White Paper
Hyper! Hyper? Worthwhile or Nonsense? Hyper-Convergence – The End of Classical IT?

Hyper-converged infrastructures are the rising stars in data centers. What is behind this hype, what are its key benefits and what does it mean in practice? Is hyper-converged always superior to traditional IT architectures? What is the impact on day-to-day operations, expandability and lifecycles? For which use cases is hyper-converged strongly recommendable or even a must? Let's have a deeper look to find the answers.

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The silver bullet for the data center?

There is much noise in the market about hyper-converged infrastructures. Analysts predict an ever increasing market for the next couple of years, with a compound annual growth rate of approximately 50% by 2021, depending on the analyst report you are considering; although the starting point is already a solid base of deployments.

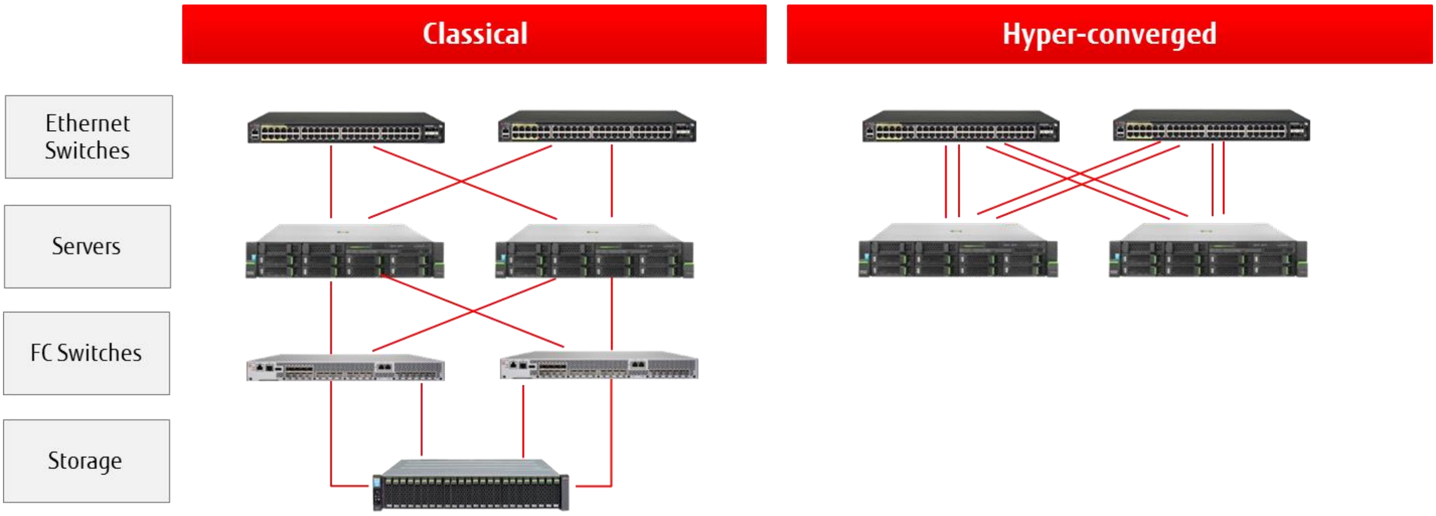
Constantly, articles are published which extraordinarily praise hyper-convergence and demonstrate a high number of benefits. This suggests that hyper-converged infrastructures are the silver bullet for the data center, and you could easily come to the conclusion that hyper-convergence will lead to the end of classical IT infrastructures. But is this really true? Is hyper-converged the right answer to every situation? Is it really jack of all trades? Is it worthwhile, or is there also some overstatement behind?

What is the promise of hyper-converged?

Having compute and storage resources integrated in a single box means less infrastructure components, less data center footprint, less energy consumption and less cooling requirements. The single pane of glass management for both, compute and storage resources, simplifies administration and reduces skills demands, which in turn means that lower paid staff can do what higher paid staff did before. Due to their flexible scalability, most hyper-converged infrastructures can be easily aligned to growing business demands, while built-in high availability ensures business continuity. Finally, all benefits aforementioned have often a positive impact on cost, operational expenditure in particular.

How do hyper-converged infrastructures look like?

