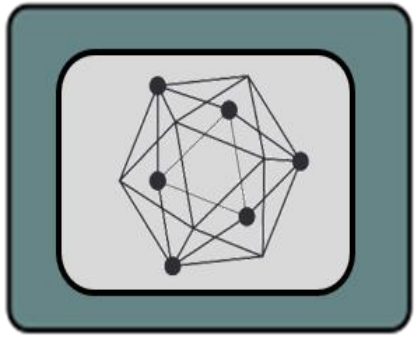
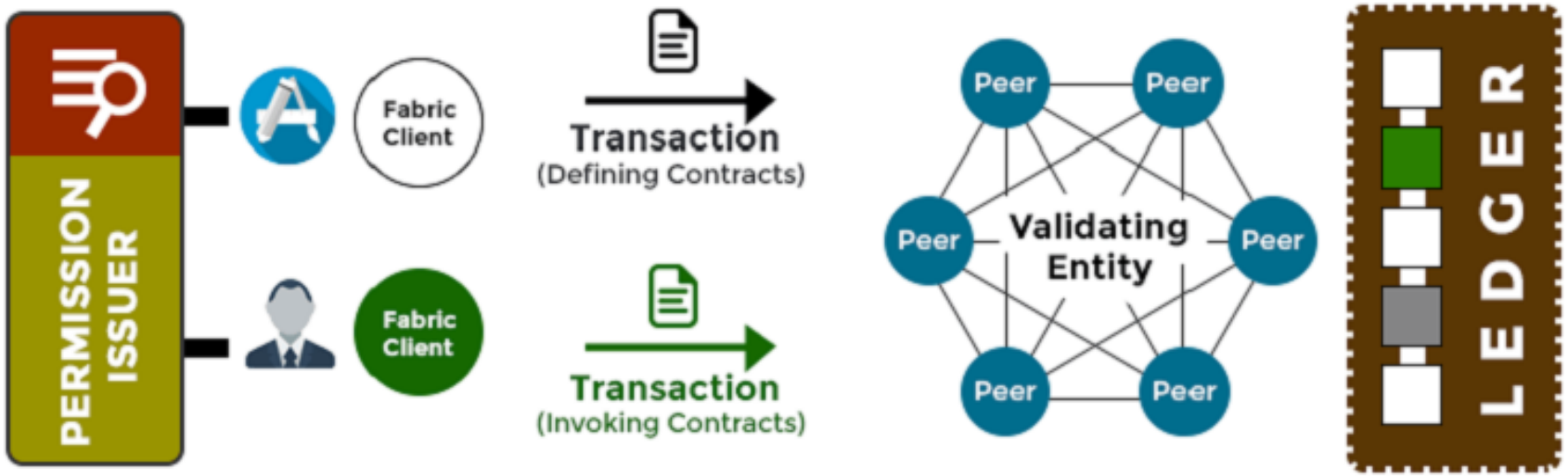
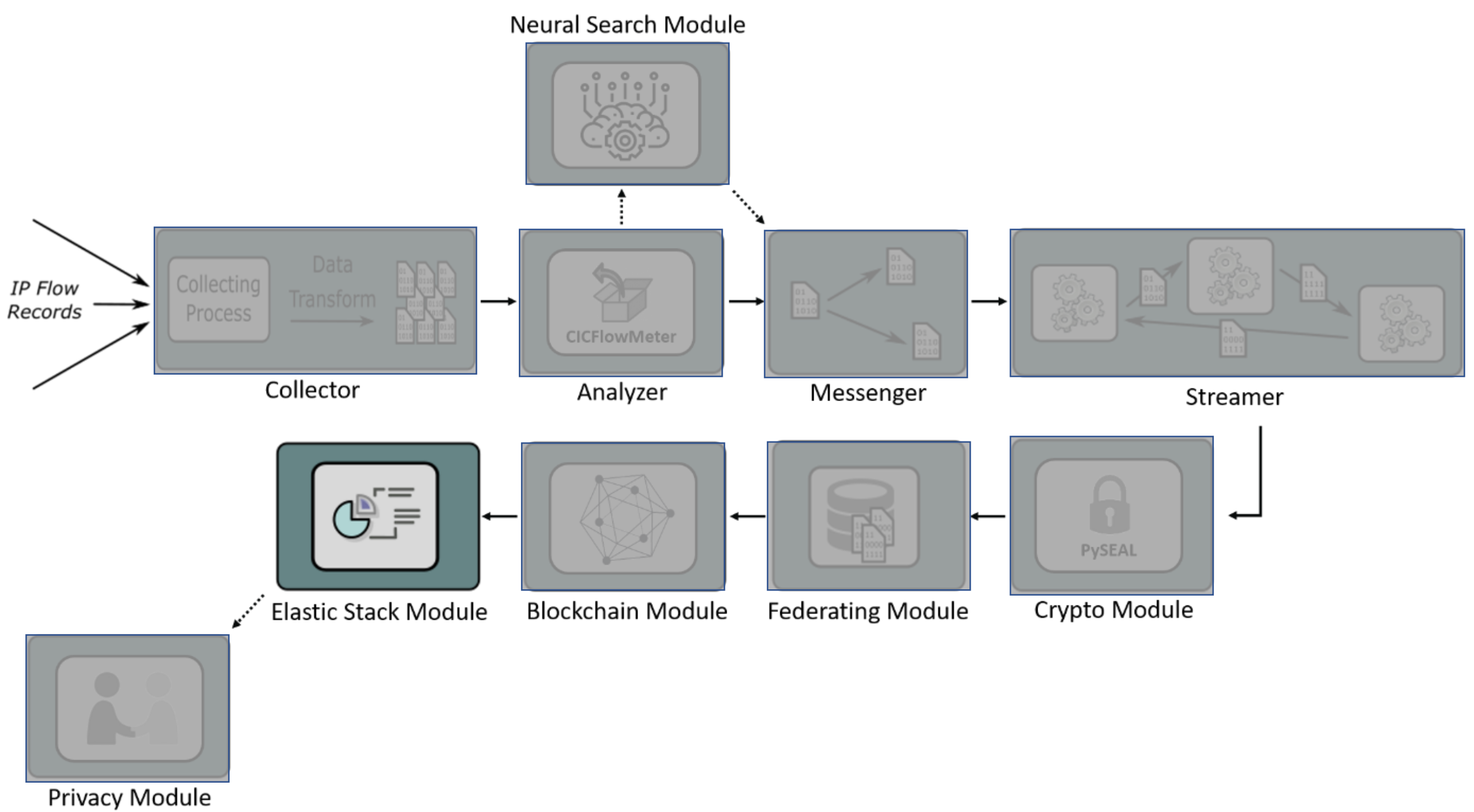


Blockchain Module

HYPERLEDGER FABRIC

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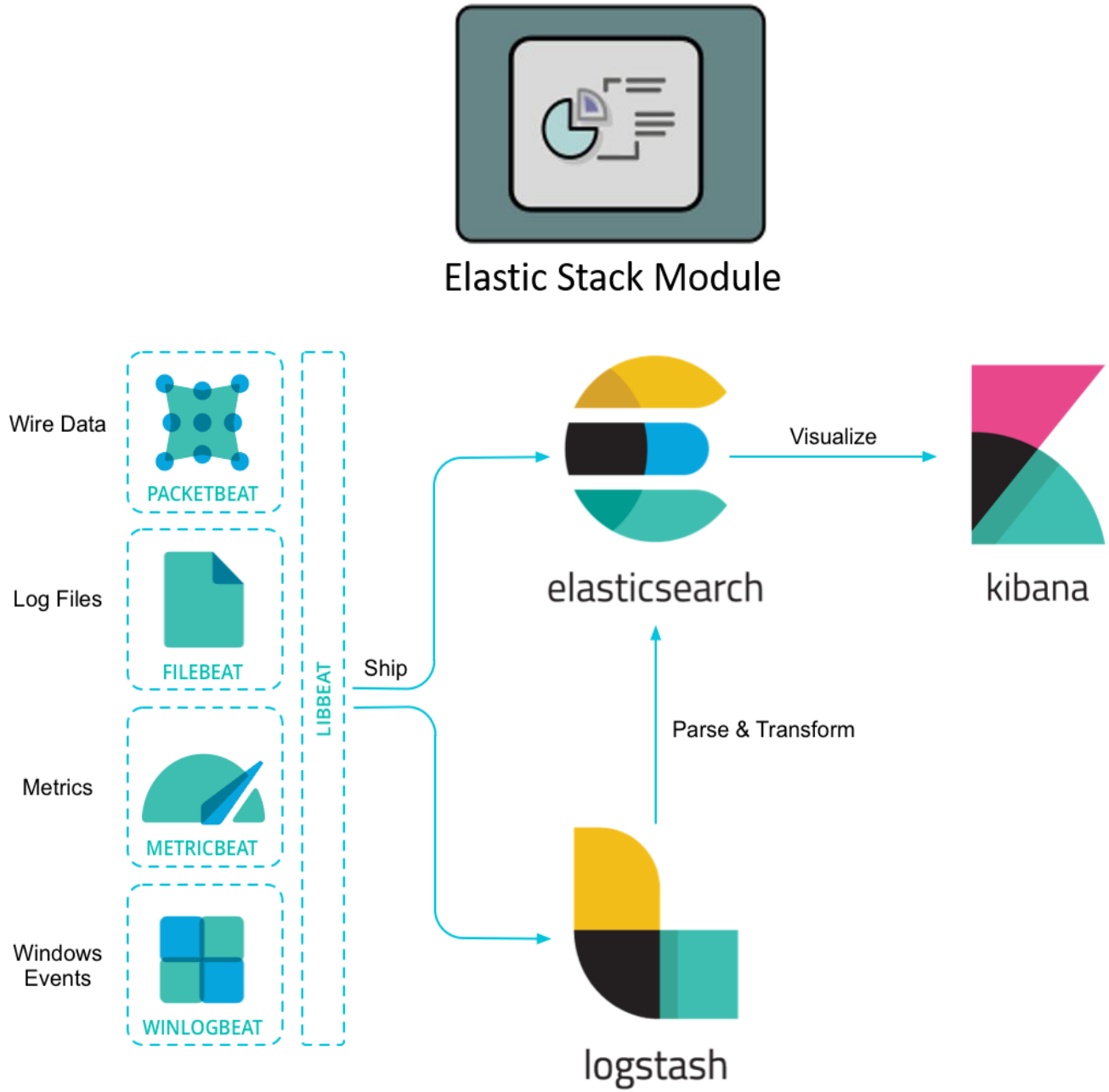
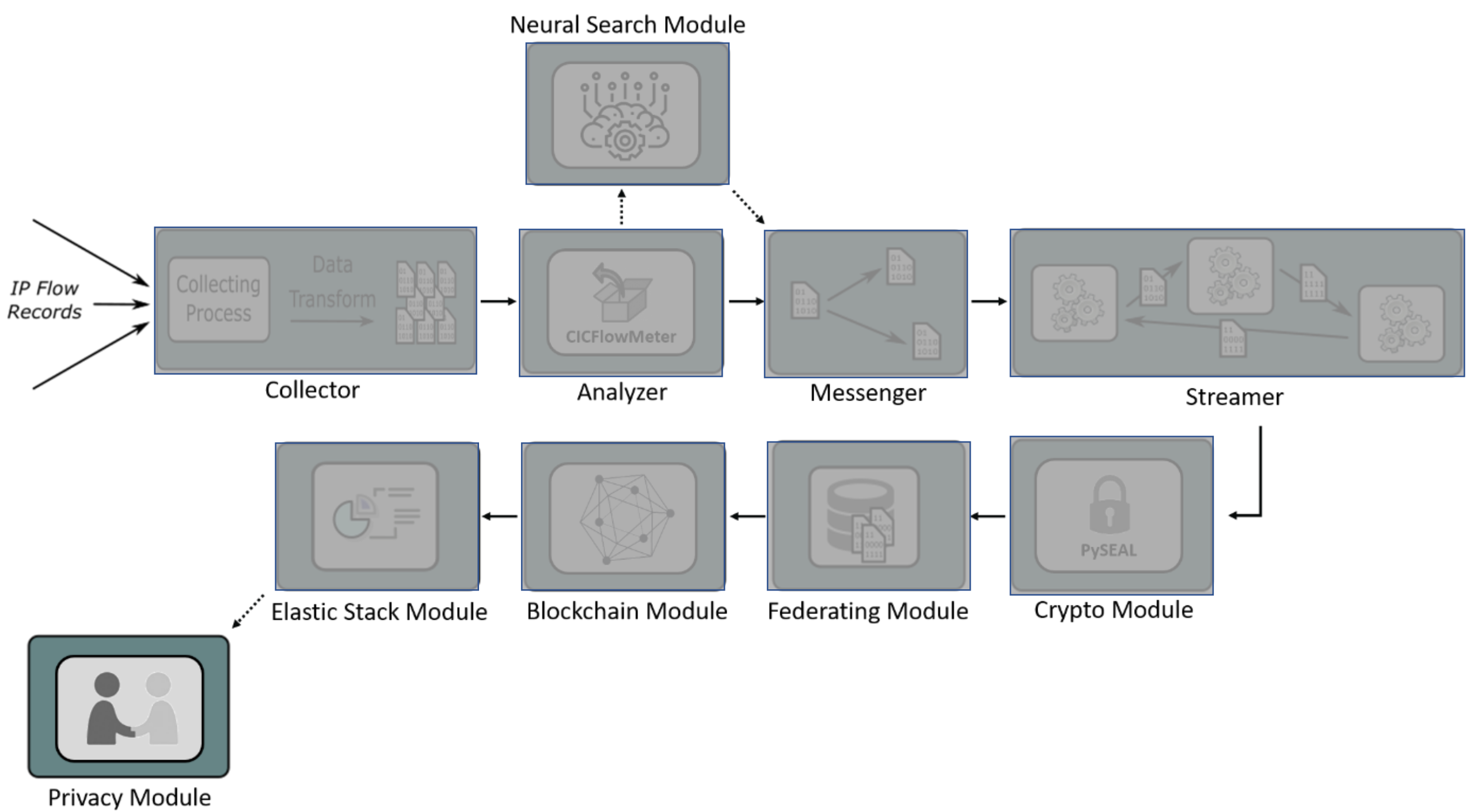

