The bridge to possible

Smart Campus Living Lab – Transforming the University

The bridge to possible

Executive summary

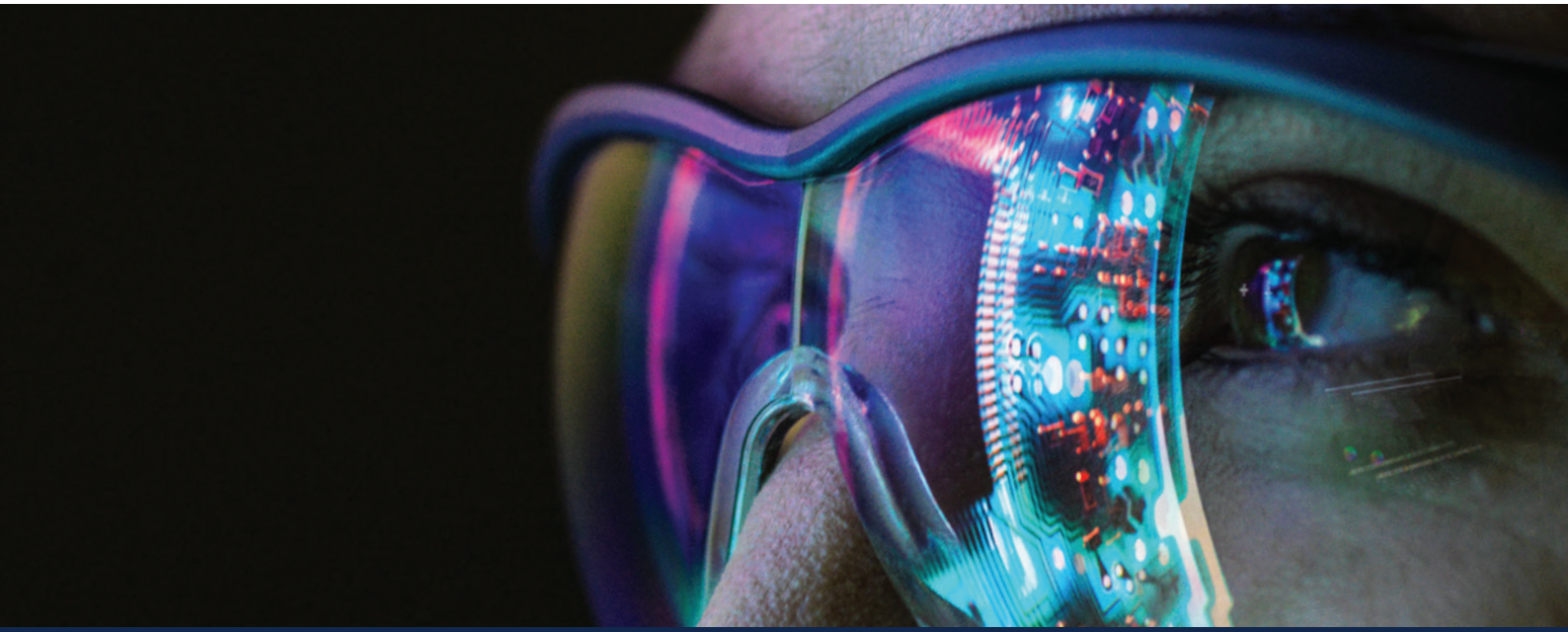
Australia's scientific leadership has eroded

Australia, one of the leaders in scientific innovation and technological adoption is exemplified by its invention of Wi-Fi, amongst other global impacts. Although a report[1] suggests that Australia ranks 29th in technological infrastructure, 22nd in scientific infrastructure, 47th in communications technology, 47th in renewable energies, 45th in medium- and high-tech value added, 40th in energy infrastructure, and 61st in entrepreneurship, Australia leads the world in research output.

However, the void of innovation outcomes point to some alarming numbers that call for immediate actions to strengthen the position of Australia.

It is not feasible for Australia to 'out-invest' all other countries on scientific infrastructure, particularly those that are more significant in size in terms of population. Rather, if Australia is to be a global leader, then it needs to focus on unlocking its natural strengths, which are:

- Early adoption of technology: Australia is considered an early adopter of mobile phones, cloud services, and myriad other technology improvements.
- Practical application of research: Australian universities are incentivized to generate research impact, not just research outputs.



With a global population share of 0.33%, and 1.87% of GDP invested in R&D, Australia punches above its weight in science. Australia published over 673k scholarly outputs (2016-2021)—equivalent to 3.3% share of world's scholarly output—and had a Field Weighted Citation Impact (FWCI) of 1.6, meaning that Australian scholarly outputs are 60% more cited than the world average. Beyond its research being of high academic quality, Australian research contributes strongly towards broader societal impact and in support of Australia's national strategic objectives[2].

