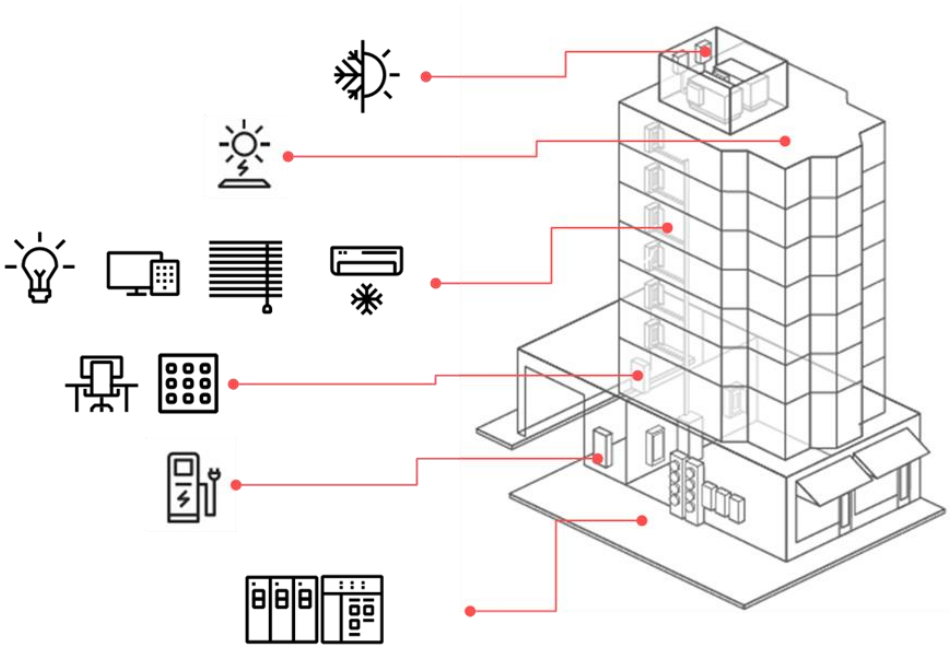
Chameleon

Chameleon HaaS

HOTEL AUTOMATION SYSTEM TECHNICAL DESCRIPTION



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Hotel Automation

The purpose of hotel automation is to integrate modern technology into the construction and renovation of a unit, thus creating a space that is environmentally friendly and welcoming to the staff and guests.
The main failure encountered in the design of hotel automation is the inability to meet the needs of all stakeholders.

Chameleon HaaS was designed with all stakeholders and their diverse needs in mind.
The owner/investor/operator is interested in a competitive advantage, low acquisition cost, support, a reliable branded solution, spare parts availability, low operating and maintenance costs, and energy savings.
Hotel staff need a simple, intuitive system that automates daily operations, providing oversight and control of the hotel.
The technical service department must have access to precise troubleshooting with a clear description of the fault and the ability to resolve it immediately.
The guests expect their stay to be a unique hospitality experience.

Chameleon HaaS derived by distilling the experience of more than 30,000 hotel rooms and is based on a decentralized architecture and an open communication protocol, thus ensuring its reliability and maximum connectivity with third-party systems.
The system brings for the first time the most popular controller on the market, Siemens LOGO! , in the ecosystem of the leading automation protocol, KNX, as a cost-effective yet feature-rich guest room automation solution.
Siemens LOGO! was created in 1996 and is now in its ninth generation. It is by far the most popular and successful microcontroller (Smart relay) of the European market and is integrated into the KNX protocol through a gateway.
The protocol dates to 1990 and under its umbrella are more than 500 manufacturers worldwide. KNX devices from different manufacturers are compatible with each other and can work in the same installation. The choice of the above materials guarantees a reliable solution, which is also future-proof, expandable and has available service and spare parts through the life cycle of the hotel unit.

Chameleon HaaS consists of two main parts, guest room automation and central visualization.
The visualization provides supervision and control of the rooms , housekeeping services (HMS) functions and check in / check out (PMS) operation with automatic pre-cooling/heating, for small units that do not have corresponding systems.
Guest room automation provides control of all room loads and heating-ventilation-air conditioning/HVAC (comfort and energy saving scenarios). The system's decentralized architecture ensures that all room functions are autonomous and the loss of a LOGO! controller is equivalent to the loss of only one room.

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Guest room automation

Chameleon HaaS guest room automation system controls lighting circuits, power sockets line and HVAC (split unit), in addition to guest presence monitoring. Reliable occupancy detection is the core of the solution and leads to maximum energy savings for the hotel.

