White Paper: PostgreSQL and SunGuide® Software Cloud Analysis

PostgreSQL

As the Florida Department of Transportation (FDOT) SunGuide® software deployments and licensors continue to grow, the need for the software to support multiple database management systems (DBMS) continues to grow. Agencies are looking for opportunities to reduce implementation and maintenance costs. In response to this need, FDOT modified the SunGuide software to add support for SQL Server, in addition to the already supporting Oracle. With FDOT now using the ERwin® data modeler to support the SunGuide software data model, additional DBMSs can be examined to determine if they:

- Offer cost-effective support (licensing and maintenance);
- Meet requirements to support SunGuide software system development, support, and deployment; and
- Provide the robustness required to meet SunGuide software deployment operational needs.

FDOT identified PostgreSQL (Postgres) as a potential addition as the SunGuide software’s DBMS. Postgres is an object-relational, “free,” open source DBMS. It has been actively in use for more than 15 years, making it a mature, complete, and robust DBMS. Postgres is currently used by the University of Maryland’s Regional Integrated Transportation Information System (RITIS) for FDOT’s central data warehouse solution.

Postgres is developed and supported by the PostgreSQL Global Development Group. This group is composed of volunteers employed by companies such as Red Hat and EnterpriseDB. Postgres has evolved into a powerful and widely used DBMS. It can manage very large datasets (e.g., one Postgres deployment manages 4 terabytes). Postgres developers have strived to make Postgres standards compliant. The current Postgres version strongly conforms to the American National Standards Institute SQL:2008 standard.

FDOT’s Central Office will examine whether Postgres is a viable DBMS for the SunGuide software. Initially, Postgres will be researched to determine if it meets SunGuide software needs and requirements at the macro level. As necessary, the review will drilldown on specific issues to perform a more in-depth analysis. Once the research is complete, the findings will be compiled with accumulated information into a final report. The report will synthesize the information into the relevant discussions of whether Postgres is a suitable DBMS for SunGuide software. Recommendations and next steps will be identified as part of the final report’s conclusion.

Currently, the following areas have been identified for initial review. These areas are critical to SunGuide software executing properly and within acceptable performance limits.

1. Platform Support
   This activity will determine what hardware is required to support Postgres. The types of servers and server specifications will be identified for a SunGuide software installation. As part of this activity, the operating systems that support Postgres will be identified. Postgres’ ability to execute on a virtual operating system will be analyzed.
2. Cost and Licensing

While Postgres is known to be free, this activity will examine what, if any, costs may be incurred. Areas with potential cost implications are joining the Postgres community, obtaining Postgres support, and obtaining the latest releases. Postgres can be licensed using a Massachusetts Institute of Technology-style license. This activity will investigate any potential costs and review the licensing to ensure that it is compatible with FDOT’s licensing regulations.

3. Compatibility

This activity will analyze how compatible Postgres is with the SunGuide software and the SunGuide ERwin data model. The investigation will examine functionality, such as connection types, integration with .NET and Java, reserved word lists, and whether ERwin can be used to support the Postgres data model. Specific SunGuide software database usages will be examined, including indexes, keys, auto-increment, character large objects, stored procedures, triggers, and views.

4. Features

SunGuide software is an important tool used by transportation management centers (TMC) to manage their roadways. As such, SunGuide software must be highly reliable and the DBMS that supports the software must be as reliable. With this requirement in mind, this activity will examine Postgres’ availability, disaster recovery, table partitioning (reduce chance of disks reaching capacity), database spaces, data objects usage, and database backup/restore capabilities. Postgres’ capabilities will be compared with what SunGuide software has currently implemented/deployed.

5. Performance

This activity will examine Postgres’ performance and compare it to SunGuide software’s DBMS performance requirements. While FDOT primarily utilizes Windows-based platforms and SunGuide software and its DBMSs are hosted on Windows-based platforms, Postgres’ ability to execute on Windows, UNIX, and Linux-based platforms will be reviewed. Specific performance characteristics, such as database optimization, database operations speed, database logging, connection capability, memory requirements, caching, and others will be analyzed. A comparison of Postgres, Oracle, and SQL Server performance characteristics will be performed by researching and reviewing existing papers on the capabilities of each DMBS.

6. Security

Data gathered and stored by SunGuide software is typically the property of the agency using the software. It is possible that the agency may have third-party data stored in the SunGuide software database where there is an agreement with the third party that the data cannot be distributed to anyone outside the agency. The SunGuide software system (including the database) typically resides on the agency’s internal network. For all of these reasons, it is important that the SunGuide software database be secure and protected from vulnerabilities and attacks on the data. This activity will examine the security features of Postgres and how well Postgres protects data and access to that data. Research on attempts to “hack” Postgres databases will be performed, since its source code is available to download, which makes it possible for malicious entities to identify security weaknesses.
7. Maintenance
Since Postgres is not a vendor-owned product, it is important to examine how its maintenance is performed. This activity will examine the Postgres maintenance cycle. Source code configuration management will be analyzed to ensure that Postgres has an acceptable change management process. The procedure for submitting and tracking change requests will be reviewed; release cycles will be determined; and testing and certification will be identified.

