



NS2022

ACCELERATING INNOVATION

IP Controllers

- Edge 10 and ACE Control Engine



Agenda

Learn about the latest IP Niagara controller platform using Niagara for EDGE control applications and how to build fast applications using the new ACE engine.





NS2022

ACCELERATING INNOVATION
CHARLOTTE, NC | APRIL 4-6

Kyle Sardinia

*Senior Application System Sales
Engineer*

Tridium



Time Flies...

April 2018

Niagara Summit 2018

July 2018

Niagara 4.6

October 2018

Niagara 4.7 and Edge 10



Edge-10 Controller

IP based general purpose IO Controller - Powered by Niagara Framework
5 Universal Input • 3 Digital Output • 2 Analog Output
1 485 Serial Port - 2 Ethernet Ports capable of daisy chaining
Expansion via IO-R-34

Fan Coil Unit • Single Stage AHU
Water Source HP • Pressure Dep Zone Control
Boiler Hot Water Reset, etc...

Performance &
Power



Deterministic Runtime
Engine

Cybersecurity



Built in Niagara Security

Time & Labor
Savings



Enhanced Niagara
workflows

Edge vs JACE - Overview

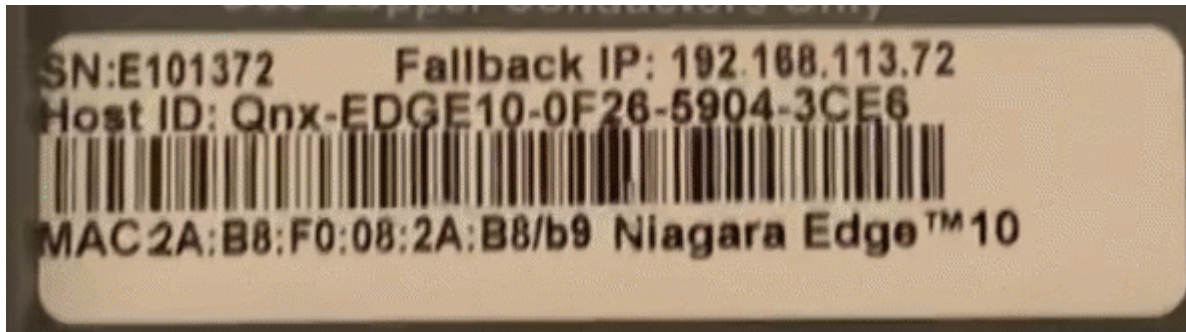
Feature	JACE	Edge-10
Full Niagara Stack	YES	YES
Secure IP Stack	YES	YES
Onboard I/O	NO	YES
Deterministic Runtime Engine	NO	YES
Daisy Chained Ethernet	NO	YES
Application	Integration Platform	Field Equipment Controller
Factory Commissioned	NO	YES
SMA	18 Months	Not Required (Perpetual)
Global Capacity Licensing	Varies	50 points, 3 devices

Edge vs JACE - Hardware

Feature	JACE	Edge-10
CPU	TI AM3352 1 GHz ARM Cortex A8	NXP iMX6 SoloX2 800 MHz ARM Cortex A9/M4
RAM	1 GB DDR3 SDRAM	512 MB DDR SDRAM
SD Card	Removable 4 GB total/2GB usable	Fixed 2 GB total/1 GB usable
WiFi	YES	NO
RS-485	2	1
USB Type A	YES (Backup/Restore)	NO
Onboard I/O	NO	5 UI, 3 DO, 2 AO
IO Expansion	Various Config 250+ points	2 IOR 34 (4 processors)
Opt Modules	Yes (485, Lon, 232)	No

Edge-10 Packaging

- Labels on box and controller provide key information.
 - MAC address for primary and secondary network ports
 - Fallback IP address
 - Host ID
 - Serial Number



Edge-10 Out of the Box State

- Upon first startup when IP connectivity is detected
 - Controller requests an IP address via DHCP.
 - If no DHCP server available, the controller utilizes a fallback IP address.
 - Fallback IP address = 192.168.1xx.xx where xx.xx is last 4 digits of serial number with a subnet mask of 255.255.0.0.
- Default credentials must be changed as part of commissioning.
 - Platform: username = “tridium” password = “niagara”
 - Station: username = “admin” password = “Admin12345”
 - Passphrase: “niagara”
- Factory station configured to auto start and assigned a unique station name based on Host ID such as Edge10-1BD5-4D59-6B22.

Edge-10 Out of the Box State

Change Platform Defaults Wizard



Change Platform Defaults Wizard

Welcome to the Change Platform Defaults Wizard!

Before you can connect to this platform, the following tasks must be completed:

- Configure the system passphrase
- Create a new platform account
- Remove the default platform account

The Change Platform Defaults Wizard will help you complete this process.

◀ Back ▶ Next ✓ Finish ✕ Cancel

Application Director

Connected to 192.168.113.63

Name	Type	Status	Details	Auto-Start	Restart on Failure
Edge10_4EF4_CDA2_1EE6	station	Running	fox=n/a,foxs=4911,http=n/a,https=443	true	true

```
INFO [nre] Launching Niagara Runtime Environment
INFO [03:55:23 01-Apr-22 UTC][nre] Booting
INFO [03:55:27 01-Apr-22 UTC][sys] Logging initialized
INFO [03:55:42 01-Apr-22 UTC][sys.registry] Up-to-date [353ms]
INFO [03:55:42 01-Apr-22 UTC][sys.registry] Loaded [577ms]
INFO [03:55:49 01-Apr-22 UTC][sys] Niagara runtime booted ("/opt/niagara") on Qnx-EDGE10-
INFO [03:55:49 01-Apr-22 UTC][sys] Loading "/home/niagara/stations/Edge10_4EF4_CDA2_1EE6/
INFO [03:56:07 01-Apr-22 UTC][sys] Loaded (18287ms)
INFO [03:56:14 01-Apr-22 UTC][alarm.database] Created
WARNING [03:56:16 01-Apr-22 UTC][search] Could not update missing default search scope pr
INFO [03:56:16 01-Apr-22 UTC][sys] Services Initialized (5249ms)
INFO [03:56:16 01-Apr-22 UTC][sys.mixin] Updated [33ms]
INFO [03:56:18 01-Apr-22 UTC][history.db] Starting async warmup of history config index..
INFO [03:56:18 01-Apr-22 UTC][history.db] Async history config index warmup completed in
INFO [03:56:33 01-Apr-22 UTC][web] Jetty web server started on HTTPS port 443
INFO [03:56:47 01-Apr-22 UTC][sys] Niagara Runtime Environment: 4.7.110.32
INFO [03:56:47 01-Apr-22 UTC][sys] *** Station Started (30970ms) [91004ms total] ***
niagara>INFO [03:56:48 01-Apr-22 UTC][fox] FOXS server started on port [4911]
```

