

ASM: A Programmable Interface for Extending Android Security

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Android Security Extensions (selected)

Security extensions focus on
specific use cases and/or security and privacy models

Privacy

*TaintDroid,
AppFence,
MockDroid*

IPC Provenance

*QUIRE,
IPC Inspection*

Fine-Grained Permissions

APEX, CRePE

Permission Constraints

Kirin

Context-based Apps

*CRePE,
ConXSense*

App Communication

*Saint, XManDroid,
TrustDroid,
Aquifer*

Mock Data

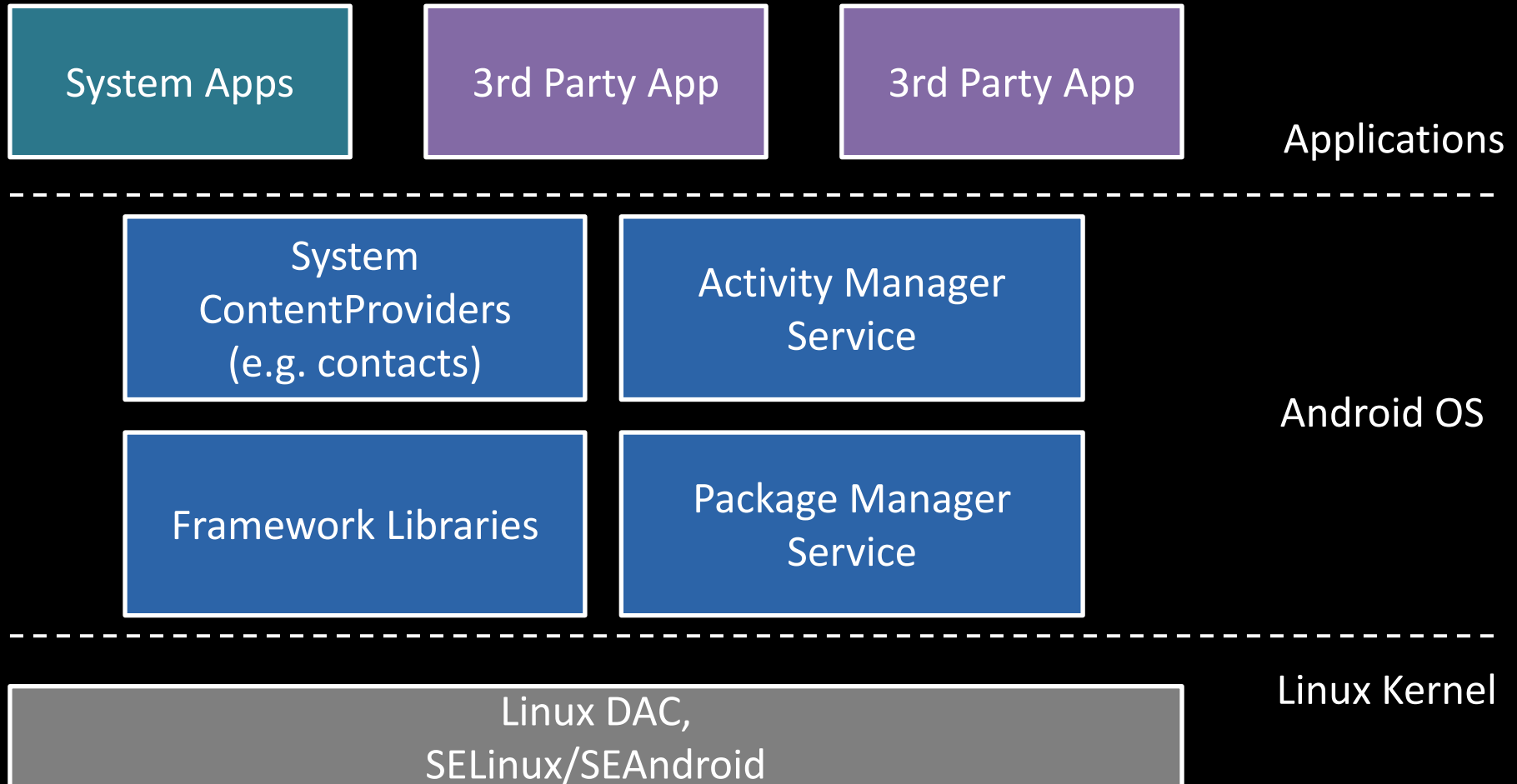
*MockDroid,
TISSA, AppFence*

Type Enforcement

*SEAndroid,
FlaskDroid*

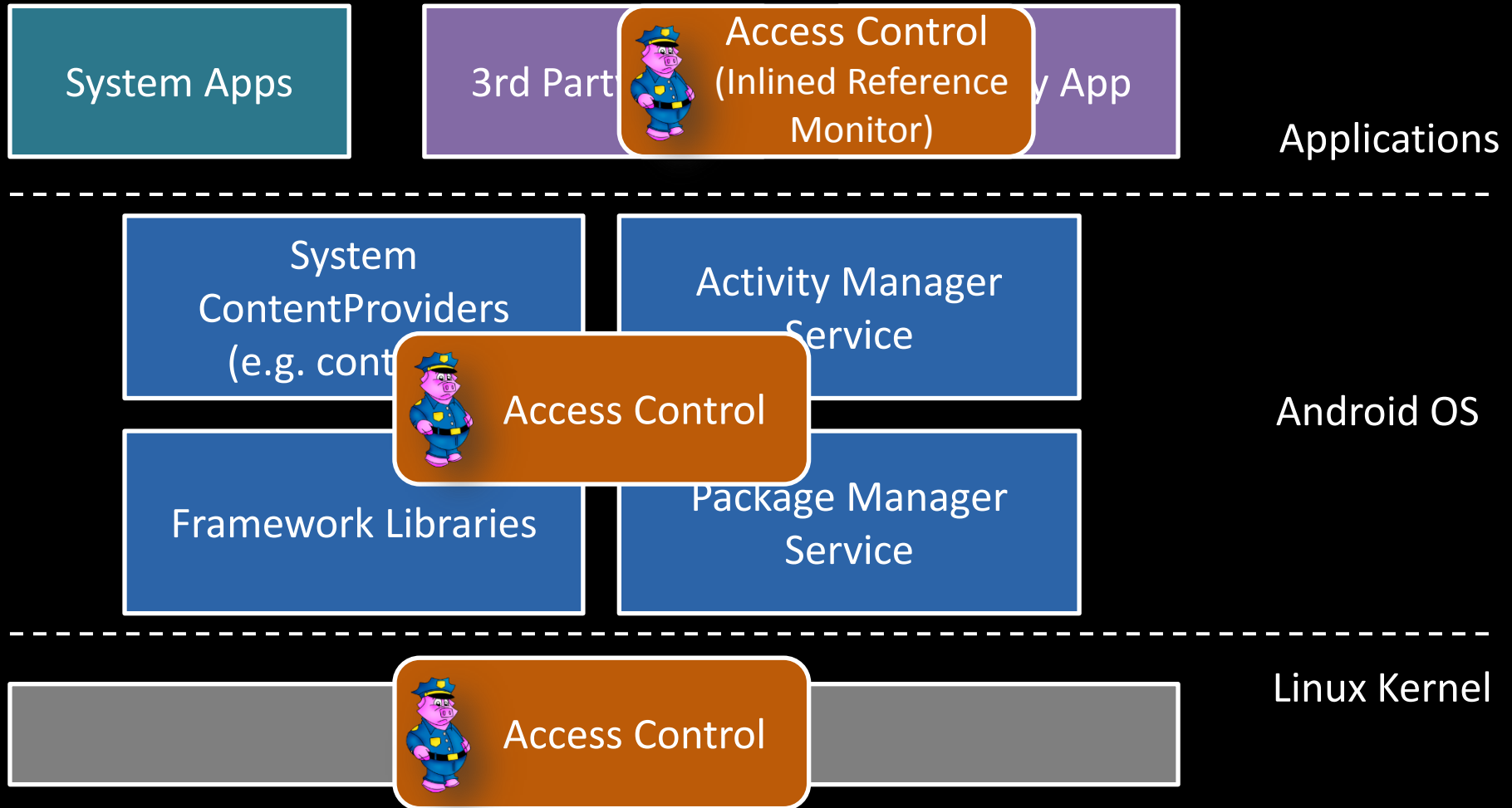
Android Security Extensions

Access control (hooks) are embedded in sensitive components



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Research Question

Is it possible to provide a *programmable* and *generic* security architecture on top of which many of these solutions can be instantiated?

