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Identification in the process of flow individuals intermodal transportation in the trans-shipping terminal

Identyfikacja w procesie przepływu jednostek transportu intermodalnego w terminalu przeładunkowym

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Abstract
In the result of the critical analysis execution of functioning trans-shipping terminals in the national forwarding system the identification JTI system was presented. It used to solve decision problems, and also it will improve the processes of the flow JTI through the trans-shipping terminal.

Słowa kluczowe: terminal przeładunkowy, RFID

Abstrakt
W wyniku przeprowadzenia krytycznej analizy funkcjonowania przeładunkowych terminali w krajowym systemie transportowym zaprezentowano system identyfikacji JTI, który pozwali rozwiązać problemy decyzyjne, a także usprawni procesy przepływu JTI przez terminal przeładunkowy.

Introduction

Two land terminals are the object of the authors' investigations A and B, they on the basis of own experiences realize in whose dispatchers on up to date facing of the distribution of Individuals Transportation Intermodal (JTI) in the hand way (i.e. writing down the number JTI in the sector of storing on the plan trans-shipping terminal). The lack is so far implementation solutions on the datum feature of the technology RFID (*Radio Frequency IDentification*) helping the processes of the flow JTI. In the future trans-shipping terminals support new technologies and not use from the newest network-broadcasting solutions they are sentenced on the "natural death". The initiate of the technology RFID in the land terminal has on the aim enlargement efficiency steers the stream JTI through what will also contribute exchange, circulation and processing of information, the lowering of costs and improvement, the quality of customers service, to the competitiveness of transportation intermodal. Replacing hand processes the implementation of the technology RFID in the trans-shipping terminal will help the management JTI. This will make possible the operators more quickly and effective to administer JTI, what the transfer function will improve in the turn, it will reduce operating costs, the time of the expectation of road vehicles on load will as also let shorten / the trans-shipment JTI, and the identifications of individuals on the square [1].

Terminals of transportation intermodal in Poland

First of all land and sea (mainly container) terminals and logistic centres (Fig. 1) create the punctual infrastructure of the lattice of transportation intermodal in Poland.

It is anticipated that in our country will increase the turnover of European trade as a result of a combination of such factors as [2]:

