

Proposal for 10SPE Industrial Automation Objectives

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Purpose

- The purpose of this presentation is to review and make recommendations on Industrial Automation objectives relative to the current progress within 10SPE

Supporters

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- Ludwig Winkel, Siemens
- Harald Mueller, Endress+Hauser
- Markus Wucher, Endress+Hauser
- Steffen Graber, Pepperl+Fuchs
- Bernd Hormmeyer, Phoenix Contact

Proposed Objectives

- Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
- Support a data rate of 10Mbps at the MAC/PLS service interface
- Do not preclude meeting FCC and CISPR EMC requirements
- Preserve minimum and maximum Frame Size of current 802.3 standard
- Support for optional single-pair Auto-Negotiation
- Support optional Energy Efficient Ethernet
- Support 10 Mbps operation in industrial environments

Proposed Objectives (2)

- Define the performance characteristics of link segments and one or more PHYs to support point-to-point operation over this link segment with single twisted pair supporting inline connections using balanced cabling
- Support a BER better than or equal to $10E-9$ at the MAC/PLS service interface
- Do not preclude working within an Intrinsically Safe device and system as defined in IEC 60079
- Specify an optional power distribution technique for use over the 10 Mb/s single twisted pair link segments in conjunction with 10Mbps single-pair PHYs

Proposed Objectives (3)

- Define one or more PHYs to support each of the following options, where at least one option must be present:
 - up to at least 1000 m reach on an industrial link segment
 - ~~up to at least 40 m reach on an industrial or transportation link segment~~
 - up to at least 15 m reach on an industrial and automotive link segment
- We don't want to end up with 3 PHY specifications
- It is assumed that the 15 m specification can operate over longer distances with adequate media

References

[1] Industrial Automation Bit Error Rate

- http://www.ieee802.org/3/10SPE/public/adhoc/brandt_082216_10SPE_01_adhoc.pdf

[2] Reduced Minimum Frame Size

- http://www.ieee802.org/3/10SPE/public/adhoc/brandt_082216_10SPE_02_adhoc.pdf

[3] Industrial Automation and Emerging Single-pair Ethernet

- http://www.ieee802.org/3/10SPE/public/adhoc/brandt_083116_10SPE_01_adhoc.pdf

[4] Process Automation Use Case for 10SPE

- <http://www.ieee802.org/3/10SPE/public/adhoc/Link%20segment%20on%20Process%20Automation%20rev3.pdf>

[5] Process Industry Requirements

- <http://www.ieee802.org/3/10SPE/public/adhoc/Process%20Industry%20Requirements.pdf>

[6] Long reach issues

- http://www.ieee802.org/3/10SPE/public/adhoc/Fritsche_Schicketanz_083116_10SPE_01_adhoc.pdf

[7] Transmission values of long reach cables

- http://www.ieee802.org/3/10SPE/public/adhoc/Schicketanz_Fritsche_Dold_10SPE_01_0916.pdf

[8] Preliminary Cable Properties

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/Graber_10SPE_02a_0916.pdf

[9] Implementation Thoughts – Proof of Concept

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/Graber_10SPE_03_0916.pdf

[10] Environmental Conditions for Industrial Areas

- http://www.ieee802.org/3/bp/public/mar13/lounsbury_3bp_01_0313.pdf

References

[11] LEGACY INDUSTRIAL PROTOCOLS

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/voss_01_0916.pdf

[12] Optional Powering based on PoDL for 10SPE

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/gardner_10SPE_01_0916.pdf

[13] Feasibility Framework for 10BASE-T1

- http://www.ieee802.org/3/10SPE/public/adhoc/cordaro_chini_10SPE_01_0916.pdf

[14] PHY Feasibility: The Impact of Signaling on Power and Area

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/gauthier_10SPE_01a_09132016.pdf

[15] IEEE 802.3 10 Mb/s single twisted pair Ethernet for Process Industry

- http://www.ieee802.org/3/10SPE/public/Sept2017_Interim/Harald_Mueller_Endress_Hauser_rev1.pdf

BACKUP DETAIL OF SUPPORTING REFERENCES

Convention

- ❑ Existing proposed objective text and chair comments

- Presenter comments
 - BLACK = recommend we accept
 - ~~BLACK~~ = recommend we drop
 - RED = recommend further work/discussion before accepting

Frame format; MAC rate; EMC (emissions)

- ❑ Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
 - Supported by [CFI], [5], MAC re-use, no change in software architecture

- ❑ Support a data rate of 10Mbps at the MAC/PLS service interface
 - Supported by [CFI], [5]
 - Need to use existing MCUs
 - Sweet spot, fast enough to solve most fieldbus applications but providing some headroom for new applications

- ❑ Do not preclude meeting FCC and CISPR EMC requirements
 - Supported by [10], [15], Typically Class A
 - Immunity understood as part of environmental objectives

Frame size; BER

- ❑ Preserve minimum and maximum Frame Size of current 802.3 standard
 - Supported by [2], reflector dialog (Buntz)
 - Frames are small, but expected to exceed minimum, especially with migration to more information as seen in IIoT

- ❑ Support a BER better than or equal to 10^{-9} at the MAC/PLS service interface
 - Supported by [1], [5], [15]
 - Consistent with existing 10/100M success
 - Metric is packets/s, not bit rate
 - Oversampling by 3x

Auto-Negotiation

- ❑ Support for optional single-pair Auto-Negotiation
 - Supported by [3], [4]
 - Consistent with broad market potential & compatibility w/existing BASE-T1 PHYs
 - Future migration path to higher rates is required

EEE; 10 M

- ❑ Support optional Energy Efficient Ethernet
 - No submissions – but motherhood and apple pie
 - Example traffic [1]: Control traffic is periodic, 10 ms rate is fast, 1000 bit frame (0.1 ms) is common
 - Low duty cycle (1%) is an opportunity to reduce heat
 - Added latency must not be low compared to a frame time

- ❑ Support 10 Mbps operation in automotive & industrial environments
 - Supported by the [CFI], market potential

Full Duplex Support

❑ NEEDS SOME DISCUSSION: FULL DUPLEX SUPPORT

❑ DO ALL PHYS HAVE TO SUPPORT FULL DUPLEX OPERATION?

