



INTEGRATED TECHNICAL EDUCATION CLUSTER
AT ALAMEERIA

E-626-A

Data Communication and Industrial Networks (DC-IN)

Lecture #10

Fieldbus & Troubleshooting

Instructor:

Dr. Ahmad El-Banna



Agenda



Fieldbus



Industrial Networks Troubleshooting



Basic Maintenance Techniques

Fieldbus

- Fieldbus is the **name of a family of industrial computer network protocols used for real-time distributed control**, standardized as IEC 61158.
- A **complex automated industrial system** — such as manufacturing assembly line — **usually needs a distributed control system**—an organized hierarchy of controller **systems—to function**.
- **In this hierarchy**, there is usually a Human Machine Interface (**HMI at the top**, where an operator can monitor or operate the system.
- This is typically linked to a **middle layer** of programmable logic controllers (**PLC**) via a non-time-critical communications system (e.g. Ethernet).
- At the **bottom** of the control chain is the **fieldbus** that links the PLCs to the components that actually do the work, such as sensors, actuators, electric motors, console lights, switches, valves and contactors.

Types

- Although fieldbus technology has been around since **1988**, with the completion of the **ISA S50.02 standard**, the development of the international standard took many years.
- In **1999**, the **IEC SC65C/WG6 standards** committee met to resolve difference in the draft IEC fieldbus standard.
- The result of this meeting was the initial form of the **IEC 61158** standard with **eight different protocol sets** called "**Types**" as follows:
 - Type 1 Foundation Fieldbus H1
 - Type 2 ControlNet
 - Type 3 PROFIBUS
 - Type 4 P-Net
 - Type 5 FOUNDATION fieldbus HSE (High Speed Ethernet)
 - Type 6 SwiftNet (a protocol developed for Boeing, since withdrawn)
 - Type 7 WorldFIP
 - Type 8 Interbus

Cost advantage

- The amount of **cabling required is much lower** in Fieldbus than in 4-20 mA installations.
- This is because **many devices share the same set of cables in a multi-dropped fashion** rather than requiring a dedicated set of cables per device as in the case of 4-20 mA devices.
- Moreover, **several parameters can be communicated per device** in a Fieldbus network whereas only one parameter can be transmitted on a 4-20 mA connection.
- Fieldbus also **provides a good foundation** for the creation of a predictive and proactive **maintenance** strategy.
- The **diagnostics** available from fieldbus devices can be used to **address issues with devices before they become critical problems**.



Standards

- There are a **wide variety of competing fieldbus standards**.
- Some of the most widely used ones include:
 - AS-Interface
 - CAN
 - EtherCAT
 - FOUNDATION fieldbus
 - Interbus
 - LonWorks
 - Modbus
 - Profibus
 - BITBUS
 - CompoNet
 - SafetyBUS p
 - RAPIEnet

Profibus

- PROFIBUS (Process Field Bus) is a **standard for fieldbus communication in automation technology** and was first promoted in 1989 by BMBF (German department of education and research) and then used by Siemens.

PROFIBUS Protocol (OSI reference model)

OSI-Layer	PROFIBUS	
7 Application	DPV0 DPV1 DPV2	Management
6 Presentation		
5 Session		
4 Transport	--	
3 Network		
2 Data Link	FDL	
1 Physical	EIA-485 Optical MBP	



Profibus electrical connector

FOUNDATION fieldbus

- FOUNDATION Fieldbus is an **all-digital, serial, two-way communications system that serves as the base-level network in a plant or factory automation environment.**
- It is an **open architecture**, developed and administered by the Fieldbus Foundation.
- It is targeted for **applications using basic and advanced regulatory control**, and for much of the discrete control associated with those functions.
- Foundation fieldbus **technology is mostly used in process industries**, but has recently been implemented in power plants.

