ORIENTATION GUIDE

Approaching x86 Consolidation

Exploring the potential of mainframe-based centralisation

Freeform Dynamics Ltd, January 2010

All IT initiatives need an objective view of requirements and choices on offer to meet performance and cost objectives. This guide explores x86 server consolidation for Linux-based workloads via a method you may not have thought a natural choice, but with the right mix of environment and requirements, may offer 'another way'.

EXECUTIVE SUMMARY

Virtualisation plus consolidation equals choice. A focus for many organisations is the consolidation of existing x86 server estates via virtualisation. Workloads can be moved into virtual machines which in turn can take advantage of the features of more modern hardware. But what is such hardware? Many would think about racks of gleaming new servers or blades, but other platforms exist. For Linux-based workloads specifically, a valid consolidation option is to take a centralised approach using mainframe technology.

Mainframe technology brings a centralised approach 'out of the box'. Today's mainframe technologies may not be 'as you thought you knew them'. The use of offload engines mean specific types of workloads can be run in a modern environment which brings with it the traditional benefits of the mainframe: reliability, availability and security – the pre-requisites for managing a virtualised environment. Other attributes of note are the scalability and centralised resource management inherent in this platform, while costs for incremental workload addition are particularly low. Favourable 'per core' application software licensing terms can also be achieved.

The centralised, mainframe based approach provides another option for consolidation. However it is clearly not the only option. To determine whether it fits with your IT strategy and requirements you need to understand what you're trying to consolidate. Not all x86 workloads will be appropriate for consolidation into a centralised virtual environment. Many are however, with Linux-based workloads forming a key group. Focusing on the cost-benefits, performance requirements and the importance of a workload to your business will help build an objective view of the value this approach may offer.

Cost-effectiveness depends on factors to consider before and after deployment. These include power and space; available skills and training; licensing and ISV support including for Linux; and a number of non-technical criteria, e.g. systems ownership and its impact on both consolidation and the provisioning of virtual machines. It is important to 'run the numbers' for the spectrum of acquisition and operational costs associated with your consolidation activities, regardless of the target platform.

A review of your computing environment will help you make an informed choice. Analysis of areas such as existing capacity and the nature of the workloads you run will help address many of the questions that should be asked to get you into a position to assess whether this approach to consolidation is appropriate to your needs. In particular, organisations that already have mainframes in place may see an opportunity to make better use of the platform. Buying in new mainframe capacity should not be ruled out; rather, it should be weighed up along-side the costs of the alternatives.

This guide is based on a number of research projects carried out in the last 12 months, all of which were designed and interpreted on an independent basis by Freeform Dynamics. The guide is sponsored by IBM.

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Virtualisation and the new consolidation wave

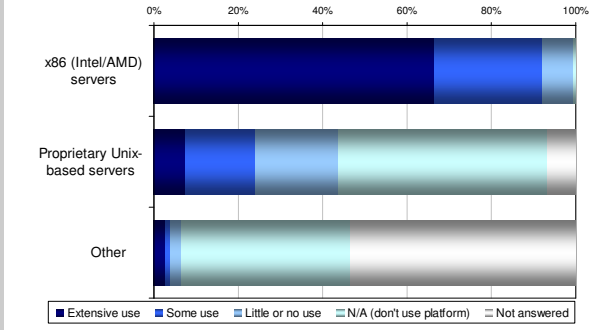
In this universe, some truths hold beyond the laws of physics. Entropy – the measurement scientists use to calculate the level of disorder – is increasing. But disorder comes at a cost: this is as true in IT as anywhere. It can be very difficult to measure such disorder in exact terms: in IT, we talk about 'total cost of ownership' or TCO, which includes elements such as user productivity, service efficiency, operational overhead and so on, all of which are notoriously difficult to calculate. However, we do know that for IT systems of all shapes and sizes, a point is generally reached where the costs of ownership start to outweigh the benefits.

