

Tracing Product Genealogy through Event Frames

Proof of Concept

Presented by Ellery Murdock



Introduction

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Agenda

- Genealogy and Event Frames
- Pharmaceutical application
- Discrete Manufacturing application
- Conclusion

Genealogy and Event Frames

Business Challenge

- Effectively trace product genealogy for a complete process timeline



Genealogy

- Genealogy is the tracing of lines of descent and history
- *Product* genealogy
 - Relates materials that combine into one product
 - Describes processes a product undergoes

Benefits of tracing genealogy

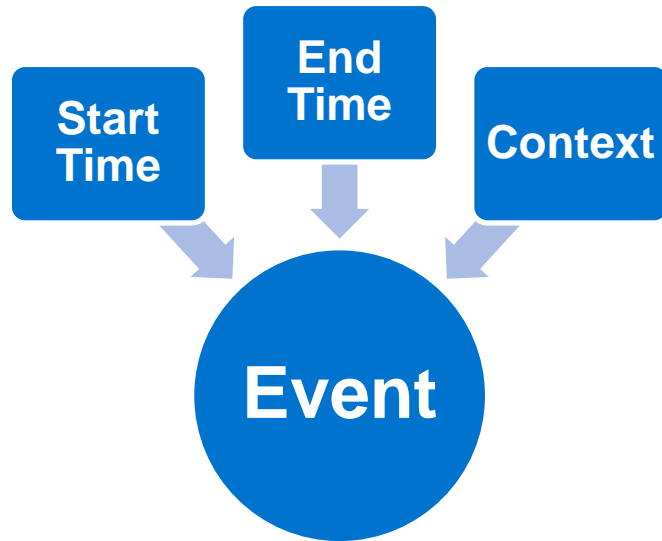
- Pinpoint anomalies and errors
- Perform product based analyses
- Provide additional context around current process
- Maximize search capability
- Enhance visualization capabilities

What are Event Frames?

- Bookmarks for time-series data
 - Capture critical event contexts
 - Provides meaning to users by making it easier to find, analyze, and report on an event



PI Event Frames



Referenced Elements	Name
	OW-206
	OW-207

Name	Value
Category: General Info	
Comment	
Operator	Bobby Wolf
Phase	Dwell
Type	LOW TEMP
Category: Limits	
Temp.Limit.High	88 deg C
Temp.Limit.Low	70 deg C
Category: Manual Logger	
Comment	
Category: Process Parameters	
Level.Start	42.7438011169434 L
Temp.End	71.1539001464844 deg C
Temp.Max	71.1538998921712 deg C
Temp.Min	62.1662445068359 deg C
Temp.Range	8.98765538533529 deg C
Temp.Start	62.1662445068359 deg C

Asset(s) associated to the event

Text entries useful for filtering/group-by analysis

Placeholders for **manual data entry**











Calculated data using event start & end time context

Why Event Frames?

- Perfect fit for traceability through the PI System
 - Used for complete product lifecycle
 - Capture process data and time contexts
 - Applicable to any industry
 - Applicable to any data source

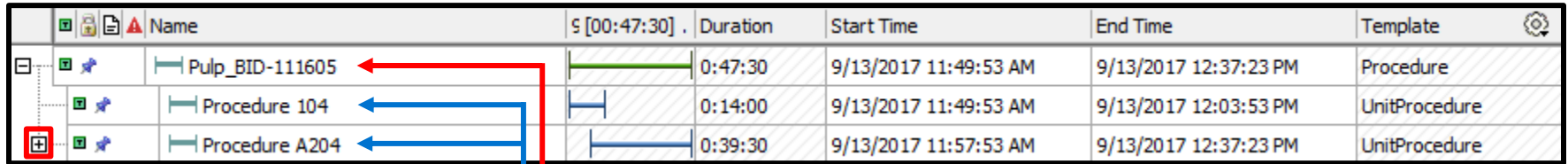
Why Event Frames?

- Structure for genealogy already in place

	    Name	⌚ [00:47:30] . Duration	Start Time	End Time	Template 
	   Pulp_BID-111605	 0:47:30	9/13/2017 11:49:53 AM	9/13/2017 12:37:23 PM	Procedure

Why Event Frames?

- Structure for genealogy already in place



	Name	Duration	Start Time	End Time	Template
☐	Pulp_BID-111605	0:47:30	9/13/2017 11:49:53 AM	9/13/2017 12:37:23 PM	Procedure
☐	Procedure 104	0:14:00	9/13/2017 11:49:53 AM	9/13/2017 12:03:53 PM	UnitProcedure
☐	Procedure A204	0:39:30	9/13/2017 11:57:53 AM	9/13/2017 12:37:23 PM	UnitProcedure

Parent Event Frame
Children Event Frames

Why Event Frames?

- Structure for genealogy already in place

	Name	Σ [00:47:30]	Duration	Start Time	End Time	Template
[-]	Pulp_BID-111605		0:47:30	9/13/2017 11:49:53 AM	9/13/2017 12:37:23 PM	Procedure
[-]	Procedure 104		0:14:00	9/13/2017 11:49:53 AM	9/13/2017 12:03:53 PM	UnitProcedure
[-]	Procedure A204		0:39:30	9/13/2017 11:57:53 AM	9/13/2017 12:37:23 PM	UnitProcedure
[+]	Idle		0:03:00	9/13/2017 11:58:23 AM	9/13/2017 12:01:23 PM	Operation
[+]	Prehydrolysis		0:22:00	9/13/2017 12:01:23 PM	9/13/2017 12:23:23 PM	Operation

Parent Event Frame
Children Event Frames
Grandchildren Event Frames

Why Event Frames?

- Structure for genealogy already in place

	Name	5 [01:26:30]	Duration	Start Time	End Time	Template
[-]	Pulp_BID-111605		0:47:30	9/13/2017 11:49:53 AM	9/13/2017 12:37:23 PM	Procedure
[+]	Procedure 104		0:14:00	9/13/2017 11:49:53 AM	9/13/2017 12:03:53 PM	UnitProcedure
[+]	Procedure A204		0:39:30	9/13/2017 11:57:53 AM	9/13/2017 12:37:23 PM	UnitProcedure
[+]	Procedure A203		0:54:00	9/13/2017 11:10:53 AM	9/13/2017 12:04:53 PM	UnitProcedure

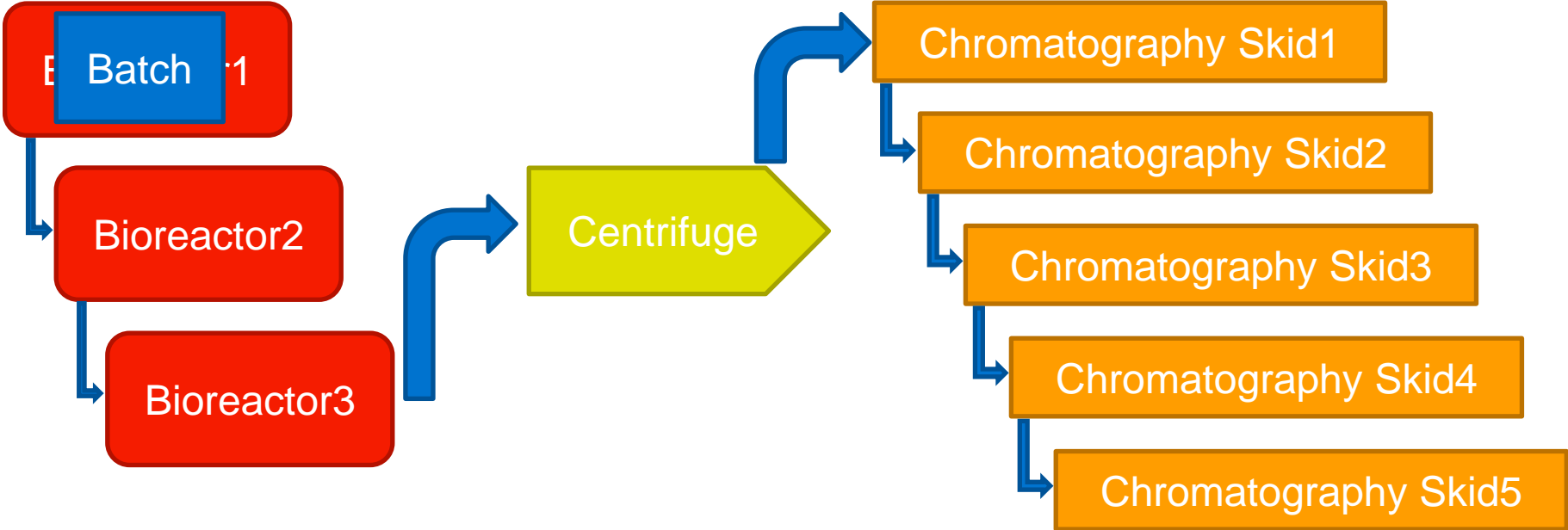
Child Reference Event Frame

Behind the scenes – how will genealogy tracing work?

