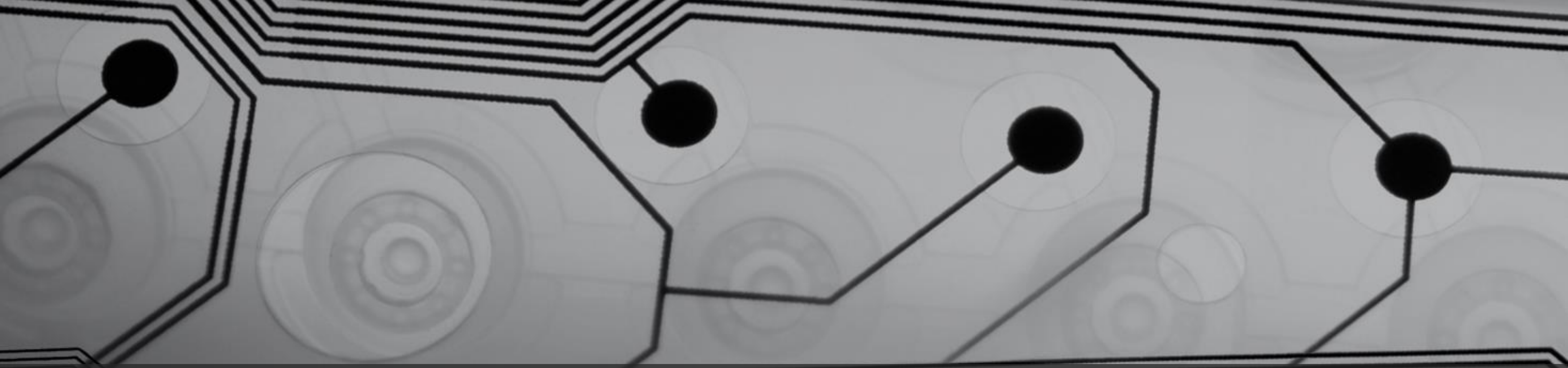

Gigascope: A Stream Database for Network Applications

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Overview

- Problem
- Goals
- Background: Data Streams
- Gigascope Data Stream Management System
- Conclusions

Problem:
Managing a Large Data Communications Network

- Requires constant network monitoring
- Decentralized → Difficult to manage
- Analyze network trace dumps
- Limited set of network monitoring reports

Goals

Develop a network data analysis tool which has:

- Speed and flexibility that network analysts require
- Provides structured querying environment to make complex analysis easy to control

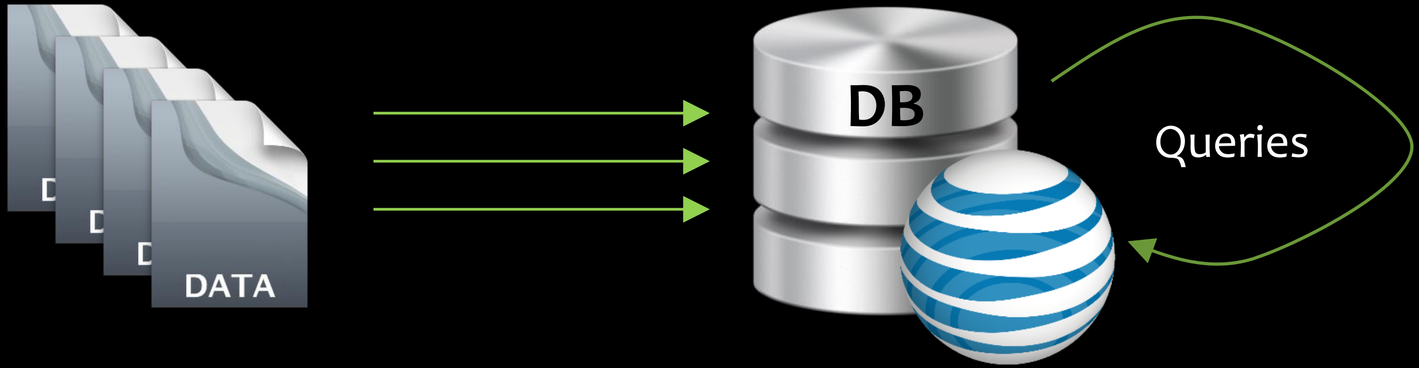
Goals

Create a data analysis engine that will be used in many settings:

- traffic analysis
- performance monitoring
- debugging
- protocol analysis and development
- router configuration
- intrusion detection
- network monitoring

Data Streams: Why Now?