In data centres around the world, 'consolidation' is the term used to describe the re-ordering of existing systems and equipment, potentially using new hardware – it is the technological equivalent of a good clear out. Understandably, interest in consolidation tends to grow when budgets are tight: IT departments looking to reduce their overheads may choose to inject some capital expenditure (Capex) in order to limit their future operational expenditure (Opex).

These factors are particularly relevant today, given how the financial turmoil of late has impacted the corporate world. Although the IT industry did not escape unscathed, at least this time around it knew what to expect. The dot-com collapse earlier in the millennium was triggered by different forces, but was in some ways a dry run for what came more recently.

We can make certain comparisons between the two events. The dot-bomb resulted in a period of intense scrutiny of return-on-investment (ROI), and a shift in spending patterns from unchecked outlay (when organisations were capital rich) to reduced capital spend and operational frugality (when they were not). These changing priorities also prompted a wave of consolidation in which older and more expensive to run hardware was replaced by more modern, efficient alternatives.

This time however, things are different: technology has moved on. Most notably x86 server virtualisation, which was little more than a twinkle in the eye of the IT industry five years ago, is rapidly moving into the mainstream.



The majority of virtualisation activity remains in pilots, non-critical workloads, or development and test environments. However there does appear to be substantial good will out there.

Figure 1

Virtualisation makes it possible to partition physical hardware resources: one physical computer can be divided into several 'virtual' computers, or a physical disk into several 'virtual' drives. This is a familiar concept to most people involved in IT for any length of time: virtualisation was available on the mainframe platform back in the 1970's for example. The difference now, however, is that computers have become powerful enough in general for virtualisation to be considered as a more standard element of IT.

The past decade has seen increasingly powerful, x86-based servers becoming a viable platform for processor consolidation through the use of virtualisation. This has catalysed a wave of interest and as a result, organisations have gained familiarity with virtualisation, seeing it as an increasingly viable technology for more mission critical workloads. Recent research suggests most organisations are making some use of virtualisation in the x86 environments today.

Consolidating the x86 server estate using virtualisation offers a number of benefits. One is of course, that there is no need for any new hardware. Each consolidation candidate workload (be it an application, web server, email or whatever) can be given its own virtual machine, enabling dependent packages such as platform software and operating systems to be kept separate, and which in turn could be run on more modern hardware.

The potential advantages are considerable: not only can one physical machine run between five and ten virtual machines (or more, if workloads are low-overhead); but also, the resulting environment can be easier to manage, given that VMs can now be moved from one physical machine to another where necessary – for example so that the machine can be shut down temporarily for maintenance.

But when we use the term 'modern hardware', many would think of racks of gleaming new servers or blades. Other platforms exist for consolidation-via-virtualisation. It is not the purpose of this guide to recommend one platform over another. Rather, it aims to ensure you are aware of one approach to consolidation you might not have considered – that of adopting a centralised approach using mainframe technology – so you can make an informed decision in comparison with the other options that exist.

What was that? *Mainframe* technology you say?

Indeed. One thing we should all have learned from the past four decades of technological progress is that nothing ever goes away. Rather than new waves of technology replacing what has gone before, they have tended to add to the mix, increasing the range of available options. This is typified by the centralised approach to computing offered by the mainframe which should, according to some quarters, have been pushed out by minicomputers and distributed servers some 20 years ago. This is far from the truth, as most if not all enterprise organisations are still reliant on these computing platforms today.

A result of this technological diversity is that many organisations have ended up with more processing power than they actually need. Until recently it has not been possible to unlock this valuable resource: software applications have tended to be tied to specific hardware. As discussed however, virtualisation technologies help break the link between application software and hardware, enabling workloads to be more easily migrated to, and run on a variety of hardware platforms.

The question is, does mainframe technology present a viable option for a virtualisation platform? We have learned from our research for example that while it may appear an expensive upfront investment, the mainframe can prove highly cost-effective when it comes to adding new workloads. Here we are thinking specifically about Linux-based applications, which are fully supported in the mainframe environment particularly given the offload processing capabilities now available won the platform.

