



Control & Communication System Profile Specification (for Machine) Part 1: General Information



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1. FOREWORD

This document is "Part 1 - General Information" of "Control & Communication System Profile Specification (for Machine)".

The Control & Communication System Profile for machine (hereinafter referred to as "CSP+ for machine") is a data set that visualizes machine information to simplify development by application vendors of application software that manages, monitors, and controls the machine, and settings by the machine users. The CSP+ for machine contains the following information related to the machine described.

- Information related to the machine specifications
- Machine information to be released for application software (machine information)
- Information related to data to be acquired from the machine and its acquisition method (machine data)
- Linked information between machine information and machine data

The CSP+ for machine is generally handled as CSP+ file for machine described in the XML format.

This document "Part 1 - General Information" shows the overall structure of "Control & Communication System Profile Specification (for Machine)", and overview, basic structure definition, and application image of the CSP+ for machine.

The version of Control & Communication System Profile for machine specification described in this document (hereinafter referred to as CSP+ for machine specification version) is version 1.0.

2. SCOPE OF APPLICATION

This document is "Part 1 - General Information" of "Control & Communication System Profile Specification (for Machine)" and shows the overall structure of "Control & Communication System Profile Specification (for Machine)", and overview, basic structure definition, and application image of the CSP+ for machine.

3. STANDARDS REFERRED

None.

4. TERMINOLOGY, DEFINITIONS, ABBREVIATIONS

4.1. Terminology

4.1.1. CSP+ for machine

Data set to describe the following information related to the machine

- Information related to the machine specifications
- Machine information to be released for application software
- Data to be acquired from the machine and its acquisition method
- Linked information between machine information and machine data

4.1.2. CSP+ file for machine

CSP+ for machine in the XML format

4.1.3. Machine

Machine controlled by machine tools or at least one controller (such as PLC and CNC)

4.1.4. Machine data

Generic term of information related to data to be acquired from the machine and its acquisition method

4.1.5. Machine information

Information created by aggregation of machine data aggregated for easy handling in application software.

4.1.6. Section

Component of the CSP+ for machine

4.1.7. Part

Component of the section

4.1.8. Element

Component of the part

4.1.9. Item

Detailed information related to the element. Example: Data type, engineering unit

4.1.10. Machine vendor

Vendors that develop the machine

4.1.11. Application vendor

Vendors that develop application software

4.1.12. Machine user

End users who use the machine and companies that provide machine installation and maintenance

4.2. Abbreviations and Symbols

CNC	Computer Numerical Control
CSP+	Control & Communication System Profile
MES	Manufacturing Execution System
PLC	Programmable Logic Controller
SCADA	Supervisory Control And Data Acquisition
SLMP	Seamless Message Protocol
UA	Unified Architecture
XML	Extensible Markup Language

5. SPECIFICATION STRUCTURE

5.1. Overall Structure

"Control & Communication System Profile Specification (for Machine)" consists of multiple part specifications.

5.2. Overview of Parts

5.2.1. Part 1 - General Information

This document. This part shows the overall structure of the specifications, overview and basic structure definition of the CSP+ for machine, and its application image.

5.2.2. Part 2 - Element/Item Definitions and File Format

This part specifies types and description rules for elements and items that can be described on the parts in the CSP+ for machine, and the file format of the CSP+ file for machine.

5.2.3. Part 3 - Recommended Description

This part specifies recommended descriptions for specifications of the CSP+ for machine. For example, recommended specifications to describe a part of KPIs specified by the ISO 22400 in the CSP+ for machine are specified.

5.2.4. Part 4 - Mapping with Communications Protocol

This part specifies element description rules corresponding to the communications protocol used for data acquisition from the machine. For example, element description rules corresponding to the communications protocol SLMP are specified. The own element description rules can be specified for the communications protocol not specified in the Part 4. Examples of communications protocol not specified in the Part 4 include a machine vendor's own communications protocol. This case requires the machine vendor to specify the vendor's own element description rules, and the application vendor to develop the application software that handles the CSP+ for machine to be able to observe the rules.

5.2.5. Part 5 - OPC UA Information Model

This part specifies specifications to map the information described in the CSP+ for machine to the OPC UA information model. The specifications specified in the Part 5 are recommended to be applied for the case where application software using the CSP+ for machine is an OPC UA server.

6. OVERVIEW

The CSP+ for machine is a data set that visualizes machine information to simplify development by application vendors of application software that manages, monitors, and controls the machine, and settings by the machine users. The CSP+ file for machine is CSP+ for machine described in the XML format. The CSP+ for machine contains the following information related to the machine.

- Information related to the machine specifications
- Machine information to be released for application software (machine information)
- Information related to data to be acquired from the machine and its acquisition method (machine data)
- Linked information between machine information and machine data
- For specific image of application of the CSP+ for machine, refer to Appendix A.

