VOYAGE2007

Kennecott Utah Copper Company PI Server

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Kennecott Company PI Server

- Overview of PI at Kennecott Utah Copper
- Business Challenges and Solutions
- Technical Details
- Issues / Problems
- Summary

Overview of PI at Kennecott

- Three Traditional PI Servers
  - Representing three different plants
  - About 20,000 points each
- Company PI Server
  - About 8,000 points

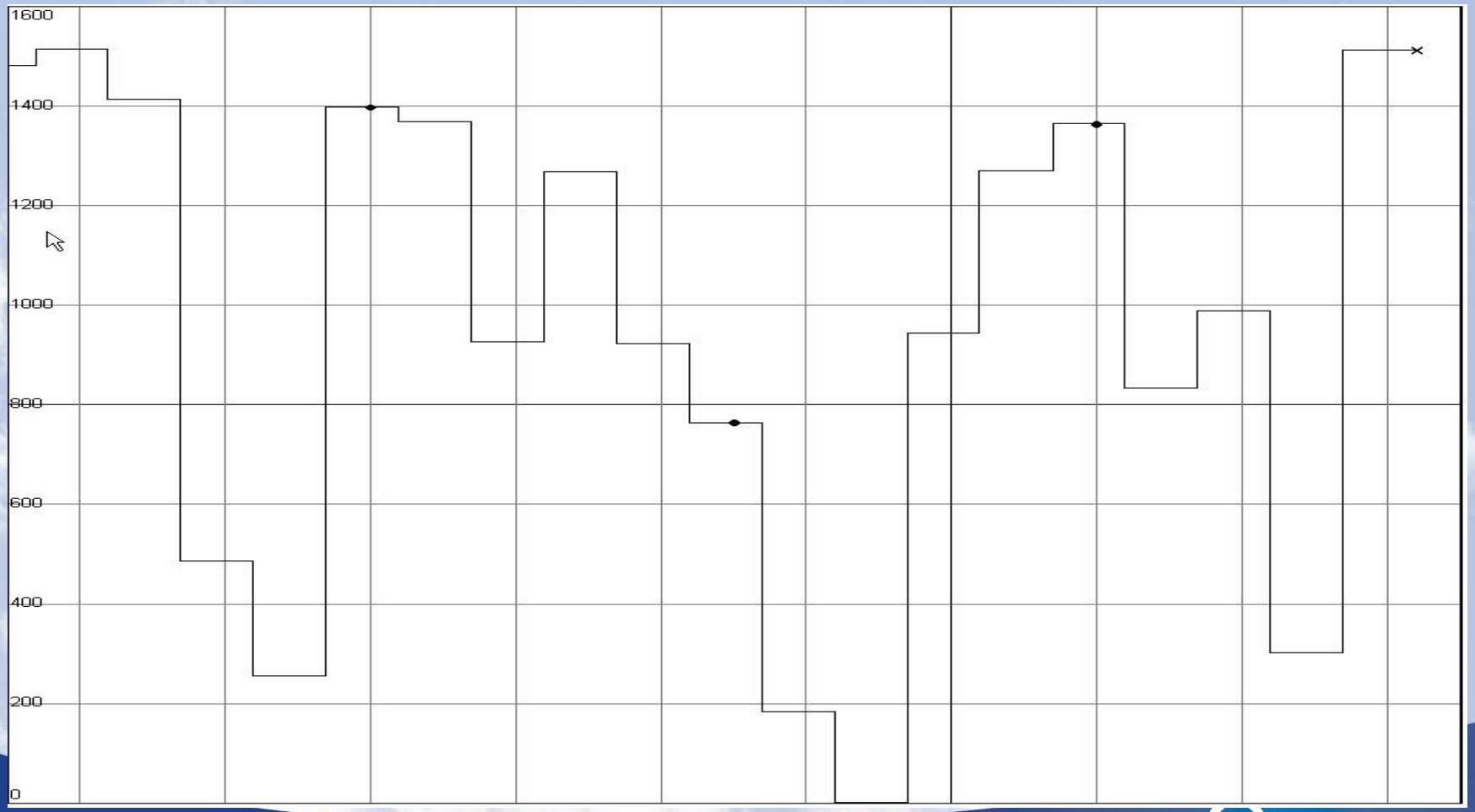
Three Traditional PI Servers

- Data fed from various control systems from several plants
- Large amount of data - hook up instrument to control system, begin feeding data to PI
- All data fed going forward in time, no back-filling of data
- No corrections to old data
- Could consolidate to one PI Server

