Goals for presentation

- Describe the use case for building automation and control
- Support CSD with respect to broad market potential

Ethernet for Building Automation and Control

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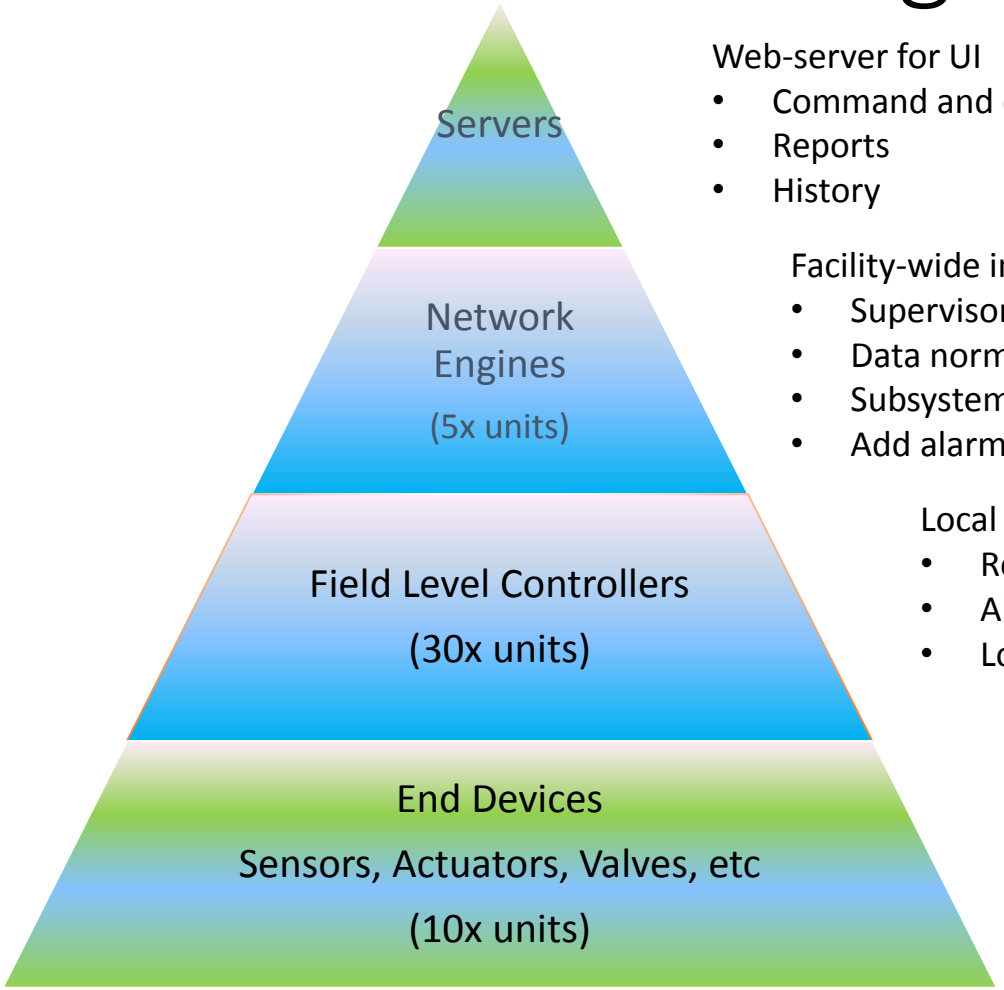
The Big Idea

- Buildings are managed by a large number of sensors connected to distributed controllers and a centralized user interface.
- It is a true Network of Things.
- It is not an Internet of Things.
- The future is IP.
  - IP networks are physically ubiquitous, particularly in buildings.
  - IP networking is the most known and familiar kind of network.

Outline

- Devices and networking for incumbent technology
- BACnet standard
  - This holds the system together.
- Present uses of Ethernet in building automation and control networks
- Future uses of Ethernet
  - As a replacement for the Field Bus
  - As a replacement for the Sensor Bus

