

Scalable NetFlow Analysis with Hadoop

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- Overview
- Hadoop-based traffic processing tool
- Evaluation
- Summary

INTRODUCTION

Internet Measurement

- Challenges
 - Scalability
 - Fault-tolerant system
 - Extensibility
- CAIDA data
 - Capture, Curation, Storage, Search, Sharing, Analysis, and Visualization
 - Ark topology: 1.8 TB
 - Telescope: 102 TB
 - Packet headers: 18.8 TB

**Josh Polterock, “CAIDA: A Data Sharing Case Study,”
Security at the Cyber Border: Exploring Cybersecurity for International Research Network
Connections workshop, 2012**

Harness Distributed Computing and Storage ?

Google MapReduce, 2004

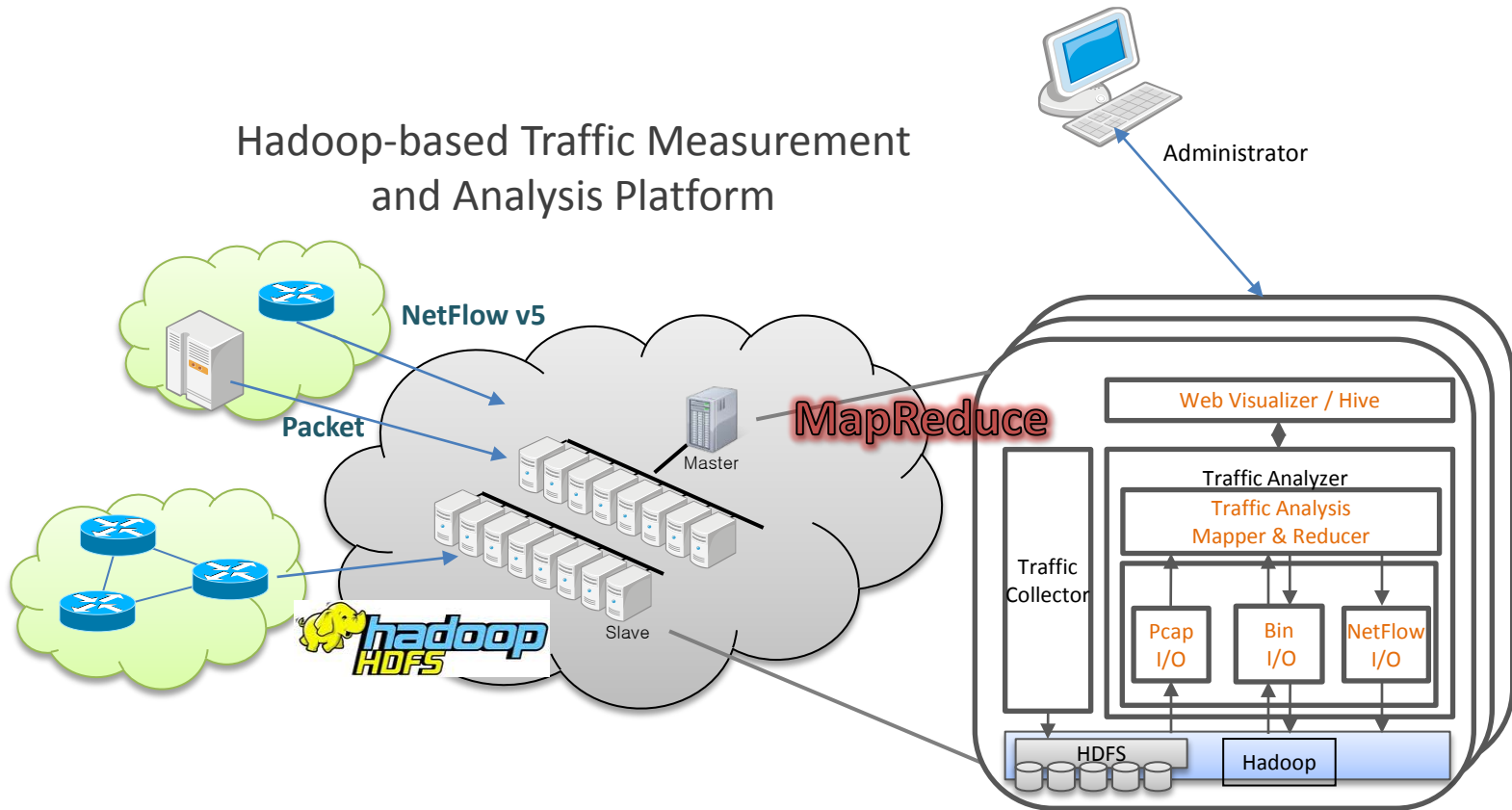
- 1 PB sorting by Google
 - 2008: 6 hours and 2 minutes on 4,000 computers
 - 2011: 33 minutes on 8000 computers
 - 2011: 10PB, 8000 computers, 6 hours and 27 minutes



Apache Hadoop project



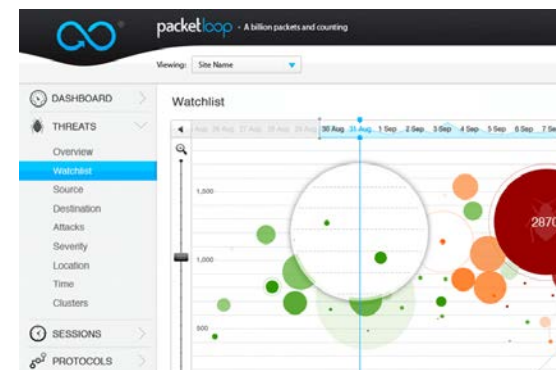
Our Proposal



1. Yeonhee Lee and Youngseok Lee, "Toward Scalable Internet Traffic Measurement and Analysis with Hadoop," *ACM SIGCOMM Computer Communication Review (CCR)*, Jan. 2013
2. Yeonhee Lee and Youngseok Lee "A Hadoop-based Packet Trace Processing Tool", *TMA*, April 2011
3. Yeonhee Lee and Youngseok Lee, "Detecting DDoS Attacks with Hadoop", *ACM CoNEXT Student Workshop*, Dec, 2011

