



**DeviceNet of Things –
Use Cases, Value Proposition and Status of Specification**

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February 22, 2017

DeviceNet of Things

The increased popularity of EtherNet/IP and the “Internet of Things” movement establishes a basis for innovation of new smart “Things” in the automation world. However, the costs associated with deploying EtherNet/IP prevent it from being successfully deployed on many low end “Things” such as contactors and push buttons. Enhancing DeviceNet as an in-panel cabling and communication solution for low-end devices will:

- Lower the cost of deployment below the levels provided by EtherNet/IP
- Provide greater information delivery capabilities over hard-wired solutions
- Enhance ease-of-use over existing networked solutions (including DeviceNet)
- Simplify physical/mechanical connection methods leading to lower panel build costs.

Since DeviceNet and EtherNet/IP share the CIP Protocol, DeviceNet of Things enhancements may also help pave the way for future adoption of EtherNet/IP as Ethernet costs continue to decline.

DeviceNet of Things Customer Requirements

Extensive customer listening sessions resulted in the following key requirements for the DeviceNet of Things:

- It must be **Functional**
 - It must simplify in-cabinet wiring for panel builders
 - It must deliver both Network Power to power device electronics and Switched (Control) Power to facilitate the actuation of Contactors and Relays
 - It must support Non-Safety and Safety devices on the same wire
- It must be **Simple** to use
 - It must use a single easy to use media connector
 - It must include a simple (or no) network commissioning methodology
 - It must eliminate the need for media trunk and drop distance calculations
- It must be **Economical**
 - It must use low cost media
 - It must allow for a reduction in price and size of typical products
 - It must allow the use of commercial off-the-shelf power supplies
 - It must result in a lower “total cost of ownership” than hard wired solutions

DeviceNet With an Easy Button

Easy Node Commissioning
(Auto-Commissioning)
(Fixed Baud Rate)

NO Scan List or
Auto-Mapping

Easy Device Configuration
(Default of No Configuration)



Easy System Integration
(Nodal Geography Identification and Reporting)

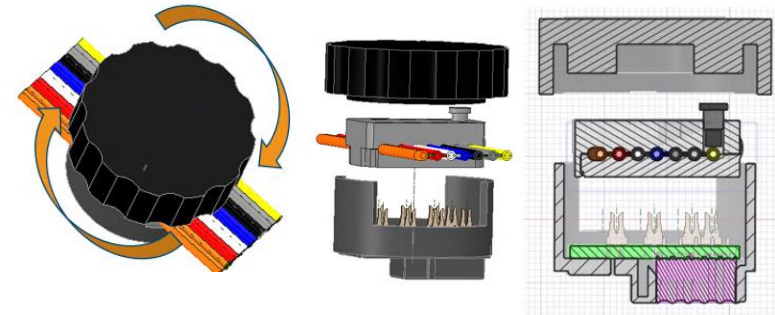
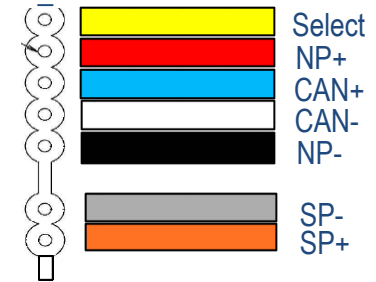
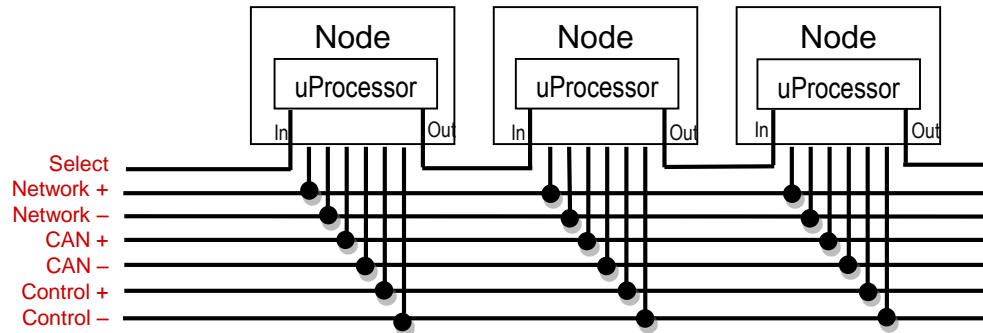
Simplified Media Selection
(IDC Ribbon Cable)
(NO Distance Calculations)

