IT-Based Safety and Security Solutions for Schools

● Atsushi Horiguchi ● Kazuhisa Shibafuji ● Kenichi Ota

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The number of violent crimes against children has increased in recent years. Various measures have been taken by schools and communities, for example, the deployment of security sensors, surveillance cameras, guards, and local residents' patrols; however, these measures have not been very effective. The key to protecting children is being able to quickly locate them. School administrators at least need to know the arrival and departure times of their students. In addition, rapid transmission of information about local areas, for example, the sighting of suspicious persons, and other messages from schools has become more important for ensuring a safe social environment. The demand for IT-based support for safety and security in society will continue to grow. This paper outlines the Students' Arrival/Departure Notification Service, which is based on radio frequency identification (RFID) tags, and the School Communication Network Service, which is based on E-mail. It also describes how these services, which are currently available only in Japan, have been developed.

1. Introduction

According to a report by the National Police Agency in Japan, the number of crimes that occurred at schools increased from 41 797 in 2001 to 46 723 in 2003, indicating a growth rate as high as 12%. This increase is expected to continue.[1)]

Particularly, several violent crimes against children, including fatal attacks have increased the demands for safety and security measures both inside and outside schools.

Many kinds of measures have been taken, for example, guards posted on school grounds, monitoring of unauthorized entry by infrared sensors, and surveillance cameras.

Accurate knowledge of the arrival and departure times of students and emergency communications with parents are crucial to preventing and responding to incidents. Currently, school staff meet these requirements through visual checks and telephone communication.

However, the Act on the Protection of Personal Information went into effect in April 2005, and as a result, parents' telephone numbers and E-mail addresses are now regarded as personal information under the law and it has become difficult to implement traditional telephone-contact networks.

Therefore, to ensure efficient school operations and safety and security for parents,[2)] we have developed two types of services, and these services are already in operation. The services are the Students' Arrival/Departure Notification Service,[3)] which uses active radio frequency identification (RFID) tags, and the School Communication Network Service,[4)] which sends E-mail notifications to parents.

This paper describes how these services were developed and gives an overview of them.

2. How the services were developed

With the recent increase of fatal attacks

inside and outside of schools, it has become a big challenge to protect children commuting to and from school. One of the most important operations for school administrators is the monitoring of their students' arrivals and departures.

A sign that parents are more anxious about their children's secure arrival and departure is the greater number of inquiries they make to schools. These days, school staff have to spend a lot of time answering phone calls from worried parents.

Since the enactment of the Act on the Protection of Personal Information, some parents have refused to make their phone numbers known to school staff. This causes various problems, for example, it takes a long time for schools to send information to every parent and information becomes inaccurate as it is passed between parents who cannot be directly contacted.

It also takes a long time for the boards of education of local governments to distribute information to schools and parents under their jurisdiction because of their hierarchical structures.

Against this background, the demand for rapid and accurate information distribution has increased.

We interviewed parents and school staff on many occasions and found they have three main requests:

1) Teachers want to reduce administrative work and concentrate on children's education as much as possible.
2) Administrators want to monitor students' arrival and departure times at the school gate. They also want to be able to send messages to parents and confirm they have received the messages.
3) Parents want to know their children's arrival and departure times in real-time.

Usually, school staff members are busy and do not have much time to spend on system administration work. Installing a new system places a heavy workload on school staff. Also, it is necessary to provide installation spaces for equipment and train system operators, so there is a delay between installation and operation.

3. Features of services

The Students' Arrival/Departure Notification Service and the School Communication Network Service have the following features.

3.1 Students' Arrival/Departure Notification Service

1) In this service, active RFID tags are attached to students' bags or other personal items. The students can then be detected by the RFID reader just by walking past it without making physical contact.
2) The RFID reader can detect multiple students with tags simultaneously.
3) School staff can easily rewrite the ID information in cases of lost RFID tags and student transfers.
4) The tags use a readily available battery that has a 12-month life and can easily be replaced at home.
5) The RFID tags contain no information about the students. Therefore, lost or stolen tags do not represent a security threat.
6) Parents can check their children's arrival and departure times using a Website and E-mail.

