

# SmartHIS<sup>™</sup>

# Smart Historical Information System





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### **A. Product Overview**

Smart Historical Information System (SmartHIS<sup>™</sup>) is the historical repository of all the information related to substation operation which is generated under normal operating conditions or during disturbances. SmartHIS<sup>™</sup> implementation will be predicated on the client-server architecture to collect, process, store, manage and retrieve data.

With SmartHIS<sup>™</sup> the operators can store and maintain real-time data from any system point. The data will be store in its exact resolution for a long time.

Multiple access security levels will be provided with firewalls, users ID and passwords. It must come with proxy server and IP masking capability to prevent unauthorized IP access to the server. Security for data access and point configuration is defined for read only; write only, both or none.

#### **ADVANTAGES**

- Massive scalability and performance: the database can be scaled to support millions of devices or time series data points in a continuous flow and perform real-time analysis.
- Reduced downtime: In scenarios where downtime is unacceptable, the architecture of a database that is built for time series data ensures that data is always available even in the event of network partitions or hardware failures.
- Lower costs: High resiliency translates into fewer resources needed to manage outages. Fast and easy scaling using commodity hardware reduces the operational and hardware costs of scaling up or down.
- Improved business decisions: customers can analyze data in real time and make faster and more accurate adjustments for energy consumption, device maintenance, infrastructure changes, or other important decisions that impact the business.



#### Figure 1. SmartHIS<sup>™</sup> system overview

SQL Database	No-SQL Database
Use predefined schemas to determine the structure of data, a change in the structure would be both difficult and disruptive to whole system.	Has dynamic schema for unstructured data, and data is stored in many ways. So you can add fields as you go.
Data tables have complex relation, so the data reading and writing pro- cessing is not fast.	Data structure allows to retrieve all information of specific item in a single query, data reading and writing is faster than SQL Database.
Sequence data query, performance is slow.	Ad-hoc data query, fast accessing historical data at a timestamp.
Built on the idea of "one size fit all", when the database is bigger, read- ing and writing performance is slower, require a larger hard disk vol- ume for storage.	Built on the idea of "one size does not fil all", there is no problem when database is bigger, data can be stored on different partitions.

Table 1. Comparision between SQL and No-SQL Database

### **A. Product Overview**

#### SmartHIS<sup>™</sup> INTERFACE

SmartHIS<sup>™</sup> Interface are applications that collect data from various sources for SmartHIS<sup>™</sup> Server. Collected data includes value, timestamp and quality of data. Common data sources are DCS systems, PLCs, relays, simulation systems, and other data sources.

Supported interfaces:

- ATS Data Client Interface.
- OPC Server Interface.
- OPC Client Interface.
- E-terraHabitat Interface

Substations (86)	<u> </u>	Tag Name	Description	Туре	Historizing
AN_KHANH_110	•	SUBSTN.AKHANH.BUSBAR.C42.ALAR.270P	UNDERVOLTAGE OPERATED	Point	<b>v</b>
E AN_NUHIA_110		SUBSTN.AKHANH.BUSBAR.C42.ALAR.590P	OVERVOLTAGE OPERATED	Point	<b>v</b>
BA_QUE0_110		SUBSTN.AKHANH.BUSBAR.C42.MEAS.VAB	VOLTAGE UAB	Analog	<b>V</b>
BAU_DUNG_110  BEN_THANH_110  BINH_CHANH_220  BINH_LOI_110		SUBSTN.AKHANH.BUSBAR.C42.MEAS.VBC	VOLTAGE UBC	Analog	<b>v</b>
		SUBSTN.AKHANH.BUSBAR.C42.MEAS.VCA	VOLTAGE UCA	Analog	<b>v</b>
		SUBSTN.AKHANH.BUSBAR.C81.ALAR.270P	UNDERVOLTAGE OPERATED	Point	<b>V</b>
BINH_PHU_110		SUBSTN.AKHANH.BUSBAR.C81.ALAR.590P	OVERVOLTAGE OPERATED	Point	<b>V</b>
BINH_TAN_220		SUBSTN.AKHANH.BUSBAR.CB1.MEAS.VAB	VOLTAGE UAB	Analog	<b>V</b>
BINH_TRIEU_110		SUBSTN.AKHANH.BUSBAR.C81.MEAS.VBC	VOLTAGE UBC	Analog	<b>V</b>
		SUBSTN.AKHANH.BUSBAR.CB1.MEAS.VCA	VOLTAGE UCA	Analog	<b>V</b>
E CHANH_HUNG_110		SUBSTN.AKHANH.BUSBAR.C82.ALAR.270P	UNDERVOLTAGE OPERATED	Point	<b>v</b>
E CHI_HOA_GA_15		SUBSTN.AKHANH.BUSBAR.C82.ALAR.590P	OVERVOLTAGE OPERATED	Point	<b>V</b>
CHU_LUN_110  DO DUAN 15		SUBSTN.AKHANH.BUSBAR.C82.MEAS.VAB	VOLTAGE UAB	Analog	<b>V</b>
E CN_CAO_110		SUBSTN.AKHANH.BUSBAR.C82.MEAS.VBC	VOLTAGE UBC	Analog	<b>v</b>
E COMMS			LOLTADE LICA		