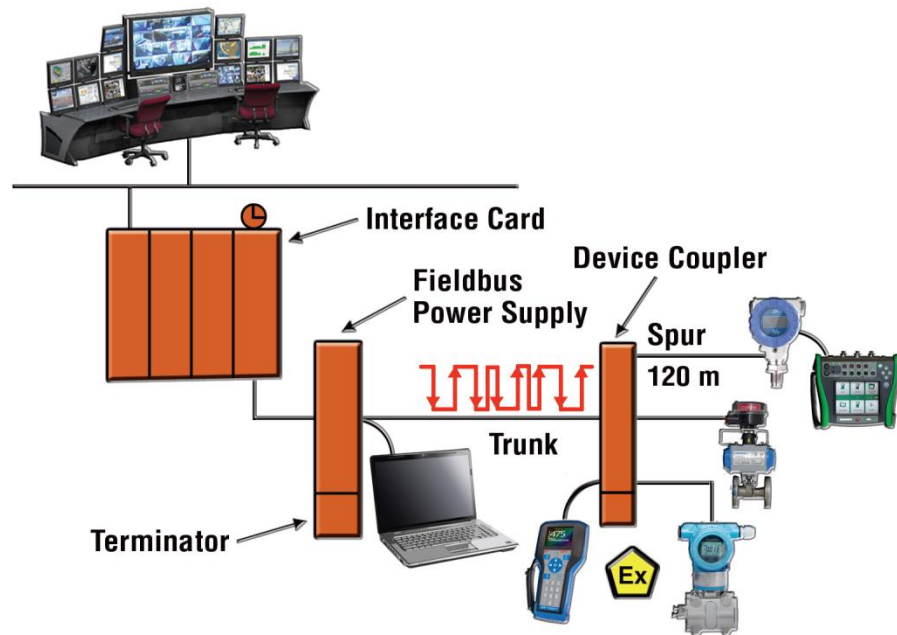
FOUNDATION fieldbus

Implementations

- **Two** related **implementations** of FOUNDATION fieldbus have been introduced **to meet different needs** within the process automation environment.
- These two implementations **use different physical media and communication speeds**.
- FOUNDATION Fieldbus H1
 - Operates at **31.25 kbit/s** and is generally used to connect to field devices and host systems.
 - It provides communication and power over standard stranded **twisted-pair** wiring in both conventional and intrinsic safety applications.
 - H1 is currently **the most common implementation**.
- HSE (High-speed Ethernet)
 - Operates at **100/1000 Mbit/s** and generally connects input/output subsystems, host systems, linking devices and gateways.
 - It **doesn't** currently provide **power over the cable**, although work is under way to address this using the IEEE802.3af Power on Ethernet (PoE) standard.

Fieldbus segment

- A typical fieldbus segment consists of the following **components**.
 - **H1 card** - fieldbus interface card (It is common practice to have redundant H1 cards, but ultimately this is application specific)
 - **PS** - Bulk power (Vdc) to Fieldbus Power Supply
 - **FPS** - Fieldbus Power Supply and Signal Conditioner (Integrated power supplies and conditioners have become the standard nowadays)
 - **T** - Terminators (Exactly 2 terminators are used per fieldbus segment. One at the FPS and one at the furthest point of a segment at the device coupler)
- **LD** - Linking Device, alternatively used with HSE networks to terminate 4-8 H1 segments acting as a gateway to an HSE backbone network.
- And **fieldbus devices**, (e.g. transmitters, transducers, etc.)



TROUBLESHOOTING & MAINTENANCE TECHNIQUES



Troubleshooting meaning

- Troubleshooting is a **form of problem solving**, often applied to **repair failed products** or processes.
- It is a **logical, systematic search for the source of a problem** so that it can be solved, and so the product or process can be made operational again.
- Troubleshooting is **needed to develop and maintain complex systems** where the symptoms of a problem can have many possible causes.
- Troubleshooting is **used in many fields** such as engineering, system administration, electronics, automotive repair, and diagnostic medicine.

Maintenance meaning

- Maintenance, repair and operations (**MRO**) or maintenance, repair, and overhaul involves **fixing** any sort of mechanical, plumbing or electrical **device should it become out of order** or broken (known as repair, unscheduled, or casualty maintenance).
- It **also includes performing routine actions which keep the device in working order** (known as scheduled maintenance) or prevent trouble from arising (preventive maintenance).

Maintenance meaning..

- In telecommunication, commercial real estate and engineering in general, **the term maintenance has the following meanings:**
 - **Any activity** – such as tests, measurements, replacements, adjustments and repairs — intended to retain or restore a functional unit in or to a specified state in which the unit can perform its required functions.
 - **For material** — all action taken to retain material in a serviceable condition or to restore it to serviceability. It includes inspection, testing, servicing, classification as to serviceability, repair, rebuilding, and reclamation.
 - **For material** — all supply and repair action taken to keep a force in condition to carry out its mission.
 - **For material** — the routine recurring work required to keep a facility (plant, building, structure, ground facility, utility system, or other real property) in such condition that it may be continuously used, at its original or designed capacity and efficiency for its intended purpose.

Maintenance types

- Generally speaking, there are **three types** of maintenance in use:
- **Preventive maintenance,**
 - where equipment is maintained before break down occurs.
- **Operational maintenance,**
 - where equipment is maintained in using.
- **Corrective maintenance,**
 - where equipment is maintained after break down.
 - This maintenance is often most expensive because worn equipment can damage other parts and cause multiple damages.

Fieldbus Foundation Example

- In this part, we will follow the presentation of:
- Fieldbus Foundation™ Bus diagnostics and troubleshooting
- By: Andreas Agostin MTL Instruments Pte Ltd Singapore
- On behalf of Fieldbus Foundation™ Marketing Committee (Malaysia)

Which tools for which purpose?


