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Mobility Work Re-Visited *Not* Considered Harmful

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**Revisit mobility concepts with respect
to the **benefit** from an Information-Centric
Networking (**ICN**) angle.**



Contents

1. Motivation
2. A Strawman ICN design
3. A Reactive and a Proactive solution approach
4. Challenges in mobility in ICN



MOTIVATION



Why mobility from ICN angle?

✗ IP is **end-point centric**

✗ Aim: successful (re)establishment of communication between endpoints

✓ Information-Centric Networking **is mobile friendly**

✓ Inborn facility for the dissemination of information

✓ Non-end point communication

– NON-Opaque transfer of content

- Better caching

- Uniform caching in network level



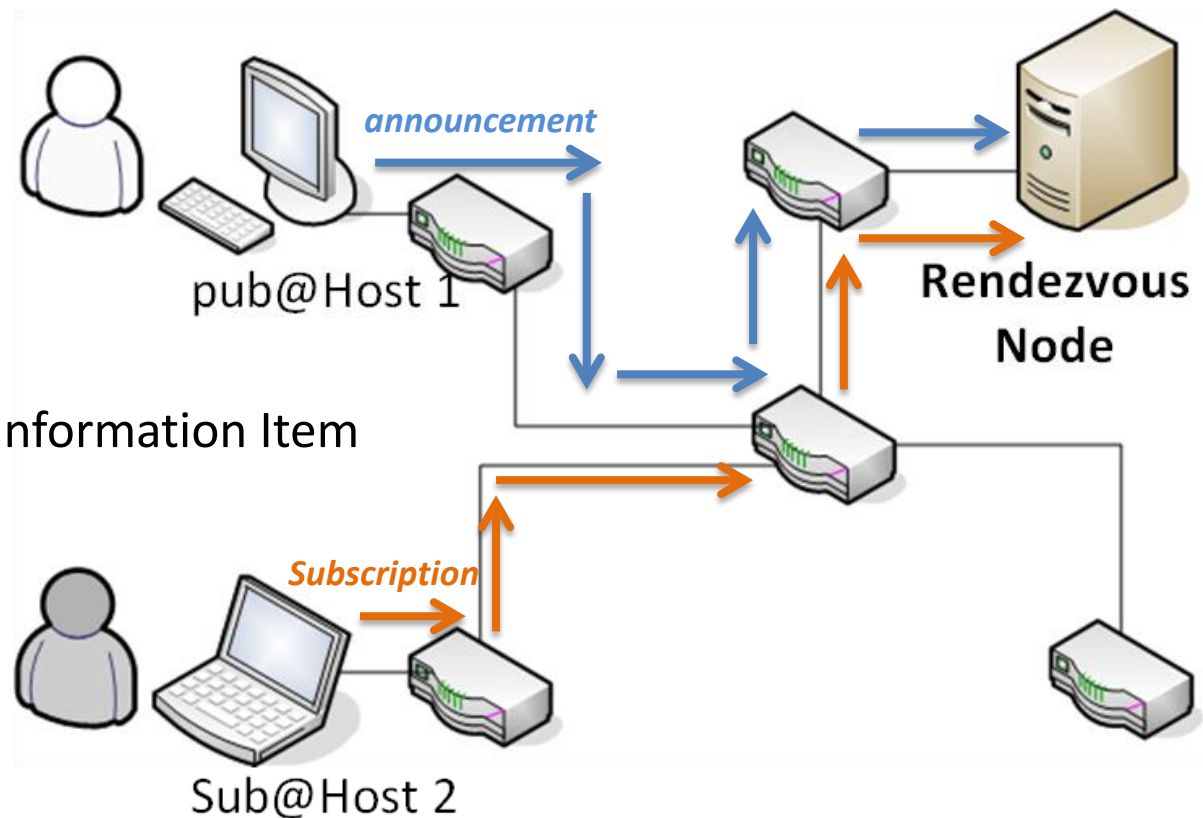
A STRAWMAN ICN DESIGN



PURSUIT Strawman design

- **Publish/Subscribe paradigm**

1. **Publish** availability (announce)



