AMIS: Software Defined Privacy-Preserving Measurement Instrument and Services

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Overview of IRNC AMIS Project

Major objectives:

- *Measurement capability*: A whitebox instrument with scalable processing capabilities on network flows at up to 100Gbps line rate;
- *Programmable*: Software defined measurement framework that allows creating measurement tasks and making queries;
- *Privacy preserving*: privacy oriented algorithms to report measurement results while protecting user flow privacy;
- *Analytics*: Analysis and visualization of measurement data to provide insights to network operations.

Overview of AMIS Framework

- Measurement substrate
  - Distributed instruments + Hadoop data analytics engine
  - Programmable measurement instrument box
  - Optimized hw/sw system for up to 100Gbps
  - Flexible to implement and deploy new functions
  - Support differential privacy on flow analysis
- Measurement Control plane
  - Equery language to compose measurement functions
  - Web interface for user interaction and data visualization

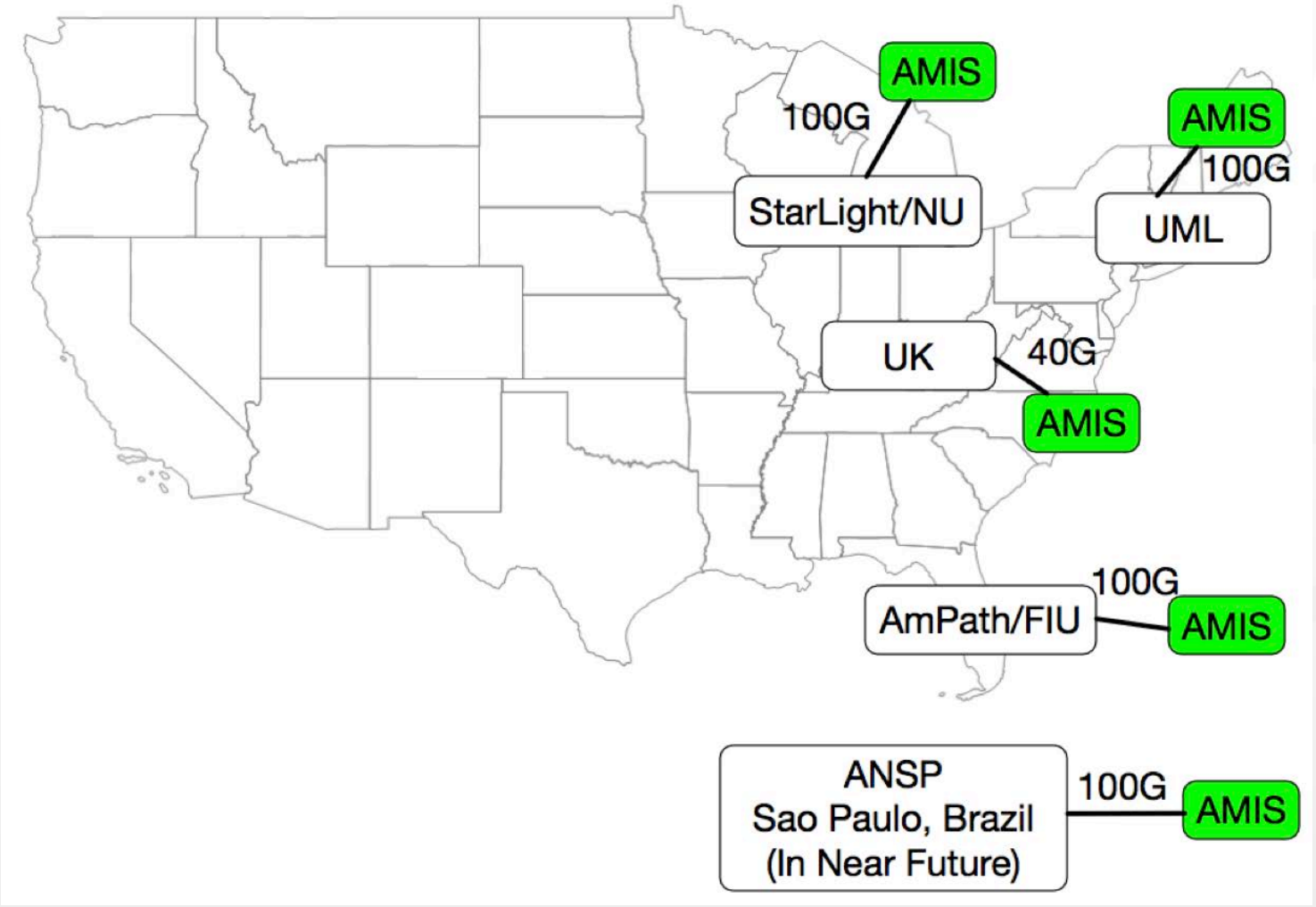
Why Another Measurement Box?

