StreamGlobe:
Adaptive Anfragebearbeitung und Optimierung auf Datenströmen

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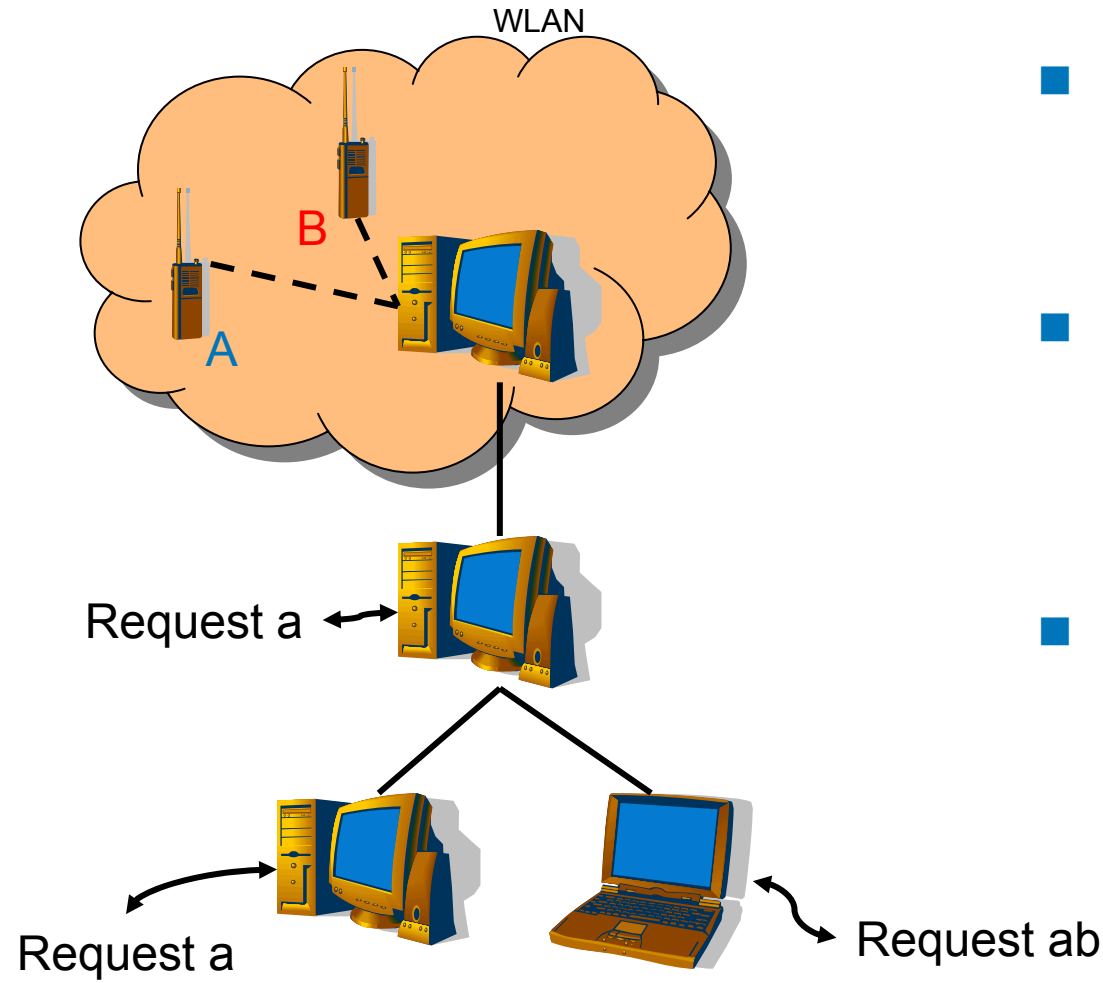
`http://www-db.in.tum.de/research/projects/StreamGlobe`

