

Risk-Transfer Configurator and Simulation Engine Providing Forward- and Backward-Looking Measures For Steering and Adjustments of Risk-Driven Portfolios of Underwriting Objects and Method Thereof

Field of the Invention

5 The present invention relates to a parametric-driven simulation engine forecasting forward- and backward-looking metric measures based on parameterized characteristics of time-dependent occurrence probabilities of physical risk events. The present invention relates to intelligent, automated optimization technologies for steering, monitoring and adapting/optimizing of portfolios of risk-driven objects and
10 related risk-transfer units. More particularly, it relates to forecasting and exposure-based signaling, steering and/or operating of risk-event driven or triggered systems, in general, but even more particular systems for automation of underwriting, risk management, risk portfolio steering and signaling involving an improved identification of the impact on a portfolio of the occurrence of risk events or catastrophes, i.e. measured catastrophe
15 showing loss impacts, and forecast or prediction of their quantified impacts, and/or an improved ability to initiate or trigger appropriate risk mitigation measures to cope with liability risks, and/or an improved scenario-based modeling quantifying catastrophe exposures, and/or improved resource/risk balancing with improved risk charge/costing signaling and optimized loss-ratio handling.

20

Background of the Invention

 In all fields of technology, it is often a requirement to make assessment, measurements and predictions based on measured parameters and sensory data regarding the future operation or status of real world physical systems, assets or living
25 objects. Important factors for such measurements/predictions are, for example, the measured exposure of the real world physical systems, assets or living objects to the impact of externally occurring risk events and possibly correlated the internal aging process of the real world physical systems, assets or living objects. This is especially true in the automated risk-transfer technology. Risk-transfer systems critically rely on adjusting
30 or calibrating determined basic rate measures for each exposure unit. The basic rates

can vary significantly for risks, i.e. time-dependent occurrence probabilities of physical risk events, with different characteristics. One of the differences between basic rate measures required in risk-transfer technology and parameters of usual products often relies on the fact that the actual impact of providing the risk-transfer on a certain basic rate measure is unknown until the predefined time period of the risk-transfer has lapsed and/or a risk-event occurred. Therefore, risk-transfer rate measures critically depend on predicted or forecasted measures by time-related propagating of current parameter values of the physical risk-events and their possible impacts rather than directly on current parameter values. In addition, the propagation mostly rely the forecast on correlations, technically lacking explicit treatment of occurrence probability measures, i.e. risk measures.

In the state of the art, most rates are determined by performing statistical analysis of measured and monitored, historically occurred losses based on specific trigger variables of the risk-exposed asset or object. Parameters that yield the best forecasts are the criteria by which rate values are set. In cases, where performing of historical analysis does not provide sufficient statistical leverage, such as for earthquake risk-transfer, catastrophe modeling techniques are typically used, but with a larger error rate. Automated risk-transfer systems have to be enabled to both, i.e. (a) setting the rate measures based on specific variables, and (b) determining which variables apply to a specific risk-transfer underwriting asset or object. Technically, the basic rates provide for measures for the resources needed to be associated with an individual transfer of risk (i.e. probability of a physical loss or damage impact due to the occurrence of a physical risk event as e.g. a hurricane or an earthquake) or in financial terms the basic rates provide for measures for the costs (or expenses) associated with an individual transfer of risk. Being based on rates allows the risk-transfer system of appropriate weighting of different transferred risks, i.e. to maintain equity among risk-exposed assets or objects, i.e. the insureds. This structure considers the fact that costs vary with each individual transfer of risk. Further, different types of cost have different correlations with the overall cost of the transfer of risk. However, each cost of providing the risk-transfer has different correlation with the risk-transfer, itself, and must be allocated in some way to the object or asset, where the risk is transferred of. In prior art, risk-transfer costs or expenses are split into one of two categories, those costs that vary with total cost of the transfer of risk and those that do not. The issue of allocating these different types of expenses has technically be addressed differently. In the state of the

art, at least two variations of structures to address the issues are known, in particular 1)
the Expense Fee Method and 2) the Workers' Comp Method. For automation of risk-
transfer, the systems rely on three important preconditions: (i) all quantities are
accurately measured, (ii) all rates are at an adequate level, and (iii) the rating
5 structures are scalable and multiplicative. Again, it is important to note, that in this
context, exposure units are the metric measures used in the risk-transfer rates, i.e. the
insurance rates. The premium is a measure for the total resources to be allocated with a
risk-transfer, i.e. the total cost of the risk-transfer, typically given by an insurance policy.
Thus, the relation of these measures is given by $\text{premium} = \text{rate} \times \text{exposure units}$. For
10 example, if premiums is measured in such units as monetary units, e.g. Euros or dollars,
and the exposures or exposure units are measured e.g. in units of "car years", then the
metric measure of the rate would be measured units of "Euros per car year". It is
therefore a demand to provide automated technical systems and methods to
technically allow fast assessments and/or automated predictions and forecasts for a
15 risk-transfer or portfolio of risk-transfers in an automatic and accurate manner based on
physical measuring parameters.

In the prior art, processor-driven systems with user interfaces for automated
receiving data for binding contract conclusions between a user and a digital platform
or channel are known in the prior art, in particular, via the Internet. In the field of risk-
20 transfer technology, such systems or platforms are e.g. automated underwriting (UW)
platforms. To increase the quality of the data acquisition, the known systems are
typically equipped with validation means in order to check the input data values on
the basis of data rules which are assigned to data input fields of the user interfaces and
for requesting, if necessary, corrections via the user interface. In the case of products or
25 services which are assigned to fixed purchase prices, sales contracts can be
automatically concluded on-line by the known systems. If, however, the objects of
contracts relate to service structures/products which cannot be simply assigned
contract conditions and, in particular, prices on an individual one-to-one basis, the
known systems are only suitable for data acquisition for ordering services or applying for
30 services which must be dealt with manually by professional assistants of the service
provider at a later time. This means that contracts for services which are dependent on
many conditions and factors, for example risk-transfers which depend on numerous and
different risk factors and risk-transfer conditions, cannot be concluded automatically
and on-line by the known systems, nor can such risk-transfers or portfolios or baskets of

risk-transfers be dynamically adapted from user side without human assistance from the provider side. In the known systems, it is possible to deal differently with users from different countries and/or language regions by selecting and activating different user interfaces in accordance with the specification of the relevant country or of relevant language region for the user. For example, the user is presented with a country- or language-specific graphical user interface. The existence of a number of different user interfaces for different user groups increases the complexity and maintenance costs of the system. For example, a general change of the user interface must be carried out in all country- and language-specific graphic user interfaces.

10

Summary of the Invention

It is an object of the invention to allow for systematic capturing, measuring, quantifying, and forward-looking generating of appropriate risk and risk accumulation measures of risk-transfers and risk-transfer portfolios associated with risk exposures of physical real-world assets and objects based on physical measuring parameter values and data, i.e. the impact of a possibly occurring physical event in a defined future time window. It is a further object of the present invention to propose a processor-driven system or platform providing an automated digital channel for automatically concluding and dynamically adapting risk-transfers between a risk-transfer service user and a risk-transfer service provider, which does not exhibit the disadvantages of the known systems. In particular, it is an object of the present invention to propose a processor-driven, metric system or digital platform which comprises a user interface, which can be operated by means of terminals via a data-transmission network for users, comprising data input fields for inputting data relating to the object of a risk-transfer, which is available and can be used as a one-stop, end-to-end process for conducting, monitoring and adapting risk-transfers or portfolios of risk-transfers by the user independently of the location or the desired object of a contract (service). In particular, it is a further object of the present invention to propose a processor-driven, computer-based system which comprises a universal user interface which can be adapted flexibly to variable risk-transfer conditions and risk-transfer types of an automated binding process without changes which are visible to the service user. The

used inventive technical teaching should be easily integratable in other processes, productions chains or risk assessment and measuring systems. Finally, the invention should be enabled to use data and measuring parameter values from multiple heterogeneous data sources. The probability and risk forecast should allow to capture
5 various device and environmental structures, providing a precise and reproducible measuring of risk factors, and allowing to optimize associated event occurrence impacts of the captured risk events.

According to the present invention, these objects are achieved particularly through the features of the independent claims. In addition, further advantageous
10 embodiments follow from the dependent claims and the description.

According to the present invention, the above-mentioned objects are particularly achieved by the inventive, automated risk-transfer configurator allowing fast composing, launching and configuration of highly customized secondary risk-transfer structures, wherein the risk-transfer configurator comprises a metric simulation
15 engine, wherein a basic rate measure and/or a structural mix characteristic of a portfolio or basket of risk-transfers comprising captured risk-exposure units is varied until a desired degree regarding the varied values of the basic rate measure and/or the structural mix characteristic is reached. In particular, the invention relates to the above-mentioned metric simulation engine for automated prediction of forward- and
20 backward-looking impact measures based on measured event parameter values of time-dependent series of occurrences of physical impacting risk-events, wherein the occurrences of the physical risk-events are measured based on predefined threshold-values of the event parameters, and wherein the impacts of the physical risk-events to a specific physical or intangible real-world asset or living object are measured based on
25 impact parameters associated with the asset or object, in that structured asset/object characteristics parameters of the physical assets or objects are captured at least partially by means of a parameter-driven, rule-based bifurcation process dynamically capturing characteristics parameter values and mapping the values to the structured characteristics parameters, wherein a plurality of risk-transfers associated with the
30 occurrence of one or more predefined risk-events impacting the physical assets or objects are captured by metric risk-exposure units and transferred to a portfolio holding the risk-transfers by means of the captured risk-exposure units, and wherein a structural mix characteristic of the portfolio is given by the measured and captured types of risks

and assigned number of risk-transfers with associated metric risk-exposure units, in that the simulation engine applies basic rate measures to the metric risk exposure units associated with a specific type of risk-transfer based on the event parameters of the risk-transfer and asset/object characteristics parameters of the physical asset or object

5 determined by means of the simulation engine, wherein the basic rate provides for a cost measure of resources needed to cover the risk associated with a specific transfer, and wherein a premium for the risk-transfer is generated multiplying the basic rate by the number of risk-exposure unit of the specific risk-transfer, and in that the simulation engine provides dynamically forward- and backward-looking impact measures based

10 on a variation of the basic rate measure and/or the structural mix characteristic of the portfolio comprising the captured risk-exposure units, wherein the forward- and backward-looking impact measures at least comprise a measure for an total amount of premiums associated with the portfolio of risk-transfers and/or a net amount of premiums given by the total amount of premiums minus premiums associated with

15 secondary risk-transfers assigned to transferred parts of the risk exposure units of the portfolio, and/or a total expected loss measure and/or a CM1 measure. As an embodiment variant, the automated risk-transfer configurator and/or the simulation engine can be realized as an integrated part of a cloud-based application. The cloud-based application can be realized as Software as a Service (SaaS) over the cloud

20 application by an appropriate provider.

