Technology and System Risk Rating Methodology: Enterprise Risk Management Solutions for Financial, Hedge Funds and All other Industries™

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Abstract

"Technology and System Risk Rating Methodology : Enterprise Risk Management Solutions For Financial, Hedge Funds and All other Industries" is a global rating methodology to measure the adequacy and reliability of technologies and systems' applications in the financial departments of all corporations and companies globally. The rating methodology provides a list of criteria and standards to measure the adequacy of the risk management technologies applied in all industries to manage financial management reporting and statements.

Systems may include trading, risk management (insurance, compliance, credit, technology, market, counterparty, collateral, interactive trading, operational, liquidity, corporate governance risks), back, middle and front office applications, infrastructural tools, exchange trading platforms, electronic trading networks, and customized architectural information technology solutions.

The main criteria and standards to benchmark the adequacy of the technologies and systems are : coverage of financial products; global corporate governance, legal and compliance applications; scalability; departmental infrastructural interactions and coverage; risk management types; quantitative capacities; qualitative capacities; global security convergence standards; geographical presence and representation; transparency abilities; price transparency.

The rating levels grade technologies and systems in four levels such as :

- One : worse
- Two : average
- Three : good
- Four : best or excellent

The rating methodology also includes the results of a global study of most financial and risk management technologies. The studied sample counts about 222 systems globally and has been analyzed individually using the criteria, standards and grading levels.

The study is to provide all industries with some basic benchmark to test and evaluate the feasibility of financial systems' and technologies' applications they may consider purchasing to manage their internal financial statements.

1. Introduction

In recent years, rating agencies provided investors with risk reports and opinions about companies' credit quality and potentials for downgrading. Grades

with regard to companies lost a tremendous amount of credibility, most particularly because they are paid directly by the entities they rate and incur a major direct conflict of interest. In many cases, gradings and ratings do not evaluate the infrastructures and the systemic framework. Often they conveniently do not take into account the qualitative aspects of the technological capabilities primarily because systemic solutions do not reconcile transactional workflow fairly and adequately, and they do not provide pure transparency and translucency with respect to financial statements' reporting. This conflict of interest also occurs to large auditing firms.

The integration of technology within the financial industry enhanced the synergy of both industries to change the market landscape with regard to rating standards globally. The emerging markets' manufacturing of intellectual capacity (notably India and China) with respect to information technology improved global connectivities and efficiencies with the customization of programming interfaces, yet without any standards of reference or specific guidelines. Westernized risk management technologies ended up being a collection of broken patchwork solutions with significant operational gaps; sometimes convenient for the insufficiencies in financial reporting of transactions. With time, the confusion of mega mergers and without corporate governance, working ethics and qualitative references, technology companies may strategize to prioritize on markets' sharing ownerships and economical monopolistic opportunities. As of yet, there exist no single global technology risk compliance standards and no rating methodologies to adequately verify solutions inside entities, to test them accordingly and to validate internal models, most specifically in financial firms. In an era of economical stakes and increasing competitiveness, some financial banking institutions may invest and allocate more of their budget toward the corporate governance transparency infrastructures of the entities; while others may simply rely on patchwork solutions that provide apparent solutions and resolve problems immediately. These solutions are most expensive to upgrade as they become dependent of the patchwork solutions they chose to buy at first. The upgraded versions do not necessary fit with the complexity of the evolved enterprise model. Customized proprietary solutions may be more qualitatively integrated than patchwork solutions that resolve issues in a specific area of the enterprise. For this reason, some companies cut more corners than others when it comes to investing in technologies and systems. Some others input more budgets in technologies that hide unethical trading practices or create infrastructural risks. Without any global standards with respect to testing and validating technology models, there will be increasing exponential economical anarchy.

In the hedge fund industry, no such services appear because the logic is the same. Investors as well as hedge fund managers figure they may share more profits by narrowing down the number of greedy intermediaries providing no value-added services or levels of transparency. An independent rating methodology produced by

third party objective players not involved with hedge funds in particular, nor with investors directly, may be able to add value by increasing the level of industry knowledge, independence and objectivity, and thus raise competitive standards.

The author compiled a database of approximately 222 global systems and technologies specializing in the financial industry and attempted to rate them according to a list of specific conditions and criteria. The database enables the author to examine market players' means to gain market shares and deals. With this tool, the author is also able to evaluate inter-market deals and international competitive market intelligence versus intra companies' product lines. In addition, the author provided more market transparency by adding an independent market study performed by AIM Software.

The author's rating methodology of technology and systems uses the same four grading principles as in the methodology proposed for operational and systemic risks described in *Hedge Funds and Operational Risks* (Guizot, 2006). The scoring scale uses four grading principles to facilitate application at a global level. In addition to grading with basic requirements such as traditional market risk tools, we will provide some basic grounds to include more variables to lead especially large global technology and systems' companies toward more converging standards. Regulations, corporate governance and compliances posed a significant challenge at coordinating the convergence of such corporate standards at a global level, primarily because they are costly, and they impose new strict standards on executives and board members of entities. W will discover that although Basel is the most widely used framework, it remains very unachieved in completeness and is applied with serious limitations within most technology firms primarily because all banks use their own proprietary technology engines. Thus hedge funds originally aimed at remaining small are to either merge with banks or buy significant expensive technology engines. Very few technologies fulfill all sides of risk management, and regulations remained mainly static because they are cost centers.

The reality of this exercise will show us that most technologies are internationally incomplete and/or unsound with current imposing regulations especially with regards to Basel, Sarbanes Oxley and International Accounting Standards. No international technological infrastructural standards exist. Yet, the management of information becomes increasingly important to global entities. Mergers of large entities enable them to acquire various databases to access new market space. For instance, financial institutions are also producing their own risk management software to sell to various clients. This enables them to access strategic information. This is even more obvious for financial technologies produced by banks sold to funds and financial clients. The rating takes into consideration the third party implication or potential conflict of interest links. The information technology security

management convergence and processes are not applied at all; in fact, they are the only new concepts that are appearing now in enterprises. Geographical distributions also expand to at least three major continents (Americas (United States), Europe (Western mostly) and Asia (Singapore, Hong Kong or Tokyo) for the vast majority of the companies. This enables them to have a presence in a market to either observe local policy makings and progresses and/or own a share of that market space. In this exercise, we will also note that technology industry for financial entities rarely applies and significantly differs in technological architectures for hedge funds primarily because no regulatory minimum standards are imposed with regard to hedge funds' infrastructures. They are also very complex to integrate as they are multi-dependent entities with third parties in offshores, fund administrators, prime brokers, risk management and external single operating trading desks. The author also noted that the number of registered hedge funds in one jurisdiction does not necessarily inform of satellite offices in other regions or cross border registrations, thus making it difficult for compliance officers and risk managers to well define or differentiate head offices from legal compliance offices to report regulatory filings, register with specific mandates or apply corporate governances. Most technology companies are not ready to track and integrate such spread out geopolitical entities with translucent undefined legal boundaries. This is primarily because those entities take advantage of countries that are not regulated or lightly regulated and thus are weakly equipped in technologies' infrastructures. The most adequate, sophisticated and advanced technology entities with global exposures seem to perform two or three specific services at most for specific clients, but none of them actually upscale to a single unified global standard of operations. Those few who attempted to reach higher global levels by accumulating tools, merging with other technological entities, buying and purchasing other systems end up compiling a library of bits and pieces of modules which are subject, upon integration in global enterprises, to more operational and systemic risks. Thus, their qualitative texture ends up as poor as those global entities specializing in a narrow incomplete type of product, risk, business line, algorithm or model. The study reveals a line of technology experts who specialize in highly customized programs to mold and comply with specific operational and systemic business and enterprises' needs. This new form of individual service may actually become more successful and efficient for the overall evolution of enterprises' progress as they adapt dynamically with ongoing challenges. Pre-packaged technology modules tend to degrade and depreciate more rapidly as regulations and global standards advance.

In the first chapter, we will propose a basic methodological framework to refer to for the global pilot study to grade every entity upon specific conditions and criteria, in quantitative and qualitative capacity as well as completeness or wholeness of all proposed aspects. The book's main body is made up of many technology and system enterprises, all offering various products and services. They are front end trading, back and middle offices' systems, compliance and corporate governance

tools and risk management solutions. Finally, we will review the overall results by criteria categories. The methodology may or may not be used as recommendation to upscale global technological and enterprise corporate governance convergence standards.

1.1 Preliminary Study and Notes Prior to Developing Author's IT Rating Methodology

According to OpRisk & Compliance of October 2006, the Markets in Financial Instruments Directive (MidFid) will start testing IT systems' compliance and corporate governance programs in September 2007. The Mifid Joint Working Group (JWG) and the IT Subject Group (ITSG) will then assess and debug applications. According to the report, some 3,000 to 4,000 firms are implicated in the MiFid testing sample, and the project is targeted for U.K. firms and Euro zones' enterprises principally. It is not transparent to evaluate that the testing is applicable to all other peer regulators.

2. Methodology Criteria and Conditions

The following report explains the methodological criteria and qualitative factors that make up the rating from 1 to 4 of the system's or technology adequacy within the infrastructural financial markets' architecture. The ratings from 1 to 4 also verify that completeness in full products' coverage in financial types of products and operational risk management coverage from back to middle to front offices are met. The systemic qualitative rating also validates that the system is technologically scalable to medium and larger size institutional enterprise and exchange. Given this framework, the author rated all the solutions and came up with individual technology findings. The technology rating results of individual technology solutions will be available independently for consulting services upon demand by various financial institutions, technology firms or clients. The combined results of the entire study of the 222 companies, however, are included in this research. Let us first define the rating framework.

The ***Technological and Systems' Information Technology Risks' Rating*** is based on the resulting grades obtained in the evaluation given the following criteria:

2.1 Financial and Commodities Products

The systems' adaptability is applicable to all or specific financial products and commodities listed in this section. In order to get a perfect grading technology, providers must obtain substantial information about financial products' derivatives, alternatives and models. If the technology also includes pricing algorithms for commodities and energy products, the system is subject to more operational risks' weaknesses and failures if it does not have tools to perform scheduling, to track transportations and to monitor the delivering of physicals. In commodities markets, physical valuations are used as collateral goods against risks of defaults. These attached features to manage risks specifically for energy and commodities are attached to those risks to monitor financial valuations such as collateral assets' valuations, counterparty risks, credit risks and Basel compliance. Operational risks arise if energy and financial risks are mixed together and not able to accurately measure collateral risks' valuations from point of trading inceptions to delivery point of the physical commodity product. The valuation of commodities products also includes the transportation premium and geopolitical costs for freight. For a system or a technology to get a 4 or a 3, the tool would have to be able to price all products or most products of each type: equity, bonds, interest rates, fixed income, foreign exchange, exotics, options, complex derivatives of those traditional asset classes and structured products. The logic behind this conveys that if the system were not able to comply with most products' risks, then it would require additional operational risks and connectivities to ramify those products at the financial aggregation levels. The additions of supplementary systems and technology to sustain all types of risks increase the operational infrastructures and the risks of missing transactions to complete sound financial reports.

- ✓ **Level 1 :** one to two types of product category or asset class
- ✓ **Level 2**: two to three types of product coverage or asset class
- ✓ **Level 3**: at least three types of products or asset class are priced or risk managed. System and technology is able to hold a significant representation of equity, fixed income, bonds, foreign exchange and interest rate products with their respective derivatives.
- ✓ **Level 4**: all financial and commodities products and their derivatives plus customized structured products' design.

List of supported financial instruments:

Interest rate instruments:

- amortizing swaps

- accrual swaps
- asset swaps
- average rate caps, floors and collars
- basis swaps and swaptions
- callable capped floater swaps
- callable inverse floater swaps
- callable range accrual swaps
- callable snowball notes
- cancelable/extendable swaps
- capped floaters, callable and noncallable
- CMS/CMT swaps, caps and floors
- compounding swaps
- constant maturity swaps
- cross currency swaps and swaptions
- digital caps and floors
- European/Bermudan/American swaptions
- in-arrears swaps
- inverse floaters, callable and noncallable
- OIS / EONIA swaps
- par swap analysis
- percentage of LIBOR swaps and swaptions
- quanto swaps and swaptions
- range accruals, callable and noncallable
- tax-exempt swaptions
- term structure calibration
- vanilla/amortizing swaps caps and floors
- variance and volatility swaps
- volatility bootstrapping (caps and floors)

Coupon paying bonds:

- (multicallable and/or putable) fixed rate bonds
- (multicallable and/or putable) step up/step down bonds
- (multicallable and/or putable) money market floater with cap/floor
- (multicallable and/or putable) constant maturity floater with cap/floor
- (multicallable and/or putable) reverse floater with cap/floor
- (multicallable and/or putable) fixed-to-floating rate notes
- (multicallable and/or putable) CMS spreads (steepener)
- (multicallable and/or putable) snowball floater (memory/cliquet inverse floater)
- (multicallable and/or putable) ratchet floater
- (multicallable and/or putable) quantos

- target redemption notes
- target redemption quantos
- target redemption CMS spreads (steepener)

Zero bonds:

- (multicallable and/or putable) fixed rate bond zeros
- (multicallable and/or putable) step up/step down bond zeros
- (multicallable and/or putable) money market floater with cap/floor on zero basis
- (multicallable and/or putable) constant maturity floater with cap/floor on zero basis
- (multicallable and/or putable) reverse floater with cap/floor on zero basis
- (multicallable and/or putable) fixed-to-floating rate notes on zero basis
- (multicallable and/or putable) CMS spreads (steepener) on zero basis

Convertible bonds with:

- soft call feature
- reset feature
- Bermudan/American conversion
- Bermudan/American call feature
- Bermudan/American put feature

Swaps:

- vanilla swaps
- (callable and/or putable) constant maturity swaps
- (callable and/or putable) amortizing constant maturity swaps
- (callable and/or putable) general constant maturity swaps
- (callable and/or putable) general amortizing constant maturity swaps
- (callable and/or putable) snowball swaps (memory/cliquet inverse swaps)
- (callable and/or putable) ratchet swaps
- (callable and/or putable) digital range accrual swaps
- (callable and/or putable) CMS spread swaps (steepener swaps)
- (callable and/or putable) quanto swaps
- target redemption swaps
- credit default swaps

Bond options:

- fixed rate bond options (Bermudan or American)

- options on step up/step down bonds (Bermudan or American)
- options on money market floater with cap/floor (Bermudan or American)
- options on constant maturity floater with cap/floor (Bermudan or American)
- options on reverse floater with cap/floor (Bermudan or American)
- options on fixed-to-floating rate notes (Bermudan or American)

Convertible bonds with specific risk management conditions:

- allow for dilution effect of conversion
- allow for conversion caps, soft calls
- define any conversion or call (put) schedule
- use a fixed or a time-varying risk free rate, exchange ratios, strike prices
- generate a host of risk statistics including fair value, probability of conversion, call, put, expected life and delta, gamma, vega, theta, rho
- calculate implied spreads and volatilities
- models cover all types of bonds (regular, step-up, accreting, roller coaster, odd coupon, amortizing, variable coupon)
- model the equity using projected dividends or a dividend yield

Mortgage securities MBS:

- accrual bonds
- CMOs
- fixed-rate passthroughs or pools
- implied prepayment speed given price and yield/z-spread
- IO/PO bonds
- PACs
- prepayment analysis
- prepayment utilities
- price given yield/z-spread and prepayment vector

- pro-rata bonds
- sequential bonds
- spread analysis
- TAC bonds and companion TACs
- utilities for creating prepayment vectors (PSA, ABS, CPR <-> SMM)
- yield analysis
- yield/z-spread given price and prepayment vector

Credit default swaps:

- first-to-default, n-to-default or n-out-of-m to default, all-to-default
- basket CDS cash flows
- calculation of default swap spreads and binary or basket-linked default swap spreads
- CDS on synthetic CDO tranches, includes cash flows
- CDS on standard CDO tranches, includes cash flows
- CDS index
- CDS index options
- CDS payoff leg cash flows
- default swaps and binary default swaps on a single name or a basket with independent or correlated defaults
- options on single asset and basket CDS
- first loss CDS and CDO tranches
- Greek and risk sensitivities on basket CDS and CDS on CDO tranches
- options on single asset and basket CDS
- single asset CDS with upfront payments, IMM dates
- underlying assets may be bonds or any type of payment such as loans or trade receivables

Credit-linked notes:

- fixed or floating CLNs
- par rates and spreads

Default probability estimation:

- from swap spreads
- from bond yield spreads from rating transition matrices
- using Merton's model (using equities)
- calculate first-to-default probabilities

Total return swaps:

- on bonds
- on equities

Utilities:

- cash flow functions for CDS
- credit loss distribution calculations
- default curve conversion utilities
- default curve interpolation
- other credit instruments:
- asset swaps
- CDO tranches
- credit-linked notes (fixed or floating)
- credit-linked notes par rates and spreads
- credit spread options
- hazard rate curves
- rating sensitive notes