Elastic Stack Module
Wire Data
PACKETBEAT
Log Files
FILEBEAT
Metrics
METRICBEAT
Windows Events
WINLOGBEAT
LIBBEAT
Ship
elasticsearch
Visualize
kibana
Parse & Transform
logstash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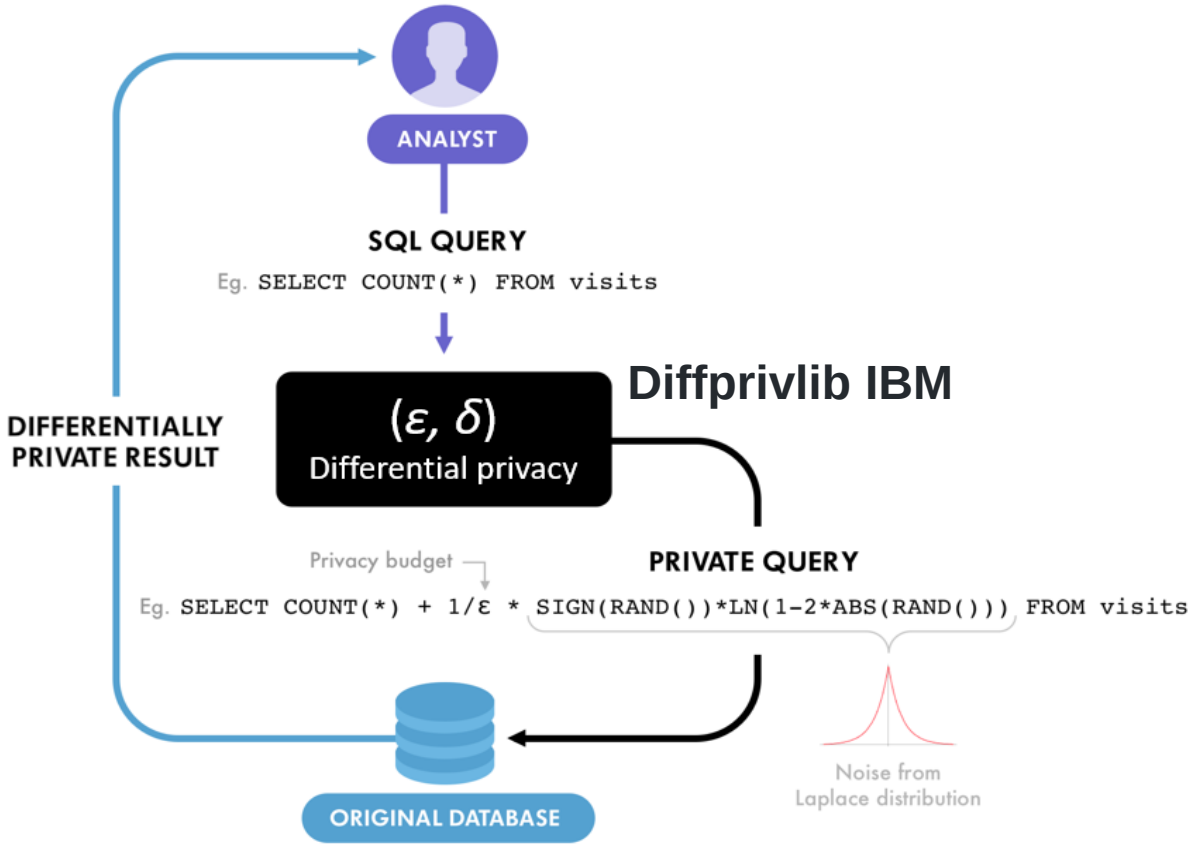

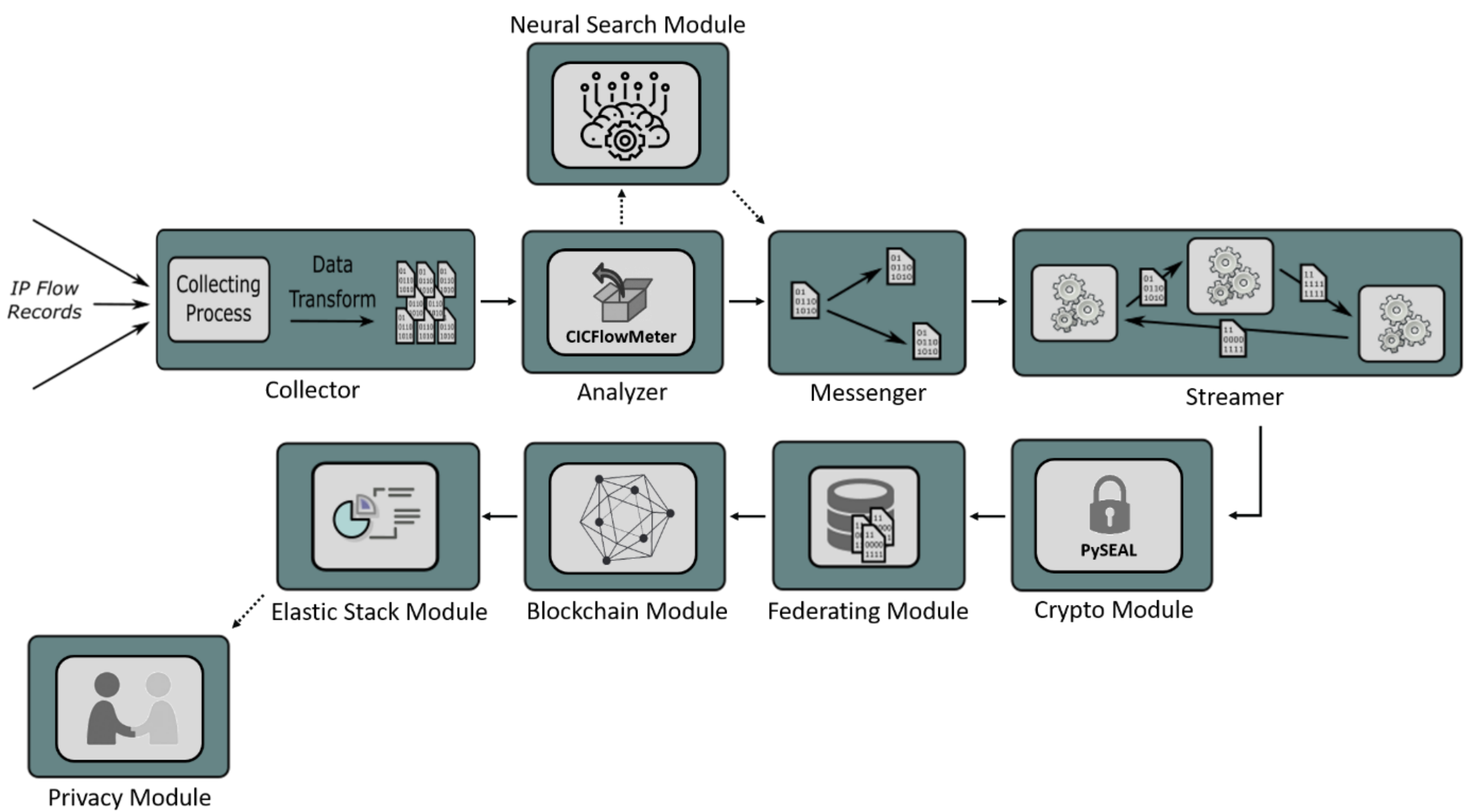
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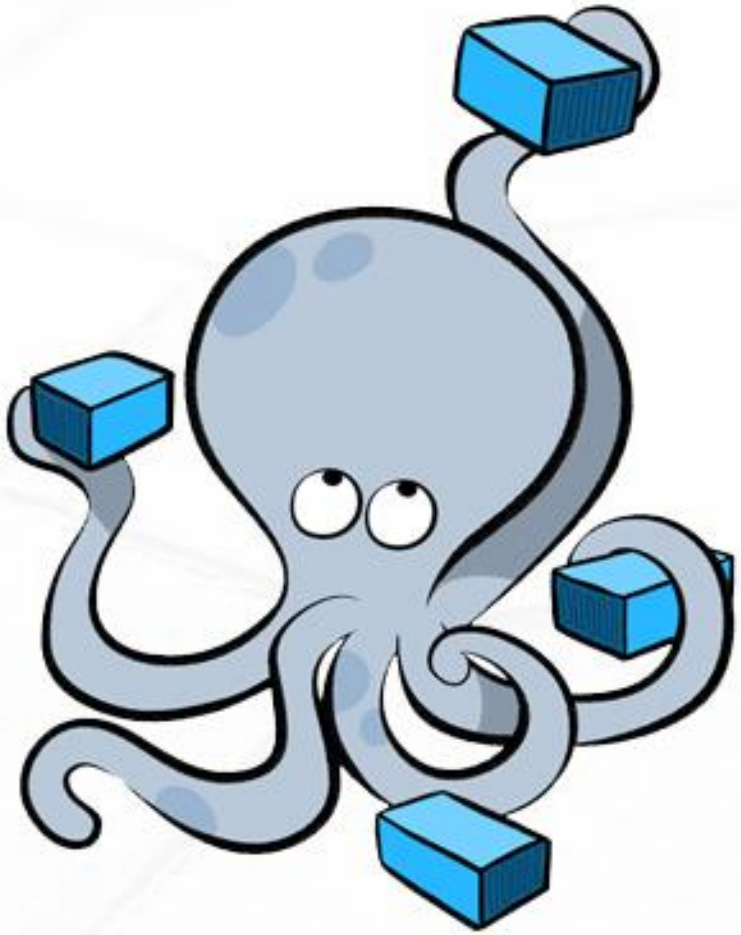


```
php:
  build: php
  ports:
    - "80:80"
    - "443:443"
  volumes:
    - ./php/www:/var/www/html
  links:
    - db
```

```
$ docker-compose up
```


