POWER SECURE CONNECT:

NEXTDC's new-generation data centres

NEXTDC

TIER IV CERTAINTY FOR DATA-DEPENDENT ORGANISATIONS

NEW GENERATION DATA CENTRES DELIVER MAXIMUM UPTIME, AFFORDABLY

In this hyper-connected world, global internet traffic is predicted to nearly triple over the next five years as we enter a new era of data-generating technologies.

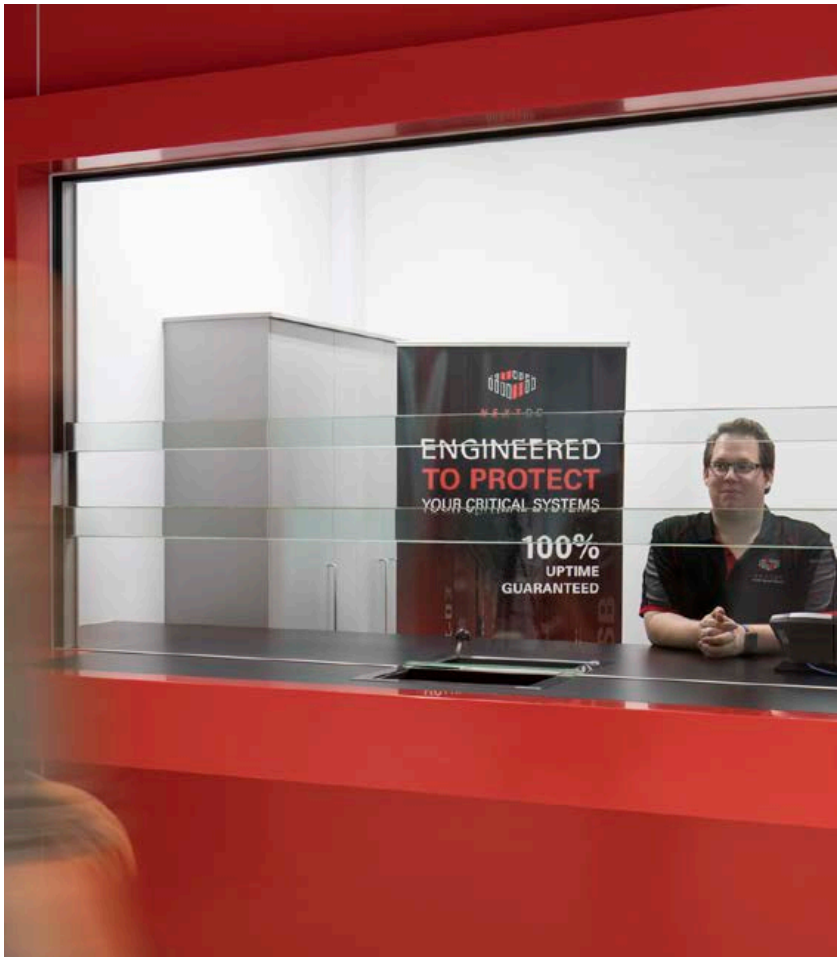
To survive this digital onslaught, a complex array of colocation, private, and/or public cloud data management solutions is rapidly superseding traditional on-premise IT.

As reliance on data — whether to be stored and analysed, or accessed on the fly — becomes ever more crucial to business, the financial and reputational risks of data centre downtime continue to escalate.

For NEXTDC, Australia's leading independent data centre operator, delivering the reliability required for the operation of mission critical IT is a core business objective. The design and build of its 'first generation' data centres already meet and in some ways exceed the standards required for Tier III certification by the Uptime Institute[1].

Now, through in-house engineering innovation and the adoption of new technologies in power and cooling systems, NEXTDC is building three new 'second generation' data centres to the more exacting standards required for Tier IV certification. Previously considered an uneconomic offering for colocation providers, Tier IV demands the highest levels of functionality and reliability by requiring Fault Tolerance for every critical system, distribution pathway or component that supports the facility's IT operations.

With data centres housing the technology that effectively maintains not just the infrastructure of business, but also society, colocating in a Tier IV data centre should be a serious consideration for all data-dependent organisations.