Of course, its suitability will depend on your own requirements and the context in which you work. 'Cost-benefit' should absolutely be measured against the benefits and costs of alternative platforms. An additional factor is the availability of existing hardware: for example, we also know that many organisations are not making full use of their mainframe assets, suggesting there could indeed be spare capacity that could be used for such a purpose.

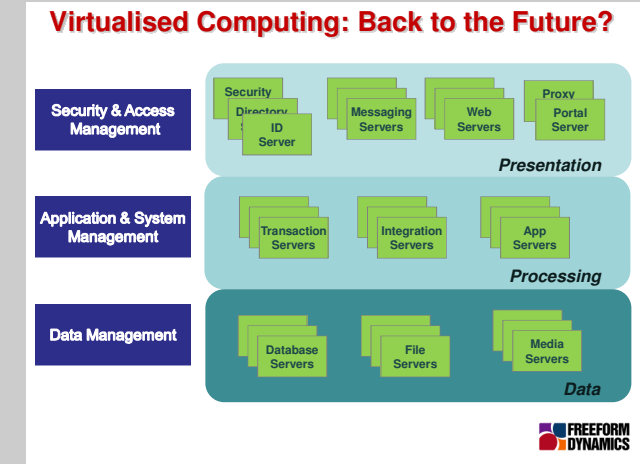
With this in mind, this paper is for you if:

- You are already undertaking a server consolidation exercise and you want a clear view on all the options before you decide which would be appropriate.
- You are not yet sure about mainframe technology in this context, and you want to clarify and validate your thinking.
- You have already made a decision to centralise to a mainframe environment, and you want a quick sanity check or another way of articulating it to an internal audience.
- You are simply curious to know more about where and how this approach might fit.

Still interested? If so, read on.

Why should I consider mainframe technology for consolidation?

As we have learned from a number of research studies and feedback from virtualisation pilots, to get the best out of the virtualised environment, it shouldn't be considered as a set of discrete components. Rather, to deliver the highest levels of availability, security, flexibility and so on it is more appropriate to design and manage it as a single entity. As shown in the figure, different layers provide different services which are then delivered to users as a unified whole. "Hang on," we hear more seasoned generations of IT professionals saying, "isn't that just a mainframe?"

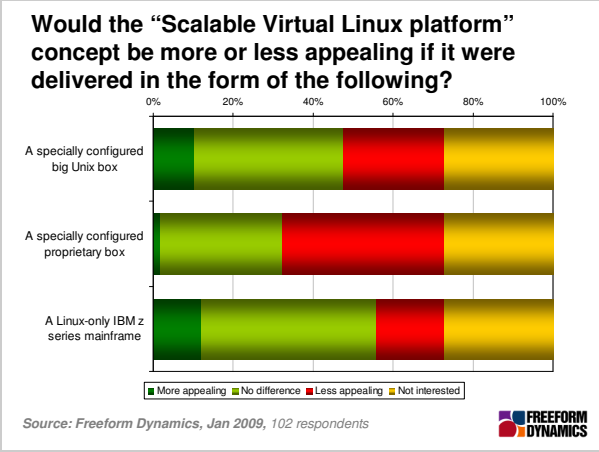


Virtualised x86 environments don't have to be consolidated to x86 platforms.

Figure 2

The answer: in many cases, it can be. x86 workloads do not *have* to be consolidated onto an x86 hardware platform: that's one of the benefits of virtualisation! But let's get one thing out of the way first: isn't the mainframe a dinosaur? Reticence around the use of mainframes seems to have subsided considerably – though it will probably remain forever the Marmite™ of hardware platforms. From our studies, we have reconciled ourselves to the fact that mainframe technologies remain alive and well in many organisations, and few that do have them in place show any sign of wanting rid.