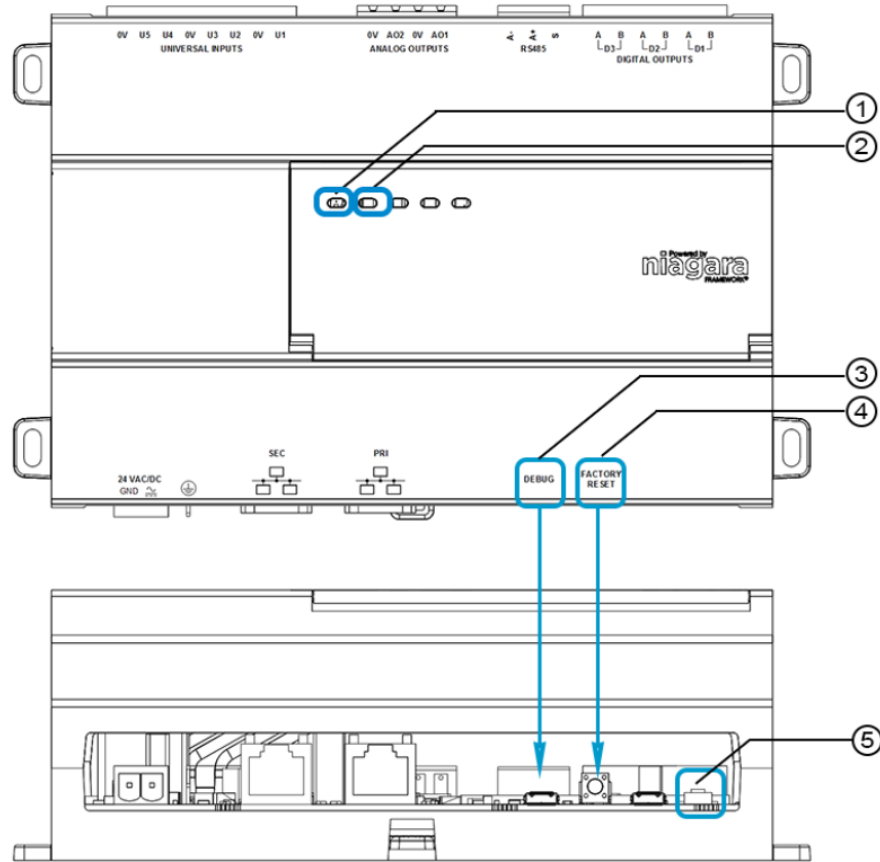
Out-Of-The Box



Edge-10 Factory Reset

- Removes all platform and station data in the device.
- Returns controller to an out of the box state with default credentials and default station.
- Resets initial IP connectivity logic to enable DHCP or utilize fallback IP address.
- Reverts Niagara software to version installed at factory, may require upgrading software after reset.

