Data communication between Distributed Control System, Serial Device and Android App

By

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Submitted to the Department of Electrical & Electronic Engineering
in Partial Fulfilment of the Requirements
for the Degree
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(Electrical & Electronic Engineering)

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CERTIFICATION OF APPROVAL

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TRONOH, PERAK

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Moataz Zoheir Mohamed Ramadan

ABSTRACT

Nowadays, the world is searching for new technologies or new methods to make the controlling process more automated or easier to access. This search has widely increased to reach such technology starting from HART technology and passing through Asset Management system (AMS). So developing such technology will open the field for another technologies to be introduced in the industry. One of those technologies is Android. Many of the machines in the plants have been purchased with its own control system , this system consider a remote system comparing with one in the control room which in most of the time the control system is Distributed Control System (DCS). This remote system is connected the control system through alarms and trips only. So Data communication between the remote system (Serial Device) and DCS was a must to reach any readings from the remote system. This data communication can be achievable through the Modbus. To reach more and more automated plants, the android technology has to take place in such industry which you can receive the real-time reading of any machine in the plant on your android platform (Mobile phone or Tablet). And the methodology of such technology can be achieved by many steps, starting with creating a database of readings of the DCS, this database has to be an online database to be able to retrieve data from it as long as you want, and the final part is to design an android application that responsible to retrieve the data from the online database. Such technology makes you to reach the readings of the plant from anywhere at any time. This technology is a step to create and fully automated plants, and you can supervise the plant from anywhere as long you an internet connection.

ACKNOWLEDGEMENTS

In the opportunity of writing this report, I would like to express my gratitude to all those who helped me to successfully complete my Final Year Project, starting and ending with my Lord, Allah, who granted me the opportunity to success completing this project, Moreover, I would like to thank my supervisor Dr. Mohamad Naufal, he was always there for me whenever I needed help, he was always supported me, he saw the best in me, he was driving me always to the best , he never stopped to give me the support and encouragement and he was an older brother all the time.

In the meantime, I would like to thank my university, (Universiti Teknologi Petronas) for offering such great opportunity in which -I think- all the university students got the chance to live the real-life project experience and live the life of getting to know a new staff to get the best out of your project.

At the end, all praise and thankfulness should return to Allah, Lord of the worlds.

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LIST OF ABBREVIATIONS

Distributed Control System (DCS)

Bently Nevada (BN)

Application (App)

Egyptian Liquefied Natural Gas (ELNG)

Input/output (I/O)

Programmable logic controller (PLC)

Database (DB)

1.0   Introduction

Sometimes control room is where the operator control and monitoring the site or the plant isn't always taking control of all the plants , so my project is a step to reach the fully control and deliver it to the control room by trying to connect the systems that can't reach to the control room to the DCS system where it's in the control room , not only that but also doing an online database of the readings and the events that happened in the control room so the operator can get access to it easily from his smart phone and he can also monitoring the status of a specific machine from home.

The project in simple words is a data communication between any system that planted in the site and the DCS that you can find it in the control room and after that the DCS has the ability to show whatever is going on in the remote system from the control room but not only that but also the readings of the remote system can be displayed on your smart phone that support android. So it's data communication remote system, DCS and a smart phone.

So in technical words, the data of the serial device will use a specific protocol like the Modbus to be sent through a cable to the DCS by calling the registers of the serial device and after displaying the data to control room, those reading will be stored in a database where the android app will retrieve the data from.

1.1   Background:

Technology is increasing widely everywhere and people start to think about it as it's the daily life of them such as smart phone s have become the best friend of the human. To widen this concept in a bigger scale like an oil and gas plant, my project is a step to bring the whole plant to your small phone. Sometimes taking control of what's going on in the plant or the field is one of the goals that any management want to reach, so taking one step to reach the fully control of the plant is so important and the plant and the operator will reach the full control plant by controlling the field from anywhere not a specific place .and one way of the control systems is the DCS. DCS is (Distributed Control System) that uses computer to simulate what's going on in the field or the product line and controlling the process by for example controlling a pressure inside tank

by opening or closing the inlet or the outlet valves. And you can also connect it with a primary element that can measure a specific property and after that the transmitter send it to the DCS. DCS also one of the main functions that he has that he can control the quality of the product by controlling its properties. (1) DCS is a distributed control system which is widely used in many application in industrial fields such as "power plants (thermal – Hydro), Oil and gas industry and many other industries. As the importance of such system, the developing in such field is quite mature to increase the efficiency of the industry. So searching for improving the function of this system will led to take another step to new technology, not only that but also connecting between such technology and the modern technology such as mobile phone

DCS consist of three main parts as it's shown in figure 1 and figure 2:
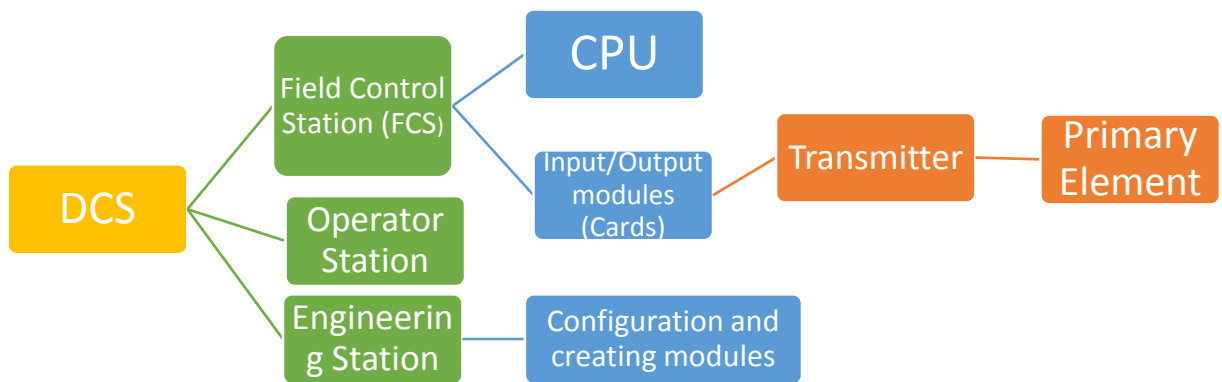
Figure 1: DCS Main Parts

As shown in figure 1 , the DCS CPU is always inside the field station which is responsible to take the action and analyzing the data that it gets from the I/O modules through programmable codes he execute and reply to the modules

Figure 2: simulation of DCS parts

As shown in the previous figure, the input signals come from the primary element and the transmitter as 4-20 mA and after that the CPU process the signal and send it to the operator station. The engineering station is the one used to program the CPU and set the values and the parameters of the element.

And here's a flow on how the DCS works

Figure 3: DCS Flow chart

In simple words, the input receive a signal from the transmitter and try to convert it from analog to digital so the CPU can analyze it and process i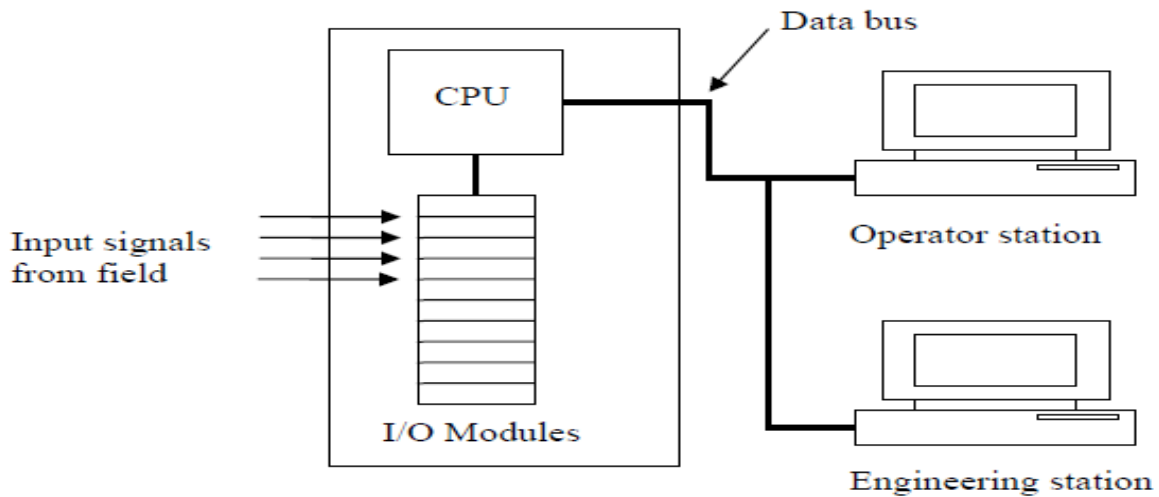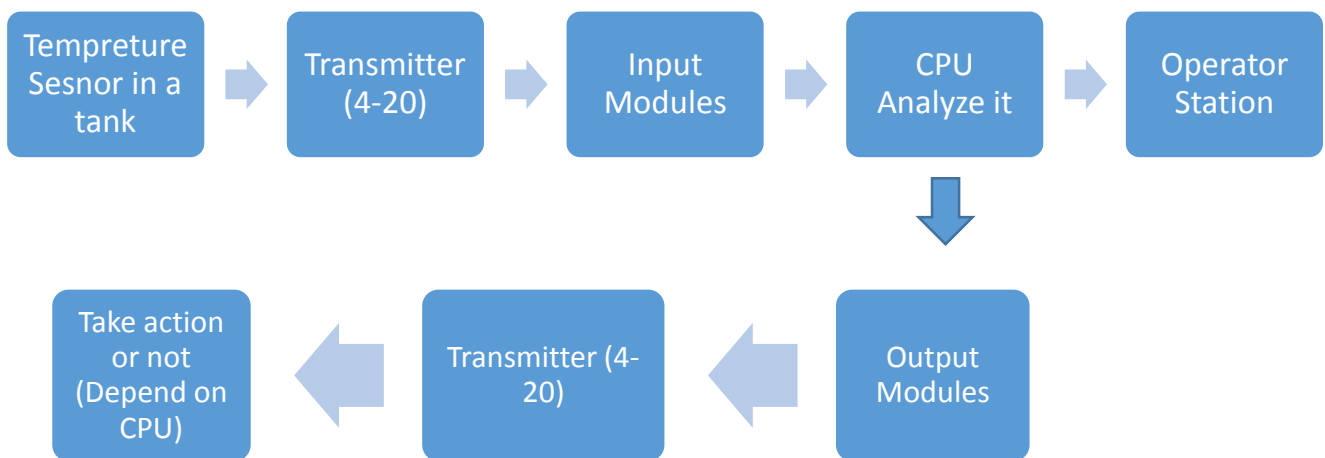t, according the signal that It comes the CPU take an action or not depend on the value that he got and after that send it to the output modules to take the action. The 4-20 mA protocol is something like a scale but in current shape, so if the pressure at its maximum point so the transmitter will send current with 20 mA which the CPU will analyze it as maximum value of the pressure and also if minimum value it will give 4 mA
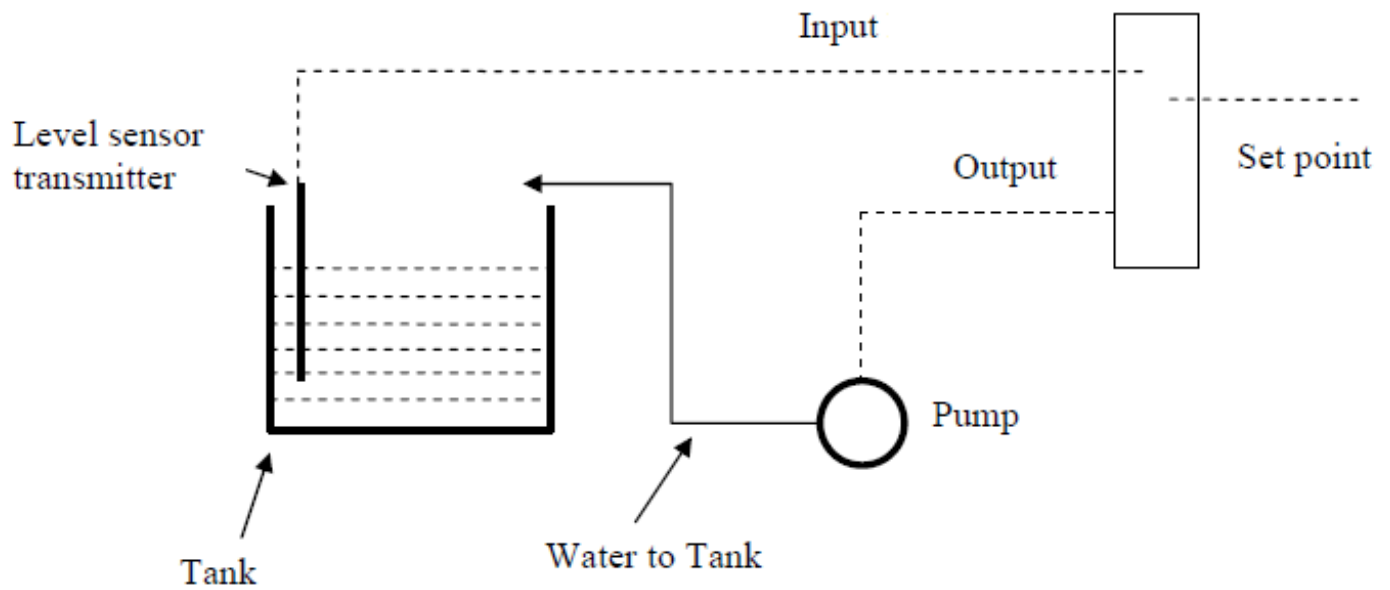
Figure 4: Simulation on DCS flow

And one of the application under the DCS is the Delta V, it's a DCS system created by Emerson Process Management.

