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USERS CONFERENCE 2016

April 4-8, 2016 | San Francisco

TRANSFORM
YOURWORLD



Building Blocks

Scalable Deployment of OSIsoft for Data Center Infrastructure Management

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Data Center Building Blocks

- Data Centers are a collection of components which are constantly changing
- It is tough making sense of the Complexity



Generators



UPS



Cabinets/Racks



Computers



Utility Power



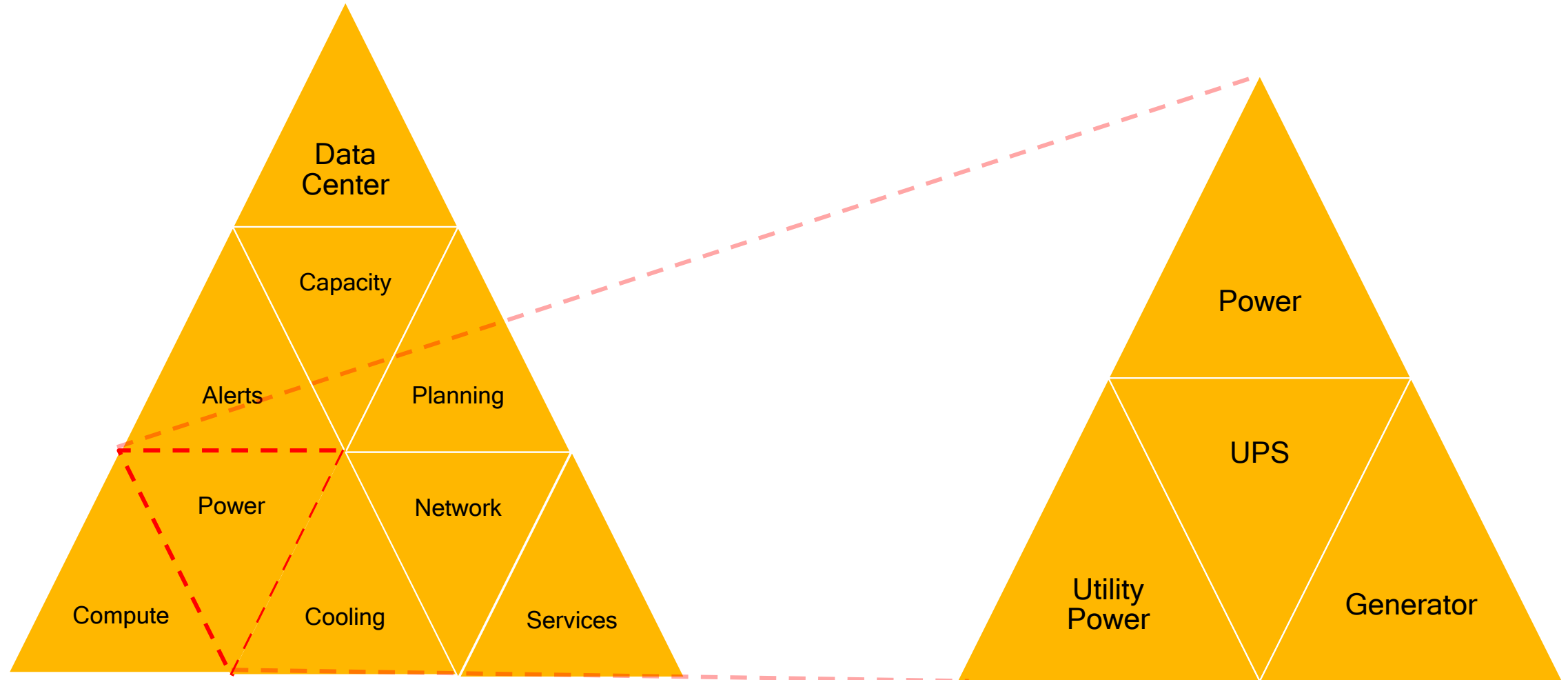
Power Distribution



Air Conditioning

Data Center Building Blocks

Developing and establishing standards helps normalize the data into building blocks



Equipment/Device Challenges

High-Level Challenges

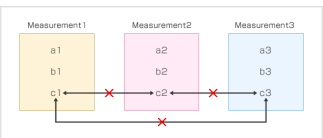
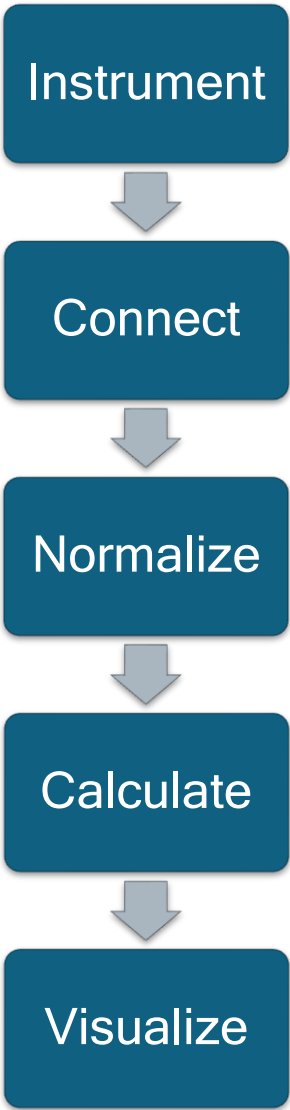
- Landscape
 - Extreme equipment Diversity & Functionality
 - Mixed equipment Ownership & Local Influence
 - Incongruent Connectivity & Instrumentation
 - Global Reach & Sprawl
- Device Growth to Head Count
 - > **1,000:1** Device Ratio
 - > **10,000:1** DB Object Ratio
- Tools & Services
 - Information Accuracy
 - Processes & Standardizations
 - Cross-Integration
 - Required Features/Functionality



