Systems and Internet Infrastructure Security
Network and Security Research Center
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# Seeding Clouds with Trust Anchors

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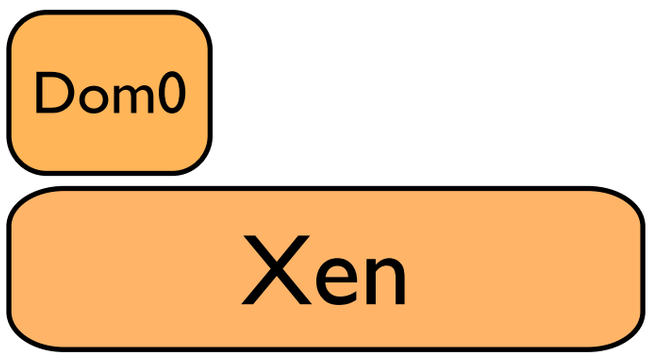
# Hurdles to Cloud Adoption

- Clouds offer customers a platform for on-demand resources and reduced administrative effort
- However, fears of **data loss** and **security breaches** have stifled adoption by many businesses
- We propose increasing the **transparency** of cloud platforms to build trust in them

# Uncertainty in Clouds

- Customers are concerned with:
  - Host and VM integrity
  - VM isolation / protection
  - Data leakage
- Need to verify integrity of those components



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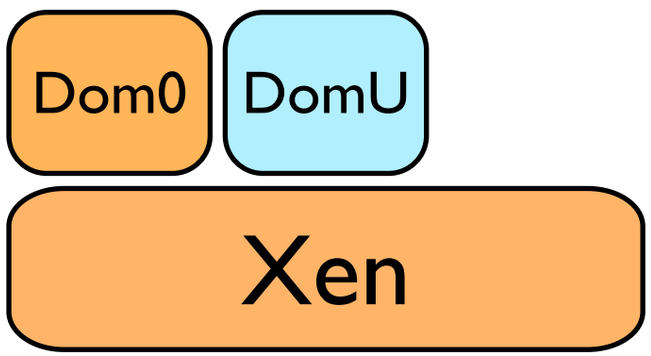

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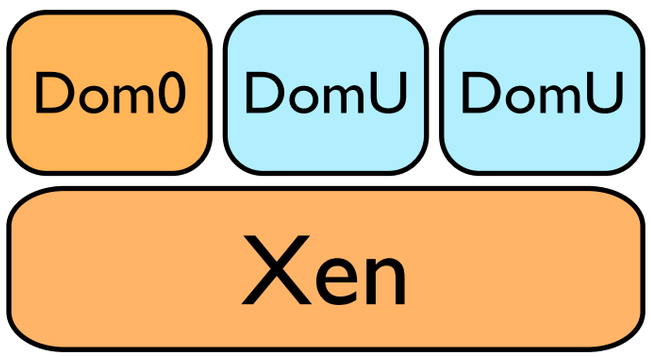

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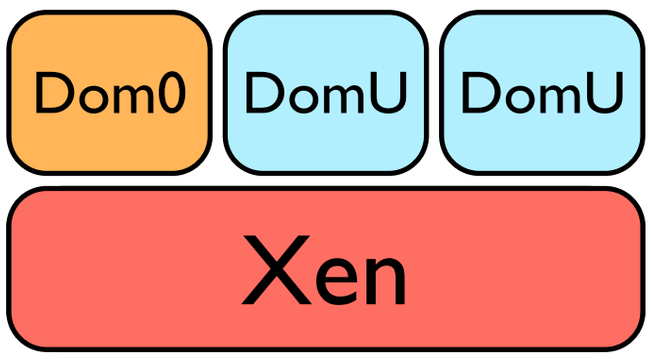

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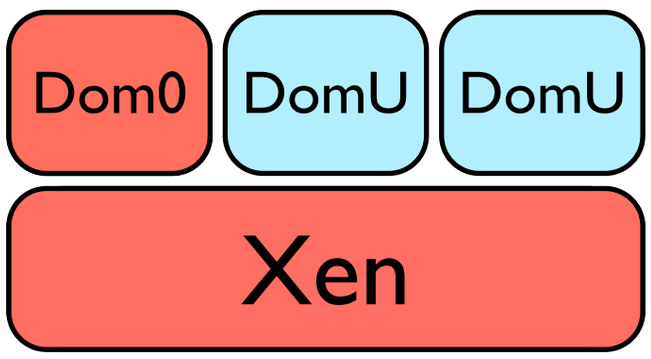

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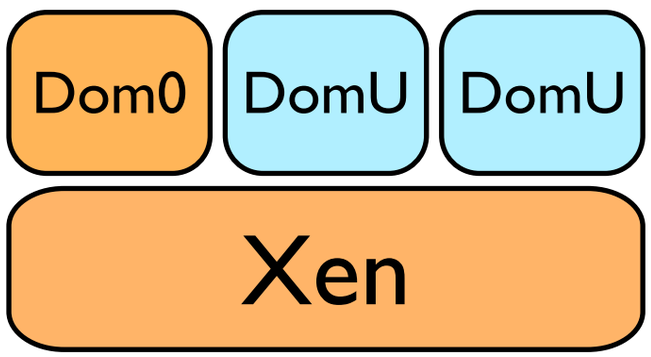

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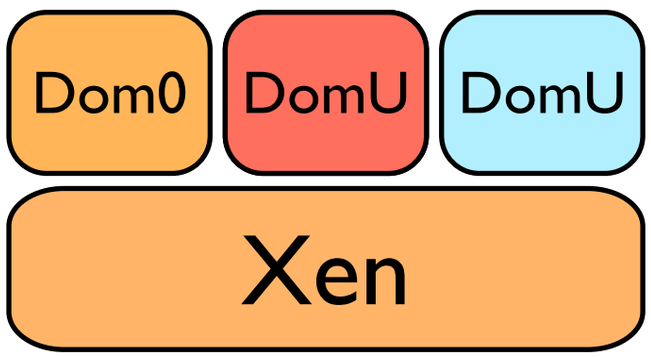

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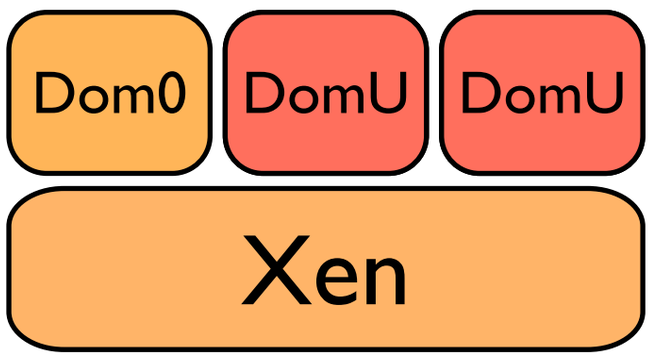

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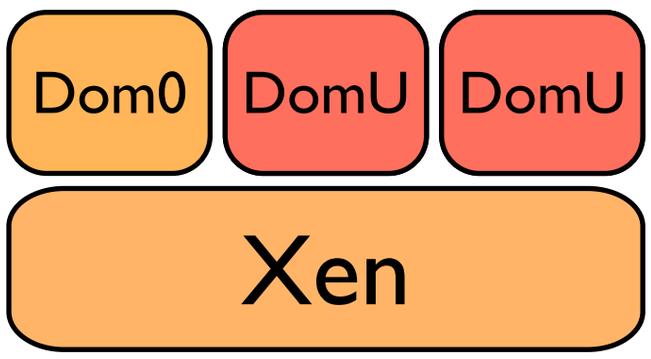


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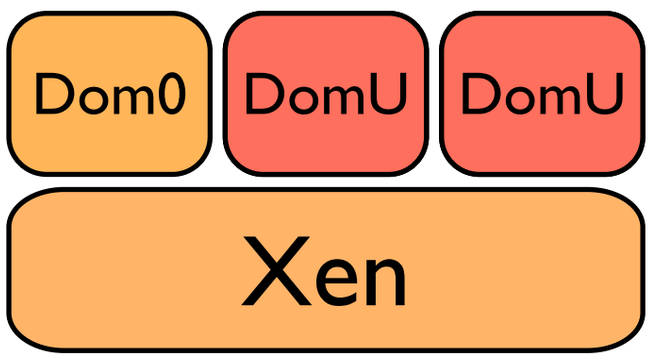


