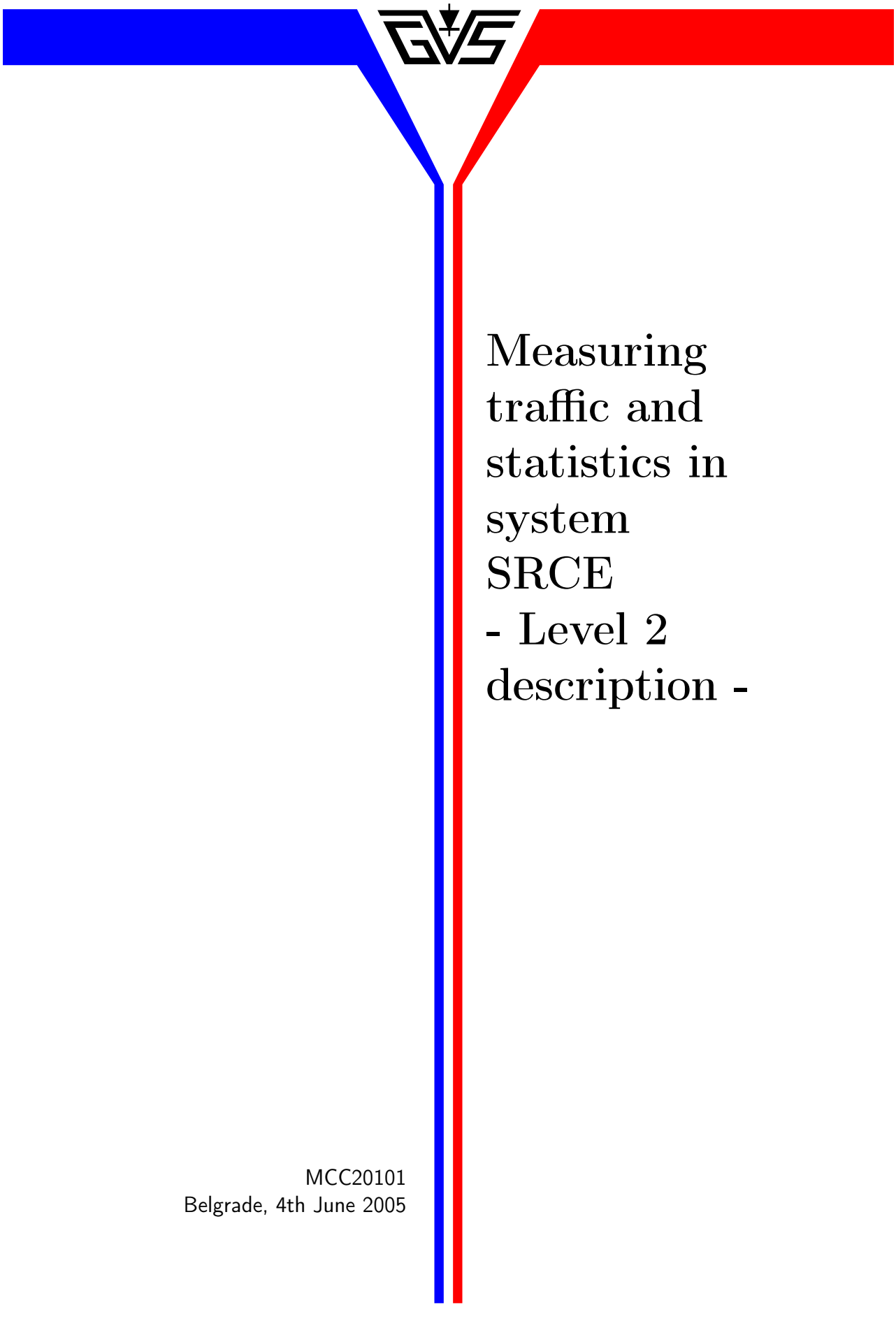

Measuring traffic and statistics in system SRCE - Level 2 description -

MCC20101
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Contents

1 Concept of measuring traffic and statistics

Measuring traffic and statistics in SRCE exchange is realized as two independent processes: *call statistics* and *measuring on resources*.

Call statistics represents the part of measuring and statistics which is performed for *calls*. Call represents the connection between two users, i.e. in the SRCE exchange, between two *connecting points*, which can be: subscribers, trunks or voice machines.

Call statistics represents:

Collecting data concerning calls (information about the events during call: time of seizure, release, dialed digit...)

- Forming *reports* based on call (these are appropriate tables where call data is grouped and processed). One part of contents of these reports is the result of *traffic measuring*, and the other is the *statistical data*, i.e. various counters of certain events.

Software module which we will call *module for call statistic* is assigned for gathering data and forming reports. Its functions are described in detail in this document.

Measuring on resources supply results of measuring and statistical counters related to individual resources in the exchange. Therefore, in this sense all calls (and other functions in the exchange) that use certain resource influence one measuring. Measuring on resources is designed for some resources like R2 transmitters and DTMF receivers.

Call statistics represents the basic mechanism for gathering statistical data in the exchange. Measuring on resources is somewhat separate mechanism which includes the measuring that needs to be made, and which were hard to perform by statistic call mechanism.

In this document are given:

- Description of gathering statistical data within call statistics
- Description of reports which the exchange generates based on gathered data from call statistics
- Description of reports which can be gained by further processing from these data, using helpful tools
- Description of gathering data concerning measuring on resources, as well as data themselves.

2 Data for call statistics

This chapter provides general information about what is contained in the data gathered during *call statistics*.

2.1 Call processing notification

Call processing in SRCE exchange forwards certain relevant events for each call to other "interested" modules. During an event, therefore during call processing itself, these events are distributed to other modules, which receive them and can use them to various purposes (notification, measuring etc.). One of these modules is the call statistics module. Information about call processing event, forwarded to other software modules, is called *call processing notification*.

Here with provide the list of call processing events along with a short description of situations in which these events take place. The terms used to describe these events ("incoming connecting point", "outgoing connecting point", "call table" etc.) are described in the appropriate document concerning call processing.

