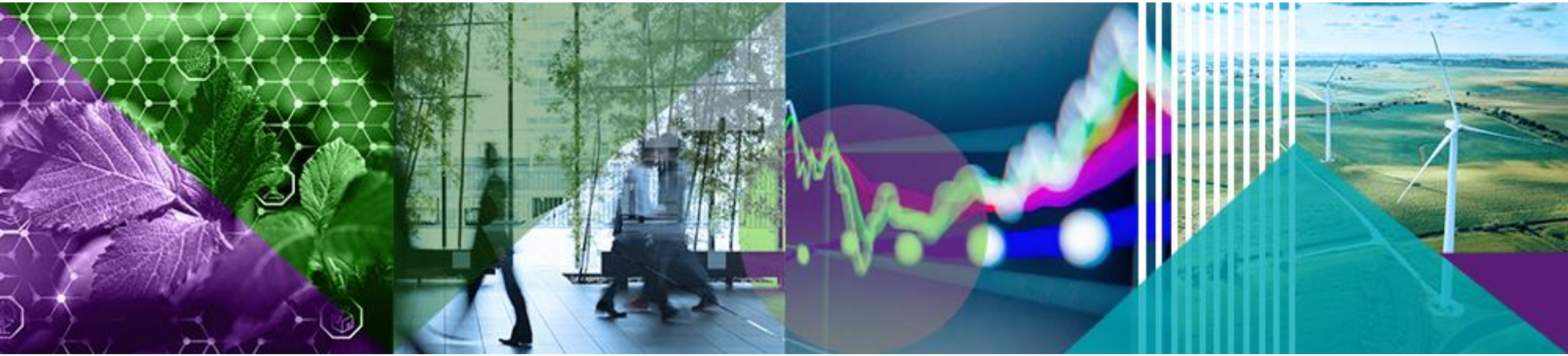
GROUPE BPCE

GLOBAL FINANCIAL SERVICES



Global Financial Services

X-HEC/Natixis Data Challenge – Kick off

January 04th 2023

NATIXIS INVESTMENT MANAGERS | NATIXIS CORPORATE AND INVESTMENT BANKING

X-HEC Data Challenge
Kick off - Agenda

15:00-15:15	Groupe BPCE & Global Financial Services **Corporate presentation**
15:15-15:45	Use Case n°1 : IT Porto **Optimization of IT Infrastructure Consumption**
15:45-16:15	Use Case n°2 : Entreprise Risk Management **Derivatives Deep Hedging**
16:15-16:25	**Questions & Answers**
16:25-16:30	**Conclusion**

01

Global Financial Services

Global Financial Services

At the heart of Groupe BPCE

GROUPE BPCE

Retail Banking and Related Business Lines

- Banking & financial services
- Advisory services & specialized financing
- Insurance
- Digital & Payment solutions

BANQUE POPULAIRE

CAISSE D'EPARGNE

BANQUE PALATINE

oney

Global Financial Services

- Asset & Wealth Management
- Corporate & Investment Banking

NATIXIS INVESTMENT MANAGERS

NATIXIS CORPORATE AND INVESTMENT BANKING

+ a large brand portfolio
(eg. Natixis Wealth Management, Natixis Interépargne)

Global Financial Services

A strong brand portfolio – selected examples

Asset & Wealth Management

Corporate & Investment Banking

Global Financial Services

A global presence

~ 12,500 employees across **35 countries**

AMERICAS
~ 2,700 staff

APAC
~ 800 staff

EMEA
~ 8,900 staff
including ~ 6,800 in France

Global Financial Services

Key figures in 2021*

~ €7.5bn

2021 net revenues with a balanced contribution between GFS' two businesses

+ 27%

Increase in revenues in 2021 vs. 2020

€2.3bn

Gross operating income generated in 2021

~ 30%

GFS' contribution to Groupe BPCE's NBI in 2021

In 2021, robust commercial activity, buoyed by an upbeat market environment

Global Financial Services businesses draw on Groupe BPCE's solid financial ratings:

STANDARD &POOR'S	A
Moody's	A1
FitchRatings	A+
R&I Rating and Investment Information, Inc.	A+

* Data before integration of the effects of the Pléiade project

Global Financial Services

Common drivers and business ambitions

Three common drivers for 2024

- **#diversify** for the benefit of our **clients** and **development**
- **#commit** to the **energy transition** and to **responsible finance**
- **#transform** to **deliver sustainable value**

NATIXIS
INVESTMENT MANAGERS

Reinforce Natixis Investment Managers' position as a global leader in asset management

NATIXIS
CORPORATE AND
INVESTMENT BANKING

Become the go-to bank for our clients in selected and diversified areas of expertise

Global Financial Services

A strong corporate culture

entrepreneurial mindset | **collective intelligence** | **sustainable impact**

All our teams at Global Financial Services share the same mindset and common singularities, across our businesses:

They think and act as entrepreneurs, constantly pursuing client satisfaction with a view to meeting their expectations and offering them strong growth prospects.

They are convinced that **collective intelligence** is the key to unlocking their full potential.

They are rooted in the real world and are determined to have **a sustainable impact**.