The invention has inter alia the advantage that it provides an automated electronic digital channel to individually place and manage risks and risk-transfers between first risk-transfer systems or insurers and second risk-transfer systems reinsurers, in particular a digital B2B channel for secondary risk-transfer between two risk-transfer

25 systems (insurer - reinsurer). The invention provides the technical infrastructure for an automated one-stop system for users' reinsurance approaches comprising automated underwriting and user-specific data capturing, automated claim handling, automated accounting (technical and financial) and automated reporting all in one technical system. The system provides automated secondary risk-transfer (reinsurance) coverage

30 for all risk-specific fields as e.g. property and casualty risks, life and health risks, any line of business or industry risks, single risks, treaty and facility risks, and accumulation or clash risk involving loss exposure of one event spreading to multiple lines of business, i.e. correlated risk structures. The inventive system allows in a new technical way a user to monitor and fully control his risks along the entire value chain at any time. The system

further allows to have an additional focus on brokers, which can e.g. contribute up to 40% to the bound risk-transfers by the inventive system. The invention provides a new kind of direct and full control and transparency of his risk-transfer portfolio to the user, in particular the invention provides early recognition of trends and agile risk-transfer steering by means of forward- and backward-looking metrics and measure values. The invention also provides technical means which can be seamless integration with other technical solutions and systems as e.g. portfolio monitoring platforms.

The invention has further the advantage that it provides a technical basis, which allows the user to significant faster develop a "go to market" strategy compared to prior art systems and technologies available in the technical field. For example, the invention allows new risk-transfer structure/product deployment within 48h by means of the inventive risk-transfer product composer having a higher speed in quote delivery and a more enhanced referral and configuration application than the conventional technical systems in the field. The inventive, highly efficient process and structure allows to keep costs and men-power to a minimum due to high process automation, for example providing a cost leadership of around 2%, a high automation degree of 90% for the entire value chain, a simplified costing structure, a dynamic pricing structure (e.g. different price tags for different wordings), an easy steering of capacity deployment, and an efficient online accumulation control for the user, in particular e.g. realized as SaaS. The invention, realized as a digital, electronic and automated channel, allows an immediate notification to an underwriting request if the request does not qualify for automated processing, otherwise the invention provides risk-transfers at least for offline channel. For users, the invention provides an easy to use risk-transfer platform, where the user can manage his risk-transfer whenever he wants in a fast and efficient manner. The system provides a seamless data induction through an user's channel of choice (electronic reinsurance, automated broker platform, via an Application Programming Interface (API), electronic mail transfer, or semi-automated via user interface), where the user's expenditure of time and the administrative workload is heavily reduced through the automation, and where the system allows to provide efficient digital user support (e.g. chatbots). Finally, the invention allows to leverage existing platforms and applications and is scalable and technically integratable with no duplication. The invention provides one platform covering the whole end-to-end process applicable for internal and external usage. Due to its

technical flexibility, the invention can also be provided to the user over mobile application realization in particular based on cloud-based realization.

Brief Description of the Drawings

5 The present invention will be explained in more detail below relying on examples and with reference to these drawings in which:

Figure 1 shows a block diagram, schematically illustrating the automated end-to-end process according to the invention providing an efficient, automated online risk placement, claims and accounting channel for users with a complete
10 electronic solution for automated facultative business structuring. The reference number 2 denotes the automated end-to-end process, 21 the automated underwriting process by means of a rule-based bifurcation process, 211 the creation of a submission, 212 the receiving and binding of a quotation, 213 the modifying and renewing of an acceptances, 22 the technical accounting process, 221 the booking of the premiums,
15 222 the advising on new claims, 223 the booking and updating of claims, 224 the rectifying of premiums, 225 the submission of a statement of accounts, 23 the financial accounting process, 231 the advising and/or requesting of payments, 232 the seamless pairing, and finally 233 the setting of the accounts. The proposed invention and method provides a fast and easy access to first and secondary risk-transfer underwriting,
20 technical and financial accounting. The invention allows to reduce technical and administrative input and costs for managing mid-market risk-transfer portfolios. It further provides fast accessing and automatic capacity approval for medium-sized single risks or facilities. Finally, the invention allows relieving technical and administration time by providing an easy-to-use and efficient online risk placement, claims and accounting
25 channel for clients, which is available 24x7, is feedable over a management dashboard, and allows the user full control of all accounting and claims functions. The invention provides an automated one-stop solution covering the complete end-to-end process for reinsuring mid-market risk portfolios. The invention allows to implement a consistent underwriting guideline structures for the whole technical process ensuring a
30 consistent reply to the user's risk submissions with full control and transparency of the portfolio.

Figure 2 shows a block diagram illustrating schematically an exemplary risk-transfer setup for the capturing of the characteristic data associated with the risk-transfer. It shows an exemplary sample risk information capturing for a property proportional product at a certain location/region.

5 Figure 3 shows a block diagram illustrating schematically an exemplary the rule-based bifurcation underwriting process of the inventive electronic platform or system, i.e. the automated, risk-transfer specific data-capturing of the characteristics data of the physical assets or objects by means of the parameter-driven bifurcation process dynamically capturing characteristics parameter values and dynamically
10 mapping the values to structured characteristics parameters. Reference number 3 denotes the rule-based bifurcation underwriting process, 31 the standard rule-based underwriting process, 311 the automatic rule-based underwriting process, 3111 the process, where the triggered parameters are compliant with trigger rules, 312 the semi-automatic rule-based underwriting process, 3121 the process, where several
15 parameters are not compliant with the fixed trigger rules, 32 the non-standard rule-based underwriting process, and finally 321 the non-standard underwriting process where process does not include automatic pricing. For example, there may be 92 different property risk-transfers available via the inventive process (e.g. 63 proportional, 28 non-proportional and one parametric). A risk-transfer structure or product in the
20 context of the invention is understood to be a risk-transfer structure triggered per line of business, type of business and market/country (e.g. property, np, Belgium).

Figure 4 shows a block diagram illustrating schematically an exemplary generation of forward- and backward-looking impact measures as output of the inventive simulation engine 10 which is based on multiple data characteristics for the
25 risk-transfer conduct and fac business. For all risk-transfers performed by the inventive system 1, the client submits the risk via the system user interface, i.e. all risks are specified by the user based on approx. 20 risk characteristic attribute parameters. Through the whole underwriting process the system is based on structured data. All submitted and validated submission data are stored in a structured database. This means that the risk
30 information of the bound risk-transfer as well as of the non-bound risk-transfer is directly available. The system provides a parameter-driven underwriting process of the data capturing of the characteristics data: Standard risk-transfers are automatically or semi-automatically underwritten based on a complex rule-set defined by the underwriting

process. If all conditions are fulfilled, then the business is immediately quoted. If some conditions are not fulfilled, the risk-transfer request is further considered by an administered underwriting desk or expert system. As embodiment variant, the system may be realized to accept user rate offerings, i.e. for some products, the use is enabled

5 to offer the rate the user is willing to assign to the risk-transfer, providing insights into the gap between willingness to pay and the actual costing generation by the inventive system. As seen in figure 4, The system provides forward- and backward-looking measure output, by providing (1) as-if scenarios: Key for portfolio steering and identify areas where inventive simulation engine can act on (base rates, business mix); and (2)

10 Impact assessment: The simulation engine allows user management and underwriters to assess the impact of changes to the underwriting before going to test/launch it in the actual, real-world market. Figure 4 shows the generation of the forward- and backward-looking measures by the simulation engine under changings of the base rate factors. In other word, the simulation engine predicts measures answering the question

15 of what the effect on the current risk-transfer portfolio is if the base rates changes. In the inventive method and process, the user of the simulation engine is enabled to choose changes in base rates on the required level. Then the impact on the portfolio metric Gross Written Premiums (GWP), Net Written Premiums (NWP), Expected Loss and CM1 are evaluated. In the example of figure 4, it shows a decrease in base rates by 10% on 3

20 different Level 1 PIC Codes (Administration, commercial service, public facility; Chemicals and Pharmaceuticals; Retail, trading, storage facility). Regarding the granularity, the sensitivity can be assessed and compared on every level (risk-transfer portfolio, product, PIC Level 1-3) and by underwriting year.

Figure 5 shows a diagram illustrating schematically again the generation of

25 the forward- and backward-looking measures by the simulation engine under changings of the base rate factors according to figure 4. Also, here, the simulation engine predicts measures answering the question of what the effect on the current risk-transfer portfolio is if the base rates changes. On the x-axis, figure 5 shows the change in base rates, ranging from -50% to 50%. On the y-axis, we show the impact on the

30 portfolio metric Gross Written Premiums (GWP), Net Written Premiums (NWP), CM1 and the number of bound contracts (NR). A slight increase in premiums results in an immediate drop of bound risk-transfer contracts. However, the big risk-transfer contracts are lost by a rate increase of approx. 15%. If rates decrease, then additional contracts are bound. Regarding the granularity, the sensitivity can be assessed and compared by

means of the simulation engine on every level (risk-transfer portfolio, product, PIC Level 1-3) and by underwriting year.

Figure 6 shows a diagram illustrating schematically again the generation of the forward- and backward-looking measures by the simulation engine under
5 changings of the base rate factors according to figure 4-5. Again, the simulation engine predicts measures answering the question of what the effect on the current risk-transfer portfolio is if the base rates changes. Figure 6 shows the predicted measures allowing to compare the costed rates with the written rates (weighted by volume). A value of 30% means that in average the rate offered by the client is 30% higher than our costed rate.
10 A negative value means that the written rates are in average lower than the costed rates.

Figure 7 shows a diagram illustrating schematically an example of the generation of the forward- and backward-looking measures by the simulation engine under changings of the risk-transfer mix of the risk-transfer basket or portfolio. In other
15 word, the simulation engine predicts measures answering the question of what the effect on the current risk-transfer portfolio is if the risk-transfer mixture changes. In figure 7, the user of the simulation engine chooses changes in risk-transfer volume on the required level. Then the impact on the portfolio metric measures Gross Written Premiums (GWP), Net Written Premiums (NWP), Expected Loss and CM1 are generated. Figure 7
20 shows the impact of an increase of 5% in administration, a decrease of 5% in food, and excludes risk-transfers with negative CM1 (power generation, telecommunication, textile, wood). Regarding the granularity, the sensitivity can be assessed and compared on every level (risk-transfer portfolio, risk-transfer structure (product), PIC Level 1-3) and by underwriting year.

25 Figure 8 shows a diagram illustrating schematically an example of the generation of the forward- and backward-looking measures by the simulation engine under changings of the base rate factors and the risk-transfer mix of the risk-transfer basket or portfolio. In other word, the simulation engine predicts measures answering the question of what the effect on the current risk-transfer portfolio is if the base rate
30 and the risk-transfer mixture changes. The user of the simulation engine chooses changes in business volume and the change in base rates on the required level. Then the impact on the risk-transfer portfolio metric measures Gross Written Premiums (GWP),

Net Written Premiums (NWP), Expected Loss and CM1 are generated by means of the simulation engine.

Figure 9 shows a diagram illustrating schematically an example of a simulation engine integration. In this embodiment variant, the simulation engine is realized as an integrated part to risk-transfer portfolio monitor and management platforms as an additional functionality. Therefore, being an integrated part of a risk-transfer portfolio analytics and prediction framework. Such electronic solutions allow easy access and usability by the risk-transfer portfolio monitor and management platforms and/or the underwriting systems and platforms.

