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
- Attestation Protocol Execution
- Appraisal
- Measurement
- Communication

Short term goals and milestones

Questions and guidance

Program Goal

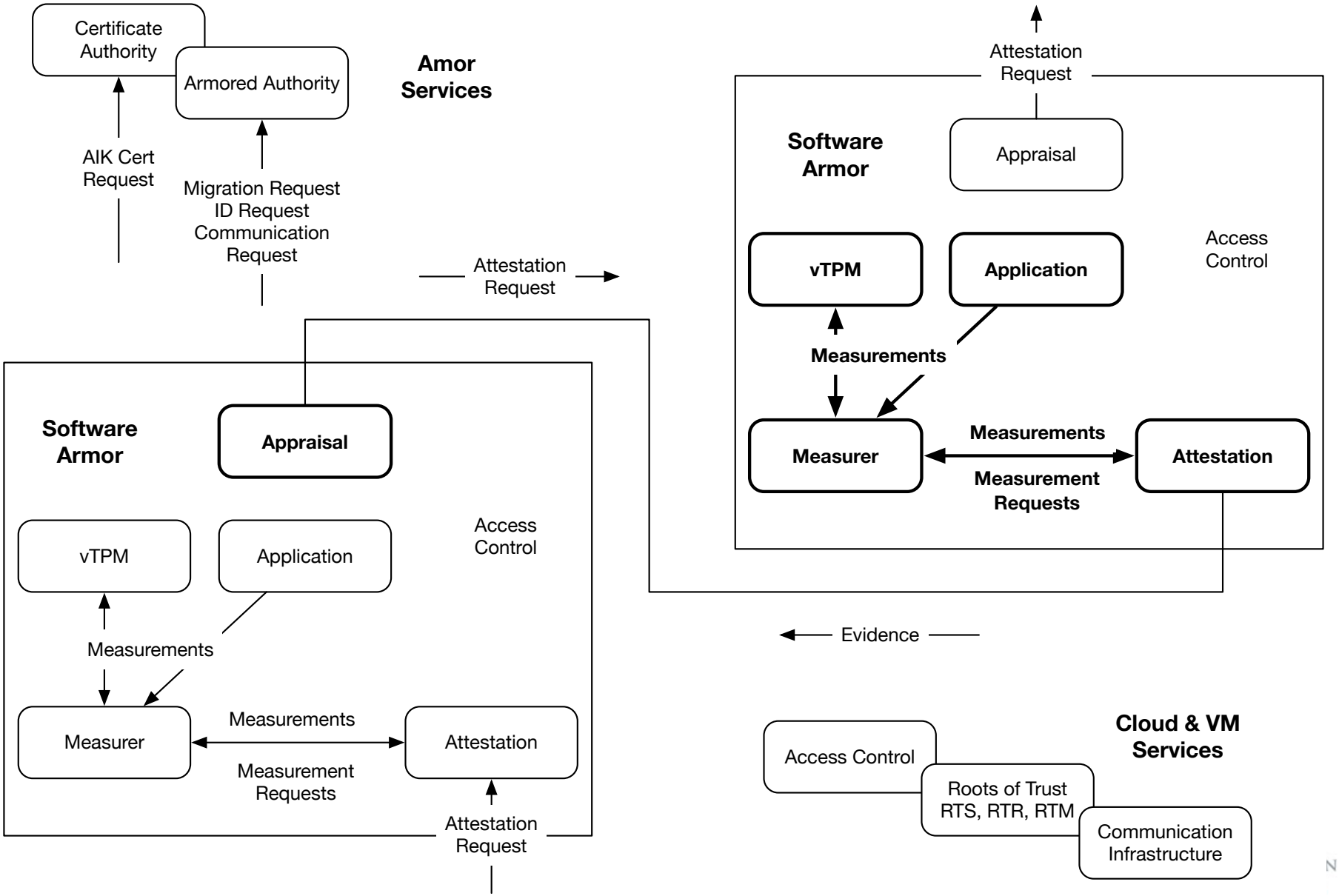
Trust in the Cloud

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



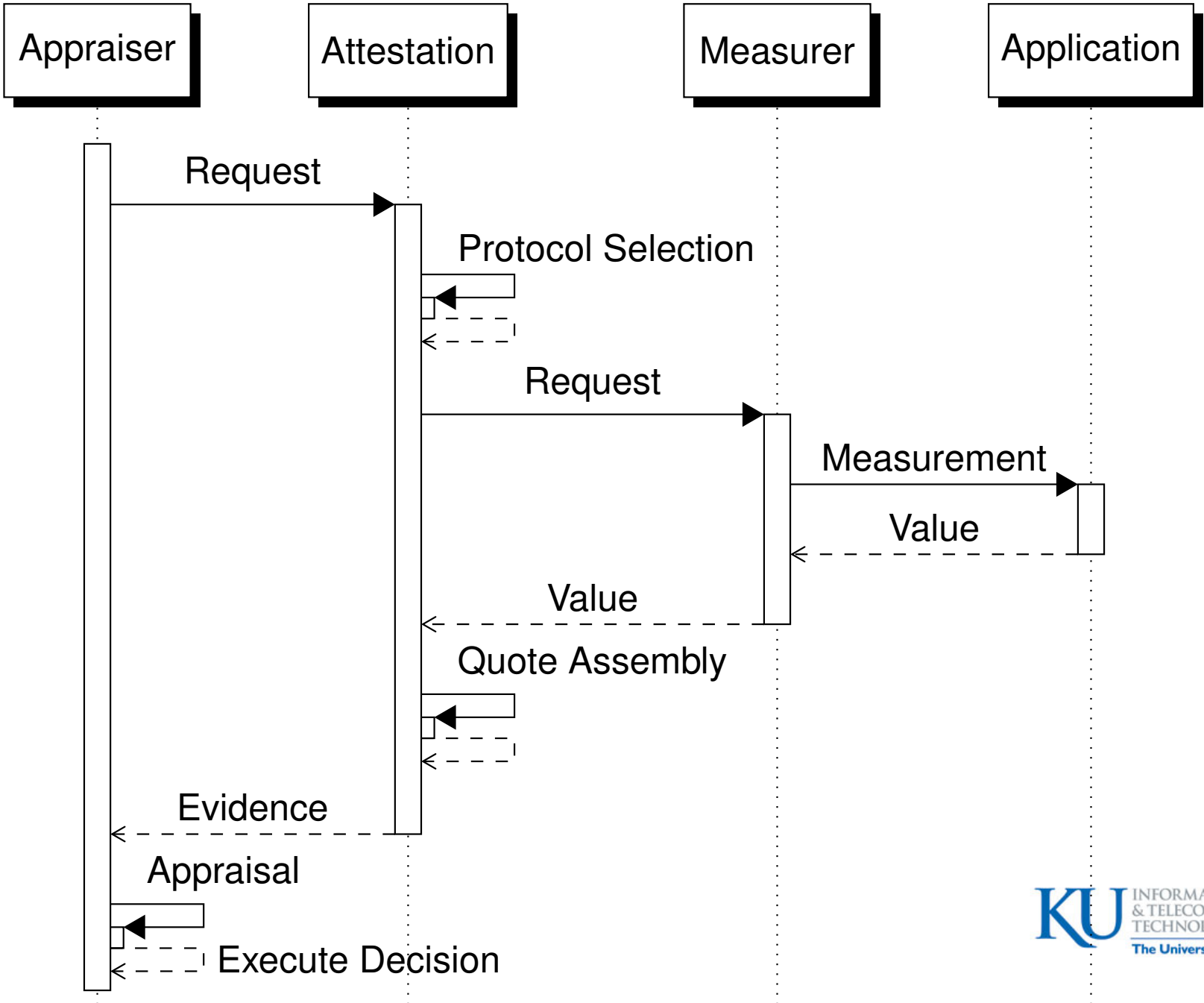
Implementation Decisions

- 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

What We Are Demonstrating

- Execution of a CA-based Attestation Protocol
  - Attestation request
  - Protocol execution
  - Evidence appraisal
- Major architectural subsystems
  - Appraiser
  - Attestation Manager
  - Measurer
  - Instrumented JVM
  - vTPM and Certificate Authority
- Anomaly Detection
  - Bad signatures and PCRs
  - Bad CA certificates
  - Bad quotes and AIKs
  - Bad measurements