Company PI Server

- Data fed via OSI's Batch File Interface
- Batch File Interface makes no use of Pointsource, so we use two-char Pointsource (business unit / plant)
- Data mostly analog, shift or daily, timestamped (exactly) at beginning of shift
- No plan to merge with other three PI Servers
  - Relatively small amount of data
  - Data often back-filled, often many years back
  - Willing to make corrections to old data

Daily Data in ProcessBook



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Company PI Server

- Short-term Goals
  - Organize data for DataLink users making morning reports
  - Feed data to Sigmafine
  - Feed data to Rio Tinto global instance of SAP
- Long-term Goal
  - Create Rio Tinto Corporate PI Server

Business Challenges & Solutions

1. Improve usability of daily / shift totals
   - Totalized in DCS or in PLC
   - Stored in relational database
   - Lots of old history
   - ODBC connections hard for IT to setup and maintain
   - Users don't know where the data is coming from

Solution: Transfer shift/daily data directly from Control System to PI

Business Challenges & Solutions

2. Improve usability of lab database
   - Stored in relational database
   - Timestamps not quite right
   - Values saved in ascii fields
   - Important lookup values stored in free-form ascii fields

Solution: Cleanup/copy data from lab database to PI

Business Challenges & Solutions

3. Save results of famous calculations
   - As simple as sum of several signals
   - Or complex recovery calculations
   - Shift / day totals
   - Data for SAP or Sigmafine

Solution: Save results of misc calculations from PI to PI

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Business Challenges & Solutions

4. Stop using Excel for data storage
   - Lab data must be massaged, so never refreshed
   - Big report, most data from PI or rdb, store a few manual entries alongside

Solution: Create generic PI Manual Entry Web Interface

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Business Challenges & Solutions

5. Resolve complaints about the accuracy of daily accumulations
   - Emerson Provox accumulation points are not good enough when digital signals are available
   - PI accumulations of analog signals are not good enough when digital signals are available

Solution: Calculate shift totals from month-to-date signals, PI to PI

Technical Details

- Applications That Feed Data to PI
- Advantages of .csv Files
- Extending the Use of the PI Point Database
- Shift / Daily Totals from Digital Signals
- PI Manual Entry Web Interface

Applications That Feed Data to PI

- Transfers
  - Accumulation points and runtimes from Provox to PI
  - Four different relational databases to PI
- Calculations
  - Shift / daily accumulations
  - Assays applied to tonnages
  - Misc calculations

Applications That Feed Data to PI

Application Features

- Written in Visual C or Visual Basic
- Scheduled to run with Windows 'Scheduled Tasks'
- Make no use of .Net or of PI-ACE
- Read PI via PI-API
- Read relational databases via ODBC
- Write to PI via OSI's Batch File Interface, via .csv files
- Typically, run several times per day, transferring or calculating a few days to a few months of data to PI
- Can be run interactively to back-fill data

Advantages of .csv Files

- Every system can create .csv files
- Any historian, database, or control system can feed the Company PI Server
- No knowledge of PI programming required
- The .csv files are an audit trail if archived
- Easy testing - .csv files can be reviewed before dropping into PI

Example .csv File

```
CFL-R2HD.Fe,    9-May-2007   5:00,    shutdown
CFL-R2HD.Fe,   10-May-2007   5:00,      1.5700
CFL-R2HD.Fe,   11-May-2007   5:00,      1.7800
CFL-R2HD.Fe,   12-May-2007   5:00,      1.6500
CFL-R2HD.Fe,   13-May-2007   5:00,      1.7900
CFL-R2HD.Fe,   14-May-2007   5:00,      1.6700
CFL-R2HD.Fe,   15-May-2007   5:00,      1.6500
CFL-R2HD.Fe,   16-May-2007   5:00,    shutdown
CFL-R2HD.Fe,   17-May-2007   5:00,    shutdown
CFL-R2TL.Fe,    9-May-2007   5:00,      1.5900
CFL-R2TL.Fe,   10-May-2007   5:00,      1.3500
CFL-R2TL.Fe,   11-May-2007   5:00,      1.4200
CFL-R2TL.Fe,   12-May-2007   5:00,      1.3000
CFL-R2TL.Fe,   13-May-2007   5:00,      1.6900
CFL-R2TL.Fe,   14-May-2007   5:00,      1.4600
CFL-R2TL.Fe,   15-May-2007   5:00,      1.3500
CFL-R2TL.Fe,   16-May-2007   5:00,    shutdown
CFL-R2TL.Fe,   17-May-2007   5:00,    shutdown
```