7. BASIC STRUCTURE OF CSP+ FOR MACHINE

7.1. Section

The CSP+ for machine consists of four type sections: FILE section, DEVICE section, COMM_IF section, and BLOCK section. Overview of the sections is shown in Table 7-1.

Table 7-1 Overview of Sections in CSP+ for Machine

Section name	Overview	Number of sections
FILE	Describes management information for CSP+ file for machine.	1 section
DEVICE	Describes information such as machine name, identification information, and machine specifications.	1 section
COMM_IF	Describes definition information for the machine information.	1 or more sections
BLOCK	Describes updates of the machine information.	1 or more sections

Figure 7-1 shows the structure image of the CSP+ for machine.

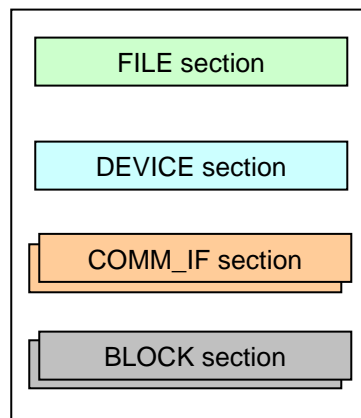


Figure 7-1 Structure Image of CSP+ File for Machine

7.2. Part

The sections consist of one or more parts. Figure 7-2 shows the structure image in a section.

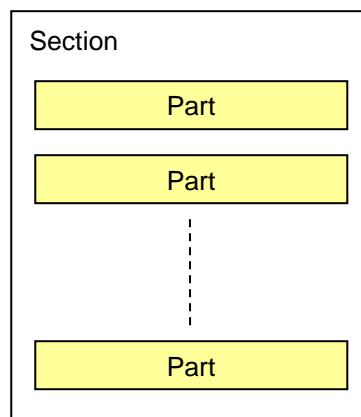


Figure 7-2 Image of Section Structure

Type of parts included in the sections varies depending on the parts. Type of parts included in the FILE section is shown in Table 7-2, type of parts included in the DEVICE section is shown in Table 7-3, type of parts included in the COMM_IF section is shown in Table 7-4, and type of parts included in the BLOCK section is shown in Table 7-5.

Table 7-2 Parts Included in FILE Section

Part type	Information to be described	Number of parts
FILE_INFO	- Management information for CSP+ file for machine (e.g. Date of file created, language information, file version)	1 part

Table 7-3 Parts Included in DEVICE Section

Part type	Information to be described	Number of parts
DEVICE_INFO	- Machine identification information (e.g. Vendor name, model name) - Machine's product information (e.g. Specifications, image file name)	1 part
DEVICE_IF	- Information related to communications with the machine (e.g. Communications protocol type)	1 or more parts

Table 7-4 Parts Included in COMM_IF Section

Part type	Information to be described	Number of parts
COMM_IF_INFO	- Machine identification information	1 part
COMM_IF_VARIABLE	- Machine information for realtime monitor (e.g. Current value)	0 or more parts
COMM_IF_CONFIGURATION	- Machine information for general purpose (e.g. Power consumption for 30 minutes)	0 or more parts
ENUM	- Options for setting range	0 or more parts

Table 7-5 Parts Included in BLOCK Section

Part type	Information to be described	Number of parts
BLOCK_INFO	- Machine data identification	1 part
BLOCK_MEMORY	- Variable machine data acquired from the machine (e.g. Current value, measurement time)	0 or more parts
BLOCK_PARAM	- Machine-specific machine data not acquired from the machine (e.g. Accuracy, collection cycle)	0 or more parts
ENUM	- Options for setting range	0 or more parts

There are COMM_IF_VARIABLE part and COMM_IF_CONFIGURATION part as parts managing the machine information. Machine information for realtime monitor is described in the COMM_IF_VARIABLE part and machine information for general purpose is described in the COMM_IF_CONFIGURATION part. As the information allowed for the COMM_IF_VARIABLE part is limited for realtime monitor, description is easy but the application is limited. On the other hand, there is less restrictions on the description for the COMM_IF_CONFIGURATION part where the machine information for the general purpose applications can be described. For example, a window display layout includes a monitoring window for machine information in the COMM_IF_VARIABLE part and a machine parameter read/write window for machine information in the COMM_IF_CONFIGURATION part.

7.3. Element and Item

The parts consist of one or more elements. The elements consist of one or more items. Figure 7-3 shows the image of the part structure.

