Designing An Android Sensor Subsystem

Pitfalls and Considerations

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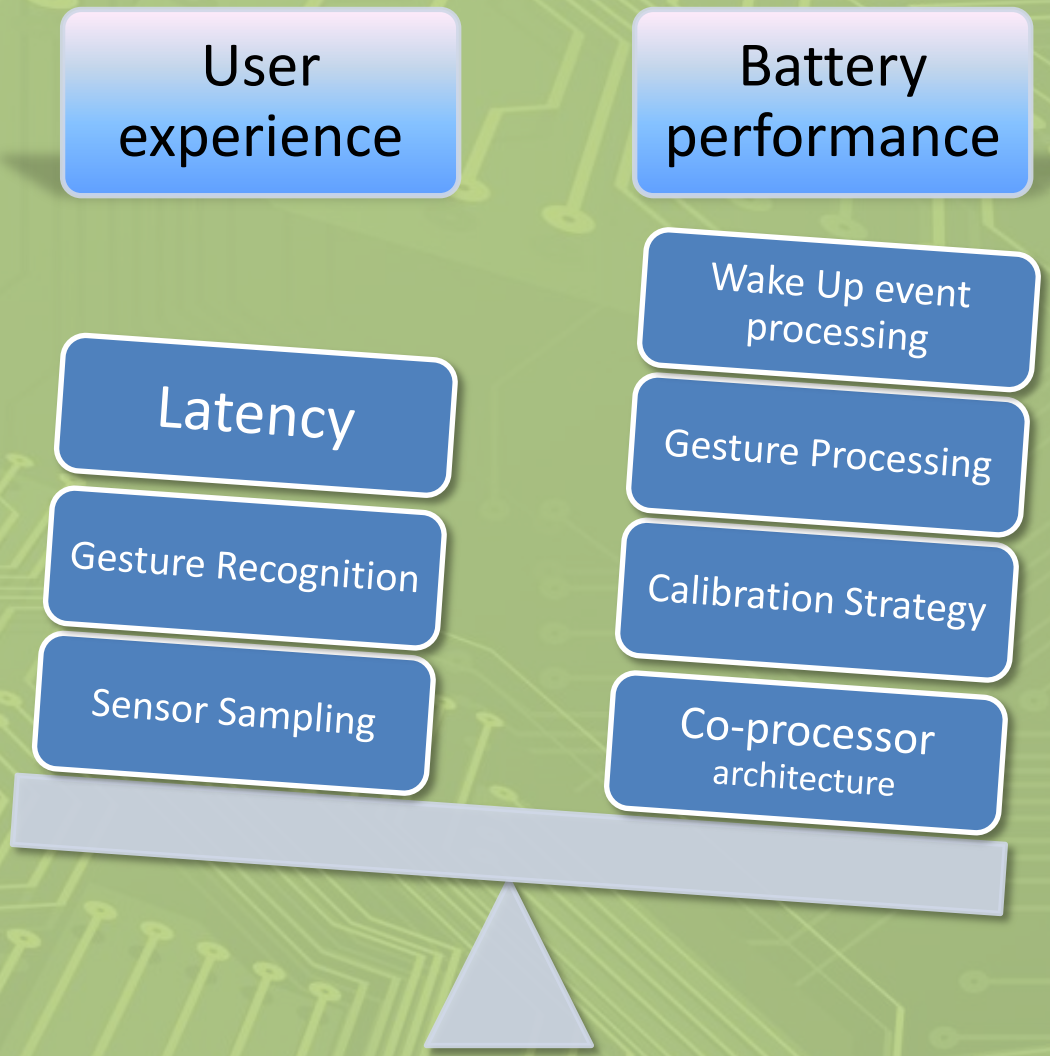
Simple Choices



Established or Innovative Product?

Established

- Will I be making another new product in 6 months?
- Is the reference design considered good enough for the application?