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Use of the PI Point Database

Configuration requirements for Totals

- Store only analog data, we use Float32
- Step flag is On
- Compress flag is Off

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Extending the Use of the PI Point Database

Use of PI Point Db Locations 1-5 by Applications

- (Batch File Interface makes no use of Locations 1-5)
- Location1 - point frequency
- Location2 - assigns a point to a web page
- Location3 - an ordinal for ordering tags on the web pages
- Location4 - not used
- Location5 - a number that represents the application that feeds the data to PI

Extending the Use of the PI Point Database

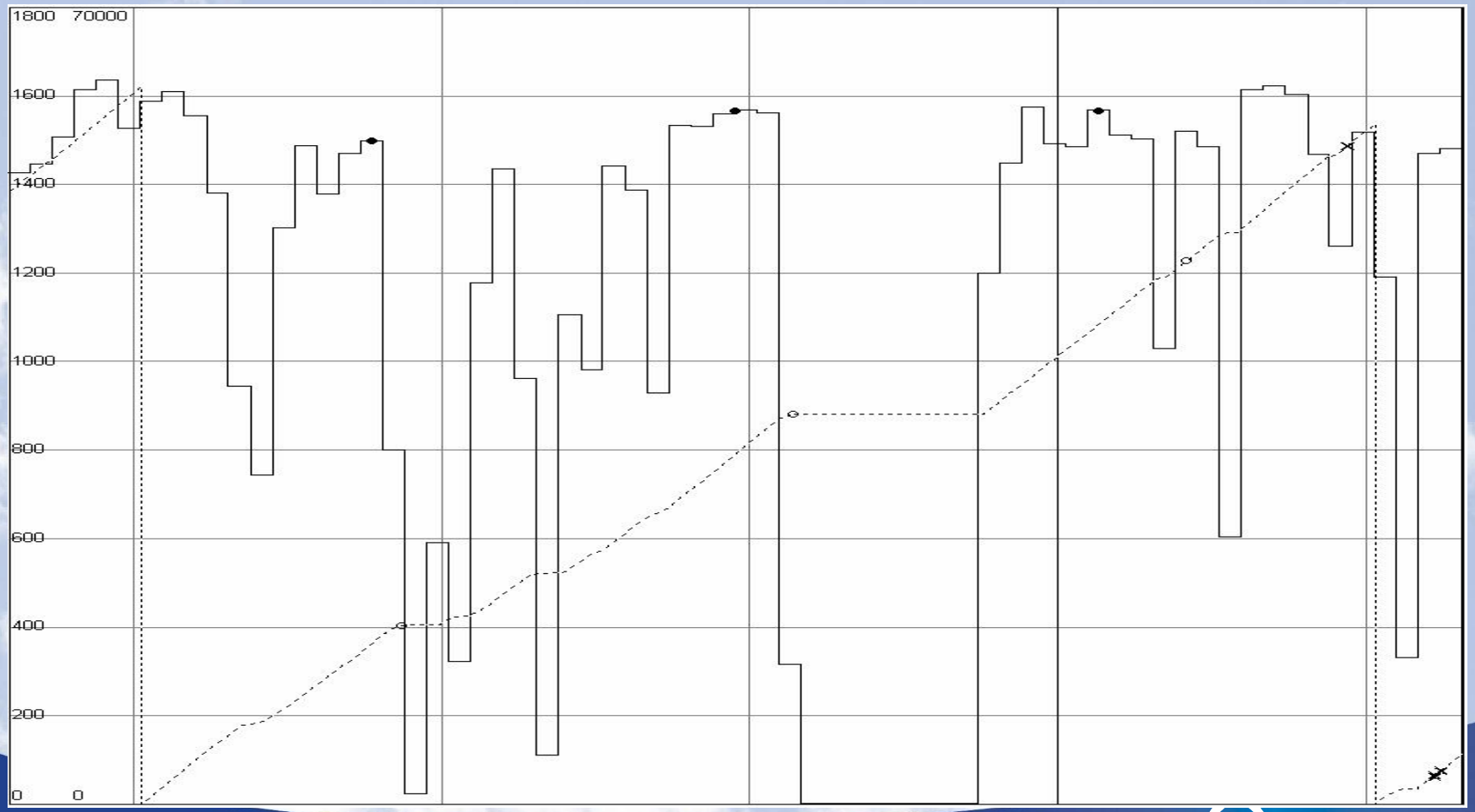
Location 1 – Point Frequency

- 1 - traditional PI point - no timestamp restrictions
- 2 - two shifts per day
- 3 - three shifts per day
- 4 - daily
- 5 - weekly
- 6 - monthly
- 7 - quarterly
- 8 - annual
- 9 - month-end inventories

