Real Time and Embedded Systems

by

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Adapted from guest lectures by Chris Simmons and the Extreme Programming Home Page

Simon Fraser University

Slide Set: 4

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Slide Set Overview

- How to tackle a BIG programming Problem
  - Software Engineering Considerations
- Extreme Programming
- How to draw threads/mutexes with CGN

How to tackle a ***big*** programming problem?

Software Engineering

- ***<u>HAVE A PLAN!!!</u>***
- Different software design methodologies:
  - Waterfall Method (older/traditional)
  - Agile

What is the Waterfall Method?

- W.W. Royce introduced a phased, linear software development methodology in 1970
  - He didn’t call it the “waterfall” method
  - Presented it as a flawed methodology
- Emphasizes:
  - Detailed project specs (Big “up-front” design)
  - ***Lots*** of Documentation on deliverables

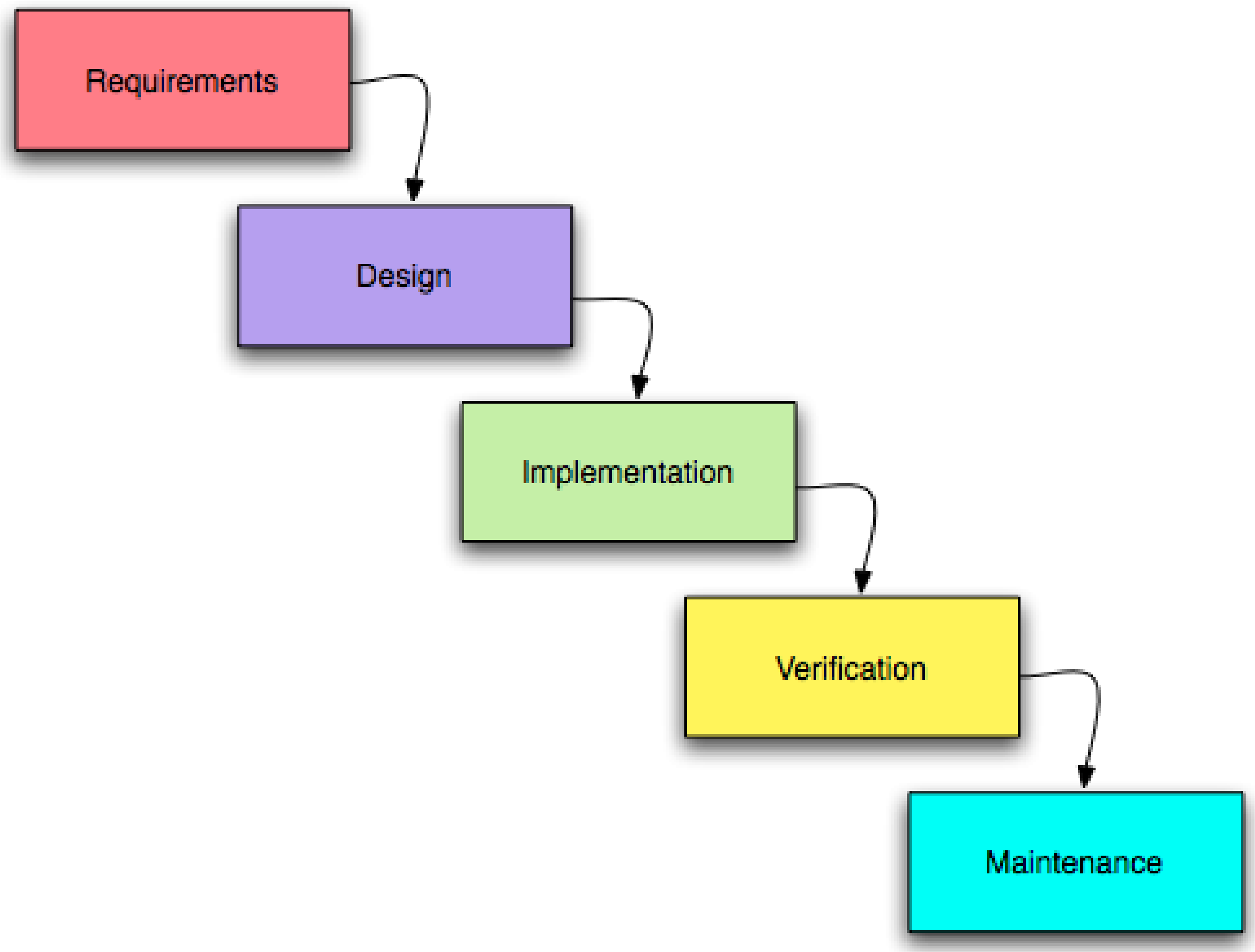
What is the Waterfall Method?

