Risk Solution Architecture for Regulatory Capital

By: Dilip Krishna
and Mitch Zarkovic

Teradata
a division of NCR

You've never seen your business like this before.

Risk Solution Architecture for Regulatory Capital

Table of Contents

Introduction

Basel II is an accord that aims for regulatory control of the banking system by requiring banks to maintain capital. It is a major modification to the existing BIS-88 rules that regulate banks in G-10 countries, and significantly increases the risk sensitivity of the regulation.

Losses in banking can be classified as *expected* or *unexpected* losses. Expected loss is considered a normal cost of being in business and may be estimated from historical analysis of the bank's and external loss experience; this loss is typically provided for in banks' financial statements. In contrast, unexpected loss describes those loss events that, by definition, cannot be estimated from past history alone, and are not provided for. These losses are covered by capital.

There are typically two kinds of capital – *regulatory* and *economic* capital. The former is the regulator's estimate of the amount of capital required to protect against unexpected loss, while the latter is the bank's own estimate of the same loss. In the past, these estimates have been vastly different due to the relative lack of risk sensitivity on the part of the BIS-88 rules for calculating capital [3]. While the newest Basel accord goes a long way to addressing these deficiencies, it is expected that significant differences between these calculations will still remain.

While this paper primarily discusses calculation of regulatory capital using the Basel II approach, linkages to economic capital calculation are also discussed where appropriate.

Risk Solution Architecture for Regulatory Capital

Data and Calculation Requirements

Capital Calculations

Regulatory capital calculations are specified in Pillar I of the Basel II Accord. They are, in general, quite simple and require relatively little computational power to execute. There are four parameters or *Risk Components* that are required: Probability of Default (PD), Loss Given Default (LGD), Exposure at Default (EAD) and for some portfolios, Effective Maturity (M). These parameters are estimated using Risk Models that are run using numerous bank-specific data inputs.

These inputs are used to calculate *Risk-Weighted Assets (RWA)* for credit risk, which, along with RWA for market and operational risk, is the basis for calculating regulatory capital. The Basel II Accord specifies minimum capital at eight percent of calculated risk-weighted assets, but it is expected that in most jurisdictions, the actual regulatory capital held will be somewhat higher – between nine and 11 percent. The amount of capital held will also depend on the desired credit rating of the bank.

Capital calculation rules vary across the different portfolios in the bank. These portfolios have been classified in Pillar I of the accord as Corporate (loans to banks, sovereigns, commercial enterprises both large and small) and Retail (loans to individuals or small businesses treated by the bank as individuals). Other portfolios with unique characteristics, such as securitization and non-traded equities, have been afforded their own treatment. In particular, the risk components for securitization are quite different from those for regular loan portfolios in the Corporate and Retail books[1].

Pillar II of the Accord describes the supervisory process, and does not directly yield any data requirements. However, a critical success factor in Basel II compliance is the ability to abide by the audit and traceability needs of Pillar II. This implies a framework to efficiently trace data from the calculated final results through intermediate stages to the source system data. As well, there is a need to maintain an audit trail for changes in calculation input variables due to external factors such as adjustments and customer matching during the reporting period.

This also implies that there is a high degree of quality and integrity throughout the data infrastructure used to generate Basel II capital calculations.

Business Process

Capital calculations need to be run monthly. There may, however, be requirements for running these calculations more frequently, if there is need for revised data.

For the most part, this is an automated process for generating capital numbers and producing required reports. There may be cases where adjustments will be required to data in the warehouse before regulatory reports are generated. These will require manual intervention. In addition, for special portfolios, such as Asset Securitization, the calculation process has to be preceded with a deal by deal analysis.

Capital Adequacy Reporting

The Capital Adequacy Report (CAR) is submitted to the finance group monthly. The report should contain data such as Basel Exposure Class (e.g., Sovereign), Exposure Type (e.g., Repo Style, Undrawn, and OTC Derivatives), Product (e.g., Over one year, and Direct Credit Substitutes), and Notional Principal Amount.

Management Reporting

Reporting to management is similar to CAR (Regulatory) Reporting. However, the data will be presented in a different way. Management reporting will also require the ability to perform a wider range of analytical queries. In addition, the frequency of reporting may be higher than that required for CAR reporting.

[1] See p538-643 of Basel II Accord for further details about the Securitization Framework

Risk Solution Architecture for Regulatory Capital

Regulatory Capital Solution

The regulatory capital solution is presented in Figure 1.

