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The potential of new technologies to disrupt housing policy

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Related reports and documents

Pettit, C., Liu, E., Rennie, E., Goldenfein, J., Glackin, S. (2018) *Understanding the disruptive technology ecosystem in Australian urban and housing contexts: a roadmap*, AHURI Final Report No. 304, Australian Housing and Urban Research Institute Limited, Melbourne, https://www.ahuri.edu.au/research/final-reports/304, doi:10.18408/ahuri-7115101.

Crommelin, L., Troy, L., Martin, C. and Parkinson, S. (2018) *Technological disruption in private housing markets: the case of Airbnb*, AHURI Final Report No. 305, Australian Housing and Urban Research Institute Limited, Melbourne, https://www.ahuri.edu.au/research/final-reports/305, doi:10.18408/ahuri-7115201.

Sharam, A., Byford, M., Karabay, B., McNelis, S. and Burke, T. (2018) *Matching markets in housing and housing assistance*, AHURI Final Report No. 307, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/307, doi:10.18408/ahuri-5315301.

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Acronyms and abbreviations used in this report

AHURI	Australian Housing and Urban Research Institute Limited
APM	Australian Property Monitor
AURIN	Australian Urban Research and Infrastructure Network
CBL	Choice-Based Letting
CHPs	Community Housing Providers
DTA	Digital Transformation Agency
GIS	Geographical Information Systems
ICT	Information Communications Technology
LTR	Long-term rental
NDIS	National Disability Insurance Scheme
NFPs	Not-for-profits
OSM	Open Street Map
PRS	Private Rental Sector
REITS	Real Estate Investment Trusts
STL	Short-term letting

Glossary

A list of definitions for terms commonly used by AHURI is available on the AHURI website www.ahuri.edu.au/research/glossary.

Executive summary

Key points

- The research identified four main fields of technological advancement that are likely to disrupt the housing sector in future, or are already doing so: matching markets; big data; GIS mapping software; and blockchain.
- Technological change presents real opportunities for the housing sector, including more efficient allocation of housing stock, more accurate and transparent property management systems, and better informed planning and development processes.
- At the same time, however, the most advanced technological disruption to date in the housing space—the matching market Airbnb—highlights the ways in which responding to and regulating disruptive technologies presents new challenges for governments and is challenging for governments.
- Key challenges include the protection of privacy, the need to ensure transparency in increasingly complex technological systems, the cost and access risks associated with the commercialisation of significant technological systems, and the potential for disruption in one housing market to cause negative spillover effects in other parts of the housing sector.
- In responding to future technological disruptions, governments need more agile and critical policy making approaches to allow effective short-term responses to digital disruptions, as well as strategies for implementing longer-term cultural change and systems upgrades. The report identifies 10 key principles and strategies as a starting point for developing this new policy making 'playbook'.

The emergence of new digital and disruptive technologies has meant that housing policy makers and practitioners now find themselves facing new opportunities and challenges. Governments, non-profit organisations and businesses are all grappling with the complex and fast-moving impacts of technology-enabled change. This Inquiry examined these disruptive digital technologies, investigating their potential for reshaping housing markets and reconfiguring housing policy. It provides housing policy makers and practitioners with a nuanced understanding of how technology is already restructuring housing markets and affecting housing assistance programs, as well as insights into likely future developments. This has important implications for ensuring that the provision of housing and housing assistance is as efficient and equitable as possible.