Currently Delta V is taking control of most of the plant but still faces some difficulties such as: some machines come with its system and sometimes have problems with distance. So most of the plants is trying to solve this problem by making a sub-stations of control rooms (small ones) to take over the process or trying the serial interface between Delta V and the serial Devices (other systems) this serial interface is happened between the serial interface card in delta v racks through specific protocols such as Modbus

Bently Nevada Monitoring system is one of the systems that needs to be installed beside the machine that the Bently Nevada controlling and the machine and the system came as one package with its own system so you will always find a sub-station beside the machine to control and monitoring the process of the machines like a compressor, Bently Nevada is the system that responsible for measuring the vibration of the shaft of the compressor and sometimes the temperature inside the compressor , those readings appear only on the sub-station.

As smart phone s are taking part of everyone daily life. So it's so practical to convert the huge computers into tiny device called smart phone, today Android is making a huge growth in the smart phone s softwares and a lot of users are using android, the number of users maybe reach around billion persons with tabs or smart phone s. So it's important to keep updated with the technology and android. Android developers are increasing every day to make the life of a person easier. And many of the Android applications will need to interact with Internet data, which comes in a variety of formats.

1.2   Problem Statement

"The problem started when ELNG installed a new regional compressor in the field and the package of compressor came with two systems

Bently Nevada: for vibration and machinery monitoring
PLC: for the emergency
The BN system has a display; this display was installed in the field beside the compressor and if the operator needs the reading he has to go to the site to get the readings and check the status of the compressor. The other system is the PLC was communicating with the control room, and the problem started when the operator of control room getting a common trouble through the PLC and don't the reason of it because he doesn't have any readings on the operator display so he has to go the site to check the readings and the status of the compressor.

So the problems

1. There's no data communication between the readings of the compressor and the operator
2. To check the status of the compressor you have to go to the site and check it

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3. Any readings you have to take it from the site

4. Any trouble happening or alarms you can't know the reason unless you go to the site

5. The disability of controlling the compressor from the control room " (2)

1.3   Objectives

Upon completion of this project, some goals are set to satisfy the scopes of study that have been underlined, which are relevant to the requirement of the project. The aims of this project are as follows:

1. Try to monitor and watch the plant from your smart phone from anywhere

2. Have a data communication between any system in the plant and the Delta V (DCS control room)

3. Reaching a step of fully control plants

2. Scope of the work:

1. Try to reach the perfect protocol and data communication between Bently Nevada and Delta v

2. Creating a computer data base of the Delta V readings

3. Converting the database into an online one

3. Literature Review

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│                   DCS                     │
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                    ▼
┌─────────────────────────────────────────┐
│                 Delta V                   │
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┌─────────────────────────────────────────┐
│            Serial Device (BN)             │
└─────────────────────────────────────────┘
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┌─────────────────────────────────────────┐
│          DCS Data Communication           │
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│             DataBase ( MySQL)             │
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│               Why Android                 │
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│              Other Systems                │
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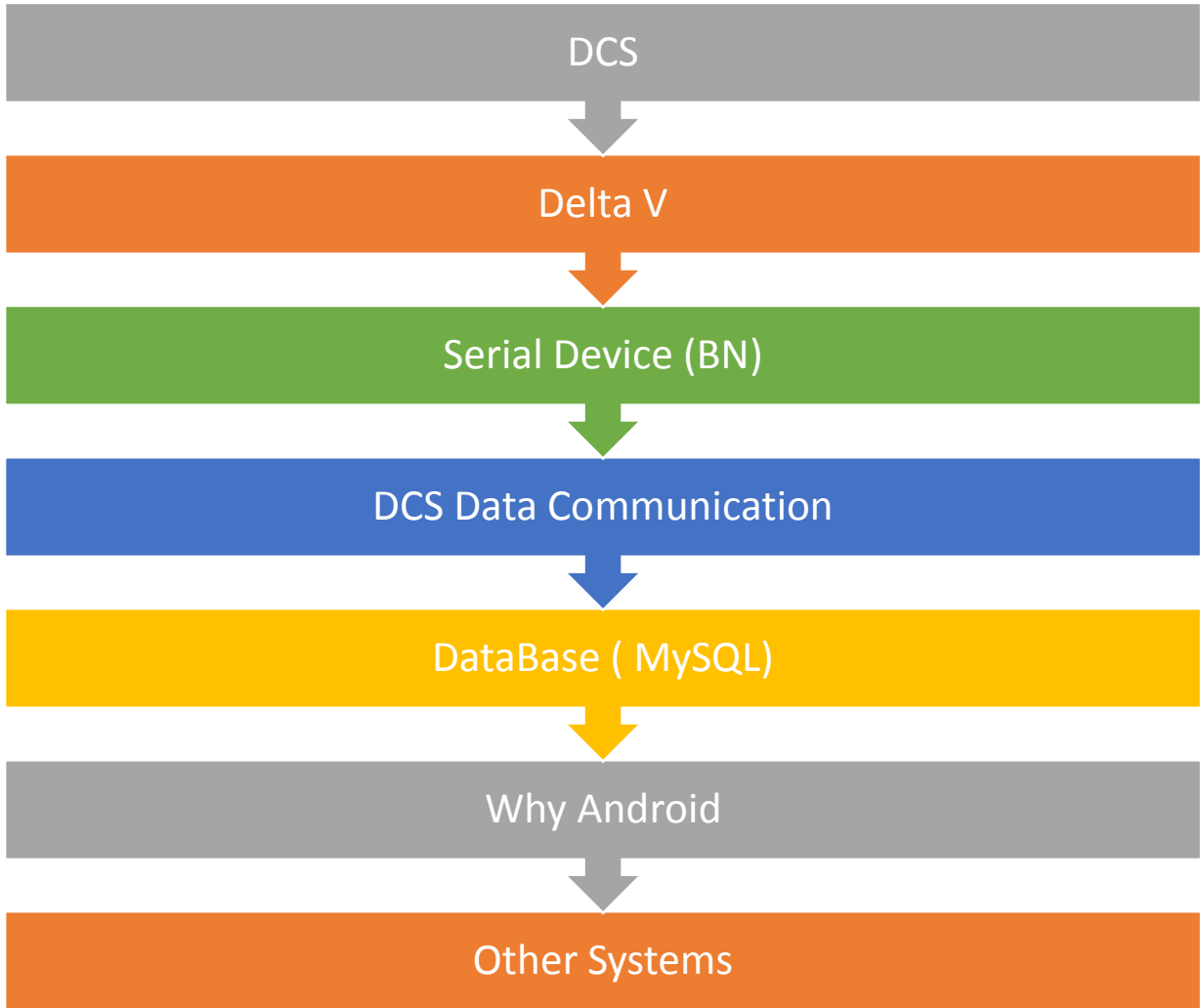
The previous chart shows how I built my literature review and how I started my work I started with the DCS system then as example of the DCS we proceed to Delta V as it's the center point of my project and the connecting ring between the other parts of the project .

companies have spent a lot of money to try improving the control of the plant or the field so they can maintain and support the instruments and the control loop and a lot of money has been lost to reach the point where you can reach the right control of the field or the plant and that happened

because sometimes the systematic control doesn't work with the condition of the process and makes some problems with the diagnostic and performance of the control (3)

"The characteristic of distributed control system is centralized management, decentralized control". (4)

Many industries in oil and gas fields for example are trying to create or develop a trusted and reliable technology to improve the efficiency and safety of the industry and product, and one step to get those goals by the data collection and as DCS is one of the reliable methods to reach such goals so it's important to say that implementing and developing such programs is necessary to increase the safety and the efficiency of the plant

So improving the function of DCS will give the reliable results that we need to acquire later, so the model has to go through so many assessment to make sure of the reliability of the data

- (Probabilistic) risk assessment
- (Functional) safety assessment
- Condition based maintenance
- Preventive maintenance (PM)
- Risk based inspections (RBI)
- Reliability centered maintenance (RCM)

Most of this reliability of programs aren't engineering related but important to get the best results (5)

With such increasing in the technology of simulation a huge plant to a small desktop pc , a new era has to shine this new era has to take the simulation from multitasking computer to a new level to the mobile phones and the tablets where you can control and simulate plant into a small phone, In past years the eyes were going to increase and develop the simulation of the plant into the computer by increasing and upgrading the hardware of the simulator (DCS system) , and due to this technology it's now possible and available to have a virtual simulation of what's happening in the field (3), my project is trying to take the 1st step to transfer the technology from the PC to the mobile phone by transferring the simulation between the PC and the mobile phone or the tablet.

Most of the industries in recent years in order to meet integration, high performance and high reliability, research and developing the DCS of the industry or the plant is necessary. For example, the aviation of marine gas turbine. In such technology they are trying to reach a new technique by using a CAN-bus as the network carrier which led to establish and create semi physical simulation

platform. In this technology, although CAN-bus has a good communication protocol, but sometimes it needed to develop its corresponding application. CAN bus was chosen as the data bus of DCS LAN data bus of the gas turbine. (6)

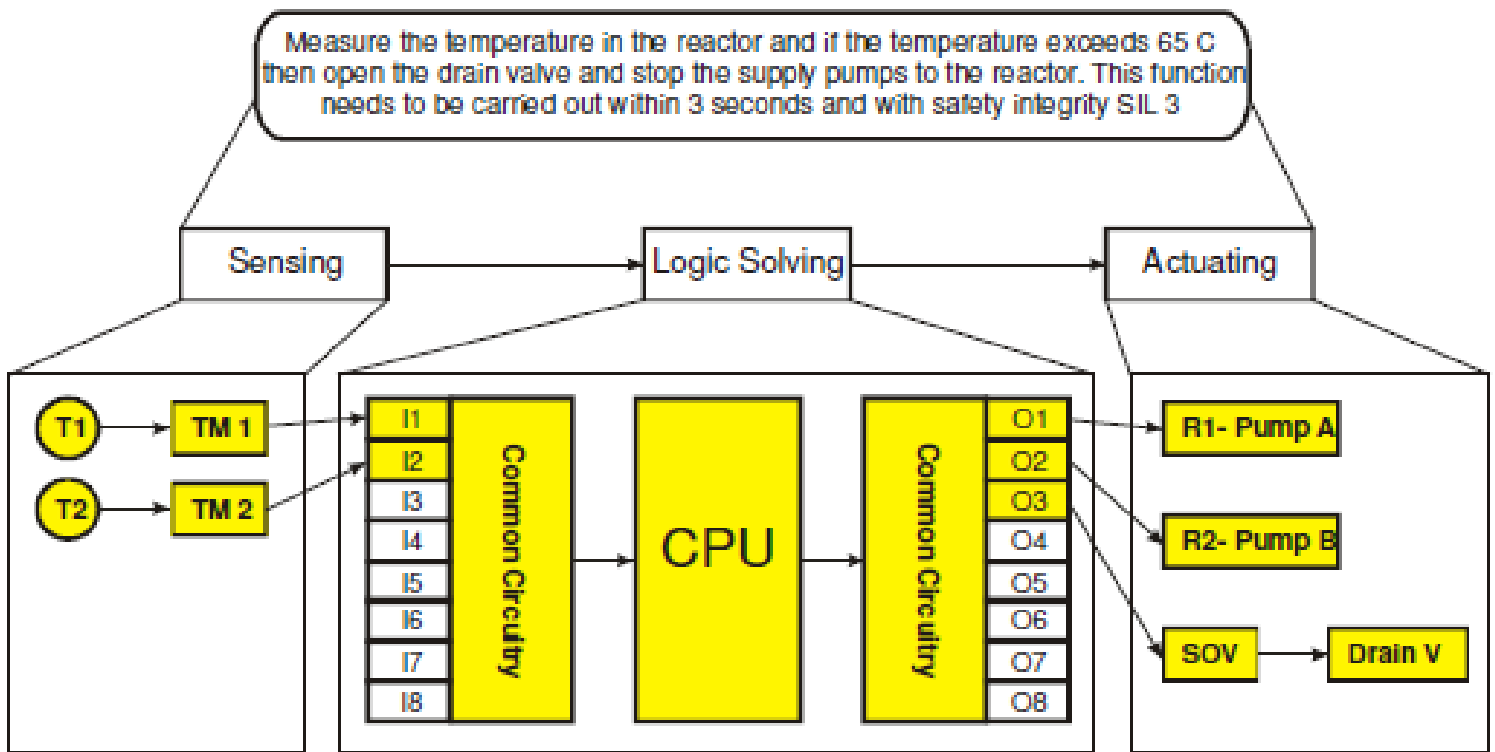An overview on how DCS Works in a process

