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Realization of Name Lookup Table in Routers Towards Content-centric Networks

Research Background

・Communication model of Internet

Emphasis on *who* (identifier) and *where* (physical attachment point) → Emphasis on *what* (information/content/resource itself)

Route on IP address → Route on *what*

・Route on what (content-centric networking)
Does not know nor care on which node the desired data or service resides.
Network with high intelligence would look at the content of the message from the source and route it to the appropriate destination.

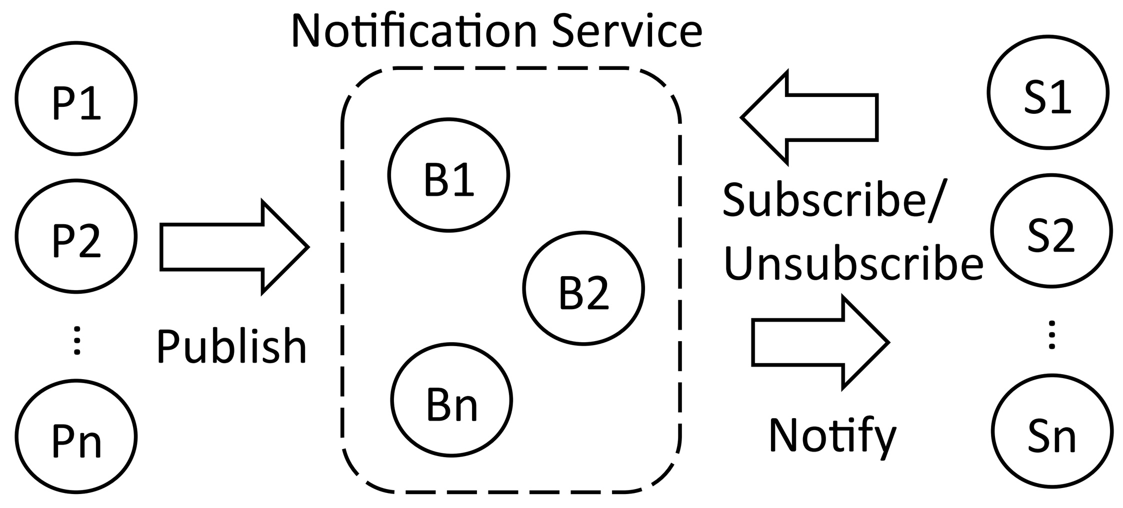
Motivation

・Hardware in Network Layer should support this paradigm shift from 'who and where' to 'what'
→ Name lookup table in routers should have a structure to manage and search a large-scaled information of named content and subscribers

Research at a Glance

Propose a hardware architecture where the network layer routers behave as the brokers in publish/subscribe that can perform well even when the number of the subscribers increases drastically

Publish/subscribe (pub/sub) model



・Publisher: Generates events
・Subscriber: Registers interest in an event, or a pattern of events
・Notification Service: Stores and manages subscriptions

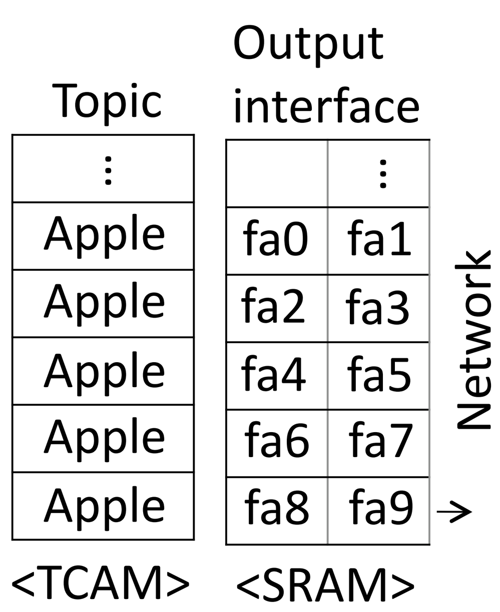
・Types of pub/sub model
- Topic-based: Events are grouped by topic names. Subscribers receive all events published by the subscribing topic name
- Content-based: Events are described by data attribute and meta data. Subscribers selectively receive events by specifying detailed conditions.

