Receiver Driven Content Routing for the Internet

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Introduction

Network endpoints are more and more interested in content.

Publish/subscribe is a candidate paradigm for content distribution.
   Many-to-many, control distributed between subscribers (receivers) and publishers (senders).

Inherently receiver driven

A content distribution system needs to know about packet replication points and policy-compliant paths.
Background

Related systems include NIRA, DONA, ROFL, CCN, PSIRP, and PURSUIT

PSIRP includes a 2-tier system where a hierarchical DHT based rendezvous interconnect network joins multiple rendezvous networks together for global reachability

Publications are identified by scopes and flat identifiers

Typically only scopes are advertised in the interconnect

Hierarchical structure guarantees locality for the communication
<table>
<thead>
<tr>
<th>Layer</th>
<th>Underlying transport</th>
<th>API</th>
<th>Namespace</th>
<th>Self-certification</th>
<th>Receiver driven</th>
<th>Key application</th>
</tr>
</thead>
<tbody>
<tr>
<td>DONA</td>
<td>L4-L7</td>
<td>TCP/IP</td>
<td>Anycast</td>
<td>Flat</td>
<td>Yes</td>
<td>Yes, fetch operation</td>
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<td></td>
<td></td>
<td></td>
<td>Content discovery and delivery</td>
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<tr>
<td>CCN</td>
<td>L3</td>
<td>Unreliable data transport, flow control</td>
<td>Name-based (with leases)</td>
<td>Hierarchical</td>
<td>Yes</td>
<td>Yes</td>
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<td></td>
<td></td>
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<td>Content delivery, voice</td>
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<tr>
<td>PSIRP</td>
<td>L2-L7, layerless</td>
<td>Ethernet, TCP/IP and PLA</td>
<td>Pub/sub and metadata-based</td>
<td>Various, recursive</td>
<td>Yes</td>
<td>Yes</td>
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<td>Content delivery</td>
</tr>
<tr>
<td>Internet Indirection Infrastructure (i3)</td>
<td>L7</td>
<td>TCP/IP</td>
<td>Trigger-based</td>
<td>Flat</td>
<td>Yes</td>
<td>Yes (also sender driven)</td>
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<td></td>
<td>Various</td>
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<tr>
<td>Haggle</td>
<td>Layerless</td>
<td>Packet-based</td>
<td>Metadata-based</td>
<td>ADU, user level names</td>
<td>Possible</td>
<td>Receiver/sender</td>
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<td></td>
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<td>Mobile environment</td>
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<tr>
<td>Siena</td>
<td>L7</td>
<td>TCP/IP</td>
<td>Pub/sub</td>
<td>Content-based</td>
<td>No</td>
<td>Yes</td>
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<td>Content delivery</td>
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</tbody>
</table>
PSIRP Architecture

AS: Rendezvous

AS: Topology

Forwarding node

AS: Topology

Forwarding node

Forwarding node

Data Forwarding

Publisher

Subscriber

Create delivery Structure (slow path)

Configure Forwarding Structure (fast path)
Canopy: Using Upgraphs for Pub/Sub

The NIRA system used upgraphs for
Allowing more control for receiver
Finding best paths for unicast

**Canopy** uses upgraphs for pub/sub
Upgraphs combined at publisher-side rendezvous point
Can take both subscriber & publisher policies into account
Supports multi-path routing
Result is a policy-compliant multicast structure
Can be used for both overlays and on the network layer
Works with in-packet Bloom filter-based forwarding

An **upgraph** is a dag that contains all the possible paths from a given node to the tier-1 networks. 
Publisher upgraph roots from the publisher and contains all possible uphill and peer-to-peer paths. 
Subscriber upgraph does not contain peer-to-peer links, but only all possible uphill paths.
Conclusions

Receiver driven communications has favourable properties
   Pub/sub is inherently receiver driven

Research question: How to make content supply and demand meet in the network and how to make it scale?

Canopy uses upgraphs for determining policy-compliant multicast structures for publish/subscribe
   Representing packet replication points and network paths in upgraphs
   Combining subscriber and publisher upgraphs at designated rendezvous points in order to determine policy-compliant data distribution strategies