IDA - Ethernet based Realtime LAN for Automation Applications

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Abstract

IT- and automation technologies come more and more together. Ethernet TCP/IP could seen as one of the basic technology in this context. The reason is, that communication is one of the most important area in the automation market. Devices are getting smaller and they include there own intelligence. Now its the discovery to create a network that could be handled by the application engineers and the service engineers. In the fieldbus world this is a real problem, because of the hierarchical automation pyramid.
Distributed intelligence is the way to fold up this hierarchical pyramid. Distributed intelligence means a free communication between all automation devices. Every information is in Real-Time available for every other device. So the application engineer must not write any line of program code for the communication between the different devices. All this will be done by the system based on distributed intelligence. Interface for Distributed Automation (IDA) is a standard for distributed intelligence in automation. One of the main part is the Real-Time communication over Ethernet TCP/IP.

Motivation

The traditional programmable logic controller known as PLC is a combination of a central processing unit with centralized peripheral modules with a less or more simple structure.

The arrival of fieldbusses has led to migration of these modules to the sensors and actors installed in the field.

The driving force behind this development was to reduce planning and installation costs of extensive parallel wiring with its costly interface levels.

Technological and functional modules have shaped up due to production's growing demands in terms of quality and quantity with ever-increasing complexity of manufacturing processes.
Robots, bonding and welding controllers, closed-loop process controls as well as drive control systems have turned into intelligent peripheral modules linked with the fieldbus.
These modules are able to execute independent operations autonomously. However, their operation needs to be coordinated within the PLC program.

Due to the growing interlinkage of control systems and, at the same time, the wish to have transparent production processes regarding flexibility, quality data and plant diagnostics, the classical PLC, which was originally autonomous, became the central point of networked plant structures.

This structure symbolizes the principal problem of current automation solutions.
The central position of the PLC requires that in the control program not only operating and control sequences of machines or plants have to be programmed, but also communication with lower-level functional and technological modules, as well as communication with interlinked control systems and connection to the plant management level.
In complex automation structures, the proportion of these administrative tasks in no time can exceed the proportion of the machine control itself which results, for the total service life of a plant, in higher and higher expenses of engineering of more and more complex and confusing application programs.

Drastic reduction in engineering costs and at the same time quality's improvement in the field of application software are top priority in the next developing cycle in automation technology.
In this respect, plans for modular machines are being discussed with ever-increasing intensity. The latter are planned to enable as a modular system to meet individual customers' demands effectively and immediately by configuring standardized and coordinated modules and components.
Components that are ready for use can be integrated into the modular system. This approach facilitates their reuse either in the same or in other applications.

IDA'S basic element: the automation module

The basic element of the module based automation system defined by IDA is the automation module. It is an application-neutral top-quality system module representing a complete function which can be used to solve one or several automation problems without requiring any modification.
Plant engineering using IDA's module based automation system enables already completed automation solutions to be reused since all functions are enclosed in application-neutral automation modules. Therefore, they can be used independently of any specific context.
Since automation modules not only include pure automation technology, it is possible to commission units and sections of machines irrespective of the order, and, thus, significantly reduce throughput time of the complete order thanks to parallel fabrication and prefabrication of units.

Moreover, re-use of an automation module facilitates the import of the entire know-how with regard to this module tested in various application areas into a new automation solution, thus, improving quality and reliability from the beginning. This approach increases maintainability and reduces downtime of a machine or plant at any stage of its lifetime.

Transparent Communication

The IDA communication model is based on an integrated approach containing the following: modeling of communication aspects and network view of the functionality.
IDA device communication is based on existing Ethernet communication standards and protocols, such as IP, UDP, TCP, HTTP, FTP, SNMP, DHCP,NTP and SMTP. The IDA communication system provides realtime as well as non-realtime communication services.
On the whole, non-realtime services are based on the above mentioned Ethernet communication protocols.
Realtime capable communication services (e.g. data distribution, RMI, event notification) use the RTPS (Real-Time Publish/Subscribe)protocol which is based on the UDP protocol. To configure and execute realtime capable communication services, IDA specifies an object-oriented model which builds up a hierarchy of communication objects accessible through IDA-API(Application Programm Interface).
Moreover, IDA–API provides specific support for applications important to safety.

Real-time Communication Services

The IDA real-time communication is based on the use of the RTPS-Protocol (Real-Time Publish/Subscribe). The RTPS protocol and the middleware are built on top of the UDP protocol.
Real-time services generally have the highest priority of all IDA communication services. Depending on the requirements of the application, real-time communication relationships and the associated network traffic may be

- preconfigured or dynamic,
- cyclic or on-demand,
- best effort or reliable,
- point-to-point or group-oriented,

Fortunately the offer can be reduced to four types of API services covering the reasonable combinations.

Data Distribution Services are based on a publish / subscribe mechanism provided by the middleware. The term Data Distribution refers to the fact that in each issue the value of an IDA type-defined application data object is published according to the following criteria:

- The application is interested in using the most recent data values only.
- Data transfer is frequent and usually cyclic. Loss of an issue will therefore be mended in the next cycle.
- Bandwidth use is to be minimized.
- Data transfer must be fast.

