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## GENERALI PANEUROPE LIMITED

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Considerations for Variable Annuity  
Writers when internalising their  
hedging activities

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# GPE OVERVIEW

## Purpose

- Operates on a Pan European basis
- FOS model leveraging off Irish base
- Address the needs of markets (geographic or segments) not serviced by country specific Generali operations

## History

- 1999 – Originated as Exere Life International, part of INA group
- 2003 - re-launched as Generali PanEurope with mandate to support group companies and partners
- 2009 - Variable Annuity division opened

## Market Share

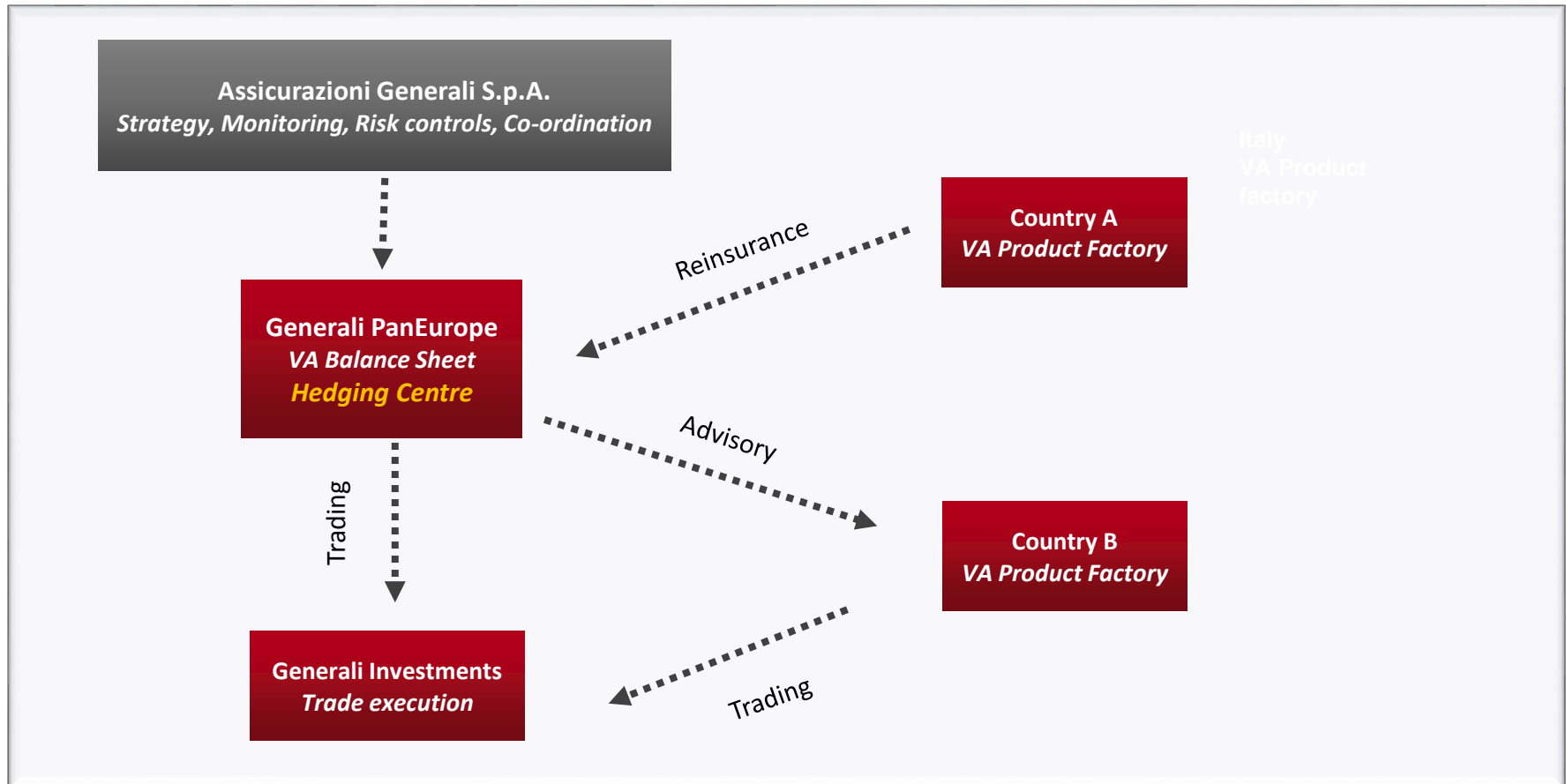
- 7<sup>th</sup> Largest Cross Border Life Assurer with market share of 5%