Event	Meaning
Occupied DPT	Occupied incoming connecting point for call
Occupied OPT	Occupied outgoing connecting point for call
Released DPT	Released incoming connecting point for call
Released OPT	Released outgoing connecting point for call
Received digits	Received digit sequence (digit block or separate digits)
Received category	Caller category received by signaling
Received A number	Caller number received by signaling
Determined category	Determined caller category (not by receiving, but call processing determined category based on adjustments in database)
Determined A number	Determined caller number (i.e. not received by signaling, but call processing determined it based on adjustments in database)
Performed modification	Call processing for some additional service performed modification of dialed digits
Directed call	Transmitted occupying signal by outgoing trunk, dialed subscriber ringing current or linked connection to voice machine
Determined traffic destination	Determined traffic destination in B analysis. More details concerning traffic destinations in paragraph 2.2
EOS code	Registered EOS code
State "free"	Received or determined called subscriber state "free"
...	

Event	Meaning
Answering	Called subscriber answered
B passed	Called subscriber put the handset down
B answered again	Called subscriber answered again after putting the handset down
Release	Caller put the handset down or release is received from incoming transmitter
Forced release	Forced release signal received from outgoing transmitter
Release	Release signal received from outgoing connecting point
Call VK expired	Time control for waiting for called subscriber to answer has expired
Connection failed	The call failed (at command by the operator or because diagnostics reported an irregularity)
DPT reset	Incoming connecting point transferred to state "in reset"
OPT reset	Outgoing connecting point transferred to state "in reset"
Call occupied	Call record occupied in call table. Call initiated
Call released	Call record released in call table. Call ended
No free call	Free call record not found in call table. Call denied
Restart	Big restart performed (for the given call: therefore, the call is charged and broken)
Charge	Call is charged
Link chain occupied	Link chain is occupied toward subscriber connecting point in the connection
Link chain released	Link chain is released toward subscriber connecting point in the connection
Transferring connection - stays	Call included in connections transfer and stays after transfer (the other call is canceled)
Transferring connection - fails	Call included in connection transfer, but after transfer it is canceled (the other call stays)

From these events, the following events: *call freed, call failed, restart* and *transferring connection - fails* are mutually exclusive and represent the four ways that a call in SRCE exchange can be ended (regularly, by failure, in restart or during connection transfer). Each call begins with an event *call occupied* and ends with exactly one of these four events.

Example: subscriber 510256 calls subscriber 510257. Call was successful. Sequence of events would be:

- Call occupied
- DPT occupied

- Digits received (e.g. 51025)
- Category determined: regular subscriber
- A number determined (e.g. 11510256, if 11 is the network group code)
- Traffic destination determined
- Digits received (and digit 7)
- OPT occupied
- Link chain occupied (for caller)
- Link chain occupied (for called subscriber)
- Directed call
- State "free"
- Answering
- Charge
- Release
- Freed DPT
- Link chain freed (for caller)
- Link chain freed (for called subscriber)
- Free
- Freed OPT
- Freed call

2.2 Traffic destinations

2.2.1 Purpose of traffic destinations

Prefixes of B analysis are used to recognize dialed digits. Therefore, dialed digits in each call pass through B analysis in order to determine where the call will be directed. More about this mechanism can be viewed in the appropriate document describing call processing. Traffic destination is a parameter assigned to prefixes in B analysis.

The purpose of traffic destinations is to sort the prefixes in B analysis in a way that is suitable for measuring and statistics. In the B analysis there's often a large number of prefixes, which are entered as different by reasons involving call processing or charging, but are not significant for measuring and statistics.

For instance, there are a lot of long distance prefixes in the country and often each of them will be entered separately, in order to determine various call directions and charging. However, from the statistical point of view, commonly the only relevant difference will be between long distance prefixes in the same transit area and long distance prefixes outside that area. That is, it will be necessary to count calls and measure traffic separately for one and separately for other prefixes, but nothing more than that (they should not be divided to separate prefixes).

To that purpose, it is intended that all prefixes that are *equal* when measuring and statistics are concerned get the same traffic destination. In the example above, all prefixes that direct traffic to other network groups of the same transit area would receive one (and the same for all) traffic destination, while other prefixes (network groups outside of transit area) would have another (but also the same for all) traffic destination.

The operator can, of course, alter assigned traffic destinations, and therefore group prefixes in various ways, depending on the application.

2.2.2 Way of determining traffic destination

Traffic destination is determined simultaneously with identifying dialed digits in B analysis. This determination is performed by call processing, considering that analysis of dialed digits is its assignment.

Prefix in B analysis may and may not have assigned traffic destination. If during the processing of a single call, B analysis is performed several times, the first assigned traffic destination is taken (the one corresponding to the first identified prefix with this parameter assigned).

Therefore, traffic destination does not have to be determined for *call* (e.g. no unidentified prefix in B analysis has assigned traffic destination, or if not existing prefix is dialed). If so, it will be determined maximum once, and call processing will in that moment forward the notification *traffic destination determined*.

2.3 EOS Codes

The following is a brief explanation of the event *EOS code*, which is forwarded by call processing as notification.

EOS code is an event identified during call processing that, generally, represents call failure in *register* phase: from the moment of occupying incoming connecting point to the moment of receiving subscriber state "free" or connection release. Various EOS codes are assigned to various "connection failure causes".

After identifying EOS code, call processing performs analysis by *EOS tables*, which enable certain call to be:

- disconnected (with appropriate signal or tone to caller)
- redirected using digit modification and B analysis
- continued by choosing next available OPT or next alternative in the route case.

For data statistics it is significant that each identified EOS code is forwarded from call processing as notification. If during call processing EOS code with configured connection failure is identified, it is often the only EOS code that will be identified. However, if EOS code is identified for which the call is redirected or continued, the call will not be disconnected immediately and it is possible that new EOS codes are identified later on.

Example: if for certain dialed digits call processing is configured so that it uses route case with two outgoing routes (”first choice” route and alternative route), with the alternative route being both way, the following sequence of EOS codes is possible:

1. EOS code ”no free trunks in the route”: set for continuance by the next alternative in route case
2. EOS code ”double occupation” identified when an attempt to occupy an alternative route was made, but double occupation is detected. Set for continuance (choice of the next available OPT)
3. EOS code ”double occupation”: that tempted was made to occupy free OPT with the same outcome as the first time (another double occupation)
4. EOS code ”no free trunks in the route”: alternative route is exhausted, this EOS code is set for continuance by the next alternative in route case
5. EOS code ”end of route case”: set for disconnecting line by ”block” signal.

If in step four there were available trunks in the route, this call could even work, i.e. to identify called subscriber state ”free”.