Outline

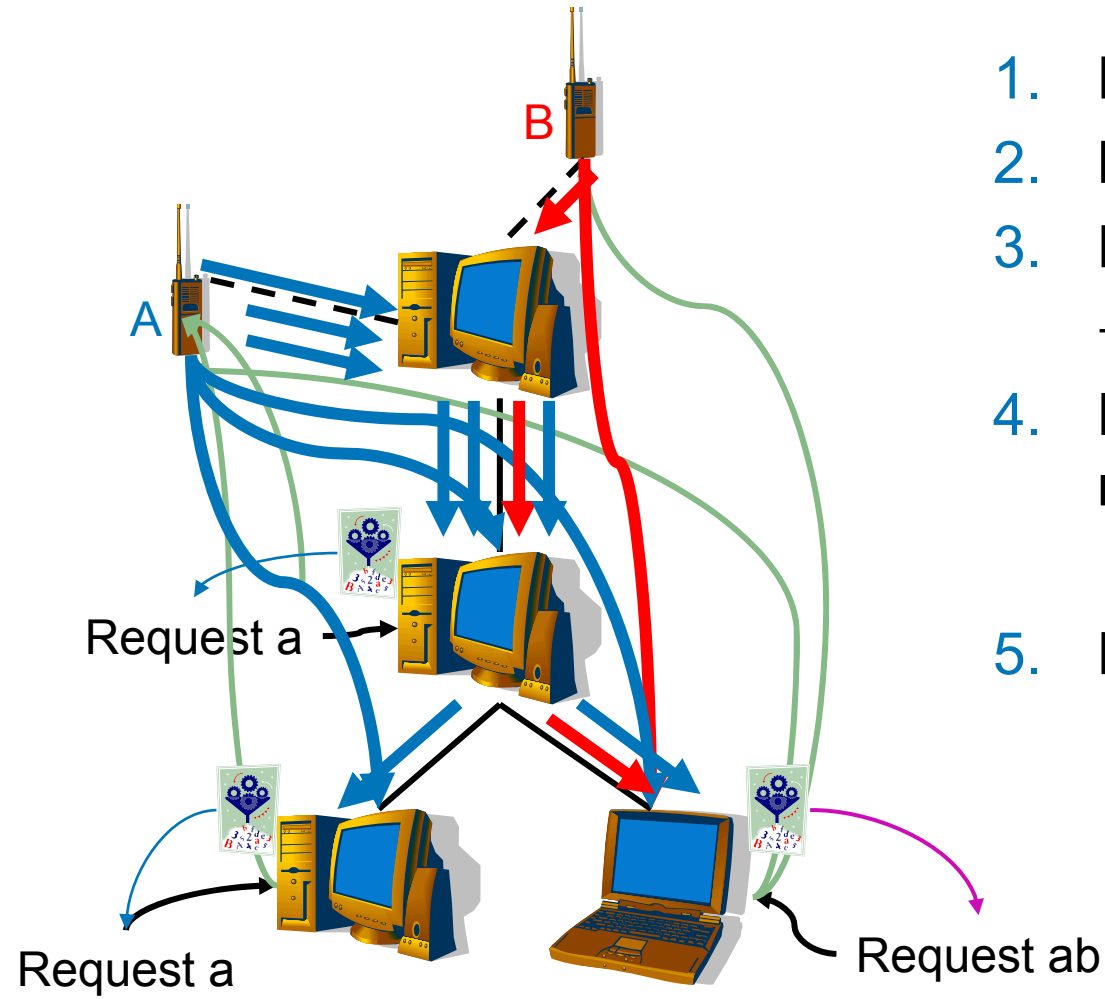
- Motivation
- StreamGlobe
  - The StreamGlobe Approach
  - Architecture Overview
- Current and Future Research
- Conclusion