Before having a closer look at hyper-converged infrastructures, let us remember the well-known classical virtualized infrastructure approach with several servers interconnected in a Local Area Network (LAN) by redundant Ethernet switches. The data resides on an external storage system which can be accessed through a Storage Area Network (SAN) whose core elements are usually redundant Fiber Channel (FC) switches.



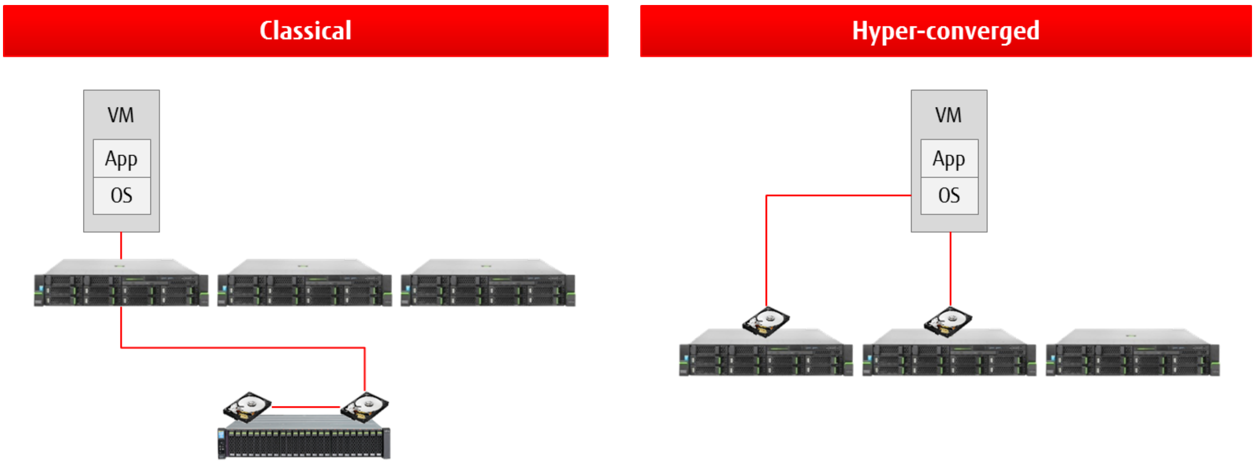
Hyper-converged infrastructures are also built from multiple servers interconnected in a LAN by redundant Ethernet switches. But in contrast to classical architectures, storage spreads across the local disks of the server nodes, making a central storage system and its dedicated physical SAN with its management, or a central Network-Attached Storage (NAS) superfluous.

The built-in storage features, such as data replication, deduplication and compression, turn hyper-converged infrastructures into a software-defined storage platform. Solid State Disks (SSD) can be used as a cache contributing to an enormous performance boost. High availability is built-in, because whenever one of the server nodes fails, another server can take over the workload running on the failed one, and data is not lost due to data replication. Compute performance and storage capacity can be scaled easily, just by adding or removing servers.

To be fair, we should not conceal that also the components of classical virtualized infrastructures can be reduced by using the same Ethernet switches for the LAN and the SAN, or by using a NAS in the same physical LAN. But in all these cases, we are still faced with two logically separated networks, and therefore a separate storage management is still required.

