Paper 116-26

Informational System for Planning and Consolidation

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ABSTRACT

Data processing model for MDDS editing was developed after analysis of planning and consolidation business processes, and was tested by prototype implementation of the Informational System using SAS/EIS customization and SAS/AF tools. The sense of new approach consists in using SAS Multidimensional Report object not only in passive mode for browse data, but also in active mode for dynamically modification both data and dimension values, for formulas building. Special rules are stated for edit value in any cell of any report. They are based on balance keeping and allow changing aggregate tables data in any order with keeping data mismatch at levels of RESERVE, which are below in hierarchy. User may create and modify own multidimensional database beginning just from one cell, to fill it by data and dimensional values from EXCEL tables with hierarchical header and left side-header with arbitrary tree structure, by computed values, manually edit and distribute values by some ways. User may control the upper boundary level of data consolidation, to prevent from changing the values of upper levels - responsibility of another users. Intended audience - application developers and end users with unsatisfied needs.

INTRODUCTION

It seems to be quite naturally and it has legitimate expectations that some SAS/EIS users make instinctive attempts to edit data values presented by Multidimensional Report, but it is useless now and data may be only browsed. The needs to change data values firstly concerns cells with planing data, but some reports data may be absent and preliminary estimates should be entered.

We suppose that systematic approach in developing and building multidimensional data model without editing restrictions would enlarge way for new class of program solutions, based on interactively building and modification multidimensional data structures, because there are many planning program products on a market, which does not allow to change data from up to low, for example, work duration's in SAS Project, in MS Project.

Computing data integrity is main prevention for arbitrary changing data in MDDS (MultiDimensional Data Structure or PROC SUMMARY output data set) and we focus only on these data transformations, which keep computing integrity. SAS MDDB data structure is tool for compact storage MDDS and rapid data extraction, so we frequently will not distinguish them.

Actual article is some result of R and D work of IT specialists from IBS Company with economists of Russian Railway branch. During the cooperative work we have encountered with three main problems on the background of permanent transition situation from established and developed system of information technology based on paper to electronic tolls:

1. How to manage with hundreds and thousands variables, describing activities of any railway enterprise or the whole branch, which are the base for some hundreds established report forms - standard of railway branch?
2. How to arrange a work with computed variables in easy manner, suitable for economists to work with computing models and methods of calculations?
3. How to edit MDDS with keeping the computing integrity and without ER model using, which allows avoiding ineffective renormalization operations?

Faced these problems we were interested firstly by questions of comparing multidimensional data modeling with ER data modeling and how these two approaches transient each other. The key moments for us in understanding these problems and data modeling were following:

1. Normalized ER model is too narrow oriented, mainly to data entry, for work with fixed hierarchy set, and adding new hierarchy is much more difficult in comparison with MDDS;
2. Establishing the fact that practically any table from the album of railway branch standard reports is just some multidimensional report from some hypothetical MDDS;
3. All multiformity OLAP reports from MDDS is produced by some geometrical object which is presented in different coordinate systems;
4. Optimization of physically structure MDDS is based on selection the best variant from different equivalent database presentations as geometrical object;
5. All three problems, mentioned above, have the same fundament – the control method for large amount objects by combinations of small amount parameters (in this case dimensions and dimensional values);
6. It seems the most appropriate mathematical tool for solving the mentioned above problems should be based on tensor analysis. Because it includes descriptions of roll-up and roll-down by dimensions, formulas for new coordinates calculation in different coordinate systems. It also allows formulation the financial-economical enterprise model with in time development, of course, based on conservations laws.

However, we have not know any applications of tensor analysis to financial-economical calculations with OLAP technology, may be it is future theme and shows only direction of our work.

Actual work is devoted mainly to the last problem; it states background for changing the data in MDDS with keeping the computing data integrity in the case of additive measures (statistics as N, SUM). After preliminary consideration MDDS decomposition this paper answers the following questions:

1. How to edit the value of measure in any aggregate point?
2. What changes should be done to keep the computing integrity of the whole structure?
3. How to control upper level of consolidation to prevent from changing the data above some aggregation level?

The power of user entry MDDS modifications is increased by with formulas building and integration with EXCEL. By this reason loading model will be described and computing model will be presented shortly, because it will be described in separate article.