・Brokers (notification service) are typically overlay nodes
Problem: (i) Multiple overlay edge crossing the same physical links, generating redundant traffic
(ii) Reliability of the network depends on end nodes (peers)

Implementation of pub/sub model in Network Layer

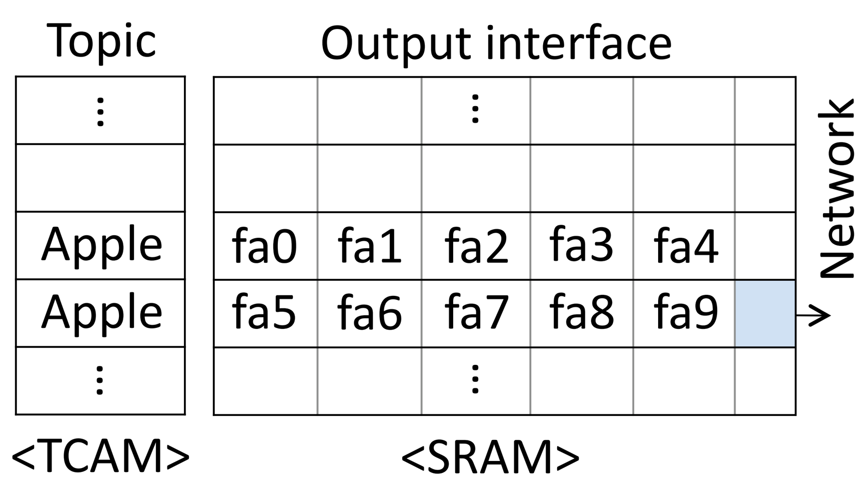
・Pro: (i) Effective usage of physical topology
(ii) "Network Layer service", not a service of a specific application
・Con: Requires a new mechanism to store and manage published event and subscriptions in hardware in Network Layer, i.e., routers

Proposal of Name Lookup Table



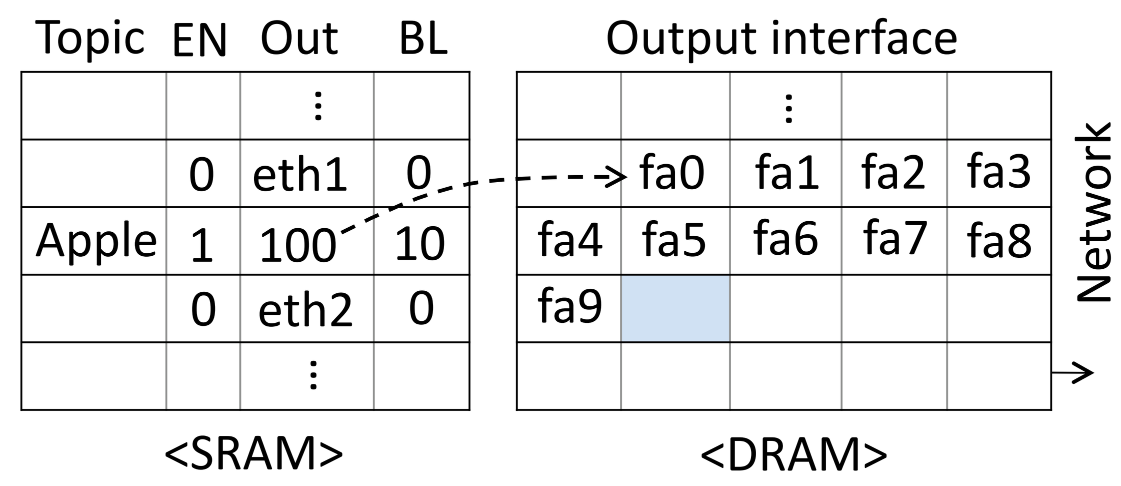
(a) Active TCAM, passive SRAM

・Pro: High search speed using TCAM and parallel process of searching the next key using the latency
・Con: Number of keys that can be searched simultaneously depends on the number of FNH bits