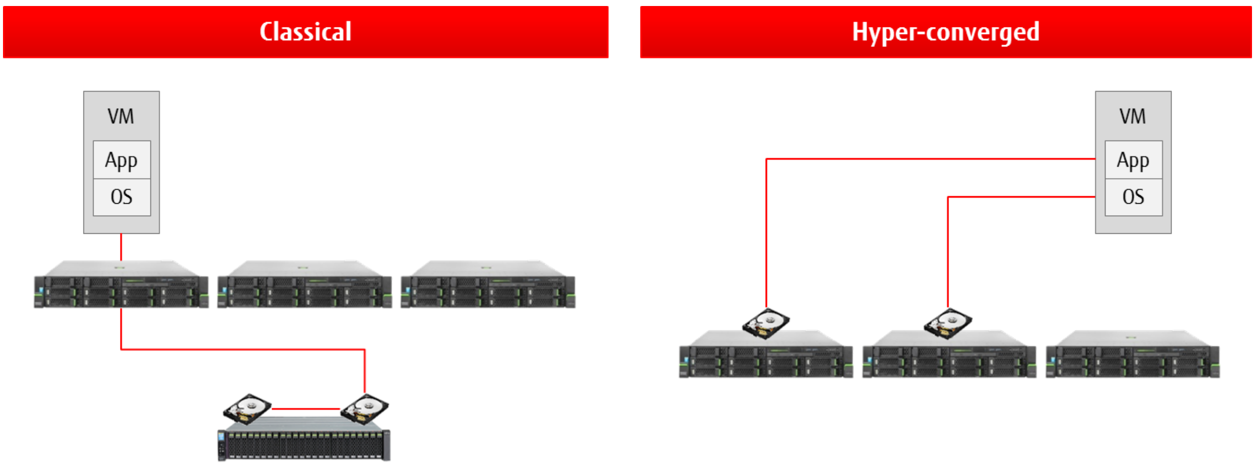
The working principle

Let us start with the classical architecture, where virtual machines (VMs) run on the servers and their data resides on the central (external) storage system. If you have to move VMs from one server to another one, e.g. because of planned downtime, the VM can still access their data on the central storage. In order to protect data against being lost in the event of a disk failure, any type of RAID level should be implemented in the storage system.



In a hyper-converged architecture, the situation is somewhat different. If a server fails, for sure, the VMs running on that server will also be restarted on another server of the cluster. But as there is no external storage, server failure affects all the data which reside on this server, too. In order to prevent data loss in the event of a server failure, the data connected to a VM is redundantly distributed over different server nodes by data replication.

It is worth mentioning that a VM does not necessarily run where its data is. Having the VM and its data on the same server is certainly an advantage for read operations; but when it comes to write operations, you will always have to move data through the network to another server. Otherwise you would not be able to leverage all benefits of virtualization, e.g. providing the flexibility to move VMs to any node in the server cluster. This means, that data locality does not really matter in any case, quite in contrast to what some vendors try to make their customers believe. Remember with write operations, it is always the slowest member which determines the overall speed.



Potential planned downtime per year

Why are we talking about planned downtime? The answer is fairly simple: Statistically, every server is out of order in the range of 4 to 19 times per year, according to plan. 3 to 8 times, the hypervisor requires an update, what may happen during operation. At the end, it is just the restart which causes approximately 15 - 20 minutes of downtime.

Apart from this, some firmware updates are due again and again. With the integrated remote management controller, this occurs maximally once per year at the average during operation with a subsequent restart of the controller itself which usually causes no downtime. The BIOS requires 1 to 6 encapsulated updates with a subsequent restart causing ca. 30 minutes of downtime. Finally, disk controllers as well as I/O adapters require max. 2 encapsulated updates with a subsequent restart causing some 20 minutes of downtime.

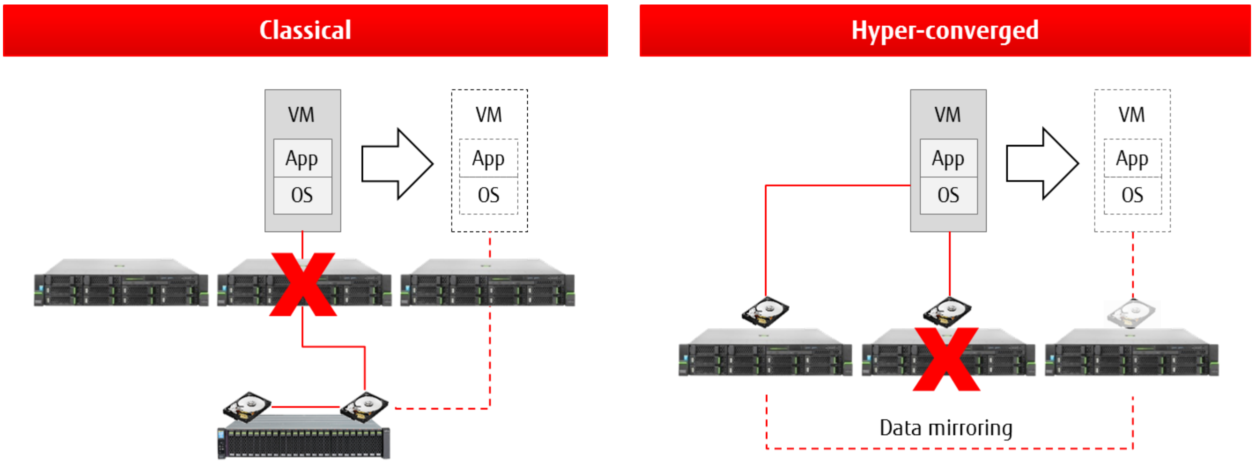
Apart from the servers, storage firmware is updated maximum 3 times per year at the average. Here, a controller restart taking some 15 minutes is required during which the controller itself is not available. But this restart causes no downtime of the overall system, if at least two controllers are built in.

