

Fieldbus 102

Fieldbus communications

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Overview

How does data get where it's needed -- when it's needed?

One of the most important aspects of FOUNDATION fieldbus is its ability to collect and deliver vast amounts of information -- not only process variables and control signals, but other types of instrument and process data as well.

It does this consistently and reliably, while also providing interoperability between devices from different manufacturers -- and compatibility with existing wiring. This course describes key features of the technology that make this possible.

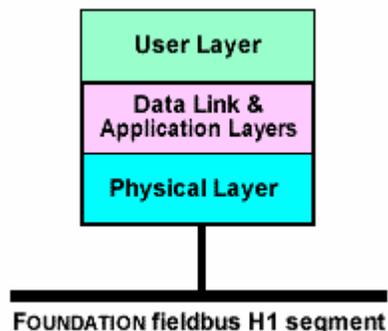
Hint: As you go through the topics in this course, watch for answers to these questions:

- *What kinds of information are transmitted using unscheduled communications?*
- *How does FOUNDATION fieldbus improve alarm and event time-stamping?*
- *What are the three possible labels that FOUNDATION fieldbus can use to describe the status of a process parameter?*

The communications model

The FOUNDATION fieldbus communications model has three parts:

- The physical layer
- The data link and application layers
- The user layer

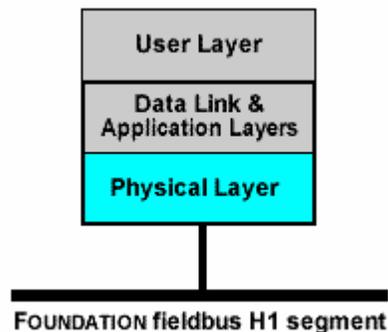


The physical layer and the data link and application layers make up the communications stack. The user layer sits on top of the stack and enables you to interact with the other layers and with other applications in your system.

You don't have to remember the details of the communication model to use FOUNDATION fieldbus. But the information on this and the next three pages will help you understand the relationship between different aspects of fieldbus technology.

Physical layer

The first functional layer of the FOUNDATION fieldbus communications model is the physical layer, which deals with translating messages into physical signals on the wire -- and vice versa.

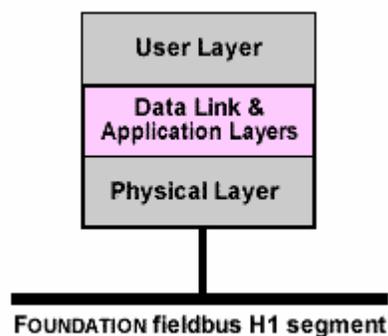


The physical layer also provides the common electrical interface for all FOUNDATION fieldbus devices. FOUNDATION fieldbus H1 segments require 9-32 volts DC power and approximately 15-20 mA of current per device. They operate at a communication speed of 31.25 kbaud.

The FOUNDATION fieldbus physical layer is defined by approved standards (IEC 61158-2 and ANSI/ISA 50.02, part 2). It can run on existing field wiring over long distances, supports two-wire devices, and offers intrinsic safety as an option. In short, it's an ideal match for a typical process-automation environment.

Data link and application layers

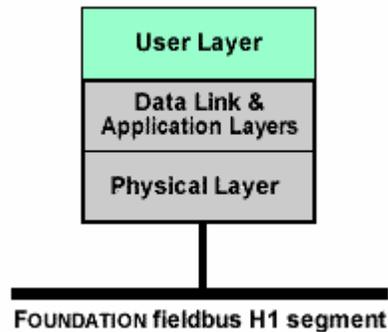
The second part of the communication model combines several technologies that together control transmission of data on the fieldbus.



The data link and applications layers provide a standard way of "packaging" the data, as well as managing the schedule for communication and function-block execution. They enable process control while providing standardization and interoperability.

User layer

The user layer sits on top of the communications stack, where it enables you to interact with the other layers and with other applications.



The user layer contains resource blocks, transducer blocks, and function blocks that describe -- and execute -- device capabilities such as control and diagnostics. Device descriptions enable the host system to interact with and understand these blocks without custom programming.

Blocks and device description language are covered in more detail in later courses.

Scheduled communications

All devices and function blocks on a FOUNDATION fieldbus segment execute and communicate **process control information** on a **regular, repeating cycle**.

Timing for this type of communication is **determined by a master schedule** in a Link Active Scheduler, which is a function residing in the host system or one of the devices on the segment. You'll learn more about the Link Active Scheduler later in this course.

These scheduled (also called "cyclic") communications use a **publisher/subscriber** method. This means data is sent on the bus or "published" once, and all devices that need the data listen to or "subscribe" to the same transmission. A specific parameter can therefore be used by as many different devices or functions as you want, without increasing traffic on the bus or potentially affecting control performance.

These communications are also **deterministic**. This means that they always occur on a pre-determined schedule, so information is certain to be broadcast (and received) precisely when it's needed.

The result is regular and precise execution of communication and control, which helps reduce process variability. For fast or time-critical control loops, control on FOUNDATION fieldbus can improve plant performance.