Innovation

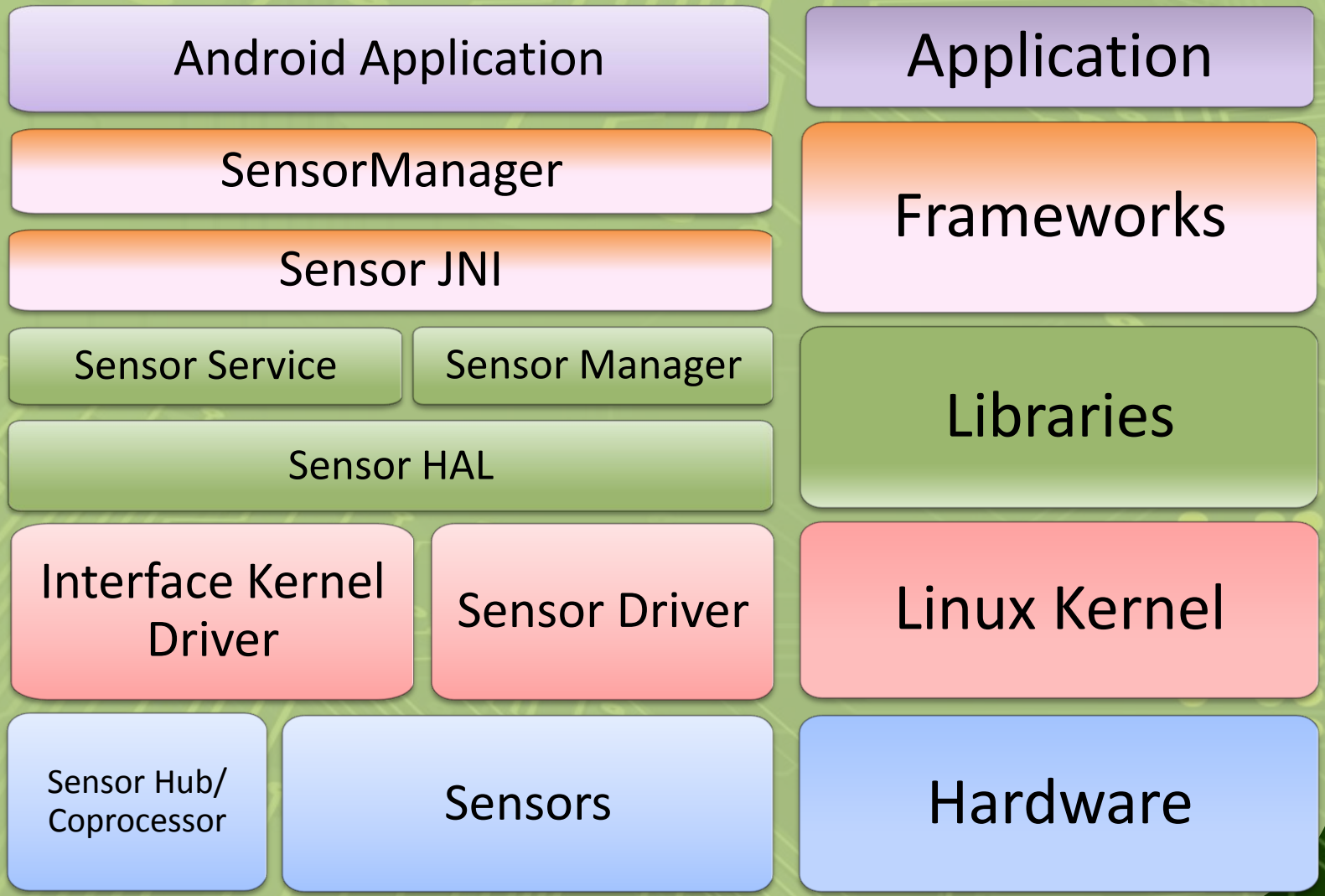
- Do I have new sensors types?
- Are features more important than release date?
- Are money and resources no problem?

Forsaking Reference Designs

Going On Your Own

- If you make your own,
  - You're on your own
  - Integration pains
  - Test time increase
  - Gesture testing becomes a challenge
  - Calibration blues
  - Larger mechanical footprint
- But…
  - power ↓
  - Control code size
  - Control mechanical footprint
  - In-house expertise

Android Universe



HARDWARE

Hardware Architecture

Sensor Selection

- Limited types
- New type
- Latency
- Power consumption

Sensor Sampling Rate

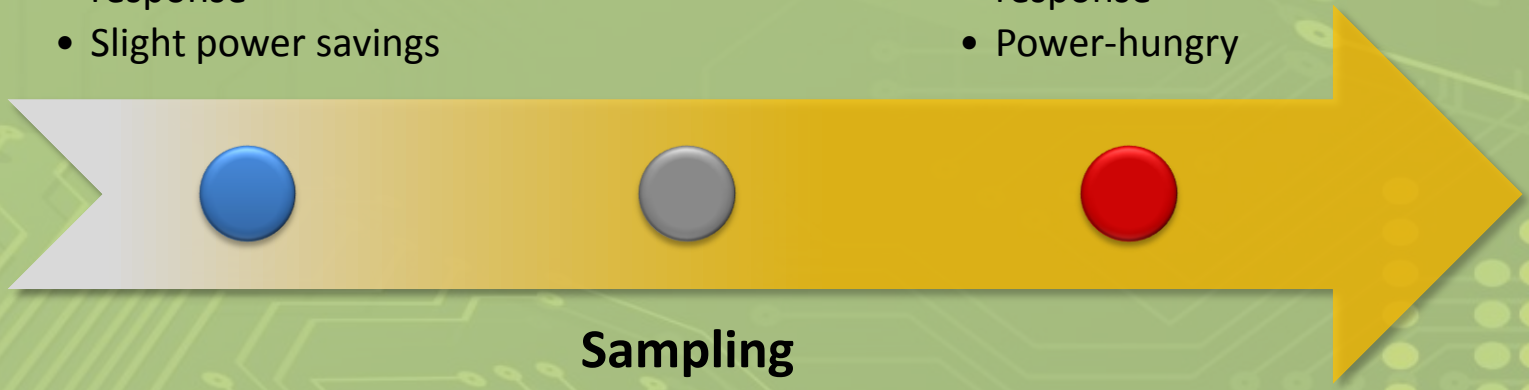
Sampling Rates: ★ The 3 Rates

Under-sampling

- Inaccurate, sluggish response
- Slight power savings

Over-sampling

- Accurate, smooth response
- Power-hungry



Sampling Rate

Polling versus Interrupt

Pros:

- Simplicity
- Throttle data throughput

Pros:

- Low power Sleep Mode
- Use fewer timers

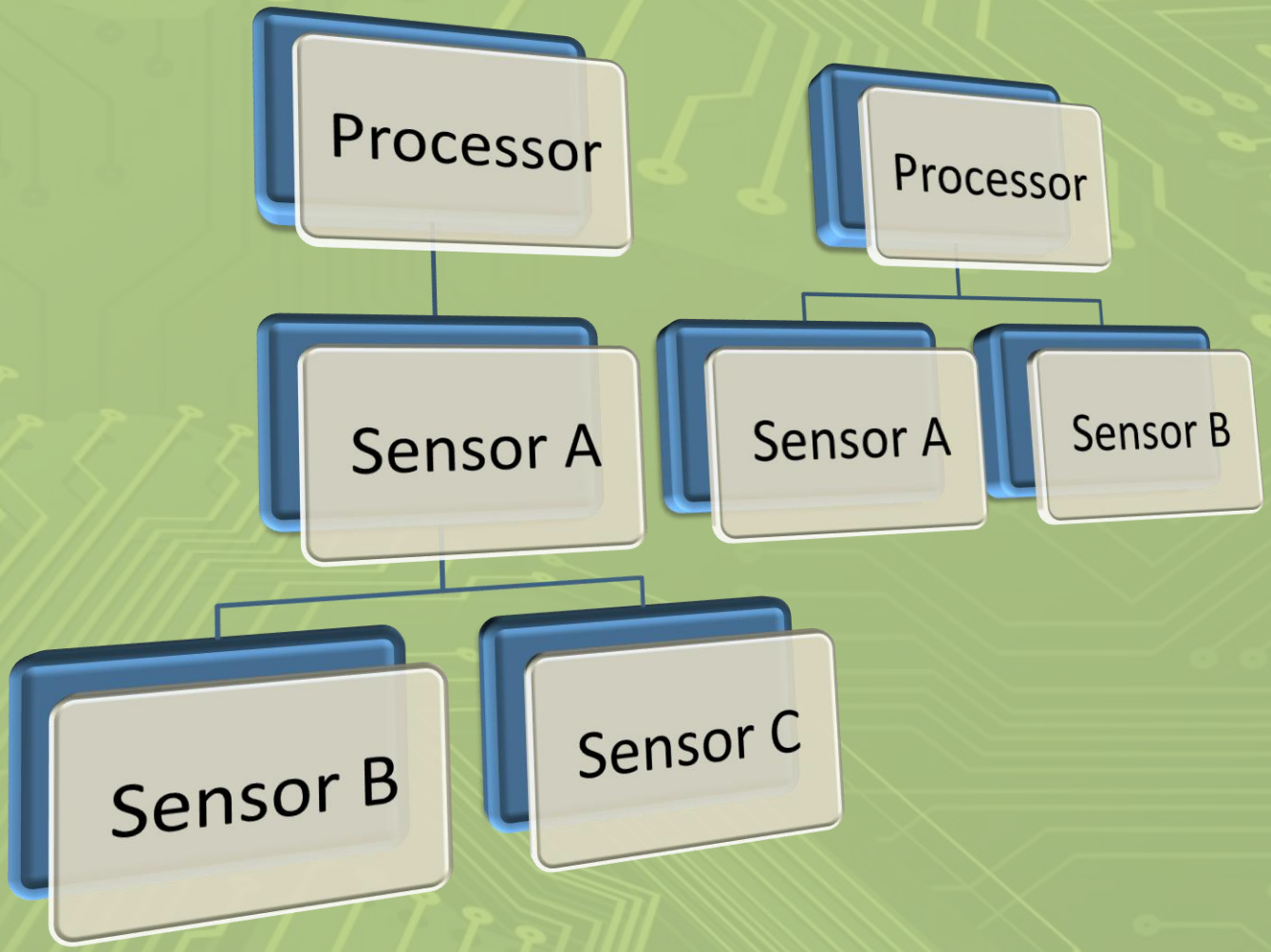
Cons:

- Less sleep
- Latency ↑
- Data loss

Cons:

- Complex program structure

Interfaces


Processor
Processor
Sensor A
Sensor A
Sensor B
Sensor B
Sensor C

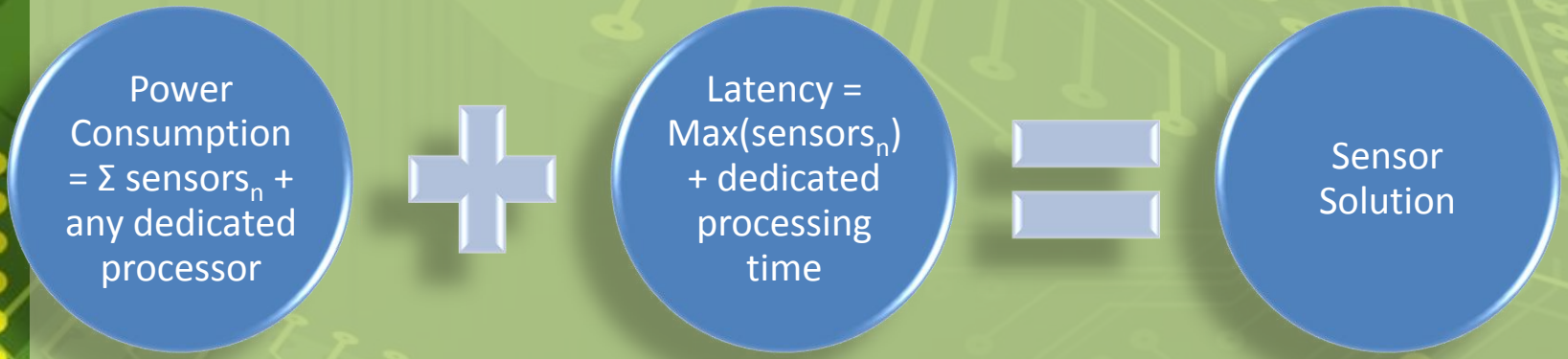
Wake up events and power considerations ★

Application Processor only	Internal Coprocessor	External Processor
		
Reference supported Most power hungry	Reference supported Most work done for you	More processor selection More outcome control Most customized Footprint impact

Sensor Subsystem/Hub

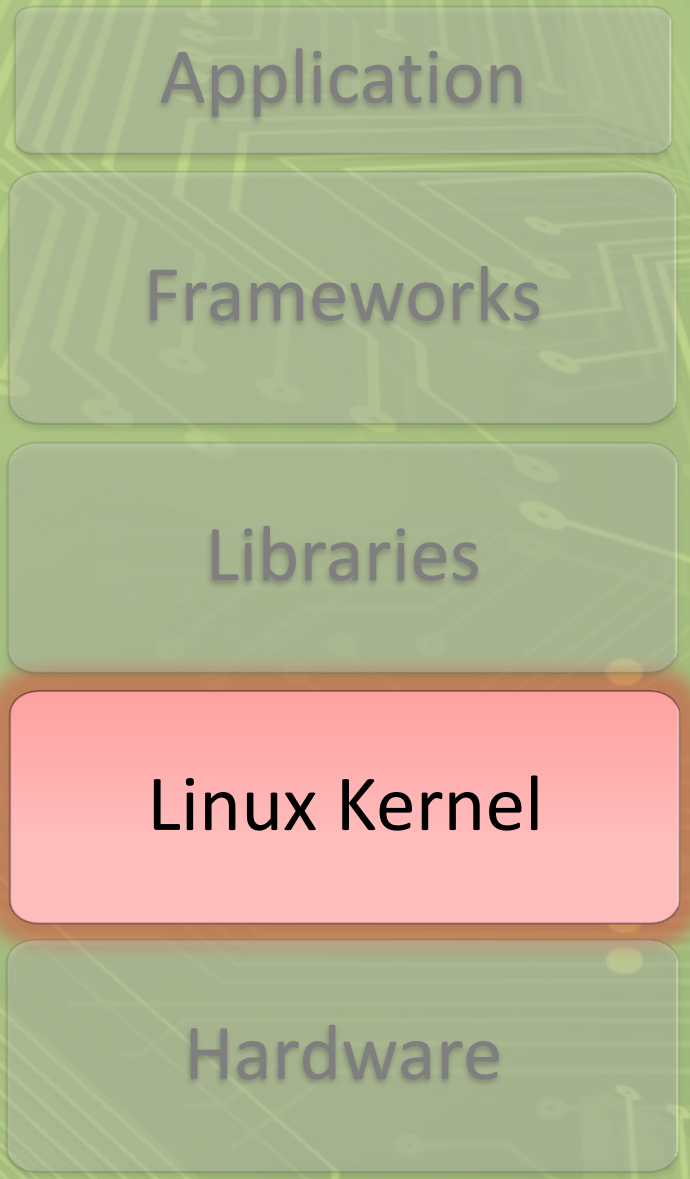
- Separate processor or part of the Application processor
- How to evaluate?
  - *Latency*
  - *Power consumption*
  - *Low power modes*