An important lever available to universities is their campus infrastructure. The same buildings, outdoor spaces, and facilities that are used to create great student experiences can also be used as testing grounds for research. Using the campus in this way, i.e., as a living lab, not only helps to create research advantage it also enables universities to derive more value from sunk cost investments in physical and digital assets. Universities existing governance models and readily available talent pools provide a natural advantage to quickly spin up new living labs and run them efficiently. Living labs need to be carefully curated and we outline the methods in this paper.

The biggest challenge in 2023 is the lack of a real-life testbeds. At La Trobe University we are meeting the challenge with a post-covid return to campus proof-of-concept and our context in an emerging city university of the future. These projects allow us to fully realise the technology infrastructure needed to make a living lab an asset to the community as well as to the research and residents with in it.

Together, Cisco and La Trobe University have identified living lab as one of the key approaches to accelerate scientific innovation and mass adoption of advanced technologies in the society. Living lab is an ecosystem and platform for co-creation and open innovation. It utilizes existing infrastructure (offices, apartments, factories, buildings, or even a whole city) as a real-life testbed to evaluate latest advances in different areas (public health and safety, space optimization, agrifood, etc.) without having to move users into a controlled environment. This report provides a set of recommendations, a guideline, and a framework on how to set-up and run a living lab, and identifies key digital technologies underpinning living labs, which are artificial intelligence, Internet of Things, advanced networks, cyber security, and digital twins.

Maximizing the economical, commercial, environmental, and societal benefits provided by living labs requires strong support, commitment, and investment from the government, industry, and public sectors.

The National Industry Innovation Network (NIIN) is an alliance between industry and universities, working on nationally significant projects through a range of initiatives including partnerships, innovation centres, specialised centres, research chairs, and skill and talent development. The NIIN is well positioned to lead the multidisciplinary research at the core of the living lab movement to address a wide range of societal challenges that align to the Australian Government's Science and Research Priorities, to significantly improve quality of life.

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Introduction

This report introduces living lab – a methodology that is not new, but has gained considerable international traction recently as a result of huge investment in AI and IoT. Living Labs are one key enabler to accelerate the adoption of life-changing behaviours and innovations in the public sector, facilitating experiential education and rapidly translating scientific research into real impact, significantly improving human quality of life. Living lab is a sustainable and open platform that can address a wide range of societal challenges, ranging from climate change, net zero, public health to workplace productivity, operational effectiveness, and building management.

Setting up and running a living lab effectively requires a framework, in which advanced digital technologies (artificial intelligence, machine learning, Internet of Things, advanced networks, cyber security, and digital twins) play a critical role. Universities have a unique advantage to get a living lab up and running quickly. This report also identifies some roadblocks that might prevent livings labs from being fully utilized as well as providing several recommendations on what actions should be taken by relevant stakeholders and policymakers. This report is divided into four chapters as highlighted below.

Chapter 1	Chapter 2	Chapter 3	Chapter 4
Smart campus as a living lab accelerates human-centered innovation	What does it take to set up and run a living lab?	Living labs need a new kind of advanced network infrastructure	A future outlook on living labs

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Chapter 1: Smart campus as a living lab accelerates human-centered innovation

The challenge of turning research into impact

Traditionally, turning novel research into real-world applications with real impact can take years. The process of accepting, trialling, and implementing the latest academic findings faces numerous challenges, the biggest being the lack of a real-life testbed. In other words, there is no playing field for researchers to quickly realize their research outputs and consequently provide direct benefits to the users.

The solution to this problem lies right where the ideas are generated – the university campus. By transforming the university campus into a living lab, it allows researchers and students to rapidly implement new innovations and evaluate their impact in a live real-world setting. Living labs synergize innovation, development, and adoption to rapidly integrate innovative solutions into the society.

What is a living lab?

In essence, a living lab is a place-based ecosystem or platform for human-centered open innovation, co-creation, collaboration, and experiential learning. It is established in a real-life context such as building, a street, a suburb, a campus, or even a whole city. Users and citizens are placed at the centre of the living lab as an active participant instead of a test subject. Different living labs might be vastly different from each other, but they all share several common elements:

Real impact

All activities, research, and innovations take place in a real-life setting to solve real-world problems that directly impact the human quality of life in the long term.

DigiTech-enabled

There is no single methodology when it comes to operating a living lab. However, all living labs are powered by advanced digital technologies such as advanced networking.

Human-centric

Users and citizens act as active and contributing participants instead of test subjects. In fact, living labs are built around users instead of forcing users into a living lab.

