

ONYX: Towards an Internet-Scale XML Dissemination Service

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Several slides are courtesy of Yanlei Diao

Background: XQuery

- Xpath: i.e., //section/*/title and returns a node set
- A query is a FLWOR expression enclosed by a constant tag
- XML filtering and transformation

```

<sections>
{
  for $s      in $doc//section
  where $s/title = "XML"
    and $s/figure/title = "XML processing"
  return <section>
    { $s//section//title }
    { $s//figure }
  </section>
}
</sections>

```

binding path
predicate paths
return paths

YFilter: High-Performance XML filtering

A large set of linear path expressions:

Q1=/a/b	Q2=/a/c
Q3=/a/b/c	Q4=/a/b/c
Q5=/a*/c	Q6=/a/c
Q7=/a*/*/c	Q8=/a/b/c

A single NFA sharing all the common prefixes:

Path sharing is the key to efficiency and scalability!

CBDD (Content-Based Data Dissemination)

- User queries: Specification of data interests, written in an XML query language.
- Data sources: Continuously publish XML data items.
- The service: Delivers to each user the XML data items that match her data interests; the delivered results are presented in a customized format.

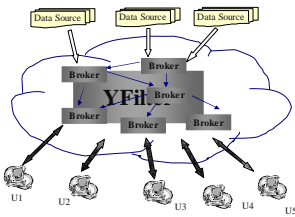
Applications of XML Dissemination

- News feeds via RSS (Really Simple Syndication)
 - My Yahoo!: updated headlines from BBC, CNet, NPR.
- Mobile services
 - Mobile operators: connect content providers with millions of clients running a multitude of operating systems.
- Stock tickers
 - QuoteMedia: fast access to real-time and historical stock data.
- Online auctions
 - freebiddingtools.com: create your own feed for your favorite eBay search.
- Network monitoring
 - Ganglia: a distributed monitoring system for clusters and grids.

Why distributed processing?

- Privacy
 - Regulations: e.g., CA Senate Bill No. 1386.
 - Policies: e.g., customers' data stay behind the firewall.
- Locality of data interests
 - Disseminate regional data directly to local subscribers.
- Scalability
 - Data volume: number of messages per second up to thousands, message size from 1 KB to 20 KB.
 - Query population: up to millions.
 - Frequency of query updates: from a daily basis to every few minutes.
 - Result volume: can amplify the input data volume by a large factor.

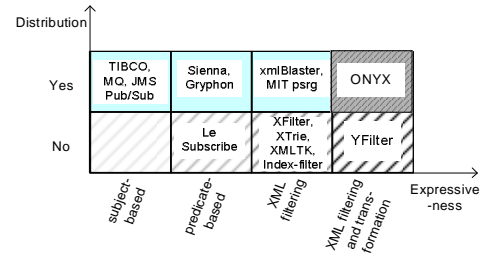
Here comes ONYX...



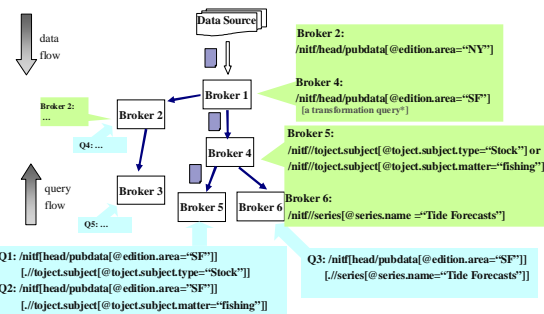
ONYX: Operator Network Using YFilter for XML Dissemination

Design space: Expressiveness & Scalability

Expressiveness: data model + query language a service supports



An example



Using YFilter as a message broker

Q1:

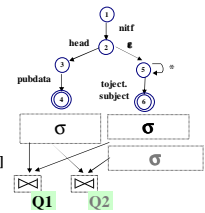
```
/nitf
[head/pubdata[ @edition.area="SF"]]
[./toject.subject[ @toject.subject.type="Stock"]]
```

Q2:

```
/nitf
[head/pubdata[ @edition.area="SF"]]
[./toject.subject[ @toject.subject.matter="fishing"]]
```

Benefits:

- Fast structure matching.
- A small maintenance cost for query updates.
- Extensibility for supporting new operators.