## Business Lines

- Wealth Protection
- Investment Planning
- Employee Benefits
- Variable Annuities

## Variable Annuities – Business Model

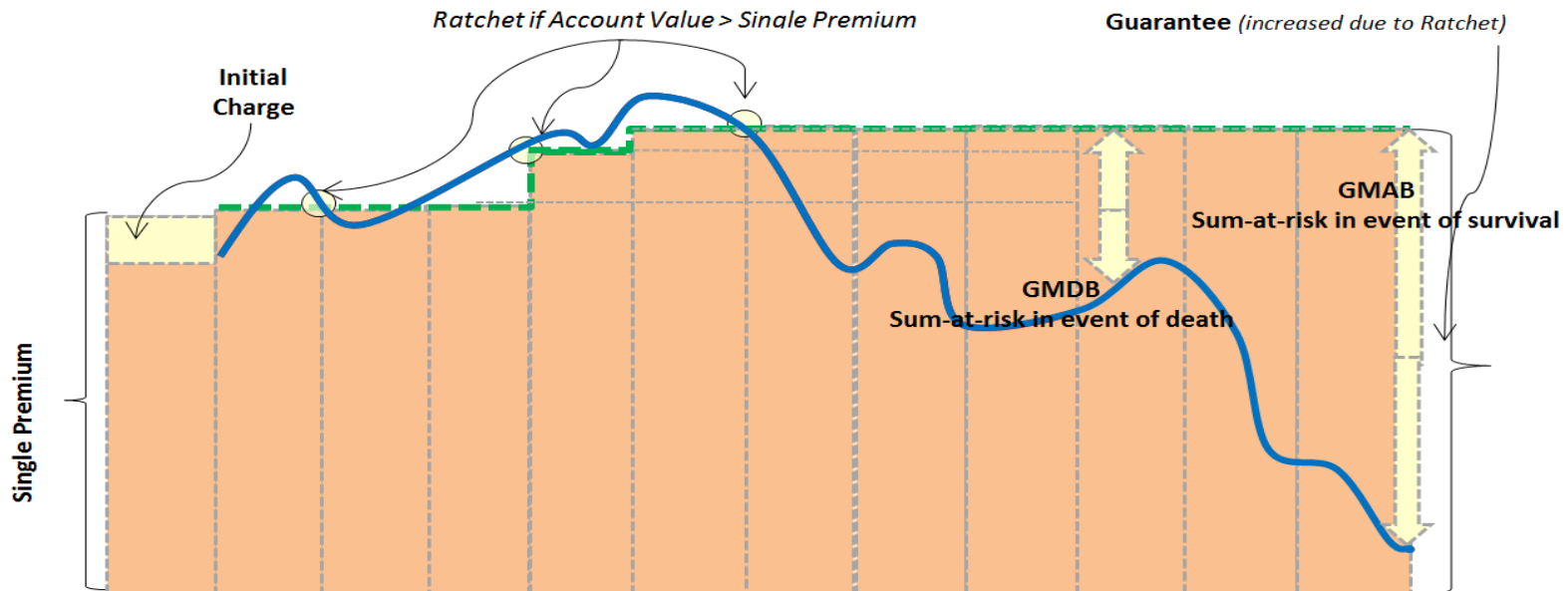
- Competence centre for managing VA guarantee risks across the Generali Group.
- GPE reinsures the VA guarantee risks from other group companies
- GPE also offer hedging services to other group companies



## Recap of Variable Annuities

### What is a **variable annuity**?

- A unit linked life insurance product with embedded guarantees e.g.
  - GMAB – Guaranteed Minimum Accumulation Benefit
  - GMDB – Guaranteed Minimum Death Benefit
- Underlying fund should be benchmarked to a weighting of hedgable indices e.g. 20% Eurostoxx 50, 80% bond index.
- Liability Option Value (LOV) = PV of Claims – PV of Premiums



## Recap of hedging program

Guarantees in these VA products need to be hedged in the derivative market

Dynamic hedging is the construction of an asset portfolio with the same sensitivities or Greeks as the liability option value.