BUSINESS PROCESSES AUTOMATION APPROACH

Planning is complex interactive business process involved many people from different levels of organization structure, including negotiating features between them. Closely related is reporting business process of collecting data for last timed intervals and estimated data for future intervals, because they usually use the same dimension values.

We proceed from assumption that at first step for automation purposes we should focus only on data treatment processes, which are born by business processes of planning and reporting, and build appropriate mathematical data transformations model. The better the model catches data transformations features the easier process of automation is. The poor model may not prevent automation, but leads to unnecessary and progressive resource expenses in advance by all program product life circle – designing, development, testing, implantation, and exploitation.

We suppose that sense of data treatment concerned with planning business process consists in distribution data values from higher aggregation level to levels of lower data aggregation, and horizontally from one cell to another. Otherwise, data treatment concerned data consolidation is directed in opposite from detail to aggregate data.

Most planning persons usually are situated in the middle of organization hierarchy and deal with mix of these two processes with opposite directions. Any of these persons receives some limits for resources from upper level and distributes these more details for lower levels, which became limits for the lower level planning person. The new detail values are consolidated in aggregate values, which are presented for browsing and comparing to upper level persons.

MDDS DEFINITIONS

To be correctly we need to introduce definitions, the base of our method. It seems that agreed notation of MDDS is not exists, but we looked mainly SAS/EIS Multidimensional Report behavior and objects from other software vendors (SAP, Oracle, Microsoft, Cognos, Business Objects). We will use as synonymous following words: point of multidimensional space, node of multidimensional lattice, item of multidimensional matrix, cell of multidimensional report.

Dimension – axis with named points (dimension values). Point's order and distance between them is not significant. There is null point and there is Reserve point between others.

Multidimensional space (or lattice) is Cartesians product of dimensions crossing in null points.

Event – value registration of some scalar function in the point of multidimensional space. Each event record should have attributes set – dimension values. Informational systems for work at events level of details are named "transactional systems", but systems for reporting, analysis, planning work with measures of events values on time intervals.

Measure – scalar function computed in lattice nodes according some rules. Measure type 1 for detail points is defined as values and for aggregate points is computed by all points included by this aggregate point. Measure type 2 is computed over points of the same aggregation level.

Examples of measure type 1 are FREQ, N, SUM and other statistics in point, for measure type 2 are cumulative totals for time interval.

Projective hyper plane – hyper plane containing all nodes of multidimensional lattice with fixed values of one or some coordinates.

Projection operation gives rules for computing measure type 1 in lattice nodes by following: measure in current node is computed over all nodes of projective hyper plane crossing current node. This operation is named by roll up, and reverse operation for data navigation is named roll out or expand.

Detail point is the point of multidimensional space with absence null coordinate of any dimension.

Aggregate point is the point of multidimensional space with presence null coordinate of any dimension.

Reserve point is the point of multidimensional space with presence Reserve coordinate of any dimension.

Compound dimension – axis with named points with one-to-one correspondence to non empty points of multidimensional space, produced by some set of dimensions (simple or compound), crossing by null points. Point's order on axis is not important.

Hierarchy is compound dimension with imposed order of simple dimensions. It may be presented by fixed height trees graph, number of trees is equal first dimension values number and level number is equal number of simple dimensions. For points of any dimension the order is not important, but exchange point positions will exchange whole according underlying trees.

Dimensional crossing is two-dimensional lattice as Cartesians product of axis with simple or compound dimensions; in nodes of it the measure value is presented.

Parallel top is geometrical figure (set of points) produced by all possible projection operations for one detail point. Applying the PROC SUMMARY to one detail point may produce all points of this figure and measure will have equal values in them.

CONSEQUENCES FROM DEFINITIONS

The previously stated definitions followed by many conclusions concerning MDD structure. At first we consider the decomposition of MDDS by parallel tops as base for MDDS editing.

MEASURE DECOMPOSITION

There are at least two ways for work and imagine multidimensional structure. One way consists in working with terms of projection operations and hyper planes. We found more useful another way of working with geometrical images of parallel tops, because on this way we have automatically supported condition of computing integrity independently from used hierarchies.

The parallel top is a figure from all possible ways of aggregation some detail point to the point of origin (zero point). All parallel tops have common zero point and have some crossings in other aggregate points. Aggregate point's SUM is equal the sum of elemental functions from all parallel tops crossing this point.