Figure 10 shows an example of a U.S. location where street address information can typically be captured and where the system 1 can retrieve a virtual look at the property e.g. with Street View.

Figures 11 show the ground-up loss, i.e. the loss before insurance conditions apply. Figure 11a a ground-up loss for the example property rated based on the primary attributes set, while figure 11b shows the ground-up loss for the example property rated based on the attributes set retrieved from the exposure database 2151.

Figures 12a/b illustrate the attribute of the data records 21511,...,2151i, which can e.g. be grouped into geographical, physical, flood physical, storm physical, earthquake physical properties and expert attributes, as can be seen from figure 12a/b, representing e.g. tabs of the forward-looking modelling module 21532. Figure 12a shows an example location1, screenshots of the data record 21511,...,2151i geographical location tab, showing the geo input and geocoded data. Figure 12b shows an example location1, screenshots of the data record 21511,...,2151i property data tabs. In this particular case, the following parameters could be retrieved from exposure data intelligence 215: (i) occupancy level 1; (ii) occupancy level 2; (iii) main structure type; (iv) detailed structure type; and (v) design year.

Figures 13a/b show views, in particular a StreetView in figure 13a, and a satellite view in figure 13b, of the locations belonging to the same street address. Both buildings are mapped to same address. In this case, a majority voting would not lead to the desired result, unless a better clustering logic gets implemented. A possible solution

would be to take all available attributes from all records clustered into account for matching.

Figure 14a/b illustrate the technical matching problem of two locations based on their Latitude and Longitude coordinates, where the matching can be an efficient preprocessing/refining step for address matching, essentially because it allows to overcome address formatting issues: once the search is narrowed down to a grid cell 215221 around the property/object 12 of interest, one can match the two locations 215112 based just on the house number or other attributes. The technical problem arises when choosing the size 215222 of the search cell 215221. Often, it turns out to be not big enough to enclose both [Lat, Lon] tags, this is especially true when matching large properties with large parcels of land, for example: 3860 W Peterson Ave, Chicago, IL 60603, USA (StreetView on figure 14b; satellite view on figure 14a).

Figure 15 shows exemplarily the system 1's integrated OSM's (OpenStreetMap) default geocoding processing module 216 by means of its interface, which allows for forward and reverse geocoding at different levels (Building / Street / District / Suburb / County / State...). It makes use of NLP for its address standardization and can perform house number interpolation when it is not available by default. For example, in the US, a good coverage for house numbers and roads is obtained from the Topologically Integrated Geographic Encoding and Referencing system (TIGER) data, produced by the US Census Bureau.

Figure 16 shows exemplary a user interface of the Overpass API (Application Programming Interface). In this case, the system 1 is realized to query all other components of the OSM database (nodes, ways and relations) by their location, geometry, tag and relation with the Overpass API (Application Programming Interface).

Figure 17 and 18 show an example of 3-way validation of the raw portfolio data 215113: (a) Raw portfolio data 215113 address yields OSM [Lat, Lon], (b) Raw portfolio data 215113 [Lat, Lon] to OSM (Rev) Address; and (c) Coordinates matched with Footprint. In the example of figure 18, the footprint-matching is visualized on the map. This is an example where the coordinate marker is just "close enough" to the correct building.

Figure 19 shows exemplarily the matching of coordinates to an OSM footprint. In this step, the system 1 determines if any of the found locations belonged to a building footprint. Queries are constructed with a modified overpass python module. In the first step (I), all building footprints were retrieved within a certain grid cell, e.g. a 5 100m radius of the raw portfolio data coordinates 215113 with an overpass query (all ways and relations having the tag 'building'). The retrieved geometries were processed with the GeoPandas and Shapely libraries (GeoPandas allows working with geospatial data in python. GeoPandas extends the datatypes used by Pandas to allow spatial operations on geometric types. Geometric operations can e.g. be performed by 10 Shapely. GeoPandas further depends on Fiona for file access and Descartes and Matplotlib for plotting.) for the calculation of the convex hull of each footprint, to simplify the shapes. (II) The algorithm can then perform a point-in-polygon search for both, the raw portfolio data coordinates pair 215113 & OSM coordinates in all the obtained shapes. If the first search returns only one polygon, the match is labeled as 15 'exact'. Else, all matches are returned without the 'exact' label. In case of no match, a buffer is added to all shapes and the search is repeated. (III) If no match is found, the buffer is increased, and the search is repeated. To keep track of uncertainty, the size of the buffer is returned with each match (see figure 19 steps I-III).

Figure 20 shows exemplarily two schematic histograms, with an upper 20 histogram of distance-errors between raw portfolio data coordinates pair 215113 and OSM coordinates in the 100m range. 85% of the geocoding results fall in this range. The lower histogram shows a histogram of distance-errors for distances greater than 100m, representing 15% of the results.

Figure 21 illustrates a generic cluster dendrogram visualizing agglomerative 25 and divisive clustering.

Figure 22 illustrates the original purpose of clustering: deduplication of raw portfolio data 215113 records 21511, ..., 2151i.

Figure 23 illustrates one of the proposed clustering hierarchies with streets at root level.

Figure 24 shows an exemplary clustering hierarchy with site at root level. Clusters defined by their geometry at different levels → clusters can't be confused, no chance for duplicates. The applied "Top-down Divisive Clustering" approach can e.g. be visualized the diagram of figure 24. In this approach the granularity increases with the addition of each cluster-nodes (before adding a cluster, its parent must be known), so that it resembles a 'top-down' approach. At root level, there are site-, neighborhood- or block-clusters, which are formed by road intersections. The next level of clusters is formed by individual buildings inside the root cluster. On the lowest level, there are individual risks/insured items with a defined [Lat, Lon] and address, which can be essentially seen as de-duplicated raw portfolio data 215113 records 21511,...,2151i. The diagram of figure 24 also shows examples of meaningful cluster attributes for each level.

Figure 25 shows extracted drivable road network from OSM (using OSMnx python module) for the creation of root-level clusters.

Figure 26 shows closed polygons as root-level clusters, visualized on map.

Figure 27 shows footprints of Washington DC derived from satellite image.

Figure 28 illustrates the use of OSM as a source of portfolio data enrichment from where interesting metadata tags and keys can be fetched (i.e. for the building key, we can find out its type/value, similarly for, the industrial key – the type of industry).

Figure 29 shows a possible split of the raw portfolio data 215113 into building and low-level risk attributes. The hierarchy explained in figure 29 is particularly useful when it is desired to add a new risk to the scheme or perform a lookup/aggregation at a particular level.

Figure 30 shows a location intelligence engine 2156 of the exposure data intelligence 215. The use and access of the exposure database 2151 can easily be made more user-friendly by implementing the querying of the database accessible over an appropriate user interface as a Web Application, which enables the user to lookup clusters by address and coordinates and browse the corresponding attributes by means of the location intelligence engine 2156 (see figure 30).

Figure 31 shows an example of such an encoding scheme. Each index corresponds to a character at the corresponding index location in the encoding alphabet, for example: (i) Negative indices: 23456789CF, (ii) Positive indices: GHJMPQRVX.

5 Figures 32 illustrate that such a cell can be encoded with one of 20 characters for 5m precision on a 100m range. A single point/sub-cell can e.g. be defined as shown in figure 32a, whereas an area can be defined by adding multiple sub-cells together, as shown in figure 32b.

10 ***Detailed Description of the Preferred Embodiments***

Figure 1 to 32 schematically illustrate an architecture for a possible implementation of an embodiment of the digital platform 1 and the inventive metric simulation engine 10 for automated prediction of forward- and backward-looking impact measures based on measured event parameter values of time-dependent series of occurrences of physical impact events and electronic risk-transfer configurator and risk-transfer portfolio management platform. As figure 1 shows, the inventive, automated end-to-end process 2 provides an efficient, automated online risk placement, claims and accounting channel for users with a complete electronic solution for automated facultative business structuring.

20 The digital platform and system 1 provides an automated, multi-channel, end-to-end risk-transfer product configuration process 2 for configuring, launching and processing of customized second-tier risk-transfer structures. Thus, the digital platform and automated risk-transfer configurator 1 allows fast composing, launching and configuration of highly customized secondary risk-transfer structures. An automated risk-
25 transfer product placement is provided by the system 1 as a first online channel comprising a parameter-driven, rule-based underwriting process 21 for creating a portfolio of customized second-tier structures. An automated claim handling 22 is provided by the system 1 as a second online channel, and an automated accounting 23 is provided by the system 1 as a third online channel. The system 1 comprises a
30 product configurator 214 for providing the automated underwriting by means of a rule-

based bifurcation process 21. The product configurator 214 comprises at least four structuring blocks, a first structuring block for setting coverage area parameters 2141 of the risk-transfer product, a second structuring block for setting line of business parameters 2142, a third structuring block for setting type of risk-transfer parameters 2143, and a fourth structuring block for setting risk information parameters 2144. For capturing the risk information parameters 2144 the product configurator 214 comprises a machine-based exposure data intelligence 215 enabled to automatically identify unique risks of objects 12 based on a precise location of the objects 12. The system further comprises the metric simulation engine 10 for automated prediction of forward- and backward-looking impact measures 101 based on event parameter values 111 of time-dependent series of occurrences of physical impacting risk-events 11. The occurrences of the physical risk-events 11 are measured based on predefined threshold-values of the event parameters 111 and the impacts of the physical risk-events 11 to a specific asset or object 12 are measured based on impact parameters 112 associated with the asset or object 12. The system 1 comprises a graphical user interface of a portfolio analytics framework 6 providing a dynamic representation 61 of the portfolio structure 14, wherein the metric simulation engine 10 forms an integrated part of the portfolio analytics framework 6. By means of the metric simulation engine 10, the dynamic representation of the portfolio structure 14 provides forward- and backward-looking insights to the user thereby enabling portfolio steering by identification of critical areas of the portfolio 14 and impacts of possible changes to the underwriting before going to launch it in the market.

As an embodiment variant, the digital platform 1 comprises a client rate offering module 7, wherein by means of the client rate offering module 7, the user is enabled to input and offer a rate he is willing to pay, thereby allowing the system to capture insights into the gap between willingness to pay and the costing generated by the digital platform 1.

