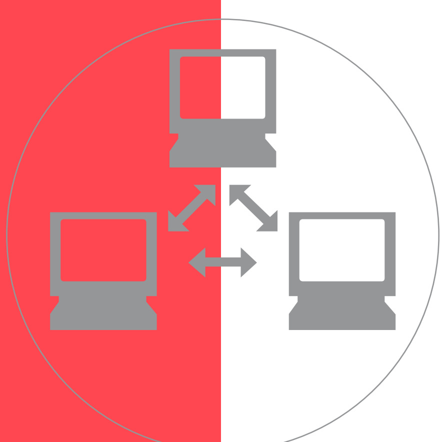
TRANSITION networks®

The Conversion Technology Experts

Media Conversion for Industrial Applications



Introduction

While network managers yearn for the latest equipment and higher speeds, budgetary restrictions impose limitations and precipitate a less than homogenous network. Inevitably, network administrators must contend with a variety of protocols, speeds, and media in their networks. Media conversion technology was developed to address these problems and has evolved from a stop gap technology into a technology that offers network administrators new choices for deploying fiber optics into their networks cost effectively. Those in industrial environments face the added challenge of creating interoperability throughout a network in less than ideal conditions. Network administrators in industrial environments are challenged to ensure network performance in harsh outdoor and factory floor conditions.

The following paper will provide an overview of media conversion technology and the role it plays in industrial applications.

Introduction to Media Conversion

For those unfamiliar with conversion technology, media converters connect dissimilar cable types, making it possible to mix media and speed on a network to optimize price and performance. Whether extending legacy networks with the latest technology, or connecting inexpensive, lower bandwidth desktops to a state of the art fiber optic backbone, media converters offer a viable lower cost solution.

Media converters are commonly used to connect UTP (unshielded twisted pair) copper cabling and fiber optic cabling in a network cabling plant. Media converters can be effective in networks that have legacy cabling such as Coaxial or Twinaxial cabling and need to be integrated with UTP or fiber optic cabling. Converters are also used to convert multimode fiber into single mode fiber for the purpose of extending distance. Multimode fiber has a distance limitation of 2 kilometers while single mode fiber can be used to extend distances up to 80 kilometers.

Media converters are protocol specific; meaning an Ethernet converter is needed to convert 10BASE-T to 10BASE-FL. Media converters do not convert protocols, such as Serial to Ethernet. However, media converters exist for a broad range of protocols including Ethernet, Fast Ethernet, Gigabit Ethernet, T1, DS3, RS232, RS485, V.35, analog phone lines, video, and more.

Conversion technology solutions offer the ability to:

- Add new devices without replacing costly equipment and cabling
- Extend network distances by adding fiber where and when it is needed
- Provide a link between media types, transparent to the network
- Keep pace with growing demand and new technology
- Integrate high bandwidth devices into the network

Converters exist in a variety of form factors, such as standalone, multi-port, and modular chassis. These different physical forms address the various applications that exist.

Figure 1: Media Conversion Form Factors

Multiple connections as well as multiple protocols can be easily accommodated by a media conversion chassis or in a rack for standalone converters.

As alluded to earlier, there are numerous applications for media conversion products. The following outlines various industrial applications and media conversion solutions. The applications have been grouped into categories for ease of understanding:

- Factory Floor Applications
- Network Management
- Legacy Equipment Applications
- Extreme Temperature Environments

Whether you require several disparate interfaces to be networked or you have Ethernet throughout the network, Transition Networks can provide you an integrated cost effective solution.

Figure 2 represents different types of interfaces accommodated by using Transition's Point System chassis and various remote end conversion solutions.

