The Basic NIUSR Functional Model for WMD Incident Operational Management

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Please check out the Fall Conference in Huntsville, AL
Three Key Ingredients of Requirements Documentation

The most important aspects of developing good requirements are . . .

1) Structure
2) Structure
3) Structure

Ideally, structures with scalable, hierarchical, multidimensional, cross-relational attributes . . .
A 2-D Static Model can’t account for the evolving nature of WMD Incident parameters across time and space. It is a fixed viewpoint of the Emergency Response “System”.
There are pyramids and there are pyramids

Federal
State
Regional
Local

What are these levels?

- National Hierarchy of Jurisdictional levels or groups

Each Jurisdictional Group is Autonomous, and has its own levels of operational functionality

Law – what may be done
Operations – what can be done
Response – what must be done

Incident – Victims needs & timing
CONCEPT OF COMMAND PROTOCOL LEVELS
(NGO, Industry, and Medical Community Views Not Shown Here for Simplicity)

Notice that all organizational views span all levels, from law at the top to victims needs at the bottom!
FEDERAL GOVERNMENT COORDINATION
- “Federal” Includes Civilian and Military Agencies-

DIMENSIONS OF COORDINATION

Up and Down
In Each Organization

Across ALL Organizations

Across Composite Mgmt Teams for an Incident

ORGANIZATIONAL - OPERATIONAL INCIDENT COORDINATION *

FED-DoD
FED-CIVIL

Multiple Federal-Civil Agencies At Each Level

Multiple DoD Agencies/Services At Each Level

System Levels

Command Coordination
Responder Coordination

FEDERAL GOVT COORDINATION AT EVERY LEVEL. . .

* For Simplicity the State, Industry, and NGO domains are not shown here
CONCEPT OF MULTI-JURISDICTIONAL COORDINATION vs. SCENARIO TYPE & OPERATIONAL PHASE

INCIDENT OPERATIONAL COORDINATION

INCIDENT OPERATIONAL COORDINATION

INCIDENT OPERATIONAL PHASES

Prevent  Plan  Prepare  Respond  Recover  Rebuild

TYPES OF SCENARIOS

SCENARIO “HEAT”

NATURAL DISASTER
EXPLOSIVE ATTACK
PLAGUE ATTACK
COMBINATION
CHEMICAL ATTACK
ANTHRAX ATTACK
SPILL
911

Incident operational coordination is different for every type of scenario and for each operational phase of a scenario.

Multiple Agencies At Each Level

Command Coordination Responder Coordination

SYSTEM LEVELS

MULTI-JURIDICIONAL COORDINATION AT EVERY LEVEL

GOVERNMENT

INDUSTRY

PRIVATE

NON-GOVT (NGO)

(ONOB)
The FRP model emphasizes Static, two-dimensional Jurisdictional Ownerships and Responsibilities only. Operational functionality is oversimplified and in narrative form only - no dynamic features!

The NIUSR Information-Model for WMD Incident Management

The NIUSR Information-Model emphasizes Dynamic information interfaces that support situation-knowledge coordination and a common operational-situational view.
Static Models vs. Dynamic Models

A Static Model doesn’t account for the evolving nature of WMD Incident across time and space. It is a fixed viewpoint of the Emergency Response “System”.

A Dynamic model accounts for multiple dimensions across time and space, and through operational organization evolution... including evolving command protocols.
Dynamic Model Dimensions

- From LOCAL 911 coordination at bottom to International cooperation at top
- Across all threats (All-Hazards, including all WMD)
- Across all jurisdictions and types of participants from law to medicine
- Across all essential elements of information and communication needs
- Across all operational phases from analysis, to planning, to training, to exercise, to execution, to resolution
- Across all evolutionary changes of command protocols from small incident to catastrophic medical emergency
Using XII Model to Show Basic E-911 Emergency Interfaces

