Horizon Scanning Series

The Internet of Things

Smart Homes into Smart Places & Infrastructure and Utilities Management

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INTRODUCTION

Purpose

This paper is the IoTAA's contribution to the ACOLA Horizontal Scanning Series – The Internet of Things Project. The IoTAA has been engaged to specifically comment on smart homes and their integration in smart cities and regions, as well as on infrastructure and utility management more generally.

Smart homes, infrastructure and utilities work package

This work package is a component of Chapter 4: Smart cities and regions. This chapter examines the implementation of IoT through a smart cities and regions lens, with particular consideration of the questions below.

Work package questions

Infrastructure and utility management

- Is IoT likely to have an impact on infrastructure and utility management in smart cities and regions? If yes, how so?
- What are the opportunities and challenges (economic, commercial, environmental and sustainability) for smart cities and regions with regards to IoT use in infrastructure and utility management?
- Are there any practical measures that are likely to be needed, by either government or industry, to support IoT usage in infrastructure and utility management?
- Are there any areas in infrastructure and utility management in smart cities and regions in which Australia has a comparative advantage or could become a world leader?

Smart homes

- How might IoT applications in smart homes feed into broader operations in smart cities and regions? Examples of considerations include the possible effect of smart homes on public transport, traffic, utility management and the health care system.

INFRASTRUCTURE AND UTILITY MANAGEMENT

Every infrastructure has significant legacy. Both technical and business model. The advent and proliferation of IoT can change a lot of things. This can be divided into two categories.

- Doing old things better, leveraging sensors and data analytics – this falls into the general category of iterative business improvement and business process automation
- Doing new things that change the game completely. IoT and the resulting data that leads to new insights is driving both categories. This can be grouped under the common expression – digital transformation/disruption

  Doing old things better – The market is full of simple early steps towards better infrastructure performance and utilisation from IoT. In cities, lowering the electricity usage by upgrading lighting to LEDs is one of the most common first steps. With this, comes the ability to better manage and control LED lighting to further improve usage. IoTAA member cities include Gold Coast https://www.goldcoastbulletin.com.au/news/council/gold-coast-council-to-install-energy-saving-lights-in-surfers-paradise-to-reduce-power-costs/news-story/134957bc18723aa227b6d1d8a8da80d7
  Salisbury, Newcastle and Ipswich. These Councils have all deployed LED lighting to save energy costs and it is the IoTAA's understanding that most councils across the country have made or are considering at least this step.

1. Many infrastructure operators have been sensing and monitoring their valuable infrastructure for decades using SCADA systems. Modern IoT solutions dramatically lowers the cost of deployment and operation of data collection, management and analysis enabling automated and finely grained monitoring of asset utilisation to better predict, cost and plan capital expenditure and lifecycle costs. The construction industry, as well as building operators and city councils are relatively immature in their application of IoT which points to significant opportunity for better service provision and improvements in costs.

2. Doing new things that change the game – This area is much more interesting and has much more far reaching implications as well as threatening significant disruption in existing business models, competition, sharing of services between public and private providers and consumer participation.

    I. Electricity – The traditional way to see this market has been from the perspective of the consumer power meter – hence terms such as "behind the meter" when referring to what happens in a customer's

premises regarding energy consumption and generation. In this view, power generators and distributers see that their service stops at the meter and how the consumer uses electricity is their domain. A simple billing model is the result.

II. The relatively recent "Power of Choice" reforms https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Power-of-Choice overseen by the Australian Energy Market Operator (AEMO) came into operation from 1 December 2017 and are resulting in significant changes in what meters are being installed in customers premises, who installs the (retailer or distributer) and what might be measured. This gives far greater choice to consumers and is having a dramatic industry effect.

The further evolution and adoption of distributed energy resources (DER) by consumers, through solar panels, batteries, usage monitoring and analysis, demand side management and the onset of electric vehicles, coupled with new model flexibilities enabled by Power of Choice opens new business opportunities. This all leads to model where the end-user becomes both a supplier and a consumer – a Prosumer. According to the Australian Renewable Energy Agency, ARENA , https://arena.gov.au/ penetration of rooftop solar panels passed 2million homes in 2018. While the average penetration has reached 20% of homes in 2019, anecdotally there are some regions with over 70% penetration.

Further, as electric vehicles and other batteries become more cost effective and penetration increases, the "behind the meter" generation, consumption and demand management of electricity becomes a more dominant component of the overall electricity value chain – disrupting existing business models and introducing new market players such as energy aggregator.

Given Australia's relatively high cost electricity market this transformation offers a significant opportunity for improving costs for consumers as well as global competitiveness, in the long term. Standard definition of data to be collected from DER, sharing constructs and reliable localised smart grids will be essential to realise these gains. The Energy Security Board (ESB) has been tasked by the COAG Energy Council to develop advice on a long-term, fit-for-purpose market framework that could apply from the mid-2020s.

III. Water - Australia is a nation with limited and patchy water supply. We are also one of the most urbanised markets with over 80% of the population living in cities. We have limited water reserves and with all this, we recycle very small amounts of this resource. Our drinking water is very high quality but less than 1%[1] of it is consumed by people directly, e.g. https://www.rwcc.nsw.gov.au/save-water/average-water-use. The remainder is for gardens, washing, toilets etc. IoT provides some outstanding opportunities to monitor and control the use of water much more effectively than is generally accepted today. With significant pressure and incentive from government, recycling of water is an enormous opportunity to change the game. An example of precinct scale recycled water is the Central park (Sydney) and UTS sharing of recycled water generated by Central park water harvesting. https://www.thefifthestate.com.au/energy-lead/business-energy-lead/central-park-recycled-water-uts/

IoT also offers significant opportunity for reducing the 20-30% water loss in utility reticulation networks through better pinpointing, detection and prediction of leaks and better targeting of the $4Bn maintenance program of the legacy $140Bn pipe investment.

IV. Waste – The management of public waste is already starting to see efficiency improvements using smart bins [2]for example. These bins simply monitor and report when full to facilitate the efficient emptying event. This starts as a "doing old things better" approach but as information about bin utilisation improves, new strategies can be deployed to further improve health as well as things such as crowd movements for example. Recycling can be made much more efficient using IoT Technologies to separate specific materials at point of waste collection. Investigations into the feasibility of low cost IoT technologies are in their infancy, but hold great promise. Over time these technologies will enable a very specific and targeted selection of waste which will enable new business to develop new products based on recycled materials. Australia is very well placed to be a global leader [3]in recycling technologies but today is a minor player. This is a critical area for Government influence and incentive specifically to drive both jobs growth and sustainability outcomes.

