

Open Sensor Platform White Paper

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First open source software to enable implementation of sensor hubs

1 Introduction

More and more mobile devices (smart phones, tablets, wearables, the Internet of Things, and a growing number of medical and environmental devices) are utilizing sensors. Many such systems utilize a sensor hub not only to coordinate input from various sensors but also provide additional functionalities such as always-on context-aware capabilities. These sensor hubs could also coexist with other functionalities, such as audio processing.

Up to now, use of sensors and sensor hubs in embedded mobile devices has been fragmented and ad hoc. As innovation in the sensor space accelerates, however, it is prudent to provide an open source framework to simplify the integration of sensor hubs into mobile devices and provide a consistent interface for sensors across processors and platforms.

Open Sensor Platform (OSP) is open source software built to enable systems with sensor hubs. Released by Sensor Platforms Inc., it is a framework specifically for sensor data acquisition, communication, and interpretation, compatible with any CPU architecture or real-time operating system. OSP encourages developers to focus on creating low-level applications for sensors rather than reinventing the wheel on the sensor interface. By open sourcing this software, community contributions can continue to develop this framework.

The first sample OSP implementation is an Android KitKat-compliant sensor hub providing always-on sensor data up to the Android Hardware Abstraction Layer (HAL) on the Application Processor (AP). However, the framework is simple and flexible enough to be extended to more use-cases.

OSP developers will also be able to seamlessly take advantage of higher-level sensor interpretation such as that available through Sensor Platforms' own FreeMotion™ Libraries that provide robust Sensor Fusion, always-on Context Awareness, and Pedestrian Dead Reckoning (PDR).

2 Architecture and Building blocks

Before discussing the embedded architecture for OSP, it is useful to review the sensor framework utilized in any Android AP. The Android Open Source Project (AOSP) is built on a Linux kernel which itself is open-sourced. Code modifications to either of these projects needs to adhere to their respective licenses and generally be contributed back to the project. Any closed source aspects such as binary libraries need to live in User-Space. Many potential interfaces to the embedded sensor hub are already supported by Linux including input event, IIO, and the hardware interfaces SPI, I2C, and UART. This is shown in Figure 1.

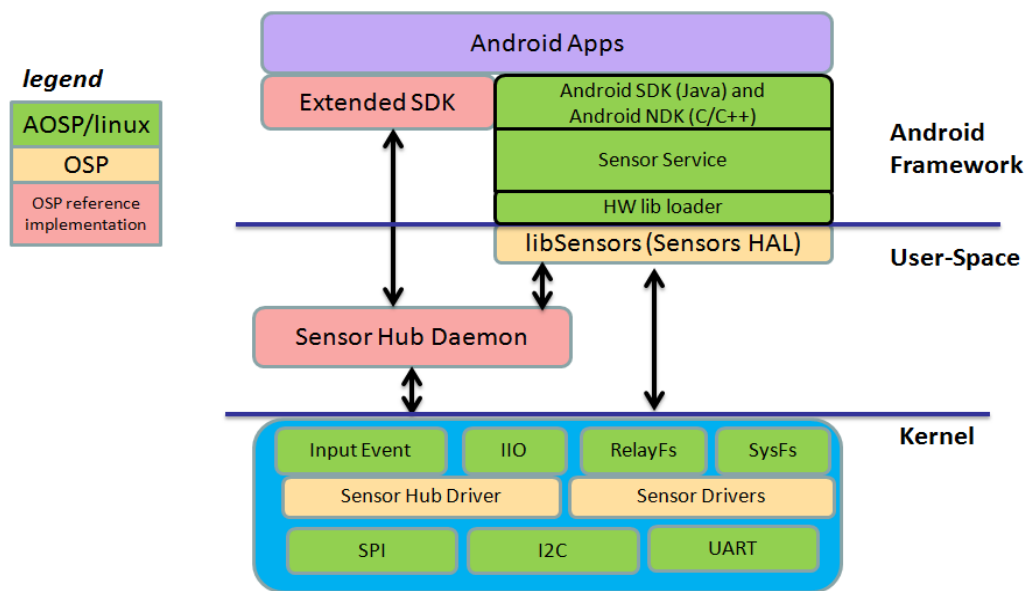


Figure 1: A sensor-centric view of the Android Host framework, showing general open source parts (green), OSP open source parts (beige), and reference implementations included in OSP (pink).