It has the following salient features:

- A *Data Warehouse* on a single physical platform
- A single, consistent *Logical Data Model*
- A *Regulatory Capital Calculation Engine*, which may be implemented in several different ways
- Integration to other relevant processes, such as *Retail Pooling, Capital Allocation, Economic Capital* and *Customer Profitability* calculations.

Single Warehouse Data Model

Compliance with the Basel II Accord requires aggregating capital for exposures across all the bank's operations. Two of the typical challenges in doing this involve lack of *Common Customer Identifiers* and *Metadata Collision.*

The former problem arises because it is quite common for the same customer to be served by different areas of the bank. For example, corporate customers may have loan facilities, trade finance facilities, and trading room facilities for hedging purposes. Many banks have partial data aggregators that may integrate some of these exposures. Calculating capital from these partial aggregators leaves open the very real possibility of double-counting exposures that may already be accounted for elsewhere leading to an overestimation of required regulatory capital.

In addition, it is also quite common for different areas of the bank to use the same business term to refer to different concepts, or alternatively, to use different names to describe the same business concept. For example, the term facility may have a different meaning in the corporate bank as opposed to the trading room. To ensure a robust solution of assured longevity, it is necessary to ensure that these collisions in metadata be resolved before using the data for capital calculations.

The best way to do this is to use a common data model for all exposures within the bank. Resolving the customer identifier problem is a prerequisite to aggregating exposures in this way. In addition, the data model acts as a central focal point for resolving problems with inconsistent metadata; the very process of modeling data within the enterprise forces consistency in business meaning across the business lines in the bank.

The data warehouse model must capture the underlying patterns and relationships between various data items in the business.

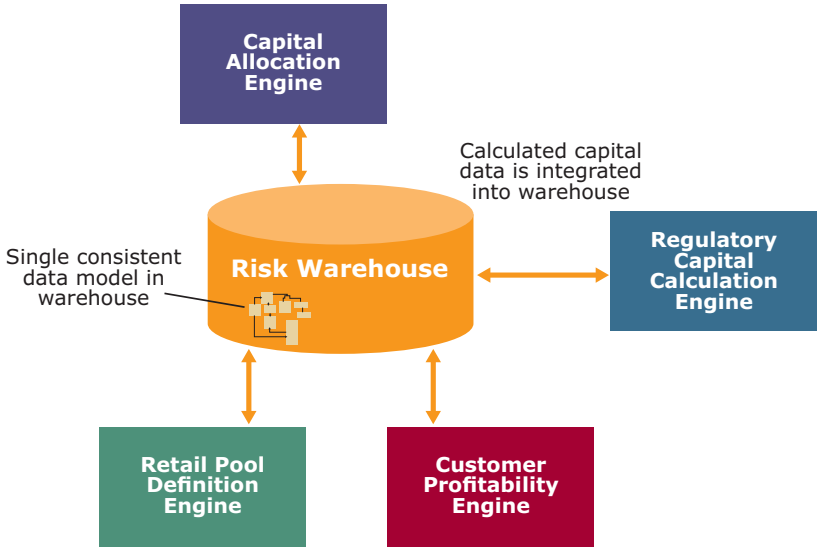

Figure 1: Solution Architecture for Regulatory Capital Calculation

Risk Solution Architecture for Regulatory Capital

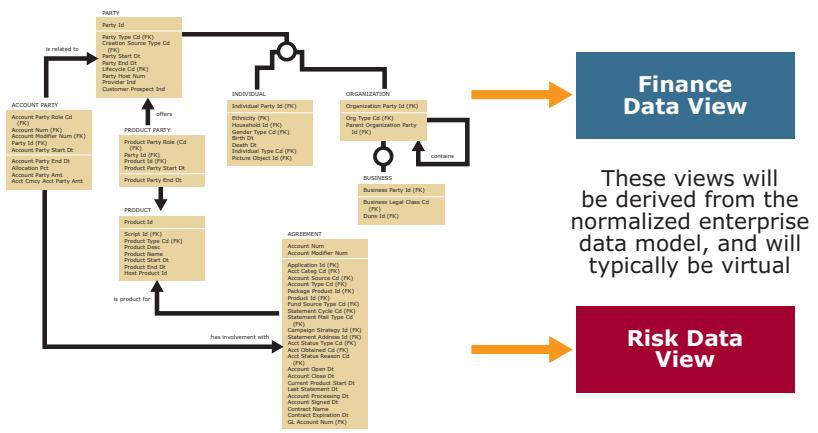

Figure 2: Normalized Enterprise Data Model and Dependant Data Views

The proper modeling technique to achieve this goal is to use a normalized model. This is shown in Figure 2.

