

LONWORKS® Crash Course



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 1

Overview

- What is a protocol
- Networking
- Network variables
- Configuration properties
- Functional Profiles
- ProgramID, XIF file
- LNS
- LNS Plug-In



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 2

Terminology

- **LONWORKS®**: “umbrella term” for the technology related to ANSI/CEA-709.1 protocol
- **LonTalk®** is the colloquial term for the ANSI/CEA 709.1 standard ‘Control Network Protocol’ originally developed by Echelon Corporation
- **LONMARK®** International (www.LonMark.org):
 - Industry association of vendors and end-users for open systems and LonWorks technology
 - Maintains interoperability guidelines
 - Certifies ANSI/CEA-709.1 dev



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 3

What is a Protocol?

- Set of rules on how devices communicate
- ANSI/CEA-709 specifies an open protocol
 - ANSI/CEA-709.2 thru 4 specify the physical media (wires) and the interface to the physical media
 - ANSI/CEA-709.1-B specifies ‘everything else’; the encoding and decoding of the signals sent over the media
- Useful analogy: think of the protocol as the United States Postal Service (USPS)

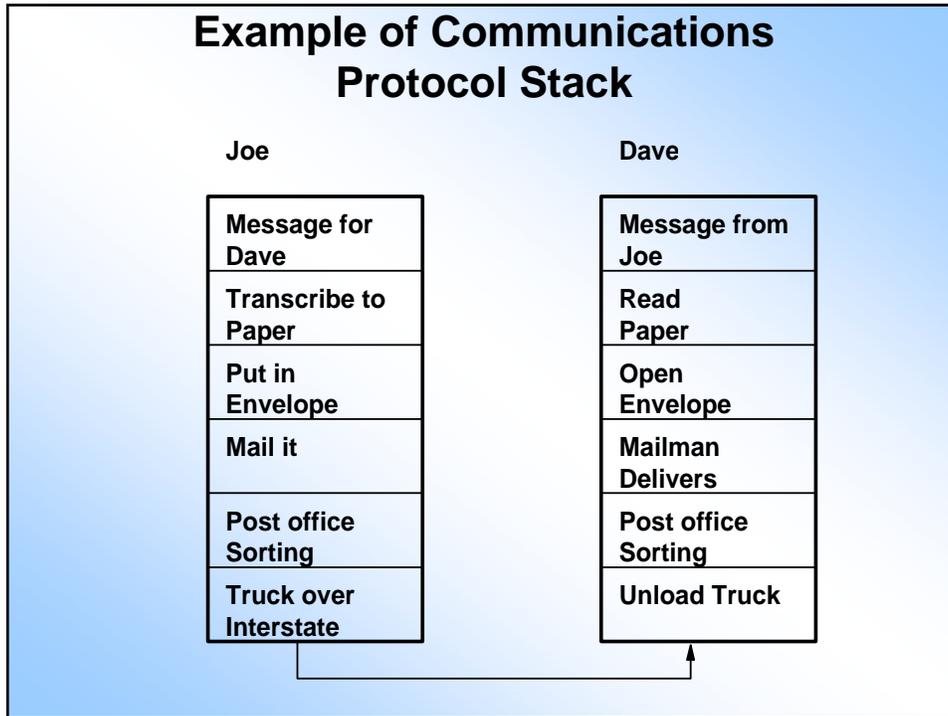


US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 4

Example of Communications Protocol Stack



OSI Reference Model Layers

#	Layer Name	Purpose / Function
7	Application	<u>Application Compatibility</u> . End-user and end-application protocols/services. Message types.
6	Presentation	<u>Data Interpretation</u> . Where application data is packed or unpacked, ready for use by the application.
5	Session	<u>Control</u> . Provides for two communicating presentation entities to exchange data with each other.
4	Transport	<u>End-to-End Reliability</u> . Where the TCP lives; relieves the Session Layer (5) of the burden of ensuring data reliability and integrity.
3	Network	<u>Messaging</u> . Provides a means for communicating open systems to establish, maintain, and terminate network connections.
2	Data Link	<u>Media Access and Framing</u> . Defines the access strategy for sharing the physical medium, including data link and media access issues.
1	Physical	<u>Electrical Interconnect</u> . Defines the physical and electrical characteristics of the network.