Above: **24/7 onsite customer service representatives, security and technical support.**

Above: **Bullet-resistant security portals from Gunnebo provide access to the most secure areas, accessed via combined biometric fingerprint readers and swipe card authentication.**

Cover Image: **B2 data centre in Brisbane's Fortitude Valley.**

1 The Uptime Institute, founded by Kenneth G. Brill, is the IT industry's most trusted and adopted global standard for the proper design, build and operation of data centres. It utilises a four Tier classification system (Tier I-IV), that evaluates various data centre facilities in terms of site infrastructure performance, or uptime. See, www.uptimeinstitute.com

THE PROCESS, INNOVATIONS AND TECHNOLOGIES

This whitepaper outlines the design and benefits of building a data centre to Tier IV standards, and the innovations and technologies deployed in NEXTDC's second-generation facilities in Brisbane (known as 'B2' and commissioned in September 2017), Melbourne ('M2', scheduled to be operational in Q4 2017), and Sydney ('S2', which is on track for 2H 2018).

THE VALUE OF UPTIME CERTIFICATION

While many data centres claim levels of uptime and reliability based on a number of different self-certified guidelines, such as the American TIA-942 standard, NEXTDC has opted for the more rigorous testing and verification regime conducted by the Uptime Institute.

Globally recognised as the gold standard for third-party validation of critical data centre infrastructure, the Uptime Institute Tier Certification process includes:

Tier Certification of Design Documents

Detailed engineering and architectural drawings are reviewed to confirm Tier compliance, providing the design team with the opportunity to resolve any discovered challenges before moving to construction, and in the meantime receive formal TCDD certification.

Tier Certification of Constructed Facility

Involves a detailed and exhaustive test program carried out on the fully functioning data centre over a number of days by the deeply experienced Uptime Institute team. Success confirms that the facility was constructed and behaves as designed, and that the required functionality and system independence is maintained during a wide variety of simulated catastrophic failure events.

Tier Certification of Operational Sustainability

A process that evaluates the effectiveness of each component of site and critical infrastructure management by the local operations team, as well as the facilities design characteristics. The goal is to certify that the facility's operational methodology further enhances the delivery of the uptime for which it is certified.

B2 is the first Australian data centre – and the first Asia Pacific colocation data centre – to receive Uptime Institute Tier IV Certification of Constructed Facility (TCCF).

The Tiers (from I to IV) are progressive in nature, with each one building on the requirements of its predecessor. For instance, a key characteristic of Tier III is Concurrent Maintainability, which requires that each and every capacity or distribution component necessary to support the IT processing environment is maintainable on a planned basis via a redundant delivery path, without impact to the IT environment.

Tier IV then takes that baseline, and adds the concept of Fault Tolerance, which requires that the facility will tolerate the impacts of a catastrophic failure, or unplanned outage, of a system or distribution component, so that there is no interruption to the operation of the IT processing environment.

INNOVATIVE, INDUSTRY–LEADING POWER SYSTEMS

DEPENDABLE, COMPREHENSIVELY PROTECTED POWER

As power is one of the most critical resources for a data centre, the electrical power infrastructure plays a major role in the facility's capacity to efficiently provide scalable, reliable and continuously available power that will meet peak demands.

In addition, with data so mission-critical for many organisations, and given that the business implications of data loss can be quite catastrophic, it is imperative that the design of such power systems incorporates comprehensive power protection measures. Yet despite this, power system faults (whether due to equipment failure or human error), remain one of the key causes of data centre down-time[2].

For Jeff Van Zetten, Head of Engineering and Design at NEXTDC, one of the keys to designing a robust and low-risk power distribution system is to select the best quality equipment and to work with premium suppliers that have a track record of supporting their products and technologies. For this reason, following an exhaustive analysis of electrical design options and manufacturers, NEXTDC chose to work with the German power systems manufacturer, Piller, who are renowned for their innovative and world-leading, mission-critical uninterruptible power systems.

Likewise, German manufacturer MTU, a division of Rolls-Royce Power Systems (and the supplier of power generation systems to seven of the top ten global online companies), was chosen to supply the emergency power generators.

