Design and Development of the Platform for Network Traffic Statistics and Analysis

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IHEP

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Outline

1. Motivation
2. Platform design
3. Function modules
4. Future Plan
5. Summary

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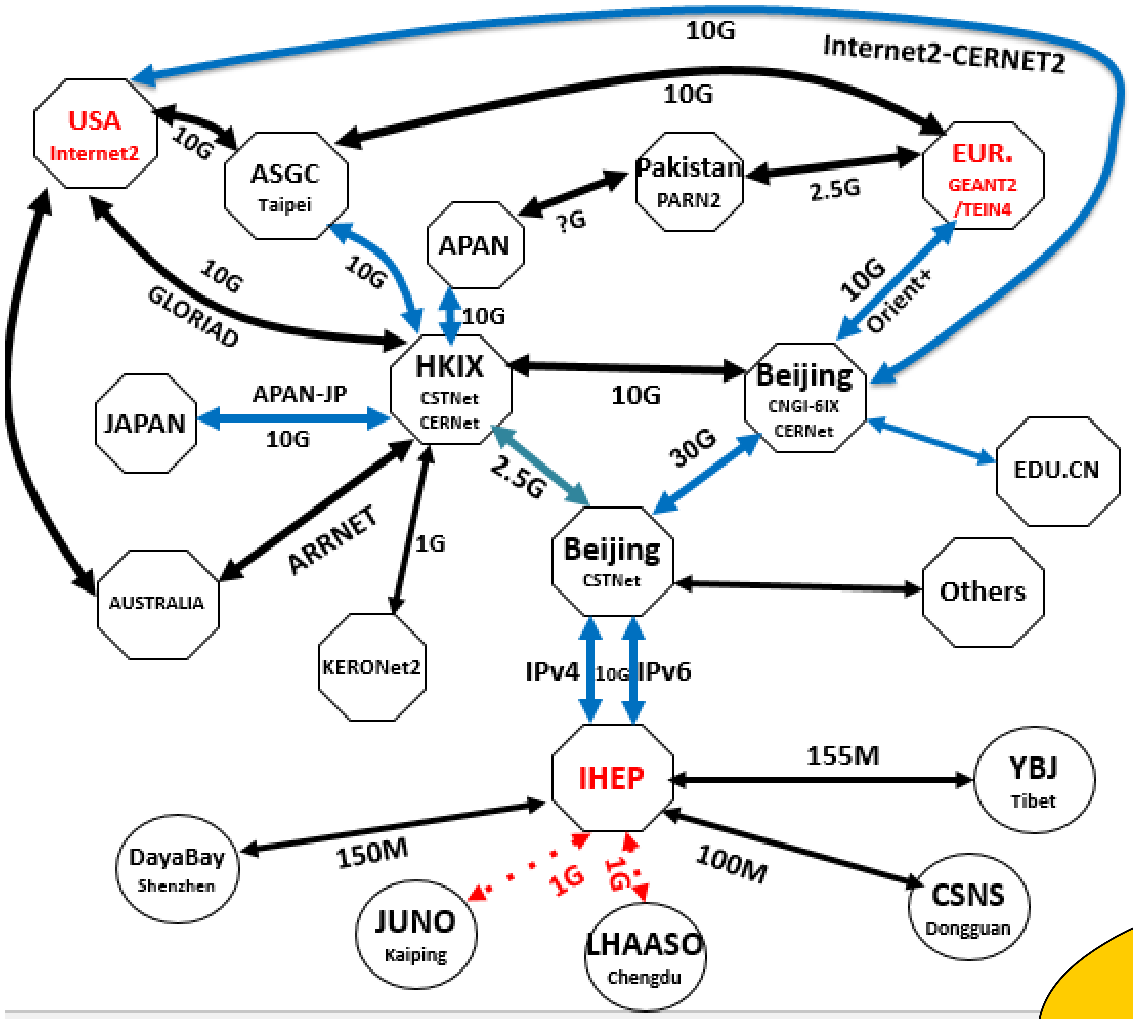
IHEP WAN Topology