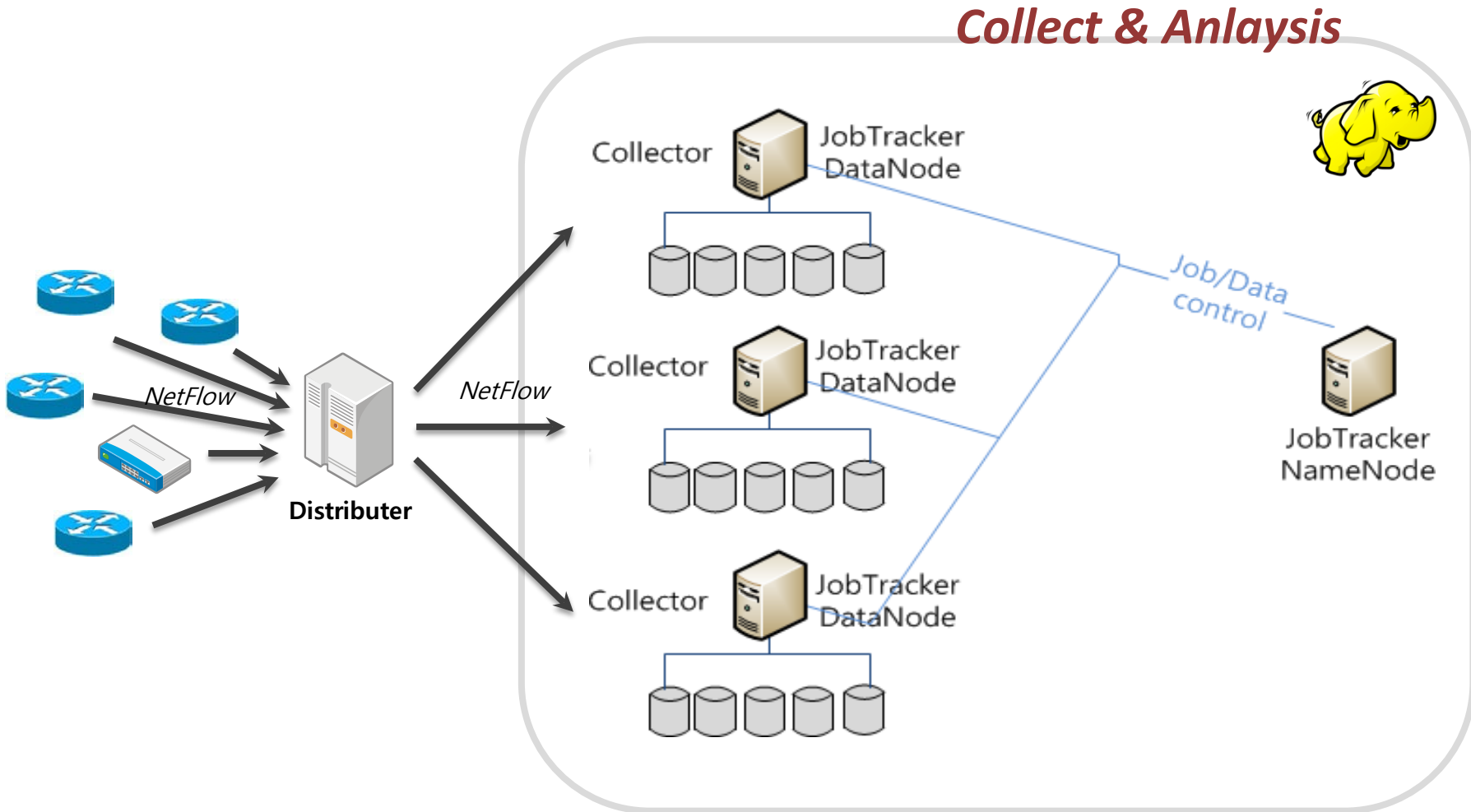
Related Work

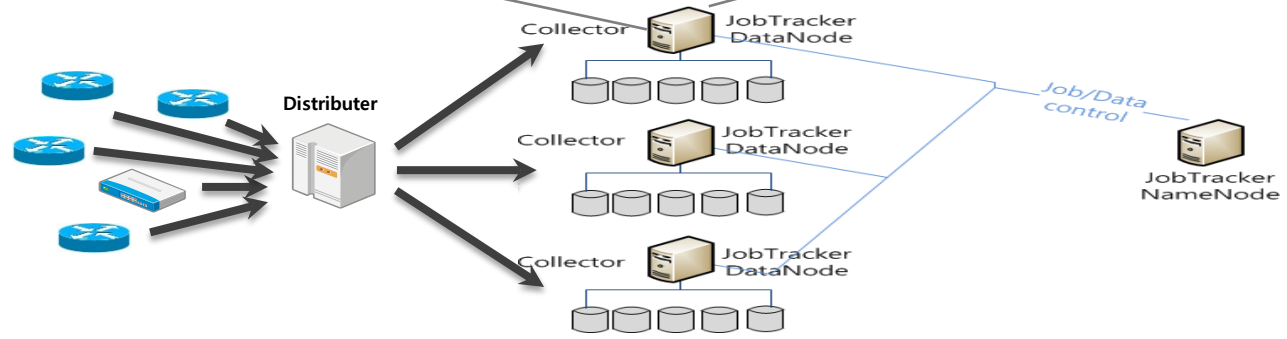
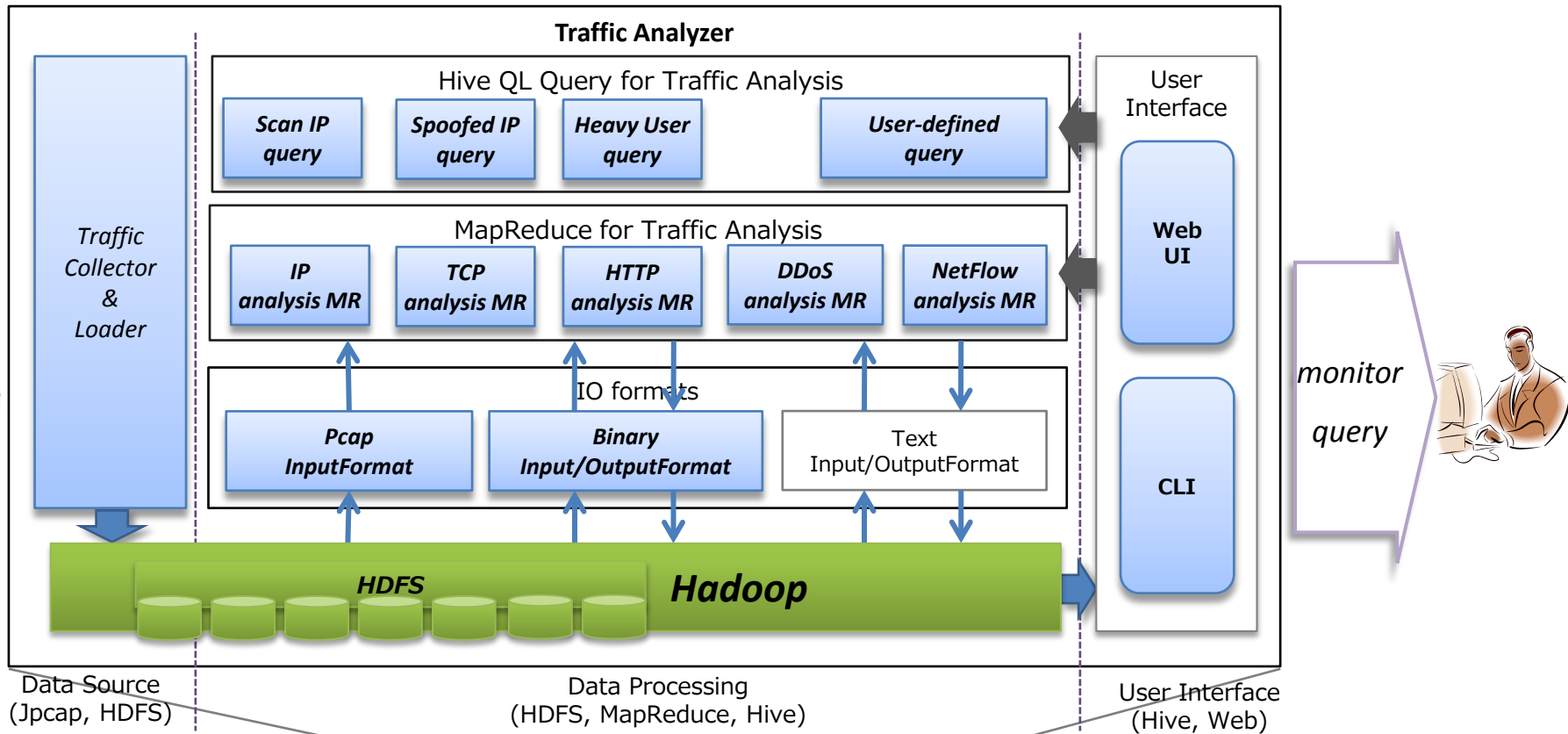
- Traffic analysis of DNS root server (RIPE, 2011.11)
- PacketPig (2012.03) - Big Data Security Analytics platform
- Sherpasurfing – Open Source Cyber Security Solution, Hadoop World 2011
 - Firewall/IDS logs, netflow/packet
- Performing Network and Security Analytics with Hadoop, (Travis Dawson, Narus), Hadoop Summit 2012
- Distributed Bro (IDS)



OVERVIEW

Hadoop-based NetFlow Analysis





HADOOP-BASED TRAFFIC ANALYSIS

Challenges

1. Data handing issue in HDFS
2. Distributed traffic analysis MapReduce algorithms
3. Performance tuning in a large-scale Hadoop

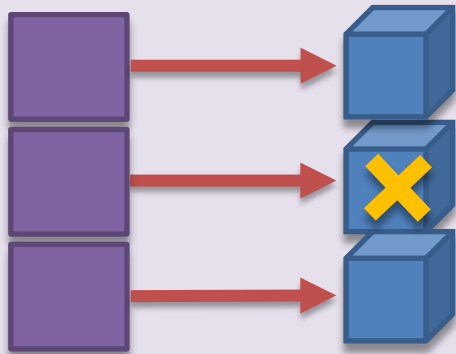


Challenges

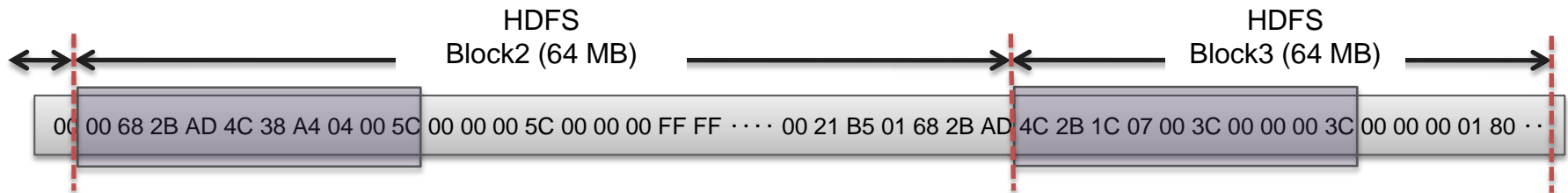
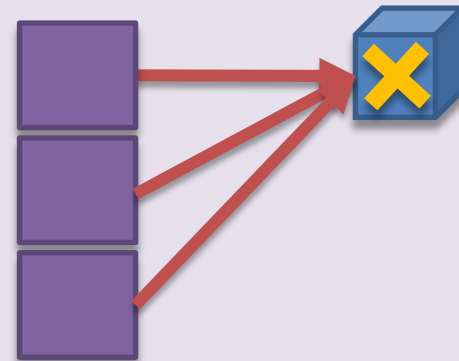
1. Data handing issue in Hadoop
2. Distributed traffic analysis MapReduce algorithms
3. Performance tuning in a large-scale Hadoop testbed