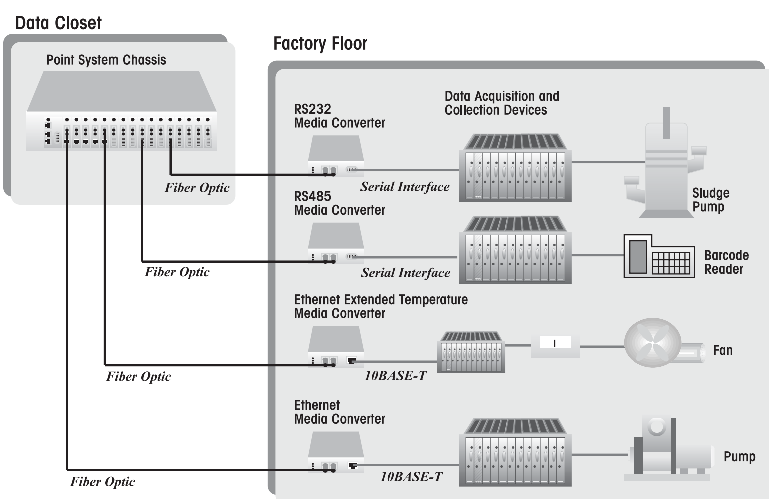


Figure 2: Indoor Industrial Application

Factory Floor Applications

There are instances in a large factory in which a connection may have to run through the manufacturing floor to connect to a remote device. (Figure 2). Some factory environments, as well as power plants and sub-stations, have equipment that may produce significant levels of EMI (electromagnetic interference), which can have adverse effects on data transmitted across copper based cabling. Use of fiber optic cabling virtually eliminates any effect EMI may have on the data transmission. Media converters convert electrical signaling into fiber optic lightwaves, eliminating EMI and RFI (Radio Frequency Interference).

Network Management

Some network applications are mission-critical and require SNMP management. SNMP management is useful in industrial environments where devices may not be accessible during factory operations or may be inconvenient due to distance or location.

SNMP has many advantages. SNMP management allows network administrators greater monitoring control. One advantage of SNMP is the ability to set traps. Traps can be used to trigger alarms in the event of a problem. For example, a wastewater treatment plant may have a remote pumping station with a SCADA system attached to several devices. The SCADA system has an un-interruptable power supply. Transition's media converters are placed at each device to provide fiber to copper conversion. Communication between the pump and the main control station are done via Ethernet. The SNMP Management software can monitor the remote media converters and use traps to determine if there is a power loss to the pump station, which could then send notification to maintenance. SNMP Management allows for greater control and less downtime.

Figure 3 below depicts the functionality of Transition's SNMP management software, Focal Point.

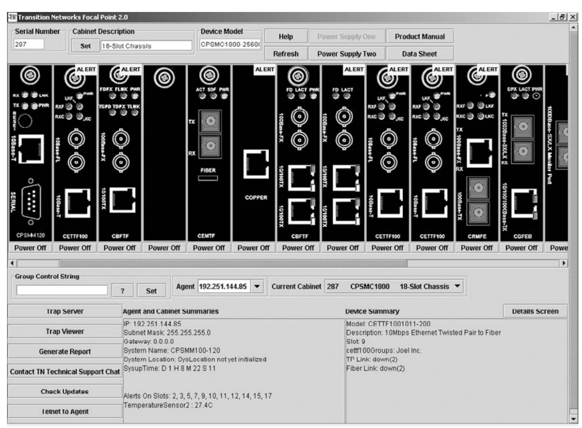


Figure 3: Focal Point Management Software

Legacy Equipment Applications

Many industrial locations have intelligent device monitors and other equipment that needs to be networked together. Media converters can be used at either end of the fiber optic cable to allow for centralized control.

For example, a wastewater treatment plant has a processing building, a maintenance building, and a main plant. Each building had legacy PLC (Programmable Logic Controller) stations located throughout. The PLCs had serial interfaces and were connected to a main controller within each building. The wastewater treatment plant wanted to migrate to centralized control. Stand alone High Speed Serial media converters are used at the remote locations to connect to the remote PLCs and transmit the data back to the main building. A Point System chassis with High Speed Serial media conversion cards are used to connect to the new centralized main controller in the main plant. The High Speed Serial conversion solution allowed the wastewater treatment plant to move from distributed control to a more centralized control system while saving money.