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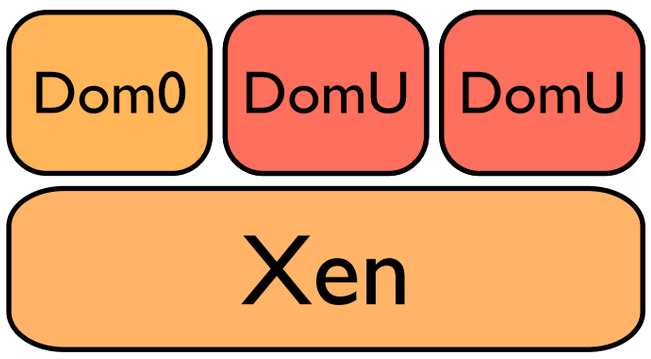


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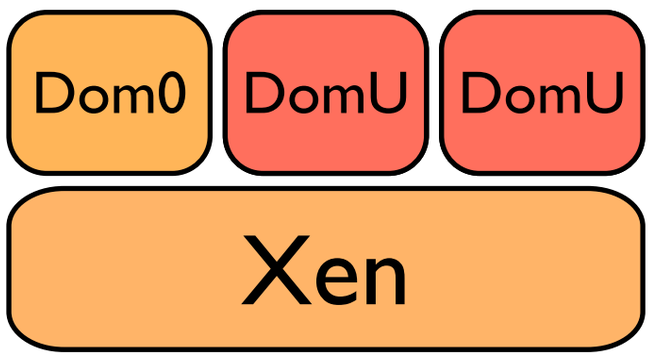


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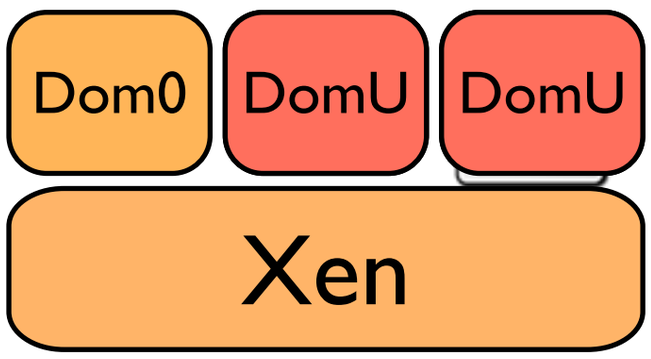
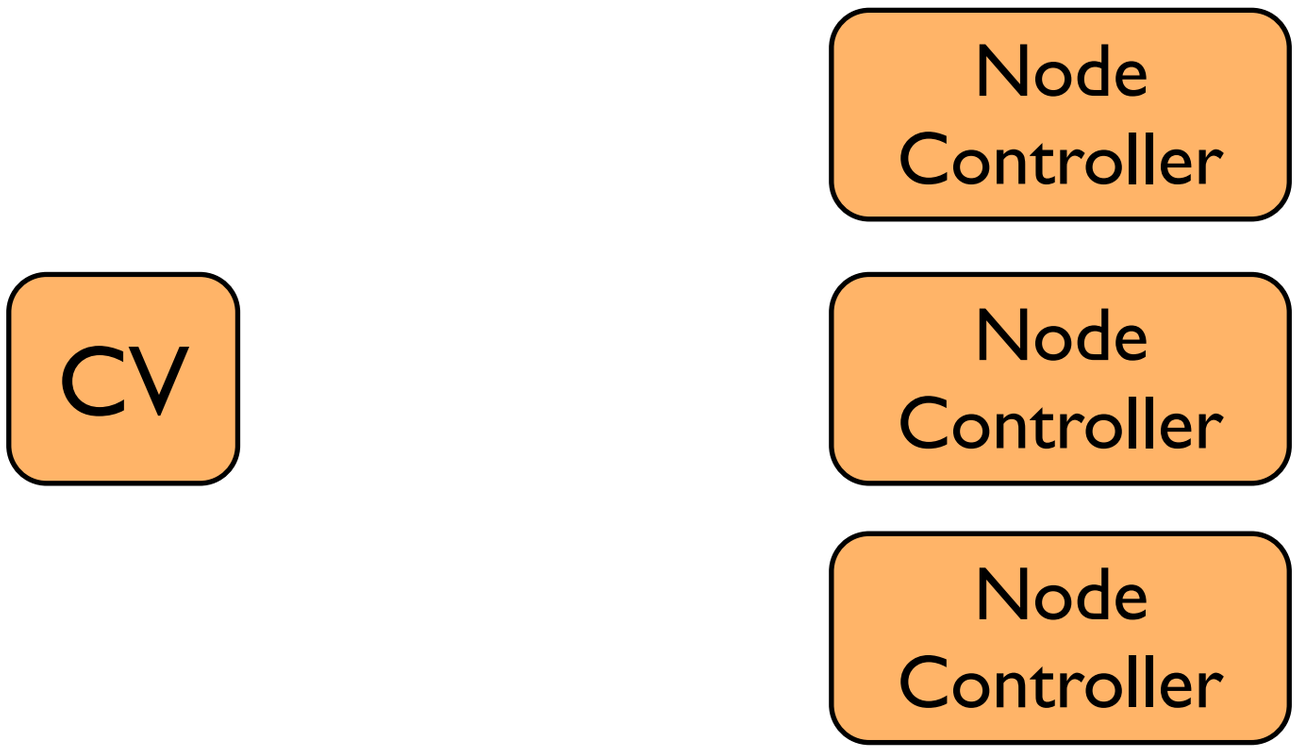



# Cloud support for proofs

- Clouds offer a unique administrative environment for integrity measurement
  - Physical security, internal PKI, consistent components
  - Centralized administration over many systems
- Focus on using hardened / proven components
  - Assured hypervisors (e.g., SEL4) and code
  - Verifiable enforcement policies

# Cloud Verifier

- We propose a Cloud Verifier (CV) mechanism to enable verification of cloud platforms by proxy
  - Verifiable component in the cloud
  - Monitors the integrity of VM hosts using a public integrity criteria



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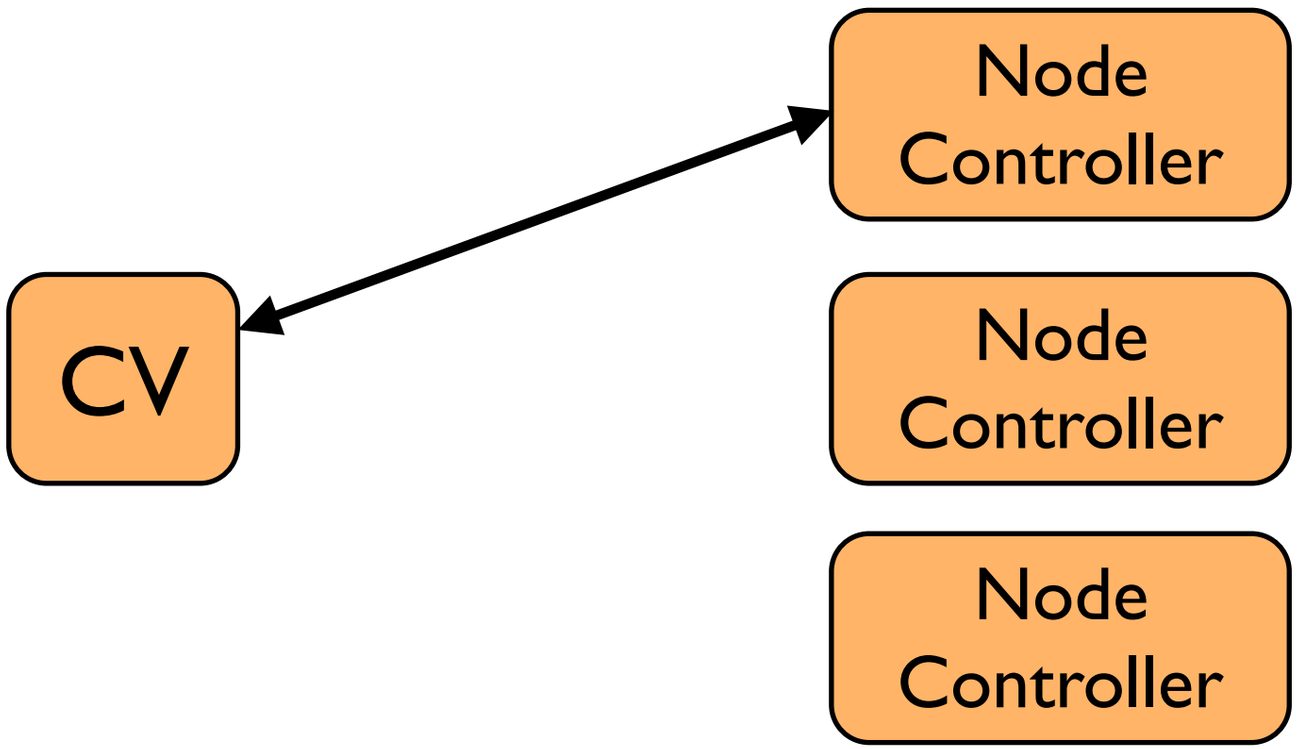

