

INDUSTRIAL NETWORKS: OVERVIEW AND SELECTION CRITERIA

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Industrial networks have been used with great success for about two decades, addressing the many shortcomings of discretely wired automation systems. Ever since the shift-register based INTERBUS-S was introduced in 1987 users demanded new functionalities and features, driving the engineering departments at automation equipment suppliers to come up with increasingly more capable solutions. During the *network-war* of the late 90's many solutions disappeared and today only a few more or less open networks are still in the race.

Years before INTERBUS-S changed the way automation professionals designed their systems, Xerox PARC (Palo Alto Research Center) developed a powerful networking solution that was quickly adopted in office environments: Ethernet¹.

Over the last 5 years the number of serious industrial networking solutions has shrunk, and today most factories and production lines run on one of the following: PROFIBUS, DeviceNet, ModBus², CC-Link and AS-Interface. Among those networks, the open standard AS-Interface solution is unique because:

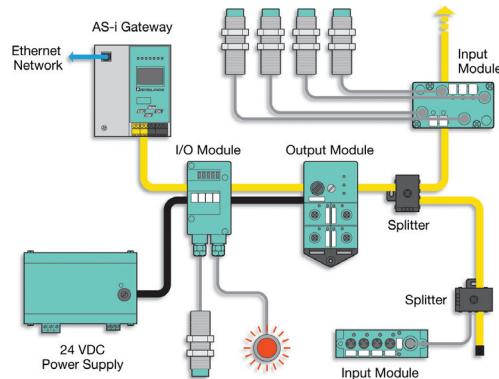
- AS-Interface is a low level solution designed and optimized for the efficient transmission of sensor and actuator data. I/O nodes are small and inexpensive, allowing solution providers to develop highly distributed I/O systems, minimizing the total cable cost (i.e. network cable plus all sensor-to-I/O node cables.) Furthermore, the installation technology developed for this network reduces installation and commissioning time as much as possible.
- AS-Interface is the only truly independent solution with regards to other networks. Gateways to virtually any industrial network, not just the ones mentioned above, can be purchased. (AS-International, the open member organization that owns and manages the technical specification of AS-Interface is not part of any other organization promoting another networking technology.)
- AS-Interface is the only network where technological modifications are not dictated and dominated by a PLC manufacturer. As a consequence backplane scanner cards for all major PLCs are available. The reason is that AS-International was founded by a consortium of 11 industrial automation suppliers working jointly on the development of the technology. Virtually all other networks have been developed by a PLC manufacturer to address their needs first.
- AS-Interface does not compete with or attempt to replace any of the traditional upper level networks but rather enables users to utilize them to their full potential, by increasing data transmission efficiency, addressing installation shortcomings like topology limitations, inflexible I/O distribution and high cost of the physical media including cable, taps and terminators. Complex devices (RFID systems, drives, HMIs, etc.) are still good candidates for these upper level networks.

1. *Ethernet was originally developed as one of the many pioneering projects at Xerox PARC. Ethernet was invented in the period of 1973–1975. Robert Metcalfe and David Boggs wrote and presented their “Draft Ethernet Overview” some time before March 1974. Source: Wikipedia*

2. *Including ModBus+*

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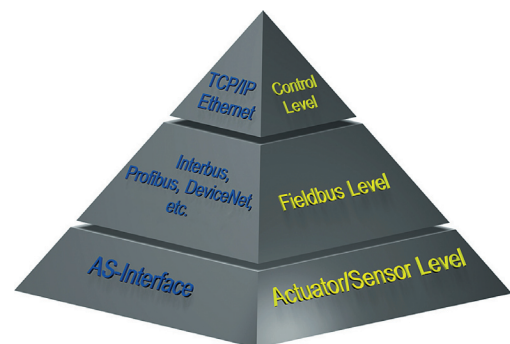
- AS-Interface enables users to network safety devices at up to Category 4, while still transmitting standard, non-safe data over the same network.