Hardware Summary

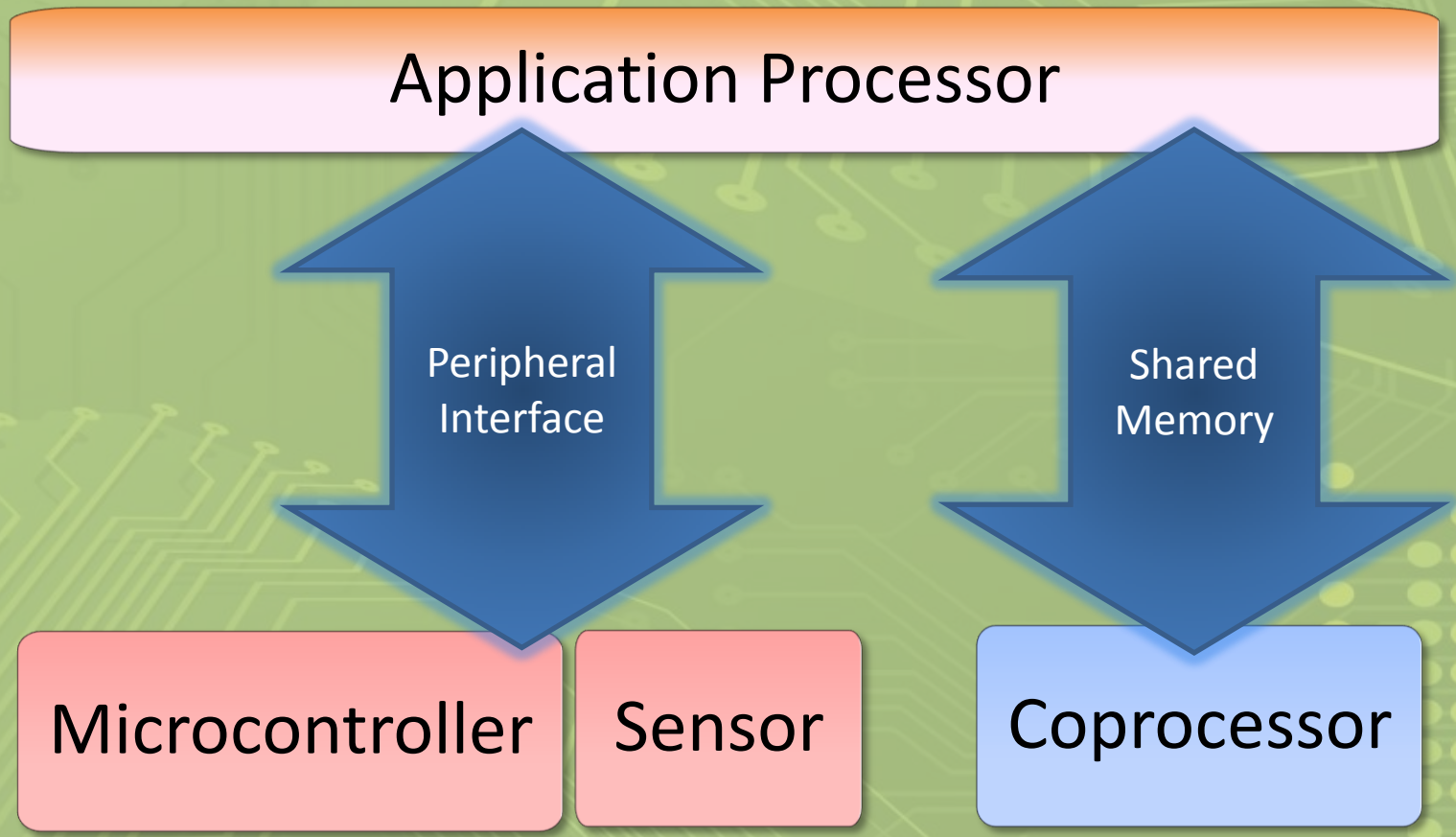


- Use tie-breaker criteria

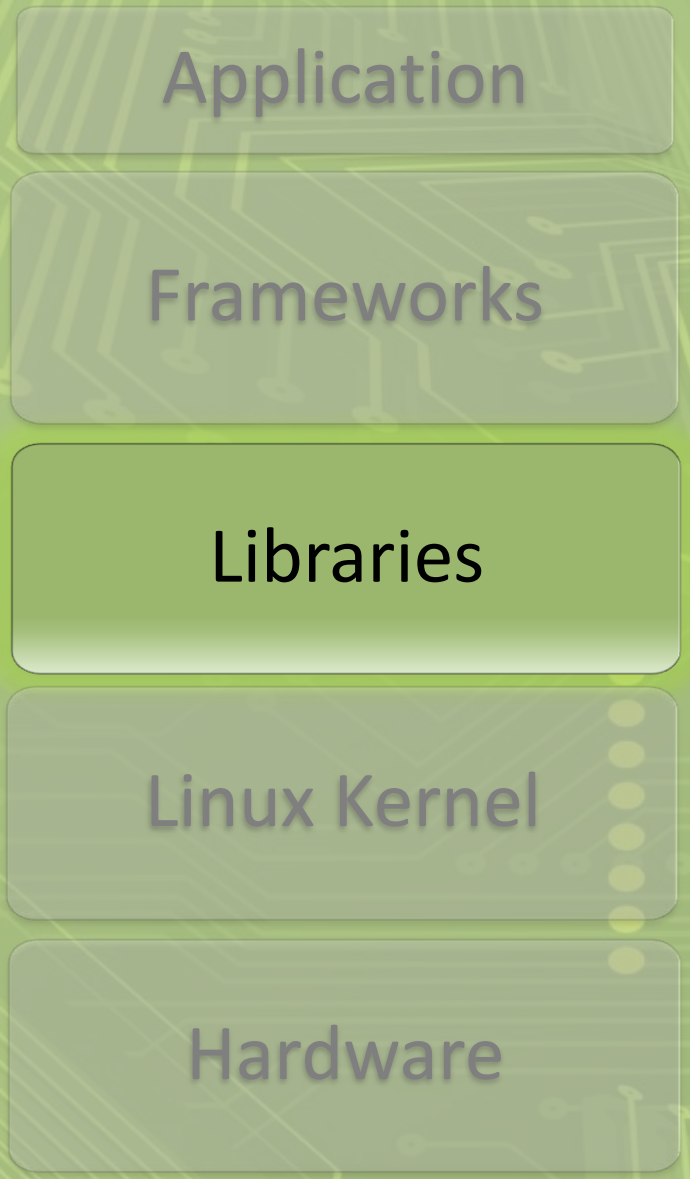
KERNEL



Kernel Driver



LIBRARIES AND SERVICES



Sensor HAL and Services

- **HAL**
  device/<vendor>/<board name>/libsensors
- **Service**
  frameworks/base/services/sensorservice
- **Manager**
  frameworks/base/libs/gui

Quick HAL Intro

Create:

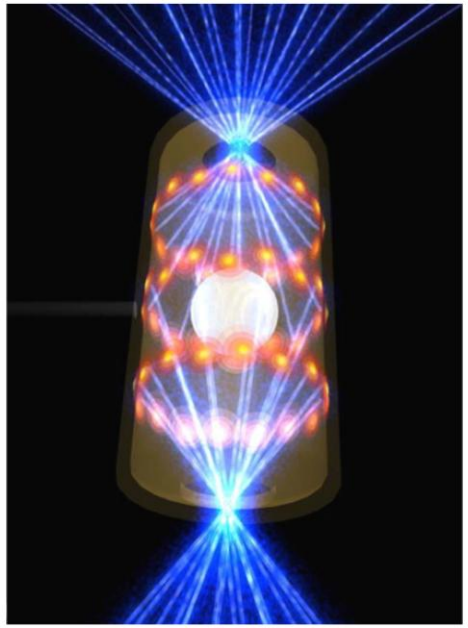
- List of sensors in **sSensorList**
- Class for each sensor supporting
- A new sensor **instance** in **sensor.cpp**

Update:

- **sensors_poll_context_t** to handle requests
- **Android.mk** to build library

Sensor Fusion

Sensor fusion is the combining of sensory data or data derived from sensory data from disparate sources such that the resulting information is in some sense *better* than would be possible when these sources were used individually. The term