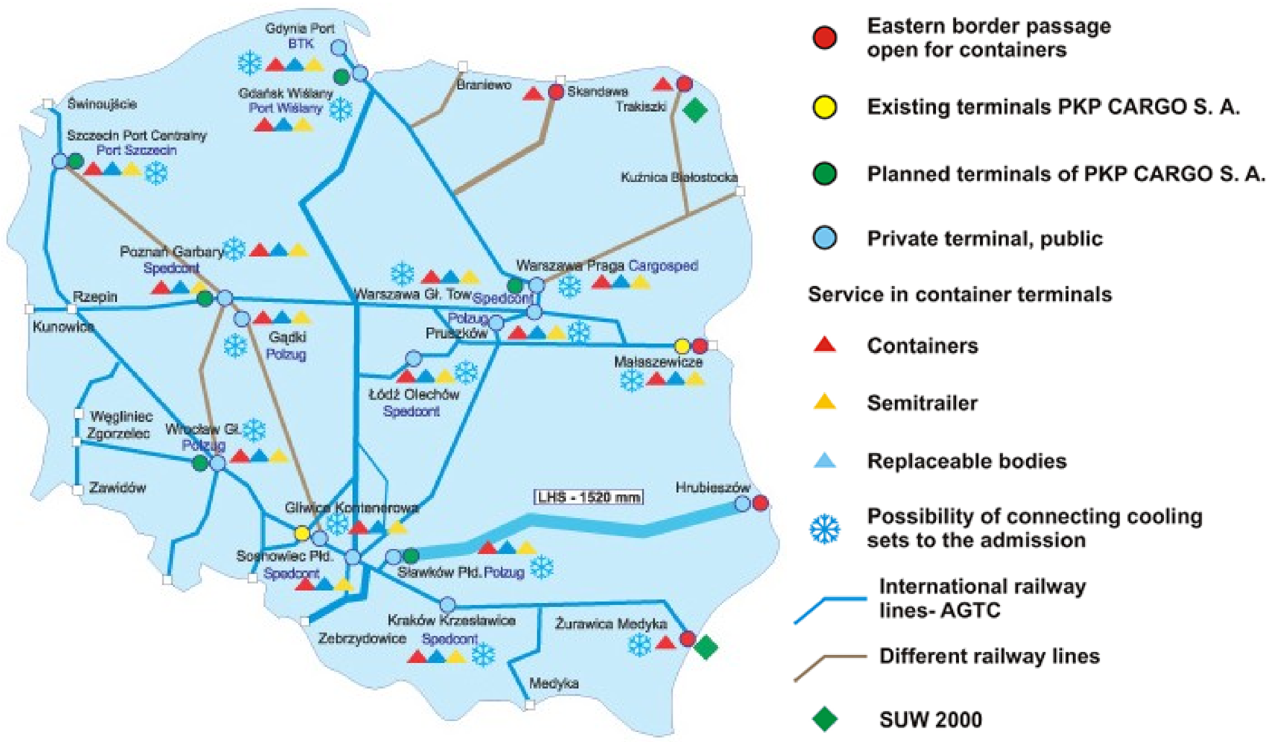

Fig. 1. Intermodal transport terminals in Poland [3]
Rys. 1. Terminale transportu intermodalnego w Polsce [3]

- **natural increase** – the increase of trade between EU countries and neighboring countries in Central and Eastern Europe;
- **increase the limit** – environmental tightening that will enhance the development of intermodal transport;
- **increase the efficiency** – the development of EU policy on transport users load fees, which will cause competition between different transport modes and will promote intermodal transport;
- **EU enlargement to new countries** – should create significant opportunities for further development of the morsels – land intermodal transport chains, and this applies to, among others, Baltic Sea countries, and especially Poland, the significant increase in turnover with the EU is particularly important from the standpoint of marine Polish position in the region.

Given the above trends, loading terminals in Poland must be prepared to accept JTI that processes are in them without interference.

Analysis examined the functioning of terminals

An analysis of the surveyed land terminals flows the following disadvantages faced in their daily work:

- communication via walkie-talkies;

  Operators and dispatchers handling devices communicate with each other via walkie-talkies, and usually more than one operator is trying to get information about the position of dispatcher JTI or payroll office, which leads to a telecommunications network congestion [4].
- confusion between JTI;

  Handling equipment operators must seek information about the location of the dispatcher JTI or payroll office, which leads to increased confusion generated by the human factor.
- reliance on experienced personnel;

  Because not all information is stored on computer, to a large extent the importance of knowledge workers' is the location of the JTI in the terminal. In case of illness, or the employee leaves the terminal, loses much of its functionality. Furthermore, the process of training new employees takes a long time.
- low efficiency of the search JTI;

  After receiving the order from a customer to a specific JTI, which meets the requirements, the dispatcher salary must first find the JTI that meets the stated requirements. Since the JTI could be shifted, often they are not there, where it shows functioning system (if any).

The analysis conducted by the authors during research shows that an effective system of identification of land-based terminals JTI should meet the following conditions:

– provide for monitoring of changes in the position of JTI;
– ensure the accuracy, availability, exchange, circulation and processing of data;
– streamline processes, management;
– the identification system should be integrated with the operating systems, planning and land management in the terminal.

As a result, the analysis found that the best set of requirements can be met in the process of RFID system flow JTI transshipment terminal, which will implement the following results:

- reading will take place immediately after finding marked JTI within the antenna transmitting – receiving;
- unrestricted access to data;
- reduce administrative costs – the circulation of documents;
- faster, more efficient flow control JTI.

The aim of achieve specified above conditions, it should consider many aspects regarding the standard of RFID, the first point to precisely analyze the architecture of a standard RFID system, its parameters, and that creates opportunities for exploitation.

Infrastructure and the technical possibilities of trans-shipping terminals

Infrastructure and the technical possibilities of trans-shipping terminals studied by authors were introduced in the table 1.

