Introduction to LONWORKS® Control Networking
LonWORKS Use Cases

>140M LonWorks Devices Installed

- Building automation
  - HVAC controls
  - Lighting and sunblind controls
  - Emergency lighting controls
  - Elevator and escalator controls
  - Access controls
- Outdoor lighting controls
- Security system controls
- Semiconductor fab monitoring
- Electrical energy meters and sub-meters
- Sound system controls
- Transportation automation
- Train braking control
- Industrial automation
- Runway lighting control
- Quick service restaurant automation
- Retail store automation
- Renewable energy management
- Demand response and energy management
- Backup power generation control
- Agricultural equipment automation
- Dairy farm automation
Control Network

Network of intelligent devices that communicate with each other using a common protocol over one or more communications channels.
Device/Node

Sensor

Intelligent device that communicates on a LONWORKS network.

Actuator

Controller
The communications medium that connects LONWORKS devices.
Network Variable (NV)/Datapoint

- **Sensor**: Creates the logical interface of the device to the network, typically using a SNVT.
- **Actuator**:
Binding

Type safe “Virtual connections” between device network variables/datapoints for event driven exchange of control data.
LON & Latterly LON/IP

Sensor

Communications protocol - language of LONWORKS

nvo_temp = 0x0898

Actuator
Configuration Property (CP)

Integrators modify CPs to change a device’s application behavior. They are stored in non-volatile memory.
Neuron Chip

A microprocessor designed for LonWorks control applications
Transceiver

Used to connect Neuron Chip and therefore device to selected transfer medium
A VLSI component that integrates a Neuron processor core with a twisted pair or power line transceiver.
Processor Choices

Single Chip

- Application layer: Neuron C Application (NodeBuilder, Mini EVK)
- Presentation layer
- Session layer
- Transport layer
- Network layer
- Data link layer
- Physical layer: Transceiver and wiring

ShortStack + Host

- Application in any suitable language
- Link layer
- SCI or SPI serial I/O link and driver software
- System Firmware
- ShortStack Micro Server
- Transceiver and wiring

IzoT SDK 2.0

- User C/C++ Application
- User Python Application
- C API
- Python Package
- ISI Engine
- Control Services
- Linux UDP/IP Stack
- Ethernet / Wi-Fi
LonMark International

Global non-profit organization created to promote open, interoperable multi-vendor LONWORKS control systems

Provides a forum (task groups) to define application-specific design requirements.
Thermostat, VAV Controller, Chilled Ceiling Controller, Smart Luminair Controller…
External Interface File (XIF)

- File that fully describes the contents of a device
- External Interface File
  - Functional Blocks
  - Network Variables
  - Configuration Properties
  - Hardware Characteristics

If XIF is not available, it can be uploaded from the device.
LON/IP Control Services

- **One-to-one and one-to-many peer addressing**
  - Devices communicate directly with each other, eliminating single points of failure and reducing transaction times

- **Reliable message delivery**
  - The LON/IP stack can automatically repeat datapoint updates until all receivers get the update
  - Acknowledged, repeated, request/response, authenticated services

- Up to 228 bytes per datapoint
- Up to 4096 datapoints per device
- 32,385 devices per community (domain)
- 256 groups per community
Routers are used to connect channels together and provide selective isolation of network traffic.
Applications such as the IzoT Commissioning Tool® are used to design, configure and install LONWORKS networks.

Physically install devices on a network and enable them to become active participants by:
- Assigning logical network addresses
- Binding network variable connections
- Configuring devices
- Commissioning devices
LonWorks Installation Options

- **Interoperable Self-Installation (ISI)**
  - Lowest cost
  - Suitable for simple networks with simple configuration and connections

- **Standard installation tool using an i.LON SmartServer**
  - Simplest solution for small networks
  - Suitable for simple networks with simple configuration

- **Standard installation tool such as the IzoT Commissioning Tool**
  - Best flexibility and network documentation
  - Lowest development cost

- **Custom installation tool (based on IzoT Net Server®)**
  - Most customized solution
  - Highest development cost
Network Tools

