

# **A Scalable and Extensible Interactive Scenario Architecture for Distributed C2 Simulations**

**Dr. Magy Seif El-Nasr**

Assistant Professor

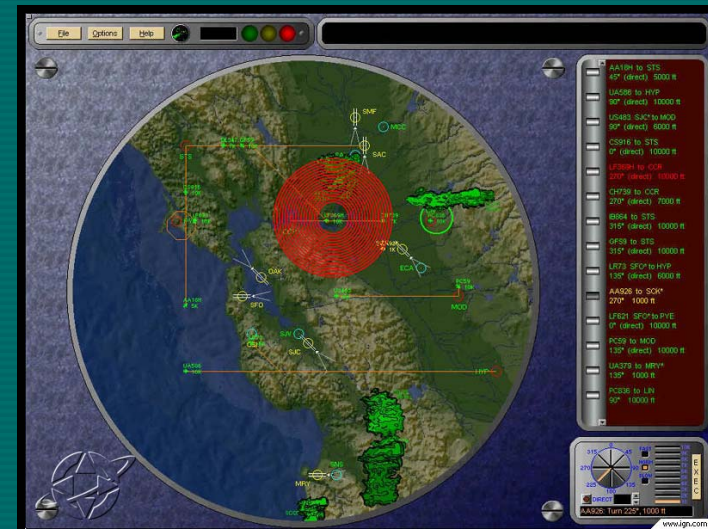
School of Information Science and Technology

Pennsylvania State University

# Command & control applications and game environments

## Examples:

- Training
- Assessment
- Experimental studies
  - User behavior
  - Collaborative design-making



# NeoCITIES

The screenshot displays the NeoCITIES Police Team interface. At the top, the title bar reads "NeoCITIES - Police Team" and "POLICE". The main header shows the date and time: "Thursday, July 3 11:25 am". A prominent alert bar at the top center contains the text "Chemical fire reported in Fenske Building... (11:15) - Parki" and a "View Past Alerts" button. On the left side, there is a "Feedback Meter" with a smiley face icon and a green progress bar labeled "Approval Rating". Below this is the "DHS Threat Level" section, which features a vertical stack of five colored buttons: "BEVERE" (red), "HIGH" (orange), "ELEVATED" (yellow), "GUARDED" (green), and "LOW" (dark green). The "ELEVATED" button is highlighted with a blue box. The "Resources Panel" is located below the threat level, showing a list of resources: "Squad Cars: 25 / 30", "K-9 Units: 5 / 6", and "Armored: 3 / 3". At the bottom left, a "Mini-Map" shows a larger geographic area with a red box highlighting the current view. The central part of the interface is a large map showing a street grid with "POLLOCK RD" and "SHORTLIDGE R" labeled. A red event icon is placed on the map, with a callout box titled "Resource Details" showing information for "Squad Car #04" (2 officers, arrived 11:24 am) and "K-9 Unit #66" (1 officer, 1 canine, arrived 11:25 am). Below the map are tabs for "Map", "Information", "Chat", and "Whiteboard". At the bottom, there is an "Action Menu" with a dropdown menu labeled "Select an action for the unit..." and a "Send Resources" section with a text input field for "Send how many cars?" and radio buttons for "With crews" and "No crews".

Alerts Bar

Past Alerts Button

Feedback Meter

DHS Threat Level

Resources Panel

Mini-Map

Action Menu

Send Resources

Resource Details

On-Map Event Icon

# Scenario Structures

---

- **Linear**

events follow a certain sequence in time not affected by interaction

problems:

- scenario is rigid
- assumes certain user behaviors

- **Branching**

the events change due to user actions

problems:

- Exponential growth limits computation and design

# Scenario Structures

---

Previous Research on scenario Architectures:

- **Mateas's** work using OZ project work at CMU
- **M. Young's** work on the use of plan-based architectures

