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(54) Title: ENHANCED MECHANISMS FOR MANAGING MULTIDIMENSIONAL DATA

(57) Abstract: An enhanced multidimensional data management system significantly reduces the resources required to convert a spreadsheet into an enterprise collaborative system. A spreadsheet may be imported as is without modifications. Additional information that cannot be automatically inferred about the data model used in the spreadsheet is obtained. Dimensions, timescale, and measure data are clearly defined and located. The spreadsheet is kept in the system in the form of both a spreadsheet and as a multidimensional data structure such as an online analytical processing (OLAP) cube or structure. This duality allows the spreadsheet to be manipulated as if it was an OLAP cube, modifying iterations within the dimensions, and the OLAP cube to be computed as if it was a spreadsheet.

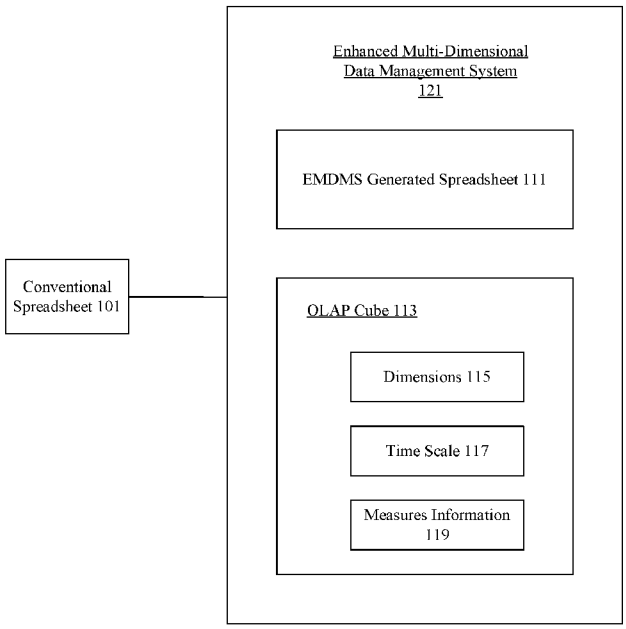

Figure 1

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GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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ENHANCED MECHANISMS FOR MANAGING MULTIDIMENSIONAL DATA

TECHNICAL FIELD

[0001] The present disclosure relates to generating, managing, maintaining, and manipulating multidimensional data.

DESCRIPTION OF RELATED ART

[0002] Numerous entities maintain and manipulate multidimensional data by using spreadsheets. Spreadsheets have been widely adopted because they can be easily implemented by people who do not have an information technology (IT) background, reducing the need to have people with both business logic familiarity and technology expertise. However, large scale organizational and corporate systems relying on spreadsheets have a number of drawbacks.

[0003] For example, spreadsheet based systems lack of collaborative capabilities, suffer from version management deficiencies, do not scale well, and are prone to bugs. That is, adding significant amounts of data or a large number of users can stress a spreadsheet based system. Multiple different subgroups within an organization cannot easily synchronize versions and changes. Furthermore, spreadsheet systems are prone to errors since the business logic is not separated from the data imposing the logic to be repeated independently on every cell composing the spreadsheet. Auditability is poor as it takes a considerable amount of time to understand the business logic involved in a spreadsheet. Versioning is not natively supported inside the spreadsheet. For example, a spreadsheet does not track when the content of a cell is modified, i.e. only the new value is kept and the old value is lost.

[0004] Nevertheless, because of the simplicity in their implementation, spreadsheets very often correspond to a first attempt of addressing a business problem in an automated fashion. They are logically seen as a very precious source of information for IT people when implementing a more robust IT system as soon as the inconveniences of using spreadsheets are too restrictive. When building an IT solution, a lot of effort can be dedicated to analyzing the information in spreadsheets and to replicating the exact same results obtained by them. This process usually results in the discovery of many bugs and the slow convergence between the two systems.

[0005] Consequently, it is desirable to provide enhanced mechanisms for managing multidimensional data including mechanisms for analyzing, generating, manipulating, and maintaining multidimensional data in spreadsheet form and as multidimensional data structures that overcome some of the drawbacks of conventional systems.

OVERVIEW

[0006] An enhanced multidimensional data management system significantly reduces the resources required to convert a spreadsheet into an enterprise collaborative system. A spreadsheet may be imported as is without modifications. Additional information that cannot be automatically inferred about the data model used in the spreadsheet is input. Dimensions, timescale, and measure data are clearly defined and located. The spreadsheet is kept in the system in the form of both a spreadsheet and as a multidimensional data structure such as an online analytical processing (OLAP) cube or structure. A mapping produces a bi-directional link between the spreadsheet and the dimensions and iterations of an OLAP cube. This duality allows the spreadsheet to be manipulated as if it was an OLAP cube, modifying iterations within the dimensions, and the OLAP cube to be computed as if it was a spreadsheet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The disclosure may best be understood by reference to the following description taken in conjunction with the accompanying drawings, which illustrate particular embodiments of the present invention.

[0008] Figure 1 illustrates one example of a spreadsheet and OLAP cube duality.

[0009] Figure 2 illustrates one example of a flow process diagram.

[0010] Figure 3 illustrates one example of entry of dimension information during importation of a spreadsheet.

[0011] Figure 4 illustrates one example of entry of timescale information during importation of a spreadsheet.

[0012] Figure 5 illustrates one example of entry of measures during importation of a spreadsheet.

[0013] Figure 6 illustrates one example of a computer system.

DETAILED DESCRIPTION

[0014] Reference will now be made in detail to some specific examples of the invention including the best modes contemplated by the inventors for carrying out the invention. Examples of these specific embodiments are illustrated in the accompanying drawings. While the invention is described in conjunction with these specific embodiments, it will be understood that it is not intended to limit the invention to the described embodiments. On the contrary, it is intended to cover alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

[0015] For example, the techniques of the present invention will be described in the context of particular data structures such as online analytical processing (OLAP) cubes. However, it should be noted that the techniques of the present invention apply to a wide variety of different data structures and different types of multidimensional data. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. Particular example embodiments of the present invention may be implemented without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure the present invention.

[0016] Various techniques and mechanisms of the present invention will sometimes be described in singular form for clarity. However, it should be noted that some embodiments include multiple iterations of a technique or multiple instantiations of a mechanism unless noted otherwise. For example, a system uses a processor in a variety of contexts. However, it will be appreciated that a system can use multiple processors while remaining within the scope of the present invention unless otherwise noted. Furthermore, the techniques and mechanisms of the present invention will sometimes describe a connection between two entities. It should be noted that a connection between two entities does not necessarily mean a direct, unimpeded connection, as a variety of other entities may reside between the two

entities. For example, a processor may be connected to memory, but it will be appreciated that a variety of bridges and controllers may reside between the processor and memory. Consequently, a connection does not necessarily mean a direct, unimpeded connection unless otherwise noted.

