Runtime Assurance for Big Data Systems

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System Measurement for Assurance at Runtime

Big Data systems have a very dynamic runtime context – assurance “by design” is still necessary but not sufficient

- New and changing data sources – sensors, humans, systems
- Evolving user workloads driven by new missions and new data
- Shared infrastructure – variable quality of service

Need to monitor the big data system in its runtime environment

- Collect measurements/metrics
- Assess health and trigger action to assure capability delivery

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Focus of this year's project

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Future Work – Predict, Diagnose

Technical Challenges – Measurement Collection in Big Data Systems

System scale

- 1000s of nodes
- Millions of measurement time series streams
- Efficiency is critical

Processing and storage framework resiliency and redundancy makes individual node status less meaningful

- Need aggregate application-level measurements composed from component data
- End-to-end system performance is the ultimate health measure

Solution Approach

Scale → Automation

- Monitor generation
- Monitor insertion
- Measurement collection and aggregation
- (Future) Generate visualizations

Architecture Styles → Abstractions and constraints to enable efficient automation (metamodels)

- Styles/Patterns capture common architecture approaches
  - Restrict types of components and topologies
  - Establish semantics for a class of functionality
  - Define what to measure, where to measure, how to aggregate

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New Contribution

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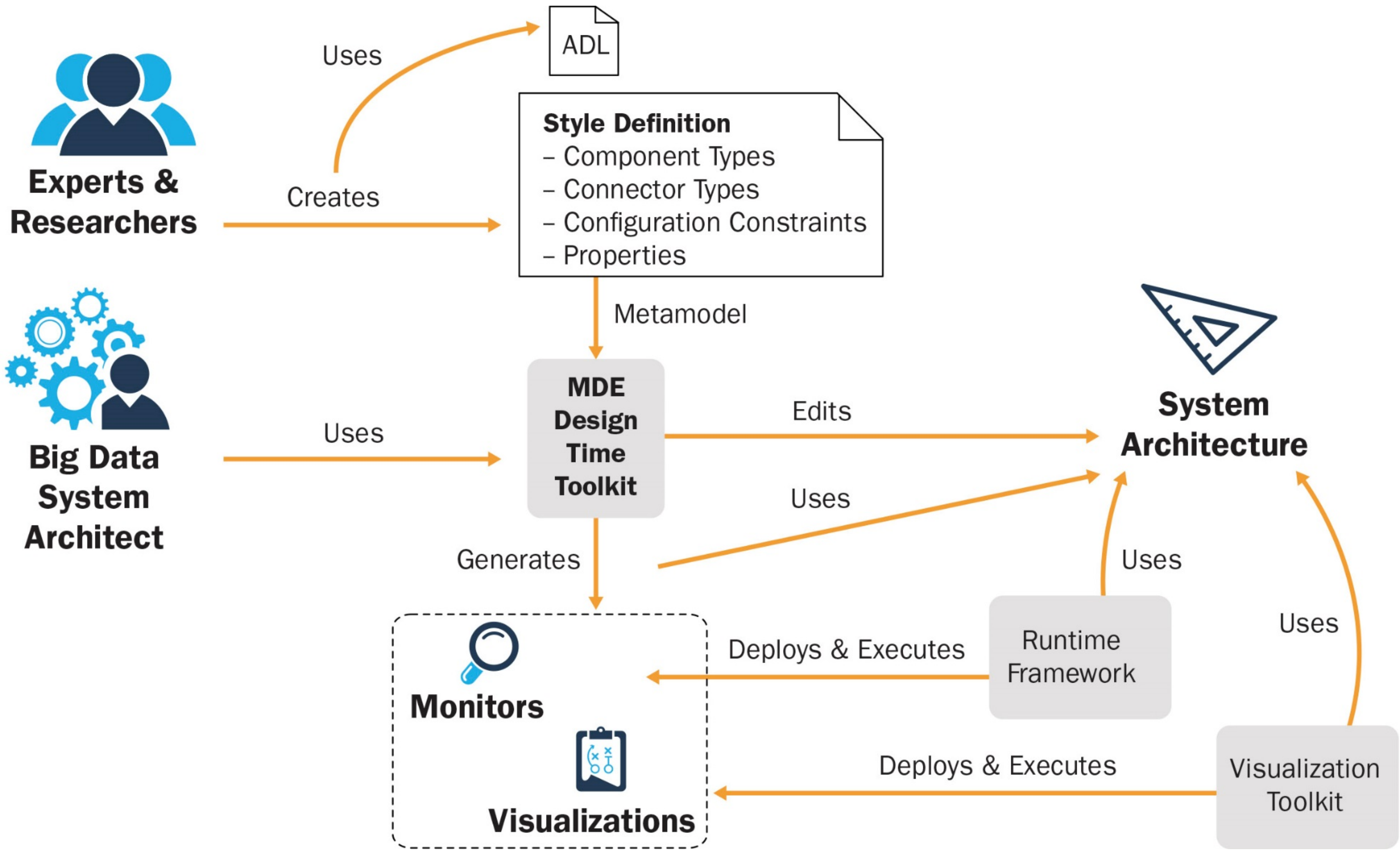
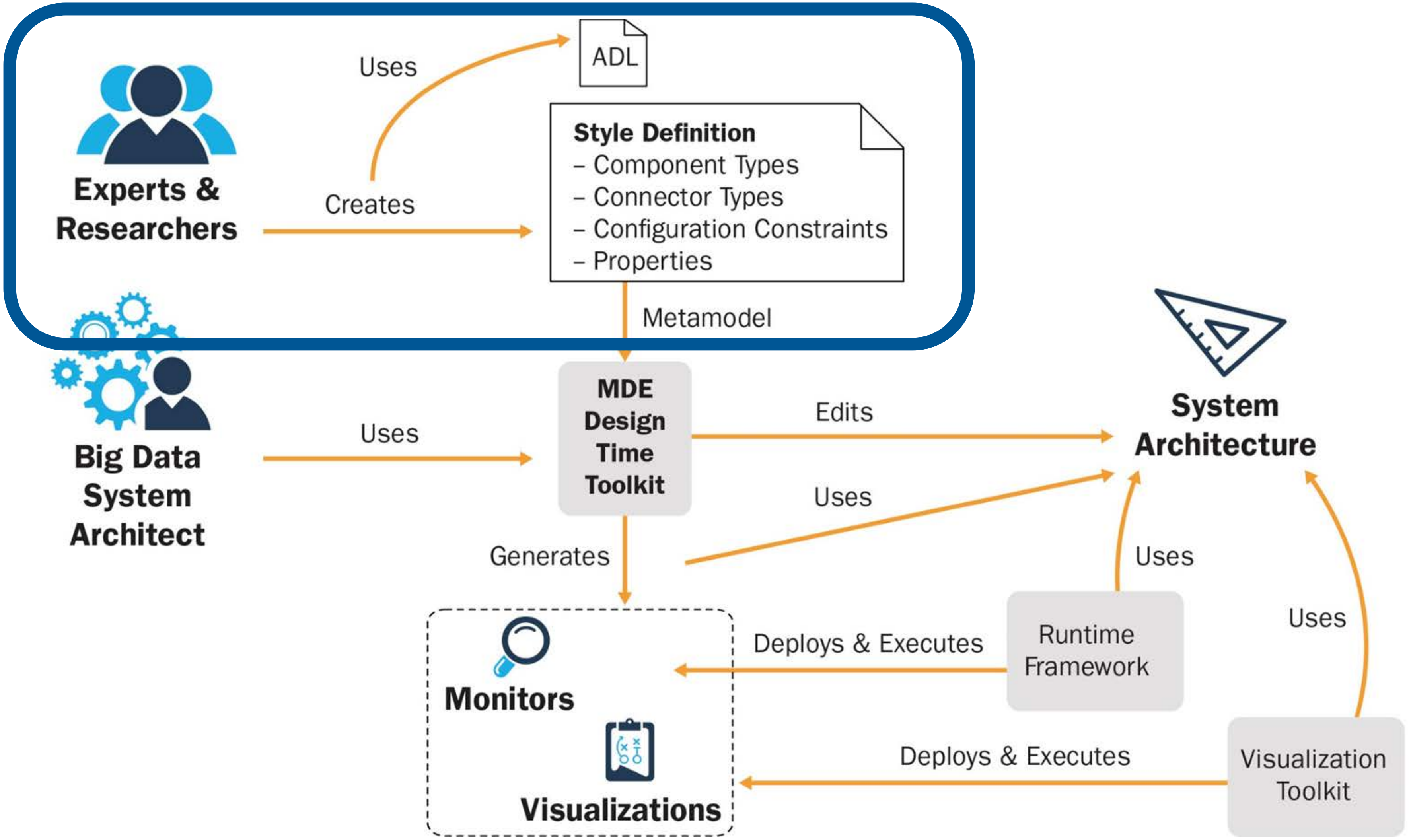
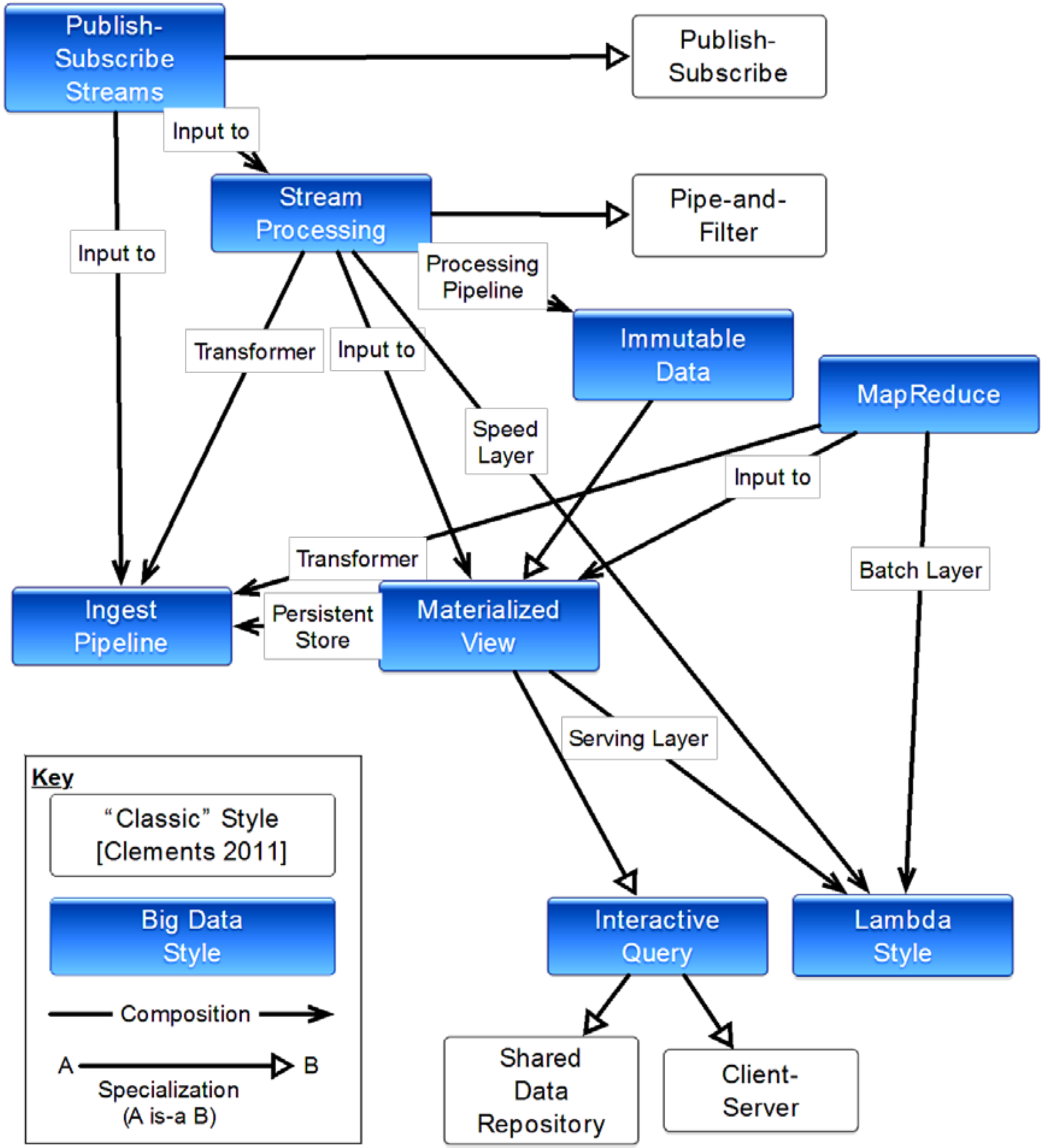
Scale → Automation
Leverage Architecture Styles to Automate



