Sustainability Through Intelligent Controls Workshop

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Mr. Bernstein is President of RBCG, LLC providing consulting services to organizations needing help navigating their energy and automation strategy. He has over 30 years experience in industrial, commercial and residential automation and controls technologies. RBCG provides building automation standards, specification development support, educational program development, and facility master planning.

Key areas of focus include energy management and open solutions for energy efficient control networking. He helps organizations evaluate and implement technologies and solutions based upon open interoperable system architectures. He is an active member of several standards bodies including ASHRAE, ANSI/CEA, CEN, LonMark, OASIS and ISO.

Mr. Bernstein holds the position of LonMark International Chief Ambassador, is a Director of the Smart Buildings Institute, curriculum advisor to Mt. San Antonio College, frequent lecturer, published author, and educator.

He holds a BS in Mechanical Engineering from Carnegie Mellon University, a Masters in Psychology from The University of Santa Monica, and a Masters in Philosophy from PTS College of Philosophy.
Workshop Agenda

- Introduction, Energy Efficiency Through Intelligent Controls
- The Trend Towards Open, Integrated Control Systems
- Elements of an Open Controls Platform
- Enterprise Applications, Cloud Computing, and System Security
- Specification Development Requirements
- Introducing the Three-Tier Building Automation System Spec
- Energy and Cost Savings - Use Case Examples
- Tools, Resources and Standards
Energy Efficiency Through Intelligent Controls
Green building is the practice of increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials, and reducing building impacts on human health and the environment, through better site selection, design, construction, operation, maintenance, and removal — the complete building life cycle.

Green sustainable building benefits:
- Reduced operating costs
- Increasing productivity
- Using less energy and water
- Improved public and occupant health
- Improved indoor air quality

Energy Consumption Data

- Buildings represent 70% of U.S. energy consumption
- Energy consumption represents 30% of a typical commercial office building’s operating costs
- A 30% reduction in energy use can yield the equivalent of a 5% increase in Net Operating Income
- One of the strongest selling points for green construction is reduced operating costs from increased energy efficiency
Typical Building Energy Costs

- Super Structure: 0.1%
- Exterior Closure: 9.5%
- Roofing: 1%
- Interior Construction: 14.5%
- Conveying Systems: 5%
- Plumbing: 5%
- HVAC: 5.4%
- Fire Protection: 0.1%
- Lighting: 48%
- Power: 8%
- Equipment: 1%
- Site Work: 2%

Source: U.S. Department of Energy
## Energy Savings By Type of Technology Applied

<table>
<thead>
<tr>
<th>Control Technology</th>
<th>Energy Savings</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Management and Control System</td>
<td>5 to 15%</td>
<td>8 to 10 years</td>
</tr>
<tr>
<td>Commissioning</td>
<td>5 to 15%</td>
<td>2 to 10 years</td>
</tr>
<tr>
<td>Continuous Commissioning</td>
<td>5 to 15%</td>
<td>1 to 3 years</td>
</tr>
<tr>
<td>Occupancy sensors for lighting control</td>
<td>20 to 28%</td>
<td>1 to 5 years</td>
</tr>
<tr>
<td>Photo sensor based lighting control</td>
<td>20 to 60%</td>
<td>1 to 7 years</td>
</tr>
<tr>
<td>Demand Controlled Ventilation</td>
<td>10 to 15%</td>
<td>2 to 3 years</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Energy
Most Likely Systems To Integrate

- HVAC: 91%
- Fire Safety: 77%
- Electrical Monitoring: 50%
- Access Control: 45%
- Power Consumption: 45%
- Life Safety: 36%
- Lighting Controls: 36%
- CCTV: 27%
- Lighting Management: 27%
- Vertical Transport: 18%

Source: U.S. Department of Energy

Leveraging Costs of Multiple Integrated Building Systems

Openness facilitates Integration!
# System Integration Life Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Life Cycle Cost Component</th>
<th>Non-Integrated Building</th>
<th>Partial Integration</th>
<th>Full Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparative First Cost</td>
<td>$75,000</td>
<td>$78,000</td>
<td>$33,000</td>
</tr>
<tr>
<td>Changes, Upgrades &amp; Additions</td>
<td>$129,379</td>
<td>$126,379</td>
<td>$88,052</td>
</tr>
<tr>
<td>Operating &amp; Maintenance</td>
<td>$21,250</td>
<td>$5,250</td>
<td>$3,750</td>
</tr>
<tr>
<td>Utility Cost</td>
<td>$200,000</td>
<td>$179,400</td>
<td>$179,400</td>
</tr>
<tr>
<td><strong>Net Present Value</strong></td>
<td><strong>$2,325,232</strong></td>
<td><strong>$2,074,091</strong></td>
<td><strong>$1,773,493</strong></td>
</tr>
<tr>
<td>Discount Rate</td>
<td>9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Cycle Period (yrs)</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— ► Savings</td>
<td>($300,598)</td>
<td>($551,739)</td>
<td></td>
</tr>
</tbody>
</table>

Source: CABA

The Trend Towards Open, Integrated Control Systems
Open Systems Defined

- Open building systems are created using the products and systems from multiple vendors that in the end offer greater flexibility, easier management, higher levels of scalability, and lower life cycle costs.

- Fully Open Systems Will Deliver
  - Greater choices in vendors and suppliers
  - Lower energy costs
  - Lower install and life cycle costs
  - Easier add, moves, and changes
  - Greater system scalability
  - Better access to information
  - Greater control over the facility
Multi-Subsystem Integration

Enterprise Applications

Any TCP/IP network

Smart Access Control
Smart Lighting
Smart Metering
Smart Grid
Smart Buildings
Smart Elevators
Smart Renewables
Solutions That Meet the Need

- **Give Me Access**
  - From any location
    - Phone
    - Email
    - Home
    - Office

- **Make It Easy**
  - Decision making
  - Alarming
  - Reporting
Building Automation Market Trends

- Industry preference for open systems
- Expectation for better energy efficiency
- Demanding lower operating expenses
- Growing requirement for integration
- Enterprise access via web – leverage growing IT infrastructures
- Do more for less
Data-Bus Technologies

- Top-down design
- Centrally located processor
- No integrated intelligence
- Single point of failure
- Maintenance restricted to provider of processor station
Data-Bus Technologies

- Programmable Logic Controller design
- Centrally located processors
- Distributed intelligence
- Single point of failure reduced
- Maintenance restricted to provider of PLCs
Data-Bus Technologies

3rd Generation
Decentralized Automation

- [Intelligent-devices design](#)
- [No central processor needed](#)
- [Fully distributed intelligence](#)
- [Single point of failure eliminated](#)
- [Maintenance not restricted to providers of hardware](#)
Traditional Closed System

- Single vendor
- Leads to costly service and system expansion
- Limits sub-system expansion
- Limits number of service providers
- Restricts interoperability with other vendors / systems
- Limits choices
- Creates “Islands of automation”

➤ Locks owners in for the life of the system!
Open System, Not Just and Open Protocol

- Multiple vendors
- Affordable and economical service and system expansion
- Sub-system and device-level expansion at any time
- Full choice of service providers
- Facilitate interoperability with other vendors / systems
- Plethora of choices
- Flexible, expandable automation

➤ Owners retain freedom of choice throughout the lifetime of the system!
Focus on End User Requirements

- Choice of vendors – “Best of breed” products
  - Not locked into single supplier
- Easy integration
  - Quicker, lower cost installation
- Use of third party tools
  - Eliminates need for multiple or proprietary tools
- Easier adds, moves, and changes
  - Reduces life cycle costs
- Greater level of integration between sub-systems
  - HVAC, Lighting, Energy Management, Security, Irrigation, etc.
## Open Versus Closed