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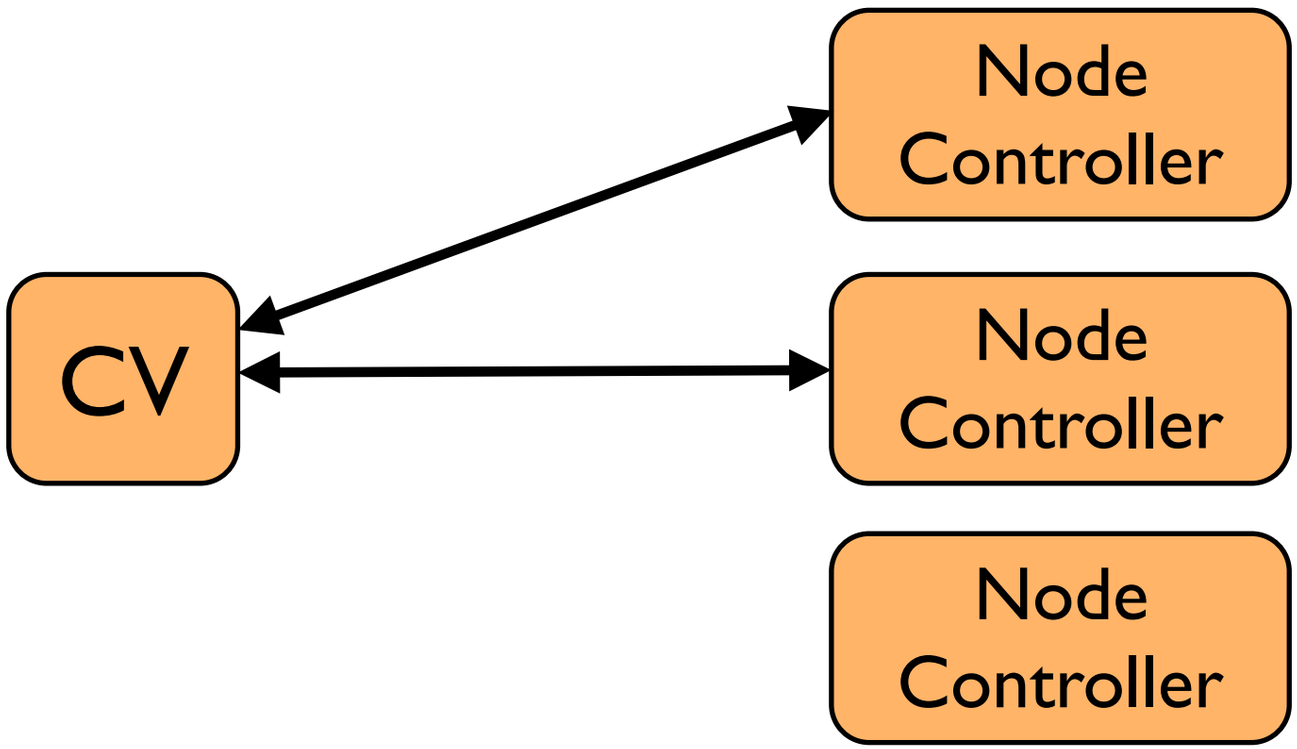

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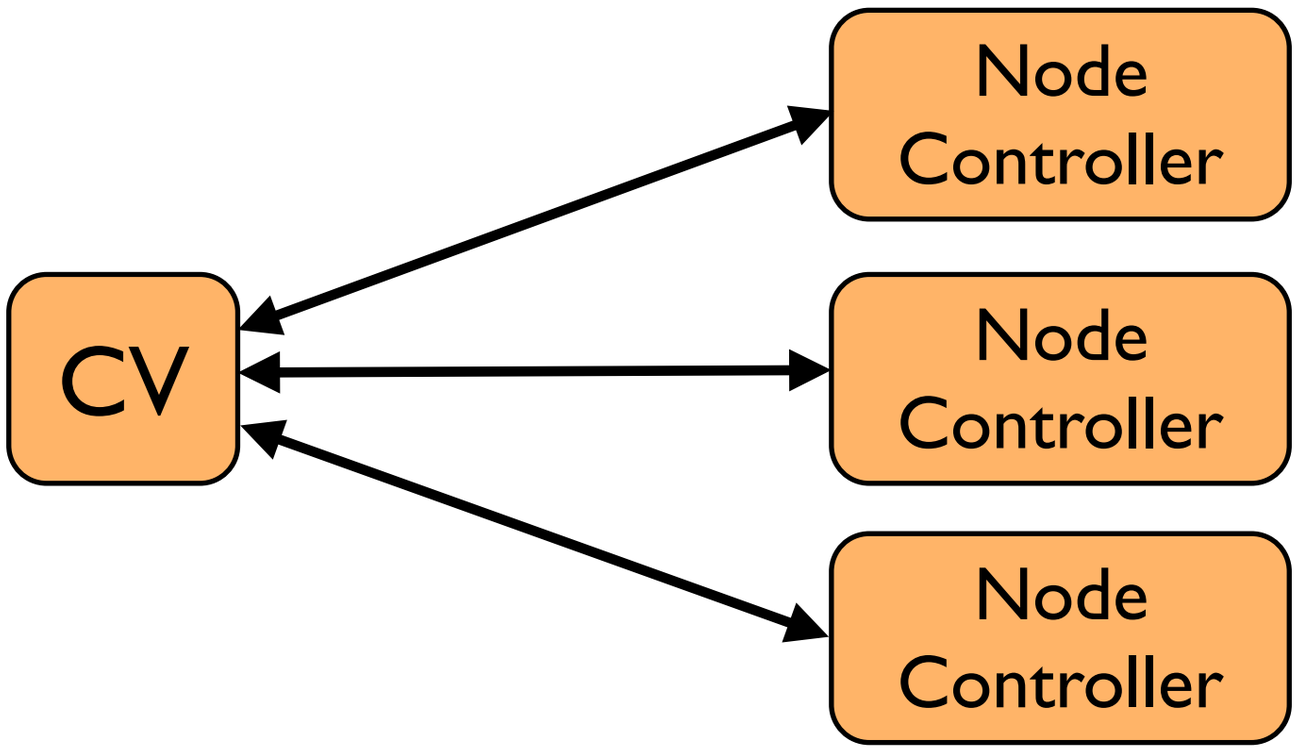