For two dimensional space we have a set of partially overlapping rectangles defined by detail points as it is shown on Figure 1, for three dimensions we have a set of parallelepipeds and so on.

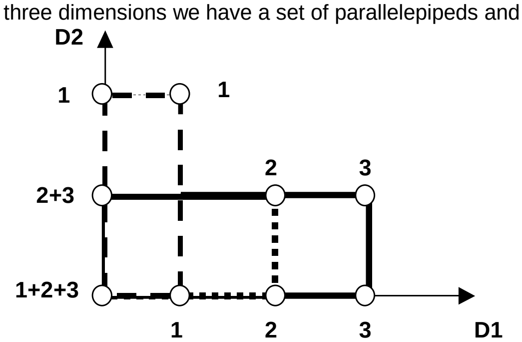

Figure 1 Decomposition of MDDS with 3 detail points (1,2,3) for two dimension space (D1, D2). Three rectangles (parallel tops) are defined by detail points and for six other aggregate points there are superposition (crossings) of the rectangles. 2+3 means sum of measures from 2 and 3 parallel top.

This property follows from independents of SUM from order of components, and exists for other similar permutable measures. Average is ratio of SUM and N (number of non-missing values) and this measure is based on two permutable measures.

This view easy explains by geometrical way as composition of geometrical figures the complex trees presentation of many hierarchies, which may be considered on detail points.

MORE COMMON MDDS VIEW

The discussion may be more concrete, without limitation of generality, on the following example of MDDS of 3 dimensions. Program for creating 8 points x1-x8 in space d1, d2, d3 is below.

```
data a;
array x{*} x1-x8;
i=0; do d1=2,3; do d2=2,3; do d3=2,3;
     var=round((normal(0)+10));
     i+1; x{i}=var; output; x{i}=.;
     end;end;end;
run;
```

Following code compute aggregate sums for VAR and by the same way creates parallel tops from detail points x1-x8.

```
proc summary ;
class d1 d2 d3; var x1-x8 var;
output out=b sum=;
data c;set b; sum_x=sum(of x1-x8);
run;
proc print; format _type_ binary3.;
run;
```

Result is presented on Figure 2 in the form of full MDDS for all detail points. Columns x1-x8 are parallel tops, sum of them by horizontally is column SUM_X, which is equal to column VAR. This proves out expected decomposition, because columns are equal, despite the different order of summarization.

Obs	d1	d2	d3	_TYPE_	_FREQ_	x1	x2	x3	x4	x5	x6	x7	x8	var	sum_x
1	.	.	.	000	8	10	10	11	9	8	10	11	8	77	77
2	.	.	2	001	4	10	.	11	.	8	.	11	.	40	40
3	.	.	3	001	4	.	10	.	9	.	10	.	8	37	37
4	.	2	.	010	4	10	10	.	.	8	10	.	.	38	38
5	.	3	.	010	4	.	.	11	9	.	.	11	8	39	39
6	.	2	2	011	2	10	.	.	.	8	.	.	.	18	18
7	.	2	3	011	2	.	10	.	.	.	10	.	.	20	20
8	.	3	2	011	2	.	.	11	.	.	.	11	.	22	22
9	.	3	3	011	2	.	.	.	9	.	.	.	8	17	17
10	2	.	.	100	4	10	10	11	9	.	.	.	.	40	40
11	3	.	.	100	4	.	.	.	.	8	10	11	8	37	37
12	2	.	2	101	2	10	.	11	.	.	.	.	.	21	21
13	2	.	3	101	2	.	10	.	9	.	.	.	.	19	19
14	3	.	2	101	2	.	.	.	.	8	.	11	.	19	19
15	3	.	3	101	2	.	.	.	.	.	10	.	8	18	18
16	2	2	.	110	2	10	10	.	.	.	.	.	.	20	20
17	2	3	.	110	2	.	.	11	9	.	.	.	.	20	20
18	3	2	.	110	2	.	.	.	.	8	10	.	.	18	18
19	3	3	.	110	2	.	.	.	.	.	.	11	8	19	19
20	2	2	2	111	1	10	.	.	.	.	.	.	.	10	10
21	2	2	3	111	1	.	10	.	.	.	.	.	.	10	10
22	2	3	2	111	1	.	.	11	.	.	.	.	.	11	11
23	2	3	3	111	1	.	.	.	9	.	.	.	.	9	9
24	3	2	2	111	1	.	.	.	.	8	.	.	.	8	8
25	3	2	3	111	1	.	.	.	.	.	10	.	.	10	10
26	3	3	2	111	1	.	.	.	.	.	.	11	.	11	11
27	3	3	3	111	1	.	.	.	.	.	.	.	8	8	8