Shift / Daily Accumulations to PI

- Get greater accuracy with pulse counter or with a total generated in DCS/PLC
- Create monthly running totals in DCS/PLC floating point registers
- Create month-to-date PI points, digital signals, which are useful by themselves
- Snapshot month-to-date PI points, calculate shift totals (noticing any reset to zero)
- PI is responsible for determining the start and end of shift
- Write back to PI as shift totals, timestamped at beginning of shift

Shift Totals from Month-to-Date Digital Signal



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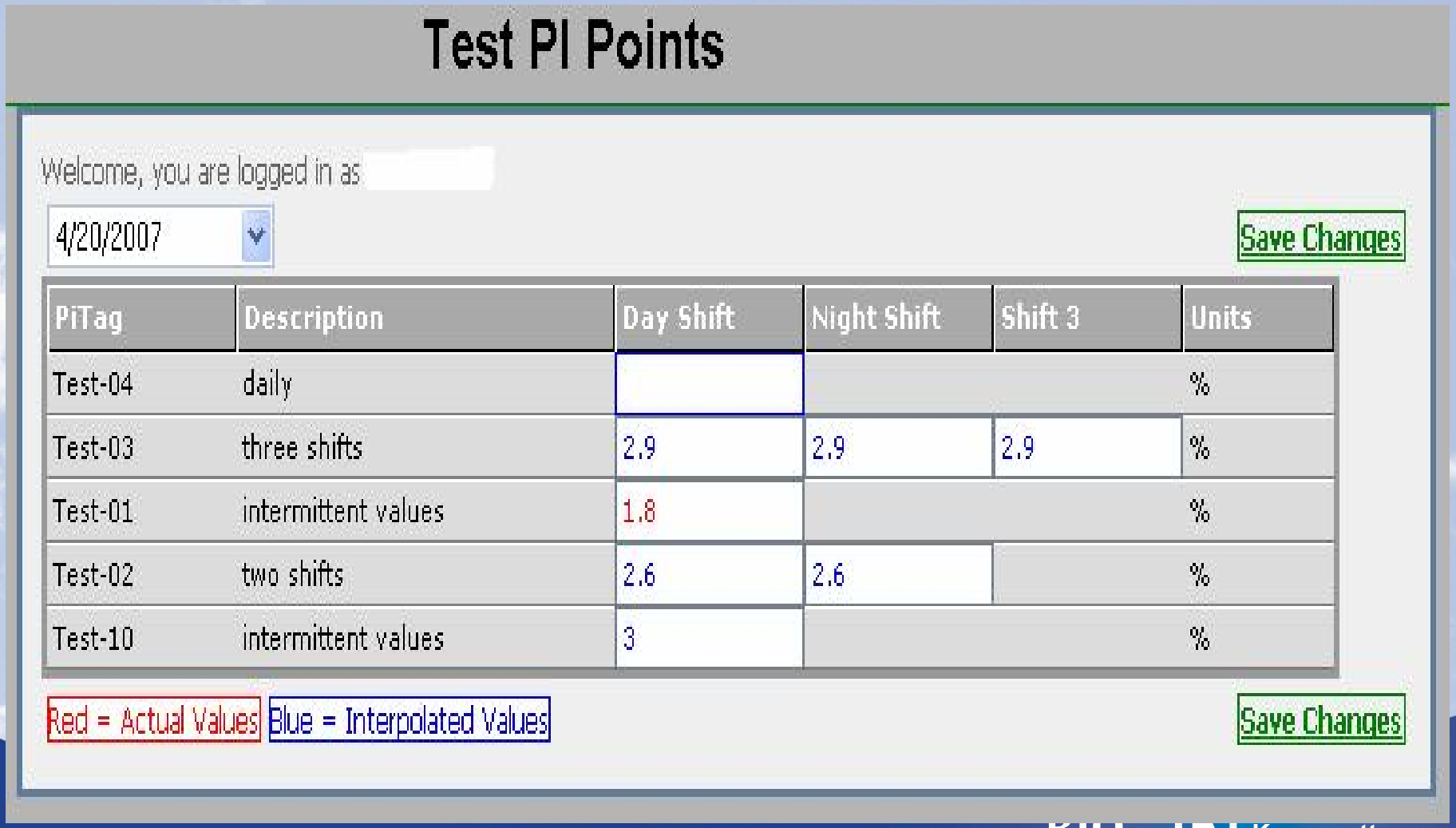
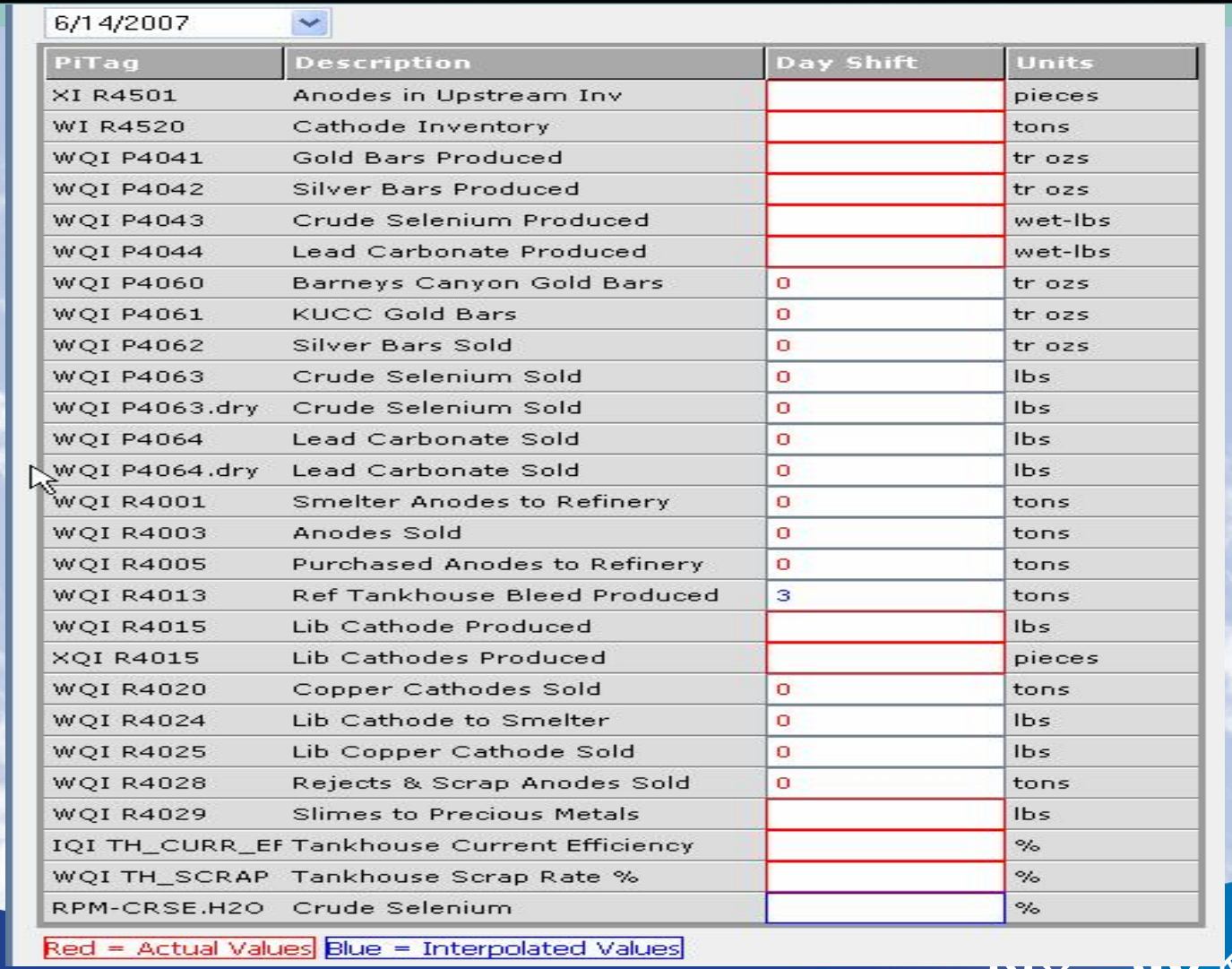
PI Manual Entry Web Interface

- Example Web Pages
- Features
- Use of an External Relational Database Table
- Use of the PI Point Database