ANSI/CEA-709.1 (LonTalk®)

- **ANSI/CEA-709.1-B 'Control Network Protocol Specification'**
 - Internationally recognized ANSI standard
 - Optimized for efficient transmission of small packets
 - Provides direct application level support for peer-to-peer network communication



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 7

ANSI/CEA-709.1 Implementation

- Usually implemented on a Neuron® chip
 - Multiple chip manufacturers
 - Chip is inexpensive and readily available
 - Little incentive for additional chip manufacturers
- 709.1 'reference implementation' means anyone can implement the protocol or manufacture their own chip
 - There are non-Neuron chip implementations
- Communications chip (Neuron) can also perform control functions



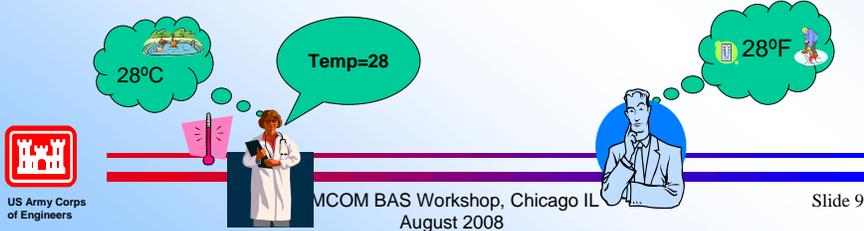
US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 8

What is the ANSI/CEA-709.1 Protocol?

- What does the protocol do?
 - Provides a means for devices to share information
 - Makes sure the information is 'read' as it was 'written'
- What doesn't the protocol do?
 - Standardize content of the message
 - Guarantee that the second device actually understands the message
 - Specify what information should be shared
 - Specify anything besides device communication



Network Variable

- A *Network Variable* is “the letter” - a packet of information on the network
- **SNVT: Standard Network Variable Types** (sniv-it)
 - Defined & published by LonMark
 - Standard format of information
 - Standard units and limits (i.e. temp in degrees C)
- **UNVT: User Defined Network Variable Type** (u-niv-it)
 - Defined by device manufacturers
 - Proprietary format of information
 - Not always well documented
- The term SNVT is often used to mean “a network variable of a standard network variable type”



Example SNVTs

Name	Description	Units	Range	Resolution
SNVT_temp_p	Temperature	Degrees Celsius	-273.17-327.66	0.01 degC
SNVT_flow	Flow Volume	Liters/Sec	0 – 65,534	1 Liter/Sec
SNVT_speed	Speed	Meters/Sec	0 – 6,553	0.1 m/s
SNVT_elapsed_tm	Elapsed Time	HH:MM:SS	0 – 65,535 days	1 msec
SNVT_lev_cont	Continuous Level	Percent	0 - 100%	0.5%
SNVT_ascii	ASCII String	Characters	30 Chars	N/A
SNVT_count	Events	Count	0 – 65,535	1 Count

Ref: LonMark® SNVT Master List, Version 12



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 11

Configuration Properties

- Used to set device parameters
- Define how settings are written to/read from the device
- **SCPT:**
 - **Standard Configuration Property Type** (skip-it)
 - Defined and published by LonMark
- **UCPT:**
 - **User-defined Configuration Property Type** (u-keep-it)
 - Defined by device manufacturer



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 12

LonMark® Functional Profile

- Describes the network variables, configuration properties, and default and power-up behaviors required of LonMark devices for specific, commonly used control functions
- Provides a universal shorthand to describe functional network behavior
- Standardizes network functions, not products
 - Doesn't fully define the control application
- Eases the specification process
- LonMark has Functional Profiles covering all aspects of building automation (HVAC, Lighting, Security etc.)