Figure 5: DCS Process

Examples of DCS:

1- DCS for distillation column

The next procedures are examples of DCS used for Distillation column what we need from such project the data collection and the human machine interface, this interface is consisting of 3 main parts:

1-Visaulize the process

2-Interaction with the process

3-Data collection
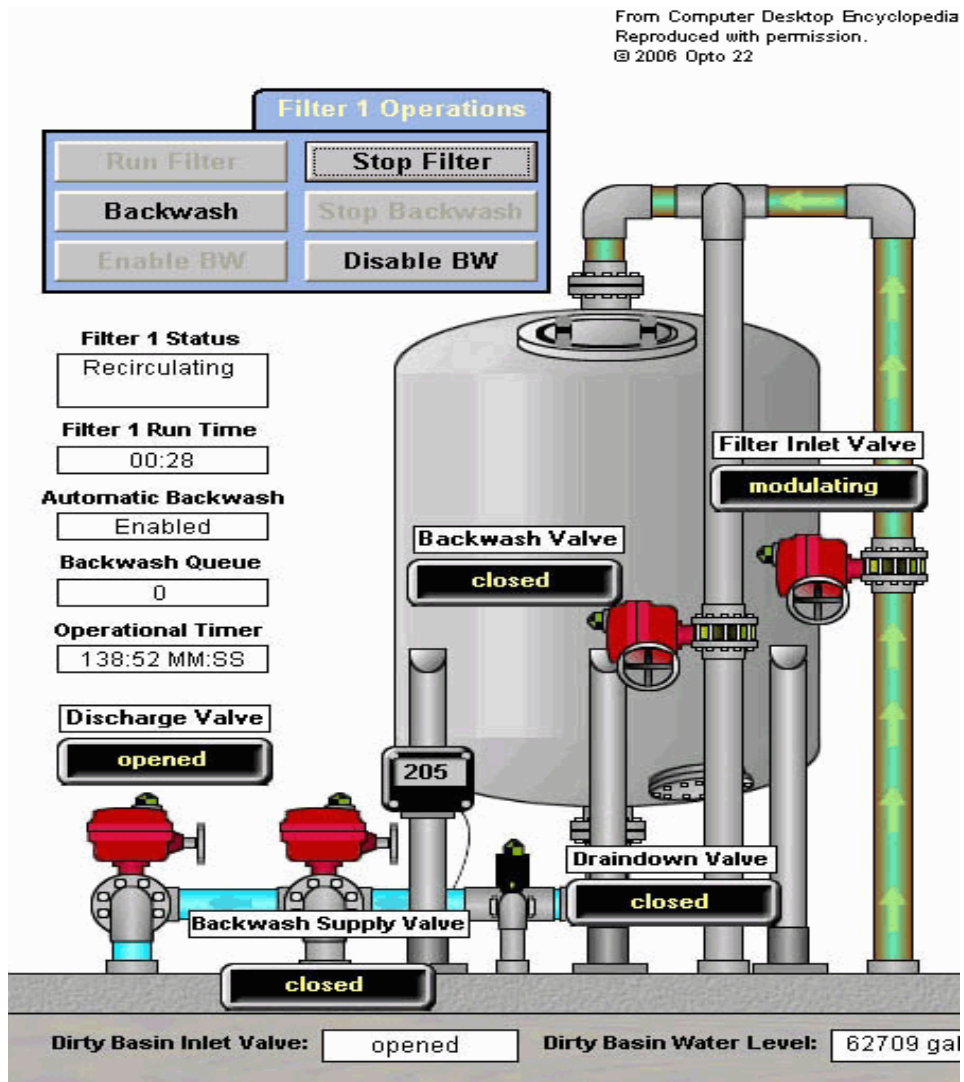
And those all parts are shown in the next figure

Figure 6: DCS Distillation column Process

As you can interact with the process either from the same display or another window with a specific control function. (7)

2- for DCS in air compressor , and here's a flow chart on how the process goes
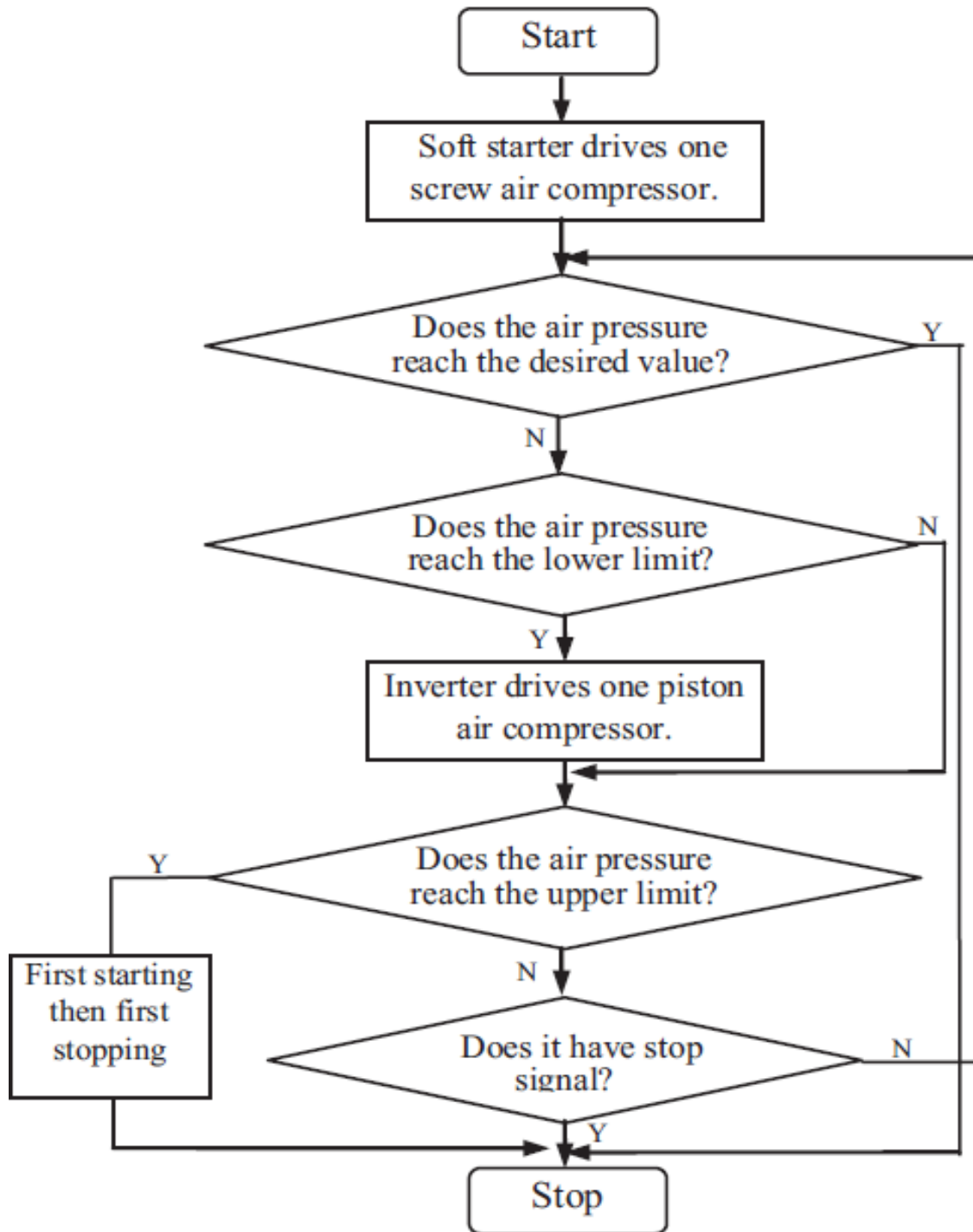

Figure 7: Flow chart of the process of the control logic of DCS in air compressor

One of the control systems that used widely in the plants is the Delta V system, delta v is one of the distributed control system (DCS), and Delta V is a process controller and operator to

monitoring and controlling the system. This system communicates with the elements and the field through a communication mode and through this communication mode you can copy what's going on in the field to the control system and as a part of monitoring delta v helps the operator to check out the readings and make sure there's no problem is the process by having an alarm system that warn the operator if something wrong in the process happened.

This system satisfies the needs of the operator to control the field as the delta v system has the ability to satisfy what the operator wants, when he needs it, which place he needs to control and sometimes where he can use this data. This feature can be found in the system through the I/O demand system that helps you make an integration between the system and the field , and one of the I/O system advantages in the delta v that the operator can smart-wireless control the measurement or configuration of a reading of the an element of the field for . This can happened through a communication protocol this communication protocol called HART, The HART is a self-organizing wireless network that offers a secure robust and reliable performance. This HART protocol helps to make a communication between the field instrument and the I/O cards without any wires and what's make it more practical is I/O cards is auto detected cards on the delta v system and the HART communicator is autosensed device. And sometimes the reliability of this system reach 99%.The delta V is one of the systems that has an embedded intelligent controller. Most of the processes has many changes and not all the systems can cope up with the variety that the process can have, but with the embedded intelligent control feature, delta v is able to stay monitoring and controlling or even diagnose the process with its varieties. The system can also deal with that kind of problems such as:

- Under performing control loops
- Diagnose and troubleshoot that happened due to changes in the process
- Increasing the quality of the control
- Focusing on the performance improvements

This system is user-friendly that can help you to form the control to a specific process with the changes with any process you can have delta v for any process whatever it was because you are the one who create and design for the process and delta v is suitable for most of the processes and the plants. (9)
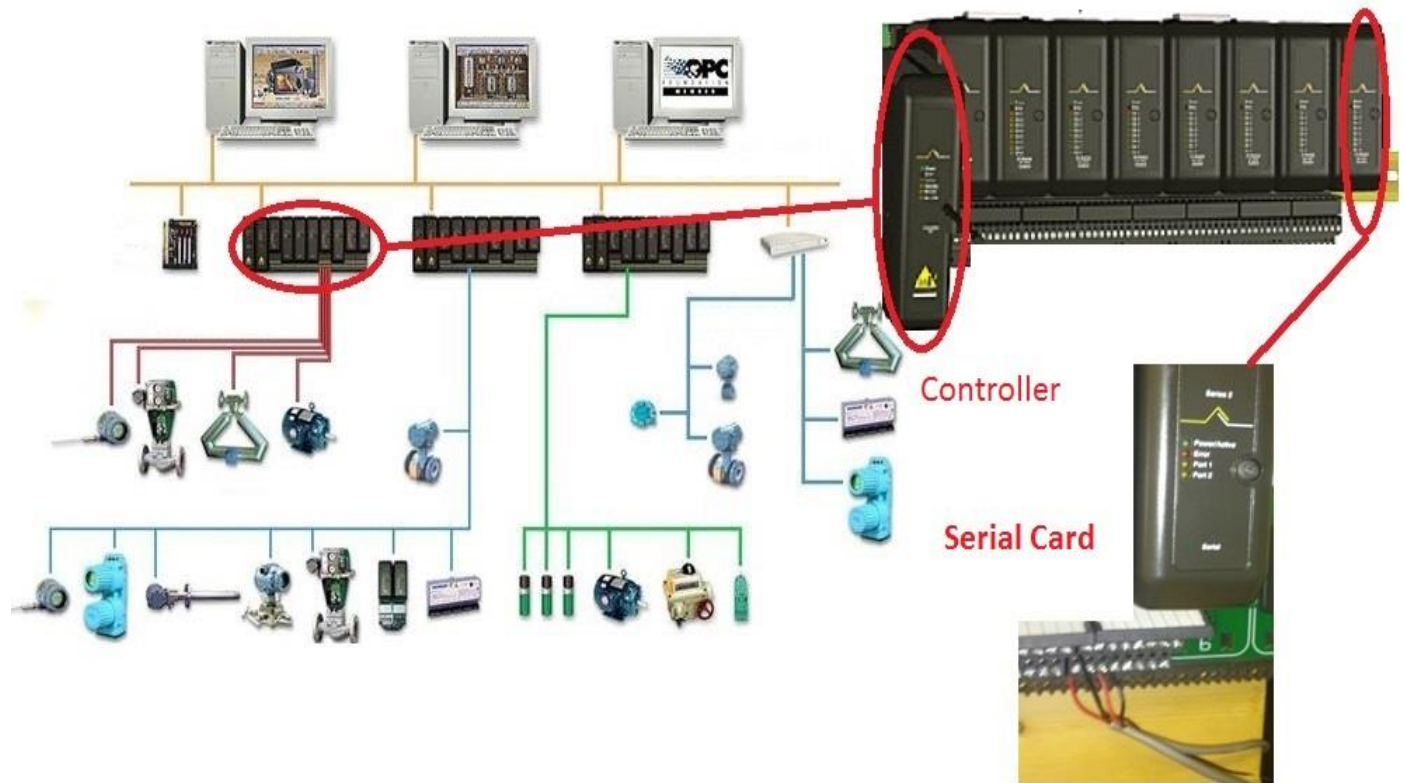
But what delta v system consist of? :

