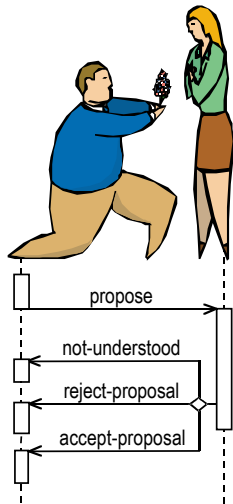


Representing Social Structures in UML



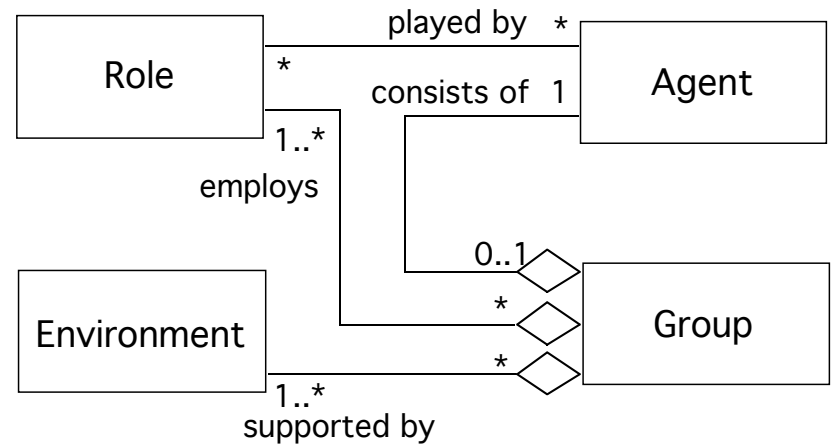
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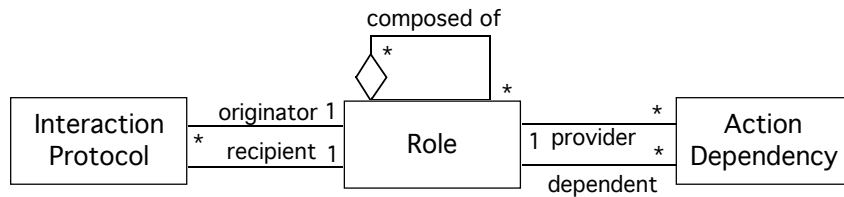
SOCIAL STRUCTURE ARCHITECTURE OVERVIEW



- An *agent* is an autonomous entity (process) that interacts with its environment.
- A *role* is a class whose members participate in a dependency or an interaction protocol.
- A *group* is a set of agents related through their roles.
- An *environment* consists of the conditions under which an entity (agent or object) exists.

ROLE

An agent's role mediates between it and the group.



□ Dependency Theory (Castelfranchi)

Dependence relationships- patterns of dependence between an agent and a resource or another agent(s), such as autonomy, unilateral dependence, mutual dependence, reciprocal dependence.

e.g., if an agent Y depends on an agent X for an action a
 $(\text{Dep } Y X a)$

then Y is not autonomous from X relative to its action a .

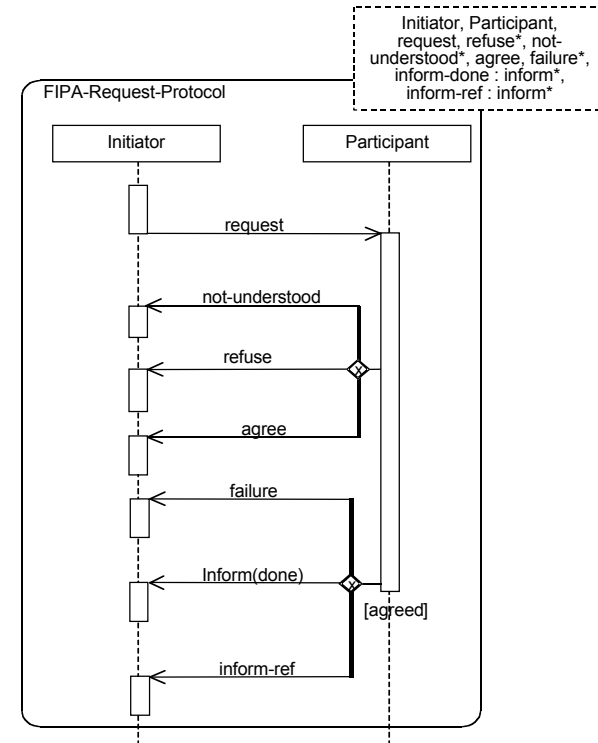
Also then, $(\text{Autonomous } Y X a) \implies (\text{Not } (\text{Dep } Y X a))$