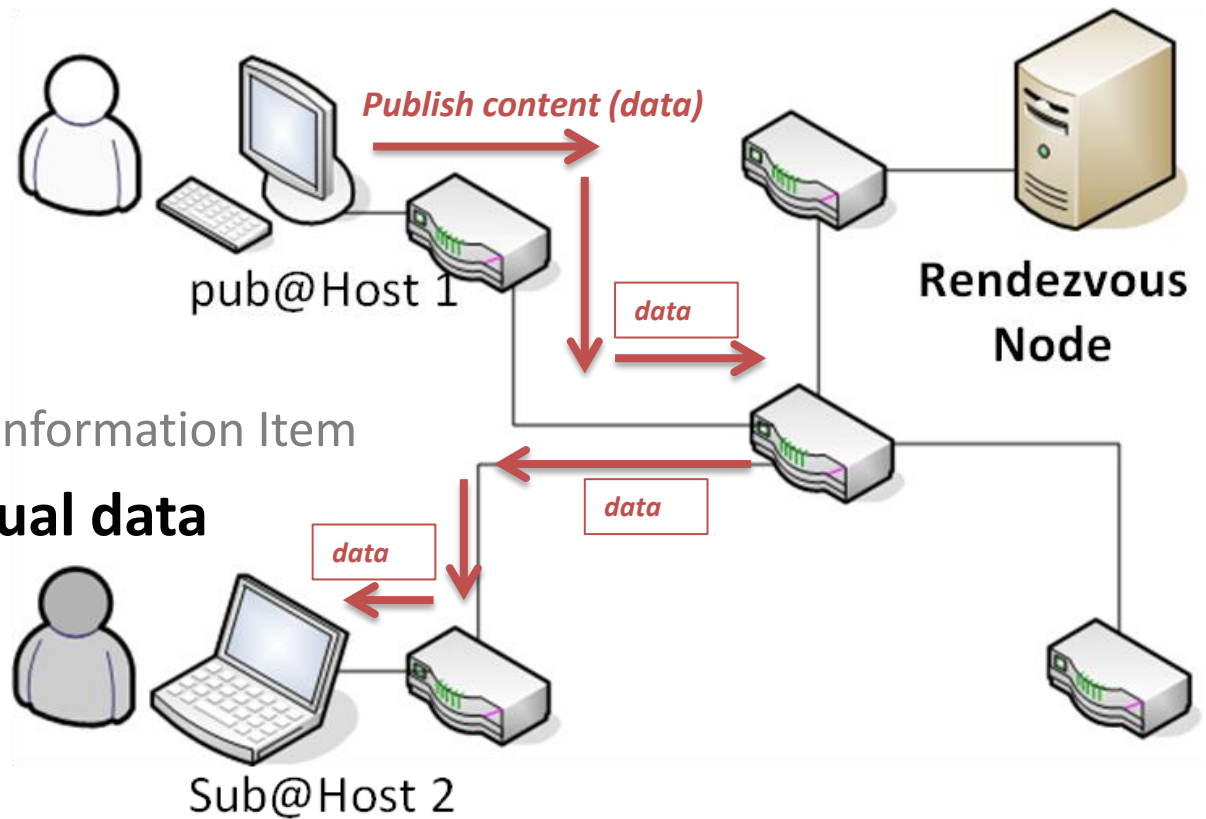
2. **Subscribe** to Information Item



PURSUIT Strawman design

- **Publish/Subscribe paradigm**

1. **Publish availability (announce)**

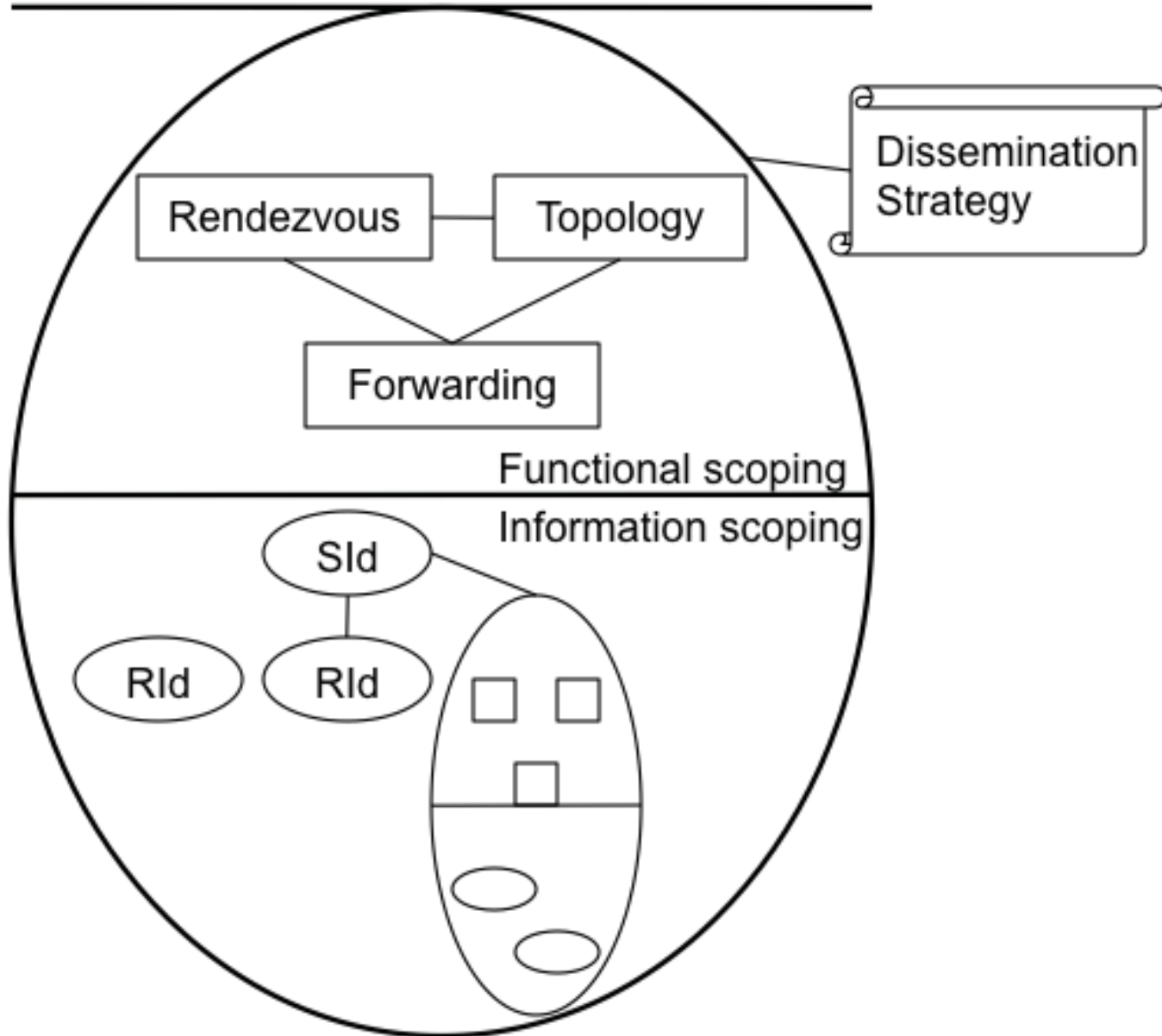


2. **Subscribe to Information Item**

3. **Publish actual data**



Pub/Sub Service Model





A REACTIVE AND A PROACTIVE ICN MOBILITY APPROACH



Use of Proxies

- **Proxy:**
 - **Handles subscriptions on behalf** of Mobile Nodes
MNs or software Mobile Agents (MAs)
 - **Buffers subscriptions and data**
 - Recall that data is not opaque in ICN



(A) *Proactive Approach*

(1/2)

- Prefetching subscriptions to neighboring proxies
- Upon moving to a neighboring proxy
 - **immediately receive data and data transmitted while moving**
 - ✓ Ideal for delay-sensitiveness
 - ✓ Real-time
 - ✓ Streaming
 - ✗ Costs in caching memory for subscriptions and data
 - ✗ Tradeoff between consuming caching space or bandwidth