Figure 8: Delta V hardware

The controller: The DeltaV Controller mounts in the right slot of the 2-wide Power/Controller Carrier as illustrated above. Vertical mount carriers are also available for Controllers and I/O cards. And also the controller can be the CPU of the system where the operations can happen inside the controller

Serial Card: The DeltaV system can act as both a MODBUS master and MODBUS slave device to fully integrate with any automation system you omit have.
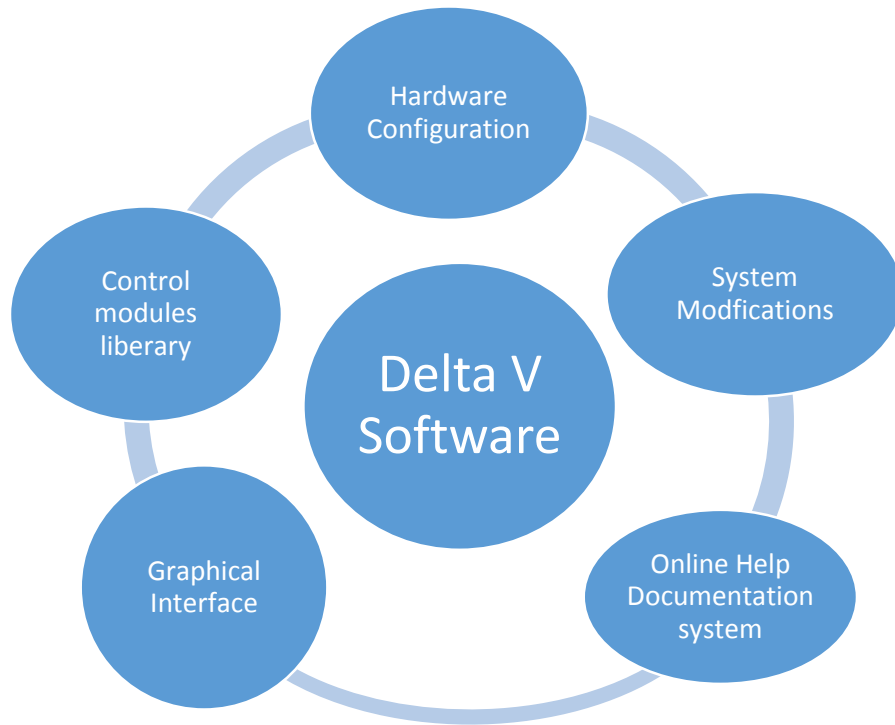
Delta V softwares

Figure 9: Delta V software

Delta V has many softwares and programs that helps the operator in controlling the process and plant. Delta V softwares are the platform of the operator to be able to control, monitoring, diagnose and troubleshoot the field parameters, it also is the linkage between the operator and the hardware in the field.
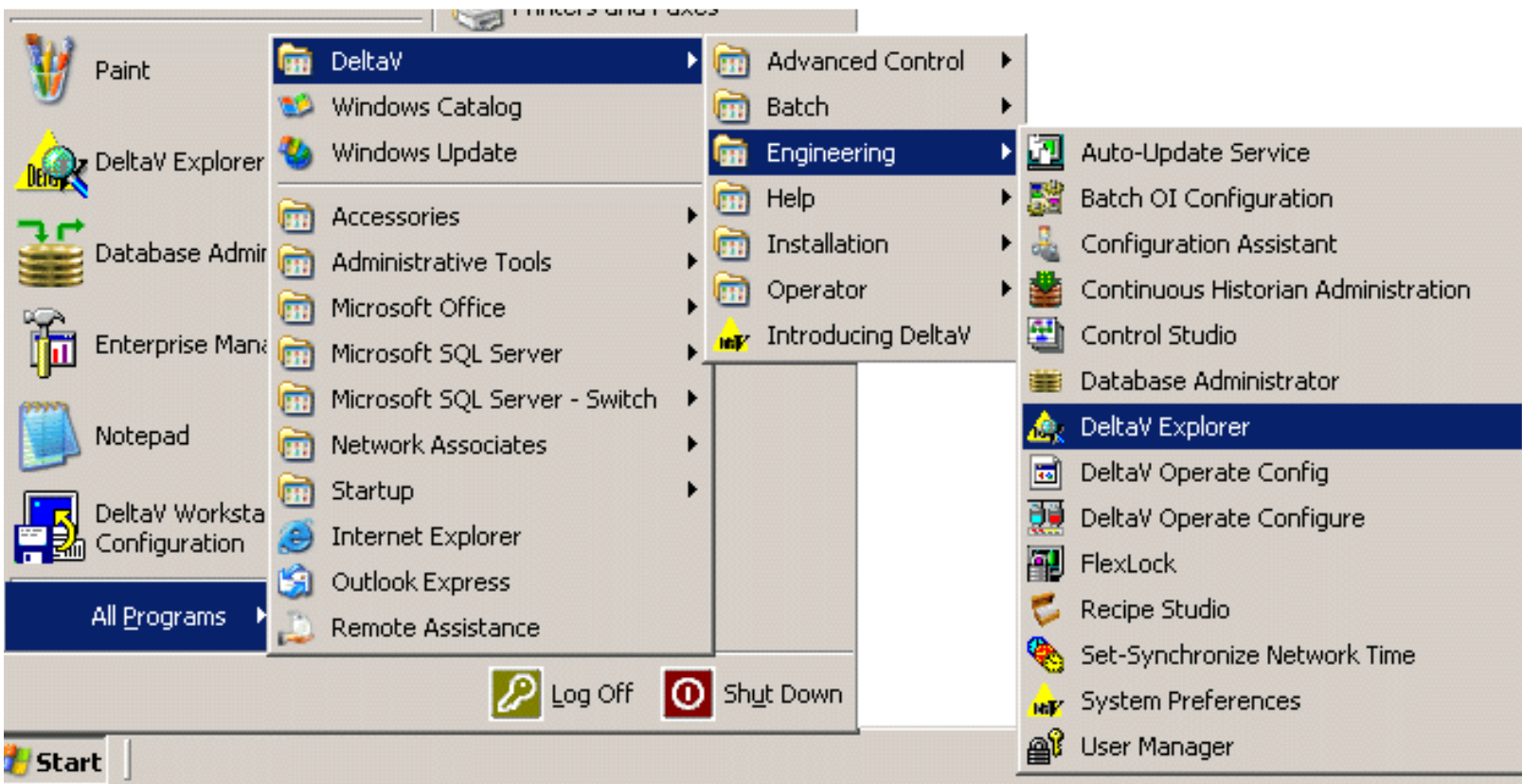
And here's some of the delta V programs

Figure 10: Delta V applications

Those applications are the way to achieve the control of the plant and it also a part of the data communication between the delta V and any serial device even with the OPC server. (10)

So most of the systems that has its own station can be connected to the delta V and appeared on the control room, BN can be as a serial device can be added to the delta v

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Serial Device

Serial Port is the port responsible for the data communication and data transmission between a computer and an external serial device. Serial Device is a widely used device which is very important inside the automatic control systems such as PLC, Bently Nevada and SCADA. Also you can find it with the filed bus systems, intelligent buildings, power transmission and much more applications. The smart devices has the technology of Ethernet to data communicate which is common used in TCP/IP and due to its speed, it's improve the efficiency of data communication. When the host server controlling and monitoring the serial device , it tries to analyze the configuration of serial device by a XML file format , after analyzing the file , the server can reach the address and control command conversion to complete the data communication between serial device and the computer

Definition of XML file format (config.XML)

```
<Config>
   <Device>
        <Name="Video Matrix" />
        <Port="Com2" />
        <Baud rate=9600 />
        <Serial function>
            <funciton1>
                <command ="switch">
                <format string="#90,1,2">
                <arg1="100">
                <arg2="200">
            </function1>
        </Serial function>
   </Device >
……
</Config>
```

(11)

The serial Device (Bently Nevada):

Bently Nevada is monitoring instrumentation and services, most notably sensors, systems, and diagnostic services for monitoring machinery vibration. The offerings are primarily intended for assessing the mechanical condition of rotating equipment found in machinery-intensive industries such as oil & gas production, hydrocarbon processing, electric power generation, pulp & paper, water and wastewater treatment, mining, and the like.

Figure 11: Bently Nevada Rack

DCS Data Communication

Most of DCS systems has a specific card which is responsible for the communication this card supports the MODBUS. Modbus is a half-duplex, master/slave system designed to connect a single master with up to247 slaves ─ although a typical Modbus installation would have one master and only two or three slaves. The Modbus protocol describes the process that a controller uses to request access to a slave device ─ how it will respond to requests from the other devices, and how errors will be detected and reported. So the master is the one who initiate transaction (query) to the other device. Transactions are either a query/response type where only a single slave is addressed, or a broadcast type. The broadcast mode, in which all the slaves are addressed and no response is required, is implemented by simply using the address 0.In the RTU transmission mode (the most widely used) each 8-bit byte in a message is sent as two 4-bit hexadecimal

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characters. The main advantage of the RTU mode is that it achieves higher throughput. For the addressing through the Modbus protocol there's some confusion although there are absolute addresses for each data type (coils, discrete inputs, input registers and holding registers), Modbus makes use relative addresses that are referenced to zero. And to muddy the water even further the actual addressing would be carried out using hexadecimal notation.

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal to form a single RTU character. The data field transmitted by the master contains additional information which the slave must use to take the action defined by the function code. If, for example, the master writes to a group of registers in the slave, function code 16 (10 hexadecimal), the data field specifies the starting register, how many registers to write, the count of data bytes to follow in the data field, and the data to be written into the registers.(12)

Another mean of communication is Profibus. Profibus (**Pr**ocess **Fi**eld **Bus**) is the outcome of a joint project started in 1987 by Siemens and supported by Bosch and Klöckner-Müller. Profibus was a designed for transparent networking at both the field and cell levels of the production process. Since no single protocol can adequately span the diverse requirements of these two layers, Profibus comprises a suite of three protocols:

- Profibus-FMS (Fieldbus Messaging Specification)
- Profibus-DP (Distributed Peripherals)
- Profibus-PA (Process Automation).

General Purpose Automation	Factory Automation	Process Automation
PROFIBUS-FMS Universal	**PROFIBUS-DP** Fast	**PROFIBUS-PA** Application Oriented
•Large variety of applications •Multi-Master communications	•Plug-and-play •Efficient and cost effective	•Power over the bus •Intrinsic safety

Figure 12: Profibus Protocols

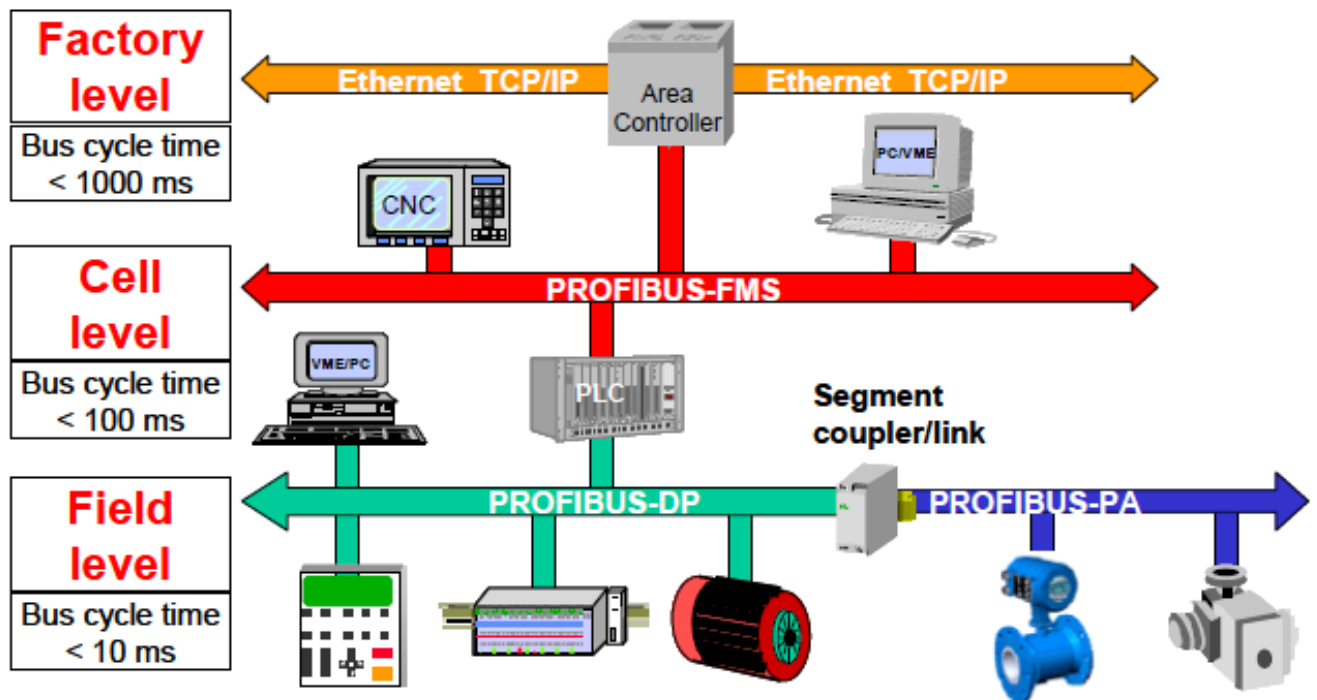The relationship of the three protocols in the Profibus suite

Figure13: The Relationship between profibus protocols

At the *field level*, devices such as I/O modules, measuring transducers, drive units, valves and operator terminals are required to communicate with the automation systems via an efficient

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real-time communications system. Further, whilst the transmission of process data is effected cyclically, information such as parameterization, alarms, and diagnostics need to be effected cyclically. At the cell level, the automation controllers communicate with each other. The information flow requires large data packets and a large number of powerful communication functions. Communication at the cell level is gradually being taken over by TCP/IP.

