

# *Developing a National Emergency Response Modeling & Simulation Framework*

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# Introduction

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*Promote development of a simulation framework to allow distributed, integrated execution of a broad range of simulation systems...*

*Identify resources needed to develop, demonstrate & deploy a simulation framework ...*

- ! Sufficient expertise & computing resources are available within US scientific community to permit workable framework to be rapidly developed
- ! Objective is to discuss numerical problems & currently available solutions associated with implementing a nationwide integrated ER simulation framework

# *Presentation Overview*

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- ! Notional description of ER M&S framework
- ! High-level discussion of design & integration considerations
  - + **Present potential solutions**
- ! Suggest scientific/programmatic mechanism for developing & implementing framework

# *One Vision for a Fully Implemented National ER Simulation Framework*

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- ! **Highly-integrated on-demand analysis capability**
  - + **Terrorist attacks, industrial accidents, natural disasters**
  - + **Maximize use of existing analysis software & data**
- ! **Complete *occurrence-evolution-operational-resolution* problem space**
  - + **Incident/locale specific scenarios**
- ! **Would support**
  - + **Administrative planning**
  - + **First responder training & real-time operational support**
- ! **Available via network to any federal, state, local agency**
  - + **Administrators, first responders, law enforcement**
  - + **Software & hardware developers**

# *Implementing Framework Presents Non-trivial Computational Problems*

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- ! Methodology to permit scientifically accurate integrated analysis using existing non-homogeneous software
  - + **User base includes non-computing professionals**
- ! Access to statistically consistent, locale/incident specific data & software needed for integrated analysis
  - + **Archived & real time**
- ! Operational management of large scale geographically dispersed distributed computing network
  - + **Configuration would approximate information grid with attendant stability & reliability issues**
- ! Providing analysis capability to all concerned agencies
  - + **Many local agencies do not have expertise & computing resources needed to utilize framework**

# Software Integration Issues: Non-homogeneous Legacy Software

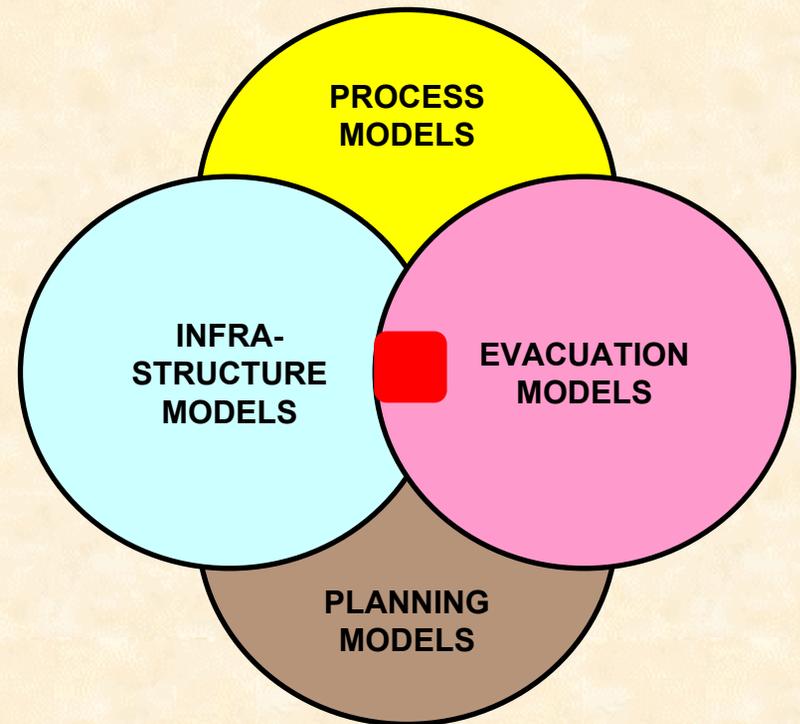
! ER modeling requires extremely broad range of simulation tools

- + NBC agent dispersal
- + Facilities damage
- + Resource utilization
- + Incident command

