

Requirements and Specification, ESOF 328, Spring 2021
Embedded and other real-time system projects, Chapter 26, March 22nd

Embedded systems and other real-time systems often include:

- Sensors
- Controllers
- Motors
- Power supplies
- Integrated circuits
- Other mechanical and electrical devices

Real-time system can be hard or soft:

Hard – rigid time constraints

Soft – have time constraints but the timing isn't so rigid

More constraints with hardware:

- Physical component sizes
- Electrical components
- Connectors
- Voltages
- Communication protocols
- Sequences in which operations must occur

Architecture and design choices are more tightly linked with requirements analysis than in software-only systems. Constraints and quality attributes need increased considerations and are often interwoven with the operating system. Careful consideration of many interfaces is needed.

SRS – Software Requirements Specification

SyRS – System Requirements Specification

System architecture:

- Components – sw, hw or a person
- Externally visible properties of the components
- Connections (interfaces) between system components (this section can make these documents much large)

Poor decisions can result in:

- The software is expected to perform functions that would have been better performed in hardware (or vice-versa)
- A person being expected to perform functions that would have been easier or cheaper for hardware or software to perform (or vice-versa)
- Inadequate performance
- The inability to easily upgrade or replace components

Modeling real-time systems

Context diagram
State transition diagram
Event-response table
Architecture diagram

Still need:

Functional requirements
Business rules
Prototypes

Prototype:

- Test operational concepts
- Explore both requirements and design options
- Better understand user interface displays and controls
- Explore network interactions
- Hardware-software interfaces

Interfaces

Timing Requirements

Multiple dimensions to timing requirements:

- Execution time – elapsed time from when task is initiated to when it completes
- Latency – time lag between when a trigger event occurs and when the system begins to respond to it
- Predictability – repeated, consistent timing of a reoccurring event (even if not fast, you'd like it to be predictable)

Issues to explore regarding the timing and scheduling requirements:

- Periodicity (frequency) of execution of the tasks and their tolerances
- Deadlines and tolerances for execution of each task
- Typical and worst-case execution time for each task
- Consequences of missing a deadline
- Minimum, average, and maximum arrival rate of data in each relevant component state
- Maximum time before the first input or output is expected after a task initiates
- What to do if data is not received within the maximum time before the expected first input (time out)
- Sequence in which tasks must run
- Tasks that must begin or end execution prior to other tasks beginning
- Task prioritization, so you know which tasks can interrupt or preempt others, and on what basis
- Functions that depend on what mode the system is in (normal mode versus firefighter service mode for an elevator, for example)

Quality Attributes

Quality attributes are typically more important than for information systems where there is less variation in the environment. With real-time and embedded systems there are be variability in:

- Temperature extremes
- Vibration
- Shock

Performance must satisfy the timing needs and constraints but also

- Includes startup and reset times
- Power consumption
- Battery life
- Battery recharge time (as with electric automobiles)
- Heat dissipation
- Many other questions

Efficiency – consumption of resources including processor capacity, memory, disk space, communication channels, electrical power and network bandwidth.

Reliability – some systems (medical devices and airplane avionics) have stringent reliability and availability requirements.

Robustness

Security

Usability

Other quality attributes

- Size
- Shape
- Weight
- Material
- Flammability
- Connectors,
- Durability
- Cost
- Noise levels
- strength