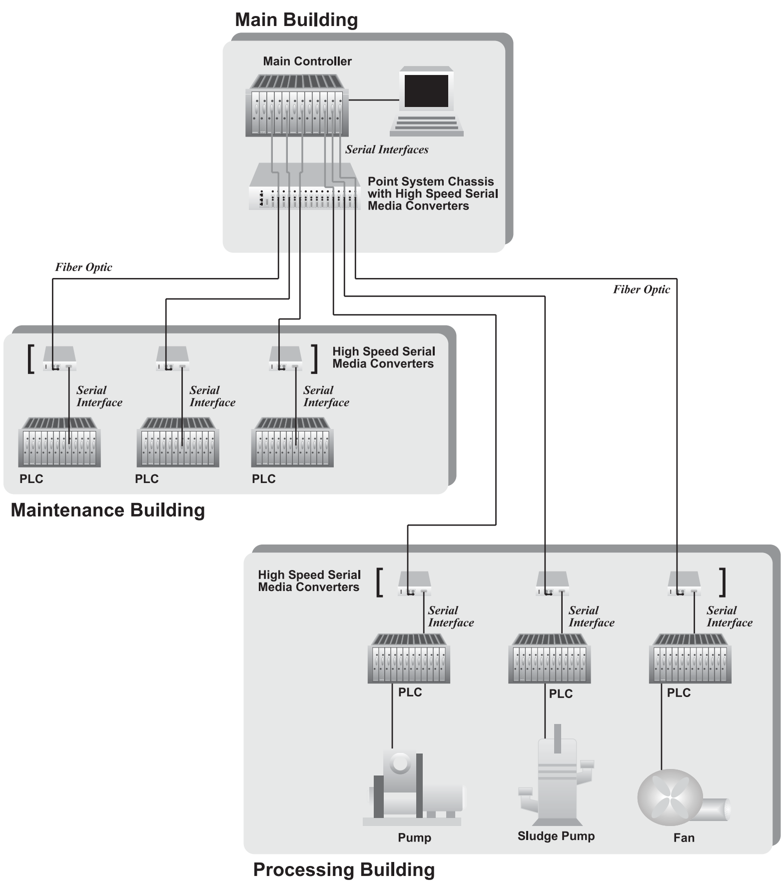


Figure 4: Wastewater Treatment application

This solution enabled the wastewater treatment plant to incorporate their existing equipment, while reducing costs and allowing for future growth.

Extreme Temperature Environments

In addition to factory applications, industrial products are needed to address outdoor environments. Outdoor applications are primarily concerned with temperature extremes. Other elements such as moisture, dust, and debris are minimized with the use of equipment enclosures. Outdoor enclosures are subject to industry standards for performance such as standards set by NEMA, UL, and IEC.

An example of an outdoor industrial application is traffic control. Traffic control systems have traditionally used coaxial or serial interfaces for the interconnection of outdoor traffic data devices and the control center. The video Codec in this application converts the analog video signal into an Ethernet signal.

Stand alone Extended Temperature media converters from Transition Networks are placed at the remote end, connecting pole top cameras with copper interfaces to fiber optic cabling. The fiber can extend the distance up to 80 kilometers(depending on the protocol) using single mode fiber back to the control center. A Point System chassis located in the data closet at the control center accepts the fiber signal, converts it, and connects to the copper equipment at the main site.

Extended Temperature media converters at the remote end ensure successful transmission for non climate controlled environments.In this scenario, equipment enclosures are used to protect against other environmental factors such as debris, wind, and water.

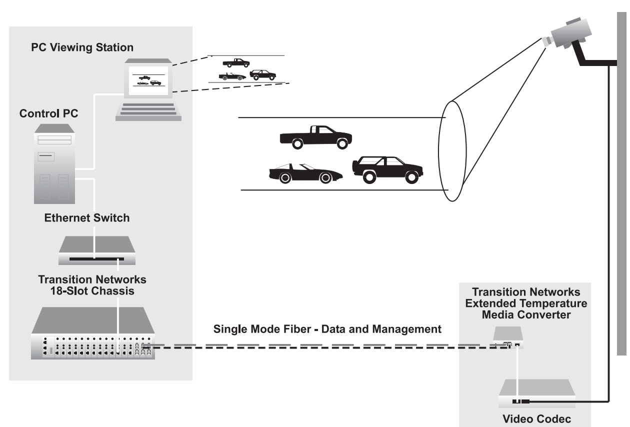


Figure 5: Outdoor Media Conversion Application

Transition Networks offers a couple of ways to manage remote media converters. Network administrators who require more detailed information regarding remote converters can utilize Transition's remotely managed converters in conjunction with our SNMP management software. Transition's unmanaged media conversion products offer similar feature functionality through Link Pass Through and Far End Fault. Media converters with these features allow both near and far end equipment too be alerted in the event of link loss.