02

IT Porto

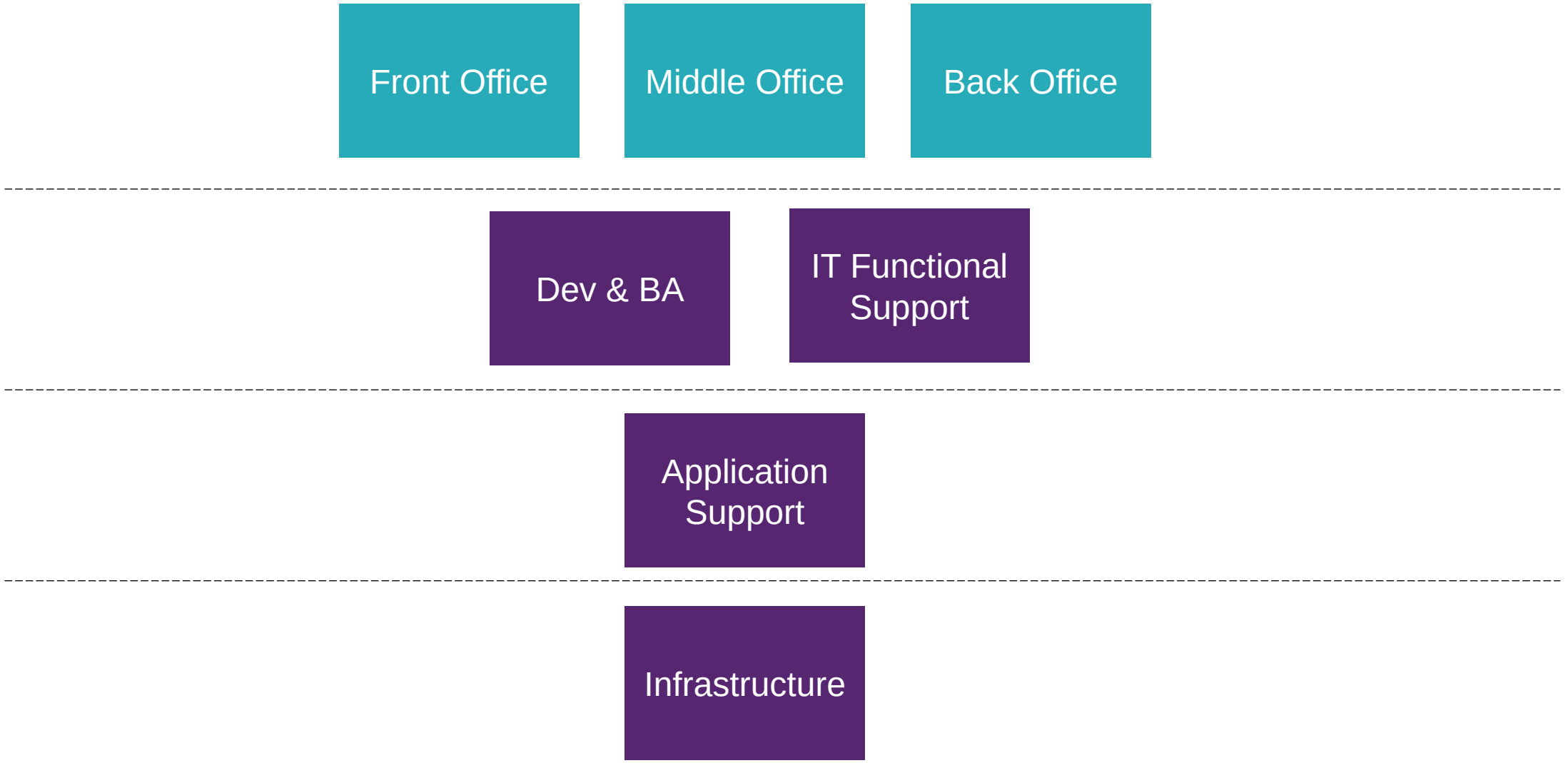
Optimization of IT Infrastructure Consumption

IT Porto Division

AM & CIB Application Support team

IT Porto Division

Simplified Bank organization between Businesses and IT



IT Porto Division

Application Support missions

Change Management	*Production of new versions of applications and any change on infrastructure part.*
Backup Data	*Manage backup data and ensure regular restoring test*
Life Cycle Management	*Carry out the commissioning of the new versions of applications in collaboration with the development and technical teams*
Monitoring Application	*Monitoring application and infrastructure with efficient alerting system to guarantee SLA with business line*
Treatment Scheduling	*Management of treatment scheduling*
Load Capacity	*Control load capacity for application and adapt infrastructure resource by more allocation or redesigning architecture*
Incidents Resolution	*Participate in the resolution of production incidents and contribute in problem management*
DRP	*Guarantee DRP (Disaster Recovery Plan) : twice test a year to ensure different scenario (like Datacenter lost, server or network failure …)*
Security	*Fix vulnerabilities and keep the servers monitored by Qualys*
DevOps	*Adjustment of current applications to the DevOps process*

IT Porto Division

CIB & AM Application Support Teams Organization

- User support
- Databases
- Global Markets
- Financing
- Global Trade
- Asset Management

Use Case

Optimization of IT Infrastructure Consumption

Data Challenge Use Case

Optimization of IT Infrastructure Consumption - Tool

Infrastructure Optimization Control (or IOC) tool created in 2021 acquires and displays servers' data on CPU and RAM

Data stored

- **Servers' features acquired from a referential called Cockpit (core, RAM size, date, environment, etc)**
- **Data related to servers is historized from a monitoring tool called Zabbix into IOC database. It stores min, max, avg of the aggregated day**
- **First historization made on May 27th, 2021**

Display

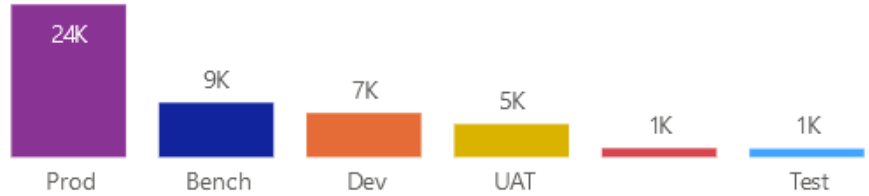
- **Power BI**
- **Able to get multiple filtering (department, application, OS, date etc)**

Department: All
Application: All
Function: All
SubFunction: All
Server: All
Site: All
IUA: All
Model Type: All

Os type: Linux | Other | Solaris | Windows
Work Days: False
MyCloud: No | Yes

46,104	48024	2544
#Hosts	#Servers	#AppsUsi...

Last 1 Months
11/15/2022 - 12/14/2022
11/15/2022 12/14/2022



CPU Avg usage in time

IUA	Department	Function	SubFunction	Application	host	Avg	Min	Max	#Hosts	#Core	#Cpu	#Ram (Gb)	#Age
BPN	prd-garanties-caution	APPLICATION	Application Server	ZEPHYR-CEGC	SWUCFRBPN258	81.18%	68.82%	96.24%	1	2	2	4	440
ZCB	prd-sdm-fit-transverse	APPLICATION	Application Server	ZcBump	SWBCFRNXZCB4404	55.96%	31.18%	67.18%	1	2	2	8	195
ZCB	prd-sdm-fit-transverse	APPLICATION	Application Server	ZcBump	SWPCFRNXZCB4484	82.31%	65.16%	96.67%	1	2	2	4	85
ZCB	prd-sdm-fit-transverse	APPLICATION	Application Server	ZcBump	SWPCFRNXZCB9330	74.16%	21.04%	96.36%	1	2	2	4	84
ZCB	prd-sdm-fit-transverse	APPLICATION	Application Server	ZcBump	SWPCFRNXZCB9808	61.64%	19.77%	89.03%	1	2	2	4	84
DH4	prd-metrologie-instru	ADMIN SERVER	Application Server	Zabbix	slpifrzxsgri1	11.81%	1.69%	30.81%	1	12	2	31	3439
DH4	prd-metrologie-instru	ADMIN SERVER	Application Server	Zabbix	slqzxs01	98.72%	98.13%	99.49%	1	24	4	191	7954
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Proxy	Zabbix	slpifrzabxd01	23.61%	22.98%	24.22%	1	16	2	127	1115
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Proxy	Zabbix	slpifrzabxp01	79.27%	76.50%	83.20%	1	16	2	31	2086
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxd01	12.43%	2.98%	22.58%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxd02	21.22%	18.70%	22.84%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxl01	21.55%	2.67%	51.95%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxl02	18.57%	14.64%	19.60%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxp01	24.48%	2.63%	27.67%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxp02	17.38%	15.13%	19.23%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxp03	13.25%	6.12%	17.95%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slbifrzabxs02	16.78%	15.87%	17.72%	1	16	2	63	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	sldzxdev01	55.00%	48.04%	74.66%	1	2	2	15	3493
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slpifrzabxd02	7.68%	2.87%	8.93%	1	16	2	127	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slpifrzabxd03	11.19%	8.71%	12.33%	1	16	2	127	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slpifrzabxd04	8.68%	8.06%	9.48%	1	16	2	127	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slpifrzabxe01	18.26%	3.99%	23.76%	1	16	2	127	1119
DH4	prd-metrologie-instru	ADMIN SERVER	Supervision Server	Zabbix	slpifrzabxe02	9.72%	2.81%	11.37%	1	16	2	127	1112

