What is Offered Traffic in a Real Telecommunication Network?

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Abstract: A detailed conceptual and a corresponding analytical traffic models of an overall (virtual) circuit switching telecommunication system are presented. The models are relatively close to real-life communication systems with homogeneous terminals. A normalized presentation model is used for the numerical results obtained. It is shown, that the ITU-T definition of offered traffic is not valid for the systems studied, because in the case of nonzero blocking, real offered traffic may be much bigger than in the case of zero blocking. The two predicted traffic phenomena must be confirmed in real communication systems.

Keywords: PSTN, GSM, Network traffic, Offered Traffic, ITU-T Definition.

1. INTRODUCTION

The ITU-T definition of "traffic offered" (ITU E.600) is: "The traffic that would be carried by an infinitely large pool of resources." This definition implies independence of the offered flow intensity and duration of the service time from the actual capacity of the used pool of resources (i). It might be true in an infinitely large telecommunication network, but since Engset (1918) we know the importance of taking into account the number of subscribers.

Another decision of Engset, in the same paper - "We disregard the effect of terminating calls" (ii) - is continuously in use till now. Respectively Call Holding Time is considered independent from the state of the system (iii) (Zeng et al 2002). Other common, but wrong, premises are: Occupation times for calling (A) and called (B) terminals differ a little (iv); Traffic intensities of A and B-terminals are almost equal (v).

As a result of these implicit and explicit ("…on the assumption that augmentation of the circuit group would have no effect on the mean holding time of calls carried or on the completion ratio of calls carried,…" (ITU E.501)) assumptions, the values of the "traffic offered" (ITU E.600) and the "equivalent traffic offered" (ITU E.501) may differ by as much as a factor of 2, as it is shown in this paper.

We propose a detailed conceptual traffic model of a (virtual) circuit switching telecommunication network, like PSTN and GSM, including users' behaviour, and, based on it, an analytical macro-state model of the system in stationary state, with: BPP (Bernoulli–Poisson–Pascal) input flow; repeated calls; limited number of homogeneous terminals; losses due to abandoned and interrupted dialing, blocked and interrupted switching, not available intent terminal, blocked and abandoned ringing and abandoned communication. The model
is relatively close to real-life systems and the approach used allows avoiding the five (i-v) assumptions mentioned above.

The numerical results obtained, are accurate enough, as a first approximation, and show that the ITU-T definition of "traffic offered" simply do not apply to the considered real-life telecommunication systems. The successful application of the Erlang's formula in such systems is a result of the de-facto ignoring of this definition.

The only way to work out a valid offered traffic definition is to consider Network and Terminal Traffic Models of the overall communication systems. In this paper one of the possible approaches is demonstrated and some considerations toward more realistic definitions are made.

2. CONCEPTUAL MODEL

In this paper two types of virtual devices are used: base and comprising base devices.

2.1. Base Virtual Devices and Their Parameters

We will use base virtual device types with names and graphic notation shown on Fig.1. For every device we propose the following notation for its parameters: Letter $F$ stands for intensity of the flow [calls/sec.], $P$ = probability for directing the calls of the external flow to the device considered, $T$ = mean service time, in the device, of a served call [sec.], $Y$ = intensity of the device traffic [Erl], $N$ = number of service places (lines, servers) in the virtual device (capacity of the device). In the normalized models (Poryazov 2001), used in this paper, every virtual device, except the switch, has no more than one entrance and/or one exit. Switches have one entrance and two exits. For characterizing the intensity of the flow, we are using the following notation: inc.$F$ for incoming flow, dem.$F$, ofd.$F$ and rep.$F$ for demand, offered and repeated flows respectively (ITU E.600). The same characterization is used for traffic intensity ($Y$).

2.2. The Virtual Base Device Names

In the conceptual model each virtual device has a unique name. The names of the devices are constructed according to their position in the model. The model is partitioned into service stages (dialing, switching, ringing and communication).

