MEP Building Services Advanced Course

BMS & SMART BUILDINGS

Course No Eight

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Buildings management system History

- Building Management Systems have been employed for as long as commercial buildings have existed.
- the concept being introduced in the early 1970s (the terms BAS-building automation system, and EMS-energy management system are also used).
- the phrase has only really existed since the introduction of complex electronic devices that are capable of retaining data for the purposes of managing services such as power, lighting, heating and so on.

- It was the advent of the "modem", or "modulator-demodulator" which allowed analog signals to be digitized so that they could be communicated over long distances with a high degree of accuracy that spurred the development and deployment of modern BMSs.
- The Powers 570 was an example of such a system. Developed and marketed by Powers Regulator Company (later purchased by Siemens), it was deployed into the market in May 1970, as the model number suggests.

What is the BMS

- Building Management System (BMS) is one of the most important components in constructing green building it ensures that the building remains 'green' through it's life.
- BMS is basically a solution is put into a facility to ensure an environment that is safe, secure, comfortable and energy efficient.

When properly installing into a facility, BMS can result in the following benefits:

- Optimize energy conception.
- Provide alarm systems so as to take corrective actions.
- Monitor and control indoor comfort conditions

Building Management System (BMS)

is a computer-based control system installed in buildings that controls and monitors the building's mechanical, electronical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems…….

BMS consists of

BMS consists of software and hardware:

- hard ware board, cables , … etc.
- software the software program usually configured in a hierarchical manners. Can be proprietary using such protocols as c-bus, prohibus, etc…

Functions of Building Management Systems

To create a central computer controlled method which has three basic functions:

- controlling
- monitoring
- optimizing

the building’s facilities, mechanical and electrical equipment for comfort, safety and efficiency.

BMS system normally comprises(contains)

- Power systems
- illumination system(lightings)
- Electric power control system
- Heating, Ventilation and Air-conditioning HVAC System
- Security and observation system(CCTV)
- Magnetic card and access system(Access control)
- Fire fighting
- Fire alarm system
- Elevators

Benefits of BMS

1-Building tenant/occupants

- Good control of internal comfort conditions
- Possibility of individual room control
- Increased staff productivity
- Effective monitoring and targeting of energy consumption
- Improved plant reliability and life(green buildings)
- Effective response to HVAC-related complaints
- Save time and money during the maintenance
- Friend to Environment (ECO system)

2-Building owner

- Higher rental value
- Flexibility on change of building use
- Individual tenant billing for services facilities manager
- Central or remote control and monitoring of building
- Increased level of comfort and time saving

3-Maintenance Companies

- Ease of information availability problem diagnostics.
- Computerized maintenance scheduling
- Effective use of maintenance staff
- Early detection of problems
- More satisfied occupants

How do we connect and install BMS

- DDC (Direct Digital Control)
- IQ (controller)
- Signal Cables
- IP (Addressable)
- Local Area Network
- control room (computer)

Direct digital control (DDC)

- **Direct digital control** (DDC) is the automated control of a condition or process by a digital device (computer)
- The unit controllers typically have analog and digital inputs, that allow measurement of the variable (temperature, humidity, or pressure) and analog and digital outputs for control of the medium (hot/cold water and/or steam). Digital inputs are typically (dry) contacts from a control device, and analog inputs are typically a voltage or current measurement from a variable (temperature, humidity, velocity, or pressure) sensing device

Digital outputs are typically relay contacts used to start and stop equipment, and analog outputs are typically voltage or current signals to control the movement of the medium (air/water/steam) control devices. Usually abbreviated as "DDC"

Data communication

- When DDC controllers are networked together they can share information through a data bus. The control system may speak 'proprietary' or 'open protocol' language to communicate on the data bus. Examples of open protocol language are BACnet (Building Automation Control Network), LON (Echelon), Modbus.

Integration (connecting together)

- When different DDC data networks are linked together they can be controlled from a shared platform. This platform can then share information from one language to another. For example, a LON controller could share a temperature value with a BACnet controller. The integration platform can not only make information shareable, but can interact with all the devices.
- Most of the integration platforms are either a PC or a network appliance. In many cases, the HMI (human machine interface) or SCADA (Supervisory Control And Data Acquisition) are part of it.

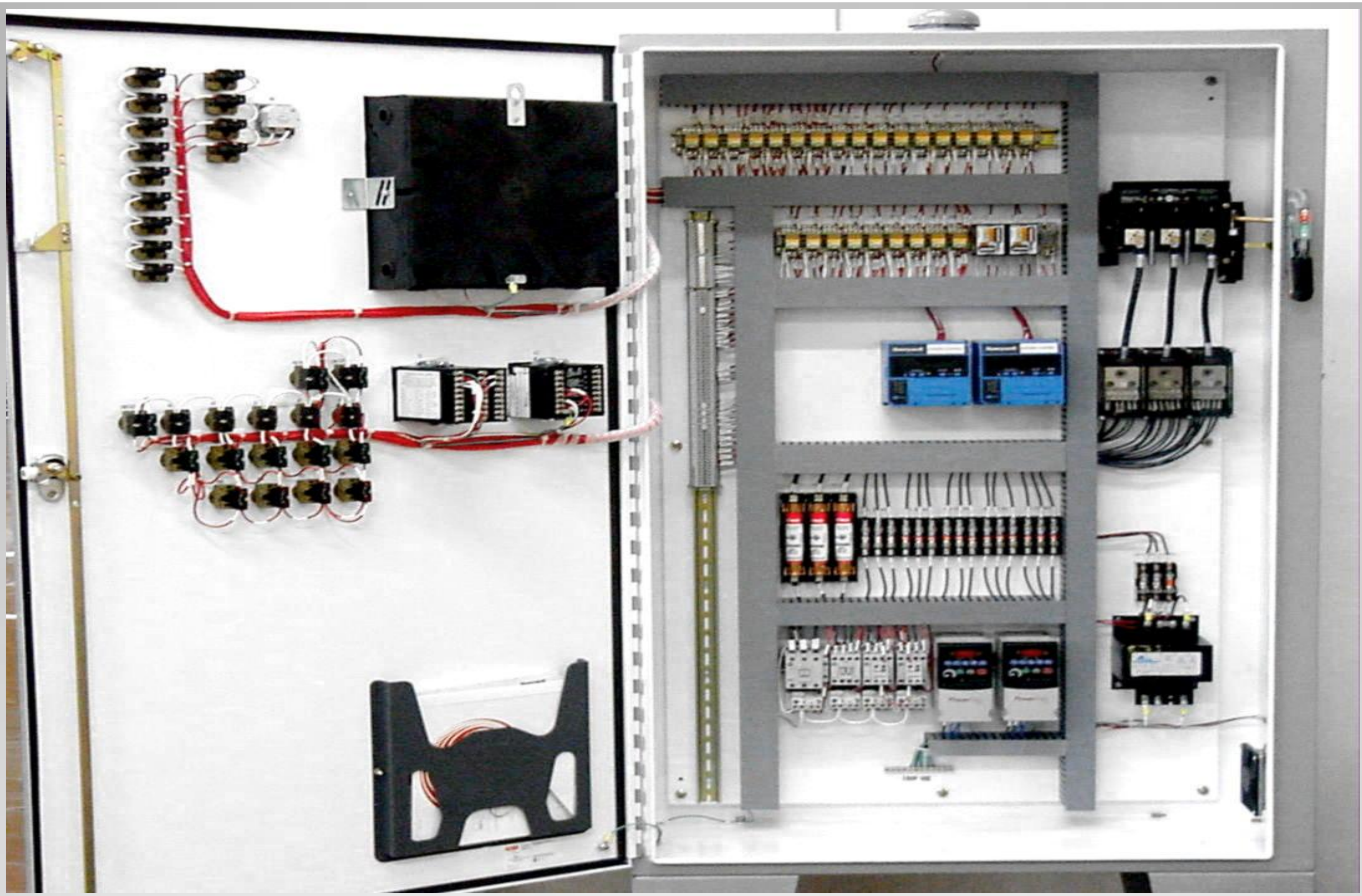
The Network Controller
(The IQ)

- The controller should be connected to an Ethernet hub or switch using Cat 5e unshielded or shielded (UTP or FTP) cable and RJ45 plugs (shielded or unshielded appropriate to the cable). A local PC (Ethernet) can either be connected to an adjacent port on the hub, or can be connected directly to the IQ3 Ethernet port using a standard Ethernet cable in conjunction with a crossover adapter .
- This is the main network for the IQ3 controller. It enables PCs to connect directly to Ethernet and communicate with the IQ3 using IP addressing. It also enables Inter-Controller Communications
- The strategy and all other configuration files may be downloaded to the IQ3 from SET (System Engineering Tool) across Ethernet

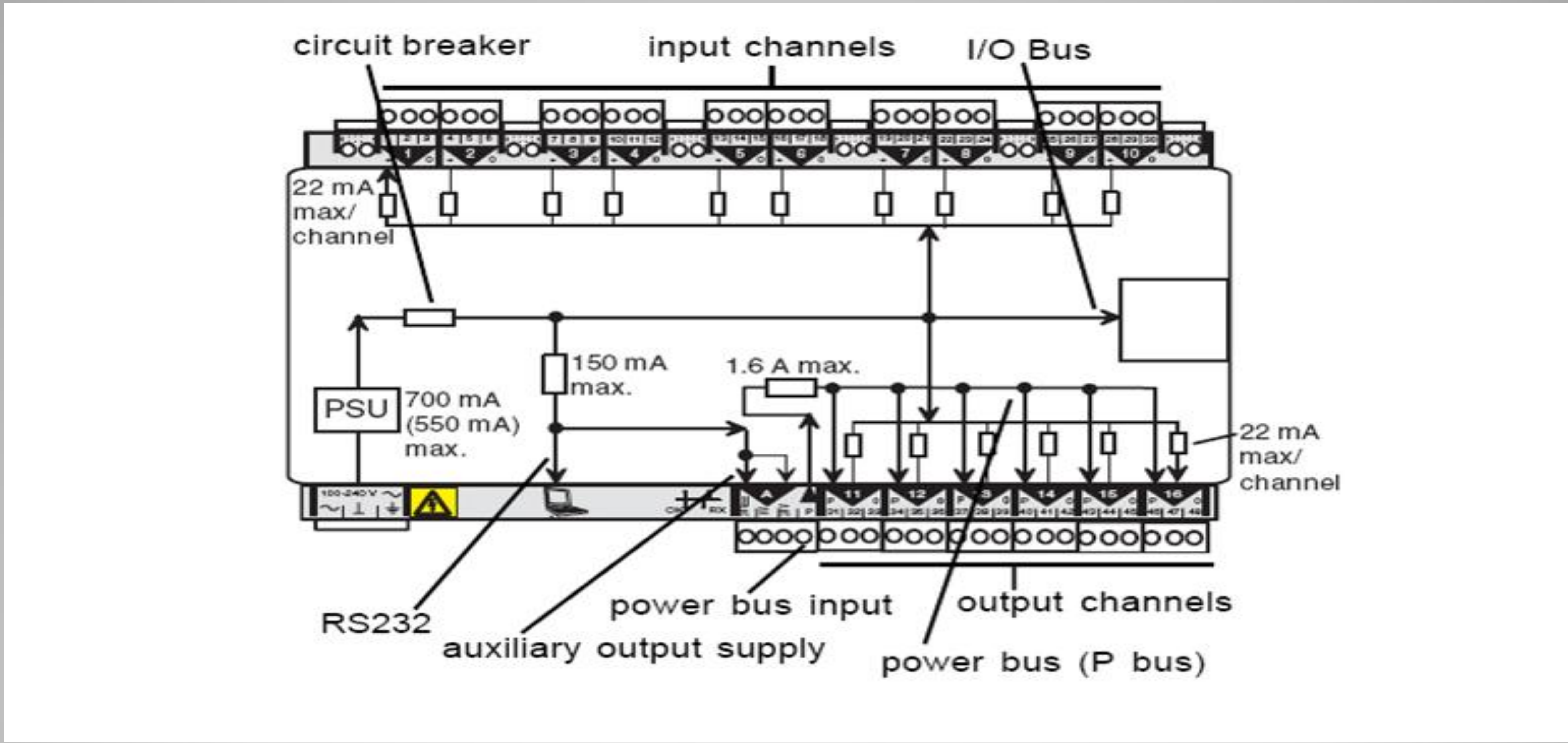
Ethernet

Ethernet

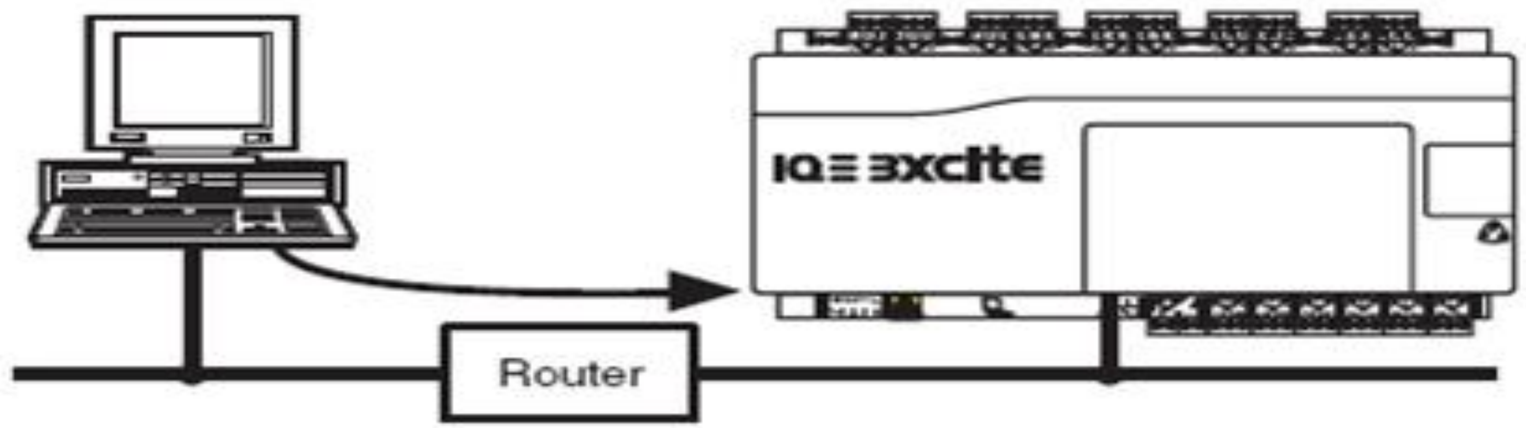
The DDC



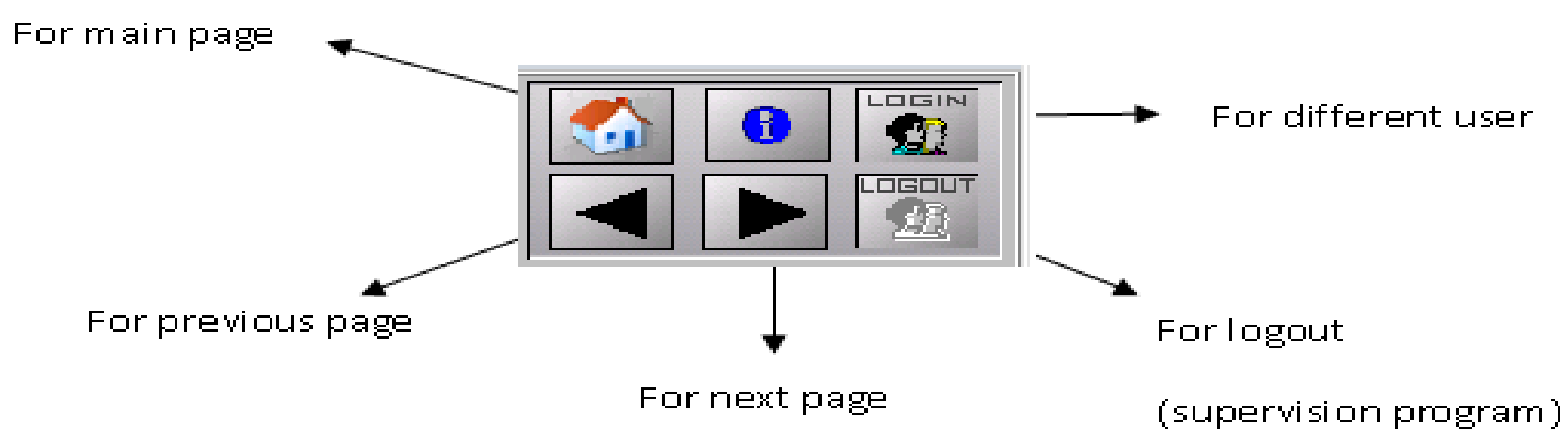
The DDC


circuit breaker
input channels
I/O Bus
22 mA max/ channel
150 mA max.
1.6 A max.
PSU
700 mA (550 mA) max.
22 mA max/ channel
RS232
power bus input
output channels
auxiliary output supply
power bus (P bus)