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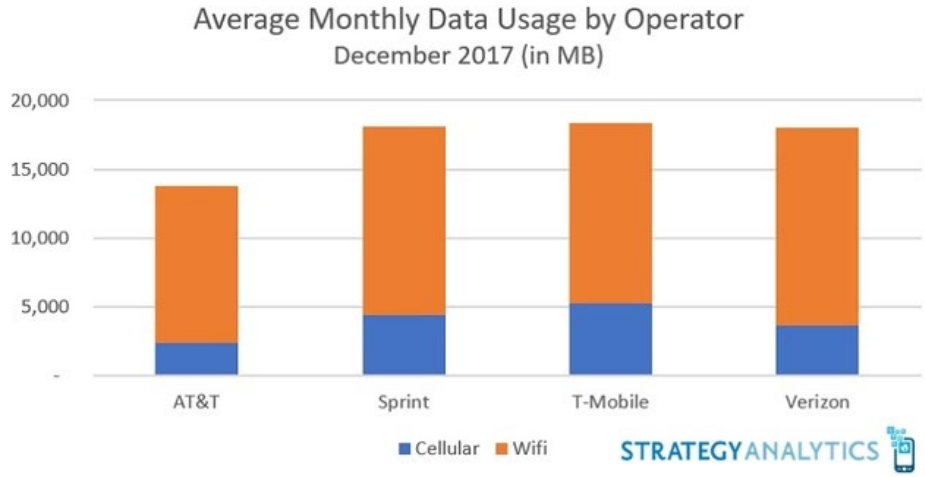
[1] Water providers such as Sydney Water and Hunter water both indicate that less than 1% of tap water is consumed by people.

[2] Refer to smartbin.com, solarbins.com.au, yindibins.com and many others

[3] This is the view of the IoT Alliance Australia

V. Telecommunications – underpinning all IoT business improvements and transformations is a national telecommunications capability and capacity, and at better cost. The telecommunications infrastructure is the critical enabler for all of these smart solutions.

Our telecoms networks for both the fixed and mobile networks for IoT requires basic enabling infrastructure. This means that the architecture and deployment must meet the infrastructure needs for everyone and at most likely at differing levels of cost and reliability, depending on the service needs.



https://www.strategyanalytics.com/strategy-analytics/what-we-do/consumer-telemetry#.WIeUR6inGyI

This above figure shows the amount of mobile data and fixed-network-via-Wi-Fi data downloaded to mobile devices. Data from the US is typical of most countries and what this says is that about 70% of all data downloaded to mobile devices is coming from the fixed network via Wi-Fi___33 and not from the mobile network at all.
Even when 5G is deployed, it is the IoTAA's view that this ratio of fixed to mobile traffic will remain similar. Furthermore, if all traffic to mobile devices was connected only via the mobile network then the mobile network today and into the future would be so overloaded that it would not ever function effectively. Congestion would render the mobile network useless under these circumstances. It is therefore the IoTAA's view that in the future we will need both a ubiquitous mobile and fixed network to support the telecommunications needs of the country.

Today we have fixed broadband with poor world ranking of between 50th and 60th [4] by some measures and a mobile ranking in the top ten. We need both to be competitive and enable smart infrastructure. The next wave of carrier investment in 5G will take a decade or more and it will help but is not sufficient. The demand for low cost sensing in every sector is accelerating and the lower-cost network options are very effective for many applications. We will need all the wireless solutions – on licenced and un-licenced spectra to be well managed and cost effectively available. We will also need fixed networking to be better performing and more ubiquitous.

For example, a farmer may need to see the data from his farm in real time, wherever he/she is and this means a high quality connection to their personal device which will probably need to be high bandwidth too, in addition to high quality backhaul for remote analysis to support the rich nature of the information being delivered to aid critical decision making.

VI. Transport

Management of public transport infrastructure utilisation, passenger and vehicle tracking enabled through IoT is a powerful tool in managing and planning for congestion mitigation and urban planning.

Transport for NSW is a great example of a public entity using IoT to track all forms of public transport; ferries, busses, light rail and trains, including occupancy and using the data and analytics to better plan timetables and provide better customer information. In addition, TfNSW provide this data to third parties for added value applications. A recent example is the announced Uber/TfNSW app which combines Uber data and TfNSW data to offer customers a range of public/private transport options.

In rural, remote, widely dispersed and also international connectivity, particularly a growing area of innovation and opportunity is from leading satellite options for national IoT connectivity from Fleet Space and Myriota.

VII. Food Production and Supply Chain – Australia is a well-regarded, high quality food producer and exporter today. IoT solutions are building on this very successful base and extending the quality throughout the

[4] Referenced https://www.speedstest.net/global-index

supply chain and the potential to further add to our competitive advantage for global markets. Examples for great advances using IoT in food and agribusiness are many, but not evenly spread. Food Agility, a Food and Ag CRC has a number of projects underway https://www.foodagility.com/projects that showcase the application of IoT. Costa Foods, the poster child of the Horticulture industry presented has implemented IoT into most of its 65 farms, two thirds of which are under cover, use a quarter of the water normally needed and have greater yield.

This is dramatically improving more sustainable food production, with better targeted water and fertiliser usage improved yield and accompanying data on product provenance as well as delivering more reliable and complete information to the consumer. We have a very significant opportunity to produce and deliver more with less energy and water use while also providing evidence of higher quality all the way to the consumer. This brings together the food production industry and the food packaging industry along with the transport sector to deliver much better results for the entire ecosystem.[5]

[5] Refer to the Food Agility CRC https://www.foodagility.com/

SMART HOMES, CITIES and REGIONS

Smart Homes, Buildings, Cities and Regions have a common attribute – that of place and with that the opportunity for collecting, overlaying, analysing and make decisions of the wide array of jurisdictions, services, product and infrastructure that affect that place.

Sources of data and analyses relating to a place are enabled by IoT, and especially the opportunity for leveraging data we currently don't have and may need from localised (and hyper-localised – in home, in car, in park) and real-time data.

