Software Defined Privacy-Preserving Measurement Instrument and Services

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Outline

- Overview of IRNC AMIS Project
- Overview of Project Tasks
  - Software Defined Measurement
  - Privacy Preserving
  - Data Management and Processing
  - Traffic Modeling and Analytics
- Project Schedule and Milestones

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NSF IRNC Program

- NSF International Research Network Connections
  - NSF investments on high performance network required by international science and engineering R&E
  - Supports backbones, exchange points, NOC, and network measurement
- Requirements on Advanced Network Measurement Infrastructure (AMI)
  - Flow granularity, 40+Gbps line rate, aggregate and summary reporting (protocol, AS-level s/d matrix), protect user privacy
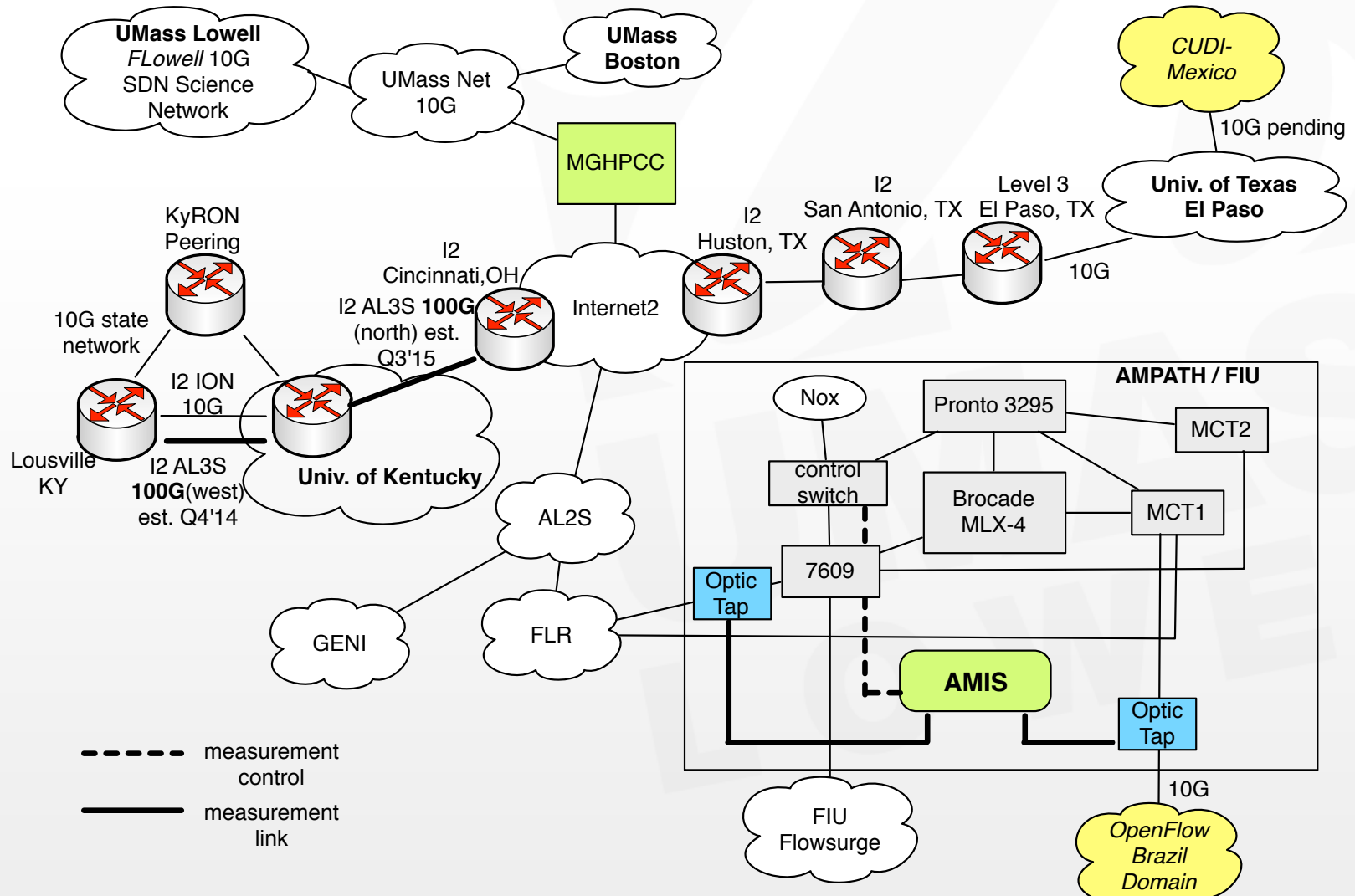
AMIS Project