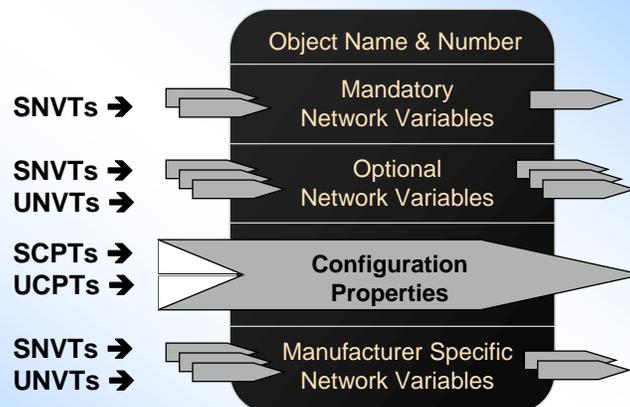


US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 13

LonMark® Functional Profile



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 14

Functional Profile

- Also called 'LonMark Object'
- Standardizes network variables & configuration parameters for ASCs
- A device may have multiple Functional Profiles/Objects
- LonMark certifies devices according to Functional Profile
- What is it good for?
 - Helps ensure that device doesn't do anything 'bad' on the network
 - Ensures that certain Network Variables and Configuration Parameters are there
- What doesn't it do?
 - Fully define the control application
 - Define all the network inputs/outputs we need; many points normally required are 'optional' for the Functional Profile

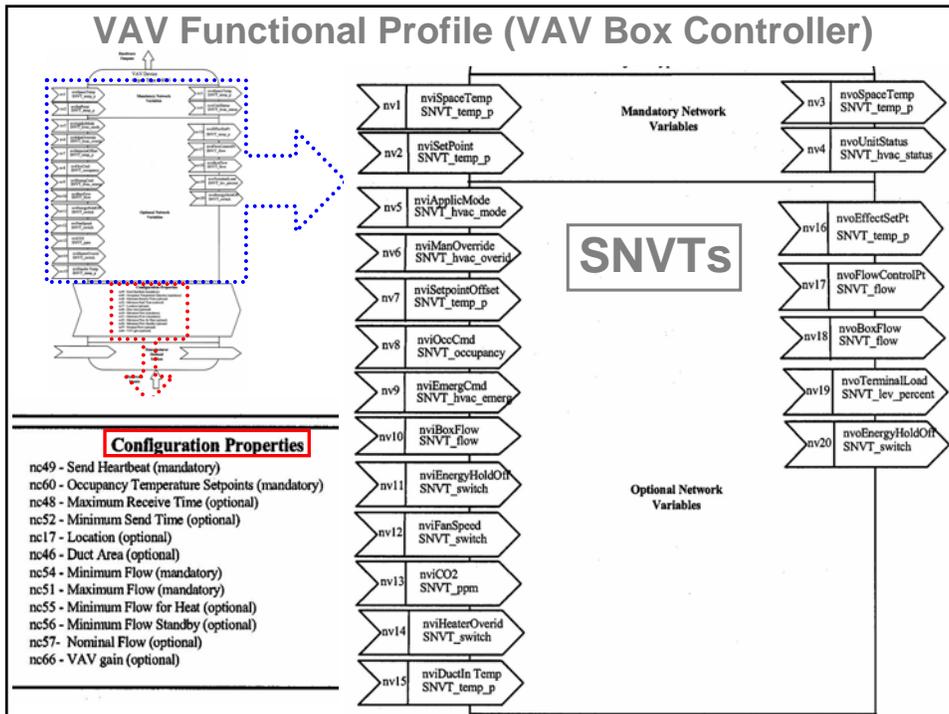


US Army Corps of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 15

VAV Functional Profile (VAV Box Controller)



Controller Types

- **Application Specific Controller (ASC)**, also called a configurable controller:
 - Comes from the factory with a built-in application, and has settings used to tailor that application
 - Generally configured via *Network Variables* and/or *Configuration Properties* in the device
- **General Purpose Programmable Controller (GPPC):**
 - Comes from the factory without a program and is programmed to perform a custom application
 - Requires vendor-specific programming software
 - Must be programmed to allow for any future configuration
 - Cannot be LonMark certified – at least not meaningfully
 - LonMark calls this a “Custom Application Controller (CAC)”



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 17

Controller Types

- **Application Generic Controller (AGC):**
 - Comes from the factory with a limited built-in application
 - Can be (is) programmed for the custom application
 - Requires vendor-specific programming software
 - Programming software may be an LNS plug-in
 - Think of it as between an ASC and a GPPC



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 18

Controller Types

- **Local Display Panel (LDP):**
 - DDC Hardware with a limited user interface for monitoring and control



