Social Structures

SOCIAL STRUCTURE ARCHITECTURE
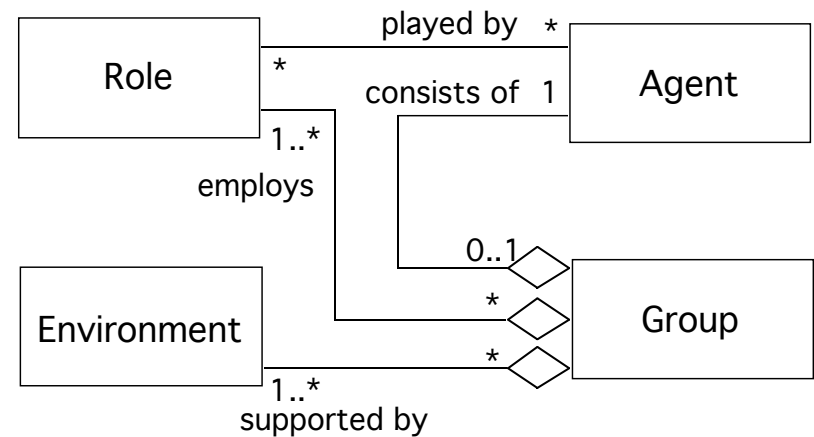
Role — played by — * Agent
* / consists of 1
1..* employs
Environment — 0..1 / * / * — Group
1..* supported by
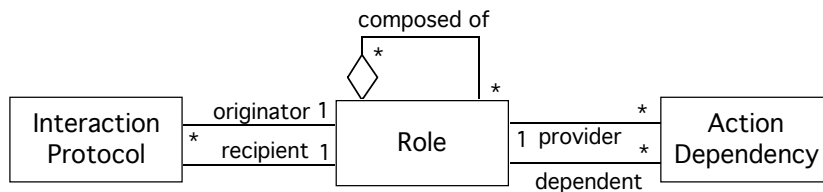
- ❏ An *agent* is an autonomous entity (process) that interacts with its environment.

- ❏ 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 *environme*nt is the conditions under which an entity (agent or object) exists

Page 3 (left slide)

ROLE

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

composed of

Interaction Protocol — originator 1 / recipient 1 — Role — 1 provider / dependent — Action Dependency
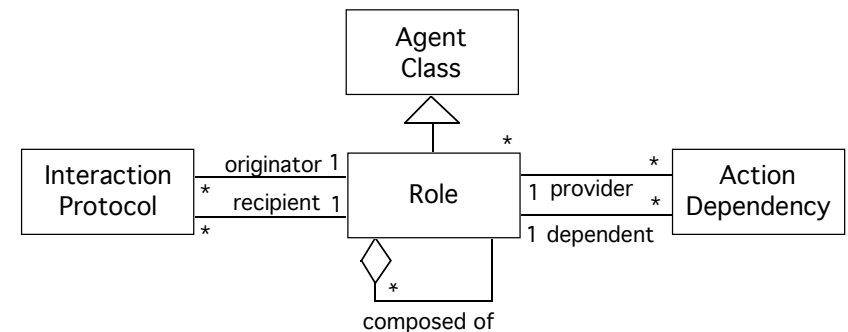
❑ **Dependency Theory (Castelfranchi)**

If an agent Y depends on an agent X for an action a
(Dep $Y X a$)
then Y is not autonomous from X relative to its action a.

(Autonomous $Y X a$) ==> (Not (Dep $Y X a$))

❑ **Interaction templates**

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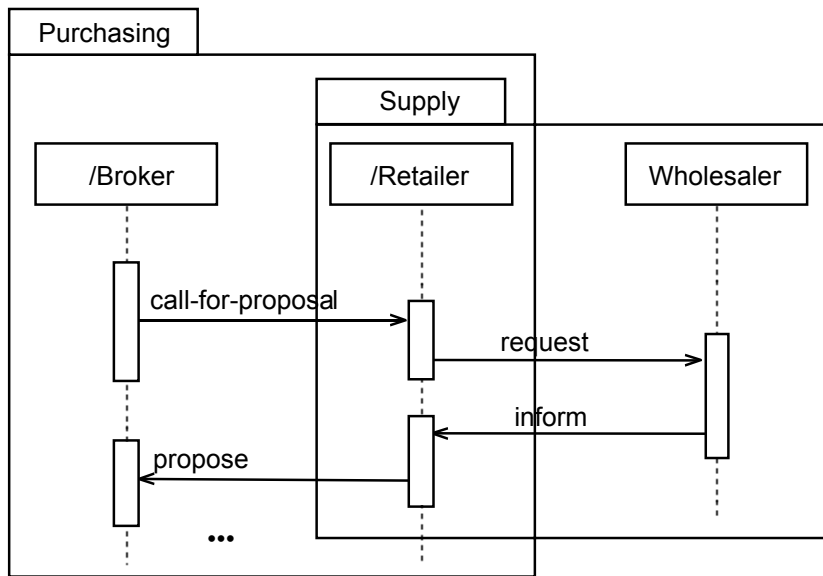
Social Structures