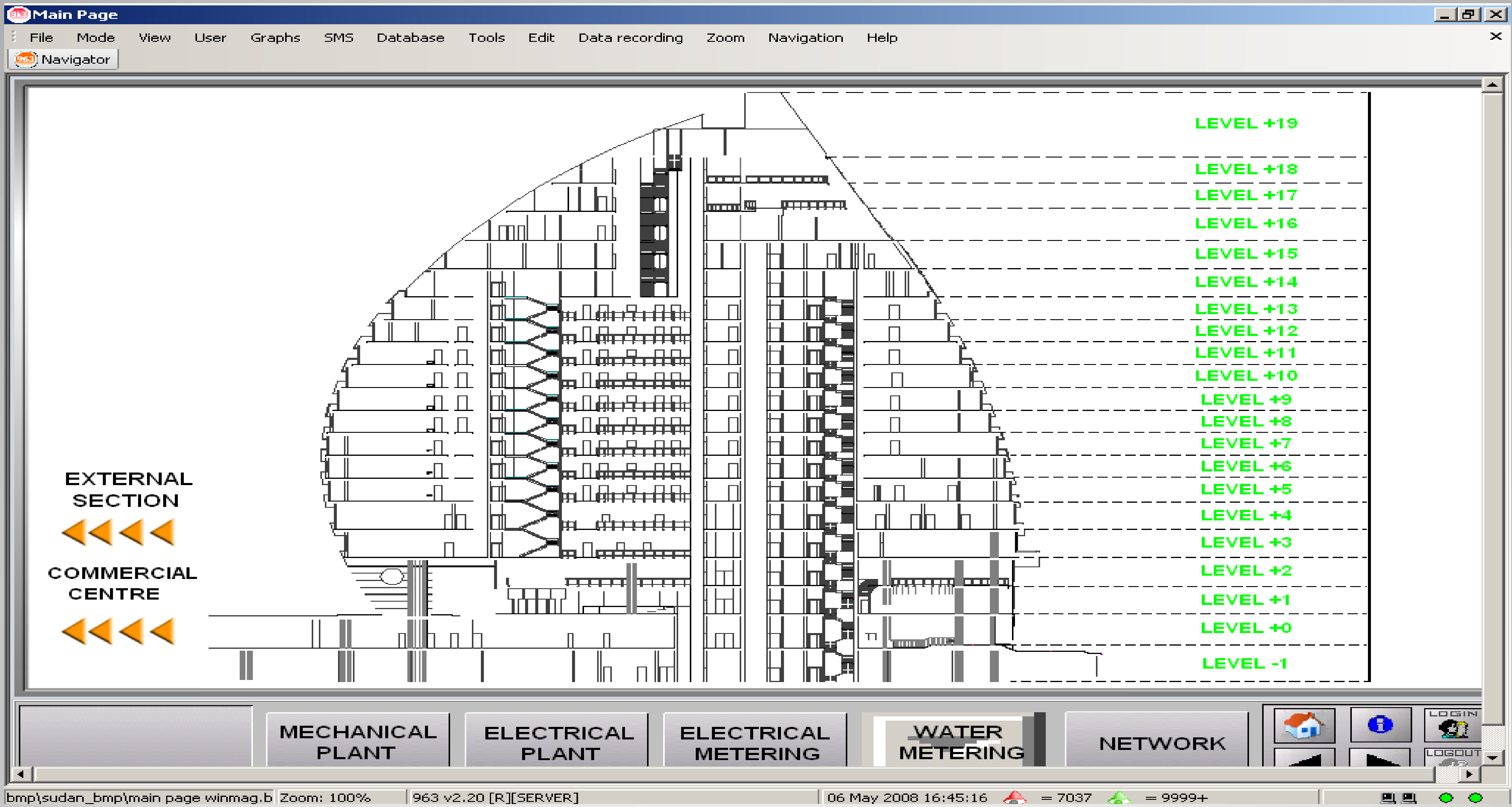
IQ



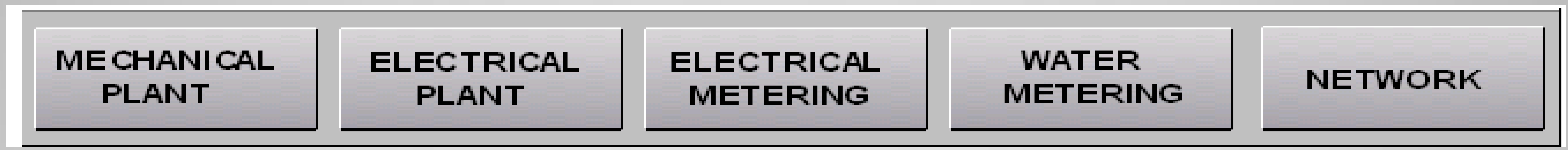
The Network



The main page of the BMS program



The main tower



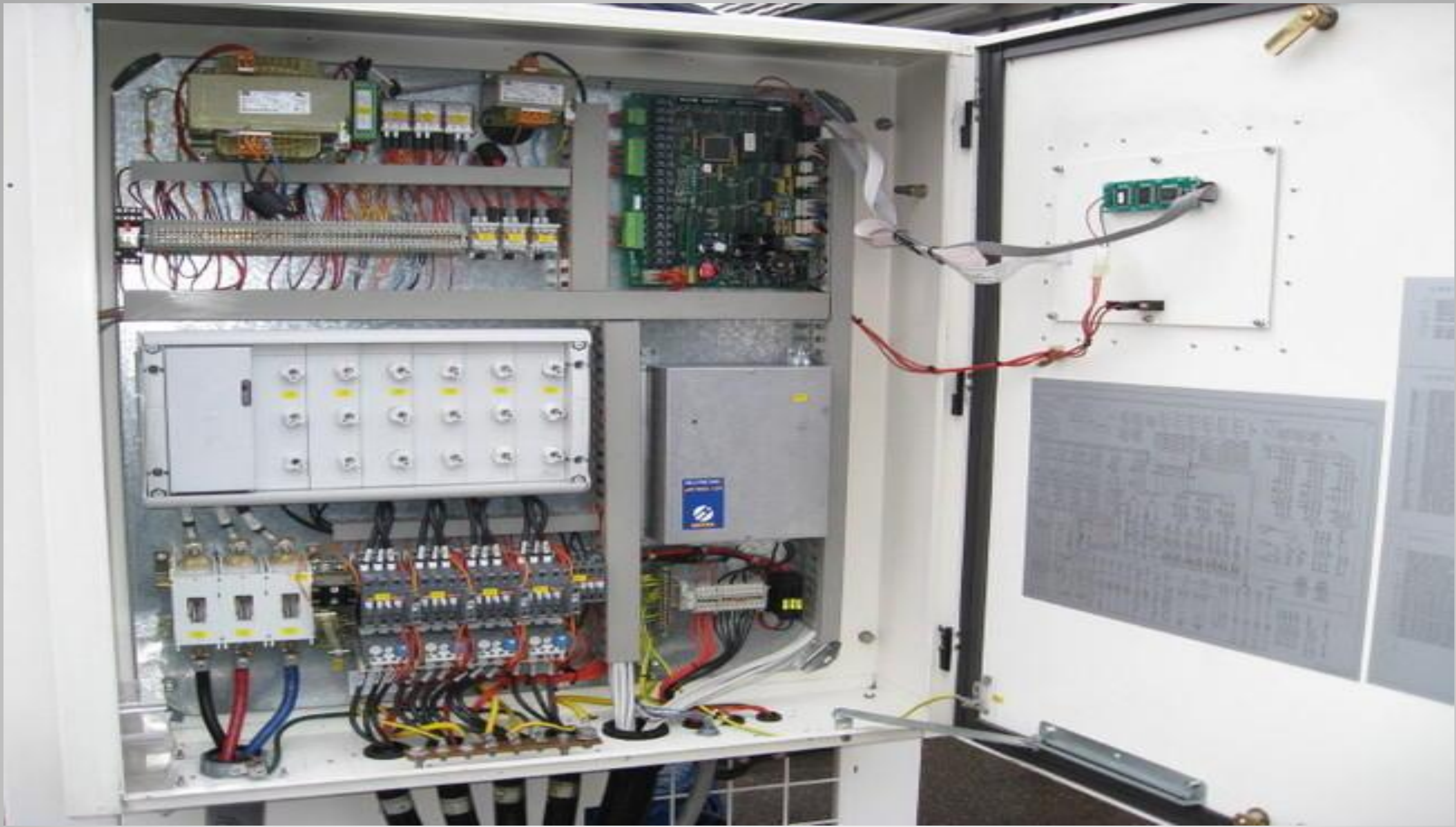
The toolbar of the BMS program

BMS applied in Sudan

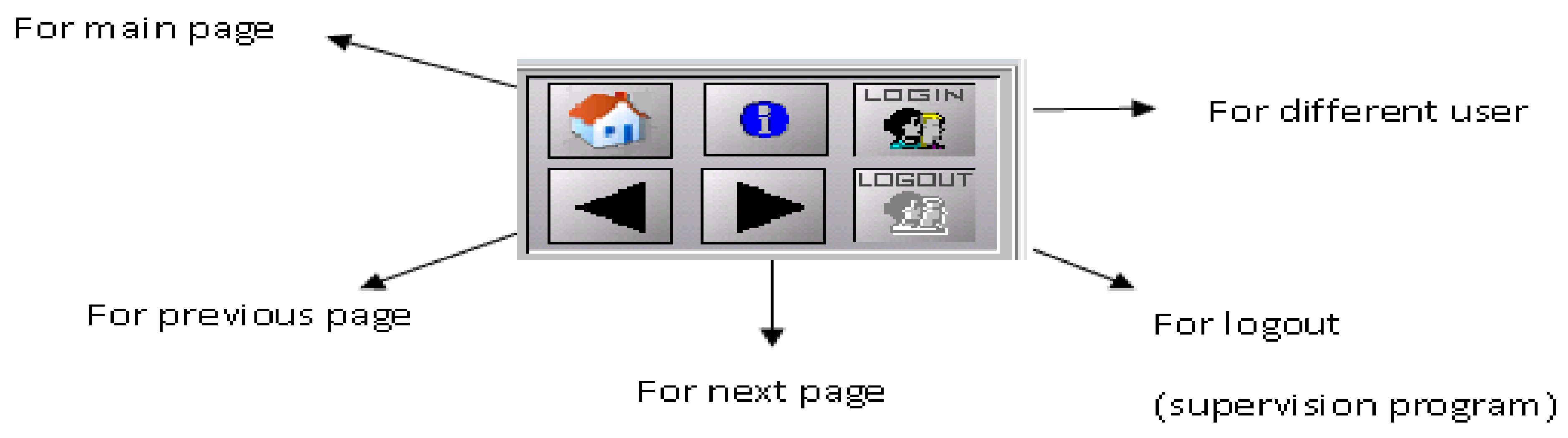
- Greater Nile petroleum operating company new tower
- Petrodar petroleum company new tower
- Byblos bank new tower
- Bank of Sudan
- Sudapet tower
- Telecommunication new tower
- Alfateh hotel tower
- Judgement new tower
- Al-waha complex tower Khartoum
- Alsalam rotana hotel

Chiller

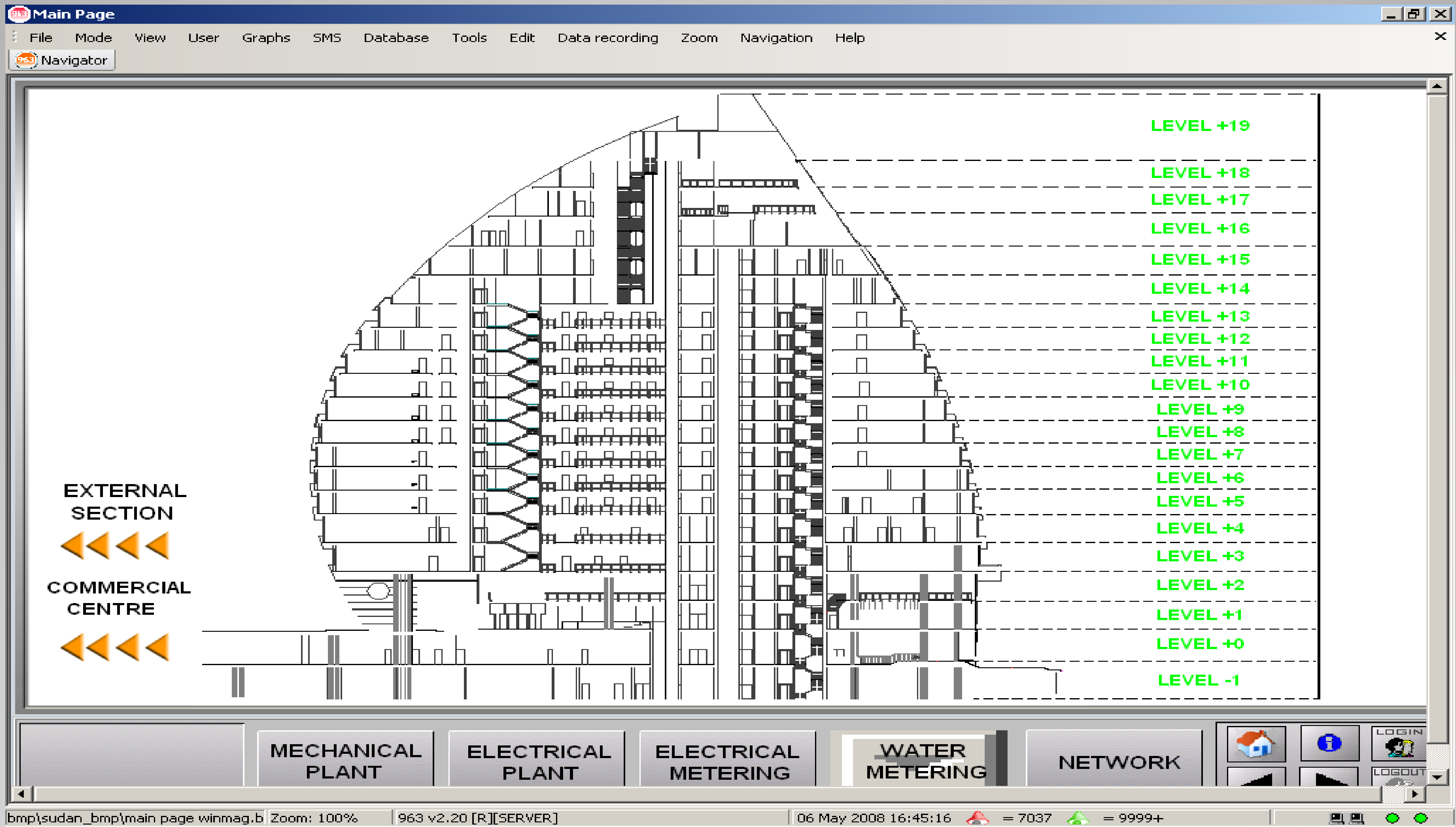
Chiller control panel



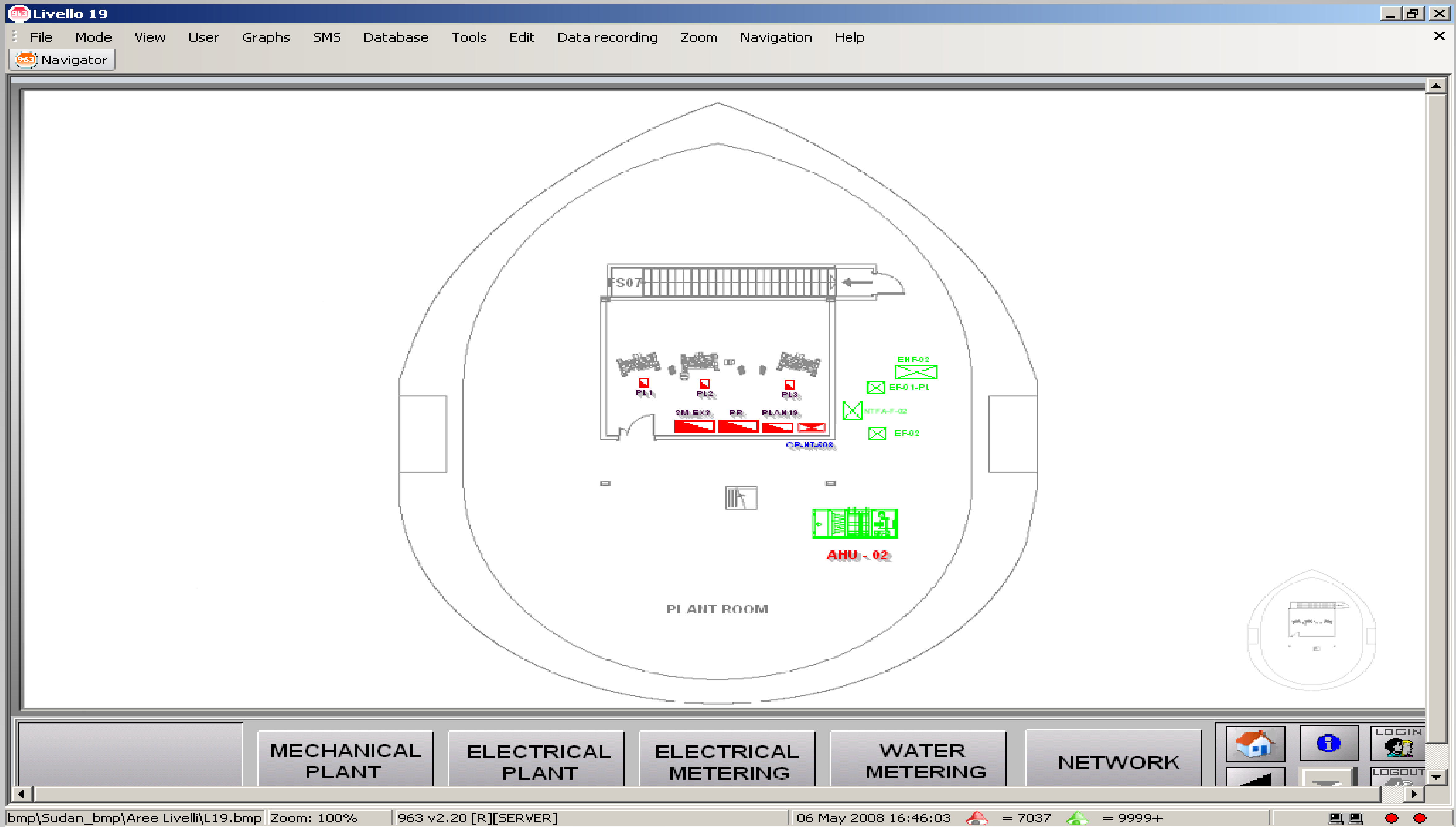
Chiller control panel
(electrical connections)



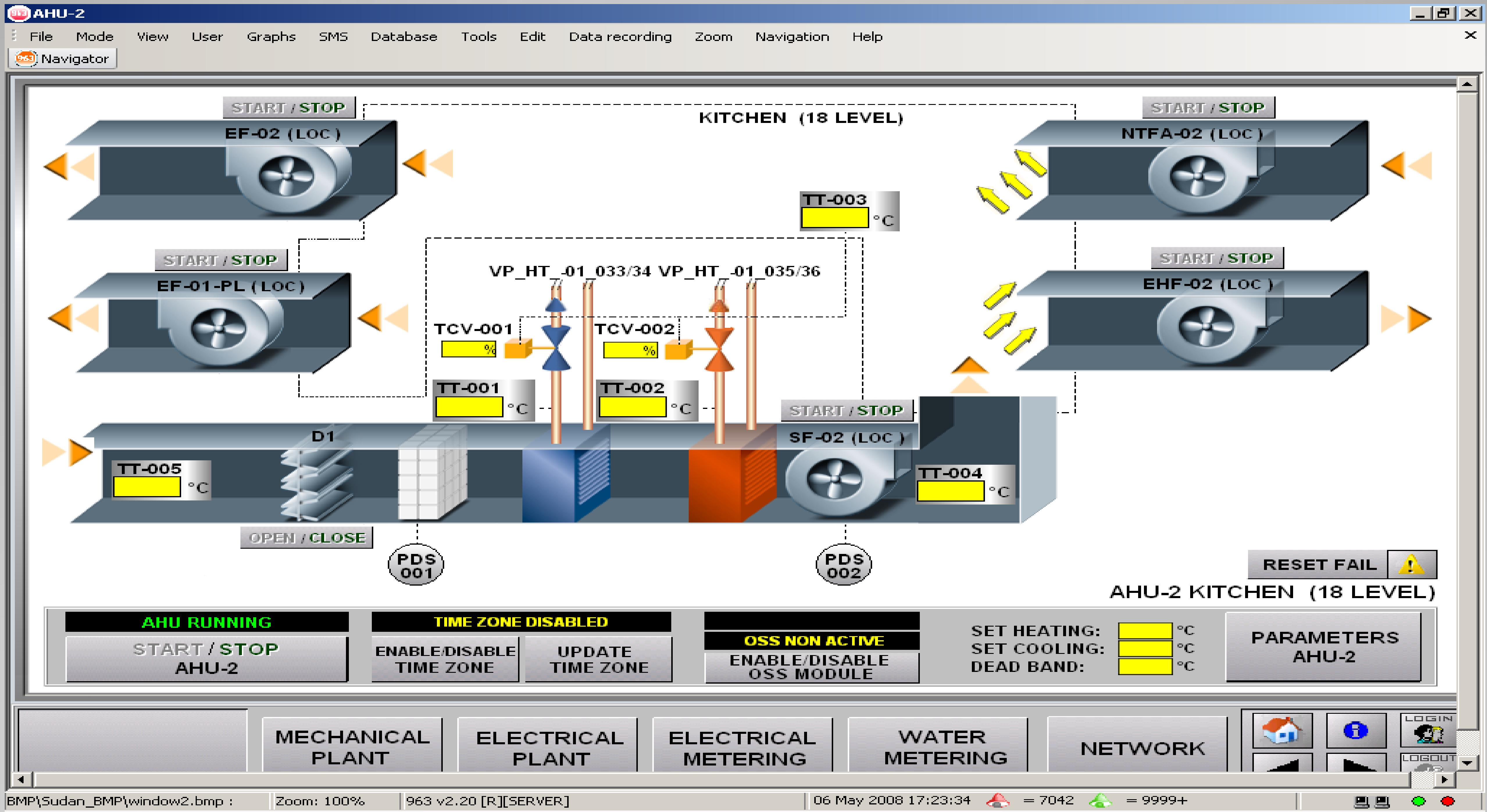
Log in to the program



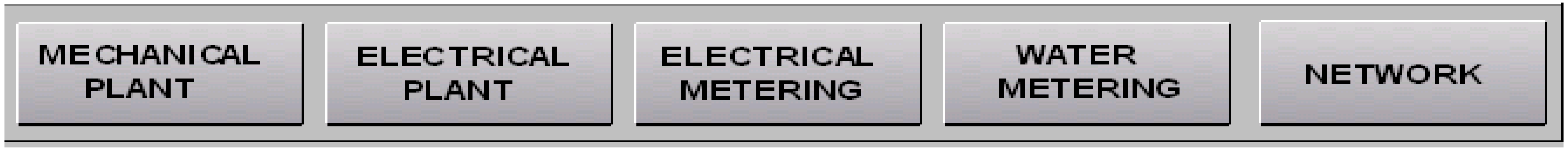
Main tower(main page)