Figure 2 Example of MDDS as output data PROC SUMMARY with parallel tops decomposition x1-x8, SUM_X, VAR. Sign "." for d1, d2, d3 notes 0 coordinate values or aggregate points indication, other columns points indicate empty cell. Circles are all aggregate points containing point (3,2,2) as sum component.

AGREGATE HIERARCHY

In MDD structure from Figure 2 column _TYPE_ shows aggregate subspace binary number, where 0 in some position means roll up produced in corresponding dimension, and 1 means that data is expanded. Detail table is defined by _TYPE_ from all 1, which means that data is not rolled up any dimension. Maximum aggregates number is 2**N, for N dimensional space.

Number of possible ways of roll up for detail to point of origin is equal N! and is equal the number of roll out of point of origin to detail table. Aggregates _TYPE_ value, after roll up in some dimension, should be changed by replacing 1 by 0 in correspon-ding position. Since the roll out order is given by dimensions sequence, then the value of relation `N!/2**N` represents the robust estimation of hierarchies number to be supported by one aggregate table, it many times exeed 1 just for N>4.

Consequently, there are aggregate hierarchies in MDDS in the form of chains with max length N, types of neighbors different by 1 in some position. These chains of tables contain preliminary calculated measures and used for rapid data navigation.

GEOMETRY OBJECTS HIERARCHY

Column VAR in detail table represents geometrical figure, which is controlled by permutation group of dimensions d1, d2, d3 and dimension values. Columns x1-x8 in detail table gives better presentation of VAR items transformations after exchange columns d1, d2, d3 or dimensional values.

Term detail table or aggregate table is conditional. Each aggregate table may be considered, as detail table in the subspace of its roll out dimensions and its geometrical figure is result of roll up the figure from all space.

So, we have consistent hierarchy of geometrical figures to be in computing integrity, which is controlled by permutation group of dimensions and dimension values as one whole figure.

LINEAR SPACE FOR ACTIVITY VARIABLES

Columns x1-x8 and VAR of matrix on Figure 2 are vectors of linear space, which dimension equal now 27. All possible parallel tops give nonzero domains for bases functions of this space. But number of dimensions much more then number of bases functions and it is impossible to vary aggregate values and keep computing integrity. The situation became full changed by introducing reserve values in dimensional values.

Every aggregate point have one corresponding reserve point, which may be get by change zero coordinate values by reserve value. These reserve points are detail points too; they have not zero coordinates more. All detail points form full set of base functions to get any column VAR not only in detail space, but in space with number of dimensions equal the number of all detail and aggregate points, for given figure.

The differences in dimensions numbers of these two spaces: detail with reserve and detail with reserve plus aggregate is compensated by additional number of equations (value in aggregate point minus value in corresponding reserve point equal some initial value, which is determined by figure).

So, introducing reserve values and set of equations, which followed from computing integrity, makes it possible to vary any aggregate value of VAR column and keep computing integrity.

TWO AND MORE DIMENSION MDDS REPRESENTATIONS

In practice we firstly use one or two compound dimensions for MDDS presentation. Figure 2 shows one compound dimension with imposed order of dimensions (hierarchy) representation. PROC SUMMARY produces this canonical representation.

There are many equivalent representations of MDDS on a plane in the form of dimensional crossing, formed by two compound dimensions (hierarchies). Every simple dimension should be included only in one compound dimension and these two hierarchies are parts of one hierarchy. Two-dimensional representation has practical sense by following reasons:

1. Two way representation is more compactly and informatively on a screen;
2. Ability to apply column computing model, because rows computing model for SAS table is not provided;
3. One, two (and more) dimension representations are used for optimal database design;
4. Manage with activities measures by compound names.

