031.0226

WHITEPAPER

Beyond 100 Meters

Preserving Generic Cabling While Engineering Extended-Reach Exceptions

R&M

Executive Summary 3
Key recommendations 3

1. Market context: Why overlength is being discussed 4
The practical tension

2. Why generic cabling still matters 5
What generic cabling protects

3. Standards landscape as of May 2026 6
Generic cabling standards
Application and physical-layer standards
Extended distance work

4. Technical background: what actually limits extended copper 7
Transmission parameters
Why equipment-only validation is not enough
Cable construction and performance class

5. Solution options beyond 100 m 8
Single Pair Ethernet in the architecture
Fibre and hybrid approaches

6. Design framework for planners and owners 10
Decision matrix
Exception approval logic

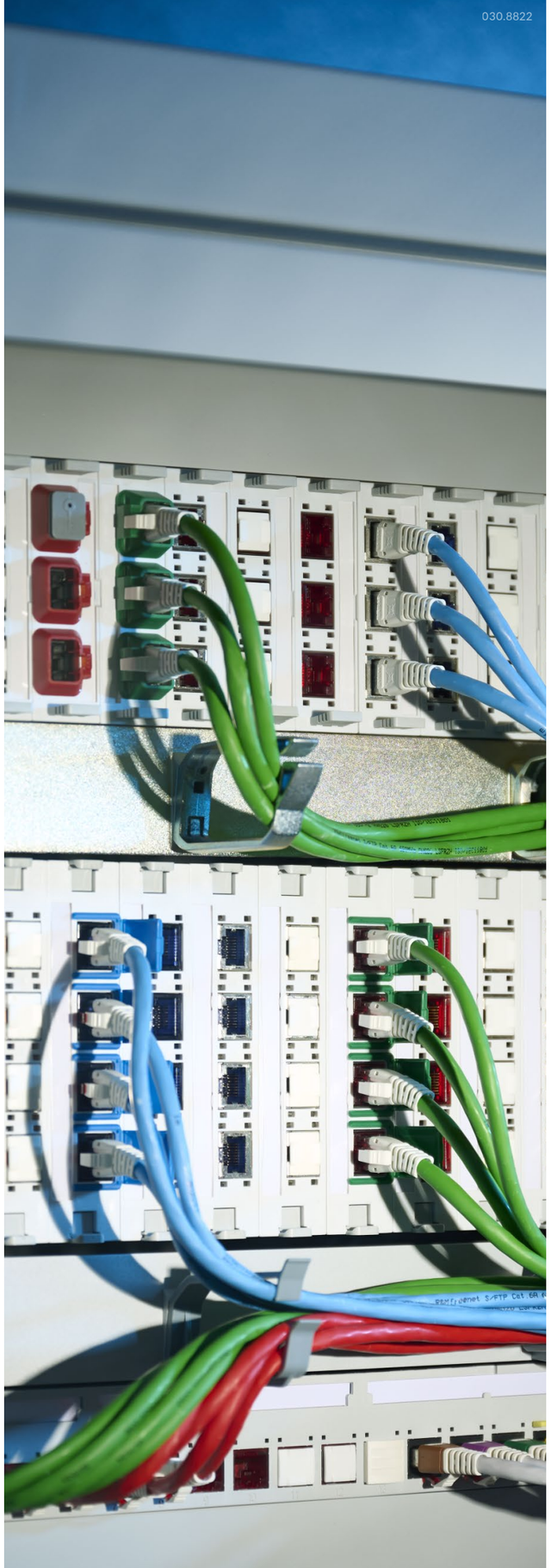
7. In short... 12
Three messages for stakeholders

8. Practical recommendations 13

Appendix A: Example technical figures 14
Application-specific channel lengths by cable type at 20°C
Temperature derating above 20°C

Appendix B: Draft checklist for exception approval 15

References and source notes 16



Executive summary

Extended-distance copper can be valuable at the edge of a smart building, warehouse, industrial site, or campus. But it should not become the default planning model for LAN infrastructure. The most resilient approach is to preserve generic, application-neutral cabling as the foundation, and to treat overlength links as engineered exceptions with explicit performance, power, thermal, documentation, and lifecycle controls.

