Overview

- Elevator Controller
- HP Plotter
- Bluetooth Baseband Controller

Part of Chapter 8 (Section 8.7) of Text by Wolf
Elevator Systems

CRC cards is a well-known method for analyzing a system and developing an architecture.

**CRC**
- Classes
- Responsibilities
- Collaborators

**Elevator Control Classes**
- Elevator car, Passenger, Floor control, Car control, Car sensors, etc.

**Architectural Classes**
- Car state, Floor control reader, Car control reader, Car control sender, Scheduler.
<table>
<thead>
<tr>
<th>Class</th>
<th>Responsibilities</th>
<th>Collaborators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevator car*</td>
<td>Move up and down</td>
<td>Car control, car sensor, car control sender</td>
</tr>
<tr>
<td>Car control*</td>
<td>Transmits car requests</td>
<td>Passenger, floor control reader</td>
</tr>
<tr>
<td>Car state</td>
<td>Reads current position of car</td>
<td>Scheduler, car sensor</td>
</tr>
</tbody>
</table>
Elevator System

**Terminology**

**Elevator Car**

**Hoistway**

**Car control panel**

**Floor control panel:**

![Diagram showing Elevator System with Hoistway-1 and Hoistway-2]
Elevator Operation

• Each floor has control panel, display
• Each car has control panel:
• Controlled by a single controller
• Elevator control has up and down
  ▪ To stop, disable both
• Master controller:
  ▪ reads elevator positions
  ▪ reads requests
  ▪ schedules elevators
  ▪ controls movement
  ▪ controls doors
Elevator Position Sensing
<table>
<thead>
<tr>
<th><strong>Elevator System Requirements</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>name</strong></td>
</tr>
<tr>
<td><strong>inputs</strong></td>
</tr>
<tr>
<td><strong>outputs</strong></td>
</tr>
<tr>
<td><strong>functions</strong></td>
</tr>
<tr>
<td><strong>performance</strong></td>
</tr>
<tr>
<td><strong>manufacturing cost</strong></td>
</tr>
<tr>
<td><strong>power</strong></td>
</tr>
<tr>
<td><strong>physical size/weight</strong></td>
</tr>
</tbody>
</table>
Elevator System Classes

Coarse-Sensor*
Fine-Sensor*
Car-Control-Panel*
Floor-Control-Panel*

Car

Controller

Master-Control-Panel*

Motor*

Floor
Physical Interfaces

Sensor*
- hit: boolean

Coarse-sensor*

Fine-sensor*

Motor*
- speed: \{o, s, f\}

Car-control-panel*
- Floors[1..F]: boolean
- emergency-stop: boolean
- open-door, close-door: boolean

Floor-control-panel*
- up, down: boolean

Master-control-panel...
Architecture

Computation and I/O occur at:
- Floor control panels/displays
- Elevator cars
- System controller

Panels Controller

Cab Controller
- read buttons and send events to system controller
- read sensor inputs and send to system controller
System Controller

Must take inputs from many sources:

Must control cars to hard real-time deadlines
User interface, scheduling are soft deadlines

Testing

Build an elevator simulator using SystemC and/or FPGA
  • Simulate multiple elevators
  • Simulate real-time control demands.
HP Drafting Plotter

Plots up to 36 inches wide at 300 DPI.
Combines a variety of tasks:

Design Considerations
Memory utilization is important

36 inches × large × 300 DPI × n bits/pixel is a lot of memory
Needs clever algorithms to minimize raster memory requirements

• Requires real-time control
• Requires concurrency
HP Plotter HW-Architecture

- i960KA
- adr latch
- bus i/f
- 1 MB ROM
- 2 MB DRAM
- RS-422

- EEPROM
- swath RAM
- pen ctrl ASIC
- proc. support ASIC
- DRAM ctrl
- carriage PC board
- stepper motor
- front panel
- stepper motor
- servo processor (8052)
The Plotting Process

HP-GL/2 → Rasterizer → Raster memory → Plotter Controller

PostScript → Rasterizer → Raster memory → Plotter Controller
Early Architectural Decisions

- Chose Intel 80960KA as main processor
  - Handled parsing, rasterization control, print engine control.
  - Multiplexed bus reduced pin count.
  - Could be upgraded to floating-point if necessary.
- Used modular I/O to host system.
- Did not use disk for local storage.
- System components
- 2 MB RAM (SIMM sockets for more).
- Three ASICs:
- Servo processing performed by 8052 Microcontroller
Data Flows

- i960KA
- RAM
- ASIC
- Proc. support ASIC
- DRAM ctrl
- Servo proc. (8052)
- EEPROM
- swath ctrl
- pen ctrl
- Front panel
- stepper motor
- PC board
- RS-422
- 1 MB ROM
- 2 MB DRAM
- if
- bus if
- adrs latch
Rasterization and Operations

Rasterization

- Plot is generated in swaths.
- Pixels are generated in row order by main processor.
- Pixels are fed to pens in column order.
- Pen interface ASIC transforms row order to column order.

Operations

- Servo processor controls stepper motor.
- Carriage processor must write, read pen alignment marks.
- Processor support ASIC provides multiple functions.
- Motion controller decodes position of print carriage and paper.
Pen Interface and Carriage ASICs

Pen Interface ASIC
- Interfaces to i960 bus, swath memory, carriage ASIC.
- Pen interface reads pixels from swath in predetermined pattern using pixel address generator.
- Must support bi-directional printing since head prints both ways.

Carriage ASIC
- Interfaces to processor bus, pen interface ASIC, servo controller.
- Reads timing control registers using the CPU bus.
- Delay registers add correction for pen alignment.
Development Process

Pixel shuffling algorithm for pen interface/carriage ASICs was prototyped in C.

Software Development Environment

- Plotter software could be run on Unix workstation or target platform.
- Used in-house RTOS, HP-GL/2 parser was legacy code
- Rewrote vector/raster converter from assembly language to C to port to i960.
- Front panel developed on PC, tested by user i/f designers/marketing.
- Paper loading designed by mechanical engineers.
Bluetooth Baseband Controller

Bluetooth is a de-facto standard for wireless data communication for 2.4GHz band. It is developed by a consortium including, Ericsson, Intel, Nokia and Toshiba.

Bluetooth Support

- Short-range communication (10cm to 10m)
- Intends to support laptop to cell phone, printer, fax machines, keyboards, etc.
- Provide a bridge to existing data networks.
- A gross data rate of 1Mbit/s
- Uses frequency hopping scheme and forward error correction.
- Robust communication in a noisy and uncoordinated environment.
Bluetooth Baseband Controller

Uses an ARM7TDMI core with
- 64Kbytes of fast RAM.
- 4Kbyte of instruction cache.

Sharing pin peripheral modules of 3 UARTS & a USB interface

Bluetooth Baseband Controller includes a power optimized hardware block, the Ericsson Bluetooth Core (EBC) that handles all the Link Controller functionality.
- EBC performs all the packet handling functions for point-to-point, multi-slot and point-to-multipoint communications.
- The protocol uses a combination of circuit and packet switching.
- Slots that can be reserved for synch channels (e.g. to support voice transmission).
A Typical Bluetooth Application

Baseband controller needs a radio module and ROM

A Typical Bluetooth Application

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controller needs a radio module and ROM

Baseband controlle