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(54) **Title**: ARRANGEMENT AND METHOD FOR EXCHANGING ENGINEERING INFORMATION

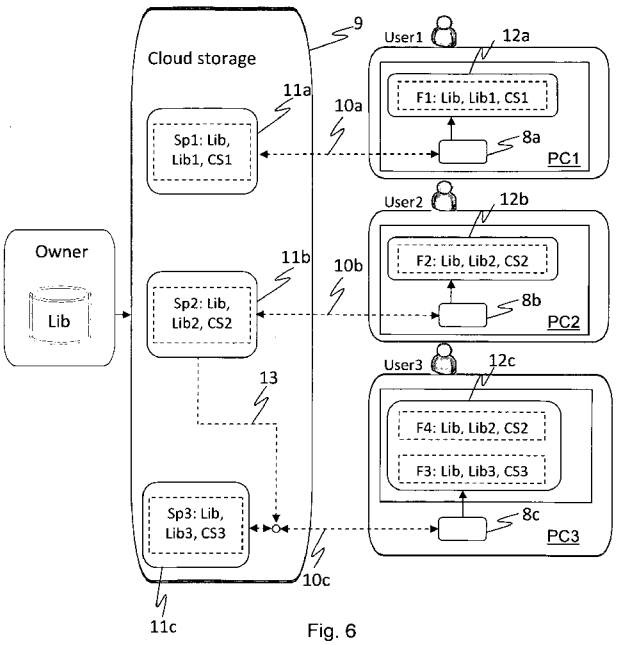

Fig. 6

(57) **Abstract**: An arrangement for exchanging at least one engineering artifact (Lib, Lib1 to Lib3, CS1 to CS3) between a first (PC1) and at least one further (PC2, PC3) computer device comprises at least one synchronization unit (8a, 8b, 8c) and a cloud storage (9) containing virtual storage spaces (1 1a, 11b, 1 1c). The cloud storage (9) is arranged to copy the at least one engineering artifact (Lib) into the first (11 a) and the at least one further (11 b, 11c) virtual storage spaces. The at least one synchronization unit (8a, 8b, 8c) is arranged to establish communication links between the virtual and corresponding local storage spaces (12a, 12b, 12c) contained in the respective computer device, as soon as a respective communication connection (10a, 10b, 10c) is established between the cloud storage (9) and the respective computer device. The synchronization unit is further arranged to compare the contents of the local storage spaces with the contents of the corresponding virtual storage space, and in case that the first and/or the at least one further virtual storage space contains an additional and/or more recent version of the at least one engineering artifact compared to the corresponding first and/or at least one further local storage space, respectively, to automatically start a copy process of the additional and/or more recent version of the at least one engineering artifact to the corresponding first and/or the at least one further local storage space, respectively

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ARRANGEMENT AND METHOD FOR EXCHANGING ENGINEERING INFORMATION

Description

The invention relates to an arrangement and a method for exchanging one or multiple engineering artifacts between a first and at least one further computer device.

The area of control system engineering and engineering for industrial automation applications plays a role in different industry sectors, such as process industry like pharmaceutical and chemical industry, or manufacturing industry, power generation and distribution, mineral or oil and gas industry. The term control system engineering is used for all kinds of activities which are related to the designing, verification and validation, implementation and testing of a control system for a technical system used in these industry sectors, where the technical system may be a technical installation, an industrial plant or an industrial process. The control system comprises at least one industrial control device, at least one sensor and at least one actuator, where the control device receives measurements taken by the at least one sensor from the technical system and determines based on these measurements and, if applicable, based on further information suitable actions of the at least one actuator to regulate the behaviour of the technical system.

Control system engineering usually requires the use of advanced control system engineering tools in the form of software products with complex functionalities, e.g. RobotStudio for programming robots, CoDeSys for programming programmable logic controllers (PLCs), Function Designer for programming ABB's AC800M controllers or Fieldbus Builder for configuring field devices. It may also involve different engineers which stepwise design and commission different domains of the industrial plant or industrial process. Hence, different engineering software may be used by different groups and persons.

The result of the engineering process, or in other words the output of the control system engineering tools, is a plan for the automation system, in the following called automation solution or control solution. The automation solution may comprise planning information about hardware, e.g. automation devices, control software executed on the automation devices and additional automation system related information, such as information relating to a control network infrastructure and corresponding device configurations, as well as configuration data relating to a human machine interface (HMI) of an HMI computer device. The automation devices, also called industrial control devices including software and configurations, as well as the HMI software and computer devices are usually installed at a customer's site, where the customer is a company operating an industrial plant from one of the above named industry sectors which purchases the control solution adapted to the operational requirements of the industrial plant.

During the designing of automation or control solutions, hardware and software libraries are used, where the library elements of which contain information about predefined and tested hardware or software components. A library element may be a simple function block or a complex automation solution. Usually, such libraries are installed as part of a control system engineering tool and are thereby bound to the respective installation of the tool. The software components from the libraries may be used by referring to them in the development or working files generated by using the engineering tool, as for example in the source code of the control application software.

The most widely known way of using standard libraries across different users is the usage of a standard library that is obligatory for each user, as is depicted in Fig. 1. On the engineering device of each user, usually a PC, the same control system engineering tool 3 and its corresponding library or libraries 1 are installed. Each user may now develop his own control solution 4 (CS). With standard libraries, changes in the libraries or the inclusion of new library elements by the user are not allowed, in order to avoid version incompatibilities and unwanted branching of library versions. Only the owner of the standard library may develop new library versions, which will then co-exist beside the previous versions so that control solutions which are based on the previous versions are still valid. One of the drawbacks of this concept of standard libraries is that it does not provide the possibility to be adapted to suit today's globalized world, since not all requirements defined by customers from different regions of the world can be met with fixed predefined software components. Additionally, there are more and more customers providing their own individualized libraries in order to

optimize their internal workflow. These individual libraries cannot easily be shared with other engineers if they are installed locally on a PC, as described above.

In general, there exists a certain variety of control libraries: standard libraries, customer specific libraries, personal libraries for individual users, local libraries for local groups or organizations, regional libraries valid for specific geographic regions, vendor specific libraries, domain specific libraries etc.

As mentioned above, the engineering process involves a group of different engineers and software developers which may all require access to the same kind of libraries which needs to be distributed to them by the owner of the respective library. In addition, it may be desirable that the results or intermediate results of the engineering process, i.e. the control solutions including individual project data, such as source code and/or executable files of control application software, configuration data for an industrial control device, configuration data for a display device including trend configuration data etc., are shared and distributed between the members of the engineering group. These results together with the libraries and any further type of information required during or resulting from the engineering process are in the following called engineering artifacts. Accordingly, an engineering artifact may be a simple function block or a complex control or automation solution, a predefined hardware structure, a predefined communication infrastructure or a predefined device configuration set. Engineering artifacts can be collected themselves in libraries, where they are called standard engineering artifacts, or they can represent engineering project results which are not fed back into a library, and then they are called individual engineering artifacts. Hence, the term engineering artifacts represents all re-usable elements of the control system engineering.