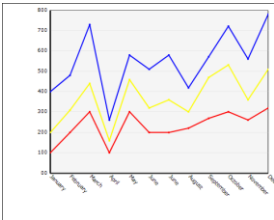
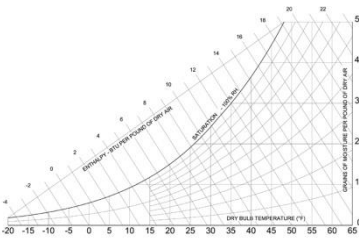
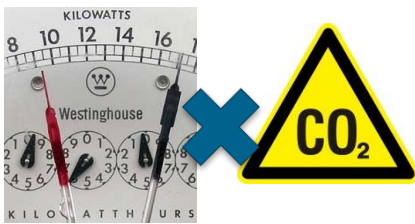
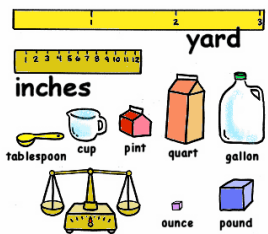
Fundamental Problems for Ongoing Support:

- Software/FW Upgrades
- Tool Transitions
- Information Reliability
- Auditing & Security

Turn Equipment Data into useful Business Information



Length	1 in	→	25.4 mm	1 mm	→	0.03937 in
	1 ft	→	0.3048 m	1 m	→	3.281 ft
Mass	1 oz	→	0.0283 kg	1 kg	→	35.3 oz
	1 lb	→	0.454 kg	1 kg	→	2.205 lb
Force	1 oz	→	0.278 N	1 N	→	3.597 oz
	1 lb	→	4.45 N	1 N	→	0.225 lb
Temperature	T [°F]	→	5/9 x (T [°C] - 32)	T [°C]	→	9/5 x (T [°F] - 32)
	0 K	→	-273.15 °C	0 °C	→	273.15 K
Torque	1 oz-in	→	7.06 mNm	1 mNm	→	0.1416 oz-in
	1 lb-in	→	0.113 Nm	1 Nm	→	8.849 lb-in
	1 lb-ft	→	1.356 Nm	1 Nm	→	0.7376 lb-ft
	1 kgf-m	→	9.807 Nm	1 Nm	→	0.102 kgf-m
	1 gf-cm	→	0.098 mNm	1 mNm	→	10.204 gf-cm
Inertia	1 mass	→	7.06 x 10 ⁻⁶ kgm ²	1 kgm ²	→	141643 mass
	1 oz-in ²	→	1.83 x 10 ⁻⁵ kgm ²	1 kgm ²	→	5.46 x 10 ⁴ oz-in ²
	1 oz-in ²	→	7.06 x 10 ⁻³ kgm ²	1 kgm ²	→	141.6 oz-in ²
	1 lb-in ²	→	2.05 x 10 ⁻⁴ kgm ²	1 kgm ²	→	3418 lb-in ²
	1 lb-in ²	→	0.113 kgm ²	1 kgm ²	→	8.85 lb-in ²



Qualcomm deployment

PI System in Action

40K

Native Data
Points

- UPS
- Power Distribution
- Transfer Switches
- Generators
- Flow Meters

From

3.9K

Infrastructure
items
worldwide

- Air Conditioners
- PQMs
- Fire Systems
- Fluid Detection
- Environmental Sensors

60K

Equipment
Configuration
Items

- Location
- Manufacture
- Model
- Serial Number
- Set Points

5K

Locational
Configuration
Items

- Address
- SqFt
- Space Allocation
- Capacities & Demands
- 29 Countries
- 65 Cities
- 127 Buildings
- 380 Rooms