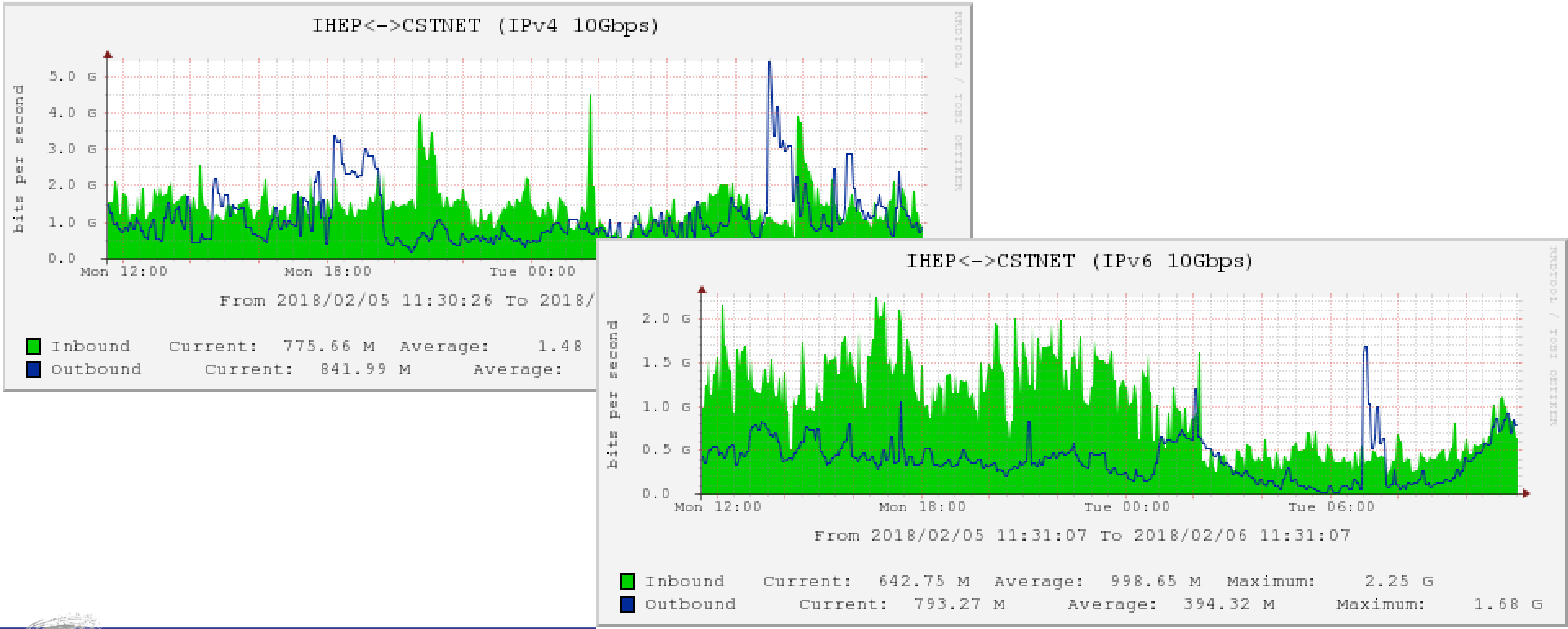


- **IHEP- USA**
  - IHEP-CSTNet-CERNet-USA
  - 10Gbps
- **IHEP- EUR**
  - IHEP-CSTNet-CERNet-London-EUR
  - 10Gbps
- **IHEP- Asia**
  - IHEP-CSTNet-HKIX-Asia
  - 2.5Gbps
- **IHEP- Domestic Univ**
  - IHEP-CSTNet-CERNet-Univ
  - 10Gbps

Bandwidth utilization of the links between IHEP and USA/EUR/ASIA?

Motivation--IHEP Traffic Status

- IPv4 average traffic: 2.5Gbps(in+out), Max. 7Gbps
- IPv6 average traffic: 1Gbps(in+out), Max. 1.5Gbps
- Data exchange: over 7PB/year



Motivation

- Know clearly for: Who, When, What, Where, Why in the network traffic

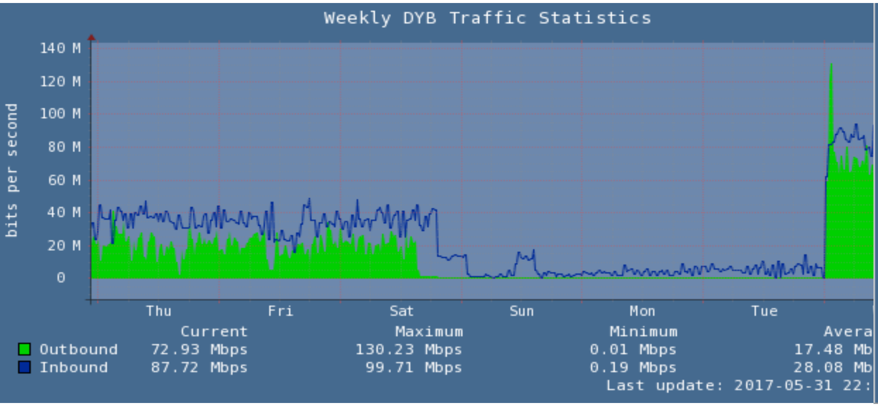
WHY
WHO
5W
WHAT
WHAT
WHERE

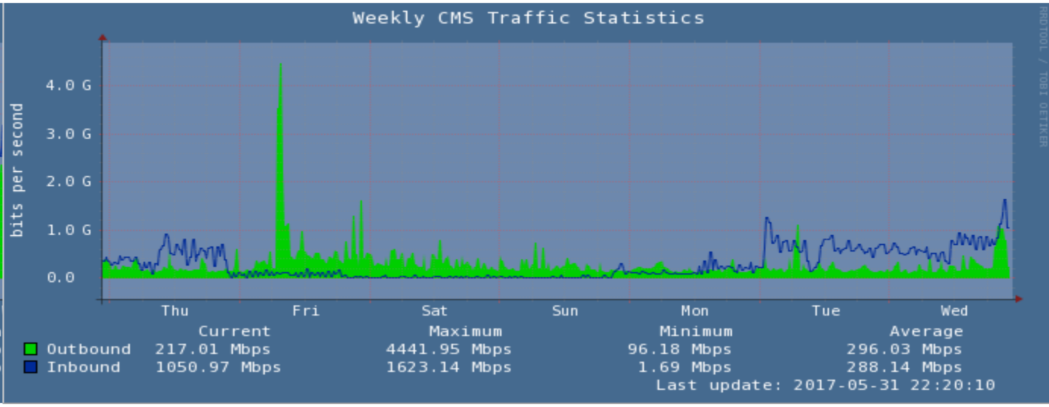
- Network optimization--Reliability/Performance/Efficiency
- Historical trends for strategic planning
- Network security analysis
- ....

Who: IP addresses / Users
When: on which time
What: protocols, ports, data traffic, applications, etc.
Where: flow direction, which countries/regions (max.volume)
Why: malicious attacks or normal data transfer

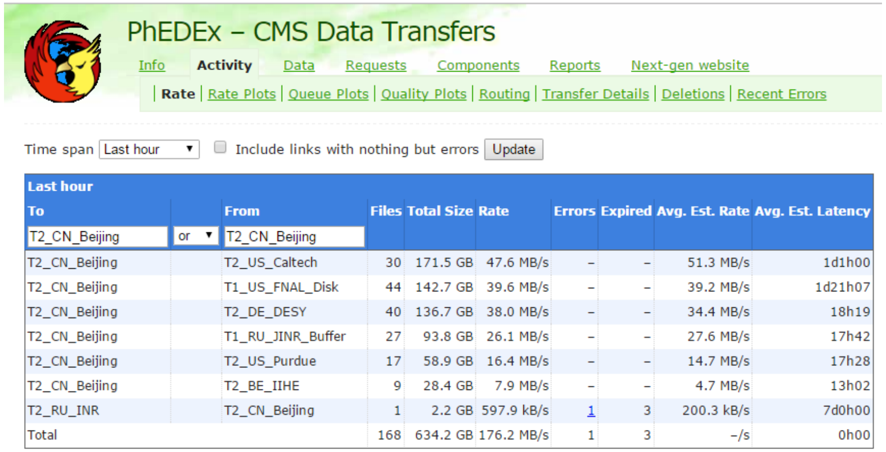
Motivation--IHEP traffic statistics status