What happens, if a server fails?

Let us now consider what happens, if a server fails. In the classical architecture, the VMs usually running on the failed server will be restarted on another server node. The data of the VMs on the central storage is not affected, and is still accessible by the VMs.

If your servers are not configured for more performance than needed, every server failure will degrade performance, because a smaller number of servers have to take over all the load of the failed servers, in addition to their usual load. And this will be critical especially, if it comes to the rare event that several servers fail at about the same time. However, the good thing is that the operation can still go on. Just if once the central storage system fails, all VMs will be stopped, and the entire operation will be out of order.

If a server fails in a hyper-converged infrastructure, the VMs running on that server will also be restarted on another server. But in addition, we have to bear in mind, that data is also affected. To ensure that the next planned or unplanned server downtime will cause no data loss, the original data redundancy has to be rebuilt; e.g. by mirroring the data to other intact servers. While data is being mirrored, operation is going on. Similar to classical environments, spare compute capacity is needed in hyper-converged environments in order to avoid performance degradation. But the servers need to provide the extra storage capacity, in addition.



How long will data mirroring take?

It sounds trivial that in the event of a server failure, data copies need to be mirrored between servers. But do you have an idea how long data mirroring will take?

Data mirroring will not just happen while clicking one's fingers. Assuming you have a 10 Gigabit Ethernet with a maximum throughput of 80%, transferring 1 TB of data through the network will take 17 minutes. Transferring 20 TB will take 5 hours and 33 minutes. Conducting the same exercise in a 1 Gigabit Ethernet will take 2 hours 47 minutes with 1 TB, and 55 hours 33 minutes with 20 TB. The conclusion might be that you are bound to 10 Gigabit Ethernet when going for hyper-converged.

It is true, that built-in data services, such as deduplication and compression, may reduce the data volumes by a factor of 7; nonetheless data mirroring will always take a considerable amount of time. And this exactly will be the critical thing, if the server, on which the data to be mirrored resides, fails before data mirroring is completed.

In this case, at least a part of the operation will be out of order. It is only a part of the operation, because VMs not depending on the data mirroring can still continue running. But usually it is not quite clear what is still running and what is stopped; and this is an uncertainty which is usually not acceptable.

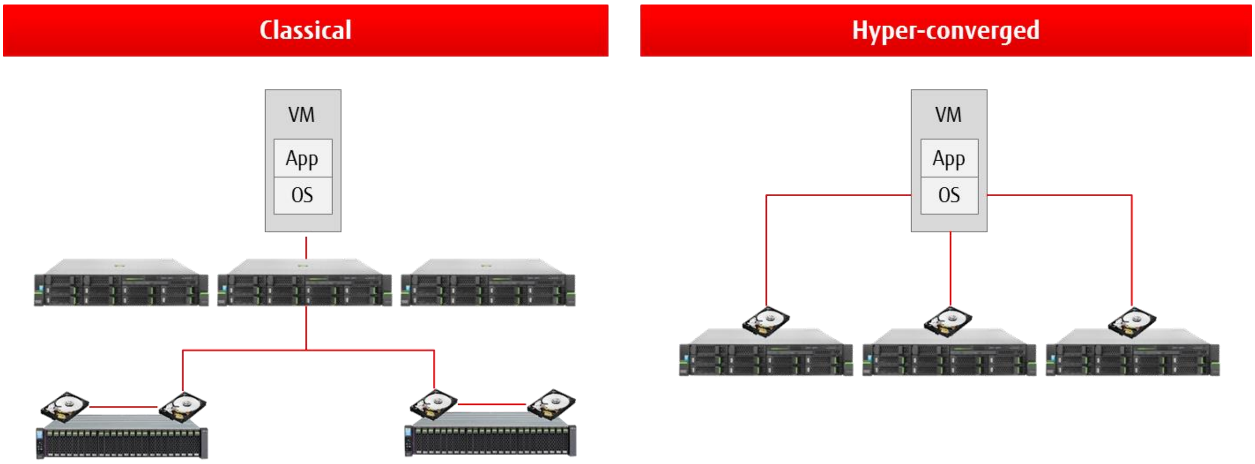
Bottlenecks and how to counteract them

From what we described afore, we recognize that in both cases, with classical and with hyper-converged infrastructures, there are bottlenecks and events which compromise or even stop operation.

