Modern Computing Paradigms: Mobile Applications and Infrastructure as Code

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Overview

- **Introduction**
- Haiti Infrastructure Surveyor (HIS)
  - Background
  - Related Work
  - Mobile Application
- Infrastructure as Code (IAC)
  - Background
  - Related Work
  - CRC Puppet Modules
- **Conclusion**
Introduction

- Modern Computing Paradigms
  - Mobile Applications and Infrastructure as Code
  - Waterfall method to an agile approach

- Haiti Infrastructure Surveyor Mobile Application
  - Use untrained Haiti community members to gather structural data
  - Civil engineers analyze the collected data to determine the risk of collapse
Introduction Cont'd

- Infrastructure as Code (IAC)
  - Create a constant computing environment for developers, testers, and system administrators
- Center for Research and Computing (CRC)
  - Automate the provisioning of physical and virtual machines
  - Create Puppet modules
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HIS – Background

- January 12, 2010
  - 7.0 Magnitude earthquake
  - Epicenter was Leogane
    - 15 km southwest of Port-au-Prince
    - 90% of buildings destroyed
  - 220,000 died in 30 seconds [1] (3 times the attendance at the 2013 Super Bowl)
  - 1.5 million people were instantly homeless and 3.5 million people were affected [1]
HIS – Why the Devastation?

- Epicenter located near major city and occurred 10km below the ground
- Inadequate structural infrastructure
  - Haiti is the poorest country in the western hemisphere
    - 80% of country lives below the poverty line [2]
  - Lack of educated personnel and resources to build structures “to code”
  - Lack of government support
HIS – Current Structures

- Unreinforced masonry construction
  - Lack of reinforcing steel
  - May take over 10 years to build
  - Perform poorly in earthquakes
- Yellow/Red tagged structures
- Semi-permanent structures
- Masonry structures with modifications
HIS – Yellow/Red Tagged Structures

- Attempts to repair condemned houses
- Reoccupy these structures
- Unsafe
HIS – Semi Permanent Shelters

- Stay while saving for a masonry home
- Temporary Fixes
- Decreased safety
  - Future Disasters
  - Theft
HIS – Masonry with Modifications

- Modifications
  - Amount of steel in the columns and walls
  - Quality of block used
- Very few
- Expensive
- Unclear if construction is being done safely
- Will modifications be effective?
HIS – Mobile Solution

- Document photographs and notes about a structure
- Upload to a remote server
  - Search/filter
  - Download
- Civil engineering research team performs structural analysis to determine if the building is at risk of collapse
- Respond with local resource solutions to improve stability

Motorola XT720s
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HIS – Crowdsourcing

- **Stardust@Home** [3]
  - Search for interstellar dust from any internet connected computer
  - User ‘score’ rankings

- **CamClickr** [4]
  - Catalog nesting behaviors of birds
  - Captured over 600,000 images

- **eBird** [5]
  - Document bird observations through a web-interface
  - March 2012 there was 3.1 million reported bird observations submitted
HIS – Data Obtainment

- **FrontlineSMS [6]**
  - Open source software to distribute and collect information via text messages
  - Used after Haiti earthquake to submit crisis alerts

- **GeoChat [7]**
  - Open source group communication tool
  - Helps team members communicate and keep track of what everyone else is working on

- **LocoBlog [8]**
  - Mobile blog application
  - Allows user to submit photos to a personal blog directly from a mobile device
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HIS - Mobile Application

- Developed using the waterfall method
  - Part of Fall 2012 CSE 60232 Software Engineering course
  - Requirements, Design, Development, Testing, Deployment, Maintenance
- 4 modules
  - Structure Selection
  - Questionnaire
  - Exterior Observations
  - Data Submission
HIS – Structure Selection

- Add structure
- Structure status
- List of created structures
- Preview thumbnail
HIS - Questionnaire

- 3 pages of questions
  - Text, dropdown, checkbox
  - Text/Number appropriate keyboard input
  - Future error checking
- State saved after each page submission
HIS – Exterior Observations

- 4 sides of a structure
- Status Indicators
  - Green Checkmark
  - Photo saved pop-up
  - Red X
- All 4 photos are required
HIS – Data Submission

- Context menu from long press
- Edit structure description
- Delete structure
- Upload to backend with spinning status bar
HIS – Backend Database

- Developed by an EPICS team at Notre Dame
  - Fall 2012: Basic functionality
    - Capture data from mobile application via POST
    - Insert data into database and display
    - PHP used
  - Spring 2013: Improving functionality
    - User interface
    - Filter / Search
    - Download
    - Security
# HIS – Backend Database

