Data-intensive Storage Services on Clouds: The VISION Cloud Project

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Outline

- Introduction
- Innovations
- Use Cases
- Architecture
Goal

- Architect and implement an infrastructure for the reliable and effective delivery of data-intensive storage services, facilitating the convergence of ICT, media and telecommunications

Innovations

- **Raise Abstraction Level of Storage**: objects with user- and system-defined metadata
- **Computational Storage**: technology for specifying/executing computations close to storage
- **Content-Centric Storage**: facilitate access to data by content and its relationships
- **Advanced Capabilities for Cloud-based Storage**: support delivery of data-intensive services securely, at the desired QoS, at competitive costs
- **Data Mobility and Federation**: enable comprehensive data migration and interoperability across remote locations

Use cases: Media, Telco, Healthcare, Enterprise

Facts:

- A 3-year project, started Oct 2010
- www.visioncloud.eu
Store video of the summit together with rich metadata

- Title of Event
- Date/time
- Agenda
- Video format

What is new:

- Metadata is an integral part of the storage
- Rich metadata model describing both handling of an object and its content
A storlet is triggered to automatically extract metadata

What is new:
- Architectured and safe way to run computations in the storage system
Content-Centric Storage

- Access data according to metadata values
- Build content networks

• Title of Event
• Date/time
• Agenda
• Video format
• Transcript

Relations:
Equivalence, list, set

- What is new:
  - Storage leverages metadata and content networks to optimize itself

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Delegate right to access an object to people that are not known by the storage system

What is new:
- Flexible yet secure access control
Federation and Interoperability

- Change storage providers without data lock-in

Provider A

User's View of his/her Storage

Provider B
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Telco use case

Video from media use case

Photos

Storlet to transcode format

Storlet to classify photos

Content-centric relationships from data

Storlets for additional services

Third party storlets as a service
Media use case

Ingest videos

- Content-centric relationships from data
  - Storlet to create material-track-essence relationships
  - Storlet for feature extraction
  - Storlet to extract shot and keyframe
Healthcare

Medical Data Storage Service

Complex Medical Data Model

Medial Data Integration/Link Layer

RIS ... HIS PACS

Hospital 1

Hospital n

Patient Mobile, @Home

Subset of Clinical Data

E-Services (Service Interfaces)

VISION Cloud

Health Insurance

Pharmacy

Practice

Medical Center

Diagnostics Laboratory

Healthcare Communities

Government

Health Services Provider (e.g. Medication Check)

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Healthcare use case

- DICOM data
- Storlet to extract metadata and create relationships
- Storlet to extract data for patient
- Storlet to anonymize data
- Anonymized data authorized for study
- Data made available to patient with restrictions on some data access
- Data made available to another doctor with restrictions on some data access
- Content-centric relationships from data
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The VISION Cloud Architecture

Data access

Access and Interface Layer
- Data Access Layer (DAL)
- Management Interface Layer (MIL)

Operating Layer
- Data Operating Layer (DOL)
- Management Operating Layer (MOL)

Management/control

DATA SERVICE
- Content networks/objects,
- Computation on storage,
- Mobility, availability, reliability, security

MANAGEMENT SERVICE
- Monitoring, Metering, Billing,
- Security management, Tenant/User management, SLA
High Level Concepts and Data Model

- Objects are write all-at-once
- Metadata
  - System
    - Management directives
  - User
    - Key-value pairs
    - Schema
- Metadata can be updated
- Versioning for logical protection
- Symmetric replication for resiliency
- Eventual consistency
Storlet Life Cycle and States

**Definition**
- Computation
- Parameters

**Initialization**
- Capabilities
- Constraints
- Trigger Conditions
- Dataobjects

**Storlet Definition**

1 Definition → * Instance

**Storlet Instance**

- **Active**
  - Execution
  - Obeying Constraints

- **Passive**
  - Scheduling

- **Unregistered**

- **Death**
  - Cleanup

- **Terminate**

- **Kill**

- **Transfer**

- **Register**

- **Trigger**

- **Waiting**
  - Change Trigger
Physical Model

- 100s of Data Centers (DC)
- Each DC 10s of storage clusters
- Each storage cluster 100s of servers with direct attached disks
Data Access Flow

Client

Global View
- A1 A2 H2
- H1 H2 A1
- Z1 H1 H2

Cluster H1
- Catalog GPFS-SNC
- Catalog GPFS-SNC
- Catalog GPFS-SNC

Cluster H2
- Catalog GPFS-SNC
- Catalog GPFS-SNC

Cluster A1
- Catalog GPFS-SNC
- Catalog GPFS-SNC

Cluster A2
- Catalog GPFS-SNC
- Catalog GPFS-SNC

Cluster Z1
- Catalog GPFS-SNC
- Catalog GPFS-SNC

DC-H

DC-A

DC-Z
Logical model

- External interface is REST

- Every server runs same software stack
  - Basic stack – Apache, Cassandra, file system
  - VISION Cloud components of DAL, DOL, MIL, MOL

- Many independent requests processed in parallel by each server

- Some servers in each cluster also run global view

- An object can be placed on a specific server

- Shared state at the cluster level belongs in the catalog

- Shared state at the cloud level belongs in the global view
Global View

- Global Catalog
- User Services
  - Identity/Policy Services
- Resource Map
Suggested Enhancements to CDMI

- Large binary objects with metadata
  - Eliminate conversions in the JSON payload

- Advanced queries
  - Support range queries, list container, cursors, etc.
  - Not just query queues

- Computational storage
  - Add interface for managing and triggering computation in the storage