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1) Briefly discuss the pushing factors of the emerging technologies in Embedded System and the issues behind it with examples in order to illustrate your answer.

a) Embedded IoT with Edge Computing

Edge computing has been around for many years especially in today's applications which require huge amounts of data to be quickly and reliably processed in a secure way, arising the need for more computing, storage and analytics capabilities at the edge. More powerful and intelligent devices mean more value extrapolated from data, more efficient operations and cost-effective business decisions for organizations.

Some of the factors that are pushing embedded IoT system with edge computing into the mainstream are:

- **The Internet of Things (IoT)** – Analysts estimate that by 2020 more than 5.6 billion IoT devices owned and operated in enterprise and government environments will utilize edge computing for data collection. That represents significant growth over 1.6 billion devices in 2017. While most information will be uploaded and processed via the cloud, some business-critical applications will demand real-time data which requires the use of a physical or virtual computing infrastructure on the edge of the network to minimize the bandwidth needed to access data that is centrally stored.

For example, spatial computing technologies use IoT sensors which could transmit the data to the cloud in real-time. In this technology, the ambient light sensor and proximity sensor are used in a room. This is to detect if there is any user pass through or stay inside the room. If one or more users are detected, the system will receive the information as an input and therefore send to the controller. The controller will decide to light up the light inside the room based on the number of persons inside the room or through thermal imaging process and determine the brightness of the light to light up. Using voice assistant to make a system as edge computing, such as Amazon Echo, Google Home, and Apple Siri, among others, are pushing the boundaries of AI which

requires advanced AI processing and low-latency response time to deliver effective interactions with end-users.

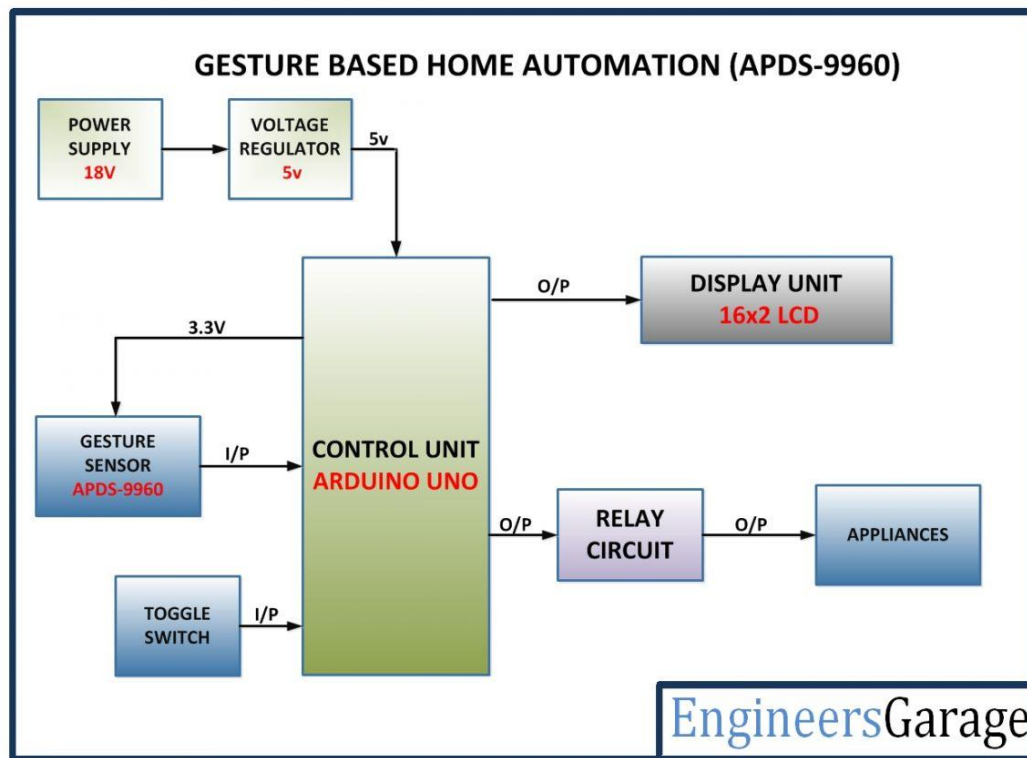


Figure 1 Block diagram of Google Home

- **Real-time business decisions** – More industries are using the technology to leverage real-time data to drive better decisions. The emerging technology is now helping to revolutionize industries in need of innovation, such as manufacturing, transportation, energy, food and beverage, and waste management.

For example, in manufacturing industry, IoT sensors can monitor machine health and identify signs of time-sensitive maintenance issues in real-time. The data is analysed on the manufacturing premises and analytics results are uploaded to centralized cloud data centers for reporting or further analysis.

