Myths and Actual Practice with industrial data communications and hazardous areas

Steve Mackay FIE (Aust) Technical Director IDC Technologies

1.0 Introduction

This discussion gives some pointers to applying industrial data communications systems in hazardous areas using standards such as Ethernet, Foundation Fieldbus, Profibus or RS-485. It is hoped that will give some practical guidelines to best practice in designing your next industrial data communications system in a hazardous area.

Most process plants and factories have unique requirements for communication networks that differ from those of a commercial network. Industrial network components must withstand harsher environmental conditions such as extreme temperature ranges, physical stresses, surges and in some cases lightning strikes, electromagnetic interference and hazardous locations

Until about ten years, industrial data communications technology was not accepted by industry for direct control and data acquisition and in many cases not for within hazardous areas. However there has been massive growth in using fieldbus devices and even in transferring control down to the field level (in place of the PLC, for example). And currently there is a vigorous debate about using industrial wireless for transferring of critical data and performing control.

The current driving force behind all the industrial data communications has been Ethernet. Initially scorned as a technology applicable to the automation and process control; but now accepted and used throughout the world. And growing fast. Frost and Sullivan estimate that there is international market growth at a remarkable 50% per year since 2000. But there has been some debate and concern about how best to apply industrial data communications systems within hazardous areas.

This discussion is broken down into the following sections:

- Survey on Global market in intrinsic safety
- Background to industrial data communications
- Hazardous areas practical Guidelines
- Conclusion

2.0 Survey on Global market

As can be seen below (The Industrial Wireless Book - VDC Survey 2006), there has been considerable growth in intrinsic safety devices even in North America. Intrinsically safe devices were thought to be mainly European but not according to this survey. Explosion-proofing and encapsulation – popular in America for hazardous areas protection does not

apply to mobile or wireless devices. Explosion proofing and encapsulation, the North American approach is not easy to apply to mobile devices (eg steel-encased cell phone !) Other results from the survey (not directly covered in the graph below) are that the majority of instruments used in intrinsic safety applications are still Profibus. HART is still the leading bus network for instruments. The highest growth for wireline (9% pa) is in intrinsically safe distributed/remote I/O. The highest growth (35%pa) for wireless are intrinsically safe (wireless) transmitters. And despite Ethernet's penetration, proprietary networks are still dominant for safe monitoring and control components.