## HIS Database

| Surveyor * | Structure | phone       | owned? | yearBuilt | Duration | builder | Steak? | nChildren | nAdults | nFloors | roofType | photoFront | notesFront | photoRight | notesRight | photoBack | notesBack | photoLeft | notesLeft |
|------------|-----------|-------------|--------|-----------|----------|---------|--------|-----------|---------|---------|----------|------------|------------|------------|------------|------------|-----------|-----------|-----------|-----------|
| aaron      | Aaron     | 15073542158 | 0      | 1988      | 3        | aaron   | 0      | 2         | 2       | 1       | Metal    | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| aaron      | house 1   | 5073564258  | 0      | 1966      | 2        | joe     | 0      | 2         | 2       | 0       | Metal    | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| Brian Calcutt | house 1 | 2032577678 | 0      | 1992      | 3        | joe     | 0      | 2         | 2       | 1       | Concrete Slab | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| Brian Calcutt | UGBC1    | 2032577678 | 0      | 1992      | 3        | joe     | 0      | 2         | 2       | 1       | Concrete Slab | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| Brian Calcutt | Sorin Hall | 2032577678 | 0      | 1886      | 1        | Fr Edward Born, CSC | 0 | 145 | 8 | 4 | Other | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| dan        | walmart   | 1111111    | 0      | 0         | 0        | 0       | 0      | 0         | 0       | 0       | Select One | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| Dan Courtney | walmart  | 1111111    | 0      | 0         | 0        | 0       | 0      | 0         | 0       | 0       | Select One | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| dave mix   | mix house | 2315965555 | 0      | 1970      | 1        | contractor | 0 | 3     | 2 | 2 | Other | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| dave mix   | mix house | 2315965555 | 0      | 1970      | 1        | contractor | 0 | 3     | 2 | 2 | Other | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |
| Dustin Mix | casa de dustin | 5555555555 | 0      | 2013      | 5        | Mic | 0      | 0         | 1       | 2       | Concrete Slab | ![Image](photo1) | ![Image](notes1) | ![Image](photo2) | ![Image](notes2) | ![Image](photo3) | ![Image](notes3) | ![Image](photo4) | ![Image](notes4) |

Showing 1 to 10 of 17 entries
HIS - Testing

- Tested with EPICS and civil engineering students on 3/28/2013
  - Summer 2013 trip to Uganda, Costa Rica, Ecuador, and Tanzania
  - Identified software bugs
HIS - Deployment

- 100 Motorola phones donated
- Deploy to citizens of Haiti
  - Community leader
  - Involved socially
- Currently manually installed on each phone
HIS – Future Work

- Host .apk file on private server
- Feature implementation
  - Additional questions
  - Optional photos
  - Upload all structures
- Continued testing
  - Error checking
  - Improved user interaction
  - Network speeds
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IAC - DevOps

Facilitates the relationship between development, quality assurance, and the operations team [9]
IAC – DevOps Hierarchy

- Development role
- Operations role
IAC – Infrastructure as Code

- Automation of configuration management
  - Changes may effect multiple computers
  - Development, test, and production environments
- Modular representations of systems
  - Software installed is customized to the project
  - Central repository of software components
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IAC – Machine Provisioning

  - Coordinate and scale service management and administration activities
  - Performed across multiple nodes

- SmartFrog [13]
  - Java-based software framework
  - Configure, deploy and manage distributed software systems
IAC – System Administration

- Test-Driven/Diagnostic approach [14]
  - System regulated by continual re-provisioning of the machine definition
  - If a system deviates from its model, then with proper automation it self-repairs
  - Autonomic computing: self-configure, self-heal, self-optimize, and self-protect
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IAC – Design Decisions

- Puppet, Chef, or CFEngine
  - CRC chose Puppet due to independent language syntax
  - Large developer community

- Virtual Machine or Physical Machines
  - Developers use VMs
    - Likely to break, easy to re-provision
    - CentOS
  - Production infrastructure may be a physical machine
IAC – Software Requirements

- VirtualBox
- Vagrant
- Veewee
- Puppet
- Jenkins
- Lettuce
IAC – VirtualBox [15]

- A cross-platform virtualization application
  - Developer to choose host OS in which he/she is most comfortable
  - Identical development environments
IAC – Vagrant

- Creates and configures lightweight, reproducible, and portable development environments
- Creation and maintenance of VMs
- Requires VirtualBox with potential future VMware compatibility
IAC – Veewee

- Initially used to create vagrant base box
- Configuration files
  - Definition.rb
    - Memory, HD size, ISO location
  - Postinstall.sh
    - Installs Puppet, Vbox Guest Additions
  - Preseed.cfg
    - Timezone, partitions size and type
- 28 predefined downloadable templates
IAC – Puppet [17]

- Google, Mozilla, Stanford University [18]
- Puppet client runs locally
- Puppet master server
  - Centralized location to store all puppet modules
  - Puppet clients are updated via check-ins with the puppet master
IAC – Jenkins [19]

- An extendable open source continuous integration server
- Deploy and obtain test results of developed infrastructure
- Ensure infrastructure configured as desired
IAC – Lettuce [20]

