

Self-Check-In Hotels Using RFID Technology

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I. The Need

More and more travelers are booking their entire trip online to be in total control of air travel, hotel accommodations, rental cars, etc. Not only does online booking allow for optimized travel prices for the customer, it allows the customer to be self-sufficient with no need to rely on travel agents, phone operators, etc. In response to this shift, the travel and hospitality industries have begun to automate many of their processes in order to cut costs and become less intrusive in their customers' travels. For example, some companies in the rental car industry have gone as far as to allow their membership customers to arrive at the rental car lot, choose any car in a select group of vehicles, and immediately leave the lot. This method has been very popular with customers because it allows the customer to bypass the wait in line at the check-in desk and even gives them a variety of vehicles to choose from instead of being assigned a single vehicle model. The next logical step is to implement a system like this into the hospitality industry.

While making hotel reservations online has been around for some time, self-check-in at hotels is still a relatively new concept. Currently, some hotels have implemented self-check-in kiosks where the customer uses a computer kiosk in the hotel lobby to have a room assigned and receive a keycard rather than using a front desk clerk. This has been proven as a rather successful system, but there is still more convenience to be had to truly attract today's travelers.

II. The Solution

A hotel would implement a self-check-in system using a new or existing membership rewards program. Each member will receive a membership card with an

RFID tag embedded in the card. When the member goes online to book a trip, they will make a hotel reservation and choose the self-check-in option, if they wish. When the customer arrives at the hotel on the day their reservation begins, they will proceed to a designated section or floor where the rooms are dedicated to the self-check-in service. The customer will proceed to any vacant room they desire and wave their membership card in front of the door lock equipped with an RFID reader. The reader will cross-check the membership number with the hotel's reservation system to verify the reservation. When the reader verifies this information, it will unlock the door and will continue to unlock the door with this membership card for the length of the customer's reservation. There is no waiting in line, no staff interaction, and no computer kiosks. The customer goes straight from their car to their room in the quickest, most convenient way possible.

III. The RFID Tag

To implement the system, membership cards must be produced with an embedded RFID tag to act as the member's personal room key. Each member will be assigned a unique ID number that will be the only information stored in the RFID tag. Consequently, a passive embedded tag would be used since the card will require only a minimal amount of memory and require none of the "smart" features of an active tag.

The card will be compliant with the ISO 14443 Type A standard operating at 13.56MHz. The Type A standard was chosen because it is most commonly used for public RFID programs and has been extensively evaluated for public use. Part 1 of the standard defines the size and physical characteristics of the card. The size of the membership card will be the common credit card form factor defined by ISO 7810 ID-1,

namely 85.60×53.98 mm, in order not to inconvenience the user. Part 1 also defines the environmental conditions the card must be capable of working in. For example, the card must be capable of operating in a temperature region of 0° - 50° C. Part 2 of the standard defines the radio-frequency power and signal interface. The tag is capable of transmitting at 106 kbit per second in both directions, which is more than adequate for the very small amount of information required to be transferred from the room key. Part 3 defines the initialization and anti-collision protocols for both Type A and B. Part 4 defines the high-level data transmission protocols.

RFID cards manufactured to ISO 14443 specifications are typically low cost. One technology, MIFARE®, is very applicable to the self-check-in hotel concept because of its wide-spread public use today, particularly in public transit where it is used in 80% of the market.¹ Because of this large-scale production, card costs are very low and the technology is known to be reliable. The MIFARE Mini card is a perfect choice for the self-check-in membership card because it is tailored to applications that need only small memory size. It features 320 bytes of electrically-eraseable programmable read-only memory (EEPROM) and a data retention period of 10 years. The embedded RFID tag itself consists of a MF1 IC S20 chip module mass-produced by NXP Semiconductor with a 4-turn wire coil antenna looped about the perimeter of the card. MIFARE Mini RFID cards can be purchased for as low as

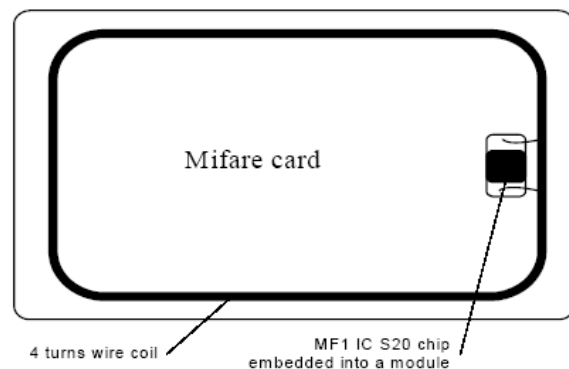


Figure 1. MIFARE Mini RFID card internal layout (© NXP Semiconductors)

