

***CHAPTER 04 - Smart Water Management with “scada” System***



**4.1 Introduction:**

Dhaka Water Supply and Sewerage Authority (DWASA) is the Government authority for water supply and sewage disposal of the city Dhaka, DWASA operates a big water production and distribution network. The pumping stations equipped with deep tube wells, are the main network nodes of the system. DWASA management wants to implement a SCADA (Supervisory Control and Acquisition) system in the network, complete with remote monitoring and control. For that reason, DWASA management had formed a committee to produce a conceptual overview to WASA for a unified, fully integrated Central SCADA Platform with Interactive loT and HMI Dashboard. The report meant to provide a brief overview of the architecture and framework that has been envisioned by the SCADA Committee for deploying the ideal solution at Dhaka WASA. This automation guideline was meant to guide water production and distribution monitoring and control processes mainly.

The following were the scope of work for that committee:

1. SCADA Software Specification Preparation
2. Detail specification preparation of required field devices
3. Specified of Standard Communication Protocol
4. Proposed common platform to integrate DTW, Meter, Valve and Treatment Plant's SCADA or non-SCADA data.
5. Compatibility assessment of existing piloting SCADA.

Although I was not a formal member of the committee, as divisional head of Planning and Design (Electrical & Mechanical) division I worked with the team, joined their meetings and gave inputs into the planning.

**4.2 What is SCADA:**

**4.2.1 SCADA stands for: Supervisory Control & Data Acquisition**

* It is a technology to collect data and monitor the performance of production and distribution processes.
* It is an application that can help to increase efficiency, lower costs and increase the profitability of operations by turning data into information.
* Reduce manpower needed for operation and monitoring activities thus reducing costs.

**4.2.2 Components of SCADA:**

SCADA encompasses two components:

Component 1:The first component is the **equipment** that is installed in water distribution network we want to monitor and control.

Component 2: The second component is the network of intelligent devices called Remote Terminal Units (RTU) and/or Programmable logical controller (PLC). RTU’s and PLCs are able to send and receive information for monitoring and operation.

* + 1. **Activities of a SCADA System:**

1. Data acquisition through sensors from various field devices.
2. Data transfer using communication network to various RTU, Local SCADA or Central SCADA.
3. Data processing and data or information presentation
4. User authentication and user access control into the SCADA monitoring and control system based upon various levels of user roles.
5. Instruments Control – Control various pumps motors, valves, chlorination systems remotely.
   * 1. **SCADA system monitoring parameters for measurement and control:**
6. Pump on/off & pump running time
7. Power consumption
8. Chlorine cylinder full or empty
9. Pressure & flow
10. Failures & pump malfunctioning
11. Water level in well/ Dry-running protection system
12. Water sensor in DMA chamber etc.
    * 1. **SCADA system outputs:**
13. Alarm analysis – Causes of alarm and response to alarm from DWASA.
14. Trend analysis – Analyze various patterns of device performance, operator behaviour & mistakes, system or failures, maintenance work, impacts etc.
15. Periodic reports – daily, weekly, monthly & yearly etc.

**4.3 Existing Status of SCADA:**

Present and future use of SCADA:

At present DWASA uses SCADA mainly for:

* “Visualization” = see what is happening, monitoring.

In future DWASA can use SCADA for

* “Automation” = work with data in a more comprehensive way and operate remotely, example – Automated or semi-automated control of a pressurized water network.

In 2017, Dhaka WASA started the piloting project work for DTW (Deep Tube Well) SCADA, and has covered 163 out of 913 DTW under SCADA systems. Around 8 (eight) company was done this work. Above them 77 DTW has done by one vendor and he had sold the License software to Dhaka WASA and also found that the software is not perfect to fulfil WASA requirements. All SCADA are running under the vendor-controlled demo software. Vendors used several different field devices as well as different demo software which is running at vendor end. On the other hand, total 23 used such communication device which are infeasible to integrate into central SCADA.

Two type of standardized Demo software was used named Rockwell Talk View and SIEMENS WINCC software. On the other hand, one company had used own developed customized software which is cloud based hosting.