□ Interaction templates

Interrelated sets of speech and other behavior that an agent might undertake (e.g., FIPA interaction protocols)

INTERACTION PATTERNS

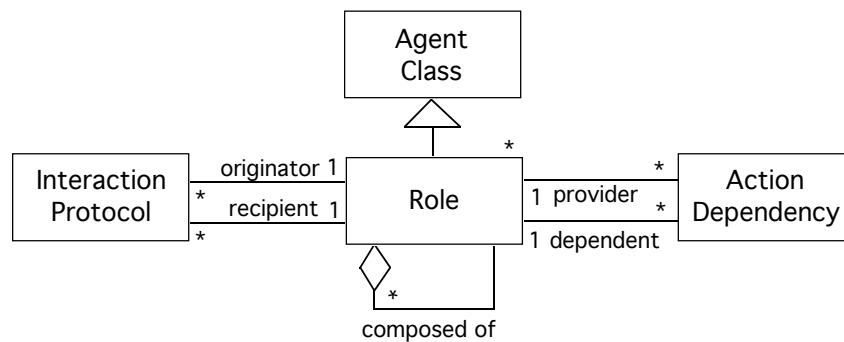
FIPA "INTERACTION PROTOCOLS"



The FIPA *Request* protocol specifies how two agents —playing *Initiator* and *Participant* roles, respectively— can interact regarding a request to perform some action.

ROLE

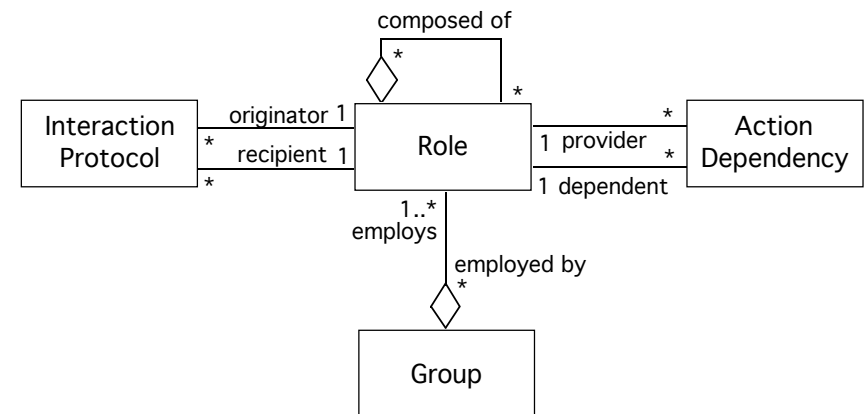
A class whose members participate in a dependency or an interaction protocol



A *role*, then, is an abstract representation of an agent's function or service—for the purpose of participating in a dependency or an interaction protocol.

GROUP

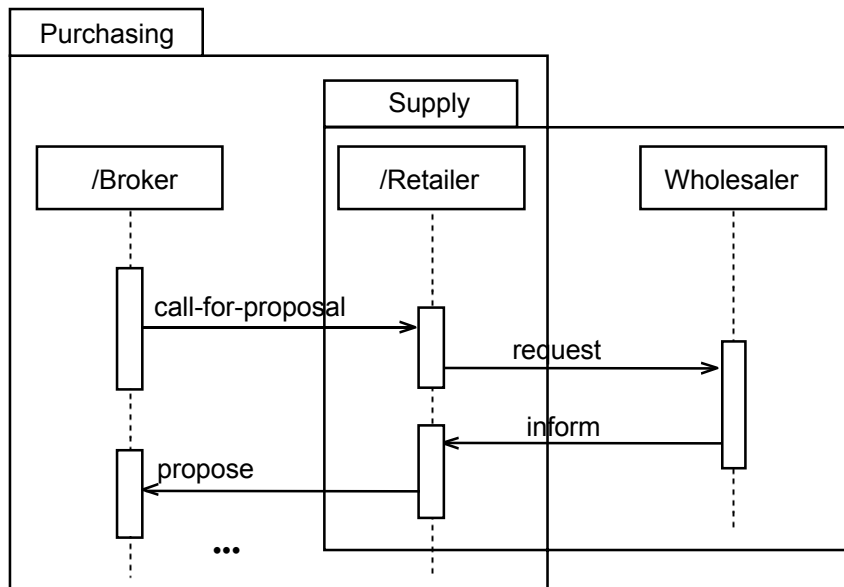
A set of agents related through their roles