! Each can have different

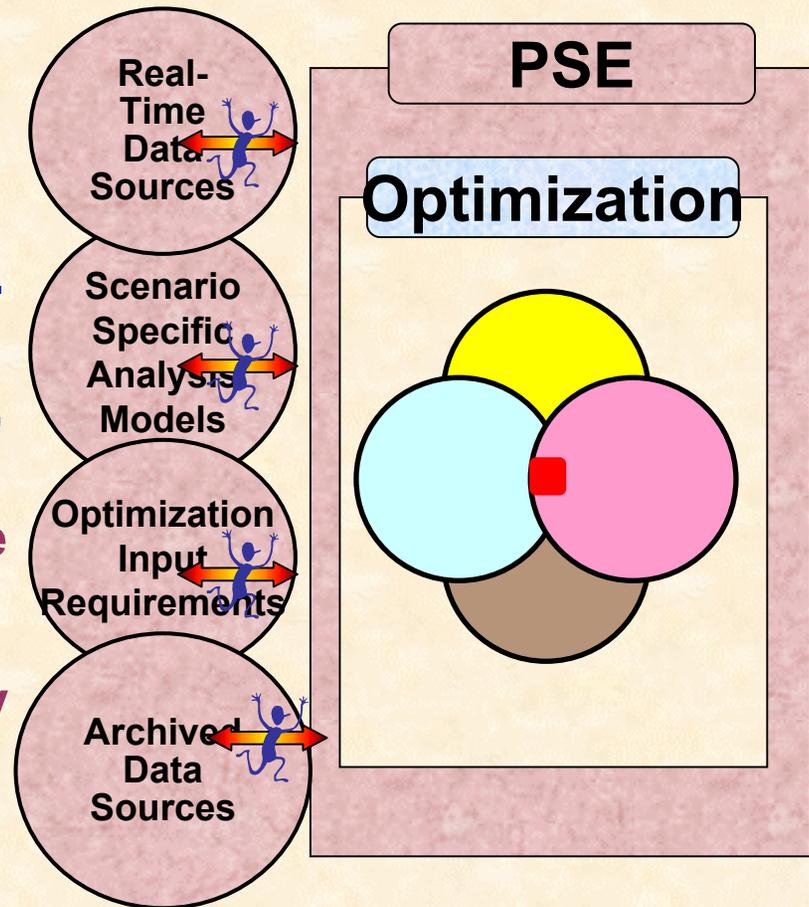
- + Variable granularity, time scales, storage needs, logic structures that limit integration, conformance with programming standards

! Analysis framework must accommodate these programming non-homogeneities at run time; **BUT** there will be limits to the extent to which legacy codes can be integrated



# Software Integration Issues: Non-homogeneous User Base

- ! Different computing skills
  - + ER professionals vs software developers
- ! Varying analyses scope
  - + Planning & training vs real-time incident support
  - + Incident scenarios, locales, on-site resources
- ! Analysis framework should be implemented with *Problem Solving Environment (PSE)* to manage computing complexity at run time
  - + On-line & on-demand



# Software Integration: Two Example Methodologies

! **Cognitive Agent Architecture Open Source (Cougar)** software **OPTIMIZATION**

Originally developed by DARPA & ALPINE for military logistics

Millions of different object types to be managed

10's of thousands interleaved processes

Thousands of non-homogeneous databases

Ideal for analysis of complex domains

Enables rapid development of distributed-agent based applications that are powerful, expressive, scalable

Qualitative Problem Definition

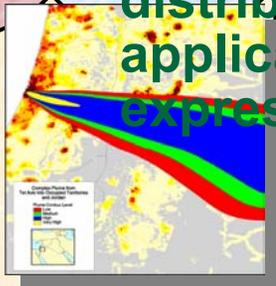
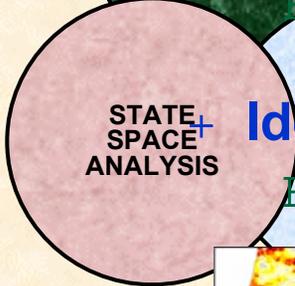
Reality Embedding

