SAND2007-7840P

Overview of the Computer Science and Information Technologies Center

Sandia National Laboratories, CA

USC Visit

12-05-07

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Agenda

- Center Overview
- Selected Projects
  - *Seldon* (agent-based social simulation)
  - *ISECAP* (game-based critical asset protection)
  - *DART/UQ* (workflow and
  - *IPAWS* (public alert and warning system)
  - *Secondary Reachback* (tools, event analysis, and threat assessment for customs and border protection)
  - *Jess* (Java-based rule engine/scripting language)
- Sandia Institute for Modeling and Simulation – Summer internship opportunities for graduates and undergraduates

8900 Research & Development Areas

- Decision Support
- Distributed Intelligent Systems and Applications
- Knowledge Environments
- Informatics
- Network Traffic & System Assessments
- Scientific Computing
- High Performance Computing

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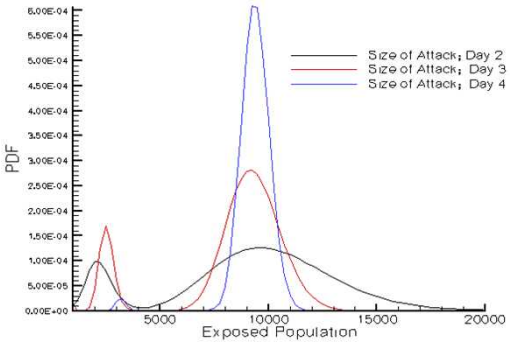
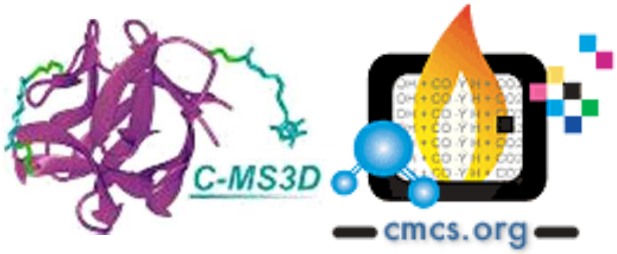
Decision Support

Combine domain expertise with advanced software tools to support national security decisions.

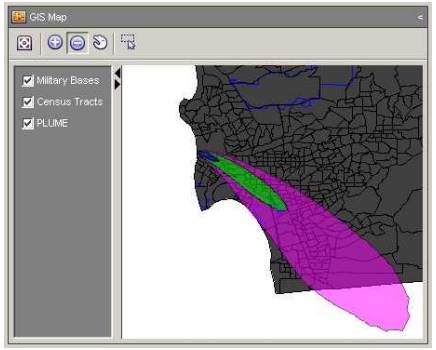


Inferring information about bio-attacks



Knowledge environments for bio and combustion research

Jess: A java enabled rules engine



Discrete event human-in-the-loop simulations

Nuclear Asset Security

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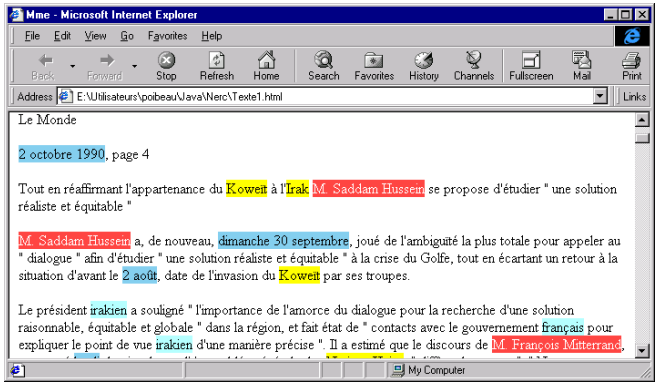
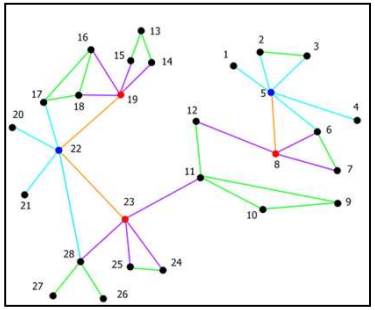
Informatics

R&D in scalable knowledge discovery, machine learning, and data visualization for national security and science applications.

Sensor network management and data analysis

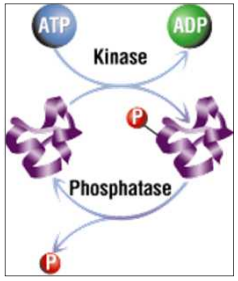


Analyzing text and documents

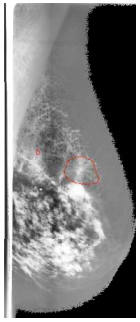


Link analysis on semantic graphs

Data fusion for predicting protein phosphorylation



Algorithms for detection of breast cancer



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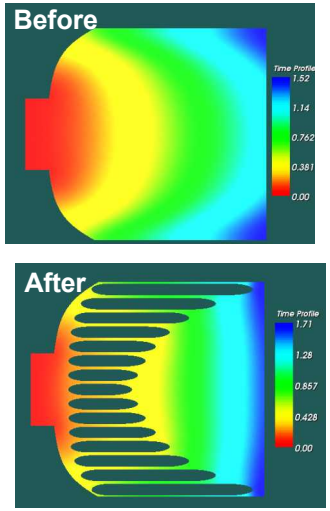
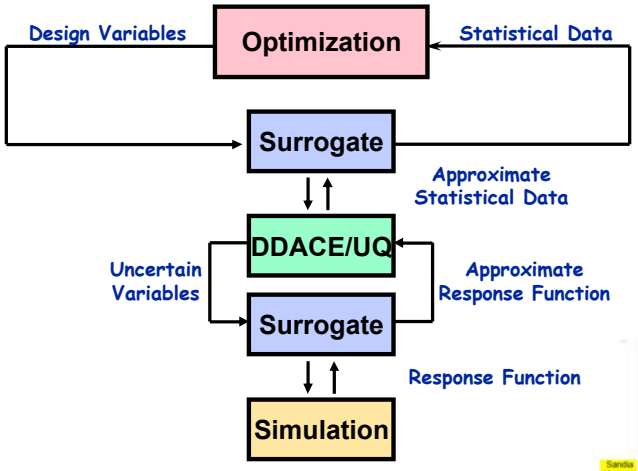
Scientific Computing & HPC

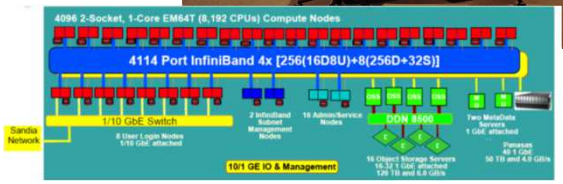
Computational science and platforms to analyze and solve scientific and engineering problems.