The globally successful technology leader ABB were selected to provide the third leg to the power system: the transformation, distribution and switching infrastructure supporting the high voltage connection to the city grid, the single-phase connection to a rack, and everything in-between, including the vital protection breakers.

Above and below: **High-performance MTU diesel engines from Penske Power Systems.**

2 A 2016 survey of 150 UK organisations found that power failures accounted for 25% of outages, with software issues rated second highest at 21%. See: http://www.datacenterdynamics.com/content-tracks/power-cooling/power-problems-are-the-biggest-cause-of-it-outages/94602.fullarticle In a similar 2016 US study by the Ponemon Institute, 25% of survey participants nominated UPS system failure as the primary root cause of the outage. See: https://www.vertivco.com/globalassets/documents/reports/2016-cost-of-data-center-outages-11-11_51190_1.pdf

ADDING FAULT TOLERANCE TO A CERTIFIED AND TESTED DESIGN

The power system being utilised in NEXTDC's second-generation data centres builds on the award-winning design[3] deployed in its Tier III facilities, combining Piller's state-of-the-art Isolated Parallel Bus (IP-Bus) concept with the large-scale Piller Uniblock UBT Rotary Uninterruptible Power Supply (RUPS).

This system provides a redundant UPS scheme in a concurrently maintainable and fault tolerant configuration. By aligning all the UPS units in a ring, if one unit experiences performance issues, the others automatically increase their output – a portion of which is naturally directed to wherever it is required in the data centre.

The IP-Bus plus RUPS solution also eliminates the risks and hazards associated with both battery based solutions (lead acid batteries are complex to manage in the built environment and have varying reliability and longevity performance) and those that employ automated load transfer switching (which can leave the system vulnerable to human error during complex switching procedures, and have blind failure modes).

The NEXTDC engineering team has clearly addressed the fault tolerance requirement for an Uptime Institute Tier IV-Certified data centre in two ways: The addition of differential fault protection and isolation transformers to the electrical system; and the complete fire-segregation of each power string. As a result, if an electrical fault develops in any one part of the system, that part is very quickly isolated — and in the case of fire, contained — meaning that although the amount of systems supporting the load has been reduced from N+1 to N, the rest of the system remains unaffected. That 'rest of the system', i.e. the remaining N capacity, automatically ramps up, ensuring continuous availability of power throughout the data centre without interruption.

Above: ABB supplied boards enable Piller's Isolated-Parallel Bus-based electrical distribution and protection scheme (IP-Bus).

Above: The Piller Rotary UPS can support 1.6MW of load for up to 15 seconds while the MTU generator fires up.

TIER IV FAULT TOLERANCE AT COSTS COMPARABLE TO TIER III

In the past, the cost of constructing an Uptime Institute Tier IV-Certified data centre — generally involving the use of N+N or 2N+1 designs — was only economically viable for large data-dependent organisations such as banks. For colocation providers focussed on delivering competitive value, the potential increase in reliability did not justify the substantial additional investment required.

However, by combining cutting-edge technologies with innovative engineering and design, NEXTDC is now building its second-generation facilities to Tier IV fault tolerance standards, at almost the same cost as a Tier III facility. As a result, this exceptional level of reliability and resilience is now an economically viable option for any enterprise looking to de-risk its reliance on data by maximising uptime.

3 In 2015, NEXTDC received a Brill Award for Efficient IT (Product Solutions category), for its power system design centred on Piller's IP DRUPS solution. For more, see: http://www.piller.com/en-GB/news/528/piller-technology-commended-in-coveted-uptime-institute-brill-awards

A MODULAR APPROACH TO COOLING

SIMPLIFIED AND SEGREGATED, EFFICIENT AND RELIABLE

The design and engineering of the NEXTDC second-generation cooling systems achieves a balance between providing the optimal climatic conditions for IT equipment, and lowering the power usage effectiveness ratio (PUE) of the entire facility, which is currently around 1.3[4] for NEXTDC's first-generation data centres.

Achieving these objectives, while also meeting the fault tolerant requirements for an Uptime Institute Tier IV-Certified data centre, meant completely re-evaluating the current cooling system configuration.