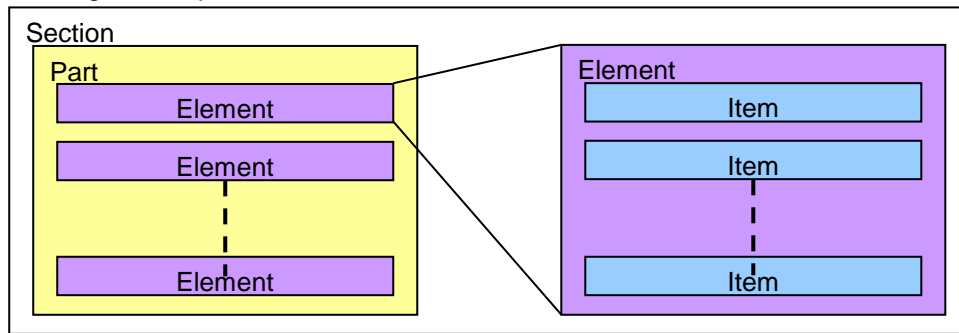


Figure 7-3 Image of Part Structure

Details of the elements and items included in the parts are specified in "Part 2 - Element/Item Definitions and File Format" and "Part 3 - Recommended Description". Elements included in the parts consist of elements specified as specifications of CSP+ for machine and elements that can be flexibly specified by the machine vendors. In contrast, all the items included in the elements are specified by specifications of the CSP+ for machine.

Common elements of the CSP+ for machine are specified in the Part 2 for the parts shown below. A machine vendor's own element specification can be specified but it is not mandatory.

FILE_INFO
 DEVICE_INFO
 DEVICE_IF
 COMM_IF_INFO
 BLOCK_INFO
 BLOCK_MEMORY
 BLOCK_PARAM

Elements depending on the machine specifications are basically specified by the machine vendors for the parts shown below. However, when adequate elements have been specified in the Part 3, use of the elements specified in the Part 3 is recommended.

