InSight2

An Interactive Web Based Platform for Modeling and Analysis of Large Scale Argus Network Flow Data

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InSight2 Foundational Work

- GLORIAD: World wide network for research & education

  Global **Ri**ng Network for **A**dvanced Applications **D**evelopment

  NSF sponsored project 2006-2015, Greg Cole (PI)
- InSight: Visualization of GLORIAD Argus flow-data

  Development ended with GLORIAD
- InSight2: Newly developed, completely redesigned tool

InSight2 Motivation

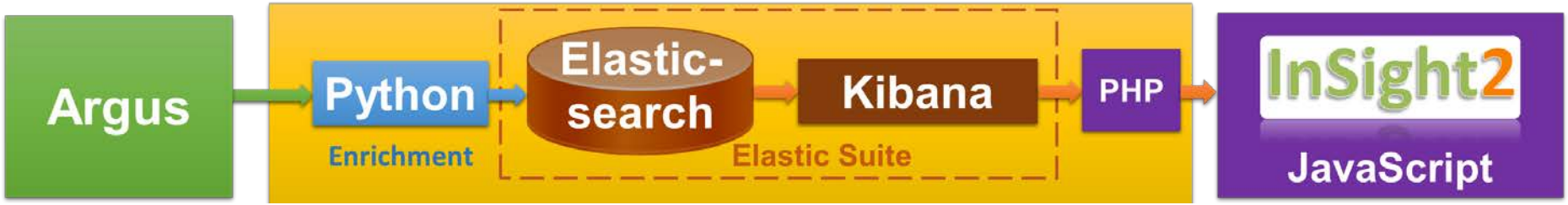
- Open-source Argus flow data analytics platform that provides:
  - **Performance metrics**
  - **Threat detection**
  - **Advanced analytics**
  - **Web based visualization**
- **Modular** architecture that supports **large scale data**, **real-time processing**, and **site-specific requirements**

InSight2 Features

- Core functionality: Performance metrics
- Plug-in extensions: Advanced analytics
  - Markov chain: Behavior prediction
  - Tensor analysis: Anomaly detection
  - Community plugins: TBD
- Data enrichment: Value-added knowledge
  - Geo-IP, Global Science Registry (IP-org mapping)
  - Threat lists, Blacklists (botnets, ransomware etc.)

InSight2 Implementation

- Enrichment: Python
- Database: Elasticsearch
- Visualization: Kibana
- Front-end: HTML/JS



InSight2 Capabilities 1/2

- Measurements
  - **Network statistics** (load, packets dropped, retransmitted)
  - **Usage statistics** (countries, organizations, ISPs)
  - **Diagnostics** (jitter, packet size, hops, delay)

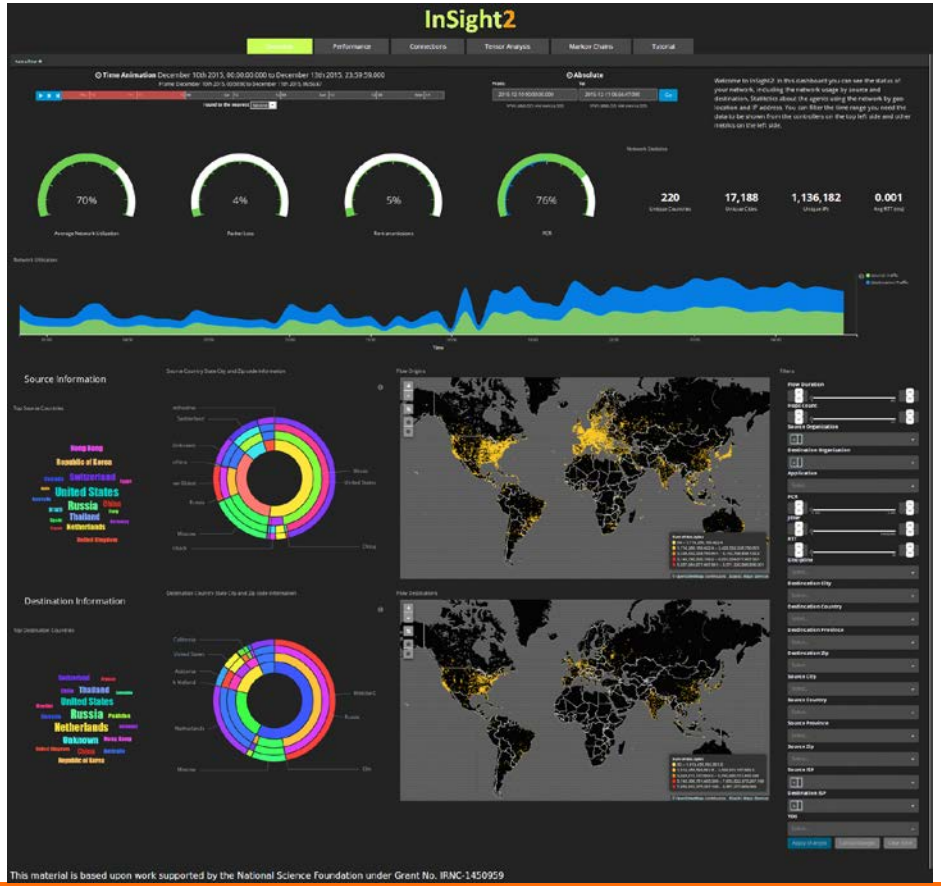
- Visualizations
  - Critical **activity gauges**
  - Overlaid **advanced metrics**
  - **Connections graphs** of top users

InSight2 Capabilities 2/2

- Intuitive filtering by UI interactions
  - Click UI elements to add/remove filters by country, ISP etc
  - Click and drag to filter time range in timeline
  - Click and drag define visual geo-location bounds in geo-maps
- Geo-location mapping: MaxMind Geo-IP database
- Threat detection: Miscl. on-line databases
- Utilization prediction: Markov chain modeling
- Anomaly detection: Tensor based data analysis