Jacques Ferber (*Multi-Agent Systems*)- a group (also “grouping”) draws agents closer to form more or less homogeneous units. Some usages: defense, robustness, convenience due to proximity, simplification in movement and manipulation, effort reduction, encourages role specialization.

Social psychology- a set of agents associated together by some common interest or purpose, united by a common agreement, holding the same belief or opinion, following the same trade or profession, and so on.

INTERACTION VIA DEPARTMENTAL (GROUP) ROLES



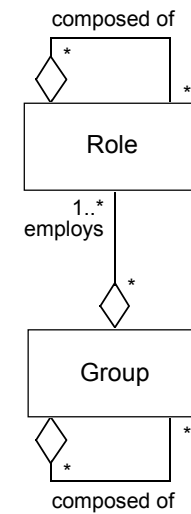
SOME GROUP ISSUES

So then, is it possible for a role to exist outside a group?

i.e., can agents interact for their own purpose and not a group's? Or, does that imply a group consisting of agents acting solely for their own purpose?

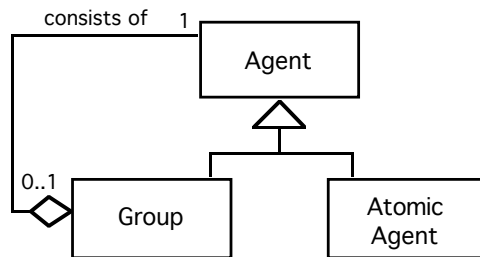
Is a role an interacting class within a group?

Can groups contain groups?

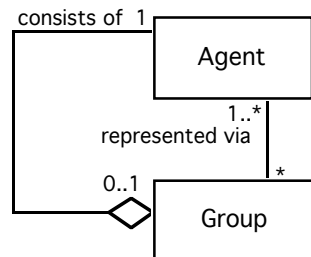


GROUPS AS AGENTS

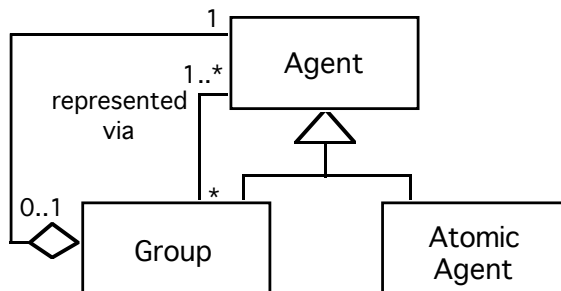
*Holonic Perspective
(University of Hanover)*



*ALAADIN Perspective
(Ferber and Gutknecht)*



*Consolidated
Perspective*



CASE STUDY

The terrorist organization (TO) has roles:

- Operative**- who actually deploys and operates the instrument of terrorism (e.g., plants and detonates the bomb, or shoots the gun) (= A).
- Ringleader**- who sets the vision for the organization and may bankroll it personally.