Page 4 (right slide)

ROLE

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

Agent Class

Interaction Protocol — originator 1 / recipient 1 — Role — 1 provider / 1 dependent — Action Dependency
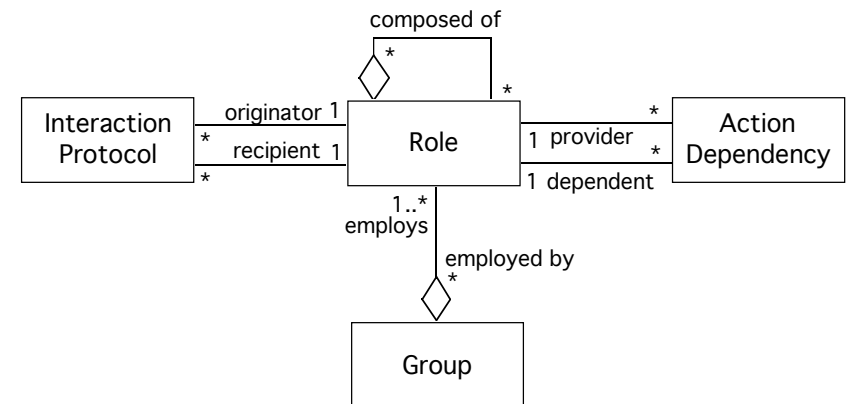
composed of

**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.**

Social Structures

INTERACTION VIA
DEPARTMENTAL (GROUP) ROLES

Purchasing

Supply

| /Broker | /Retailer | Wholesaler |

call-for-proposal

request

inform

propose

...

GROUP

A set of agents related through their roles.

composed of

*

*

Interaction Protocol — originator 1 — recipient 1 — Role — 1 provider * / 1 dependent — Action Dependency
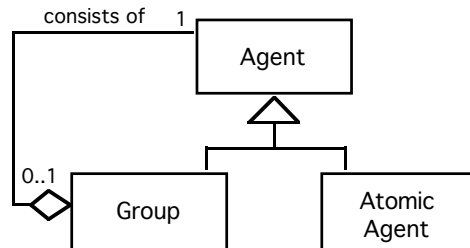
*

*

1..*
employs

employed by
*

Group

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 activity solely for their purpose?
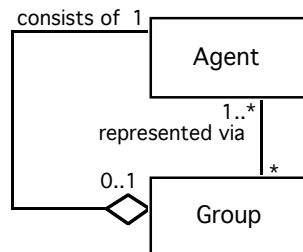
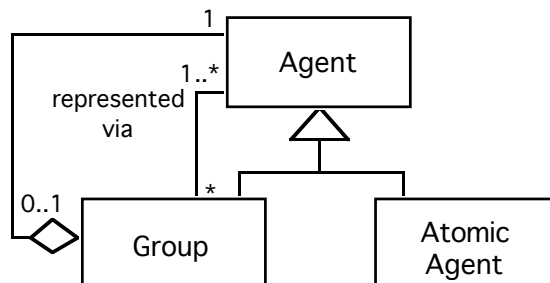*Is a role an interacting class within a group?*

GROUPS AS AGENTS

**Holonic Perspective
(University of Hanover)**

consists of   1

Agent

0..1   Group   Atomic Agent

**AALAADIN Perspective
(Ferber and Gutknecht)**

consists of   1

Agent

1..*
represented via

0..1   Group   *

**Consolidated
Perspective**

1

Agent

1..*
represented
via

0..1   *   Group   Atomic Agent

HOW WILL WE USE AGENTS?

