A Framework for Vulnerability/Lethality Modeling and Simulation

National Industrial Association 47th Annual Fuze Conference
April 10, 2003

Mr. Eric Scarborough
(850) 678-5222
scarboro@ara.com

Mr. IanTalbot
(850) 882-4665
ian.talbot@eglin.af.mil

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Presentation Outline

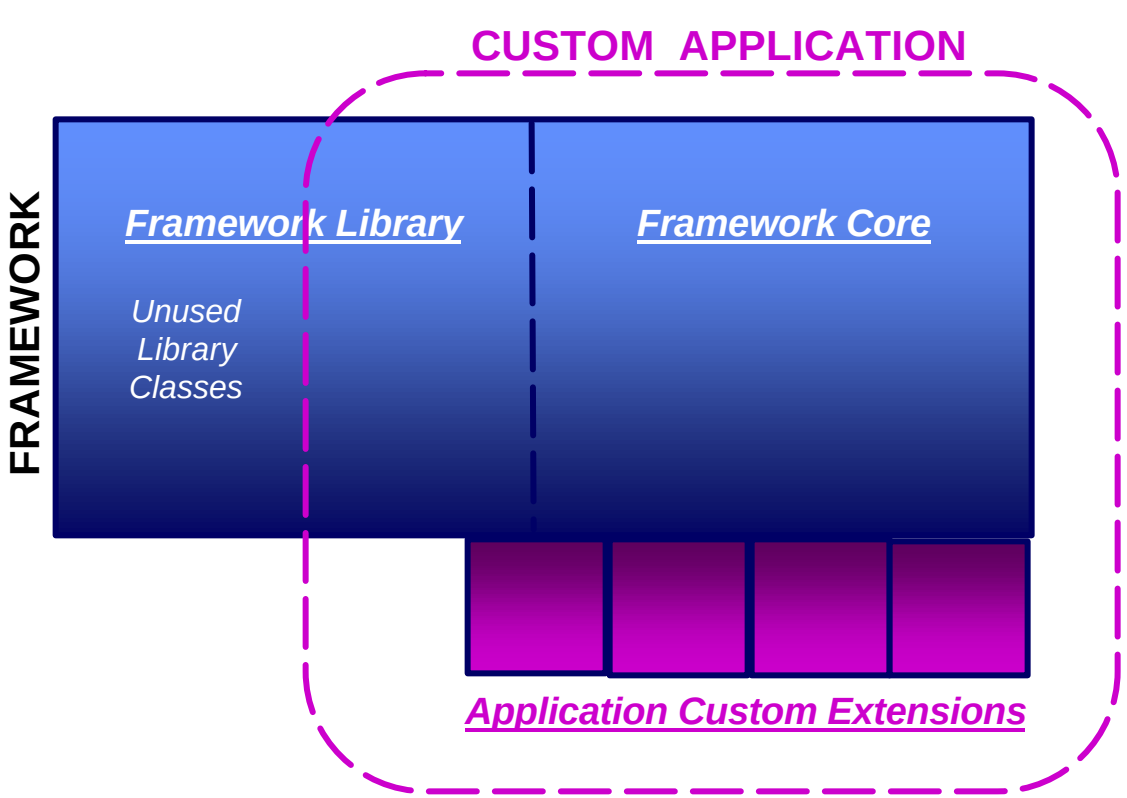
- Introduction
- The Framework Concept
  - Base Fuze Class
- The PILR Architecture
- Endgame Framework Benefits

Current M&S Deficiencies

- Monolithic software - not configurable
- Data driven
- No synergy
- Empirically-based
- Lack visualization
- Cannot link to other models
- High/redundant maintenance
- Expert-friendly
- Platform specific
- Lack V&VA
- Inconsistent units
- Geometry-specific

"Technical frameworks must be developed to ensure appropriate interoperability across different simulations; reuse of simulation components; insertion of new technologies; and flexibility to respond to changing requirements." DoD 5000.59-P

What is a Framework ?