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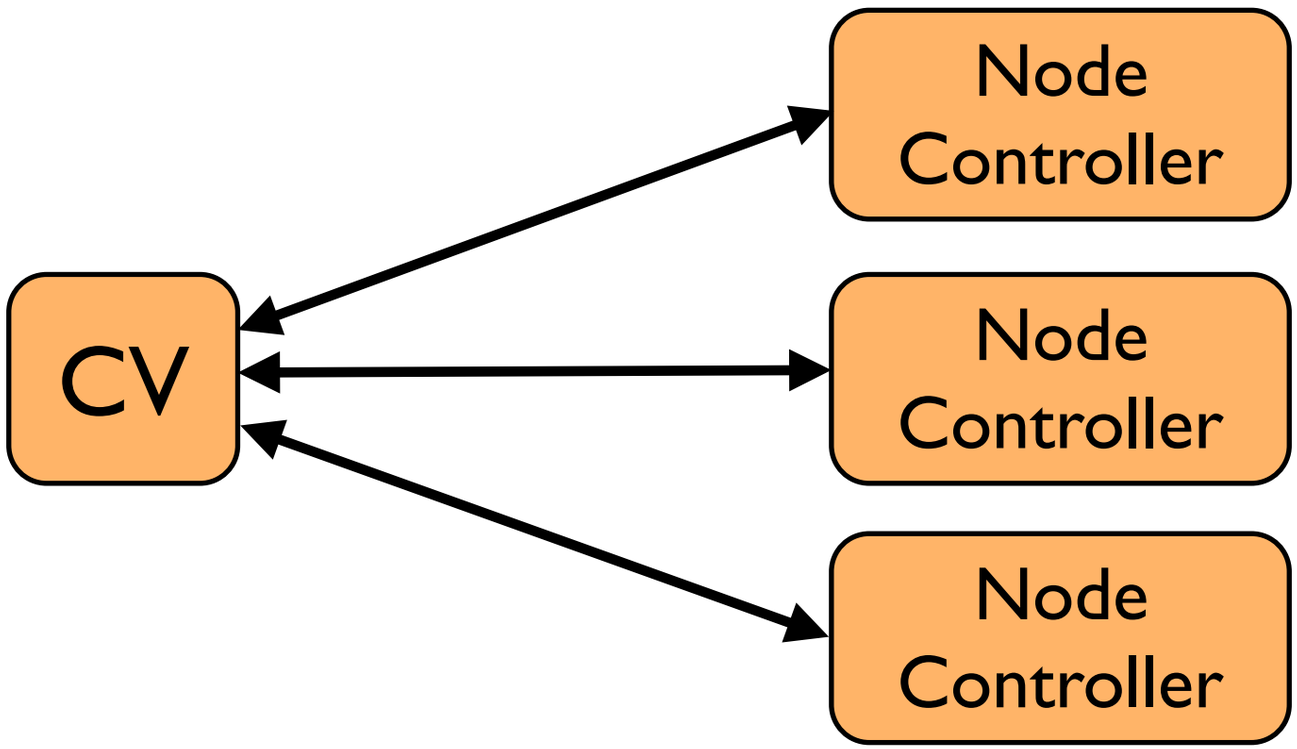
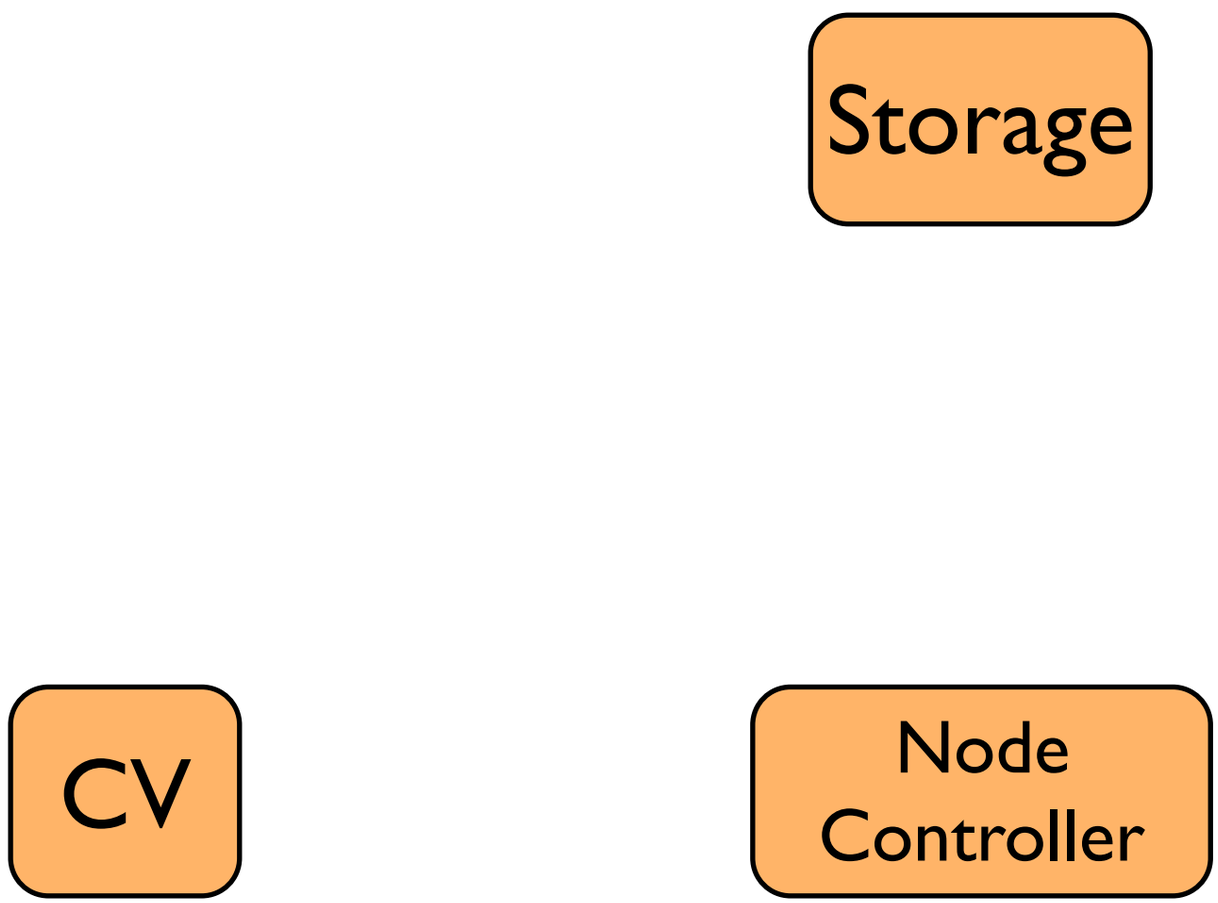
Integrity Criteria