ONYX core techniques

Processing planes: Query Plane and Data Plane

Planes	Query Plane	Data Plane
System Tasks		
Content-Driven Routing	Building Routing Tables	Lookup in routing tables
Incremental transformation	Building transformation plans	Executing transformation plans
Final query processing	Building query plans	Executing query plans

Routing Table Design

Routing query

- The data interests of queries down from an output link
- Data interests of a query: XPath expression (equivalent of the *for* and *where* clauses of FLOWR expressions)
- Multiple routing queries can be connected by *or*.

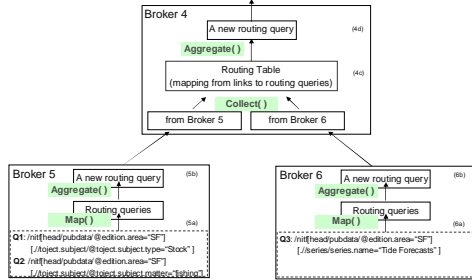
Routing table representation

- Merge routing queries into a *single combined* operator network.
- Map from output links to routing queries.

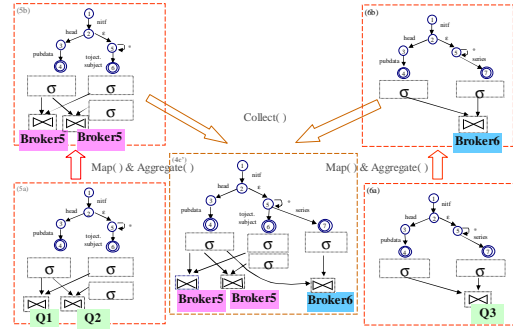
Construction algorithm

- Map(): a user query \rightarrow a routing query in the canonical form.
- Collect(): routing queries sent from child brokers \rightarrow a routing table.
- Aggregate(): all the routing queries (at a node) \rightarrow a new routing query.

Routing Table Construction



Routing Table Construction(conf.)



Sharing and Short-cut evaluation

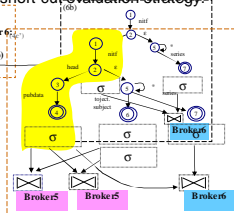
■ A problem with sharing

Separate routing query representations: short-cut evaluation.

Combined one: sharing may sacrifice the short-cut evaluation strategy.

■ Solution: dynamic pruning operator network at runtime

- Each operator/NFA state has a static set of broker ids that it can reach.
- Set of `Brokers` is a dynamic set of broker ids that have been reached.
- YFilter execution is extended to prune the operator network using these sets.



Other Routing Considerations

■ Filtering Power of Routing

- Fraction of messages filtered by routing.
 - Selectivity of the union of the user queries at the node.
 - Loss in precision in the routing queries representing this node.
- If inherently low, partition the query population to improve it.
 - An Exclusiveness Pattern: e.g., `"a/b[@id=?]"`
 - Identify a set of such patterns, and partition queries using them.

■ Routing Efficiency

- Number of messages routed per second
- Conflicting goals to filtering power of routing: tradeoff

Incremental Message Transformation

■ Goal: reduce message size and avoid redundancy

- Early projection
 - Remove unnecessary data.
- Early restructuring
 - Transcode messages based on user profiles such as wireless users.
 - Be agreed upon all users downstream of a link.
- Method: attaching transformation queries to the output links of brokers on the path of routing

Relations to other techniques

■ Multicast

- Augmenting content-based routing features is proposed.
- Doesn't support fine-grained customized user profile.

■ Publish/Subscribe system

- Doesn't necessarily support XML messages.

■ XML-based overlay network

- Such as mesh-based overlay network we discussed.
- Doesn't talk about XML query processing issues.
- Doesn't support customized transformations.

Conclusion

- ONYX enables internet-scale XML CBDD.
- YFilter's NFA-based operator network can do routing.
- Locality of data interests is key to filtering power.

- Fixed brokers and Fault-Tolerance
- Rethinking routing query representation
- Optimizations
 - Incremental message transformation
 - Routing table design