EDGE
COMPUTING

postdoc…

Δ Φάση

Διάχυση των αποτελεσμάτων της έρευνας

- Journals
- Conferences
- Collaborations
- Research Projects

publications…

publications…International Scientific Journals

1. **Demertzis, K.**, Iliadis, L., Tziritas, N., Kikiras, P., 2020, ***Anomaly detection via blockchained deep learning smart contracts in industry 4.0.*** Neural Comput & Applic (2020), ***(Impact Factor 4.774)***
2. **Demertzis, K.**, Iliadis, L. & Bougoudis, I., 2019, ***Gryphon: a semi-supervised anomaly detection system based on one-class evolving spiking neural network***. Neural Comput & Applic (2019), ***(Impact Factor 4.774)***
3. Xing, L., **Demertzis, K.** & Yang, J., 2019, ***Identifying data streams anomalies by evolving spiking restricted Boltzmann machines***. Neural Comput & Applic (2019), ***(Impact Factor 4.774)***
4. **Demertzis, K.**; Iliadis, L.; Pimenidis, I., **Geo-AI to Aid Disaster Response: Domain Adaptation with Memory-Augmented Deep Convolutional Reservoir Computing,** Integrated Computer-Aided Engineering, IOS Press ***(Impact Factor 4.904)*** (*in press*).
5. **Demertzis, K.**; Kikiras, P.; Tziritas, N.; Sanchez, S.L.; Iliadis, L., 2018, ***The Next Generation Cognitive Security Operations Center: Network Flow Forensics Using Cybersecurity Intelligence***. Big Data Cogn. Comput. 2, 35, MDPI.
6. **Demertzis, K.**; Tziritas, N.; Kikiras, P.; Sanchez, S.L.; Iliadis, L., 2019, ***The Next Generation Cognitive Security Operations Center: Adaptive Analytic Lambda Architecture for Efficient Defense against Adversarial Attacks***. Big Data Cogn. Comput. 2019, 3, 6.
7. **Demertzis K.,** Iliadis L., Anezakis V. D., 2018, ***An innovative soft computing system for smart energy grids cybersecurity***, Advances in Building Energy Research, 12:1, 3-24, DOI: 10.1080/17512549.2017.1325401, Taylor & Francis.
8. **Demertzis, K.**; Iliadis, L., 2019, ***Cognitive Web Application Firewall to Critical Infrastructures Protection from Phishing Attacks***, Journal of Computations & Modelling, vol.9, no.2, 2019, 1-26, ISSN: 1792-7625, Scienpress Ltd.
9. **Demertzis, K.**; Iliadis, L., 2020, ***GeoAI: A Model-Agnostic Meta-Ensemble Zero-Shot Learning Method for Hyperspectral Image Analysis and Classification***. Algorithms 2020, 13, 61.

publications…International Conferences Proceedings

1. **Demertzis K.,** Iliadis L., Anezakis VD., 2018, ***A Dynamic Ensemble Learning Framework for Data Stream Analysis and Real-Time Threat Detection***. In: Kůrková V., Manolopoulos Y., Hammer B., Iliadis L., Maglogiannis I. (eds) Artificial Neural Networks and Machine Learning – ICANN 2018. ICANN 2018. Lecture Notes in Computer Science, vol 11139. Springer, Cham,
2. **Demertzis, K.,** Iliadis, L., Anezakis, V., 2018. ***MOLESTRA: A Multi-Task Learning Approach for Real-Time Big Data Analytics***, in: 2018 Innovations in Intelligent Systems and Applications (INISTA). Presented at the 2018 Innovations in Intelligent Systems and Applications (INISTA), pp. 1–8. https://doi.org/10.1109/INISTA.2018.8466306
3. **Demertzis K.,** Iliadis L., Kikiras P., Tziritas N., 2019, ***Cyber-Typhon: An Online Multi-task Anomaly Detection Framework***. In: MacIntyre J., Maglogiannis I., Iliadis L., Pimenidis E. (eds) Artificial Intelligence Applications and Innovations. AIAI 2019. IFIP Advances in Information and Communication Technology, vol 559. Springer, Cham.
4. **Demertzis K.,** Iliadis L., Pimenidis E., 2020, ***Large-Scale Geospatial Data Analysis: Geographic Object-Based Scene Classification in Remote Sensing Images by GIS and Deep Residual Learning***. In: Iliadis L., Angelov P., Jayne C., Pimenidis E. (eds) Proceedings of the 21st EANN (Engineering Applications of Neural Networks) 2020 Conference. EANN 2020. Proceedings of the International Neural Networks Society, vol 2. Springer, Cham.
5. **Demertzis, K.,** Iliadis, L., 2018, **A Computational Intelligence System Identifying Cyber-Attacks on Smart Energy Grids**, in: Daras, N.J., Rassias, T.M. (Eds.), Modern Discrete Mathematics and Analysis: With Applications in Cryptography, Information Systems and Modeling, Springer Optimization and Its Applications. Springer International Publishing, Cham, pp. 97–116. https://doi.org/10.1007/978-3-319-74325-7_5.
6. **Demertzis, Konstantinos,** Iliadis, L.S., 2018. **Real-time Computational Intelligence Protection Framework Against Advanced Persistent Threats**. Book entitled "Cyber-Security and Information Warfare", Series: Cybercrime and Cybersecurity Research, NOVA science publishers, ISBN: 978-1-53614-385-0, Chapter 5.

editorial…

editor

- Special Issue “**Advances in Machine Learning**" *Processes*— Open Access Journal, MDPI – **IF 2.753**

editor

- Special Issue "**Bio-inspired Hybrid Artificial Intelligence Framework for Cyber Security**" Applied Sciences — Open Access Journal, MDPI – **IF 2.474**

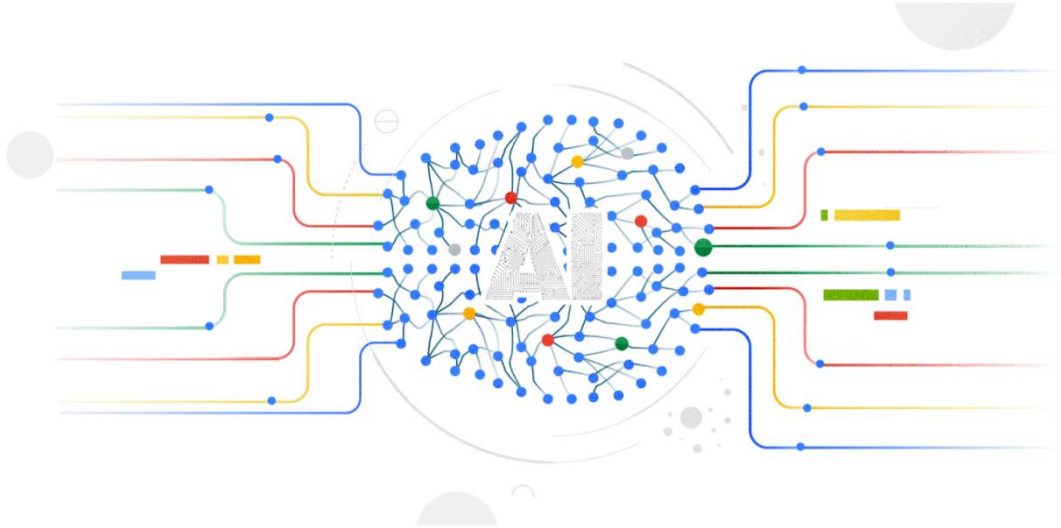
editor

- Special Issue "**Sustainability Science and Technology**" Sustainability — Open Access Journal, MDPI – **IF 2.576**

lecturer…

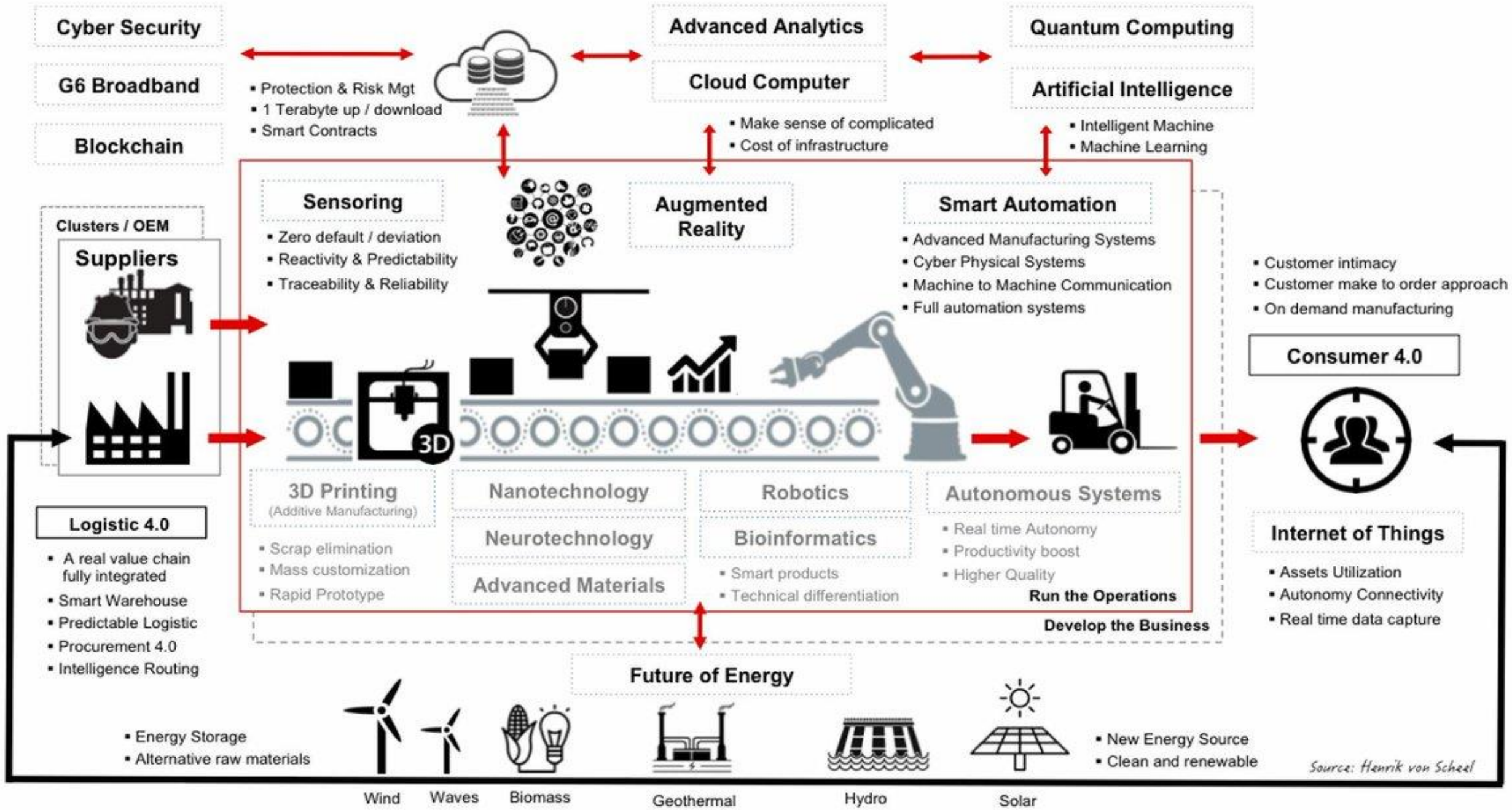
ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