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

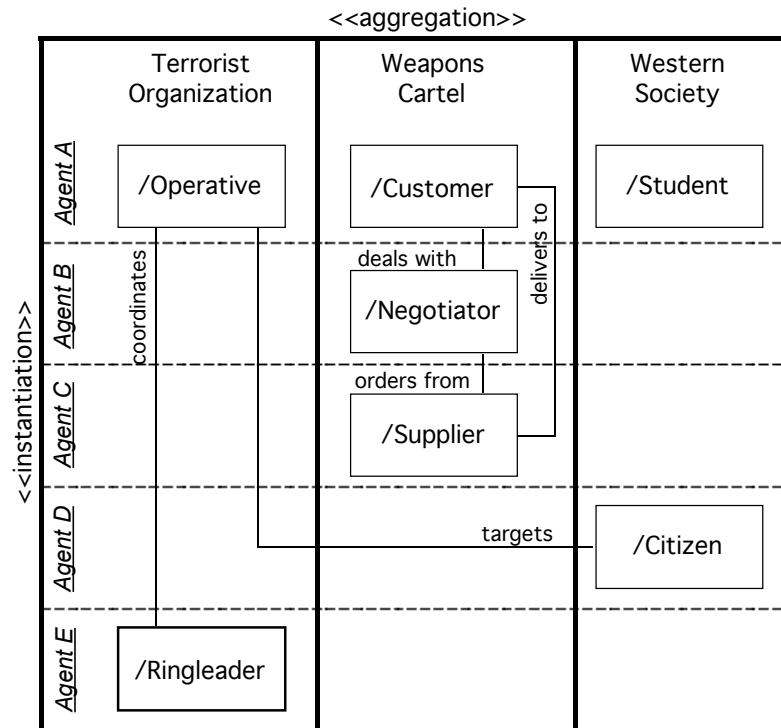**The weapons cartel (WC) has roles:**

❑ *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

<<aggregation>>

	Terrorist Organization	Weapons Cartel	Western Society
Agent A	/Operative	/Customer	/Student
Agent B		/Negotiator	
Agent C		/Supplier	
Agent D			/Citizen
Agent E	/Ringleader		

<<instantiation>>

coordinates

deals with
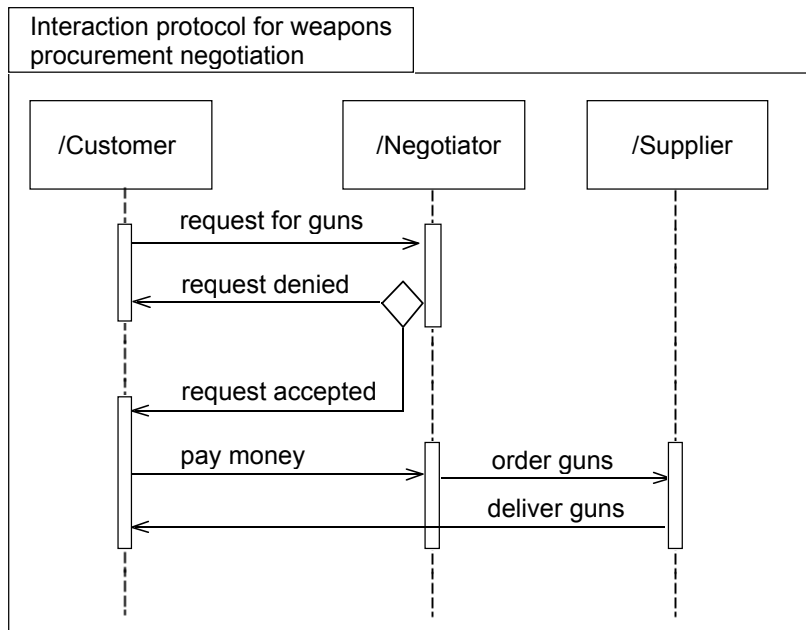
delivers to

orders from

targets

Class diagram with two-dimensional swimlanes

depicting interrelated roles with their agents and groups
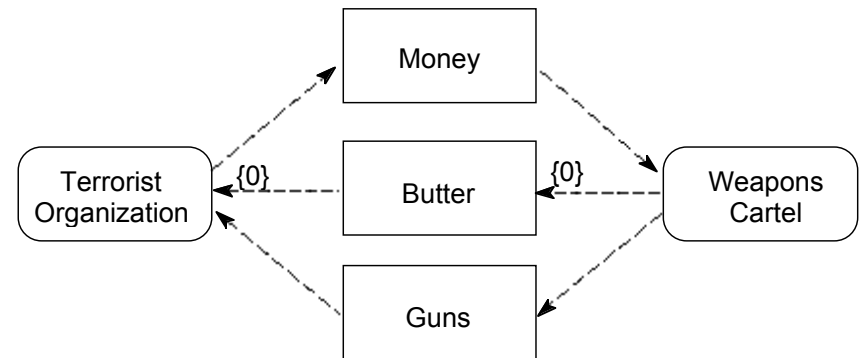
GROUPS AS AGGREGATES
OF ROLES

