Distributed Control System and its Future Scope

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ABSTRACT

Modern technology has made such a great impact on the development of control system. Today distributed control systems (DCS) have become one of the hottest subjects for discussion for technical personnel, because of its use and capabilities. DCS are normally suitable for the very large processes, which can be divided into different and functionally independent section. To meet these requirements, the structure of DCS has parallel processing, physical link between different sections and man machine interface etc. Development in the field of control technology and comparison of the most widely used DCS in industries are compiled in a tabular form in this paper. The standard signals used till date are also given in the paper. At the end the important points for selection of DCS, concept of field bus and future of DCS are discussed.

INTRODUCTION

Distributed control system (DCS) is not a new concept as far as control theory is concerned. DCS first appeared in 1975 and now constitutes the main stream of process control. DCS is the generic term related to miniaturized version of multitasking, multivariable, multi-loop controller used for process control. In a DCS system the control is distributed into a number of small process modules. They can be calssified into two broad categories (I).

- Distributed independent control sytems used in applications such as continuous control in oil refineries, and which are easily configured as a combination of independent controllers.
- Supervisory control systems involve coordination between distributed or separate individual control systems. A supervisory control system is used to coordinate the various subsystems to realize an integrated system.

Distributed systems are suitable for the process control, which have following characteristics.

- Very large processes where a single centralized system is not adequate (e.g. power-plants, steel plants, fertilizer plants, pulp and paper plants).
- Processes, which can be divided into different and functionally independent section, based on:
- Functional scope.
- Geographical distribution.
- Processes of different level of hierarchy.

The future development in the signal standard is the field bus concept. Field bus is a serial data link capable of working with twisted pair cables up to a distance of 2 km with speed of about 125 bits/sec (2).

Structure of distributed control system

In order to meet the above demand of different processes, the structure of distributed system should have the following features:

Parallel processing

It is evident that distributed systems are multiple systems and hence simultaneous processing of data/information should be possible at more than one place (more than one stand alone independent units).

Link among different system

A physical link should exist among all constituents of distributed system so that data transfer can take place from one point to another. (Data highway based communication link).

Man Machine Interface

The distributed system should be able to present the consolidated view of the process status to plant operator/ plant engineer and should be able to accept commands from them for control of process. (Graphics, CRT terminal, process monitoring).

Functional requirements

Each constituent unit of distributed system should be able to perform some or all of the functions like, Signal conditioning and signal processing; Logic control functions, Analog control functions; Open loop/closed loop control function; Arithmetic computations; Process optimization; Data acquisition, Data processing and storage; Display and monitoring functions; Report generation and printing of logs for process faults etc; Graphic functions; Man-machine communications; Communication with system a higher/lower level, different/similar systems, dedicated devices; and program development, debugging and testing. The detailed description of architecture, specification and configuration of the DCS system is given in chapter 7.7 of Liptak (I).

Functional of DCS

The major functions performed by a DCSare, Plant data input/output with alarm detection and persentation; Data presentation; Continuous control; Batch control; Historical data recording; Trend recording; Process modeling; and Operator/ Process interaction. DCS distributes the control not the process and that distribution or characterization comes out of process and not the system considerations. Hence, it is essential to know system capabilities as well as process knowledge to configure system. Meaning of distributed system would be a microprocessor-based system having datahighway communication link, which meets the needs of distributed control.

As users become knowledgeable of the capabilities and reliability of DCS systems, their use is increasing from systems that monitored and controlled about 2000-3000 points. Today's larger systems that encompass five to ten times as many points, and have man-machine interface, higher pixel resolution, windowing, touch screens, trackball and a mouse. Controller now combines ladder logic, loop control and provide redundant processors, data highways, expert systems and more.

