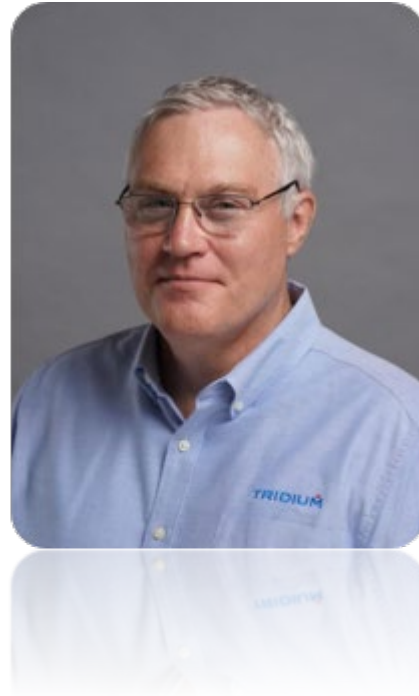




Enterprise Design Fundamentals

Kevin Mamajek
Sales Engineering
Manager
Tridium, Inc.



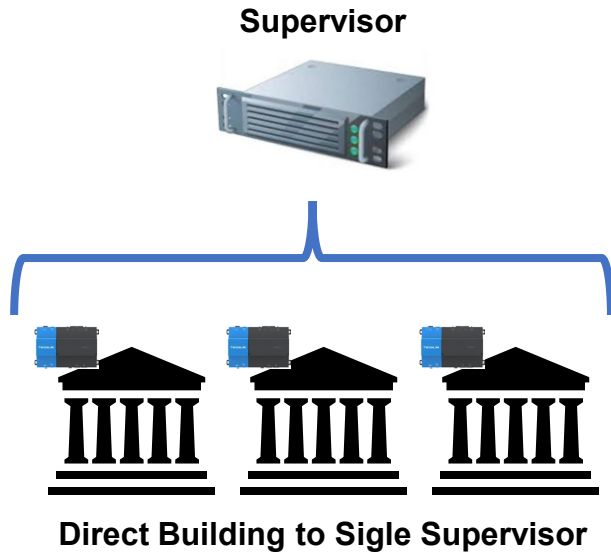
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Agenda

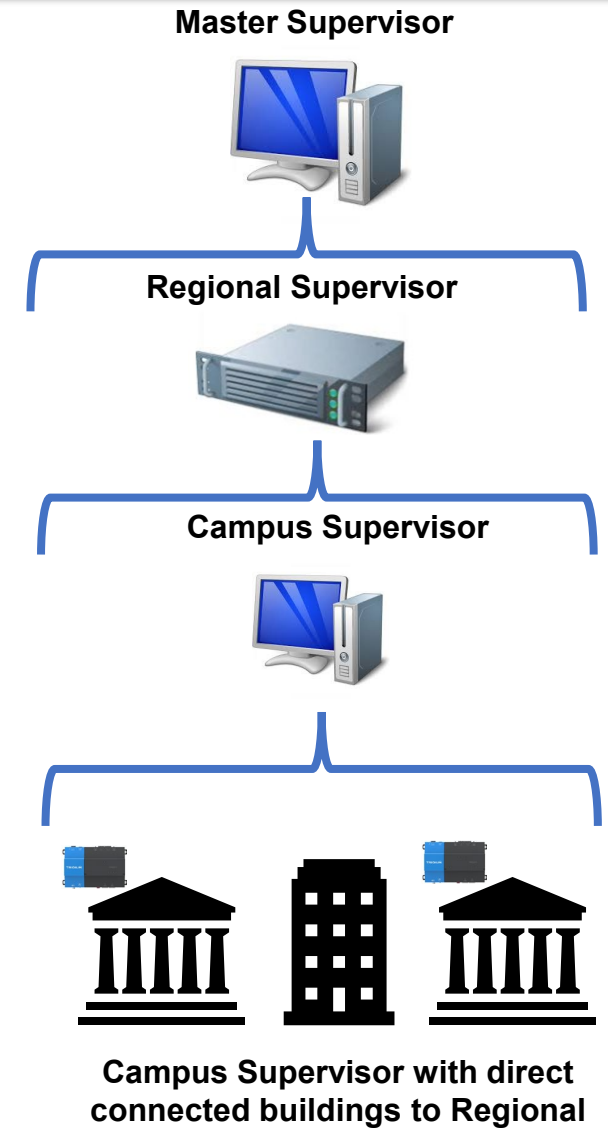
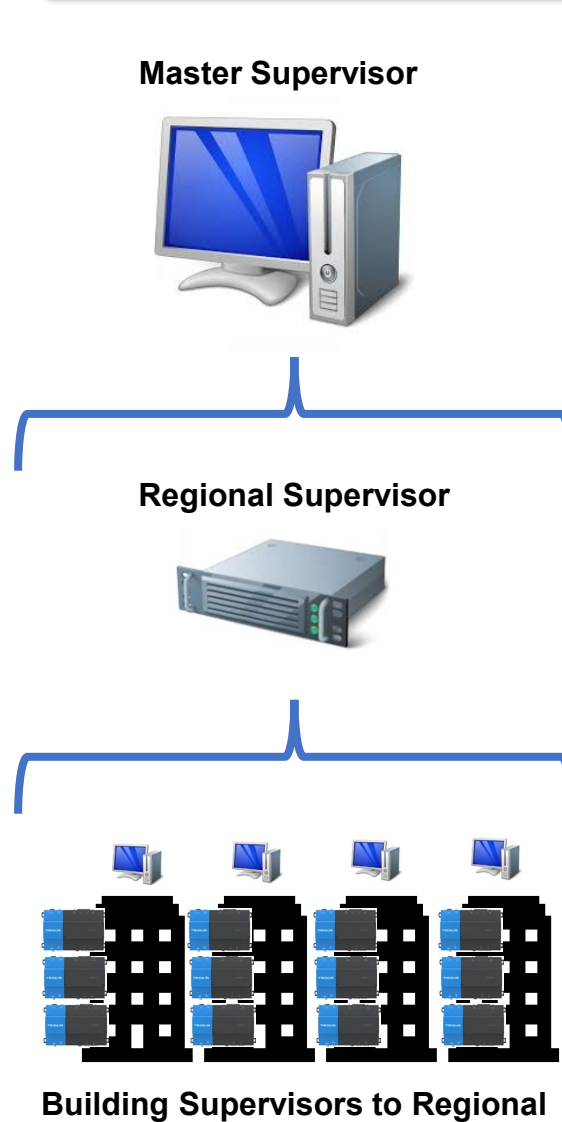
- Network architecture
- Relational databases
- System database
- Reachable stations and multi-tiered design
- On demand Px views
- Enterprise hierarchies
- nspace and sys ord schemes
- Alarm management