Libraries

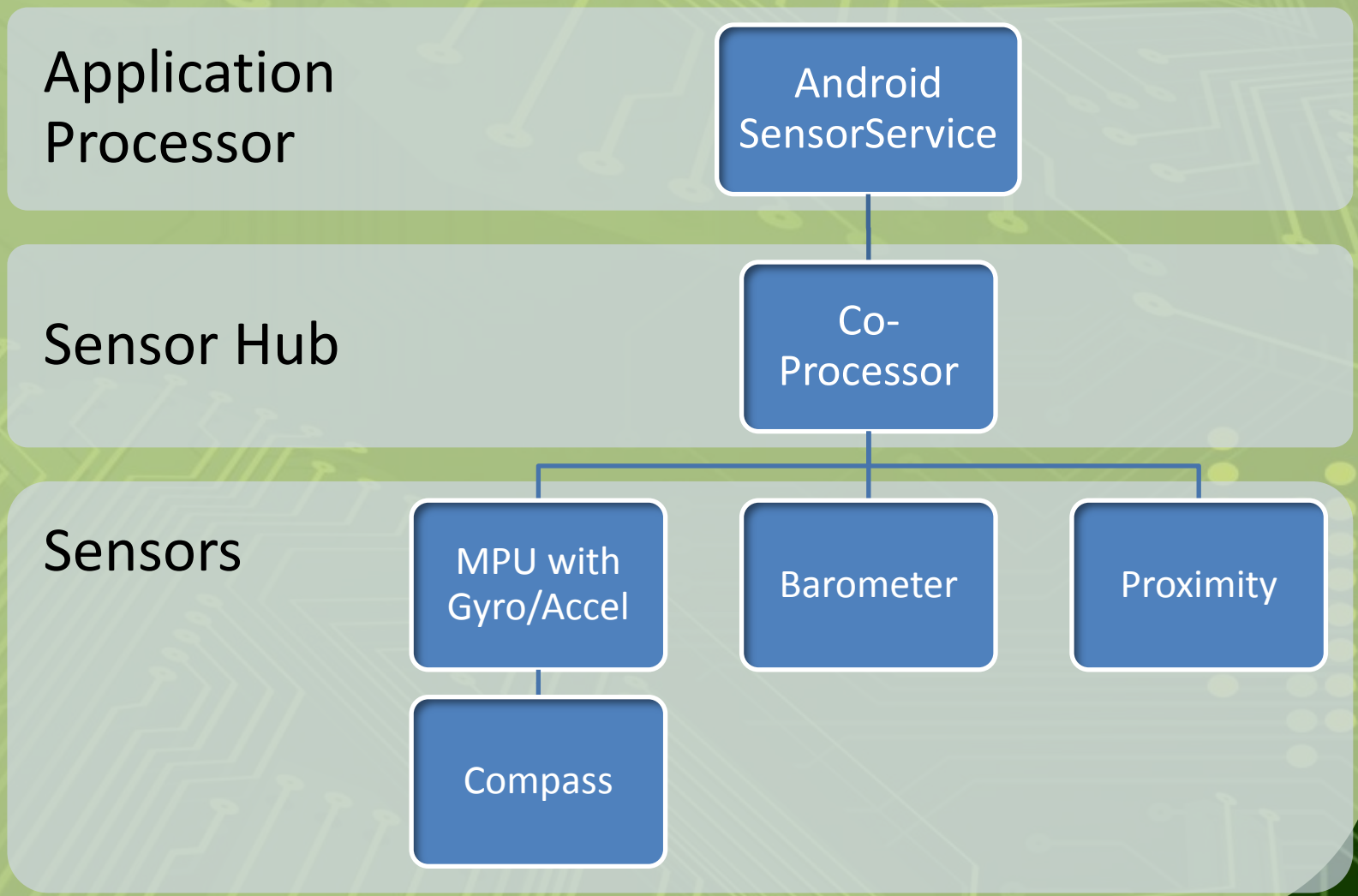
Linux Kernel

Sensor Hub

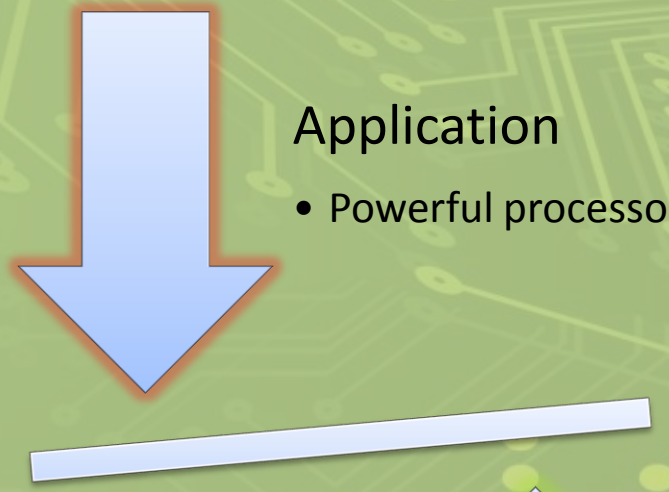
Sensors

http://en.wikipedia.org/wiki/Sensor_fusion
https://www.llnl.gov/news/newsreleases/2010/NR-10-01-06.html