Complete table of codes depends on the software version in SRCE exchange. Still, in all the reports the operator can receive from data gathered for call statistics, EOS codes are displayed as a short explanation (e.g. *End of route case*), so that the operator can easily conclude the meaning of a given EOS code.

3 Gathering statistical data

3.1 Statistical cases

Gathering statistical data from call statistics is organized by *statistical cases*. Statistical case represents a set of rules by which the exchange is governed when selecting calls for which data is gathered.

When the operator specifies a statistical case, he in fact specified:

- Criteria based on which the exchange determines for which calls will the events be recorded
- Identifier by which recorded events will be stored in the exchange, i.e. by which they will be accessed later on.

For instance, an operator can enter a statistical case 0 with some parameters. This would mean:

- All calls that satisfy criteria issued in parameters will be recorded. Each event from these calls will be recorded
- All data recorded in the exchange are "classified under the number of statistical case 0". Therefore, if an operator wishes to create a report based on the gathered data, he will have to specify a number of statistical case (in this case 0) whose gathered data will form a report.

The exchange can simultaneously operate with a large number of statistical cases (the exact number depends on software version). One call can satisfy criteria of some (or all) of these statistical cases and it will be recorded for these cases.

3.2 Specified criteria in statistical case

The operator can issue certain *criteria* in a statistical case. These criteria are used to determine the calls for which data gathering is performed, for that statistical case. Issued criteria are:

- **Dialed prefix.** Data for call will be gathered only if a given prefix is selected in dialed digits. Empty prefix marks the collecting of all calls (i.e. cancels this criteria)
- **Call state**. Data is gathered only if a call entered the second state. It can have a value: *any* (this criteria is canceled), *directed call* (call must have an event *Directed call*), *call waiting* (call must have an event *State "free"*), *conversation* (call must have an event *Calling*) and *B passed* (call must have an event *B passed*)

- **EOS code**. Data is gathered only if a given EOS code occurs during call processing. This criterion may be issued or not
- **Category**. Data is gathered only if caller category is as issued. This criterion may be issued or not
- **Traffic destination**. Data is gathered only if traffic destination is as issued. This criterion may be issued or not
- **Incoming connecting points**. Criteria consist of a list of incoming connecting points. Data is gathered only if incoming connecting point of a given call is one of the listed points.
- **Outgoing connecting points**. Criteria consist of a list of outgoing connecting points. Data is gathered only if outgoing connecting point of a given call is one of the listed points.

This list of criteria is given for easier viewing. The *details* concerning the application of these criteria are explained in chapter 4. For instance, it is clear that for a call which *has a determined* traffic destination, if criteria *traffic destination* is set, the decision whether or not it will be recorded (e.g. it's data) depends on whether its traffic destination is as issued. However, what if a call *has no* determined traffic destination? These and similar questions will leave for chapter 4, paragraph 4.3.4.

3.3 Specifying statistical case

Operator specifies a statistical case:

- By entering the number and criteria of statistical case (except for the list of incoming and outgoing connecting points) and then:
- By adjusting the list of incoming connecting points and
- By adjusting list of outgoing connecting points.

In other words, the operator first specifies the number of statistical case and *all* the criteria except for the list of connecting points. Then he must make this list.

For making the list of connecting points the operator has a possibility to *add* connecting points into the list and to *erase* them. Commands for adding and erasing are conceived so that the operator can add/erase connecting points one by one, or a large number at once. Connecting points grouped by exchange organization are entered/erased at once: for instance, all trunks in a route, all subscribers on user frame, or the *entire exchange*.

The last possibility is left if the operator wants to disconnect criteria regarding the list of connecting points. By entering *all* connecting points in the exchange as incoming and *all*

connecting points as outgoing, practically no calls will be rejected (for data collecting) because their incoming or outgoing connecting point is not in corresponding list.

If an operator during specification of statistical case cancels *all* criteria, and when making a list of incoming and outgoing connecting points enters *all* connecting points off the exchange, all criteria will be canceled and within that statistical case *all* calls will be monitored! This of course does not disable collecting of *those same* calls and for other specified statistical cases.

3.4 Initiating and stopping a statistical case

Specifying a statistical case only issues *criteria* for which calls will data be collected. The collecting itself did not start.

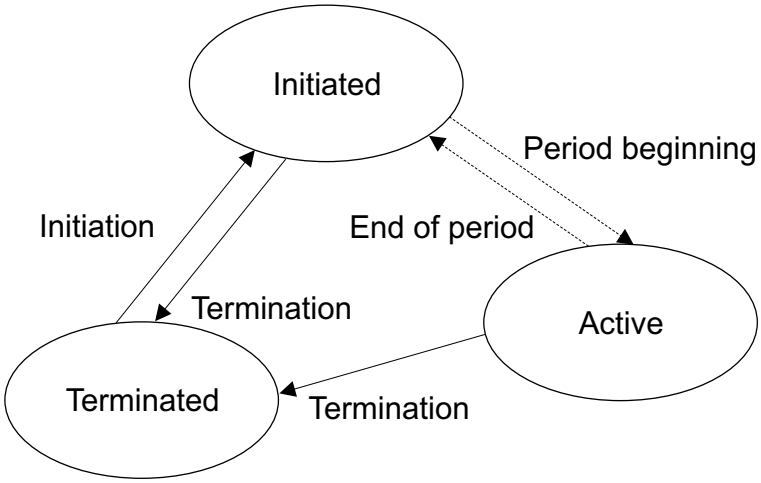
It can be considered that each statistical case is in one of three states: *stopped*, *initiated* and *active*. When a statistical case is specified, it is in state *stopped*. Only in that state is allowed its erasing (if, for instance, it is no longer needed). In this state there is no gathering of statistical data.

The operator can *initiate* a statistical case if it is in state *stopped*, which transfers it into state *initiated*. During initiation, the operator specifies the time of day when data collecting will be performed. For instance, an operator can specify a "main traffic hour", i.e. an hour with the highest traffic during the day. In state *initiated* there is also no collecting of statistical data.

Module for call statistics translates to physical case from state *initiated* the state *active* at the beginning of the specified period and, vice versa, from state *active* to state *initiated* at the end of a specified period. Only in state *active* is statistical data about calls collected.

The operator can stop a statistical case, which translates the statistical case from state *initiated* or *active* to state *stopped*.

The following figure displays these states.



(full line displays operator commands, and dotted line displays transitions that automatically take place).