Enterprise Design

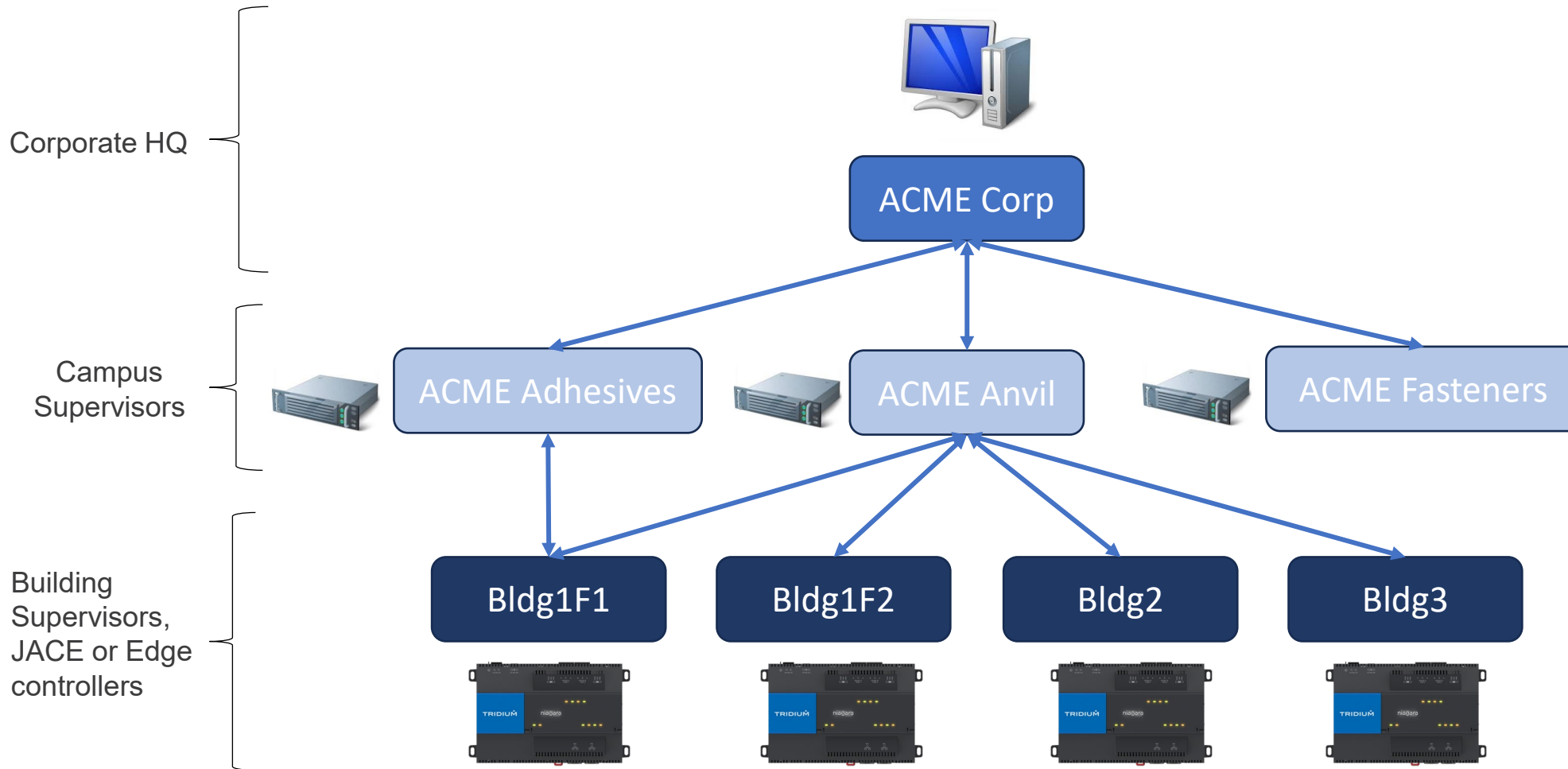
Single Tier Design



Multi Tier Design



Demonstration Architecture

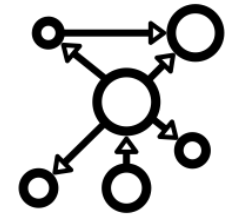


How do we accommodate 2 million + points

First, we need to talk about efficiency

Relational and Graph Databases

- **Relational database** such as SQL, My SQL and Oracle work well with structured data like trend data, financial data, etc.
- IoT networks typically generate a lot of unstructured data which relational database servers can't accommodate easily.
- **Graph databases are NoSQL databases** which use a graph data model comprised of vertices and edges
 - Vertices are entities such as people, places, objects or pieces of data
 - Edges represent relationships between two vertices



PRODUCT_CODE	DESCRIPTION	COST
PVC 00300-1400	4" PVC 90 deg elbow	\$12.00
PVC 00324-1200	4" PVC 22 ½ deg elbow	\$13.00

PRODUCT_CODE	LOCATION	QUANTITY
PVC 00300-1400	Bldg A, Isle 12B	50
PVC 00324-1200	Bldg A, Isle 12E	125

SystemDB

*Oh yeah, I remember hearing
about that.*

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System Database (SystemDb) Overview

- A graph database running on the Supervisor station which indexes entities, tags and relations from the entire Niagara enterprise application.
- SystemDb only supports **NEQL** queries run against it.
- Data is entered in the SystemDb based on BQL or NEQL queries processed by the **System Index Service**.
- Entities may include **networks, devices, control points, schedules and other station components**.
- A JACE station will not have a SystemDb, but its entities may be indexed and stored in the **Supervisor's SystemDb**.

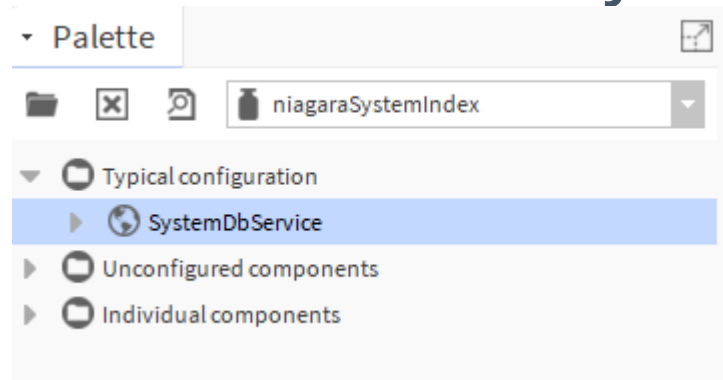
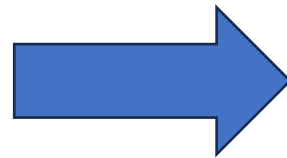


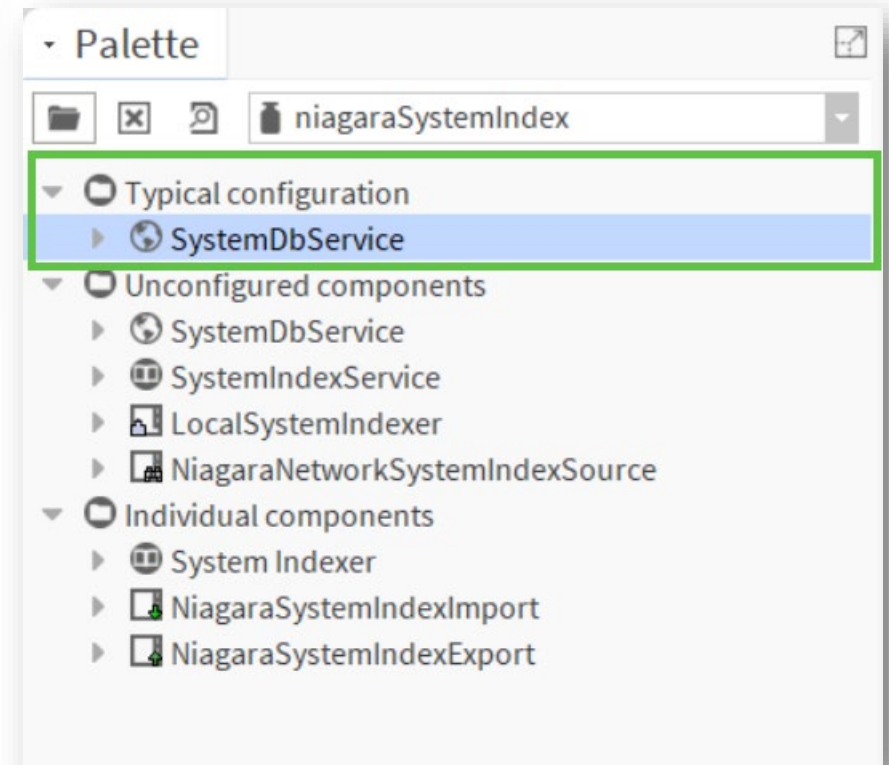
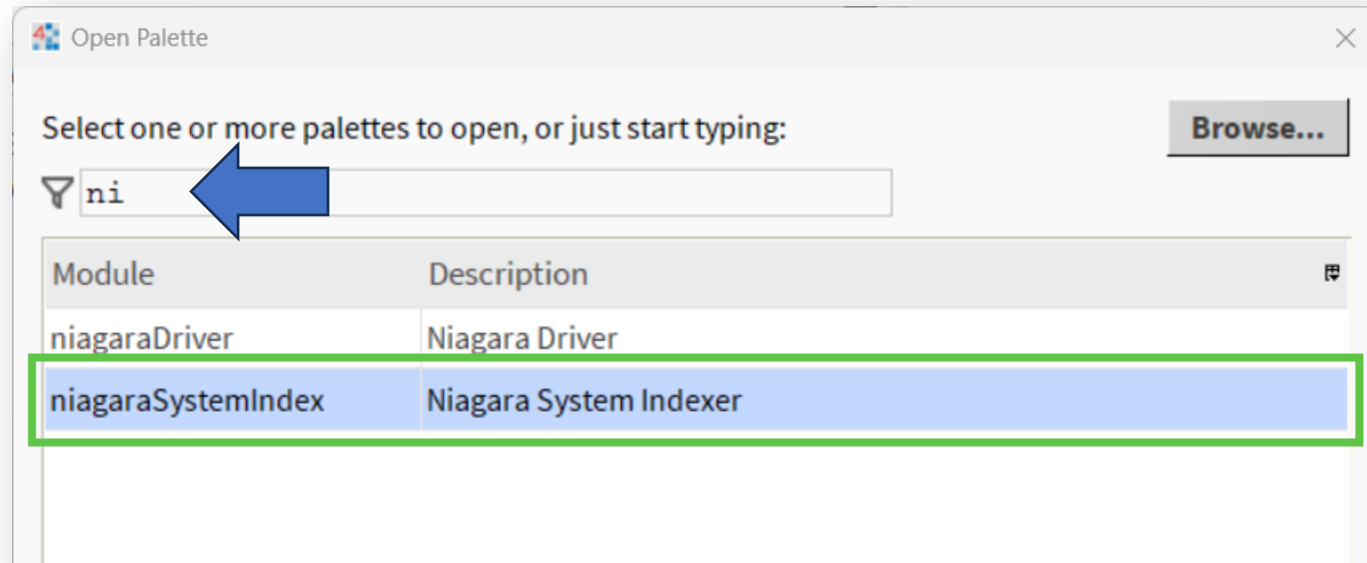
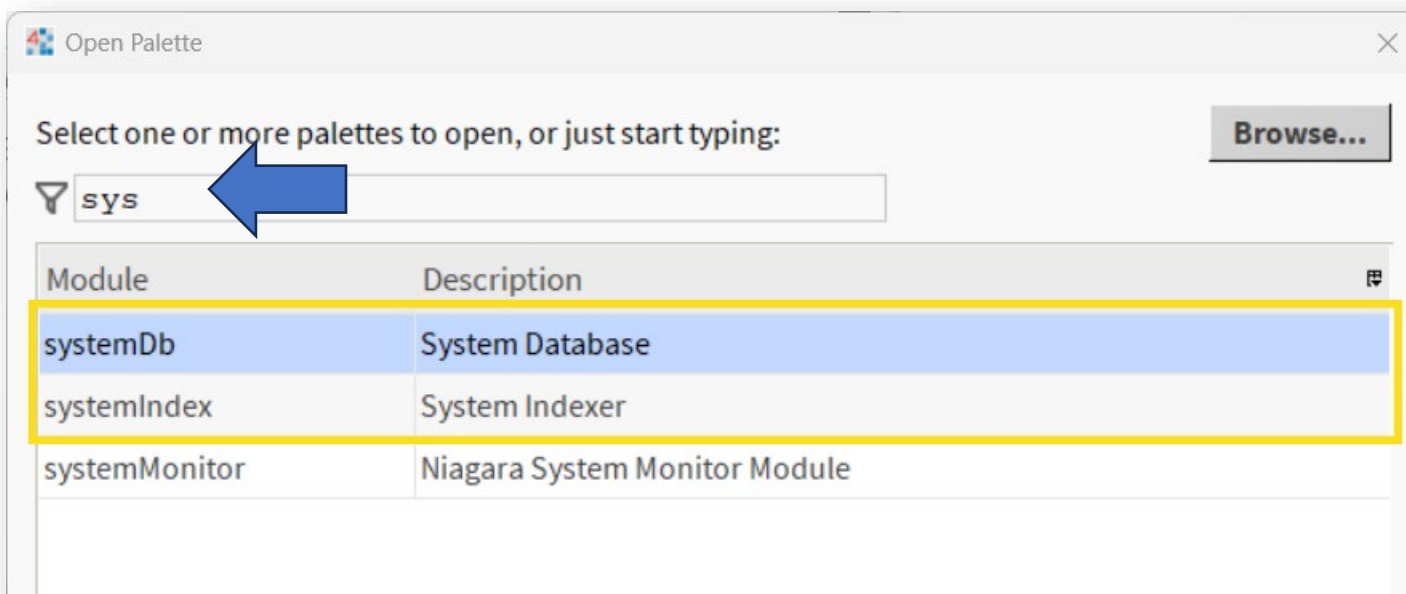
SystemDb Indexing

