Trading Platform for the Global Warrant Markets

Iosif ZIMAN
Nomura Principal Investments Hong Kong Ltd.
iosif.ziman@nomura.com

Global warrant markets are among the most active financial markets in the retail derivatives investment landscape currently. In this context some of the most relevant markets in the last years have been the ones across Asia and in particular Hong Kong, Korea and Japan. This paper introduces the financial instruments used in connection with the warrant markets, presents and offers suggestions for setting up a generic warrant market making system and introduces the main concepts and components that need to be taken into account when developing these systems targeting an exchange driven or E-Businesscontext.
Keywords: *Trading, E-Business, Warrant, Market Making*

1 Introduction

Global warrant markets represent a specificgroup of markets that have been developed predominantly over the last 15 years. The products traded on these markets are a category of derivative investment instruments. These are option-like products generally issued by a third party and are usually traded on the exchanges or on E-Business online platforms. When traded on exchanges, unlike exchange traded options, only the issuers are allowed to short sell the warrant. The reasons why warrants are attractive investment vehicle include: their leveraging effect and limited loss feature, attractive to aggressive investors, andalso they can serve as hedging instruments to reduce the risk exposures arising from other related investments. The paper also addresses concerns related to issuer market manipulation.

While exchange traded warrants are well represented in global markets on exchanges including the ones in Hong Kong, Korea, Frankfurt, London, New York and others, there are also other legislations, such as in Japan but also many other markets including emerging ones, where warrants are traded predominantly outside exchanges on licensed portals implementing E-Business infrastructures. Worth noting is that it has been observed that smooth trading in the warrant market may add to the depth to the market that eventually leads the issuance of more warrants and market growth. Easley, O'Hara and Srinivas (1998) for example suggest option markets with better liquidity attract traders to use such markets more.

Considering the variety of exchanges that support trading warrants we can observe different approaches to the way the markets are regulated and issuers are allowed to participate.

In Hong Kong, one of the markets with the largest degree of freedom, derivative warrants have been particularly well adopted by retail market participants. For a few years,between 2003 and 2007, the turnover in Hong Kong's derivative warrants market averaged HK$3.5 billion a day, representing about 20% of the average daily total stock market turnover. This level of monetary turnover made Hong Kong the most actively traded warrants market in the world. It also suggests a large deal of retail participation. This large degree of retail participation comes with its problems. Concerns and allegations have been raised about certain illicit practices in the derivative warrant market and the suitability of derivative warrants for retail investors; however such claims have been generally refuted [1] [2] [3].

In Korea, where the participation is more restricted and the rules imposed on issuers and market participants are stricter, the access to the market has been highly monitored by the regulatory bodies.Due to local expertise participants from within Korea held a significant advantage. To that extent many foreign companies interested to issue warrants on the Korean market choose to use a venture type ve-

hicle in association with Korean entities. Retail investment has been still large in relative terms but still a degree of magnitude smaller than Hong Kong.

In Japan, where warrant market making has not been in the mainstream of the investment vehicles and as such has not been implemented by the major exchanges, the products issues by various market participants such as investment banks have been listed on online E-Business platforms.

The types of products traded as part of the warrant market making business have in the past predominantly been European or American Call/Put Options which tended to be Vanilla, or eventually Vanilla with Averaging Tail (averaging of the last 5 days close prices, also called in Asia as Asian Tail). The underlying set ranges from equities, either outright or indexes, to commodities, such as gold and others, and become increasingly sophisticated.

One of the main attractions to the warrant markets is the relatively small sizes that are traded, which allow private retail investors to participate in trading of products that they otherwise could not trade in. This is possible because institutions which issue warrants and offer them to the public structure them such that each warrant represents rights for ownership of a fraction of the underlying for which they are issued. Important active participants in the market are also the issuers, which need to manage the risk of their inventory positions. The trading patterns have been examined in a number of papers and they tend to show that issuers trade mainly to manage inventory risk and not to manipulate the market, a major concern for market participants [5] [6] [8].

2 Elements of a Warrant Market Making Engine

A warrant market making engine is a system with a number of core components that collaborate and react to external events and perform required actions. The system continuously receives data from the markets, processes these prices and, using relevant pricing and risk models, generates corresponding buy/sell orders for the relevant instruments. At the same time the system needs to be able to execute commands coming from users. As an effect the warrant market making system carries out the corresponding actions such as estimating hedge points for delta and/or gamma, eventually executing auto-hedging algorithms and changing the quoted prices by continuously generating cancel/replace orders to keep in line with the changing underlying prices and associated volatility market.

Several types of existent events contribute to a warrant market making engine:

- market information events such as quote data (bid/ask/last/high/low/close),
- trade events (order placement/order cancellations/order amendments/execution fills),
- user driven events (clicking the buy/sell order button,
- changing the parameters for example the trade volatility or the spread value),
- system events (market status, system health states, network links).

In general the actions taken by the system in response to these events include:

- pricing of fair values and implied volatilities,
- cancel and replace bids/offers in the market,
- computing individual and overall exposures,
- trade misprice opportunities in the market, update the latest status to the user,
- start/stop the quoting mechanism.