Current
proxy



MN



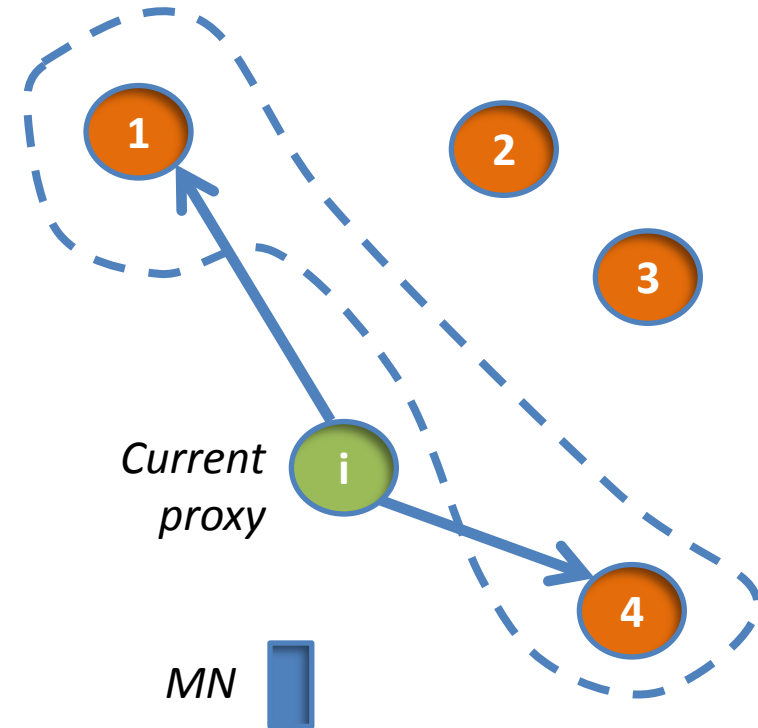


(A) Proactive Approach (2/2)

How to reduce cost ?

→ Use only a subset S of proxies

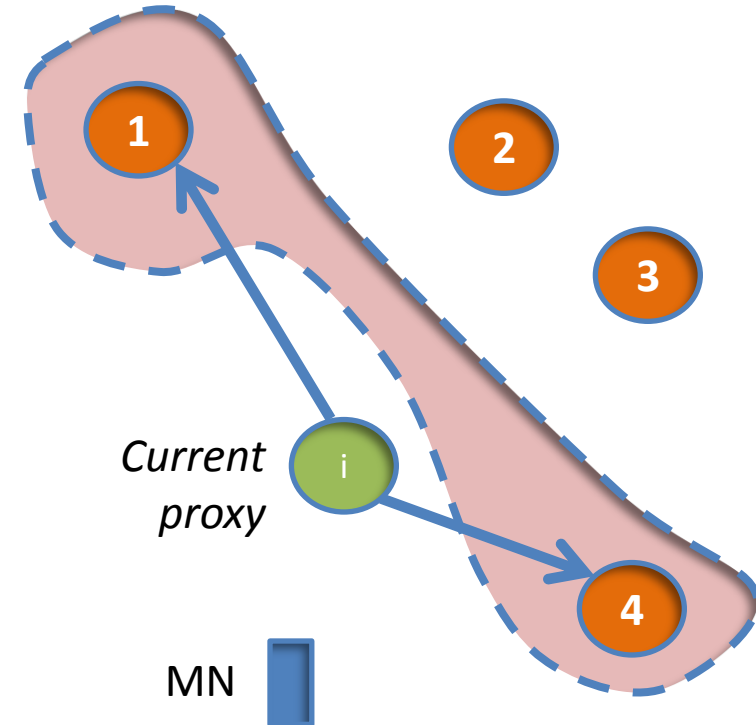
- C_s : Cost to serve the MN from a broker in a subset S
- $C_{s'}$: Cost to serve the MN from the original publisher
- C_c : Cost to cache data during MN disconnection





(A) Proactive Approach (2/2)

