The views expressed are those of the authors and do not necessarily reflect the official views of the SAS Institute, PPF group or Česká Pojišťovna.

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Risk aggregation (Marek Hlaváček)

- business point of view (why)
- mathematical point of view (how)
- automation of risk aggregation in PPF group

MARS – SAS solution for aggregation process automation (Martin Mrázek)

- Architecture and main features
- Building blocks and integration with other analytical tools
- Efficiency tricks

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Risk Aggregation (not only) within Financial Holding

Marek Hlaváček, Česká pojišťovna

ČESKÁ POJIŠŤOVNA

Economic Capital

- Unified concept for risk management
- Basic idea: as a company is exposed to risk it should hold enough capital to cover potential losses
- Economic Capital is the minimal capital that should cover potential losses in given time period with high probability
- Risk is measured in terms of capital
- Once all risks in company are expressed as volumes of economic capital, it is possible to compare or sum different types of risks

ČESKÁ POJIŠŤOVNA

Economic Capital Usage

Risk management

- Risk Limits
- Reinsurance Strategy

Profitability measurement

- Comparison of different business lines considering capital costs

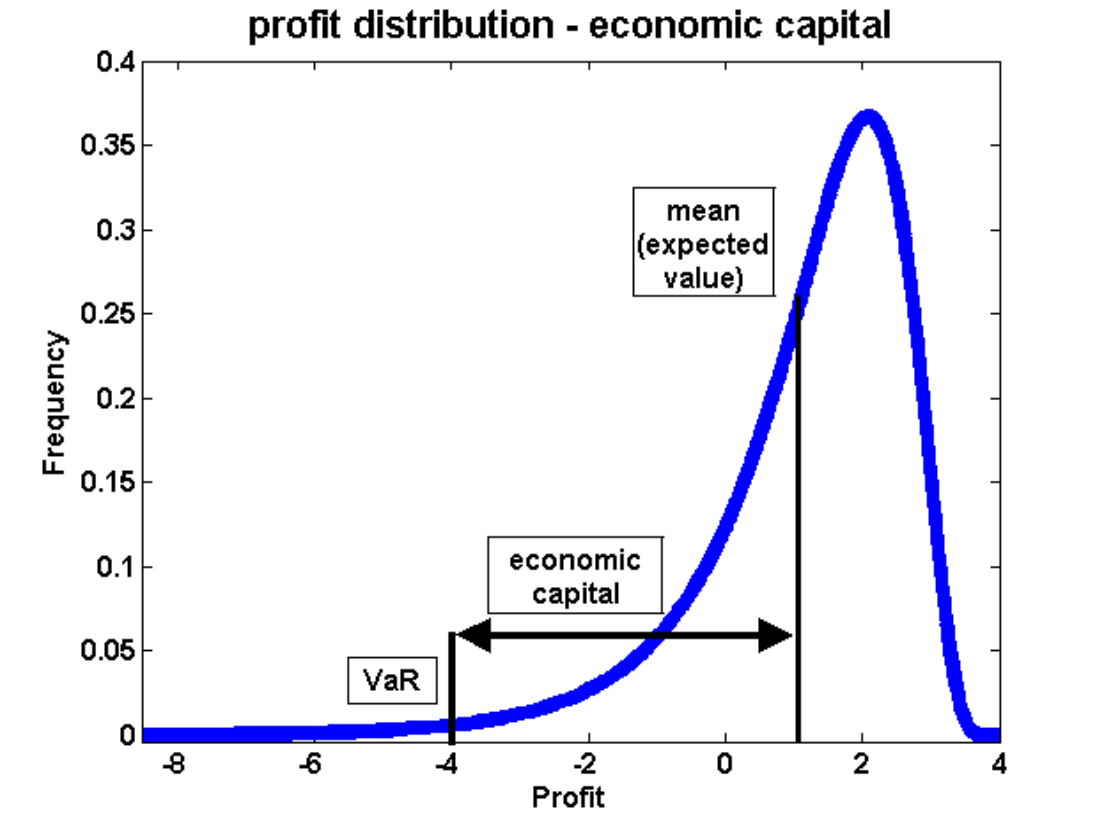
Capital management

Regulatory requirements

- standard and internal models

ČESKÁ POJIŠŤOVNA

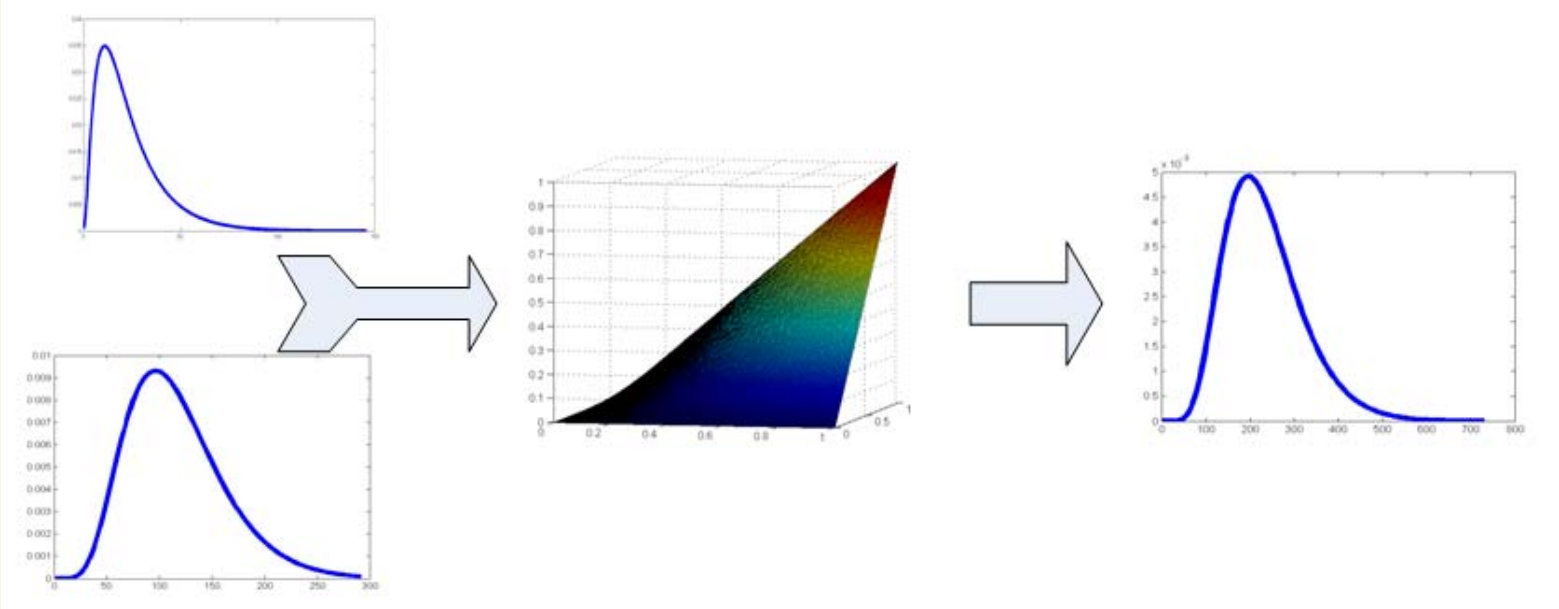
Economic Capital Evaluation



Economic Capital is derived from the probability distribution function of the risk.

ČESKÁ POJIŠŤOVNA

Economic Capital Aggregation



probability distributions of marginal risks

correlation structure described by copula function

probability distribution of aggregated risk

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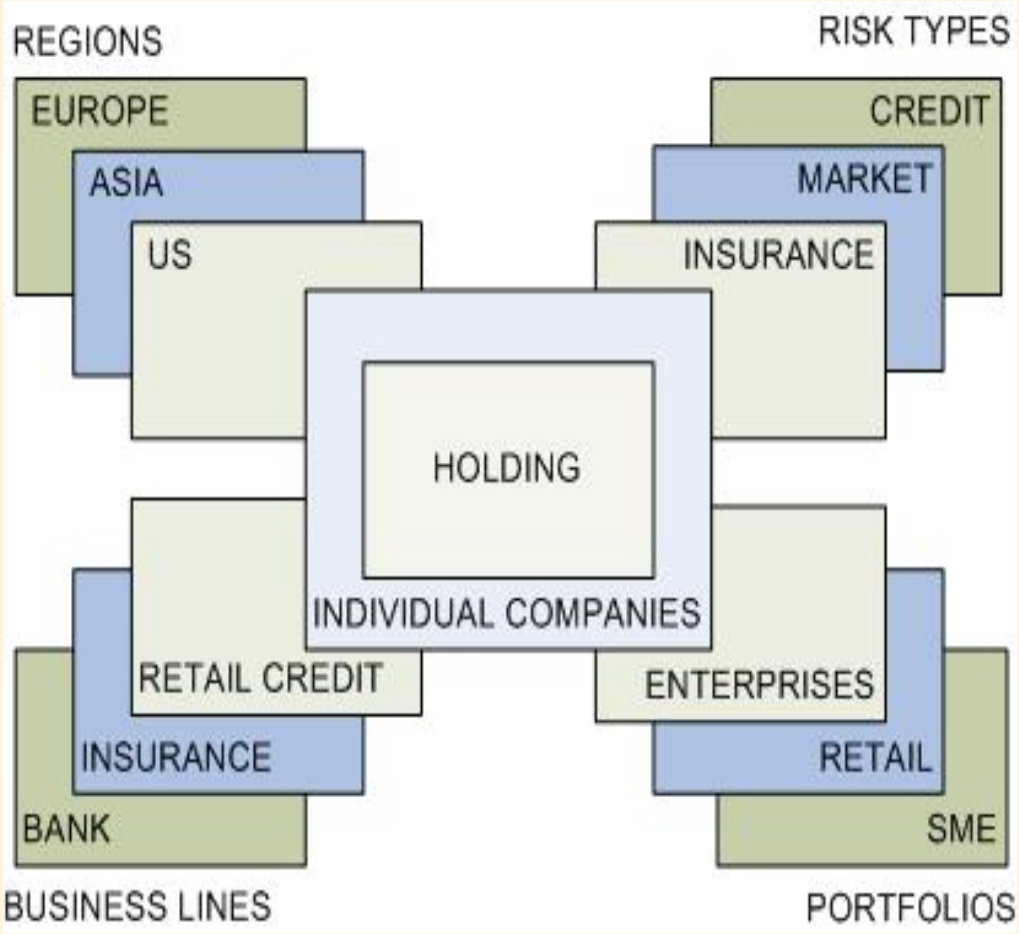
Economic Capital Reporting