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

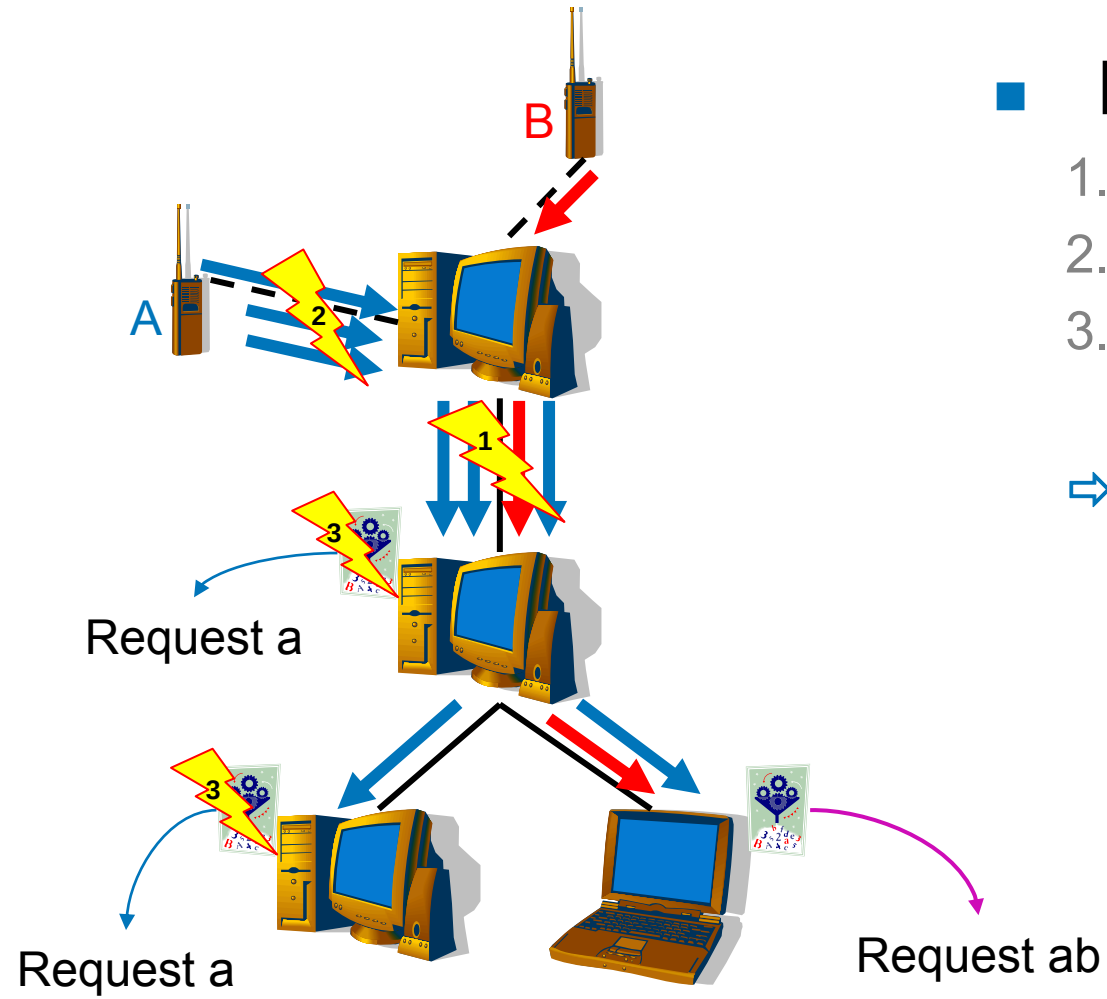
General Traditional Approach



1. Register requests
2. Lookup data sources
3. Establish data transfer

   ⟶ Peers may connect arbitrarily
4. Process / Execute requests
5. Routing of streams