Block-level Parallelism

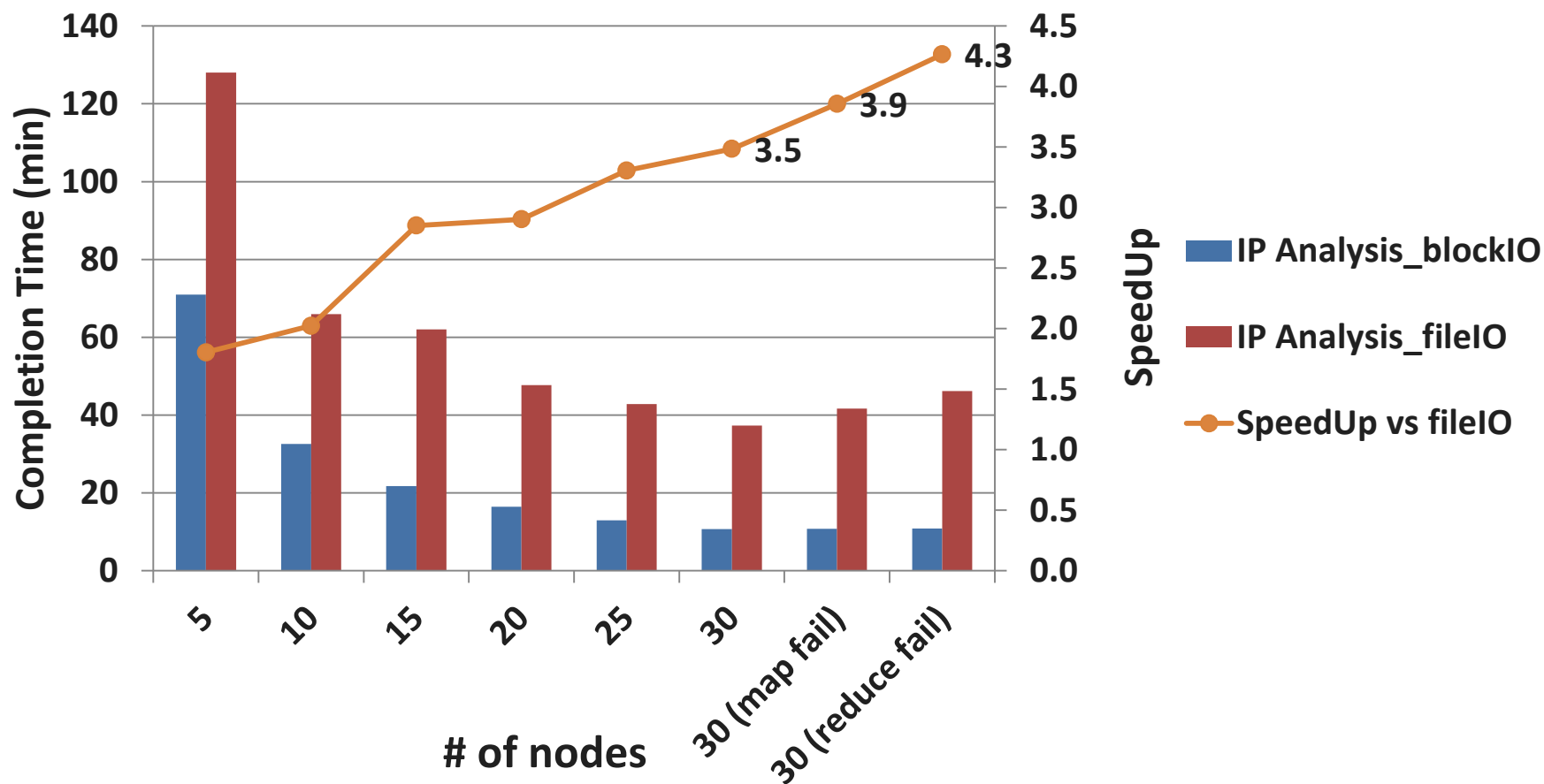
block-level processing



file-level processing



Block-level IO vs. File-level IO



Challenges

1. Data handing issue in Hadoop
2. Distributed traffic analysis MapReduce algorithms
3. Performance tuning in a large-scale Hadoop testbed

Aggregation

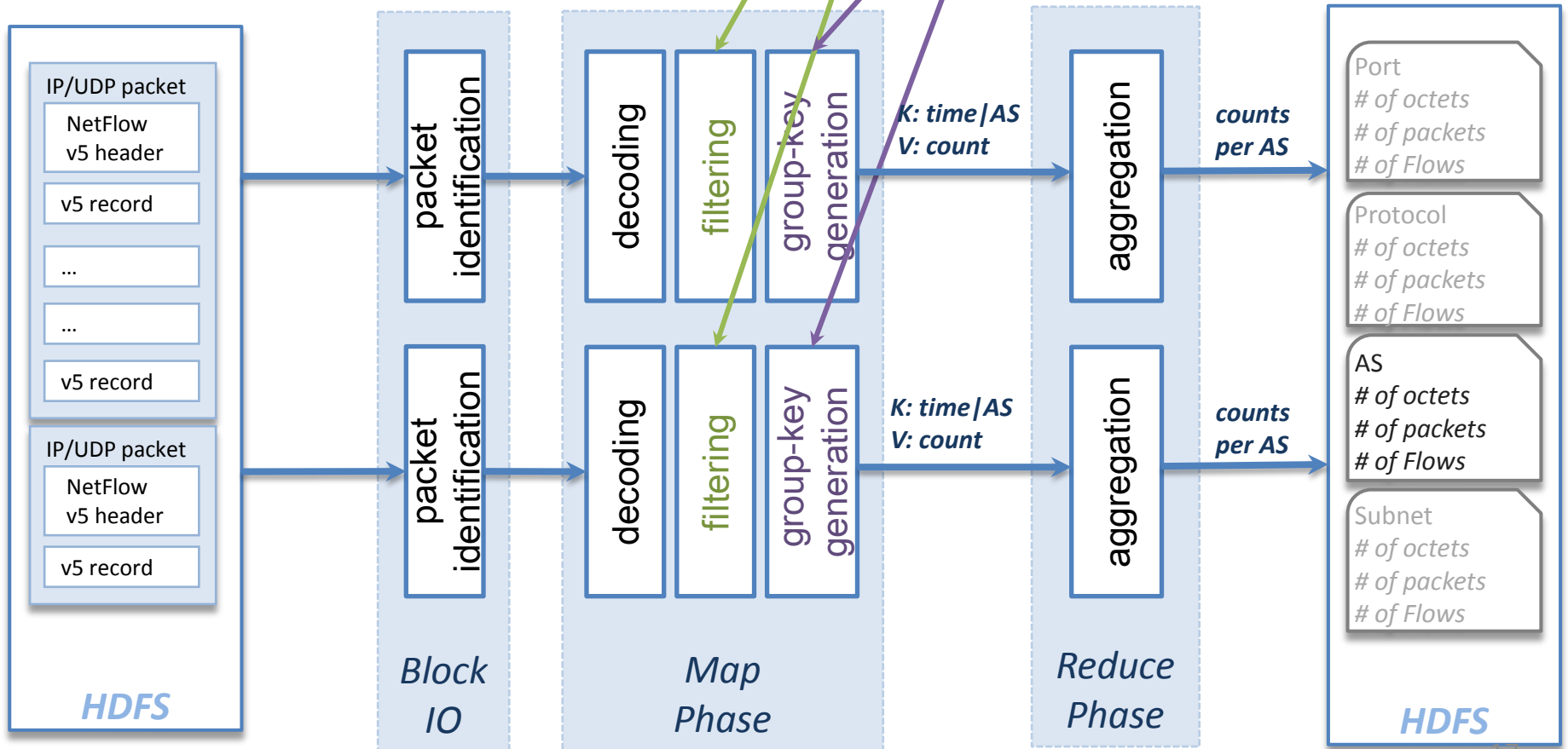
DistributedCache

Filtering Rule

cnu;srcip=168.188.0.0-168.188.255.255

Aggregation Rule

as;ip;subnet;port;protocol;srcas;dstas;srcip;dstip;srcsubnet;dstsubnet;srcport;dstport;

