Requirements for accessing data in network storage

draft-ohlman-decade-add-use-cases-reqs-01

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IETF DECADE  Maastricht
July 27th, 2010
Requirements for accessing data in network storage

- Additional requirements to complement “draft-gu-decade-reqs-05”

- Requirements:
  - Application agnostic
  - Data reuse
  - Roaming users
Requirement: Application agnostic
Requirement: Data reuse

With current draft

Same data multiple copies

In-network storage
Requirement: Data reuse

With Data reuse requirement

- Multiple references, one data copy
- In-network storage
Requirement: Roaming users

Diagram:
- Roaming user
- Local in-network storage
- Cache
- Low capacity or congested link

27 July 2010
FP7 4WARD Project - www.4ward-project.eu
Requirement: Roaming users

With current draft

Home in-network storage

2 Cache

Low capacity or congested link

1 Cache

Roaming user
Requirement: Roaming users

With Roaming user requirement

- Low capacity or congested link
- Roaming in-network storage
- Roaming user
Allowing remote in-network storage

With current draft

Local in-network storage

Local access

Cache

Low capacity or congested link
Allowing remote in-network storage

Local access

Remote in-network storage

Low capacity or congested link
Requirement: Application-agnostic

- The specification of DECADE SHOULD strive to make the DECADE in-network storage application-agnostic. As a verification of this effort DECADE SHOULD be specified in such a way that it can address at least one other application type, besides P2P applications.

- Rationale
  - To build separate in-network storage infrastructures for other application types, beside P2P, seems wasteful
  - IPTV Use case: distribution of video content, mainly focusing on Video-on-Demand (VoD) services and user-generated contents.
  - Characteristics of IPTV scenario:
    - support an efficient large-scale distribution of video;
    - high degree of replicated contents to a multiplicity of fixed and mobile users
Requirement: Data reuse

- When certain content is popular and used by many users, the network part of DECADE SHOULD be able to store only one (or any limited number) copy of that data. The same data can then be used to serve requests from multiple DECADE users.

- Rationale
  - Generally several copies in multiple storage good for user response – when data popular and copies in different locations
  - Target is efficient use of available data, unnecessary data copies not needed
Requirement: Roaming users

- DECADE SHOULD have the ability to support roaming for terminals/users/applications by allowing the use of in-network storage in the visited network.

- Rationale:
  - A user of DECADE in-network storage that roams to a visited network could potentially cause very inefficient access to that user's DECADE storage.
  - It is therefore essential that the user is able to acquire new DECADE storage which is better located in the visited network.

- Discussion:
  - A related issue is the possibility to migrate content from one DECADE storage to another when roaming.
  - We believe that this is covered by the requirements on Efficient Transfer (section 3.3) and Communication among In-network Storage Elements (section 4.3) of [I-D.gu-decade-reqs].
Summary and Conclusion

- Additional requirements
  - Application agnostic
  - Data reuse
  - Roaming users
- Adopt requirements into “draft-gu-decade-reqs”
- Selection of reference non-P2P application

- Information on the related concept Networking of Information (NetInf)
  - http://www.netinf.org
  - http://www.4ward-project.eu/
Backup slides
Problems resulting from Host-centric view

- No common *persistent naming scheme* for information
  - URLs and IPs overloaded with locator and identifier functionality
    - Moving information = changing it's name ("404 file not found" errors)
  => Use *flat namespace* for persistent identification
- No consistent *representation of information* (copy-independent)
  - No consistent way to keep track of *identical copies*
  - Different *encodings* (e.g., mp3, wav) worsen problem
- Information dissemination is inefficient
  - Can’t benefit from existing copies (e.g. local copy on client)
    - Also true for *Content Delivery Networks* (e.g. Akamai)
  - No “anycast”: e.g., get “nearest” copy
  - Problems like *Flash-Crowd effect, Denial of Service, …*
- Security is host-centric
  - Mainly based on *securing channels* (encryption) and *trusting servers* (authentication)
  - Can’t trust a copy received from an untrusted server