Enhanced P/S Architecture
(Configurable Power Taps)
(Network & Control Power)
(Single Standard 24Vdc Supply)

DeviceNet of Things Media Basics

7 Wire Keyed Cable Includes

- Network Power to power device electronics
- Switched (Control) Power to actuate contactor coils
- CAN lines for CIP messaging
- Select Line for simple sequential network service delivery
 - This allows us to be able to discover the nodal geography



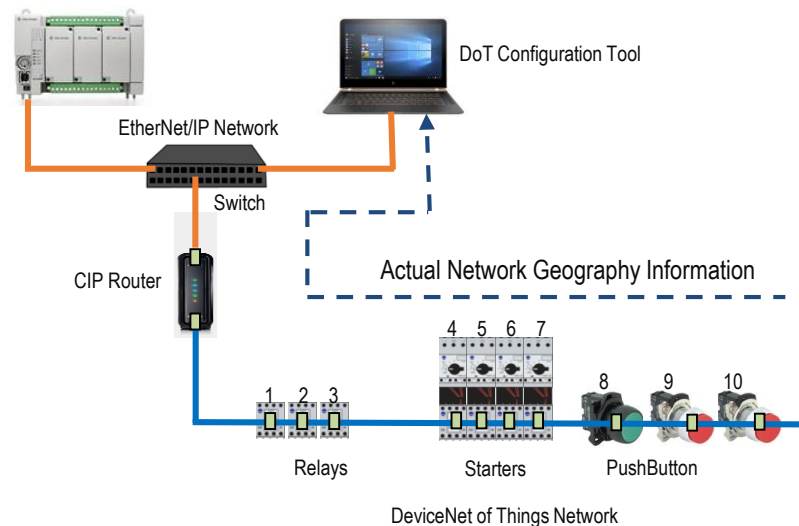
New Insulation Displacement Connector

- No need for special crimping tools
- Can support the cutting of multiple conductors in support of the Power Supply Tap Architecture.

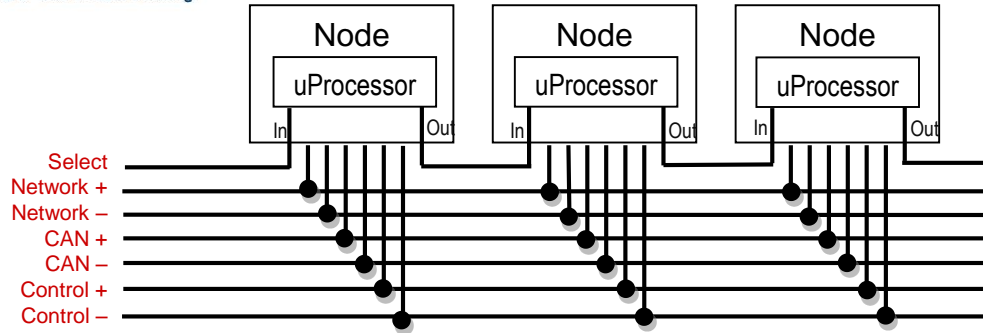
Nodal Geography Discovery

A “**Nodal Geography**” is a complete ordered set of device keys for all devices on a network.

In a subnet system, the CIP Router device will include the ability to discover the entire subnet Nodal Geography and deliver it to a commissioning tool or processor on the other side of the gateway for display.



Nodal Geography Discovery – Select Line Messaging



Select Line Messages are received on the Select In line. The device services the message, and after processing is complete, the message is retransmitted on the Select Out line. The result is sequential message delivery from “left to right”.

Select Line Message Format

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
				0	0	0	0	0	0	0	0				0	1

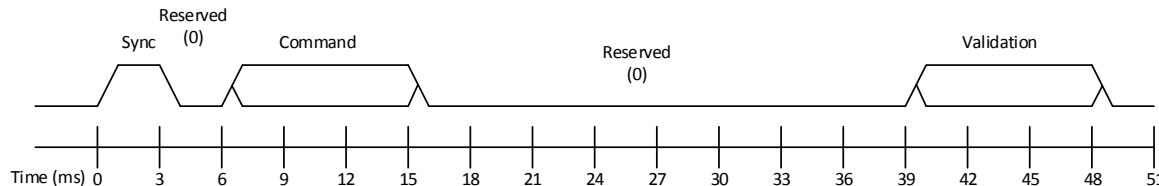
Validation

Reserved

Command

Reserved

Sync



Select Line Message Timing
3 msec. per bit

Nodal Geography Discovery – Group 5 Messaging

Relevant Nodal Geography information is reported in 2 new Group 5 CAN messages:

- Device Key messages
- Offline Status messages

Production of the new Group 5 messages is allowed when a device is in the “Communication Faulted” state.