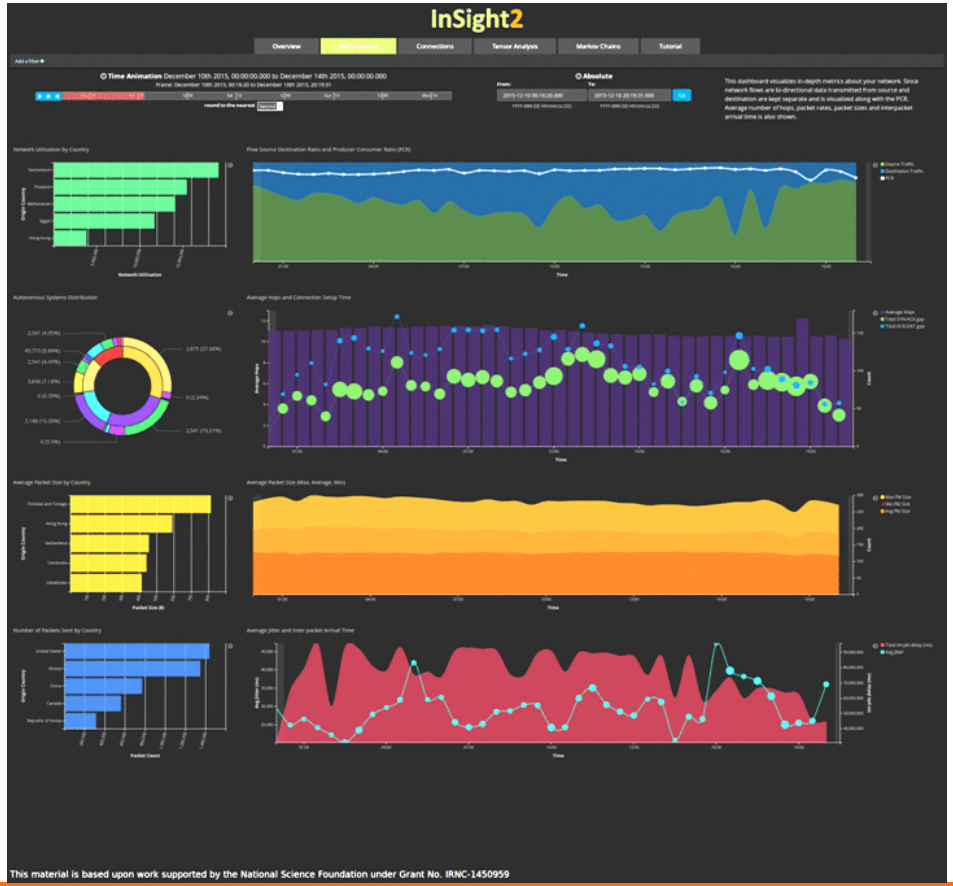
InSight2 Traffic Overview

- Main Dashboard
- Activity Gauges
- Country Tag Cloud
- Geo Map
- Intuitive filters

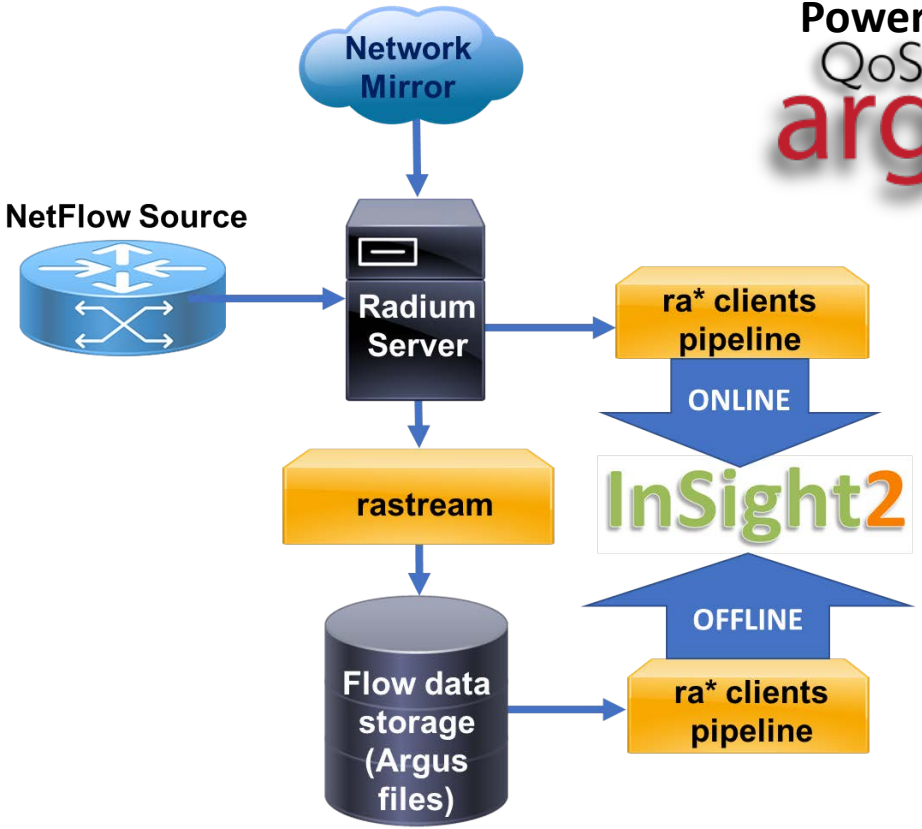


InSight2 Performance Metrics

- Traffic ratio and PCR
- Setup time and hops
- Packet size
- Jitter and inter-packet arrival time