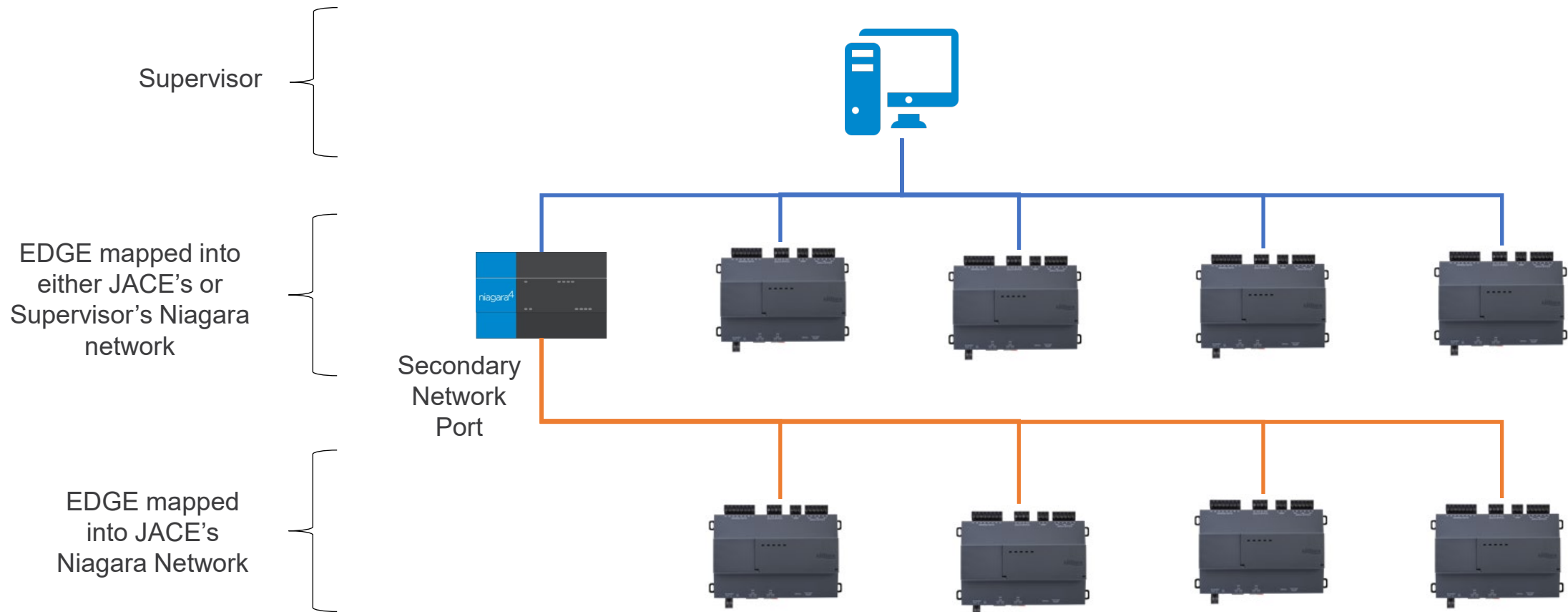
Edge-10 Factory Reset



Edge-10 IP Networking

- Default Link Mode is Daisy Chain which bridges the primary and secondary network ports to a single MAC address and IP address.
- Allows for loop-free daisy chain network topology with a maximum of 16 devices.
- Optional Rapid Spanning Tree Protocol (RSTP) supports intentional loops to increase fault tolerance on network.
- RSTP requires all controllers in chain to be configured and connected to a network switch that supports RSTP.

Edge-10 Network Topology



Edge-10 Network Topology Considerations

- Flat network topology
 - Edge-10 can be mapped directly into either a JACE's or Supervisor's Niagara network.
 - Requires Supervisor Niagara Network connection licensed for each Edge-10 controller.
 - Workbench client connectivity directly to Edge controller possible.
- Connected to secondary network port on JACE.
 - Does not count against global capacity device limits.
 - May utilize DHCP server on JACE-8 for Edge-10 IP addressing.
 - No IP routing between primary and secondary network port on JACE-8, so Workbench client connectivity may be an issue.



JACE as a DHCP Server

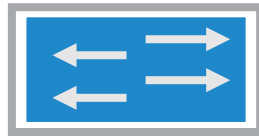
- The secondary Ethernet port on the JACE can be configured to be a DHCP server to allow for a private network of devices to be run from the secondary port of the JACE.
- The devices can be isolated from the main JACE network and all management can be done from the JACE.
- This feature allows you simplify the discovery of Niagara devices

IEEE 802.1x Support

802.1x Supplicants



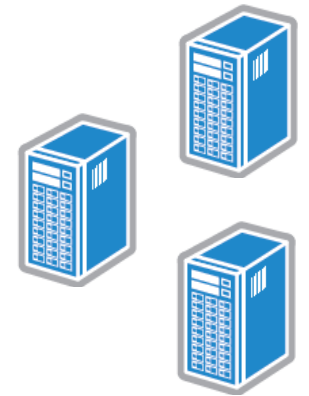
Wired Switch
(Authenticator)



RADIUS Server
(Authentication Server)



Identity Sources



- 802.1x, an IEEE standard for network access control, is typically used in enterprises and campuses with large scale networks to provide security, scalability and ease of management. The JACE 8000 and Edge 10 are now compliant with this standard and can be used as wired clients (supplicants) in a 802.1x based network.

Niagara Station vs Niagara Edge Station

- Updated Niagara Edge license model starting with 4.10 version.
10 Niagara Edge Station devices = 1 Niagara Station devices
- Use Niagara Edge Station component instead of Niagara Station.
- Update Niagara Edge license to pickup new platform feature.

```
<feature name="platform" expiration="never" type="edgeLite1"/>
```

- Supervisor license must include Niagara Driver feature

```
<feature name="niagaraDriver"  
edgeLite1_device.percentage="10"/>
```

Edge IO Network

- Network for local I/O points, similar to NRIO.

▼ Palette

edgelo

- ▶ EdgeloNetwork
- ▶ EdgeloPointFolder

Edge Io Point Discover

Discovered

Point Label	Point Id
UI1	201
UI2	202
UI3	203
UI4	204
UI5	205
N A01	301
N A02	302
B D01	501
B D02	502
B D03	503

Property Sheet

Config (Station)