<table>
<thead>
<tr>
<th>Open</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Published industry standard</td>
<td>Single company promoted</td>
</tr>
<tr>
<td>Adopted by major industry suppliers</td>
<td>Adopted by only a few or single supplier</td>
</tr>
<tr>
<td>Multiple vendors products work on single system</td>
<td>Only one/limited vendors product works on system</td>
</tr>
<tr>
<td>No engineering effort needed to “make them talk”</td>
<td>Complex engineering effort required to “make them talk”</td>
</tr>
<tr>
<td>Multiple integrators can work on same job</td>
<td>Only one integrator can work on job</td>
</tr>
<tr>
<td>More than one GUI type on system</td>
<td>Only one GUI type usable on system</td>
</tr>
<tr>
<td>Multiple sources of competitive, interoperable product</td>
<td>Limited or sole source of product</td>
</tr>
<tr>
<td>Service of system from multiple sources</td>
<td>Service of system by single source</td>
</tr>
<tr>
<td>Network management tools available for installation from multiple sources</td>
<td>One or limited tools available. Can only work with one suppliers devices.</td>
</tr>
<tr>
<td>Flat architecture</td>
<td>Tiered architecture</td>
</tr>
<tr>
<td>Expandable with transparent Routers</td>
<td>Limited expandability, no routing</td>
</tr>
<tr>
<td>No Gateways or gateway to legacy system only</td>
<td>Extensive use of gateways, new or legacy system</td>
</tr>
<tr>
<td>Empowers independent integrators</td>
<td>Empowers single company solution</td>
</tr>
</tbody>
</table>
Workshop Discussion Question #1

What issues do facility owners, end users, managers, system integrators face today?
Results from Prior Workshops

1. Save energy, quantify energy usage, define ROI for energy reduction
2. Capture and present information (power, water, CO2, temp, humidity, etc)
3. Access to information [Data Stratification]
4. Integration of systems
5. Open vs. Proprietary platform
6. Competition, fair competitive bid
7. Life cycle costs of buildings
8. Value of automation
9. Security, data and system integrity
10. Technology selection, partner selection, product selection
11. How to sell the value to the client
12. Operation and maintenance costs
13. Training (technology, technical)
14. Legacy system integration and migration
15. Need for better education (market, options)
16. Government incentives
17. Energy evaluation and assessment
18. Open protocols
19. Specifications
The Elements of an Open Controls Platform
Elements of an Open Control Networking Platform

- Networking Protocol for Device Level Communication
- Low Cost
  - Solutions on a chip (multiple solutions/sources available)
- Peer-to-Peer
  - No master needed – no vendor lock in
- Interoperable
  - Devices from hundreds of suppliers work together
- Open – ISO Standard
  - Open Interoperable standards for control communication
  - Certify devices for standards compliance
  - Certify industry professionals for technical proficiency
  - Certify System Integrators – provide high level of competence
  - Simplify specifications, installation, and integration
Essential Elements of an Open Control System

- **Devices**
  - The controllers on the network
  - Applications specific devices
  - Programmable devices
  - Packaged equipment
  - Scheduling, Alarming, Data logging

- **Infrastructure**
  - The wire the nodes connect to
  - The routers that pass the data
  - Termination
  - Traffic issues
  - Systems architecture
  - IT Routing
  - When are gateways necessary?

- **Host Interface**
  - PC Based
  - Cloud/Web Based
  - Flexibility and Choices
  - Secure, IT Compliant

- **Tools**
  - Design Tools
  - Commissioning Tools
  - Database issues
  - Plugins
  - Scheduling, Alarming, Data logging

- **Enterprise Connectivity**
  - IT Interface
  - Large project architecture
  - Design for the future
  - Scalability issues

- **Life Cycle**
  - Long term service contract
  - Staff training
  - Sustainable design

Don’t get locked in!
Total Facility Control
The Need for Higher Level Connectivity
Foundation of an Open System

- Products from multiple vendors interoperate
  - Common physical interface - transceiver
- Tools from multiple vendors interoperate
  - Common network management model - LNS
- Opens up for fair competitive bidding
  - Unbundling hardware from software from engineering
- Enables owners to “own” their systems
- Removes the “Locks”
- Open specs: Reduces costs, improves efficiency
- International standard – worldwide adoption
Information Access – The Key

- Alarming
- Control
- Monitoring
- Setpoint changes
- Overrides
- Schedule changes
- Maintenance schedule
- Event reporting
- Quality control
- Energy Management
- Enterprise-wide consistency
Information Access – The Key

- And I want it from my browser
- From any computer on my network
- Or from home
- With different access levels for different personnel needs
- With my full campus integrated into one system
- And all of my subsystems working together
- To simplify my facility management
- And reduce my operating costs!

- Alarming
- Control
- Monitoring
- Setpoint changes
- Overrides
- Schedule changes
- Maintenance schedule
- Event reporting
- Quality control
- Energy Management
- Enterprise wide consistency
Which Means…

- I need a fully integrated system
- With a solution platform that will grow over time
- That isn’t limited today or in the near future
- That uses the latest advancement in technology
- But is proven to work – I don’t want to be the guinea pig
- And it will reduce my install and life cycle costs
- Simplifying my management operation
- And provides a positive return on my investment
## Total Facility Control Access to Data

<table>
<thead>
<tr>
<th>Layer</th>
<th>Stakeholder</th>
<th>Data level</th>
<th>Data Types Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td>User/Occupant/Manufacturer/Vendors/Integrators</td>
<td>2, 3 - Status/Mode/Scene, schedule</td>
<td>Occupied mode, Load Shed mode, Lighting scene</td>
</tr>
<tr>
<td>Room</td>
<td>User/Occupant/Manufacturer/Vendors/Integrators</td>
<td>2 – Status Mode Scene</td>
<td>Occupied mode, Load Shed mode, Lighting scene</td>
</tr>
<tr>
<td>Device</td>
<td>Manufacturer/Vendors Integrators</td>
<td>1 - on/off/control, low level data</td>
<td>Temp, pressure, status, set points, mode, scene</td>
</tr>
</tbody>
</table>
# Total Facility Control
## The Players

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers Manufacturers</td>
<td>Core technology, Transceivers, Protocol, Security, Applications</td>
</tr>
<tr>
<td>Vendor/Supplier/Distributor</td>
<td>Interoperability, Sourcing, Costs, Codes, Availability, Features</td>
</tr>
<tr>
<td>Consulting Engineers</td>
<td>Specifications, System Architecture, Functionality</td>
</tr>
<tr>
<td>System Integrator</td>
<td>Bids, Specs, Submittals, Tools, Integration Support</td>
</tr>
<tr>
<td>Master Integrator</td>
<td>IT, Interoperability, System Level Functionality, Openness, Front Ends</td>
</tr>
<tr>
<td>Facility Manager</td>
<td>Front End, Functionality, Training, Operational Efficiency</td>
</tr>
<tr>
<td>Owner</td>
<td>Energy Savings, Operational Savings, Down Time, Costs (short and long term)</td>
</tr>
<tr>
<td>Aggregator</td>
<td>Access to Building Data, Interoperability, Simplicity, Costs</td>
</tr>
<tr>
<td>Service Provider</td>
<td>Applications, Access to Data, Interoperability</td>
</tr>
<tr>
<td>Application Provider</td>
<td>IT Integration, Standard Interfacing, System Integration, User Interface, Platform</td>
</tr>
</tbody>
</table>
Open, Integrated Controls

- Competitive advantage over proprietary, closed systems
- Perfect solution for campuses, multi-building, integrated buildings
- Provides for competition at every stage of the project (Owners demands are met!)
- Wide array of available solutions
- Enables “Enterprise Connectivity, Enterprise Independence”
  - From sole source products
  - From locked-in bundled hardware/software solution
- Three-Tier Specifications give owners more control
- Based on open industry standards
Workshop Discussion Question #2

What are the **Wants, Needs, and Desires** of facility managers?
Results of Prior Workshops

- Cost savings
- Competitive bid
- System ownership
- Future proof / flexibility
- Choice
- Vendor independence
Grid-Aware Building

- Stove-piped functions (silos)
- Multiple front-ends
- Proprietary

- Partial integration across silos
- Multiple open protocols
- Comms link to Internet

- Multi-protocol, cross-silo framework for new applications
- Dynamic load modulation
- Fine-grained load control
Smart Building Concepts