Abstract CA-Based Attestation Protocol



Message List Representation

$App \rightarrow Att : d, N_{\text{App}}, PCR_{\text{m}}$ on C_{AppAtt}

$Att \rightarrow TPM : make\_and\_load\_identity$ on C_{AttTPM}

$TPM \rightarrow Att : Att, AIK_h$ on C_{TPMAtt}

$Att \rightarrow CA : Att, AIK^+$ on C_{AttCA}

$CA \rightarrow Att : \{K, |AIK|\}_{EK^+}, \{[AIK^+]_{CA^-}\}_{K^+}$ on C_{CAAtt}

$Att \rightarrow TPM : activate\_identity(AIK_h, |AIK|)$ on C_{AttTPM}

$TPM \rightarrow Att : K$ on C_{TPMAtt}

$Att \rightarrow Meas : d$ on $C_{AttMeas}$

$Meas \rightarrow Att : e$ on $C_{MeasAtt}$

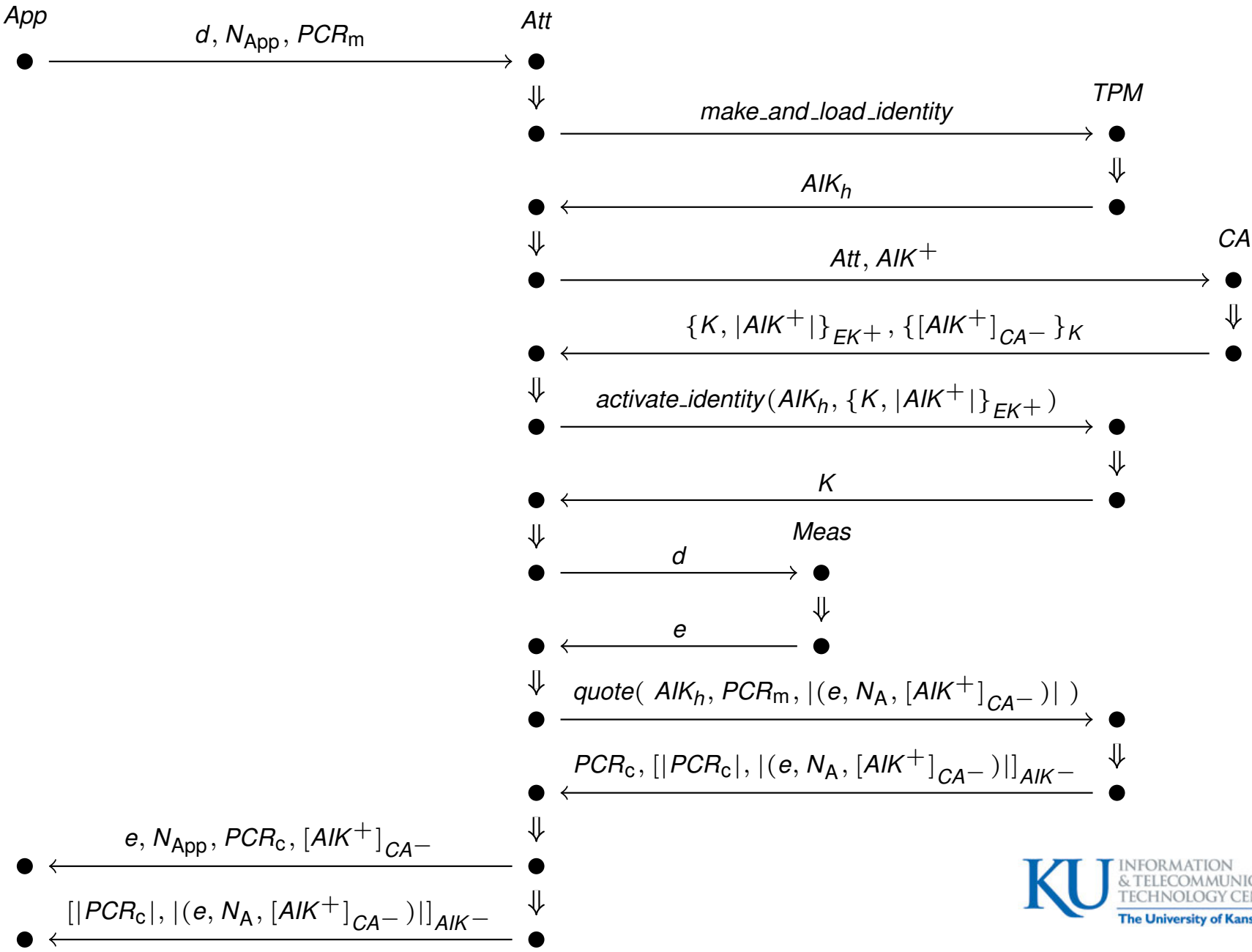
$Att \rightarrow TPM : quote(\ AIK_{\text{h}}, PCR_{\text{m}}, |(e, N_{\text{A}}, [AIK^+]_{CA^-})|\ )$ on C_{AttTPM}