Occupancy detection

In most hotel units, the common practice for monitoring guest presence inside a room is implemented with a card holder. When a guest enters the room, he must insert a card into the room card holder to turn on the lights and HVAC and be able to control them ("Welcome Guest" scene). Likewise, when a guest leaves the room and removes the card from the card holder, the lights and HVAC turn off with a small-time delay ("Guest Out" scene). This approach can easily be bypassed by the guest, leading to huge energy waste for the hotel.

Chameleon HaaS overcomes this disadvantage by not using a card holder. Instead, occupancy monitoring is based on a sophisticated presence detection algorithm with a magnetic contact on the door and a conventional presence detector in each room.

The detection of entrance door opening triggers the start of presence detection algorithm, for a specified time. If movement/presence is detected within this time interval, the system sets the state of the room to "Occupied" and stops presence monitoring, avoiding any false presence/absence detections while the guest is in the room. When the entrance door closes, the system will start monitoring guest presence again. If no movement/presence is detected within this time interval, the system sets the state of the room to "Vacant" and activates energy saving scenes. The presence control algorithm also has a failsafe for the case of wrongly estimating the absence of a guest from the room. If movement is detected in an "empty" room, the algorithm will put the room in "Occupied" state, without changing the state of the lighting in the room ("Welcome Guest" scene is not activated).

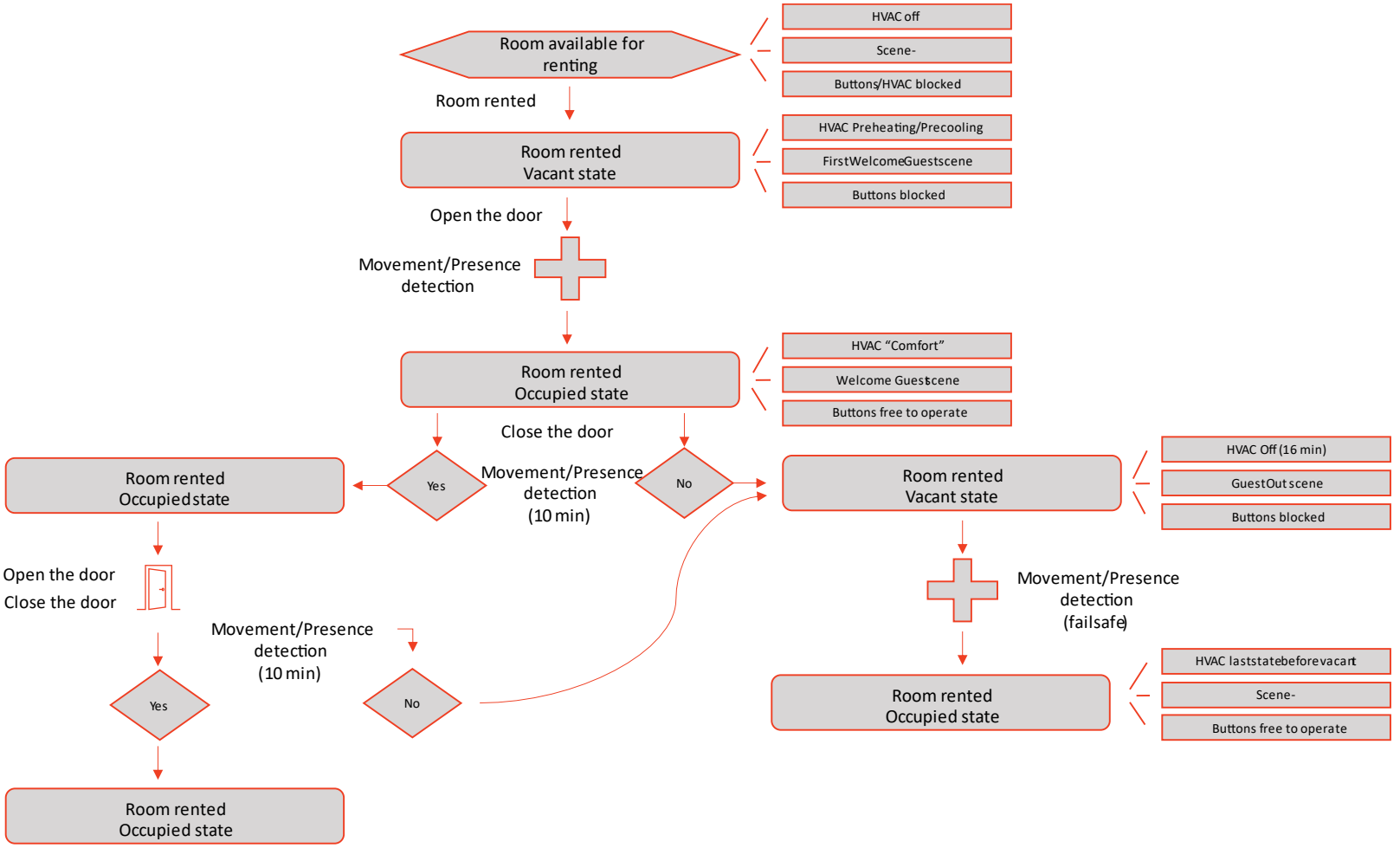
When a guest enters or leaves the room, the following action occur:

Entering the room

- When the guest enters the room, the scene "Welcome Guest" is activated, which turns specific light circuits on, sends "comfort" mode to the air condition unit (26 °C if heating mode, 21 °C if cooling mode and fan speed to auto) and activates power sockets.
- If the room is in occupied state, **no scene is activated** when a guest enters the room, avoiding discomfort of occupants that are already inside the room(e.g. someone is sleeping)

Leaving the room

- When the guest leaves the room, the scene "Guest out" is activated, which turns all the lights off, sends "standby" mode to the air condition unit and after a specified time, it switches it off. The power socket line is also turned off.


Room available for renting
HVAC off
Scene-
Buttons/HVAC blocked
Room rented
Room rented Vacant state
HVAC Preheating/Precooling
FirstWelcomeGuestscene
Buttons blocked
Open the door
Movement/Presence detection
Room rented Occupied state
HVAC "Comfort"
Welcome Guestscene
Buttons free to operate
Close the door
Yes
Movement/Presence detection (10 min)
No
Room rented Occupied state
Room rented Vacant state
HVAC Off (16 min)
GuestOut scene
Buttons blocked
Open the door
Close the door
Movement/Presence detection (10 min)
Yes
No
Movement/Presence detection (failsafe)
HVAC laststatebeforevacant
Scene-
Buttons free to operate
Room rented Occupied state
Room rented Occupied state

Switches / Buttons

The system assumes conventional push buttons for the control of lighting and scenes by the guest. This design implementation offers:

- Reduced initial investment cost
- Low cost of ownership, since the expensive electronic units that make up the system are not exposed to wear due to usage by the guest
- Increased security by denying physical access to system components. Only authorized personnel have access to the consumer unit and false roof of the room
- Minimizing the single points of failure that lead the system to malfunction
- Increased reliability for functions that are perceived by the guest – Front of House (FoH)
- Reduced system downtime, since in the event of a possible failure, it is easier to identify, isolate and repair the issue (Mean Time to Discover, Mean Time to Isolate, Mean Time to Repair)
- Minimum number of system components, which facilitates maintenance and service and reduces cost of topology components
- Compatible with any design and brand of conventional push buttons, allowing freedom of choice for the architect and owner, in regards with aesthetic design or total cost of materials
- Renovating the guest room and replacement of switch range does not require reprogramming or additional costs

It should be noted that the implementation with conventional push buttons **does not have** a technical disadvantage compared to the classic implementation with electronic/system switches. Any conventional push button can be programmed to control lighting, HVAC, scenes and other functions we need.
The push buttons can either control individual lighting circuits (e.g. foyer light, WC light) or activate a scene where it is possible to control more than one lighting circuit. As an example, the push button beside the bed can activate a “Night” scene where the guest can turn all the lights off.

Chameleon HaaS offers three types of different scene function:

Default Scene (one scene):

The classic implementation of a scene, as we find it in KNX. Every time we press the push button, the scene is activated and sends a command to multiple loads. As an example, we decided that “Master On” turns three lighting circuits on. When we press “Master On” these three lighting circuits will turn on simultaneously. If we press it again and these lights are on, no change will occur.

Bright/Dark Scene (two scenes):

This option allows for one push button to send two different scenes, based on measured brightness (requires external brightness sensor when ordering Chameleon). As an example, we decided that scene “TV” should close all the lights that reflect on the TV and turn on the ambient lighting, if there is not sufficient lighting. In this case, if we press push button “TV” and the room is dark, ambient lighting will turn on and some lights will turn off. If it is in the morning and the room is bright, ambient lighting will remain turned off when we press “TV” scene. Implementing Bright/dark scenes can lead to energy savings and comfort for the guest, since we make sure an adequate level of lighting is turned on without needlessly wasting energy.