Development of control technology

Over the last fifty-two years, plant control technology has been progressing continuously to meet the ever-increasing demands of efficiency and reliability. These developments are summarized in Table-l. Rapid developments in the field of microelectronics, communications and networking constitute the technology push factors influencing plant controls (3,4,5). Similarly market demands of increased availability and reliability, environmental protection, ease of maintenance and reduced costs constitute the market pull factors, which are driving the technology further. Interplay of these factors is shown in Fig 1.

Standard signals

Around 50 years ago, most of the plant used the 3 to 15psi pneumatic signals to control their process.

Eventually that standard was replaced by 4 to 10 mA analog signals. Both of the standards were entirely analog and the information only flowed in one direction. The last change in signal standard was the open protocol HART (Highway Addressable Remote Transmitter) digital communication with the 4 to 20 mA output and Ihas gained widespread acceptance with the process control industry. The next protocol changed will be field bus in a signal standard. Field bus is entirely digital, there is no analog signal. Fig. 2 shows the evaluation of signals standards.

Table 1 Progress in Control

Year	Control	MMI	Computer	Field Devices
1950s	Pneumatic	Bulky Recorders & Indicators	None	Pneumatic
1960s	Analog Electronics	Recorders, Indicators & Annunciator	Data Logger	Electrical Sensors
1970s	Analog Electronics (Semi-Cond)	CRT Message, Miniature Tiles Trend Rec.	Central Computer	Sensors with better accuracy & reliability
1980s	Digital (μm based)	CRT message, Graphics, Control,	Improved Speed, Power Storage	Smart Transmitters (Proprietary protocol)
1990s	Digital (up-based) whole Plant	CRT for Plant control, Work station	Integrated with DCS	Smart Transmitters (Standardized protocol)
1995s	Digital-open system based 32 Bit	Open system, Large displays, Touch screen,	Network system very high speed Memory & Power	Smart Transmitters & smart valves
2000s	Digital with Flattened structure (64 Bit)	Hardware independent	Completely Integrated & Open system	Digital Communication through field bus
2002-2010	Digital controller with data address	Computer and laptop	Computer with network, Fieldbus Artificial Intelligence	Vitrual instrumentation wire less communication

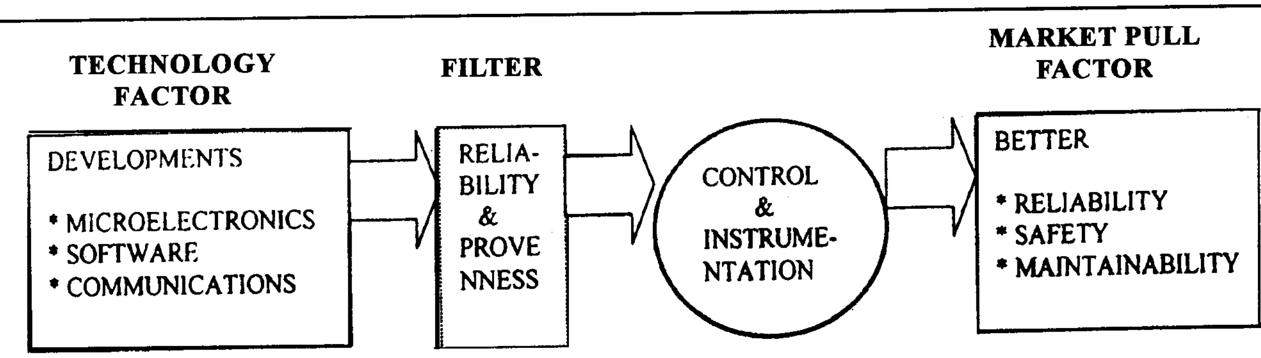

Fig. 1 Factors Influencing Process Control Technology

Field bus is a serial data link capable of working with twisted pair cabapales up to a distance of2 Km with speed of about 125 bits/sec. Field bus will provide two distinct advantages:

- Owing to expanded capabilities offered by 2-way communication between field devices and subsystems of the process control system, supplementary v:) information for improved process control can be transmitted.
- 'Intelligent' microprocessor based field devices can assume automation functions for individual process control (e.g. drive control, simple closed loop control).

