

or the OML. This is an excellent example of the benefits of a layered architecture in supporting component reuse and replacement.

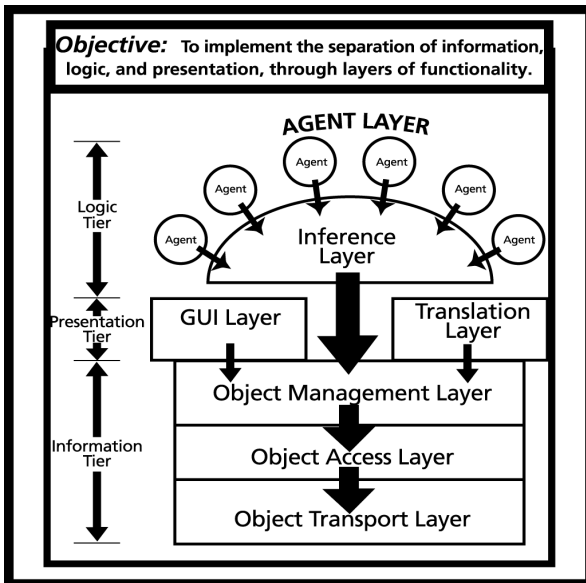


Figure 7 – Design Principle:
Multi-Tiered, Multi-Layered Architecture

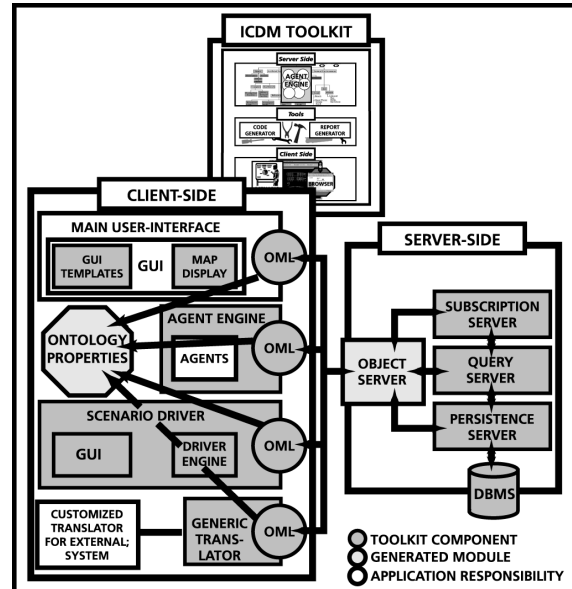


Figure 8 – ICDM-Based System
Component Types

The Logic Tier contains the business rules (i.e., agents) and analysis facilities by which these rules are managed. Although extensible to include other forms of reasoning the current version of ICDM focuses on opportunistic rule-based analysis. Regardless of which form of reasoning is employed this capability is supported by two layers namely, the Business Rule Layer (BRL) and the Business Engine Layer (BEL). The BRL is primarily system-specific and contains the agent-based analysis facilities resident in the system. Execution of agents is in turn managed by the BEL. To integrate the Logic Tier with the Information Tier the BEL interfaces with OML permitting the agents to both access and contribute to the ontology.

The final tier is the Presentation Tier. This tier is responsible for interfacing with the various users of the system. In this sense a user may be a human operator or an external system. In the case of a human operator support is provided through a Graphical User Interface Layer (GUIL) that presents and promotes interaction with the contents of the Information Tier. In the case of an external system, support takes the form of a Translation Layer (TL) that manages the mapping of representations between systems. Like the GUIL, access to and from the Information Tier is supported by OML.

Conclusion

As a toolkit for the development of agent-based, decision-support systems ICDM supports three types of components each working in conjunction with the others to form a complete decision-support system, namely: the toolkit facilities; the automatically generated modules; and, the application-specific code that must be created manually (Figure 8). The first type of component is automatically generated from the ontology. Among the generated artifacts is a property file that contains detailed characteristics of each object described in the ontology. These properties

are used to configure the second type of component. Configuration of the second type of component takes place during runtime and essentially conforms this category of components to the specific system in which they are operating. The third type of component is system-specific and the responsibility of the particular project. This set of components primarily includes the agent rules and user-interface. Together, these three types of components are integrated at the project level to formulate a specific agent-based, decision-support system.

Adhering to the design principles of collaboration, context-based representation, extensibility and adaptability, and a multi-tiered, multi-layered architecture, ICDM can be effectively utilized in the rapid development of agent-based decision-support systems spanning a variety of complex domains. ICDM has been successfully employed by the CADRC in the development of decision-support systems ranging from architectural design (e.g., ICADS and KOALA, (Pohl et. al. 1991; Pohl K. 1996)) to tactical command and control (e.g., IMMACCS and FALCON, (Pohl et. al. 1999)). Profiting from being founded on a framework embodying the principles described in this paper each such decision-support system exhibits the key qualities (e.g., collaborative, high level representation, and tools as opposed to predetermined solutions) that the CADRC has found to be vital to the effectiveness of agent-based, decision-support systems.

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