Observations

Diverse Goals, but use similar security hooks and mechanisms

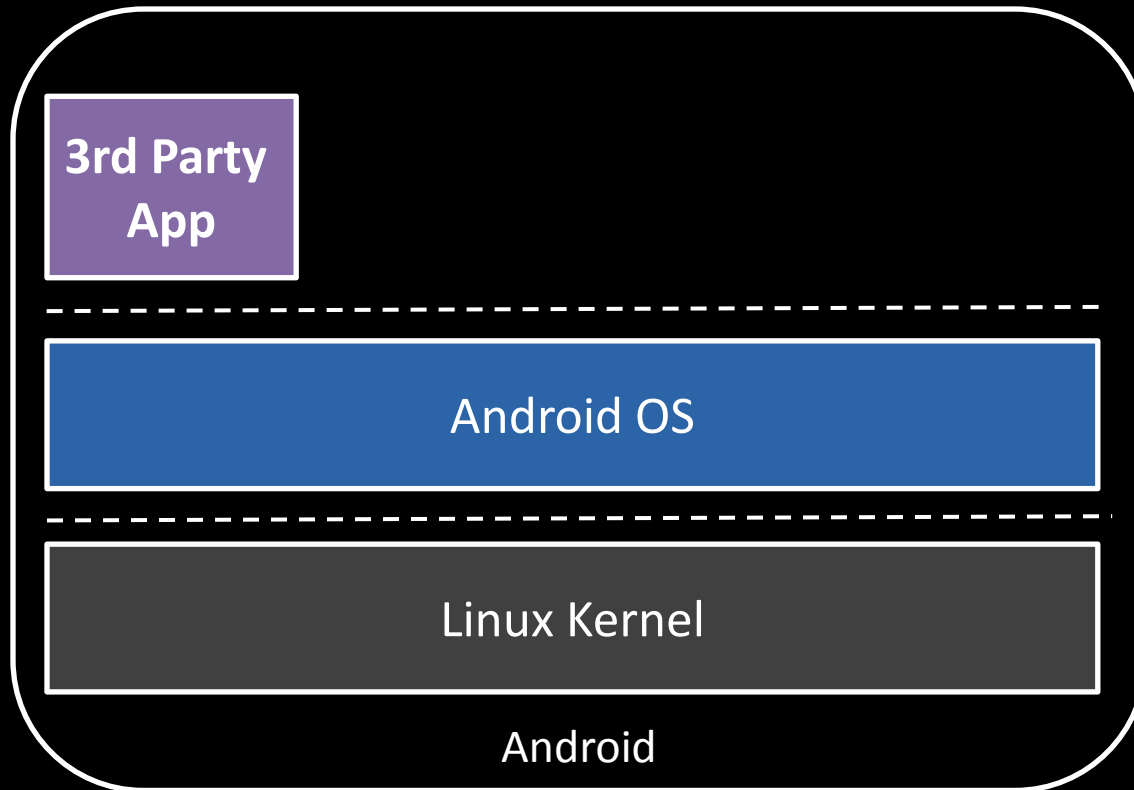
System	Android ICC	Package Manager	Sensors / Phone Info	Fake Data	System Content Providers	File Access	Network Access	3rd Party Hooks
MockDroid		✓	✓	✓	✓		✓	
XManDroid	✓	✓	✓			✓	✓	
TrustDroid	✓	✓			✓	✓	✓	
FlaskDroid	✓	✓	✓	✓	✓	✓	✓	✓
CRePE	✓		✓					
Quire	✓	✓						
TaintDroid	✓		✓			✓	✓	
Kirin		✓						
IPC Inspection	✓	✓						
AppFence	✓	✓	✓	✓	✓	✓	✓	
Aquifer	✓					✓	✓	
APEX	✓	✓	✓					
Saint	✓	✓						✓
SEAndroid	✓	✓				✓	✓	
TISSA			✓	✓	✓			

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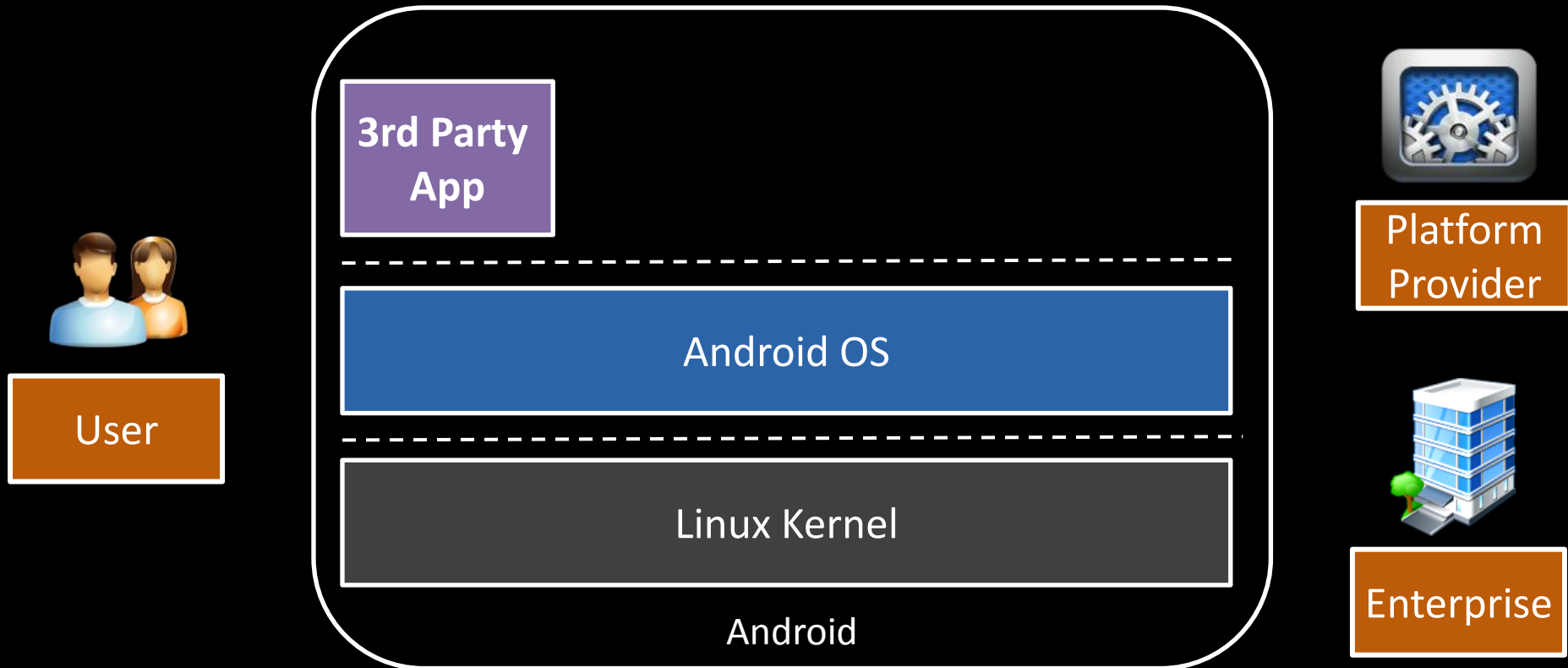
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CRaPE	✓		✓					
Quire	✓	✓						
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Kirin		✓						
IPC Inspection	✓	✓						
AppFence	✓	✓	✓	✓	✓	✓	✓	
Aquifer	✓					✓	✓	
APEX	✓	✓	✓					
Saint	✓	✓						✓
SEAndroid	✓	✓				✓	✓	
TISSA			✓	✓	✓			