Other options:

- Commodities: Asian options
- average strike options
- barrier options (knock in/out)
- basket options
- binary spread options
- call/puts American
- call/puts European
- call/puts Bermudan
- chooser options
- compound options
- currency translated options
- average options
- double barrier options
- options on futures
- forwards
- forward start options
- futures
- lookback options
- multi-asset options
- options on futures
- quanto options
- spread options
- swaps
- swaptions

- cash flow CDOs
- synthetic CDOs
- credit default swaps
- digital credit default swaps
- guarantees
- lines of credit with full or partial drawdown
- common stock
- preferred stock
- convertible bonds
- equity options
- warrants
- forward rate agreement
- basis swap
- cross currency swap
- constant maturity swap
- forward start swap
- pay later swap
- asset swap
- amortizing swap
- roller coaster swap
- normal cap and floor
- European swaption
- set-in arrears swap
- accreting swapconstant maturity treasury

- deferred start swap
- American (fixed maturity) swaption
- Bermuda (fixed maturity) swaption
- average rate swap
- barrier swap
- overnight index swap
- quanto swap
- binary caps and floors
- binary corridors
- bond futures
- bond futures options
- money market futures
- money market futures options
- bond forward settlement
- non government bond
- bond option
- foreign exchange forward
- foreign exchange swap

- foreign exchange option
- credit derivatives
- asset-backed securities
- mortgage-backed securities
- collateralized mortgage obligations
- floating rate securities with a cap
- floating rate securities with a floor
- floating rate securities with a cap and a floor
- callable floating rate securities with a cap
- callable floating rate securities with a floor
- callable floating rate securities with a cap and a floor
- putable floating rate securities with a cap
- putable floating rate securities with a floor
- putable floating rate securities with a cap and a floor
- irrationally callable floating rate securities with a cap
- irrationally callable floating rate securities with a floor
- irrationally callable floating rate securities with a cap and a floor
- irrationally putable floating rate securities with a cap
- irrationally putable floating rate securities with a floor
- irrationally putable floating rate securities with a cap and a floor
- call option on floating rate securities with a cap
- call option on floating rate securities with a floor
- call option on floating rate securities with a cap and a floor
- call option on callable floating rate securities with a cap
- call option on callable floating rate securities with a floor
- call option on callable floating rate securities with a cap and a floor
- call option on putable floating rate securities with a cap
- call option on putable floating rate securities with a floor
- call option on putable floating rate securities with a cap and a floor
- call option on irrationally callable floating rate securities with a cap
- call option on irrationally callable floating rate securities with a floor
- call option on irrationally callable floating rate securities with a cap and a floor
- call option on irrationally putable floating rate securities with a cap
- call option on irrationally putable floating rate securities with a floor
- call option on irrationally putable floating rate securities with a cap and a floor
- put option on floating rate securities with a cap
- put option on floating rate securities with a floor
- put option on floating rate securities with a cap and a floor
- put option on callable floating rate securities with a cap
- put option on callable floating rate securities with a floor
- put option on callable floating rate securities with a cap and a floor

- put option on putable floating rate securities with a cap
- put option on putable floating rate securities with a floor
- put option on putable floating rate securities with a cap and a floor
- put option on irrationally callable floating rate securities with a cap
- put option on irrationally callable floating rate securities with a floor
- put option on irrationally callable floating rate securities with a cap and a floor
- put option on irrationally putable floating rate securities with a cap
- put option on irrationally putable floating rate securities with a floor
- put option on irrationally putable floating rate securities with a cap and a floor
- put option on floating rate securities with a cap
- put option on floating rate securities with a floor
- put option on floating rate securities with a cap and a floor
- irrationally exercised call option on callable floating rate securities with a cap
- irrationally exercised call option on callable floating rate securities with a floor
- irrationally exercised call option on callable floating rate securities with a cap and a floor
- irrationally exercised call option on putable floating rate securities with a cap
- irrationally exercised call option on putable floating rate securities with a floor
- irrationally exercised call option on putable floating rate securities with a cap and a floor
- irrationally exercised call option on irrationally callable floating rate securities with a cap
- irrationally exercised call option on irrationally callable floating rate securities with a floor
- irrationally exercised call option on irrationally callable floating rate securities with a cap and a floor
- irrationally exercised call option on irrationally putable floating rate securities with a cap
- irrationally exercised call option on irrationally putable floating rate securities with a floor
- irrationally exercised call option on irrationally putable floating rate securities with a cap and a floor
- irrationally exercised put option on floating rate securities with a cap
- irrationally exercised put option on floating rate securities with a floor
- irrationally exercised put option on floating rate securities with a cap and a floor

- irrationally exercised put option on callable floating rate securities with a cap
- irrationally exercised put option on callable floating rate securities with a floor
- irrationally exercised put option on callable floating rate securities with a cap and a floor
- irrationally exercised put option on putable floating rate securities with a cap
- irrationally exercised put option on putable floating rate securities with a floor
- irrationally exercised put option on putable floating rate securities with a cap and a floor
- irrationally exercised put option on irrationally callable floating rate securities with a cap
- irrationally exercised put option on irrationally callable floating rate securities with a floor
- irrationally exercised put option on irrationally callable floating rate securities with a cap and a floor
- irrationally exercised put option on irrationally putable floating rate securities with a cap
- irrationally exercised put option on irrationally putable floating rate securities with a floor
- irrationally exercised put option on irrationally putable floating rate securities with a cap and a floor
- forward settlement floating rate securities with a cap
- forward settlement floating rate securities with a floor
- forward settlement floating rate securities with a cap and a floor
- forward settlement callable floating rate securities with a cap
- forward settlement callable floating rate securities with a floor
- forward settlement callable floating rate securities with a cap and a floor
- forward settlement putable floating rate securities with a cap
- forward settlement putable floating rate securities with a floor
- forward settlement putable floating rate securities with a cap and a floor
- forward settlement irrationally callable floating rate securities with a cap
- forward settlement irrationally callable floating rate securities with a floor
- forward settlement irrationally callable floating rate securities with a cap and a floor
- forward settlement irrationally putable floating rate securities with a cap
- forward settlement irrationally putable floating rate securities with a floor
- forward settlement irrationally putable floating rate securities with a cap and a floor

Range accruals:

- (callable and/or putable) CMS range accruals
- (callable and/or putable) digital range accruals
- (callable and/or putable) digital spread range accruals

Other interest rate instruments:

- forward rate agreements (FRA)
- caps/floors
- American/European/Bermudan swaptions
- captions/floortions
- switch obligations

Bonds and fixed income products:

- amortizing bonds
- bond forwards
- bond futures
- bond options
- callable bonds
- cash flow calculations
- conversion factors
- convertible bonds
- credit spread analysis
- discount securities
- floating rate notes
- forward rate agreements
- government and corporate bonds
- index-linked principal protected bonds
- inflation bonds
- interest at maturity securities
- jurisdictional specific models (35 countries)
- municipal and tax-exempt bonds
- option adjusted spread analysis (OAS)
- repos
- step-up coupon bonds
- structured notes
- super Asian bonds
- T-bills
- term structure models
- treasuries
- zero-coupon bonds

- caps & floors
- credit derivatives
- floating rate notes
- foreign exchange options and futures
- interest rate swaps
- options on interest rate futures
- value-at-risk (VaR)

Foreign exchange:

- Asian options
- average strike options
- basket options
- binary options
- calls/puts American/Bermudan/European
- chooser options
- cross currency swaps
- currency swaps and swaptions
- currency translated options
- double average options
- double barrier options
- forward start options
- fx barrier options
- fx forwards / futures
- fx options
- fx quanto options
- fx swaps
- fx swaptions
- lookback options
- multi-asset options
- spread options
- interest rate forwards/futures
- interest rate swaps and swaptions
- value-at-risk (fx VaR)

Inflation instruments:

- inflation curves
- inflation swaps
- inflation indexed bonds

Equity/FX instruments:

- vanilla options (European/Bermudan/American)
- barrier options (European/Bermudan/American)
- up & out options with/without rebate
- up & in options with/without rebate
- down & out options with/without rebate
- down & in options with/without rebate
- double barrier out options with/without rebate
- double barrier in options with/without rebate

Path dependent options:

- Asian options
- floating strike lookback options
- fixed strike lookback options
- forward start options
- time-switch options

Other equity/FX instruments:

- digital options
- digital (up/down, out/in) barrier options
- digital double (out/in) barrier options
- compound options
- chooser options
- extendible options
- gap options
- supershare options

Commodities/energy instruments:

- power electricity
- natural gas
- metals
- coal
- emissions
- agricultural products
- jet fuels
- other types of commodities and energy and their respective derivatives.

2.2 Funds' Styles or Trading Strategies

In order to leverage from market inefficiencies, hedge fund managers create a portfolio of various strategies. Hedge funds' categories evolved with markets' opportunities. These exposure categories do not completely describe hedge fund managers. In addition to those strategies, some hedge fund managers use a combination of strategies, style, products, geography and industry or sector focus to define substrategies. For instance, strategies are convertible arbitrage, capital structure arbitrage, statistical arbitrage and special situations. Securities are product types, or asset classes such as equities, futures, corporate credit, options and interest rate products. Styles are defined as short bias, systematic and low net exposure. Geography is defined by a market focus area such as Asia, Europe, the United States and emerging. Focus/sector is defined by specific industry sectors such as health care, pharmaceutical, energy and commodity, technology, small cap and high yield.

- Equity hedged: This category represents managers that are primarily fundamental long and short publicly traded equities. The overall portfolio may be net long, net short or neutral at any given time. The managers may be generalists or may focus on specific niches within the equity markets, such as sectors, market cap or geography. In addition to publicly traded stocks, the managers may trade modest amounts of options, ETFs, indices and private positions.
- Credit driven: This category includes managers whose returns are directly affected by changes in the pricing of company-specific or industry-specific credit. The category includes strategies such as capital structure arbitrage, credit arbitrage (long and short corporate bonds), emerging market debt, distressed debt and credit-oriented convertible arbitrage.
- Interest rate driven: This category includes any strategy designed to profit from changes in the relationship between different types of fixed income investments, usually in G-10 securities. The managers attempt to exploit the spread between agency bonds or treasuries, yield curve anomalies, on-the-run versus off-the-run issues, mortgage and asset back securities. This also includes interest rate volatility trades and basis trades. These may be structured as directional and/or relative value trades. Credit may be a limited exposure focused on macro credit direction rather than company-specific credit.
- Volatility driven: Managers in this category are affected by the level of volatility, primarily in the equity markets. These include options trading and convertible bond gamma trading. Interest rate and credit derivative

volatility trading would also be included in this category but to date have not evolved into a stand-alone hedge fund strategy category.

- Global macro: In this group, managers employ an opportunistic, top-down approach, to capture major trends or changes in global markets. They attempt to profit from shifts in global interest rates, equity markets, currencies and/or commodities. The managers typically implement their positions using futures but may also use cash securities and options.
- Managed futures: Managers in this category are usually organized as commodity trading advisors (CTAs) and include systematic and/or discretionary traders. Typically the strategies are directional and take long and short positions in interest rate, currency, equity and commodity futures.
- Technology sector: Manager is primarily invested in securities revolving around the technology sector such as Internet, semiconductors, hardware, software, etc.
- Venture capital and private equity: Any manager who invests in companies that are not publicly traded. Vested entities have a component of venture capital or private equity.
- Value: Manager invests in stocks which are perceived to be selling at a discount to their intrinsic or potential worth; i.e., "undervalued," or stocks which are out of favor with the market and are "underfollowed" by analysts. Manager believes that the share price of these stocks will increase as "value" of company is recognized by the market.
- Capital structure arbitrage: A relative value fund that attempts to capture pricing inefficiencies among various tranches of debt or equity of the same or related companies. This pertains more to banking restructuring inefficiencies' trading.
- Convertible arbitrage: Manager focuses on obtaining returns with low or no correlation to the market. Manager buys different securities of the same issuer (e.g., the common stock and convertibles) and "works the spread" between them. For example, within the same company the manager buys one form of security that he believes is undervalued and sells short another security of the same company.
- Distressed: Buying the equity or debt of companies that are in or facing bankruptcy. Manager hopes to buy company securities at a low price and that company will come out of bankruptcy and securities will appreciate.
- Emerging markets: Manager focuses on investing in the securities of companies from "emerging" or developing countries.
- Event driven: Manager takes significant position in limited number of companies with "special situations": companies' situations are unusual in a possible variety of ways and offer profit opportunities; e.g., depressed stock; event in offing offering significant potential market interest (e.g., company is being merged with or acquired by another company);

reorganizations; bad news emerging which will temporarily depress stock (so manager shorts stock), etc.

- Fund of funds (single strategy): Fund of funds that invest only in one type of single strategy manager; e.g., s fund of funds that invests only in convertible arbitrage would have fund of funds (single strategy) be their primary strategy and convertible arbitrage as their secondary strategy.
- Fund of funds (market neutral): Fund of funds that targets near zero correlation to the market or invests exclusively in market neutral or arbitrage strategies.
- Fund of funds (multi-strategy): Fund of funds that invests in a basket of different strategies.
- Health care sector: Manager is primarily invested in securities revolving around the health care sector, including biotechnology.
- Long only: Similar to a mutual fund, except the manager can trade a variety of financial instruments and use leverage.
- Long/short equity: Also known as "Jones Model." Manager buys securities believed to go up in price and sells short securities believed to decline in price. Managers will be either "net long" or "net short" and may change "net" position frequently. For example, a manager may be 60 percent long and 100 percent short, giving him a market exposure of 40 percent net short. The basic belief behind this strategy is that it will enhance the manager's stock picking ability and protect investors in all market conditions.
- Market neutral equity: Any strategy that attempts to eliminate market risk and be profitable in any market condition.
- Market timer: Manager attempts to "time the market" by allocating assets among investments primarily switching between mutual funds and money markets
- Mortgages: A single strategy hedge fund that primarily invests in mortgage-backed or mortgage-related securities.
- Multi-strategy: A single hedge fund that runs several different strategies that make up the total performance of the fund. Multistrategy is different than a fund of funds (multi-strategy) in that the money is kept in-house as opposed to being farmed out to external managers.
- Options strategies: A loosely defined category that describes any manager that focuses on options.
- Other arbitrage: A relative value strategy that does not fall into any of the other categories, e.g., dividend reinvestment arbitrage.
- Regulation D: Manager will make private investments in public companies in need of financing. Generally, the manager will receive a discounted convertible note in return for a capital allocation, essentially locking in a profit.

- Merger/risk arbitrage: Also known as "merger arbitrage." The manager invests in event-driven situations, such as leveraged buyouts, mergers, and hostile takeovers. Managers purchase stock in the firm being taken over and, in some situations, sell short the stock of the acquiring company.
- Short bias: Any manager who consistently has a "net short" exposure to the market. This category also includes short only funds.
- Short-term trading: Manager focuses on short duration, opportunistic trades, and sometimes this strategy will include "day trading."
- Small/micro cap: Usually long biased, the manager will exclusively focus on small and micro cap stocks.
- Special situations: "Special situations" may broadly consist of some type of event-driven strategy. Managers will opportunistically trade in any type of security that they believe to be a "special situation."
- Statistical arbitrage: Leverage opportunities upon which equities behave in a way that is mathematically describable, managers perform a low risk, market neutral analytical equity strategy. This approach captures momentary pricing aberrations in the stocks being monitored. The strategy's profit objective is to exploit mispricings in as risk-free a manner as possible.

The technology supporting these hedge funds' strategies may get qualitative and quantitative ratings depending on the complexity, accuracy, variety and completeness of the hedge funds' strategies it fulfills:

- **Level 1:** worse state; the technology supports parts of the strategies but not all of them and seem to be an institutional technology adapted with patched modules to serve hedge funds. Technology typically started to provide institutional solutions and moduled itself to serve hedge funds. It is not an original hedge funds' technology solution. Technology solution did not go through independent testing in practicality in hedge funds to verify accuracy, completeness and objectivity. The technology is not yet used in hedge funds but assumes its feasibility in practicality.

- **Level 2:** average rating best describes level 2. The technology supports some but not all strategies and is adaptable to hedge funds. The technology is implemented and may be used in hedge funds. The technology may not be yet used in hedge funds but has the capability and scalability to adapt to hedge funds.

- **Level 3:** good; the technology is geared especially for hedge funds' strategies and serves some of them. The technology is applied in hedge funds and has been under independent testing to ensure feasibility and accuracy of pricing models and feasibility with internal and external infrastructural entities.

- **Level 4:** excellent, the technology is specialized for hedge funds. It serves all hedge funds' strategies or categories and is widely applied in hedge funds' industry. The technology is a full services platform with various modules to adapt to all strategies, styles, geographies, asset classes, products, internal back, middle, front offices and external financial institutional entities such as exchanges, prime brokers, liquidity providers, fund administrations and custodians.