Summary

Media converters have evolved from their initial intent of adding one or two fiber strands to a network as a quick resolution to a problem. Today, media converters are offered in a wide variety of protocols and form factors to address the complex needs of industrial applications.

Conversion systems from Transition Networks offer management software which allows the network manager to fully monitor and configure the systems. Even unmanaged Transition converters provide critical features such as Link Pass Through, Far End Fault, Pause, and Auto negotiation. Transition Networks offers full featured conversion products to meet the requirements of industrial applications. As demonstrated in the applications mentioned, media converters provide unique solutions for difficult problems and cost savings when implementing fiber into your network.

Ethernet
One of the most common data communication protocols used in Enterprise applications is Ethernet. The Ethernet protocol was developed in the 1970s by the Xerox Palo Alto Research center. Primarily used as the Local Area Network technology for offices, it was standardized in 1983 by IEEE (802.3 standard). The popularity of Ethernet has pushed many improvements. Increases in technology have led to the development of Fast Ethernet, Gigabit Ethernet, and 10Gigabit Ethernet. Bandwidth demands will continue to drive the evolution of Ethernet.

The advantages of Ethernet are becoming applicable in industrial environments. A more open standard for data acquisition and transmission is needed for industrial automation. An increasing number of companies are looking to Ethernet rather than the traditional proprietary bus topologies, such as Fieldbus, Modbus, Interbus, Profibus, etc. The use of Ethernet protocol is increasing in process control, building automation, traffic control systems, power stations, medical, and wastewater treatment applications.

What is giving rise to the use of Ethernet in Industrial Applications?
Ethernet provides many advantages to the office environment. It allows users to share files, printers, search the Internet, and support other high bandwidth applications for office workers. A factory floor has more complex communication needs. Data must be accessed from workstations, I/O devices, and other automation systems. The data for a factory floor is very time sensitive and requires real-time communication. For example, the timing for robotic equipment needs to be real-time in order for the automation process to work.

In the past, industrial automation protocols were proprietary and locked users into a specific architecture. Ethernet's widespread popularity, performance, low cost, and its standardized PC and Windows compatibility have made it attractive for industrial applications. Ethernet capability is being built into industrial measurement equipment such as I/O devices and data acquisition equipment. Data acquisition and I/O products are use to interface directly thermocouples, strain gauges, load cells, flowmeters, waveform signals, etc.

Ethernet Challenges
One issue with Ethernet in the industrial market is interoperability or interchangeability between devices from different vendors. In regards to the OSI model, Ethernet only provides physical and data link protocols. The upper layer protocol determines which devices can connect and interoperate at the network layer.

Determinism, the ability to predict when information will be delivered, is an issue with standard Ethernet that needs to be addressed for industrial Ethernet. As mentioned above, Industrial networks have time critical applications and require scheduled bandwidth to guarantee delivery.

Originally, Ethernet was half-duplex and existed on a bus topology. In classic or shared Ethernet, all the network users share one collision domain. In half-duplex environments, the network access is controlled by CSMA/CD (Carrier Sense Multiple Access with Collision Detection). Each device on the network senses whether the line is idle. If the network is idle the device begins to transmit data; other devices can be transmitting at the same time. Collision occurs when two or more devices are transmitting. Consider an industrial scenario in which a robotic arm solders a component, adding a specific part. If the network is congested the robotic arm fails to add the component at the appropriate time.

Several improvements have been made to Ethernet all of which make it beneficial for industrial automation:

- Segmentation - subdividing the collision domains
- Higher bandwidths – the development of Fast Ethernet, Gigabit, and 10 Gigabit technologies
- Switched Ethernet
- Interoperability

Switched Ethernet separates collision domains into point to point connections between the network components and the equipment, allowing full bandwidth availability for each connection. The separate pair of wires used to detect collision is now used for transmission, increasing transport speeds.

Several proprietary and open fieldbus networks (application layer) are being used in industrial automation applications. The most common control networks are Profibus, DeviceNet, ControlNet, and Foundation Fieldbus. These control networks include standardization at the application layer and provide a higher level of interoperability. Ethernet is being considered for these control networks as well. The advantage of Ethernet is its wide spread acceptance, cost and speed. The industrial protocols competing for acceptance includes Ethernet/IP, PROFInet, IDA, and Foundation Fieldbus.