High-level Idea of ASM



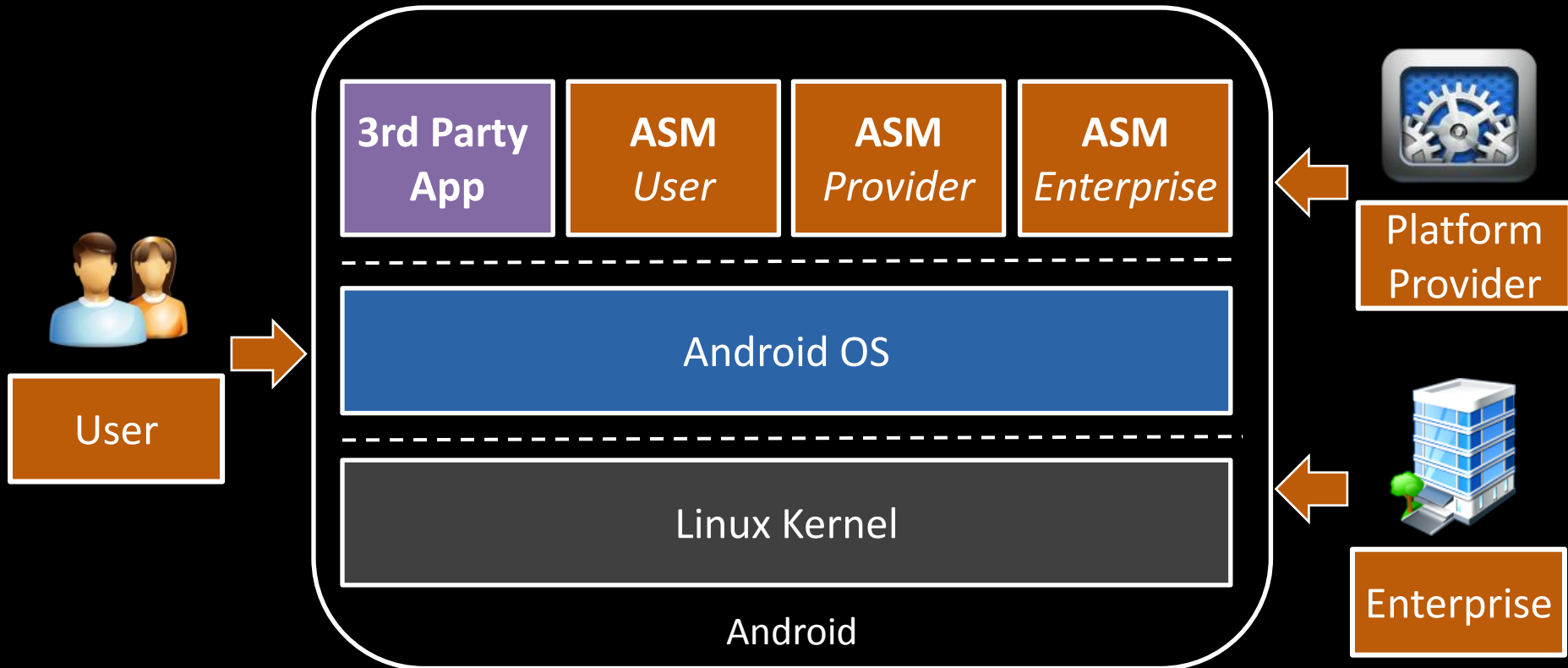
High-level Idea of ASM

- ♦ A modular access control architecture supporting *multiple stakeholders*



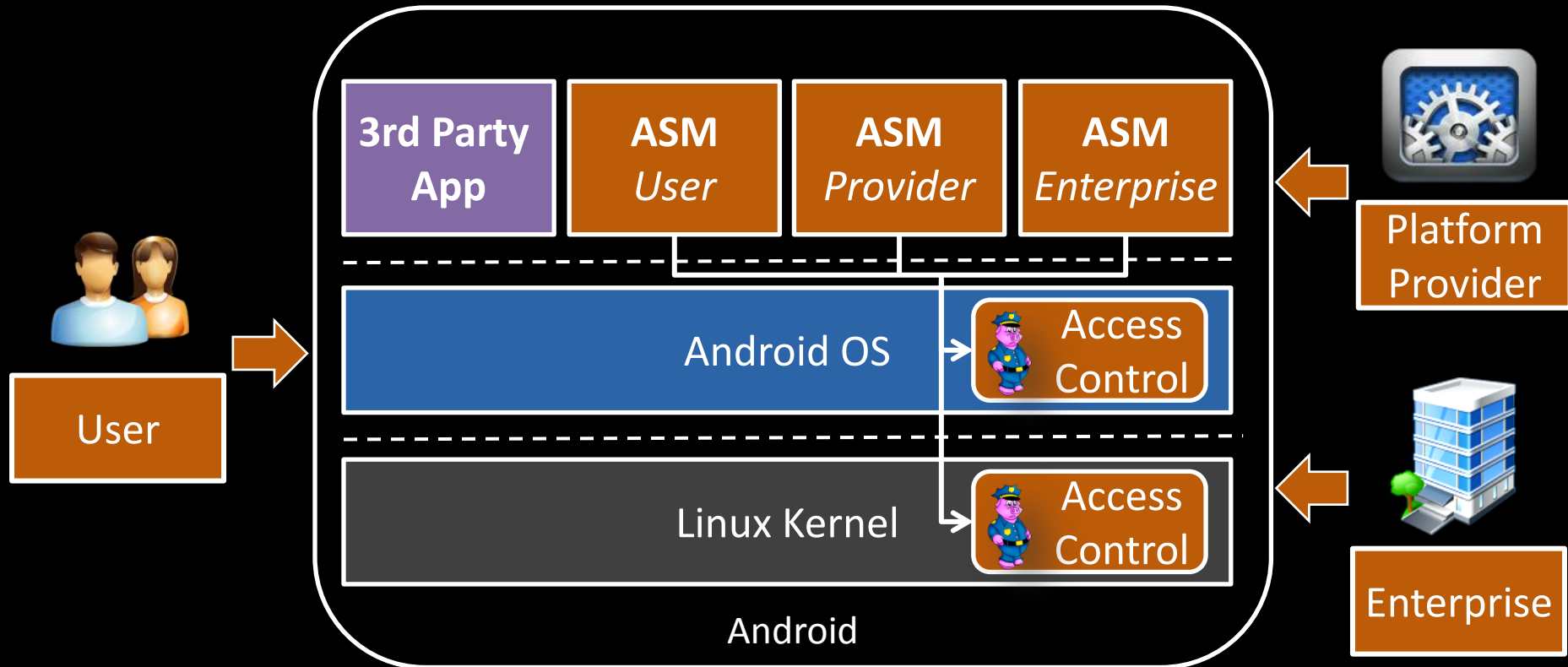
High-level Idea of ASM

- ♦ A *modular* access control architecture supporting *multiple stakeholders*
- ♦ Deploy *Android Security Modules (ASMs) as apps*



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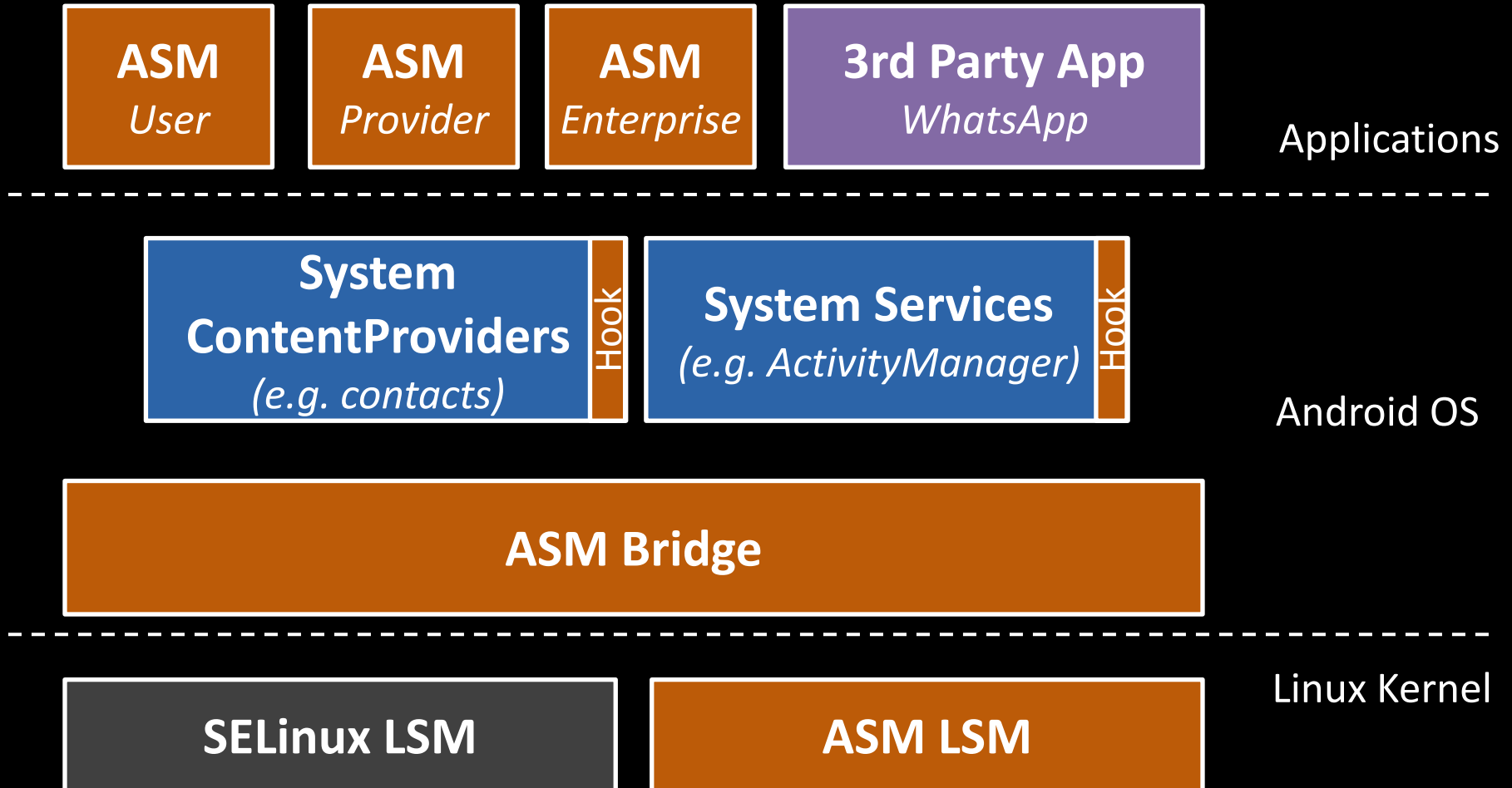


Challenges

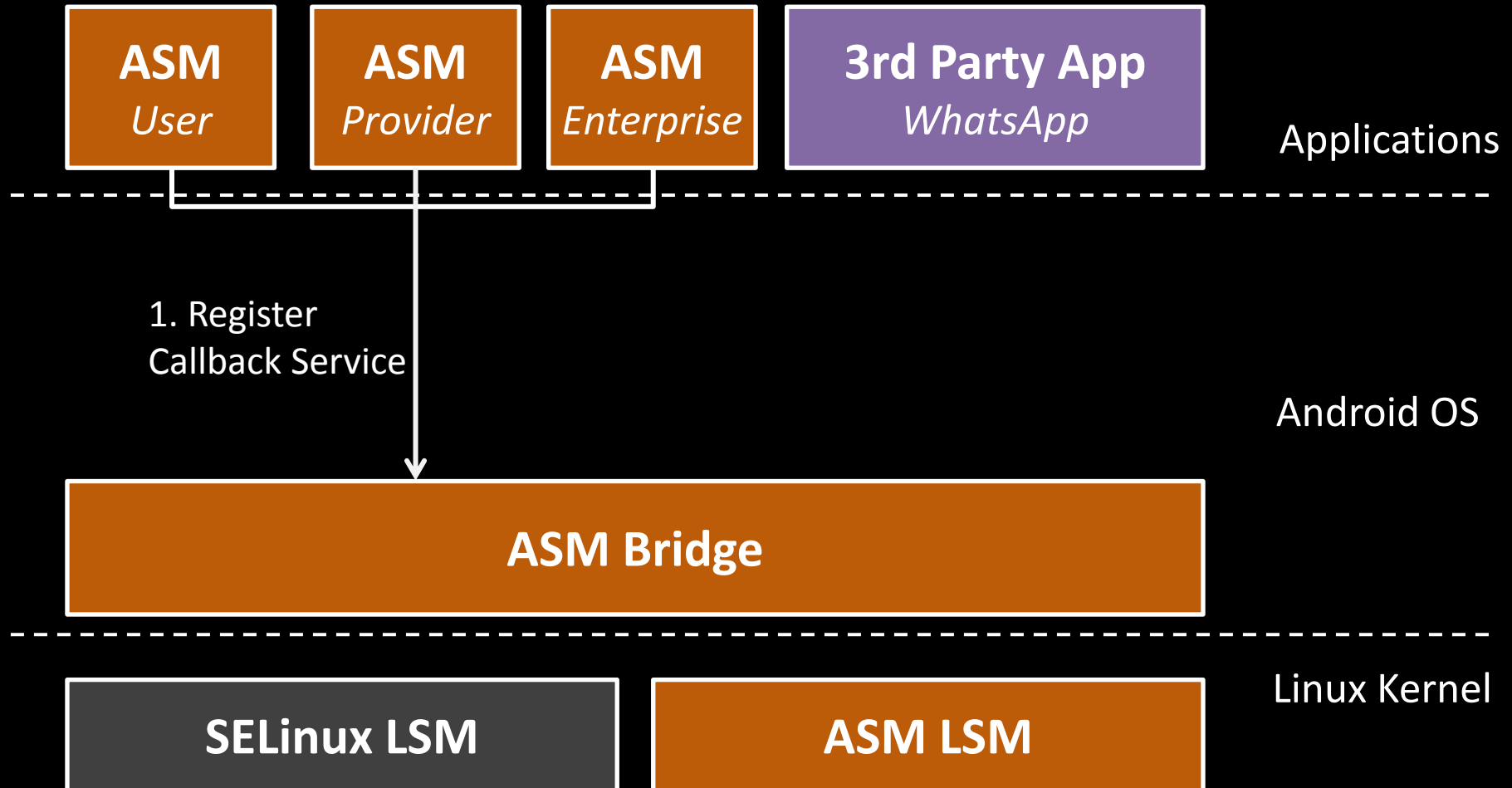
- ♦ **Fine-grained access control on all abstraction layers**
 - ♦ Handle the *semantics and peculiarities* of each layer
- ♦ **Preserve existing security invariants**
 - ♦ Don't overrule *denials* by *default Android access control*
 - ♦ Data modification by ASMs only in *well-defined bounds*
- ♦ **Efficiency**
 - ♦ Only activate hooks when they are *required*
 - ♦ Whitelisting for *root processes* and *system apps*
- ♦ **Policy Reconciliation**
 - ♦ Handle *decision conflicts* (currently consensus strategy)