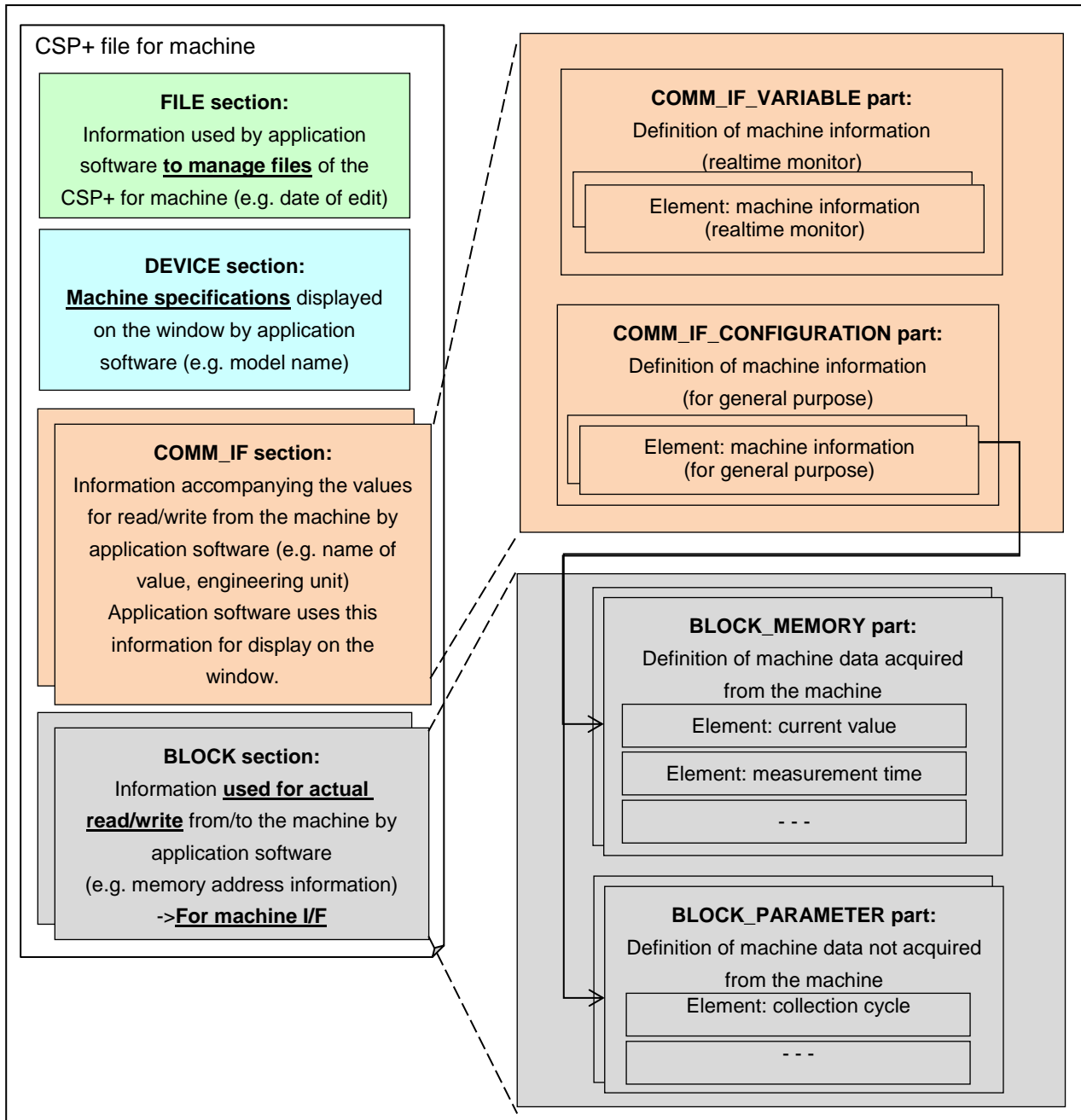
COMM_IF_VARIABLE
 COMM_IF_CONFIGURATION
 ENUM

7.4. Machine Information and Machine Data

Association information is set from one element in the COMM_IF_CONFIGURATION part managing machine information to one or more machine data in the BLOCK_MEMORY part or BLOCK_PARAM part. This means that aggregation of more than one machine data creates one machine information. The reason why this structure is required is that the information required by application software needs not only a simple measured value (current value) but also the accompanying information such as the time when the value is measured and accuracy of the value.

In contrast, setting association information from the element in the COMM_IF_VARIABLE part as the machine information to the machine data in the BLOCK_MEMORY part or BLOCK_PARAM part is not allowed. This is because the application is for realtime monitor and all the information required in the machine information can be described.

Association between the machine information and machine data is illustrated in Figure 7-4. Use Figure in Appendix A for reference.



**Figure 7-4 Structure Image of CSP+ for Machine
(Association Between Machine Information and Machine Data)**

APPENDIX A: APPLICATION IMAGE

A.1. Application Image of CSP+ for Machine with Application Software

This section describes general examples of application image of CSP+ for machine with application software. The application software generally uses the CSP+ for machine with the following procedure.

- (1) Processing execution instruction
For example, the application software starts processing execution by an instruction from the user of the application software. Other examples include periodical processing start in the application software, not by the user's instruction.
- (2) Acquisition of data list and communication procedure information from the CSP+ file for machine
The application software acquires machine information, machine data list, and information related to machine data read/write procedure from the CSP+ file for machine. Information can be acquired from the CSP+ file for machine at every processing execution, at the first processing execution only, before processing execution, or at other timing.
- (3) Reading/writing data from/to the machine
The application software reads/writes data from/to the machine based on the information read from the CSP+ file for machine.
- (4) Window display
The application software uses the data read/written from/to machine for the specified purposes. For example, the read/written data is displayed on the application software's window.

Figure A-1 illustrates the application image.