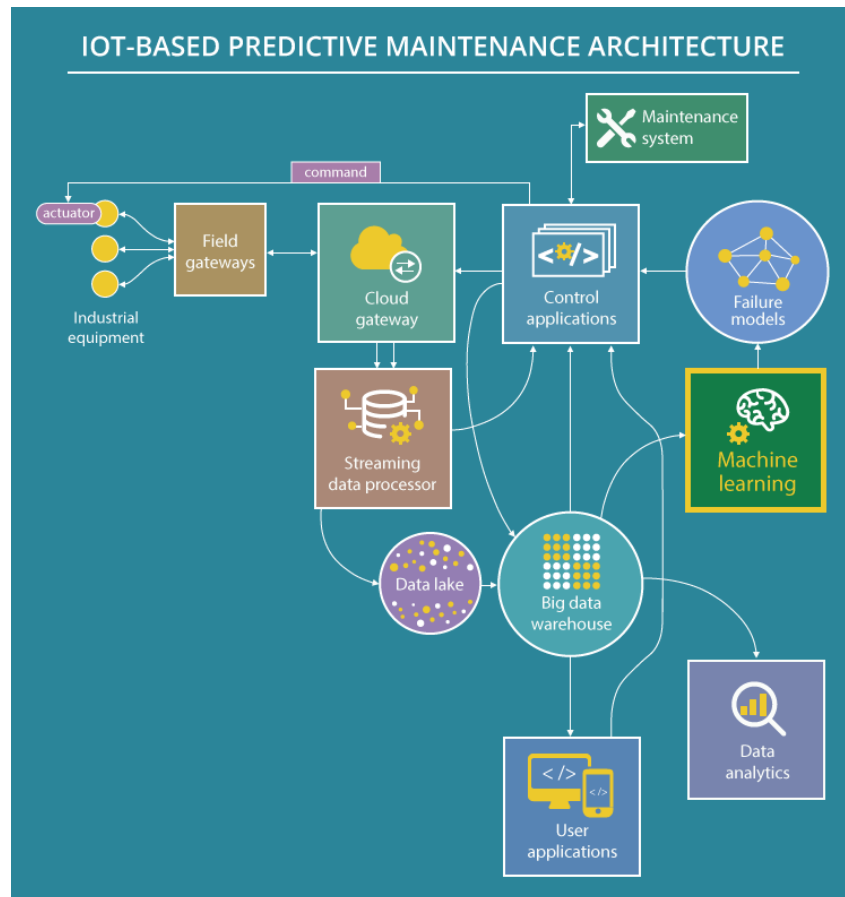


Figure 2 Architecture of IoT-based Machine for Maintenance Prediction

- Improved security and compliance** – Edge computing alleviate the risk by making much of that data transfer avoidable in some environments. With edge computing it is possible to filter sensitive information locally and only transfer data important to model-building information to the cloud. This means enterprises can build an adequate security and compliance framework that meets their needs and ensures compliance with audits.

For example, autonomous driving technologies replace human drivers, hence cars must be capable of reacting to road incidents in real-time. On average, it may take 100 milliseconds for data transmission between vehicle sensors and backend cloud data centers. In terms of driving decisions, this delay can have significant impact on the reaction of self-driving vehicles. Therefore, AI will further facilitate intelligent decision-making capabilities in real-time, allowing cars to react faster than humans in response to abrupt changes in traffic flows.

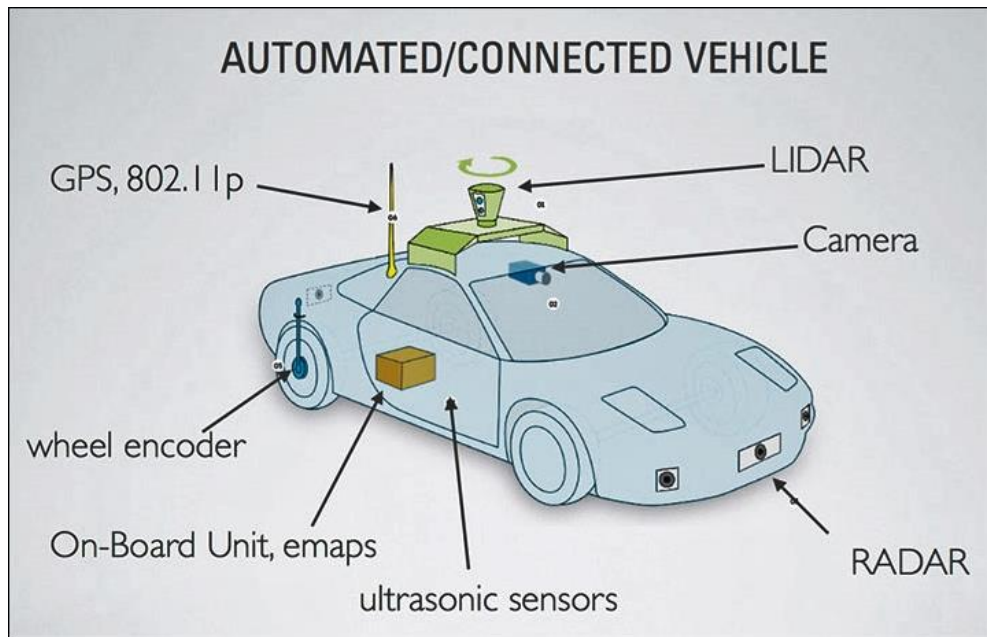


Figure 3 Simple view of sensors used on autonomous vehicles

- Closing modernization gaps** – IoT and edge computing are driving the next wave of data center modernization and improvement. Virtualization represents an affordable means of updating and innovating IT environments and addressing immediate needs with cutting-edge technology with our breaking the bank. Edge computing enables enterprises to capitalize on modern devices which allows legacy industrial environments to connect to modern devices or IoT solutions and provides immediate benefits of capturing and integrating real-time data from both legacy systems and modern devices for better decisions.

For example, in health care industry, bio-medical devices tech is being applied into wide variety of analytical problems including medicine, surgery and drug discovery. These devices are portable diagnostic imaging and home monitoring such as cholesterol monitors, blood glucose meters. With recent innovations paving way for miniaturization of devices, AI plays a role with more advancement of sensors, computing, communication technologies by using modern devices to provide immediate benefits or information in real-time data. Therefore, the information can be accessed by the authorization person to monitor the progress in faster way.

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