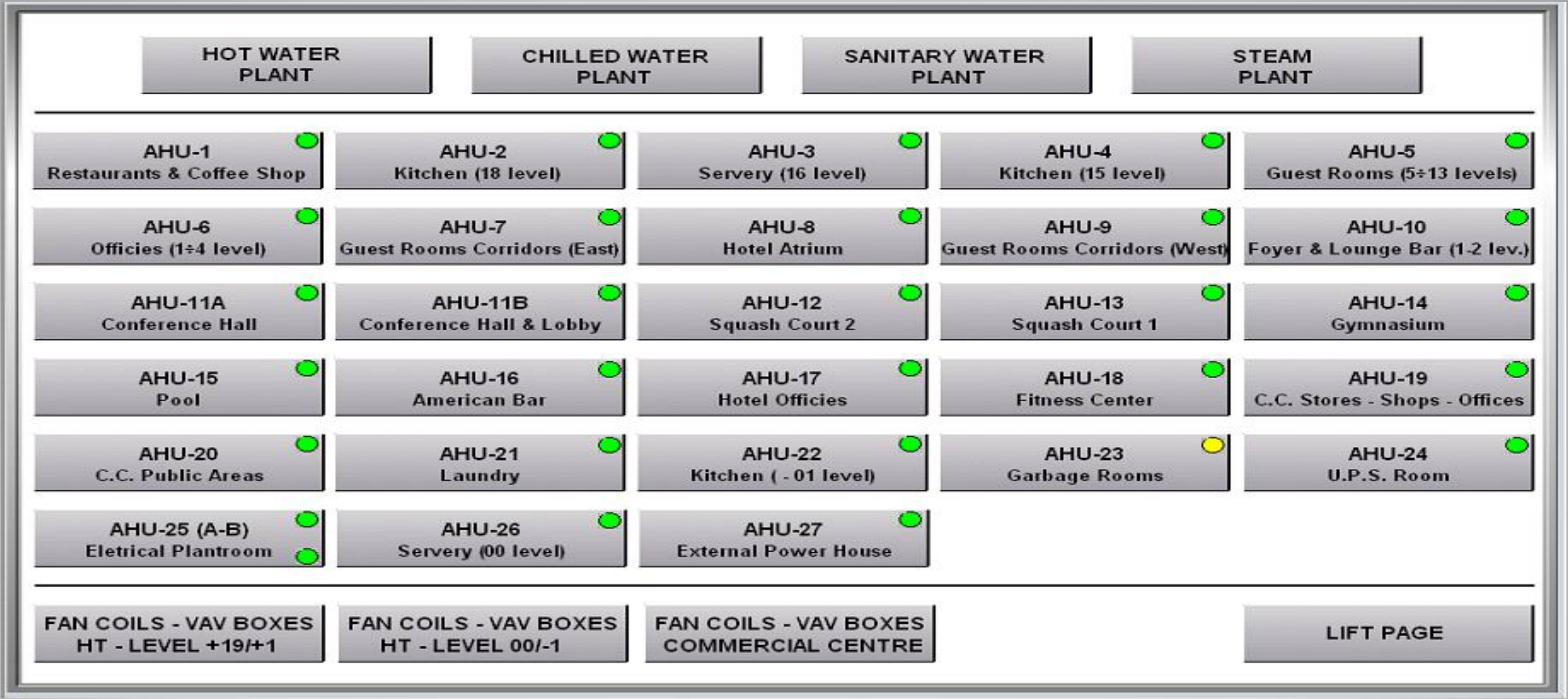
Level 4 equipment



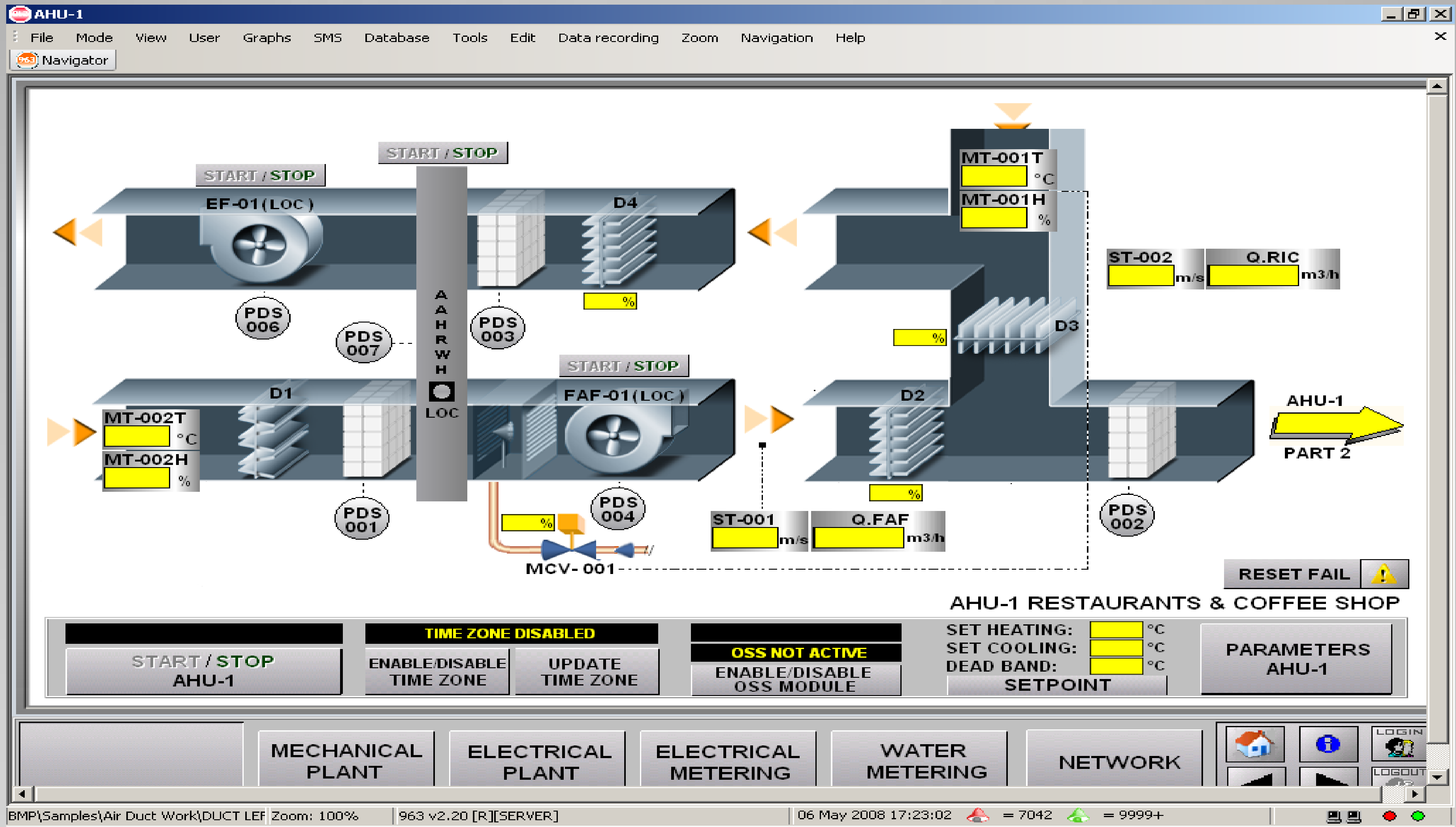
Air handling units



Main command bar



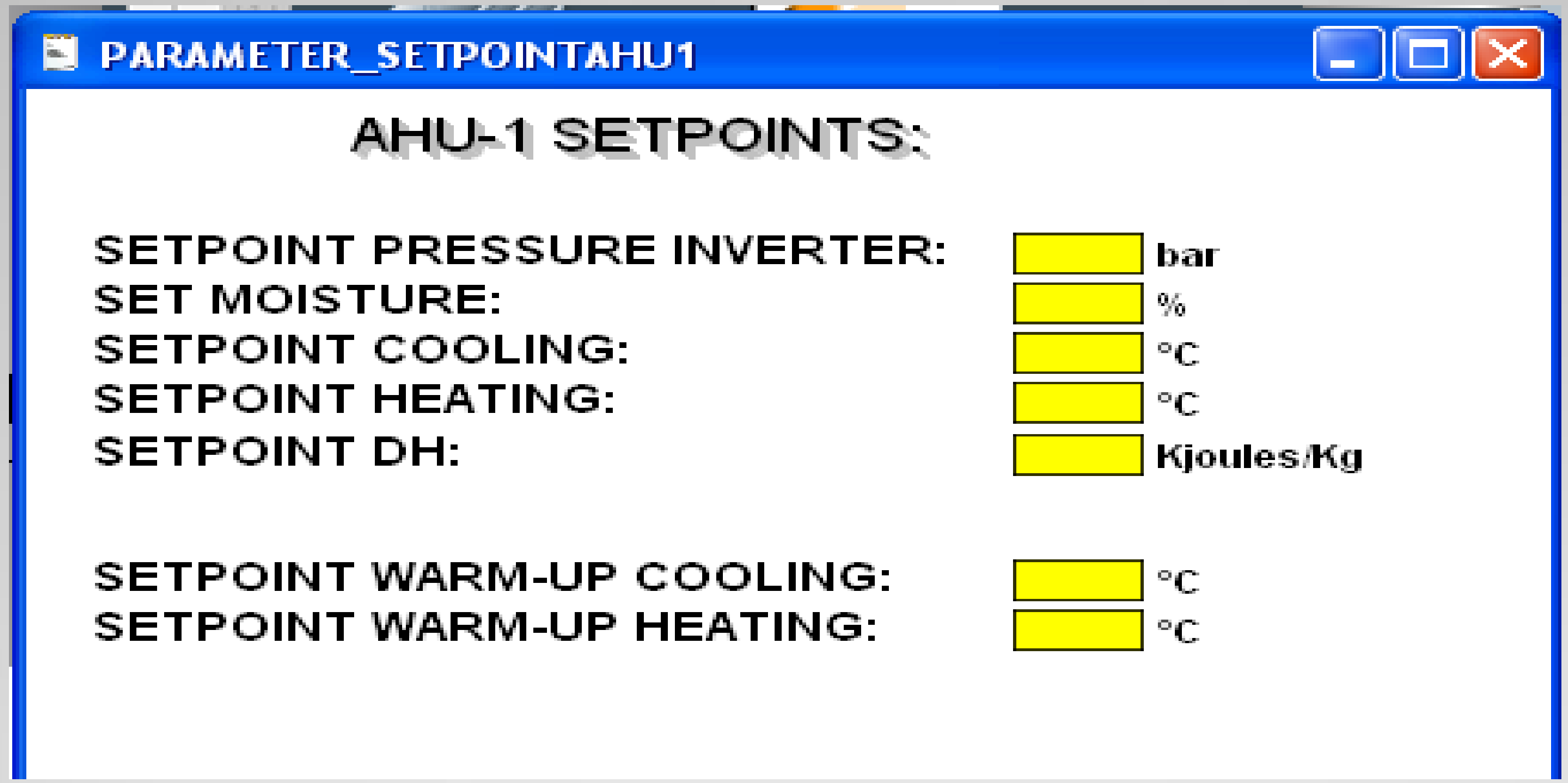
mechanical plant



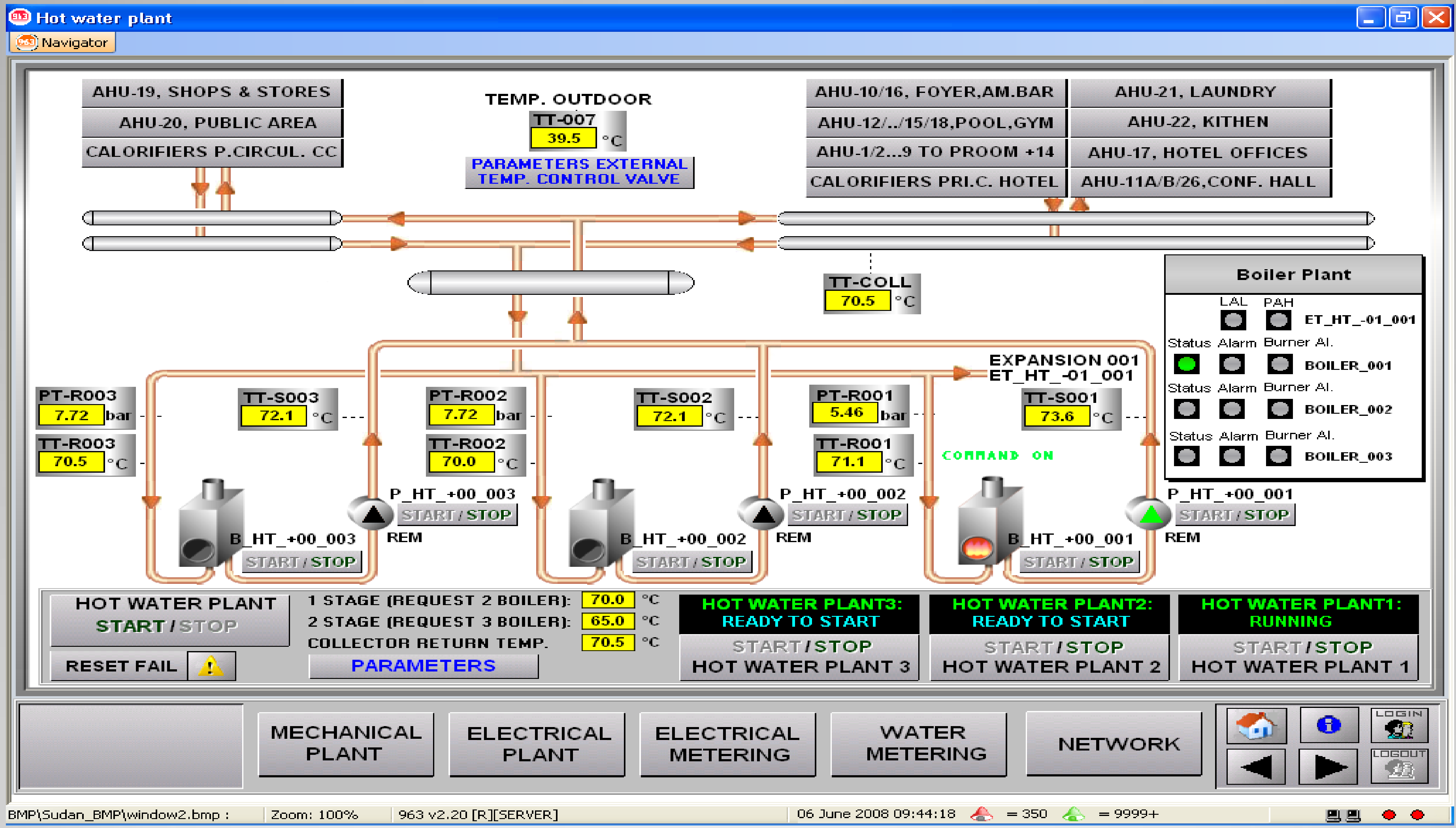
Air handing unit


TIME ZONE DISABLED
START / STOP AHU-1
ENABLE/DISABLE TIME ZONE
UPDATE TIME ZONE
OSS NOT ACTIVE
ENABLE/DISABLE OSS MODULE
SET HEATING: °C
SET COOLING: °C
DEAD BAND: °C
SETPOINT
PARAMETERS AHU-1

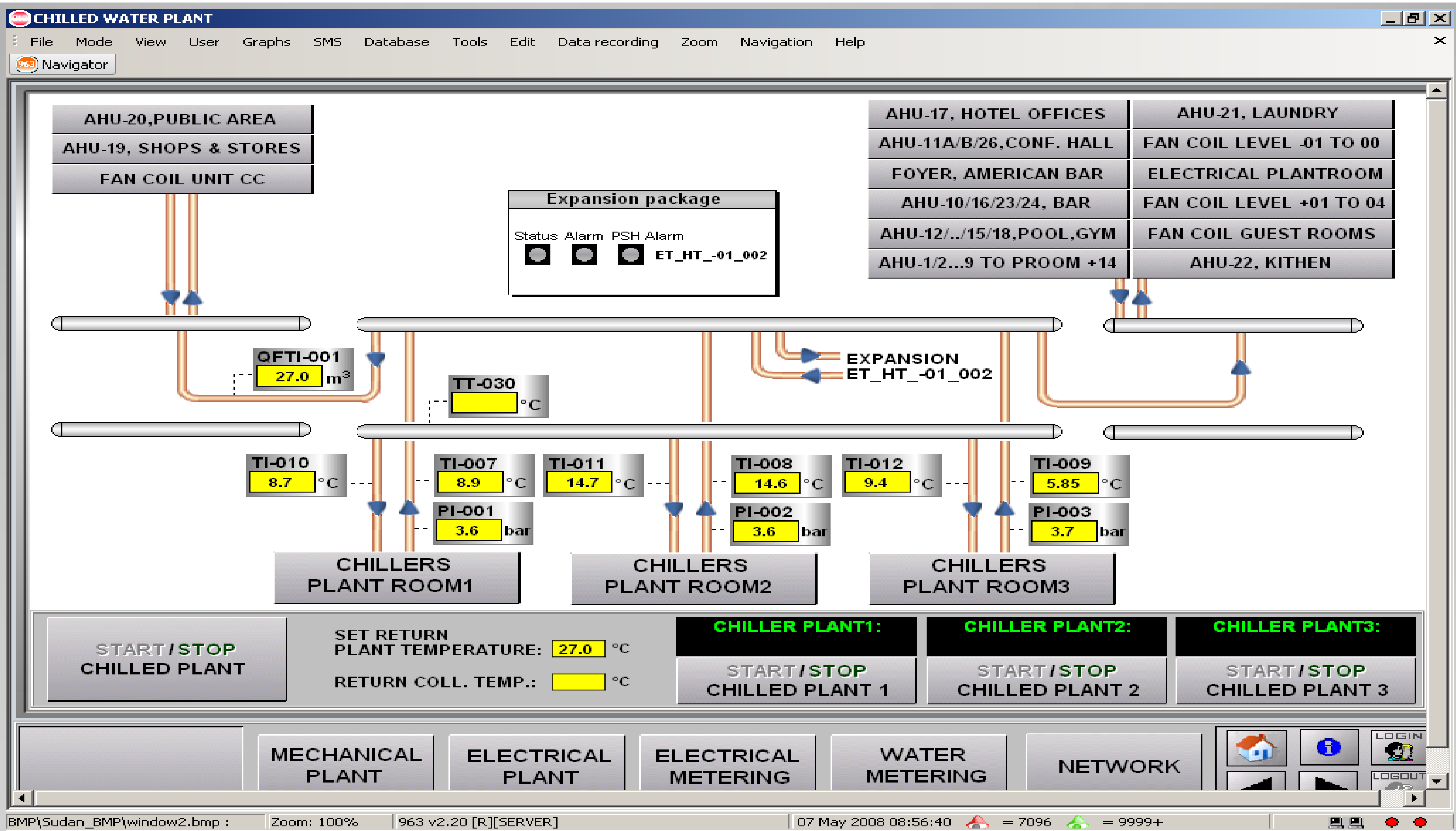
command bar



set points and parameters

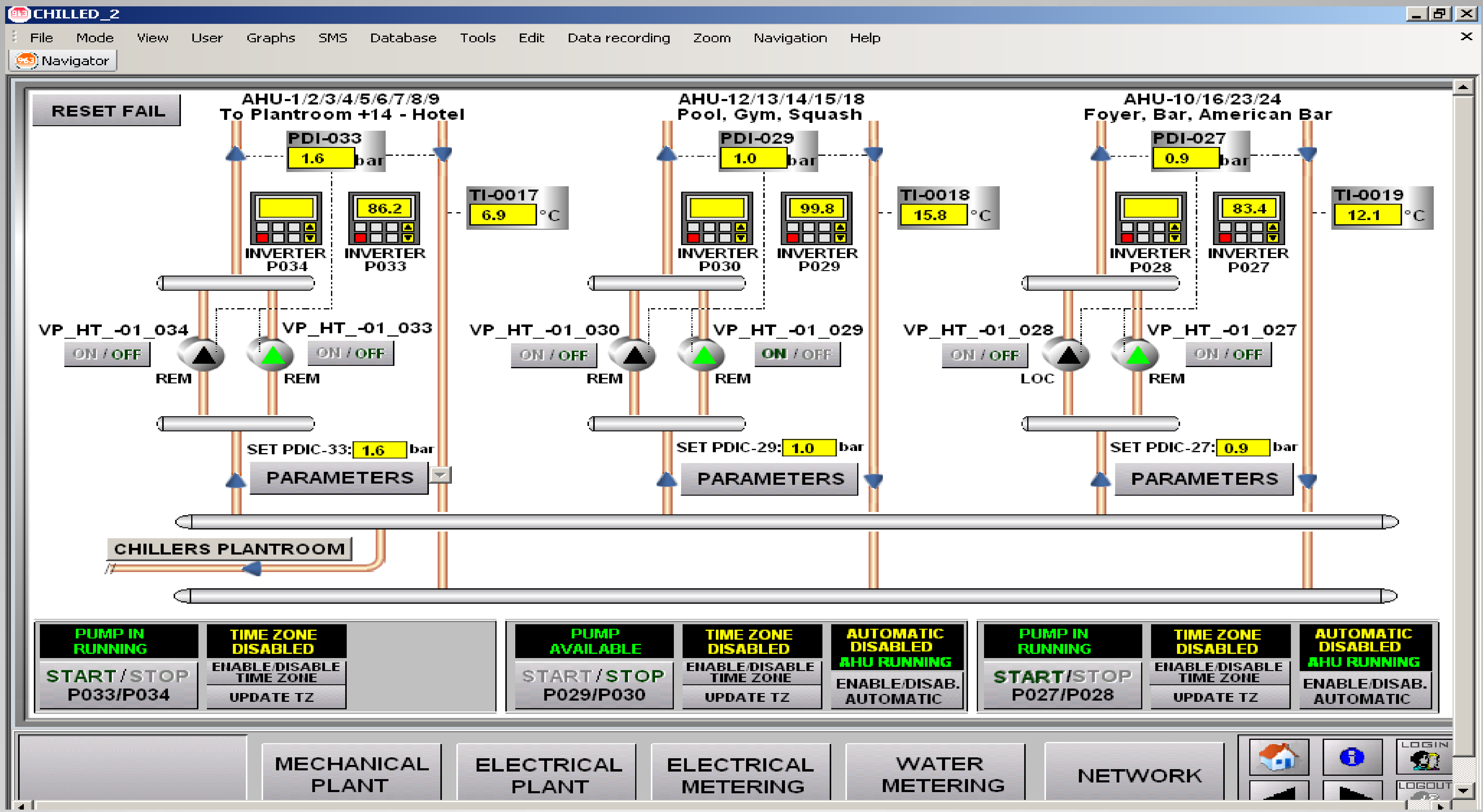


Hot Water Plant



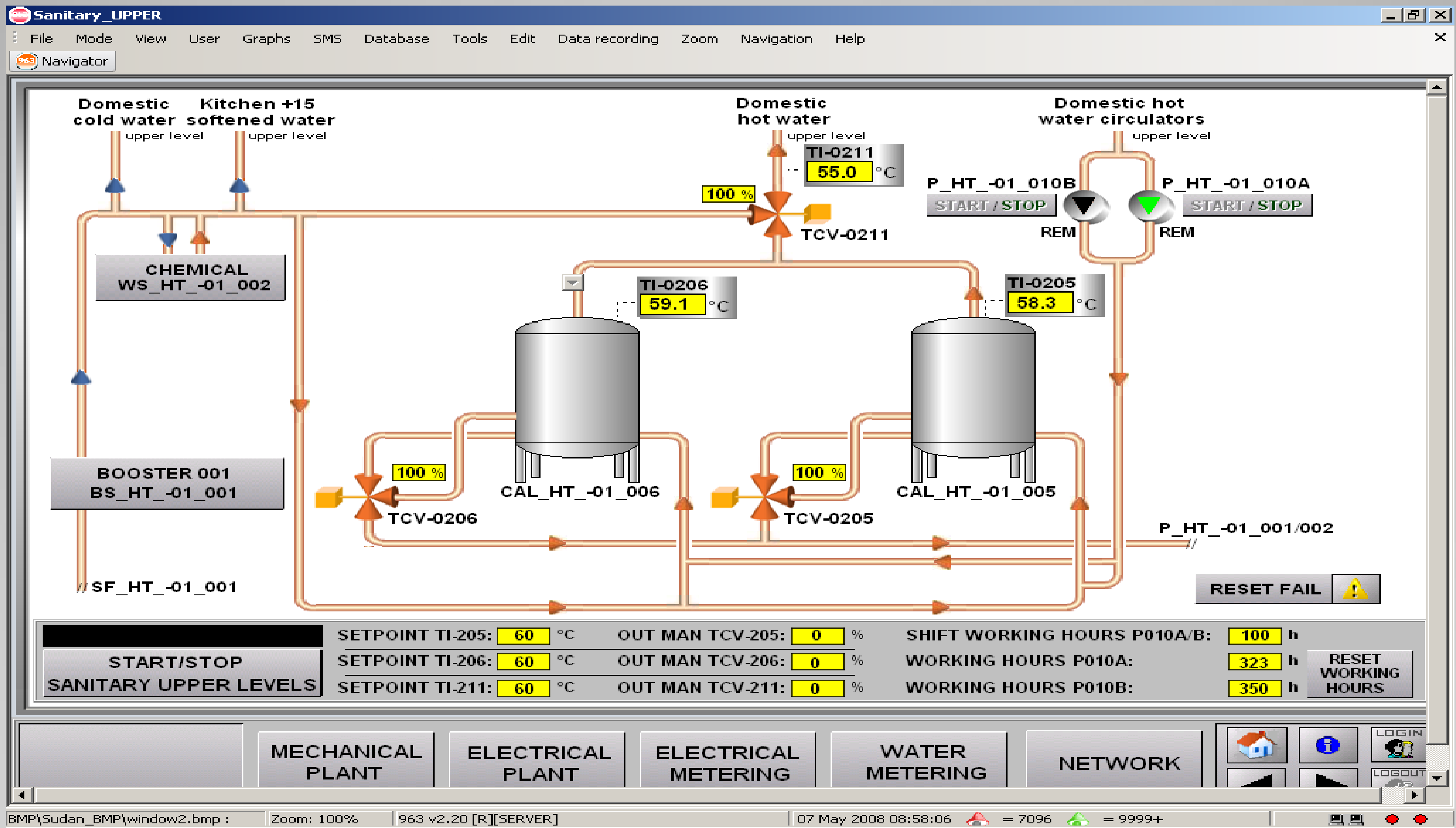
Chilled Water

Chillers command bar


CHILLED_2
File Mode View User Graphs SMS Database Tools Edit Data recording Zoom Navigation Help
Navigator
RESET FAIL
AHU-1/2/3/4/5/6/7/8/9
To Plantroom +14 - Hotel
AHU-12/13/14/15/18
Pool, Gym, Squash
AHU-10/16/23/24
Foyer, Bar, American Bar
PDI-033 1.6 bar
PDI-029 1.0 bar
PDI-027 0.9 bar
TI-0017 6.9 °C
TI-0018 15.8 °C
TI-0019 12.1 °C
INVERTER P034
INVERTER P033
INVERTER P030
INVERTER P029
INVERTER P028
INVERTER P027
VP_HT_-01_034
VP_HT_-01_033
VP_HT_-01_030
VP_HT_-01_029
VP_HT_-01_028
VP_HT_-01_027
SET PDIC-33: 1.6 bar
SET PDIC-29: 1.0 bar
SET PDIC-27: 0.9 bar
PARAMETERS
CHILLERS PLANTROOM
PUMP IN RUNNING
PUMP AVAILABLE
TIME ZONE DISABLED
AUTOMATIC DISABLED AHU RUNNING
START/STOP P033/P034
START/STOP P029/P030
START/STOP P027/P028
ENABLE/DISABLE TIME ZONE
UPDATE TZ
ENABLE/DISAB. AUTOMATIC
MECHANICAL PLANT
ELECTRICAL PLANT
ELECTRICAL METERING
WATER METERING
NETWORK

Pumps Plant

Pumps command bar



Sanitary_UPPER
File
Mode
View
User
Graphs
SMS
Database
Tools
Edit
Data recording
Zoom
Navigation
Help
Navigator
Domestic cold water
upper level
Kitchen +15 softened water
upper level
Domestic hot water
upper level
Domestic hot water circulators
upper level
TI-0211
55.0 °C
100 %
TCV-0211
P_HT_-01_010B
START / STOP
REM
P_HT_-01_010A
START / STOP
REM
CHEMICAL WS_HT_-01_002
TI-0206
59.1 °C
TI-0205
58.3 °C
BOOSTER 001 BS_HT_-01_001
100 %
TCV-0206
CAL_HT_-01_006
100 %
TCV-0205
CAL_HT_-01_005
P_HT_-01_001/002
SF_HT_-01_001
RESET FAIL
START/STOP SANITARY UPPER LEVELS
SETPOINT TI-205: 60 °C
SETPOINT TI-206: 60 °C
SETPOINT TI-211: 60 °C
OUT MAN TCV-205: 0 %
OUT MAN TCV-206: 0 %
OUT MAN TCV-211: 0 %
SHIFT WORKING HOURS P010A/B: 100 h
WORKING HOURS P010A: 323 h
WORKING HOURS P010B: 350 h
RESET WORKING HOURS
MECHANICAL PLANT
ELECTRICAL PLANT
ELECTRICAL METERING
WATER METERING
NETWORK
LOGIN
LOGOUT
BMP\Sudan_BMP\window2.bmp :
Zoom: 100%
963 v2.20 [R][SERVER]
07 May 2008 08:58:06
= 7096
= 9999+

Clarifiers

Complete Building Solutions

We help the best buildings in the world get that way.

What is a Building Automation System?