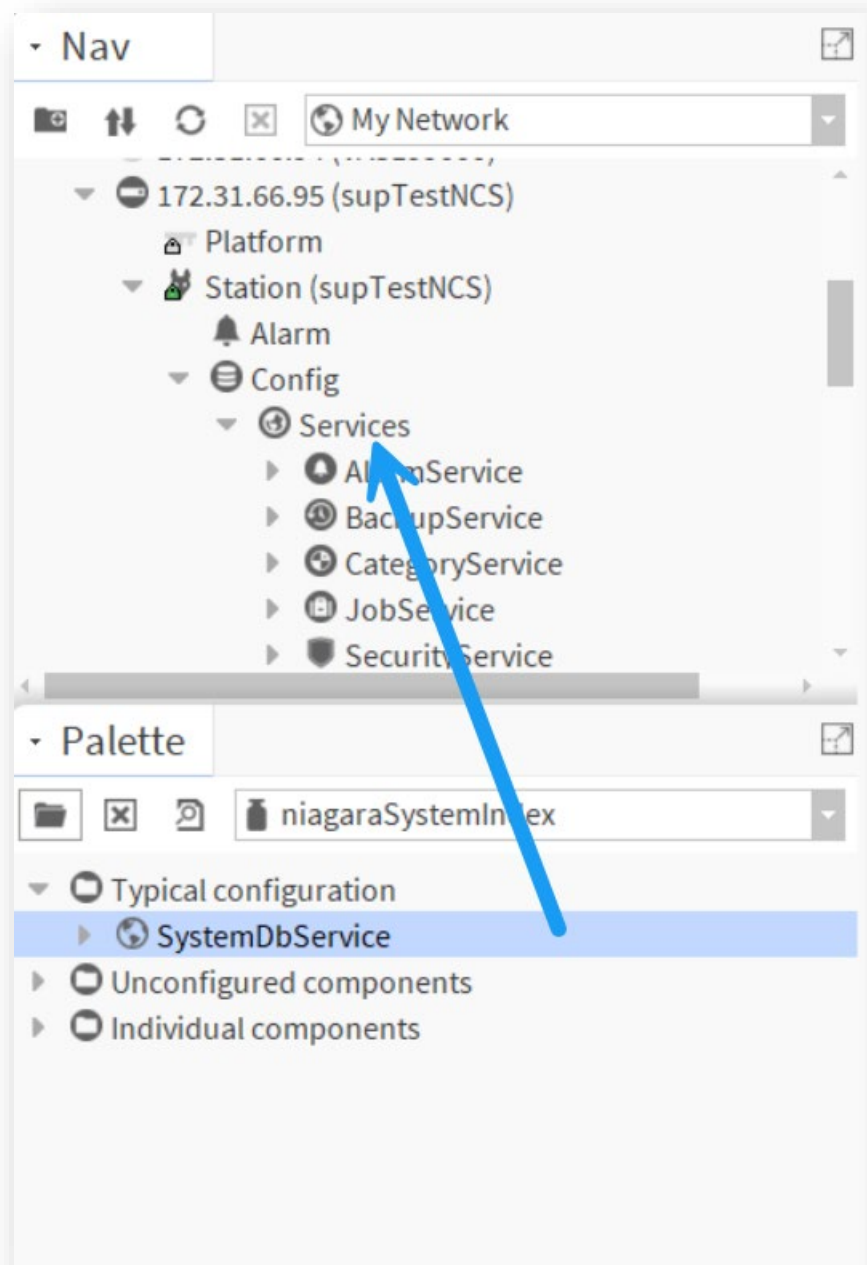
- **Export** – Remote stations running 4.6 or newer build may be configured to **push** indexing to the Supervisor.
- **Import** – Supervisor may be configured to **pull** indexing from the remote stations running **4.4 or newer build**.
 - **Individual** – Remote stations may be configured with unique indexing rules on a per station basis.
 - **Global** – Uses common indexing rules for all remote stations.
- May also need to index the local Supervisor station.
- Indexing may need to be performed on a periodic basis.

SystemDb and SystemIndex Setup

- Unconfigured services and components are found in **systemDb** and **systemIndex palettes**.
- The **niagaraSystemIndex palette** contains services and components with **typical configurations**.
- Must configure the System Database Type Selection to **orientSystemDb**
- Optionally configure Niagara Network and Local System Indexers.







Nav

My Network

- HistoryService
- AuditHistoryService
- LogHistoryService
- ProgramService
- SearchService
- TagDictionaryService
- TemplateService
- WebService
- BatchJobService
- SigningService
- PlatformServices
- SystemDbService**
 - Alarm Source Info
 - Monitor
 - System Database
 - SystemIndexService
- Drivers
- Apps
- Files
- Hierarchy
- History

Property Sheet

SystemDbService (System Db Service)

Status	{ok}
Fault Cause	
Enabled	<input checked="" type="checkbox"/> true
Health	Ok [13-Apr-24 7:24 PM EDT]
Alarm Source Info	Alarm Source Info
Monitor	System Db Ping Monitor
System Database Type Selection	<input type="text" value="orientSystemDb"/> <input type="text" value="OrientSystemDb"/>
System Database	Orient System Db
SystemIndexService	System Index Service

Setup Indexer

Property Sheet

SystemDbService (System Db Service)

Status {ok}

Fault Cause

Enabled ☒ true

Health Ok [13-Apr-24 7:24 PM EDT]

Alarm Source Info Alarm Source Info

Monitor System Db Ping Monitor

System Database Type Selection orientSystemDb OrientSystemDb

System Database Orient System Db

Database Encryption Encrypted

Orient Db Server Config File module://orientSystemDb/rc/orientdb-server-config.xml

SystemIndexService System Index Service

Status {ok}

Fault Cause

Enabled ☒ true

Max Concurrent Index Executions 50 [5 - max]

Max Concurrent Index Executions Per Device 1 [1 - max]

Retry Trigger 1 hour {Sun Mon Tue Wed Thu F...

