- due to full "transparency" in terms of the installation and presence of the system on the network, the solution does not affect the operation of other nodes and components of your IT infrastructure;
- Flowmon is the only solution on the market that supports traffic monitoring at speeds up to 100 Gbit/s;
- Flowmon is a solution for networks of any scale;
- the best price / functionality ratio among similar solutions.

This development is a tool that allows to increase fault tolerance and facilitate the administration of automated systems. The consequence of this is a reduction in the maintenance costs of the AU as a whole. In addition, a short-term malfunction of most existing information systems can lead to the loss of important information, significant economic damage, a decrease in the number of customers, etc..

As a result, we get a tool that detects any anomalies in our network and deviations from the characteristic behavior. Here are a couple of examples that the system allows you to detect:

- distribution of new malware on the network that is not detected by antivirus signatures;
- building DNS, ICMP or other tunnels and transmitting data bypassing the firewall;
- the appearance of a new computer on the network, posing as a DHCP and/or DNS server.

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DEVELOPMENT OF THE BASE STATION COVERAGE MODEL OF THE RAILWAY TRUNK CHANNEL

Abstract. This article considers methods of data transmission over the radio channel for information security, the issues of communication of the radio locking center and the TETRA switching center, linking the radio locking center with electrical interlocking systems. A model of base station coverage for trunking communications, taking into account information security requirements, has been developed to determine the losses on the route. Characteristics of distance and frequency influence on the trace loss are obtained, from which it can be seen that the wireless trunking communication is affected by the Doppler shift and the fast Doppler transition.

Keywords: radio blocking, information security, track loss, doppler shift, base station.

Аннотация. В данной статье рассматриваются способы передачи данных по радиоканалу для обеспечения информационной безопасности, вопросы связи центра радиоблокировки и центра коммутации TETRA, увязки центра радиоблокировки с системами электрической централизации. Для определения потерь на трассе разработана модель покрытия базовой станции для транкинговой связи с учетом требований по информационной безопасности. Получены характеристики влияния расстояния и частоты от потерь на трассе, из которых видно, что на беспроводную транкинговую связь влияют доплеровский сдвиг и быстрый доплеровский переход.

Ключевые слова: радиоблокировка, информационная безопасность, потери на трассе, доплеровский сдвиг, базовая станция.

Аңдатпа. Бұл мақалада ақпараттық қауіпсіздікті қамтамасыз ету үшін радиоарна бойынша деректерді тарату тәсілдері, радиоблокировка байланыс орталығының және TETRA коммутация орталығының, электрлік орталықтандыру жүйелерімен радиоблокировка орталығын байланысытыру қарастырылған. Жолдағы байланыстың жоғалуын анықтау үшін ақпараттық қауіпсіздік талаптарын ескере отырып, транскрингтік байланыстың базалық станциясының моделі жасалды. Жолдағы байланыстың жоғалуына дейінгі қашықтық пен жиіліктің әсер ету сипаттамалары алынды, олардан доплердің жылжуы және доплердің жылдам ауысуы сымсыз транкингтік байланысқа әсер ететіні анық.

Түйінді сөздер: радиоблокировка, ақпараттық қауіпсіздік, жолда байланыстың жоғалуы, доплерлік жылжу, базалық станция

At present, the network of railroads of JSC «National Company «Kazakhstan temir zholy» for the purpose of its continuous operation transmits significant amounts of responsible confidential information through various systems of data reception and transmission. Responsible information here is understood to be the information used in a discrete system, the distortion of which brings the system into an inoperable state, at which a dangerous distortion of the functioning algorithm occurs. The commands carrying responsible information directly influence functional security of transportation. In addition, high commercial value is the logistic information about the schedule and location of trains. The basis for ensuring the safety of train traffic are systems of railway automation and telemechanics (RATS) [1].

RATS are a set of technical means that provide control and management with the established level of traffic safety of stationary track and mobile objects of railway transport, in which the role and requirements to the information transfer channels are significantly increased. The trend of development of information transfer systems based on foreign and domestic experience indicates that in addition to traditional means, such as rail circuits, it is necessary to use new systems, such as digital radio channels. At the same time the aspects of information security and noise protection of wireless systems are an important factor.

The model of covering the base station for railway trunking communication was developed. By experiment, determined the percentage of packet loss in the radio network, losses on the track and Doppler shift depending on the location at a frequency of 450 MHz.

The practical application of the radio blocking system was considered at the section Zhetygen - Altynkol of the Almaty branch of the trunk network. At practical application the questions of communication of the center of radio blocking and the center of switching TETRA, coordination of the center of radio blocking with systems of electric centralization, modernization of the onboard equipment of a locomotive, check of algorithms of work of the onboard and stationary equipment are considered.