Machine-based exposure data intelligence 215

The machine-based exposure data intelligence 215 comprises an exposure database 2151, e.g. based on a SRX+ database scheme, comprising a plurality of data

records 21511,...,2151i holding attribute parameter 215111 of properties and/or objects 12, respectively, with assigned geographic location parameters 215112. For example, the exposure database 2151 can be realized as a world-wide centralized geodatabase providing inter alia standard repository for geographical data. In particular, the

5 exposure database 2151 stores pools or portfolios of risk-exposed properties and/or objects 12, where a portfolio of objects 12 is assigned to a specific user. Further, the machine-based exposure data intelligence 215 comprises a EDI engine 2153 (Exposure Data Intelligence engine) providing exposure-based risk modelling and rating, as e.g. Nat Cat modeling. The exposure data intelligence 215 comprises appropriate

10 application programming and graphical user interfaces (API/GUI) or other data interfaces. If the machine-based exposure data intelligence 215 is mainly focused on natural catastrophe (Nat Cat) handling, it can also be denoted as NCEDI (Nat Cat Exposure Data Intelligence). Thus, the EDI engine 2153 can e.g. provide a lookup service access 21531 for users based on the exposure database 2151 and the clustering

15 of the data records 21511,...,2151i, wherein an automated identification of location-specific risks is assessable by a user based on the precise location of the properties and/or objects 12. To provide the automated modelling and rating, the EDI engine 2153 can e.g. comprise a forward-looking modelling module comprising e.g. a natural catastrophe risk modelling structure. The modelling structure can e.g. generate loss

20 distributions for the major perils as seismic events, windstorms and floods geographically in respect to their largest exposure. For the loss measures used, the probabilities and portfolios of economic and insured values can be used to assess the annual expected total and insured losses caused by each peril in a specific year. The modelling scenarios with expected loss estimations can be complemented by data of external sources, as

25 e.g. the United Nations Office for disaster risk reduction's global assessment data. The machine-based exposure data intelligence 215 comprises a clustering module 2152 for clustering stored properties/objects 12 of the exposure database 2151 related to their assigned geographic location parameters 215112. Stored data records 21511,...,2151i of the exposure database 2151 can e.g. covers a vast range of worldwide information

30 and measuring data, including data on countries, states, counties, zip codes and communities as well as global natural hazard measuring data. Different data records 21511,...,2151i of the exposure database 2151 having the same assigned geographic location parameters 215112 are matched and mutual aligned, in case of triggering inconsistencies for data records 21511,...,2151i having the same assigned geographic

35 location parameters 215112.

The machine-based exposure data intelligence 215 can further comprise a user data interface 2154 enabling access via mobile devices 5 to input location data 215112 by a GPS-module 54 or optical sensor and/or camera 55 of the mobile devices 5. The mobile device 5 can e.g. be realized as a smart phone 53. A user can e.g. be enabled to scan for insured properties 12 by means of the mobile devices 5 using data transmission to the digital platform 1 of GPS-module 54 or optical sensor and/or camera 55 data. The machine-based exposure data intelligence 215 can e.g. comprise an cross-level analysis module 2155 providing identification 21551, analysis 21552 and visualization 21553 of large risk pools, wherein a risk pool comprises a plurality of objects 12 of the exposure database 2151, wherein the different levels and channels comprise at least facultative risk-transfer and/or treaty risk-transfer and/or customized corporate direct risk-transfer, and wherein risk of properties/objects 12 are analyzed based on the attributes 215111 and location 215112 at different levels and for different channels allowing for automated tracking of risk accumulation and/or capacity thresholds,

The clustering module 2152 of the machine-based exposure data intelligence 215 can e.g. comprises an automated address matching 21521 based on the latitude and longitude coordinates 2151121/2151122 of a location, wherein for the clustering a search is narrowed down to a grid cell 215221 around the property/object 12 of interest to a scale 215222 where two locations 215112 are matchable based just on the house number or other location-dependent attributes. For the clustering, the clustering module 2152 can e.g. use an adaptive cell size and/or shape 215223, depending on the local housing/construction density. Alternatively, for the clustering, the clustering module 215 can also use accessible building footprints to check if latitudinal/longitudinal-tags are enclosed with the footprint of interest, wherein any latitudinal/longitudinal-coordinate 215112 is mapped to a unique building and/or associated to sites.

In risk-transfer systems, exposure databases 2151 are typically established over years from client portfolios. Because often contracts are renewed every year for the same property/object 12, it can appear multiple times in the database 2151, but sometimes with different attribute sets. This technically leads to a lookup problem, as there is no unique property identifier. The solve this issue by clustering those properties by location allowing for a lookup service. Further, often the street address, building type and sometimes construction type, roof type and cladding of insured buildings known,

i.e. can be retrieved from the data sources. The present invention is able to provide appropriate data enrichment, e.g. by means of the forward-looking modeling module 21532. As example of a U.S. location where street address information can typically capture and where the system 1 can retrieve a virtual look at the property e.g. with
5 Street View (see figure 10). For the data enrichment, the present invention combines various heterogeneous data sources, as insurance systems' internal data sources, as e.g. the exposure database 2151, and external data sources as the 'GeoFacts' data set from Google to supplement used data for modelling, exemplified for properties and objects 12. If losses are simulated by means of the EDI engine 2153 and/or the forward-
10 looking modeling module 21532 for this example building shown in figure 10, once with the minimum attributes, once enriched with the information retrieved from the system 1 and the exposure data intelligence, respectively, the expected loss of the two approaches can be compared. In figures 11a and 11b the ground-up loss is shown, i.e. the loss before insurance conditions apply, where figure 11a shows the ground-up loss
15 for the example property 12 rated based on the primary attributes set and figure 11b shows the ground-up loss for the example property 12 rated based on the attributes set retrieved from the exposure data intelligence 215 (in figure 11b denoted as NCEDI). The data records 21511,...,2151i can e.g. take a format encoding a predefined set of attributes which can take specific values. Those attributes can be grouped into
20 geographical, physical, flood physical, storm physical, earthquake physical properties and expert attributes, as can be seen from figure 12a/b, representing e.g. tabs of the forward-looking modelling module 21532. Figure 12a shows an example location1, screenshots of the data record 21511,...,2151i geographical location tab, showing the geo input and geocoded data. Figure 12b shows an example location1, screenshots of
25 the data record 21511,...,2151i property data tabs. In this particular case the following parameters could be retrieved from the exposure database 2151: (i) Occupancy level 1, (ii) Occupancy level 2, (iii) Main structure type, (iv) Detailed structure type, and (v) Design year.

During the validation and enrichment process, the exposure data
30 intelligence 215 automatically avoid incorrect entries by users into the exposure database 2151: instead, the system 1 is able to automatically identify unique risks by their precise location. Also, the system 1 allows to map policy ownership from multiple submissions: for example, if Cluster K belongs to user Z in submission X and in submission Y the policy owner is unknown, then this could be looked up via the link back to Cluster

K. As an embodiment variant in the technological field of smart homes, the system 1 provides a data interface, allowing users to get/buy risk-transfer directly from an App and profit from adequate rates through the integration of their IoT data into the exposure database 2151. The system 1 allows to provide a user access, which is as
5 simple as enabling the user to use a smartphone (with GPS, and camera capabilities) to determine the precise location and scan their insured items. This can e.g. involve building a risk index for properties to get better loss estimates.

As an further embodiment variant, the exposure data intelligence 215 (NECDI) allows to create a property location network providing the identification,
10 analysis and visualization of global risk pools. It can e.g. be used as a foundation for analysis of risk by attributes and location at different levels (clustering) and allows for better tracking of risk accumulation and capacity: for example, same risks can be ceded to a second-tier risk-transfer system, i.e. a reinsurance system, through multiple channels: via facultative, treaty reinsurance business or via corporate, customized
15 direct solution risk-transfer/insurance. Being enable, by the system 1, to track each risk from different sources allows technically to track the reinsurance systems capacity on a risk. For example, when capacity is calculated for a given building, and by predefined rules or boundary condition parameters the reinsurance system does not want to take a higher capacity than 100 M, the reinsurance system must be able to look up whether it
20 is participating on other risks in the same building and adjust the exposure so that the reinsurance system does not exceed its predefined capacity limit.

Regarding the portfolio data clean-up and location validation process of the exposure data intelligence 215, it was discussed above that items returned from exposure database 2151 and the exposure data intelligence 215, respectively, may not
25 have a precise location assigned, either through [Lat, Lon] or address (i.e. markers set on roads or parking lots instead of the actual property). This can, e.g., be due to either human error during input or due to inaccurate/inconsistent geocoding. The difficulty of validating geo-data can e.g. be demonstrated on the following examples:

(A) Street address validation problem: In figure 13, for both buildings the
30 street address is: 10 S Dearborn St, Chicago, IL 60603, USA (StreetView on figure 13a; satellite view on figure 13b): (i) Chase Bank tower, (ii) Public Art Chagall's Four Seasons. The technical issue here is, that two buildings are mapped to same address (see figures

13a/b showing satellite views of the locations belonging to the same street address). Thus, (i) GeoFacts returns Chase Bank tower with 74 floors, (ii) the clustering by the clustering module 2152 (by majority voting) returns Public Art Gallery with 1 floor, and (iii) the exposure database 2151 only returns the occupancy level, i.e. either 'commercial building >30 floors (?)', or 'art gallery (?)'. The technical problem is that the public art gallery appears more often in the exposure database 2151 than the Chase Bank tower. In this case, a majority voting (i.e. when the attribute values that show up most often for a given cluster are chosen as the significant and most representative for the whole cluster) does not lead to the desired result, unless a better clustering logic is used. As solution, the system 1 takes all available attributes from all records clustered into account for matching and receives the correct result.

(B) [Lat, Lon] validation problem: Matching two locations based on their Latitude and Longitude coordinates can be an efficient preprocessing/refining step for address matching, essentially because it allows to overcome address formatting issues: once the search is narrowed down to a grid cell 215221 around the property/object of interest, one can match the two locations 215112 based just on the house number or other attributes. The technical problem arises when choosing the size 215222 of the search cell 215221. Often, it turns out to be not big enough to enclose both [Lat, Lon] tags, this is especially true when matching large properties with large parcels of land, for example: 3860 W Peterson Ave, Chicago, IL 60603, USA (StreetView on figure 14b; satellite view on figure 14a): (i) Felician Sisters Convent, (ii) Church/religious building, (iii) huge property. The technical issue is that Lat/Lon might be mapped to (i) mailbox on the road or (ii) actual building 100m away. As an embodiment variant, the system 1 uses an adaptive cell size and shape 215223, depending on the measured local housing /construction density. As another variant, the system 1 use available building footprints to check if the [Lat, Lon] tags are enclosed with the footprint of interest. In fact, this has the technical advantage allowing to map any [Lat, Lon] coordinate to a unique building and associate them to sites (if useful, e.g. for industrial sites). Note, that these are just two example, but they may be representative for many locations in the exposur database 2151. They show the technical need to curate, validate and pre-process portfolio data prior to clustering. In summary, the technical improvements by the system 1 and the exposure data intelligence 215 related to the content of the exposure database 2151 can be categorized as follows: (i) clean up and deduplication of raw location data, (ii) re-geocoding of location data, (iii) Improvement of clustering

hierarchy and logic, and (iv) visualization of the data of the exposure database 2151 in a WebApp or in another graphical user interface.

Regarding the technical validation of the location data 2151 12, the large size and continuous growth of the portfolio database make it technically non-trivial to
5 keep it organized, accurate and efficient to query. Curation of initial data is technically absolutely crucial. To validate this initial data, the system 1 proposes to setup and implement a new geocoding service process, different parsing algorithms for the raw data and appropriate visualization tools to view the results.

The present system 1 has inter alia advantage that, for example, files
10 containing corrupted lines, as e.g. having more entries than the number of header columns (perhaps related to wrong special character escaping) are automatically omitted. Other entries e.g. have to be de-duplicated etc..