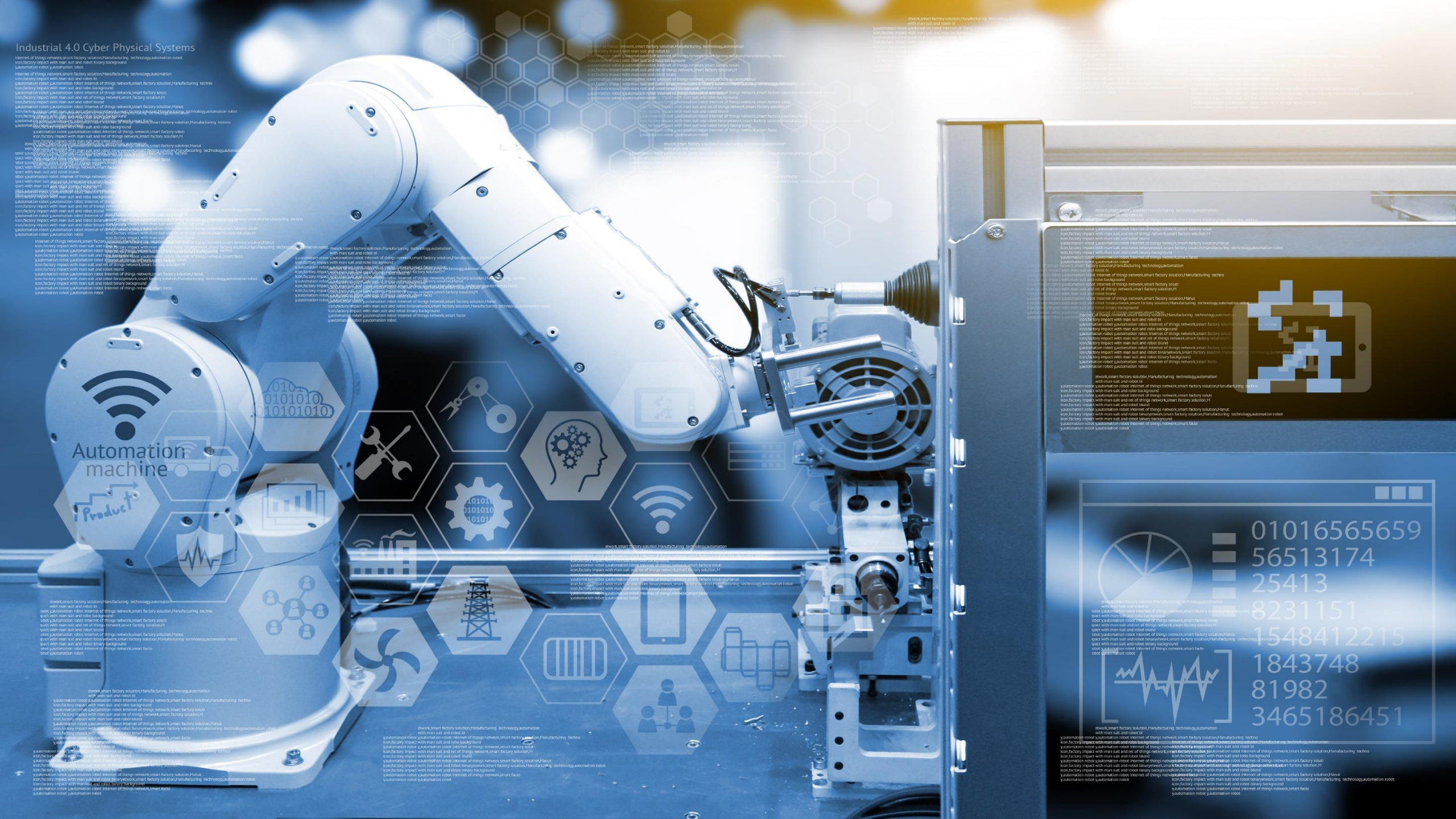
School of Civil Engineering, Democritus University of Thrace, **Postgraduate Program "Applied Mathematics"**, **"Intelligent Models and Hybrid Soft Computing Information Systems"**



universidad de león

Industry 4.0 ecosystem




Industrial 4.0 Cyber Physical Systems
Automation machine
Product
01016565659
56513174
25413
8231151
1548412215
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ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ

ΥΠΟΥΡΓΕΙΟ ΨΗΦΙΑΚΗΣ ΔΙΑΚΥΒΕΡΝΗΣΗΣ

ΕΘΝΙΚΗ ΑΡΧΗ ΚΥΒΕΡΝΟΑΣΦΑΛΕΙΑΣ

Δεκαπέντε ειδικοί στόχοι στο πλαίσιο στοχοθεσίας της Εθνικής Στρατηγικής Κυβερνοασφάλειας 2020-2025

1. Ένα λειτουργικό σύστημα διακυβέρνησης

- 1.Α. Βελτιστοποίηση του πλαισίου οργάνωσης και λειτουργίας δομών και διαδικασιών
- 1.Β. Αποτελεσματικός σχεδιασμός αποτίμησης επικινδυνότητας και διαχείρισης έκτακτης ανάγκης.
- 1.Γ. Ενδυνάμωση συνεργασιών σε εθνικό, ευρωπαϊκό και διεθνές επίπεδο

2. Θωράκιση κρίσιμων υποδομών, ασφάλεια και νέες τεχνολογίες

3. Βελτιστοποίηση διαχείρισης περιστατικών,καταπολέμησης του κυβερνοεγκλήματος και προστασία της ιδιωτικότητας

2.Β. Αναβάθμιση της προστασίας κρίσιμων υποδομών

4. Ένα σύγχρονο επενδυτικό περιβάλλον με έμφαση στην προαγωγή της Έρευνας και Ανάπτυξης

- 4.Α. Προαγωγή της Έρευνας και Ανάπτυξης
- 4.Β. Παροχή επενδυτικών κινήτρων
- 4.Γ. Αξιοποίηση Συμπράξεων Δημόσιου και Ιδιωτικού τομέα (ΣΔΙΤ)

5. Ανάπτυξη ικανοτήτων (capacity building), προαγωγή της ενημέρωσης και ευαισθητοποίησης

- 5.Α. Βελτίωση ικανοτήτων μέσω οργάνωσης κατάλληλων ασκήσεων
- 5.Β. Αξιοποίηση σύγχρονων μεθόδων και εργαλείων κατάρτισης και εκπαίδευσης
- 5.Γ. Διαρκής ενημέρωση Φορέων και πολιτών αναφορικά με θέματα κυβερνοασφάλειας

9.1.1 Σύσταση Κέντρου Παρακολούθησης Κρίσιμων Υποδομών Security Operations Center – SOC)

Κρίνεται απαραίτητη η ανάπτυξη δυνατότητας παρακολούθησης και απόκρισης σε συμβάντα ασφάλειας και η ανταλλαγή στοιχείων με τους αρμόδιους Φορείς. Η εν λόγω δυνατότητα παρέχεται μέσω υποδομής Κέντρου Παρακολούθησης Κρίσιμων Υποδομών (Security Operations Center – SOC) και σύστασης Ομάδας Απόκρισης Κυβερνοπεριστατικών (CSIRT).

Η λειτουργία Κέντρου Παρακολούθησης Κρίσιμων Υποδομών (SOC), απαιτεί, κατ' ελάχιστον, τα ακόλουθα:

Εικόνα 14 Λειτουργία SOC

Σκοπός του Κέντρου αποτελεί η διαρκής παρακολούθηση των κρίσιμων υποδομών Φορέων και η έγκαιρη αναγνώριση και αντιμετώπιση των περιστατικών ασφάλειας.

The Next Generation Cognitive Security Operations Center

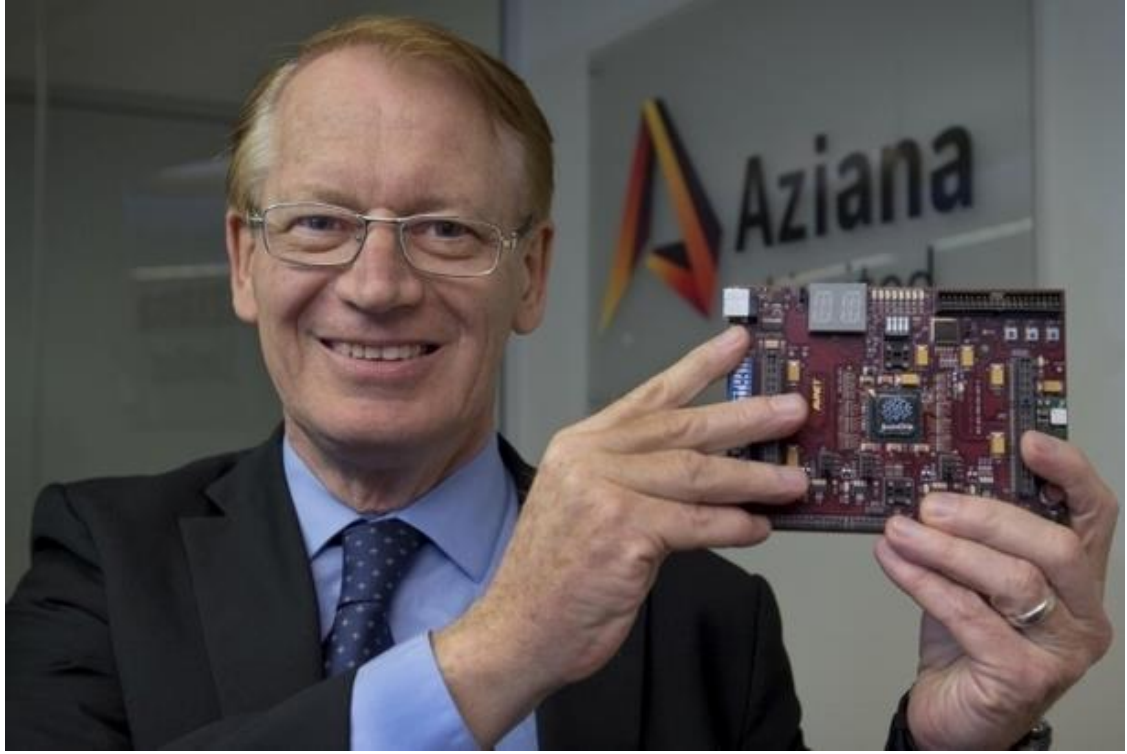
- Network Flow Forensics Using Cybersecurity Intelligence
- Adaptive Analytic Lambda Architecture Framework for Efficient Defense Against Adversarial Attacks

#brainchip

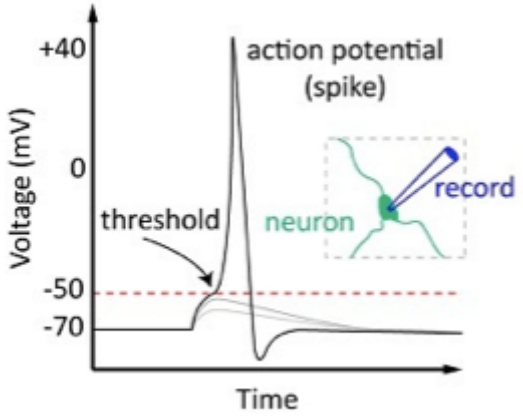
research projects…

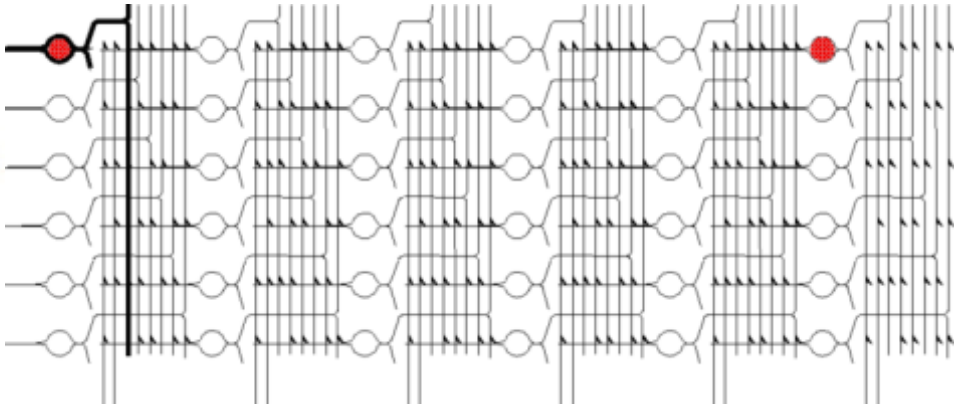
2018 – 2019, “Cybersecurity Algorithms for Spiking Neural Networks”, BrainChip - DUTh