Some of the features required in a warrant market making engine include:

- the ability to process large amounts of data efficiently without slowing other system components,
- the ability to compute fair values and/or intrinsic values for large amount of warrants instantly in real-time,
- accessing and processing ‘low-latency’ market data from exchange connectivity,
- support high volume trading such as placing tens and thousands of orders in a burst,

- an architecture to support various placement strategies,
- a responsive GUI front end for the traders monitoring and adjusting market making strategies, a customizable GUI allowing traders to select what they want to see and control.

The system must include safety features to avoid potential huge losses, this may include:

- the control of limits and order size,
- a panic control to withdraw all active orders in the market, or stop quoting when it detects the possible mis-pricing of its own warrants,
- the ability to monitor 'Greeks' and react with auto-hedging actions and warning alerts,
- ability to withdraw and place new orders without self-matching own orders that comply with exchange regulations and trading rules.

3 Warrant Market Making System Architecture

The architecture of a warrant market making system may be designed is such a way that it can support both institutional as well as retail client [9], a sample architecture is presented in Figure 1.

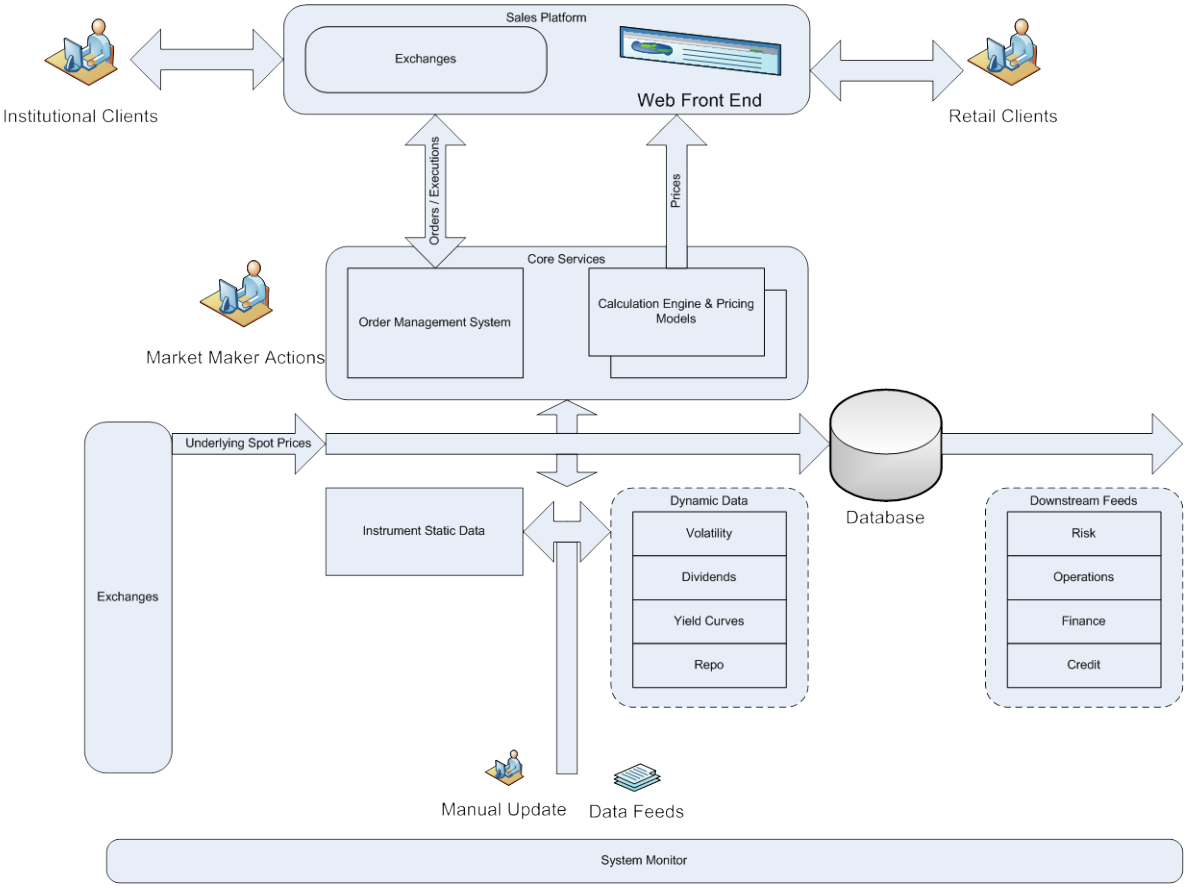

Fig. 1. Generic warrant market making system architecture

The implementation of a warrant market making system of this nature will be able to support business models that cater to both institutional clients as well as retail clients using an E-Business model. The requirements for the two businesses are somewhat different, with the exchange driven one being more regulated from a service level agreement and price quotation point of view than the E-Business model. However, current standards tend to bring the E-Business model towards requirements that are very close in terms of stringency to the exchange driven one. As a result the dedicated systems tend to be able to cater for both.

