INTRODUCTION TO EMBEDDED SYSTEMS

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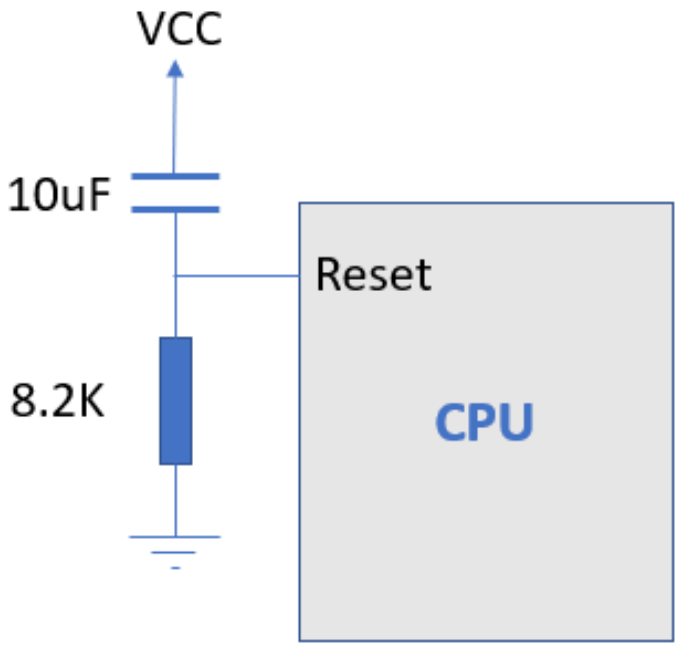
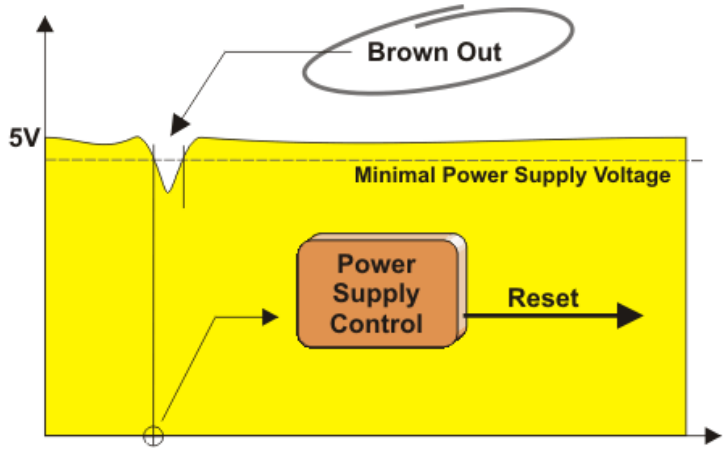
OTHER SYSTEM COMPONENTS

- **Reset Circuit**
  - To ensure the device is not operating at a voltage level where the device is not guaranteed to operate, during system power ON
  - Reset signal brings the internal registers and the different hardware systems of the processor to a known state and starts the firmware execution from the reset vector
  - Reset signal can be either active high or active low
  - Some microprocessors/controllers contain built-in internal reset circuitry



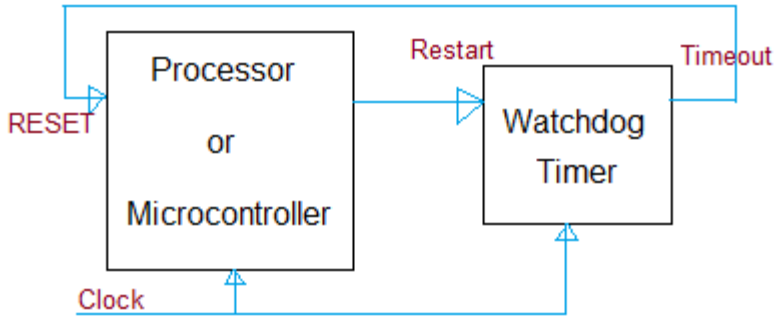
OTHER SYSTEM COMPONENTS

- **Brown–out Protection Circuit**
  - It prevents the processor from unexpected program execution behaviour when the supply voltage to the processor falls below a specified voltage
  - Processor behaviour may not be predictable if the supply voltage falls below the recommended operating voltage
  - A brown–out protection circuit holds the processor in reset state, when the operating voltage falls below the threshold until it rises above the threshold voltage
  - Certain processors support built in brown–out protection circuit which monitors the supply voltage internally