- **Building automation systems (BAS) are networks of microprocessor controls that:**

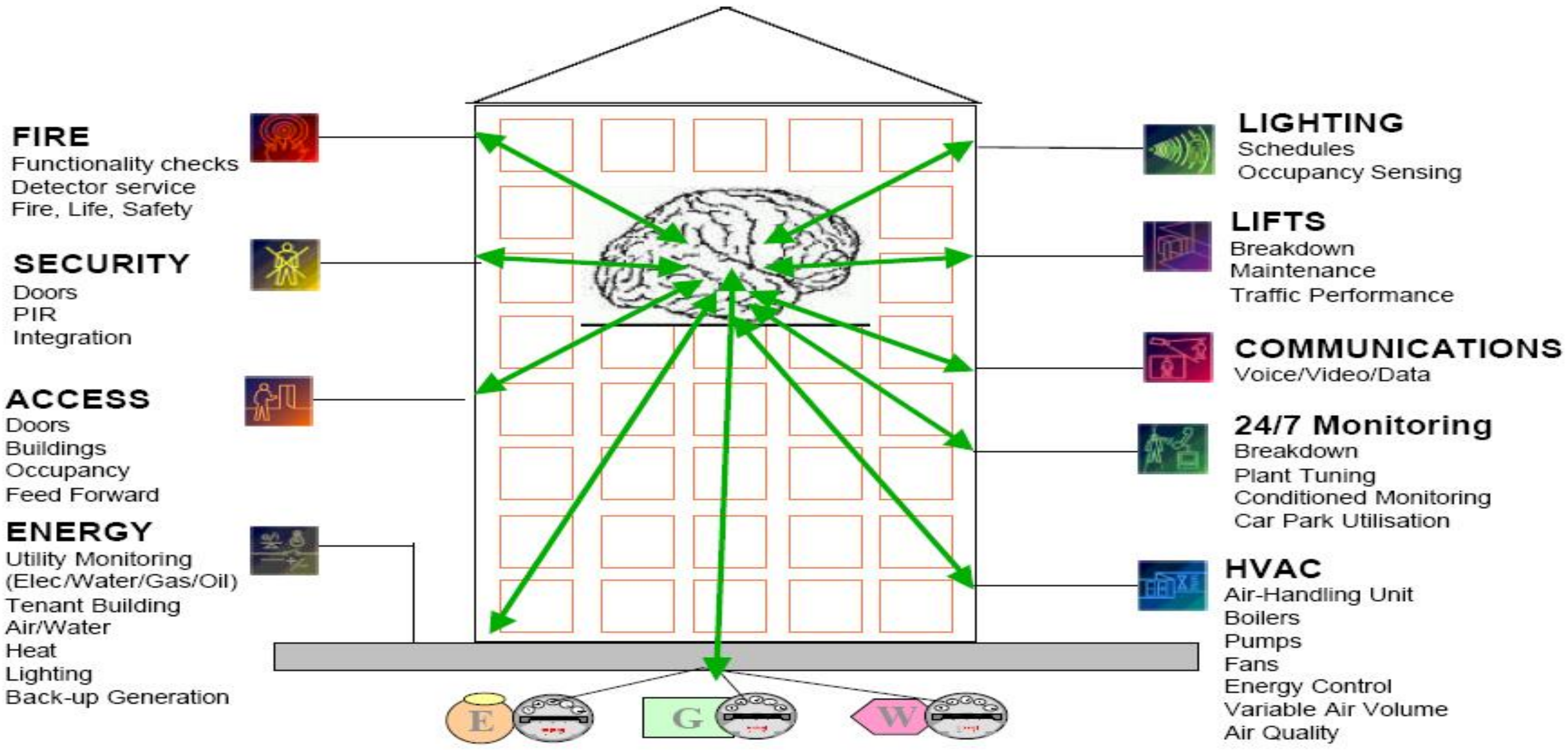
- => control the climate in the building
- => supervise and control the heating, ventilation, and air conditioning equipment
- => perform facility management (generate reports, graphs and annunciate alarms when there is a problem)
- => perform energy management strategies to reduce operating and energy costs.
- => integrate building systems such as security, fire alarm, lighting controls,etc.

Intelligent Buildings

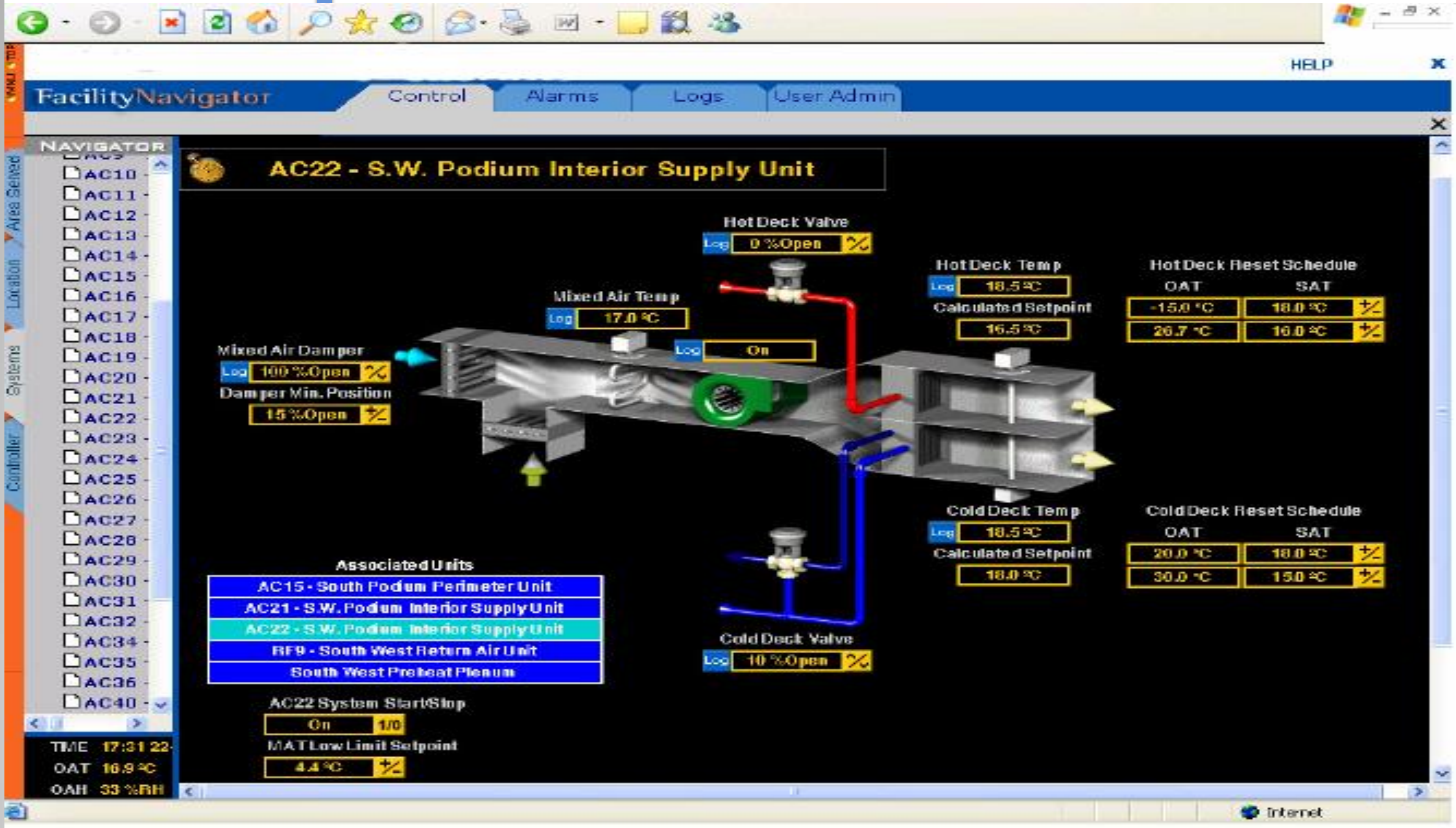
Technologies can incorporate:

- • Fire and life safety systems
- • Heating ventilating and air conditioning (HVAC)
- • Elevators and escalators
- • Access control systems and security systems
- • Lighting management
- • Energy management systems
- • Telecommunications
- • IT infrastructure
- • Community infrastructure
- • End user services

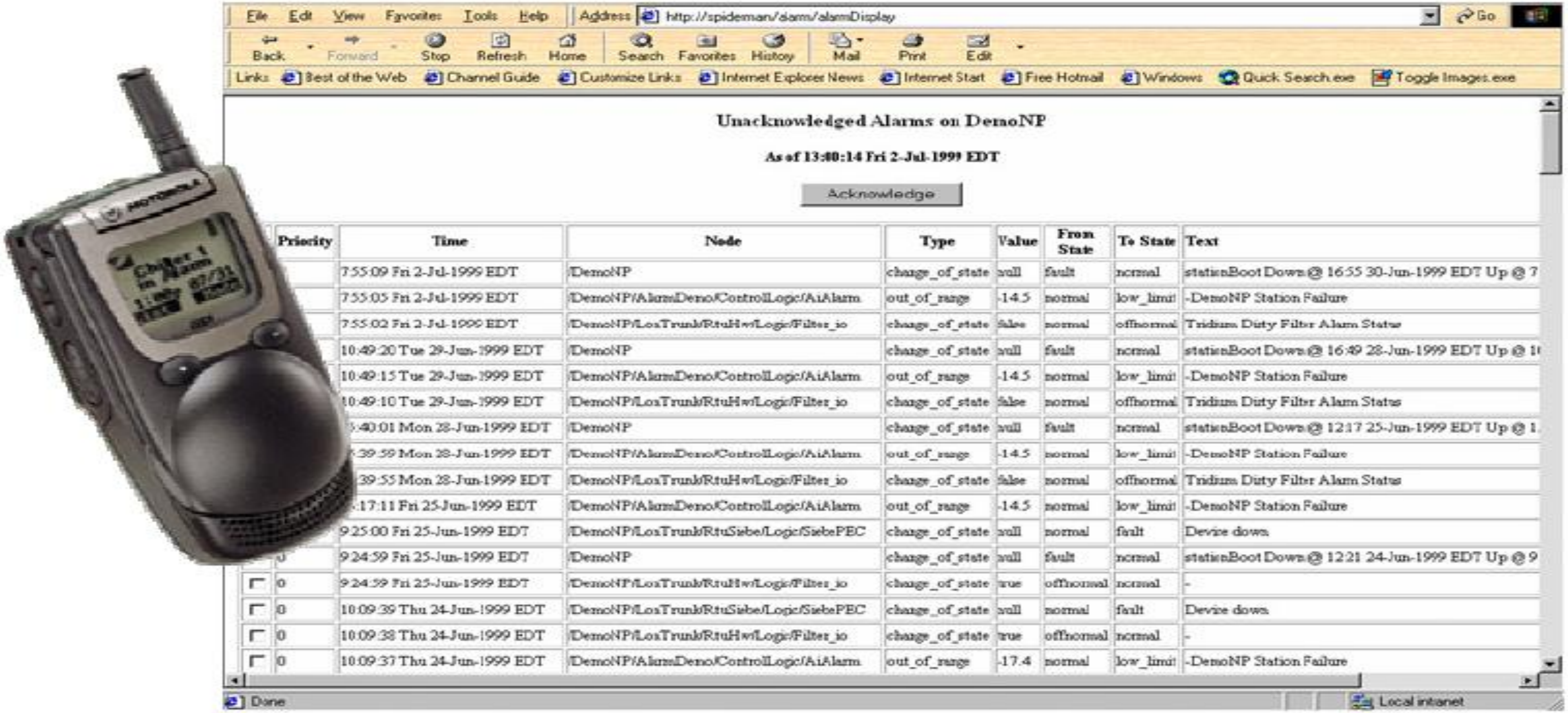
What is an Intelligent Building?



Graphical User Interface

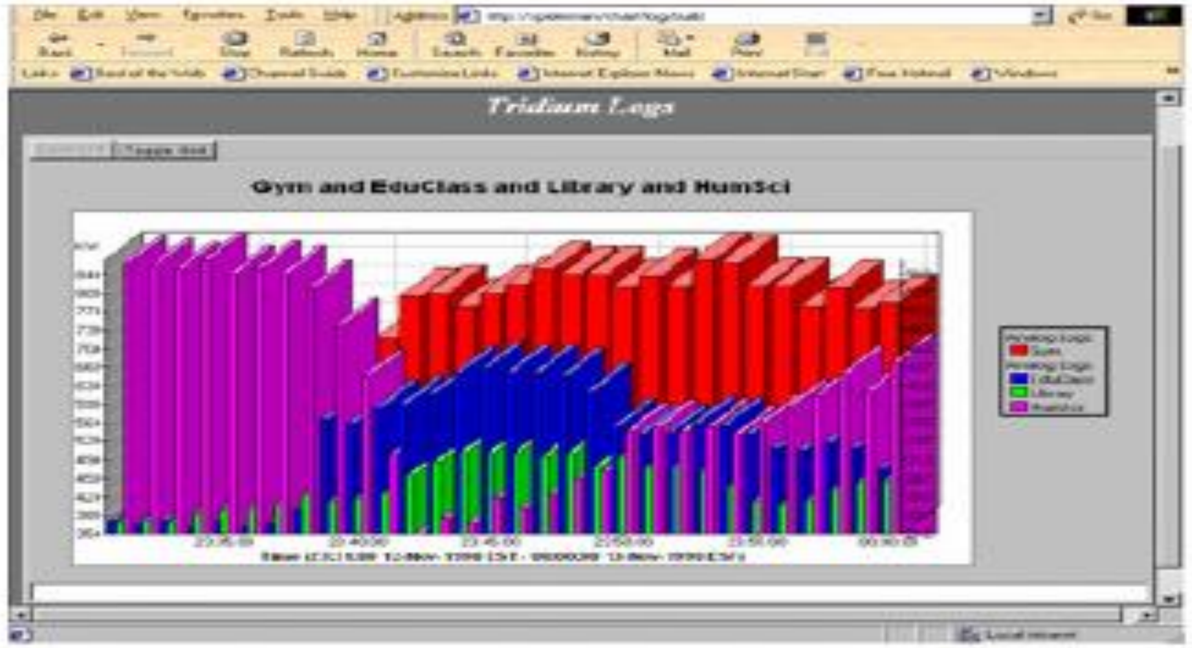


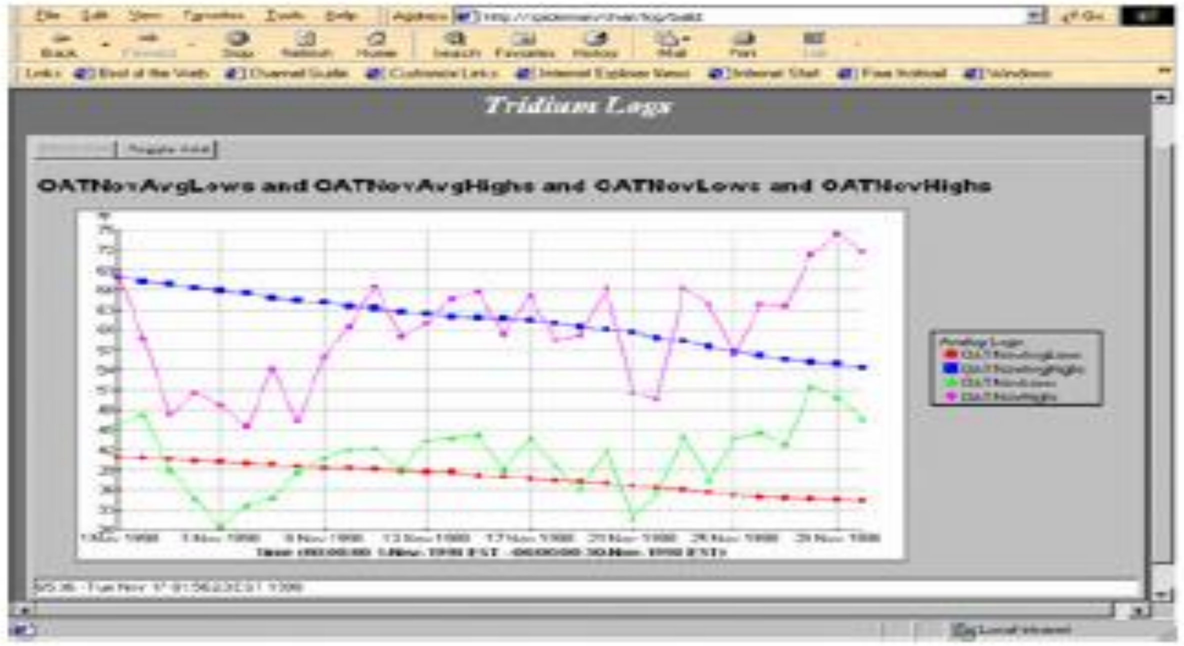
Alarm Logging & Notification



Priority	Time	Node	Type	Value	From State	To State	Text
	7:55:09 Fri 2-Jul-1999 EDT	/DemoNP	change_of_state	null	fault	normal	stationBoot Down @ 16:55 30-Jun-1999 EDT Up @ 7
	7:55:05 Fri 2-Jul-1999 EDT	/DemoNP/AlarmDemo/ControlLogic/AiAlarm	out_of_range	-14.5	normal	low_limit	-DemoNP Station Failure
	7:55:02 Fri 2-Jul-1999 EDT	/DemoNP/LoxTrunk/RtuHw/Logic/Filter_io	change_of_state	false	normal	offnormal	Tridium Dirty Filter Alarm Status
	10:49:20 Tue 29-Jun-1999 EDT	/DemoNP	change_of_state	null	fault	normal	stationBoot Down @ 16:49 28-Jun-1999 EDT Up @ 1
	10:49:15 Tue 29-Jun-1999 EDT	/DemoNP/AlarmDemo/ControlLogic/AiAlarm	out_of_range	-14.5	normal	low_limit	-DemoNP Station Failure
	10:49:10 Tue 29-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuHw/Logic/Filter_io	change_of_state	false	normal	offnormal	Tridium Dirty Filter Alarm Status
	:40:01 Mon 28-Jun-1999 EDT	/DemoNP	change_of_state	null	fault	normal	stationBoot Down @ 12:17 25-Jun-1999 EDT Up @ 1.
	:39:59 Mon 28-Jun-1999 EDT	/DemoNP/AlarmDemo/ControlLogic/AiAlarm	out_of_range	-14.5	normal	low_limit	-DemoNP Station Failure
	:39:55 Mon 28-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuHw/Logic/Filter_io	change_of_state	false	normal	offnormal	Tridium Dirty Filter Alarm Status
	:17:11 Fri 25-Jun-1999 EDT	/DemoNP/AlarmDemo/ControlLogic/AiAlarm	out_of_range	-14.5	normal	low_limit	-DemoNP Station Failure
	9:25:00 Fri 25-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuSiebe/Logic/SiebePEC	change_of_state	null	normal	fault	Device down
0	9:24:59 Fri 25-Jun-1999 EDT	/DemoNP	change_of_state	null	fault	normal	stationBoot Down @ 12:21 24-Jun-1999 EDT Up @ 9
0	9:24:59 Fri 25-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuHw/Logic/Filter_io	change_of_state	true	offnormal	normal	-
0	10:09:39 Thu 24-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuSiebe/Logic/SiebePEC	change_of_state	null	normal	fault	Device down
0	10:09:38 Thu 24-Jun-1999 EDT	/DemoNP/LoxTrunk/RtuHw/Logic/Filter_io	change_of_state	true	offnormal	normal	-
0	10:09:37 Thu 24-Jun-1999 EDT	/DemoNP/AlarmDemo/ControlLogic/AiAlarm	out_of_range	-17.4	normal	low_limit	-DemoNP Station Failure