8. Technical Support
SunGuide software is a mission-critical system for agencies to manage their roadways. Agencies expect the software to be available 24/7; therefore, the DBMS supporting SunGuide software must be available 24/7. With these requirements in mind, research into what technical support is provided and what cost, if any, is involved (see previous discussion regarding Cost) will be performed.

9. Current Postgres Implementations
As with any product, it is important to obtain references. This activity will identify candidate Postgres deployments, research the deployments (contact directly if possible), determine if the deployments are similar to a SunGuide software deployment, and compare the successes and lesson learned (if available) to SunGuide software experiences. When meeting with agencies that have deployed Postgres, it is important to ascertain what the purpose of their system is; how much data is stored; how much “data traffic” moves into and out of the database; the number of users; the successes and the lessons learned. Research will be performed to review papers and published comparison information that discusses current Postgres deployments. All this information will be compiled to form a view of Postgres’ status in the database market.
Cloud Computing

Cloud computing has been in existence for many years in various forms. The cloud was originally used to denote the internet in 1994. Since that time cloud computing has been evolving to where it is today. Cloud computing is the use of shared hardware and software provided to users over a network as a service. Within the cloud, there may be multiple servers, databases, applications, and other devices that provide subscription services. Another derivative of cloud computing is the use of virtualization. Virtualization allows one server to virtually represent many servers. In this type of cloud computing, one server could conceivably execute several versions of the SunGuide software and databases.

Agencies are looking for opportunities to reduce the support and maintenance costs of running SunGuide software. Cloud computing offers a potential solution for this need by providing a consistent platform for many software deployments. Having a consistent platform reduces the need to support a wide variety of server environments and configurations that are different for each user. Furthermore, providing a cloud hosted solution together with the software support as a bundle will further reduce cost of procuring support for these components individually.

FDOT’s Central Office will investigate the viability of using cloud computing as a mechanism to deploy the SunGuide software. One of the challenges for SunGuide software is determining what applications and hardware should be in the cloud, outside the cloud, and possibly exist both inside and outside the cloud.

Initially, cloud computing will be reviewed to determine if it meets SunGuide software needs and requirements at the macro level. As necessary, the review will drill down on specific issues to perform a more in-depth analysis. Once the research is complete, the findings will be compiled and accumulated into a final report. The report will synthesize the information into relevant discussions of whether cloud computing is a viable option for SunGuide software implementations. Recommendations and next steps will be identified as part of the final report’s conclusion.

This task will be performed by examining the following areas. These areas are critical to SunGuide software executing properly and within acceptable performance limits.

1. User Interface

Cloud computing implies the use of browser-based or thin client user interface. While this type of user interface is not required, most cloud applications utilize this approach. Currently, SunGuide software utilizes a browser-based interface that supports Internet Explorer 8 (IE8); but there are plans to move the user interface to a thick client because IE8 limits some of the SunGuide software-supported functionality. An application would be installed on the user workstation to install the thick client. This effort will examine how both a browser-based and thick client user interface can be used to communicate with the SunGuide software cloud.
2. SunGuide Software Architecture

   The SunGuide software architecture will be examined to determine the feasibility of dividing the software system between cloud computing (remote hosting) and local deployment (local hosting). The current SunGuide software architecture is modularly designed, implementing well-defined interfaces, which lends itself to cloud computing. This effort will analyze databus, subsystems, and support applications (e.g., status logger) to determine where these applications should reside based on the type of hosting selected. Additionally, compression, data packet combinations, and other optimizations will be examined to improve the protocol communication between the driver and subsystem.

3. SunGuide Hosting Options

   In today’s cloud computing environment, there are multiple methods to implement cloud technology. This effort will identify possible SunGuide software cloud implementations, including physical servers and virtual servers, their pros and cons, and discuss how each implementation would affect the user interface, SunGuide software architecture, on-site requirements, latency, uptime, and security.

4. On-Site Requirements

   Regardless of how the SunGuide software cloud is implemented, each software deployment will require some amount of physical hardware, software applications, and other potential devices. This effort will identify those pieces that will be required for each identified SunGuide software cloud implementation.

5. Latency

   Latency, especially concerning the pan, tilt, and zoom of cameras, is especially critical to obtaining user acceptance of the SunGuide software cloud implementation. This effort will identify and review the performance-critical components of SunGuide software, analyze (through research) how well these components can be expected to perform, and identify any potential architecture alternatives to address latency issues.

6. Uptime

   Current SunGuide software deployments are a critical part of the TMC’s tools for managing congestion. Because of this criticality, SunGuide software is expected to have high availability. Many of the current deployments utilize storage area networks to ensure high reliability of the software system. This effort will examine how a SunGuide software cloud could be implemented to ensure the same type of high reliability as exists today. Part of this analysis will be to determine if the SunGuide software cloud could improve the current reliability.
7. Security

SunGuide software e is deployed on the FDOT District's intelligent transportation systems (ITS) network, interconnected via the FDOT ITS wide area network, and isolated from the public internet. This protects SunGuide software from potential attacks and viruses. Moving SunGuide software to a cloud implementation will require additional security, assuming the SunGuide software cloud implementation is hosted at a non-FDOT facility; thus requiring SunGuide software applications to communicate over the public internet. This effort will investigate the security risks that implementing SunGuide software in the cloud pose and recommendations on what actions could be taken to minimize risks.