# Agent Technology for Military Applications *With Dynamically Changing Rules* Using Human Reasoning Processes

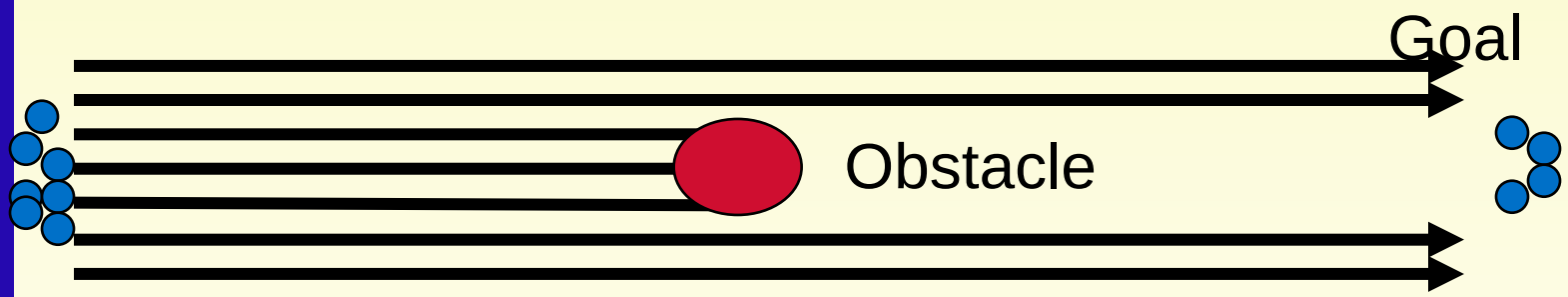
# Autonomous Military Applications

From a recent Army solicitation: **A04-055 "Command Decision Modeling in Distributed Combat Simulation"**

Objective – "To provide an asymmetric, non-scripted, adaptive model of battlefield decision-making to the Command, Communications, and Control Grid…"

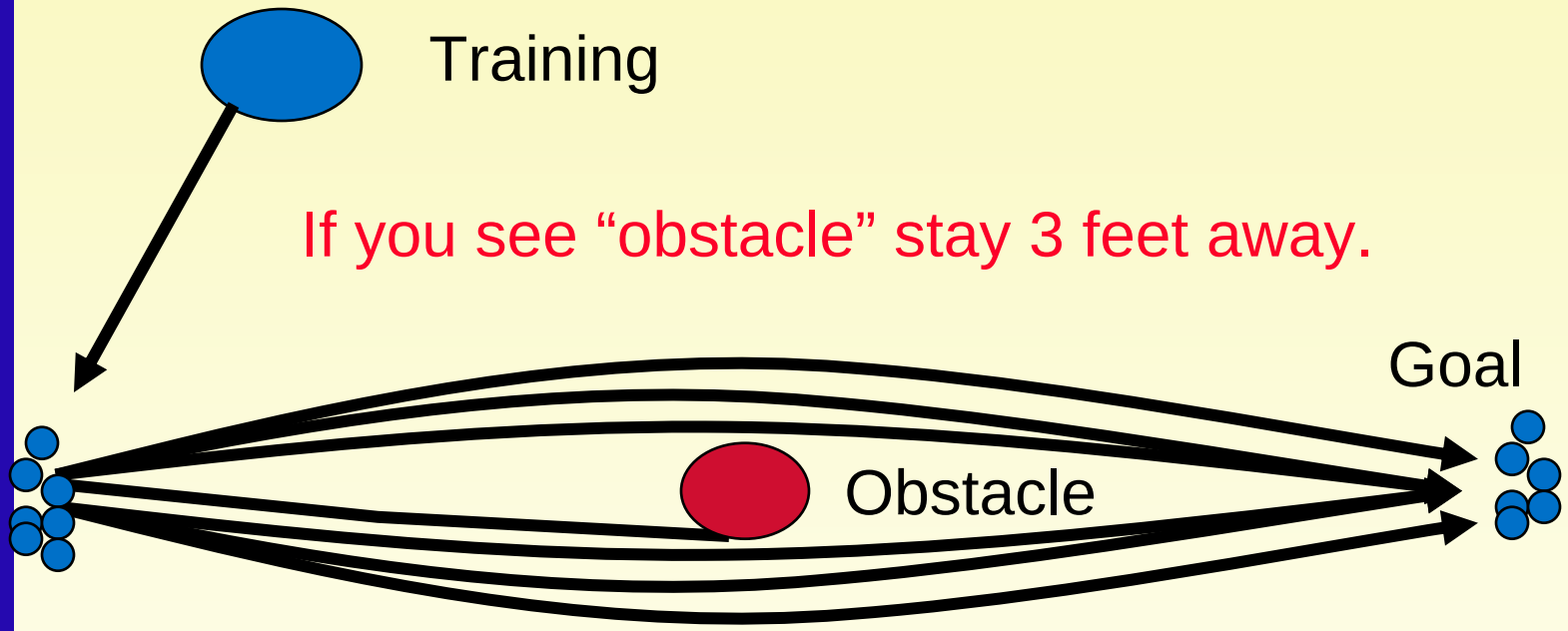
Requirements – "The rapid explosion in information circulating on the modern battlefield presents a huge challenge to the decision makers and warfighters who must plan and dynamically adapt to changing circumstance and new information, often under conditions of time pressure, uncertainty, and stress."