In this way an operator can specify multi-day collecting of statistical data. Every day in a specified time the collecting begins (and of course stops in a specified time). After a few days, the operator will have these data *collectively,* within the same statistical case, so all these data will be considered when making the report.

(Of course, there is an operator command which enables erasing the data collected for a statistical case, which starts the collecting "from the beginning").

This raises a question: what happens with the calls that have been initiated at the time the statistical case becomes active, or the ones that lasted at the time it ceased to be active (becomes *initiated* or *stopped*)?

Generally, the answer is: when a statistical case is initiated, during initiation all active calls are viewed and it is determined which of these satisfy the criteria of a given statistical case. For those that satisfy the criteria, an *artificial event recording* is performed as if the events for that call happened at the time the statistical case passed into state *active*.

When a statistical case leaves the state active, for all still lasting calls an event *freed call* is recorded as if it just happened.

For each call with artificially recorded events, a special indicator of *artificial events recording* is recorded. Recording these events is necessary for the functions that make reports to work properly. Still, an operator will have in his reports an indication for each call that was artificially altered. Once again, this indication relates only to calls active at that time a given statistical case became *active* or ceased being *active*.

More details about this artificial recording of events can be found in paragraphs 4.4 (transfer into state *active*) and 4.5 (leaving that state).

4 Mechanism for collecting data - detailed description

In this chapter is the detailed description of the mechanism for collecting statistical data. Basically, this is the explanation of the algorithm based on which the module for call statistics sorts events from various calls by various statistical cases. The chapter is technical and is not necessary for understanding the rest of this document. There are, however, certain details in terms of collecting statistical data that have influence on the sum of data collected in each particular statistical case, and which can be understood only on the basis of the material in this chapter. Therefore, for *total* understanding of collecting data we should (maybe not on the first read) study this chapter too.

4.1 Tables for adjusting statistics

Collecting statistical data in exchange is adjusted with the contents of the following tables in the database: *statistical cases, incoming connecting points for statistics* and *outgoing connecting points for statistics*.

Table of *statistical cases* covers the following fields:

- Number of statistical case
- Prefix (for criteria *dialed prefix*)
- Call state (for criteria *call state*)
- EOS code (for criteria *EOS code*). One separate value is used to label that this criteria is not specified
- Category (for criteria *caller category*). One separate value is used to label that this criteria is not specified
- Traffic destination (for criteria *traffic destination*). Value 0 labels that this criteria is not specified
- Indicator: is the statistical case initiated (0: *stopped*, 1: *initiated* or *active*)
- Indicator: is the statistical case active (0: *stopped* or *initiated*, 1: *active*)
- Start of collecting (i.e. time of transfer into state *active*)
- End of collecting (i.e. time of leaving state *active*)

Obviously, state of statistical case is represented by two listed indicators.

Tables of *incoming connecting points for statistics* and *outgoing connecting points for statistics* have similar structure. Cells in them are:

- Number of statistical case
- Type of connecting point (subscriber, trunk, voice machine)
- Number of connecting point.

In each of these tables, for each statistical case separately, are given corresponding lists of connecting points used as criteria for collecting data.

4.2 *StatStores (statistical buffers)*

Collecting statistical data is organized using *statistical buffers* (Statstores). One statistical buffer is an area of memory where events are collected for one call. Even if events for one call are collected for more statistical cases at one time, only one buffer is used.

This buffer contains the following data:

- Number of *call* which it relates to. That is the number of a given call in call table (used by call processing)
- List of statistical cases for which events from a given call are collected
- List of collected events so far. Here are recorded events which call processing forwarded as notifications during processing of that call (they are listed in paragraph 2.1).
- Time of last event
- Indicator of whether there were *artificial* recordings of the event.

Basic algorithm for recording events would be:

- For each notification of a call, a statistical buffer which records events for that particular call is requested. If it is not found, that means that for a given call there will be no recording of events and notification is ignored. If it is found, event is added to the list of events for that call
- Some of notifications are used to test criteria from statistical cases. When such a notification occurs, before it is recorded in a statistical buffer, it is tested if it is in compliance with the criteria of those statistical cases which are in the list of a given statistical buffer. Those statistical cases whose criteria are not satisfied are erased from the list. If in the end there are no more statistical cases for which the data is collected for a given call, statistical buffer itself is erased. If not, notification is added in the list of events in that buffer.
- When the call has ended, the contents of a given statistical buffer are added by the exchange to data collected so far, especially for *every* statistical case which remained in the list, i.e. whose criteria is satisfied (*recording statistical buffer*, see *4.3.2*).

4.3 Recording events

Here is given a *detailed* algorithm of recording events during call statistics. It assumes that *notifications* were received from call processing and that there is a sum of *statistical buffers* (see *4.2*) where call events were collected so far. This algorithm determines the *precise* interpretation of criteria specified in a statistical case (described in *3.2*).

4.3.1 Notification processing

Most notifications are *recorded* in a statistical buffer. During recording, *event itself* and the *time of its origination* are recorded, relatively compared to the previous. In this way, from the recorded data it is possible to reconstruct the flow of call for which the data is recorded in specified buffer. The following table explains all the notifications that are processed during call statistics, as well as how each particular notification is processed.

Events	Processing
Occupied DPT	For each active statistical case is tested if a specified connecting point is in its list of incoming connecting points. If at least one such statistical case is found, a new statistical buffer is formed and this event is recorded in it as first.
No free calls	Within this notification number of connecting point is specified from which call was attempted. For each active statistical case is tested if a specified connecting point is in its list of incoming connecting points. If at least one such statistical case is found, a new statistical buffer is formed and this event is recorded in it as the only one, an end test is performed (4.3.3) and, if it is successful, buffer recording (4.3.2).
Occupied OPT	A statistical buffer is requested for a given call (if it is not found - notification is ignored). Then, in the list of statistical cases for this statistical buffer is checked if a specified connecting point is in their lists of outgoing connecting points. All statistical cases for which this does not apply are excluded from the list. If there are no statistical cases in the list, statistical buffer is erased. If there are, this event is added to it.
...	