Shape and topology optimization incorporating manufacturability constraints

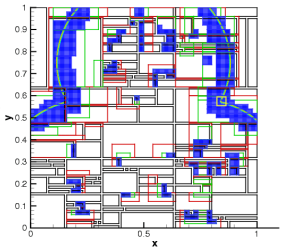


Multi-level optimization under uncertainty



Visualization and cluster computing R&D

Common Component Architecture (CCA)



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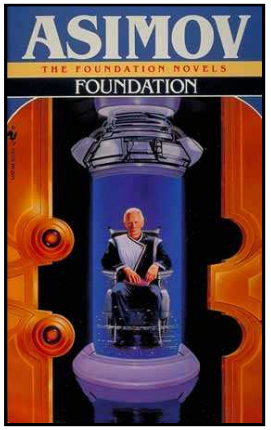
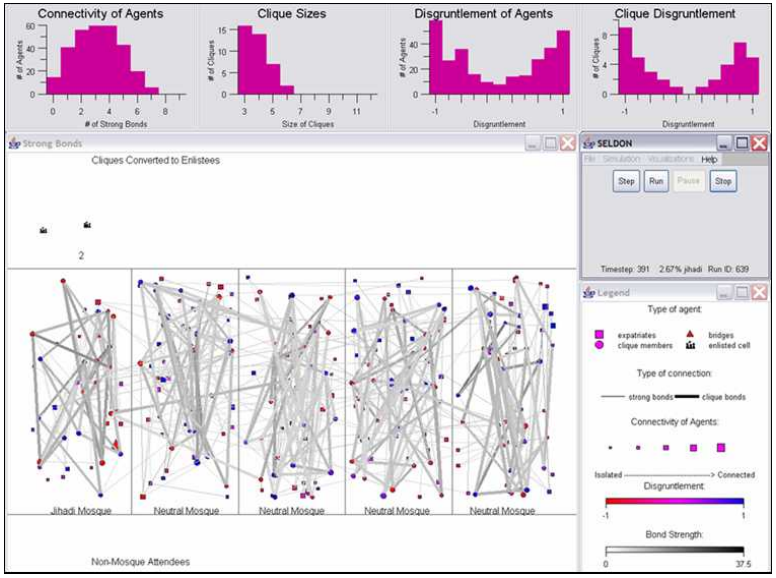
Seldon

- Seldon is an agent-based social simulation toolkit that combines technology and concepts from a variety of fields
- Name comes from Hari Seldon in Isaac Asimov's *Foundation* stories
- An agent can be an individual or a collective (i.e. school, mosque)
- It allows for dynamic social network evolution
  - Agents interact according to exchangeable rule sets, which build relationships and form the social networks





- Seldon has been parallelized to allow for large HPC simulations on the scale of hundreds of thousands of agents
- Includes the "Big Five" personality model and an enhanced relationship model
- Agents can use cognitive models for a more realistic representation

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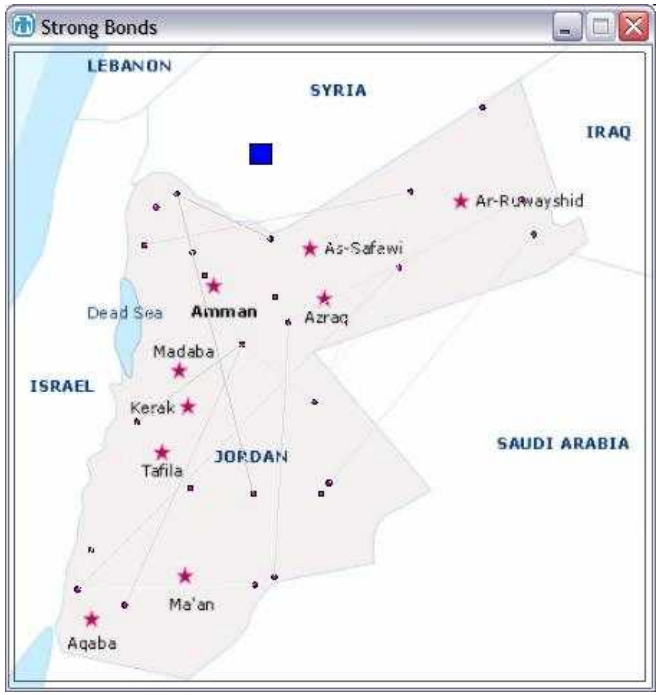
Seldon Use Cases

- Urban gang recruitment in FY03
- Terrorist recruitment in FY04-FY05
- Large Scale Social Simulation in FY06-FY08
  - Validation study will focus on the November 2005 Jordan hotel bombings



- In real life, there was an 18% negative shift in Jordanian public opinion polls of Al-Qaeda taken before and after the bombings
- We have been working with the Institute for Defense Analysis to get relevant data from sources like the *Jordan Times*
- The goal is to introduce the documents into a Jordan social model and hopefully see the same results

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Large Scale Social Simulation - Goals

The future of national security requires not only force of arms, but also winning the hearts and minds of political leaders and global populations

Individuals are highly influenced by the information available from mass media (e.g. newspapers, internet forums, weblogs), which can convince them to form communities and collective beliefs, take responsive action, etc.