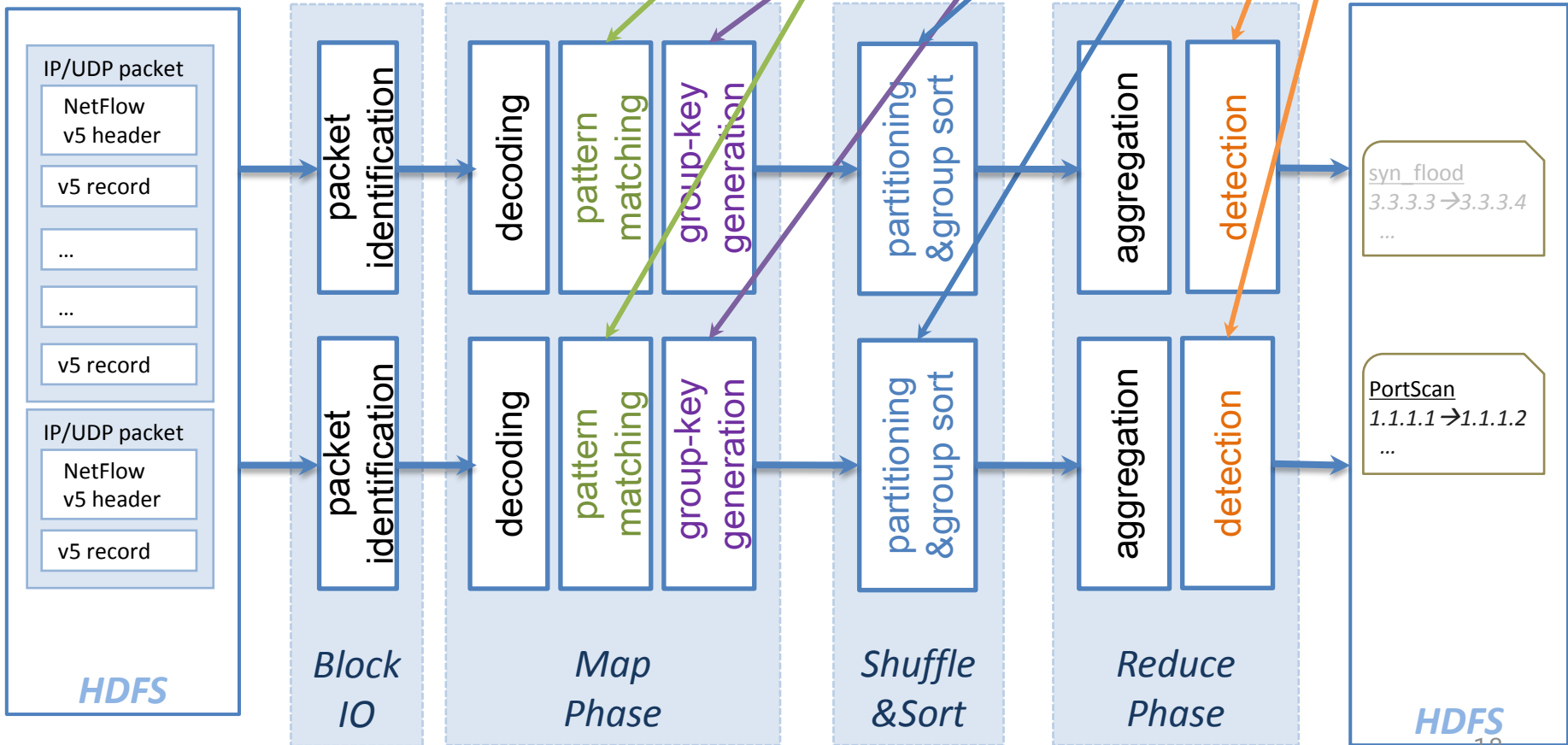


Anomaly Detecti

DistributedCache

Detection Rules

port_scan;ip,proto=6;srcip,dstport;srcip;pkts=20-
 syn_flood;ip,proto=6,syn-fin=1-
 ;srcip,dstip;srcip,dstip;syn-fin=5-



Challenges

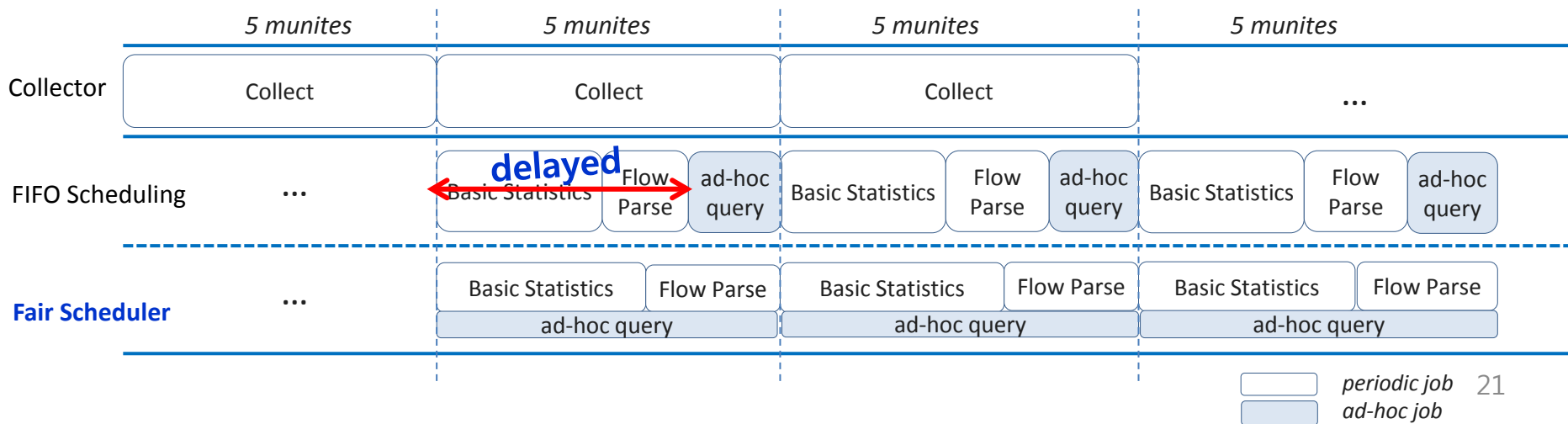
1. Data handing issue in Hadoop
2. Distributed traffic analysis MapReduce algorithms
3. Performance tuning in a large-scale Hadoop

Performance Tuning

- Configuration
 - Hadoop IO Buffer (128K → 1 MB)
 - Java heap space (300 MB → 1 024 MB)
 - # of MapReduce Slots (→ # of cores)
- MapReduce Algorithm
 - normal combiner vs inMapper combiner
- Job scheduling

Job Scheduling

- Different job types
 - Periodic jobs (for monitoring)
 - guaranteed service within time
 - e.g Aggregated Statistics for monitoring, Flow Parse job for analytics
 - Small ad-hoc query job (for analytics)
 - fast response time