While data is being increasingly gathered from more and more sources and at lower cost than ever before, questions and challenges remain in how homeowners, cities, and governments:

- Share the cost in collecting data
- Make collected data visible and accessible by others
- Determine and guarantee levels of data accuracy and authenticity
- Protect citizen, commercial and state rights
- Ensuring data is not faked
- Protecting against intrusion, and disruption

The above governance, security, privacy protection, discovery and also interoperability challenges limit the deployment, progress and breakthroughs that place-based information and insights can bring. As a result, initial advances are happening within established use cases and verticals (iterative business improvement) which hopefully will set up the promise of future transformative advances.

Examples include: Consumers authorising smart home providers to gather and use data for home automation, security, energy management etc. Common examples are Google, Amazon, Microsoft, Facebook and many others. Smart Homes are leveraging hyper-local information to make decisions and actions in the home that are simpler, better informed and increasingly automated. These non-government businesses leverage data in very sophisticated ways using artificial intelligence and other techniques to maximise both value to users and revenues to themselves.

Government agencies despite a wealth of information, are limited by different obligations regarding privacy and risk of using their constituent's data, lack of data sharing incentives, tools and security concerns and lack of access to trusted non-government data. Nevertheless, with government (sub)verticals significant progress is being made in state public transport (see TfNSW example earlier), council parking and rubbish services and selected infrastructure projects, such as the Victorian level-crossing replacement program.

Data and data insight sharing enables innovation.

IoT data gathered and acted on in the home can contribute in many ways when combined with State Government data to improve services and improve asset and resource utilisation. Examples include:

- Demand-side management for electricity supply and storage to provide flexibility during high demand periods to improve network reliability
- Remote and mobile patient monitoring and alerts for health allowing predictive action for services, optimising hospital occupancy and lowering cost of services. For in home care, IoT offers many ways to better monitor and support wellness for all ages. This is especially evident in the aged care sector. With so many ways to better monitor the elderly we see the extension of the retirement village into the home[6]. Unobtrusive monitoring of activity, sleep, nutrition and waste output are all making rapid advances. Helping to understand changing patterns of movement can enable prediction of increased likelihood of a fall or reduced social interaction can point to increasing chronic illness. Changing sleep behaviours indicate a range of concerns for wellbeing. Sensing all of these things and more, will give rise to a significant change in the way medical support services are delivered and probably increase the expectation of living at home longer which can reduce pressure on aged care facilities as well as the medical system overall. Health insurance businesses are already seeing these advances as a major driver in cost reduction and this in turn can lower the cost of insurance to those who are leveraging the supporting technology. For example, Lorica Health, https://www.loricahealth.com/ collects 80% of health Insurance claims for the Health Insurance Industry which enables insurance companies to understand revisit rates, etc to better manage and tune their offerings.
- Ability to advise a consumer when is the optimum time to leave home to arrive at a pre-allocated parking destination that becomes available just as you arrive. Reducing the time and energy wasted searching for parking.
- In the future, with forecast rapidly rising water prices, water use, sharing, recycling will require visibility across hone, precinct, buildings, council, and utilities to balance use with availability and capital costs of new dams and desalination plans and increasing restrictions on water use.

Digital Built Britain[7], is a program launched in 2015 to leading the way in delivering sustainable construction solutions that also give British builders and operators a competitive advantage. Amongst its many aims, Digital Built Britain is a program to

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[6] https://www.csiro.au/en/News/News-releases/2016/Home-monitoring-of-chronic-disease-could-save-up-to-3-billion-a-year

[7] Refer to https://www.cdbb.cam.ac.uk/

add real-time data to static building "BIM" models to enable dramatic reduction in energy and water use of buildings (up to 50%). This was prompted by data that indicated buildings consume up to 80% city water and energy resources but are also up to 80% inefficient in how they and their users operate. Such a program might also be considered in Australia, where we have significant energy and water challenges.

IoT Security

While the internet is chronically insecure, the Internet of Things can and will considerably increase the risks of security breaches which affect data security, accuracy and service resilience. IoTAA[8] strongly recommends the introduction of an IoT security accreditation scheme[9] with a supporting certification ark. By this mechanism buyers purchase home and business IoT products and services with lower risk and early knowledge.

SUMMARY

Every sector and every infrastructure are making small steps to embrace IoT Smart technologies and in most cases these steps are enabling old things to be done in new ways with a resulting improvement in productivity, efficiency and customer outcomes. We have seen some early examples of transformative IoT enables industry change, such as the introduction of Uber in the Taxi industry, but are yet to see the next major advances in electricity, construction, water etc happen at scale when new insights create new opportunities for much more change. These changes will challenge the way we view market sectors and industry verticals.

It is incumbent on Government to recognise that traditional sectoral boundaries are being tested, enabled by IoT, and that are stressing and disrupting existing business models, regulations and the role that government plays in the delivering and enabling public and private services.

Important areas where Government can and should help promote positive IoT outcomes include:

- Enabling data discovery and sharing from public and private sources by addressing:
    - Data privacy concerns
    - Harmonising data standards in key industries – including electricity for DER
    - Making managed data available for innovation

[8] Refer to https://www.iot.org.au/wp/wp-content/uploads/2016/12/IoTAA-Security-Guideline-V1.2.pdf

[9] Refer to http://www.iot.org.au/wp/wp-content/uploads/2016/12/IoTAA-Strategic-Plan-to-Strengthen-IoT-Security-in-Australia-v4.pdf

- Promoting and supporting IoT security practices and consumer trust and visibility
- Facilitating collaboration and cost sharing for deployment of IoT sensing, collection and analysis. For example: the benefits are broader than City Councils can fund and often fall outside their remit. Conversely, we cannot afford to hugely replicate local sensing and parallel data collection stacks for narrow use cases.
- Set goals that improve Australia's competitivity and better use our resources and assets
    - E.g. Digital Britain like building efficiency targets

APPENDIX

The following material is provided as some background to the IoT and Smart technologies and business models.

SCOPE OF SMART HOME PRODUCTS ON THE MARKET

Smart Home Trends

IoT is a critical enabler for all smart home technologies and products that provide opportunities to develop and incorporate connectivity. These goods include smart wearables, home systems, personal electronics, and household appliances – to name just a few.