Design

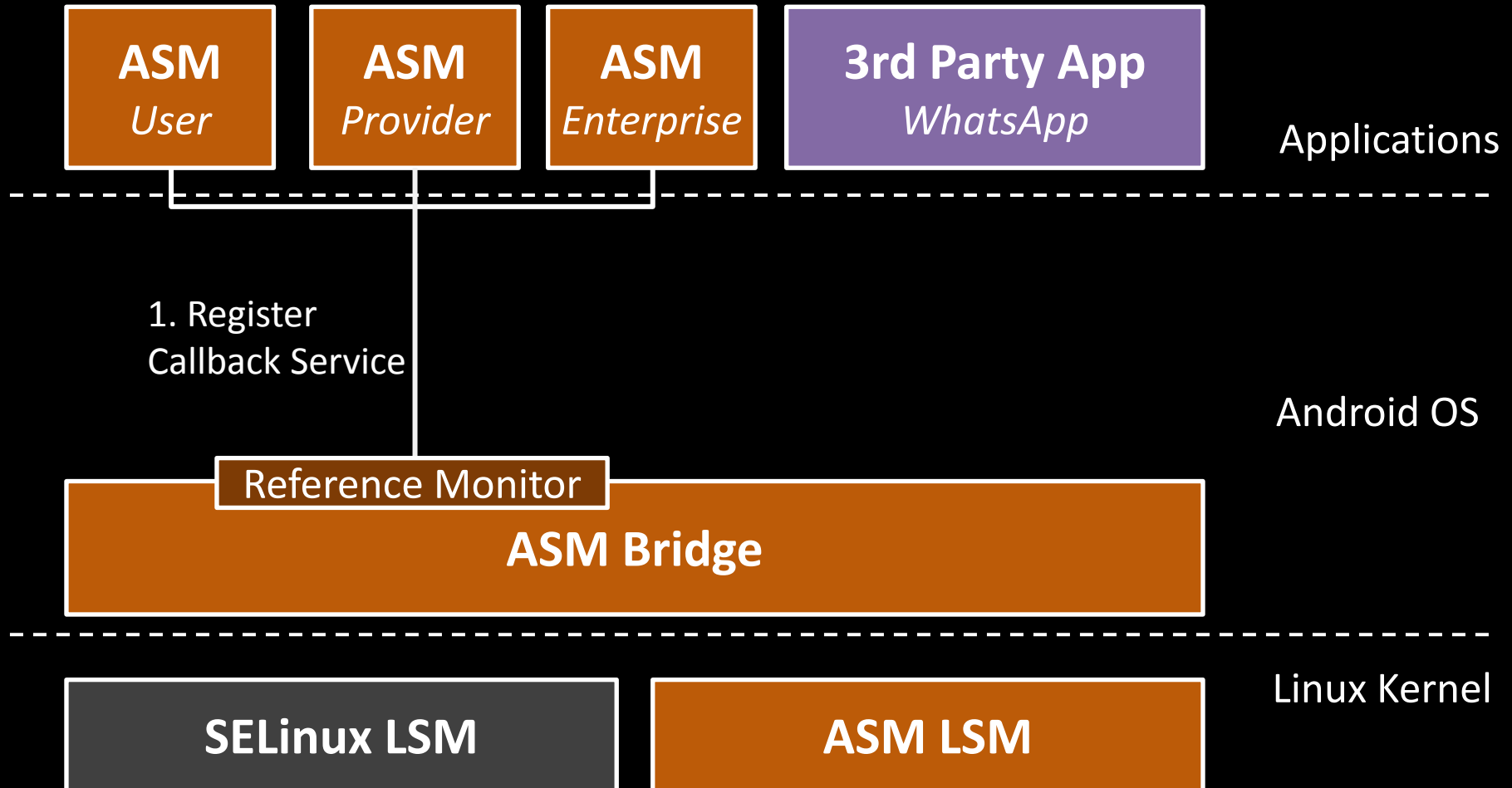
ASM Framework



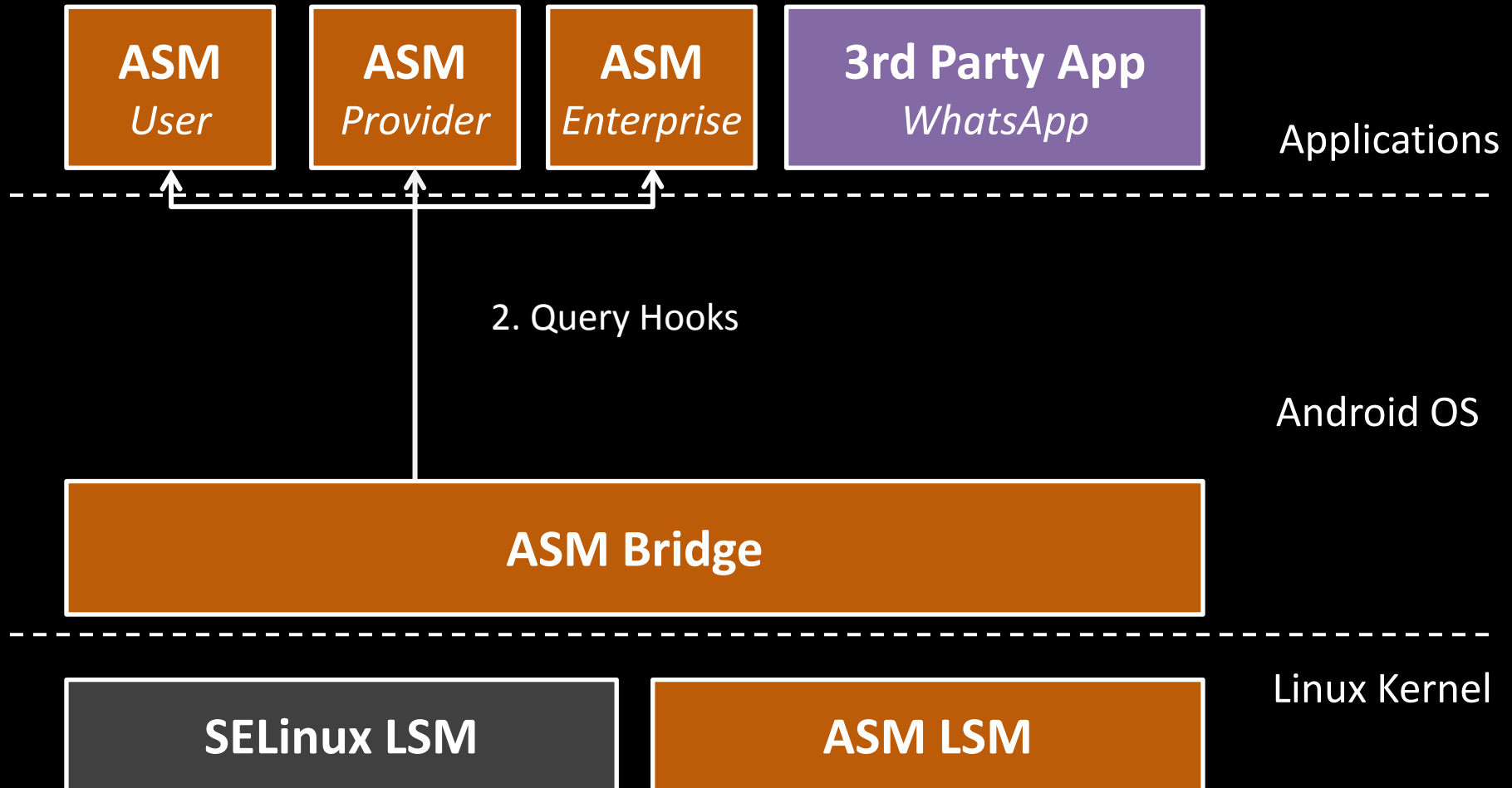
ASM Framework



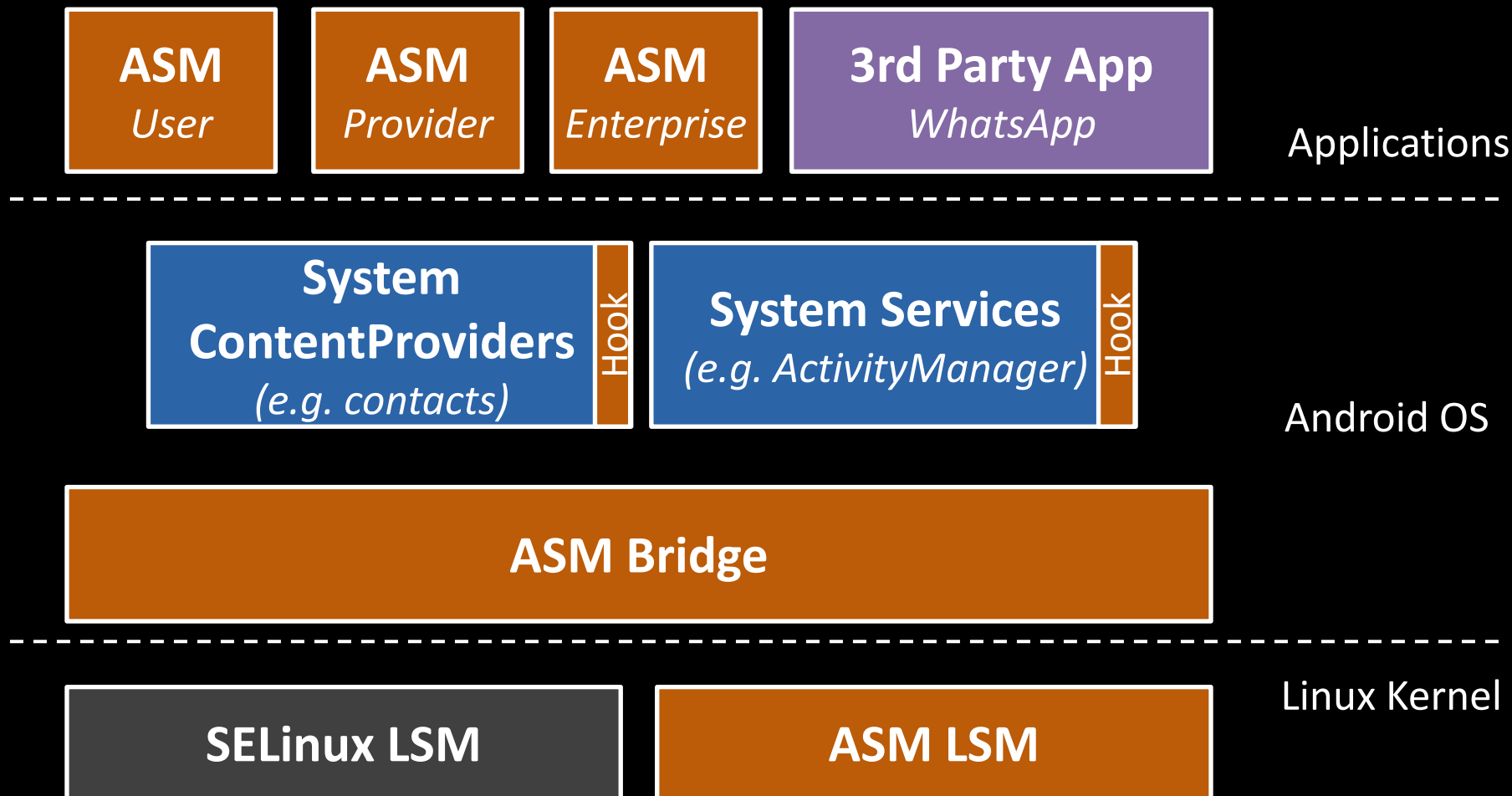