### **Greeks:**

- Delta – sensitivity to underlying asset price (e.g. change in liability for 1% increase in Eurostoxx 50)
- Rho – Sensitivity to interest rates (e.g. change in liability for 5bps increase in swap rates)
- Vega - Sensitivity to volatility (Interest rate/Equity)

GPE implemented a Delta/Rho/Interest Rate Vega greek matching program.

Thresholds will need to be set on the mismatch of asset versus liability – trade off between frequency of trading and hedging effectiveness (also liquidity of underlying instruments).

Not all risks can be hedged e.g. actuarial impacts – lapses, mortality, etc. theta, basis risk, etc

Careful product/fund design should be used as a mitigating factor for these risks

## Recap of hedging program

Assets to use for hedging greeks:

- Equity delta – Futures and/or total return swaps
- Bond delta – Futures and/or total return swaps
- Currency delta – Currency forwards
- Interest Rate Rho – Swaps
- Interest Rate Vega – Swaptions
- Equity Vega – Equity options (put options, variance swaps)

## Reasons for insourcing

Many companies initially outsource their modelling and hedging platform because:

- Implementation of a hedging program is a major undertaking
- Extensive modelling and hedging expertise is required and this takes time to build up
- Uncertainty over the volumes of business that will be written

Some companies, after building up their expertise then decide to take the hedging and modelling capabilities back in-house

- It allows the company to be more flexible and respond more promptly to changing requirements
- The budgetary constraints with implementing changes/ customising their systems are not as high
- Continue to increase and build on expertise/skillset acquired.

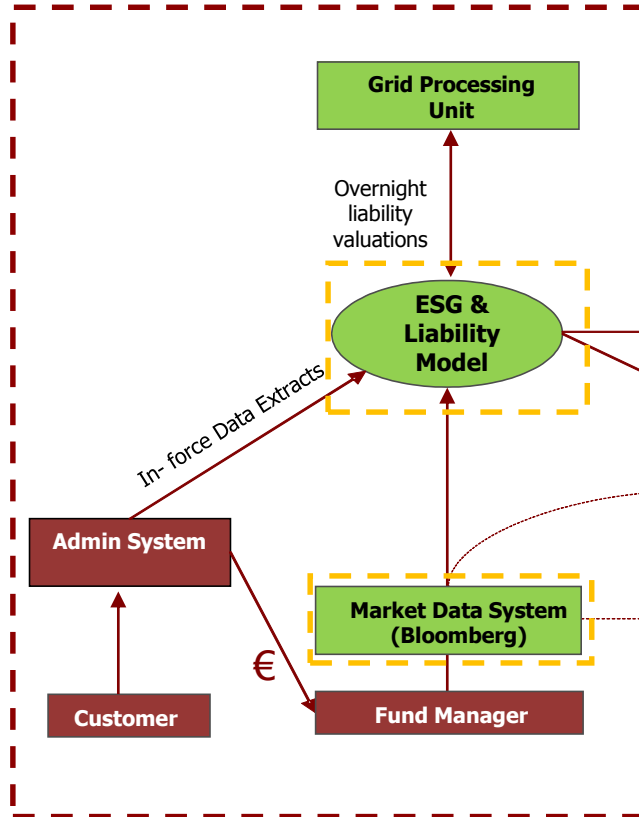
However:

- The proposed insourcing does come with increased internal operational risk (trade off with outsourcer operational risk)
- There may be high upfront costs, even if the long term costs are lower.