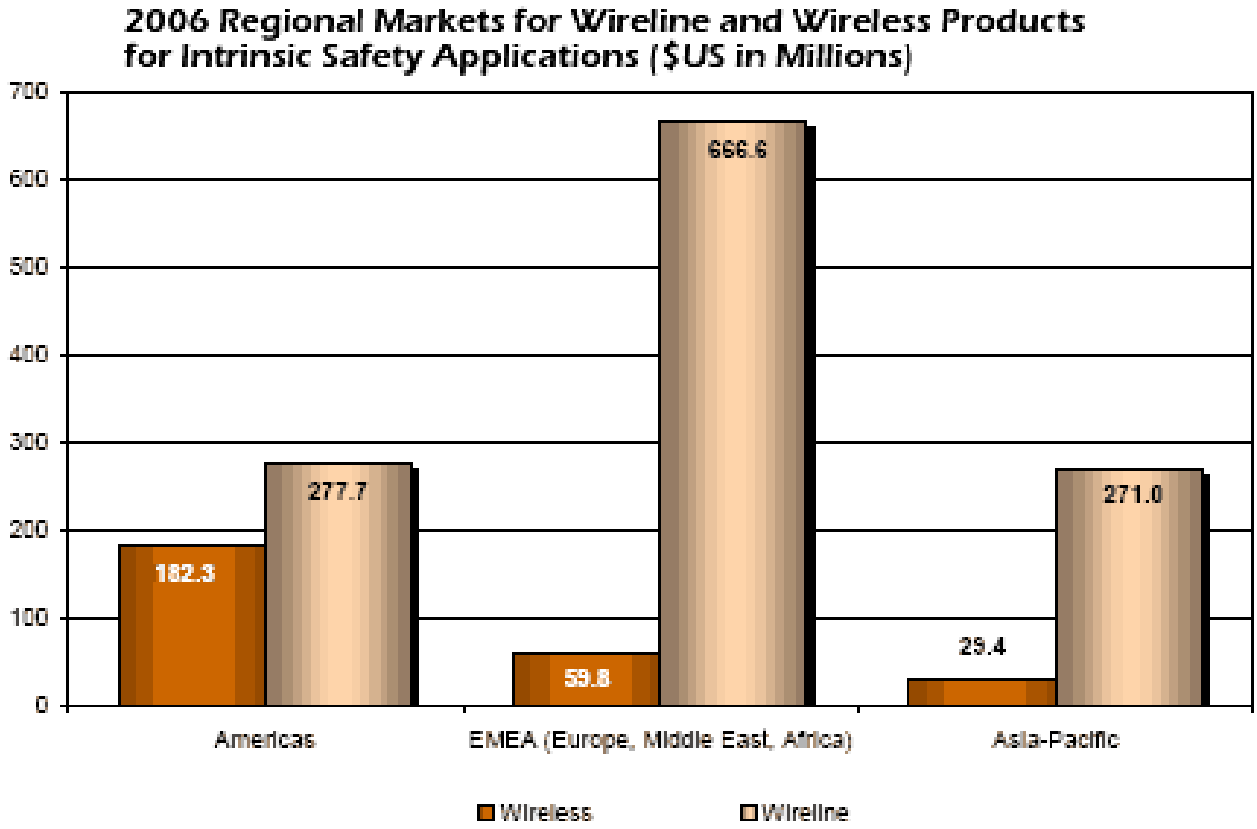

Table 1
Wireline and Wireless Products in Intrinsic Safety applications

3.0 Background to industrial data communications

Before discussing hazardous areas, a brief review and a useful comparison between some of the different industrial communication standards is given below (the red dot indicating the degree of success with a particular characteristic). There is always debate about the "best" standard but for field intelligence, Foundation Fieldbus with its well developed field layer is arguably the best. In terms of straightforward market penetration and affordability, Profibus probably has the edge. Ethernet is certainly the cheapest but doesn't have a good reputation for field intelligence (at this stage).

Bus	Ease	Field Intelligence	Acceptance	Knowledge Base	Price
AS-I	●	○	◎	◎	●
Devicenet	◎	◎	◎	◎	◎
Profibus DP	◎	◎	◎	◎	◎
Profibus PA	○	◎	◎	○	◎
FF	◎	●	◎	◎	◎
HART	●	◎	●	●	◎
Ethernet	●	○	●	●	●

(Compliments of Emerson Process Management)

Table 2
Comparison between different standards

The well canvassed benefits of Fieldbus (and DeviceNet) include:

- Wiring savings
- Hardware savings - fewer devices (instruments barriers and I/O)
- Documentation savings - Simpler layout and drawings
- Reduced Engineering costs
- footprint savings
- Multi-variable field devices
- Interoperability and freedom of choice
- Reduced Commissioning and startup costs
- Reduced downtime
- Integrity improved
- DCS future capacity savings

A typical layout of a Foundation Fieldbus installation is given in the figure below.