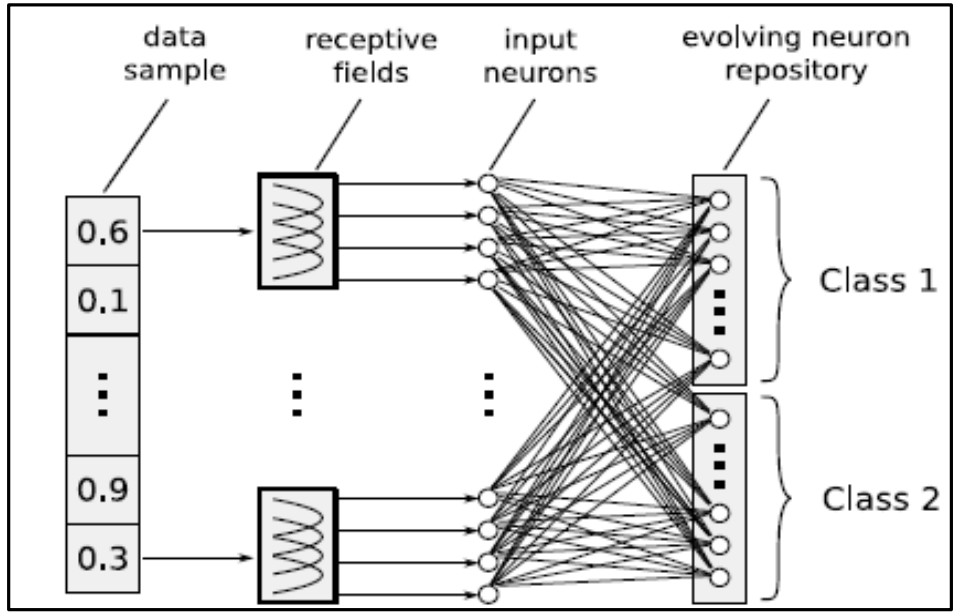
brainchip

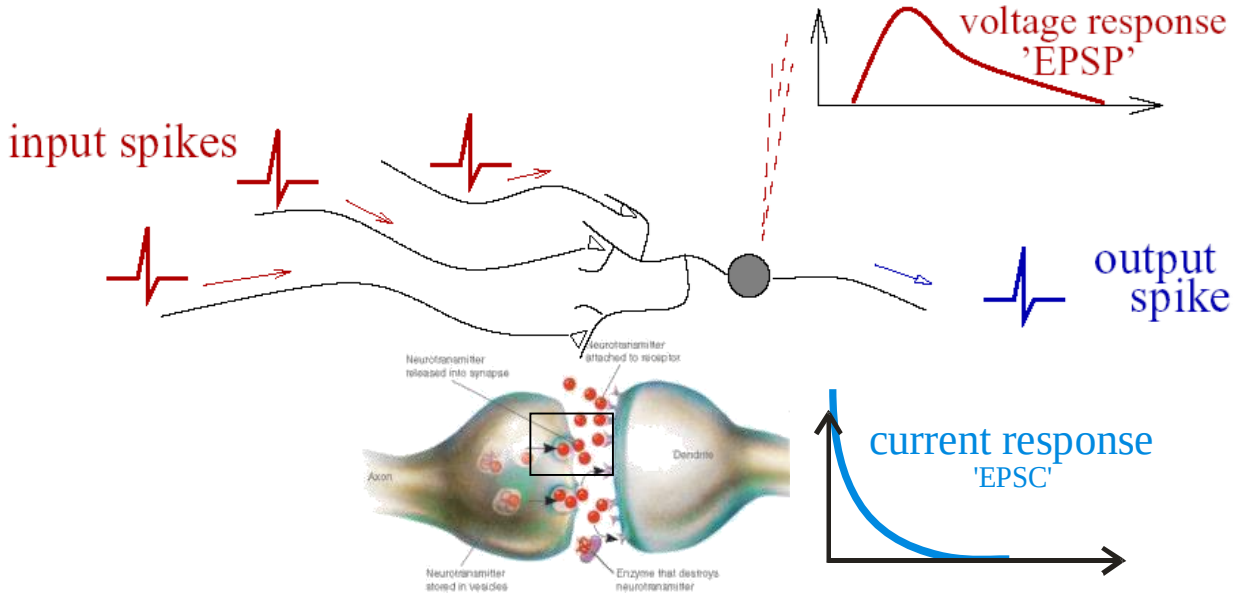


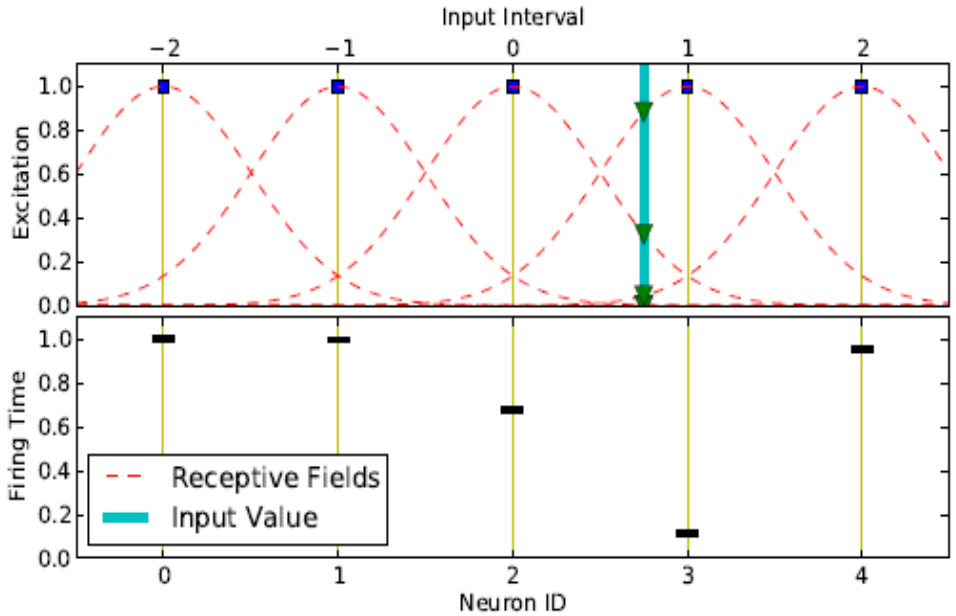
Spiking Neural Network











akida NSoC

Biologically Inspired, Digitally Engineered

Neural Network Comparison

	Convolutional Neural Networks		Spiking Neural Networks	
	Characteristic	Result	Characteristic	Result
Computational functions	Matrix Multiplication, ReLU, Pooling, FC layers	Math intensive, high power, custom acceleration blocks	Threshold logic, connection reinforcement	Math-light, low power, standard logic
Training	Backpropagation off-chip	Requires large pre-labeled datasets, long and expensive training periods	Feed-Forward, on or off-chip	Short training cycles, continuous learning

- Math intensive cloud compute
- Low power edge deployments

akida NSoC

Biologically Inspired, Digitally Engineered

- World's first Neuromorphic System on Chip (NSoC)
  - Efficient neuron model
  - Innovative training methodologies
- Everything required for embedded/edge applications
  - On-chip processor
  - Data->spike conversion
- Scalable for Server/Cloud
- Neuromorphic computing for multiple markets
  - Vision systems
  - Cyber security
  - Financial tech

Akida NSoC Architecture

Conversion Complex

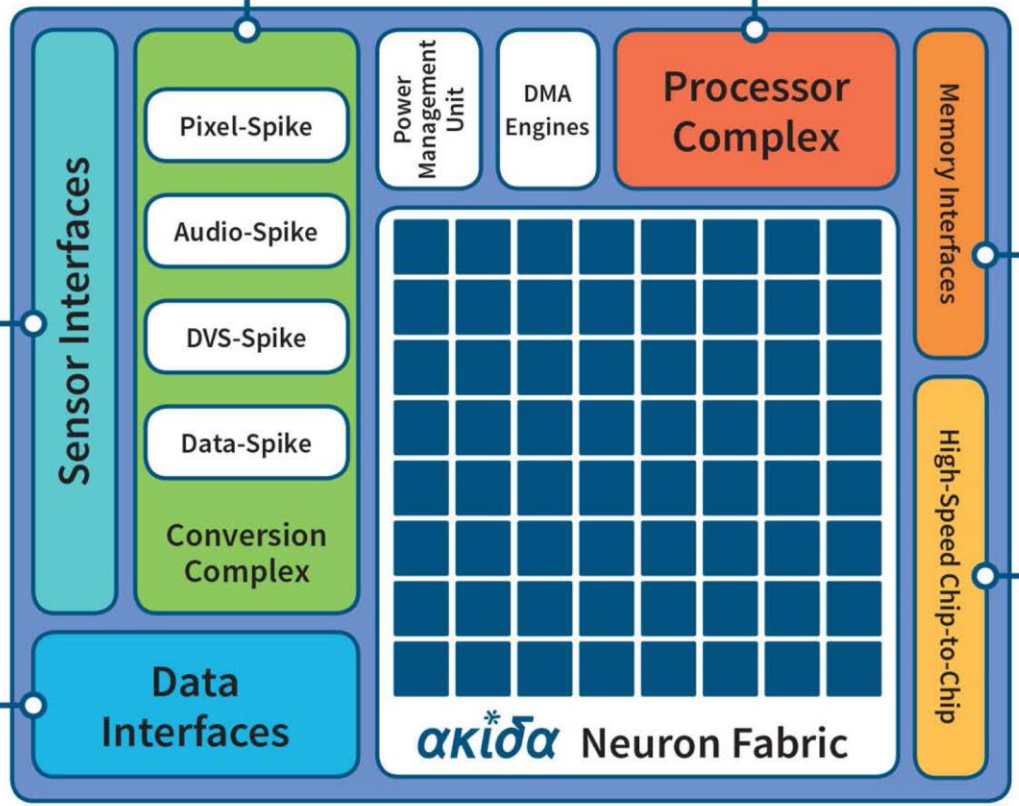
- Converts multiple data types to spikes
- Pixel for vision
- Audio for sound
- DVS for dynamic vision sensors
- Data for fintech and cybersecurity

Sensor I/F for Embedded Applications

- Pixel
- Audio
- DVS Sensor
- Analog
- Digital

Data Interface for Co-Processor Applications

- PCIe
- USB 3.0
- Ethernet
- CAN
- Uart



On-Chip Processor Complex

- System and data management
- Training/Inference control

Memory I/F

- Flash for boot and program/data
- LP/DDR4

Multi-Chip Expansion For Server Acceleration

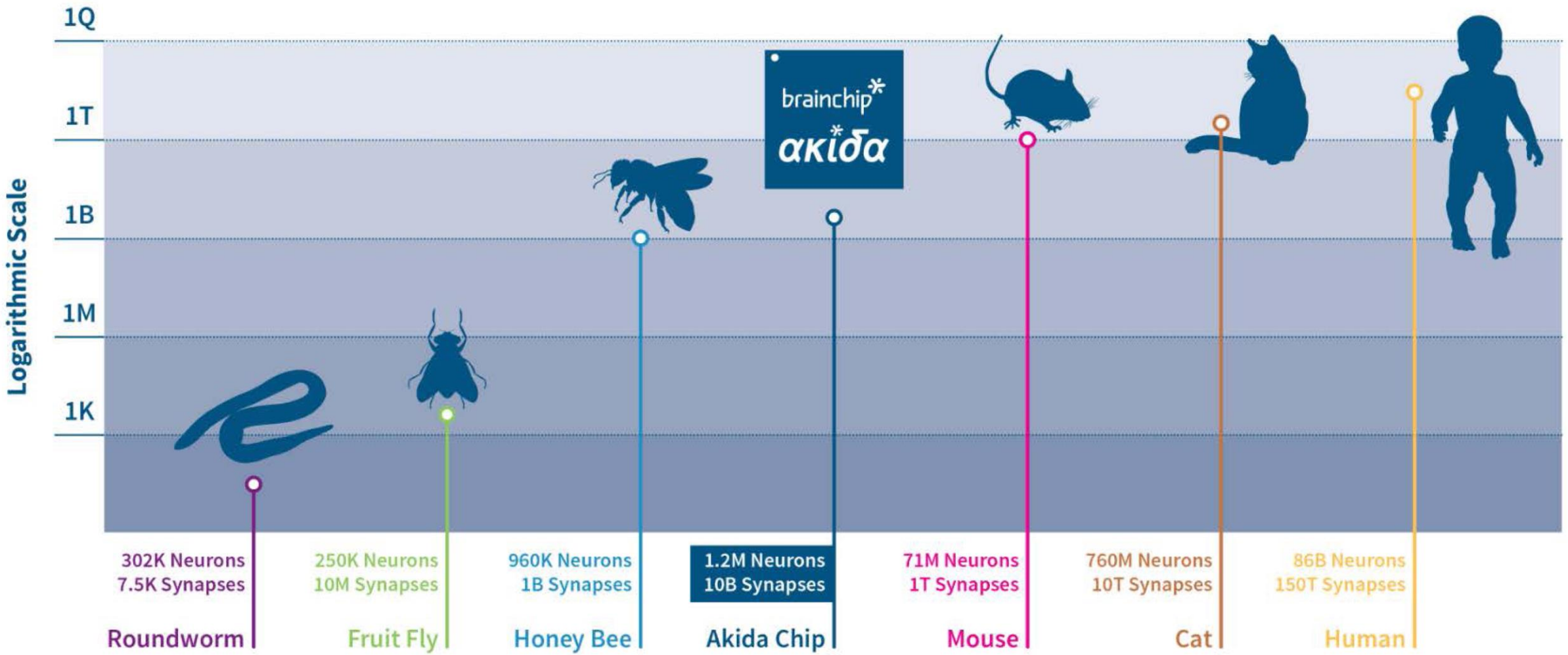
- High-Speed Serial Interface
- Expandable to 1024 devices