¹ <http://www.mifare.net/about/>

approximately 0.36 USD at a volume of 200,000, with the potential for even lower costs at higher volumes.²

IV. The RFID Reader

The RFID reader must be capable of three main functions for this particular self-check-in concept. First, the reader must be capable of reading tags defined by the ISO 14443 Type A specification. Second, the reader must communicate to the room's door lock to unlock the door when approval is given. Third, the reader must be capable of conversing with the hotel's reservations system.

While there are many RF door locks on the market today, there are very few that actually meet these three requirements and are of upscale hotel quality. The difficulty is not in meeting the first two requirements but the third requirement. Most RF door locks for the hospitality industry are made to be reprogrammed using a hand-held encoder. This means they must be manually reprogrammed with this encoder each time you want the door lock to recognize a different tag as the key. This is fine for the kiosk-style self-check-in where rooms are assigned and RF key cards encoded appropriately to the assigned room. But, this is not an efficient system for the concept at hand.

There is one company that is making an RF door lock for the hospitality industry that is capable of being reprogrammed remotely. The Quantum RFID™ by Saflok coupled with Safelok's Messenger™ wireless communications system meets all three of the requirements and provides a great foundation to expand upon. The RF reader is capable of reading ISO 14443 tags and unlocking the door when the appropriate key is recognized. The Messenger system allows for communication between the RF reader and

² MIFARE Mini pricing- <http://www.smartcardworld.com/mifaremini.htm>

the hotel's central operating hub. Messenger can remotely activate and cancel key authorizations, report door lock usage statistics, locate what rooms staff are in, and a variety of other beneficial information. The door lock also comes in a variety of styles and finishes to fit the hotel's current design scheme. In addition to all these features, the lock and the Messenger system are built with open architecture, allowing third parties to design custom software or hardware to further optimize the system for the particular application.



Figure 2. Quantum RF door lock by Saflok. (© Saflok)

Another feature that will be useful for the self-check-in concept is a small light panel on the outside of the door to inform the new guest whether the room is vacant or occupied. This could be a simple, two-node LED panel with a green light that is lit when the room is vacant and a red light for when the room is occupied. The current Quantum hardware does not offer this feature, but it is something that should be easily configurable due to the open architecture of the Quantum hardware.

To keep the RF readers small and energy efficient, the readers will only be required to perform the following tasks:

- Provide the inductive coupling to the RF membership card.
- Query the middleware regarding a new membership card being used.
- Unlock the door when the appropriate card is used.
- Power the LED panel regarding occupancy of the room.
- Report low battery warnings

These five tasks should keep the reader hardware relatively simple and compact, which is necessary for an aesthetically-pleasing door lock in the hotel industry.

V. Middleware

The next critical item in the concept would be the implementation of software to allow for the remote query of the door locks to verify reservations in the hotel's reservation system. The customer will make their hotel reservations online, and the reservation information will be sent and stored to the individual hotel's reservation system. When the guest arrives and chooses a self-check-in room, the RF reader must be capable of instantly cross-checking the guest's customer ID number with the reservation system and promptly allowing entry into the room upon verification.

While some RF hotel door lock companies offer software for use with their door locks, none offer quite the type of software applicable to this concept. Saflok does offer their System 6000™ software to monitor a hotel's network of door locks, encode key cards, etc., but it does not provide quite the same function required in this particular application. Despite this, the reason the Saflok hardware and software was chosen was because of its open architecture to allow for the custom application needed here.

The middleware will be tasked with the memory- and power-intensive jobs required of the system, allowing the RF readers on the door locks to remain small and energy efficient as outlined in the previous section. The easiest implementation of middleware would be to create a stand-alone program that queries the existing reservations system and controls and performs audits on the network of RF door locks. This program should therefore be capable of performing the following operations:

- Receive keycard queries from multiple door locks to verify reservations.
- Query the reservations system to cross-check customer ID numbers with existing reservations.
- Write to the reservations system to log check-in time, room number, etc., to the new guest's account.
- Communicate back to the RF door locks to either grant or deny access to the room.
- Encode the RF door lock to accept the guest's customer ID card.
- Monitor reservation periods and re-encode RF door locks once a guest's reserved stay has completed.

