Chapter 4

Real-World Design Constraints

4.1 Devices and Networks:

- The devices that form networks in the M2M Area Network domain must be selected, or designed, with certain functionality suitable to IoT applications.
- The devices must have an energy source (e.g. batteries), computational capability (e.g. an MCU), appropriate communications interface (e.g. a Radio Frequency Integrated Circuit (RFIC) and front end RF circuitry), memory (program and data), and sensing (and/or actuation) capability.
- These must be integrated in such a way that the functional requirements of the desired application can be satisfied with additional nonfunctional requirements.

4.1.1 Functional Requirements:

1. Specific sensing and actuating capabilities

2. Sensing principle and data requirements: Sometimes continuous sampling of sensing data is required. For some applications, sampling after specific intervals is required.

3. The parameters like higher network throughput, data loss, energy use, etc are decided based on sensing principle.

4.1.2 Sensing and communications field:

- The sensing field is to be considered for sensing in local area or distributed sensing. The distance between sensing points is also important factor to be considered.
- The physical environment has an implication on the communications technologies selected and the reliability of the system in operation thereafter.
- Devices must be placed in close enough proximity to communicate. Where the distance is too great, routing devices may be necessary.

4.1.3 Programming and embedded intelligence:

- Devices in the IoT are heterogeneous such as various computational architectures, including MCUs (8-, 16-,32-bit, ARM, 8051, RISC, Intel, etc.), signal conditioning (e.g. ADC), and memory (ROM, S/F/D) RAM, etc.), communications media, peripheral components (sensors, actuators, buttons, screens, LEDs), etc.
- In every case, an application programmer must consider the hardware selected or designed, and its capabilities.
- Application-level logic decides the sampling rate of the sensor, the local processing performed on sensor readings, the transmission schedule (or reporting rate), and the management of the communications protocol stack, among other things.
- The programmers have to reconfigure and reprogram devices in case of change in devices in IoT application.

4.1.4 Power:

- Power is essential for any embedded or IoT device.
- Depending on the application, power may be provided by the mains, batteries, or hybrid power sources.
- Power requirements of the application are modeled prior to deployment. This allows the designer to estimate the cost of maintenance over time.

4.1.4 Gateway:

- Gateway devices or proxies are selected according to need of data transitions.

4.1.5 Nonfunctional requirements:

The non-functional requirements are technical and non-technical.

1. Regulations:
   - For applications that require placing nodes in public places, prior permissions are important.
   - Radio Frequency (RF) regulations limit the power with which transmitters can broadcast.
2. Ease of use, installation, maintenance, accessibility:
   - This relates to positioning, placement, site surveying, programming, and physical accessibility of devices for maintenance purposes.
3. Physical constraints:
   - Integration of additional electronics into existing system
   - Suitable packaging
   - Kind and size of antenna
   - Type of power supply

4.1.6 Financial cost:

Financial cost considerations are as follows:

- Component Selection: Typically, the use of these devices in the M2M Area Network domain is to reduce the overall cost burden. However, there are research and development costs likely to be incurred for each individual application in the IoT that requires device development or integration. Developing devices in small quantities is expensive.
- Integrated Device Design: Once the energy, sensors, actuators, computation, memory, power, connectivity, physical, and other functional and nonfunctional requirements are considered, it is likely that an integrated device must be produced.

4.1.7 Data representation and visualization:

Each IoT application has an optimal visual representation of the data and the system. Data that is generated from heterogeneous systems has heterogeneous visualization requirements. There are currently no satisfactory standard data representation and storage methods that satisfy all of the potential IoT applications.