server	type	model	baie	cpu	#Ram (Gb)	#Cpu	#Core
SLBCFRGCN723	VIRTUAL MACHINE	VIRTUAL_MACHINE	VEG.13_AN38	INTEL(R) XEON(R) GOLD 5120 CPU @ 2.20GHZ:X86_64	32	12	12

1 #Servers

1 #Hosts

1 #Apps

OS type

Linux

Environment: All

Department: All

Application: All

Host: SLBCFRGCN723

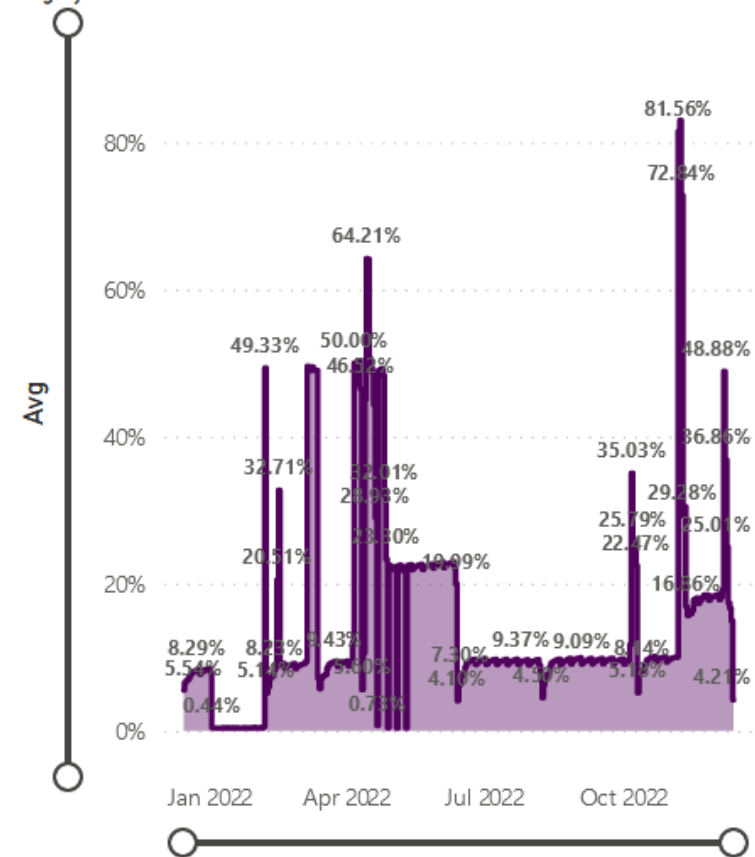
Avg: -2,733.30 — 47,728,275,456.00

Date: Last 1 Years

Date: 12/15/2021 — 12/14/202

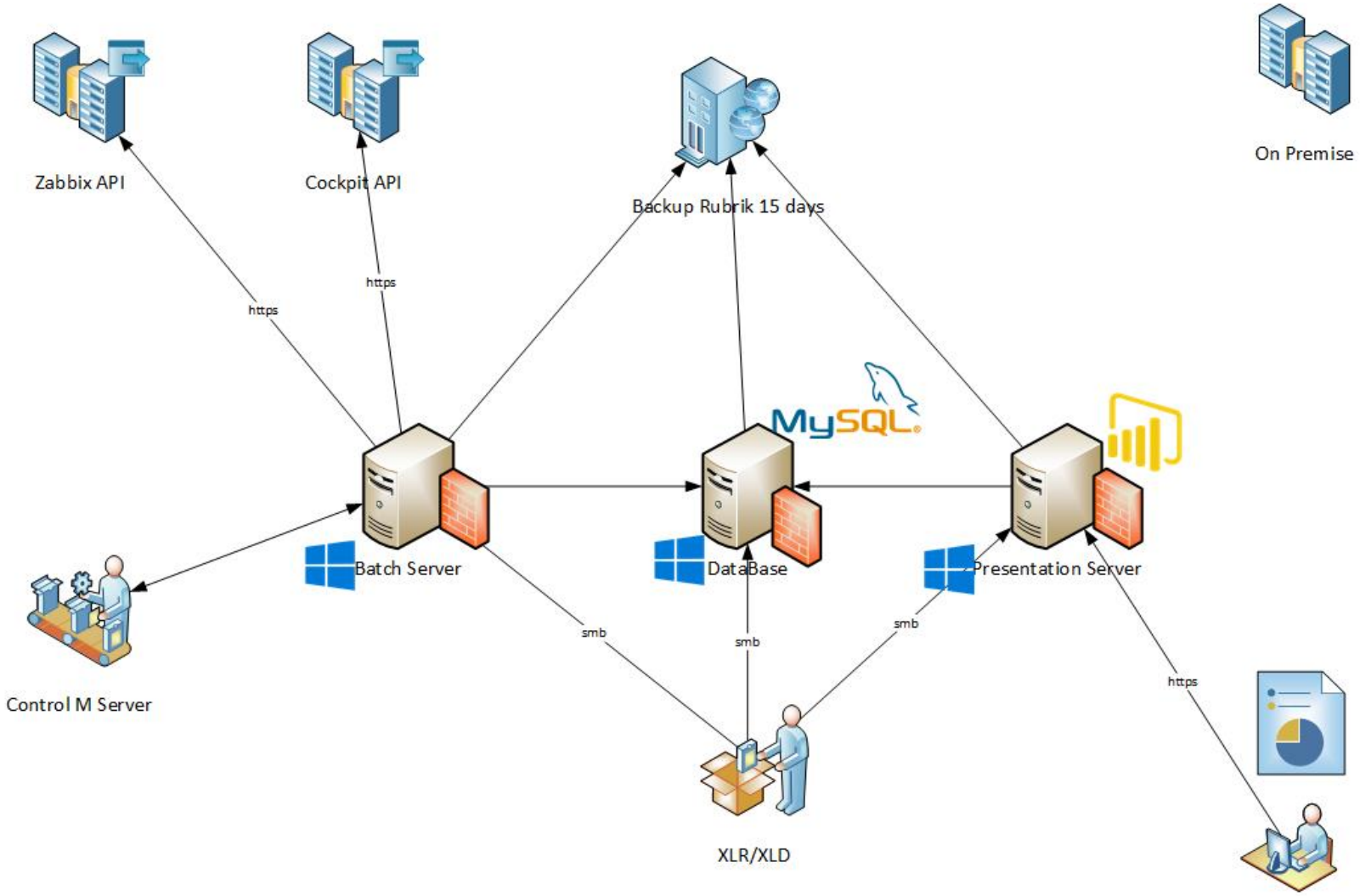
Country	Env	Department	Application	Server	#AppsUsing	Avg	electrical_power	#Servers
FRANCE	Bench	prd-nam	Moneyball	SLBCFRGCN723	1	15.17%		1
Total					**1**	**15.17%**		**1**

