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International Command and Control Research and Technology Symposium
C2 for Complex Endeavors
June 17-19, 2008
The Meydenbauer Center
Bellevue, WA

The Command and Control Research Program
www.dodccrp.org
Plenary Panel II

Empirical Analysis of Complex Endeavors

June 18, 2008

Golden Phoenix 07

Richard E. Hayes, Ph.D. President, Evidence Based Research, Inc.
Donald G. Owen, Evidence Based Research, Inc.
Agenda

• What is Golden Phoenix 07?
• CCRP Focus in Golden Phoenix 07
• Data Collection
• Data Reduction
• Findings
  – Connectivity (Technical Interoperability)
  – Quality of Interaction
  – Familiarity and Trust
• Conclusions
Golden Phoenix 07
Purpose and Participants (1)

- Multiple, linked training events at the tactical level for:
  - Greater Los Angeles area police and sheriff departments
  - Greater Los Angeles area fire departments
  - USMC, National Guard (limited), ARNORTH Defense Coordinating Officer and support element, California State Military, and USAF Reserve Liaison Officer.

- Los Angeles County Sheriff as Unified Area Commander (5 standing Incident Management teams in shifts)
  - Law Enforcement Mutual Aid Area C Incident Commander from Alhambra Police Department
  - Law Enforcement Mutual Aid Area G Incident Commander from El Segundo Police Department

- Military organizations in support roles
Golden Phoenix 07
Purpose & Participants (2)

• Scenario events span a 30-hour period immediately following a 7.9 earthquake in Los Angeles
  – Civil unrest at the Rose Bowl
  – Night riot at Hawthorne Mall
  – Civil unrest at Inglewood Forum
  – Hazmat events
  – Medical triage

• Operation Freedom Ring (independent but coordinated)
  – Lost children and pets
  – High and low bandwidth civil reachback networks
  – GIS area mapping updated by network of deployed sensors
Complex Civil-Military Endeavors (CC-ME) are increasingly important

- Effectiveness of CC-ME depends in large part on the quality of “collective C2”
- Network Centric C2 (Command and Control) concepts and value chain provide the framework for analyzing the maturity and effectiveness of CC-ME
- Lack of empirical data about CC-ME, particularly at the tactical level, inhibits programs of research, development, and training
Take advantage of exceptional access, cooperation, and support

- Fifteen USMC Reserve data collectors
- Unusual willingness from civilian participants to be observed
- Cooperative collection with SPAWAR Systems Center San Diego (SSC San Diego), Interoperable Communications Technical Assistance Program (voice networks), and Naval Postgraduate School Center for Hastily Formed Networks (data and human factors)
Primary Questions of Interest to the CCRP

• What was the nature of the collective and individual approaches to C2 used by Golden Phoenix 07 participants?
  – Patterns of interaction
  – Information distribution
  – Allocation of decision rights

• How effective were individual and collective Command and Control?
Network Centric Value Chain for CC-ME

Quality of Decisions

Degree of Synchronized Planning

Quality/Extent of Shared Awareness

Extent of Shared Information

Quality of Information

Quality/Extent of Connectivity

Golden Phoenix 07
Data Collected
Data Collection Plan

- Collect connectivity data for both voice and data linkages
- Collect event data on:
  - Semantic Interoperability
  - Willingness or Reluctance to Interoperate
  - Shared Information
  - Shared Awareness
  - Collaboration
  - Decisions and Synchronization
- Collect *technical interoperability* and *human factors* information in concert with the Naval Postgraduate School and Space and Naval Warfare Systems Center San Diego
Data Collected

• More than 1,600 events recorded in observer journals
• More than 200 pre- and post-event questionnaires on perceptions of organizational performance and trust
• Technical Voice Interoperability matrix developed from data recorded by SSC San Diego’s Interoperable Communications Technical Assistance Program
• Technical Data Interoperability matrix developed from data recorded by NPS Center for Hastily Formed Networks
• Human Factors data collected by Australian Defense College in conjunction with NPS
Data Reduction (1)

- Connectivity (Technical Interoperability)
  - *Ideal* technical interoperability assumes every organization is directly connected to all other organizations.
  - *Expected* planned technical interoperability determined by examining organizations’ role and participation in each event.
  - *Documented* technical interoperability matrices by event for voice and data relying on collection by NPS and SSC San Diego.
  - *Scenario-based shortfalls* were observed lack-of-interactions based on scenario needs and reports from CCRP observers.
Data Reduction (2)

• Quality of interaction data
  – Coded from observer journals
  – Associated with meta-data including date, time, observer, location, and participants
  – Excel spread sheets developed to support analysis

• Pre- and post- event surveys
  – Responses scored and arrayed by topic and organization
  – Issues included familiarity, recognition of dependencies, organizational capabilities, and trust
**Net-centricity goal:** 100% of organizations have the capability to interoperate as needed. Participants choose partners based on scenario and roles.