Indeed, when we researched platform types earlier in 2009 with respect to Linux consolidation we found little resistance to the principle of using mainframe technology (Figure 2).



Is it all about the name, or the purpose and capability of the platform?

Figure 3

So what does it bring to the party? It's important to acknowledge that today's mainframe technologies may not be 'as you knew it' due to a fair amount of evolution over the years. One development of relevance is 'offload processing'. Offload 'engines' are dedicated processors which can run eligible workloads instead of running them on the main processors.

The Integrated Facility for Linux (IFL) engine is of particular interest, as it enables Linux-based workloads to be run. Also, the System Assist Processor (SAP) offloads I/O activity from the main

processor – important given the increased I/O often resulting from consolidating virtual machines. For the record there are two others: zIIP engines were designed to enhance the performance of business applications and zAAP engines enable offload processing for Java workloads.

'Offload-engine-enhanced' mainframe technology offers several benefits for x86 consolidation:

- **Reliability, availability and security.** It is generally accepted in IT circles that mainframe technology sets the gold standard when it comes to reliability and availability, offering 'greater than five nines availability' – that is, 99.999%, which equates to less than five minutes of downtime per year. This is a very important point given the inevitable 'eggs-in-one-basket' effect of consolidation by virtualisation. From a security perspective, the mainframe offers a lower risk platform than distributed systems – but note, however, that in this context we also need to consider the security of the Linux-based workloads.
- **Scalability and manageability.** Few environments can beat a mainframe approach when it comes to scalability, particularly because it all happens 'in the same box' – i.e. resource management takes place centrally. In this context a single 'box' can support hundreds of Linux virtual machines in parallel. Mainframe virtualisation technology is designed to cope with variations in workload, which is also of significant help in the consolidation environment where the needs of multiple workloads are being balanced in real time.
- **Centralised resource management.** From a manageability and performance point of view, centralisation is a key part of the practical and business case justification. For example, memory is managed centrally across all virtual machines, and cache memory is designed to be subdivided and used across virtual machines, maximising the performance of each. Certain disk volumes can be shared between virtual machines, for example /usr libraries, simplifying patch management.
- **Storage and networking integration.** One lesson being learned in current virtualisation projects is around the need for sufficient storage and networking bandwidth to support each individual virtual machine. This connectivity is provided 'in the box' with the mainframe architecture.
- **Space and power.** A many to one approach to consolidation may present a compelling choice in a data centre where physical space or energy availability is an issue.
- **Consolidation scale and management.** A mainframe can run several orders of magnitude more virtual machines than a single x86 (see sidebar). Multiple servers still operate as independent physical devices. However, a mainframe is a single device and can be managed as such. This is particularly relevant in the context of software patching, as they need to be applied to individual servers in the distributed environment.
- **Software licensing.** Depending on licensing terms, organisations can reduce their software licensing costs by consolidating specific workloads onto a central server. Database licensing is charged on a per processor basis, (but is not the only example). The savings associated with consolidating from 20 cores to a single core could be significant.

Workload consolidation ratios experienced by some mainframe customers

Customer	Distributed cores	Centralised cores	Consolid-ation ratio
Building society	350	15	23:1
Govern-ment Agency	292	5	58:1
Transport Company	186	3	62:1
Financial Institution	1324	36	36:1

(Source: IBM)

These criteria need to be considered relative to the costs of procurement. Server replacement is never going to be a petty cash purchase, and we understand from IBM that the price of a mainframe

for use in this context starts at £200K (including maintenance, they add!) which effectively sets the threshold to mean organisations looking to consolidate hundreds, rather than tens of servers. However as already mentioned, organisations that already have a mainframe in place may well be able to take advantage of spare capacity in this regard.

A second factor is the cost of management tools for the workloads themselves, which can be expensive particularly for some legacy software applications. There are a number of other reasons why you might choose to go down the distributed systems route instead, for example:

- You are consolidating Windows-based workloads.
- You already have significant, up-to-date investment in x86 server or blades
- The number of servers to consolidate is insufficient to justify the capital outlay.