Results –
Architecture Styles for Big Data Systems



Results



Architecture Styles for Data-Intensive Systems

Example – Ingest Pipeline Style

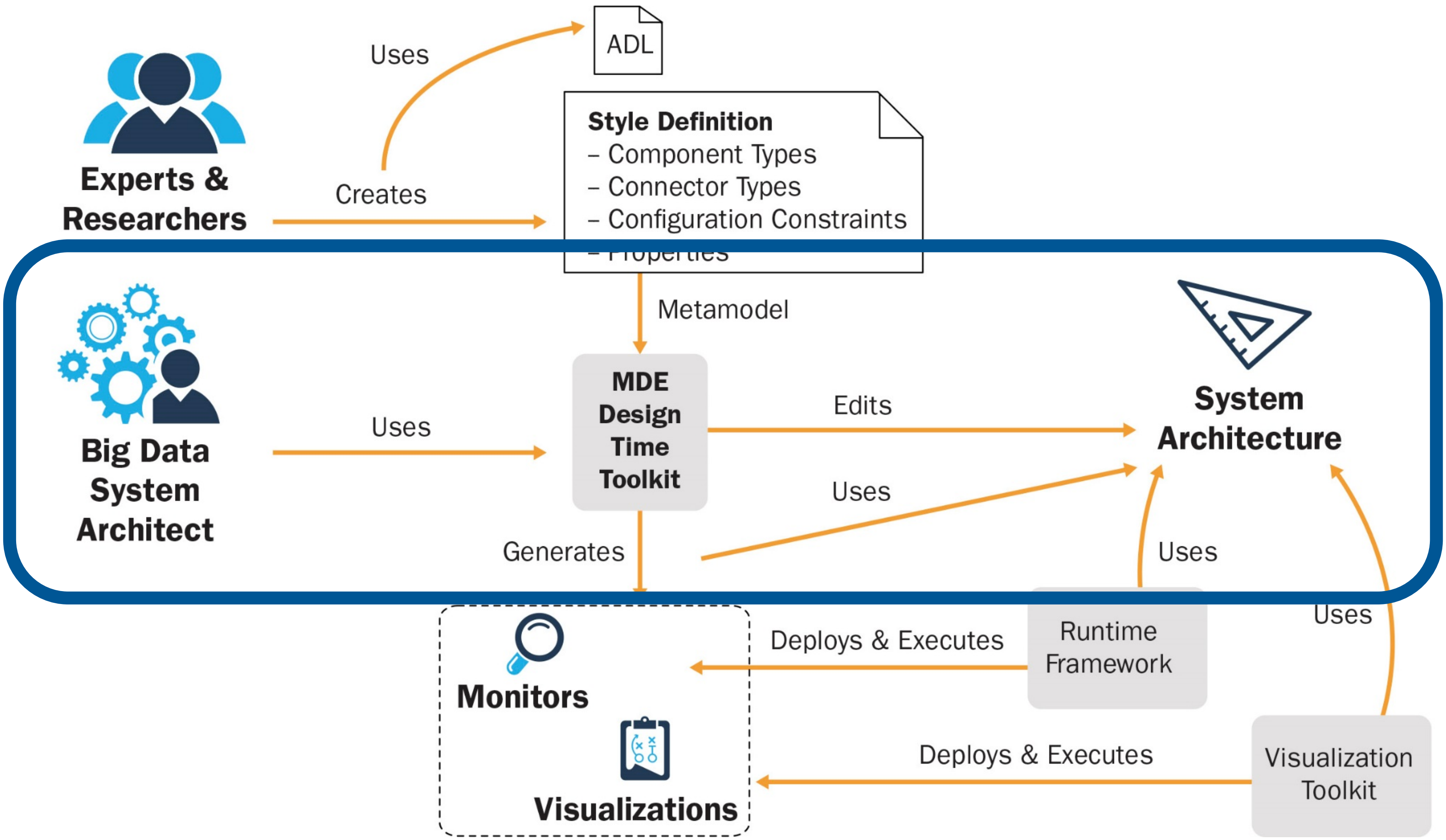
Component Types

- Source Adapter, Transformer, Writer, Persistent Store

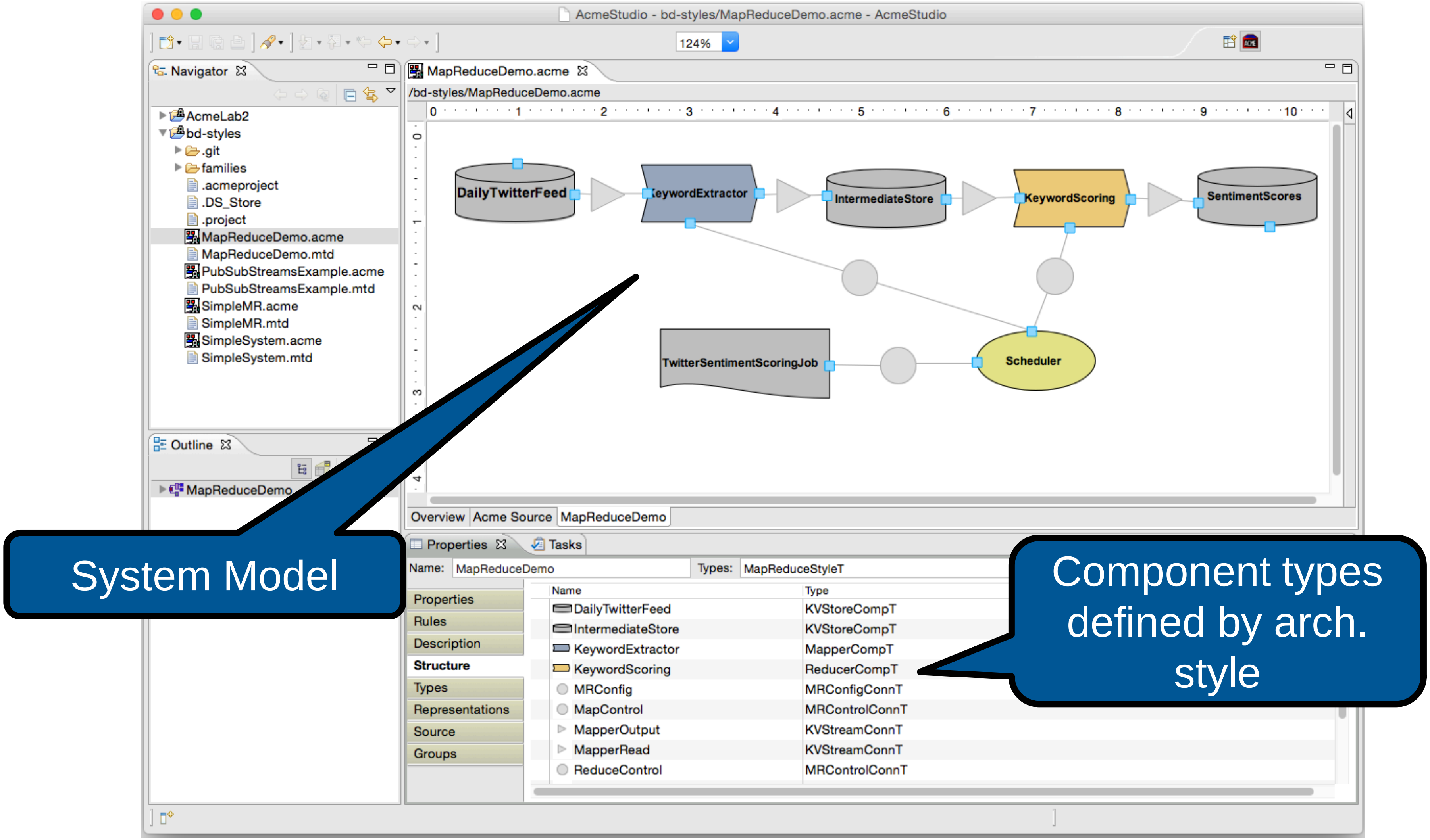
Measurement Metamodel

- A healthy instance of the *ingest pipeline style* processes data at a rate that keeps ahead of incoming data. The measurements to provide visibility into this include:
  - # of input messages/records and rate for each input source
  - # of data store writes per namespace and write rate
  - Application-specific counts of values of particular input and output data types (“peg counts” or histograms) to assess the distribution of input and output data sets.