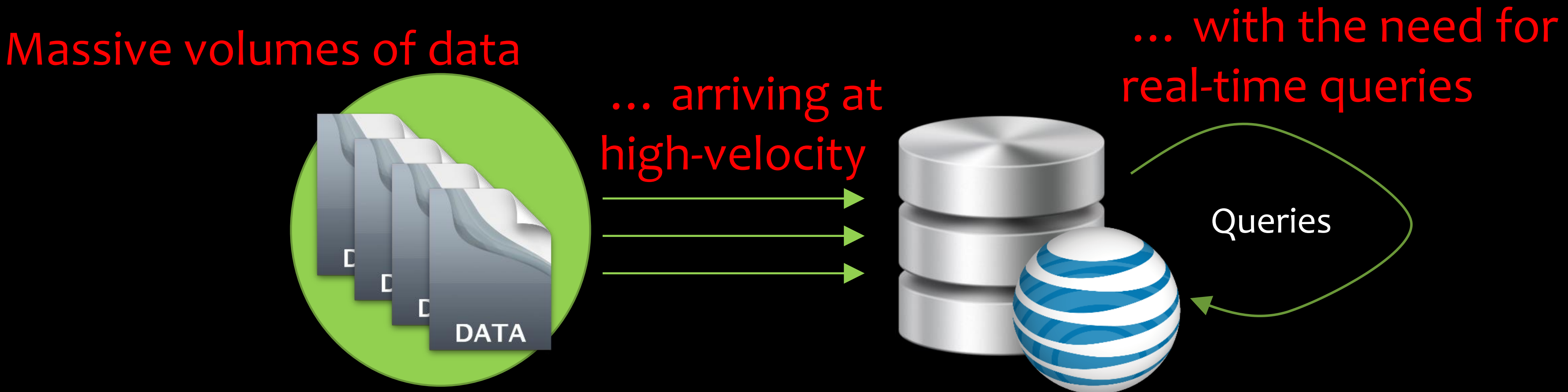
- Haven’t data feeds into databases always existed? Yes
  - Modify underlying databases and data warehouses
  - Complex queries are specified over stored data



- With traditional data feeds
  - Simple queries needed in real-time
  - Complex queries performed offline

Data Streams: Real-Time Queries, High-Volume and High-Velocity Data

- Two recent developments: application and technology driven
  - Need for sophisticated real-time queries/analyses
  - Massive data volumes of transactions and measurements


Massive volumes of data
DATA
… arriving at high-velocity
… with the need for real-time queries
Queries

Databases vs Data Streams

Database Systems

- Relation: tuple set
- Data Update: modifications
- Query: transient
- Query Answer: exact
- Query Evaluation: arbitrary

Data Stream Systems

- Relation: tuple sequence
- Data Update: appends
- Query: persistent
- Query Answer: approximate
- Query Evaluation: one pass

Gigascope: Data Stream Management System (DSMS) for Network Applications

- Designed for monitoring high-rate data streams
  - Pure stream database (no stored relations or continuous queries)
  - Pipelined operators that rely on properties of the stream
- Uses SQL-like language, named GSQL
  - Input is a data stream, output is a data stream
- Simplicity of implementation, does not transform input data stream into a windowed table, operate on data stream directly

The GSQL Language

- Supports selection, join, aggregation, and stream merge
- GSQL processor is a code generator, translating the query to C or C++ code resulting in a fast execution system
- Example 1: Get destination IP, port, and timestamp from TCP packet on the first Ethernet interface card