Clearly, there's no one-size-fits-all answer when it comes to consolidation, on mainframe or otherwise. To determine whether a centralised approach to consolidation is valid for you, the question now is: are such on-paper benefits as these, attractive enough when weighed up against your own, real world requirements?

Will a centralised approach work for me in the real world?

Generic benefits are a good starting point, but you need to confirm that they fit with your own IT strategy, requirements and organisation. In this section we consider the following questions:

- Should you be consolidating your x86 workloads at all?
- If so, do you have sufficient spare capacity to enable consolidation, or 'critical mass' to merit use of mainframe capacity?
- What other factors and hurdles should you take into account?

Workloads, workloads, workloads

Before you even think about whether or not a centralised approach is most appropriate, you will need to understand what you're trying to consolidate, and whether it is worth your while in the first place.

To be specific, we are really talking about x86 workloads here – that is, applications and operating systems currently running on servers that follow the standards for x86 architecture. While this might seem quite a rigid scope, quite a few workload types fit. Application types that may be appropriate targets for consolidation include:

- Web servers
- Application servers
- E-mail servers
- File and print servers
- Database servers
- Bespoke applications

Not all of your x86 workloads will be appropriate for consolidation into a centralised virtual environment. Notable exceptions are applications that absolutely do require as much number-crunching horsepower as possible. Not all applications are thus, however, and the majority of x86 workloads will be (at least in principle) appropriate consolidation targets. Further triage should be able to separate Linux-based workloads from workloads running on other x86 operating systems, such as Solaris-X86 and Windows.

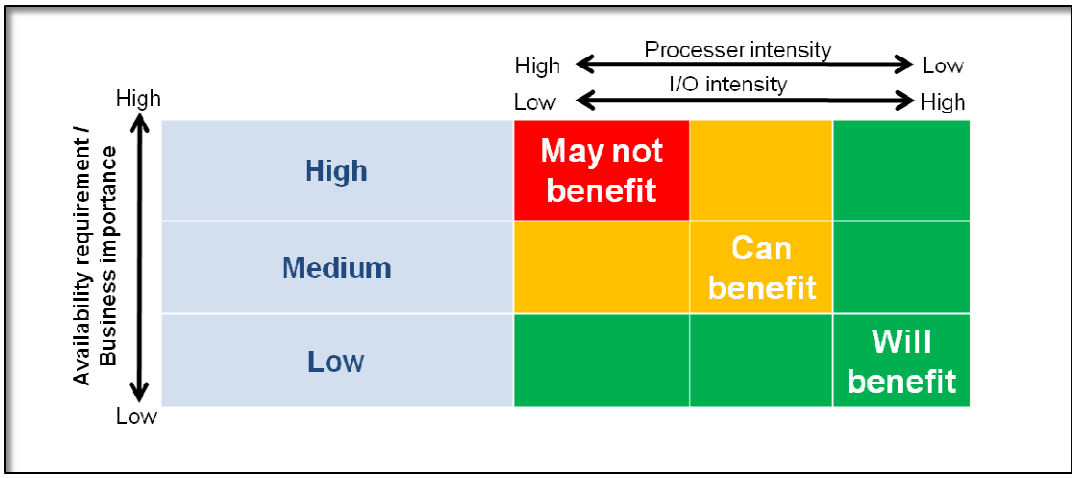
Having established the group (Linux-based workloads) that we are interested in, we can focus in on the cost-benefits of consolidation. Not all workloads are created equal, and in general terms, it is estimated that only about 30% of server estates are utilised. This suggests that there can be quite

considerable gains from consolidating. However, these gains need to be considered in financial terms particularly if there is going to have to be some initial outlay to get there.