- Traffic statistics based on IP address range： Daya Bay、CMS、ATLAS





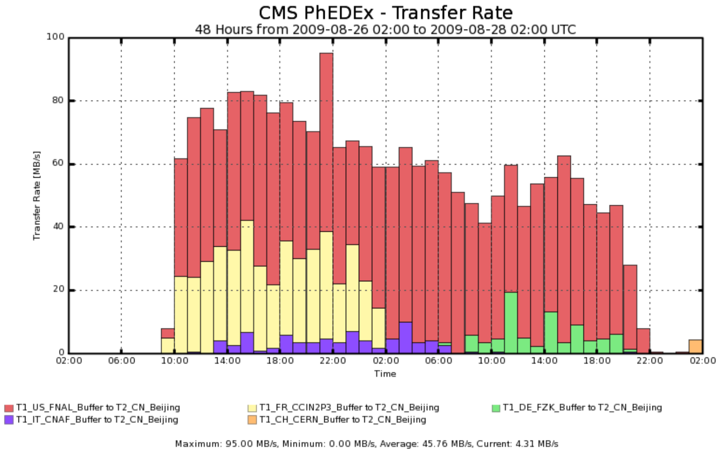
- Traffic statistics based on experimental data transfer system： PhEDEx



Time span Last hour ▾ □ Include links with nothing but errors

Last hour

To		From	Files	Total Size	Rate	Errors	Expired	Avg. Est. Rate	Avg. Est. Latency
T2_CN_Beijing	or ▾	T2_CN_Beijing							
T2_CN_Beijing		T2_US_Caltech	30	171.5 GB	47.6 MB/s	–	–	51.3 MB/s	1d1h00
T2_CN_Beijing		T1_US_FNAL_Disk	44	142.7 GB	39.6 MB/s	–	–	39.2 MB/s	1d21h07
T2_CN_Beijing		T2_DE_DESY	40	136.7 GB	38.0 MB/s	–	–	34.4 MB/s	18h19
T2_CN_Beijing		T1_RU_JINR_Buffer	27	93.8 GB	26.1 MB/s	–	–	27.6 MB/s	17h42
T2_CN_Beijing		T2_US_Purdue	17	58.9 GB	16.4 MB/s	–	–	14.7 MB/s	17h28
T2_CN_Beijing		T2_BE_IIHE	9	28.4 GB	7.9 MB/s	–	–	4.7 MB/s	13h02
T2_RU_INR		T2_CN_Beijing	1	2.2 GB	597.9 kB/s	1	3	200.3 kB/s	7d0h00
Total			168	634.2 GB	176.2 MB/s	1	3	–/s	0h00



Lack of overall fine-grained network traffic statistics and analysis

Lack of user behavior analysis and intrusion detection in cyber security

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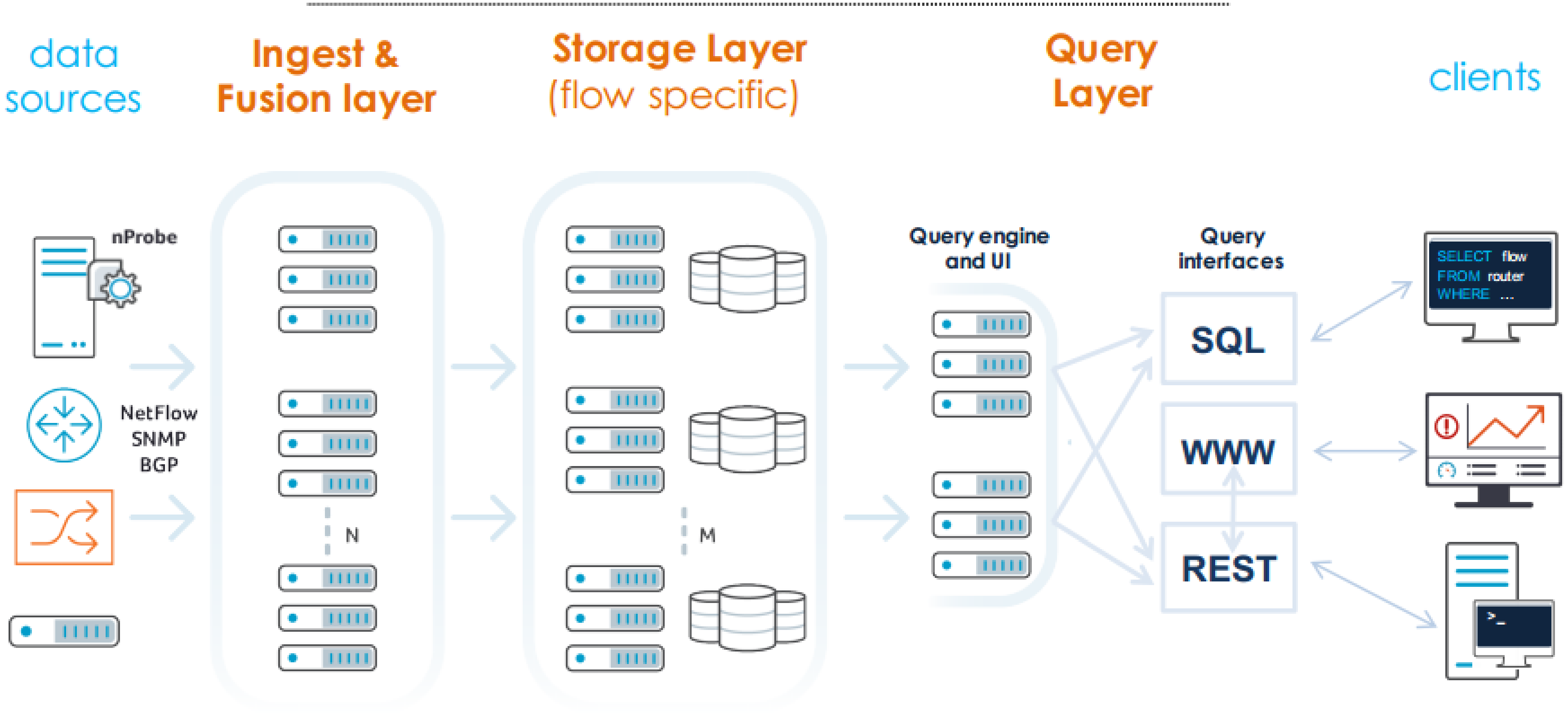
General design principles