IDENTIFIER BITS											HEX RANGE	IDENTITY USAGE
10	9	8	7	6	5	4	3	2	1	0		
0	Group 1 Message ID				Source MAC ID						000-3ff	Message Group 1
1	0	MAC ID						Group 2 Message ID			400-5ff	Message Group 2
1	1	Group 3 Message ID			Source MAC ID						600-7bf	Message Group 3
1	1	1	1	1	Group 4 Message ID (0 – 2f)						7c0-7ef	Message Group 4
1	1	1	1	1	1	1	0	Group 5 Message ID			7f0-7f7	Message Group 5
1	1	1	1	1	1	1	1	X	X	X	7f8-7ff	Invalid CAN Identifiers

Byte	7	6	5	4	3	2	1	0
0	Vendor ID (low byte)							
1	Vendor ID (high byte)							
2	Device Type (low byte)							
3	Device Type (high byte)							
4	Product Code (low byte)							
5	Product Code (high byte)							
6	Major Revision							
7	Minor Revision							

Device Key Message Format

Byte	7	6	5	4	3	2	1	0
0	MAC ID							
1	Duplicate MAC ID Faulted Status							
2	Serial Number (low byte)							
3	Serial Number (byte 1)							
4	Serial Number (byte 2)							
5	Serial Number (high byte)							

Offline Status Message Format

Nodal Geography and the DoT Commissioning Object

The DeviceNet of Things Commissioning Object:

- Initiates Select line messaging
- Captures, Stores and Reports an “Actual” Nodal Geography
- Accepts a “Reference” or “Desired” Nodal Geography
- Facilitates Automatic Node Commissioning based on a Reference Geography

The DeviceNet of Things Commissioning Object may be implemented in

- A CIP Router
- A DeviceNet of Things Master Scanner
- A DeviceNet of Things Commissioning Tool

In all cases, the DeviceNet of Things Commissioning Object resides in the “First” or “Leftmost” node on the network whose MAC ID is fixed at Address 0.

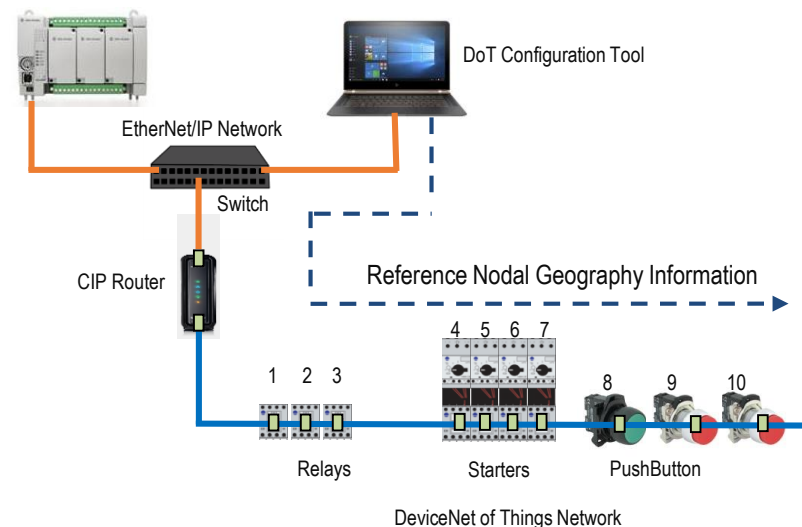
DoT Commissioning Object Instance Attributes

- Attribute 1 Reflects the Nodal Geography Status
- Attributes 2-66 store an “Actual” Geography i.e. the “discovered” geography of an actual network.
- Attributes 182-246 accept and store a “Reference” or “Desired” Geography, often delivered by a DoT Commissioning Tool.
- Attribute 99 Enables/ Disables automatic commissioning based on a Reference Geography.