Although the NEXTDC first-generation cooling systems are incredibly efficient, they are also relatively complex. They rely on delivering chilled water via a common network of stainless steel pipes up to 600mm in diameter. To achieve fault tolerance, this part of the critical infrastructure alone would require extensive re-design. This might include the implementation of an intricate, automatic failure-detection system linked to potentially hundreds of motorised control valves, so that any leak or failure could be automatically isolated. With so many additional parts and controls, such automated modifications would be extremely costly and difficult to implement and maintain reliably.

Rather than retro-design the existing system, NEXTDC's engineering team explored recent advances in cooling technology and developed simplified and highly segregated cooling system solutions, which are both fault tolerant and meet each data centre's cooling requirements.

At the same time, the data centre industry's acceptance of the ASHRAE 2011 standard and subsequent deployment of more environmentally robust IT equipment, has allowed for an increase in the supply air temperature and a broadening of the acceptable humidity range – another factor that could be taken advantage of in the new design.

Nevertheless, the configuration of each second-generation cooling system varies slightly, based on factors such as the average relative humidity of the location and the physical characteristics of the built structure (e.g. low rise or multi-story). However, one common feature is the use of a series of incredibly efficient, stand-alone modular cooling units, which are a crucial factor in achieving the system's fault tolerance.

Above: **B2 features incredibly efficient, stand-alone modular cooling tower units, instead of one large, central water plant unit, each linked to a different set of risers.**

4 A data centre's PUE is a ratio of its total power usage, divided by the power used by the ICT equipment. A PUE of 1.3 means that for every watt powering the ICT equipment 0.3 watts is being used by overheads.

SUSTAINABLE, ENERGY EFFICIENT CLIMATE CONTROL

OPTIMISING THE USE OF FREE COOLING

The financial and environmental costs of data centre power and cooling systems are a key concern to both data centre operators and users. In light of this, a major objective of the NEXTDC Engineering team for the second-generation data centres was to further improve energy efficiency, and to achieve an even lower footprint in terms of the amount of power drawn from the grid per unit of power required by the IT equipment.

As cooling accounts for up to 40 percent of a data centre's energy consumption[5], the engineering team focused on ways to optimise free cooling, and limit the use of energy-hungry mechanical compressors.

The cooling systems in NEXTDC's first-generation facilities include mechanisms for utilising direct free-air where possible (such as opening louvres or dampeners when the outside air conditions are suitable) – its use is limited by humid air in summer and dry air in winter – as well as indirect free cooling (pre-cooling of the return chilled water before it arrives at the large scale mechanical chillers). However the opportunities for these sub-systems to kick in are relatively limited throughout the year and add complexity to the facilities' operation.

Conversely, NEXTDC's second-generation cooling systems primarily utilise indirect free cooling (where the outside air is used to cool the return air, via a heat exchanger), as well as evaporative free cooling (which utilises cooling tower water that has a lower temperature than the return air from the data centre), and only use small amounts of mechanical cooling for a few times of the year when required by external conditions.

Further efficiency improvements are also achieved through a range of containment measures such as the cold rooms/hot aisles configuration, which separates the cold supply airflow from the IT equipment's hot air exhaust, as well as a focus on tuning at the rack/aisle level to ensure optimum airflow rates and return air temperatures.

By combining indirect free cooling with physical containment, in combination with the development of a unique system that automatically provides optimal cooling where it is needed, the use of compressors is minimised to those relatively few hours of the year that are particularly hot or humid.

EXTERNAL RISER PIPES

In NEXTDC's second-generation Brisbane data centre (B2), the riser pipes run along the exterior of the building, almost completely removing the threat of water damage to infrastructure or equipment. If a pipe suffers a catastrophic failure, its contents will simply run down the outside of the building.

Similarly, the pipework only enters through the façade at the closest point to a particular piece of cooling equipment. By securing the equipment in a bunded area, there is also no possibility of water entering the data centre from that area.