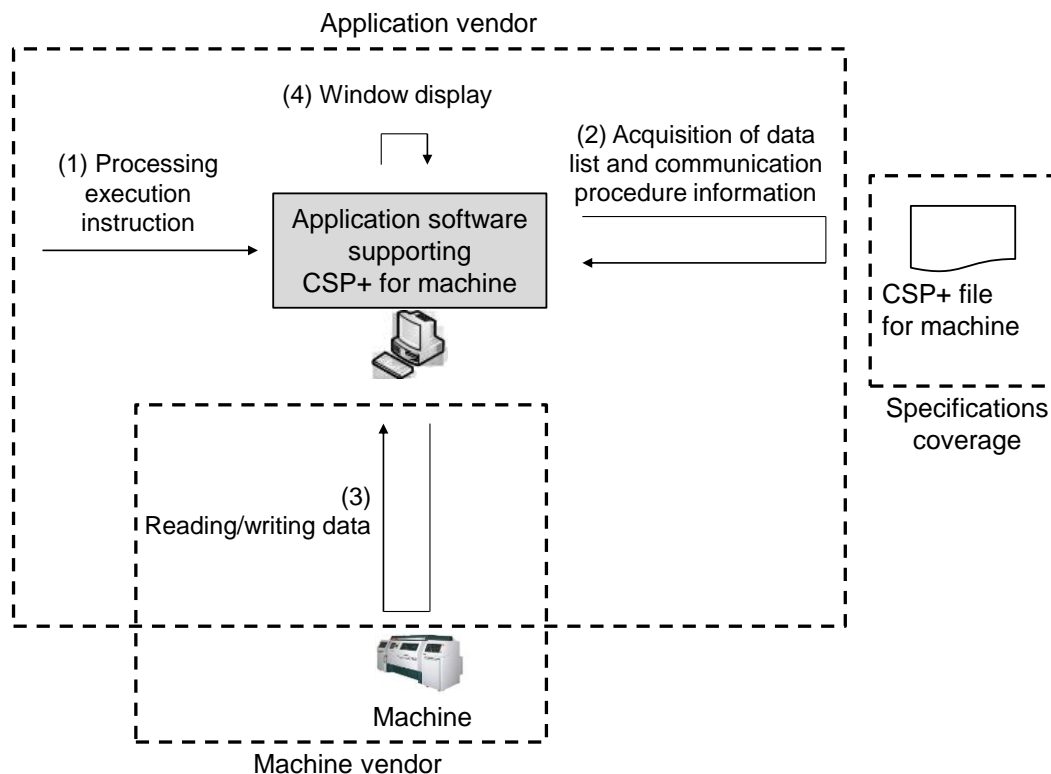


Figure A-1 Application Image of CSP+ for Machine with Application Software

A.2. Flow of Creation and Application

This section describes the flow of creation and application of the CSP+ files for machine from the viewpoints of machine vendors, application vendors, and machine users.

- (1) Machine vendor
The machine vendors create CSP+ files for machine for existing machines or newly developing machines and deliver the files to the machine users. Before creating the CSP+ files for machine, refer to related parts of "Control & Communication System Profile Specification (for Machine)" for compliance with the specifications.
- (2) Application vendor
The application vendors, who develop application software to manage, monitor, and control the machines, import the CSP+ files for machine and acquire information from the CSP+ files for machine to develop application software. Before developing the import function, refer to related parts of "Control & Communication System Profile Specification (for Machine)" for compliance with the specifications.
- (3) Machine user
The machine users obtain application software from the application vendors depending on the purposes such as machine management, monitoring, and control. They then obtain the CSP+ files for machine corresponding to the machine to be used from the machine vendors and import them to the application software. After the import, they make additional settings such as communications settings with the machine as required and use the functions of the application software.

Figure A-2 illustrates the flow of CSP+ file for machine creation and application.

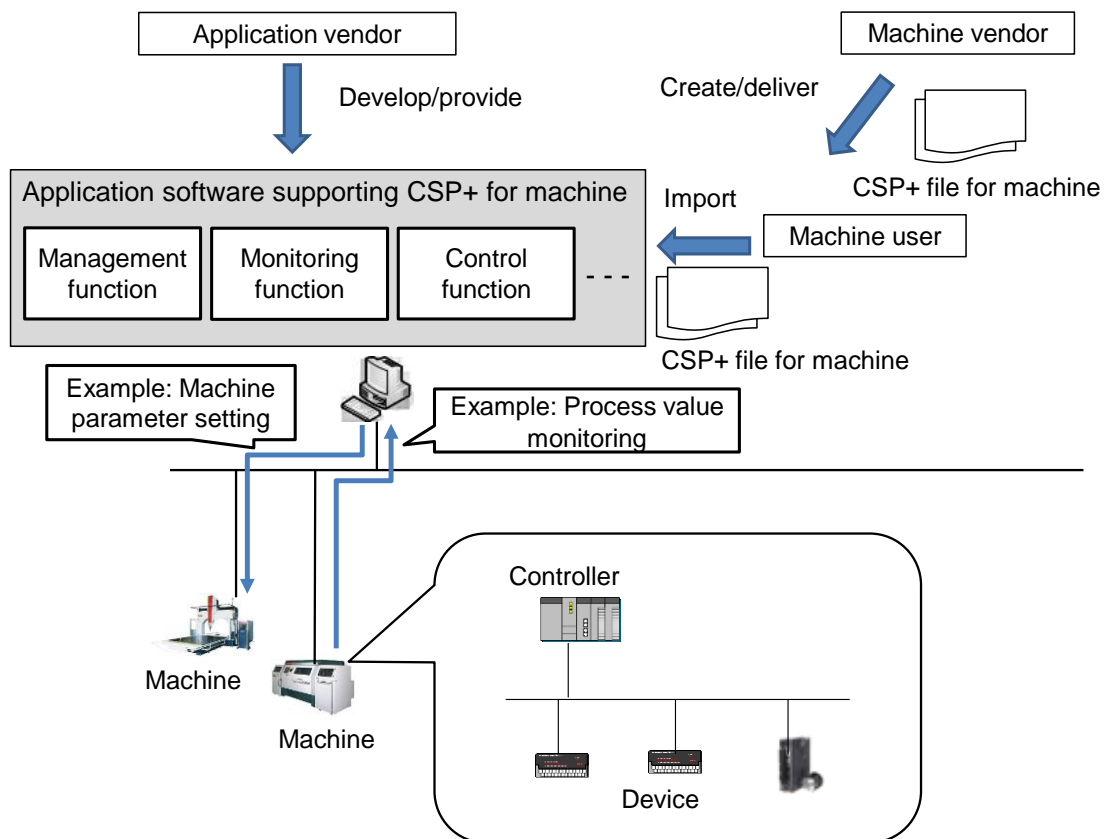


Figure A-2 Creation and Application Flow of CSP+ File for Machine

A.3. Example of Association Between Description and Machine Function

This section shows the image of description for the CSP+ for machine and examples of association between descriptions and machine functions.