This will also mean less expenditure in cabling and related planning, better maintenance due to extensive diagnostics, and improvement in transmission reliability due to reduced interference and reduction in hardware costs. With the growth of Internet connectivity, it is expected that virtually all future industrial input/ output protocols and processes to have significantly expanded embedded intelligence. The significant reduction in the price of processing power and memory, embedded processors will penetrate and populate virtually every input/output point, making each appliance intelligent (4).

Comparison of DCS

Today the most of DCS's have incorporated personal computer into their systems. Some companies actually use PCs as a process interface and control device, whether using their own software or that of third party. However, the most common use of PCs in DCS applications is to actually configure the system. The configuration can be downloaded into the DCS and checked along with rest of the system. Customs graphics usually cannot be built in this manner, but PC software that does exist can be extremely useful and time saving tool. Most ofDCS's are sufficiently advanced today that engineers with little practical experience can accomplish configuration and software development. A comparative statement of DCS is prepared based on the information available from catalogues/ discussions. Comparison is made on basis of, product/ system configuration, funcational capabilities, hardware feature, software feature, communication link, manufacturing facility, and after sale service. The detailed comparative statement of Bailey-Infy 90, Taylor Mod 300, Fisher & Porter, Fisher Controls, Honeywell TDC-3000, Morre Mycro II, Rosemount RS-3 and Foxboro DCS system are summarized in Table 2.

Selection of DCS

Selection of DCS is tedious process. Before selecting a DCS one should carefully check, Field interface galvanic isolation for input and output, Redundancy level, On line configuration, Off line configuration, Level of security, Software up-gradation, Online replacement,