Example Web Page



Example Web Page



6/14/2007

PiTag	Description	Day Shift	Units
XI R4501	Anodes in Upstream Inv		pieces
WI R4520	Cathode Inventory		tons
WQI P4041	Gold Bars Produced		tr ozs
WQI P4042	Silver Bars Produced		tr ozs
WQI P4043	Crude Selenium Produced		wet-lbs
WQI P4044	Lead Carbonate Produced		wet-lbs
WQI P4060	Barneys Canyon Gold Bars	0	tr ozs
WQI P4061	KUCC Gold Bars	0	tr ozs
WQI P4062	Silver Bars Sold	0	tr ozs
WQI P4063	Crude Selenium Sold	0	lbs
WQI P4063.dry	Crude Selenium Sold	0	lbs
WQI P4064	Lead Carbonate Sold	0	lbs
WQI P4064.dry	Lead Carbonate Sold	0	lbs
WQI R4001	Smelter Anodes to Refinery	0	tons
WQI R4003	Anodes Sold	0	tons
WQI R4005	Purchased Anodes to Refinery	0	tons
WQI R4013	Ref Tankhouse Bleed Produced	3	tons
WQI R4015	Lib Cathode Produced		lbs
XQI R4015	Lib Cathodes Produced		pieces
WQI R4020	Copper Cathodes Sold	0	tons
WQI R4024	Lib Cathode to Smelter	0	lbs
WQI R4025	Lib Copper Cathode Sold	0	lbs
WQI R4028	Rejects & Scrap Anodes Sold	0	tons
WQI R4029	Slimes to Precious Metals		lbs
IQI TH_CURR_EF	Tankhouse Current Efficiency		%
WQI TH_SCRAP	Tankhouse Scrap Rate %		%
RPM-CRSE.H2O	Crude Selenium		%

Red = Actual Values Blue = Interpolated Values

PI Manual Entry Web Interface

Features

- Written in C#.net
- Reads PI Point database via OLEDB
- Reads/writes PI archives via OLEDB
- Validates data against Zero and Span
- Uses piManualAreas table in SQL Server, one row per web page
- Called like this: http://webserver/piManualEntry.aspx?bu=kucc?area=test

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piManualAreas - Actual Data

manGroup	bu	area	ptType	sh-hr	sh-min	earlydate	header
100	KUCC	test	4	5	0	*-200	Test PI Points
101	KUCC	ccAssay	4	5	0	*-40	Copperton Assay Substitutions
102	KUCC	crushConvey	2	6	0	1/1/1990	Mine Conveyor to Copperton
103	KUCC	ccMisc	4	5	0	*-180	Copperton Misc
105	KUCC	smasManual	4	5	0	1/1/2006	Smelter Metals Accounting
106	KUCC	refinery1	4	5	0	1/1/2006	Refinery Production / Inventories
107	KUCC	anodes	2	5	0	*-80	Anode Plant

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piManualAreas - SQL Table

Database Columns

- manGroup - lookup into piPoint Location2
- bu - business unit
- area - name of manual group
- ptType – (like Location1) used to determine the initial date
- shiftHour – hour of start of shift
- shiftMin – minute of start of shift
- earlyDate – earliest date allowed (absolute or relative)
- header – title / header of web page
- domainGroup – (security)