One or more pieces of machine information and one or more machine data comprising machine information are described in the CSP+ for machine. In the example shown in Figure A-3, machine information "Mean Operating Time Between Failures" and four machine data "Current Value", "Measurement Time", "Measurement Period", and "Collection Cycle" comprising the machine information "Mean Operating Time Between Failures" are described in the CSP+ for machine. Three machine data "Current Value", "Measurement Time", and "Measurement Period" are held by the machine as variables and the "Collection Cycle" is described in the CSP+ for machine as fixed values specific to the machine.

Data unit information that can be acquired from the machine and information required to acquire data from the machine (memory address information in the machine here) are described in the machine data as variables "Current Value", "Measurement Time", and "Measurement Period". Although not shown in the example, data type and access attribute of each machine data can also be described.

Collection cycle recommended for the data that can be acquired from the machine is described in the machine data as fixed value "Collection Cycle". The example shows that application software periodically executes data acquisition request to the machine. However, a method to push the data from the machine as required can be used.

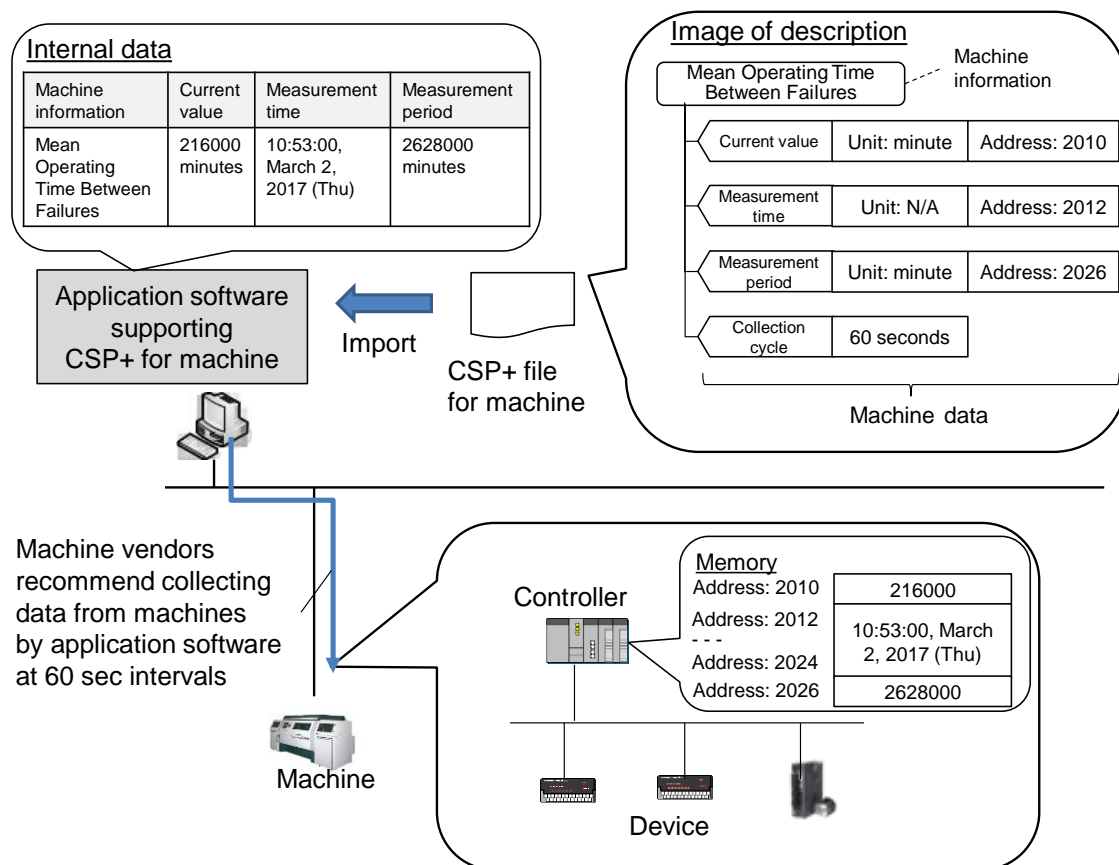


Figure A-3 Example of Association Between Description of CSP+ File for Machine and Machine Function

The example Figure A-3 shows that the information related to the "Collection Cycle" is handled as machine data. However, the information related to the "Collection Cycle" can also be described in a part to which the machine information belongs, not independent machine data. In that case, the same collection cycle is applied to all the machine information included in the part.

A.4. Example of Application Software Processing

This section describes examples of how application software executes processing according to the image of the CSP+ for machine description shown in Figure A-3.

