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Provable Security: How feasible is it?

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In Short

- Very feasible
  - For certain systems and security properties
  - But feasible does not mean easy
- Let’s stop being lame, and start doing
  - **real proofs** of
  - **real security properties** of
  - **real code** of
  - **real systems**

Real proofs

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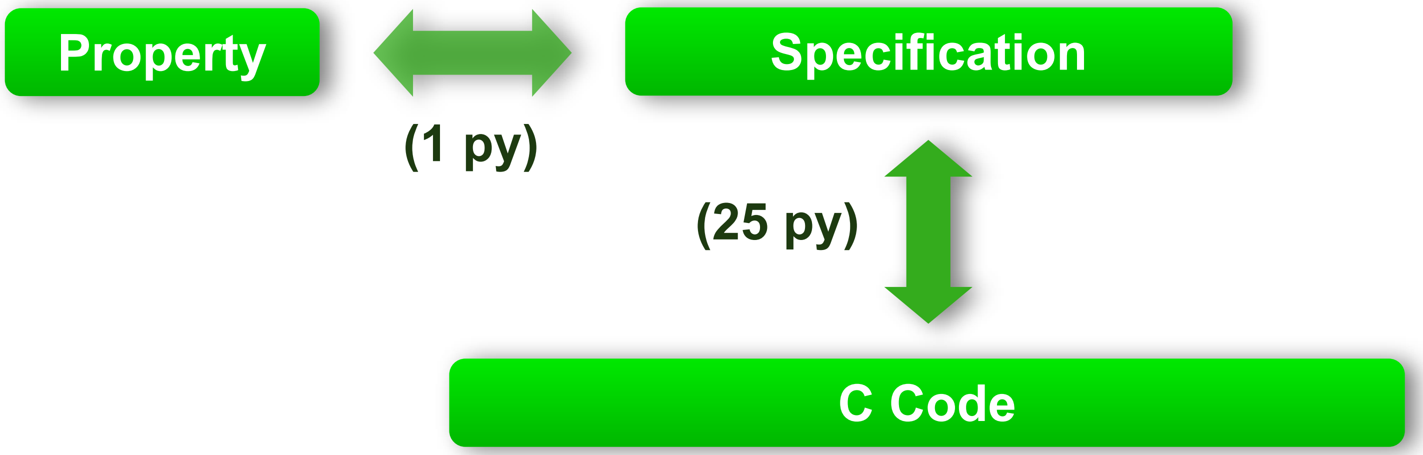
- Are not done with pen and paper
- Are machine-checked
- Turn up unexpected things you didn't know about your system or property
  - When the proof fails
  - Usually, in the more complicated parts of the API

Real security properties

- Are not absence of buffer-overflows etc.
  – (these should be trivially implied)
- Are specific to the purpose of each system
  – Are properties of whole systems
- Include high-level security goals, like:
  – Integrity, Confidentiality
- Reflect the complexities of real systems
  – e.g. authority encoded in non-cap state in seL4

Real Code

- Is not a high-level logic or language
  - Is C or assembler
- Is written to be run, not to be proved
  - Often trades-off clarity for performance
- Can be reasoned about via abstraction
  - But you have to prove the abstraction is sound



Real Systems

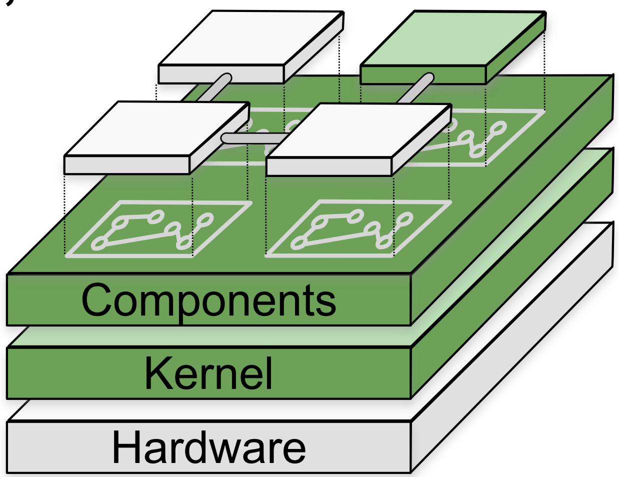
- Are deployed in the wild
- Are big (> MLOC)
- Are the imperfect results of balancing many (competing) tadeoffs
  - Performance, security, usability, simplicity
- Contain design- and implementation-quirks
  - Inevitably reflected in proofs and properties
  - May not adhere to “textbook” security defns
- Require real security properties

Example: seL4 Enforces Integrity

- Machine-checked proof (~10,000 LOC)
  - took 12 person-months (atop 30 py FC proof)
- 2-part security property of the seL4 kernel:
  - write-authority enforcement, and
  - authority-propagation
- Applies to the kernel's source code
  - Reflects the curiosities of the seL4 API
- Is a general property about the kernel
  - not yet fully applied to a specific system

The Immediate Horizon

- Security Properties
  - Integrity
  - Confidentiality excluding timing channels (e.g. untimed noninterference)
- Systems
  - MILS architectures with few, small (~10,000 LOC each) trusted components,
  - built atop small, proven kernels



What Is Still Too Hard

- Proving the absence of timing channels
  – Requires very detailed model of hardware
  – Likely infeasible on high-performance, commodity hardware
  – Will have to live with mitigation only, or use custom hardware that allows OS to carefully control timing effects
- Systems with large trusted components
  – Linux, Windows

Conclusion

- Real kernels need real security properties
- Now feasible to prove for small kernels
  - – And carefully architected whole-systems
- Not all properties are feasible
  - – e.g. absence of timing channels
  - – But this is still a huge step forward
- Security-critical systems demand real proofs of their code
  - – Not only necessary, but now feasible at reasonable cost

Thank You