Often these are described as 'smart' devices that enable users to measure aspects of their environment and control traditional actions in new ways.

In recent time, prominent IoT consumer products the like of Google Assistant within Google Home, Amazon's Alexa or Apple's Siri have become common in the home, particularly in the younger demographics. These products are not only connected devices themselves, but also act as Connected Gateways to the internet and can connect to a wide array of IoT consumer items in the home such as Bluetooth speakers, smart WiFi-enabled power points, lighting and heaters. It won't be long before they'll be able to connect to a lot more home appliances.

It is likely that in the future all consumer goods will be IoT-enabled or connected products, and they will not be labelled as IoT product anymore, just plain consumer products! The consumer will not know, or care, as long as the product works.

Many homes incorporate a range of devices with sensors, internet connectivity and remote-control capability. As this market expands, a number of home product segment players are building their IoT consumer portfolios.

The burgeoning smart home marketplace includes:

- Televisions and home entertainment
- Games consoles
- Large appliances (including white goods)
- Small appliances
- Computers and IT
- Wearables – mobile phones, tablets and smart watches
- Telecommunications service providers
- Home automation
- Home security and video surveillance
- Electricity hardware providers
- Lighting providers
- Garage door remotes
- Swimming pool automation

- Personal medical devices

The IoT enables an army of electronics hobbyists, small to medium independent developers, and manufacturers to develop innovative IoT consumer products quickly and at scale.

The 'maker' movement is proliferating in Australia with a number of home-grown 'hacker spaces' being set up where hobbyists gather to share their knowledge and DIY software and hardware which is generally internet connected.

IoT consumer goods that come onto the market may vary in terms of reliability, quality, safety and security. This will present challenges for regulators, retailers – and consumers. This raised the question: will the IoT consumer goods market be looking like the **Wild West of IoT**?

For example, consumers may make the assumption that larger better-known vendors provide a better level of safety and security by default, however this may not necessarily be the case. Likewise, hobbyists, smaller developers/manufacturers or independent niche market IoT product providers may not have the awareness or resources to provide adequate levels of safety and security in their devices.

The IoT Alliance Australia has produced an IoT Reference Framework, http://www.iot.org.au/wp/wp-content/uploads/2016/12/IoT-Reference-Framework-v1.0.pdf that explains IoT in simple terms – irrespective of the industry sector an IoT deployment takes place in.

IoT CONSUMER GOODS – THE SUPPLY CHAIN

The IoT presents opportunities for consumer goods vendors and service providers to explore new business models, to streamline processes and achieve efficiencies.

IoT ECOSYSTEM/VALUE CHAIN

Figure 114 illustrates a number of IoT ecosystem stakeholders, including hardware, software, platform, product and different types of service providers. A brief explanation is provided below.

IoT Platform Provider – There are over 450 IoT platform vendors[10] providing a multitude of IoT functions and capabilities (see definition of IoT Platform in section Definitions and Interpretations above) in the market. Examples of IoT Platform vendors include Google, AWS, IBM, Microsoft Azure, Bosch, Siemens, Kaa, Cumulocity, Cisco-Jasper, ThingWorx PTC, Particle, Reekoh, Conctr, and so on. While these providers offer all different off-the-shelf functions and capabilities, many

[10] https://iot-analytics.com/product/list-of-450-iot-platform-companies/

enterprises have chosen to develop their own IoT platforms, due to many different reasons.

Anything as a Service – Also known as XaaS, that can incorporate platform, infrastructure and Software as a Service. These can support analytics, AI, the Blockchain and a range of other systems and activities. Selected examples of service providers in this space include AWS, Google, Microsoft Azure, IBM.

IoT Device Supplier – These range from large consumer goods vendors like Samsung and Apple to smaller device manufacturers and suppliers.

IoT Product HW/SW/FW Supplier – These include specialist IoT device design and developer houses that can offer capabilities in hardware and embedded software design to create any product to specification.

IoT Product Manufacturer – A range of R&D and manufacturing firms operate in countries like China. These firms enable businesses to outsource product design and manufacture. Depending on the type of IoT products, either industrial, or consumer type, IoT product manufacturers include Bosch, Samsung, Apple, Siemens, and other household appliances manufacturers.

Sales/Distributors/Retailers – These organisations sell and distribute IoT products to consumers. They include online stores such as e-commerce giants Alibaba and Amazon.

IoT Module Supplier – these include well-established companies such as Qualcomm, Quectel, u-Blox and Huawei that supply IoT modules to product design companies.

What is an IoT Module?

According to Gemalto, an IoT module is a small electronic device embedded in objects, machines and things that connect to wireless networks and sends and receives data. Sometimes referred to as a 'radio chip', the IoT module contains the same technology and data circuits found in mobile phones but without features like a display or keypad.

Connectivity Network Provider – Providers of public or private IoT networks. Some examples of network providers in Australia include Telstra, Vodafone, Optus, Thinxtra, NNNCo, GeoWAN and Meshed, to name a few. There are many other specialist providers of private IoT connectivity networks in the market. One such example is Blue IoT, who provide private LoRaWAN networks in the smart buildings sector.

IoT Solution Provider – Those who offer IoT solutions which could include network connectivity, devices and application platforms. There is no one standard solution offering, it is likely that the business model of a solution provider can be quite different from one to another.

Software and App Developer – Provide a whole range of services, from writing mobile apps for accessing IoT solutions, to creating dashboard for monitoring

solution, to creating rules engines that assist in the data analysis. In some cases, software developers are tasked with creating a complete 'IoT Platform'.

IoT Consumer Goods as a Service – As described in the IoT Supply Chain Model, this is an emerging service model, particularly in the enterprise, or smart cities sector. For example, a smart building service can provide HVAC (Heating, Ventilation, and Air Conditioning) services to a number of buildings owned by a city council. The city council does not have to purchase any products required to monitor and report the usage. They only need to pay a service fee. The vendor takes on the responsibility to plan, build, and operate the solution, and maintain all the sensors and connectivity network. See further description and example in the IoT Supply Chain Model.

Data as a service vendor – IoT entails extracting value and insight from large data volumes. Businesses are emerging that can broker, buy or sell data to other organisations. For example, a service provider that sells Mobility as a Service would need to obtain traffic and mobility related data from many different sources thereby enabling them to aggregate, analyse and deliver value added insights and/or outcomes from the resulting information. It could do so by purchasing additional data feeds from other vendors.