[0017] Various organizations and enterprises rely on spreadsheets to organize, manipulate, and manage business data and logic. Spreadsheets are accessible to people without technology backgrounds because of their ease of use and relatively friendly user experiences. Spreadsheets have been widely adopted because they can be easily implemented by people who do not have an information technology (IT) background, reducing the need to have people with both business logic familiarity and technology expertise. Spreadsheets from certain vendors also have fairly robust ecosystems with add-ons and tools designed for use with those spreadsheets. However, conventional spreadsheets have a number of limitations. For example, spreadsheet based business systems lack collaborative capabilities. It is typically burdensome and error prone for different departments and different people to work on the same spreadsheet simultaneously. Individual spreadsheet files may be locked and unlocked for particular users, but this limits manipulation of the spreadsheet to a single user. If multiple versions of the same spreadsheet file are manipulated simultaneously, there is no easy way to synchronize the cells of the different spreadsheet files, even if there are technically no cell conflicts. Although spreadsheets can sometimes be shared, spreadsheet cells have no versioning mechanism, even if some outside tools may support versioning. For example, most third-party versioning and revision control tools can generate graphs of revisions and commits to allow tracking and comparison of modifications. However, they are difficult to use without technical skills. Although it may be difficult for many people from different departments to work independently on the same business data or logic maintained in spreadsheet files, it is even more difficult for many people to work together on the same cells, data, and logic within a spreadsheet simultaneously.

[0018] Collaborative limitations become even more apparent as an enterprise system is scaled. Many conventional spreadsheet based systems are not designed to scale and extensive efforts are required to allow them to grow as a business grows. Many spreadsheet based systems are designed to allow only one person to use the spreadsheet at a time. Data errors, business logic errors, and copy and paste errors become increasingly common because spreadsheets lack scaling, tracking, and validation mechanisms necessary for large systems. Auditability is poor as it takes a considerable amount of time to understand the business logic involved in a spreadsheet. Versioning is not natively supported inside the spreadsheet. For example, a spreadsheet does not track when the content of cell is modified and when the old value is forgotten. What-if analyses, where the business logic is applied to many datasets and the results compared to one another, may be possible only if they are originally included in the design of the spreadsheet.

[0019] Consequently, various embodiments of the present invention provide enhancements that allow more efficient and effective management of multi-dimensional data. According to various embodiments, an enhanced multidimensional data management system significantly reduces the resources required to convert a spreadsheet into an enterprise collaborative system. A spreadsheet may be imported as is without modifications. Additional information that cannot be automatically inferred about the data model used in the spreadsheet is collected from the user. Dimensions, timescale, and measure data along with other types of data as well as outputs can be clearly defined and located. The spreadsheet is kept in the system in the form of both a spreadsheet and as a multidimensional data structure such as an online analytical processing (OLAP) cube. A bidirectional mapping between the spreadsheet and the multidimensional data structure is maintained. This duality and bidirectional mapping allows the spreadsheet to be manipulated as if it was an OLAP cube, modifying iterations within the dimensions, and the OLAP cube to be computed as if it was a spreadsheet.

[0020] An existing spreadsheet can be kept as is. An enhanced multidimensional data management system is able to handle a variety of spreadsheets that were not

initially designed with the objective of potential enhancements and modifications. Once the spreadsheet is imported into an enhanced multidimensional data management system, typical limitations due to the usage of spreadsheets vanish. The ability to collaborate between a large number of people is enhanced.

[0021] According to various embodiments, Figure 1 shows one example of a spreadsheet and OLAP cube duality. Spreadsheet 101 may be part of a conventional business system maintaining both business data and business logic. An organization may wish to expand and enhance business system functionality. Some multidimensional management systems require importation and conversion of spreadsheet business data and business logic into their own proprietary formats. Conversion can often be problematic as data and logic may be lost or converted incorrectly. Formula translations from a conventional spreadsheet to an enhanced data management system may be error prone or imprecise. Nonetheless, some entities will exert Herculean efforts to convert conventional spreadsheet based solutions to proprietary enhanced spreadsheet or enhanced data management systems. However, even if the conversion process goes smoothly, the entity is still left with a proprietary system that may not have the support of 3rd party vendors, may not be associated with a robust ecosystem, and may not be compatible with other existing entity resources.

[0022] It may be possible to convert proprietary system data back into a conventional spreadsheet format, but the conversion is again potentially error prone or imprecise. Furthermore, the reimport of these exported spreadsheets can also be problematic. Consequently, various embodiments of the present invention provide mechanisms for maintaining a conventional spreadsheet along with providing enhanced multi-dimensional data management functionality. According to various embodiments, conventional spreadsheet 101 may be maintained as both a spreadsheet 111 and an OLAP cube 113 in an enhanced multi-dimensional data management system (EMDMS) 121. Spreadsheet 111 in an enhanced multi-dimensional data management system 121 is also referred to herein as a server side generated spreadsheet or an enhanced multi-dimensional data management system

generated spreadsheet. In particular example embodiments, the OLAP cube 113 includes dimensions 115, time scale 117 and measures information 119. According to various embodiments, changes made to the enhanced multi-dimensional data management system 121 are made both to the OLAP cube 113 and to the spreadsheet 111. In particular example embodiments, the enhanced multi-dimensional data management system 121 is associated with a server side spreadsheet engine compatible with standard format OpenXML. There is a bidirectional mapping between the spreadsheet engine and the OLAP structure or OLAP cube 113.

[0023] Figure 2 illustrates one example of a flow process diagram for using an enhanced multi-dimensional data management system. In particular example embodiments, a conventional spreadsheet is selected for import into an enhanced multi-dimensional data management system at 201. According to various embodiments, at 203, the structure in the spreadsheet is identified based on cell formula and cell location as well as information provided by users and/or information already stored in a target system, e.g. referential data. Patterns can be identified based on cell relationships and OLAP mapping at 205. The user can then correct the model by redefining the identified structure between 203 and 205. According to various embodiments, calculations are performed using an embedded spreadsheet calculus engine and no formula translations are necessary at 207.

[0024] According to various embodiments, insertion and/or deletion of lines and rows can be based on the formula pattern and the layout to allow for automatic update of both an OLAP cube and the spreadsheet with enhanced functionality at 209. Similarly, values of cells can be modified and changes can be propagated accordingly to the OLAP cube. All scenarios are versioned at 211.

[0025] In particular example embodiments, export and reimport of a conventional spreadsheet is also allowed. Reimport of the conventional spreadsheet can trigger an update of the spreadsheet computed by the enhanced multi-dimensional data management system at 213.

[0026] After re-importing the data in the spreadsheet, the OLAP can be modified and then go back in the workflow at 207 as shown by the feedback arrow from 213 to 207.