Price formation is a very important component of the warrant market making system and requires a high degree of attention and scrutiny from outside the actual trading group. All parameters that feed into the pricing models need to be *verified*. Pricing models themselves need to be validated through thorough testing. The *accuracy and latency* of the entire *price flow* for underlying instruments from exchanges, through the internal distribution layers and into the pricing engine requires great attention. Price formation is one of the areas where a great deal of attention and time is spent when implementing warrant market making systems.

Order execution is another area where the accuracy and timing of the information is very important as this is the area where all the market making quotes are being sent out to the exchange or E-Business platform, and any errors not detected up until this stage will have a direct impact on investors and the market making agent. Mistakes in this area may bring monetary costs that can be more or less significant, and in extreme cases may even lead to a market maker losing their license for a determined or even undetermined length of time in a given market.

3.1 Sales Platform for E-Business

The sales platform represents the platform used by the warrant market maker to interact with the end clients. There are two main venues where the market maker interacts with the investors. The decision on which one to use depends largely of the regulatory environment of the jurisdiction in which the business is set up.

In general in jurisdictions where exchanges are prepared to offer the ability for issuers to list warrants and allow market making on these an exchange based sales platform will be used.

In jurisdictions where there are no existing exchanges where warrants may be listed by issuers, the issuers will generally choose an E-Business sales model interacting with investors using a web portal.

3.1.1 Web Front End

The web front end is used by some market participants as a sales platform for E-business for the warrant market making. Most notably such platforms are available in Japan where the regulatory environment at the exchange level precludes market participants from listing such products directly on exchanges. A market leader in Japan is Goldman Sachs, whose business covers a large percentage of the warrants volume in the country.

The web front end contains a number of required pieces of information which include:

- warrant instrument parameters – all relevant details which contribute to defining the market and contractual data used to define a warrant
- pricing information - updated in real time for all active warrants
- order transaction pages – allowing the buying / selling of active warrant instruments at the real time quoted prices
- historical information - pages that allow market participants to view and/or download all historical information for any warrant ever transacted by the firm
- sample warrant trading training pages – market participants may use such pages to get accustomed to the most important information relevant for trading warrants

The web platform is used as an all encompassing source of information and interaction between market participants and the firm issuing the warrants.

All relevant information is meant to be published on the E-Business platform and all actions taken either by market participants or by the issuer, with respect to the warrant market making activities are meant to be executed using the web platform (sample information in Figure 2).

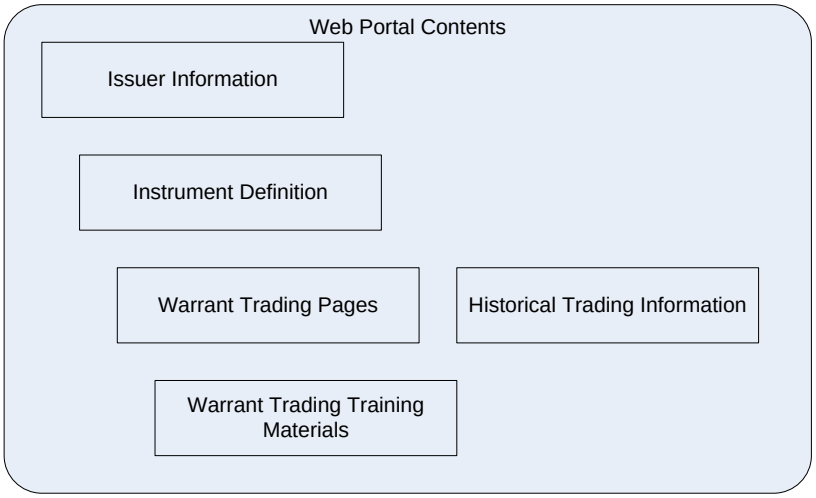

Fig. 2. E-Business web portal

The main distinctive difference between the warrant markets making business conducted using an E-Business platform and an exchange environment is that in the E-Business model all contractual obligations are between the client and the issuer directly with no intermediary regulating agency, as is the case in an exchange regulated environment.

3.1.2 Exchanges

An exchange based warrant market making environment conforms to the same rules and regulations as all the other exchange regulated environments used to trade other traditional instruments such as stocks, futures, listed options and so on.

In this case all the obligations of the issuer are taken over by the exchange, such as guaranteed timely bid/ask price formation and so on. The exchanges impose at their turn these rules on the issuers wishing to participate in the exchange regulated market. In general countries and legislations where warrant markets are exchange based do not also permit an E-Business model implementation.

While many countries and legislations have implemented to date warrant markets in an exchange driven environment (UK, Germany, Italy, Hong Kong, Korea and others) an interesting market is the one in Korea. In Korea exchange based warrant market making is nominally open to any market participant, be it a local Korean one, or a foreign based one. In fact however the rules and regulations required by the exchange to allow participants to issue warrants in Korea are so restrictive that most foreign based issuers are compelled to establish a Korea based subsidiary of a significant size, or more generally, collaborate with a local Korean issuer. This presents retail market participants with challenges with regards to fair competition in the market due to limited competition which determines larger bid/ask spreads and more significant profits for issuers than in other more open markets, such as Hong Kong.