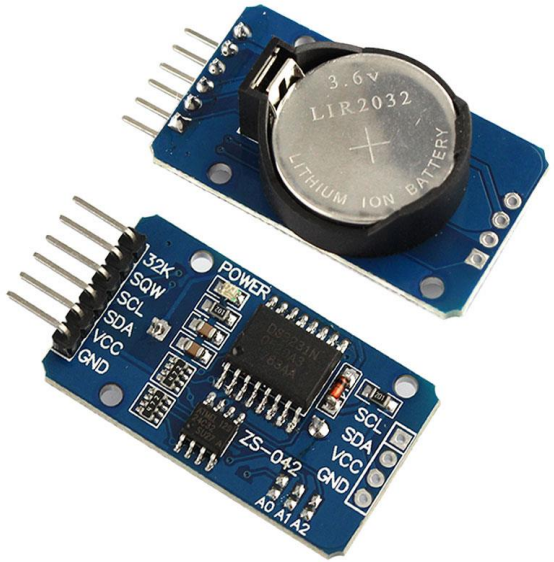
OTHER SYSTEM COMPONENTS

- **Watchdog Timer**
  - Hardware timer for monitoring the firmware execution
  - Increments or decrements a free running counter with each clock pulse
  - It generates a reset signal to reset the processor if the count reaches zero for a down counting watchdog, or the highest count value for an upcounting watchdog
  - If the firmware execution doesn't complete due to malfunctioning, within the time required by the watchdog to reach the maximum count, the counter will generate a reset pulse and this will reset the processor



