# Hot tech at CES: Sensor hub solutions

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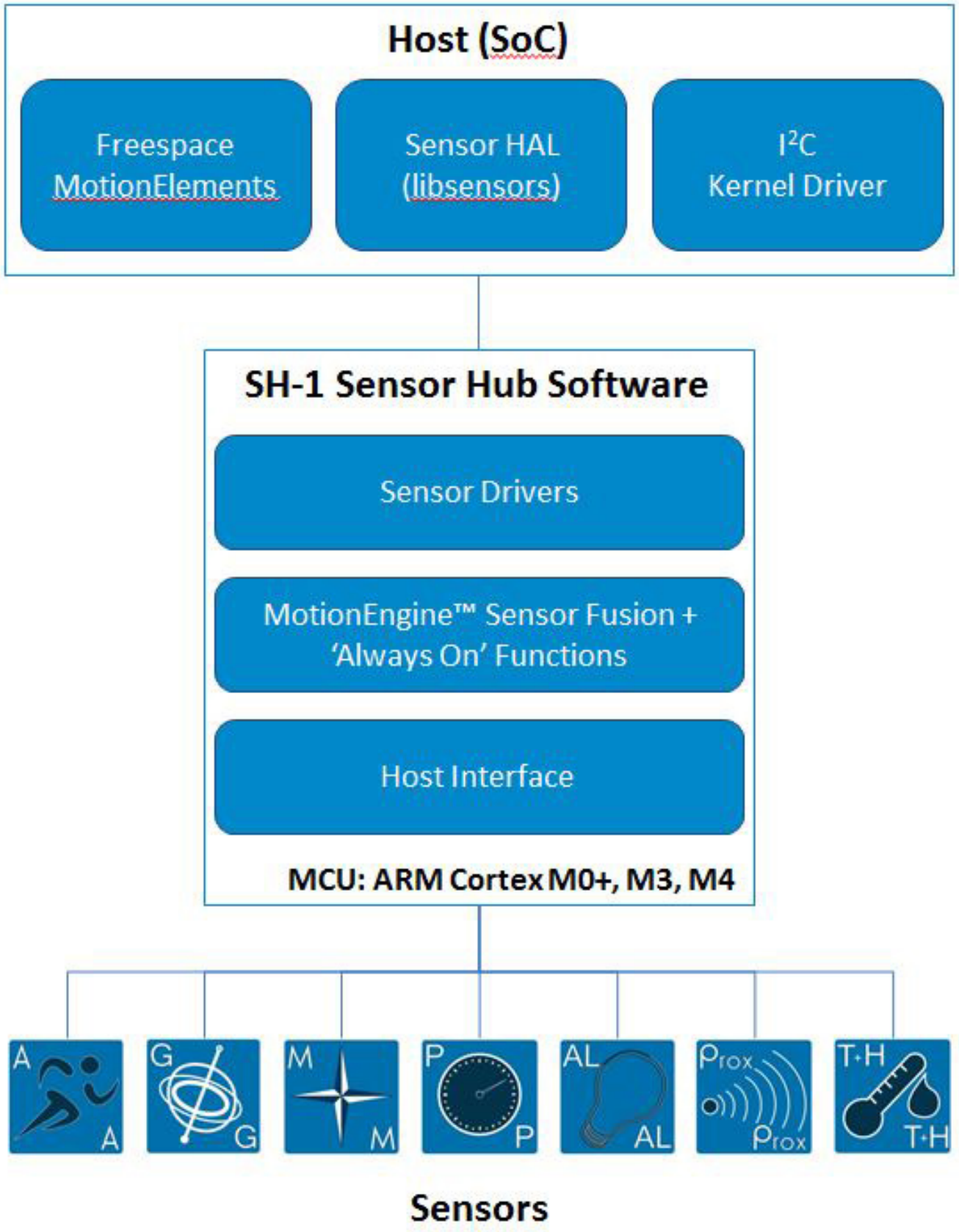
 Hillcrest Labs believes sensor hubs will be all the rage in consumer electronics this year and will be seen in mobile, wearable and Internet of things (IoT) devices. Let’s explore why.

The latest generation of smartphones uses sensor-based functionality such as motion gestures as key differentiating features. Wearable devices use sensors to enable the quantified-self movement. Endless other products from Smart TVs and robotic vacuum cleaners to bovine monitoring collars use sensors to enable new functionality in the technology. However, sensors need processing, and both sensors and processing need power to provide meaningful data. Power is at a premium in all of the devices mentioned above. That’s the driving force behind ‘sensor hubs’, a new architecture which will expand the way sensors are used by dramatically lowering how much power it takes to collect and process data from them.

