Improving Customer Trust in Cloud Services

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1. Problem

- **Cloud computing is attractive to many companies**
  - Ability to elastically launch *virtual machines* (VMs) such as Amazon EC2 and GoGrid
  - Can reduce costs by offloading IT to cloud providers
- **But, data privacy and integrity is a serious concern**
  - Data can leak out or be tampered with by privileged administrators of the cloud provider
  - Surveys show such concerns prevent companies from adopting cloud services
- **Our approach:**
  - Prevent data access by *untrusted* cloud nodes
  - Let customers decide which cloud nodes are trusted

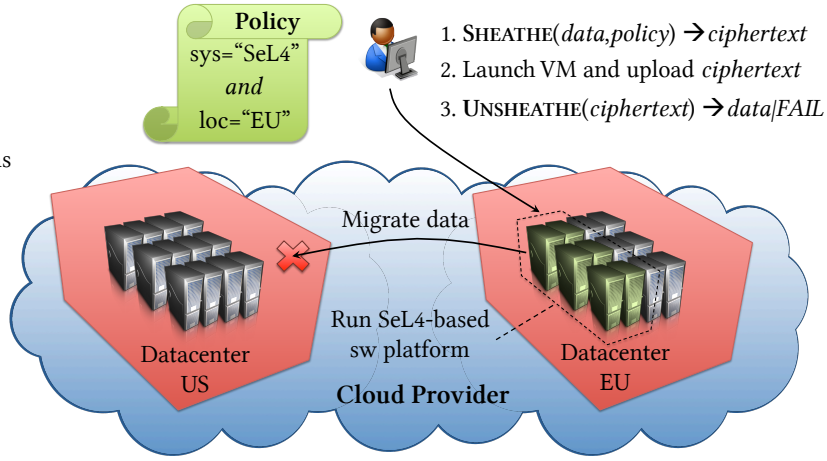
2. Key Idea: Policy-Sealed Data

- **Primitives restrict access to customer data in the cloud**
  - Customer binds data to a policy (*sheathe*)
  - Cloud nodes must satisfy policy to access data (*unsheathe*)
  - Resilient to software admin activity
- **Policy specifies configurations of cloud nodes**
  - Software configuration (e.g., hypervisor)
  - Physical configuration (e.g., location, hw components)
- **Used to design *trustworthy services*, which can:**
  - Protect confidentiality and integrity of customer data
  - Restrict location of data processing
- **We build Merlin to implement policy-sealed data**

3. Usage Example of Policy-Sealed Data

Cloud Compute Service akin to EC2
- Sw platforms: Xen- or SeL4-based
- Datacenters: US or EU
- Let customers choose preferred configurations

Threats and trust assumptions
- Adversary: software admin
  - e.g., can migrate data, reboot nodes
- Mitigation: cloud service developer
  - Sw platforms restrict admin privileges and sheathe data before migrating data
- Cloud nodes physically secured

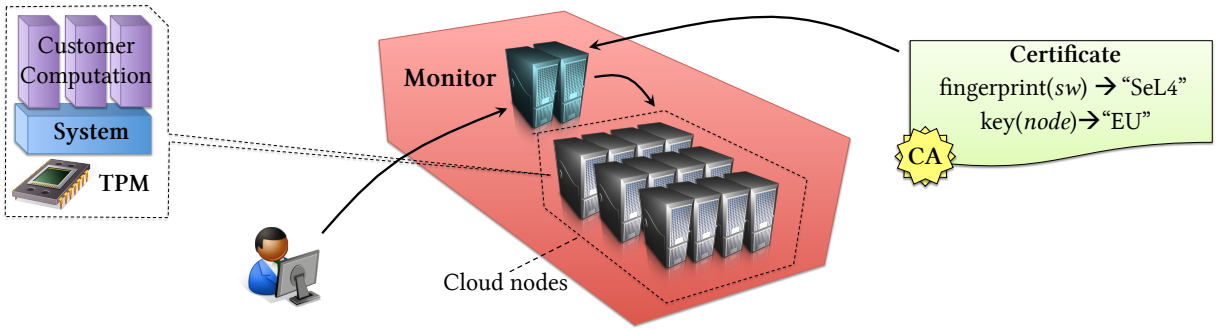


4. Merlin: Implementing Policy-Sealed Data

1. Install TPM chips on nodes
- Provide unique cryptographic key
- Store fingerprint of sw platform

2. Deploy dedicated monitor
- Checks node configurations using node TPMs
- Enforces policy-sealed data with CPABE

3. Upload certificates issued by certifier
- Map TPM fingerprint to software attributes
- Map TPM key to physical attributes



4. Monitor checks node configurations
- Determine TPM key and fingerprint
- Detect node attributes based on certificates
- Send CPABE capability with attributes

5. Customer attests the monitor
- Determine monitor key and fingerprint
- Validate them against certificate

6. Sheathing and unsheathing
- Customers sheathe using CPABE public key
- Nodes unsheathe using CPABE capability

5. Status

- **Full implementation and evaluation of Merlin**
  - Verification of Merlin protocols using an automated verification tool: ProVerif
  - Proof-of-concept cloud compute service using Eucalyptus, an open-source cloud backend platform