3.2 School Communication Network Service

1) School staff can distribute information simultaneously to every parent.
2) Information distribution via E-mail speeds up communication.
3) Because message reception can be confirmed with reply E-mails, school staff can determine which parents have not received or read a message.
4) Information distribution via E-mail enables communications to be handled by all mobile carriers.
5) Messages can be sent from not only an administrator's PC but also a mobile phone.

Both services can be provided via an application service provider (ASP), which allows users to reduce their system administration load.

4. Students' Arrival/Departure Notification Service

In the Students' Arrival/Departure Notification Service, students carry active RFID tags to record the exact time when they enter and exit the school gate and a camera takes video images of them. Parents can receive the arrival and departure information for their children via E-mail (**Figure 1**).

The service is outlined below.

1) RFID tag selection

RFID is the generic name for wireless data identification technology. It can identify information about a person or object without the need for physical contact. Systems that use RFID tags consist of a tag that can store electronic information and a reader that can read and write information from and to the tags. Each RFID tag has a memory chip and a small built-in antenna for exchanging information with the reader.

The communication range of an RFID tag system depends on the type of system and the operating frequency (**Table 1**).

There are two types of RFID tags: passive and active.

Passive RFID tags obtain their electrical power from the radio waves transmitted from the reader.

Active RFID tags obtain their electrical power from a built-in battery. Passive RFID tags have a short communication range and therefore need to be held close to the reader to be scanned. Active RFID tags, on the other hand, have a communication range of up to 10 m (**Figure 2**).

We selected active RFID tags because 1) we considered that if students had to bring their tags