Every service stage has branches (enter, abandoned, blocked, interrupted, not available, carried), correspondingly to the modeled possible cases of ends of the calls' service in the branch considered.

Every branch has two exits (repeated, terminated) which show what happens with the calls after they leave the telecommunication system. Users may make a new bid (repeated call), or to stop attempts (terminated call).

In virtual device name construction, the corresponding bold first letters of the names of stages, branches end exits are used in the order shown below.

Virtual Device Name = <BRANCH EXIT><BRANCH><STAGE>

A parameter's name of one virtual device is a concatenation of parameters name letter and virtual device name. For example, "$Yid$" means "traffic intensity in interrupted dialing case"; "$Fid$" means "flow (calls) intensity in interrupted dialing case"; "$Pid$" means "probability for interrupted dialing"; "$Tid$ = "mean duration of the interrupted dialing"; "$Frid$ = "intensity of repeated flow calls, caused by (after) interrupted dialing".
2.3. The Paths of the Calls

The network under consideration corresponds to the reference configuration "terminal - subscriber switch - terminal" (Iversen 2003). We ignore the signalling network.

In this paper "call" means "call attempt" or "bid" according to (ITU E.600). Figure 1 shows the paths of the calls, generated from (and occupying) the A-terminals in the proposed network traffic model and its environment. $Fo$ is the intent intensity of calls of one idle terminal; $M$ is a constant, characterizing the BPP flow of demand calls ($dem.Fa$). If $M = -1$, the intensity of demand flow corresponds to Bernoulli (Engset) distribution, if $M = 0$ - to the Poisson (Erlang), and if $M = +1$ - to the Pascal (Negative Binomial) distribution. In our analytical model every value of $M$ in the interval $[-1, +1]$ is allowed. The BPP-traffic model is very applicable (Iversen 2003) (the handbook is a clear comparison basis for the main ideas, discussed in this paper), but in the numerical examples, presented here, $M = 0$, because the conclusions made are independent from the input flow model.

![Diagram of call paths](image)

Virtual Device Name = <BRANCH EXIT><BRANCH><STAGE>

**Figure 1.** Conceptual model of the telecommunication system and its environment, including: the paths of the calls, occupying A-terminals (a-device), switching system (s-device) and B-terminals (b-device); base virtual device types, with their names and graphic notation.

2.4. The Comprising Virtual Devices and Their Names

The following important virtual devices, comprising several base virtual devices and shown on Fig.1, are considered:

- **a** = virtual device that comprises all the A-terminals (calling) in the system (shown with continuous line box). The devices outside the a-device belong to the network environment.
- **b** = virtual device that comprises all the B-terminals (called) in the system (shown with dashed line box). The devices outside the b-device belong to the network environment.

The calls in the environment do not occupy network devices, but they form the incoming flows to the network;
\(b\) = virtual device that comprises all the B-terminals (called) in the system (box with dashed line). The paths of the calls occupying B-terminal and corresponding virtual devices;

\(ab\) = this device comprises all the terminals (calling and called) in the system (not shown on Fig. 1);

\(s\) = virtual device corresponding to the switching system. It is shown with dashed line box into the \(a\)-device. \(Ns\) stands for the capacity (number of internal switching lines) of the switching system.

The flow of calls (B-calls), with intensity \(F_b\), occupying the B-terminals, is coming from the Copy device. This corresponds to the fact that at the beginning of the ringing a second (B) terminal in the system becomes busy. The second reason for this conceptual modelling trick is that the paths of the A and B-calls are different in the telecommunication system's environment, after releasing the terminals (compare environments of \(a\) and \(b\) - devices on the Fig. 1).

There are two virtual devices of type Enter Switch (Fig. 1) - before Blocked Switching (bs) and Blocked Ringing (br) devices. These devices deflect calls if there is no free line in the switching system or the intent B-terminal is busy, respectively. The correspondent transition probabilities depend on the macrostate of the system (\(Y_{ab}\)).

