Support for Notifications in CCN ("draft-ravi-icnrg-ccn-notification-01.txt")

IETF/ICN-RG -100, Singapore

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https://tools.ietf.org/html/draft-ravi-icnrg-ccn-notification-01

Draft History

- First presented in IETF 95
- IETF96 we added more discussion around flow and congestion control
  - Also a related ICN Sigcomm paper last year
    - Jiachen Chen et al, “SAID: A Control Protocol for Scalable and Adaptive Information Dissemination in ICN”
    - Motivated by how simple AIMD and flow balance doesn’t prevent congestion with heterogeneous receivers.
      - They show, eventually slower ones fall behind and stop benefitting from the network cache.
- Feedback from chairs to include more discussions on why current Interest/Data Abstraction fails
- This revision attempts to do that.

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Motivation for PUSH in CCN

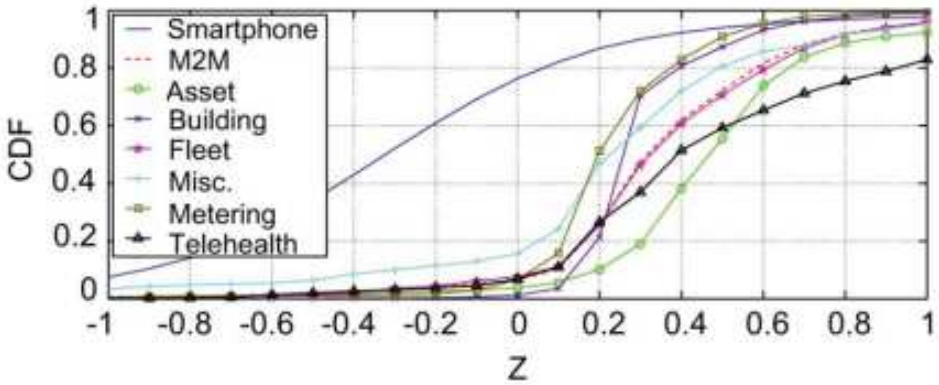


Fig. 1: Log Ratio of Upstream to Downstream traffic for M2M and Smart Phone

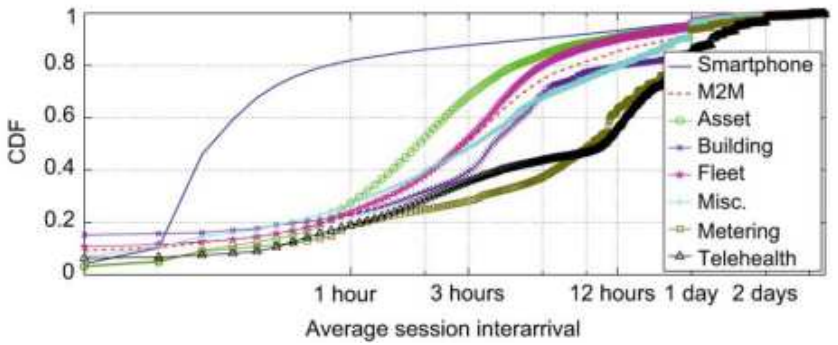


Fig. 2: Distribution between transmission range from hours to days.

• PUSH is a norm in IoT system, many messaging systems e.g. MQTT

•From Fig 1., significant (>80%) number of M2M devices have traffic that is upstream heavy.

• From Fig. 2, the distribution between the transmission vary from mins to days.

• Some of these updates are mission critical [2], with latency and reliability requirements for URLLC class of applications in 5G 1-10ms, and no message loss.

• This is just one data point, pub/sub is standard in the industry e.g. Social Networks

• Other ICN protocols such as MobilityFirst, NetInf support both PUSH and PULL.

[1] Shafiq et al, “Large scale measure and characterization of cellular machine-to-machine traffic”, IEEE, Transactions on Networking, 2013

[2] **ITU, FG, IMT 2020 – “Network Standardization Requirement for 5G”**
http://www.itu.int/en/ITU-T/focusgroups/imt-2020/Documents/T13-SG13-151130-TD-PLEN-0208!!MSW-E.docx

CCN PUSH Requirements

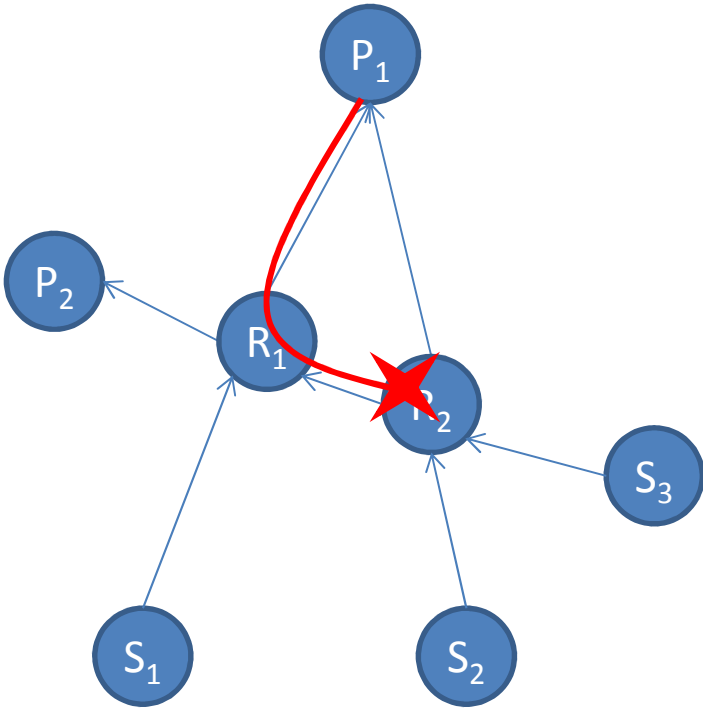
- **Supporting PUSH Intent**
  - This should match application's intent to PUSH content similar to the PULL primitive.
  - Feature to be supported considering efficiency and scalability
- **Support Multicast**
  - Support network service where an application PUSH can be multicasted to **all** intended receivers (just like Interest Multicast)
- **Security**
  - Should be able to deliver secure (authenticated and encrypted) NDO
- **Routing and Forwarding Support**
  - Push prefixes (Multicast or Unicast) should be treated differently from prefixes for regular Interests from routing and forwarding perspective, to support the PUSH intent.
- **Minimizing Processing**
  - PUSH flows shouldn't be subjected to PIT/CS processing, considering latency and application intention.

