Progress – past, present and future

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We are now past the first anniversary of the latest black September and we are still in business! In fact, quite the contrary, volumes are up, shape sizes down, and the proof is that, after a short interlude of potential meltdown, the markets are still with us and they will trade going up or down.

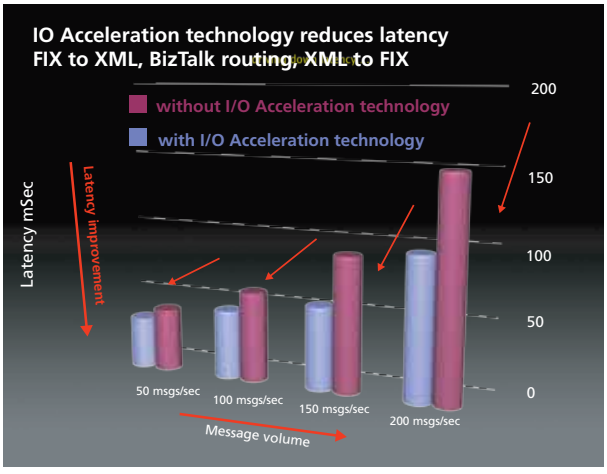
For the trading market it could be argued that the last 18 months have done us a service. 2006-2008 was the latency arms race. The learning curves across the market, from technology vendor to buy, sell-side and new liquidity providers were colossal as we all invented new business models on the fly. As we sit looking forward to 2010, it looks like rationalisation has set in. We know who needs low latency, how it's affected and the remedial causes. So let's see how we have arrived at today, what we now have and what we might usefully do with it next year and beyond.

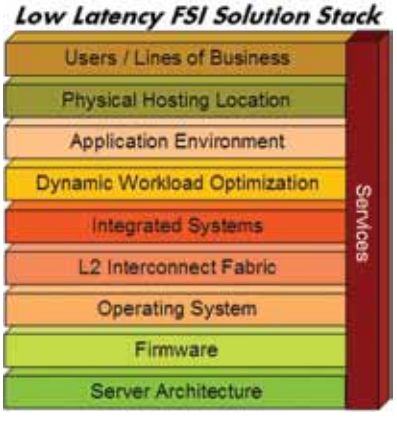
We have come through a phase of almost unprecedented hype in technology marketing around low latency. This has often been at the expense of understanding where the causes of latency are likely to exist, and the practical options to cure the symptoms – from tuning the engines to wholesale replacement of aging parts.

In this context the task is multi dimensional. One has to look across the spectrum of processes that make up the pre-trade life cycle and the supporting technologies at each phase, from receipt of market data and the firing of the starting gun, through intervening analyses and checks, to the trade instruction hitting the execution venue. Technically a variety of components interoperate to enable this, which is where the leading edge computer engineering skills exist. The Formula 1 racing analogy plays amazingly well, where fast is never fast enough. Here CAPEX (capital expenditure) is not an issue and only the best and latest components are used, if necessary custom made, and simulated on massive supercomputers by a singularly focussed technical team working to get the car round the circuit fractions of a second faster than the nearest rival.

So how has this market matured over the last 2 years? We know that certain technology elements are now playing best on the race circuit. Like the Formula 1 car, a complete solution stack needs to be tuned to interoperate at maximum efficiency – beginning with the latest multi-core x86 industry standard microprocessor and a tuned operating environment in power-efficient hardware blades where horsepower can be dialled up on demand – all networked via advanced non-blocking and optical techniques light years removed from a connecting copper rod.

This is computer science at its leading edge – and the parties behind this paper – Hewlett-Packard, Intel Corporation and BT all have synergistic expertise in this space which is playing efficiently together. A quick walk through the major considerations across the landscape is valid – before unprecedented deep dive hands-on testing and simulation of the interdependencies in lab and then production environments





At the heart of trading is market data, and hence the ability to move, handle and manipulate it is a basic foundation. Data Fabrics and message bus technologies have come to the fore in this space as the backbone of trading solutions – with NYSE-Euronext (Wombat Data Fabric), Thomson Reuters (RMDS and TRADS) and 29 West (LBM) leading the charge at present – joined by interesting innovation from the bank driven open source initiative of AMQP by Rabbit MQ, iMatix, Red Hat and 29West. The messaging fabric is the vehicle which takes market data from the point where it reaches the firm from the publisher (exchange, venue etc) and makes the price information ubiquitously available to consuming analytical applications. Ideal performance is blistering speed and no variation in reliability of delivery – "jitter".

Real time operating systems have become a new option in this battle for competitive advantage. As the controller of the overall architecture, the OS has to be at least as capable as all other elements – otherwise it is an obvious bottleneck. The real

time market includes Red Hat's specialised real time, messaging and grid offering dubbed MRG, Novell SUSE Linux real time option "SLERT" and SUN Solaris, the legacy OS for market data made contemporary through Solaris 10 and the specialist features of containers and DTrace for tuning. For the brave hearted, the open source market for Linux and Unix provides limitless depth of innovation, subject to the vagaries of entering the race track with parts from the neighbourhood enthusiast.