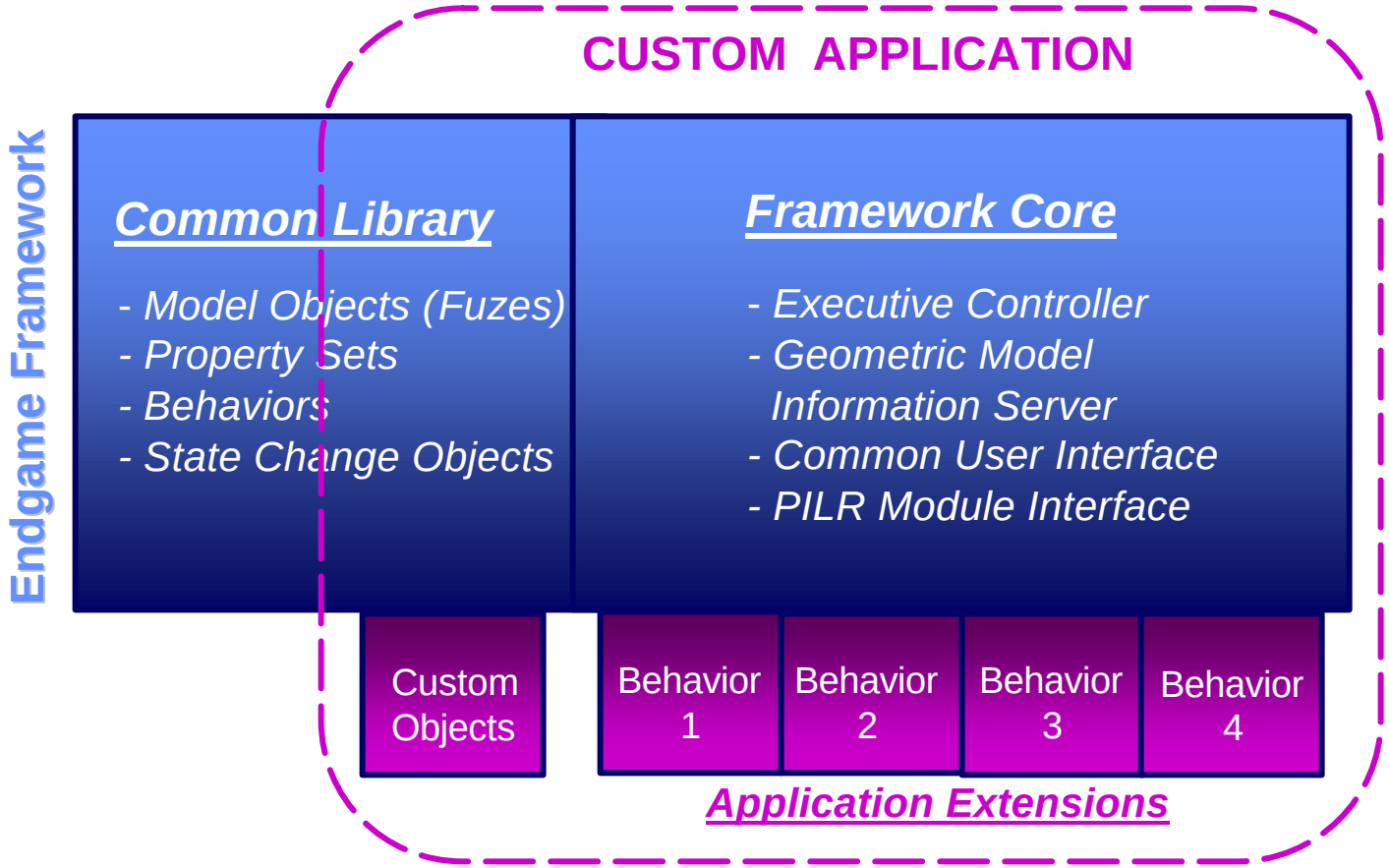


A collection of classes that abstract the common functionality needed by similar applications

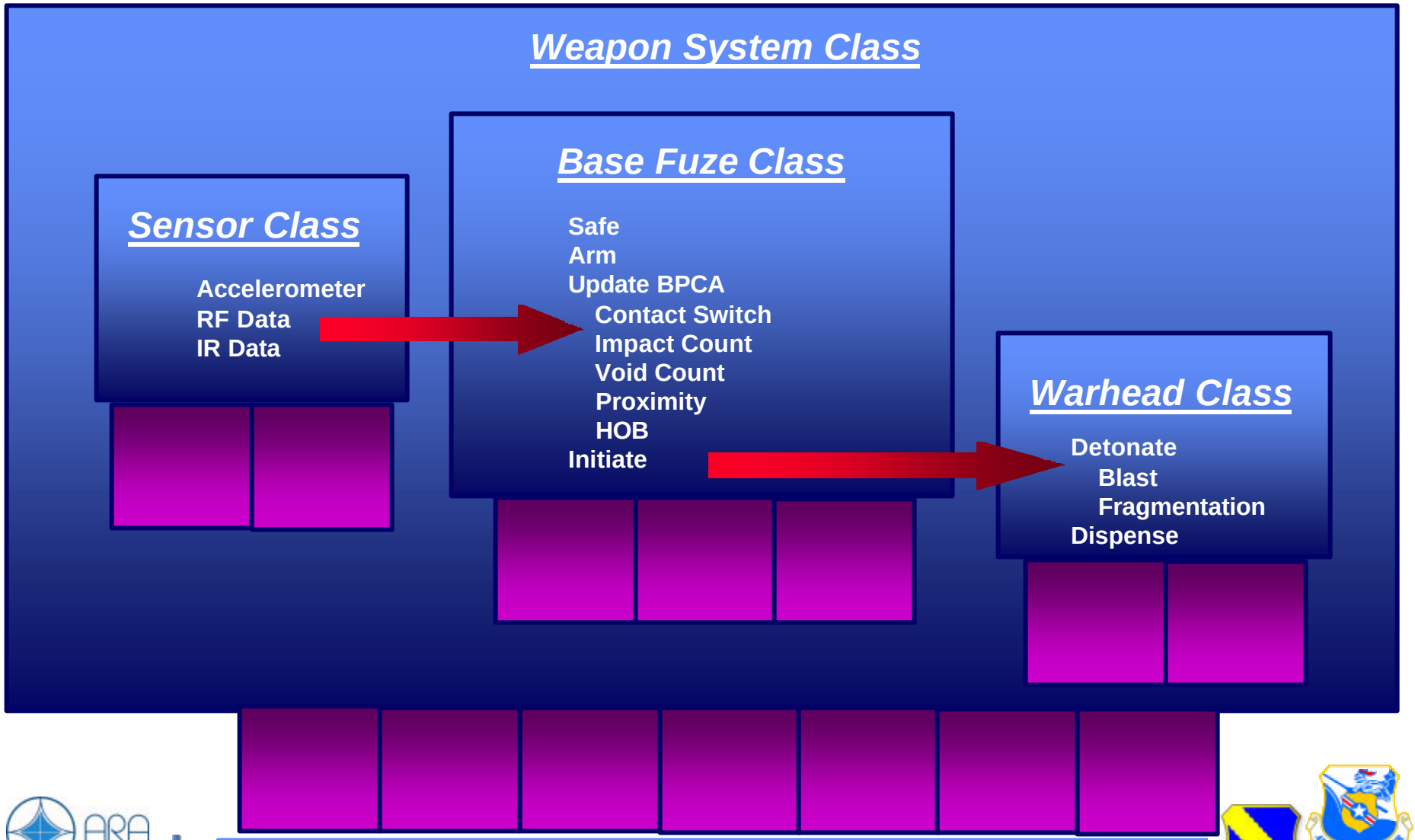
Provides general solution mechanisms for a set of similar problems.