Water Treatment Plant SCADA: In Dhaka WASA, Three WTP has used SCADA for Plant. All SCADA brand are Schneider.

**4.3 Dividing the Requirements:**

The Committee divided WASA's requirements for SCADA automation for smart water management into 4 parts

Its compatibility from Deep Tube Well, District Metered Area and Water Treatment Plant - all the way to Central SCADA will be possible as long as standardized along international best practices. The four requirements are described with their functionality as below.

1. Field Devices
   1. Collect data from Field
   2. Monitoring Status of Equipment
   3. Control Equipment
   4. Communicating with remote station
2. Communication Network
   1. Use safe & standard protocol to communicate or send/receive data
   2. Between field devices and Central SCADA at least two types of connection.
3. SCADA Software Platform
   1. Application Data Acquisition & Supervisory control by Zonal Personnel
   2. Device Configuration
   3. Central data preservation and distribution
   4. Template creation for operation and management
4. Common Infrastructure and Computer-network & hardware
   1. Establish Data center or operation room
   2. Establish communication tool
   3. Install software
   4. Establish video wall

**4.4 Compatibility assessment**

DWASA aims to integrate of the existing SCADA with Central SCADA. Future expansion and up-gradating will be made under proposed system.

Following challenges were determined-

1. Current SCADA servers are located remotely on vendor’s servers or on cloud servers, not in Dhaka WASA office.
2. Each contractor implemented its own device and software.
3. No compatibility in Field Remote Terminal Units, Communication & Network.
4. Current SCADA software makes the integration into Central SCADA infeasible.
5. Dhaka WASA local office does not possess the ownership of the data and server control.

**4.5 Major Integration steps:-**

1. Micro-controller based system shall be replaced with PLC (programmable logic controller)-based system which have compatible communication system for hardware compatibility.
2. Electric meter, Water Flow meter shall be connected to PLC in order to maintain records of power consumption and water supplied.
3. Old software cannot be integrated into new central SCADA. Only hardware can be saved through required modification to certain degree.
4. Those are general requirement. Individual system in each DTW shall be closely examined to determine required modification and/or replacement in order to integrate to zonal or central SCADA.

The SCADA system (Supervisory Control and Data Acquisition) is a complete system consisting of hardware and software, whereby information regarding the status of pumps and regulation valves, flow rates from pumps and distribution pipes, pressures in the network, water's level of PTWs, water consumers consumption in Dhaka is sent to a central server (computer) in the desired local and central offices of DWASA.

With this information, DWASA has insight into the water balance within the distribution network, and it should be able to take necessary corrective measures to control the flow and pressure through the DMAs of Dhaka city.

**Design Considerations for Scada Systems:**

a) Electronic instruments shall utilize solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.

b) All instruments shall be suitable for continuous operation;

c) All digital outputs shall be volt free; transmitting a sensor’s output as a voltage over long distances has several drawbacks,

d) All instrumentation systems for use out of doors shall be protected to IP 65 for sensors and transmitters, while enclosures under submersible conditions shall be protected to IP 68;

e) All analogue displays shall be of the digital type with no moving parts utilizing back lit liquid crystal diode technology;

f) For transmitting instruments, output signal shall be 4-20 mA DC linear having two wire system.

g) Unless otherwise stated, overall accuracy of all measurement systems shall be .5% of measured value.

h) After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.

i) The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.

j) The instruments shall be designed to work at extremes of the ambient conditions of temperature, humidity, and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion.

k) Lockable enclosure shall be provided for the field instruments wherever required

l) All field instruments, and cabinets / panel-mounted instruments shall have tag plates / name plates permanently attached to them.

m) The performance of all instruments shall be unaffected for the $10% variation in power supply voltage and 15% variation in frequency simultaneously.

n) All wet parts of sensors shall be made out of non-corrosive material capable of working with chlorine content of 5 ppm

o) For all instruments (transmitting analogue signals) installed in the field, surge protection devices (SPDs) shall be provided at both ends of the connecting cable for the protection against static discharges / lightning and electromagnetic interference.

p) Pressure transmitters shall be provided with two valve manifold and a test port, so that in situ calibration can be carried out.

q) Two wire transmitters shall be provided with on-line test terminals.

r) The ranges of all instruments shall be suitable for the application in the process.

s) Instruments of similar type shall be of same type of specification for appropriate inventory of spares, ease of maintenance and training.

t) The Bangladesh agents of imported equipment should have establishment to provide after sales maintenance facilities.