Figure 2. E-terraHabitat Interface Tools

#### SmartHIS<sup>™</sup> SERVER

SmartHIS<sup>™</sup> Server has several modules for processing, storage and sharing of data, including:

- Base module
- Snapshot module
- Archive module
- Alarm module
- Message module
- Network Manager module
- Logging module
- Random module
- Replication module

#### **CLIENT APPLICATIONS**

Client applications are built on API to retrieve data from SmartHIS<sup>™</sup> Server for analysis, report, and data sharing.

Client applications are:

- Historical Management Tools.
- ATS Data Link.
- ◆ SmartHIS<sup>™</sup> ODBC Driver.
- ◆ SmartHIS<sup>™</sup> Web Service.
- RealTime Portal<sup>™</sup>.
- ATS Manual Logger.



Figure 3. Connection between nodes in SmartHIS™ system

#### **1. SOFTWARE AND HARDWARE REQUIREMENTS**

#### **1.1. Software Requirements**

SmartHIS<sup>™</sup> System is running on Microsoft Windows Operating System, from Windows 7 or later (Windows 7, Windows 8, Windows 10, Windows Server 2008, Windows Server 2012, etc.)

SmartHIS<sup>™</sup> System is a system running on .Net environment. Minimum requirement is .Net Framework 4.0.

#### 1.2. Hardware Requirements

Hardware requirements (CPU, RAM, Disk Drive) may vary depending on the number of data points to store, the fineness of data, and the duration of stored data.

#### **2. KEY FUNCTIONS**

#### 2.1. Data Collecting

SmartHIS<sup>™</sup> is built with multiple interfaces to collect data: OPC DA, OPC UA, Web Service, Relational database (ODBC/SQL), Custom Data (APIs/SDKs), and Habitat System data.

The data can be collected with various methods:

- Exception: i.e., capable of storing any and all the changes that have occurred in the power system within user-defined thresholds
   Configurable on a per tag basis or per scan point basis.
- Periodically: With a user-selectable storage frequency down to Millisecond interval and configurable on a per tag point basis.

SmartHIS<sup>™</sup> will preserve data timestamps as delivered by the Data acquisition processing. The times will be stored utilising UTC.

Collected data can be filtered to discards the interferences from the data source.

Data buffering shall make sure that data will not be lost if HIS is not available in case disconnection with server at the time the collected data is to be stored.



#### Figure 4. HIS Data Connection

#### 2.2. Data Processing

- SmartHIS<sup>™</sup> supports various data type, such as integer 16, integer 32, integer 64, float 32, float 64, boolean, date-time, string, digital, bloob.
  - \* Various processed data are stored in the HIS including:
  - \* Status Data and the associated quality flags for each status point in the database.
  - \* Analog data in engineering units including the associated quality flags.
  - \* Accumulator data and the associated quality flags for each accumulator point in the database.
  - \* Alarm and Event messages.
  - \* SOE data.
  - Application results.
  - \* Manually entered information, with appropriate time stamps.
- Data can be processed from other HIS Server to make sure Redundancy.
- SmartHIS™ supports calculations using the stored data. The SmartHIS™ report generator will also be able to execute calculations when printing the reports.
- The calculations will be user definable. It is not necessary to generate a database, nor will it be required to restart the system after data editing or entry, or to enter again the calculation steps.
- All the calculations will be execute either by event based (when the value changes) or when the collection period for all the data involved in the calculations has elapsed. The following calculations will be supported:
  - \* Summation of natural, integer and floating point values
  - Absolute values
  - \* Multiplication with natural, integer and floating point values
  - \* Division with natural, integer and floating point values
  - \* Square or cubic root
  - \* Exponential
  - \* Conditional tests (>, >=, = =, <=, <, !=, <>)
  - Boolean operations
  - \* IF, THEN, ELSE constructs
  - \* Trigonometric functions
- In addition, the following types of calculations on data sets will be supported:
  - \* Minimum, maximum, sum, average, standard deviation and range
  - \* Average characteristics over a period of time defined by the user including complete half-hour, hour, day, week, month, trimester and/or year
  - \* All the calculated data will include a quality flag.
- Support SLIM3 compression method to discards values that fall on a line connecting values that are recorded in the Archive but maintain the integrity of the data, and support Snappy compression method to increase storage capacity.