The macrostate of a (virtual) device (including the overall network, considered as a device) is defined as the mean number of simultaneously served calls in this device, in the observed time interval (similar to “mean traffic intensity” in (ITU E.600)).

3. ANALYTICAL MODEL

3.1. Main Assumptions

For creating a simple analytical model, we make the following system of fourteen (A-1 – A-14) assumptions:

A-1. (Closed System Structure) We consider a closed telecommunication system with functional structure shown in Fig. 1;

A-2. (Device Capacity) All base virtual devices in the model have unlimited capacity. Comprising devices are limited: \(ab\)-device contains all the \(Nab \in \mathbb{N}\) terminals; switching system \((s)\) has capacity of \(Ns\) calls (every internal switching line may carry only one call); every terminal has capacity of one call, common for both incoming and outgoing calls;

A-3. (Calls' Capacity) Every call occupies one place in a base virtual device, independently from the other devices (e.g. a call may occupy one internal switching line, if it find free one, independently from the state of the intent B-terminal (busy or free));

A-4. (Channel Switching) Every call occupies simultaneously places in all the base virtual devices in the telecommunication system (comprised of devices \(a\) or \(b\)) it passed through, including the base device where it is in the moment of observation. Every call releases all its occupied places in all base virtual devices of the communication system, in the instant it leaves comprising devices \(a\) or \(b\).

A-5. (Environment) The calls in the communication systems' environment (outside the blocks \(a\) and \(b\) in Fig. 1) don't occupy any telecommunication systems' device and therefore they don’t create communication systems' load. (For example, unsuccessful calls, waiting for the next attempt, are in "the head of" the user only. The calls and devices in the environment form the intent and repeated calls flows). Calls leave the environment (and the model) in the instance they enter a Terminator virtual device;
A-6. (Parameters' Independability) We consider probabilities for direction of calls to, and holding times in the base virtual devices as independent from each other and from intensity \( Fa = \text{inc} \cdot Fa \) of incoming flow of calls. Values of these parameters are determined by users' behavior and technical characteristics of the communication system. (Obviously, this is not applicable to the devices of type Enter Switch, correspondingly to \( Pbs \) and \( Pbr \) - see 2.4.);

A-7. (Stationarity) The system is in stationary state. This means that in every virtual device in the model (including comprising devices like switching system), the intensity of input flow \( F(0, t) \), call holding time \( T(0, t) \) and traffic intensity \( Y(0, t) \) in the observed interval \( (0,t) \) converge to the correspondent finite numbers \( F \), \( T \) and \( Y \), when \( t \to \infty \). In this case we may apply the theorem of Little (1961) and for every device: \( Y = FT \);

A-8. (Randomness) All variables in the analytical model may be random and we are working with their mean values, following the Theorem of Little.

A-9. (Terminals' Homogeneity) All terminals are homogeneous, e.g. all relevant characteristics are equal for every terminal;

A-10. (A-Terminal Occupation) Every call, from the flow incoming in the telecommunication system (\( \text{inc} \cdot Fa \)), falls only on a free terminal. This terminal becomes a busy A-terminal;

A-11. (A-Calls Directions) Every A-terminal directs uniformly all its calls only to the other terminals, not to itself;

A-12. (B-flow ordinariness) The flow directed to B-terminals (\( Fb \)) is ordinary. (The importance of A-12 is limited only to the case when two or more calls may reach simultaneously a free B-terminal);

A-13. (B-Terminal Occupation) Probabilities of direction of calls to, and duration of occupation of devices \( ar, cr, ac \) and \( cc \) are the same for A and B-calls;

A-14. (B-Blocking Probability for Repeated attempts) The mean probability (\( Pbr \)) of a call to find the same B-terminal busy at the first and at the all following repeated attempts is one and the same. (This is the only assumption in this paper, causing systematic error. In (Poryazov 1992) it is shown, on the basis of simulation (Todorov, Poryazov 1985) results, that this relative error doesn't exceed 5% of the \( Pbr \), in a reasonable traffic load interval. Moreover the model without repeated attempts gives qualitatively the same results about the discussed problem (Poryazov, Bararova 1999).)