Doubtlessly, there are options to counteract these bottlenecks. In the classical approach, you may just add a second external storage system to have an insurance against the failure of one of them, while of course more than doubling your storage budget.

In the hyper-converged approach, you may apply multi-mirroring of all data. Having multiple data copies reduces not only the risk of data loss, but also potential interruption times in the event of server failures. But for sure, multi-mirroring requires many more disks and therefore a higher budget. But hoping that after the failure of a server no further server will fail before data mirroring is completed is perhaps not the safest foundation for business continuity.

At the end, it is just a matter of investment and it is about the question what you are willing to pay for which service level.



Architectures in comparison and what it means for you

Let us now summarize the main characteristics of both architectures. A classical architecture includes servers, storage systems, as well as a LAN and a SAN or NAS. Consequently, you have to look after the lifecycle management for multiple components with different lifecycles; and you have to maintain two separate networks. Storage activities (also denoted as data services) such as snapshots are separated from servers. The classical architecture scales by adding multiple components, primarily separately. And it is about an approach which has been established for many years.

A hyper-converged architecture is based on servers and a LAN, with storage being included in the servers. While lifecycle management is needed for fewer components compared to the classical architecture, a more powerful LAN is required. Servers are involved in every storage activity, which should be considered when sizing the compute resources. According to our design guidelines, up to 10% of the CPU performance should be considered as storage activity overhead. Hyper-converged architectures scale by adding servers, primarily in a linear manner, which means compute and storage resources usually scale in tandem. And we should bear in mind that the hyper-converged approach is less established, because it just entered the market some 4 years ago.

What do these differences mean for you? Classical architectures are used for general purposes. They support virtual environments including multi-hypervisor environments and even physical (bare-metal) environments, if necessary. There is certainly a high level of hardware dependence, primarily related to storage. Typically the operational complexity is higher compared to hyper-converged architectures. Hardware cost is possibly higher, but software cost may be lower instead. The vendors of classical architectures that you find in the market are mainly well-established ones.

Hyper-converged architectures are usually tied to virtualization. There is basically no hardware dependence at all, but software dependence related to the virtualization software instead. Compared to classical architectures, operational complexity is definitely lower. Hardware costs are possibly lower, but software costs may be higher instead. Hyper-converged infrastructure solutions are mainly driven by newcomers, but more and more established vendors are joining.

As you can see, both approaches provide unique advantages. This means that there are good reasons for both architectures to coexist and to be taken into account.

Aspects to consider when taking your choice

If your workloads scale horizontally, hyper-converged will be a perfect fit, especially if compute and storage resources need to scale in tandem. This applies to workloads which require a fixed amount of CPU performance, main memory, disk space and IOPS. Typical examples are Hosted Virtual Desktops and Hosted Shared Desktops. If your workloads scale vertically, or they require a granular expansion on the component level, hyper-converged might be less appropriate. An example is monolithic applications, which cope with increasing data volumes using a scale-up approach.

For hyper-converged infrastructures, virtualization is a prerequisite. Therefore they cannot be used for workloads which run on bare-metal only, maybe because a virtual environment would be ineffective and slow them down. And as most implementations of hyper-converged are based on a single hypervisor, they won’t fit if a mixed operation of multiple hypervisors is needed to run different workloads.

Hyper-converged has become an attractive option for remote offices and branch offices. As no external storage infrastructure needs to be maintained, frequent costly onsite visits can be avoided. There are customer cases where travel time could be reduced by 99%, just by replacing a physical SAN by a hyper-converged infrastructure.

If your workloads benefit from the data services coming with hyper-converged, you may use these services without any additional investment. If you don’t need them, you will pay indirectly for things you don’t use. Another aspect worth considering is the expected growth. The more frequently you have to expand your infrastructure, the more you will benefit from the ease of scalability that features hyper-converged.