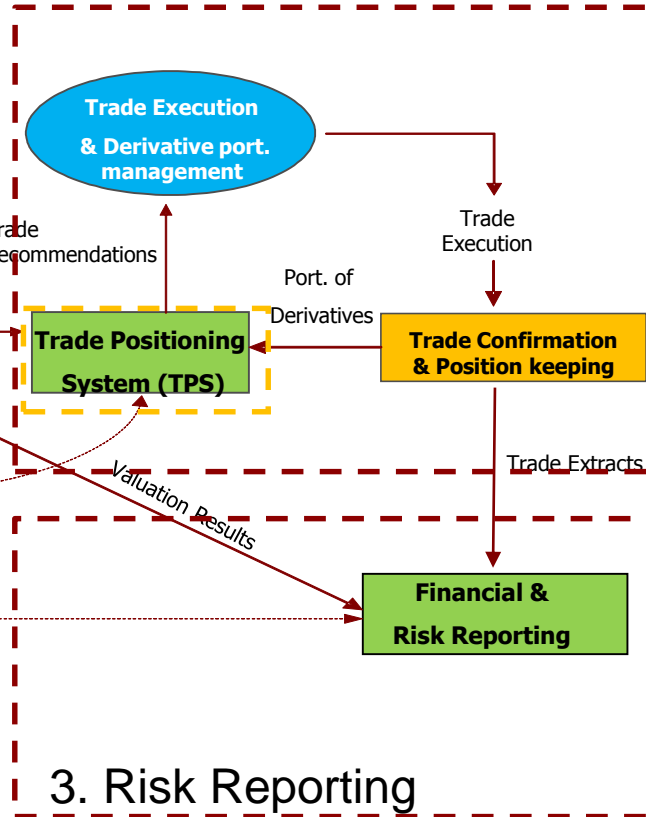


# Model prior to in-sourcing

## 1. ESG & Liability Valuation



## 2. TPS - Risk Monitoring & Trading



## 3. Risk Reporting



## Considerations for implementing ESG and Liability Valuation solution

	<b>Build in-house</b>	<b>Use existing actuarial platforms</b>	<b>Core VA platform with customisation</b>	<b>Off-the-shelf third party VA hedge platform</b>
<b>Resource requirement</b>	High	High	Medium	Low
<b>Run Speed</b>	Potentially fast	Slow	Very fast	Very fast
<b>Flexibility</b>	Very flexible	Moderate	Highly flexible	Low flexibility
<b>Implementation risk</b>	Very high	High	Medium	Low
<b>End result</b>	May be the ideal solution but requires huge investment of time and resources	Lack of speed rules this solution out for many	Represents a balance between “off-the-shelf” capabilities with opportunity for more customized development	Easiest to implement but tends to be least customisable

# Considerations for implementing ESG & Liability Valuation

In coming to a decision – questions to ask:

- How stable, scalable is the solution
- How easily implemented is a VA product/features e.g. ratchet, dynamic lapses, etc.
- Specifically designed for stochastic testing i.e. speed/performance not an issue
- Does it support the models that are required
- Easily integratable with common database and spreadsheet tools
- What level of output – aggregate, scenario x duration, seriatim, etc
- What will the liability solution be used for: Product design and pricing, Economic & statutory valuations (CTE, SII, etc), Financial statement projections, planning, economic capital

GPE opted for hybrid approach choosing a software provider with highly parameterised design within an open architecture.

- Can be modified to support more than just hedging
- Doesn't require major development effort to create a fully tailored company platform
- Avoids the monumental speed problems associated with traditional actuarial software and does not require specialized IT architecture

## Choice of model in ESG

Interest rate model – Hull White (1 factor/2 factor), LMM, etc

- Tractability, negative interest rates, calibration.
- Risk neutral vs Real world
- Model validation - Martingale test

