BIOGRAPHICAL INFORMATION

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Systems Analyst
Dominion Resources

Specific Responsibilities

- Joined Dominion Resources in 1986 as a programmer/analyst.
- Joined Project ICE (pipeline Integrity Compliance and Effectiveness) in 2002 as the IT technical lead.

Past Experience

- Systems Analyst in Fossil & Hydro Generation, Nuclear Generation, Electric Delivery, Wholesale Power, Taxes and Plant Accounting, and Retail Energy.
- Taught programming at J. Sargeant Reynolds Community College.
- Worked as a residential carpenter for 5 years.
- Drove a truck for the Salvation Army.

Educational Information

- 1979, The University of Virginia, BA in Economics, With Distinction.
- 1984, Virginia Commonwealth University, Post-Baccalaureate Certificate in Information Systems.

Professional Memberships

- PODS Board of Directors

INTEGRATING DATA FOR PIPELINE COMPLIANCE
PART 2 – IMPLEMENTATION AT DOMINION RESOURCES

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ABSTRACT

New integrity rules require that pipeline operators have the ability to integrate all pipeline data. This article is part 2 of a two part series. Part 1 describes data integration concepts and this article describes how data integration is being implemented at Dominion Resources.

- Using the PODS data model to build centerlines in the Smallworld GIS.
- Integrating legacy systems using the GIS object ID.
- Staging compliance data to an Oracle reporting database.
- Using Oracle views to export and mine data.
- Using Oracle to store the data dictionary.
- Using centerline trace reports as a survey (ILI, CIS) alignment tool.

TEXT

Introduction

New integrity rules require that pipeline operators have the ability to integrate all pipeline data. This article is part 2 of a two part series. Part 1 describes data integration concepts and this article describes how data integration is being implemented at Dominion Resources.

One of the first compliance tasks at Dominion was to bring in new risk analysis software. We had already been performing risk analysis on our lines and our integrity engineers recognized that what we would need better tools to comply with the new regulations.

So we did software searches, came up with candidate vendors, and arranged for them to demonstrate their wares using our data. The demonstration required the vendors to import a few prototype lines into their software and then integrate inline inspection (ILI) data on to the lines.

We used our Smallworld GIS to export shape files and other data for use in the demonstration. This data included the original survey stationing which matched the original construction data but didn't always match the current view of what constitutes a line. For example, lines that were originally built in segments had stationing that would increment to the end of the original segment, and then restart at zero in the next segment. Or lines that since been broken into smaller lines contained the large stationing associated with the old line.

The ILI data we provided was linear referenced using continuous odometer readings from the launch point. The data called out features using text descriptions such as road names, valve names, and casings. So the data integration task for the vendors was to align GIS and ILI data when ILI odometer readings don't match historic stationing, and ILI text descriptions don't always match pipeline attributes.

To do this, each of the vendors began by building a measured centerline. This is a set of data that describes each feature along the line as a distance from the start of the line, and unlike historic stationing, the measures are continuous from start to end. The vendors used a combination of GIS tools and our line data to create the centerline measures, which is sometimes referred to as continuous stationing.

We knew we didn't want to go through this process of conversion process each time we exported data to the risk tool. So we decided to create what some call a smart centerline. It's smart because centerline measures are automatically recalculated and stored after pipelines are reconfigured or refined. Sample events that trigger a recalculation are line relocations, pipe swaps between lines, and line reversals. We based our design on the stationed centerline in the PODS (www.pods.org) data model and implemented the centerline within our Smallworld GIS. Now, network trace functions in the GIS automatically produce continuous centerline measures for every feature on the line.

The next problem was to feed the risk analysis tool with data coming from multiple systems. We store all asset data in our GIS, and asset performance data in many other systems, sometimes called satellite systems. For example, we store all valve geometry and attributes in Smallworld but we store valve inspection data in an Oracle based inspection system. The risk analysis tool needs all asset and performance data so the task was to efficiently relate all data.

We already had descriptive data that would allow a user to, using the example, look at a valve in the asset system and match it to a valve in the inspection system. What we needed was an enterprise key that would allow the computer to make these matches. We chose the asset system id, a unique key that is generated by Smallworld for each instance of an object. It is an eleven-digit number and can be thought of as equivalent to the PODS event_id.

