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Management of a transhipment terminal supported by ICT systems

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ABSTRACT
Effective functioning of terminals has a significant impact on the entire intermodal transport chain promoted by the European Union. A system for information exchange, circulation and processing, presented by the authors in the paper, is one of factors ensuring a high attractiveness of intermodal shipments, which together with an ITU flow control system will increase the efficiency of a transhipment terminal.

KEYWORDS: Transhipment terminal, DECT, RFID

1. Introduction

Transhipment terminals in transport chains provide space, equipment and the environment ready to move intermodal transport units (ITU – Intermodal Transport Units), between different transport connections. So we can present them as a black box, Fig. 1, to which ITU come by a road vehicle, and after transhipment they leave the terminal on freight cars formed in a train or, vice versa, units arrive at the terminal by rail and after the terminal handling they leave on road vehicles. Such presentation of an ITU stream introduces a need to implement a system for information exchange, circulation and processing, which together with a system of units flow control will enable increasing the efficiency of a land terminal in intermodal transport chains [3].

The increase in the efficiency of a transhipment terminal operation to a significant extent results from an ITUs flow control system, Fig. 2, and from a system for information exchange and processing. Systems presented by the authors in the paper will substantially improve operations of ITUs planning and deployment, which so far been have carried out in the form of labour-intensive documents – manually, which was observed during studies on actual facilities.

Fig. 1. (JTI/ITUs/ – Intermodal Transport Units) at the input and output of a transhipment terminal [3]

2. System for information exchange and processing

An effective system for information exchange in transhipment terminals must meet the following conditions:

1. Provide continuous communication in the area of terminal;
2. Allow a cumulative digital communication of short information packages from any object located within the terminal;
3. A selective bidirectional contact with external users should be possible, both for communication and in the form of short messages from any external system;
4. The information exchanged in the communication system should be protected from access by unauthorized persons;
5. A wireless communication system should be used, adapted to specific conditions of the land terminal.

As a result of the analysis it has been stated that the above requirements can be best met by two systems: a system of automatic identification – RFID and a wireless communication system – DECT.

We have analysed many aspects relating to RFID and DECT systems [1]: a standard architecture of systems, their characteristics, we have analysed the specific site for the propagation of electromagnetic waves, the way of collecting information about units, telecommunications traffic, as well as what operational possibilities they create [2, 6]. To this end, for the proposed system, it was necessary to develop a design of base stations deployment (RFP), that will form radio cells for the purpose of wireless communication, so as to provide coverage of the entire land terminal area, Fig. 2. For this purpose a multifunction device has been used, converting RFP signals to signals of WLAN and DECT interface. The yard employees will be equipped with handheld readers that enable reading and sending data to compatible RFID tags, while mobile devices operating within the land terminal will be equipped with stationary readers, Fig. 3. All the information on ITUs goes to the data processing system, which is integrated with the radio network. It will enable an easy management of the warehouse (storage yard) via an unrestricted access of employees to data on ITUs, an optimal use of the storage area, optimisation of sectors loading in terms of ITUs availability, ITU type, operators and dispatchers productivity.

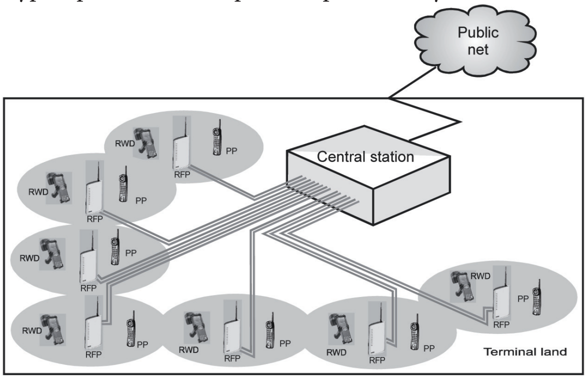

Fig. 2. Implementation of a DECT, RFID system in a land terminal [own work]

Fig. 3. Idea of communication in a land terminal [own work]

Another important issue, determining the efficiency of processes within the land terminal, was the adaptation of digital DECT wireless telephone system, as mentioned earlier [4]. As the communication system is not the main problem, the paper comprises a simulation only for its selected part. It is based on the examination of the quality of the radio transmission between the base station and a mobile station (PP). The bit error rate (BER) of the data transmission was adopted as a quality criterion.

