INTERNATIONAL SEVEN JOURNAL OF MULTIDISCIPLINARY
ISSN: 2764-9547

INTERCONNECTIVITY: DATA NETWORK PLANNING, ONE OF THE BASES OF INDUSTRY 4.0

INTERCONECTIVIDADE: PLANEJAMENTO DE REDES DE DADOS, UMA DAS BASES DA INDÚSTRIA 4.0

INTERCONECTIVIDAD: PLANEACIÓN DE REDES DE DATOS, UNA DE LAS BASES DE INDUSTRIA 4.0

https://doi.org/10.56238/isevmjv4n4-036

Data de submissão: 07/28/2025 **Data de publicação:** 08/28/2025

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ABSTRACT
The German government proposes a new industrial era like Industry 4.0. Hyperconnectivity is a defining characteristic of the new era. The current and future technological advances should allow the creation of a convergent network that meets all the information needs of Industry 4.0. Convergent networks or multi-service networks refer to the integration of digital voice, data and video services through communication networks in a single network based on IP (Internet Protocol) as a network level protocol. This article presents a project methodology for network structures for interconnectivity in Industry 4.0.

Keywords: Industry 4.0. Connectivity. Communications Network.

RESUMO
O governo alemão propôs a nova era industrial como Indústria 4.0. A hiperconectividade é uma característica definidora dessa nova era. Os meios tecnológicos atuais e futuros devem permitir a criação de uma rede convergente que atenda a todas as necessidades de informação da Indústria 4.0. Redes convergentes ou redes multisserviços referem-se à integração de serviços digitais de voz, dados e vídeo por meio de redes de comunicação em uma única rede baseada em IP (Protocolo de Internet) como protocolo de nível de rede. Este artigo apresenta a metodologia de projeto para estruturas de rede para interconectividade na Indústria 4.0.

Palavras-chave: Indústria 4.0. Conectividade. Rede de Comunicações.

RESUMEN
El nuevo avance en las eras industriales ha sido propuesto por el gobierno alemán como Industria 4.0. Las hiperconectividad es una característica por lo que se distingue este nueva era, los medios tecnológicos actuales y futuros deben de permitir crear una red convergente que solvente todas las necesidades de información de Industria 4.0. Las

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redes convergentes o redes multiservicio hacen referencia a la integración de los servicios digitales de voz, datos y video sobre redes de comunicación sobre una sola red basada en IP (Protocolo de Internet) como protocolo de nivel de red. En este artículo se presentan la metodología de proyectos para estructuras de redes para la interconectividad en la Industria 4.0

Palabras clave: Industria 4.0. Conectividad. Red de Comunicaciones.

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1 INTRODUCTION

The speed with which technological changes advance increases the need for companies to share the information that these changes produce, for this reason, the installation of robust and flexible communications networks, which make this data flow to all the places in the company where it is required, becomes a daily necessity for continuous growth. Companies are constantly adding users and connecting new areas, which is not only a source of pressure for those in charge of this task, but also a possible cause of problems. A primary advantage of structured cabling is isolation from problems. By dividing the total infrastructure into separate management blocks, it's much easier to troubleshoot any issues that may arise with minimal hassle to users of the entire network. A structured use of cabling helps to reduce maintenance costs in the same way (López, 2004).

For organizations today, traditional structures are beginning to be unproductive and they are beginning to adopt new structures, leaving aside hierarchies to begin to form a more dynamic, flexible and innovative work group all in search of satisfying the needs of customers or target audiences (Duarte, 2015).

Industrial communications are those that allow the flow of information from the controller to the different devices throughout the production process; detectors, actuators, sensors, among others. Given the wide variety of communication systems between industrial equipment, most of which are closed, it has been decided to develop an environment that allows both the implementation of protocols of known specifications in a complete communication system, from the physical medium to the highest level of the network. One of the main trends in today's industrial environment is the migration to open and fully specialized automated systems. Undoubtedly, one of the main factors that has driven this growing trend has been the introduction of Ethernet in the industrial environment (Salazar & Correa, 2011).