Reporting structure might be really complicated and it might change from report to report.

ČESKÁ POJIŠŤOVNA

Automation of EC aggregation in PPF group

- Set of MATLAB scripts performing data manipulation and computation
  - the reporting structure was described directly in the scripts
  - all data stored in files (xls, csv); no database storage
- Due to the group's dynamics a more robust system become necessary
  - original plan: MATLAB + MySQL
  - finally the solution was implemented as a minor part of more general project using SAS platform
- Duration of implementation: 1 year
- Result:
  - all data stored in database (including company and reporting structure)
  - solution is opened to user defined aggregation methods

ČESKÁ POJIŠŤOVNA

Lessons learned

- EC aggregation might be automated using MATLAB as well as SAS
- Base SAS solution might be easily integrated using standard SAS BI tools into enterprise solution accessed through web portal
- Each specialized SAS procedure uses its own syntax which generates extra learning costs; GUI tools like SAS/Enterprise Guide provide more comfortable way to use the procedures for ad-hoc analysis;
- SAS/Macro language:
  - efficient and flexible text-preprocessor, allows to effectively parameterize SAS procedures
  - lacks features useful in huge projects (declarations, types, …)
  - SAS/SCL module (object-oriented encapsulation of SAS/Macro and SAS/Base codes) might be more comfortable

Lessons learned

- Data might be easily reported in (HTML, PDF,...) using Base SAS
- Access to databases:
  - use of SAS direct connectivity is faster than using ODBC
  - in some cases SAS sequential approach allows more efficient manipulation with data then SQL does
- Processed data might become to large to be stored in memory using 32bit architecture; using of 64bit architecture or a file system (like SAS dataset) is then necessary