Desirable properties:
- Consistent
- Extensible
- Flexible

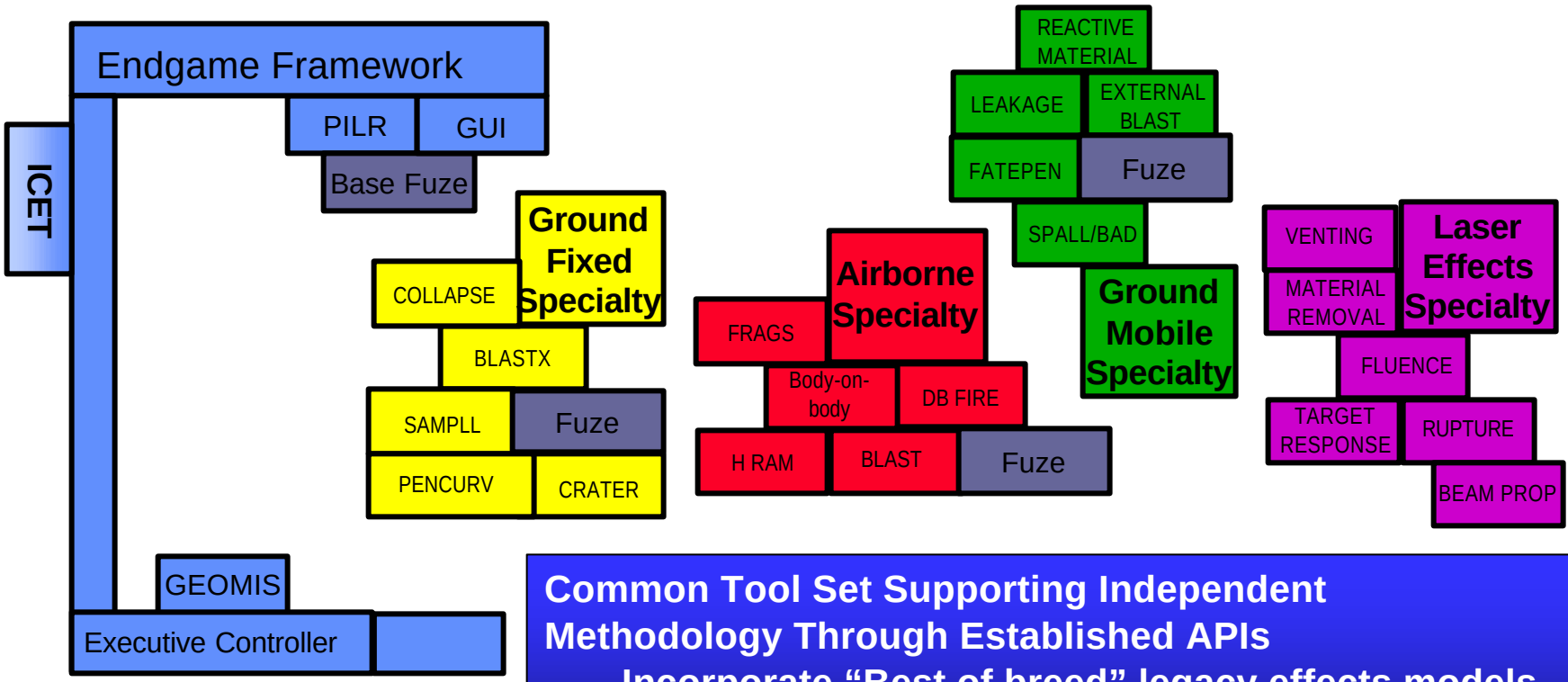
Endgame Framework



Base Fuze Class

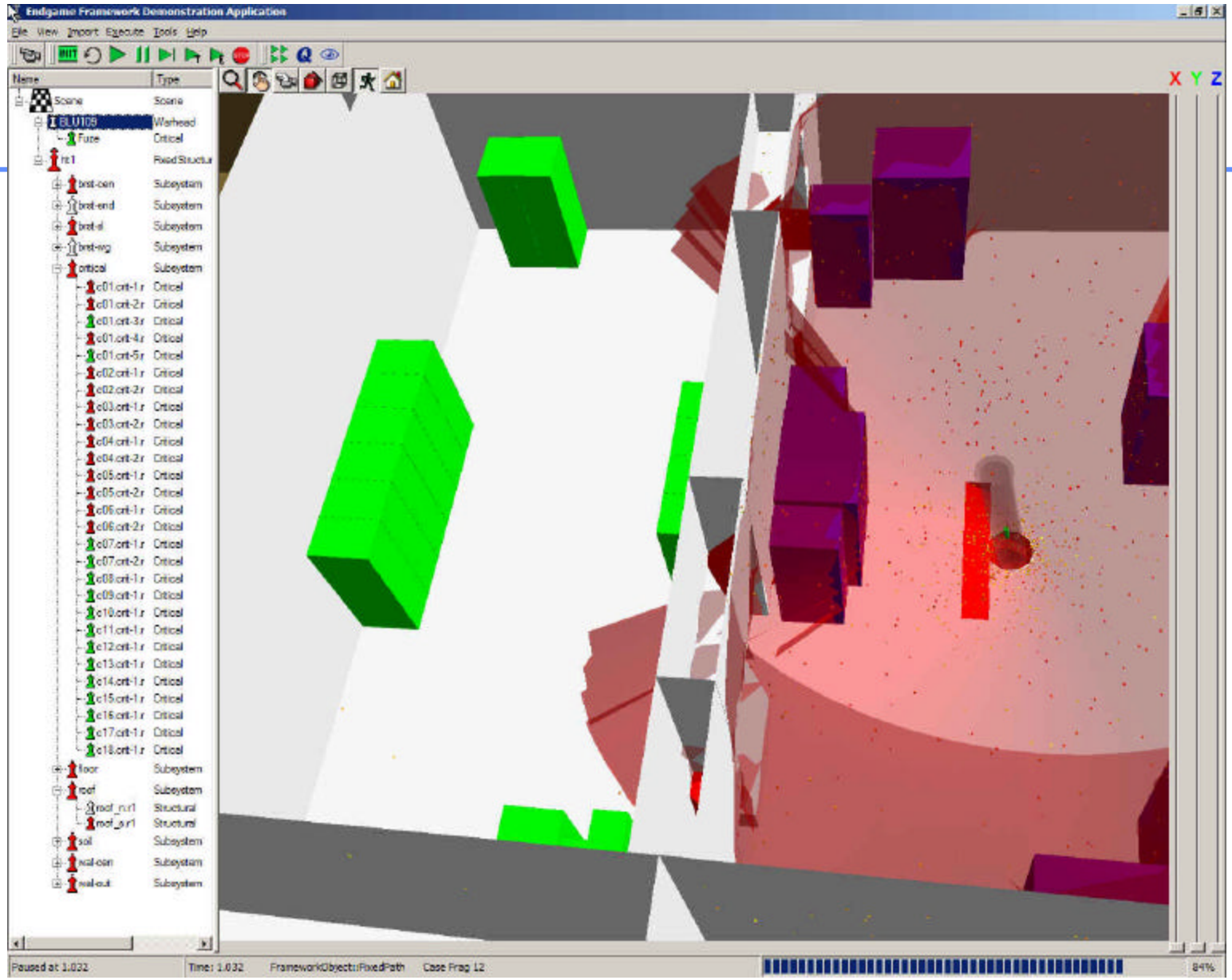


Endgame Framework Vision



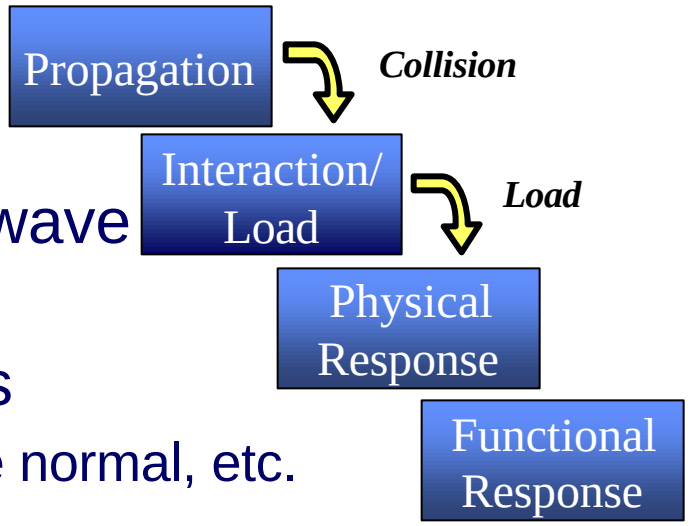
Common Tool Set Supporting Independent Methodology Through Established APIs

- Incorporate "Best of breed" legacy effects models
- Technology to enable new effects methodology
- Combine ground fixed, mobile, airborne, DE domains


Endgame Framework Demonstration Application
File View Import Execute Tools Help
Name
Type
Scene
BLU109
Warhead
Fuze
Critical
rt1
Fixed Structu
brst-con
brst-end
brst-sl
brst-wg
Subsystem
ortical
c01.crt-1.r
c01.crt-2.r
c01.crt-3.r
c01.crt-4.r
c01.crt-5.r
c02.crt-1.r
c02.crt-2.r
c03.crt-1.r
c03.crt-2.r
c04.crt-1.r
c04.crt-2.r
c05.crt-1.r
c05.crt-2.r
c06.crt-1.r