InSight2 Argus Flow Data

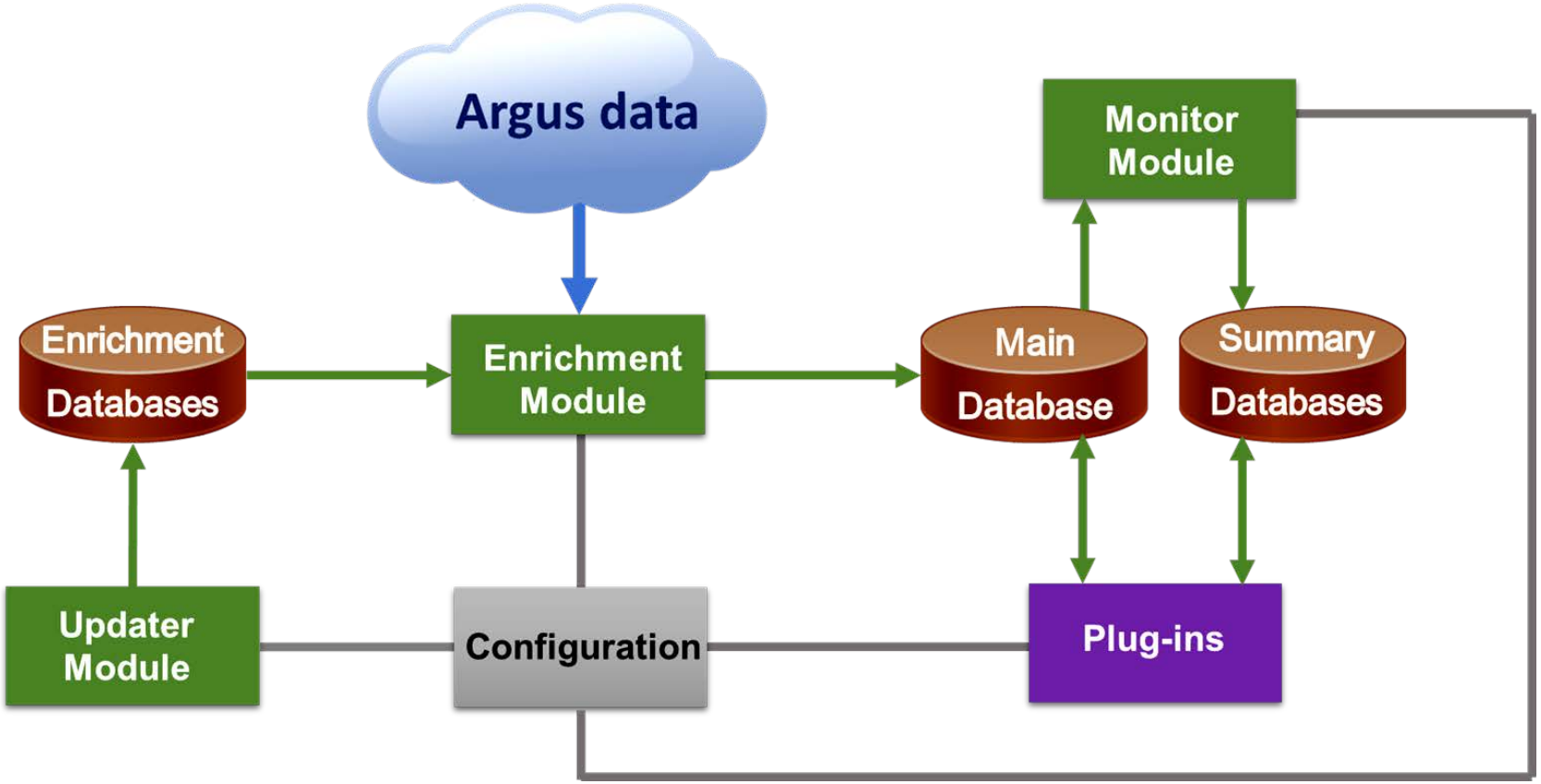


Powered by QoSient argus

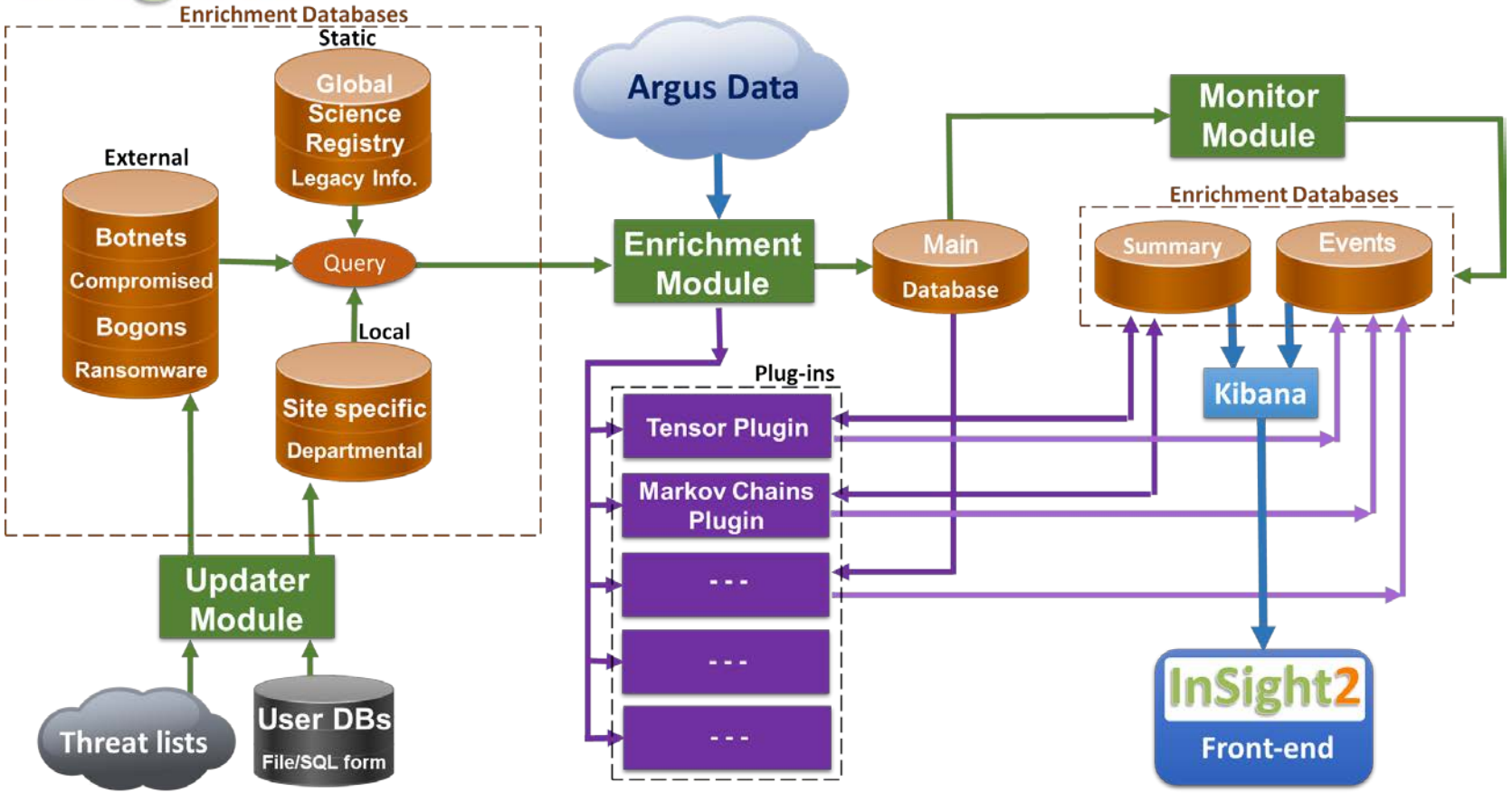
Argus is used by

OAK RIDGE National Laboratory
Carnegie Mellon University Software Engineering Institute
Stanford University
SONY
MaxMind®
NSF
CERT
ArcSight
Pluribus NETWORKS
MySQL