PERFORMANCE EVALUATION

Experiments

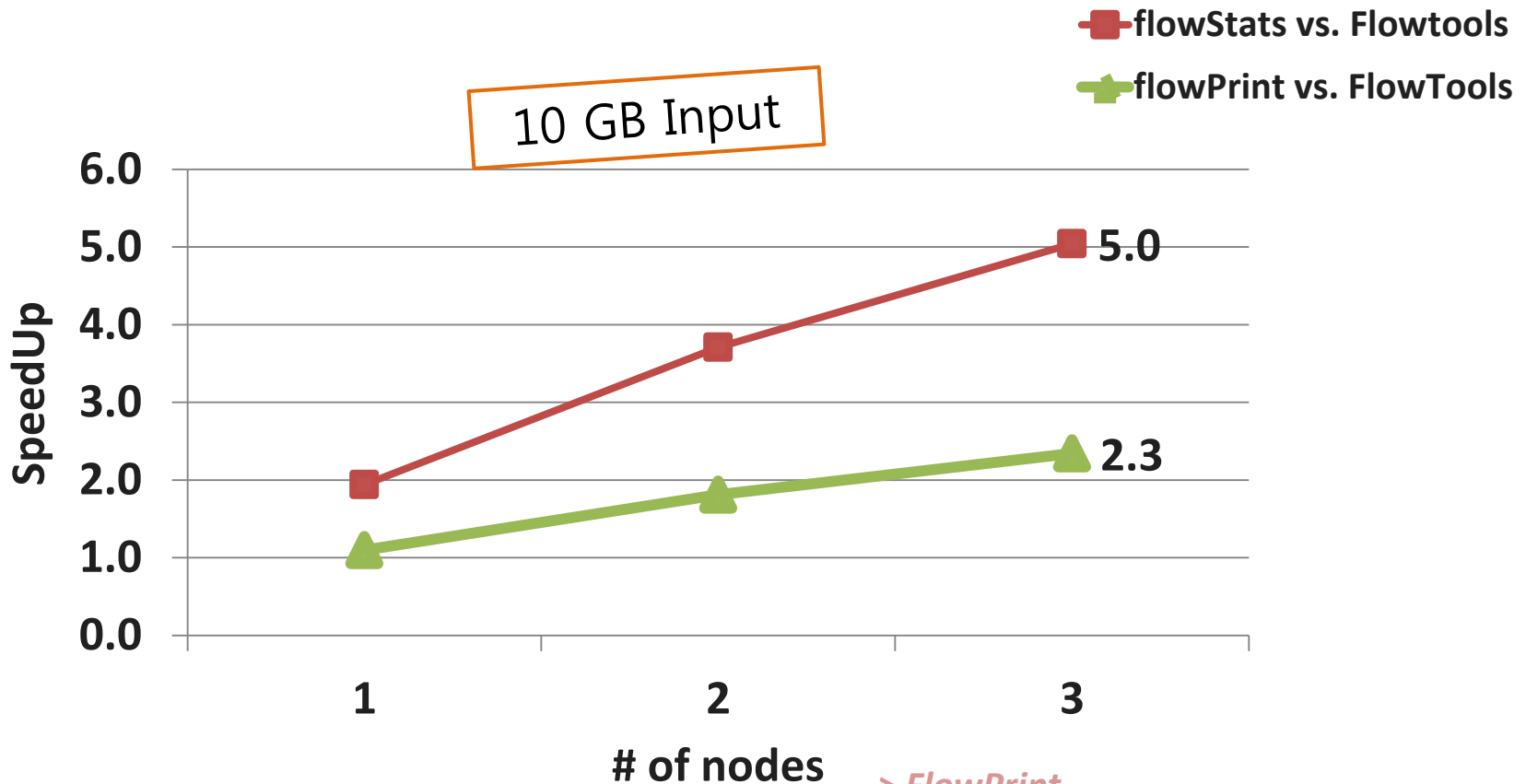
- Testbed

Type	Nodes	Cores	CPU	Memory	HardDisk	Rack
Small	3	24	3.4 GHz 8 core	16 GB	2 TB	1 Rack
Medium	30	240	2.93 GHz 8 core	16 GB	4 TB	1 Rack
Large	200	400	2.66 GHz 2 core	2 GB	500 GB	4 Racks

- Data and MapReduce jobs

Type	Dataset	MapReduce Job	Testbed
NetFlow	1 TB from KOREN	flowStats, flowDetect, flowPrint	Small
Packet	1 ~ 5 TB from CNU campus N/W	IP, TCP, Web (webpop, User Behavior, DDoS)	Medium, Large

NetFlow: SpeedUp (vs. Flowtools)



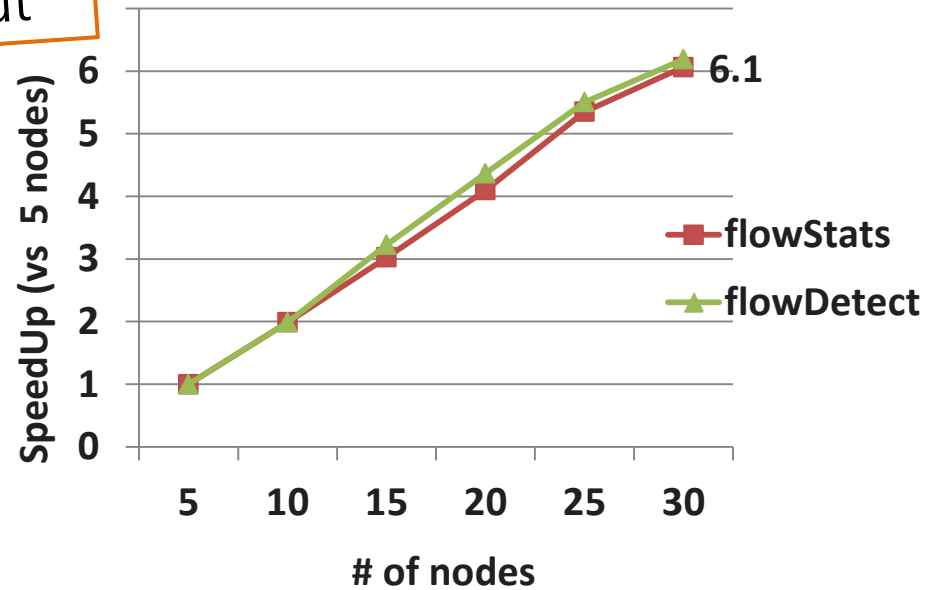
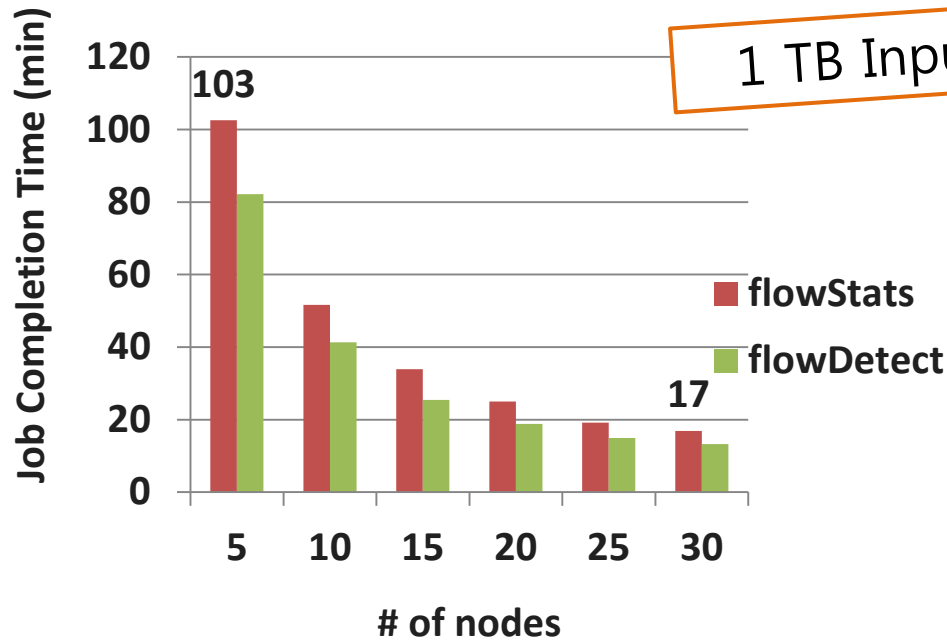
> FlowPrint

```
flow-cat -p flowfile |flow-print -f14
```

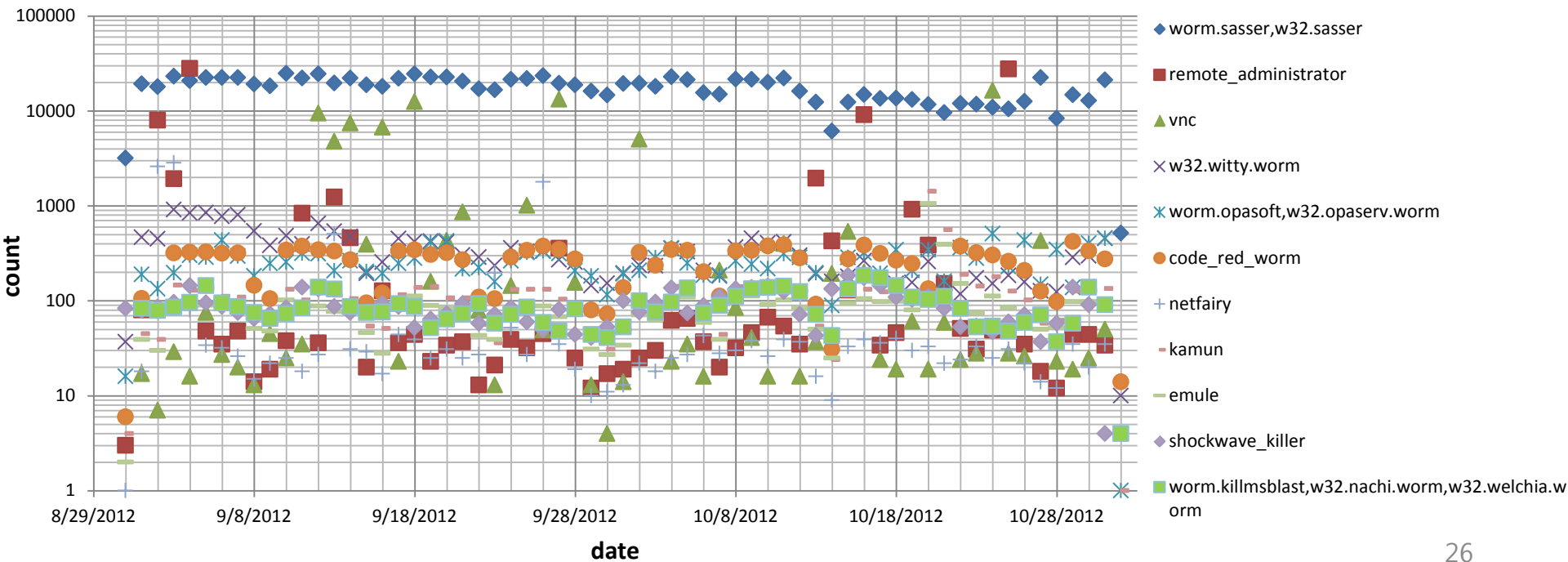
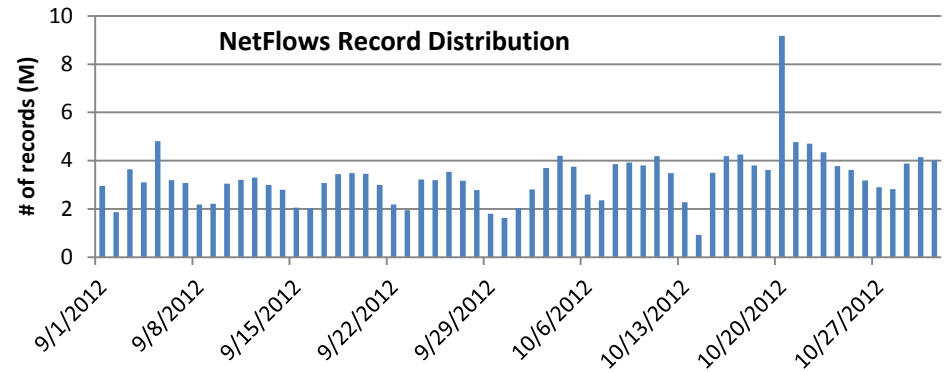
> FlowStats

```
flow-cat -p flowfile |flow-stat -f12  
flow-cat -p flowfile |flow-stat -f524
```