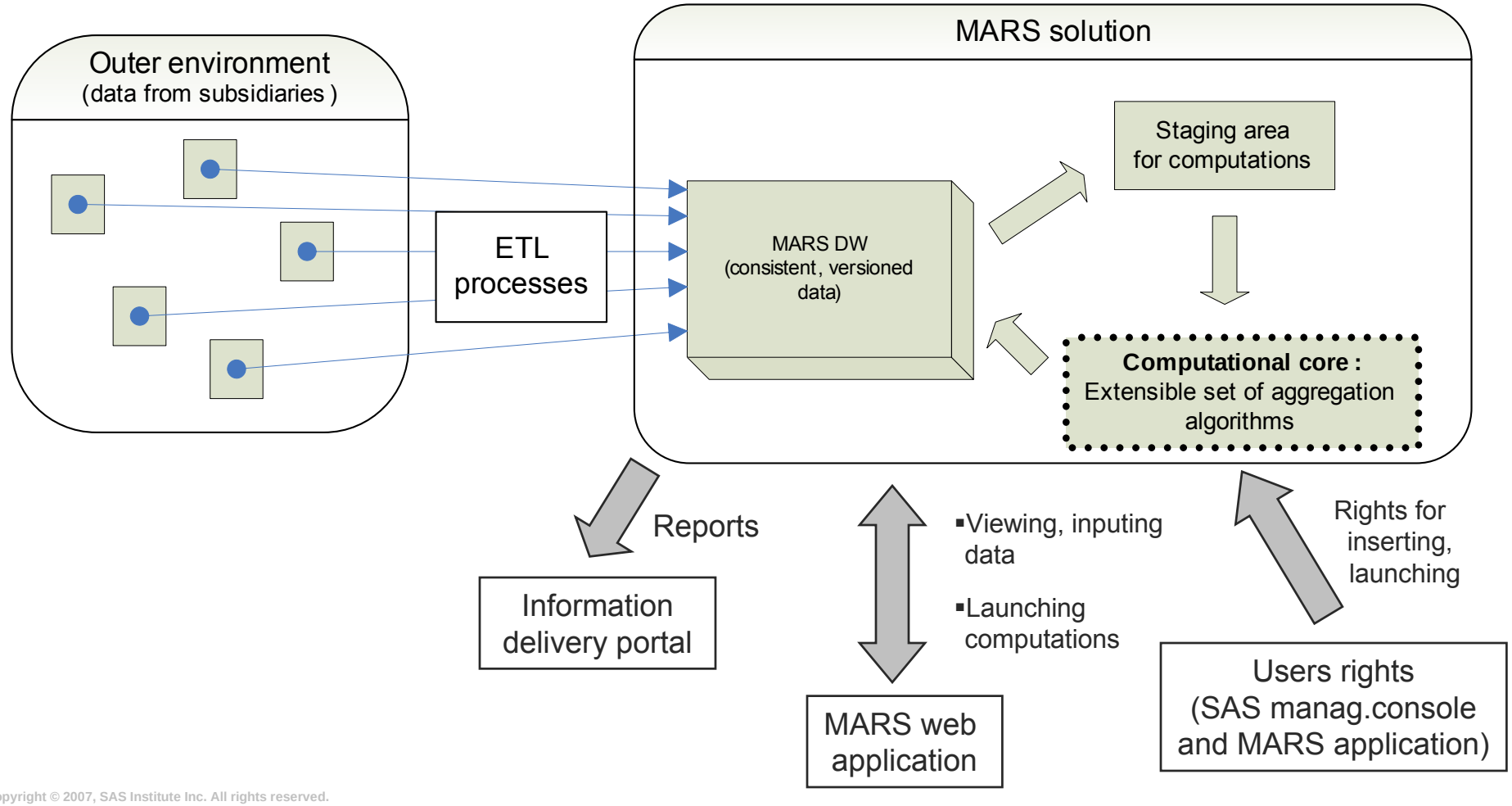
ČESKÁ POJIŠŤOVNA

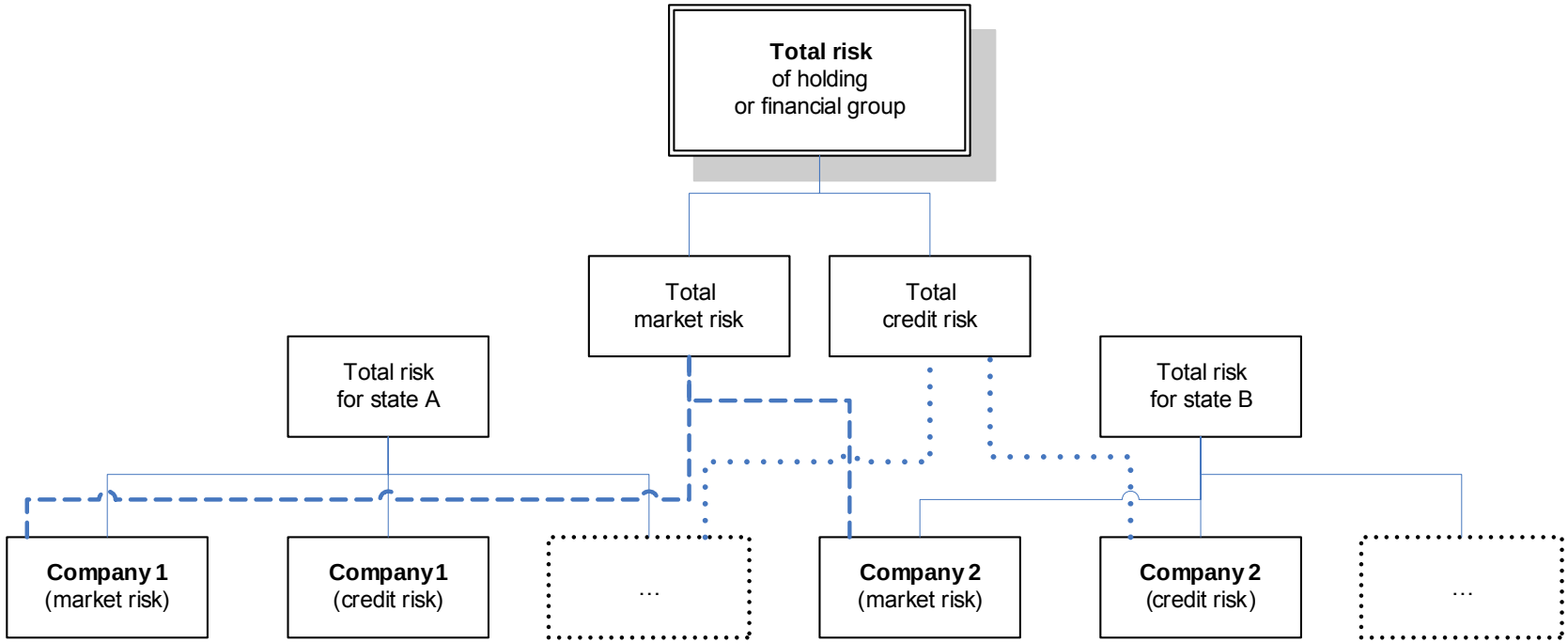
THE POWER TO KNOW.®

SAS® MARS

Solution for Economic Capital Aggregation

- extensible by any external aggregation method,
- fully automated and parameterized run of aggregation scenarios,
- multilevel aggregations,
- parametrized “moods” of aggregations,
- versioning of data

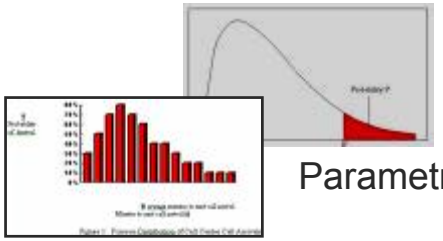




Shown aggregation are related – results of lower aggregations are input of higher ones, all shown aggregations can be computed automatically in one run of the process, each included aggregation can have different set of reported results which are automatically computed during the process.