Problems can be solved in a consistent manner via an information-centric architecture
1. Step: Persistently identify information via identifier/locator split
   - Location-independent identifiers
   - Represent multiple copies

2. Step: Representation of information via Information Objects (IOs)
   - Another level of indirection
   - Represent information independent of specific copy and encoding
     - E.g. a text, a song
   - Contains information-specific metadata
     - E.g. access rights, attributes

Information Objects can do more:
   - Representation of:
     - Streams
     - Services
     - Real-world objects (e.g., a book, person)
   - IOs can be used to organize information

Enables efficient information dissemination
   - System can automatically choose encoding and copy (e.g. based on metadata)
   - User can navigate information (e.g. choose encoding)
### NetInf Naming Scheme

**Type**
- Defines the format
  - e.g. Hash algorithm used (SHA1, MD5, …)

**Authenticator (A)**
- Binds the ID of the IO to a public key PK
  - Hash function used to compress length of PK

**Label (L)**
- Identifying individual object published by Authenticator
  - contains a number of identifier attributes associated with an IO
  - (A, L) combination needs to be globally unique

- Supporting the combination of:
  - name persistence, self-certification, owner authentication, and owner identification
  - for information objects that are static or dynamic, that change location, that change owner, and whose owner change organisational affiliation
  - without need to trust the delivering host

- Security metadata include
  - Cryptographic hash of the data
  - Certificate chain binding the IO key (PK\_IO) to owner key (PK\_owner)
  - Signature of the self-certified data with SK\_IO or any other authorised SK
  - All data needed for owner authentication and identification

- Separation of notion of *publisher* and *owner*, where the latter can stay anonymous

<table>
<thead>
<tr>
<th>Type</th>
<th>A = Hash(PK_IO)</th>
<th>L = {identifier tags}</th>
</tr>
</thead>
</table>

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Mapping Information Model to NetInf name resolution

IO ID: Type $A=\text{hash}(PK_{io}) \quad L=\text{label}$

Name resolution system

- Name resolution records
  - type
  - content
    - metadata
    - IO ID'
    - locator$_A$
    - locator$_B$

Storage/caching

A
BO

B
BO
NetInf Node Architecture

Resolution and Routing functionality

Data transport functionality

Additional services

Applications

NetInf Node

NetInf API

NetInf Storage API

NetInf Search API

Resolution controller

Storage engine

Search engine

Transport controller

Local storage engine

Cache engine

TCP/IP

GP

Other

(M)DHT

Broadcast

Local

...
Scalable Name Resolution System

- Combination of:
  - Hierarchical DHTs (Provider-based)
  - Topological embedding of DHTs
  - Name-based routing
Standardization issues

Issues to be considered for standardization:

- **NetInf interfaces**
  - User-Network Interface
  - Inter-Provider Interface
    - Name resolution service between different domains
      - registration/query protocols
      - name resolution records
    - Transport and routing of messages

- **Naming scheme**
- **NetInf APIs**
Summary and Conclusion

- NetInf is about the design of a *new network architecture* based on an *information-centric* paradigm
- Some problems that are addressed by the NetInf
  - Naming scheme for *naming information*
  - World-wide scalable *Name Resolution* mechanism for flat names
  - IOs as *representation of information*
  - Enable *efficient information dissemination*
    - Benefit from *available copies, anycast, caching, solve Flash-Crowd*, …
  - *Secure information-centric architecture* by embedding security into identifiers
- Some significant results up to date
  - Naming scheme with integrated security that is independent of hosts
    - Detailed definition and security analysis
  - Design of a scalable integrated name resolution and routing scheme (MDHT)
  - Scalable solution for mobility of objects, hosts and networks (LLC)
  - Overall NetInf architecture prototype
    - Demonstrated at international conferences
Thank you!

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