(b) Passive TCAM, active SRAM

・Pro: Utilizes cheaper memory (SRAM:TCAM≒1:5) and minimizes the number of multimatch, reducing the need for many FNH bits
・Con: Reserving too many lateral SRAM bits for popular topics may cause wasted bits for other topics

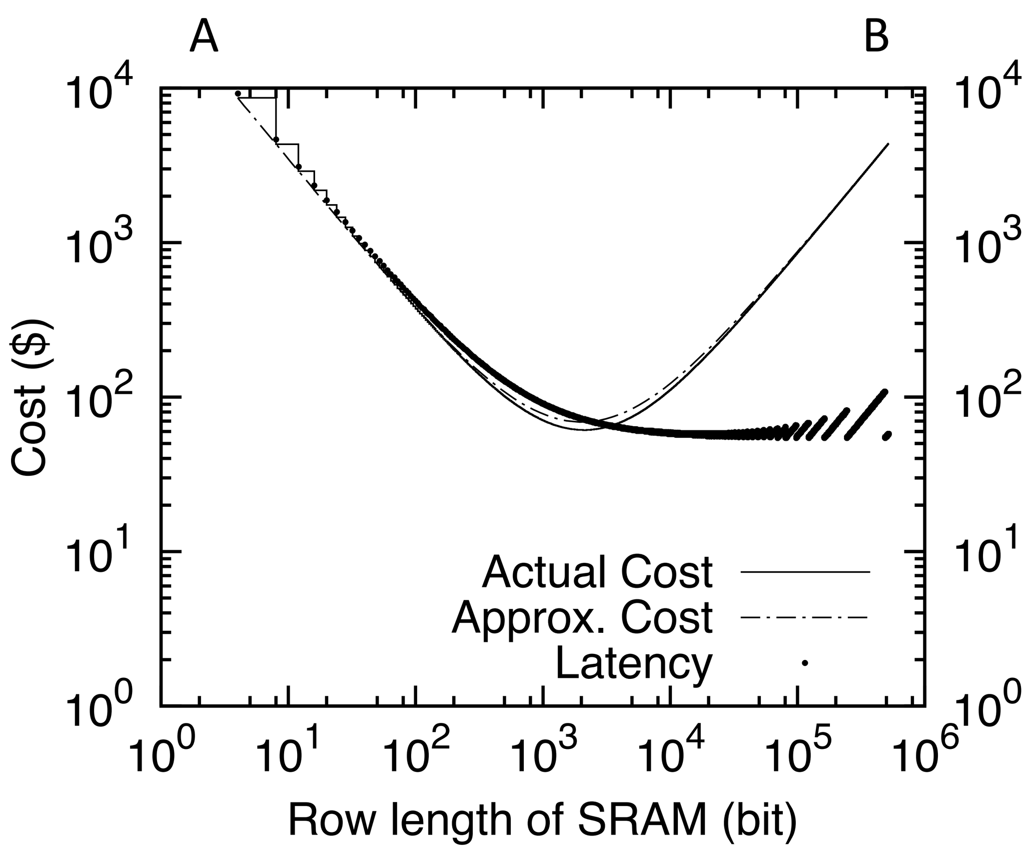


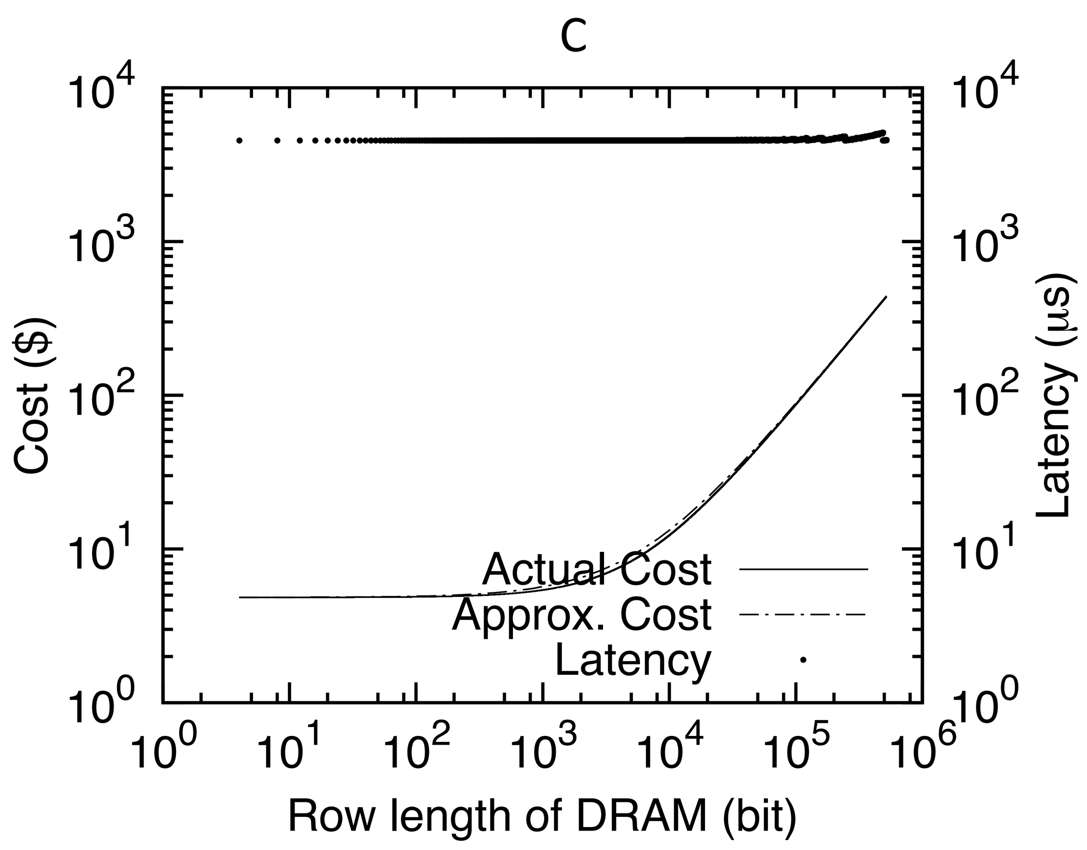
(c) Passive SRAM, active DRAM

・Pro: Reduces memory cost by utilizing DRAM to the maximum (DRAM: SRAM≒1:1000)
・Con: Higher latency compared to SRAM and TCAM

