ISO 20534:2018 (E)

Industrial automation systems and integration — Formal semantic models for the configuration of global production networks

Contents

Foreword

Introduction

1 Scope

2 Normative references

3 Terms and definitions

4 Abbreviated terms

5 Formal semantic models for the configuration of global production networks

5.1 Formal semantics
5.2 Overview of the levels of specialization

6 System functionality formal semantics — Level 1

6.1 Overview
6.2 Level 1 formal semantics — Context
6.2.1 Context
6.3 Level 1 formal semantics — Properties
6.3.1 Property — Basic
6.3.2 Property — Entity
6.3.3 Property — Activity
6.3.4 Property — System function
6.3.5 Property — Energy
6.3.6 Property — Material
6.3.7 Property — Information
6.3.8 Property — Role
6.3.9 Property — Input
6.3.10 Property — Output
6.3.11 Property — Resource
6.3.12 Property — Control
6.3.13 Property — Scenario
6.4 Level 1 formal semantics — Relationships
6.4.1 Relationship — Affects state
6.4.2 Relationship — Basic affects role
6.4.3 Relationship — Role affects the state of role
6.4.4 Relationship — Plays role
6.4.5 Relationship — Role requires a context provided by an activity
6.4.6 Relationship — Basic composed of a basic
6.4.7 Relationship — Role composed of a role
6.4.8 Relationship — Activity contains a role
6.5 Level 1 formal semantics — Axioms
6.5.1 Axiom — Role requires an activity to provide a context
6.5.2 Axiom — An activity cannot contain a role and play the role
6.6 Level 1 formal semantics — Rules
6.6.1 Rule — Role requires an activity
6.6.2 Rule — Activity containing a role

7 Designed systems formal semantics — Level 2

7.1 Overview
7.1.1 Level 2 Systems overview

7.1.2 Level 2 Role overview
7.1.3 Level 2 Network overview
7.1.4 Product overview at levels 2 and 4
7.1.5 Overview of Location
7.2 Level 2 formal semantics — Context
7.2.1 Context — Designed systems
7.3 Level 2 formal semantics — Properties
7.3.1 Property — Network
7.3.2 Property — Product
7.3.3 Property — PhysicalProduct
7.3.4 Property — Physical product with service
7.3.5 Property — Service
7.3.6 Property — Service using physical product
7.3.7 Propery — Prototype
7.3.8 Property — Organization function
7.3.9 Property — Facility function
7.3.10 Property — Actor type
7.3.11 Property — Actor
7.3.12 Property — Customer
7.3.13 Property — Supplier
7.3.14 Property — Gateway
7.3.15 Property — Diverging gateway
7.3.16 Property — Converging gateway
7.3.17 Property — Inclusive diverging gateway
7.3.18 Property — Inclusive converging gateway
7.3.19 Property — Exclusive diverging gateway
7.3.20 Property — Exclusive converging gateway
7.3.21 Property — Condition
7.3.22 Property — Business event
7.3.23 Property — Start event
7.3.24 Property — End event
7.3.25 Property — Decision event
7.3.26 Property — Plan
7.3.27 Property — Project
7.3.28 Property — Location
7.3.29 Property — Zonetype
7.3.30 Property — Area/city
7.3.31 Property — State/province
7.3.32 Property — Country
7.3.33 Property — Region
7.3.34 Property — Global
7.4 Level 2 formal semantics — Relationships
7.4.1 Relationship — Plays role actor
7.4.2 Relationship — Plays role Service
7.4.3 Relationship — Plays role physical product
7.4.4 Relationship — Flow occurs from an output to an input
7.4.5 Relationship — Gateway contains role
7.4.6 Relationship — Start event has an output role
7.4.7 Relationship — End event has an input role
7.4.8 Relationship — Define a project
7.4.9 Relationship — Project contains scenario
7.4.10 Relationship — Project has chosen scenario
7.4.11 Relationship — Physical product with service
7.4.12 Relationship — Service contains physical product
7.4.13 Relationship — Physical product has a prototype
7.4.14 Relationship — Organization function is composed of facility functions
7.4.15 Relationship — System function location
7.4.16 Relationship — Facility function location
7.5 Level 2 formal semantics — Axioms
7.5.1 Axiom — A system function cannot both play a role and contain the same role
7.5.2 Axiom — A network shall contain a flow between two system functions
7.5.3 Axiom — A flow can only exist between an input and an output or an output and an input