5 http://www.datacenterknowledge.com/archives/2016/06/14/impact-of-cooling-and-efficiency-in-modern-data-center-design

A DESIGN THAT MAXIMISES UPTIME AND EXPEDITES SCALING

One of the challenges of designing for fault tolerance is to understand and address the conundrum that high levels of redundancy and complexity do not necessarily lead to greater levels of reliability (nor automatically guarantee an increase in expected uptime).

Put simply, as the number of system parts and the degree of complexity increases, more controls and fail-safe devices are required. As a result, system management and maintenance becomes more difficult, and the likelihood of some type of componentry or system breakdown or indeed human error increases.

The simplicity and modularity of the design concept for NEXTDC's second-generation power and cooling systems is central to achieving the Uptime Institute Tier IV standard. Modularity ensures that each unit is separate and can be fire segregated, within an overall system that is always set-up in an N+1 configuration. Therefore, any fault, breakdown or even the total destruction of one unit will not impact the other units or the capacity of the system.

In terms of fire risk, each data hall is engineered to act as a separate fire-rated compartment, so a fire and the immediate fire suppression action in one data hall does not affect any other data hall.

Deploying an inert-gas based suppression system (rather than water sprinklers) avoids the potential for catastrophic water damage to a large number of servers when the fire suppression system is activated. By installing two complete sets of gas suppression tanks at each data centre, if gas-suppression is required, the system will continue to protect the facility against a second fire risk while the first set of tanks is replenished.

DESIGNED TO SUPPORT A NABERS 5-STAR RATING FOR ENERGY EFFICIENCY

NEXTDC's first-generation Melbourne (M1) and Sydney (S1) data centres have achieved a NABERS[6] 4.5-star rating for energy efficiency (NABERS ratings are based on a full-year analysis). While this is one of the highest ratings for an Australian data centre, the NEXTDC's second-generation facilities in Brisbane, Melbourne and Sydney are designed to deliver NABERS 5-star performance.

Above: **Cylinders of inert gas for the fire suppression system.**

Modularity also delivers a number of other distinct business benefits. For example, it facilitates fast and efficient scaling of the power and cooling systems to match each stage of the data centre's development. Fewer units are required upon opening, more are added as operating capacity increases. All of this contributes to the combined goals of simplicity, reliability and affordability.

In addition, off-site prefabrication, testing and commissioning of the units removes the inherent risks of having teams of specialists working under pressure to install complex equipment on-site and enables a faster response to capacity demands.

6 Launched in February 2013, the National Australian Built Environment Rating System (NABERS) for Data Centres rates the environmental impact of data centres based on performance rather than design. It includes an IT Equipment Rating, an Infrastructure Rating and a Whole Facility Rating. For more information, see: https://nabers.gov.au/public/WebPages/DocumentHandler.ashx?docType=3&id=79&attId=0

A DIVERSE, READY–TO–ACCESS, DIGITAL ECOSYSTEM

CARRIER AND VENDOR–NEUTRAL ICT PARTNERS AND PROVIDERS

NEXTDC's pioneering Data-Centre-as-a-Service (DCaaS) model combines a first-class colocation environment with a choice of connectivity services and real-time analytical data centre management software. This model recognises that the ability to integrate multiple applications, data types and data sources is essential to the success of digital business.

For customers colocating their servers, storage and networking equipment within a NEXTDC data centre, this offering includes immediate access to the rich carrier and vendor–neutral ecosystem of information communications technology (ICT) partners and service providers already established within each location's corresponding first-generation data centre.

Across Australia, the NEXTDC digital ecosystem includes:

- More than 50 national and international telcos (providing either just connectivity between the data centre and a customer's offices, or also offering specific IT services).
- Secure on-ramps to major public cloud platforms such as Amazon Web Services (AWS), Microsoft Azure, IBM Cloud and Google Cloud Platform.
- Over 350 partners delivering a wide array of ICT and connectivity services.