**Equipment needed in a SCADA system:**

**Various equipment and tasks of SCADA system:**

* Bulk water flow meter - A water flow meter is needed for measuring the amount of water passing through a pipe. The meter creates a pulse signal and transmits them to SCADA system or data loggers.
* Pressure Sensor - Pressure sensor is capable to detect the system pressure and convert it in an electrical signal. This allows the pressure to be monitored by SCADA or other relevant systems.
* Water Level Sensor - A water level sensor is a device that relays information back to a control panel to indicate whether the aquifer has a high or low water level.
* Chlorination Sensor and Monitoring - Chlorination Sensor used in DWASA SCADA System shows if the chlorination unit is active or inactive. The Chlorination chamber has separate monitoring of the chlorine system.
* Electric Meter - Electric Meter is sued to measure the amount of electricity use. This meter is also connected with SCADA system so that the energy consumption can be monitored.
* RTU (Remote Terminal Unit) - Sensors and process controller devices are attached to remote terminal units (RTU). Multiple remote terminal units at different sites transmit the data collected to a single master station which displays the information in a browser.
* PLC (Programmable Logic Controller) - Data from sensors on individual assets is transmitted to the PLC. The PLC translates that data into a format that can be used by the software. Users access the data through the HMI on the software. If the data crosses certain thresholds, a maintenance work order is created.
* HMI (Human-Machine Interface) - An HMI SCADA system, or SCADA Master, can provide several helpful extensions for network alarm management of monitoring equipment. If connected to an RTU, the gathered data can be filtered, analyzed, and monitored against functional standards. Out-of-range data can generate alerts to operators or maintenance personnel as required.
* Internet/radio frequency/GPRS - Wireless SCADA systems are the ones in which the communication between the Remote Terminal Unit (RTUs) and Human Machine Interface (HMI) is wireless in nature. General Packet Radio Service (GPRS) is the commonly used wireless technique used in wireless SCADA systems.
* Data base, cloud, server, SD card - To store the data and operated the equipment.
* Physical monitoring facility - Reading and analyzing on Desktop Computer, Laptop Computer, mobile, tablet, staff, and panel - To see the data and use it accordingly.

**Standard Communication Network and Protocol:**

Since Central SCADA is to be used at Water treatment Plants and a large number of Deep

Tube Wells including DMA, standardization of key components is crucial to integration

of all facilities into Central SCADA.

Interface equipment to enable communication between water supply system field

instruments, PLC's, RTU's, LCC SCADA at WTP's, RTU's at DMA's and Local &

Centralized Monitoring Control Center at DWASA.

Supply, installation, testing commissioning of RTU's along with GPRS modem at DMAs

o transmit flow, pressure and actuated pumps data to Locals and Central Monitoring and

Control Centers (L&CMCC) for monitoring and control.

The monitoring and control of all the DMAs in the Water Supply system shall be at

Locals and Central Monitoring and Control Centers, for this purpose Bulk flow meters

and pressure transmitters at strategic locations in the DMAs shall be provided along with

RTU's, GPRS modem and shall be interfaced with the Local Monitoring and Control

Center. The instrumentation provided at the DMAs shall be capable to measure and

record reverse flow and uncommon flow shall be alarmed at the Locals and Centralized

Monitoring and Control Centers.

The communication equipment required to achieve this interfacing complete with all

required accessories shall be supplied, installed, tested and commissioned under this

contract.

Data acquisition and processing

Processing: The data acquisition, processing and interfacing with

the Locals and Centralized Monitoring and Control Centers of entire water supply

scheme of Dhaka city is covered under this package. The domestic water meters data

shall be collected and this data shall be fed into the Centralized Monitoring and Control

Centre SCADA system for records and further analytical purposes.