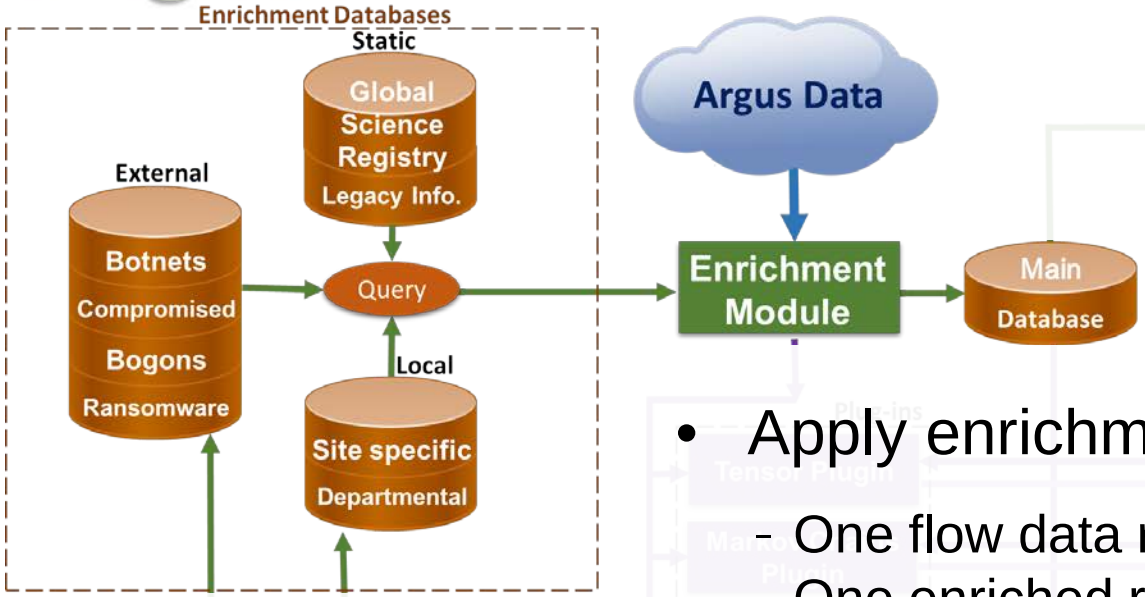
InSight2 Software Architecture 1/6



InSight2 Software Architecture 2/6



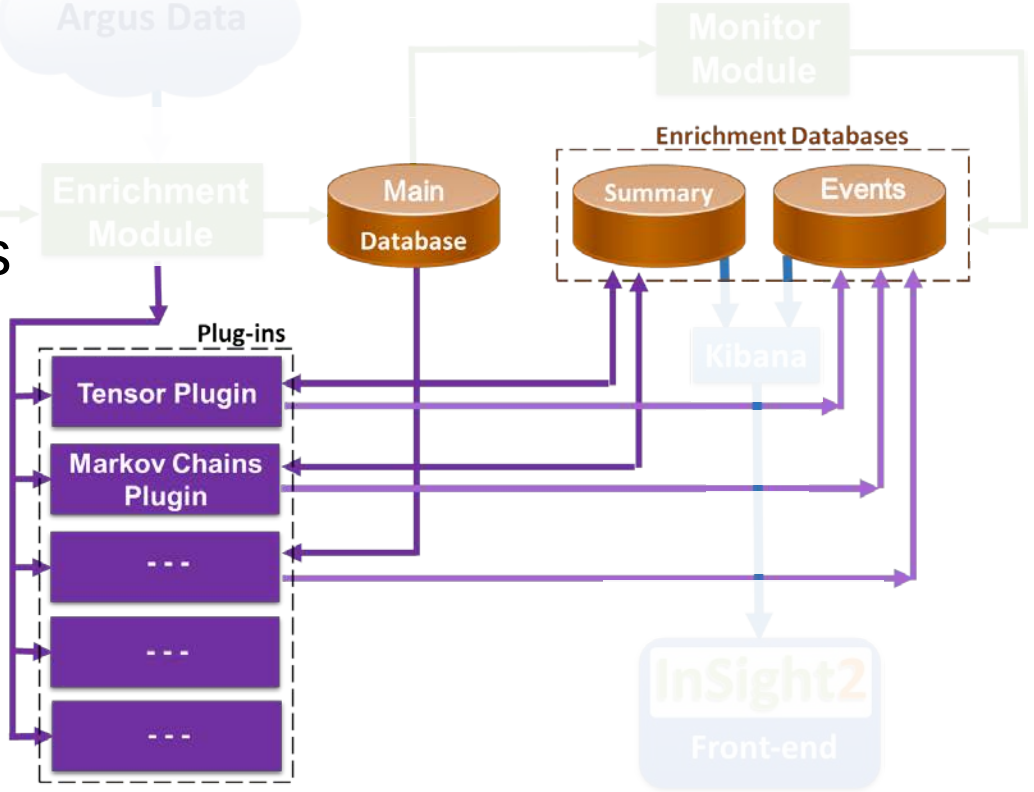
InSight2 Software Architecture 3/6



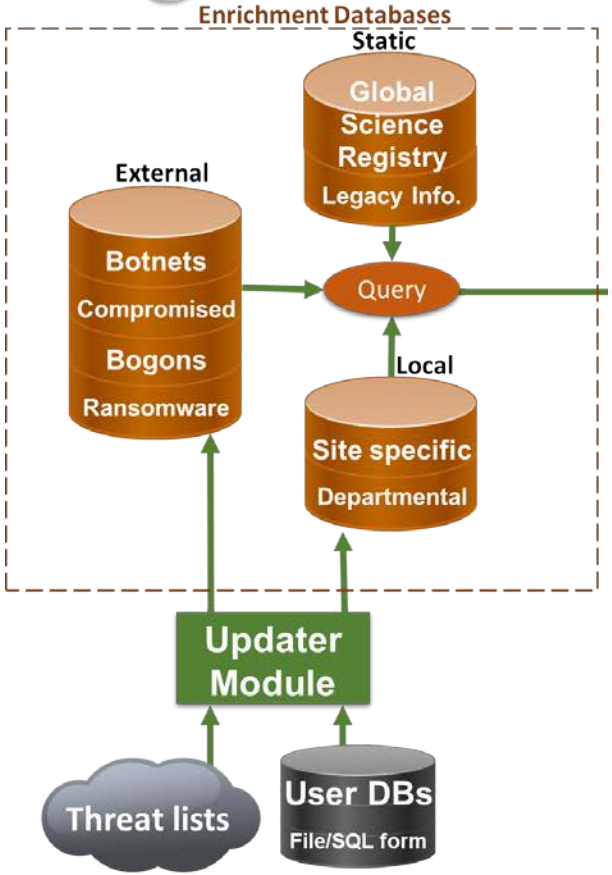
- Apply enrichment databases
  - One flow data record in
  - One enriched record out
- Store results in Main database

InSight2 Software Architecture 4/6