- Integration of multiple building systems
  - HVAC, Lighting, Energy, Emergency/Life Safety

- Common platform for data mining and exchange
  - Using open communications standards
  - Common infrastructure and data delivery mechanisms

- Enterprise data access
  - IT standards and communication interface

- Able to act and react
  - Internal and external influences

- Monitor, Alarm, Schedule, and Manage
  - Central or remote access
  - Variety of User Interface Options
The Scope: Energy and Control
A Holistic Approach

GUI - USER APPS
Alarms, Reports, Control, Monitoring, Load Shed, Demand Limiting, Financial Performance

Enterprise

Campus

Building

 Enterprise

 Campus

 Building

 GUI - USER APPS
Alarms, Reports, Control, Monitoring, Load Shed, Demand Limiting, Financial Performance

Enterprise

Campus

Building

Utility
Indoor Facility
Outdoor Facility
Energy

Demand Response
HVAC
Lights
Parking Irrigation
Street Lighting
Metering Sub Billing

System Integration and Access

- **Sharing data from sensors**
  - Occupancy sensor data used by HVAC, Lighting, and Security

- **Monitor and effect energy consumption**
  - Used by demand limiting control strategy
  - Real time adjustments via control system

- **Who’s in control**
  - Direct occupant control over environment
  - Facility staff control
  - Subsystem dependent - Lighting, HVAC, Security

- **Alarm management**
  - Single alarm, multiple recipients
  - Remote acknowledgement and response
  - Preventative maintenance based upon actual usage
Subsystem Intelligence
Smart Everything

Any/IP network

Smart Grid – Enterprise Applications

Smart Access Control

Smart Lighting

Smart Metering

Smart Grid

Smart Buildings

Smart Elevators

Smart Renewables
Standards-based Communication
Common Data Models

Enterprise Applications
PC, MAC, Android, iPhone

IP/852
Modbus
M-bus
LonWorks®
BACnet/IP
DALi®
EnOcean®
Zigbee®

SOAP/XML
Modbus
M-bus
LonWorks®
Other...

IP-852
BACnet/IP
ISO/IEC14908

Smart Buildings
Smart Campuses
Smart Buildings
Smart Branches

Platform Example in Smart Building

Need: Open at every level – From System to Device

Enterprise Applications

Energy Analytics
Energy Asset Management
Automatic Demand Response
Peak Day Pricing
Facility Management

Any IP network

Local IT Network Subsystem Interfaces

Device Level Network

LonWorks
BACnet
Modbus, KNX
DALI, M-bus
EnOcean

Common App Model
Mix and match best-in-class subsystems – One App interface

- Integrate LonWorks, BACnet, DALI, Zigbee, Modbus systems across IP
- Define common App interface using LMI Profile model
- Enable App independence from control network
- Multiple device networks – LonWorks, Modbus, M-bus
- Co-develop by LonMark, ASHRAE, DALI, Zigbee, TC-247, ???

Enterprise Common Profile Model
Subsystem Driver Level Interface

SOAP/XML

LonWorks  DALI  Modbus  BACnet, Zigbee
Enterprise Application Standard Interface

- Analytics App
  - Standard profile model
  - Start simple – 10 profiles
  - Reduce application interface complexity

- Reporting App
- O&M App
- Alarming App

Common Profile Model

Users

XML/SOAP
Web Service

Data Server Appliance

LonWorks System
Modbus System
BACnet Sub-System
Zigbee Sub-System
EnOcean System
DALI System
KNX System

- Host applications interface is protocol neutral
- Commonality, normalization
- Unbundle the app from the controls

Top Down - User Perspective

- User allowed to pick and choose Apps based on need, not bells and whistles
  - Solution is more open, less bundled
- Easier to specify multi-tier integrated solutions
  - App providers have common interface model to build to
  - Lower the cost for Apps
- Increases flexibility for integrators, installers
- Enable Demand Response type applications
  - OpenADR and LonMark Profile combined into one interface
- Better scalability and interaction across subsystems
EASI: Enterprise Application Standard Interface

- CEN/LONMARK/BACnet/ASHRAE Joint Working Group
- Enable App developers to work with any sub-system
- Protocol neutral networks interface to host Apps
  - Application independent interface model – co-developed
  - Scalable solutions for any application
- Support new interface and driver products from multiple suppliers
  - Sub-system level drivers/interfaces – implementing in local data servers
  - Common data modeling – Web Services using SOAP/XML
  - Potential for network management tools for managing multiple protocols in one tool environment
Security Issues

- Password levels and strength
- IP Ports Open/Closed
- IP Protocols – HTTP/HTTPS, FTP, UDP
- Secure Socket Layer (SSL) Certificates
- Encrypted communication
- Firewall pass-thru issues
- Bandwidth utilization
- IPV4 vs. IPV6 access
- Corporate standards necessary
Security Specifications

- Specify:
  - Password strength, passphrase minimums
  - Require password changed on install (no defaults)
  - SSL for WEB interface (HTTPS vs HTTP)
  - Install Security Certificates
  - Port Lock Down (FTP, UDP, TCP)
  - Firewall requirements (DMZ, Active Anti-Hacking)
  - Min/Max bandwidth requirements
  - IP Addressing Schema/Standards
  - Naming Conventions, Location Conventions
Cloud Computing

- Databases hosted remotely
- Analysis performed remotely
- Compute hardware located remotely
- Software at the remote server
- Software-as-a-Service (SaaS)
  - Pay as you go
  - Pay only for what you need/use
- Security
  - Data ownership
  - System ownership

OR???
Cloud Computing Concerns

- Who owns the data?
- Who owns the software?
- Up time minimum requirements
- What happens if cloud inaccessible?
- Fail safe and local fallback requirements
- Annual maintenance requirements
- Cost offsets for hosted vs. non-hosted systems
- Security and reliability issues
Facilities are and will continue to be multi-platform, multi-protocol, multi-system.

Communication and data standards is critical.

New applications, new platforms, common data.

Communication at the building to the enterprise becoming mainstream.
  - Security is critical – enforcement of procedures.
  - Cloud computing evolving for BMS.

Find ways to make integration simpler.

New emerging standards and solutions supporting open integrated environments.
Specification Development
Requirements
Specification Development – Phase 1

- Developing the scope
- Defining the team
- Basic data architecture elements
- Elements of the spec
- Master planning requirements
- Developing a sustainable approach
- Ensuring an open systems approach with interoperable products
Specification Development – Phase 2

- Writing the specification
  - Understanding the components
  - Define the scope and intent
  - Defining integration requirements
  - Defining cross system functionality

- Fair competitive bidding concepts
  - Three tier spec model
  - Following standard design principles
Specification Development – Phase 3

- Technology selection
- Product selection
- Contractor responsibilities
- System integrator qualifications
- Master system integrator requirements
- Specification enforcement
The Purpose of the Spec

- To define the sequences, functionality and architecture of a controls system required to ensure the affected systems (mechanical, lighting, access etc.) function and perform per the engineers intent.