Building infrastructure systems are becoming more IP-connected, device locations are moving to ceilings, perimeters, warehouses, campuses, and outdoor zones, and owners want to avoid additional telecommunications rooms which can be costly or impractical. These developments make debate around application-specific cabling beyond the traditional 100 m copper channel increasingly important. The question is not whether longer copper links work - the question is when they should be used, how they should be engineered, and how to prevent short-term extended reach solutions from weakening the long-term value of the cabling infrastructure. [1] [2]

This whitepaper takes a pragmatic position: it is vital not to deny the need for longer reach, but not to let that need overturn the principles that made structured cabling successful. Generic cabling separates the installed physical layer from the shorter lifecycle of switches, endpoints, protocols, and service models. That separation makes it possible for owners to change applications and suppliers without reopening walls, ceilings, risers, and pathways. [1] [3] [8]

Standards activity confirms the same direction. ISO/IEC 11801 continues to define generic cabling for multi-vendor customer-premises environments; TIA-568 defines generic telecommunications cabling structure, topologies, distances, installation, performance, and testing; and TIA has initiated TSB-5073 to develop guidance for extended distance over four-pair balanced twisted-pair cabling. This is not a signal to abandon generic cabling, but instead to bring engineering discipline and experience to a developing exception case. [6] [7] [8] [12]

Key recommendations

- Keep application-neutral, standards-based cabling as the default design principle for LAN infrastructure and smart-building backbones.
- Use application-specific overlength copper only when the application, bandwidth, power, environment, and expected lifecycle are known and documented.
- Base maximum length calculations on IEEE application limits and cabling performance, then apply temperature and PoE/bundle derating. Do not rely solely on vendor reach claims or one-time link-up tests.
- Where extended copper is justified, prefer solutions that preserve normal-length Class EA/10G capability wherever possible, especially in mixed office and smart-building environments.
- Evaluate alternatives before committing to a long copper exception: additional distributors, zone cabling/digital ceiling, fibre/copper hybrid, fibre with local power, or Single Pair Ethernet for low-bandwidth sensor/actuator zones.
- Label, administer, and restrict overlength circuits so future network teams understand that the link is application-specific and may not support future higher-speed services.

i

Extended-reach copper should be welcomed as an engineering tool, not promoted as a new default architecture. The value of generic cabling is not the 100 m number itself; it is the application independence, interoperability, and upgrade freedom that the standard channel model has provided for decades.

1. Market context

Why overlength is being discussed

Copper LAN cabling is now expected to support far more than traditional office connectivity. Smart buildings, industrial edge sites, logistics facilities, campuses, and outdoor areas increasingly place IP endpoints beyond the normal office floorplan and away from the nearest telecommunications room or distributor.

Cameras, access control, sensors, warehouse systems, small cells, wireless access points, signage, and automation controllers may all require reliable data and remote power where standard 100 m links are impractical. In these cases, extended copper links can avoid new distributors, cabinets, power supplies, switches, fibre runs, or media converters while preserving the simplicity of data and power over one connection.

TIA's motivation for TSB-5073 reflects this shift: smart buildings, industrial environments, and IoT deployments are creating longer-reach requirements that need guidance for reliable performance and interoperability beyond traditional distances. [7]

However, extended reach should not be treated as proof that generic cabling is obsolete. It is a design constraint and practical exception, not a reason to abandon the separation between physical infrastructure and the applications running over it. [1]

Dimension	Implication
Short-term pressure	Reach a distant device, avoid a new telecommunications room, reduce installation effort, or provide power and data on one copper link.
Long-term requirement	Preserve application independence, multi-vendor interoperability, upgrade options, warranty clarity, and manageable operations over multiple active equipment refresh cycles.
Whitepaper position	Use application-specific reach as an engineered exception within a generic, standards-based architecture - not as the replacement architecture.

2. Why generic cabling still matters

Generic cabling is successful because it deliberately and by design goes beyond the applications requirements of any given moment. Cabling is embedded in the building fabric and normally outlives several generations of switches, endpoints, wireless systems, building-management platforms, security devices, and automation protocols. If the physical layer is tied too closely to one application, one data rate, one device class, or one vendor proposition, the building may be lacking capacity and flexibility when new services are needed. [1]

This is particularly important in smart buildings. ALL-IP can act as the foundation for digitalized building automation, where routers, switches, servers, WLAN access points, door openers, LED lights, sensors, cameras, air-conditioning devices, and other systems communicate via IP. A smart building benefits from a universal, application-neutral network and an open, shared communication protocol. [4]

Advanced LAN also reinforces the generic model: a structured cabling solution makes IT infrastructure easier to build, operate, and maintain, whilst being application-neutral and capable of handling current and future transmission protocols. This aligns with ISO/IEC 11801-1, which specifies a multi-vendor cabling system that can be implemented with material from one or more sources and can support voice, data, video, and power. [3] [8]

What generic cabling protects

- Freedom to change endpoints, switch platforms, and service providers without replacing installed cable.
- Multi-vendor procurement and competitive sourcing over the entire building lifecycle.
- Backward and forward migration across Ethernet generations when the class/category permits.
- Simpler administration, troubleshooting, and moves/adds/changes.
- More predictable warranty, testing, and commissioning expectations.
- Common physical infrastructure that can support IT, OT, building automation, security, and occupant services.