System Console: Control room furniture (system console) including but not limited to

control console for dual redundant workstations, desk for engineering workstations,

Servers, ODMS workstations and printer compartment along with chairs. The system

console design shall be submitted to the Employer for prior approval.

**Protocol for SCADA:**

1. It shall support all telemetry protocols such as Modbus, DNP 3.0, IEC 104, MOTT etc

2. Users should be able to retrieve data from RTU data log in case of communication failure using DNP3.0 communication.

3. It shall support OPC DA and OPC UA communication.

**The minimum requirements of the SCADA Software include:**

Support situational awareness graphic development.

Adherence to ISA 101 standards and guidelines.

Support business system integration using industry accepted protocols (SNMP, OPC, etc).

Support 3rd party systems and control vendors (SNMP, etc.)

Provide a seamless and simple transfer of programming and configuration from a

Development environment to the Production Environment.

Support a modular object-based development environment with direct links between graphic elements and control elements as in the latest Industrial robust PLC systems

built in full featured Trending package.

built in Reporting capability

built in Alarm / Event Analysis and Alarm Management tools.

support key performance indicators, dashboards and overview displays

SCADA Historian - Operations Data Management System (ODMS)

The historian will be a key source of data for the DWASA Integrated Intelligent Water

Operations Center (IIWOC) to find data trends through analytics. The minimum

requirements of the SCADA Historian include:

a minimum of five years of real-time data must be actively available to be

retrieved and displayed both on the SCADA Operator Workstations and on systems in

the DMZ.

archive data will be available for comparative historical trend analysis on the

SCADA Operator Workstations and on systems in the DMZ.

SCADA systems reports will be capable of being generated on demand from

CADA Operator Workstations and on systems in the DMZ. Does not need to be

embedded in HMI Screens

support data exchange with external SQL Databases.

capability to create dashboard without the need for third party software packages.

SCADA Application change Management

B.

The SCADA System shall maintain a record of changes made to the application. The

minimum requirements of the SCADA Software Systems include:

provide centralized software application configuration version control.

provide centralized patch management and platform version control.

provide a Disaster Recovery point for the HMI Applications.

. Remote and Mobile Access

IT, Operations, and Maintenance staff members may require remote access to SCADA

System components, such as the SCADA Network equipment, HMI workstations, PLCs,

Vendor Package Systems, and the Historian. The minimum requirements for SCADA

Remote and Mobile Access include:

on-call SCADA and Maintenance staff may require remote access to the SCADA

Systems from anywhere in the DWASA service area, both inside the SCADA network and outside of the SCADA network during normal business hours Operations and Support staff may require access to SCADA from remote water facilities.

Secure remote access could be provided for access to the corporate network for

email and network maintenance.

IT will require remote access to networking equipment from a central location /

IIWOC (Intelligent Integrated Water Operations Center) & IISOC (Intelligent Integrated

Security Operations Center).

Training

Training should include configuration interface, troubleshooting the SCADA system,

display building, security, and ongoing operation of provided computer software

components.

Maintenance and Support with the DBO

The Contractor shall include maintenance support for all software components of the

HMI system software.

The Contractor will provide SCADA software service support, updates, and upgrades for

a period of at least 5 years following completion of the Design and Build Phases of the

DBO (Design, Build and Operate) Contract.

Detail Specification of SCADA plugin application packages (annexure- 5). This is not

enterprise or DCS software, it's a application which will be delivered as part of central

Command Center for below benefits.

. As DWASA is integrating a very large water distribution network, it is not always possible

to keep an eye on every condition on field so to provide decision support to DWASA

Management and stakeholders regarding abnormal conditions or deviations smartly,

package is offered with capabilities of alarms/incident/calibration/maintenance and

asset management, so dwasa will not only able to monitor but also will be able to

handle situations in more better way. Also DWASA will be able to justify ROI on

investment with managing maintenance/calibration activities on time, managing

complete life cycle of their asset, optimizing energy efficiency and water quality

Now a days these trend is adopted in most of central command control platforms for

water, smart cities and smart infrastructures globally to empower decision making fo

optimizing sources and justify ROI. So DWASA will be also able to set global benchmark.