Issues / Problems

- Missing Data
- Back-Filling Data
- Daily Data vs Shift Data

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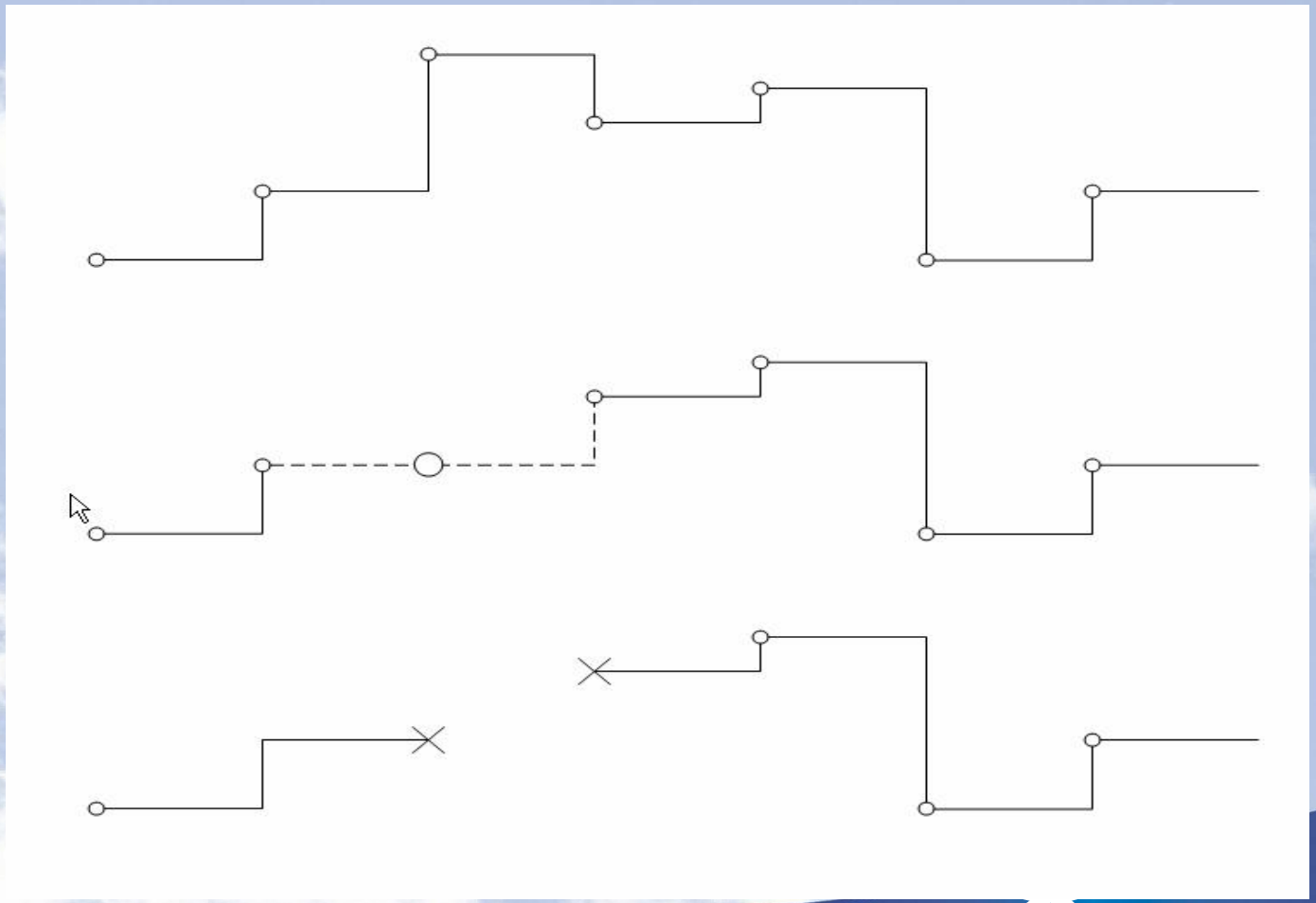
Missing Data

Normal

Missing Data will be Interpolated

Missing Data with Shutdown



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Missing Data

- Default, to use previous day's value again, is OK for some points
- Some points require that missing data be highlighted
- Must do something about missing data
- SAP and Sigmafine have different requirements for missing data