Collaborative nature

Public-private people partnership between stakeholders - researchers, practitioners, domain experts, policy makers, companies, institutions, and users or citizens.

La Trobe University City of the Future

This $5 billion plan aims to transform La Trobe's 235-hectare Bundoora, Victoria (Australia) campus into a vibrant, multi-purpose, sustainable and mixed-use city[3]. A core component of this project is the concept of using the campus as a living lab to develop and test existing and emerging technologies with opportunities related to sustainability, supply chain, and waste reduction. Within it is a Research and Innovation Precinct ecosystem and a Digital Innovation Hub that connect businesses with research, students, and infrastructure.

Smart campus as a living lab is the first step toward solving global challenges

Numerous university campuses worldwide have been utilized as living labs for multi-disciplinary research across many areas and achieved great success, contributing to the improvement of human life. They are an excellent launchpad for innovations that aim to reach the United Nations' Sustainable Development Goals[4].

Fighting climate change | Net Zero

HKUST's Sustainable Campus as Living Lab[5] focuses on sustainability with a wide range of projects such as Autonomous Greywater Treatment, Sustainable Movable Vertical Garden, Internet of Tree Things, Upgrading the Pond Water Treatment System, Digital Twin+ for HKUST Campus, Food Waste Analytics and so on. All those projects take advantage of the existing infrastructure on HKUST's campus for staff, students, and businesses to field-test new research and innovations.

University of Cambridge's Living Lab[6] also features a number of sustainability projects on renewable energy, energy efficiency and monitoring, biodiversity, productivity, and smart parking. A study found that encouraging behavior change amongst building occupants could reduce energy use by as much as 20%. The lab also offers practical projects and paid internships to students and graduates.

MIT's Living Lab[7] includes initiatives such as Cambridge Solar Map, Urban Modeling Interface, Sustainable PPE, and Recovering Fresh Water. It is also leveraged by a Solving for Carbon Neutrality course at MIT to facilitate project-based learning and ideation. Using this platform, students have crafted plans to reach Net Zero by 2050.

Readers can refer to this report[8] for a detailed overview of the framework and digital technologies required to accelerate progress towards Net Zero, as well as research and skills needed to meet Net Zero demands.

Wellbeing and productivity

Harvard's Living Lab[9] allows researchers to study the correlation between building conditions and occupants productivity and well-being. A study found that occupants in high performing, green certified buildings achieve higher cognitive function scores.

AgriFood

University of Illinois' Campus as a Living Lab program[10] utilizes a 160-acre animal farm field on campus to study agricultural sustainability, farmer profitability, and cattle health and nutrition.

Sustainable infrastructure

Curtin University's Building 215 Living Lab[11] incorporates an extensive network of IoT sensors (temperature, humidity, thermal efficiency, and water pressure dynamics), accelerometer, and strain gauges embedded directly into the building, generating a large amount of valuable real-time data for examining air-conditioning services and structural monitoring. It illustrates the fundamentals of engineering and provides a comprehensive picture on building design in terms of sustainability, structure, and comfort.

The University of Sydney's Living Lab[12] engages its staff and students in using its campuses as living labs to produce and evaluate new sustainability research to solve infrastructure-related issues across its campuses such as eco-concrete pavement incorporating fly ash, ground recycled glass and carbon dioxide, and off-grid solar smart benches.

Chapter 2: What does it take to set up and run a living lab?

Establishing and running a successful living lab requires adhering to an operational framework with well-defined stages and components.

In a living lab, things constantly change and require frequent updates due to its fast-moving, collaborative, and supportive nature. The whole living lab ecosystem forms a feedback loop in which users are heard and can voice their opinions, making improvements accordingly.

This high-level framework is an iterative process that keeps improving itself constantly based on user feedback, business requirements, and industry demand. It provides an overview of the stages required when setting up and running a living lab; namely planning, discovering, innovating, making, reflecting, and scaling. There are five critical areas that act as the building blocks of any living lab - organizational structure, technology, infrastructure, stakeholder, and policy, which are equally important and must be clearly defined since the living lab's inception.

Figure 1. Operational framework of a living lab

Universities are uniquely positioned to get living labs up and running quickly and effectively. This is why there has been an international emergence and movement of university-based living labs. There are three key factors that explain this phenomenon:

Large pool of talent	State-of-the-art facilities	Existing governance models
Universities have a readily available pool of talent at their disposal, including students, researchers, staff, industry and academic partners, who are often more than willing to contribute to living labs. They can also act as the users in the living labs, hence no need to recruit external users.	Universities are often equipped with state-of-the-art facilities and resources. Many university campuses are also a self-contained ecosystem with gardens, ponds, shops, restaurants, gyms, and residential areas to simulate different types of real-life environments.	The way universities function makes it very convenient to set up and run living labs. Their existing governance models, business models, organizational structures, and financial structures create an ideal environment for living labs to thrive.