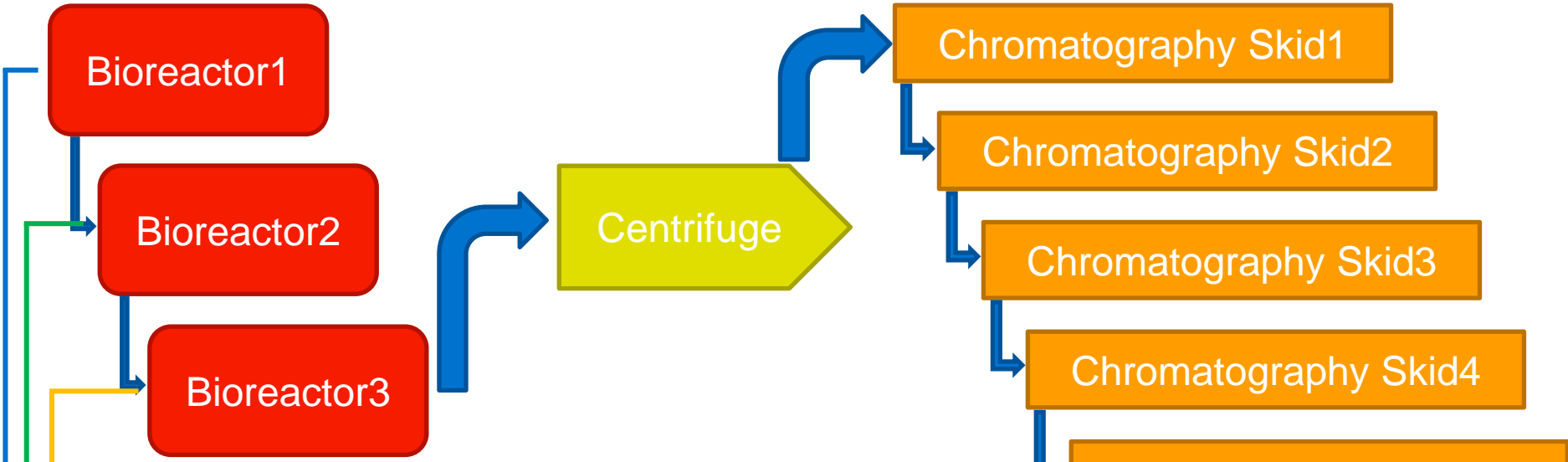
- Custom service will be used
 - Create Parent-Child references
 - Link Event Frames based on matching criteria:
 - Descriptions
 - Names
 - Attribute Values