Attribute ID	Need in Implementation	Access Rule	NV	Name	Data Type	Description of Attribute
1	Required	Get	V	Status	WORD	Status of the object Bit 0 = Reference Data Ready Bit 1 = Actual Data Ready Bit 2 = Geography Mismatch Bits 3-15 = Reserved
2	Required	Set	NV	Number of Nodes in Reference Geography	USINT	Number of nodes in the stored reference geography for the network
3	Required	Set	NV	Reference DoT Commissioning Object Node	STRUCT	Structure describing the identity of the expected device at MAC ID 0
4	Required	Set	NV	Reference First Position	STRUCT	Reference geography information for first node (position 1) on network
5	Required	Set	NV	Reference Second Position	STRUCT	Reference geography information for second node (position 2) on network
...						
66	Required	Set	NV	Reference Sixtythird Position	STRUCT	Reference Geography information for 63rd node (position 63) on network
99	Required	Set	NV	Auto Apply Reference Geography	BOOL	Enables the Auto-Commissioning of DoT network devices in a System based on the Reference Geography.
182	Required	Get	V	Actual Number of Network Nodes	UINT	Actual number of Nodes on the network
183	Required	Get	V	Actual This Node	UINT	Actual geography information for this node.
184	Required	Get	V	Actual First Position	STRUCT	Actual geography information for first node (position 1) on network
185	Required	Get	V	Actual Second Position	STRUCT	Actual geography information for second node (position 2) on network
...						
246	Required	Get	V	Actual Sixtythird Position	STRUCT	Actual geography information for 63rd node (position 63) on network

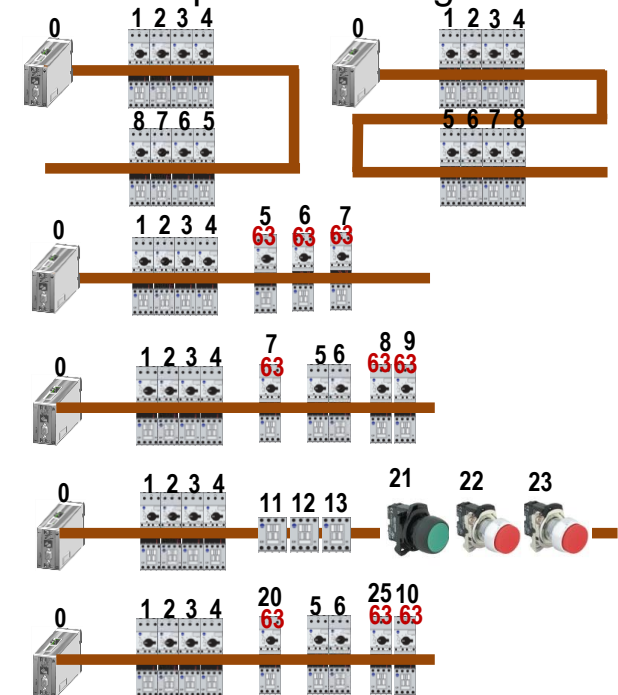
Nodal Geography Delivery – Auto-Commissioning

In a subnet system, the CIP Router device will also be able to receive an entire Reference subnet Nodal Geography from a commissioning tool or processor, and compare it to the actual Nodal Geography. If the network geographies match, automatic network commissioning can be accomplished for the entire network.



Flexible Addressing – NOT Auto-Addressing

- Various addressing schemes can be implemented in the DoT Configuration Tool and full Reference Geographies can be Applied at the network level. Example addressing schemes include (but are not limited to):
 - **Sequential Full**
 - Addresses are sequential based upon geographical location of device on the cable
 - **Sequential Light**
 - Addresses are sequential based on the 'next available node address' for each newly added device on the cable
 - **Sequential by Device Type**
 - Addresses are sequential in a device type-specific range.
 - **Traditional Node Commissioning**
 - Allows OEM's to set Fan=20, Pump=10



Auto-Device Replacement and Geographic Device Keying

The replacement of a node with a compatible device will include the ability to check that the replacement device was placed on the network at the same geographic position as the original device before the "Auto Device Replacement" feature is triggered, effectively adding a new and important device keying criteria.