- Basic Computer-Aided-Dispatch (CAD) for Everyday Incidents -

- Government Infrastructure
- Emergency Management
- C4I
- C5I

**E-911 “First Responders”**

- Wide arrows show flow of response resources and responder teams

- Fire
- Police
- Medical
- SAR
- Other

**911 Operations**

- 24/7 operation

**Municipal Agencies**

- Response Teams/Cmd

**Response / Aid**

- Local Care Facilities

**Victims & Worried Well**

**Concerned Public, Officials, and Media**

- Incident Scene

**Purple arrows represent flow of incident knowledge using interoperable communications links of all kinds:**
- telephone, fax, radio, computer

**911 call**

**911 CAD**

**telco**
The true nature of the WMD incident remains unknown until first responders arrive on scene and start assessing the situation. The incident response then escalates stage by stage. The exact nature of the threat remains unknown for some time.
Modeling The Later-Beginning of a Chemical WMD Incident

- More Responder Teams Are Called In, Situation Unfolding and Expanding -
- Cell Phones and E-911 may become overloaded and unusable -
Modeling The Middle Stage of a Chemical WMD Incident

- Situation Beyond Local Abilities to Handle, Outsiders Called In (by who?) -

Information sharing at all levels becomes difficult because of communications interoperabilities and especially because of lack of common information formats - even solving these problems leaves the problem of finding out who has what information.

Multiple levels of EMA-EOC involved, Public and Press must be brought in on situation.

Unified Command and Inter-agency coordination are now much more complicated - not clear who's in charge of what now.

The threat agent determined as chemical warfare agent, source ID'd, plume being worked - population at risk must be alerted, given instructions for safety.

Some Medical Care Facilities may become contaminated by victims, or be in path of plume.

Many more outside agencies now involved and sending help and needing information.

On-Site Response Team

On-Site Response / Aid

Response / Aid

Victims & Worried Well

Concerned Public, Officials, and Media

Response

Teams/Cmd

911 Operations

C4I

C5I

County Agencies

County EOC

State Agencies

State EOC

6. Situation Beyond Local Abilities to Handle, Outsiders Called In (by who?)

Information sharing at all levels becomes difficult because of communications interoperabilities and especially because of lack of common information formats - even solving these problems leaves the problem of finding out who has what information.

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MODELING THE "FEDERAL" PHASE OF A CHEMICAL WMD INCIDENT

-SITUATION HAS ESCALATED TO FULL-BLOWN FEDERAL WMD INCIDENT-

**Once the Federal Government WMD “system” is activated, the command control and “ownership” problems escalate, as do the information sharing problems. Feds tend to take over and use their own C2 protocol; locals won’t want to give up information that weakens local control. Information “righteousness” and access control becomes big issue. Coordination can deteriorate.**

Even when all this is solved, interoperable information formats are still problematic!!
Modeling The BIG PICTURE for Emergency Management

- Natural Disasters, Technological Disasters, Emerging Infectious Diseases, WMD Terrorism

C4I + Information Coordination = C5I

Government Infrastructure
- Int’l Agencies
- Federal Agencies
- State Agencies
- County Agencies
- Municipal Agencies

Emergency Management
- GDIN/NDIN
- Federal EOCs
- State EOC
- County EOC
- 911 Operations
- Unified Cmd
- 911 call

Industry Management
- Industrial EOCs
- Chemical
- Nuclear
- Energy
- Transportation

INDUSTRY

Response / Aid
- On-Site Response Team

Concerned Public, Officials, and Media
- Victims & Worried Well

Incident Scene

Response Teams/Cmd

Local Care Facilities

Response Teams/Cmd

911 CAD

telco

THREAT
Features of XII Information Interoperability Model

First Response
- Local
- Private
Second Response
- Mutual Aid
- State, NG
Third Response
- Federal

Inherited Response
- Hospitals
- Care centers
- Morgues

Response Teams Technologies
- Hazmat
- SAR
- Medical
- Biological/Chemical
- Radiological
- Explosives
- Fire
- Law Enforcement

International Agencies

Government Agencies

State Agencies

Local Agencies

State EOCs

Local EOCs (911)

GDIN/NDIN EOCs

Government EOCs

Industry EOCs

Public/Media

C2 Hierarchy and Data Ownership Chain

Interoperability Network Links and Information Protocols
- Special purpose
- Public/Private
- State & Local
- Federal
- Civil & DoD

All Hazards Threat
-including including extreme events

Incident Command
- ICS (offsite-onsite)
- Special Commands
- Unified Command

Incident events, response situations, and victim’s needs

On-Scene Incident data collection and derived information

(All items interrelated to Scenario event flow and timeline)
The XII is an information infrastructure OVERLAY that allows cooperative interchange of information between all the different emergency management and response players from top to bottom and from side to side -- facilitating the exchange of the right information at the right time in the right place.