Core principle
The more intelligent and converged the building becomes, the more universal the infrastructure should be. Smart-building convergence argues for generic cabling as the foundation, not for a patchwork of undocumented application-specific exceptions.

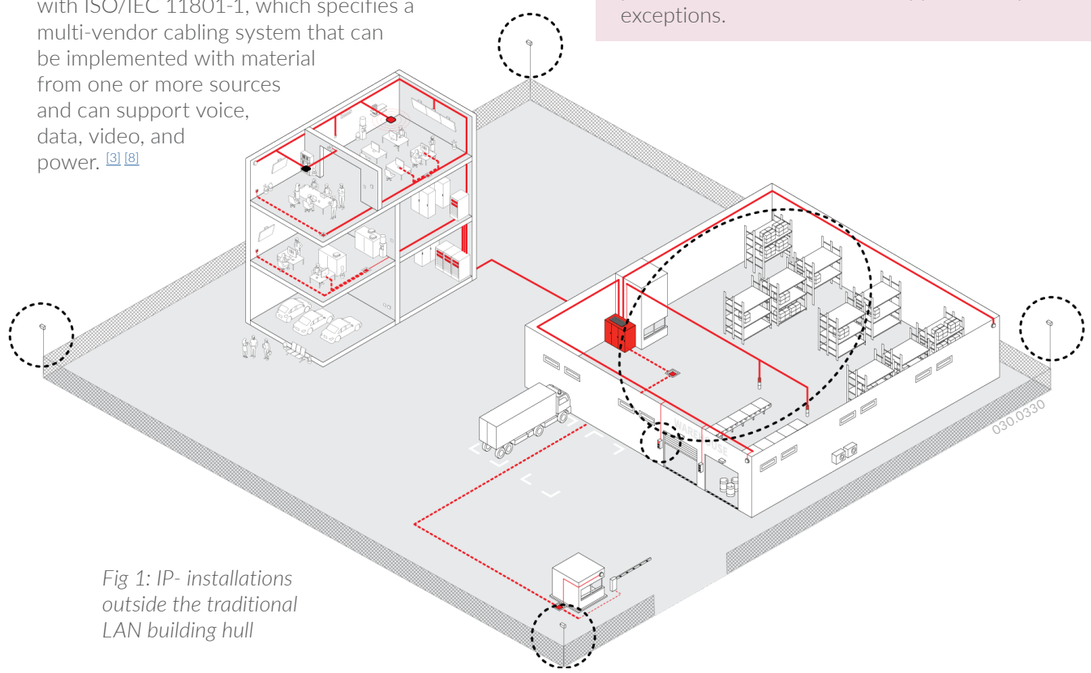


Fig 1: IP- installations outside the traditional LAN building hull

3. Standards landscape as of May 2026

The standards landscape is evolving, but it does not support a conclusion that generic cabling should be replaced by application-specific long copper runs. Instead, standards bodies and technical institutes are documenting how to handle edge cases with more discipline.

Generic cabling standards

ISO/IEC 11801-1 defines general requirements for generic customer-premises cabling, describing a multi-vendor system that supports voice, data, video, and power services. ISO/IEC 11801-3 applies these principles to industrial premises and automation islands, while ISO/IEC 11801-6 covers distributed building services across single buildings or multi-building campuses. [8] [9] [10]

TIA-568.0-E defines the structure, topology, distances, installation, performance, and testing requirements for generic telecommunications cabling. TIA FOTC also notes the channel basis of 90 m permanent-link equivalent cable plus 10 m of cordage, with updates recognizing new media and building-system connection models. [12]

Application and physical-layer standards

IEEE 802.3 defines Ethernet physical layers and remote powering mechanisms. Its 802.3an listing specifies 10GBASE-T as a LAN interconnect for up to 100 m of balanced twisted-pair structured cabling, while related 802.3 amendments cover power over data lines for single-pair Ethernet and higher-power Ethernet designs. [11]

For remote powering, ISO/IEC TS 29125 sets cabling requirements, and TIA-568.2-E incorporates power-delivery guidance previously covered in TIA-568.2-D-2. Where overlength PoE links are used, thermal behaviour and cable bundle design must be treated as core channel-engineering considerations, not secondary issues. [14] [15]

Extended distance work

TIA TR-42.7 has issued a call for interest for TIA-TSB-5073, initially titled “Guidelines for Supporting Extended Distance over 4-pair Balanced Twisted-Pair Cabling.” [6] [7]

ICT Today, BICSI’s official trade journal, describes the developing TSB as engineering guidance for channels exceeding 100 m while maintaining performance and interoperability. It also notes that the established 100 m model—90 m solid-conductor cable plus 10 m patch/equipment cords—has endured because it supports multiple Ethernet generations and predictable multi-vendor performance. [13]

> *i* TSB-5073 should be considered as engineering guidance for exceptions. It should not be framed as permission to redesign the LAN around long, application-bound copper runs.

