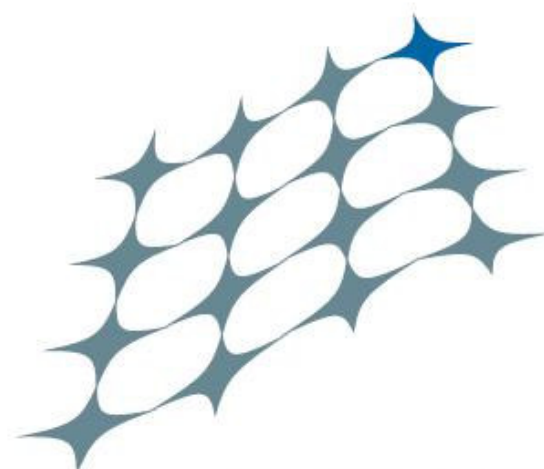




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**VALUATION OF VARIABLE ANNUITIES  
USING GRID COMPUTING  
AXA LIFE EUROPE HEDGING SERVICES  
(ALEHS)  
05/06/2008**

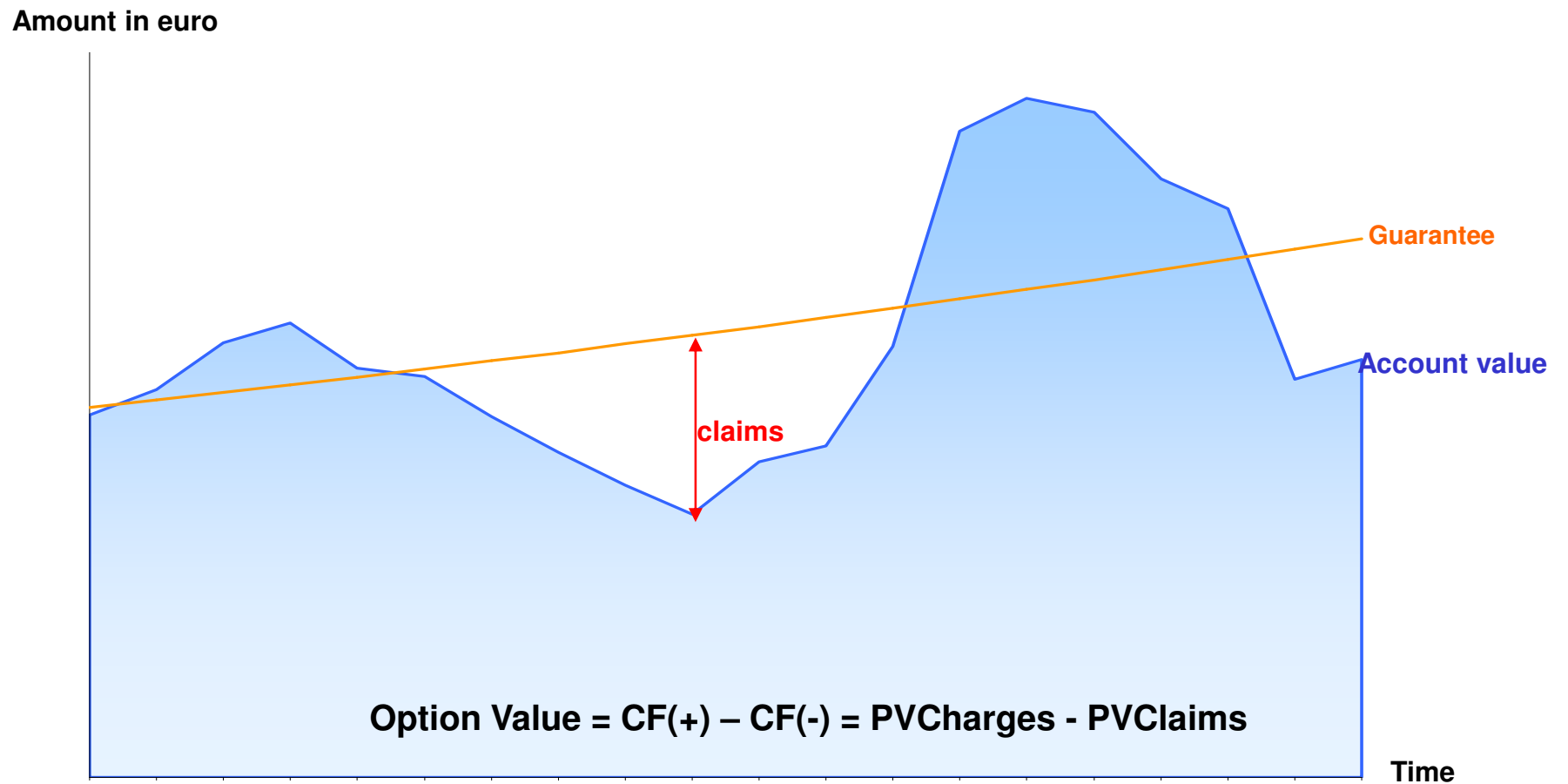
# Structure

- **Variable annuities**
- **ALEHS liability valuation software (MoSes. Tower Perrin)**
- **The run time issue**
- **AXA grid server solution**
- **Conclusion**

# Variable annuities

- **Life insurance product providing futur payment (ex : retirement)**
- **Exposed to the market stock risk**
- **Bring guarantees to the policy holder**
- **Difficult to value and hedge**
  - **Financial risk**
  - **Actuarial risk**