A detailed analysis of Ethernet protocols is beyond the scope of this paper. However, Ethernet/IP is considered a front runner due to its popularity and sponsorship by The Industrial Ethernet Association, the Open DeviceNet Vendor Association (ODVA), and ControlNet International (CI).

Ethernet/IP is an industrialized version of Ethernet TCP/IP. Ethernet/IP uses TCP/IP encapsulation to provide a common application layer protocol over Ethernet designed to handle both implicit and explicit messages. The standard application layer allows interoperability and interchangeability among industrial automation and control devices. It does this by using both the DeviceNet and ControlNet standards called Control and Information Protocol (CIP). It defines the access, behavior and extensions, which allow different devices to be accessed using a common protocol. Using the CIP layer over Ethernet/IP offers consistent devices access. It organizes network devices as a collection of objects and means it can use one configuration tool to configure disparate devices on a network. Its tie to Ethernet ensures that Ethernet/IP will evolve as Ethernet evolves. (See Figure 6)

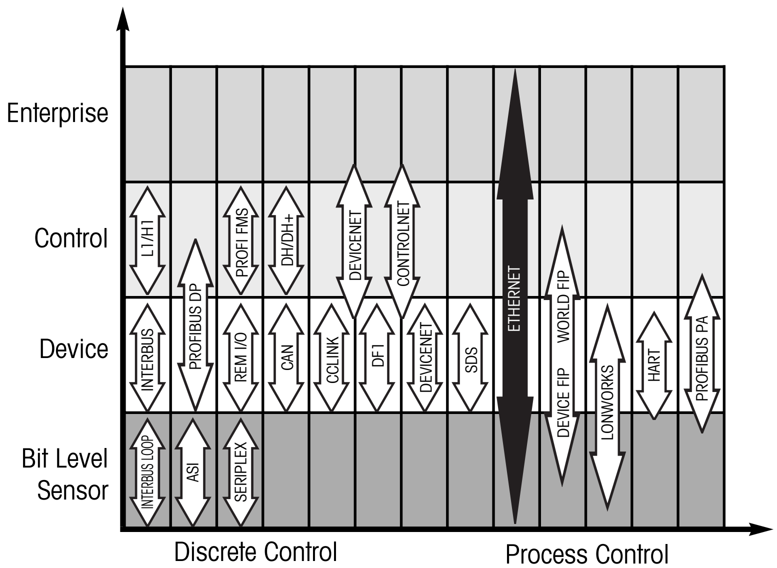


Figure 6: Industrial Protocols

Role of SNMP

Most industrial automation environments require remote device management. The device requesting information is referred to as the manager, while the agent is the device being managed. SNMP is an application layer protocol that uses UDP (datagram) protocol for communication between the manager and the agent. SNMP allows network managers to monitor the health of the network and the devices attached to the network. In analyzing devices for industrial environments SNMP management is an important consideration.

General Requirements for the Industrial Environment

Ethernet works well in controlled office environments, but most equipment developed for commercial use is not robust enough for the demanding industrial environment. Dust, temperature extremes, moisture, and other outside factors affect industrial applications and play havoc on equipment. Ethernet equipment designed for an office generally does not work in an industrial environment. If it does, it may only work temporarily.

New products are being introduced to meet Ethernet needs for the industrial workplace. The industry standards are still being finalized, but companies are beginning to release industrial Ethernet products.

Industrial conversion products from Transition Networks

Transition Networks brings their reputation of product excellence to the industrial environment. Transition Networks' extended temperature media converters can be placed in harsh temperature environments where many traditional conversion products fail to meet the extended temperature range necessary for reliable operation.

