Requirements for converged networks

2021-10-14 Version 1

Industrie 4.0 – Future of industrial automation

SIEMENS
Ingenuity for life

Four basic principles to enable Plug & Produce for Industrie 4.0

Connectivity and Communication

- Easy access to data from sensors, devices, machines, productions cells, …

Information transparency

- Create information out of data by adding semantics

Technical Assistance

- Ability of assistance systems to support humans, e.g. by augmented reality

Decentralization of Decisions

- Ability to make decisions and perform tasks as autonomous as possible

-> all together based on an converged network

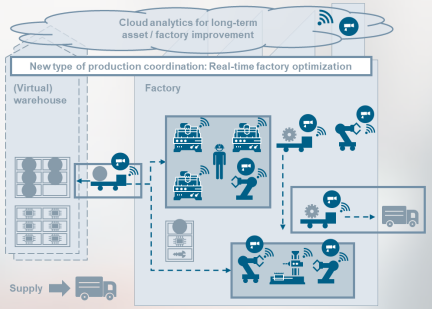
Definitions

Plug & Produce

: capability to establish connectivity after plugging [this include plugging of devices/module in Edge] to a communication network

Especially : the ability to receive and apply communication and connectivity configuration after plugging

Industrie-4.0-_Plug-and-Produce-zvei.pdf



Connectivity

: the quality, state, or capability of being connective or connected

Especially : the ability to connect to or communicate with another automation device or computer system

Connectivity | Definition of Connectivity by Merriam-Webster (merriam-webster.com)

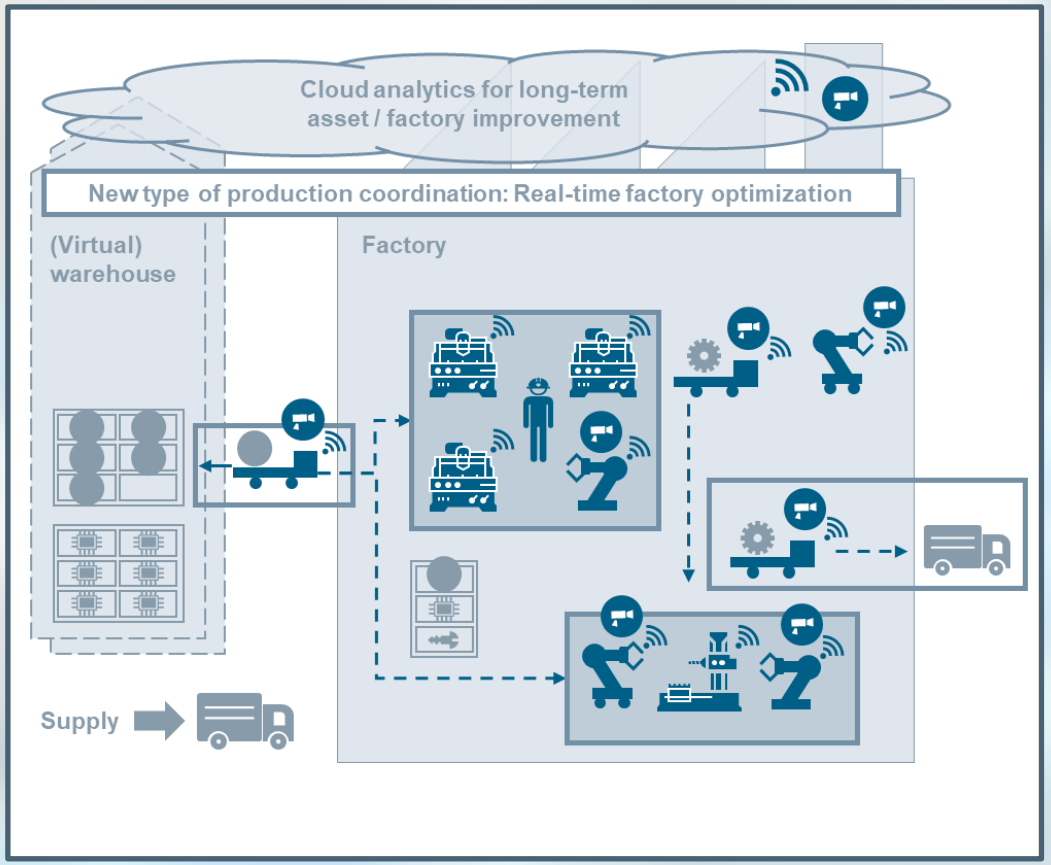
Communication

: a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior

Especially : means to exchange of information e.g. by Ethernet, Wi-Fi or 4G/5G

Communication | Definition of Communication by Merriam-Webster (merriam-webster.com)