There is a great deal of interest in wireless network research and development. In networked control systems, for example, there is great interest in the development of wireless technology as a potential replacement for current generations of industrial wired networks. Current wired technologies present difficulties in certain environments such as the petrochemical industry and where mobile and portable devices are used (Monsalve, Arias, & Mejía, 2015). Therefore, it is necessary to solve these intercommunication

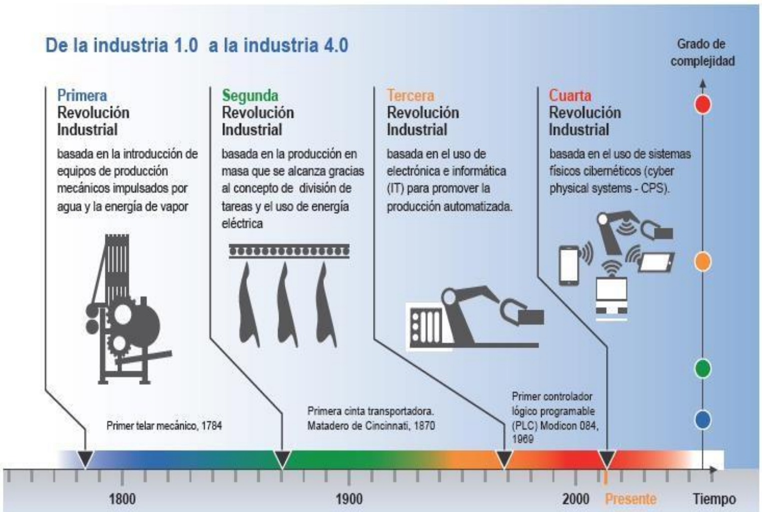
INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

problems for the new generations of technological devices that are proposed for a fourth industrial era known as Industry 4.0.

The term Industry 4.0 arises as a reference to what is considered to be the fourth industrial revolution, arising from the digitalization and extreme interconnection of productive activity. According to the promoters of this movement, the first industrial revolution arose at the end of the eighteenth century as a result of the introduction in the manufacturing industry of mechanical equipment powered by steam engines. The second industrial revolution began at the beginning of the twentieth century, supported by electricity and characterized by the mass production of goods. The third revolution, which began in the early 70s and continues to the present day, uses electronics and information technologies to increase the automation of manufacturing processes.

Figure 1

From Industry 1.0 to Industry 4.0



Source: (Engineers Ireland, 2016).

The fourth revolution, which is therefore called Industry 4.0, and which, unlike the previous ones, is more of an a priori announcement than the confirmation of something already achieved (Navarro & Sabalza, 2016), would essentially consist of "the technical integration of cyber-physical systems in manufacturing and logistics and in the use of the internet in industrial processes" (Kagermann, Wolfgang, & Johannes, 2013).

The goal of Industry 4.0 is to connect and integrate traditional industries, particularly manufacturing, to achieve flexibility, adaptability, and efficiency and to increase effective communication between producers and consumers (Li, Li, Wan, &

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Athanasios, 2015). One of the challenges of this era is transport, storage and processing the amount of data generated by all stages of the industry as expected. Adding to this the multiplication of devices that require connection to this information network.

Industry 4.0 is marked by a technical integration of cyber-physical systems in manufacturing and logistics processes as well as the use of the Internet of Things (IoT) and services in industrial processes. New technologies will have various impacts on the creation of value, work organization, secondary services and business models of companies. At the forefront of all Industry 4.0 developments, the concept of smart manufacturing plays a significant role in organizing the vision of a new industrial age. In literature and scientific journals, experts mention a complete paradigm shift in manufacturing. It is said that decentralized, self-organized, and flexible production will replace the centrally controlled classical production hierarchy (Bartodziej, 2017).

For the reasons mentioned above, it is necessary to have a network infrastructure that is reliable, that allows access and communication of devices of different nature and that allows you to be connected at all times in order to have the most timely information possible.