▶ Objectives

- 40+Gbps flow-granularity network measurement instrument
- Software defined measurement
- Preserving privacy of network flow info
- In-depth flow analytics

▶ Project Team:

- Yan Luo, PI, University of Massachusetts Lowell
- Gabriel Ghinita, Co-PI, Univ. of Massachusetts Boston
- Cody Bumgardner, Co-PI, University of Kentucky
- Michael McGarry, Co-PI, University of Texas El Paso

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AMIS At a Glance

Yan Luo, NSF GENI-FIRE Workshop,
Sept 17-18, 2015

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The Sensor: Advanced Measurement Appliance

Network Processor based Advanced Measurement Appliance
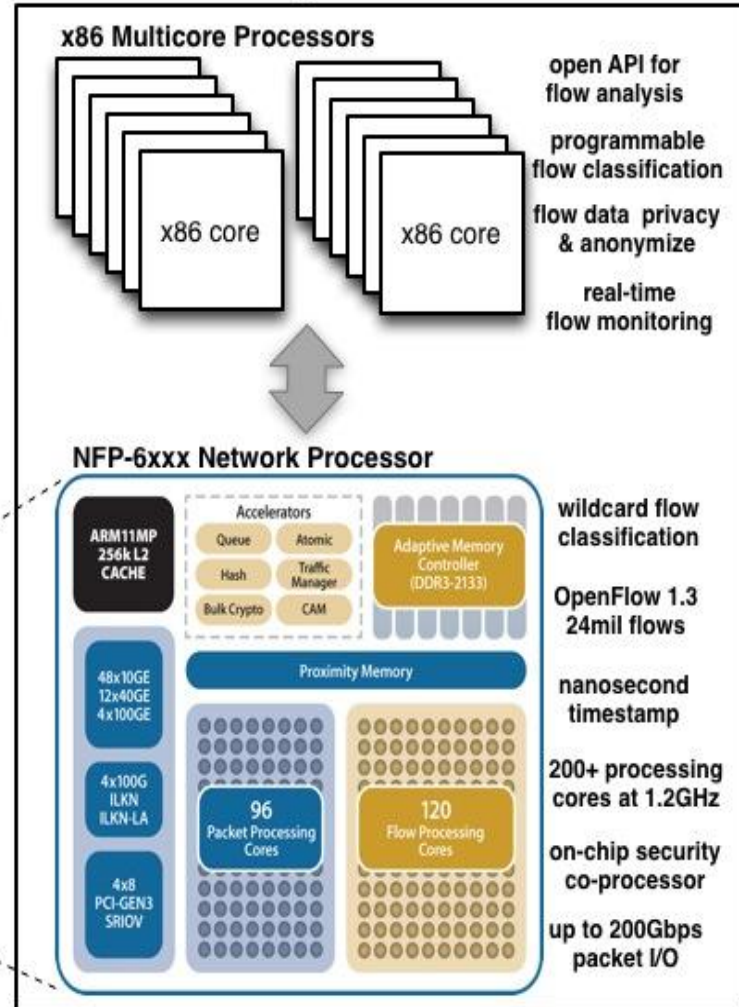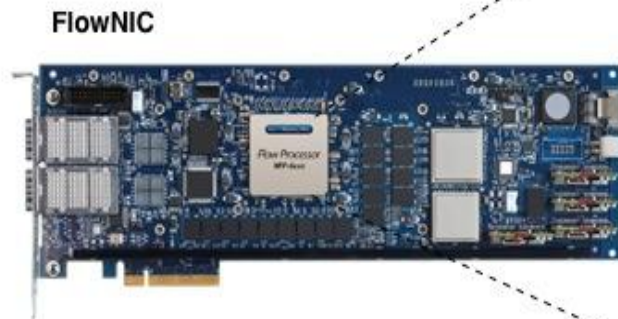
Advantages of AMA

▸ Superior in both performance and programmability

▸ Clean architectural separation between measurement data plane and measurement control plane

