

IEEE Recommended Practice for Industrial Agents: Integration of Software Agents and Low-Level Automation Functions

IEEE Industrial Electronics Society

Developed by the
Standards Committee

IEEE Std 60.1™-2020

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of the
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Approved 24 September 2020

IEEE SA Standards Board

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Abstract: The recommended practices to solve the interface problem when applying industrial agents, namely, integrating intelligent software agents with low-level automation devices in the context of cyber-physical systems, are described in this recommended practice. In particular, a method to select the best interfacing practice for a given application scenario, defined by the user, from a set of available interfacing templates and technologies, aiming to improve reuse, consistency, and transparency in the integration of industrial agents and low-level control functions, is defined.

Keywords: cyber-physical systems, IEEE 2660.1™, industrial agents, industrial automation, intelligent agents, multi-agent system

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Introduction

This introduction is not part of IEEE Std 2660.1-2020, IEEE Recommended Practice for Industrial Agents: Integration of Software Agents and Low-Level Automation Functions.

This document provides assistance on how to select a recommended practice with respect to the interfacing when applying industrial agents, namely, integrating intelligent software agents with low-level automation devices in the context of cyber-physical systems. The recommended practice defines a set of interfacing templates and a method to select the best interfacing practice for a given application scenario, defined by the user, considering the defined set of interfacing templates and a repository of feedback assessment of the implementation of these interface practices from experts in the field.

This recommended practice aims to help the engineers by leveraging the best practices of developing industrial agents for specific automation control problems and application fields, improving the reuse, consistency, and transparency in the integration of industrial agents and low-level control functions.

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1. Overview

1.1 General

The recommended practice is organized as follows: [Clause 1](#) provides an overview of the scope of this recommended practice. [Clause 2](#) lists normative references to other standards and documents that are useful in applying this standard. [Clause 3](#) provides definitions that are either unavailable in the *IEEE Standards Dictionary Online* or have been modified for use with this standard. [Clause 4](#) presents a justification for this proposal with a brief description of it. [Clause 5](#) introduces the methodology to select the recommended interface practice, which is detailed in the three next clauses. Namely, [Clause 6](#) describes the established interfacing practice templates that will be considered to select the recommended one, [Clause 7](#) defines the method to score the existing interfacing practices taking into consideration the feedback from experts, and finally [Clause 8](#) defines the engine to sort the alternative interface practices for a specific application scenario and ultimately select the best one.

Annexes are included for completeness. [Annex A](#) provides examples of application the described methodology for selection of recommended interface practices in industrial agents, and [Annex B](#) provides the repository data. [Annex C](#) provides a bibliography.

1.2 Scope

This recommended practice describes integrating and deploying the multi-agent systems (MAS) (Ferber [[B4](#)] and Wooldridge [[B24](#)]) technology in industrial environments for use in building the intelligent decision-making layer on top of legacy industrial control platforms.¹

The integration of software agents with the low-level real-time control systems, mainly based on the programmable logic controllers (PLCs) running the IEC 61131-3:2013 control programs (forming in this manner a new component known as “industrial agents”) are also identified.² In addition, the integration of software agents with the control applications based on IEC 61499-1:2012 or executed on embedded controllers is described. This recommended practice supports and helps the engineers leverage the best practices of developing industrial agents for specific automation control problems and given application fields. Therefore, corresponding rules, guidelines and design patterns are provided.

¹The numbers in brackets correspond to those of the bibliography in [Annex C](#).

²Information on references can be found in [Clause 2](#).