3.2 Calculation Engine& Pricing Models

The *calculation engine &pricing models* are responsible for aggregating all the data required (instrument static & dynamic data) in order to calculate the fair values of the warrants being quoted on.

The calculation engine may be simple or complex and it depends highly of a number of factors which include the issuer's sophistication and level of development, the type of instruments/warrants that are being issued, the regulatory requirements in place for such engines and others. At the lower level of the spectrum the calculation engine may be as simple as an Excel spreadsheet connected using custom and bespoke methods to the various sources of data and feeds both incoming and outgoing. At a higher level of sophistication issuers may use dedicated market making systems provided by vendors such as ORC, Horizon and others, and customized to fit their needs. At a further higher level some issuers choose to implement their own dedicated systems completely dedicated to the warrant market making business fully inte-

grated with the firm in all relevant aspects and in this context the calculation engines may be implemented using distributed calculation grid environments (thousands of calculation engines and processor cores).
The pricing models may be again ranging from relatively simple pricing libraries to more complex either licensed or custom built libraries. The levels of sophistication tend to depend of similar factors as the calculation engines.
The calculation engines tend to be implemented such that they can be controlled through user actions. Such user actions are designed to change relevant parameters used to the pricing of the warrants, mainly including volatility and reference price levels.
Sophisticated calculation engines that use a distributed grid model tend to use a combination of calculation managers and calculation workers in a distributed computing environment. There may be multiple calculation managers and workers associations depending on the scale and magnitude of the implementation. Figure 3 presents a diagram of the calculation engine.

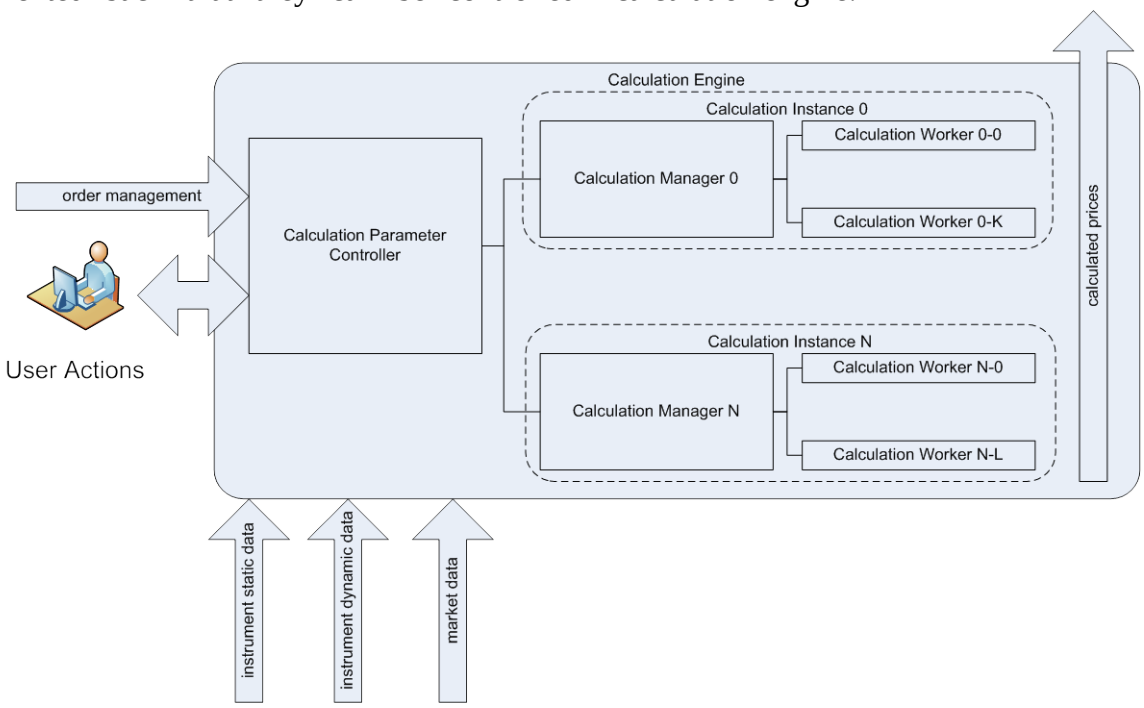

Fig. 3. Calculation engine

3.3 Order Management System

The *order management system* is responsible for ensuring that an accurate account of the current positions is maintained during the life of a warrant. The starting values need to be loaded at the beginning of the day, each trade accounted for during the day, and end of day position information needs to be saved in the database in order to be loaded again the next day.
The main components of an OMS include the *order management controller*, responsible for all interaction with user's and feeds (trades, market data, else), a bespoke *order manager*which keeps track of the current status of trades as well as a *persistence server* which ensures that all transactions are persistence to a physical device which allows recovery from errors.
OMS's have come a long way since these systems have become the core of trading environments and currently many of these systems go above and beyond their initial design purposes implementing such services as real time compliance, load balancing, trade allocations across funds and many others (see Figure 4 for sample components).
One of the important functions that current OMS users tend to need more and more is the real time compliance and limit checks. These include at least 2 main areas: exposure limit checks (maximum exposure for a given set of

parameters, limits which may be soft – self imposed, or hard – exchange or regulatory imposed) and restricted issuers enforcing and monitoring (ensuring that warrants whose base underlying is on the restricted list cannot be traded, this is a strict compliance rule which if broken may trigger severe consequences including sizable fines and possibly stopping a firm from trading).