Thus, a smart deduplication of records is achieved by the system 1. In addition, a validation is also processed by the system 1, though the validation of millions
15 of locations is technically not a straightforward task. For such large amounts of data, it is often technically not reasonable to use external data sources, as current geocoding providers (Google). Thus, bulk geocoding requires integrated solutions and geocoding technics and servers. The present invention technically uses a bulk Geocoding approach based on OpenStreetMap. Thus, the system 1 sets up its own geo-server
20 based on OpenStreetMap (OSM) data, which brings the following benefits: (i) It is free, open source, runs locally and has no query limits, (ii) It's database is frequently updated and growing steadily, (iii) it includes data from many publicly available, global and local sources (Government, Wikipedia, etc.) as well as contributions from users, (iv) it provides a forward and reverse geocoding solution, (v) it supports advanced query
25 logic with 1000s of location features (tags), (vi) it technically allows to query points, polygons and relations. At this point, it is important to mention, that the present system 1 can be easily integrated in other technical solutions.

As an embodiment variant, the system 1 uses an integrated OSM's (OpenStreetMap) default geocoding processing module 216 and interface (see figure
30 15), which allows for forward and reverse geocoding at different levels (Building / Street / District / Suburb / County / State...). Also, the variant makes use of NLP for its address

standardization and can perform house number interpolation when it is not available by default. In the US, a good coverage for house numbers and roads can e.g. be obtained from the Topologically Integrated Geographic Encoding and Referencing system (TIGER) data, produced by the US Census Bureau.

5 The system 1 can be realized and designed to deal with only address-related queries, however, as a variant, it can e.g. also be realized to query all other components of the OSM database (nodes, ways and relations) by their location, geometry, tag and relation with the Overpass API (Application Programming Interface). Figure 16 shows exemplarily a user interface of the Overpass query. The Overpass API
10 can provide a variety of search possibilities, i.e. querying. The results of the searches or queries can be displayed directly on a map, but it is also possible to retrieve only the data. The Overpass API is realized as a read-only API that serves up custom selected parts of the OSM map data. It acts as a database over the web: the system 1 sends a query to the API and gets back the data set that corresponds to the query. The
15 Overpass API provides optimized access for the system 1 that in many cases need a few elements, both selected by search criteria like e.g. location, type of objects, tag properties, proximity, or combinations of them. Thus, the Overpass API acts to the system 1 as a database backend for various data retrievals.

 The system 1 can e.g. comprise a 3-way validation of locations (see figure
20 17). Herein, by validation of locations, the verification of street address and coordinates is understood. This consists in the following steps:

(a) Raw portfolio data address 215113 → OSM [Lat, Lon]: *Determining the coordinates belonging to a raw portfolio data address 215113.* This can e.g. be realized by using a GeoPy module (GeoPy is a Python 2 and 3 client applicable to several
25 geocoding data services. GeoPy allows for Python developers to locate the coordinates of addresses, cities, countries, and landmarks across the globe using third-party geocoders and other data sources.) with the local geocoding processing endpoint and some custom scripts. It is important to notice that this step may require a smart preprocessing of the address stored in raw portfolio data 215113, because: (1)
30 The street address was not standardized, it included information about street name, house number and apartment, but not the city, district or postcode. This issue can technically be solved by standardizing the address with an address module, e.g. an

address python module, to keep or filter only the street and house number. The geocoding results were refined by including the postcode, suburb, district and city attributes that can be resolved from reverse geocoding, discussed below. (2) It contains addresses with house number ranges (i.e. 1201-1223), which technically must be disaggregated into a list of individual addresses and which results in a list of coordinates. This disaggregation step helps to determine the corresponding building footprints which is in turn necessary to build building-level clusters.

(b) Raw portfolio data [Lat, Lon] 215113 → OSM Address: *Matching a raw portfolio data coordinate pair 215113 to an address in the OSM database.* This can e.g. also be realized using GeoPy. However, this step is typically less useful: The main technical issue here is house number interpolation, which sometimes does not yield correct results. Furthermore, the data processing returns POIs (Person Of Interest) instead of addresses, if the query is close enough.

(c) All obtained [Lat, Lon] → OSM Footprint: *Matching coordinates to an OSM footprint.* In this step, the system 1 determines if any of the found locations belonged to a building footprint. Queries are constructed with a modified overpass python module. In the first step (I), all building footprints were retrieved within a certain grid cell, e.g. a 100m radius of the raw portfolio data coordinates 215113 with an overpass query (all ways and relations having the tag 'building'). The retrieved geometries were processed with the GeoPandas and Shapely libraries (GeoPandas allows working with geospatial data in python. GeoPandas extends the datatypes used by Pandas to allow spatial operations on geometric types. Geometric operations can e.g. be performed by Shapely. GeoPandas further depends on Fiona for file access and Descartes and Matplotlib for plotting.) for the calculation of the convex hull of each footprint, to simplify the shapes. (II) The algorithm can then perform a point-in-polygon search for both, the raw portfolio data coordinates pair 215113 & OSM coordinates in all the obtained shapes. If the first search returns only one polygon, the match is labeled as 'exact'. Else, all matches are returned without the 'exact' label. In case of no match, a buffer is added to all shapes and the search is repeated. (III) If no match is found, the buffer is increased, and the search is repeated. To keep track of uncertainty, the size of the buffer is returned with each match (see figure 19 steps I-III).

The system 1 provides significant improved technical processing and results compared to the prior art systems: a) For example for forward Geocoding looking at an sample of 4'017'430 unique raw portfolio data records 215113, only 2'664'826 supplied an address, and only 1'947'876 raw portfolio data addresses 215113 could be

5 geocoded. The obtained coordinates can e.g. be compared against the raw portfolio data coordinates 215113 by calculating the geodesic distance between the two points. After 99% outlier filtering, the results were assigned to 1m bins and counted. The obtained histograms can be seen in figures 20. It can be noticed that 85% of the distances lie in a 100m range, with two distinct peaks at 10m and 20m. These peaks

10 may correlate with the distribution of the building size corresponding to each location: OSM geocoding returns locations close to the street, whereas the raw portfolio data coordinates 215113 usually represent the centroid/point within a building. Thus, the distance-error would be small for smaller buildings and large for larger buildings. The obtained distances can be used as a confidence metric. Figure 20 shows exemplarily

15 two schematic histograms, with an upper histogram of distance-errors between raw portfolio data coordinates pair 215113 and OSM coordinates in the 100m range. 85% of the geocoding results fall in this range. The lower histogram shows a histogram of distance-errors for distances greater than 100m, representing 15% of the results.

b) Regarding the reverse Geocoding, the following technical results can

20 exemplary be given: All raw portfolio data entries 215113 can be geocoded to an OSM address by the system 1, because every record contains by definition a coordinate pair. However, the obtained results have varying accuracy: 74% of addresses could be resolved up to a house number, however only 5% matched with the RATOS entry (when available). This is because the system 1 relies on house number interpolation, when it is

25 not specified in the address. This additional street address information can, inter alia, be used for enrichment when no other source is available (70% street names matched with the raw portfolio data 215113 street name). c) Regarding the matched footprints, the following technical results can exemplary be given: The footprint matching was

30 measured performance, in that 99% of the raw portfolio data 215113 entries could be matched to one or multiple building footprints. The following was measured: (i) more than 50% matched with 100% confidence, (ii) roughly 90% matched with 5m tolerance, and (iii) about 85% matched with exactly one building. Furthermore, the 4M rows could be assigned by the system 1 to 1'692'538 unique buildings in this example performance,

when considering only raw portfolio data 215113 coordinates, which proves that the building-level clustering can technically be achieved with the present inventive system

1. Additional matching with OSM coordinates can be used for higher-confidence results. For example, from the above results, one can conclude that 395'622 of those
5 buildings (row-wise intersection set) are very likely to belong to the corresponding raw portfolio data 215113 locations.

- Regarding the clustering module 2152 and the associated clustering processing of the exposure data intelligence 215, one of the main technical challenges in the system 1 development is the technical clustering hierarchy and the logic behind
10 it. The system 1 implementation may feature only one level of clusters, which do not have explicitly defined attributes yet, apart from their coordinates, ID and contained records. There are two different possible technical approaches and embodiment variants to the technical hierarchical clustering problem: one of them is realized as an *Agglomerative Clustering* (see figure 21), which is a bottom-up approach. The other
15 applied processing is called *Divisive Clustering* and follows a top-down approach (see figure 21). Figure 22 illustrates the original purpose of clustering: deduplication of raw portfolio data 215113 records 21511,...,2151i.

- The applied "Bottom-up Agglomerative Clustering" approach, proposed herein, is technically realized based on nearest-neighbors clustering and fuzzy street
20 address matching (Levenshtein distance) of individual raw portfolio data 215113 records 21511,...,2151i, currently at highest granularity level, hence called 'bottom-up' approach, herein. The main advantage of this technical structure is that it can handle generic/ unnamed cluster levels, however only when the corresponding distance functions are appropriately designed: this may become a technical challenge when
25 operating on non-numeric and non-Euclidean space (for example for the occupancy description space it is difficult to come up with a meaningful distance metric). On the other hand, if the cluster levels are explicitly named (like in figure 23), the database records 21511,...,2151i must provide the corresponding flags and in the contrary case, a way to determine a meaningful closest cluster-node must be provided. The main
30 disadvantage, however, is that it does not take the geometry of the clusters into account, so that it is not possible to bind an address to a particular building, but rather only to a house number. However, multiple different house numbers and even multiple street addresses can belong to the same building, which will then result in different

clusters. Finally, the system 1 must be realized to deal with records 21511,...,2151i that have no assigned street address but only [Lat, Lon] coordinates, and to include them into this hierarchy (see figure 23). The applied "Top-down Divisive Clustering" approach, proposed herein, can e.g. be visualized the diagram of figure 24. The main difference compared to the previous processing structure (discussed above), is that this approach technically accounts for the geometry of the clusters and not just the semantics. In this approach the granularity increases with the addition of each cluster-nodes (before adding a cluster, its parent must be known), so that it resembles a 'top-down' approach. At root level, there are site-, neighborhood- or block-clusters, which are formed by road intersections. The next level of clusters is formed by individual buildings inside the root cluster. On the lowest level, there are individual risks/insured items with a defined [Lat, Lon] and address, which can be essentially seen as de-duplicated raw portfolio data 215113 records 21511,...,2151i. The diagram of figure 24 also shows examples of meaningful cluster attributes for each level. It can e.g. be beneficial to perform an intermediate aggregation at root-cluster- and building-cluster-level (technically, this speeds up aggregation additionally when the database becomes larger). a) campus/site/block-level: The technical key assumption for system 1 is that campus/site/blocks can be extracted from road intersections (see figure 25). The applied technique should be applicable for any location with roads. As an embodiment variant, they can be extracted as polylines from OSM (by defining which roads types and tags to look for), but can technically also be derived from other data sources (like satellite images for example). The obtained collection of lines can then e.g. be polygonised. Technically, this results in a collection of polygons, which define root-level clusters, as shown in figure 26.

b) Building-level: Building footprints (see figure 27), can be realized similarly to streets for system 1: they can be extracted from OSM where available, or other data providers, or even derived in-house from satellite imagery and measurements. The advantage of OSM is that it can be used as a source of portfolio data enrichment from which interesting metadata tags and keys can be captured (i.e. for the building key, we can find out its type/value, similarly for, the industrial key – the type of industry), as illustrated in figure 28.

c) Insured-item/risk-level: At this level the de-duplicated raw portfolio data 215113 records 21511,...,2151i are stored, with a special entry containing all the IDs of

the duplicates. For system 1, it is not necessary to store all the metadata of the duplicates in the cluster database, as it can be looked up in the raw portfolio data 215113 with the IDs. A possible split of the raw portfolio data 215113 into building and low-level risk attributes is presented in figure 29. The hierarchy explained in figure 29 is particularly useful when it is desired to add a new risk to the scheme or perform a lookup/aggregation at a particular level: since the necessary clustering information is not automatically included in each record (i.e. to which building, or even to which street it belongs), it should be determined separately through coordinates and geometric boundaries of clusters. From here arises the challenge of efficiently storing and indexing these geometries/clusters, leading towards the creation of a spatial database.