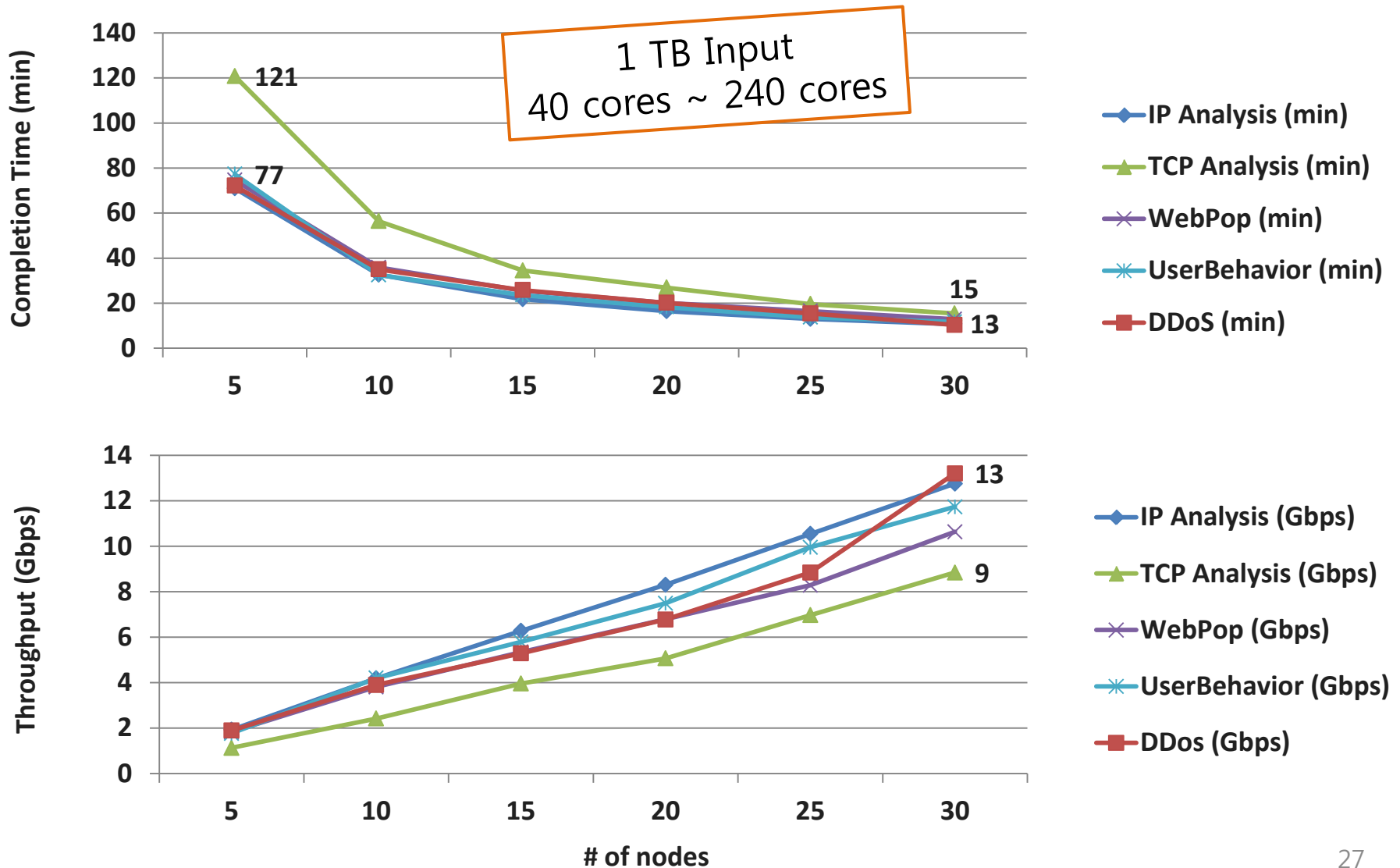

NetFlow: Scalability



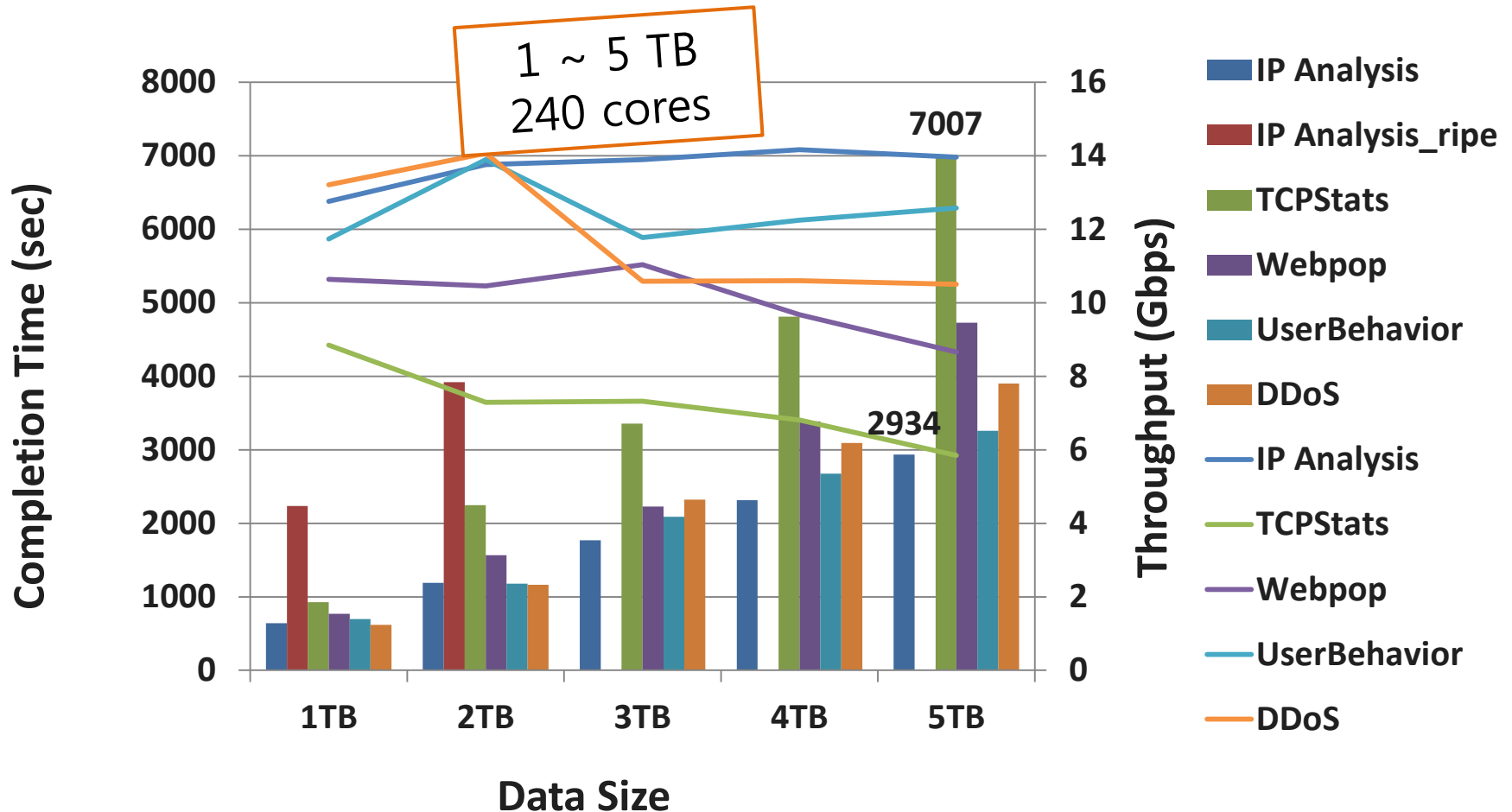
NetFlow: Pattern Matching Result



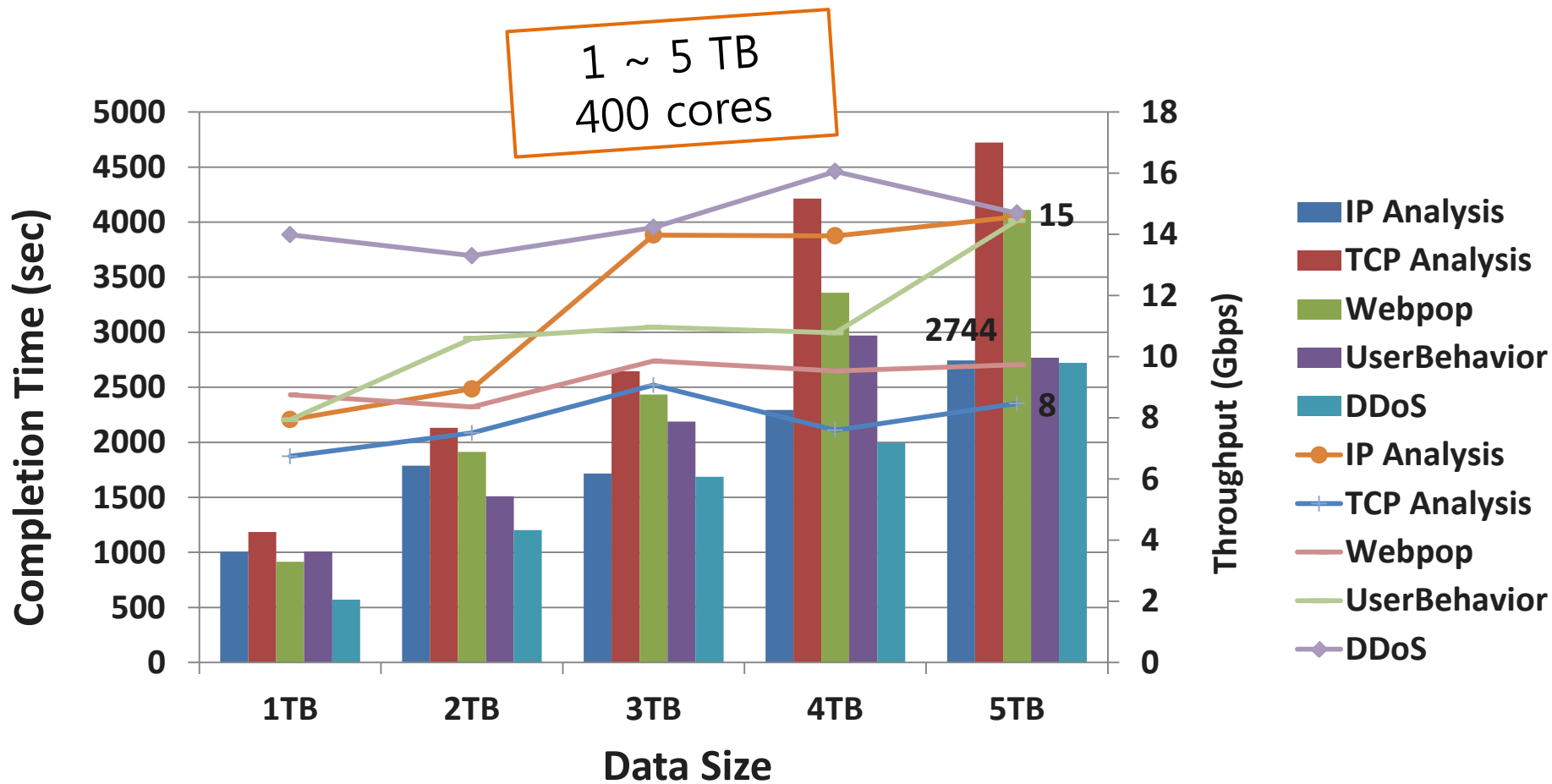
Packet: ScaleOut



Packet: SizeUp (30 nodes)



Packet: SizeUp (200 nodes)



SUMMARY

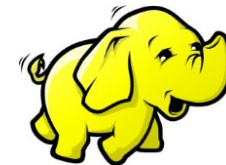
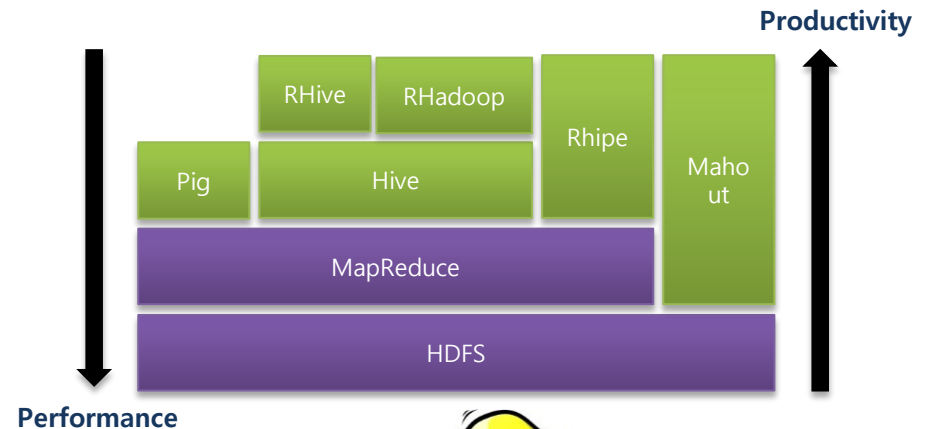
Summary

- NetFlow analysis with Hadoop
 - NetFlow v5 processing module
 - MapReduce algorithms: statistics
- Distributed computing and storage with Hadoop
 - Fits Internet measurement application
 - Scalability
- Source codes are available at
 - Packet, NetFlow
 - <https://sites.google.com/a/networks.cnu.ac.kr/dnlab/research/hadoop>
 - <https://github.com/ssallys/pcap-on-Hadoop>

Ongoing Work