- Widely used in the "real" world
  - 44% of companies according to recent survey

  http://searchsoftwarequality.techtarget.com/news/article/0,289142,sid92_gci1318992,00.html

- Phases:
  1. Requirements Specification
  2. Design
  3. Construction
  4. Integration
  5. Testing and Debugging
  6. Installation
  7. Maintenance

The Waterfall Method



Benefits of the Waterfall Method

- More “up front” time is good for some apps:
  - e.g. safety critical, protocol specs
- Documentation is good
  - particularly for large safety critical apps
- Well defined deliverables
- Good for projects that don’t change
- Easier to understand long term requirements

Problems with the Waterfall Method

- Requirements aren’t always known up front:
  - Customers don’t know “exactly” yet
  - Market Changes
- Integration and testing done very late
  - Design Problems can be disastrous
- Customers don’t see it until you are done
  - Sounds good but customers “change their mind”
- Remember: described as a flawed method

Now Agile Software Development …

WE'RE GOING TO TRY SOMETHING CALLED AGILE PROGRAMMING.
THAT MEANS NO MORE PLANNING AND NO MORE DOCUMENTATION. JUST START WRITING CODE AND COMPLAINING.
I'M GLAD IT HAS A NAME.
THAT WAS YOUR TRAINING.
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Agile “Manifesto”

- The Agile software development methodology “values”:
  - Individuals and interactions over process and tools
  - Working software over comprehensive documentation
  - Customer collaboration over negotiation
  - Responding to change over following a plan

Agile Software Development

- Emphasis on iterative development
  - 1-4 week blocks of time
  - Portions of the various Waterfall phases are combined into each iteration
- Each iteration ***should*** be a stable deliverable
  - Think latest software releases/patches
- No big upfront design
  - Design spec updated dynamically as needed
- And …

Agile Software Development

- Close contact with the customer
  - Or at least their “representative …
- THIS IS BOTH GOOD AND BAD IDEA

Agile Software Development

- Close contact with the customer
  - Or at least their “representative …

THIS IS BOTH GOOD AND BAD!!!

This leads us to Extreme Programming …

Extreme Programming

Why do we care about software engineering?

"Programming today is a race between software engineers striving to build bigger and better idiot-proof programs, and the Universe trying to produce bigger and better idiots. So far, the Universe is winning."

- Author **Rick Cook**, *The Wizardry Compiled*

Extreme Programming

- A weird name for a good set of practices
- Created by Kent Beck (mid-90’s)
  - Checkout: *Extreme Programming Explained* (1999)
- An implementation of an Agile software development methodology
  - Takes Agile practices to their logical limit

Extreme Programming “Values”

- Communication (is “good noise”)
  - Know what’s going on with the team
- Simplicity
  - Do the simplest (not easiest!) thing that works
- Feedback
  - Retrospectives, unit tests, customer interaction

Extreme Programming “Values”

- Courage
  - Don’t be afraid to refactor/throw away code
- Respect
  - Good environment with reasonable hours

XP (practices)

- Fall into four main practices:
  1. Fine Scale Feedback: are we doing the right thing
  2. Shared Understanding: do we all agree on how to work
  3. Continuous Process: small improvements are better than nothing
  4. Programmer Welfare: aka work-life balance

XP practices: Fine Scale Feedback

- Includes:
  1. Pair Programming: Driver/Navigator model
  2. Planning “Game”:
     1. Release planning and
     2. Iteration Planning
  3. Test Driven Development

XP practices: Shared Understanding

- Includes:
  1. Coding Standards : K&R C, Code Conventions for Java, etc
  2. Collective code ownership:
     - ***<u>EVERYBODY is responsible for the code base</u>***
     - There is no such thing as “your code”
  3. Simple Design: Do the simplest thing possible that works (prevents “Big Upfront Design”)
  4. System metaphor: aka naming conventions

XP practices: Continuous process

- Includes:
  1. Continuous integration: much easier with revision control systems and automatic builds
  2. Design improvement: counterbalances “simplest first” with “refactor complex code”
  3. Small releases: prevent “going dark” encourage early feedback, not necessarily for customers

XP practices: Programmer Welfare

- Well rested employees are better employees, so overtime should be rare and spread out

I WORKED AROUND THE CLOCK AND FINISHED A PROJECT THAT WOULD NORMALLY REQUIRE TEN PROGRAMMERS.
UM... DID I JUST ESTABLISH A NEW BASELINE EXPECTATION THAT WILL TURN MY JOB INTO A TRAGIC DEATH MARCH?
IT'S TIME TO SET SOME STRETCH GOALS.
STUPID! STUPID! STUPID!
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Extreme Programming