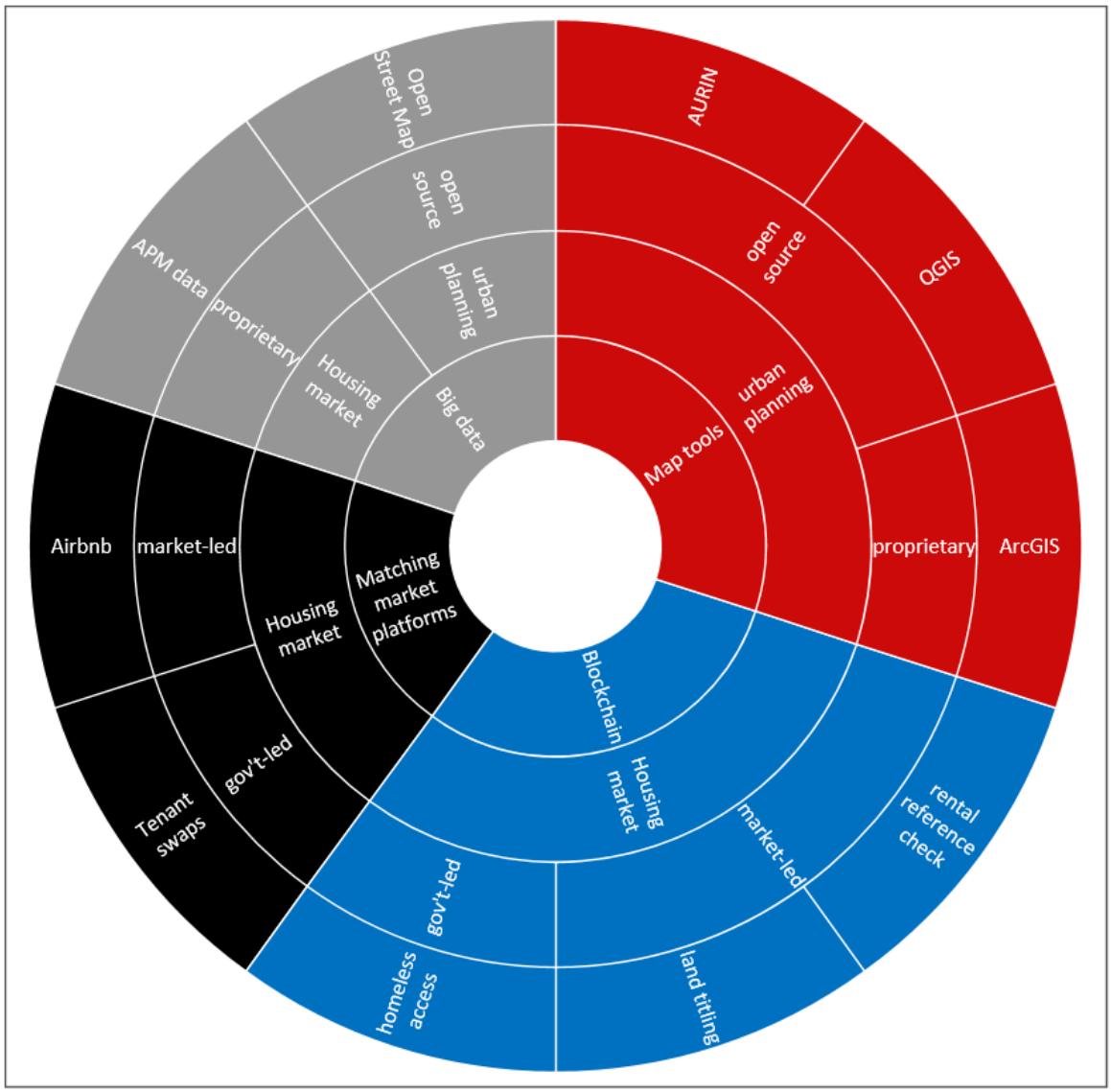
The Inquiry responds to current and emerging digital and disruptive technologies by examining the way in which they are reshaping housing markets and assistance, consumer opportunities and service provision. 'Disruptive technologies' were defined by Christensen (1997) as innovations that disrupt or redefine performance trajectories and consistently cause the failure of an industry's leading players. Today, the terminology of 'disruption' is used more generally to describe situations where technology drives significant changes to existing practices, whether that of an industry, a market or a regulatory structure.

The focus of this final Inquiry report is to identify options for governments to be ready to respond to future disruptions, and proactively embrace technology to develop policies that promote better market outcomes and deliver more efficient and effective housing assistance.

Key findings

Disruptive digital technologies are best seen as part of an ecosystem, as shown in Figure 1 below. While this diagram necessarily oversimplifies the drivers and impacts of technological change, it nonetheless helps to highlight some shared trends amidst the seemingly chaotic landscape of fast-moving technological disruption.