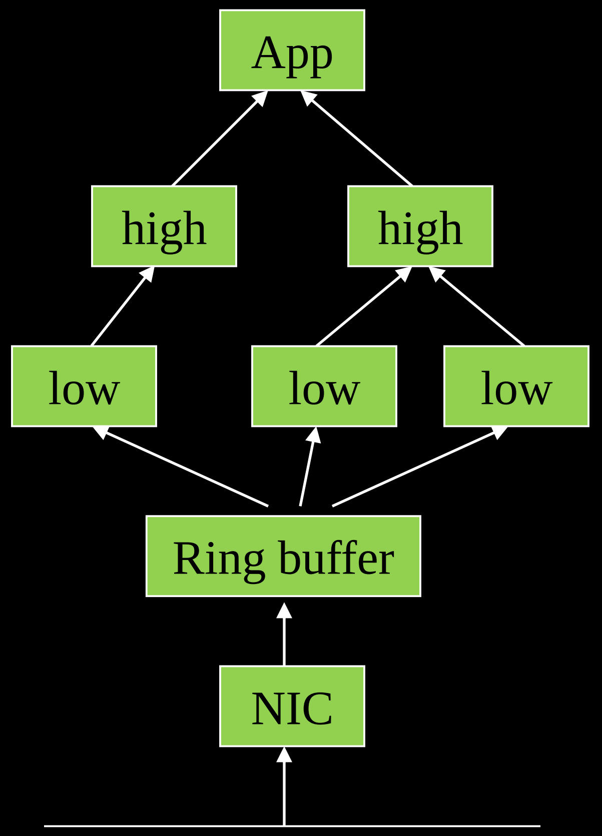
```
DEFINE { query_name tcpDest0; }
  Select destIP, destPort, time From eth0.TCP
  Where IPVersion = 4 and Protocol = 6
```

- Example 2: Combine streams from multiple sources into a single stream

```
DEFINE { query_name tcpDest; }
  Merge tcpDest0.time : tcpDest1.time
  From tcpDest0, tcpDest1
```

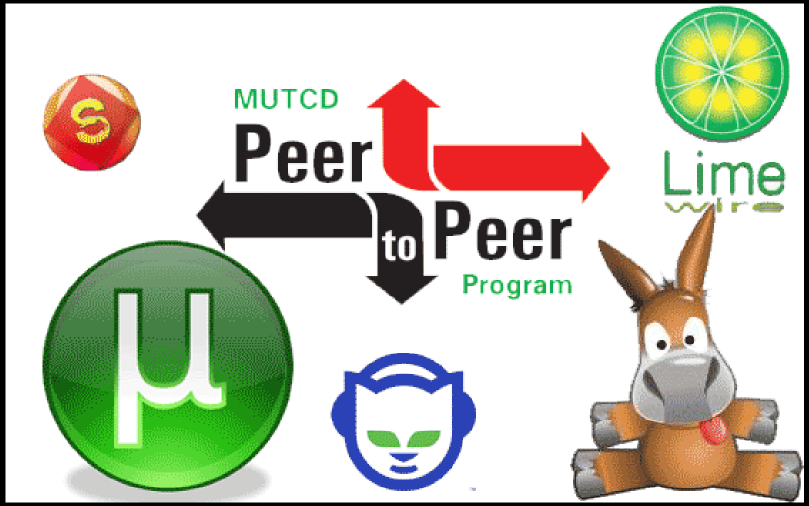
Gigascope Architecture

- Two layer architecture for early data reduction
  - High level queries for expensive processing (High-level Filtering, Transformation, and Aggregation – HFTA)
  - Fast lightweight data reduction queries (Low-level Filtering, Transformation, and Aggregation – LFTA)
    - Possible to push the query as far down as the NIC as an optimization



Gigascope: Hidden P2P Traffic Detection

- Business Challenge: AT&T IP customer wanted to accurately monitor peer-to-peer (P2P) traffic within their network
- Previous Approach: Using TCP port number found in Netflow data
- Issues: P2P traffic might not use known P2P port numbers
- Solution:
  - Use Gigascope to search for P2P related keywords within each TCP datagram
  - Identified 3 times more P2P traffic than when using Netflow



Gigascope: Web Client Performance Monitoring

- Business Challenge: AT&T IP customer wanted to monitor latency observed by clients to find performance problems
- Previous Approach: Measure latency from "active clients" that establish network connections with servers
- Issues: Use of "active clients" is not very representative
- Solution:
  - Use Gigascope to track TCP synchronization and acknowledgement packets
  - Report round trip time statistics: latency

Gigascope: Other Applications

Desired goals for Gigascope:

- traffic analysis (E.g. Hidden P2P Traffic Detection)
- performance monitoring (E.g. Web Client Performance Monitoring)
- debugging
- protocol analysis and development
- router configuration
- intrusion detection
- network monitoring

Conclusions

- Querying and finding patterns in massive streams is a real problem with many real-world applications
  - Need for sophisticated real-time queries
  - Massive data volumes of transactions
- Fundamentally rethink data management issues under stringent constraints:
  - Single-pass algorithms with limited memory resources
  - Resource limitations at low-level
- Important to think of end-to-end architecture