Station Name: Edge10_4EF4_CDA2_1EE6

Sys Info

Services: Service Container

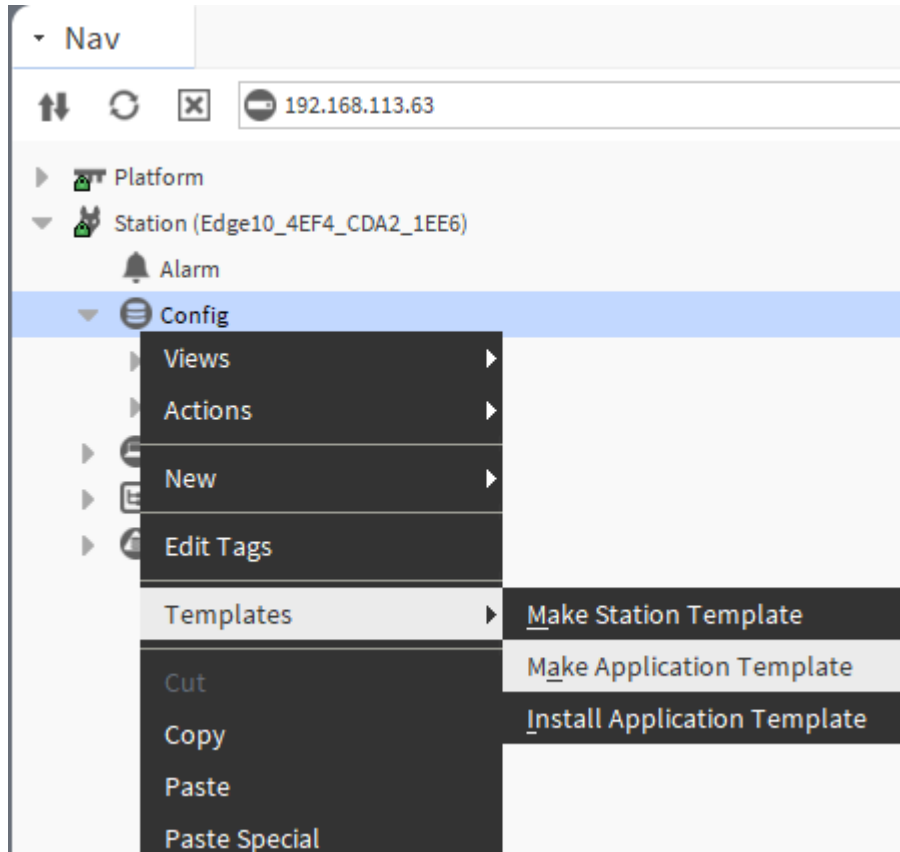
Drivers: Driver Container

- ▶ NiagaraNetwork: Niagara Network
- ▼ EdgeloNetwork: Edge Io Network
 - Status: {ok}
 - Enabled: true
 - Fault Cause:
 - ▶ Health: Ok [01-Apr-22 5:50 AM UTC]
 - ▶ Alarm Source Info: Alarm Source Info
 - ▶ Monitor: Ping Monitor
 - ▶ Tuning Policies: Tuning Policy Map
 - Enable Comm Loss Defaults: enabled
 - Comm Loss Timeout: 8 s [8 - 3600]
 - ▼ Local: Edge Io Device
 - Status: {ok}
 - Enabled: true
 - Fault Cause:
 - ▶ Health: Ok [01-Apr-22 5:50 AM UTC]
 - ▶ Alarm Source Info: Alarm Source Info
 - ▶ Points: Edge Io Point Device Ext
 - pollScheduler: N Poll Scheduler

Application Templates

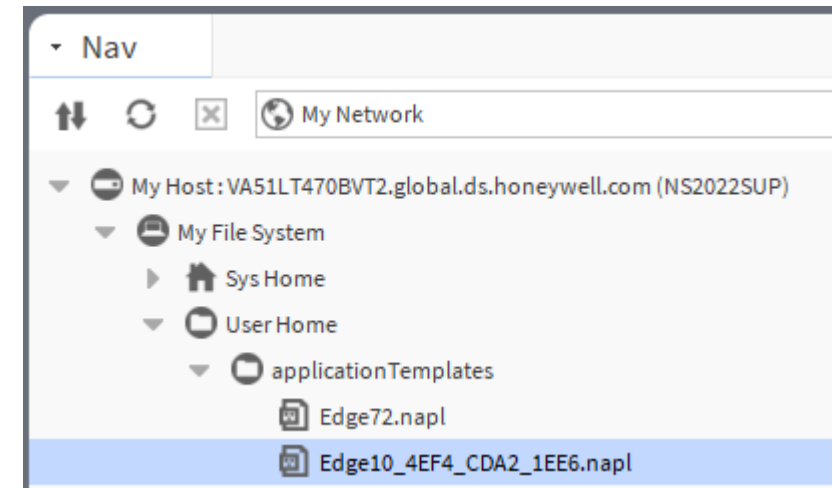
- Mechanism to deploy and entire station application to a running station, used primarily with Edge devices.
- Similar to station templates, but application templates can be installed to a running station and upgraded.
- Use an NAPL file extension to differentiate from station and device templates.
- Stored in applicationTemplates sub folder under Niagara user home.
- Right click root Config node in station and select Templates menu item allows making an application template from current station or installing an application template to the Edge device.

Application Templates



Application Template: Edge10_4EF4_CDA2_1EE6 Vendor: Tridium Version: 1.0

A screenshot of the 'Template Info' tab in the application template editor. The tab is selected, and the following fields are visible: 'Filename' (Edge10_4EF4_CDA2_1EE6), 'Title' (Edge10_4EF4_CDA2_1EE6), 'Vendor' (Tridium), 'Version' (1.0), 'State' (Draft), and 'Description'. The 'Info' section is empty, and the 'Icon' section shows 'NO ICON SELECTED' with a folder icon.



Edge-10 Summary

- Niagara Edge controllers are IP based field controller which run the full Niagara 4 stack.
- Shipped from the factory fully commissioned.
- Utilize Edge IO network for onboard I/O.
- Application templates provide a mechanism to deploy and entire station application to a running station.

Edge 10 and Niagara Provisioning

- **Bootstrap Mode** – enables provisioning station to connect to Edge controllers out of the box without having to change default passphrase or platform/station credentials while using a default self-signed certificate.
- **Update Connections** – updates IP connection for Edge controllers
 - Utilize Niagara network discovery (broadcast UDP)
 - Utilize DHCP server lease information (JACE-8 secondary network port)
- **Install Application Template** – deploys application templates to Edge controllers utilizing Excel spread sheet to specify unique configuration properties.
- Standard steps for updating licenses, upgrading/installing software and managing PKI certificates.