- Cucumber vs. Lettuce
  - Ruby
  - Python
- Behavior driven development tool
  - Write a unit test
  - Run the test
  - Test fails
  - Write additional code
  - Test passes
IAC - Hypothetical Situation

- You are a new developer and are told that you will be working on creating a new website.
  - Apache?
  - Hello world page
  - Include java?
    - OpenJDK
    - Oracle/Sun JDK
  - Configure firewall to allow port 80 connections
Developer’s Perspective
IAC – Vagrant

- Apache
  - Puppet module
  - `index.html` template
- Java module
  - OpenJDK
  - Oracle/Sun JDK
- Firewall module
  - Allow port 80 connections
  - Open other ports
- Checkout environment
IAC – Development Environment

- Apache_ENVIRONMENT
  - Vagrantfile
  - puppet
    - manifests
      - base.pp
    - modules
      - java
      - firewall
      - httpd
config.vm.box = "CentOS_63"

config.vm.network :hostonly, "192.168.33.10"
config.vm.forward_port 80, 8080

config.vm.provision :puppet do |puppet|
  puppet.manifests_path = "puppet/manifests"
  puppet.module_path = "puppet/modules"
  puppet.manifest_file = "base.pp"
end
IAC – Development Environment

- Apache_Environment
  - Vagrantfile
  - puppet
    - manifests
      - base.pp
    - modules
      - java
      - firewall
      - httpd
# Installs apache web server
   include httpd

# Installs java
   class {'java':
      java_version => '1.6.0_37',
      java_base => '/opt/java',
   }

# Opens port 80 on firewall
   firewall { '056 INPUT allow web in and out':
      action => accept,
      proto => 'tcp',
      port => 80
   }
IAC – Development Environment

- Apache_Environment
  - Vagrantfile
  - puppet
    - manifests
      - base.pp
    - modules
      - java
      - firewall
      - httpd
IAC – httpd Puppet Module

- httpd
  - README
  - Manifests
    - params.pp
    - init.pp
  - files
  - templates
  - tests
    - init.pp
# Include http params file

include httpd::params

# Copies default index.html file

file { $httpd::params::index_to:
  ensure => file,
  source => $httpd::params::index_from,
  notify => Service['httpd']
}

# Installs the httpd package

package { 'httpd':
  ensure => present,
  name   => $httpd::params::httpd_name
}

# Ensures service is running

service { 'httpd':
  ensure  => running,
  name    => $httpd::params::httpd_name,
  enable  => true,
  subscribe => Package['httpd']
}
System Administrator’s Perspective
IAC – Client-Server Architecture

Node 1

Node 2

Node 3

Node 4

Node 5

Puppet Client

Puppet Master
node default {
}
...
node apache_server{

# Installs apache web server
  include httpd

# Installs java
  class {'java':
    java_version  => '1.6.0_37',
    java_base     => '/opt/java',
  }
...
}

IAC – Client-Server Advantages

- Central puppet module location
- Continuously updated every 30 minutes by default
- Easy to change configuration of an entire node
### IAC – Created Puppet Modules

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apache</td>
<td>HTTP server</td>
</tr>
<tr>
<td>Celery</td>
<td>Asynchronous task queue/job queue based on distributed message passing.</td>
</tr>
<tr>
<td>Compute Node</td>
<td>Base CentOS machine image</td>
</tr>
<tr>
<td>Fedora Commons</td>
<td>A general-purpose, open-source digital object repository system</td>
</tr>
<tr>
<td>Jenkins</td>
<td>An open-source continuous integration server with 300+ plugins to support all kinds of software development</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Behavior Driven Development tool used to perform software testing</td>
</tr>
<tr>
<td>MongoDB</td>
<td>An open source document-oriented database system</td>
</tr>
</tbody>
</table>
### IAC – Created Puppet Modules

<table>
<thead>
<tr>
<th><strong>Name</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>mySQL</td>
<td>An open source relational database management system</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>A object-relational database management system available for many platforms</td>
</tr>
<tr>
<td>Puppet Server</td>
<td>A server used to manage puppet clients through a client-server architecture</td>
</tr>
<tr>
<td>RabbitMQ</td>
<td>An open source message broker software that implements the AMQP standard</td>
</tr>
<tr>
<td>Redis</td>
<td>An open source, BSD licensed, advanced key-value store</td>
</tr>
<tr>
<td>Tomcat</td>
<td>An open source web server and servlet container</td>
</tr>
</tbody>
</table>
IAC – Future Work

- Continue the integration of IAC into development practices at the CRC
- Add additional puppet modules to central repository
- Look at continuous integration
- Test driven development with Lettuce
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Conclusion

- HIS Mobile Application
  - Improve structural safety in Haiti
  - Development process transition to agile development
  - Getting started documentation

- Infrastructure as Code
  - 13 puppet modules
  - Utilize puppet modules within current projects
  - Getting started with IAC presentation
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References


References


References

[20] Lettuce. URL http://lettuce.it/
Questions?