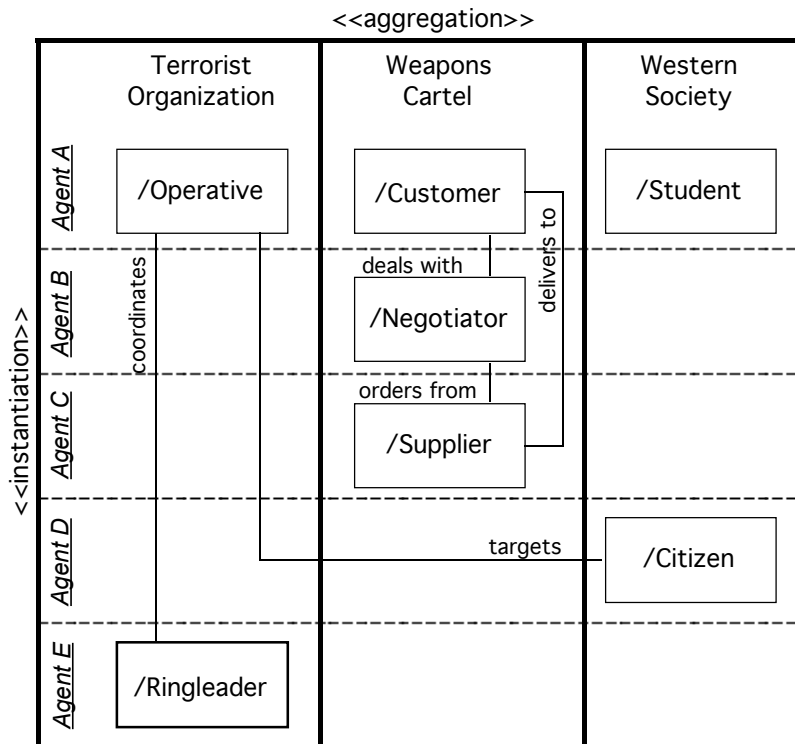
The weapons cartel (WC) has roles:

- Customer**- who wishes to procure arms (= A).
- Supplier**- who delivers arms to the customer.
- Negotiator**- who negotiates the deal with the customer and receives payment.

Western society (WS) has roles:

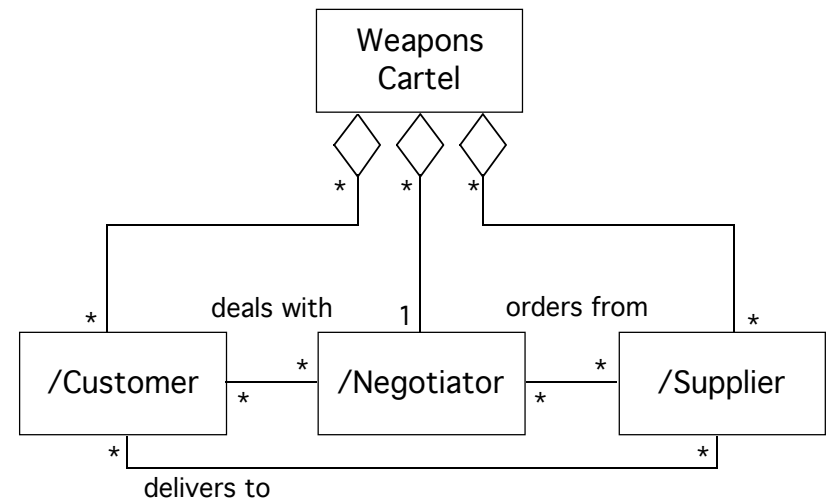
- Citizen**- whom the terrorist operative wishes to target.
- Student**- a convenient cover for a foreign national (= A).

AGENT INSTANCES PLAYING ROLES IN GROUPS



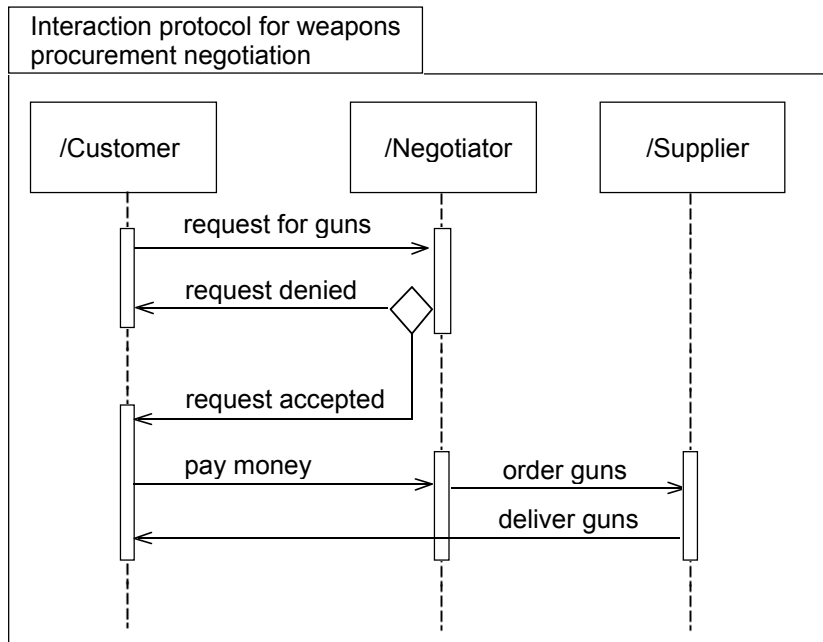
***Class diagram with two-dimensional swimlanes
depicting interrelated roles with their agents and groups***

