CoNeX

COORDINATION AND NEGOTIATION SUPPORT FOR EXPERT TEAMS IN PROJECT MANAGEMENT (Extended Abstract*)

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1 Project Goals

Current technologies for group decision support only rarely account for the *qualitative* mechanisms underlying problem solving processes of multiple persons, i.e. on-going task negotiations, debates of contradictory issues, alterations of commitment-based contracts, e.g., redefining tasks due to resource allocation constraints or dynamic changes in the project environment. The CoNeX system* (COoperation and NEgotiation among eXperts) currently under development is particularly dedicated to integrate these qualitative aspects of group work [HJ88]. The application scenario considers the problem solving activities of physically distributed experts in the field of information system design, development, and maintenance under the perspective of software project management [DAIDA88].

2 A Conceptual Model

The design of CoNeX covers the cooperation- and negotiation-expensive aspects of the following group problem solving process model:

- *Idea generation* and *idea structuring (brainstorming)* introduce relevant issues into the agenda of group discussions to start effective group problem solving.
- A *concept formatting* phase relates the informal issue items resulting from brainstorming to the remote domain knowledge base in order to formally check the conceptual validity, exhaustiveness and consistency of the various proposals.
- Any conflicts identified in the formatting phase are subject to a *conflict resolution* process which is based upon appropriate resolution policies (further information supply, argument exchange, constraint relaxation, voting procedures etc.) advocated by a policy scheduler.
- Given a set of valid, complete (under closed world assumptions), and consistent alternatives the group enters a *discussion* round whose rationality is controlled by a *group argumentation model* (based upon the proposals of [TOUL58]) and whose final outcome consists of a coherent *group decision* which characterizes the *activity goals* to be pursued by the problem solving team.
- Next the activity goals settled upon by the group have to be transformed into *action plans*, procedural specifications how actually to achieve the goals agreed upon; this requires mechanisms for goal and action decomposition, resp., the generation of action alternatives and evaluation tools to decide among them.
- To each of the decomposed actions *realization responsibilities* have to be assigned on the basis of *task-oriented negotiations* [WF86]; the resulting commitments [FIKE82] are represented as contract nets [DS83] which also lay down the conditions under which goal-oriented activities are considered to fulfil their (sub)goal descriptions.
- Based on these contracts the agents are supposed to *act* according to the constraints and commitments related to the planned activities.

* Work on CoNeX is supported within a major resarch program on object bases in expert domains (*Objektbanken für Experten*) by the *Deutsche Forschungsgemeinschaft (DFG)* under grant Ja 445/1-1. The authors are grateful to K.-U.Baryga, C.Maltzahn, T.Rose, and S.Strippgen for their contributions.

- The final step of group activity support consists in an *evaluation* of the states of achievement of these actions, i.e. the degree of match- ing plans for actions with their realization status; in particular we concentrate on the negotiation-intensive range between the bi-polar positions of strong accept/reject among the contract holders.

This view of group problem-solving has been formalized as a metalevel model expressed in the extensible knowledge representation language CML/Telos [KMSB89]. CML provides a strictly constrained semantic network structure where predicative assertions and validity time intervals can be attached to each node or link of the network. Moreover, both nodes and links can be organized in instantiation, generalization (isa), and aggregation (attribute) hierarchies.

Figure 1 shows the meta-level model consisting of node and link metaclasses. It can be instantiated with the description of a particular project environment defined at the simple class level. For example, such a model could define the particular protocols of messages and commitments, the available tools, and the organization of the project team. The aggregation hierarchy can be used to model complex structures, such as groups of human agents, conversations composed of messages, plans composed of subplans, etc.

This simple-class model can then be again instantiated by the documentation of actual projects, that is: actual group activities, message sequences, plan executions, etc. By the axioms of CML, the instantiation relationship implies that integrity constraints defined at the class (metaclass) level are enforced at the instance (class) level. Similarly, deduction rules defined at the class level are applied to instances. For example, when the simple class level defines a conversational protocol like the one used in the Coordinator system [WF86], integrity constraints would define the message protocol, i.e., the allowed sequence of message types; deduction rules can be used to trigger reminders when deadlines are not conformed with.