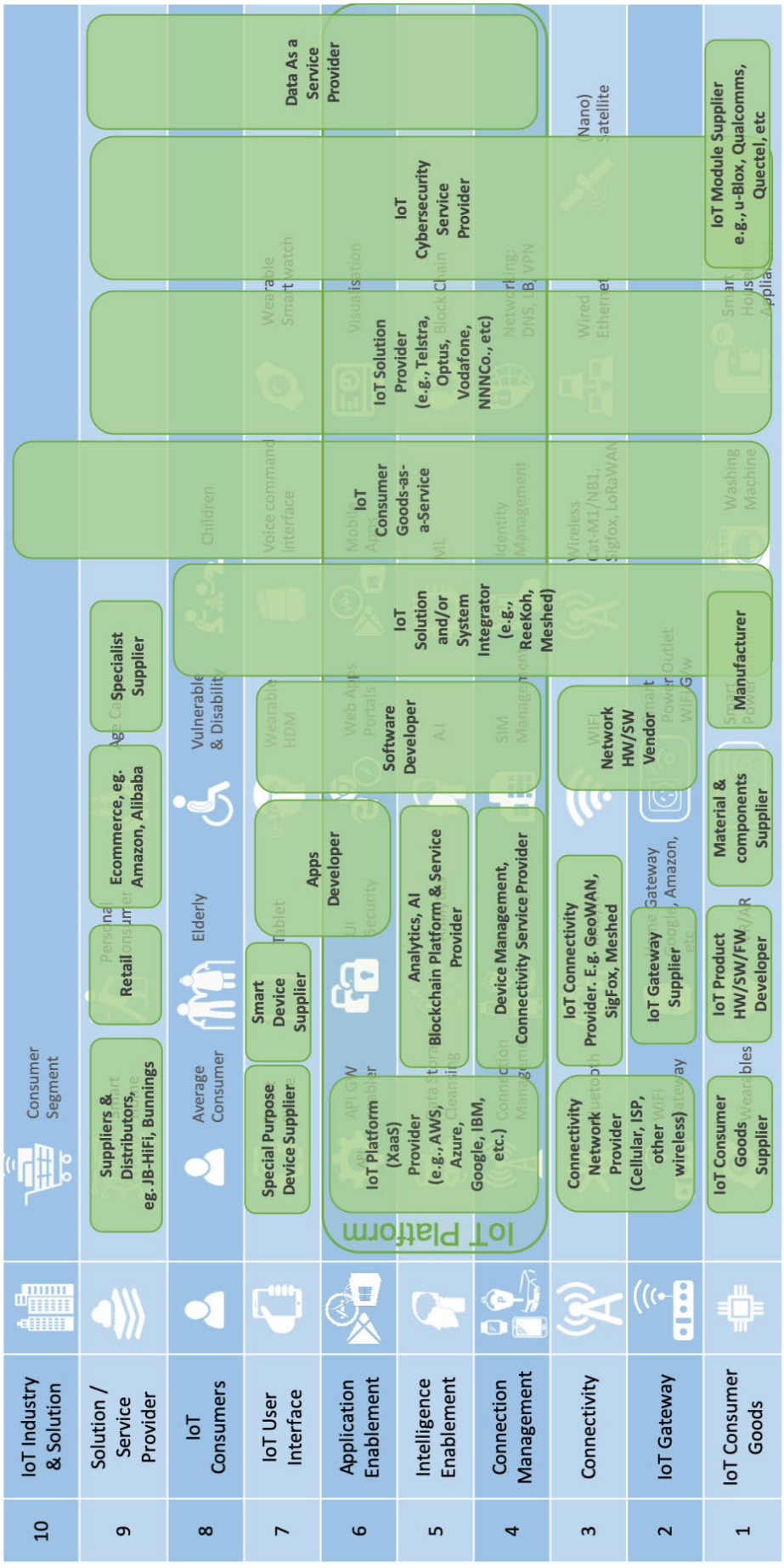

10
IoT Industry & Solution
Consumer Segment
9
Solution / Service Provider
Suppliers & Distributors, eg. JB-HiFi, Bunnings
Retail
Ecommerce, eg. Amazon, Alibaba
Specialist Supplier
8
IoT Consumers
Average Consumer
Elderly
Vulnerable & Disability
Children
7
IoT User Interface
Special Purpose Device Supplier
Smart Device Supplier
Apps Developer
Wearable HDM
Voice command Interface
6
Application Enablement
IoT Platform (XaaS) Provider (e.g., AWS, Azure, Google, IBM, etc.)
Analytics, AI Blockchain Platform & Service Provider
Software Developer
IoT Solution and/or System Integrator (e.g., ReeKoh, Meshed)
IoT Solution Provider (e.g., Telstra, Optus, Vodafone, NNNCo., etc)
IoT Consumer Goods-as-a-Service
IoT Cybersecurity Service Provider
Data As a Service Provider
5
Intelligence Enablement
4
Connection Management
Device Management, Connectivity Service Provider
3
Connectivity
Connectivity Network Provider (Cellular, ISP, other wireless)
IoT Connectivity Provider. E.g. GeoWAN, SigFox, Meshed
WIFI Network HW/SW Vendor
Wireless Cat-M1/NB1, Sigfox, LoRaWAN
Wired Ethernet
(Nano) Satellite
2
IoT Gateway
IoT Gateway Supplier
Material & components Supplier
1
IoT Consumer Goods
IoT Consumer Goods Supplier
IoT Product HW/SW/FW Developer
Manufacturer
IoT Module Supplier e.g., u-Blox, Qualcomms, Quectel, etc
IoT Platform

Figure 1 IoT Ecosystem/Value Chain Player

IoT SUPPLY CHAIN MODELS

There are at least seven different models beyond traditional product purchase that businesses and consumers can employ to take advantage of IoT. However, businesses and consumers need to be aware that several of these models raise questions about safety and liability that need to be addressed. The article by IoT product coach, Daniel Elizalde, 'Monetize Your IoT Product' [Error! Reference source not found.] describes these seven models as follows:

1. **Subscription Model** – A subscription model enables an IoT product to implement many of the benefits available to software-only products. Basically, introducing an 'as a Service' business model for a system that includes both software and hardware. This model also empowers the company to foster an active relationship with the consumer.
2. **Outcome-based Model** – The concept is for consumers to pay for the outcome (or benefit) the product provides, as opposed to the product itself.
3. **Asset Sharing Model** – This IoT business model revolves around selling extra capacity back into the market. The goal is to maximise the utilisation of the IoT product across multiple consumers. That way, each consumer pays a reduced price and the vendor is able to get faster market penetration, compared to when a single consumer has to pay for the complete product.
4. **'Razor Blade' Model** – Some IoT products can be designed for selling other products. In this model the vendor might sell the IoT product at cost or even at a loss since the goal is to get the product in the consumers hands so they can start selling the other products. This business model is sometimes called the 'Razor Blade' model, where the goal is to sell more and more disposable razors, and therefore, the razor handle is usually sold at cost or even given away for free.
5. **Monetising IoT Data Model** – IoT vendors can build products to provide value to the end user and also to collect valuable data that they can then sell to a third party. In this approach, they can potentially offer their IoT device at no monetary cost to eliminate the buying friction for the consumer. The goal is to deploy as many devices as possible to collect data that they can on-sell.
6. **Pay per Use Model** – Sensors on IoT hardware devices means vendors can monitor their consumers environment and how much they use the product. This opens the door to an IoT business model where they can charge their customer for the amount of time they are actively interacting with the product.
7. **Offer as a Service Model** – Vendors can use an IoT product to offer a new service (or enhance their existing service) to customers. In this case, the author is not talking about an 'as a service' type model. Here they mean providing a service, with real people involved.

THE IoT CONSUMER GOODS-AS-A-SERVICE MODEL

A household consumer may choose to purchase IoT offerings as services rather than as products. This service model is more complex and less predictable.

A service that leverages IoT devices, networking, data storage, processing, analysis and an application can be marketed to consumers as a simple, outcomes-based service. However, many of these use cases raise questions about consumer liability and protection.

Example 1: Aerial home photographs – Drones are a typical IoT device with a camera, network connectivity and an application for managing video and photos. It is becoming more common for consumers to purchase drones and use them to take aerial photos of locations such as their properties. This activity may be outsourced to a provider that can offer, as a service, digital photos of a property.

Example 2: Outsourced swimming pool management – IoT devices and networks can remotely control pool pumps and monitor and adjust pool chemistry. Consumers can take advantage of IoT services to manage a pool more easily and effectively. Service providers are operating that offer complete pool management and retain ownership of equipment such as pumps, chlorinators, filters, sensors and network connections.

Example 3: Home printers – As the low-cost printer market matures, printer manufacturers are obtaining more revenue from ink cartridge sales than sales of the devices themselves. In many cases the product is heavily discounted to gain the cartridge sales over the life of the product.

Printers can now automatically trigger a cartridge reorder when ink is running low. As this approach matures, it is feasible that the printer will be provided free of charge by the service provider and the user pays for printing services that guarantee ink/toner will always be provided. These services will also replace a printer in the event of a machine breakdown or significant problem.

Example 4: Car sharing – An autonomous passenger vehicle is a very expensive IoT consumer device. Consumers will buy rides as a service or possibly purchase a share of a vehicle and share it with a group of compatible consumers. A consumer may also purchase a vehicle and through an application make it available for others to use during its otherwise idle time. All these variations on this business model test traditional models of insurance and liability. The business models described here are examples of asset sharing and subscription models.

Example 5: Home surveillance and security – An insurance company may provide a service that incorporates free supply and installation of home surveillance devices and deliver a service of management, monitoring, alert/alarm, response and analytics. The company could offer that consumer reduced insurance premiums to account for the increased protection and management, and the ability to collect

and leverage data for analysis. In this example the solution is provided at lower cost to the consumer because the insurance company will obtain revenues from affiliates for part of all of the data collected, and also reduce its risks, and therefore costs, by analysing the aggregated data and identifying patterns. This is an example of monetising IoT data.

SMART HOME / HOUSEHOLD IoT CONSUMER GOODS

Household IoT consumer goods are shared by a household, rather than by an individual. They include, but not limited to:

- Smart home assistants – e.g. Google Home, Alexa
- Single purpose IoT devices – e.g. Amazon's IoT button
- Smart appliances – e.g. televisions, microwaves, washing machines, fridges, dishwashers, ovens, coffee makers
- Aged/healthcare assistance devices e.g. personal assistant devices that incorporate AI/ML capability
- Smart plugs – e.g. connected switches, power plugs and lighting technologies
- Home security – e.g. video security systems, web cameras, smart locks and smart smoke detectors
- Home networking and entertainment – e.g. modems and routers, smart speakers
- Robotics – e.g. vacuum cleaners, pool cleaners

HOW DO IoT CONSUMER GOODS WORK?

The 'things' connected to the internet are a complex and evolving ecosystem of technology platforms, products and services.

These things are equipped with sensors and actuators that can be programmed to sense and monitor their environments; detect movement; record activity; or report their location.

Data collected by things is typically sent to a central platform, often called an IoT Platform. An IoT Platform can store data, facilitate analysis using data science, manage IoT devices, apply machine learning, connect with other business systems, provide user security and visualise data.

The requirements of IoT platforms depend on the needs of individual businesses and use cases. In 2017, IoT Analytics produced a commercial report[11] claiming there were over 450 IoT platform companies. Interaction with the IoT industry indicates that there are many enterprises that are building their own in-house IoT Platform.

[11] https://iot-analytics.com/product/list-of-450-iot-platform-companies/

The disparate nature of IoT and its application across sectors such as health and aged care, transport, mining and agriculture has created a proliferation of new terms and concepts.

HOW PRODUCTS BECOME CONNECTED?

One particular area that is central to the IoT is connectivity. There are many different types of connectivity technologies available, as shown below.