- Traffic of high-speed network can be captured without missing： 10Gbps
- Traffic flow records should include the following elements: 5-Tuple(src_ip, src_port, dst_ip, dst_port, protocal)
- Large amount of historical data can be stored and queried efficiently: at least 1 year raw data
- Data analysis module should be extensible (add or remove analysis plugins)
- Flexible and friendly user interface

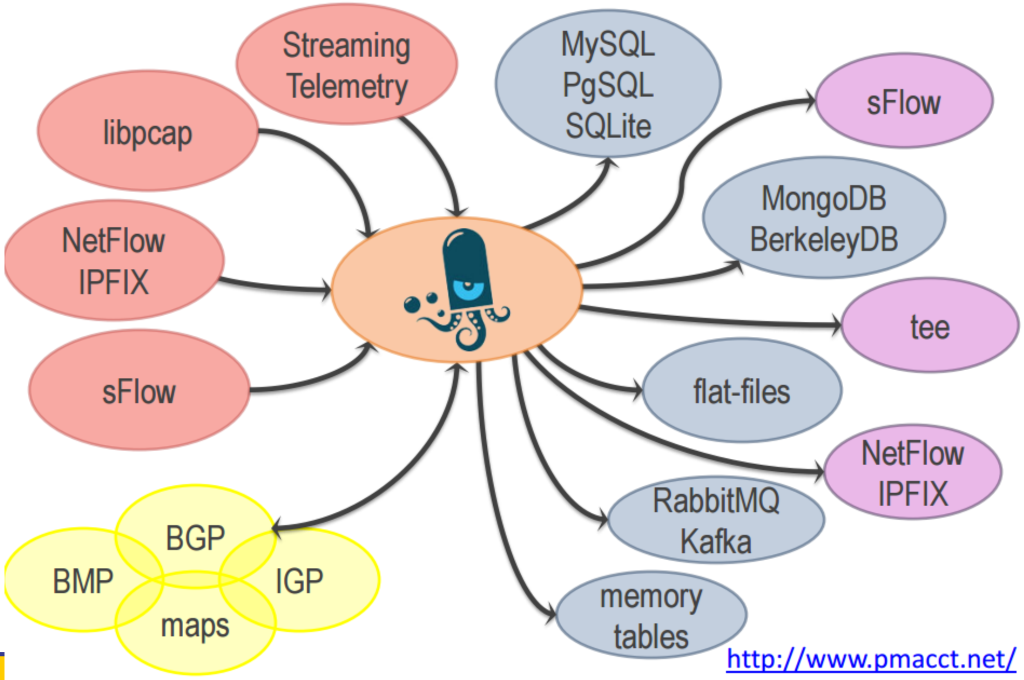
Architecture

- Data Sources + Data preprocessing (ingest & fusion) + Storage + Data Query + Graphic Display
- Principle: loose coupling between layers--extensible



Key tool— pmacct

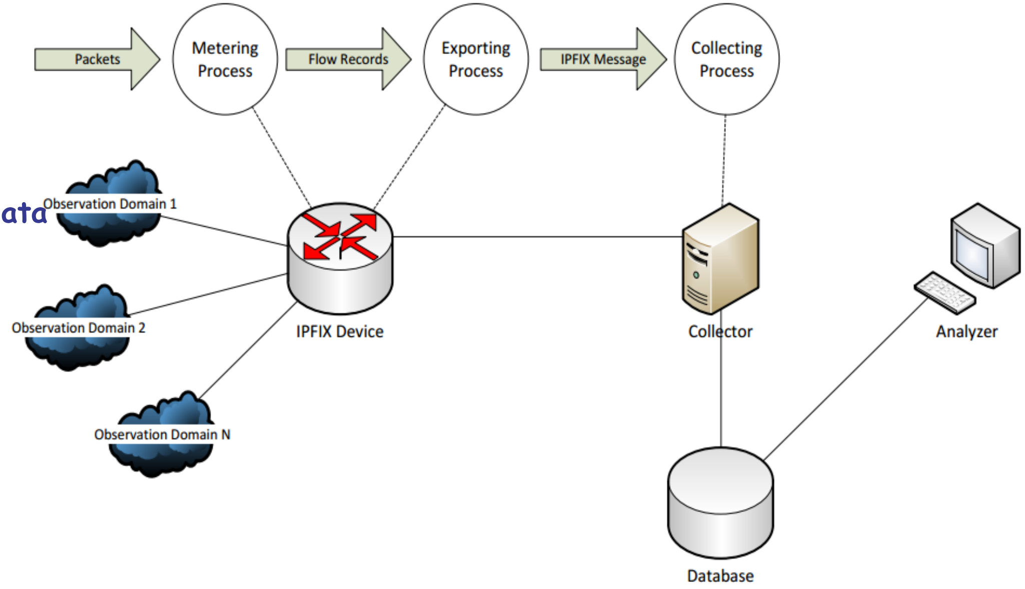
- Open source software
- A small set of multi-purpose passive network monitoring tools which can account, classify, aggregate, replicate and export forwarding-plane data, ie. IPv4 and IPv6 traffic;
- Collect data through: libpcap, Netlink/NFLOG, NetFlow v1/v5/v7/v8/v9, sFlow v2/v4/v5 and IPFIX
- Save data to backends including: Relational Databases, NoSQL databases, RabbitMQ, Kafka, memory tables, flat files