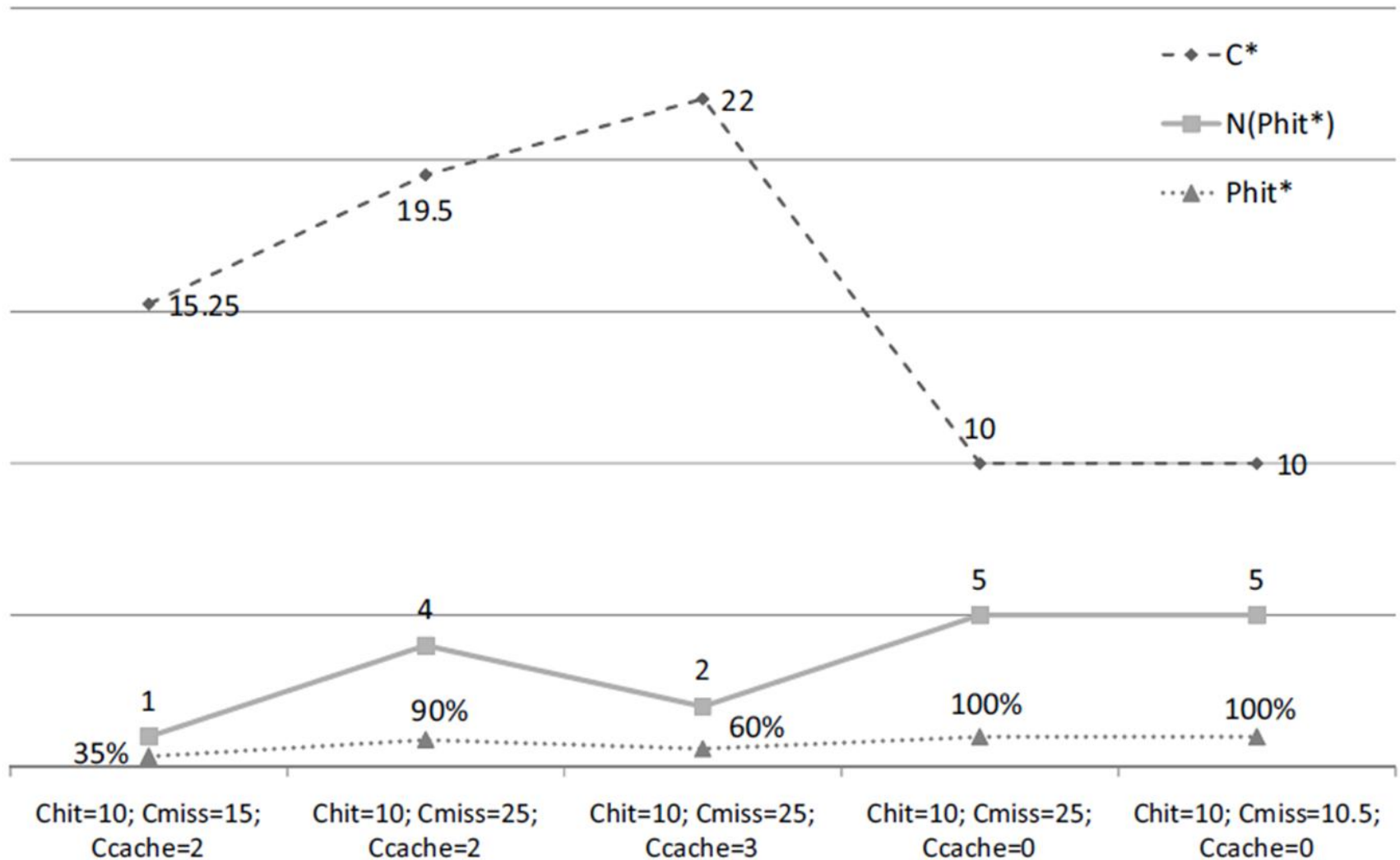
- **Input:**
 - The set of all neighboring brokers
 - **handover probabilities**
- P_s : probability that the MN will handover in subset S
- $N(S)$: number of selected candidate brokers
- S^* : the set of selected candidate brokers that minimizes:



$$\underbrace{P_s \times C_s + (1 - P_s) \times C_{s'}}_{\text{Average delay}} + \underbrace{N(S) \times C_c}_{\text{Cache cost}}$$



Proactive Approach





(B) *Reactive Approach* (1/3)

1. MN publishes a **notification to the proxy before detaching**

- The proxy subscribes to the same items with MN
- It **becomes** also a **publisher** for the items it receives
 - Forwards publications to rest of the connected subscribers matching subscription(s)



(B) *Reactive Approach* (2/3)