Using Interest/Data Abstraction for Push

- Discusses how Interest/Data Abstractions can be used to achieve PUSH.
- Four Basic Approaches
  - Long Lived Interests
  - Polling
  - Overloading Interests
  - Interest Trigger
- We offer design choice discussions for each of these cases with its pros and cons.
- The discussion assume multiple providers within the same GROUP_PREFIX generating content randomly and receivers seeking to sync with the producers.

Using Interest/Data Abstraction– Long Lived Interest v

- Assume consumers know all the names [No message loss]
  - Content name: /GroupID/ContentID
    - ContentID: sequential across all providers
  - Query: /GroupID/ContentID (full name)
- Problem with solution:
  - Inefficiency in multi-provider case
    - All Interests have to be send to all providers
    - Redundant Interest delivery
    - Some PITs will never be consumed (e.g., pkt1 from P2 to R1)
- Problem with assumption:
  - How can the providers synchronize? E.g., 2 providers send at the same time, who uses which name?
  - Even if the providers can synchronize, what's the cost?
  - Providers have to address another sync problem



PIT of /GroupID

Using Interest/Data Abstraction– Polling v1

- This is to prevent the issues with the previous approach, the providers can publish content using timestamps.
- Assume the consumer only know the group name
  - **Content name**: /GroupID/<Timestamp>
    - No need for synchronization across providers
  - **Query name**: /GroupID/<earliest after XXX>
    - XXX: the latest version (timestamp) I have
- Problem with solution:
  - Need to have a synchronized time over the service providers and consumers
  - Ambiguous content when two providers publish using the same timestamps or when the clocks drift apart
  - **Message loss**:
    - P1 has notification t=1234, P2 has notification t=1327
    - Consumer query with <earliest after t=1200>
      (he can't query 1201, since he is not sure if there is such a content)
    - P2's version might arrive before P1's version
    - Consumer will query <earliest after t=1327> and miss P1's content

Using Interest/Data Abstraction– Long Lived Interest v2

- Assume consumers know all the names
  - Content name: /GroupID/ProviderID/ContentID
    - ContentID: sequential per provider
  - Query: /GroupID/ProviderID/ContentID (full name)
- Problem with assumption:
  - Consumers have to know all the potential providers
  - The solution becomes more “host-centric” than “information-centric”
- Avoids the packet losses from the previous case
- Problem with solution:
  - Increases the PIT state in the network
  - If the Group_ID is shared among multiple devices (laptop, smart phone etc.), the issues are similar to the long lived interest- v1 case.

Using Interest/Data Abstraction– Polling v2

- To reduce the PIT states in the network, we could process Interests in the Application Layer
  - Useful in applications like Gaming
- Assume consumer knows all the providers
  - Content name: /GroupID/ProviderID/ContentName/<timestamp>
    - ContentID: sequential per provider
  - Query: /GroupID/ProviderID/<updates after t>/nonce
  - Response: all the contents during the period (in a single response), or “no update” response
  - Aggregates the responses & the providers do not have to follow the sequential version
- Problem with solution:
  - Inefficiency with polling
  - More load on the providers
  - Caching not useful here
  - Consumers have to know all the potential providers

Using Interest/Data Abstraction– Polling with a Server

Using Server for Aggregating Provider Notifications:

- Offloads Provider level data aggregation to a server
- The providers would publish data into the server and the consumers would poll for the updates from the server (similar to Twitter and Facebook in IP network).
- Server will offer aggregated response.

Problems with the Solution:

- Single point of failure, just as in case of IP services today
- Server has to use one of the previous mechanisms to sync their current content state with providers.
- Caches are not useful here just in the previous case
- This approach boils down to a host-centric approach by tying down to a server

Using Interest/Data Abstraction– Interest Overloading

Approach

- Notification Payload can be inserted into the Interest itself
  - Interests takes the form /GROUP_ID/NONCE/<Payload>

Problems with this Solution

- Routing and forwarding has to differentiate between Regular Interests from Interests with Notifications
- Storing PIT state has to be avoided for efficiency
- Consumer oriented FIB entry should reach all the providers
- Payloads beyond a certain size has to be avoided considering engineering assumptions on Interest sizes.

Using Interest/Data Abstraction– Interest Trigger

- **Solutions**
  - Takes care of avoiding inserting Payload into the Interest and routing and forwarding complexities of the previous scheme
  - Send a trigger with the content name, and the content will then be pulled
- **Problems**
  - Atleast a RTT delay, affects mission critical applications
  - Triggers still have to reach all the receiving points, so still has the routing and forwarding challenges.
  - Trigger name space should be defined carefully.

Other updates

- The remaining part of the draft hasn’t been changed.
- We provide discussions on protocol semantics, router operation
- Flow congestion control discussions are also provided
- Use case on using this for pub/sub is also provided.

Next Steps

- Comments from the chairs and the group to further this draft are welcome.