GROUPS AS AGGREGATES OF ROLES



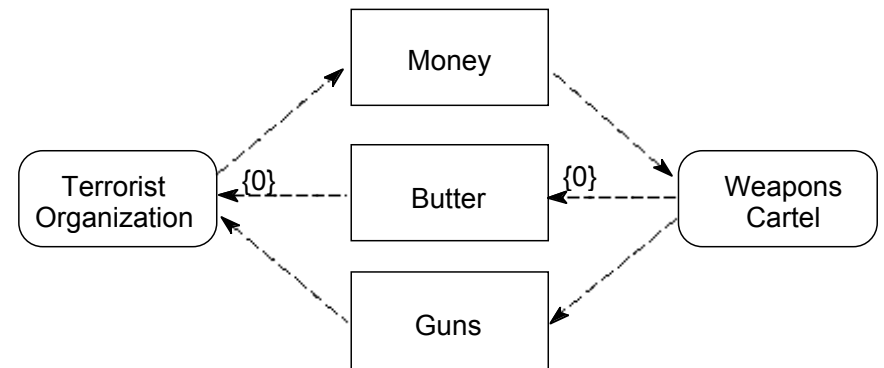
***Class diagram depicting a group
consisting of distinct roles***

ROLES IN AN INTERACTION PROTOCOL



Packaged sequence diagram with roles

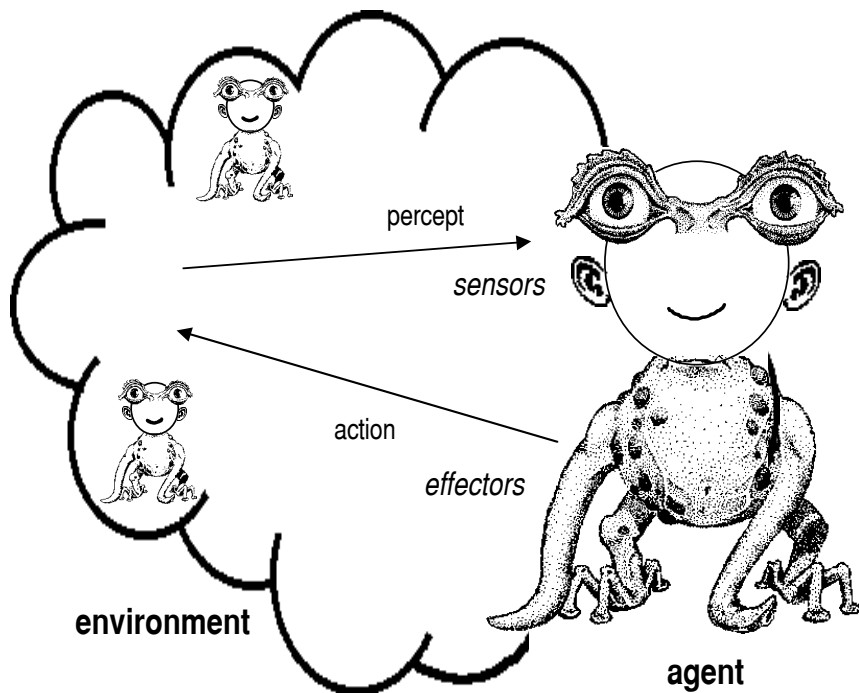
PRODUCTION AND CONSUMPTION BY GROUPS



***Object-flow activity graphs showing
groups as patterns of dependencies***

ALSO: ENVIRONMENT

The conditions under which an entity (agent or object) exists.



Two aspects of an agent's environment:

- Physical environment*
- Social environment*

PHYSICAL ENVIRONMENT

The physical environment provides the principles and processes that govern and support physical existence of entities (agents and objects).

