New trends in Process Automation for the cement industry

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1. Abstract:

Process Automation is an important component of modern cement production. The versatility of the control system in a plant defines the efficiency of the plant operation and hence the cost leadership a cement producer can achieve in the market. ABB's Distributed Control System (DCS) has been widely used across all industry segments for many decades.

ABB's philosophy in this field has been a path of continuous evolution protecting existing customer's investments as well as bringing the latest IT technologies in a safe and secure manner to the industrial world. Its award winning latest 800xA DCS system is a package of traditional industrial controls, open industrial fieldbus network topologies and the latest trends in the IT world. The software engineering and visualization graphics is standardized by using cement process control libraries.

ABB also delivers process optimization software & information management software to cover the higher levels of cement plant automation needs. The paper discusses the above mentioned technologies and a cost efficient application of the same.

2. Process Automation structure:

A brief description of the structure of the control and information levels in modern plants is mentioned below. Please refer to Figure 1

Level 0 can be treated as the elementary field devices and sensors which represent the state of the process. These can typically be switches indicating the position of the dampers, gates or temperature values of the gases, etc.

Level 1 can be treated as the nodes collecting the above mentioned field information, grouping them into related areas and taking logical actions based on this information. This is traditionally based on input / output (I/O) cards, the processor (CPU) and the basic visualization displays like the operator stations (OS), CCTV systems etc.

Level 2 is a combination of more involved process operations related to Human Machine Interfaces (HMIs) which are typically the more advanced operator stations, remote clients, reporting packages, interfaces to process model based controls etc.

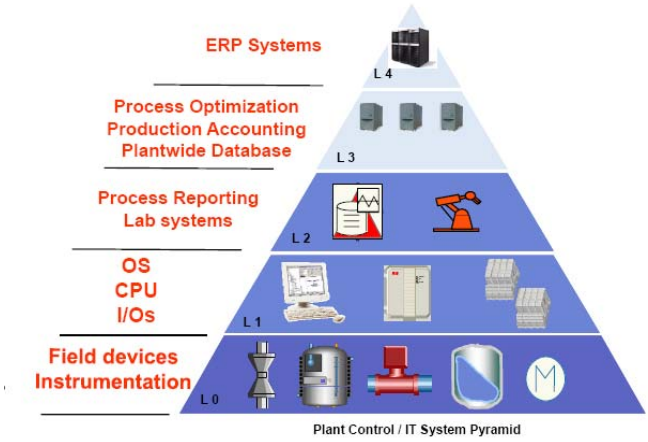

Figure 1: Control and information structure

Level 3 is the Management Execution Systems (MES) level where the systems will support decision making for optimizing the operations integrating the information from quality systems and also taking into consideration the constraints in plant capacity, raw material availability and economic parameters.

Level 4 is considered as the Enterprise Resource Planning (ERP) level involving business and financial decision making systems. These systems can be seamlessly integrated with the above mentioned plant process control levels by the use of ABB's ERP connectors.

3. Overview of ABB products and solutions for cement plant automation:

ABB's package of Process Automation products and solutions cover a wide range of the control levels described above.

The field instrumentation scope includes open fieldbus standards like Foundation fieldbus, Profibus and the traditional HART based Smart instrumentation. ABB's well accepted gas analyzer range has been enhanced with an option for higher corrosion resistant probes and built in plunger designs where required.

ABB's current version of the 800xA 5.1 Process Control System extends the reach of traditional automation systems – beyond control of the process – to achieve the productivity gains necessary to succeed in today's business markets. A single user interface can be configured to present information and provide interaction in a context appropriate to all related disciplines. This is achieved through the Industrial^{IT} Aspect Object^{TM} technology platform on which System 800xA is based.

The systems object-oriented system architecture enables the structured software design with pre-defined and tested functions. The ABB Minerals Library provides tools and functions to cover almost 80–90% of the standard control functions of a cement process like standard DI/DO/AI/AO objects, motors, damper, group, sequence controls, weighing and feeding controls etc. The current version of the Minerals Library SV5.1 SP3 is the result of continuous evolution of almost three decades and applications in over 200 minerals projects. The result is standardized engineering, less commissioning and maintenance time over the whole lifecycle of the installation

For efficient operation of the plant automation it requires seamless interfaces to other major automation areas in the plant like Auto Lab, sub-control systems, high temperature CCTVs and kiln shell scanners. ABB provides seamless interfaces for these on OPC or also delivers some of these systems in-house.