LocalSystemIndexer Local System Indexer

NiagaraNetworkSystemIndexSource Niagara Network System Index ...

Refresh

Save

Local System Indexer

- Disabled by default.
- May need to enable if using IP based drivers or creating Niagara network device folders, points folders and points.
- **Default configuration indexes the local station root component and local (non-Niagara driver) networks, device folders, devices, point folders, points, schedules and any component assigned a Px view.**
- May disable the default index queries to use **custom** index queries or may merge custom index queries with the default.

LocalSystemIndexer

Property Sheet	
Local System Indexer	
Status	{disabled}
State	Idle
Enabled	<input checked="" type="radio"/> false
Execution Time	2:00 AM {Sun Mon Tue Wed Thu...
Last Attempt	null
Last Success	null
Last Failure	null
Fault Cause	
Alarm On Failure	<input checked="" type="radio"/> true
Alarm Source Info	Alarm Source Info
Default Index Queries	station: slot: bql:{asComponent} station: slot: bql:select * from driver:DeviceNetwork where type != niagaraDriver:NiagaraNetwork station: slot: bql:select * from driver:DeviceFolder where type != niagaraDriver:NiagaraStationFolder station: slot: bql:select * from driver:Device where type != niagaraDriver:NiagaraStation and type != niagaraDriver:NiagaraPointFolder station: slot: bql:select * from driver:PointFolder where type != niagaraDriver:NiagaraPointFolder
Use Default Index Queries	<input checked="" type="radio"/> true (Merge with Custom)
Custom Index Queries	<div></div> <div>+</div> <div>×</div>
NiagaraNetworkSystemIndexSource Niagara Network System Index ...	

Niagara Network Indexers

- Enabled by default and re-indexes every day at 2:00 AM.
- Default configuration indexes the remote station root component and remote (non-Niagara driver) networks, device folders, devices, point folders, points, schedules, and any component assigned a Px view.
- May disable the default index queries to use custom index queries or may merge custom index queries with the default.
- May setup Import or Export indexers for specific Niagara stations which override global indexing.
- Reminder: Should enable the Import **Virtual Px Files On Demand** property under Virtual Policies in the Niagara Network.

NiagaraNetworkSystemIndexSource

Property Sheet	
▼ NiagaraNetworkSystemIndexSource	Niagara Network System Index ...
Status	{ok}
Fault Cause	
Enabled	<input checked="" type="checkbox"/> true
▼ Global Niagara Network Indexer	Niagara Network System Indexer
Status	{ok}
State	Idle
Enabled	<input checked="" type="checkbox"/> true
▶ Execution Time	2:00 AM {Sun Mon Tue Wed Thu...}
Last Attempt	null
Last Success	null
Last Failure	null
Fault Cause	
Alarm On Failure	<input checked="" type="checkbox"/> true
▶ Alarm Source Info	Alarm Source Info
Default Index Queries	station:/slot:/bql:select * from driver:Device where type != niagaraDriver:NiagaraStation and type != station:/slot:/bql:select * from driver:PointFolder where type != niagaraDriver:NiagaraPointFolder station:/slot:/bql:select * from control:ControlPoint where proxyExt.type != niagaraDriver:NiagaraP station:/slot:/bql:select * from schedule:AbstractSchedule stop station:/slot:/neql:n:hasPxView
Use Default Index Queries	<input checked="" type="checkbox"/> true (Merge with Custom)
Custom Index Queries	<div>⊕ ✕</div>
Global Index Timeout	00002h 00m 00s [1 ms - +inf]
Include Reachable Stations	<input type="checkbox"/> false
Global Index Last Result	

Accept Global Requests & Receive Exported Indexes

Station (AcmeCorp) : Config : Drivers : NiagaraNetwork

Database

Name

- AcmeAnvil
- AcmeFasteners
- AcmeAdhesives

Edit

Name	Type	Address	Fox Port	Use Foxs	Credential Store	Enabled	Virtuals Enabled
AcmeAnvil	Niagara Station	ip:acmeanvil.ns24.lan	4912	true	Client Credentials	true	true

Name: AcmeAnvil

Type: Cannot edit

Address: IP acmeanvil.ns24.lan

Fox Port: 4912

Use Foxs: true

Credential Store: UsernameAndPassword

Username: SystemServiceAccount

Password:

Enabled: true

Virtuals Enabled: true

Accepts Global Index Requests: true

Receive Exported Index From Remote Station: false

Sec Dash Import Enabled: true

About This Demo

- We are deliberately slowing this down
- Cooking Recipe concepts so you can see how each ingredient mixes.
- If you feel you need to yell out, that I missed a Configuration option
 - That was done on purpose
 - Please hold your excitement to the end

System Indexing Demo

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FileEditSearchBookmarksToolsWindowHelp

Quick Search

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp) : Station (AcmeCorp) : Config : Services : SystemDbService

AX Property Sheet

Nav

My Network

My Host: ZEUS (transformTesting)

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp)

Platform

Station (AcmeCorp)

Home

Alarm

Config

Services

AlarmService

AuditHistoryService

AuthenticationService

BackupService

BatchJobService

BoxService

CategoryService

DebugService

FoxService

HierarchyService

HistoryService

JobService

LogHistoryService

ProgramService

RoleService

SAMLIdPService

SearchService

SecurityService

SystemDbService

TagDictionaryService

TemplateService

Palette

niagaraSystemIndex

Typical configuration

Unconfigured components

Individual components

Property Sheet

SystemDbService (System Db Service)

Status

{ok}

Fault Cause

Enabled

true

Health

Ok [11-Apr-24 4:00 PM EDT]

Alarm Source Info

Alarm Source Info

Monitor

System Db Ping Monitor

System Database Type Selection

orientSystemDbOrientSystemDb

System Database

Orient System Db

SystemIndexService

System Index Service

Status

{ok}

Fault Cause

Enabled

true

Max Concurrent Index Executions

50

[5 - max]

Max Concurrent Index Executions Per Device

1

[1 - max]

Retry Trigger

1 hour {Sun Mon Tue Wed Thu F...

LocalSystemIndexer

Local System Indexer

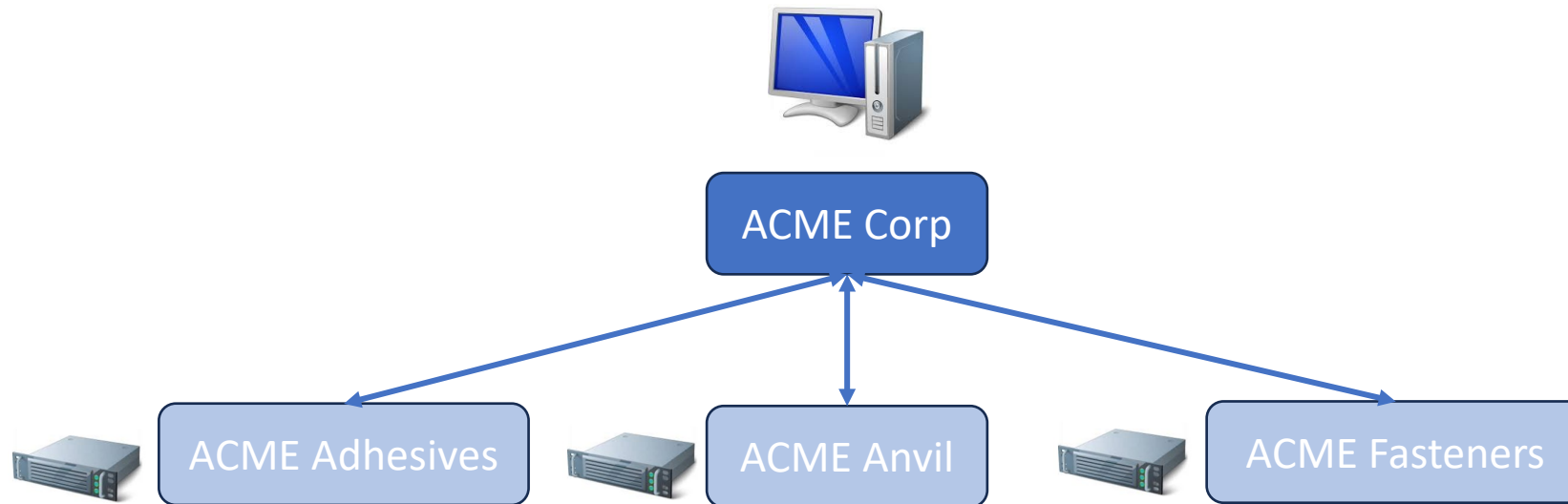
NiagaraNetworkSystemIndexSource

Niagara Network System Index ...