Table 1. Technical possibility of terminals A and B
Tabela 1. Możliwości techniczne terminali A i B

Technical possibility	**Terminal A**	**Terminal B**
Trans-shipping possibilities	41 ton	41 ton
Number and the length of railway tracks	2 × 700 mb = 1400 mb	2 × 700 mb = 1400 mb
Surface of the terminal	76 000 m^2	84 000 m^2
Area of storing	53 800 m^2	42 800 m^2
Possibility of storing	6000 TEU, 3layer	5000 TEU, 3 layer
Kind reloaded JTI	containers, replaceable bodies, semitrailers	containers, replaceable bodies, semitrailers

Architecture of the system RFID

Technology RFID (*Radio Frequency IDentification*) is wireless identification of objects marked tags. The RFID system consists of with at least one reader that communicates (Called Read \ Write Device) via a radio link with at least one transponder, to read (write) a unique identification number and other data stored in nonvolatile memory tag. The informations read from the radio transponder (e.g. 96-bit code EPC – *Electronic Product Code*) [5] are transmitted to a computer system, for proper processing. To read, the transponder must be placed in an electromagnetic field generated by the reader antenna, the read range can vary from a few mm to several hundred meters, including depending on whether the transponder is passive (power to operate is provided by the reader), or active (has its own power supply). Tags can operate in different frequency ranges (Fig. 2) depending on the application and the country (Fig. 3). Most are not licensed, the public ISM band (Industrial Scientific Medical). Until not long in Poland and most of the force standard ETSI (European Telecommunications Standards Institute) EN 300 220-1 (869.40–869.65 MHz, 0.5 W), which limited the possibilities of this technology to reach about 1.5 m. at the end of 2005, nearly half of European countries including Poland adopted a new standard EN 302 208 (ETSI), which envisages use a wider frequency range (865–868 MHz). Selected band affects the read range and method of coupling between the reader and tag identified [6].

Due to the different nature of electromagnetic fields, depending on the distance from the radiating antenna is distinguished by the range of fields near and far fields, where the description of phenomena occurring is based on different physical models. The boundary between the frequency ranges for which the model is used, it is conventional and falls on the VHF band [2]. The area near field applies to bands from LF to HF (Fig. 4.) and is characterized by the stored energy in the field of one type, not showing the same energy propagation. Far field (UHF) is characterized by the propagation of energy radially from the antenna.

Conjugation through the electromagnetic field (far field)

Everything may be found in between the reader and the other systems (frequently WMS or ERP), can be generally defined as an intermediate layer (middleware) [1].

The functions of the middleware include:

- **Management of readers** – allows users to configure, monitor, running, and send commands directly to readers through the common interface.

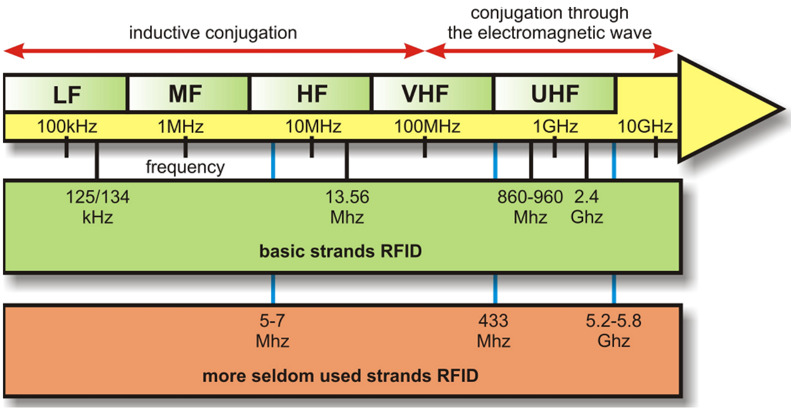

Fig. 2. Frequence strands used in the technology RFID [6]
Rys. 2. Pasma częstotliwości używane w technologii RFID [6]