Plant life cycle

Engineering



Calculation tools

Installation



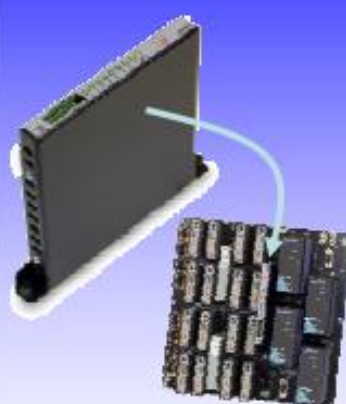
Wiring tools

Commissioning & Troubleshooting



Commissioning & troubleshooting tools

Operation & Maintenance



Predictive Maintenance tools

Which tools for which purpose?

Plant life cycle

Engineering



Calculation tools

**Proper engineering ensures that the plant works as designed.
Flaws in engineering will cause the actual plant not to work, and will trigger expensive redesign and re-work.**

Which tools for which purpose?

Plant life cycle

Installation



Wiring tools

¹ Source:
<http://forums.fieldbus.org/showthread.php?t=1298>

According to field experience, approx. 95%¹ of the problems occurring in a plant's lifetime are related to installation.

Cause can be:

- Wrong ferrule diameter
- Wrong crimping tool
- Wrong crimping method
- Wrong wire cutter
- Wrong screw driver
- Wrong torque
- ...

Foundation Fieldbus Seminar Malaysia
November 2009

Which tools for which purpose?

Plant life cycle

Commissioning & Troubleshooting

Commissioning should be done one-by-one. There are voices suggesting to connect all instruments and then switch on. However, a fault such as the frequently seen short-to-shield, will be impossible to locate. Connecting devices one-by-one will tell you that the problem occurred at the device you connected last.



Commissioning & troubleshooting tools

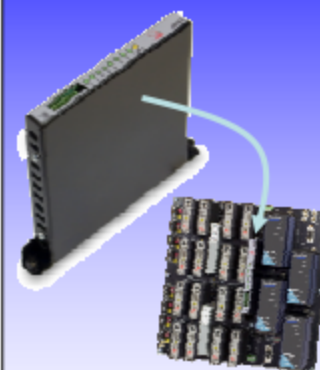
Which tools for which purpose?

Plant life cycle

In large installations with hundreds of bus segments, it can be of help to use physical layer online monitoring (“advanced diagnostics for the physical layer”). Using such tool you can detect degradation in the installation.

There are voices suggesting to use such tool for troubleshooting. However, due to the location of the tool in the control room, accurate measurements are not possible, and some faults are even not detectable (e.g. short to shield on a spur of a fieldbus barrier).