Figure 1: The disruption ecosystem



Source: Authors.

The research identified four main fields of technological advancement likely to disrupt the housing sector in the near term: matching markets; big data; GIS mapping software; and blockchain (shown in the inner circle in Figure 1). These emerging technological changes present both opportunities and challenges for housing policy makers and the sector, across the different contexts shown in the middle rings of Figure 1. The most significant opportunities are:

- improved efficiency in matching markets in housing through the use of digital platforms, including swaps and transfers within social housing, an inventory of accessible housing for sale or rental, and allocation of affordable market rentals for lower income households
- improved market-led development processes, including more supply of new apartments specifically designed for owner-occupation by low- to middle-income households, and land reaggregation for precinct-level urban redevelopment and the renewal of 'greyfield' suburbs
- more accurate and efficient processes for property-related transactions, including property rights registers and management of private rental properties, through the use of the blockchain automated ledger system, and
- more powerful analytics to support better informed urban planning, underpinned by big data and locational intelligence tools.

However, the case study of the most advanced technological disruption to date in the housing space—the matching market Airbnb—highlights how responding to disruptive technologies has often proven difficult for government. The Inquiry research identified multiple ways in which disruptive technologies present significant, and in some cases novel, challenges for government. These include:

- **Spillover effects:** As the Airbnb example shows, disruption in one market (visitor accommodation) can have damaging spillover effects in other markets (long-term housing), highlighting the need for regulators to recognise and be ready to respond to the systemic impacts of technological change.
- **Privacy:** the responsibility to protect the privacy of citizens is a growing challenge given increasing aggregation of big datasets, and the trend towards making data open access.
- **Commercialisation:** The computing power and technical expertise required to develop these new technologies has meant that they have largely been private sector products (albeit with some notable exceptions emerging from university and non-profit collaborations). This commercialisation puts government and non-profits at risk of losing access to essential programs or datasets, or of being charged significant licensing costs.
- **Complexity:** in an increasingly data-driven world, an organisation is 'only as good as its data', meaning the need to ensure data accuracy is intensifying, just as the complexity in the systems needed to collect and manage this data is increasing.
- **Transparency:** contrary to popular assumptions that data-driven systems are 'objective', there are real risks of implicit bias being built into technological decision-making processes. This puts an onus on government to ensure transparency in its data and systems, which can be undermined by the growing commercialisation and complexity of key technologies.

Addressing these challenges will require significant financial investment and cultural change across the housing sector, but particularly within government. Such change inevitably takes time. Unfortunately, however, the luxury of time is in short supply in the context of fast-moving technological change. This means that governments need advice on how to respond effectively to disruptions in the short term, while also making the broader structural changes needed to enable them to harness new technologies and capitalise on the opportunities they offer.

Policy development options

The Inquiry has identified a number of strategies and priorities to help housing policy makers grapple with these challenges, including guidance on:

- more agile and critical policy responses to technological disruptions like Airbnb

- the importance of integrated and well-resourced data assets and infrastructure
- the changes needed to update data and privacy protection policies
- the policy frameworks required to ensure transparency of digital systems
- the key requirements for upskilling of policy makers and regulators
- strategies to manage relationships with corporate technology providers, and
- options for regulating to prevent market-based discrimination.

While government is unlikely to be well placed to pre-empt technological change, it can develop key principles and strategies—a technological change response 'playbook', if you like—on how to respond more proactively and productively to future disruptions. Such a playbook would include:

- key principles that should underpin responses to new technologies (e.g. privacy, access)
- steps to manage the early phases of the response to a disruptive technological change, before the impact is entirely clear
- an outline of the pros and cons of different regulatory responses for the medium-term, and
- steps for moving towards a more responsive organisational culture in the longer term.

While the details of this playbook would necessarily vary between departments and agencies, this report identifies 10 helpful key principles as a starting point (see Chapter 4).