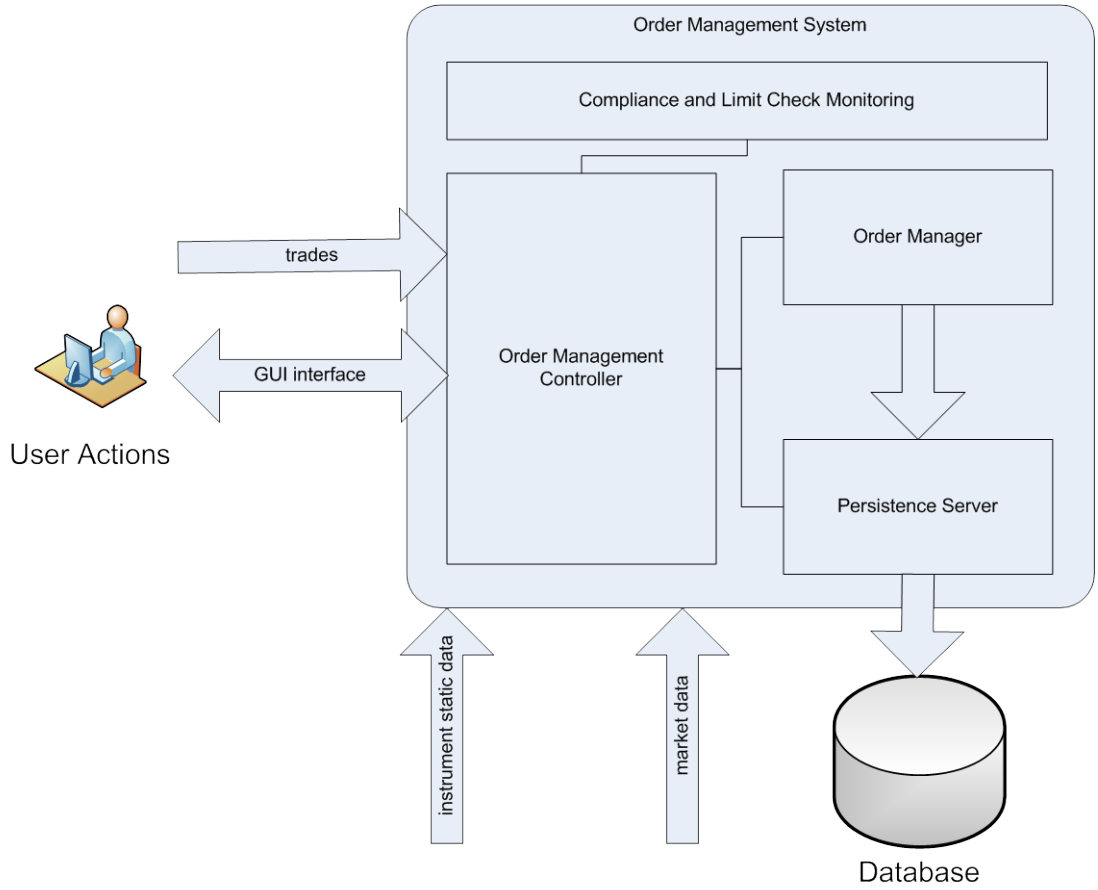

Fig. 4. Order management system

3.4 Instrument Static Data

The instrument static data service is responsible for storing all the data parameters that represent the contractual details for the warrants transacted as well as the instruments representing the underlying on which the warrants are issued.

The data for the warrant instruments is generally defined by the firm and being presented to investors in various ways including flat file feeds, web interface or through the exchange. The data for the underlying on which the warrants are issued is required for internal systems such as the order management system and the calculation engine. This data is generally sourced from generic data sources such as Bloomberg Data Service, Reuters Reference Data or directly from exchanges (see Figure 5).

The instrument static data and all its associated attributes tends to be stored in relational database models which are then used by the warrant trading systems that require them, either directly by connecting to databases or through intermediary extracts such as flat files or similar.