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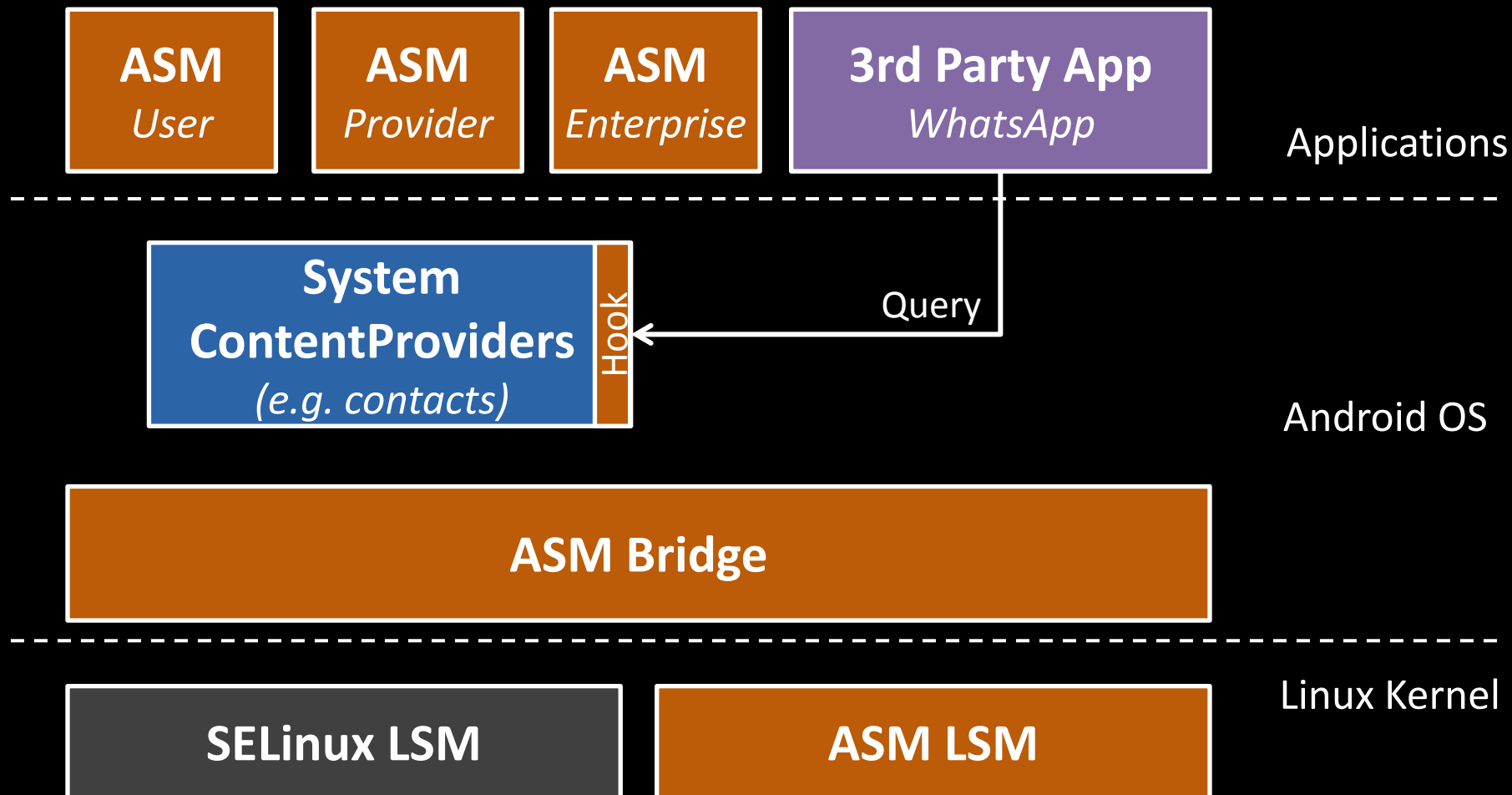
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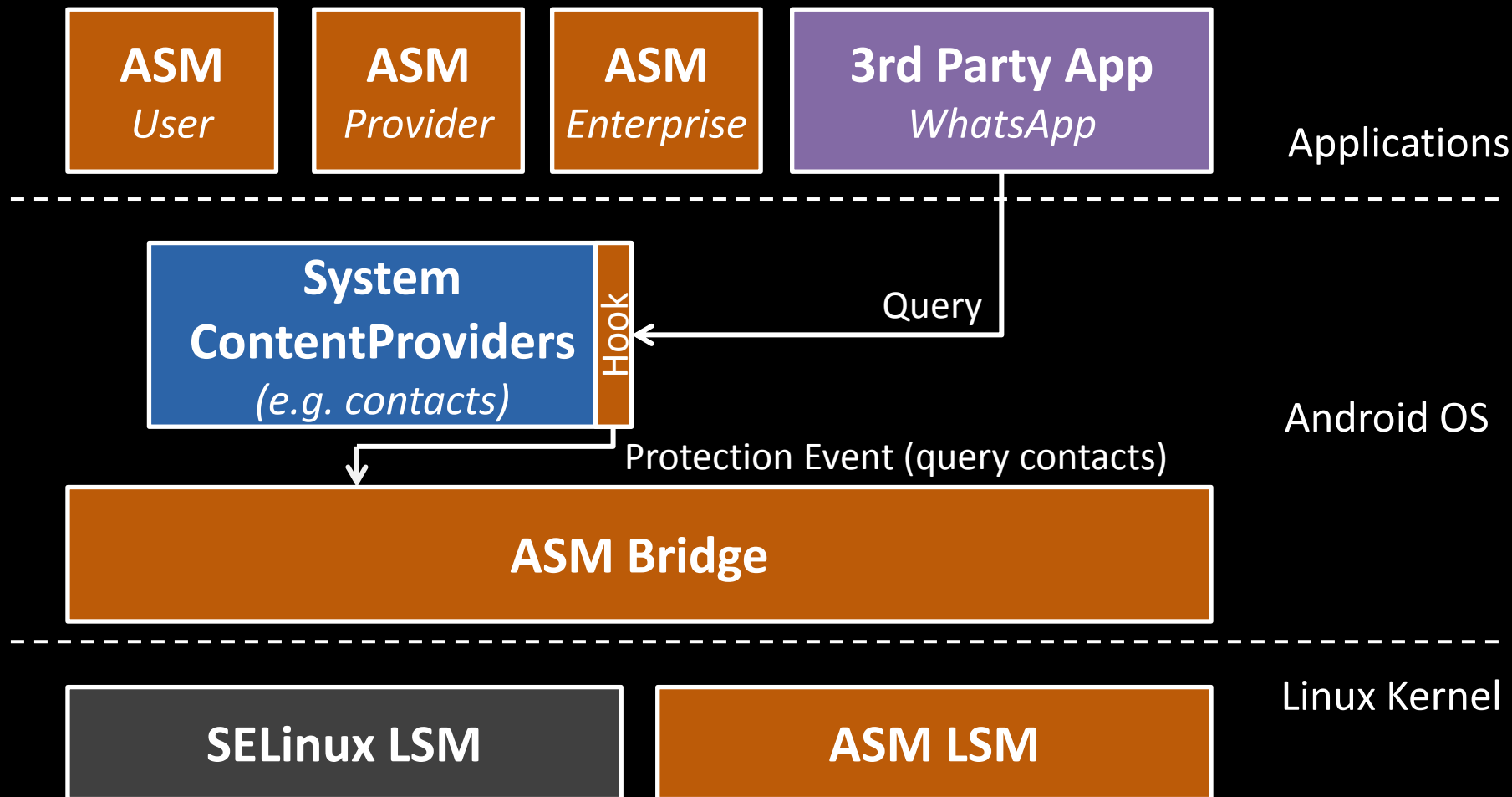
Hook Invocation