# Our Approach

---

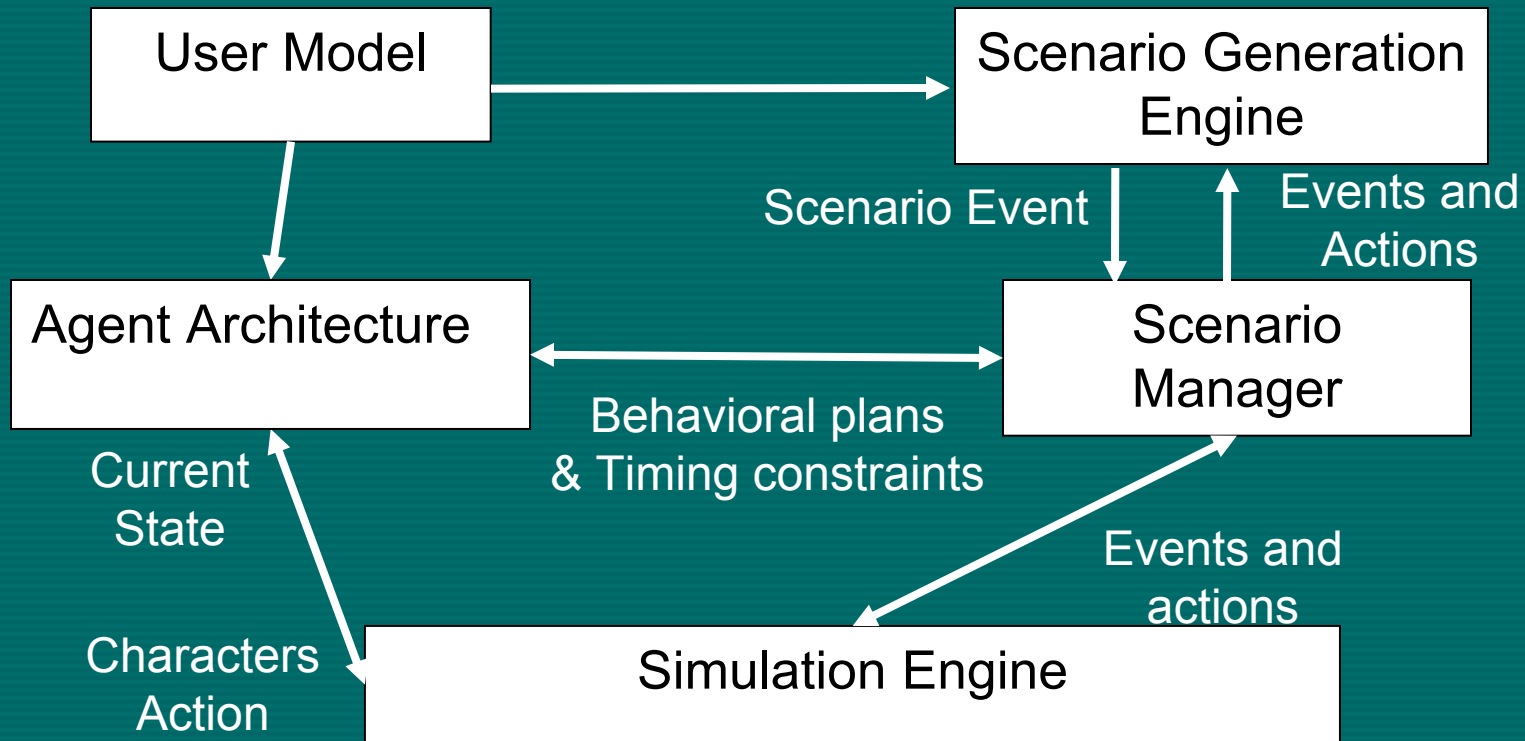
- Scenario Architecture
  - Scenario authoring split into several layers
  - Scenario representation

Contribution: easily maintainable, extensible, scalable, scenarios made up of reusable units
- Several novel techniques
  - Dynamic interactive Scenario
  - Responsive agent systems
  - Use of User modeling to adapt scenarios

Contribution: enhances adaptability, realism, and overall experience

# Dynamic Scenario Architecture

---





# Scenario Representation

---

- Three layers of abstraction: scenes, scenario events, individual agents
- Basic idea: Each *scenario* has a **scenario goal** achieved by some *scenes* whose **scene goals** are achieved by some *scenario events* whose **scenario-event goals** are achieved by some *agents behaviors*