❑ Note that this is with regards to the 802.3 MAC meaning of full/half-duplex (collisions on the medium, not whether the PHY is echo-cancelled, TDD, FDD,...)

➤ Long reach industrial:

➤ Full Duplex is supported by [1], [5], [CFI]

➤ Trunks aggregate as many as 50 end devices through a field switch [5]

➤ Example traffic [1]: Control traffic is periodic and bidirectional, as high as 10 ms rate, 1000 bit frame (0.1 ms) is common

➤ This uses $1000 \text{ bits} * 50 \text{ devices} * 2 \text{ connection} * 100 \text{ updates/s}$, or **10 Mb/s**

➤ There is additional traffic [CFI], IIoT, video, etc.

Link segment target

- ❑ Define the performance characteristics of link segments and one or more PHYs to support point-to-point operation over this link segment with single twisted pair supporting up to four inline connectors using balanced cabling including automotive and industrial environments
 - SUGGEST WE ACCEPT: (Discuss, Any alternative wording?)

- Long reach industrial
 - Supported in [CFI], [6], [7], [8], legacy cable is single twisted pair, [4], [5] support point-point operation
 - [5] presents the use case of 10 links of 100 m (**nine inline connectors**)

- [10] supports communication need to operate in industrial environments (see next slide)

Intrinsic Safety

- Do not preclude working within an Intrinsically Safe device and system as defined in IEC 60079
 - Supported by [3], [4], [5], [8], [9]
 - Feasibility demonstrated by [9]

Fast startup

- ❑ Define optional startup procedure which enables the time from power_on=FALSE to valid data to be less than 100ms
 - SUGGEST WE ACCEPT: FEASIBILITY IS REFERENCE 802.3BP/BW
- Define optional startup procedure which enables the time from power_on=FALSE to valid data to be less than TBD
- Require fast link recovery of 50ms in [5] in case of fault conditions
- Fast startup exists in at least one fieldbus (DeviceNet) of 500ms for robot head tooling exchange

Power

- ❑ Specify an optional power distribution technique for use over the 10 Mb/s single twisted pair link segments in conjunction with 10Mbps single-pair PHYs
 - SUGGEST WE HAVE CONSENSUS ON THIS, STILL NEEDS FEASIBILITY PRESENTATIONS
 - Maybe an overview of 802.3bu and possible modifications?
 - Do we need powering levels vs. links? (PoDL didn't have these)

- Support in [CFI], [3], [4], [5], [12]

Separate power; Industry standards; Intrinsic safety

- ~~☐ Allow for operation if a PHY is not present
 - Support in [3] for communication pair
 - Requirement for separate power in a cable, not PoDL~~

- ~~☐ Do not preclude compliance with standards used in industrial automation, building automation, automotive, and transportation industries when applicable
 - Already part of the environment cover in the link segment~~

- ~~☐ Do not preclude working within an Intrinsically Safe device and system as defined in IEC 60079
 - Support in [CFI], [3], [4], [5], but duplicates another objective~~

PHY Combinations

- ❑ Define one or more PHYs to support the following options, where at least one must be present:
 - ❑ up to at least 1200 m reach on an industrial or link segment
 - ❑ up to at least 40 m reach on an industrial or transportation link segment
 - ❑ up to at least 15 m reach on an industrial and automotive link segment
 - ❑ (Automotive feasibility of this one is HIGHLY sensitive to economics in both environments)

- Submission [3] describes for industrial automation:
 - Applicability of 15 and 40 m for cost sensitive applications
 - Cost sensitive devices are densely packed into groups and the groups are interconnected over longer distances
 - This places a separation (sometimes a switch) between the two communication domains

Product requirements, but not necessarily objectives

- Low power PHY operation
 - Support in [5, Page 11]
- Define a reduced peak modulation voltage level to support optimized power consumption and power distribution schemes

CSD-RELATED

Feasibility

- ❑ Technical Feasibility/Economic Feasibility presentations
 - ❑ 15m/automotive:
 - Support in [3] for low cost industrial as point-point
 - [13], [14] support feasibility
 - ❑ 40m:[CFI](#) (slide 41 is >40m), could use more backup:
 - Support in [3] for low cost industrial <50 m as a bus
 - [13] supports feasibility
 - ❑ 1km:
 - Support in [3], [4], [5] for 1000 m in Process Automation
 - Technical feasibility in [8], [9]
 - Support in [CFI] for 1200 m, inclusive of Factory Automation fieldbuses and Building Automation

Broad market potential

- ❑ Broad market potential presentations to support individual reaches:
 - Long reach industrial: [CFI]
 - Low cost industrial: [3]