Events	Processing
Occupying chain of links, Received A number, Determined A number, Modification performed, EOS code, Routed call, Charge, Switching connec. - stays, State "free", Answering, B passed, B answered again, Disconnect, Forced disconnect, Release, BK call expired, DPT reset, OPT reset	A statistical buffer is requested for a given call (if it is not found - notification is ignored). If found, this event is added to it
Received digits	A statistical buffer is requested for a given call (if it is not found - notification is ignored). Then, for each statistical case in the list for detected statistical buffer, compares digits of a certain call (from the first digit, not only digits recently received) with prefix specified as criteria in statistical cases. Inconsistency is detected if dialed digits do not contain prefix, nor the prefix contains dialed digits. Each statistical case for which inconsistencies are detected is erased from the list. If there are no statistical cases in the list, statistical buffer is erased. Otherwise, this event is added to it.
Received category, Determined category	A statistical buffer is requested for a given call (if it is not found - notification is ignored). Then, in the list of statistical cases for this statistical buffer is checked if for some of them caller category is specified as criteria, different from the received (determined). All statistical cases for which this occurs are taken out of the list. If there are no statistical cases in the list, statistical buffer is erased. Otherwise, this event is added to it.
...	

Events	Processing
Determined traffic destination	A statistical buffer is requested for a given call (if it is not found - notification is ignored). Then, in the list of statistical cases for this statistical buffer is checked if for some of them statistical category is specified as criteria, different from the determined. All statistical cases for which this occurs are taken out of the list. If there are no statistical cases in the list, statistical buffer is erased. Otherwise, this event is added to it.
Switching connection - failure, Released call, Call failure, Restart	A statistical buffer is requested for a given call (if it is not found - notification is ignored). Then, end test is performed (4.3.3) and, if successful, buffer recording (4.3.2)
Other	Are not processed

We can see that notifications are not processed: *released DPT* and *released OPT* (for they practically come together with notifications *disconnection*, or *release*) and *released linked chain* (appearing when a call enters disconnection phase, which is easily reconstructed from the existing data, if needed) and *call busy* (because it is followed by notification *occupied DPT*).

4.3.2 Recording statistical buffer

Statistical buffer during the time of its existence contains a list of collected events (notifications) for one call and the list of statistical cases for which the events are collected. When data collecting is finished, i.e. when either notification *no free calls* is received, or one of these notifications: *Call switching - disconnection, Released call, Disconnection, Restart,* collected data should be distributed for each statistical case. This distribution is called *recording statistical buffer.*

After recording statistical buffer, data concerning specified call (collected in statistical buffer) are added to previously collected data for each statistical case separately. That way, when forming statistical reports, operator will see the same call in all those statistical cases for which that call is collected (i.e. those that were active during call and whose criteria was fulfilled by that call).

4.3.3 Final checkup

Final checkup is always performed before *recording of statistical buffer* (see *4.3.2*). The purpose of this checkup is to secure that all criteria of statistical cases that could not have been fulfilled before are fulfilled now.

Let's look at all the criteria in short.

- *Dialed prefix.* During notification processing *Received digits*, all statistical cases whose prefix does not match the dialed digits are denied.
- *Category.* During notification processing *Received category* and *Determined category*, all statistical cases that have this criteria set and whose received (determined) category does not match that criteria are denied.
- *Traffic destination.* During notification processing *Determined traffic destination*, all statistical cases that have this criteria set and whose determined traffic destination does not match that criteria are denied.
- *Incoming connecting points.* During notification processing *Occupied DPT*, all statistical cases whose list of incoming connecting points does not contain specified connecting points are denied.
- *Outgoing connecting points.* During notification processing *Occupied OPT*, all statistical cases whose list of outgoing connecting points does not contain specified connecting points are denied.

The only criteria *not* checked by this are: *EOS code* and *call state*. These criteria are such that it is not possible to conclude whether specified call satisfies specified criteria based on an event. Both criteria are formulated as a request for event occurrence *during call processing*. If up to a certain point the event did not occur, it doesn't mean that it won't occur later!

Therefore, *final check up* represents the check up of these two criteria. It consists of checking the *entire list* of collected events and establishing whether a specified EOS code or specified event (*directed call*, *state "free"*, *calling*, *B passed*) are present on the list for each statistical case separately. Those statistical cases whose criteria are not satisfied are erased from the list. If the lists remains empty in the end, *final check up* failed, and specified statistical buffer is erased. If there is at least one statistical case on the list, *final check up* was successful, and *recording* can be performed for the specified statistical buffer.

4.3.4 Detailed description of statistical cases criteria

Previously described notification processing method, i.e. satisfying certain criteria from statistical cases during call processing, and others in the *final check up* (see *4.3.3*), leads to these applications of the criteria from a statistical case (description is given from the statistical case's "point of view"):

- *Dial prefix.* Criteria are not satisfied only if it is discovered that dialed digits in the call do not contain prefix, nor the prefix contains dialed digits. Criteria are satisfied if subscriber *did* choose the specified prefix (and maybe some other digits). Criteria *are* also satisfied if subscriber chose only a part of the specified prefix.

- *Category.* Criteria are not satisfied if a different category than the specified one is received (or determined). Therefore, for calls with undetermined category (e.g. calls without dialing) these criteria are considered *satisfied.*

- *Traffic destination.* Criteria are not satisfied if a different traffic destination is specified. Therefore, for calls with undetermined traffic destination, this criterion is considered *satisfied.*

- *Incoming connecting points.* Criteria are satisfied only if incoming connecting point from call is on the list of incoming connecting points of a given statistical case. In every call, incoming connecting point is occupied first (and only once), so it cannot be changed later.

- *Outgoing connecting points.* Criteria cease to be satisfied if outgoing connecting point that is not on the list of outgoing connecting points for specified statistical case is occupied. In other words, if for that call *several* outgoing connecting points were occupied, it is sufficient that one of them is not from the list, and the criteria is not considered to be satisfied. It is regardless of whether the call entered conversation state or not. On the other hand, if outgoing connecting point was not occupied for that call, the criteria stay *satisfied.*

- *EOS code.* Criteria are satisfied if between events for a given call, during the final checkup, specified EOS code is found (at least once!). If this EOS code enables call continuance, specified EOS code can be found several times, and our call can be either successful or unsuccessful.

- *Call state.* Criteria are satisfied if between the events for a specified call, requested event is found at least once (see description in *3.2*).

