XIA: Architectural Evaluation

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presenting on behalf of the XIA team

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Past as prologue: Levels of Architecture

• Principles and Invariants ("IRTF level"):  
  • e.g., the idea of using multiple principal types; using intrinsic security;  
  • the requirement that XIA addresses support fallback for unsupported principal types.

• Concrete spec: ("IETF level")
  • What is a host ID principal type? What crypto is used?

• Implementation ("Cisco level")

XIA-NP evaluation philosophy in a nutshell

• Direct evaluation to identify & evaluate metrics from the architecture itself
  – evaluation at the “IRTF level”
• Complement with use-case based evaluation at concrete spec / implementation levels
  – video + vehicular deployments, user studies
  – centers more on performance & functionality
  – not the primary focus of today’s talk

Proposed Evaluation Criteria for XIA

• Security, broadly defined
• Evolvability
• Manageability
• Incentive-compatibility
• Explicit rich interfaces between actors
• Implementability

Not all criteria cut across all FIA-NP projects. Nor should they. Or, should they?
Useful Evaluation Methodologies

- Argumentation and discourse
  - e.g., these PI meetings, public discussion facilitated by upcoming CCR papers, other open fora
- Purely quantitative evaluation
  - for example, via notion of threat modeling, well established in network security community
  - Concrete example: DDoS guarantees provided by STRIDE
- Hybrid (semi-quantitative) evaluation
  - propose and define multiple applicable metrics
  - argue for applicability and relevance in context
  - as we exemplify with evolvability next...
- Third party evaluation: e.g., external collaborators

Evaluating Evolvability

**Thrust 1: Architectural embedding**

Q: How hard or efficient is it to achieve or embed the key features of one architecture inside another?

Our focus so far, marrying criteria of evolvability and implementability: are reasonable embeddings of features onto XIA even realizable?

XIA as a Platform for Architectural Exploration

- Our approach: port alien designs
  - Pushes evolvability to one extreme
  - Realizes pluralism through inclusiveness
- Recurrent porting questions
  - How to best map Y’s identifiers to XIDs?
  - When can we reuse XID types?
  - How to break Y into principals?
  - Are there interesting alternative interpretations?

Case study: porting Serval to XIA

- Serval: Service-centric architecture providing:
  - Late binding to servers
  - Multiple flows with mobile connection ends
  - Connection migration and failover
  - Reliable transport
  - Component of NEBULA FIA
- Designed to run over legacy IP networks
- As seen in [NSDI ‘12, ICNP ‘12]
**XIA Serval in action**

**How XIA improved Serval**

- Componentized Serval made room for intrinsic security
- More manageable code
- Straightened up Serval headers

**Evaluating Evolvability**

**Thrust 2:** Apply the theory of *competitive analysis* to network architecture.

**Motivation:** Can we quantify benefits of a highly evolvable architecture, or equivalently, any risks of “over-fitting” an architecture to specific applications?

**Modeling a future application mix**

- Vector for types of communication
  - e.g., small and large packets; short flows, long flows; delay-tolerant, latency-sensitive, or hard-realtime traffic
- Application defined using weights in that communication-type vector
  - YouTube: high weight on large packets, long flows
  - Skype: high weight on latency-sensitive, small packets
- Future: frequency vector across applications
Applying competitive analysis

- For a given future application mix $M$ and an architecture $E$:
  \[ \text{competitive ratio} = \frac{\text{perf}_{\text{OPT}}(M)}{\text{perf}_E(M)} \]

- An architecture $E$ is competitive if
  - for all $M$, its competitive ratio is bounded.
- Emphasizes worst-case performance when future is unknown.

Gameplan

- Direct evaluation of XIA architecture
  - Compare and contrast with IP, other FIAs
- Use-case based evaluation for
  - video + vehicular deployments, user studies
  - Focus on challenges, opportunities specific to XIA
- Third-party evaluation with external collaborators