The simulation was carried for three options:

- a mobile station is located inside a building.
- a mobile station is located outside a building.
- a mobile station is located outside a building and moves at an average speed of 20km / h.

Relationships obtained are shown in Fig. 4, Fig. 5

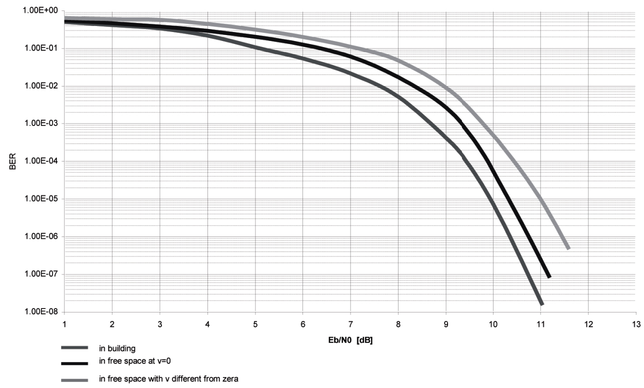

Fig. 4. BER versus E_b / N_0 [5]

The results obtained comply with the DECT standard, hence the authors conclude that the pre-designed communication system will operate according to the assumptions and will provide a full mobility of workers by reducing the response time, at the same time increasing productivity, reducing costs and increasing revenues of the transhipment terminal.

Simulation studies were conducted for a transhipment terminal with parameters of a real facility and after the implementation of RFID technology. At one service station operating in the tested terminal during 8 hours of work, the queue of ITUs waiting for service increases, Fig. 7; the station utilization rate is as high as 95%, Fig. 6. At such rate the station is very loaded.

As a result of observations and simulations of a real facility and of subsequent analysis a question arises, how the considered terminals will cope when the intensity flow will increase in line with expectations, as it was in the period before Poland's accession to the EU. At that time terminals in our country faced the necessity to receive a much larger number of inflowing ITUs. Queues in front of them were growing at an alarming rate, in other words there was confusion, which ITUs should be accepted – from the road or rail part, where they are on the yard, etc. Using the hitherto service technology of road ITUs it was necessary to increase the number of service stations.

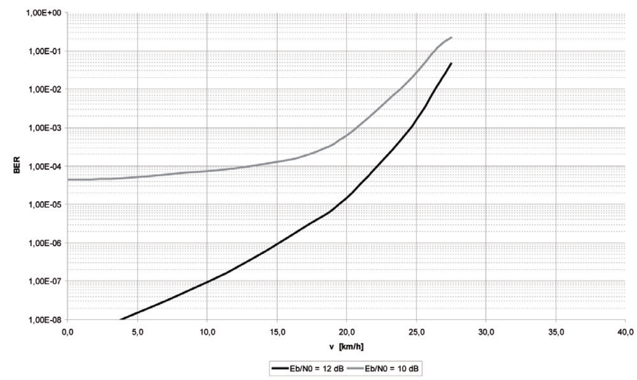

Fig. 5. BER versus the mobile station speed [5]

2.1 Simulation of the road part of transhipment terminal (studies on a real facility)

significant service time savings and the improvement in the ITUs identification result from the implementation of RFID in the transhipment terminal, the station utilization rate is 4%, Fig. 8 There is a very large reserve before it approaches the value of 1. Such a low rate eliminates the increase in the queue and the time spent by ITUs waiting for service, Fig. 9.