Sample relevant instrument static data stored in the database depends on the instrument type:

- Warrants = plain vanilla options (underlying, call/put, European/American, strike, maturity)
- Equities (name, symbols)

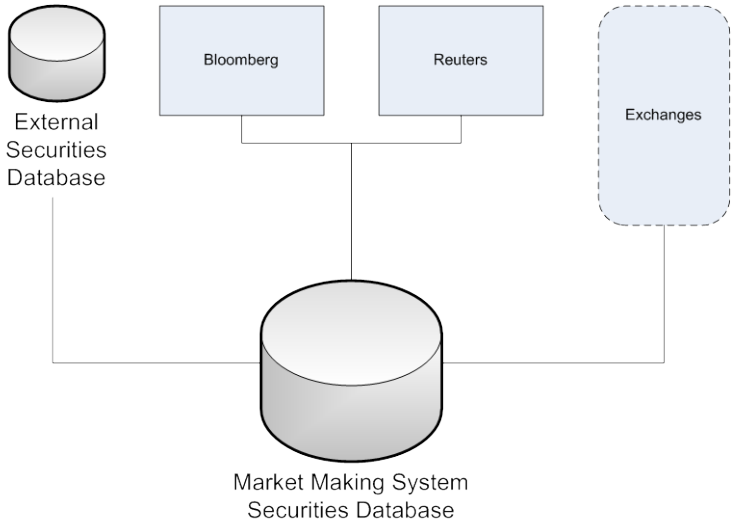

Fig. 5. Instrument static data database construction

3.5 Dynamic Data

Dynamic Data: Volatility represents the volatility surfaces for each of the underlying instruments on which there are warrants defined. The volatility data may be maintained either by using external feeds from vendors or manually with reference to inter-broker quotes.

The volatility information of an underlying may be represented as a 3 dimensional surface. A sample volatility surface for an underlying is presented below using a strike/maturity/volatility-in-% representation (Figure 6).

The volatility data is arguably the most important of the dynamic data parameters that are being fed into the calculation models for the warrant instruments. The reason for that is that most warrants are option type instruments which are highly sensistive to changes in volatility. The volatility parameters that are being used in this case are also called *implied volatility*, or the volatility as it is extracted from instruments whose prices may be observed in the market, prices for which a reverse calculation is used for volatility (calculate volatility from option price, assuming all other parameters are known).

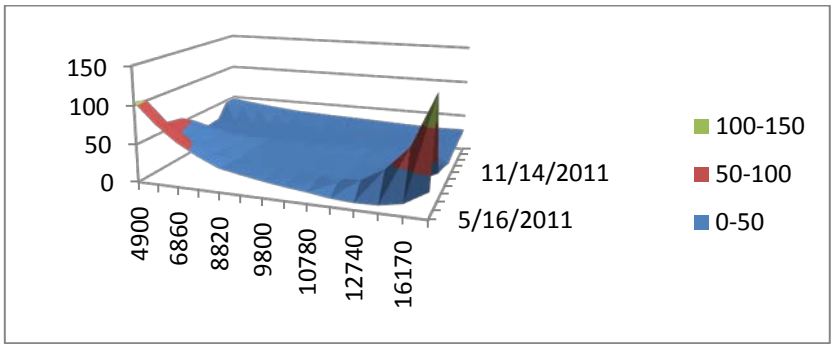

Fig. 6. Example of a volatility surface

Dynamic Data: Dividends represents the cash dividend information or the dividend yields being used to price the warrants.

The cash dividend information is generally sourced from sources such as ([7] Markit) or Bloomberg. In some markets dividends are hard to track due to a lack of available public information, case in which alternate methods are used. For some instruments, such as indices, dividend information is inferred from the dividend information of all constituents, for such instruments a dividend yield number is used in general. Cash dividends are represented as one dimensional array with cash

payments stacked over time. Dividend yield is represented as a single number associated to a given maturity.

Dynamic Data: Yield Curves represents the yield curves for each of the currencies for which there are warrants listed in. The data is generally expressed as yield curve term structures.

Yield curve data is inferred from various representative instruments such as money markets cash rates, interest rate futures and others. The data is represented as a one dimensional array with the determining parameter being the maturity.

Dynamic Data: Repo Curves represents the repo curves for each of the instruments for which there are warrants listed in. The data is generally expressed as repo curve term structures.

Repo data is inferred from the repo rates provided by the counterparties which offer repo products to the issuer. The data is represented as a one dimensional array with the determining parameter being the maturity.

3.6 Market Data & Data Feeds

Market data represents in this context the market specific instrument related information as well as the pricing information.

The market specific instrument information tends to be downloaded daily from the relevant market interfaces (Exchange, Bloomberg, Reuters, else) for the purpose of providing an up-to-date record of all the contractual information specified by the exchanges for the underlying instruments, as well as some of the derivative instruments, for example listed options, in case the market making system is designed to keep track and transact on other instruments than the ones it is defining warrants itself.

Conversely when the underlying markets move the warrant market making system needs to ensure that the liquidity is maintained and that may mean that new warrants need to be defined at new strike levels in order to allow market participants to keep track of the market at the appropriate levels. In the sample below we show how the strike prices of warrants may need to change as the underlying price level changes (Table 1).