Akida Neuron Fabric

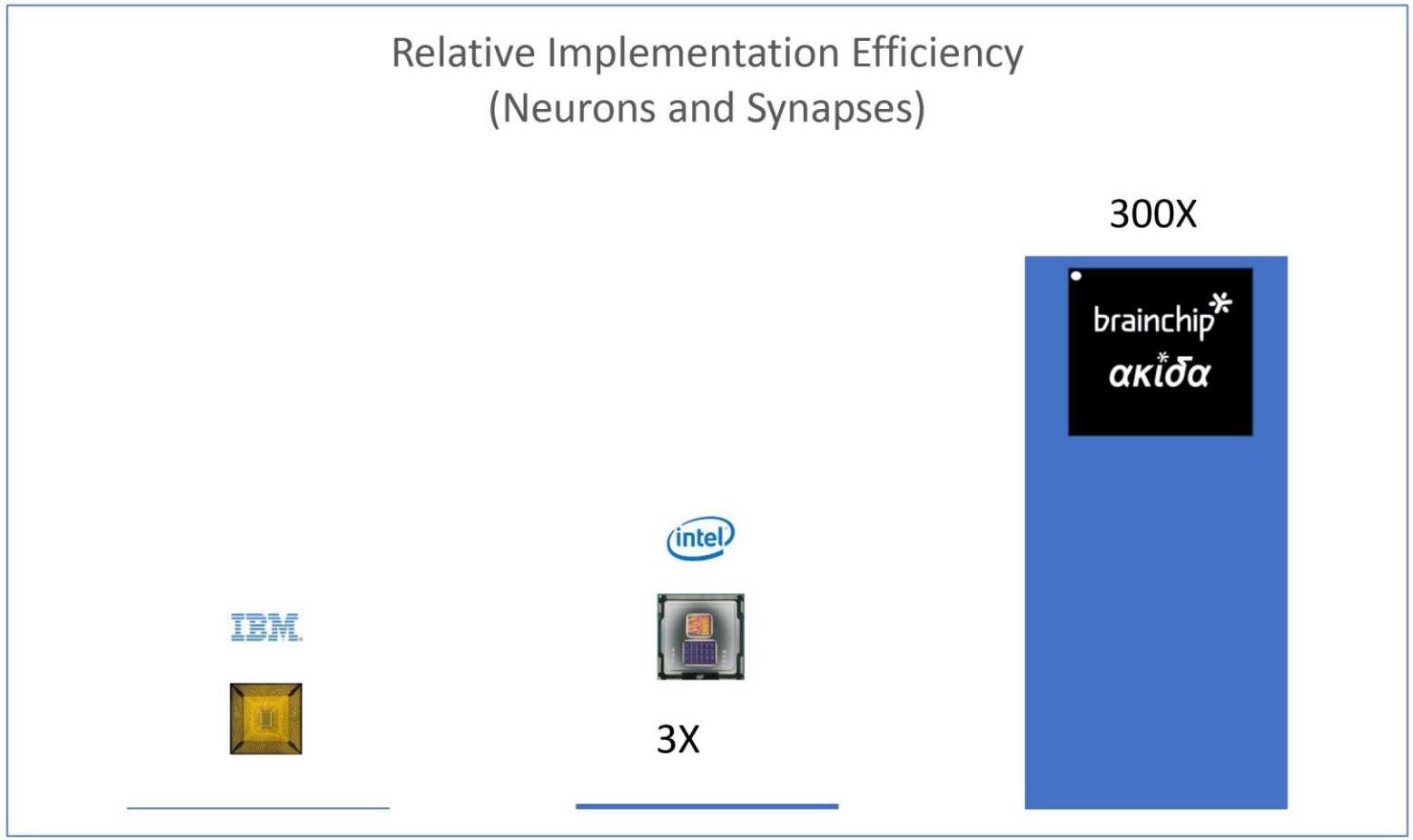
- Most efficient spiking neural network implementation
  - 1.2M Neurons
  - 10B Synapses
- Able to replicate most CNN functionality
  - Convolution
  - Pooling
  - Fully connected

- Right-Sized for embedded applications
- 10 classifiers (CIFAR 10)
  - 11 Layers
  - 517K Neurons
  - 616M Synapses
- Meets demanding performance criteria
  - 1,100 fps CIFAR-10
  - 82% accuracy

Neuron and Synapse Counts in the Animal Kingdom



The Most Efficient Neuromorphic Computing Fabric



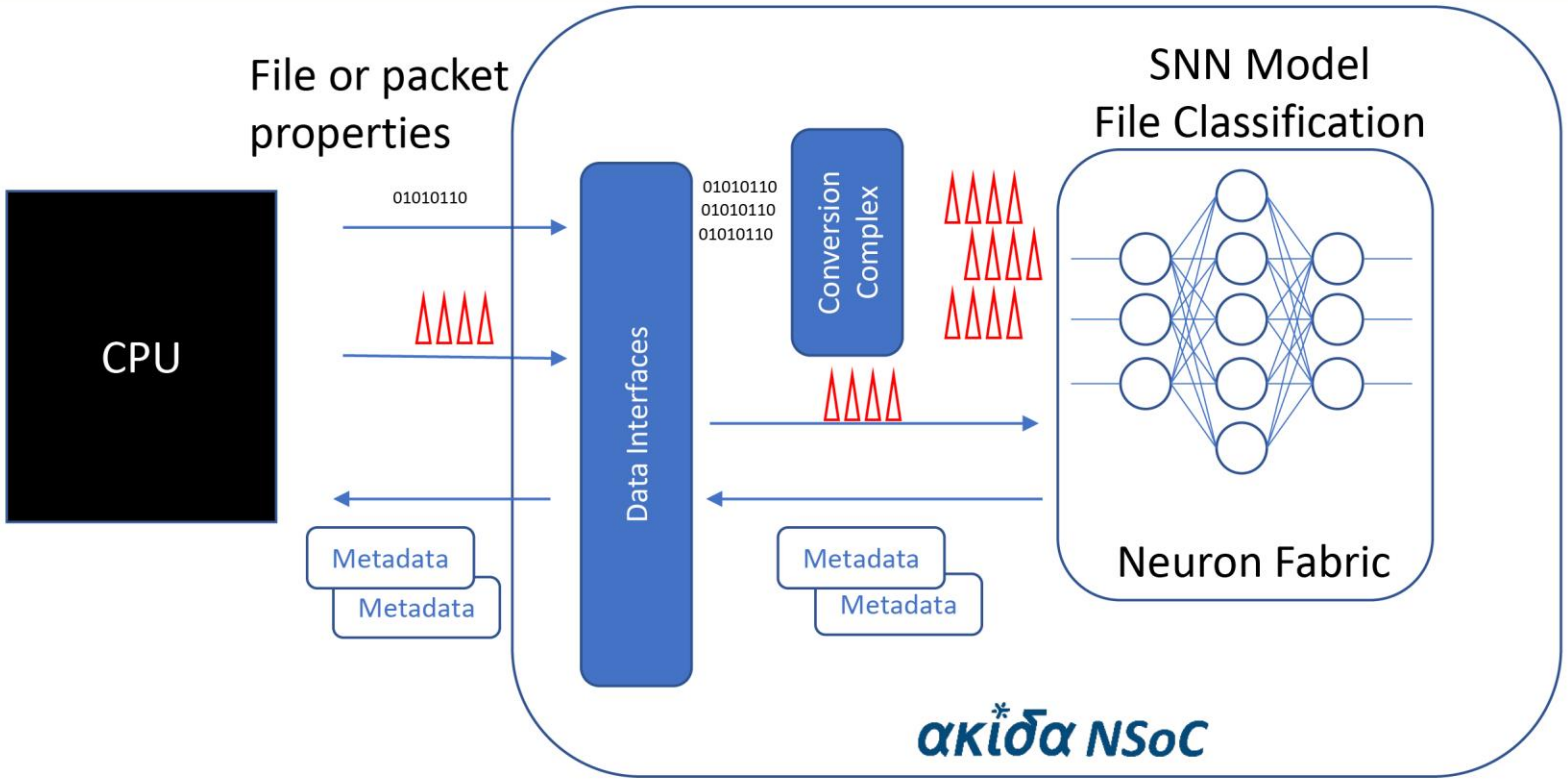
Keys to efficiency

- Fixed neuron model
  - Right-sized Synapses minimized on-chip RAM
    - 6MB compared to 30-50MB
  - Programmable training and firing thresholds
- Flexible neural processor cores
  - Highly optimized to perform convolutions
  - Also fully connected, pooling
- Efficient connectivity
  - Global spike bus connects all neural processors
  - Multi-chip expandable to 1.2 Billion neurons

Akida NSoC Applications

MARKET	Embedded vision	Cybersecurity	Financial Technology
	✲ Object classification ✲ ADAS/AV ✲ Surveillance ✲ Vision guided robotics	✲ Packet inspection ✲ File property classification ✲ Anomaly detection	✲ Trading pattern detection ✲ Price prediction
TRAINING METHOD	Supervised	Supervised	Unsupervised