ACE



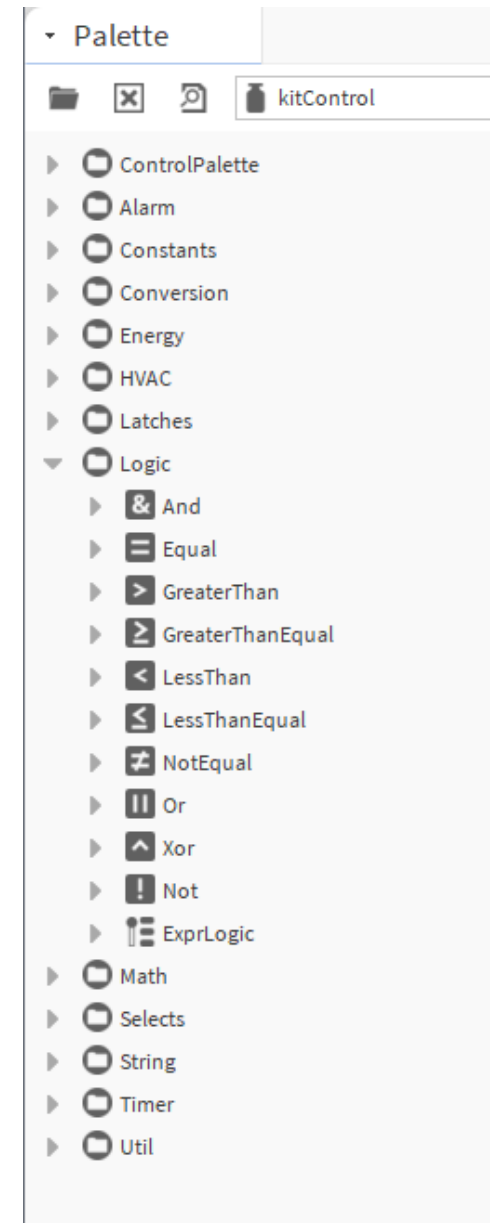
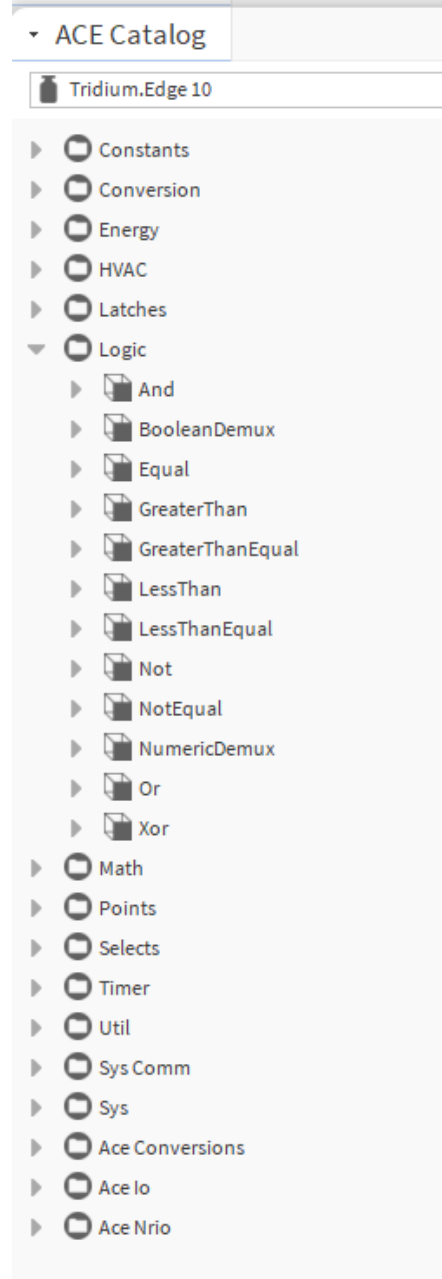
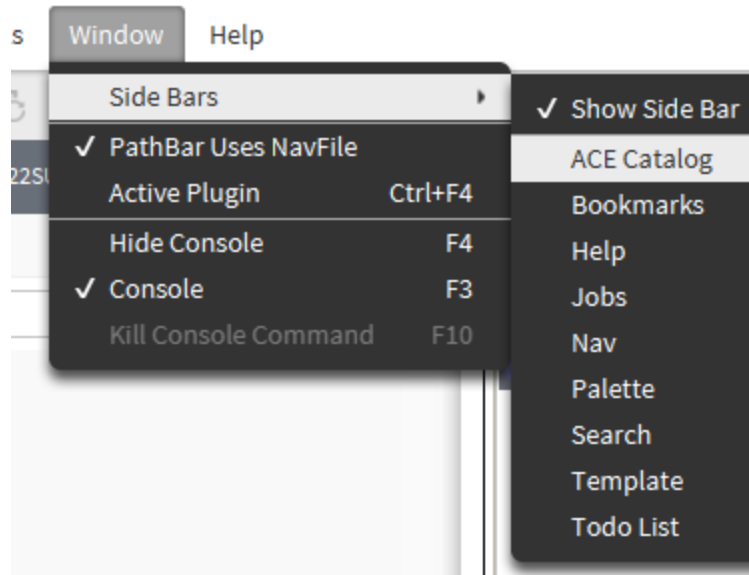
Application Control Engine (ACE)

- **C++ based application** which runs in parallel with Niagara 4.8 or newer on a Niagara Edge device (not available on JACE).
- **Independent** of the Niagara station, but **can proxy components** from the ACE application into Niagara station running on the same Edge device.
- ACE applications are built using familiar Workbench **wire sheet programming** and the **ACE catalog**.
- Can **directly access onboard I/O**.
- **Quick start up times** compared to Niagara station.
- **Time based execution** instead of event driven execution.
- **Deterministic control engine**.

ACE Catalog

- Similar to the Palette sidebar.
- Contains components **used to build ACE applications.**
- Many components are **similar to kitControl components.**
- Names and sub folder structure **consistent with kitControl palette.**
- **Can't view components in the ACE Catalog, must copy to an ACE application.**

ACE Catalog



ACE Application – Wire Sheet

- Offline applications are saved in the **ace** sub folder under the Niagara User Home location.
- ACE Wire Sheet view has a **light blue background color** to differentiate from standard wire sheet views.
- Select Workbench menu **Tools → New ACE App** to create a new offline application.
- **Can only use components from the ACE Catalog.**