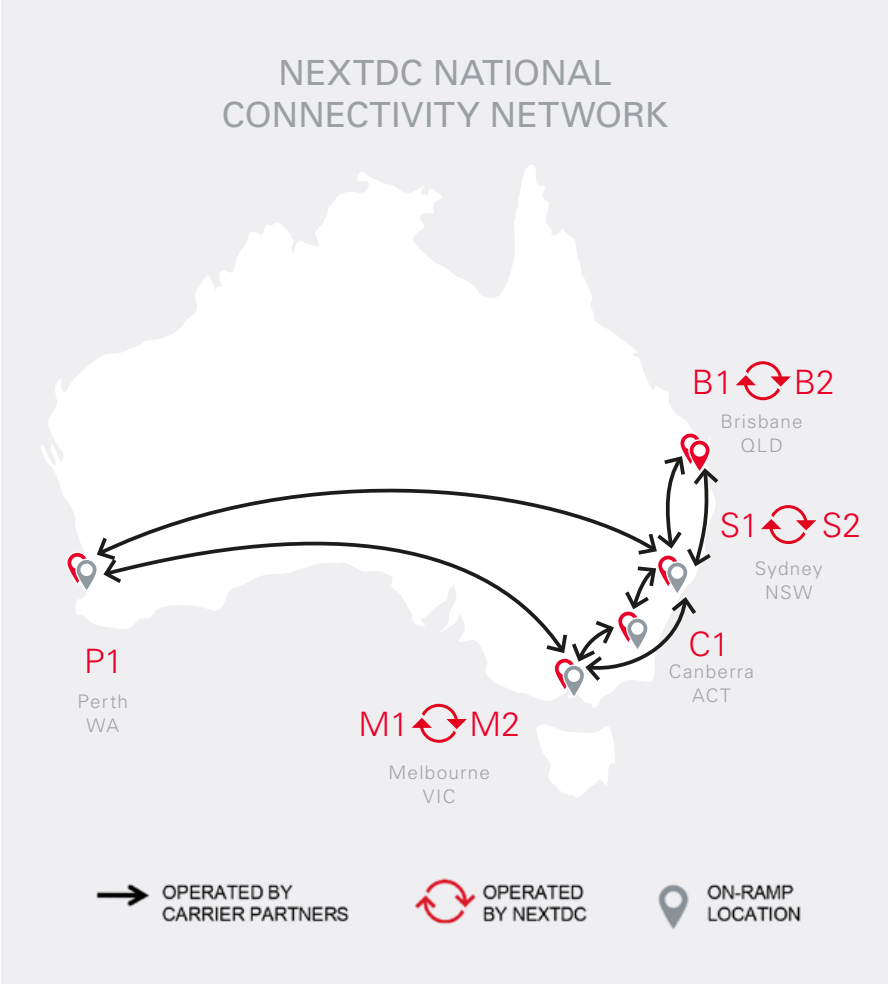
Having high-speed access to service providers and network carriers within the NEXTDC's nationwide ecosystem also reduces costs and minimises latency.

INTRA AND INTER-CITY CONNECTIVITY OPTIONS

To ensure seamless connectivity between each second-generation data centre and the digital ecosystem already established within its first-generation counterpart, NEXTDC has invested in two dedicated and completely separate fibre optic cables between its same–city data centres.

Similarly, NEXTDC's AXON Ethernet connectivity platform provides organisations with high performance, on–demand access to their carriers, clouds and data centres across Australia, and enables them to link racks across multiple locations.

By providing the flexibility to add further capacity and connectivity only when required — whether in an existing location, or in one of the second-generation facilities — the DCaaS model also ensures that customers only need to commit to the inventory they currently require.



Above: **Flexible, direct connectivity to major carriers and public clouds.**

ENHANCEMENTS TO THE BUILT ENVIRONMENT

IMPROVING THE PHYSICAL ENVIRONMENT FOR PEOPLE AND MACHINES

The design of NEXTDC's second-generation data centres takes into consideration the impact of the physical environment on both people and machines. From welcoming lobbies and client lounges, or access to meeting rooms and chill-out areas, there's a strong focus on enhancing the client experience. Loading docks are easier to access, while extra-wide doorways and lifts significantly improve the process of quickly moving large amounts of equipment into the building, which can then be quickly and safely deployed.

As is the case with the first-generation facilities, a range of professional services are available for every stage of the IT life-cycle, including 'Remote Hands'. This service offers first-class technical assistance to customers, including the management of deliveries and installations, preparing equipment to ship, performing a rack audit, racking and connecting equipment, undertaking a fault investigation, or escorting a contractor to the correct location on the customer's behalf.