An alternative technique, dimensional modeling, is appropriate for presenting a certain perspective of the business as suits a particular business unit. For example, customer exposures are of interest both to credit risk management and finance groups. However, the data derivations and business questions that each group is interested in will be quite different. The former will probably be interested in customer centric views ("which industries am I most exposed to") while the latter is typically not interested in this view.

Therefore, the architecture advocates the use of dependant, virtual data layers that are used to translate enterprise data into the forms required by risk management and finance.

Subdivision of Model

Notwithstanding the previous comments about the model, it is possible to judiciously segment the enterprise model. The bank may do this in order to achieve efficiencies in building and managing such a large pool of data.

In general, warehouse data may be segmented into wholesale and retail data sets, since these businesses are typically managed quite differently and don't have a large overlap of customers. The best way to classify these portfolios is to use the Basel II Accord definition[2], rather than bank specific distinctions.

While this kind of segmentation does make the task of building the warehouse easier, there are types of data analysis, for example credit concentration risk analysis that will not be possible with this approach. When making the decisions around segmentation, the bank should carefully weigh the costs of the single model approach against the possibility of requiring this kind of analysis at some point in the future.

Data Required for Regulatory Capital Calculations

The inputs into capital calculations are the four risk components – PD, LGD, EAD, and M. These inputs are not typically available in front-office systems, but must rather be derived from available front-office data, such as obligor and facility risk ratings, as well as the history of loss experience. Another important data requirement is information about credit mitigants, such as collateral and guarantees.

For special portfolios, the data requirements may be somewhat different. For example, trading room portfolios require information about net present value and notional values. Note that this may change as per latest consultative papers from the Basel Committee. Similarly, securitized portfolios require a number of special data points, such as current outstanding balance, presecuritized capital, expected loss amount for the asset pool, portfolio share associated with the largest exposure in the pool, and specific provisions.

In most cases, balance-level data is sufficient for calculations. A few specific calculations, especially those around estimating economic loss, do require transaction-level data to be recorded.

[2] See p215 of Basel II Accord

Risk Solution Architecture for Regulatory Capital

Warehouse on Single Platform

The architecture prescribes both a single data warehouse model, as above, as well as a single data warehouse platform. While the business benefits of consistency in modeling are easy to understand, a single consistent platform and data management solution is also critical due to the increased needs for metadata management, data quality, and robust data management solutions.

Consistent Metadata and Data Quality Processes

Consistent metadata is critical both in construction, as well as maintenance of the data management solution. While the Basel II Accord does not directly require metadata to be stored, there are many indirect drivers, such as Data Consolidation, Audit and Control, Traceability, Operational Metadata for Data Adjustments, and Impact Analysis, that cause metadata storage to be an important requirement.

Data Quality is also a key requirement[3]. Regulators are keen to ensure that the reports that are generated at the end of the process are based on data that have a high degree of integrity. This data must cover all relevant lines of business so that there is full coverage of the banks exposures. There is also a strong desire to ensure that the data in the risk reports reconcile back to the data used for generation of GL postings and financial reports.

To preserve the integrity of metadata and data quality throughout the life of the warehouse, it is necessary to put into place robust data governance processes that involve units across the enterprise. In addition to the enterprise-wide scope of data governance, it tends to involve officers of varying degrees of seniority in the firm.

These data management functions can only be efficiently performed by taking advantage of economies of scale.

Since data governance processes for Basel II need to be, in general, enterprise-wide, it is challenging to simultaneously attempt this exercise with many independent warehouse platforms. In addition, many of the tools and processes involved tend to be quite expensive, and typically not cost effective in smaller environments. Therefore, only a centralized data warehouse solution can justify the cost and scale of the management processes, tools, and technologies required.

Consistent Data Management Operations

Management of data in a data warehouse is an expensive proposition. As the warehouse grows, there are large costs involved in maintaining the service levels required by the increasing business interest in the data in the warehouse. Setup costs of hardware and software are themselves quite high. In addition, the costs of running a robust data management environment – personnel required and licensing costs for hardware and software – are also significant.

This cost is easily justified if the warehouse platform's potential is fully realized. Doing this involves aggregating as much enterprise data in the warehouse as possible, and then searching for patterns and opportunities that are afforded by the unprecedented aggregation of information that is offered by a robust warehouse.

Regulatory Capital Calculations – Two Solutions

The process of calculating regulatory capital takes as input the data elements discussed above, and performs a series of transformations and calculations on these data. There are two alternatives for performing capital calculations within these architecture. These are warehouse-integrated calculator or an external application.