- Make the system work!
The Value of a Good Spec

- Write the spec to the performance of the system, not the parts and pieces
- Write a spec that various applications of the technology be applied
  - Mechanical, Lighting, Access, Energy, etc.
- Focus on system functionality
- Not on product features, bells and whistles
Project Team Development

- Develop a “TEAM” approach
- Set a clear vision for the project
- Establish domain expertise (team leaders)
- Define cross domain interactions
- Develop information stratification model
  - (WYSIWYNTS – “What you see is what you need to see”)
- Define information flow
- Enable cross domain interaction
- Establish “Human Factor” Issues
- Educate team fully – share cross domain knowledge
- Get team “commitment to success” – no “NIH” holdouts
Project Scope Development

- Owner/Owner Advocate Responsibility
- Single facility or multiple facilities
- One time installation or long term plan
- Coordination with facility master plan
- Set objectives and priorities
- Key project drivers
  - Energy Efficiency
  - Improve Operational Performance
  - Improve Comfort
  - Reduce Maintenance
  - Full or Partial System Integration
  - Common GUI
  - Fair Competitive Bidding
Basic System Architecture

- Define data flow
  - Peer-to-peer communication
- Define level of IP integration
  - Host workstation interface
- Define common GUI needs
- Define enterprise integration
- Define remote access requirements
- Engineer basic system structure
  - LON – Local Operating Network (control)
  - LAN – Local Area Network (monitor)
  - WAN – Wide Area Network (remote)
System Architecture Layers

Enterprise Applications
Building Operations Center
Cal/Dispatch Center
Reporting/Scheduling

Remote Access
Email Alarms
Browser Based Monitoring and Control

Graphical User Interface
Network Tools
Diagnostics
Web interface

Gateway to proprietary/legacy systems

Internet/VPN/Frame Relay

Firewall

IP-852 Router or
oBIX XML Server or
Web Server

IP/Ethernet

Device Network

Standard Network Variables
Exchanged Between Devices and to PC, Web, Remote Access

LON

LAN

WAN

Enterprise Applications
Building Operations Center
Cal/Dispatch Center
Reporting/Scheduling

Remote Access
Email Alarms
Browser Based Monitoring and Control

Graphical User Interface
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IP/Ethernet

Device Network

Standard Network Variables
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LON

LAN

WAN
System Integration

- Define integration scope
- Define level of integration of sub-systems
  - HVAC
  - Lighting
  - Security
  - Metering
  - Energy
- Define cross system information flow
- Legacy system integration
Product Interoperability

- Define interoperability requirements
- Control network protocol
  - Field level device interoperability
  - Ensure/enforce compliance
- Network media type(s)
  - Installation reliability and cost issues
  - Free topology wire, Powerline, IP, WiFi
- Functional interoperability
  - Devices tested to meet strict certification requirements
  - Functional profile compliance
- Define enforcement vs. exception rules
  - What are you willing to live with/without?
LONMARK Interoperability with Network Variables

Thermostat

nvoSpaceTemp
SNVT_temp_p

Fan Coil

nviSpaceTemp
SNVT_temp_p

Standard Network Variable Type

LONMARK®
Layer 1 – 6
Interoperability Guidelines

LONMARK®
Application-Layer
Interoperability Guidelines

LONMARK Functional Profiles

Sunblind Controller

<table>
<thead>
<tr>
<th>Mandatory Network Variables</th>
<th>rvoSblndSetting SNVT_setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional Network Variables</td>
<td>rvoSblndStates SNVT_sblnd_state</td>
</tr>
<tr>
<td>nviLocalControl SNVT_setting</td>
<td></td>
</tr>
<tr>
<td>nvoGroupControl SNVT_setting</td>
<td></td>
</tr>
</tbody>
</table>

For other possible inputs, refer to Table 1

Configuration Properties

Mandatory:
- Send Heartbeat
- Receive Heartbeat
- Input Priority
- Weather Sensor Fail Default
- Window Sensor Fail Default
- Location Label
- Object Major Version
- Object Minor Version

Optional:
- nvoSblndSetting
- nvoGroupControl

SFPTsunblindController
LONMARK Interoperability Guidelines

- Data interpretation
  - Standard representation of data types
- Standardized functional behavior of a nodes
  - LONMARK objects
  - encapsulated network interaction of defined functions
- Standardized support of smooth and trouble free installation
  - Self documentation of a network oriented external interface
  - Guidelines for Network Management
Writing an Integrated Controls Spec: The Challenges

- CSI Master Spec format (Construction Specification Institute)
- Division of labor doesn’t support integration
  - Competitive issues must be addressed
- Change orders are profit centers
- Risk avoidance
- Incomplete or ill defined specs
- Control vendor specific specs
  - Be cautious about solution specific specs
  - Embrace a more open approach
- Look to vendor and technology neutral sources for help and support
  - LonMark International can help
Legacy System Integration

- Which Direction?
  - Upgrade
    - As systems fail, replace with new controls
    - Move to a more open model
  - Replace
    - “Dumpster retrofit”
  - Integrate
    - Gateways, gateways, gateways = $$$

- Multiple Factors
  - Life Cycle
  - Functionality
  - Reliability
  - Initial Costs
The Components of a Good Spec

- **Text**
  - Define Scope and Intent
  - Define Functionality

- **Drawings (and as-builts)**
  - These are separate, but important

- **Call-outs**
  - Provide back up details so there is no confusion

- **Points List**
  - Detailed hard points, trend points, alarm points etc.

- Minimize misunderstandings and discrepancies
Foundation of an Open System

- Products from multiple vendors interoperate
  - Common physical interface - transceiver
- Tools from multiple vendors interoperate
  - Common network management model - LNS
- Opens up for fair competitive bidding
  - Unbundling hardware from software from engineering
- Enables owners to “own” their systems
- Removes the “Locks”
- Reduces costs, improves efficiency
- International standards enforcement
Essential Elements of an Open System

- **Devices**
  - The controllers on the network
  - Applications specific devices
  - Programmable devices
  - Packaged equipment
  - Scheduling, Alarming, Data logging

- **Infrastructure**
  - The wire the nodes connect to
  - The routers that pass the data
  - Termination
  - Traffic/bandwidth issues
  - Systems architecture
  - IT Routing
  - When are gateways necessary?

- **Host Interface**
  - PC Based
  - Web Based
  - Integrated Graphics

- **Tools**
  - Design Tools
  - Commissioning Tools
  - Database issues
  - Configuration Plugins
  - Scheduling, Alarming, Data logging, Overrides

- **Enterprise Connectivity**
  - IT Interface
  - Large project architecture
  - Design for the future
  - Scalability issues

- **Life Cycle**
  - Long term service contract
  - Staff training
  - Sustainable design

Don’t get locked in!
Top 10 List to Open Systems

1. Open Communication Protocol
2. Device Interoperability
3. Infrastructure Standard
4. Open Tool Sets
5. Graphical Interface Interoperability
6. Integrator Proficiency
7. Contracting Requirements
8. IT Integration
9. Vender Selection Criteria
10. System Performance Standards

1. Can devices from different manufacturers be installed and commissioned on the same physical wire and be capable of true peer-to-peer communication?
2. Have devices been tested for interoperable compliance; and are there any closed aspects of these products inhibiting an open system?
3. Is the network infrastructure adequate and correctly installed?
4. Are network management and commissioning tools capable of completely installing all nodes in the system?
5. Are the front-end tools truly open and non-proprietary?
6. Are the people doing the work qualified, certified, credentialed?
7. Do you have control over your building and access to all data points, tools, and databases?
8. Is the connection to your data network based on open standards?
9. Are the controls and products openly available from multiple sources?
10. Is there proof your network was designed and installed correctly?

**BONUS QUESTION: Are you about to undermine all of your efforts?**
No Alternates Will Be Accepted.
The Questions

1. Can the devices from different manufacturers be installed and commissioned on the same physical wire and be capable of true peer-to-peer communication?
   "All devices on the network shall be capable of true peer-to-peer communication, without requiring a host or zone controllers. Logical layer 3 routers shall be used to logically isolate channels of devices."

2. Have the devices been tested for interoperable compliance? Are the manufactures of the device level product adhering to interoperable standards when designing and delivering their products? And are there any closed aspects of these products that would inhibit an open system in which they are intended to be used?
   "All devices shall implement the ISO/IEC 14908-1 protocol standard and shall do so using standard mechanisms for sharing data as defined by LonMark International. Applications specific devices shall be LonMark Certified only. Closed or non-standard communications protocol implementations will not be accepted. All devices (nodes) on the network shall conform to the LonMark International Interoperability Guidelines and be tested for compliance on the open systems network."
The Questions

3. Is the integrator meeting the requirements for the network infrastructure?
   “The network infrastructure shall conform to the published guidelines for wire
type, length, number of nodes per channel, termination, and other relevant
wiring and infrastructure criteria as published (see reference documentation).”

