Distributed Control Systems

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Introduction

Stand-alone controller is a controller type that handles an operation without communicating with other controllers, but only with the one control loop of which it is a part.

However, the present-day microcomputer-based control systems are capable of communicating with other controllers through a network, and this is referred to as a **distributed control system**.

This type of control, that is, distributed control system, is usually employed for the operation of a large processing facility like a refinery, a manufacturing company, a power plant, and the like that involves many control loops.

Shown in Figure 1 is a typical distributed control system with components given below.

Components of a Distributed Control System

1) Control Network
2) Application Stations
3) Mass Storage Devices
4) Workstations
5) Engineering Workstations
6) Operator Stations
7) Remote Control Units (RCUs)
8) Fieldbuses/Smart Devices
9) Real-Time Clocks

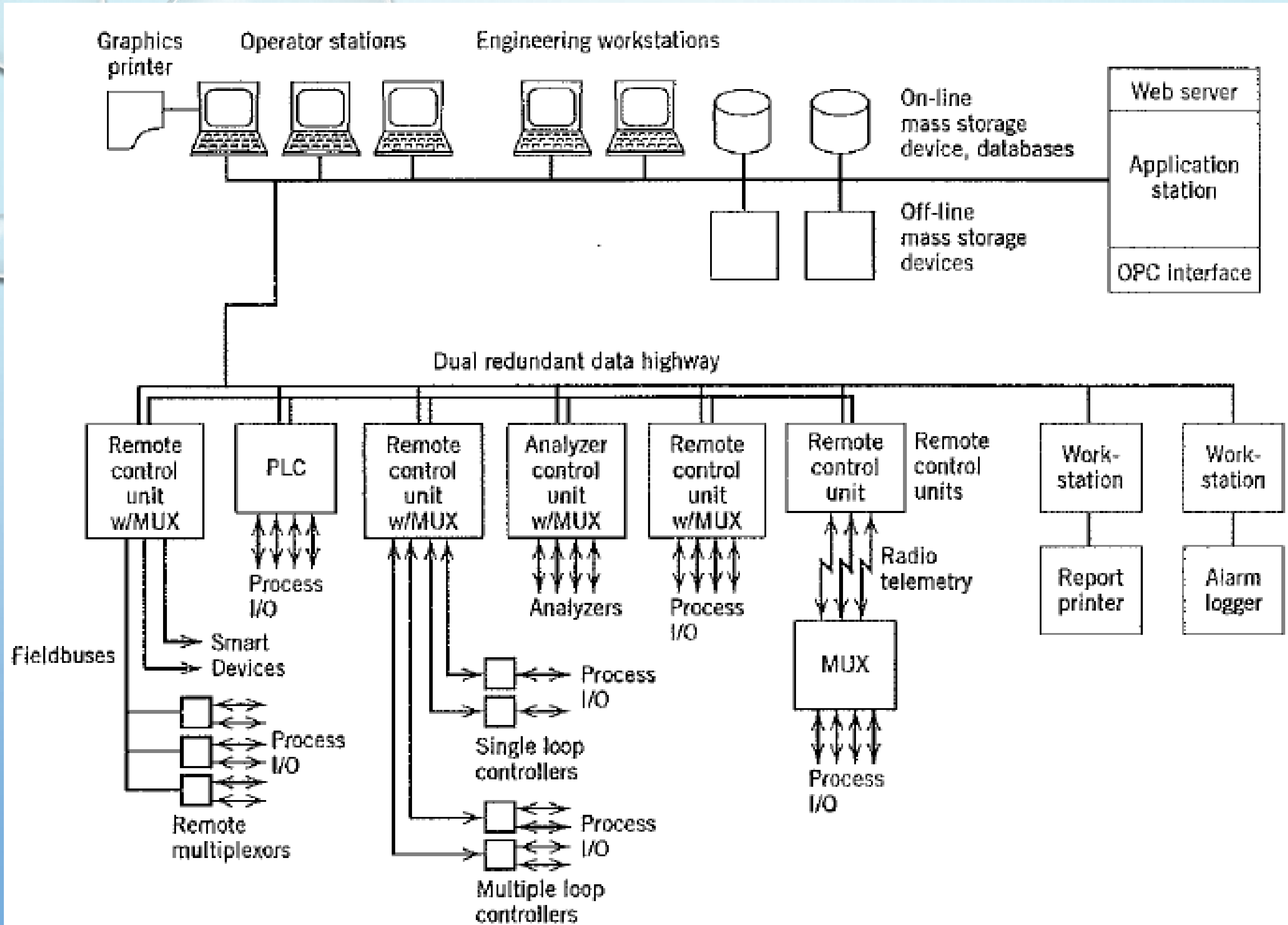

Figure 1. A typical distributed control system (DCS) (Source: Seborg, 2004)

Description of the Components

(1) Control Network: This is the communication link between the individual components of a network. Coaxial cable and, more recently, fibre-optic cable have often been used, in competition with Ethernet protocols. To reduce the possibility of link failure, a redundant pair of cables (dual redundant highway) is normally supplied.

(2) Application Stations: These separate computers run application software such as databases, spreadsheets, financial software, and simulation software via an OPC (object linking and embedding for process control) interface. These stations can be used for e-mail and as webservers, for remote diagnosis, configuration, and even for operation of devices that have an IP (Internet Protocol) address. Application stations can communicate with the main database contained in on-line mass storage systems.

(3) Mass Storage Devices: These are, typically, hard disk drives that are used to store active data, including on-line and historical databases and non-memory resident programs. Memory resident programs are also stored to allow loading at system start-up.

(4) Workstations: These are the most powerful computers in the system that are capable of performing functions not normally available in other units. A workstation acts both as an arbitrator unit to route internodal communications and a database server. Through the workstations, an operator interface is supported, and various peripheral devices are coordinated. Computationally intensive tasks like real-time optimization and/or model predictive control are implemented in a workstation.

(5) Engineering Workstations: They are similar to operator stations but can also be used as programming terminals to develop system software. This arrangement reduces compatibility problems between the development and application environments for the system software. Typically, users may also develop their own application programs on these workstations.

(6) Operator Stations: These typically comprised colour graphics monitors with special keyboards to perform dedicated functions. The control processes from the workstations are supervised by operators. These stations may also be connected directly to printers for alarm logging, printing reports, or process graphics.

(7) Remote Control Units (RCUs): These are the components used to implement basic control functions such as Proportional-Integral-Derivative (PID) control. Some RCUs may be configured to acquire or supply set points to single-loop controllers. In addition, radio telemetry (wireless) may be installed to communicate with MUX units located at great distances.

(8) Fieldbuses/Smart Devices: An increasing number of field-mounted devices are available that support digital communication of the process input/output (I/O) in addition to, or in place of, the traditional 4-20 mA current signal. These devices possess greater functionality, resulting in reduced setup time, improved control, combined functionality of separate devices, and control-valve diagnostic capabilities. Digital communication also allows the control system to become completely distributed where, for example, a PID control algorithm could reside in a valve positioner or in a sensor/transmitter.

(9) Real-Time Clocks: Generally, process control systems must respond to events in a timely manner and should have the capability of real-time control. As such, some DCSs are connected to atomic clock signals for maintenance of accuracy.

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