Far Cry: Will CDNs Hear NDN's Call?

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Evolution

• Transport Network
  • End-point to end-point
  • Operates on IP addresses

• Content Network
  • End-point to content
  • Operates on content’s names

Content Delivery Network (CDN)
  • Implements a content network over a transport network (i.e., the Internet)
ICN/NDN

• A young networking technology to build a content network
  • Simple architecture & Secure design

• Goal:
  • Compare content networks built by CDNs and NDN

• Important Note:
  • This work is only focused on caching and retrieval of static contents
Real-World Measurements

• Deployed an adaptive video streaming service
• Evaluated content networks:
  • Akamai
  • Fastly
  • NDN testbed
• Users in four different continents
• Two-week experiment

Metrics:
  1. Quality of Experience (QoE)
  2. Origin workload
  3. Failure resiliency
  4. Content security
Quality of Experience (QoE)

- Video resolution
- Video startup delay
QoE – Video Resolution

The diagram illustrates the video resolution quality of experience (QoE) across different regions: North America, Canada, Europe, South America, and Asia. The graph shows the distribution of video resolutions (240p, 360p, 480p, 720p, 1080p) across different months (A, F, N). The data suggests that 1080p resolution is more popular in North America and Canada, while 720p and 480p are more common in Europe, South America, and Asia.
QoE – Video Resolution – Parallelism
QoE – Startup Delay
QoE – Startup Delay – Caching

![CDF graph showing the cumulative distribution function of the average RTT between end-users and their surrogate (ms) for different content delivery networks (CDNs): Akamai, Fastly, and NDN. The graph highlights a ~6x difference in performance between Akamai and Fastly, indicating a significant improvement in efficiency for Akamai.]
QoE – Software Maturity

• A new set of experiments
  • **Exclude** contribution of parallelism and large deployment of CDNs

• **Average** throughput:
  • NDN testbed ➔ 7.54 Mbps (23.48 Mbps at best)
  • Akamai ➔ 96.7 Mbps
  • Fastly ➔ 83.2 Mbps
QoE – Summarize

• Akamai and Fastly try to:
  1. Cache contents as close as possible to end-users
  2. Download contents through a massive parallelism, using optimized software/protocols

• NDN can barely meet these two goals
  • Lack of software maturity and large deployment
Akamai incurs 1.77 times more traffic load to the video server than NDN does.

Fastly is accountable for 38% of the total traffic received by the video server from all three networks.
Origin Workload – Why NDN is better?

Two main contributors to NDN testbed’s performance:

• **Network architecture**
  • Akamai and Fastly partition their network to *islands*

• **Request aggregation**
  • Akamai does not aggregate requests seeking for the same content
Failure Resiliency

The success ratio of each network in serving the end-users’ requests from their caches when the origin stops serving content

<table>
<thead>
<tr>
<th>Network</th>
<th>Akamai</th>
<th>Fastly</th>
<th>NDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success ratio</td>
<td>9.42%</td>
<td>13.98%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Origin Workload & Failure Resiliency – Summarize

• High traffic load and failure resiliency issues in CDNs are related to their network design
  • Resource over-provisioning in CDNs cannot address these issues

• NDN benefits from:
  • Stateful forwarding plane
  • Non-partitioned network design
  • Unique in-network caching features
Content Security

- CDNs secure channels by Transport Layer Security (TLS)
  - TLS guarantees *data privacy*

- NDN secures contents by data signature
  - NDN guarantees *data integrity*
Security – Real-World Scenarios

- Keep your private key private

- Schematize trust for dynamic contents
Security - Summarize

• NDN security model is promising for large content distribution purposes

• Main issue of NDN security model
  • Lack of privacy
Lessons & Challenges

- Hardware & Software Maturity
- The Need for NDN Applications
- Management and Debugging
Conclusion

• Compare the content networks built by NDN and CDNs

• QoE is mainly determined by hardware and software maturity
  • CDNs outperform the current NDN deployment in terms of QoE

• Origin workload and failure resiliency are mainly the products of the network design
  • NDN testbed outperforms CDNs

• NDN \textit{can} realize a resilient, secure, and scalable content network if accompanied by
  • Mature software and protocols
  • Sufficient hardware resources
Thank You