c06.crt-2.r
c07.crt-1.r
c07.crt-2.r
c08.crt-1.r
c09.crt-1.r
c10.crt-1.r
c11.crt-1.r
c12.crt-1.r
c13.crt-1.r
c14.crt-1.r
c15.crt-1.r
c16.crt-1.r
c17.crt-1.r
c18.crt-1.r
Critical
floor
roof
roof_n.r1
roof_s.r1
Structural
soil
wal-con
wal-out
X Y Z
Paused at 1.032
Time: 1.032
FrameworkObjectsFixedPath
Case Frag 12
84%

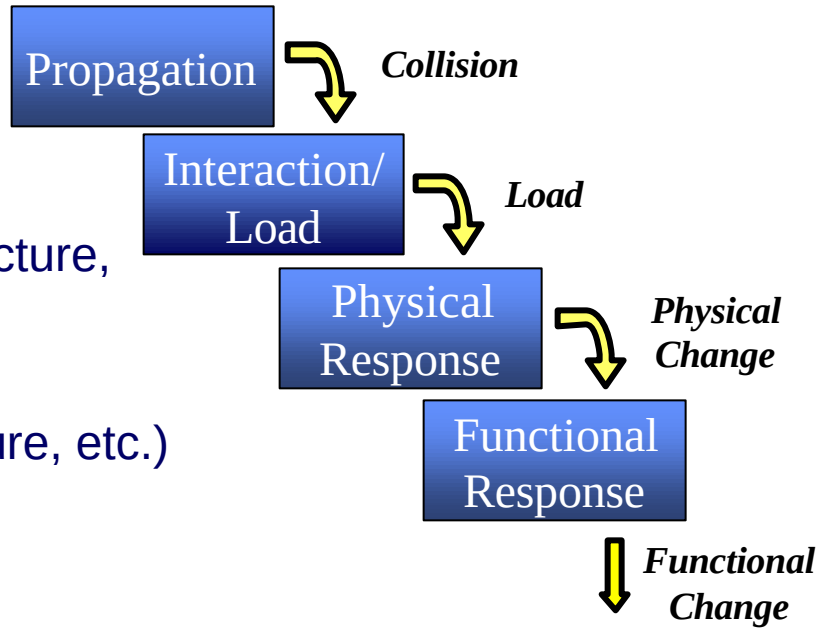
PILR Behavior Methods

- Propagation
  (damage mechanism)
  - Penetrator, fragment, blast wave
    - Ray traced or time stepped
  - Determine impact conditions
    - Impact angles (in/out), surface normal, etc.
- Interaction/Load
  - Based on component type or material type
  - Determine and apply load to component
    - KE load, pressure, thermal transfer, etc.
    - may include damage mechanism



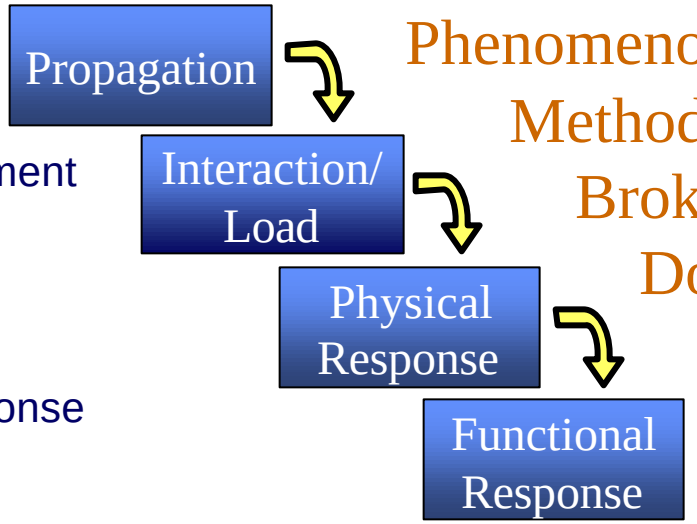
PILR Behavior Methods (cont.)

- Physical Response
  - Determine component physical response to applied load
    - Breach hole, spall generation, fracture, igniting, etc.
    - May include damage mechanism (Fragment breakup, warhead failure, etc.)
- Functional Response
  - Based on damage applied
    - Simple Pk
    - Initiate method for leakage
    - Initiate method for component failure or degraded performance



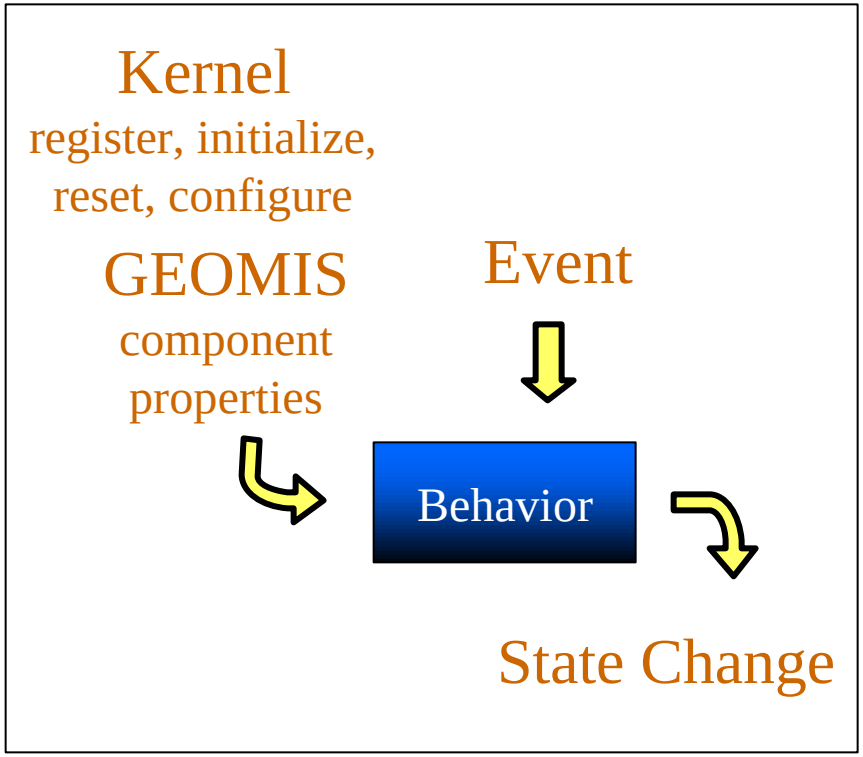
PILR Architecture

- Behavior Module
  - Template for phenomenology development
  - Registration of PILR methods
  - Provides event generation
- Standardize low-level interfaces
  - Interface between interaction and response methodologies
    - Allows higher fidelity physics-based representations
  - Loose coupling between behavior methodology and component property sets
- Extensible design
  - New methodologies require new state change information
    - New load types
    - New physical change types (damage, temperature, pressure,…)
    - New functional change types

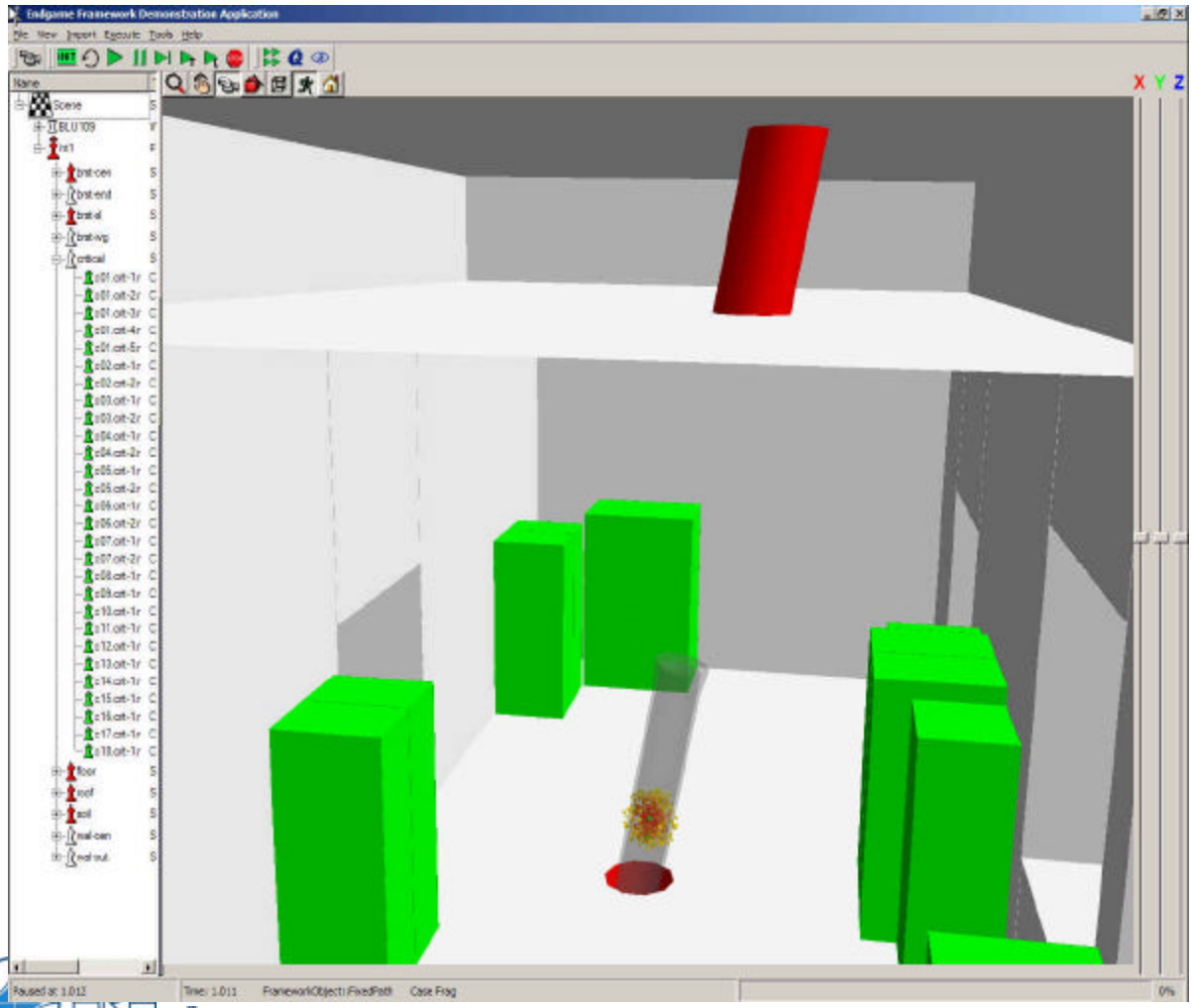


Behavior Module Interface

- Kernel interactions
- Interrogate Geometry
  - Ray trace, geometric primitive info
- Get/Set Spatial Info
  - Location/orientation/kinematics
- Submit Events
  - Automated within behavior module
  - Understanding of PILR tables
- Apply State Changes
- Get Model Properties
  - Materials, dimensions, others

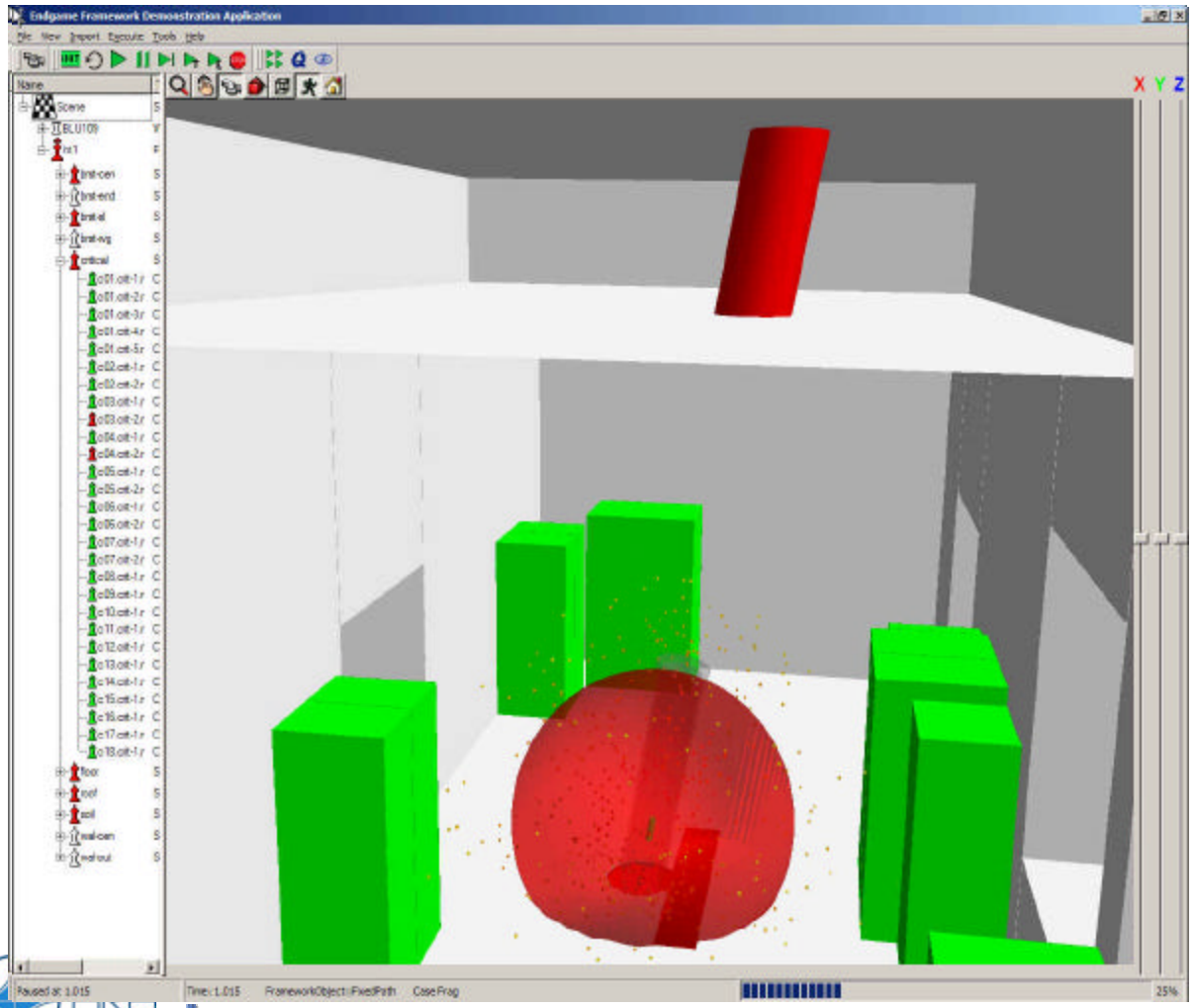


PILR Example



Detonation
(System Behavior)

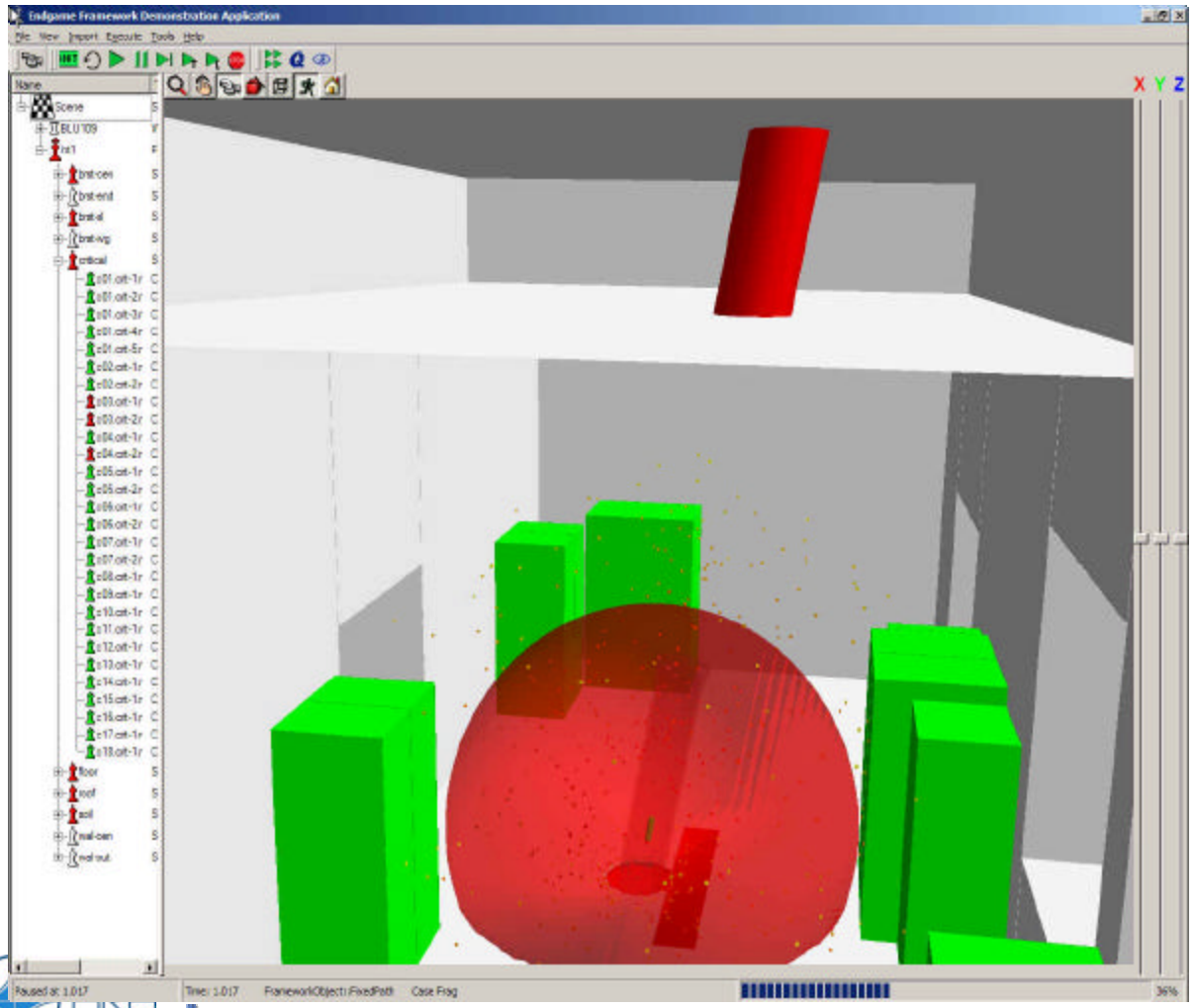
PILR Example



Detonation
(System Behavior)

Propagation
(Blast Wave, Fragments)

PILR Example



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Interaction
(DM vs. compnent)

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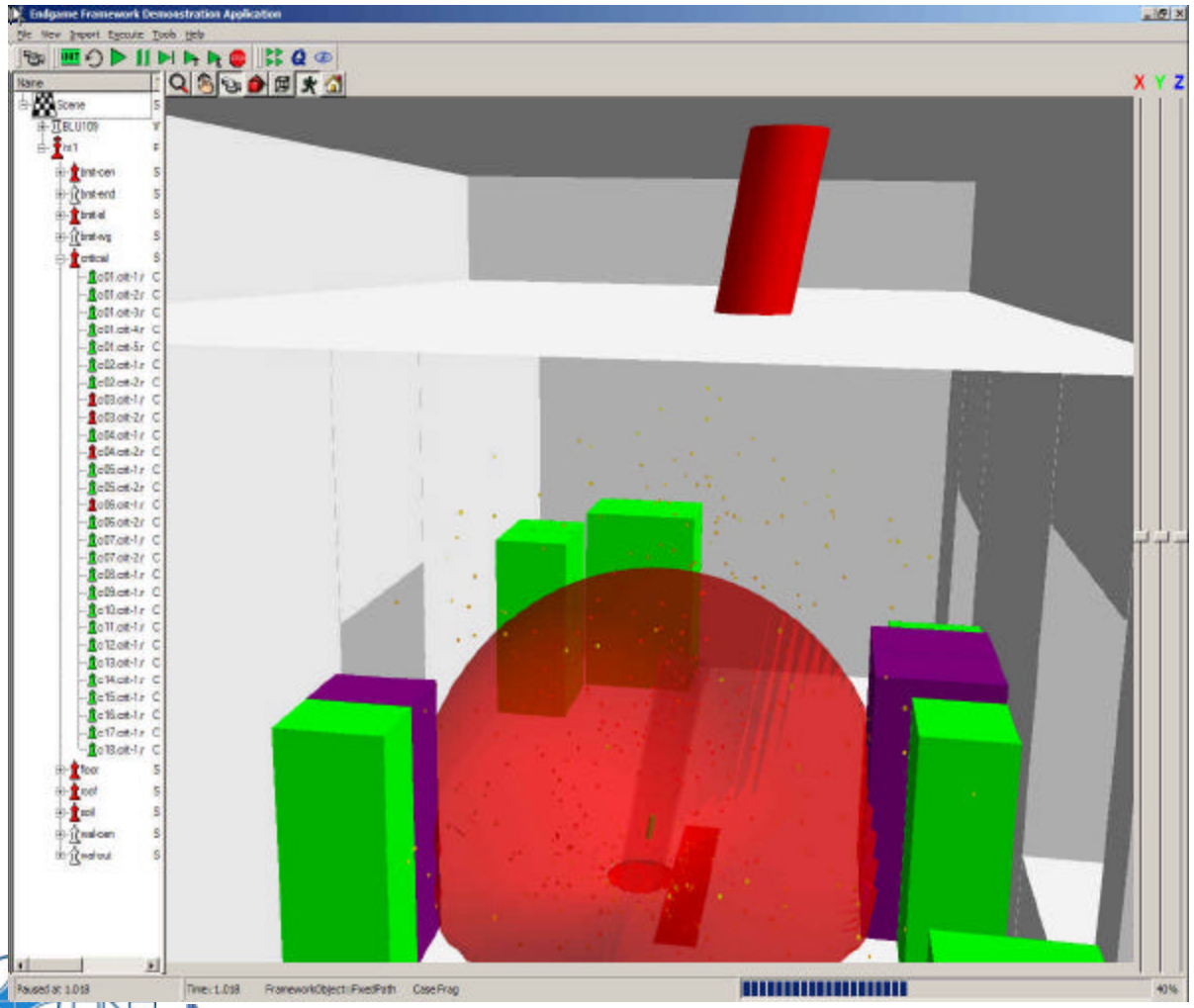

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Interaction
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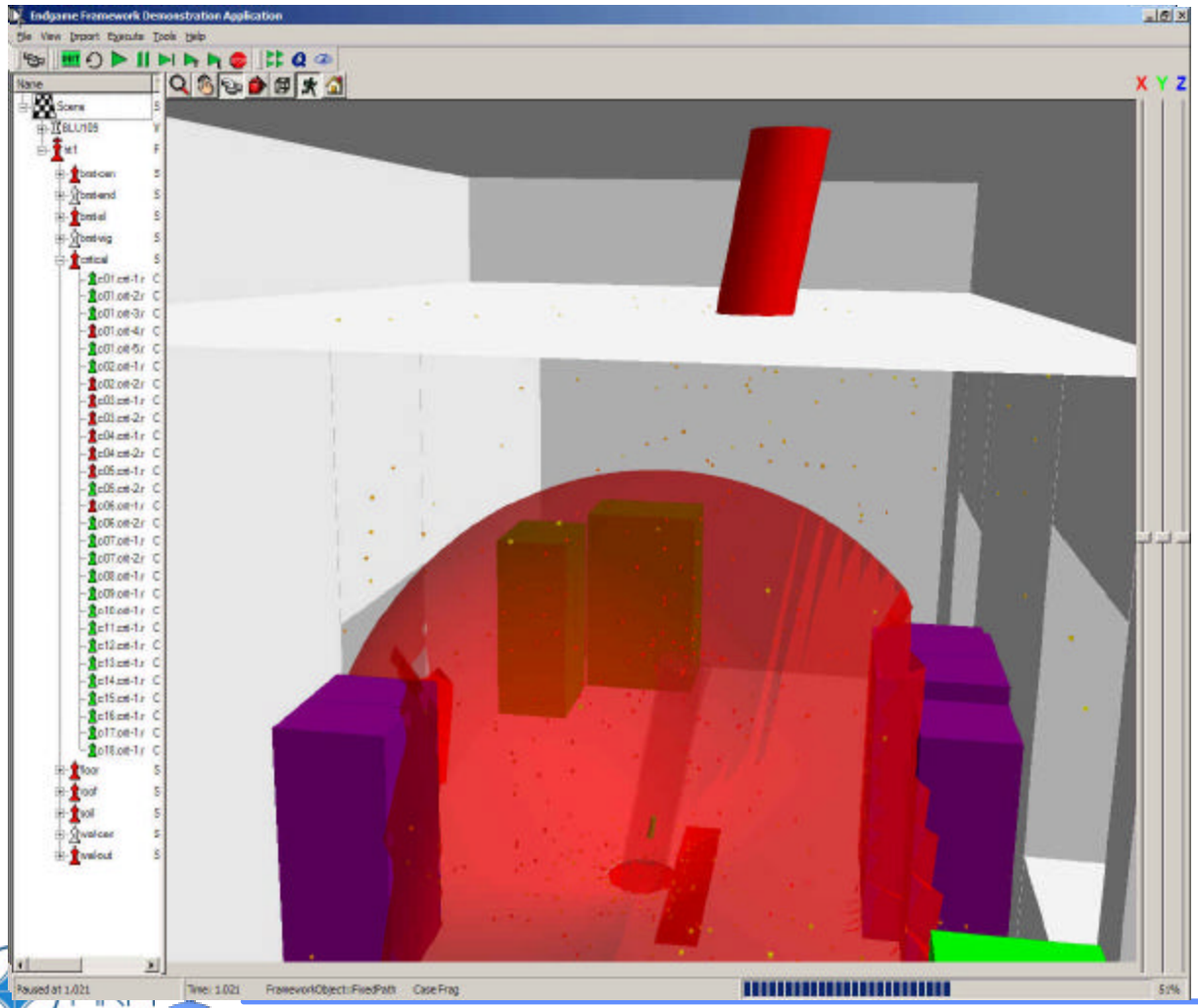
Physical Response
(component damage)

PILR Example



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(DM vs. component)

Physical Response
(component damage)

Functional Response
(component P_K
start leakage, etc.)

Endgame Framework Features

- Software Architecture
  - Object Oriented
  - Improved target interrogation
  - Time-stamped events & component state history
  - Improved stochastic capabilities
  - Dynamic object creation
  - Modern software design
    - C++/OpenGL based
    - GUI: Qt based
    - Cross platform code & libraries
- Methodology Benefits
  - Based on physics (PILR)
  - Collision detection
    - Wires/hydraulics
  - Synergistic effects
    - Multiple weapons
  - Probability distribution w/ confidence bounds
  - Secondary spall
  - Lower support costs
    - Extensible standards
    - Enhanced visualization
    - Portable
      - Windows & Linux

Summary

- Framework ready for adaptation of existing V/L legacy applications
  - Immediate benefits gained
  - Existing conventional legacy M&S applications currently undergoing transformation
- Developer's Release allows third party participation