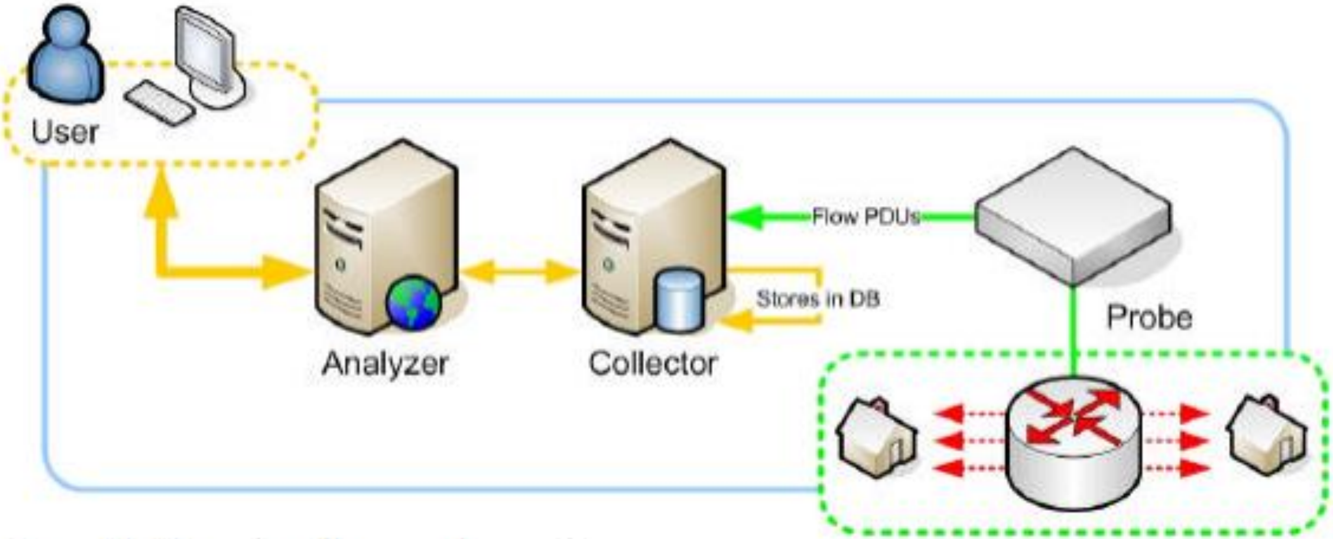


http://www.pmacct.net/

pmacct workflow

- **Workflow:**
  - » Receives sFlow/netflow/IPFIX data from devices
  - » Network flow aggregate
    - » Reduces data diversity
    - » Precompiles statistics -> reduces amount of data
    - » Looks like RRD (round robin database)
  - » Resolution of statistics
    - » sFlow 15 seconds
    - » IPFIX 5 minutes
  - » Output with tab-spaced/CSV/Avro/JSON format





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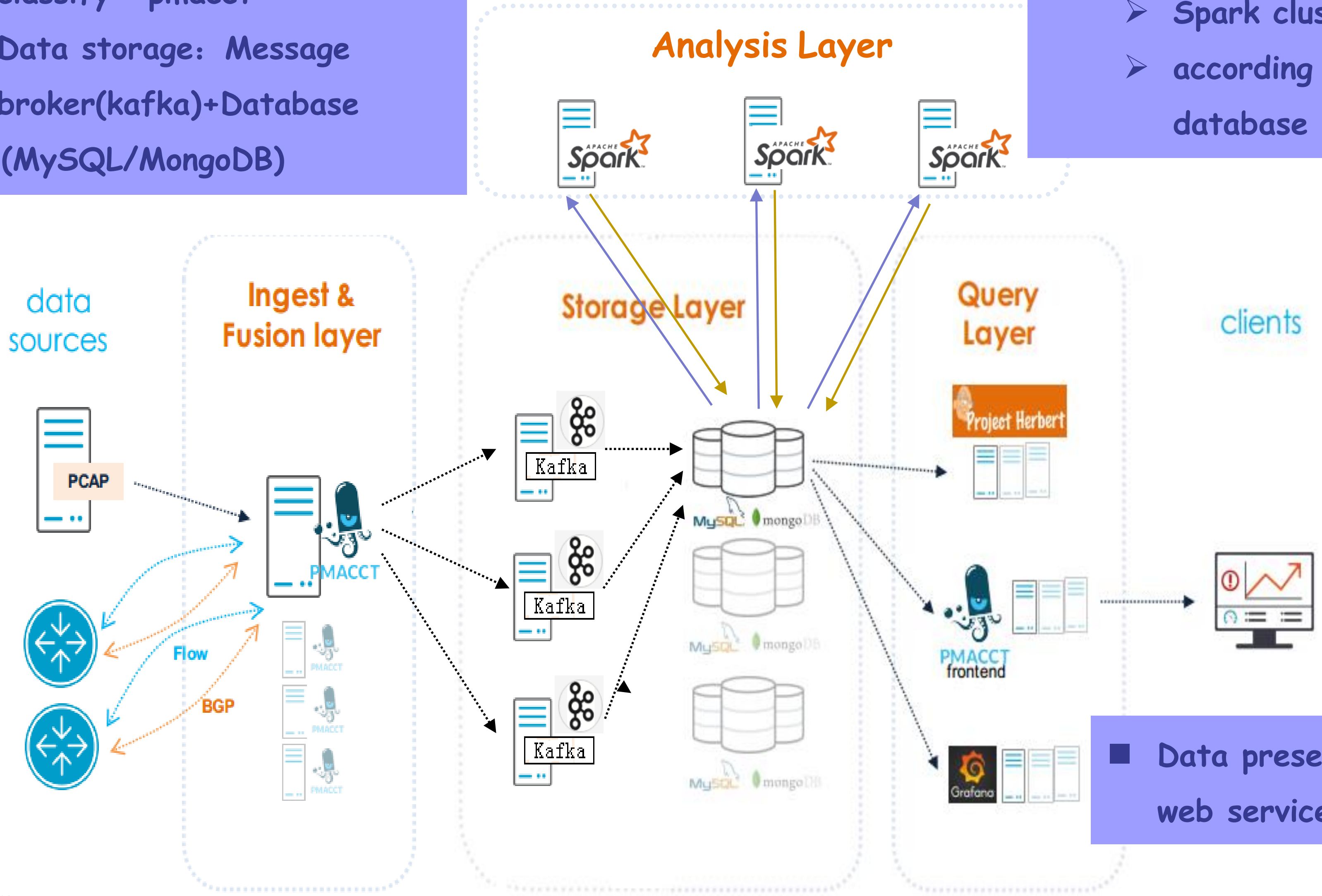
Realization: Function modules

- Data acquisition: aggregate, classify--pmacct
- Data storage: Message broker(kafka)+Database (MySQL/MongoDB)