▸ Software based flow analysis on x86 multicores

▸ Line-rate measurement capabilities with no impact to user's traffic

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AMIS Workflow
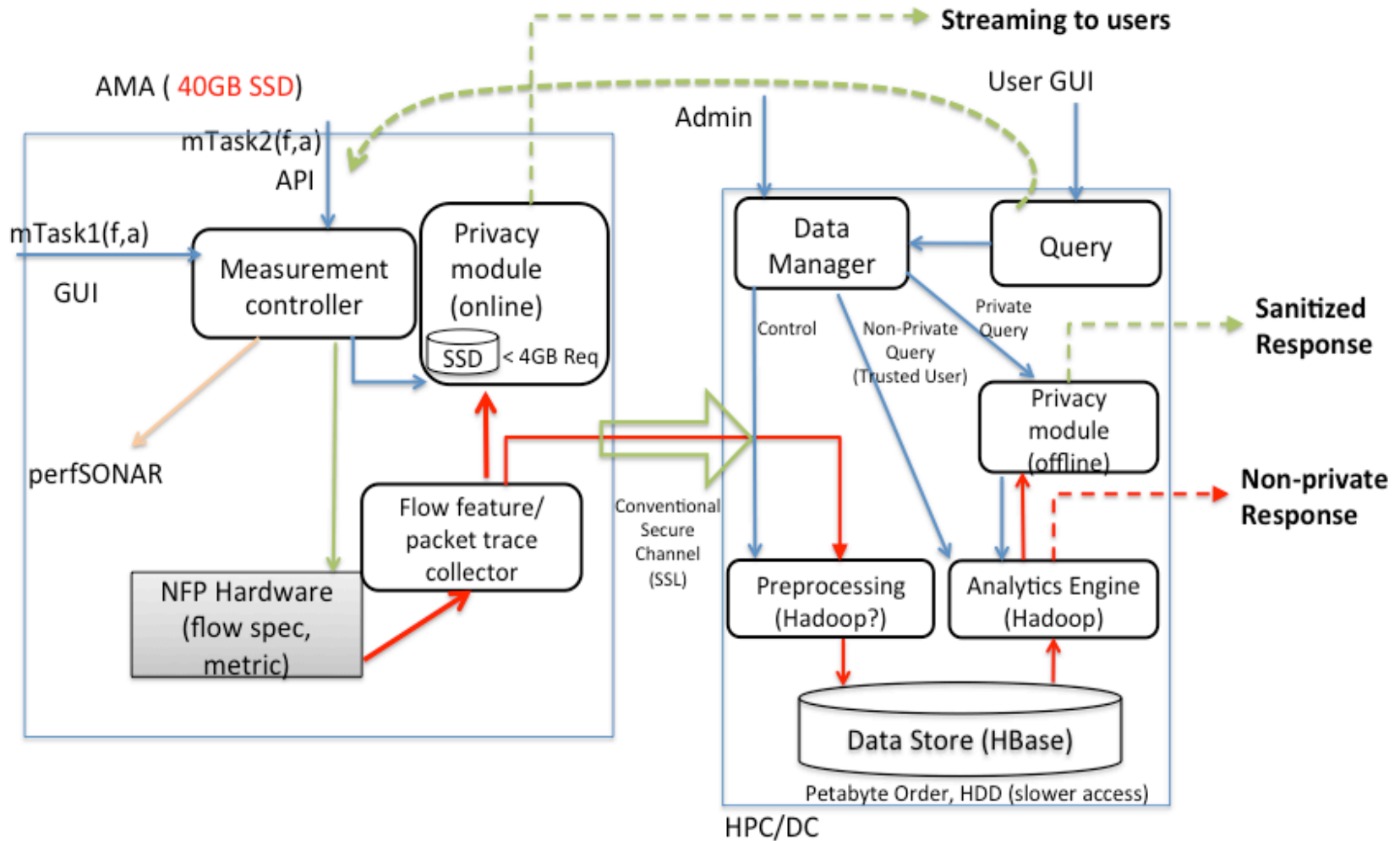
Software Defined Measurement

▶ Why
  - target changes (flows, subnets, ASes)
  - measurement metrics changes
  - Changes in measurement condition or period

  e.g. measure packet inter-arrival time when flow duration is longer than 5 minutes