Pharmaceutical Application

Current Process

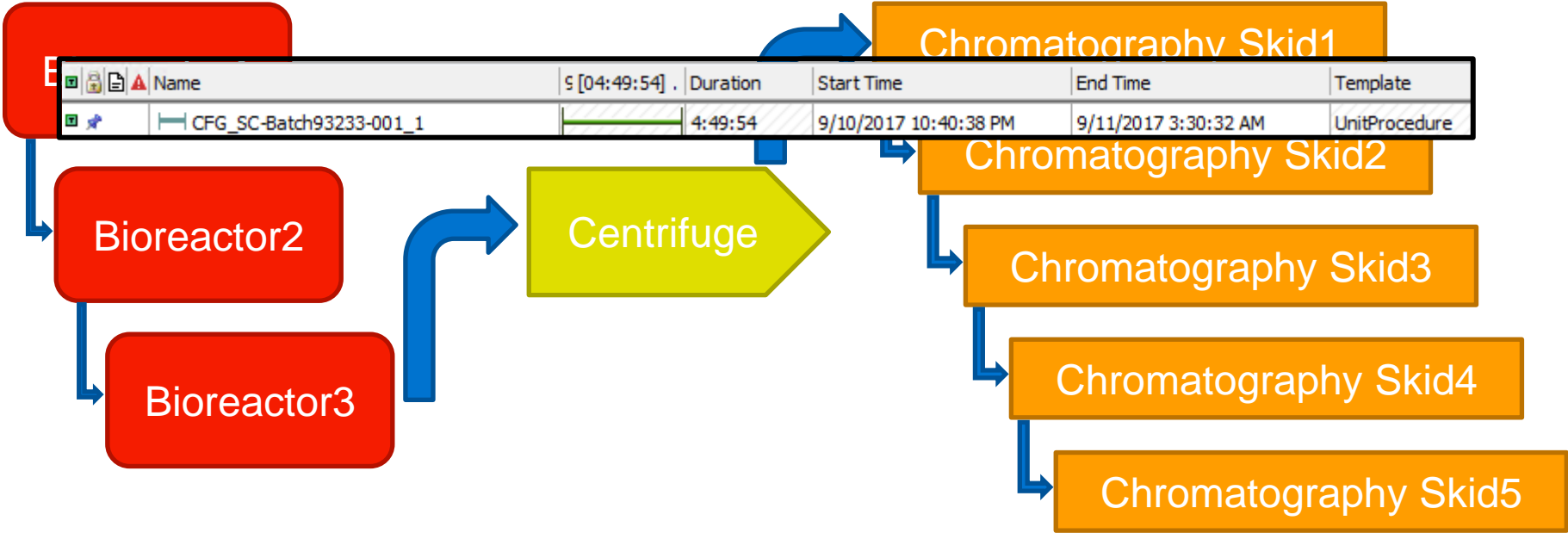


Current Process

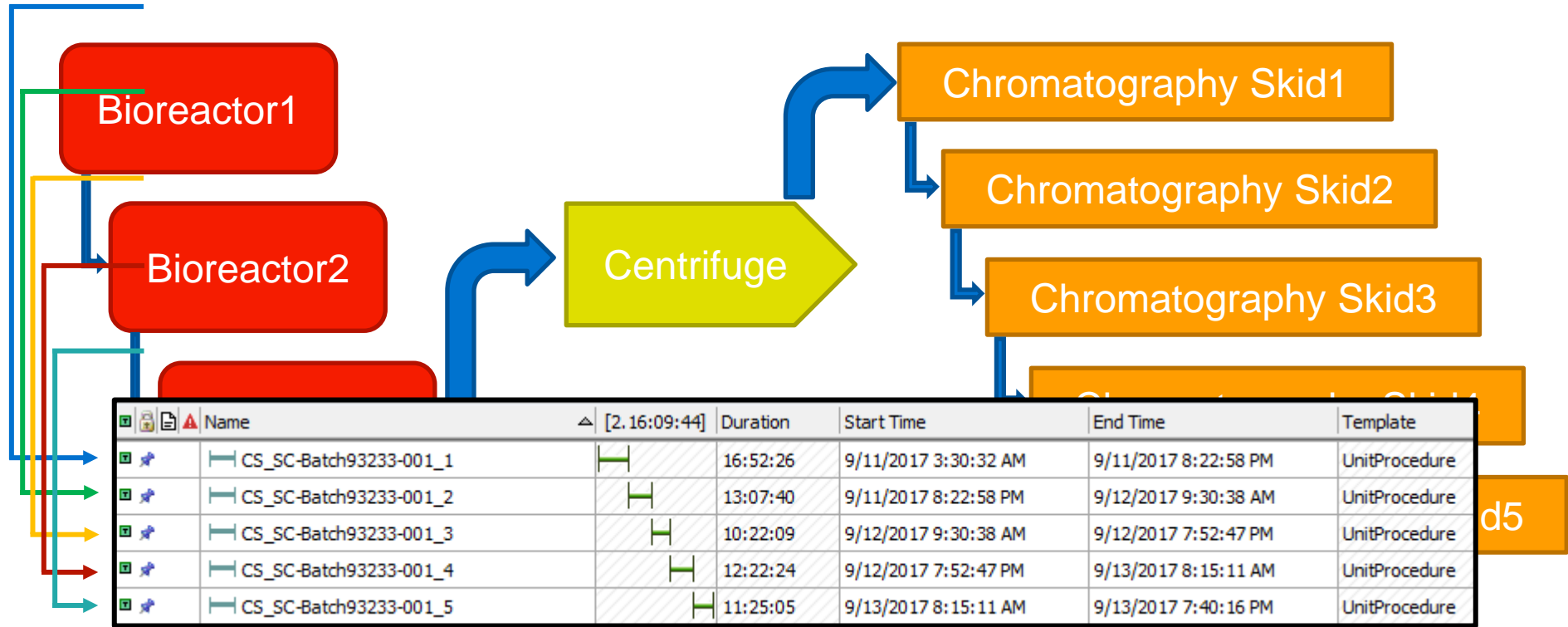


Name	Duration	Start Time	End Time	Template
BR_SC-Batch93233-001_1	2:19:36:03	9/1/2017 1:56:35 PM	9/4/2017 9:32:38 AM	UnitProcedure
BR_SC-Batch93233-001_2	3:5:19:50	9/4/2017 9:32:38 AM	9/7/2017 2:52:28 PM	UnitProcedure
BR_SC-Batch93233-001_3	3:7:48:10	9/7/2017 2:52:28 PM	9/10/2017 10:40:38 PM	UnitProcedure

Current Process



Current Process



Current Process

Event Frame Search 1						
Filter						
	Name	▲ 9... [12.05:43:41] 9...	Duration	Start Time	End Time	Template
+	BR_SC-Batch93233-001_1		2:19:36:03	9/1/2017 1:56:35 PM	9/4/2017 9:32:38 AM	UnitProcedure
+	BR_SC-Batch93233-001_2		3:5:19:50	9/4/2017 9:32:38 AM	9/7/2017 2:52:28 PM	UnitProcedure
+	BR_SC-Batch93233-001_3		3:7:48:10	9/7/2017 2:52:28 PM	9/10/2017 10:40:38 PM	UnitProcedure
	CFG_SC-Batch93233-001_1		4:49:54	9/10/2017 10:40:38 PM	9/11/2017 3:30:32 AM	UnitProcedure
+	CS_SC-Batch93233-001_1		16:52:26	9/11/2017 3:30:32 AM	9/11/2017 8:22:58 PM	UnitProcedure
+	CS_SC-Batch93233-001_2		13:07:40	9/11/2017 8:22:58 PM	9/12/2017 9:30:38 AM	UnitProcedure
+	CS_SC-Batch93233-001_3		10:22:09	9/12/2017 9:30:38 AM	9/12/2017 7:52:47 PM	UnitProcedure
+	CS_SC-Batch93233-001_4		12:22:24	9/12/2017 7:52:47 PM	9/13/2017 8:15:11 AM	UnitProcedure
+	CS_SC-Batch93233-001_5		11:25:05	9/13/2017 8:15:11 AM	9/13/2017 7:40:16 PM	UnitProcedure

Challenge

- Not possible to track the batch
- No method to relate all Event Frames for a batch



Linking Schema

		Name	[12.05:43:...	Duration	Start Time	End Time	Template
		SC-Batch93233-001		12:5:43:41	9/1/2017 1:56:35 PM	9/13/2017 7:40:16 PM	BatchBackbone
		Name	[12.05:43:...	Duration	Start Time	End Time	Template
+	+	BR_SC-Batch93233-001_1		2:19:36:03	9/1/2017 1:56:35 PM	9/4/2017 9:32:38 AM	UnitProcedure
+	+	BR_SC-Batch93233-001_2		3:5:19:50	9/4/2017 9:32:38 AM	9/7/2017 2:52:28 PM	UnitProcedure
+	+	BR_SC-Batch93233-001_3		3:7:48:10	9/7/2017 2:52:28 PM	9/10/2017 10:40:38 PM	UnitProcedure
+	+	CFG_SC-Batch93233-001_1		4:49:54	9/10/2017 10:40:38 PM	9/11/2017 3:30:32 AM	UnitProcedure
+	+	CS_SC-Batch93233-001_1		16:52:26	9/11/2017 3:30:32 AM	9/11/2017 8:22:58 PM	UnitProcedure
+	+	CS_SC-Batch93233-001_2		13:07:40	9/11/2017 8:22:58 PM	9/12/2017 9:30:38 AM	UnitProcedure
+	+	CS_SC-Batch93233-001_3		10:22:09	9/12/2017 9:30:38 AM	9/12/2017 7:52:47 PM	UnitProcedure
+	+	CS_SC-Batch93233-001_4		12:22:24	9/12/2017 7:52:47 PM	9/13/2017 8:15:11 AM	UnitProcedure
+	+	CS_SC-Batch93233-001_5		11:25:05	9/13/2017 8:15:11 AM	9/13/2017 7:40:16 PM	UnitProcedure

Linking Schema

SC-Batch93233-001

General Child Event Frames Referenced Elements Attributes

Name: SC-Batch93233-001

Description:

Template: BatchBackbone Severity: None

Start time: 9/1/2017 1:56:35 PM End time: 9/13/2017 7:40:16 PM

Categories: Default Attribute: <None>

[Extended Properties \(0\)](#) [Annotations \(0\)](#) [Security](#)

Find: [Parents](#) [Children](#)

Actions: [Capture Values](#) [Lock](#)

BR_SC-Batch93233-001_1

General Child Event Frames Referenced Elements Attributes

Name: SC-Batch93233-001_1

Description:

Template: UnitProcedure Severity: None

Start time: 9/1/2017 1:56:35 PM End time: 9/4/2017 9:32:38 AM

Categories: OSIBatch;OSIBatchDB Default Attribute: BatchID

[Extended Properties \(0\)](#) [Annotations \(0\)](#) [Security](#)

Find: [Parents](#) [Children](#)

Actions: [Capture Values](#) [Lock](#)

Outcome

Name	[12.05:43:...	Duration	Start Time	End Time	Template
SC-Batch93233-001		12:5:43:41	9/1/2017 1:56:35 PM	9/13/2017 7:40:16 PM	BatchBackbone

Name	[12.05:43:...	Duration	Start Time	End Time	Template
BR_SC-Batch93233-001_1		2:19:36:03	9/1/2017 1:56:35 PM	9/4/2017 9:32:38 AM	UnitProcedure
BR_SC-Batch93233-001_2		3:5:19:50	9/4/2017 9:32:38 AM	9/7/2017 2:52:28 PM	UnitProcedure
BR_SC-Batch93233-001_3		3:7:48:10	9/7/2017 2:52:28 PM	9/10/2017 10:40:38 PM	UnitProcedure
CFG_SC-Batch93233-001_1		4:49:54	9/10/2017 10:40:38 PM	9/11/2017 3:30:32 AM	UnitProcedure
CS_SC-Batch93233-001_1		16:52:26	9/11/2017 3:30:32 AM	9/11/2017 8:22:58 PM	UnitProcedure
CS_SC-Batch93233-001_2		13:07:40	9/11/2017 8:22:58 PM	9/12/2017 9:30:38 AM	UnitProcedure
CS_SC-Batch93233-001_3		10:22:09	9/12/2017 9:30:38 AM	9/12/2017 7:52:47 PM	UnitProcedure
CS_SC-Batch93233-001_4		12:22:24	9/12/2017 7:52:47 PM	9/13/2017 8:15:11 AM	UnitProcedure
CS_SC-Batch93233-001_5		11:25:05	9/13/2017 8:15:11 AM	9/13/2017 7:40:16 PM	UnitProcedure