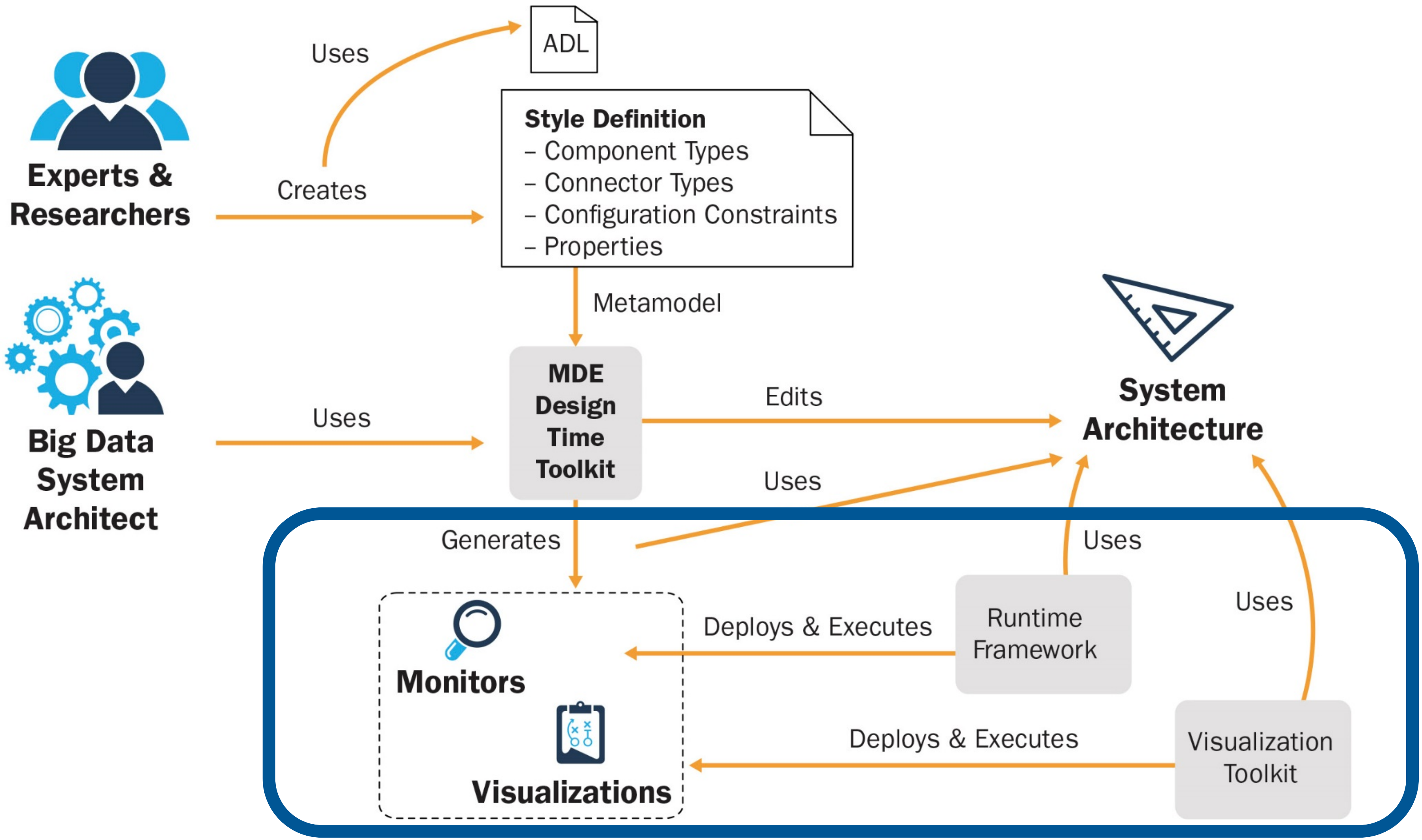
Results – Using Styles to Model Big Data Systems