It is very suitable to use SAS procedure PROC TRANSPOSE for transformations from canonical one-dimensional to different two-dimensional representations and back transformations after column calculations and for creating composed variable names from dimension values.

One-dimension representation of MDDS may usually drop all empty points and point's position may not be calculated as array item, but in this case point's value should be keep together with all coordinate values. Multidimensional representations should keep dimensional crossings, which may contain large amount of empty points. So, there are two opposite factors of resource spending: keeping empty cells and dimensional values.

What points are empty, it is characteristics of real data structure. Maps of the dimension crossings define design of compound dimensions after combining these dimensions in compound one. Most software vendors propose the simplest design of MDDS as multidimensional array, beginning from simple dimensions, which in our terms are compound dimensions. They reflect subject area and should be named as business dimensions.

We prefer to keep simple dimensions and to build compound dimensions as possible combinations of simples one: they should not give rare crossing, but rather full plane to be useful in work.

Simple dimensions are also used for manage by variable names of activities just the same nature (km, hour, ton). Compound name of activity directly relates to compound dimension value.

ROLL OUT IN DIFFERENT DIMENSIONS

One of the main MDDS features is ability to roll out any aggregate value in different dimensions, or in set of dimensions. The deeper we are in MDDS, the less possible roll out directions we have. But to every detail point we are able to come from N directions, for N dimensional space.

A minimum complexity structure item of roll out is the combination of two one-dimensional simplexes master-detail, where master is one-dimensional simplex with aggregate points which parallel one dimension and detail line is parallel to another dimension and may move by common point along master line. Figures 3 shows the ability of roll out by one to one or by two to two dimensions.

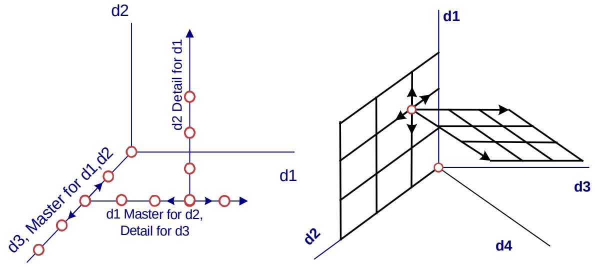

Figure 3 Step by step roll out aggregate values by master-detail. Master value is equal sum of detail values.

RARITY STRUCTURE OF MDD

The functionality of Multidimensional Report object from SAS/EIS demonstrates in action full multiformity representations of just the same geometrical figure produced by permutation group of dimensions and dimension values. Sequent, user can select any different dimensional crossings and investigate not only pictures of data, but also relations between dimensional values.

Geometrical figure is determined by all non empty detail points, which should be specified at the development stage of MDDS. The real world structure is reflected in the form of relations between dimensional values. There may be two main relations between dimensional values: one to many and many to many.

For example, year and quarter dimensional crossing should produce densely filed table (many to many relations), but quarter and month should always produce rare structure (one to many relations). Compound dimension year, quarter, month does not contain any empty cells. How to describe hierarchically structures in MDDS (organization or budget structure)? The solution is following: each hierarchy level represents one simple dimension.

The rule for editing MDDS values allows not only to fill cells by real data values, but also to form the geometric figure at any stage of work with MDDS (design or exploitation of MDDS).

The removing empty cell from compound dimension is the principle "data driven application" in action. Design of the geometrical figure may be allowed to users and various consecutions of points editing may exist. At first only detail reserve point (all coordinates equal reserve value) should exist, and user may add some dimension values, then he creates dimension crossing and fill by zeros appointed cells of structure, and so on steps down to detail points. Another way is to fill detail points by zeros and all aggregate points will be zeros filled too.

EDITING MDDS

We should understand under editing of the MDDS the changes of aggregate values and definitional domain by the way of add or delete detail points, aggregate points, dimensions, which preserve computing integrity, that is the equation of measure values in aggregate points to computed by detail points.

The measure decomposition principle follows that editing MDDS with computing integrity consists in to add (or delete, or change) some parallel tops to structure. It is more obvious for detail point, than for aggregate point, because always each parallel top is crossing only one detail point (and is determined by it).