ACE Application Wire Sheet

New ACE App

New ACE App

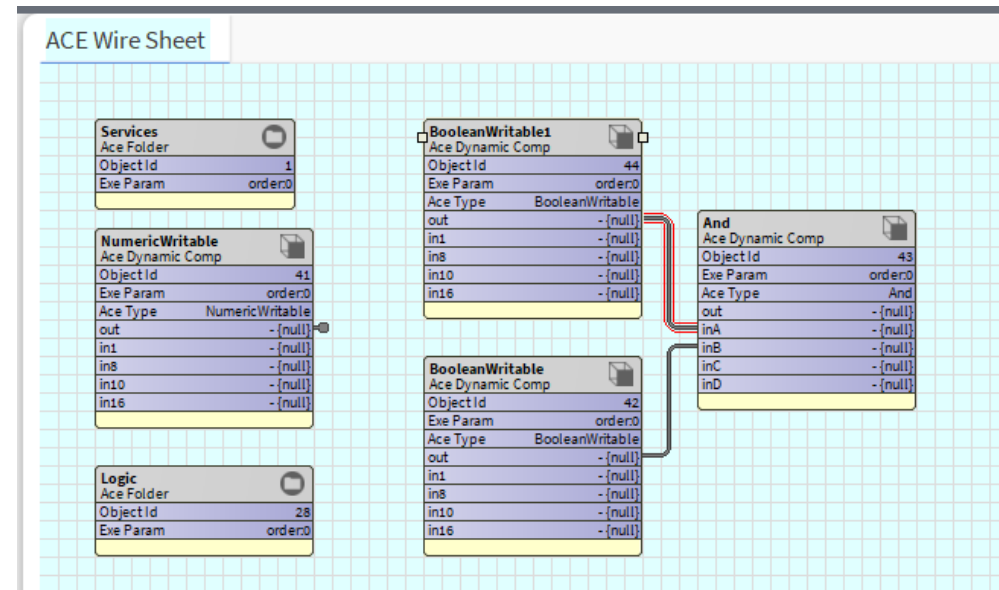
ACEApp Path
~\ace

ACEApp Name
myNewAceApp

Catalog File
Tridium.Edge 10

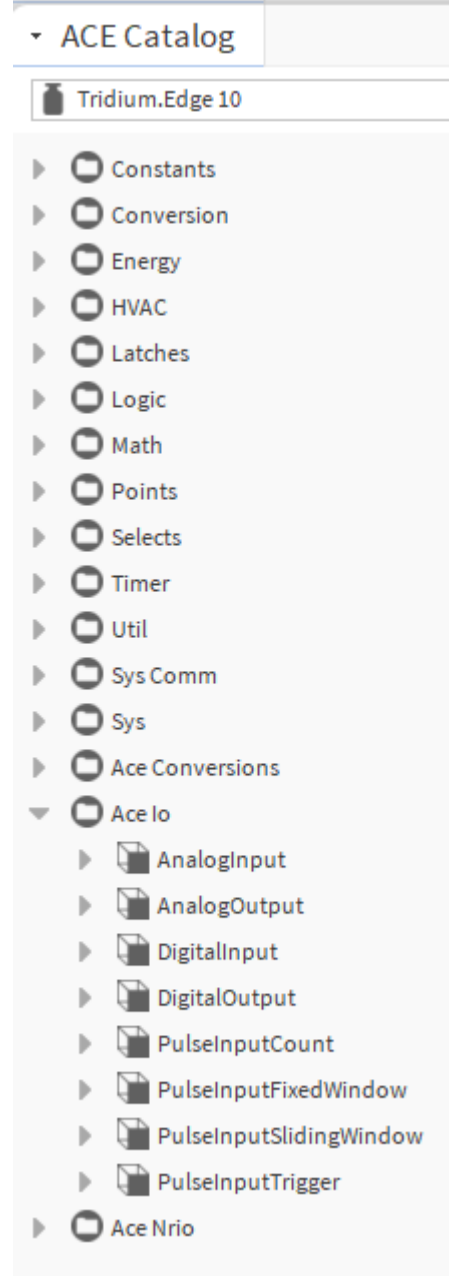
Back Next Finish Cancel

- Tools Window Help
- Options
- Alarm Portal
- Bacnet EDE
- Certificate Management
- Certificate Signer Multiple Selection Tool
- Certificate Signer Tool
- Driver Upgrade Tool
- Embedded Device Font Tool
- Jar Signer Tool
- Kerberos Configuration Tool
- Lexicon Tool
- Local License Database
- Logger Configuration
- Lon Xml Tool
- Manage Credentials
- Module Info
- NDIO to NRIO Conversion Tool
- New ACE App**
- New Driver
- New Module
- New Station
- Ram Disk Estimator
- Request License
- Resource Estimator
- Time Zone Database Tool
- Todo List
- Workbench Job Service
- Workbench Service Manager



ACE IO

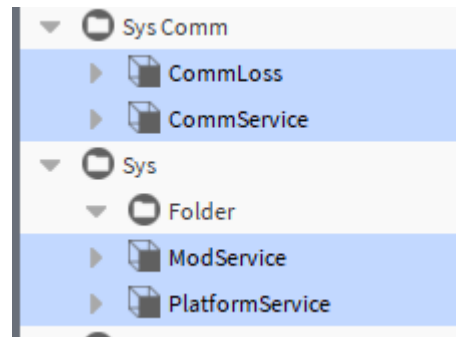
- Unique components for various input and output types.
- Point Index is a **one based index** which maps to physical I/O input or output.
- Inputs and Outputs have an **override action** which places the physical input or output out of service and **simulates a value for testing**.



ACE Services

- CommService and CommLoss **work in conjunction to monitor communication** with the Niagara station running on the Edge device.
- CommLoss can be used to **implement fallback set points or logic** when there is no communication between the ACE application and the Niagara station.
- ModService **persists ACE component value changes** in the running application (RAM memory) until the application is saved (flash drive).

