The Design and Implementation of a Next Generation Name Service for the Internet

Venugopalan Ramasubramanian
Emin Gün Sirer
Cornell University

Presented by Eugenia Gabrielova

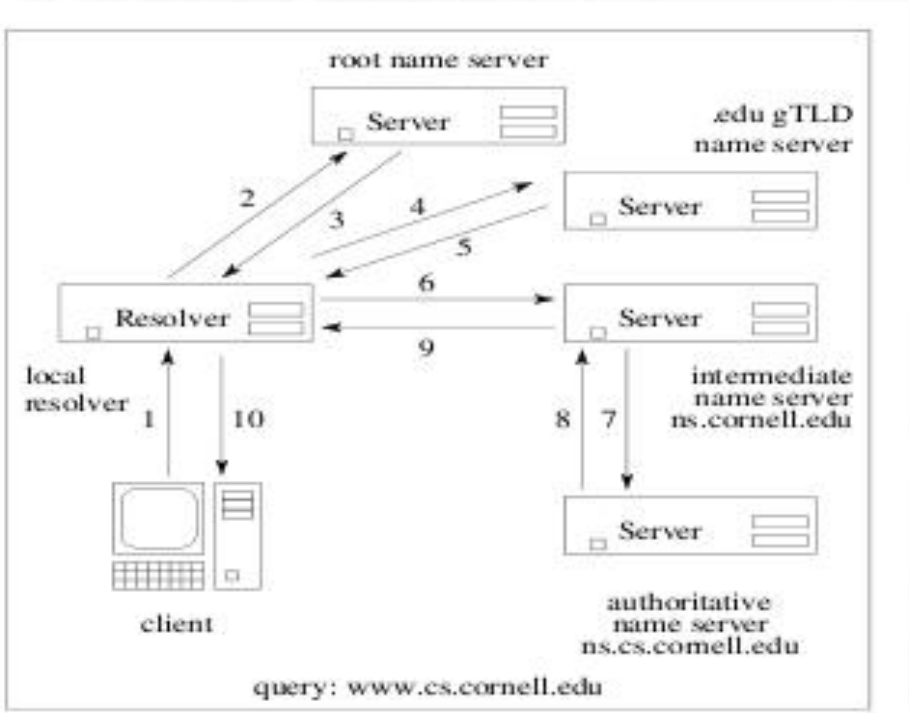
Legacy DNS and its Problems

Name translation is critical for communication in networks. The Domain Name System (DNS) translates names to network addresses on the Internet.

Legacy DNS unsuitable for changing Internet environment

- Increasing number of malicious attacks
- Explosion in client population
- Need for fast reconfiguration

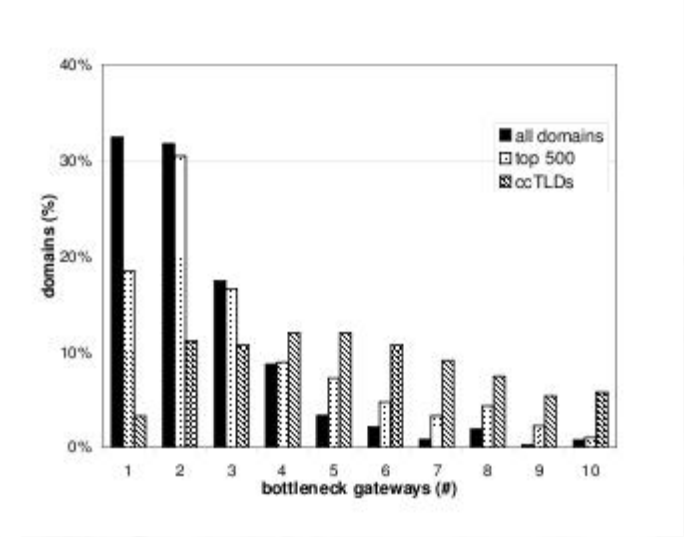
Legacy DNS Operation



Static, distributed tree hierarchically partitioned into non-overlapping domains

Failure Resilience

Highly vulnerable to network failures and malicious compromise



Implementation errors lead to security faults, putting nameservers at risk for attack.