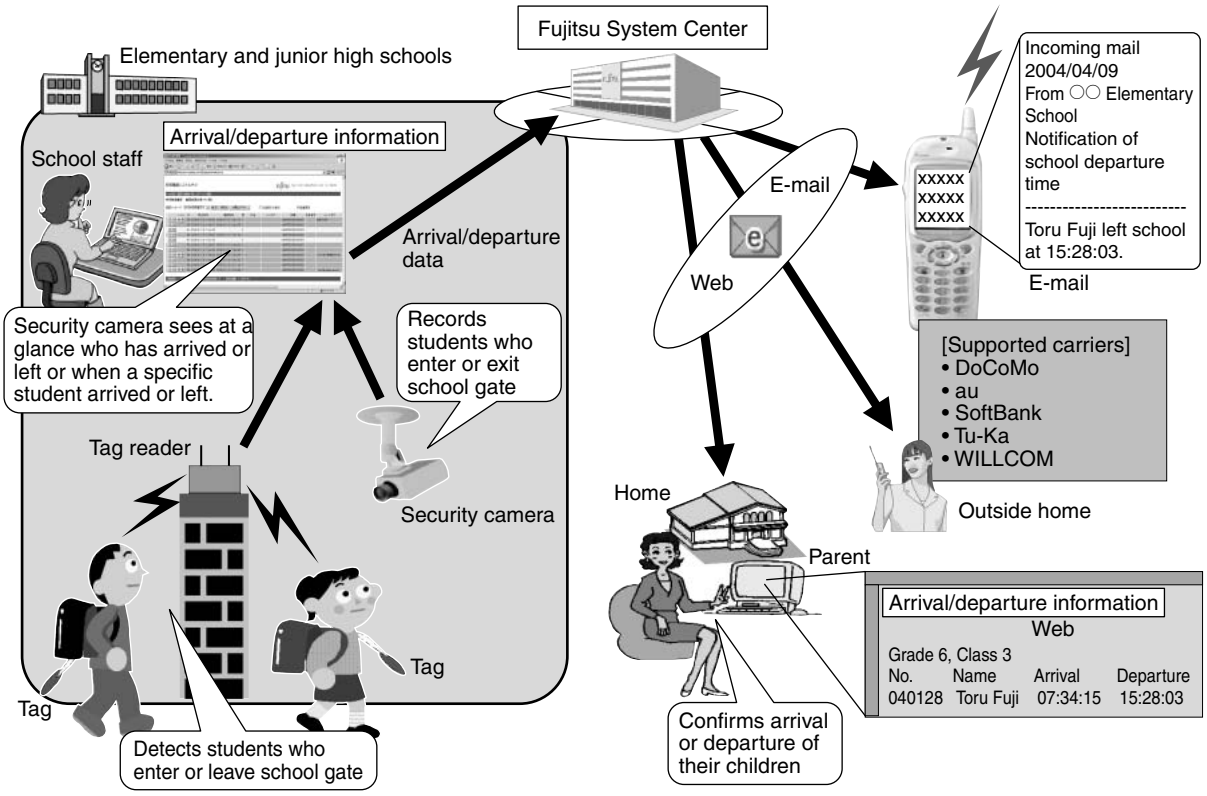

Figure 1
Overview of Students' Arrival/Departure Notification Service.

Table 1
RFID tag features.

Frequency band	135 kHz or lower	13.56 MHz	300/400 MHz	800/900 MHz	2.45 GHz
Communication type	Electromagnetic induction			Radio wave	
Communication range	Several cm	70 cm	15 m	8 m	2 m
Characteristics	No battery required but shorter communication range	No battery required but shorter communication range	400 MHz system operates in ham radio band	3 m or less according to restriction to be established	Interferes with wireless LANs
Remarks	Shorter communication range but transmission pattern is omnidirectional. Great flexibility in tag shape.			Longer communication range	