Avg by Date



Data Challenge Use Case

Optimization of IT Infrastructure Consumption - Architecture



Data Challenge Use Case

Optimization of IT Infrastructure Consumption – Data acquired until now

Data

- BPCE and Natixis servers
- 48 000 servers
- 32 millions lines of data (CPU and RAM)

Use case data scope

- Teams involved: CIB and Asset Management application support across 12 teams
- More than 5000 virtual servers
- 3,8 millions lines of data

Data Challenge Use Case

Optimization of IT Infrastructure Consumption

Use case synthesis

As the Application Support department for CIB and Asset Management, part of our mission is to adapt our infrastructure resources and identify idle servers or on the opposite undersized ones. In the first case, it would enable to create savings and be greener ; in the second case, it would help to improve the performance of our processes.
After more than one and a half year of data acquisition, it is now time to be able to spot virtual servers which need to be modified by implementing some optimization models. We ask you to help us study and find models which would allow to get the list of servers to be optimized (today we can only observe raw data in the tool). Those would be therefore integrated later in the IOC tool for decision making purposes.

Guidelines

1. **Preliminary thoughts:** Review the data tables to try to understand how the servers are linked with the consumption, price and configuration.
2. **Quantitative analysis:** Use the data at your disposal to
    - Identify servers being idle on CPU or consuming low RAM quantity
    - Identify servers being undersized on CPU or consuming high RAM quantity
    - Detect patterns to see if some servers show unusual activity and need to be either increased or decreased
3. **Qualitative interpretations:** Interpret your results to offer a list of servers to be optimized according to the right configuration, as well as a list of servers presenting unusual behaviors. Raise any data inconsistency if you find some (missing data, incoherency etc.).

Expected business value

Impact

- Able to decrease cost and be greener on oversized servers
- Improve the undersized servers' performance

KPI

- Model(s) to identify servers to be increased/decreased
- Target configuration & cost associated
- 1 Pattern model with unusual behavior

Data Challenge Use Case

Optimization of IT Infrastructure Consumption

1. **A high-level understanding** of the data and the Application Support teams constraints (ex: primary and backup servers, disaster recovery plan)
   - Expected deliverables: Being able to map the data between tables available and gather Application Support teams prerequisites
   - Data source: Cockpit, Zabbix tables

2. **Drill down analysis** getting the appropriate criteria and define methodologies you will use (formula, algorithm, artificial intelligence etc)
   - Expected deliverables: Find and define criteria to modify the servers configuration (trigger levels, period)
   - Data source: Cockpit, Zabbix tables

3. **Recommendation proposals:** provide a list of what needs to be modified, how, as well as cost decrease/increase.
   - Expected deliverables: Recommendation of target configuration (numbers of cores, RAM size) and its associated costs
   - Data source: Cockpit, Zabbix, MyCloud tables

4. **Methodology:** detail the methodology of the above so that it can be replicated and implemented as a working tool for Natixis' Application Support teams and provide ideas for future areas to be developed
   - Expected deliverables: Detailed overview of methodology and tools used. The models will have to be able to adapt to changing configurations table (MyCloud table)
   - Data source: No specific additional data source

Data Challenge Use Case

Data Overview

INTERNAL SOURCES (NATIXIS)

- **Perimeter:** AM and CIB servers handled by 12 Application Support teams
- **Servers:** virtual servers as they are easy to decrease/increase. X servers
- **Data servers**: 3,8 million rows representing 1,5 years of data from referential and monitoring sources (Cockpit, Zabbix, MyCloud)