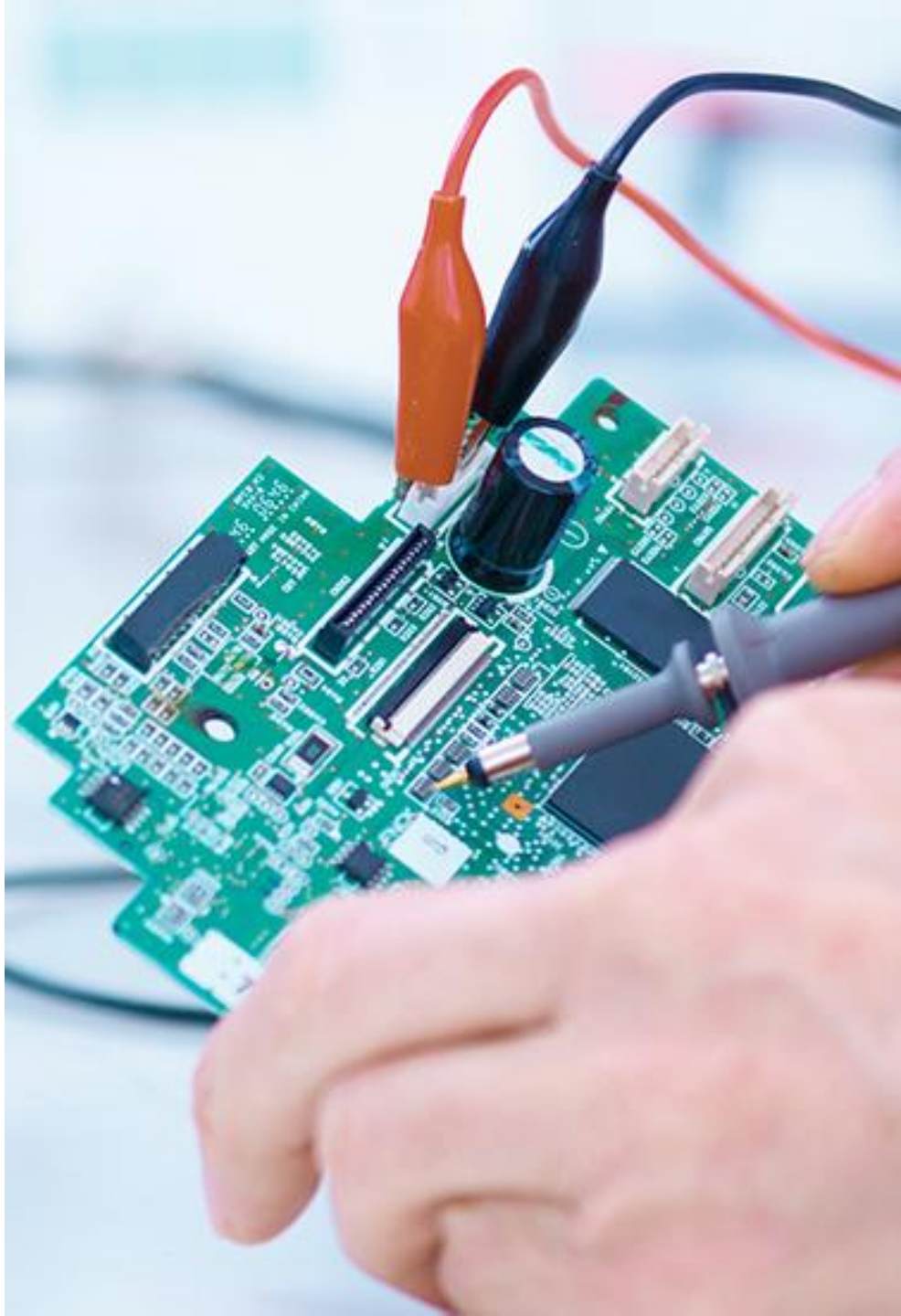
OTHER SYSTEM COMPONENTS

- **Real Time Clock (RTC)**
  - RTC holds information like current time (In hours, minutes and seconds) in 12 hour / 24 hour format, date, month, year, day of the week, etc.
  - RTC chip contains a microchip for holding the time and date related information and backup battery cell for functioning in the absence of power, in a single IC package
  - RTC can interrupt processor to perform necessary operations like system date time updation, managing software timers etc. when an RTC timer tick interrupt occurs.
  - RTC can be configured to interrupt the processor at predefined intervals or to interrupt the processor when the RTC register reaches a specified value (used as alarm interrupt)



CHARACTERISTICS OF EMBEDDED SYSTEMS

- Application and domain Specific
- Reactive and Real time
- Operates in harsh Environments
- Distributed
- Small size and Weight
- Power concerns

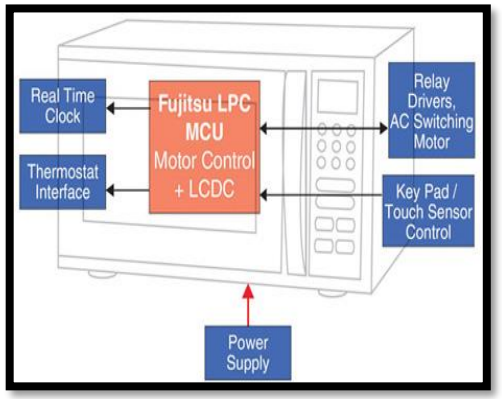


Application and domain Specific

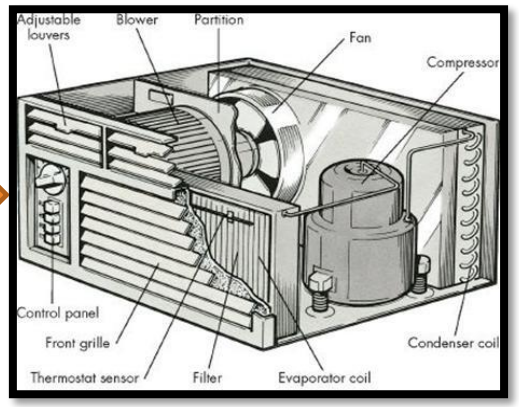
Developed in such a manner to do the intended functions only.

