Real-time Systems

A software system where time is of the essence. There are timing constraints that must be met or the system has failed.

- There are three types of real-time constraints:
  - Hard real-time constraints - a specific time schedule must be met.
  - Soft real-time constraints - a specific time schedule is desirable, but not required.
  - Firm real-time constraints - a specific time schedule is desirable and the acceptable miss rate or magnitude is limited.
• Typically, design parameters specify the response properties of a real-time system for each and every event.
• E. / D. / Jensen has suggested a continuum method known as the *benefit accrual method* that schedules based on the benefit to the system of each task rather than time constraints.
System Architecture

![Diagram of System Architecture]

- Processor
- Software
- Interface Hardware

Hard Constraint ↔ Processor

Firm Constraint

Soft Constraint
Software Architecture

- Not like general-purpose computing architecture.
- Response to events (external and internal) is critical.
- The primary components are the scheduler and event handlers.
Example Architecture

External Events

Scheduler

- Idle Task
- Work Task

Event Handler

- Event Handler
Scheduler Code

Let $t$ be the task with the highest priority in the queue.

If $t$ is a higher priority than the current task, $T$,
context-switch $t$ and $T$. 

Typical Handler Code

Harvest event data and store.
If necessary, start the scheduler.
Typical Task Code

Fetch data if necessary.
Do any necessary calculations.
Start output processes if any.
Start the scheduler.
A Weather Station Example

- Display the current wind speed at 150 ms intervals.
- Display maximum wind speed at 150 ms intervals.
- Use a button to determine which to display.
- Indicate maximum wind speed display with light.
- Have a button to reset the maximum wind speed.
- Display the wind direction (8 dirs) every 110 ms.
- Flash a light every 30 ms to show system health.
- If wind speed is zero, show the zero wind speed light.
Diagram of Weather Station System

Diagram showing connections and components:
- 68HC11 microcontroller
- PORT B
- PORT D
- PORT E
- STAF
- 8 Seg
- One-shot
- Anemometer
- Wind Vane
- Flashing Light
- Reset Highest Wind Speed
- Display Highest Wind Speed
- No Wind Light
- Highest Wind Speed
- Switch

Connections:
- PORT B to PORT E
- STAF to PORT C
- 8 Seg to PORT C
- One-shot to PORT C
- Anemometer to PORT C
- Wind Vane to PORT E
- Flashing Light to PORT E
- Reset Highest Wind Speed to PORT E
- Display Highest Wind Speed to PORT E
- No Wind Light to PORT E
- Highest Wind Speed to PORT E
- Switch to PORT E