CANADIAN NATURAL RESOURCES LTD.

FACILITIES GROUP

VTScada Enterprise Architecture

WHITE PAPER

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1.0 INTRODUCTION

Canadian Natural Resources Limited (CNRL) is one of the largest independent oil and gas producers in the world. The company operates primarily in Western Canada where the company has been growing both organically and through strategic acquisitions of crude oil and natural gas assets. Over the years, CNRL has acquired and operates over 200 SCADA hosts in Western Canada. While there is recognized value in consolidating and standardizing the SCADA hosts, the overall cost to replace these vital and aging hosts have been prohibitive for all but the most critical systems.

This white paper discusses the value and challenges of SCADA host upgrades at CNRL and how the company is on the path to success using VTScada software from Trihedral Engineering. CNRL has chosen VTScada as its enterprise SCADA software for its conventional oil and gas operations. The company has found VTScada to be transformational both technologically and operationally.

2.0 CHOOSING VTSCADA

CNRL has had extensive experience with SCADA software over the lifetime of the company. The company owns over 200 SCADA hosts and process control systems on over 20 types of software. Many of the systems came to CNRL through acquisitions of crude oil and natural gas assets from other companies. Every company has its own standards for software products, configuration and the visual look and feel of the system. In short, acquisitions can be a standards killer. Over the years, CNRL made attempts to standardize the software within the company without success. The implementation costs did not bring a justifiable return in value, the complexity was higher than necessary and the software did not perform to expectations.

In 2014, CNRL went back to the drawing board to evaluate SCADA software. The company narrowed the list to six titles; five that were widely used in the Western Canadian crude oil and natural gas industry and one newcomer, VTScada, that was new to the Western Canada crude oil and natural gas industry. CNRL quickly found that most of the available SCADA software was needlessly complex, had challenging licensing structures, used dozens of parts and pieces that were individually priced and sold as add-ons, and most relied heavily on Microsoft. Some of the software packages also lacked sufficient device drivers to communicate to CNRL's field equipment without purchasing additional third party device driver software.

CNRL selected VTScada and Trihedral Engineering after conducting an extensive evaluation process on software, vendors, integrators, architecture, technology and future needs. Both the product, VTScada, and the vendor, Trihedral Engineering, were equally important in the decision. VTScada offered a modern software product that was intuitive to configure and met CNRL's technical requirements. Trihedral Engineering offered commercial terms that were simple to understand, worked with CNRL to develop a modernization plan to make VTScada deployments successful and has offered exceptional technical support the entire way.

3.0 TECHNOLOGICAL ADVANCEMENT

The aging SCADA hosts at CNRL are similar to many of its industry peers, as is the common need to modernize them. Traditional SCADA hosts in Western Canada were standalone systems. The host resided in a field office or control room. The host connected to equipment using serial connections and communicated to remote sites over radio networks. IT departments were generally not involved in system administration and many hosts were not accessible over corporate networks.