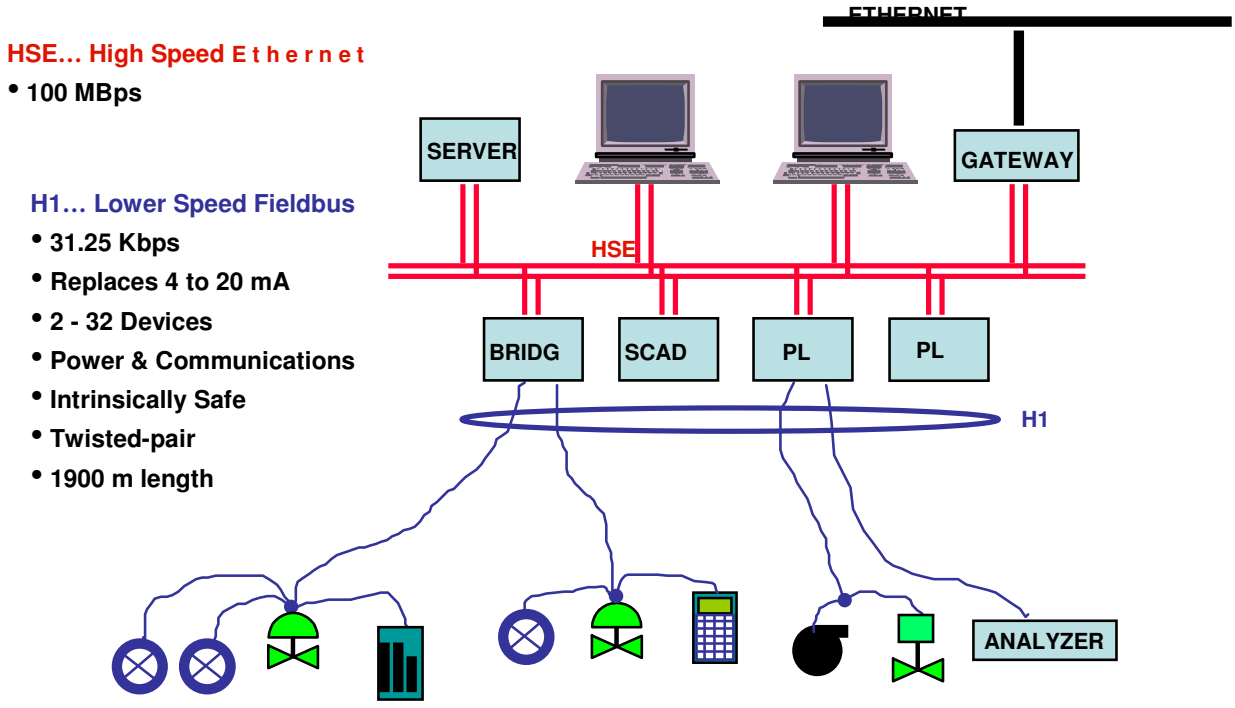

Figure 1
Typical Foundation Fieldbus Installation

The standard which has been lurking in every Fieldbus closet has been Ethernet. Ethernet was based on 10BaseT which operated at 10Mbit/second over twisted pair cable. The next variation was Fast Ethernet (100BaseT for copper cables and 100Base-FX for fibre optic cables). Gigabit Ethernet operating at 1Gigabit/sec (1000Base-T for copper, 1000Base-SX or LX for fibre optic cables) is very popular. 10Gigabit/sec (10GBase) is the latest commercial release with very little evidence in 2006/7 at present.

There are three media that are used with Ethernet:

- Copper
- Fibre Optics
- Wireless

Figure 2 gives an idea of the penetration of Ethernet from the high level back office all the way down to the shop floor. At this stage, Ethernet is not used much with instruments on the shop floor.

