

# Cooperative Validation in Distributed Control Systems Design

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**Abstract.** The team of engineers designing and implementing distributed control system software must communicate within a multidisciplinary environment. One of the main problems is the interaction between hardware and software solutions. Software project presumptions may not be based only on minimum hardware requirements and on technology rules. Modern distributed control systems embrace all aspects of a complex and widespread object. Hence, every modification within any discipline requires interference into the system and validation of its new features, which in turn constraints effectiveness of designing. This paper discusses how to increase effectiveness and speed up validation, in a standardised CAD environment, by using: Multi-Agent System in order to limit the number of interactions between particular subsystems, ontology for assisting topology description and properties of system entropy for assessment of introduced solutions. The proposed system was implemented and worked out in a biotechnological pilot plant.

**Keywords:** Collaborative design, multi-agent systems, knowledge ontology, web environment for collaborative working, multiple location collaborative design, industrial applications.

## 1 Introduction

Design of modern industrial plants creates problems because the control system running this plant needs to be taken into account. Such a system usually comprises a great amount of different components, such as control instrumentation, control software and communication networks. Design and integration of the control system are difficult tasks, both during operation of the process in normal condition and in emergency situations. Another problem arises from a significant difference in mean time between failures (MTBF) of the mechanical and electronic plant components (control and information devices should be frequently upgraded). Therefore, during normal exploitation of the plant, the control and information instrumentation should be redesigned. A multi-agent-based system for cooperative design, validation and operation of industrial processes proposed in the paper facilitates those tasks. The proposed system includes several modern ideas such as multi agent systems

(MAS) – see for example [1], control algorithms of hybrid systems [2] hybrid I/O automata [3], knowledge ontology [4], cooperative systems for design [5],[6],[7],[8] as well as network-based collaborative design systems [9],[10].

## 2 Problem Under Consideration

Our research, using a biotechnological pilot-plant as an example [11], has proven that the control system may be represented by a hybrid system model. This system consists of an automaton having a finite number of states. Transition conditions between those states are described by two sets defining controllable and uncontrollable events. Control of a system modelled in this way is realized within MAS. The control agent tries to maintain the given state despite disruption caused by uncontrollable events, while the supervisory agent tries to change the current state into another desirable state, by applying a sequence of controllable events. Any transition functions that are missing or not specified, may be developed by an expert.

Because of technological constraints and limited capabilities of measurement, control and powering devices and also because of the information structure of the distributed communication equipment, the system has been divided into subsystems. This division is based on ontology that takes the semantics used in CAD systems into account. Apart from the subsystems, the system possesses defined functions, the taxonomy of which is based on phenomenological models. The main technological concepts are based on those phenomenological models. Architecture of the proposed system is presented in Fig. 1.

An impartial assessment of the distributed control system operation is very difficult and depends on the goal of this assessment. One of the important aspects is determination, whether the system's user, who is not familiar with control theory,

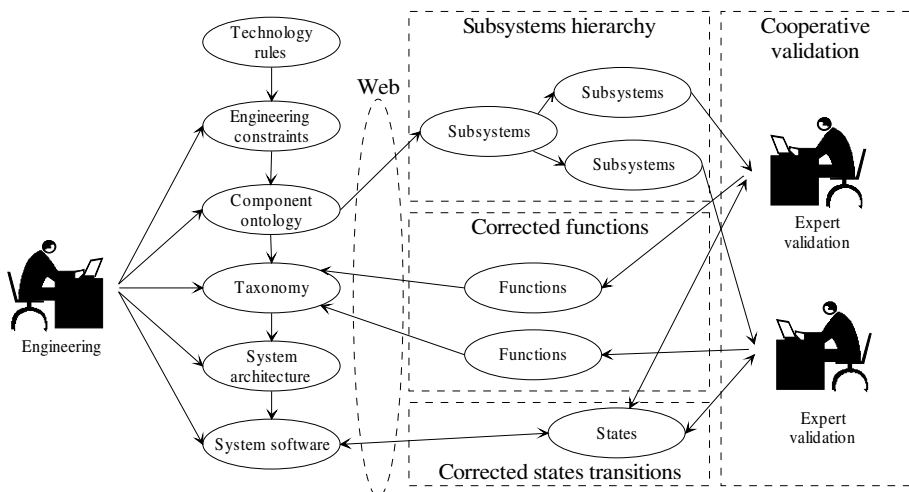


Fig. 1. Concept of the hybrid system