Currently, engineering artifacts are distributed in the following ways. The simplest and above described way of sharing a library is a local installation of the library on each user's PC, as is illustrated by Fig. 1. The library 1 is a standard or fixed library. Accordingly, changes in the library are not allowed, and additions or new versions may only be provided by the library owner and need to be delivered and installed for each engineer individually. Since the standard library is fixed, certain customer requirements may not be met by its contents. Apart from the standard library 1, individual solutions which are created during engineering, indicated as control solution 4, are not shared to the other users User1 to User3 in a systematic way but only by means of individual export/import procedures, as is indicated by arrows 2. This requires user interaction. Due to the fixed library 1 and since the control solution 4 and the library 1 are bound to each other, import, export and reuse of the control solution 4 works only fine with engineers which have the same library 1 and the same

version of it installed. Otherwise, the required version of the library 1 needs to be taken into account and may even fail due to version incompatibilities.

Another known way to distribute engineering artifacts to different users is to provide permanent remote access to a reference installation of a standard library on a server, where the server belongs to the owner of the library and may be located on a customer site, on vendor site or on a third party site. This situation is illustrated by Fig. 2, where different users of the standard library 1 have permanent access to the installation of the library 1 via a permanent communication line 5, which can be a wireless or a wire-bound connection to the server. As a result, the problem connected with version incompatibilities of library 1 is solved. Technically, the same communication line 5 may also be used to exchange individual engineering artifacts, such as the control solution 4, between the users via export/import procedures, where again a systematic way of exchanging the individual engineering artifacts is missing. In addition, this concept still faces the drawbacks connected with the use of standard libraries. An additional drawback is that in order to ensure the appropriate availability and usability of the server installation, the connection to the server needs to be permanent, reliable and should provide the necessary bandwidth.

A variation of the solution of Fig. 2 is shown in Fig. 3, where again the standard library 1 is available on the server belonging to the library owner and the users User1 to User3 have local and permanent network access to that server. The users cannot change the standard library 1 on the server, but they can copy parts of it and develop individual libraries 6 (Lib1 to Lib3) and individual engineering artifacts, such as control solution 4, for their own purpose. Even though this way of handling engineering artifacts allows for the development of engineering solutions which are better adapted to customer needs, the drawbacks of the previously described Figs. 1 and 2 are maintained and even aggravated, such as the requirement of a permanent and reliable server connection with sufficient bandwidth and the problems occurring when sharing engineering artifacts between the users, since the individual libraries 6 need to be exchanged and installed or updated each time as well.

The currently most advanced method of sharing engineering artifacts is a central database on a server, as depicted in Fig. 4. The central database contains all engineering artifacts, i.e. all libraries, i.e. a standard library 1 provided by the library owner and individual libraries 6, as well as individual engineering artifacts, like automation solutions or control solution 4. All tools installed on the PCs of the users User1 to User3 have access to the central database, so that the sharing of the engineering artifacts becomes a natural function of the system. The disadvantage of this technique is again the required permanent and reliable online access to

the server including enough bandwidth for the engineering purposes. In addition, a permanent online access requires precautions for ensuring safety and confidentiality of user data.

The drawbacks of the known solutions for distributing and sharing engineering artifacts are mentioned above. In addition, all server based variants do not allow the inclusion of users in the engineering process and activities which are not connected to the server.

Accordingly, the problem solved by this invention is to provide an arrangement and method for exchanging engineering artifacts with which the above named drawbacks are overcome.

On solving the problem, the inventor recognized different developments and facts from the field of consumer software, which form the background of the present invention. These developments and facts are presented below.

Recently, cloud based storage has become more and more popular. Different vendors and their cloud storage solutions, as for example DropBox, Microsoft with Live Sync, Apple with iDrive, iCloud and Google with GDrive, provide cloud storage that allows storage of data, e.g. documents or photos, on one or more servers, where the storage servers are not individually visible to the user. The user just sees "the cloud storage" as his storage medium and connects to it via an Internet based network connection. The stored data is permanently synchronized with a local folder on the personal computer or computers of each user. The principle of cloud storage is illustrated by Fig. 5. Each user has access to only his personally assigned space, Space1 to Space3, in the cloud storage. Specific synchronization software, in the following called cloud software, is installed on each individual computer device, PC1 to PC3, to permanently perform the synchronization process in the background between one or more designated folders on the respective computer device PC1, PC2 or PC3 and the corresponding space in the cloud storage, Space1, Space2 or Space3, respectively. The synchronization is performed whenever the respective computer device has online access via communication line 7 to the cloud storage and a difference in the data exists. A useful feature of cloud storage is the possibility to share files or folders to other users across different operating systems and across firewalls. Cloud storage not only works on computer devices as personal computers (PC) but also on mobile devices like tablet PCs or mobile phones. In addition, existing cloud storage solutions provide versioning functionality for individual data files which allows to restore data from older file versions and to track changes between files.

Based on the known cloud storage concepts and in order to solve the above named drawbacks of current methods to exchange engineering artifacts, the invention suggests an arrangement and a method according to the independent claims.

The arrangement for exchanging at least one engineering artifact between a first and at least one further computer device comprises at least one synchronization unit as well as a cloud storage containing at least a first virtual storage space.

According to the invention, the cloud storage is arranged to copy the engineering artifact into the first and the at least one further virtual storage spaces, and the at least one synchronization unit is arranged

- to establish a communication link between the first virtual storage space and a first local storage space contained in the first computer device as soon as a first communication connection is established between the cloud storage and the first computer device,
- to establish at least one further communication link between the at least one further virtual storage space and at least one further local storage space contained in the at least one further computer device as soon as at least one further communication connection is established between the cloud storage and the at least one further computer device,
- to compare the contents of the first local storage space with the contents of the first virtual storage space and the contents of the at least one further local storage space with the contents of the at least one further virtual storage space, and
- in case that the first and/or the at least one further virtual storage space contains an additional and/or more recent version of the engineering artifact compared to the corresponding first and/or at least one further local storage space, respectively, to automatically start a copy process of the additional and/or more recent version of the engineering artifact to the corresponding first and/or the at least one further local storage space, respectively.

The method according to the invention comprises the corresponding steps performed by the at least one synchronization unit.

Accordingly, it is the main idea behind the invention that the owner of an engineering artifact, which can be for example the owner of a standard library, the owner of standard engineering artifacts or the creator and owner of an individual engineering artifact, distributes the engineering artifact to an engineering team via individually allocated, virtual storage spaces

in a cloud storage, where each virtual storage space is allocated to a local storage space on a particular computer device belonging to a user of the library. The owner may be a vendor of the engineering artifact, but can also be a member or the head of the engineering team. Each virtual storage space is assigned to a specific customer or to a specific user, i.e. no third party has generally access to the virtual storage spaces. The owner of the engineering artifact uses the virtual storage spaces as a container for providing the latest suitable version or the latest suitable update of the engineering artifact to a particular user, by transferring the latest suitable version or update into the virtual storage space assigned to the particular user. As soon as the computer device of this user "goes online" and gets connected to the cloud storage via an Internet based network connection, a synchronization unit automatically checks whether an additional and/or an updated and thereby more recent version of the engineering artifact is present on the virtual storage space. If so, the additional and/or more recent version is copied into the local storage space of the user and is thereby available for being used by the user for future engineering purposes. This procedure can be performed individually for each user, i.e. each virtual storage space may contain a different configuration of a specific control system engineering tool.