Today the list of plant network solutions has gotten a bit longer. Industrial Ethernet-based solutions are gaining popularity and acceptance and are already preferred by many engineers for their automation applications. The reason is simple - communication over Ethernet allows device manufacturers to add previously impossible features. These features make working with Ethernet-based devices easy and convenient while providing plant personnel the tools they need to increase overall machine uptime and availability. Integrated web servers simplify diagnostics and configuration, fault notifications can be sent via e-mail, and the ability to easily route data to the PLC and a monitoring application running on a PC, are just a few of the most significant advantages. No wonder that Ethernet solutions are used increasingly to replace networks like PROFIBUS, DeviceNet and others.

That said, users should note that the development of any AS-Interface based I/O structure does not change when transitioning from one of the traditional networking solutions to a modern Ethernet-based top level architecture. This is important to know since users may not currently be able to purchase every complex device they need with a connection to Ethernet, and must therefore use the traditional solutions in the interim. By connecting simple devices like sensors and actuators to AS-Interface, the time and engineering effort invested in the low level I/O structure is protected. Going from one network (e.g. DeviceNet) to another (e.g. EtherNet/IP) is effortless. In addition, the performance of the upper level network is significantly improved, with utilization efficiency increases of approximately 10 when AS-Interface is used to consolidate I/O.

With AS-Interface utilized at the I/O level, selecting the correct upper level network for an application becomes much simpler and safer. Since these networks are heavily influenced by certain PLC manufacturers, selecting the PLC effectively selects the network. Table (1) shows the preferred networks supported by some of the major PLC manufacturers.



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While most of them support an Ethernet solution, this does not mean that they are compatible. The reason is that “Ethernet” by itself does not fully define a communication procedure.

Users must get used to talking about the specific Ethernet protocol they intend to use. For instance, Modbus/TCP is an Ethernet-based protocol that is not compatible with EtherNet/IP. Even though both utilize standard Ethernet frames and employ TCP as the data transport mechanism, they do not share a common application layer and thus can not exchange information. Some manufactures address this dilemma at the PLC level by designing devices that simultaneously implement several Ethernet protocols. One such device is IDENT Control from Pepperl+Fuchs, an RFID system that supports four different Ethernet protocols: Modbus/TCP, EtherNet/IP, PROFINET and serial stream over TCP/IP.

In summary, selecting a network for complex devices is primarily driven by the PLC to be used. Using AS-Interface at the I/O level removes all uncertainty with respect to the network used for complex devices. The flexible gateway approach completely shields the user from any changes that occur at the I/O level, and allows engineered solutions, including control drawings, to be reused as new networks and network protocols become available.

With a growing number of the players offering Ethernet-based solutions, users have an increasing number of hardware options. And because device manufactures can implement many Ethernet protocols on the same hardware (by adding additional software stacks) it will be faster and much less costly to develop for multiple markets dominated by different PLC’s. In the past a DeviceNet solution was just that; communicating on DeviceNet. If PROFIBUS was subsequently needed, new hardware and software had to be designed - a costly proposition considering the added engineering time, approvals and long term cost due to increased total stocking quantities. With all that in mind AS-Interface combined with Ethernet may very well be the winning combination for the future.

PLC Manufacturer	Preferred traditional network	Preferred Ethernet network
Allen-Bradley	DeviceNet	EtherNet/IP
Siemens	PROFIBUS	PROFINET
Schneider	ModBus	Modbus/TCP
Mitsubishi	CC-Link	No preferred network

Table 1

Table: Most PLC manufactures prefer one upper level network. This means that device manufactures have to support a large number of different hardware devices, each of which adds engineering cost for hardware and software. At the Ethernet level the situation is less complex. It is possible to design a single piece of hardware that implements a variety of different Ethernet protocols. AS-Interface gateways to each of those networks (traditional and Ethernet based) are available today, protecting the I/O level engineering effort is easy.