7.5.4 Axiom — A flow can only exist from a target to a source or a source to a target but not in both directions
7.5.5 Axiom — In a flow relation the source basic shall flow to a target
7.5.6 Axiom — A basic playing the role of an output in an network shall play the role of an input
7.5.7 Axiom — A start event is a specialized type of basic which shall have an output role only
7.5.8 Axiom — An end event is a specialized type of basic which shall have an input role only
7.5.9 Axiom — A gateway shall have at least one input and one output
7.5.10 Axiom — A diverging gateway shall have only one input and two or more outputs
7.5.11 Axiom — A converging gateway shall have has two or more inputs and only one output
7.5.12 Axiom — An inclusive diverging gateway has one input and two or more outputs
7.5.13 Axiom — An inclusive converging gateway has one default output and two or more inputs
7.5.14 Axiom — An exclusive diverging gateway inherits from an inclusive diverging gateway
7.5.15 Axiom — An exclusive converging gateway inherits from an inclusive diverging gateway
7.5.16 Level 2 formal semantics — Rules

8 Manufacturing business systems formal semantics — Level 3

8.1 Overview
8.2 Level 3 formal semantics — Context

9 Global production systems network formal semantics — Level 4

9.1 Overview
9.2 Level 4 formal semantics — Context
9.3 Level 4 formal semantics — Properties
9.3.1 Property — Production network
9.3.2 Property — GPN
9.3.3 Property — Producer
9.3.4 Property — Manufacturer
9.3.5 Property — Manufactured product
9.3.6 Property — Manufactured product service
9.3.7 Property — BOM
9.4 Level 4 formal semantics — Relationships
9.4.1 Relationship — gpn in scenario
9.4.2 Relationship — Manufacturer produces manufactured product
9.4.3 Relationship — Manufactured product has a bill of materials
9.4.4 Relationship — Manufactured product service contains service
9.5 Level 4 formal semantics — Axioms
9.5.1 Axiom — The role producer shall be played in a production network
9.5.2 Axiom — The role product shall be played in production network
9.5.3 Axiom — The role supplier should be played in a production network
9.5.4 Axiom — A supplier shall have an output
9.5.5 Axiom — A producer shall have an output
9.5.6 Axiom — A customer shall have an input
9.5.7 Axiom — A facility in a GPN shall have a location/city/country
9.5.8 Axiom — A GPN shall have facilities located in more than one country

Annex A (informative) Highfleet Ontology Library Reference

A.1 General
A.2 Upper Level Ontology (ULO)
A.2.1 General
A.2.2 Top
A.2.3 Particular
A.2.4 Concrete Entity
A.2.5 Abstract Entity
A.2.6 Location
A.2.7 Occurrence
A.2.8 Participation
A.2.9 Groups
A.2.10 Identity and Equality
A.3 Description of Individual Ontology Modules