A Comparison with PerfSONAR

Differences	AMIS	PerfSONAR
Measurement method	Passive (do not generate traffic)	Active (generate traffic)
Real-time	Measure flows in real-time	Has no visibility of real-time flows
Flow granularity	Yes	No
100Gbps	Yes	Yes
Privacy preserving	Yes	No
Support event driven measurement	Yes	?

Current Deployment of IRNC AMIS

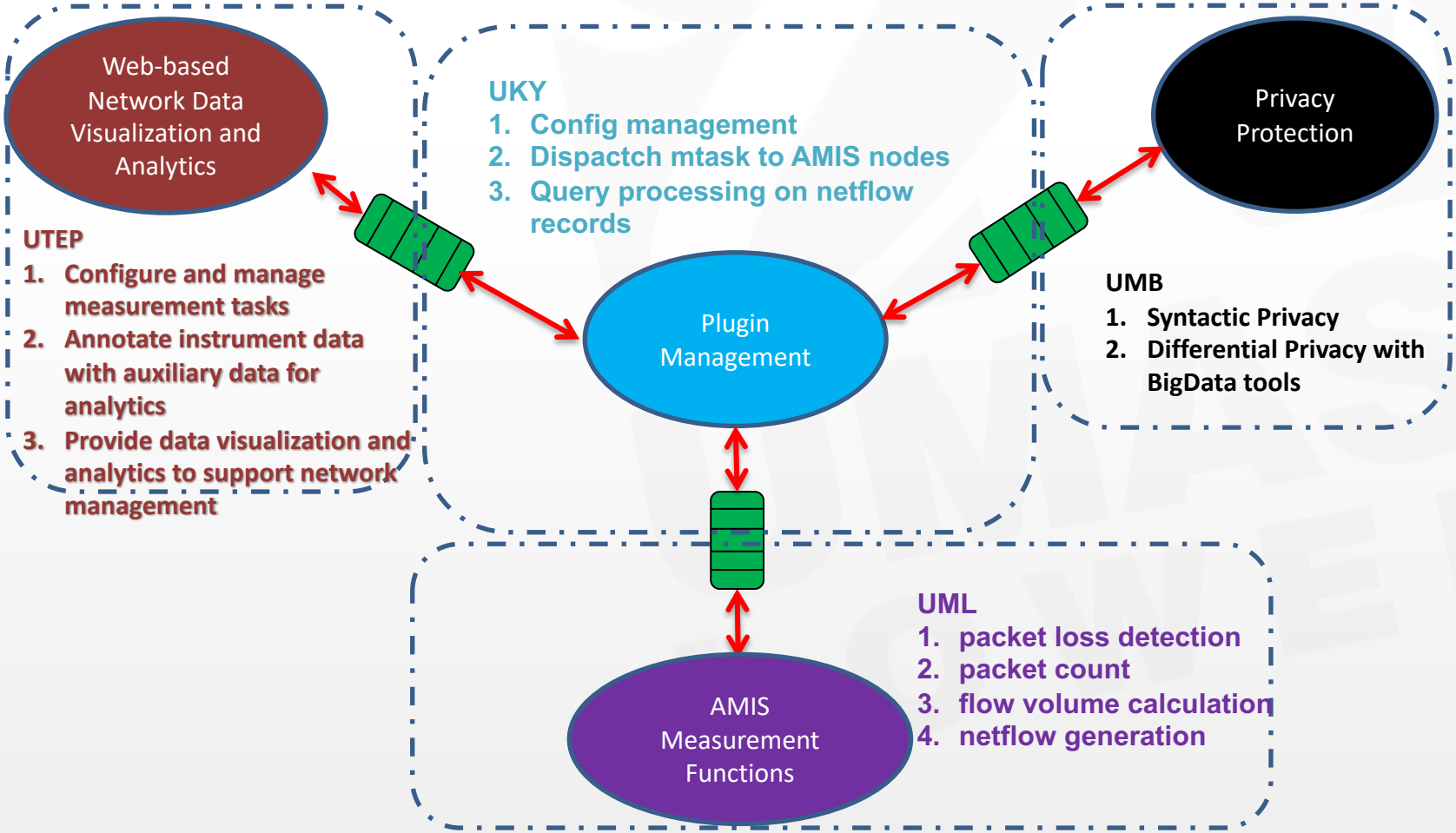
As of June 2018



Measurement Instrument and Functions

- A whitebox and open source software
  - Multicore x86 server with 100Gbps NICs (Mellanox)
  - DPDK + AMIS software modules
  - Measurement functions an run in a VM
- Measurement functions
  - Top 10 flows
  - Netflow generation
  - Link throughput
  - TCP window size
  - Packet tracing
  - *new ones can be created*