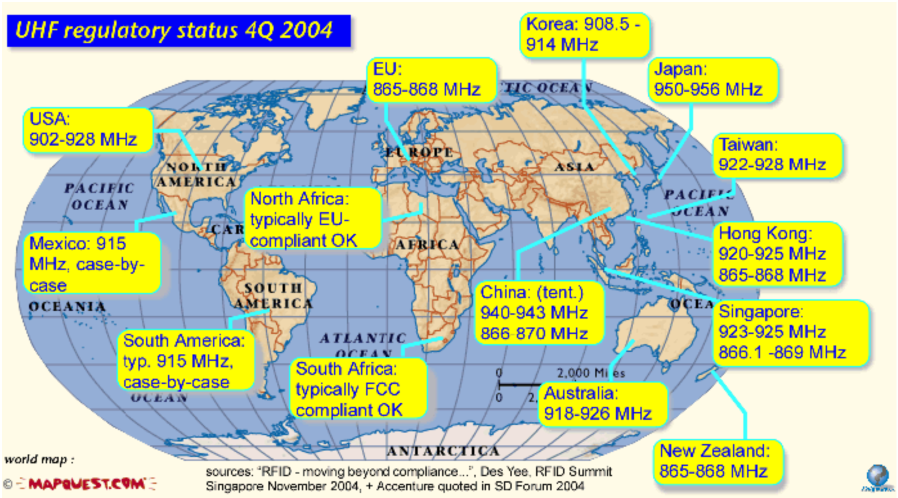

Fig. 3. Frequence strands used in the technology RFID in the world [5]
Rys. 3. Pasma częstotliwości używane w technologii RFID na świecie [5]

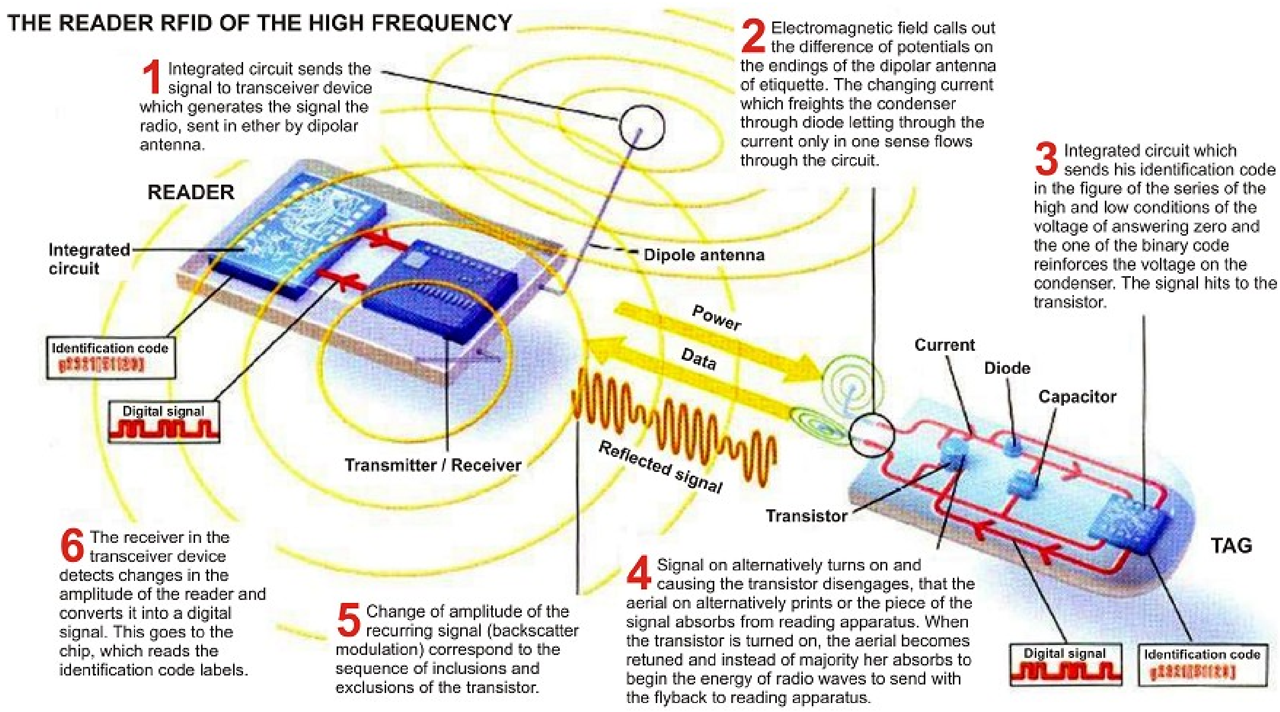

Fig. 4. Working principle of the technology RFID for high frequencies [7]
Rys. 4. Zasady działania technologii RFID dla wysokich częstotliwości [7]