3.2. Equations
From the conceptual model, assumptions made and theorem of Little, we may almost directly obtain the next system of equations (1) (Poryazov 2004):

\[
\begin{align*}
Yab &= \text{Fa} \cdot \text{Ted} + \text{PadTad} + (1 - \text{Pad})[\text{PidTid} + (1 - \text{Pid})[\text{Tcd} + \text{PbsTbs} + (1 - \text{Pbs})[\text{PisTis} + (1 - \text{Pis})[\text{PnsTns} + (1 - \text{Pns})[\text{Tcs} + \text{PbrTbr} + 2(1 - \text{Pbr})\text{Tb}]]])].
\end{align*}
\]

where \( Tb \) obviously (from Fig.1) is:

\[
Tb = \text{ParTar} + (1 - \text{Par})[\text{Tcr} + \text{PacTac} + (1 - \text{Pac})\text{Tcc}].
\]

\[
\text{Fa} = \text{dem.Fa} + \text{rep.Fa}.
\]

\[
\text{dem.Fa} = \text{Fo} \cdot (\text{Nab} + \text{M Yab}).
\]
Equation (1.1) presents the intensity of the overall terminal teletraffic \( Y_{ab} \) as a function of \( F_a \), probabilities and holding times, shown on Fig. 1, as well as the mean occupation time of the B-terminals \( \frac{Y_{ab} - 1}{N_a - 1} \); Equation (1.2) simply expresses that the intensity of the flow of calls occupying A-terminal is the sum of the intensities of the primary (demand) and the repeated calls (ITU E.600) (see Fig. 1); Equation (1.3) shows the intensity of demand calls flow as a function of the intensity of generated calls from one idle terminal \( F_o \) and the macrostate \( Y_{ab} \) of the system (BPP - flow, see 2.3); Equation (1.4) determines the intensity of the repeated calls flow \( rep.F_a \), as a function of transition probabilities in the model. It is obtained in the same way as (1.1), directly from Fig. 2; Equation (1.5) is a conclusion from A-1, A-3, A-7, A-8, A-9, A-11, A-12 and A-14 (Poryazov 2004); Equation (1.6) expresses the intensity of the offered to the switching system flow of calls; Equation (1.7): \( Ts \) is the mean holding time of calls in the switching system, obtained in the same way as (1.1) (see s-device on Fig. 1); Equation (1.8) defines the offered traffic \( ofd.Y_s \) (ITU E.600) to the switching system; Equation (1.9) is a usage of the Erlang-B formula for evaluation of the blocking probability \( P_{bs} \) in the switching system, on the basis of the number of internal switching lines \( N_s \) and offered traffic \( ofd.Y_s \).

4. COMPUTATIONAL MODEL

In this paper, we classify the 41 parameters of the system of equations (1) as belonging to two types: 31 static and 10 dynamic. The 31 static parameters have known (given) constant values: \( M = 0; N_{ab} = 2000; N_s = 400 \) (20% from \( N_{ab} \)), or \( N_s = 2500 \) (125% from \( N_{ab} \)), in the case of a system without
blocking due to lack of internal switching lines; \( Ted = 2 \text{ sec.}; Pad = 9\%; Tad = 5 \text{ sec.}; Prad = 95\%; Pid = 1\%; Tid = 11 \text{ sec.}; Prid = 10\%; Tcd = 12 \text{ sec.}; Tbs = 5 \text{ sec.}; Prbs = 82\%; Pis = 0\%; Tis = 5 \text{ sec.}; Pris = 80\%; Pns = 1\%; Tns = 6 \text{ sec.}; Tcs = 0.5 \text{ sec.}; Prns = 1\%; Tbr = 5 \text{ sec.}; Prbr = 80\%; Par = 15\%; Tar = 45 \text{ sec.}; Prar = 75\%; Tcr = 10 \text{ sec.}; Pac = 20\%; Tac = 13 \text{ sec.}; Prac = 90\%; Tcc = 180 \text{ sec.}; Prcc = 1\%.

