ArmoredSoftware: Trust in the cloud

Annual Demonstration

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Outline

Introduction and Project Goals

- Big Picture
- Implementation

Prototype demonstration and discussion

- Refine big picture to current demo
- Protocol Execution
- Appraisal
- Measurement
- Communication
- Demonstration

Short term goals and milestones

Questions and guidance

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Program Goal

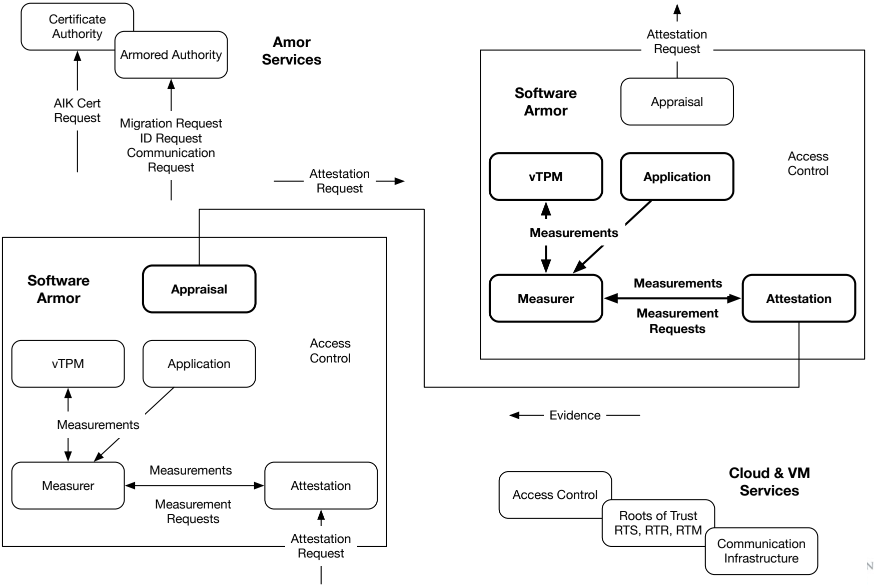
Trust in the Cloud

Provide new capabilities that help establish and maintain trustworthy cloud-based application deployment

New Capabilities

- Establish trust among cloud components
  - trust among cohorts of processes
  - trust among processes and environment
- Promote informed decision making
  - data confidentiality can be confirmed
  - execution and data integrity can be confirmed
- Autonomous run-time response and reconfiguration
  - responds to attack, failure, reconfiguration, and repair
  - response varies based on measurement
- Lightweight integration with existing cloud
  - targeting TXT, Xen, Linux, and OpenStack infrastructure
  - user-space measurement and attestation