2.3 Enterprise Compliance and Corporate Governance

Needless to say that as of 2006, no technologies and systems comply with the full list of global standards tools dealing with compliance and corporate governance. Yet, most companies do claim to enforce corporate governance. Their extent of doing so mostly consists of auditing, boards of directors and chairmen. Technology is tested for compliance abilities, audit trailing, Sarbanes Oxley, data capacity and maintenance, International Accounting Standards, Basel Operational Risk Framework, capital at risk calculations, credit risk netting, International Swaps Derivatives Association (ISDA), Groupe d'Action Financière (GAFI), Know Your Customer (KYC), Antimoney Laundering (AML), U.S. Patriot Act, self evaluations, score cards and operational risk tools to monitor infrastructural and enterprise risks. Completeness of full compliance and corporate governance package is rated with a "4" while partial tools options get rewarded from a 1 to a 3 depending on the qualitative tools and their scalability to larger enterprises.

Enterprise legislative and compliance features:

- ✓ Intellectual property
- ✓ Labor laws
- ✓ U.S. Patriot Act Section 326,
- ✓ Know Your Customer,
- ✓ Anti money Laundering
- ✓ Corporate governance independence and transparencies
- ✓ Companies Act
- ✓ Discrimination Protection Act and quota requirements
- ✓ Electronic Communications and Transactions Act
- ✓ Employment Equity Act
- ✓ Environmental Health Safety (EHS)

- ✓ Environmental Protection Agency (EPA)
- ✓ European Savings Directive effective as of July 2005
- ✓ Equal Employment Opportunity Commission (EEOC) rights
- ✓ Basic Conditions of Employment Act
- ✓ Financial Intelligence Centre Act (FICA)
- ✓ Federal Energy Regulatory Commission (FERC) for energy and commodity products
- ✓ Public Finance Management Act (PFMA)
- ✓ Health Insurance Portability and Accountability Act (HIPAA)
- ✓ Global Investment Performance Standards (GIPS) embedded in technologies and systems' internal abilities
- ✓ Gramm-Leach-Bliley Act
- ✓ Reg NMS
- ✓ Prevention of Organised Crime Act
- ✓ Compensation for Occupational Injuries and Diseases Act
- ✓ Labour Relations Act
- ✓ National Archives Act
- ✓ Occupational Health and Safety Act (OSHA)
- ✓ Office of Foreign Assets Control (OFAC)
- ✓ Financial Action Task Force on Money Laundering (FATF)
- ✓ Pension Funds Act
- ✓ Preferential Procurement Policy Framework Act
- ✓ Prevention of Corrupt Activities Act
- ✓ Promotion of Equality and Prevention of Unfair Discriminations Act
- ✓ Promotion to Access to Information Act
- ✓ Protected Disclosures Act
- ✓ Regulation of Interception of Communications Act
- ✓ Skills Development Act (ongoing education)
- ✓ Skills Development Levies Act
- ✓ Unemployment Insurance Act
- ✓ Unemployment, Insurance Contributions Act
- ✓ Injury Act
- ✓ MiFID: Markets in Financial Instruments Derivatives
- ✓ Capital convergence standards according to Bank of International Settlement
- ✓ Prospectus and Transparency Directives
- ✓ Total Quality Management (TQM)
- ✓ Registrations licenses to trade specific products ; for instance, according to the German Banking Act, forex trading is not classified as banking, but as purchases and sales of currencies as either spot deals or futures trades
- ✓ Financial Advisory and Intermediary Services Act (FAIS)
- ✓ Financial Crimes Enforcement Network; issued new guidance designed to assist money services businesses in understanding the regulatory

requirements regarding conducting independent reviews of their antimoney laundering programs (AML). While the United States requires independent audits to test programs, the Bank Secrecy Act regulation requires money services businesses to establish AML programs with written legislation.

- ✓ International Financial Reporting Standards (IFRS) and International Accounting Standards (IAS) were created by the International Accounting Standards Board to promote internationally comparable financial statements. Regulation 2002/3626 requires that some 7,000 listed companies in the European Union prepare their consolidated financial statements in accordance with IFRS/IAS.
- ✓ Liquidity Trading Mandate 2007: Securities and Exchange Commission requires that brokers are fully equipped to be able to mail or send orders to destinations with an electronic quote that is the best in market as of 2007.
- ✓ International Auditing and Assurance Standards Board (IAASB)
- ✓ European Federation of Accountants (FEE); to implement enterprises' audits at the same benchmark level as the European Union (EU) level
- ✓ Financial and Banking Information Infrastructure Committee (FBIIC) & Framework; to test the resilience of the financial system and its responses to vulnerabilities; this is part of the global convergence security framework.
- ✓ Sarbanes Oxley (SOX 302, 404, 409, 802, 906): SOX documentation, audit trail, control and process testing are required. According to the *OpRisk & Compliance Magazine* of October 2006, the U.S. Government Accountability Office (GAO) found that costs associated with the implementation of the SOX legislation prompted some financial services to cancel and/or defer information technology solutions.

- 302—Corporate Responsibility for Financial Audits

The CEO and CFO must certify "the appropriateness of the financial statements and disclosures contained in the (annual) report, and that those financial statements and disclosures fairly present, in all material respects, the operations and financial condition of the issuer" and will be held personally liable for willful violations of this section. CEOs and CFOs must also attest that internal controls are accurate and effective. Technology tools complying with Sarbanes Oxley must enable such certifications in compliance modules.

- 404—Management Assessment of Internal Business Controls

Technology tools must enable that annual report include an "internal control report" that certifies management's responsibility for creating and maintaining internal controls and processes for financial reporting, and contains an assessment of the effectiveness of these internal controls and

processes. The firm must also appoint an independent auditor to verify that these internal controls and processes are adequately applied.

- 409—Real Time Issuer Disclosure

  Technology must enable data disclosure. Section 409 requires information disclosure with regards to material changes in financial condition or operations on a "rapid or current basis."

- 802—Records and Retention

  Technology tools must enable that records are authentic, consistent and immutable, and that they have, and follow, appropriate records security and retention policies.

- 906— Reporting must Comply with the Act

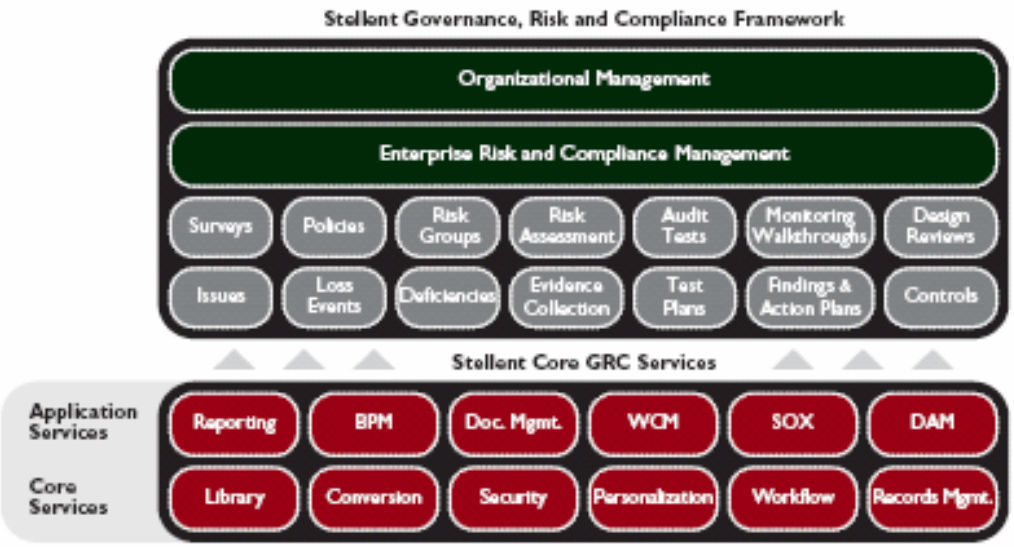
  Technology reporting tools must be able to ensure that all financial reporting, including annual and periodic, provide an accurate representation of the firm's financial position and that they conform and comply with Sarbanes-Oxley.

  For instance, Stellent system and technology provides a solution for Sarbanes Oxley Rules 302, 404 and 409.

The Sarbanes-Oxley compliance process.

✓ Financial Professional Registrations and Licenses for trading employees Series 7, 63, CFA

- ✓ Audit and Accounting SAS 70
- ✓ Financial Registrations for companies' trading activities and memberships to exchanges (NYSE, NASDAQ, CTA, CPO)
- ✓ International Accounting Standards (IAS 1–41) with IAS 39 as mainly applied accounting rule for hedging accounting derivatives.
- ✓ Intellectual property rights
- ✓ Budget risk and finance limits tools
- ✓ ERISA Pension Fund Protection Act August 2006
- ✓ FASB 133
- ✓ Internal trading and risk management limits: Types of products, capital at risk, geographical limits, leverage limits, return limits, risk ratio limits (skewness, kurtosis, jensen, treynor, calmar), Greek limits, stress testing, capital adequacy calculations, scenarios, event and country risks
- ✓ Basel Compliance Pillar I, II, AMA
- ✓ Operational risk data collection, remediation, mitigation, capital at risk assignments
- ✓ Audit trailing and recording: for example, Stellent compliance and corporate governance:



- ✓ Securities and Exchange Commission Act 1934 Section 28 with regards to treatment of soft dollars, commissions and fees for services and products rendered to hedge funds by prime brokerage firms. The Securities and Exchange Commission has issued interpretive guidance on Section 28(e) of the Securities Exchange Act of 1934 which permits investment managers to use client commissions or "soft dollars" to pay for certain brokerage and research services. The Interpretive Release provides a framework to help

determine the scope of the products and services that are covered under the statutory safe harbor of Section 28(e) by establishing standards as to what constitutes brokerage and research services. It is effective as of Jan. 24, 2007.

Qualitative scale:

Level 1: Most of technological and systemic tools perform one or two of those legislations, laws, rules, compliance or reforms. The fact that the technology is able to only sustain to a restricted number of compliance necessitates a connection with other new systems and technologies, thus creating a more complicated infrastructural technological map to ensure ongoing transactional flows and complete adequate compliance framework. Most systems and technological tools have an audit trailing and recording ability and have a database holding and maintenance capacity to comply with Sarbanes Oxley without explicitly complying with it. While most systems are risk management tools, they all partially complete the entire features with some better at capital at risk calculations and other better at data collections. Fewer have a combination of all tools: risk management, corporate governance, compliance tools, international accounting for hedging standards, taxes and audit tools.

Level 2: The system is able to support technologies with at least two or three features of the list.

Level 3: The technologies have more than three but not all features. Those focus on the most important ones such as Basel II, Sarbanes Oxley, International Accounting Standards IAS 39, 32, FASB 33, capital adequacy requirements, audits' recording and trailing and basic risk management limits.

Level 4: None actually have all compliance, audit, risk management, financial, trading registrations and licensing, human resources, employment labor rights and corporate governance tools.

2.4 Scalability

Hedge fund sizes vary from small to large enterprises and thus the technologies and systems accompanying their infrastructures must be scalable to adapt to the size of the ramifying infrastructures such as prime brokerage firms, exchanges, fund administrators and independent liquidity providers and market makers. The technologies' ability to connect systems with multi-package programming tools is essential. Now, more information technology companies offer customized programming skills to be more adaptable to operational infrastructures. Some companies used the strategy to be scalable by purchasing a patchwork

collection of technologies. These entities tend to be less operationally sound than others because they require additional risk management to ensure continuous transactional flows between various systems and modules servicing various business lines. These technologies bought smaller companies to gain clients and market shares as opposed to gaining by creating an operationally sound and smoothed infrastructure. While the merging and acquisitions of financial information technologies' companies used to be and still may be adequate, an excessive compilation of tech tools' libraries may be harmful to the operational translucency of the global enterprise. The ramification of modules gets highly complicated with additional manual and/or patchwork programs that requires continuous unresolvable expensive operational risk monitoring without the insurance of capturing all financial flows.

- ✓ Is it a fully integrated system with interacting departmental modules?
- ✓ Are all systems and technologies connected to maintain smooth transactional flows and information connectivity?
- ✓ Is it a library of various tools and modules to patch together on demand basis or on departmental need basis?

Scalability depends on the expandability of the service-oriented architectures throughout various business' functions and lines. Scalability tools that improve business' integration are:

Service-oriented architecture (SOA) platforms are used to develop and deploy composite applications. They enhance legacy system preservation and rapid flexible adaptable platform for standardization. They are useful for merger and acquisition application overlap, legacy application backlog and policy rating data access.

- ✓ Enterprise Service Bus (ESB) is a Web services orchestration and mediation platform that enhances real time environment, complex rule based processing, scalability and reliability. ESB is used for proprietary messaging infrastructure, high cost of maintenance and support and remote management.

  Business Process Management (BPM) is a framework for service encapsulation, workflow integration and business activity monitoring to facilitate process automation and monitoring, Web services based orchestration, automated and human workflow integration. BPM is useful to reduce manual processing errors, and eliminate overtime personnel costs.

- ✓ Business to Business (B2B) is an EDI transaction management between business partners to enhance trading partner profile management and

partner communication protocol. It is used for sub advisor trade reconciliation and corporate client transaction hub.

Straight Through Processing (STP) is a financial institution and corporate messaging platform to ensure payment or securities message transformation and validation, message gateway and communication protocol, and swiftnet solutions' support. It is used to increase transaction volume and institutional client connectivity.

- ✓ FIX is a global messaging protocol to enhance standardization of coded communications.

- ✓ TCM "Transaction process and event monitoring" is a transaction lifecycle management, proactive SLA measurement and dashboard monitoring and event history. It is used to reduce intraday costs and process cycle times.

  Enterprise Service Bus (ESB) corresponds to the internal enterprise service processes that enable the service providers to connect to the consumers. Intra-enterprise services bus contains concepts such as security, information technology logging, data monitoring, transaction processing and BPM.

- ✓ ISOA "industry reference framework" enhances industry process reference model, customizable standards based framework and faster, lower risk SOA developments. It is useful to cut costs and enhance profits and to enforce industry standards' protocol.

Actual current financial industry focus prioritizes on communication protocol such as X.25, FIX, FIXML, e-connectivity and e-platform.

FIX is the standard coded communication protocol transforming disparate financial products into having similar characteristics and functions. According to *Hedge Fund and Investment Technology* (October 2006), the functionality of the ideal multi-asset trading platform comprehends the following features:

- ✓ Order driven, quote driven or OTC trade matching mechanisms,
- ✓ Functions common to all asset classes should be grouped into abstract and core services,
- ✓ Asset-class specific functions like fixed-income and derivatives pricing mechanisms should be managed by a higher level of industry available on "demand,"
- ✓ Industry standard, "open" data exchange protocols with FIX or FIXML,

- ✓ A workflow manager responsible for managing services specific to the order lifecycle of certain products,
- ✓ An intelligent OMS designed to seek liquidity, best execution and algorithmic trading mechanisms.

The scalability of a technology depends primarily on the robustness of its technological programming capacity to support voluminous and sizable business. Technology programming languages support voluminous portfolio with synchronized live electronic updates more than simpler limited computer programming languages. For instance, the following programming languages enhance e-connectivity and e-enterprise interfaces to smooth information transactional flows within enterprise systems and technology infrastructures. These programming standards would provide the company with a minimum of "3" as a grading in scalability to enhance business' expansions without jeopardizing compliance, corporate governance and operational infrastructures.

Programming languages with codes and objects:

- ✓ C++, C#
- ✓ Delphi
- ✓ Eiffel
- ✓ Java
- ✓ Python
- ✓ Ruby
- ✓ Simula
- ✓ Small Talk
- ✓ Visual Basic
- ✓ WinDev

Imperative programming languages:

- ✓ APL

- ✓ ASP
- ✓ Basic
- ✓ C
- ✓ Cobol
- ✓ Forth, Fortran
- ✓ Logo, Pascal, Limbo, Perl, PHP

Functional languages:

- ✓ Haskell
- ✓ ML/Ocaml
- ✓ Lisp/Common Lisp
- ✓ Scheme
- ✓ XSLT

Declarative languages:

- ✓ Clips & Prolog

Concurrent languages:

- ✓ Ada 95 & Erlang

Balisage languages:

- ✓ HTML
- ✓ SGML
- ✓ XML
- ✓ S-Expressions

Examples of scalable technological means:

- ✓ **Mathematica Notebook Interface**: MathLink is a notebook graphical user interface (GUI). It provides access to the full range of Mathematica capabilities, including interactive mathematical typesetting, graphics, online documentations and automated help system. GUI may be customized.