Devices for Building Automation and Control



Web-server for UI
- Command and control
- Reports
- History

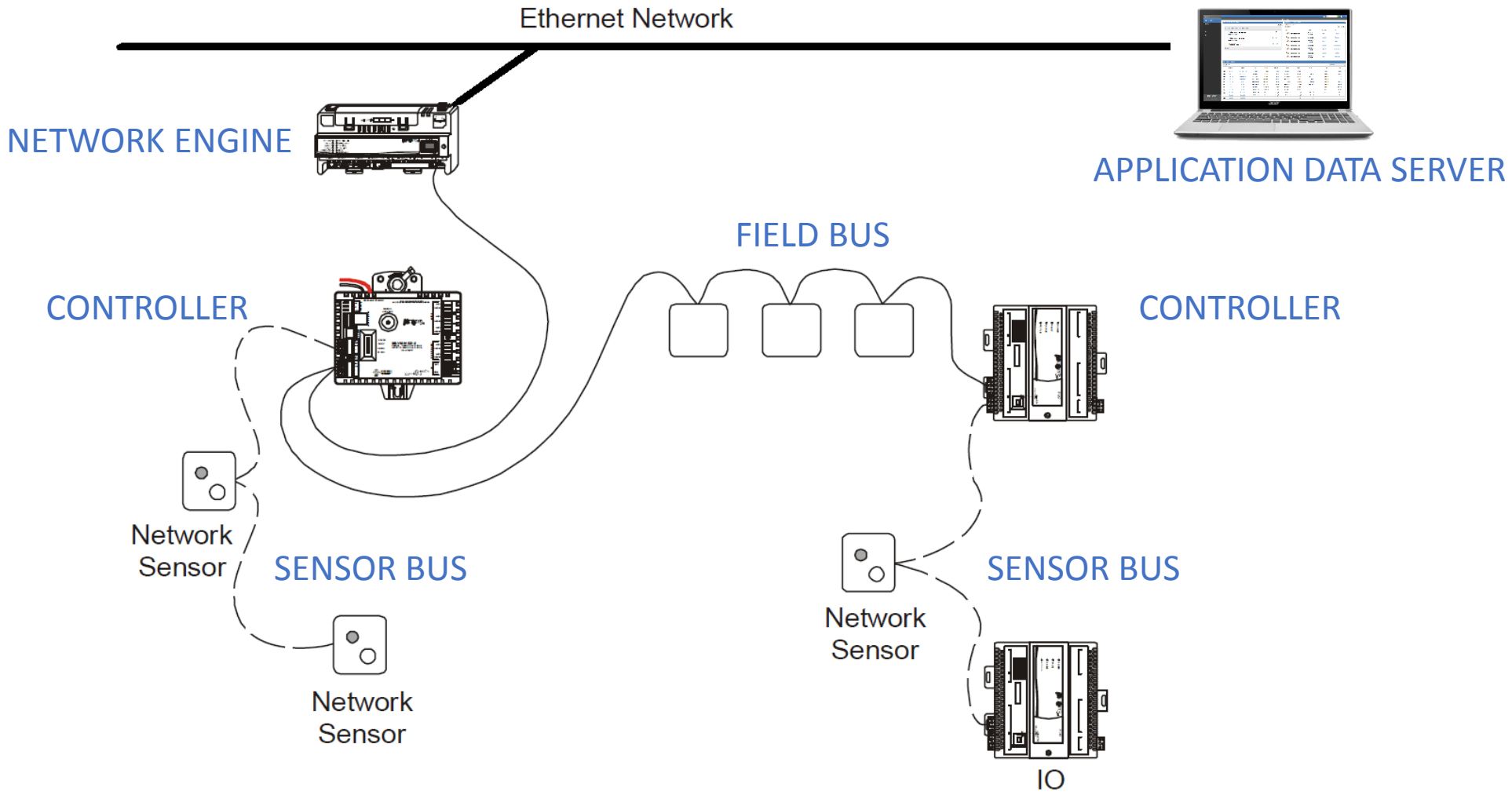
Facility-wide integration and control
- Supervisory control
- Data normalization/routing/organization
- Subsystem integration
- Add alarm/trend functions for simpler devices

Local control and interface to instrumentation
- Real-time logic
- Alarm/trend/schedule options
- Local UI