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 19

ANSI/CEA-709.1 Node

- A **Node** is a device on the ANSI/CEA-709.1 network
- Has a unique address: domain, subnet, node
 - Like a state, city, street address...
 - (deliver letter to whomever is at this address)
 - Assigned during network configuration using by a network management tool (software package)
- Has a Unique NodeID (aka Neuron® ID)
 - Unique identifier (48 bit serial number)
 - Permanent number. Assigned at the factory.
 - Like a name (or SSN). Can be used for addressing.
 - Different from address in “domain, subnet, node”



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 20

Service Pin

- Each node has a service pin
- Used during network configuration / controller setup
- When pin is pushed, node broadcasts a message (over the network) containing its Node ID and Program ID
- Network configuration tool receives broadcast message
- Service pin function can be activated by software
- Some devices use an LED to indicate the state/status of the node (off-line, no program, etc.)



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 21

Program ID

- Included in every LonWorks node
- An identifier (number) stored in the device (usually EEPROM) that identifies the node:
 - Manufacturer
 - Functionality of device (application & sequence)
 - Transceiver used
 - Intended device usage
- Analogy: manufacturer, make, and model of a car
- Broadcast (transmitted) over the network during network configuration when the service pin is pushed
- Generally used for LonMark certified ASC's



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 22

External Interface (Program Interface)

- Describes how the device network interface appears to the installing computer / network tool
- Also contains self-documentation information about the device and all of the network variables to define:
 - Number and types of LonMark objects
 - Number, types, directions, connection attributes of network variables
 - Number of message tags
- Contains a Program ID field used as key to identify each external interface
- Resides in EEPROM of the node/device



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 23

External Interface File (XIF)

- External Interface (Program Interface) on a diskette
 - Some manufacturers XIF files available for download from Internet/website
- Usually accompanies the device but also resides in the device
- Network configuration tool can use the XIF file to pre-install the node (communications parameters) before the actual node is connected to the network



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 24

DDC Architecture

- ANSI/CEA-709.1 standard “control bus” network options:
 - **TP/FT-10** (ANSI/CEA-709.3)
 - Fiber Optic (ANSI/CEA-709.4)
 - Powerline carrier (ANSI/CEA-709.2)
- ANSI/CEA-709.1 standard for “high speed” backbone is IP per CEA/ANSI-852
- Other proprietary networks (TP/XF-1250, etc.) available for ANSI/CEA-709.1
 - TP/FT-10 is the most common “control bus”
 - IP is the most common high speed backbone
- Other (proprietary) methods for communicating over IP exist. Example: Remote Network Interface (RNI)



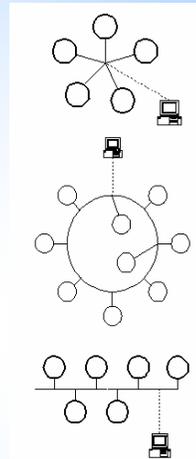
US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 25

DDC Architecture – Topology

- Various control network topologies are possible
 - Star
 - Ring
 - **Bus**
 - Mixed
 - Free