4.4 Switching statistical case to state "active"

Module for call statistics constantly checks if "it is time" to switch some of statistical cases from state *initiated* to state *active.*

When such a statistical case is found, i.e. when system time in the exchange matches the time specified during initiation of a statistical case, the exchange labels the statistical case initiated. Furthermore, it checks if the existing calls in the exchange should be recorded for that statistical case. It uses the following algorithm:

- For each call present in the exchange at that time, it checks all the criteria not checked in the *final checkup* (4.3.3). Therefore, it checks the validity of: dialed digits, category, traffic destination, incoming and outgoing connecting point. It only checks what is actually specified. For instance, for calls with unoccupied outgoing connecting point, it does not check outgoing connecting point.

- If some of these criteria are not satisfied, it simply proceeds to the next call
- If all criteria are satisfied, it looks for possible statistical buffer (in which data for that call are collected, possibly for some other statistical cases)
- If statistical buffer is found, it merely adds specified statistical case to it
- If statistical buffer does not find it, it generates a *new one*, and then performs *artificial recording* of event to it. Specified statistical case that switched to *active* state is recorded as the only statistical case for that buffer.

Artificial recording represents transcribing everything that can be significant for further statistical operation, like events, but the recorded time of occurrence for *all* these events is the current time. Specifically, this is recorded during transfer of a statistical case to *active* state, for calls for which a new statistical buffer is generated:

- If incoming connecting point is occupied for a specified call: event *Occupied DPT* is recorded
- If outgoing connecting point is occupied for a specified call: event *Occupied OPT* is recorded
- If some of the link chains are occupied for specified call: event *Occupied link chain* is recorded (separately for link chain toward DPT, separately toward OPT)
- If there are dialed digits for specified call, event *Received digits* is recorded along with the digits received until that time
- If category is received or determined for specified call, event *Received category* is recorded
- If A number is received or determined for a specified call, event *Received A number* is recorded
- If at least one EOS code is identified for a specified call, event *EOS code* is recorded with last identified EOS code
- If traffic destination is determined for a specified call, event *determined traffic destination* is recorded
- Depending on whether the specified call is in state "waiting for caller state", "awaiting call", "conversation", or "B passed", it records events:
- *Routed call*,
- *Routed call* and *State "free"*

- *Routed call*, *State "free"* and *Call*
- *Routed call*, *State "free"*, *Call* and *B passed*, respectively.

In this way, it is assured that these events will be available for processing during the generation of various statistical reports. For instance, in reports for calculating total traffic in the exchange in conversation phase, a sum of all periods of time in all collected calls in conversation phase is given. By artificially recording event *Calling* for call in conversation phase at the time of statistical case's transfer to *active* state, precise calculation of the part of call spent in conversation phase is enabled. If that was not the case, during processing it would be considered that there was no call, i.e. for that call the duration of time spent in conversation phase would be 0.

4.5 Switching statistical case from state "active"

When collecting data with this call statistics, the moment when a statistical case leaves state *active* is very complex. At that moment we should stop collecting data for the statistical case being stopped, without making any impact on other statistical cases. Quite separate problem is the simultaneous stopping of several statistical cases.

Module for call statistics constantly checks whether a statistical case that was *active* should cease to be active. When that happens, this module determines the *list* of statistical cases for simultaneous stopping.

If there is at least one statistical case on this list, each statistical buffer is checked and its list of statistical cases is viewed. Two lists are created from this list: the list of stopped statistical cases and the list of statistical cases that are still active.

If the list of *stopped* statistical cases is empty, i.e. no statistical cases were stopped for specified statistical buffer, there are no further actions, and specified statistical buffer remains to collect events for its own statistical cases (obviously - still active).

If there is at least one statistical case on the list of *stopped* statistical cases, a *copy* of statistical buffer is made, whose list of statistical cases contains only stopped cases. Furthermore, event *Freed call* is *artificially* added to this copy, as if it just occurred, and then the *recording* of statistical buffer takes place (4.3.2), i.e. previously mentioned copies.

In regards to the original buffer, it is not modified, but all finished cases are removed from its list of statistical cases, i.e. only those that are still active remain. If *all* statistical cases are removed by this, specified statistical buffer is also erased; otherwise it stays (in order to collect events for remaining statistical cases).

5 Statistical reports

Section 3 describes the procedure for acquiring data related to call statistics. As previously stated, data is:

- Organized by statistical cases, i.e. they are collected in a separate place for each statistical case and their separate processing is enabled
- Within the data collected for one statistical case, organized by calls, i.e. containing information about calls that satisfied criteria of a specified statistical case while it was active
- Within one call - organized by *events*. Events are notifications that call processing distributed during processing of a specified call.

Module for call statistics itself provides a *net* of various statistical reports: *detailed review of statistics, review in table, review of traffic type, statistics for connection success per traffic destination* and *statistics of connection success per route.* Basically, the last type of report contains two types - *statistics of connection success per incoming route* and *statistics of connection success per outgoing route.*

Specified reports are described in this chapter.

5.1 Detailed review of statistics

Detailed review of statistics is the most simple (but also the largest) review of statistical data. Its purpose is to provide the operator with full access to call processing, when separate calls are concerned. Using this report, operator can conclude what are the reasons for which some call (or calls) did not succeed, or why some calls are processed in an unexpected way.

Report consists of the output of all events, for each event separately, collected within a specified statistical case. Operator can filter these events by time of origination (specifically, the time of last event). Other filters are not anticipated, considering that the statistical case itself is - a filter.

In the output, the operator can see the sequence of events as they are collected for each call within a statistical case. Time between each two consecutive events is also visible.

During generation of this report, no processing is performed. Data is displayed as they are.

5.2 Tabular review of statistics

Tabular review of statistics is the report in which each call is represented by one table row. Therefore, the entire report represents a table, suitable for *post processing* by various tools.

Cells of produced table are:

- **Time of occupation**. That is the moment of occupation for incoming connecting point, i.e. the event *Occupied DPT*.