03

Entreprise Risk Management

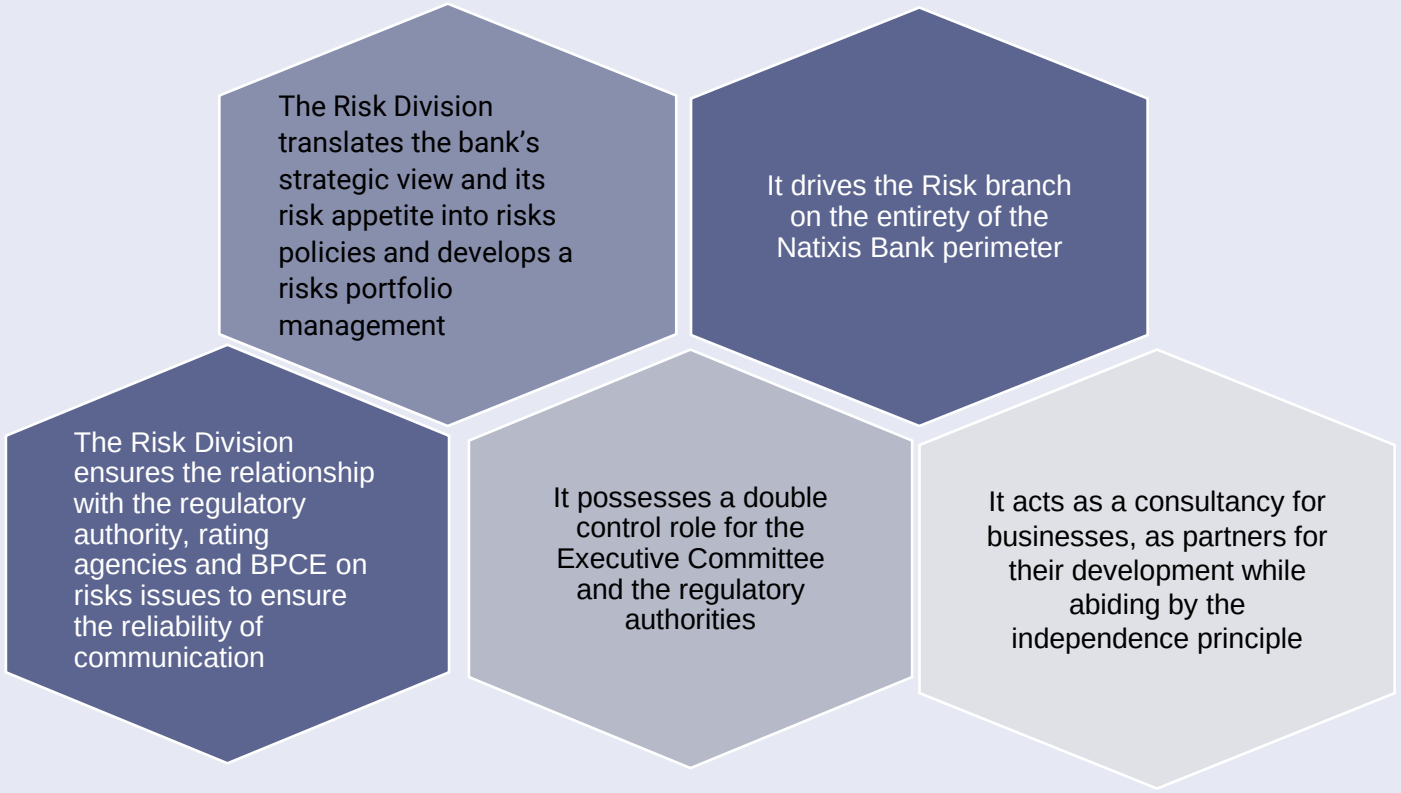
Derivatives Deep Hedging

Risk Supervision Division

Enterprise Risk Management

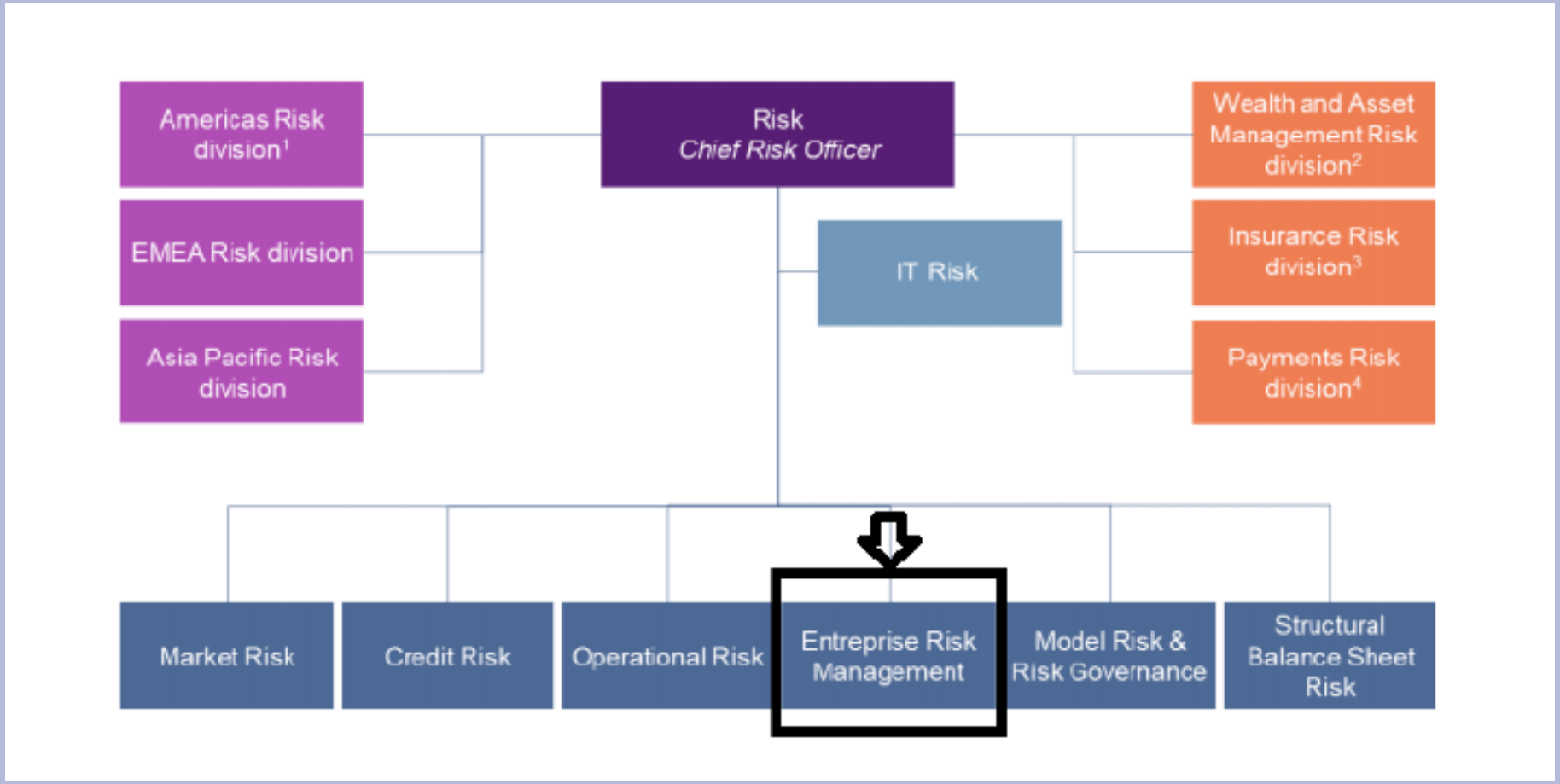