Table 1. Warrant price changes in relation to underlying price changes

Put Option Strike	Underlying Level	Call Option Strike
		105
		104
103		103
102	102	102
101	101	101
100	100	100
99	99	99
98	98	98
97		

Put Option Strike	Underlying Level	Call Option Strike
		107
		106
105		105
104		104
103		103
102	102	102
101	101	101
100	100	100
99	99	
	98	

At the same time the pricing information retrieved in real time is also market data and it needs to be very accurate and timely as it could make the difference between a well performing market making system and a poorly performing one. To that extend some of the warrant market making participants choose to develop their own pricing feeds sourced directly from the exchange, in order to minimize any delays that there may be on sources provided by major market data distribution platforms which may need to aggregate data and then re-distribute it using sub-optimal electronic routes. As can be seen below (Figure 7) several hubs may be removed along the way by using a proprietary approach. However in many cases implementation costs for proprietary solutions may

also be prohibitive for some market participants.

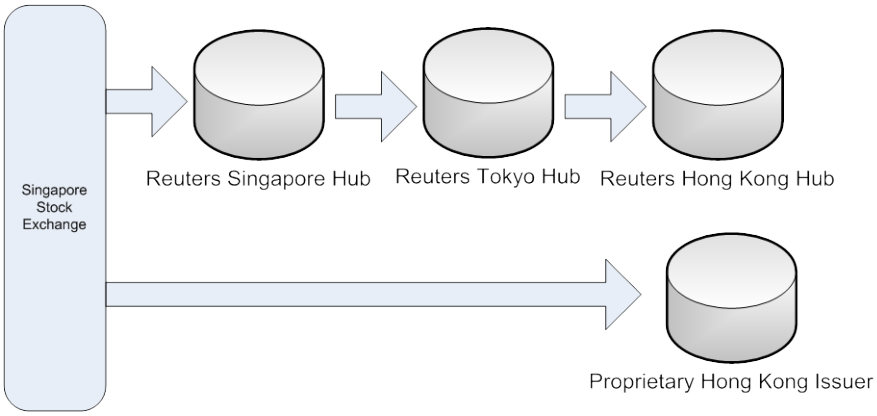

Fig. 7. Market data flow

3.7 Downstream Feeds

A warrant market making system will need to provide feeds to a number of corporate areas within the institution. The purposes of these feeds will be varied and the way these feeds are implemented, as well as the information that they contain, will be dependent on the internal rules and regulations on the one side, and on the other side on the regulatory reporting that the firm needs to provide to the regulatory bodies in the markets where it is active.

While the feeds themselves may be implemented in a variety of ways, at least some of the feeds are needed for all issuers. The feeds are generally implemented as flat file batch process based feeds. In rare occasions real time feeds may be required trade-by-trade.

Risk Feed – Provides risk data to the risk department. Generally includes instrument definition, main pricing parameters for underlying and warrants as well as calculated Greeks (delta, gamma, vega, theta, rho).

Operations Feed – Provides all the relevant information for the operations department to be able to execute any actions required after trades are executed. This generally includes all information static data as well as some pricing information such as market and/or theoretical prices for warrants instruments and execution details (size/price) for trades.

Finance Feed – Provides all the relevant information for the finance department to be able to evaluate the prices of the totality of the positions that the issuer holds related to the warrant market making business. This generally includes all information static data as well as all pricing information such as market and/or theoretical prices for warrants instruments and execution details (size/price) for trades.

Credit Feed – The feed generally includes all information required to allow an estimate of the credit liabilities of the issuer.

All of these areas may impose limits on relevant parameters and these limits will be monitored and reported to the market makers, who in turn need to ensure that these limits are not broken and in case there is a break in the limits actions are taken to ensure that conformance is restored.

3.8 Database Data Model

In general market making system implementations tend to use relational databases when implementing the persistent layers of the system. Without going into the details some of the elements that the persistent layers need to include are:

- instrument static data definition (underlying and warrants)
- user related information
- configuration information
- client information
- order/execution information

3.9 System Monitor

A warrant market making system is a real time system and for most of the businesses active in this area the financial implications of any system errors tend to be significant.

To that extent the system monitoring implemented for a market making system tends to be a pro-active one instead of a reactive one. The goal of the monitoring is to ensure that any possible problems are resolved well in advance, before they impact the functions of the system itself.

While the levels of checks can be exhaustive we can mention some of them, recognizing that just this area could be the subject of a very in-depth analysis:

- System availability - infrastructure is working and has enough resources ex. space in the database is adequate and all processes are working
- All dependencies are accounted for – all feeds are functioning ex real time pricing, instrument data feeds and others
- All parameter calculations are working within parameters
- Order/Execution functions are available and work within accepted latency parameters

4 Global Implementation

Some warrant market making businesses are global businesses which require global synchronization across multiple locations (Figure 8). There are several implementation approaches, either based on database replication (model which allows full persistent data distribution, but tends to be less flexible) or message based replication (which replicates a subset of the entire data and it may generate inconsistencies) or using both.