# Customers using the CV

- CV then vouches for integrity of a VM's host using a signed public key



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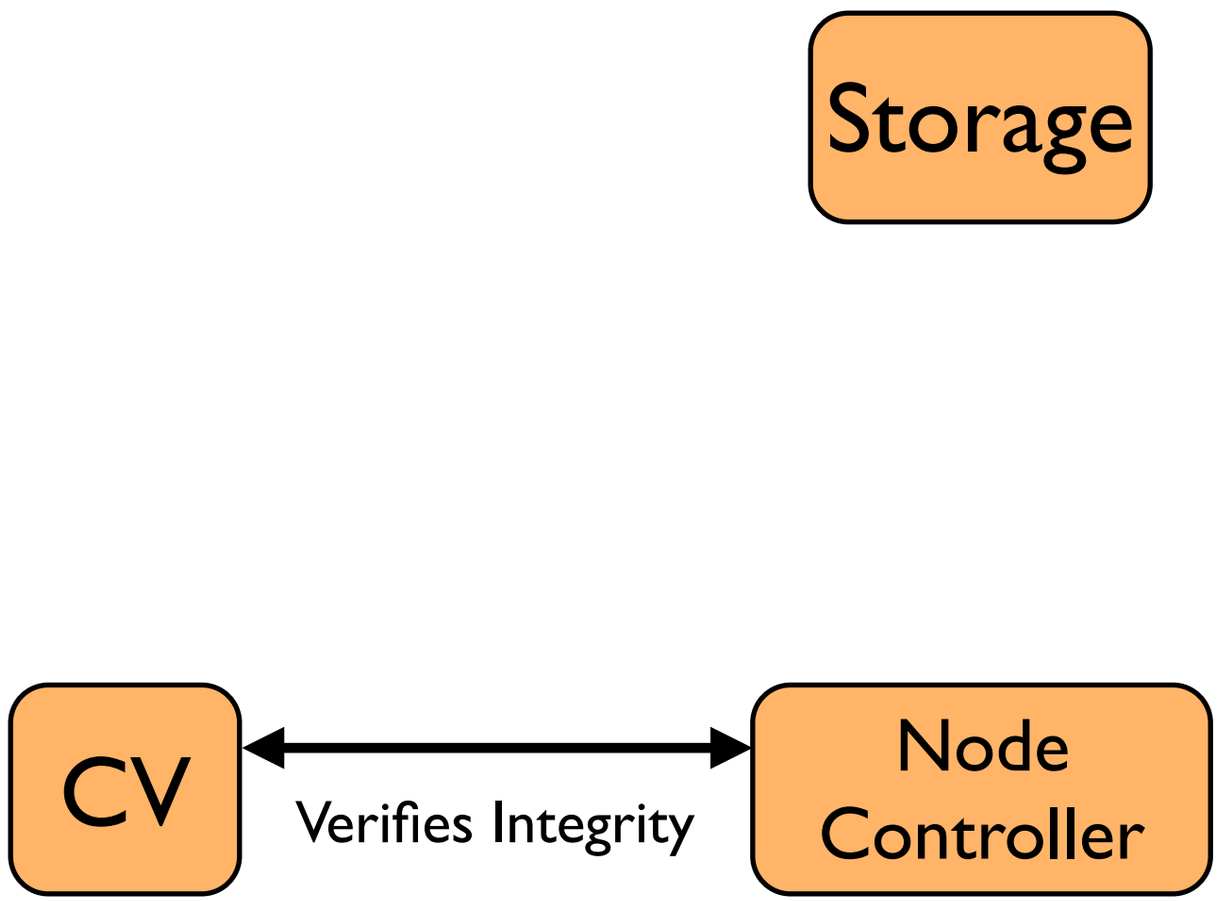

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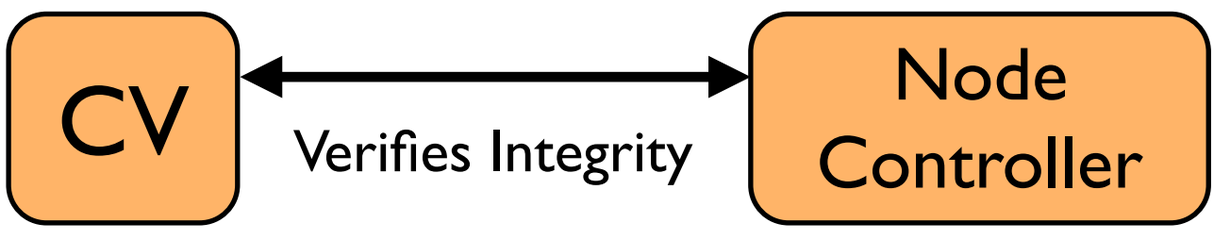

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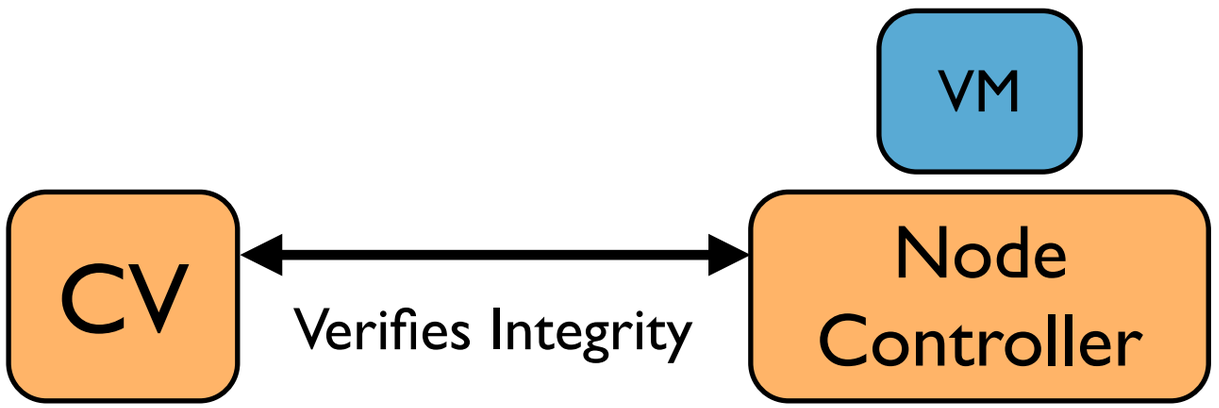

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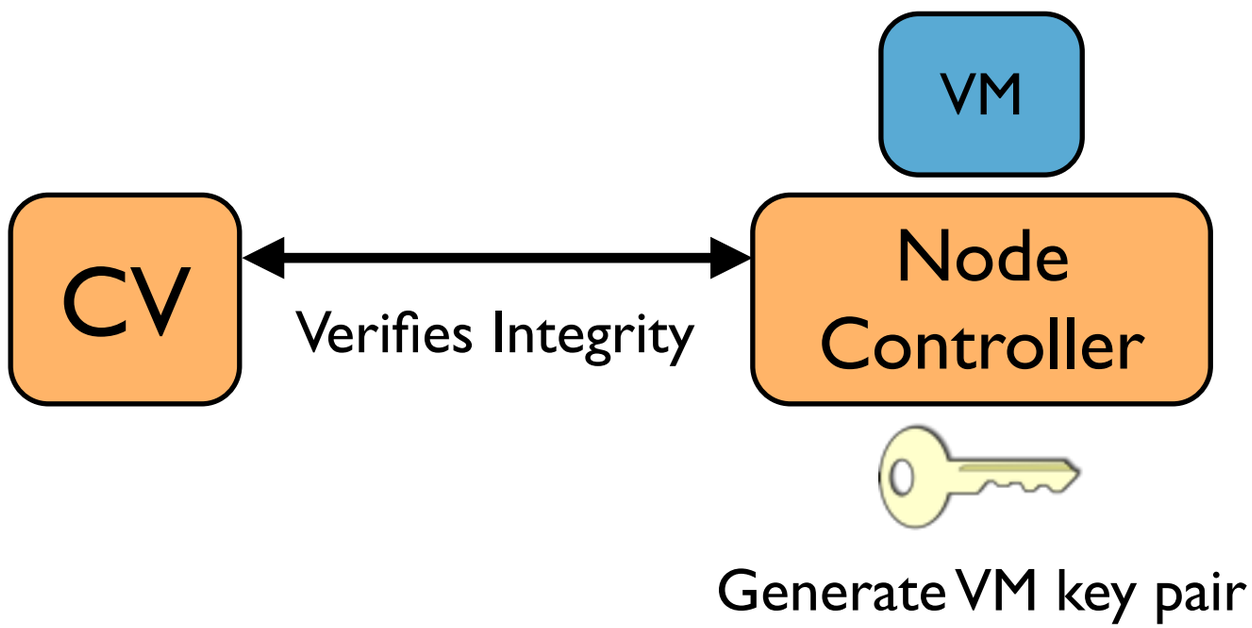