Specifically designed to perform certain specific tasks

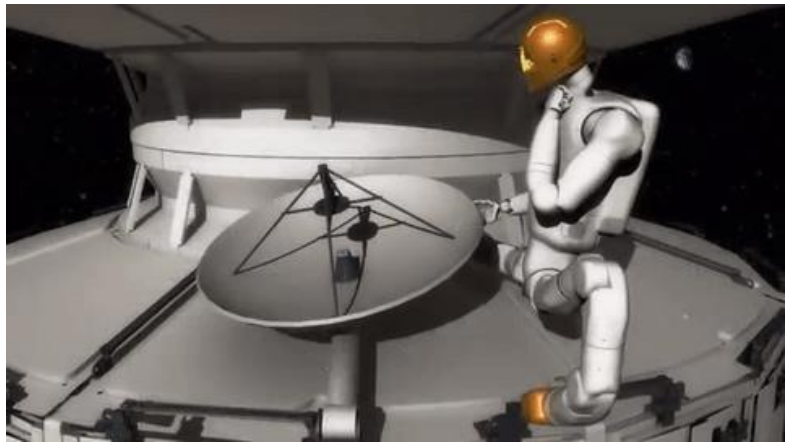
Control unit developed for a particular application/domain cannot be replaced with another control unit designed to serve another application /domain



Embedded control unit of Microwave oven



Embedded control unit of Air conditioner



Reactive and Real time

Reactive Systems are those Embedded systems which produce changes in output in response to the changes in the input

Timing constraint play a critical role in their design and implementation

Types of Real-Time Systems

Hard Real-Time System

Soft Real-Time System

Operates in harsh Environments

- Do not operate in a controlled environment.
- Need for protection from vibration, shock, lightning, power supply fluctuations, water, corrosion, fire, and general physical abuse
- Capable to withstand all adverse operating conditions.
- Design should take care of the operating conditions of the area where the system is going to implement

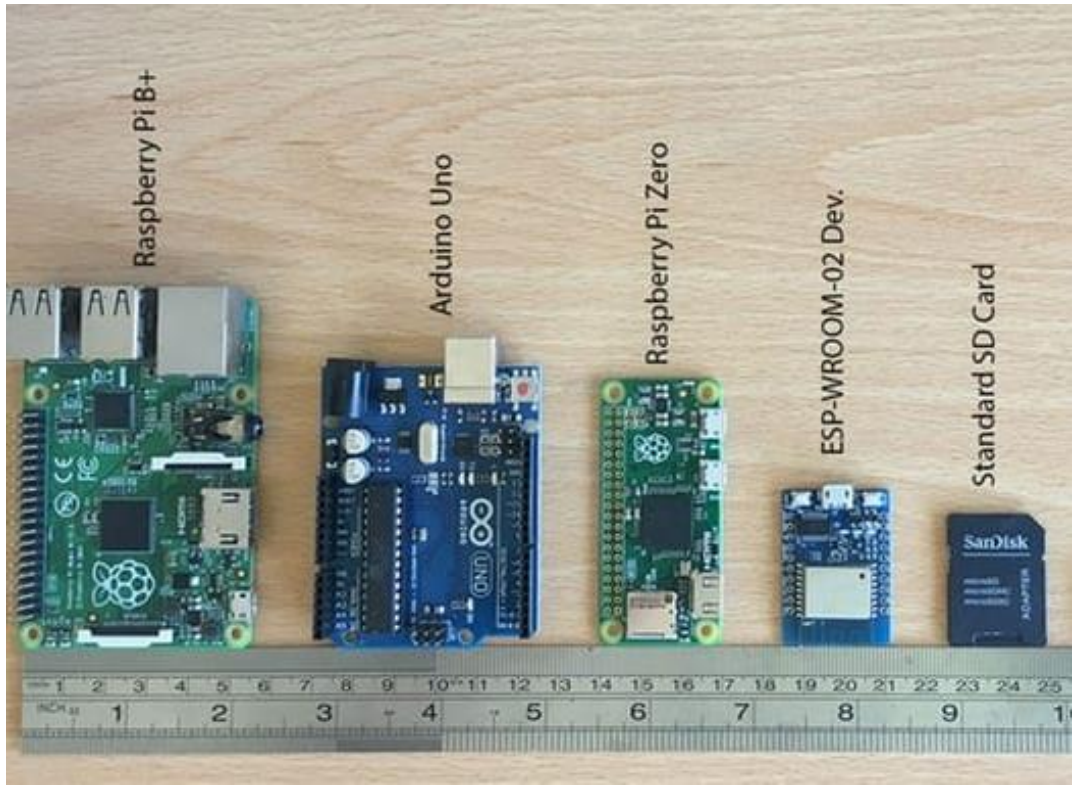
Distributed

"Distributed" means that embedded systems maybe a part of larger system

Many number of such distributed embedded systems form a single large Embedded Control Unit