- Data analysis:
  - ➢ Spark cluster
  - ➢ according to GeoIP database



- Data presentation: web service + Echarts

Data Acquisition--pmacct

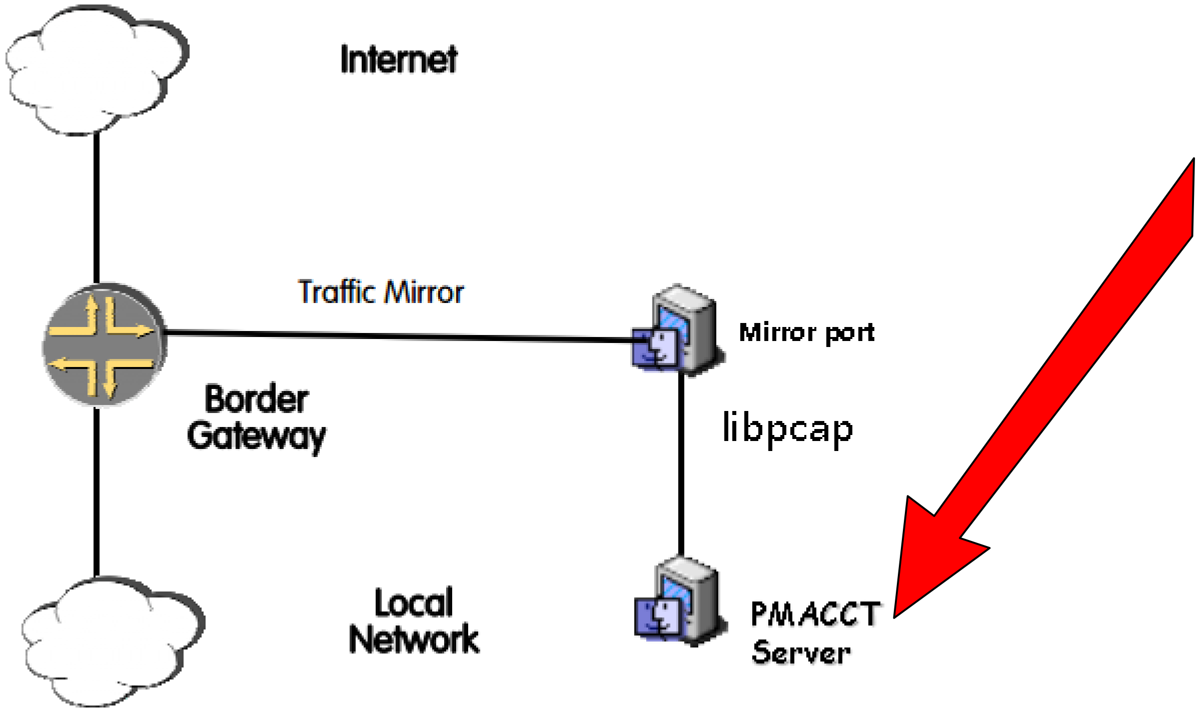
- Data source：

  collected from border router of IHEP

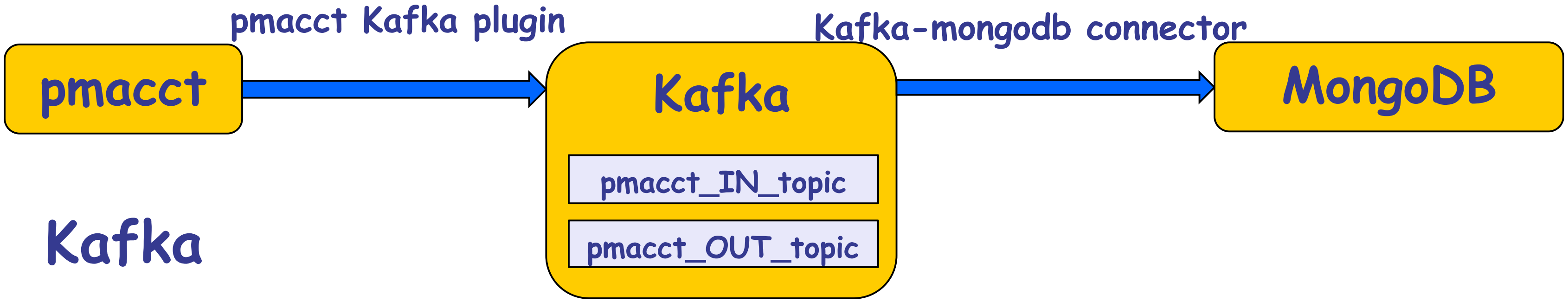
- Key points:
  - PMACCT server collects data through libpcap (according to the network device)
  - Mirror port: avoids the impact on the performance of network devices

Data preprocessing

- purpose：improving the efficiency of data storage and data reading
- PMACCT configuration：aggregation, filtering, classification
- aggregation：5mins
- rules：src_ip, dst_ip, src_port, dst_port, proto
- filtering：pcap_filter（collect IN/OUT source data）