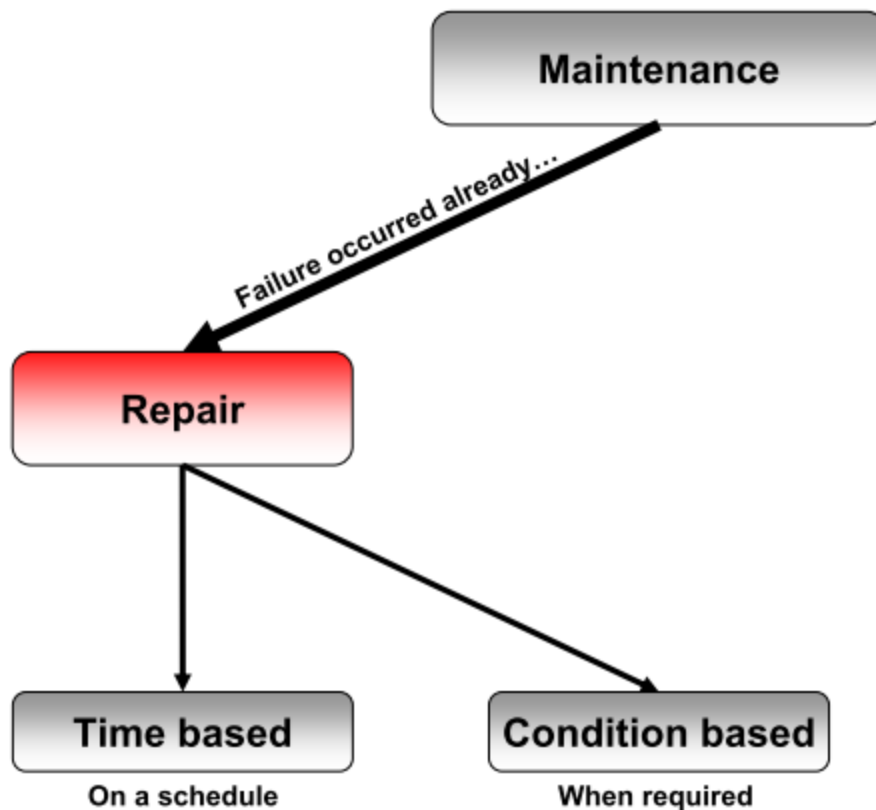
Operation & Maintenance



Predictive Maintenance tools

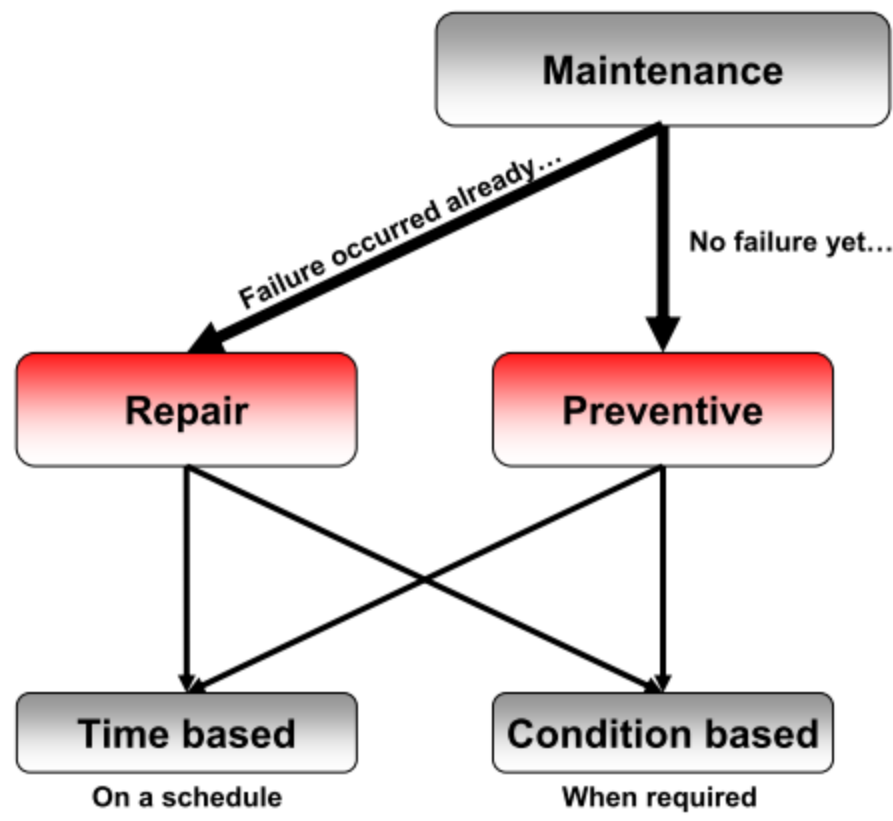
Foundation Fieldbus Seminar Malaysia
November 2009

Maintenance Strategies



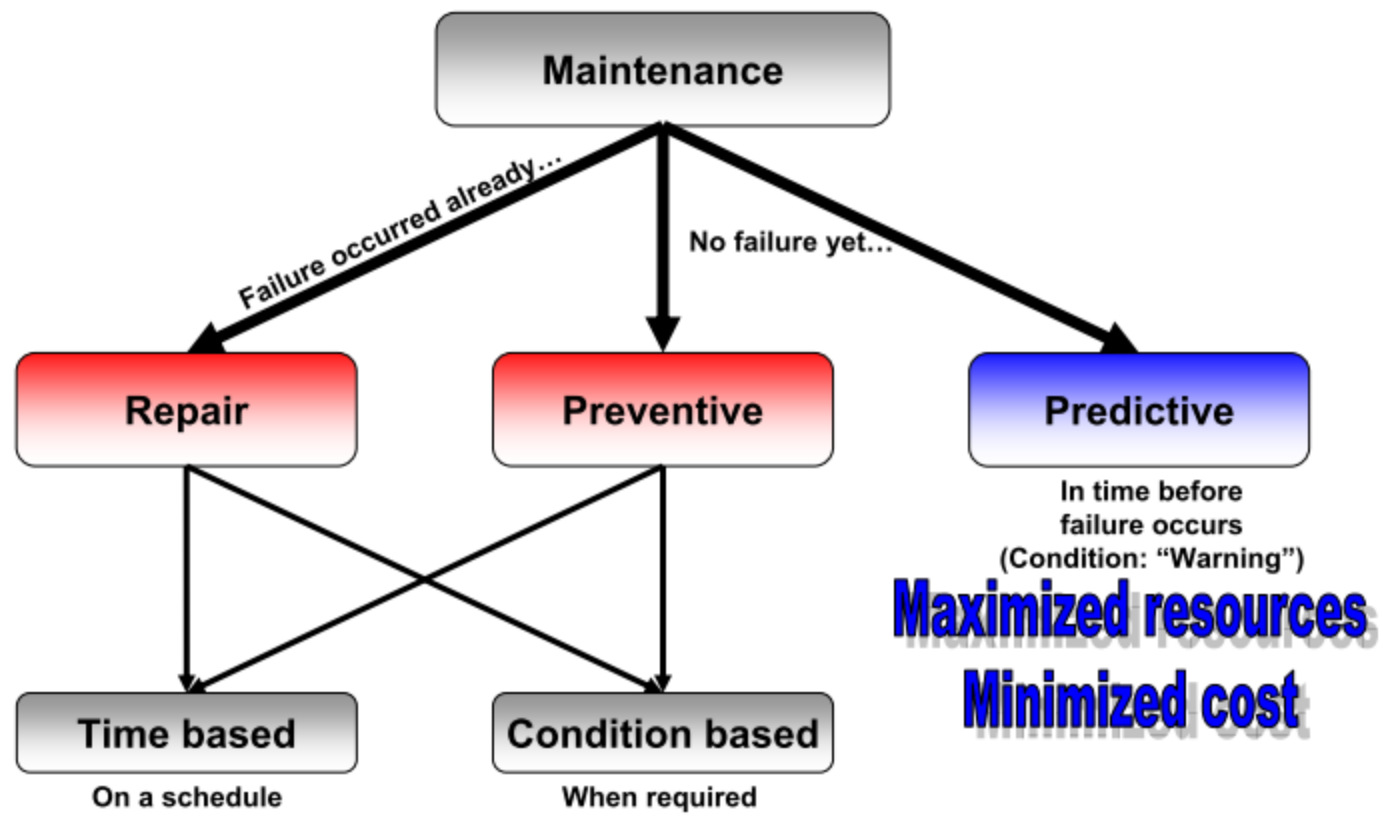
- Failure already occurred
- Failure causes production loss
- **Potentially very high costs**