Aggregation scenario

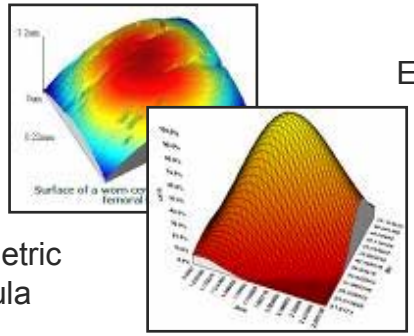
Marginal distributions of risks



Parametric

Empirical

Copula aggregation method



Empirical copula

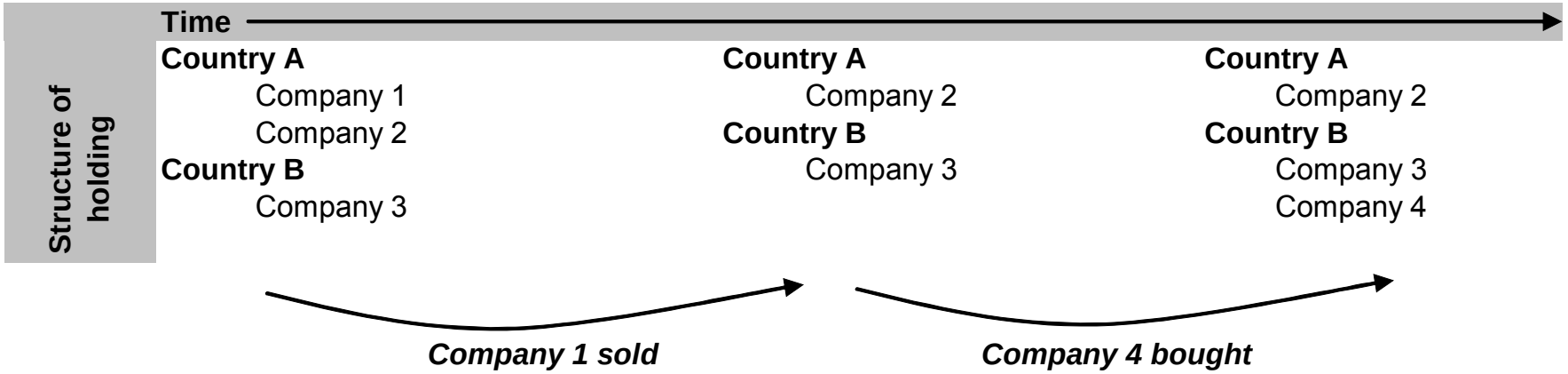
Parametric copula

Derived statistics for reports

Parameters of aggregation

Optimistic

Pesimistic



Store information about development of the holding structure

Just choose a historical moment

→ **Computation is automatically adjusted to the holding structure valid in moment M**

Two time dimensions:

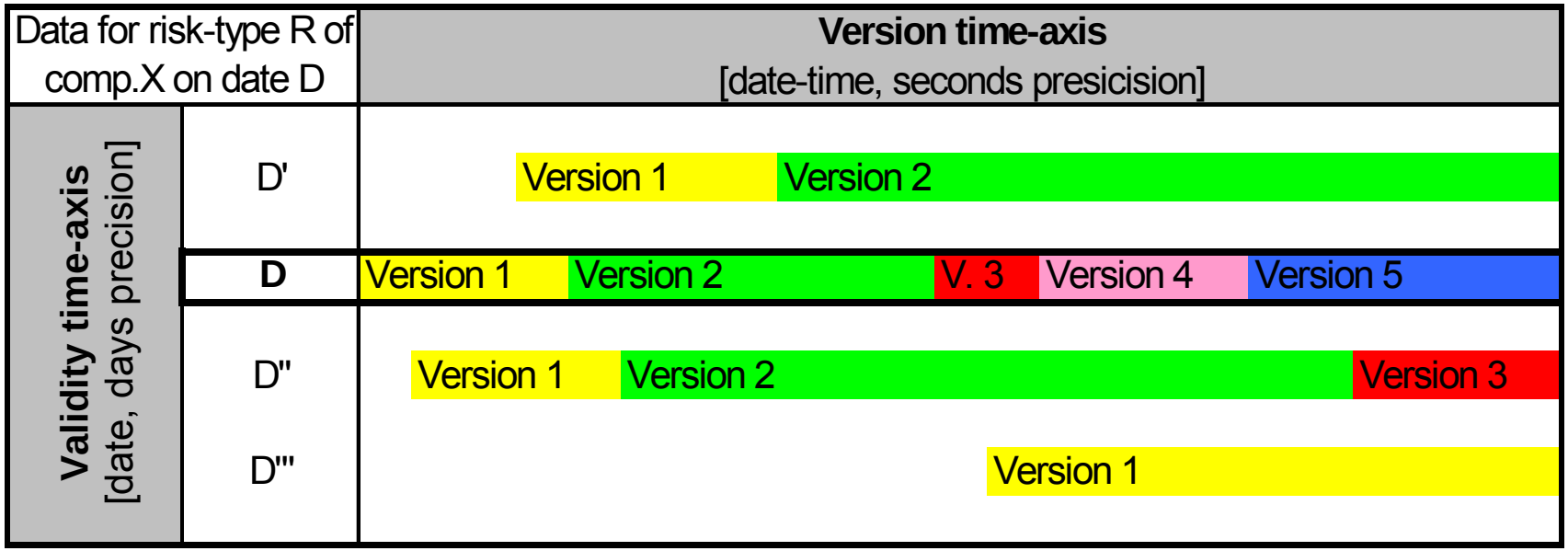
validity … tells when the event occurred
version … shows, how information about the event developed