Toggle Scene (two scenes):

This option allows for one push button to send two different scenes. The first time the button is pressed it will activate scene number 1. The second time we press it, it will activate scene number 2 etc. A typical use for this option can be the scene “Night”. We can make the push button “Night” a toggle scene, in which case the first time we press it, it will turn all the lights off. The second time we press it, it will turn on a night light or the bathroom light. A third press will turn all the lights off again.

In addition to the scenes controlled by the push buttons, there are also available the scenes for “Welcome Guest” and “Guest Out”, which are activated when a guest enters or leaves the room.

HVAC Control

A great percentage of a hotel unit’s energy consumption during its lifecycle is due to heating, ventilation and air conditioning (HVAC). Most studies have shown that this percentage amounts to 40% of total electricity consumption of a hotel. Integrating HVAC with the hotel automation system and implementing control strategies, allows maximum energy savings during the operation of the unit and brings a significant improvement in the reduction of operating costs, while contributing to the creation of comfortable conditions for the guest.

The guest room automation system integrates control of the air conditioning unit through a gateway device. This device allows bidirectional communication between the system and the unit, allowing for control and monitoring of parameters such as fan speed, temperature setpoint, cooling/heating switchover and activation/deactivation.

One gateway device is used per room, offering

- Increased system reliability by maintaining autonomous room principle, since a faulty gateway does not affect the operation of other rooms HVAC control
- Reduced mean time to repair fault, since we can quickly identify where the error occurred and fix it

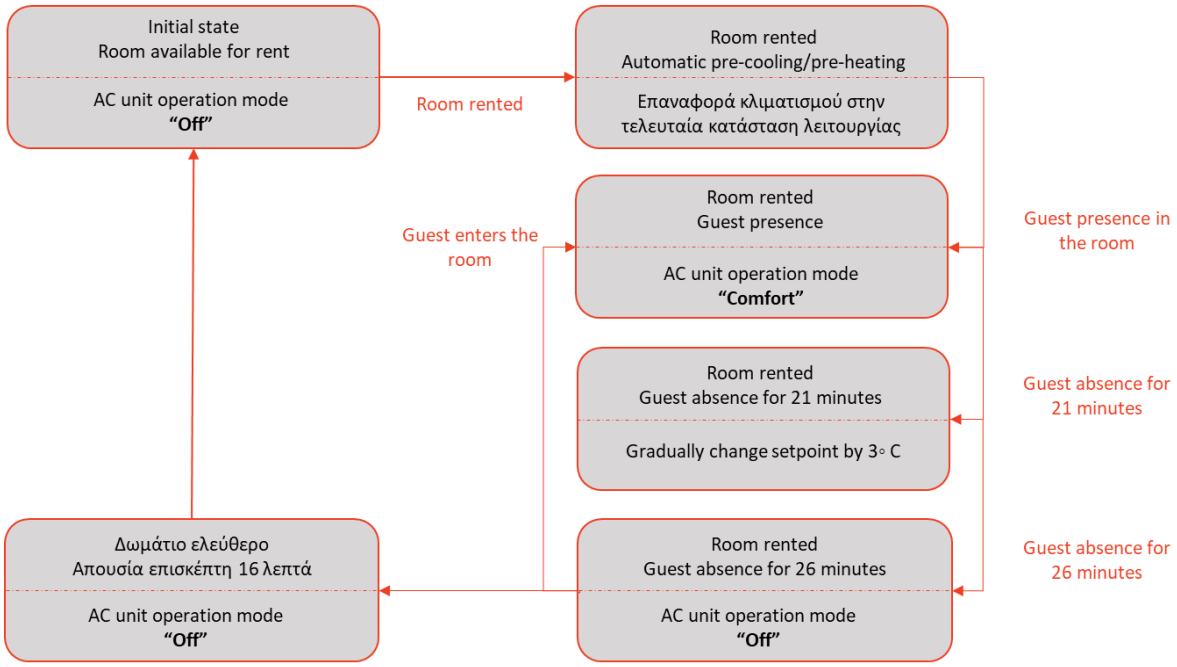
The guest will operate the air conditioning unit through the HVAC manufacturer’s digital thermostat, minimizing this way the required automation devices, reducing total cost per room and complexity of the system. By keeping the factory thermostat, any fault that might occur in the gateway device is not perceived by the guest and the room air conditioning remains operational, ensuring guest comfort until the technical issue is resolved.