# Human Systems



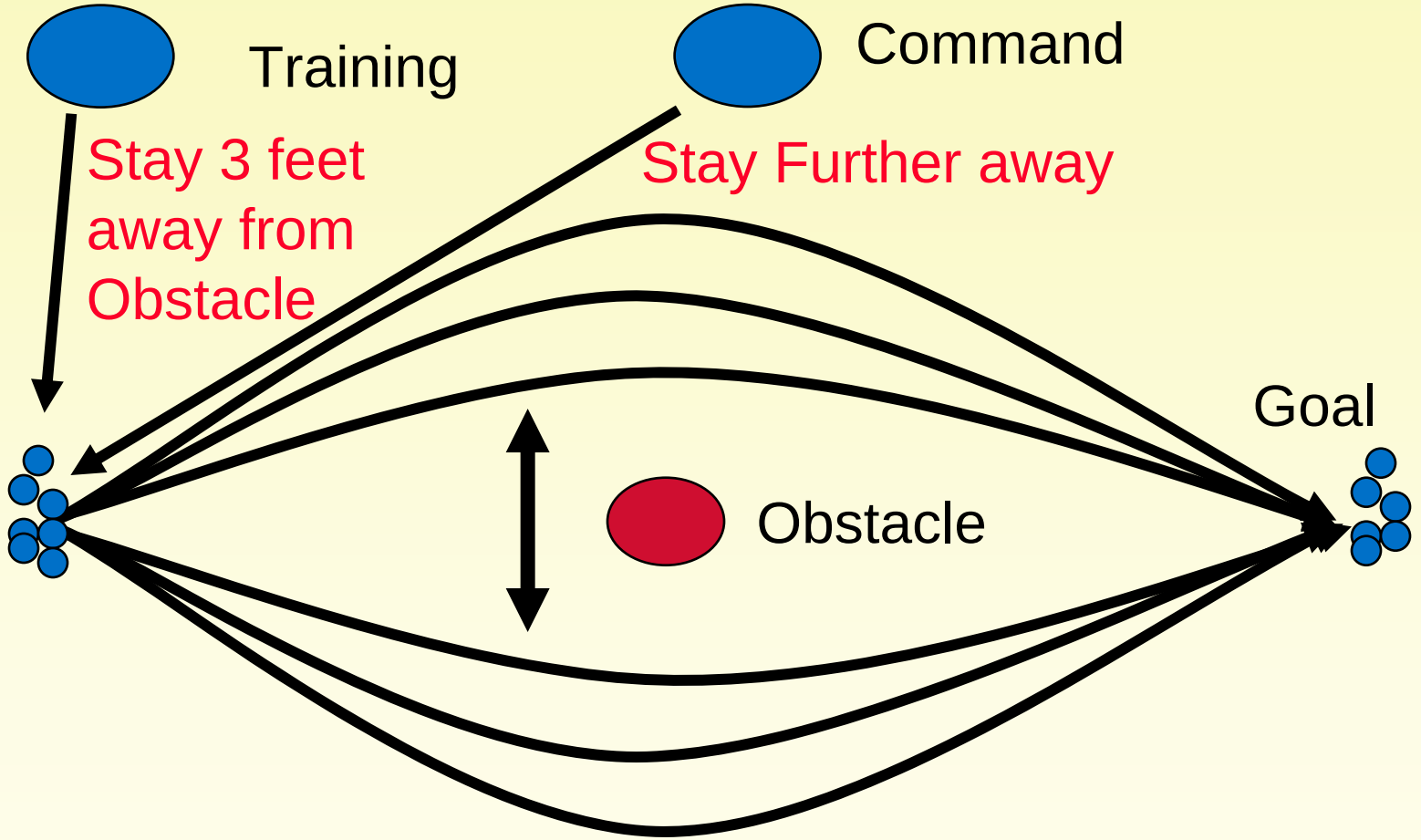

Operating With Little Information

# Human Systems with Training



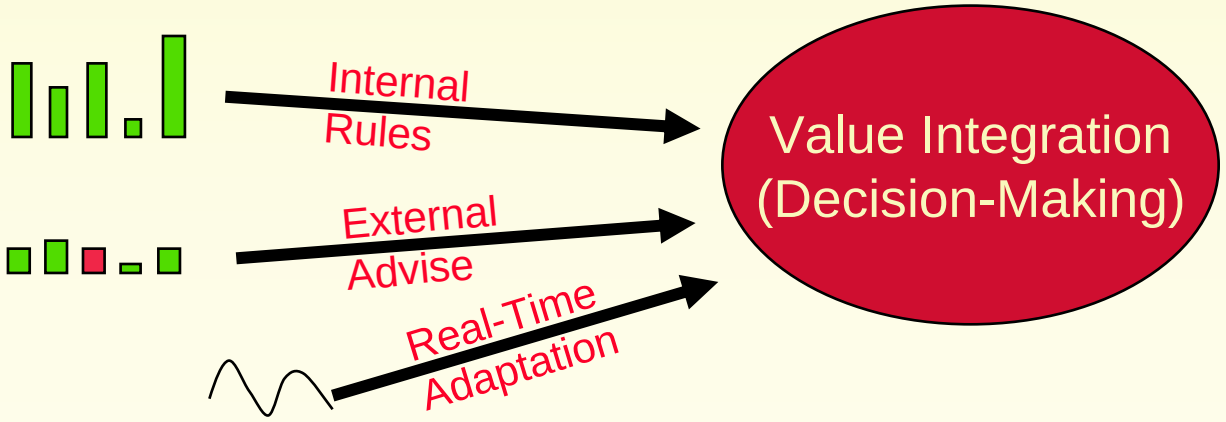

Remote Control Approach

# Human Systems under Command



# Rules Change in Dynamic Systems

- Agents (intelligent devices) need to adapt
  - They adjust their internal value system
    - Internal Knowledge / Understanding (Preconceived Rules)
  - They are “advised” of how to adjust their internal value system
    - External Knowledge / Understanding (Modified Rules)
  - They react to real-time environments



# What is KEEL?

- KEEL® (Knowledge Enhanced Electronic Logic) Technology
  - Allows domain experts to put human-like decision-making in products or software applications
  - An “expert” system that uses the decision-making skills of a human as the basis of judgmental decisions.
    - The KEEL Toolkit provides the mechanism to collect and test those reasoning skills before deployment in the final product.
- KEEL is:
  - A development environment
  - A model for accumulating supporting and objecting arguments in order to make a decision or take an action
  - A small footprint engine that processes sensors or other inputs according to the design of a system created in the development environment