[0027] Figure 3 illustrates one example of entry of dimension information during importation of a spreadsheet. According to various embodiments, a spreadsheet 301 computed by an enhanced multi-dimensional data management system includes dimensions 311, measures 313, and timescales 315 corresponding to elements of an OLAP cube. During importation of a spreadsheet, a user might select particular entries as dimensions. For example, country 321 and product 323 may correspond to dimensions. Spreadsheet 301 computed by the enhanced multi-dimensional data management system may also include timescale information. Examples of measures information may include sales 331, cost of sales 333, gross profit 335, and gross margin 337.

[0028] As shown in the present embodiment, the dimensions of the EMDMS spreadsheet 301 are being set, as indicated by the checked box in the tools area. A check box allows a user to switch between two different modes. In the outline dimensions mode, cells that belong to a dimension/time axis/set of measures are colored. Different dimensions / time axis/ set of measures are colored differently. A user does not necessarily have to be in this mode to select dimensions / time axis / set of measures. However, it is useful since a user has an immediate overview of the cells that already are part of a dimension / time axis / set of measures. In particular, the "Outline Dimensions" box is checked, indicating that the EMDMS spreadsheet 301 is in this mode. In the present example, country 321 is already selected and listed as one of the dimensions 311, as indicated in the area listed below the tools section. A product P1, located in cell B13, is being added as a new dimension 311 from the pulldown menu shown. Once selected, this product 323 will be added to the dimensions 311 area below the tools section and above the cells.

[0029] Figure 4 illustrates one example of entry of timescale information during importation of a spreadsheet. According to various embodiments, a spreadsheet 401

computed by an enhanced multi-dimensional data management system includes dimensions 411, measures 413, and timescales 415 corresponding to elements of an OLAP cube. During importation of a spreadsheet, a user might select particular timescales corresponding to particular time periods such as months, quarters, and years. Spreadsheet 401 may also include dimensions 411 such as country 421 and product 423. Other examples may include SKU, indications, dosage, etc. Examples of measures information may include sales 431, cost of sales 433, gross profit 435, and gross margin 437.

[0030] As shown in the present embodiment, the dimensions of the EMDMS spreadsheet 401 are being set, as indicated by the checked box in the tools area. A check box allows a user to switch between two different modes. In the outline dimensions mode, cells that belong to a dimension/time axis/set of measures are colored. Different dimensions / time axis/ set of measures are colored differently. A user does not necessarily have to be in this mode to select dimensions / time axis / set of measures. However, it is useful since a user has an immediate overview of the cells that already are part of a dimension / time axis / set of measures. In particular, the "Outline Dimensions" box is checked, indicating that the EMDMS spreadsheet 401 is in this mode. In the present example, country 421 and product 423 are already selected and listed as two of the dimensions 411, as indicated in the area listed below the tools section. Timescales 415 are now being selected. In particular, the year 2017, located in cell E1, is being added as a new timescale 415 from the pulldown menu shown. Once selected, this year will be added to the timescales 415 area below the tools section and above the cells.

[0031] Figure 5 illustrates one example of entry of measures information during importation of a spreadsheet. According to various embodiments, a spreadsheet 501 computed by an enhanced multi-dimensional data management system includes dimensions 511, measures 513, and timescales 515 corresponding to elements of an OLAP cube. During importation of a spreadsheet, a user might select particular measures corresponding to elements such as sales 531, cost of sales 533, gross profit 535, and gross margin 537. A user may also enter timescales 515 corresponding to

particular time periods such as months, quarters, and years. Spreadsheet 501 may also include dimensions 511 corresponding to country 521 and product 523.

[0032] As shown in the present embodiment, the dimensions of the EMDMS spreadsheet 501 are being set, as indicated by the checked box in the tools area. A check box allows a user to switch between two different modes. In the outline dimensions mode, cells that belong to a dimension/time axis/set of measures are colored. Different dimensions / time axis/ set of measures are colored differently. A user does not necessarily have to be in this mode to select dimensions / time axis / set of measures. However, it is useful since a user has an immediate overview of the cells that already are part of a dimension / time axis / set of measures. In particular, the "Outline Dimensions" box is checked, indicating that the EMDMS spreadsheet 501 is in this mode. In the present example, country 521 and product 523 are already selected and listed as two of the dimensions 511, as indicated in the area listed below the tools section. In addition, year 541 has already been selected as a timescale 515, as indicated in the timescales area 515 below the tools area and above the cells. On this screen, measures 513 have just been selected. In particular, gross profit 535, located in cell C15, has been added as a new measure 513, along with sales 531, cost of sales 533, and gross margin 537, as listed in the measures 513 area below the tools section and above the cells.

[0033] According to various embodiments, the EMDMS spreadsheet includes improved functionality over the originally imported spreadsheet. In particular, by specifying parameters such as dimensions, measures, and timescales, data is accurately mapped and can be tracked more effectively. Additionally, errors in calculations or data entry can be more easily detected. Moreover, formulas applied to particular cells can be accurately outlined using these parameters.

[0034] According to various embodiments, insertion of data into an OLAP cube will insert or remove rows and columns corresponding to the data in the EMDMS spreadsheet with appropriate formulas and styles. Existing formulas will also be

modified. For example, insertion of data into the OLAP cube will change summations and totals included in the EMDMS spreadsheet.

[0035] Various computing devices can implement the methods described. For instance, a mobile device, computer system, etc. can be used to generate artificially rendered images. With reference to FIG. 6, shown is a particular example of a computer system that can be used to implement particular examples of the present invention. For instance, the computer system 600 can be used to provide generate artificially rendered images according to various embodiments described above. In addition, the computer system 600 shown can represent a computing system on a mobile device. According to particular example embodiments, a system 600 suitable for implementing particular embodiments of the present invention includes a processor 601, a memory 603, an interface 611, and a bus 615 (e.g., a PCI bus). The interface 611 may include separate input interface 613 and output interface 615, or may be a unified interface supporting both operations. When acting under the control of appropriate software or firmware, the processor 601 is responsible for such tasks such as optimization. Various specially configured devices can also be used in place of a processor 601 or in addition to processor 601. The complete implementation can also be done in custom hardware. The interface 611 is typically configured to send and receive data packets or data segments over a network. Particular examples of interfaces the device supports include Ethernet interfaces, frame relay interfaces, cable interfaces, DSL interfaces, token ring interfaces, and the like.

[0036] In addition, various very high-speed interfaces may be provided such as fast Ethernet interfaces, Gigabit Ethernet interfaces, ATM interfaces, HSSI interfaces, POS interfaces, FDDI interfaces and the like. Generally, these interfaces may include ports appropriate for communication with the appropriate media. In some cases, they may also include an independent processor and, in some instances, volatile RAM. The independent processors may control such communications intensive tasks as packet switching, media control and management.