Maintenance Strategies

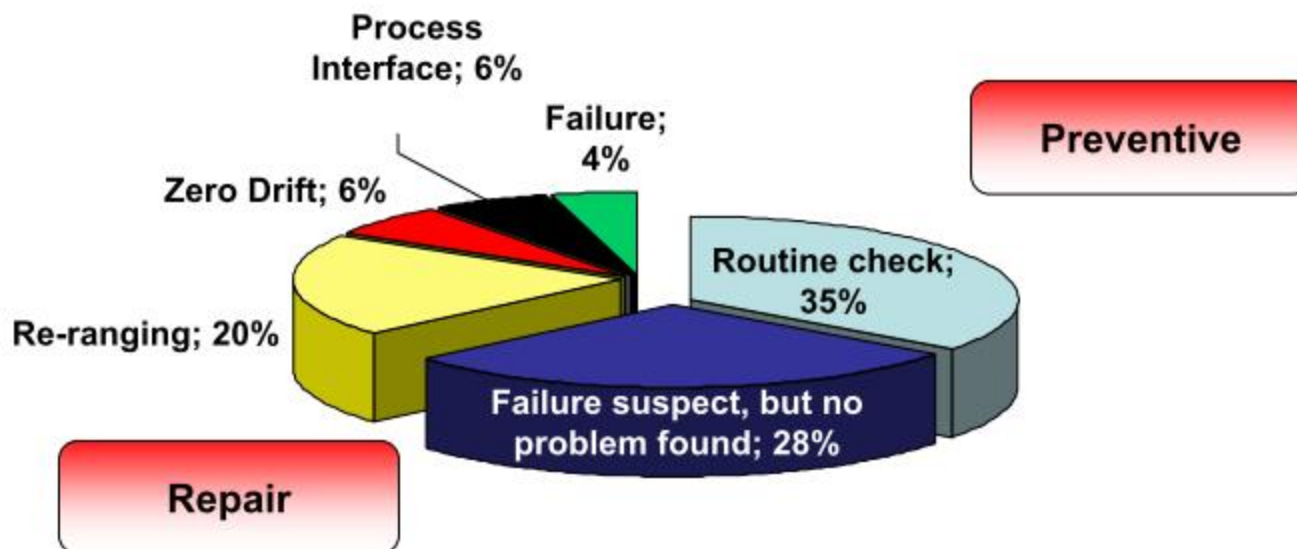


- No failure yet
- **High and regular maintenance costs**

Maintenance Strategies



Device Maintenance Effort

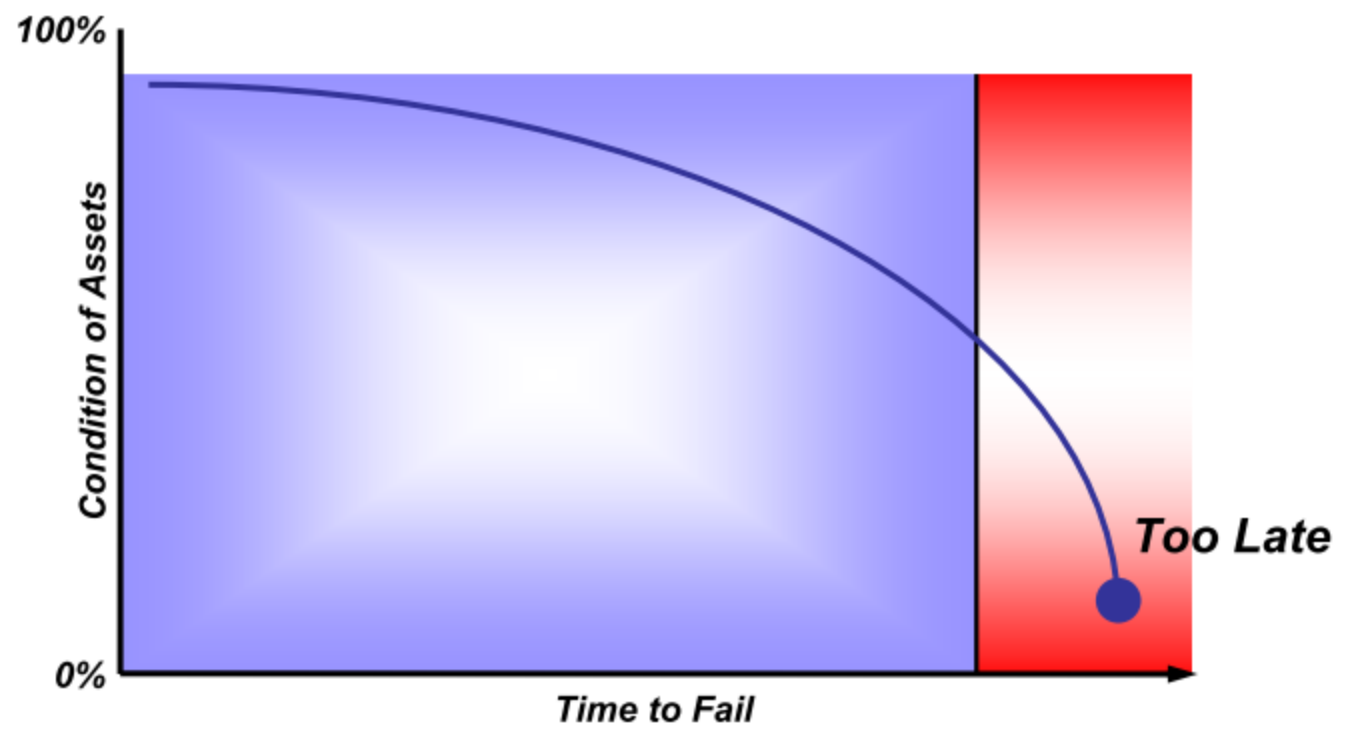


63% of time is spent investigating “problems” that do not exist. On