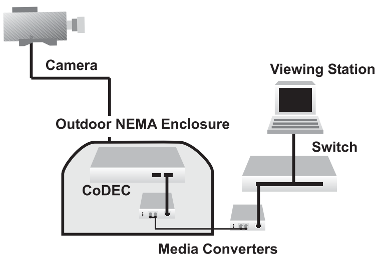


Figure 7: Extended Temperature Media Conversion Application

Transition's industrial Ethernet media converters have:

- Extended temperature operating ranges
- Tradition of ruggedness
- Choice of wide input 18 – 72 VDC power
- DIN-Rail mounting options

Transition's industrial offering includes extended temperature ranges for Ethernet and Fast Ethernet. The Extended Temperature media converters have a broad operating temperature range of -25°C to +70°C, which is a drastic improvement over many competitive products with a 0°C to +40°C operating temperature range. In addition, both products include many of the extensive features commonly found on Transition's stand-alone media converters. The extended temperature Ethernet product includes AutoCross™ and Link Alert™, while the extended temperature Fast Ethernet product includes Auto-Negotiation, AutoCross™, Link Pass Through™, Far End Fault (FEF) and Pause. Feature functionality is important in industrial applications to determine link failure.

Figure 8: Din Rail mounting bracket

Transitions' Din-Rail mounting options take the converter off the workstation and out of the way. Use Din-Rail to mount multiple media converters on the wall, making installation simple and efficient.

Transition's Extended Temp Ethernet and Fast Ethernet products are available immediately. Both are offered in a stand-alone form factor only. Transition Networks continues to monitor the progress of industrial Ethernet standards and continually adds features to meet the needs of our industrial clients.

Please contact Transition Networks at (800) 526-9267 or +952-941-7600 to determine how we can meet your industrial requirements.

Glossary

ControlNet – a real-time, control layer network providing for high speed transport of both time critical I/O data and messaging data, including upload and download of programming and configuration data and peer to peer messaging, on a single physical media link.

Ethernet/IP – an industrial application layer protocol designed for industrial automation applications. It is built on the standard TCP/IP protocol and uses Ethernet hardware and software to define an application layer protocol for configuring and controlling industrial devices. It is based on the Control and Information Protocol (CIP) layer used in ControlNet and DeviceNet.

IEC - International Electrotechnical Commission – The global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts.

ISO - ISO, founded in 1947, is a worldwide federation of national standards bodies from some 100 countries, one from each country. Among the standards it fosters is Open Systems Interconnection (OSI), a universal reference model for communication protocols. Many countries have national standards organizations such as the American National Standards Institute (ANSI) that participate in and contribute to ISO standards making.

Modbus – a protocol that is a messaging structure developed by Modicon in 1979. Modbus is used to establish primary-secondary/client-server communication between intelligent devices.

OSI Model - Open Systems Interconnection is a standard reference model for communication between two end users in a network. The OSI Reference Model describes seven layers of related functions that are needed at each end when a message is sent from one party to another party in a network.

PLC – Programmable Logic Controller. A device used to automate monitoring and control of industrial plant. Can be used stand-alone or in conjunction with a SCADA or other system.

PROFIbus HSE - One of the fieldbus standards represented by the Fieldbus Foundation, which is designated for an Ethernet backbone and for industrial automation. It uses TCP, UDP, and IP protocols.

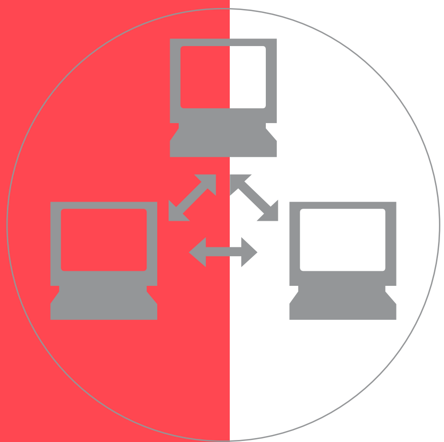
UDP/IP – User Datagram Protocol/Internet Protocol. Used by Ethernet/IP for real-time messaging. UPD/IP can multicast and send implicit and explicit

SCADA – (Supervisory Control and Data Acquisition) is a category of software application program for process control, the gathering of data in real time from remote locations in order to control equipment and conditions. SCADA is used in power plants as well as in oil and gas refining, telecommunications, transportation, and water and waste control.

SNMP - Simple Network Management Protocol (SNMP) is the protocol governing network management and the monitoring of network devices and their functions.

TCP/IP - (Transmission Control Protocol/Internet Protocol) is the basic communication language or protocol of the Internet. It can also be used as a communications protocol in a private network (either an intranet or an extranet).

UL – Underwriters Laboratories Inc. Enclosure rating organization which requires performance testing by qualified evaluators. An independent, not-for-profit product safety testing and certification organization.



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