Intelligent building automation in one of Germany's tallest skyscrapers minimizes energy consumption and lowers operating costs

Tower 185:
Beckhoff automation platform manages 60,000 data points

With the completion of Tower 185, the skyline of Frankfurt am Main now has one more attraction: with a height of 200 meters the 50-story high-rise office building is one of the four tallest skyscrapers in Germany. The contract for the entire building automation infrastructure was awarded to Hermos AG, a specialist in IT solutions for properties and production processes. The medium-size enterprise, which has already implemented several building automation projects with Beckhoff as a technology partner, once more relied on the PC-based control platform for this building project. The FIS# building management system developed by Hermos – for use at the management and operating level – and the Beckhoff technology components together create an intelligent, highly efficient building automation system that fulfils all requirements of both the operator and occupants of Tower 185.

Tower 185, designed by the Frankfurt architectural office Prof. Christoph Mäckler Architekten, rises to its impressive height out of a horseshoe-shaped base, the so-called east and west perimeter blocks. These blocks house shops, restaurants, offices and a conference center, as well as a restaurant and daycare for children of employees. The high-rise office building offers a total floor space of 100,000 m^2 across 50 floors. The main tenant of Tower 185 is the auditing company PricewaterhouseCoopers (PwC) which has rented an area of 71,000 m^2. Further tenants of the building include the globally active law firm Mayer Brown LLP as well as Excellent Business Centers GmbH.

Building automation platform in XXL format

Hermos was commissioned by the building owner, CA Immo to implement the complete building automation of the office building – from the management and operating level to HVAC and room automation systems. With an office space of 100,000 m^2, both the individual room control and the dynamic room management are extraordinarily complex and represent a challenge in terms of control: On the one hand, the management and operating level must acquire and evaluate the requirement signals from the office rooms. On the other, global control functions must be executed, including changing room sizes, lighting as well as various user and shading scenarios. And finally the needs-based control for the required amount of heating, cooling and air quality must be activated and controlled.

A total of 700 PC-based controllers from Beckhoff are in use to implement all control and regulation tasks in Tower 185. About 60,000 data points are connected via Ethernet and a TwinCAT ADS communication interface to the FIS# management and operating level system developed by Hermos which is implemented on the central building management server. FIS# connects the room automation with the building management system and is responsible for the central operation, monitoring and control of the technical building equipment (HVAC) as well as the dynamic room management. Thomas Sturm, Hermos' project manager for the Tower 185, adds: "The data points are connected via standard Beckhoff I/O, DALI, EIB/KNX and EnOcean terminals. A total of 170 Beckhoff Embedded PCs of the CX9010 series, 500 Embedded PCs of the CX9001 series as well as 80 C6925 Industrial PCs (IPCs) take care of the data processing. On each floor, a C6925 filters or qualifies the data in order to transmit them, then structures and consolidates the information for the FIS# server. For example, it collects actual and setpoint values for the room temperature and transmits them to the management and operating level according to a defined time pattern." All data captured by the building automation system are merged in the FIS# and represent the basis for benchmarking and controlling, for example, the energy consumption, the system availability or the operating costs, as well as for the integrated maintenance management.