Planning

A living lab must have a concrete set of mission principles (such as sustainability, human values, or open science), a clear vision of the impact scope, and a well-defined list of objectives, key performance indicators, methodologies and strategies. The organizational structure, technology, infrastructure, stakeholder, and policy must be clearly identified.

Discovering

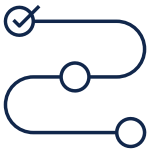
Once the organizational structure of the living lab has been established, it is time to discover the range of challenges needed to be solved by the living lab. It is essential to note that those challenges must not exceed the lab's capabilities. This is followed by other discovery tasks such as acquiring talent, skills, funding, infrastructure, data, internal and external collaborations, and so on.

Innovating

Close collaboration is strongly emphasized in a living lab. Each member's responsibilities must be explicitly defined. Innovations are researched and developed in this phase by all involved stakeholders to solve the identified challenges. In many cases, innovations are simply figuring out how to adapt an existing innovation to the living lab's environment.

Scaling

The core value of any living lab is its ability to rapidly bring latest scientific innovations into the society, or to as many people as possible. It is important to disseminate the knowledge and expand those innovations beyond the boundary of the living lab.



Reflecting

The stakeholders need to answer several important questions in this phase to assess the development progress of the living lab. Has the implementation or trial of the innovations been successful? Does it deliver on any societal values or further advance the science? What can be improved? What's next? This is an important but often overlooked phase in the life cycle of a living lab.

Making

This is when the innovations are trialed to transform an office, a street, or an entire campus into a living lab. The philosophy of living labs lies in the 'living'. Everyone who is living, studying, and working in it is part of the living lab and can contribute ideas, opinions, feedback, and solutions. This is one of the key advantages of living labs – users are already living in the experimental environment, there is no need to move them to another controlled environment.

The advancement of digital technology is the reason that has made living labs feasible in the first place, and living lab is one of the catalysts that accelerates the technological advancement. The past two decades have witnessed the mass adoption of advanced digital technologies by consumers, enterprises, and governments in every single sector.

A smart campus as a living lab is more likely to be successful if it effectively embraces advances in the following five areas:

Artificial intelligence (AI) and Machine learning (ML)

From detecting specific objects in video streams to enabling robots to work autonomously on factory floors, the wide range of AI/ML applications have attracted a massive market size, which is projected to reach USD 641.30 billion by 2028, increasing at a CAGR of 36.1% from 2021 to 2028[13]. With new techniques on the rise like edge AI or embedded AI, this number could even be higher.

Internet of Things (IoT)

If AI is considered the brain of the digital world, then IoT can be considered the bones and muscles. Physical objects with sensing capability are being used to capture every tiny piece of information surrounding them and instruct robots to perform complex tasks. The number of IoT devices is expected to reach 27 billion by 2025[14], showing the mainstream of IoT technologies.

Advanced networks and Network as a platform

Legacy networks are being replaced by newer cellular (4G/5G/6G) and other non-cellular communication techniques (LoRaWAN, Sigfox) to accommodate the massive amount of data, network telemetry, and connected devices with extreme reliability, high speed, and low latency. Complementing this evolution is the emergence of multi-access edge computing.

Cyber security

COVID-19 saw the rapid adoption of digital technologies worldwide, which resulted in a significant increase of cyber security incidents. A report suggests that in 2020, global losses from cybercrime hit nearly $1 trillion[15]. The world needs to pay special attention to cyber security, especially in the context of living labs, where there is a large amount of sensitive data shared through users activities.

Digital twins

A digital twin is an exact virtual replica of a physical object (a robot, room, entire campus) or a process that is built with actual real-time data. This, combined with AI/ ML technologies and advanced networks, gives valuable insights into operations and procedures for real-time monitoring, predictive maintenance, operations optimization, impact assessment, and so on.

These technologies are strongly intertwined, being able to utilize them to their full extent will give the living lab an edge to tremendously enhance operational effectiveness and accelerate science innovation and adoption.

PlaceLab: Opened in 2004 at MIT, PlaceLab[16] is widely considered as one of the first living labs. It recorded all environmental data and every routine activity of daily home life in a 1000 square foot lab realistically architected as a real home. PlaceLab would not have been possible without IoT, having an extensive network of hundreds of devices and sensors (temperature, humidity, light, barometric pressure, motion sensors, door actuators, microphones, cameras).