- **Incoming connecting point**. Also produced from the event *Occupied DPT.*
- **Incoming route**. For subscribers and voice machines instead of route name it is only displayed that this is a subscriber (voice machine)
- **Dialed digits**. They are received by tracking event *Received digits:* initially, sequence of dialed digits is empty. For each event *Received digits,* digits recorded for that event are added to the sequence of dialed digits
- **Caller category**. That is a category that is received or determined (event *Received category* or *Determined category*). If category was not received/determined, cell is empty
- **Outgoing connecting point**. Produced from event *Occupied OPT.* If this event did not occur, this cell is empty. If there were several events, only the last is taken.
- **Outgoing route**. Produced from event *Occupied OPT.* For subscribers and voice machines instead of route name it is only displayed that this is a subscriber (voice machine)
- **Transmitted digits**. They are produced by tracking the events *Received digits, Modification* and *Routed call* in the following way: initially it is considered that the sequence of digits is empty. For each event *Received digits*, digits recorded in that event are added. For each event *Modification*, specified modification is performed on a sequence of digits. For event *Routed call*, the ordinal number of digit from which digits were transmitted is recorded. Finally, if there was an event *Routed call*, displayed digits in this cell are actually a formed sequence of digits, beginning with the recorded ordinal number of that digit. If that event did not occur, the cell is empty.
- **Linking time**. It is the time of event *Occupied OPT.* If that event did not occur, cell is empty. If there were several events, the last one is taken
- **EOS code**. If there was no event *EOS code,* cell is empty. Otherwise, it contains the last EOS code.
- **Indication "is subscriber free"**. These indications will occur if there was an event *State "free"*
- **Indication "was there a call"**. This indication will occur if there was an event "Answering"
- **Number of charging pulses**. Cell is empty if there was no event *Charge.* Otherwise, it contains the number of charging pulses
- **Time of release**. It is the time event *Release* occurs. Cell is empty if this event did not occur (e.g. if the call failed)

- **Indication "was there freeing"**. This indication will occur if there was an event *Freeing*
- **Freeing time**. It is the time event *Freeing* occurs. Cell is empty if this event did not occur (e.g. if the call failed, or if OPT was not busy)
- **Indication "incoming blockade"** (so far it is not used).
- **Indication "outgoing blockade"** (so far it is not used).
- **Indication of artificial recording.** This indication will occur if *artificial recording* of event was performed for a specified call. Basically, it means that the call was already in progress when the collection of statistical data began, or it was in progress at the time collecting stopped.

We should say that expandable tools called *KM* are developed in GVS, used for *post processing* of this table. Input for these tools is the table itself in a form of text file. The tools generate several reports based on the table:

- Report about the distribution of traffic (data is classified by pair incoming route/outgoing route; all subscribers form one route, all machines form another route):

- Number of call
- Percentage of B subscribers answering
- Review of average call duration
- Traffic on incoming route (in Erlangs)
- Traffic on outgoing route (in Erlangs)
- Distribution of EOS codes: Sorted list of all EOS codes (similar to the summation report in *5.4* and *5.5*), as well as the number of linked and unlinked calls, number of calls where called party was free, where there was an answering, and also the review of the number of unlinked calls without EOS code and with EOS code, classified per number of dialed digits (1, 2, 3, 4, 5, 6 and more).

5.3 Reviewer of traffic type

5.3.1 Description of report

In this report, it is possible to see all calls from the specified statistical case classified per type of incoming and outgoing connecting point in:

OPT type/DPT type	Subscriber	Trunk	Voice machine
Subscriber	Local	Outgoing	Subscriber -GM
Trunk	Incoming	Transit	Trunk - GM
Voice machine	GM - Subscriber	GM - Trunk	GM - GM
Not occupied	Subs.-unocc. OPT	Trunk - unocc. OPT	GM - unocc. OPT

For each of these types of traffic, there is an additional division to successful and unsuccessful. Call is successful if dialed subscriber was free. Types of traffic with unoccupied OPT cannot fail, and all other types of traffic are divided to successful and unsuccessful.

For each of the 21 types of traffic gained in this way, a total number of calls is displayed. For successful calls, the average duration of conversation phase is displayed as well as the traffic in Erlangs.

5.3.2 Generating reports

Report is generated in the following way: initially *call charging meters* and *charging meters of conversion phase total duration* of all types of traffic are annulled. Then, for each call collected for specified statistical case, requested events are:

- *Occupied DPT*. This event must be found and it determines the type of DPT (subscriber, trunk, voice machine)
- *Occupied OPT*. This event does not have to be found. If it is found, the last such event (if there are several) determines the type of OPT (subscriber, trunk, voice machine). If it is not found, OPT was not occupied.
- *State "free"*. If this event is found, call is declared successful, otherwise it failed.

Furthermore, if event State "free" is found, the duration of conversation phase is calculated (from this event to the end - to the last event in call).

In this way, traffic type is determined for specified call. Call counter for that type of traffic is increased by one, and the charging meter of the total duration of conversation phase is increased by the time of conversation phase for that call.

Finally, all call counters are displayed in the final report. For successful calls, the average duration of conversation phase is equal to the charging meter of total duration of conversation phase divided by the number of calls. Traffic is equal to *total duration of statistics* divided by the value of the charging meter of total duration of conversation phase.

(During transition from all calls of a statistical case, *total duration of statistics* is determined approximately, based on duration of events recorded in statistical case).

5.4 Statistics of connection success by traffic destination

5.4.1 Description of report

This report consists of two tables. In the first table are listed all traffic destinations and the following parameters for each of them:

- Number of traffic destination
- Total number of calls
- Number of calls with EOS code
- Number of calls with called subscriber free
- Percentage of calls with called subscriber free
- Number of calls with no answering
- Percentage of calls with no answering
- Number of "remaining" calls
- Average duration of register phase
- Average duration of call waiting
- Average duration of conversation

One table row consists of calls for which the traffic destination was not determined. Finally, there is a "summation" row - for all calls (regardless of the traffic destination).

"Other" calls are mostly calls in which caller put the phone set down (released the connection) in register phase. From the explanation of how this report is generated (*5.4.2*) it will be clear why this is so.

In the second table, for each traffic destination EOS codes are classified. For each traffic destination and every EOS code that answered, in here is listed the number of appearances of that EOS code and the percentage of uses of that EOS code within the specified traffic destination. This table also has a "summation" part, where EOS codes (with number and percentage of appearance) are listed for all calls, regardless of the traffic destination.

5.4.2 Generating reports

Previously mentioned tables are generated in the following way: one sum of counters and charging meters is generated for each statistical destination, and they are:

- Counters of EOS codes (one for each EOS code)

- Counter of answered calls
- Counter of unanswered calls with free subscriber
- Counter of "other" calls
- Charging meter of total duration of register phase
- Charging meter of total duration of call waiting phase
- Charging meter of total duration of conversation face

There is a sum of counters and charging meters for calls without traffic destination. But first, all these counters and charging meters are annulled.