In order to design, commission and maintain a non self installed or standalone network, you need a set of network tools:

- **Network Management tool**
  - To design and engineer the network design
  - To commission devices, and program the network
  - To test, modify, and maintain the network

- **Human Machine Interface (HMI) tool**
  - For monitoring and control
  - DDE
  - OPC

- **Performance/Protocol Analyzer tool**
  - For maintenance, repair and testing
PC Connectivity Options

- PCI
- Modem
- USB
- RNI
- IP-852 Routing
- Modbus IP
- Ethernet

choices:

- PCLTA-20: TP-1250 SMX
- FT-10, PL-20 (Modem Option)
- U20: PL-20
- U10: TPFT-10
- i.LON 600
- FT-10, XF-1250
- i.LON 600
- FT-10, PL-20
- SmartServer
- SmartServer
- SmartServer
- SmartServer
- PCLTA-21: FT-10, TP-78, TP-1250, RS-485
IzoT Net Server (Formally Open LNS)

Provides unified functions: directory, installation, management, monitoring and control services

Platform for interoperable multi-vendor tools
Main purpose of device specific plugin is to setup device configuration and application logic.

Passive configuration tools used in integration tool to set device parameters.
IZOT Commissioning Tool (CT)

**EASY NETWORK DESIGN AND COMMISSIONING**

- Simple network design and commissioning
- Includes integrated IzoT Net Server for network management
- Compatible with all classic LON media plus all LON/IP-compatible media such as Ethernet, Wi-Fi, FT, and RS-485

- Provides an open platform for multiple simultaneous users and multiple applications from multiple vendors
- Supported by hundreds of third-party applications and plug-ins
- Backward compatible with classic LON devices and existing LON networks
Channel Options

• PL-20x  5.4kbps Power Line
• TP/FT-10  78kbps Free/Bus Topology Twisted Pair With Link Power Support
• TP/XF-1250  1.25Mbps Bus Topology Twisted Pair
• TP/RS485-xxx  39kbps -> 1.25Mbps Twisted Pair
• FO-20x  2Mbps Fibre
• IP-70  WiFi, Ethernet

• ISM-RF  100kbps 868MHz ISM Meshed RF
• HD-PLC  90Mbps* Power Line
Free Topology (Twisted Pair)

- Ring, star or combination layout of network media
  - All except ring are polarity insensitive
  - One terminator installed anywhere on the segment
  - Join the dots!
- Typical for device channels
- Simple to expand and add new devices
Bus Topology (Twisted Pair)

- Daisy chain structure with beginning and end
- Must be terminated at beginning and end of segment
  - TP/FT-10 Free Topology terminators are different from TP/FT-10 Bus Topology terminators
  - TP/XF-1250 channels use different terminators than TP/FT-10 channels
LON/IP: The multi-media IIoT Solution

- Devices all use LON/IP Control Services with IP connectivity to every device
- LON/IP is fully compatible with existing LON devices and existing workstation and SCADA applications for easy retrofits

Resilient Community of Devices
Series 6000: Multi-Protocol Support On Chip

Series 6000 Chip

14908-1 L4-L6
14908-1 L2-L3
14908-1 MAC
14908-2 PHY (FT 6010 / 6050) or Neuron Comm Port (Neuron 6050)

LON*
FT-X3 (FT 6050 / 6010) or External PHY (Neuron 6050)
RS-485 PHY

Application (up to 256Kbytes)
BACnet
IPv4
BACnet/MS/TP
BACnet/IP
LON/IP

UART
Custom IP
BACnet MS/TP

Neuron I/O

* FT 6050 and Neuron 6050 only
IzoT BACnet devices simultaneously provide a LON, LON/IP, BACnet/IP Server, and BACnet MS/TP Server interface.