Fieldbus, the **fieldbus diagnostic module** will alert you when maintenance is needed, and will keep quiet if not.

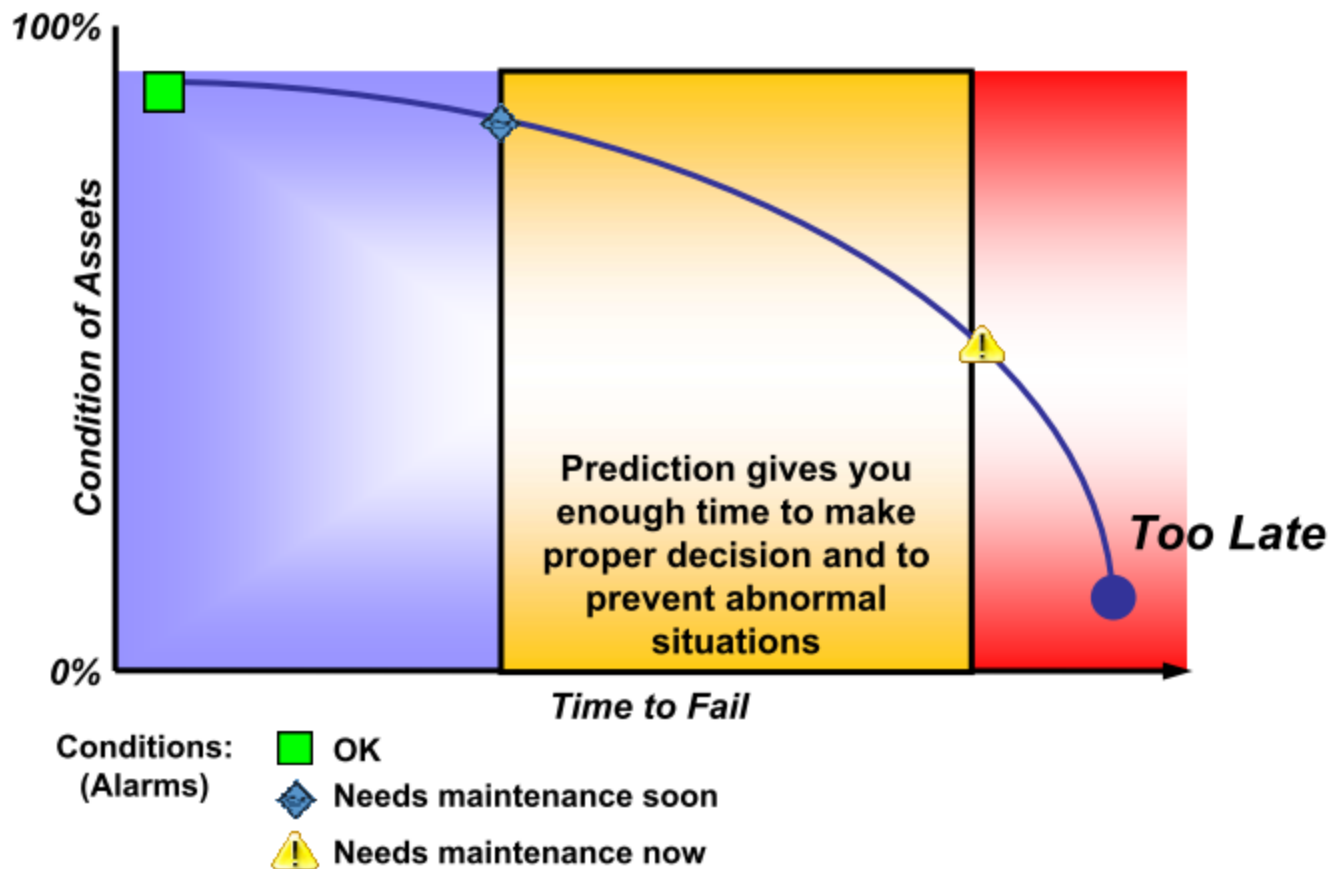
Source: ARC Advisory Group, Intelligent Devices Provide Foundation for Operational Excellence – ARC Strategies, January 2003.