Warehouse-Integrated Calculator

This configuration uses a calculation engine that operates directly against the data in the warehouse. The calculator reads data from the integrated data warehouse model, perhaps with the assistance of a virtual view, generates calculated results for Risk Weighted Assets, and writes this data directly into the warehouse.

External Application

There are a number of vendors who offer Basel II calculation packages. In most cases, these packages have their own repositories and data models, and require data to be copied from the data warehouse to the proprietary data model before capital

[3] See p751 of Basel II Accord

calculations can be run. Most of these packages also do a certain amount of regulatory reporting.

Pros and Cons of Each Approach

The internal engine approach is attractive from the perspective that there is no duplication of data and no need to move data to an application outside the warehouse. It also affords a high degree of control of calculations.

The downside of this approach is that the bank needs to maintain the application and business rules. Additionally, the bank may not be able to take advantage of intellectual property developed by vendors in specifying Basel II rules for other clients.

The external vendor approach is also attractive in its own way. Vendors bring intellectual property to the table, and supervisors may also be comfortable with certain vendors' calculations.

The disadvantage with this approach is that in most instances, data need to be replicated. ETL work needs to be done to move the data. Users may have two reporting portals – one for reports offered by vendor solution (e.g., CAR reports), and another for reports developed against the warehouse (management reports) – issues of data consistency need to be addressed.

Depending on the bank's specific needs, either of these approaches may be used successfully. If the external vendor approach is used, however, it is imperative to ensure that all data calculated by these applications are copied back into the warehouse, since this data will be used for processes that are downstream to the warehouse. Examples of such processes are capital optimization to ensure parity between regulatory and economic capital and capital allocation to individual exposures. Historical and trending analysis of regulatory capital may also be performed on the data in the warehouse.

Integration with Other Processes

Retail Pooling

Calculating capital for retail portfolios requires the following steps[4]:

- Apply pooling criteria to historical data to calculate historical values for PD, LGD, and EAD.
- These historical values and statistics yield an initial set of forward-looking estimates for PD, LGD, and EAD at the pool level.
- The pooling criteria and resultant risk components must be verified for suitability according to a set of statistical tests.
- Apply the pooling criteria and the official estimates of PD, LGD, and EAD to the current data to produce Capital Requirement, Regulatory Capital, RWA, and Expected Loss values for each account.

While definition of pools based on historical data and calculation of forward-looking regulatory capital can be done on independent sets of data, ideally, this should not be the case. Pool definitions must be done on the same historical data as regulatory capital calculations. This becomes even more important because the suitability tests for pools must be rerun periodically.

Capital Management

Capital management is a complex topic. It involves ensuring that the capital available to the bank is optimally allocated to the business opportunities that can offer the highest return on a risk-adjusted basis.

The measure that banks use for this is typically economic capital, the internal equivalent to regulatory capital. While the Basel II Accord has come a long way in aligning regulatory capital calculations with modern methodologies, there will still be significant differences between calculated economic and regulatory capital.

Balancing out these differences should be a function undertaken by the bank. If regulatory capital is significantly greater than economic capital, this implies that the bank is underutilizing its assets by being forced to keep capital for regulatory purposes. The bank may either reduce required regulatory capital by divesting itself of assets (directly or indirectly via the use of securitizations) or by increasing required economic capital by investing

[4] See p331 of Basel II Accord

Risk Solution Architecture for Regulatory Capital

in assets that differentially increase economic, not regulatory, capital. One way to do this is to increase concentration risk, which would only affect economic capital while leaving regulatory capital unchanged.

For all these functions, a basic requirement is to ensure that the two capital calculations – economic and regulatory – are derived from the same underlying data sets. As well, it is imperative that capital is computed and/or allocated to the lowest level of granularity at the individual exposure or account.

Economic capital calculation engines have higher computational requirements than regulatory capital requirements. As well, some vendors have proprietary risk engines that are used to calculate economic capital, which cannot be integrated into the warehouse. So data will need to be extracted from the warehouse and sent to the calculation engine. It is imperative, for capital management purposes, that the calculated results be sent back to the warehouse and properly allocated to the lowest level of granularity. This allocation may also need an engine of considerable complexity because capital allocation will need to take into account diversification effects.