Trend Logs & Charts

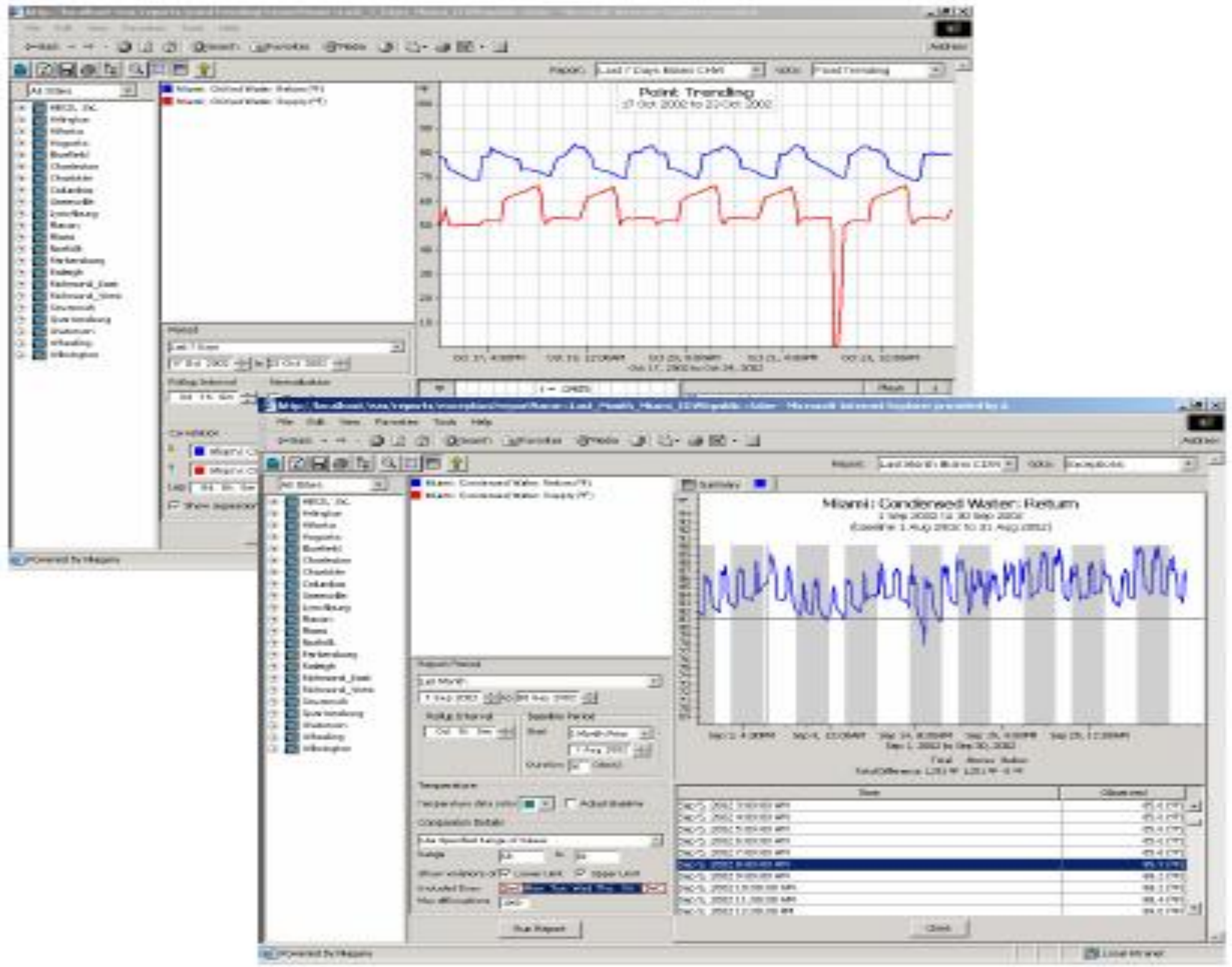




Energy Reporting

Getting from the meter…

To your Desktop…



Complete Building Solutions: Design & Installation Benefits

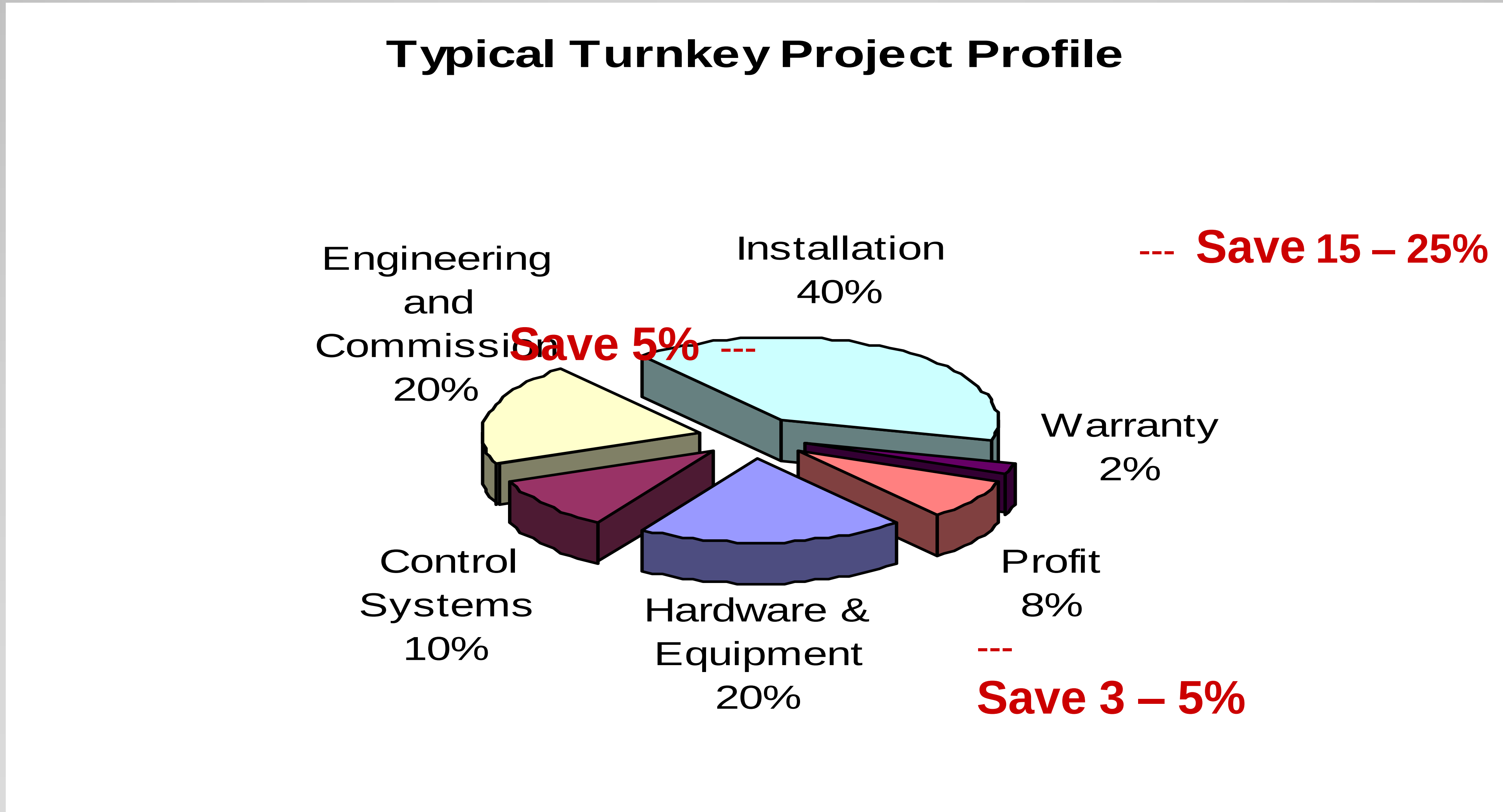
Lower infrastructure costs

- Structured/shared cabling
  - Common network/IP backbone for multiple systems
  - Maximum coverage and flexibility for growth without redundent cabling systems
- Shared system equipment optimize use
  - For example, an occupancy sensor serves both security and lighting systems.

Lower installation costs

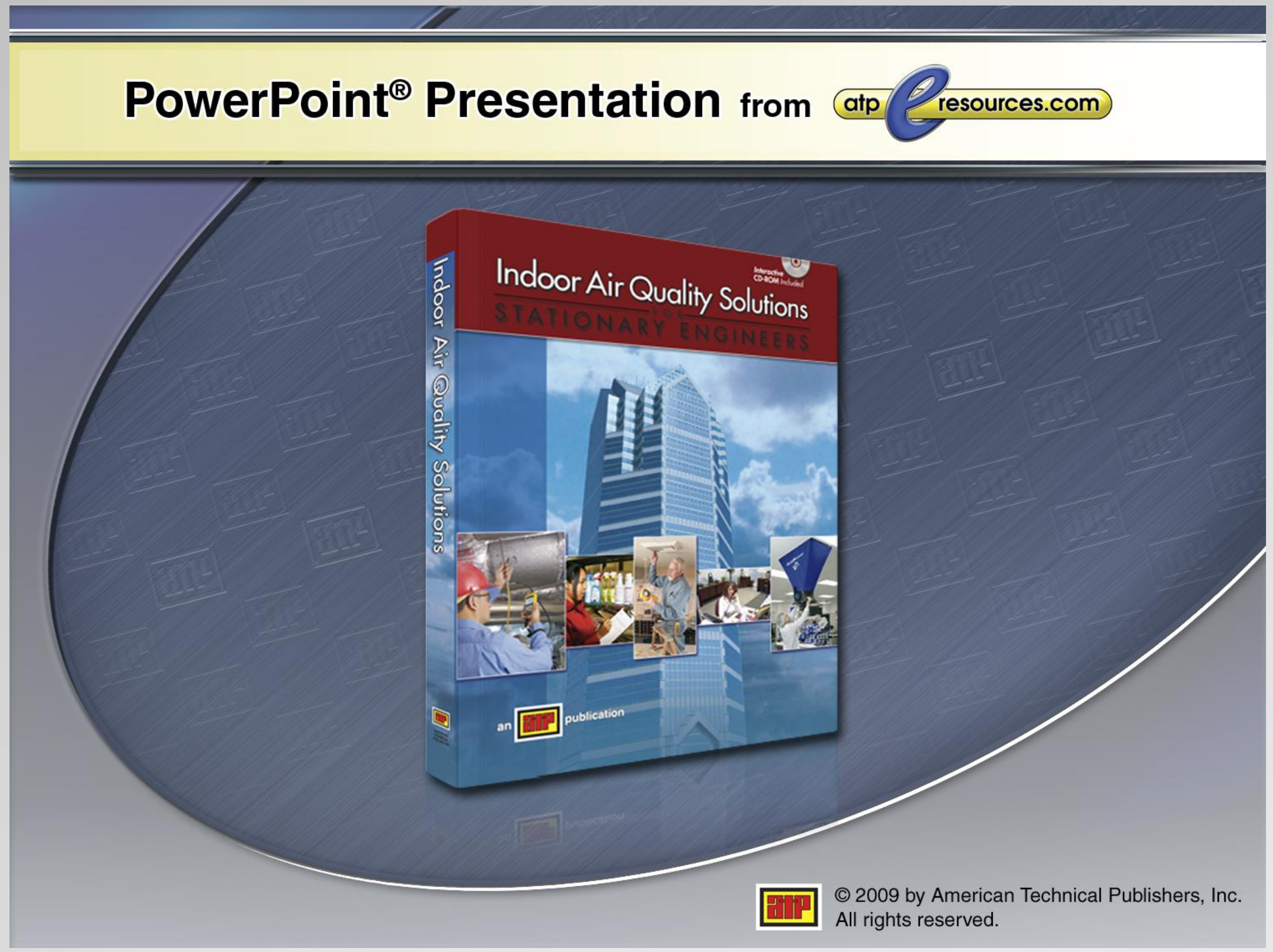
- Factory packaging simplifies installation
  - Reduced footprint optimizes space
- Reduced installation labor
- Reduced multiple levels of contractor markup

Complete Building Solutions:
Design & Installation Benefits



Savings in the Design & Installation phase can total as much as **35%**

PRESINTATION



--- **Save 15 – 25%**

Save 3 – 5%

Savings in the Design & Installation phase can total as much as **35%**

Building Management System

An Overview to BMS

Honeywell

What is BMS?

Honeywell

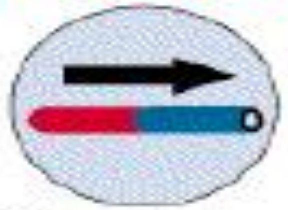
– A micro-processor based system which centralizes and simplifies…

- controlling
- monitoring
- operation and…
- management

…of heating, air-conditioning, ventilation & other building services to achieve…

Temperature

Moisture



Circulation

» safe and comfortable working environment

» energy saving & efficient operation

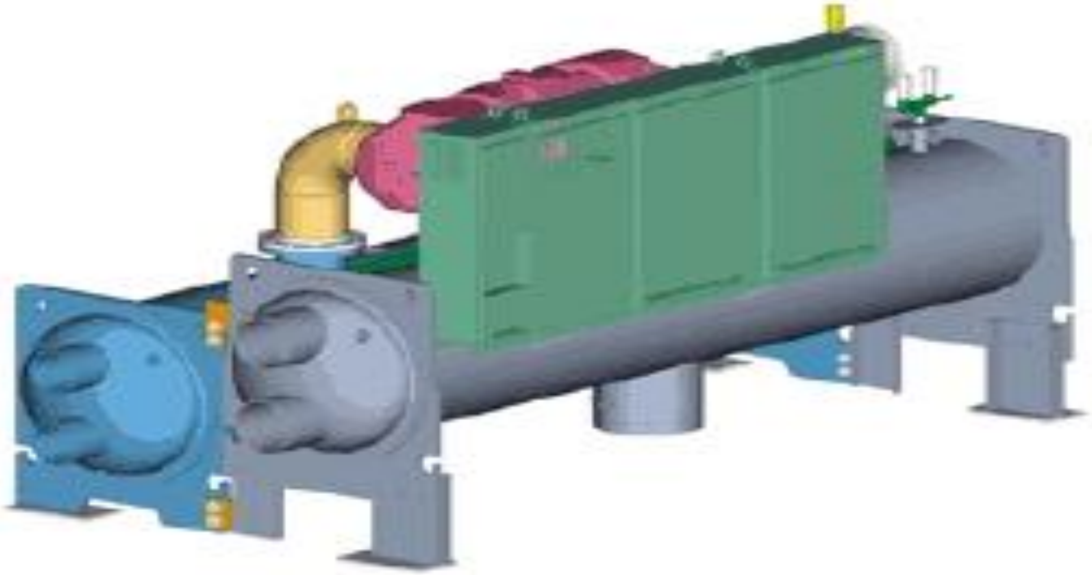
» at reduced time & cost

BMS provides…

Honeywell

Comfortable & safe environment
for your building
by controlling…..

- Air Handling Units
- Fan Coil Units
- Chillers
- Pumps
- Boilers
- VFD's



and many more…..

Components of BMS

- **Centralized WorkStation Computer**
  - With powerful user-friendly software.
  - Used for everyday building operation.

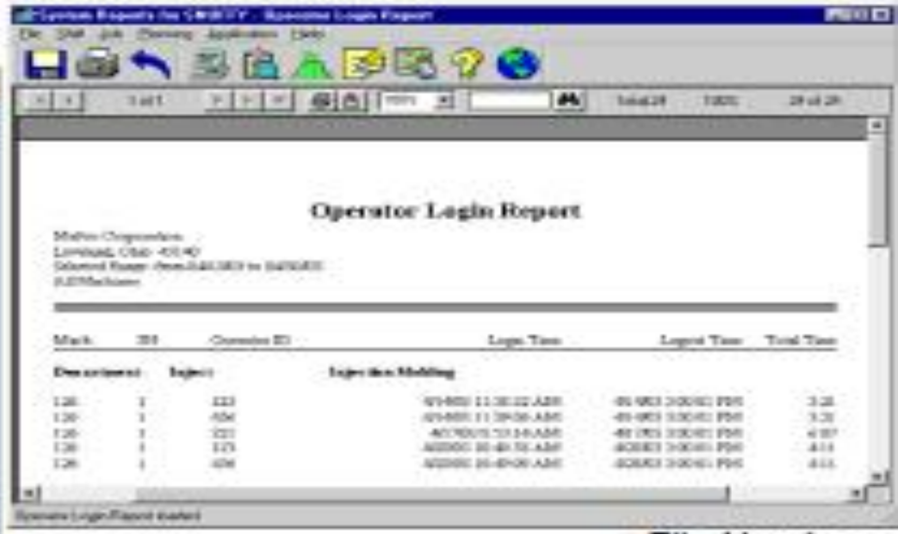
- **DDC Controllers**
  - Micro-processor based
  - Pre-configured / Freely programmable
  - Controls the HVAC equipment of the building

- **Field devices**
  - Temperature, Humidity, Pressure sensors
  - Valves, Actuators

BMS Features….

- **Man / Machine Interface**
  - interact with the connected technical building equipment.
  - user friendly
  - for operators…
  - engineers….
  - and building managers

- **System Security**
  - To prevent unauthorized use
  - Password protection
  - Operator specific access
  - Operator log summary



BMS Features....

Honeywell

- **User-friendly data presentation**
  - co-ordination of the flow of information through the system by implementing customized graphics.
  - floor plans of the building
  - graphical representation of the equipment.

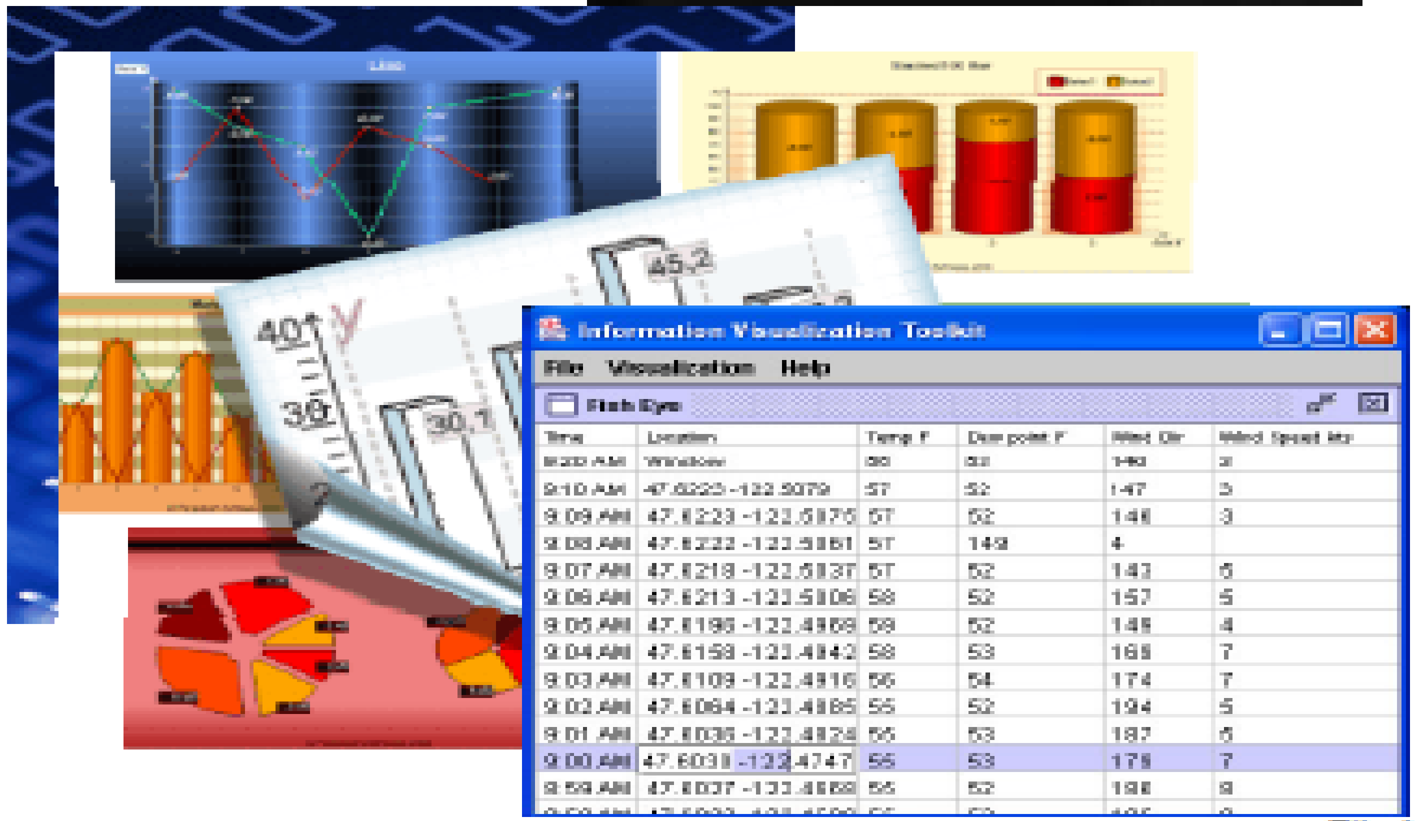
- **Alarm Management**
  - the presentation in the sequence of importance and time of..
    - potentially dangerous situations
    - process value deviations
  - guiding the operator to take appropriate action through..
    - audible and visual indications
    - Email, SMS
  - alarm summary
    - Time, date, priority and description

BMS Features....

Honeywell

- Reporting
  - present customized subsets of data
  - actual or historical state
  - export as a word or excel document or..
  - to a printer.

- Data Logging
  - The automatic gathering and storage of data from the field equipment for later analysis and reporting
  - Dynamically or historical
  - Customized charts and graphs
  - Tabular reports

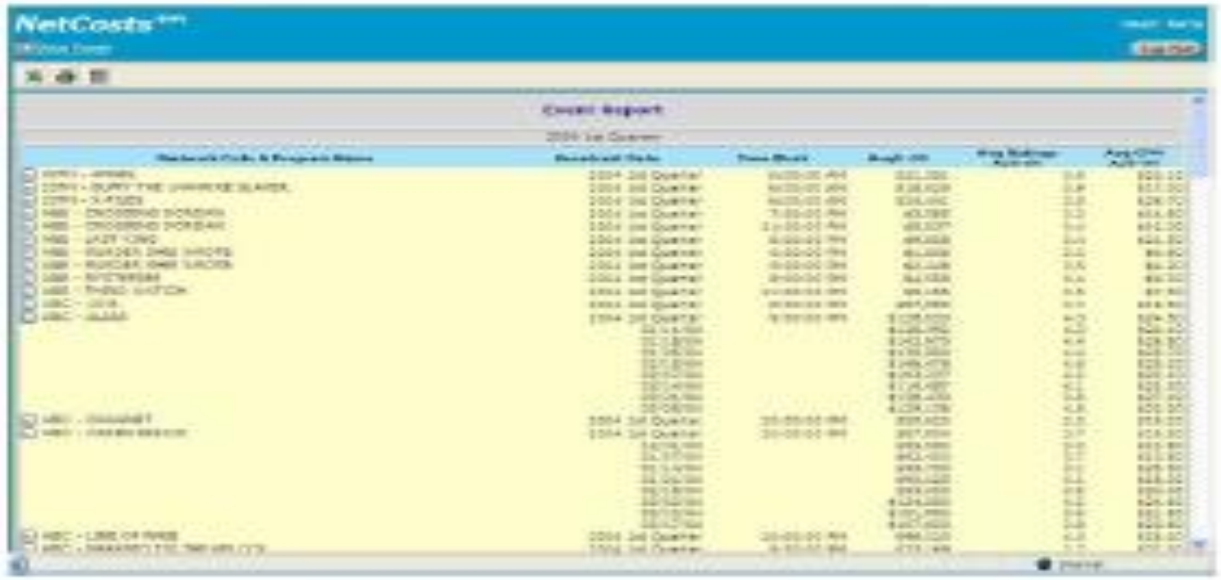


BMS Features….

Honeywell

- <u>Time Scheduling</u>
  - time-based start/stop of the equipment
  - saves energy cost and efficient operation
  - effective for lighting, occupancy control
  - can be as daily, weekly, for holidays or events

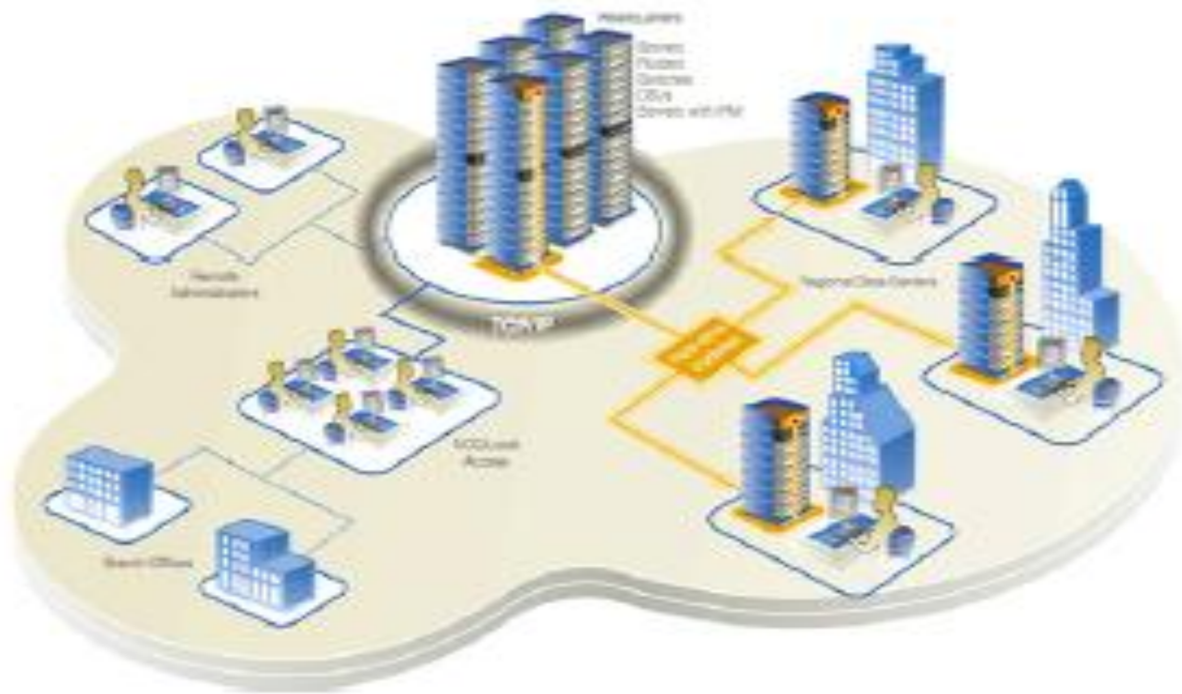
- <u>Event recording</u>
  - automatic logging of…
    - operator activities and commands
    - processes related to connected devices
    - workstations and printers.



BMS Features….