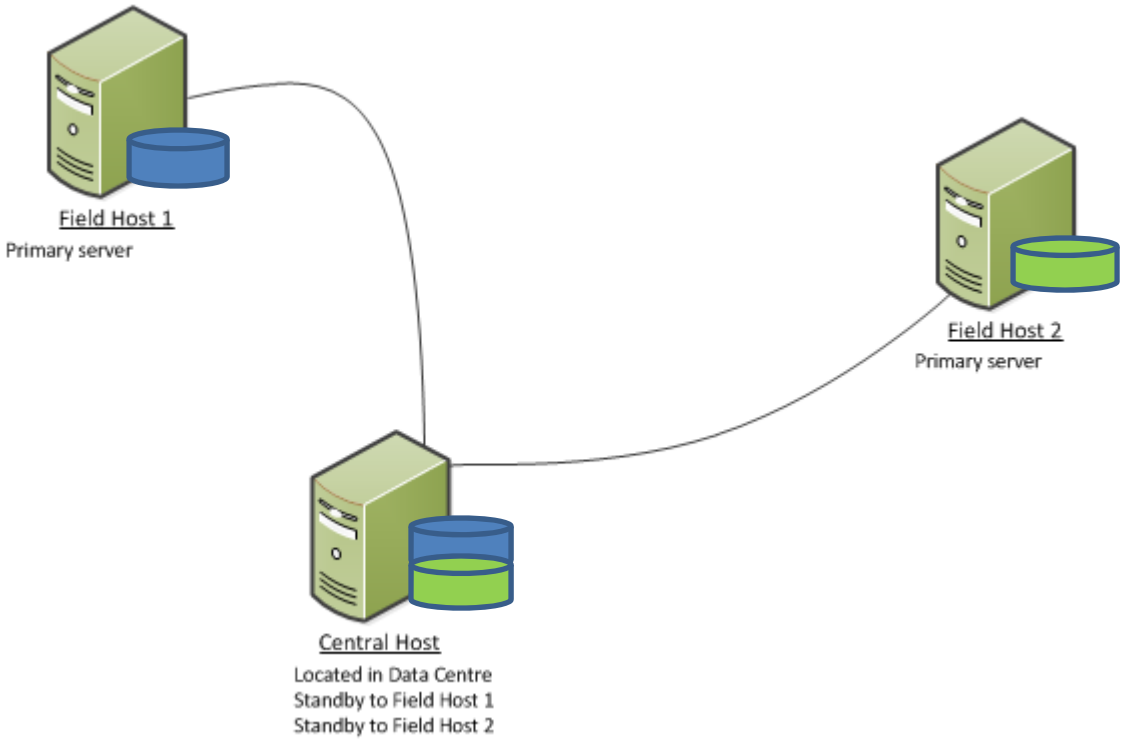
In recent years, the configuration and the role of SCADA hosts have evolved with technology. Some hosts are still deployed in field offices where geography has not made it feasible to install reliable high speed communications, but there are a growing number of hosts installed in centralized data centres. Some serial communications have been replaced by Ethernet and cellular communications. Now typical SCADA hosts interface with other corporate systems such as field data capture and historians as well. User access to the SCADA host has also improved to allow corporate desktops and mobile devices to connect to the SCADA host. SCADA has the capability to become much more accessible to users. The VTScada architecture developed at CNRL has taken these present and future technological advancements into consideration.

4.0 VTSCADA ENTERPRISE ARCHITECTURE

CNRL has created a VTScada enterprise architecture that uses field hosts, local backup hosts and a powerful centralized server farm in the corporate data center. The server farm can expand as required to include more central hosts, dedicated data historians and connections to other corporate systems such as field data capture, measurement and data visualization systems.

