

Evolution of Control Platform

FFCS-V High Performance Controller

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In recent years, the advanced functionality embedded in field instruments and the evolution of the field network require the field control station (FCS) to process a wide variety of information (field instrument data) such as instrument information of field instruments and diagnostic information of facilities, in addition to a large amount of process data. FFCS-V, a newly developed FCS for the CENTUM VP integrated production control system, has four times faster computing performance than the previous model (AFV10□) and can gather a large amount of field instrument data.

INTRODUCTION

As for a controller used in a distributed control system (DCS) shown in Figure 1, covering as many applications as possible with a single controller will bring cost reduction effects such as easy engineering and a small controller installation area. Therefore, the controller is required to process large amounts of data more quickly. Furthermore, as field instruments advance, there is increasing demand for more stable plant operation by collecting various types of information (hereinafter referred to as “field instrument data”), such as instrument information of field instruments and diagnostic information of equipment, in addition to process data directly used for control, and by managing the information by the upper asset management software⁽¹⁾.

The field control station (FCS), a controller for the CENTUM VP integrated production control system, is strongly required to have faster processing performance, because it has to process increasing amounts of process data and field instrument data at high speed.

This paper introduces the new architecture of the

newly developed FCS (FFCS-V) for significantly improving the processing performance of process data and field instrument data among the features for improving processing performance.

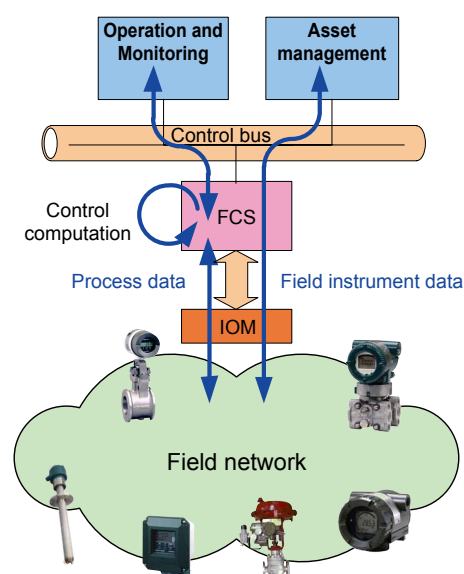


Figure 1 Flow of data processed by FCS

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IMPROVEMENT IN PROCESSING PERFORMANCE OF PROCESS DATA

In the development of the CENTUM series, its I/O access method has continuously evolved. This section describes the features of a new I/O access method for FFCS-V and compares them with conventional ones.

Asynchronous Parallel Access Method

The asynchronous parallel access method was adopted in CENTUM CS. As shown in Figure 2, the FCS has an I/O communication module separately from the CPU module. The I/O communication module inputs and outputs process data at its own periodic intervals, and maps the data in the memory storage which can be accessed from the CPU module. The main processor of the CPU module accesses the I/O data mapped on the memory to update the I/O data for control computation, thus this method has an advantage of reducing the load of the main processor for I/O access. However, since the I/O access cycle of the I/O communication processor is not synchronized with the control scan of the main processor, the reaction time tends to be longer, which is the time from when a process data value is detected by sensor devices to its use in the main processor for control computation.

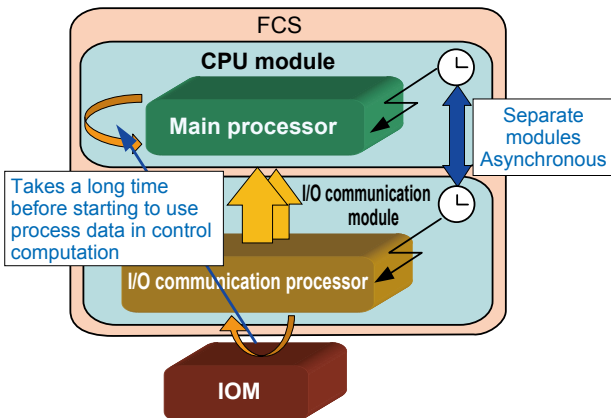


Figure 2 Asynchronous parallel access method

Direct Access Method

The direct access method was adopted in CENTUM CS3000. As shown in Figure 3, the main processor of the CPU module directly communicates with I/O modules (IOMs) to obtain process data from IOMs.