Redundant Ethernet network for 24/7 availability

An autonomous Ethernet-TCP/IP-based network forms the "backbone" of the building management system. The network infrastructure of the building is divided into three areas, namely the east and west perimeter blocks and the tower itself. There is a redundant fiber-optic cable ring in each section of the building, so that the data traffic is maintained even if the network cable is interrupted. The entire management and operation level, consisting of redundant servers and
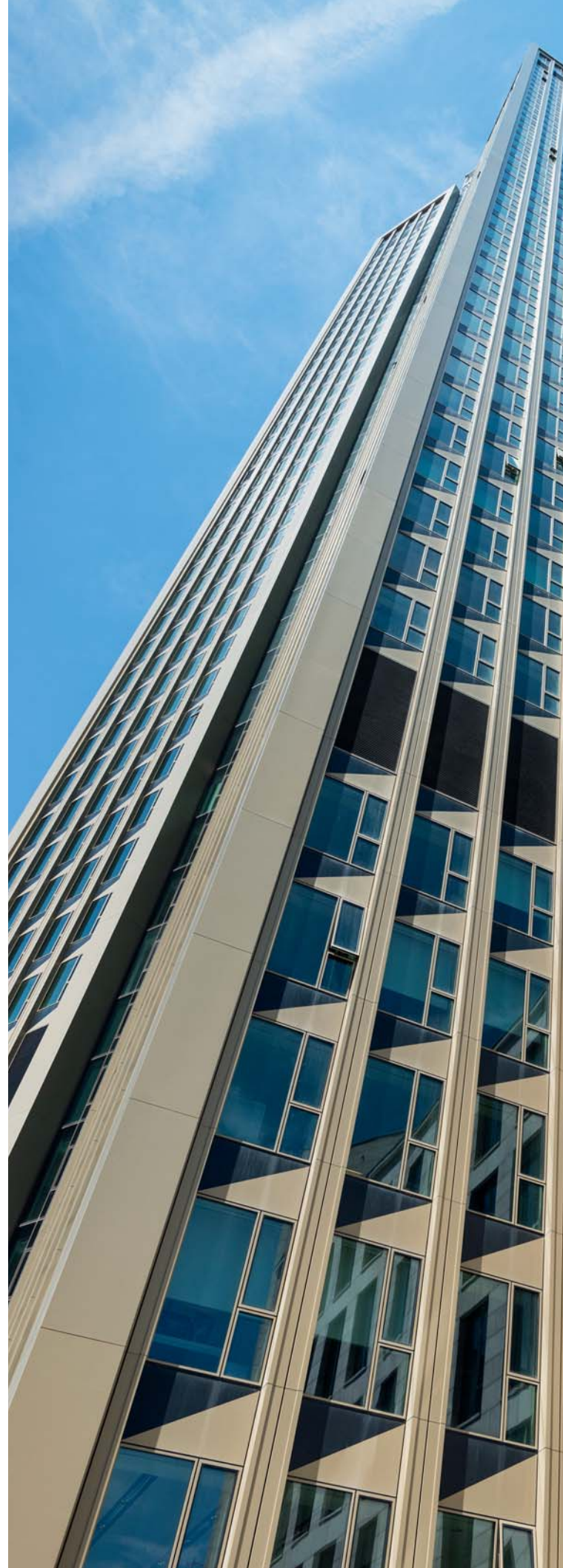
client stations, is networked by a fiber-optic cable ring and by means of Ethernet TCP/IP. The fiber-optic cable ring couples the automation devices floor by floor via switches, i.e. the lower-level Beckhoff IPCs are connected by copper-based Ethernet cables in a star topology to the control level which is networked via optical fiber.

Connected to the Industrial PCs are Bus Terminals and to these in turn the room control units, sensors and actuators. Thomas Sturm explains: "The Tower 185 building can be completely supervised and controlled via the monitor by the building operator Hochtief Solutions with the clients in the building automation control room." However, Hermos also has the possibility to access the building controller via a client station for remote maintenance.

Designed for flexibility: individual room control

Individual room control in Tower 185 encompasses light control with DALI as well as blind control via SMI. Room control units with EnOcean technology are used to enable flexible room usage on the basis of the small office units. These are each equipped with an occupancy sensor, a selector switch for room temperature, a temperature sensor and a pushbutton for blind operation. All signals from the room control units, such as the actual and setpoint temperature values, are sent by EnOcean wireless technology to KL6583 EnOcean Bus Terminals and transmitted to the Embedded PC.

A prerequisite for dynamic room management is adherence to predefined control variables. Thomas Sturm explains: "With regard to the usage scenarios we had to meet exact specifications, also taking the needs of tenants into account. In room automation the adherence to maximum permissible deviations is demanded. Accordingly we have defined three modes of operation for the office spaces: day, night and weekend, and comfort mode. With regard to the night and weekend mode, we must adhere to limit values of ± 3 K (Kelvin) in order to properly condition the room. The day mode is defined by timers; this means that from 7 am until 7 pm the room is maintained in such a way that it can be quickly put in comfort mode as soon as the occupancy sensor is activated."