As an embodiment variant, the two technical processing approaches can be combined in the system 1 into one, as follows: First, the fuzzy matching logic of the first approach for deduplication of raw portfolio data 215113 records 21511,...,2151i (at the lowest level) and for cases when a record cannot be assigned to a building (or other level) node can be used, thus requiring the creation of an unnamed cluster level, which can be handled by the distance functions developed for the agglomerative clustering. Secondly, cluster geometry can be provided from the divisive approach. It can be then decided how to define and implement the root level clusters: either keep them as streets (with a buffer), however this automatically produces duplicates (for buildings bordering multiple streets); or use the polygons created by road intersections, which can also be used for efficient indexing. Thus, as an embodiment variant, a hybrid approach is realized, as long as there is an agreement on the main intermediary cluster level and the root level, and is worth a try.

The use and access of the exposure database 2151 can easily be made more user-friendly by implementing the querying of the database accessible over an appropriate user interface as a Web Application, which enables the user to lookup clusters by address and coordinates and browse the corresponding attributes by means of a location intelligence engine 2156 (see figure 30). Such a location intelligence engine 2156 WebApp can be realized by using an exposure database 2151 API which returns e.g. a list of all matches in the exposure database 2151 as well as the best 10 matching cluster. The current implementation of the API has limited functionality, as

there is yet insufficient structure in the database. For this reason, the development of the backend (clustering algorithms) should be prioritized.

As an embodiment variant, the exposure database 2151 can be realized to comprise persistent cluster IDs. I.e. the creation of a clustering scheme implies the
5 definition of unique cluster IDs, which has to be also persistent for such large databases as the exposure database 2151 for obvious reasons (addition of new clusters and lookup). Technically important is that the exposure database 2151 as a spatial-database, allows to implement a most efficient lookup structure: a naive point in polygon search is simply unfeasible for the given number of records a clusters. This
10 problem can e.g. be solved by the exposure database 2151 by the solution, proposed below, allowing a more user-friendly, meaningful and efficient implementation, as prior art systems. The technical approach of the solution is based on using appropriate hash codes. This allows encoding locations into a form that is easier to use than showing coordinates in the usual form of Lat-Lon. For this, for example Open Location Codes
15 (OLC), also known as Google Plus Codes, can be used. They are designed to be used like street addresses, and can be implemented in places where there is no formal system to identify buildings, such as street names, house numbers, and post codes. Open Location Codes can e.g. be derived from latitude and longitude coordinates, so they already exist. They are similar in length to a telephone number – 849VCWC8+R9,
20 for example – but can often be shortened to only four or six digits when combined with a locality (CWC8+R9, Mountain View). Locations close to each other have similar codes. They can be encoded or decoded offline. The character set avoids similar looking characters, to reduce confusion and errors. As embodiment variants, similar methods can be used, too, like GeoHash, MapCode, what3words and others.
25 However, they all have the disadvantages that (i) locations at boundary (close t.e.o.) have different prefix, (ii) grid cuts through buildings, and (iii) encoding geometries yields a long list, prefix not reused. Thus, as a preferred embodiment variant, the system 1 comprises a geo-hashing algorithm which is applicable to both single points and polygons. This approach is implemented in a way, which also allows determining if a
30 point belongs to a polygon by just looking at the code.

Finally, it should be noticed that all prior art systems lack the functionality of adaptive grids, which technically avoid cutting through cluster geometry. As an embodiment variant, the system 1 uses polygonised roads as grid. It happens, that

roads, by nature, define a grid and do not cut through buildings. Furthermore, their intersections already define site-level / block-level clusters. In other words, they create meaningful boundaries for clusters. The system 1 allows to index such a cell/cluster by e.g. calculating the centroid and simply encode it with a short OLC (so that it is still distinguishable from others).

For locations inside the cell, the reference system can e.g. be changed, and the previously calculated cell centroid can be used as origin of new x-y axes/ Geo Reference System (GRS) (precisely the edges defined by an OLC cell). Such a cell can be encoded with one of 20 characters for 5m precision on a 100m range. Thus, a single point/sub-cell can e.g. be defined as shown in figure 32a, whereas an area can be defined by adding multiple sub-cells together, as shown in figure 32b. Figure 31 shows an example of such an encoding scheme. Each index corresponds to a character at the corresponding index location in the encoding alphabet, for example: (i) Negative indices: 23456789CF, (ii) Positive indices: GHJMPQRVX. In practice, this grid level can be as big as 1000m in both directions, which means that, for example, the approach either needs 200+ characters, lower precision or longer codes. The main advantage of this embodiment variant is that it allows for a very efficient lookup, which narrows down to a simple string search/comparison. The only prerequisites of this technical approach are: (i) Knowledge of the cell centroid, either [Lat, Lon] or OLC, which can be looked up/ learned e.g. by applying ML techniques; (ii) Knowledge of the encoding alphabet and scheme in the new GRS. The above scheme is only an exemplary implementation. There are other ways of encoding geometries, especially large ones which are made up of many sub-cells making the resulting code of the above embodiment variant long.

The invention has inter alia the advantage that it help to create an enriched, clean and structured representation of large raw portfolio data 215113: the system 1 allows to produce unique footprint-aware building clusters, as well as block/site-level clusters with a persistent and modular cluster-ID. This allows to build a unique database which takes automated data insight and handling to a new level and broaden the landscape for data analysis, as large amounts of previously unscrubbed, raw data become available. The proposed system 1 can e.g. be used to improve in-house portfolio data curation and clustering. It allows to cluster and identify unique risks that appear countless times in large databases as the exposure database 2151, and perform an efficient aggregation and tracking of risk attributes. Further, the system 1

can easily be applied to different lookup services as for example for underwriting/
 NatCat purposes and also to end-users e.g. in the context of emerging smart-home
 applications. The system 1 and the exposure database 2151 allows providing a large,
 client fed and database of properties which can serve as an enrichment source for
 5 clients' portfolios, but can also be applied to other fields. With regard to current state-
 of-the art Nat Cat modeling and underwriting, the system 1 is able to: (i) Identify
 buildings by their coordinates or unique ID; (ii) Query the containing risks and attributes,
 for ex.: occupancy, incl. information about the content of the building and business; (iii)
 Group buildings to sites (campus and alike); and (iv) Track the evolution of attributes in
 10 time (construction and retrofitting year).

The system, inter alia, provides (i) new bulk geocoding solution, (ii) a
 geometry-aware clustering method, (iii) a persistent and location-aware indexing
 method for every property that is entered as raw portfolio data 215113, and (iv) a more
 user-friendly solution for querying and visualizing large databases as the exposure
 15 database 2151. Further the system 1 has the advantage of being easily integratable.
 Integrating system 1 as a service into other applications or client tools/software not only
 leads to a significant improvement of the user experience and risk assessment, but it
 also gives a new perspective over possible portfolio evolution in time and on different
 levels of aggregation.

20

Metric simulation engine 10

As mentioned, the automated digital platform or digital risk-transfer
 configurator 1 allows fast composing, launching and configuration of highly customized
 secondary risk-transfer structures. The digital platform 1 comprises, as an embodiment,
 25 the of the metric simulation engine 10 as an integrated part. By means of the simulation
 engine 10, a basic rate measure 103 and/or a structural mix characteristic 141 of the
 portfolio 14 comprising captured risk-exposure units 102 is varied until a desired degree
 regarding the varied values of the basic rate measure 103 and/or the structural mix
 characteristic 141 is reached. The metric simulation engine 10 for automated prediction
 30 of forward- and backward-looking impact measures 101 is based on measured event
 parameter values 111 of time-dependent series of occurrences of physical impacting

risk-events 11. The occurrence of the physical risk-events 11 are measured based on predefined threshold-values of the event parameters 111, wherein the impact of the physical risk-events 11 to a specific physical or intangible real-world asset or living object 12 is measured based on impact parameters 112 associated with the asset or object 12.

Structured asset/object characteristics parameters 121 of the physical assets or objects 12 are captured at least partially by means of a parameter-driven bifurcation process 3, as automated underwriting process, dynamically capturing characteristics parameter values and mapping the values to the structured characteristics parameters 121. A plurality of risk-transfers 13 associated with the occurrence of one or more predefined risk-events 11 impacting the physical assets or objects 12 are captured by metric risk-exposure units 102 and transferred to a portfolio 14 holding the risk-transfers 13 by means of the captured risk-exposure units 102. A structural mix characteristic 141 of the portfolio 141 is given by the measured and captured types of risks 132 and assigned number of risk-transfers 142 with associated metric risk-exposure units 102.

The computer-based automated risk-transfer configurator 1 and risk-transfer portfolio management platform 1 enabled for automated conduction of binding risk-transfers between a user and the automated risk-transfer configurator 1, acting in particular as an automated transaction platform. The risk-transfer configurator 1 can e.g. be operated by the service provider as an integrated part of a cloud-based service, in particular as a Software as a Service over the cloud realization. The system 1 connected to various client terminals of users via a data-transmission network 4, such as a telecommunication network and/or the word-wide backbone network internet. The data-transmission network 4 can e.g. comprises a landline network and/or a mobile network and/or satellite-based network. The network 4 can comprise, for example, the public switched telephone network, an ISDN (Integrated Services Digital Network) network or preferably the Internet or an intranet. The mobile network can comprise, for example, a GSM network (Global System for Mobile communication), a UMTS network (Universal Mobile Telephone System) or another, for example, satellite-based mobile network, or a WLAN (Wireless Local Area Network). The reference 5 designates the user clients to access the system 1. Reference number 51 designates a client or terminal which can e.g. realized as PC (Personal Computer), the reference symbol 52

designates a client or terminal which is realized as mobile notebook or laptop computer, and the reference symbol 53 designates a terminal or client which is realized as mobile telephone or PDA computer (Personal Digital Assistant). The system 1 comprises a communication module 15 with an appropriate network interface 151 for the communication, i.e. for the data exchange, with the user clients 5/51/52/53. The communication module 15 is, for example, adapted to set up in each case a virtual private network (VPN) with the user clients 51/52/53 via the data-transmission network 4 and to communicate with the user clients 51/52/53 via this virtual private network.

As indicated in fig. 2, for the data capturing 3, the system 1 comprises appropriate technical data capturing means 16, in particular a rules database 161 and a number of processing modules, namely a control module 162, validation means 163, evaluation means 164, a transfer process module 165 and a user interface module 166. The transfer process module 165 comprises an automated transfer process 311 and a semi-automated transfer process 312 which will be described in greater detail below with reference to fig. 2. The data capturing means 16 can e.g. be constructed at least partially as programmed software modules or software parts on a computer program product.