IoT Connectivity	
WIRELINE	eg. Ethernet, Modbus, powerline, etc.
WPAN	Wireless Personal Area Network – Bluetooth (BLE), 6LoWPAN, RFID, NFC, Z-Wave, ZigBee, wireless USB,
WLAN	Wireless Local Area Network – WiFi, DECT, WirePas
LPWAN	Low Power Wide Area Network technologies such as Sigfox, LoRaWAN, Cat-M1, Cat-NB1, Weightless-P, WiSUN, 5G
WWAN	Wireless Wide Area Network – GPRS, 3G, 4G, LTE, CAT-1, 5G,
LPGAN	Low Power Global Area Network technologies refer to nano-satellites in low earth orbit. Examples includes satellites from Fleet Space Technology, Myriota, Hiber

Figure 2 Different types of IoT connectivity technologies

All IoT devices require some form of connectivity. Figure 228 represents the different choices for connectivity, and this can be confusing for IoT product developers if they are not aware of the differences.

In the consumer segment, most IoT products come with Wi-Fi connectivity by default. In other words, Wi-Fi is the most common wireless connectivity in this segment.

The connectivity capability of an IoT device is achieved through a piece of hardware, known as an IoT module. An IoT module can be designed to support one technology, such as WiFi, or Bluetooth, however, most IoT modules are designed to support multiple wireless technologies.

WIRELINE

Wireline connectivity requires a physical connection, usually with a cable from the IoT device to a gateway to the cloud, or the internet. In the home environment, this is mostly done through an Ethernet cable. In enterprise or industrial IoT applications, there are other types of cable such as Modbus, and or achieve through the use of existing power lines.

WPAN

The Wireless Personal Area Network refers to short range radio technologies that are suitable for short distance applications. Some common uses of WPAN include

proximity cards found in offices, Bluetooth speakers that works with a smart phone, smart phone use to pay for groceries at checkout terminals.

Many IoT consumer goods use the WPAN technologies such as Bluetooth trackers.

WLAN

Wireless Local Area Network is often associated with the most ubiquitous Wi-Fi that we all have at home and in the office.

Just about every consumer product now come with Wi-Fi support. Your smart phone, Hi-Fi systems, computers and laptops, Google Home, Amazon's Echo Dot, Apple TV, are to name a few common items.

Many IoT consumer products are designed with Wi-Fi capability.

LPWAN

These Low Power Wide Area Network technologies have recently emerged as the go to connectivity for industrial IoT applications. The technologies in this LPWAN category include SigFox, LoRaWAN, NB-IoT, Cat-M1, Weightless and WiSUN, to name a few.

As the name suggests, LPWAN can cover large geographical areas, and have been deployed for applications such as smart cities, water utilities, smart buildings and agriculture.

The network operators in this space are SigFox, NNNCo, Meshed, GeoWAN and Blue IoT. Telstra and Vodafone also provide NB-IoT and Cat-M1 network (Telstra only to date).

WWAN

The Wireless Wide Area Network category usually refers to public mobile networks, ie. 3G, 4G (LTE) and the upcoming 5G. These networks cover vast geographical areas, but usually expressed in terms of percentage of population coverage. For example, Telstra claims to have provided up to 98% of population areas.

Operators in this space are Telstra, Optus and Vodafone.

LPGAN

Low Power Global Area Network refers to the global coverage of a new class of satellite, the Low Earth Orbit, LEO satellites. These LEO satellites are very small, known as Nano-Sat, and are designed to be used either as an access network or backhaul network, with very small payload capability.

As these LPGAN networks have only recently launched, their constellation of satellites is still low in number, meaning they could only provide connectivity for a short window of time during any 24 hour period.

Examples of companies in this space are Fleet Space Technology[12] in Adelaide, Myriota[13] also from Adelaide, and Hiber[14] from the Netherlands.

IOT PLATFORM AND SOFTWARE

The key feature of IoT products is their ability to sense/measure/collect data, and then sends it to a server, commonly known as IoT Platform[15]. The function of an IoT Platform can vary depending on the different type of IoT use cases, but in general, it performs three sets of functions.

- IoT device connection, security and configuration management
- Data storage, and analysis including using advance algorithms such as artificial intelligence, machine learning or deep learning.
- Application enablement, which could be simply viewed as how IoT devices are linked to applications. This could include anything from the ability to view your IoT solution through to performing firmware updates