Room HVAC control is integrated with occupancy detection algorithm of the system, sending different temperature setpoints based on room state, to achieve maximum energy savings:

- When a guest is checked in, a pre-cooling or pre-heating scene is activated, creating a comfortable environment when the guest arrives at the room
- When a guest enters the room, **“Comfort**” mode is activated (26 °C in heating, 21 °C in cooling and fan speed set to auto)
- When a guest leaves and the room is empty, the temperature decreases or increases (based on heating/cooling mode) by 1 °C after 1 minute
- Thereafter, if the room remains empty, the temperature decreases or increases (based on heating/cooling mode) by 1 °C every 5 minutes, up to a maximum 3 °C increase/decrease (15 minutes)
- The AC unit will turn off after a total of 26 minutes (10 minutes after guest leaves and “Guest out” scene activates and another 16 minutes for gradually turning off the AC) , saving significant amounts of energy during hotel operation.

Gradually turning off the AC unit contributes to guest’s comfort by maintaining a satisfactory room temperature in case of a short absence. Additionally, by not turning off the AC unit immediately, errors in occupancy detection do not affect guest’s comfort, e.g. while sleeping.

The diagram below shows the change of states in a guest room in accordance with occupancy detection:



Balcony door magnetic contact

The information from the magnetic contact of the balcony door will control the room's split type air conditioning unit, deactivating its operation if the window has remained open for a specific period of 8 minutes.
In case the balcony door has the possibility of retraction, it is recommended to place the magnetic contact at the bottom so that the operation of the air conditioning is not interrupted when it is retracted.

Special functions

Emergency cord

The guest room automation system integrates an emergency button/cord for the bathroom which will inform the reception, in case someone has an accident and pulls it. The alarm can only be deactivated by reception staff.

Housekeeping services (HMS)

Two buttons are available in each room for housekeeping services, a “Make Up Room/MUR” button and a “Do Not Disturb/DND” button. Each of these buttons has a light indication when activated and they are interlocked with each other, so it is not possible for both to be activated simultaneously. A light indication on the outside of the room can be implemented, allowing hotel staff to easily view whether a room requires a service.

The reception is immediately informed from the visualization, when a housekeeping button is activated. A “secret” function is available in the MUR button and can be activated by pressing it for 5 seconds. When a room is free for renting, hotel cleaning staff can inform the reception that the room is cleaned and ready, by pressing the MUR button for 5 seconds. The reception can monitor this state in the visualization and only then can the room be rented to a customer, by performing a Guest check in operation.

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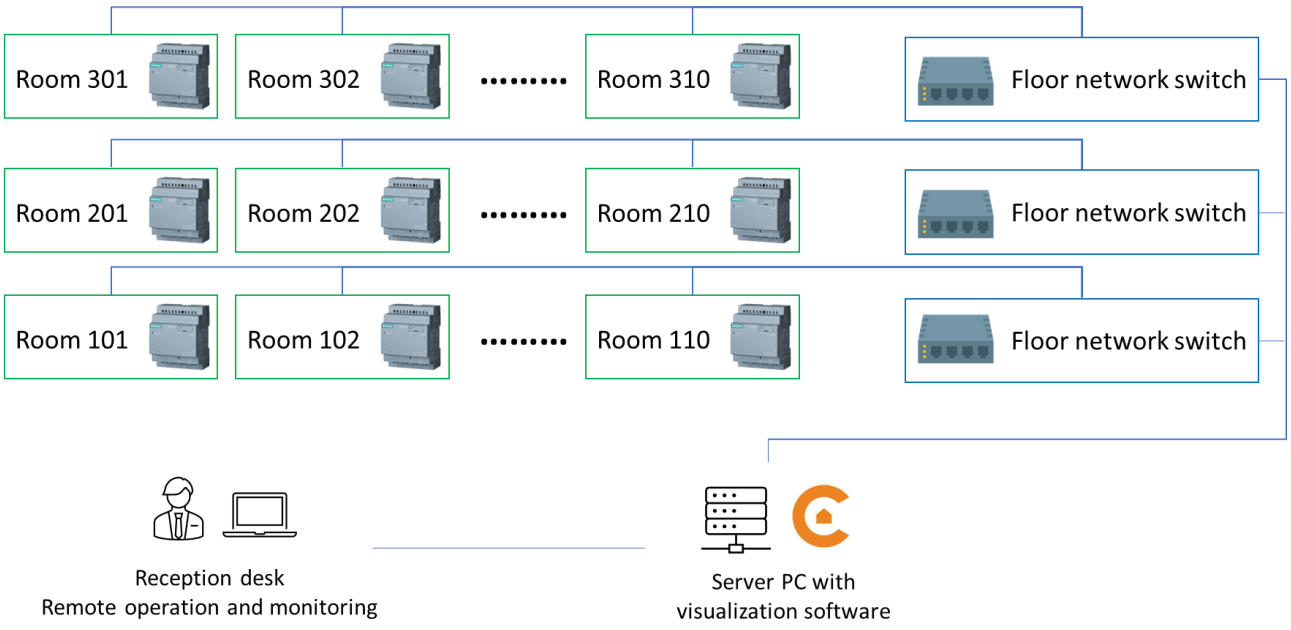
Visualization