The unified management of compute and storage resources reduces operational complexity, administration efforts and cost. But bear in mind that going this new way will change existing staff roles and require other organizational changes. You may expect resistance from your IT staff, especially in the storage area. Will you counter this resistance? This aspect is also closely related to your storage strategy. If you intend to utilize existing storage, hyper-converged will hardly fit to your strategy. If in contrast you intend to replace your existing storage sooner or later, going for hyper-converged may be a good start.

The storage capacity of a hyper-converged infrastructure is limited by the number of server nodes. If you have to cope with amounts of data which are larger than the maximum storage capacity of your server cluster, hyper-converged will be no option. Though hyper-converged promises linear scalability, predictable network performance with larger deployments is sometime questioned, mainly caused by a lack of experience.

Beside the technical appropriateness of workloads, it is also software licensing aspects which should be taken into account. For instance, a database application may be a perfect fit for hyper-converged, but if you have to pay license fees per CPU socket or even per CPU core, hyper-converged will quite likely be a no-go for commercial reasons.

At the end, it will be all about cost. As mentioned before, operational expenditure always tends to be much lower with hyper-converged infrastructures compared to classical converged ones. But when it comes to capital expenditure, it is hard to make a general statement. Typically, from a hardware cost perspective, hyper-converged is certainly more attractive than classic, from a software cost perspective it is just vice versa. But hyper-converged requires a minimum number of server nodes; it requires special, certified hardware components, and license fees need to be paid for the virtualization software either. You will find lots of examples with cost advantages on either side. Make a simple cost comparison for your concrete project and you will find out which is the more cost-effective option for you.

All told: When it comes to the question "classical converged or hyper-converged", the use case matters. There are good reasons to look at both architectural approaches. It is recommendable to take the decision specifically per each use case, and go for hyper-converged systems, if their benefits outweigh the drawbacks.

What to consider when going for hyper-converged?

Coming from classical architectures and going for hyper-convergence requires a certain rethinking. Most important is the question how to deal with potential downtime. Will you reduce the risk of downtime by multi-mirroring or rather aim the gap and hope that data mirroring will never be disrupted by further failures.

But it is also about considering spare capacity in terms of processor performance, memory, disk space and IOPS on every server. It is true that servers may be sized individually, but you are well advised to size them equally. Life will be much easier for the scheduler of your hyper-converged infrastructure, and of course it will consume fewer system resources, then.

A last recommendation is related to software licenses. While the hardware costs decrease, the overall software costs increase in hyper converged environments. Typically, the software licenses are based on the number of CPU cores, what implies that fewer but large servers with less CPU cores in total help save money; similar to what you may have experienced with the licensing of your operating systems and applications.

Stress-free deployment using FUJITSU Integrated System PRIMEFLEX

We have a clear picture now, how hyper-converged infrastructures look like compared to classical architectures, we discussed the working principles of both approaches and their behavior in the event of failures. But the question remains how to get there. There is no doubt that building an infrastructure is complex, the classical one certainly more than the hyper-converged one. You need to select the right components, procure and configure them, before you integrate the individual components onsite. As the compatibility of the components is not guaranteed at all, extensive testing is a must. The fact that these components may originate from multiple vendors does not make things easier. All these activities are time-consuming and expensive, while presenting businesses with multiple risks, that things won't work as desired at the end of the day. A deep knowledge of all components is required, and an understanding of their various interdependencies. And as every installation is different, maintenance will be complex, too. Therefore the question suggests itself, if there is a better way of doing it.

Of course there is a better way to go: FUJITSU Integrated System PRIMEFLEX, a pre-defined, pre-integrated and pre-tested combination of data center components, such as servers, storage, network connectivity and software. Based on best practices and real-life project experience, PRIMEFLEX systems are designed in a way that their components will work optimally together.

The benefits resulting from Integrated Systems are manifold. Complexity is reduced; you need less time for planning; you accelerate deployment; no trouble through trial-and-error testing, and you minimize the risk that anything won't work at the end of the day. Operation will be more efficient and maintenance efforts will be reduced. All these aspects help reduce cost, both CAPEX and OPEX. Finally, we should not ignore the fact that all these benefits enable IT organizations to focus on the really important aspects of the business.