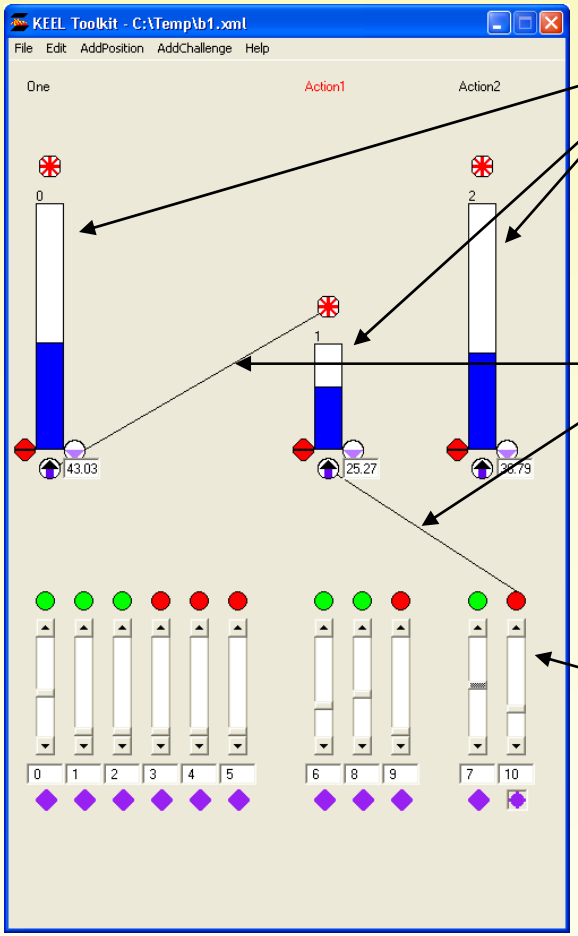


# What is KEEL?

- KEEL Technology allows subjective, “right brain” reasoning to be encapsulated using dynamically changing rules
- As a result:
  - Human-like reasoning can be put into very small devices (due to the small memory footprint)
  - A single design can be deployed in a variety of environments
  - Any architecture can be chosen (simple stand-alone applications, client-server, distributed)
  - The technology is easy to integrate into existing systems (it has a simple API)
  - Decisions or Actions are 100% explainable



# Graphical Language for Reasoning

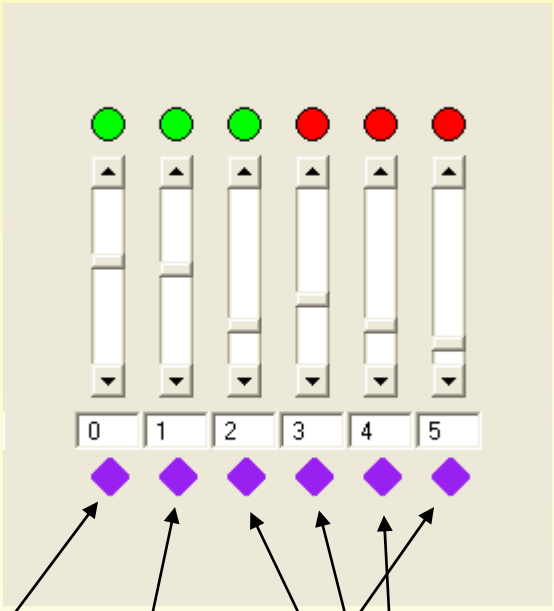



Outputs (Height indicates importance, Blue indicates accumulated support)

