ECEN 5803

Mastering Embedded Systems Architecture

Be Boulder.

University of Colorado Boulder

Review Topics – Buy Versus Build

Your company needs to determine whether or not to buy or build an embedded system for their IoT Vending Machine. The NRE to build the system is $600k and the design will take 1 year to complete. Volume is expected to be 12000 machines/year. At that volume, unit cost of the design is $100. Unit cost of the commercial off the shelf (COTS) unit is $500. Gross profit for the machines is $500 each with the COTS solution. Fixed costs are $200k/month Calculate:
The profit made in the first year, assuming the COTS solution. _____
The costs savings/month for the design and build solution versus the COTS solution. _____
The number of months until breakeven for the build solution _28.5, or 12 + 16.5__
Circle what your company should do BUY BUILD

10.5 if no Build initial FC

Let Y = Buy, D = Build
YC = Buy Costs, DC = Build Costs YI = Buy Income, DI = Build Income YPR = Buy Profit Rate, DPR = Build Profit Rate
UC = unit cost GP/U = Gross Profit/Unit
FC = Fixed Cost Rate, T = time in months since start. TP = Time in months since production V = Volume in U/month
In this case,
YC = FC * T = $200k*T; YPR = GP/U * V = 500 * 1000/month; YI = YPR*YTP – YC = 500k*T – 200k *T; @ T=12 YI=3.6M
Cost savings/month = (YUC – DUC)*V = (500-100)*1000 = 400k
Breakeven for Build: Find T so that DI >= YI DI = DPR*DTP – FC*T – NRE = V*(GP/U + (YUC-DUC))*(T-12) – FC*T - NRE
= 1000*(500+400)*(T-12) – 200k*T – 600k = 500k*T – 200k*T => 900k*T – 900K*12 – 600k = 500k*T 400kT = 11400k

Review Topics

Super Loop Embedded Software and how to implement it.
Embedded OS Selection
Super Loop vs. RTOS, Advantages of each
Processor Configuration and Examples (Drivers)
RTOS Scheduling
Embedded Development Tools – Hardware
Embedded Development Tools – Software
Architecture Tradeoffs: Buy Versus Build
Software Modem Case Study
Instrumentation Case Study

Review Topics

Memories – Types and capabilities, Memory Hierarchy Design
Memory Interfacing – Design Issues
Memory Bus Access & Wait States
Serial Buses and I/O
Cortex ARM-M4 processor architecture
Bus Systems , including PC104, PCI, Compact PCI, VME, etc..
COMs and SOMs

Review Topics

Alarm Clock case study
Digital Audio Player case study
Project 3 and Telecom Case Study
Killing Bugs

Review Topics

Know how to:

Draw a block diagram of an Embedded System.
Determine best implementation architecture for an application, including MCU, MPU, ASIC, FPGA, Embedded PC, Backplane System, SBC, COM, or SOM.
Examine ARM M4 assembly code and determine outcomes and program flow, including specific uses of registers.
Analyze C code used in embedded systems for correctness, including use of type qualifiers.
Read a schematic and identify functions and parts.
Select the best processor based on a set of requirements.

Review Topics

Know how to:

Identify data structures for peripheral drivers
Select the best OS based on a set of requirements
Explain the operation of the ST-Nucleo development board
Determine whether to Build Custom or Buy COTS for a set of requirements for an embedded system
Discuss Architectural Tradeoffs for each Case Study
Design a simple memory interface, including wiring, timing and programming of registers
Determine the range of allowable baud rates for a given source clock for a serial port

Options for Building Embedded Systems

	Implementation	Design Cost	Unit Cost	Upgrades & Bug Fixes	Size	Weight	Power	System Speed
Dedicated Hardware	Discrete Logic	low	mid	hard	large	high	?	very fast
	ASIC	high ($1M/ mask set)	very low	hard	tiny - 1 die	very low	low	extremely fast
	Programmable logic – FPGA, PLD	low to mid	mid	easy	small	low	medium to high	very fast
Software Running on Generic Hardware	Microprocessor + memory + peripherals	low to mid	mid	easy	small to med.	low to moderate	medium	moderate
	Microcontroller (int. memory & peripherals)	low	mid to low	easy	small	low	medium to low	slow to moderate
	DSP processor	low	mid	easy	Small	Low	medium to low	moderate to fast
	Embedded PC (motherboard)	low	high	easy	medium	moderate to high	medium to high	fast
	Computer on Module	low	mid	easy	medium	moderate	medium	fast
	System on Module	low	mid	easy	small	low	medium to low	fast
	PC104 stack	low	high	very easy	medium	moderate	medium to high	fast
	Chassis System (VME, etc.)	low	Very high	very easy	large	high	medium to high	Very fast