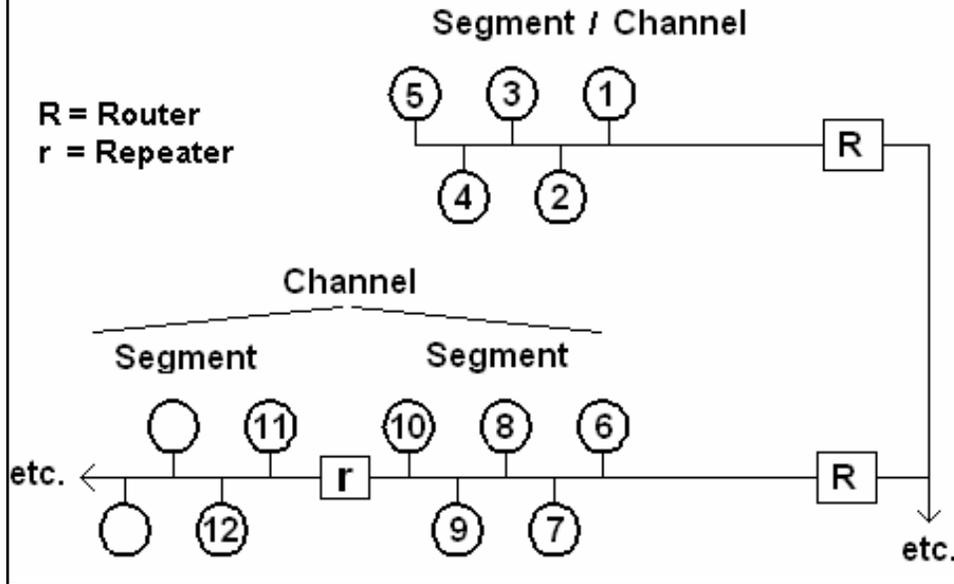


US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 26

ANSI/CEA-709.1 Network Nodes, Segments, and Channels



DDC Architecture – Network

- Segment - A 'single' piece of wire. Device quantity limitation is dependent on topology/media. 64 nodes.
- Channel - One or more segments connected by repeaters **r**. Channels are separated by routers **R**.
- Device qty limitation is dependent on topology/media
- Subnet - A logical grouping of up to 127 nodes
 - Part of the node address
 - Defined by addressing, not physical location
- Domain - A grouping of up to 32,385 nodes that can communicate with directly with each other. (Devices in different domains can't communicate directly.)



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 28

DDC Architecture

- Lon-to-Lon router: **R**
 - Sub-divides 78 kbps network
 - Serves as filter (by destination address) to limit passage of SNVTs
 - Isolates local traffic and reduce network bandwidth usage
 - Can extend wire distances / support media changes
 - Can increase number of devices on network



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 29

DDC Architecture

- Lon-to-IP router:
 - Connects control network to IP network
 - It's a "media converter", not a "protocol converter"
 - Performs packet filtering
 - Uses ANSI/CEA 852 standard for sending ANSI/CEA-709.1 data over an IP network



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 30

Network Management

- 'Managing' the network includes adding, removing or relocating devices, establishing communication between devices
- Somewhere a 'map' (database) of the network is stored so that there is a record of what the network looks like. This map is used for managing the network and by the 'front-end' for monitoring the network.
- Note: In the LonWorks 'world' the establishment of communications is called "binding". For example, you could bind the outside air temperature SNVT from a networked sensor to multiple air handler controllers.



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 31

Network Management

- The Network Configuration Tool ('Tool') is what you use to perform these network mgmt functions. This is a software package.
- The Network Management Standard (AKA Network Database Standard or Network Operating System) defines how the tool makes these changes and how the changes are recorded. It's what the Network Configuration Tool uses to make the changes. This is a set of rules and standards used by the Tool, and is not another piece of software itself.



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 32

LNS[®]

- **LNS: LonWorks Network Services** Network Operating System:
 - Database standard: how to store a 'picture' or 'map' of the network
 - Network Management standard: how to interface to the network to perform network configuration and management
 - Provides an interface to the system for info from devices (i.e. programs can request info from LNS, LNS gets the info from the network)
- Provides a standard that is available to multiple vendors, so devices installed by different vendors can be integrated into a single system
- This allows "easy" replacement of front-end M&C Software... i.e. the ability to change vendors if needed