Band adopted

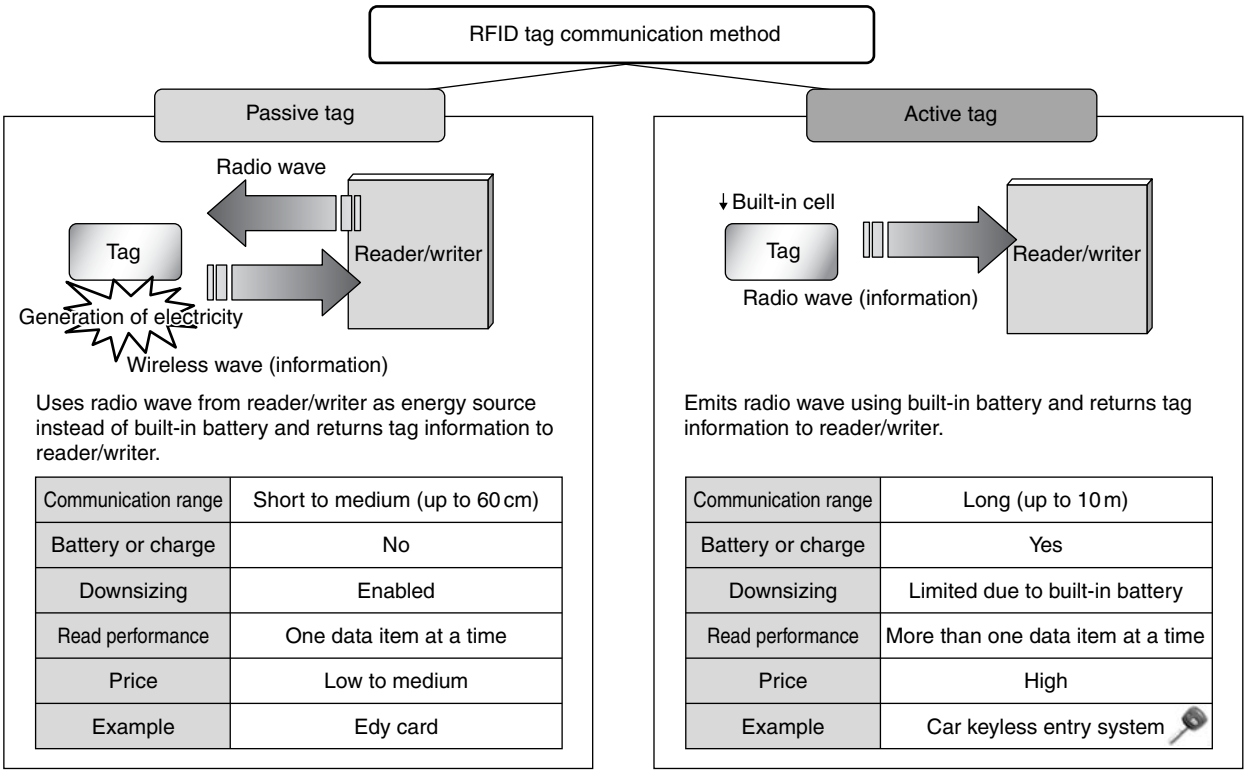

Figure 2
Passive and active tags.

close to the reader, they would regard it as an imposition, which would be detrimental to their education, and 2) it is necessary to be able to simultaneously scan multiple students with unpredictable movements.

2) Radio communication method

Before implementing active RFID tags, we examined which was the most appropriate radio communication method for detecting the arrivals and departures of multiple students passing through a school gate. Active RFID tags use one of two modulation methods: frequency shift keying (FSK) or amplitude shift keying (ASK). While the FSK method has the advantages of good noise immunity, stable operation, and a predictable battery life, it has the disadvantage of high power consumption. The ASK method has a long battery life but poor noise immunity and an unpredictable battery life because its radio output power gradually decreases.

The tag batteries must provide stable operation for more than a year because most schools have yearly entrance and graduation ceremonies and class recompositions. Therefore, the ASK method was selected. This method is more suitable for capturing students' movements because it performs communications between the reader and tags more frequently. However, this shorter interval reduces the battery life and also places a heavier ID recognition load on the system. On the other hand, if the communication interval is too long, the system might not be able to capture the students' movements, especially if they are running. Consequently, we chose an optimum communication interval based on the results of demonstration experiments.

3) Antenna installation

The weak radio signals from the students' tags are directional due to the students' bodies. In addition, because 20 to 30 students might consecutively or concurrently pass through the school gate, the reader's antennas must be able to receive radio waves from all directions. The frames of school gates were investigated, and experiments were conducted to determine the optimum locations for antennas. Preliminary surveys are needed before installing the antennas because the installation conditions differ from school to school.

The system is designed so it can detect 50 tags per second. We chose this level of performance after carefully considering the antennas, readers, and mode of use based on several in-depth preliminary surveys.

4) Notification to parents

When students carrying RFID tags pass through a school gate with a reader, the information is reported to parents using E-mail. This information can be confirmed on a Website. Parents can access the Website with an ID and password to confirm the arrival and departure times of their children.

Parents can specify up to three E-mail addresses to which information is sent and change them as required on the Website. This arrangement reduces the burden on school staff because it would be difficult for them to quickly update the address database if parents often change their E-mail addresses (e.g., to avoid spam). However, because the staff do not manage parents' E-mail addresses, the parents must check for undelivered messages based on the send logs on the Website and then correct their E-mail addresses if they are incorrect.

5) Operation management at schools

School staff can check the arrivals and departures of students on the Website. School staff can manually input the arrival times of students who have left their tags at home and send the information to parents using E-mail.

Images taken by security cameras installed at the school gate are accumulated, and the images of several seconds or minutes before the students' arrivals and departures can be displayed for confirmation.

6) Information security

The RFID tags carry no information except a tag ID code, and the codes are matched to

students within the database. The database servers include a mail server and a Web server to assure high security.

Each tag is given a unique ID when it is manufactured, and if students report they have lost their tags, the school staff delete the tags' IDs and give the students new tags.

5. School Communication Network Service

The School Communication Network Service enables E-mail communication between a board of education and a school and between a school and parents as an alternative to telephone communication. This service provides interactive information exchange to confirm the reception of transmitted messages (**Figure 3**).

1) Setting user authorities

There are various levels of user authority, for example, operations manager authority and parent authority. Operations managers manage all the information in the database, but parents can only view their own information.

User authorities can be grouped according to the organization structures of schools and boards of education. For example, a school district, school, grade, class, or club can be selected depending on the information to be distributed.