2. Upon MN reconnection from a different proxy

- MN issues the same subscription
- The role of the network :
 - Directs to the MN any new matching publication,
 - **Notifies the proxy** to publish the stored publications to the MN



(B) *Reactive Approach* (3/3)

3. Cached data/subscription(s) for the MN are erased

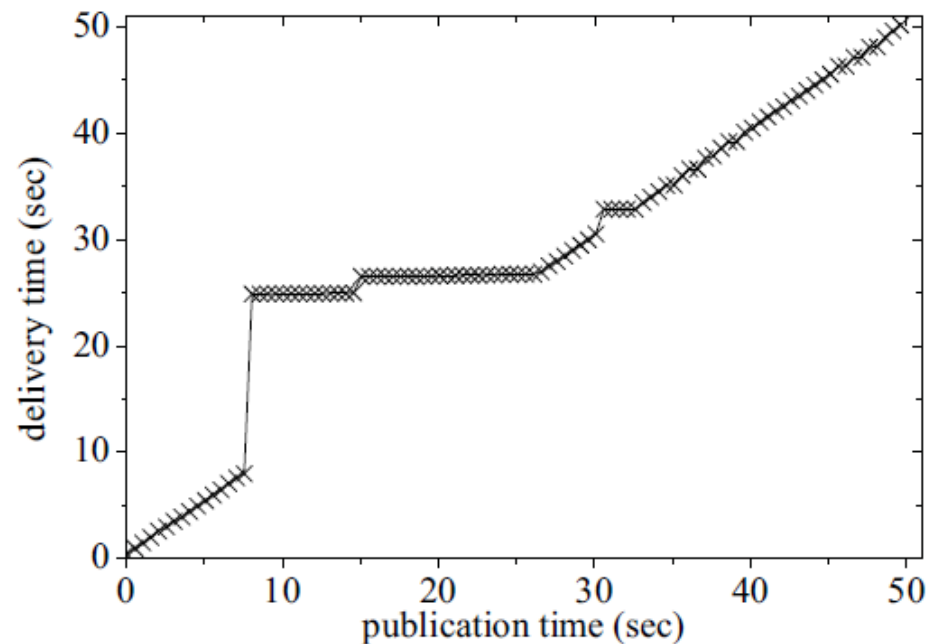
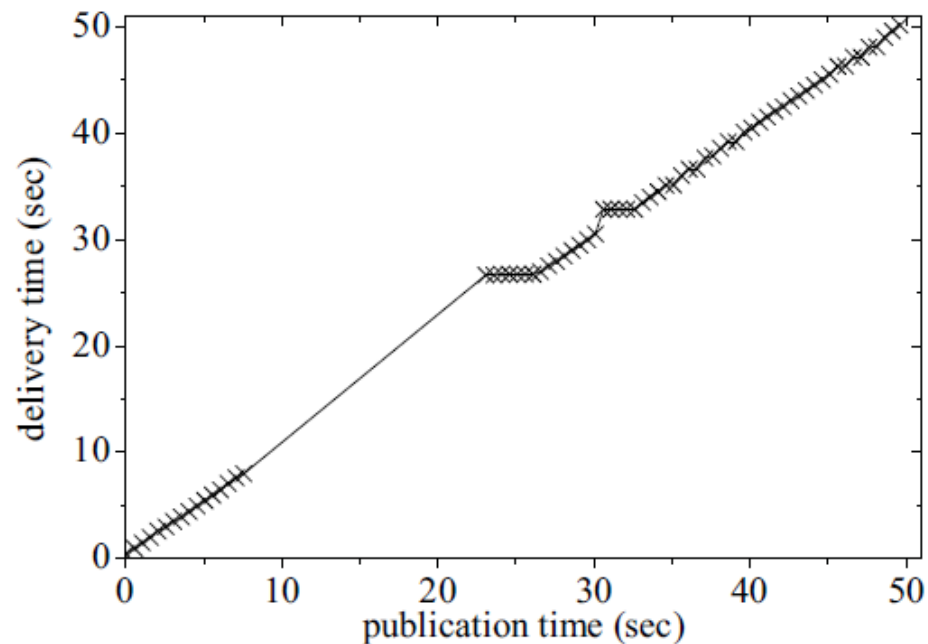
- The proxy unsubscribes
- Also Stops acting as a publisher.