Foundation Fieldbus Seminar Malaysia
November 2009

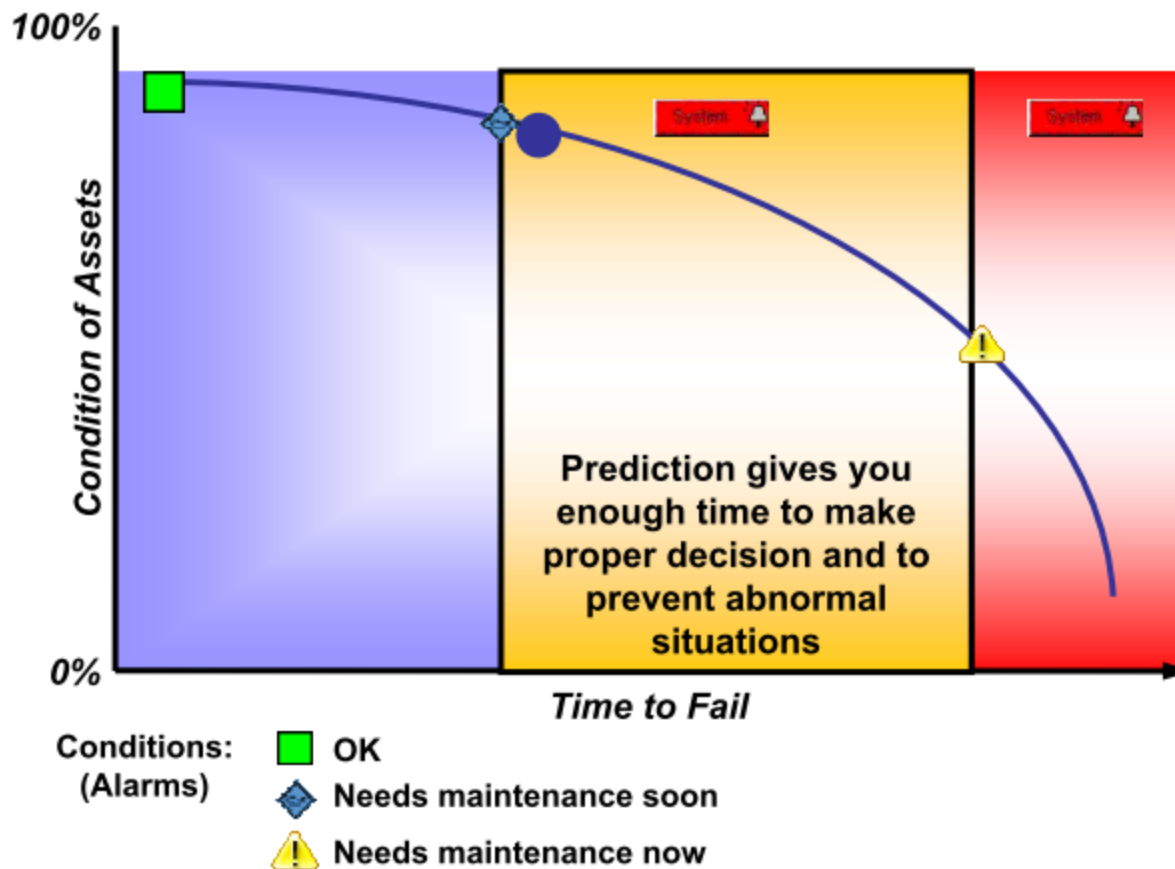
Why Predictive Intelligence?