Performance

- Latency
- Misconfigurations
- Load Imbalance

Update Propagation

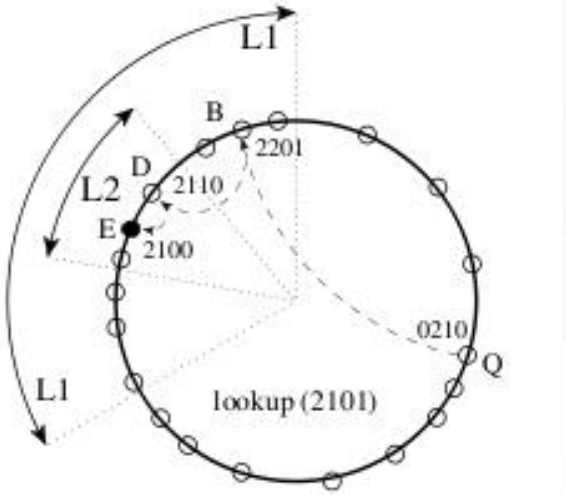
- Large-scale caching conflicts with dynamic content
- Slow update time

CoDoNS: A DNS replacement

- Goals
  - High performance, Resilience to attacks, Fast update propagation
- Cooperative Domain Name System (CoDoNS)
  - Structured peer-to-peer overlays
  - Analytically informed proactive caching
  - Backwards-compatible replacement for DNS
  - Namespace Control

Beehive: Proactive replication framework

An object replicated at all nodes with *i* matching prefixes incurs *i* hops for lookup (*level i replication*)



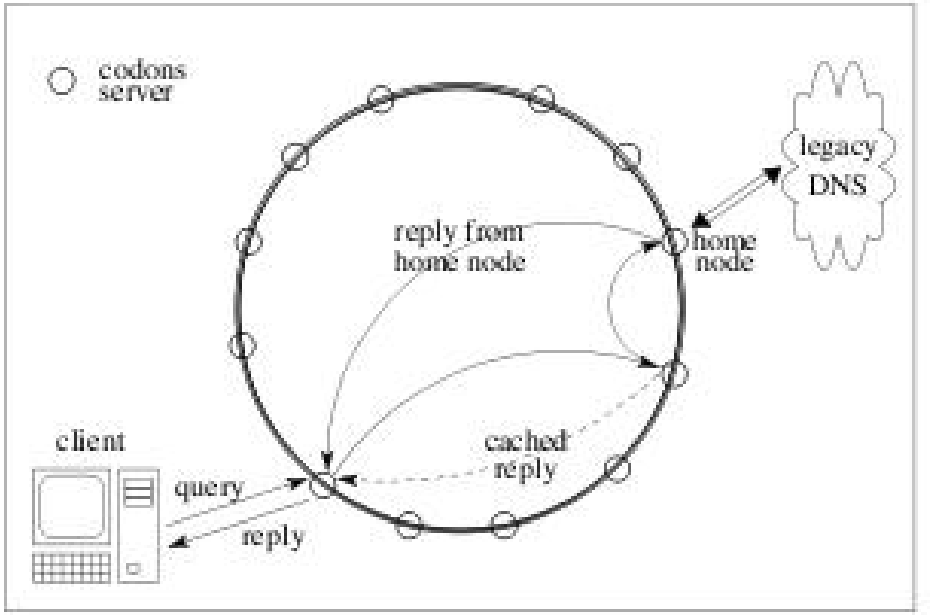
Uses prefix-matching DHTs for *O(1)* lookup performance

Beehive optimizes bandwidth and space consumption

$$x_i = \lfloor \frac{d^i (logN - C)}{1 + d + \cdots + d^{logN-1}} \rfloor^{\frac{1}{1-\alpha}}, \text{where } d = b^{\frac{1-\alpha}{\alpha}}$$

- Aggregate lookup latency < C
- Space-Time Trade off
- Minimal bandwidth and storage overhead
- Level of replication useful for updates

CoDoNS Architecture



- Self-organizes into p2p network
- Compatible query resolution
- Home node pushes updates

Implementation Highlights

- DNSSEC public key cryptography
- Freedom for namespace management
- Peer-to-Peer Overlay
- CDN performance

CoDoNS fulfills DNS redesign goals

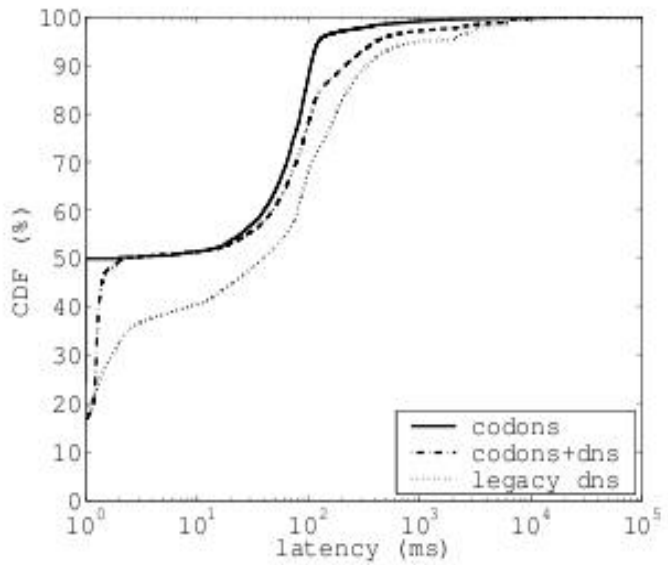
- Optimized lookup performance with modest overhead
- Automatic replication and load balancing
- Rapidly pushes updates to all replicas