So, measure in any aggregate point is equal sum of measures from all parallel tops crossing this point. We use this for building the following rule for changing values in aggregate points and preserve computing integrity: **If we want to change value in aggregate point and keep computing integrity of MDDS, we must add (or subtract) in MDDS new parallel top crossing this aggregate point.**

For the aggregate point one should decide which parallel top of many possible should be used for correction. Detail point for this parallel top may exists or may be used reserve point, if we do not know what detail point to use. What reserve point may be used? We introduce common rule: **all zero coordinate values of the aggregate point must be changed to RESERV values**, and we get detail point, which parallel top is crossing the aggregate point with guarantied computing integrity.

Next step is to calculate all points of the parallel top – to apply PROC SUMMARY to the reserve-detail point and modify the MDDS. Limited number of aggregate tables is used in practice for supporting the hierarchies and not all apexes of parallel top should be used, because each apex corresponds to one aggregate table (has unique _TYPE_ value).

In the most simple case only detail table used, aggregate calculations are quickly produced in passing and all edit rules also work.

DELETE FOR AGGREGATE POINT

The operation of deleting aggregate point from MDDS is not so simple as adding operation and may entail deleting some other aggregate points. At first step zero value should be entered in this point, it leads the moving value to another point according planning directions set. At second step we may to delete all hyper plane, crossing the aggregate point. But some parallel tops based on deleted detail points also may cross another aggregate points with zero value after deleting. Some of these zero aggregate points should be delete, because they have not more background in the form of detail point. We have some analog with situation of reference integrity violation in form of suspended reference.

Fortunately, this problem has following solution: if aggregate point statistic N (number of crossing parallel tops), will be equal or less zero after delete all hyper plane detail points, then this aggregate point must be delete from MDDS.

SCALABILITY

In practice composite key on all classes (dimension) variables is used and scalability of solution is guarantied by the circumstance that for adding parallel top in MDDS it is need to find and edit only one record from every aggregate table. Modification MDDS produced by place using MODIFY operator.

SENSE OF RESERVE POINTS

If we understand MDDS as set of reports of different levels of aggregation keeping computing integrity, then all space of reserve points will keep differences between reports, which may exist during the planning work. We use yellow color for reserve points. When measures in all reserve points equal zero, then different levels plans (or reports) are in conformity state, else values of reserve must be used to distribute for plan values. It follows creating reserve point on next lower level and so on.

SET OF PLANNING DIRECTIONS

When we distribute reserve value to the point of current level we subtract one parallel top crossing reserve point and add parallel top crossing target point, both parallel tops have equal measure. User can see simple redistribution effect of some value from one point to another, and for his common work it is not necessarily to know that picture is much more complex and is multidimensional.

We may get reserve value directly from the upper levels points of current subspace by adjust the column of check boxes controls, placed in user interface of "Value editing" window as is shown in Figure 6. This window contains names up to ten current dimensions and after '=' current dimensional values. Set of turn on check boxes, from current available, identifies reserve cell. If all directions are turn off then only one parallel top will be added and consolidation up to zero point aggregate will take place. If point of origin value used as computing integrity (or balance) indicator, then adding single parallel tops should be prohibit.

UPPER LEVEL CONSOLIDATION BOUNDARY

Superpositions of two parallel tops, described above, produce interesting and useful effect of the upper level consolidation boundary. On all levels between reserve value level and target point (it may be aggregate or reserve or detail point) level the consolidation process will take place. Values on all levels upper the reserve level will not be changed, because result of superposition equal zero. Figure 4 demonstrates consolidation boundary effect in the case 3 aggregate levels on a screen.

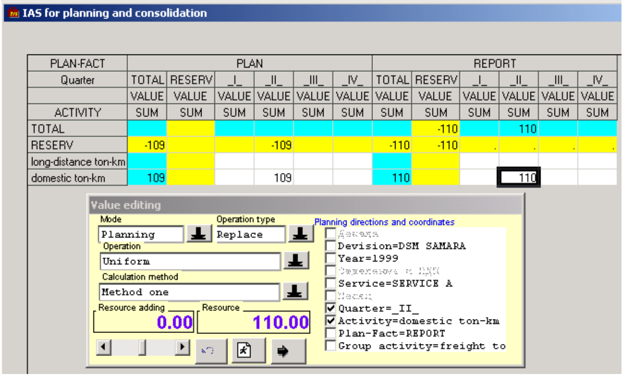

Figure 4 Left table Plan shows planning operation in direction Quarter, values in up TOTAL line are not changed. Right table REPORT shows planning operation in direction Quarter and Activity, value in (TOTAL,TOTAL) cell is not changed, but both aggregates (sum by rows and sum by columns) are consolidated.