Honeywell

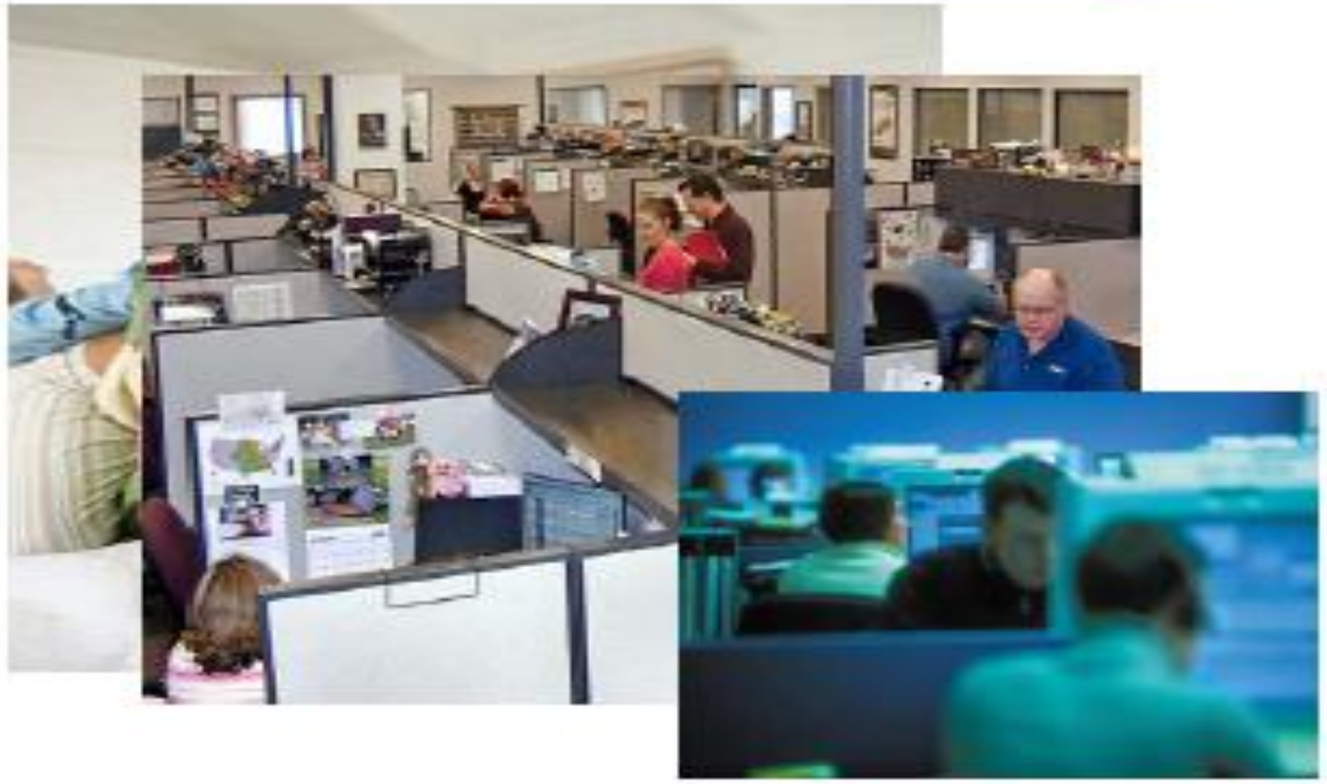
- **Remote connectivity**
  - provide remote access to the system with full functionality through..
    - **local area network**
    - **dial-up**
    - **internet via web browser**



BMS Benefits….

Honeywell

- **Improved indoor environment quality**
  - Comfortable living and working environment – domestic or commercial
  - Better temperature and humidity control
  - Good air quality



- **Faster response to ..**
  - occupant needs
  - end-user complaints
  - trouble conditions

BMS Benefits….

- **Maintenance Savings.**
  - efficient control gives less wear and strain of mechanical equipment.
  - provides longer life
  - runtime monitoring alerts timely maintenance of equipment
  - avoids expensive failures

- **Energy Savings**
  - eliminates unnecessary system operation.
  - accurate energy usage information
  - helps you to take steps to reduce energy consumption like…
    - Optimum-Start
    - Night-Purging
    - Time-Scheduling

BMS Benefits….

Honeywell

Consolidated facility control…
- One point centralized operation
- Simpler operation
- Reduces time and resources

- **Reduced operator training**
  - on-screen instructions
  - user-friendly graphic displays
  - simpler operation programmed for routine and repetitive operation

BMS Benefits….

Honeywell

- Improved management reporting
  - Provides valuable real-time data
  - Creates reports, charts…
  - Critical information immediately sent to printers, emailed
  - or sent via SMS

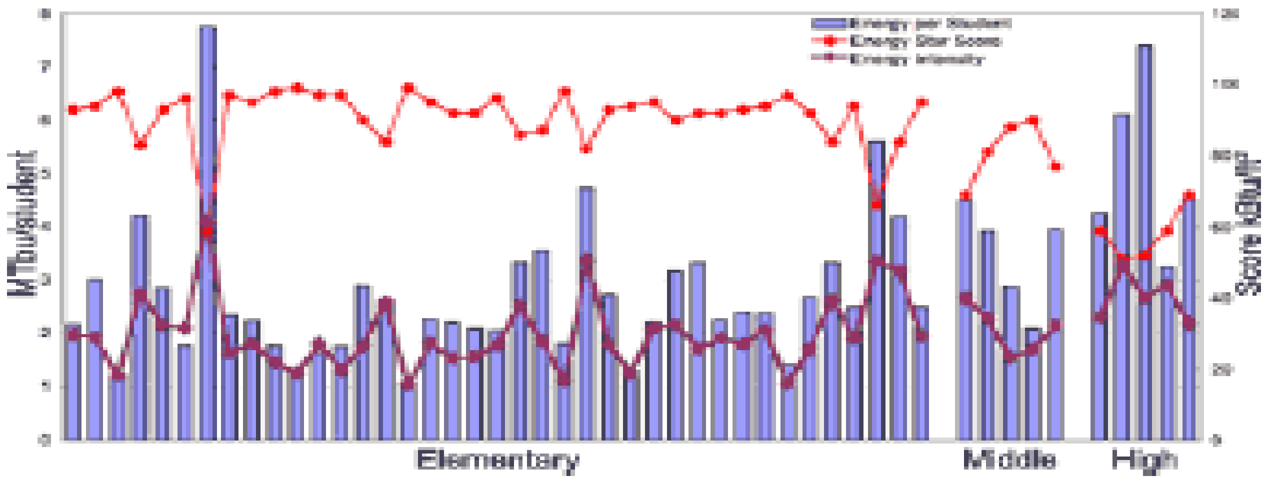
- Timely and effective control
  - alerts your employees when your facility is not operating correctly
  - reduce troubleshooting and down time.
  - Remote access connectivity without site visits.

Remote Access

BMS Benefits....

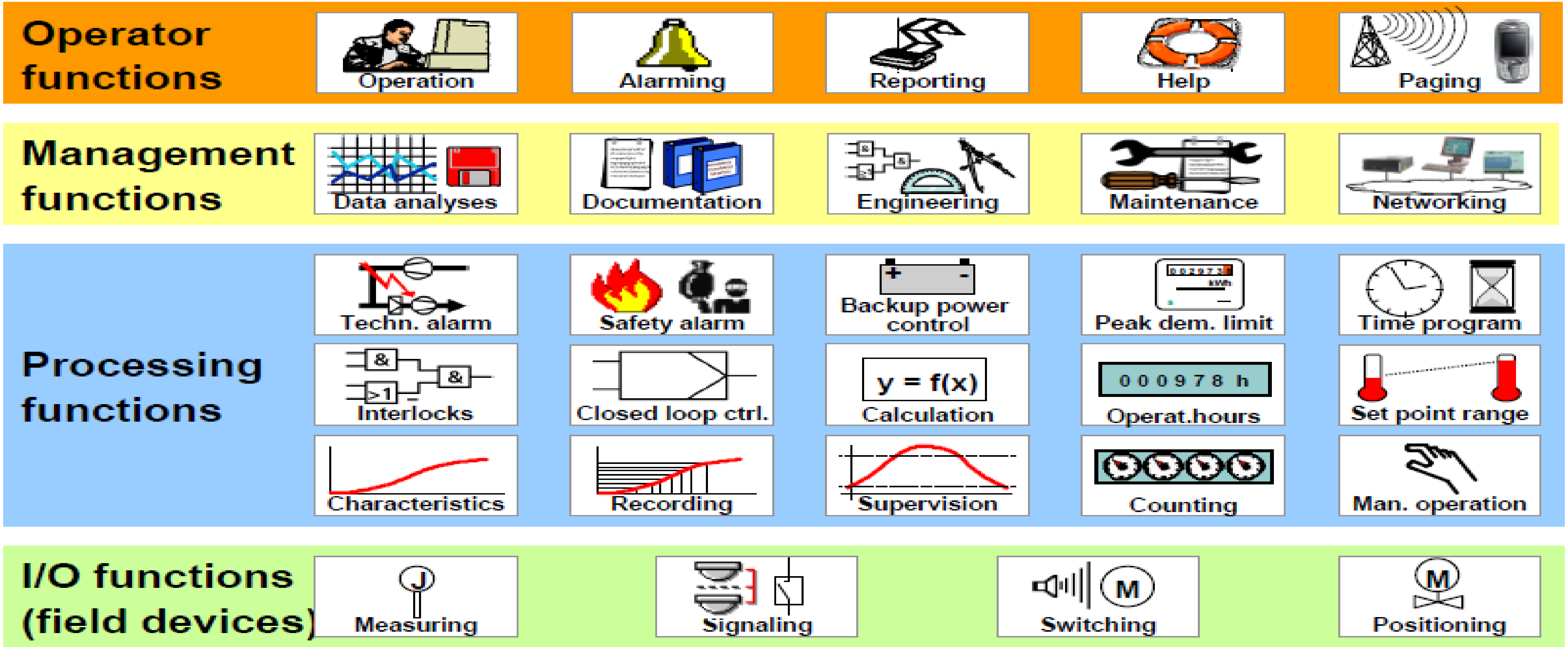
Honeywell

- **Performance Benchmarking**
  - Facilitates the overall system performance measurement
  - Comparison with set benchmarks



Almost all applications in building automation are based on a common functionality

Honeywell



Introduction To BMS

Effective well utilised Building Management Systems (BMS) provide the core management tool required by building managers to ensure compliance with, and achievement of, Green Lease requirements, such as the target NABERS rating, monitoring of the Energy Management Plan (EMP), and reports for the Building Management Committee (BMC). It enables Building Managers to provide the optimal working environment consistent with maintaining the required NABERS rating while minimising the costs to both landlords and tenants. Effective BMS utilisation allows for optimal building performance by extending the operational life of equipment and systems through reducing loads and operating hours. Maintenance and capital costs are therefore reduced and less embedded energy is consumed through equipment replacement and upgrades.

When a building has been completed the impact of its structure on its energy consumption performance is normally fixed until refurbishment occurs. Base Building and Tenant Light and Power energy consumption can however be increased or decreased by the performance of both building systems and tenants. A BMS will show increases in energy use due to equipment failure or adjustments to operating parameters. For example, heating valves opening when the building requires cooling or whole floors of lights being left on for extended periods of time due to cleaning activity. A BMS may also indicate that air-conditioning is starting up hours before the building is fully occupied due to activities of security staff. With this information in hand, the building manager may be able to rectify such issues through consultation or engineering solutions.

In the absence of a BMS, the impact of such events can be disguised by seasonal variations, changes in occupancy levels or technology upgrades. A correctly configured BMS with an adequate number of correctly located monitoring points is the only way a building manager can be quickly alerted to problems which could otherwise remain undetected until annual inspections or external audits are undertaken. A BMS is also a primary tool for identifying energy intensity improvement opportunities, for example refining the size and number of lighting time blocks, providing meaningful reports to the Building Management Committee on issues and opportunities, and enabling identification of faults, maintenance planning, and energy saving upgrades.

NABERS Rating

The Australian Government Energy Efficiency in Government Operations (EEGO) policy requires new buildings, major refurbishments and new leases to meet a minimum energy performance standard of 4.5 star NABERS energy rating. NABERS is an actual performance based rating that underpins the Green Lease Schedule.

The BMS is the major diagnostic tool for both owner and tenant when issues regarding NABERS ratings arise. It can be used to assess changes in usage patterns, environmental settings, or equipment performance. This can inform either an upward revision of NABERS rating or a rectification program to achieve agreed outcome. The BMS should be configured to identify small tenancy areas or individual plants performing outside agreed parameters.

Green Lease Schedules require the owner and tenant to collaborate in management of the building and in data collation, to enable an accredited NABERS assessor to formally rate the building after detailed modelling, with an approved computer program. The lease schedules detail the mechanisms to achieve, then sustain and improve the rating over time. Standard reports and graphic presentation of trends in data can be set up in the BMS and automatically prepared at set times. Regular use of this material will ensure that if slippage in energy efficiency starts to occur it will be identified quickly with the cause clearly identified.

Green Lease Schedule negotiations and their relationship to BMS

All of the commonly utilised BMS models in Australia have the inherent capability to effectively manage a fairly complex building. However, the manner in which they have been installed, commissioned and updated can affect the performance and effectiveness of a BMS. Building Managers also need to take into consideration changes to BMS software, building systems, and tenant usage which can lead to significant shortcomings in practice.

Tenant issues relating to BMS

There are a number of pertinent questions in relation to a BMS that tenants can ask when negotiating a Green Lease on a building. Issues that tenants, or those negotiating on their behalf, should consider include whether the BMS has:

- A current software version which is supported by the vendor;
- Support contract in place to ensure that software remains viable for duration of the tenancy. Most software requires upgrading at least annually;
- Software license covering a database size adequate for both tenant and base building current and future needs;
- The required data points for control and management built and connected to field devices;
- Sufficient graphics pages built which juxtapose relevant data;
- Intuitive and logical navigation between graphics for operators and maintenance personnel;
- Tenant pages such as time blocks for lighting and air conditioning which are fit for purpose;
- The ability to allow the building to continue to perform when the system is down, via standalone controllers;
- A functional disaster recovery plan in place;
- Remote access and alarm capability.

BMS data

For a BMS to function effectively it needs to reside on a computer that has adequate capacity and speed to support BMS function.

BMS related data storage of one year is required for all active control points. Computers and data storage hardware will normally require replacement at least once during an average tenancy.

The BMS data collection network should have capacity to provide data to the BMS at required frequency, via an industry open protocol such as a fully compliant BACNET.

NABERS and performance issues relating to BMS

Some of the NABERS and performance related issues of a BMS to consider include:

- The extent of historical data available;
- Whether programmed control strategies are efficient and tailored to tenancy requirements;
- Whether BMS control zones match anticipated tenant usage;
- The flexibility of programming and graphics to support fine tuning of building.
- Whether the BMS has a high level interface capability with key equipment including chillers, boilers, meters, zone controllers and key air conditioning devices;
- The capacity to cost effectively include additional monitoring and sub metering.

BMS Energy Intensity Enhancement opportunities

BMS energy intensity enhancement opportunities require free access of all parties to BMS data and agreement to share existing BMS capacity or fund required upgrades.

Tenants need the capability to flexibly adjust time blocks and access to a tenant terminal to the BMS.

System reports need to be configured, accurate and informative with data that includes energy consumption, hours, temperature graphs, faults, water flows and air flows.

Owners and tenants' responsibilities relating to BMS

The BMS is the building owner's primary management tool to ensure the Base Building performs in accord with the Green Lease Schedule and for the tenant to ensure NABERS tenancy rating is maintained. It is critical to effective management and fault finding of the primary heating, cooling, and ventilation systems. On a day to day basis it will be under the responsibility of a party identified in the lease. The responsible party will be obliged under the lease to operate, repair and maintain the building, and freely provide access, data and reports to the tenant, owner and BMC.

The building owner's responsibilities include providing:

- A fully functional BMS configured to manage systems, identify faults, and provide the required reports for the tenant, building owner and BMC.
- Adequate monitoring, zones, scheduling and so to enable the building to operate at maximum possible energy efficiency consistent with tenant lease provisions.
- Positive support to the BMC committee and the NABERS assessment process, including timely and regular availability of data to relevant parties.
- A commitment to a continuous improvement strategy to increase NABERS rating.

The tenant's responsibilities include:
• Providing accurate and detailed information on tenant equipment loads.
• Providing a detailed schedule on occupation and equipment loads of tenanted areas.
• Early advice on changes to usage of tenanted areas.
• Providing positive support to the BMC committee and the NABERS assessment process, including timely and regular availability of data to relevant parties.
• A commitment to a continuous improvement strategy to increase NABERS rating of tenancy.
• Vetting staff requests for system adjustments to ensure energy impacts are considered.

• Identifying changes to tenant work practices which would reduce energy intensity.
• Ensuring tenant contracts take account of energy consumption impacts.

The responsibilities of the responsible party, as identified in the lease, include:
• Daily monitoring of the BMS for faults and exceptions relating plant and equipment.
• Maintenance of the BMS.
• Management of temporary or permanent adjustments to control parameters in accord with Green Lease provisions.
• BMS software and hardware upgrades.
• Providing reports to Building Management Committee.
• Manage upgrading of BMS as required by owner and tenants to support changes in space utilisation, equipment upgrades, or energy intensity improvement projects.
• Providing timely and accurate advice and reports to the BMC.

Comparison of BMS capabilities

The capability of installed BMS systems varies from the most basic being virtually a time clock (a device which turns equipment on and off) to that of a highly sophisticated and flexible management tool.

The additional software cost of a high level system is not substantial. Additional costs of high level BMS systems are mainly due to:

- Higher computer and data storage requirements.
- Connection of more sensing and monitoring points.
- Increased networking requirements.
- Building more graphics pages
- Configuring a more sophisticated alarm system.
- Configuring external access and reporting.

A high level BMS system will:

- Fully support Green Lease tenant requirements.
- Fully support a wide range of best practice control strategies.
- Have a detailed suite of automated reports.
- Support simple set up of ad-hoc reports for maintenance or enhancement activities.
- Have an alarm hierarchy that flags relative importance of alarms.
- Not constrain use of improved equipment or strategies.
- Have capabilities that continue to be enhanced and evolved by supplier.

When the power and capabilities of a properly configured high level BMS are fully utilised by maintenance staff, operators, and tenants, the payback period of the additional cost is normally very short. It can be less than one year, and is seldom more than five years from energy savings alone. Tenant satisfaction is generally higher through better environmental control, and ease of adjusting functional usage of the building.

Basic systems can be inadequate for a Green Lease agreed rating if they:

- Have a limited number of basic graphics.
- Lack high level interfaces.
- Store data for limited periods of weeks or one to two months.
- Have few automated reports.
- Monitor the minimum of control points.
- Be configured for simple control strategies such as time block control strategies.
- May not be true open system.

A basic system has limited fault analysis capabilities, and will seldom identify energy intensity improvements, nor will it facilitate their implementation. Failures causing excessive consumption or poor environmental conditions will seldom be clearly identified. While cheap, a basic system may lead to higher maintenance and energy costs. When renting an existing building an inadequate BMS must be rated as a very negative factor in negotiations.

Integration of BMS with other tools

Integration between a BMS and a business management system such as SAP requires a detailed configuration study. A high level interface between such systems can be implemented if care is given to the following.

Control of data consistency in a BMS is a live system continuously updating second by second. Business management systems typically batch by day, week, month or year.

Business management systems require data to be presented in very specific formats. Interfaces between two such systems often fall over when one or the other is upgraded.

From a business perspective the BMS is often collating the data required to allocate costs to tenant business units, or to charge sub tenants for services. It makes sound economic sense, and reduces the probability of error for data to be migrated from one system to another, provided the costs of maintaining the interface are commensurate with the benefits.

A satisfactory alternative to a high level interface given the normal batching needs of business systems is for the BMS to download its readings of hours run, energy used etc, into a spreadsheet format at agreed times.

The business system can normally be easily programmed to populate its data fields by interrogating the spreadsheet at agreed times.

The manager of each system is then responsible when modifying or upgrading their system to ensure data moves as required. This is particularly relevant when systems are owned and operated by different parties.

High level interfaces between systems will seldom be cost effective in small or medium environments.

Best Practice Facades and Equipment Selection

The thermal performance of facades and energy efficiency limits of equipment are inherent in their design. They set the maximum efficiency a building can achieve without major refurbishment.

Facade optimization

It is important for new builds that the building envelope has good thermal characteristics, and that glazing and shading devices are selected to minimize heat loss in winter and gain in summer. They should conform to Section J of the Building Code of Australia [at the time of publication]. Design options could include:

- Minimum glazing to reduce summer heat gain and winter heat loss.
- Minimal use of floor to ceiling glazing, standard 800mm sill height preferable.
- Maximum use of correctly designed sun shading devices to northern, western, and eastern facades to optimally control solar gain and loss.
- Specifying high performance coated double glazing [Low U and low SHGC as required].
- Additional wall and ceiling insulation particularly in climatic extreme areas.

Equipment and Lighting selection

The efficiency and effectiveness of equipment is improving exponentially. Often designers and consultants can be very conservative and only consider equipment which has been marketed for some years. While proof of performance is required this should be balanced against the dramatic improvements in performance currently available on an annual basis.

Some guides to selection include:

• Use of high efficiency variable speed centrifugal chillers, water cooled, with a good co-efficient of performance across the full anticipated load range.

• High efficiency gas fired condensing boilers, with Variable Speed Drive (VSD) pump sets.

• Use of co-generation or tri- generation where appropriate.

• Use of Variable Air Volume (VAV) or chilled beam high efficiency mechanical systems, with good zone selection (separating perimeter areas with different solar conditions, and special purpose area)] and without terminal reheats.

• Intake dampers sized for economy and night purge modes particularly in areas with cooler days and in particular nights.

• Fresh air dampers linked via the control strategy to return air CO sensors for reducing energy consumption in low occupancy periods.

• High efficiency fans, pumps and motors, maximizing use of VSD's.

• Local standalone systems if small 24 hour calls for conditioned air genuinely exist. Running central Ppant for a single small load is energy intensive, and shortens major equipment life expectancy.

• High efficiency solar or gas domestic hot water systems with water conservation devices.

• Lifts with variable voltage, variable frequency, AC drives including regenerative braking, and low use modes such as lighting which turns off.

• Metering incorporated in all key equipment with reporting capability to the BMS.
• Car parks to have VSD controlled fans and CO sensors
• Lighting to common areas (fire stairs, car parks, corridors, foyers) with two stage occupancy control where allowed.
• Lobbies and toilets on occupancy control.
• Light fittings to have high efficiency reflectors
• Lighting systems to have power consumption of 1.5W/m2 or less per 100 Lux of light level.
• Lighting levels are even through zones and do not exceed specified levels.
• All ballasts and controls to DALI or equivalent standard.

Best Practice control strategies and their optimization

Control strategy optimisation requires a well configured high level BMS coupled with correctly chosen and located sensing equipment.

Below is a list of control strategies, and the BMS configuration (points, graphs and trends) to support them, which are normally most appropriate for the majority of office blocks. Some exclude use of others or best apply in specific climatic zones, or for particular tenancies and usage patterns. Technical analysis and careful selection of those strategies most applicable to particular buildings in its climatic zone is essential.

During refurbishment projects some compromise might be suggested because of heritage listing or the physical constraints of otherwise sound built structure. In such cases the impact on Green Lease requirements, can often be negated by skilled design and compensating through other mechanisms. The presumptive assumption should always be that full compliance will be achieved.