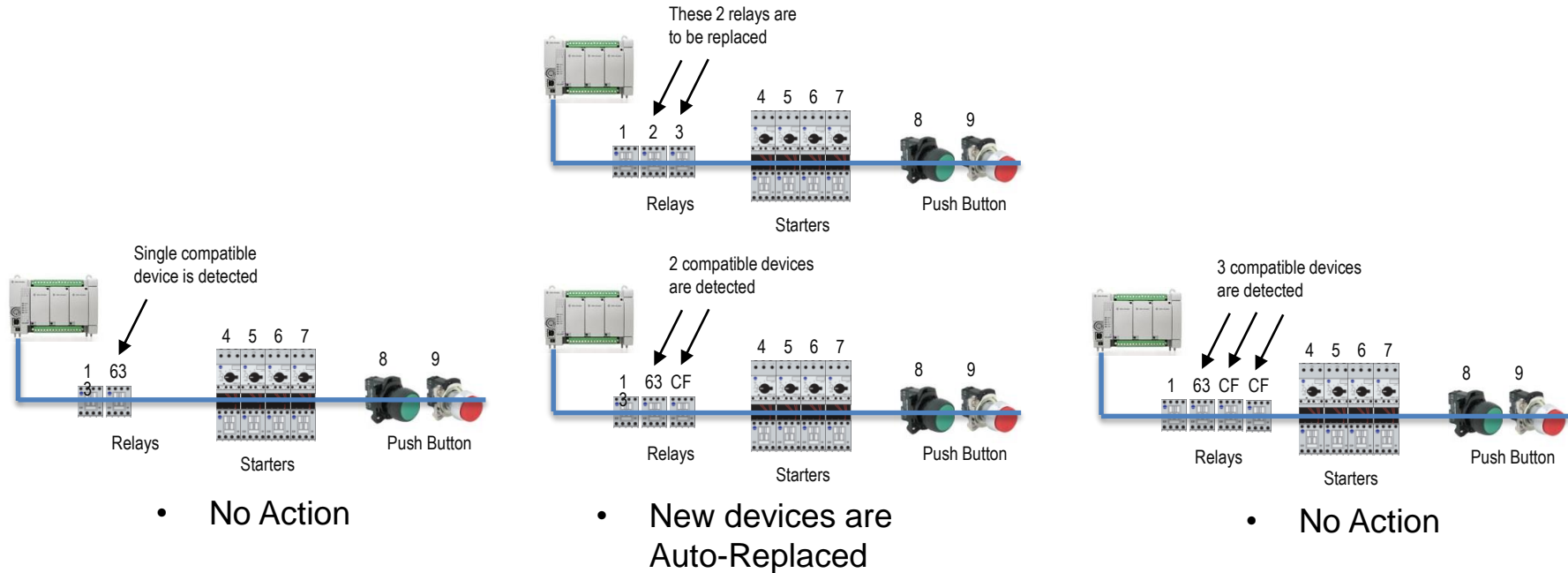
An "Auto-Device Commissioning" operation is triggered when:

- the disappearance of a node in the Reference Geography is detected **AND**
- a new node comes on-line **AND**
- comparison of the Actual and Reference Geographies shows that they are compatible (they match).


If a compatible node is detected at the same position as the missing node, the node is commissioned automatically.
If a compatible node is detected at a different geographic position, no action is taken. (Illustrated on the right above).


Auto-Device Replacement and Geographic Device Keying


Consider a system where 2 adjacent nodes are to be replaced.




Power Architecture – Four Power Tap Styles

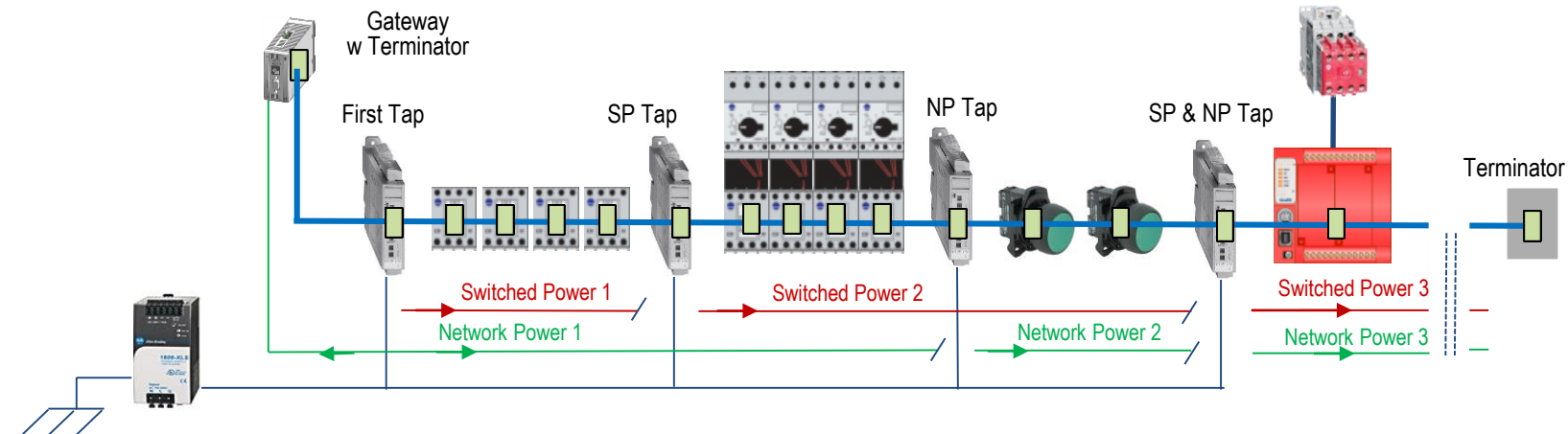
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• **1st Tap** - Puncture NP & SP and inject Network Power left (bridge) and right (nodes) & Switched Power to right
- 