[0037] According to particular example embodiments, the system 600 uses memory 603 to store data and program instructions and maintain a local side cache. The program instructions may control the operation of an operating system and/or one or more applications, for example. The memory or memories may also be configured to store received metadata and batch requested metadata.

[0038] Because such information and program instructions may be employed to implement the systems/methods described herein, the present invention relates to tangible, machine readable media that include program instructions, state information, etc. for performing various operations described herein. Examples of machine-readable media include hard disks, floppy disks, magnetic tape, optical media such as CD-ROM disks and DVDs; magneto-optical media such as optical disks, and hardware devices that are specially configured to store and perform program instructions, such as read-only memory devices (ROM) and programmable read-only memory devices (PROMs). Examples of program instructions include both machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter.

[0039] Although many of the components and processes are described above in the singular for convenience, it will be appreciated by one of skill in the art that multiple components and repeated processes can also be used to practice the techniques of the present disclosure.

[0040] While the present disclosure has been particularly shown and described with reference to specific embodiments thereof, it will be understood by those skilled in the art that changes in the form and details of the disclosed embodiments may be made without departing from the spirit or scope of the invention. It is therefore intended that the invention be interpreted to include all variations and equivalents that fall within the true spirit and scope of the present invention.

CLAIMS

What is claimed is:

1. A method comprising:

identifying a structure in a conventional spreadsheet based on cell formula and cell location during import of the conventional spreadsheet, the structure in the conventional spreadsheet including a set of cells;

bi-directionally mapping the set of cells to iterations and aggregations on a multidimensional data structure, wherein the mapping associates ranges and objects from the multidimensional data structure, wherein the multidimensional data structure is an online analytical processing (OLAP) structure;

maintaining a duality between the conventional spreadsheet and the OLAP structure and avoiding formula translations;

generating an enhanced collaborative spreadsheet using the OLAP structure;

receiving modifications to the enhanced collaborative spreadsheet and the corresponding OLAP structure, wherein modifications to the conventional spreadsheet are made to match the data modified in the OLAP structure.

2. The method of claim 1, wherein modifying iterations to dimensions/measures/timescale in an OLAP structure modifies rows/columns in the enhanced collaborative spreadsheet along with corresponding formulas.

3. The method of claim 1, wherein enterprise wide spreadsheets can be merged into an OLAP structure according to an existing spreadsheet.

4. The method of claim 1, further comprising receiving modifications to the conventional spreadsheet, wherein modifications to the conventional spreadsheet are propagated as modifications to the OLAP structure.

5. The method of claim 1, further comprising maintaining a bidirectional mapping between the enhanced collaborative spreadsheet and the OLAP structure.

6. The method of claim 1, further comprising updating the OLAP structure during re-import of the conventional spreadsheet.

7. The method of claim 1, wherein a plurality of conventional spreadsheets are modified at a plurality of client devices.

8. The method of claim 1, wherein the OLAP structure is maintained at a server.

9. The method of claim 1, wherein a server side spreadsheet engine is used to evaluate formulas.

10. The method of claim 1, wherein the enhanced collaborative spreadsheet is compatible with OpenXML.

11. The method of claim 1, wherein dimension, measure, and timescale information are received during import of the conventional spreadsheet.

12. The method of claim 11, wherein dimension, measure, and timescale information are used to generate the OLAP structure.

13. The method of claim 1, wherein the OLAP structure is an OLAP cube.

14. A computer readable medium comprising:

computer code for identifying a structure in a conventional spreadsheet based on cell formula and cell location during import of the conventional spreadsheet, the structure in the conventional spreadsheet including a set of cells;

computer code for mapping the set of cells to iterations and aggregations on a multidimensional data structure, wherein the multidimensional data structure is an online analytical processing (OLAP) structure;

computer code for maintaining a duality between the conventional spreadsheet and the OLAP structure and avoiding formula translations;

computer code for generating an enhanced collaborative spreadsheet using the OLAP structure;

computer code for receiving modifications to the enhanced collaborative spreadsheet and the corresponding OLAP structure, wherein modifications to the conventional spreadsheet are made to match the data modified in the OLAP structure.

15. The computer readable medium of claim 14, wherein modifying iterations to dimensions/measures/timescale in an OLAP structure modifies

rows/columns in the enhanced collaborative spreadsheet along with corresponding formulas.

16. The computer readable medium of claim 14, wherein enterprise wide spreadsheets can be merged into an OLAP structure according to an existing spreadsheet.

17. The computer readable medium of claim 14, further comprising receiving modifications to the conventional spreadsheet, wherein modifications to the conventional spreadsheet are propagated as modifications to the OLAP structure.

18. An apparatus comprising:

means for identifying a structure in a conventional spreadsheet based on cell formula and cell location during import of the conventional spreadsheet, the structure in the conventional spreadsheet including a set of cells;

means for mapping the set of cells to iterations and aggregations on a multidimensional data structure, wherein the multidimensional data structure is an online analytical processing (OLAP) structure;

means for maintaining a duality between the conventional spreadsheet and the OLAP structure and avoiding formula translations;

means for generating an enhanced collaborative spreadsheet using the OLAP structure;

means for receiving modifications to the enhanced collaborative spreadsheet and the corresponding OLAP structure, wherein modifications to the conventional spreadsheet are made to match the data modified in the OLAP structure.

19. The apparatus of claim 18, wherein modifying iterations to dimensions/measures/timescale in an OLAP structure modifies rows/columns in the enhanced collaborative spreadsheet along with corresponding formulas.

20. The apparatus of claim 18, wherein enterprise wide spreadsheets can be merged into an OLAP structure according to an existing spreadsheet.