Example: In September 2005, a Danish newspaper cartoon was deemed offensive by the Muslim community, and its propagation and media coverage caused riots and global reaction

Our goal is to aid analysts and policy makers in understanding how the propagation of information may be perceived throughout a society

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Integrated Seldon/ Cognitive Framework Solution

Agents exchange cognitive information when they interact

Each agent has a cognitive model that is created automatically from text-based documents. The agents use this model to comprehend new information

Media agents can also introduce new cognitive information during the simulation

The agents interact, form networks, etc. within Seldon

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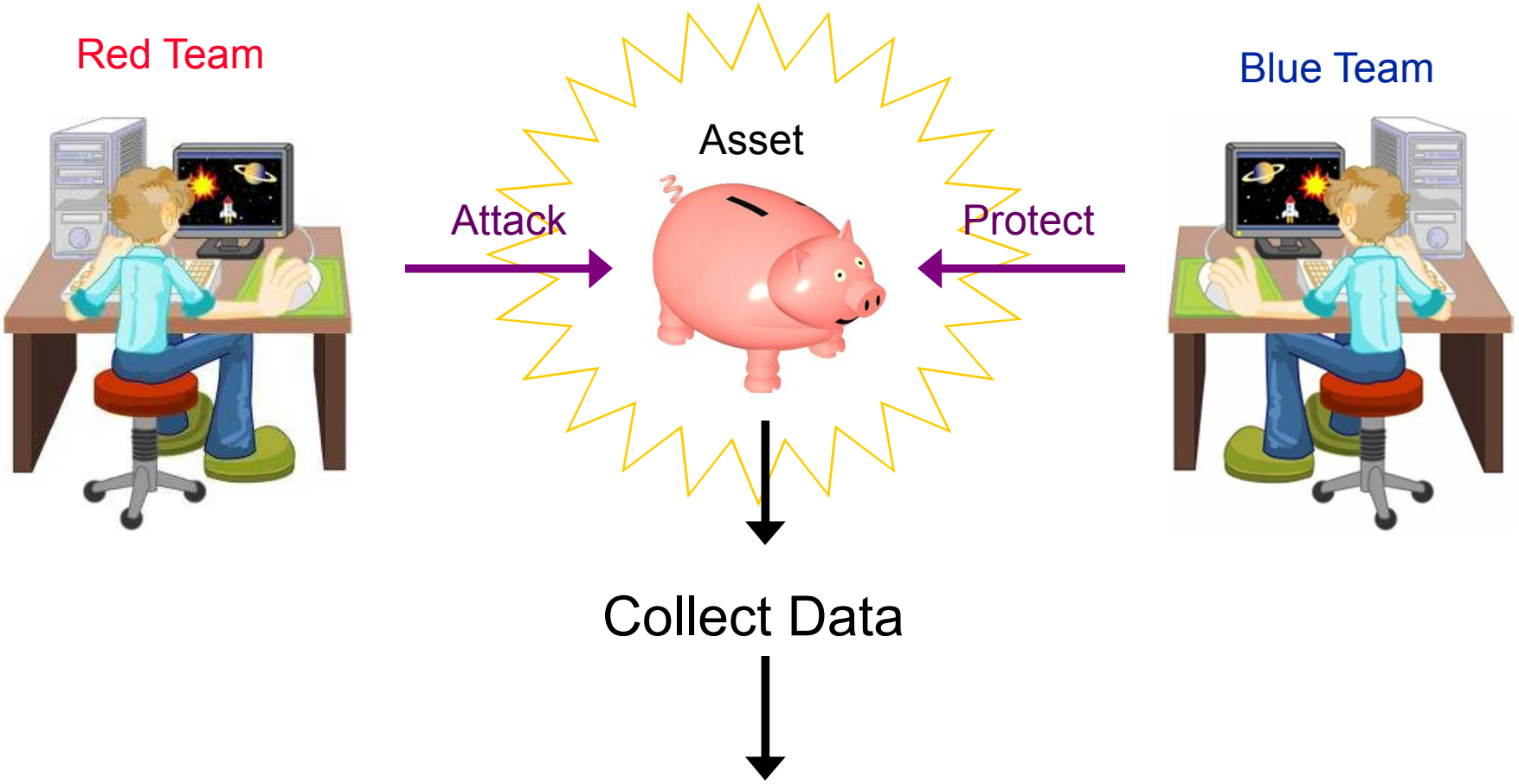
ISECAP – Immersive Simulation Environment for Critical Asset Protection



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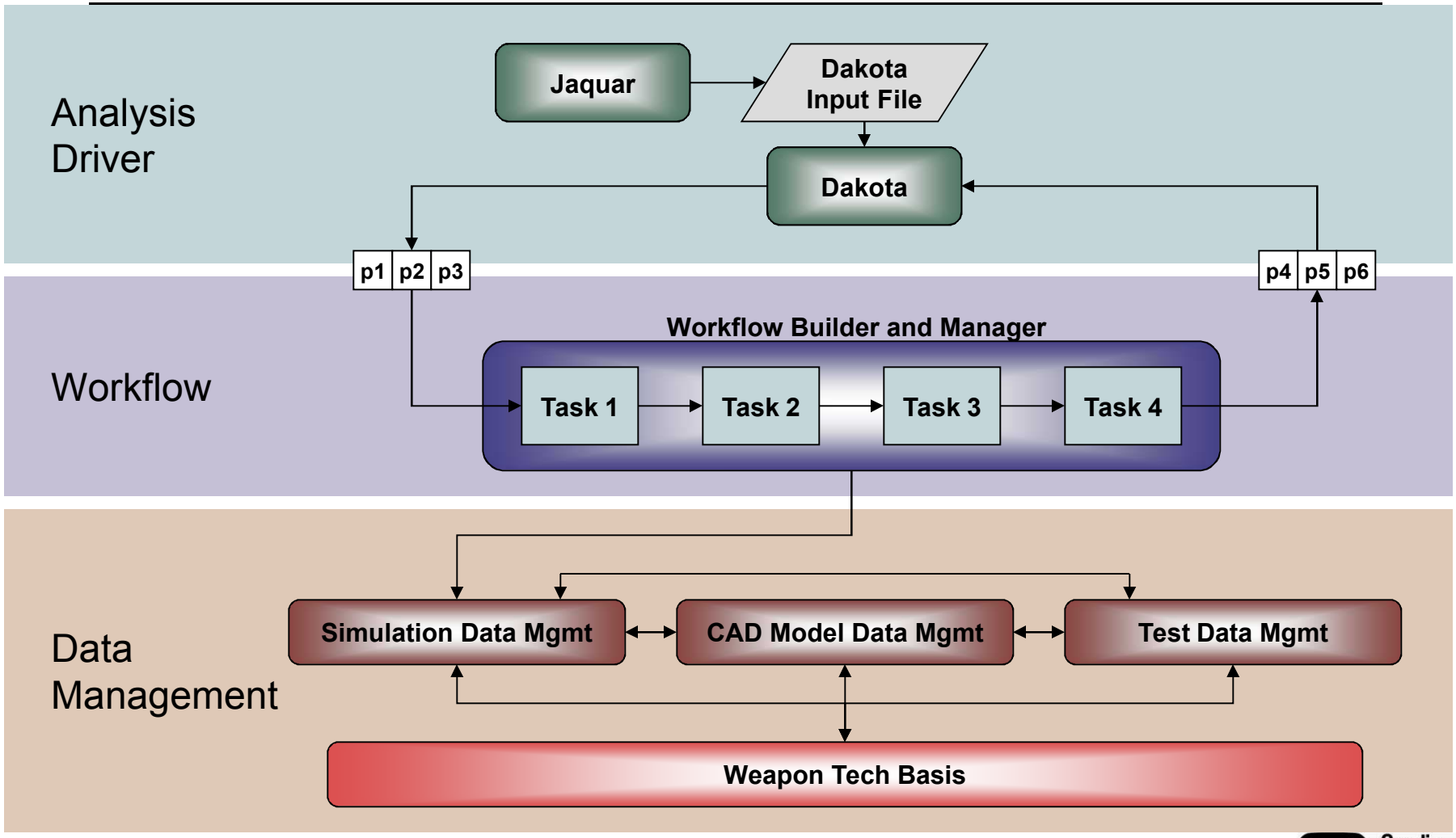
ISECAP