A visualization of a hotel automation system allows management and supervision of the various functions that are implemented to it, through a computer or smart device that has access to the installation's IP network.

Chameleon offers a visualization based on Comfort Click software, which must be installed on the server of the hotel and will be connected through the IP network with the rest of the automation system.

Topology



Main page

On the main page of the visualization, the hotel staff can find information such as number of available rooms and the number of rooms that have a technical issue/fault. There is also available the number of the first free room, which is renewed every time there is a room status change, assisting the reception staff with their daily operations.
On the bottom of the page, we can find information messages regarding the PLC license (OPTA) of the system for this specific project.

Maintenance page

On the maintenance page, reception staff has an overview of the condition for each LOGO! room unit, LOGO! gateway devices and the AC split units and gateways. Additional information regarding the AC split unit is available on the dedicated HVAC page, where the staff can view operating hours of each AC unitm air filter state and error codes, if there is a fault.

Admin page

On this page, the operating hours of the air conditioning units can be reset, both by schedule (e.g. at the beginning of the season) or manually (e.g. after maintenance)

Room overview page

This page has an overview of the hotel rooms, with a maximum of 10 rooms per page. The following actions are available for each room on this page:

- Navigation link to room page
- Emergency cord indication (we can also deactivate the alarm from this page)
- Indication of room availability for rent (If the room solution includes a MUR button, this field is automatically updated, it must be set manually otherwise)
- Guest in/Guest out button for checking a guest in or out of a room. **We cannot check a guest in** a room that is not available for rent!

Room page

The user of the reception computer will have supervision of the hotel rooms through the graphical environment of the visualization application. Available information per room is:

- Housekeeping services, such as clean my room and do not disturb (Make Up Room – Do Not Disturb)
- State of occupancy for the room, occupied or vacant
- Information for the AC unit of the room, such as power on/off, operation mode, room temperature and fan speed
- Entrance and balcony door open status (open/closed)
- Emergency signal for bathroom cord
- Error code information from the AC unit

Reception staff can operate all the above air conditioning parameters as well as activate/deactivate housekeeping services.

System devices

Στο **Chameleon HaaS** υπάρχουν συσκευές που τοποθετούνται εντός των δωματίων. Each room has a LOGO! base module, a LOGO! expansion module and A 24 [V] / 1.3 [A] DC power supply, installed in the consumer unit. In addition to the din rail mounted automation components, an AC unit gateway is required in each room.
Occupancy detection requires one conventional presence detector in each space of the room (e.g. bedroom, bathroom).

Type	Description
LOGO! 12/24RCEO	LOGO! 24RCEO (AC), logic module
LOGO! DM 16 24R	LOGO! DM16 24R expansion module
Aidoo KNX Inverter/VRF	HVAC bidirectional gateway
LOGO! Power 24 V / 1.3 A	LOGO! Power 24 V / 1.3 A
0 489 41	PIR IP 20 ceiling-mounting motion sensor, 360°

A KNX/LOGO! gateway along with a 24 [V] / 0.6 [A] DC power supply is installed per 5 LOGO! base modules (5 rooms), in the consumer unit located in the common areas (typically in room floor corridor).

Type	Description
LOGO! CMK2000	LOGO! CMK2000 Communication module
LOGO! Power 24 V / 0.6 A	LOGO! Power 24 V / 0.6 A

Finally, one KNX/IP router **per building** is installed in the common areas' consumer unit along with one or more KNX power supplies.