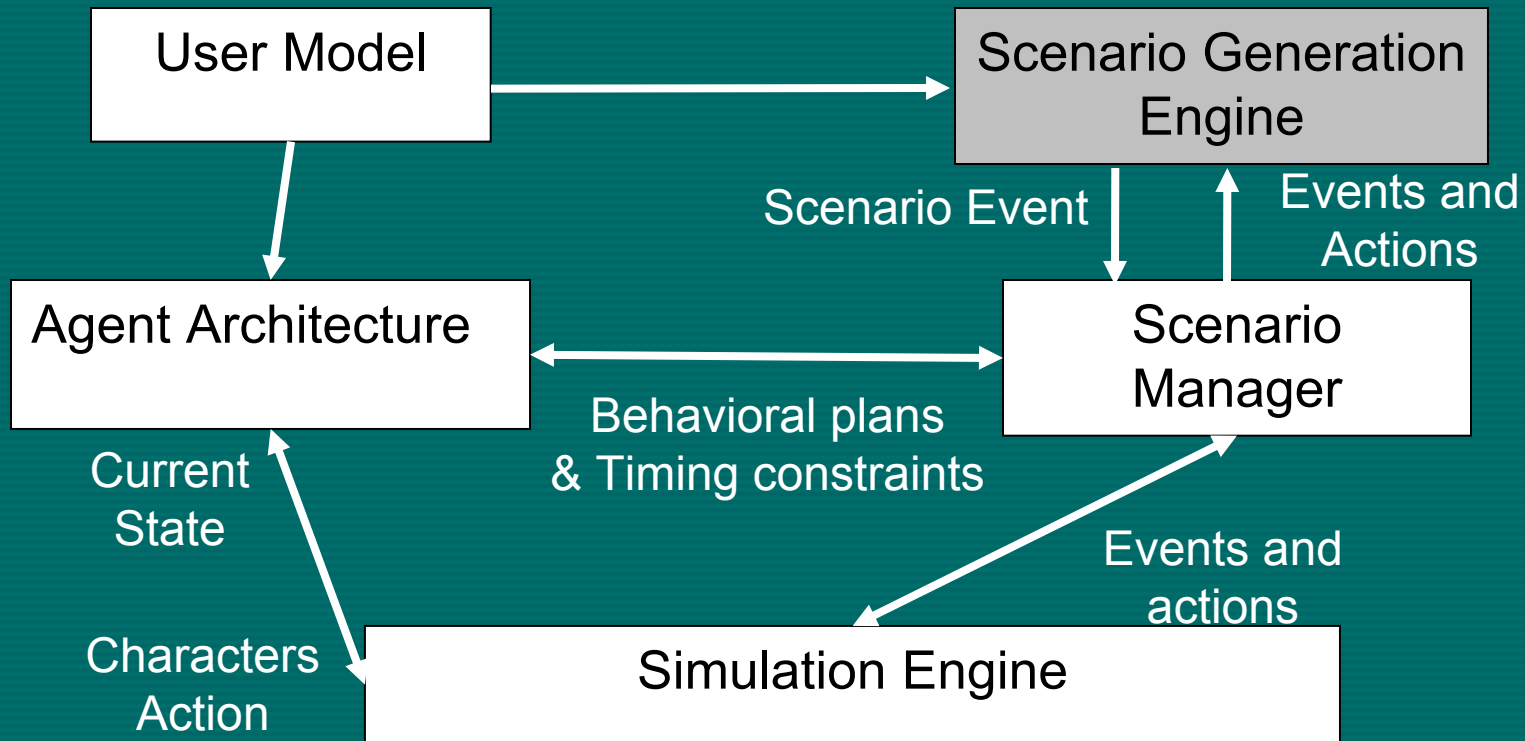


# Scenario Representation

---

- Scenes: highest layer of abstraction
  - Scene goals
  - Preconditions
  - Posteffects
  - Subgoals (Scene goals | Scenario-Event goals)
- Scenario Events: second layer of abstraction
  - Scenario-event goals
  - Preconditions
  - Posteffects
  - Subgoals (Scenario-Event goals | Agent goals)