Above: The onsite chill-out room features meeting rooms, kitchenette, large flat screen TVs, massage chair and free Wi-Fi.

Above right: Customers can control access to their racks and monitor the environment through our DCIM-as-a-Service platform – ONEDC.

Below right: Overhead bus duct and solid data hall floors allow for rapid installation of customer racks.

DATA HALL SLAB FLOORS

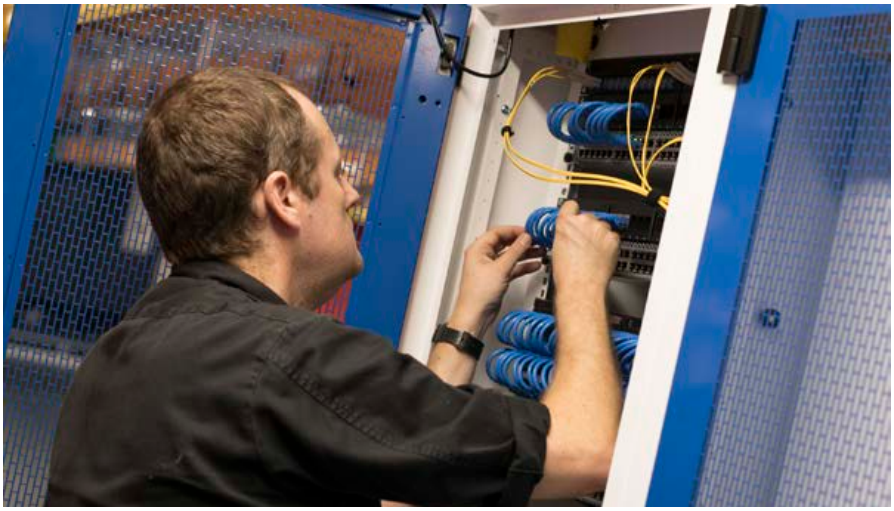
While data halls have traditionally featured raised floors (initially to house large cables and connectors for hardware and peripherals, and later to deliver spot–cooling from below using underfloor air), the increasing density of racks, together with underfloor obstructions (such as cabling), made such flooring and the associated cooling distribution less efficient and more expensive.

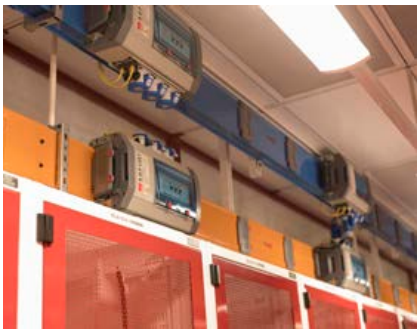
To provide greater efficiency and amenity, the data halls in the second-generation data centres make direct use of the slab floor. Power is now accessed via an overhead bus-duct, which provides the flexibility to immediately connect power wherever it is required, rather than having to first remove floor tiles (as with raised floors) and run dedicated cables. This arrangement also makes it easier to set–up racks of various widths, and to deploy them faster.

COLD ROOMS WITH HOT AISLES

Data halls in the second-generation facilities are somewhat smaller than those in NEXTDC's first-generation sites. This makes it easier for customers with multiple racks to secure an entire hall, and provides more opportunity for intra-data centre diversity. They also utilise a cold room/hot aisle layout, where every other aisle between the racks is contained. The air from the servers is blown into this hot aisle, and exhausted through the false ceiling into a return-air ceiling plenum.

This configuration delivers improved energy efficiency and provides a more comfortable working environment for data centre technicians. While the racks are accessible from either aisle, access to the connections at the back of the rack (where most of the work takes place, once installation of the kit is complete) is then from the cold room.