At the first stage, the experiments are conducted according to the scheme shown in Figure 1.

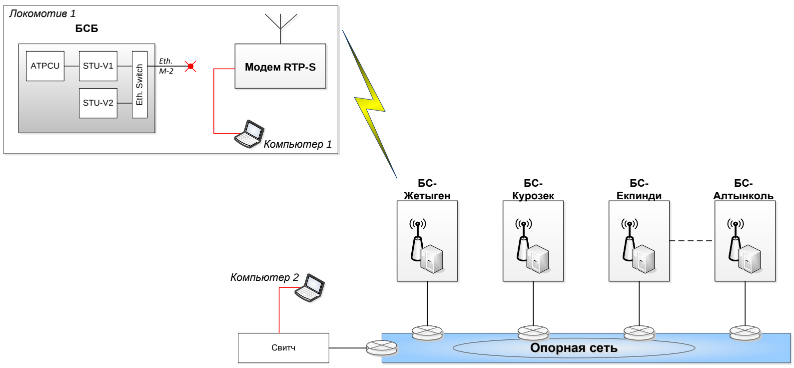

Figure 1 – Scheme of experiments - stage 1

The results of the measurements, which include data on the channel capacity, time of the packets passing, data on the packet loss in TETRA radio network are presented in Figures 2-4.

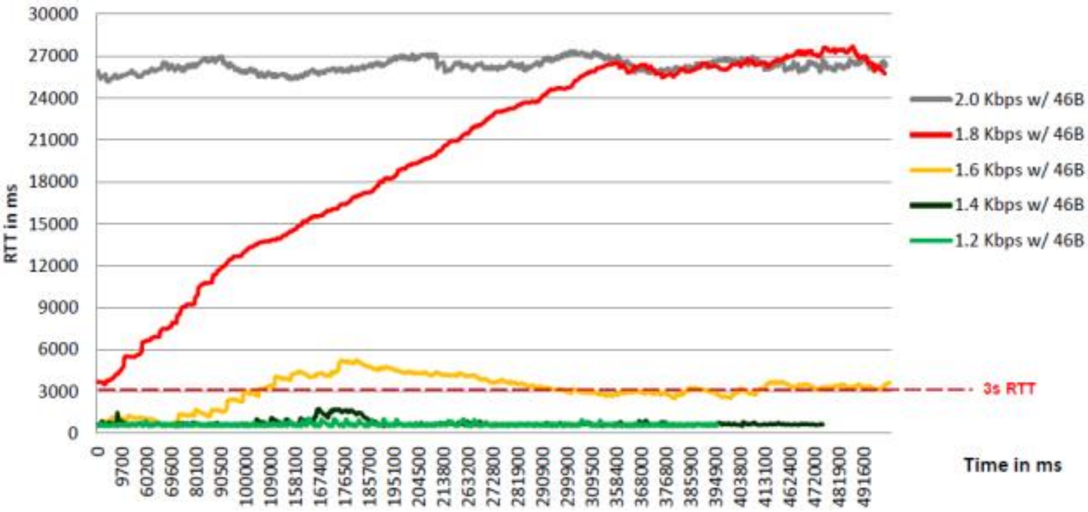

Figure 2 – Passage time of a 46-byte package

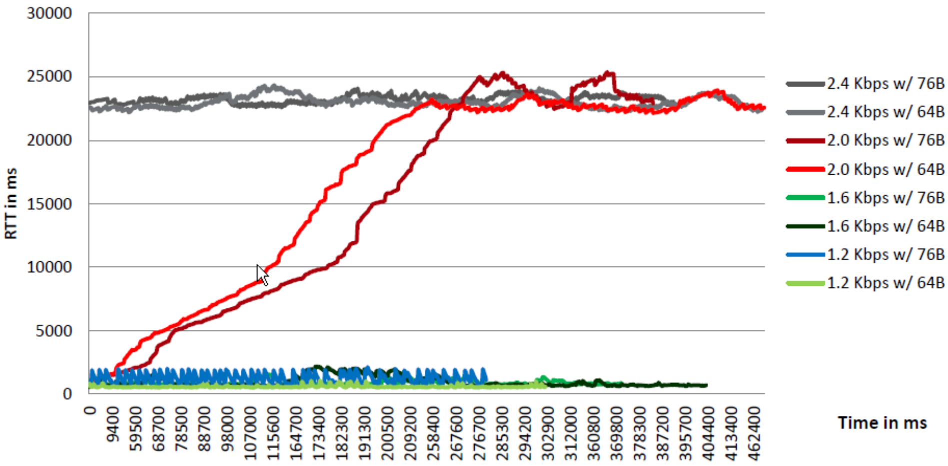

Figure 3 – Passage time of a 64-byte and 76-byte package

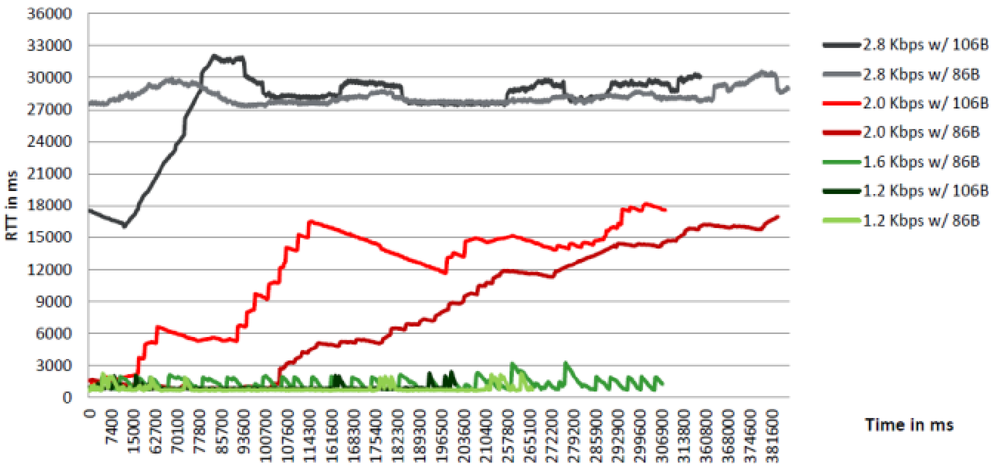

Figure 4 – Passage time of the package of 86 and 106 bytes

At the second stage, the experiments are conducted according to the scheme shown in Figure 5.

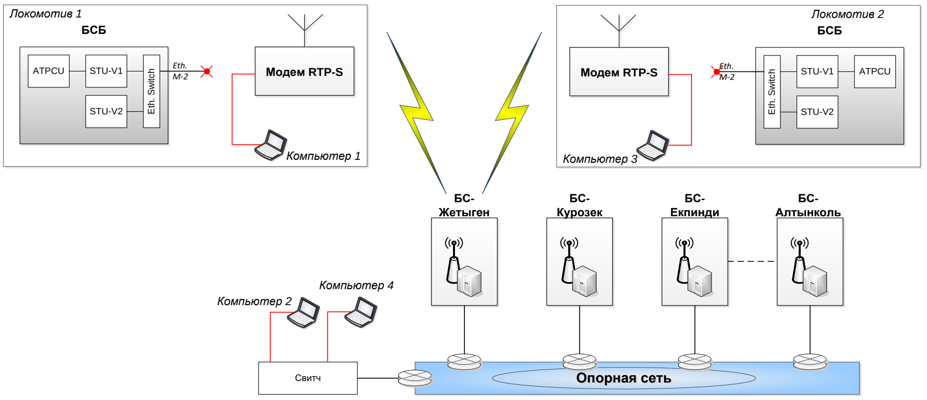

Figure 5 – Scheme of experiments - stage 2

The results of the measurements, including data on the channel capacity, time of the packets passing, data on the packet loss in the TETRA radio network are presented in Figure 6.

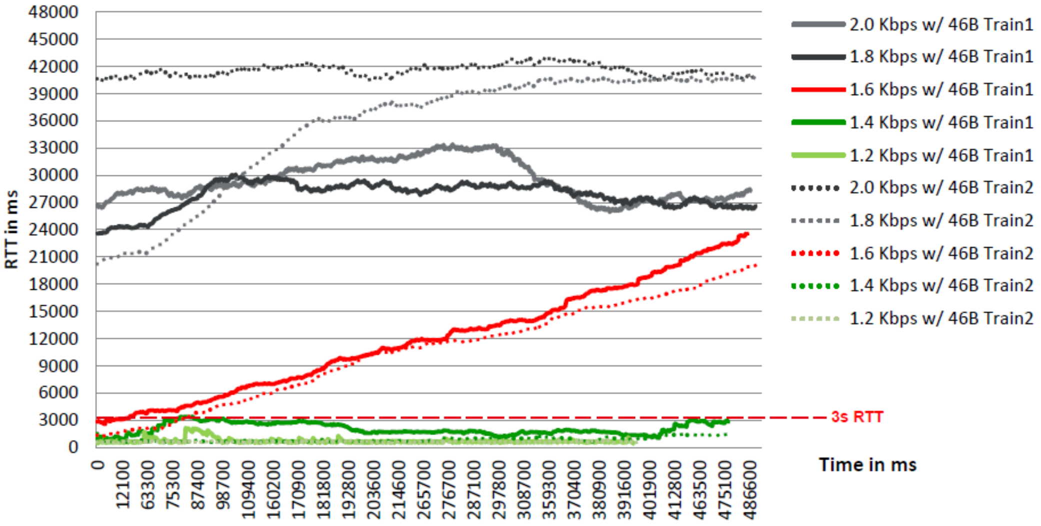

Figure 6 – Time of passage of a package of 46 bytes

Figure 7 – Percentage of packet loss on the radio network

The experiments show that at any packet size in the TETRA digital radio system, the time of packet passage increases as the load on the system increases. For transmission speeds up to 1.4 kbps the system meets the requirements for packet passing time. Starting from the load of 1.6-2.0 kbps the time of packet passing becomes unacceptably large and reaches 30-40 seconds, which does not meet the requirements. At the same time, the percentage of lost packets (up to 50%) is increasing, with several consecutive packet losses [2, 3].

The developed model of BC coverage for trunk communication is shown in Figure 8. The base stations are located along the railway with a spacing of 2R, which represents the service distance of one BS. The train is moving at a constant speed along the rail.

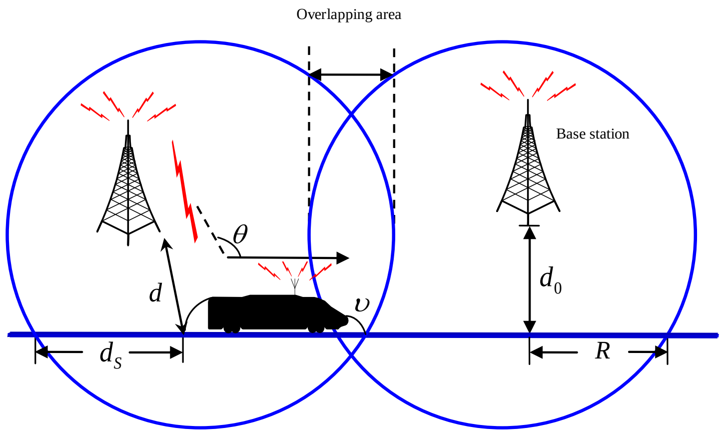

Figure 8 – Coverage model of the base station for railway trunk communication

When the train is in position d_s of the current cell for $0 \le d_s \le 2R$, the distance between the BS and the train is $d = \sqrt{d_0^2 + (d_s - R)^2}$,, where d_0 – the distance between the BS and the railway line. Based on the assumption of ignoring the difference in height between the BS antenna and the railway line, the losses when passing the line of sight in the free space is determined:

$$L = 20\log_{10}\left[\frac{4\pi df}{c}\right], \tag{1}$$

where f and c - the emitted frequency and speed of light, respectively.

It can be seen from (1) that losses on the L trace are related to distance d and frequency f.

To conduct the experiment, the base station is located at point 0, the radius of cell R is 1500 m, and the speed of the train v is 100 km / h.

Figure 9(a) shows the effect of distance and frequency from losses on the track. As can be seen from the figure losses on the track quickly change depending on the location of the train. When a train moves to the edge of a cell, the losses on the track become more and the corresponding channel state deteriorates. On the contrary, when a train moves to the center of a cell, the losses on the track become less and the corresponding channel state changes better. Thus, periodic change of the channel state causes that power control over time has a great impact on transmission performance.

High mobility causes a large Doppler shift and spread. In this section, the ratio of energy in the line-of-sight path to energy in multi-beam propagation is relatively high, and the delay of multi-beam propagation is relatively small. As shown in Figure 8, when a train moves along the rail, the Doppler shift can be calculated as follows

$$f_p = f_d \times \cos\theta, \tag{2}$$

where $f_d = \frac{v}{c} \cdot f$ - maximum Doppler frequency, θ - angle between the direct direction of the train and the line of sight from the BS to the train. Based on the information on geometry, from Figure 8, we have $\cos\theta = \frac{R - d_s}{d}, \quad 0 \le d_s \le 2R.$

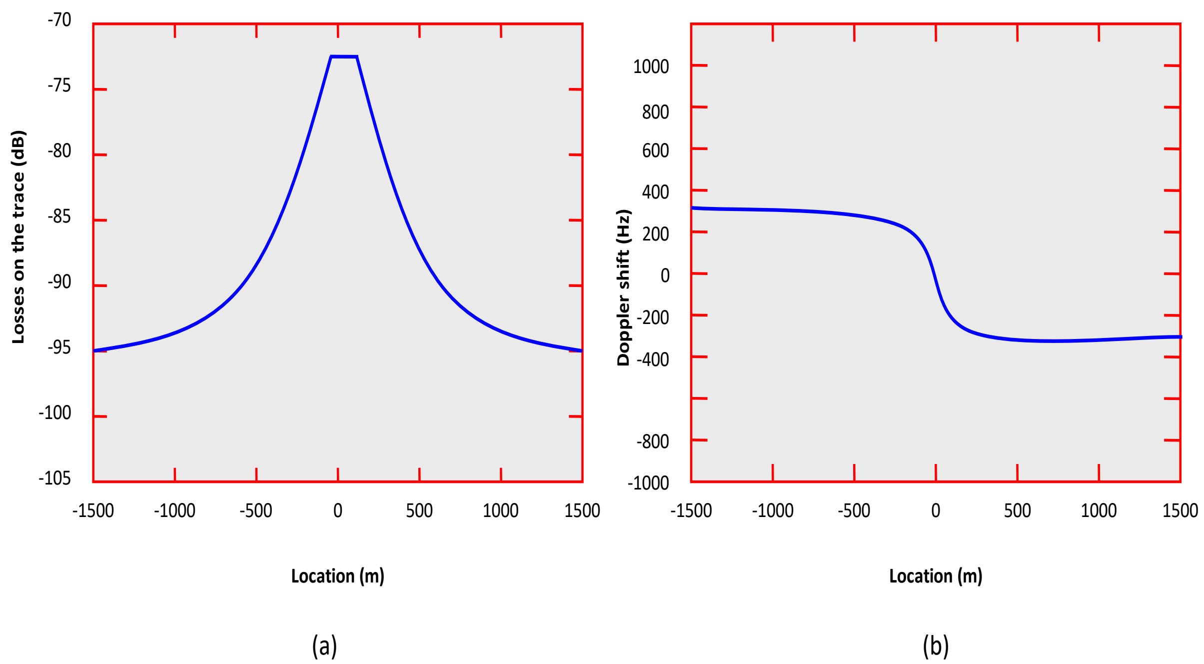

Figure 9 – Loss on track and Doppler shift depending on location at 450 MHz

Thus, when the BS is located far from the rail, that is $d_0 >> R$, f_p, relatively low, because it will be approximately 90◦. However, this will lead to high losses on the track according to equation (1). Thus, there is a trade-off between loss on a trace and Doppler shift in optimization of BS assignments.

Figure 9(b) shows the Doppler offset along the rail for the carrier frequency of 450 MHz:

- f_p varies in time from the maximum positive value to the maximum negative value when the train moves through a cell;

- there is a Doppler offset while the train is moving;

- f_p although very little when the train moves through the BS, it will encounter a fast Doppler junction;

- f_p will move from the maximum negative value to the maximum positive value when the train moves to the area of overlap between adjacent cells, as shown in Figure 8.

For wireless trunking, serious problems with Doppler shift and fast Doppler transition must be solved before practical application. Serious Doppler shift can lead to difficulties in synchronization and bit error rate. It should be noted that although the Doppler shift is large, its change is so small that it can be accurately estimated and easily compensated for with accurate information about the speed and location of the train. Also, a fast Doppler shift in the center of the cell makes it much more difficult to estimate the channel and the Doppler shift.

Conclusion. For wireless trunking communications, serious problems with Doppler shift and fast Doppler transition must be solved before practical application. Serious Doppler shift can lead to timing difficulties and bit error rates. It should be noted that although the Doppler shift is large, its variation is so small and the Doppler shift can be accurately estimated and easily compensated for with accurate train speed and location information. Also, the fast Doppler transition in the center of the honeycomb makes estimating the channel and Doppler shift much more difficult.

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УДК 656.256.3

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МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ОСНОВНЫХ ПАРАМЕТРОВ КООРДИНАТНОЙ СИСТЕМЫ ИНТЕРВАЛЬНОГО РЕГУЛИРОВАНИЯ ДВИЖЕНИЯ ПОЕЗДОВ

Аннотация. В статье рассмотрены принцип работы системы радио блокировки, построены функциональная схема управления движением поездов при координатном