Improving Timeliness of Information through Replicating Requests

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Introduction

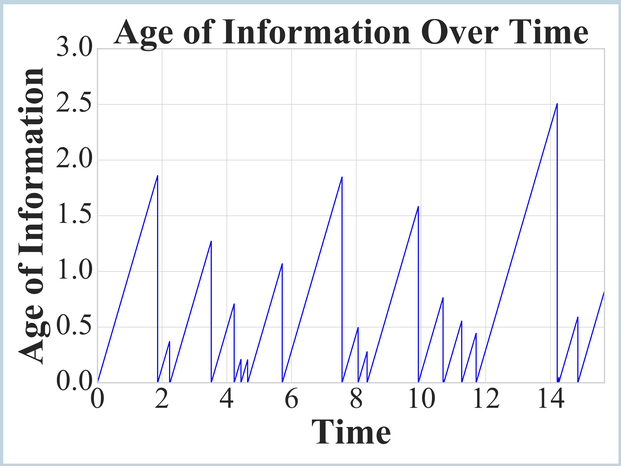
The Internet of Things is rapidly increasing the number of data-generating devices. Applications that use these devices require that generated data be transmitted in a timely manner. Timeliness, also known as freshness, can be estimated using age of information, or age. We propose the use of a replication scheme to reduce the average age. This scheme duplicates data requests to all sources and waits for responses. Increasing the number of responses waited for increases the probability of receiving fresher data and the amount of time spent waiting for data.

Objectives

- Analyze the effects of waiting for responses on age of information.
- Show through simulation that the optimal number of responses to wait for varies

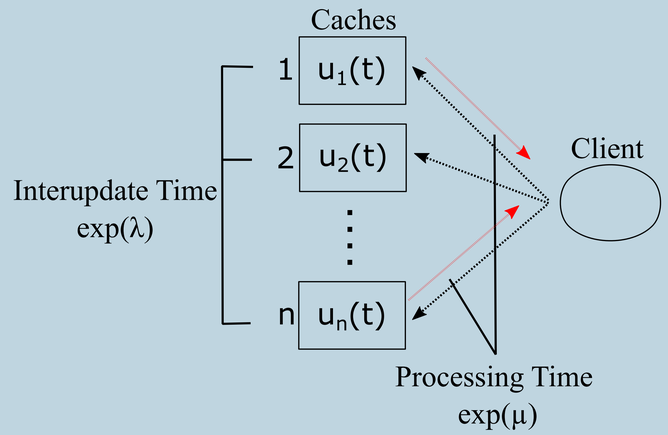
Age of Information

Age of information, or age, is a metric of data freshness. Age is the time elapsed since the generation of data. If data is generated regularly, age rises until the next update.



System Model

- Client that waits for d responses from n caches
- Caches have timestamps, $u(t)$, Poisson distributed updates, exponentially distributed inter-update times, and exponentially distributed processing times.
- Client calculates age using t - max($u(t)$).



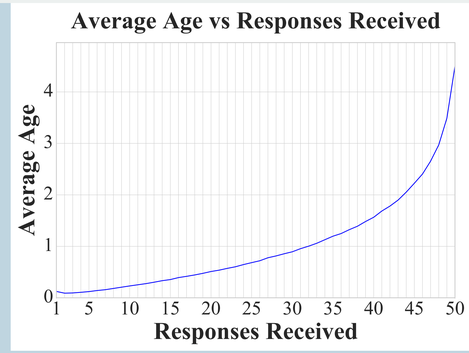
Results

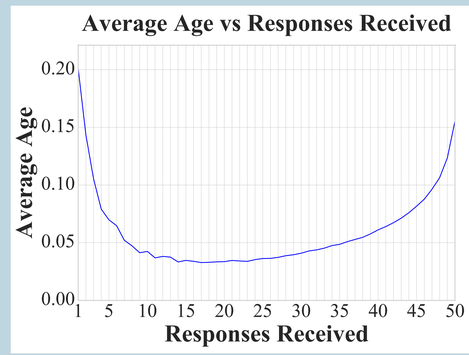
We expected the following behaviors as d increased.

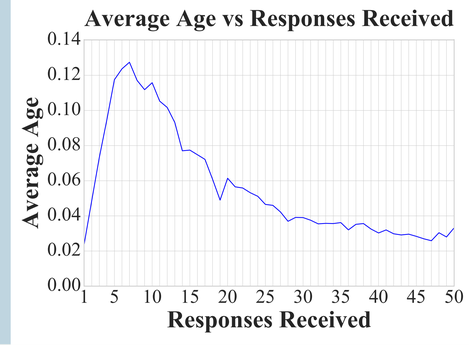
- Age increasing while updates are faster than processing.
- Age decreasing and then increasing while updates and processing were nearly equivalent.
- Age decreasing while processing is faster than updates.

These results were found by simulating 1000 data requests for various parameter pairs with $n = 50$.

- Age increased when updates were faster than processing.
- Age decreased and then increased when updates and processing were nearly the same time and when processing was faster than updates.
- Age increased then decreasing when processing was significantly faster than updates.







Conclusions

- The effect of waiting for responses is dependent on the relationship between average update times and average processing times.
- Depending on the system parameters, the optimal number of responses to wait for varies.

References

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[2] C. Kam, S. Kompella and A. Ephremides, "Age of information under random updates," in Proc. IEEE ISIT, 2013.
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