Additionally, the program could be capable of logging door lock usage data, low battery warnings, whether staff are in the room, and other general audit data.

VI. Security Issues

Security concerns are kept to a minimum because of the negligible information stored on the card. The fact that only the member's ID number is present on the RFID tag means no personal information can be stolen. The ID number cannot be used by itself except to open an already-reserved room. But this security risk is no different than if someone were to steal a normal room key. The ID cannot be used to make reservations or access personal information online because, like all membership programs, a password is required to access the user's account.

The main security concern with RF tags is that a thief with an RF reader can read the membership card and then replicate the signal the tag emits to open the reserved room.

This scheme is limited by the short distance the tag is able to be read, approximately 10cm. The MIFARE-type cards have a good level of embedded security, including:

- Mutual challenge and response authentication (three pass) per ISO/IEC DIS 979802
- Data encryption on RF channel with replay attack protection
- Individual set of two keys per sector (per application) to support multi-application with key hierarchy
- Unique serial number for each device

These security features seek to prevent simple, fraudulent reads. Also, the thief must know which room the member is staying in since the room number is not memorized by the membership card. If a thief is willing to go to such lengths to get into a member's room, they will always find a way to enter the room whether or not they can crack the built-in security features of the MIFARE Mini card. Therefore, it does not appear to be financially worthwhile to invest in RFID cards that have additional security features if only the membership ID number is stored on the card.

VII. Difficulties

As with the implementation of any new system, there are some inherent difficulties. Some of these difficulties include:

- 1) introduction of a new membership program
- 2) developing the appropriate middleware program
- 3) installing the new RFID hardware
- 4) educating staff and customers as to how the system works

The introduction of a new membership program will involve updating the hotel's website to discuss the benefits of the new program, purchase the MIFARE Mini membership cards to distribute to new members, and even creating a new marketing campaign.

New middleware development will be the most time-consuming operation in the system's implementation. Working with a third-party middleware developer, the hotel managers will have to decide which features, discussed previously, they would like to implement into the system. The program will also have to be configured to operate with a hotel's existing reservations system. Much time will need to be allotted to prototype testing and debugging before the system could be fully operational. Thanks to the open architecture of the Saflok products, the middleware development time will be drastically reduced compared to if the middleware programmers had to determine the reader's controls themselves.

Installation of the new hardware would probably require the most capital investment next to the middleware development. Hotels slated to receive the system would need to determine how many rooms they would devote to self-check-in. The actual installation of the RF door locks should not pose a major problem. The locks themselves follow an industry standard, and the RF reader will require only minimal modifications to the door and can be installed without the door being removed. Not only will RF door locks need to be installed, but a hotel's wireless network capacity may need to be increased depending on the number of RF door locks installed. Additionally, a computer server would most likely need to be dedicated to the operation of the middleware.

Educating the staff on the use of the system would take time but should not be too difficult. For the most part, the staff would not play a part in the system except to help customers with questions or to troubleshoot problems. Most likely, a hotel would train just a few employees in the use of the system to create specialists since heavy staff involvement is not required. Additionally, signs would need to be created and posted to inform self-check-in customers where to proceed upon entry into the hotel to find the self-check-in rooms.

VIII. Other Possible Implementations

Although they are beyond the scope of this report, other areas within the hotel that could be used with these RF membership cards are:

- Access to guest amenities like the pool and gym
- Charging the room for guest services like restaurants, gift shops, and massages
- Access to the hotel's parking garage
- A kiosk could be set up where the member can wave their card in front of a reader to let the hotel know they would like their room cleaned.

These additional ideas could be implemented into the middleware program, as well, so that a complete redesign of the hotel's network software is not required to gain the benefits of these features.

IX. Conclusion

Today, the idea of self-check-in hotel rooms is becoming a reality through the use of check-in kiosks at select hotels. But today's travelers are looking for even more efficient ways to travel and methods to reduce wait time everywhere they go. The next step in self-check-in hotels is to allow the guest to proceed straight from the curb to their room with no staff or computer interface required. The idea of using RF door locks tied wirelessly to middleware developed to interact with a hotel's existing reservation system means that with a very cheap membership card embedded with a passive RF chip, a guest could achieve the most efficient hotel check-in in the hospitality industry to date. If travelers know of a certain hotel where they can do all the check-in work before they travel, that hotel can be sure to see an increase in its customer base as word of the new system spreads.

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