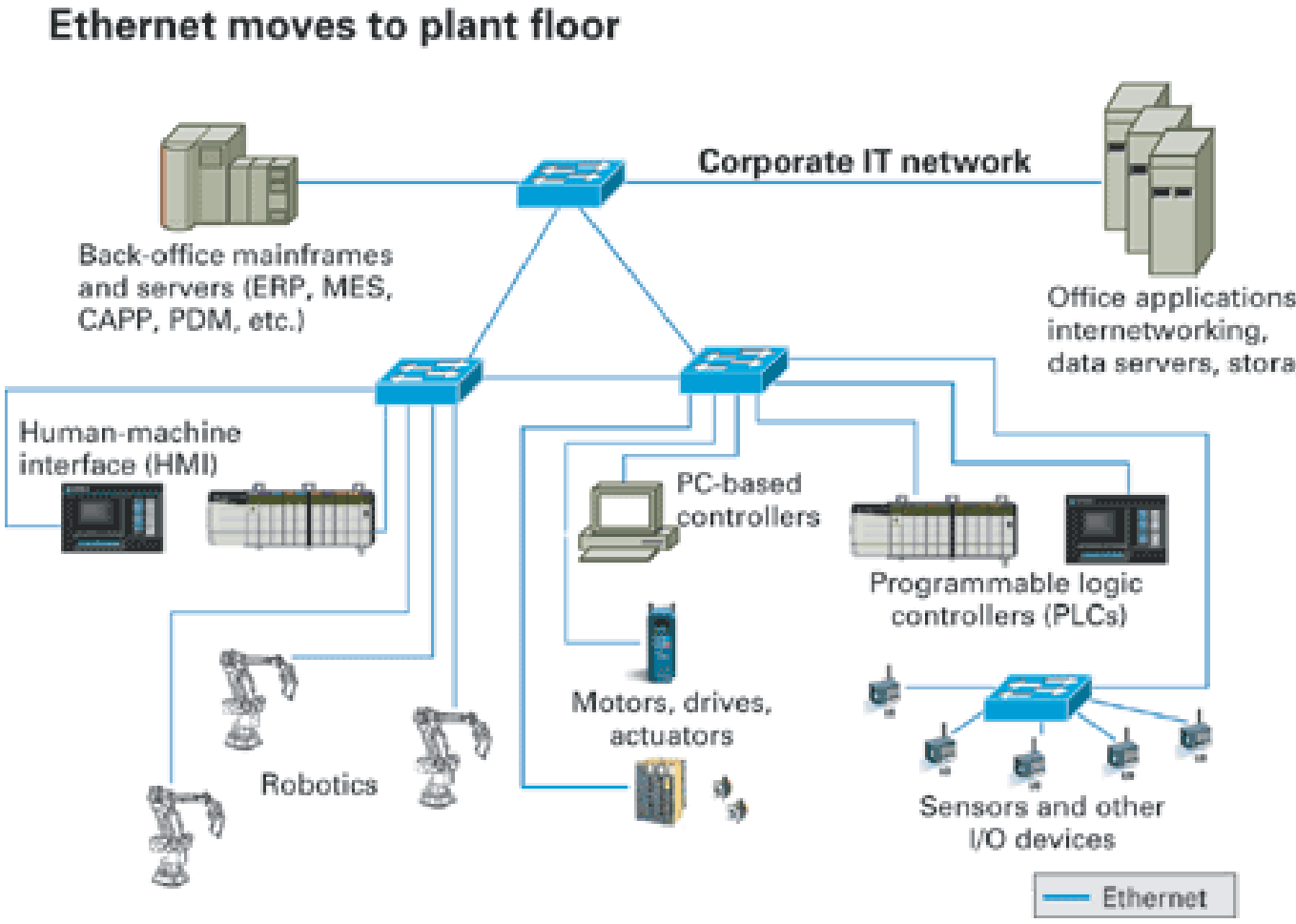

Figure 2
Typical Ethernet Layout
(courtesy of ISA)

4.0 Hazardous areas practical guidelines

Before we discuss how the various industrial data communications technologies are used in hazardous areas, a few words on the various methods. These include: Explosion proof, purging, oil immersion, encapsulation, intrinsically safe and non incendive. The underlying principle is to eliminate one of the three parts of the combustion triangle: fuel/oxygen and heat

A brief review of the different approaches are:

Intrinsic Safety

The premise of intrinsic safety is to keep the energy to well below that which would ignite an explosive atmosphere. It is normally associated with 4-20mA signals and standards such as Profibus PA, Foundation Fieldbus H1.

A summary of the various buses as far as intrinsic safety support is given in the table below.

Name of Bus	Intrinsic Safety	Bus powered
FF H1	√	√
FF HSE & Ethernet		
Profibus DP		
Profibus PA	√	√
ASi		√
Ethernet PoE		√
LONWORKS	√	√
CAN		
HART	√	√

Unfortunately it does limit the maximum specified distances over which one can run the cables.