3.4K

Alert
Notifications

- 56 Templates

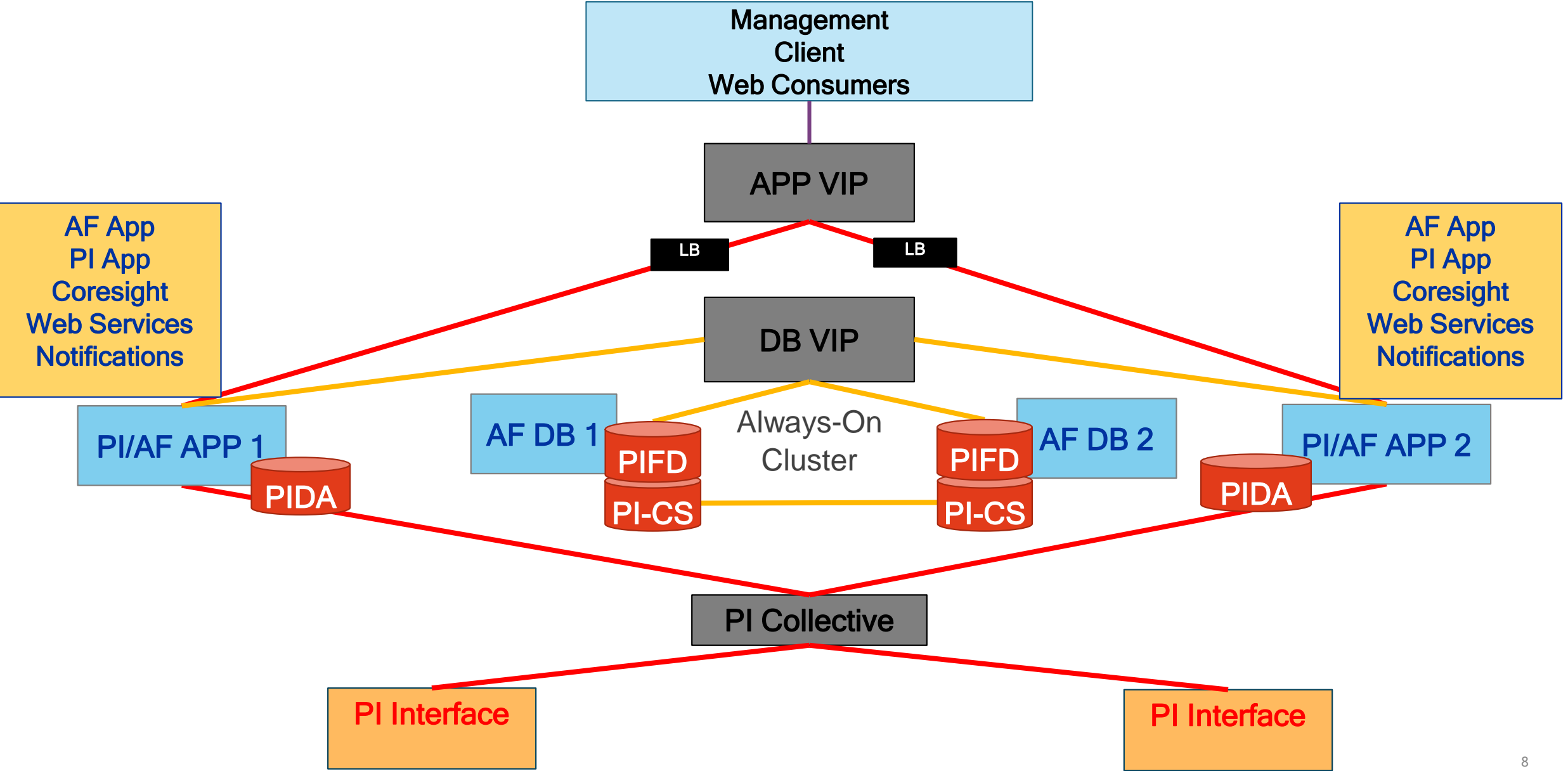
BMS Integrations

- 3 - COGEEN/Central Plants
- 5 - Office Buildings

Interfaces and Connectors

- SNMP, BacNET, Modbus UFL REST
- CSV File, PItoPI, Web API

OSIsoft PI System Functional Deployment Design



AF Structural Design

- Top Level - Corp
- Region
- Country
- City
- Building
- Room

The screenshot displays the WSI-APP1\QCOM - PI System Explorer application. The main window is divided into several panes. On the left, a hierarchical tree of elements is shown, starting from 'Qualcomm' at the top, followed by 'Asia Pacific', 'Australia', 'Sydney', and 'AUSTR.F'. Under 'AUSTR.F', there is a list of equipment elements, including '(AUSTR.F-2525) CRAC-A02', '(AUSTR.F-2525) CRAC-A08', '(AUSTR.F-2525) PDP-A04', '(AUSTR.F-2525) RPDU-A03-L', '(AUSTR.F-2525) RPDU-A03-R', '(AUSTR.F-2525) RPDU-A04-L', '(AUSTR.F-2525) RPDU-A04-R', '(AUSTR.F-2525) RPDU-A05-L', '(AUSTR.F-2525) RPDU-A05-R', '(AUSTR.F-2525) RPDU-A06-L', '(AUSTR.F-2525) RPDU-A06-R', '(AUSTR.F-2525) RPDU-A07-L', '(AUSTR.F-2525) RPDU-A07-R', '(AUSTR.F-2525) RTS-1-1', '(AUSTR.F-2525) RTS-A03', '(AUSTR.F-2525) SPDU-1-1', '(AUSTR.F-2525) UPS-1-1', and '(AUSTR.F-2525) UPS-A01'. A bracket labeled 'Equipment' groups these elements. Below the equipment list, there are other elements like 'China', 'India', 'Indonesia', 'Japan', 'Korea', 'Singapore', 'Taiwan', 'Vietnam', 'EMEA', 'North America', and 'UPL'. At the bottom of the tree, there are 'Smart Campus', 'Co-Location', 'References', 'Performance', and 'Element Searches'. On the right, a detailed view of a 'Co-Location' element is shown, with tabs for 'General', 'Child Elements', 'Attributes', 'Ports', 'Analyses', and 'Version'. The 'General' tab is active, showing a table with columns 'Name', 'Value', and 'Time Stamp'. The table is empty, and a message states: 'There are no attributes configured for this element. Attributes represent a single value that is used to represent a specific piece of information that is part of an element, event frame, transfer, case, or notification. [New Attribute](#)'. At the bottom of the window, there is a 'Project Elements' section with a list of elements: 'Event Frames', 'Library', 'Unit of Measure', 'MyPI', 'Notifications', 'Contacts', 'Analyses', and '0 Attributes'.