The application software reads data from the machine based on the description in the CSP+ for machine with the following procedure.

(1) Reading description

The application software checks and acquires four data of the machine associated with the "Mean Operating Time Between Failures" from the information described in the CSP+ for machine. The application software also acquires the machine data acquisition procedure from the machine at the same time.

(2) Reading machine data (variables)

The application software uses the communications protocol specified in the CSP+ for machine (e.g. SLMP) to read the machine data ("Current Value", "Measurement Time", "Measurement Period") stored in the machine. In this case, an address on the machine memory corresponding to the machine data stored in the machine is described in the CSP+ for machine and a read command is executed for the address. The reading is executed every 60 seconds based on the description of the "Collection Cycle" of the machine data as a fixed value.

(3) Using machine information and machine data

The application software associates the machine data as variable "Current Value", "Measurement Time", and "Measurement Period" with the machine information "Mean Operating Time Between Failures" and uses them for specified purposes. For example, the information of the machine information and machine data acquired is displayed on the application software's window.

The procedure example above is explained for reading. However, the same procedure can be used for data writing.

A.5. Example of Application

A.5.1 KPI dashboard

This section describes an example to develop a KPI dashboard application software supporting machines to be provided by the one or more vendors, using the CSP+ for machine.

The "Part 3 - Recommended Description" specifies elements recommended to be commonly used across the machine vendors for the CSP+ for machine. For example, the KPI "Mean Operating Time Between Failures" specified by the ISO 22400 is specified as an element recommended to be used in common. This allows the CSP+ for machine created by any vendors to acquire the KPI information with a same name from the application software. Even if machine data acquisition method varies depending on the machine, the method described in the CSP+ for machine allows the application software to acquire the KPI information by the method for each machine based on the description of CSP+ for machine.

The feature above allows application vendors to easily develop the KPI dashboard application software monitoring the KPI "Mean Operating Time Between Failures" across one or more machines. Figure A-4 shows the operation image of the KPI dashboard application software. The KPI dashboard application software has one or more KPI display window program elements, and each window program element is allowed to import the CSP+ files for machine. With the use of names specified by the imported CSP+ file for machine, the "Mean Operating Time Between Failures" element is searched, data is acquired using the data acquisition method described in the CSP+ file for machine, and the results are displayed on the KPI display window program elements.

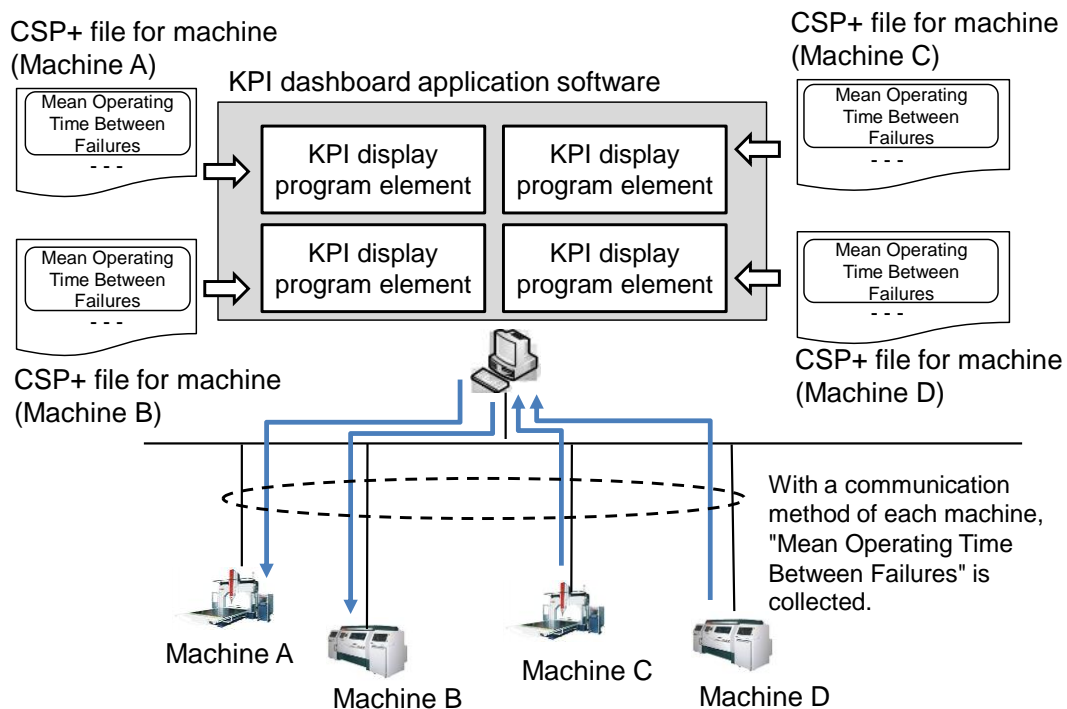


Figure A-4 Operation Image of KPI Dashboard Application

The following procedure allows the machine users to easily monitor all machines in the factory.

