Reducing the Subscription Latency in Reliable Causal Publish-Subscribe Systems

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Publish-Subscribe
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Subscription Latency
Subscription Latency

this paper: interplay between reliability and $\delta$
Reliability vs Subscription Latency

• **Best-Effort Delivery**
  • Subscriber can miss some events

• **Gapless FIFO Delivery (GFD)**
  • After receiving some event $e$ from publisher $p$, the subscriber receives all future events from that publisher $p$

• **Gapless Causal Delivery (GCD)**
  • After receiving some event $e$ from publisher $p$, the subscriber receives all future events, that causally depend on $e$, from any publisher (and not only from $p$).
Gapless FIFO vs Gapless Causal Delivery
Gapless FIFO vs Gapless Causal Delivery
Gapless FIFO vs Gapless Causal Delivery

Paper in Computer cites a paper in Comm ACM
Gapless FIFO vs Gapless Causal Delivery
Gapless FIFO vs Gapless Causal Delivery

Diagram showing the comparison between gapless FIFO and gapless causal delivery.
Gapless FIFO vs Gapless Causal Delivery
Gapless FIFO vs Gapless Causal Delivery
Gapless FIFO vs Gapless Causal Delivery

GAP in the causal history of the subscriber!
Reliability vs Subscription Latency

• FIFO is **stronger** than best-effort.
• FIFO brings **higher** subscription **latency** than best-effort.
Reliability vs Subscription Latency

• CAUSAL is **stronger** than FIFO.
• Does CAUSAL bring even higher latency subscription than FIFO?
Reliability vs Subscription Latency

• CAUSAL is **stronger** than FIFO.
• Does CAUSAL bring even higher latency subscription than FIFO?

• To answer this question, we need to understand how we can enforce GFD and GCD in practice.
Implementing GFD on a broker network
Implementing GFD on a broker network
Implementing GFD on a broker network
Implementing GFD on a broker network

Subscription acknowledgement

Alan 21
Implementing GFD on a broker network

Subscription acknowledgement

Alan
Implementing GFD on a broker network

Subscription acknowledgement

Good to go!

Alan
Enforcing GFD and GCD

• Necessary and sufficient conditions to enforce GFD and GCD.

  • A subscription is **stable on path** if it known by all nodes on that path.

  • 1\textsuperscript{st} Result: For GFD, it is sufficient that ONE path is be stable.
Good to go!

Alan
Enforcing GFD and GCD

• Necessary and sufficient conditions to enforce GFD and GCD
  
  • A subscription is stable on path if it known by all nodes on that path.
  
  • 1\textsuperscript{st} Result: For GFD, it is sufficient that one path is be stable.
  
  • 2\textsuperscript{nd} Result: For GCD, it is also sufficient that one path is be stable!
Enforcing GFD and GCD

• Necessary and sufficient conditions to enforce GFD and GCD.

• A subscription is stable on path if it known by all nodes on that path.

• 1\textsuperscript{st} Result: For GFD, it is sufficient that one path is be stable.

• 2\textsuperscript{nd} Result: For GCD, it is also sufficient that one path is be stable!

GCD is NOT inherently more expensive than GFD!
Leveraging Coverage

• If another subscription is already in place, can we use it to reduce the subscription latency?
roundtrip to publisher required?
roundrip to the pivot broker
pivot broker
roundtrip to publisher required?
pivot broker

Luís

Alan
Can we do better?

pivot broker

Luís

Alan
pivot set!
Good to go!

pivot set!

Luís

Alan
Publisher, pivot broker, and pivot set

• **Previous works:**
  - Subscription stable on one or more paths to the publisher

• **Our work:** subscription stable on
  - One path to the pivot broker
  - OR
  - One path to each member of the pivot set
Relevance of the pivot set

• For fault-tolerance you want to have multiple disjoint paths to the publisher.
• No pivot-broker
Finding the pivot set

- In general graphs it may be hard to find the pivot set.
LoCaPS

• LoCaPS: publish-subscribe implementation that leverages our findings.

• It is possible to build the broker overlay that is fault-tolerant and where it is easy to find the pivot-set.
LoCaPS
LoCaPS
LoCaPS
LoCaPS

pivot broker in the base graph
LoCaPS

pivot broker in the base graph
LoCaPS
LoCaPS

Good to go!

pivot set!
LoCaPS

• Evaluation against:

  
LoCaPS

nd = 18, pd = 9, f = 1

Subscription Latency

Coverage probability

- Delta
- Gryphon
- LoCaPS
LoCaPS

nd = 18, pd = 9, p = 100%

Subscription Latency

Size of the pivot set

Delta

LoCaPS
Conclusions

• We have studied the necessary and sufficient conditions that need to be met to offer different reliability semantics to subscribers, namely Gapless FIFO delivery and Gapless Causal delivery.

• We shown that Gapless Causal delivery can be implemented as efficiently as Gapless FIFO delivery.

• Unlike previous systems, LoCaPS can leverage existing subscriptions to reduce the latency of a new subscription.

• More details and more evaluation results on the paper!