Equipment

Project Elements

- Uses Element references to pull in specific assets
- Enables Rollups that are outside the parent/child boundary

Elements References


- Uses Element references to pull in specific assets by groups
- Offers the users a quick shortcut to assets without navigating the hierarchy

Tags & Attributes

- PI Data Archive
 - Tags

- Asset Framework (AF)

- Elements (EQUIPMENT/LOCATIONS)
- Attributes
 - Child Attributes
- Analysis



LOC	UNIT	ATTRIBUTE	UOM
AF-140B	UPS 1	Output Load Phase 1	kW

- PI Tag Name
 - **\\PI-DA-COL\AF-140B.(AF-140B) UPS-1.Output Load (kW) – Phase 1**
- AF Path Name
 - **\\OSI-APP1\QCOM\Qualcomm\North America\United States\San Diego\AF\AF-140B\AF-140B) UPS-1|Output Load (kW) - Phase 1**
- Template Attribute to PI Tag
 - **\\%Server%\%..\Element%.%Element%.%Attribute**

Templates

➤ Base Template

- Automatically creates the PI Point

The screenshot shows a configuration table for the Base Template. The table has columns for a tree view icon, a name, and a value. The 'Category: Output Power Information' is highlighted in orange. The 'Total Load (kW)' row is highlighted in blue and has a value of '0 kW'. To the right, the 'Settings...' dialog box is open, displaying the following text:

```
\\%Server%\%..\Element%. %Element%. %Attribute  
%;UOM=W;ptclassname=classic;pointtype=Float32;exdesc="OID  
=%@. |OID%;CS=public;V=1";instrumenttag="host=%@IP  
Address%";location1=96;location4=1;pointsource=SNMP
```

➤ Consolidation Template

- Automatically references PI Point

The screenshot shows a configuration table for the Consolidation Template. The table has columns for a tree view icon, a name, and a value. The 'Total Load (kW)' row is highlighted in blue and has a value of '0 kW'. The 'OID' row is highlighted in blue and has a value of '0 kW'. To the right, the 'Settings...' dialog box is open, displaying the following text:

```
*.. \(",%..\Element%,") RPDU-" ,Right("%Element%",3), "-","Trim  
(Right("%..\Attribute%",2)), "[Total Load (kW)];
```

Templates at the Extreme

+	Chassis 2	0 W
+	Chassis 3	0 W
-	Chassis 4	0 W
-	Power Supply 1	0 W
-	CHASSIS	
+	Power Supply 2	0 W
+	Power Supply 3	0 W
+	Power Supply 4	0 W
+	Power Supply 5	0 W


Settings...

```
"..\\";%..\Element%"); OA-BLC";Replace(Replace("%..  
Element%", "-", "")," ", "");-;Replace(Replace(Replace  
Replace(Replace(Replace(Replace(Replace(Replace(Replace  
Replace(Replace(Replace(Replace(Replace(Replace(Replace  
Replace(Replace(Replace(Replace(Replace(Replace(Replace  
Replace(Replace(Replace(Replace(Replace(Replace(Replace  
Replace(Replace(Replace(Replace(Replace(Replace(Replace  
Replace(Right(" %Element  
%", 3), "A01", "A1"), "A02", "A2"), "A03", "A3"), "A04", "A4"), "A05", "A5"  
), "A06", "A6"), "A07", "A7"), "A08", "A8"), "A09", "A9"), "C01", "C1"), "C0  
2", "C2"), "C03", "C3"), "C04", "C4"), "C05", "C5"), "C06", "C6"), "C07", "C  
7"), "C08", "C8"), "C09", "C9"), "B01", "B1"), "B02", "B2"), "B03", "B3"), "B  
04", "B4"), "B05", "B5"), "B06", "B6"), "B07", "B7"), "B08", "B8"), "B09", "B9  
06", "D6"), "D07", "D7"), "D08", "D8"), "D09", "D9"), "E01", "E1"), "E02", "E  
2"), "E03", "E3"), "E04", "E4"), "E05", "E5"), "E06", "E6"), "E07", "E7"), "E0  
8", "E8"), "E09", "E9"), "F01", "F1"), "F02", "F2"), "F03", "F3"), "F04", "F4"  
, "F05", "F5"), "F06", "F6"), "F07", "F7"), "F08", "F8"), "F09", "F9");"-;Tri  
m(Right("%... |Attribute% ", 2)); "a"; "I"; "%... |Attribute%";
```

RESULT

		Power Supply 1	596 W
		CHASSIS	.. \((P-CDC2) OA-BLCPDC2-A3-1a Power Supply 1

[-]	Chassis 4	0 W
[-]	Power Supply 1	0 W
	CHASSIS	
[+]	Power Supply 2	0 W



Settings...