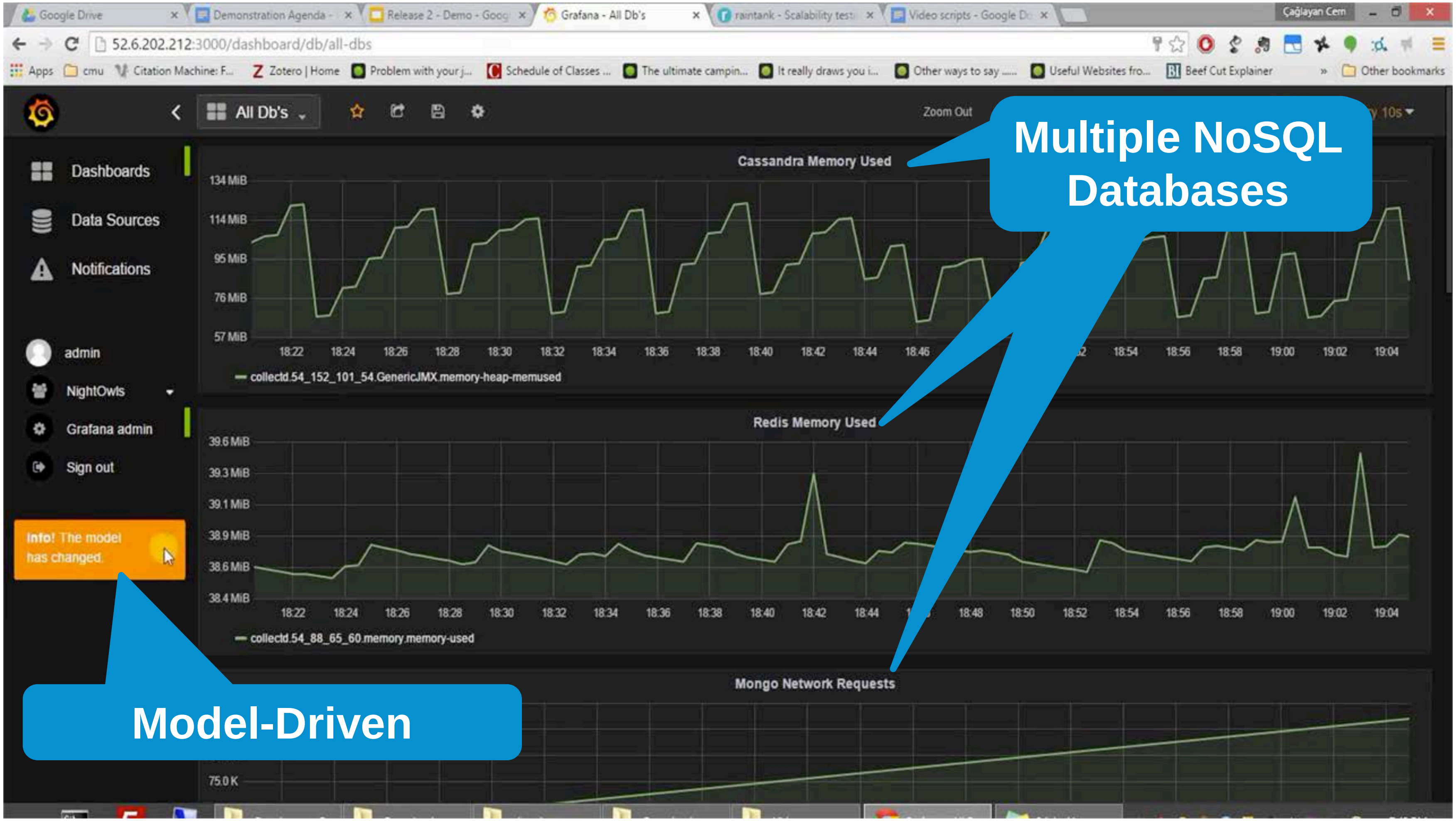
Style-Based System Modeling in Acme Architecture Description Language



Results – Automated Monitor Generation and Measurement Collection



Model-Generated Monitors and Collection for NoSQL Persistence (CMU MSE Project)



Results and Future Work

Demonstrated feasibility of automating measurement collection and aggregation

- Steps are manually integrated
- Limited monitor generation

Future Work:

- Transparent monitor insertion into existing systems that use open source processing frameworks (e.g., NTC using Apache Storm)
- Extension of style catalog for machine learning systems
- Automated generation of advanced visualizations
- Anomaly detection analytics (e.g., analytics like Netflix “starts per second” analytics)

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