Example from accountancy:

31-Jan-05 … end of year
20-Feb-06 … preliminary results of year 2005 (1st version of 05'results)
20-Apr-06 … final results of year 2005 before audit (2nd version 05'results)
20-Jun-06 … final results after audit (3rd version of 05'results)

MARS solution:

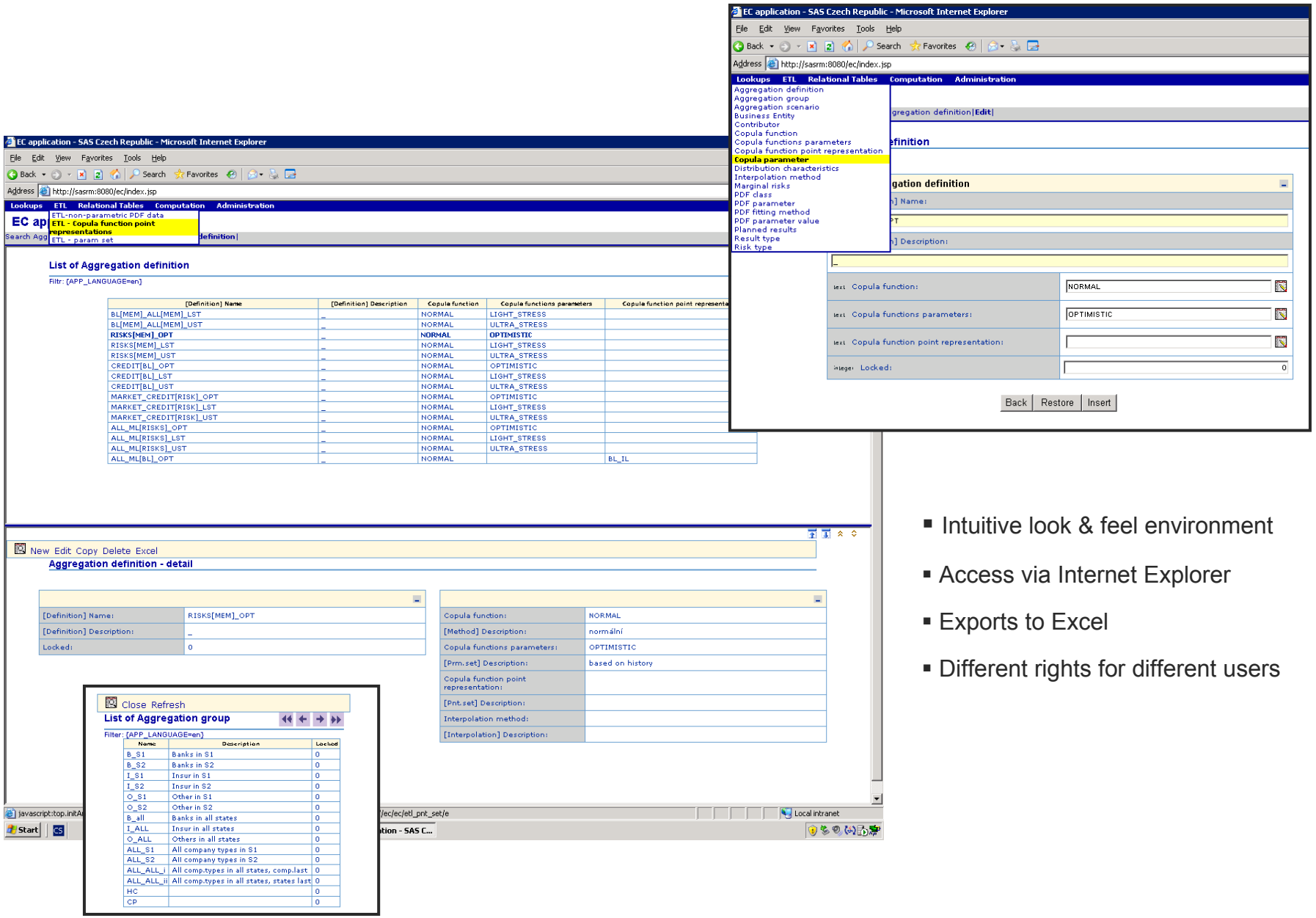
The data can have arbitrary amount of versions…