Serial Interface

2 Port Modbus Protocol, RS-232/RS-485 or 2 Port Programmable

Specifications	RS-232	RS-422	RS-485
Mode of Operation	Single-Ended	Differential	Differential
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS-485 networks)	1 Driver 1 Receiver	1 Driver 10 Receiver	32 Drivers 32 Receivers
Maximum Cable Length	50 ft (2500 pF)	4000 ft	4000 ft
Maximum Data Rate (40 ft - 4000 ft for RS-422/RS-485)	160 kbits/s (can be up to 1Mbit/s	10 Mbit/s	10 Mbit/s

Table 1: RS-422 & RS-232 & Rs-485

The essential difference between RS 422 and RS 485 is that RS 422 is primarily intended for point-to-point communications, whilst RS 485 is used for multipoint communications. The EIA-RS 422 standard defines point-to-point interfaces with up to 10 receivers for a single transmitter. Two separate pairs of wires allow data to be transferred in both directions simultaneously, RS 422 is often used to extend an RS 232 line or in industrial environments. The limiting parameter is the receiver input impedance where Ri =4 kΩ. RS 422 transmitters do not usually have tri-state outputs.

Data Reading and Writing from Delta V (DCS)

Data Read: By selecting two adjacent cells and using the Function Wizard to set up a real-time read, the status of the value being read will also be displayed
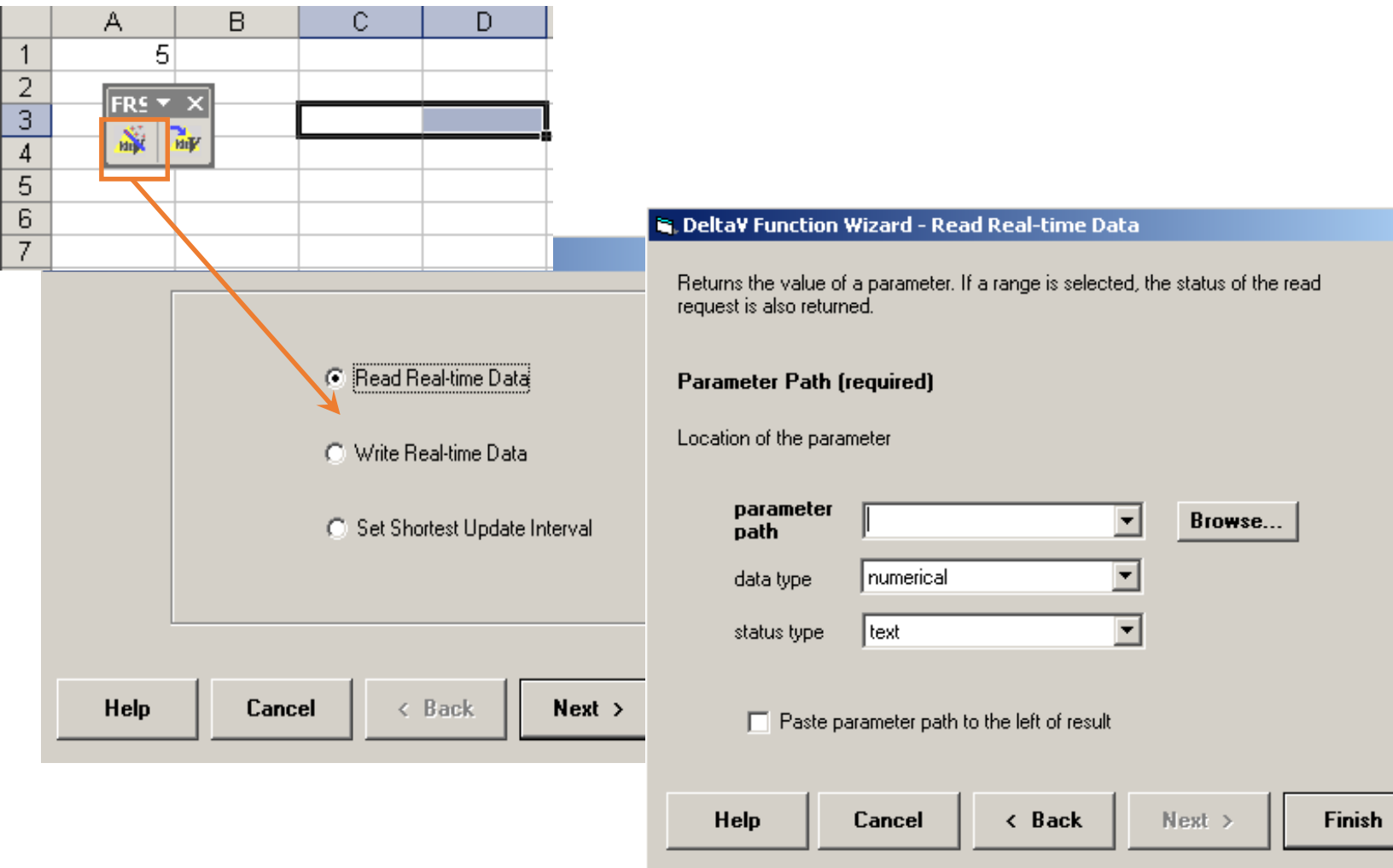

Figure 14: Read Real-Time Data

Data Write: Select a cell(s) and use the Function Wizard to set up a DeltaV Write. This inserts a DVWrite function into the formula bar for the cell, but does not execute the write.

Note: Another cell could be referenced for the value to write instead of input-ting the actual value; i.e., if C4 were used in place of 75, the value in that cell would be written.
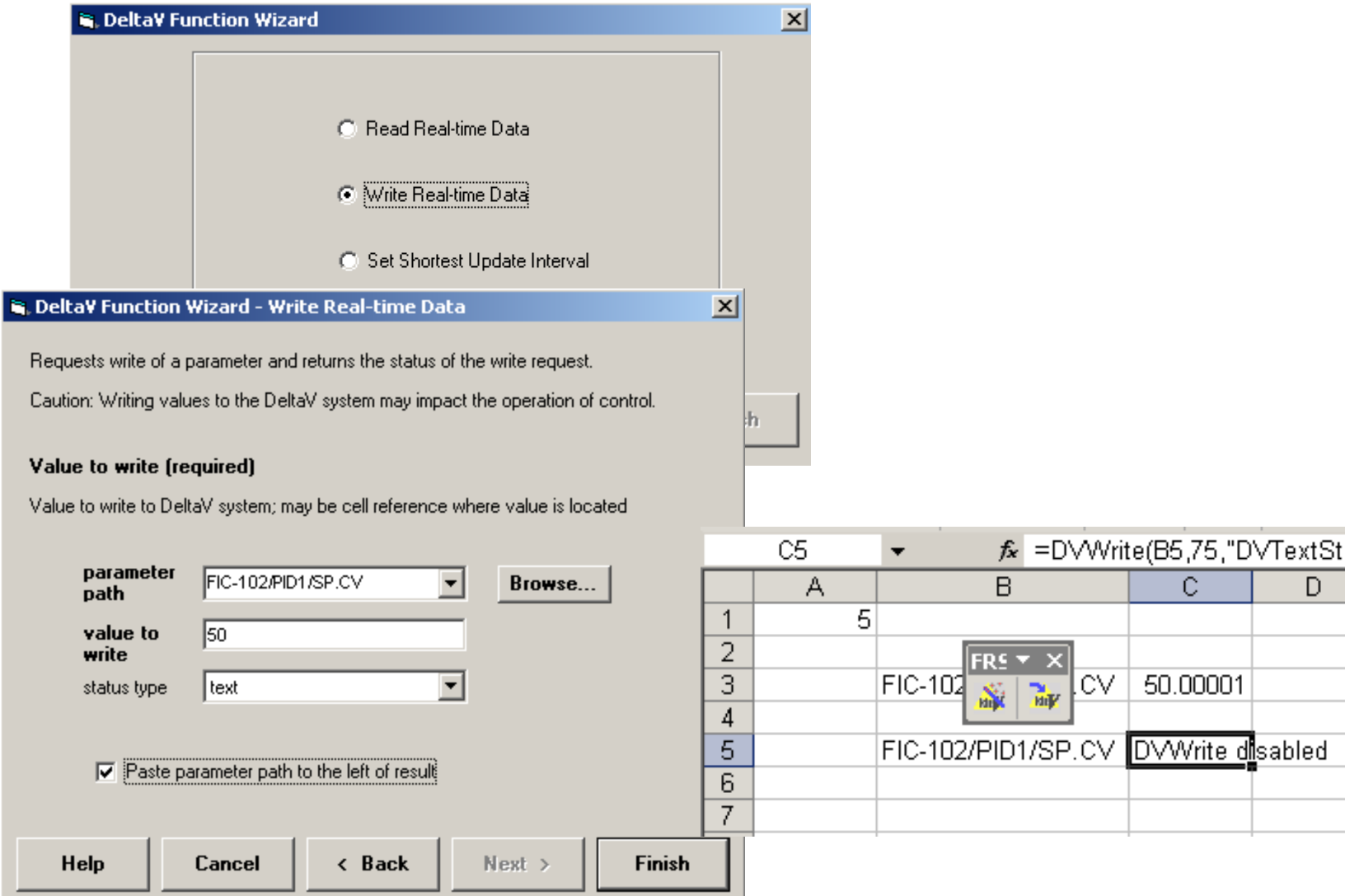

Figure 15: Write Real-Time Data

Real-time data displayed in Excel is shown below.

Figure 16: Real-Time Data

Plant Messenger

My project is a step to the technology that can take control of a very complicated plant through your tiny mobile phone after searching and knowing more about the project I've found the Emerson Process Management have developed a concept of having the data and the alarms of the plant anywhere and anytime and that by developing an interface on the internet explorer that can view the data of the plant and can give the alarm if anything wrong would happen.

The data can be sent to the user through 3 different ways:

This plant messenger can be accessed through internet explorer web page, by specific user name and password you can reach your data

The problem with this messenger can be explained in 3 points:

2.0   it's not compatible with all versions of Delta V

3.0   sometimes it needs specific requirements for the pc

4.0   It's only working with internet explorer 8 (not any other browser (13)

SQL server

Microsoft SQL Server is a cloud-ready information platform that will help organizations unlock breakthrough insights across the organizations and quickly build solutions to extend data across on-premises and public cloud. (14)

And for the place of storing it's usually decided by the host if it's a virtual storage, but if it's an own server it always stored in the local host (localhost or 127.0.0.1)

What kind of data can be stored in the server?
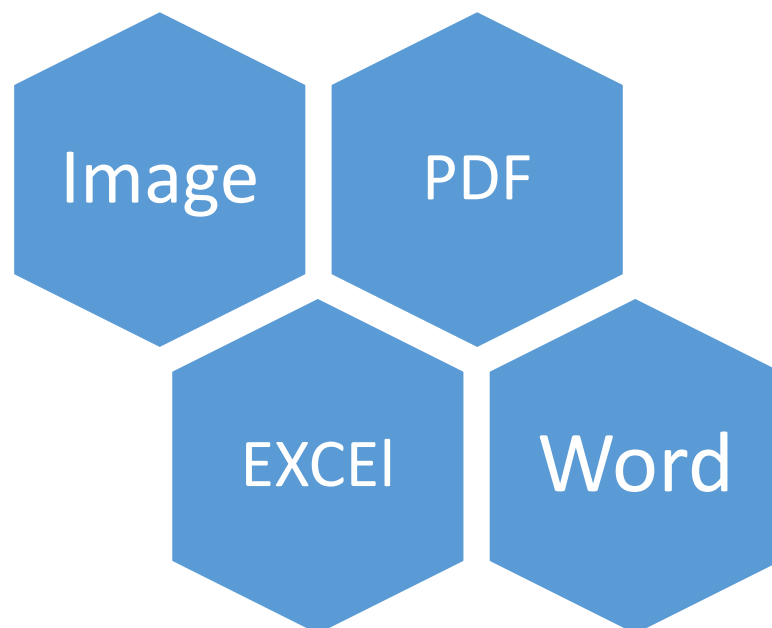
As any database, SQL can store any kind of data, but to be able to store or retrieve you need some coding experience to be able to store the data within the SQL