- Supported BACnet Object types
  - Analog Input – sensor input
  - Analog Output – control output
  - Binary Input – switch input
  - Binary Output – relay output

- Supported BACnet BIBBs—can be BTL certified
  - Application-specific Controller
  - Smart Sensor
  - Smart Actuator

- Other BACnet features
  - Read Property Multiple
  - Change of Value (COV)
  - BACnet/IP and BACnet MS/TP support
Benefits of BACnet/IP-FT over BACnet MS/TP

- **BACnet/IP-FT** is easier to install
  - FT: 2 wires per device, polarity insensitive, no shield required
  - MS/TP: 3 wires plus shield per device, polarity sensitive

- **BACnet/IP-FT** is more reliable
  - FT continues to work even when a short occurs somewhere in the channel and degrades gracefully when a break occurs
  - MS/TP fails completely if a short or break occurs in the channel
  - MS/TP fails occasionally due to lost tokens
  - FT has higher noise immunity

- **BACnet/IP-FT** is higher performance
  - MS/TP token passing has high overhead – significant overhead if the number of devices on the channel is high

- BACnet/IP-FT supports standard IP addressing to the end-point
Cabling: Common Pitfalls

- Change of cable type
  - the cable type should not change within the same segment (except in case of a stub)
  - Use a Physical Layer Repeater to change cable types within the same segment
- Using non-approved cable types
- Miscalculated cable length
- To untwist the pair excessively (e.g. at connection points)
- Cable diameter must match length and power consumption on Link Power channel
Termination: What is it?

- A termination is a load connected across the network pair.
- It absorbs unwanted reflections that naturally occur at the end of cable runs which would otherwise interfere with communications.
- Incorrect termination results in high CRC counts.
Termination: Common Pitfalls

- Wrong termination
  - terminator type varies as a function of transceiver type and channel topology
- Missing terminator
- Multiple terminators
- Terminator in bad location
  - Bus topology
    - one terminator must be at each end
  - Free topology
    - one termination must be present anywhere
How to Measure the Termination?

- LonWorks terminators are AC-coupled resistors or RC-combinations
- Complex impedance
- DC-based multi-meters are NOT appropriate
- Must be measured using an AC bridge
- Link-power supply in TP/FT-10 channel must be turned off and fully discharged
Heartbeat and Max Receive Time

- Used to ensure the integrity of the event driven paradigm
- Originator sends updates periodically as defined by the *Heartbeat* value
- *Max Receive Time* is used by destination objects to supervise the originator
- If the *Heartbeat* value is too low, the device will send more updates than necessary
Throttle

- *Throttle* defines the minimum period between two updates
- Ensure a maximum bandwidth consumption by a given network variable under normal conditions
- Facilitates simple channel maximum bandwidth calculation in conjunction with heartbeats
LonScanner FX Protocol Analyzer

- Protocol Analyzer tool
- Packet display
- Packet filter
- Traffic Analysis tool
- Packets count
- Errors count
- Statistics
Troubleshoot LON/IP and BACnet/IP network problems with Wireshark

Download Wireshark for free at www.wireshark.org

Plug-in for LON/IP available from Echelon

Plug-in for BACnet/IP built in
Test Function Results

- Query status results
  - Errors statistics
  - Last reset cause
  - State of the node
  - Last run-time error logged
- Functional blocks status for LonMark compliant devices
  - self-test
  - FB status
- Duplicate addressing
- Incorrect Subnet/Node address
Lonmark WebServices IIOT Edge Server Architecture

- Analytic Engines
- AI Applications
- SCADA Applications
- IoT Apps & Web Pages
- Embrace, Extend, Enhance
- CMS
- Ethernet Interface
- IAP/MQ Message Bus
- Scheduler Service
- Log Service
- Alarm Service
- IAP/MQ Message Broker
- CMS IAP/REST Server
- Custom Web Pages
- Custom Service
- Ethernet Interface
- LON/IP, LON IP-852, BACnet/IP, Modbus TCP
- RS-485 Interface
- Modbus RTU
- RS-485 Interface
- BACnet MS/TP
- Ethernet Interface
- LON FT, LON HD-PLC, LON TP-1250, LON PL-20, LON ISM-RF
- >140M Lonworks Devices
Thank You