- Plug-ins invoked after enrichment epoch
- Perform data analytics using main and summary databases
- Store results in summary and events databases



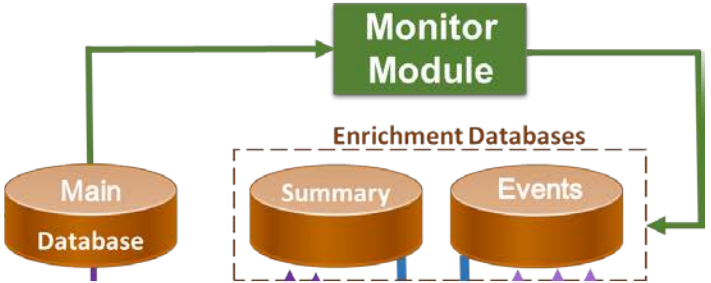
InSight2 Software Architecture 5/6



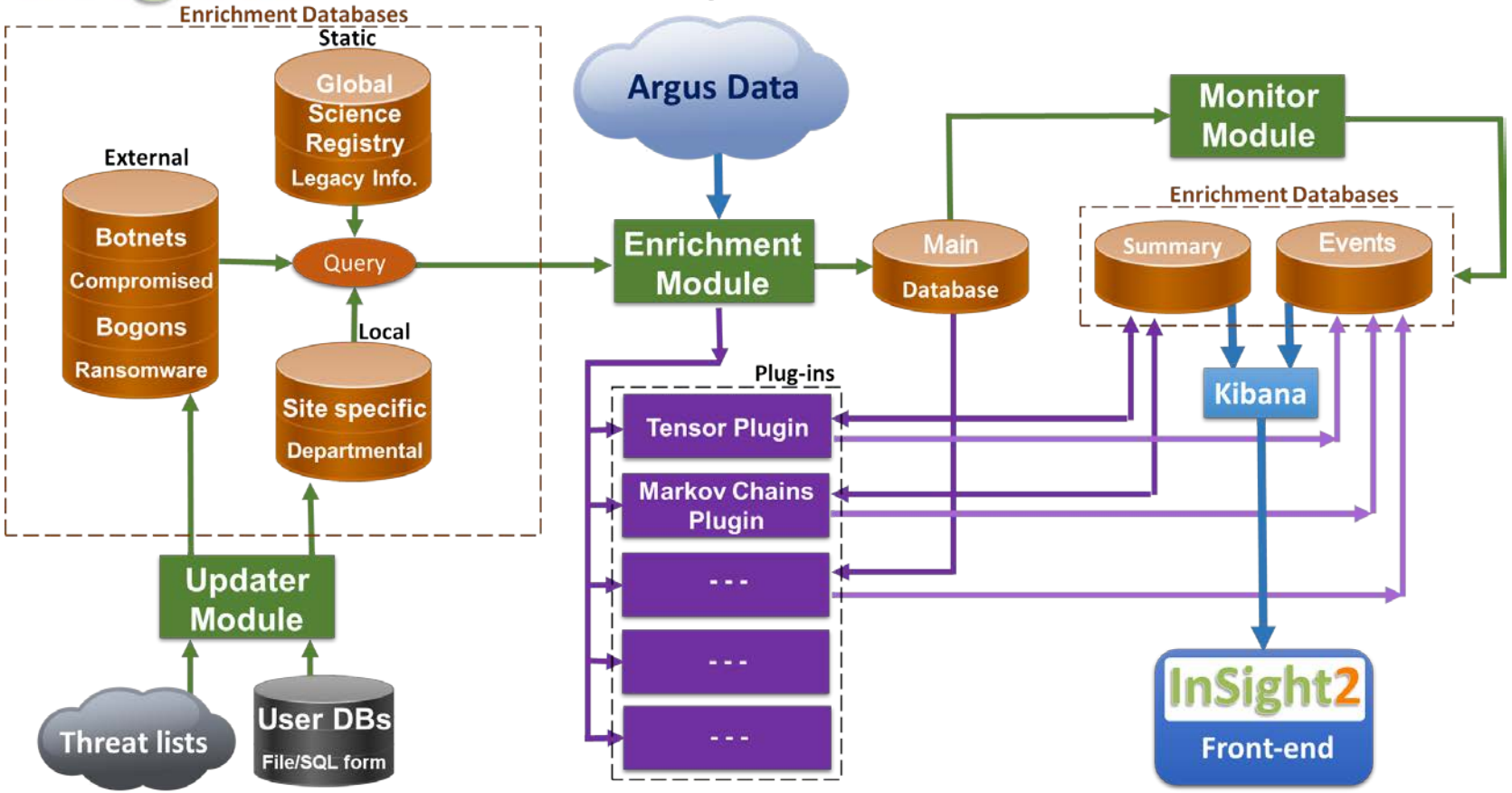
- Check user databases for changes
- Poll threat lists for new updates
- Aggregate, de-duplicate, and update enrichment databases