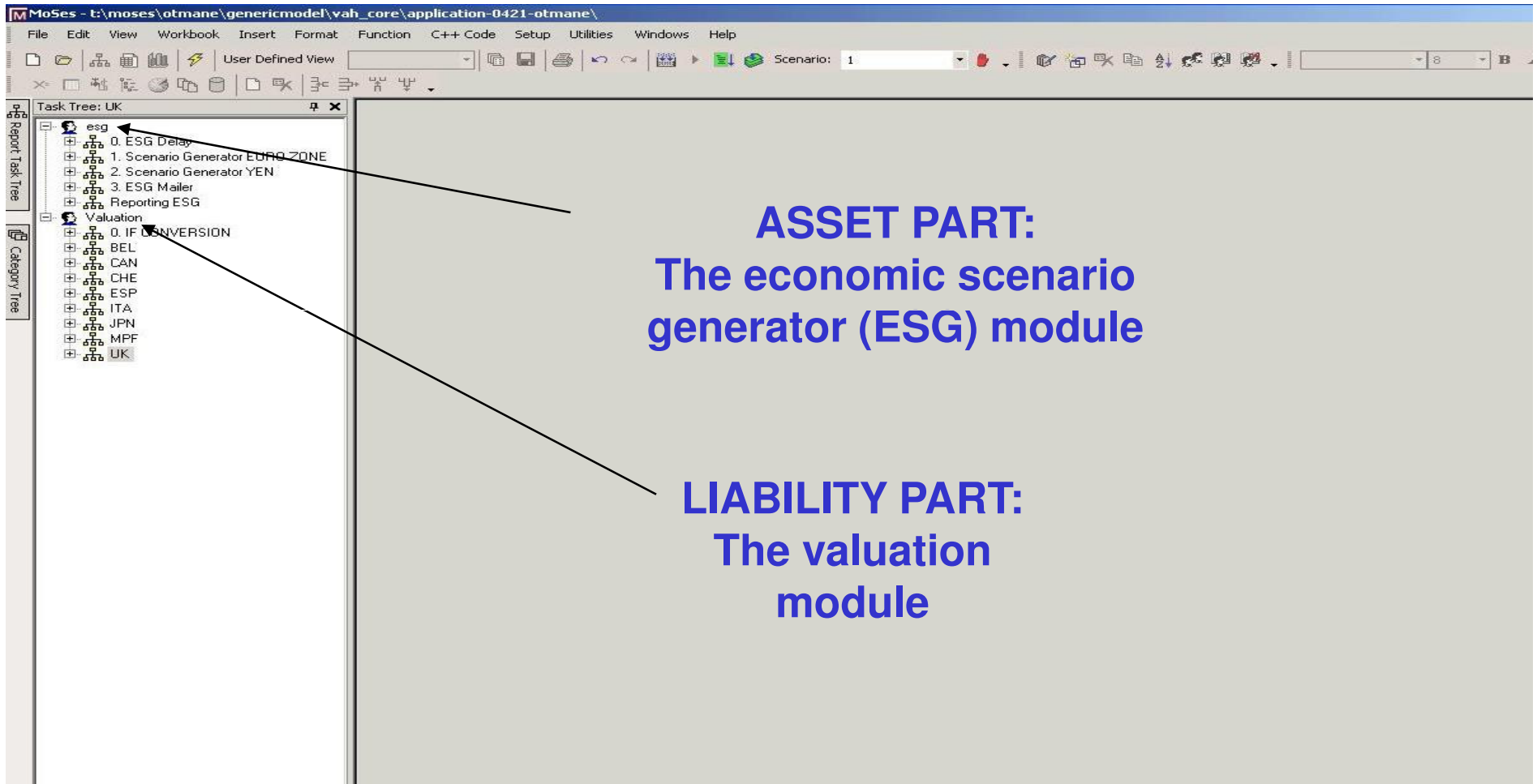
- Valuation of the variable annuities



## ALEHS liability valuation software (MoSes)

- **The Moses structure**
- **The asset part (The economic scenario generator)**
- **The liability valuation part**
- **Standalone vs Grid mode**

- The MoSes structure



The screenshot shows the MoSes software interface. The main window displays a task tree for the UK. The tree is organized into two main sections: 'esg' and 'Valuation'. The 'esg' section includes tasks such as '0. ESG Delay', '1. Scenario Generator