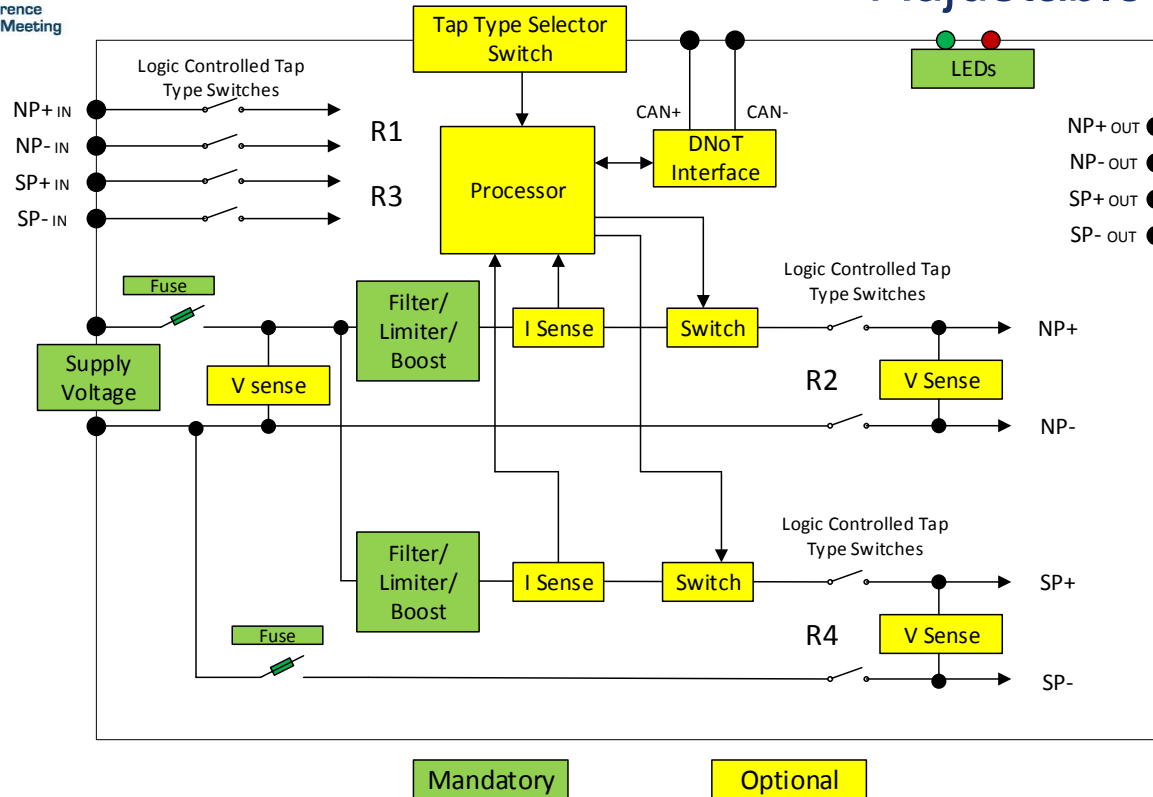
• **NP & SP** - Puncture NP & SP and inject Network Power left (bridge) and right (nodes) & Switched Power to right
- 

• **NP Only** - Puncture NP and inject Network Power to right (SP is not punctured and passes thru)
- 

• **SP Only** - Puncture SP and inject Switched Power to right (NP is not punctured and passes thru)