$TPM \rightarrow Att : PCR_{\text{c}}, [|PCR_{\text{c}}|, |(e, N_{\text{A}}, [AIK^+]_{CA^-})|]_{AIK^-}$ on C_{TPMAtt}

$Att \rightarrow App : e, N_{\text{App}}, PCR_{\text{c}}, [AIK^+]_{CA^-}$ on C_{AttApp}

$Att \rightarrow App : [|PCR_{\text{c}}|, |(e, N_{\text{A}}, [AIK^+]_{CA^-})|]_{AIK^-}$ on C_{AttApp}

Strand Space Diagram Representation



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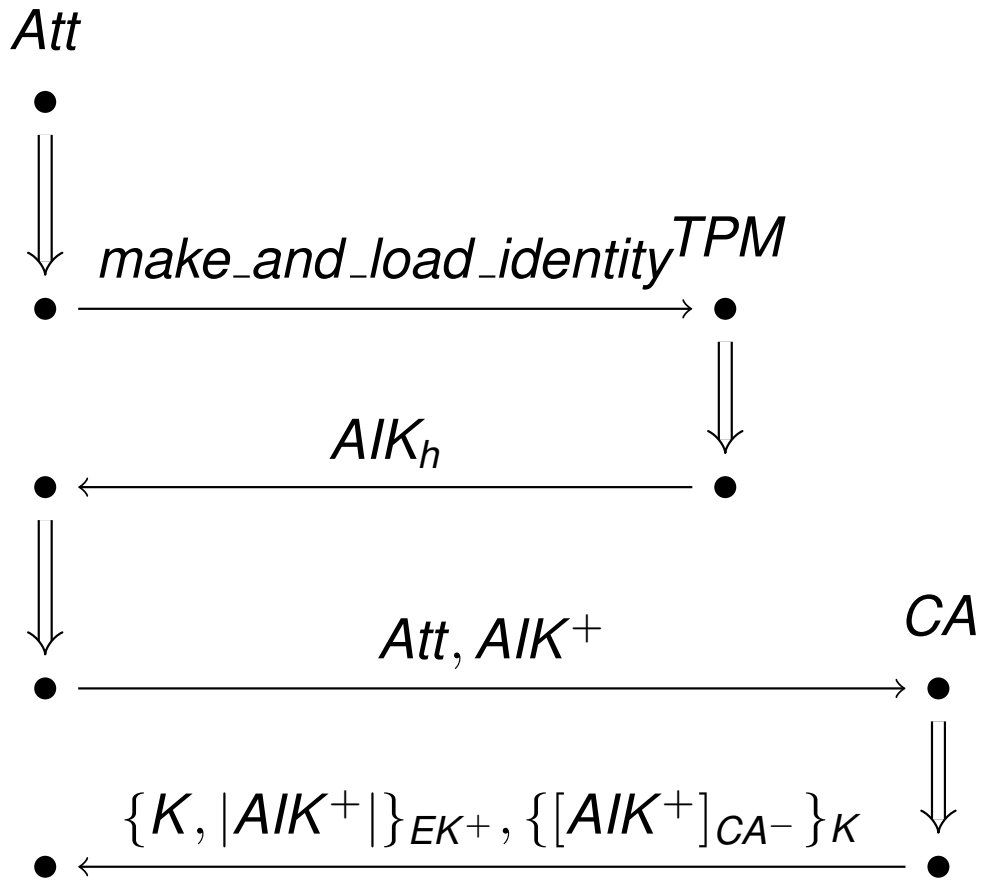
Attestation Request