- Network connectivity is only a foundation
  - nodes and links provide connectivity and accessibility, throughput capacity
  - networked services provide security, reliability, graceful degradation, information delivery confirmation, data archiving
- Common message formatting necessary to facilitate information interchange
  - In absence of common formatting, information translators can be used
- Creation of common, shared, incident knowledge base is dependent upon data-fusion activity
  - Intelligent Information search-agents are required to acquire data for data fusion
- Information ownership, access controls, data righteousness are totally separate issues
XII Interoperability Model Across Incident Lifecycle Timeline

XII Information Interoperability Model across Incident Lifecycle

Why Do We Need and Information Model?
- To facilitate the exchange of the right information, at the right time, in the right place . . .
  - Which requires knowing what information is needed, when, and where, and why . . .
  - Which requires and information model across events, time, organizations, and users . . .
A very simple example of the use of an XII information translator is when a Federal Response Team arrives on site for assistance and needs to use some detailed GIS mapping information. The local GIS detailed maps prepared by and owned State or Municipality resources may be in a format different than that used by the Federal Team. A translator is needed so the Federal Team can use the local detailed maps, and then add and share incident specific knowledge with other incident participants.
Net-Centric View of the “XII System”

Emergency Management Network

Middleware Services

- Translator Source
- Data Fusion Engine

- GDIN/NDIN
- Federal EOCs
- State EOC

- Int’l Agencies
- Federal Agencies
- State Agencies
- County Agencies
- Municipal Agencies

- INDUSTRY
  - Chemical
  - Nuclear
  - Energy
  - Transportation

- INDUSTRY
- Industrial EOCs

- MEDICAL COMMUNITY
  - Federal Facilities
  - State / Regional Facilities
  - Public Health
  - Clinics
  - Local Hospitals

- 911 Operations
- County EOC
- Unified Cmd
- Response Teams/Cmd
- Onsite Care Facilities

- Exercise Control
- Scenario Injectors

- Info Translator master

Network Links
- Translators
Summary of XII Net-Centric Requirements

Five Key Requirements for Emergency-Incident Knowledge Exchange

1) Communications Interconnect Accessibility
   - Requires compatible network links and protocols

2) Data Accessibility
   - Requires access privilege (includes need-to-know), identity verification, common directory, intelligent search agents (these require knowledge to work well), and data interoperability

3) Data Interoperability
   - Requires compatible data exchange formats or translators

4) Information Sharing
   - Requires common data context, which means common information formats or templates, and common glossary

5) Knowledge Sharing
   - Requires that all event, time, and space relationships between information parcels be referred to a common operational model having end-to-end, top-to-bottom, side-to-side, and front-to-back interactions defined with common symbology, glossary, format.
Why is the XII Model Needed?

The XII Information Model is can help understand what kinds of information are needed at what places and what times for what purpose, in order to build a “smart” directory and knowledge agents for decision support, and to define the common incident “picture” components and format.

It can also be used to track the evolution of command protocol as the situation progresses from strictly local to national catastrophic medical disaster.

