A Flexible and Secure Shared Object Storage Service for the Cloud

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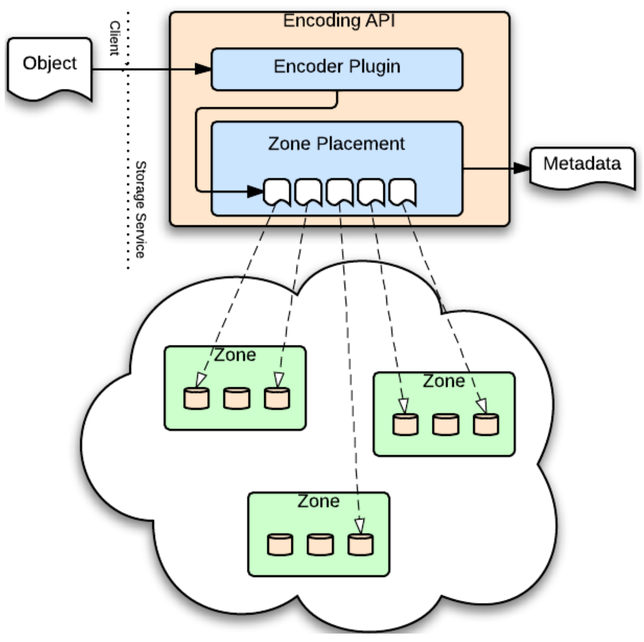
Motivation and Objectives

- Storing sensitive data in the cloud remains challenging – high redundancy exposes data to threats from cloud admin, multi-tenancy.
- Build a service that provides flexible options for storing and operating on sensitive data in the cloud.
- Use data encoding and virtualization to secure information on shared infrastructure; give users control over levels of security for data.

Flexible support for dynamic data encoding

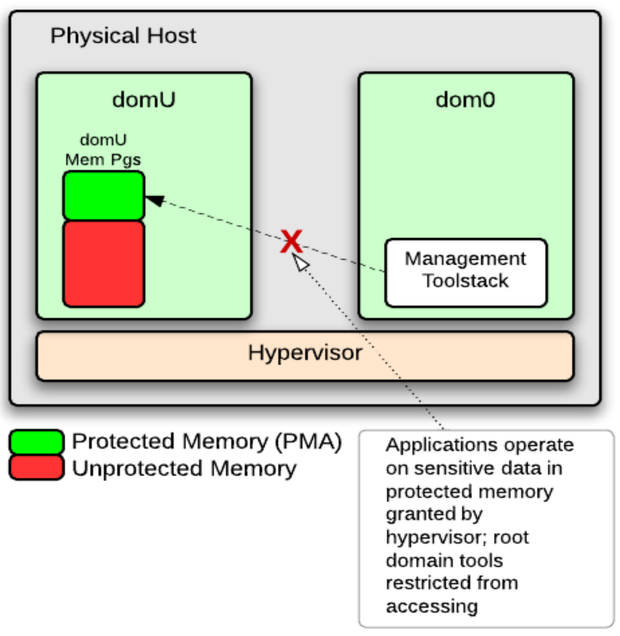
- Support multiple data encoding schemes through plugin API; encoders transform objects into fragments, stored independently in the cloud.
- *Storage zone hierarchies* provide data isolation across admin domains and physical cloud resources.
- *Placement strategy* intelligently maps fragments to zones with *constraints*.



- Encoding plugins provide flexible tradeoffs for security, efficiency, high availability.

Protected Memory – Keep sensitive data secure on virtualized infrastructures

- Virtualized servers use *Protected Memory Area (PMA)* – pages allocated by hypervisor to guest that root domain cannot access through standard management toolchain.
- Protection from threats originating within the cloud administrative domain – malicious software or "honest but curious" admins.