Since the main processor can directly obtain the data from IOMs, the reaction time can be shorter and controllability better than when the asynchronous parallel access method is adopted. However, the load of the main processor becomes higher because the main processor must wait to receive the data from IOMs. Particularly when IOMs are distributed over a wide area via optical fiber, the required I/O access time for the main processor to communicate with IOMs becomes longer, making the load of the main processor too high to ignore.

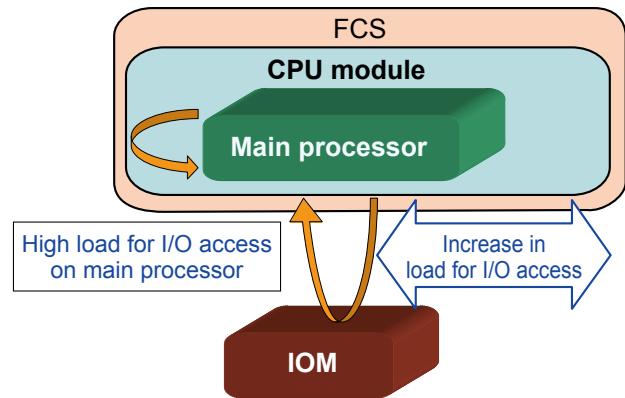


Figure 3 Direct access method

Synchronous Parallel Access Method (New Method)

The new synchronous parallel access method combines the advantages of the asynchronous parallel access method and direct access method. As shown in Figure 4, it decreases the reaction time and provides excellent controllability as well as keeps the load of the main processor low.

To synchronize the control scan of the main processor with the I/O access, both the I/O communication processor and main processor are mounted on the CPU module.

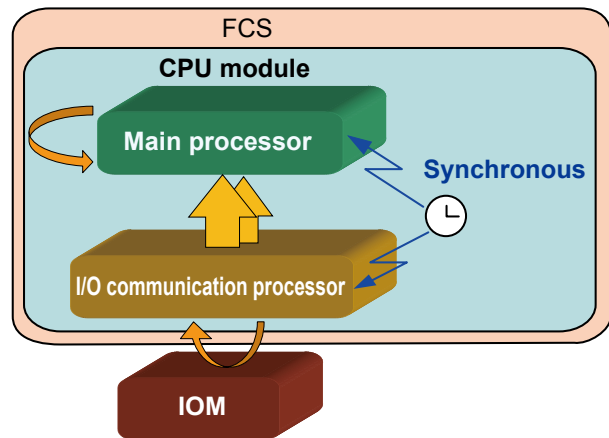


Figure 4 Synchronous parallel access method

Figure 5 shows the time chart of the data processing sequence in the synchronous parallel access method.

In case of the synchronous parallel access method, the I/O communication processor completes the collection of process data just before the start of the control scan cycle in the main processor. To achieve this, a mechanism has been developed by which periodic interrupt events along with assumed I/O processing time based on the amount of input process data are sent to the I/O communication processor.

The main processor clocks the time based on periodic interrupt events, and the time for starting the control scan cycle is determined by these periodic events. Thus, the I/O communication processor starts inputting process data at the time the I/O processing begins before the periodic interrupt