ABB provides process optimization systems to optimize the kiln cooler and the mills area around the defined constraints. Our Optimize^{IT} Expert Optimizer (EO) has been applied on many kilns and mills worldwide.

Knowledge Manager (KM) is a proven production information and management system with more than 400 installations worldwide, providing a flexible way of collecting, optimizing and distributing plant wide production data with regard to quality, maintenance and economics.

ABB's cpmPlus Enterprise Connectivity (ECS) connectors offer the complete solution for seamless manufacturing and business process integration. Out-of–the-box connectivity with ERP systems like SAP are implemented at many sites.

The above mentioned level 3 solutions like EO, KM & ECS connectors form ABB's Collaborated Production Management (CPM) system which is based on several Knowledge Base Solutions (KBS) applications.

A general configuration of a typical plant automation system implementation is shown in Figure 2 below.

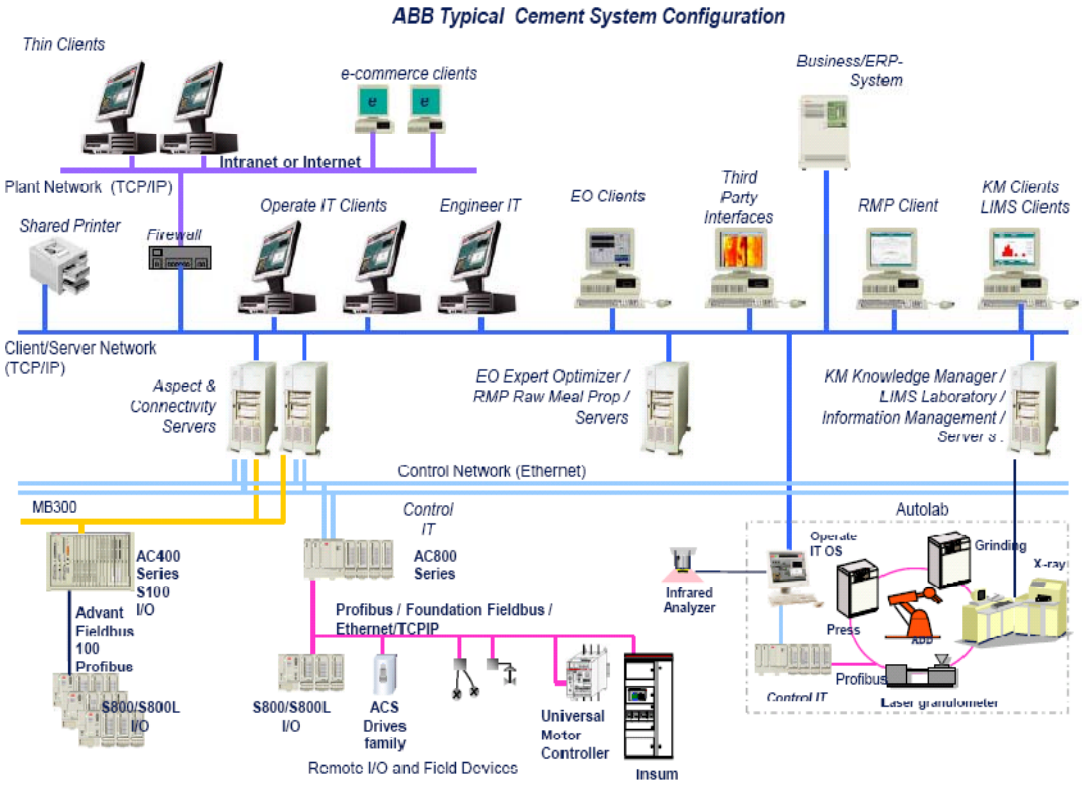

Figure 2: ABB 800xA configuration

4. New trends in control systems:

Fieldbus:

Various types of fieldbuses for level 0 instruments have been in use for quite some time. However its applications for the complete plant integration are gaining wider acceptance now. ABB's System 800xA provides the flexibility of implementing multiple types of fieldbuses, like Profibus, Foundation Fieldbus, Modbus etc. on the same controller, making it a truly integrated platform and giving independence to the user to choose the fieldbus of his/her preference.