Risk Supervision Division

Missions of Risk Supervision Division

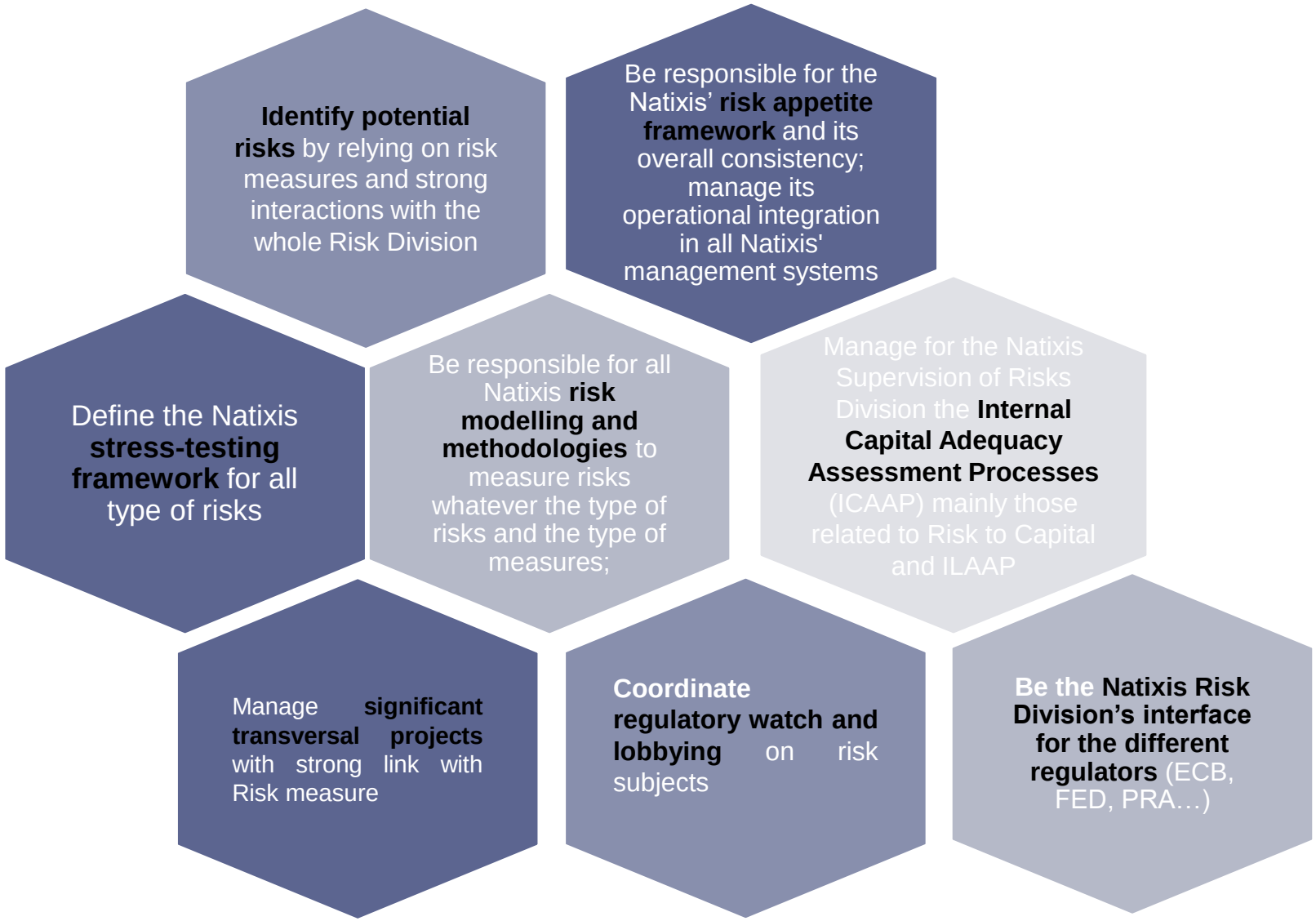


Risk Division

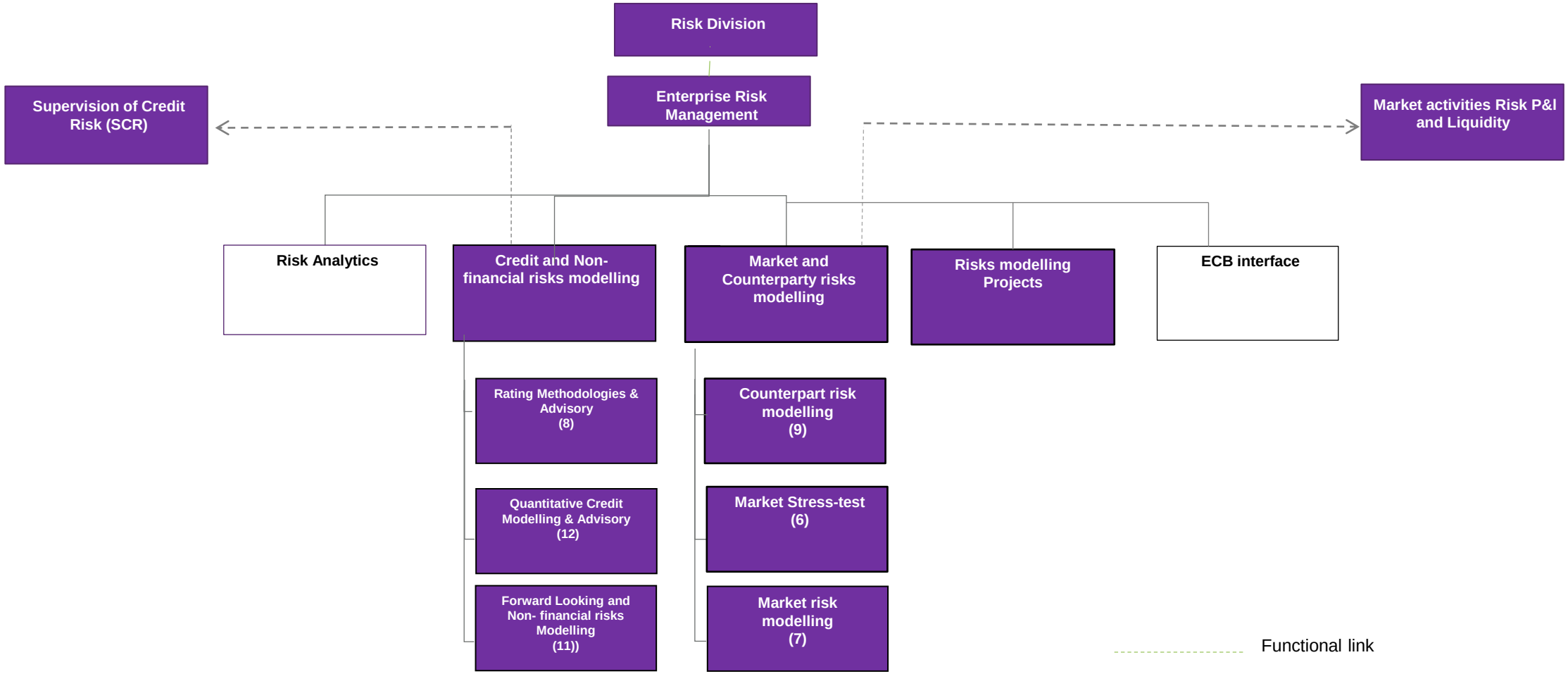
Organization chart of Natixis Risk Department