‘Sensor hub’ is a term used to describe a low power microcontroller (MCU) which is dedicated to sensor management functions. Depending on the specific MCU chosen, the level of functions can be anything from basic sensor calibration and sensor fusion to advanced application-level data processing to support activity monitoring, context awareness and pedestrian navigation. The architecture was originally devised for smartphones, where hubs offload sensor management from the power-hungry application processor (AP). However, sensor hubs are also finding a home in wearable computing and IoT devices that desire sensor-based functionality without hefty power requirements.




Several low-power MCU cores have been used as the processor for hubs. The Atmel UC3 was used for a number of the early smartphone hubs (including the Galaxy Note II, Galaxy S4 and the Surface Pro), and more recently a number of ARM Cortex M0+ cores have been used. As hubs add more functionality and the M0+ lacks adequate processing resources, low powered ARM Cortex M4 cores are being looked

at. The MCUs can manage as many as ten different sensors, commonly including accelerometers, gyroscopes, magnetometers, pressure sensors, ambient light sensors, and temperature / humidity sensors.

The glue that holds the sensor hub together and the main value driver of the approach is the sensor hub software. The standard sensor hub software package includes sensor drivers, sensor calibration, sensor fusion, always-on activity monitoring, and the hub/host interface. Usually the hub will also have intelligent power management logic, using some basic context detection steps to determine what sensors need to be powered on and what rate they need to be sampled at. For example, a gyroscope can provide excellent tracking of rotational movement of the device, but consumes around 5µA of power when it is powered on. An accelerometer and magnetomer can provide more rudimentary tracking of the same movement, but consume less than 1µA combined when powered on. The context detection on the hub can intelligently detect the type and intensity of activity with the lower-powered sensors to determine whether or not to power up the gyroscope to improve performance at the cost of extra power. This kind of gated sensor activation can make sure sensor hubs remain a low power sensing solution.

So what to do with this low power sensing capability? In the last year, we've seen sensor hubs appear in a variety of the most popular mobile devices. Apple recently announced its M7 'motion coprocessor' sensor hub chip for the iPhone 5s, all Windows 8 phones provide built-in support for sensor hubs, and the Samsung Galaxy S4 and Motorola MotoX both integrate sensor hubs. The functions for these hubs can be broadly grouped into two categories: context awareness and gesture recognition.


Examples of this include a ‘crank’ gesture that MotoX users use as a shortcut to quickly open the camera app without having to power on, unlock, and launch the camera app. The iPhone 5s uses context awareness to detect steps and provide feedback on the number and intensity of steps taken during the day. The Samsung Galaxy hubs are also context aware--they detect whether the phone is in the user’s hand, pocket, on the table, in the car, etc., and then uses this data to change sound profiles, manage battery life, and make other context-appropriate changes. While today’s hubs implement sensor-based functionality in basic forms, sensor hubs will be able to add more functionality as the software and hardware mature and improve. Taking gestures as an example, advanced motion can make gesture recognition more accurate, easier to use, and allow for a greater range of gestures to be used. This could be used to enable an in-air signature to unlock your phone. This provides both added convenience of not having to look at or touch the screen, as well as the ultimate level of security through a self-defined, 3D motion pattern unique to the individual user. The phone needs to be ‘always listening’ for the unlock command, as having to fiddle with the screen defeats the convenience of the feature. And, accuracy is paramount. Without high performance tracking to make the detection consistent and repeatable, the password is either insecure or impossible to use. So a low power, high performance sensor hub is the only way to bring this feature to the mobile devices. The same gesture recognition functions could also allow for enhanced interaction with wearable devices, such as fitness tracking wristbands, which have minimal interfaces with which to access their data.

Consumer awareness of sensors and their potential applications is set to explode, starting at CES 2014. We'll see heavy marketing of sensor functionality by the smartphone OEMs, more health and fitness wearable products released for consumers and for the medical industry, and continued publicity around 'other' wearables such as the Google Glass head-mounted display. This will cause acceleration in both the use of sensor hubs and the demand for more advanced sensor hub functionality.


How quickly the sensor hub software evolves to meet the power, performance and functionality needs will be key to determining how quickly we live in a world of ubiquitous sensing. Here at Hillcrest we're excited to find out, and will be looking out for the latest sensor hub enabled products on display while at CES 2014.