2) Send operation

Information can be sent using the PC or mobile phone Website (**Figure 4**).

Users can set information using the same procedure as for entering E-mail messages. To avoid misunderstanding about E-mail messages, answer-selection type reply requests can be created.

3) Receipt confirmation with reply E-mail

To confirm message reception, the receivers send a reply E-mail and the administrators manage the reply logs.

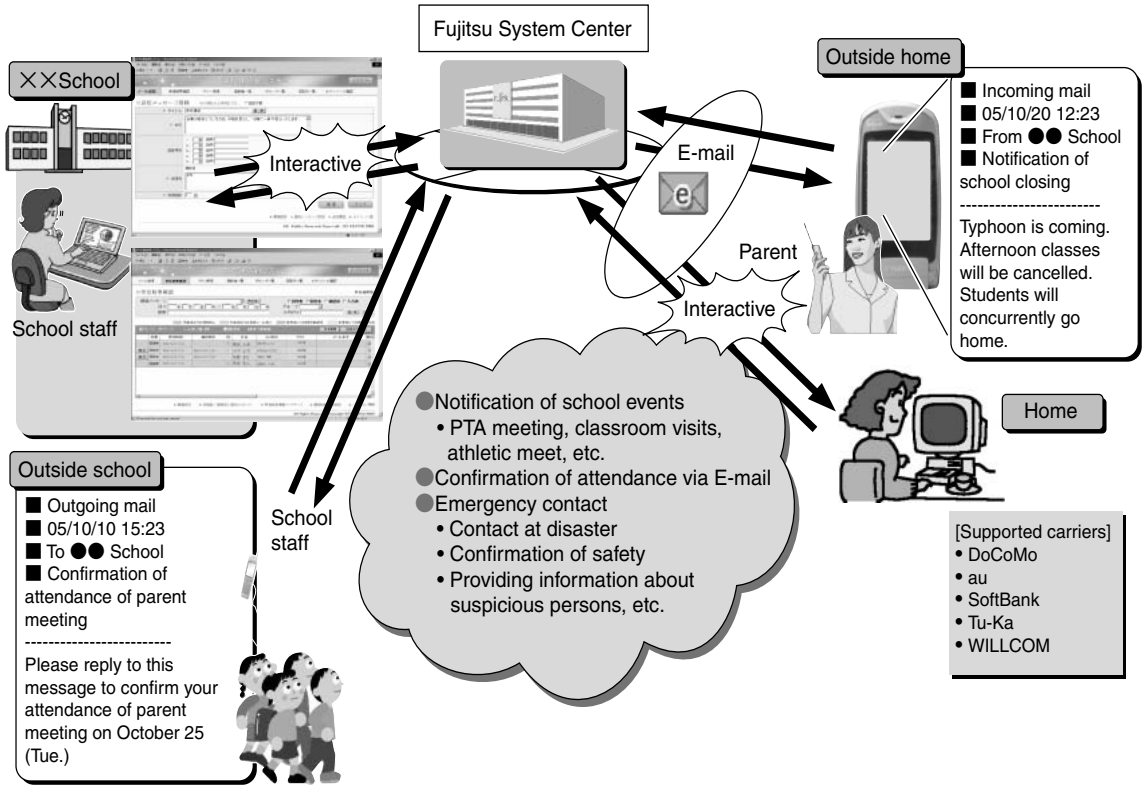

Figure 3
Overview of School Communication Network Service.