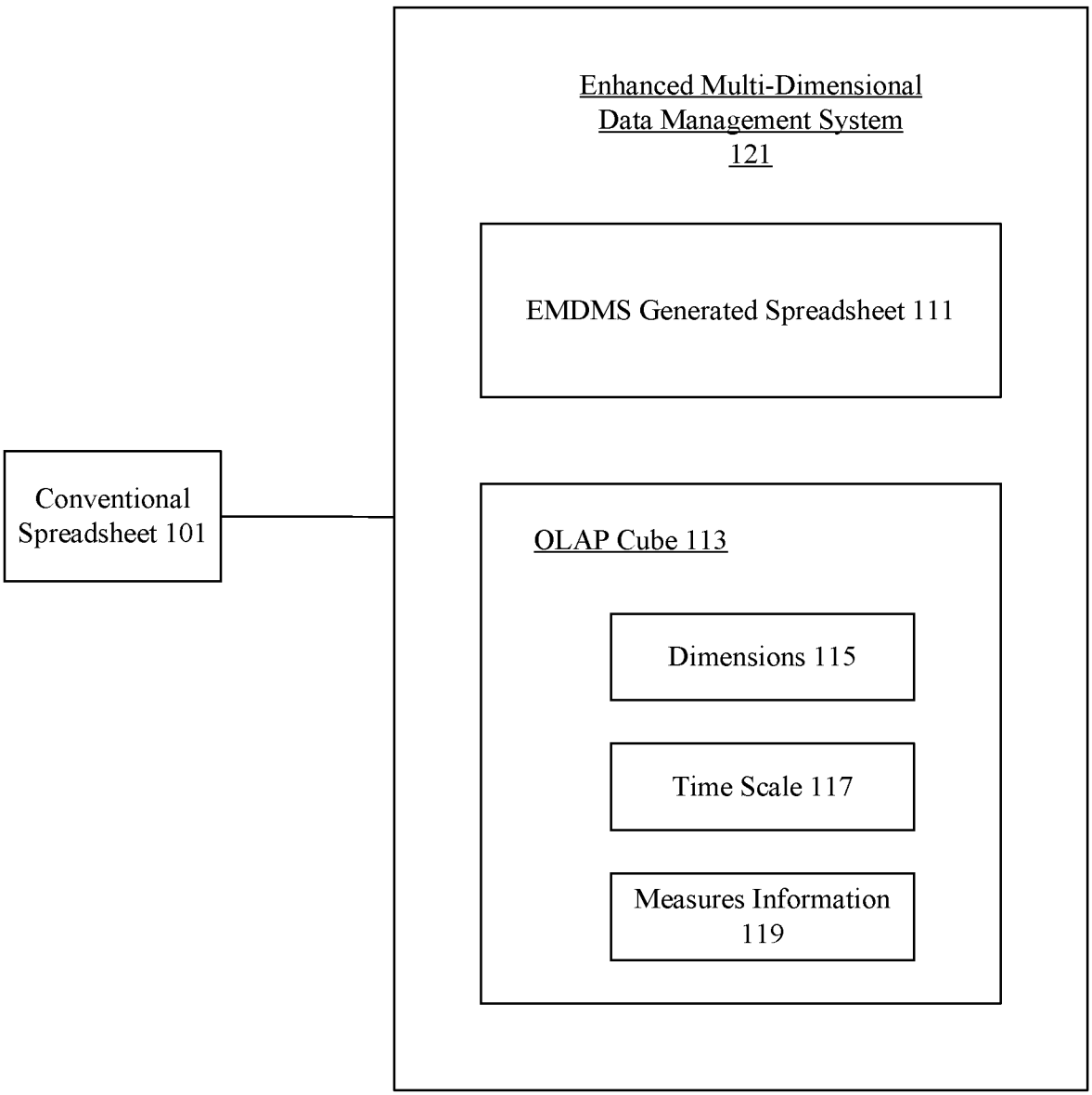

Enhanced Multi-Dimensional
Data Management System
121
EMDMS Generated Spreadsheet 111
Conventional
Spreadsheet 101
OLAP Cube 113
Dimensions 115
Time Scale 117
Measures Information
119