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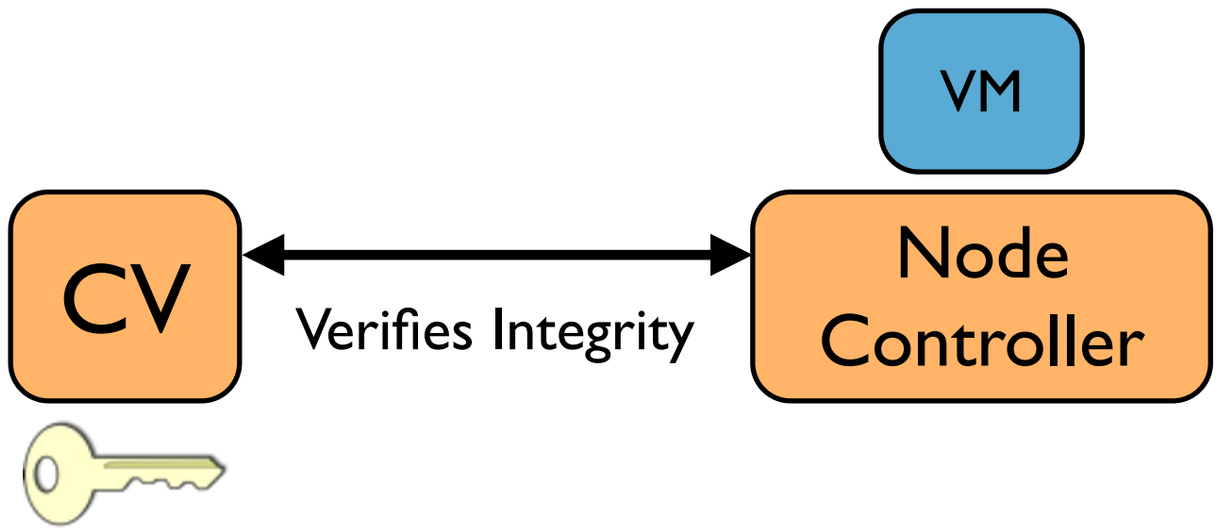


Generate VM key pair

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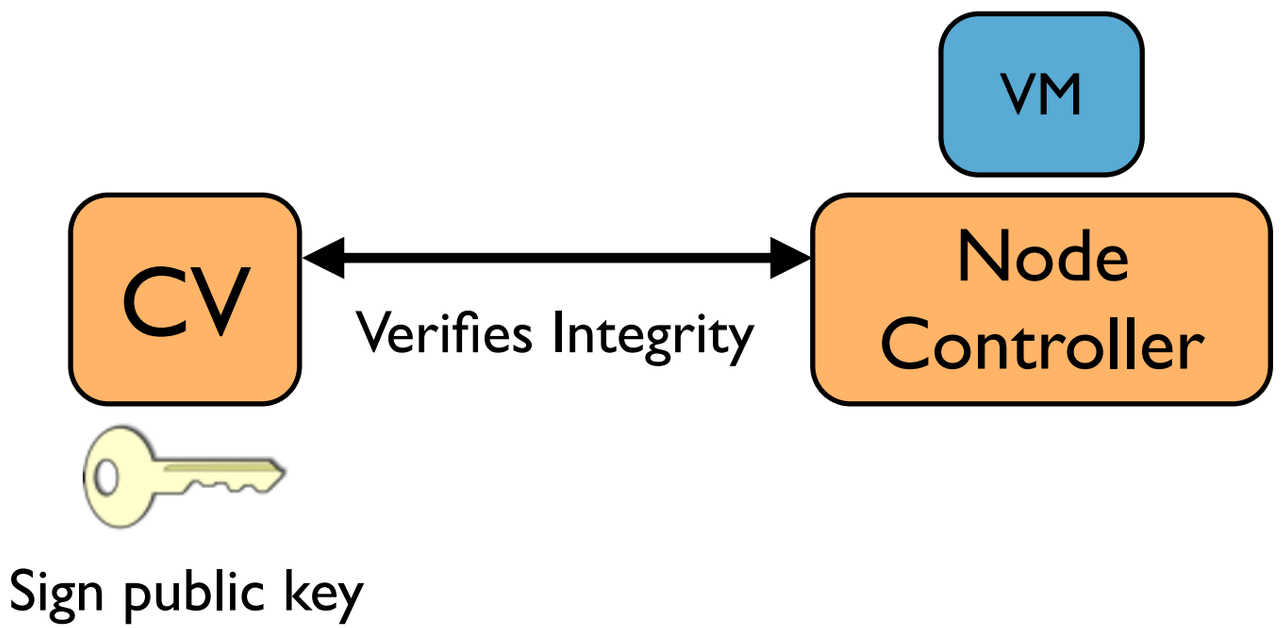

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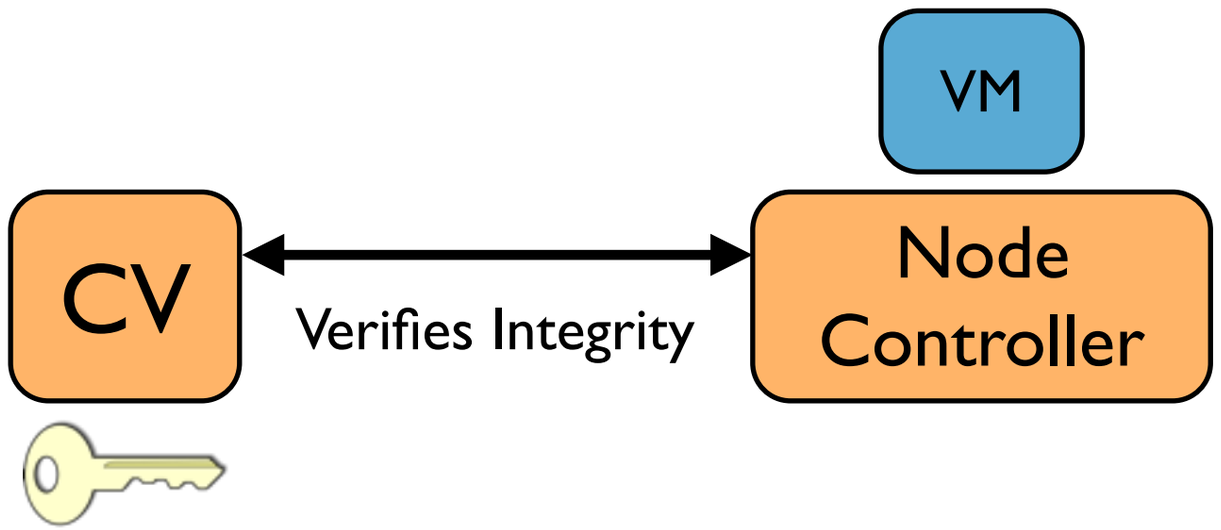

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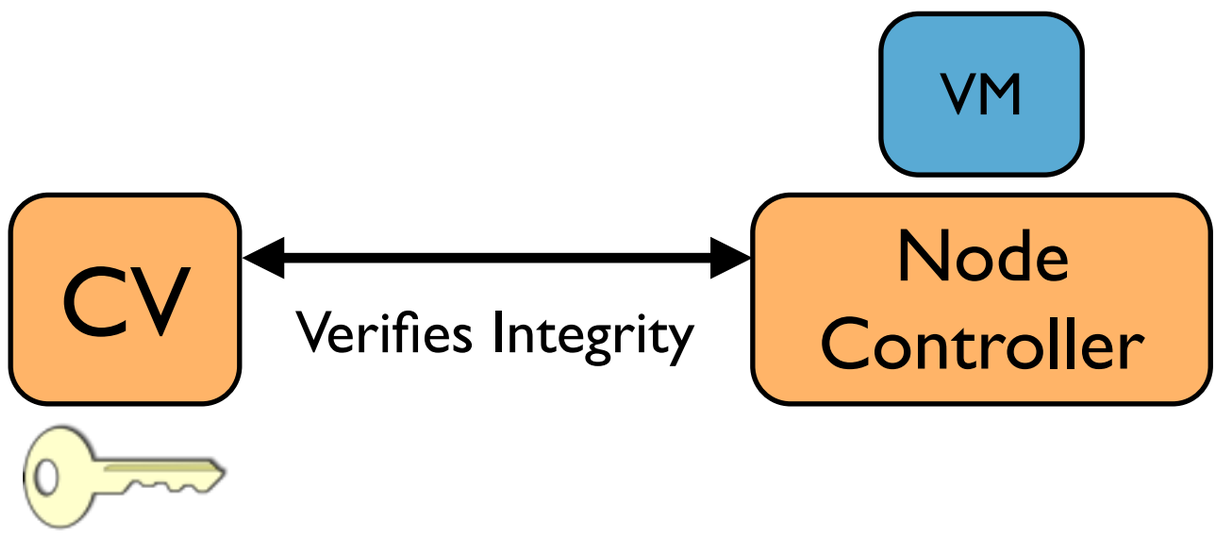
Get VM key