InSight2 Software Architecture 6/6

- Create per-second summary
- Collect events from main database and append to events database
- Purge expired data from main database



InSight2 Technologies Used



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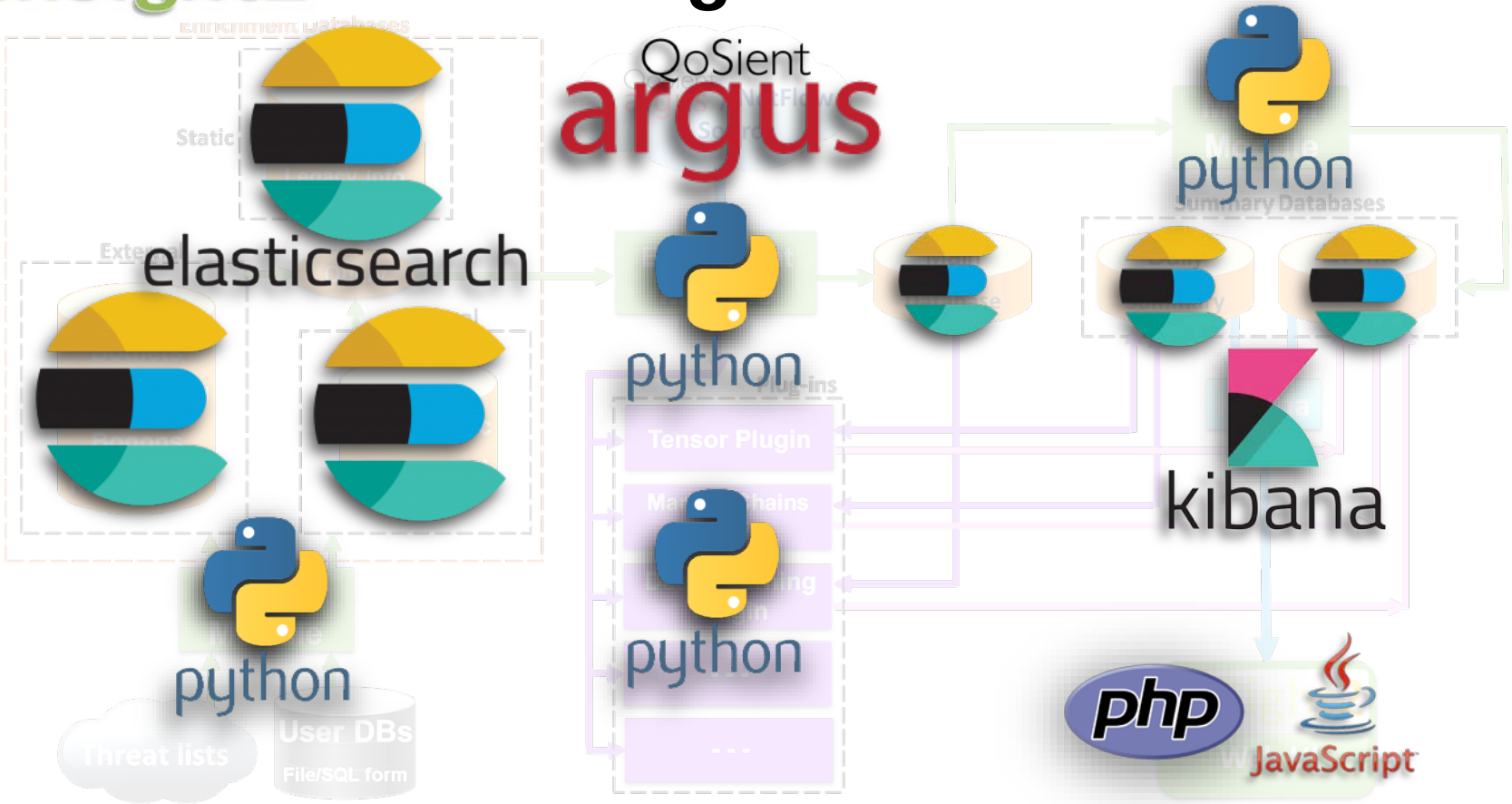