In this way, it is ensured that each user gets his update of an engineering artifact immediately and directly to his control engineering platform, without any need for the user's interaction and without any need for permanent on-line access to a server. As a result, the distribution of engineering artifacts, in particular of standard libraries, is performed rapidly and in a customized way, which simplifies any proceedings between library owner and user.

In an embodiment of the invention, the cloud storage is arranged to copy the engineering artifact into the first and the at least one further virtual storage spaces simultaneously. In a situation where all users are supposed to be provided with the same new library version, for example, this solution provides the fastest way to achieve it.

In a further embodiment of the invention, the cloud storage is arranged to copy an individualized version of the engineering artifact into the corresponding first and/or at least one further virtual storage space, i.e. on the side of the owner of the engineering artifact, the process for keeping the virtual storage spaces updated is automated so that always the latest and most up-to-date version of the respective engineering artifact is present.

In a preferred embodiment of the invention, the at least one synchronization unit is arranged to compare the contents of the first local storage space with the contents of the first virtual storage space and in case that the first local storage space contains an additional

engineering artifact and/or a more recent version of the at least one engineering artifact compared to the first virtual storage space, to automatically start a copy process of the additional engineering artifact and/or of the more recent version of the at least one engineering artifact to the first virtual storage space. Further, the at least one synchronization unit is arranged to establish a further communication link between the first virtual storage space and at least one further local storage space contained in the at least one further computer device, as soon as at least one further communication connection is established between the cloud storage and the at least one further computer device, to compare the contents of the at least one further local storage space with the contents of the first virtual storage space, and in case that the first virtual storage space contains an additional engineering artifact and/or a more recent version of the at least one engineering artifact compared to the at least one further local storage space, to automatically start a copy process of the additional engineering artifact and/or of the more recent version of the at least one engineering artifact to the at least one further local storage space.

This preferred embodiment provides a solution for exchanging engineering artifacts between different computer devices. The exchanging is performed via one or more individually allocated, virtual storage spaces in a cloud storage, where each virtual storage space is allocated to a local storage space on a corresponding computer device and where for each computer device access can be given not only to the allocated virtual storage space but in addition to one or multiple further virtual storage spaces belonging to one or multiple other computer devices.

The basic setup is that each computer device belongs to a specific customer or to a specific software user, in the following called user, where several computer devices may belong to one and the same user. In general, no third party has access to the virtual storage space or spaces allocated to the computer device or devices of one particular user. In order to simplify the further description, the concept of the invention is in the following explained for the special embodiment of one allocated virtual storage space per user.

According to the preferred embodiment, the engineering artifacts stored in the local storage space of a first computer device are copied by the at least one synchronization unit into the allocated virtual storage space as soon as a communication connection between the first computer device and the cloud storage is established, where the copy process takes into account only any new and therefore additional engineering artifacts as well as the most recent version compared to the engineering artifacts already present in the virtual storage space. As a result, the virtual storage space is kept up-to-date with the intermediate or final

results of any engineering activities performed on the first computer device. Further, it is suggested by the invention that an additional communication link is established between a further local storage space of a further computer device and the virtual storage space, i.e. it is suggested that a third party is granted access to the virtual storage space. As soon as the further computer device is online, i.e. has a working communication connection to the cloud storage, the at least one synchronization unit copies the most recent version of the engineering artifacts into the further local storage space, where any new engineering artifacts not yet present in the further local storage space are included in the copy process.

In this way, the preferred embodiment allows for the exchange of engineering artifacts across different computer devices without requiring permanent on-line access to a server, where the computer devices may belong to one and the same user and the exchange is performed between different engineering tools installed on the computer devices or where the computer devices may belong to different users coming from different parts of an engineering team.

Accordingly, the preferred embodiment allows on one hand for a user to always keep the most recent version of his engineering artifacts in the virtual storage space and to keep all the computer devices belonging to him synchronized with the versions in the virtual storage space. As a result, the user may continue with the engineering process from whichever computer he wants to, since his development environment, i.e. source code, libraries and configuration data, is always up-to-date. On the other hand, the invention facilitates collaboration inside an engineering team since engineering artifacts are easily shared between different users. In particular, no special attention needs to be paid any longer to keeping the versions of libraries up-to-date whenever a corresponding control solution is changed, since this is done automatically by the at least one synchronization unit.

It is to be noted that according to the preferred embodiment, new versions of the engineering artifacts are copied in both directions: from the computer devices into the cloud storage and also from the cloud storage to the computer devices. This possibility may in addition to the above described situations also be useful, where it is desirable that engineering artifacts originally belonging to one computer device and being owned by one of the users, i.e. personally developed non-standard libraries as well as control solutions, are allowed to be changed and amended externally, either on other computer devices of this user or by third parties. These externally amended engineering artifacts are then copied back to the original computer device where they stem from.

In a development of the preferred embodiment, the at least one synchronization unit is arranged to copy the engineering artifacts to the at least one further local storage space only when the engineering artifact to be copied belongs to a predefined class of engineering artifacts. Thereby, it becomes for example possible to exclude the automatic exchanging of the class of standard libraries since standard libraries need to be installed only once and are not altered afterwards so that no updating is necessary. Another situation could be that the exchanging of files or data which are to kept secret shall be prevented. Accordingly, a certain class of configuration data or a certain file type can be excluded from the copy process.

In another development of the preferred embodiment, the at least one synchronization unit is arranged to copy the engineering artifacts to the at least one further local storage space only when the at least one further local storage space belongs to an authorized user. The authorization can be done either by the user of the first computer device or by a system administrator, and the presence of an authorization flag or certificate is then checked each time engineering artifacts are to be copied. Access to the engineering artifacts is thereby performed in a controlled and secure way.

In a further embodiment of the invention, the at least one synchronization unit is arranged to copy the engineering artifacts as soon as an updated version of the respective engineering artifact is available. Supposing that the first and/or at least one further computer device have an online connection to the cloud storage over a prolonged period of time, it is advantageous if new versions of the engineering artifacts are not only copied at first communication contact with the cloud storage but also afterwards, with every update and while the computer device stays on-line.

In advantageous embodiments, the at least one synchronization unit is arranged to allow for the restoration of a previous version of the at least one engineering artifact and/or to manage simultaneous accessing to the at least one engineering artifact in the virtual storage spaces in order to avoid conflicts when more than one computer device has access to the same virtual storage space. Simultaneous accessing can for example be managed by allowing for the checking in and checking out of those engineering artifacts which are currently under the copy process, where the checking in and checking out mechanisms are known from software development tools.

Further, it is suggested that the at least one synchronization unit is arranged to adjust the maximum bandwidth of the network load for the communication links and/or to provide time limited access to the cloud storage.

In all the embodiments described above, the at least one synchronization unit is arranged to be operated either individually on the first and/or the at least one further computer device or on a system containing the cloud storage.

In an embodiment of the method according to the invention, several engineering artifacts are grouped in a specific set and a baseline of this specific set is created.

In another embodiment of the method, at least two engineering artifacts are compared and/or a previous version of the at least one engineering artifact is compared with a more recent version of the at least one engineering artifact.