Instrumentation

5 to 5000 devices per installation

Networking for Building Automation and Control

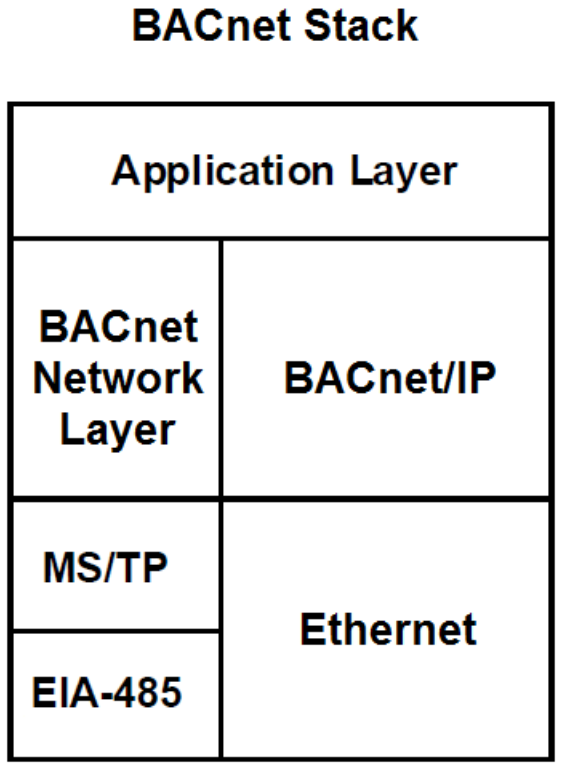


BACnet Standard

- Short for “Building Automation Control Network”.
- Both an international (ISO) and ANSI standard for interoperability between cooperating building automation devices.
- “The motivation for this Standard was the widespread desire of building owners and operators for ‘interoperability,’ the ability to integrate equipment from different vendors into a coherent automation and control system – and to do so competitively.” (from the Foreword to the BACnet standard)
- Customers have opted for open standards.

BACnet Networking

- BACnet supports several networking options, including Ethernet.
- BACnet/IP is dominant for devices in the upper tiers of the network.
- BACnet MS/TP is dominant for the more numerous devices in the lower tiers of the network.
- The BACnet/IP and BACnet MS/TP are compatible at the application layer.
- The two-PHY approach means one translation layer



BACnet/IP

- BACnet/IP was published as a standard in 2004.
- We know Ethernet works, for example:
  - Frame format and frame size.
  - Typical message size.
- Implemented at the top tier devices because:
  - Need for bandwidth.
  - Need for IP connectivity.
  - Ethernet became standard on the computers required to run the software.

BACnet/IP

- Historically the problems using Ethernet in lower tiers were:
  - Cost of the wiring infrastructure.
  - Cost pressure on the hardware (cost of chip sets).
  - Complexity of integrating the microcontroller, MAC, and PHY as a system.
  - General unfamiliar with Ethernet.

  - These issues have faded.

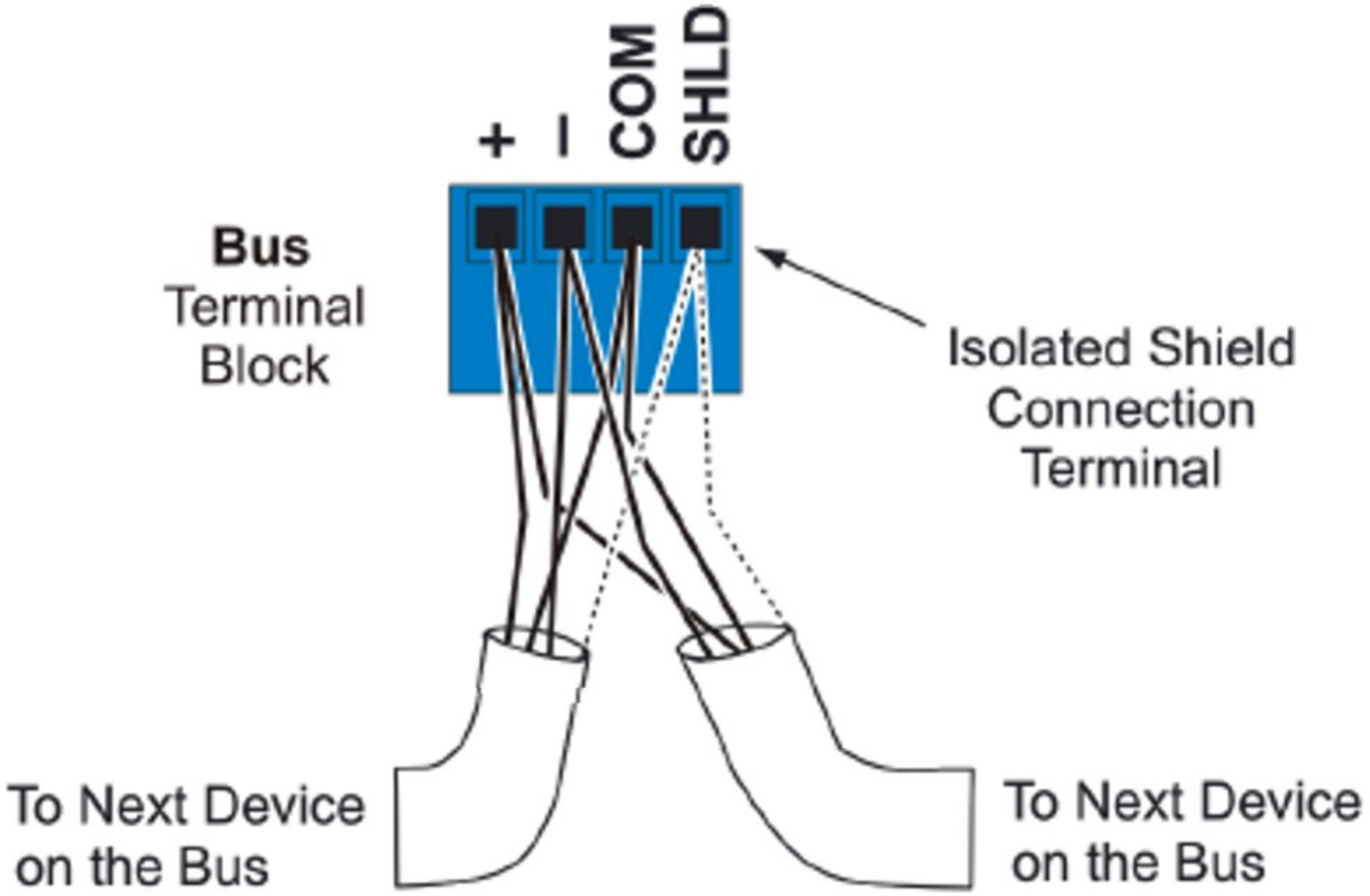
Need and Opportunity (I)