In this sense, the application of the Internet Protocol (IP) for the integrated transmission of voice and data is a concept that has revolutionized the telecommunications industry, elevating the position of the Internet to a level of commercial competition. Voice transmission services can already be offered over the Internet, at prices much lower than traditional ones, thanks to the development of real-time applications over IP.

Within the existing services for communications within the Internet protocol, differentiated services are a protocol architecture standardized by the IETF (Internet Engineering Task Force) to provide class-based QoS (Quality of Service). In this architecture, each package has a service type field in its header so that it can be placed with the other packages that belong to the same class and are guaranteed the corresponding resources and type of service (Mejía Fajardo, 2004)

It is essential, under the communication requirements suggested by Industry 4.0, to have a formal and applicable methodology that allows the communication lines of all devices that need to give their information to the technological ecosystem, thus complying with connectivity requirements.

2 DESCRIPTION OF THE METHOD

The methodology proposed for the installation of communications networks consists of four steps, where the documentation step is linked to all the other steps that are developed below and can be seen in the following figure:

Figure 2

Methodology for installing communication networks

Source: The authors.

Gathering Information: Initial information is of great importance for making decisions throughout the project. This information includes several aspects that were classified into three: the physical aspect, the economic aspect, and the growth plans of the organization.

Information with a physical appearance must be gathered documents such as plans of buildings, architectural plans with dimensions, measurements and labels or names of each space on the plan. In addition, information must be gathered on the type of walls, floors, ceilings and existing facilities in the building (electrical power installations, physical land, water, drainage, air conditioning and even existing structured cabling) that could influence the development of the project.

the information on where the computer equipment will be installed in the work areas, the locations of the industrial equipment that will be connected to the network, areas where mobile devices are required as information generators and mobility ranges throughout their stay in the buildings. Distribution of which teams belong to which areas.

In addition, it is necessary to have knowledge of the applications that will be implemented in the communications system (telephony, data, video), its requirements will be of vital importance, since it will allow the selection of the technical, design and location characteristics of the equipment and materials to be used. When designing a plant from scratch, the central point of the surface should be considered as the tentative area for the communications site as the starting point and choose according to the information provided the area with the highest density of non-mobile devices and on that surface take it as the starting point for the distribution of connectivity.

The economic aspect involves knowing the budget that the company would have for the development of the project, after knowing the maximum applicable margins, the availability of financial resources, the dates and ways of obtaining them.

The growth plan aspect of the organization gives the design flexibility to adjust to future changes and can be added to later expansions. All this information is obtained from the company's personnel, consulting technicians to obtain diagrams, layouts, diagrams and locations of equipment, installations and ducts. Administrative staff can provide information about the growth of the last few months, including the last three years, both in terms of personnel and work areas. The managers contribute with the information of the growth plans to the near future that could generate the need to establish the design plans at the time of establishing the project and leave a scheme already foreseen to meet the projected requirements). Extra but valuable information consists of identifying in the diagrams electrical installations, the possible EMI (ElectroMagnetic Interference) sources, the existence of pipelines and their location, the intersection with other installations such as gas, high voltage, air conditioning, water and drainage.

Recommendations for obtaining this information are:

- Always request it electronically and if this is not possible, in writing.
- Never believe or assume, always verify.
- Always have documents such as wiring or safety standards at hand.
- In the event that the requested information does not exist, ask for it to be generated at the time.
- Verify that the information is as current as possible.

Information analysis and design of the structured cabling system: Once all the information is available, it is processed to have all the details for the design.

The design is analyzed in a modular way, each module corresponds to each of the subsystems specified by the ANSI/TIA/EIA-568 standard (Anixter Inc., 2016), the following will be considered: the equipment room, the telecommunications rooms, the backbone routes, the horizontal cabling routes, the service entrance, the work areas, in addition to the physical ground systems.