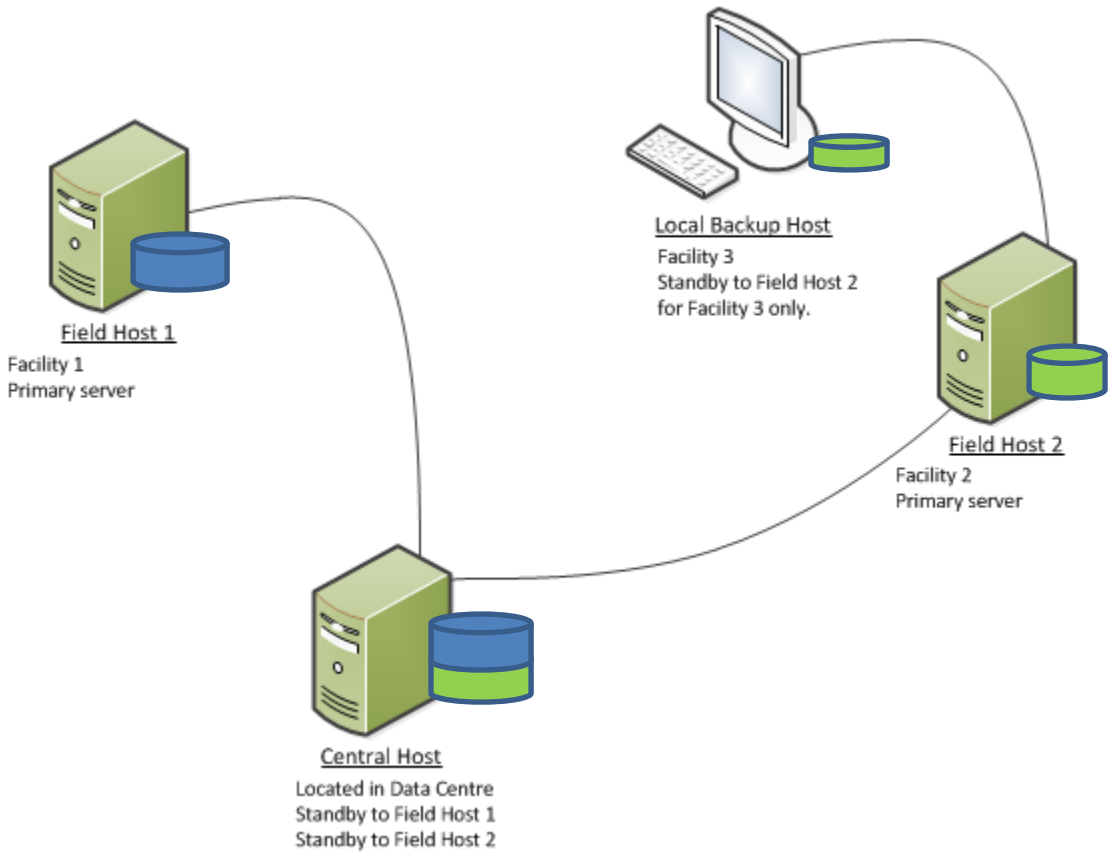
Field Hosts

SCADA hosts are installed in the field for a variety of reasons. CNRL installs VTScada hosts in the field that run as primary servers. Every field host has at least one level of redundancy to the central host, which acts as a hot standby. The field hosts are capable of standalone operations including acting as a local historian that is bi-directionally synchronized with the backup located at the central host in the case of network failure.