Above: **Switchboards (L) and Piller UPS (R).**

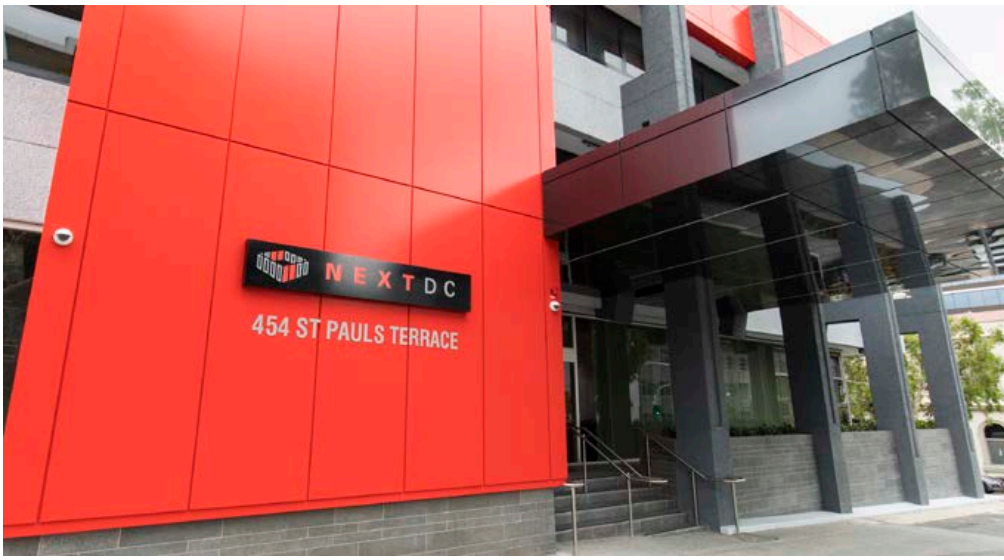
THERE'S NO DOWNSIDE TO GUARANTEED UPTIME

NEXTDC's second-generation data centres confirm the company's leadership position in Australian data centre design, engineering, equipment selection, commissioning, testing and operation.

By delivering cost effective facilities with Uptime Institute Tier IV Certification, NEXTDC has raised the standard for the industry, and recognised the growing importance of guaranteed uptime to every business and every part of an increasingly data-dependent society.

More importantly, NEXTC's three second-generation facilities will provide customers with the surety and peace-of-mind that their IT systems and applications reside in an optimal operating environment, designed and engineered for fault tolerance and delivering an unprecedented level of reliability, availability and scalability – an important part of the solution to surviving that data tsunami.

In the 'always on' world of business in the digital age, colocating in a facility like B2, M2 or S2 has become the standard, not the exception.



Above: **B2's inner-city location is convenient for staff and only a kilometer from B1 in the Brisbane CBD.**

Simon Cooper
Chief Operating Officer

Simon Cooper directs the data centre design, construction and operations businesses at NEXTDC. He is a qualified engineer with extensive leadership experience in the international IT and telecoms industry. Simon was previously based in Singapore as Senior Vice President at Tata Communications, responsible for strategic network development in support of the company's global portfolio.

John Turner
Head of Construction and Project Management

John works closely with NEXTDC's suppliers to maintain schedules, and the quality of the infrastructure and services contracted by NEXTDC, while directing the on-going development of NEXTDC's facilities, both operational and in development. John Turner previously held senior positions in, or contracted to, major corporations including Westpac and CSC, where he was responsible for the delivery of critical operation facilities, data centres and large scale commercial projects throughout Australasia.

Jeff Van Zetten
Head of Engineering and Design

Jeff Van Zetten is responsible for the overall design, commissioning, Uptime Institute Tier Certification process, on-going performance, and energy tuning of NEXTDC's data centres. Prior to joining NEXTDC, Jeff was based in Singapore as the Asia-Pacific technical director for a leading high-performance, buildings technology company. Jeff has experience in on-site commissioning and troubleshooting data centre and major projects throughout Asia, Australia, Europe, North America, and South America.

Jeff Burvill
Head of Facility Management

Jeff oversees NEXTDC's five operational data centres – soon to be eight – and the facilities teams. Not only does he ensure the facilities are maintained and run 24/7, but the safety and security of the people working onsite. Previously an Operations Manager at Alcatel-Lucent, and before that AAPT, Jeff has over 20 years' experience in managing infrastructure for large-scale telecommunications enterprises.