- ✓ **Mathematica toolkit** also named GUIKit for building and running graphical user interfaces. GUIKit is a complete cross platform but native looking standalone application that leverages the computational power of Mathematica. Mathematica provides customized user interface construction that uses Java libraries without having to actually program Java directly. Mathematica solves many GUI issues such as layout, cleans data and simplifies it, and links event functions with intelligence programs. It also synchronizes access to all GUI properties with automated look up functions.

- ✓ **Web-browser Based Mathematica Server Pages (MSP)** is a technology that requires a Web-Mathematica driven by http request and response mechanisms. Its results may be in the forms of HTML, images, applets, XML, MathML and many other formats. This programming language Web browser based provides users with Mathematica functionality through a familiar Web browser interface that may be custom created for a particular application. It also may contain standard interface items such as HTML buttons and form tags, Java applets and JavaScript technology.

- ✓ **Mathematica Package** is a Web service package using http to connect to Web service interfaces, messages sent and received using Web services that are encoded with XML and use standards specified by the SOAP specifications. It provides access to additional data and functionality using familiar technologies such as XML and http. It invokes platform independent remote functionality in the standard Web service way. This is also a Database Link that uses JDBC to connect Mathematica with relational database management systems. It provides functions for using Mathematica to access and manage large database stored in relational interconnected databases.

- ✓ **Microsoft Office Products** is a Mathematica Link for Excel that links to Mathematica at the click of a button via the add-in functionality available in Excel. It makes new Mathematica toolbars, once installed as part of the Excel workspace. It also provides familiar interfaces to the popular Excel

software component of Microsoft Office. It allows the power of Mathematica to be directly applied to data already stored in Excel format without having to manually export the data first.

- ✓ **Enterprise Internet and Intranet:** Internet layers to enhance intra-enterprise infrastructures and ramify various global intercompanies' Web structures.

- ✓ **Java and Java/Link** directly calls Java methods from Mathematica or calls Mathematica from Java. Java provides access to Java libraries and allows the use of GUI interface elements via Swing and AWT classes. It enables any Java-based GUI to be combined with Mathematica, providing access to a wide range of interface building tools and libraries.

- ✓ **Microsoft. NET, Visual Basic.NET, C# is a NET/Link** that directly calls methods in .NET language from Mathematica or calls Mathematica from .NET. It provides access to any .NET assembly and allows the use of .NET based GUI elements. It has special features that allow calling functions in standard Windows DLLs and Com components from Mathematica. It offers tight integration in both directions between Mathematica and .NET.

- ✓ **Visual Basic-Based Interface** is Mathematica for Active X to allow Visual Basic Interfaces and to integrate Mathematica with the standard Windows technology for application interoperability.

- ✓ **C/C++** is a MathLink that defines certain functions allowing C/C++ to call Mathematica and to call C/C++ functions. It provides direct access to the MathLink libraries and allows users to write graphical user interfaces in C/C++ IDEs such as Visual C++, Kylix, or C++ Builder. It also may be used to access Mathematica functionality in the C/C++ program.

The following provides the most basic core standards for markup technologies:

Foundational Standards and Specifications Used in Markup Language Technologies:

Without this rating methodology, there are no required minimum principles to define what constitutes the most used and appropriate markup language technologies. The following eight standards are perceived as "core standards" related to markup language technologies. Depending on the analytical perspective (breadth of use, location in the Internet stack, natural competitors), standards may be defined as "core," "critical" or "foundational" to the Internet technology infrastructure. These

eight selections represent some of the more common standards domains considered interesting and/or important for developing markup-based Internet applications. Historically, SGML and XML are the main metalanguage standards used to define specific markup languages. The foundational principle of both metalanguages is to separate the specification for structure/vocabulary/serialization from other specifications that define processing of the "document/data" instance. For visual presentation, then, something like XSL, CSS or DSSSL is necessary to define the processing semantics. Of course, visual display is just one of many kinds of data processing applicable to XML-encoded information. Many other important standards underlie both SGML and XML (e.g., standards for character encodings) and many adjunct, collateral standards are needed in connection with both XML and SGML to make them useful. Data structured using markup does nothing: it just sits there. For processing, one may need standardized formal models for the information set (e.g., XML Infoset) and for interfaces (e.g., DOM).

- XML: The Extensible Markup Language is a profile or restricted subset of SGML as a metalanguage. XML is used to define application-specific XML vocabularies, or XML markup languages.
- SGML: The Standard Generalized Markup Language (ISO 8879:1986) is historically the dominant (meta-)markup language.
- Schemas: Whereas SGML and XML 1.0 use a special-syntax notation to formally define markup language grammars (DTDs), XML applications are using a wide range of formalisms to express datatypes and other (semantic) constraints.
- XSL/XSLT/Xpath: the Extensible Stylesheet Language is a language for expressing 'style'(sheets). Its components include XSL Transformations (XSLT), an XML Path Language (XPath), and XSL Formatting Objects (XSL-FO, an XML vocabulary for specifying formatting semantics).
- Xlink/Xpointer: XLink (XML Linking Language) supplies basic facilities for defining links between resources. The XML Pointer Language (XPointer) is partitioned into four parts; it supports addressing into the internal structures of XML documents.
- XML Query: Various query languages have been proposed and implemented for querying XML documents.
- CSS: W3C's Cascading Style Sheets provide a simple mechanism for adding style (e.g., fonts, colors, spacing) to Web documents.
- SVG: Scalable Vector Graphics is a language for describing two-dimensional graphics in XML. Other graphics formats may be used in XML documents.

Qualitative Scale for Scalability from 1 to 4:

- ✓ Level 1: The vast majority of systems acknowledge having scalability but very few actually are able to expand business enterprise without incurring major operational and systemic risks. System and technology are not scalable and highly restrictive to limited size of enterprise. As of 2006, most technologies use Java and Web interfaces to solve their connectivities and operational risks. Yet, the sub layers of the IT infrastructures remain highly superficial and inefficient. They do not ramify to all systems, and they leave out some of the continuous transactional flows to ensure completeness of global infrastructures. If businesses merge and/or get acquired, the infrastructures cannot adapt and integrate with other parts of the enterprise if properly connected within the IT framework. Statements of cash flows are incomplete or inaccurate as a result. IT systems are best adapted for small size companies that are limited in infrastructural expansions with less than 20 desks. The technological software is not scalable to large enterprise or else its applications are subject to significant operational risks, insufficient smoothed information flows, gaps in processes, people and systems. Usually typical products are Excel spreadsheets, pre-packaged program software with limited integrations needing ongoing expensive supports and upgrades. These particular software packages are also limited in the modeling of extravagant complex hedging solutions, complex derivatives' products and financial engineering. Quantitative models only produce efficient pricing solutions if and only if volatilities' levels are within reasonable scales. Excel spreadsheet models have limitations in the quantitative aspects of the models' quality and in the number of trade or total portfolio capacity it may hold. Since 50 percent of hedge funds are commingled with institutional and prime brokerage portfolios, the Excel types of packages no longer represent adequate infrastructures to support large scale global portfolios of trades.

  - ✓ **Level 2**: A smaller majority have scalability. Scalability is more achievable without operational and systemic in small- to medium-sized enterprises. These entities are typical regional firms extendable to national sizes but not international. In this category, database infrastructures do not have the supportive infrastructures to be fully leveraged and exploitable. Infrastructural technology does not adapt with patched other business entities that could merge or get acquired. This is one scale above the Excel spreadsheet types of work environments with many surrounding information technology security weaknesses and possibilities for breaches. Quantitative and qualitative abilities to support significantly complex derivatives and large scale capacity of trades are very limited in this business environment too. This category of scalable infrastructure may only have a limited well

defined number of business entities, products to price and manage and does not survive vast expanding technological competition.

- ✓ **Level 3:** This category has scalable technology and systems. Typically, scalable entities own vast programming abilities to integrate business lines more smoothly. This category owns a proprietary information technology quantitative team that adapts, integrates and synchronizes operational infrastructures with current technological progresses. This category has the programming capacity to enhance technological architectures according to expanding business needs. Performing programs are adaptable and tested in most environments from small, medium to large institutions. E-connectivity is also easy to make with exchanges. All firms use FIX protocol (www.fix.org) and e-messaging tools to code all securities for global hedging, trading and netting of exposures at funds' levels. Technological infrastructures are translucent and transparent in onshore and offshore operations. All accounts are connected to master feeders and infrastructural reconciliations of reporting are also verified at hedge fund levels to net exposures and dynamically hedged potential naked exposures. Instant dynamic financial engineering limits alerts both trading and independent risk management of adverse positions.

- ✓ **Level 4**: Highly scalable in all environments. This category provides means for full integrations of all enterprise technological parts bought from expanding business. The business entity has various quantitative programming capacities to enhance with technological developments and progresses its infrastructural transparency and translucency, e-connectivity adaptability to all servers, institutional entities, exchanges, external and intra-enterprise business lines such as offshore fund administrators. Corporate scalability enables offshore and onshore to ensure that all financial accounts, funds, classes and positions and trades are hedged and ramified to master feeders to capture all financial transactional flows.

2.5 Infrastructural Interfaces

Hedge funds' technologies and systems must, at best, interconnect and interface with all the following departments with added security barriers and identification screening filters to ensure independencies between front-end trading with middle and back offices. Upscaled state of the art e-connectivities dynamically updating all parties' information screens may be intra-enterprise dependent (inside

the hedge funds' internal operations) and/or inter- or extra-enterprise dependent (outside the hedge funds).

Intra-enterprise Team:

- ✓ Finance
- ✓ Accounting
- ✓ Fund administration
- ✓ Internal audit
- ✓ Risk management: market, credit, operational, quantitative analytics
- ✓ Information technology
- ✓ Pricing verification and product control
- ✓ Data quality assurance
- ✓ Information technology (proprietary quantitative programmers)
- ✓ Servers' maintenance and database storage (if in-house)
- ✓ Compliance and legal
- ✓ Corporate governance and independent committees
- ✓ Marketing
- ✓ Research
- ✓ Trading, investor and client relationships
- ✓ Management
- ✓ Intra-enterprise contingency planning servers (visible and known to employees)

Inter-enterprise Team:

- ✓ Exchanges
- ✓ Independent data feeders
- ✓ Trade processing, clearing and settling (usage of FIX protocol and securities industry codes)
- ✓ Information technology (hardware and software)
- ✓ Fund administration
- ✓ Custodian
- ✓ Processing clearing and settling
- ✓ Independent consulting research
- ✓ External audit
- ✓ Rating agencies
- ✓ Extra-enterprise contingency planning servers (at distance of employees but known)
- ✓ Prime brokerage

Infrastructural technological interfaces that facilitate more transparency with regards to the services and relationships that hedge funds entertain with prime

brokers and dealers will get a more valuable review. For instance, some technologies remain very opaque in nature as to how to differentiate the various products and treatments they provide to third parties. Those technologies typically do not have modules and patched tools to monitor fees, commissions, and expense for the various services prime brokers provide to hedge funds. For instance, merlin products provide technologies to differentiate the treatment of fees, margins and commissions so that there is clear and compliant transparency with regards to the various separate services brokers dealers provide. The latest Securities and Exchange Commission (SEC) release deals with client commissions and soft dollars for various third parties' services. The SEC release on Section 28(e) of the Securities Exchange Act of 1934 permits investment managers to use client commissions or "soft dollars" to pay for certain brokerage and research services. The Interpretive Release provides a framework to help determine the scope of the products and services that are covered under the statutory safe harbor of Section 28(e) by establishing standards as to what constitutes brokerage and research services (margins, short sales, lendings, risk management outsourcing, research, analytics, trades' processing clearing and settling, data). The Interpretive Release replaces Sections II and III of the SEC's 1986 Interpretive Release, which gives guidance on third-party research and the meaning of brokerage and research services. Investment managers may continue to rely on the SEC's prior interpretations of Section 28(e) until Jan. 24, 2007.

Hedge funds' technological connectivity infrastructures ought to be rated according to the author's operational scaling levels from 1 (poorest) to 4 (best) to ensure proper financial flows and reporting of transactions and cash flows and to maintain fair disclosures of risky assets and off balance sheet products. The rating comprehends the wholeness of the technology ensuring that it complies with risk management pricing and it connects back, middle and front offices. The rating evaluates if the technology maintains security barriers between front-end trading and independent risk pricing verifications. The rating methodology assesses on whether the technology includes abilities to audit, comply with Basel, AML, Know Your Customer, credit risk collateral assets calculations, Sarbanes Oxley, market risk stress testing, scenarios, Greeks and mark to market validations. The rating also checks for gaps between finance and accounting with middle operations to ensure that all financial flows in various currencies, classes, accounts, onshore and offshore are captured.

Qualitative Rating of Infrastructural Architectures:

- ✓ **Level 1:** The vast majority of the systems and technologies are not infrastructurally clean and fully integrated; one to two of the business lines' lists are dependable on the system 2.5. Other business lines have to purchase other modules and systems from other companies to comply with their own departmental compliance or technical requirements. Thus, the more there are

patched modules from diverse companies, the less operational the infrastructure becomes. This type of infrastructure incurs operational gaps between people, departments, business lines, systems and reports. There are difficulties in integrating all the business lines and functions together, and there is not full connectivity flow and operational smoothness. At this level, not all financial transactions are flowing and recorded. Security barriers between legal entities are not all established to protect information, network access and conflict of interest. Corporate environment is automatically characterized as inadequate if it has been under numerous mergers and acquisitions of portfolio, funds or entities during a limited amount of time.

- ✓ **Level 2:** Three different departments or business lines depend or rely on the application to perform the respective job. A technological system is able to provide most departments of a company with all the adaptable business functions and types' specific tools. Some technologies are modules and building blocks to mold to specific types of financial products and/or departments or business lines depending on budgetary constraints. Some systems are fully integrated and sold as is. Companies are stand-alone entities still not fully integrated with larger institutionals and exchanges. Technology entities have somewhat of a connection; however there is no logical flow between entities, and there are many overlapping inefficient tasks. Some entities operate services without value-added verification means such as fund administrators who provide prices usually fed by fund managers. A third level of independent verification would be proactively value-added. Few technologies have complete infrastructure intra- and inter-connections and fulfill all departmental tasks or business lines' job descriptions. Fewer than 10 percent of the total technological applications are complete; more than 10 percent are complementary of each others.

- ✓ **Level 3:** Technologically sound tools for all departments, products and business lines. Few operational risks gaps between business departments, systems, technologies, servers and entities. At that level, entities are connected with larger institutionals and exchanges and transactional financial flows incur low operational risks. Security barriers protect conflict of interest and information between legal entities. A minority of the technology and system only ramify to all entities with keen security access.

- ✓ **Level 4:** All parts of the business are technologically and fully integrated with low operational gaps and full connectivity between all entities to ensure smooth financial transactional flows and smooth information ramifications. In these categories, there are low instances for operational failures. Systemic translucency and transparency best characterizes the infrastructural architecture. Very few enterprises globally connect to all entities without

overlapping and duplicating tasks and works. All entities are ramified and fully connected within clean efficient infrastructures.

2.6 Technology: Risk Management System and Framework

Some technologies are Web-based platforms and do not respond to value-added quantifications of risks. These informational qualitative reporting tools will soon phase out into a greater scheme of technological quantitative analytical tools enabling the collection and quantification of capital at risk from unfixable operational risks.

The technology's types of risk management abilities are also rated under the following conditions and/or completeness of risk tools:

- ✓ **Market risk analytics**: Market risk analytics provide intra-day interactive mark to market verifications and Greeks' calculations, scenarios, stress testing parallels and yield shifts' scenarios, value at risk under historical data and Monte Carlo simulations.
- ✓ **Credit risk analytics**: This framework allows institutions to create and deploy internal rating models based on both quantitative and qualitative criteria. The risk management system and framework enables hedge funds an optimized calculation of required regulatory capital across any reporting jurisdiction. Credit risk analytics' tool produces expected default frequency and severity credit measures for individual borrowers. The framework produces estimates of loss in the event of default. Credit risk analytic tools provide implementation, modeling, portfolio advisory and benchmarking services for the banking industry. Some technologies enable managers to net all hedging legs and search for adequate hedges for those net naked positions. At the hedge fund levels, there are no reconciliations of hedges for all strategies. Each fund is viewed as a separate strategy, but with rising credit risk standards, matching trades and hedges' tools are more adequate. (See Chapter with regards to credit risks in hedge funds). This module includes the monitoring of various counterparties' downgrades or upgrades and the adjustments of respective credit risk exposures with respect to these legal entities.
- ✓ **Legal and Compliance Risks**: The legal and compliance risk framework enables one to advise and capture trading deviations, inconsistencies in trading strategies and products' usage as agreed per initial trading agreement. System is able to flag out of scope risk appetite in positions size, to limit leverage, to monitor volatility of

products' returns ranges. Compliance testing software also must ensure that proper registrations are performed with the adequate authorities: NASDAQ, NYSE, CTA, CPOs, Sarbanes Oxley SOX 404, Long Form reports. Another part of this platform enables users to update modules with antimoney laundering laws, Know Your Customers' rules, Users' Identifications and Level of Information Granted.