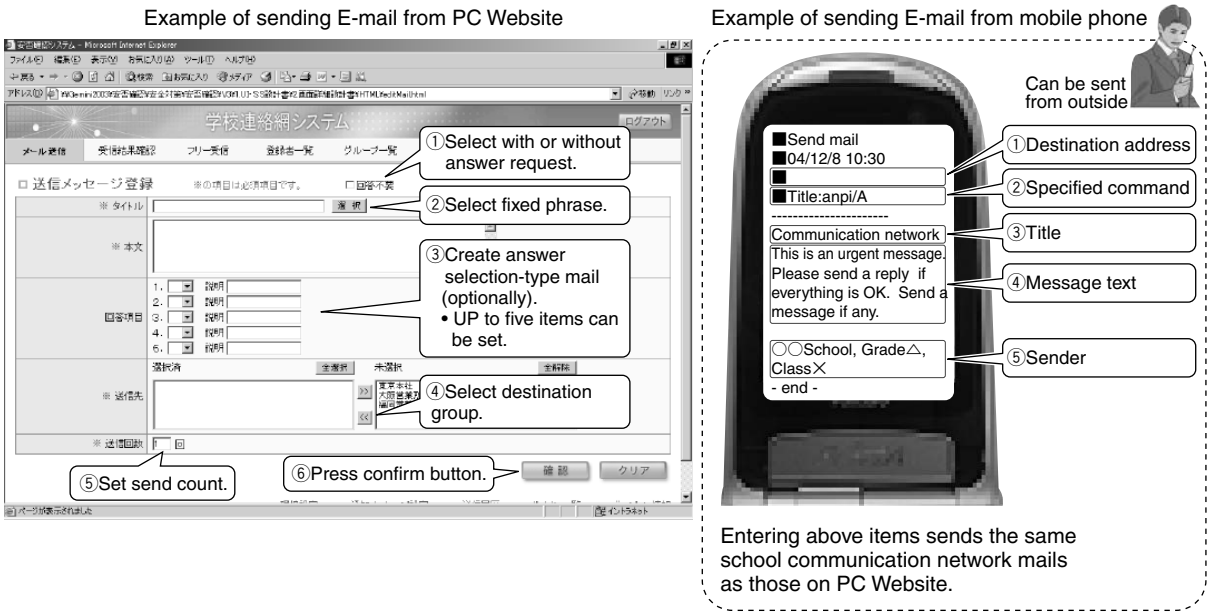

Figure 4
E-mail sending screen of School Communication Network Service.

Because of the possibility of weak signals, non-functioning mobile phones, and changed E-mail addresses, the send logs alone cannot be used to confirm whether a message has been correctly sent and received. Therefore, the users can send a reply E-mail to confirm they have received an E-mail and also answer any questions the administrators may have asked in it.

For example, when a sender distributes a message asking for attendance to a meeting, a receiver can enter text indicting, for example, that the receiver will attend but will be slightly late. This makes it easier for the sender to manage attendance.

Message reception can be confirmed with reply mails on the PC or mobile phone Website (**Figure 5**).

The PC Website displays a color-coded chart that indicates which receivers will attend and also displays the receivers' reply E-mails, which enables rapid confirmation of the communication status. It also provides the aggregate results for answer-selection type E-mails, which reduces the aggregation load.

6. Provision as ASP services and implementation effects

The systems for the Students' Arrival/Departure Notification Service and School Communication Network Service are hosted in the Fujitsu System Centers and are provided as ASP services.

The need to protect personal and administrative information puts a great burden on school operations. Therefore, to ease this burden, the Fujitsu System Centers provide high-security services for managing this information.

In one school, the Students' Arrival/Departure Notification Service has reduced administrative work by about 40 hours a month, and the staff greatly appreciate this improvement in efficiency. Many parents also appreciate the service because it allows them to confirm the arrival and departure times of their children in real time.[5)]

The School Communication Network Service is increasingly being used for regular communication as well as in emergency situations. This service has been effectively used as an applica-