Event Analysis Software

Event Schedules & Supporting Data

Subsystem Performance

Results Visualization



# *Data Requirements: Categories are Complex in the Extreme*

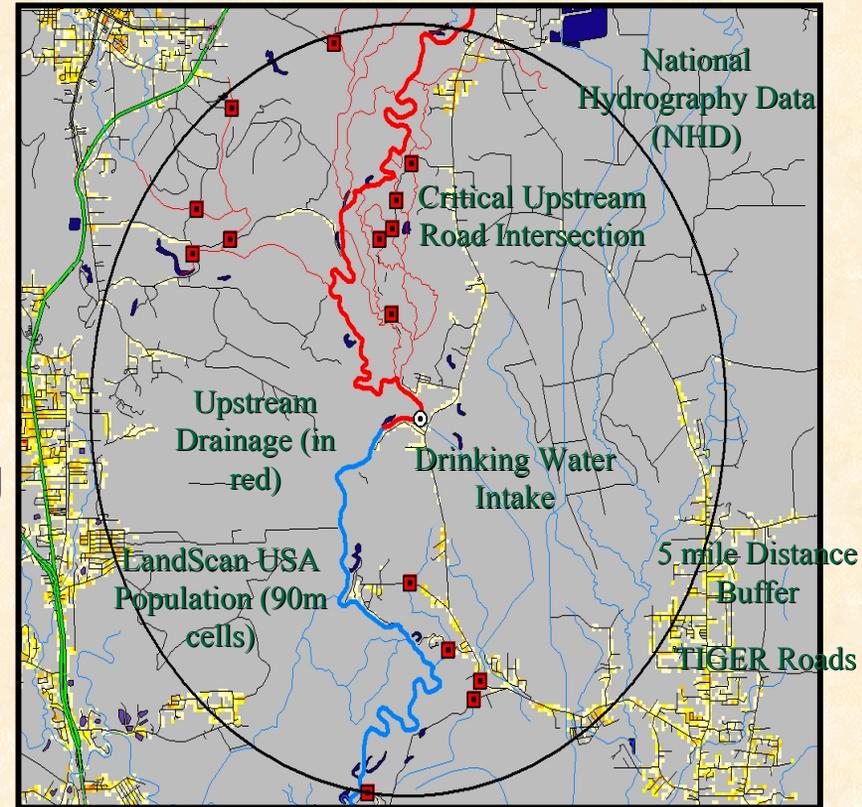
**! Context driven & typically only fully defined at run time**

Occurrence	Evolution	Operational	Resolution
! Initiating event	! Meteorology	! Mobile & fixed resources required	! Post-event evaluation
! Intelligence	! Duration	! Mitigation measures	! Revise planning/training
! Location	! Consequence	! Secondary effects	! Update data
! Population, infrastructure, & environment at risk	! Dispersion	! Routes	! Prepare for future events
! Prediction	! Response time	! Contingency	
	! Infrastructure data		