The chosen values of the static parameters are illustrative only and correspond to the classic PSTN.

The 10 values of dynamic parameters are mutually dependent and we choose one of them – the intensity of the input calls flow \( F_0 \) as the main input variable and its values cover the entire allowed interval. In this case, the system of equations (1) has 9 equations and 9 output parameters with unknown values (the main output variables): \( Y_{ab}, F_a, dem.F_a, rep.F_a, P_{bs}, P_{br}, ofd.F_s, T_s, ofd.Y_s \).

5. MODEL VALIDITY

The model presented is verified through mathematical analysis and confirmation tests of values of the main output variables. It is validated using a detailed simulation model, a development of (Todorov, Poryazov 1985), and qualitative behaviour comparison with measurements in real PSTN. The simulation model is with Poisson input flow of calls and all holding times, of the base virtual devices, are random variables with usual distributions. After theorem of Sevastianov (1957) we know that Erlang's loss formula is insensitive to the holding time distribution, therefore our mathematical model is practically insensitive to holding time distributions in every base virtual device, because we use the insensitive Little's formula. As a result, despite all inaccuracies in the assumptions (e.g. A-14) and mathematics (using the Erlang's formula for a limited number of sources) we reckon the model is valid, as a first approximation, for telecommunication systems with homogeneous terminals and (virtual) circuit switching. In any case, the conceptual and mathematical models are accurate enough as a basis for discussions of the paper's topic.

6. PRESENTATION MODEL

Detailed analytical study of the mathematical model gives limitations of the variables in the entire allowed intervals. Besides verification of the model, this makes possible the presentation of values of the overall network parameters, as normalized (all belonging to the interval \([0, 1]\)) and dimensionless.

7. NUMERICAL EXPERIMENTS

In our computational model, the system of equations (1) is nonlinear and has no explicit analytical solution. We are using an iterative numerical method, after a partially analytical solution. Some numerical results are presented on Fig.2, 3 and 4.

On Fig. 2 the main traffic characteristics of the communication system are shown, as a function of its macrostate, in the overall theoretically allowed interval. \( T_a \) depends on the state of the system, through \( P_{bs} \) and \( P_{br} \) (see Fig.1) and is decreasing with increasing of \( Y_{ab} \). \( Y_a \) may differ considerably from \( Y_b \). \( T_b \) is a constant (see Fig. 1 and Equation (1.1)) but \( Y_b \) depends on \( F_b \). When \( P_{br} = 1 \) then \( F_b = 0 \) (see Fig.1). \( Yab = Nab \) (see (1.5)) and obviously \( Yb = 0 \). One may see that the traffic \( Y_s \), carried by the switching system, reaches, but doesn’t exceed, the \( N_s \). \( Y_b \) is lower than \( Y_s \), because is a part of it (see Fig. 1). The traffic of listening busy tone (\( Y_{br} = \) blocked ringing), when the B-terminal is busy, is carried by the switching system, in our model, but it is not a part of the \( Y_b \). In general, the behaviour of the values expresses the mutual concordance of the model's results.
On Fig. 3 the significant influence of the call blocking on the communication system's parameters is seen: One and the same macrostate Yab is caused by different Ta and Fa in the two cases. The decrease of Ta, in the case without blocking in the switching, is due to Pbr only (see explanations to Fig. 2). The bigger decrease of Ta in the case with blocking, caused by Pbs in addition, is compensated (receiving the same Yab) by corresponding increase of Fa. This happens in the entire interval, where Pbs is not zero. In the rightmost point (Yab = Nab), Pbs = 23.13% and difference is not seen on the Fig. 3, because it is a small one: Ta/max.Ta = 13.84% without blocking and Ta/max.Ta = 13.76% with blocking. The maximum of the relative difference between values of Ta, in both cases, at one and the same Yab, is 90.78%, in comparison with the case with blocking.