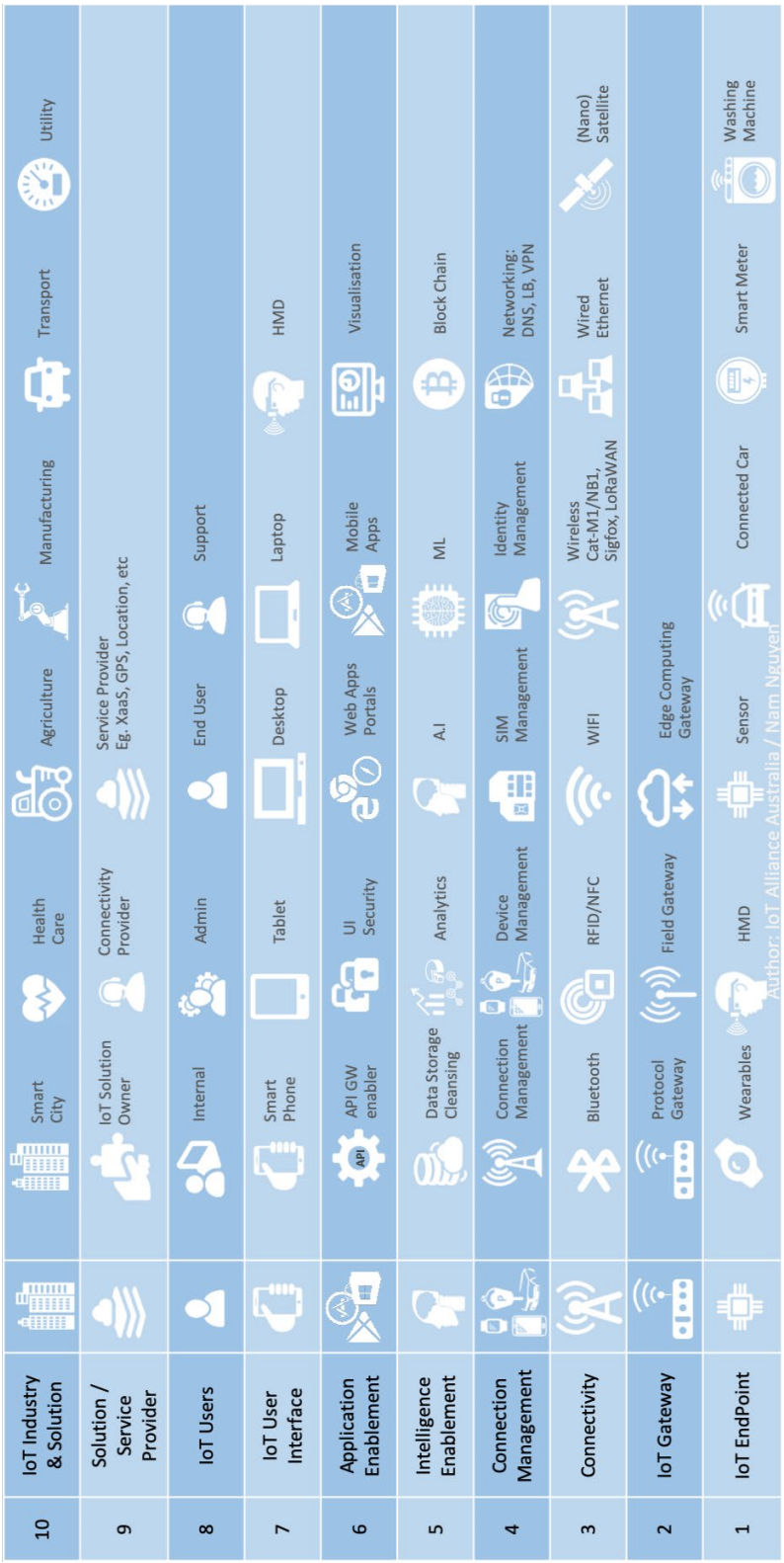
[12] www.fleet.space

[13] www.myriota.com

[14] www.hiber.global

[15] IoT Platform is denoted in the IoT Reference Framework as layer 4 – Connection Management, layer 5 – Intelligence Enablement, and layer 6 – Application Enablement.

IoT REFERENCE FRAMEWORK



Visit the IoTAA website for explanatory documents. www.iot.org.au/resources

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ABOUT IoT Alliance Australia (IoTAA)

IoTAA is the peak industry body representing IoT in Australia. Over 500 participating organisations and 1000 individual participants are working to accelerate the adoption of IoT across the Australian economy and society.

IoTAA's purpose is creating and developing sectoral IoT advancement and alignment with key sectors, including through Government Industry Growth Centre activities, Infrastructure Australia, state governments and key sectoral bodies with an initial focus on water and energy resource management, food and agribusiness, transport and smart cities.

IoTAA's Terms of Reference

- Providing an IoT strategy and policy recommendations with focus sectors to align with government and industry priority areas.
- Engage and collaborate with key stakeholders including major sector aligned growth centres, industry associations, major government influencers
- Align IoT solutions to meet the needs of industry and consumers
- Create more IoT awareness, engagement and education for consumers, markets and governments.
- Apply the learnings of global best practice sector initiatives such as the US Smart Cities IoT initiative.

IoTAA's work-program spans 12 workstreams which focus on industry vertical sectors and key IoT enablers. They are:

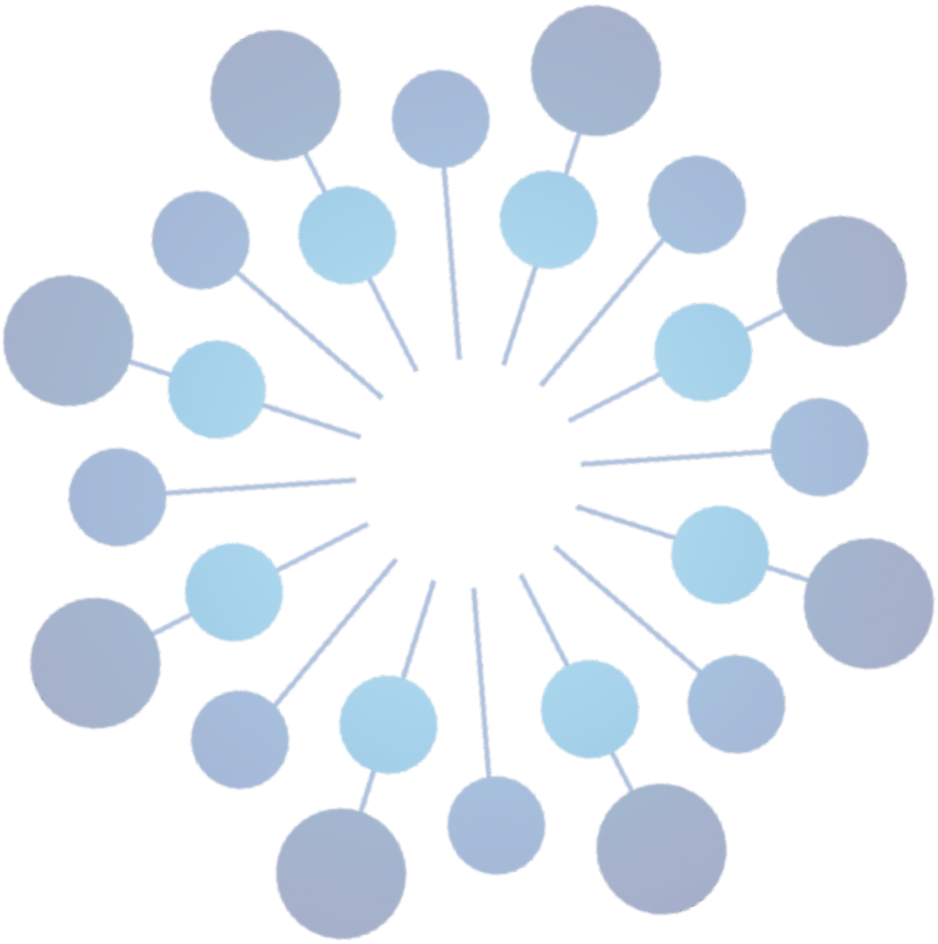
Sectoral Focus

1. Smart Cities
2. Food and Agribusiness
3. Water
4. Energy
5. Transport
6. Manufacturing
7. Health

IoT Enablers

1. Collaboration
2. Data Use, Availability and Privacy
3. Cyber security and Network Resilience
4. Platforms and Interoperability
5. IoT Start-ups

IoTAA Contribution

IoT Alliance Australia

http://www.iot.org.au/