Networking – the connectivity between domains in the architecture is crucial. Pressure on traditional Ethernet in its 1 Gig form opened the door in 2007 to innovation where specialist highly engineered devices and communication products based on Infiniband for FSI, led by Voltaire on a Mellanox base, accelerate messages bypassing bottlenecks in the OS kernel and traditional network layers. Now in late 2009 we see the Ethernet alternative 10GbE technology mature, delivered by specialised switch vendors like Voltaire and Arista combined with optimised 10GbE network cards for enhanced performance. Here the NIC market is around Mellanox ConnectX, Chelsio TOE, Solarflare Open Onload, and Intel's NetEffect iWARP technologies which are having the effect of moving the domain from niche innovation to mainstream industry standard. Lab based tests are delivering the results at this leading edge. The best performance on Niantic 10Gig E ("standard" NIC) is around 10-12 micro seconds one way hop (application to application data transfer).

The same packet workload tested on NetEffect will take 5.5 microseconds. So 2x performance improvement is achieved from a hardware swap out which may either give a vital 'arb'ing' opportunity or compensate for performance issues elsewhere. This speed up is achieved due to the way NetEffect talks to the application, a fundamental change in approach – which is kernel and kernel network stack bypass using hardware features in NE.

Acceleration has been a market buzz for some time and trading has provided the opening for engineering shop to meet commercial market. At the leading edge of statistical arbitrage the world of the fastest cat in the game reserve applies to pounce on a vulnerable price out in the market. Here accelerator devices using GPGPU (graphics processing) and FPGA (field programmable gate arrays) apply. Feed handling and market data has been the focus for this innovation. The considered thinking at this stag is for heterogeneous architecture designs which offload cleansing and feed handling activity around the pipe to these fast environments, sitting alongside mainstream CPUs handling maths, analytics, trade routing and so forth – therefore spreading the load and using appropriate tools for the job in hand.

It is in the leading edge of lowest latency trading that hardware has re-discovered its value add contribution to solution architectures. From the micro-architecture design and features of the chip to the slot and carcass capability of blade frames housing a complete solution environment in a few square feet. Intel's Core2 micro-architecture has seen unprecedented take up in trading since 2007 as its bi-annual tick-tock engineering upgrade schedule delivers performance enhancement every year and with it a direct and immediate contribution to the horsepower that drives the solution stack above. Code named Nehalem and now established in production as Xeon 5500 Series, the inclusion of the CPU in this its latest form has easily leapt into double digit percentage gains in performance for the overall solution – and hence CPU and server upgrade has been a popular route to boost performance. HP's BladeSystems and DL servers frame a complete range of options all optimised for this Intel architecture ("iA")

The picture painted so far is one of complexity and interaction between different parts of the technology infrastructure. It is a window into the

engineering environment which is the Formula 1 pit stop of high frequency trading (HFT) technology support. The development of these disciplines has been promoted significantly by the insight and skills of the niche advisory firm STAC (Securities Technology Research Council) who have both contributed to the science of analysing the respective contributions of each layer and worked to create consensus in how to measure and report on performance. This is starting to take Formula 1 knowledge into the top end of the domestic boy-racer market, still an enthusiast's market where detail will pay dividends but nonetheless better and more broadly understood.

One of the most recent phenomena is the effect regulation has had on the market and the arrival of new execution venues. Enter the rapid arrival of new pools (dark or otherwise) of liquidity, coming to market on lower cost industry standard hardware and hosted in proximity data centres from providers such as BT – the combination lowers barriers to entry and enables fast time to market. As latency then seeks out every opportunity for reduction – a new market of CoLo – collocation of trading routing systems alongside venue matching engines has emerged. The business model of exchanges has been turned upside down (or at least augmented) and new players enter the mix of what makes up a solution. Recent collaboration between Intel and HP has opened the opportunity to test some of the above engineering concepts in the real world of execution environments.

In all the scenarios and individual elements painted above – do not under estimate the value of collaboration and interaction. Joining a number of these worlds is "service" – service as a hosting environment of datacentres and CoLo (where the global reach of BT acted as an early market maker in the trading life cycle), and services to advise on the technical design details of the various moving parts. Cooperation between HP and BT is long established and niche expertise in the firms can be brought to bear in the context of trading. Both firms have invested in the Intel fasterLAB environment – a proven cross-vendor test bed for all the vital infrastructure components which affect latency in the trading context.

The Formula 1 car will not optimise its time trials if there is not near perfect synergy between its moving parts from a dedicated engineering team. To win, a Formula 1 car must tightly integrate and tune all parts within a balanced aerodynamically optimised platform; this requires and accommodates a "bleeding edge" engineering focus. The world of HFT and low latency is the same – and it is no accident that this paper comes together from three major technology players collaborating around their core competencies, stretching the envelope in terms of how solutions are developed for today's trading world. Hewlett-Packard realises that supporting HFT and LLT is not just a statement; it's a commitment, a vision and a holistic approach. This includes driving standard efforts to foster an ecosystem of high performing parts, engineering platforms that facilitate integration of these parts without introducing latency and jitter, conducting on-going end-to-end testing of the integrated platforms under typical trading conditions, and driving a research agenda that enables higher performing trading systems. Also, just as Formula 1 races have gas caps, trading platforms must achieve peak trading performance while optimising consumption of power, space, cooling, and investment. Hewlett-Packard takes a holistic view and recognises that systems must deliver this capability within a constrained environment.

The technology market is far from perfect and often represents a challenge to optimise its delivery. However, in trading, the winner's spoils from leading edge of performance are significant. As an enabling and disruptive force, never has technology engineering been such an obvious and visible a contribution to business performance.