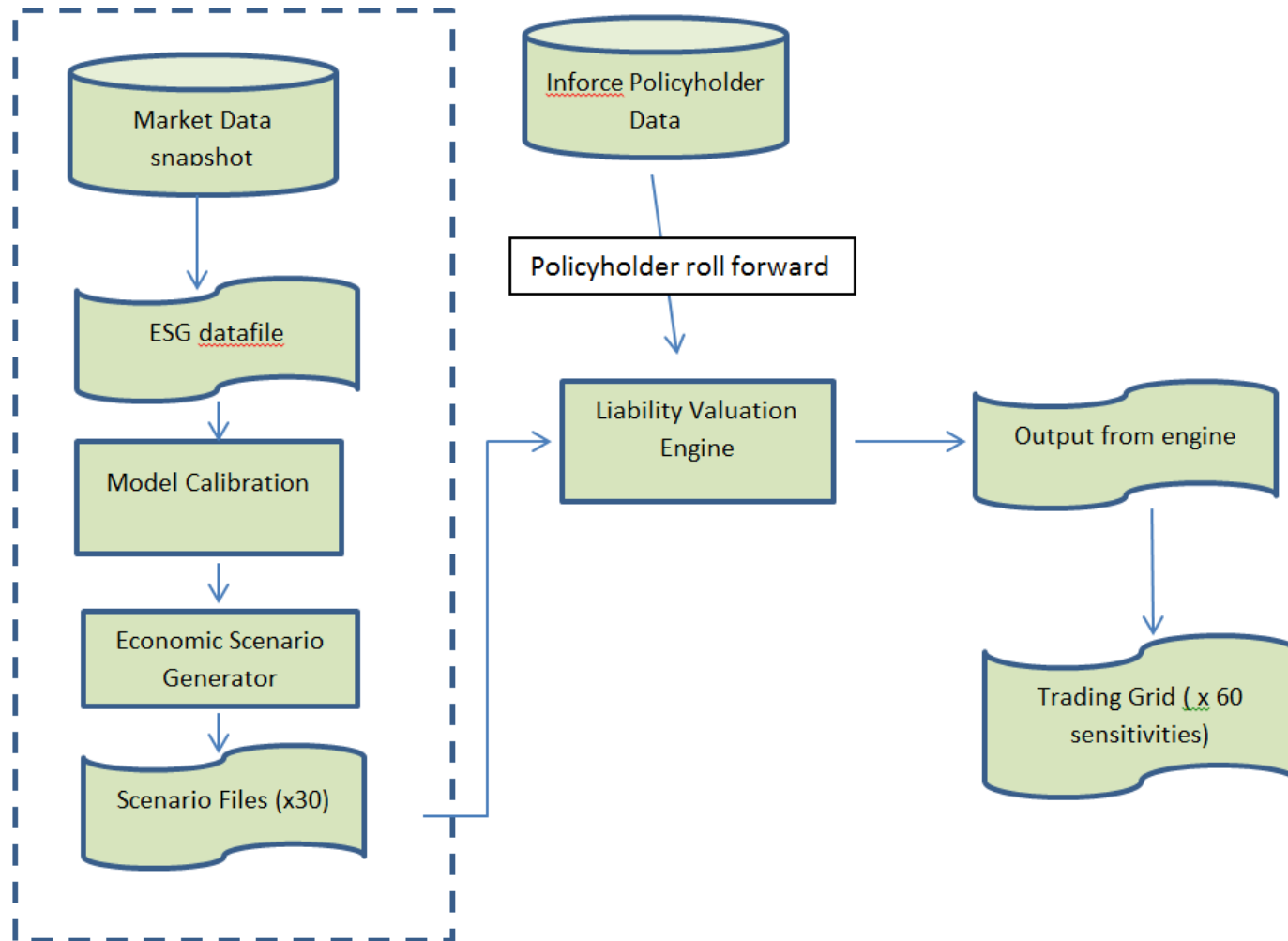
$$dr = a \left( \frac{\theta(t)}{a} - r(t) \right) dt + \sigma dz$$

Equity model – Log-normal equity model using associated index correlations, Heston model, etc

Currency model – Interest rate parity model

“Essentially all models are wrong, but some are useful” George E.P. Box

# Trading Grid generation process



## Run time of the liability valuation

Example of the amount of projections required:

Trading grid: 50 year projection \* 30k (policies) \* 5k (scenarios) \* 60 times (sensitivities) = 6 bln projections

Variance reduction techniques: Sampling antithetic pairs of scenarios, control variates.