ACE Services



ACE Wire Sheet	
PlatformService Ace Dynamic Comp	
Object Id	2
Exe Param	order:0
Ace Type	PlatformService
CommService Ace Dynamic Comp	
Object Id	3
Exe Param	order:0
Ace Type	CommService
ModService Ace Dynamic Comp	
Object Id	4
Exe Param	order:0
Ace Type	Mod Service

ACE Application – Property Sheet

- **Configuration properties** for application scan times.
- Scan Levels provide for **execution of components at different frequencies**.
- **Scan Period** is Scan Level 1.
- Scan Levels 2-4 are **multiples of Scan Period** time.
- If **Scan Diag Enable** equals true, the application **updates statistics** for actual scan times.

ACE Application – Property Sheet

Property Sheet

myNewAceApp.ace (Ace App)

Object Id	0	[0 - max]
Meta	0	
Exe Param	level 1	exeOrder 0
App Name	myNewAceApp	
App Version	1.0.0	
Framework Version		
Scan Period	50	ms [5 - 10000]
Min Sleep Time	20	ms [3 - 50]
Overruns	0	
Time To Steady State	0	ms [0 - 60000]
Log Level	Trace	
Scans Level2	2	[1 - 100]
Scans Level3	4	[1 - 100]
Scans Level4	8	[1 - 100]
Scan Diag Enable	<input checked="" type="checkbox"/> false	
Scan Time1	0.00	ms
Scan Time2	0.00	ms
Scan Time3	0.00	ms
Scan Time4	0.00	ms

Deterministic

- In mathematics, computer science and physics, a deterministic system is a system in which no randomness is involved in the development of future states of the system.
- A deterministic model will thus always produce the same output from a given starting condition or initial state.
- A deterministic algorithm is an algorithm which, given a particular input, will always produce the same output, with the underlying machine always passing through the same sequence of states.

https://en.wikipedia.org/wiki/Deterministic_system

ACE Application – ACE Comp Manager

- Configures **order of execution** for components in application.
- Level **sets the frequency** of component scanning.
- **Valid Level values are 1-4** corresponding to Scan Period and Scan Level 2-4.
- Order sets the **order of execution within a Scan Level**
- Scan driven execution provides **deterministic control**.

ACE Application - ACE Comp Manager

system : UserHome : ace : myNewAceApp.ace

Ace Comp Manager

Database

Name	Objectid	Level	Order
Services	1	1	0
Logic	28	1	0
NumericWritable	41	1	0
BooleanWritable	42	1	0
And	43	1	0
BooleanWritable1	44	1	0

- ACE Wire Sheet
- Ace Comp Manager
- AX Property Sheet
- Property Sheet
- AX Slot Sheet
- Relation Sheet
- New View

ACE Edge Network

- Requires upgrading Edge device to 4.8 version and updating license to enable the new feature.
- ACE Edge and Edge IO networks are **mutually exclusive** drivers because both are capable of controlling the onboard I/O.
- ACE Edge network **Local device** has a right click ACE Application menu used to **View App, Download App, Upload App and Save App.**

ACE Edge Network

Property Sheet

AceEdgeNetwork (Ace Edge Network)

Status	{ok}
Enabled	<input checked="" type="checkbox"/> true
Fault Cause	
▶ Health	Fail [null]
▶ Alarm Source Info	Alarm Source Info
▶ Monitor	Ping Monitor
▶ Tuning Policies	Tuning Policy Map
▶ Poll Scheduler	N Poll Scheduler
▶ Comm Config	Ace Ipc Comm Config
▼ Local	Ace Device
Status	{ok}
Enabled	<input checked="" type="checkbox"/> true
Fault Cause	
▶ Health	Fail [null]
▶ Alarm Source Info	Alarm Source Info
▶ Poll Frequency	Normal
▶ Points	Ace Point Device Ext

Local Device – View App

- **Loads the ACE** application from the Edge device's file space into the station.
- Provides **live wire sheet** programming view.
- **Transient** object and is **not saved** to the config.bog file.

Local Device - View App

bldg1f2.ns2022.lan:192.168.1.72 (Bldg1F2) : Station (Bldg1F2) : Config : Drivers : AceEdgeNetwork : Local : App

Nav

My Network

- Drivers
 - NiagaraNetwork
 - BacnetNetwork
 - AceEdgeNetwork
 - Local
 - Alarm Source Info
 - Points
 - App
 - Services
 - Logic
 - NumericWritable
 - BooleanWritable
 - And
 - BooleanWritable1

ACE Wire Sheet

The ACE Wire Sheet diagram illustrates the following components and their connections:

- Services** (Ace Folder, Object Id 1): Exe Param order:1
- NumericWritable** (Ace Dynamic Comp, Object Id 18): Exe Param order:1; Ace Type NumericWritable; out - {null}; in1 - {null}; in8 - {null}; in10 - {null}; in16 - {null}
- BooleanWritable1** (Ace Dynamic Comp, Object Id 21): Exe Param order:1; Ace Type BooleanWritable; out - {null}; in1 - {null}; in8 - {null}; in10 - {null}; in16 - {null}
- BooleanWritable** (Ace Dynamic Comp, Object Id 19): Exe Param order:1; Ace Type BooleanWritable; out - {null}; in1 - {null}; in8 - {null}; in10 - {null}; in16 - {null}
- And** (Ace Dynamic Comp, Object Id 20): Exe Param order:2; Ace Type And; out - {null}; inA - {null}; inB - {null}; inC - {null}; inD - {null}

Connections shown in the diagram:

- Services is connected to BooleanWritable1.
- NumericWritable is connected to BooleanWritable1.
- BooleanWritable1 is connected to BooleanWritable.
- BooleanWritable1 is connected to And.
- BooleanWritable is connected to And.

