Pushing The Limits Of Possibility

Exploring the true potential of HPC in the cloud:
a (multiple) opinion piece

An Introductory Viewpoint

Assessing the current limits of possibility

When it comes to HPC workloads today, ambitions may be limitless but questions still remain around what's actually possible. HPC clusters are generally expensive to build and maintain and require a level of expertise that often precludes most organizations. This is why they have long been the preserve of governments, academic institutions and large organizations that are actually able to buy and run them. Yet even here the 'limits of possibility' are constrained from the get-go, due to the need to define and deploy a rigid multi-year contract that typically remains static until the agreements ends. An arrangement that's unable to incorporate any changes of new processor architectures outside of future budget or maintenance cycles.

Not that finance is the only factor. There's also usage, where the way a cluster is put to work can also place limits on what's possible. Obviously the value of any HPC deployment comes from it being utilized, but the way this is managed can also be the source of on-going concerns:

- In high-demand clusters, usage is constant, which while great for maximizing ROI can also lead to the prioritization of projects – with 'less strategic' projects struggling to get a look in.
- Then there are 'burst workloads', which deliver more flexibility to organizations in terms of resource accessibility, but can sit idle in between.

Questions and answers

The challenge of expanding HPC accessibility is made more immediate by the growing number of 'non-traditional users' (start-up companies, limited-duration project teams, temporary government projects etc.) also wanting access to raw processing power. Organizations that lack the financial support needed to build out a comprehensive HPC infrastructure, or to maintain on-going operational expenditures. Factors that further restrict both the 'limits of possibility' and their freedom to imagine, unless they're prepared to take a step back and ask:

- Why can't different teams, departments, and business units access all the processing power they need on demand?
- Why can't they push out a request (for defined processing resource) and quickly access the precise machine allocation needed to complete the job?
- And why can't they scale this demand up and down at speed to optimize cost and management time?

Answering these questions will of course involve the cloud for accessing HPC clusters where and when they're needed. Attempts to make this happen however have seen many organizations try to replicate their on-premises philosophy for provisioning HPC resources in a public or hybrid cloud environment. The challenge here though is that to still think in terms of limited resource accessibility and prioritization, or the need to carefully orchestrate burst workloads, only serves to displace the same 'old' problems. Worse still, if the move does not include the right management tool, costs can rapidly go north and at a surprising velocity.

A world of choice

While the above situation is predictable, it doesn't actually have to manifest. Instead, it is possible to offer users the ability to access the exact processing power they need at the exact time they need it – and then to discard it the moment a job is complete. This is the world of intelligent provisioning. VERY intelligent provisioning that enables the most dynamic scaling possible, while also enabling both users and IT to seamlessly manage the process with confidence. Capabilities made available irrespective of the size of job or organization. A new reality that the multi-cloud workload management solution from YellowDog was designed to empower:

- Achieve the full financial advantages of moving HPC requirements from a CapEx to an OpEx model.
- Scale machines, including huge amounts of cores when/if needed, at a lightning-fast pace, before taking them down with equal speed.

- Run simultaneous workloads from a single control point, while maintaining a real-time view of exactly what's running and the progress of each job.

What this all means is that those who need access to HPC resource, irrespective of size and complexity, can access it quickly, easily, and in the most cost-effective way possible. Rather than a priority list of different jobs, individual teams can access the precise HPC setup they require simultaneously, without the need to wait and arrange. They're also instantly aware of the cost involved, and can therefore dynamically set a budget at a departmental level – and focus on outcomes rather than operational complexity.

What we all know for certain is that powerful HPC capabilities are already available in the cloud. The task now is to access them in the most flexible and cost-effective way possible.

What next?

Over the following pages the topic of 'pushing boundaries' is explored from a number of different angles. Each one an amalgam of our collective experience at YellowDog, and the insights gained from working with clients at the cutting edge of HPC:

Never Say Never Again

Or why organisations should always be able to crunch any data set at any time

HPC capabilities are increasingly needed by individuals, businesses, and institutions to help make sense of the digital world. A demand that's fuelled by data growth in the region of 60% per annum, with 30% of this virtual resource requiring real-time data processing if it's to convey any measurable utility[1]. Factor in the growth of sensors and IoT devices for example, that are helping boost this surge in unstructured data, and it's unsurprising that data crunching capabilities are at a premium.

What's more, this is a demand that's consistent whether we're talking tightly or loosely coupled workloads. It must be said however, the nature of this 'coupling' does have a marked impact on the shape and make-up of processing power made available – with the former more restricted by location and the latter able to enjoy more flexible, 'volunteer compute' resource. Important points when considering the two key enabling factors needed to inspire greater HPC utility:

- **Agility –** and the ability to use all available tools and resources at speed, across multiple workloads to ensure all insights generated are timely and relevant
- **Mobility –** and the ability to dynamically select the preferred compute resource based on where it's available, or for other reasons relating to cost, performance, and environmental impact etc.