The user interface module 166 can e.g. comprise a program code for the generation of a user interface 1661 to the system 1 which can be operated by users by means of the user clients 51/52/53 via the data-transmission network 4. The user interface is provided, for example, via so-called browser programs or as API (Application Programming Interface). The man skilled in the technical field will understand that the user interface 1661 can also be constructed as GUI (Graphical User Interface) in a client server architecture. The user interface module 166 comprises a number of data input modules 1662. The data input modules in each case comprise data input fields which, in particular, are used for inputting data relating to the asset or object of a risk-transfer. Depending on the realization of the user interface 1661, the data input modules 1662 in each case comprise one or more displayable windows or GUI images ("screens") or a scrollable form. The data input modules are preferably assigned to various paths of a workflow. The user interface 1661 can also be provided with a voice recognition module for the data input.

The rules database 161 comprises information on data rules and risk-transfer rules. The data rules 1611 and risk-transfer rules 1612 in each case comprise one or more rule parameters 16111/16121 and a rule logic 16112/16122. In the rules database 161, at least the rule parameters but preferably also the rule logic are stored. The rule logic can
5 e.g. be stored as process code which can be executed on the system 1, for example as so-called applet in Java. For the risk-transfer rules, the rule logic 16112/16122 can e.g. comprise at least one or more regulatory conditions or other compelling boundary conditions. For example, the regulatory conditions can relate to the data values of the data input fields and to different rule parameters. Also examples of regulatory actions
10 can be concerned which are executed in accordance with an evaluation result which is determined on the basis of the regulatory conditions. For example, regulatory actions which can be specified can relate to the activation of different data input modules 1662 and to the activation of the automated risk-transfer process PA or the semiautomatic contract negotiation process 311. The rule logic 16112/16122 stored in
15 the rules database 161 can comprise said regulatory conditions. In the various variants of embodiments, the regulatory actions can either be permanently coded as part of the control module 162 or stored in the rules database 161 as part of the rule logic 16112/16122.

The data rules 1611 and risk-transfer rules 1612 are in each case assigned to
20 one or more data input fields of the data input modules 1662. The data rules 1611 are used by the validation means 163 for triggering and ensuring the quality of the data input. The data rules 1611 technically specify correct syntax and format, define prescribed value ranges, regulate plausibility and relations between data values of a number of data input fields, for example a first data item must come before a second
25 data item, and prescribe which data must be mandatorily input. The data rules 1611 are also used for checking and ensuring that the data values input fit into a defined mathematical model or a mathematical formula. The risk-transfer rules 1612 are used by the evaluation means 164 and the control module 162, respectively, for controlling the bifurcated workflow process on the basis of the data input, selecting various flow paths
30 and activating assigned data input modules and/ or risk-transfer processes 31/32. The risk-transfer rules provide for a data-controlled multi-stage nested process of selection. For example, the user can be requested by activation of a data input module 1662 to input further additional data values if a data value input or a sum of a number of data values input exceeds a defined threshold value or if a particular class or group of

contract objects is specified on the basis of the data input. As long as the evaluation means 164 consider the conditions set by the risk-transfer rules 1612 to be met (positive evaluation result), the control module 162 conducts the process flow along paths with minimum data input. If, however, the evaluation means 164 consider the conditions set
5 by the risk-transfer rules 1612 as not met (negative evaluation result), the control module 162 conducts the process flow along paths with additional data input and activates corresponding additional data input modules. The data rules 1611 and/or the risk-transfer rules 1612 are assigned to sets of rules which are assigned different set identification data. The set identification data can e.g. comprise geographic data, user
10 identification data and/or service identification data. The set identification data enable data rules 1611 and/or risk-transfer rules 1612 to be selected and activated in dependence on data values input.

The simulation engine 10 applies basic rate measures 103 to the metric risk exposure units 131 associated with a specific type 132 of risk-transfer 13 based on the
15 event parameters 111 of the risk-transfer 13 and asset/object characteristics parameters 121 of the physical asset or object 12 determined by means of the simulation engine 10. The basic rate 103 provides for a cost measure of resources needed to cover the risk associated with a specific transfer 13. A premium 104 for the risk-transfer 13 is generated multiplying the basic rate 103 by the number 131 of risk-exposure unit 102 of the specific
20 risk-transfer 13.

The simulation engine 10 provides dynamically forward- and backward-looking impact measures 101 based on a variation of the basic rate measure 103 and/or the structural mix characteristic 141 of the portfolio 14 comprising the captured risk-exposure units 103. The forward- and backward-looking impact measures 101 at
25 least comprise a measure for an total amount of premiums 1011 associated with the portfolio of risk-transfers and/or a net amount of premiums 1012 given by the total amount of premiums 1011 minus premiums associated with secondary risk-transfers assigned to transferred parts of the risk exposure units of the portfolio, and/or a total expected loss 1013 measure and/or a CM1 measure 1014.

30 As discussed above, the relation of the parameters providing physical correlation between the measuring parameters of basic rate, product mix to GWP, NWP, expected loss and CM1 is based on measuring and balancing the level of

parental resource pools. Technically, for the measurement, the risk pool level measure, i.e. the capital amount measure required to balance payment transfer of the pool to an asset or liability to bring it to default-free parameter value in relation to its measured risk exposure. Every risk-transfer to an second-tier insurance (reinsurance) system as here

5 the automated risk-transfer system 1 in a risk-transfer portfolio of the first-tier risk transfer system assigned to the portfolio is associated with a parental guarantee measure. Should the second-tier risk-transfer system be unable to pay for its own claims, the first-tier risk-transfer system can draw upon the available funds of the reinsurance system. When an insurance system writes a policy with defined risk-transfer parameters (which

10 technically define the range and scope of the risk-transfer), a premium is received. A portion of this policy can be viewed as the loss component. When a particular risk-event occurs with a consequential loss, the insurance system has three possibilities to cover the loss. The first place is the loss component of the risk-transfer policy itself. In many cases, this will not be sufficient to cover and equalize the loss. The second source

15 is unused loss components of other risk-transfer policies. In most cases, these two sources will be sufficient to pay the losses. In some years, it will not, and the insurance system has to look to a third source, the surplus, to cover the measured losses associated with the occurrence of a risk event. In the third case, insurance system might be able to cover the value of a guarantee by its cover by a second-tier risk

20 transfer system. To technically allow for implementation and capturing the relation, the person skilled in the technical art can e.g. based the system 1 on the following technical assumptions and boundary conditions: (A) An first-tier risk-transfer system's capital is a shared asset, with all risk-transfer policies in the portfolio having simultaneous rights to access potentially all that shared and pooled capital; (B) The impacts on an

25 first-tier or second-tier risk-transfer system from underwriting a risk-transfer policy and implementing appropriate risk-transfer parameters are (i) the occupation of some of the system's finite underwriting capacity over a period of time (as determined by required capital measurements and predictions), and (ii) the extension of a guarantee by the risk-transfer system to the contract assigned system or risk-exposed unit to fulfill

30 legitimated claim requests for measured losses. These impacts represent distinct types of usage of the risk-transfer system's pooled capital and monetary resources, respectively; (C) Each distinct capital usage type will result in a unique charge: a capacity occupation cost measure and a capital call cost measure; (D) The expected parameter value of these two cost parameters over all possible risk-transfer policy

35 outcome scenarios is herein defined as the capital usage cost parameter, and will be

- treated as an expense measure in the risk-transfer policy pricing parameters predictions. The contribution to the risk-transfer system of a risk-transfer policy is therefore not a return on capital, like the ratio of expected profit to allocated capital, but rather the profit less the capital usage cost parameter; (D) A preferred technical
- 5 decision metric then becomes an economic value added, a means of risk-adjusting return by subtracting the opportunity cost of capital. In summary, technically, an risk-transfer's actual capital pool level measure creates underwriting capacity, and underwriting (i.e. risk-transferring) activity (either past or present) uses up (consumes) underwriting capacity.
- 10 The generation of required capital, i.e. pooled resources, whether by premiums' transfers or reserve parameter values of the system, temporarily reduces the amount of capacity measured for other underwriting. Being temporary, it is similar to capacity occupancy measure, for the risk-transfer system a non-consumptive use of the shared asset. Capacity consumption occurs when reserves must be increased beyond
- 15 predicted level measures. This can e.g. technically involve a transfer of funds from a capital account measure to the reserve account measure. The entire surplus measure is available to every policy to cover losses in excess of the aggregate loss component. Some risk-transfer policies are more likely to create this need than others are, even if the expected and predicted loss portions are equal. Thus, for risk-transfer policies with similar
- 20 expected losses, the system can be implemented to automatically expect the policies with a large variability of possible results to require more contributions from surplus to cover the losses by resources-transfer. E.g. the risk-transfer system can be realized requesting a charge parameter for giving access to the surplus resources. This charge parameter can e.g. depend, not just on the likelihood that surplus might be needed,
- 25 but on the amount level of such a surplus call or request. The two distinct technical impacts of risk-transfer underwriting a risk-transfer portfolio on the risk-transfer system in total are therefore: (i) Certain occupation of underwriting capacity for a period of time, and (ii) Possible consumption of capital measures. This "bi-polar" capital measure usage can e.g. provide one of basis for the technical structure of the system. This dual
- 30 form of monetary payment transfers for the technical dual nature of usage can e.g. be adapted for the unique technical characteristics of risk-transfer system.

It is important for understanding the technical challenges of the automation of risk-transfer systems, that it is, for the technical skilled person, already challenging to

set the appropriate boundary structure and framework allowing to operate the system on a technical basis. For example, under the technical boundary assumption of a perfect, free market environment, an entity offering a product for sale should try to set a price at which the entity is willing to sell the product without corrupting its operation and the consumer is still willing to purchase it. Determining the supplier-side price to charge for any given product is conceptually straightforward. The simplest model focuses on the idea that the applied pricing should reflect the costs associated with the product as well as incorporate an acceptable margin for profit. For many non-risk-transfer related products and services, the production cost is known before the product is transferred to the buyer, i.e. sold. Therefore, the initial price can be set by the system so that the desired profit per unit of product will be achieved without corrupting the operation of the system. Risk-transfer is different from such products as it relies on the technical object to do something in a predicted future if certain physical events take place and will be measured during a specified time period. For example, risk-transfer may be associated with a future object to cover for the rebuilding of a house if it burns to the ground or to cover for medical treatment for a worker injured on the job. Unlike a can of soup, a pair of shoes, or a car, the ultimate and actually measured cost level of an risk-transfer policy is not known at the time of the sale. This places the classic, technically trivial object of balancing product and monetary transfer in a technically different, predictive and difficult context and introduces additional complexity into the process of pricing and operational parameter setting for an risk-transfer system. Thus, expected loss measures are not time-invariant, but rather need to be readjusted by the risk-transfer system when environmental measuring parameters or other external circumstances change. Sometimes both the measured probability of default and the measured loss given default can both rise, giving two reasons that the expected loss increases. For example, over a 20-year period only 5% of a certain class of homeowners' default. However, when a systemic crisis hits, and home values drop 30% for a long period, that same class of borrowers changes their default behavior. Instead of 5% defaulting, say 10% default, largely due to the fact the LGD (loss given default) has catastrophically risen. To accommodate for that type of situation a much larger expected loss needs to be predicted. This is the subject to considerable technical challenges as it has a large impact on the operation of automated risk-transfer systems for the mitigation of systemic risk measures. Thus, for a possible technical implementation for expected loss measures, this parameter can be realized as the measured sum of the values of all possible losses, each multiplied by the probability of

that loss occurring. Technically, three factors can be assumed to be relevant in predicting expected loss values: (i) Probability of default (PD), (ii) Exposure at default (EAD), (iii) Loss given default (LGD, where the loss given default is set to be the magnitude of likely loss on the exposure / exposure at default.