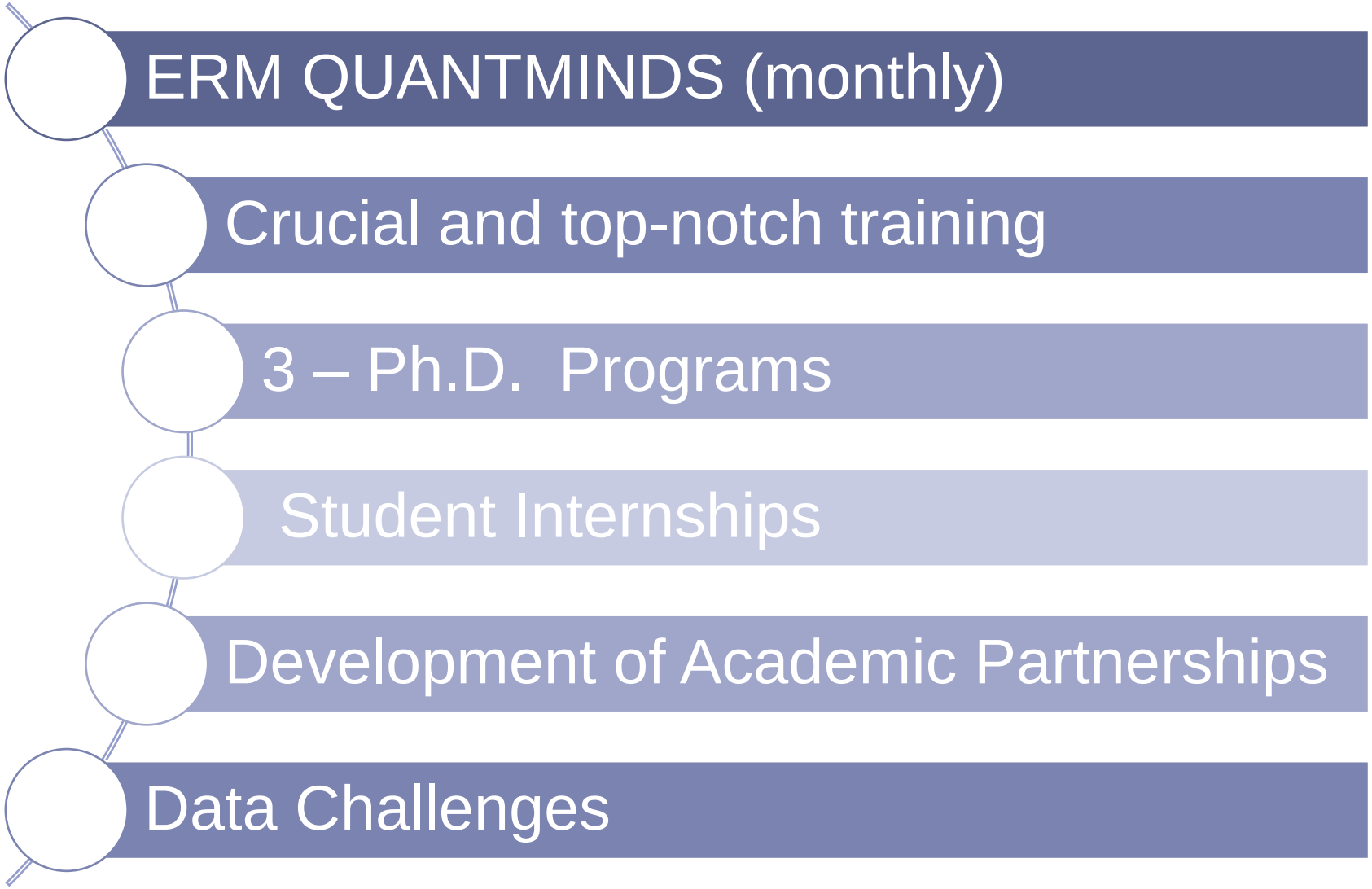
ERM Division’s main missions



Enterprise Risk Management (ERM)



ERM innovation framework



Use Case

Derivatives Deep Hedging

Derivatives Deep Hedging

Derivatives Hedging

- **Derivatives hedging has important applications in risk management**. In its most simple form, options hedging is a trading strategy in a security and a risk-free bank account
- An option written on the security is hedged by this strategy if the strategy is self-financing, and replicates the price of the option at all times and in all states of the world
- In the simple Black Scholes model, where only one source of uncertainty is present, it can be shown that such strategies do exist and a closed formula can be found for the proportion of wealth that should be invested in the underlying security (the delta).

Derivatives Deep Hedging

Derivatives Deep Hedging

- Recent progress achieved in **data science and deep learning** make a **model independent approach** for hedging possible
- These hedging approaches well known as deep hedging are machine learning algorithms able to consider market frictions as well as trading constraints **without using risk sensitivities metrics computed by pricing models**
- The objective of the challenge is to replace classical hedging strategies founded on the calculation of risk sensitivities (Greeks) by machine learning algorithms (ML).

Derivatives Deep Hedging

Hedging under Black & Scholes Model

- The Black & Scholes Model is still an industry widespread model used by traders to hedge vanilla options.
- The goal is to hedge a short call option position of maturity 30 days with daily rebalancing

$$F(S_T) = (S_T - K)^+$$

- The price process S_T will be simulated under the Black & Scholes framework :

$$S_t = S_0 \times \exp\left(\left(r - \frac{\sigma^2}{2}\right)t + \sigma\sqrt{t} \times \varepsilon\right) \quad \text{where } \varepsilon \sim \mathrm{N}(0,1)$$

Derivatives Deep Hedging

Hedging under Black & Scholes Model

- **Mathematical formulation of discrete hedge**
  - The hedging strategy is organized over discrete times $0 = t_0 < t_1 < \cdots < t_{n-1} < t_n$
  - The main objective is to look at the best discrete stochastic called hedging strategy and defined by:

$$\delta = (\delta_0, \delta_1, \ldots, \delta_{n-1})$$

  - To both comply with the self-financing condition and thus to minimize the losses (i.e., the negative values) of the following quantity called **profit and loss** (**P&L**):

$$(\delta . S)_T - F(S_T) = \sum_{k=0}^{n} \delta_{k-1} . \left(S_{t_k} - S_{t_{k-1}}\right) - (S_T - K)^+, \delta_{-1} = 0$$

