Introduction

**Problem:** Routing in Pub/Sub systems

Publishers who submit information and Subscribers who express their interest to receive messages in specific types of information.

Two common forms of filtering:
- Topic-Based
- Content-Based

- Decoupling in **Space**, **Time** and **Flow**
- Fixed or Dynamic set of **Brokers**
- **Broker overlay** is important, no flooding
  - Change overlay in order to make content related nodes closer.
SIENA

Related Works

**Scalable Internet Event Notification Architecture**

- Generic **Scalable** Pub/Sub Event Notification Service
- Maximizing both expressiveness and scalability
- A network of Servers.
- Tree based routing scheme.

**API:**
- **Publish**: a publisher publish a notification.
- **Subscribe**: a subscriber describe types of notifications it is interested in.
- **Unsubscribe**: a subscriber describe types of notifications it is no longer interested in.
- **Advertise**: a publisher describe types of notifications it publishes.
- **Unadvertise**: a publisher describe types of notifications it no longer publishes.
SIENA (cont.)

Routing

- Simple Solution: broadcast (flooding)
  - has a lot of overhead

- Some principles to improve it:
  - **Downstream replication**
  - Upstream filtering and pattern assembly
  - Common principles: loop-free paths, efficient forwarding, reduced state, etc.
  - Implemented by two classes of algorithms: subscription forwarding and advertisement forwarding.
Reorganizing topology

Contributions and Algorithms

- **Main goal**: brokers with more similar interests become closer to each other
- **Main idea**: Bi and Bl are not directly connected, their similarity > the similarity of a pair of directly connected brokers in their path => 1. they should be connected, 2. those two brokers should be disconnected.
- **Similarity Function**:

\[ a_{i,j} = \frac{|\{e \in m_i : \exists s \in S_{B_j}, e \text{ matches } s\}|}{Q_i} \]
Reorganizing topology (cont.)

- **Four phases:**
  
  a. Triggering of a similar broker discovery.
  b. The actual broker discovery phase.
  c. Tear down link selection.
  d. Overlay topology update.
Reorganizing topology (cont.)

Phase 1: Triggering of a similar broker discovery

- Periodically
- Backoff policy
  - delta
- checks this predicate for all links

- intuition: probably there should be some broker behind Bj
- too little information? mi has to have at least Q/2 events.

**AP:** \( \alpha_{i,j}(m_i) > a_{i,j} \).
Phase 2: The actual broker discovery phase

- done for any link for which AP holds

- DREQ message:
  - HS is built up through the forwarding process
  - for each broker HS has
    i. broker similarity to the initiator
    ii. link weight of broker and the previous broker
  - checks FP and forwards DREQ on each link for which FP holds:

  \[ \text{FP} : \exists l_{j,h} \neq l_{j,k} : \alpha_{j,h}(m_i) > a_{i,j}. \]

  - of no link holds FP, DREP is created and sent back.

- DREP message: A tree recursive approach is used to return the most similar broker to the initiator.
Reorganizing topology (cont.)

Phase 3: Tear down link selection
- Bi and Bl are the two ends of the resulting HS
- The new link to be added is then selected:
  - $l(Bi) = 0 \& l(Bl) = 0$
  - $l(Bi) > 0 \& l(Bl) > 0$
  - $l(Bi) > 0 \& l(Bl) = 0$ or $l(Bi) = 0 \& l(Bl) > 0$
- the next phase is done if $l_{new}$ is not NULL

Phase 4: Overlay topology update
- before adding the teardown link some link should be removed to keep the acyclic property
- LOCK command sent from the initiator
- path is locked and ACK is sent back to the initiator
- CLOSE message is sent from both sides (Bi and Bl)
- UNLOCK is sent back to both of them
Reorganizing topology (cont.)

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Experimental Results

- **Data model**: The experiments were run over a 100 nodes TCP/IP network
- **Performance metrics**:  
  - Number of reorganizations  
  - Notification cost  
  - Percentage of brokers involved  
- **Two scenarios**: U (Uniform) and G (Gaussian)

Left: average notification cost for event dissemination (values are normalized with CBR set to 100%), Right: average percentage of brokers involved in each event dissemination
References