%@. |CHASSIS%

[-]	Chassis 3	0 W
[-]	Chassis 4	0 W
[-]	Power Supply 1	0 W
	CHASSIS	
+	Power Supply 2	0 W

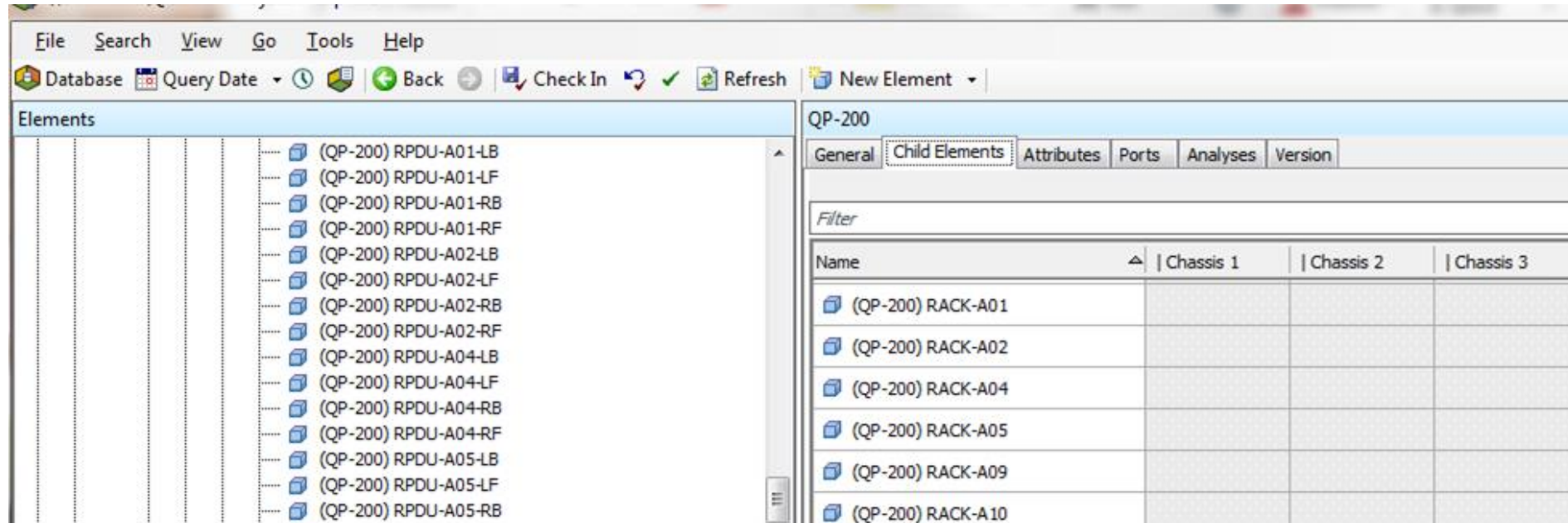
Settings...

A=|Chassis 4|Power Supply 1;B=|Chassis 4|Power Supply 2;C=|Chassis 4|Power Supply 3;D=|Chassis 4|Power Supply 4;E=|Chassis 4|Power Supply 5;F=|Chassis 4|Power Supply 6;[if badval(A) then 0 else A+if badval(B) then 0 else B+if badval(C) then 0 else C+if badval(D) then 0 else D+if badval(E) then 0 else E+if badval(F) then 0 else F];UOM=W

Data Center Rack Power

➤ Rack Power Distribution Elements

- Usually two per rack/cabinet for Redundant A/B power, but can be four due to power loads
- Element naming, like Hostname, identifies location: Building, Room, Rack and Position



➤ Rack Power Monitoring Elements

- Sums the Rack Power Distribution Elements
- Provides for a Max Design Capacity attribute (set by authorized user)
- Provides for a Manufacturer Max Capacity (model reference table)

Data Center Rack Power

➤ Rack Power Monitoring Elements (cont.)

The screenshot displays the PI System Explorer interface for the element (QP-200) RACK-A01. The left pane shows a tree of elements, including various PDPM and RACK elements. The right pane shows the configuration for the selected element, with tabs for General, Child Elements, Attributes, Ports, Analyses, and Version. The General tab is active, showing a table of attributes and their values.

Name	Value
Capacity (kVA) Available	0.23 kVA
Capacity (kVA) Rating	23 kVA
Capacity (kW)	28 kW
Capacity (kW) Available	4.77 kW
Capacity (kW) Rating	23 kW
Category: Equipment Information	
Equipment Type	RACK
Firmware	
Manufacturer	
Model	
Owner	
Serial Number	
Category: Output Power Information	
Power Factor	1 %
Total Load (kVA)	23.23 kVA
Total Load (kW)	23.23 kW
Total Load (kW) - LB	4.6 kW
Total Load (kW) - LF	6.98 kW
Total Load (kW) - RB	4.67 kW
Total Load (kW) - RF	6.98 kW

➤ Notification Template compares the total power load with the design maximum load.