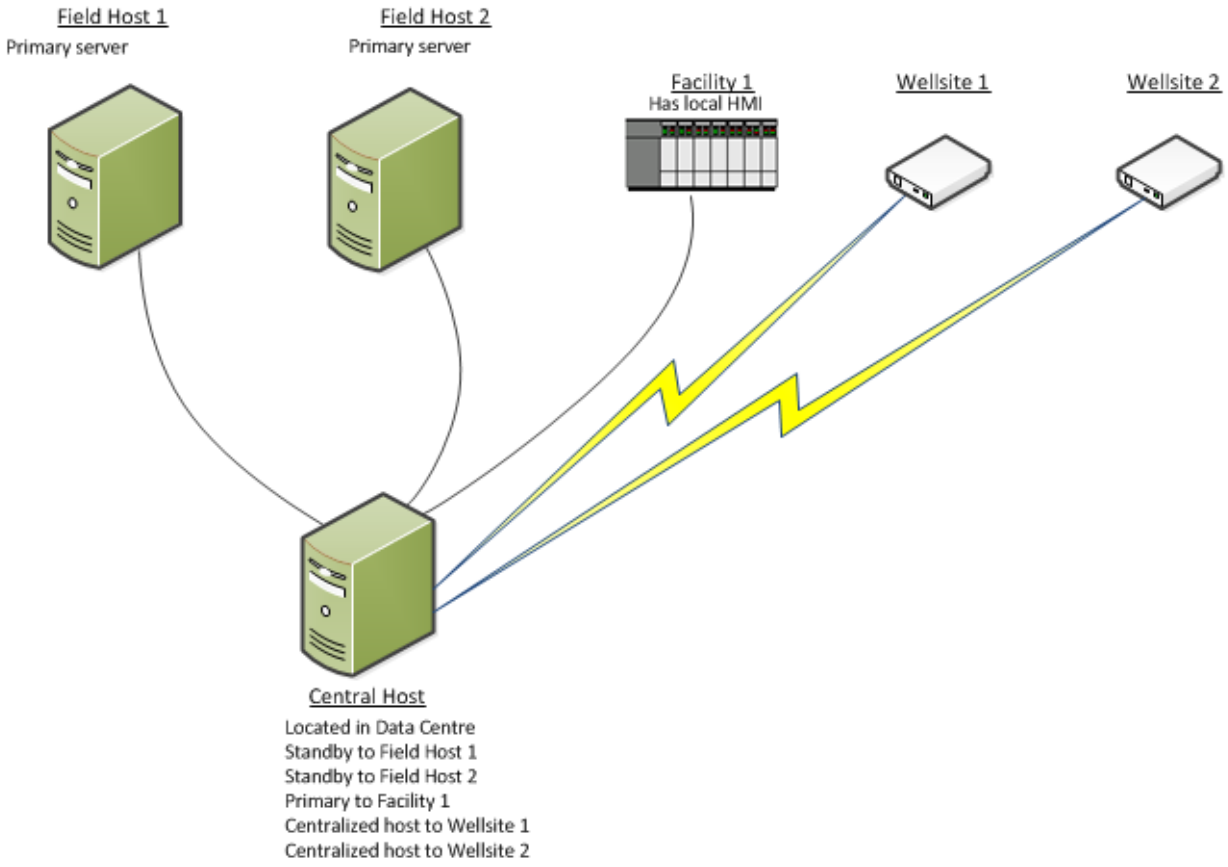
Local Backup Hosts

Field hosts poll data from facilities and wells. It is common for multiple facilities to be configured on a SCADA host, which means the host is required to poll some facilities remotely. Many facilities have a local HMI mounted on the PLC panel. If there is a SCADA or network outage, operations staff can continue to operate the facility using the local HMI panel. If the facility does not have a local HMI panel, CNRL installs a VTScada backup host at the facility. The backup host is configured with just the subset of I/O tags and data historian for that facility. When the primary field host has an outage, the local backup host will switch from standby to active and operate the facility. The facility's local area network remains operational and the VTScada host can communicate to the facility devices.