Chapter 3: Living labs need a new kind of advanced network infrastructure

Living lab is a rapidly evolving environment with frequent updates. The already-under-pressure network, which is the technological backbone of organizations, will need to adjust to accommodate the rapid growth of living labs, which come with many additional challenges.

Continuously evolving business objectives and requirements

A living lab often works on a variety of cutting-edge projects with very different business objectives, expectations, and requirements. For example, security and privacy might be of the utmost importance for some projects while other projects might prioritize processing speed.

Growing complexity of users, devices, applications, and services

A vast number of new users and stakeholders join the system as a living lab grows. Numerous heterogeneous user devices, IoT devices, and specialized equipment is being added to the internal network infrastructure. High-demanding applications and services for monitoring, automated control, data processing, real-time reporting is being developed and increasingly distributed across public, private, and hybrid clouds – all the way to remote network edges to provide greater digital agility and flexibility. All of which add substantial complexity to a living lab.

Innovation integration

Technology innovations in AI, IoT, digital twins, 5G/6G, and so on, is being accelerated and combined with living labs to offer tremendous social, economic, and scientific values, which all have unique requirements that must be met. For instance, some AI methods might require ultrafast connectivity between processing nodes. A new IoT project might require hundreds of new wireless sensors (e.g., air quality, light intensity, soil monitoring, vibration) to be integrated into the existing network infrastructure systematically. Another project might need a shared and robust storage solution to be spun up quickly.

Security, privacy, and compliance

Cyber-attacks are getting more commonplace and challenging than ever before due to the increasing sophistication and sensitivity of the digital landscape, inducing significant damages to organizations. Living labs, which heavily rely on digital infrastructure and possess a huge amount of intelligence and knowledge, will be a hot target for attackers.

The traditional network infrastructure and life cycle management approaches are too rigid and labor-intensive to scale with the growing complexity of living labs and solve the aforementioned challenges. This calls for a new generation of advanced network infrastructure and networking strategy that:

Aligns to the living lab's business objectives and requirements

The new network must be an enabler, not a barrier, to the living lab. It needs to be highly dynamic to quickly realign with the rapidly changing requirements and objectives of the living lab, as well as disruptions.

Assures the quality of service

The network must be able to provide full visibility into its operational states, or how well it is performing, in real time. This helps to assure that the network is supporting the living lab's needs and improving user quality of experience.

Has high scalability

The network infrastructure must be highly sustainable and scalable as well as easy to deploy, configure, operate, and maintain; matching with the living lab's fast growth rate.

Reduces risks

Constantly reducing security and privacy threats through zero-trust models, discovering and neutralizing threats before they cause harm.

Simplifies the network life cycle

Keeping pace with the living lab's expanding demands as technologies and requirements change by simplifying and streamlining how the organizations acquire, consume, maintain, and update their networks.

Cisco Networking Strategy

Cisco's Networking portfolio is developed to keep up with all the demands of a modern living lab. It employs a controller-based Intent-Based Network (IBN) architecture that delivers insights and automation to continuously learn and adapt the end-to-end network to the living lab's needs (intents), bridging the gap between business and IT. It spans access, software-defined wide area network (SD-WAN), data center, and cloud environments to interconnect users, devices, applications, and services, anywhere.

Cisco's IBN building on Software-Defined Networking (SDN) principles transforms a hardware-centric and labor-intensive approach to a software-centric and fully automated one, that enables context learning and assurance capabilities, continuously self-aligning the network to the evolving business requirements. This allows the living lab to quickly adapt to changes, simplify and scale research operations, and protect against service degradation and security threats. Cisco's programmable network devices and open-platform extensibility enables living labs to integrate and power new innovations seamlessly.