**Expected interoperability:** Linkages based on expectations and the nature of the scenario. Some unexpected participants complicated identifying emergency management relationships.

**Documented interoperability:** Linkages reported by observers from NPS, SSC San Diego, and CCRP. These represent actual linkages established.

**Scenario-based shortfalls:** Important expected interoperability pairs that were not present when needed during the scenario. (Shown in red).
### Overall Voice Connectivity

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent of Ideal</th>
<th>Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ideal Technical Voice Interoperability for Golden Phoenix:</strong></td>
<td>100%</td>
<td>871 Organizational Pairs</td>
</tr>
<tr>
<td>(All participants capable of interacting by voice)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Expected Technical Voice Interoperability:</strong></td>
<td>49%</td>
<td>426 Organizational Pairs</td>
</tr>
<tr>
<td>(Voice linkages anticipated)</td>
<td></td>
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</tr>
<tr>
<td><strong>Documented Technical Voice Interoperability:</strong></td>
<td>29%</td>
<td>253 Organizational Pairs</td>
</tr>
<tr>
<td>(Voice linkages reported during Golden Phoenix)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario-based shortfalls:</strong></td>
<td>2%</td>
<td>17 Organizational Pairs</td>
</tr>
<tr>
<td>(Expected Technical Voice Interoperability pairs needed but not present)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Observed Interactions by Type

- Total Interactions: 1621
- Positive Interactions: 1417 (87.4%)
- Problems: 204 (12.6%)

Collaboration: 125 (7.7%)
Shared Awareness Problems: 54 (3.3%)
Positive Shared Awareness: 40 (2.5%)
Information Sharing Problems: 96 (5.9%)
Decisions and Synchronization: 54 (3.3%)
Semantic Interoperability Problems: 21 (1.3%)
Willingness to Interoperate: 78 (4.8%)
Reluctance to Interoperate: 33 (2.0%)
Positive Information Sharing 1120 (69.1%)
Observed Interactions by Organization Type

- **Other Civilian:** 79 (4.9%)
- **Medical:** 101 (6.2%)
- **Incident Command:** 158 (9.7%)
- **Unified Area Command:** 381 (23.5%)
- **Military:** 357 (22.0%)
- **Law Enforcement:** 471 (29.1%)
- **Fire Department:** 74 (4.6%)
Percentage of Observed Interactions by Organizational Pairs

<table>
<thead>
<tr>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
<td>7.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incident Command</td>
<td>2.4%</td>
<td>0.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>14.2%</td>
<td>7.8%</td>
<td>14.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>1.6%</td>
<td>1.8%</td>
<td>0.8%</td>
<td>0.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military</td>
<td>7.4%</td>
<td>3.6%</td>
<td>4.4%</td>
<td>1.4%</td>
<td>13.0%</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>1.4%</td>
<td>1.5%</td>
<td>0.3%</td>
<td>2.7%</td>
<td>0.3%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Other Civilian</td>
<td>5.7%</td>
<td>1.0%</td>
<td>1.7%</td>
<td>0.0%</td>
<td>0.9%</td>
<td>0.2% 0.1%</td>
</tr>
</tbody>
</table>

Total Number of Observed Interactions: 1621
Mean Value: 3.6
Standard Deviation: 4.3
# Methodology for Characterizing Interaction Data

## Positive Observations

<table>
<thead>
<tr>
<th>Color</th>
<th>Comparison to Standard Deviation from Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>More than 2 Standard Deviations</td>
</tr>
<tr>
<td>Blue</td>
<td>Between 1 and 2 Standard Deviations</td>
</tr>
<tr>
<td>Red</td>
<td>Less than 1 Standard Deviation</td>
</tr>
</tbody>
</table>