Unscheduled communications

FOUNDATION fieldbus supports a great deal of information beyond process loop control data. These other types of information include

- Configuration information sent to devices or a central database
- Alarm, event, and trend data
- Information for operator displays
- Diagnostic and status information.

This information is important, but not as time-critical as loop control information. If it's transmitted 1/8 second early in one communication cycle and 1/8 second late in the next cycle, there's no impact on process control or plant operation.

Flexible timing. FOUNDATION fieldbus gives this information a lower priority on the segment than scheduled control-loop-related communications. However, a certain amount of time in the communication cycle is reserved for these unscheduled (or "acyclic") communications to ensure that the segment is not too loaded to carry the information.

During this time, a **token-passing** method gives each device on the segment the opportunity to transmit messages until it has finished or an allotted time has expired.

Parameter status

FOUNDATION fieldbus supports a variety of data redundancy checks to avoid message-bit errors. Two additional features that help ensure data reliability are an **application clock** (the next topic in this course) and a status associated with every parameter.

Each device is designed to check for problems and label the data it sends accordingly. This status label shows whether the quality of the data is **good**, **bad**, or **uncertain**.



For example, a **bad** status signal could indicate a device failure, such as a failed sensor on a temperature transmitter.

An **uncertain** status indicates that the quality of the data is unknown. For example, a pressure transmitter reading that's 110% of the device's upper limit may be accurate -- or it may be inaccurate because the device has saturated high and the actual pressure is even higher.

Practical pointer

Device status information is made available to the host system, but not all hosts use this information. You should therefore check for this functionality in any host system you consider. The host should display this status information to the operator and support use of the information to modify the control action if appropriate.

The PlantWeb advantage

In a PlantWeb architecture, the DeltaV and Ovation systems read device status information and propagate it through the system. As a result,



- Operators can know the validity of information they use for decision-making.
- Control strategies can be configured to modify their control action depending on device information status.
- Advanced Control strategies such as Model Predictive Control or Neural Network Control can be notified if the data they're using is bad or suspect.
- AMS Suite applications present the information to maintenance personnel so they can verify proper operation, or more quickly identify and localize actual or predicted error conditions.

Application clock

Every device on a FOUNDATION fieldbus segment shares the same time.

A system management function called the **application clock** periodically broadcasts the time -- either local time or Universal Coordinated Time -- to all devices. Each device uses an internal clock to keep time between these synchronization broadcasts.

Alarms and events are time-stamped at the device where they occur, when they occur --not later when they're received by a historian, alarm log, or other application on a host system.

Because of this approach, FOUNDATION fieldbus provides superior time resolution and accuracy for activities such as sequence-of-events recording and analysis.

Link active scheduler

The link active scheduler (LAS) function maintains the central, deterministic schedule for communication between devices on a segment. It improves overall communication reliability by compelling each device to transmit cyclic data when it's scheduled to do so.

Message retries also increase communication reliability. If a device doesn't respond to the LAS "compel data" message -- for example, if a momentary electrical transient at a device prevents it from communicating -- then the LAS will re-send the message to compel the device to publish its information.

The LAS resides in a device or host system component (such as an H1 interface card) on the segment. If the LAS fails, then a **backup LAS** in another device or host system component takes over as master scheduler.

There can be more than one backup LAS on a segment. If the first backup fails, the second backup takes over, and so on. This means that FOUNDATION fieldbus is designed to degrade gracefully, further increasing reliability.

Device address assignment

As a digital, multidrop bus, FOUNDATION fieldbus carries signals to and from several devices over the same cable. To identify which information is associated with which device, each device is assigned an address.

Depending on the communication protocol, addresses can be assigned in several ways, from dip switches or off-line addressing to automatic online assignment.

Methods such as using dip switches or offline addressing carry the risk of human errors, such as inadvertently assigning an address to more than one device. These addressing errors can cause communication problems, or in extreme cases prevent the bus from working. That's why FOUNDATION fieldbus doesn't allow these methods of address assignment.

Online addressing helps avoid problems such as duplicate devices with the same address, but by itself does not guarantee there are no addressing errors. You can avoid this risk if addresses are assigned automatically by a configuration tool or host system as each device is connected to the segment.

The PlantWeb advantage

In the PlantWeb architecture, the DeltaV and Ovation configuration tools automatically assign device addresses to eliminate unnecessary work and the possibility of duplicate assignments.



FOUNDATION fieldbus reserves some addresses for hosts and for temporary devices such as maintenance tools. The DeltaV and Ovation systems' automatic address assignment makes sure these reserved addresses aren't assigned inappropriately.

Finally, you can override the default addresses and assign specific addresses to certain devices when necessary.

Find tag service

Many communications protocols require the user to identify devices and parameters, and then link them by address and/or register assignment. This can be a difficult and error-prone process.

FOUNDATION fieldbus, on the other hand, is a tag-based bus. Instead of requiring a hardware or register address, it can find devices or variables by tag (such as "FT-101").

To find a specific tag, a **find tag query** is sent out on the bus. As each device receives the query, it searches itself for the requested tag.

When a device finds the tag, it sends back complete path information and all necessary parameters and descriptors associated with the tag. The host or maintenance tool can then use the path to access the data for the tag. This feature also helps avoid duplicate tag assignments.