Splitting distributed control for a refinery expansion

A refiner's expansion plan required a second distributed control system, achieved by splitting the original system without a shutdown

PETER HELMERSSON and SVEN WINBERG
Preem AB

Preem, with headquarters in Stockholm, Sweden, is the country's largest supplier of petroleum products, and is responsible for 80% of national refinery capacity and 30% of Nordic capacity. Total refinery capacity is more than 18 million tonnes of crude oil at the company's two refineries in Gothenburg and Lysekil.

The Lysekil facility, located on the south western coast, can process about 11 million t/y, shipping the majority of its output by sea.

In the past, the refinery (see **Figure 1**) had been controlled by a single DeltaV distributed control system (DCS) with nearly 15 000 device signal tags (DST), 56 redundant controllers, one wireless gateway, 28 operator stations and nine servers. The company has several projects and expansions in mind, yet over time it became apparent that such expansions would be difficult with a single system. The best way forward would be to split the DeltaV system into two. The challenge was to do this without a shutdown and without disrupting production.

Figure 1 Preem's Lysekil refinery split its single DeltaV control system into two to allow for expansion

Consulting with Emerson Process Management, Preem decided to split the system into two systems joined by DeltaV Zones, which is an architecture designed to operate and manage large systems. Because the communication across zones was process critical, Preem chose to implement redundant inter-zone servers. **Figure 2** shows two zones, each representing a DeltaV system, defined by a ProfessionalPlus (ProPlus) Station, with necessary data exchange between domains handled seamlessly by the redundant DeltaV Inter-Zone Network using Inter-Zone servers. Any operator workstation within the unified architecture can view and control the areas assigned to that workstation, regardless of domain.

The immediate questions concerned where precisely to make the split and which controllers, with their I/O and associated equipment, would be assigned to which of the two new systems.

The first consideration in this process was to avoid splitting

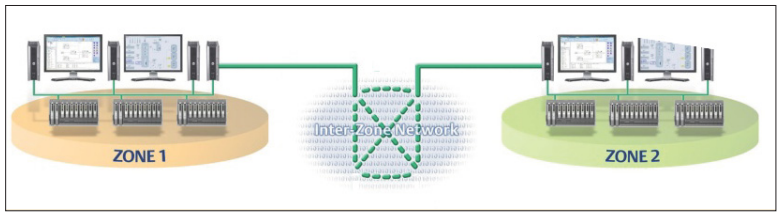

Figure 2 Because the communication across zones was process critical, Preem chose to implement redundant inter-zone servers

apart any controllers that are sharing data for control purposes; the ideal would be to find a logical point where the interfaces between controllers are at an absolute minimum. Logically, the split point should fall somewhere in the middle of the facility, based on unit operations.

To aid in choosing the split point, Preem engineers undertook a study that included reference visits to other companies that use Zones architecture. The refinery is already divided into two processing areas, called Area 2 and Area 3, and it was decided to make the split between them, with each to get its own DeltaV system. It was further decided that the existing system would be used by Area 3 because it contained equipment that could not be stopped during the turnaround, and the new system would be assigned to Area 2.

Preparations

Preem commissioned Emerson Process Management Sweden to carry out the project, including planning, factory testing, implementation and site acceptance testing. In order to keep everyone up to date, meetings between Emerson and Preem personnel were scheduled at two-week intervals.

The Emerson engineers analysed the database on the existing DeltaV system, looking at the configuration to see which controllers were exchanging information with others to try to identify clean break lines – places where the systems could be split between the two systems without having to do a great deal of software modification. They were able to identify a number of these; in the small number of instances where this was not possible because controllers contained modules from different areas, communications between one destination system and the other were run through the Inter-Zone Network.

Setting up the test system

Such a profound change in the refinery's control system would, of course, require complete off-line testing to ensure that, when implemented, the split would not produce any unexpected results that would disrupt production or, worse, create any safety hazards.

While the configuration changes to the controllers themselves were straightforward, the testing was considerably more about making sure that everything that was supposed to happen did indeed happen, and that the operational speeds were satisfactory.

Because this was a live split on a plant running at reduced capacity, one of the biggest and most important tasks was to ensure that data that was moving between controllers in the original system would be able to go through the zone server as they were split into new networks.

Emerson Sweden set up a test system at its office in Karlstad. The user configuration database from the existing system's ProPlus workstation was exported and the relevant portions were imported to the test system ProPlus workstation (ProPlus 2), which was to become the workstation for the second DeltaV system after the split. After that, the controllers and operator stations were moved from one system to the other as required, and the inter-zone server was set up.

The next step was to run tests with a set of field instruments maintained at the test site, check out operation of the Foundation Fieldbus segments, and check the status of communications.

It was also necessary to verify whether a problem during operation would trigger a redundant inter-zone server switch-over to its standby partner – which is supposed to be completely transparent – without creating any issues for the process. A considerable effort was put into the necessary configuration changes to make this work.

Next, the factory acceptance test (FAT) took place. This was essentially a repeat of the items previously mentioned, with

Preem personnel observing and signing off.

Software freeze

One week before starting the split, a software freeze was implemented. No further configuration changes could be carried out because that could cause unpredictable system behaviour when the split was implemented.

A full back-up of the system was sent to the Emerson office in Karlstad, where it was cleaned up to remove any items that were remaining in the new Area 3 zone, based on the original system. This left a clean database to utilise for the new Area 2 zone.

After several iterations and modifications to plans based on information gathered during the testing, it was time to move on to implementation.

Implementation

Emerson was given full responsibility for the split, with the work done by two of its system engineers and two system engineers from Preem. The work was performed during the first two weeks of a turnaround period of five weeks. The actual splitting of the hardware was completed in the first week, while the second week was devoted to cleaning up Area 3 and installing Emerson's AMS Suite predictive maintenance software in the second zone. This was done following what was essentially a standard installation guide.

This was followed by the site acceptance test (SAT), which was a repeat of the FAT using the actual production system, and about two days of work to extensively check out the health of the controllers and of the communications between the systems. The team made sure everything had been configured properly to account for the split.

Building the new control room

To house the new distributed control system, Preem built a state-of-the-art control room in a hardened, blast-proof building, which is considerably sturdier than the one it replaced. Preem also built two IT-style computer rooms, one for each half of the new system. In addition, some of the equipment, such as the redundant inter-zone server, is split between the two system rooms. In many cases, even if something goes completely wrong in one of those computer rooms, there is a standby available from the alternate system. This means much of the plant can continue to operate even if one of the computer rooms is lost.

Summary

The two smaller systems are more closely aligned with the operational philosophy of the facility, increasing the serviceability of the DeltaV system. The risk assessments that must be performed as part of project work are confined to a smaller system containing fewer plant assets. The new control system will also make future expansion easier.

Lessons learned

Several important lessons were learned during the project, including the need for detailed preparation and assessment of the proper place to split the system. Preem needed to account for Guardian Support – which proactively provides critical, relevant, system-specific information to keep the plant current – and licensing for the new system. And the refiner needed to properly track the time and effort needed to upgrade graphics to bring in data from the other zone.

It was also important that Preem kept Emerson on site until everything was up and running smoothly, so there would be no surprises without the appropriate people on hand.

Peter Helmersson is an Automation Engineer with Preem AB. He has 30 years of automation experience, previously as an instrument technician, electrician, and project engineer. He has 20 years of experience within refining.

Sven Winberg is an Automation Engineer with Preem AB. He has 40 years of experience within refining as an instrument technician, working with radio communications, as a network administrator and automation engineer for 15 years.

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