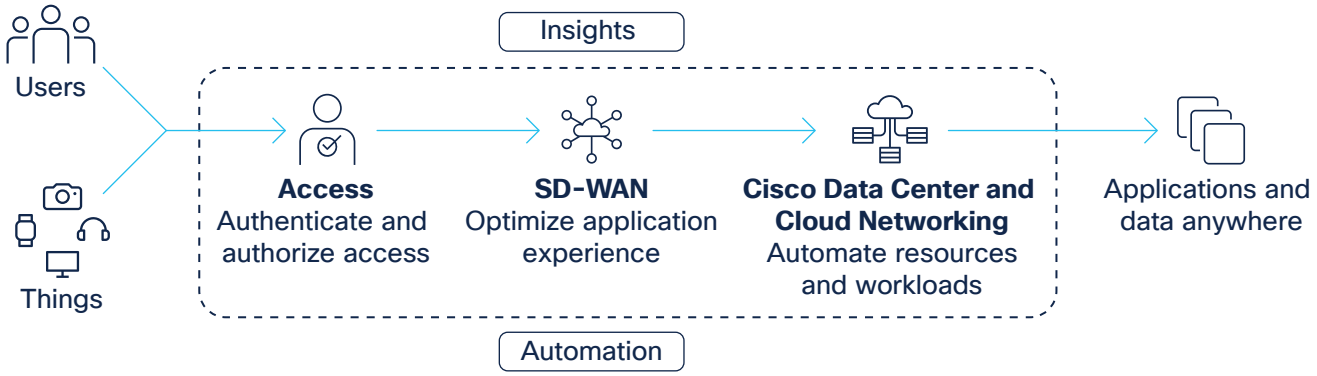
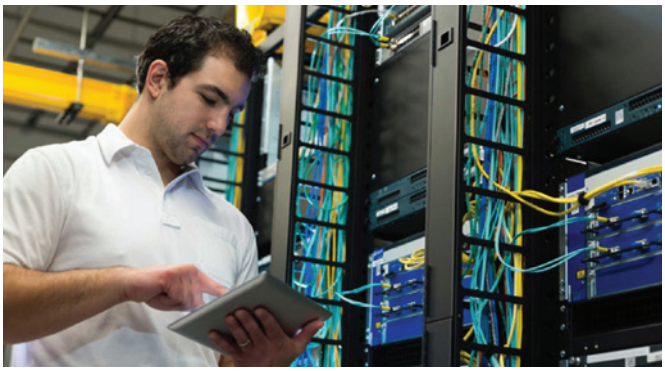


Figure 2. Cisco Networking portfolio

A lot of living labs globally have recognized the importance of advanced network infrastructure and are embracing it as the core technology that powers large living labs as it opens up many opportunities.

University City of the Future and Safe Return to Campus proof-of concept project, La Trobe University, Australia

University City of the Future is La Trobe University's grand plan to transform its campus into a multipurpose and sustainable community, using the concept of living lab as one of the core methodologies. Situated within it is the Cisco-La Trobe Centre for AI and IoT, an Australian first specializing in the intersection between AI and IoT technologies. The centre conducts state-of-the art research into advanced AI and IoT technologies (predictive analytics, computer vision, digital twins, physics-informed artificial intelligence, embedded artificial intelligence, automated solutions for advanced manufacturing, IoT communications, etc). To transform La Trobe University's campus into a smart living lab, the centre has been utilizing Cisco networking products and platforms such as Webex, Cisco Spaces, Meraki cameras, and Catalyst industrial switches. In response to the COVID-19 pandemic, the centre deployed a network of CO_2 sensors around its campus and leveraged Cisco Spaces to facilitate a safe return to campus for students and staff through real-time monitoring of air quality, indoor environmental condition, space density, and occupant count. Not only does this project improve public health and safety, but it also enables other applications such as space utilization and building management optimization or smart energy control. The collected data is also used by students in various data analytics subjects.



Danish Outdoor Lighting Lab (DOLL), Denmark

DOLL is one of the world's first living labs and was originally intended to create a ground for the trialing of smart lighting technologies in industry. The triple helix partnership was based in an industrial estate on the outskirts of Copenhagen and is open to industrial users globally. The anchor partner, Danish Technology University (DTU), provides deep research capability. Over time the scope of the living lab has broadened to include applications in the wider 'Smart Cities' portfolio, including intelligent transport.

The Porto Living Lab, Portugal

The Porto Living Lab[17] is part of the Future Cities Project, Portugal. It is turning Porto into a smart city through a wide range of sensors and communication equipment. The building blocks of its large-scale experimentation facilities include: 1) Vehicular Ad-hoc Networking (VANET) to connect vehicles to each other and to the infrastructure; 2) Hybrid Sensor Networking (UrbanSense Platform) for local monitoring of a dedicated environment using wireless sensors (environmental sensors and pedestrian counters); and 3) Crowdsensor SenseMyCity infrastructure and smartphone app for simplified collection of geo-indexed data through crowd sensing technologies.

Smart Cities by SMART, Australia

SMART Infrastructure Facility is a research institution at University of Wollongong, Australia, which houses its Digital Living Lab[18]. It initiated several projects on digital transformation throughout Australia such as Smart Waterways, Smart Digital Twin Building, Liverpool Smart Pedestrian, Air Quality Monitors, and Greenhouse Gas Emissions in Estuaries. These projects employ an extensive range of AI, IoT, and networking technologies including IoT LoRaWAN network, Message Queuing Telemetry Transport (MQTT), connected sensors, power-efficient embedded computing device (Nvidia Jetson TX2), and video analytics.