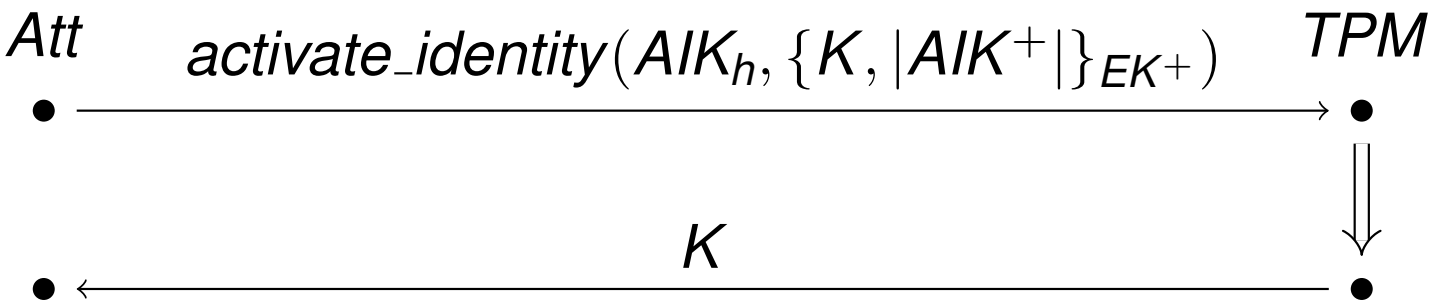
- Initiate with an attestation request
  - d abstractly defines desired evidence
  - N_{App} is the appraiser's nonce
  - PCR_{m} selects PCRs
- Attestation agent selects and executes protocol based on request

Generating and Certifying an AIK

- Request a new *AIK* from TPM (optional)
- Receive *AIK* handle
- Request AIK^+ signed by CA (*AIK* cert)
- Receive *AIK* cert encrypted with session key *K*
- Receive *K* encrypted with private *EK*