- **Data management** – data retrieval from the readers. The possibility of intelligent filtering and directing them to appropriate destinations.
- **Application Integration** – provides the possibility of sending messages, the communication required to integrate RFID data with existing supply chain management (SCM), ERP, warehouse management (WMS), and relationship management (CRM).
- **Integration with partners** – provides a solution for collaboration, such as the integration of business-to-business (B2B) between partners.

It operates in the market many types of equipment and standards for radio frequencies on which they operate. For these reasons, each of the elements of the system chosen must be appropriate to implement, considering the particular needs and expectations of the user and the environment (environment and scale), in which the RFID system will work.

Signal propagation in free space

Mobile radio communication is a branch of telecommunications aiming to transfer information by radio to and from objects moving, or stationary on land sea and air [8].

In the real environment (trans-shipping terminal) in land mobile radio communication, in the distinction from the open space, radio waves on road among broadcasting aerial and aerial receiving face of the obstacle which change their gear as a result of phenomena such as: reflections, diffraction (deflectior), refraction (dissipation), propagation which bring in additional suppression and the fading of the signal cause. On figure 5 the patternel of two-way propagation being the simplification of the practical situation was introduced [9]. The broadcasting aerial of the basic station will be placed on the height h_1, and the receiving aerial on the height h_2. It carries out metric along the surface of the ground among aerials d and is considerably larger the than height the suspensions of aerials. It was put that the signal ground in to receiver set after two roads: direct and with the reflection from base paper (Fig. 5) near what let the coefficient of the reflection $a_1 = -1$, what marks that base paper works as the ideal loss-free surface printing. Power of the signal grinding in to receiver set carries out then [10]:

$$P_R(d) = P(d_0)d_0^2 \left| \frac{1}{d_1} e^{j\varphi_1} - \frac{1}{d_2} e^{j\varphi_2} \right|^2 \qquad (1)$$

Prime geometrical dependences let mark the lengths of individual roads [10]:

$$\begin{aligned} d_1 &= \sqrt{(h_1 - h_2)^2 + d^2} \\ d_2 &= \sqrt{(h_1 + h_2)^2 + d^2} \end{aligned} \qquad (2)$$

For some distance, the signals on both roads add up with opposite phases, which causes a decrease in signal strength. For other values of the distance, the signals add up to compatible phases, so that the signal level increases again. Of course there are many intermediate situations. Two-way channel model is a major simplification, but represents the essence of the impact of multipath on the reception. The following will be dealt with even approximate the received power variation as a function of distance $P_R(d)$, which will be characterized by a downward trend mentioned. With the adopted assumptions of much larger distance d between the antennas than their height, the distance d_1 and d_2 are slightly different, so that it can be replaced by