- Covers
  1. Planning
  2. Designing
  3. Coding
  4. Testing
  5. ***Managing***
- For the purpose of the project the first two steps are done for you
  – Only need to worry about coding and testing

Extreme Programming - Designing

1. Simplicity
2. Choose a system metaphor
3. No functionality is added early
   – Use customer feedback to focus/tune next release
4. Refactor whenever and wherever possible
   – Counterbalance to get simple things done first
   – Simplify code as you add new features making operations more complex

Extreme Programming - Coding

1. The customer is ***<u>always available</u>***
   – Involved in the whole process
2. Code must be written to agreed standards
   – K&R C, Code Conventions for Java, etc.
3. Code unit test first
   – Test Driven Development
4. All production code is pair programmed
5. Only one pair integrates code at a time
   – Driver/Navigator model

Extreme Programming - Coding

6. ***Integrate often***
   - Almost requires revision control and automatic builds (makefiles/etc)
7. Use collective code ownership
   - Everybody is responsible for the code base
     - Not just “your code"
8. Leave optimization till last
   - Do the simplest thing that works first and build on it

9. No overtime

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Extreme Programming - Testing

1. All code must have unit tests

2. ***<u>All code must pass all unit tests</u>*** before it can be released
   – This should prevent you from “going dark”
3. When a bug is found tests are created

4. Acceptance tests are run often and the score is published

Extreme Programming Reference

- Check out the web page:
  - www.extremeprogramming.org
- Planning to have a guest speaker (Chris Simmons) from industry (Sophos) come and talk about actual commercial uses of this technique
  - Attendance to their talk will be ***mandatory***
  - You will be responsible for the material he covers

Limitations of Extreme Programming

- It can break down in large groups
- Management needs to buy in to the idea
- Customer can be the single point of failure
- Teams must communicate
- Lack of documentation can clash with regulations
- Taken to the “extreme” can cause problems

XP for School: Least Useful Parts

- Planning game:
  - Release and iteration planning is often overkill
    - Exceptions: capstone projects/452/etc
- Since the requirements are fixed, don’t require close contact with the customer (me)
  - Remember there’s only one of me
- Design Improvement
  - You’ll likely never see coursework code again

XP for School: Medium Useful Parts

- Coding standards
  - Good for shared code development and coops
- Pair programming
  - Applicable for some courses and often a better learning experience
- Sustainable Pace
  - Lots of Classes, keep the work balanced

XP for School: Medium Useful Parts

- Collective Code Ownership
  - One person is ***NOT*** responsible for the project
- System Metaphor
  - Improves Code readability

XP for School: Very Useful Parts

- Test Driven Development
  - Using unit tests (when appropriate)
- Simple Design
  - KISS Rule: Do what you need to do to get the job done
  - Refactor and improve as you go
- System Metaphor
  - You'll be programming with another pair and you need to be able to read each others code

XP for School: Very Useful Parts

- Continuous integration
  - Revision Control becomes crucial
    - You’ll thank me
- Small Releases
  - Coding all day without compiling is BAD
  - If you can’t get it all done, at least you have something to show
  - Finish the important features first

Other Software Engineering Thoughts

- Learn an editor
  - It will save you time in the long run
    - Can be incorporated into IDE/Eclipse environments
- vim: http://www.vim.org
  - Extremely powerful and Concise
    - But the learning curve can be steep
  - Available on almost any unix/linux box (download for windows)

Other Software Engineering Thoughts

- Learn an editor (cont'd)
  - It will save you time in the long run
    - Can be incorporated into IDE/Eclipse environments
- Emacs: http://www.gnu.org/software/emacs/
  - Also powerful, but has a different input style
  - Also available on most boxes

Useful links for Unit Testing

- libtap:
  - http://jc.ngo.org.uk/trac-bin/trac.cgi/wiki/LibTap
  - Check: http://check.sourceforge.net
- Unit testing in almost any language:
  - http://www.testingfaqs.org/t-unit.html
- A list of papers on unit testing:
  - http://tinyurl.com/2ncqrf

Drawing threads sharing a semaphore

Drawing Threads Sharing a Semaphore

Drawing Threads Sharing a Semaphore

Drawing Threads with Message Passing

Drawing Threads with Message Passing

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Questions?

- Why use extreme programming techniques for commercial projects?

- How would you draw the CGN for the “Sleeping Barber” problem?