4. Are there network management and commissioning tools available from
   multiple sources that can completely install all the nodes in the system?
   "All devices (nodes) on the network shall be able to be installed and configured
   using a standard network management tool as defined by the LonMark System
   Definition. No closed or partially closed tool set for installation or configuration
   will be accepted. All tools must be generally available for purchase to any
   integrator from multiple sources. Complex devices shall be configured with a
   vendor supplied LNS plug-in."
5. Are the front-end tools open?
"Any host PC GUI interface shall use openly available software packages that are non-exclusive. No closed software will be accepted. Software must be generally available on the market from multiple sources. Devices must communicate to the GUI workstation using Standard Network Variable Types (SNVT) Standard Configuration Property Types (SCPTs) as defined by LonMark. No non-standard communication to devices will be allowed."

6. Who is doing the work on your building?
"Integration of the controls network shall be performed by a qualified network integrator. A qualified network integrator must have technical staff members who have attended at least 80 hours of LonWorks network design and network management tool training and have passed the LonMark Certified Professional exam. It is also recommended that the integrator have staff members competent in IT connectivity and advanced troubleshooting of LonWorks networks. The integrator shall provide references of prior successful LonWorks open systems jobs experience. The Network Integrator must demonstrate their ability and intent to design, architect, and install a open, flat, LonWorks system and have on staff at a minimum two technically trained members.
Or simply state “Integrator must be a LonMark Certified System Integrator”
7. Do you have control over your building?
“All configuration tools, installation tools, Plugins, databases, software shall remain with the job and be owned by the property. All software tools shall be properly licensed and conveyed at contract sign-off. No exclusive or non-open integration tools, devices, or host software shall be used as part of this open system”

8. How are you connecting to your data network?
“If Internet or IP connectivity is specified, all devices connecting to the LAN shall use the TCP/IP protocol stack. Any LAN to LON routers shall use the ANSI/EIA-852 standard layer 3 transparent routing protocol. Specific IP interconnectivity shall follow IT standards for security, firewalls, address, etc. published in separate documents (if appropriate).”
9. What controls are you using?

“The control system shall be installed using the best available products from the currently available suppliers that meet the system specification. Controllers from multiple manufactures are encouraged.”

10. Are you certain your network was designed and installed correctly?

“The system integrator shall provide a protocol analyzer log summary for each channel for a minimum of 24 hours showing system performance. The statistical summary shall show that all bandwidth utilization and error limits are within acceptable ranges and that there are no network traffic problems, node communication problems, or system sizing problems.”
11. Are you about to undermine all of your efforts?

No Alternates Will Be Accepted.

Submittal documents and drawings must adhere to both the scope and details of this specification.

Bidders must prove they will deliver the open system specified and provide a complete, working, serviceable system.

Bidders must include service contract costs for 5 years as a separate cost, not included in the initial installation. Annual costs shall be identified for each successive year.
Workshop Discussion Question #3

What are the **challenges, obstacles, and blocks** to getting more efficient facility management?
Results of Prior Workshops

- Lack of training and education
- Vendors “hide” information from owners
- We don’t “own” our systems
- Competitive bidding issues – can’t get “Apples-to-Apples” bids
- Lack of good specifications – lacking detail
- We can’t control our facilities because we can’t see the data – minimal control
- We can’t find qualified integrators
Introducing the Three-Tier BAS/BMS/EMS Spec
3-Tier Architecture

Tier 1
- Device Level: Sensors
- Actuators
- Controllers

Tier 2
- Building Infrastructure Connectivity

Tier 3
- Enterprise/Campus Connectivity

Building Data Abstraction
3-Tier Architecture

Tier 3
Multiple Buildings

Tier 2
Single Building

Tier 1
Single Sub System

Campus/Enterprise
Multi-Data Construct
Demand Response, Load Shed

Multiple Sub-System Integration
HVAC, Lighting, Shading

HVAC
Tier 1 - DDC Devices

- Tier 1
  - DDC Devices
    - Mechanical Electrical Contractors
  - Meters
  - Sensors
  - Actuators
- Tier 2
  - Building Infrastructure
- Tier 3
  - Enterprise Connectivity

Building Data Abstraction
Tier 2 - Infrastructure

Tier 3
- Enterprise Connectivity

Tier 2
- Building Infrastructure
- System Integrator Controls Contractor

Tier 1
- DDC Devices

Tier 1
- Communications
- Control Network
- User Interfaces
- BMS/BAS Control
- Controllers Routers/Gateways
- Media (wired, wireless, PLC, Fiber)
Division of Responsibilities

- **T1 - Traditional Controls Contractor**
  - Hired by Mechanical/Electrical Contractor
    - Only sees his scope, typically one sub-system
    - Limited or no integration

- **T2 - System Integrator**
  - Performs and or manages all work related to Building Automation Systems
    - Better integration capabilities

- **T3 - Master System Integrator**
  - Manages the work at the network level and higher
  - Acts as the owner rep to manage the System Integrators work
  - Long term relationship
  - Applies to larger Multi-Building systems, longer term projects
  - Allows for easier management of multiple vendors
Three Tier Specs

- **Tier 1: Sub-System Spec**
  - Field device bus, monitoring/control – single sub-system focused
  - Performed by controls contractor (system integrator)
  - Often hired by Mechanical Contractor

- **Tier 2: Integration Spec**
  - System and cross system functionality
  - Multiple Sub-system interaction
  - Cross system sequence of operations
  - Hired by General Contractor

- **Tier 3: Enterprise Integration/IT Spec**
  - Integration of multiple building into campus/enterprise
  - IT and GUI integration
  - Facility Master System Integrator
  - Hired direct by owner

- Provides check and balance
  - Reduces “Lock-in”
  - Encourages fair competitive bidding
  - Provides options for long term service
HVAC Lighting

Server (PC):
• Manage Data
• Alarms
• Eng. Tools

WAN / LAN / Internet

Web Browser:
• Access - No Proprietary Software Required

Master System Integrator Responsibility

Integrator Responsibility

Controls Contractor Responsibility

Architecture – Three Tier System Integration

NASA – Introduced the Concept

- **Scope**
  - Kennedy Space Center - Florida
  - Upgrades to existing control systems – built in the 70s – started in 2002
  - Multi-year, multi-phase project
  - Open bidding process across multiple projects/buildings
  - One Common Front End

- **The Spec**
  - Calls for LNS, LONMARK, and IT connectivity into existing Citect SCADA front end

- **Status**
  - Several projects underway using spec
  - Multiple bidders winning jobs
NYC Schools
Enhanced Concept - Developed 2 Tier Spec

- **Scope**
  - 1200 buildings
  - Upgrades to existing pneumatic systems

- **The Spec – Started in 2002**
  - Has two components
    - Building level
    - Enterprise connectivity
  - Bidders on the buildings cannot bid on the enterprise and vice versa

- **Specs released in January 2004**
  - Multiple buildings bid and won by multiple controls contractors
  - Master Systems Integrator (MSI) contract awarded
Army Corps of Engineers
Broad Adoption Across Multiple Facilities

- Two level specification – Started in 2003
  - Calls for open LONMARK certified devices, LNS® network management and LNS plug-ins for all devices
  - Identifies building and integration requirements in different spec docs
- Released Sept 2004
  - “Tri-Branch” spec - Army, Navy, and Air Force
- CorpsLON enforcement and support
- Spec being used by other government and commercial organizations
Open System Goals

1. **One system.** Multiple buildings with controls installed by multiple vendors are integrated into one system.

2. **One common front-end** that provides users with the capability to interface with all buildings (monitoring, supervisory control, etc.).

3. **One common tool** for network management and device configuration. One common tool for device programming would be great!