Outcome

Event Frame Search 1

Filter

	Name	9... [12.05:43:41] 9...	Duration	Start Time	End Time	Template
[-]	SC-Batch93233-001		12:5:43:41	9/1/2017 1:56:35 PM	9/13/2017 7:40:16 PM	BatchBackbone
[+]	BR_SC-Batch93233-001_1		2:19:36:03	9/1/2017 1:56:35 PM	9/4/2017 9:32:38 AM	UnitProcedure
[+]	BR_SC-Batch93233-001_2		3:5:19:50	9/4/2017 9:32:38 AM	9/7/2017 2:52:28 PM	UnitProcedure
[+]	BR_SC-Batch93233-001_3		3:7:48:10	9/7/2017 2:52:28 PM	9/10/2017 10:40:38 PM	UnitProcedure
[+]	CFG_SC-Batch93233-001_1		4:49:54	9/10/2017 10:40:38 PM	9/11/2017 3:30:32 AM	UnitProcedure
[+]	CS_SC-Batch93233-001_1		16:52:26	9/11/2017 3:30:32 AM	9/11/2017 8:22:58 PM	UnitProcedure
[+]	CS_SC-Batch93233-001_2		13:07:40	9/11/2017 8:22:58 PM	9/12/2017 9:30:38 AM	UnitProcedure
[+]	CS_SC-Batch93233-001_3		10:22:09	9/12/2017 9:30:38 AM	9/12/2017 7:52:47 PM	UnitProcedure
[+]	CS_SC-Batch93233-001_4		12:22:24	9/12/2017 7:52:47 PM	9/13/2017 8:15:11 AM	UnitProcedure
[+]	CS_SC-Batch93233-001_5		11:25:05	9/13/2017 8:15:11 AM	9/13/2017 7:40:16 PM	UnitProcedure

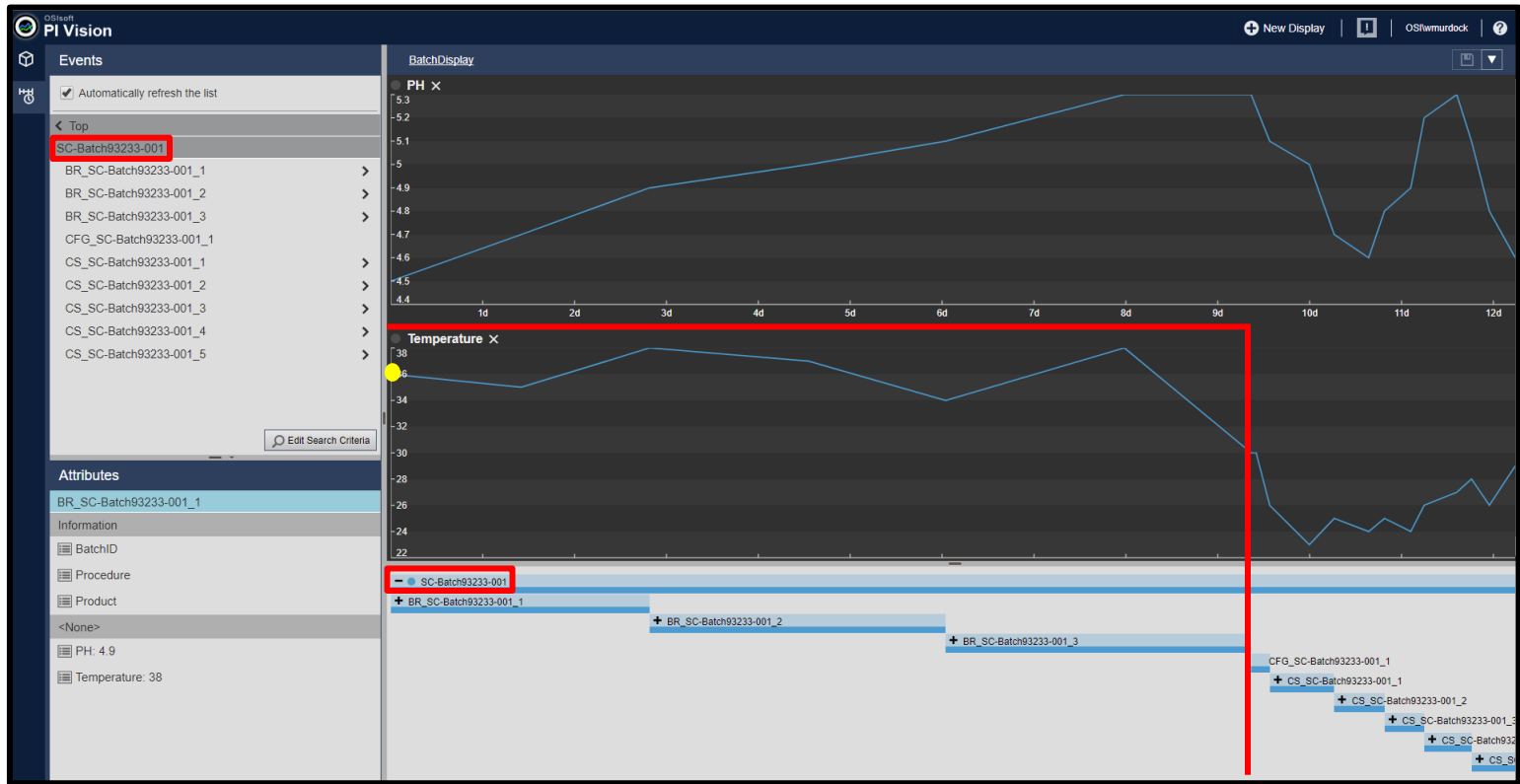
Outcome

- Created a backbone 'Parent' Event Frame
 - Associated Event Frames that shared a common batch
- Traced a batch as it flowed through equipment/processes
- Successful example of product genealogy