Adjustable Smart Power Taps



Switch R1

- Connects NP_{IN} to NP_{OUT}

Switch R2

- Connects Voltage Supply to NP_{OUT}

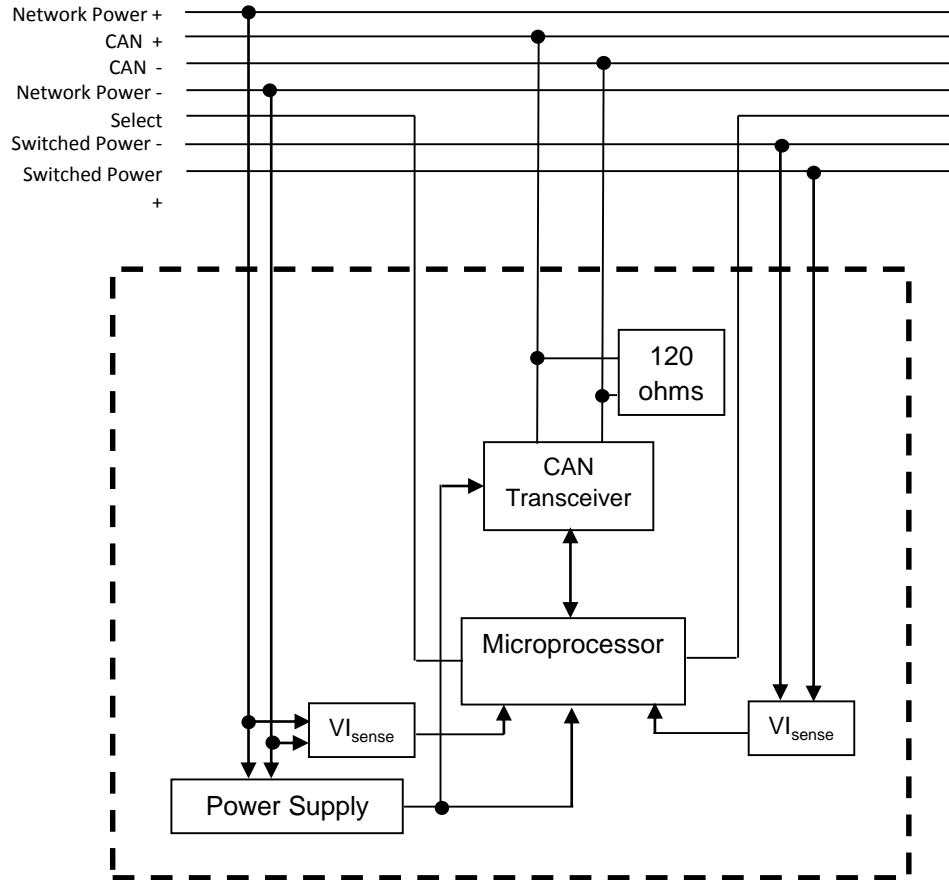
Switch R3

- Connects SP_{IN} to SP_{OUT}

Switch R4

- Connects Voltage Supply to SP_{OUT}

The tap is an active node on the network. This allows the tap to report diagnostic information such as CIP Energy data for each power segment.



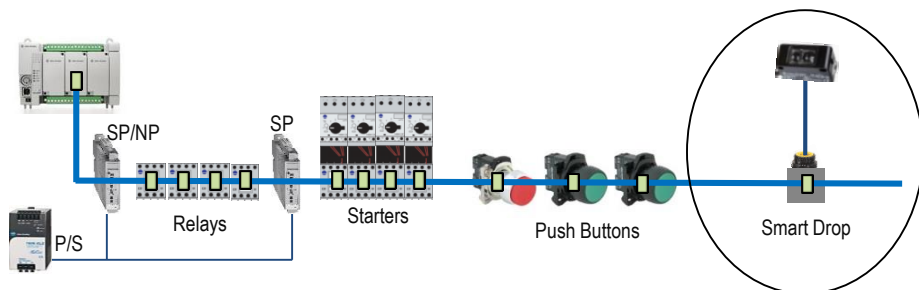
Smart Terminators

Improper termination of DeviceNet networks is a common problem in the field.