The invention and its embodiments will become apparent from the example and its embodiments described below in connection with the appended drawings which illustrate:

Figs. 1-4 known processes of exchanging engineering artifacts,

Fig. 5 the known way of using cloud storage for permanently synchronized storing of files,

Fig. 6 a first embodiment of the arrangement and method according to the invention,

Fig. 7 a second embodiment of the arrangement and method according to the invention.

Fig. 6 shows a cloud storage 9 which may be assigned to an engineering team working in the field of control system engineering and engineering for industrial automation, or it may be assigned to or even operated by a vendor of engineering tools and software libraries to be used by the engineering team. For three different users, user1, user2 and user3, an individually assigned virtual storage space, 11a to 11c, is arranged in the cloud storage 9, where in general only the user himself has access to. Each user has a computer device, PC1 to PC3, which he uses for the engineering purposes. On each of the computer devices, a local storage space, 12a to 12c, is present, which contains one ore more special file folders, F1 to F4. The virtual storage spaces in the cloud storage are each individually allocated to one of the local storage spaces.

In the file folders of the local storage spaces, 12a to12c, individual engineering artifacts in the form of individual software libraries, Lib1 to Lib3, and control solution, CS1 to CS3, are

stored. Each of the computer devices comprises further a synchronization unit, 8a to 8c, which manages the communication between the local storage space of the particular computer device and the corresponding virtual storage space.

Each of the synchronization units, 8a to 8c, is arranged to establish a communication link between its corresponding local storage space, 12a to 12c, and the correspondingly allocated virtual storage space, 11a to 11c, as soon as a communication connection, 10a to 10c, is established between the corresponding computer device, PC1 to PC3, and the cloud storage 9. The synchronization unit then compares the contents of the local and the allocated virtual storage space and copies the latest version of the engineering artifacts, Lib1 to Lib3 and CS1 to CS3, as well as any engineering artifacts which are completely new, from the local into the allocated virtual storage space and/or vice versa, so that both storage spaces are up-to-date.

In the situation depicted in Fig. 6, the synchronization units are arranged to copy the standard library Lib from the respective virtual storage space to the corresponding local storage space. The standard library Lib is provided by a third party, called Owner, to the cloud storage 9. The cloud storage 9 is arranged to copy the standard library into each of the individual virtual storage spaces, 11a to 11c, so that they can be copied from there to the corresponding local storage space with the next online connection of the respective computer device. In this way, updates of the standard library Lib can be distributed easily, timely and without requiring any interactions from the user and without the need of a permanent online connection to the cloud. In order to copy the standard library Lib from its original storage space belonging to the Owner, i.e. outside of the cloud storage 9, into the virtual storage spaces, the Owner has write access to a personally allocated storage space in the cloud storage 9 (not shown) or the cloud storage 9 has read access to the original storage space of the standard library Lib, respectively. The cloud storage 9 has then the right to access the virtual storage spaces in addition to the respective, individually assigned user and its corresponding computer device, PC1 to PC3, so that it can copy the standard library Lib either from the original external storage space or from the storage space personally allocated to the Owner into the individual virtual storage spaces. In the alternative, it could also be arranged for the Owner to have direct access to the virtual storage spaces.

The copying direction from the local storage spaces 12a to 12c into the corresponding virtual storage spaces 11a to 11c will inherently never be used for the standard library Lib, since the standard library remains unchanged. In case that the owner of the standard library Lib provides an update of it, this update will by definition always come as a new version in order

not to render the control solutions CS1 to CS3 which are based on the previous version invalid. Accordingly, an update of the standard library Lib will always be recognized as an additional engineering artifact which is then copied in addition to the engineering artifacts already present into the local storage spaces 12a to 12c.

In the example of Fig. 6, the second user, user2, has given access to his personally allocated virtual storage space 11b to the third user, user3. Accordingly, access is allowed for the computer device PC3 and its synchronization unit 8c. As a result, the synchronization unit 8c is arranged to establish a further communication link 13 between the local storage space 12c of computer device PC3 and the virtual storage space 11b allocated to the second user. The copy mechanism towards a third party local storage space is the same as for the copying towards the individually allocated local storage space, i.e. the most recent version of the engineering artifacts including any new engineering artifacts are copied. It is to be noted that in this example, copying from a virtual storage space to a non-allocated local storage space, i.e. a local storage space belonging to another user, is limited only to the forward direction. Copying into the opposite direction, from the non-allocated local storage space to the virtual storage space, is not allowed, i.e. only the original owner of the engineering artifacts is entitled to change and amend them. However, in another embodiment of the invention it may also be provided for the copying of externally amended engineering artifacts back into the virtual storage space of the original owner. This is indicated by the differently shaped arrow pointing toward the virtual storage space 11 b. In that case, it is essential that mechanisms are in place for the handling of software versions including the possibility for restoration of previous versions and for the prevention of simultaneous accessing to one and the same engineering artifact from different computer devices, so that the co-working on the same engineering artifacts is ensured. These mechanisms are preferably executed by the at least one synchronization unit 8.

In order to clearly distinguish between own individual engineering artifacts, Lib3 and CS3, which can be modified and copied back into the cloud storage 9, and third party individual engineering artifacts, Lib2 and CS2, the local storage space 12c belonging to the third user user3 contains separate file folders, F3 and F4.

Further modifications and options for the operation of the at least one synchronization unit, 8a to 8c, are available, such as for example the possibilities to adjust the maximum bandwidth of the network load for the communication link between virtual and local storage spaces or to only provide time limited access to the cloud storage 9. It is further possible that several engineering artifacts are grouped in a specific set and a baseline of this specific set

is created, or that different engineering artifacts are compared with each other, or that a previous version of one engineering artifact is compared with a more recent version of this engineering artifact.

Fig. 7 differs from Fig. 6 in that a central synchronization unit 8 is arranged in the cloud storage 9, instead of having a local synchronization unit, 8a to 8c, in the individual computer devices. Further, the second user, user2, has been given access to the virtual storage space 11c allocated to the local storage space 12c belonging to the third user, user3. As a result, the central synchronization unit 8 performs all tasks of establishing communication links between the virtual storage spaces and the allocated as well as the further permitted local storage spaces, of copying the most recent versions of the engineering artifacts including any new engineering artifacts and of managing the copying process in terms of controlling simultaneous accessing, adjusting the time period and bandwidth of the communication links etc.