Weapons Cartel

*   *   *

/Customer   *   deals with   1   /Negotiator   *   orders from   *   /Supplier

*   *   *

delivers to
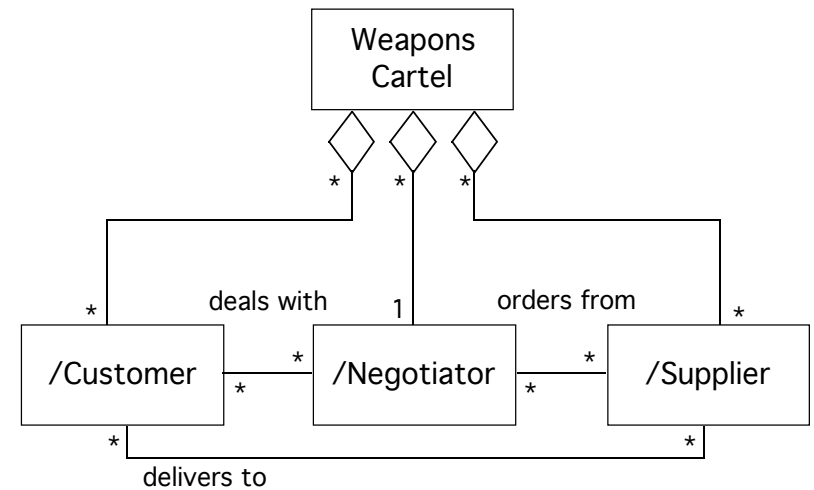
Class diagram depicting a group

consisting of distinct roles

ROLES IN AN
INTERACTION PROTOCOL

Interaction protocol for weapons
procurement negotiation

/Customer	/Negotiator	/Supplier

request for guns

request denied

request accepted

pay money

order guns

deliver guns

Packaged sequence diagram with roles

PRODUCTION AND CONSUMPTION
BY GROUPS

Money

Terrorist
Organization

{0}

Butter

{0}

Weapons
Cartel

Guns

Object-flow activity graphs showing

groups as patterns of dependencies

AND NOW: ENVIRONMENT

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

percept

sensors

agent

action

effectors
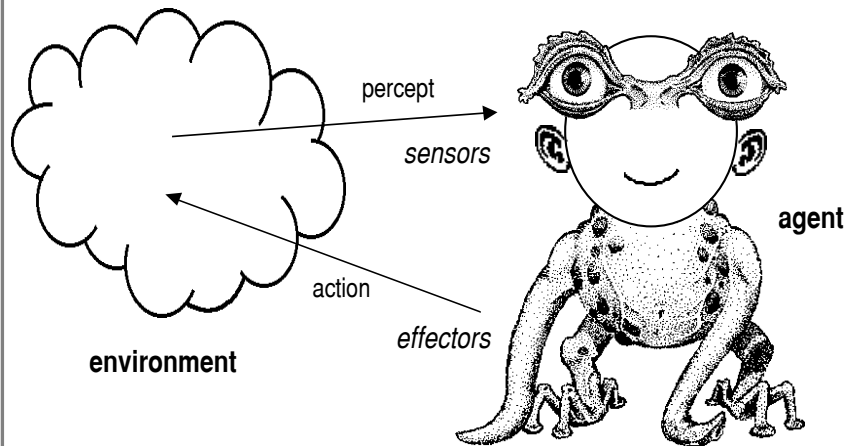
environment

Three aspects of an agent's environment:

- ❏ ***Physical environment***
- ❏ ***Social environment***
- ❏ ***Spatial environment***

PHYSICAL ENVIRONMENT

The physical environment provides the principles and processes that govern and support a population 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. An environment is effectively accessible if the agent can access the environmental state relevant to the agent's choice of action. Another consideration is whether the available resources are 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 discrete time steps or episodes.

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

Population- *An agent population, therefore, is the totality of entities under the physical environment's consideration.*

SOCIAL ENVIRONMENT

❒ *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 protocols**- 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. Additionally, it must define types of messages that will be employed (e.g., assertions, queries, replies, requests, and denials) and the ontology. Common agent communication languages (ACL) languages include FIPA ACL and KQML.

❑ **Interaction protocols**- an agent interaction protocol (AIP) describes a communication pattern as an allowed sequence of messages between entities and the constraints on the content of those messages.

❑ **Coordination strategies**- agents communicate to achieve their goals and the goals of the social group in which they participate. Cooperation, competition, planning, and negotiation are common principles used to perform activities in a shared environment. (AIPs can be associated with each of these strategies.)