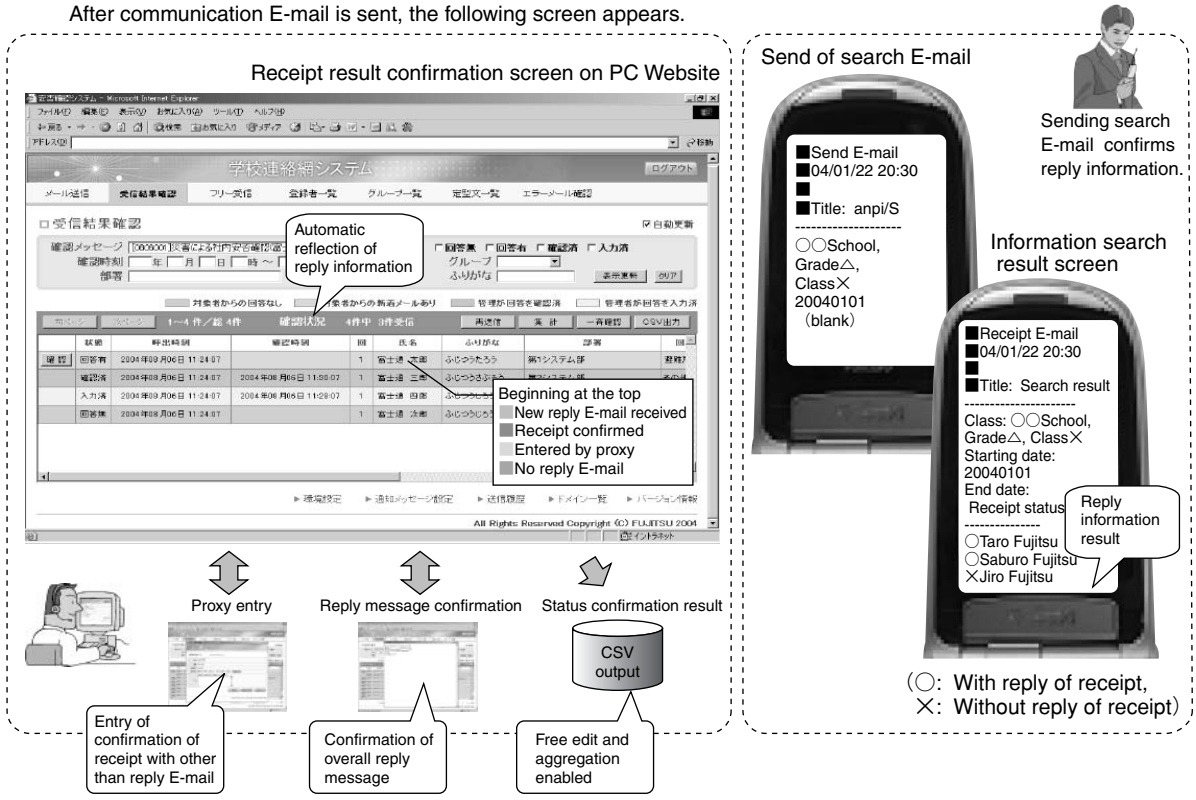

Figure 5
Screen of confirmation by reply E-mail for School Communication Network Service.

tion service for broader purposes.

7. Conclusion

This paper outlined the Students' Arrival/Departure Notification Service for increasing children's safety when they are commuting to and from school and the School Communication Network Service for supporting smooth communication.

In the future, it will be essential to provide these services in conformity with the individual school environments and operation needs and also carefully consider safety and security.

Above all, the key concept of "IT-based support for safety and security" will be further emphasized.

Fujitsu supports various safety solutions other than the services described in this paper. We have provided many of them to clients from different industries and have had many excellent results. Fujitsu will continue to develop its safety and security solutions business as a solution vendor that supports the social infrastructure.

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Atsushi Horiguchi, *Fujitsu Ltd.*
Mr. Horiguchi received the B.E. degree in Architecture from Meiji University in 1991. He joined Fujitsu Ltd. in 1991, where he has been engaged in the planning and development of safety and security solutions.

Kazuhisa Shibafuji, *Fujitsu Ltd.*
Mr. Shibafuji received the B.E. degree in Architecture from Kanagawa University in 1980. He joined Fujitsu Ltd. in 1980, where he has been engaged in the planning and development of safety and security solutions.

Kenichi Ota, *Fujitsu Ltd.*
Mr. Ota received the B.E. degree in Electric Engineering from Tohoku Gakuin University in 1993. He joined Fujitsu Ltd. in 1993, where he has been engaged in the planning and development of safety and security solutions.