The implementation of fieldbus for level 0 devices integration helps reduce control cabling during the project implementation. It also enables a remote configuration of the devices from the integrated engineering station. Further, during the plant operation System 800xA asset monitoring features can be used for health diagnostics of the online smart instruments, leading to advanced information on impending failures and hence less plant downtime.

Electrical device Integration:

The concept of fieldbus integration is extended to more complex electrical devices like AC drives, MCC and MV switchgears.

ABB's intelligent MCC solutions provide options for interfacing individual feeders of the MCC or one MCC as a whole with the control system. The MNS*i*S range of MCC solutions provides maximum intelligence to the MCC. The control circuits for each individual feeder can be soft-programmed in this

MCC. During plant commissioning we only need to establish the fieldbus communication with the MCC and the CPU. This avoids the need of large control cabling which is otherwise required.

The Substation Automation industry has now almost standardized on the IEC61850 protocol for interoperability between protection & control IEDs (intelligent electronic devices). ABB's 800xA platform has followed this development and created a solution that integrates the electrical and process side on this protocol. IEC 61850 communication works to some degree like a fieldbus, but it is reasonably faster because of the underlying Ethernet. As fast communication is a prerequisite for load shedding applications, horizontal communication is available and so the IED may respond in time-critical manner. A typical configuration is illustrated in Figure 3 below.

Load management system

Many cement plants depend on interconnected power sources like multiple diesel generator plants or utility grids for their power requirements. This requires proper load management for power system stability during plant and power side disturbances.

Due to the interoperability and integration of the power and process side ABB has developed solutions for load management on the plant automation platform for selective shedding and reconnection of loads based on defined priorities.

This saves the user many downtimes and startup delays giving overall economic benefit.

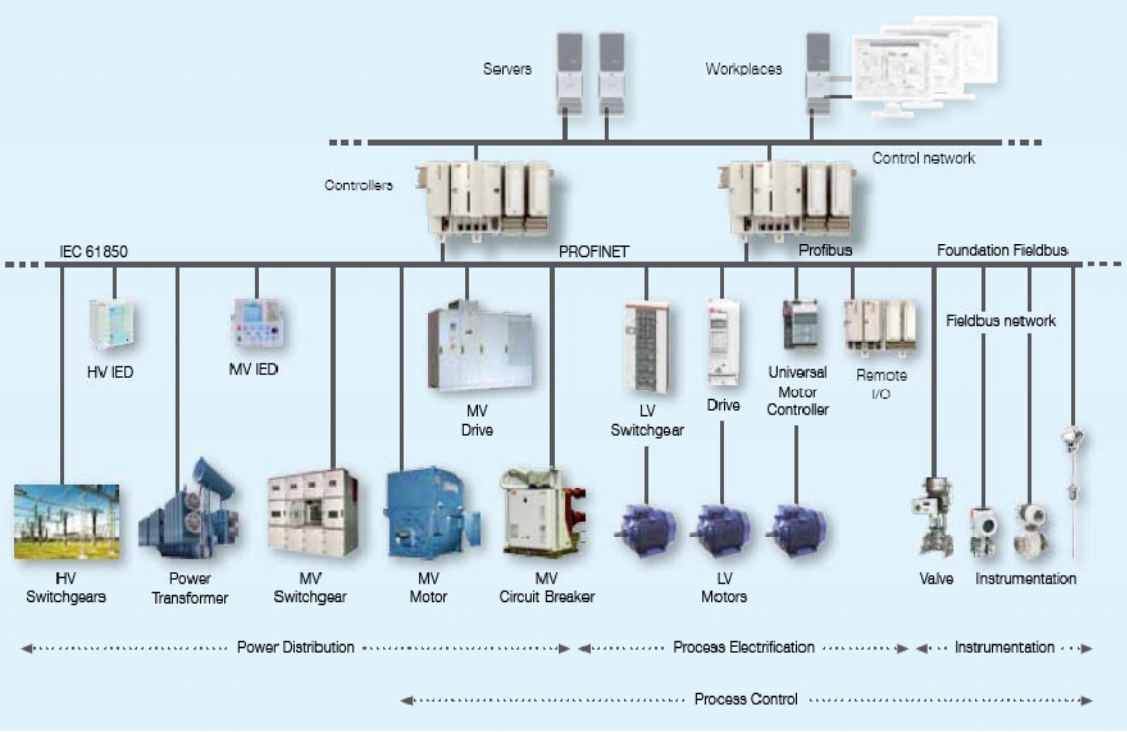

Figure 3: Process and power system integration

ABB Minerals Library

Further to the brief overview above some more elaboration is made on this important product enabling easy application of the 800xA DCS platform for cement plant automation.

