A Prototype Virtual Emergency Operations Center using a Collaborative Virtual Environment

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Fifth International ISCRAM Conference—Washington, DC
May 2008
Background

• Project Ensayo—virtual Emergency Operations Center (vEOC): platform for research and training

• Problem: collaboration over a network
  – Synchronization
  – Atomicity

• Croquet
  – Full-featured CVE
  – Solves synchronization/atomicity
Hurricane Katrina
1445 UTC 29 August 2005
GOES-12 visible channel
over a MODIS true-color background
Hurricane Katrina (2005)

• Fatalities
  – 1,836 total

• Damage
  – $81.2 billion (2005 USD)
  – $89 billion (2008 USD)

1) Long-term warning went unheeded and government officials neglected their duties to prepare for forewarned catastrophe;

2) Government officials took insufficient actions or made poor decisions in the days immediately before and after landfall;

3) Systems on which officials relied on to support their response efforts failed; and

4) Government officials at all levels failed to provide effective leadership.

Hurricane Andrew (1992)

- Fatalities
  - 65 (26 direct, 39 indirect)
- Damage
  - $26 billion (1992 USD)
  - $40 billion (2008 USD)
Lessons Learned from Andrew
.... Same as Katrina!

1) Clearly defining and communicating leadership roles, responsibilities, and lines of authority for catastrophic response in advance of such events,

2) Clarifying the procedures for activating the National Response Plan and applying them to emerging catastrophic disasters,

3) Conducting strong advance planning and robust training and exercise programs,

4) Strengthening response and recovery capabilities for a catastrophic disaster

Disaster Management

- **Florida** ➔ one of the most effective in disaster management

- **Miami-Dade County Office of Emergency Management (OEM)**
  - Lead agency in an emergency event
  - The Emergency Operations Center (EOC) is the central site for all of the emergency management operations
  - Participating agencies organized by function ...
    - Public Safety
    - Human Services
    - Infrastructure
The Miami-Dade Emergency Operations Center (EOC)

- The Public Safety Functional Group Branch includes:
  - US Coast Guard, National Park Service, Miami-Dade Fire Rescue Dept., Florida Dept. of Law Enforcement, Florida National Guard, Miami-Dade Police Dept, Florida Fish and Wildlife Conservation Commission, Miami-Dade Corrections Dept., Florida Highway Patrol, Animal Services, Department of Environmental Resources Management (DERM), and others
The Miami-Dade Emergency Operations Center (EOC)

- The **Public Safety Functional Group Branch**
- The **Human Services Group Branch** includes:
  - Dept. of Human Services, American Red Cross, Miami-Dade County Public Schools, Miami-Dade Voluntary Organizations Active in Disaster (VOAD), Dept. of Mental Health, Miami-Dade County Health Dept., Team Metro, Salvation Army, Greater Miami Convention and Visitors Bureau, Miami-Dade Housing Agency, Florida Dept. of Children and Families, Florida Agency for Health Care Administrators (AHCA), and the Miami-Dade Fire Rescue Emergency Management Services *and others*
The Miami-Dade Emergency Operations Center (EOC)

• The **Public Safety Functional Group Branch**
• The **Human Services Group Branch**
• The **Infrastructure Group Branch** includes:
  – Miami-Dade Solid Waste Dept, Miami-Dade Water and Sewer, Miami-Dade Transit Evacuation, South Florida Water Management District, Miami-Dade Transit-Regular Services, Miami-Dade Public Schools, Miami-Dade Public Works, Florida Dept. of Transportation, BellSouth, Agriculture Extension, City Gas Comcast, Miami-Dade Enterprise Technology Services Dept. (ETSD), and Florida Power & Light, the airports, and the Port of Miami *and others*
The Miami-Dade Emergency Operations Center (EOC)

- The **Public Safety Functional Group Branch**
- The **Human Services Group Branch**
- The **Infrastructure Group Branch**
- Additional **Interacting Organizations** include:
  - Florida Division of Emergency Management (DEM), neighboring county's emergency management liaisons (including Monroe County, Broward County, Florida City, Martin County, and Collier County), the Divisional EOCs (Miami Beach, North Miami, North Miami Beach, Homestead, Coral Gables, Hialeah, and the city of Miami), and representatives from Homestead Air Force Reserve Base and FEMA
The Miami-Dade Emergency Operations Center (EOC)