Claims

1. Arrangement for distributing an engineering artifact to a first (PC1) and at least one further (PC2, PC3) computer device, the arrangement comprising at least one synchronization unit (8a, 8b, 8c) and a cloud storage (9) containing a first (11a) and at least one further virtual storage spaces (11b, 11c), where
    - the cloud storage (9) is arranged to copy the at least one engineering artifact (Lib) into the first (11a) and the at least one further (11b, 11c) virtual storage spaces,
    - the at least one synchronization unit (8a, 8b, 8c) is arranged
        - to establish a communication link between the first virtual storage space (11a) and a first local storage space (12a) contained in the first computer device (PC1) as soon as a first communication connection (10a) is established between the cloud storage (9) and the first computer device (PC1),
        - to establish at least one further communication link between the at least one further virtual storage space (11b, 11c) and at least one further local storage space (12b, 12c) contained in the at least one further computer device (PC2, PC3) as soon as at least one further communication connection (10b, 10c) is established between the cloud storage (9) and the at least one further computer device (PC2, PC3),
        - to compare the contents of the first local storage space (12a) with the contents of the first virtual storage space (11a) and the contents of the at least one further local storage space (12b, 12c) with the contents of the at least one further virtual storage space (11b, 11c), and
        - in case that the first and/or the at least one further virtual storage space (11a, 11b, 11c) contains an additional and/or more recent version of the at least one engineering artifact compared to the corresponding first and/or at least one further local storage space (12a, 12b, 12c), respectively, to automatically start a copy process of the additional and/or more recent version of the at least one engineering artifact to the corresponding first and/or the

at least one further local storage space (12a, 12b, 12c), respectively.

2. Arrangement according to claim 1, where the cloud storage (9) is arranged to copy the at least one engineering artifact (Lib) into the first (11a) and the at least one further (11b, 11c) virtual storage spaces simultaneously.

3. Arrangement according to any of the previous claims, where the cloud storage (9) is arranged to copy an individualized version of the at least one engineering artifact (Lib) into the corresponding first (11a) and/or at least one further (11b, 11c) virtual storage space.

4. Arrangement according to any of the previous claims,
   - where the at least one synchronization unit (8b, 8c) is arranged
     - in case that the first local storage space (12b) contains an additional and/or more recent version of the at least one engineering artifact (Lib2, CS2) compared to the first virtual storage space (11b), to automatically start a copy process of the additional and/or more recent version of the at least one engineering artifact to the first virtual storage space,
     - to establish a further communication link (13) between the first virtual storage space (11b) and at least one further local storage space (12c) contained in the at least one further computer device (PC3), as soon as at least one further communication connection (10c) is established between the cloud storage (9) and the at least one further computer device (PC3),
     - to compare the contents of the at least one further local storage space (12c) with the contents of the first virtual storage space (11b),
     - in case that the first virtual storage space (11b) contains an additional and/or more recent version of the at least one engineering artifact (Lib2, CS2) compared to the at least one further local storage space (12c), to automatically start a copy process of the additional and/or more recent version of the at least one engineering artifact to the at least one further local storage space (12c).

5. Arrangement according to claim 4, where the at least one synchronization unit (8c) is arranged to copy the at least one engineering artifact to the at least one further

local storage space (12c) only when the engineering artifact belongs to a predefined class of engineering artifacts.

6. Arrangement according to claims 4 or 5, where the at least one synchronization unit (8c) is arranged to copy the at least one engineering artifact to the at least one further local storage space (12c) only when the at least one further local storage space (12c) belongs to an authorized user.

7. Arrangement according to any of the previous claims, where the at least one synchronization unit (8c) is arranged to copy the at least one engineering artifact as soon as an updated version of the respective engineering artifact is available.

8. Arrangement according to any of the previous claims, where the at least one synchronization unit (8a, 8b, 8c) is arranged to allow for the restoration of a previous version of the at least one engineering artifact.

9. Arrangement according to any of the previous claims, where the at least one synchronization unit (8a, 8b, 8c) is arranged to manage simultaneous accessing to the at least one engineering artifact (Lib2, CS2) in the first and/or the at least one further virtual storage spaces (11a, 11b, 11c).

10. Arrangement according to any of the previous claims, where the at least one synchronization unit (8a, 8b, 8c) is arranged to adjust the maximum bandwidth of the network load for the communication links.

11. Arrangement according to any of the previous claims, where the at least one synchronization unit (8a, 8b, 8c) is arranged to provide time limited access to the cloud storage (9).

12. Arrangement according to any of the previous claims, where the at least one synchronization unit (8a, 8b, 8c) is arranged to be operated individually on the first and/or the at least one further computer device (PC1, PC2, PC3).

13. Arrangement according to any of the previous claims 1 to 11, where the at least one synchronization unit is arranged to be operated on a system containing the cloud storage.

14. Method for distributing an engineering artifact to a first (PC1) and at least one further computer device (PC2, PC3), where a cloud storage (9) contains a first (11a) and at least one further virtual storage space (11b, 11c),
characterized by the steps
- copying the engineering artifact (Lib) into the first (11a) and/or the at least one further (11b, 11c) virtual storage spaces,
- establishing a communication link between the first virtual storage space (11a) and a first local storage space (12a) contained in the first computer device (PC1), respectively, as soon as a first communication connection (10a) is established between the cloud storage (9) and the first computer device (PC1),
- establishing a communication link between the at least one further virtual storage space (11b, 11c) and at least one further local storage space (12b, 12c) contained in the at least one further computer device (PC2, PC3), as soon as at least one further communication connection (10b, 10c) is established between the cloud storage (9) and the at least one further computer device (PC2, PC3),
- comparing the contents of the first local storage space (12a) with the contents of the first virtual storage space (11a) and the contents of the at least one further local storage space (12b, 12c) with the contents of the at least one further virtual storage space (11b, 11c),
- in case that the first and/or the at least one further virtual storage space (11a, 11b, 11c) contains an additional or more recent version of the engineering artifact compared to the corresponding first and/or at least one further local storage space (12a, 12b, 12c), respectively, to automatically starting a copy process of the additional or more recent version of the engineering artifact to the first and/or the at least one further local storage space (12a, 12b, 12c), respectively.

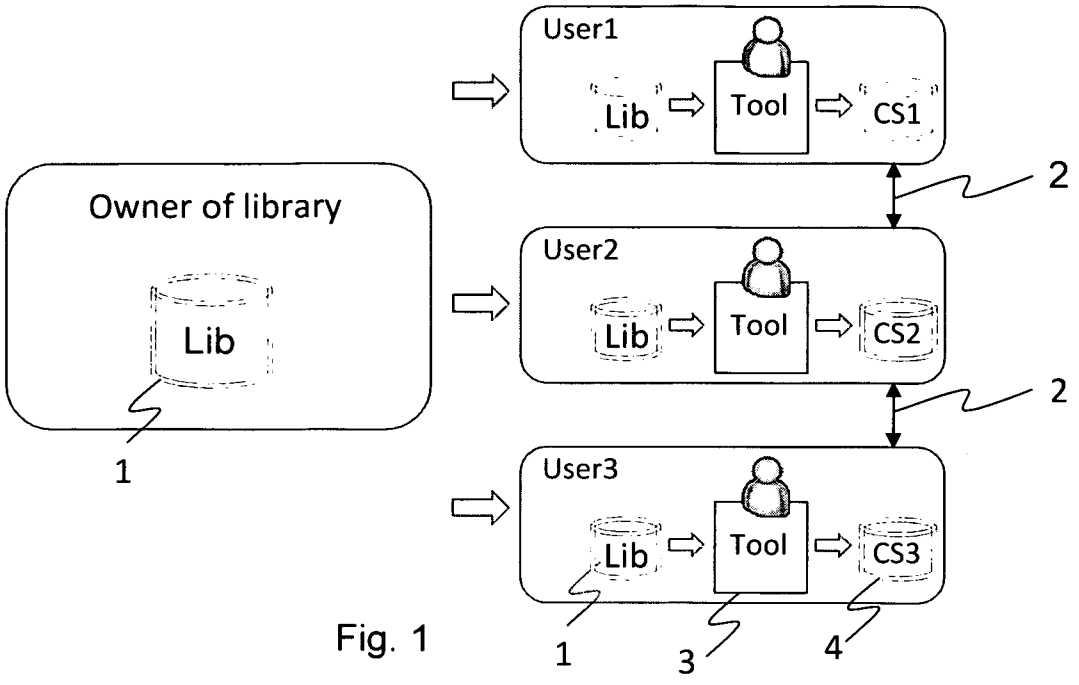
15. Method according to claim 14, comprising the further steps
- in case that the first local storage space (12b) contains an additional and/or more recent version of the at least one engineering artifact (Lib2, CS2) compared to the first virtual storage space (11b), to automatically starting a copy process of the additional and/or more recent version of the at least one engineering artifact to the first virtual storage space,
- establishing a further communication link (13) between the first virtual storage space (11b) and at least one further local storage space (12c)