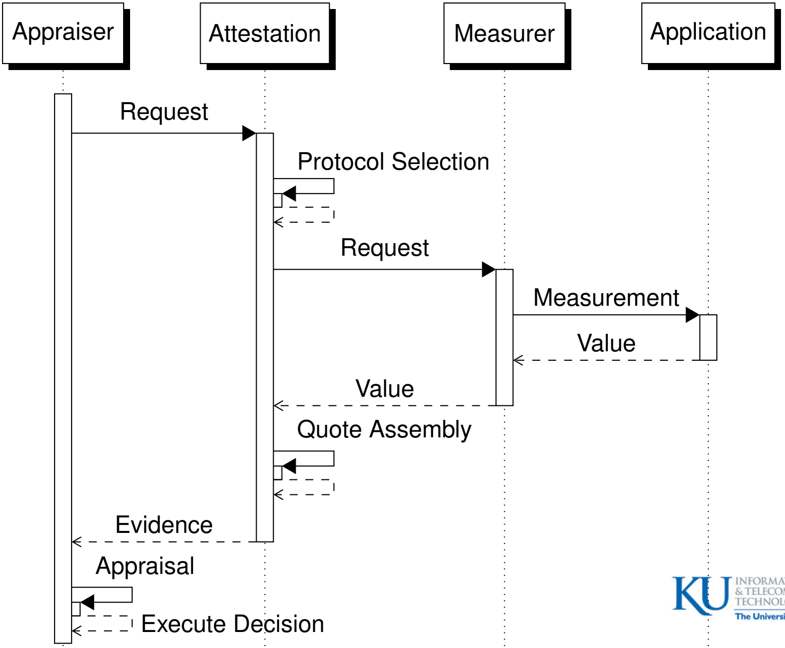
High-Level Architecture



Implementation Decisions

- Standard delivery platform
  - Xen+XSM VM infrastructure
  - OpenStack cloud infrastructure
  - Fedora, HotSpot JVM, GHC
- Standard communication mechanisms
  - JSON structures for all exchanged data
  - *vchan* for on-platform communication
  - TCP/IP for off-platform communication
- Trusted Computing Group standards compliant
  - Trusted Platform Module (TPM) 1.2
  - TCG vTPM in principle
- Executable protocol representation
  - protocol fragments as first-class structures
  - strand space formal semantics

CA-Based Attestation Protocol



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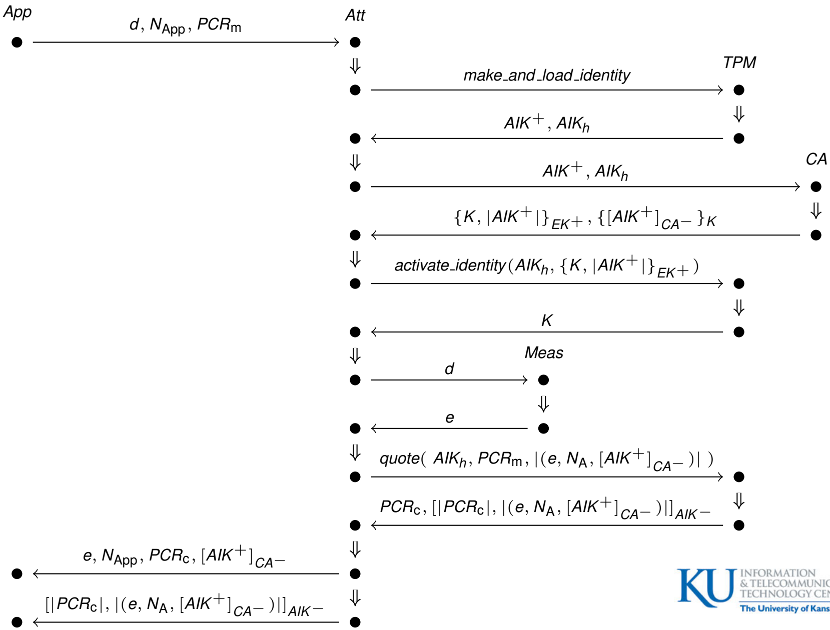
What We Are Demonstrating

3-4 Slides on Attestation Protocol Execution

Strand Space Diagram



App

Att

$d, N_{\mathrm{App}}, PCR_{\mathrm{m}}$

TPM

$\mathit{make\_and\_load\_identity}$

AIK^{+}, AIK_{h}

CA

AIK^{+}, AIK_{h}

$\{K, |AIK^{+}|\}_{EK+}, \{[AIK^{+}]_{CA-}\}_{K}$

$\mathit{activate\_identity}(AIK_{h}, \{K, |AIK^{+}|\}_{EK+})$

K

Meas

d

e

$\mathit{quote}(\ AIK_{h}, PCR_{\mathrm{m}}, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA-})|\ )$

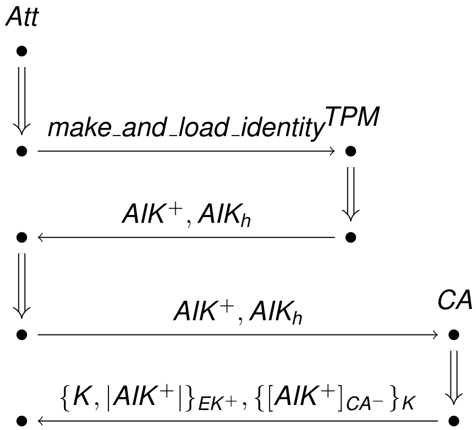
$PCR_{\mathrm{c}}, [|PCR_{\mathrm{c}}|, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA-})|]_{AIK-}$

$e, N_{\mathrm{App}}, PCR_{\mathrm{c}}, [AIK^{+}]_{CA-}$

$[|PCR_{\mathrm{c}}|, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA-})|]_{AIK-}$