Flameproof enclosures

This is one of the oldest methods of protection against explosions. The impact of a potential explosion is limited to a well constructed enclosure in which the equipment is placed. Special tested bushings are required to allow satisfactory cable entry for Ethernet. Products are available for this but one is limited to a maximum of 100m of Ethernet cable and the installation of a bushing is complex.

Flameproof Ex d connectors

There are some connector systems which can be used in hazardous areas and some of them even are suitable for a hot plug application without intrinsic safety protection. Cable distance is still a limiting feature.

Fibre Optic cable

Fibre optic cable can extend the distance of operation from 100m for copper to 2000 m depending on the type of fibre. However unfortunately even light can cause an explosion and due care has to be taken. There are three types of protection defined in IEC60079-28 standard:

- Inherently safe optical radiation “op is”
- Protected optical radiation “op pr”
- Optical system with interlock “op sh”

In comparing fibre to twisted pair, it should be noted that harsher environmental conditions such as extreme temperature ranges, lightning strikes, electromagnetic interference, ground loops and hazardous locations are easily handled by fibre.

Fibre is a good choice for hazardous areas but there are few disadvantages:

- It costs more
- Bend radiuses can be problem
- Twisted pair can be impervious to certain types of noise

As indicated earlier the advantages are significant and include:

- Impervious to noise and lightning
- No ground loops
- Security of data better
- Longer distances (2kms)

Note that when using either fibre or twisted pair cabling, give serious consideration to a cable jacket for weld splatter, moisture and UV.

Wireless

At the time of writing there is no international standard available that deals with explosion protection for radio frequency signals. But it will be added to the IEC60079-0 Ed.5. Obviously explosion proofing and encapsulation (the North American approach) is not easy to apply to mobile devices (eg steel-encased cell phone !). Wireless intrinsically safe transmitters can be particularly cost-effective for remote monitoring

Some of the key issues to weigh up when installing a industrial data communications system in a hazardous area are:

- Area classification
- Size and Scalability
- Technology/product selection
- Safety consideration
- Maintenance and downtime
- Engineering considerations
- Control System considerations
- Acceptance and ownership
- Calibration

5.0 Conclusion

There is no doubt that Foundation Fieldbus H1 and Profibus PA are appropriate for instrument level hazardous areas. However Ethernet with fibre works well for high level communications in hazardous areas and is growing rapidly in importance. Industrial wireless is growing fast but has some unpredictability in terms of application for control and reliability. And the author believes (admittedly subjectively !) that this is going to be the horse to back over the next few years as a replacement for many cable based applications in hazardous areas.

References

Implementing Foundation Fieldbus H1 Networks in Hazardous Areas by MooreHawke from www.miinet.com/moorehawke

Network Infrastructure for EtherNet/IP: Introduction and Considerations by ODVA from www.odva.org

Intrinsically Safe Foundation Fieldbus H1 Networks by Bruce Bradley November 2006 from www.Controlglobal.com

Industrial Ethernet solutions under the spotlight by Lars Larsson Siemens AB from www.ferret.com.au/articles

Economic Fieldbus Solutions for Hazardous Area installations by Jonas Berge in Instrumentation and Control Society, Singapore

Global Markets for Wireline and Wireless Intrinsically safe Devices and Equipment by James K. Taylor and Tracey Tranen of Venture Development Corporation from www.vdc-corp.com

Iceweb resources by Jim Russell and Ian Verhappen from www.iceweb.com.au

Industrial Ethernet goes Process Automation..and what about explosion protection by Andre Fritsch at 4th Petroleum and Chemical Industry conference Europe – Electrical and Instrumentation Applications June 13-15, 2007 Paris, France.

Every year from their headquarters in Perth, IDC Technologies provides practical training workshops to tens of thousands of engineers and technicians throughout the world. Visit us at our web site at www.idc-online.com to download further useful information.