Each of the components are independent of each other but they work together to achieve a common goal

Small size and Weight



- Product aesthetics
- Compactness is a significant deciding factor.
- Applications demands small size and low weight products.
- Small size and low weight systems are portable

POWER CONCERNS

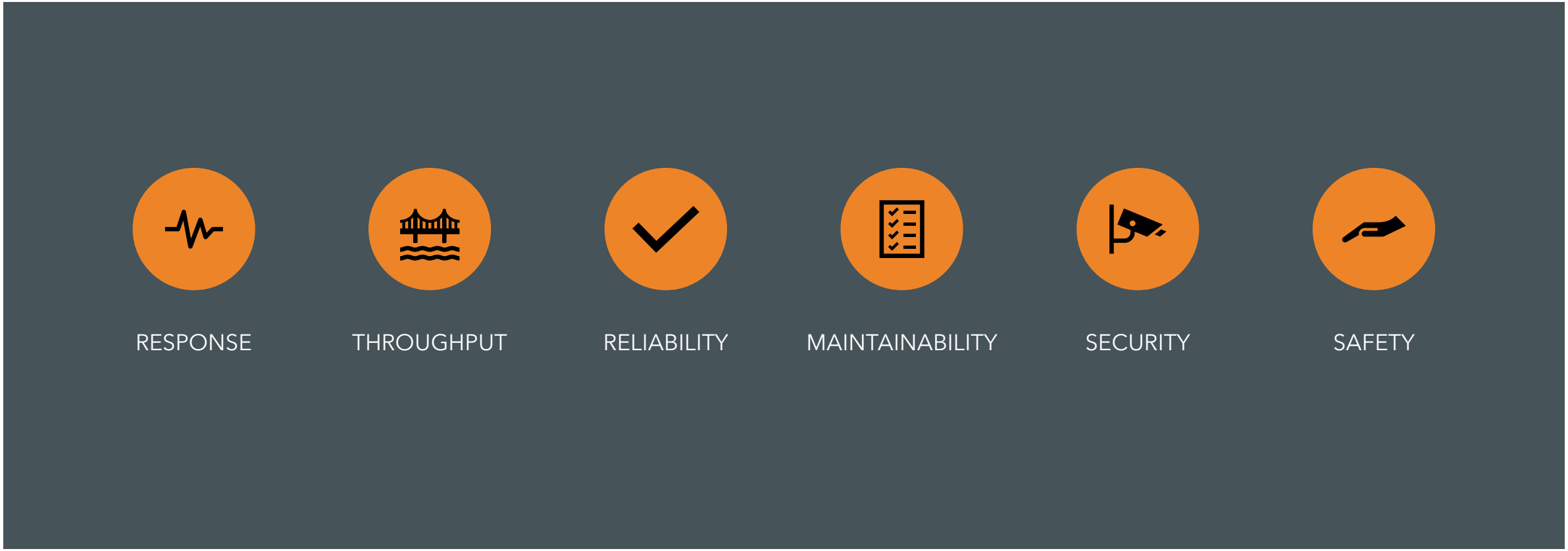
- Minimize the power consumption factor
- Minimizes the heat dissipation by the system
- High amount of heat will require cooling fans which in turn will make the system bulky
- More the power consumption the less the battery life

QUALITY ATTRIBUTES

Quality attributes are system properties that describe how services are performed