The study

This research is part of a wider AHURI Inquiry into the potential for new technologies to disrupt housing policy. The overall question guiding this Inquiry was:

> *How could Australia's housing policy and assistance settings be reformed to achieve more efficient and equitable outcomes in the light of evidence on housing system impacts of first-wave change, current developments and future possibilities for digital and disruptive technologies?*

The Inquiry research program was designed to equip housing policy makers, providers and consumers to engage productively with emerging digital and disruptive technologies. The Inquiry was informed by three research projects which provide a past, present and future perspective on technically-enabled change and housing and housing assistance. The first wave impacts of technological disruption are identified through the research project examining Airbnb (Crommelin, Troy et al. 2018b). The project mapping out the present landscape of new and emerging technologies outlines the likely impact of these technologies on housing markets and assistance (Pettit, Liu et al. 2018). And looking to the future, the research on matching markets leverages off the experience of change and identifies five opportunities and one risk (Sharam, Byford et al. 2018).

The question of how best to manage technological disruption remains firmly on the policy agenda at all levels of government (e.g. Australian Government 2018; Productivity Commission 2016, 2017; NSW Government 2015; City of Sydney 2016). As the Productivity Commission (2016: 1) has noted: 'digital technologies offer opportunities for higher productivity growth and improvements in living standards. But they also pose risks of higher inequality and dislocation of labour and capital'. Public criticism of state governments' efforts to regulate short-term letting is now likely to bring the risks of inadequate policy responses to digital disruptions into even sharper relief. The focus of this report is to identify options for governments to be more

proactive in responding to future disruptions in the Australian housing system, while ensuring that the necessary protections are in place.

1 Introduction

- Key issues defining the Australian housing market at present include declining home ownership, longer if not permanent tenure in private rental housing, the residualisation of the social housing system, the invisibility of market accessible housing, the challenges of sustainable urban renewal, and the lack of private owner-occupation take-up of new apartments.
- While these issues may seem a long way from the world of digital disruption, the example of Airbnb demonstrates how technological interventions can facilitate rapid restructuring of markets, with both good and bad results.
- Meanwhile, some areas of housing provision, such as social housing are quarantined from the technological innovation that has fuelled the transformation of many markets.
- A lack of knowledge about technological innovation and risk aversion may preclude the development and uptake of new forms of technology-enabled housing assistance. One reason for this may be uncertainty, reflecting the relative dearth of research on impacts of disruptive technology on housing markets and housing provision.
- This Inquiry has addressed this issue through a three-pronged research approach, examining existing disruptions (Airbnb), identifying significant technological developments (such as big data and blockchain) that are likely to reshape the housing sector in the near future, and unpacking the business models that underpin many of the new disruptions (matching market platforms).

1.1 Why this research was conducted

The dramatic growth of first-wave disruptive technology applications such as Airbnb (an online short-term letting platform) has fuelled significant public interest in how disruptive technologies are reshaping opportunity for housing market participants (e.g. Said 2015; Coldwell 2016; Ting 2016). Concerns about the impact of technology-enabled disruption now extend well beyond the private sector, however, with the prospect of fundamental technology-led change now receiving serious consideration in the government and non-profit sectors as well. Indeed, the question of how best to manage technological disruption is now on the policy agenda at all levels of government (e.g. Productivity Commission 2016; NSW Government 2015; City of Sydney 2016).

There remains much confusion, however, around what 'disruption' involves (Gans 2016), and how such 'technology-enabled' change can be harnessed to ensure positive outcomes for both providers and consumers. Recognising this uncertainty, the Productivity Commission tackled the question of disruptive technologies, and offered the following helpful definition (2016; 15):

> *A general and more policy-relevant characterisation of disruptive technologies is that they are developments that drive substantial change across the economy for many firms, households or workers, with impacts that impose significant costs of adjustment*

as they make capital obsolete and leave some workers significantly underutilised for some time. In other words, 'big, sometimes fast and always unruly'.

The Productivity Commission report (2016:19) identifies a number of features of new digital technologies that make them particularly adept at creating this kind of disruption, as they:

- reduce information asymmetries and transaction costs (including information transmission)
- enable 'almost boundless' data collection and processing
- facilitate 'the increasing automation of tasks and the replacement of workers', and
- allow much easier marketisation of household assets, including labour.