Then every record of call is processed, within the specified statistical case. For each call, based on the events recorded for that call, specified call is classified:

- If there was an event *Answering*, call was answered,
- Otherwise, if there was an event *State "free"*, call is placed in a group with free subscriber, but no answering
- Otherwise, if there was at least one event *EOS code,* call is placed in a group of calls with EOS code
- Otherwise, call is placed in group "other".

In group "other" therefore, belong mostly calls where dialer cut the connection in registered phase.

Besides, during call duration time is measured: time until event *State "free"* is the duration of register phase, then time until event *Answering* is the duration of call waiting phase, and then comes the duration of conversation phase.

Finally, a traffic destination is determined for a call. Whether it is determined (i.e. there is an event *Determined traffic destination*) or not, this undeniably specifies the sum of counters and charging meters.

Now this sum is updated. To charging meter values are added measured durations of register phase, call waiting phase and conversation phase. Depending on how a call is classified, counter increases for calls that had answering, for calls where subscriber was free, but they didn't have answering, and one of the counters for EOS codes or counter of "other" calls.

Sums of data gathered in this way are sufficient for generating reports.

First table: number of calls with some EOS code is the simple sum of a number of calls by each EOS code separately. Number of calls where subscriber was free is produced by adding counters for those calls *without answering* and *with answering*. Sum of *all* counters makes the total number of calls. If this total number of calls is not zero, it is easy to calculate call

percentages with EOS code, with state ”free” and with answering. Finally, the average duration of register phase, call waiting and conversation phase is gained by dividing charging meters of total duration of these phases, in order, by the total number of calls, the number of calls where dialed scriber was free, number of calls where there was an answer.

Second table: Practically contains the counters of EOS codes, only sorted by frequency of answering EOS codes and displayed.

5.5 Statistics of connections success per route

For this report, we give only the description, considering the way of generating this report is *identical* as in the previous report, except that instead of traffic destination incoming or outgoing route is determined. Furthermore, it is not necessary for route to be defined (if corresponding connecting point is not occupied). Besides, all subscribers are counted as one route and all voice machines are counted as one route.

When issuing report, operator decides if he wants the report by *incoming routes* or by *outgoing routes*. The report itself, as the previous one (Statistics of connections success by traffic destination, see *5.4*) consists of two tables.

In the first table are listed all the routes that occur between call data. If the operator issued a report by *incoming routes*, those are all incoming routes from which calls recorded for specified statistical case have arrived (all subscribers count as one route; all voice machines count as one route). If the operator issued a report by *outgoing routes*, those are all outgoing routes to which calls recorded for specified statistical case are directed to (all subscribers count as one route; all voice machines count as one route), as well as a special record for ”non-existing” route (outgoing connecting point was not occupied). For each route are listed the following parameters:

- Route name (there are names assigned for ”route” ”all subscribers” and for ”route” ”voice machine”)
- Total number of calls
- Number of calls with EOS code
- Number of calls where dialed subscriber was free
- Percentage of calls where dialed subscriber was free
- Number of calls where there was no answering
- Percentage of calls where there was no answering
- Number of ”other” calls

- Average duration of register phase
- Average duration of call waiting
- Average duration of conversation

Finally, there is a ”summation” row - for all calls (regardless of route).

”Other” calls are mainly calls where dialed subscriber hung up the phone (released connection) in register phase. The reason is the same as the previous report (see *5.4.2*).

In the second table, EOS codes are classified for each route. For each route and each EOS code that answered, in here is listed the number of appearances of that EOS code and the percentage of that EOS code appearance within the specified route. This table also has ”summation” part, where EOS codes (with the number and percentage of appearance) are listed *for all calls*, regardless of the route.

6 Measuring on resources

Measuring on *resources* is performed by separate modules for each resource. There is *measuring of traffic on DTMF receivers* and *measuring of traffic on R2 receivers*.

6.1 Measuring traffic on DTMF receivers

6.1.1 Measuring possibilities

Considering the DTMF receivers are organized by user groups, this measuring is issued within user group. Measuring is issued by specifying a time interval (in minutes) and the number of receiver on which the traffic is measured, or by issuing measuring on *all* receivers.

In report that is later generated, is the record of measuring duration, number of occupied DTMF receivers, average duration of occupation and traffic on receiver.

6.1.2 Module for measuring

Module for measuring traffic on DTMF receivers is developed more generally, so it is applicable for measuring and statistics on other resources of user group. It uses the following abstraction:

- Measuring relates to a group of resources
- Each resource in a group is in one of several possible states
- At the start of measuring, module can read how many resources are in which state
- Module receives information about changes of resource states and updates the number of resources by states
- Module can *count* transfers from specified states to other states (updates counters when it receives information about change of resource state)
- Module can *measure* total time all resources spent and in each state (it updates the measured time when it receives information about the change of resource state)
- At the end of measuring, module can extract data needed for the report from the data received by counting and measuring.

Specifically, for measuring on DTMF receiver, the number of resources in group is 1 (the DTMF receiver itself), states of receiver are: busy and free, *occupations* are counted (i.e. transfers from state *free* to *occupied*) and total time in state *occupied* is measured.

For measuring on *all* DTMF receivers, *all* DTMF receivers are in one group, states of receiver are also: busy and free, *occupations* are also counted (i.e. transfers from state *free* to *occupied*) and total time in state *occupied* is measured.

Finally, in both cases, traffic is calculated as the total time in state *occupied* divided by the total time of measuring, and the average duration of occupation - as the total time in state *occupied* divided by the number of occupations.

6.2 Measuring traffic on R2 receivers

As R2 receivers are organized by trunk cards, this measuring is issued for trunk cards. Module for measuring traffic on R2 receivers can measure traffic on one R2 receiver or on all R2 receivers. When measuring is issued, duration of measuring is specified (in minutes) and the number of R2 receiver for which traffic is measured (if measuring is issued on one R2 receiver).

After issuing measuring, module labels those R2 receivers for which measuring is performed (therefore, one or all). During measuring, occupations of those receivers are counted, and the time of occupation is calculated by recording the time of occupation during the occupation of any of them. When one of them is freed, by subtracting that moment from the entered is determined how long was the specified receiver occupied.

In the report at the end of measuring, we can also receive: the number of occupation, total time of receiver occupation, traffic by receivers and average duration of occupation. Traffic is calculated as the total time of occupation divided by the total time of measuring, and the average duration of occupation - as the total time of occupation divided by the number of occupations.