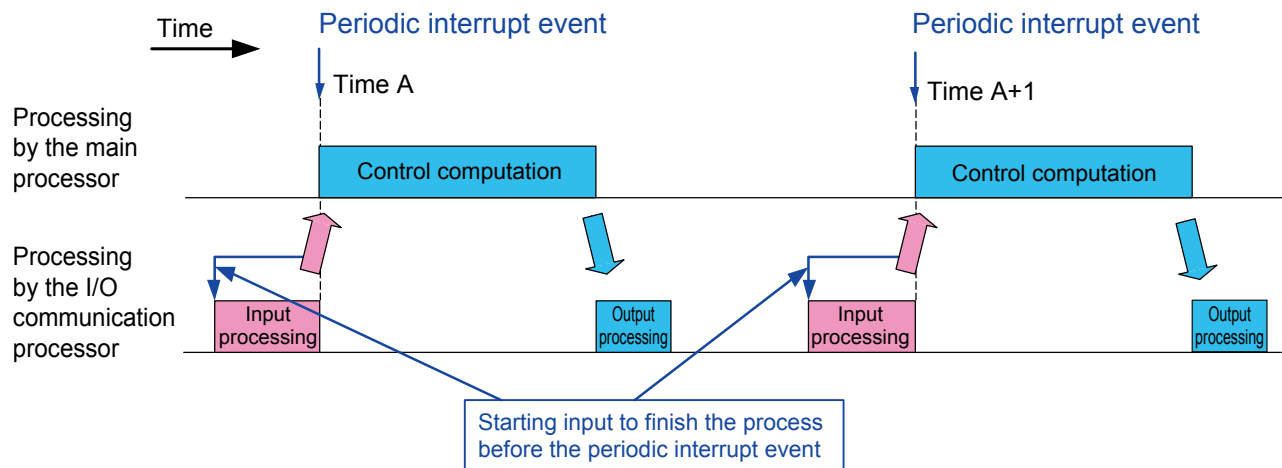


Figure 5 Time chart of data processing sequence (Synchronous method)

event. The time the I/O processing begins is counted backward from the periodic interrupt event at which the next control scan cycle starts. Therefore, the collection of process data can be completed just before the timing when the main processor starts the control scan cycle.

IMPROVEMENT IN PROCESSING PERFORMANCE OF FIELD INSTRUMENT DATA

For CENTUM VP FFCS-V, use of the synchronous parallel access method has improved the processing performance of not only process data, but also field instrument data. This section describes the mechanism that improves the processing performance of the field instrument data.

Current Problems

As mentioned in the INTRODUCTION section, the FCS is required to process a large amount of various types of process data from field instruments. In case of the conventional direct access method adopted in CENTUM CS3000, the main processor accesses field instrument data and then sends it to the upper asset management software as shown in Figure 6. The main processor needs to perform control computation using process data and also execute processing related to the field instrument data, which is required for the asset management software. For this reason, increasing amounts of field instrument data may disturb the control computation of the main processor, thus the architecture with the direct access method places an upper limit on the demand for processing a large amount of field instrument data.

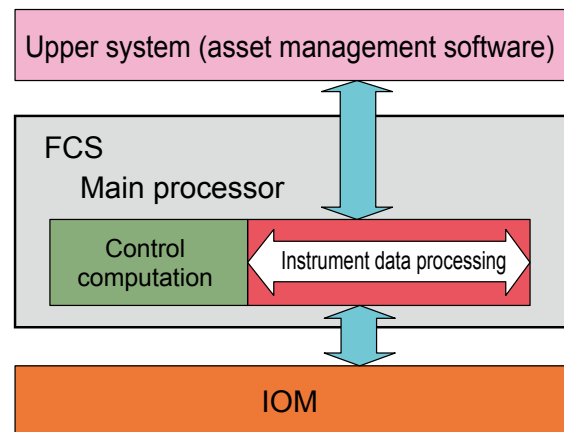


Figure 6 Flow of field instrument data (Previous method)

Solution by applying an I/O Communication Processor

Since field instrument data is not used for control computation, the main processor does not need to communicate with IOMs and the asset management software. In terms of improving the performance of control computation as mentioned in the IMPROVEMENT IN PROCESSING PERFORMANCE OF PROCESS DATA section, it is desirable to process field instrument data without increasing the load of the main processor. In the new mechanism shown in Figure 8, the I/O communication processor performs all sending and receiving of field instrument data, including communication with IOMs and the asset management software which was previously performed by the main processor.