At this point, we had a spatial reference system in the GIS, a linear reference system in our stationed centerline, and all asset data logically connected using an enterprise key. Next, we needed a way to pull everything together for export to the risk analysis system.

The Smallworld GIS has the ability to retrieve data from Oracle databases and so we had the option of using Smallworld as our data assembly tool. The GIS could have read each satellite system and assembled the data for export. Instead, we chose to create a new Oracle database and have the GIS and all satellite systems publish integrity data to it.

This has many advantages. It allows all system owners to publish their data to the repository rather than having any one system burdened with having to subscribe to other systems. This way, each individual system has the responsibility of pushing data out instead of a single system trying to navigate all the others. It also freed our scarce GIS programmers from having the burden of managing the process; and it placed all data into an industry standard Oracle database that supports standard SQL and third party reporting tools.

At this time we have nearly ninety tables in our data repository. This could present difficult and error-prone queries to anyone trying to mine data. To simplify data retrieval for both developers and end users, we make extensive use of database views. For example, we have several views that join all of the centerline tables together, called core event views. These present a one-table virtual view of all stationing and features and is used in the FROM clause of most subsequent database queries. All data exported to the risk analysis tool is handled in database views. Again, this provides a one-table virtual view of all subjects that are sent to the risk tool, and allows a user to bring up them up using a tool such as MS Access.

Finally, we need a data dictionary, a system to store data definitions, where data came from, how it was transformed, and where it was being sent. Our data architects looked for a third party package that would meet our data dictionary needs but couldn't find what they wanted. So we designed and built a custom Oracle database. Again, database views are used to simplify data retrieval.

Integrating ILI and CIS Data

Now let's look at how our new tools helped us to improve the integration of asset data with ILI and CIS performance data. We've already described the old process for aligning survey data. We spent a lot of time trying to match features called out in the survey with features in our asset system and a lot of time generating line maps for vendors.

The survey process now includes what we call our pipeline trace, a report that calls out every feature of interest on the line, a report that and can be exported as a spreadsheet. ILI trace reports will list features like pipe diameter changes, fittings, valves, casings, and above ground markers. CIS trace reports will list features visible from above ground like CP test points, rectifiers, valves, and road crossings.

In both cases, the report will include the feature type (e.g. valve, pipe segment), the enterprise ID of the feature, the centerline measure, latitude and longitude of points, and a description. We use this data to QA the line and correct any data problems before we send it out to the vendor.

In the past, we'd spend time answering questions about ground terrain so that survey could plan their jobs. Now vendors can plug the lat/longs into topographic tools like www.topozone.com or Delorme maps and get their own topo maps and aerial photos.

Vendors used to call out features using descriptive text. This required a human to interpret the text and match the fit point up to our data so that the data could be aligned. Now we ask them to call out the enterprise id of the feature they are crossing. This allows the computer to match fit points and do QA on missing points. The vendor still includes the feature type and a description like a road name to make the report readable and as help in tracking down any enterprise id errors.

This is the first year of the new survey process and we are just beginning to see the data returned in the new format. CIS and ILI vendors have accepted using an enterprise id for matching fit points. The trace reports have been a good QA tool and have helped the vendors plan jobs, collect field data and analyze the results. We should now be able to replace manual matching with automated matching.

We should also be able to automatically QA vendor data by quickly displaying fit points to do not match our enterprise id, or fit points that fall out of tolerance with our centerline measures. Vendors are beginning to include spatial coordinates with their surveys and we'll use that to look for survey coordinates that are out of tolerance with our GIS coordinates.

Conclusion

Dominion Resources built several data integration tools in response to new pipeline compliance regulations. First we built a common linear reference system in our GIS, using the PODS stationed centerline as a model. Next we added an enterprise key by storing the GIS system id with asset data in our satellite systems. Then we built a data repository in an Oracle database and had source systems publish integrity data to the repository. A custom built data dictionary records data sources, transformations, and targets. Exchanging and aligning vendor survey data demonstrates how these tools come together to improve quality and reduce labor.