Converged Network
Big picture – factory of the future

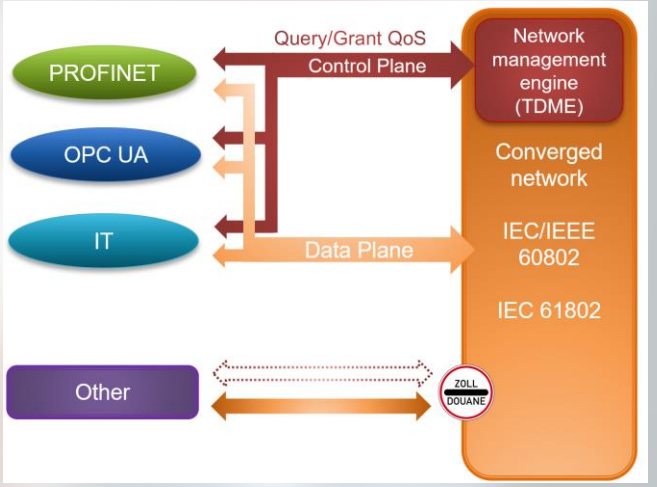


- Transparent access to data and information models
- Ease of management including security
- Digital Twin including simulation of (wireless) communication
- Converged networks covering domain specific requirements
- Flexibility & mobility in manufacturing demand wireless infrastructure

Converged Network
Detailed requirements

SIEMENS
Ingenuity for life

- **IT and OT** devices in one network **sharing QoS**
- Applications can be **engineered, implemented and deployed independently** from the network
- **Self-protecting** network e.g. against wrong connections, unexpected devices or network load
- Dynamic adaption: **plug and produce** (AGV, …), topology changes, extensions for IT and OT devices
- **Network provides** required **QoS** for the applications
- **Efficient bandwidth** utilization for OT and IT communication
- Link speeds from **10 Mbit/s up to 10 Gbit/s** and Link speed transitions
- **Topologies**: ring, line, tree, star and combinations
- **Media types**: fiber, copper and radio (e.g. wireless and 5G)
- Bridges with up to 255 ports
- **Scalable availability** for the network and the devices e.g. by media, network and device redundancy
- **Reliable and accurate** time synchronization for site, plant, line, cell and machine

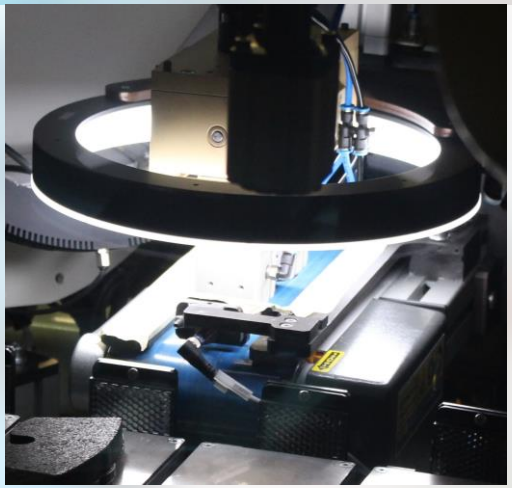


Different industries
All requiring a converged network


Factory Automation


Process Automation


Motion Control


Camera Integration


Worker Environment

One converged network needs to cover concurrently the requirements of the different industrial verticals

Converged Network Quantities

A vehicle manufacturing facility uses more than 50,000 Ethernet nodes in manufacturing.

Bigger production cells implement Layer 2 networks with up to 1000 nodes.

Automation devices requires up to 2000 streams or time-sensitive streams. This number doubles if seamless redundancy is demanded.

Multiple wireless connected AGVs or robots are entering and leaving the production cell concurrently.

Flexible production requires adding and removing of machines or machine-parts, AGVs, and robots or robot-tools without production disturbance.