• The Public Safety Functional Group Branch
• The Human Services Group Branch
• The Infrastructure Group Branch
• Additional Interacting Organizations
• Facilities for Situational Awareness, Coordination, Communication, Decision Making, Resource Allocation, and Documentation include:
  – GIS/Mapping, Press Room, Answer Center (911/311), Special Needs Support Center, News Feeds (TV/Cable), WorkStations/Phones, Logistics Support Center, E-Team, Weather, e-Mail, etc.
  – Modes: Synchronous, Asynchronous, Face2Face, Remote
Miami-Dade Emergency Operations Center
Activation floor plan

**PUBLIC SAFETY FUNCTIONAL GROUP**
- Miami-Dade Schools Police
- Miami-Dade Corrections Dept.
- Florida Dept. of Law Enforcement
- Florida Highway Patrol
- Miami-Dade Police Department
- Miami-Dade Police Department
- Miami-Dade Fire Rescue Dept.
- Miami-Dade Fire Rescue Dept.

**HUMAN SERVICES FUNCTIONAL GROUP**
- Dept. of Human Services
- Salvation Army
- Greater Miami Convention & Visitors Bureau
- American Red Cross
- Miami-Dade Public Schools

**INFRASTRUCTURE FUNCTIONAL GROUP**
- Miami-Dade Solid Waste Dept.
- Miami-Dade Water & Sewer
- St. V. Water Management District
- Miami-Dade Transit Regular Sys.
- Miami-Dade Transit - Evacuation
- Miami-Dade Public Schools

**NOTE:** REP Only - Agencies that only are present for radiological emergencies.

07/01/07
## Resource Requests & Commitments

### Historic Data (E-Team) - Wilma

<table>
<thead>
<tr>
<th>Type</th>
<th>Priority</th>
<th>Status</th>
<th>Qty</th>
<th>Units</th>
<th>Est. Cost</th>
<th>Resource No.</th>
<th>No. %</th>
<th>Requestor</th>
<th>Responsible Agency</th>
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<tbody>
<tr>
<td><strong>E - Wilma</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Equipment - Other</strong></td>
<td>High</td>
<td>Red-Action</td>
<td>1</td>
<td>lot</td>
<td>10,903</td>
<td>Res-032315-660-102605</td>
<td>235</td>
<td>100.0%</td>
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<td><strong>Repair auth for state owned equipment</strong></td>
<td>High</td>
<td>Red-Action</td>
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<td>n/a</td>
<td>NR</td>
<td>Res-071116-860-102905</td>
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<td>Homestead Divisional EOC</td>
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<td><strong>MRE</strong></td>
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<td>Red-Action</td>
<td>1</td>
<td>truck</td>
<td>NR</td>
<td>Res-082419-577-110105</td>
<td></td>
<td></td>
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<tr>
<td><strong>Police-Security</strong></td>
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<td>1</td>
<td>NR</td>
<td>NR</td>
<td>Res-083100-525-110205</td>
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<td>NR</td>
<td>NR</td>
<td>Res-084911-891-110105</td>
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<td></td>
<td>Florida Power &amp; Light (FPL/ESF-12)</td>
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<td><strong>Ice</strong></td>
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<td>truck</td>
<td>NR</td>
<td>Res-090349-100-110105</td>
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<td><strong>Other</strong></td>
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<td>Red-Action</td>
<td>1</td>
<td>Traffic Message Board</td>
<td>NR</td>
<td>Res-091049-917-103005</td>
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<td></td>
<td>Miami-Dade EOC for Biscayne Park</td>
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<td><strong>Fuel-Gasoline</strong></td>
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<td>NR</td>
<td>NR</td>
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<tr>
<td><strong>Meals</strong></td>
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<td>Red-Action</td>
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<td>each</td>
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<td><strong>Generator</strong></td>
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<td><strong>Forklift</strong></td>
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<td>NR</td>
<td>NR</td>
<td>Res-105821-496-103105</td>
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<td></td>
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<tr>
<td><strong>Pump Station repair</strong></td>
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<td>Red-Action</td>
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<td>NR</td>
<td>NR</td>
<td>Res-112735-507-102605</td>
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<td></td>
<td>City of Miami Divisional EOC</td>
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<tr>
<td><strong>Ice</strong></td>
<td>High</td>
<td>Red-Action</td>
<td>1</td>
<td>Truckload</td>
<td>NR</td>
<td>Res-113022-262-103105</td>
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<tr>
<td><strong>Pump Station Repair</strong></td>
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<td>Red-Action</td>
<td>1</td>
<td>NR</td>
<td>NR</td>
<td>Res-114559-636-102605</td>
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<tr>
<td><strong>Power</strong></td>
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<td>Red-Action</td>
<td>1</td>
<td>NR</td>
<td>NR</td>
<td>Res-115145-844-102405</td>
<td></td>
<td></td>
<td>EOC (ESF-3)</td>
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<tr>
<td><strong>Forwarding</strong></td>
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<td>Red-Action</td>
<td>1</td>
<td>NR</td>
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<td>Res-116163-675-102605</td>
<td></td>
<td></td>
<td>MD Office of Emergency Mgmt. (OEM)</td>
</tr>
</tbody>
</table>
About Croquet