4. **No future need for** the original (installing) contractor or any particular device manufacturer. Additions, modifications, and retrofits can be easily (without significant additional cost) made to the system without dependence on the original contractor nor require substantial engineering or other technical development.
One or more servers running:
- LNS Server
- Network Management Tool
- Graphical User Interface (GUI)
- Monitoring and Control Software
- Web Server (optional)

One or more workstation running:
- GUI Clients
- Network Management Tool Clients
- Web Clients (optional)

Basewide ANSI 709.1B over IP Network (EIA-852) >=100Mbps

BPOC = Building Point Of Connection
RTR = Router
RPTR = Repeater
Circle = node (ANSI-709.1 device)

More devices
No more RTRs or RPTRs

More devices
and/or ‘subnets’

Non-ANSI 709.1 legacy system

LONWORKS®
Army Corps of Engineers
UMCS/DDC System
Use Case Examples
McDonalds and QSR Market

- **Scope**
  - QSR (Quick Serve Restaurants) Smart Networked Kitchens
  - Enable networked intelligent kitchen equipment

- **Application/Need**
  - Energy savings
  - Operational efficiency
  - Integration of process and facility
  - Enterprise Dashboard Applications

- **Impact**
  - 5000 restaurants installed
  - Thousands more planned
  - Entire QSR supplier marketing supporting effort
  - Potential adoption by entire QSR Market (KFC, YUM!, Wendy’s, etc)

- **Status**
  - LonMark Sponsor, Board Member, Driver
  - LonMark Certified Smart Kitchen Equipment
  - Integrating process to facility
  - Building automation and restaurant automation
  - Enabling access to enterprise applications (NEEDED!)
  - “If you build it, they will come” model
  - LonMark driving industry support with NAFEM Committee
California State Office of the Courts – State GSA

- **Scope**
  - 550 building management systems statewide
  - Court Houses
  - Office facilities
  - Multi-story, multi-use facilities

- **Application/Need**
  - Focus on Energy Savings, Operational Efficiency (COST SAVINGS)
  - One common front end access for ALL facilities
  - Network access using web browser and IT tools
  - Separate building controls contract from front end contract

- **Impact**
  - 20 new construction buildings in 2011
  - 6 “Dumpster Retrofits”
  - Ongoing for next 5-7 years

- **Status**
  - Directed by state engineers
  - Educated on needs, technology, and spec development
  - Enforcing state needs
  - Following LonMark Guidelines, Specs, Certifications
NTT DATA Shinagawa Building

- **Scope**
  - 3,459.07 m² with 29 floors with three sub floors
  - Mixed use facilities
    - Offices
    - Restaurants
    - Retail stores
    - Branch shops
    - Conference facilities

- **Application/Need**
  - Open, integrated control system
  - Multiple view into system from GUIs

- **Solution**
  - IP Backbone
  - Integrated BMS, CCTV, access control
  - VOIP Communications
  - LONWORKS open architecture
OVERVIEW:
- 37,000m², four story Pfizer pharmaceutical research laboratory in Sandwich R&D facility
- Ove Arup & Partners were appointed by Pfizer Ltd to provide the engineering design services for the new building

SOLUTION:
- TAC/Schneider Electric – highly integrated job
- Uses open LONMARK solution for BMS for monitoring, metering, operational and supervisory control, trending, alarm handling and web browser functions.
- 2435 LONWORKS devices from over 15 different vendors
- Connected on over 60+ sub nets, backed by dual redundant IP network.
- 51,475 total points monitored
OVERVIEW:
- World’s largest stand-alone LONWORKS enabled building project with 759,100 m²
- Four zones, 13 Buildings
  - Mori Tower; Four residential towers

SOLUTION:
- 16,500 LONWORKS devices primarily HVAC&R
- Over 170,000 points monitored
- Schneider IBMS with Citect front end
- Over 20% savings in energy costs over projection
- LONWORKS/IP integration using i.LON® servers
- Mori Building general developer/operator
  - Urban developer operating more than a hundred buildings
  - Extensive use of LONWORKS planned for world’s tallest building
    - Shanghai World Financial Center
OVERVIEW:
- Installed state-of-the-art Intelligent Building Management System (IBMS)
- Multiple buildings
  - Class rooms
  - Dormitories
  - Offices
  - Restaurants
  - Conference facilities

SOLUTION:
- Integrated HVAC, lighting, access control, hot water
- Project 20% energy savings
- IP backbone
- LONWORKS open architecture
Coeur Defense Complex - France

- Building required a flexible, high tech, and open solution for its control-networking needs

- The Benefits
  - Cost-reductions
  - Flexibility
  - Easy changes and upgrades

- Products used in this project:
  - Desigo RXC21.1 fan-coil regulators – Siemens BT - Landis & Staefa Division
  - LRC 5048 8-way lighting controllers – Philips
  - 120 routers and 22 LNS servers - Echelon Corporation
Overview:
- 5 buildings (80 000 m²) in different locations.
- Offices rented to various IT based companies
- HVAC : Chillers, AHU’s, VAV Boxes.
- 2500 I/O : Power, UPS, Plumbing, Firefighting, Lifts, DG…

Customer needs:
- Flexibility
- Peer-to-peer communications
- Open technologies,
- Many remote I/O’s …

How to :
- Reduce wiring costs
- Enable automated sequences
- Maintain flexibility & reprogramming
- Maintain high speed communication

Solution:
- LON was the preferred technical solution :
  - Enable flexibility thru easy reconfiguration
  - Bindings technology allows for tying many remote I/O’s in logical sequences, with reduced wiring costs
  - Open & evolutive

- BCU’s on IP Backbone
- LonMark MP 581, MP501/503
- Seamless integration
University of Miami Medical Campus

- $1.5M Clinical Research Building
- Completed Nov 2006, LEED Project
- 15-Story Medical Research Offices, Wellness Center, Parking Garage
- 20 AHUs, VAVs, Underfloor Air System, CHW Supplied from Campus CHW Loop
- UL864 Smoke Control, Fireman’s Smoke Control Station, Siemens F/A System
- Douglas Lighting Controls, TAC LonWorks controllers, Viconics Thermostats
- User Interface handled on SI contract with UM Master Systems Integrator
Jumeirah Islands - UAE

Overview:
- District cooling for 1000 villas. Cooling capacity = 5 750 tons.
- Residential
- HVAC : Chillers
- Power

Customer needs:
- Energy Savings
- Energy monitoring (Current, Voltage, Power)
- Reliable communications
- Reduced I/O wiring

Solution:
- LON was selected:
  - Greater choice of power monitoring modules
  - Open & evolutive
- Direct integration of power metering module onto BCU
- Tracer Summit Chiller Plant Application
Kuwait Institute for Scientific Research

- **Scope**
  - Demand Response Control
  - Government – Ministry of Education and Ministry of Electricity

- **Application/Need**
  - Energy reduction control via Demand Response program
  - Open network platform
  - Flexible solution, multiple technologies integrated into common architecture

- **Status**
  - Pilot in 2008 - 8 Buildings
    - proof of concept phase completed
  - Phase 2 - 2012 - **102 Schools**
    - 450 points/building
    - HVAC, Lighting, Power Meters, Solar
    - District Wide LON/LAN/WAN
  - Phase 3 - 3000+ buildings
    - Mosques, Schools,
    - Government, Homes

120 Split Units
5 Power Panel Sub-meters
15 Lighting Panels
10 Packaged Units

Workshop Discussion Question #4

What are your key learnings today and your next steps?
Results of Prior Workshops

- I can get an open system, I just have to demand it
- Integration of my systems into one control system is needed to be more efficient, save costs, and improve energy usage
- We need a good master plan for our facilities
- Open systems provide advantages we need to implement
- Help is available and there are solutions that we need to investigate
- Others have successfully implemented an open solution, we should too
LONMARK Programs And Resources
LONMARK Overview Document

- Compilation of all ‘about’ documents
- Available
  - Marketing-in-a-Box CD
  - Information CD
  - Printed copy
  - PDF

http://www.lonmark.org/about/docs/LonMark_Overview%20Ver4%20May%202009.pdf

Integrator Training, Testing, Certification Programs

- Programs to deliver a comprehensive professional testing and certification
- Worldwide standard of proficiency
- Web-based exam
- Professional, Integrator, and Expert Credentialing
- www.lonmark.org/testing
LMI Training Classes
  - LonMark Professional Certification one day refresher class
    • Followed by testing
    • Available now
    • Contact LMI to schedule local class/test
  - Custom Onsite “Project Specific” training
    • Available now
    • Flexible Agenda – Basics to Advance – Project Guidance
    • Fee based (time and expenses)
  - Online web based interactive training (in development)
    • LON basics and advanced modules
    • Compliment the testing program
    • Sneak Preview of First Module
  - See www.lonmark.org/training
LONMARK Credentialing Programs