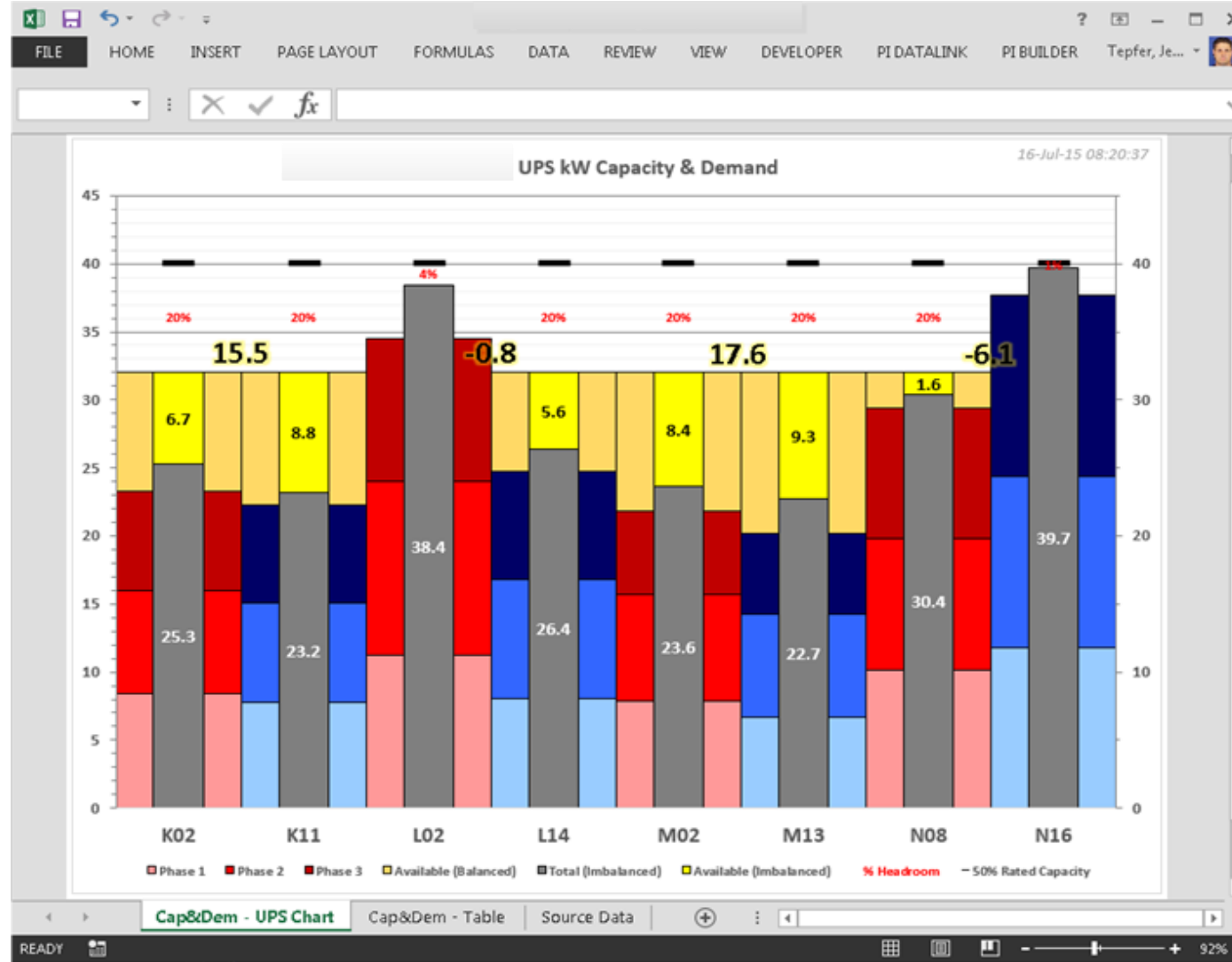
PI DataLink

Rack Power Loading based on rack layout



PI DataLink

Row Power loading based on Electrical Phases



PI Coresight

➤ Real-time Heat Map of 1,280 Servers in 320 Square Feet

Rack	Chassis 1	Chassis 2	Chassis 3	Chassis 4	Total Chassis	Total Rack
A01	4.42 kW	2.71 kW	6.13 kW	4.79 kW	18.05 kW	17.39 kW
A02	6.13 kW	3.31 kW	5.59 kW	5.14 kW	20.17 kW	20.13 kW
A03	6.21 kW	3.66 kW	3.01 kW	5.01 kW	17.90 kW	17.91 kW
A04	3.08 kW	6.73 kW	4.67 kW	2.08 kW	16.57 kW	15.78 kW
A05	4.30 kW	5.65 kW	2.85 kW	2.34 kW	15.14 kW	15.04 kW
A06	3.06 kW	5.37 kW	5.02 kW	4.81 kW	18.25 kW	19.69 kW
A07	5.18 kW	4.80 kW	5.27 kW	5.36 kW	20.61 kW	20.63 kW
A08	2.89 kW	4.18 kW	3.72 kW	5.65 kW	16.44 kW	16.78 kW
A09	4.04 kW	3.99 kW	4.84 kW	5.18 kW	18.04 kW	18.56 kW
A10	4.15 kW	6.67 kW	6.25 kW	5.93 kW	23.00 kW	22.05 kW
A11	4.00 kW	2.92 kW	2.64 kW	2.51 kW	12.08 kW	12.43 kW
A12	4.22 kW	3.40 kW	2.07 kW	2.52 kW	12.22 kW	12.58 kW
A13	1.79 kW	4.95 kW	4.91 kW	5.45 kW	17.10 kW	17.35 kW
A14	1.76 kW	3.17 kW	5.58 kW	5.22 kW	15.73 kW	16.22 kW
A15	4.83 kW	5.33 kW	6.37 kW	5.33 kW	21.86 kW	23.23 kW
A16	3.85 kW	4.87 kW	5.47 kW	3.02 kW	17.21 kW	17.06 kW
A17	3.49 kW	3.85 kW	5.32 kW	1.62 kW	14.29 kW	14.60 kW
A18	2.99 kW	5.56 kW	5.64 kW	2.25 kW	16.45 kW	16.25 kW
A19	3.09 kW	2.92 kW	5.18 kW	5.50 kW	16.70 kW	16.85 kW
A20	2.93 kW	6.02 kW	5.51 kW	5.57 kW	20.03 kW	20.19 kW