- ✓ **Operational and Systemic Risks**: The operational risk framework enables to monitor all parties' infrastructural inefficiencies and it remedies to escalating to technology team and/or peer groups. For unresolvable unfixable audit issues, risk must be accepted and capital at risk must be allocated to quantify for adverse potential losses. The technology enables the user to install key risk indicators to measure operational gaps between systems and processes.

- ✓ **Risk Ratios**: The technology allows the manager to compute various risk ratios such as: average monthly gain, average monthly loss, compound geometric average monthly return, monthly standard deviation, gain standard deviation, loss standard deviation, semi deviation, skewness, kurtosis, sharpe ratio, calmar ratio, maximum drawdown, gain to loss ratio, beta, annualized alpha, treynor ratio, jensen alpha, information ratio, up capture, down capture, up number ratio, down number ratio, up percentage ratio, down percentage ratio.

- ✓ **Transparency Test**: The technology enables the user to access library of algorithms and tools with ease. The system has adequate barriers of access for specific users in order to limit independencies between internal and external entities. The technology complies with adequate security identifications' accessibility.

- ✓ **Statistical Graphing Tools**: Statistical graphing tools enable to construct mathematical functions and they use best fits' plugging to derive a mathematical equation. The technological tool also gets valued added factors if it is able to forecast and construct expected functions.

- ✓ **Accounting, Budget Risk and Finance**: Accounting, finance and budget risk framework allows the system to budget risk and to capture incomes from realized trading operations, fees and commissions. These finance tools also monitor expenses and create adequate statements of cash flows. On and off balance sheet reporting is also part of this module. The system ought to have the ability to comply with

International Accounting Standards and treatments of risk exposures' hedging. (IAS 1-41, FASB 133).

- ✓ **Audit Risk Trailing and Recording**: The technology enables the manager or trader to record steps and verifies adequacies of trading with independent third parties such as auditor or risk manager.

- ✓ **Database Maintenance**: The technology enables data quality, data verifications with third parties and data capacity holding for a given number of years. Upon mergers and acquisitions, data does not always get fully integrated, cleaned and reclassified with new larger set of data. The technology solution has database capacity to hold significant amount of memory.

- ✓ **Archiving and Data Maintenance**: The technology is able to archive documents and index them in such manner that one could retrieve information logically, rapidly and easily. The archiving system enables users to collect information and data historically and to manage data electronically.

- ✓ **Administrative Functionalities**: The technology is structured in such a manner that it is adaptable to perform administrative, secretarial and bureaucratic functionalities.

- ✓ **Liquidity Provider or Market Maker**: The technology may be scalable enough to enable direct provisions of liquidity with technological connectivity to large institutional or private market makers.

- ✓ **Information Technological E-connectivity Infrastructure**: The technology must be adaptable to connect to as many entities and as many geographical servers with efficiency. The technology's ability to connect and integrate to exchange and prime brokers using Fix protocol messaging also gets value added grading on the scale from 1 to 4. The sole usage of Excel spreadsheets only without added software and technology gets no more than a factor of 2 rating on the global technological qualitative scale. Excel spreadsheet models are difficult to integrate into larger e-connectivities and to link their feeds to larger institutional technological platforms upon settlements and clearing of Excel spreadsheet trades. They do not account all the complex risks and are not stable for excessively large portfolios' intraday pricing. In this category, security barriers also must enable separations of duties between front end trading and middle and back offices' pricing verifications' tasks.

- ✓ **Energy Risk Physicals, Delivery and Transportation**: The technology supporting the trading of physical commodities requires significantly different interconnections. If mixed to financial institutions, those technological schemes are subject to higher operational risks and thus get a downgrade on the qualitative scale. If traded alone, commodities' products and technology get a higher grade. Also, commodity and energy risk management products ought to include a scheduling, transportation monitoring tool and physical delivery validating tool to ensure that speculative energy and commodity prices fit the actual tangible products' valuation models and quantitative financial engineering analytics for matching of collateral assets' valuations.

- ✓ **Fiduciary Risk**: Technology models and products aim to reproduce models and quantitative analytics in line with efficient market risks' outcomes and in line with users' trusts and confidence put in the result of the technology products. Any distorting, glitches or weaknesses in the technology products ought to be signaled or warned as part of the fiduciary agreement between the producers of the technology products and the risk users. Some models are more conservative than others depending on the assumptions and benchmarks. Note there are no global governmental body as part of the international security convergence task force to monitor the population of limited technologies and systems that contribute to markets' parameters' library. There are a few associations and organizations that are made up of those institutional private firms and therefore are highly biased.

- ✓ **Collateral Risk**: Technology models and products offer the opportunity to reconcile legs of various hedging strategies. The technology is robust and uses drag and drop fields to create reports to reconcile individual trades' assets' valuations between two counterparties or legal entities. The technology module offers the opportunity to add limits to monitor margin calls in case collateral valuations are being surpassed and liquidity or capacity is no longer sufficient to meet margin calls.

Technological Qualitative Scale Methodology:

- ✓ **Level 1:** The majority of the systems and technologies aim at covering *just one type* of risk. Most technologies include market risk principally because it used to be required by regulations in large scale financial institutions to apply minimum standards such as value at risk, stress tests, scenario, and Greeks. Now that enterprise environments have

changed, some companies (a minority) take the initiative to comply with more risks such as credit, compliance, fiduciary, operational and systemic. Some technologies are solely market risk tools; others are operational risk monitoring devices; while some are only credit risk focused. In this category, the technological application only covers one specific type of risk management function and thus implies further operational risks in the ramifications and connections with other systems and technologies. In this particular category, chances for operational gaps and failures are high. The infrastructural architecture is defined as a patchwork of modules and building blocks with significant potentials for operational transactional failures. Other types of risks are assumed by specific departments without clear verifications of risk consistencies and upgrading industry education about progresses, scientific and compliance changes and advances.

- ✓ **Level 2**: More and more technologies and systems cover in their packaging tools, *at least two* types of risks which are mostly market risks and operational risks. In some cheaper more budgetary constraints' environments, operational risk management is assumed by audit. In this category, fewer than three types of risk management are covered.

- ✓ **Level 3:** Lesser technological infrastructures deal with *at least three types* of risk management but fewer than four. In most funds and institutions, market, credit and operational risks are covered by separate entities and rigorously applied. Additionally, compliance risk management is part of the office of the council or legal department.

- ✓ **Level 4:** Very few technological infrastructures include all risk management tools and deal with market, credit, operational, audit, legal, reputational, compliance, data, statistics, accounting, liquidity and product types of risk management. In this category, *all risks* are covered and verified with independent internal and external risk engines and transparency enhancers.

2.7 Quantitative Abilities

The technology has defined analytical quantitative modeling capabilities. The scaling from 1 to 4 reviews the analytical abilities from Excel programming to full scaled technological programming algorithmic engines (Mathematica, Algorithmics, Moodys). Trading systems are considered quantification risk technologies if they have an independent risk verification team; otherwise, they qualify as front-end solo trading operators, or liquidity market makers. A full or most comprehensive quantitative models' list of various financial derivatives gets completeness of grade

of 4. Very few systems have embedded quantitative requirements imposed by Basel Pillars II and III. Additionally, few have embedded algorithms include:

- ✓ Black Scholes
- ✓ Cox Rubenstein
- ✓ Black Litterman
- ✓ Interest rate models such as Black, Hull White short rate (1 and 2 factor), Black Karasinski short rate (1 factor), Two Additive Factor Gaussian short rate, Libor Market Model (BGM/J), Heath, Merton, Jarrow.
- ✓ Garman Kohlhagen
- ✓ Cross currency multifactor hybrid IR/FX
- ✓ Credit Derivative Models (displaced diffusion model for CDS index options Liu and Jackel), and Multi-period credit index model (Hull White)
- ✓ Black Karasinski Model
- ✓ Spot Skew Model
- ✓ Black Derman Toy Model
- ✓ Classic Brace Gatarek Musiela Model
- ✓ Shifted BGM Model
- ✓ Stochastic Volatility BGM Model
- ✓ Generic Tree N Factor Models For Multicallable Exotics
- ✓ Longstaff Schwartz Method
- ✓ Whaley Adesi
- ✓ Roll Geske Whaley
- ✓ Hybrid credit risk and interest rates risk models with deterministic and stochastic components
- ✓ Gaussian and t copula Model
- ✓ Multiperiod Simulation Models Hull White
- ✓ Twisted Monte Carlo Simulations
- ✓ Direct Grid Convolution
- ✓ Fourier Laplace Transform
- ✓ Asymptotic SaddlePoint Methods
- ✓ Dupire Volatility
- ✓ Heston Model
- ✓ SABR Model

Quantitative and Analytical Scale:

Level 1: The vast majority of the technological engines have limited quantitative analytical abilities and large scale capacity. Typically, funds and institutional funds rely on Excel functions and access queries to reproduce quantitative models. In this category, no independent technological engines are applied. Qualitative infrastructure of quantitative modeling is very low. Quantitative models embedded in technological systems are not verified and are

not independently rated. The mathematical models in this category are copies of another algorithm on the market, subject to potential litigations and intellectual property rights' violations. Quantitative structurers typically bring new models and pay off formulas as they change firms. The technology in this category has only one specific pricing model and applies it to many products and business' lines without verifications and adaptations. This category does not have a quantitative risk management team or independent analytical research.

Level 2: Lesser of the technological tools are qualitative verified and independently modeled by researchers. This rating also counts two pricing models in the library and has an independent quantitative research analytics' department.

Level 3: Fewer of the technologies own three or more pricing models in the quantitative library and have an independent quantitative analytical risk management department. All models are archived in electronic filings in a compliance database. Quantitative payoff formulas and models are tested and reviewed on an ongoing basis.

Level 4: Near to none of the systems and technological tools have all the complex derivative products pricing models algorithms and a supportive quantitative team of analytical risk management engineers to enhance upgrades and invent new models. This category owns its proprietary quantitative risk models and research.

2.8 Qualitative Grading: Reasonableness, Consistency, Accuracy and Completeness

We just evaluated the technology and system with regards to:

- ✓ Product types
- ✓ Compliance and corporate governance (all policies)
- ✓ Scalability or capacity of national to international business expansion
- ✓ Reliability
- ✓ Business enterprise integration (few operational and systemic gaps between entities upon mergers or acquisitions, all departments are smoothly updated with new sets of data)
- ✓ Infrastructural interfaces (all business lines and departments are affected)
- ✓ Risk management types (all types of risks are covered and applied)
- ✓ Quantitative abilities (all mathematical financial engineering models and algorithms)

The technological framework is to be defined as complete or incomplete. Completeness comprehends a 3 to 4 qualitative grade in all aspect of the review. Otherwise, if at least one of the aspects is not met, the system is incomplete or insufficient.

Level 1: In this category, technology and systems are qualified as incomplete in products' coverage, partial and insufficient geographical services' coverage, inaccurate unverified quantitative model applications, inconsistencies in technological and systems tools usage or unreasonableness in technological applications. Many applications are not feasible to meet any of the four criteria in completeness, consistency, reasonableness and accuracy. Some applications in this category only meet one of the four qualitative attributes. Many energy and commodities' technological tools also trading financial products use the same financial models without independent quantitative models' validation. Those tools rarely include credit risk applications to calculate collateral tangible asset valuations, transportation costs, scheduling and delivery of physicals. Industry regulations do not enforce independent qualitative and quantitative model validations and, thus, quality downgraded with times. About 80 percent of technological tools are complementary of one another but very few have even two of those qualitative attributes in completeness, reasonableness, consistency and accuracies. Most of them are reasonable but incomplete in product types, risk management functions, geographical coverage or inaccurate in inefficient markets, inconsistent across industry applications and usages. At this level, technology and system outcomes are misinterpreted and mismanaged. This level also implies significant operational risks such as gaps in modules' connections between back, middle and front offices but also between inter-entities or outsiders (fund administrators, prime brokers, auditors, market makers) and internal departments. Responsibilities' levels and ownerships of risks are undefined and unclear.

Level 2: Fewer technologies and systems have two of four of the factors. Very few in this category are complete in product types, model library, risk management types and geographical coverage. Very few are also validated for quantitative accuracy, precisions or model validations. Many use and apply technologies across various very different industries without regulatory testing and approval; and thus have inconsistencies of applications and limitations. Risk ownerships at this level remain partially defined and translucent. Infrastructural interfaces are not all connected; operational gaps subsist between back, middle and front offices and/or with external entities. Integration of all risk modules is subject to operational failures and incomplete transactional flows and cycles.

Level 3: Fewer technological tools comply with three of the factors. Risk ownerships are assigned between specific entities and distributed among heads of

each department. In this category also, qualitative factors are mostly met but in insufficiencies and partially in each of their descriptive attribution. Models, types of products, geographical coverages, types of risk management functionalities and connectivities are all near qualitative but imperfect and partially rated as good. Connectivities are smoothed between internal entities and external infrastructures. All servers are connected and security barriers are implemented to separate independencies of duties and risk ownerships.

Level 4: Near to none (none) of the system and technology comply with all four qualitative criteria: completeness of product types, of quantitative models, of geographical distribution, of risk management functionalities (market, credit, legal, compliance, audit …), reasonableness of usage and applications, consistencies of usage and applications and accuracy of purpose. Very few systems and technology appear to fulfill all those qualitative factors. Risk ownerships are rotationally defined and shared. Infrastructures are technologically sound and transparent. Securities barriers are implemented to define departmental responsibilities, independencies and objectivity of tasks. Full integrations of servers and accessibility permissions are independently monitored to ensure information sharing levels between onshore, offshore, prime brokerage, fund administrations, exchanges, institutional custodians and investors.

2.9 Geographical Operational Coverage and Distribution

The technological tools must be supported by adequate personnel to implement and service the ongoing upscaling and integration of the information technological environment. New products, models or algorithms might need to be integrated, and adequate technological support must be able to upgrade the technological infrastructure. The technology tool must also have adequate servers' abilities to simultaneously dynamically update all synchronized information. The tool must be adaptable for both offshore and onshore areas. A geopolitical map of the operational risk infrastructure is provided.

Geographical Scale:

Level 1: Just one region, nation or specific country is locally distributed. Technology solutions have low geographical exposures to expand services and distributions. Ongoing service support is not adequately dispatched across significant and spread out geographical regions. Global adhesions to standardize the product are low and unsuccessful as the company does not have international satellite offices. Technological and system firm focusing on national clientele falls under this category and does not go beyond global standards for regulatory upgrades, usage adequacy and feasibility. Technology does not go beyond global standards for regulatory upgrades, usage adequacy and feasibility. Technologies

are country specific and are limited to a specific distribution language application and/or of types of clientele. Of the 10,000 hedge funds' universe, very few end up spending extra budgets on improving risk management infrastructures. Eighty percent of the small- and medium-sized hedge funds operate with Excel spreadsheets and limited intranet applications. They may or may not have extended networks but operate under limited conditions with maximum capacity. The vast majority of those small- and medium-sized funds operate with poor risk management infrastructures. Some hedge funds focus on global investors with only one office; and thus operational risks are not known, and servers ramifying all accounts between onshore and offshore are not connected with independent security barriers and validations' means.

Level 2: The technology and system company covers two regions countries or continents in this context (for instance United States and China) to implement, apply, distribute and service the tools. For instance, technologies and systems developed and created in the United States also tend to have distributions in the United Kingdom. Or those in the United Kingdom also may have distribution centers in Australia or Hong Kong. In this category, there are two points of geographical coverages. Very few hedge funds spend at improving infrastructural technological framework and on quantitative engines to independently calculate risk scenarios and measures. Near to none of them that have satellite offices in other regions calculate a global capital adequacy reserve that gets shared on regional basis. The main purpose of using various geographical regions within the hedge funds industry is to leverage from trading inefficiencies between two markets. Inefficiencies may be in equities' products, time zones, differentiations of interest rates and/or foreign exchange valuations. Risks are much greater, yet no specific legislations are required with regards to risk taking and technology primarily because there are no smooth specific international policies' frameworks with regards to convergence of macroeconomical standards. Yet the vast majority of hedge funds typically have one onshore headquarter and one offshore operation centers such as Bermuda, Cayman, Virgin Islands, Bahamas, Gibraltar or Cyprus with limited technological sophistications, supports and services. Very few are required to report all their ramified entities to any specific regulators. They may all operate together but yet independently of each other, creating more or less more economical market risks' gaps between their respective regions. Independent quantitative models' verifications, as well as derivatives' products pricing validations never occur in those offshore principally from inadequate technological companies' presence. Ten percent of the hedge funds' populations operate with adequate, good and sound regional support in both onshore and offshore. The vast majority of the hedge funds do not have technological means to verify quantitative models and independent pricing technological tools especially so in offshores.