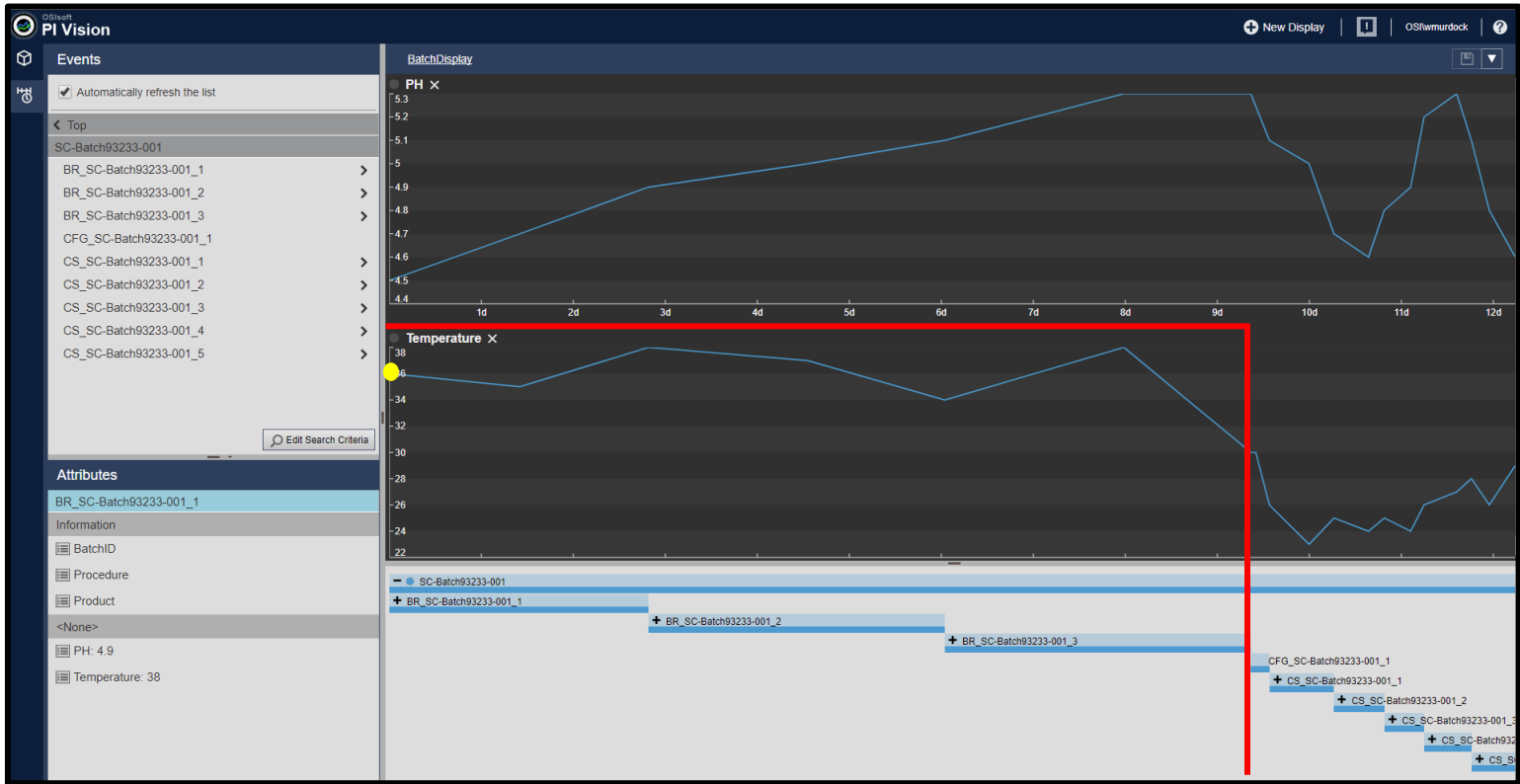
Benefits

- View batch based displays in PI Vision
 - Increased situational awareness of process
- Find *all* related process data with BatchID search
 - Decreased time for anomaly and error analysis
- Third-party systems can consume entire batch at once

