Single Pair Ethernet

The Evolution of Automation Device Communications

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Topics

1. Why Single Pair Ethernet?
2. SPE Standards & Applications
3. SPE Development
4. SPE Moving the Industry Forward...
5. Discussion
What if...?
WHAT IF...

Devices could be powered by their data connection?
WHAT IF...

Devices could be powered by their data connection?

- Unlock space – how much space is used for panel power supplies
- Centralize power – cost of distributed UPS for critical devices
- Reduce installation cost – of bringing AC to the edge panels
- How many IoT devices/sensors use Batteries?
WHAT IF...

Data could be freely accessed without gateways?

The gap at the edge is commonly filled by application-specific Gateways
WHAT IF...

Security on the OT network could be easier to implement?

**Application**
- Telnet, FTP, https, snmp

**Transport**
- TCP/UDP

**Network**
- IP, ICMP, Routing Protocols

**Link**
- Network Interface, Drivers

**Physical**
- Device access

*Defense in Depth*
WHAT IF...

Controls networking expertise could be easier to find?

“Technical limitation and lack of skilled expertise is expected to hamper the growth of building automation system market during forecast period 2016-2022.”

Market Watch, October 2018, marketwatch.com

“In contrast to other industries, where employers cite worries about declining workforce productivity, dynamism and outdated skillsets, the manufacturing industry’s greatest concern associated with the aging workforce is “brain drain,” the loss of institutional and technical knowledge.”

One Protocol to Rule them All
Single Pair Ethernet

STANDARDS & APPLICATIONS
Deep & Broad Industry Leadership on SPE

IEEE 802.3
- Data, Powering, Electrical Properties
- 802.3cg
- 802.3bw
- 802.3da (future)

ISO/IEC
- Connectors
- SC48b
- Cable
- SC46b

TIA TR42
- Premises physical layer
- Enterprise
- (TR42.1, TR42.7)
- Industrial
- (TR42.9)

ODVA
- Physical Layer for Industrial Network applications
- Volume 2, Chapter 8
- Participation in APL for process

NEC
- CMP-03
- Article 725.144 update under review to accommodate single pair cables
ISA 95 and Industrial Networks
ISA 95 and Industrial Networks

Already Ethernet

Hundreds of connections

Will evolve to Ethernet

Thousands of connections

Level 4
Business Process Information Network
ERP, APO, Logistics

Level 3
Operations Information Network
MES, LIMS, WMS, CMMS, QMS

Level 2
Automation Network: EtherCat, E-Net/IP, Profinet, etc
HMI, SCADA, Batch

Level 1
Discrete & Process Device Communication Networks
PLC, DCS, Motion, Robot, CNC
I/O Link, DeviceNet, Sensors

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Ethernet to the Edge of Building Automation

A secure, reliable, cost-effective way to bring Ethernet to the field device level
Building Automation Behind the Scenes

Basic Building Automation Controls

BACnet Network

Mixed Networks

Proprietary Network

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Case Study

Panduit World Headquarters

- 600,000 feet of 4-pair
- 500,000 feet of 2-wire
- Proprietary gateways for HVAC, glass break, duress, lighting, etc.

What could it have been?
Single Pair Ethernet

WHAT IS SPE?
HOW DOES IT WORK?
Single Pair Ethernet Overview

• SPE can provide:
  – Power + Data
  – 2 point to point reaches: 15m and 1000m
  – Reuse of 2-wire cable and topology
  – Noise immunity
  – Compact Connector
  – Easy deployment