Cisco case studies

Cisco's vast networking portfolio has helped facilitate digital transformation in key industries such as education, government, media, healthcare, manufacturing, mining, generating tremendous business and societal value.

Cisco Smart Building Solution

Smart building transformation is part of many living labs to create intuitive and smart facilities that help enhance public health and wellness, work productivity, sustainability, and energy efficiency. The network is fundamental to the smart building as the fourth utility. Cisco smart building solutions is made up of the following five building blocks.

Cisco Catalyst Series switches

Provide the bandwidth, speed, and scalability required to support any smart buildings of any scale. 90W UPOE+ technology delivers DC power to devices over Ethernet cabling, eliminating the need for separate power supplies and outlets, helping to further embrace sustainability.

Cisco Spaces

Provide deep, real-time insights into the behavior of occupants and things (user devices, network equipment, IoT sensors) and how they interact in a smart building to help optimize modern workplaces, reduce the carbon footprint and energy consumption.

Cisco Meraki MV smart camera family

On-camera storage and processing that eliminates the complexity of separate storage, servers, and analytics. Provide real-time AI-based video intelligence to enhance safety and security, location analytics, and smart building automation as in-person students as well as whiteboard.

Software-Defined Access

Built on intent-based networking principles, Software-Defined Access enables policy-based automation for users, devices, and applications across the network. Benefits include end-to-end segmentation, deep insights, improved workforce experience and operational effectiveness.

Cisco collaboration devices

Transform collaboration in hybrid workspaces with Cisco smart room and desk booking, touchless voice assistants, digital signage, way finding, and workplace analytics from built-in IoT sensors.

Smart campus of the future

Cisco has been working with educators and education leadership to develop a vision and solutions to meet education's biggest goals, including sustainability, hybrid learning, and student engagement[19].

Hybrid Learning

The presenter tracking camera above the AV booth, follows the presenter whilst streaming to all remote students. The educator can see remote students in the back of the room at the same size on the collaboration device. Cisco Networking Academy offers curriculum in cyber security, networking, and more.

Sustainability and Smart Zero

Sustainable linear lighting fixtures are powered by Power over Ethernet (PoE). Wireless controllers and PoE automated shades help to keep windows cooler. About one-third of commercial building HVAC energy use is due to heat gains and losses from windows. Approximately 40% of the cooling/heating requirement for a typical building is due to heat gains/losses through windows[20]. Cisco Catalyst access points can work with different industrial wireless protocols by integrating with third party gateways, such as building management systems. With this integration it is possible to automatically adjust the thermostat depending on occupancy. Even greater sustainability benefits are possible from the use of advanced networks to automate the monitoring, measurement, and offsetting of emissions, as detailed in the Smart Zero[8] report.

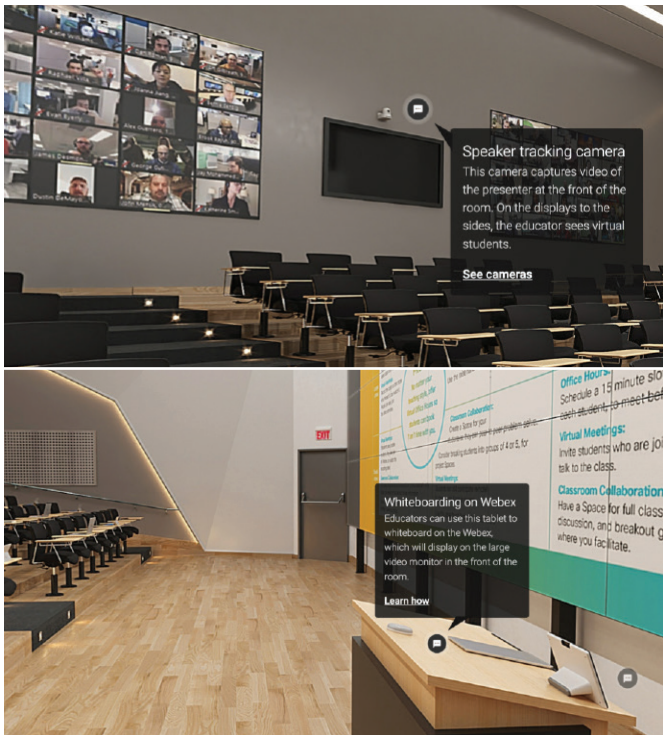
Chapter 4: A future outlook on living labs

Setting up and running a living lab is not without challenges. A number of living labs around the world either have failed prematurely or are not considered to be a true living lab. So, what do institutes need to pay attention to?