Level 3: The technology and system company owns operational offices in three regional zones such as for instance: United States, Europe (UK or another country) and Asia (Singapore or Hong Kong or Tokyo). Hedge funds are not as well equipped as banks as far as technological tools are concerned primarily because hedge funds are limited in capacity and size. Software, Excel spreadsheets and intranets are the main tech tools of alternative investment managers. Besides, regulations do not enforce hedge funds to spend on infrastructures and qualitative risk management tools. And so despite the fact that many technology and system companies have wide and broad regional coverage, their applications and distributions to the hedge funds' industry remains very low. Only very few of the listed technological tools are actually implemented in hedge funds as of 2006 primarily from insufficient risk management pro-activity in the industry and zero global regulatory benchmarks and minimum recommendations. Global technological requirements for hedge funds' platforms are not applied. Each regional office operates with its own way of doing business with total freedom.

Level 4: The technology and system company are implemented in all main global cities and regional zones. Largest qualitative technological firms have offices in United States, South America, Europe, India, Middle East, South Africa, Asia and Australia. Additionally, to ensure qualitative ongoing technological support for upgrades and environmental testing of new models and tools, a few regional offices ensure follow up of customer services and support. While there are a significant number of technological firms selling risk management products, the few larger ones bought smaller ones to become as large as they are. Yet, their geographical completeness does not necessarily mean that they operationally are sound all around and that their infrastructure is totally transparent. In many cases, the buying and selling of entities becomes a compilation of patched modules that lacks insufficient full integration, smoothness and continual logical flow. Hedge funds ramifying all offshore with onshore systemic infrastructures with independent security barriers, and spending significant budgets on sophisticated proprietary engines are few. Only a small percentage of hedge funds use all modules and fulfill all technological, operational, architectural, systemic and infrastructural aspects. Institutional hedge funds depending on investment banks and using their proprietary technological risk engines are not qualified as a 4 but a 3 primarily because they are embedded with operational risks of the financial institution with suspect conflicts of interests at stake, sharing of competitive hedge funds' clients' accounts and information, as well as easy access to competitive market share intelligence of prime brokerage pricing and positions.

2.10 Enterprise Security Convergence Risk Standards

Hedge funds and institutionals sharing common technology are subject to e-technological issues such as intelligence, information flow from point to point and data ownership rights. ***International Enterprise Security Convergence*** *is defined as the identification of security risks and interdependencies between business functions and processes within the enterprise and the development of managed business process solutions to address those risks and interdependencies*. For instance, some jurisdictions are covered under secret banking laws to protect privacy and identification of customers' accounts and rights. Technological framework connected to those legal jurisdictions are compelled to share part of their information infrastructures with those other more open jurisdictions that require clients' background and personnel information sharing (U.S. Patriot Act, Know Your Customer Rules, European Savings Directive) versus Luxembourg Secretive Banking Laws or Switzerland Accounts' Privacy Laws. The flow of e-information from point to point of connectivity has a defined enterprise risk owner depending on what point of the e-connection the information is stored; this new era challenge is also part of the global web regulations' framework for dealing with enterprise security and governmental ownerships of data. Additional technological barriers of access are installed for such circumstances. Technology servicing cross borders' entities is subject to comply with new particular security risk convergence requirements such as:

a) Physical security management
   - ✓ Card issuance and revocation
   - ✓ Access device monitoring
   - ✓ Access violation handling
   - ✓ Journal management
   - ✓ Emergency access process
b) Corporate security management
   - ✓ Criminal investigation
   - ✓ Policy development
   - ✓ Employee security
   - ✓ Ethics investigations
   - ✓ Security audits
c) Information technology security management
   - ✓ Firewalls
   - ✓ Antivirus and vulnerability management
   - ✓ Intrusion detection and prevention
   - ✓ User access management
   - ✓ Backup and recovery

Enterprise Security Convergence Rating Scale:

Level 1: Targeted enterprise at risk complies with only one of the three types of security convergence: physical security management, corporate security

management or information technology security management and complies with only one of the subdefinitions. For instance, a hedge fund may only have employee access cards and follow lame enterprise technology criteria. Of the global universe of hedge funds and interdependent dealing institutions, none of them are enforced to comply with all security convergence characteristics as they are budget constraints. About 80 percent of the hedge funds incur poor enterprise security convergence quality.

Level 2: Hedge funds comply with two types of security convergence and insufficient completeness of underlying characteristics. However, due to their costly budgetary constraints and competitive intelligence information and market share, fewer hedge funds comply with qualitative security convergence standards. This is considered to be a costly not required not enforced value added services that most investors do not question.

Level 3: Hedge funds comply with two types of enterprise convergence standards and all underlying characteristics. About a minority of the hedge funds fall in this category and there are primarily those directly ramified with large institutionals such as exchanges.

Level 4: Hedge funds rarely apply all three categories with all underlying criteria to fully comply with international security convergence standards. Maintaining securities' standards are costly and because hedge funds are not required to hold minimum standards; they tend to cut corners to prioritize on trading and front-end returns instead of cost centers such as complying with securities' standards or risk management of information flows. Not until hedge fund managers will realize that eventually, they will have to protect themselves against market hackers who access their insider information to trade against them competitively in the same market space.

2.11 Third Party Implications: Conflict of Interest

To achieve state of the art technologies without any ambiguous relationships between the client and the systemic solution provided, the technology tool should not be involved in the selling and buying of securities or any sorts of financial products. Selling a technology and financial products at the same time implies access to special information of clients such as prices and positions using the systemic technological solution and leveraging on this client's insider information to resell identical financial products and act as a direct competitor of the clientele's market. On one hand the technology is a product that services the client in risk management or pricing or whatever else, and on the other, it is a spying tool to access clients' prices and positions to trade against that client in the same of market or in other markets to competitively outscale the client. Many clients ought to not use a financial

institution to purchase a specific technology system because the financial institution will access the client's prices or positions or strategies and it increases its chances of conflict of interest by using this information against the clients for the benefit of the financial institutions. A technology company ought to remain a technology company and nothing else not a seller of financial products and nor a rating agency product lines. Global mergers and acquisitions, since the '90s, have destroyed internal operational risk frameworks if they are involved with a second or third party product line. Another kind of conflict of interest involves technology companies and rating agencies. For instance, rating agencies may purchase technology products' lines or technology companies to access their market customers and to upgrade ratings of their actual clients if they purchase the technology products. For example, Fitch Rating Agency purchased Algorithmics, NetRisk and OpVantage to rebrand and repackage the risk management products and sell their rating at a higher premium. Rating clients can purchase their Algo risk products in exchange for better rating and higher fees. Fitch Rating purchased Algorithmics in the beginning of 2005 for $175 million. On Aug. 10, 2005, Finextra and the Financial Technology Network, Fitch, bought, for £6 million cash and £ 625,000 in deferred income, ValuSpread which is a credit derivative pricing data business from Lombard Risk Management. ValuSpread was bought by FitchDerivatives to enhance its rating products' portfolio.

The following provides the scale to grade the various levels of conflict of interest and third party implications:

Level 1: A client purchasing a financial technology from a bank, a fund, a prime broker or any entity that is not a specialist in technologies but more a specialist in financial products. The entity from which the client purchases the systemic tool is mainly a financial entity susceptible to use the technology tools to access the client's prices and positions to trade competitively. This implies acting on insider information, breach of security convergence standards and higher risks to incur conflict of interests and reputational litigation risks. No proof of internal security convergence standards are included or proved. At this level, there are high risks for conflict of interest, stealing of information and insider trading breach.

Level 2: The client relies on financial institutions to provide the technologies and systemic tools to perform risk management or trading with some assurance of internal security standards to ensure that the financial entity selling the financial technologies to the client has some security barriers in place to avoid intra-enterprise flow of information and insider trading on client's prices and positions or corporate strategies.

Level 3: The client relies mainly on technologies sold by independent technology specialists, not financial firms. Most of the client's systemic solutions are provided by technology providers, not banks, financial institutions or others.

Level 4: All technologies used by the client are produced and sold by independent technology specialists who do not sell financial instruments and who do not act as a direct competitor of their client's market space. To achieve state of the art independence, it is best to rely on independent technology only from companies specializing in the production and maintenance of systemic solutions (not financial products).

The following financial banking institutions have intra-enterprise branches that do sell technology systemic solutions to leverage a separate business from their proprietary internal technologies: According to Wall Street and Technology, most large institutional firms such as Bank of America, Merrill Lynch, Goldman Sachs, Fidelity, Bank of New York, Bear Stearns and others are involved in the selling of their proprietary systemic solutions. For example, the following provides the name of the institutions along with their respective technologies: Bank of America Securities' Electronic Trading Services (ETS™) platform provides institutional investors with automated access to liquidity systems and venues. Barclays' BARX provides algorithmic trading across multiple asset classes such as equities, futures, fixed income and foreign exchange on the BARX platform, third party EMS vendors and via FIX. Bloomberg Tradebook AlphaPro is a suite of algorithmic trading strategies. Citigroup offers a global algorithmic trading platform to institutional clients. AES is Credit Suisse's suite of algorithmic trading strategies, tools, and analytics for global securities trading. UBS Electronic Trading Services has a platform for US, EU, Asia Equities, Options, Futures. LMX(tm) is Lehman Brothers' suite of model-driven order execution strategies operating in 19 countries. JPMorgan's Electronic Client Solutions provide a comprehensive suite of electronic execution products to institutional clients, including direct market and algorithmic access, pre- and post-trade analytics as well as a variety of algorithmic trading tools and services. Deutsche Bank's Autobahn Equity algorithms provide a suite of global algorithmic execution options. Goldman's multi-product global trading strategies for single stock and portfolio level execution are supported by a suite of analytics. All strategies take advantage of the aggregated dark pools of liquidity via SIGMA X, available in REDIPlus.

2.12 Price Transparency Framework

Even these days, price transparency remains a significant operational risk issue. The technologies' prices are not defined in any or very few technologies' software marketing materials. The technology firms are very opaque and usually fix prices by licenses depending on financial banks' deal sizes. The price may be defined as a bulk with models, hardwares, software licenses' numbers, insurance, customer services and over a period of years for an entire institution or by individual departments. Depending on the uniformity, standardization, consistency and

reliability of the pricing application to various clients, the technology firm may be getting a rating grade:

Level 1: The technology does not provide any transparency whatsoever about the various technology products it sells across various regions. The marketing materials do not indicate any ranges by regions about the technologies. Not only does the technology firm not provide any information about its pricing ranges, but it is also very unreliable and inconsistent in its pricing ranges. Depending on customers' abilities to pay, the technology charges different prices inconsistently. The technology does not have a pricing scale across regions to apply consistent prices and with respect to local regional market pricing levels (foreign exchange, clienteles, market shares, etc.). There are no pricing scales for various markets and it relies mainly on "black markets" wide operational pricing ranges. No pricing precisions or details are revealed.

Level 2: The technology has some pricing transparency, but it is inadequate, incomplete and/or only given upon request. The pricing information does not figure on the marketing materials and is only provided last in the dealing process. Pricing may be reliable but in some instances, it may not be applied consistently depending on the scale, capacity and size of the institution it services. At this level, the pricing framework is not scaled to accommodate thoroughly with other geographies. It is more or less pricing by customers' abilities. The pricing scale is more or less vague and leaves very wide open opportunities for changes, adjustments or and inadequate pricing treatments depending on customers' abilities or faces.

Level 3: The technology is providing on its marketing materials some pricing ranges in consistency with its applications with all customers. The ranges are adequate and are based on serious market study. At this level, the technology company reveals some pricing information or ranges for at least three regions of the globe. The pricing scale is adapted to local markets' currencies, needs and market shares' availability or concentrations. The pricing scale is not as precise and as detailed.

Level 4: This level has been unachieved. The technology company reveals complete marketing pricing ranges by geographies. The technology pricing scale is applied in consistency with its originally agreed pricing framework. The technology prices are reliable, transparent and consistent. The prices are the object of serious marketing studies depending on competition, supply and demand, and local regional markets' availability. The pricing scale is detailed as bulk or as individual parts. It is precise and detailed.

2.13 Final Scaling Grade

In conclusion, the following grading scale is the methodology to grade operational systemic infrastructures and technologies for hedge funds and other financial entities.

Level 1	**Level 2**	**Level 3**	**Level 4**
Weak Infrastructural Operational Enterprise	**Average Infrastructural Operational Enterprise**	**Good Infrastructural Operational Enterprise**	**Excellent or Best Infrastructural Operational Enterprise**

The author selected a sample of technologies and rated them according to the described rating scale. According to global results, she invented the following standards. By summing all points from each category for every respective technology system, the resulting scores allow to classify technologies and systems into the following category:

Level 1	**1,0**	**Poor infrastructure, incomplete. Needs more of other technology to accomplish corporate governance infrastructure adequacy**
Level 2	**2,0**	**Average infrastructure; highly incomplete and inadequate in products types, risk management types, infrastructural capacities, business lines' completeness, corporate governance lists**
Level 3	**3,0**	**Good or valuable: meet most of methodology list criteria and standards but incomplete**
Level 3.5	**3,5**	**Better than "good": near complete and totally adequate**
Level 4	**4,0**	**Excellent perfect, complete, adequate, tested—meet under all standards and conditions. Not really achievable**

The majority of the selected sample has at least one international satellite office and/or one international client. This is what differentiates from the actual reality upon which the majority of firms operate at national levels and do not have the capacity, the ability and/or the proven skills to operate abroad unless they are

majority funded by the headquartered companies. To comply with the convergence of globalizations' standards, we do not use those entities operating at national restricted levels and thus the results we obtain concern those entities operating internationally or having exposures to global markets or clients. In these particular conditions, we note that most entities are graded with levels 2 or 3 from "average" to "good." Some of the national entities are restrictive and thus are limited in scales and scopes of risk types, or corporate governance types. National restrictive technology companies also would not be compelled to be subject to all risk management types required by global regulatory entities such as Basel or Sarbanes Oxley. While in quality they would appear to be a 2 or 3, they could not be, in reality, a "real" representation for what constitutes global standards in quantitative infrastructural completion and qualitative wholeness. This is why we make such distinctions with regards to the selected sample we chose.

3. Author's Methodology's Results

The author selected 222 technological firms and rated them according to the invented above standards from 1 to 4. Individual results for various companies are available upon request in separate reports. The following results were obtained**.**

3.1 Financial and Commodities Products

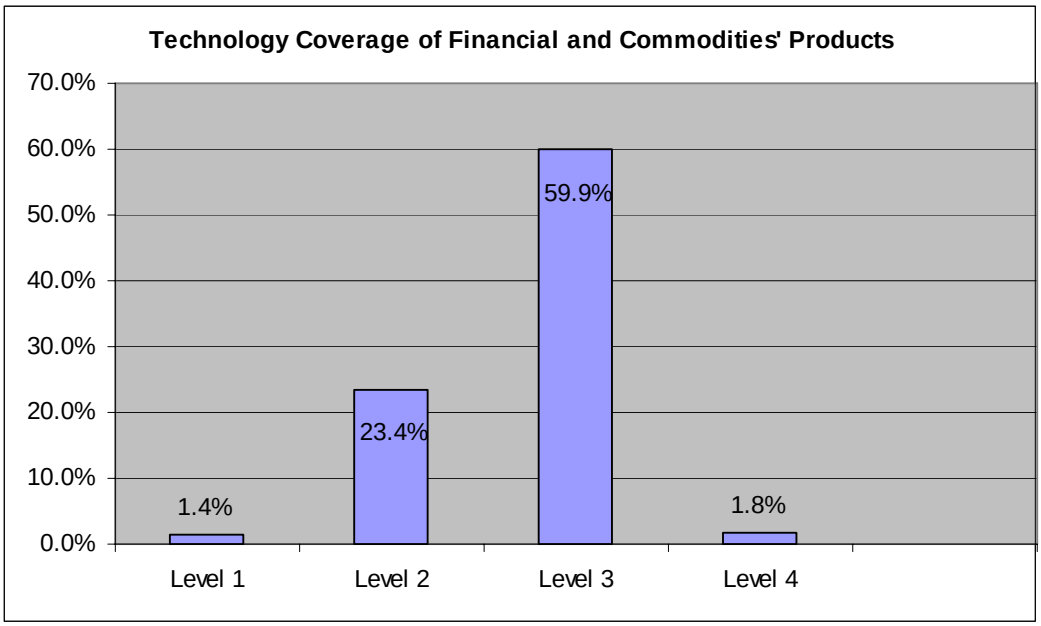
The systems' adaptability with all or specific financial products is assessed. In order to get a perfect grade, technology providers must provide substantial information about financial products' derivatives and alternatives and models. If the technology also includes algorithms for commodities and energy products, the system is subject to more operational risks' weaknesses if it does not have tools to perform scheduling and track transportations and delivery of physicals. Operational risks arise when energy and financial risks are mixed together and not able to accurately measure collateral risks' valuations from point of trading inceptions to delivery point of the commodity product. For a system or a technology to get a "4" or a "3," the tool would have to be able to price all products or and most products of each types: equity, bonds, interest rates, fixed income, foreign exchange, exotics, options, complex derivatives of those traditional asset classes and structured products.