- Distributed real-time monitoring
 - Rule matching for Streamed NetFlow
 - Developing rule for MapReduce
 - Rule classification for dedicated rule matching
- Integration
 - Streaming packages
 - Enhanced analytics
 - Data mining: Mahout
 - Machine learning

- Scalable collection
 - E.g.) 10GE → 10 X 1 GE HDFS



Reference

- Papers

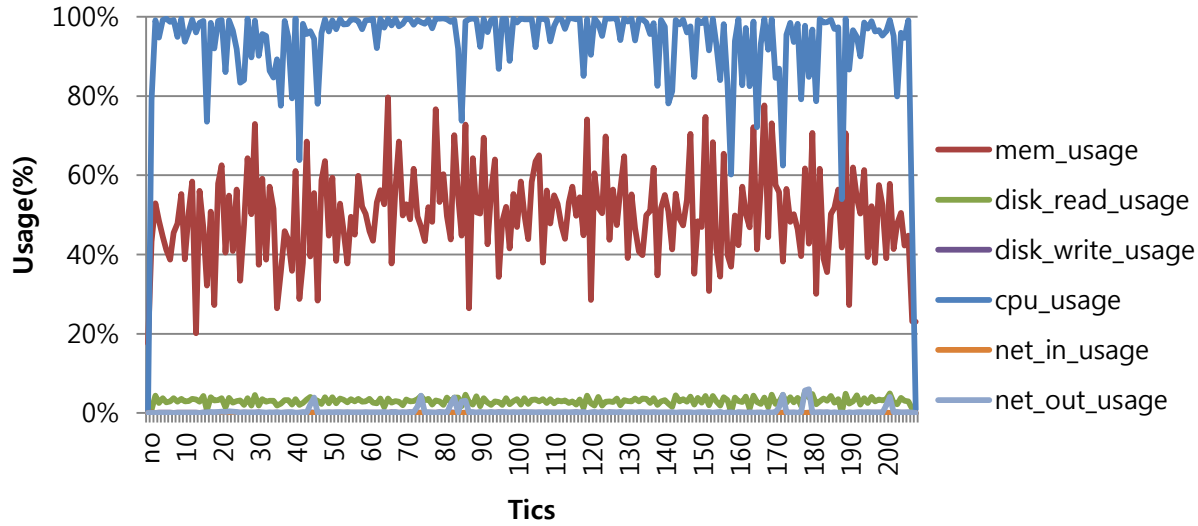
1. *Y. Lee and Y. Lee, "Toward Scalable Internet Traffic Measurement and Analysis with Hadoop," ACM SIGCOMM Computer Communication Review (CCR), Jan. 2013*
2. *Y. Lee, W. Kang, and Y. Lee, "A Hadoop-based Packet Trace Processing Tool," The Third TMA, April 2011*
3. *Y. Lee and Y. Lee, "Detecting DDoS Attacks with Hadoop", ACM CoNEXT Student Workshop, Dec, 2011*