P2P network of CoDoNS servers deployed on PlanetLab

	Parameter	Value
Pastry	base	16
	leaf-set size	24
Beehive	target C	0.5 hops
	aggregation interval	6 min
	analysis interval	60 min

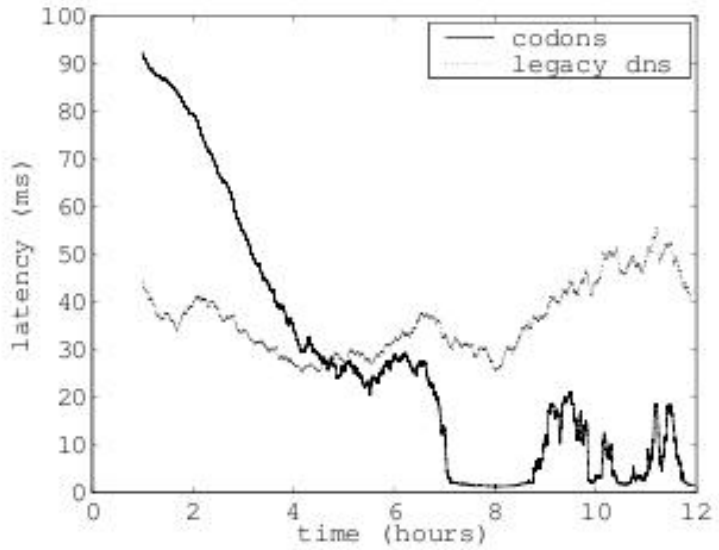
Applied same 12-hour DNS workload trace to CoDoNS, legacy DNS

Faster lookup performance



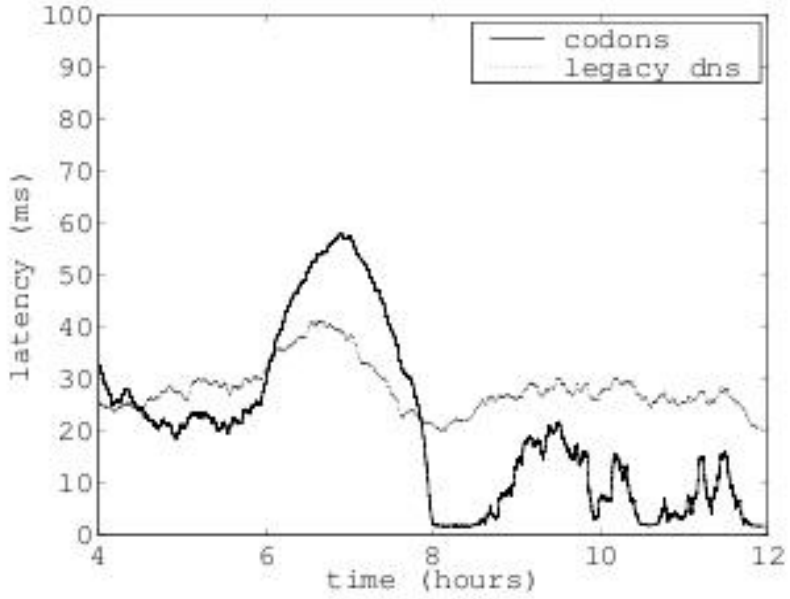
More than 50% of queries incur no network delay