#### 2.3. Data Archiving

- No-SQL database technology: This technology is used to develop historical data management (Historian Data) for industries with data characteristics generated during the operation in a continuous manner (processing industry). This technology allows users to store large amounts of data and ad-hoc queries while saves memory resources and CPU power of the central computer system.
- Any data written to SmartHIS™ will include all of the timestamp with resolution of 1ms and quality codes.
- Once data has been stored in SmartHIS™ it will remain available to applications accessing HIS data until deleted from the SmartHIS™ data store by specific administrator action. That is, removal of data from the source database or the real-time database will not result in removal of the data from the SmartHIS™ store.
- The Data Storage will collect the specified individual telemeter and calculated data (status, analog and pulse accumulator) with quality codes at the following data collection rates:
  - Less than a second
  - One second
  - One minute
  - \* One hour
  - \* One month
  - One year
  - \* Or any data scan rates
- Data storage optimizer allows fast access to data in seconds and save its size the amount of storage devices, therefore ensure continuous work in long time.
- Unlimited data storage period (thus depend on capacity of hardware storage device).
- It will be possible to manually archive any information for longterm storage. In addition any archived information available on-line and will be retrievable without the need to load or unload external storage media (both optical disks and tape units). SmartHIS<sup>™</sup> will issue alarm messages indicating when the storage medium is reaching its maximum capacity in order to remove it and store it off-line.
- It is possible to reload any SmartHIS<sup>™</sup> external storage medium that has been extracted from the system in order to have access to the archived information, without affecting the data collection, archiving and information recovery process. SmartHIS<sup>™</sup> will include a directory that contains all the historical information that has been registered by the system, either on line or removed from the system for off-line archival.

#### 2.4. Data Managing and Retrieving

- Authorized users will be able to access the information stored in the SmartHIS™ from:
  - \* Substation Computers.
  - \* PCs on the Off-Line System Support LAN.
  - \* PCs and / or workstations on the Corporate LAN
- An audit trail of all changes made to the SmartHIS<sup>™</sup> database will be maintained and made available for display and printout.
- The users can configure access rights for each tag.
- Unlimited amounts of historical data can be previewed and printed.
- Recorded data can be retrieved within few seconds.
- Report generate for any data at any time or time period.
- Data Playback system can show all data at any time as you request
- Historical data can be exported to a CSV, HTML, or XLS file.
- Standard database access tools (OLEDB, ODBC) or non-standard (API, Web Service).
- Database can be read and written with standard protocol OPC UA.
- The information stored in SmartHIS<sup>™</sup> will also be accessible via:
  \* SQL queries.
  - \* Modern office applications, such as spreadsheets, word processors and graphic software.

#### 2.5. Redundancy

- SmartHIS™ supports capability archived and automatic synchronization engine data in the operating mode "Hot" or "Standby".
- Historical data backup and restoration



Figure 5. Redundancy Configuration

#### **3. APPLICATIONS**

#### 3.1. Historical Management Tools

- ◆ Management Tools supports multiple SmartHIS<sup>™</sup> Servers.
- Only authorized users are allowed to access the tools.
- It will possible to search tag within SmartHIS<sup>™</sup> Server according to specific filter, such as:
  - \* SmartHIS<sup>™</sup> Server
  - \* Tag Name
  - Tag Type
  - \* Tag Class
- ◆ User can add, edit or remove tag within SmartHIS<sup>™</sup> Server.
- User can retrieve snapshot value or archive value with timestamp and quality.
- User can add, edit, or remove account.
- User can manage data archive.

#### 3.2. Reports

Reports can be created using Data Link tool. Data Link is an add-in for Microsoft Excel. This add-in can allow data to be retrieved directly from within the spreadsheet program. Users can create complex reports and graphs using current or historical data from the SmartHIS<sup>™</sup>.