EURO\_ZONE', '2. Scenario Generator YEN', '3. ESG Mailer', and 'Reporting ESG'. The 'Valuation' section includes '0. IF CONVERSION' and a list of countries: 'BEL', 'CAN', 'CHE', 'ESP', 'ITA', 'JPN', 'MPF', and 'UK'. Two blue arrows point from the 'esg' section to the text 'ASSET PART: The economic scenario generator (ESG) module'. Another blue arrow points from the 'Valuation' section to the text 'LIABILITY PART: The valuation module'.

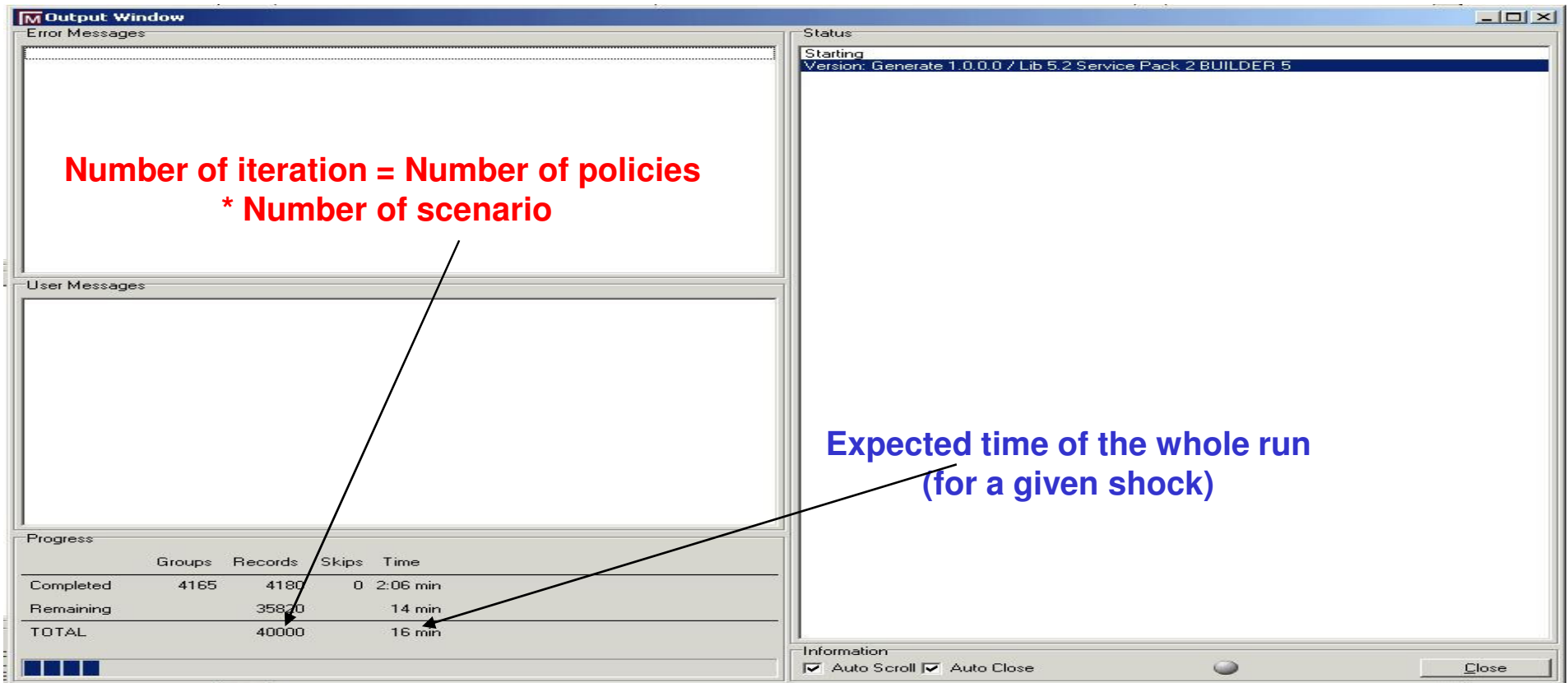
**ASSET PART:**  
The economic scenario generator (ESG) module