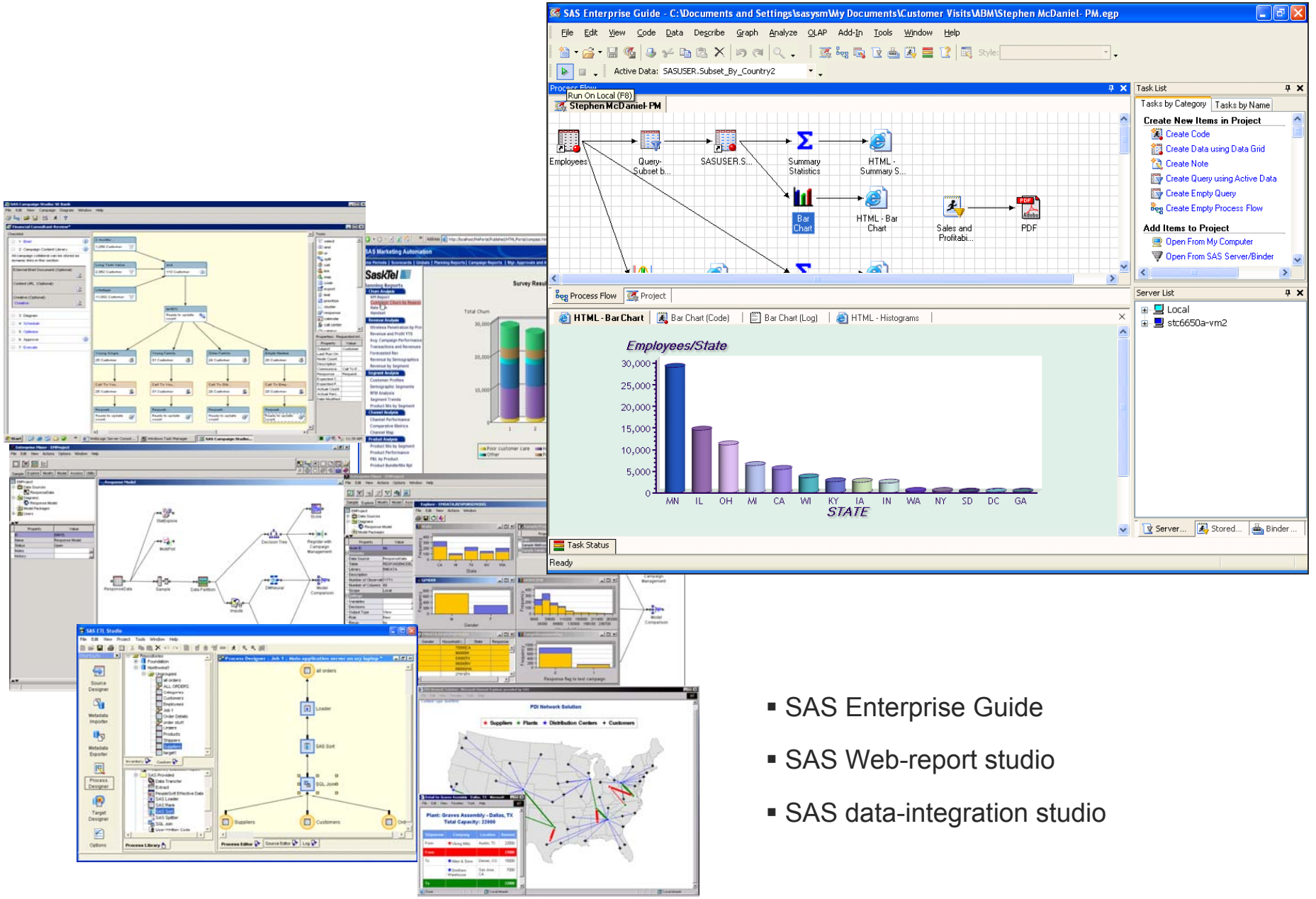
Easy way of making experiments in MARS:

many versions for one validity and testing, which version is the most suitable

Needed functionality	Specific technology used in PPF
General procedural or OO language	SAS/Base, SAS/Macro
Efficient matrix language	SAS/IML
Libraries with statistical and probabilistic functions	SAS/Base, SAS/STAT
Data-storage	MySQL*), SAS tables
Reporting system	SAS/Base, SAS/Graph, SAS/Enteprise Guide
GUI for data inputs, launching computations and scheduling	Java/Spring web application
Security/users metadata administrator	SAS/MC and web application
Aggregation methods	Set of macros / functions / method programs performing ETL, analysis and computations



