DATA CENTRE IN A CONTAINER

A FRAME BRIEFING PAPER

Foreword

The data centre industry can now boast two types of data centre environments. There is the data centre in a warehouse (DCIW), where the data hall is part of the architectural fabric of a building, either as a stand-alone facility or part of an office building. And, now, there is the data centre in a container (DCIC) where the container is the data hall.

This paper explores the data centre containerisation industry and what the DCIC product means to the data centre paradigm.

A brief history

DCIW, the data centre archetype, is a base building which houses the necessary facility infrastructure and the associated information technology that constitutes a data centre. The IT equipment is housed in a data hall, and the data hall forms part of the building's architectural interior fit-out. The data hall is a purpose-built room which integrates the primary elements that support the modern IT systems, such as power, cooling, racking and cabling systems. So, the conventional data hall is virtually nailed to the building, from an architectural perspective.

Over the last ten years, however, there has been a progressive evolution of the underlying data centre infrastructure, based on the design premises of flexibility, modularity and scalability. An inherent benefit of this is mobility.

Enterprising IT service companies—who have massive computing requirements—together with some IT vendors, have recognised that the evolution of data centre infrastructure has reached a point whereby it has become an expensive exercise—cost and time—to deliver a fully-functional data hall. What these market leaders have done is taken the basic data hall building elements and integrated them into a universal form-factor shipping container. Technical elegance aside, the idea of packaging a data hall into a container opens up a raft of alternative data centre deployment options, with implications to cost and time-to-deploy.

The data centre in a container is a relatively recent development, the concept first mooted in 2003. The military, with its need for mobility and modularity, was the genesis for the product.

The standard shipping container has been around since the late 1960s and its primary purpose is for shipping goods by rail, sea and road. It is now been adopted as affordable housing, temporary offices, a multitude of storage facilities, and even as walls. With the advent of data centre-centric IT servers (with their slim form-factor of 1 RU) and the power and cooling solutions for high-density computing found in the standard DCIW, the container presents an ideal capsule to build high-density computing.

The DCIC is equivalent to the DCIW data hall. But unlike DCIW, DCIC is not the whole architectural environment of the data centre, which of course incorporates plant facility rooms—electrical switch rooms, UPS rooms, generator halls—as well as the office area, staging room, storage room and security. It can sit outside of a building as it is weather-proof, but in most cases it would be housed in a low-cost structure such as a warehouse (metal fabrication or tilt-up slab design) or any higher-grade building (predicated by client's requirements).

www.framegroup.com.au

ABN 48 095 369 403

Email info@framegroup.com.au

In the last twelve months, the DCIC product has started to gain traction and there have been deployments of the solution, albeit by Microsoft and Google who one wouldn't consider to be average users. These companies have built industrial warehouses to house hundreds of the containers. The facilities are not designed as showcase data centres with elegant architectural features, but rather information technology factories. And it is Google and Microsoft which have actually invested the greatest R&D in the data centre containerisation industry, having established very significant facilities to trial the DCIC product.

However, DCIC is not **yet** a mainstream data centre solution.

The general data centre user currently views the DCIC phenomenon as something that two IT industry giants, namely Google and Microsoft, are experimenting with to overcome their significant equipment refresh and deployment problems. The vendors, of course, see a niche market which allows the conventional user to augment their existing data centres as they approach maximum capacity, or as a very viable disaster recovery solution. The DCIC will no doubt be well received by companies needing a transportable IT environment, such as mining companies and the military, or where there has been a disaster and computing needs to be deployed to maintain services. Mainstream up-take is not far off, as more organisations realise the benefits of adopting the product.

Benefits of DCIC

While similar, the noticeable difference between the solutions is in terms of space and the implication for the power density per square metre. The DCIC is a DCIW on steroids, with a highly-concentrated power density. For example, a 40' container (approx. 90 m^2, minus entry and facility infrastructure support) with a design load of 6600 W/m^2, is equivalent to a DCIW data hall of 396 m^2 with a design load of 1500 W/m^2. The DCIC occupies a foot print that is 25% of the equivalent DCIW; a ratio of 1:4.

This translates into less capital cost in the base building construction to house the DCIC, as well as simpler fit-out. Being an integrated, pre-fabricated data hall in a container, fit-out of the DCIC is measured in weeks (average 6 weeks) while the equivalent DCIW data hall is measured in months (average of 4-6 months). This translates into:

- reduced labour costs, as there is a significant time differential between the two constructs
- reduced capital cost for construction materials (full-size data hall versus an existing universal form-factor shipping container)
- reduced cost of the base building. The DCIW needs to be of a higher construction quality to ensure environmental and security integrity, as the data hall literally is part of the building fabric. A DCIC can easily exist in a simple warehouse construction with lesser environmental integrity as the container is a hermetically-sealed environment. For those data centre users who may wish to use an existing facility, the DCIC foot print allows it to be located in some tight spaces and areas that are not considered high-premium amenities, such as carparks. The limiting factor is that it must have a suitable base to sit on due to its weight, so the slab would need to meet the necessary design loads.

From the perspective of the operational costs, both the DCIW and the DCIC solutions seek to maximize energy efficiencies by driving to the lowest PUE (if the client seeks this requirement). Power usage effectiveness (PUE) is a standard used to measure data centre energy efficiency. It measures the amount of power delivered to IT equipment in the data centre, compared to the total power used by the data centre. Greater energy efficiency means lower power costs.