ACE Point Manager

bldg1f2.ns2022.lan : 192.168.1.72 (Bldg1F2) : Station (Bldg1F2) : Config : Drivers : AceEdgeNetwork : Local : Points

My Network

- Drivers
 - NiagaraNetwork
 - BacnetNetwork
 - AceEdgeNetwork
 - Local
 - Alarm Source Info
 - Points
 - App
 - Services
 - Logic
 - NumericWritable
 - BooleanWritable
 - And
 - BooleanWritable1

systemLogic

aceEdge

- AceEdgeNetwork
 - Local
 - AcePointFolder

Template

ACE Catalog

Ace Discovery

Success

60 objects

Point	Comp Name	Prop Name	Comp Id	Prop Id
Logic.BooleanDemux				
Logic.Equal				
Logic.GreaterThan				
Logic.GreaterThanEqual				
Logic.LessThan				
Logic.LessThanEqual				
Logic.Not				
Logic.NotEqual				
Logic.NumericDemux				
Logic.Or				
Logic.Xor				
NumericWritable				
NumericWritable.sourceLevel	NumericWritable	sourceLevel	18	2
NumericWritable.out	NumericWritable	out	18	3
NumericWritable.in1	NumericWritable	in1	18	4

Database

2 objects

Name	Type	Out	Fault Cause	Comp Name	Prop Name
NumericWritable.out	Numeric Point	-{null}		NumericWritable	out
BooleanWritable.out	Boolean Point	-{null}		BooleanWritable	out

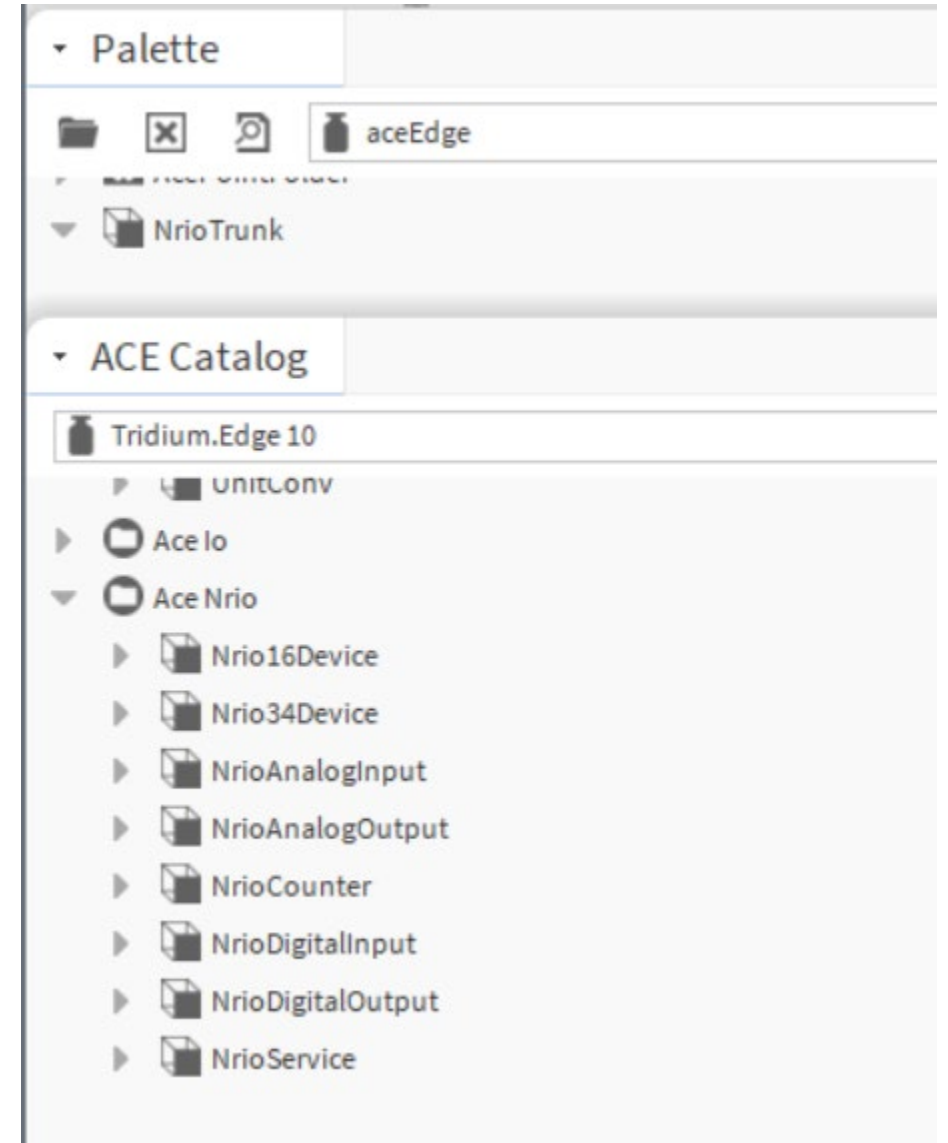
New Folder Edit Discover Add TagIt

Application Templates

- Mechanism to **deploy and entire application** to an Edge device.
- Includes **ACE and station** application files.

ACE - NRIO

- NRIO support added in 4.9 version.
- Using NRIO in ACE application prevents using NRIO network in station.
- NRIO module firmware can only be downloaded using the NRIO network in a JACE or Edge station.



Setting up the NrioService

1. Open the ACE App wire sheet.
2. Open the ACE Catalog sidebar.
3. From the Ace Nrio subfolder in the sidebar, drag the NrioService onto the App wire sheet.

NOTE: The NrioService is required in the ACE app in order to use NRIO devices.

4. From the Ace Nrio subfolder in the sidebar, drop an NrioXXDevice onto the ACE App wiresheet, where NrioXXDevice is either Nrio16Device or Nrio34Device.
5. Right-click the NrioDevice and click Actions > Match.
6. In the Match window, click Discover, click to select one of the discovered UUIDs and click Match.
7. The NrioDevice component's status should be OK

Summary – ACE Programming

- ACE is a **C++ based application** which **runs in parallel** with a Niagara station on a Niagara Edge device.
- ACE applications have **quicker startup times** and **scan based execution** compared to the Niagara station.
- ACE applications are **deterministic**.
- ACE Edge and Edge IO networks are **mutually exclusive** because both are capable of controlling the onboard I/O.
- Application templates **include ACE application files**.