• Multidrop in the future – 25m and 8 stations
## Single Pair Comparison

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Cable Length</th>
<th>Bit Rate</th>
<th>Power Delivered</th>
<th>Number of Conductors</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/100/1000/2.5/5/10GBASE-T</td>
<td>100 m</td>
<td>10 Gbit, full duplex</td>
<td>Yes, up to 90 W</td>
<td>4 to 8</td>
<td>RJ45</td>
</tr>
<tr>
<td>10BASE-T1L</td>
<td>1000 m (2.4 V) with up to 10 joints (terminal boxes)</td>
<td>10 Mbit, full duplex</td>
<td>Yes, up to 60 W</td>
<td>2</td>
<td>LC style IDC connector</td>
</tr>
<tr>
<td>10BASE-T1S</td>
<td>25 m with up to 8 connections on one port</td>
<td>10 Mbit, full duplex</td>
<td>No</td>
<td>2</td>
<td>LC style IDC connector</td>
</tr>
<tr>
<td>PROFIBUS PA</td>
<td>1200 m</td>
<td>31.25 kbps, bus, half duplex</td>
<td>Yes</td>
<td>2</td>
<td>M12, terminal screw</td>
</tr>
<tr>
<td>Modbus RTU and Other RS-485 Protocols</td>
<td>1200 m (up to approximately 185 kbps, at 375 kb 300 m, at 500 kb, 200 m)</td>
<td>Typically 19.2 kbps, bus, half duplex</td>
<td>No</td>
<td>2</td>
<td>DB9, M12</td>
</tr>
<tr>
<td>I/O Link</td>
<td>20 m</td>
<td>Max 230.4 kbps, half duplex</td>
<td>No</td>
<td>2</td>
<td>M12</td>
</tr>
<tr>
<td>4 mA to 20 mA</td>
<td>&gt;10 km</td>
<td>-/-</td>
<td>Yes, 36 mW</td>
<td>2</td>
<td>Screw</td>
</tr>
<tr>
<td>HART</td>
<td>&gt;1500 m</td>
<td>1200 bps, bus, half duplex</td>
<td>Yes, 36 mW</td>
<td>2</td>
<td>Screw</td>
</tr>
</tbody>
</table>
SPE General Topologies
SPE Connectors: IP20

- Approved by IEC SC48B, standardized as IEC 63171-1
- Approved by TIA as connector for Single Pair Ethernet
- Based on fiber optic LC form factor
- Positive latch Engagement
- IDC connection
- Simple, tool-less field termination
SPE Connectors: IP67

- IP67 version still in standards definition with ODVA, APL and other bodies
- May have extra pins for positive shield engagement to pin (still 2 wires)
SPE Cable

- 18 AWG, shielded twisted pair cable
  - Cable construction optimized to achieve 1000-meter maximum link distance
  - Shielded to perform in E2/E3 environments

- 23 AWG
  - Can reach up to 400m distance
  - Could be shielded or unshielded

“I’ve heard talk of cable reuse …”
Cable Reuse for SPE

- Electrically, it **may be possible** to reuse cables that carry legacy protocols today
  - The forces that degrade cable performance are available in abundance in factories
  - Some installed cable is very old
  - Network topologies **may be** compatible, legacy routes versus new SPE routes

- Field test procedures are being developed to determine cable reuse viability
Single Pair Ethernet

WHAT NEXT?
Industry groups coalesce around SPE

**Telecommunications Industry Association (TIA) TR-42**
- Develops and maintains Telecom industry standards for cabling infrastructure
- Single Pair Ethernet Consortium (SPEC) to accelerate the adoption of next generation Operational Technology (OT) and Internet of Things (IoT) connectivity

**Ethernet Alliance**
- Dedicated to the advancement of Ethernet
- Single Pair Ethernet team partnering on content and technology development
- Partnering with OT standards organizations
Evolving from...

BACnet/IP

4-pair 100BASE-T

SPE -T1S

SPE -T1L

DALI/IP?

BACnet/IP

BACnet/IP
Expect to See

Growing industry support, see [www.ethernetalliance.org/single-pair-ethernet](http://www.ethernetalliance.org/single-pair-ethernet) and [spec.tiaonline.org](http://spec.tiaonline.org)

Initial use cases to launch in Q1 ’21

Device vendors turning to SPE for simple device connectivity & DC power

Growing importance of Structured Cabling in Ethernet Networks

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