❑ **Social policies**- declarations of rules or conditions that must be satisfied for social behavior. The general focus here is on the application and management of policies and constraints on agents and groups of agents, not the detailed management of agent lifecycle, and areas currently addressed by FIPA agent management specifications.

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. (AIP adherence must be maintained by the interacting agents participating in the protocol. How will this be accomplished?)

❑ **Directory service**- locating agents can be supported by white-page (individual) or yellow-page (categories) methods.

❑ **Mediation services**- acting through intermediate agency to act as a communication intermediary for activities such as transaction management or ontology translation.

❑ **Policy enforcement service**- control of the agent by the environment or the social group to which it belongs. Enforcing policy mechanisms can include reputation and social sanctions, and to complete withdrawal of supporting services for a non-conforming agent.

❑ **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.

Population- *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 ENVIRONMENT

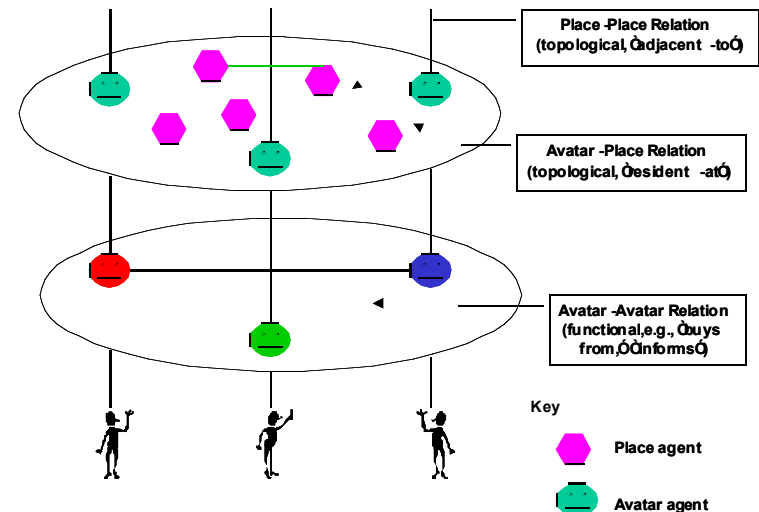An agent's environment must occupy or take up space. As such it needs an identifiable place to reside and function.

Principles- *The principles of agent space involve 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. These regions, or *places*, partition the agent's physical environment in some manner—where each place may have different or unique characteristics.

❏ **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. .

Processes- *The primary processing concern for agent space is how physical and social processing occurs with in the space*:
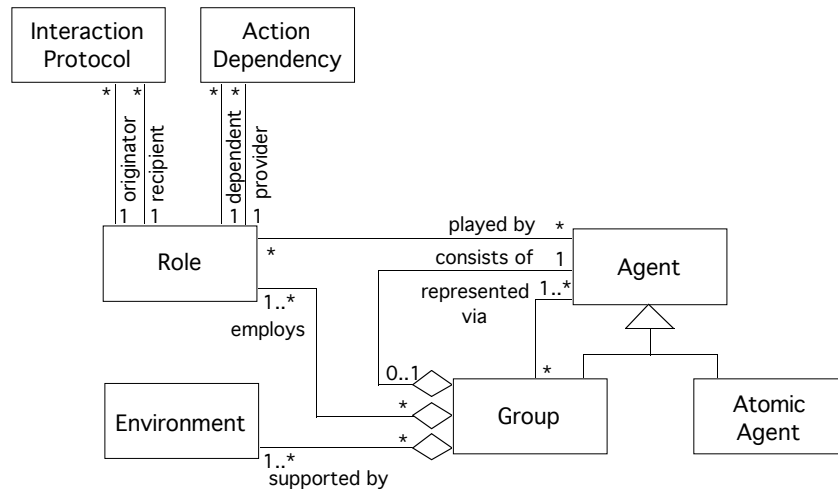
❏ one overall environment (i.e. no partitioning) that oversees all environmental processing, or

❏ partitions of the overall space into discrete places, where each place oversees only the environmental processing within its boundaries.

AVATAR AND PLACE AGENTS

When places must be agents, too.

CONSOLIDATED ONTOLOGY

Interaction Protocol | Action Dependency

originator | recipient | dependent | provider

Role — played by * Agent
consists of 1
represented via 1..*

employs 1..*

Environment — Group — Atomic Agent

0..1
supported by 1..*

❑ An *agent* is an autonomous entity (process) that interacts with its environment.

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