In the case of the DCIW, the expansiveness of the environment is quite problematic. DCIW cooling systems need to contain a significant area if they are to prevent the mixing of hot and cold air which is core to reducing energy consumption. Mechanical energy consumption accounts anywhere from 45–55% of total energy consumed in a DCIW data centre. The DCIC environment can provide efficiencies up to 80% and a PUE closer to 1.05, where as an equivalent DCIW would have a PUE of 1.5. This translates into lower energy costs over the life of the DCIC.

For a DCIW to drive to this level, free-air cooling would need to be implemented. Such systems have a higher capital cost due the scale of the mechanical plant to effect sufficient cooling, and they need more base building as well. Furthermore, in most city climates, standby closed-cooling systems are needed to supplement the free-air system when the external temperatures are not ideal to cool—thus, additional capital has to be expended.

In terms of capital and operating costs, DCIC has a commercial advantage over DCIW, and that means a lower total-cost-of-ownership.

The tangible benefits of the DCIC are listed in *Table 1*.

Table 1. Benefits

Fast deployment
• The DCIC is prefabricated. The basic infrastructure is already deployed inside the container: floor, racks, cooling, lighting, power distribution, etc. The external services to support it are easier to deploy and interface to the DCIC.
• From time of order to deployment can be 3–4 months (DCIC comes from the USA on a ship).
Capital cost of base build and fit-out
• The base building can be a simple warehouse structure or any greater grade of building. Fit-out is simplified by not having to build a data hall to exacting standards to meet energy efficiencies, security, fire suppression, etc., as a DCIC already offers this engineering. The supporting services can easily be incorporated into the building.
• An existing building does not need extensive fit-out to incorporate a data hall and, again, the supporting facility infrastructure can be built near the DCIC.
Lower operational costs and higher energy efficiencies
• Due to the closed architecture of the DCIC, the energy use can be tightly managed, thus lowering energy use. The mechanical cooling is by far the greatest energy-consumer in any data centre, so a DCIC can manage air (cooling) far better than a DCIW.
High density
• Slim form-factor appliances or devices drive the need for high heat-cooling requirements. The closed-cooling architecture permits these high heat densities.

Conclusion

As the DCIC is nothing more than a concentrated DCIW data hall, its use as the basis for mainstream data centre solutions is not high risk. The DCIC has already been used by two significant IT users as a ready-built data hall. Housed in a shipping container, DCIC creates a mindset of transport, but the container solution is nothing more than … containment. The DCIC is technically elegant and it presents a raft of alternative deployment opportunities without changing any of the backend facility infrastructure services. It integrates the best of the current data centre design principles and will, with imagination, become a mainstream production solution for many data centre users within the next five years.

DCIC versus DCIW

Table 2 offers a comparison of the DCIC and DCIW data hall.

Table 2. Comparison of a DCIC and DCIW data hall

	DCIC	DCIW data hall
DC hall containment	• Container	• Standard block or Gyprock walls
Access floor	• Yes, used as a plenum to deliver cold air to the closed architecture racks. Keep in mind that the rack itself does not need an access floor but a plinth arrangement can be used to support the container above the slab to reticulate services into the container.	• Yes and no. An access floor can be used as a plenum to deliver cold air or reticulate cabling, but it's not necessary as cabling can be delivered from overhead.
Cable paths	• Integral to the racking in the container	• Can be both above and below the racking (below, if an access floor is utilised) • Integral to the racking
Equipment rack	• Standard 19" rack used, with rails for device access • Can be suspended from the container roof or located on the access floor	• Standard 19"rack used, with front and rear access • Supported on access floor or slab
Mechanical (cooling)	• Uses in-row cooling which is serviced by chiller • Hot/cold containment (closed-cooling architecture) via floor and ceiling plenum • PUE is quoted at 1.05–1.5 Would not utilise free-air cooling as the container could not cycle the air required to cool such densities quick enough, due to the small volume in the container.	• Hot/cold aisle containment (closed cooling architecture) or can be open architecture • PUE at 1.5 or higher • Uses CRACs and in-row cooling, serviced by chillers, aircoolers. Can utilise free-air cooling depending upon the atmosphere enthalpy as there is a greater volume with such facilites.
Power distribution	• PDU integral to rack • External mains, UPS, generator	• PDU generally on data hall wall • External mains, UPS, generator
Fire detection and suppression	• VESDA • Gas Does not require pre-action water due to the compact size. Gas is very effective in the enclosed container.	• VESDA • Gas and pre-action water. The size of the room predicates whether a pre-action system is required as gas becomes extremely expensive as the space increases.
Security	• Biometric, swipe, CCTV, RFID	• Biometric, swipe, CCTV, RFID
Redundancy	Can incorporate redundancy in the facility infrastructure to increase the resiliency and meet ANSI/EIA/TIA-942 Tier ratings.	Can incorporate redundancy in the facility infrastructure to increase the resiliency and meet ANSI/EIA/TIA-942 Tier ratings.

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FRAME®

Sydney (Head Office)
Level 11, 189 Kent Street
GPO Box 4647
Sydney NSW 2001

Tel +61 (0) 2 9323 2800
Fax +61 (0) 2 9323 2828

Canberra
Unit 9, 25 Buckland Street
PO Box 224
Mitchell ACT 2911

Tel +61 (0) 2 6122 6800
Fax +61 (0) 2 6122 6868

Melbourne
Level 7, 31 Queen Street
Melbourne VIC 3000

Tel +61 (0) 3 9927 3800
Fax +61 (0) 3 9927 3838

Brisbane
Level 1, 21 Mein Street
Spring Hill QLD 4000
GPO Box 2502
Brisbane QLD 4001

Tel +61 (0) 7 3009 7800
Fax +61 (0) 7 3009 7878