# Dynamic Scenario Architecture



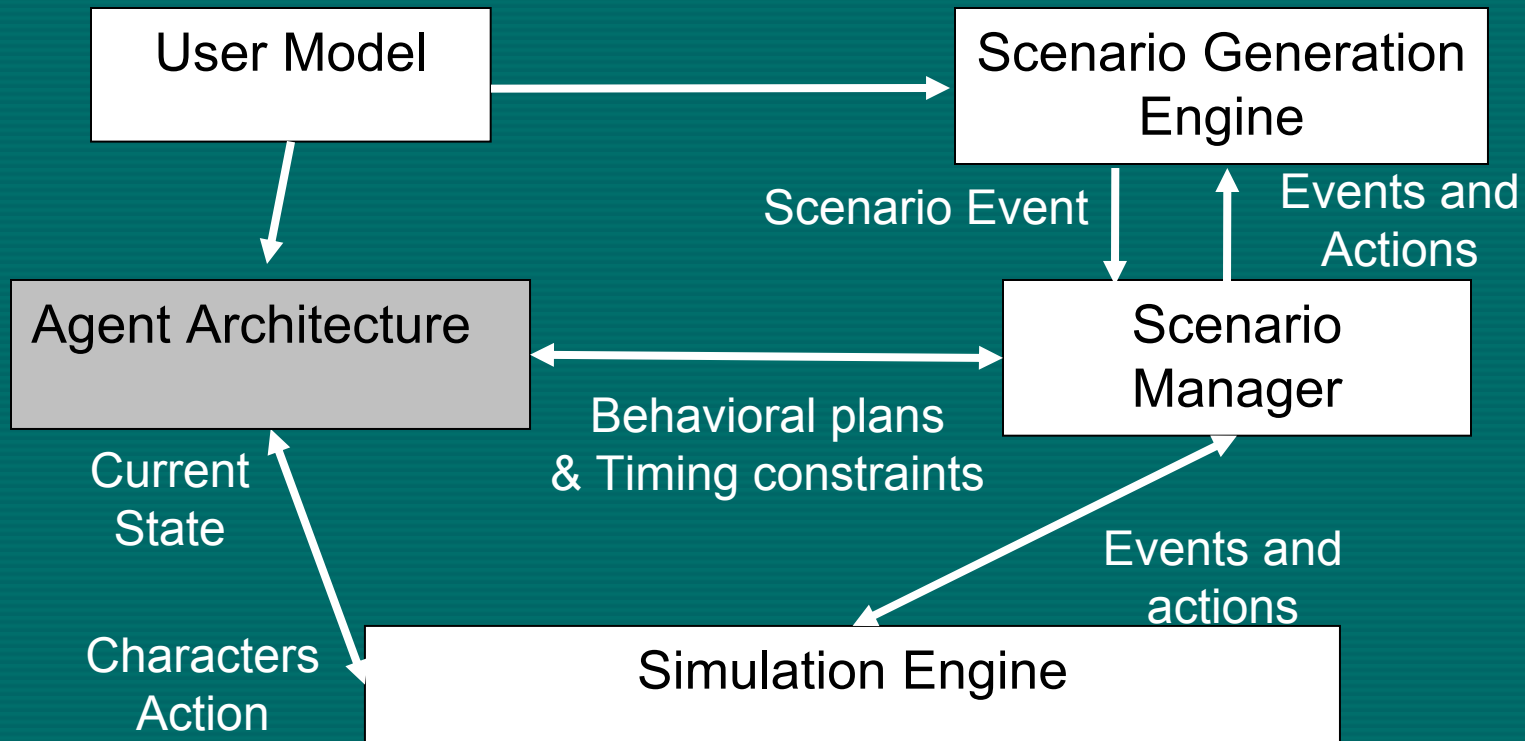
# Scenario Engine

---

- Reactive planning is used to
  - *select scenes*
  - *Then select scenario events*To solve scenario goal
- Selection Process, considers
  - User model
  - Scenario event and Scene history
  - Favors varying difficulty depending on user actions and model