contained in the at least one further computer device (PC3), as soon as at least one further communication connection (10c) is established between the cloud storage (9) and the at least one further computer device (PC3),

- comparing the contents of the at least one further local storage space (12c) with the contents of the first virtual storage space (11b),
- in case that the first virtual storage space (11b) contains an additional engineering artifact and/or a more recent version of the at least one engineering artifact (Lib2, CS2) compared to the at least one further local storage space (12c), to automatically starting a copy process of the additional engineering artifact and/or of the more recent version of the at least one engineering artifact to the at least one further local storage space (12c).

16. Method according to claim 14 or 15, where several engineering artifacts are grouped in a specific set and where a baseline of this specific set is created.

17. Method according to any of claims 14 to 16, where at least two engineering artifacts are compared and/or a previous version of the at least one engineering artifact is compared with a more recent version of the at least one engineering artifact.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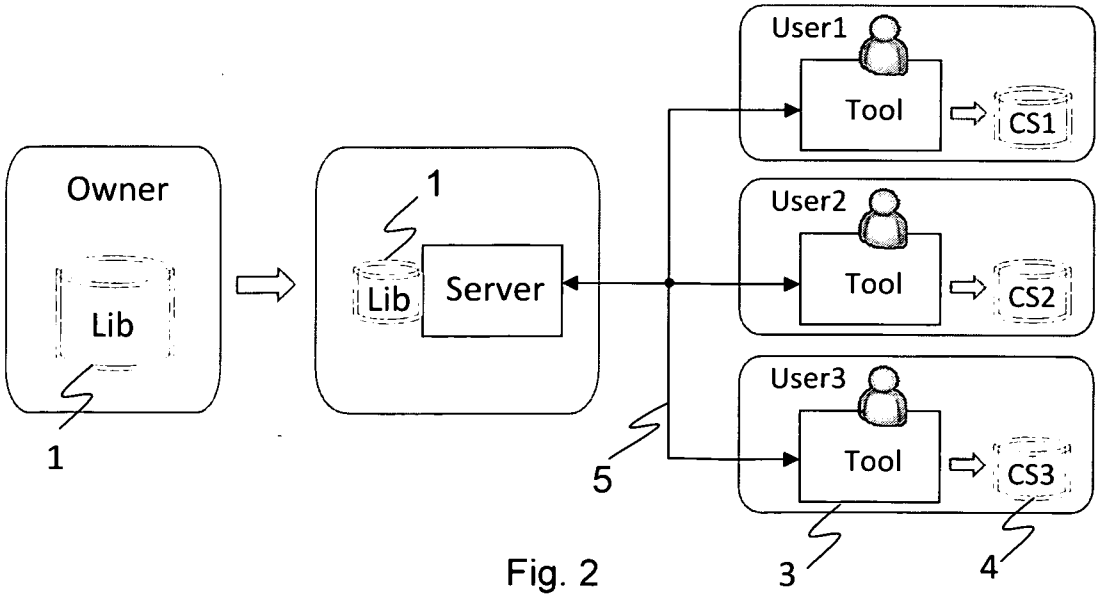
Lib
Tool
CS1
2
Owner of library
Lib
User2
Lib
Tool
CS2
2
User3
Lib
Tool
CS3
1
1
3
4

Fig. 1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Tool
CS1
Owner
Lib
1
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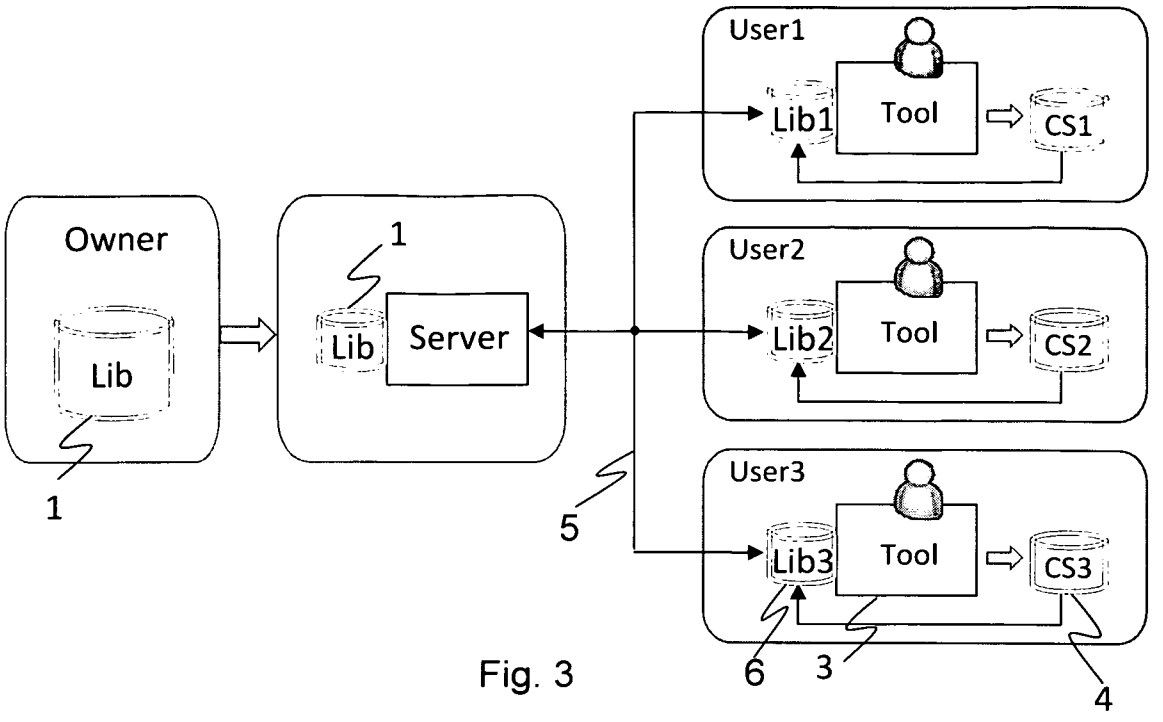
Lib
Server
User2
Tool
CS2
User3
Tool
CS3
5
1
3
4