Overview of AMIS Software Framework

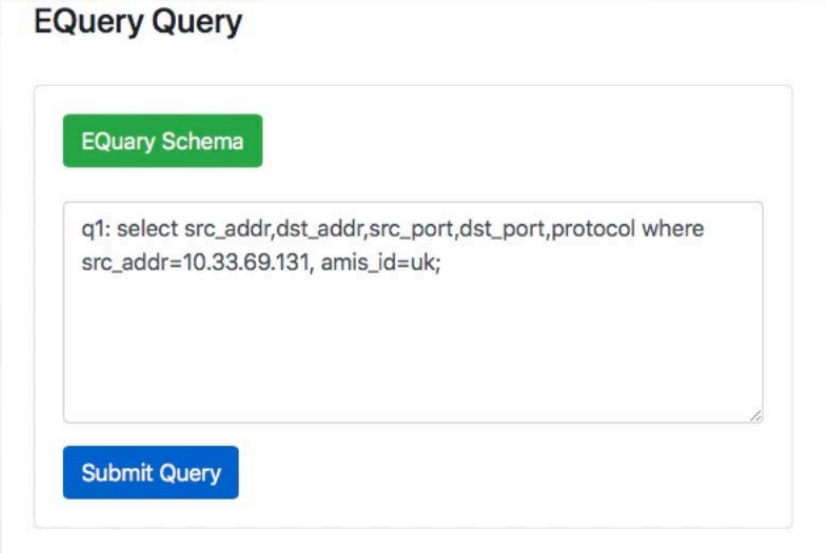


Equery Language for Network Measurement

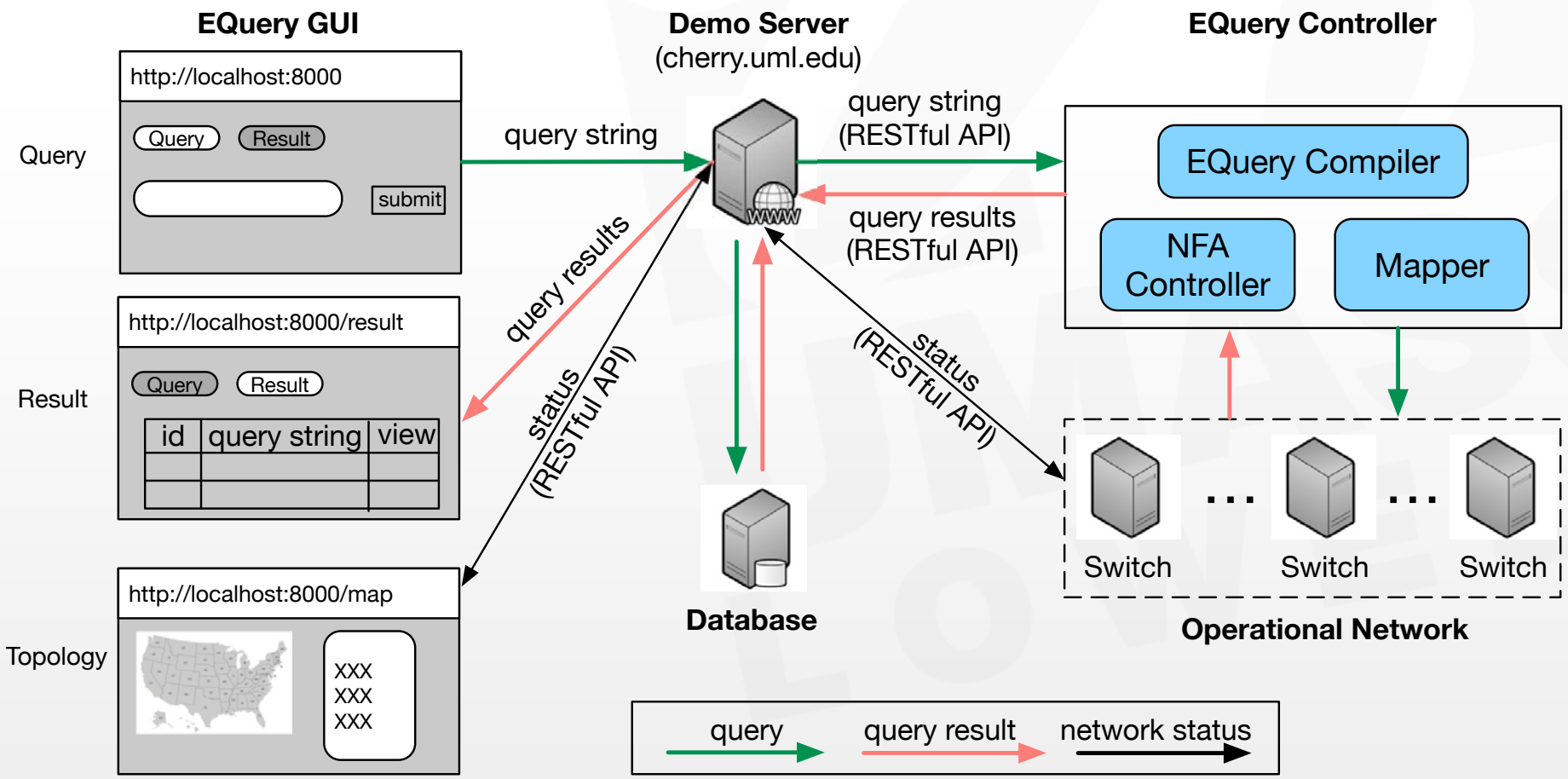
- An event driven declarative language
- Language spec: SQL like with network oriented primitives

Query q	:=	Select$(h, s, f(h, s))$
		Where(p)
		Groupby(h, s)
		When(e)
		Start(t)
		Within(i)
		Every(i)
Pkt hdr h	:=	$src\_ip \mid dst\_ip \mid src\_pt...$
Switch s	:=	$sw\_id \mid pt\_in \mid pt\_out...$
		$\mid q\_id \mid q\_in \mid q\_out \mid q\_size...$
Agg $f(h, s)$	:=	function of h, s (§**??**)
Event e	:=	$(q : g(q.h, q.s, q.f) \bowtie \text{threshold}) \mid (q : true)$
Time t	:=	start time
Interval i	:=	integer in s or ms
Predicate p	:=	$((h \mid s \mid f) \bowtie \text{value}) \mid p\&p \mid (p \mid p) \mid\sim p$
Optr $\bowtie$	:=	>|<|>=|<=|~=