## COMMUNICATIONS

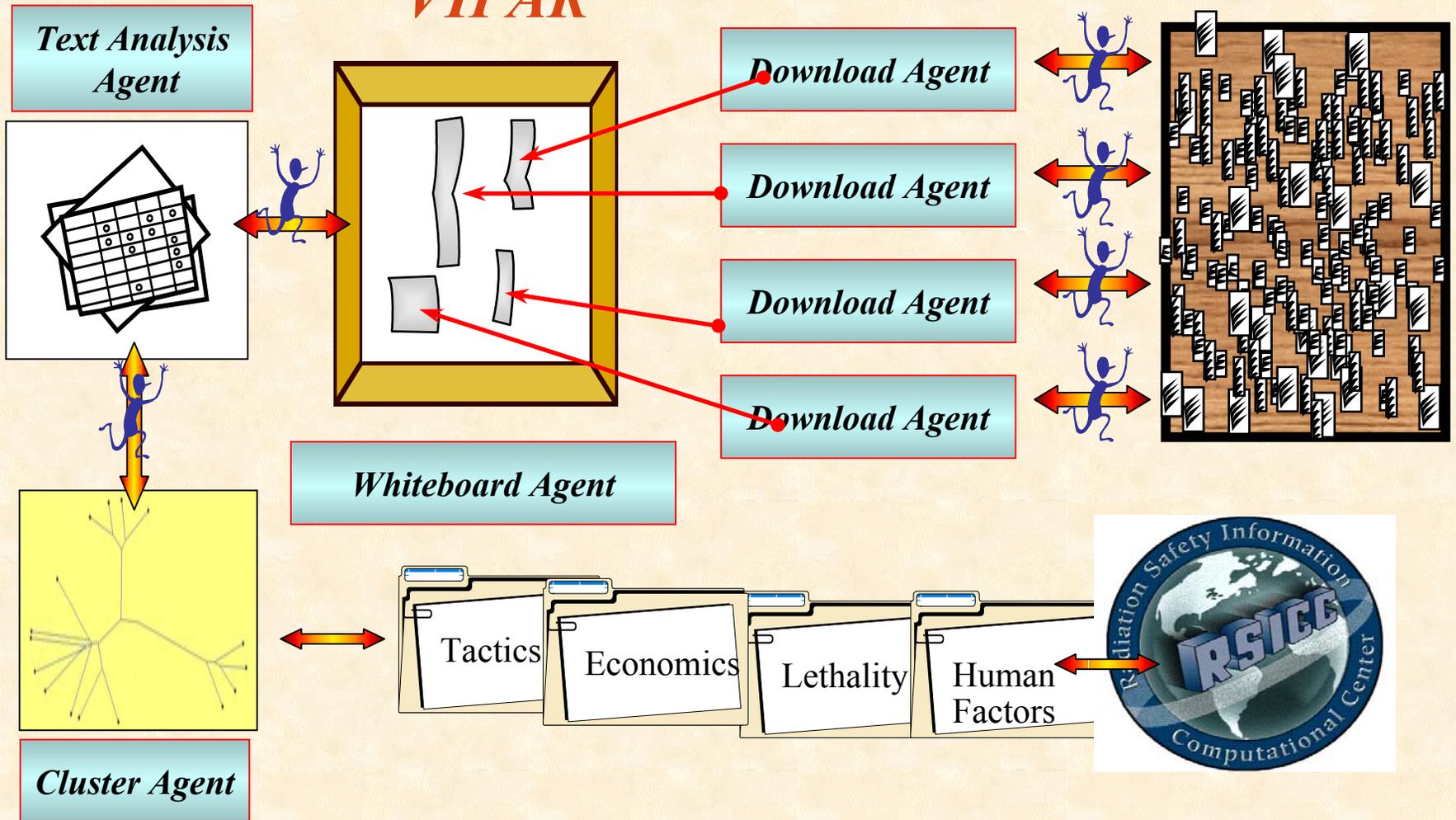
# *Data Requirements: Within a Category Data Values Can Vary Significantly*

- ! Steady-state vs transient
- ! Standardized archived vs real-time
- ! Deterministic vs probabilistic  
+ Stand-alone vs integrated
- ! Conversion inaccuracies
- ! Technical rigor & lack of unifying standards
- ! Analysis framework must facilitate on-demand on-line data identification, retrieval, validation, standardization