Figure 1

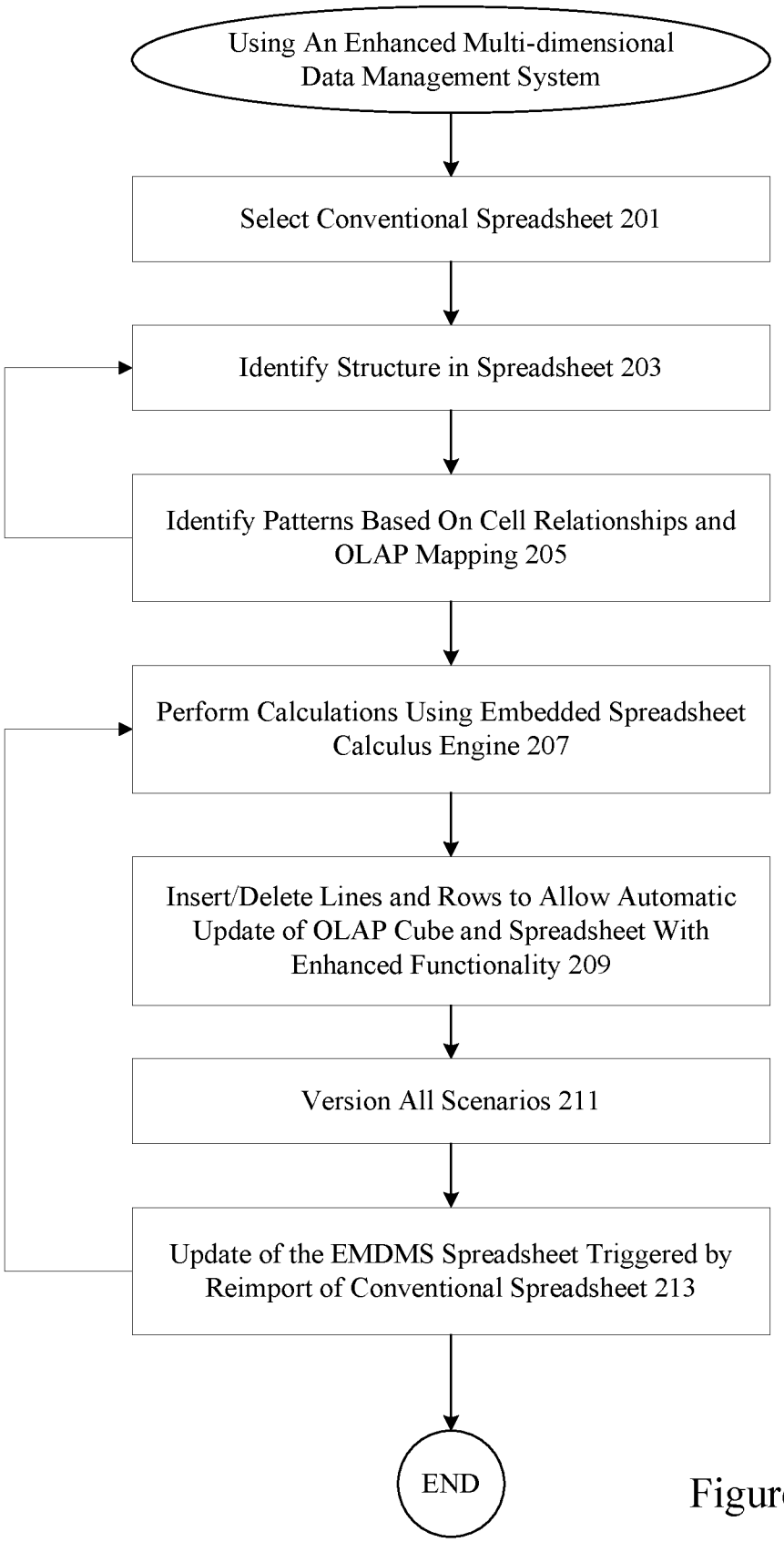
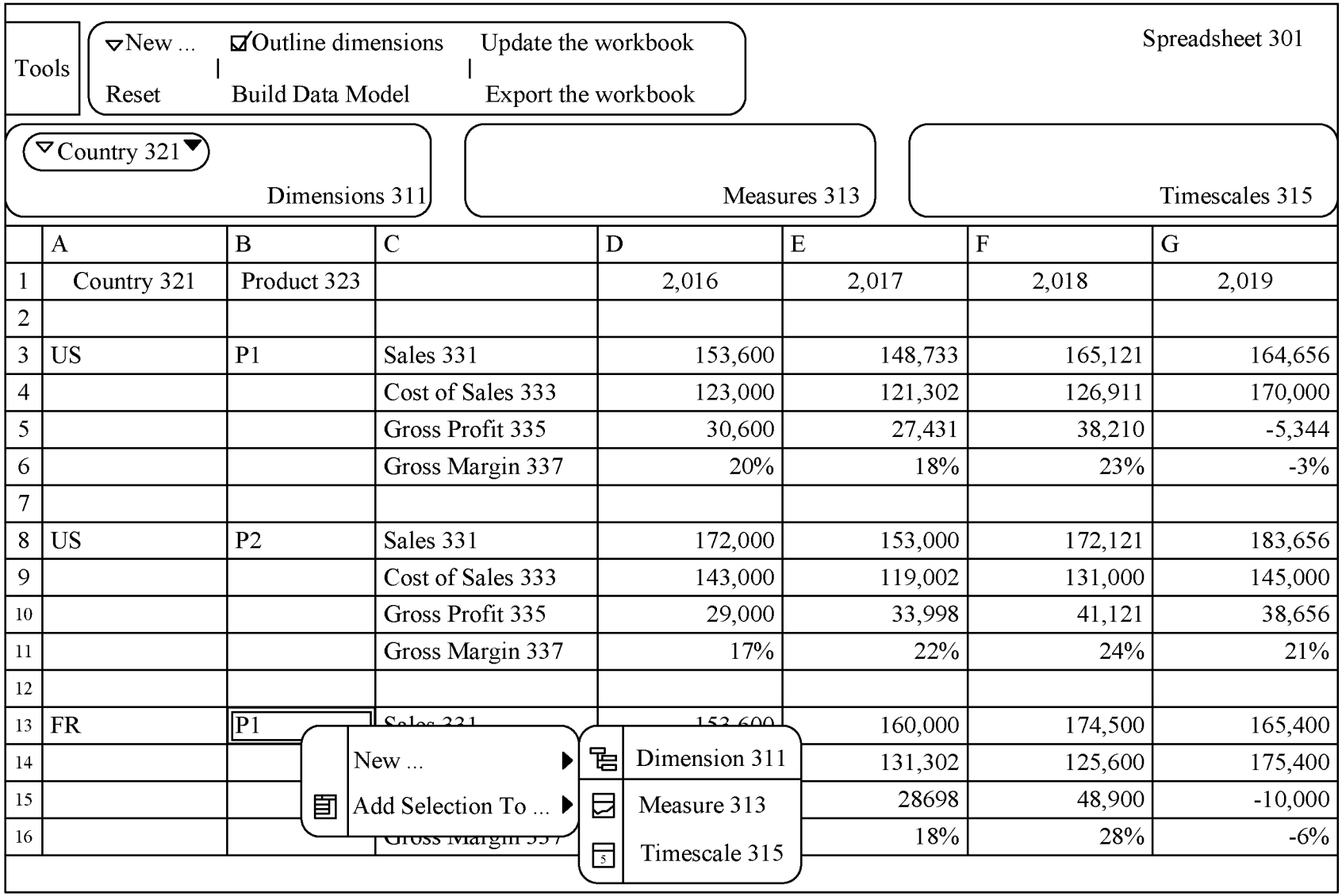
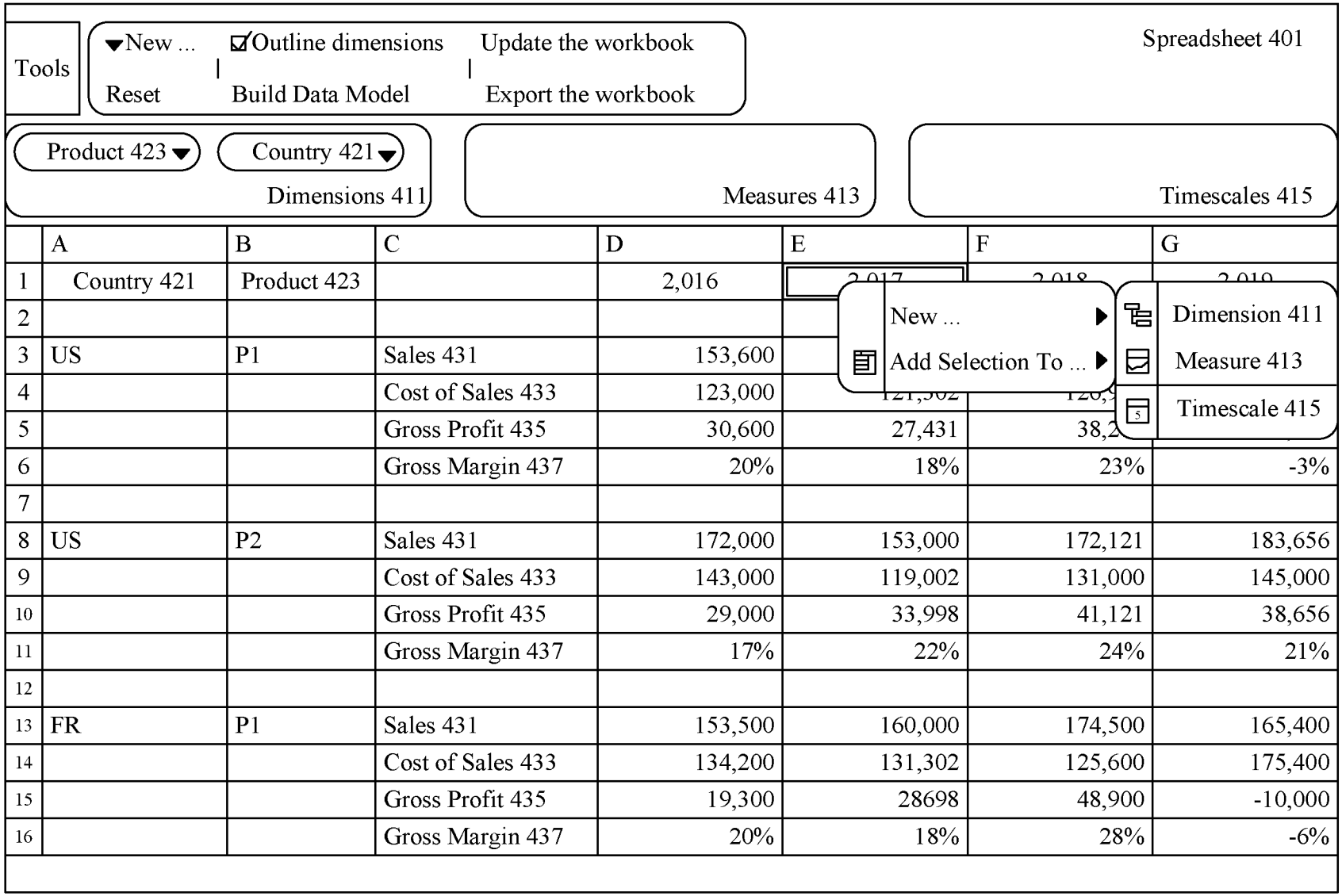