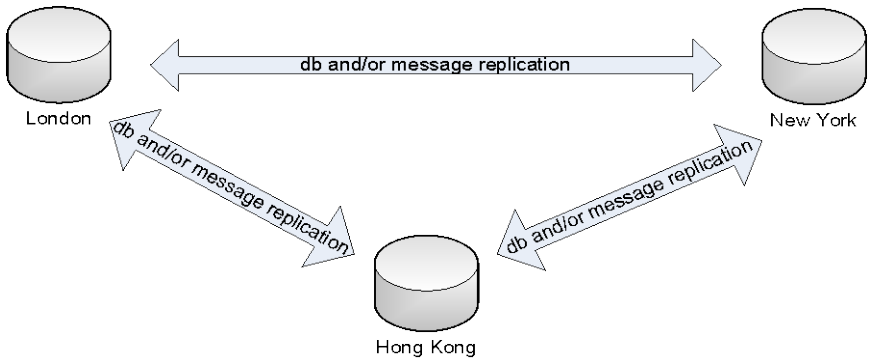

Fig. 8. Global implementation

Whether or not a global implementation approach is needed depends highly on the business model and the types of products that are being traded. For example a centralized risk control approach will require the data to be aggregated in a given location but may not require all data to be available real-time in each location. An approach that may require global replication is one where the product offering overlaps across markets and as such the data is required to be available in real time in each location to allow efficient hedging and risk management (ex. a model where warrants are offered in other locations than where the underlying are being listed). In a highly integrated business model where the warrant offering attempts to blur the difference between product origination and end customers highly integrated models are required to be implemented. As a result costs will also grow significantly; therefore the business model needs to be validated using cost/benefit analysis.

5 Conclusion

This paper presents a brief description of the warrant markets, explainsin some detail how warrant market making systems are implemented and what are the main requirements for such a system, presents the impact that the warrants markets have had for retail investors globally and how it has created E-Business models for the financial industry and also presents considerations on how such models are implemented in a local, regional or global context.

The paper shows that contrary to concerns raised on occasion, warrant issuers tend to

trade fairly and mostly manage their inventory rather than manipulate the markets.
Deploying a warrant market making engine is a relatively complex task and requires careful planning to be considered by new market participants. The parameters and approaches described each have their pros and cons. A warrant market making engine interprets many thousands of events and reacts with low latency based on preset parameters and predefined algorithms and requires in general a significant investment that needs careful consideration.

The warrant market making business is currently very competitive due to the large number of firms already in the market which cover the demand among retail investors. The business has been gaining ground globally but most notably recently in Asia and it is expected that more exchanges will list warrants in new types of products to help increase liquidity and offer a diversity of products for the public. At the same time existing and new E-Business models will become increasingly adopted by participants in emerging markets.

References

[1] Y. Amihud and H. Mendelson, "Dealership market: Market making with inventory,"*Journal of Financial Economics*, no. 8, pp. 31-53, 1980.
[2] Y.F. Chow, L. Jianwei and L. Ming, 2007, Making Hong Kong's Derivative Warrant Market, *China International Conference in Finance*, Chengdu, China.
[3] P. Draper, B.S.C. Mak and G.Y.N. Tang, "The Derivative Warrant Market in Hong Kong: Relationships with Underlying Assets,"*The Journal of Derivatives* Vol. 8, pp. 72-83, 2001.
[4] D. Easley and M. O'hara, "Price, trade size and information in securities markets,"*Journal of Financial Economics*, no. 19, pp. 69-90, 1987.
[5] J. Hasbrouck and G. Sofianos, "The trades of market-makers: An analysisof NYSE specialists,"*Journal of Finance*, no. 48, pp. 1565-1594, 1993.
[6] A. Madhavan and S. Smidt, "An analysis of changes in specialists inventories andquotations,"*Journal of Finance*, no. 48, pp. 1595-1628, 1993.
[7] Markit dividends, http://www.markit.com/news/Markit-Dividends.pdf.
[8] A. Madhavan and G.Sofianos, "An empirical analysis of NYSE specialist trading,"*Journal of Financial Economics*, no. 48, pp. 189-210, 1998.
[9] I. Ziman, Warrant Market Making Implementation, Dresdner Kleinwort Japan, *Internal Documentation*, 2002.

Iosif ZIMAN is Nomura Principal Investments Hong Kong's head of technology since 2008. He has spent the past 15 years in Asia as a technology professional with a wide range of expertise across trading systems areas including order execution, risk management, operations and control areas across equities and fixed income. Mr.Ziman joined Lehman Brothers Japan in 2004 where he lead equity derivatives trading technology teams most notably implementing the suite of the company's next generation's equity derivatives structured products risk management systems. From 2000 he joined Dresdner Kleinwort Japan where he has been responsible for cash and portfolio trading technology and implemented the firm's warrant market making platform for Japan. Before 2000 he spent 3.5 years with Fusion Systems where he has been the lead for the FOX (Fusion Order eXecution) system which has been implemented by more than 15 major investment banks in Japan and Asia region (including Goldman Sachs, Morgan Stanley, JPMorgan and others) to the extent that in the early 2000's about 30% of the Tokyo Stock Exchange volumes went through the system's various implementations. Mr.Ziman holds a B.S. (1994) and a M.Sc. (1995) in Computer Science from the Technical University of Cluj-Napoca, Romania.