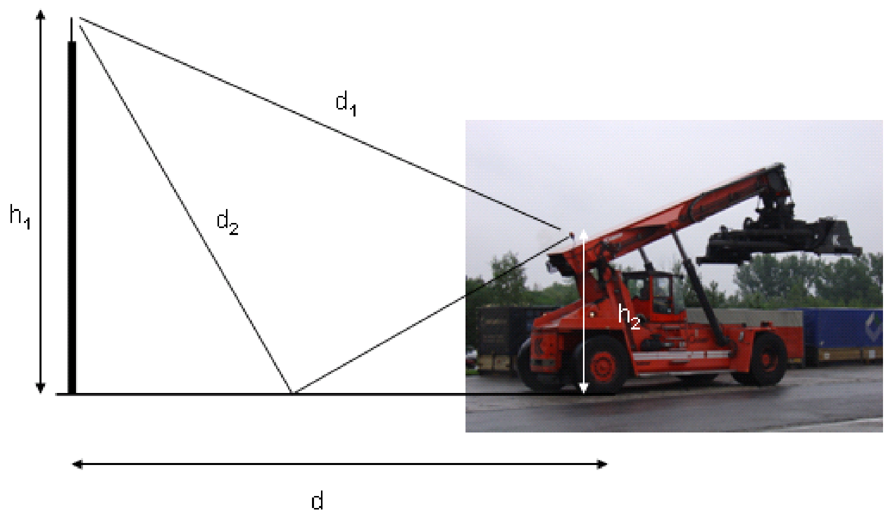

Fig. 5. Illustration of the phenomenon of multipath propagation in the trans-shipping terminal [9]
Rys. 5. Ilustracja fenomenu wielościeżkowego rozładunku w terminalu przeładunkowym [9]

the distance d and remove it from the sign of absolute value. The phase difference signal coming from both roads is as follows [10]:

$$\Delta\varphi = \frac{2\pi f \Delta d}{c} = \frac{2\pi}{\lambda}\Delta d \qquad (3)$$

They can be brought more closer by formulae near the exchanged foundations of metric d_1 and d_2 [10]:

$$d_1 \approx d + \frac{(h_1 - h_2)^2}{2d} \qquad (4)$$

$$d_2 \approx d + \frac{(h_1 + h_2)^2}{2d} \qquad (5)$$

This results approximation from the use of the developed view of the radical function in the Taylor's row and leaving the word of first stage. It results that the difference of metric carries out then from these equations, therefore, the difference of the bevels of signals coming after both roads is even [10]:

$$\Delta\varphi = \frac{2\pi}{\lambda}\frac{2h_1h_2}{d} \qquad (6)$$

Ultimately, the power received by the adopted assumptions can be expressed by the formula:

$$P_R(d) \approx P(d_0)\left(\frac{d_0}{d}\right)^2 \left|1 - e^{j\Delta\varphi}\right|^2 \qquad (7)$$

that for small angles $\Delta\varphi$, knowing $\left|1 - e^{j\varphi}\right| \approx \approx \left|1 - (1 - j\Delta\varphi)\right| \approx \left|\Delta\varphi\right|$ that simplifies to the form [10]

$$\begin{aligned} P_R(d) &= P(d_0)\left(\frac{d_0}{d}\right)^2 \left|\Delta\varphi\right|^2 = \\ &= P(d_0)\left(\frac{d_0}{d}\right)^2 \left(\frac{2\pi}{\lambda}\right)^2 \frac{4h_1^2h_2^2}{d^2} = P_T G_T G_R \frac{h_1^2h_2^2}{d^4} \end{aligned} \qquad (8)$$

This formula shows that the appearance of the second route (in addition to the direct route) has serious consequences for the drop in received power as a function of the distance. When two-way received power is inversely proportional to the fourth power of the distance. The logarithmic scale means that power loss is 40 dB per decade distance, in contrast to 20 dB per decade in the case of single pipe transmission, direct space. Two-way is only a theoretical chance that gives insight into the impact of multipath transmission on the channel properties. In practice, we are dealing with a larger number of roads caused by the particular shape of the environment. In general, the received signal strength at a distance d from the transmitting antenna is often referred to by the formula [10]:

$$P_R = P(d_0)\left(\frac{d_0}{d}\right)^{\gamma} \qquad (9)$$

where the value of the power γ depends on the environment propagation and contained in the locker from 2 to 5.5.

It should be noticed that power taken back in the function of metric among aerials in the case many ways is characterized by periodical fading. These fading, called short term, they have various frequency and the time of duration in dependence from applied bearing frequency, the metric of aerials and the connected with her level of the envelope of the signal grinding in to receiver set. The frequency of short term fading and the average time of duration on the level R are essential parameters characterizing the radio channel. The illustration of the fading of envelope about various depth and the time of duration was introduced on figure 6.