Using An Enhanced Multi-dimensional Data Management System
Select Conventional Spreadsheet 201
Identify Structure in Spreadsheet 203
Identify Patterns Based On Cell Relationships and OLAP Mapping 205
Perform Calculations Using Embedded Spreadsheet Calculus Engine 207
Insert/Delete Lines and Rows to Allow Automatic Update of OLAP Cube and Spreadsheet With Enhanced Functionality 209
Version All Scenarios 211
Update of the EMDMS Spreadsheet Triggered by Reimport of Conventional Spreadsheet 213
END

Figure 2



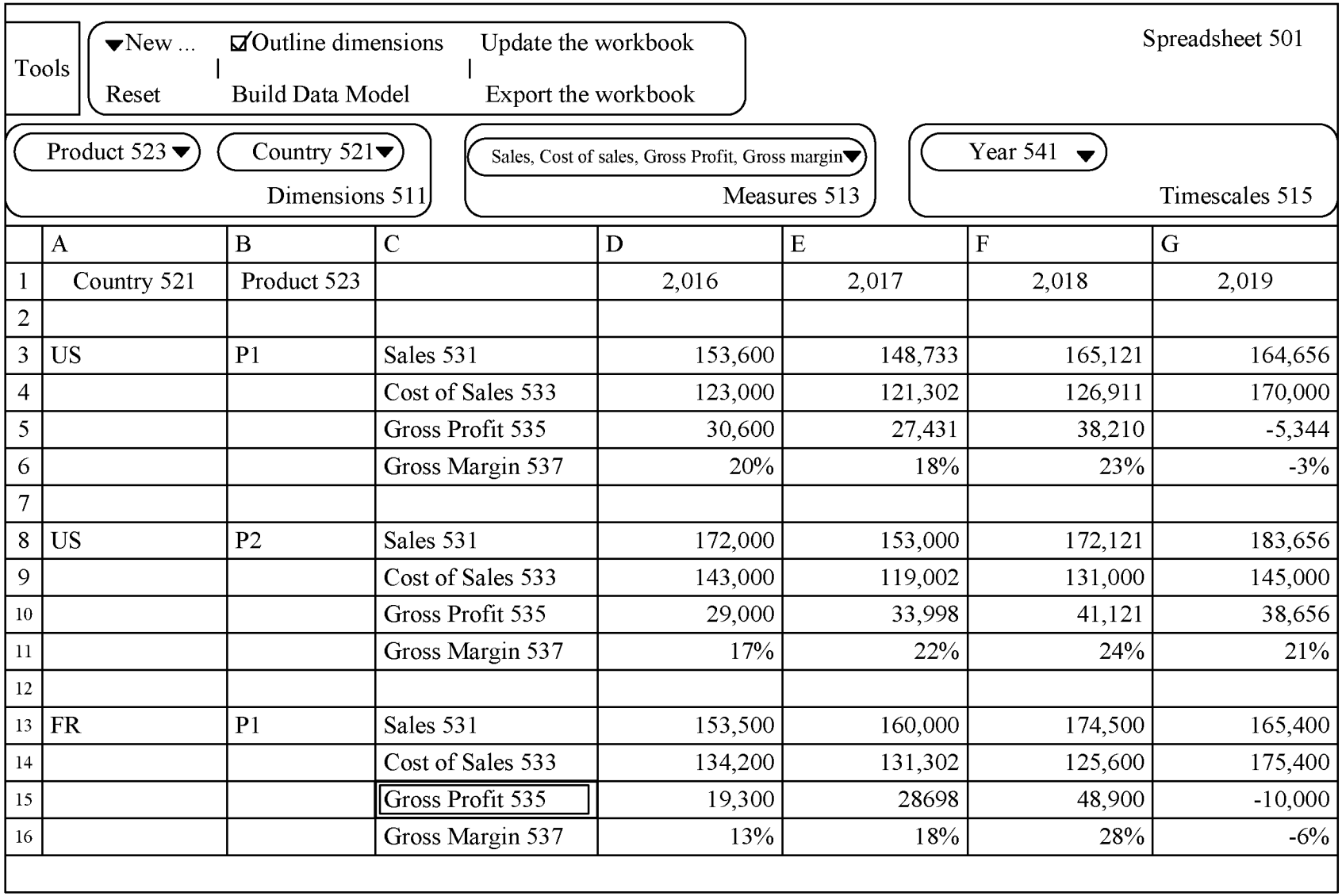
	A	B	C	D	E	F	G
1	Country 321	Product 323		2,016	2,017	2,018	2,019
2							
3	US	P1	Sales 331	153,600	148,733	165,121	164,656
4			Cost of Sales 333	123,000	121,302	126,911	170,000
5			Gross Profit 335	30,600	27,431	38,210	-5,344
6			Gross Margin 337	20%	18%	23%	-3%
7							
8	US	P2	Sales 331	172,000	153,000	172,121	183,656
9			Cost of Sales 333	143,000	119,002	131,000	145,000
10			Gross Profit 335	29,000	33,998	41,121	38,656
11			Gross Margin 337	17%	22%	24%	21%
12							
13	FR	P1	[illegible]	[illegible]	160,000	174,500	165,400
14					131,302	125,600	175,400
15					28698	48,900	-10,000
16			[illegible]		18%	28%	-6%

Figure 3



	A	B	C	D	E	F	G
1	Country 421	Product 423		2,016			
2							
3	US	P1	Sales 431	153,600			
4			Cost of Sales 433	123,000			
5			Gross Profit 435	30,600	27,431	38,2	
6			Gross Margin 437	20%	18%	23%	-3%
7							
8	US	P2	Sales 431	172,000	153,000	172,121	183,656
9			Cost of Sales 433	143,000	119,002	131,000	145,000
10			Gross Profit 435	29,000	33,998	41,121	38,656
11			Gross Margin 437	17%	22%	24%	21%
12							
13	FR	P1	Sales 431	153,500	160,000	174,500	165,400
14			Cost of Sales 433	134,200	131,302	125,600	175,400
15			Gross Profit 435	19,300	28698	48,900	-10,000
16			Gross Margin 437	20%	18%	28%	-6%