Type	Description
N 125/22	Τροφοδοτικό N 125/22, 640 mA
N 146/03	IP Router Secure N 146/03

Network and cabling

Chameleon HaaS is implemented on two types of networks.
The first network is KNX over twisted pair cable (TP) and must be routed to each room for the connection of the AC unit gateway device, as well as to each CMK2000 device in the common areas' consumer unit. The KNX TP cable will end up at KNX IP Routers and KNX power supplies (one or more) depending on the number of KNX lines defined.

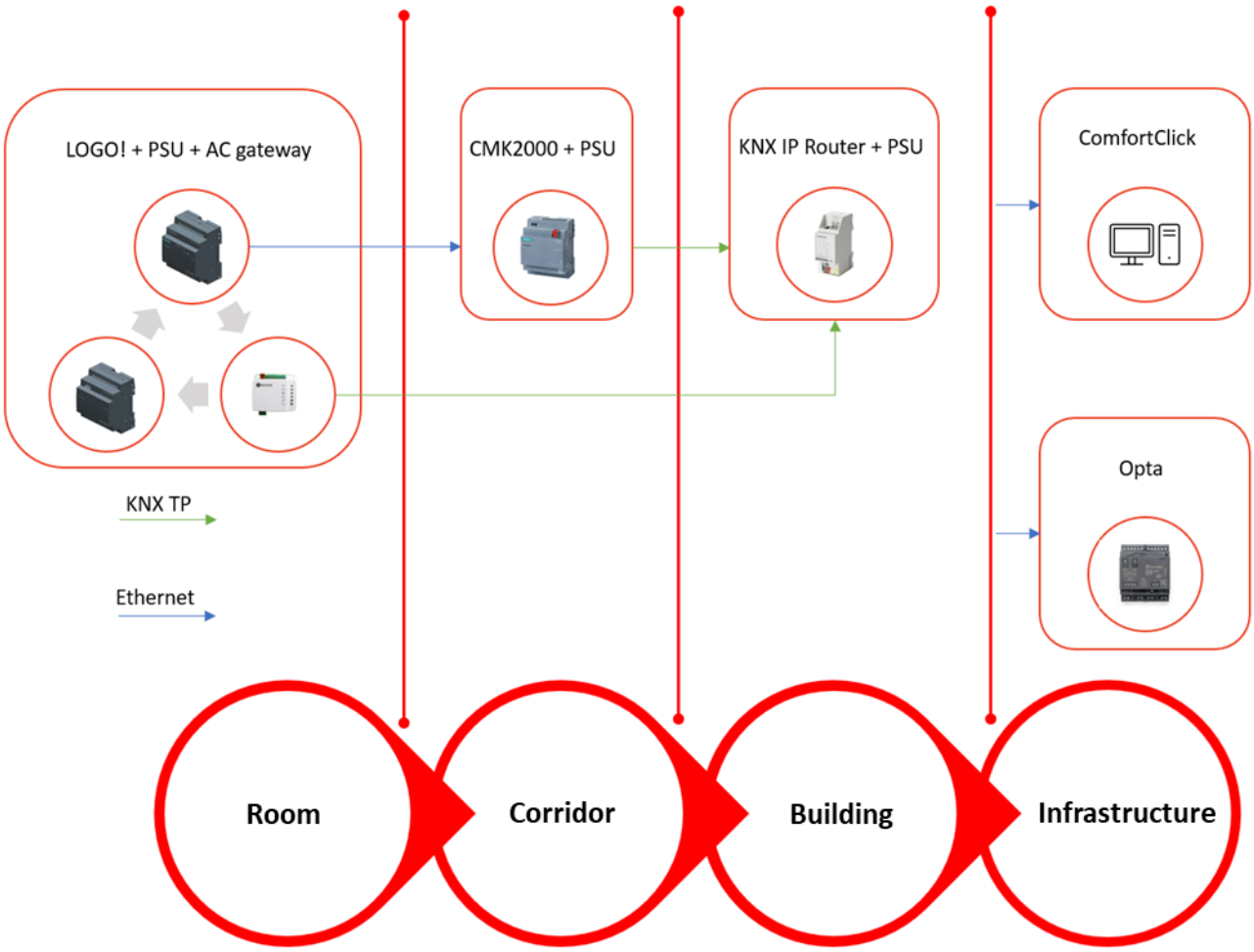
The second type of network is Ethernet. This cabling is part of the hotel's structured cabling and is recommended to be implemented in a separate VLAN. Each LOGO! base module must be connected to the

VLAN with the corresponding CMK2000 gateways and KNX IP Router. Therefore, an ethernet cable must be routed to each room and to the KNX/IP routers in the consumer units of the common areas.