- **LONMARK Certified Professionals (individuals)**
  - Comprehensive testing program for engineers, installers, integrators
  - Over 400 LonMark Certified Professionals
    - [http://www.lonmark.org/certifications/professional_certification/](http://www.lonmark.org/certifications/professional_certification/)
    - Available Languages
    - English, German, Spanish – Available Now
    - Japanese (in 2013)
  - Recertification process (every 3 years)
    - Includes Online Training and Test
    - Ongoing training and education
  - Meets specification requirements for professional proficiency
LONMARK Credentialing Programs

- **LONMARK Certified System Integrator (companies)**
  - Proven proficiency and commitment
  - Employ LM Certified Professionals
  - Strong training and field experience
  - Prior successful projects
  - Peer-review panel
- Establishes high level of proficiency
- Benefits owners/contractors
- Ensures contractor qualification are met
Specs, Tools, and Resources

- **Sample Specifications**
  - LonMark Master System Specification
  - Army Corps Specification
  - Army Corps document library
  - Functional and Performance Open Spec - NEW 2010

- **Tools**
  - Sample Point Schedule Template

- **Resources**
  - Product and Services Guide
  - Case Studies
  - Product Database
  - Certified Professional Directory
Additional Resources

- The LonWorks Installation Handbook
- Overview of LonWorks
- LonMark Interoperability Guidelines
- Training and Certification
- www.lonmark.org
LonMARK Helps Large Customers

- Helping Develop Open Specifications
  - LONMARK Training for Writing Good Open Specs
  - Educational Seminars
- Facilitating Vision Setting With Project Teams
  - Green Energy Efficiency Programs
- Help with Master Planning
  - Unified System Architecture Support
- Support for Open Bidding
  - Qualified System Integrators
  - Certified Interoperable Products
- Resources
  - Master Specification Examples
  - Case Studies, Research
LonMARK Helps Large Customers

- LONMARK Specifications – Large Projects
  - New York City Schools
  - US Military - Americas
  - City of San Jose, CA
  - McDonalds - Worldwide
  - GSA - America
  - NASA, FL
  - Military Base; Okinawa, Japan
  - Kuwait Demand Response Project
  - City of Masdar, MIST, UAE
  - Columbus Regional Hospital, IN
  - And many more…
Summary

- Demand is growing for good open specifications
- Help is available to deliver more open solutions
- We are committed to
  - Expanding the market for Open Systems and certified products
  - Enhancing the standards as technology advances
  - Increasing the number of certified products
  - Supporting Owners, Integrators, Vendors
- Develop new programs, resources, and tools
- Focus on Education, Training, Certification
Questions

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Additional Topics and Backup Slides
Workshop Agenda

- Introduction to Energy Efficiency Through Intelligent Controls
- The Trend Towards Open, Integrated Control Systems
- The Elements of an Open Controls Platform
- Introducing LON – Local Operating Networks
- Specification Development Requirements
- The Changing Contractor World
- Introducing the Two-Tier BMS Spec
- Use Case Examples
- Tools, Resources, and References
Introducing LON
Local Operating Networks
What is LonWorks

- LON – Local Operating Network
  - A open platform for interoperable controls
  - Designed specific for control communications
  - High speed, high reliability
  - Short messages for control
  - Thousands of devices in a peer-to-peer network
  - Standards data types, device profiles
  - Worldwide platform adoption
<table>
<thead>
<tr>
<th><strong>LonMark®</strong></th>
<th><strong>Echelon Corporation’s trade name for the ANSI/CEA-709.1-B protocol</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LonTalk®</strong></td>
<td><strong>The ANSI standard name for the communications protocol underlying LONWORKS networks</strong></td>
</tr>
<tr>
<td><strong>ANSI/CEA-709.1-B</strong></td>
<td><strong>ISO international standards for LonWorks</strong></td>
</tr>
<tr>
<td><strong>ISO/IEC 14908-1,2,3,4</strong></td>
<td><strong>Products and applications based on LON technology. Also, a description of products that use the Neuron® microprocessor, e.g., “a LONWORKS valve controller”</strong></td>
</tr>
<tr>
<td><strong>LONWORKS®</strong></td>
<td><strong>“Local Operating Network” – the most-common way of referring to a device, network, or application based on LONWORKS</strong></td>
</tr>
<tr>
<td><strong>LON</strong></td>
<td></td>
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</tbody>
</table>
LONMARK: The Organization & The Mark

- **LONMARK®**
  - International
  - Logo

Brand of Recognition:

1. Organization of ~400, worldwide, member companies dedicated to advancing LONWORKS technology
2. “The Mark”
Nearing 90 million installed products
ISO/IEC 14908 International Standard

Further Standards Adoption
EU – Buildings, Gas Stations, Home Appliances
NA – Homes, Buildings, Trains, Freight Trains, Semiconductor Manufacturing
ASIA – Buildings, Controls, Homes

Standardized as ANSI/CEA-709.1-B
Became more commonly known as
LON® technology or simply, LON

LonMark International

The LonWorks® Platform

History of LON – Adoption / Time

1990 2010
Benefits of Energy Efficient Controls

- Open Integrated Systems Goals
  - Lower Install Costs
  - Lower Life Cycle Costs
  - Lower Energy Costs
  - Greater Performance
  - Improved Occupant Comfort
  - Reduced Operation and Maintenance Costs
  - Smarter Systems
  - Lower Risk, Higher Security
Project Types

- **Design/Build**
  - Private sector
  - Negotiated contract
  - Single project
  - Engineered system
  - Heavy reliance on contractors

- **Plan/Spec**
  - Public sector
  - Fair competitive bidding
  - Multiple projects over time
  - Need for master plan
  - Need for project coordination
Specification Types

- **Single Premise**
  - One building
  - One contractor team
    - General
    - Mechanical
    - Controls
  - One system architecture
    - Minimal integration
  - One GUI
    - Local access only

- **Campus/Enterprise**
  - Multiple buildings
  - Multiple contractors
    - Multiple Generals
    - Multiple Mechanicals
    - Multiple Controls
  - Multiple system architectures
    - Massive integration
  - Multiple GUIS or one common GUI for all projects
  - Local, remote, enterprise access to data
Introducing
LONMARK International
LonMARK International

- Independent, non-profit worldwide member supported organization
  - Product Manufacturers
  - System Integrators
  - Engineers
  - End Users
- Vision
  - LonMARK is the recognized industry authority for certification, education, and promotion of interoperable standards for the benefit of manufacturers, integrators, and end users
LONMARK Devices Guarantee
Interoperability

- LONMARK International
  - Independent Industry Association
  - Established in 1994
  - Task groups focus on specific industry requirements
  - Define device SNVTs, Objects, Profiles, IP connectivity
- What we provide
  - Interoperability design guidelines
  - Product conformance testing
  - Professional testing
  - Marketing assistance
- LONMARK Stamp of Approval Means Devices Will Interoperate
The LON Protocol
An International Standard

ISO/IEC 14908
ANSI/CEA-709.1-B
EN 14908-1:2005
GB/Z 20177.1-2006
IEEE 1473-L
Members Around the World

- ≈400 member strong independent, non-profit standards organization
  - Product Manufacturers
  - System Integrators
  - End Users
LONMARK International Standards and Program Offerings

- Manufacturers
  - Interoperability guidelines
  - International standards body adoption
  - Product design support
  - Certification of interoperability
  - Promotion and adoptions support

- Integrators
  - Training and education programs
  - Proficiency and credentialing
  - Product resources
  - Integration resources

- End-users, Owners, Specifiers
  - Specifications examples
  - Project support
  - Interoperability and open systems support
  - Qualified vendors, professionals, and integrators
LONMARK Interoperability with Network Variables