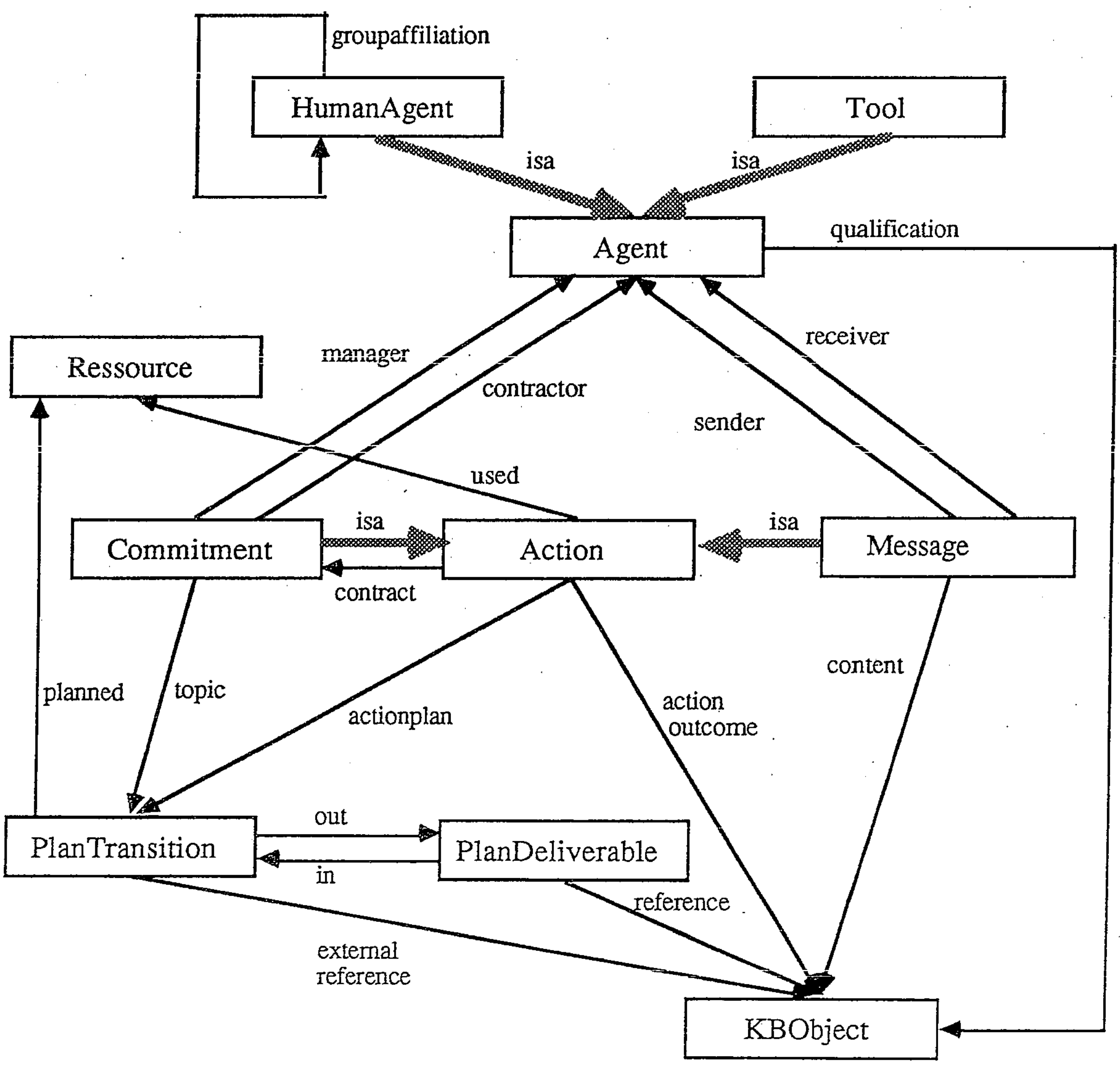

Figure 1: Meta-level Model of Group Problem-Solving in CoNeX

In the CoNex prototype, the simple class level of the model currently consists mostly of two message protocols. One is intended for argumentative, topic-centered discussions; similar to the SYNVIEW system [LOWE85], it is based on Toulmin's [TOUL58] model of argumentation but the use of the underlying knowledge representation, together with the attachment of external knowledge bases (*KBObject* in figure 1), enables more formal control not only of the argument structure but also of the contents of arguments. This is of particular interest in the context of software engineering where *KBObject* is instantiated with a sophisticated conceptual model of software processes in a knowledge- based software environment (the DAIDA environment [DAIDA88]). Another application knowledge base to which our model is being attached, is the CoAUTHOR environment for collaborative hypermedia document creation [HJKFP89].

The other protocol implements a contract-net like procedure of conversations for action, as discussed in [DS83] and [WF86]. This supports the negotiations involved in obtaining and monitoring commitments, as outlined above. Again, the attachment of application knowledge bases enables computer support not only from a communications but also from a content perspective; for example, a formal verification tool can support the process of determining whether an external software object offered as a solution actually satisfies the agreed-upon requirements.

Group structure and tool model mirror the actual situation in our research group. For plan representation, a simple Petri net-like approach has been chosen.