NB: We do not propose that you attempt a detailed study of each application or software package at this point. However, it is worth categorising your Linux-based workloads on two axes:

- **Performance requirements:** are the workloads processor intensive, low-use or somewhere in between with regards to 'number crunching', and /or transaction (e.g., database calls) intensive or not?
- **Importance to your business:** are they mission critical, low priority or again, somewhere in the middle? Risk may be in terms of any current difficulties you may have with a given application, or the fact that the organisation would suffer if there was a problem with it.

Processor intensive workloads may not benefit from virtualisation. However, the majority of your applications will not fit this profile and so everything else can be considered as 'fair game': in the table below, we would expect that only a small proportion of x86 Linux workloads can be ruled out. From this point on, it comes down to the numbers.



Consolidation is indeed largely a 'numbers game' – that is, how do the finances stack up when you compare leaving everything as it is, versus consolidating things down? This is not the place to go into detail of measuring processor loads, cost per CPU and so on. However, you should be able to come up with a reasonable picture of how things currently stand by reviewing the different application types in your environment and considering how they map onto the criteria we present here.

As a rule of thumb, if you can identify tens of servers that are potential consolidation targets, then you can probably save money by going through the effort required to consolidate. The second question, then, is 'consolidating to what?' The choice is twofold - whether to use existing capacity versus new capacity, and then, whether to take a centralised or distribute systems approach. If you have spare existing capacity it makes sense to use it. Alternatively, you may decide that you need to consolidate to a new hardware platform. To help get things clear, it is probably worth drawing up a number of target scenarios for consolidation, not least:

- **Existing or new distributed systems:** if you have recently refreshed your X86 server estate, you may be able to build virtualisation into the mix. Immediate benefits are likely to be power and licensing cost savings. You may consider adding to your pool of rack or blade servers to accommodate your consolidation needs.
- **Spare centralised capacity**: few organisations maximise the use of their mainframe platform, which offers (in cost-per-CPU-hour terms) cheaper capacity than equivalent distributed systems.
- **New centralised capacity**: if the number of server workloads you wish to consolidate is large, you may even find it appropriate to procure additional mainframe capacity.

The question for all these scenarios is one of maths, as to whether the basic finances stack up. While we are not advocating any one approach, we would encourage you to take as open-minded a perspective as possible: the results may surprise you.

Gearing up for centralised consolidation

Consolidation involves more than hardware. Increasing your knowledge of the following areas with respect to the computing environment that exists in your organisation will help you address may of the questions that should and will arise:

- **Power and space requirements.** As we have discussed, a significant benefit of a centralised approach (with an existing mainframe) is that you will need no additional space and minimal additional power. This should be factored against alternative scenarios in which new hardware is required.
- **Skills and training costs.** While existing mainframe shops should not have any additional technical knowledge requirements when consolidating existing workloads, there may be skills gaps around provisioning and service management of the virtualised environment.
- **Cost of virtualisation management tools.** Such tools include the ability to provision, migrate and monitor virtual machines. Of particular concern is the potential issue of virtual machine sprawl, so it makes sense to deploy the right level of tooling early on.
- **Licensing / ISV support issues.** There may be a number of licensing benefits to running certain workloads on the mainframe platform (as mentioned earlier in the context of databases for example). However you should also be careful that your existing application vendors recognise the mainframe as a support target, or you may find yourself with unexpected costs or even with no support at all.
- **Linux support.** Depending on the versions of Linux supported, it may be necessary to recompile and test workloads that have been built for other distributions.
- **Politics and other non-technical issues.** Politics enters into the mix, notably around challenges of the 'system ownership' culture in an organisation. We suggest you treat this issue with the respect it deserves. In many organisations, applications are considered to be linked to specific departments or business groups, and you may face considerable resistance when it comes to moving 'their' workloads onto a single hardware platform. Any consolidation exercise should be treated as a change programme, whatever the target platform.

