CT420

Real-Time Systems

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1 Introduction

1.1 Lecturer Contact Information

- Name: Dr. Michael Schukat.
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1.2 Assessment

- 2 hours of face-to-face & virtual labs per week from Week 03.
- 30% Continuous Assessment:
  - 2 assignments, 10% each.
  - 2 in-class quizzes between Week 07 & Week 12, worth 5%.

1.3 Introduction to Real-Time Systems

A system is said to be **real-time** if the total correctness of an operation depends not only upon its logical correctness but also upon the time in which it is performed. Contrast functional requirements (logical correctness) versus non-functional requirements (time constraints). There are two main categorisation factors:

- **Criticality:**
  - **Hard RTS:** deadlines (responsiveness) is critical. Failure to meet these have severe to catastrophic consequences (e.g., injury, damage, death).
  - **Soft RTS:** deadlines are less critical, in many cases significant tolerance can be permitted.
- **Speed**
  - **Fast RTS:** responses in microseconds to hundreds of microseconds.
  - **Slow RTS:** responses in the range of seconds to days.

A **safety-critical system (SCS)** or life-critical system is a system whose failure or malfunction may result in death or serious injury to people, loss of equipment / property or severe damage, & environmental harm.

2 The Essence of Time: From Measurement to Navigation & Beyond

Time is the continued sequence of existence & events that occurs in an apparently irreversible succession from past, through the present, into the future. Methods of temporal measurement, or chronometry, take two distinct forms:

- The **calendar**, a mathematical tool for organising intervals of term;
- The **clock**, a physical mechanism that counts the passage of time.

Global (maritime) exploration requires exact maritime navigation, i.e., longitude & latitude calculation. **Latitude** (north-south) orientation is straightforward; **longitude** (east-west orientation) requires a robust (maritime) clock.

Ground-based navigation systems like LORAN (LOng RAnge Navigation) were developed in the 1940s and were in use until recently, and required fixed terrestrial longwave radio transmitters, and receivers on-board of ships & planes. They are also referred to as hyperbolic navigation or multilateration. The principles of ground-based navigation systems is as follows:

1. A **master** with a known location broadcasts a radio pulse.
2. Multiple **slave** stations with a known distance from the master send their own pulse, upon receiving the master pulse.
3. A **receiver** receives master & slave pulses and measures the delay between them.
4. This allows the receiver to deduce the distance to each of the stations, providing a fix.