Data Link includes a tag search dialog, a dialog for viewing point configuration, a dialog for managing connections to multiple SmartHIS<sup>™</sup>, and support for login security to SmartHIS<sup>™</sup>.

- This add-in can support full method to create every complex reports such as:
  - \* Current Value: Retrieves the current or most recent (snapshot) value of a HIS point, based on tag name.
  - \* Archive Value: Retrieves a HIS point value, or evaluates an expression corresponding to a specified timestamp.
  - \* Compressed Data: Returns either all values of a HIS point occurring within a specified time range.
  - \* Sampled Data: Returns evenly-spaced, interpolated sample values for a HIS point or expression over a regular interval.
  - Timed Data: Returns actual or interpolated sample values for a HIS point to match an array of specified timestamps.
  - Calculated Data: Returns one or more evenly-spaced, calculated values based on HIS point values or evaluated expressions. A range of different calculation and sampling preferences are provided.
  - \* Time Filtered: Returns the amount of time over which a HIS expression evaluates as true for a specified time range.
- Data Link add-in has only read-only permission to access to SmartHIS<sup>™</sup> database and real-time database, and support some calculation functions for creation of reports.
- Reports can be uploaded to a website for multiple access.
- Schedule printing of reports on demand.



#### Figure 6. History Management tools



Figure 7. Data Link add-in tool for Excel

#### 3.3. SmartHIS<sup>™</sup> ODBC Driver

SmartHIS<sup>™</sup> ODBC Driver is an ODBC Driver (32 bit) on the Windows Operating System that provides tools to retrieve historical data from SmartHIS<sup>™</sup> Server, through SQL statements.

SmartHIS<sup>™</sup> ODBC Driver makes it easy for developers to use standard interfaces for historical data mining.

#### 3.4. SmartHIS<sup>™</sup> WebService

SmartHIS<sup>™</sup> WebService is an application that provides services for accessing historical data of SmartHIS<sup>™</sup> Server. These services use standard XML language, running on intranet or internet, for sharing historical data to remote users or users who uses handheld devices.

📷 ODBC Da	ta Source Administrator 🛛 🔀
User DSN	System DSN File DSN Drivers Tracing Connection Pooling About
System D	ata Sources:
Name	Driver Add
ATS.HIS	ATS.HIS.ODBCDriver
	Configure
	An ODBC System data source stores information about how to connect to the indicated data provider. A System data source is visible to all users on this machine, including NT services.
	OK Cancel Apply Help

# Figure 8. SmartHIS<sup>™</sup> ODBC Driver in Windows OS

#### WebService

The following operations are supported. For a formal definition, please review the Service Description.

- <u>GetAlarms</u>
- <u>GetAllHisPoints</u>
- <u>GetArchive</u>
- <u>GetArchiveEx</u>
- <u>GetArchiveEx\_MultipleExpression</u>
- <u>GetArchiveExs\_MultipleTimeStamp</u>
- <u>GetArchives\_MultiplePoint</u>
- GetArchives MultipleTimeStamp
- <u>GetCalculate</u>
- <u>GetCompress</u>
- GetHisPoints
- <u>GetHisPoints DataType</u>
- <u>GetHisPoints PointClass</u>
- <u>GetSample</u>
- <u>GetSampleEx</u>
- GetServerNames
- GetSnapshot
- GetSnapshots
- Login

#### Figure 9. Provided Services in SmartHIS WebService

#### 3.5. Web-based Real-time Data portal subsystem

- This application subsystem can allow external users retrieve real time data and historical data.
- The benefit of web-based interface includes:
- \* Using new technologies (HTML5, CSS3, SVG...)
- \* Only a device with web browser is needed from client side (pc, laptop, tablet, smartphone ...)
- \* Can connect to multiple data sources
- \* Ensure reliability and security
- \* Multiple users can connect at the same time
- HIS data will be available for display in tabular, graphic, chart and gausses.
- Any quality code, tag, timestamp or data value stored for any HIS data value will be displayable.
- It will be possible to display any calculated data value.
- Reports can be presented in both real time mode and historical mode and can be downloaded in Microsoft Excel format or pdf format for reading / printing.
- It will be possible to notify any alarm and report though SMS, Email (text, voice).
- User can query historical data with SMS query command.



Figure 10. Real-time Data Portal Structure



#### Figure 10. Real-time and Historical Data presented on Web

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