Storing binary data in SQL server

```sql
set ANSI_NULLS ON
set QUOTED_IDENTIFIER ON
GO

-- EXEC dbo.spStoreBinaryFiles
'C:\eFaxFiles\eFaxPromo.pdf;D:\eFaxFiles\eFaxPromo.pdf;'
CREATE PROCEDURE [dbo].[spStoreBinaryFiles]
 @FILE_PATH    VARCHAR(MAX)
AS
BEGIN
        SET NOCOUNT ON;
        DECLARE @FILE_LENGTH  BIGINT
        DECLARE @FILE_DATA    VARBINARY(MAX)
        DECLARE @FILE_NAME       VARCHAR(100)
        DECLARE @DOCUMENT_NAME VARCHAR(100)
        DECLARE @DOCUMENT_NATURE VARCHAR(5)

        DECLARE @VAL1 VARCHAR(100)
        DECLARE @VAL2 VARCHAR(100)

DECLARE curDOCUMENTS CURSOR FOR SELECT *  FROM dbo.SPLIT ( ';', @FILE_PATH )
OPEN curDOCUMENTS
FETCH NEXT FROM curDOCUMENTS
INTO @VAL1,@VAL2

WHILE @@FETCH_STATUS = 0
BEGIN

        IF OBJECT_ID('#ORStable') IS NULL
                BEGIN
                        CREATE TABLE #ORStable _
                                (Length BIGINT, vDocument VARBINARY(MAX))
```

```sql
                        DECLARE @SQL_QUERY        NVARCHAR(1000)

                        SET @SQL_QUERY= '
                        INSERT INTO #ORStable
                        SELECT len(bulkcolumn), *
                        FROM OPENROWSET(BULK '''+@VAL2+''', _
                                SINGLE_BLOB) AS BinaryData'
                        exec SP_executesql @SQL_QUERY
        END


                EXEC dbo.spGetDocumentNature @VAL2, @DOCUMENT_NATURE  OUTPUT
                EXEC dbo.spGetDocumentName @VAL2, @DOCUMENT_NAME  OUTPUT


        SELECT TOP 1 @FILE_LENGTH = Length, @FILE_DATA = vDocument FROM
#ORStable
        INSERT INTO dbo.tblBinaryFiles
                        (
                                [File]
                        ,[Path]
                        ,[Ext]
                        ,[Size]
                        ,[Binary]
                        )


        VALUES(
                                @DOCUMENT_NAME
                        ,@VAL2
                        ,@DOCUMENT_NATURE
                        ,@FILE_LENGTH
                        ,@FILE_DATA
                        )

 DROP TABLE dbo.#ORStable

FETCH NEXT FROM curDOCUMENTS
INTO @VAL1,@VAL2
```

```
END
CLOSE curDOCUMENTS
DEALLOCATE curDOCUMENTS

END
```
 (15)

And one of the application under SQL a small database that can be stored on the disk of the computer called "Sqlite"

"SQLite is a software library that implements a self-contained, server less, zero-configuration, transactional SQL database engine. SQLite is the most widely deployed SQL database engine in the world. The source code for SQLite is in the public domain."(9)

Sometimes Sqlite is the best solution for the smart phone s as it's a very light version of the sqlite , it also uses dynamically and weakly typed SQL syntax that sometimes doesn't have the domain integrity , Android platform is using Sqlite as system level software that helps the android platform (16)

And that's why we are biasing to Android software

Database Server:

Using MySQL database is helping to create a database for the reading that will be send to the android, it stores the reading on localhost database. You can insert, update or Change the data to the server. MySQL database has a lot of features that can help to store data and also have some modification on it.

 The database will host the readings from the DCS system to make it easy for the android application to access it. With some help from php language to create output from the database that will help the android application to get it and retrieve it on the phone.

PHP language is the language responsible to handle the server like MySQL database, it's well known scripting language it's well known among the web developers , but for MySQL it a management system for databases. The main target of PHP language to create a server that uses database to store information in it, the android application will communicate with such

language. (15)

Some codes of PHP

```php
<?php

// array for JSON response

$response = array();

// include db connect class

require_once __DIR__ . '/db_connect.php';

// connecting to db

$db = new DB_CONNECT();

// check for post data

if (isset($_GET["subject_id"])) {

    $subject_id = $_GET['subject_id'];

    // get a product from products table

    $result = mysql_query("SELECT * FROM subject_offered WHERE subject_id =
'$subject_id' ");

    if (!empty($result)) {

        // check for empty
                result

        if (mysql_num_rows($result) > 0) {

            $result = mysql_fetch_array($result);

            $product = array();
```

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```php
        $product["subject_id"] = $result["subject_id"];

    $product["lecturer_name"] = $result["lecturer_name"];

    $product["time_offered"] = $result["time_offered"];

    $product["subject_details"] = $result["subject_details"];

    //$product["updated_at"] = $result["updated_at"];

    // success

    $response["success"] = 1;

    // user node

    $response["product"] = array();

    array_push($response["product"], $product);

    // echoing JSON response

    echo json_encode($response);
} else {

    // no product found

    $response["success"] = 0;

    $response["message"] = "No subject found";


    // echo no users JSON

    echo json_encode($response);

}

  } else {
```

```php
        // no product found

        $response["success"] = 0;

        $response["message"] = "No subject found";

        // echo no users JSON

        echo json_encode($response);

    }

} else {

    // required field is missing

    $response["success"] = 0;

    $response["message"] = "Required field(s) is missing";


    // echoing JSON response

    echo json_encode($response);

}

?>
```

ANDROID

Why android

- Linux → Open Source
- Consumer-driven apps
- Hardware/software choice

Android is widely known open source software, and as the result of the growing that android has, a lot of developers have created and developed android application to meet the demand and supply of the consumers around the world.

And as examples for android application with different usage and techniques:

1. Evernote is an easy-to-use, free app that helps you remember everything across all of the devices you use. Stay organized, save your ideas and improve productivity. Evernote lets you take notes, capture photos, create to-do lists, record voice reminders—and makes these notes completely searchable, whether you are at home, at work, or on the go it's developed by Evernote Corporation. In order to function properly, Evernote needs access to several different software components and services, some of which contain private user information. The purpose of this article is to describe what data is used by Evernote and specifically how the data is used. (17)
2. Another application is my prayer which calculates Muslims prayer times using the phone's location (latitude and longitude) based on different conventions.it retrieve the phone location and start to confirm the location to get the exact times of the prayers (18)

Other Systems

As the need of improvement in controlling the plant most of the control systems companies is trying to reach the improvement in the system by applying new techniques so that you can reach the improvement one of those control system is WÖHWA Control System which is helped to reach some advantage of it such as:

- energy management system to cut energy costs

- automatic operation of primary crushing plant (no personnel required), processing plant, conveyor belts and feedings

- night operation of processing plant

- error messages transmitted via SMS to cellular phones (20)

As a part of improving the control of the system delta V started to improve the way that you can get access to the data of the plant so Emerson Process management started to use the historical events and data that restored in the system and try to send it through the internet to reach an application or web service based client applications so the operator can reach the data through the internet or through the local network of the plant and that helps the operator to monitor more and more of the field anywhere and anytime and to reach such a technology a new server has to be introduced so it can send the data this server is called under the name of OPC server (Open Process Control) (21)

4. The Methodology

Shows a flow chart consisting of the planned process workflow for this project.
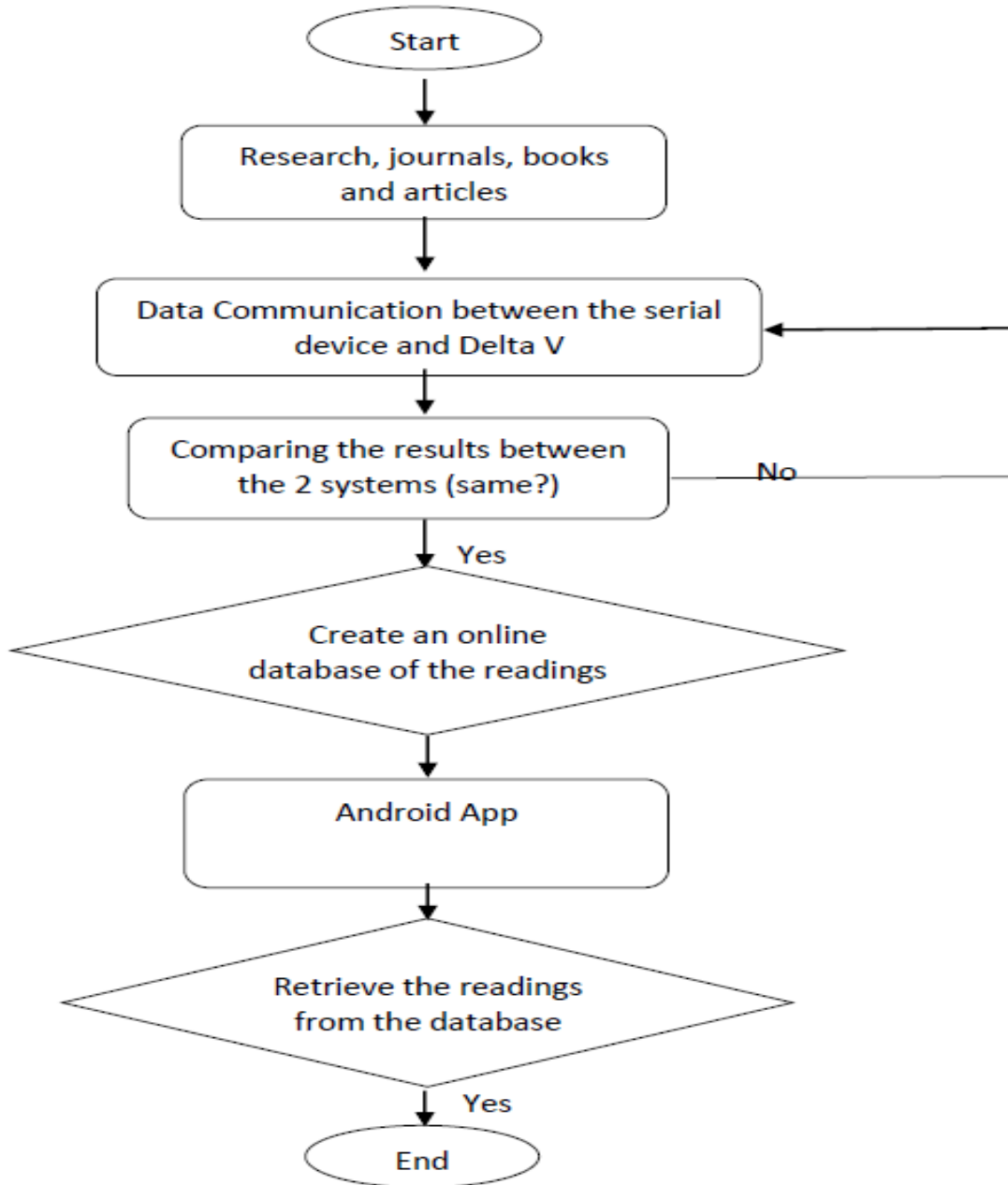

Figure 17: The methodology flow chart of the project

System Component:

DCS system: the system responsible for displaying and monitoring the systems and also displaying the result that sensed by a sensor and transfer it through the system to RTU

Database Server: It's the component is like a safe for the readings and the data in other words it's the database which we will be able to host the readings of the sensor for example Microsoft SQL , the android app will try to retrieve data from the database

Figure 18: Overview on project Methodology

Web service: is the medium where the android application would be able to retrieve the data from the database

Android application: is the platform that will help us to display the data that has been retrieved from the database

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Tools

Eclipse SDK 4.2 is the new platform for building Eclipse rich client applications. This new platform makes it easier for developers to develop and assemble applications based on Eclipse.
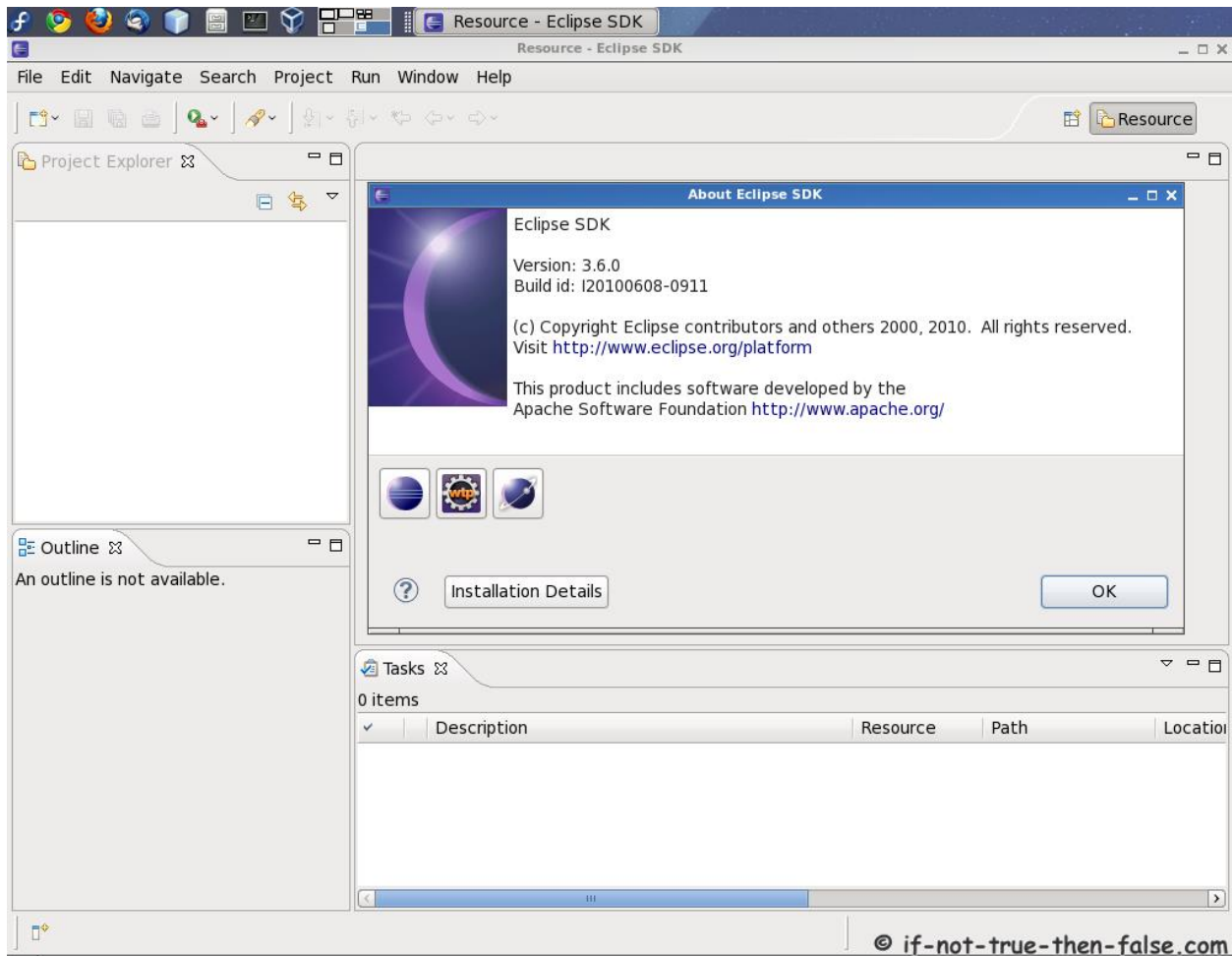

Figure 19: Eclipse

XAMPP is a free and open source cross-platform web server solution stack package, consisting mainly of the Apache HTTP Server, MySQL database, and interpreters for scripts written in the PHP and Perl programming languages.
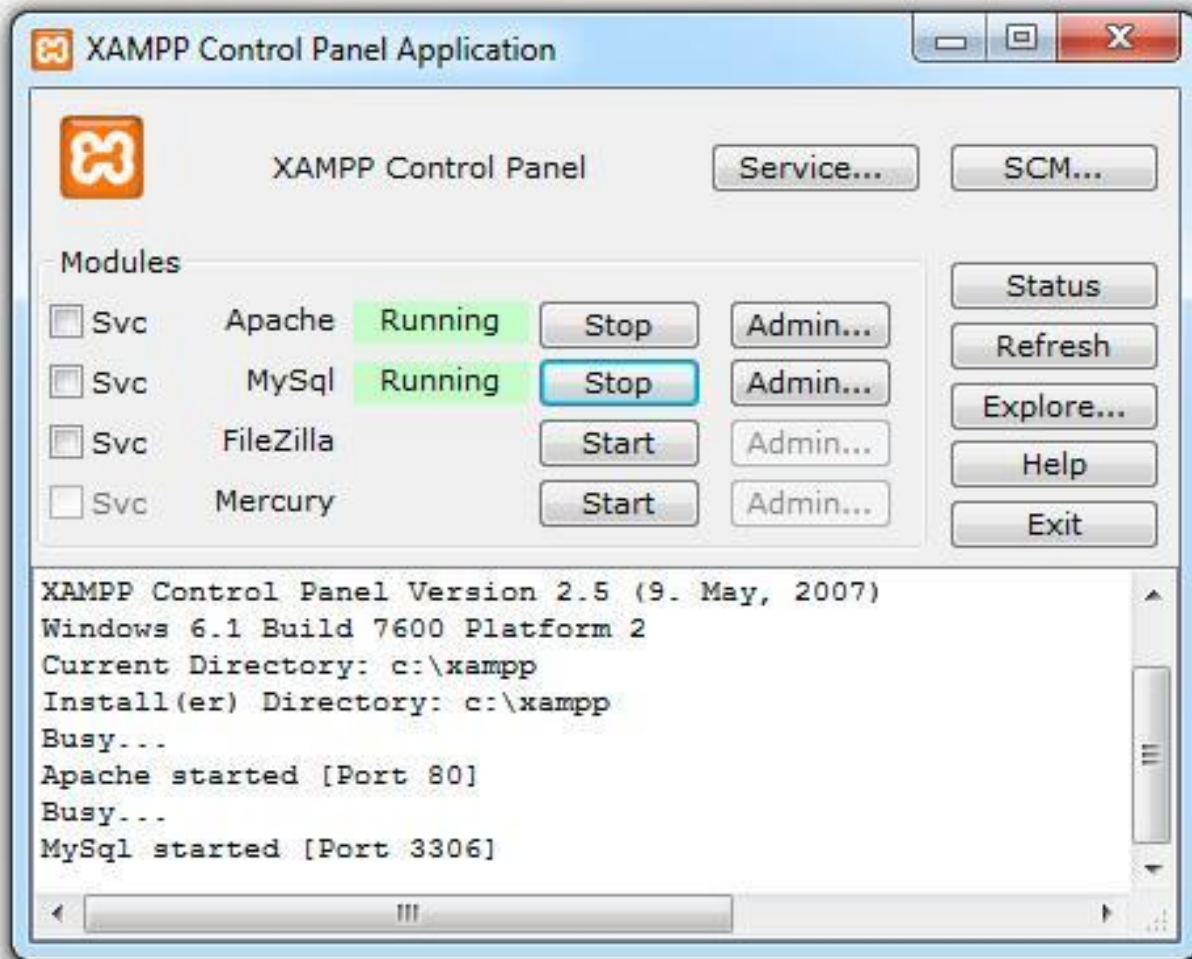

Figure 20: XAMPP CONTROL PANEL APPLICATION

4.1 Coding and Programming part

PHP script:

This script is responsible for displaying the data from MySQL database