Generating and Certifying an AIK

- Request a new *AIK* from TPM (optional)
- Receive public *AIK* and hash
- Request *AIK* signed by CA (*AIK* cert)
- Receive *AIK* cert encrypted with session key *K*
- Receive *K* encrypted with private *EK*



Att

TPM

CA

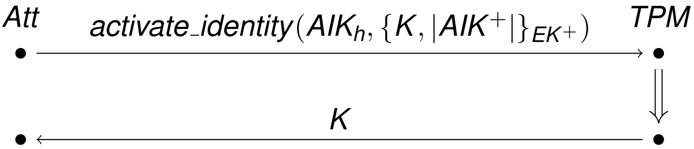
make_and_load_identity

AIK^{+}, AIK_{h}

AIK^{+}, AIK_{h}

$\{K, |AIK^{+}|\}_{EK^{+}}, \{[AIK^{+}]_{CA^{-}}\}_{K}$

Activating the AIK



Att

TPM

$\mathit{activate\_identity}(\mathit{AIK}_h, \{K, |\mathit{AIK}^+|\}_{\mathit{EK}^+})$

K

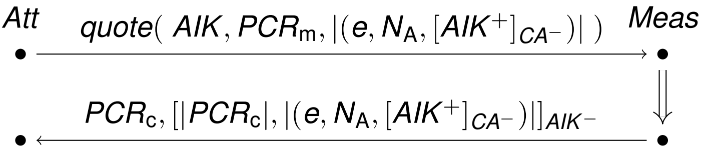
- Request TPM decryption of the *AIK* cert
- Receive *K* used to decrypt signed public *AIK*
- Only TPM can gain access to *K*
- Only TPM can obtain signed, public *AIK*
- Oddly, No manipulation of the *AIK* in this “activation” process

Measurement

$$\begin{tikzcd}
\overset{Att}{\bullet} \arrow[rrrr, "d"] & & & & \overset{Meas}{\bullet} \arrow[d, Rightarrow] \\
\bullet & & & & \bullet \arrow[llll, "e"']
\end{tikzcd}$$

- Request information from measurer
- Receive evidence *e* from measurer
- *d* is abstract allowing protocol reuse
- Most protocols make many requests of the measurer

Generating a Quote



Att

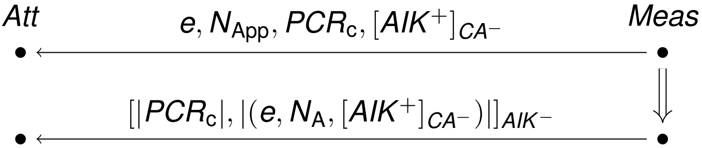
Meas

$quote(\; AIK, PCR_{\mathrm{m}}, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA^{-}})| \;)$

$PCR_{\mathrm{c}}, [|PCR_{\mathrm{c}}|, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA^{-}})|]_{AIK^{-}}$

- Request a quote from the TPM
  - *AIK* identifies the signing *AIK*
  - PCR_m identifies desired PCRs
  - $|(e, N_{\mathrm{A}}, [AIK^{+}]_{CA^{-}})|$ guarantees integrity of returned evidence
- Receive quote from TPM
  - PCR_{c} is PCR composite built from requested PCRs
  - $[|PCR_{\mathrm{c}}|, |(e, N_{\mathrm{A}}, [AIK^{+}]_{CA^{-}})|]_{AIK^{-}}$ is the signed quote

Appraisal



Att

Meas

$e, N_{\text{App}}, PCR_{\text{c}}, [AIK^{+}]_{CA^{-}}$

$[|PCR_{\text{c}}|, |(e, N_{\text{A}}, [AIK^{+}]_{CA^{-}})|]_{AIK^{-}}$

- Receive quote from the attestation manager
- Receive evidence from the attestation manager
- Evaluate evidence and quote

1-2 Slides on Appraisal

3-4 Slides on Measurement

2-3 Slides on Communication Mechanisms

Step Through Demonstration

Goals and Milestones for 2015

- Push to the cloud
- Establish roots of trust and trust argument
- Executable protocol representation and protocol semantics
- Operational, integrated vTPM prototype
- Name Server / Certificate Authority prototype
- More capable measurement
- Downloadable demonstration

Questions and Guidance

- What problems are interesting?
- What problem would be a nice attention grabber?
- What should we be watching and integrating with?

References