A.3.1 Theory of Business Rules
A.3.2 Theory of Genealogy
A.3.3 Theory of Measurement
A.3.4 Theory of Spatial Relations
A.3.5 Theory of Temporal Relations
A.3.6 Theory of WordNet Relations
A.4 Built-in Data Types
A.4.1 Times
A.4.1.1 TimeInstant and TimeSpan
A.4.1.2 Date and Span
A.4.1.3 Time Zones
A.4.1.4 holdsin
A.4.1.5 Comparing Time Spans
A.4.1.6 Span Arithmetic
A.5 Strings
A.5.1 General
A.5.2 String Operations
A.6 Numbers
A.6.1 General
A.6.2 Number Properties
A.6.3 Number Relations
A.7 Intervals
A.7.1 Defining Intervals
A.7.2 Interval Operations
A.8 Lists
A.8.1 General
A.8.2 List Operations
A.9 Aggregation
A.9.1 General
A.9.2 Aggregation and Variable Binding Lists
A.9.3 Full Form, Brief Form, and Distinguishing Variables
A.9.4 Binding Across Aggregation Operators
A.9.5 Aggregation Syntax
A.9.6 Multiple Aggregation Operations
A.10 Materialization
A.11 Ontological Introspection
A.11.1 General
A.11.2 Taxonomic Structure
A.11.2.1 General
A.11.2.2 sup
A.11.2.3 supRel
A.11.3 Relation Structure
A.11.3.1 General
A.11.3.2 argProp
A.11.3.3 arity
A.11.4 Property Instance Structure
A.11.4.1 General
A.11.4.2 inst
A.11.4.3 instDirect
A.11.4.4 instAsserted
A.12 Administrative: pseudoPredicate

Annex B (informative) Ontologies in Knowledge Framework Language (KFL)

B.1 Overview
B.1.1 General
B.1.2 What is KFL?
B.1.3 Contexts
B.2 Properties
B.2.1 General
B.2.2 Useful property kinds
B.2.3 Disjointness, Partitions and Covers
B.3 Relations
B.3.1 General
B.3.2 Special Kinds of Binary Relations

B.3.3 MetaProperty
B.3.4 Functional Relations and Cardinality
B.3.5 Rigid and Nonrigid Relations
B.3.6 Intensional and Extensional Relations
B.3.7 Forming the Relations Heirarchy
B.4 Logic, Rules and Integrity Constraints
B.4.1 General
B.4.2 Variables
B.4.3 Logical Operators
B.4.3.1 General
B.4.3.2 Implication
B.4.3.3 Chains of Implication
B.4.4 Rules
B.4.4.1 General
B.4.4.2 Example Rules
B.4.5 Integrity Constraints
B.5 Functions
B.6 Constants
B.6.1 General
B.6.2 Choosing to declare a constant in KFL versus ECLIF
B.6.3 Declaring Constants in KFL
B.7 Documentation
B.8 More on Directives
B.8.1 Declaration and Support Directives
B.8.2 Relations as Directives

Annex C (informative) ECLIF language reference

C.1 General
C.2 ECLIF Motivations and Goals
C.3 ECLIF Concepts
C.3.1 ECLIF Concepts Overview
C.3.2 First-order Logic
C.3.2.1 Statements
C.3.2.2 Simple Statements
C.3.2.3 Complex Statements
C.3.2.4 Polish Notation
C.3.3 ECLIF Ontologies and Entailment
C.3.4 Built-in predicates
C.4 ECLIF Assertions and ECLIF Queries
C.5 ECLIF Terms
C.5.1 General
C.5.2 Scalar terms
C.5.3 Variables
C.5.4 Function terms
C.6 ECLIF Abstract Syntax
C.6.1 General
C.6.2 ECLIF Terms
C.6.2.1 General
C.6.2.2 ECLIF Identifiers
C.6.2.3 ECLIF Literals
C.6.2.4 ECLIF Variables
C.6.2.5 ECLIF Function Terms
C.6.3 ECLIF Statements
C.6.3.1 General
C.6.3.2 ECLIF Simple Statement
C.6.3.3 ECLIF Complex Statements
C.6.3.3.1 General
C.6.3.3.2 Boolean Operator Syntax
C.6.3.3.3 Quantification Operator Syntax
C.6.3.3.4 Aggregation Operator Syntax
C.6.3.3.5 Temporal Operator Syntax
C.6.3.3.6 Special Operator Syntax
C.6.3.3.7 Sample
C.6.3.3.8 Unique

C.6.4 ECLIF Queries
C.6.5 ECLIF Template Expansion
C.7 ECLIF BNF Grammar

Annex D (informative) FLEXINET overview and approach

Page count: 121