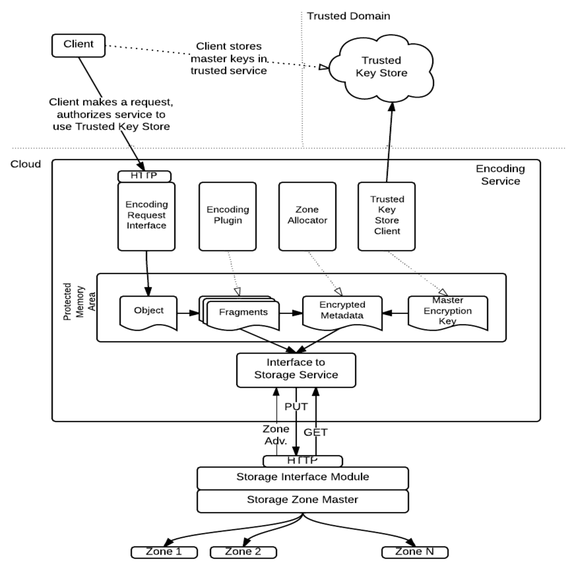


Data placement constraints secure data-at-rest

- Zone placement strategy optimizes allocation of encoded fragments to storage zones to ensure isolation and data security.
- Geographic distribution and hardware-separation between zones protects data from failures in cloud infrastructure *(replication, erasure codes)*.
- Threshold encoding strategies used to minimize information leakage *(secret sharing)*.
- Future efforts will investigate constraint-based programming for optimal fragment placement.

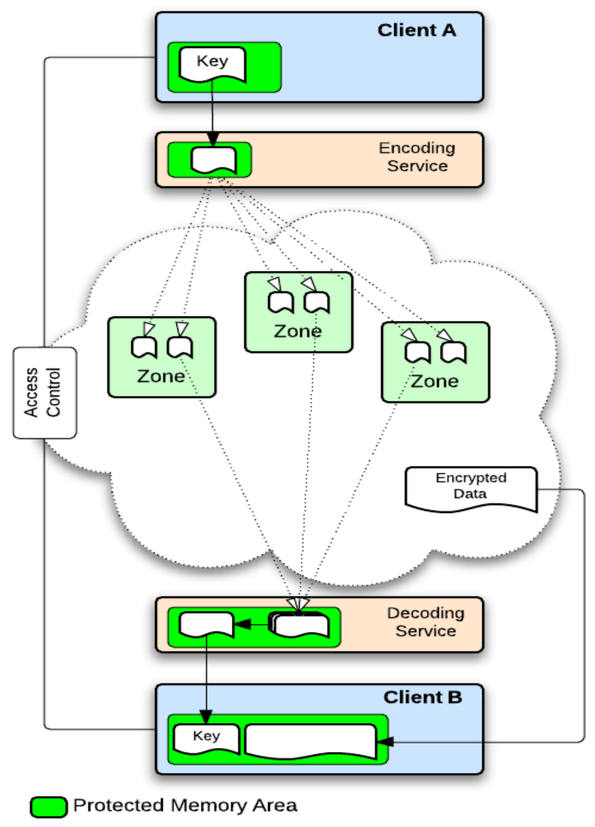
Managing object encoding as a service

- Cloud service encodes/decodes objects; metadata mapping fragments to zones is encrypted and persisted in the cloud
- Clients manage master encryption keys in a *Trusted External Key Store*; encoding service granted access only when needed.
- Encoding service uses PMA on virtualized servers in the cloud to protect data during fragmentation and recovery.



Use case: sharing encryption keys in the cloud

- Allow clients to share and operate on encrypted data stored in the cloud.
- *(k,n)* threshold secret sharing scheme to encode encryption key; shares are stored across zones.
- Clients share access to fragments and metadata via ACLs.
- Keys recovered from shares within PMA and sent to clients via HTTPS.
- Clients keep keys secured within PMA on virtualized servers.



Current Implementation and Future Work

- Modified OpenStack Swift object store to implement service-managed encoding in proxy server.
- Developed and deployed on GT "Jedi" IaaS research cloud infrastructure.
- Encoders for replication, secret sharing and forward erasure codes (decoding in progress).
- Fragments assigned to nodes using Swift's consistent hashing algorithm.
- Future work involves:
  - Evaluation of encoding plugins.
  - Development and evaluation of efficient zone placement algorithms.
  - Evaluation of efficiency and security on large-scale cloud deployment with real applications.

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