Industrial Automation common requirements

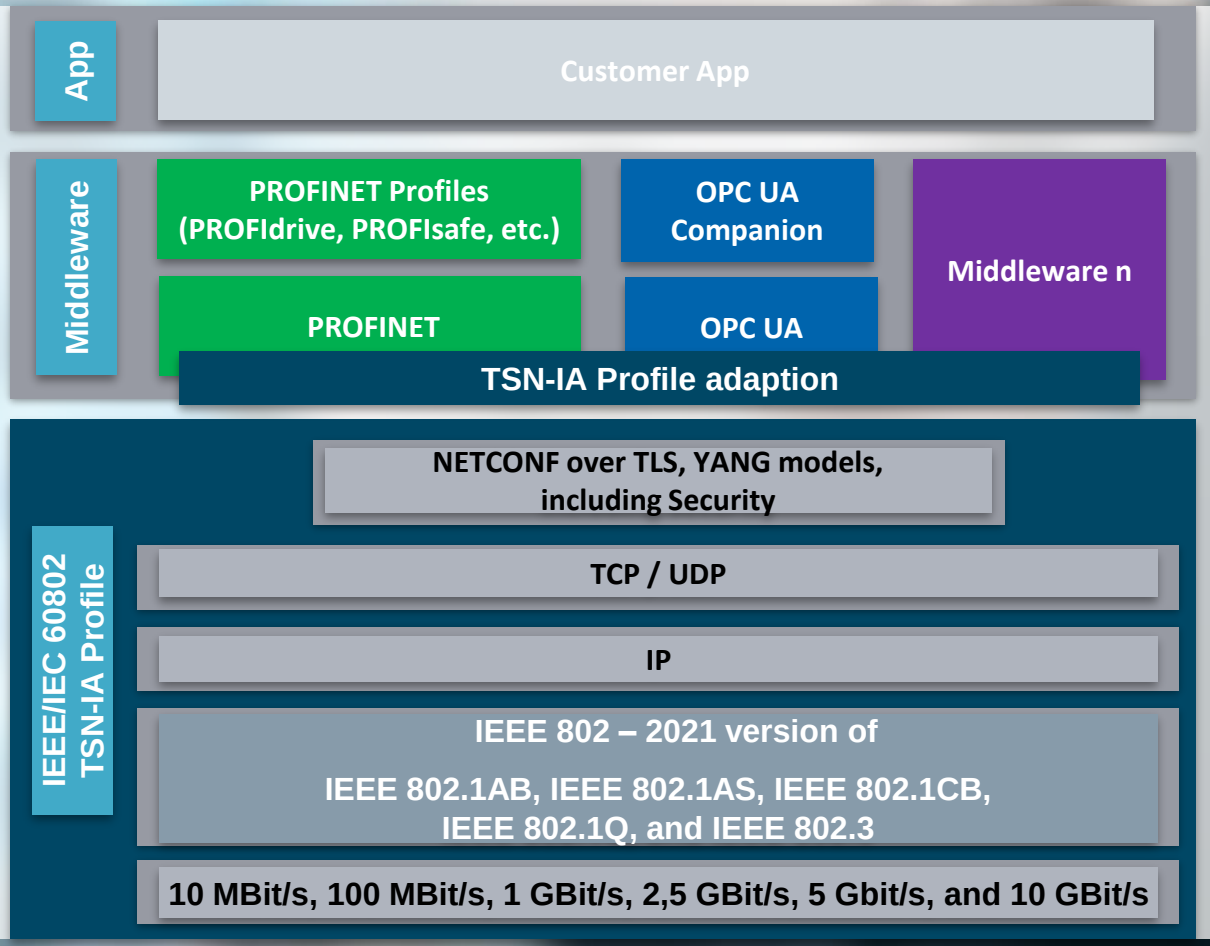
Precondition for implementing a converged network is the decoupling of middleware and application from the network.

This requires an adaption of the existing middleware and engineering concepts which assume an ownership of “their” network.

Additionally, any time-aware management of bridges in the network is almost impossible – network usage is no longer known upfront.

Thus, a converged network will be in most cases optimized first for flexibility and second for performance.

This naturally limits the to be used tools from the TSN toolbox.



Conclusion

- Different industrial verticals have some **unique application requirements** but end stations are still able to **share the same network** (build from the same bridges) **via common interfaces** (same network requirements)
- **Network convergence must be understood and taken into account** in how TSN is used in end stations and bridges
  - **Required network size and number of streams**
  - **Required dynamics / reaction to change, e.g. Plug and Produce**
  - **Security convergence for identification and configuration**
- **Decoupling of application and network is required** for convergence and scale over time

SIEMENS
Ingenuity for life

Questions

Bibliography

IEC/IEEE 60802

Additional information is available at the IEC/IEEE 60802 public folder provided by the IEEE 802.1
http://www.ieee802.org/1/files/public/

You will find contributions for the 60802 provided by the people from the companies by seeking for the term “60802*” in the folders!

Example:

- 60802-Steindl-et-al-ExampleSelection-0520-v24.pdf
- 60802-Steindl-et-al-ExampleSelectionTables-0520-v24.pdf

Please check regularly for new contributions!

PROFINET over TSN specification

https://www.profibus.com/download/profinet-specification
Version V2.4MU2 (expected release date 2021-05-22)

Disclaimer

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

All product designations, product names, etc. may contain trademarks or other rights of Siemens AG, its affiliated companies or third parties. Their unauthorized use may infringe the rights of the respective owner.

Contact page

SIEMENS
Ingenuity for life

Published by Siemens

Günter Steindl
Principal Engineer
Siemens DI FA TI ART EA

Werner-von-Siemens-Str. 48-50
D-92224 Amberg
Germany

Mobile: +49 173 913 7406

E-mail:
Guenter.Steindl@siemens.com

#automation
#totallyintegratedautomation
#digitalization
#futureofautomation

siemens.com/tia