Level 1: One to two types of products' category or assets' class. Only 1.4 percent of the selected 222 financial engineering technologies comply with all traditional assets' classes and fall under category 2.

Level 2: Two to three types of products' coverage or assets' class. Twenty-three percent of the firms comply with just a restricted list of assets' classes.

Level 3: At least three types of products or assets' class are priced or risk managed. System and technology is able to hold a significant representation of equity, fixed income, bonds, foreign exchange and interest rates' products with their respective derivatives. More and more financial technologies are fine tuning their library of products by adding more and more complex structures. Those models may or may not have been independently tested by independent objective quantitative analysts. About 60 percent of them comply with at least three major assets' classes and derivatives.

Level 4: All financial and commodities' products and their derivatives plus customized structured products' design. 1.8 percent are very sophisticated and also have adequate tools to measure risks of structured complex products.



Source: Author's technology database and findings as of 2006; technology database sample : 222

3.2 Hedge Fund Styles or Trading Strategies

There are very few systems and technologies specializing specifically in the hedge fund industry. Hedge fund managers use a combination of strategies, style, products, geography and industry or sector focus to define substrategies. For instance, strategies are convertible arbitrage, capital structure arbitrage, statistical arbitrage and special situations. Securities are product types, or asset classes such as equities, futures, corporate credit, options, interest rate products, etc. Styles are defined as short bias, systematic, low net exposure, etc. Geography is defined by a market focus area such as Asia, Europe, United States, emerging, etc. And Focus/Sector is defined by specific industry sectors such as health care, pharmaceutical, energy and

commodity, technology, small cap, high yield, etc. The author provides an independent study of hedge funds' technology specifically upon request.

3.3 Corporate Governance, Compliance and Regulations

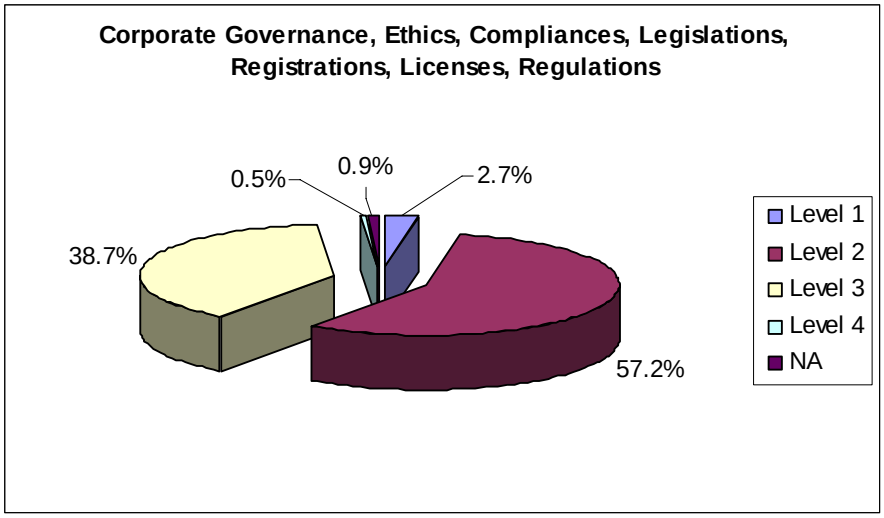
Technology is tested for compliance abilities, audit trailing, Sarbanes Oxley, data capacity and maintenance, International Accounting Standards, Basel Operational Risk Framework, capital at risk calculations, credit risk netting, ISDA, GAFI, KYC, AML, U.S. Patriot Act, self evaluations, scorecards and operational risk tools to monitor infrastructural and enterprise risks. Completeness of full compliance and corporate governance package is rated with a 4 while partial tools' options gets rewarded from a 1 to a 3 depending on the qualitative tools and their scalability to larger enterprises.

Level 1: Most technological and systems tools perform one or two of those legislations, laws, rules, compliance or reforms. Most systems and technological tools have an audit trailing and recording ability and have a database holding and maintenance capacity to comply with Sarbanes Oxley without explicitly complying to it. While most systems are risk management tools, they all partially complete the entire features with some better at capital at risk calculations and others better at data collections. Fewer have a combination of all tools: risk management, corporate governance, compliance tools, international accounting for hedging standards, taxes and audit tools. So, about 2.7 percent of the firms operate with minimum level of compliance or corporate governance types.

Level 2: A slightly narrower number of technologies have at least two or three features of the list. 57.2 percent fulfill at least two regulations—for instance Sarbanes Oxley, Basel, Audits, risk limit monitoring.

Level 3: Few have more than three but not all features. Those focus on the most important, such as Basel II, Sarbanes Oxley, International Accounting Standards IAS 39, 32, FASB 33, Capital Adequacy Requirements, Audits' Recording and Trailing and Basic Risk Management Limits. 38.7 percent comply with international accounting standards, capital adequacy regulations, audits' trailing and recording and employment laws.

Level 4: None actually have all compliance, audit, risk management, financial, trading registrations and licensing, human resources, employment labor rights and corporate governance tools. 0.5 percent contribute to the perfection of corporate governance and are susceptible to comply with all listed global enterprise regulations.



Source: Author's technology database (222) and findings as of 2006

3.4 Audits and Internal Controls' Policies and Procedures

Very few enterprises and hedge funds have an internal control system that differentiate fees and commissions from specific activities. Very few also provide transparency with regard to employees' expenses.

Most businesses have some sort of procedure for reimbursing the business-related travel and entertainment expenses of their employees. This practice creates an opportunity for dishonest employees to steal from their employers by claiming fraudulent expenses. Indeed, the 2004 Report to the Nation (U.S.) on Occupational Fraud and Abuse notes that the median cost to employers of a single fraudulent expense reimbursement scheme is $92,000. Enterprises do not have as of yet a standard system or technology to fairly estimate expenses and costs of average employee with respect to industry peers. The research provided by Perkins (2005) also shows that corporate entities do not have reasonable means to measure and distribute adequately expenses' proportions between clients and specific employees, and that there are no actual independent means to verify and control such potential corruptive abuses. Internal auditors are in direct conflict of interest for investigating such possible malpractices. Regulatory examiners seldom verify and investigate boards', employees' or clients' entertainment expense lists.

3.5 Information Technology Auditing Practices

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) does not provide specific information technology control objectives. There are some generally recognized standards that provide guidance on IT control

objectives. The Control of Business Information Technology (CobiT) is a recommended objective to improve industry standards. CobiT is a framework of IT control objectives and practices that was first published by The Information Systems Audit and Control Association (ISACA) in 1996. With over 25,000 members in over 100 countries, ISACA is the largest professional organization of IT auditors.
Yet, there is no independent international information technology regulator examining and validating the adequacy of the marketed systems. The marketing claims that many firms subjectively provide are not verified by any independent international entity as of 2006. It is also worthwhile to note that there are no actual international IT standards to impose specific qualitative guidelines around the industry and global markets.

3.6 Scoring Scalability: Business Expansion and Integration Ability

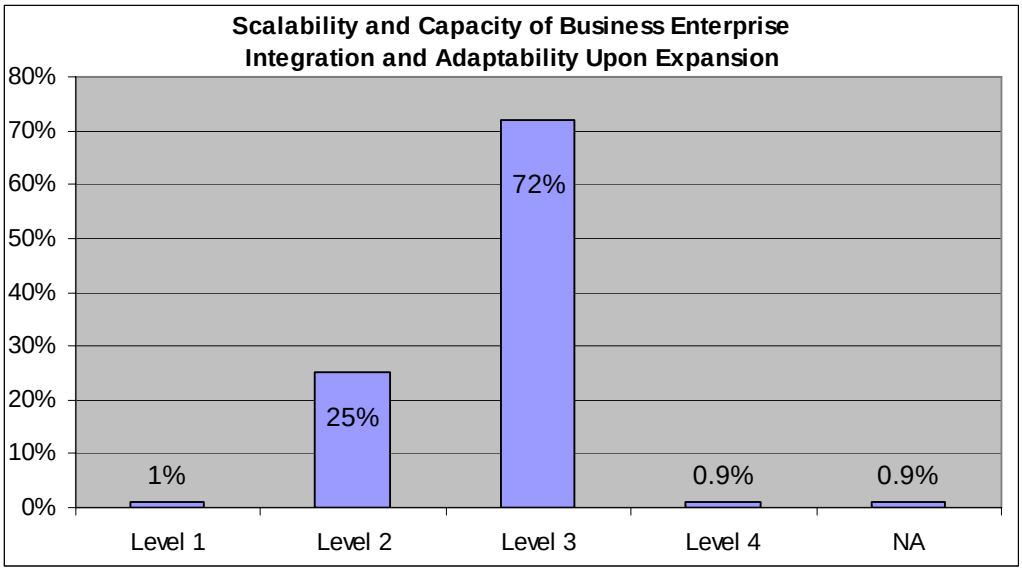
Level 1: The vast majority of systems do acknowledge having scalability but very few actually are able to expand business enterprise without major operational and systemic risks. Systems and technology are not scalable and highly restrictive to limited size of enterprise. If businesses merge and/or get acquired, the infrastructures cannot adapt and integrate with other parts of the enterprise. This level is best defined and characterized with Excel spreadsheet models which have high limitations. About 1 percent of the firms fall under this category.

Level 2: Databases' infrastructures do not have the supportive infrastructures to be fully leveraged and exploitable. Infrastructural technology does not adapt with patched other business entities that could merge or get acquired. This is one scale above the Excel spreadsheets' types of work environments with many surrounding information technology security weaknesses and possibilities for breaches. Quantitative and qualitative abilities to support significantly complex derivatives and large scale capacity of trades are very limited in this business environment too. This category of scalable infrastructure can only have a limited well defined number of business entities, products to price and manage and does not survive vast expanding technological competition. This category may be able to expand its business to a national level but is restricted with e-connectivity and e-platform flexibility. It has limited Web-based connectivity with peer institutionals and may incur operational and infrastructural risks if expanding beyond this level. Twenty-five percent of the technology firms are in this category.

Level 3: This category owns a proprietary information technology quantitative team that adapts, integrates and synchronizes operational infrastructures with current technological progresses. This category has the programming capacity to enhance technological architectures according to expanding business needs. Performing programs are adaptable and tested in most environments from small, medium to

large institutions. About 66 percent of the enterprises own their quantitative specialists, especially in the financial industry fall into this category. Hedge funds typically also have a minimum number of quantitative researchers to ensure model validations and "independently" test risk management systems. About 72 percent of the selected technologies are in this category and demonstrate reasonable adequate infrastructures able to scale with further business extensions.

Level 4: All parts of the enterprise are fully integrated, and the technology enables smooth transitions from business lines to new departments. The technology also avoids duplications of roles and tasks to maximize enterprise efficiencies and human resource usages. Adapted specifically to hedge funds, corporate scalability, at level 4, enables offshore and onshore to ensure that all financial accounts, funds, classes, positions and trades are hedged and ramified to master feeders to capture all financial transactional flows. As of 2006, no enterprise ran fully efficiently after merging and acquiring. They are still undergoing a phase of infrastructural and data clean-up, so no technology was rated in level 4. Fewer than 1 percent (0.9 percent) are able to fully comply with global enterprise scalability standards such as full e-connectivity with international exchanges, secured Web-based e-platforms, translucent IT fluidity throughout global enterprise infrastructural network.

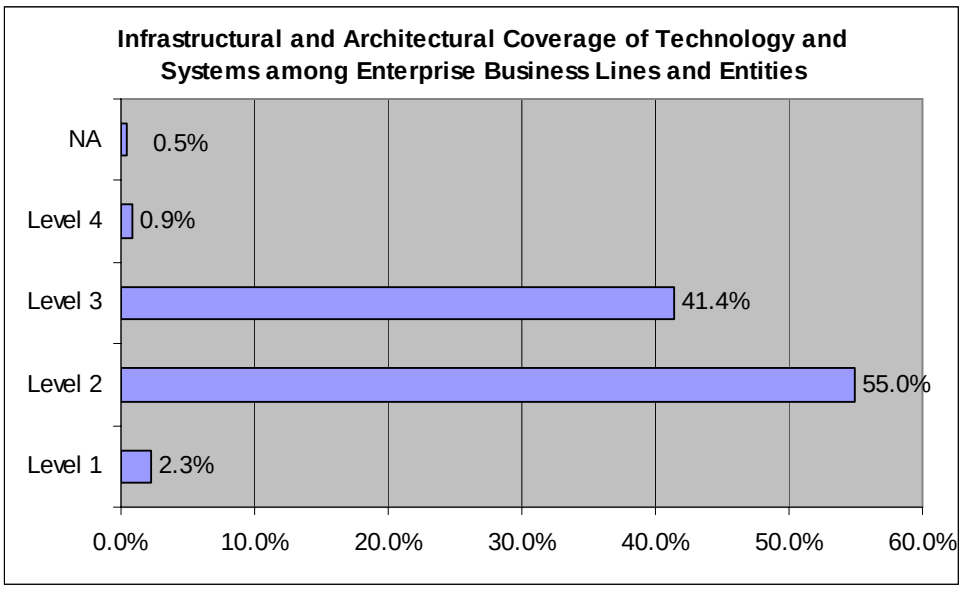


Source: Author's technology database (222) and findings as of 2006

3.7 Infrastructures: Business Lines

Hedge funds' technologies and systems must, at best, interconnect and interface with all of the following departments and business lines. 2.3 percent of the selected sample fall into the level 1 category, meaning those enterprises do not have

sufficient adequate infrastructures and rely more on patched modules, or packaged software limited to be infrastructurally integrated within the global scale. Upscaled state of the art e-connectivities dynamically updating all parties' informations' screens may be intra-enterprise dependent (inside the hedge funds' internal operations) and/or inter- or extra-enterprise dependent (outside the hedge funds). Most enterprises are not independently tested and verified by third parties and 55 percent of them fall into the average level 2 category primarily because most of the enterprises do not have full compliance with regard to information technology security barriers. Entities servicing back, middle and front offices incur conflicting interests and inadequate insufficient means between enterprise entities. 41.4 percent of those comply to some degree with technological protections and fulfill at least three various business lines or departments adequately. Only a tiny minority (0.9 percent) completely comply with all departments and business lines' needs.

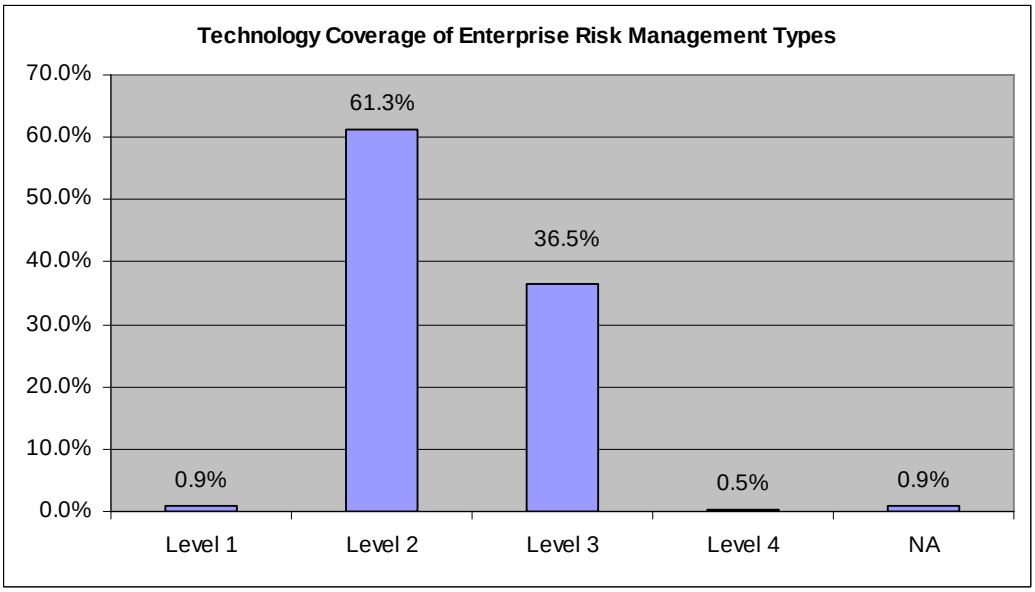


Source: Author's technology database (222) and findings as of 2006

3.8 Risk Management Types

The technology is to comply with various types of risk management such as quantitative, market, credit, counterparty, legal, transparency, fiduciary, volatility, liquidity, correlation, information ratio, data, statistical, models, financial, budget, operational and systemic risks. Depending on the number of risk management types, their quality and completeness, the technology tool is attributed a rating from level 1 (worse and most incomplete) to level 4 (accurate risk management and most complete). Only fewer than 1 percent (0.9 percent) of the companies still have archaic traditional old market risk management with basic value at risk calculations, Greeks, stress testing and scenario risk evaluations. Most of those upgraded their market risk management standards to add at least an operational risk line to monitor enterprise

risks. About 61.3 percent of the technology comply to this, collect data, and attempt to remediate to the infrastructural fragmentations caused by mergers and acquisitions, upgrading of technologies and enterprise evolutions. Those 61.3% entities are defined in Level 2 primarily because these criteria were required and enforced by Basel in the late '90s. Market risks goes hand and hand with liquidity and pricing risks directly linked to marked to market verifications. About 36.5 percent of technologies get an ameliorated version of market risks and expand their abilities to credit and operational risks. Those tend to be fully compliant with Basel II. Only 0.5 percent comply to all risk management types or level 4: credit, market, counterparty, collateral, technology, liquidity, Basel, regulatory, accounting, corporate governance, operational and infrastructural.