Mechanical Services

It is recommended that software be optimised for start and stop schedules. Rather than starting to pre-condition a building at a set time, each zone starts just in time to reach minimum set condition as occupants start to arrive. For example, a cold winter's night may need an extra hour of air flow compared to a milder night. Tenant complaints led to fixed settings for earlier starts than actually required. This typically means that energy requirements for heating and cooling greater will be extended, on average, by several hours per day. For example, many buildings provide full heating and cooling to 5.30 or 6 pm. In well built and insulated buildings, chillers and boilers can turn off at 4pm or earlier, and remain within agreed temperature parameters for two hours or more utilising the heating or cooling energy within the water loops.

Other mechanical service considerations include:

- An open system such as a fully compliant BACNET enables a wide range of compliant sensors controls and equipment which can flexibly plug and play without special programming having to be added or written.
- Automated seasonal temperature adjustment, lowering set point temperature at low temperatures and gradually raising through the seasons, giving immediate savings.
- Remote alarming to pager, mobile, I-phone, blackberry or fixed line as needed.
- Secure remote access as agreed for fault response, diagnosis, and tenant emergency need. For example, the tenant may need to set up a crisis response unit over a weekend or out of hours. Maintenance contractor may need to drive isolation valves to isolate a water leak, or remotely isolate equipment which has failed to the 'on' position.

- Scheduling calendar to be highly sophisticated so as to be able to check and adjust for daylight saving, Easter and other events which can be adjusted without programming skills. For example, shutting down unoccupied zones or temporarily varying working hours.
- High turndown capability utilising VSD's for reduced airflow in low occupancy periods. This generally should go to 20 per cent or less of full flow.
- Use of CO2 sensors in car parks and return air ducts to sense when air requirements are reduced. For example, in many car parks it may be sufficient for fans to run for one to two hours per day rather than 12 or 24 hours.
- Occupancy sensors, many areas have minimal occupancy at any time or highly variable loads such as conference rooms. In such cases it may be appropriate to provide minimal conditioned air during normal hours, and ramp up only when space is fully occupied. Ramp up can sometimes be most effectively provided by standalone units to avoid over sizing the central plant to respond to low frequency situation.
- Utilise enthalpy control in low humidity environments. This can improve air quality and lower energy consumption as air cools when moisture is added.
- Economy cycle to fully utilise free cooling. In many environments the outside air temperature is lower than return air temperature when cooling is required. Even when this is the case, the energy intensity of many buildings is such that during spring and autumn they may need cool air to maintain required conditions. If the fresh air intakes can provide more than minimum fresh air requirements then "free" cooling is available from the atmosphere.

- Night Purge. In many hot climatic zones several hours of low overnight temperatures occur. If fans are run in this period this cold air can pre cool the internal structure reducing the day time cooling load at minimal cost during off peak tariff periods.
- Control zones to be limited in size, in the order of 100m2, and of uniform thermal need. Do not mix perimeter and core space in a single zone or low heat generating offices with more densely populated open plan equipment intensive areas.
- Ensure sensors are correctly located. Sensors must be at the correct height, not above heat generating equipment, or hidden behind office fit-out, within supply air flow, or where external events can effect. For example, a thermostat mounted on an external wall must be insulated from the wall cavity, or it will read cold in winter, and hot in summer. A thermostat used as a coat rack will have a delay in registering actual room temperature. A thermostat above a photo copier may consistently read four degrees higher than actual temperature when copier is at full power to correct temperature when it is in sleep mode.
- Calibrate sensors. While many modern sensors do not suffer accuracy drift over time, a base line error of up to one degree can occur. It is essential that offset to correct occurs at the zone or at the BMS so that control strategies utilise a true reading at all times.
- Calling after hours air conditioning. The ability to call must be limited to genuine operational needs in small areas, and turn off after a limited period or as soon as no occupation is detected. Many systems lack the turn down capacity to service small areas, so entire floors or wings are turned on for the comfort ofone or two people. Consider providing airflow only and activate heating or cooling when two-four out of hours calls are made.
- C02 sensors for system control in low occupancy periods.

- Control strategies to have proportional control tailored to building needs, combined with adequate dead bands and predictive control algorithms. Systems must not overheat and then enter cooling mode (particularly in winter), nor over cool in summer then call for heating.
- Ideally no or minimal heating should be called by the system in summer, and similarly in winter minimum or no cooling should be required.

Electrical Services

- Lighting controlled in zones by occupancy sensors, whose area will generally not exceed 100m2 unless special circumstances exist.
- Fire stairs on occupancy sensors with automatic override to full lighting during fire alarm events.
- Car park daylight adaptation lighting to be dual dimmer controlled by photoelectric (PE) cell and occupancy sensors.
- Car park lighting to have two stage occupancy sensor control covering normal and out of hours lighting levels.
- Perimeter office zones to have PE cells operating dimmer controls in addition to occupancy sensors.
- Entry lobbies to revert to occupancy sensor control outside of operating hours.
- General security lighting to minimum level required by security cameras. With modern cameras this is very low and less than human eye requires.
- Responsive security lighting to be event activated with time controlled manual over ride for emergency situations.
- External lighting as required by code and assessed safety need under PE control.
- Toilet lights under PE control.
- Metering of equipment and zones to be integrated through BMS to required reports.
- Lift operation to be optimised via intelligent lift controllers, with activity and consumption reports to BMS.

Hydraulics

- Meters to report to BMS (number must enable excess consumption to system or zone).
- Temperature optimisation control of boilers, by control strategy.
- Flow meters to alarm on abnormal consumption.
- Boiler temperature reset optimisation, to match actual and predicted loads.
- Automated shut down valves in critical areas to avoid waste and damage from major failure, with BMS over ride function

BMS Configuration Active Point Control

- Must default to safe condition on failure and trigger alarm.
- All events to be achieved.
- Points to be actively interrogated on status to ensure they are operating and reporting.
- Point trending and graphing to be flexible and comprehensive.
- Demand limiting algorithm in place and load shedding if indicated.
- Alarms have priorities set to at least three levels, are placed in permanent archive file, with name of operator who responded to alarm. Archive can only be by a person with highest authority level, and only when record is over one year old.

Graphics & User Interface

- To clearly present data required to check status of system or sub system without clutter and in logical visual presentation.
- Navigation from a graphic page either up to a system overview or down to sub unit or point history to be intuitive, point and click.
- Graphics available of all systems and sub systems.
- Temporary trend graphics able to be set up by all users, and not require high level skills or access.
- A full suite of reports is configured to enable effective management of system and building.
- Four level or equivalent user authorization level control. Programmer, system controller, maintenance staff, tenants.
- Simple click and point to data, graphics, and agreed control functions of each user.

BMS case studies

CASE STUDY 1 – Substantial reductions in energy consumption at Questacon, Canberra.

An enhanced and upgraded BMS was a major tool in identifying and implementing energy saving strategies at Questacon, the National Science and Technology Centre, located in Canberra. Effective use of the BMS lead to dramatic reductions in gas consumption and electricity consumption resulting in substantial reductions in greenhouse emissions and recurrent financial savings of some $100,000 per annum. The savings obtained would not have occurred without the BMS and its effective operation and utilisation.

The BMS was critical in identifying:

- Areas which reached temperature required up to one hour prior to occupation
- Areas within temperature control band up to two hours after occupants left
- Control sensors out of calibration
- Sensors incorrectly located
- Identifying additional sensors and controls required for fine tuning.
- Graphic data trend logs were utilised to assess and adjust control strategies

CASE STUDY 2 – BMS used to indentify increased gas consumption.

In a medium sized Australian Government public building in Canberra, a BMS was used to detect an increase in gas consumption. The Facility Management staff were actively monitoring consumption, and committed to implementation of energy conservation projects.

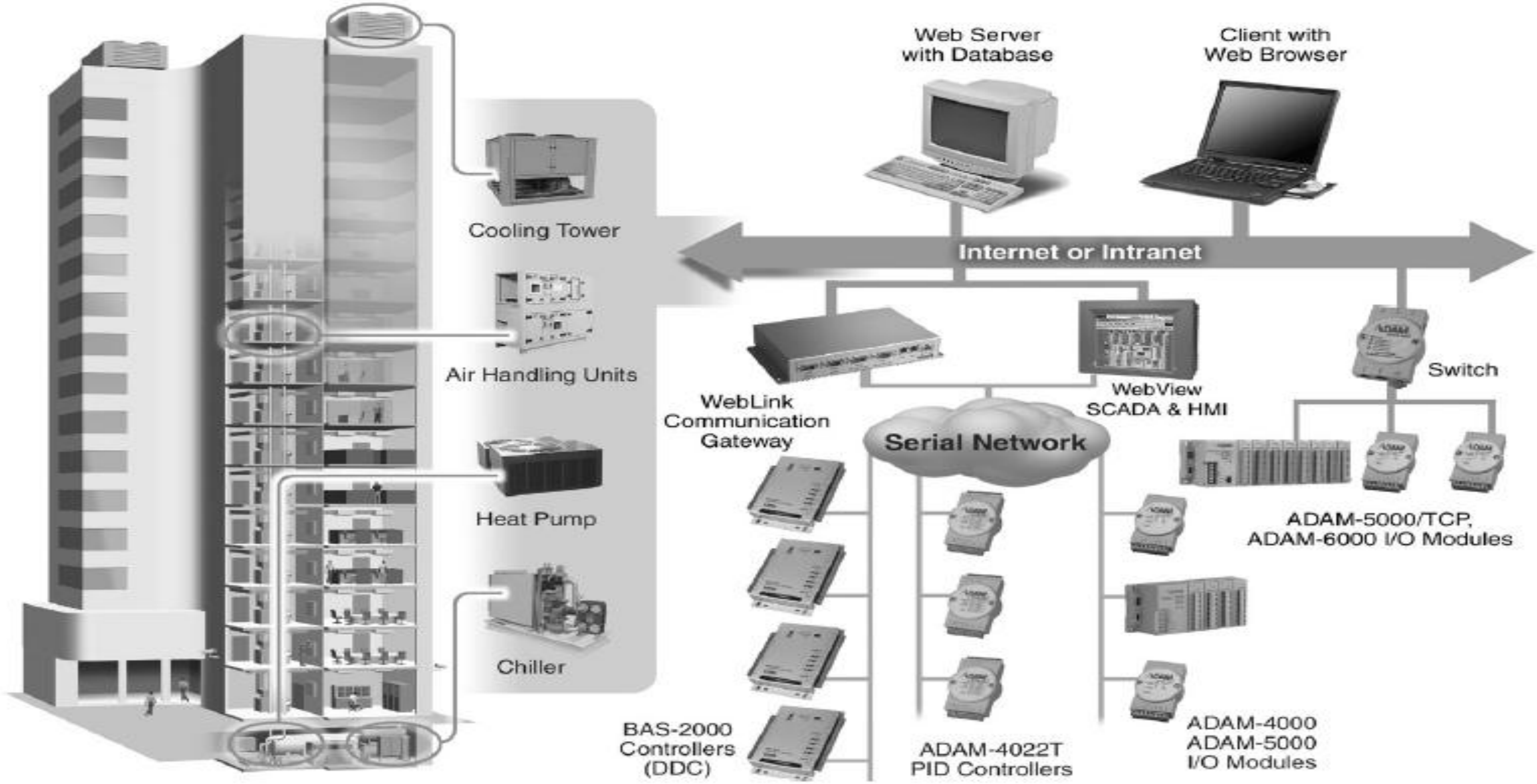
Previously the BMS system was only metering energy in large blocks at the main switchboard, and when an unusual increase in gas consumption was queried the system was not adequate to identify its source and the increased consumption was put down to climate extremes and usage variations.

A consultant was reviewing consumption reports and advised they indicated a 20 per cent increase in gas and a lesser increase in electricity which could only be explained by a problem or problems in the buildings mechanical systems or their controls and not climatic or usage variations. The conclusion was accepted and a detailed investigation ensued. It was discovered that three cooling valves were failing to fully close. This was leading to excessive cooling in winter in three areas which in turn was opening numerous heating valves further than normally required. The result was increased consumption of both gas and electricity.

It is probable that at least one of these problems had existed for a significant period of time, but that the degree of metering and BMS data available was insufficient to raise an alarm. The Facilities Managers took immediate action to rectify the problems. In addition the funds for conservation projects were adjusted to enable installation of additional meters and BMS points for each plant room to commence as a matter of urgency. This event clearly demonstrated that measuring energy consumption solely at the main switchboard was inadequate. The impact of local faults was disguised, and it gave no help in locating the faulty valves. The main gas meter to the site was read daily after rectifying the faults and showed an instant reduction of some 17 per cent.

This incident clearly demonstrates the need for adequate BMS and sub metering particularly in large buildings and those with complex or changing usage patterns. Meters were added at each air handler and control zone.

Building Automation Systems



Working Tasks

- Chiller Plant Control
- Water Pump Control
- Cooling Tower Control
- Waste Water Treatment
- Heat Pump Control
- HVAC Equipments Control
- Environment Monitoring (Temp., Humidity, Smoke...)
- Other Facility Control/Monitoring Functions
- BACnet/Modbus Protocal

BAS Architecture

The figure above shows the typical Building Automation architecture. Various devices and sensors are controlled and monitored by BAS-2000 Controller, ADAM-4022T PID Controller, ADAM-4000/5000/6000 series modules. Through serial and Ethernet networks, data is transferred to WebLink communication gateway, as well as WebView SCADA and HMI hardware. Operators can monitor and control the system locally on WebView. People in the control center can connect to the WebLink and WebView through Internet, and this makes the system convenient & flexible. Advantech provides complete Building Automation solution:

1. Software: Advantech WinCE WebAccess
2. Communication gateway: WebLink
3. SCADA and HMI hardware: WebView
4. DDC controller: BAS-2000 series
5. PID controller: BAS-4022T
6. I/O modules: ADAM-4000, ADAM-5000, ADAM-6000 series modules

Controller for Building Automation

A Building Automation system is a different purposed application from typical industrial automation applications. It is designed for commercial building requirements, not for industrial environment requirements. So the controller should be designed for this purpose.

The DDC (Direct Digital Controller) is a controller dedicated to Building Automation applications. The DDC controller must be a standalone operating unit, and in order to satisfy the requirements of building I/O and control applications, the I/O design of DDC is universal. Because of wiring costs and wiring installation environments, RS-485 is the major physical layer of the network. Most importantly, the DDC must be a standalone operation. Advantech provides BAS-2000 series as the DDC controller.

System Network

Because of the lower wiring costs and simpler installation, RS-485 is the standard network protocol in the control and device layer of building automation system networks.

Power Supply Requirements

The power supply requirements of typical BAS devices are quite different from industrial equipment. Most industrial controllers and devices are designed with 110/220 V AC or 24 V DC power supply, while most BAS controllers use 24 V AC.

Powerful WebLink Communication Gateway and WebView SCADA

Installed Advantech WinCE WebAccess, WebLink and WebView become ideal gateway and SCADA hardware for Building Automation application. They are web-based solutions which implement the latest web and internet technology. Programmers can easily configure and build the application through internet, intranet or LAN. Operators can simply control and monitor WebView and WebLink using ordinary Web Browser such as Microsoft Internet Explorer(IE), without purchasing any other software. Moreover, Advantech WinCE WebAccess features rich functionality such as graphics, calculation, data logging, real-time and historical trends, alarms, scheduler, and recipe. This helps the system integrator to save more time and money to complete their own project. The WebView and WebLink provide device driver, which gives them ability to connect to different devices like PLC, PAC, and I/O modules.

Communication Protocol

BA system networks have their own standards. There are two major standards for BAS networks: BACnet and LonWorks. BACnet (Building Automation Control network) was defined by ASHRAE (American Society of Heating, Refrigerating and Air-conditioning Engineers), the major institute of HVAC vendors in the world. Because it was defined by ASHRAE, it is widely used and accepted for HVAC equipment. LonWorks was defined by Echelon, which is a private company. The basic system architectures of these two standards are different. The BACnet system architecture is quite similar to a typical industrial control system network, so it is more suitable for BA systems in commercial buildings. It has therefore gained the position of almost becoming the de-facto standard for BA systems in commercial buildings. The Advantech BAS-2000 system is designed with this protocol as its standard communication protocol, and for compatibility with 3rd party devices, MODBUS/RTU is also supported.

Why BACnet ?

BACnet (Building Automation Control network) protocol is developed by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). It has become the most popular Building Automation network standard worldwide, and most BAS devices and HVAC equipment have been built with this protocol now. Because the main physical layer of the network in the BAS controller layer is RS-485, the format of the BACnet protocol being used in RS-485 is BACnet MS/TP. This is a good reason why the BAS-2000 series use the BACnet MS/TP as its default protocol.

Why Modbus ?

Modbus is the most popular protocol in automation systems so far. Almost all traditional control systems or equipment support or is compatible with this protocol. It is widely used in general-purpose devices and equipment.

In a typical building there are power systems, water supply systems, HVAC systems, water treatment systems and so on. These systems require quite a lot of machinery, and most of this machinery is not designed for building automation systems. They are designed for both building and industrial applications, and therefore do not support the BACnet protocol. But the Modbus protocol can usually be found in these machines.

For a complete building automation system, all equipment should be controlled by one system. The easiest method to implement this is by using a BAS DDC controller. But most traditional DDC controllers don't support this feature. The BAS-2000 series controllers supprts Modbus, which means you can create Modbus compatible building automation control systems and control all equipment in a building with one system.

BACnet

Modbus-IDA

the architechure for distributed automation

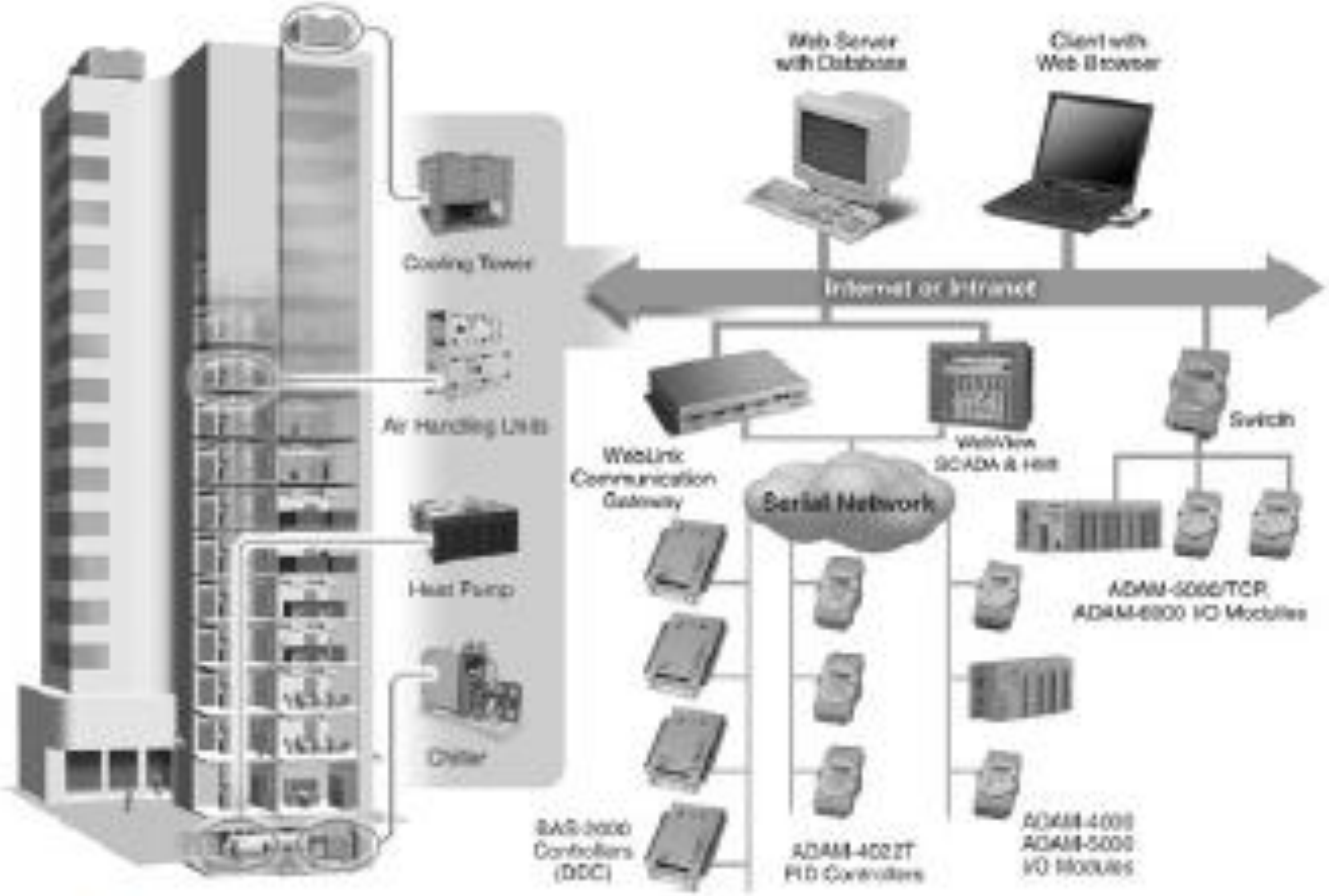
Introduction

Advantech offers a total solution for Building Automation systems including facility management (HVAC, water treatment, power, etc.), security (access control, door/window alarm, etc.) and CCTV systems. Equipped with Advantech's BAS-2000, WebLink, WebView and ADAM modules, system integrators can easily create powerful and flexible BAS applications.