▶ How
  - Measurement Data Plane
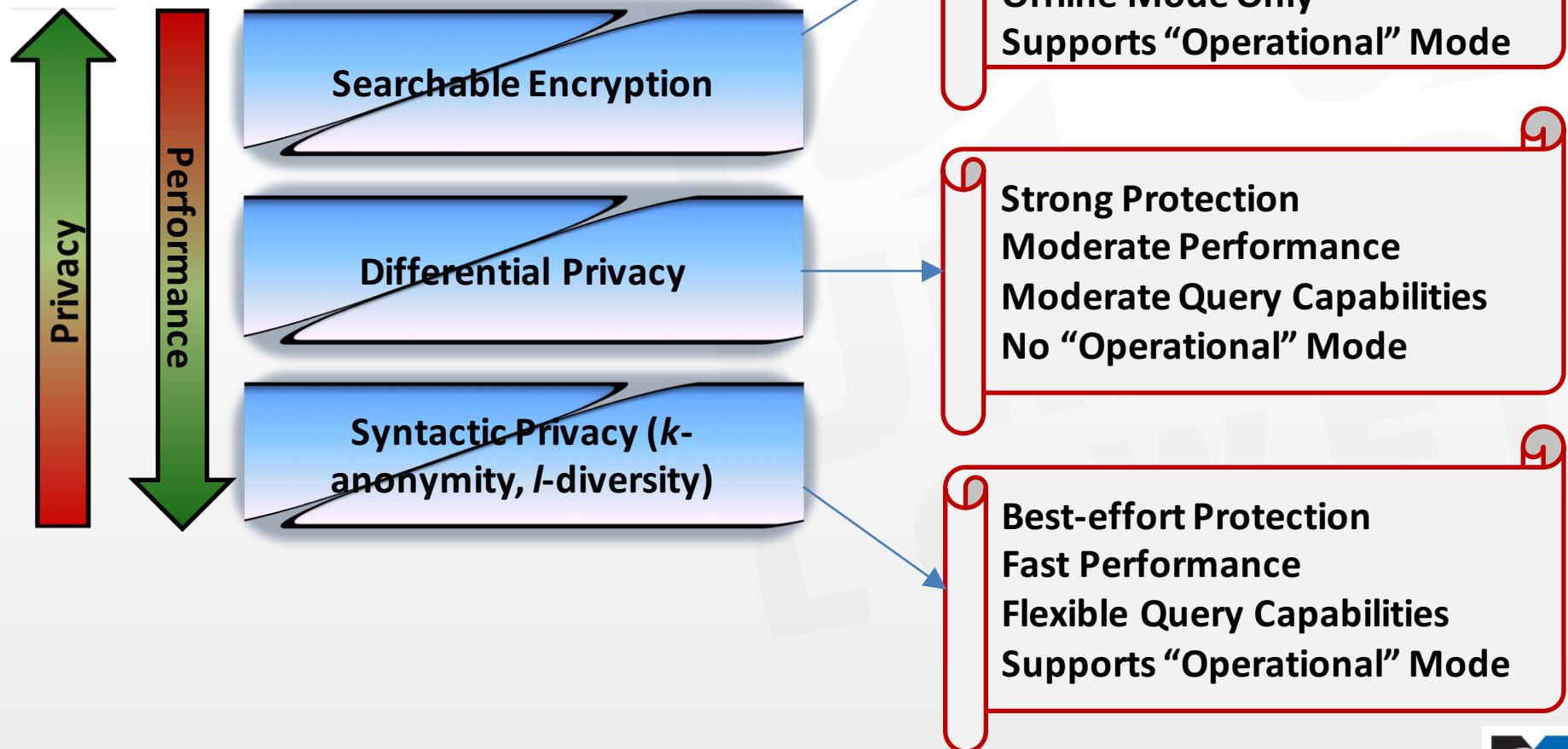 - Measurement Control Plane

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SDM Data Plane

▶ Challenges

- Application and protocol diversity
- Streaming
- Line-rate
- Distributed

▶ Possible solutions

- Programmable parsing
- Data stream computation
- Hardware acceleration
- Collaborative measurement

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Privacy Preserving Measurement

▸ Privacy is a challenge in network measurement
- What levels of details to report
- Network operators have different policies
- Sometimes bigger than technical challenges

▸ Comprehensive framework that encapsulates most prominent privacy models
- Syntactic models (generalization/suppression)
- Semantic models (differential privacy)
- Cryptographic models (searchable encryption)

▸ Supports diverse set of data uses
- E.g., operations, statistics, data mining

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Supported Privacy Models

Searchable Encryption

Differential Privacy

Syntactic Privacy (*k*-anonymity, *l*-diversity)

Privacy

Performance

Strongest Protection
Slow Performance
Limited Query Capabilities
Offline Mode Only
Supports "Operational" Mode

Strong Protection
Moderate Performance
Moderate Query Capabilities
No "Operational" Mode

Best-effort Protection
Fast Performance
Flexible Query Capabilities
**Supports "Operational" Mode**