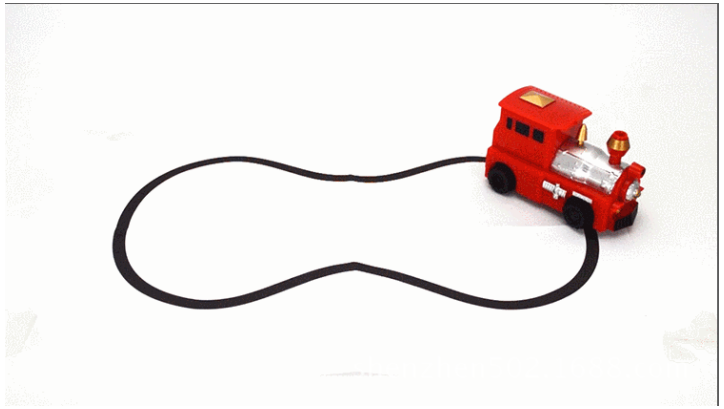
Quality Attributes are broadly classified into two:

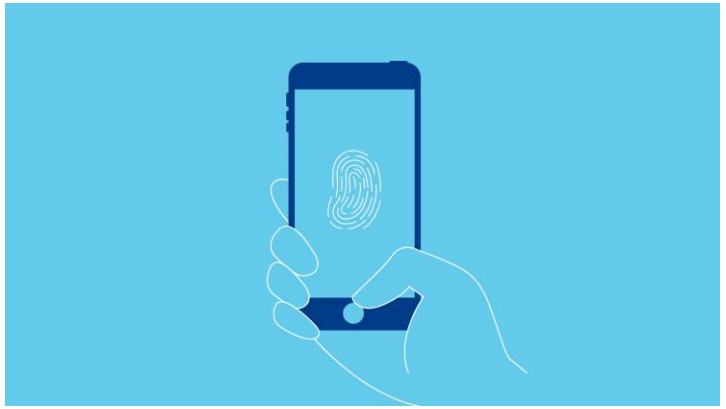
- **Operational Quality Attributes**
- **Non-Operational Quality Attributes**