It begins with the equipment room, where it is taken into account that the servers and the main applications are located in these areas. Continue through the telecommunications rooms, places where the horizontal cabling starts and where the backbone cables arrive. After having selected the best locations of the rooms, the backbone routes are traced to interconnect them, then the service points of the work areas and finally the routes between these and the communication rooms that will result in the horizontal cabling.

The equipment necessary to establish communication, what would be the most convenient means to guarantee information and efficiency, design of equipment room, telecommunications rooms, vertical and horizontal wiring routes, service entrance are defined in this phase.

Project execution (project control and installation): Carrying out the project involves more than just installing the cables. The resources available must be controlled, so that there are no losses or waste. The project is developed in a better way if it has an information system that, among other things, has control of material, human and financial resources.

Using a software tool (Microsoft Project Manager) the activities are planned based on the design obtained, the schedule is built with the organization and assignment of the following tasks.

- Installation of ducts in cases where they do not exist, whether pipes, gutters, ladders, etc., both for which horizontal and vertical wiring will support.
- Installation of horizontal wiring (this task is carried out for each floor of each building).
  - Lay the cables of what will be the IDF (Intermediate Distribution Frame) to where the telecommunications outputs will be.
  - Install the infrastructure that will support the cabling termination equipment (patch panels) consisting of racks, wall mounts, and cabinets.
  - Place the patch panels in their respective mounts and patch the cables.

- o Attach the boxes and covers, attach the connectors to the cables, and assemble the data output.
- o Perform the tests relevant to the installation
- o Correct possible errors and failures in the installation.
- o Document the installation.
- Installation of backbone cabling inside buildings (this task is done for each building).
- o Lay the backbone cables that go inside the building from each of the IDFs.
- o Install the connectors on each end.
- o Perform the relevant tests and correct possible errors or failures.
- o Document the installation.
- Installation of backbone cabling between buildings
- o Lay the cables that will connect the buildings to each other.
- o Install the connectors on each end.
- o Perform the relevant tests and correct possible errors or failures.
- o Carry out the documentation
- Installation of active equipment.
- Connect workstation equipment.
- After the installations, the finishes are checked, such as sealing the passes (perforations in the structures), placing the fire blocks, either with metal covers or silicone foams, as well as sealing the accesses through which water can be mined.

As progress in the tasks, it must be communicated to the coordinator or head of the project, so that he or she can update the control of the project if required, as well as the consumption of material resources and the assignments of the tasks. In this way, efficient management of the project and available resources is maintained. Once the operational tasks are completed, the documentation is carried out to generate a technical report.

Documentation and administration: An important part of the project is the documentation, since this is the guide for the administration of the infrastructure and the services that were distributed on it. There will be many ways to document the project: the ANSI/TIA/EIA - 606 standard recommends making a report with the information of each of the elements of the wiring, making tables of references to them with a consistent identification scheme. The data in these tables will be those necessary to identify each element, such as: identifier, type, load, occupation or use and some data for cross-references such as the identification of the IDFs in the route identification tables.

Another way to keep the documentation is to do it on a plan, assigning symbology to each element of the wiring in such a way that when observing the image and comparing it with the symbology, the information of each element can be quickly known. That is, a red color will be assigned to the fiber optic backbone, an orange color to the telephony backbone and a yellow color to the video backbone.

The documentation consists of a concentration of all the plans, tables and data of the project in a technical report in addition to the placement of the labels and placement of the identifications in all the telecommunications rooms. If a certification of the different means of communication is carried out, it is important to attach these documents, since the wiring will be guaranteed for the life time that the manufacturer specifies of its material as long as the wiring does not suffer alterations after having been traced and its certification carried out.

Once these tasks are completed, the telecommunications infrastructure project is concluded.

3 FINAL COMMENTS

This methodology (López, 2004) with some complements has been applied on constant occasions, providing a desirable level of control for projects that can quickly become very conflictive due to the speed of business needs. Recommended both for new communication network structure projects and for annexes to existing communication structures. Providing successful results at the end of projects, always with growth and slack capabilities.

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