Fig. 2


Owner
Lib
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Lib
Server
5
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Tool
CS1
User2
Lib2
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CS2
User3
Lib3
Tool
CS3
6
3
4

Fig. 3

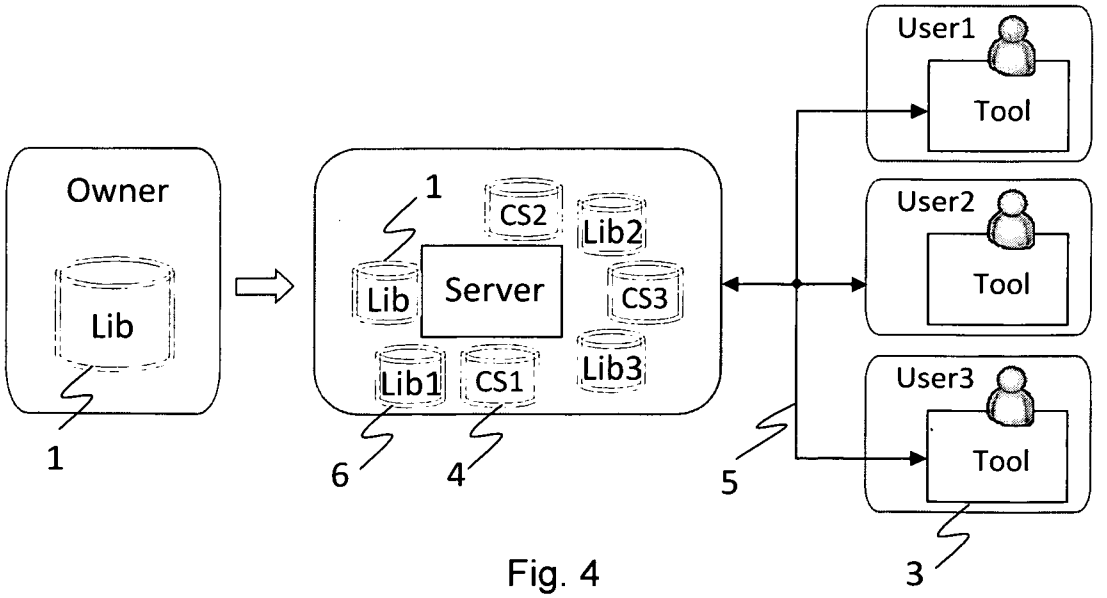
Owner
Lib
1
1
CS2
Lib2
Lib
Server
CS3
Lib1
CS1
Lib3
6
4
5
User1
Tool
User2
Tool
User3
Tool
3

Fig. 4

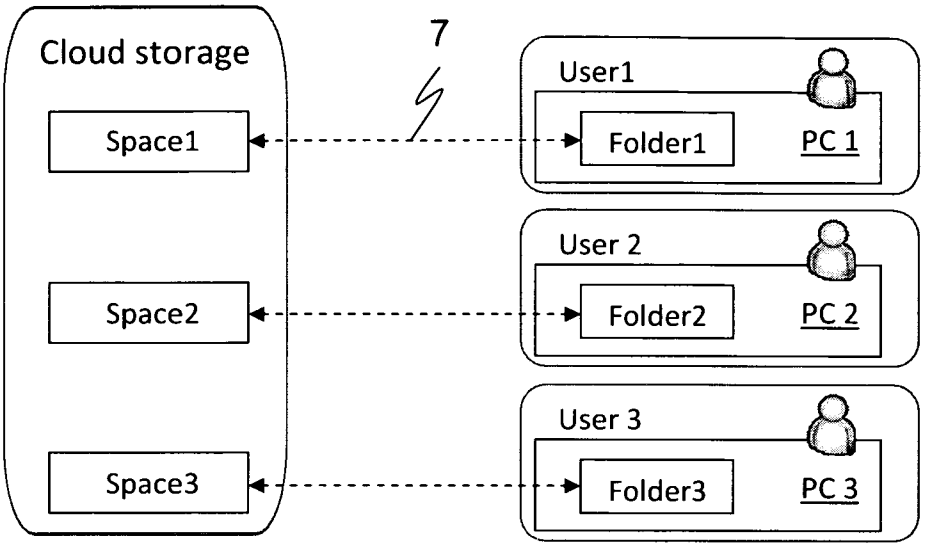
Cloud storage
Space1
Space2
Space3
7
User1
Folder1
PC 1
User 2
Folder2
PC 2
User 3
Folder3
PC 3

Fig. 5

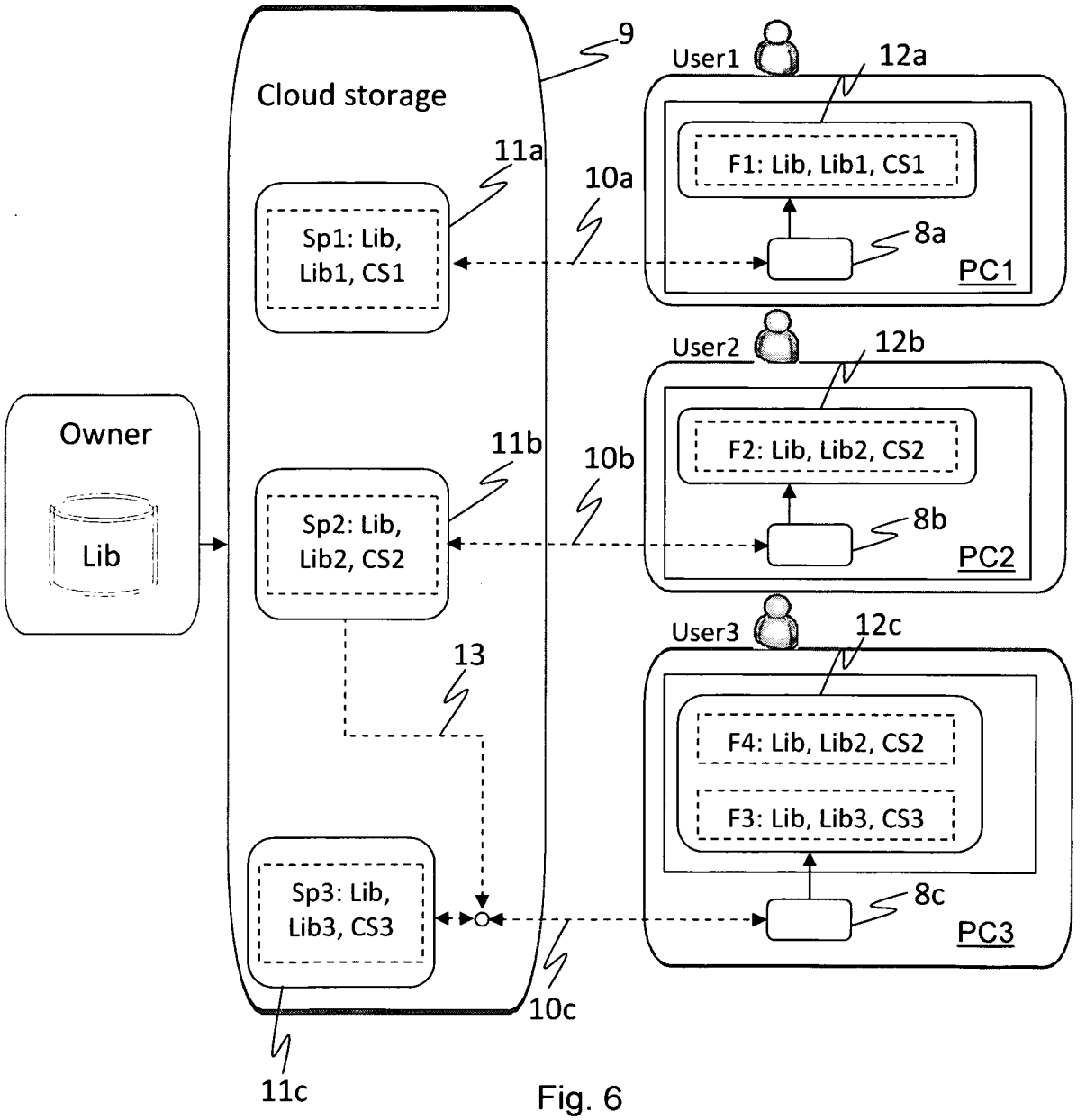
Cloud storage
9
User1
12a
F1: Lib, Lib1, CS1
11a
10a
Sp1: Lib, Lib1, CS1
8a
PC1
User2
12b
F2: Lib, Lib2, CS2
Owner
Lib
11b
10b
Sp2: Lib, Lib2, CS2
8b
PC2
User3
12c
13
F4: Lib, Lib2, CS2
F3: Lib, Lib3, CS3
Sp3: Lib, Lib3, CS3
8c
PC3
10c
11c