Example

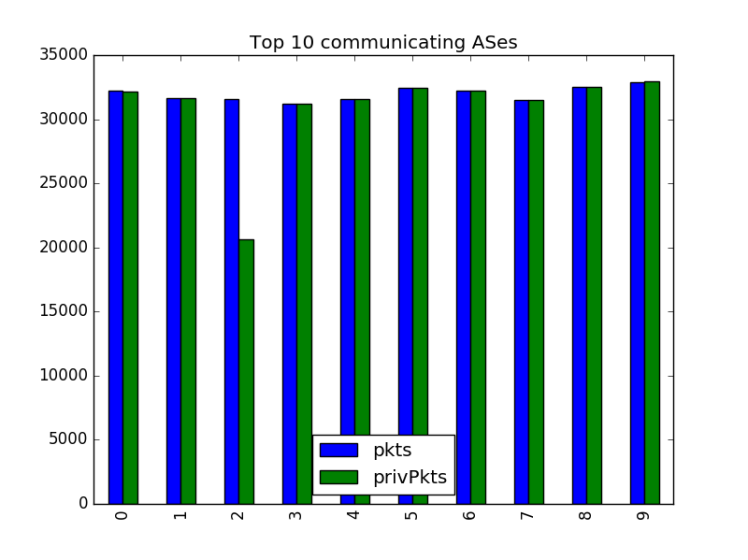


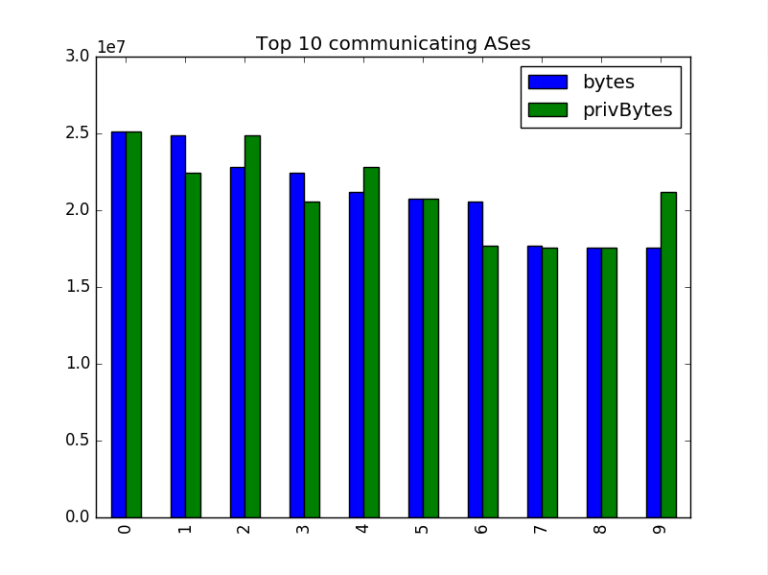
EQuery Demo


EQuery GUI
Demo Server
(cherry.uml.edu)
EQuery Controller
http://localhost:8000
Query
Result
submit
Query
query string
query string
(RESTful API)
query results
(RESTful API)
EQuery Compiler
NFA
Controller
Mapper
http://localhost:8000/result
Query
Result
id
query string
view
Result
query results
status
(RESTful API)
status
(RESTful API)
http://localhost:8000/map
Topology
XXX
XXX
XXX
Database
Switch
Switch
Switch
Operational Network
query
query result
network status