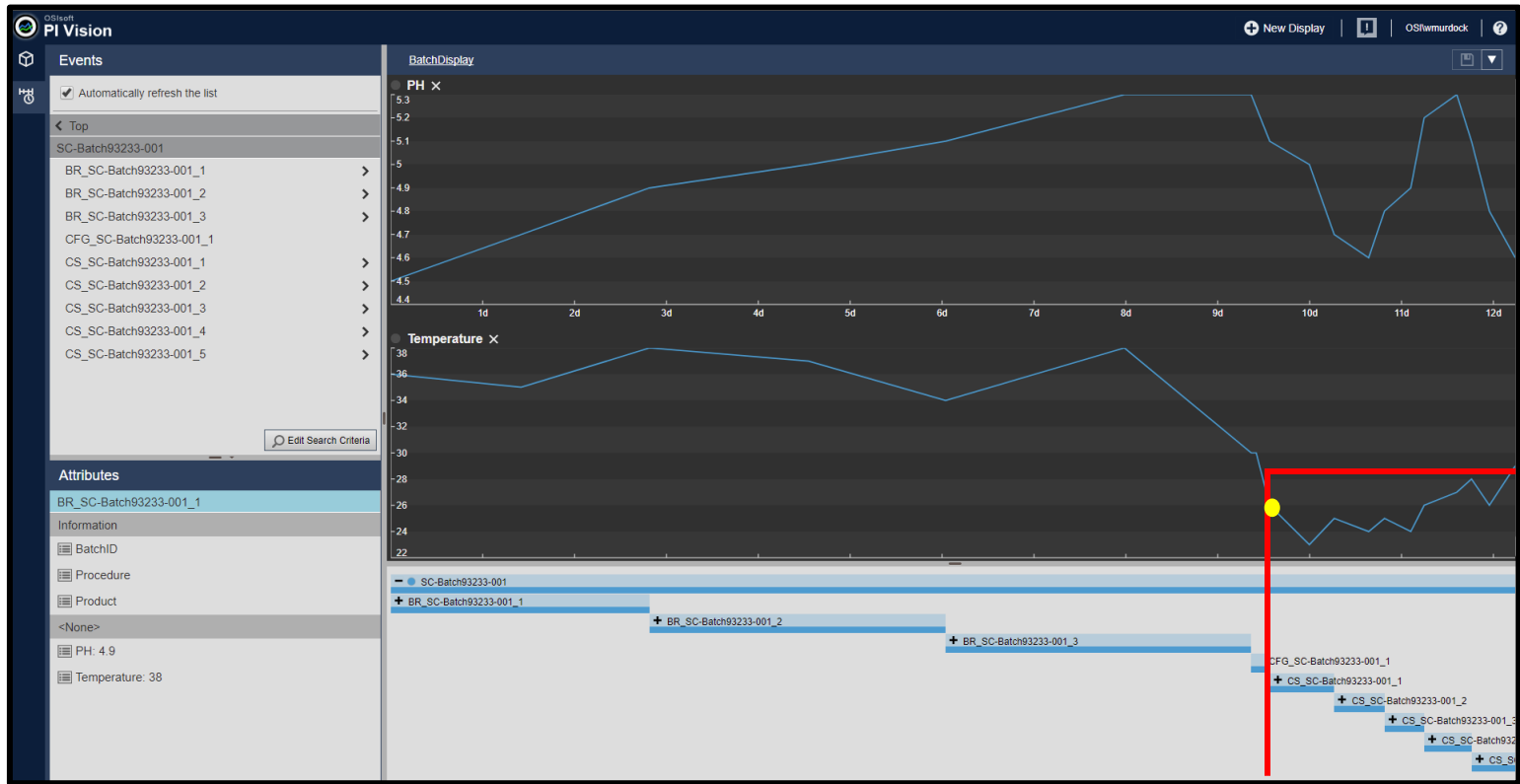
Benefits



Benefits

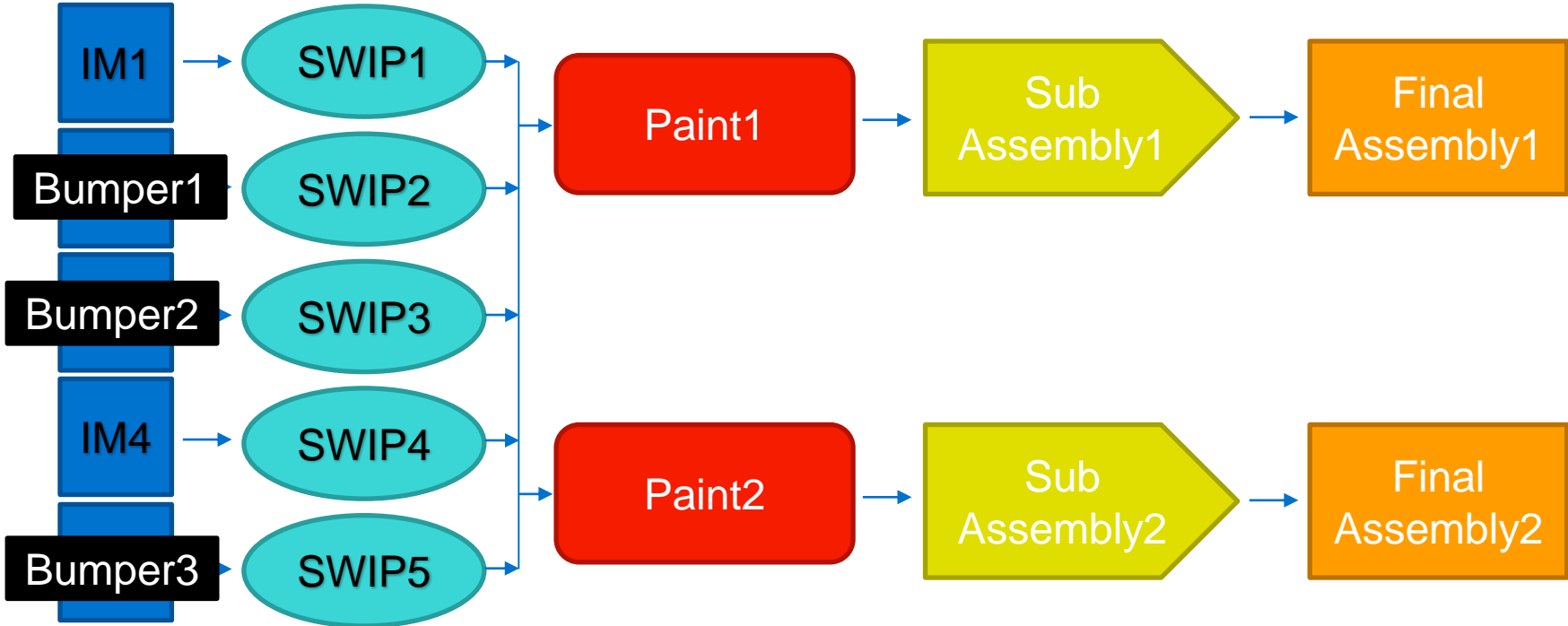


Benefits

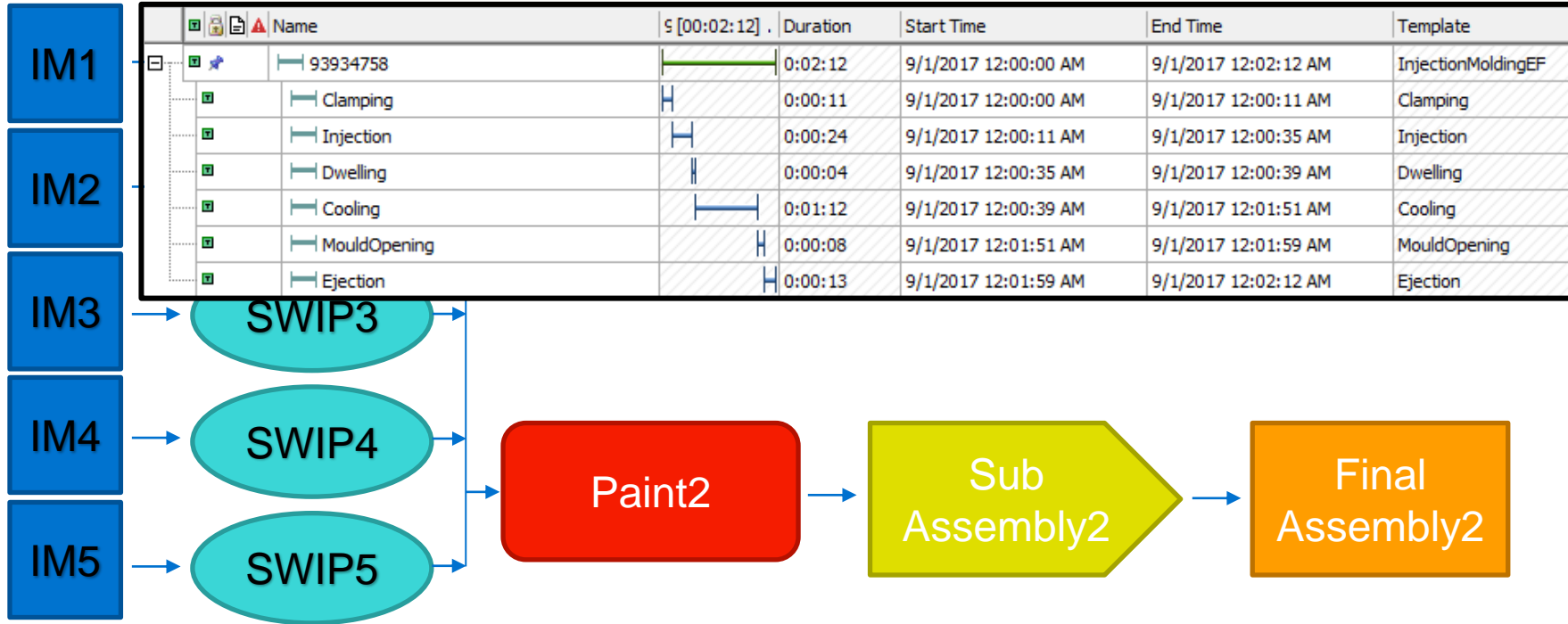


Discrete Manufacturing Application

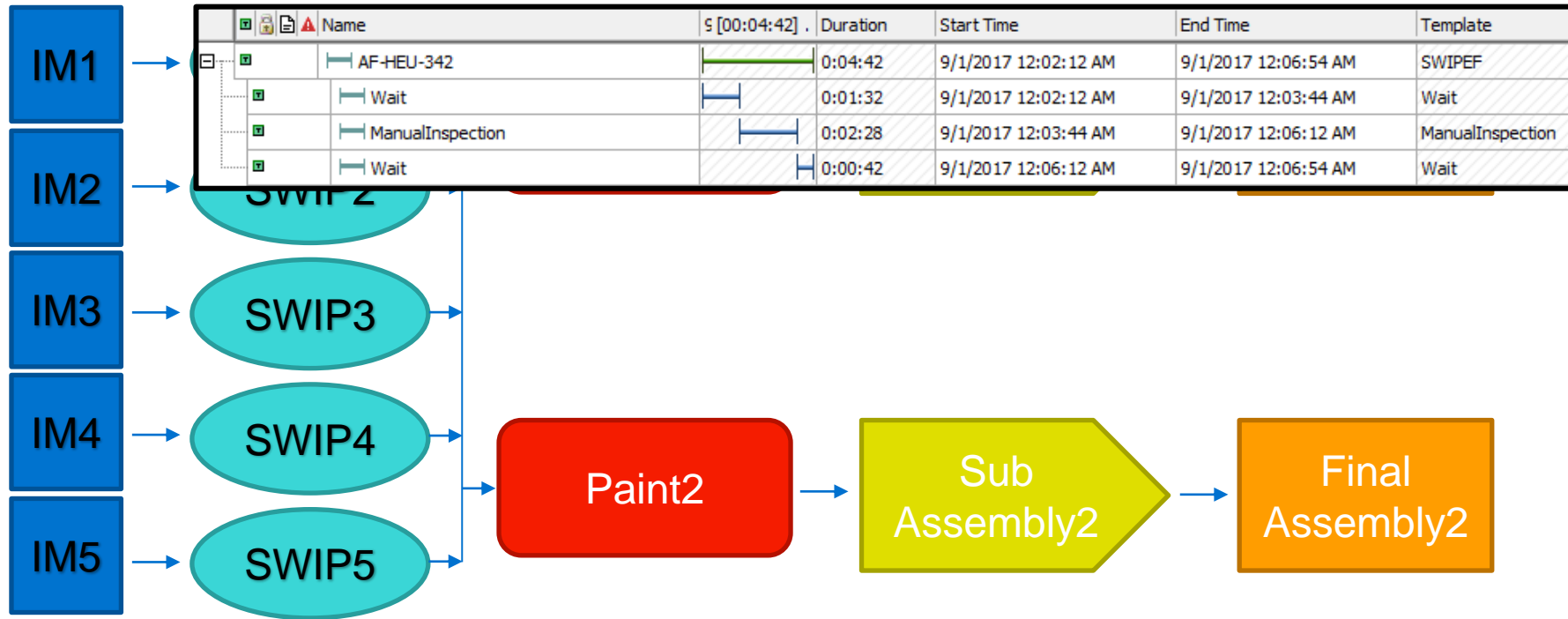
Current Process



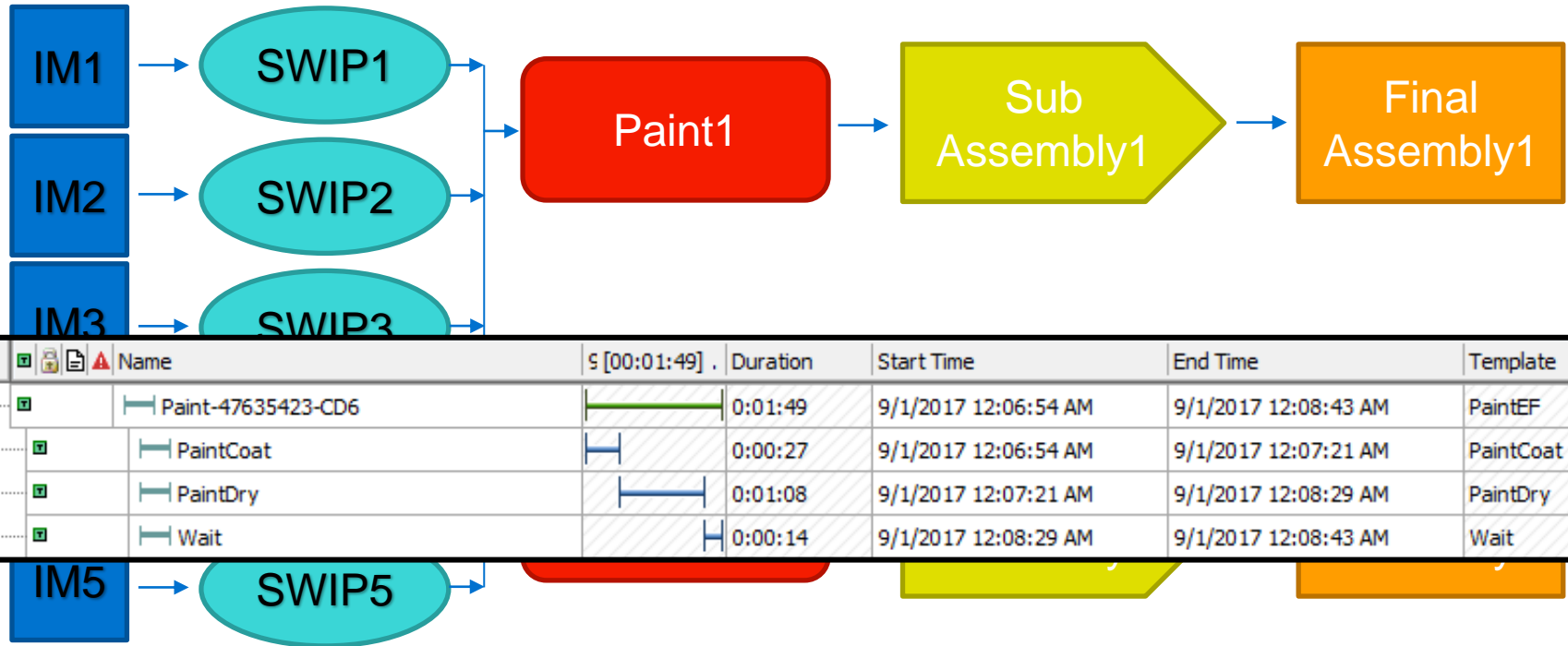
Current Process



Current Process

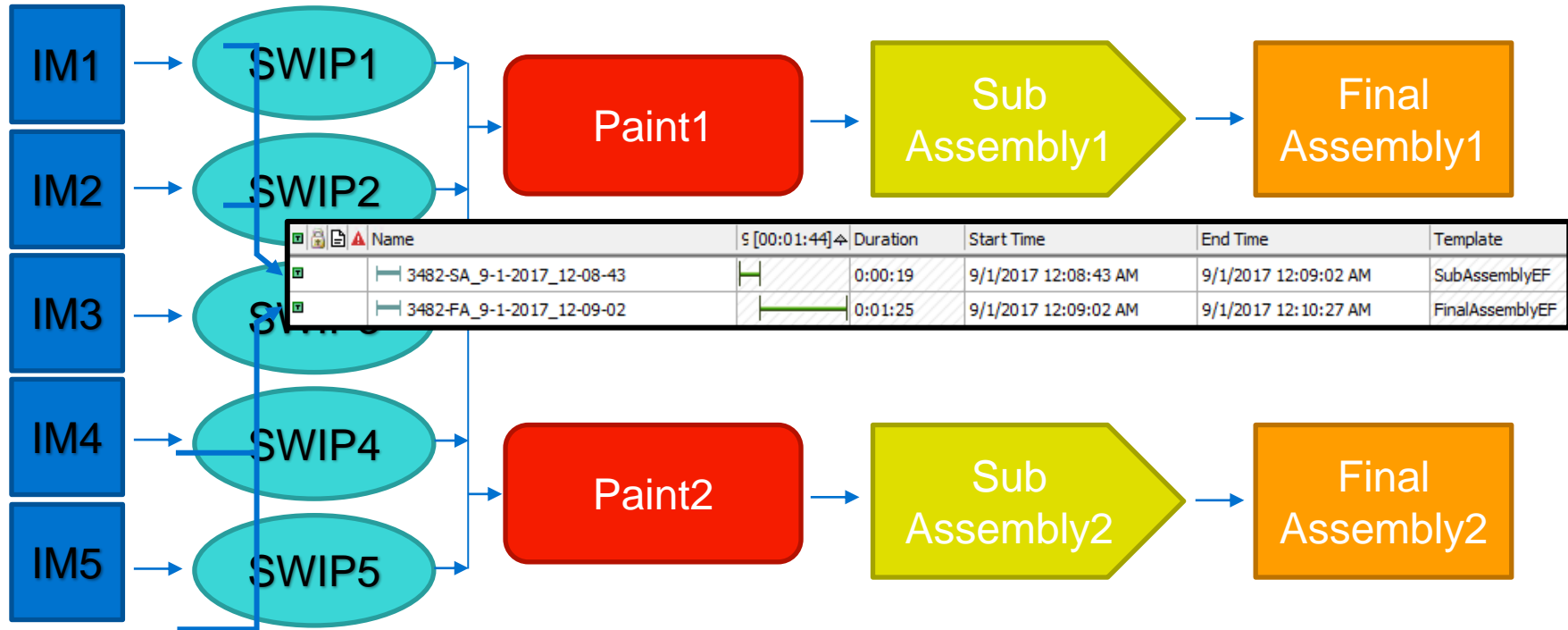


Current Process



Name	Duration	Start Time	End Time	Template
Paint-47635423-CD6	0:01:49	9/1/2017 12:06:54 AM	9/1/2017 12:08:43 AM	PaintEF
PaintCoat	0:00:27	9/1/2017 12:06:54 AM	9/1/2017 12:07:21 AM	PaintCoat
PaintDry	0:01:08	9/1/2017 12:07:21 AM	9/1/2017 12:08:29 AM	PaintDry
Wait	0:00:14	9/1/2017 12:08:29 AM	9/1/2017 12:08:43 AM	Wait

Current Process



Current Process

	Name	Σ [00:10:27]	Duration	Start Time	End Time	Template
	74637839474636352738		0:00:08	9/1/2017 12:00:00 AM	9/1/2017 12:00:08 AM	Label
+	93934758		0:02:12	9/1/2017 12:00:00 AM	9/1/2017 12:02:12 AM	InjectionMoldingEF
+	AF-HEU-342		0:04:42	9/1/2017 12:02:12 AM	9/1/2017 12:06:54 AM	SWIPEF
+	Paint-47635423-CD6		0:01:49	9/1/2017 12:06:54 AM	9/1/2017 12:08:43 AM	PaintEF
	3482-SA_9-1-2017_12-08-43		0:00:19	9/1/2017 12:08:43 AM	9/1/2017 12:09:02 AM	SubAssemblyEF
	3482-FA_9-1-2017_12-09-02		0:01:25	9/1/2017 12:09:02 AM	9/1/2017 12:10:27 AM	FinalAssemblyEF

Challenge

- Different backend data sources (DCS, MES, SCADA)
 - No continuity
 - No communication
- Cannot track product through manufacturing process

Linking Schema

The screenshot displays a software interface for managing event frames. A main table lists event frames with columns for Name, Duration, Start Time, End Time, and Template. A pop-up window for event frame 93934758 shows its attributes: Part Number (74637839474636352738) and Barrel Temperature (255 °C). A red box is at the bottom.

