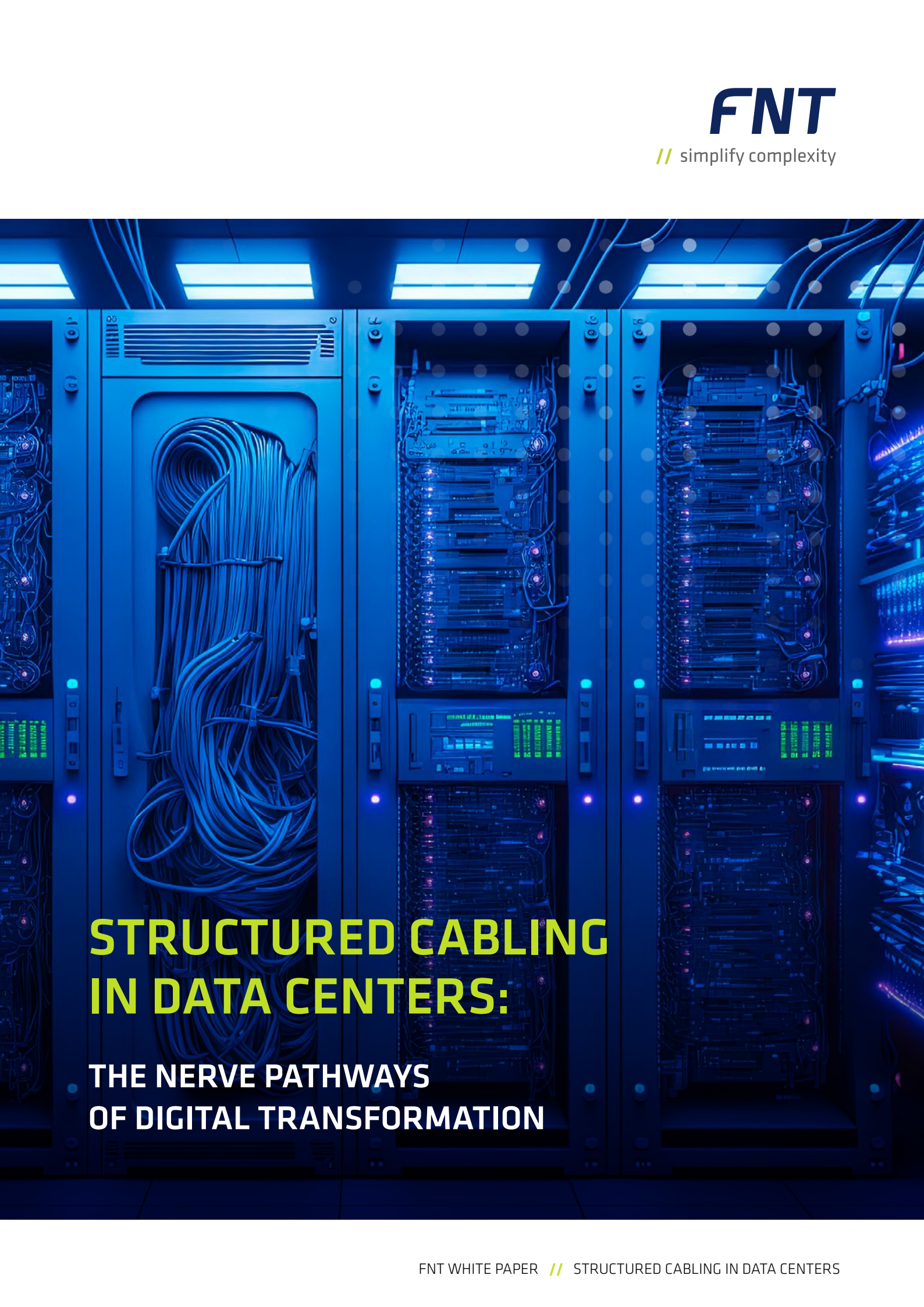


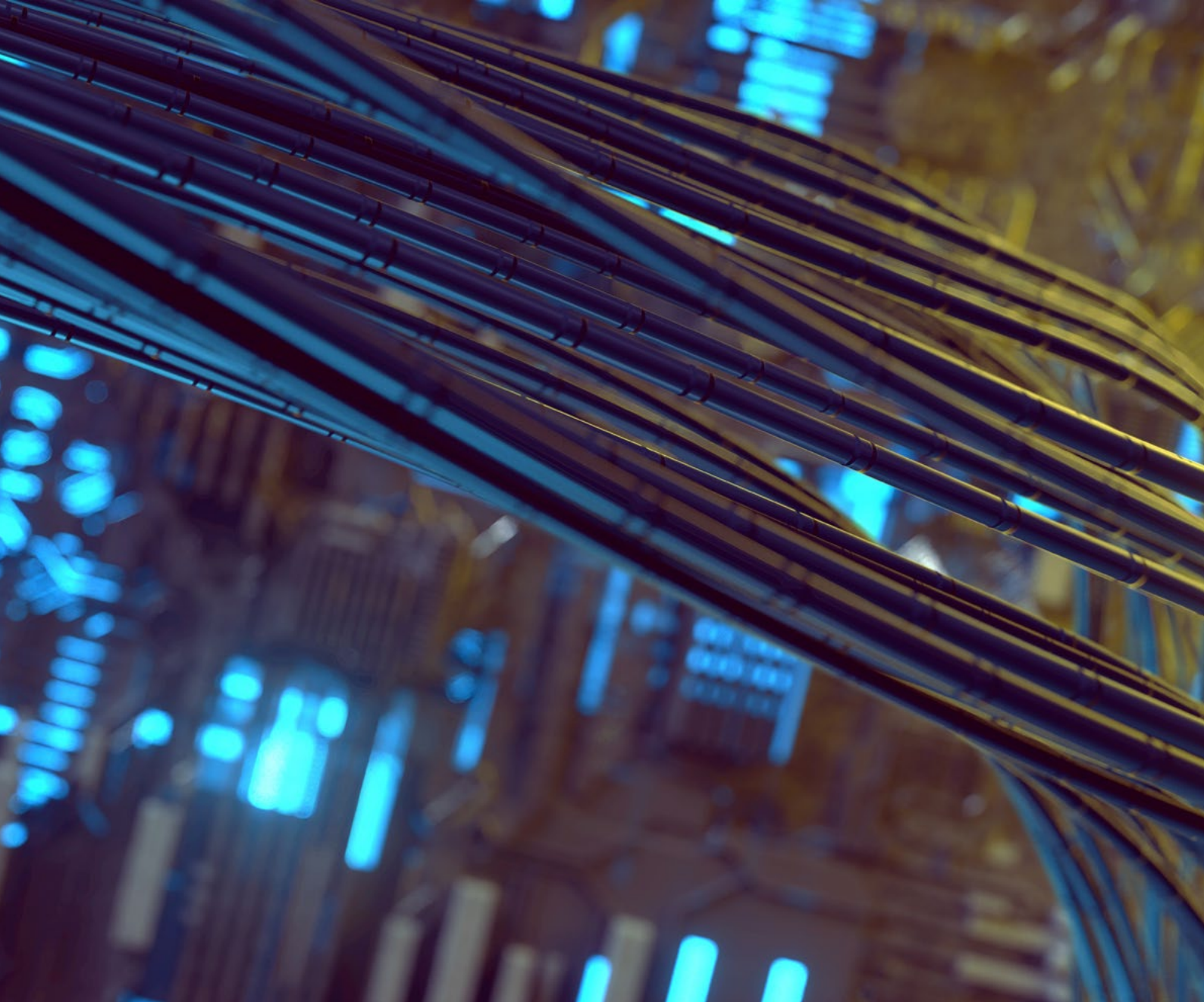


FNT

// simplify complexity

STRUCTURED CABLING IN DATA CENTERS:

THE NERVE PATHWAYS OF DIGITAL TRANSFORMATION



IN THIS WHITE PAPER:

Few aspects of digital infrastructure are as undervalued as network cabling – yet few are as critical to the process. Cabling provides the essential foundation for all forms of connectivity, data communication, and digital value creation. At the same time, the cables themselves are largely invisible, with more and more IT services being consumed from the cloud via WLAN. The highly qualified teams that provide and operate the cabling also work behind the scenes. This is especially true of the cabling in data centers, which is often regarded as a black box.

In this white paper, we highlight the importance of cable management and discuss the challenges that operators of complex cabling need to address, what happens when these challenges are not handled properly, the important role documentation plays, and when it is time for a paradigm shift.

CONTENTS

Data cables in data centers – the backbone of global data communication	3
Cable management in data centers – challenges for operators	5
Sign 1: The Number of Components	5
Sign 2: The Mix of Cables	5
Sign 3: The Operational Situation	5
Traditional mechanisms and aids for cable management – why they fail	7
Summary: The target vision for modern cable management	8
About FNT	9



Data cables in data centers – the backbone of global data communication

Data transmission continues to grow in importance and scale: more than five billion people are now online and using the Internet, Google processes more than 3.3 billion search queries a day, and more than 300 billion e-mails are sent and received every day. The users of just one streaming service, Netflix, streamed around 203.8 million hours of content per day in 2022, and there are expected to be 75 billion IoT devices in use and transmitting data by 2025.

Network cables are the nerve pathways of this rapid and constantly advancing digital revolution. They connect the nodes of the Internet, companies, and people. Without them, global communication and information flows would cease, supply chains would shudder to a halt, self-driving cars would be grounded, and aircraft would be grounded. These are just a few examples that illustrate the dependence of modern societies on smooth data communication.

Data centers form the backbone of this communication infrastructure, whether they are hyperscaler facilities, telecommunications provider hubs, edge data centers, or the enterprise IT data centers of all sizes found in almost every company across all industries. Vast volumes of data transmissions are concentrated in data centers, in a relatively small space. Flawless communication between all devices and the integrity of data links to and

from the outside world are critical. This is dependent on wholly functioning structured cabling and the interaction of the cables with all the active and passive components of the network.

Cable management in data centers

Cable management in data centers covers all the capabilities that support initial installation, operation, and expansion of the cabling infrastructure, its ongoing development, and adaptation to new architectures and transmission technologies. The purpose of structured cabling in a data center is to raise data transmission rates while keeping the space requirement the same by increasing the density, boosting capacity utilization, guaranteeing high reliability and availability, minimizing downtime in the event of outages, and simultaneously reducing running costs. Documentation plays a key role in all of this. Structured cabling incorporates many passive elements that cannot be automatically detected or interactively queried, so the documentation represents the central “memory” of the cable infrastructure.



Without quality cable management, the risk of something going wrong in your network is high.

Making management of this cabling as simple and cost-efficient as possible, despite its inherent complexity, is a critically important part of professional data center management. However, that is easier said than done. There are plenty of real-world examples of what happens without appropriate cable management in a data center:

- Insufficient knowledge of existing connections leads to duplicate installations, which drives up costs and prematurely exhausts capacity reserves for cable management elements (trays, clamp rails, etc.).
- Existing installations are expanded ad hoc as needed, without any consultation and without the changes being documented.
- Incomplete knowledge about the as-is cable network makes planning future changes difficult, since key knowledge about prerequisites, dependencies, and undesired cross-effects is lacking.
- Uncontrolled and uncoordinated use of cable media (copper, fiber, coax) leads to elevated maintenance costs, disruption of data transmission, and a higher risk of outages.
- Poorly planned and often incomplete removal of cable connections, where the cable is left in place for possible use again in the future, can no longer be identified at a later date and makes an existing cable spaghetti problem even worse.



You can get more worst practices in our white paper [Cable spaghetti as a 3-course meal](#).

Cable management in data centers – challenges for operators

How do you know when it's time to professionalize your data center cable management?

SIGN 1: THE NUMBER OF COMPONENTS

The scale of the data center infrastructure being used is one key indicator. Depending on the deployed technology, even a mid-sized data center with 50 racks can have between 20,000 and 50,000 individual cabling and port components that need to be managed and documented. If we then look at a data center that serves a corporate campus and add the connections to the backbone cabling infrastructure of the individual buildings and the distribution cabinets on each floor, the number of structured cabling elements soon rises exponentially.

One of the drivers behind this growth in elements that need to be documented and managed is the continuing increase in density. Standard tool-based approaches to documentation using Excel-style spreadsheet lists don't cut it at this kind of scale. Although things may appear to be under control, the situation is actually dangerous and involves significant operational risks.

SIGN 2: THE MIX OF CABLES

Secondly, the mix of cabling technologies and architectures plays a role. Powered and unpowered copper (PoE, Power over Ethernet), fiber optic cabling in the usual dual-fiber configuration, MTP/MPO multifiber trunk, breakout and conversion cables for high-density backbone cabling, a switch from point-to-point cabling to structured cabling, different architectural designs such as top-of-rack (ToR) and end-of-row (EoR) – those are just a few of the key aspects worth mentioning. When different technologies and architectures are involved or changes are planned, a professional approach to cable management becomes essential in order to manage the complexity. This is the only way projects aimed at changing architectures and technologies can be implemented on time and on budget.

SIGN 3: THE OPERATIONAL SITUATION

Thirdly, the day-to-day experience of operating the data center and its cable infrastructure provides clear signs that managers need to engage with professional data center cable management. The most important reasons for taking action are:

- 1 Stability and availability:** You are experiencing faults and outages of communication services that can be attributed to technical defects in network cabling or improper modifications.
- 2 High implementation and communication effort coupled with poor work outcomes:** You find when making changes to structured cabling that implementation is time consuming and mistakes are common.
- 3 Inefficient deployment of technical teams:** You establish that the reason your budgets for expanding and modifying structured cabling and establishing new network connections are used up so quickly is that technicians are sent to the same location too frequently and at too short intervals.
- 4 Capacity problems:** Regardless of how much you invest in expansion as a data center operator, there is a perpetual shortage of ports.
- 5 Thermal hotspots in cabling:** Heat effects are reported in cable trays containing large numbers of cables laid together. In a worst-case scenario, you may have already had to deal with a smoldering cable or fire.

Searching for the causes involves huge effort, and long response times have a negative impact on the user experience. You become increasingly aware that network outages, which affect mission-critical business applications or cripple data center services provided to external customers, can hurt the bottom line. Increasing density, with large numbers of data connections via individual fiber cables, brings with it the risk that uncontrolled disconnection of a single MPO plug could affect the work of entire corporate divisions or endanger the organization's business model. You need to guard against this scenario.

Investigating the issue, you realize there is a strong correlation with poor planning quality and difficulties around managing the implementation process. Technicians receive incomplete work instructions or encounter a reality that deviates from the planning assumptions when they arrive on site. They may then improvise, leading to faulty installations and even more divergence between documentation and reality.

Many planners lack an overview of which change requests can be handled in close succession. It is also important to know which planned and approved sub-orders relate to the same data center, the same room, or even the same rack. In other words, you are wasting a lot of money on inefficient service calls.

You discover that the most common cause of port shortages is cabling that has become obsolete but has not been removed. You invest unnecessarily in expensive port capacity expansion when you could have freed up and used existing ports, tying up key funding that could have been put to better use.



When looking for the cause or during an excessive heat investigation, you discover that nobody knows which cables run through the hotspot. Are they purely data cables or do they also carry electricity (e.g. Power over Ethernet, PoE)? The fact that this was not identified in advance is most likely due to inadequate labeling of the cables and not knowing or documenting their characteristics.

6 Hindering of efforts to achieve good PUE values and improve sustainability: Growing focus on how data center operation impacts the environment and changing regulations make you take a more critical look at your cabling.

You discover that poor cable management results in challenges to your green IT objectives on many fronts. On the one hand, poorly laid cables impair the flow of cooling air, thus preventing you from achieving the desired energy efficiency values. On the other hand, data centers without complete documentation find it difficult to achieve circular reuse of cabling equipment. The same also applies to progress on the preferred use of cabling components that have been manufactured according to sustainability criteria with a minimized CO2 footprint.

7 Audit stress: You find that preparing for certification with regard to key standards, such as ISO 27001, or an audit to ensure compliance with structured cabling standards is very demanding on your organization.

In an audit, critical findings (i.e., discrepancies that must be corrected) arise because the requirements of the relevant standards have not been met. You discover that the cause lies in a lack of knowledge of the ex-

isting structured cabling; the documentation is incomplete and the necessary corrections were not identified in day-to-day operation. Last-minute changes ahead of an audit are often not possible and you face the real risk of failing to acquire an important certification. Furthermore, things tend to slide again after an audit, leading to new issues to deal with on re-certification.

Cables are cheap – a myth

Estimates of the cost of cable infrastructures and the value of individual cables are often shaped by the experience of the end user, and their experiences may not be an accurate reflection of reality. Their perception of the average CAT5e patch cable with an RJ45 plug for 59 euro cents a meter for home use leads to the misconception that cables are consumables. When it comes to data center cabling, many cables are laid in long runs with higher quality shielding to ensure interference-free transmission of higher bandwidths. They also need to be more flame-retardant to meet fire protection standards. The consequence is that in large data centers, cabling can cost several hundred thousand euros. And that's before taking fiber optics into account – a price of around 130 euros for a single MTO/MPO fanout cable quickly dispels the illusion that cabling is cheap. The raft of additional components, such as converters, splitters, signal amplifiers, professional cable ducts, and quality assurance equipment like optical test tools, make it clear that data center cabling is a significant investment and should be treated as such – with professional handling and documentation.



Traditional mechanisms and aids for cable management – why they fail

Complex cable infrastructures are often the result of evolution over many years. They may have started out small, but have gradually grown both in size and substance. Developments in technology and innovations in architectural design lead to significant changes in the cable network over time. In contrast, companies often fail to evolve the tools used to document the cable infrastructure. This results in a mismatch between the cables being managed and the tools being used to manage them.

The original, quite modest infrastructure was often documented using tools such as spreadsheets or in-house solutions that were not very user friendly. This, coupled with the fact that documentation was often not made a high priority, resulted in information being out of date, incomplete, and erroneous.

Further functional deficits exacerbate the problem, including a lack of feasibility testing and checks on threshold violations, missing information on cable connection endpoints, poor integration into processes and communication mechanisms, along with problems with visualizations, early change planning, and multi-user capability.

The consequences can be serious, as the examples below show:

- Any combination of plugs and cables can be documented, even if they are completely nonsensical from a technical viewpoint.
- Cable runs can be recorded even if they are not supported by the technologies used.
- Ports of active and passive devices in the structured cabling can be assigned multiple times without this being detected.
- The inherent complexity of multi-hop connections means that they exceed the capabilities of makeshift documentation, often ending up unrecognized in limbo.
- In the absence of the ability to document the signals and services transmitted over the connections in question, the documentation offers no value when it comes to determining how important a connection is and whether it is redundant.
- It is correspondingly difficult, if not impossible, to avoid SLA violations when changes are made and users cannot be notified with timely, specific information on unplanned downtime.
- Changes and patch orders cannot be planned properly in advance, preventing the reliable instruction and management of internal or external technical teams and a stringent target-actual comparison for quality control purposes.
- Team members unwittingly work on the same documentation entries and overwrite each other's data.
- Without any graphical navigation capability, finding their way around the cable network structure is an extremely time consuming and difficult process for new employees.



Summary: The target vision for modern cable management

You know it's time to adopt a new approach to cable management if you find that your data center and cable infrastructure:

- have reached or exceeded a certain size
- have become highly complex
- are correlated with negative operational experiences
- exhibit numerous deficits in your documentation

The relevant principles are examined in detail in our white paper **"Cable Chaos in Data Centers"**. It also addresses the question of how the latest cable management tools can help to implement these principles in a networked system – a challenge that can no longer be dealt with using spreadsheets and homemade solutions.

Modern software provides a basis for meeting your commercial and organizational goals. These goals include:

"Get ahead of things" – Passively documenting changes after an event is not helpful. You should be able to use high quality documentation to proactively plan changes to the cable infrastructure, perform quality assurance on the results with a target-actual comparison, and update documentation so it stays current and useful for planning the next round of changes.

"Optimize in advance" – Use autorouting to identify the ideal path between end points and optimize material utilization in cabling.

"Execute control over the workforce" – Achieve better work order and deployment planning for teams with improved ability to handle cabling work and patching.

"Create the actual status by confirming the target status" – Ensure a seamless transition to the server and storage infrastructures connected to the cables.

 [Download the white paper now.](#)



About FNT

FNT GmbH, headquartered in Ellwangen (Jagst), Germany, simplifies the management of highly complex digital infrastructures in companies and public authorities with its FNT Command Platform. With the cloud-enabled “software made in Germany”, IT, telecommunications and data center infrastructures can be efficiently recorded as digital twins and documented across all levels from buildings to digital services. The software also offers open interfaces and numerous functions for planning,

implementing and automating transformations and changes in an integrated manner. FNT’s customers include more than 500 companies and government agencies worldwide, including more than half of the DAX-40 listed corporations. FNT operates offices in several locations in Germany as well as in New York, London, Singapore and Timisoara and has an international partner system with market-leading IT service providers and system integrators.

© Copyright (C) FNT GmbH, 2023. All rights reserved. The content of this document is subject to copyright law. Changes, abridgments, and additions require the prior written consent of FNT GmbH, Ellwangen, Germany. Reproduction is only permitted provided that this copyright notice is retained on the reproduced document. Any publication or translation requires the prior written consent of FNT GmbH, Ellwangen, Germany.