Privacy Preserving Query

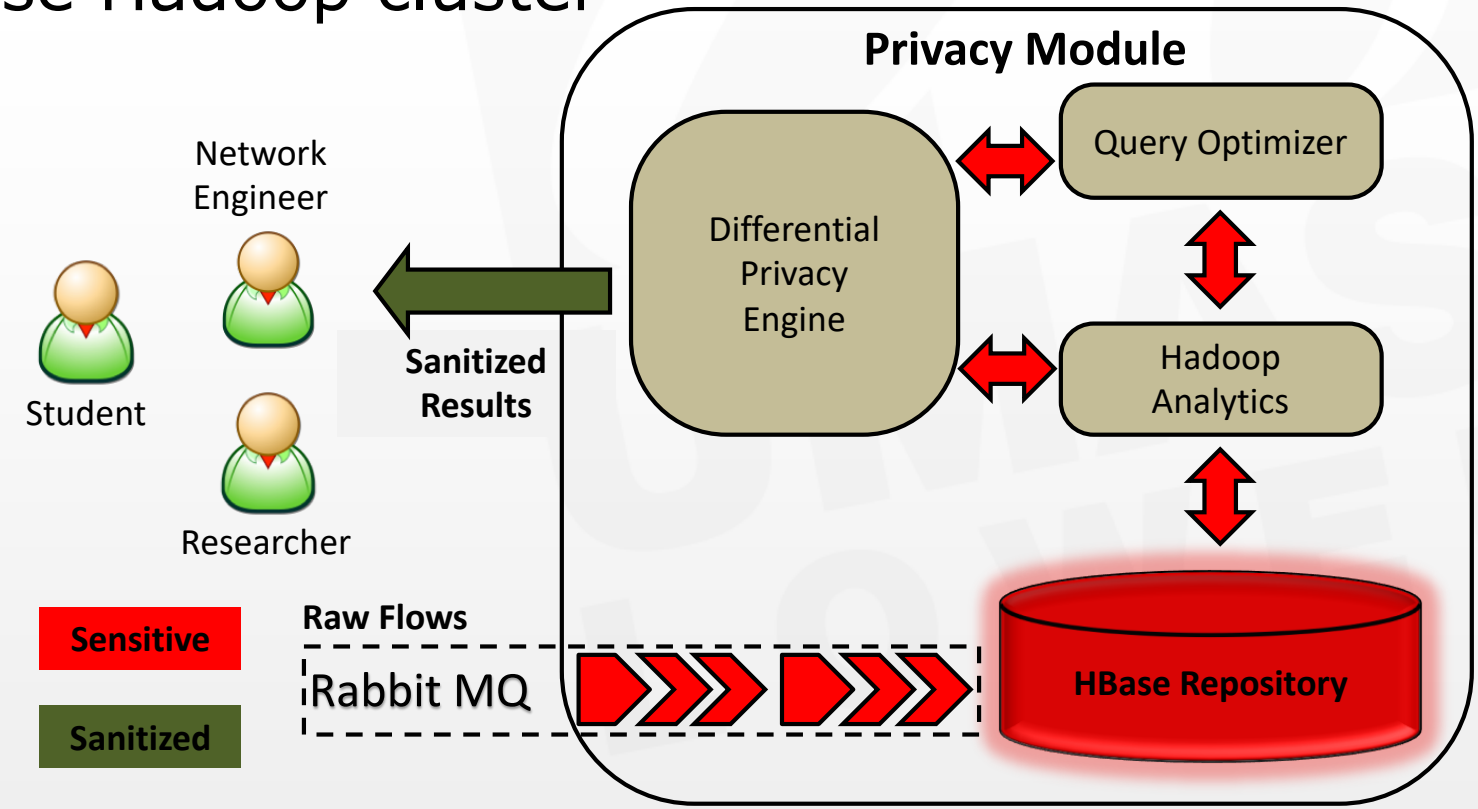
- To protect privacy, Differential Privacy adds Laplace noise to results
- We do show ASNs but protect individual flows
- Good accuracy obtained, even for strong privacy (ε=0.2):
  - 100% precision and recall for *Top10-communicating ASN*



