StreamGlobe
Adaptive Query Processing and Optimization in Streaming P2P Environments

A. Kemper, R. Kuntschke, and B. Stegmaier

TU München – Fakultät für Informatik
Lehrstuhl III: Datenbanksysteme

http://www-db.in.tum.de/research/projects/StreamGlobe
Outline

- Motivation

- StreamGlobe
  - The StreamGlobe Approach
  - Architecture Overview

- Current and Future Research

- Conclusion
Exemplary Initial Situation

- **Network**
  - Consists of peers
  - Given or grown topology

- **Data Sources**
  - Provide XML data stream
  - Possibly infinite streams (e.g., sensor measurements)

- **User requests**
  - Continuous queries
  - Query language XQuery
  - Registered at a peer
General Traditional Approach

1. Register requests
2. Establish data transfer → Peers may connect arbitrarily
3. Process / Execute requests
4. Routing of streams → Map streams to network
General Traditional Approach (ctd.)

- **Drawbacks**
  1. Transmission of useless data
  2. Redundant transmissions
  3. Multiple request evaluation

⇒ Network congestion and processing overhead
Why StreamGlobe?

- Other Systems / previous work
  E.g. Cougar, TelegraphCQ, Multicast techniques:
    - Focus on specific aspects (e.g., query optimization)
    - Tailored to specific domains

- StreamGlobe
  - Contribution is combination of techniques:
    In-network query processing combined with routing
  - Constitutes a generic infrastructure
    - Independent of domain
    - Efficient data stream transformation and distribution
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The StreamGlobe Approach

Intelligent Routing

- Multicast routing techniques
  *Data Stream Clustering*
- Push query execution into network
- Multi-query optimization

- Reduce network traffic
- Avoid redundant transmissions
- Reduce processing cost
Basic Concepts

- P2P Network Topology
  - No arbitrary communication
    → Communication via *transfer paths*
  - No fixed P2P topology

- Classification of peers
  - Thin-Peers
  - Super-Peers
    → Constitution of a super-peer backbone

- Hierarchical organization
  → *Speaker-peer* responsible for certain subnet
StreamGlobe Peer Architecture

- Based upon *Open Grid Services Architecture* (OGSA)
- Integration similar to OGSA-DAI or OGSA-DQP
- Layers as grid-services
- Availability according to peer capabilities
- Message exchange via RPC and notifications
- Data stream transfer via direct TCP connections
Optimization

Goals
1. Registration of arbitrary subscriptions at any peer
2. Achieve good distribution of data streams
3. Optimize evaluation of many subscriptions

Achievement
- Pushing query execution into the network → (1) and (3)
- Multiquery optimization → (3)
- Early filtering of data streams resp. evaluation of subscriptions → (2)
- Data stream clustering → (2)
Multi-Query Optimization

- Performed by speaker-peer
- Analyze subscriptions and streams
  - Common subqueries
  - Re-usability of streams
  - Based on properties of subscriptions / streams
- Computes
  - Filters and queries
  - Data stream clustering
  - Execution locations
Query Execution

- Basic concepts
  - Streaming evaluation and push-based techniques
  - Preclude unbounded buffering by requiring window constraints
  - Extensibility by means of mobile code

- Evaluation of subscriptions with *FluX*
  - Designed for streaming processing of XQuery
  - Event-based extension to XQuery
  - Usage of schema information for buffer minimization

→ *Visit my talk at the VLDB: Tomorrow, Research Session 6: XML(II)*
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Current and Future Research

- Current Research
  - Optimization techniques
  - Extension of FluX

- Future Research
  - Quality-of-Service management
  - Explicit load balancing
  - Load shedding techniques
  - Construction of overlay network
  …
Conclusion

StreamGlobe

- Exploiting in-network query processing capabilities
- In combination with data stream clustering
  - Minimization of network traffic

- Query execution with FluX
  - Efficient and scalable execution of subscriptions
- Multi-query optimization
  - Parallelization and load balancing in the network
Related Work

- Carney, Cetintemel, Cherniack, Convey, Lee, Seidman, Stonebraker, Tatbul, Zdonik. “Monitoring Streams – A New Class of Data Management Applications”. VLDB 2002
- Chandrasekaran, Cooper, Deshpande, Franklin, Hellerstein, Hong, Krishnamurthy, Madden, Raman, Reiss, Shah. “TelegraphCQ: Continuous Dataflow Processing for an Uncertain World”. CIDR 2003
- Cherniack, Balakrishnan, Balazinska, Carney, Cetintemel, Xing, Zdonik. “Scalable Distributed Stream Processing”. CIDR 2003
- Krämer, Seeger. “PIPES – A Public Infrastructure for Processing and Exploring Streams”. SIGMOD 2004
- Madden, Shah, Hellerstein, Raman. “Continuously Adaptive Continuous Queries over Streams”. SIGMOD 2002