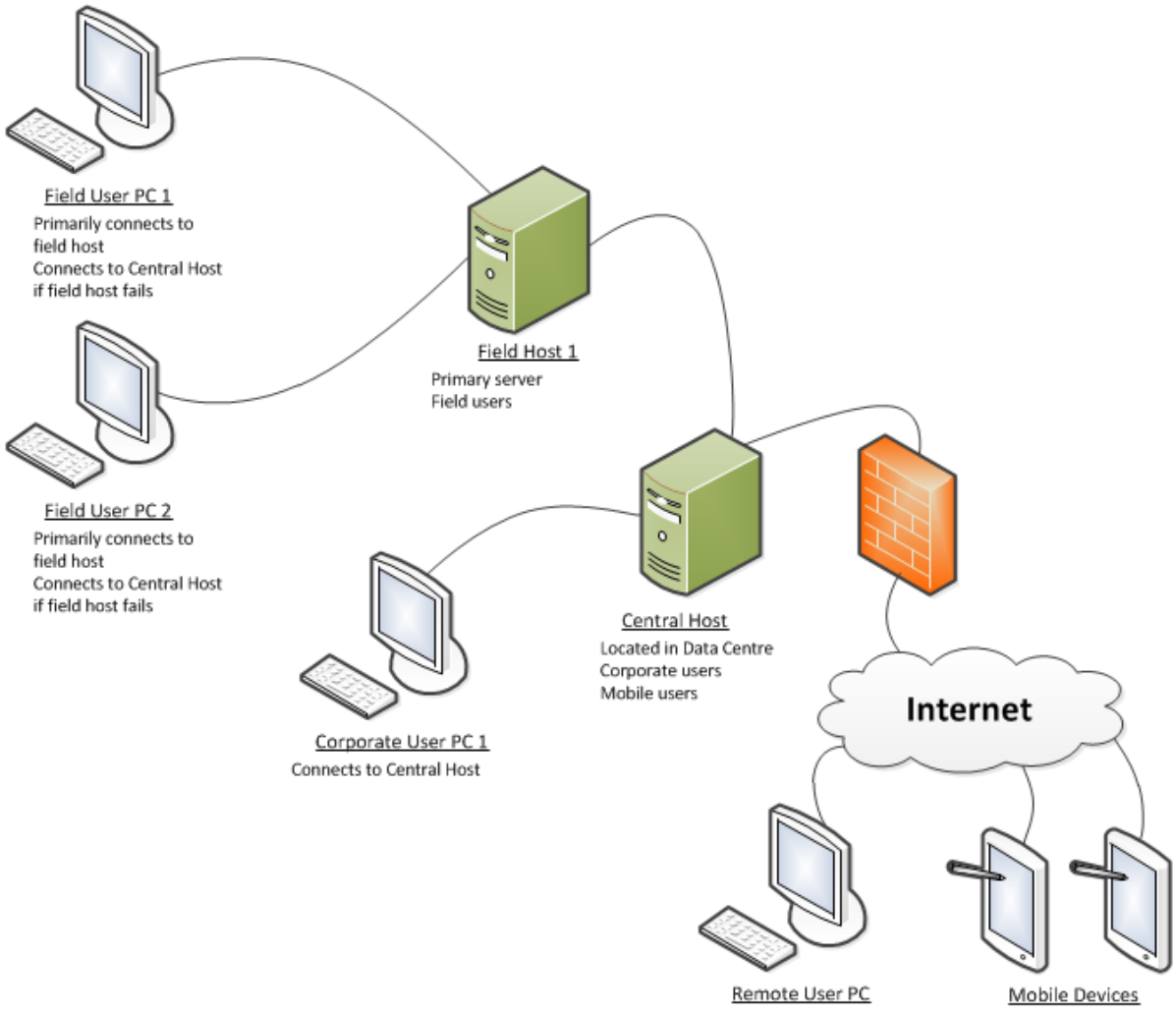


Central Host

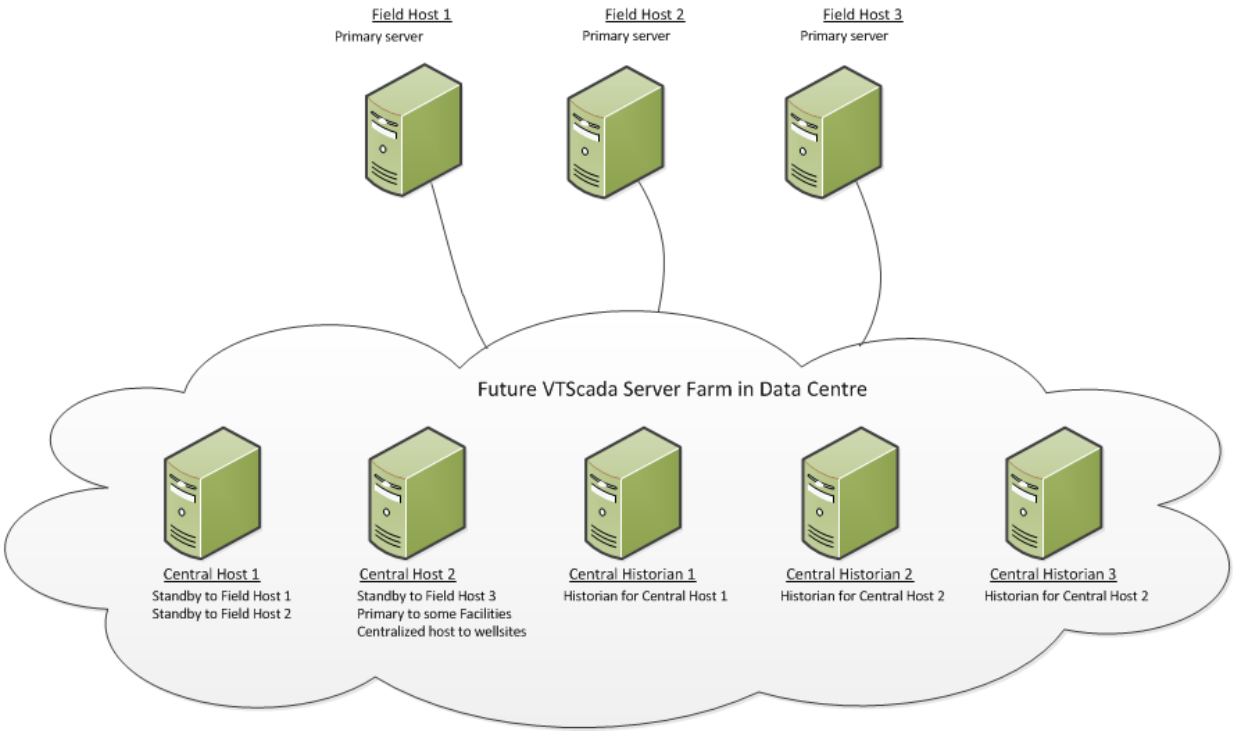
CNRL's central host in the corporate data center takes advantage of VTScada's capability to run multiple applications at the same time. The central host acts as a backup server to field hosts. It is also configured as a primary server for small fields that do not require their own field host.



Users can login to either the primary server or the backup server. During normal operations, field operations staff login to the field host and corporate users in the head office can login to the central host. This reduces the field server load and network bandwidth usage. Corporate users include production and engineering staff that may be interested in running large historical trends and data reports for analysis. To handle data processing, central hosts are configured as virtual machines that can be expanded with processors, memory and disk space as required to meet performance requirements.



As the central host reaches the maximum I/O count and practical limit on the number of VTScada applications running simultaneously, it can be expanded into a farm of central hosts. Initially each central host was licensed for 2.5 million I/O, though this is not a finite limit and the actual final number may vary by user load or operations requirements. Central hosts can be added for real-time SCADA as well as specific uses such storing historical data. This allows dedicated servers to store years of data and process large queries from users without interrupting critical real-time operations.