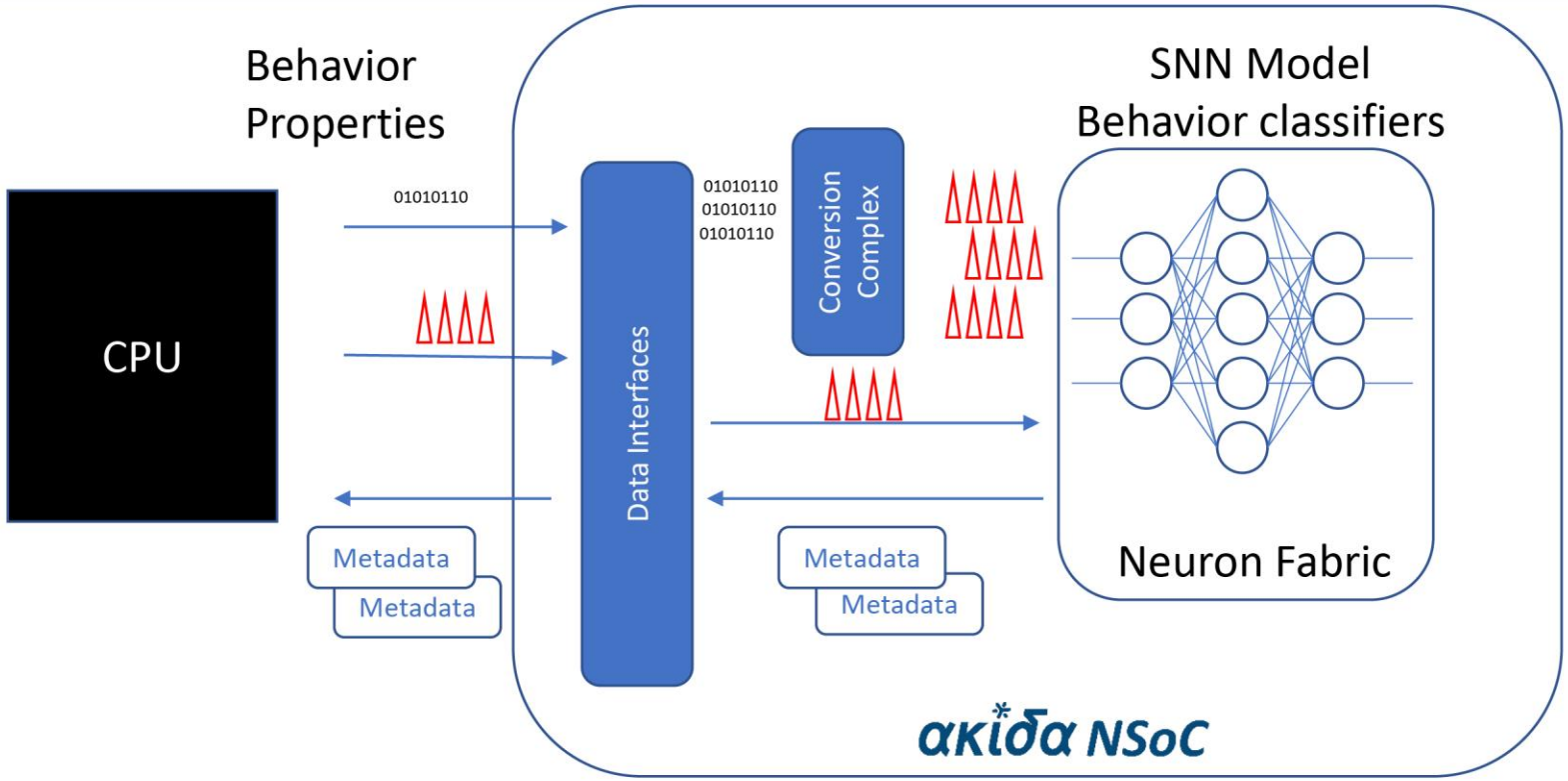
Cybersecurity Applications: Malware Detection



- Supervised learning for file classification based on file properties

File or packet properties – distinguishing parameters for files/network traffic, can be converted to spikes in SW on CPU or by Akida NSoC

Cybersecurity Applications: Anomaly Detection



- Supervised learning on known good behavior and anomalous behavior

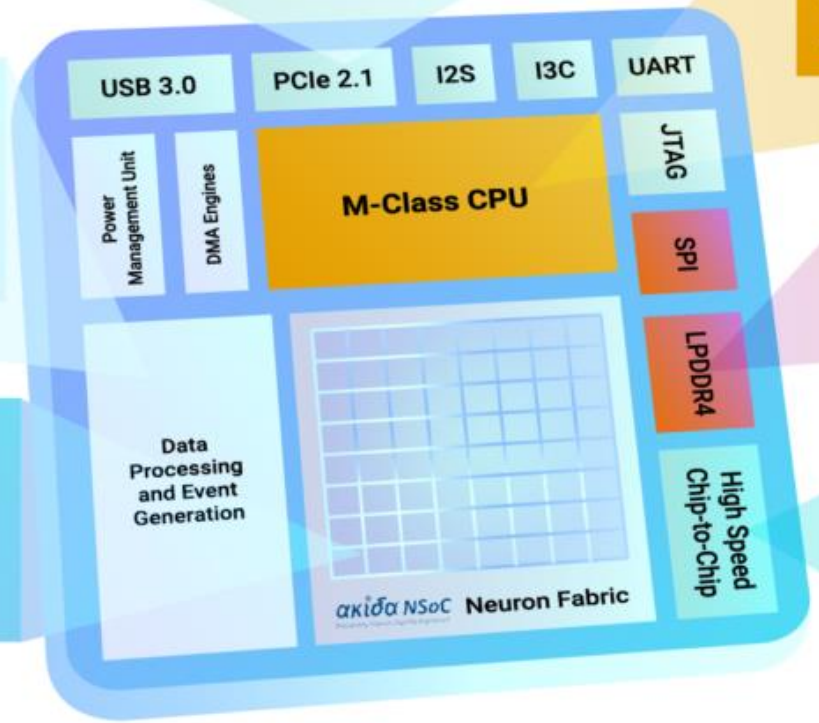
Behavior properties can be CPU loads for common applications, network packets, power consumption, fan speed, etc..

Features of Akida NSoC

Data input interfaces
- PCI-Express 2.1 x2 Lane Endpoint
- USB 3.0 Endpoint
- I3S, I2C, UART JTAG

On-Chip Processor
- M-Class CPU with FPU & DSP
- System Management
- Akida Configuration

Data Processing
- Pixel-Event Converter
- SW Data-Event Encoder
- Any multivariable digital data
- Sound, pressure, temp others

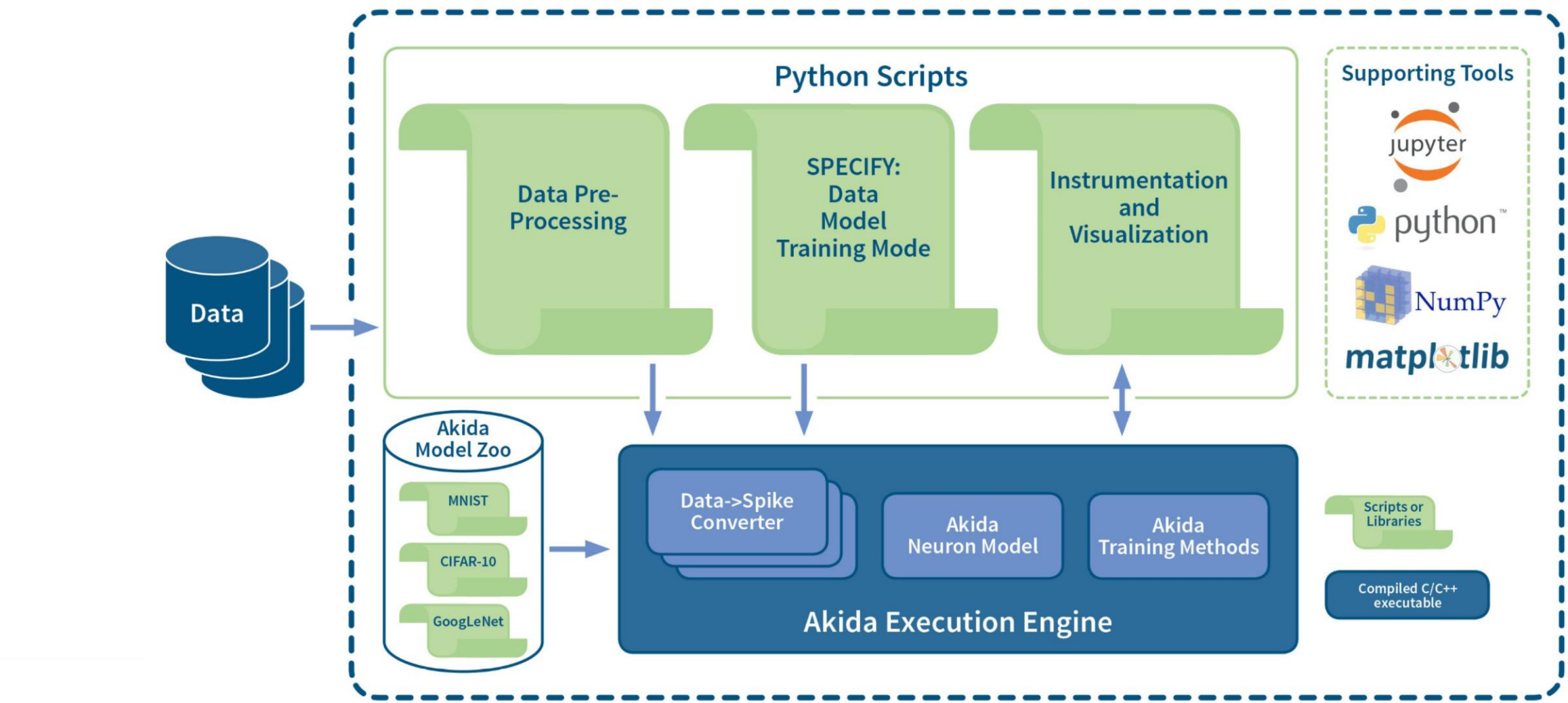


External Memory Interfaces
- SPI FLASH for boot/storage
- LPDDR4 Program/Weights

Flexible Akida Neuron Fabric
- Implements 80 NPUs
- All Digital logic with SRAM (8MB)
- Also Available as Licensed IP Core
- First Implementation: TSMC 28nm

Multi-Chip Expansion
- PCIe 2.1 2 lane root complex
- Connects up to 64 devices

Creating SNNs: The Akida Development Environment



AKIDA Training Methods

- Unsupervised learning from unlabeled data
  - Detection of unknown patterns in data
  - On-chip or off-chip
- Unsupervised learning with label classification
  - First layers learns unlabeled features, labeled in fully connected layer
  - On-chip or off-chip

akida NSoC

Biologically Inspired, Digitally Engineered

- World's first NSoC
  - Low power and footprint of neuromorphic computing
  - Highest performance /w/$
  - Estimated tape-out 1H2019, samples 2H2019
- Complete solution for embedded/edge applications – but scalable for cloud/server usage

brainchip

Electronic Product Design&Test
AVNET INTEGRATED
Embedded technology

News

BrainChip acquires licence to university's cybersecurity technology

04 OCTOBER 2018

Neuromorphic computing firm BrainChip Holdings have entered into a cybersecurity implementation agreement with Greece's Democritus University of Thrace (DUTH) – using the former's neuromorphic SoC for system acceleration.

The agreement consists of a licence to DUTH's cybersecurity technology and their researcher's support in porting the technology to the Akida Development Environment. Such cybersecurity technology includes data-to-spike convertors, and it is specifically designed for network intrusion and anomaly detection: this is through a spiking neural network (SNN) that can be accelerated by the Akida Neuromorphic system-on-chip (NSoC).

As Lazaros Iliadis, a professor of the DUTH's School of Engineering, is responsible for the program, commented: "We have been working with spiking neural networks for several years and our cybersecurity technology has proven highly accurate in detecting threats. The Akida NSoC is an ideal platform to accelerate our SNNs."

To quote Robert Beachler, BrainChip senior VP of Marketing and Business Development, moreover: "As the Akida NSoC design progresses, it is important that we have proven examples of SNN models and data to spike convertors for our target markets.

"According to MarketsandMarkets, the artificial intelligence cybersecurity market is estimated to be $35B by 2025 and this technology acquisition will jump-start our solutions in this lucrative application space."

Peter van der Made, BrainChip founder and CTO added: "Working with the exceptional team at the Democritus University of Thrace will serve to increase our expertise and knowledge in the area of cybersecurity – and widen the reach of our low-power and low-latency Akida NSoC device."