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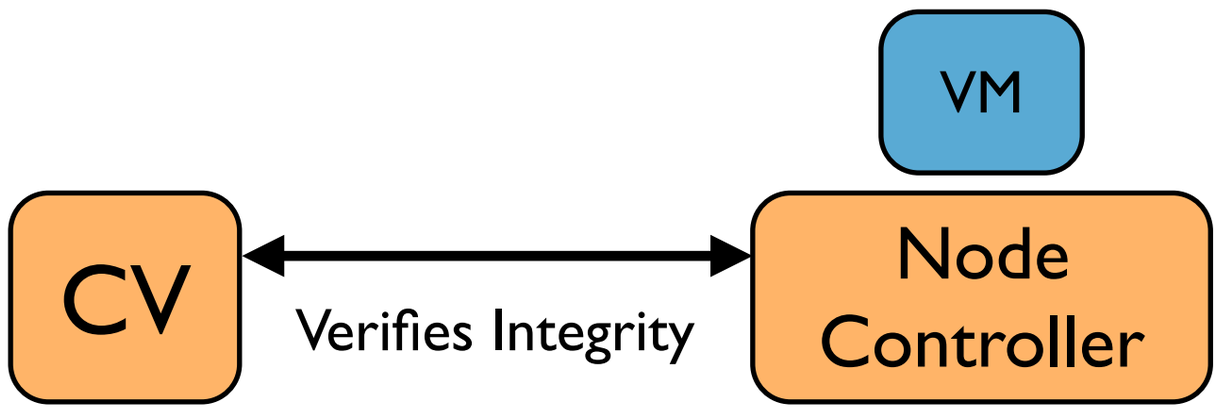

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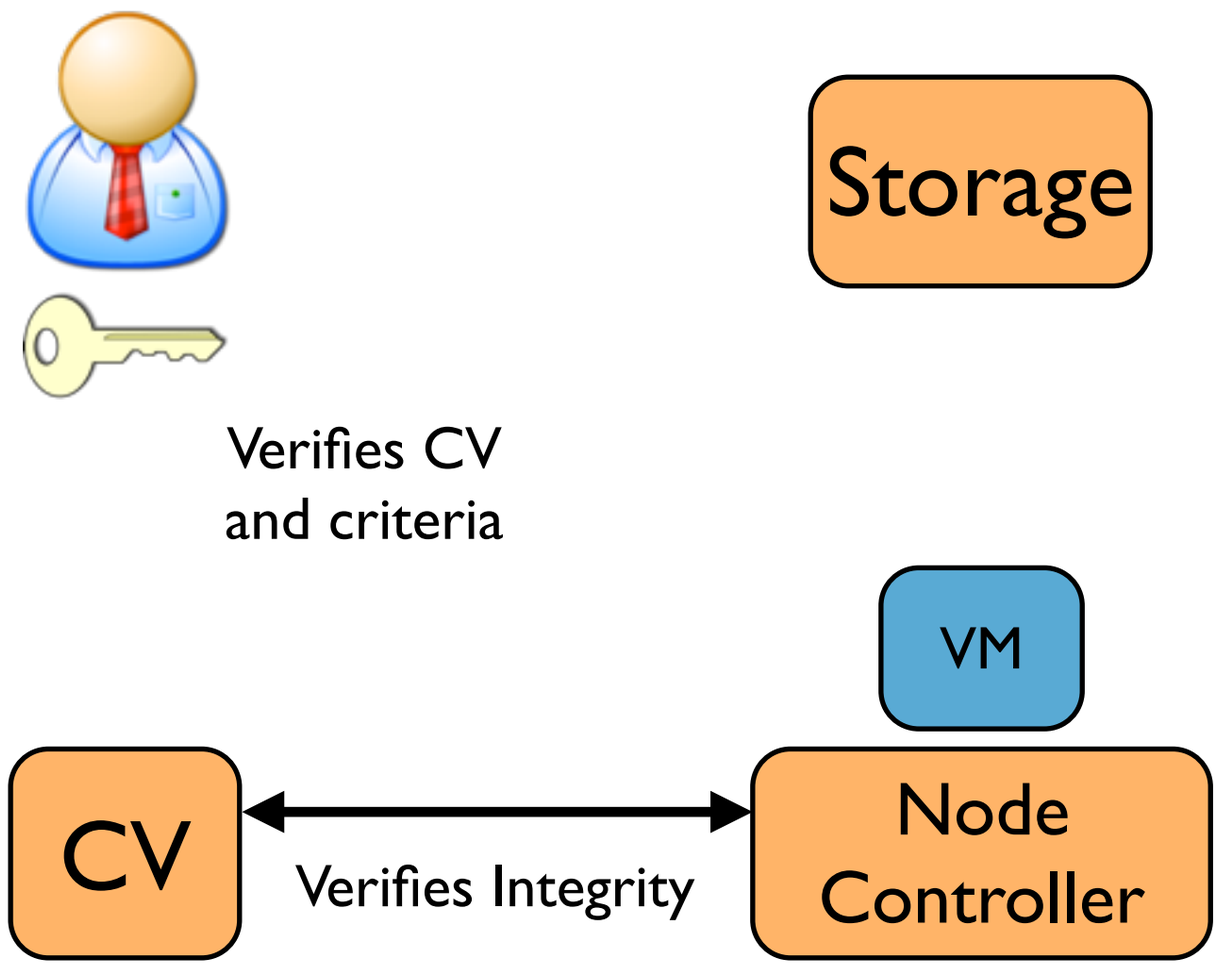

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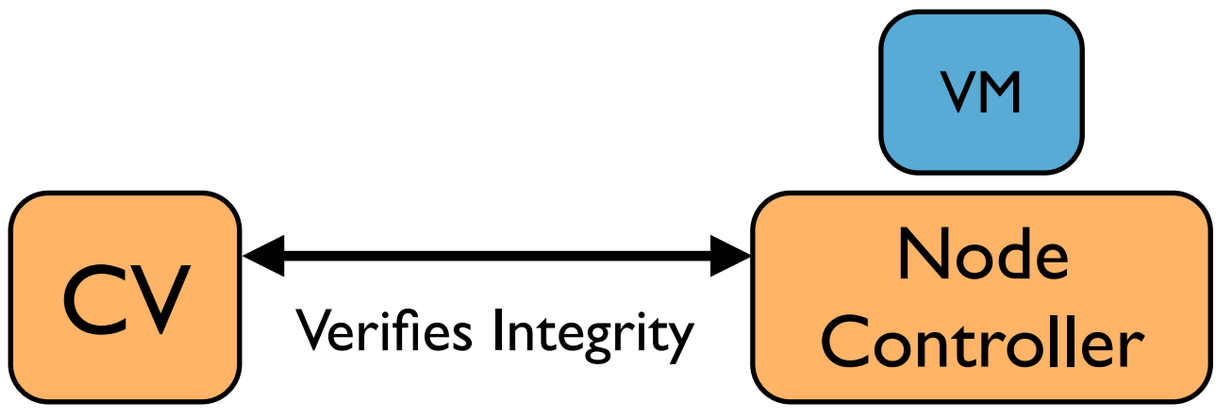