Data storage: Kafka + MongoDB

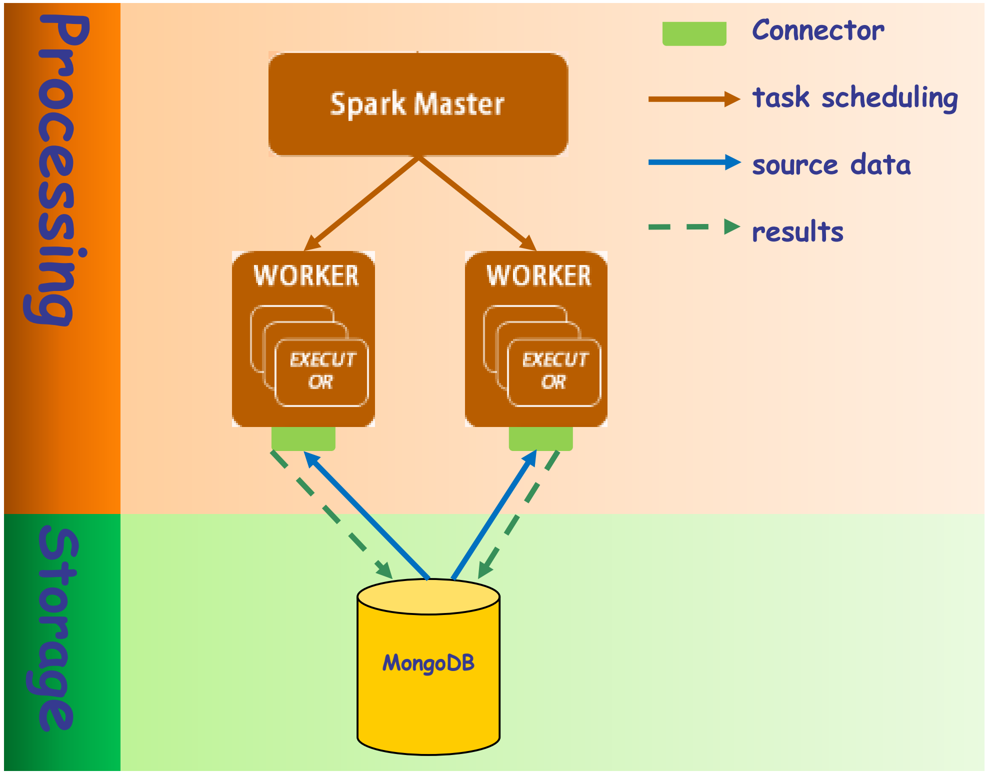


- **Kafka**
  - fast, scalable, durable and distributed
  - for big data: Millions of records within 5 minutes(IN+OUT)
  - The data within 1 week are preserved
- **MongoDB**
  - Distributed and document-oriented database(15G/month)
  - With high insert and query performance, the average insert speed is up to 7000 records/s
  - Source data are saved as:

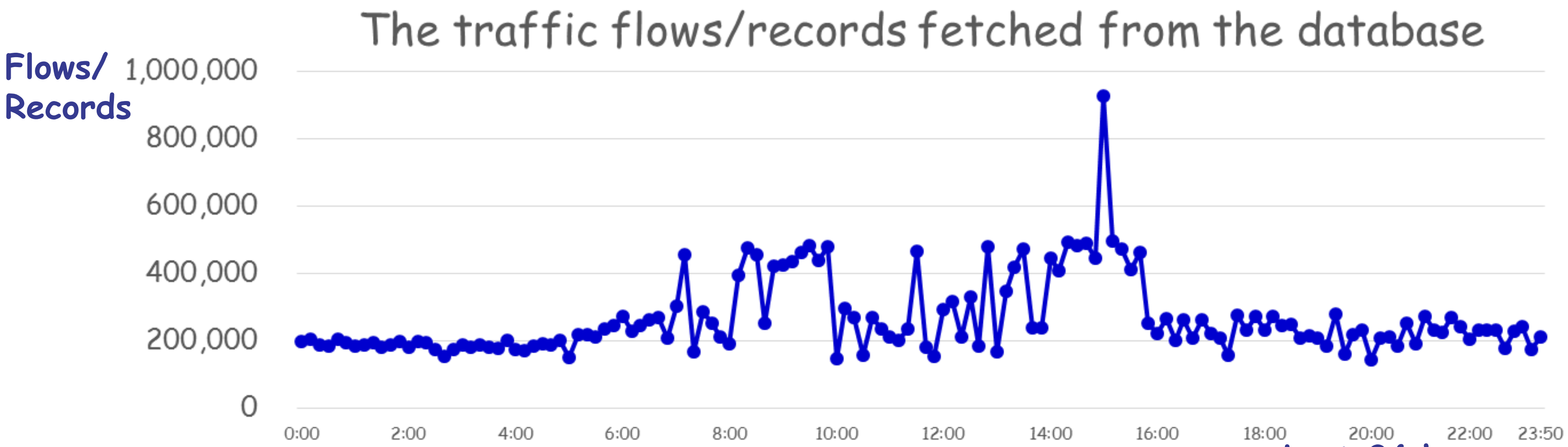
ip_src	ip_dst	src_port	dst_port	ip_proto	packets	bytes	stamp_ inserted	stamp_ updated

Data analysis

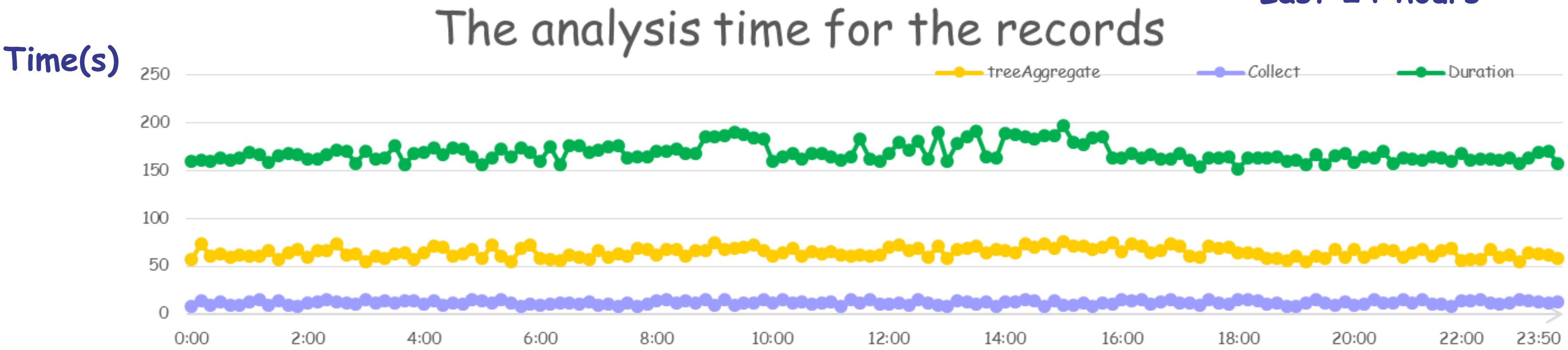
- Open-source & cluster-computing framework: Spark cluster.
- Task: timed cron jobs are set to calculate IN/OUT cumulative traffic between IHEP and domestic/international IP addresses within 10mins, 1hour, 1day separately.
- GeoLite2 database is used to classify the regional information of the traffic.