# Dynamic Scenario Architecture

---



# Adaptable/Responsive Agents

---

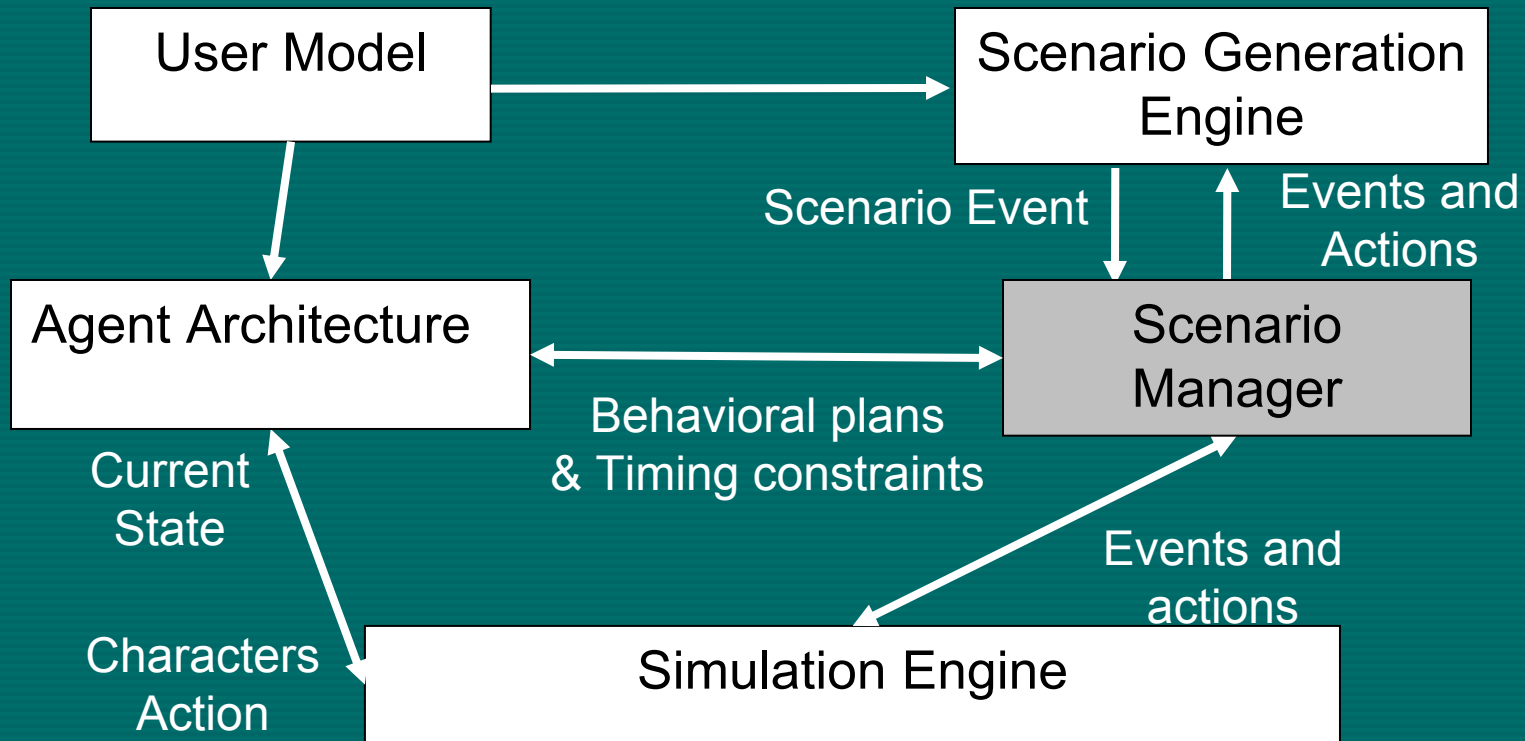
- Agent behavior Representation
  - *Behavior goal*
  - *Behavior Precondition*
  - *Behavior Posteffects*
  - *Behavior Effects*
  - *Behavior Subgoals*
- Reactive planning is used to select simple character actions given agent-behavior selected

# Adaptable/Responsive Agents

---

- User monitoring
  - Mouse clicks
  - Object interaction
  - Abstraction of: user attentiveness
- Feedback System for behavior failure declaring and reselection
  - Failure Condition
  - Failure Tolerance