Wires define relationships

Scroll Bars emulate supporting and blocking inputs

# Modification of Agent “Reasoning”



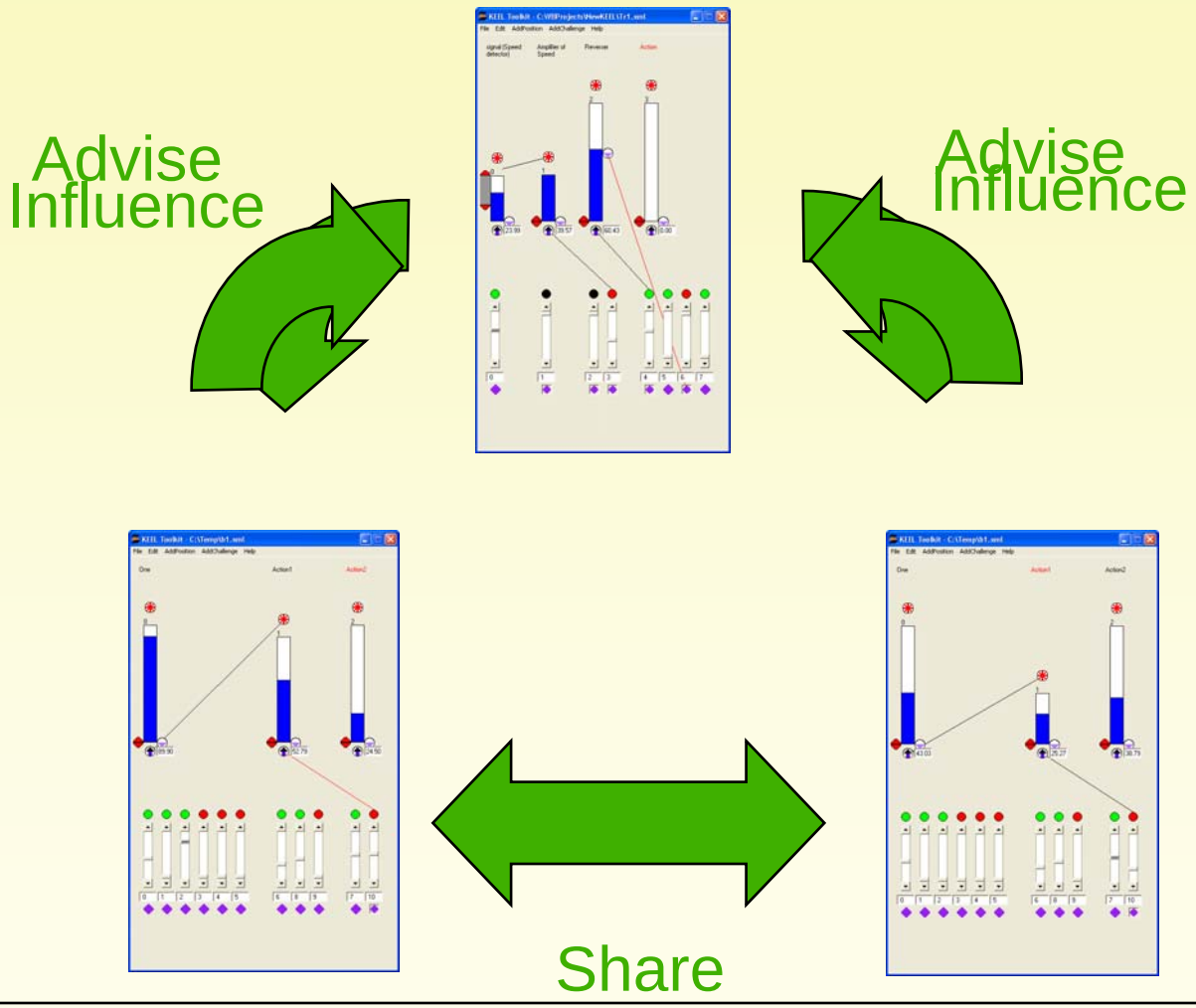

Internal Value

Command Modifier

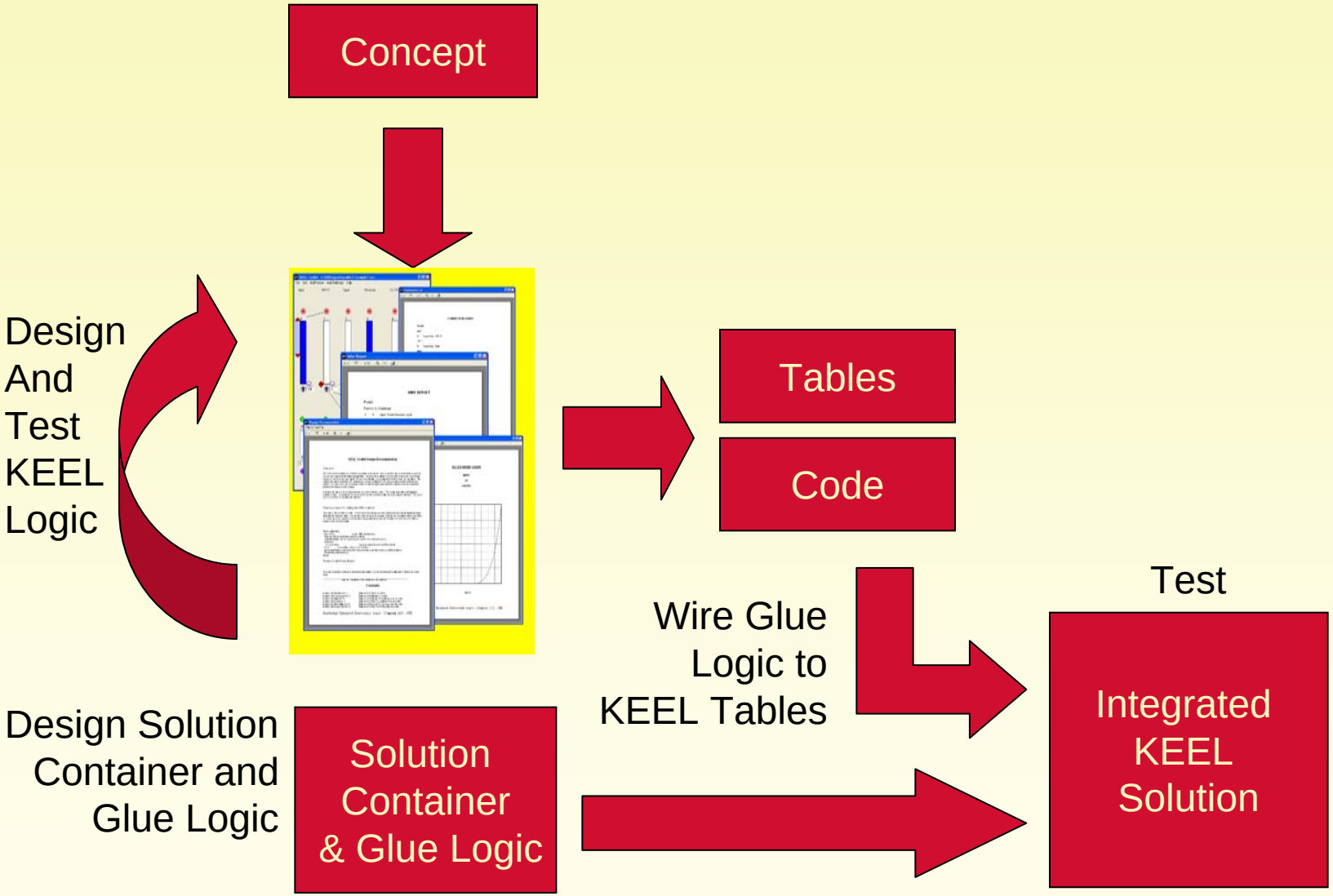
Peer Modifier

Real-Time Sensors

# Multiple Agents in Command & Control



# Process


Concept
Design
And
Test
KEEL
Logic
Tables
Code
Wire Glue
Logic to
KEEL Tables
Test
Integrated
KEEL
Solution
Design Solution
Container and
Glue Logic
Solution
Container
& Glue Logic

# Competing Solutions

- Conventional Code ("IF / THEN / ELSE" code)
  - Complex / Brittle / Hard to manage
- Text based Expert Systems
  - Brittle / Hard to maintain / Difficult to address dynamic environments
- Fuzzy Logic
  - Design is an 'art' / Actions hard to explain
- Artificial Neural Nets
  - Actions not explainable



# Summary

- Many Military Applications could be enhanced by deploying software agents that exercise their own intelligence while still allowing a higher level command process to have some control over the solution.
  - Command elements understand the “big picture” but don’t have the intimate view of the “real world”.
  - Commanded elements see the “real world” but don’t always know the “big picture”.

*(The system needs BOTH – autonomous agents + higher level command!)*



# Summary (continued)

- If KEEL engines are employed as autonomous “agents” they can dynamically adjust to the environment. Using a set of rules these agents can emulate the “thinking” or “reasoning” process of humans; producing outputs such as “actions” or messages which are explainable and auditable.

# Contact Information

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