- Intuitive look & feel environment
- Access via Internet Explorer
- Exports to Excel
- Different rights for different users



- SAS Enterprise Guide
- SAS Web-report studio
- SAS data-integration studio

Information delivery portal

(MARS called from portal, reports visible on portal)

Several user groups

(junior-analyst, senior-analyst, admin, reader)

Automatic assignent of appropriate rights

(rights to read/write data, launch processes, view reports)

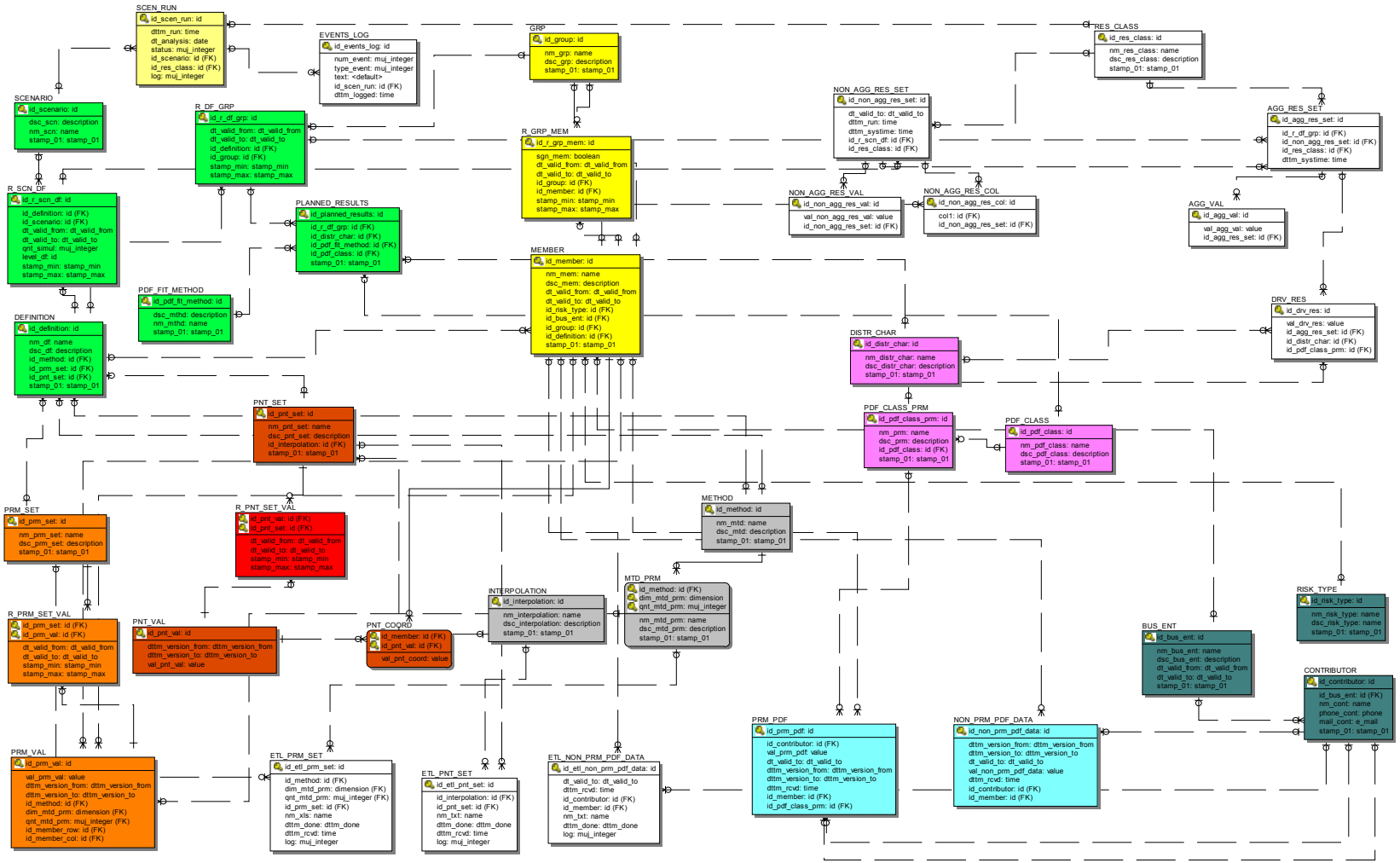
Unioning methodology:

Saves hours of computational time,

intermediate results for one report can be used in other reports

Ready for optimization and experiments:

- Arbitrary amount of preliminary results
- Possibility to choose what will be stored in DW and what only left on analyst HDD
- Arbitrary number of simulations



- Denormalized storage for multidimensional surfaces (easy)
- All data-consistency checks on DB-level (medium)
- Wizards for scenario definitions, graphical depiction of scenario structure and versioned data (hard)