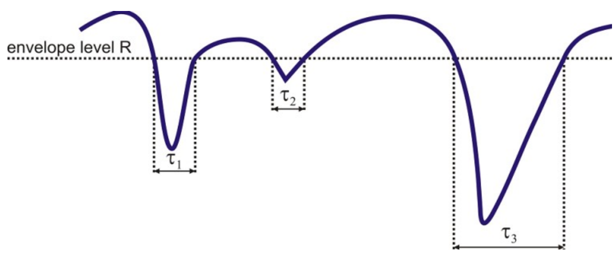

Fig. 6. The example course of envelope in the time with clear fading [8]
Rys. 6. Przykład okrywania w czasie z wyraźnym zanikiem [8]

As it is known, the function of the thickness of the probability of envelope r is described by Rayleigh's expansion:

$$p_r(r) = \frac{r}{\sigma^2}\exp\left(-\frac{r^2}{2\sigma^2}\right) \qquad (10)$$

where σ^2 are the average power of the signal. Element from the average-square value of envelope is appointed as [10]:

$$R_{\text{rms}} = \sqrt{E\{r^2\}} = \sqrt{2}\sigma$$

The frequency of these outages on the boundary of a specified level R is defined as the average number of exceedances of this level in the second at the rising edge of failure (when the derivative of the envelope signal r' is greater than 0). It can be deduced from the following formula [10]:

$$N(R) = \int_0^{\infty} r'\, p(R, r')\,\mathrm{d}r' \qquad (11)$$

$p(R, r')$ is the associative thickness of the probability of the variable random r' and R where, the probability expresses now, that R carries out the level of the envelope of the signal and the derivative envelope of the signal carries out r'. The function of the associative thickness of the probability $p(R, r')$ can be expressed for the help of the product of thickness probability function $p_r(R)$ and $p_r(r')$ which means that changing random R and r' are independent:

$$p(R,r') = p_r(R) \cdot p_r(r') \tag{12}$$

After substituting the above expression (12) to formula (11) we obtain:

$$\begin{aligned} N(R) &= \int_0^\infty r' p_r(R) p_r(r') \, \mathrm{d} r' = \\ &= \frac{R}{\sigma^2} \exp\left(-\frac{R^2}{\sigma^2}\right) \cdot \int_0^\infty r' p_r(r') \, \mathrm{d} r' \end{aligned} \tag{13}$$

It can be converted into:

$$N(R) = \sqrt{\frac{\pi}{\sigma^2}} \cdot R \cdot f_{D\max} \cdot e^{-\frac{R^2}{2\sigma^2}} \tag{14}$$

where: $f_{D\max}$ – the maximum Doppler frequency [9].

Problems resulting from the implementation of RFID system

Although the implementation of RFID system is beneficial in transshipment terminal, there are several problems that still need attention:

- Material problems;

Container is made from the metal, which prints the radio wave. Water absorbs radio waves, the public meeting is unusually hard to follow products with the high content of water, or the one who is from the metal. The working of the system will be, so strongly disturbed by these two factors, however, the reasonable disposing Tag to this of adapted should eliminate this problem.

- Electromagnetic interference;

Testing the system has to be executed very thoroughly, because of many sources of electromagnetic interference function on the terrain trans-shipping terminal, e.g. different systems.

- Issues of human nature, resistance to change;

People treat changes often reluctantly, especially so radical, how presented system. It maybe comes to torpedoing the implementation of this system.

- Problems of the business nature;

The implementation of the technology RFID attracts for oneself the necessity of the sudden change of whole lattice organizational trans-shipping terminal and the principles of its working in the aim of the achievement of advantage from the system implementation [4].

Conclusions

In comparison with the decided majority of European countries, Poland (31) does not run away from them – except of Germany (119), Italy (104), Czech (65), France (83) in relation to the quantity of terminals. Although there are questions. How many of the Polish terminals remain only in name? And how the existing ground terminals in our country will cope with the greater number of JTI, which will be streamed to them in accordance with estimated forecasts? The answer is simple. To effectively operate the intermodal transport chains in terrestrial terminals need to deploy modern technologies to form of harmonization of transport systems in Europe.

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