## Negative Observations

<table>
<thead>
<tr>
<th>Color</th>
<th>Comparison to Standard Deviation from Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Less than 1 Standard Deviation</td>
</tr>
<tr>
<td>Yellow</td>
<td>Between 1 and 2 Standard Deviations</td>
</tr>
<tr>
<td>Red</td>
<td>More than 2 Standard Deviations</td>
</tr>
</tbody>
</table>

For all characterizations:

- **Mean:** 3.6
- **Standard Deviation:** 4.3

Based on distribution calculated for the entire set of observations.
Semantic Interoperability: Observed Problems

<table>
<thead>
<tr>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
<td>4.7%</td>
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<td></td>
</tr>
<tr>
<td>Incident Command</td>
<td>0.0%</td>
<td>0.0%</td>
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<td></td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>9.5%</td>
<td>4.7%</td>
<td>9.5%</td>
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</tr>
<tr>
<td>Fire</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.0%</td>
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</tr>
<tr>
<td>Military</td>
<td>38.1%</td>
<td>0.0%</td>
<td>9.5%</td>
<td>4.7%</td>
<td>9.5%</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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</tr>
<tr>
<td>Other Civilian</td>
<td>4.7%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>4.7%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Color
- Less than 1 Standard Deviation
- Between 1 and 2 Standard Deviations
- More than 2 Standard Deviations

Mean: 3.6
Standard Deviation: 4.3

Total Number of Observed instances of Semantic Interoperability Problems: 21
# Observed Positive Information Sharing

Total Number of Observed instances of Positive Information Sharing: 1119

<table>
<thead>
<tr>
<th></th>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
<td>5.4%</td>
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</tr>
<tr>
<td>Incident Command</td>
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<td>2.2%</td>
<td>0.2%</td>
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<tr>
<td>Law Enforcement</td>
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<tr>
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<tr>
<td>Military</td>
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<td>3.6%</td>
<td>3.1%</td>
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</tr>
<tr>
<td>Medical</td>
<td></td>
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<td></td>
<td>1.6%</td>
<td>1.8%</td>
<td>0.4%</td>
<td>3.7% 0.4% 3.6%</td>
</tr>
<tr>
<td>Other Civilian</td>
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<td></td>
<td></td>
<td>5.7%</td>
<td>1.0%</td>
<td>2.0%</td>
<td>0.0% 0.6% 0.1% 0.1%</td>
</tr>
</tbody>
</table>

Mean: 3.6  
Standard Deviation: 4.3

Color Comparison to Standard Deviation from Mean

- **More than 2 Standard Deviations**
- **Between 1 and 2 Standard Deviations**
- **Less than 1 Standard Deviation**
## Observed Problems in Information Sharing

### Total Number of Observed instances of Problems in Information Sharing: 97

<table>
<thead>
<tr>
<th>Category</th>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
<td><strong>13.4%</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Incident Command</td>
<td></td>
<td><strong>3.1%</strong></td>
<td><strong>12.4%</strong></td>
<td><strong>14.4%</strong></td>
<td></td>
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</tr>
<tr>
<td>Law Enforcement</td>
<td></td>
<td></td>
<td><strong>7.2%</strong></td>
<td><strong>12.4%</strong></td>
<td><strong>14.4%</strong></td>
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</tr>
<tr>
<td>Fire</td>
<td></td>
<td></td>
<td><strong>1.0%</strong></td>
<td><strong>4.1%</strong></td>
<td><strong>0.0%</strong></td>
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<td></td>
</tr>
<tr>
<td>Military</td>
<td></td>
<td></td>
<td></td>
<td><strong>6.2%</strong></td>
<td><strong>1.0%</strong></td>
<td><strong>3.1%</strong></td>
<td><strong>21.6%</strong></td>
</tr>
<tr>
<td>Medical</td>
<td></td>
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<td><strong>1.0%</strong></td>
<td><strong>1.0%</strong></td>
<td><strong>0.0%</strong></td>
<td><strong>0.0%</strong></td>
</tr>
<tr>
<td>Other Civilian</td>
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<td></td>
<td><strong>6.2%</strong></td>
<td><strong>2.1%</strong></td>
<td><strong>1.0%</strong></td>
<td><strong>1.0%</strong></td>
</tr>
</tbody>
</table>

### Color Comparison to Standard Deviation from Mean
- **Less than 1 Standard Deviation**
- **Between 1 and 2 Standard Deviations**
- **More than 2 Standard Deviations**