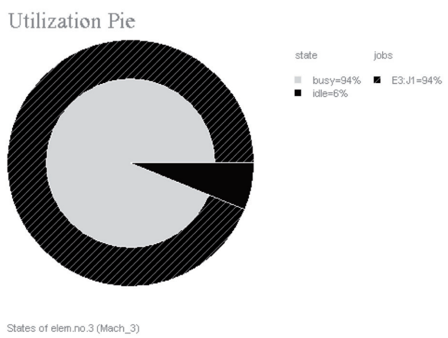

Fig. 6. Service station utilisation

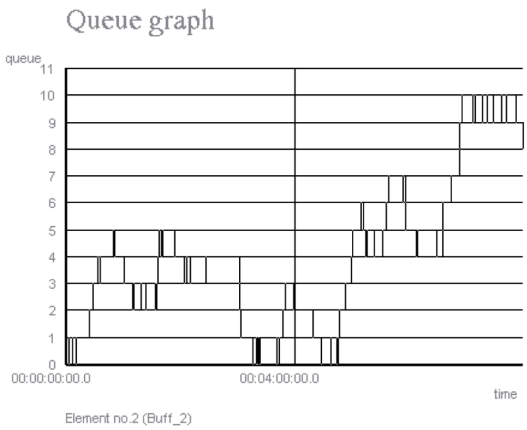

Fig. 7. Queue of ITUs arriving at the transhipment terminal

2.2 Simulation of the road part of transhipment terminal, RFID technology

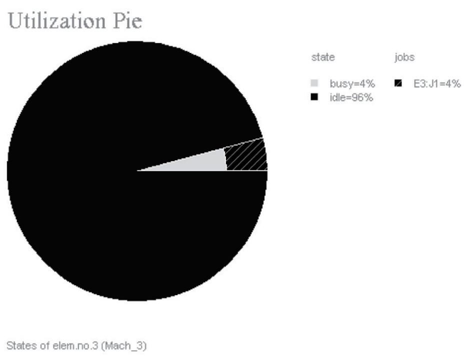

Fig. 8. Service station utilisation

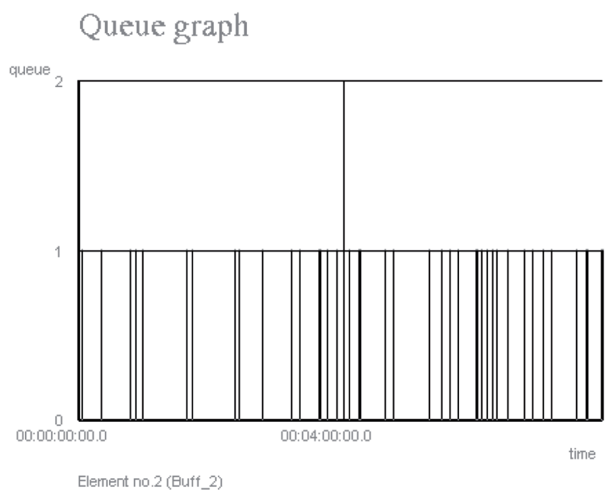

Fig.9. Queue of ITUs arriving at the terminal waiting area

3. Conclusions

Effective functioning of transhipment terminals has a significant impact on the entire intermodal transport chain promoted by the European Union. A system for information exchange, circulation and processing, presented by the authors in the paper, is one of factors ensuring a high attractiveness of intermodal shipments, which together with an ITU flow control system will increase the efficiency of a transhipment terminal.

The obtained results of authors' considerations in the paper, based on the current assessment of the transhipment terminal operation, Fig. 6 and Fig. 7, at simultaneous implementation of an ICT structure, provide an evidence of the proposed system rightness, because:

1. an efficient system of DECT and RFID information exchange and processing in a transhipment terminal has been proposed, which will allow to solve decision problems, as well as will streamline the ITUs flow through the terminal;
2. a computer implementation has been carried out, which is limited only to the transmission from the transmitter to the receiver in order to verify correct operation of the proposed DECT system in the transhipment terminal;
3. performed simulations allow assessing the pertinence of all investment decisions related to the RFID implementation in the transhipment terminal.

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