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Data transmission technology:

STANDARDS – INSTALLATION – MEASUREMENT TECHNOLOGY

- Testing and measuring
- Troubleshooting
- Documentation of projects

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2nd Edition 2022

On the way to new frontiers

In Local Area Networks (LANs), high-quality copper cabling links form the basis for fast and secure data communication. In the mid-90s, network users were satisfied with data rates of 10 & 100Mb/s, which is no longer considered sufficient today. Today, we operate LANs with data rates of 1 & 10Gb/s and – in data centers – with 25 & 40Gb/s and soon also with 100Gb/s – all using copper cabling.

The latest technologies in multimedia, such as the next generation Wi-Fi (IEEE 802.11ac/ax) and Ultra-HDTV (such as 4K/8K and 16K) are driving faster transmission speeds – and thus the bandwidths – in copper data networks to new heights. To ensure system warrantees and proper functioning of these high-speed copper data networks, this requires measuring and testing these copper cabling systems.

The field measurement technology and the measurement technician and installer must be prepared for these changes. The cabling industry is talking about Cat 8, Cat 8.1, Cat 8.2 and Class I & II, all of which will be covered in this manual. We are continuing the tradition of summarizing all questions concerning measurement and testing technology for these high-speed copper data networks in a practical and small manual.

The first edition of this cabling handbook was published in 2007, and this new 2022 edition of the “Handbook of Cabling and Measurement Technology” should find its place in the toolbox or measurement equipment bag of every data cabling and measurement technician and installer: Always on hand, quick to look up, with comprehensive up-to-date information.

We wish you smooth installations and acceptance measurements of copper data cabling.

With kind regards

Dipl.-Ing. (FH) Thomas Hüsch
Technical Support & Training, Softing IT Networks GmbH

CONTENT

DATA TRANSMISSION TECHNOLOGY:

STANDARDS – INSTALLATION – MEASUREMENT TECHNOLOGY

PRINCIPLES OF NETWORK TECHNOLOGY

This manual deals with data transmission technology from network development, standards, acceptance measurements and troubleshooting to documentation. Did you know that the well-known and popular Ethernet is more than 40 years old and that the standardization of Ethernet by IEEE 802 with the first 802.3 standard also began more than 30 years ago?

The use of computers, smart TVs, telephone systems with VoIP technology as well as building communication (door intercoms, alarm systems) has become commonplace. Not so long ago, separate communication networks were used for this purpose: twisted wires for the telephone, coaxial lines for television and chunky Twinax data cables (IBM) for the first office computer systems. Today, however, “Ethernet” has become the standard for communications technology and is used equally by various trades. Today, the term “Ethernet” refers to the physical interface (cables, connectors) as well as the transmission protocol as the basis for the well-known “TCP/IP” world – the logical functions of network components.

In this manual, however, the focus is on one of the physical transmission media of the Ethernet, which has established itself as GCS (“Generic Cabling System”). Even as an electrician, you must deal with its planning, installation, acceptance measurement and its operation.

First, we want to look at the basics of our current network infrastructure.

We always talk about the so-called „Universal Structured Building Cabling“ – what is meant by this and what standards exist for it?

CHAPTER 1:

REVIEW, HISTORY

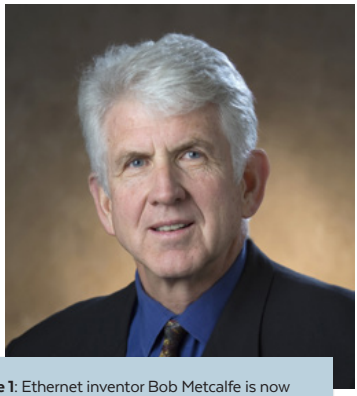

Figure 1: Ethernet inventor Bob Metcalfe is now Professor of Innovation at the University of Texas at Austin, Texas, USA; *Source: UTECE*

THE DEVELOPMENT OF THE ETHERNET

Here are some historical data from the mouth of Robert "Bob" Melancton Metcalfe ***(see Figure 1)***, the inventor of the Ethernet and now Professor of Innovation at the University of Texas at Austin, who comments on the joyous event in 2013: "On May 22, 2013 we celebrated the 40th anniversary of the invention of the Ethernet at Xerox PARC. Now, on June 23, 2013, we are celebrating the 30th anniversary of Ethernet standardization through IEEE 802." Of course, Ethernet has been standardized many times since 1983, when IEEE 802.3 adopted the rapid innovations from 2.94 Mbps to 400Gb/s, from thick to thin coaxial cables, to twisted pairs and finally fiber-optic cables, as well as Wi-Fi, from CSMA/CD bus networks to switches and access points. At the same time, a high degree of backward compatibility was ensured. "In 1983 there were people who bought Ethernet and whom I did not know personally. In 1985 there were even people I did not know who invented Ethernet. And they continue to do so today with great success, using the open standardization process of the IEEE. Congratulations and many thanks," Metcalfe continues *(source: IEEE SA)*.