Data analysis—processing efficiency



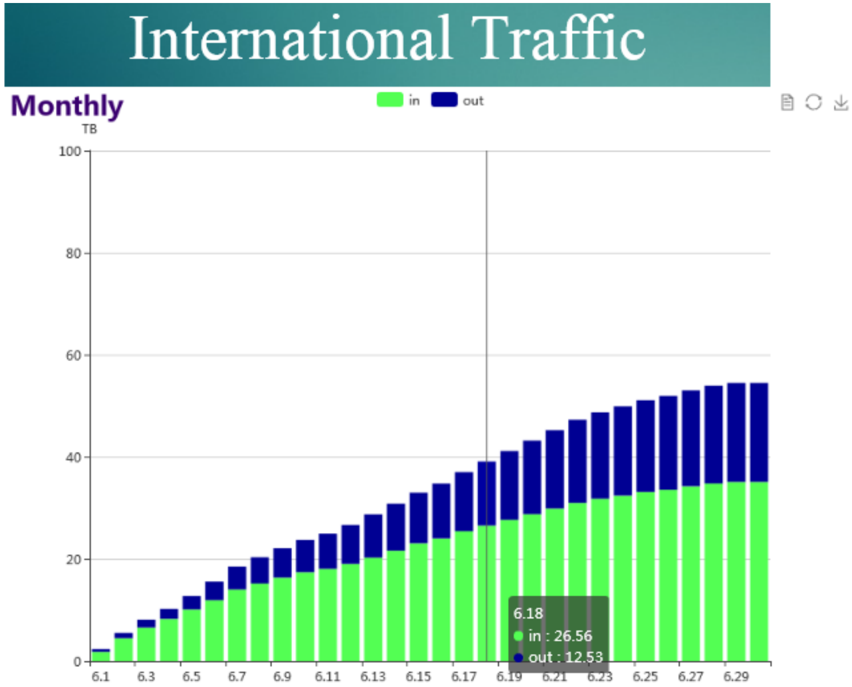
Last 24 hours



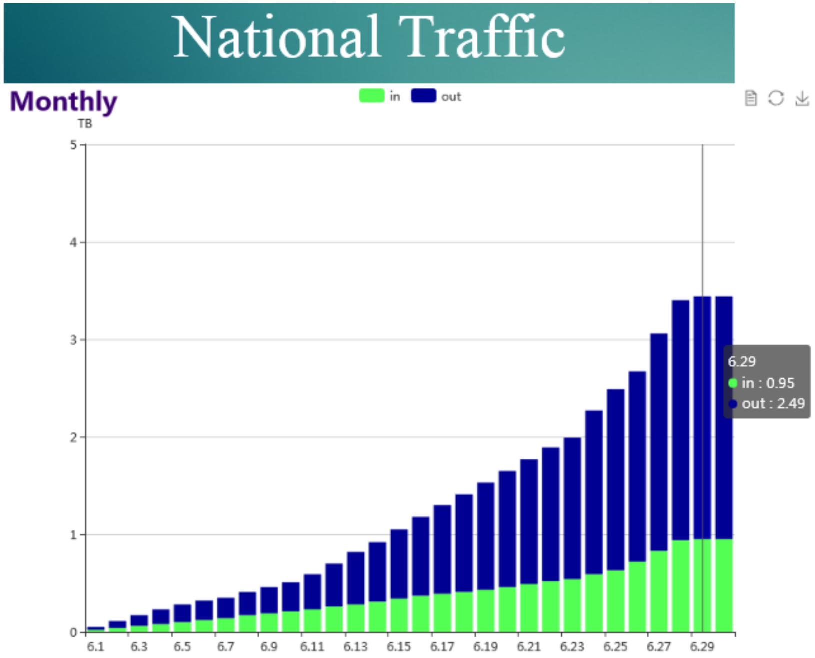
Last 24 hours

- The amount of data records every 10 mins (IN): 200,000 – 900,000
- Processing time is stable: less than 200 seconds
- Computing source can be increased for larger volumes of data

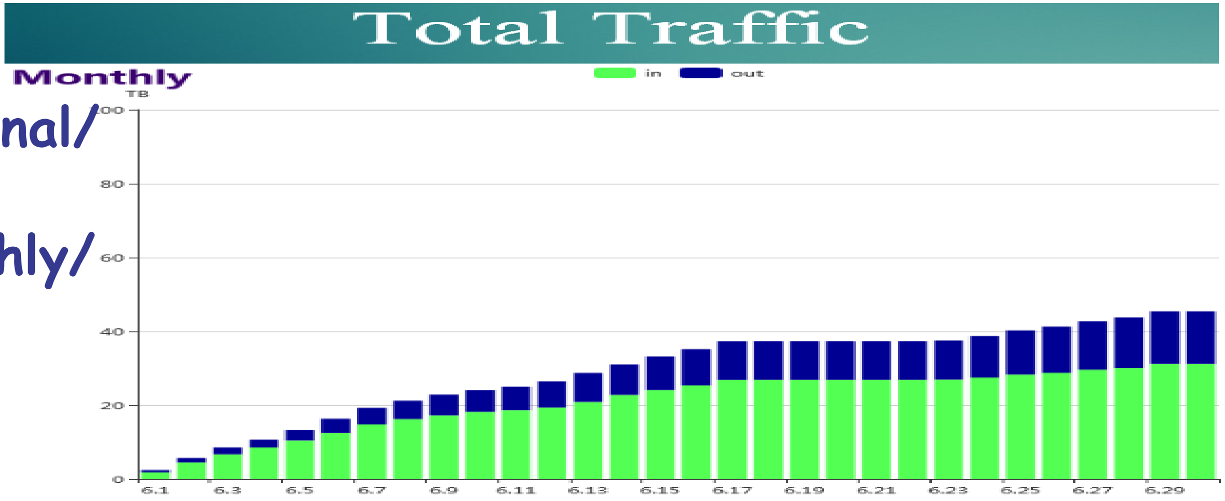
Data Presentation



International Traffic



National Traffic



Total Traffic

1. International/National/ Total traffic
2. Daily/Weekly/Monthly/ Yearly

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Future Plan

- Data Analysis
  - Rule-based network intrusion detection module will be added to identify the malicious action in network(DDoS attack, Scans, Worms)
  - User behavior analysis(P2P Apps, Botnets)
- Display
  - GeoIP plugin will be used to display regional traffic data on a map.

Summary

- A framework with network traffic data acquisition, storage, analysis and graphic interface has been finished.
- The network traffic statistics based on IP prefix and GeoLite2 database has been realized.
- Network security detection plugin and network traffic statistics display on map are under developing.

Thank you for your attention!