OPERATIONAL QUALITY ATTRIBUTES

RESPONSE

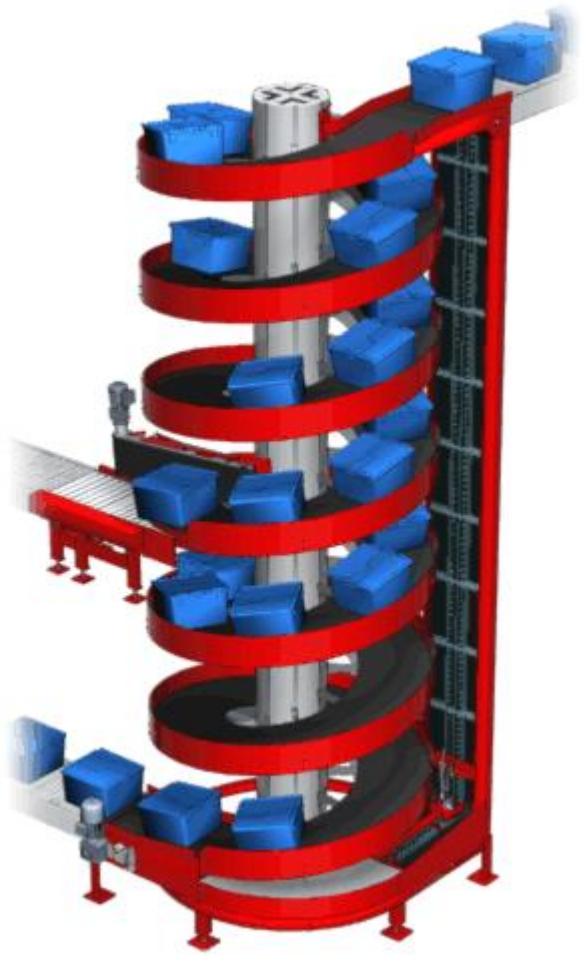




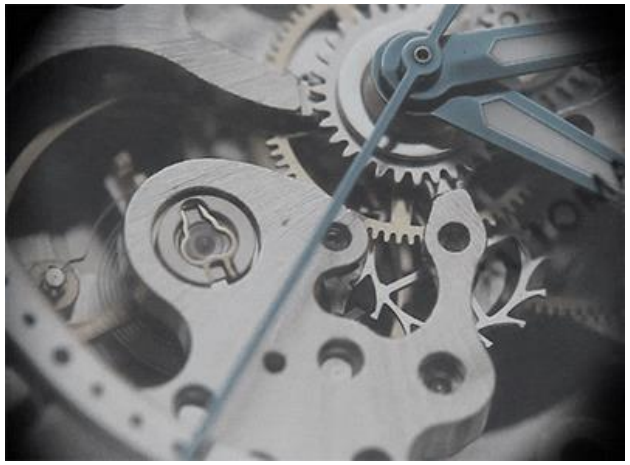
- Measure of quickness of the system
- Tracking the changes in input variables
- Most of the embedded systems demand fast response which should be almost Real Time

THROUGHPUT

- Rate of production or operation of a defined process over a stated period of time
- **Benchmark** is a reference point by which something can be measured



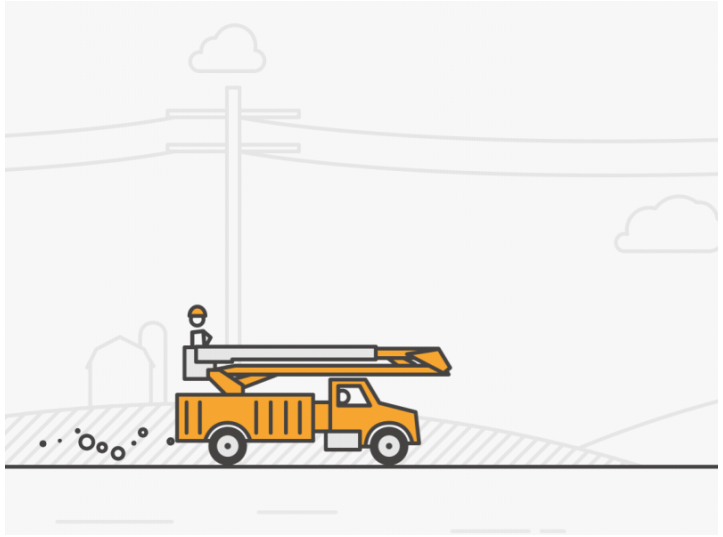
RELIABILITY



- Reliability is a measure of how much you can rely upon the proper functioning of the system
- Susceptibility of the system to failures
- Terms are used to define system Reliability
  - Mean Time Between Failure (MTBF)
  - Mean Time To Repair (MTTR)

MAINTAINABILITY

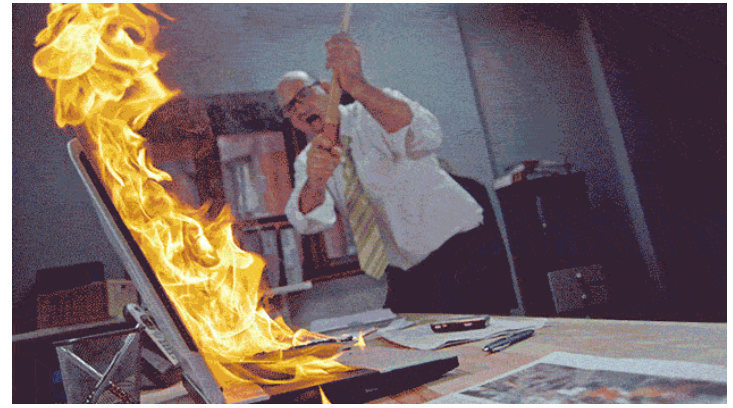
- Maintainability means maintaining the system in good condition by checking or repairing it regularly
- As the reliability of the system increases, the chances of failure and non–functioning also reduces, thereby the need for maintainability is also reduced
- Maintainability can be broadly classified into two categories, namely:
  - Scheduled or Periodic Maintenance (Preventive Maintenance)
  - Maintenance to unexpected Failures. (Corrective Maintenance)



SECURITY

- Confidentiality
- Integrity
- Availability

SAFETY



- Safety deals with the possible damages that can happen to the operators, public & environment due the break-down of the embedded system.
- Break-down can happen due to:

  Hardware failure

  Firmware failure