# Dynamic Scenario Architecture



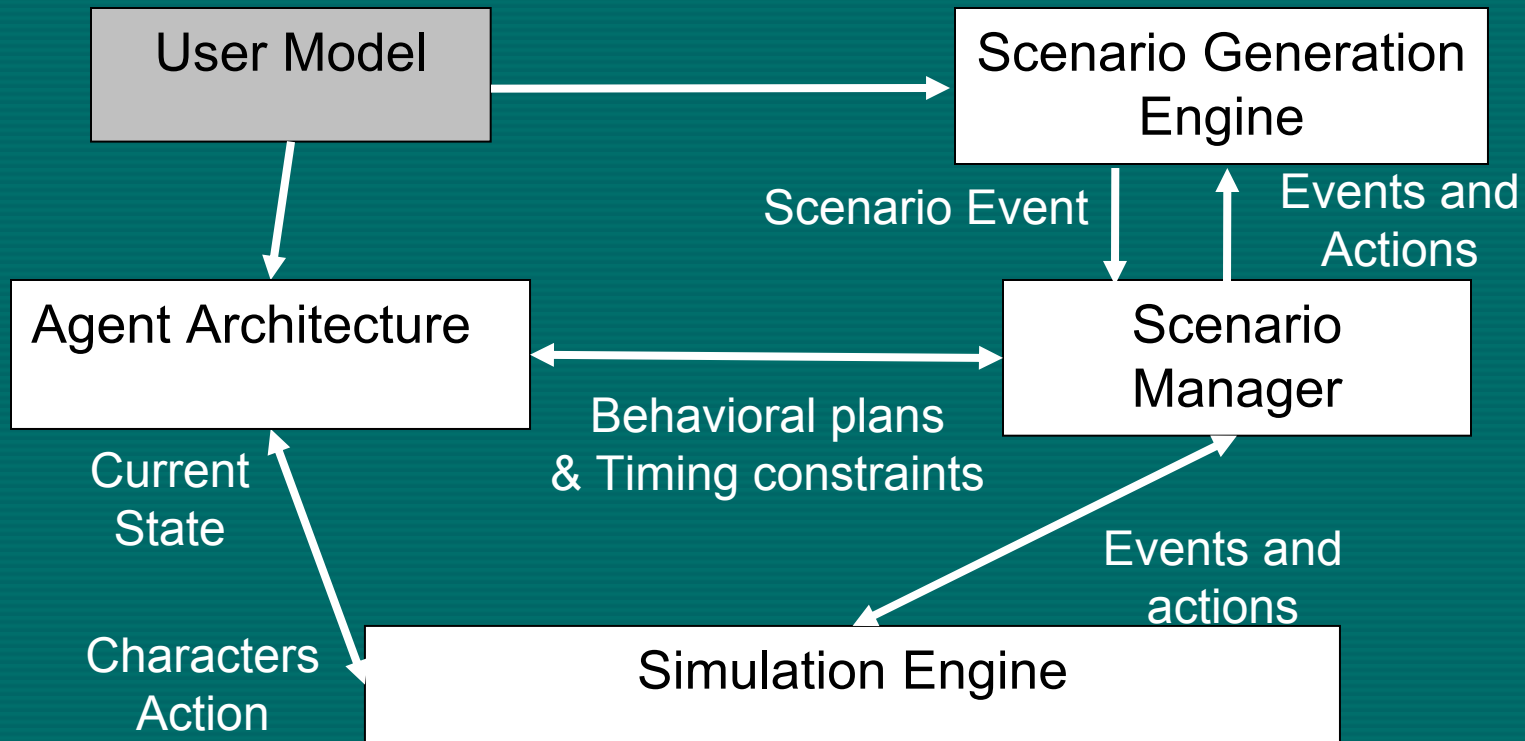


# Scenario Manager

---

- Hidden agent that
  - Coordinates agent behaviors
  - Synchronizes timing of agent behaviors
- Uses rules to synchronize timing
  - E.g. do not start talking until character ?x finishes talking
- It coordinates behaviors by forming a unified plan of behaviors

# Dynamic Scenario Architecture



# User Modeling

---

- Representing user patterns of decision-making
- represented as a vector of qualities  
e.g. <impulsive, attentive, self-interested>
- calculate vector values using rules; given
  - user actions, history of user actions, scenario state

# Conclusion

---

- Scenario Architecture
  - Scenario authoring split into several levels
  - Scenario representation

Contribution: easily maintainable, extensible, scalable, scenarios made up of reusable units
- Several novel techniques
  - Dynamic interactive Scenario
  - Responsive agent systems
  - Use of User modeling to adapt scenarios

Contribution: enhances adaptability, realism, produces better mechanism for training and assessment.