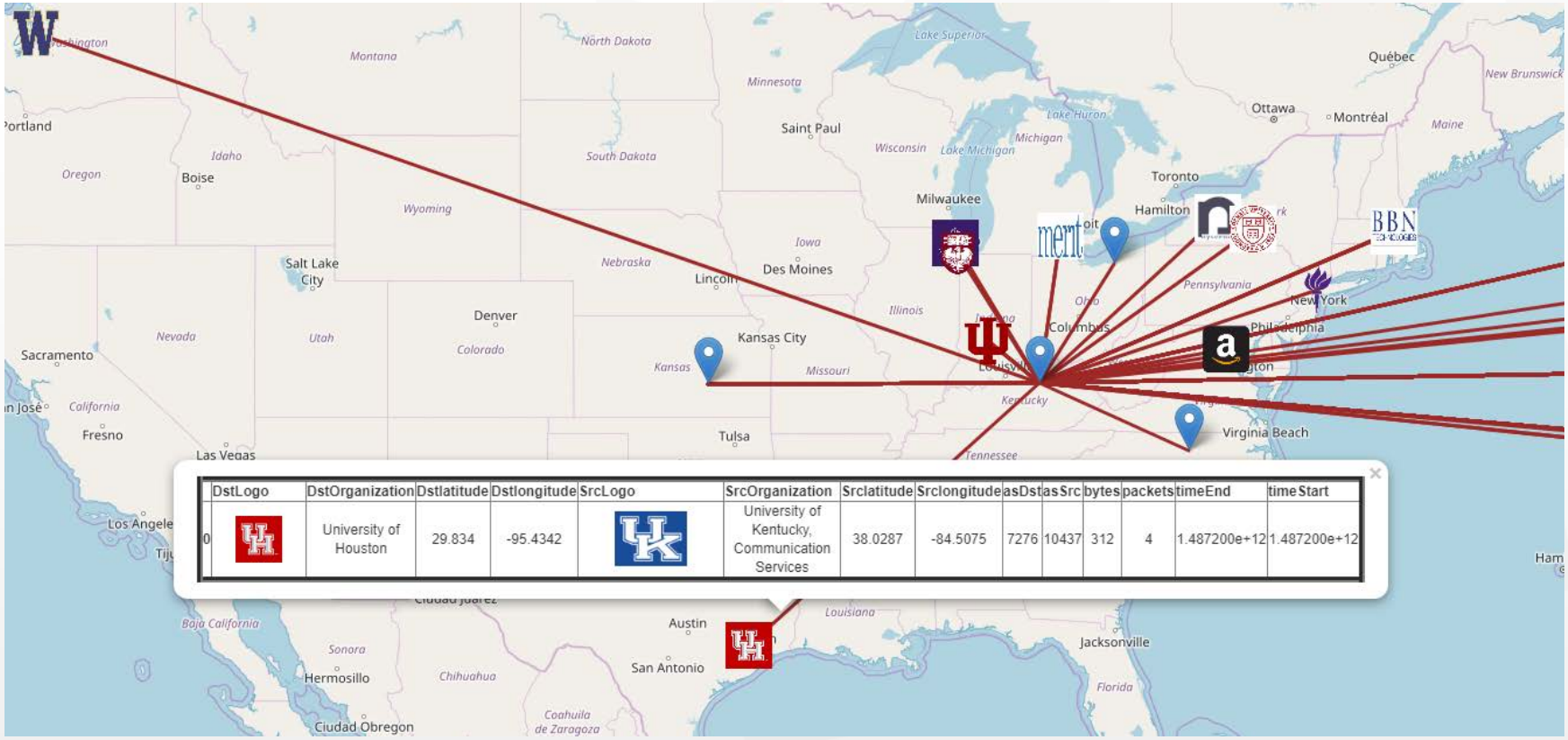


Privacy Preserving Modules

- Differential privacy algorithms
- Hbase Hadoop cluster



Traffic Matrix Visualization



DstLogo	DstOrganization	Dstlatitude	Dstlongitude	SrcLogo	SrcOrganization	Srclatitude	Srclongitude	asDst	asSrc	bytes	packets	timeEnd	timeStart
0	University of Houston	29.834	-95.4342		University of Kentucky, Communication Services	38.0287	-84.5075	7276	10437	312	4	1.487200e+12	1.487200e+12