System 800xA Minerals Library contains pre-engineered objects containing control logic, human machine interface and communication for application creation in drag-and-drop manner. It provides a complete set of operator functions, including realistic process displays with graphic elements and faceplates, superior trending capabilities, intelligent alarm and event handling with remote messaging,

reporting, as well as drawings such as wiring diagrams. It provides intelligent connectivity between objects and parameterization rather than programming during engineering.

The Minerals Library is supported with a MS Access based engineering tool called Plant Design & Allocation (PDA) tool which has pre-defined functionality to accelerate application development.

Some typical faceplates for objects, load shedding and alarm management described above are illustrated in Figure 4 below.

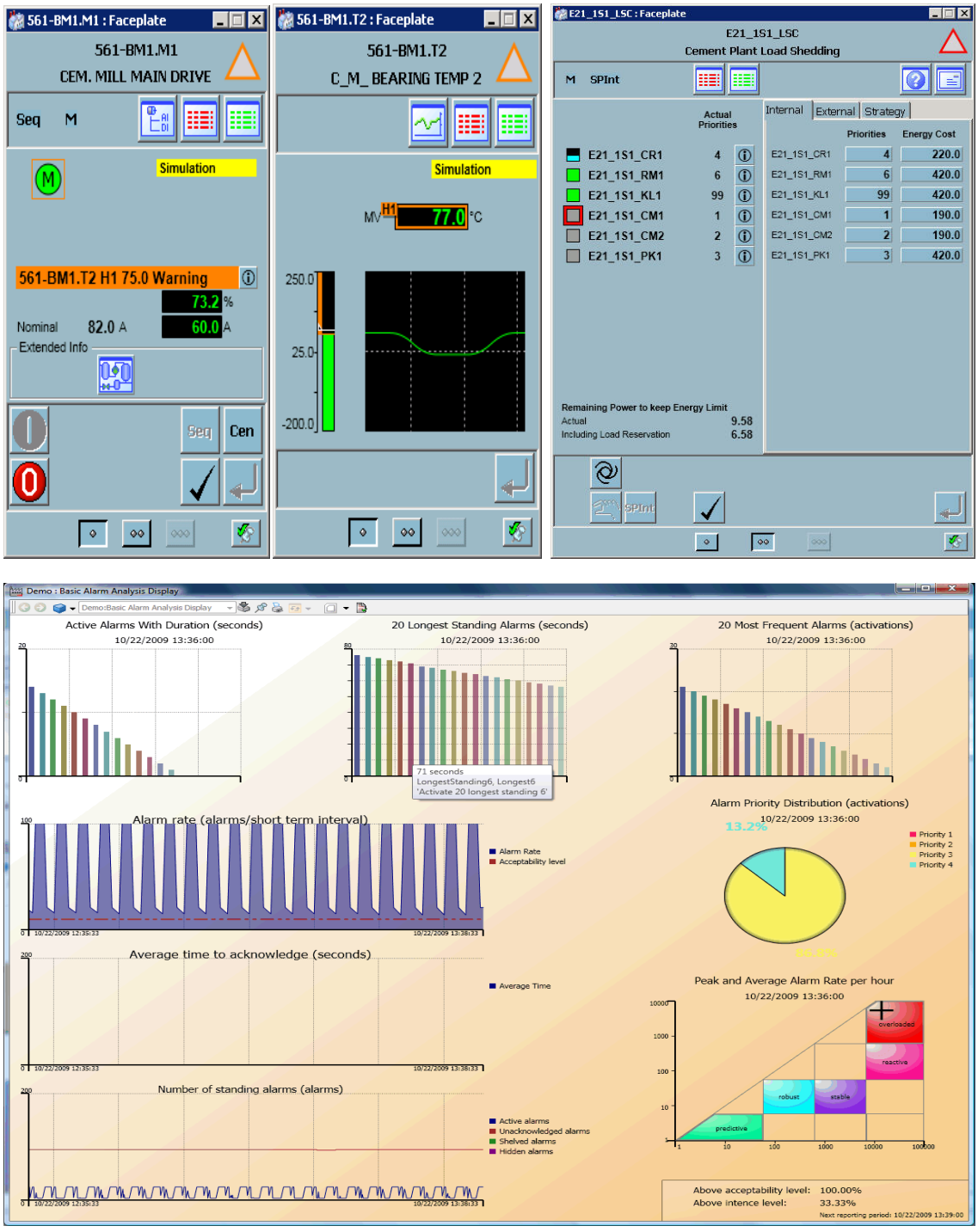

Figure 4: Minerals library

ABB's bulk and powder material analyzers SOLBAS

ABB has implemented its revolutionary non-radioactive online material composition analyzers for applications on the limestone conveyors and in the raw meal air slides. As this technology is based on infrared light the implementation process and maintenance is very user friendly. This solution opens up new possibilities for the cement users to integrate quality control into the control system in online mode. This can partially relieve the load on the traditional lab systems and perform as a backup for maintaining quality records and standards.

5. Trends in Collaborative Production Management (CPM) solutions :