A key element in working out if this type of approach will suit your organisation is to 'run the numbers' and get a clear picture of whether there is a compelling enough argument for you to consider the mainframe for consolidation. It is important to take the full picture into account as it may throw up some unexpected issues or perhaps 'bonus' findings. For example, IBM told us that a financial institution found the primary benefit was in terms of power consumption (see sidebar): your own mileage will no doubt differ.

Having 'run the numbers' and tested the possible scenarios, you may decide that at least part of your estate is a candidate for centralised consolidation via a mainframe platform. The question then becomes how to maximise the success of such a project. As ever, the starting point is to build a business case which accurately reflects the work to be done and the costs involved. The work you have already undertaken when deciding whether such an approach is appropriate, will certainly give you a running start.

Power consumption savings for one financial institution

Customer	Distributed	Centralised	+/-
Power (kWhr)	36	22	-38%
Heat (kBTU/hr)	110	74	-33%
Space (Racks)	6.5	4.5	-31%
Carbon (Tonnes)	66	40	-39%

(Source: IBM)

Elements of the business case include:

- A view of current cost of ownership and operation of the non-consolidated environment, together with a review of available capacity on consolidation target platforms (i.e. existing mainframe spare capacity).
- Identified candidate workloads together with an indication of the financial impact of consolidation in both capital and operational expenditure terms. The goal here should be to demonstrate pay-back and 'profit' within a certain timescale.
- Pictures of current dependencies (OS, middleware, skills etc.) so as to ensure any knock-on effects of consolidation are captured and dealt with.
- Operational pre-requisites, e.g. in terms of data protection, service management, security etc., as well as application development and testing impacts and plans.
- Additional benefits, for example for development and test environments, or non-business critical workloads, it can provide temporary capacity that would not make sense to purchase individually as physical servers.
- Requirements based on the ongoing management of consolidated workloads, including costs of service & availability reporting, and/or reporting tools / chargeback capabilities to report on quality and cost of service delivery.
- Other organisational and political criteria that will need to be dealt with using appropriate change management techniques.

This last point, about change management is important as this is not just about technology. A phased approach to consolidation to minimise risks and ensure buy-in at every stage is desirable.

Taking things from here

Organisations don't consolidate servers because they want to; they do it because they have to. However, virtualisation does offer considerably more flexibility than in the past, both in how consolidation takes place, and the target platforms available.

As advertised, we have focused on taking a centralised approach to x86 server consolidation by way of mainframe technology in this paper, and many organisations are recognising that it is indeed an option that merits consideration. We firmly acknowledge that it is not the only option available. However, you have nothing to lose in exploring this approach in the context of your own business, and you may find a great deal can be gained in terms of overall operational benefit.

Both mainframe-based centralisation and consolidation to distributed platforms can benefit from best practice lessons learned from organisations which have already been through this kind of process. At the very least, you would do well to keep in mind the following:

- **Gain appropriate stakeholder buy-in**: given that mainframe technology is 'just computer stuff', it does get a good amount of bad press. You may need to do some internal 'sales and marketing' to build understanding of why it is an appropriate consolidation platform.
- **Take a phased approach to consolidation**: don't bite off more than you can chew. Ensure one phase is complete and successful before embarking on the next; start with lower-risk workloads for 'quick wins'.
- **Build in disaster recovery from the outset:** virtualisation does enable more straightforward workload duplication and movement, but it needs to be treated as an integrated element of a well-managed consolidation environment.
- **Find the 'hidden' costs:** be sure you have taken into account all aspects of skills, licensing, failover etc from the outset, or they may turn up later as unexpected additional costs.

We hope you have found this report useful and we would welcome any feedback you may have.

About Freeform Dynamics

Freeform Dynamics is a research and analysis firm. We track and report on the business impact of developments in the IT and communications sectors.

As part of this, we use an innovative research methodology to gather feedback directly from those involved in IT strategy, planning, procurement and implementation. Our output is therefore grounded in real-world practicality for use by mainstream business and IT professionals.

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