arm Education

Embedded Systems Essentials with Arm: Getting Started

Module 1

KV3 (1): Introduction to the Internet of Things (IoT)

The Internet of Things or IoT is a special application of embedded systems. A physical device is equipped with a microcontroller, sensors and communication interface, enabling it to connect with its environment and network with the whole world.

The overarching goal of IoT is that everything should be able to communicate with everything: washing machines with buildings, fridges with supermarkets, personal schedules with traffic management systems. This is a form of ubiquitous computing, meaning, that computing is everywhere – not just in our desktop computers. The goal of the IoT and ubiquitous computing is to make daily life more efficient, and make better use of global resources.

Because virtually any device could have an embedded processor, IoT presents many opportunities for the growth of embedded systems. These can be loosely grouped into 3 main areas: industrial, consumer, and wearable.

The IoT is driven by vast technical development in embedded chips. With smaller packages of embedded systems and more efficient production, prices can drop, allowing the number of applications and systems to increase. Consequently, production becomes more efficient, prices drop further, and units increase. This cycle promotes new opportunities for innovation. For example, smaller chip systems consume less power, creating possibilities for new applications.

The number of IoT devices has already surpassed the human population, and huge growth is predicted for the future: according to various researchers, by 2030 the total number of connected devices may reach more than 125 billion. Arm estimates that by 2035, the total number of connected devices will reach 1 trillion.

However, there are many challenges to overcome before we can live in an IoT world.

For example, as more and smaller devices require chips, chip manufacturing prices need to continue to go down. Chips need to become smaller. Programmers have to work within of the resource constraints of embedded devices.

As the number of Internet-connected devices grows, scalability issues must also be addressed and the pool of numbers that can be assigned is limited. IPv6 could address this problem, though not all devices have sufficient resources to run an IPv6 protocol stack.

Alongside device constraints, data centers and servers must adapt to cope with the huge amounts of data being sent back from these devices. They need to be able to store the data and process it. The underlying network to connect devices to the Internet must be reliable. Cloud services must be able to handle large data volumes, process it and make decision based on in real-time. All of this calls for more computing power.

Even with this infrastructure, devices may not be able to communicate. Right now, we have lots of smart devices around us, but most of them do not speak to each other. This situation is referred to as ‘Silos of Things’. Various technologies are currently being developed to enable devices to talk to each other and exchange data.

This raises questions of safety and security. Guidelines to ensure user and data safety, which include tamper resistance, data encryption, accompanying network protocols, and legally-binding regulations must also evolve, not only for functionality, but also so users trust these devices

Users are also concerned with battery life and efficiency. Power consumption might decrease as chips become smaller, but battery and charging technologies still have to advance in order to extend battery life and reliably ensure long operating periods.

There are also human constraints. Product designers must consider the socio-technical and demographic aspects of the users they're designing systems for. What are the barriers to user adoption or 'buy-in', and how can they be resolved?