ABB's CPM portfolio covers the Level 3 space for cement plant automation. It consists of process optimization solutions and intelligent data gathering, analysis, presentation and seamless integration between the process control area and ERP systems. Please refer to Figure 5 below.

The loop performance manager (LPM) keeps the plant instrumentation and the control system operating at the peak performance. It monitors the loops through LPM auditing and optimizes the same by defining optimal PID parameters with LPM tuning.

The Expert optimizer (EO) helps optimize the process. The product consists of modules for raw mix preparation (RMP) which can be integrated with the online analyzers, kiln and mill optimization. It uses fuzzy logic, neural networks, linear & non-linear MPC with a simple but extensive graphical toolkit. The application of EO brings improvement in productivity, energy and fuel efficiency and profitability.

The Knowledge Manager functions include core functions like reporting, trending, mimics, calculation and KPIs. It further includes functionality of process and production management, emissions and energy monitoring, maintenance support and downtime management as well as alarm and event management. Important to its structure is a single plant wide Knowledge Database Warehouse making it a seamless interface between the Level 2 and Level 4 ERP systems.

The cpmPlus Enterprise Connectivity Solutions (ECS) provide bi-directional information exchange between the production plant and the ERP systems. Validated information from the KM production accounting and other modules can be exchanged through these standardized connectors.