**LIABILITY PART:**  
The valuation module

## ALEHS liability valuation software (MoSes)

- **The asset part**
  - Projection of Equity returns, rates ... for Monte Carlo Simulation
- **The liability valuation part**
  - Customization per product/country
    - Product feature (GMxB configuration)
    - Actuarial assumption (Mortality, Lapse configuration)
    - Policies
    - Run settings (scenario, policies, shock configuration)

- **The Standalone mode**

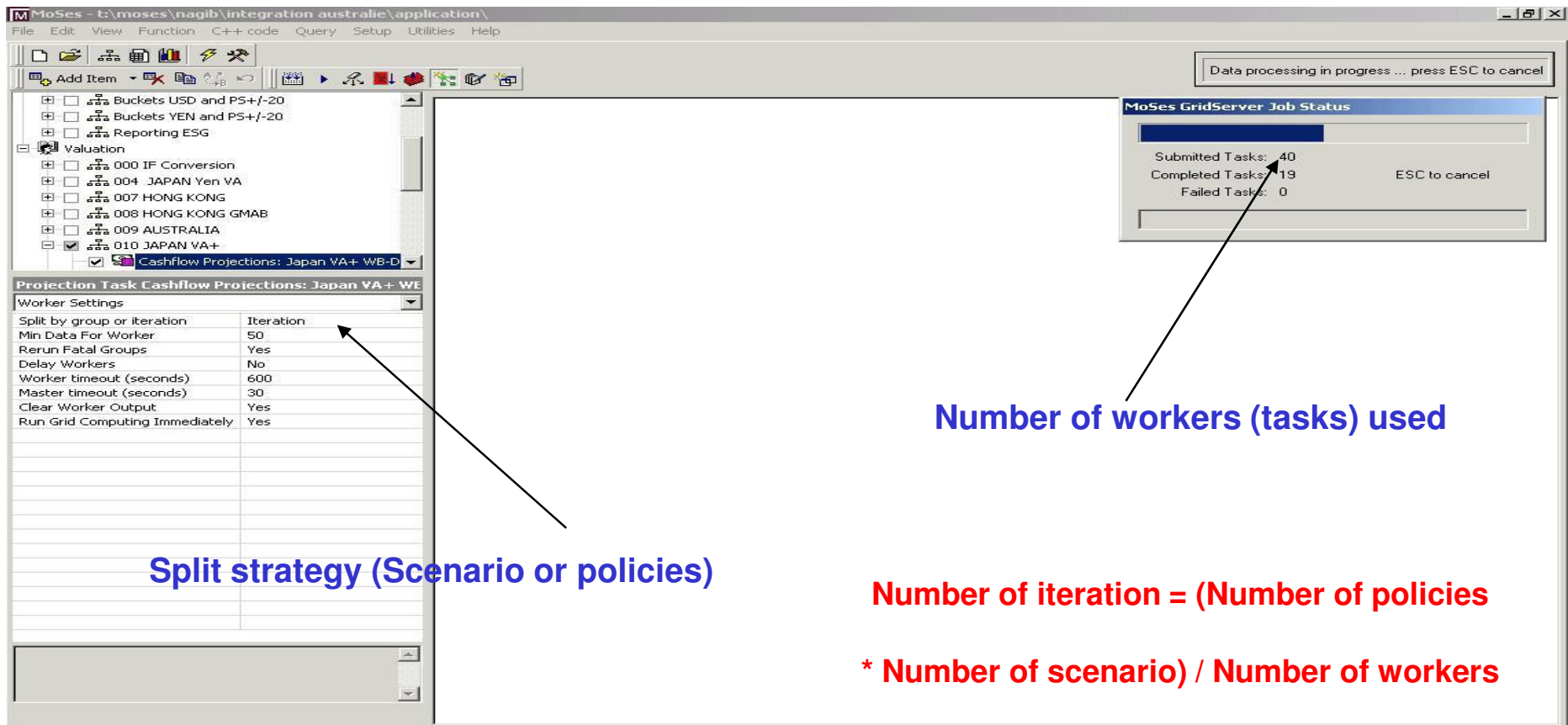


**Number of iteration = Number of policies  
\* Number of scenario**

**Expected time of the whole run  
(for a given shock)**

	Groups	Records	Skips	Time
Completed	4165	4180	0	2:06 min
Remaining		35820		14 min
<b>TOTAL</b>		<b>40000</b>		<b>16 min</b>

- The Master/Worker mode



The screenshot shows the MoSes application window. On the left, a tree view lists various tasks under 'Valuation', including '000 IF Conversion', '004 JAPAN Yen VA', '007 HONG KONG', '008 HONG KONG GMAB', '009 AUSTRALIA', and '010 JAPAN VA+'. Below this is a 'Worker Settings' table. On the right, a 'MoSes GridServer Job Status' window displays task statistics.

Projection Task Cashflow Projections: Japan VA+ WE	
Worker Settings	
Split by group or iteration	Iteration
Min Data For Worker	50
Rerun Fatal Groups	Yes
Delay Workers	No
Worker timeout (seconds)	600
Master timeout (seconds)	30
Clear Worker Output	Yes
Run Grid Computing Immediately	Yes