It can be used to establish a foundation for modeling and simulation work, leading to capabilities for a national simulation capability for catastrophic medical emergencies.
The NIUSR High Level Reference Model for Disaster Management

B. L. Hartway
Requirements Chairman, NIUSR
June 14, 2001
Operational Concept Model for Emergency Response

- Imagery & Navigation
- EOC Installations & Nearby Communities
- Upgraded EOC Emergency Operations Centers
- LOCAL-STATE-FEDERAL AUTHORITIES
  - Faster Decisions & Better Support Information
  - Map-Based Operations Data
  - Decision Aid
- Enhanced DISASTER RELIEF - OPERATIONS -
  - Command & Control for Emergency Response Units
  - Integrated GIS DB, Preplans, Status, and updates

Information Packages
- GIS
  - Updated Site data
  - Aerial Photos
  - "Realtime" Site updates
    - Field Status & Assessment Data
    - Realtime Status updates
      - site, victims, resources

Emergency Support Functions (ESFs)
  - Civil, Military...Local, State, Regional, Federal RESPONSE RESOURCES

Emergency Support Functions (ESFs)
  - Civil, Military...Local, State, Regional, Federal RESPONSE RESOURCES
The updated NIUSR High Level Reference Model (HLRM) - Showing the many faces of “Emergency Management”

**All Hazards Emergency Management**

**C6I**

**C6I** = **C4I** + Multi-Agency Cooperation and Coordination

**Disaster Emergency Management Support Agencies**

**Public Safety (First Responder) Emergency Management**

**Catastrophic Medical Disaster Emergency Management**
The updated NIUSR High Level Reference Model (HLRM)

C4I
Support Infrastructure
Govt/NGO/Private Agencies

- Int’l Agencies
- Federal Agencies
- State Agencies
- County Agencies
- Municipal Agencies

C6I
Crisis, Consequence, and Emergency Management Infrastructure

- GDIN/NDIN
- Federal EOCs
- State EOC
- County EOC
- 911 Operations
- Unified Cmd

C4I
Medical Management Infrastructure
Health Care Community

- WHO
  - Public Health
  - Hospitals
  - Care Centers
  - Clinics
  - Physicians
  - Hospital EDs

Hot Zone Response and Aid
Triaged, Treated, Transported

Victims & Worried Well (know they’re victims or think they are)
Concerned Public (may be victims and not know it), Officials, and Media

Everybody calling everybody about everything – CNN everywhere
An Expanded On-Site Casualty Situation (Mutual-Aid)

C4I
Support Infrastructure
Govt/NGO/Private Agencies

C6I
Crisis, Consequence, and Emergency Management Infrastructure

911 Operations

1. Concerned Public (may be victims and not know it), Officials, and Media
2. Field Medical care
3. Medical Management Infrastructure

C4I
Municipal Agencies

Response Teams/Cmd

911 CAD

Unified Cmd

Hot Zone Response and Aid

Triaged, Treated, Transported

Victims & Worried Well (know they’re victims or think they are)

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THREAT
Bio-Situation Recognized as Some Kind of Perpetrated Event

- C4I: Support Infrastructure (Govt/NGO/Private Agencies)
- C6I: Crisis, Consequence, and Emergency Management Infrastructure
- C4I: Medical Management Infrastructure (Health Care Community)

**Scene**
- Health Care Community
- Medical Management Infrastructure
- Support Infrastructure

**Response**
- 911 Operations
- Concerned Public (may be victims and not know it), Officials, and Media
- Incident Site
- Victims & Worried Well (know they're victims or think they are)

**Support Agencies**
- County Agencies
- Municipal Agencies
- Unified Response Teams/Command

**Disaster Command/Control**
- County EOC
- 911 Operations

**Medical Care**
- Public Health
- Hospitals
- Clinics
- Physicians
- Hospital EDs
A “Homeland Defense” Situation for a Recognized Attack

**C4I**
Support Infrastructure
- Govt/NGO/Private Agencies
  - Federal Agencies
  - State Agencies
  - County Agencies
  - Municipal Agencies

**C6I**
Crisis, Consequence, and Emergency Management Infrastructure
- 911 Operations
- Unified Cmd
- County EOC
- State EOC
- Federal EOCs

**C4I**
Medical Management Infrastructure
Health Care Community
- Public Health
- Hospitals
- Care Centers
- Clinics
- Physicians
- Hospital EDs

Emergency Response Teams/Cmd
- Hot Zone Response and Aid
- Field Medical care
- 911 CAD
- Federal EOCs
- County EOC
- State EOC
- 911 Operations
- Unified Cmd