```php
<?php

 // Connects to your Database
$link = mysql_connect("localhost", "root", "") or die("error loging: " . mysql_error());

mysql_select_db("fyp") or die("error dbtable");

//  selection of the table

$result = mysql_query("SELECT * FROM `read` order by clock desc limit 4");

// displaying the data

echo "<td><font color='grey'><font size='6'>Tempreture Values of Compressor 11</td>";

echo "<table border='1'>

<tr>

<th><font color='red'><font size='6'>Time</th>

<th><font color='blue'><font size='6'>MV</th>

<th><font color='green'><font size='6'>PV</th>

</tr>";

// Retrieving the data

 while($info = mysql_fetch_array( $result ))

 {

Print "<tr>";

 Print "<td><font color='red'><font size='6'>".$info['clock'] . "</td> ";
```

Print "<td><font color='blue'><font size='6'>".$info['value'] . "</td> ";

Print "<td><font color='green'><font size='6'>".$info['aver'] . "</td> ";

}

Print "</table>";

?> //end

Java Script of Android Application:

Programing and coding for the android application to be able to display the data on the mobile phone

```java
package com.mkyong.android;

import android.app.Activity;
import android.os.Bundle;
import android.webkit.WebView;

public class WebViewActivity extends Activity {

    private WebView webView;

    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.webview);

        webView = (WebView) findViewById(R.id.webView1);
        webView.getSettings().setJavaScriptEnabled(true);
// local server

        webView.loadUrl("http://192.168.170.1/m.php ");
// Internet or online server   server
        //webView.loadUrl("http://mofyp.hoselectro.com/qwer.php ");

        //String customHtml = "<html><body><h1>Hello,
WebView</h1></body></html>";
        //webView.loadData(customHtml, "text/html", "UTF-8");