Topology

The below picture shows the system topology. In addition to the materials mentioned in the structured network (ethernet connection), the OPTA licensing device must be connected to the computer / server where the ComfortClick visualization will be installed.

Type	Description
Comfort Click Pro	bOS PRO License (2 users)
OPTA Lite + PSU	PLC for licensing of the project.



Chameleon HaaS

Design principles/Advantages

The design of the **Chameleon HaaS** system is based on the following principles:

Autonomous room

All room functions, such as occupancy detection, AC unit control, lighting control and scene activation (both “Guest in” and “Guest out”, as well as scenes from push buttons) are implemented on room devices (LOGO! and AC gateway).
Failure of one device is equivalent to the loss of only one room, which even applies to the power supply of the devices.

Differentiation between FoH and BoH functions

In guest room automation design, a careful separation between functions that are perceived by the guest (Front of House/FoH) and functions that are perceived by hotel staff (Back of House/BoH) is formulated.

The system ensures to the maximum extent possible, that there will be no failure in any function that is FoH, as the customer experience directly depends on them. A failure in BoH operation should be avoided but does not affect the customer's stay.

FoH functions

- Local control of AC unit, lighting and scene activation
- Occupancy detection and scene activation based on room state (Welcome Guest, Guest Out)
- Turning the AC unit on or off, when a guest enters or leaves the room

BoH functions

- Automatic pre-cooling/pre-heating of the room when a guest is checked in
- Gradually turning off the AC unit (26 minutes cycle)
- Balcony door functionality

Minimize Single Points of Failure

We define a Single Point of Failure as a point which can disrupt system operation as a whole, or a big part of it. In **Chameleon HaaS** system, all the necessary devices for room operation are part of the guest room automation system and are installed in the consumer unit of the room. Only the connection between the AC unit gateway is implemented through CMK2000, which assumes the communication for five rooms. This, however, does not constitute as a Single Point of Failure, because LOGO! base module monitors the status of the connection with CMK2000 in real time and activates a failsafe action to ensure normal execution of every Front of House function.

Minimize mean down time

The time to repair a system malfunction can be divided in three stages, all of which can be added to give us the total time to repair the failure

- **MTTD** (Mean Time To Discover a failure) is defined as the time required to discover the existence of a failure. In the case of **Chameleon HaaS**, this time is zero since all system devices are monitored for faults in real time.
- **MTTI** (Mean Time To Identify a failure) is defined as the time required to recognize the existence of a failure. This time is also zero since a notification will inform the hotel staff for unit failures and there will be a specific error code in case of AC unit malfunction.
- **MTTR** (Mean Time To Repair a failure) is defined as the time required to repair the failure. In the case of a FoH failure, this time is very short and does require the involvement of the system integrator. To πρόγραμμα του LOGO! αποθηκεύεται σε κάρτα SD εντός του. The program of LOGO! is stored on an SD card. In case of failure, a new LOGO! unit is wired from the hotel's maintenance team and the new LOGO! can be fully programmed by inserting the SD card and resetting the voltage.

Low Total Cost of Ownership

The total cost for a hotel automation system comprises of the initial investment cost and the cost of operation/maintenance during the unit's lice cycle.

Chameleon HaaS has a low initial investment cost compared to other KNX implementations, because:

- The heart of the system is the LOGO! base module which allows for a powerful implementation with extensive functionality and is cost effective compared to a classic KNX system design
- Occupancy detection algorithm is implemented entirely inside LOGO! base module, allowing use of conventional presence detectors instead of KNX system devices, which are more expensive and more difficult for maintenance and system management
- It uses conventional push button switches instead of KNX switches which have an increased cost of ownership. It is worth noting that the use of conventional switches offers freedom in choosing the design of the switch, according to the preferences of the architect and the owner and disconnects the offered functionality of the system from the aesthetic choice of the switch material.

Chameleon HaaS offers low cost of operation and maintenance because:

- The electronic units that make it up are not exposed to wear and tear due to use by the visitor
- Minimization of the number of electronic units that make up the automation system, which reduces the cost of peripheral components for the system topology
- Fault recovery for LOGO ! modules , switches and monitors require no additional maintenance costs for their reprogramming and commissioning