GENERAL QUESTIONS

Q: What role can machine learning play in asset monitoring application?

Omdia: At the moment, most asset monitoring is based on "basic" threshold analytics and simple anomaly detection. This may help identify when an asset's performance moves outside of predetermined tolerances to give a real-time type alert. However, through improved analytics and ML, companies will be able to predict future events. For example, identifying degradation in an asset's health well in advance of its failure. This can help understand root causes to the issues, plan and direct maintenance activities as well as identifying and assessing the risk of failure of the asset.

Silicon Labs: Machine Learning can perform some of the data analysis on the edge, thereby reducing the number of data uploads from the asset monitoring device to the cloud. This can lead to significant battery life improvements for the device.

Q: What is the current trend in asset monitoring sensor implementation? Do we have targeted sensing for a single parameter or do the devices sense multiple parameters at a given time?

Omdia: This will be influenced by the application. Monitoring corrosion in a pipeline would best utilize oil analysis. In contrast, vibration sensing is commonly used and is a good early indicator in monitoring the health of motors and motor driven equipment. However, increasingly solutions are being used that fuse data from multiple parameters both directly related to the process (such as temperature or acoustics) as well as external factors (e.g., weather conditions), to better identify challenges as well as root causes of problems.

Silicon Labs: We have both categories of devices in market currently. Devices used for cargo sensing are predominantly capable of measuring multiple parameters, but targeted sensing is also performed for temperature, humidity, shock and tilt.

Q: What features exist in current products to maximize battery life?

Silicon Labs: MCU supports battery life estimation and monitoring capabilities that can allow the application to modify measurement and transmission intervals. The MCU also has different energy modes that one can leverage to maximize battery life.

Q: How are concerns with wireless, such as signal reliability and security, being addressed? What are the limitations and where are the opportunities?

e-peas: These concerns are not addressed by the PMIC (e-peas AEM devices).

Silicon Labs: Signal reliability is huge concern in industrial settings. Existing products use mesh networks and gateways to enable easy transfer of data from devices to cloud. But mesh networks drain the battery very quickly. Energy harvesting can help in this scenario. Security concerns are related to device commissioning, OTA updates, data storage and data transfers. There are many security features available to address these concerns.

Q: What is the range of the average power requirement?

e-peas: Average power can vary depending on the system. The e-peas device requires 50mV to 5V input. It takes 3 microwatts to cold start the device.

Silicon Labs: This varies from product to product. Asset monitoring sensors have different capabilities such as the type of wireless interface used, TX power of the device, number of IoT sensors used and measurement and transmission intervals. Battery capacity and energy harvesting requirements needs to be estimate with respect to the product in hand. This will determine the design of the PV cell and the energy harvesting solution itself.

Q: What is the range of vibration frequencies and amplitude of relevant Industrial machines?

e-peas: From DC to GHz. The Energy Harvesting circuit does not care. The key will be the front-end circuitry (including a rectifier) that needs to ensure the PMIC receives a DC voltage in.

Silicon Labs: For industrial machines, existing devices monitor the 10Hz to 1Khz range.

Q: What would you consider an industrial ‘asset’?

e-peas: Industrial Asset is a general term used to describe a machine or tool that is being monitored by a sensor.

Q: It is stated that MEMS vibration sensors cost a few hundred $ today. There are also $5 MEMS vibration sensors. Why do we need high end MEMS vibration sensors for IIOT?

e-peas: Vibration sensors can range in price from a few dollars to hundreds of dollars depending on the type, industrial rating, size, robustness, etc. Certain factory machines require the more expensive sensors, which relative to the machine cost and maintenance expenses, is well worth it.

Omdia: Algorithms are only as good as the data they're applied to and as such the quality of sensors for industrial is key. For manufacturing companies there's a significant cost that's associated to inaccurate data that could lead either to equipment failure, but equally to false alarms. Also, sensors deployed in the industrial environment may be exposed to vibration, extremes in temperature, dirty and possibly hazardous conditions. Both from the perspective of the longevity of the sensor as well as the quality of data companies shouldn't cut costs on sensor quality.

Silicon Labs: Cost of MEMS vibration sensors can be determined by their capabilities. This can include measurement frequency, range, accuracy, inclusion of ADC to digitize the sensor data, ASIC to perform some post processing of the data, etc.

Q: What is the best IoT protocol to use in harvesting energy supplied devices?

e-peas: The IOT protocol depends on many factors. The range (distance) to be covered, the amount of data to be transferred, the environment, etc. Energy Harvesting can be done with any of these protocols (it is radio agnostic).

Silicon Labs: Wireless protocol choice is determined by the use-case requirements. If the use-case requires engineers and technicians to monitor the data on a smart device, using BLE will be a straightforward thing to do. It allows easy data read, commissioning, OTA updates etc. If the use-case requires data analysis to be performed on the cloud and there is a gateway associated with the device, then BLE or Wi-Fi will be a promising protocol. If there is no gateway, cellular connection will be a good choice. Network congestion, cost to use the protocol, mesh requirements etc. may also influence the choice of protocol used.