Consequently, this mechanism provides parallel processing as shown in Figure 7: control computation performed by the main processor and communication of field instrument data performed by the I/O communication processor, thus efficiently obtaining a larger amount of field instrument data.

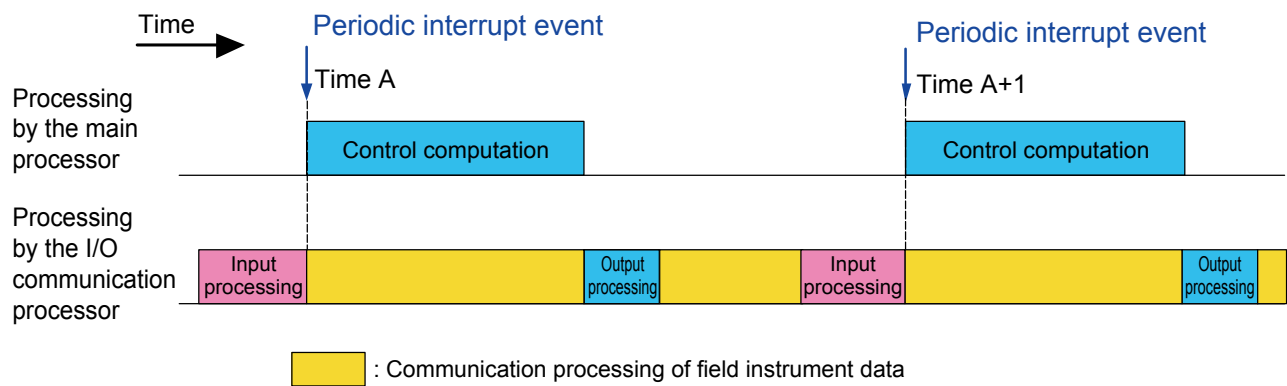


Figure 7 Improving the efficiency of field instrument data communications processing

When adopting this new mechanism, instead of the main processor, the I/O communication processor needs to generate the communication frames to be sent to IOMs. To ensure the same level of reliability as before, a new mechanism to collate the frames repeatedly by hardware and software has been adopted.

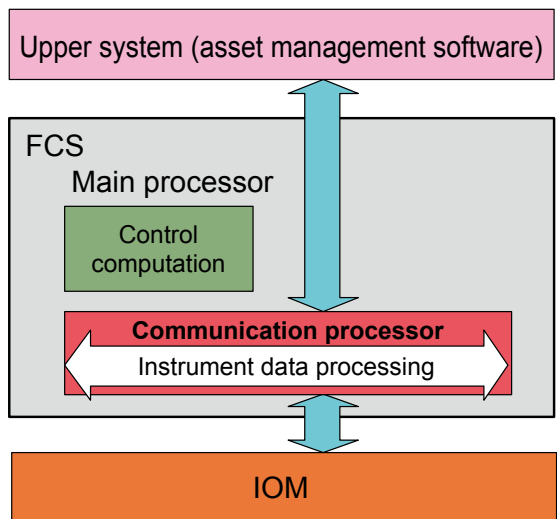


Figure 8 Flow of field instrument data (New method)

CONCLUSION

This paper has introduced the architecture of CENTUM VP FCS for processing a large amount of process data and field instrument data.

By adopting the synchronous parallel access method in which the I/O communication processor is equipped in the CPU module, the FFCS-V satisfies two demands at the same time: improving the processing performance of process data and improving the processing performance of field instrument data.

Since this architecture achieves field instrument data processing without any increase in the load of the main processor which performs control computation, it provides an easy functional improvement environment for a possible increase in the amount of field instrument data. For example, if some of the functions performed in the asset management software are executed in the I/O communication processor in the FCS, responsive usability of the field instrument data will be improved. Therefore, this architecture is expected to lead to functional enhancements and faster processing of field instrument data.

REFERENCES

(1) Shinji Oda, "Integration of Field Networks with CENTUM CS 3000 R3," Yokogawa Technical Report English Edition, No. 32. 2001, pp. 13-15

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