“Push it” – update 1

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Disclaimer

This talk is only indirectly about Secure Scuttlebutt (SSB) and other decent(ralized) projects per se, see e.g. the Berlin DTN meeting in May 2019.

Instead, this talk is about push-based communication (which surprised SSB proponents because they thought they were pull-based)
History of this “Push”-Thread

• Sep 2018 - ICN2018-Panel: “Pull() vs Push() is an ill posed problem”
  I introduced SSB, its use of append-only logs, and remained the only person on the panel in favor of push, for unclear reasons at that time

• Feb 2019 - submission of a CCR editorial note “A Broadcast-only communication model”, regarding the relation between PUSH and append-only logs

• Mar 2019 - presentation at ICNRG meeting in Prague (with a lot of interrupts)
  “PUSH is for gods, PULL is for mortals”

• May 2019 - CCR-online editorial note goes online (1)

• July 2019 - recap and new insights

(1) https://ccronline.sigcomm.org/2019/a-broadcast-only-communication-model-based-on-replicated-append-only-logs/
1. Mindset: cumulative immutable data and the “freshness frontier”

2. Recap of CCR-online note: broadcast-only through append-only logs

3. The need for push (not contested if it’s at app level)

4. Two problems of emulating “app-level push()” using “net-level pull()”

5. Extrapolations:
   - push and Shannon entropy
   - in-network memory is not optional
1) Cumulative Immutable Content

- Humanity’s generated content so far, named via some hash function
- Image of the hash function (e.g. $2^{256}$ distinct values)
- Universe of all content items (to be folded onto the hash’s image)
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![Diagram with axes: space (vertical), number of hash repl. (horizontal). The y-axis ranges from 100% to 0% (full replication to 0% replicated). The x-axis ranges from number of hash repl. to number of hash names. A point is marked at 100% replicated. The data (freshness) frontier is a horizontal line indicating the boundary between replicated and pending repl. contents.](image)
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- Growing set of hash-named content
- Accumulation so far: WORM (write-one-read-many)
- Frontier: HEAD (à la Git, also called “tips” in IOTA)
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ICN2018 panel  CCR submission  ICNRG Prague  CCR note online  ICNRG Montreal

this talk
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  prototypical **HEAD**: hash (or seq#) of newest entry
- "Single-author append-only event log": SSB’s basis
2) Broadcast-only communication

- **Reliable global broadcast**: desirable networking service, used in: secure scuttlebutt, cert transparency (CT), Google Pub/Sub, Amazon SNS

- Global broadcast must be built from local broadcast range (due to limited reach, but also to handle offline situations)

- Global broadcast needs relays with memory, will propagate content as soon as possible, and only once

- Append-only log “induced” by global broadcast networking task
3) The need for global push()

- Known under many names: SYNC, NOTIFY, PUB/SUB...

- Recent example from the NDN app space

```python
face = Face()
image = Namespace("/foo/someimage/v42")
image.setFace(face)
def onSegmentedObject(handler, obj):
    print("Got image")
SegmentedObjectHandler(image, onSegmentedObject).objectNeeded()
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- Q: How to implement the notification? —> Pub/Sub library over pull-based ICN, long-lived interest… But once satisfied, things become "interesting"
4) Two problems of emulated push()

- Problem 0: routing to multiple replicas, getting the freshest content fastest … see ICNRG Prague talk, case still needs to be written up, basically can only be solved by (global) interest flooding …

- Problem 1: pull leads to “inter-notification gap >= RTT”

- Problem 2: pull leads to “recursion corridors"
4a) Inter-notification gap $\geq$ RTT

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- Moreover, could lose events:
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- Protection via publisher-side queue (log...)
4b) Recursion corridors

- Context: COIN (compute-in-the-net)
- Consider chain of calls $f(g(h(x)))$ executed at FRA, YUL and SFO, requested from LAX
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![Diagram showing recursion corridors with nodes labeled SFO, LAX, YUL, FRA, and edges labeled f, g, h, data, and interest.]
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```
SFO g h FRA f
LAX

YUL

PULL-world

SFO h Data FRA f
LAX Interest
```
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**Diagram:**

- **SFO**
- **LAX**
- **FRA**
- **YUL**

- **PULL-world**:
  - Data
  - Interest

- **PUSH world**:
  - $x$
  - $h(x)$
  - $g(h(x))$
  - $f(g(h(x)))$
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- In a **PUSH** world: only two Atlantic-crossings in the critical path (compared to four when using PULL)

- **PUSH** world: pipelining (no rate-limiting)

- Corridors can be fixed in the PULL model (→ new emulation library, special name prediction tricks) but rate limitation will remain
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• Replicating append-only logs is about Shannon entropy:
  - Heat entropy = “Verwandlungsgehalt” (transformational content)
  - Information entropy = “delta”
Once new content is replicated (the world has reached the same temp)
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  Once new content is replicated (the world has reached the same temp)

- Unlike the NDN mantra that cache is an optional optimization: PUSH and storage go together: in-net storage is a MUST
  —> towards massive memory nets