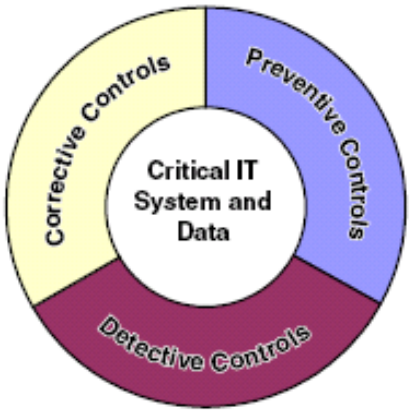
Source: Author's technology database (222) and findings as of 2006

According to the research provided by Syntex Management Systems in "Unlocking the Value of Enterprise Risk Management," enterprise risk management quantifies and prioritizes risks across main domains and defines two categories of risk management types:

1. Reactive risk management types that include asset damages, product quality (ISO 9000), security.
2. Proactive and prevention risk management types that include risk management technologies, systems, assessments, audits, operational reviews, processes' hazards, behavioral risk management and financial operations.

Michael Perkins (2005) defines in "Taking Control of your Environment: Regulatory, Compliance and Operational Excellence" various risk management levels to remedy to internal enterprise infrastructural processes:

- Preventive controls are intended to prevent or reduce the likelihood of a particular negative outcome.
- Detective controls are intended to detect and report that a particular negative outcome has occurred.
- Corrective controls are intended to minimize, remedy and correct for a particular negative outcome once it has occurred.

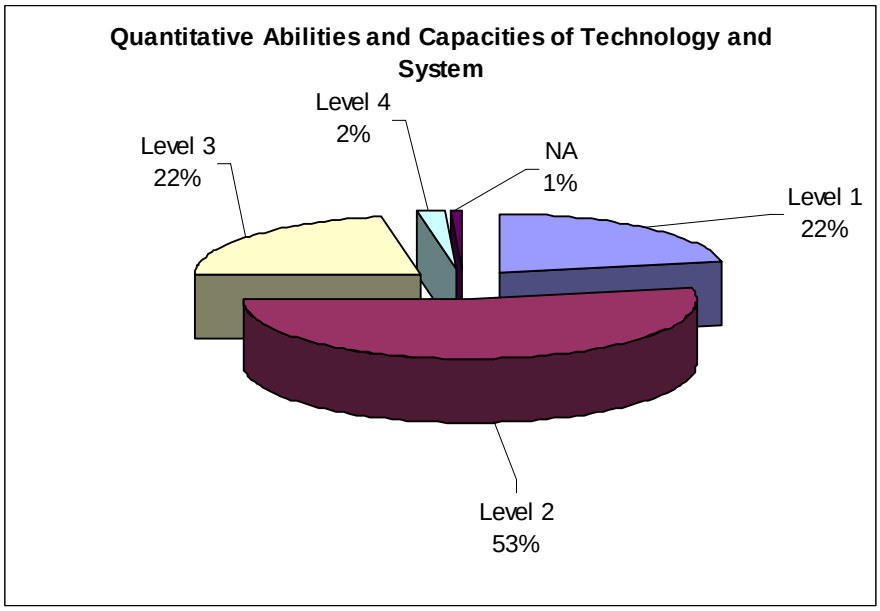


According to Mark Beasly's 2005 Enterprise Risk Management Report, about 50 percent of enterprises admit having either no ERM plans or had not decided yet to implement an enterprise risk management project or are thinking about it in the future. About 37 percent have incomplete ERM plans while 11 percent only dispose of a complete ERM system. A significant majority reports being in the process of ERM implementation and are ongoingly improving it. For instance, in 2005, only 12 percent of the firms have a substantial level of automated produced reports. As of 2006, more and more enterprises are getting away from Excel spreadsheets and are upgrading information reporting standards across global enterprises. According to the latest CFO study of the IBM Institute of Business Value, more than 75 percent of the studied finance departments support their company in designing an enterprise risk management framework and in developing a corresponding ERM culture. Furthermore, more than 90 percent of the involved finance entities already fully or partially manage compliance risk' while fewer than 70 percent manage event risk.

3.9 Quantitative Abilities and Programming Capacities

The technology enables the user to access customized programs and a library of models, algorithms that have been independently and objectively tested by third parties. Models are such that they do not provide the user with a financial advantage

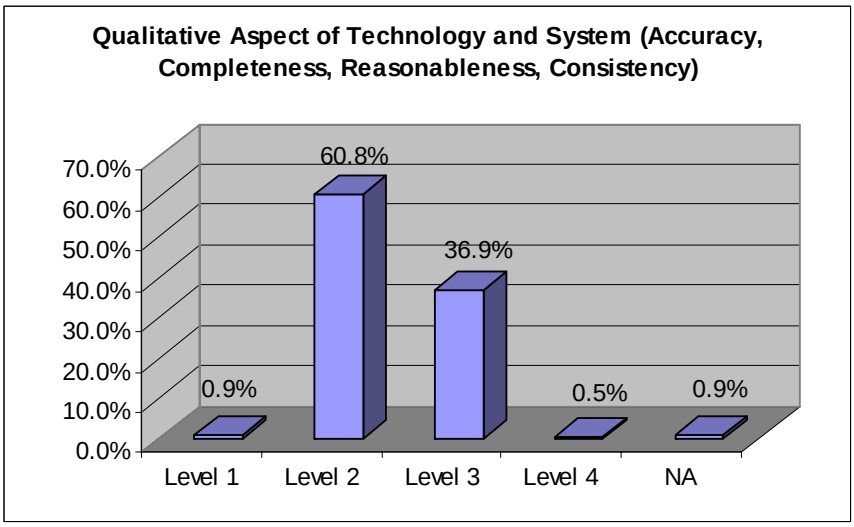
with regard to profits' generations. Level 1 or 21.6 percent will dispose of only one type of programming language and/or algorithms. Level 2 or 53.6 percent of the sample of technologies profit from at least two types of programming models, while level 3 or 22.1 percent is a better grade for disposing of more programming languages, mathematical models or algorithms to price more products accurately. Level 4 or 1.8 percent is a grade for having customized multiple programming languages and practically all financial engineering algorithms.



Source: Author's technology database (222) and findings as of 2006

3.10 Qualitative Aspect

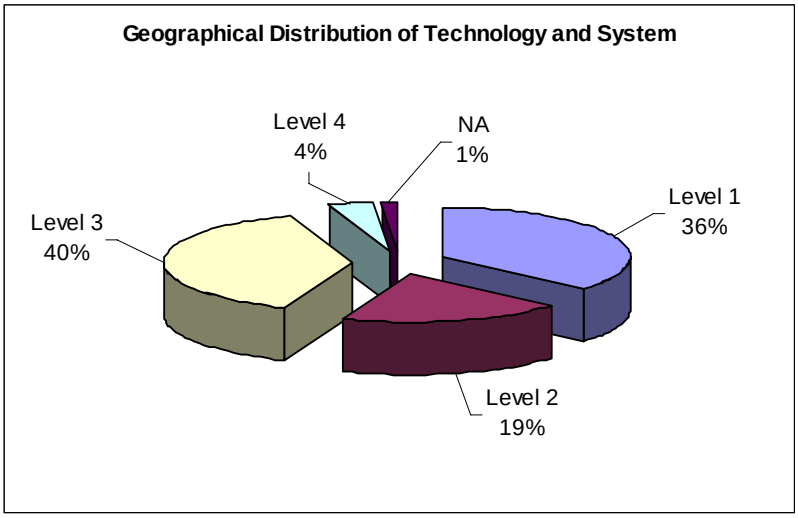
The technology and system is rated with regards to completeness of all rating aspects, accuracy of operations and results, reasonableness of goals and consistency of results and usage. Very few technologies, 0.5 percent, fulfill all criteria for all internal and external infrastructures, business lines, quantitatively and qualitatively. In fact the majority of the technologies (60.8 percent) are revealed to barely meet global standards and reach the level 2. 36.9 percent dispose of an ameliorated qualitative overall framework. Most of the technologies that have merged in attempt to get completeness failed at the qualitative infrastructural level while those focusing on customized services fail at being complete. The combination of both would result into a near perfect qualitative aspect of the enterprise infrastructure.



Source: Author's technology database (222) and findings as of 2006

3.11 Geographical Distribution

The technology and system company is distributed in three various continents and obtain a level 3 for being internationally distributed mostly in the United States, Europe and Asia. About 38.7 percent of the technology companies fall in this profile. Level 1 is more or less restricted and limited to "national" geographical distribution (one country can be appointed to represent "euro zone") and many companies (36.5 percent) are restrained to this class primarily due to economical limitations and regulatory barriers of operations. Only 19.4 percent of the technology firms comply to level 2 and expand operations to at least two major geographical zones, for instance Europe and the United States. Level 4 not only covers most continents but also has offices in emerging markets, countries at risk and sub-regional offices. Most companies now have distributions offices in two regions, primarily the United States and Europe. Those reaching that international level tend to quickly also develop and start an office in the Asia zone. Europe distributions focus near exclusively within Western Europe with the United Kingdom, as apparent from main European satellite offices. Very few install operations in Eastern Europe and fewer than 5 percent of the companies have offices in Russia. About 4.1 percent as of 2006 fall into a full global map distribution.



Source: Author's technology database (222) and findings as of 2006

3.12 Information Technology Security Convergence

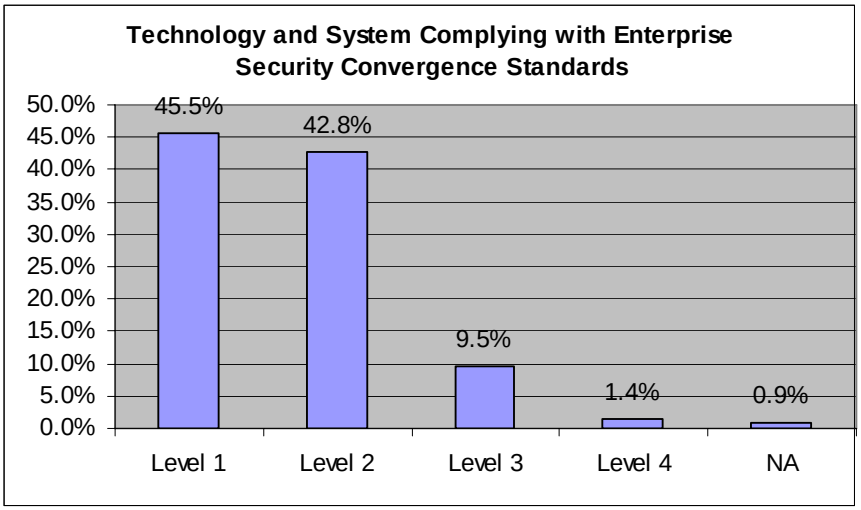
The technology and system complies with specific levels of the policy (level 1) or all levels (level 4) of the Information Technology Security Convergence policy with:

- Physical security management: card issuance and revocation, access device monitoring, access violation handling, journal management, emergency access process.
- Corporate security management: criminal investigations, policy development, employee security, ethics investigations, security audits.

- Information technology security management: firewall and VPNs, antivirus and vulnerability management, intrusion detection and prevention, user access management and backup and recovery.

These concepts are expensive and not well applied as of yet in large corporations. This is the type of criteria that is yet to be improved in the new era of global enterprises. This is the most important one and most neglected one also as of date. Very few enterprises comply to all aspects of this category. Most companies that operate at national levels do not yet foresee the need to monitor employees' identities, accesses or information risk management. Most companies comply to level 1 (45.5 percent) with basic firewall, identification cards and data management; 42.8 percent comply to two categories with, in addition to level 1 criteria, value added elements in policy developments and security audits and near to no enterprises fulfill level 3 (9.5 percent) and level 4 (1.4 percent). Some specific jurisdictions are very particular about electronic means of data transportations in Web and Internet

networks. For instance, data or information ownerships gets defined from points to points of the network from release of messages to reception. Also in most financial enterprises, internet messages going out to clients are to be encrypted and all mails get read and verified by enterprise third parties' agents.

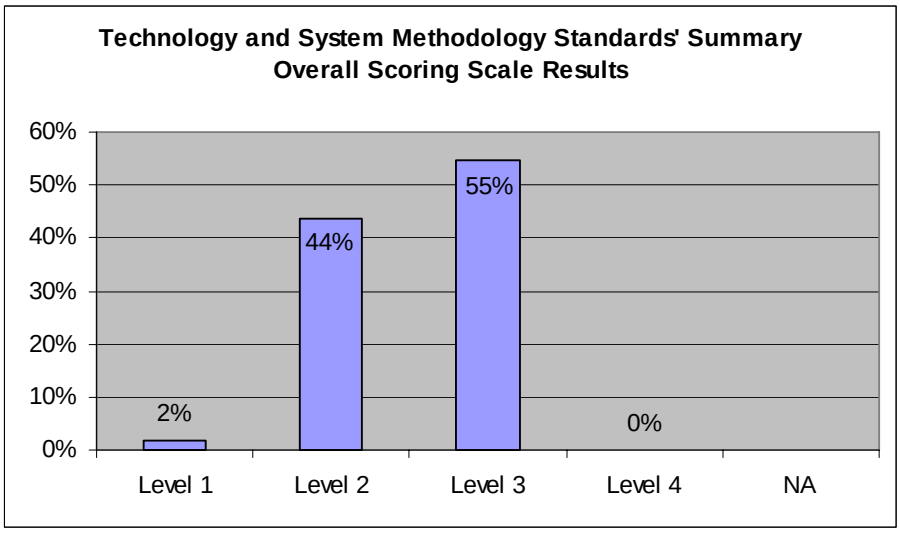


Source: Author's technology database (222) and findings as of 2006

The increasing use of electronic business communication and multiple data storage options for business records created substantial efficiencies for medium and large corporations. However, these new communication devices also altered litigations and compliance fields. Attorneys and legal councils now work closely with risk managers to avoid rising risks. Yet legal compliance officers do not have the aptitude to understand technological model pricing risks. Some systems do not replicate the same risk exposures as others depending on how their internal quantitative algorithms have been tested and validated. Electronic means to transport information and data suggest rising liability from sharing ownerships of data and exposures. Fulbright & Jaworski, an international law firm, reported in its 2005 Annual Trends in Litigation Survey, which found that nearly 90 percent of U.S. corporations were engaged in lawsuits, and that the average $1 billion company in the United States faces 147 cases at any given time. Electronic documents, information and data storage and maintenance also represent main challenges to general corporate counsels.

4. Conclusions

While reviewing all entities with specific conditions as noted in the rating methodology, we report that 44 percent of the technologies comply with average criteria and 55 percent of them mean to invest to improve qualitative and global corporate standards.



Source: Author's technology database (222) and findings as of 2006

None of them pass beyond the exceptional levels defined by level 4 primarily because they are either in a phase of cleaning their patchwork expanded infrastructures, incurred during mega-mergers, or they are too small or too specific or have unproven capabilities to enter that particular selective class. Conservatively, the author also found that fewer than 20 percent of the technologies are fully compliant with regard to International Accounting Standards (IAS) and International Financial Reporting Standards (IFRS), which were created by the International Accounting Standards Board to promote internationally comparable financial statements. Regulation 2002/3626 requires that some 7,000 listed companies in the European Union prepare their consolidated financial statements in accordance with IFRS/IAS. While some acknowledge complying, a vast majority remains incomplete with regard to global financial standards. As of Jan. 1, 2007, European financial institutions will have to be Basel II compliant and, as of 2009, so will American institutions. While data collection occurred, no standards with respect to actual technologies were created. And most of the technology companies discovered to conduct the study have been subjectively financed by U.S. and U.K. firms despite the latest offshoring of customized systemic tools based in India. The validation of basic standards of reference ought to promote global entities with more objectivity as far as abilities of investing and intentions of making a difference in the deployment of corporate governance and information technology security standards.