Beside the standard office space, special and comfort rooms were set up on the 48th and 49th floors of Tower 185. Room control takes place here using operating panels that employ EIB/KNX technology. The panels encompass pushbuttons for various room functions, such as the control of the blinds and lights, as well as the digital specification of the set temperature value. Here, the tenant has the possibility, for example, to call up stored lighting scenarios and to modify them via the FIS# client. In addition, the operating panels provide status information about various room parameters, such as temperature or air quality, etc. The outside temperature is displayed, five climate elements are shown and the flow rate is controlled by means of a PWM controller. A dew-point sensor indicates the possible formation of condensation on the ceiling. The control function is implemented using a TwinCAT software module.

Dynamic room management without hardware changes

Since each standard office is equipped with a room control unit with EnOcean technology, the room layout can be arranged flexibly if its usage changes. If standard rooms are combined to form an open-plan office, the components

The floor computers: a total of 80 Control cabinet Industrial PCs of the type C6925 are used in the Tower 185. A C6925 is installed on each floor for the filtering or qualification of the data.

belonging to the basic units are assigned to the master controller. "The room control units are removed for this. The necessary regrouping, for example of lighting and heating elements or blinds, is defined in the FIS# system by our dynamic room management or by suitable task assignments. Modifications to the wiring or installation are not required," explains Thomas Tröger, software expert from Hermos.

In special rooms with movable partition walls, the wall position is detected by signalling contacts in order to control the room conditioning. If two rooms are combined the operation is adapted accordingly and the control processes are aligned via both control panels. For other room changes, the tenant must make a request to building operator Hochtief Solutions who then adapts the visualization of the management and operation level or the room control in accordance with the changed floor plan.

Centralized blind control improves energy efficiency

Tower 185 uses so-called "global blind control" which is carried out centrally at the management and operation level. For this, the blinds of the entire facade of the tower and perimeter blocks are divided into segments. They are controlled in relation to the level of sunlight, light direction and temperature. A weather station installed on the 6th floor of the east perimeter block measures not only the temperature, but also the wind velocity, wind direction, rain and brightness. In order to account for the effects of the surrounding high buildings on the control parameters of Tower 185, further weather sensors were installed on the 53rd floor that measure brightness levels without impediment.

Thomas Tröger explains the concept of the shading control as follows: "An input mask was created for this in the FIS# into which the operator can enter the values. The sun protection is then operated globally in accordance with these criteria. It can quite easily be the case that the east side is shaded in the early morning while the south side is still open. If the conditions change over the course of the day, the global controller changes the blind segments. Nevertheless, each room user naturally has the possibility to operate the blind on each window individually using the room control unit. In the case of an approaching storm or rain, however, the central controller automatically takes command again."

The data processing is carried out by a total of 670 Embedded PCs of the type CX9001 or CX9010. In the basic configuration, two RJ 45 sockets that are internally connected to an integrated switch are available as interfaces. This facilitates the wiring in a line topology.

User-friendly operating interface

The operating interface of the FIS#, which summarizes all information that is relevant for the operator, is arranged into two large sections. The system tree reflects the overall project structure and is subdivided into room management and technical systems. The room management encompasses the individual floors, from the ground floor to the 50th floor. The technical systems have been divided into the individual subsystems, including ventilation and cooling systems. The ventilation systems, for example, are subdivided into supply and exhaust air as well as into air-conditioning subsystems. An operator is thus able to access individual systems via the operating interface.

Flexibility – from the management and operation level to the automation platform

With a large building project like Tower 185 with a usable floor area of 100,000 m² it is only natural that the leases extend over a longer time period. Thus, a high degree of flexibility in the building automation system is required as well as trouble-free interaction of all systems and components employed. "Both the Hermos management and operation level and the Beckhoff automa-

tion platform are characterized by openness. They offer numerous interfaces to other communication and technology concepts. Hermos has developed its own ADS driver for coupling the control system and TwinCAT which enables universal access to the system," explains Wolfgang Negele, Beckhoff sales representative from the company's Nuremberg branch office.

Further Information:
www.tower185.com
www.caimmo-deutschland.com
www.hermos.com
www.beckhoff.com/building