- Software

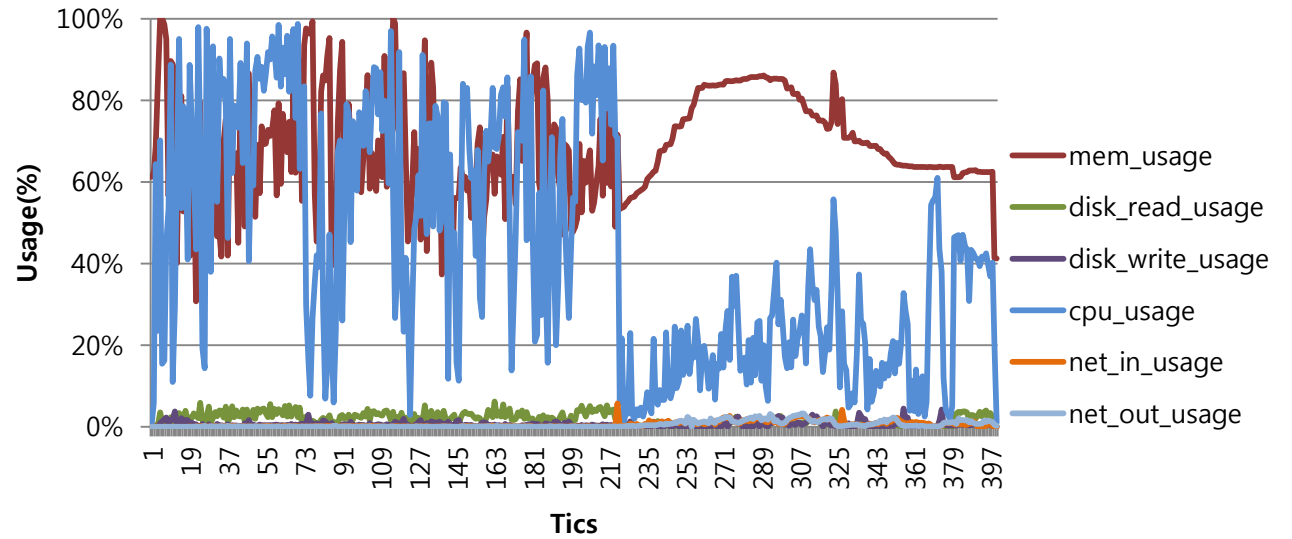
1. <http://networks.cnu.ac.kr/~yhlee>
2. <https://sites.google.com/a/networks.cnu.ac.kr/dnlab/research/hadoop>
3. <https://github.com/ssallys/pcap-on-Hadoop>

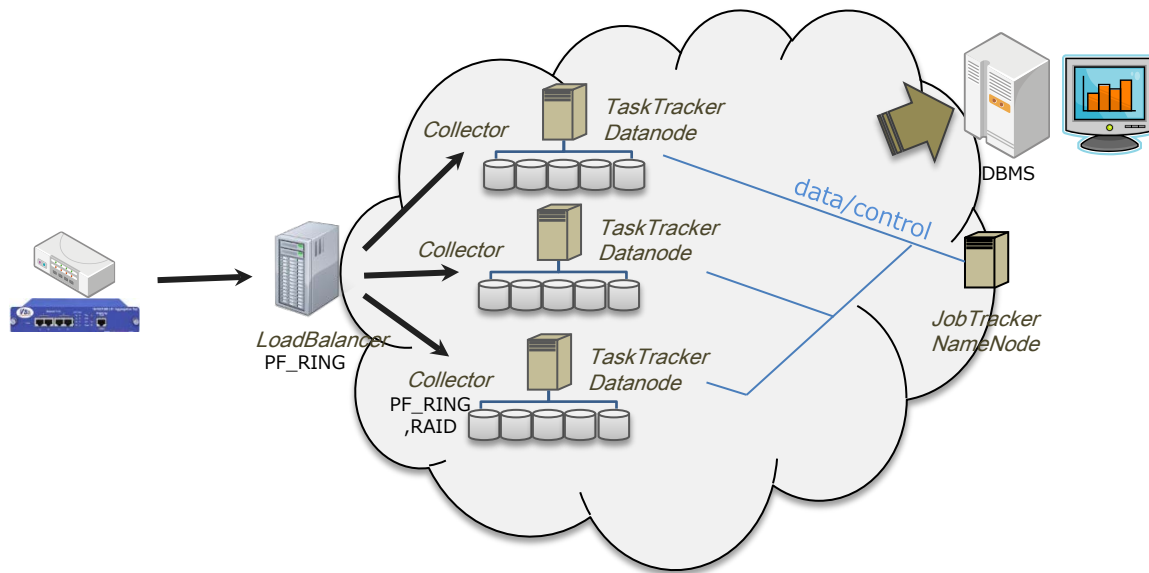
THANK YOU !

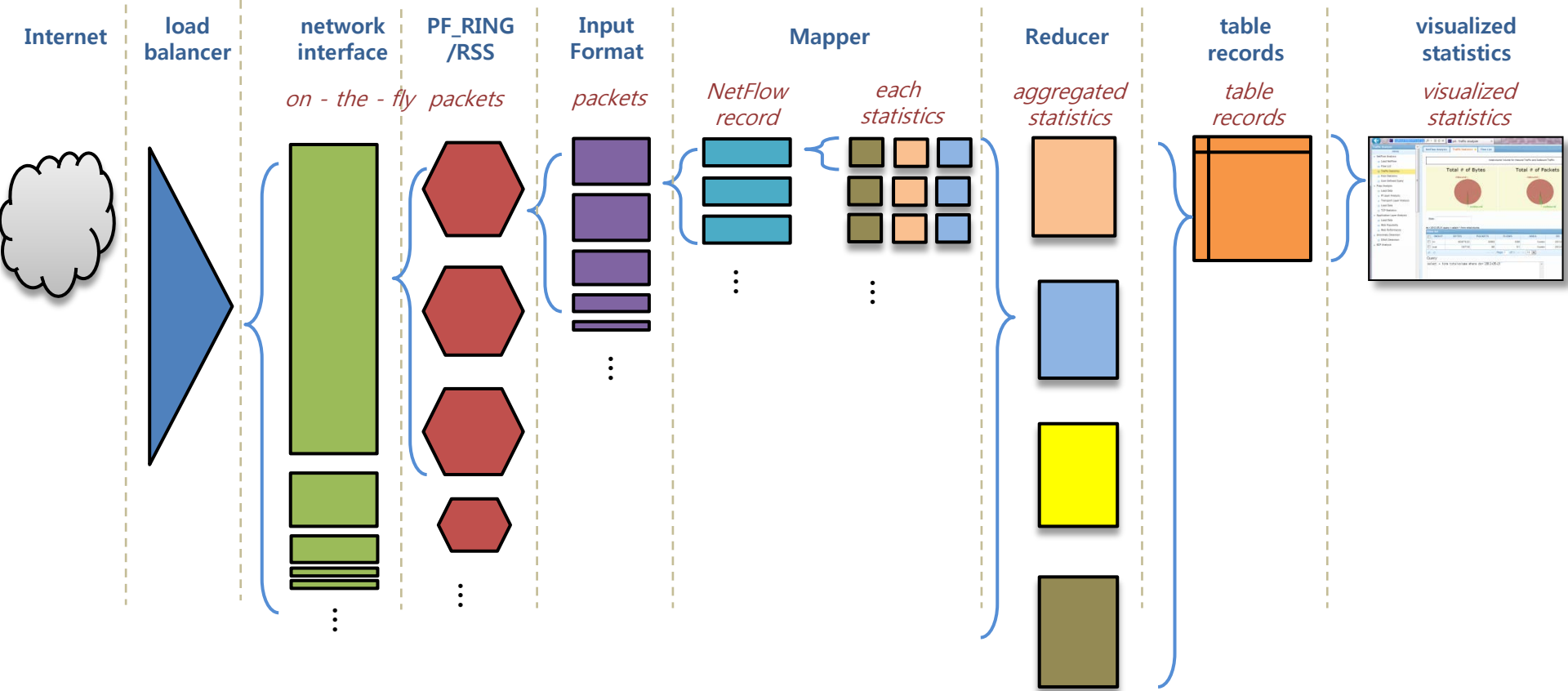
IP Analysis



TCP Analysis







rule name; filter pattern; mapout key; patition&groupsort key;detection condition; action

ex)

port_scan;ip,proto=6;srcip,dstport;srcip;pkts=20-

syn_flood;ip,proto=6,syn-fin=1-;srcip,dstip;srcip,dstip;syn-fin=6-