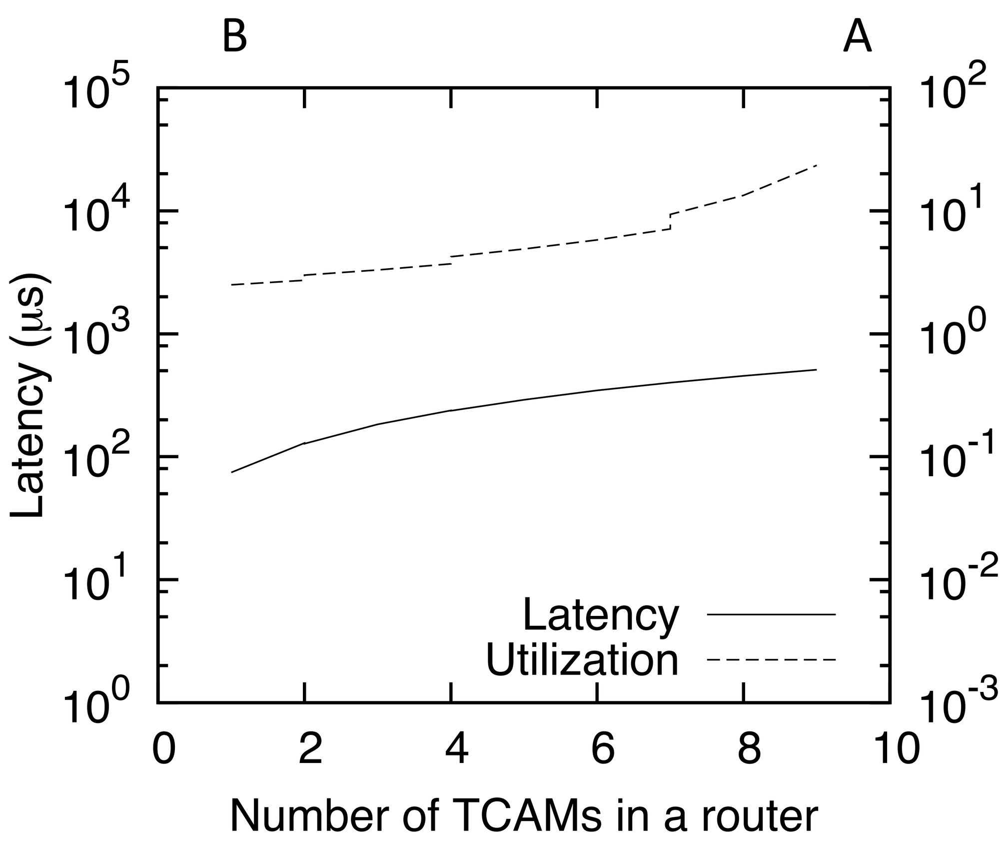
Evaluation

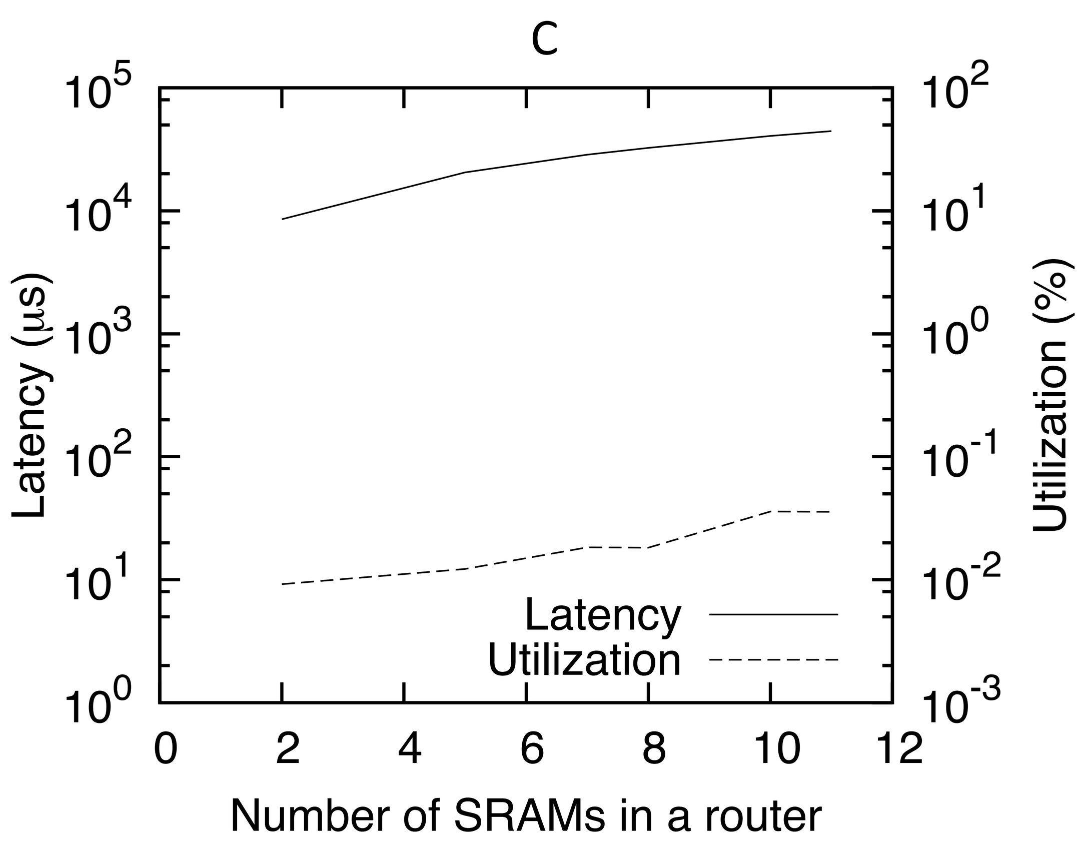
Actual cost and latency using real-life database