Convergence test- demonstration to CBI

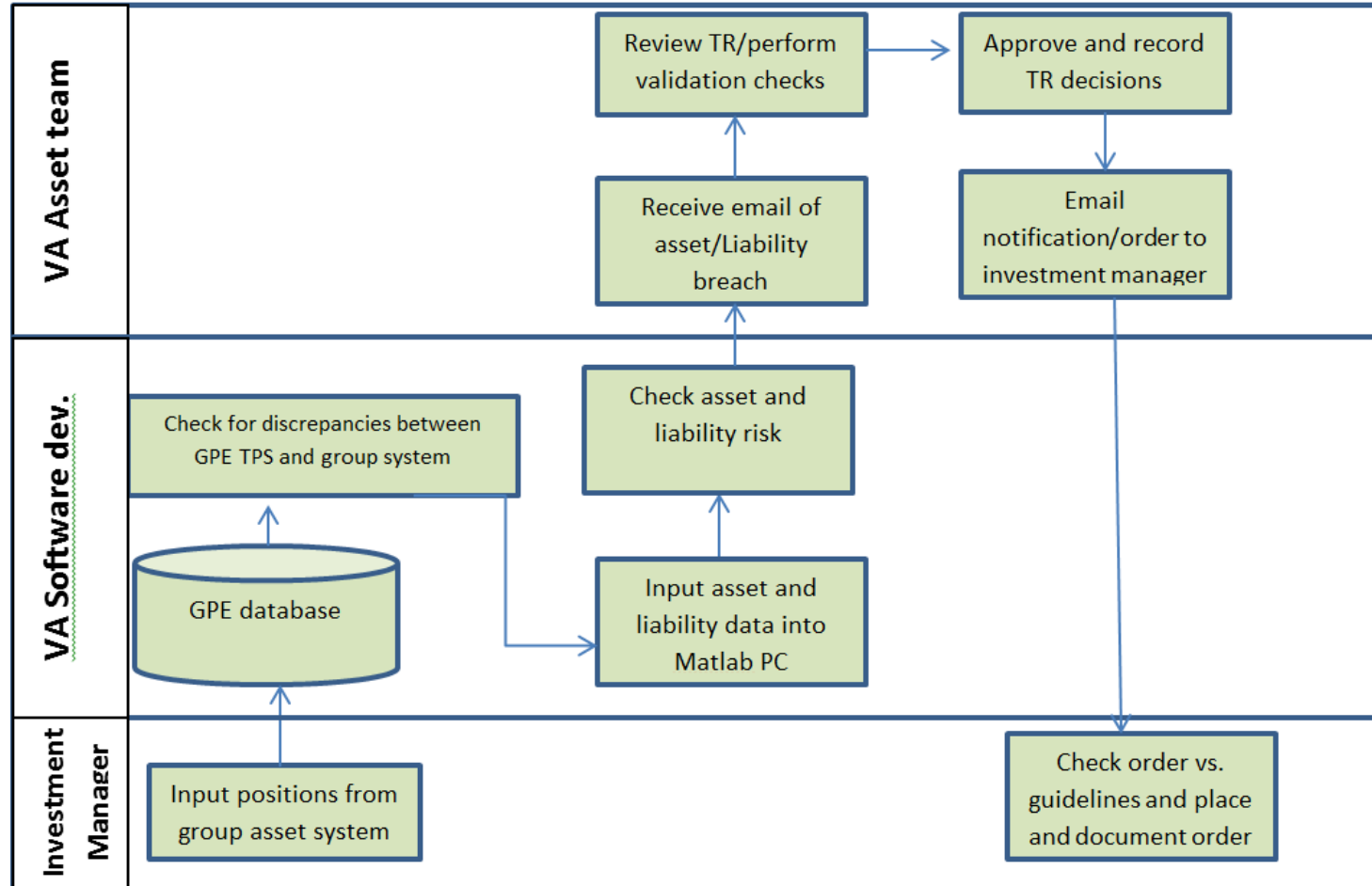
What infrastructure to use?

- Grid of High Performance Computers (HPC) or cloud (eg Microsoft Azure)
- Cluster of high spec servers optimised to run using the liability software
- Head node will farm out the calculations to the other worker nodes

## Asset and Trade Positioning System (TPS)

- Similar considerations for purchasing an asset pricing system e.g. Build in-house or off-the-shelf offering e.g. Numerix, Algorithmics, etc.
- GPE chose the former route in this case.
- Code developed in a robust versioning framework was used to value the assets using appropriate models developed by the quants on the team.
- Bloomberg used as a source of market data – market snapshots downloaded using API tools on a daily and intraday basis into our database
- Design of database is important as performance is an issue here – the intraday comparison of asset and liability greeks will be done every 15-20 minutes.
- Pricing validated during the period of mock-hedging which preceded the go-live of the project