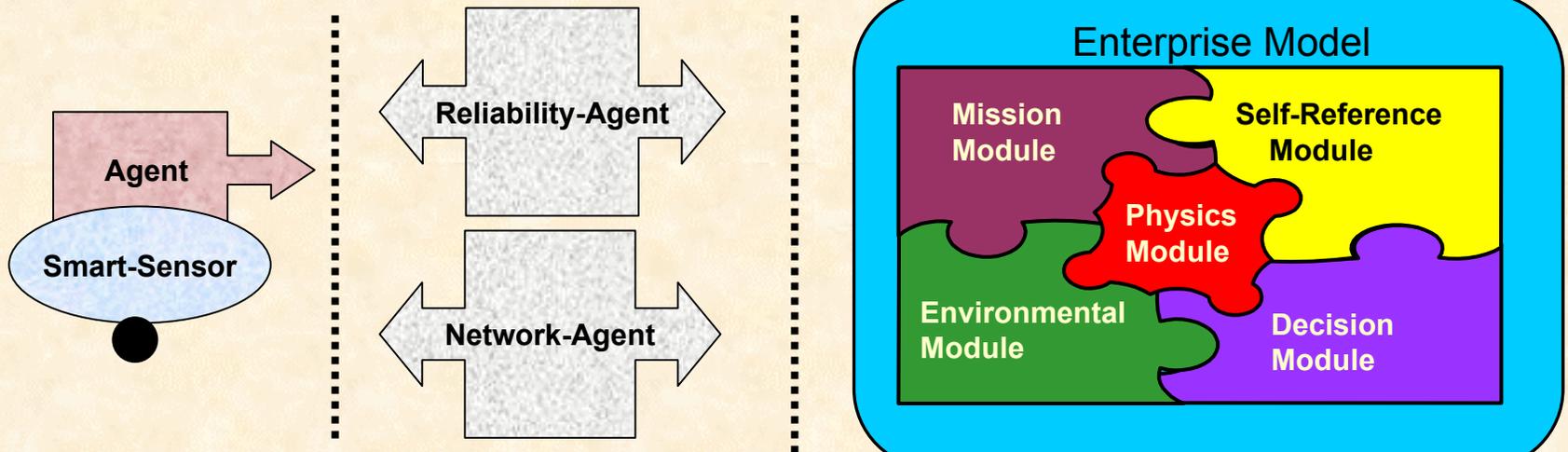
# Data Retrieval & Standardization: Two Example Technologies

## VIPAR



# Distributed Network Management

- ! Conceptually, framework functionality would include
  - + User interface to centralized computing capabilities, location & retrieval of archived software & data from distributed sources, link to real-time data sources
- ! In effect, a **complex** network-centric information grid
  - + Will require *intelligent management system* to insure stable operation



# User Access to Analysis Framework

- ! Many local agencies lack analysis expertise & computing resources to utilize proposed framework
  - + Primarily due to financial constraints & not likely to change
- ! Solution could include implementing framework within context of a National ER M&S User Center patterned after DOE Scientific User Facilities
- ! DOE-sponsored user facility capabilities are
  - + Free if results are published
  - + Cost-recovered for proprietary results



*ORNL High Temperature Materials Laboratory provides extensive technical expertise & equipment to industry & academia for materials research*

# *Federally-funded M&S User Center Ideal Mechanism for Implementing National ER Analysis Framework*

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## ! Scientific scope

- + **Open collaborative problem-solving environment to provide ER M&S**
  - E All local agencies: administrative planning, training, operational support
  - E Computing & non-computing professionals
- + **Develop & maintain analysis expertise & capabilities**
  - E Integrating methodology, standardized software library, archived & real time standardized data, advanced visualization capabilities, computing & networking hardware

## ! Programmatic scope

- + **Leverage ongoing M&S efforts within government, response community, industry, academia**

## ... In Summary

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- ! Designing & implementing National ER M&S Framework will be complicated in the extreme
  - + Should include software, data, computing hardware adequate for integrated multi-purpose analysis
    - E Can utilize existing software/data resources **BUT** will also require new software development
  - + Should provide for non-homogeneous user base
    - E PSE should be integral component of framework
  - + Should include provisions for maintaining distributed network
  
- ! Federally supported National ER M&S User Center is natural mechanism for implementing M&S goals
  - + Programmatic & scientific focal point for M&S activities

***Questions ?***

***Back Up Slides***

# Event Analysis is Enabling Numerical Technique for CA Methodology