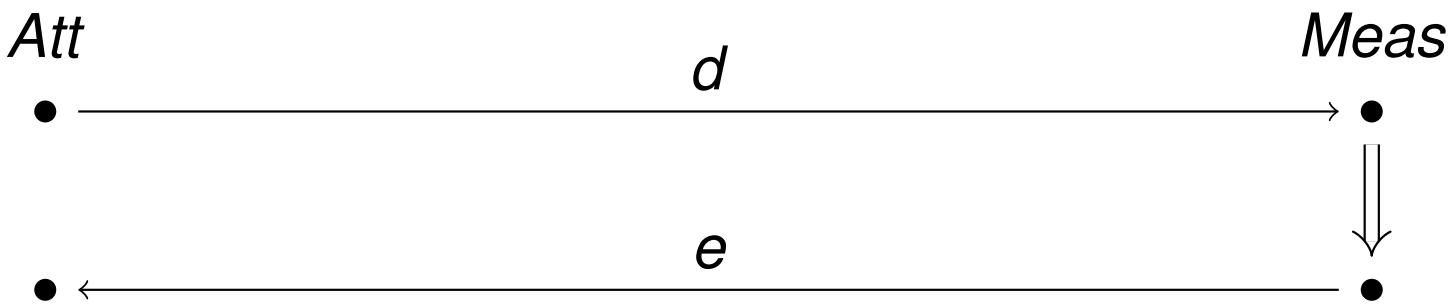


Activating the AIK



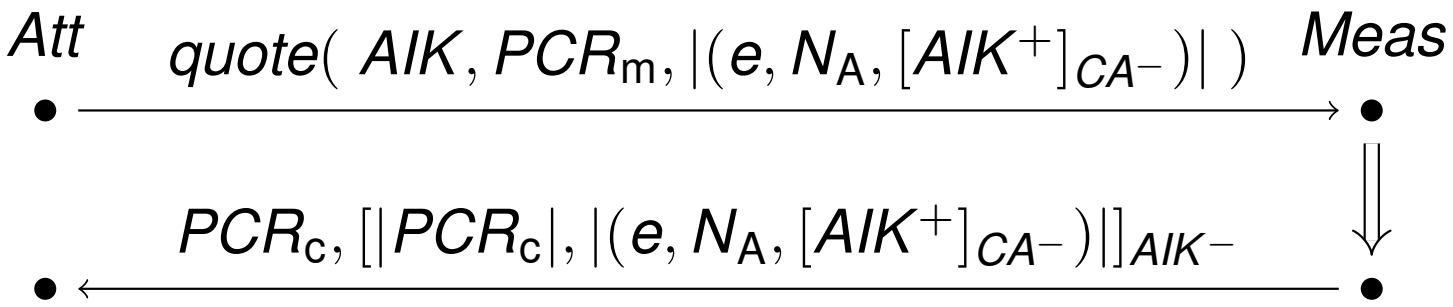
- Request TPM decryption of the *AIK* cert
- Receive *K* used to decrypt signed public *AIK*
- Only TPM can gain access to *K*
- Only TPM can obtain signed, public *AIK*
- Oddly, No manipulation of the *AIK* in this “activation” process

Measurement



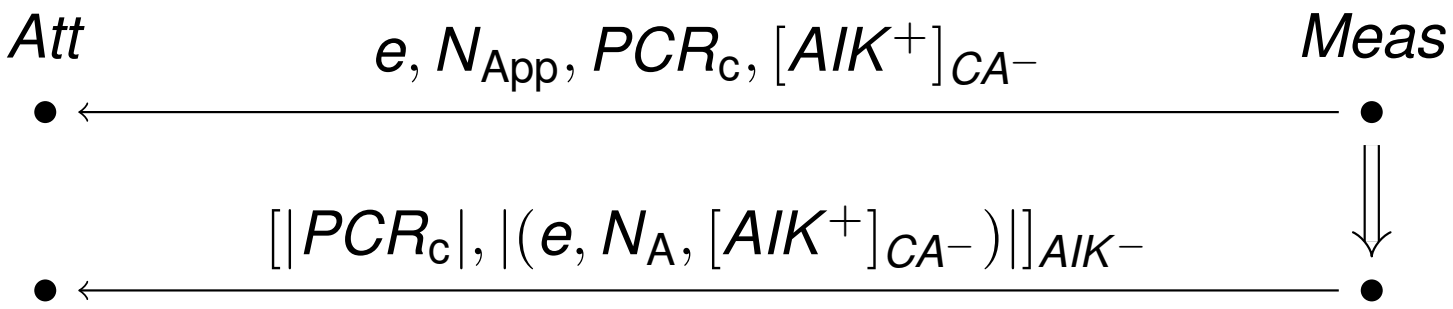
- Request information from measurer
- Receive evidence *e* from measurer
- *d* is abstract allowing protocol reuse
- Most protocols make many requests of the measurer

Generating a Quote



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

Appraisal



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

3-4 Slides on Attestation Protocol Execution

1-2 Slides on Appraisal

3-4 Slides on Measurement

2-3 Slides on Communication Mechanisms

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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