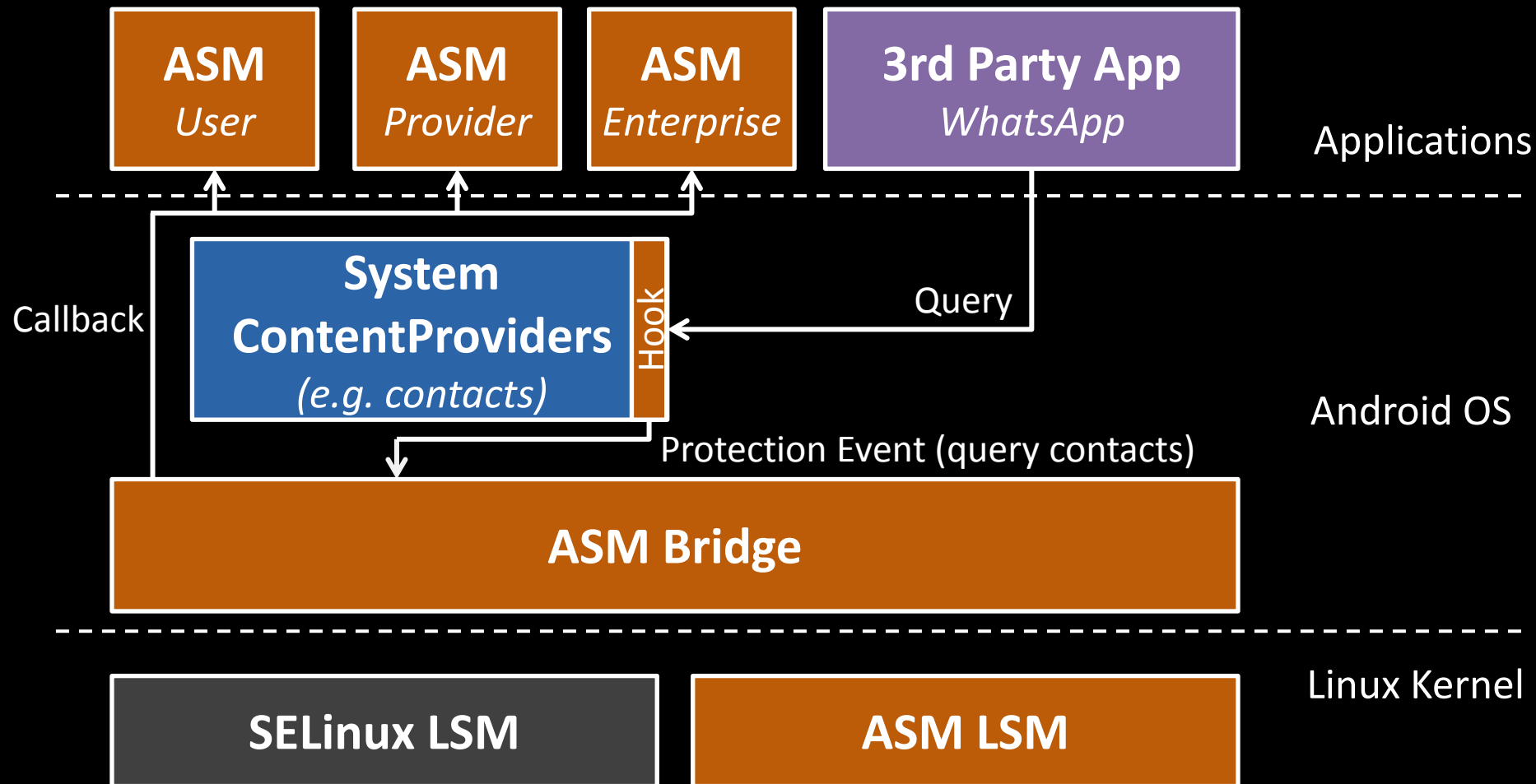
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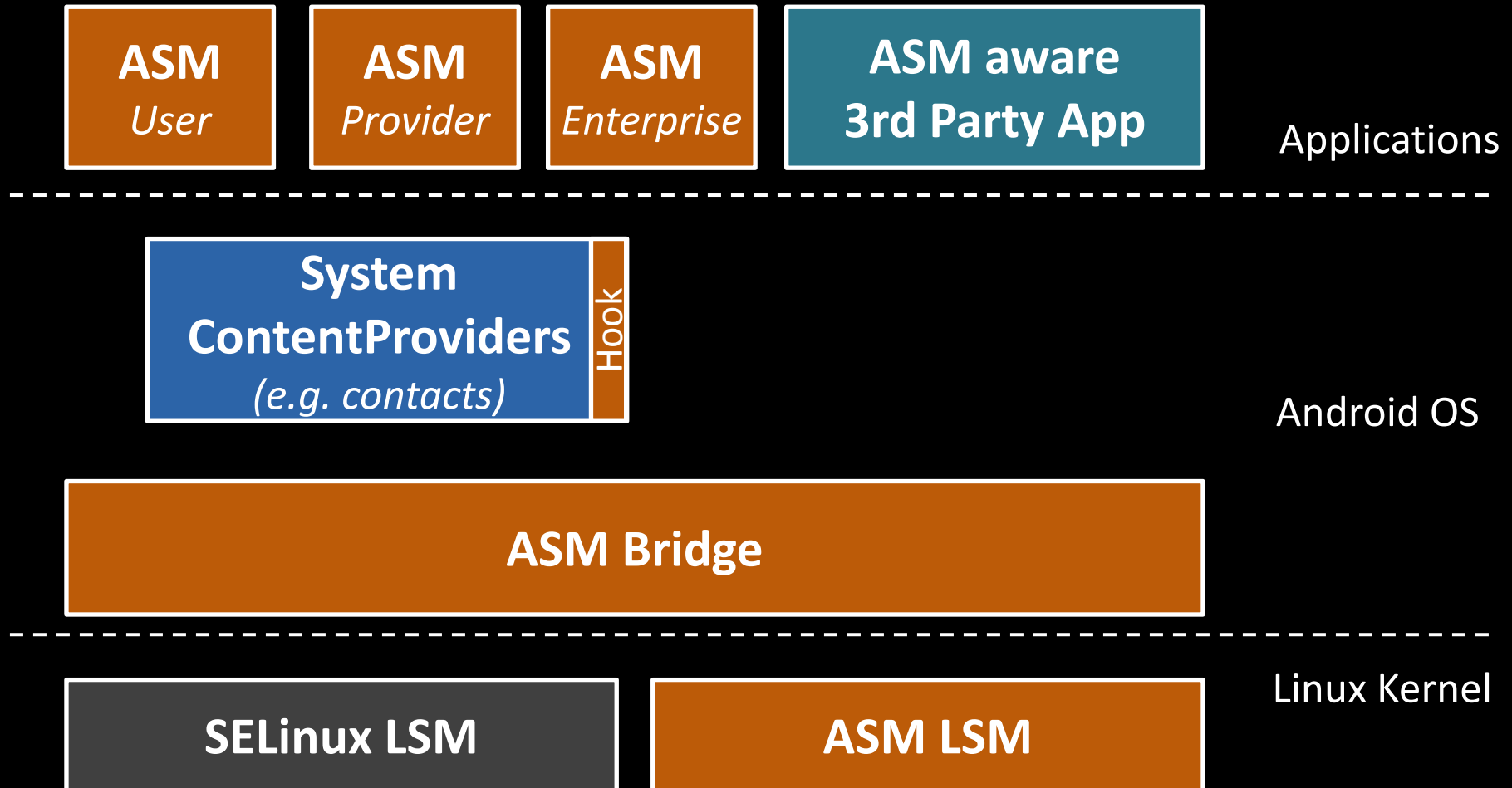
Hook Invocation