List of reference signs

	1 Automated risk-transfer configurator and risk-transfer portfolio management platform
	10 Simulation engine
	101 Forward- and backward-looking impact measures
5	1011 Total amount of premiums (GWP)
	1012 Net amount of premiums (NWP)
	1013 Total expected loss
	1014 CM1
	102 Metric risk-exposure units
10	103 Basic rate
	104 Premium (amount of resources to be allocated for the risk-transfer)
	11 Physical risk-event
	111 Risk-event measuring parameter
	112 Impact parameter to a specific asset or object
15	12 Physical or intangible real-world asset or living object
	121 Structured asset/object characteristics parameters
	13 Risk-transfer associated with the occurrence of a predefined risk-event
	impacting the physical assets or objects
	131 Number of risk-exposure units
20	132 Type of risks associated with a risk-transfer
	14 Portfolio or basket of risk-transfers
	141 Structural mix characteristic
	142 Number of risk-transfers
	15 Communication module
25	151 Network interface
	16 Data capturing means
	161 Rules database
	1611 Data rules
	16111 Rule parameters
30	16112 Rule logic
	1612 Risk-transfer rules
	16121 Rule parameters
	16122 Rule logic
	162 Control module

	163 Validation means	
	164 Evaluation means	
	165 Transfer process module	
	166 User interface module	
5	1661 User interface	
	1662 Data input modules	
	2 Automated end-to-end process	
	21 Automated underwriting by means of a rule-based bifurcation process	
	211 Creating submission	
10	212 Receiving and binding quotation	
	213 Modifying and renewing acceptances	
	214 Product configurator	
	2141 Coverage area parameters	
	2142 Line of business parameters	
15	2143 Type of risk-transfer parameters	
	2144 Risk information parameters	
	215 Machine-based exposure data intelligence	
	2151 Exposure database	
	21511,...,2151i Data records	
20	215111 Attribute parameter of prop./objects	12
	215112 Location parameter	
	2151121 Latitude coordinate	
	2151122 Longitude coordinate	
	215113 Raw portfolio data	
25	2152 Clustering module	
	21521 Automated address matching	
	21522 Grid	
	215221 Grid Cell	
	215222 Grid Cell Scale	
30	215223 Adaptive cell size and/or shape	
	215224 Local housing/construction density	
	2153 EDI (Exposure Data Intelligence) engine	
	21531 Lookup service access	
	21532 Forward-looking modeling module	
35	2154 User data interface	

	2155 Cross-level analysis module
	21551 Identification
	21552 Analysis
	21553 Visualization
5	2156 Location intelligence engine
	216 Geocoding processing module (Nominatim)
	22 Technical Accounting Process
	221 Booking premiums
	222 Advising on new claims
10	223 Booking and updating claims
	224 Rectifying premiums
	225 Submitting a statement of accounts
	23 Financial Accounting Process
	231 Advising and/or requesting payments
15	232 Seamless pairing
	233 Setting accounts
	3 Rule-based bifurcation underwriting process
	31 Standard
	311 Automatic
20	3111 Triggered parameters compliant with trigger rules
	312 Semi-Automatic
	3121 Several parameters not compliant with trigger rules
	32 Non-Standard
	321 Underwriting process does not include automatic pricing
25	4 Data transmission network
	5 Client or access terminal
	51 PC (Personal Computer)
	52 Mobile notebook or laptop computer
	53 Mobile telephone or PDA computer (Personal Digital Assistant)
30	54 GPS module
	55 Optical sensor or camera
	6 Portfolio analytics framework
	61 Dynamic representation
	7 Client rate offering module
35	

Claims

1. Metric simulation engine (10) for automated prediction of forward- and backward-looking impact measures (101) based on measured event parameter values (111) of time-dependent series of occurrences of physical impacting risk-events (11),
- 5 wherein the occurrences of the physical risk-events (11) are measured based on predefined threshold-values of the event parameters (111) and wherein the impacts of the physical risk-events (11) to a specific physical or intangible real-world asset or living object (12) are measured based on impact parameters (112) associated with the asset or object (12), characterized
- 10 in that structured asset/object characteristics parameters (121) of the physical assets or objects (12) are captured at least partially by means of a parameter-driven, rule-based bifurcation process (122) dynamically capturing characteristics parameter values and mapping the values to the structured characteristics parameters (121), wherein a plurality of risk-transfers (13) associated with the occurrence of one or
- 15 more predefined risk-events (11) impacting the physical assets or objects (12) are captured by metric risk-exposure units (102) and transferred to a portfolio (14) holding the risk-transfers (13) by means of the captured risk-exposure units (102), and wherein a structural mix characteristic (141) of the portfolio (141) is given by the measured and captured types of risks (132) and assigned number of risk-transfers (142) with associated
- 20 metric risk-exposure units (102),
- in that the simulation engine (10) applies basic rate measures (103) to the metric risk exposure units (131) associated with a specific type (132) of risk-transfer (13) based on the event parameters (111) of the risk-transfer (13) and asset/object characteristics parameters (121) of the physical asset or object (12) determined by
- 25 means of the simulation engine (10), wherein the basic rate (103) provides for a cost measure of resources needed to cover the risk associated with a specific transfer (13), and wherein a premium (104) for the risk-transfer (13) is generated multiplying the basic rate (103) by the number (131) of risk-exposure unit (102) of the specific risk-transfer (13), and
- 30 in that the simulation engine (10) provides dynamically forward- and backward-looking impact measures (101) based on a variation of the basic rate

measure (103) and/or the structural mix characteristic (141) of the portfolio (14) comprising the captured risk-exposure units (103), wherein the forward- and backward-looking impact measures (101) at least comprise a measure for an total amount of premiums (1011) associated with the portfolio of risk-transfers and/or a net amount of
5 premiums (1012) given by the total amount of premiums (1011) minus premiums associated with secondary risk-transfers assigned to transferred parts of the risk exposure units of the portfolio, and/or a total expected loss (1013) measure and/or a CM1 measure (1014).

2. Metric simulation engine (10) for automated prediction of forward- and
10 backward-looking impact measures based on measured event parameter values of time-dependent series of occurrences of physical impact events according to claim 1, characterized in the metric simulation engine is realized as an integrated part of a cloud-based application.

3. Automated risk-transfer configurator (1) for fast composing, launch and
15 configuration of highly customized secondary risk-transfer structures, characterized in that the product configurator comprises the metric simulation engine according to one of the claims 1 or 2, wherein a basic rate measure and/or a structural mix characteristic of a basket comprising captured risk-exposure units is varied until a desired degree regarding the varied values of the basic rate measure and/or the structural mix
20 characteristic is reached.

4. Automated risk-transfer configurator (1) according to claim 3 for fast
composing, launch and configuration of highly customized secondary risk-transfer structures, characterized in that the desired degree is determined by reaching a local optimum regarding the varied values of the basic rate measure and/or the structural
25 mix characteristic.

5. Automated risk-transfer configurator (1) according to one of the claims 3
or 4 for fast composing, launch and configuration of highly customized secondary risk-transfer structures, characterized in that the variation of the values of the basic rate measure and/or the structural mix characteristic is performed by the simulation engine
30 based on interactive input values of a user of the product configurator.

6. Automated risk-transfer configurator (1) according to one of the claims 3 or 4 for fast composing, launch and configuration of highly customized secondary risk-transfer structures, characterized in that the variation of the values of the basic rate measure and/or the structural mix characteristic is performed by the simulation engine
5 based on varying input values generated by the product configurator.

7. Automated risk-transfer configurator (1) according to one of the claims 3 to 6 for fast composing, launch and configuration of highly customized secondary risk-transfer structures, characterized in that adjustments to the basket measures are interactively reviewed and audited by a user ensuring governance, risk and
10 compliance requirements.

8. Automated risk-transfer configurator (1) according to one of the claims 3 to 7 for fast composing, launch and configuration of highly customized secondary risk-transfer structures, characterized in the product configurator is realized as an integrated part of a cloud based application.

9. Method for a metric simulation forecast engine for automated prediction of forward- and backward-looking impact measures based on measured event parameter values of time-dependent series of occurrences of physical impact events, and wherein the occurrence of the physical risk events are measured based on predefined threshold-values of event characteristic parameters and wherein the
15 impact of the physical risk events to a specific physical or intangible real-world asset or
20 living object is measured based on impact characteristic parameters, characterized

in that characteristics of physical assets or objects are captured at least partially by means of a parameter-driven bifurcation process dynamically capturing characteristics' parameter values and dynamically mapping the values to structured
25 characteristics' parameters,

in that a plurality of risks associated with the occurrence of one or more predefined risk-events possibly impacting the physical assets or objects are captured by metric risk-exposure units and transferred to a basket holding the captured risk-exposure units, wherein a structural mix characteristic of the basket is given by the measured and

captured types of risks and assigned number of risk-transfers and associated metric risk-exposure units,

in that the simulation engine applies a basic rate measure for a metric risk exposure unit associated with a specific type of risk-transfer based on selected event
5 parameters of the risk-transfer and selected characteristics' parameters of the physical asset or object determined by means of the simulation engine, wherein the basic rate provide for a cost measure for the resources needed to be associated with the specific transfer of risk, and wherein a premium (102) (amount of resources to be allocated for the risk-transfer) is given by the basic rate multiplied by the number of risk-exposure unit
10 of the specific risk-transfer, and

in that the simulation engine provides dynamically forward- and backward-looking impact measures based on variations of the basic rate measure and/or the structural mix characteristic of the basket comprising the captured risk-exposure units, wherein the forward- and backward-looking impact measures at least comprise a
15 measure for an total amount of premiums (GWP) associated with the basket of risk-transfers and/or a net amount of premiums (NWP) comprising the total amount of premiums (GWP) minus premiums associated with secondary risk-transfers assigned to transferred parts of the risk exposure units of the basket, and/or a total expected loss measure and/or a CM1 measure.

20 10. Method according to claim 8 characterized in that a product configurator uses the metric simulation engine for fast composing, launch and configuration of highly customized secondary risk-transfer structures, wherein a basic rate measure and/or a structural mix characteristic of a basket comprising captured risk-exposure units is varied until a local optimum regarding the varied values of the
25 basic rate measure and/or the structural mix characteristic is reached.

11. Method according to one of the claims 9 or 10, characterized in that adjustments to the basket measures are interactively reviewed and audited by a user ensuring governance, risk and compliance requirements.