Event Notification Services are based on the reliable publish / subscribe mechanism provided by the middleware. The term reliable refers to the following criteria:

- The application is interested in transferring each change in the related data value.
- Data transfer is usually not cyclic. Loss of issues is not permitted.
- In-sequence delivery of issues is required.
- Queuing of issues is required to be able to handle bursts and to allow for re-sending of lost issues.
- Bandwidth use is less important than guaranteed delivery.
- Data transfer must be acknowledged on the RTPS level.
- Data size may be nil (i.e. if the event is just used for triggering).

Remote Method Invocation bases on a reliable client/server mechanism provided by the middleware. The term client/server refers to the following criteria:

- Inherently, the relationship is based on a transaction-oriented point-to-point mechanism.

- The application is interested in having a guaranteed transaction on the network and also a guaranteed response on the application layer.
- Data transfer is usually not cyclic. Loss of issues is not permitted.
- Data transfer must be acknowledged on the RTPS level.
- Queuing of issues is required to be able to handle bursts and to allow for re-sending of lost issues.
- Delivery of requests and responses should be in-sequence.
- Bandwidth use is less important than guaranteed delivery.
- IDA communication management objects are employed which are capable of
- establishing connections dynamically at runtime
- evaluating access paths and resolving them into references to IDA Method objects
- performing execution thread instantiation and access control

These tasks are performed by the IDA Method Client and the IDA Method Server objects.

On-demand Data Exchange Service at runtime is based on the invocation of specific methods which are IDA standard. The Get method allows to read a single attribute as well as the whole data set belonging to an IDA Data object. The term on-demand refers to the fact that most parameters are set up dynamically at runtime depending on the requirements of the involved application components at a specific point in time. As a consequence, additional IDA communication management objects must be employed which are capable of

- establishing connections dynamically at runtime
- evaluating access paths and resolving them into references to IDA Data objects
- performing data access control

The IDA Method Server is optimized for the resolution of Get and Set method calls.

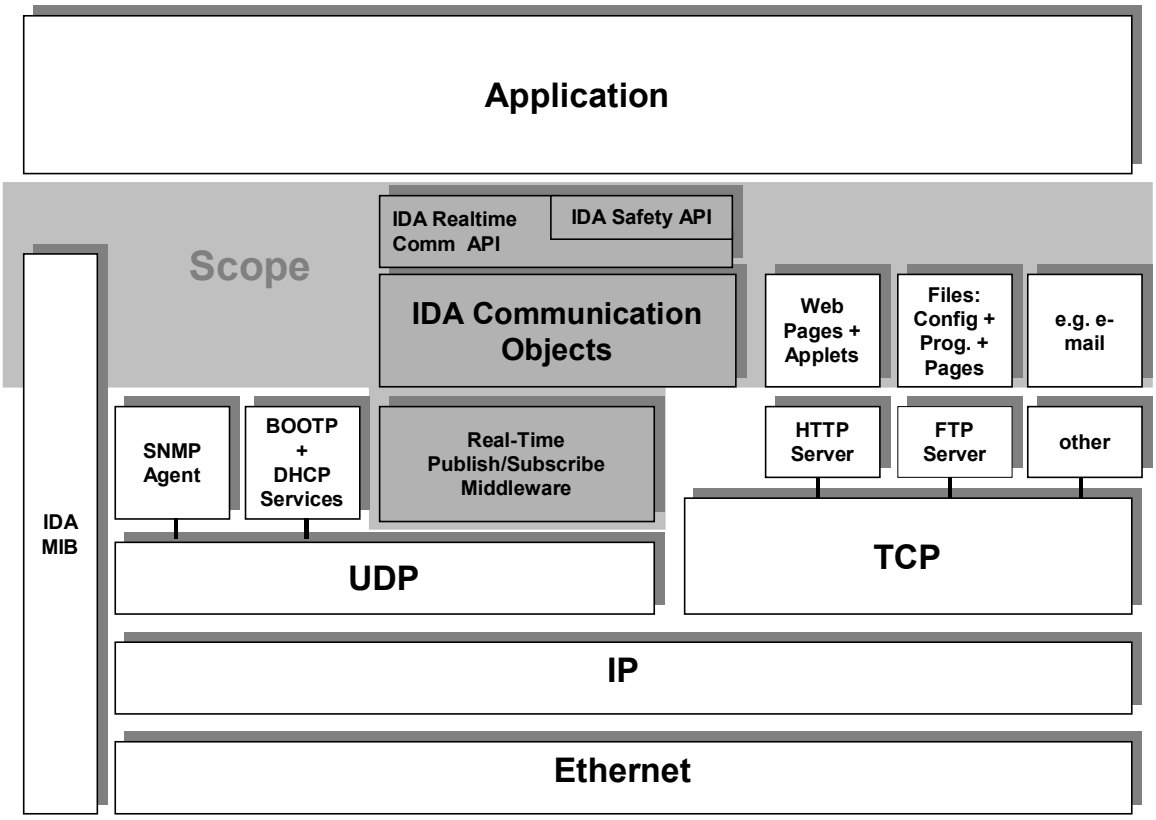

Figure 1: IDA Communication Architecture