- Incremental conversion of buses to Ethernet networking means field controllers are next.
- Worldwide market estimate for year 2016 is 9 million units of which 10% are IP enabled.
- In any given fiscal year, the opportunities for retrofit are 90% of the market.
  - The retrofit market with cable reuse is large and available, and will remain so for many years.
  - The new-construction market will be served in the short run by existing Ethernet.

Specification for Field Bus (BACnet 9.2)

- Single twisted-pair.
  - 18 AWG/3-wire stranded twisted shielded cable.
  - Reach up to 1200 m per segment up to three segments.
  - Impedance between 100 and 130 ohms.
  - Distributed capacitance less than 100 pF per meter.
- Multi-drop.
  - Up to 32 devices per segment. Up to 64 devices over 3 segments.
  - No T connections permitted.
- Speeds from 9600 baud to 76800 baud.
- No option for power (24 VAC power is available on separate wires).

Terminal block connections are typical



Reach for field bus

- The existing reach specification is largely driven by bus topology (multidrop).
- If existing devices were replaced by dual port devices, then a 1200 m reach is required only for connections between buildings.

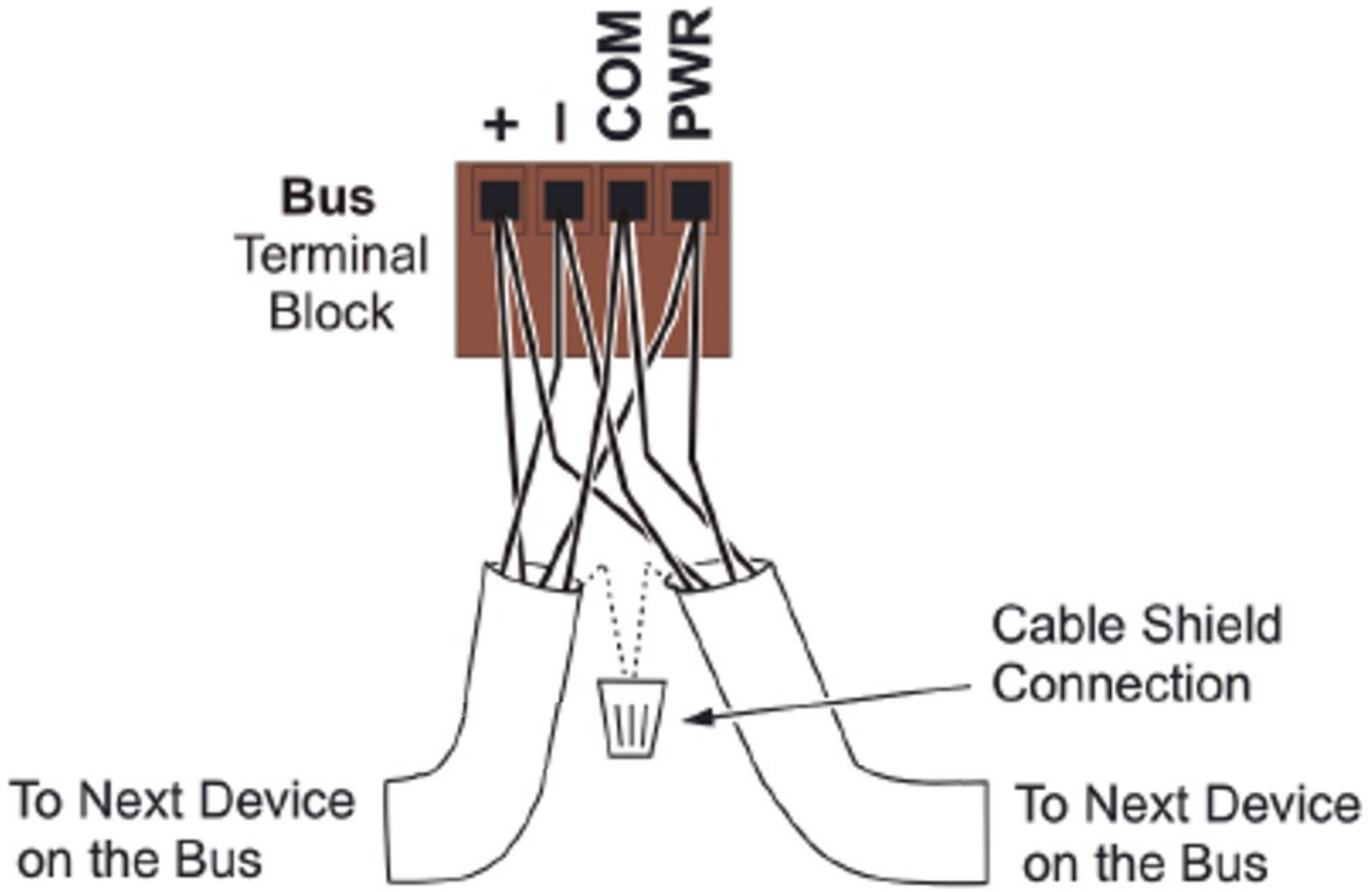
Need and Opportunity (II)

- Development of IP-enabled field controllers increases the number of possible BACnet/IP nodes per deployment by an order of magnitude.
- Market for edge devices is much larger, but much more cost sensitive.
  - No foreseeable need for significant communication bandwidth.

Specification for Sensor Bus (typical)

- Single twisted-pair wiring.
  - 22 AWG, stranded 4-wire, two twisted pair, shielded cable.
  - Reach up to 400 m.