Principles- *the laws of physics for the agent's environment.*

Basic characteristics for an agent environment could include [Weiss, 1999; Russell, 1995]:

- **Accessibility-** to what extent is the environment known and available to the agent (e.g., can the agent access those environmental states relevant to its choice of action, are resources ample or restricted?)
- **Determinism-** to what extent can the agent predict events in the environment. (The environment is deterministic when the next state of the environment can be determined by the current state and the actions selected by the agents.)
- **Diversity-** how homogeneous or heterogeneous are the entities in the environment.
- **Controllability-** to what extent can the agent modify its environment
- **Volatility-** how much can the environment change while the agent is deliberating.
- **Temporality-** is time divided in a clearly defined manner. For example, do actions occur continuously or in discrete time steps or episodes.
- **Locality-** Does the agent have a distinct location in the environment, or are all agents virtually collocated?

PHYSICAL ENVIRONMENT

Processes- *The physical environment is not static, it is dynamic: it is a series of actions and events. In an agent environment, processes implement the environmental principles, e.g., CORBA, DCOM, Java, FIPA.*

Agent Management System	<i>Execution and monitoring of active agents</i> Basic functionality (API) - Identification - Query/Search - Directory services - Negotiations - Registration - Mobility
Agent Platform Security Manager	<i>Secure transfer of messages and objects</i> Secure protocols Data encryption Digital signature Firewalls
Agent Communication Channel	<i>Provision of base communication functions</i> Protocols, document formats RPC, remote programming Remote method invocation Object serialization

Content- An environment is populated by the totality of entities under the physical environment's consideration.

- For the software ant, this population would consist of food, pheromones, and other ants.
- For a real ant, it would also include earth, twigs, trees, and picnics.
- For a stock agent in a supply network, it would include physical inventory, road and rail networks, packaging conventions,

SOCIAL ENVIRONMENT

The social environment provides the principles and processes that govern and support effective interaction among entities.

- Individualist* agent environments, agents are viewed as independent entities; whereas *collectivist* environments, agents are viewed as interdependent.
- An agent can operate by itself, but the increasing interconnections and networking require a different kind of agent: an agent that can interact effectively with other agents.
- In short, we need a social environment that provides us with an infrastructure for agents to interact productively.**

- A social environment provides two things:
 - First, it provides the principles and processes that govern and support the interrelations resulting from an agent's association with other entities in the environment.
 - Second, it provides those functions and structures necessary to membership of a group or society.

SOCIAL ENVIRONMENT

Principles- *Social principles provide us with the fundamental truths that are essential for sets of interdependent relationships, interactions, customs, norms, values, commitments, dependencies, etc., that constitute an agent society.*

In rich multiagent societies (MAS), other principles are required:

- Communication languages-** The formal study of communication has three aspects: syntax, semantics, and pragmatics. Agent-based social environments must define the principles required to address these aspects. Common agent communication languages (ACL) languages include FIPA ACL and KQML.
- Interaction protocols-** describes a communication pattern as an allowed sequence of messages between entities.
- Coordination strategies-** agents communicate to achieve their goals and the goals of the social group in which they participate e.g., cooperation, competition, planning, and negotiation.
- Social policies-** declarations of rules or conditions that must be satisfied for social behavior; i.e., policies and constraints on agents and groups of agents, not the detailed management of agent lifecycle.
- Culture-** a set of values, beliefs, desires, intentions. These can determine the characteristics of the above; e.g., English vs other different-culture language (Navajo) affects language, interaction protocol, social policies (implicit & explicit);

SOCIAL ENVIRONMENT

Processes- *An agent's social environment provides processes that enable agents to interact productively. In particular, it must provide:*

- Interaction management-** managing the interactions among entities to ensure that they are adhering to the selected AIP. (How will this be accomplished?)
- Language processing and policing-** it parses correctly, it parses correctly but is wrong (evidence or contradictory), correct but socially inappropriate)
- Coordination strategy services
 - **Directory service-** locating agents can be supported by white-page (individual) or yellow-page (categories) methods.
 - **Mediation services-** acting through intermediate agency.
- Policy enforcement service-** control of the agent by the environment or the social group to which it belongs, including reputation and social sanctions
 - **Social differentiation-** the process whereby a group or community becomes separate or distinct. To ensure the success, groups will institutionalize and employ specialized roles for their members.
 - **Social order-** orderliness within society; improving the condition of society or for the benefit of society as a whole.