Having all of the data replicate to a central server farm allows a single interface to other corporate systems such as field data capture, measurement and data visualization systems. This model simplifies configuring a connection to each of the 200 existing SCADA hosts in the field today. The initial system design criteria contemplated 7 Million I/O without rationalization.

In the future when data communications can handle the bandwidth requirements, CNRL will evaluate using the central host as the primary server with a smaller number of strategic backup hosts in the field.

Licensing

All VTScada servers at CNRL – field hosts, local backup hosts, and central hosts – are installed with runtime licenses only and are running as services. Runtime licenses allow VTScada to operate, but do not allow for application expansion or graphics modifications to be authored locally. To provide that functionality, engineering workstations are configured with development runtime licenses to access the VTScada Application Manager and graphics development in the Idea Studio. Updates can be automatically deployed to applications in real time without restart or downtime. All changes and actions are audited using an integrated version control system that operates in a distributed fashion, eliminating reliance on single server. End users login to VTScada using thin clients via a web browser using platform independent HTML5 & Java Script, or the VTScada Internet Client. This gives users, system administrators and integrators very few reasons to login to the live production servers, which reduces the human factor as a source of SCADA downtime.

VTScada Application Layers

To help standardize, configure, and maintain all of CNRL's VTScada applications, the company relies on two VTScada application layers:

1. CNRL Tools OEM layer
2. Oil & Gas Solutions layer

The CNRL Tools layer contains a custom collection of widgets, images and shapes used to configure the graphics. The collection consists of items that are included in the Idea Studio, custom images and custom widgets. For example, numeric value widgets are formatted with standard font sizes and labels. Pushbuttons are available in standard sizes. The alarm list widget provides alarm banners with consistent columns and colors. This ensures all data values on every screen use the same font properties and pushbuttons are consistent sizes across every VTScada application at CNRL.

Integrators cannot use any widgets, images or shapes outside of the CNRL Tools sandbox. Any additional items required for graphics development are approved by CNRL and then added to the CNRL Tools layer for use.

CNRL makes use of the flow computer built into the Oil & Gas Solutions layer, where possible, to quickly configure typical well sites. This helps to standardize well sites and keeps SCADA host upgrade projects affordable and justifiable. CNRL created its own set of standard flow computer graphics consistent with the same look and feel as the CNRL Tools layer widgets and images.

Security

CNRL uses the VTScada Windows Security Integration to manage user accounts and security. This ensures every user has his or her own login credentials with a password that meets the company's security requirements. It also allows the VTScada system administration team to audit the list of users periodically and remove any unnecessary accounts.

5.0 HOW IT ALL FITS TOGETHER

The VTScada software has made it possible to create an enterprise level architecture that encourages standardization and collaboration between fields that would otherwise operate independently. SCADA hosts in every area have their own custom look and feel, color palette and functionality. There is a cost that comes with that customization and a savings that come with using the CNRL Tools and Oil & Gas Solutions layers. Capitalizing on these savings is critical to CNRL as the company treads through the current low commodity price environment. Without the cost savings, many projects would not be possible.

The project costs to upgrade old SCADA hosts to VTScada at CNRL have exceeded expectations. The first projects are usually expensive as customers and integrators go through a product learning curve and develop standards. The initial phase of VTScada upgrade projects already realized a cost savings of 30-40% compared to previous SCADA project costs in the last five years. The initial phase created custom widgets, tag types, templates and other standards that will be used on future projects. CNRL is already seeing the next phase of project costs drop by 50-75%.

Over time, field hosts will be consolidated where possible. CNRL is targeting to consolidate 200 SCADA hosts down to 60 major VTScada hosts. As communication infrastructure improves, more assets will be polled from the central host in the data center environment. The company is also examining the use of VTScada in panel mounted PCs with touch screens instead of traditional local HMI panels. This would eliminate the need to develop and maintain a second set of graphics and database tags for the local HMI resulting in additional cost savings.

Once a VTScada host is implemented at a site, the reliability and user accessibility to data is instantly increased. VTScada replaces a single hosted server with an architecture that includes at least one level of redundancy. The VTScada thin clients allow simple access to SCADA data that was not always possible in the old host. There is a growing trend in the industry that data is valuable. VTScada is expected to play an important role in providing data to operations and corporate staff in the coming years.

CNRL is on its way to becoming the largest VTScada user in the world.