Facility Management System

The facility management system includes the control of :

- Chiller Plants
- Water Pumps
- Waste Water Treatment
- Cooling Towers
- Heat Pumps
- Other HVAC Equipment
- Environment Monitoring System (Temperature, Humidity, etc.)
- Other Facility Control/Monitoring Applications

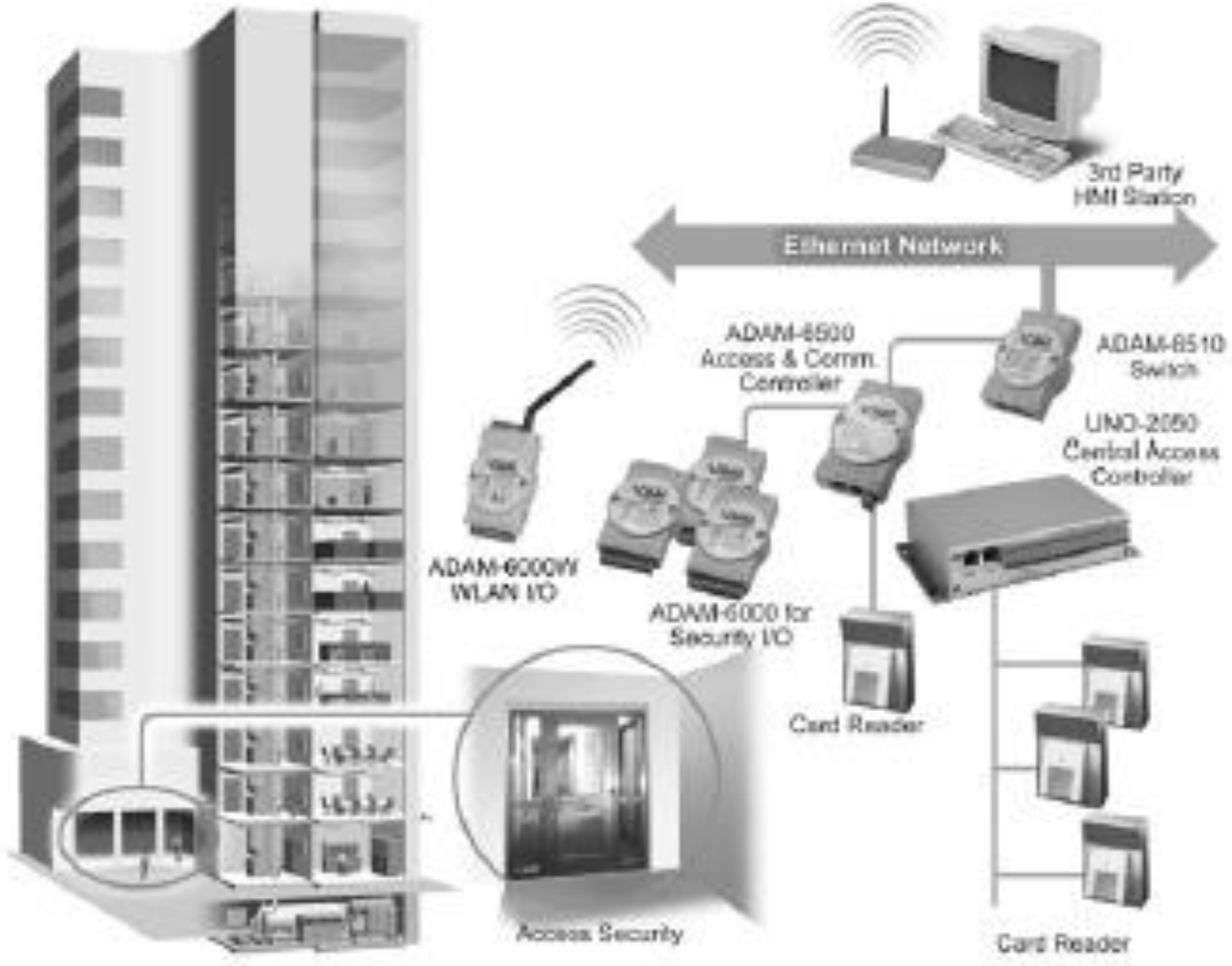


For facility control applications like chiller plant automation, water pump control and cooling tower control, the BAS-2000 system with KW's BA function block library can help build a powerful control system. For distributed zone temperature control, the BAS-4022T dual-loop PID controller would be a perfect selection, and the ADAM-4000 and ADAM-5000 I/O data acquisition modules can be used for facility and environment monitoring systems.

Security System

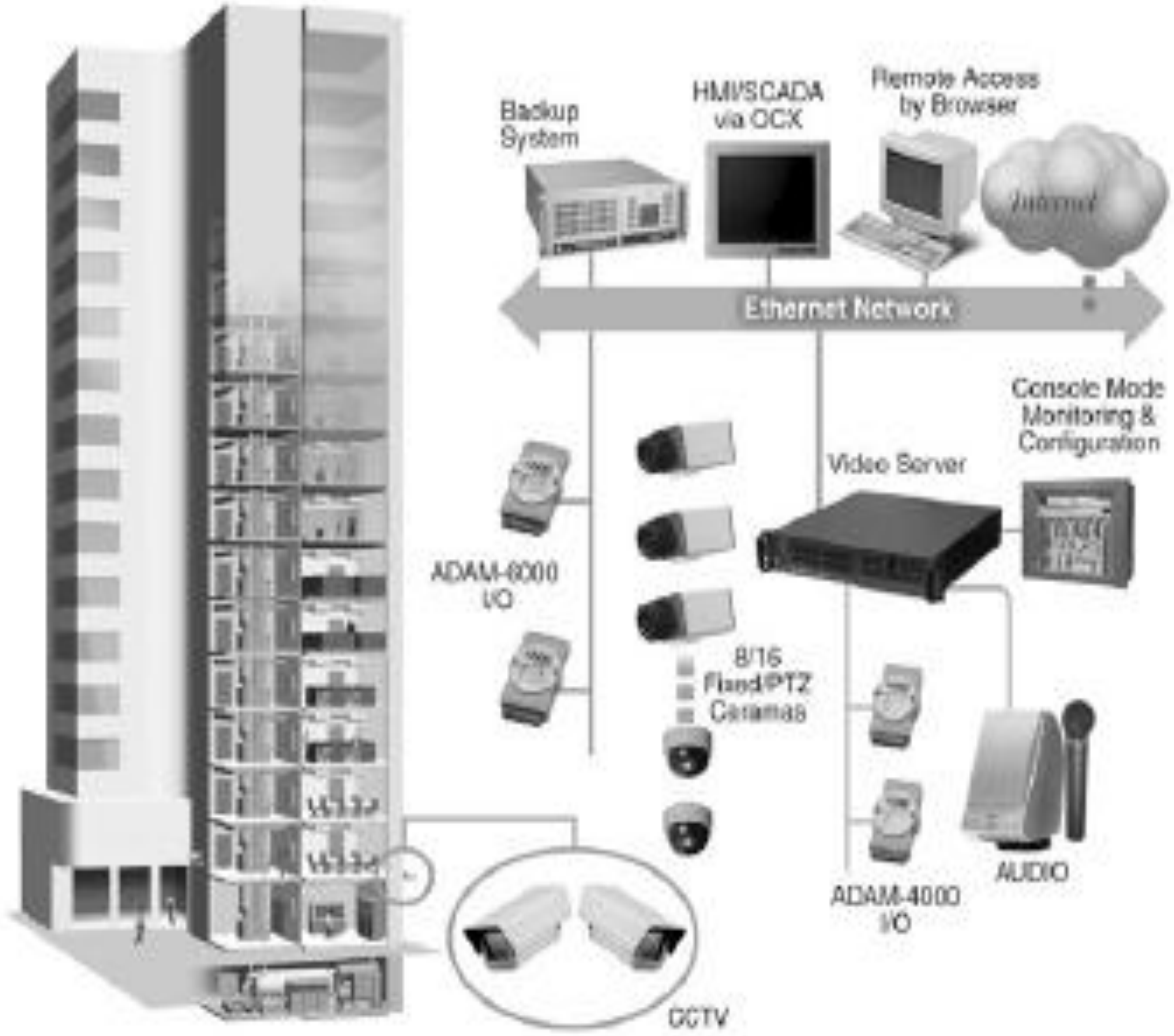
The scope of a typical security system can include :

- Access Control
  - Card reader for system access
  - Access history record
- Illegal access monitoring/alarm system



For access control systems, the UNO-2000 series and ADAM-6500 PC-based platform would be an ideal choice. The ADAM-6000 DI/O module with an event trigger function via the UDP protocol can be a real-time response to start security alarms.

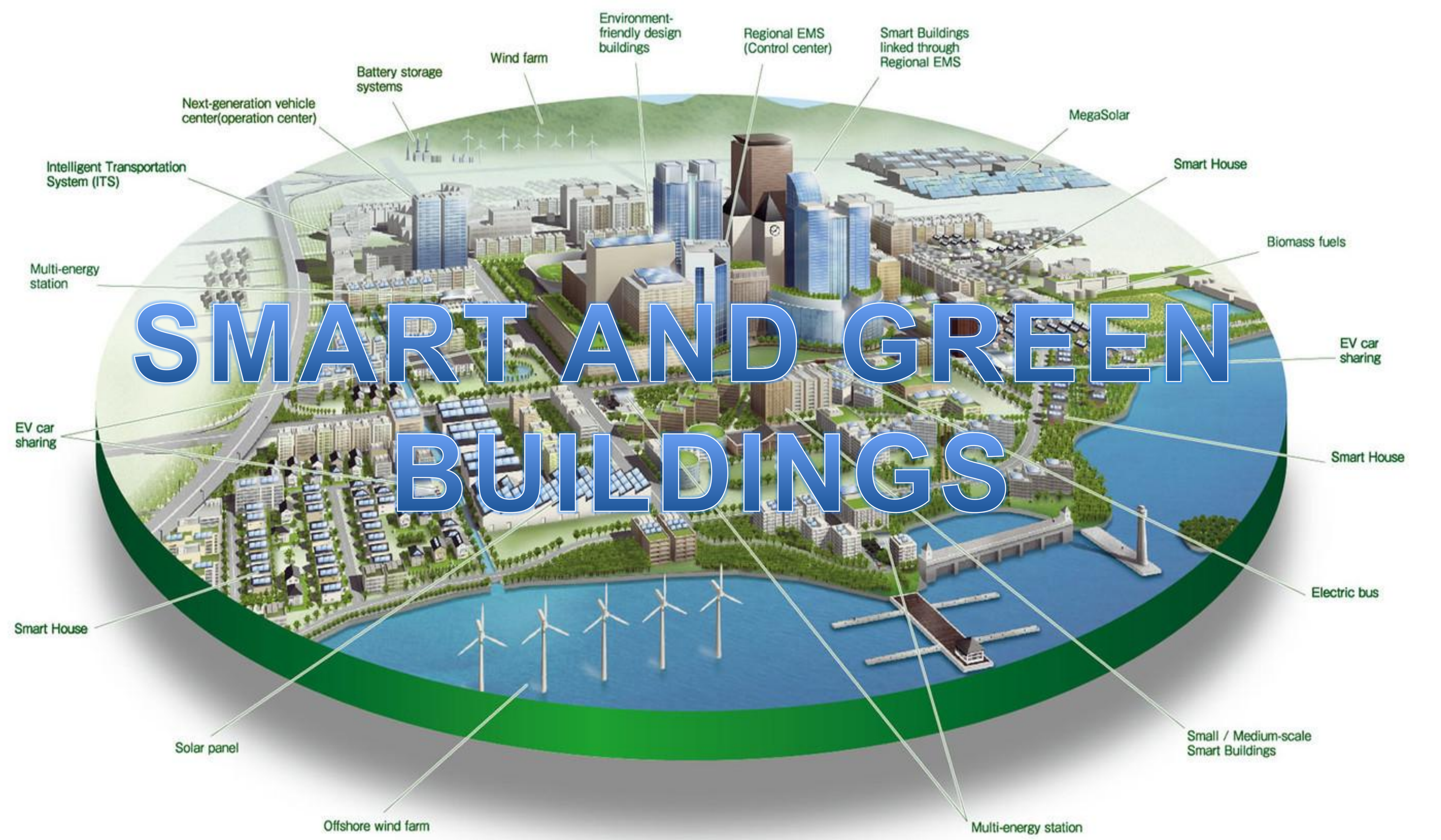
Video System



By combining a video server with ADAM I/O modules as a security interlock I/O, you have a system that can satisfy any requirement for CCTV and security applications.

Complete Product Line
SoftLogic
WebLink
BAS-2000
Air Handling Units
Security
Heat Pump
Cooling Tower
CCTV
Chiller
WebAccess
WebView
Remote I/O
Open Network
BACnet
Modbus-IDA
the architechure for distributed automation

SMART AND GREEN BUILDINGS



Intelligent systems for improving the performance of buildings

GREEN BUILDINGS
IN VANCOUVER

Summary
“Green building” is a phrase that’s used a lot, but often not explained. This *Section Brief discusses* how equipping a building with water-saving mechanisms is also a big part of being “green.” Any building, old or new, can be outfitted with low-flow plumbing fixtures, such as faucets and toilets, aiding communities and the country in water conservation programs. In addition, building occupants can reuse stormwater, graywater, and treated wastewater for everyday needs such as toilet flushing, and landscape and indoor plant watering.

What is green?

The term “green” refers to environmentally friendly practices from building design to the landscaping choices. It also encompasses energy use, water use, and stormwater and wastewater reuse.

Buildings can be rated for their environmentally sustainable construction. One such rating system is the LEED (Leadership in Energy and Environmental Design). This building rating system was developed by the U.S. Green Building Council (GBC) and was created to:

- Define “green building” by establishing a common standard of measurement;
- Promote integrated, whole-building design practices;
- Recognize environmental leadership in the building industry;
- Stimulate green competition;
- Raise consumer awareness of green building benefits; and
- Transform the standard building market to a green building market.

GBC members, representing every sector of the building industry, developed and continue to refine LEED. The rating system addresses six major areas:

1. Sustainable sites;
2. Water efficiency;
3. Energy and atmosphere;
4. Materials and resources;
5. Indoor environmental quality; and
6. Innovation and design process.

The terms “green” and “green building” apply not just to products, but to construction strategies, building design and orientation, landscaping, building operations, maintenance, and more. The less impact a building has on human health and the environment, the more green it is.

Why Going Green Makes Sense

A green building may cost more up front but, in the long run, will save money through lower operating costs over the life of the building.

The green building approach applies a project lifecycle cost analysis to determining the appropriate up-front expenditure. This analytical method calculates costs over the useful life of the asset.

The integrated systems approach ensures that the building is designed as one system rather than a collection of stand-alone systems. Some benefits, such as improving occupant health, comfort, productivity, reducing pollution and landfill waste, are not easily quantified.

Consequently, they are not adequately considered in cost analysis. For this reason, consider setting aside a small portion of the building budget to cover differential costs associated with less tangible green building benefits or to cover the cost of researching and analyzing green building options. Even with a tight budget, many green building measures can be incorporated with minimal up-front costs, and they can yield enormous savings.

What is a Smart Building?

- Can be summed up as an automated or largely automated self monitoring building
- Can be installed on any building either through tenant improvements or planned into a new construction project.
- Involves multiple dimensions that include HVAC control, Cabling, Lighting Controls, Access Control, Data Networking.
- Defined as a building that includes "integrated design of infrastructure, building and facility systems, communications, business systems and technology solutions"(1)

Image Source: Google Image

1. *Smart Buildings LLC*. N.p., n.d. Web. 2 Mar. 2014. <http://www.smart-buildings.com/>.

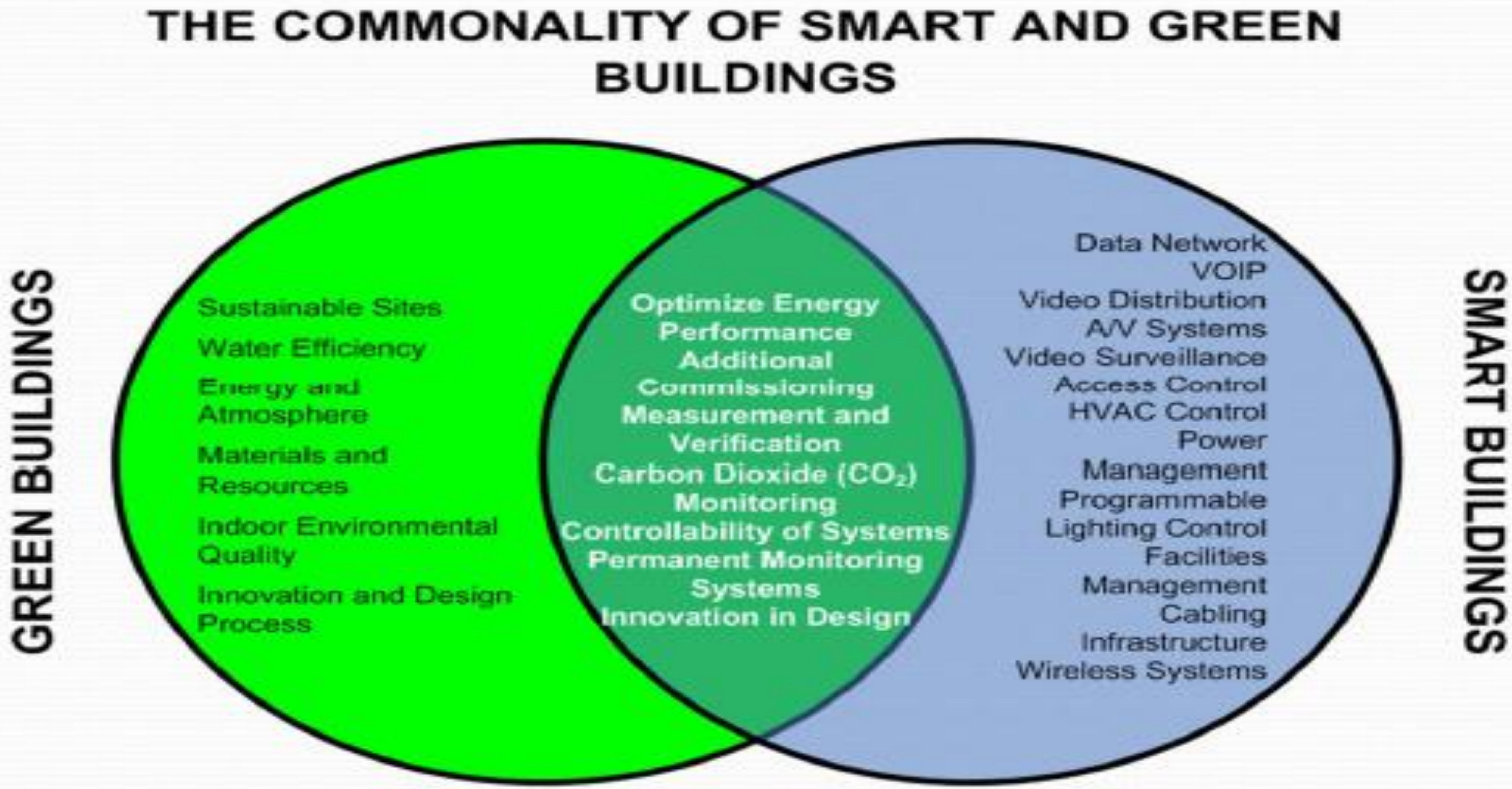
What is a Green Building

- Has very little to no impact on the environment
- Can be used in either new construction or as tenant improvements.
- Usually involves making the building more efficient in regards to consumption. This can be in terms of energy, water or other categories such as air quality.
- Multiple definitions but all involve protecting and often enhancing the land that the building is built upon.

Image Source: Google Image

Bringing them together

- (1)



1. *Smart Buildings LLC*. N.p., n.d. Web. 2 Mar. 2014. <http://www.smart-buildings.com/>.

The Intelligent Building

- An intelligent building generally takes a "Top-Down holistic perspective in looking at every aspect of a customer's operation that has the potential to impact energy and costs."(1) This includes energy generation.

- Then the "planning and specifying of the technology and systems to enable the functionality can occur. Solutions may include not only the electrical, mechanical and IT infrastructure but space utilization and people loading factors.'(1)

- Green techniques are then applied to make a business proficient building environmentally efficient and provide a sooner ROI through reduced utilities usage.

Image Source: Google Image

1. *Energy Management - The Top Down Perspective*. Smart Building LLC, n.d. Web. 2 Mar. 2014. <http://www.smart-buildings.com/>.

Energy Benefits

- Lowers energy cost and in some cases if generators are installed on the premises can actually provide power to the grid.
- Managing more green and volatile energy by up to 30%. This also allows operating the grid safely and securely and delivering better quality power while drastically reducing network losses for the building (1)
- Can be achieved with the addition of on site fuel cells or other power generation capabilities
- Advanced metering of
  - Energy use by space
  - System validation of energy management
  - Measurement of energy conservation and zero-metering

Image Source: Google Image

1. *Electric Utilites*. Schneider Electric, n.d. Web. 2 Mar. 2014. <http://www.schneider-electric.com/solutions/ww/en/seg/4663965-energy-and-infrastructure/4871102-electric-utilities>.

Benefits from an Intelligent Building

Tenant

- Good control of internal climate conditions
- Possibility of individual room control across the entire building
- Improved interior reliability and life (office plants and equipment)
- Effective response to HVAC-related complaints due to monitoring
- Easy maintenance

Owner

- Usually can receive a higher rental value
- Adaptability on change of building use
- Individual tenant billing for utilities can make leases easier to negotiate and enforce
- Central/remote control and monitoring of building
- Increased level of comfort and time saving
- Ease of information if any problems arise
- Computerized maintenance that can be scheduled
- Early detection of problems

1. *Advanced Sensors and Controls for Building Applications: Market Assessment and Potential R&D Pathways (Brampley 2005)*
2. *Energy Consumption Characteristics of Commercial Building HVAC SystemsVolume III: Energy Savings Potential (Roth 2002)*

Cost + Feasibility

- Up-Front Costs: Can vary greatly depending on the amount of effort put into the building or the budget of the project. (1)

- Savings can vary greatly based on location. Water re-capture technology if applied in a drought location will not be as efficient as one that is placed in an area that receives heavy rainfall. This means that technology within a building that the tenant does not see as a benefit may be seen different by another tenant in another industry Just as sustainability is local. Technologies depend on the local tenant and their industry.

- The life cycle is generally the life of the building although many building management systems are designed to monitor maintenance and can significantly reduce the cost of repairs. Maintenance cost of the system itself is based on the sophistication of the system and its presence in the building.

Image Source: Google Image

1. *Frequently Asked Questions*. Smart Buildings LLC, n.d. Web. 3 Mar. 2014. <http://www.smart-buildings.com/faqs.html>.

Vendors and Products

- Intelligent Buildings
  - http://www.intelligentbuildings.com/services/
- Schneider-Electric
  - http://www.schneider-electric.com/site/home/index.cfm/ww/
- Smart Buildings LLC
  - http://www.smart-buildings.com
- And many others

Image Source: Google Image

Future Technologies: Windows

- Photovoltaic Windows
- Electronic Switchable windows
- Window related control systems
- “Having windows generating DC power also begs the question of why not a DC power infrastructure? The argument for DC infrastructure in buildings is quite compelling. Most of our devices and equipment we use operate internally on DC. Power storage is DC. Plus, eliminating the conversion of AC to DC saves some energy. The market will move towards interaction and integration between photovoltaic windows, DC current, microgrids and power storage”(1)

1. Sinopoli, Jim. *Smart Building Predications for 2014*. Smart Buildings LLC, n.d. Web. 3 Mar. 2014. <http://www.smart-buildings.com/uploads/1/1/4/3/11439474/2014predictions.pdf>.

Future Technologies: People

- Tracking chips in a name tag that can prepare your workspace just how you like it as the building shows you are in the elevator and you just got to work.
- Integrated terminals that tell someone where you are in the building based on that same name tag technology
- What about your phone through a company app(1)

Image Source: Google Image

1. Sinopoli, Jim. *Smart Building Predications for 2014*. Smart Buildings LLC, n.d. Web. 3 Mar. 2014. <http://www.smart-buildings.com/uploads/1/1/4/3/11439474/2014predictions.pdf>.

Future Technologies: Structural Monitoring

- The envelope is critical for structural integrity, energy management, maintenance, operations and security. Most monitoring of a building's envelope or structure is done through periodic manual inspections. however, in 2014 we will see increased deployment of automated monitoring of building envelopes, especially for new high rise and skyscrapers in large urban areas.(1)

- These systems will monitor
  - Moisture
  - Air Leakage
  - Structural displacement and loads
  - Seismic monitoring

- These systems will also monitor doors and windows and can adjust the systems of the building as needed.

1. Sinopoli, Jim. *Smart Building Predications for 2014*. Smart Buildings LLC, n.d. Web. 3 Mar. 2014. <http://www.smart-buildings.com/uploads/1/1/4/3/11439474/2014predictions.pdf>.

Smart Cities

- Traffic Management Systems
- Water distribution
- Energy management systems
- Security management across entire city blocks
- Energy and carbon dashboards and active energy controls for homes

Image Source: Google Image
Schneider Electric, n.d. Web. 3 Mar. 2014. <http://www.schneider-electric.com/solutions/ww/en/seg/27947930-smart-cities/27957983-smart-buildings-homes>.

THE END