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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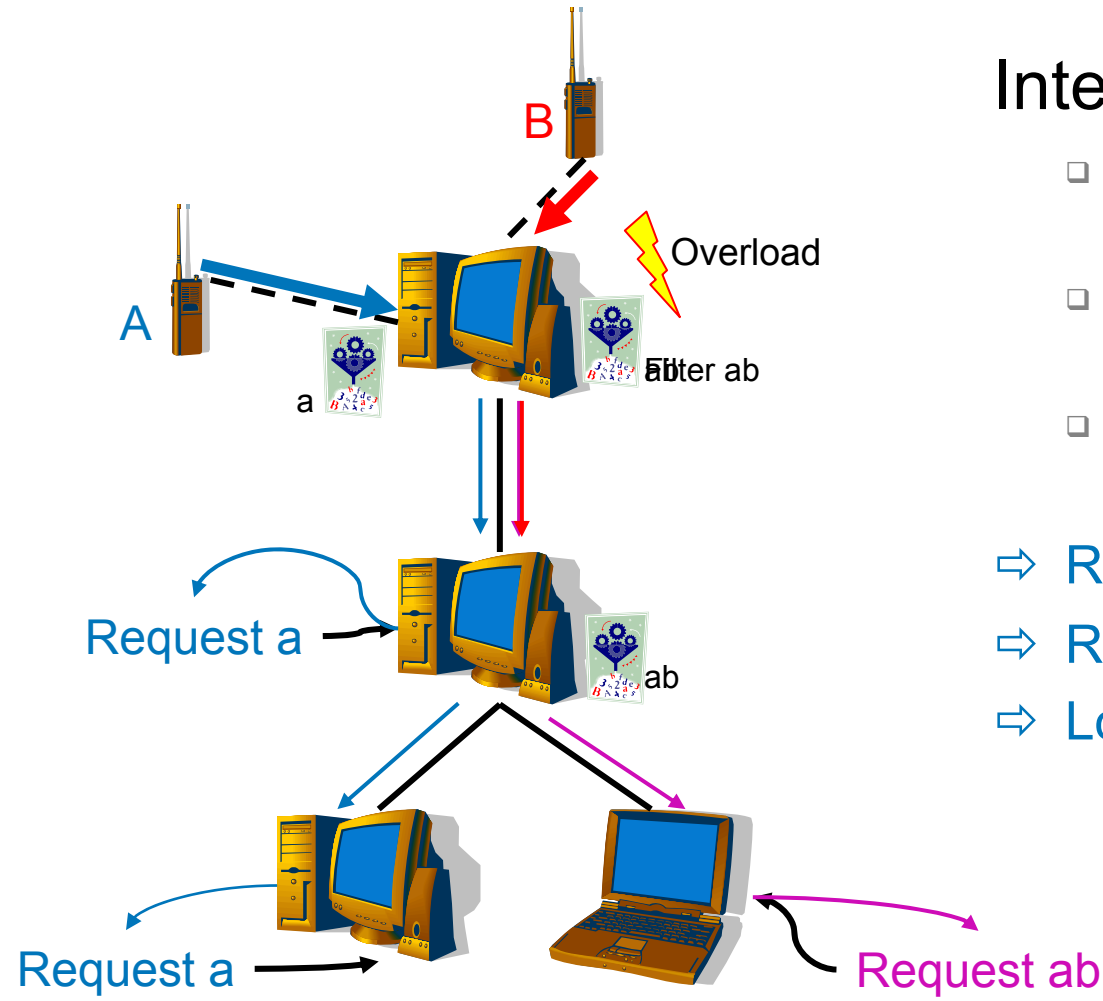
The StreamGlobe Approach