Latency and utilization using real-life database with cost limitation





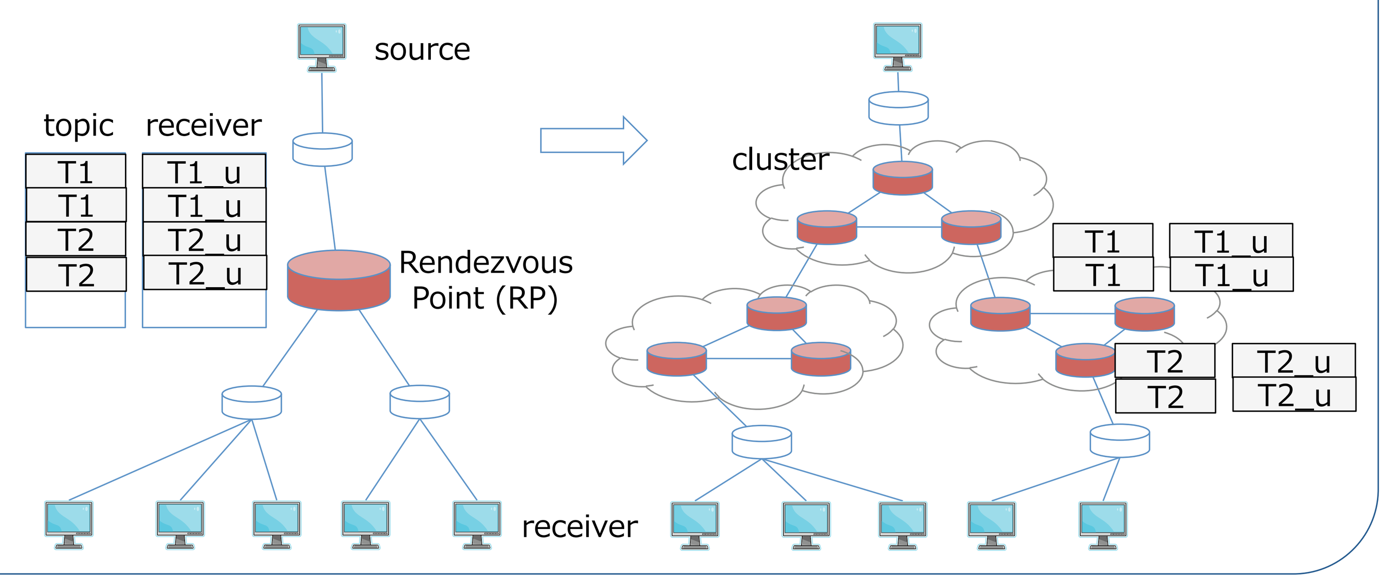
・When only the cost is considered, it seems that the Scenario C is the best solution since the information of subscribers is stored in the most inexpensive DRAM. However, the overall processing speed is affected by the slow SRAM and DRAM
・With cost limitation: Latency for Scenario A and B ranges from 75 to 510 μs whereas for Scenario C the range is from 8.5 to 45 ms.

Conclusion

・Router's Name lookup structure should be designed according to the database of topic names and users having Zipf distribution as well as the latency of each memory

Future Work

・Evaluate the effect of placing multiple rendezvous points for a topic name (+Network)
・Propose a full implementation of content-centric network in the network layer



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