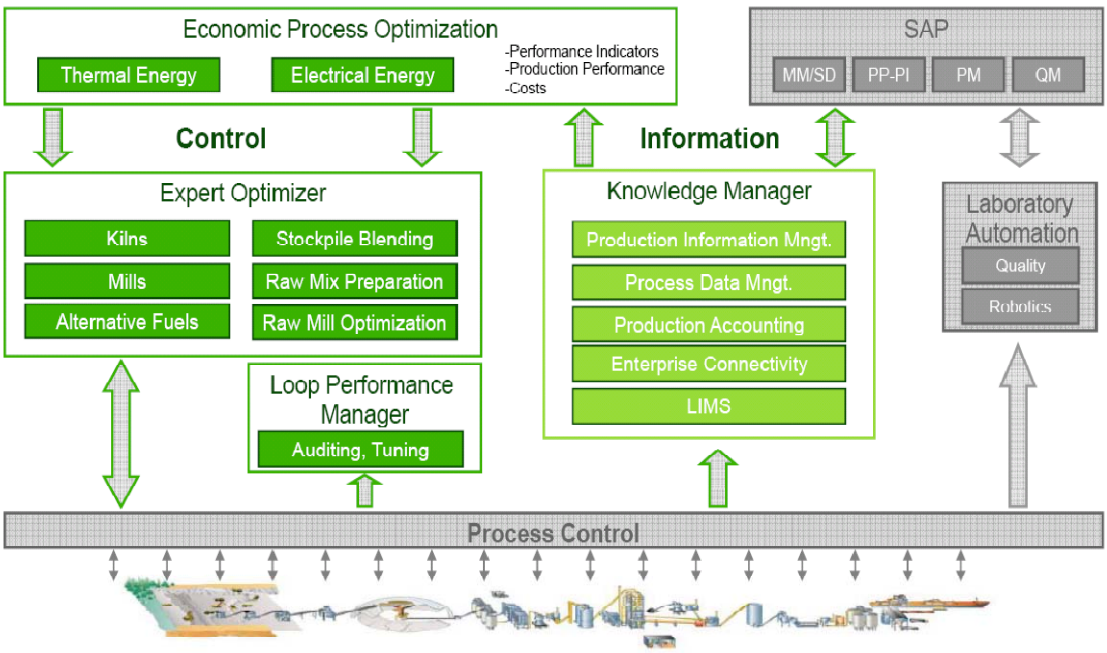

Figure 5: CPM solutions suite.

6. System 800xA configuration provided at 6500tpd - case Star cement plant, Ras Al-Khaima, UAE

A typical configuration of an implemented 800xA and Minerals Library control system is the Star Cement plant. It has Profibus based field instrumentation, other electrical interfaces as well as third party OPC interfaces. Please refer to Figure 6 below.

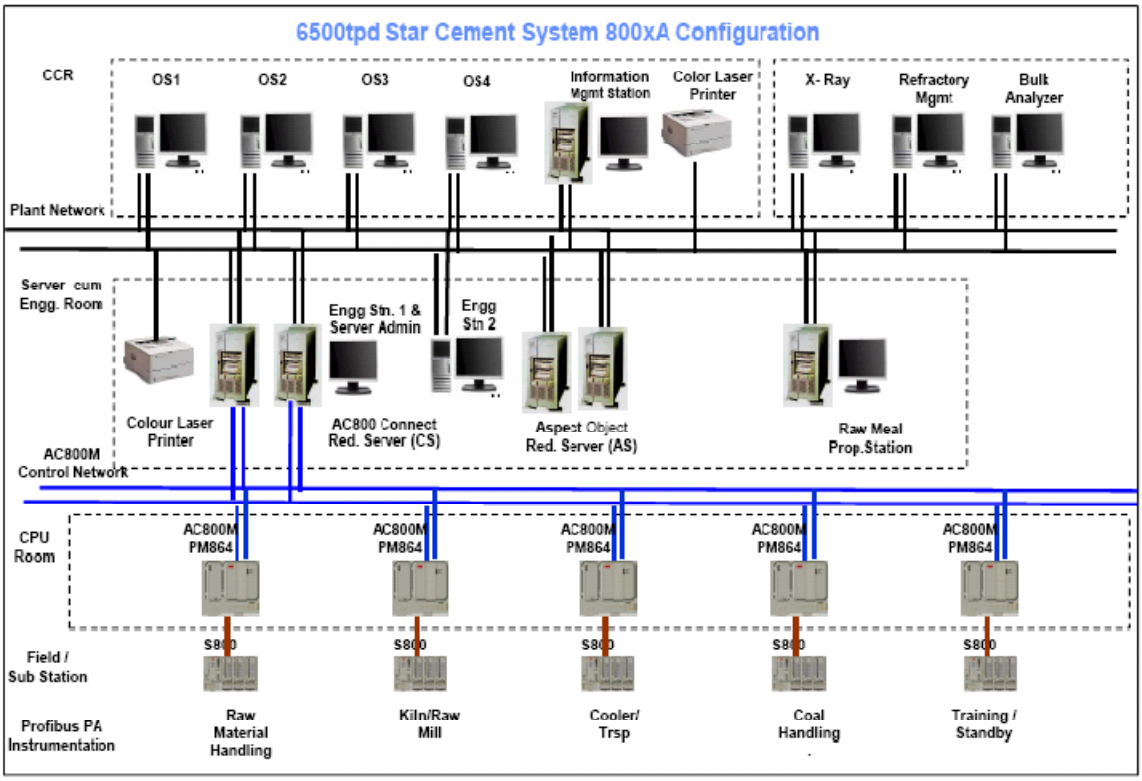

Figure 6: Star Cement system configuration

7. Conclusion :

ABB's System 800xA DCS platform has many enabling hardware and software interfaces and libraries to implement a tightly integrated modern cement plant automation system. The ABB CPM solutions suite extends the plant automation capability to optimize the production process and to provide seamless bidirectional connectivity with ERP systems for real time business decision making. An efficient & informative control system like the ABB System 800xA provides great operational advantage for modern cement plants.