InSight2 uses elastic

elasticsearch

- Highly scalable
- NoSQL database
- Full-text search engine
- Distributed

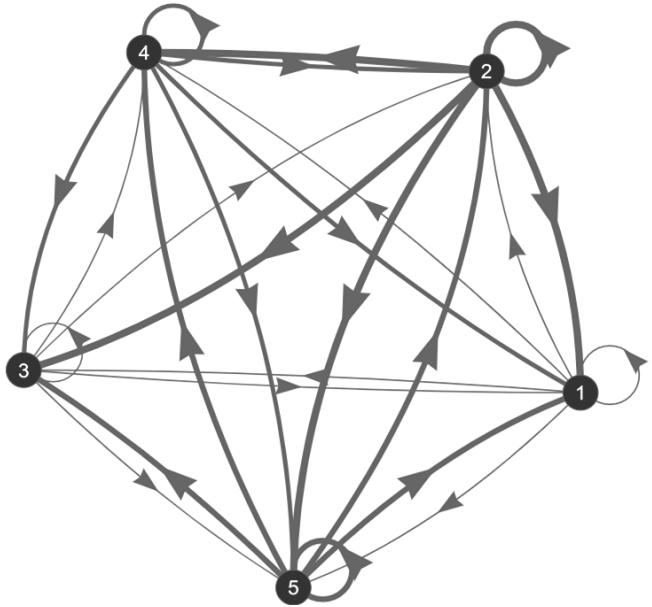
kibana

- Visualization platform
- Intuitive dashboards
- Native integration with ES
- Geo-map tile service

InSight2 Plug-in: Markov Chain 1/2

- State transition model
- Stochastic: Prob($s_{i+1}|s_i$)

- Inferred from training data
- Model analysis
  - Steady-state
  - First-transitions
- Live data processing



InSight2 Plug-in: Markov Chain 2/2

- Usage: Network utilization prediction

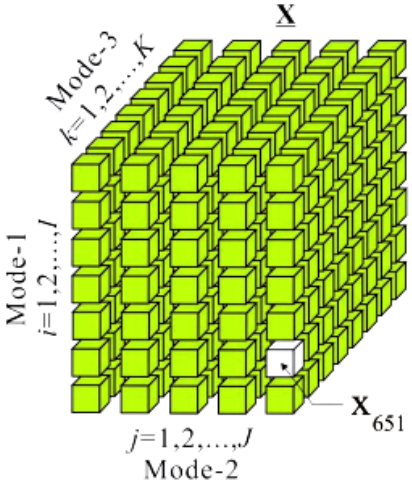
Actual Usage

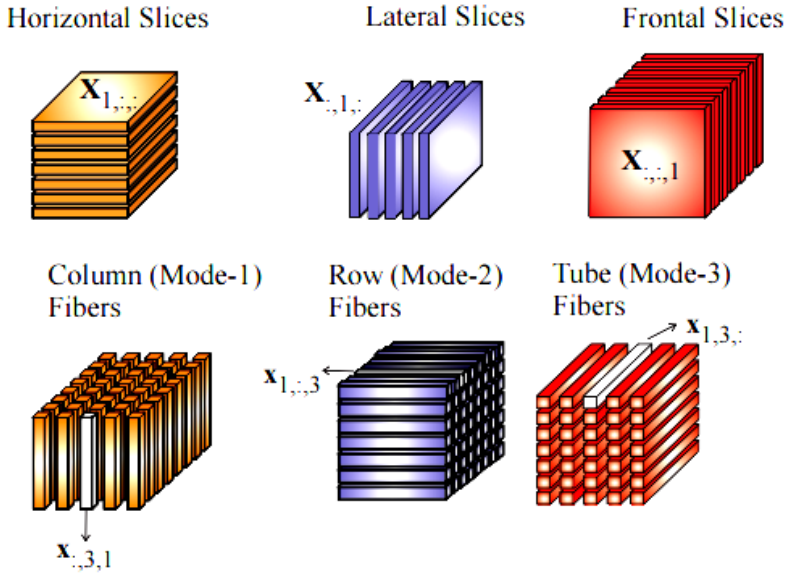
Predicted Usage

State Transition Probabilities

InSight2 Plug-in: Tensor Analysis 1/3

- Tensor: multidimensional matrix of real numbers
- Each mode is *n*-dimensional matrix (called slice)





InSight2 Plug-in: Tensor Analysis 2/3

- Tensor energy
  - Average sum of squares per slice given mode
- Data sparsification
  - Low energy change data discarded during update
- Event detection
  - High energy change data indicates new trend that may warrant investigation (anomalous behavior?)