Fig. 6

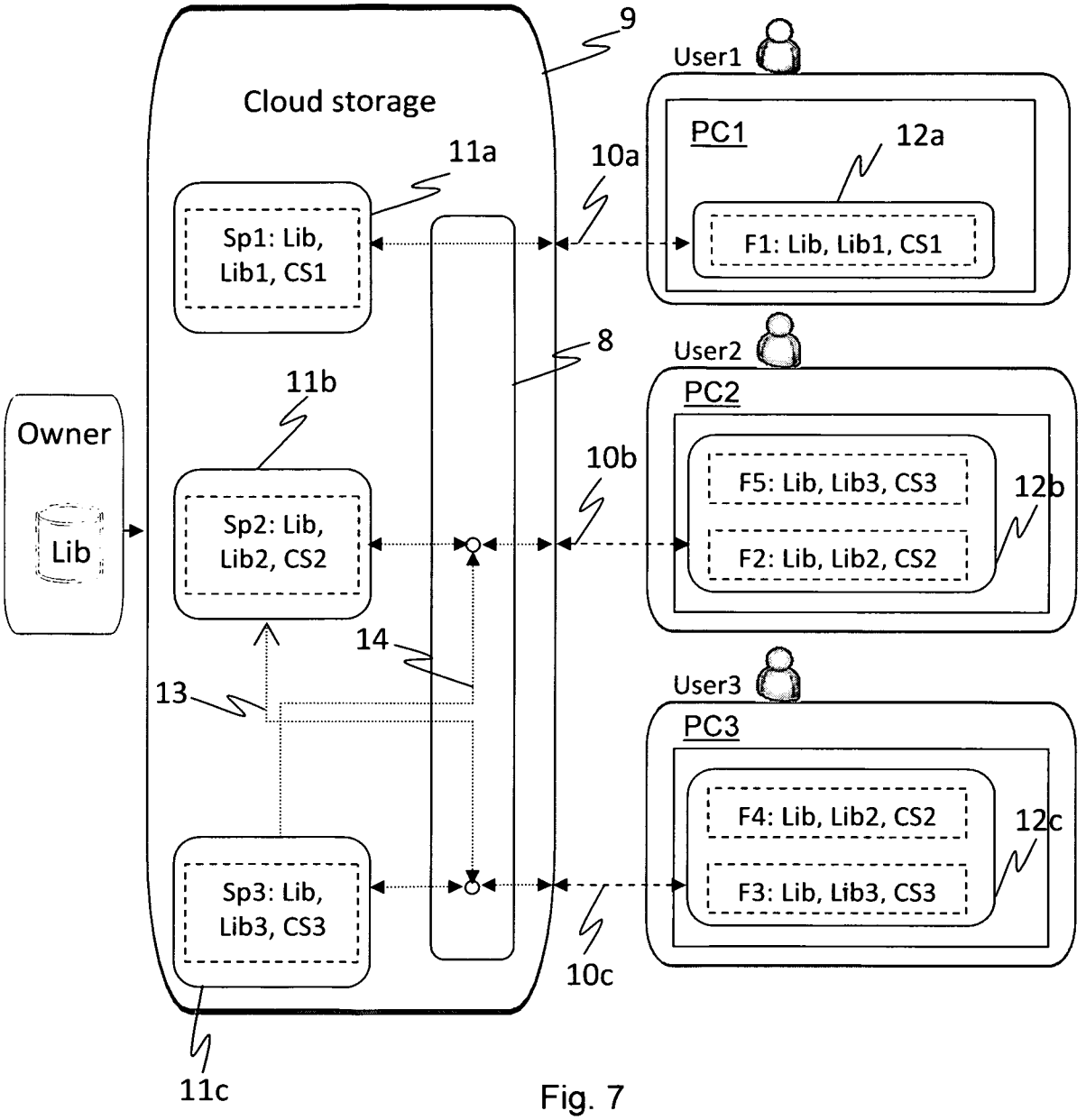
9
Cloud storage
11a
10a
Sp1: Lib, Lib1, CS1
User1
PC1
12a
F1: Lib, Lib1, CS1
8
User2
PC2
11b
Owner
Lib
Sp2: Lib, Lib2, CS2
10b
F5: Lib, Lib3, CS3
12b
F2: Lib, Lib2, CS2
14
13
User3
PC3
F4: Lib, Lib2, CS2
12c
Sp3: Lib, Lib3, CS3
F3: Lib, Lib3, CS3
10c
11c

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/005643

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F17/30
ADD.

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

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GRAY J ET AL: "The dangers of replication and a solution", SIGMOD RECORD, ACM, NEW YORK, NY, US, vol. 25, no. 2, 4 June 1996 (1996-06-04), pages 173-182, XP002146555, ISSN: 0163-5808, DOI: 10.1145/235968.233330 page 179 - page 182	1-17
X	US 7 500 020 B1 (KABRA NAVIN [IN] ET AL) 3 March 2009 (2009-03-03) column 1 - column 14	1-17
A	WO 2006/079967 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; LUITJENS STEVEN BROEILS [NL]; KAM) 3 August 2006 (2006-08-03) page 1 - page 12	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2012	26/04/2012

Name and mailing address of the ISA/	Authorized officer
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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/005643

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7500020 B1	03-03-2009	US 7500020 B1	03-03-2009
		US 7831735 B1	09-11-2010
WO 2006079967 A2	03-08-2006	CN 101111843 A	23-01-2008
		EP 1846846 A2	24-10-2007
		JP 2008536344 A	04-09-2008
		KR 20070100831 A	11-10-2007
		US 2009112936 A1	30-04-2009
		WO 2006079967 A2	03-08-2006