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Challenges in Measurement Data Analytics

- Diversity of analytics algorithms
  - Privacy preserving algorithms: differential privacy, searchable encryption, etc.
  - reports of network activities: traffic matrix, flow-level, burst-level
  - Predictive: e.g. congestion event prediction
- Variations on Traffic Load
  - variations on compute loads
  - Variations of network I/O demands
  - Streaming requirements

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Measurement Data Management and Processing in the Cloud

- A centralized Operational Data Management System to manage distributed AMAs
  - configuration
  - collection
  - storage
  - Processing
  - Reporting
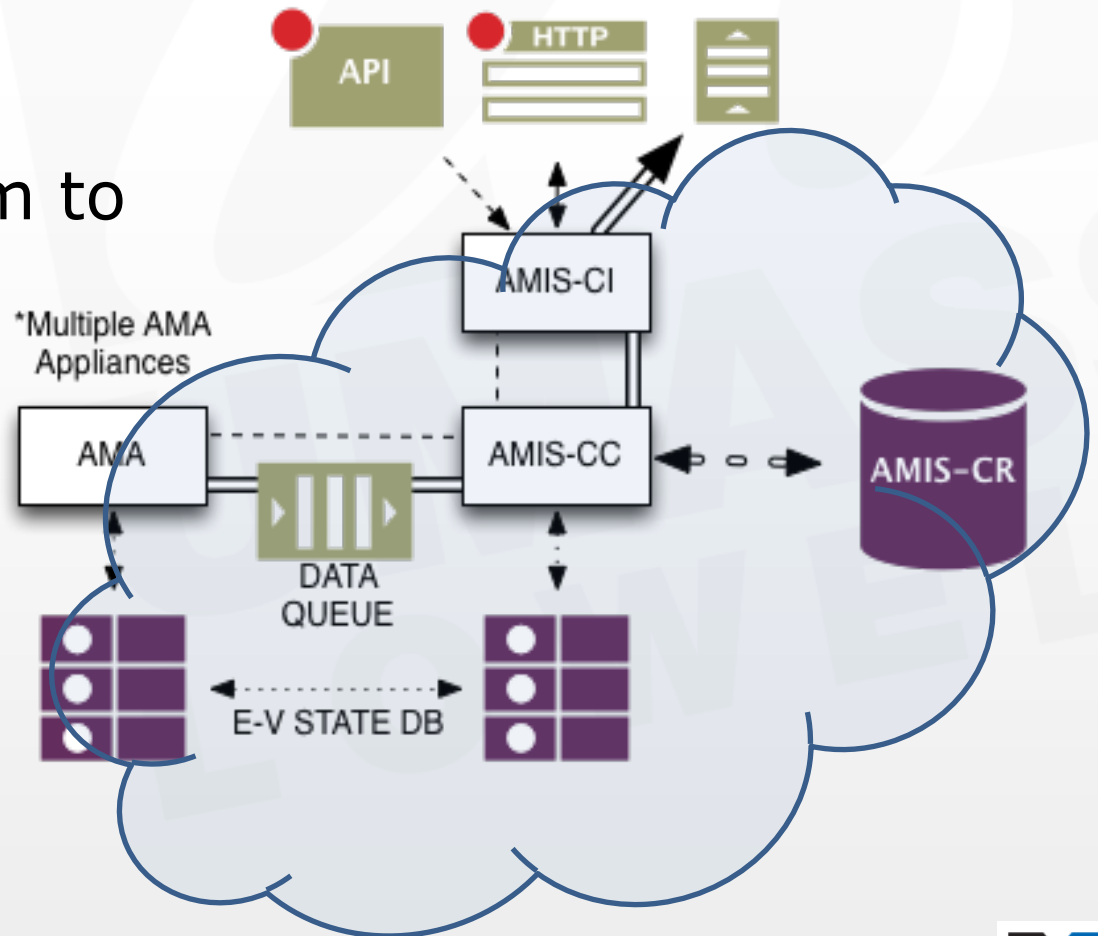
AMIS Project Schedule

- Year 1
  - Q1: design specification
  - Q2: agile development, coordination with AMPATH and CUDI about deployment and test plan, coordination with NetSage project
  - Q3: prototype development, integration and local testing
  - Q4: deployment of AMIS at AMPATH, reporting results, plan next steps
- Year 2
  - Expand to more test sites, gather feedbacks from operators, outreach
- Year 3
  - Outreach, continuous improvements, other tasks TBD

Thanks!

Q&A

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