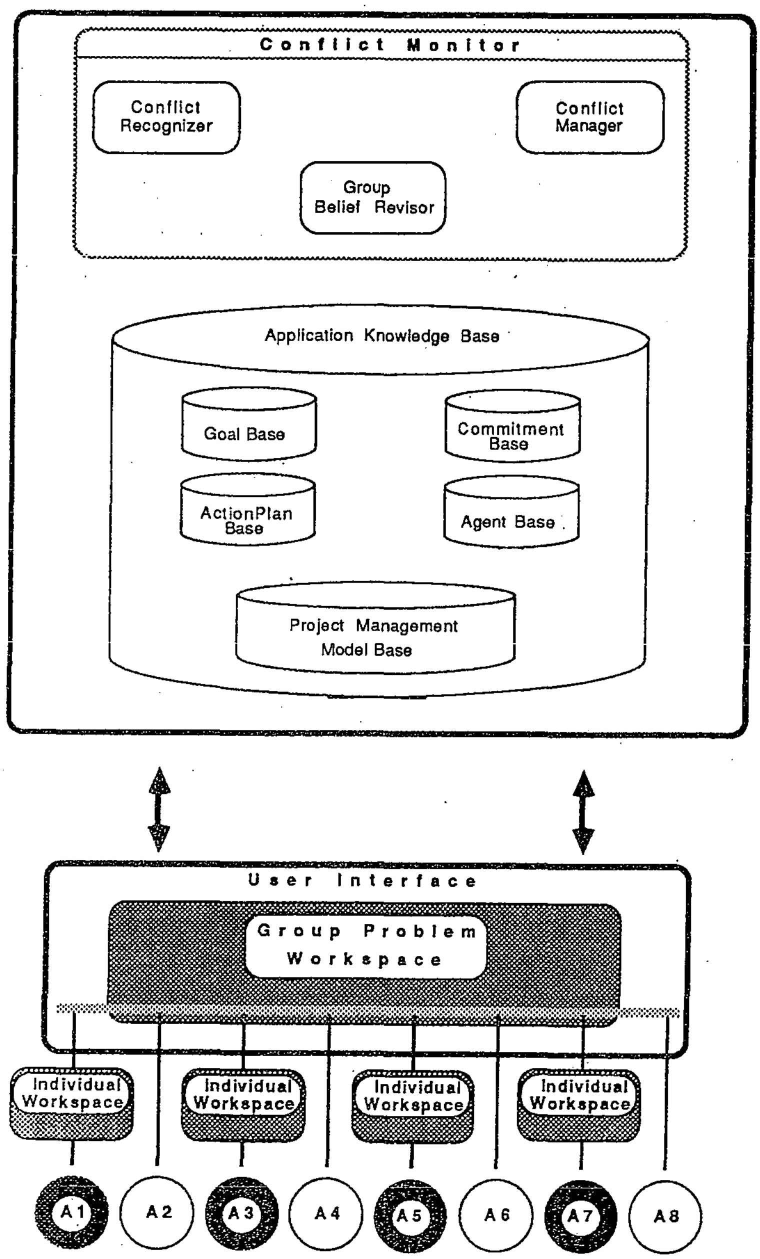

Figure 2: CoNeX Architecture

3 Implementation Aspects

A first prototype version of CoNeX has been implemented on SUN 3 workstations. The members of the problem solving team are linked by an electronic conferencing facility implemented on top of the XWindow system. The model of group cooperation and negotiation is implemented in ConceptBase [JJR89], a knowledge base management system that implements CML/Telos [KMSB89], and BIM-Prolog. The argumentative and action-oriented models connect the conferencing facility with the knowledge base in that they define message types and communication protocols that can be used by the team members. Moreover, a group workspace is provided for collaborative contributions to a common object of discussion in topic-centered argumentation.

Additionally, a graphics-oriented editor for the creation, adaptation, and monitoring of plans using the above-mentioned Petri net structure has been implemented that also allows agents (individuals or groups) to analyze the status of their commitments, plans, and actions (including subcontracts to other agents), and to initialize the appropriate actions (sending messages, starting tools, etc.).

4 Concluding Remarks

Together with its companion tools, *ConceptBase* (for software process modeling, supervision, and documentation), *Configurer* [RJ89] (for version and configuration management) and *CoAUTHOR* (for system documentation creation), *CoNeX* forms part of a major research effort in knowledge base management for design applications conducted at the University of Passau. In this context, CoNeX can simply be viewed as the multi-user component of the KBMS which may offer novel collaboration and concurrency control mechanisms to design-oriented data and knowledge bases. Further work will strengthen the formal definitions of the group model and evaluate their practical usefulness for software project management; moreover, restrictive aspects such as the security and privacy aspects of knowledge bases will have to complement the group support viewpoint.

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