S. Papadimitriou et al, Streaming Pattern Discovery in Multiple Time-Series, Proc. VLDB, Trondheim, Norway, 2005

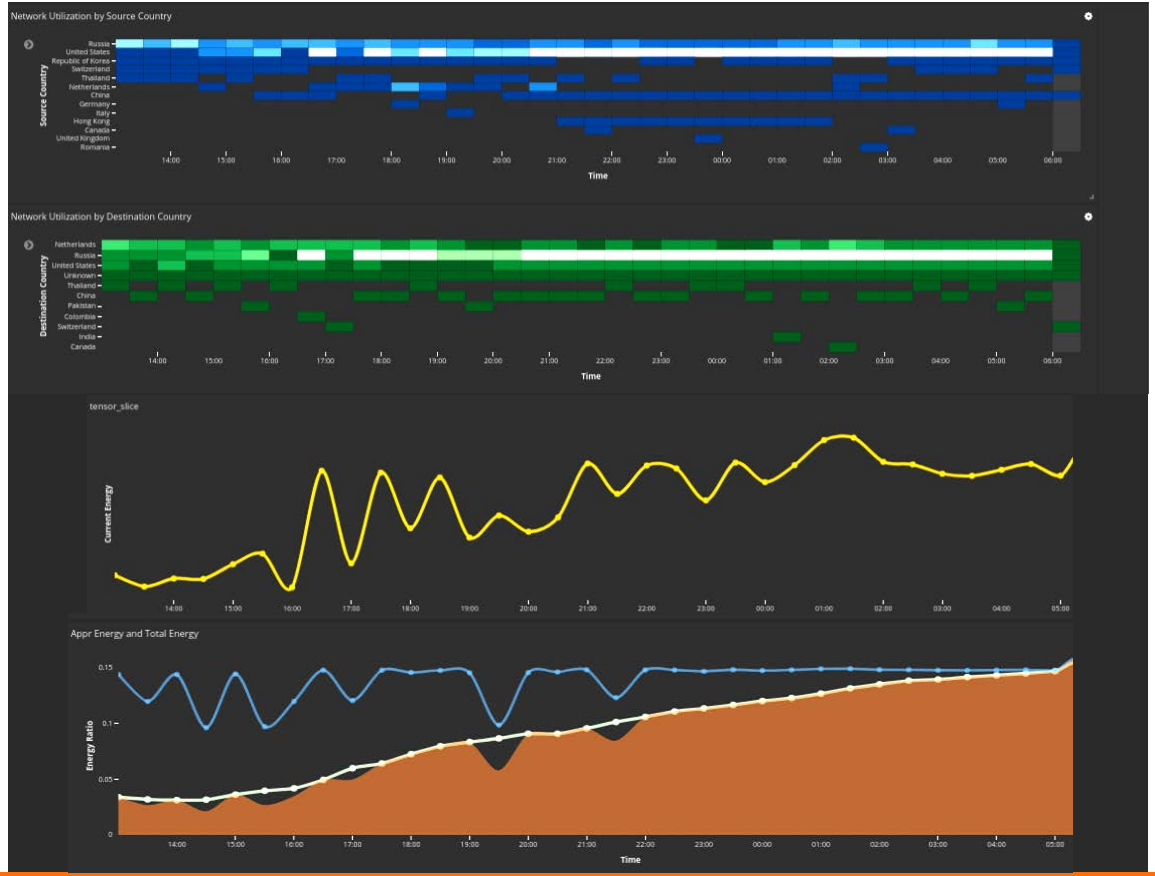
InSight2 Plug-in: Tensor Analysis 3/3

Observed source traffic

Observed destination traffic

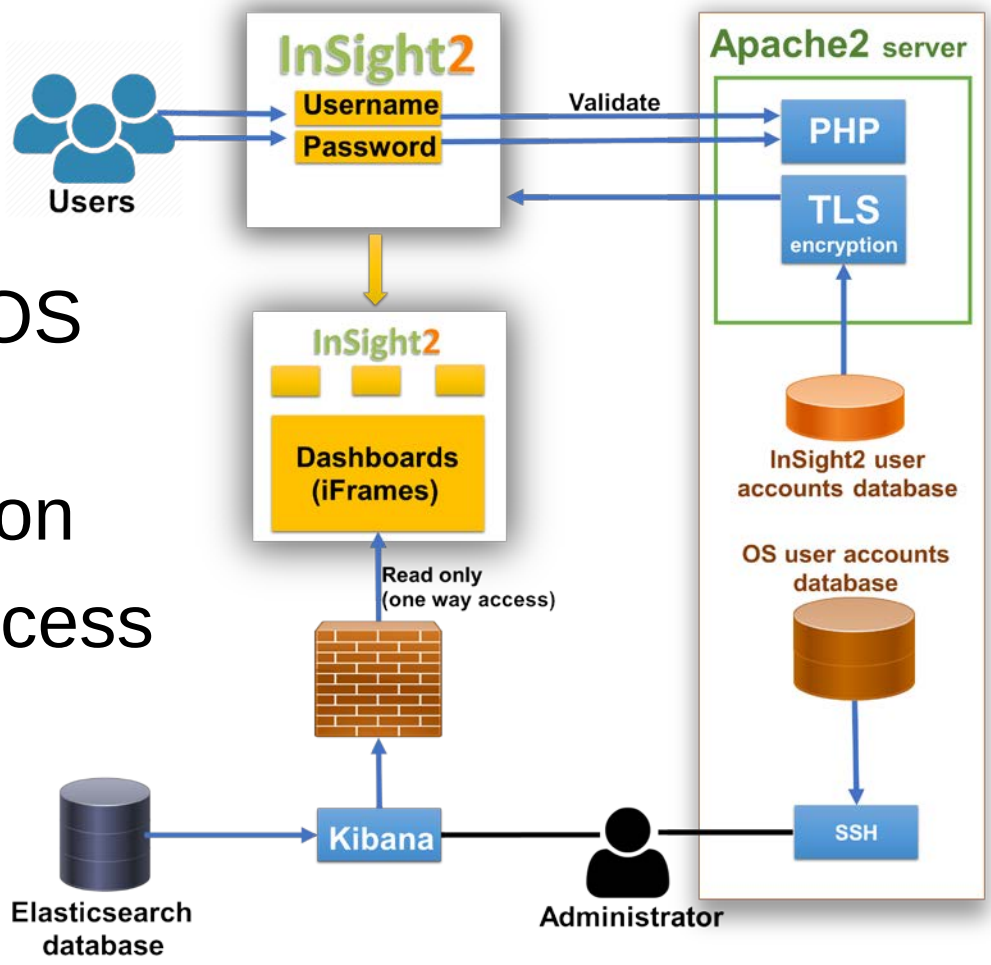
Slice Energy

Anticipated Energy
Actual Energy
Energy Ratio



InSight2 Frontend

- TLS 1.2 transport
- Separate InSight2 and OS user authentication
- Server side authentication
- Secure administrator access
- Read only / one way dashboards



InSight2 Summary

- Argus flowdata modeling and analysis
- Interactive web based platform
- Open-source modular software (release TBD)

- Partners
  - QoSient, Cisco ASIG
  - Stanford University, KISTI (South Korea)

- Work supported by NSF: IRNC-1450959