Derivatives Deep Hedging

Hedging under Black & Scholes Model

Derivatives Hedging and Transaction Costs

- In practice any purchase of instruments implies transaction costs and must be taken into account by the trader to limit his losses :

$$P\&L(T,\delta) = \sum_{i=0}^{n} \delta_{i-1}.\left(S_{t_i} - S_{t_{i-1}}\right) - c \times \sum_{k=0}^{n} S_k.\left|\delta_{t_i} - \delta_{t_{i-1}}\right| - (S_T - K)^+$$

- The proportional transaction costs can be given as follows :

$$C_T(\delta) = c \times \sum_{k=0}^{n} S_k.\left|\delta_{t_i} - \delta_{t_{i-1}}\right|$$

- The **goal of the deep hedging is to minimize the losses** of the $P\&L\left(T,\delta^{\theta}\right)$ by choosing the best hedging strategy δ^{θ}

Derivatives Deep Hedging

Hedging under Black & Scholes Model

- The **goal of the deep hedging is to minimize the losses** of the $P\&L(T, \delta^{\theta})$ by choosing the best hedging strategy δ^{θ}
- Set $L_T = F(S_T) + C_T(\delta) - (\delta.S)_T$ and it refers to reverse P&L and losses are counted positively
- From the Expected Shortfall (ES) definition, we propose the following risk measure :

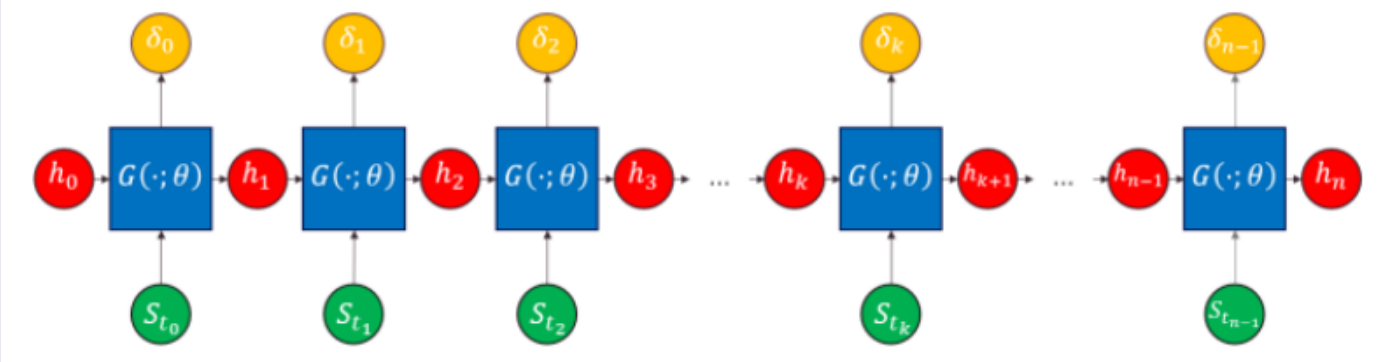
$$\rho_{\beta}(L) = \frac{1}{1+\beta}(ES_{50\%}[L] + \beta \times ES_{99\%}[L])$$

- The parameter β is a hyperparameter chosen arbitrary. We choose $\beta = 1$ to consider extreme losses

Derivatives Deep Hedging

Deep Hedging using Feed Forward Neural Networks

- One example of deep hedging is to use feed forward neural networks (FFNN) to derive the hedging strategy, with the followingsetting:



Source: Mazars – Deep Hedging – Application of deep learning to hedge financial derivatives

- Each FFNN G_i outputs the δ_i of day i by using the information S_{t_i} as input.
- The parameters of the FFNN are calibrated so as to minimize the overall loss metric $\rho_\beta(L) = \frac{1}{1+\beta}(ES_{50\%}[L] + \beta \times ES_{99\%}[L])$ ($\beta = 1$ in our case) on the training trajectories.

Derivatives Deep Hedging

Data description (Setting n° 1: Black & Scholes)

20 000 paths

10 000 training

10 000 test

One path corresponds to a simulation on 30 days: vector of 30 elements representing the evolution of the underlying price

Black Scholes case: one hedging instrument (the underlying S_t)

Data file:

- 20 000 rows
- 1 row = 1 path of 30 points
- Each point i represents the underlying price at day i.

Derivatives Deep Hedging

Data description (Setting n° 2: Heston)

20 000 paths

10 000 training

10 000 test

One path corresponds to a simulation on 30 days: vector of 30 elements representing the evolution of the underlying price

Heston case: Two hedging instruments: the underlying S_t and a variance swap σ_t

Data file:

- 20 000 rows
- 1 row = 1 path of 30*2 points
- S_i represents the underlying price at day i. Var_i represents the underlying price at day i.

Derivatives Deep Hedging

Algorithms performance evaluation

- The performance of the algorithms is evaluated on P&L statistics given by the strategies on a subset of 10 000 paths. The metric **to minimize** is:

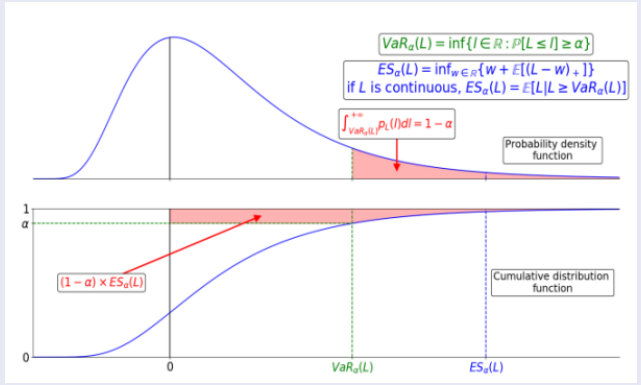
$$\rho(L) = \frac{1}{2}(ES_{50\%}[L] + ES_{99\%}[L])$$

Where:

- L represents the loss incurred at the end of a simulation path (of 30 days) by implementing the strategy given by the submitted deltas. It is the opposite of P&L (losses counted positively, gains negatively)
- $ES_\alpha[L]$ is the expected shortfall of the losses, which is simply the average loss of the worst $(1-\alpha)\%$ losses (example $\alpha = 99\%$ corresponds to the worst 1% losses):

$$ES_\alpha[L] = \frac{1}{(1-\alpha N)} \sum_{L_i \geq VaR_\alpha[L]} L_i$$

With $L_i = -P\&L(T, \delta^i)$



QUESTIONS & ANSWERS SESSION

Data Challenge Timeline

Data Challenge | Timeline


Thank
you !

PARTENAIRE PREMIUM