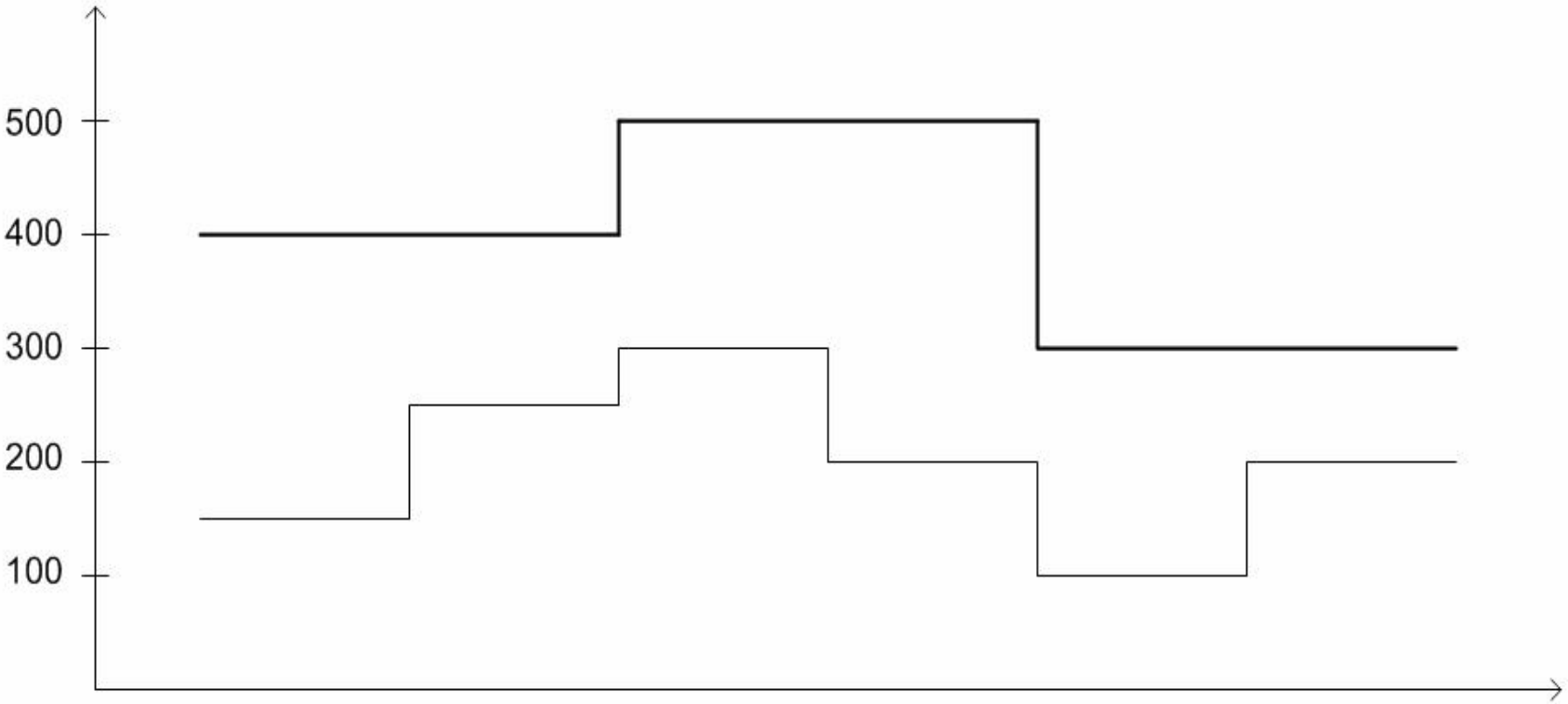
Shutdown Application

- Use ‘Shutdown’s as nulls
- Populate Shutdown and TypicalVal fields in PI Point database
- Shutdown Application marches thru the PI Point database
  - If Shutdown field is 0, do nothing
  - If Shutdown field is 1, write ‘Shutdown’
  - If Shutdown field is 2, write TypicalVal
- Write 'Shutdown' or TypicalVal for today, should be over-written tomorrow
  - For a total, at the beginning of the day, write a ‘shutdown’ as a default value
  - Once the total becomes available, overwrite the ‘shutdown’ with the actual value

Issues with Back-Filling Data

- Problems
  - Creating points in old archives requires processing of archives
  - ‘Pt Created’ gets in the way
- Solution
  - Create bank (dozens or hundreds) of dummy points
  - Delete all ‘Pt Created’s
  - Process all archives
  - Put in an early value: ‘Shutdown’ or zero
  - Instead of creating a new point, rename one of the dummy points

Issues - Daily Data vs Shift Data



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Issues - Daily Data vs Shift Data

- Shift vs Daily values can be confusing
- DataLink ‘Calculated Data’ query on Shift data will return half of desired value
- Populate the Convers (conversion factor) attribute in the Point Database
  - Convers = 1.0 for assays or inventories
  - Convers = 2.0 for shift totals
  - Convers = 1.0 for daily, weekly, monthly, etc
- Apply the conversion factor when doing Calculated Data query

Summary

- Benefits
- Future Direction

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Benefits

- Much easier to do ad hoc queries
  - Easier to do tag-based queries, to choose columns in PI vs in SQL
  - Store shift/daily totals in relational database - for a new report, call in the consultants and re-train the users
  - Store shift/daily totals in a Company PI Server - the users discover the data themselves and make their own reports
  - Users know the source of the data, are in charge of their reports
  - It is left to you to compare the meta-data capabilities of OSIsoft Analysis Framework vs Microsoft SQL Server 2005 Reporting Services

Benefits

- Users can now refresh the lab data in their reports
- Manual entries now saved in PI
  - Excel reports don't store data alongside
  - Manual values now available to everyone
- One version of the truth on famous calculations
  - Users still do calculations in Excel, this will always be a work in progress
- Accumulations done very accurately in PLC or DCS
  - PI is responsible for the time of day
  - PI breaks the totals into days or shifts with no cumulative error

Future Direction

- Setup meta-data on the shift/daily totals using Analysis Framework
- Migrate simpler Calculations to .Net with a generic program that gets details from PI Point Database (like Performance Equations)
- Use PI-ACE for complex calculations
- Continue to make use of .csv files and the Batch File Interface
- Share with other Rio Tinto business units on a common server

Questions ?

Notes:

- There are details on the slides that we did not cover
- Please contact me after the conference to discuss further

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Thank You

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