APPLICATION INTERFACES

The prototype implementation of the system for planning and consolidation is useful tool for verify described effects. We use Multidimensional Report object window for data navigation and always on top window with tools panel for data editing and formulas building as it show on Figure 5.

MODIFICATION OF HEADERS

Application supports design MDDS by user just from one point. Dimension from hierarchy for insert or delete dimension values is defined by position of active cell as shown on Fig.7. Modification of header is achieved by moving dimension to left side header and moving back after modification, by drag and drop tools.

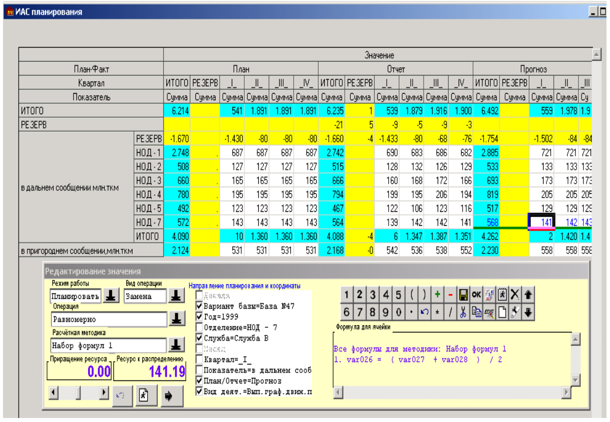

Figure 5 General view of the prototype system for resource planning and consolidation. Left side header is hierarchy activity, divisions. Header is compound dimension of Plan-Fact, Quarter, value of resource and SUM. Below is floating window with tools for editing values and for formulas building. Green lines indicate cells with formulas. Left blue side in cell may indicate that points have note comment.

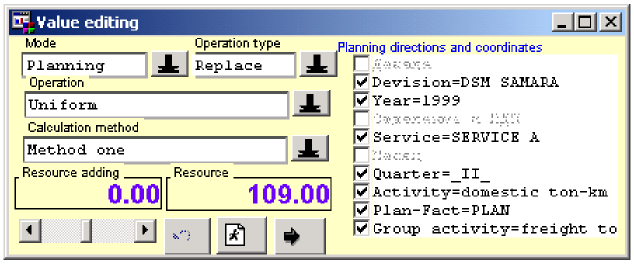

Figure 6 Value editing window is presented. The value from active cell passed to Resource entry box after point at cell and new value set back after push on Go button. On the right up to ten possible dimensions and dimension values are presented. Set of active dimensions shows depth of active cell in MDDS and for detail points all dimensions will be ungrayed. The window may be expanded to right for work with formulas building.

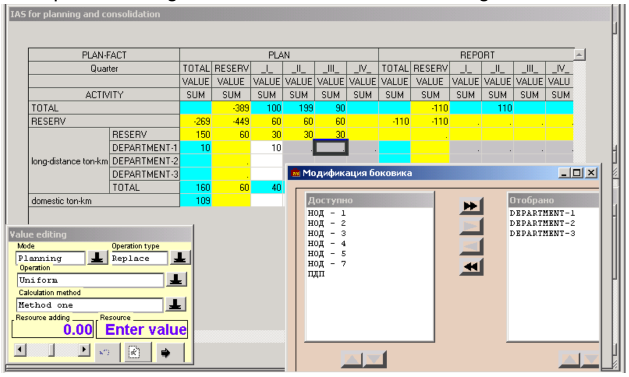

Figure 7 Modification of the left side tree header, right low window contains all possible values of dimension for insert or delete. Rows deleting produced preliminary edit them by zeros. We may also add new analysis variable by this way.

COMPUTING MODEL

Computing model is a necessary tool for planning work and applying rather vast methods of calculations on the base standard developed by economical experts. The SAS/EIS computing model have restriction by simple dimension. We expand this to compound dimension, and now formulas from arbitrary columns or rows may be produced and results are written to MDDS. Formulas in cells may be copied in set of dimensions and arguments of formulas may have some dimension coordinates to be fixed. When user builds formulas he use Multidimensional Report as database navigator to find necessarily cells and to point on them. Planning direction control elements are used for copy formulas direction setting and for the absolute values of coordinates setting for arguments.