Concerned Public (may be victims and not know it), Officials, and Media
- Field Medical care
- Response Teams/Cmd

(Everybody calling everybody about everything – CNN everywhere)

Incident Scene
(UNKNOWN)

Victims & Worried Well (know they’re victims or think they are)

Triaged, Treated, Transported
The updated NIUSR High Level Reference Model (HLRM)

**C4I**
- Support Infrastructure
  - Govt/NGO/Private Agencies
    - Int’l Agencies
    - Federal Agencies
    - State Agencies
    - County Agencies
    - Municipal Agencies
  - Response Teams/Cmd
  - 911 CAD

**C6I**
- Crisis, Consequence, and Emergency Management Infrastructure
  - GDIN/NDIN
  - Federal EOCs
  - State EOC
  - County EOC
  - 911 Operations
  - Unified Cmd

**C4I**
- Medical Management Infrastructure
  - Health Care Community
    - WHO
    - Public Health
    - Hospitals
    - Care Centers
    - Clinics
    - Physicians
    - Hospital EDs

**Incident Scene**
- Hot Zone Response and Aid
- Triaged, Treated, Transported
- Victims & Worried Well (know they’re victims or think they are)
- Concerned Public (may be victims and not know it), Officials, and Media

(Everybody calling everybody about everything – CNN everywhere)

THREAT
Technical Aspects of NIUSR High Level Reference Model

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Requirements Chairman, NIUSR
June 14, 2001
Operational Concept Model for Emergency Response

Information Packages

- GIS
- Aerial Photos
- "Real-time" Site updates
- Pre-planned, Pre-Digitized Site/Region Maps, Database & Decision Aid Tools
- Operational Guidelines and Legal References
- EOC Database with Preplanned Responses & Decision Aids

Command & Control for Emergency Response Units

EOC Installations & Nearby Communities

Upgraded EOC Emergency Operations Centers

Enhanced DISASTER RELIEF - OPERATIONS -

Faster Decisions & Better Support Information Map-Based Operations Data and Decision Aid

LOCAL-STATE-FEDERAL AUTHORITIES

Emergency Authority & Coordination

Legal

Decision Makers

Operation

Integrated GIS DB, Preplans, Status, and updates

Site-Specific Maps + Integrated data

Initial Site data

Imagery

Aerial Photos

"Realtime" Status updates
- site
- victims
- resources

Real-time updates to EOC database

Emergency Support Functions (ESFs)

Civil, Military...Local, State, Regional, Federal RESPONSE RESOURCES

ENHANCED DISASTER RELIEF RESPONSE
- Civilian & Military -

Disaster Situations

Imagery & Navigation

WL-991109V10
The updated NIUSR High Level Reference Model (HLRM)

**C4I**
- Support Infrastructure
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    - Federal Agencies
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    - Municipal Agencies
    - 911 Operations
    - Unified Cmd
- Response Teams/Cmd
- 911 CAD
- Field Medical care
- Response Teams/Cmd

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- Crisis, Consequence, and Emergency Management Infrastructure
  - GDIN/NDIN
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**C4I**
- Medical Management Infrastructure
  - Health Care Community
    - WHO
    - Public Health
    - Hospitals
    - Care Centers
    - Clinics
    - Physicians
    - Hospital EDs

**Incident Scene**
- Victims & Worried Well (know they’re victims or think they are)
- Concerned Public (may be victims and not know it), Officials, and Media

**Threat**
- (Everybody calling everybody about everything – CNN everywhere)
The updated NIUSR High Level Reference Model (HLRM) - Showing the many faces of “Emergency Management”

All Hazards Emergency Management

C6I = C4I + Multi-Agency Cooperation and Coordination

Catastrophic Medical Disaster Emergency Management

Disaster Emergency Management Support Agencies

Public Safety (First Responder) Emergency Management

C6I = C4I + Multi-Agency Cooperation and Coordination
Top Down Requirements Analysis
Using the High Level Reference Model