Refresh

Save

So far, we captured this much



System DB Spy and Search Demo

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FileEditSearchBookmarksToolsWindowHelp

Quick Search

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp) : Station (AcmeCorp) : Config : Services : SystemDbServiceAX Property Sheet

Nav

My Network

My Host: ZEUS (transformTesting)

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp)

Platform

Station (AcmeCorp)

Home

Alarm

Config

Services

AlarmService

AuditHistoryService

AuthenticationService

BackupService

BatchJobService

BoxService

CategoryService

DebugService

FoxService

HierarchyService

HistoryService

JobService

LogHistoryService

ProgramService

RoleService

SAMLIdPService

SearchService

SecurityService

SystemDbService

TagDictionaryService

TemplateService

Palette

niagaraSystemIndex

Typical configuration

Unconfigured components

Individual components

Property Sheet

SystemDbService (System Db Service)

Status

{ok}

Fault Cause

Enabled

true

Health

Ok [11-Apr-24 4:20 PM EDT]

Alarm Source Info

Alarm Source Info

Monitor

System Db Ping Monitor

System Database Type Selection

orientSystemDbOrientSystemDb

System Database

Orient System Db

SystemIndexService

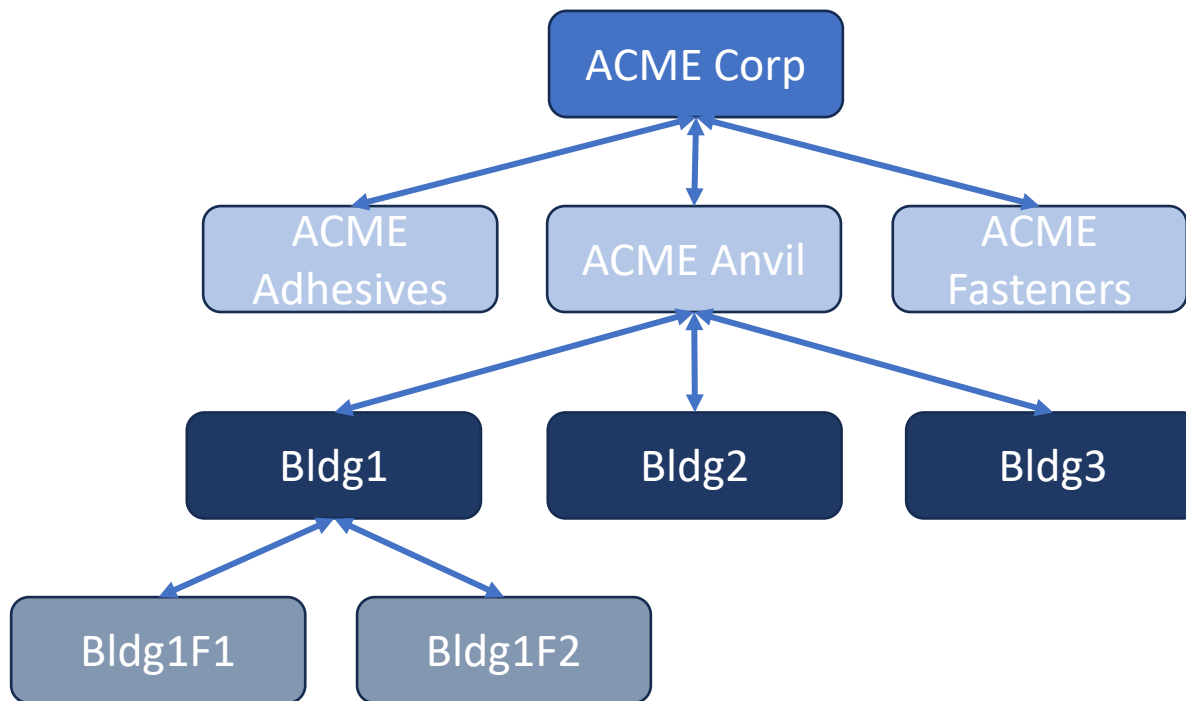
System Index Service

Refresh

Save

Reachable Stations 4.13+

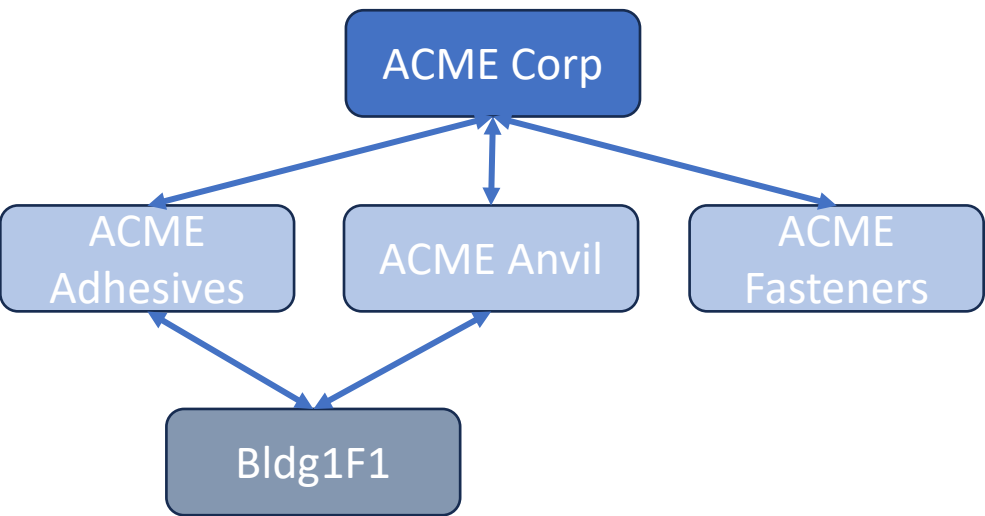
- Defines all downstream Niagara stations that are routable through this Niagara station
- **System Database** indexing (4.13+) and **Security Dashboard** (4.14+) leverage reachable stations



: Config : Drivers : NiagaraNetwork : AcmeAnvil : Sys Def	
Property Sheet	
Sys Def (Niagara Sys Def Device Ext)	
Enabled	<input checked="" type="checkbox"/> true
Status	{ok}
Fault Cause	
Role Manager	Peer
Sync Task	Sync Task
Reachable Stations	Reachable Stations
Status	{ok}
State	Idle
Enabled	<input checked="" type="checkbox"/> true
Last Attempt	05-Feb-2024 02:26 PM EST
Last Success	05-Feb-2024 02:26 PM EST
Last Failure	null
Fault Cause	
Bldg1F2	Reachable Station Info
Bldg1F1	Reachable Station Info
Bldg2	Reachable Station Info
Bldg3	Reachable Station Info

Reachable Stations Info 4.13+

- Info and Spy view shows routes to each station
- If multiple routes exist to same station, route preference is utilized



Remote Station | niagaraNetwork | reachableStations | noForceUpdateIncludeUnoperationalInc

Reachable Station	Version	Route To Reachable Station	Route Preference (0 = primary)
Bldg1F1	4.14.0.118	AcmeAnvil -> Bldg1F1	0
Bldg1F1	4.14.0.118	AcmeAdhesives -> Bldg1F1	1
Bldg1F2	4.14.0.118	AcmeAnvil -> Bldg1F2	0
Bldg2	4.14.0.118	AcmeAnvil -> Bldg2	0
Bldg3	4.14.0.118	AcmeAnvil -> Bldg3	0