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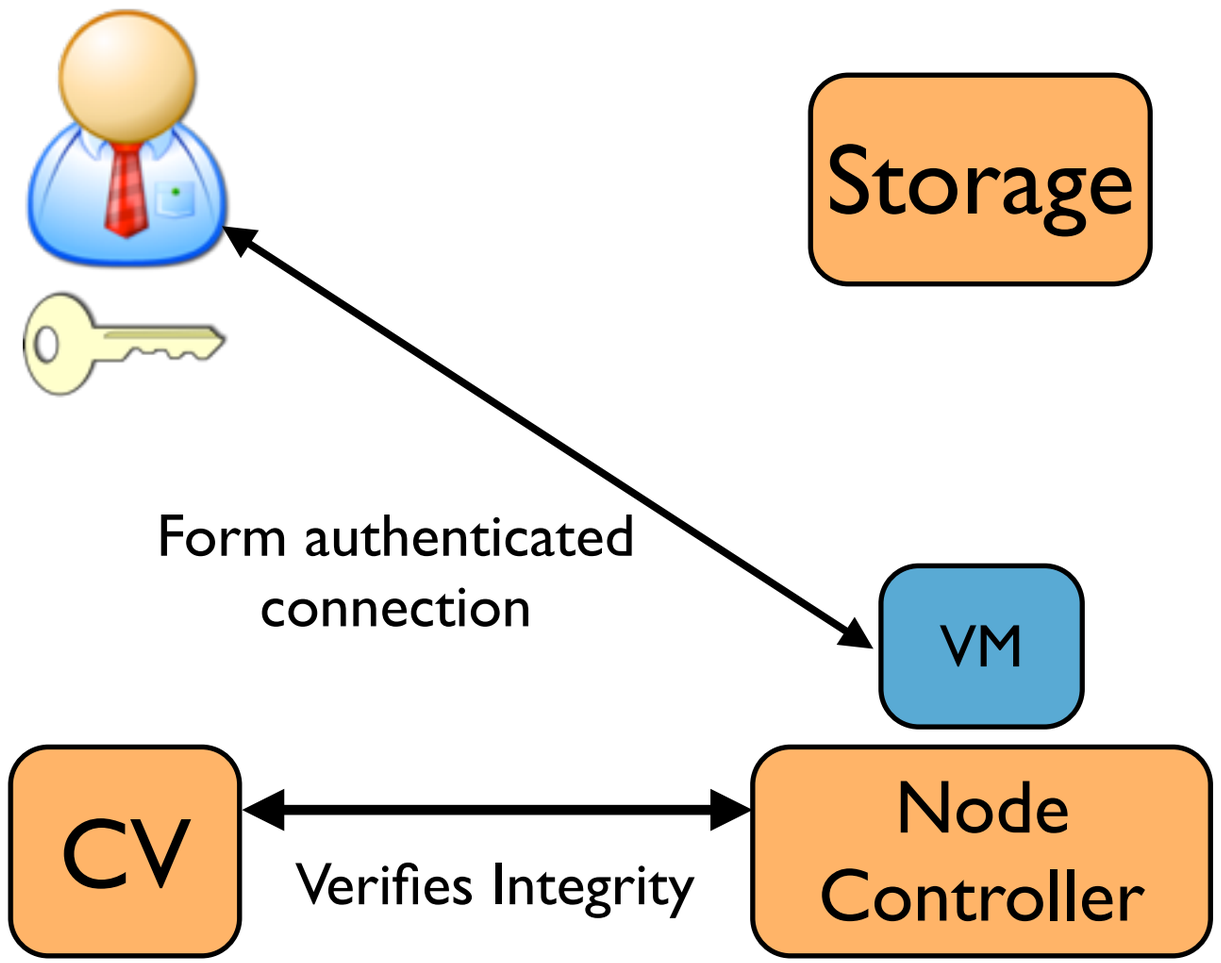

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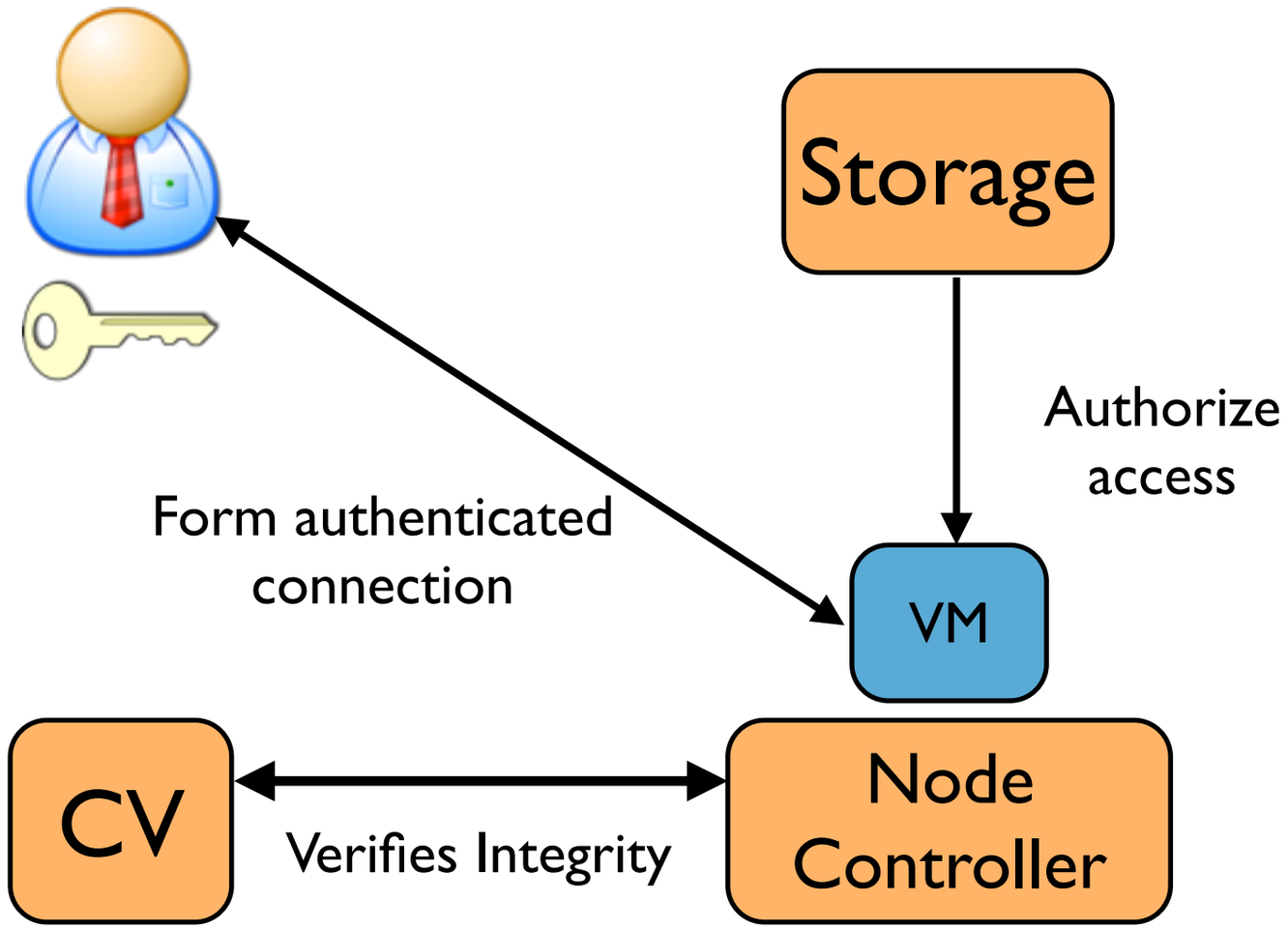

# Transparency Challenges

- How can customers verify these proofs?
  - Custom distributions
  - Copious amount of details and systems
- How can this be done efficiently?
  - Clouds operate at Internet scale
  - Commodity trusted hardware is slow

# Integrity Criteria

- Current integrity measurement approaches are very system configuration specific
  - Difficult to assess arbitrary data and custom code
  - Resolution of measurement is often insufficient
- Require an integrity criteria that focuses on integrity properties achieved by a system
  - Establish a verifiable origin for data
  - Leverage enforcement to minimize measurements
  - Enable verifiers to compare requirements

# Performance

- Constructed a testbed using Eucalyptus
  - Configured nodes using network-based ROTI installation
- Attestations take ~1 second to produce
- CV generates asynchronous attestations
  - Using an attested time server to provide nonces
  - Handle over 7,000 requests per second

# Further Challenges

- CV Scalability
- Enforcing customer security requirements
- Key revocation and remediation

# Questions?

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