Gesture Detection Algorithm



Gesture Detection Comparison

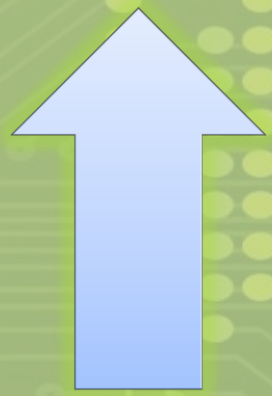


Application

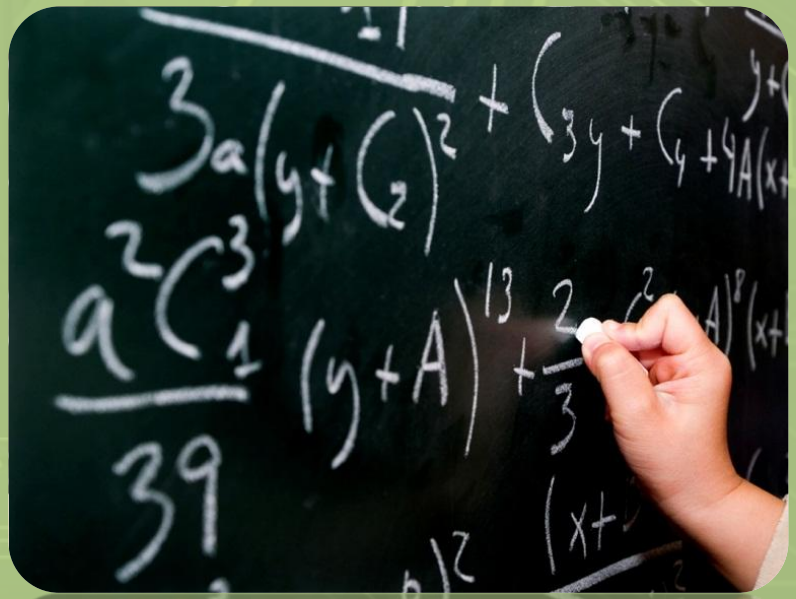
- Powerful processor

Sensor hub

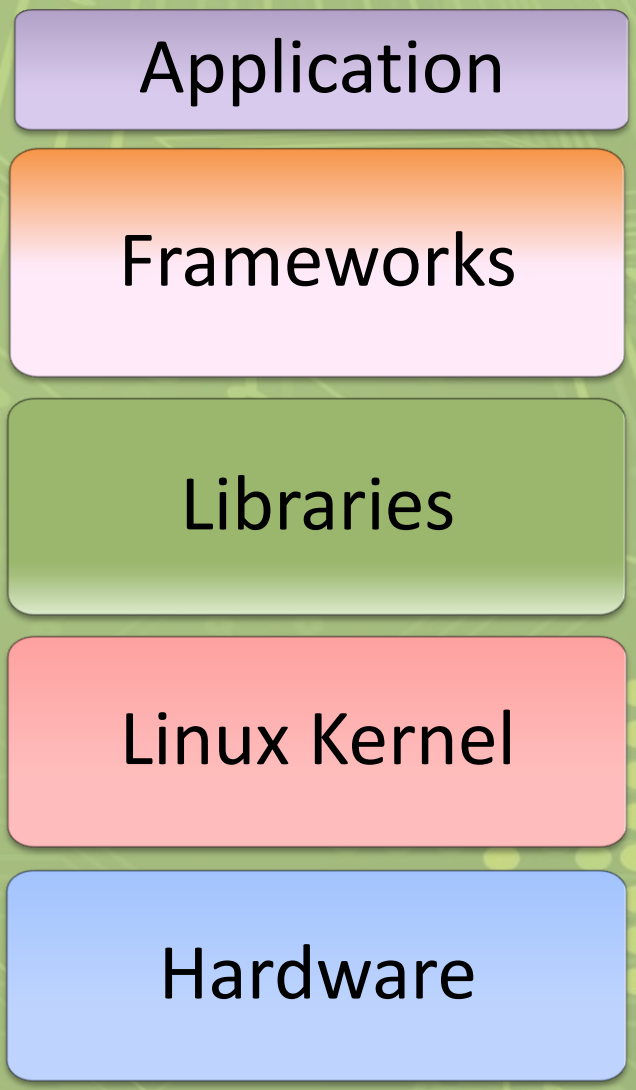
- Off-load to cheaper power
- Wake up Event Handling



Calibration



OTHER CONSIDERATIONS



Testing Methodologies

- Creating tools
- Checkpoints at all levels
- Ensure the application processor can see your sensor
- Compatibility Test Suite (CTS) at application level - **/cts/tests/tests/hardware… SensorTest.java**
- Test services - **/frameworks/base/services/sensorservice/tests**
- Manufacturing tests

QUESTIONS?

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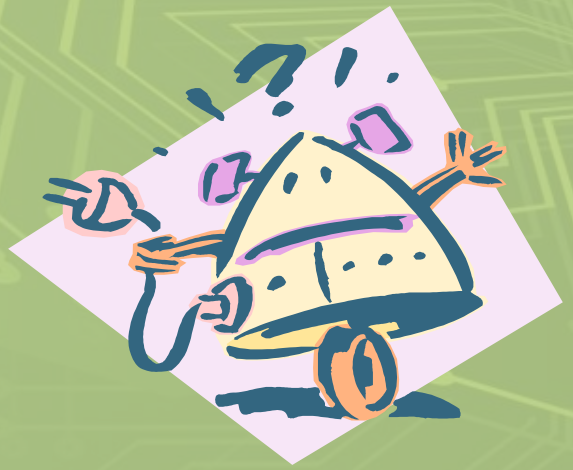

Additional resources

http://processors.wiki.ti.com/index.php/Android_Sensor_PortingGuide

http://www.kandroid.org/online-pdk/guide/sensors.html