Thermostat

Fan Coil

nvoSpaceTemp
SNVT_temp_p

nviSpaceTemp
SNVT_temp_p

Standard Network Variable Type

LONMARK
Layer 1 – 6
Interoperability Guidelines

LONMARK
Application-Layer
Interoperability Guidelines

LONMARK Functional Profiles

Sunblind Controller

Mandatory:
- nviLocalControl
  - SNVT_setting
- nvoSblndSetting
  - SNVT_setting

Optional:
- nvoGroupControl
  - SNVT_setting

For other possible inputs, refer to Table 1

Configuration Properties

Mandatory:
- Send Heartbeat
- Receive Heartbeat
- Input Priority
- Weather Sensor Fail Default
- Window Sensor Fail Default
- Location Label
- Object Major Version
- Object Minor Version
LONMARK Interoperability Guidelines

- Data interpretation
  - Standard representation of data types
- Standardized functional behavior of nodes
  - LONMARK objects
  - Encapsulated network interaction of defined functions
- Standardized support of smooth and trouble-free installation
  - Self-documentation of a network-oriented external interface
  - Guidelines for Network Management
The Stats

- ~500 Certified interoperable products
- >400 Certified professionals
- >90 LonMark standard profiles
- ~90 Million installed LonWorks devices
- ~300-400K LonWorks systems installed
- ~400 LonMark International members worldwide
- 13 LonMark International Affiliate organizations around the world
Control Networking Platform
For Smart Buildings

Enterprise Applications
PC, MAC, Android, iPhone

Any IP network

Building to enterprise Interface: protocol neutral

Smart Homes
Smart Campuses
Smart Buildings
Smart Branches

Building to enterprise Interface: protocol neutral
Building to enterprise Interface: protocol neutral
Building to enterprise Interface: protocol neutral
Building to enterprise Interface: protocol neutral
System Architecture

LON – Twisted Pair Channel

LAN - Ethernet

Energy Sub-Meter

Power Mains

LonMark Energy Meter
Profile SNVTs

LonMark SNVT

LonMark XML
Data Type

HTML Web Tag

IP Server
XML

SQL,.net, ASP

Application

LNS DDE or OPC Server

WEB Browser

WEB Server

Data Logger/Server

SNVTs

SOAP/XML

WEB Server

Soap/XML

LAN to LAN Options:
SOAP/XML
IP-852
WEB Server

WAN – Internet/VPN

LAN to WAN Options:
Wired Ethernet
WIFI
GPRS, Edge, 3G

Network Interface

LAN - Ethernet

Formats and delivers data
to LAN

Collects and stores data
from devices

Remote LNS Client

WEB Browser

WEB Browser
Option #1 - Twisted Pair/RF

PAC Unit 1
Relay to Feedback Contactor
LonMark Energy Meter Profile SNVTs

PAC Unit 2
Relay to Feedback Contactor

IO Controller
~8 UI, 8 UO
~$250
Power Supply
Deg C

LON – Twisted Pair Channel

Unit 1
LON Stat
Use existing 5 wires from existing stat – 2 power, 2 Comm.

Unit 2
LON Stat
Use existing 5 wires from existing stat – 2 power, 2 Comm.

RF-LON Bridge
Thermikon

RF

Wattnode Meter ~ $600

LON Mark
Energy Sub-Meter

Option #2 - Powerline

PAC Unit 1
- Relay
- Feedback Contact

PAC Unit 2
- Relay
- Feedback Contact

IO Controller
- ~8 UI, 8 UO
- Power Supply

LON – Powerline Channel
- Set point control via web interface
- Wattnode Meter Powerline

DSL Modem
- To Phone line
- PAC On/Off Control via Set point

Ethernet

PAC Unit 1
- LON Stat Powerline

PAC Unit 2
- LON Stat Powerline

LonMark Energy Meter Profile SNVTs

i.Lon 100 Powerline

Hardware Costs (w/Install)
Total ~ $6000/site

- IO Controller Powerline– 8 UI, 8UI - $350
- WattNode Power Sub-meter - $700
- i.Lon 100 e3 - $700
- Powerline Thermostat - $300
- Contactors (Relay – 2/PAC) - $50 per PAC X 10
  PAC ~ $500
Software

- Web Programming –
  - Create HTML/XML interface software
  - Use i.Lon Vision and Contribute (Adobe)
- IT Support
  - Need Static IP address for i.Lon 100
  - Need IP Address for Web Server PC
- Hardware/Software on Server PC
  - Graphics development, data server interface
Communication

- WAN connection to each building site
  - Provides access to enterprise server and User Interface

- Option 1
  - DSL line to each building
    - Preferable option
    - Cost effective, easy to maintain

- Option 2
  - GPRS
    - Less desirable
    - More costly, more complex
Software GUI – Coming from Central Server

Total Available
>10,000 MW

Today – 6,600 MW
Software GUI – Coming from i.Lon in 1 building

Bldg 4

Total Current Usage – 6,600 MW

Set Point = 21
Current Temp = 19.5

User Interface Examples
User Interface Examples
User Interface Examples

Building: All Campus

Rankings

- $/sqft: N/A
- kWh/student: N/A
- Reduction: 3rd

Total savings: 8%
Total consumed: 135 MWh
Avg MWh/yr: 101 MWh
User Interface Examples
User Interface Examples

[Image of user interface examples]

User Interface Examples
Common Elements

- Web or IT based interface
- Open solution
- Software GUI not “Tied” to hardware
- Dashboard options
  - Pick and choose needed options
  - Not overloaded with data
  - WYSIWYNTS – What you see is what you need to see!
    - Nothing More, Nothing Less
- Variety of vendors
  - Follows “APS” model
The Changing Contracting World
Traditional Contractor World Today
Single Building Project – Minimal System Integration

Owner

Architect

General Contractor

Consulting Engineer

Mechanical Contractor

Electrical Contractor

Plumbing Contractor

Various Other Contractors

Controls Contractor

System Integrator Specialist

IT Specialist

Integrates Primarily HVAC
The Changing Contractor World

Typical System – Single Building

Enhanced System Integration

Owner

IT Consultant

Architect

General Contractor

Consulting Engineer

System Integration Contractor

Mechanical Contractor

Electrical Contractor

Plumbing Contractor

Various Other Contractors

Controls Contractor

Integrates All Subsystems
HVAC, Lighting, Energy Mgt, Access, Security, Irrigation, Elevators, Fire, Life Safety, etc

Integrates Primarily
HVAC

Driving factors:
Changes in Master CSI Spec - Div 17 specs
Open Systems = Flexibility
Reduce Energy Costs
Requirement for better integration
The Changing Contractor World
Open Systems Changes the Model – Multi-Premise

IT Department
Owner
System Integration Contractor
Architect
General Contractor
Consulting Engineer

Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Controls Contractor
Integrates Primarily HVAC

Integrates All Subsystems
HVAC, Lighting, Energy Mgt, Access, Security, Irrigation, Elevators, Fire, Life Safety, etc

Driving factors:
Common interface for all systems
Common management for all buildings
Simplify maintenance, reduce staff
Reduce reliance on single vendors
Competitive bid/procurement process

The Changing Contractor World
Open Systems Changes the Model – Multi-Premise

Driving factors:
- Coordinate multiple projects
- Supervise system infrastructure
- Develop specifications
- Enforce specifications
- Enhance system as technology changes
- Point person for ROI evaluation
- Interface with IT, CFO, Energy Mgr…

IT Department

Owner

System Integration Contractor

Project 1

Architect
General Contractor
Consulting Engineer
Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Project 2

Architect
General Contractor
Consulting Engineer
Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Project 3

Architect
General Contractor
Consulting Engineer
Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Project 4

Architect
General Contractor
Consulting Engineer
Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

The Changing Contractor World
Open Systems Changes the Model – Multi-Premise

Driving factors:
- In house staff responsibility
- Taking ownership
- Direct involvement with master plan
- Coordination with IT department
- Taking advantage of access to information
- Integration with operations, finance, energy

System Integration Staff

IT Department

Owner

Architect
General Contractor
Consulting Engineer

Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Project 1

Project 2

Architect
General Contractor
Consulting Engineer

Mechanical Contractor
Electrical Contractor
Plumbing Contractor
Various Other Contractors

Project 3

Project 4