US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 33

LNS Plug-ins

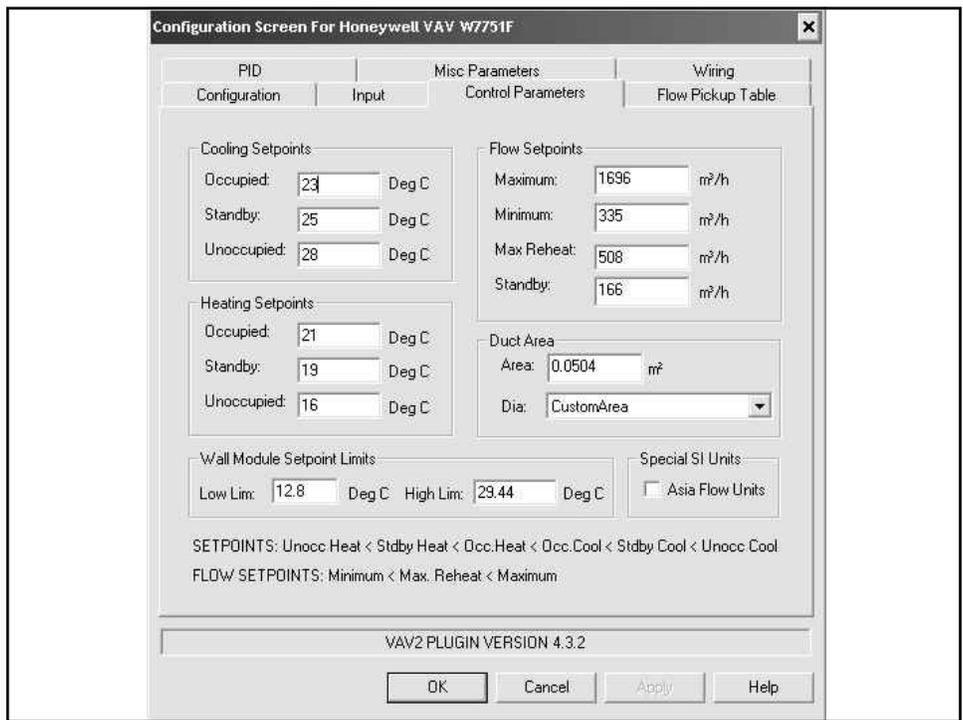
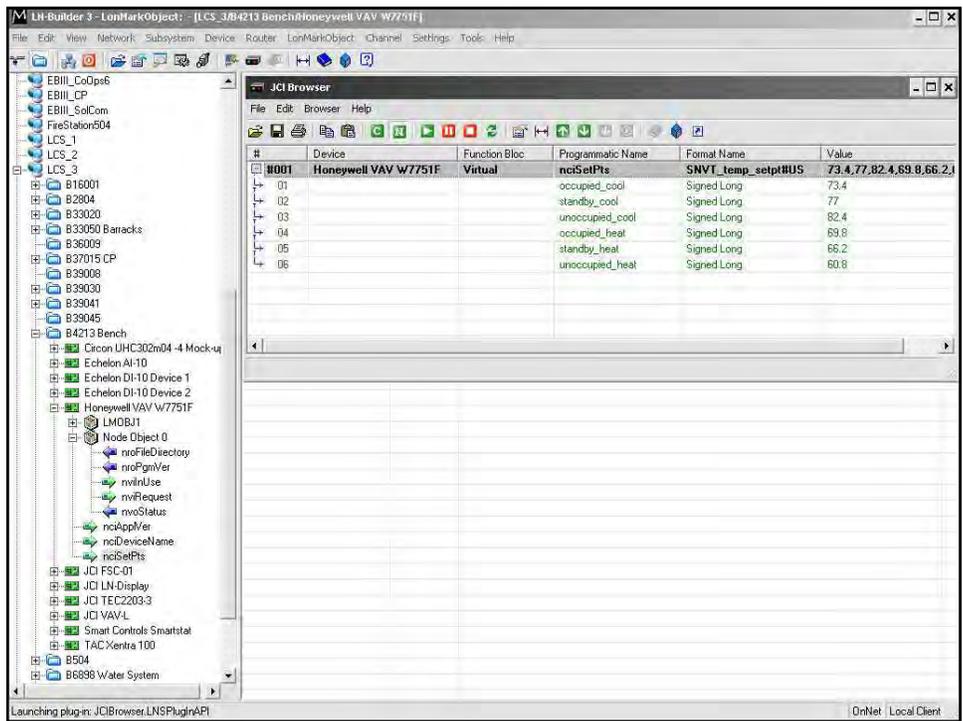
- Network Config Tool doubles as device config tool
- LNS plug-in provides user-friendly interface for device configuration (and AGC programming)
- Vendor-specific, a plug-in from one vendor won't work on another vendor's controller
- Run from (inside of) and add functionality to the Network Configuration Tool
- Plug-ins from one vendor can run from inside a Network Configuration Tool from another vendor

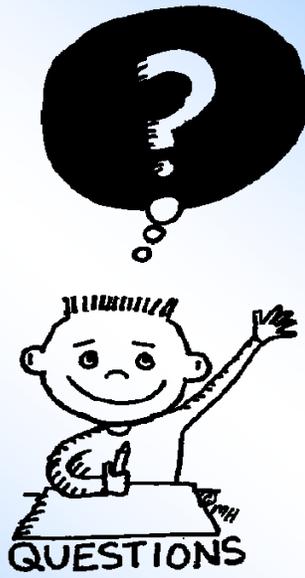


US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 34





US Army Corps
of Engineers

IMCOM BAS Workshop, Chicago IL
August 2008

Slide 39