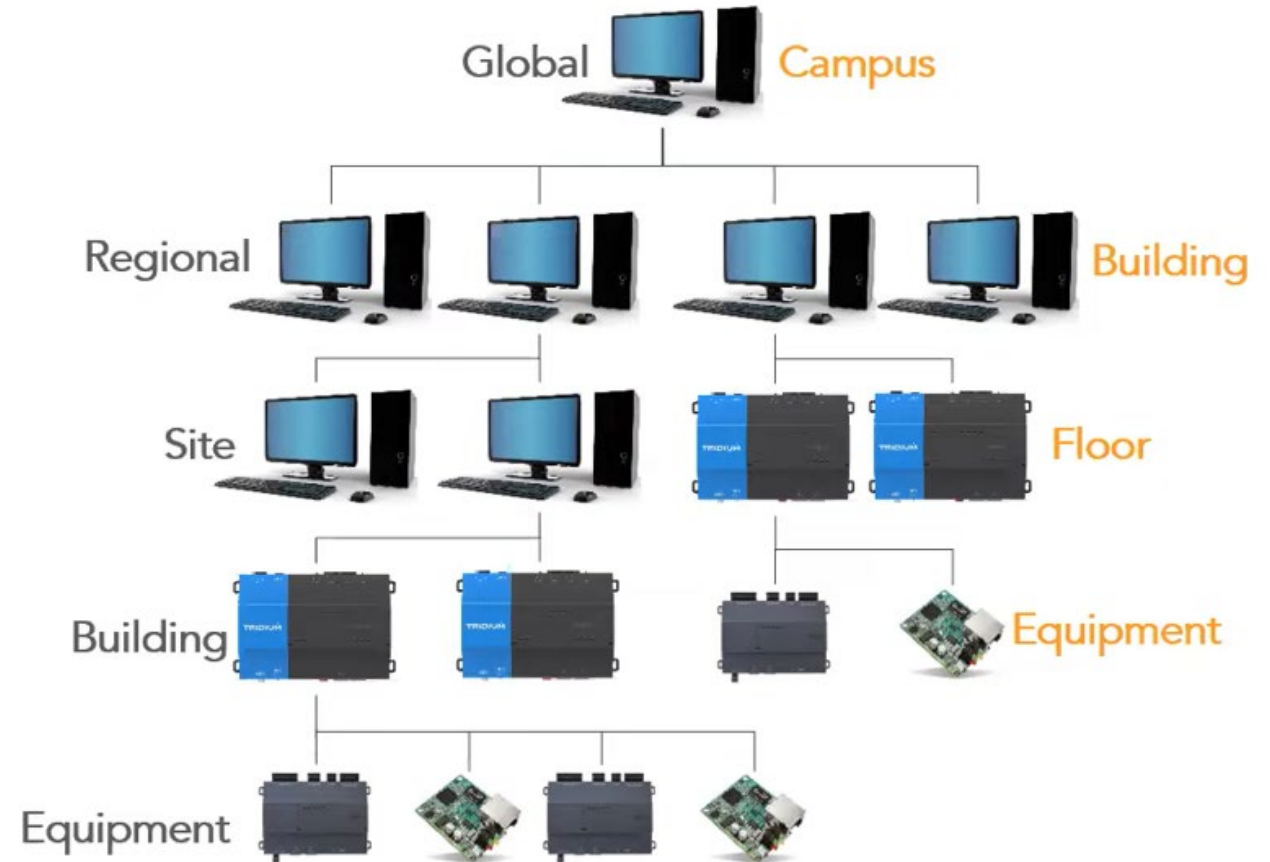
Bldg1F1

Reachable Station Info

Station Name	Bldg1F1
Station Version	4.14.0.118
Route To Station	AcmeAnvil;Bldg1F1
Min Version Along Route	4.14.0.118
Virtual Space Ord	station: slot:/Drivers/NiagaraNetwork/AcmeAnvil/virtual virt
Time To Reach	+00000h 00m 00.000s
Route Enabled	<div><div></div>true</div>


Multi-tier SystemDb Indexing (4.13+)

- Top level and intermediate stations must be at 4.13+ version, leaf node stations must be at 4.4+ version.
- Optionally enable the Import Virtual Px Files On Demand property under the Niagara Network Virtual Policies for both top level and all intermediate stations.



Multi-tier SystemDb Indexing (4.13+)

- Set Global Niagara Network Indexer's Include Reachable Stations property to true



Include Reachable Stations	<input checked="" type="radio"/> true
Global Index Last Result	<pre>3 of 3 eligible NiagaraStations successfully responded to the last global system index operation. NiagaraStations that were down: 0 4 of 4 eligible Reachable Stations successfully responded to the last global system index operation. Reachable Stations that were down: 0</pre>

Multi-tier SystemDb Indexing (4.13+)

- Reachable Stations are stored under **Sys Def** for each Niagara Station Device.
- Used to manage indexing on individual reachable stations.

The screenshot displays the Niagara 4 software interface. On the left, the 'Nav' pane shows a tree structure under 'My Network' > 'Drivers' > 'NiagaraNetwork' > 'AcmeAnvil' > 'Sys Def' > 'Reachable Stations'. The 'Bldg1F1' station is selected and highlighted in blue. On the right, the 'Property Sheet' for 'Bldg1F1 (Reachable Station Info)' is shown, containing various configuration fields.

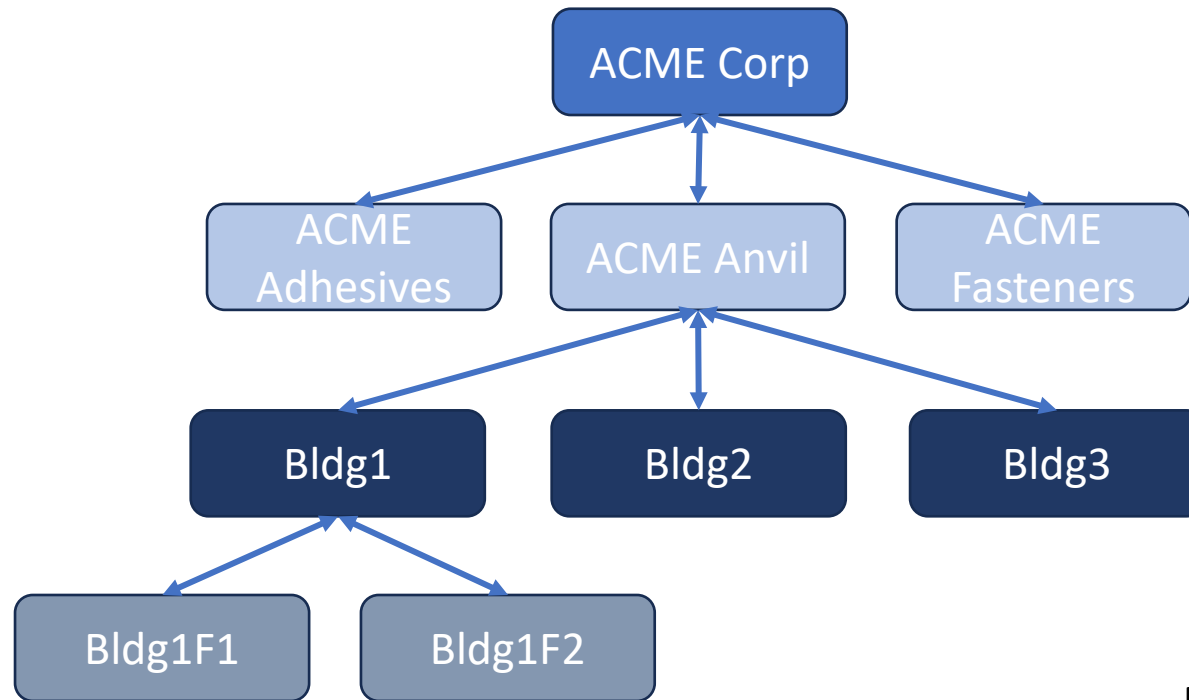
Property Sheet	
Bldg1F1 (Reachable Station Info)	
Station Name	Bldg1F1
Station Version	4.14.0.136
Route To Station	AcmeAnvil;Bldg1F1
Min Version Along Route	4.14.0.140
Virtual Space Ord	station:/slot:/Drivers/NiagaraNetwork/AcmeAnvil/virtual/virtu
Time To Reach	+000000h 00m 00.000s
Route Enabled	<input checked="" type="checkbox"/> true
Security Dashboard Ext	Reachable Station Security Dashboard D...
System Indexer	Reachable Station System Index Device E...
Retry Trigger	15 minutes {Sun Mon Tue Wed Thu Fri Sa...
Global Index Status	{ok}
Global Index State	Idle
Global Index Last Attempt	05-Apr-2024 05:52 PM EDT

► Testing

☐ false

 Save

Wait, WHAT just happened



Reachable Stations Just Happened

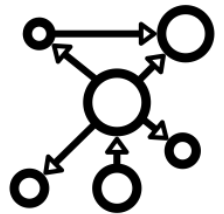
Ok, So what now

Virtuals

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Virtual Components

- Virtual components are transient, **on-demand** components in a station that **only exist when needed**.
- You **cannot** add point extensions such as history or alarm extension to virtual components.
- You **cannot** link to virtual components, nor link the virtual components to other components.
- You **cannot** assign Px views to virtual components.
- **System scalability** is increased by using virtual components because they only exist when needed, which results in fewer persistent components and requires less heap memory.



Virtual Component ORDs

- The virtual ord uses the virtual gateway and the remote station.