CoDoNS lookup latency decreases significantly as proactive caching occurs



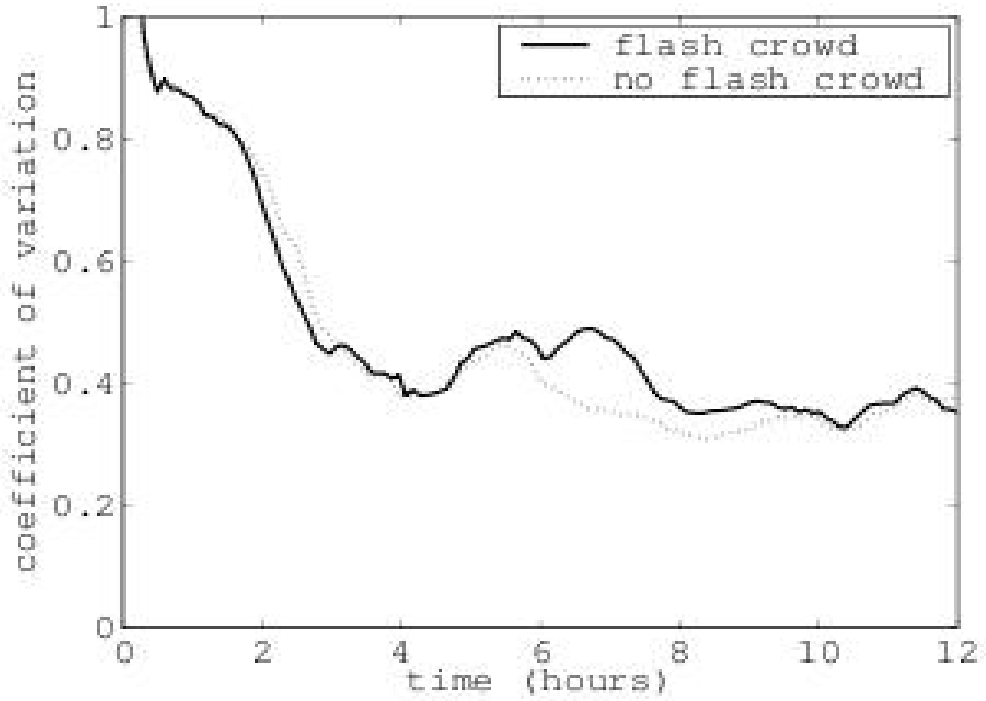
Recovers from Flash-Crowds

Flash-Crowd: Sudden popularity of a domain name



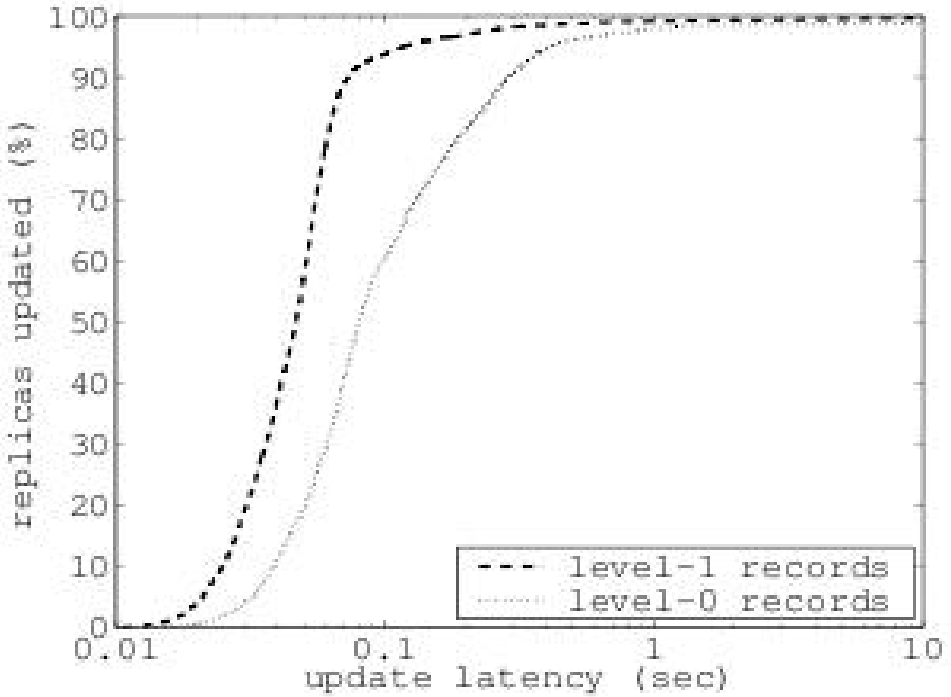
CoDoNS adjusts caching and regains performance after detecting flash-crowd.

CoDoNS balances query load uniformly across all nodes



Load Balance: Ratio of standard deviation to mean across nodes.

Propogates updates very quickly



98% of replicas updated within 1 second

Conclusions

- DNS is too static and vulnerable for growing Internet
- CoDoNS is a high performance replacement for legacy DNS
- New platform for publishing and managing data

Questions and Discussion

- DNS has many problems - why has it not yet been replaced?
- How feasible is CoDoNS deployment?
- Is the experimentation trace representative of the Internet?