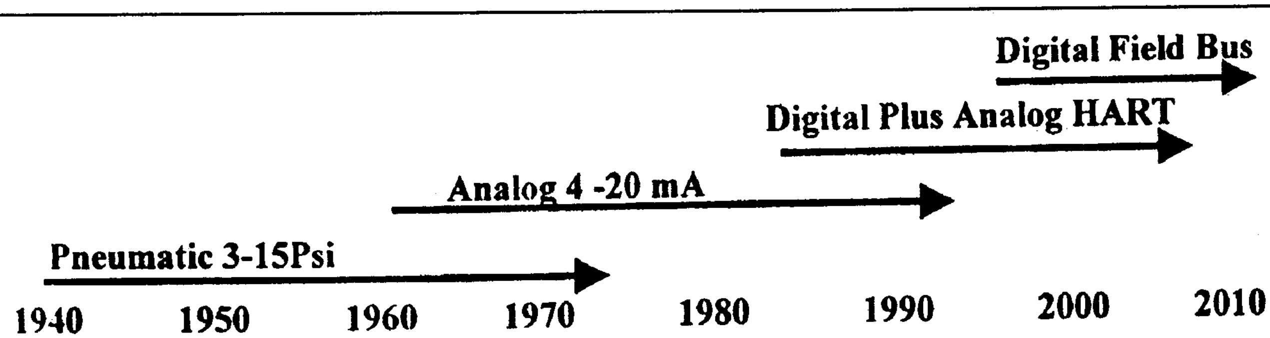

Fig. 2 The evolution of Signal Standards

Table 2 Comparison of Distributed Control Systems

	Bailey INFY-90	Taylor MOD-300	Fisher-Proter	Fisher Controls
CONTINOUS CONTROL				
Continuous Capabilities	Yes	Yes	Yes	Yes
System Controller fully redundant	Yes	Yes	Yes	Yes
Automatic bumpless transfer	Yes	Yes	Yes	Yes
Control Software Modified on-line	Yes	Yes	Yes, operating/engg Station	Yes, Proflex Workstation
redundant controllers share same backplane	Same	Separate	Separate	Separate
BATCH CONTROL				
Batch capabilities	Yes	Yes	Yes	Yes
Controller for batch/ continuous	Same	Same	Same	Same
How batch system configure	Custom function blocks	Structured language for formulations	Batch function of controlware through connection in controller	Function sequence library/fill in the blanks methods
Batch controller fully redundant	Yes, 1:1	Yes, 1:1	Yes, 1:1	Yes, 1:1
MISCELLANEOUS				
Method used to configure graphics	PC based workstation	Mode 300 page builder	Track ball and grphics symbols engg. keyboard	Proflex workstation
High density I/O available	Yes	Yes	Yes	Yes
In a power outage how do signals fail	User selectable	User selectable	User selectable	User selectable
Can rack cards be replaced under power	Yes, all	Yes, controller cards including I/O	Yes, all/I/O cards	Yes, all
Smart transmitter Communication	Yes, Bailey	No	Yes, Fisher & porter	Yes, Rosemount

MTBF/MTTR, Spares for 10 years after withdrawn of product, 2 years warranty-normally DCS manufacture provide 2 years warranty, Software configuration, Power and heat load, Surface and CMOS (because with CMOS power consumption is less), Battery back up, Redundancy in power supply, Grounding requirement, Communication-baud rate, Smart communication facility, field bus compatibility, and Scan rate should be variable.

Future development in DCS

Field Bus provides expanded capabilities offered by 2-way communication between field devices and subsystems of the process control system, supplementary information for improved process control can be transmitted and 'Intelligent' microprocessor based field devices for automation functions and individual process control. This means less expenditure in cabling and related planning, better maintenance due to extensive diagnostics, improvement in transmission reliability due to reduced interference and reduction in hardware costs. Introduction of field bus and compatible sensors and actuators, communication between the controllers and the field devices is digital. This has reduced field cabling associated civil works and planning. Smart field device collects volume of information about devices performance and operation. The modern software and cellular communication are facing with the challenge to create systems that convert data to useful on-line knowledge. The software devices are used to collect data to create database for mobile terminal. Wireless application protocol (W AP) decodes the information and delivers them to web server, which is again sent back in encoded form to the wireless terminal (5).

Table 3

	Honey well TDC-3000	Morre Mycro II	Rosemount Model-Rs-e	Foxboro
CONTINOUS CONTROL				
Continuous Capabilities	Yes	Yes	Yes	Yes
System Controller fully redundant	Yes	Yes	Yes	Yes
Automatic bumpless transfer	Yes	Yes	Yes	Yes
Control Software Modified on-line	Yes Universal station	Yes, IBM-PC	Yes, Any system console	Yes, PC-AT compatiable
Do redundant controllers share same backplane	Separate	Separate	Same	Separate
BATCH CONTROL				
Batch capabilities	Yes	Yes	Yes	Yes
Controller for batch/ continuous	Same	Same	Same	Same
How batch system configure	Control language provide sequential step	High level language with ladder logic	Recipes & control blocks	Sequencing Language, ladder logic
Batch controller fully redundant	Yes, 1:1	Yes, 1:1	Yes, 1:1	Yes, 1:1
MISCELLANEOUS				
Method used to configure graphics	Universal station in engg. mode	PC like graphic using drawing/ editing functions	CAD like pixel Configuration	Workstation or PC using default & user developed elements
High density I/O available	Yes	Yes	Yes	Yes
In a power outage how do signals fail	User selectable	Fail to closed	User selectable	User selectable
Can rack cards be replaced under power	Yes, all	Yes, all	Yes, all	Yes, all
Smart transmitter Communication	Yes, Honey well	No	Yes, Rosemount	Yes, Foxboro

CONCLUSION

Paper highlights the key role of the DCS in controlling and monitoring functions in the modern industrial process control and operations. The technical data related to DCS and control technology are compiled in a tabular form, standard textbooks and journals. Selection and comparison of most widely used DCS are compared based on the information available, which can help the technical personnel working in mills for selecting the DCS. At the end of the concepts of fields , bus and future development on DCS are given.

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