- Multi-drop and linear chain.
  - Up to 10 devices per segment.
  - No T connections permitted.
- Speeds from 9600 baud to 76800 baud.
- Power available is 15 V DC; max 100 mW per device steady-state.

Terminal block connections are typical



Reach for Sensor Bus

- The existing reach specification is largely driven by bus topology (multidrop).
- If existing devices were replaced by dual port devices, then a 40 m reach would suffice for most point-to-point connections.

Bus (typical, field bus and sensor bus)

- Operating range 0 deg to 50 deg C.
- Terminations
  - Spade lugs or screw terminals.
  - Protected against misapplication of 24 VAC.
- Meets EN61000-4-4 (Electrical Fast Transient / Burst Immunity Test) and EN6100-4-5 (Electromagnetic compatibility, surge immunity) requirements for heavy industrial applications.

Miscellany

- Simplex/Duplex – BACnet is simplex in its origins, but BACnet/IP means the duplex also works. This is an effect, not a driver.
- Reduced pin count is important because there is limited space on circuit boards.
- Already use power separate from communication.
  - Works well with multi-drop.
  - Field bus communication runs in parallel to 24 V AC power.
  - Sensor bus communication runs in parallel to 15 V DC power.

Conclusions

- The building segment is driven by the BACnet standard, which drives the need for a widely accepted communication standard.
- Controllers can absorb the cost of Ethernet more easily than sensors.
- The field bus for controllers needs longer reach than the sensor bus.
- The market for cable reuse is much larger than for new construction and gives access to the total available market.

Thank you

Questions if time permits