Decisions, decisions...

A key factor in any story relating to unconstrained HPC processing power is of course scalability. Although loosely coupled workloads have the advantage here, there are challenges associated with both types of coupling arrangement:

- **For tightly coupled workloads,** the biggest restriction here is simply the fact that all the resources involved need to be physically located together, which therefore makes the choice of location rather restrictive. Another challenge is cost. Provisioning a tightly coupled workload means acquiring the necessary compute and storage capabilities etc., and estimating the requirements up front. Doing that can be highly cost-effective, but it can also lead to a static arrangement that makes it hard to introduce new capabilities, without losing control of spend.

[1] Source: https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf

- **For loosely coupled workloads,** organizations are much more free to dial up or down compute power depending upon the performance required. As the machines have no need to be in physical proximity of one another, these workloads are able to access greater flexibility in terms of geographical spread, allowing users to distribute tasks to multiple different regions. However, to truly take advantage of this flexibility, organizations need a strategy in place to coordinate these disparate resources. Without which, cost-efficiency could be greatly impacted and workloads could be significantly delayed.

All of the challenges mentioned above help confirm what we already instinctively know: the limitations holding back HPC workloads are caused by the decisions an organization needs to take in terms of the way it provisions and coordinates processing power. With tightly coupled workloads, it is necessary to detail the specific constraints around geography upfront, to make sure machines are provisioned in the correct location, at the correct time. For loosely coupled workloads, dynamic service delivery relies on a management tool that can ensure consistent workload execution.

Maintaining control

What's also key in any discussion on processing availability is the user experience. Loosely coupled workloads may well introduce greater flexibility, but if not handled correctly can also swamp organizations with a daunting degree of complexity. What's needed to counteract this danger is a simple user interface that delivers automated, intelligent provisioning. Get this and the difficulties involved are instantly abstracted away. So wherever the clusters in use are located (including the potential for multiple geographies) the user is afforded one, single control pane. What matters here is having the ability to intuitively provision the ideal cluster for each and every task:

- Access the compute resource needed, irrespective of location or cloud provider.
- Share resources as and when needed without compromising on-going jobs.
- Tear down formed cluster arrangements the moment their task is complete.

As mentioned, the ability to crunch any data set at any time ultimately comes down to the flexibility and mobility of available HPC resources. The challenge for any technology provider is to make the provisioning of HPC clusters via the cloud an easy and agile process to manage. A process supported by templates and default settings that allow non-IT employees to quickly find their ideal, and to track cost and performance every step of the way. Entering a multi-cloud environment in search of flexible, dynamic processing power can cause organizations to fear that they're not aware of the best options, or making the most of the available budget. But introduce intelligent provisioning, and the results soon speak for themselves.

Standing On The Shoulders Of Giants

Or what it takes to compete with the world's best without breaking the bank

> "How to generate the best bang for our buck?"

All users of HPC resources start out with a budget. A bundle of cash they've fought hard to ring-fence with the intent purpose of enabling so many machines or so much time of processing to be available. The first question that needs to be answered is: "how to generate the best bang for our buck?" The destination may be clear (the best possible HPC availability), but there are several different paths leading to it:

- **There's the pre-defined model,** where purchased clusters are paid for upfront and allocated to users – the standard approach prior to the emergence of cloud computing.
- **And there's the on-demand model**, which typically involves the cloud and where HPC capabilities are only accessed when needed – the 'pay for what you use' consumption method.

Thanks to the historical ascendency of on-premises usage models, the allocation method has typically led the way. The reasons for this are not hard to uncover. First there are the rooms full of legacy infrastructure that are hard to ignore. With the investment required to buy and maintain them, it can be difficult for organizations to justify 'letting go'. Second, there's cost. With the allocation model, payment is essentially upfront, to acquire the infrastructure needed to deploy the HPC cluster purchased. But therein lies the rub: if organisations pay for and provision 50 machines, then 50 machines are what they have. No more, no less. Scaling beyond this is going to require additional budget, however pressing the priority.

Making the call to move to the cloud or stay on premise therefore requires some form of cost/benefit analysis. An assessment that's based on three core inputs:

- An understanding of historical HPC usage across the organization.
- The predicted cost of running the hardware.
- The pricing model for accessing the required capabilities in the cloud.