- Why Games?
  - Lots of users = lots of creative ideas = lots of data
  - Mature, lots of infrastructure already in place
  - Easy to learn, play, and understand what's going on
  - Immersive, lets you control the simulation as it plays out instead of tweaking knobs and hitting Play
- Other uses/features
  - Analysis environment lets you test out different security schemes for investment planning
  - Incorporation of realistic physics into the games

DART/UQ

- The DART environment is an integrated federation of analysis tools for pre-processing, job submission, post-processing, and artifact management
- We have two primary goals
  - Enable the ubiquitous use of simulation for QMU
    - Simplify the process and enable a broad set of users to run QMU studies
    - Focus on results rather than process.
  - Enable rigorous simulation data management within QMU studies
    - Build automatic data management into the QMU study process
    - Link simulation QMU data to other weapon technical basis data.

QMU Simulation Functional Architecture



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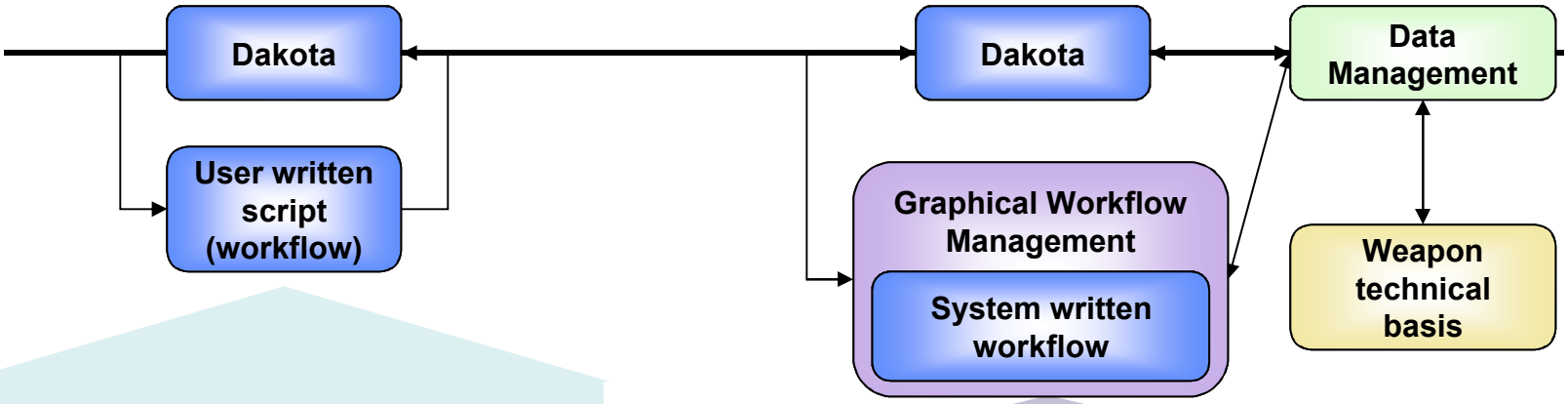
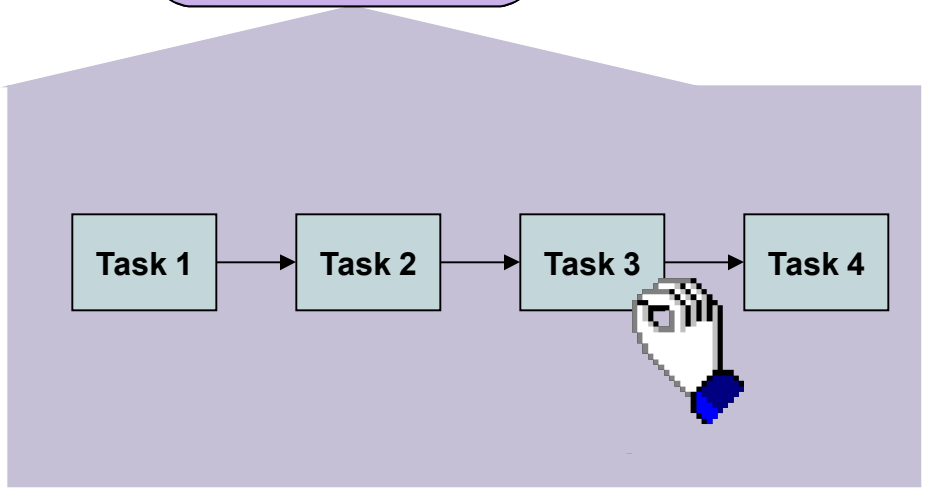
Simplify the process




```
#! /bin/sh
#PBS -l nodes=41:ppn=2:compute
#PBS -l walltime=96:00:00
#PBS -v numLSDynaProcs=8,numLSDynaJobs=10
#PBS -A 65755/05.14

# This script is submitted to qsub.  The four lines above specify the
# arguments for qsub - make sure they are set appropriately.  Of
# particular note, the value of numLSDynaJobs should be the same as
# the evaluation concurrency specified in the DAKOTA input deck.
# This is not currently checked!  Also, the following should be true
# (assuming that DAKOTA is run serially):
# 2*nodes >= numLSDynaProcs * numLSDynaJobs + 1.  This is checked
# below.

# The following determines the total number of nodes allocated by
# checking the PBS node file generated upon qsub.

nodeFile=$PBS_NODEFILE
if [ -n "$nodeFile" ]; then
   numNodes=$[0+$(wc -l < $nodeFile)]
else
   numNodes=0
fi

# The following checks 2*numNodes >=
#           numLSDynaProcs*numLSDynaJobs + 1

numProcs=`expr 2 \* $numNodes`
procsNeeded=`expr $numLSDynaProcs \* $numLSDynaJobs + 1`
if `test $numProcs -lt $procsNeeded`
then
   echo "Error: To get full concurrency, you must have"
   echo "       2*nodes >= numLSDynaProcs*numLSDynaJobs + 1."
   exit
fi

# Start the mpiexec server.  It is not required, but it is good
# practice to make sure all mpiexec'd jobs exit cleanly.

/apps/mpiexec/bin/mpiexec -server &
```