**Mean:** 3.6  
**Standard Deviation:** 4.3

### Summary
- Total number of observed instances: 97
## Observed Positive Shared Awareness

<table>
<thead>
<tr>
<th></th>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
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</tr>
<tr>
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<td>5.0%</td>
<td>2.5%</td>
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<td></td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>12.5%</td>
<td>10.0%</td>
<td>10.0%</td>
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</tr>
<tr>
<td>Fire</td>
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<td>0.0%</td>
<td>0.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military</td>
<td>17.5%</td>
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<td>2.5%</td>
<td>2.5%</td>
<td></td>
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</tr>
<tr>
<td>Medical</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>2.5%</td>
<td>2.5%</td>
<td>2.5%</td>
<td></td>
</tr>
<tr>
<td>Other Civilian</td>
<td>2.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### Color Comparison to Standard Deviation from Mean
- **Green**: More than 2 Standard Deviations
- **Light Blue**: Between 1 and 2 Standard Deviations
- **White**: Less than 1 Standard Deviation

**Mean**: 3.6
**Standard Deviation**: 4.3

**Total Number of Observed instances of Positive Shared Awareness**: 40
# Observed Problems in Shared Awareness

## Total Number of Observed instances of Problems in Shared Awareness

<table>
<thead>
<tr>
<th></th>
<th>Unified Area Command</th>
<th>Incident Command</th>
<th>Law Enforcement</th>
<th>Fire</th>
<th>Military</th>
<th>Medical</th>
<th>Other Civilian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unified Area Command</td>
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</tr>
<tr>
<td>Incident Command</td>
<td>5.6%</td>
<td>0.0%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>7.4%</td>
<td>5.6%</td>
<td>11.1%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Military</td>
<td>9.3%</td>
<td>11.1%</td>
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<td>9.3%</td>
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</tr>
<tr>
<td>Medical</td>
<td>0.0%</td>
<td>1.9%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.9%</td>
<td></td>
</tr>
<tr>
<td>Other Civilian</td>
<td>3.7%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### Mean: 3.6

### Standard Deviation: 4.3

### Total Number of Observed instances of Problems in **Shared Awareness**: 54
Organizational *Familiarity* and *Trust*

- Surveys administered as follows:
  - Pre-event distributed and collected at events preceding the Golden Phoenix 07 operational period
  - Post-event surveys distributed and collected at the conclusion of discrete operational events and at Golden Phoenix 07 Hot Wash immediately after the operational period
- Survey Responses:
  - Pre-event: 71
  - Post-event: 168
  - Pre- and post-event from the same individuals: 23
- Survey results analyzed by organizational grouping
Organizational *Familiarity and Trust* (Overall Finding)

- *Familiarity and Trust* improved significantly between pre-event and post-event surveys for the 23 participants who completed both instruments.

- *Familiarity and Trust* declined, but not significantly, when the data from those completing only the pre-event survey were compared with those completing only the post-event survey.
  - The CCRP team believes that those completing only one survey participated only briefly (less than one day)
  - They apparently came to understand the needs for interdependence and trust.
  - However, they failed to gain knowledge of others or build trust in them.

- These data suggest that Golden Phoenix 07 provided the opportunity to increase trust and familiarity but only when participation was broad and deep.
Conclusions: Lessons Learned

• Meaningful data can be collected cost-effectively in civil-military complex endeavors:
  – That address issues crucial to Network Centric Operations
  – That span data, voice, and human performance, and the Network Centric Operations Value Chain

• Successful collection requires:
  – Professional, experienced lead team (CCRP, NPS, SSC San Diego)
  – Involvement in planning
  – High quality data collection and data analysis plans
  – Access throughout the event
  – Adequate human resources (data collectors and analytical teams)
Continuing Impact

• Golden Phoenix 07 built upon successful, but smaller, training events during Golden Phoenix 06
  – Major increases in participating civilian organizations
  – Substantial increase in the breadth and depth of scenario
  – Some lessons learned about technical connectivity from Golden Phoenix 06

• *Golden Phoenix 07 created familiarity and trust that were exploited during wild fires later in the year*

• Planning for Golden Phoenix 08 includes even more civilian agencies such as the Border Patrol, DEA, FBI, and San Diego Public Health
Questions?
Thoughts?
Puzzles?