Finding the right model

It's also worth noting that the pre-defined model often turns out to be expensive. Indeed, research suggests that only around 7% of budgets spent in this fashion actually go toward the hardware[2]. The rest is consumed by staffing and infrastructure support costs (buildings, power, cooling, networking etc.). It is only in certain instances where the on-premise/allocation model works best, if for example demand is predictable and neatly inside the parameters of available machines. Basically it all comes down to usage, and as we can all appreciate predicting what's needed and when is an increasingly difficult thing to do: Unless a crystal ball is on hand.

Yet at the same time it's a good time to think bold. To unleash ambition and to ask the organization: "what more could we be achieving if we had access to the right HPC resources at exactly the right time?" And: "can we stimulate greater innovation with the help of intelligent provisioning that enables HPC clusters to spin up and down fast, and in the most cost-effective way possible?

Interesting questions for sure. The response can often be that various workloads are simply set to run regularly at certain times, and therefore offer little room for innovative thinking. And that's right. But what of other workloads that aren't so bound to a specific time period? It's here that the cost/benefit analysis can get really interesting through the introduction of fresh options:

- What if for a certain job, instead of letting it run for a week on 20 machines we 'blasted' it with 200 machines over a 10 hour period?
- How do both approaches compare financially?
- What is the cost impact/organizational value of delivering the results faster?

[2] Source: https://cloudwatchhub.eu/how-cost-efficient-hpc-cloud

Exploring all the options

Deliver greater choice to organizations, and the above scenario makes for interesting debate. A conversation that also needs to include the subject of resource availability, and avoiding the situation of machines performing 'burst' processing before sitting idle for a given length of time. Not when HPC resources are available on demand by the hour. Then there's the cost dimension. In the cloud, organizations can now make use of spot/pre-emptible instances (as opposed to regular on-demand instances) and utilize idle HPC capacity a cloud provider can have – available at a discount of up to 60%. Granted, the same cloud provider can take back this resource if a higher paying customer becomes available. But with an intelligent multi-cloud provisioning tool – as delivered by YellowDog – the relocation to a replacement resource is both automated and seamless.

All of which is to paint a picture of how HPC capabilities are becoming increasingly accessible to organizations of every shape and size. Some workloads, especially those deemed 'mission critical', can of course remain on-premises – at least for the short-term. But for other more ad hoc workloads, the technology exists to connect them with the ideal HPC cluster arrangement – for the best price possible. The only restriction then is the limit of an organisation's ambition.

There's Gold In Them There Hills

Or how to find ideal HPC resources from amid the clutter

There was an interesting study performed a few years ago on the topic of choice. Run at a typical Saturday market, two independent stalls were set up selling jam. The only difference between them was the range of products offered. One presented a wide range of flavours, the other only just a few. The result: the stall with the least choice sold far more jam.

But what's this got to do with provisioning HPC resource?

Well, what the study concluded was that the 'illusion of choice' stunted decision-making. By that the organizers meant that the more choice available, the more the buyer becomes convinced the ideal option is 'out there'. And with their imagination fired, many left empty handed – determined to find their ideal fruit-based preserve.

Now let's get to the world of cloud. Organizations here, by various counts, have a choice of over 25,000 instances offered by numerous cloud providers. A choice that therefore starts out wide, but one that can quickly narrow. Not every workload is destined for the cloud. Some can prove to run more cost effectively on-premises. While others are deemed so 'business critical' that no one dares even consider a switch. However, and it's a big however, a growing percentage of HPC workloads will run best in the cloud. Especially when the available infrastructure is factored in, alongside cost and the basic ability to dial up or down the number of machines dedicated to the task.

But is there an 'ideal' option?

The measures of success

Answering this question requires an intelligent and scalable workload manager. A tool able to sift through all the options and available computing resources to ensure every workload avoids the 'illusion of choice', and actually experiences ideal as a standard. It's also the fastest way to test assumptions for what workloads really are suited to the cloud. Better still, a multi-cloud workload management solution that's able to scale applications across the cloud also helps align outcomes to the most critical KPIs:

- **Budget:** and ensuring each workload is able to run in the cloud for an acceptable and adjustable cost.
- **Improve:** once running in the cloud, it's vital to understand how smart provisioning is helping to improve the performance of each workload.
- **Maintain:** and monitoring the mobility of each workload to allow maximum portability between regions, machines, and cloud providers to maintain operational agility.

As for what an intelligent scheduler/workload management tool can do for helping organisations determine the ideal HPC resources needed, it really comes down to visibility. Well, visibility added to the automated capabilities needed for doing the hard yards in terms of connecting workloads to actual cloud resources.

- Visibility: which in a multi-cloud environment means detailing all the different services offered by individual cloud providers. A complete view of the cloud landscape through one single management window – or one single SDK – that removes all the complexities involved.
- Automated capabilities: that enable workloads to be easily integrated into the tool, and to port them to the ideal HPC resource, irrespective of region. A provisioning strategy that instantly adapts to any issues with a cloud provider to maintain continuity of service.