The decrease of Pbs is strange at the first sight, but its explanation is on Fig. 4. On Fig. 4, offered to the switching system traffic intensity (ofd.Ys) is presented, in two cases: with and without blocking. Obviously, (see Fig.1), Ts depends only (as a linear function) on Pbr (see Equation (1.7)) and consecutively on Yab (see Eq. (1.5)). Therefore Ts has the same values in both cases, but it is decreasing faster than Ta, in the case without blocking (see Fig. 3).
Nab = 2000 terminals.
Results are presented correspondingly with:
thin lines, for Ns = 400 (20% from Nab), and
fat lines, for Ns = 2500 (125% from Nab).

\[ \text{ofd.Ys} \] is a linear function of \( Fa \) (see Fig.1 and Eq. (1.6)) and consecutively its values are bigger in the case with blocking, in comparison with the case without (see Fig. 3 and its comments). As a result (see Eq. (1.8)), the values of \( \text{ofd.Ys} \) are considerably different in both cases: At the point of their almost common maximum, \( \text{ofd.Ys/Nab} = 74.35\% \) in the case with blocking and \( \text{ofd.Ys/Nab} = 35.03\% \) in the case without blocking. The absolute difference is 39.32 and the relative difference, in comparison with the case without blocking is 112.25%.

Note: \( \text{ofd.Ys} \), in the case without blocking, corresponds to the ITU-T definition of offered traffic. We'll call it "ITU offered traffic", and \( \text{ofd.Ys} \), in the case with blocking – "real offered traffic".

Comment 1: The decreasing of \( Pbs \) (after reaching its maximum) is caused by the decrease of the offered traffic in both cases (ITU and real), because of the big decrease of the Call Holding Time \( (Ta) \), due to the increasing portion of unsuccessful calls (see Fig. 3), and, respectively, the decrease of the \( Ts \) and \( \text{ofd.Ys} \). Publications with observations of this phenomenon in real-life systems are not known, may be, because it appears in the cases of extremely high load (see Fig. 3 and Fig. 4).

Comment 2: The usual approach for specifying the necessary number of recourses (in the case if they are not enough), in the working real communication systems, includes offered traffic \( (\text{ofd.Ys}) \) estimation on the basis of the measured carried traffic \( (Ys) \) and
observed calls blocking probability ($P_{bs}$). In practice two alternative methods are used for estimation the traffic offered (Clause 5.1.2.2 of ITU E.501) – an inversion of the Erlang's formula, or the equation $ofd.Y_s = Y_s / (1 - P_{bs})$ (in our notation). (The maximal absolute difference between the values of the two sides of this equation, in our numerical results, is 8.97E-14.) Note that in this case the real offered traffic is calculated and the definition from (ITU E.600) is not used.

![Graph showing offered to the switching system traffic intensity ($ofd.Y_s$) and its components – offered intensity of the calls flow ($ofd.F_s$), and mean holding time ($Ts$) of one equivalent internal switching line, as functions of the macrostate of the system ($Y_{ab}$) in two cases – with ($Ns = 400$) and without blocking ($Ns = 2500$).]

**Figure 4.** The offered to the switching system traffic intensity ($ofd.Y_s$) and its components – offered intensity of the calls flow ($ofd.F_s$), and mean holding time ($Ts$) of one equivalent internal switching line, are presented as functions of the macrostate of the system ($Y_{ab}$) in two cases – with ($Ns = 400$) and without blocking ($Ns = 2500$).