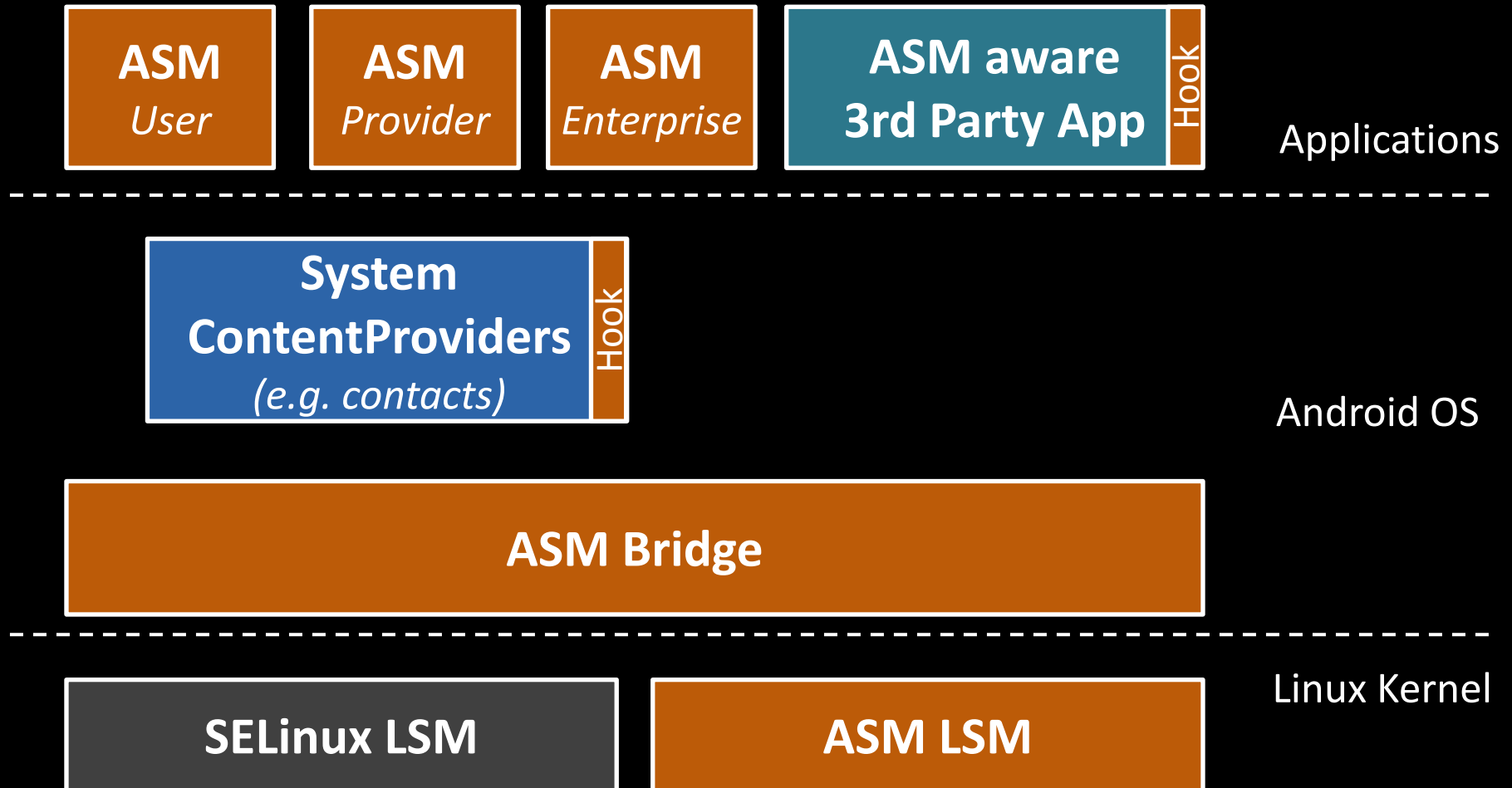
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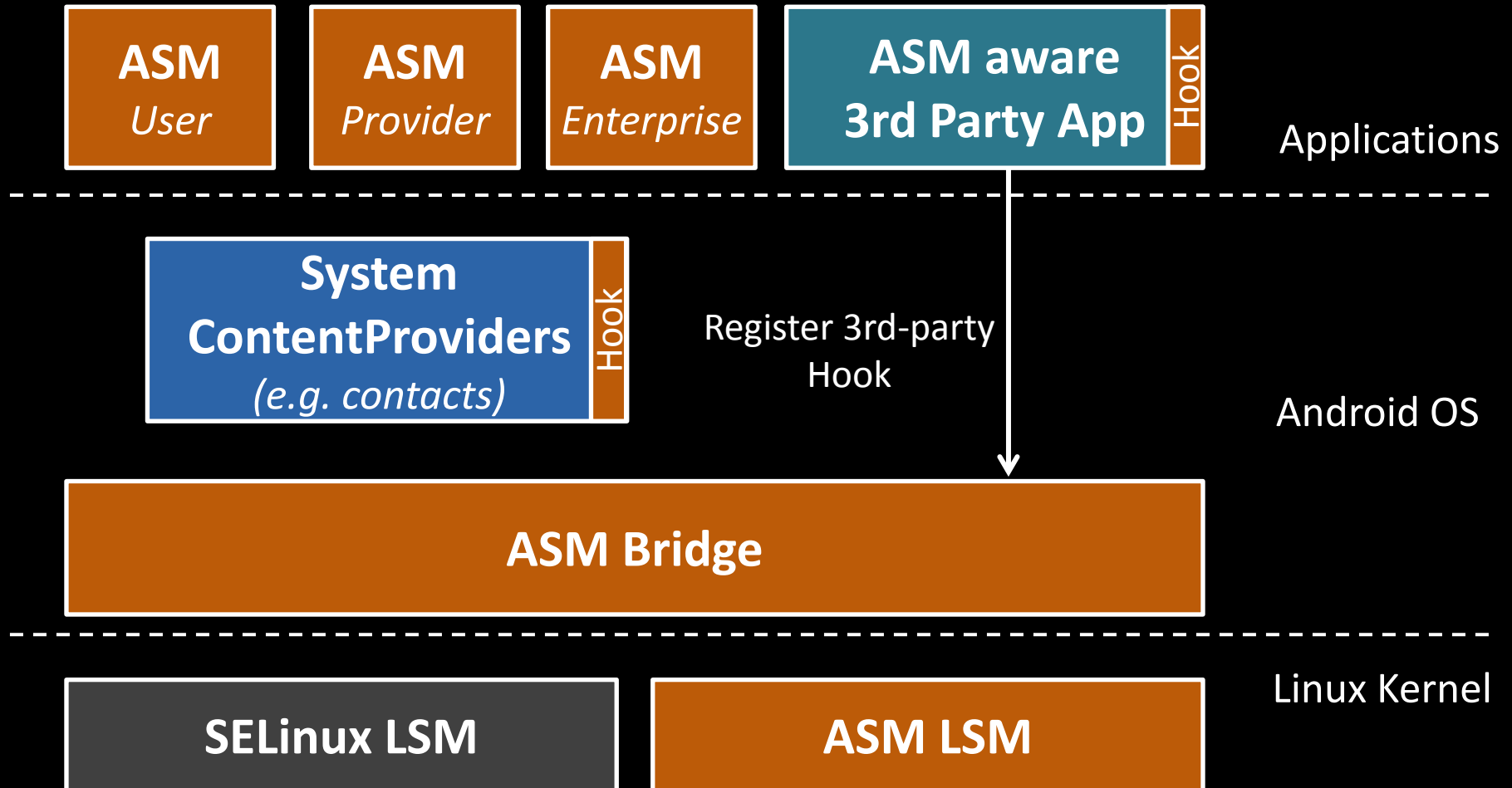
Support for 3rd-Party Hooks



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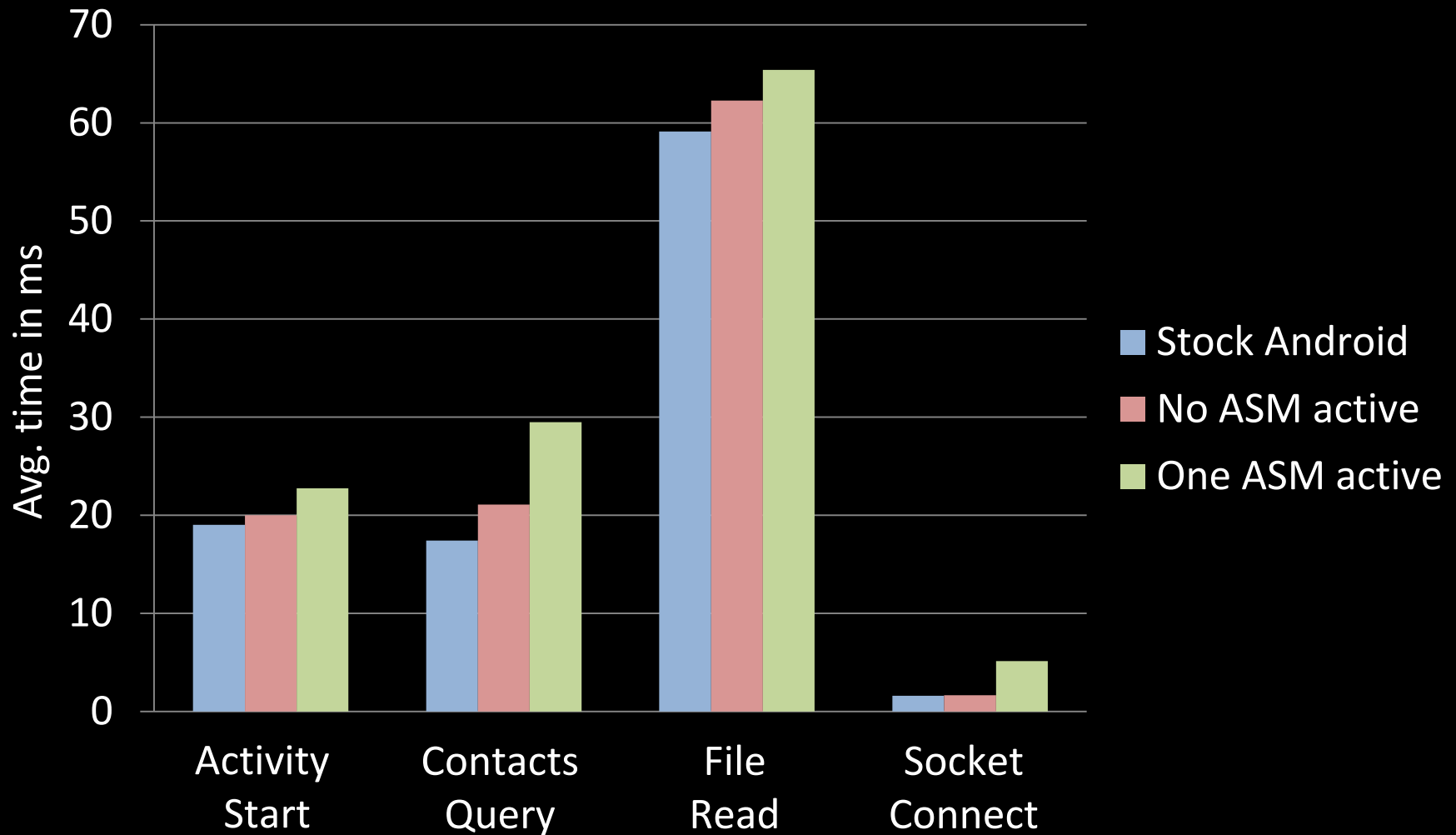