DWASA management have decided to go with all monitoring and control will happen

from Zonal scada and central platform will capture data from zonal scada, it must have

redundancy and web clients for local monitoring and control operations. Also addition

to that, historian storage up to 1 year is recommended, but it DWASA need it for 3 year,

there will not be any license cost implication

Central SCADA will not directly fetch data from PLC/RTU, but it will fetch data from

Zonal SCADA. It should be like that only. But as zonal scada is responsible for monitoring

and controlling. It should have required remote access clients (Mobile/Web) for secured

monitoring and control from field area and it must have redundancy. So continuous

operations can be ensured at zonal offices also and there will not be any loss of data on

central SCADA.

Zonal SCADA must have web/mobile clients available for their local teams (field,

maintenance, operations) to have easy remote operation, specific to their area, and

advantage of it is also that local management of change and assignment from its

respective authorities of Zonal SCADA office. Also it can have secured and limited access

across respective zonal scada teams. However offered Central SCADA should have web

clients/mobile clients for DWASA stakeholder in order to have situational awareness

from complete water distribution network with required, analysis, reporting,

monitoring and decision support.

Safety Feature - Over Current, Under Current, Unbalanced. Current, Over Voltage, Under Voltage, Unbalanced Voltage. Over voltage in any phase Pumping low water level, Excess delivery pressure, Inverter Faults and Trips. Maintaining preset delivery pressure. Pump operation time scheduling for unmanned operation.

Alarm Feature - Pump production efficiency Alarms, Low Flowrate Alarm, Over current alarm, phase loss/unbalanced alarm/high water pressure alarm/network fail alarm etc.

SCADA and Maintenance - SCADA is a useful tool for monitoring and operation of the equipment. SCADA is providing detailed information about the running machine. This can be used to customize a maintenance plan.

**Importance of proper installation and maintenance:**

* Increase Life expectancy of equipment
* Maintenance Cost reduction
* Safety during operation.

**Importance of the site survey and pay attention to the detail:**

After equipment has been installed, a site survey visit needs to be conducted to check if the equipment is installed properly. We have to check, is everything installed properly according to the contract. The site acceptance test is of great importance. Wires and cables should be lined up, coated and tagged. Connections should be watertight. Inspection team should make sure that, the chamber is covered, proper channels are there, and tag numbers are there.

**The possible solution for simple computer problem can be:**

* Update Computer Operating system – Windows/Linux regularly.
* Using firewall using the antivirus system and update them regularly.

7.7 General Recommendation

1. To build a staff awareness and Consensus

2. All staff, from senior management to the crew, should understand the SCADA and

automation systems

3. Building the understanding of top-level management on Automation

4. Middle management and staff must understand their roles and responsibilities on

automation, since it requires a long-term, combined effort from all departments in the

utility.

5. to establish any automation specially SCADA and related work should follow the

guideline and verified by SCADA team

6. SCADA team should be supervise, advice and updating the technology as required.

Every year should be check the technological change and after 5 years could be rebuild

the master plan.

7. All project and stockholder should follow the guideline of Automation Masterplan

8. Intensive training will be organized on SCADA and Automation.

8.0 Conclusion:

However, SCADA is not only brand new concept using ICT but also ordinary

management based concept. Therefore, primary and systematic operation and

maintenance of water supply system is very critical issues above all. Integrated Water

operation control and command platform is a future oriented water management strategy

by integrating ICT based water management technology. So, it is managing the entire

process of the water production source as well as water cycle scientifically and

systematically above all.

Aligning with master plan for automation will best impact on Smart water management

systems. The outcome will be sustainable provision of a more reliable, improved and

climate-resilient water supply in Dhaka city. Sustainable managerial capacity of district

metered areas enhanced DWASA's managerial and technical capacity will be

strengthened to keep Smart Water management Systems.