**MoSes GridServer Job Status**

Data processing in progress ... press ESC to cancel

Submitted Tasks: 40  
Completed Tasks: 19  
Failed Tasks: 0

ESC to cancel

**Split strategy (Scenario or policies)** (points to the 'Split by group or iteration' setting in the table)

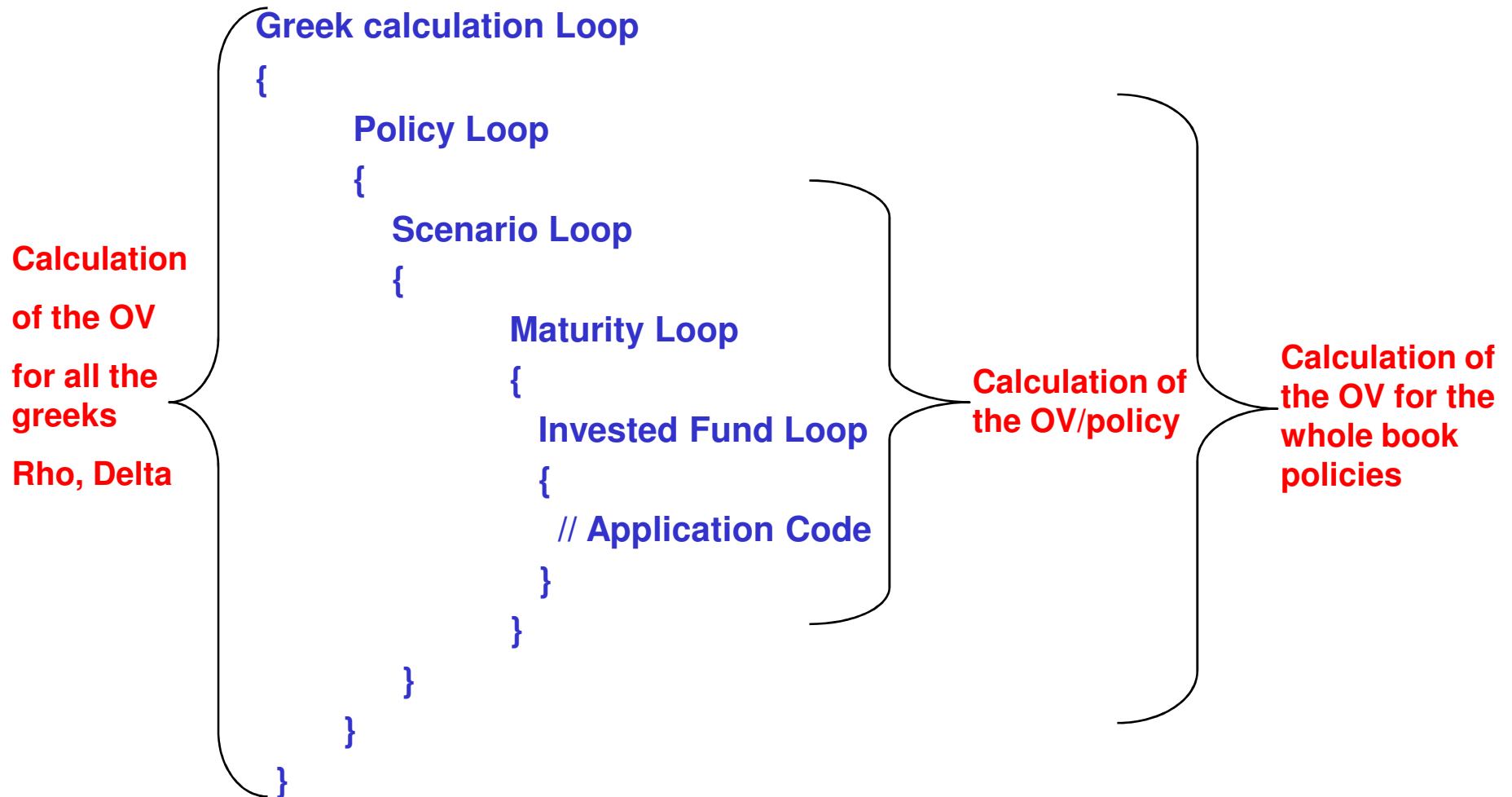
**Number of workers (tasks) used** (points to the 'Submitted Tasks' value in the job status window)

**Number of iteration = (Number of policies \* Number of scenario) / Number of workers**

# The run time issue

- **The main parameters impacting the run time**
  - The number of policies in the contract
  - The maturity of each contract
  - The number of invested funds
  - The number of scenario for the Monte Carlo simulation
  - The number of “shocks” for greek calculations