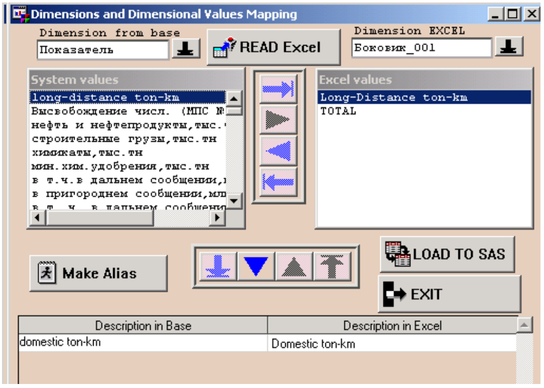

Figure 8 Window for loading back after editing EXCEL table with trees header and left side header structures and mapping synonymous dimension values. Triangle controls support set of mapping operations in single and multiple modes and backups.

CONCLUSIONS

New mathematical model of data processing for MDDS editing was proposed and tested on prototype Informational system for supporting planning and consolidation business processes, based by using SAS/EIS Multidimensional Report customization.

It was shown that based mathematical functionality of this object consists in samples generation from the presentation multiformity of the geometrical figure, produced by the permutation group from dimensions and dimension values. PROC TRANSPOSE may produce the same data transformations in batch mode

This geometrical figure contains all non-empty detail points, where some scalar function is set, and all aggregate points, where scalar function is calculated. In the case the calculation method does not depend from arguments order, like SUM, then function allows decomposition on elementary figures – parallel tops with constant values on apexes.

These parallel tops are invariant from hierarchies applied and became minimal element of the structure modification. We consider MDDS to be changed in increments from one state to another in which aggregate sums keep computing integrity.

Introducing Reserve levels in dimension values make it possible to organize MDDS as collection of coordinated hierarchical reports and differences between them in reserve space.

Reserve levels provide for degrees of freedom for editing any aggregate points data and distribute data values in any direction as from up to low as horizontally on one level of hierarchy.

It was shown how combined ideas of reserve space and movements of geometrical figure are used for optimal size database design and for combine variables of different nature and hierarchy depths in one base, for construct the structure points by step-by-step method from up to details.

Many people from different hierarchical levels of organization may work, as it is shown at Figure 9, independently each from others with the same MDDS database by transactions on the base of computing integrity and use current reserve values (yellow fields) in making decisions, they need not more wait for a moment of full data collection and became free in making own estimates of discrepancy importance.

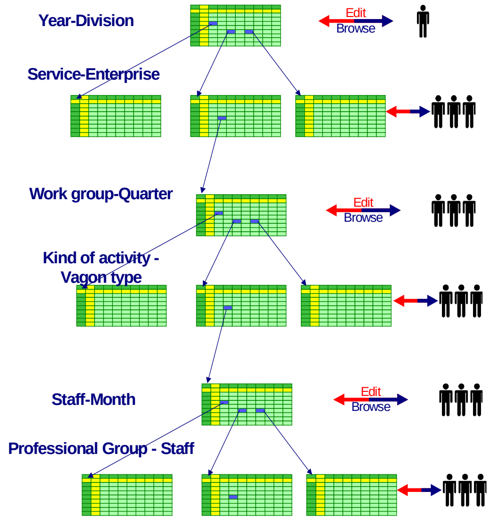

Figure 9 Many users work with coordinated hierarchical reports in independently and operatively manner. Vertical neighbourship reports must have common aggregate cell or row or column; yellow fields keep reports mismatch – base for communications.

MDDS is well suited for assigning security right access to persons and responsibility database areas, by introducing new dimension. Using the upper boundary level of data consolidation effect it is easy to arrange independent and collaborative work of many persons in online mode on the same MDDS, they would permanently communicate across visible RESERV values.

In conclusion, any multidimensional view may be used as interface for edit the underlay MDDS (MDDB) data. It may be offered to great practice demands in supporting following business processes: Budgeting, Resource Planning and Report Consolidation, Data Warehousing, and even for Bookkeeping Data Distributions between accounts.

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