Customer Profitability

Achieving Basel II compliance requires considerable investment. The way the bank can extract value from this investment is to use the capital calculations in processes that assess customer profitability. Inputs to customer profitability calculations include income and costs, as well as loss estimates, both expected and unexpected. The latter estimates can easily be derived from the risk warehouse implemented for Basel II compliance. For an estimate of unexpected loss, the bank can directly use regulatory capital; alternatively the bank may choose to use economic capital estimates derived from the same data.

Conclusion

This paper discusses a coherent enterprise framework for implementing a regulatory capital solution that will achieve Basel II compliance.

The salient features of this architecture include:

- Single warehouse data model on a unified enterprise warehouse platform.
- Regulatory capital calculation results are stored in warehouse at granular (exposure) layer.
- Economic and regulatory capital calculated from a single source of data.
- Integration of calculated capital into processes for capital management and customer profitability analysis.

This architecture has significant benefits – it not only ensures Basel compliance from the perspective of all three pillars, but also ensures that the investment in Basel can be leveraged to improve profitability of the business.

References

1. *International Convergence of Capital Measurement and Capital Standards – A Revised Framework*, June 2004 – by Basel Committee on Banking Supervision, BIS.

2. *Value Added Risk Management in Financial Institutions: Leveraging Basel II and Risk Adjusted Performance Measurement* – by David P. Belmont (Author).

3. *International Convergence of Capital Measurement and Capital Standards*, July 1988 – Basel Committee on Banking Supervision, BIS.

Appendix 1: Applicable Teradata Tools and Services

Teradata, a division of NCR, provides a number of useful tools that can be leveraged to develop effective solutions for capital calculation and allocation. This includes products such as:

1. Teradata Analytical Calculator
2. Teradata Basel II Calculator

Teradata Analytical Calculator

Teradata Analytical Calculator is an application for general calculations in the Teradata Warehouse for the business user.

It is a rules-based application that can be customized and tailored to fit the needs of any customer without requiring changes to the core application software. Any business application that uses rules to

Risk Solution Architecture for Regulatory Capital

manipulate data within the Teradata Warehouse can be built on Teradata Analytical Calculator.

Teradata Analytical Calculator provides a functional user interface into which business analysts can code the rules relevant to the application. It is a J2EE Web application based on the Teradata Application Platform.

Teradata Basel II Calculator

Teradata Basel II Calculator is a regulatory capital calculation engine for all Basel II calculations. All required analytics are performed in-place within the warehouse. As opposed to integration of warehouse data with vendor products, no ETL to an external analytic engine repository is required. This avoids all forms of data duplication and unnecessary data movement.

Teradata Basel II Calculator produces results at a granular exposure level. The coverage for calculations includes:

- Scorecard variable creation.
- Scorecard and ratings model implementation.
- Mapping of PD, EAD, LGD and Risk Weights.
- IRB risk weight calculation.
- Exposure valuation (haircuts, CCFs, and add-ons).
- Collateral valuation (haircuts).
- Collateral allocation and collateralized exposure calculation.
- RWA calculation.
- Regulatory Capital calculation.

For complex calculations, Teradata Basel II Calculator uses IRIS RiskPro calculation engines for complex low-volume effective maturity calculations.

Using Teradata Analytical Calculator and Teradata Basel II Calculator

Clearly Teradata Basel II Calculator can be used as an integral part of a regulatory capital solution since it captures a significant portion of Basel II calculations. It is also a very effective way of doing these calculations since they are done directly within the warehouse.

Teradata Analytical Calculator, on the other hand, can be used for a number of applications relevant to capital calculations. For example, it can be used to build a capital allocation engine to allocate regulatory capital, if one is required.

It can also be used to build economic capital calculation and allocation engines, as long as the algorithms for these calculations are rules-based and procedural (for example, iterative simulation based algorithms would be difficult to implement using these tools). The significant advantage of using Teradata Analytical Calculator is that the calculations are done in-place in the warehouse. All data movement and consequent reconciliation and quality assurance procedures are, therefore, rendered unnecessary. These are also user-friendly tools designed to be utilized by business analysts with little technical sophistication. This makes any solution built on Teradata Analytical Calculator easy to maintain and manage.

Dilip Krishna, CFA *– Dilip Krishna is a senior consultant with 15 years of experience in implementing large scale projects in Risk Management and securities trading. He is currently involved with consulting on enterprise risk solutions in North America and the Far East for Teradata, a division of NCR.*

Mitch Zarkovic *– Mitch Zarkovic is an experienced banking and systems professional with more than 16 years of extensive management experience in corporate, commercial, and retail banking. Currently he consults with CIBC in Toronto as senior business architect for the bank's Basel Accord implementation.*