- Sometimes called Domain Analysis -

Each Element Category of the HLRM can be decomposed into hierarchical structures

Weather or Environment (E)
Threat Conditions & Agents (T)
Detection and Sensing (S)
Communications (C)
Command Control (C2)
Intervention / Response (I)
Supporting Agency Interfaces (IF)
The victim’s needs are the key response drivers.
There are many equivalent representations of the interactions between system entities

The HYT paradigm structured interaction chart is a universal basis tool supporting all representations
Interplay of Scenario Events, Timing, and Functions Across Scenario Event Space

Key system Interactions and Functions
- Threat & Environ. Interactions
- Emergency Management Comm Messages
- EM Functions across scenario time

Threat Intel

Threat Scenarios

Scenario Key Events and Functional Timeline

Key Casualty Needs of victims

- Intelligence
- Surveillance
- Detection
- ID
- Classification
- Typing
- C2
- IF

(f_t)
Simulation Test Bed Supports Analyses for All Scenarios

Simulation Models for Test

Level of fidelity and detail of Models is chosen to match purpose of test

System Comm Messages between system elements

System Testbed can be configured to test any element or system function at any level of detail and fidelity to generate system evaluation data for selected scenarios.
• **Basic Operational Functions** are the same for all types of incidents
  - *but details are unique for each type of incident (CBRNE)*

• **Response Timeline Requirements** to Chemical and Biological Terrorism are totally driven by the clinical pathways of the threat agents!
Timeline For Medical Intervention
of Terrorist / Warfare Agents

Chemical Agents

Toxins

Conotoxin
Batrachotoxin
Saxitoxin
Tetrodotoxin

Bacteria

Tularemia
Legionnaire's
Anthrax
Plague
Shigellosis
Cholera
Salmonellosis

Encephalitis (various)
Hantaan
Congo-Crimean
Chikungunya
Rift Valley
Dengue
Yellow
Ebola/Marburg
Lassa

Smallpox

Cryptococcosis
Coccidioidomycosis
Histoplasmosis

Rickettsiae, Chlamydiaceae

RMSF
Typhus
Psittacosis
Q fever

Chemical Agents

Toxins

Conotoxin
Batrachotoxin
Saxitoxin
Tetrodotoxin

Bacteria

Tularemia
Legionnaire's
Anthrax
Plague
Shigellosis
Cholera
Salmonellosis

Encephalitis (various)
Hantaan
Congo-Crimean
Chikungunya
Rift Valley
Dengue
Yellow
Ebola/Marburg
Lassa

Smallpox

Cryptococcosis
Coccidioidomycosis
Histoplasmosis

Rickettsiae, Chlamydiaceae

RMSF
Typhus
Psittacosis
Q fever

Elapsed Time

T=0 threat first reaches victims

1st Responders Arrive

2nd Responders Arrive

Civil Support Teams Arrive

Follow-up Federal Resources & Supplies Arrive

(1) After Notification

WMD Clinical Pathways “Nomogram” is Critical Decision Aid

Clinical data of effects and critical treatment timing for selected threat agent

Threat agent 1

Threat agent N
WMD Clinical Pathways “Nomogram” For Medical Intervention

Threat Agent
- Lethality %
- Morbidity %
- Transmissivity %

Select threat agent

Available / Recommended Treatment Options for threat agent
- Vaccine
- Antibiotic
- Antidote
- Other Treatment

Effectiveness period of the Vaccine?
 Effectiveness period for the Antidote/Drug?
 Persistence of the threat agent?
 Decontamination Necessity and Method?
 Quarantine Necessity and Method?

Exposure Occurs @T₀

Effectiveness @ days before
1 5 10 30

Effectiveness @ hours after
1 4 12 24

Time?

Presentation of Symptoms

Earliest Detection and Diagnosis before symptoms?
 Time?
 Method?

Earliest Diagnosis after symptoms?
 Time?
 Method?

Incubating Illness

Transmission method?
 Prevention method?

Contagiousness develops when?
 Contagiousness ends when?

Recovery

Death
Threat Agent ID & Treatment Options is Key Scenario Driver

The threat agent and its effects on victims across time are the primary scenario event drivers . . . and also key to measuring emergency response and treatment effectiveness.