Capabilities that combined help organisations embrace the full potential of the cloud; to revel in the choice available, knowing that the more there is the better their options; and to actively identify 'ideal' amid all the competing service arrangements and sales pitches coming from cloud providers. Unlike the jam study, we believe in the value of 'going big' when it comes to choice – and have the results to prove it.

Any Workload, Anytime, Any Place

Or how to embrace any compute-intensive workload and win

Any workload, at any time: That's a lot of potential demand for HPC resources. The good news is that the computing power now exists to tackle even the most demanding of tasks. That's not in doubt. Hence why the really important factor to consider is the need to balance the supply of this processing power with demand, and doing so in the most cost-effective way possible.

It doesn't take a rocket scientist to appreciate that workloads can vary dramatically (though they alone must be running some interesting simulations!). In financial services for example, a lot of batch processing occurs at night and needs to be completed by the early hours to enable a bank to be operational by morning. Or, as with one of our clients in this field, they need to run a mix of scheduled and ad hoc simulations to test the effectiveness of various investment models – a mix of batch processing and more irregular 'burst' processing to quickly generate urgent insight.

Then there's healthcare, where any workload involving patient data faces restrictions on where they can be run. And of course there are the practical infrastructure issues that can restrict the mobility of any workload, particularly with applications that are only able to use a certain amount of cores – or licensing agreements that further impede agility.

Proof of value

Optimizing the balance of supply and demand to embrace any workload will today inevitably involve the cloud. Moving suitable workloads here opens them up to a global resource pool of computing power. What's holding back many from doing this however are two principal concerns:

- **Complexity:** with such a vast choice of cloud instances to choose from combined with an existing infrastructure, the idea of mapping demand to a cloud supply is daunting at best.
- **Cost:** where organizations are understandably concerned at the idea of somehow losing visibility of the compute resources being used, and ending up with a hefty bill that breaks their budget.

So how to overcome the fear? At YellowDog we offer a project called Proof of Value, and it does exactly what it says on the tin. Typically run over a short period of time (6-8 weeks on average), we'll take a workload that's portable to the cloud and simply do just that. Once done, the results show how:

- With an intelligent, multi-cloud workload management tool the complexity is abstracted away. The result is a single view and the ability for users to dynamically make changes in real-time with startling simplicity – while also seeing the results of any change with immediate clarity.
- Organisations also gain a complete view of what compute resource is available from individual cloud providers, including cost and geographical location.
- And finally, most importantly, the Proof of Value can be used to benchmark performance and explore different options (all guided by our experts) to calculate the value of provisioning from the cloud.

The recommendation here is to start running workloads in a 'least cost aggressive' arrangement, to first prove that an intelligent provisioning tool works in any given environment. Once this job is done, the next step is to run the same workloads in a 'high cost aggressive' arrangement to show the difference. At this point organisations can also get granular in terms of using different machine setups for generating the best results. It's also here that they can make sure every machine is being used to its full capacity, rather than a workload only using say 20%. When this is the case, the option exists to utilize smaller machines – or to increase the number of jobs running.

Summing up

Demonstrating the impact, at both a cost and performance level, of running HPC workloads in the cloud is now a simple process to achieve. Starting with a Proof of Value project also gives organisations the confidence of knowing that full control is being maintained throughout. And by optimizing not just spend but the finer points of machine performance, including utilization, they'll then be in a position to make smart decisions on what's available to run and where. Importantly, this is visibility that also enables organisations to take a more dynamic view of provisioning individual jobs to ensure no workload gets left behind. When that happens, the sky really is the limit.

A Little Bit About YellowDog

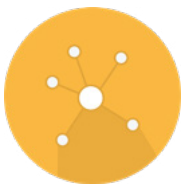
YellowDog offers a multi-cloud workload management solution that can dynamically scale applications across the cloud. As a result our clients can deliver on all their HPC commitments, while elevating their ROI by 3-10x and delivering cost savings of up to 60%.

This is a platform that delivers compute-intensive and HPC workloads on time and on budget with cloud native scheduling, multi-cloud access and on-premises efficiency.

Push back the boundaries of possible

Workload acceleration
Rapidly scale and deploy compute-intensive and HPC workloads on-demand.

Intelligent provisioning
Control costs with intelligent provisioning and make smarter decisions on cloud usage.



Powerful meta scheduling
Coordinate assorted 3rd party schedulers, with one workload submission system.

Simple cloud onboarding
Rely on our expert team to transform your workload execution, completely hassle free.

Put us to the test

Contact our team today to learn more or request a demo

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