**8. CONCLUSIONS**

1. Detailed normalized conceptual and correspondent analytical traffic models of an overall (virtual) circuit switching telecommunication system (like PSTN and GSM) are presented; The models are relatively close to the real-life communication systems with homogeneous terminals and are general and accurate enough as a basis for discussions on the paper's topic.

2. A normalized presentation model is used, for the numerical results of the next network traffic parameters, in the overall theoretically allowed intervals, as functions of the
macrostate of the system (the intensity of the overall terminal traffic \( Y_{ab} \)): for the A-terminals: intensity of the occupying calls flow (the input flow to the system) \( F_a \), mean holding time \( T_a \) and traffic intensity \( Y_a \); for the B-terminals: mean holding time \( T_b \) and traffic intensity \( Y_b \); for the switching system: intensity of the offered calls flow \( ofd.F_s \), mean holding time of one equivalent internal switching line \( T_s \), offered traffic intensity \( ofd.Y_s \), carried traffic intensity \( Y_s \) and call blocking probability \( P_{bs} \). Comparisons of results are made, in the two cases: with (number of the switching lines is 20% of the number of terminals) and without (number of the switching lines is 125% of terminals) blocking;

3. The mean holding time of the B-terminals \( T_b \) is a constant in the overall allowed interval of the macrostate of the system \( Y_{ab} \); The mean holding time of the A-terminals \( T_a \) is decreasing with increasing of \( Y_{ab} \). The minimum of \( T_a \) is 13.76% of its maximum.

4. One and the same \( Y_{ab} \) is caused by lower \( T_a \) and correspondingly higher intensity of the input flow to the system – \( F_a \), in the case of blocking, in comparison with the case without blocking. This is caused by nonzero values of the blocking probability \( P_{bs} \) only. In the case of blocking, a result is the increasing the intensity of the offered to the switching system flow of calls \( ofd.F_s \), in the point of the same \( Y_{ab} \), in comparison with the case without blocking.

5. The mean holding time of one equivalent internal switching line \( T_s \) depends on \( P_{br} \) (respectively on \( Y_{ab} \)) only, and is decreasing faster than \( T_a \) – its minimum is 3.96% of its maximum.

6. Offered to the switching system traffic \( ofd.Y_s \) is higher in the case of nonzero blocking, in comparison with the case of zero blocking (for one and the same \( Y_{ab} \)). This is because \( ofd.F_s \) has higher values at this \( Y_{ab} \) (when \( P_{bs} > 0 \), see Conclusion 4), \( T_s \) is independent of \( P_{bs} \) (see Conclusion 5) and obviously \( ofd.Y_s = ofd.F_s T_s \) (Little's formula). The relative difference between values of \( ofd.F_s \), in both cases, may exceed 112%.

7. Therefore, the ITU-T definition of offered traffic is not valid for the systems studied, because, in the case of nonzero blocking, real offered traffic may be much bigger than in the case of zero blocking. This is caused by the influence of the lack of resources on the processes in the communication system, which is not foreseen in the ITU-T definition. This influence is reflecting simultaneously on the offered and carried traffics. Because of this, creating a valid, clear and simple offered traffic definition is not easy.

8. The fast decrease of the holding time of one line \( T_s \) causes existing of a local maximum of \( P_{bs} \) and of the offered traffic correspondingly, at extremely high load of the system.

9. The predicted two phenomena in the studied communication systems (difference between the values of offered traffic in the cases with and without blocking and existing of a local maximum of \( P_{bs} \)) must be experimentally confirmed through measurements in real systems.

10. Described phenomena in time and traffic characteristics are emerging at the network level. In this paper one of the possible approaches is demonstrated, which may allows developing the Network and Terminal Teletraffic Theory and helps in determination of many network parameters of the present and next fixed and mobile networks.

11. The described approach is applicable directly for every (virtual) circuit switching telecommunication system (like GSM and PSTN) and may help considerably for ISDN, BISDN and most of core and access networks traffic modelling. For packet switching systems, like Internet, proposed approach may be used as a comparison basis.
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