- (1) Acquire the KPI dashboard application software above from the application vendor.
- (2) Obtain the CSP+ file for machine from the machine vendor of the machine in use.
- (3) Import the CSP+ file for machine above to the KPI dashboard application software.
- (4) Configure the communication setting for each machine.

A.5.2 OPC UA server

This section describes an example of the OPC UA server according to Figure A-5, as an application example of the application software using the CSP+ for machine.

In the example in A.5.1, the application software itself using the CSP+ for machine provides the KPI monitoring function for the machine users. This example shows that the OPC UA server itself as the application software using the CSP+ for machine does not provide the function for the machine users and other application software such as SCADA and MES provides the monitoring and management functions for the machine users. When the application software using the CSP+ for machine is an OPC UA server, the address space that the OPC UA server discloses to the OPC UA clients is created from the CSP+ for machine based on the specifications specified in the "Part 5 - OPC UA Information Model".

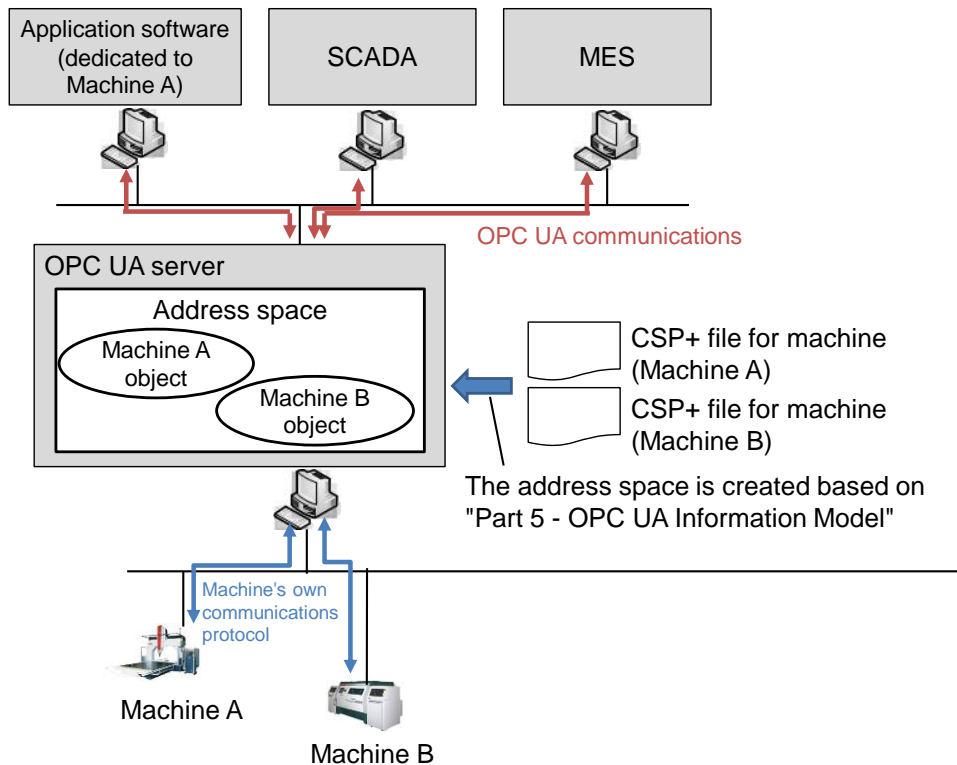


Figure A-5 Operation Image of OPC UA Server Supporting CSP+ for Machine

Since this system configuration is achievable, vendors of application software such as SCADA and MES have the following advantage.

- Since not a machine's own communications protocol but the standard OPC UA can be used for communications with machines, the development volume for the communication function can be reduced.

Vendors of OPC UA server application software have the following advantage.

- Supporting the CSP+ for machine allows handling many machines supporting the CSP+ for machine as communication partners.

Machine vendors have the following advantages.

- Since there is no need to request an application vendor to support the machine's own protocol when requesting the application vendor to develop application software dedicated to the machine, the development cost can be reduced.
- Since information to be disclosed to the application software such as process statuses and operation histories of the machine can be limited to the range described in the CSP+ for machine, information related to know-how of the machine can be set to confidential.

REFERENCES

IEC TR 62541-1, OPC Unified Architecture - Part 1: Overview and Concepts

ISO 22400-1:2014, Automation systems and integration - Key performance indicators (KPIs) for manufacturing operations management - Part 1: Overview, concepts and terminology

SLMP Specifications: Overview BAP-C2006ENG-001-D, CC-Link Partner Association