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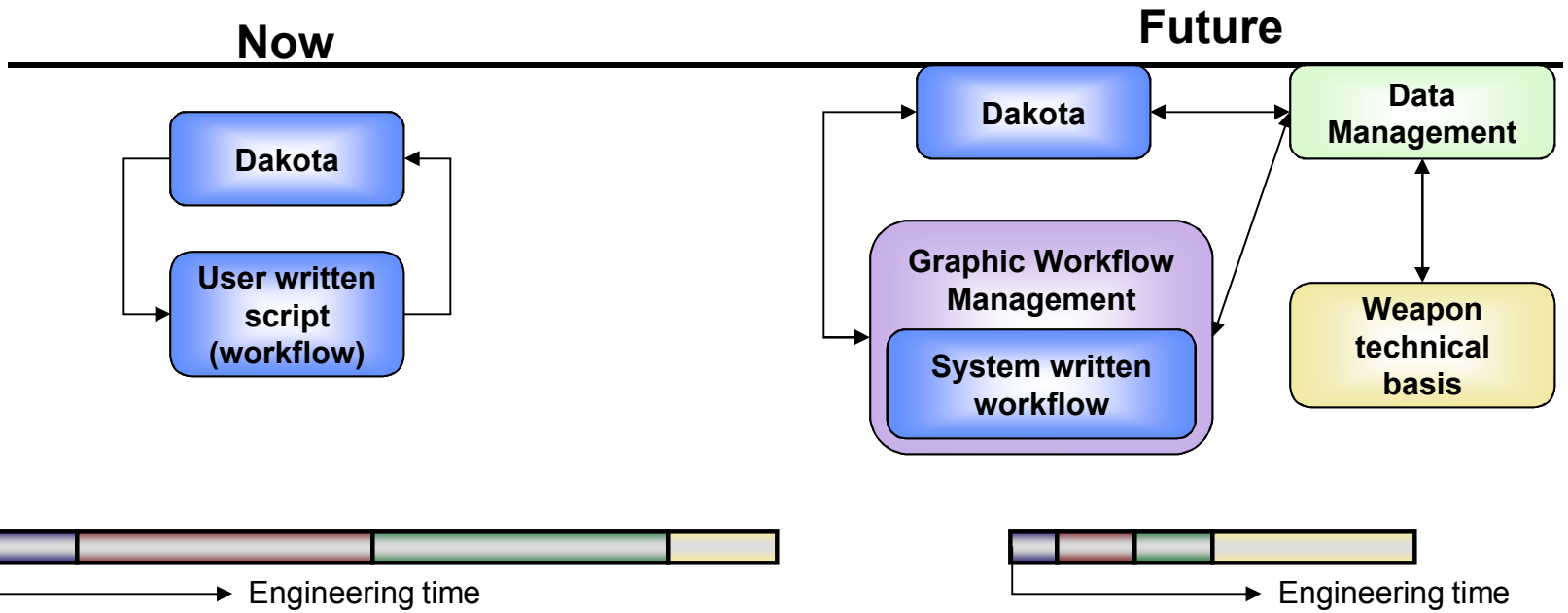
Focus on the results



- Overall study time is substantially reduced
  - Workflow creation and study run times reduced
- More time spent analyzing results
- Study data is automatically managed
  - Studies become reusable

IPAWS – Integrated Public Address and Warning System

- DHS program begun in 2004 to improve public alert & warning in partnership with NOAA*, the FCC*, & other public/private stakeholders
- Evolving "system of systems"
  - Emergency Alert System (EAS) upgrades
  - National Warning System (NAWAS) enhancements
  - New pilots and systems:
    - Digital EAS (DEAS) program with APTS* and others
    - Web Alert and Relay Network (WARN) pilot with Sandia and others
    - Geo-Targeted Alerting System (GTAS) program with NOAA and others

* NOAA = National Oceanic and Atmospheric Administration
FCC = Federal Communications Commission
APTS = Association of Public Television Stations

"DHS should establish an integrated public alert and warning system in coordination with all relevant departments and agencies."