## Asset and Trade Positioning System (TPS) – diagrammatic view





## Performance Attribution Report

- The PA report is a statement for a given period showing the profit/loss arising on the hedge portfolio, as well as a detailed analysis of sources explaining this profit.
- It is used to monitor the hedge effectiveness of the program in place
- The following are the main sources of risk that are explicitly captured in the PA report:
  - Hedged risks including
    - Equity/Bond/Currency delta
    - IR risk
    - IR volatility risk
    - Cross effects
  - Un-hedged capital market risks
    - Theta
    - Fund mapping
    - Equity vega
  - Actuarial risks
    - Mortality
    - Lapse
  - Transfer items
    - Swap coupons
    - Closing out of futures/forwards positions

## Performance Attribution Report

- On the liability side the PA is run on a nightly basis following generation of the trading grid.
- The overnight movements in risk factors will be calculated.
- The LOV will then be recalculated by shocking each risk factor individually and thus evaluating the change in LOV due to this factor in isolation.
- Various cross effects can be calculated
- Actuarial factors will update when we receive a new policy file.
- Cash impacted should be matched back to bank account.
- The base and end valuations should tie up with the relevant days trading grid.
- Basis risk can be tricky to calculate

# Sample Performance Attribution Report

**Performance Attribution / GPE Live Portfolio (currency: EUR)**
**Reporting Period from 30/09/2014 To 31/10/2014**

	Total Guarantee Liability		Hedge Assets				Shareholder Equity	
	Base	cash/Loan	Futures	Swaps	Swaptions	Total Hedge Assets	Equity	
<b>Begin Value</b>	1,200,000	40,000	10,000	-100,000	2,000,000	1,950,000	750,000	
<b>Capital Markets Impact</b>								
<b>Capital Markets Impact (Hedged)</b>								
<b>EQUITY RISK</b>								
<b>DJ Eurostoxx Risk</b>								
Delta	10,000		7,500			7,500	-2,500	
Spot / Futures Price Basis and Trades			1,500			1,500	1,500	
DJ Eurostoxx Risk Impact	10,000		9,000			9,000	-1,000	
<b>BOND FUND RISK</b>								
<b>EUR Bond Fund Risk</b>								
Delta	12,000		10,200			10,200	-1,800	
Gamma / Cross Gamma and Trades	0		-600			-600	-600	
EUR Bond Fund Risk Impact	12,000		9,600			9,600	-2,400	
<b>INTEREST RATE RISK</b>								
Impact of Rho	30,000			-2,000	26,000	24,000	-6,000	
Impact of Gamma Risk & Impact of Term Structure Risk	2,000			-200	1,000	800	-1,200	
<b>TOTAL INTEREST RATE RISK</b>	<b>32,000</b>			<b>-2,200</b>	<b>27,000</b>	<b>24,800</b>	<b>-7,200</b>	
<b>INTEREST RATE VEGA RISK</b>								
Swaption Volatility Surface	-5,000				-4,800	-4,800	200	
<b>Capital Markets Impact (UnHedged)</b>								
<b>EQUITY VEGA RISK</b>								
DJ Eurostoxx	-20,000						20,000	
<b>TIME IMPACT</b>								
Theta	-3,000			-200	-2,800	-3,000	0	
<b>FUND MAPPING BASIS RISK</b>								
Basis risk	600						-600	
<b>Total Capital Market Risk</b>	<b>26,600</b>		<b>18,600</b>	<b>-2,400</b>	<b>19,400</b>	<b>35,600</b>	<b>9,000</b>	
<b>Actuarial Impact</b>								
Actual mortality & lapse impact	-5,000						5,000	
Impact of new business - existing business	10,000						-10,000	
Hedge Cost : Actual (IF Cashflow Received)		2,000				2,000	2,000	
New policyholders	1,000						-1,000	
<b>TOTAL ACTUARIAL IMPACT</b>	<b>6,000</b>	<b>2,000</b>				<b>2,000</b>	<b>-4,000</b>	
<b>Additional P&amp;L Items</b>								
Model Changes	0				0.0	0.0	0.0	
<b>Transfers</b>								
Swap Coupon Payments		-7,000		7,000		0	0	
<b>End Value</b>	<b>1,232,600</b>	<b>35,000</b>	<b>28,600</b>	<b>-95,400</b>	<b>2,019,400</b>	<b>1,987,600</b>	<b>755,000</b>	
<b>Net Change</b>	<b>32,600</b>	<b>-5,000</b>	<b>18,600</b>	<b>4,600</b>	<b>19,400</b>	<b>37,600</b>	<b>5,000</b>	

# Team structure