- Regarding Memory

- Messages are stored in a FIFO
 - Disregards the rest of the publications
 - Preemption priority mechanism



Reactive Approach



Reactive approach: no-mobility support (left), mobility support (right).



CHALLENGES IN EVALUATION



Challenges in Evaluation

- **Publish/subscribe decouples time and space**
 - Tradeoffs between storage and bandwidth
 - Define appropriate *traffic models* for evaluation
- Mobility of end-nodes may be similar to IP mobility but.. **Information mobility?**
 - Publishers and subscribers move.
 - Reconcile different dissemination policies.
- Need to find appropriate metrics. The benefit from ICN
 - May **not** necessarily be wrt efficiency or low latency
 - May be wrt
 - Easily finding information
 - Better facilitating mobility
 - Reducing bandwidth consumption
 - Charging wrt to the source of data

Presentation End

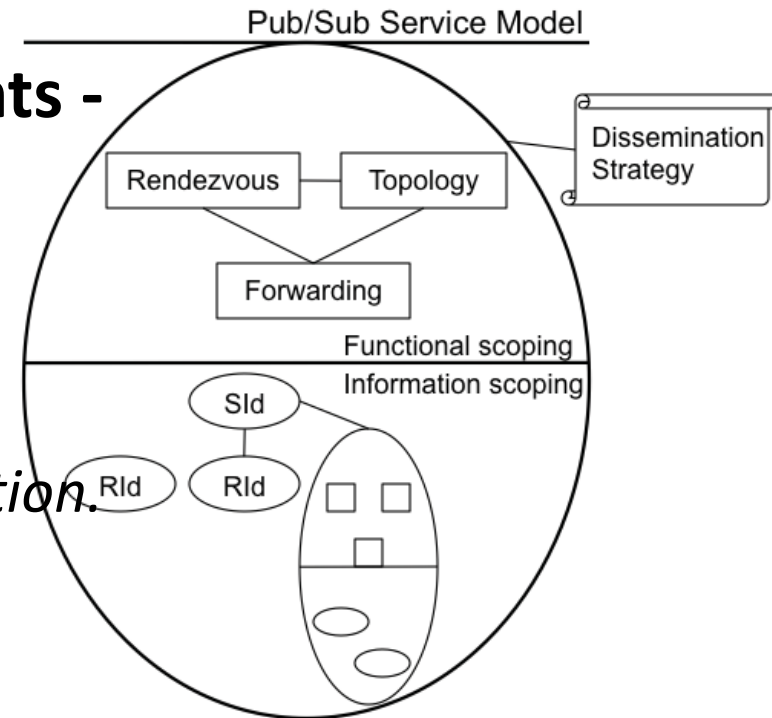
Extra Slides



A Strawman information-centric design

- Four Invariants -

1. **Service model:** Publish/Subscribe to individual information items.
2. **Referencing:** *Identities* for information items
3. **Scoping:** Scopes are *sets of information*.
 - Boundaries *dissemination strategy*
4. Three discrete functions:
 - **1) Rendezvous:** matching of availability of information and subscribers' interest.
 - **2) Topology management and formation:** determines topology for the transfer of information
 - **3) Forwarding:** executes this transfer of information.





Mobility concepts from an ICN angle (1/3)

- **IP is agnostic** to the information
 - Data is opaque
 - Aim: establish, maintain, restore **end-to-end** communication
- **ICN** focuses on **disseminating information**



Mobility concepts from an ICN angle (2/3)

- Mobility regions (*Regionalization*)
 - A **region** is some information structure **published** by network points so that:
 - Mobile Nodes (MNs) and Software Mobile Agents (MAs) can be attached to the N/W
 - Discover a region through **subscribing**
 - given that the **dissemination strategy** allows it (administrational domains)
 - Locality, regions of trust and security
 - Dissemination strategies targeting at , e.g., finding a router or how information is disseminated within a region



Mobility concepts from an ICN angle (3/3)

- Cross-region *Dissemination* of information
 - Reconciliation of different dissemination strategies
 - Information dissemination is easier to optimize:
 - Rendezvous function + Topology Formation => **other publishers** of the same information