INCREASING DATA RATES

And speeds have also increased and continue to increase today ***(see Figure 2)***. The twisted-pair cabling systems used today have developed rapidly over the last ten years. While in 1995 networks with transmission rates of 10 & 100Mb/s were still being set up and operated, the speed in our networks has increased by two decades (factor 100) since then. Since the year 2000, copper-based networks with transmission rates of 1Gb/s have been set up and operated, initially in data centers and now also at the workplace. At present, networks with

transmission rates of 10Gb/s according to the Cat 6A / Class E_A have been installed and operated for several years.

Initially, these are mainly found in data centers for connecting high-performance servers to corresponding switches and storage systems. But just as this development has been seen repeatedly in the past, today's servers are still our desktops of tomorrow – both in terms of the performance of the computers and their connection to the network. Another milestone was set on 17 June 2010. The "IEEE 802.3ba – 40Gb/s and 100Gb/s Ethernet Task Force" adopted the standard for the transmission of 40Gb/s over copper cabling and 40 / 100Gb/s over fiber-optic cabling.

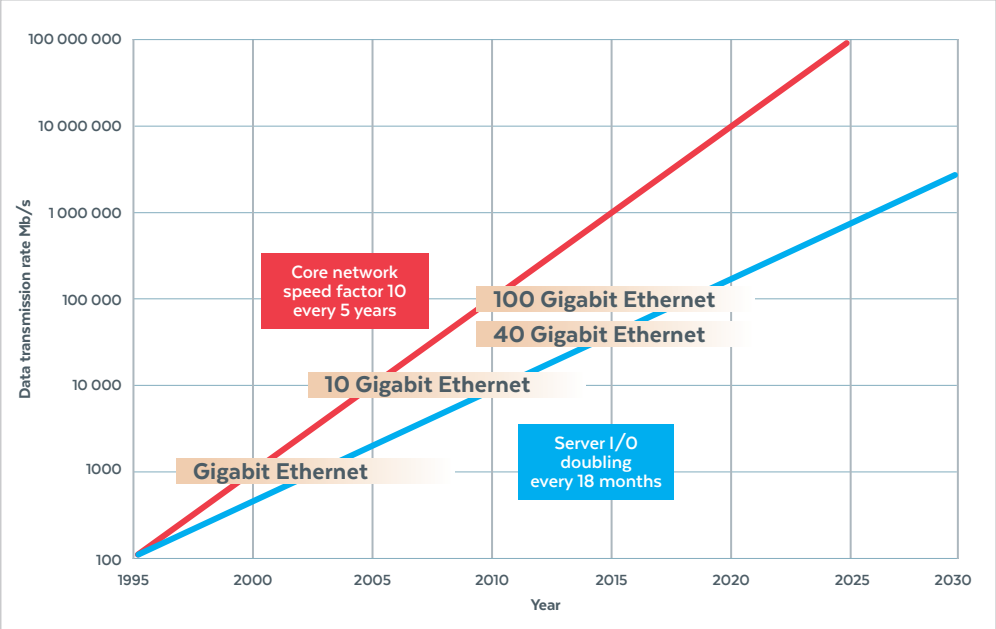

Figure 2: Increase in bandwidth requirements in networks and data centers

CHAPTER 2:

THE STRUCTURED CABLING

THE STANDARDS FOR CABLING

On June 30, 2016, the responsible IEEE committee announced the adoption of the new Ethernet standard 802.3bq for 25GBase-T and 40GBase-T over copper applications. And that is not all, the next goals of IEEE 802.3 have again been addressed. On Dec 8, 2021, the IEEE P802.3df Project Authorisation Request (PAR) was approved and shortly after that the "IEEE P802.3df Ethernet Task Force" started the work on new Ethernet standards with speeds of 200Gb/s, 400Gb/s, 800Gb/s, and 1.6Tb/s for future use in datacenter networks.

While Ethernet transmission standards describe data transmission, cabling standards describe the infrastructure. These cabling standards describe the layout as well as the transmission properties derived from the transmission requirements written in IEEE 802.3.

This structured cabling, also known as Universal Structured Building Cabling, represents a uniform layout plan for cabling for different services such as voice, data, video, control systems, etc. for structured cabling, the International Committee for Electrotechnical Standardization (ISO/IEC) has published the International Standard ISO/IEC 11801 for application-neutral cabling systems, in USA the ANSI/TIA-568 Cabling Standards have been published by the Telecommunications Industry Association (TIA), that is accredited by the American National Standards Institute (ANSI). In Europe the CENELEC has published the EN 50173 Cabling Standard following the ISO/IEC 11801 standard.

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HEADQUARTERS
Softing IT Networks GmbH
Richard-Reitzner-Allee 6
85540 Haar, Germany

+49 89 45 656 660
info.itnetworks@softing.com

Find your local distributor:
itnetworks.softing.com/contact

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