    }

}
```

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Grant Chart

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	■	■												
2	Literatures Review			■	■	■									
3	Submission of Extended Proposal						KM								
4	Data Communication between the serial device and Delta V							■	■						
5	Proposal Defense									KM					
6	Methodology and Java language										■	■	■		
7	Submission of Interim Draft Report													KM	
8	Submission of Interim Report														KM

Table 2: Grant Chart

5. Results:

As a progress of the work on the project I have reached the zone when I learnt Java language and started to design the android application as the next figures will show my app.
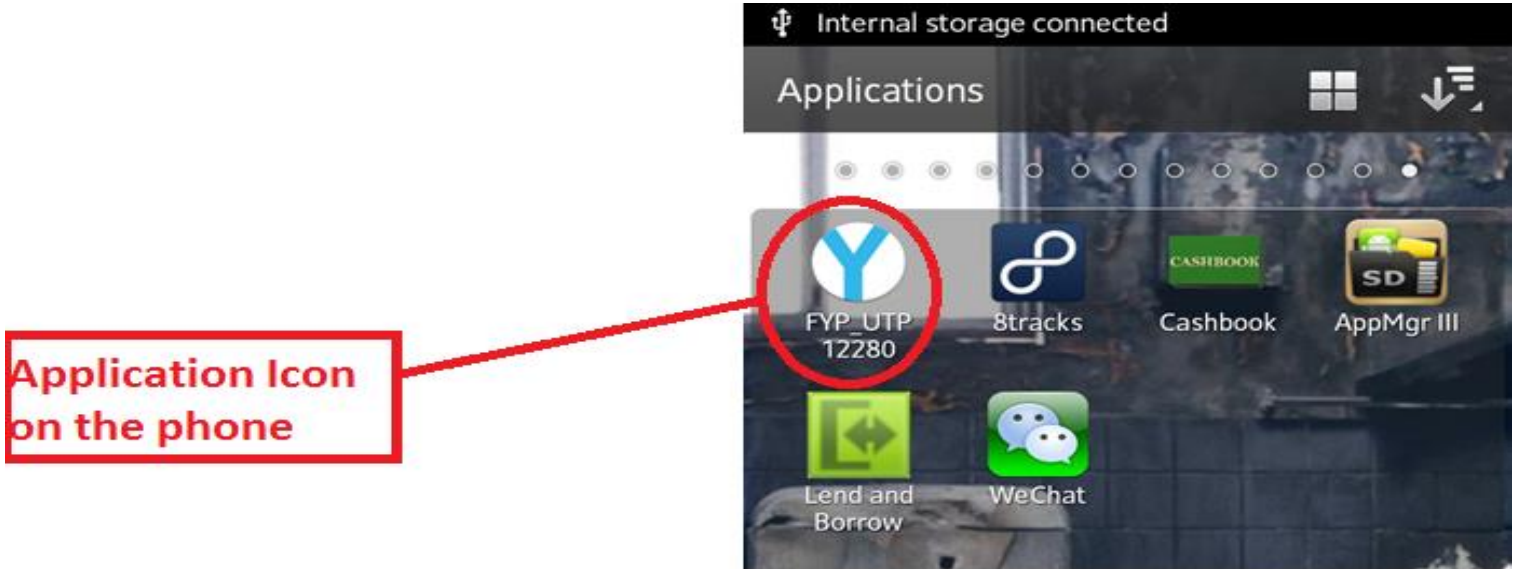
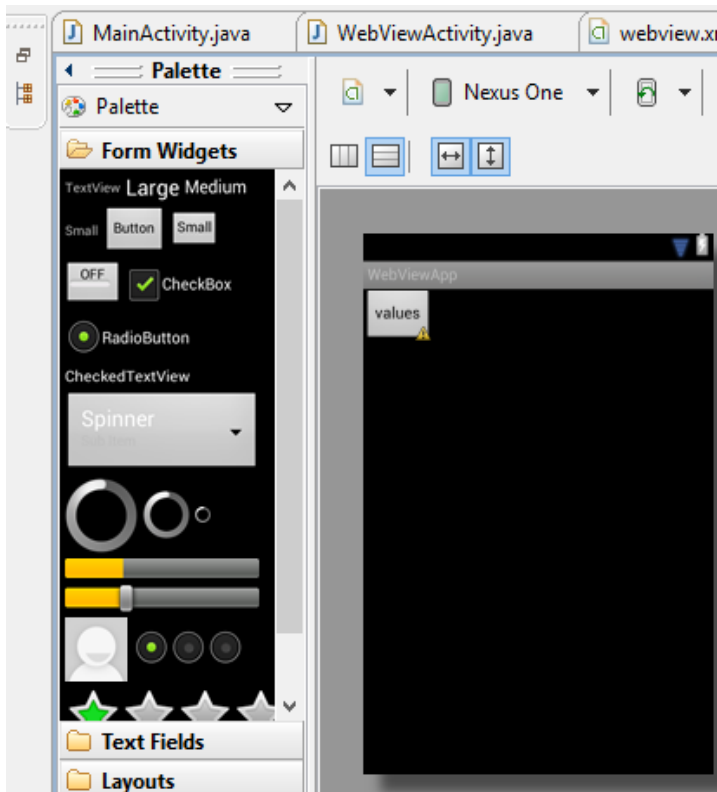
Figure 21: Application Icon on the phone
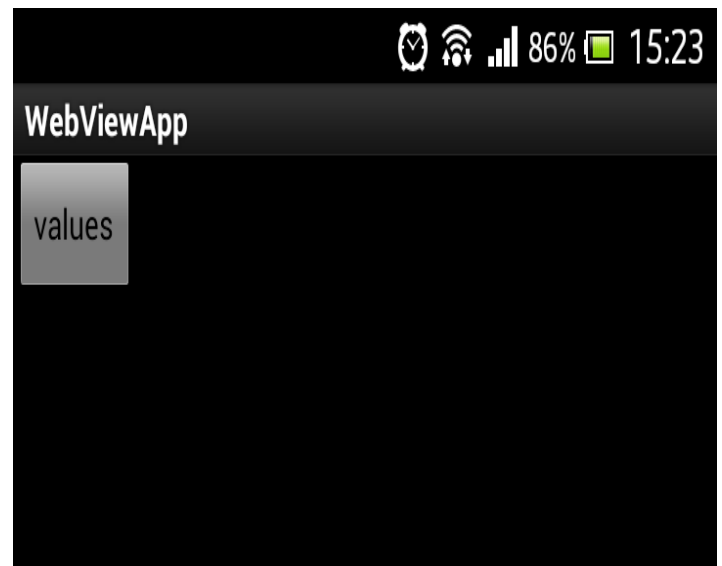

Figure 23: The application View on the phone

Figure 22: The application graphical outline on the Eclipse

The next figures will show what the progress is until I reached the final stage of the data retrieving, the next figure shows the 1st attempt to retrieve the data which ended successfully
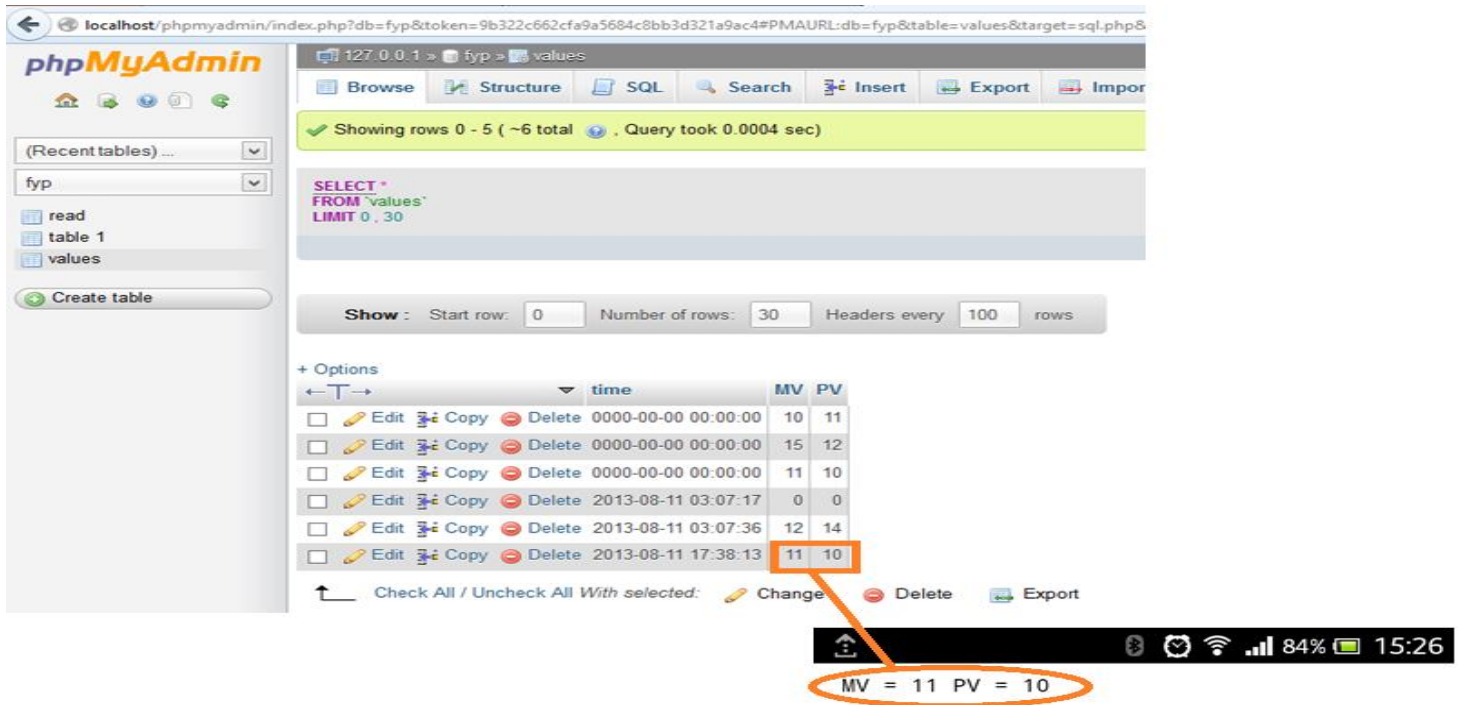

Figure 24: 1ˢᵗ result of android app and compare it to database

Figure 25: DCS Statistics Excel Sheet

And after many attempts, the final stage was successfully done, the next figure will show the final stage and compare it to the database values

Figure 26: Final Stage of reading results on the phone and compare it to database

And the next figure shows the final process by going to the application and press the values buttons then the values appears
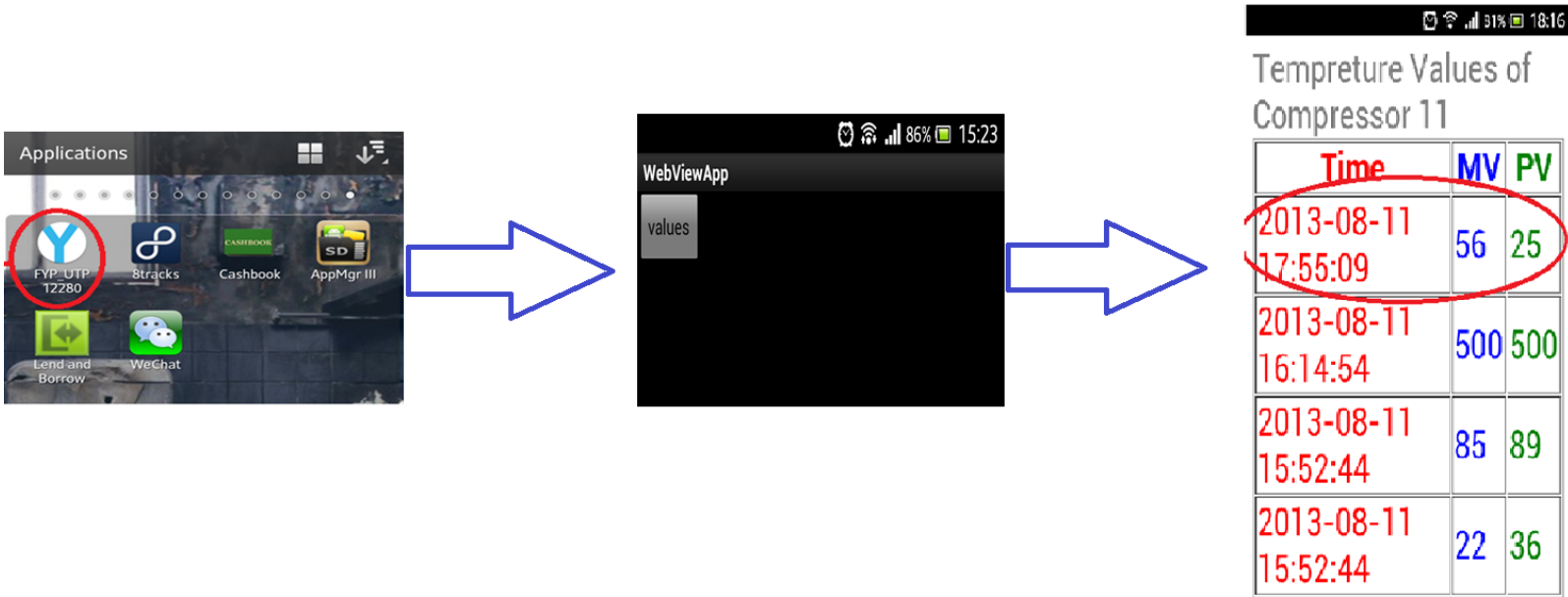

Figure 27: The process of accessing results on android platform

6. Conclusion:

Android is a disruptive technology, the technology was a simple technology with a small usage and the main target for It was the mobile phones , but now it has various usage that give the operating system to have a wider and huge potential in the future to reach the control of a huge plant in the small phone or tablet. Android is a platform where we can make use of it to control our life and make our industries more flexible and more live.

Android operating system is trying to get the best and update more to avoid any limitations or obstacles in the future and to become the world number one operating system in the world, so the android technology is a must in the near future because somehow Android has engaged with most of our daily live.

With the assistance of MySQL database technology we are able to store the data from the DCS to have a database of the readings which we will be able to send to the android app, the android app is able to retrieve the data successfully. This database allow us to have a history of the values to return to it whenever the operator needs.

This database can be accessed from anyplace in the world as soon you have the authenticating code for it.

Such technology is so effective and easy because you are trying to store the data using programing skills and coding talents but this can be happened through PHP script and C coding that have ease up the process of storing and displaying the data, not to ignore the speed of database has helped us to reach the data as soon as possible.

According to the theoretical part of try to reach a fully automated control room, The data communication between BN and DCS isn't only in alarms and trips but also in readings and all the means of data communications as rs-422 is a cable between can work for around 4000 ft., so you can control the BN in the field by the control room and the operator .Economically wise, it's just a cable and some software modification which will not exceed 150$ as the price for the rs-422 cable for 200 ft. is equal to 132 $. So my conclusion from the economically, scientific and

industrials sides this study is doable and also it helps the plant to get more and more control of the field. (2), so to conclude the whole project in many points

1. Android is a future technology for the world
2. Retrieving Plant data to android platform Is doable and can create a new technology
3. Plants can be controlled from phones
4. The data communication between Serial Device (BN) and DCS is achievable through Modbus

7. Recommendations and Modifications:

1. Apply the data communication between Serial Devices and DCS
2. Try to retrieve more than one readings in the time
3. Increase the security of the data because most of the data are confidential
4. Try to create a platform for alarms that can appear in the phone
5. Notify the phone with the readings
6. Create a faceplate of the plant on the phone
7. Open and close valves via the phone
8. Request the data as the required time

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9. Appendix

Java Programming code for the app

Manifest File:

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.mkyong.android"
    android:versionCode="1"
    android:versionName="1.0" >

    <uses-sdk android:minSdkVersion="10" />

    <uses-permission android:name="android.permission.INTERNET" />

    <application
        android:icon="@android:drawable/checkbox_on_background"
        android:label="@string/app_name" >
        <activity
            android:name=".WebViewActivity"
            android:theme="@android:style/Theme.NoTitleBar" />

        <activity
            android:label="@string/app_name"
            android:name=".MainActivity" >
            <intent-filter >
                <action android:name="android.intent.action.MAIN" />
                <category
android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

</manifest>
```

```java
package com.mkyong.android;

import android.app.Activity;
import android.content.Context;
import android.content.Intent;
import android.os.Bundle;
import android.view.View;
import android.view.View.OnClickListener;
import android.widget.Button;

public class MainActivity extends Activity {

    private Button button;

    public void onCreate(Bundle savedInstanceState) {
        final Context context = this;

        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);

        button = (Button) findViewById(R.id.buttonUrl);

        button.setOnClickListener(new OnClickListener() {

            @Override
            public void onClick(View arg0) {

                Intent intent = new Intent(context,
WebViewActivity.class);
                startActivity(intent);
            }

        });

    }
```

Layout Main file:

```xml
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:orientation="vertical" >

    <Button
        android:id="@+id/buttonUrl"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="values" />

</LinearLayout>
```

PHP codes

```php
<?php
header('Content-type: text/plain');
$link = mysql_connect("localhost", "root", "") or die("error
loging: " . mysql_error());
mysql_select_db("fyp") or die("error dbtable");
$query = "SELECT * FROM `read`";
$result = mysql_query($query) or die(mysql_error());
while($row = mysql_fetch_assoc($result)) {
            $fromID1 =
          $row["value"];
            $fromID2 =
         $row["aver"];
}
echo " MV = " .$fromID1 . " PV = " .$fromID2;
mysql_close($link);
?>
```