The PRIMEFLEX line-up includes classical and hyper-converged integrated systems, both built from best-in-class components, either from Fujitsu itself or leading technology partners. PRIMEFLEX systems are either pre-installed and handed over ready-to-run to the customer; or they are delivered as reference architectures giving you the flexibility to adapt them to your specific requirements. For all PRIMEFLEX reference architectures, installation and configuration guidelines are available as a standard. What is more, customized configurations based on PRIMEFLEX reference architectures are delivered ready-to-run as an option, too. PRIMEFLEX is supplemented by services throughout all lifecycle phases, either delivered by Fujitsu or our local partners.

Fujitsu has the longest track record in terms of integrated systems; the first system being shipped in 2002. Since then we have continuously optimized or processes for end-to-end solutions, be it in product management, quality assurance, manufacturing and support.

The following table shows the PRIMEFLEX integrated systems offerings addressing virtualization use cases including some of their main characteristics.

	PRIMEFLEX for VMware vSphere	PRIMEFLEX for VMware vSAN	PRIMEFLEX for VMware Cloud Foundation	PRIMEFLEX for Microsoft Azure Stack HCI	PRIMEFLEX for Nutanix Enterprise Cloud
Architecture	CI	HCI	HCI	HCI	HCI
Server	PRIMERGY RX	PRIMERGY RX / CX	PRIMERGY RX	PRIMERGY RX	PRIMERGY RX
Storage	ETERNUS DX / AF NetApp FAS / AFF	Local disks	Local disks	Local disks	Local disks
Networking	Extreme, Broadcom	Any	Extreme, Cisco (optional)	Any	Extreme, Fujitsu, any
Hypervisor	VMware	VMware	VMware	Microsoft	Nutanix, VMware
SDN	No	No	Yes	Yes	Yes
Infrastructure management	ISM	ISM (optional)	ISM	ISM (optional)	ISM (optional)
Scalability	2-64 servers	2-64 servers	4-240 servers	2-16 servers	Any # servers

PRIMEFLEX for VMware vSphere is a converged system based on a classical architecture with external storage and virtualization technology from VMware. You may choose between Fujitsu's ETERNUS DX (hybrid storage) and ETERNUS AF (All-Flash), as well as between iSCSI and Fiber Channel connectivity. Network switches (from Extreme Networks and Brocade), cabling and rack infrastructure are also included. There are multiple configurations varying in size.

PRIMEFLEX for VMware vSAN is our hyper-converged system based on VMware vSphere and VMware vSAN. The hyper-converged multi-rack system **PRIMEFLEX for VMware Cloud Foundation** goes even a step further. It represents a fully software-defined data center with compute, storage and networking resources being virtualized. At the same time it represents an attractive foundation for a cloud infrastructure.

PRIMEFLEX for Microsoft Azure Stack HCI is a hyper-converged system based on software-defined storage technology (Storage Spaces Direct) integrated in the Windows Server 2019 Datacenter Edition from Microsoft.

PRIMEFLEX for Nutanix Enterprise Cloud is a factory-integrated, ready-to-run hyper-converged infrastructure system based on virtualization technology from Nutanix. The system supports any number of nodes.

Summary

We started with the question whether considering hyper-converged would be worthwhile or nonsense. We pointed out a number of advantages such as fewer components, less data center space, as well as less energy and cooling requirements. Certainly, these advantages might be helpful for you, but are probably of no strong consequence. Ease of administration, in particular due to the omission of the central storage, might have a high relevance for you, because it directly translates into massive savings of operational costs. Another advantage appreciated by everyone is business continuity due to built-in high availability; but business continuity can also be achieved using the classical approach. Outstanding is the easy, fast and flexible adjustment to changing requirements, especially if scale-out is demanded.

So from our perspective, hyper-convergence is worthwhile, but it always depends on the use case; that's why it does not herald the end of classical IT yet. Fujitsu will consult its customers and elaborate the most reasonable architectural option. No matter, how this will look like, with the right integrated system from our PRIMEFLEX line-up we will help you deploy the new infrastructure – fast, efficiently and without any risk.

Contact
FUJITSU Technology Solutions GmbH
Address: Mies-van-der-Rohe-Strasse 8,
D-80807 Munich, Germany
Website: www.fujitsu.com/primeflex
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