<ordInSupervisorToVirtualGateway><ordInRemoteStation>

station:|slot:/Drivers/NiagaraNetwork/Bldg1F1/virtual|virtual:/Drivers/
BacnetNetwork/Floor/AHU_01

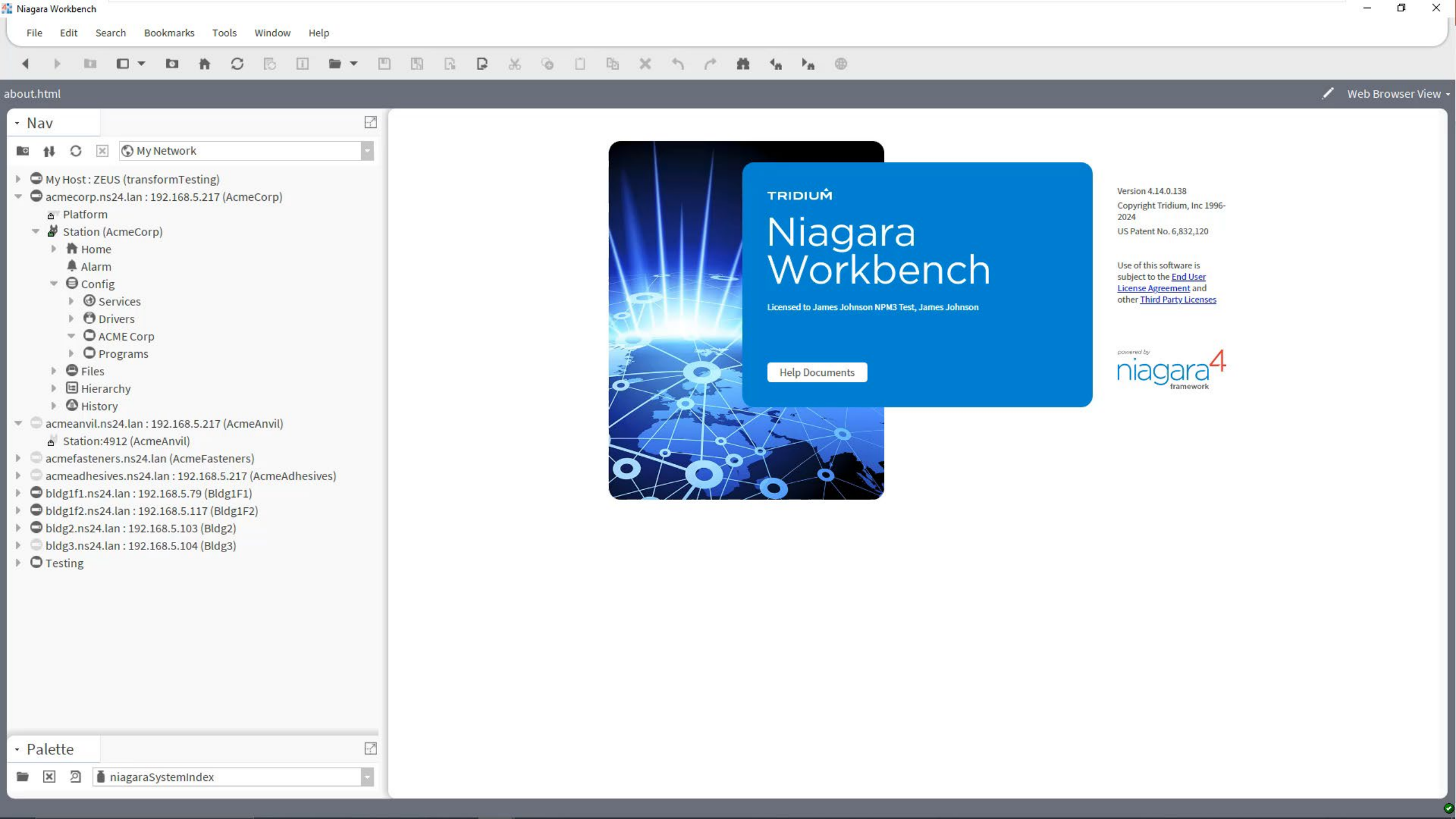
- Px views in the supervisor station can use virtual component ORDs in bindings, but those ORDS cannot be made relative.
- Historically Px View **export tags** were required to make use of the relative Px view from the remote station leveraging virtual component ords.

Workbench and Px Views on Virtual Components

- Using Niagara 4.4 and newer, Px views are available when Import Virtual Px Files On Demand is enabled.



- Using Niagara 4.6 and newer:
 - HTML5 schedule views are available
 - Component Grid and BQL Grid view are available



What else can I use SysTeDb for?

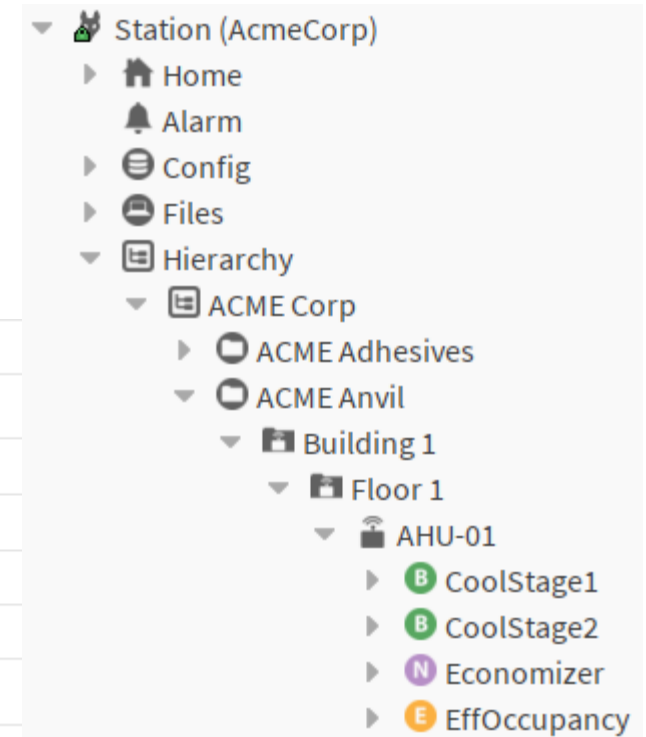
Hierarchies

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Hierarchy Component

- Provides dynamic navigation trees based on the applied data model
- Scope Ord is used to limit the NEQL query to only search within a specific location in the station or **SystemDB (sys:)**

▼ ACME Corp	Hierarchy
Query Context	» ⌚ ▼
Status	{ok}
Fault Cause	
▼ Scope	Hierarchy Scope Container
▼ Station	Hierarchy Scope
Scope Ord	sys: <input type="text"/> ▼



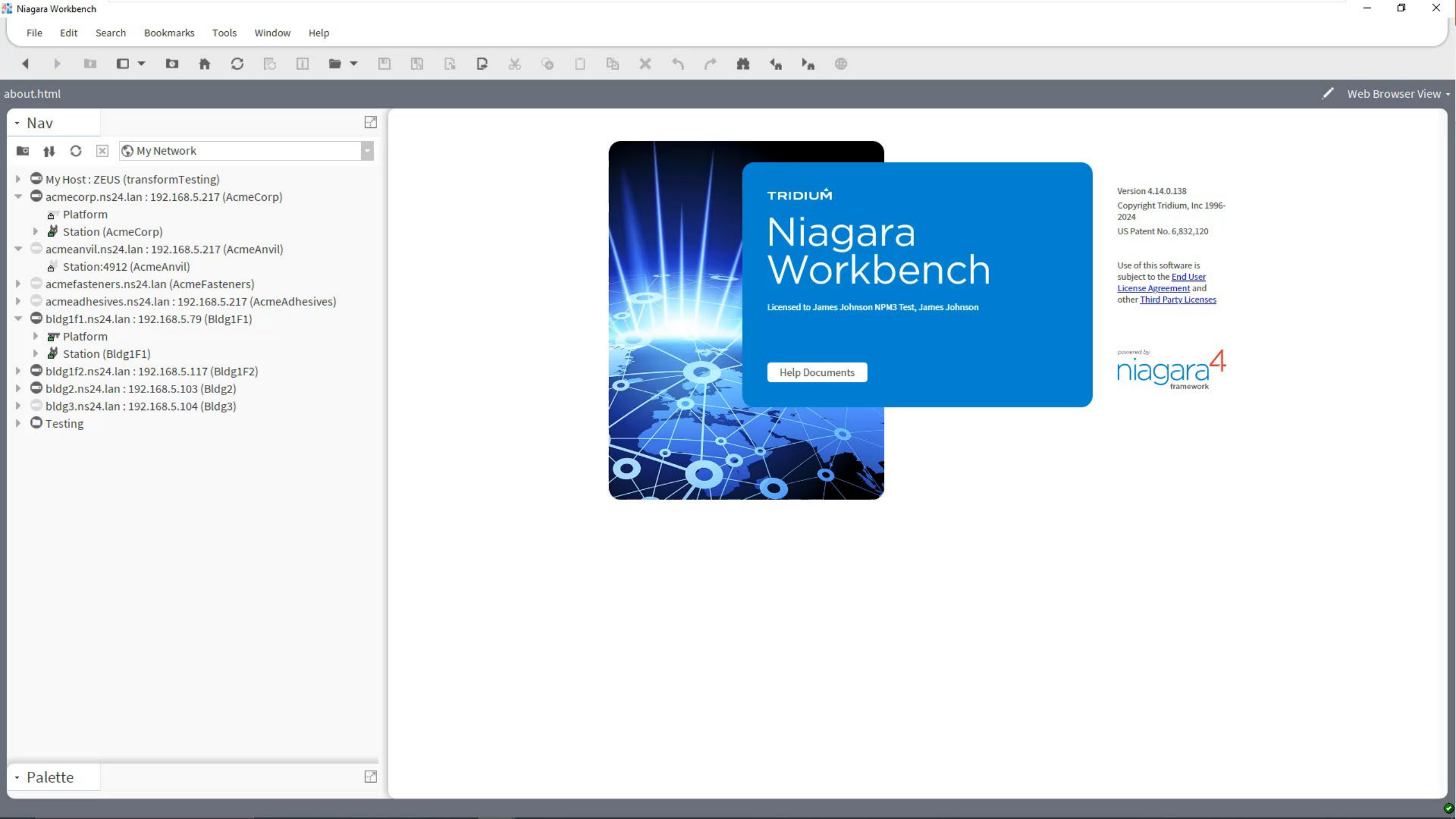
Enterprise Hierarchy & Query Context

- Enterprise hierarchies span stations and relations are limited to being assigned within a single station.
- Query context stores tag values which can be used to filter results in subsequent query level def or relation level def components.