Why Predictive Intelligence?



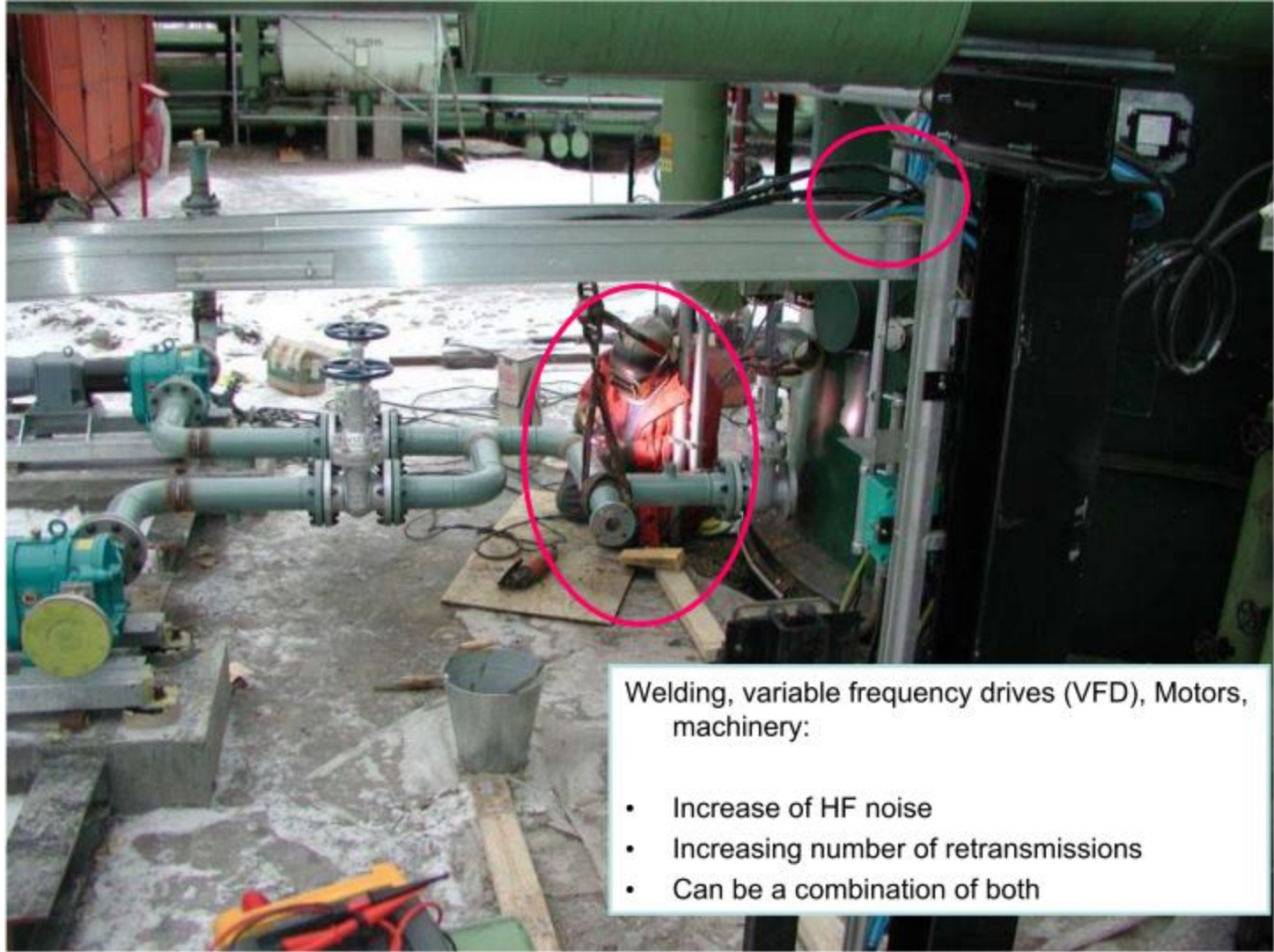
Why Predictive Intelligence?



Examples



Examples



- For more details, refer to:
 - **Fieldbus**, wiki.
 - Fieldbus Foundation™ Bus diagnostics and troubleshooting,
- The lecture is available online at:
- Lecture notes are found at:
 - <http://bu.edu.eg/staff/ahmad.elbanna-courses/12133>
- For inquires, send to:
 - ahmad.elbanna@feng.bu.edu.eg