Chassis "Cap" --> 6500 Watts

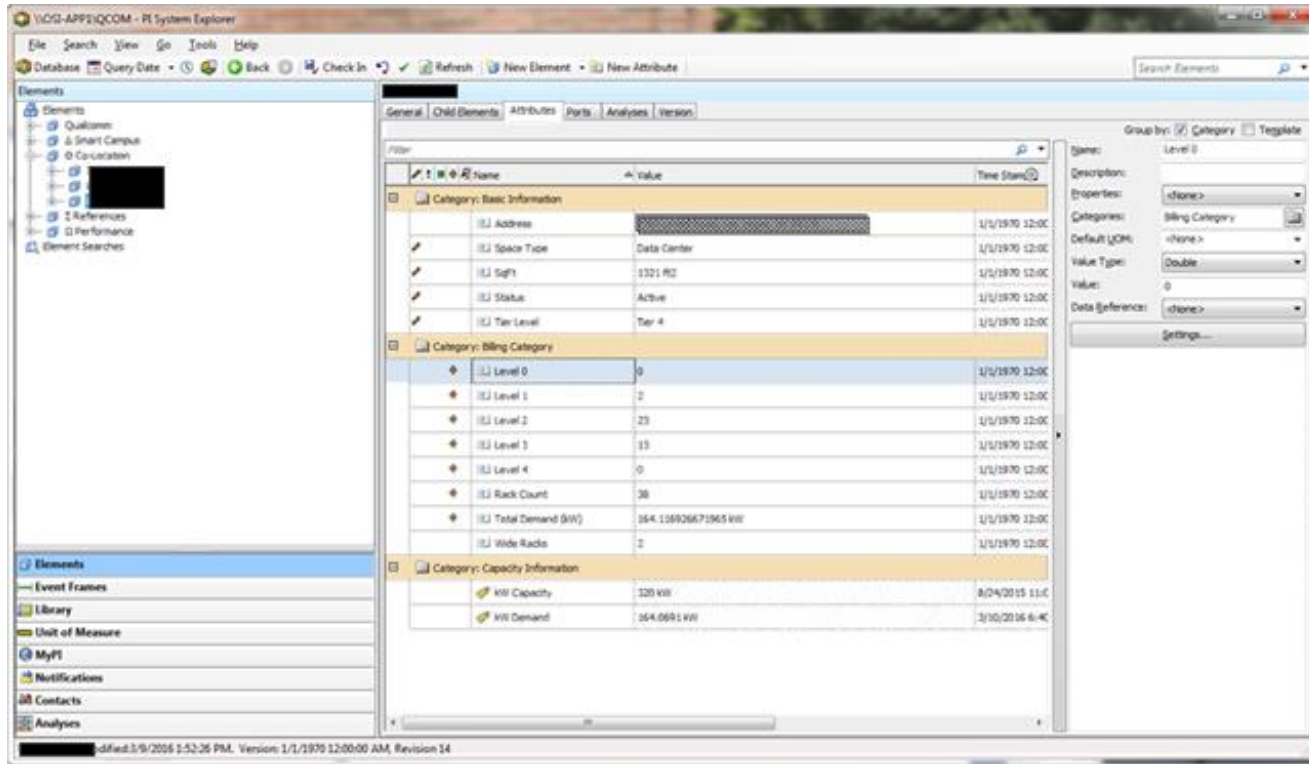
	Low End	High End
Black	0%	0%
Blue	1.0000%	49.9999%
Green	50.0000%	79.9999%
Yellow	80.0000%	94.9999%
Red	95.0000%	

Rack "Cap" --> 22500 Watts

	Low End	High End
Black	0%	0%
Blue	1.0000%	49.9999%
Green	50.0000%	79.9999%
Yellow	80.0000%	94.9999%
Red	95.0000%	

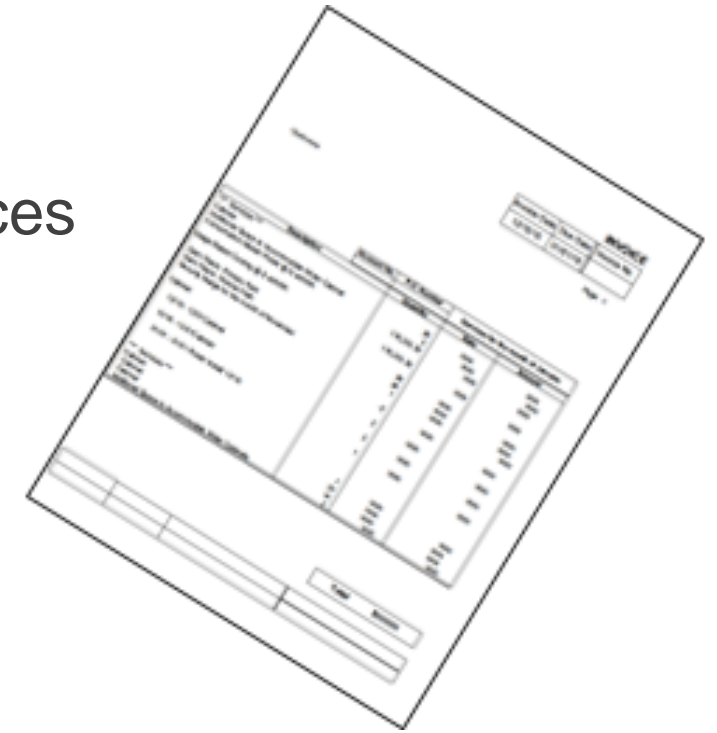
Service Provider Invoice Validation

- Before approving payment of energy consumption invoices



The screenshot shows the VCOG-APP/ICOM - PI System Explorer interface. The main window displays a table of energy consumption data, categorized into Basic Information, Billing Category, and Capacity Information. The table has columns for Name, Value, and Time Stamp.