- Hurricane Katrina Lessons Learned Report (2006)

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IPAWS is the nation's next-generation emergency warning capability

- Through the PMO, IPAWS will work with public and private sectors to integrate warning systems to effectively communicate alerts via TV, radio, telephone, internet/computer, cell phone, and other personal communications devices. The IPAWS will allow:
  - The President (or designated Federal officials) to communicate to the American people before, during, and after a crisis
  - The President and authorized Federal government officials to gain situational awareness from State and local emergency operations centers
  - Effective communications to State and territory agencies, Governors, tribal councils, and other alert and warning stakeholders
  - State and local emergency managers to send messages to residents during non-Federal emergencies

IPAWS supports FEMA's goal to reduce losses to life and property from all hazards by providing reliable and accurate information before, during and after an emergency

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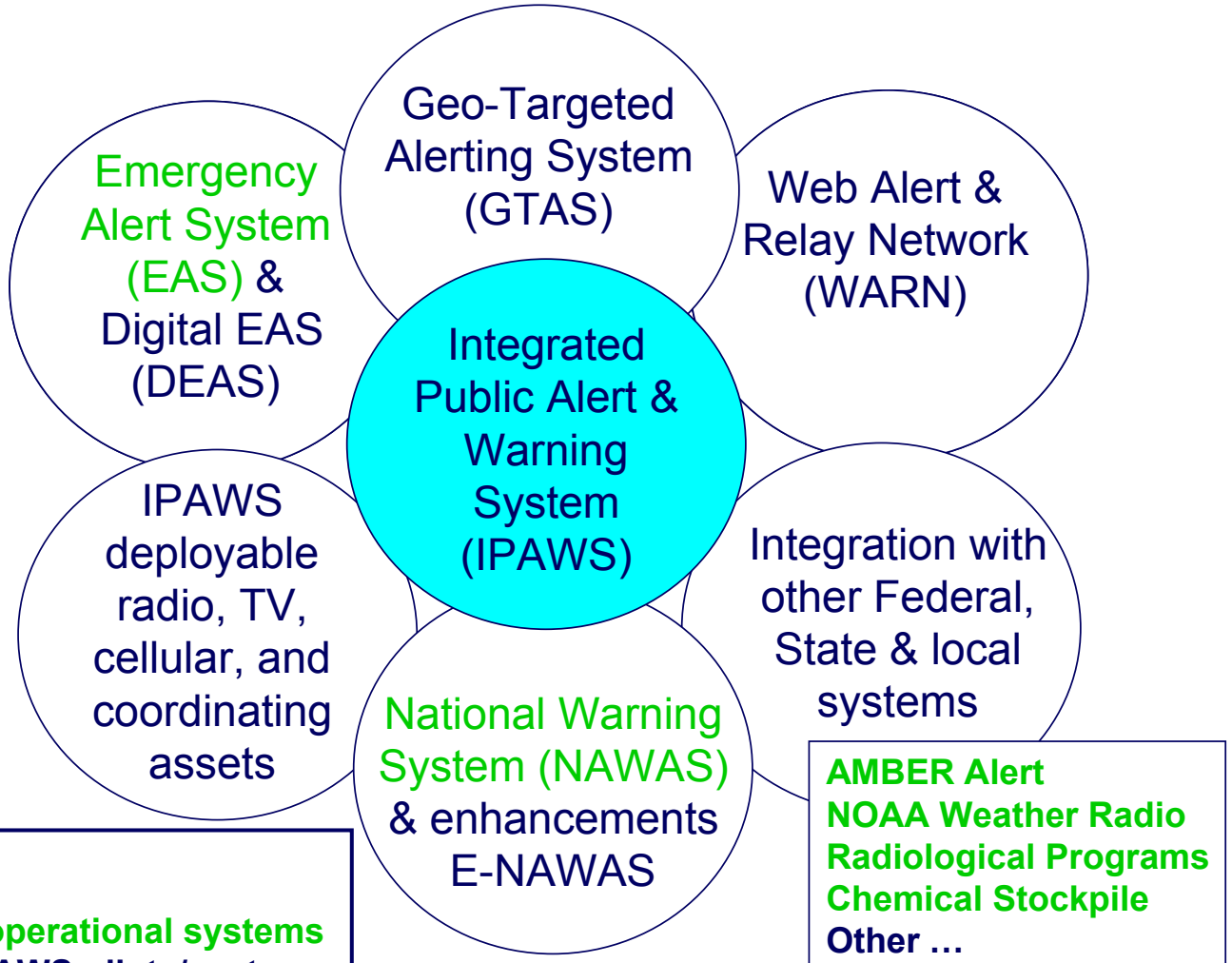
IPAWS components work with legacy alert and warning systems



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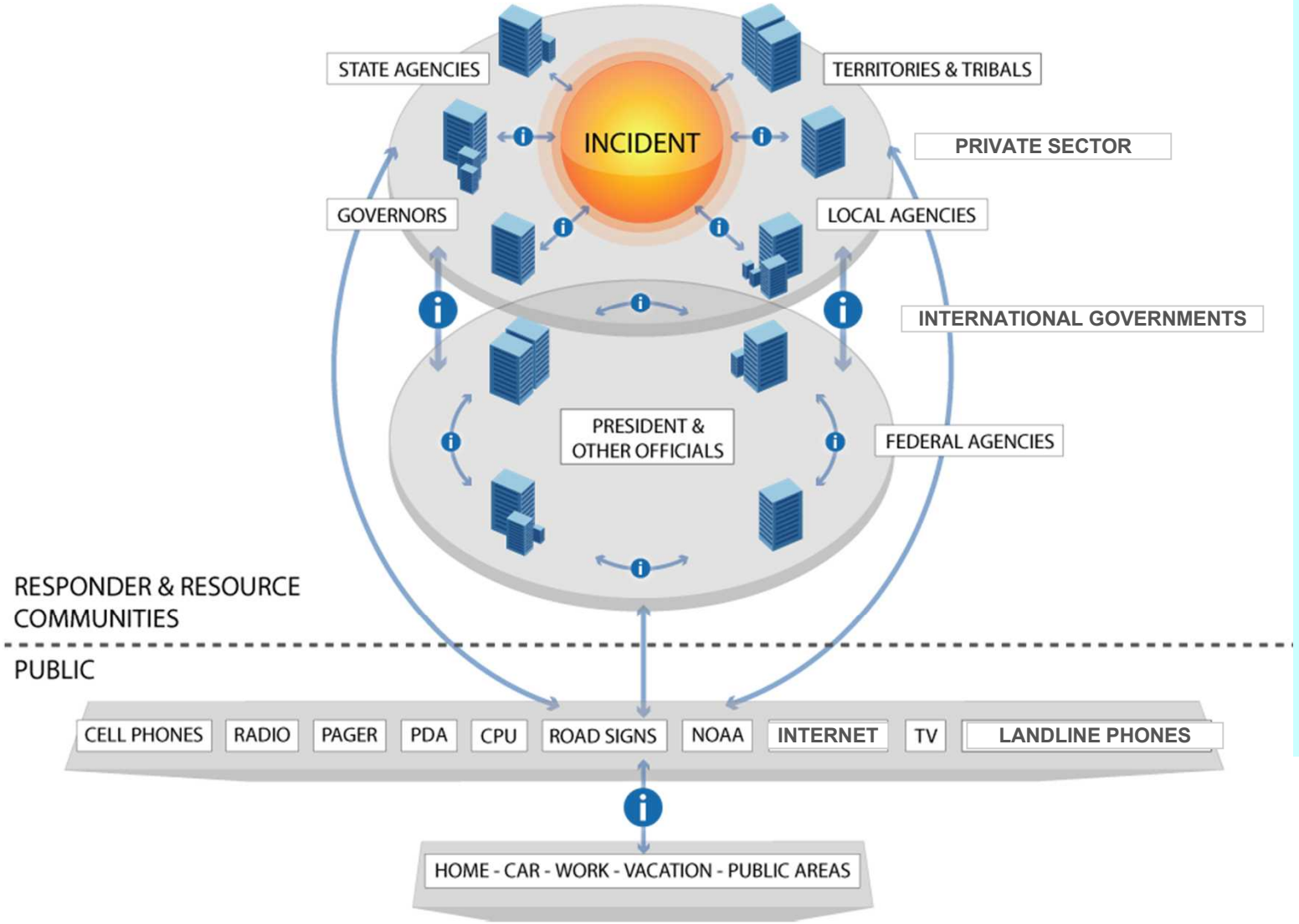
The end vision of IPAWS is to deliver coordinated messages over more channels to more people, anywhere, anytime



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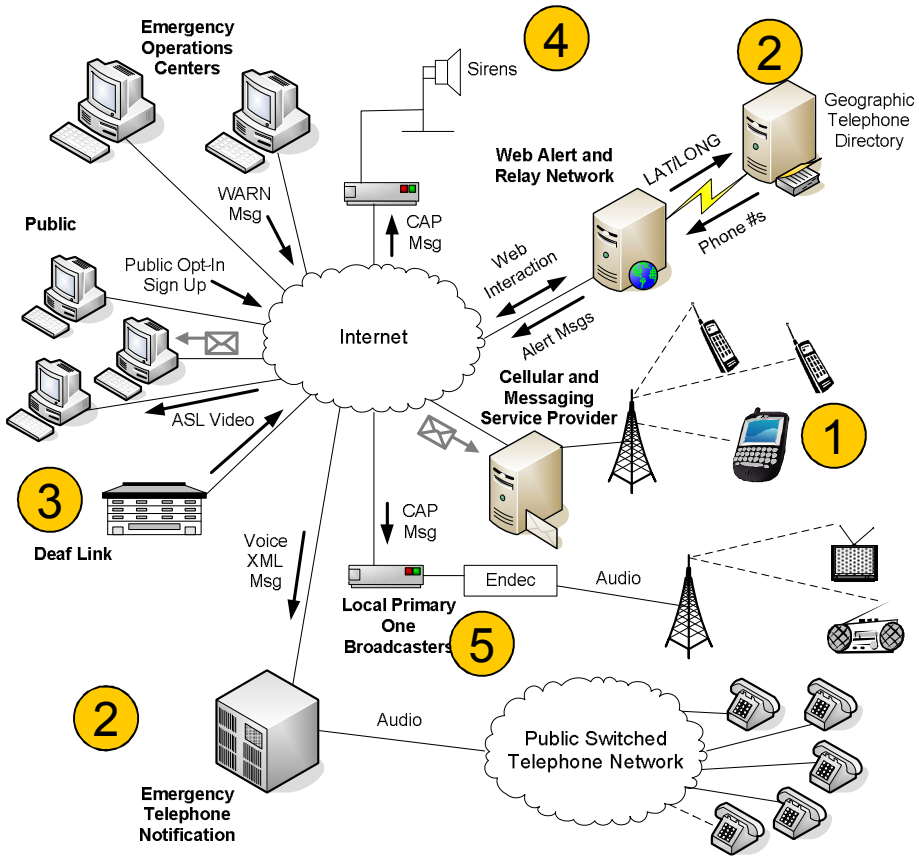
We currently are rolling out pilot projects focused on three hurricane states



1. Web Alert and Relay Network (WARN) Opt-in provides the ability for the public to sign up to receive alert and warning messages.

2. Emergency Telephone Notification (ETN) provides automated calling of all residents in a selected geographic area.

3. Deaf and Hard of Hearing Notification System (DHNS) provides emergency information to the hearing impaired community using American Sign Language videos using the Internet and personal communication devices.

Additional capabilities being fielded include:

4. Emergency Operations Centers (EOC) ability to remotely activate sirens and other equipment.
5. Capability for EOCs to issue an alert or warning over the Internet to State or local broadcasters.

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DHS Secondary Reachback Program

- Program set up by DHS to:
  - provide expert analysis to DHS in support of their mission to interdict the illicit introduction of nuclear materials into the country
  - develop tools and products that enhance the situational awareness and decision-making ability of key personnel
  - provide training for analysts
- Supports primarily Customs and Border Protection, with secondary support to other DHS entities, as well as other law enforcement agencies

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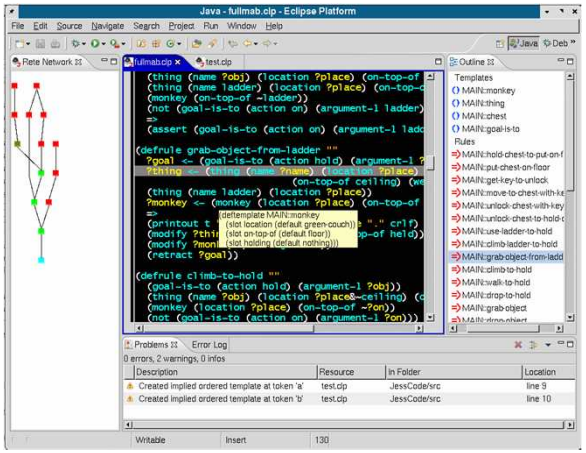
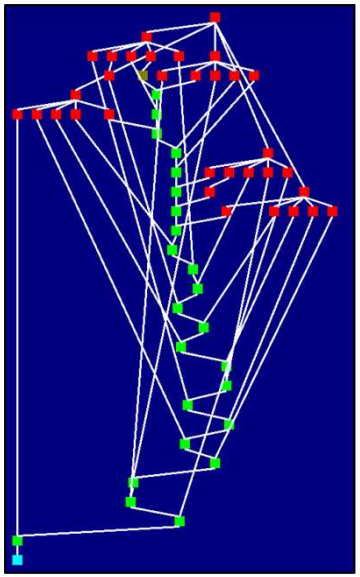
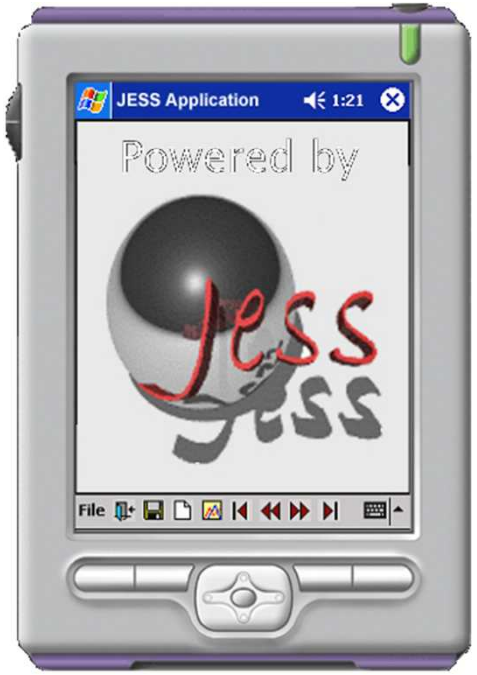
Jess – Rule Engine and Scripting Language

Jess makes expertise available to decision-makers and technicians who need answers quickly.







Knowledge capture → *Executable knowledge* → *Deployable applications*

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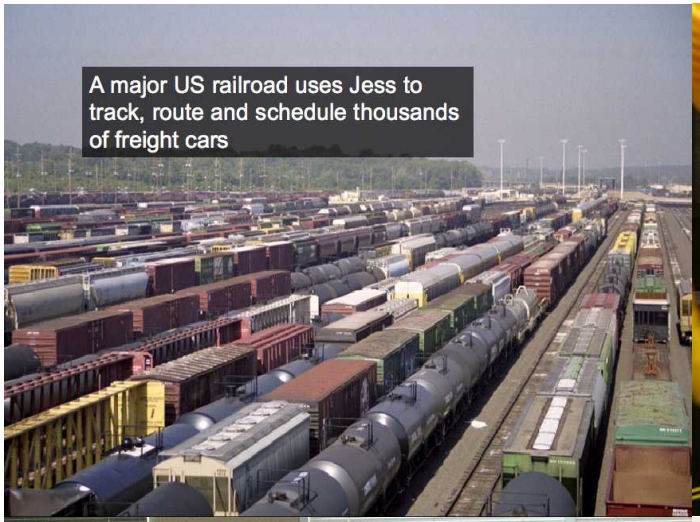
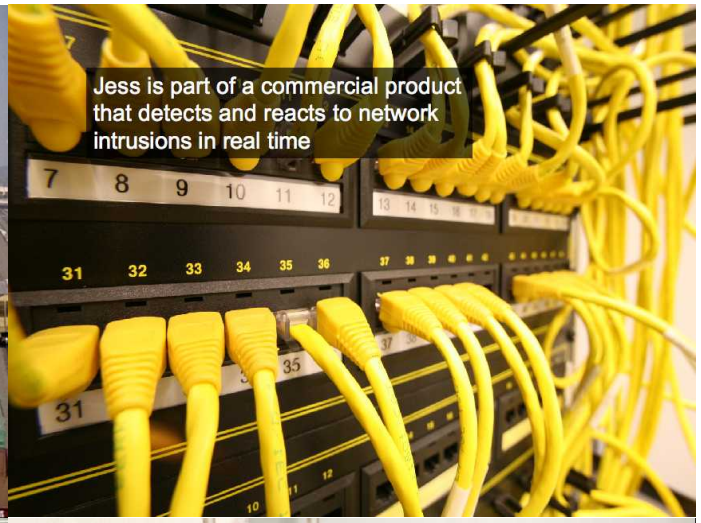
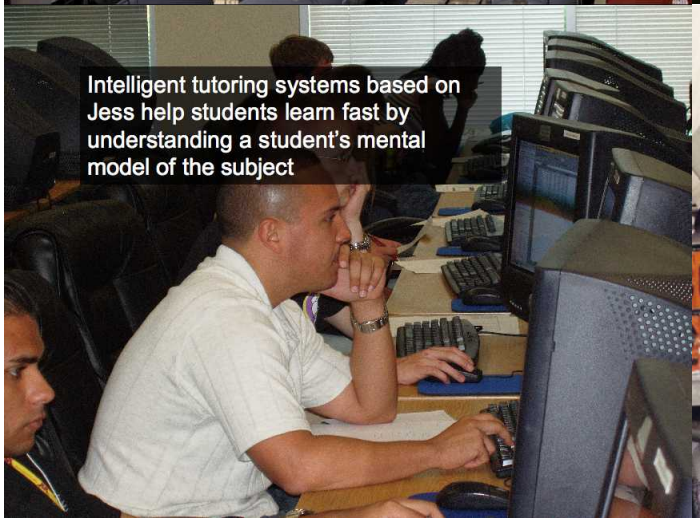
Jess Applications







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Sandia Institute for Modeling and Simulation

- We are looking for motivated students in computer science/engineering, mathematics, and related disciplines to join research and development teams working on methods and software for applying simulation, gaming, game-scenario development, advanced user input and control mechanisms, machine learning, and visualization techniques to national security problems.
  - Application areas include training systems for emergency responders, social network modeling, and vulnerability analyses for critical assets, and support U.S. Department of Homeland Security (DHS), Department of Defense (DOD), Department of Energy (DOE), and other customers.
- Students must have software development or digital arts experience.
- http://www.sandia.gov/employment/career-opp/index.html
  - Search job postings for 59077 (undergraduates) or 59079 (graduates)

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