Content- *the social population consists of social units, or groups; sets of agents associated by some common interest or purpose, united by a common agreement, holding the same belief or opinion, following the same trade or profession, etc.*

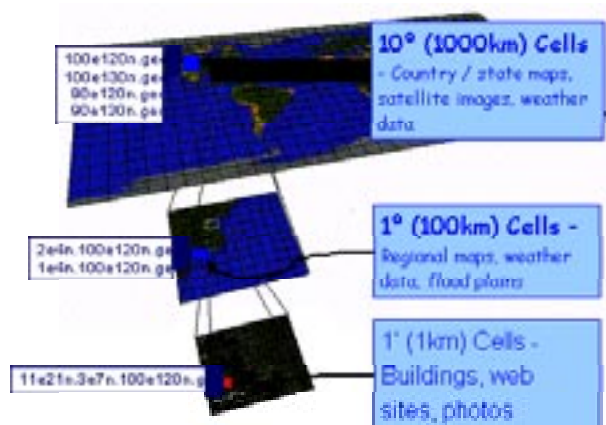
SPATIAL CONSIDERATIONS

An agent's environment—physical or social—must occupy or take up space, because it needs a place for agents to reside and function.

Agent space involves three basic concepts: extent, place, and locality.

- Extent**- agents must exist in some designated area (or volume) in space. Such designations can be expressed in various ways and shapes.
- Place**- An agent's space might contain separate regions that partition the environment called *places*—where each place may have different or unique characteristics.

Geodata Placement



Places as a hierarchy of geographic placement. [SRI, 2000]

SPATIAL CONSIDERATIONS

Locality- An agent can be characterized by its location in the environment and interacts only with the region of the environment that is near it .

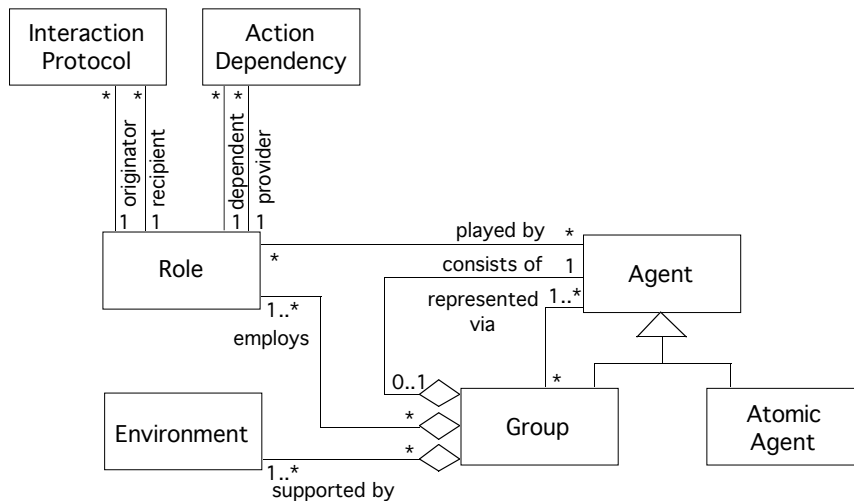


Absolute and relational locality used in sentient computing. [Buderi, 2001]

Design for discrete versus continuous space- *The primary processing concern for agent space is how physical and social processing occurs within the space:*

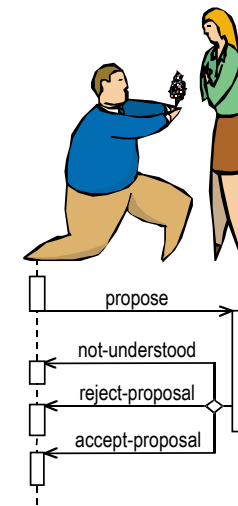
- one continuous environment (i.e., no partitioning) that oversees all environmental processing, or
- partitions of the overall space into discrete places, where each place oversees only the environmental processing within its boundaries.

CONSOLIDATED ONTOLOGY



- An *agent* is an autonomous entity (process) that interacts with its environment.
- A *role* is a class whose members participate in a dependency or an interaction protocol.
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