• A software development kit written in Squeak (SmallTalk)
• Cross-platform (Windows, OS X, Linux)
• Peer-to-Peer
  – Most CVEs use a client-server approach
  – Croquet turns this tried-and-true method onto its head
Prototypical Client-Server Model

Client Application (GUI, etc.)

TCP/IP and/or UDP: Data and Computations

Server System and Resources

TCP/IP and/or UDP: Data and Computations

Client Application (GUI, etc.)
Croquet Peer-to-Peer Model (TeaTime): Establishing the CVE

Wright and Madey; ISCRAM, May 2008
Message Passing in TeaTime

1) Message X
2) Message X; Time Stamp
3) Message X

Host 2

Router

Host 1

Controller

Message A
Message B
.
.
3) Message X

Controller

Message A
Message B
.
.

Controller

Host 3

Host 4
The vEOC

• Goals for Initial Prototype
  – Fully synchronized collaboration mechanisms
  – XML interface to uniformly specify tests/simulations
  – 3D virtual environment with programmable video and photo displays
Synchronized Collaboration

• Already built into Croquet!
  – TeaTime architecture for island communication
  – Text messaging
  – Text white boards
  – OpenGL 3D and avatar support
    • Also a synchronized collaboration mechanism
    • Enables interaction and realism
Interior of vEOC
Exterior of vEOC
Still Need to Resolve
====================
* City needs additional 500 MREs
* City requests 400 units road flares
* City needs 600 units flashlights
XML Interface

• Language for building test/simulation
  – Injection (aka “inject”) messages—one-way, for now: message records
  – Video/photo images: resource records
• Uniform, portable
• Modeled after Miami-Dade EOC test script format
• Croquet supports document type definitions (DTDs)
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE simulationScript SYSTEM "vEOC-Sims.dtd">

<simulationScript>
  <rsrcrecord>
    <time offset="5" injecNum="1"/>
    <device type="video" devID="1"/>
    <file>Content/vEOC/Movies/hurr-bertha-vid.mpg</file>
  </rsrcrecord>
  <msgrecord type="infoUpdate">
    <time offset="10" injecNum="9"/>
    <sender>
      <agency>Miami Beach EOC</agency>
    </sender>
    <receiver>
      <agency>Miami Beach Divisional</agency>
    </receiver>
    <message>City Mayor and commissioners want to confirm when tropical-storm-force winds will arrive and which shelters will be open.</message>
    <action>Access IAP or contact Municipal Branch Director for information.</action>
    <explanobj>4</explanobj>
  </msgrecord>
</simulationScript>
Scripted Inject Message

FROM : Miami Beach EOC
TO : Miami Beach Divisional
TIME : Sim +60
INJECT: 9

Fifteen patients at the special-needs shelter have arrived with their oxygen canisters. The nurse manager is concerned that they will be out of oxygen within the next 12 hours.
Video and Photo Displays

• Important to the collaboration process
  – Weather reports
  – News reports
  – EOC team updates

• Content timed with simulation/test
  – Four video (MPEG), four photo (JPEG/GIF) displays
  – Individually programmable via XML
Avatar watching a Video
Issues and Future Work

• TeaTime: Synchronization and atomicity are great, but there’s a catch!
• Message injects are a one-way street—need to solicit and critique participants
• Participant roles are lacking
• GIS is lacking
• Admin tools needed
  – Build/edit/maintain test/simulation XML
  – Manage participant accounts
Thank You!
Questions?