Name	Duration	Start Time	End Time	Template
74637839474636352738				Label
93934758				
AF-HEU-342				InjectionMoldingEF
Paint-47635423-CD6				SWIPEF
3482-SA_9-1-2017_12-08-43				PaintEF
3482-FA_9-1-2017_12-09-02	0:01:25	9/1/2017 12:09:02 AM	9/1/2017 12:10:27 AM	SubAssemblyEF
				FinalAssemblyEF

Name	Value
Part Number	74637839474636352738
Barrel Temperature	255 °C



Linking Schema

74637839474636352738

General Child Event Frames Referenced Elements Attributes

Name: 74637839474636352738

Description:

Template: Label Severity: None

Start time: 9/1/2017 12:00:00 AM End time: 9/1/2017 12:00:08 AM

Categories:

[Extended Properties \(0\)](#) [Annotations \(0\)](#) [Security](#)

Find: [Parents](#) [Children](#)

Actions: [Capture Values](#) [Lock](#)

Acknowledge

93934758

General Child Event Frames Referenced Elements Attributes

Name: 93934758

Description:

Template: InjectionMoldingEF Severity: None

Start time: 9/1/2017 12:00:00 AM End time: 9/1/2017 12:02:12 AM

Categories: Default Attribute: <None>

[Extended Properties \(0\)](#) [Annotations \(0\)](#) [Security](#)

Find: [Parents](#) [Children](#)

Actions: [Recapture Values](#) [Lock](#)

Acknowledge

Outcome

	Name	§ [00:00:08]	Duration	Start Time	End Time	Template
	74637839474636352738		0:00:08	9/1/2017 12:00:00 AM	9/1/2017 12:00:08 AM	Label

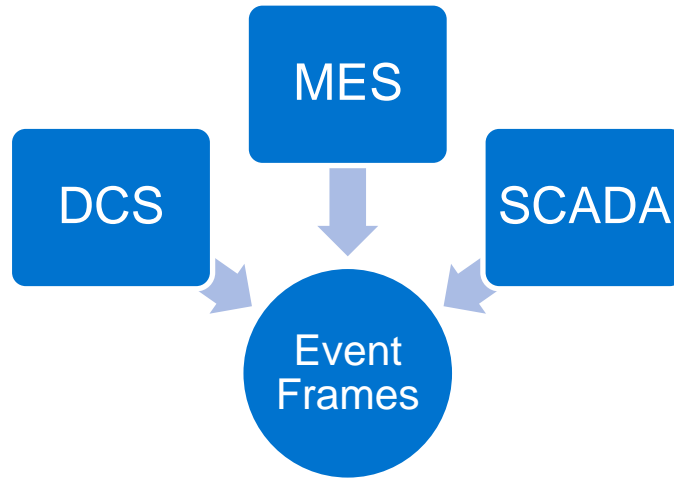
	Name	§ [00:10:27]	Duration	Start Time	End Time	Template
	93934758		0:02:12	9/1/2017 12:00:00 AM	9/1/2017 12:02:12 AM	InjectionMoldingEF
	AF-HEU-342		0:04:42	9/1/2017 12:02:12 AM	9/1/2017 12:06:54 AM	SWIPEF
	Paint-47635423-CD6		0:01:49	9/1/2017 12:06:54 AM	9/1/2017 12:08:43 AM	PaintEF
	3482-SA_9-1-2017_12-08-43		0:00:19	9/1/2017 12:08:43 AM	9/1/2017 12:09:02 AM	SubAssemblyEF
	3482-FA_9-1-2017_12-09-02		0:01:25	9/1/2017 12:09:02 AM	9/1/2017 12:10:27 AM	FinalAssemblyEF

Outcome

	Name	§ [00:10:27]	Duration	Start Time	End Time	Template
[-]	74637839474636352738		0:00:08	9/1/2017 12:00:00 AM	9/1/2017 12:00:08 AM	Label
[+]	93934758		0:02:12	9/1/2017 12:00:00 AM	9/1/2017 12:02:12 AM	InjectionMoldingEF
[+]	Clamping		0:00:11	9/1/2017 12:00:00 AM	9/1/2017 12:00:11 AM	Clamping
[+]	Injection		0:00:24	9/1/2017 12:00:11 AM	9/1/2017 12:00:35 AM	Injection
[+]	Dwelling		0:00:04	9/1/2017 12:00:35 AM	9/1/2017 12:00:39 AM	Dwelling
[+]	Cooling		0:01:12	9/1/2017 12:00:39 AM	9/1/2017 12:01:51 AM	Cooling
[+]	MouldOpening		0:00:08	9/1/2017 12:01:51 AM	9/1/2017 12:01:59 AM	MouldOpening
[+]	Ejection		0:00:13	9/1/2017 12:01:59 AM	9/1/2017 12:02:12 AM	Ejection
[-]	AF-HEU-342		0:04:42	9/1/2017 12:02:12 AM	9/1/2017 12:06:54 AM	SWIPEF
[+]	Wait		0:01:32	9/1/2017 12:02:12 AM	9/1/2017 12:03:44 AM	Wait
[+]	ManualInspection		0:02:28	9/1/2017 12:03:44 AM	9/1/2017 12:06:12 AM	ManualInspection
[+]	Wait		0:00:42	9/1/2017 12:06:12 AM	9/1/2017 12:06:54 AM	Wait
[-]	Paint-47635423-CD6		0:01:49	9/1/2017 12:06:54 AM	9/1/2017 12:08:43 AM	PaintEF
[+]	PaintCoat		0:00:27	9/1/2017 12:06:54 AM	9/1/2017 12:07:21 AM	PaintCoat
[+]	PaintDry		0:01:08	9/1/2017 12:07:21 AM	9/1/2017 12:08:29 AM	PaintDry
[+]	Wait		0:00:14	9/1/2017 12:08:29 AM	9/1/2017 12:08:43 AM	Wait
[+]	3482-SA_9-1-2017_12-08-43		0:00:19	9/1/2017 12:08:43 AM	9/1/2017 12:09:02 AM	SubAssemblyEF
[+]	3482-FA_9-1-2017_12-09-02		0:01:25	9/1/2017 12:09:02 AM	9/1/2017 12:10:27 AM	FinalAssemblyEF

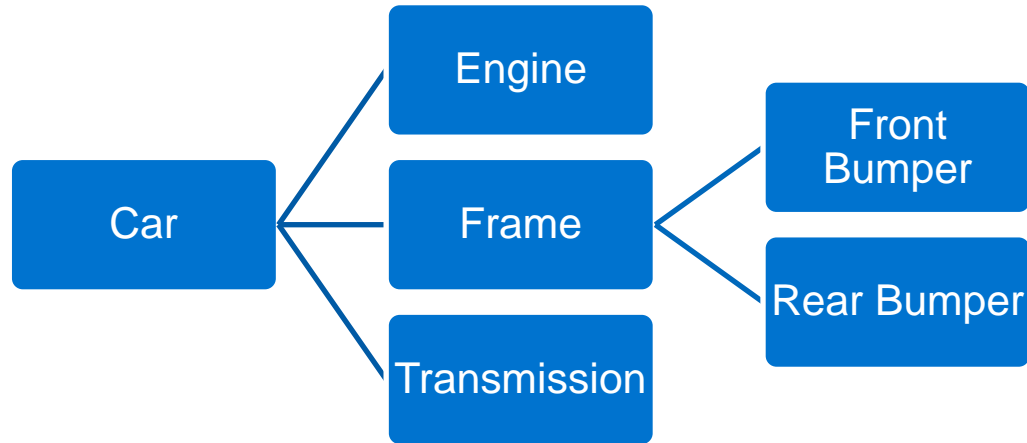
Outcome

- Linked Event Frames to produce product genealogy
- Traced product through manufacturing process
- Merged data



Benefits

- Traceability
 - Analyze bumper failure with single Event Frame search
- Repeatable process



Conclusion

Common Themes

- Backbone Event Frame for product genealogy
- Need multiple options for linking Event Frames
 - Name, Attribute value
 - Substring parsing
- Templates are required for rule-based genealogy

Overall Benefits

- Decrease effort required to detect, analyze, and investigate process anomalies
- Combine, centralize, and standardize data from different sources
- Track and trace products and events in PI Vision
- Real time product tracking

Overall Benefits

- Genealogy is:
 - Metadata that provides **additional context**
 - Allows for maximum efficiency
 - Searching
 - Visualizing

Re-visiting the Business Challenge

- Effectively trace product genealogy for a complete process timeline

Conclusion

- Event Frames provide a suitable method for tracing genealogy!
 - Capture entire process timeline
 - Event Frame template changes may be required
 - A matching linking element is necessary

Questions

Please wait for the **microphone** before asking your questions

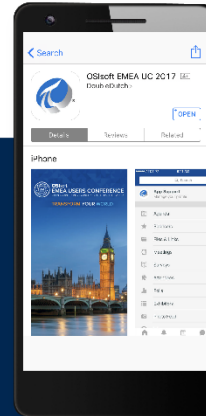


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Interested in learning more?

- Email further questions to wmurdock@osisoft.com

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Event Frames Initiative Lead

OSIsoft

감사합니다

Danke

谢谢

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado