OPTIMIZATION OF COMMUNICATION SIGNALS OF PUBLIC ADDRESS SYSTEMS

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Keywords: radio transmitter, security systems, alarm, security radio network, GPSS, LARS

This paper concerns the problems about modeling of connection between local alarm systems and monitoring center using Radio Alarm Transmitters. The parameters of the link are: length of packages; number of repetitions of packages, number of transmitters, repeater and receivers, parameters of channel. A model of a security radio network with 4000 local systems and one receiver by GPSS is presented.

1. INTRODUCTION

This investigation is oriented to connection between local alarm systems and monitoring center using Radio Alarm Transmitters (RAT). The RAT sends specific signals, correspond to the change of status of security system. The signals are:

- set (arm) / unset (disarm) the system;
- alarm / restore of alarm;
- low battery / restore battery;
- personal attack / restore of personal attack;
- mains fail / mains restore;
- system test - emits every 6 hours.

One Security Monitoring Center (SMC) serves up to **N** local security systems (N ordinary is between 2000 to 5000). If happens a common cause (mains fail in the quarter, strong lighting, collision etc.), several RAT'S transmits the signals at the same moment. The receiver (SMC) will receive only one signal at the highest level, another signal will be loss (as an message). This may have dangerous result, if any signal is alarm or personal attack.

We are searching for methods to suspend of loses of the signal.

One possibility method is the duplex link, but it makes the equipment too complex and dear.

Another approach is the repetition of the signals. Every signal will be transmitted several (n-) times in to ether, for a casual interval of time.

Lets give an example.

Number of local systems connected to one SMC are 4000 (N=4000). The signals who is received in to SMC are divided into 3 streams:

1. Every object transmit 4 test signals for twenty four hours. This makes commonly 16000 signal per day and night. Average that means one signal every 5,4s.
2. Another stream forms by the signal of status (set/unset). At an average for day they are 3 for object, and this stream will consist of 12000 signals, that means one signal every 7,2s.
3. It is possibly to expect encore one stream by 1600 accidental originate alarm events as alarm, personal attack, tamper etc. Average time here is 27s.

One receiver should be receive together tree streams.

- When the signal is transmitted one time and casual, there is possibility of their loss;
- As much repetitions (n) as possibility to receive is greater, but this will charge the receiver it to SMC;
- It is possible one signal transmit immediately until the message is changed. After this begins repetition of new message. In this way possibility of receive will grow up, but the receiver will be very load, will form big queues of massages and risk of message loss grows.

For alarm systems this is fundamental. The time here is very important parameter. Generally security firms have time for reaction up to 5 minutes. Is not must lose this time as wait in the queues of network equipment.

The purpose of this research is optimizing the parameters of the transmitted signals and their number (***n***), so there are lowest lose of messages.

2. FORMULATION OF RESEARCH TASK

Lets every signal have a duration t_s (approximately $t_s = 1$s) and repetition n times (ordinary $1 \le n \le 15$), at an casual interval of time with regular distribution t_d (ordinary $1\text{s} \le t_d \le 15\text{s}$). We think, so accepted is every message, who be received in to receiver after elapse any admissible time t_{adm} ($t \le t_{adm}$). Lost is every message who is held in to receiver track and cannot be receive in this time ($t > t_{adm}$).

The possibility to receive a message ***P*** is criteria for reliability of the system. It is obvious, so for fixed sources of messages of three steams with regular distribution, ***P*** is function of 5 variables:

$$\textbf{(1)} \quad P_{rcv} = f(t_s, t_d, t_{adm}, n, N).$$

In this case P_{rcv} is criteria for the global system safety and reliability.

The main task is to develop a function (1). The aim of this work is to show computer simulation method for decision of similar task (with more RAT'S, repeaters).

3. DECISION OF THE TASK FOR PUBLIC COMMUNICATION

The criteria of optimality is a maximum of possibility for receiving of the signal. The GPSS program model is created for decision of this task. After translation to intermediate code, the program is ran by interpreter. The program is modified by the following way, so RAT's makes from 1 to 15 repetitions of alarm signal. The program model is shown to fig.1.

```
-- define of statistical tables
attr1   table     P1,1,1,1      -- table for successful received signals
attr2   table     P1,1,1,1      -- table for lose signals
-- This segment models generation of test signal
        generate      5,5      -- Emits test signal
        split         1,efir   -- First emission into ether
        advance       5,4      -- Random delay from 1s to 9s before second emission
        split         1,efir   -- Second emission into ether
        advance       5,4      -- Random delay from 1s to 9s before third emission
        transfer      ,efir    -- Third emission into ether
-- The segment models emission of status (arm/disarm) signals
        generate      5,5      -- Emits signal for status change
        split         1,efir   -- First emission into ether
        advance       5,4      -- Random delay from 1s to 9s before second emission
        split         1,efir   -- Second emission into ether
        advance       5,4      -- Random delay from 1s to 9s before third emission
        transfer      ,efir    -- Third emission into ether
-- The segment models emission of alarm/restore, panic/restore and tamper/restore signals
        generate      27,27    -- Emits alarm/restore signal
        split         1,efir   -- First emission into ether
        advance       5,4      -- Random delay from 1s to 9s before second emission
        split         1,efir   -- Second emission into ether
        advance       5,4      -- Random delay from 1s to 9s before second emission
```

```
        transfer      ,efir    -- Third emission into ether



--      Receiver   Subsystem
efir    transfer   both,,clsn   -- If unit is busy  go to label  clsn
        seize      rcvr         -- If unit is free the
        advance    1            -- signal is receiving 1 s
        release    rcvr         -- Release the receiver
        tabulate   attr1        -- Received transaction is tabulated (into table attr1)
        terminate               -- and absorbed leaving the model
clsn    tabulate   attr2        -- Here are all collided transaction (into table attr2)
        terminate               -- and leaves the model


--      Segment timer
        generate   86400        -- After 24 hours (one day) one transaction  is generated
        terminate  1            -- counter decrease with 1 and terminate
        start      1            -- model
        end
```

fig.1.

Block GENERATE emits transactions in to model with at an average time A, regularly distributed in to interval from A-B to A+B. In this case, the transaction are analog of events emitted by RAT'S. Block SPLIT 1, EFIR splits the transaction for two, so first one continues into next block (in this case ADVANCE), a second transaction goes into block, specified with label EFIR. Block ADVANCE A,B delays a transaction for time A-B to A+B. Block TRANSFER, EFIR sends all transaction into block specified by the label (similar operator GOTO in the program languages). When a transaction enters into block TRANSFER BOTH,CLSN it checks whether next block is busy. If this case the transaction does into block specified by the label (in case CLSN). The number of received signal is mark into TABLE ATTR1 and number of loss signals is mark into TABLE ATTR2.

The receiver is modeled by the blocks SEIZE RCVR and RELEASE RCVR. To simplify the calculation is not give an account, so SMC receives high level signal and every emission is a package of repetitions.

4. RESULTS FROM SIMULATION

The results after execution of 15 modifications of program model (fig.1.) is shown in table 1. It seems that, the increasing of number of repetition of one signal makes P_{rcv} (fig.2) to goes up for first 5 times and after this goes slow down as result of charge of the receiver (fig.3).

The average time of receiving of the signal has increased the linearly with the increased number of repetitions. (fig.4).

For example at 12 repetitions the signal may be delayed with 50 seconds (up to 2 times average time). Generally speaking, security companies have contract for reaction up to 5 minutes and this delay consumes time for reaction.

Number of emissions	Number of received signals	Number of collated signals	Charge of receiver	Possibility Q = 1- P for signal lose	Possibility for receiving P of message	Average time for receiving of message [s]
1	30096	7040	0,39	0,18957346	0,81042654	0
2	51744	20240	0,59	0,281173594	0,92094141	2,5
3	63998	34760	0,73	0,351971486	0,95639639	5
4	76032	56892	0,8	0,428003972	0,966442376	7,5
5	78628	87120	0,87	0,525617202	0,959881208	10
6	80080	118998	0,91	0,597745607	0,954385979	12,5
7	82522	149666	0,94	0,644589729	0,953763637	15
8	84260	180972	0,96	0,682315859	0,953023168	17,5
9	85470	212740	0,97	0,713389893	0,95214332	20
10	86152	243562	0,98	0,738706879	0,951613809	22,5
11	87142	303512	0,99	0,77693304	0,937738511	25
12	88242	381238	0,99	0,812043112	0,917785383	27,5
15	90376	549318	1	0,85871995	0,898194019	35

table 1.

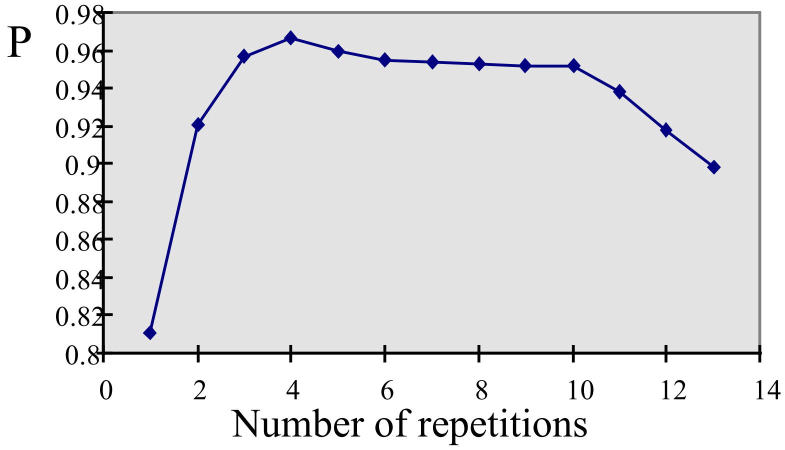

fig.2.

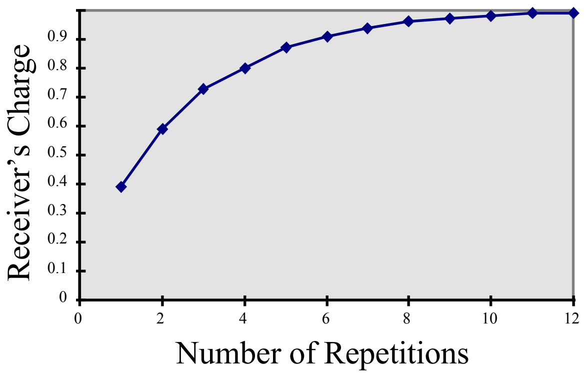

fig.3.

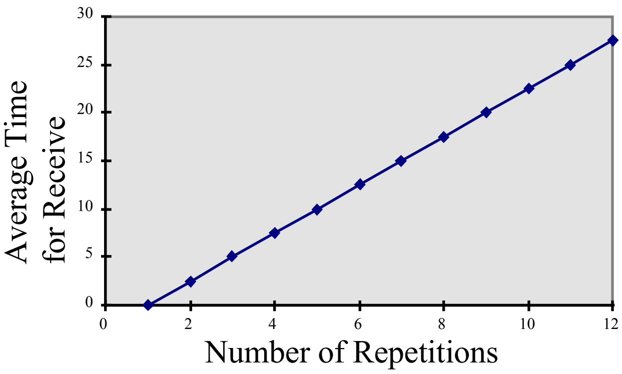

fig.4.

Notwithstanding made simplifying to a program model, the results is approximate to these, establish in to practice.

4.Conclusion

In this work is suggested approach for optimization of communication signals of public address systems. It is determined so repetitions of the signals must be an optimal number of times, who is found in this work.

5.References

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