Evaluation

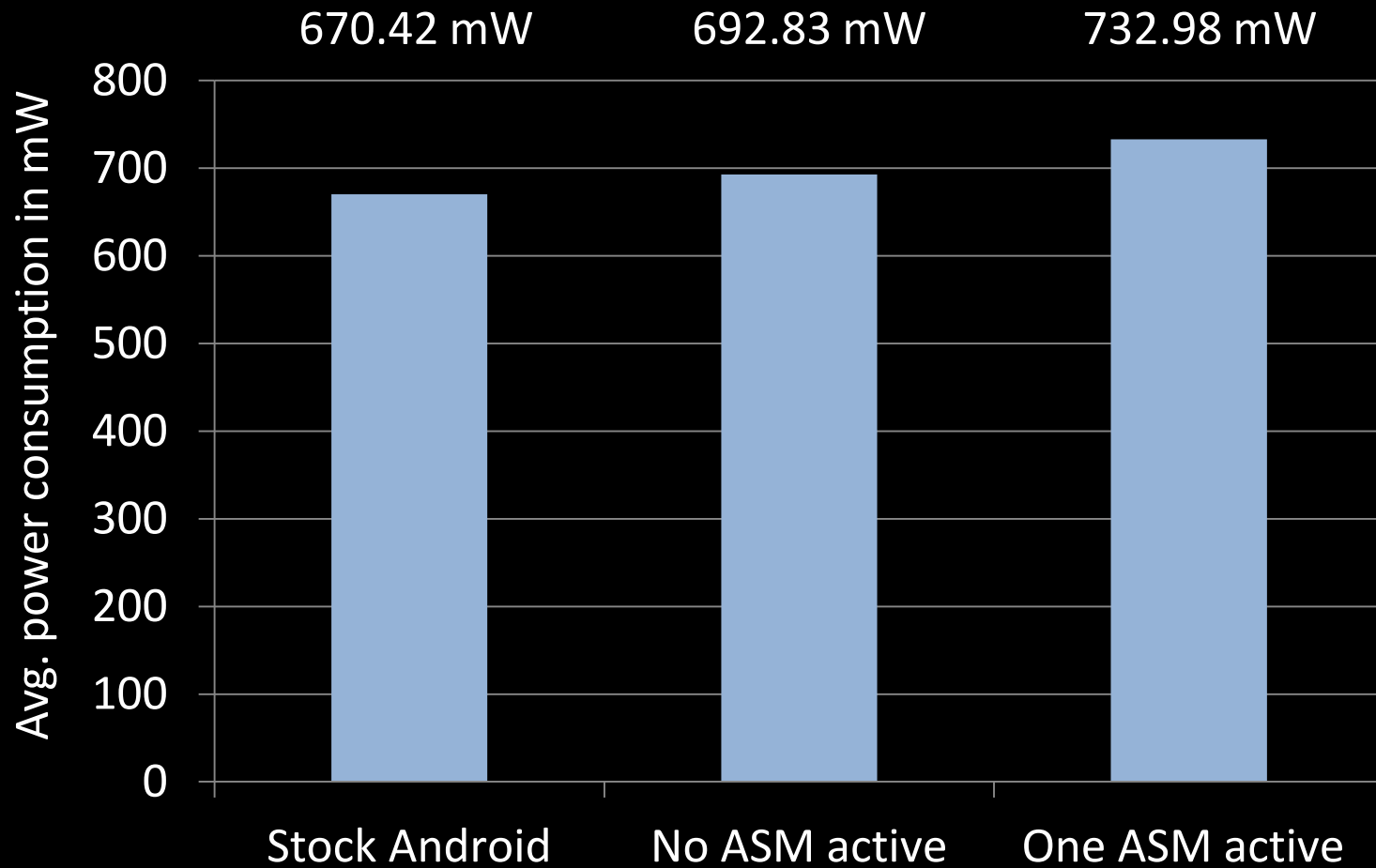
Experiment Setup

- ♦ **LG Nexus 4**
- ♦ **Android 4.4 (with ASM extensions), Linux MSM Kernel 3.4**
- ♦ **Evaluated aspects include User Interface (Activity), Contact, File and Socket operations**
- ♦ **Considered impact of a plain ASM**
- ♦ **Automated Test Suite**
 - ♦ Performance Overhead: `Java System.nanoTime()`
 - ♦ Power Consumption: Qualcomm Trepro Profiler

Performance



Power Consumption



Example Use Case

ConXSense

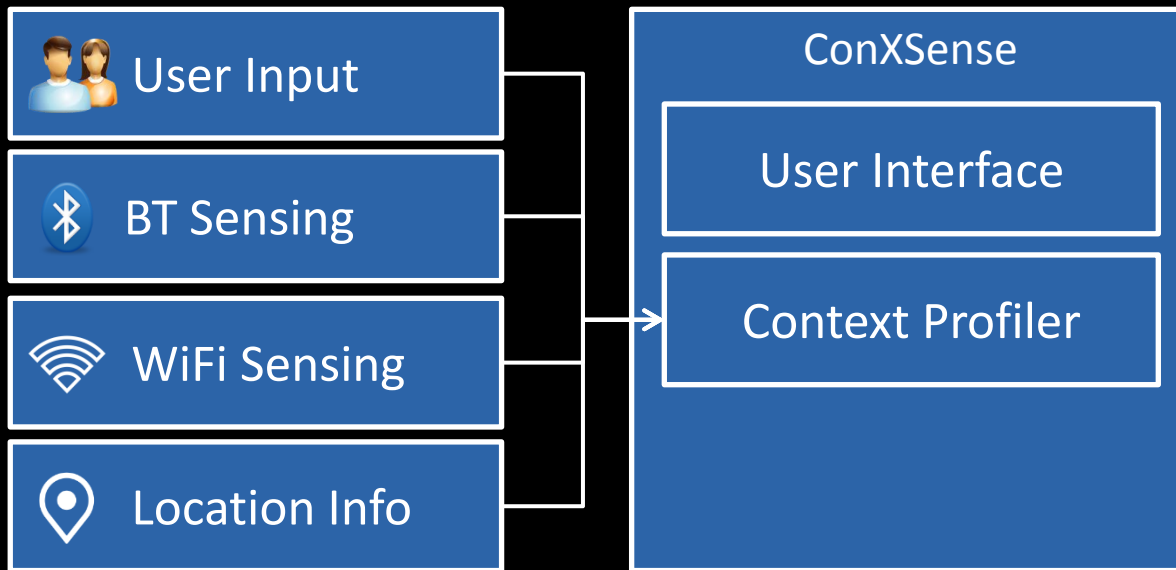
Context Aware Access Control

- Goal: Context-aware access control

ConXSense

Context Aware Access Control

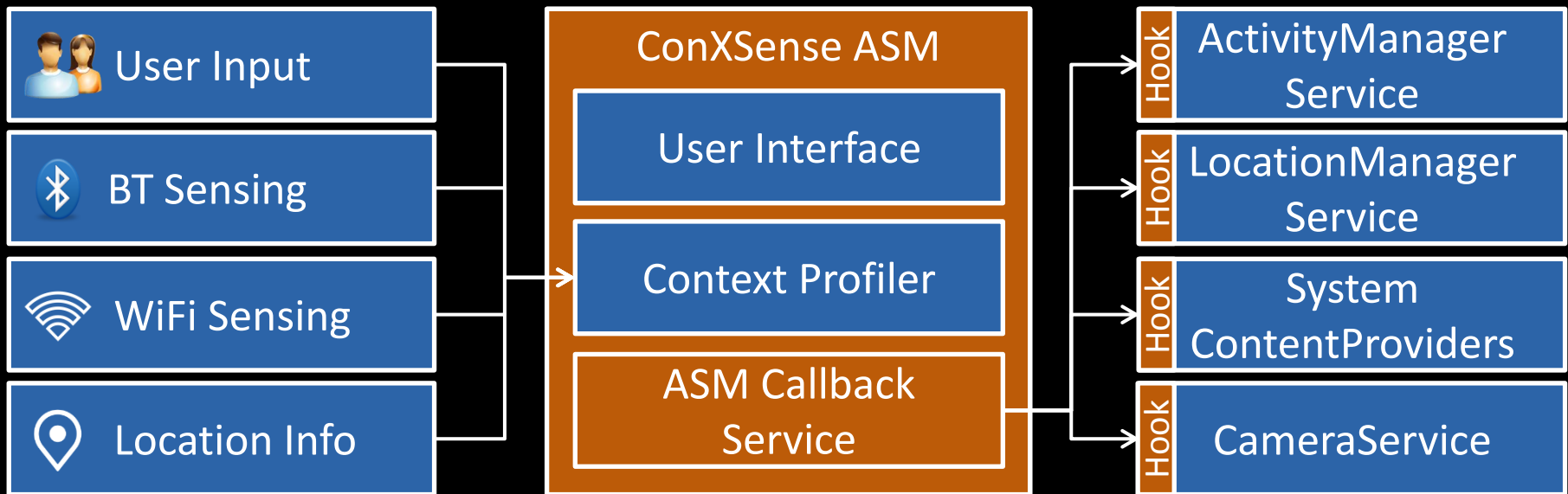
- Goal: Context-aware access control
 - Context-aware access control enforcing policies by user context profiling
 - Includes access control on sensors (e.g., GPS and camera), sensitive information (e.g., contacts) and apps



ConXSense

Context Aware Access Control

- Goal: Context-aware access control
 - Context-aware access control enforcing policies by user context profiling
 - Includes access control on sensors (e.g., GPS and camera), sensitive information (e.g., contacts) and apps
- ASM based implementation:



ConXSense [ASIACCS 2014]

Conclusion

- ♦ **ASM greatly simplifies use-case specific solutions**
 - ♦ Developers don't need to modify system components
 - ♦ Implementation of security solutions as apps
- ♦ **Currently working on further use-cases**
 - ♦ Dual Persona Phone
 - ♦ Dynamic Application Behaviour Analysis
- ♦ **Port to new Android versions**
- ♦ **Push ASM to device vendors, AOSP**
 - ♦ Google, OEMs – please call us 😊

Thank you!

Questions?



<http://www.androidsecuritymodules.org>