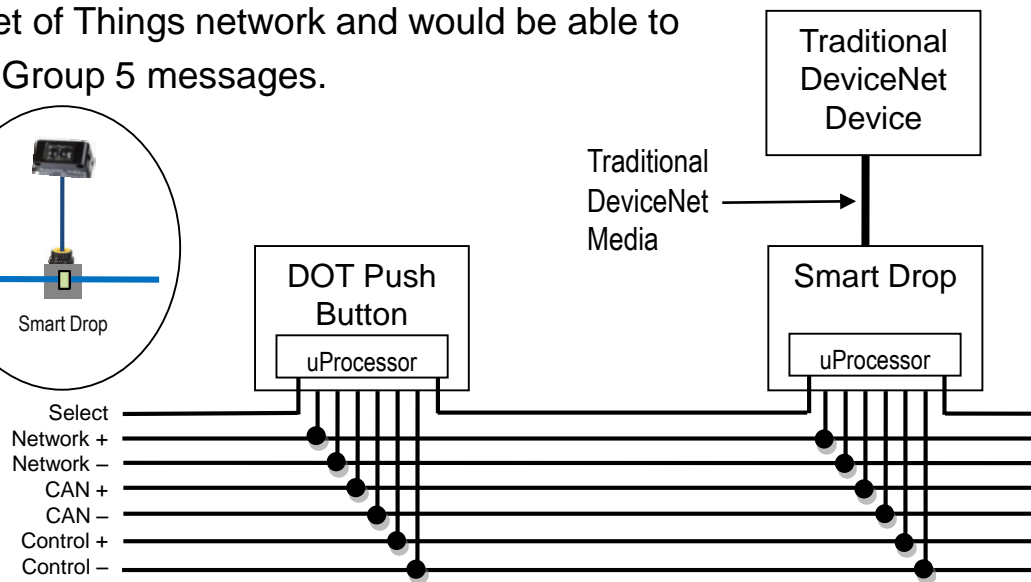
Since the cost of simple DoT nodes will be small (Cortex M0+ micros with ample Flash, RAM, CAN and peripherals are available for less than \$1), it makes sense to provide smart terminators so that tools can report improper network termination.

Smart Drops

To protect the investment vendors have made in DeviceNet, a Smart Drop can be developed to extend the functionality of existing products so they can fully participate in a DoT network. It would act as a simple DeviceNet to DeviceNet router. The DeviceNet of Things side of the router would occupy a node address on the DeviceNet of Things network and would be able to participate in Select line services and produce Group 5 messages.



This approach would not affect the DeviceNet of Things media length budget since the drop to the traditional device is a separate point to point DeviceNet network.



Specification Status

To date, the DeviceNet of Things SIG has approved the following specification enhancements and forwarded them to the System Architecture SIG for review:

- **DSE 0001-115 DeviceNet of Things Overview** including:
 - An overview work items for the SIG
 - Additions to Volume III Chapter 1 DeviceNet Adaptation of CIP.Feedback from the System SIG is pending.
- **DSE 0001-114 DeviceNet of Things Feedback from the System SIG is pending**Objects including:
 - Volume III Chapter 2 protocol updates related to Group 5 and Select Line messaging
 - Volume III Chapter 5 updates to the DeviceNet Object
 - Volume III Chapter 5 additions to define the DeviceNet of Things Link Object and the DeviceNet of Things Commissioning Object.
 - Volume III Chapter 7 EDS file definition updates

Feedback from the System SIG has been received, updates are complete, forwarded back to the System SIG for further review.

- **CIPSE 0001-252 DeviceNet of Things Hooks** including:
 - Volume 1 Chapter 5 and Chapter 7 tweaks in support of the DeviceNet of Things.Feedback from the System SIG has been received, updates are complete, forwarded back to the System SIG for further review.
- **CIPSE 0001-256 Pushbutton Portfolio Profile**
 - Adds a new device profile to support Pushbuttons, Selector Switches and Pilot Light indicators to Volume 1 Chapter 6Feedback from the System SIG is pending.

Specification Status (continued)

The DoT SIG has engaged the DeviceNet Physical Layer SIG to define the needed specification enhancements to support the new media, connector and power supply requirements. The following specification enhancement is being prepared:

- DSE 0798-001 DeviceNet of Things Physical Layer

Further related specification enhancement work to support new low-end devices for the DeviceNet of Things is being done in the ODVA Motor Control and Circuit Breaker SIG, most notably:

- CIPSE 0001-257 Circuit Breaker Profile
 - Adds a new device profile to support Circuit Breakers to Volume 1, Chapter 6
- CIPSE 0001-258 Circuit Breaker Objects
 - Adds a new Circuit Breaker Supervisor Object definition to Volume 1, Chapter 5
- Various other CIPSEs to better support component based motor starters and other devices in the ODVA Hierarchy of Motor Control Devices.

The DeviceNet of Things SIG will continue its work as follows:

- Define a Power Tap device profile.
- Define a Smart Terminator profile.
- Look into the development of other new device profiles as needed.
- Produce a DeviceNet of Things Conformance Test Specification.



THANK YOU