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Introduction to Vicor's AC Front End Module

Register

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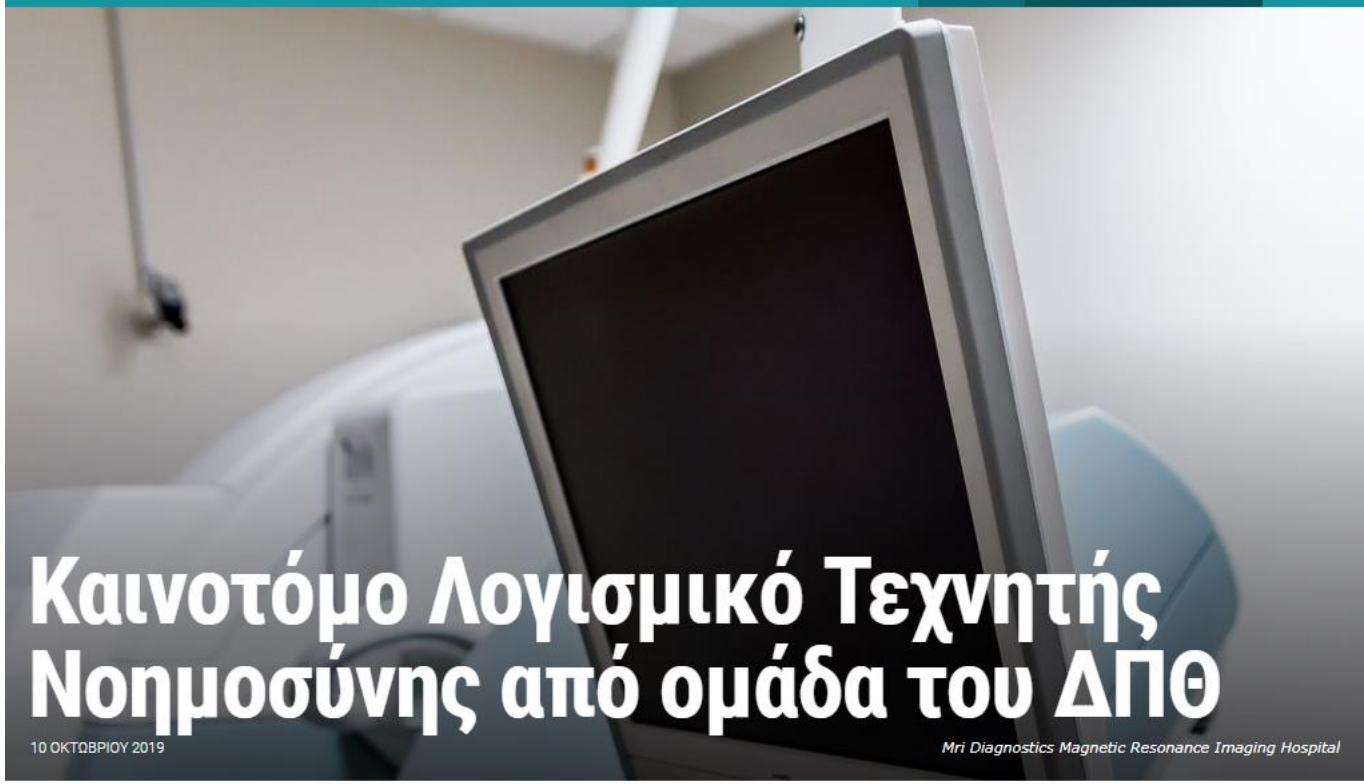


Καινοτόμο Λογισμικό Τεχνητής Νοημοσύνης από ομάδα του ΔΠΘ

10 ΟΚΤΩΒΡΙΟΥ 2019

Mri Diagnostics Magnetic Resonance Imaging Hospital

Καινοτόμο Λογισμικό Τεχνητής Νοημοσύνης με τεχνολογία Spiking Νευρωνικών Δικτύων, ανέπτυξε η ερευνητική ομάδα του Εργαστηρίου Μαθηματικών και Πληροφορικής του Τμήματος Πολιτικών Μηχανικών του Δ.Π.Θ., αποτελούμενη από τον Καθηγητή κ. Λάζαρο Ηλιάδη και τον Μεταδιδακτορικό Ερευνητή Δρ. Κωνσταντίνο Δεμερτζή.

Το λογισμικό ανιχνεύει μεγάλο αριθμό Κυβερνοεπιθέσεων, σε χρόνο που τείνει στο μηδέν. Με βάση το εν λόγω Λογισμικό, αναπτύχθηκε στις Η.Π.Α. από την εταιρεία Hardware Brainchip, το Νευρομορφικό Ολοκληρωμένο Κύκλωμα – NSoC (Neuromorphic System-on-Chip) με την Ελληνική επωνυμία

brainchip

BrainChip Holdings Limited
2,615 followers
1d •

ICYMI - NASA, in collaboration with Brainchip Inc and Vorago, uses Akida to control space flight. For example, it tries to detect and deal with possible problems in space flight https://lnkd.in/g3DJpCR #neuromorphic #nasa #ai #edge #cybersecurity

Greek cybersecurity software in space flight control ATHENS 9,84

athina984.gr • 3 min read

63 • 7 Comments

Thank you for... | I wonder... | I think... | Thanks for posting...

Like | Comment | Share | Send

αkίδα NSoC

Biologically Inspired, Digitally Engineered

Νέα | Ελλάδα | Πολιτική | Οικονομία | Κόσμος | Ομάδα | Γνώμες | Περισσότερα

TA NEA

> Επιστήμη & Τεχνολογία

Ευφυές λογισμικό

Τι είναι το τσιπ Akida που αγόρασε η NASA από το Πανεπιστήμιο Θράκης

Ως ασπίδα προστασίας από κάθε είδους παρέκκλιση από τη φυσιολογική λειτουργία και γενικότερα ως σύστημα ελέγχου διαστημικών πτήσεων της NASA, χρησιμοποιείται πλέον, πειραματικά, το νευρομορφικό ολοκληρωμένο κύκλωμα Neuromorphic System on Chip (nsoc) Akida που δημιουργήθηκε και με το ευφυές λογισμικό που ανέπτυξε ερευνητική ομάδα του Δημοκρίτειου Πανεπιστημίου Θράκης».

Τελευταία Νέα

5 λεπτά
Κορονοϊός : Αυξημένη η κίνηση στους δρόμους παρά το lockdown

14 λεπτά
Live : Ολυμπιακός – Άλμπα Βερολίνου

33 λεπτά
Εκλογές ΗΠΑ : Οι Δημοκρατικοί του Κογκρέσου ξεκαθαρίζουν

38 λεπτά
Δημοσκόπηση : Τι λένε οι πολίτες για τα νέα μέτρα – Η διαφορά ανάμεσα σε ΝΔ και ΣΥΡΙΖΑ

45 λεπτά
Κορονοϊός : Η Βρετανία βάζει σε καραντίνα όσους ταξιδέψουν από την Ελλάδα

57 λεπτά
Η Γιάννα Αγγελοπούλου – Δασκαλάκη στο MEGA για τις δράσεις της Επιτροπής «Ελλάδα 2021»

1 ώρα

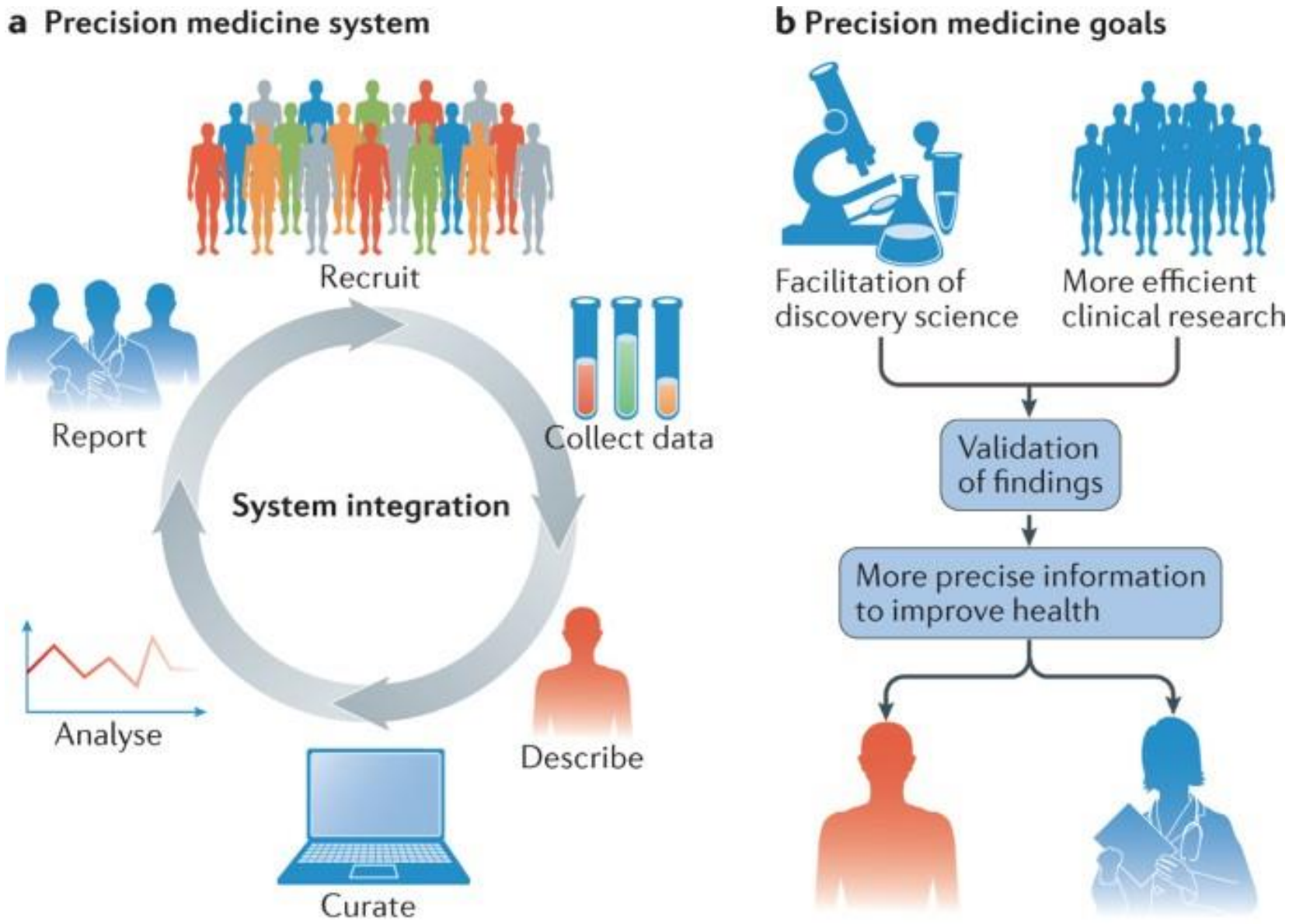
#prospects

prospects…School of Civil Engineering

Η μεταδιδακτορική έρευνα αποτελεί για το Τμήμα, **πηγή συλλογικής αριστείας**, **επιστημονικής συνεργασίας υψηλού επιπέδου και διεθνούς διάκρισης**. Με αυτούς τους τρόπους, **συμβάλλει στην ποσοτική και ποιοτική αναβάθμιση της ερευνητικής δραστηριότητας** και στη **μεταφορά τεχνογνωσίας σε νέα και δυναμικά ερευνητικά πεδία προς όφελος της κοινωνίας και της εθνικής οικονομίας**.

1. Ενίσχυση της γνωστικής περιοχής της ασφάλειας κρίσιμων υποδομών
2. Ενίσχυση της γνωστικής περιοχής της ψηφιακής ασφάλειας
3. **Συνεργασία με το University of León** (Erasmus, επίβλεψη διατριβών, ερευνητικές συνεργασίες, κτλ)
4. Περαιτέρω συνεργασίες με αντίστοιχα πανεπιστημιακά ιδρύματα ή ερευνητικούς φορείς
5. **ΜΠΣ στην ανάλυση δεδομένων** μεγάλης κλίμακας με μεθόδους τεχνητής νοημοσύνης στο γνωστικό αντικείμενο του Πολιτικού Μηχανικού
6. **Akiδa** στο Τμήμα Πολιτικών Μηχανικών

#in progress


a Precision medicine system
Recruit
Collect data
Describe
Curate
Analyse
Report
System integration
b Precision medicine goals
Facilitation of discovery science
More efficient clinical research
Validation of findings
More precise information to improve health
Nature Reviews | Cardiology


Pfizer
COVID - 19
Coronavirus Vaccine
Injection only


European Commission
Horizon Europe
THE NEXT EU RESEARCH & INNOVATION PROGRAMME (2021–2027)

#whole-heartedness

respect…

Lazaros Iliadis
Professor of Applied Informatics, Democritus University of Thrace, School of Engineering, Department of Civil Engineering, Faculty of Mathematics, Programming and general courses, Lab of Mathematics and Informatics (ISCE)

thank you

Complete List of my Publications

Journals

1. Bougoudis, I., **K. Demertzis,** and L. Iliadis. **Fast and low cost prediction of extreme air pollution values with hybrid unsupervised learning**. Integrated Computer-Aided Engineering 23, no. 2 (2016): 115–27. https://doi.org/10/f8dt4t doi:10.3233/ICA-150505. **(Impact Factor 4.904)**
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