# The run time issue

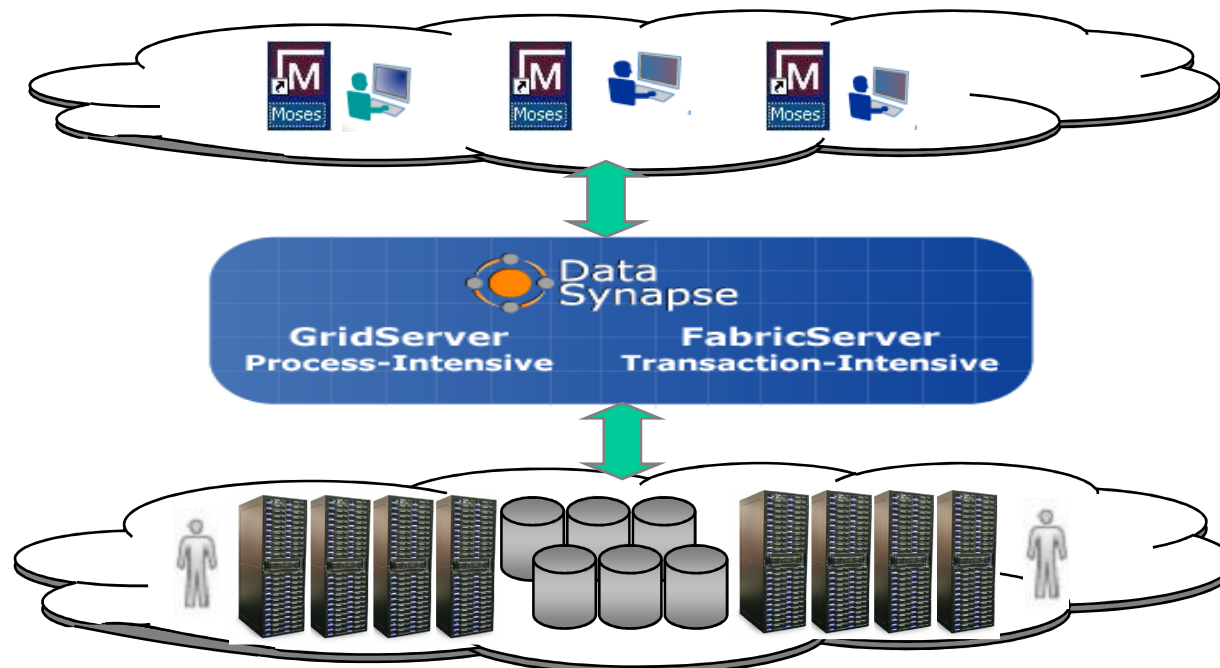


# The run time issue

- **ALEHS strategies to reduce the runtime**
    - Reduce the I/O access during the projection
    - Compression of the number of policies
    - Variance reduction strategy (Monte Carlo)
- => Must rely on a powerful grid computing technology**

# AXA grid server solution

- **ALEHS uses DataSynapse GridServer technology to parallelize a MoSes program**



**AXA Grid Infrastructure (129 servers)**

## AXA grid server solution

- **2 strategies to dispatch one MoSes program in the grid**
  - Dispatching by scenario (Number worker = Number scenario / range of scenario per worker)
  - Dispatching by policies (Number worker = Number of policies / range of policies per worker)
- **Execution time # (Standalone execution time) / Number of workers**

# Conclusion

- **Variable annuities' hedging using Monte Carlo simulation is highly time and IT consuming**
- **Algorithmic and Numerical methods can help reducing the run time but ...**

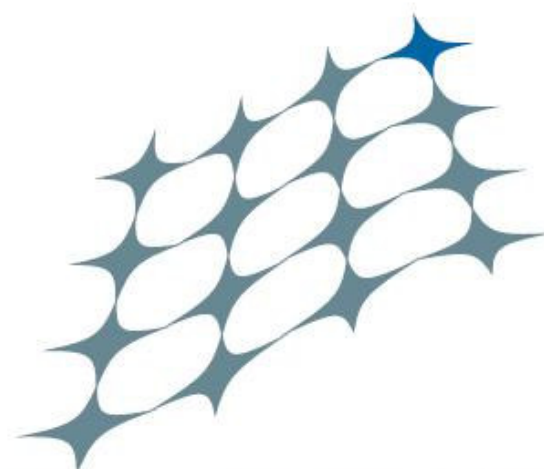
**=> A large grid infrastructure as well as a powerful grid computing middleware is necessary to price these products on a daily basis.**



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**THANK YOU**