A true living lab is the one that has clear visions and mission principles

Many living labs focus on creating new technologies and solutions without having a clear objective of what societal problems they are trying to solve. From a pure technical and scientific standpoint they hold some merits but from a societal standpoint there might be no immediate benefit for users. A true living lab must have a vision of how the users and citizens could directly benefit from the developed technologies.

Tip: Throughout the life cycle of a living lab, the stakeholders must revisit the vision, principles, and strategic goals that were set out at the beginning to ensure that the living lab still adheres to them.



A true living lab is the one that fosters collaboration among stakeholders

All living labs require the expertise from multiple domains, departments, or areas. Its multidisciplinary nature calls for tight cooperation, orchestration, and willingness to share knowledge, data, and skills among the participants and stakeholders. Decision makers play a key role in creating an environment and culture that encourages and promotes collaboration.

Tip: Collaboration and conference tools such as Cisco Webex and Cisco collaboration devices are critical for effective cooperation, especially when a big part of the world is now working remotely since COVID-19. Tools like Cisco devices are also capable of collecting occupancy and in-room environmental data for analytics tasks such as workplace optimization.

A true living lab is the one that evolves around users and for users

Users must not be taken out of the context of their everyday life. They must be treated as an active stakeholder instead of a test subject. Organizations that are looking to employ living labs must shift their perspectives away from the conventional testbeds. Failure to do so will significantly delay the integration of innovations into real-world environments and societies.

Tip: To protect user privacy and make users comfortable, living labs must adopt non-intrusive methods and technologies. For example, occupant counting using CO_2 sensors, anonymized Wi-Fi data, and occupancy sensors instead of using privacy-invasive facial recognition cameras or video feeds.

Call to action

Living labs provide a unique opportunity and a launchpad to accelerate the mass adoption of the latest innovations in the public sector. The domain of challenges that can be addressed by living labs is highly diversified. They are aligned to the Australian Government's Science and Research Priorities – Food, Soil and Water, Transport, Cyber Security, Energy, Resources, Advanced Manufacturing, Environmental change and Health.

Every university has the ability to transform its campus into a smart living lab

Universities are well positioned to transform their campuses into living labs thanks to their existing talent pool, state-of-the-art facilities, and governing model. Smart campuses are particularly suitable for field testing the latest innovations in Transport, Cyber security, Energy, Environmental Change, and Health. They can also contribute to the other priorities given sufficient facility and resources are provided. A future smart campus must embrace sustainability and circular design.

Advanced digital technology is at the core of every living lab

Regardless of the domain of the living lab, no living lab will thrive without an advanced digital infrastructure and effective adoption of digital technologies, including AI/ML, IoT, network as a platform, cyber security, and digital twins. An advanced network infrastructure is required to improve the operational efficiency of living labs.

Policymakers will determine the success of living labs

Living labs have the potential to deliver tangible economic, commercial, environmental, and sociocultural benefits with the right support from the Federal Government and other governing bodies. Policymakers need to:

1. Recognize the importance of living labs and develop a coherent nation-wide road map/action plan to accelerate the adoption of living lab methodology in industry, public, and university sectors.
2. Conduct a comprehensive analysis of the specialist skills required to set-up and run a living lab, followed by research and education strategies at tertiary and vocational levels.
3. Ensure sufficient funding allocation to establish new living labs and explore new use cases, including funding incentives from private sectors to drive increased industry investment.
4. Accelerate innovation and research into core emerging digital technologies for living labs.

Cisco-La Trobe Centre for Artificial Intelligence and Internet of Things concentrates on exploiting latest advances in AI and IoT – the two core technologies underpinning the development of living labs and virtually any other areas. The Centre has been delivering industry-driven solutions to a wide range of problems in alignment with Australian Government's Science and Research Priorities. Cisco's involvement in the Centre for AI and IoT provides access to an ecosystem of industry partners and best-in-class AI and IoT products and technological solutions.

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Methodology and approach

This report was developed as a collaboration between Cisco and La Trobe University. It draws on the perspectives of Cisco’s local and global team of engineers and vertical experts, as well as La Trobe researchers across a range of disciplines.

About the Centre for AI and IoT

The Cisco-La Trobe Centre for AI and IoT at La Trobe University is the first-of-its kind in Australia in terms of exploiting the synergy between state-of the-art AI and IoT technologies through partnering with Cisco and the wider industry and end-user community. The Centre also works with industry partners to deliver real-world industry solutions in strategic sectors such as digital health and agriculture, Industry 4.0, advanced manufacturing, smart cities.

In terms of education, La Trobe University, in partnership with the Centre, offers Australia’s first Master of IoT course, using the city of Bendigo as a living lab to field test the technology.

The bridge to possible

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Learn more about NIIN at cisco.com/au/niin

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