Level	Query Level Def	Query Context	Query	Include Grouping Queries	Sort
campus	b:Campus	campusId=n:station	b: Campus	true	Ascending
buildings	b:Building and...	bldgId=n:displayName	b:Building and n:station={campusId}	true	Ascending

Callout 1 (Red): Campus def uses Query Context to store the value of the n:station tag as a variable named campusId

Callout 2 (Teal): subsequent buildings def checks the value of the next node using the campusId variable from the query context of the previous node



nspace ORD Scheme

- Local station examples – optional to specify station name

nspace: | **slot:/Home** → station: | **slot:/Home**

nspace:Bldg1F1 | **slot:/Home** → station: | **slot:/Home**

- Remote station example – nspace resolves to virtual in supervisor

nspace:Bldg1F1 | **virtual:/Home**

station: | slot:Drivers/NiagaraNetwork/Bldg1F1/virtual | **virtual:/Home**

But WAIT

What about Alarms

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FileEditSearchBookmarksToolsWindowPx ViewerHelp

Quick Search

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp) : Station (AcmeCorp) : Home

ACME Corp

Nav

My Network

My Host: ZEUS (transformTesting)

acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp)

Platform

Station (AcmeCorp)

Home

Alarm

Config

Files

Hierarchy

History

acmeanvil.ns24.lan : 192.168.5.217 (AcmeAnvil)

Station:4912 (AcmeAnvil)

Home

Alarm

Config

Files

Hierarchy

History

acmefasteners.ns24.lan (AcmeFasteners)

acmeadhesives.ns24.lan : 192.168.5.217 (AcmeAdhesives)

bldg1f1.ns24.lan : 192.168.5.79 (Bldg1F1)

bldg1f2.ns24.lan : 192.168.5.117 (Bldg1F2)

bldg2.ns24.lan : 192.168.5.103 (Bldg2)

bldg3.ns24.lan : 192.168.5.104 (Bldg3)

Testing

Palette


Weather Forecast

Current 65.0 °F
74.0 °F/53.0 °F
Fog
Precip: 0 %


ACME Corp

NS2024
APRIL 15 - 17 | ANAHEIM, CA


ACME Anvil



ACME Adhesives



ACME Fasteners



Alarm Hyperlinks Using Virtuals (4.13+)

- Alarms routed via station recipient prepend remote station connection details and clicking the alarm hyperlink in the supervisor alarm console redirects the user to the remote station.
- New behavior utilizes the virtual space and on demand Px views

local:|station:|slot:/Services/AlarmService/TestAlarm/BooleanChangeOfStateAlarmExt; slot:/Drivers/NiagaraNetwork/Building1/Bldg1F1/alarms; slot:/Drivers/NiagaraNetwork/AcmeAnvil/alarms

Open Alarm Sources

-5/-4),escalatedF,unconvertedHyperlinkOrd=ip:acmeanvil.ns24.lan|foxs:4912|ip:bldg1f1.ns24.lan|foxs:4911|nspace:|slot:/Drivers/BacnetNetwork/Floor/AHU_01

Alarm Data	Alarm Value	true
	Count	22
	Escalated	
	From State	normal
	Hyperlink Ord	nspace:Bldg1F1 slot:/Drivers/BacnetNetwork/Floor/AHU_01

Virtual PXTile Media Directory

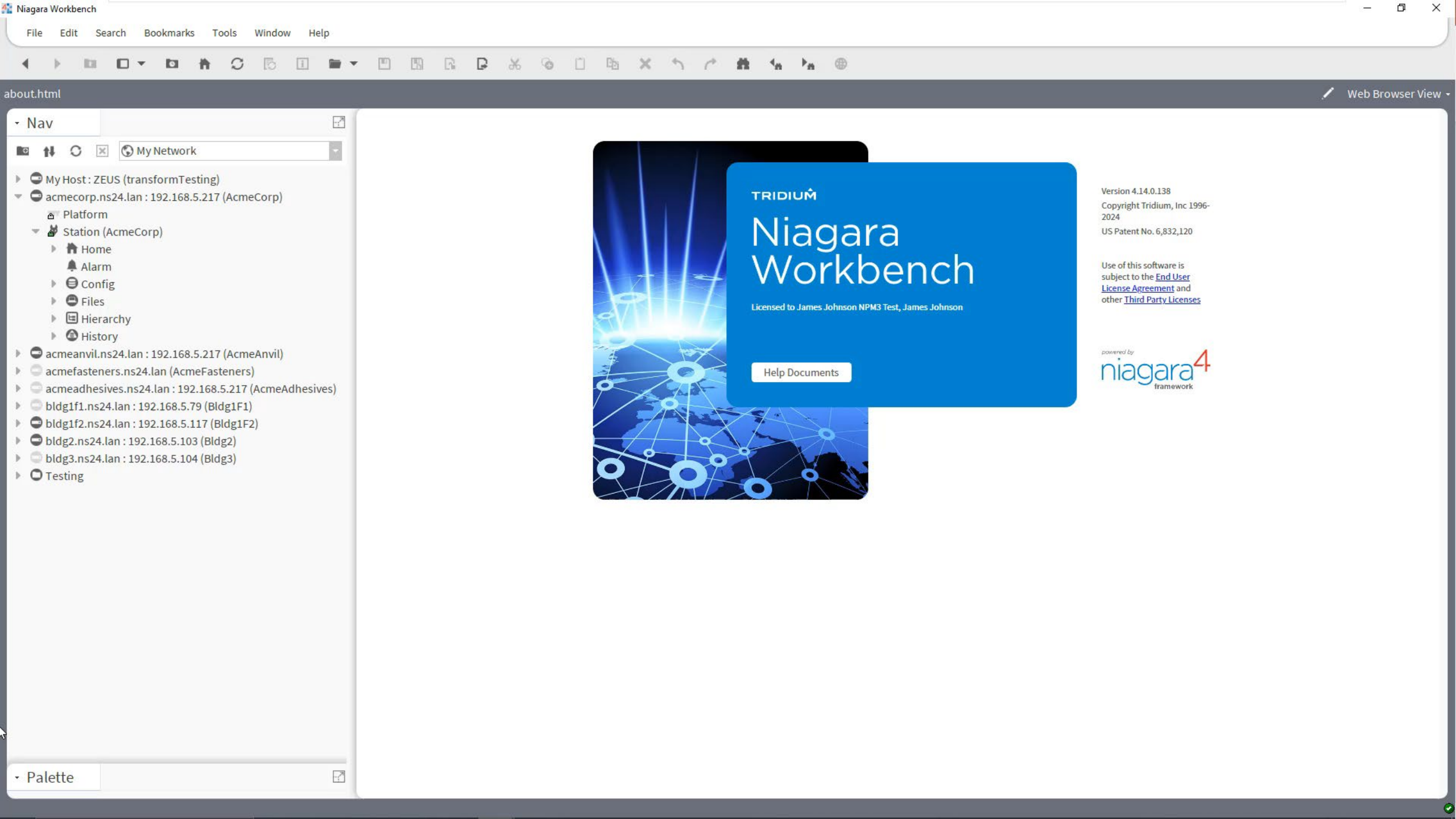
Convert Alarm Hyperlinks To Virtual Form

Persist Etched Tags

title: installation

true

false



about.html

Web Browser View

Nav

My Network

- My Host: ZEUS (transformTesting)
- acmecorp.ns24.lan : 192.168.5.217 (AcmeCorp)
 - Platform
 - Station (AcmeCorp)
 - Home
 - Alarm
 - Config
 - Files
 - Hierarchy
 - History
- acmeanvil.ns24.lan : 192.168.5.217 (AcmeAnvil)
- acmefasteners.ns24.lan (AcmeFasteners)
- acmeadhesives.ns24.lan : 192.168.5.217 (AcmeAdhesives)
- bldg1f1.ns24.lan : 192.168.5.79 (Bldg1F1)
- bldg1f2.ns24.lan : 192.168.5.117 (Bldg1F2)
- bldg2.ns24.lan : 192.168.5.103 (Bldg2)
- bldg3.ns24.lan : 192.168.5.104 (Bldg3)
- Testing

Palette



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Help Documents

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Questions