Name	Value	Time Stamp
Category: Basic Information		
Address		1/1/1970 12:00
Space Type	Data Center	1/1/1970 12:00
Spft	1321 R2	1/1/1970 12:00
Status	Active	1/1/1970 12:00
Tier Level	Tier 4	1/1/1970 12:00
Category: Billing Category		
Level 0	0	1/1/1970 12:00
Level 1	2	1/1/1970 12:00
Level 2	23	1/1/1970 12:00
Level 3	13	1/1/1970 12:00
Level 4	0	1/1/1970 12:00
Rack Count	38	1/1/1970 12:00
Total Demand (kW)	164.158926671965 kW	1/1/1970 12:00
Wide Racks	2	1/1/1970 12:00
Category: Capacity Information		
kW Capacity	320 kW	8/24/2015 11:4
kW Demand	164.0691 kW	3/10/2016 6:40



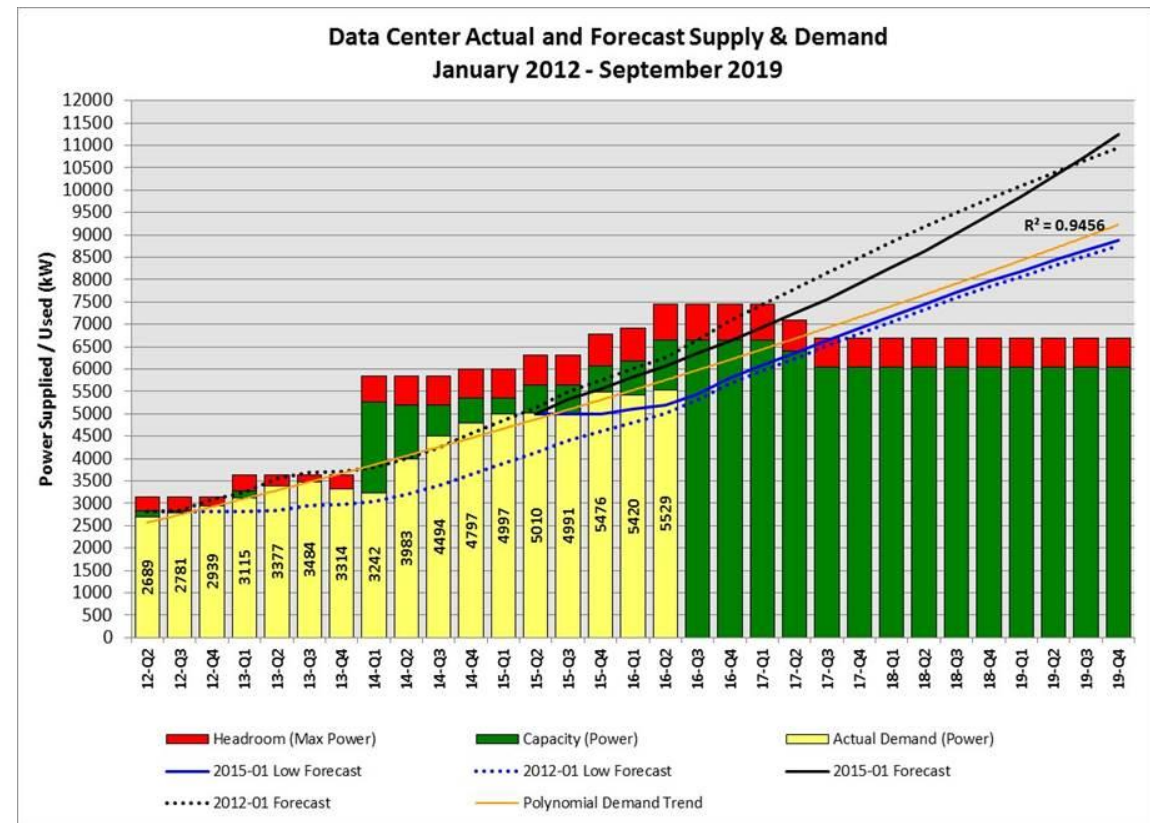
Invoice

- Site billing data is dropped into a UFL folder each month
- Invoiced consumption is matched to **measured** consumption before payment approval

Upcoming Design Work

Forecasting

- Utilization of Future Data
- Summarize data by company Fiscal Years and Quarters
- Track by Line of Business and Corporate entity
- Plan future Capacity additions
- Each location has its own LifeCycle
- Keep multiple versions of proposals

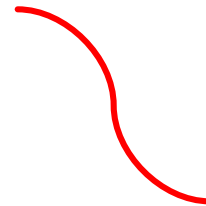
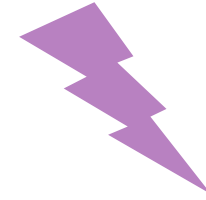


Building Blocks

Standardize the Non-Standard

OSIsoft PI Server and AF brings everything together

- Flexible Hierarchy
- User controlled naming standard
- Templating and Template Name Standards
- Power of Substitution Parameters and String Builder
- Trend display through PI System Explorer
- Builder module in MS Excel enables scalable administration of thousands of PI Points and AF Elements



Thank you



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