4. Technical background

What actually limits extended copper

The physical reasons for the 100 m copper channel model do not disappear when a low-bandwidth endpoint happens to link up at a longer distance. Longer balanced twisted-pair channels face cumulative insertion loss, propagation delay, delay skew, return loss, noise, alien crosstalk, thermal effects, and remote-power voltage drop. In addition, different Ethernet PHY implementations may have different margins even when they are standards compliant. [2] [13]

Transmission parameters

- Insertion loss/attenuation: longer cable length and smaller conductor diameter increase signal loss. Larger copper diameter can extend reach, but does not remove other constraints.
- Propagation delay and delay skew: application reach can be limited by absolute delay and by the difference in delay between pairs. Modern Layer 3 switching reduces old collision-domain concerns about propagation delay, but delay skew considerations remain channel length limiting for 1000Base-T and above. [2]
- Noise and alien crosstalk: longer channels have less Signal to Noise margin (S/N), especially in high-density pathways or electrically noisy locations.
- Temperature: cable attenuation increases with temperature. The cabling standards state derating factors above 20°C: screened installations at 0.2% per °C, and unscreened installations at 0.4% per °C from 20°C to 40°C and 0.6% per °C from 40°C to 60°C. [2]
- Remote power: PoE increases conductor temperature and voltage drop, particularly in bundles. The longer the link, the less margin remains for both signal and power.

Why equipment-only validation is not enough

A common extended-reach argument is that a specific switch, endpoint, and cable combination has been tested and works. That can be useful evidence, but it is not the same as a generic infrastructure claim. According to ICT Today, a channel that performs with one switch and endpoint combination may not maintain the same margin after equipment refresh cycles, because PHY differences can materially affect extended-distance performance. The more durable approach is an engineered channel methodology that accounts for the full operating frequency range, environmental variables, power requirements, and external noise. [13]

Cable construction and performance class

Special installation cables can improve attenuation and delay characteristics through larger conductor diameter, such as AWG22, and longer pair lay length. Simply installing today’s extended-reach cables as Category 6, does not solve the broader planning problem, since the Cat.6 cabling restricts the data bandwidth for the entire installation. A planner must decide whether the project accepts a mixed cable-type installation or whether it needs a high-performance solution that supports Class EA/10G at normal lengths while also offering application-specific reach where justified. [1] [2]

5. Solution options beyond 100 m

There is no single "extended distance" answer. The right choice depends on the application, required bandwidth, power requirement, environment, operational model, upgrade expectations, and ownership horizon.

Option	Description	Best-use notes
A. Stay within cabling-standard requirements	Use higher-performance cabling and components so the installed channel or permanent link still meets the relevant class requirements. The international cabling standards identify three conformity paths: meet all channel transmission requirements; meet permanent-link requirements with compliant patch cords; or meet reference implementation requirements including length restrictions. Of these three options, the first two options do not have any defined length restrictions. [2]	Best where a design can maintain standards-based performance and future flexibility. All requirements for a specific transmission Class according to ISO/IEC 11801 or EN50173 should be met. Typically achieves Channel lengths around 120m with purpose-built cables
B. Additional distributor, zone cabling, or digital ceiling	Move the network edge closer to devices through a floor distributor, zone enclosure, service outlet, or digital ceiling concept with service outlet.	Preserves generic architecture and moves/adds/changes flexibility. May require space, power, cooling, security, and operations planning.
C. Fibre/copper hybrid	Use fibre for data and copper conductors for power. R&M positions FO/Cu hybrid cabling for distances up to 200 m and notes that a fibre-capable device or media converter is needed at the far end. [2]	Useful for distance and EMI resilience. Adds active equipment or endpoint requirements, and power delivery must still be engineered.
D. Single Pair Ethernet	Use SPE for low-bandwidth field devices, sensors, actuators, and automation zones. SPE is a supplement for the last few meters and a problem solver for specific circumstances, not a general replacement for RJ45. [5]	Strong fit for low-bandwidth sensor/actuator level, especially where IP replaces fieldbus. Not a universal replacement for four-pair LAN or high-bandwidth endpoints. SPE is a recognized cabling option for Distributed Building Services (OT) according to the generic standards documents
E. Application-specific 4-pair overlength copper	Use a longer four-pair copper channel for a defined Ethernet application such as 10BASE-T, 100BASE-TX, or 1000BASE-T, with explicit length, thermal, power, and PHY assumptions.	Can solve difficult edge cases. Loses generic flexibility unless carefully constrained, labelled, and lifecycle-managed. IEEE-based calculation is recommended to at least ensure manufacturer independence. [2]

Single Pair Ethernet in the architecture

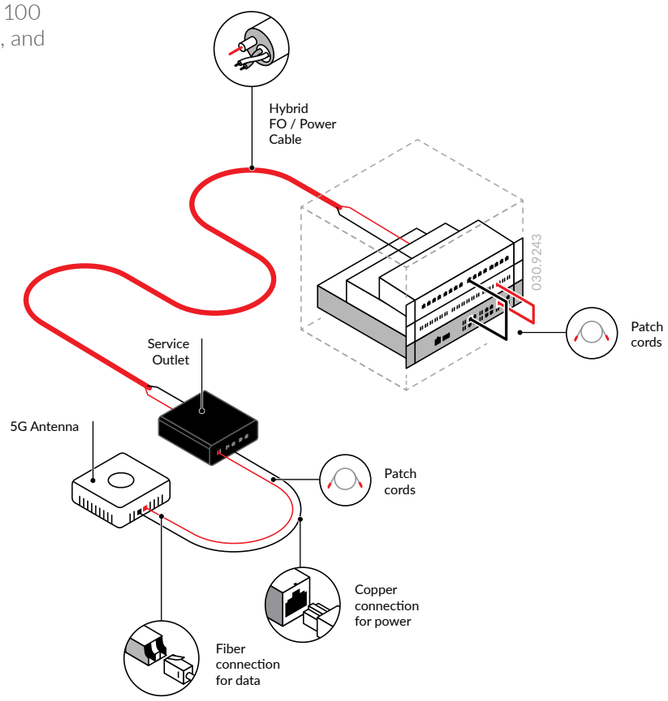
SPE deserves separate treatment because it is not simply "longer RJ45." SPE is a smart-building and industrial-automation technology that extends Ethernet/IP connectivity down to sensors and actuators. [5]

This makes SPE strategically important but complementary: it supports the ALL-IP smart-building vision without turning the whole four-pair LAN into an extended-reach, application-specific network. We can illustrate this with three zones: RJ45/4PPoE up to 100 m, SPE with remote power at roughly 200–500 m, and SPE with local power at around 600–1,000 m. [2]

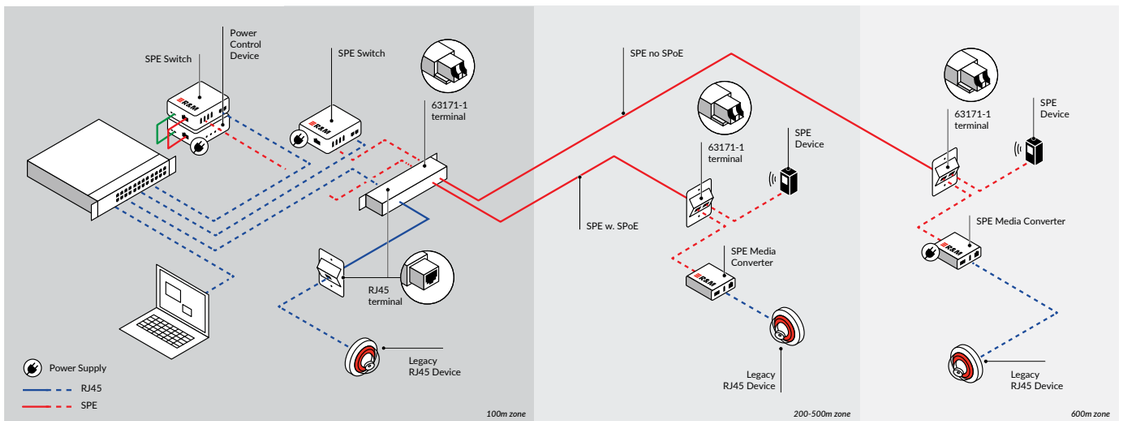
Fibre and hybrid approaches

Fibre remains the cleanest answer for many distance problems, especially were bandwidth, EMI immunity, campus scale, or upgrade headroom matter more than single-cable power delivery. The trade-off is that fibre normally requires local power or a hybrid power strategy at the far end. A FO/Cu hybrid combination is, therefore., a valid option, especially for antennas, cameras, and remote service outlets where data reach, high bandwidth and power delivery must be solved together. [2]

Hybrid FO / Power installation schematic



SPE installation use zones



6. Design framework for planners and owners

The following framework turns the position into a repeatable planning method. It assumes that generic cabling is the default, and that extended copper is an exception requiring approval.

Planning rule
A link that is only proven by a specific switch and a specific endpoint should be treated as an equipment-dependent solution. A link that is engineered against channel limits, environmental conditions, and lifecycle change is closer to infrastructure.

Scenario	Preferred architecture	Design caution
Standard office, tenant, or mixed-use area; unknown future applications	Generic application-neutral cabling, normally Category 6A/Class EA or project-standard equivalent	Avoid application-specific overlength. Preserve mobility and upgrade options.
Smart-building ceiling zone with frequent device changes	Zone cabling/digital ceiling with service outlets and distributed connection points	Supports plug-and-play device changes without replacing installed cable.
Low-bandwidth sensor/ actuator or fieldbus-replacement use case	SPE as an edge extension where devices and power model support it	Document connector type, power method, and integration to the four-pair LAN.
Remote camera/access/ control/warehouse endpoint over 100 m with stable bandwidth need	Evaluate additional distributor, fibre/ hybrid, or engineered application-specific copper	Use IEEE-based reach calculations, thermal derating, PoE bundle modelling, and lifecycle restriction labels.
High-bandwidth endpoint or potential future AP/cellular/ camera upgrade	Fibre, additional distributor, or generic higher-performance cabling within standard channel model	Avoid long copper exceptions that may block future speeds.
Outdoor/campus/perimeter endpoint in noisy environment	Fibre or hybrid FO/power, with environmental-rated components	Consider lightning/surge, grounding/ bonding, enclosure, temperature, and maintainability.

Exception approval logic

1. Identify the exact application: current protocol, expected data rate, PoE class/type, endpoint power demand, and future upgrade expectation.
2. Confirm that generic design alternatives have been considered: additional distributor, zone cabling, fibre, hybrid fibre/power, SPE, or local power.
3. Select a cable and connectivity system, including patch cords and connector count, not just installation cable.
4. Calculate application reach using IEEE-based channel assumptions and all derating factors, including temperature and PoE/bundling effects.
5. Define the test method and acceptance criteria before installation.
6. Document the circuit as application-specific, including allowed protocol(s), maximum power, maximum operating temperature, and change-control restrictions.
7. Define the migration path if the endpoint later requires higher bandwidth, different power, or a different vendor platform.

7. In short...

The approach should be balanced: acknowledge the need for reach, support standards work, and protect the infrastructure principles that building owners buy. The industry should not deny real scenarios where the 100 m assumption is under pressure, but it should resist turning every reach problem into a new application-specific infrastructure class. [1]

The main argument	Extended reach is a useful tool for specific edge cases, but generic cabling remains the foundation for smart, converged buildings.
What to avoid	“The 100 m channel is obsolete” or “application-specific long copper can replace structured cabling.”
Why it matters	Owners need infrastructure that survives multiple generations of applications, not only this year’s endpoint map.
How R&M can differentiate	By combining generic LAN, digital ceiling, PoE expertise, SPE, hybrid FO/ power, and engineering guidance into one lifecycle-based design approach.

Three messages for stakeholders

1
For owners: the cheapest immediate cable route is not always the lowest lifecycle cost if it narrows future use of the building.

2
For planners: overlength copper requires a documented engineering process, not a generic assumption or a simple product substitution.

3
For installers/integrators: labels, records, test data, and change-control notes are part of the deliverable because the link is no longer application-neutral.

8. Practical recommendations

1. Default to standards-based generic cabling for normal office, smart-building, and mixed-use LAN infrastructure.
2. Use application-specific overlength copper only for applications with stable requirements, not for generic outlets or unknown future endpoints.
3. For installations expected to support both normal LAN and selected overlength use cases, specify cable and connectivity that preserve Class EA/10G capability at normal lengths whenever practicable.
4. Calculate reach with IEEE-based application limits; do not adopt proprietary reach tables unless the resulting exclusion of minimum-compliant devices is understood and accepted.
5. Apply temperature and PoE derating above 20°C and use a thermal model or calculator for bundled PoE links.
6. Use screened, larger-conductor solutions where design depends on lower attenuation and stronger thermal/power margin.
7. Consider fibre, hybrid FO/power, or SPE before forcing a four-pair copper link beyond its generic design envelope.
8. Include explicit administration: labelling, as-built drawings, permitted applications, power limits, environmental assumptions, test results, and revalidation triggers.
9. Reassess extended-reach links during endpoint or switch refresh, because PHY margins and power demand can change.

Appendix A

Example technical figures

The following figures should be treated as draft discussion figures and verified against the latest standards, products, test methods, and project conditions before use in specifications. [2]

Application-specific electrical channel lengths by cable type at 20°C

Cable type	10BASE-T	100BASE-TX	1000BASE-T	PoE
S/FTP C7A AWG22	230 m	149 m	132 m (149 m without delay limit)	216 m
U/FTP C6A AWG23	207 m	134 m	133 m (134 m without delay limit)	171 m
U/UTP C6A AWG23	217 m	141 m	107 m (125 m without delay limit)	158 m
U/UTP C6 AWG23	213 m	138 m	112 m (138 m without delay limit)	160 m
U/UTP C6 AWG24	188 m	121 m	110 m (121 m without delay limit)	138 m
U/UTP C5e AWG24	182 m	118 m	114 m (118 m without delay limit)	127 m

Note

These are electrical channel lengths according to IEEE at 20°C. Reduced channel reach due to additional attenuation of patch cords and CP-cables must be considered according to standards guidelines.

Values in parentheses indicate reachable channel length without considering delay limits. Depending on the network equipment type and generation, specific collision domain requirements may not apply.

These distances are typical values, and not a substitute for project-specific engineering and field validation. [2]

Temperature derating above 20°C

Condition	Derating rule from cabling standards
Screened installation	Reduce achievable length by 0.2% per °C above 20°C.
Unscreened installation, 20°C-40°C	Reduce achievable length by 0.4% per °C above 20°C.
Unscreened installation, 40°C-60°C	Reduce achievable length by 0.6% per °C above 40°C after applying the lower range.

Appendix B

Draft checklist for exception approval

Checkpoint	Evidence required
☐ **Application defined**	Protocol, speed, endpoint class, power type/class, and future upgrade expectation recorded.
☐ **Alternatives reviewed**	Additional distributor, zone/digital ceiling, fibre, hybrid FO/power, SPE, and local power reviewed.
☐ **Cable system selected**	Cable type, gauge, shielding, connectors, patch cords, connector count, and pathway noted.
☐ **Channel calculated**	Insertion loss, delay, delay skew, return loss, crosstalk/noise, and power drop assessed.
☐ **Derating applied**	Ambient temperature, bundle heating, PoE load, pathway fill, and installation environment included.
☐ **Test criteria defined**	Field test method, acceptance thresholds, and documentation package agreed before installation.
☐ **Restrictions documented**	Allowed applications, maximum speed, maximum PoE level, environmental limits, and revalidation triggers recorded.
☐ **Administration complete**	Labels, drawings, records, warranty notes, and change-control warnings included in the handover package.
☐ **Migration path identified**	Plan exists if the endpoint later requires higher bandwidth, more power, or a different architecture.

References and source notes

[1] Matthias Gerber, “Extended distance and short-term thinking: why generic cabling still matters,” R&M, 2026.

[2] R&M, “Application Specific Overlength Cabling,” Customer Information, May 2026 presentation.

[3] R&M, “Local Area Networks (LAN),” https://www.rdm.com/solutions/local-area-network/

[4] R&M, “What Cabling for Smart Buildings Looks Like,” 31 March 2022, https://www.rdm.com/single-news/what-cabling-for-smart-buildings-looks-like/

[5] R&M, “Single Pair Ethernet (SPE),” https://www.rdm.com/single-pair-ethernet-spe/

[6] Telecommunications Industry Association, “TIA Issues Call for Interest on a New Project for TSB-5073 Guidelines for Supporting Extended Distance over 4-pair Balanced Twisted-Pair Cabling,” 9 September 2025, https://tiaonline.org/standardannouncement/tia-issues-call-for-interest-on-a-new-project-for-tsb-5073-guidelines-for-supporting-extended-distance-over-4-pair-balanced-twisted-pair-cabling/

[7] Telecommunications Industry Association, “White Paper: Extending the Reach of Copper Cabling,” https://tiaonline.org/resource/white-paper-extending-the-reach-of-copper-cabling/

[8] ISO, “ISO/IEC 11801-1:2017 Information technology - Generic cabling for customer premises - Part 1: General requirements,” https://www.iso.org/standard/66182.html

[9] ISO, “ISO/IEC 11801-3:2017 Information technology - Generic cabling for customer premises - Part 3: Industrial premises,” https://www.iso.org/standard/62245.html

[10] ISO, “ISO/IEC 11801-6:2017 Information technology - Generic cabling for customer premises - Part 6: Distributed building services,” https://www.iso.org/standard/65446.html

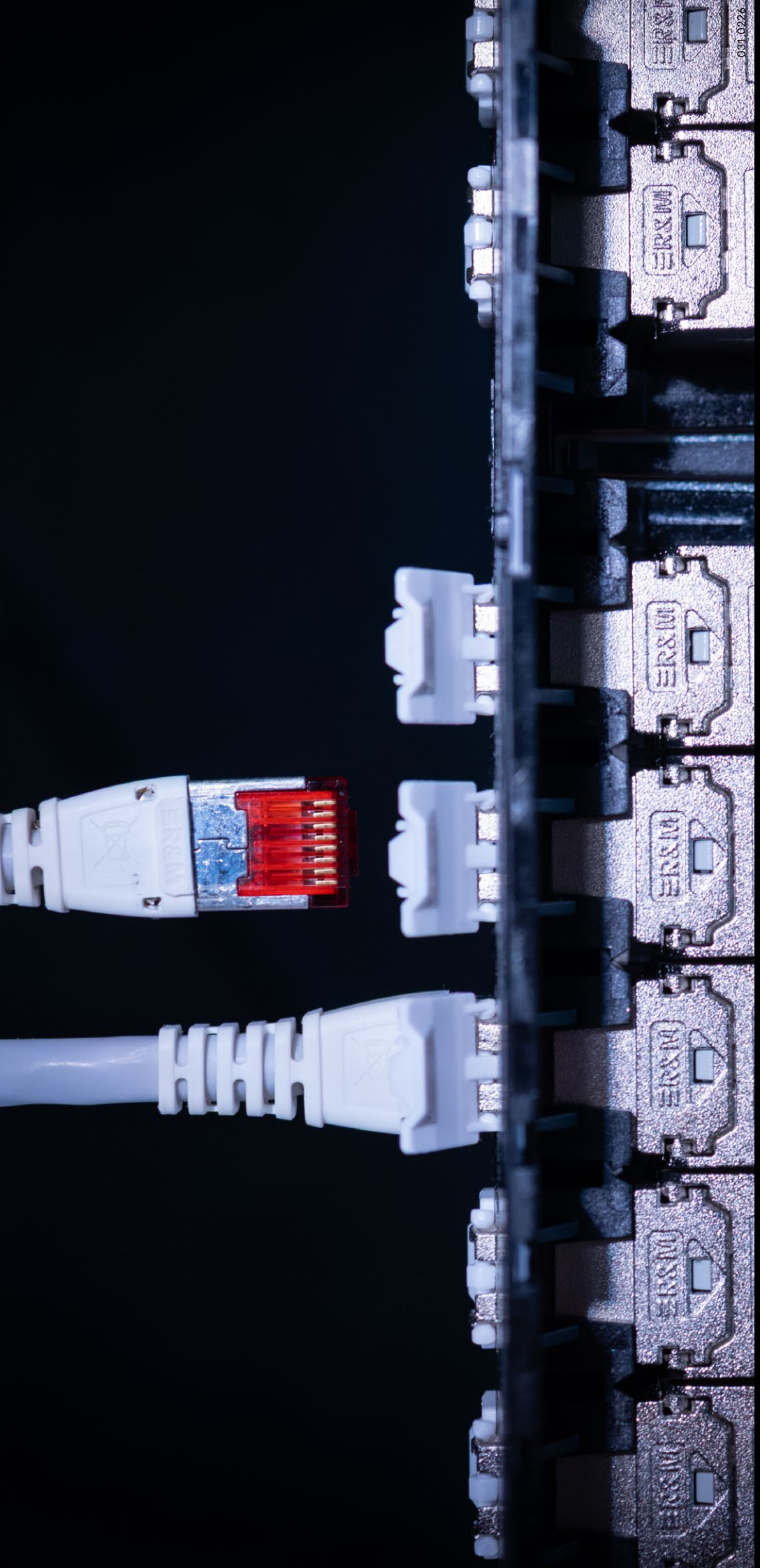
[11] IEEE Standards Association, “IEEE 802.3-2022,” https://standards.ieee.org/ieee/802.3/10422/

[12] TIA Fibre Optics Tech Consortium, “ANSI/TIA-568.0-E: Generic Telecommunications Cabling for Customer Premises,” https://www.tiafotc.org/tia-standards-update/tia-568-0-e/

[13] Diane Forbes, “Extended-Reach Structured Cabling: Applying Engineered Guidance Beyond the 100-Meter Channel,” ICT Today, Apr/May/Jun 2026, https://online.flippingbook.com/view/819806489/28-29/ and https://online.flippingbook.com/view/819806489/30-31/

[14] ISO, “ISO/IEC TS 29125:2017/Amd 1:2020/Cor 1:2025 Information technology - Telecommunications cabling requirements for remote powering of terminal equipment,” https://www.iso.org/standard/93745.html

[15] Siemon, “ANSI/TIA-568.2-E Is Here. Are Your Cables Compliant?,” 19 March 2025, https://www.siemon.com/en/ansi-tia-568-2-e-released/



Headquarters
Switzerland
Reichle & De-Massari AG
Binzstrasse 32
CH-8620 Wetzikon

www.rdm.com
Please choose your country on our global website.

Have Questions or Need More Information?

Our team is here to support you! If you have any questions or would like more details, please don't hesitate to get in touch.

We look forward to assisting you!

Get in touch

BCH_Beyond-100-Meters_28.07.2026_EN_HQ
© Reichle & De-Massari AG – All rights reserved

R&M