OSP contains the following blocks to pass sensor and sensor hub data up to the Android sensors HAL:

- **Sensor Hub Driver:** interface to the embedded sensor hub hardware;
- **Sensor Drivers:** interface to sensors not connected to the sensor hub;
- **libSensors:** the library in user-space that implements the Hardware Abstraction Layer (HAL) specified by Android;
- **Sensor Hub Daemon:** a user-space process that can implement proprietary sensor algorithms through standard Linux interfaces. OSP contains a reference implementation of this daemon in source form;
- **Extended SDK:** a software development kit (SDK) for features not currently supported in AOSP but which a Java App Developer would like to access.

Now focusing on the sensor hub architecture, the framework is shown in Figure 2. Similar to the AP, there is a low-level interface for hardware abstraction such as SPI and I2C drivers, an application support framework for applications running on the embedded hub itself, and a “user-space” product specific area for proprietary algorithm libraries.

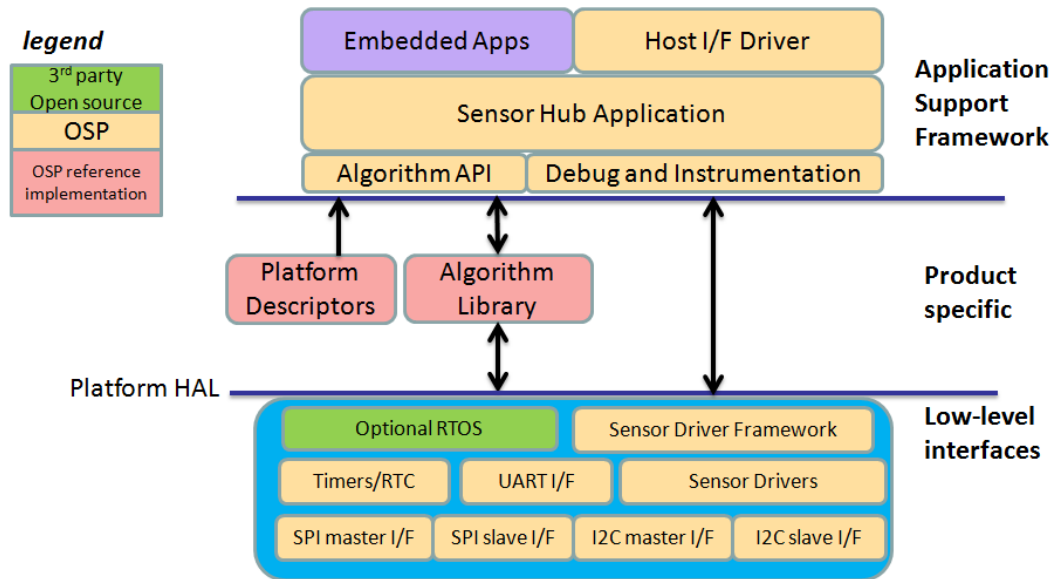


Figure 2: A sensor hub framework with similar aspects as Figure 1.

OSP implements the following to send sensor data up to the Sensor Hub Application and beyond to the AP as available:

- **Sensor Driver Framework:** processor-agnostic configuration and control of each sensor connected to the sensor hub;
- **Timers/RTC:** timers or Real Time Clock (RTC) implementation provided for high-fidelity time-stamping of sensor data;
- **UART I/F:** serial interface drivers to enable debug and rapid prototyping;
- **SPI master and slave I/F:** serial peripheral interface (SPI) drivers from hub to sensors or AP;
- **I2C master and slave I/F:** I2C drivers from hub to sensors or AP;
- **Debug and Instrumentation:** used for standard UART based data logging and error reporting;
- **Algorithm API:** the common interface for any sensor interpretation algorithms implemented on the sensor hub;
- **Sensor Hub Application:** associate the appropriate set of algorithms to host operating system sensor requirements;
- **Host I/F Driver:** generic sensor data and control protocol to communicate with the host.

3 Application Support Framework

The Application Support Framework (ASF) is the basic starting point for the sensor firmware developer. It stitches together the various system components of OSP to provide sensor data to the application. This implementation keeps portability across hardware platforms, CPU architectures, and real-time operating systems.

The ASF provides APIs, macros, and utility functions for managing tasks, timers, and message passing in the application. These methods have been created to abstract the underlying kernel or RTOS and allow porting of the existing application firmware to different platforms with minimal effort.

4 Conclusion

Open Sensor Platform (OSP) software simplifies the integration of sensor hubs into mobile devices and provides a consistent interface for sensors across processors and platforms. By open sourcing this software, community contributions can continue to develop and expand this framework. The host sensor sub-system basic requirements are met by the Application Support Framework, thereby freeing developers to focus on their unique software additions to sensor hubs.

Sensor Platforms will open source OSP under Apache License, Version 2.0, and will actively manage and incorporate community contributions.