Intelligent Routing

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

⇨ Reduce network traffic

⇨ Reduce processing cost

⇨ Load balancing

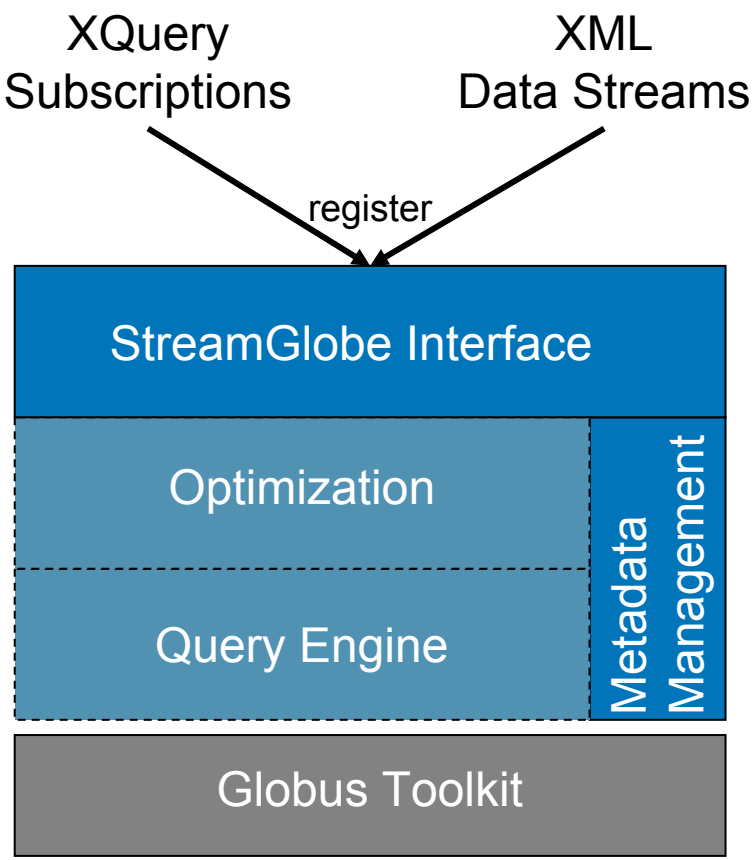
Basic Concepts

- 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

StreamGlobe Interface

- Registration of XML data streams
  - Possibilities
    - As individual data stream
    - As part of a *virtual data stream*
  - Specification of schema with XML Schema

- Registration of subscription rules
  - At a special peer (user device)
  - Specified using XQuery

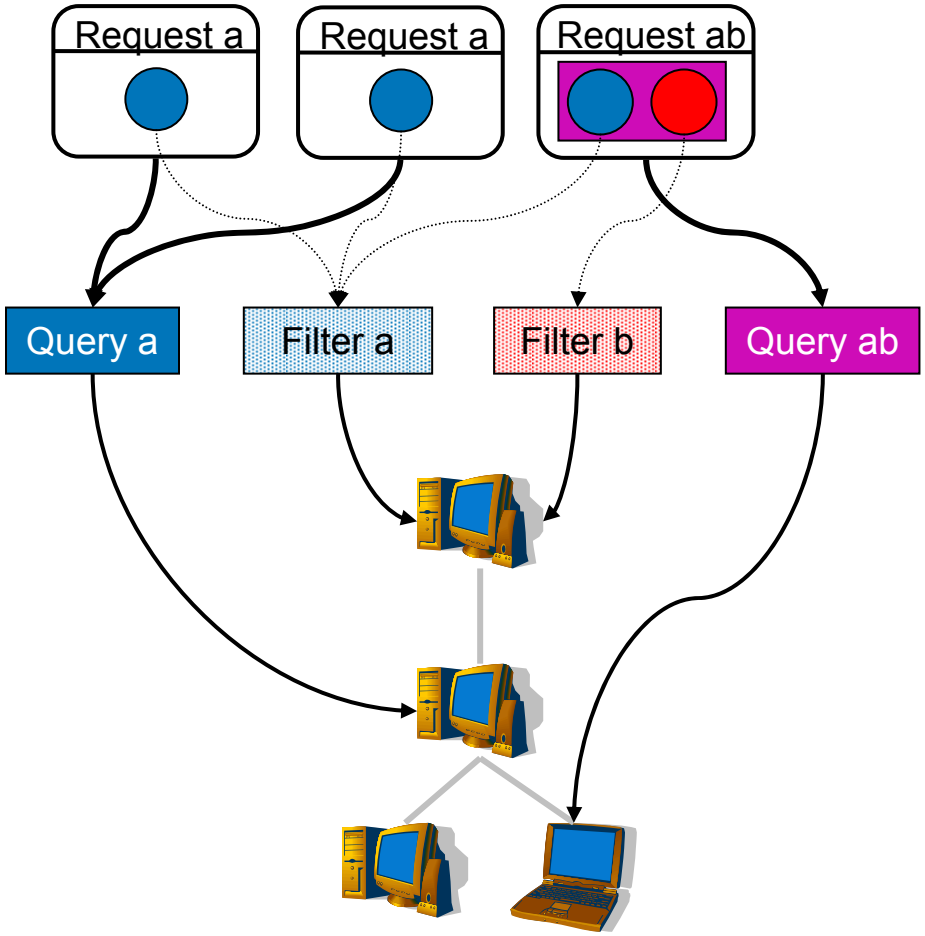
Metadata Management

- Managed information
  - Network topology
  - Registered subscriptions and data streams
  - Statistics of data streams
- Based upon service-data elements of Globus Toolkit
- Maintenance
  - E.g. peers joining/leaving, change of subscriptions, etc.
  - Using notification mechanisms of Globus Toolkit

Optimization

- Goals
  1. Register arbitrary subscriptions at any peer
  2. Reduce network traffic
  3. Optimize evaluation of many subscriptions
- Achievement
  - Pushing query execution into the network
    → (1), (2) and (3)
  - Multi-query 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

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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

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