Figure 4



	A	B	C	D	E	F	G
1	Country 521	Product 523		2,016	2,017	2,018	2,019
2							
3	US	P1	Sales 531	153,600	148,733	165,121	164,656
4			Cost of Sales 533	123,000	121,302	126,911	170,000
5			Gross Profit 535	30,600	27,431	38,210	-5,344
6			Gross Margin 537	20%	18%	23%	-3%
7							
8	US	P2	Sales 531	172,000	153,000	172,121	183,656
9			Cost of Sales 533	143,000	119,002	131,000	145,000
10			Gross Profit 535	29,000	33,998	41,121	38,656
11			Gross Margin 537	17%	22%	24%	21%
12							
13	FR	P1	Sales 531	153,500	160,000	174,500	165,400
14			Cost of Sales 533	134,200	131,302	125,600	175,400
15			Gross Profit 535	19,300	28698	48,900	-10,000
16			Gross Margin 537	13%	18%	28%	-6%

Figure 5

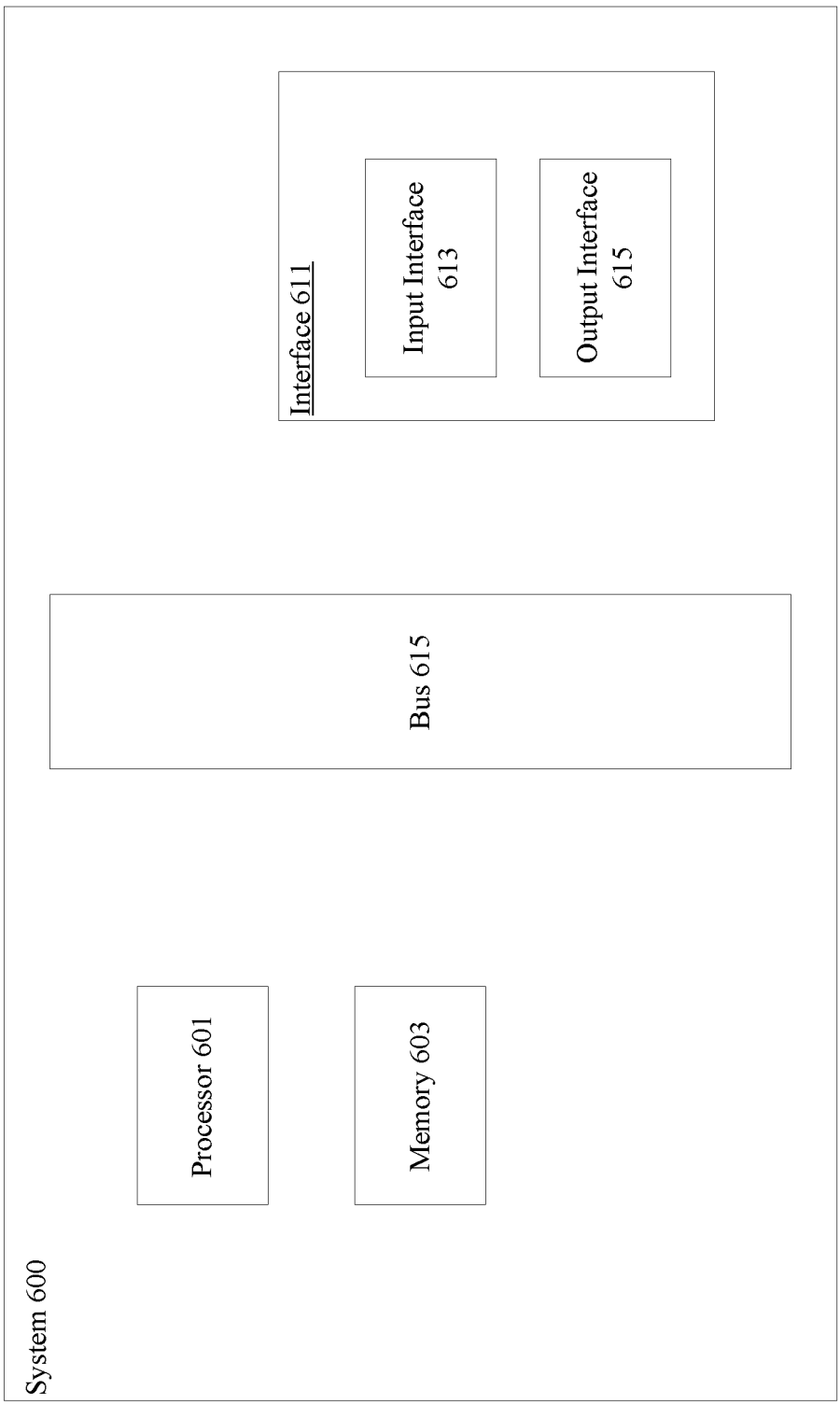

System 600
Processor 601
Memory 603
Bus 615
Interface 611
Input Interface 613
Output Interface 615

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 2016/038934

A. CLASSIFICATION OF SUBJECT MATTER

G06F 17/30 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F 17/00-17/30, 3/00-3/023, 7/00, G06B 3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/0298002 A1 (PATRICK VIRY) 07.11.2013, abstract, par. [0005], [0006], [0010], [0013], [0015], [0034], [0035], [0036], [0038], [0041], [0043], [0046], [0047], [0080]-[0084], [0086], [0090]-[0093], [0118], [0120]-[0122], [0128], [0140], [0141]	1-9, 11-20
Y		10
Y	US 2011/0137724 A1 (ICELERO LLC) 09.06.2011	10
A	RU 2013149491 A (WILLSON IAN ALEXANDER) 20.05.2015	1-20
A	US 2010/0042634 A1 (ACCENTURE GLOBAL SERVICES GMBH) 18.02.2010	1-20
A	US 2010/0169759 A1 (PIERRE JEAN LE BRAZIDEC et al.) 01.07.2010	1-20

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 September 2016 (12.09.2016)	13 October 2016 (13.10.2016)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 2016/038934

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/0319553 A1 (PIERRE JEAN LE BRAZIDEC et al.) 24.12.2009	1-20
A	US 2006/0024653 A1 (MICROSOFT CORPORATION) 02.02.2006	1-20
A	WO 2010/031081 A2 (THOMSEN ERIK) 18.03.2010	1-20
A	US 2006/0112123 A1 (MACNICA, INC.) 25.05.2006	1-20
A	US 2006/0085444 A1 (MICROSOFT CORPORATION) 20.04.2006	1-20