Q: What is the cost of energy harvesting for heat, light and vibration?

e-peas: It can vary widely depending on the application, environment, and other constraints/requirements. It can be as low as a few dollars. But when considering TCO, energy harvesting will save money over time.

Q: How can we compare light versus RF energy harvesting? Does it make sense to have RF energy if we have light? Can you make a comment on when RF harvesting is better than light harvesting?

e-peas: Light is usually an easier / better energy source. If the sensor is exposed to light (even modest indoor lighting), it is typically the less expensive, more reliable option. However, if the location of the sensor does not have access to light, then RF would be a better choice.

Q: I don't understand how a small PV cell on a small device will supply enough power to operate a device like a gas detection. Do you have examples?

Dracula: The OPV module will not directly supply the load. It will first charge a storage element that will supply the load. Depending on your needs and the environment, the storage element can either be a SuperCap, a rechargeable battery, or a hybrid.

e-peas: It is all about the power budget. If the gas detection device has a large power requirement, then the energy harvesting circuit will require a larger energy source (harvester) and a larger Storage Element (rechargeable battery or SuperCap). There are many examples on the e-peas website.

Q: What is the current cost for energy harvesting and in 5 years down the line? And what is the reliability?

e-peas: The cost of an Energy Harvesting circuit can range from ~ $2.00 today to $20.00. It depends on the volume and the type of components selected. Some PV cells can be below $1.00 for high volume. SuperCaps can easily be below $0.50. The prices will drop over time, making Energy Harvesting more justifiable for all battery products. These are very reliable solutions.

Q: What is the wireless connectivity offered by Silicon Labs for containers tracking?

Silicon Labs: Silicon Labs offers BT, BLE, BLE mesh and Wi-Fi. If a customer wants to use a 2.4GHz band for asset monitoring, we also offer sub-gig and proprietary solutions as well.

Q: What is the life of a rechargeable battery?

e-peas: Rechargeable batteries have a lifetime range. It depends on the type selected, and the amount of charges/discharges. Often, they are specified for ~10 years.

Silicon Labs: Yes, rechargeable batteries also have a certain charge / discharge cycle. But with a good application software, one can still maximize the life of rechargeable batteries compared to existing products.

Q: LoraWan already provides 10% 2B years of battery lifetime. Many assets don‘t have lifetime beyond 10 years. What is additional TCO improvement with harvesting?

e-peas: LoraWan and battery life are independent of each other. You can have a LoraWan sensor transmit and receive once a day and last several years on a small battery. You could have the same LoraWan sensor transmit and receive every 5 minutes, in which case the battery will last months. TCO can be greatly affected by replacing batteries multiple times over the life of the sensor (and disposal of the batteries).

Q: Is there any data wireless node embed with the solar panel? Like how many times TX a packet?

Dracula: There is no wireless node embed with the OPV module however we demonstrated that we could power wireless sensor nodes with a small SuperCap or even without a storage element for some applications (ex: BLE --> 6pkt/s at 1000lux with our Demokit 6.

Silicon Labs: No. There is no such feature in existing products.

Q: Light is good if it is available. What can be done at night?

e-peas: With proper planning, and a properly sized storage element, you can easily run a fully autonomous (no battery) system 24/7, based only on light for the daytime hours.

Silicon Labs: The solution from Dracula works for indoor lighting as well. The Lux requirement for the PV cell is satisfied by most indoor lighting conditions.

Q: What do you think is the most future proof green rechargeable storage unit? Li-ion, supercapacitor or Lithium-Ion Capacitor?

e-peas: SuperCaps are the "greenest" future proof storage element today.

Silicon Labs: All of these options are great. There are many upcoming technologies as well. Its too early to comment about the storage element choice right now.

Q: How can we manage assets with energy harvesting with the ambient changes (moving assets)? Do we have any solution for that? Other than multi-ambient chips.

e-peas: Energy Harvesting is used on many moving objects today (especially asset tracking type products). With proper planning, including an assessment of the environment over a 24-hour period, the proper ambient source can be selected. This can be light (PV cell), thermal, vibration, or RF.

Q: Do you see a specific energy harvesting technology leading in I-IOT? Light, vibration....

Dracula: From Dracula Technologies point of view, light/sun remain the main technology used in the Energy Harvesting market. The novelty being that OPV technology performs better for indoor applications. Light is the most tangible energy.

e-peas: Light is the most popular. But many IIOT products do not have access to light and must consider other sources. IIOT products often have access to temp variations (Thermal) or vibration (Electromechanical).

Omdia: The technology will be led by the application. Rotating equipment can provide a good source of vibration whilst outdoor applications are able to leverage light sources. As mentioned by Dracula Technologies new developments are supporting harvesting in lower light conditions,

e.g., indoor. Similarly, in building automation, some light switches are powered by the kinetic energy generated from the switch. Use what's most readily available.

Silicon Labs: Light, thermal and vibration are going to dominate the energy harvesting implementation.

Q: I am working in the IOT field, developed many nodes and gateways. What should I do to enter the IIOT field?

Silicon Labs: Having domain specific knowledge will be a good starting point.