And as the Commission also noted (2016: 1), 'digital technologies offer opportunities for higher productivity growth and improvements in living standards. But they also pose risks of higher inequality and dislocation of labour and capital'.

It is clear that disruptive technologies have the potential to significantly disrupt the housing sector, as Airbnb has already demonstrated. To date, however, there has been little research evidence available to help housing policy makers and providers assess the risks and opportunities posed by digital disruption for the Australian housing system. Likewise, there is little guidance available on how technology-enabled change can be harnessed to produce more equitable and efficient outcomes in housing provision and assistance. This Inquiry helps to address this gap, by examining three key research questions:

- Which technologies are disrupting housing markets and assistance or are likely to in coming years?
- What are the most pressing risks and most likely rewards of technological disruption for the housing sector—housing providers, consumers and others?
- How should housing policy makers and practitioners respond to and embrace disruptive technologies efficiently and equitably?

To address these questions, this report brings together the findings from three related research reports (Pettit, Liu et al. 2018; Crommelin, Troy et al. 2018b; Sharam, Byford et al. 2018), as well as input from housing and technology policy makers and professionals. The findings are of broad relevance, given the potential for disruptive technologies to improve housing opportunity both in urban areas and across regional and rural Australia, including Indigenous communities (Rennie, Hogan et al. 2016).

1.2 Policy context

This Inquiry sits at the intersection of two policy areas, technology and housing, both of which are undergoing significant transformation. While there is currently little policy guidance available for those operating at this intersection, this section provides a brief overview of the broader policy context and current directions in these two areas.

Technology policy: governments grapple with rapid change

Recent years have seen the challenges of digital disruption become a topic of significant interest for governments around the world (KPMG 2017). In the Australian context, the Productivity Commission has taken a leading role in examining the challenges and opportunities associated with disruptive technologies (2016) and the way data is produced and used (2017). As the Commission notes, governments have begun taking some important steps towards adapting to and harnessing technological change (2016: 129):

> *While Australian governments are lagging households (but on a par with the private sector businesses) in their low rates of adoption of new technologies, there is little evidence that they are passive in adopting digital technologies. Nor is there much in the literature to suggest that bureaucracies are inherently lacking in innovation or opposed to change… Australian governments (particularly at the subnational level) have already made increasing use of digital technologies in on-the-ground service delivery—sometimes in novel ways. Exemplars [include] the release of data for private development of apps, and the use of drones and sensor technology in managing infrastructure…This counters claims that Australian governments are doing little, but does not rule out the possibility that they are not doing enough.*

A key step by the Commonwealth Government has been the creation in 2015 of the Digital Transformation Agency (DTA) (https://www.dta.gov.au/). The DTA was set up to assist government departments and agencies to undergo digital transformation, offering advice on building digital capability, procurement, identity and platforms. In 2016 the DTA launched the Digital Market Place (https://www.dta.gov.au/what-we-do/platforms/marketplace/) to connect smaller business with government in the Information Communications Technology (ICT) area. However, there are not currently any specific housing-related digital services offered by the DTA.

Meanwhile, other Australian jurisdictions and government agencies have also produced policies or strategies setting out key aims and principles for grappling with new technology. This includes policies examining the impacts of digital disruption and transformation broadly (e.g. Queensland Government 2017; NSW Government 2015, 2017; South Australian Government and Deloitte Touche Tohmatsu 2014; Victorian Government 2016), as well as more targeted areas like data analytics and privacy (OAIC 2018); smart cities (Australian Government 2016); and cyber security (Australian Government 2016). To date, however, this policy interest in digital disruption has yet to focus in on how digital disruption may reshape the housing system, and the opportunities and challenges for housing policy makers and practitioners.

Housing policy: opportunity becomes increasingly siloed

Meanwhile, as digital transformation becomes an area of increasing policy focus, the Australian housing system is also changing. The idea that housing tenure changes in accordance with life stages is being challenged by a decline in home ownership, and the growth of insecure private rental as a long-term tenure of necessity for many and choice for a few (Hulse, Pawson et al. 2018). Social housing is highly residualised, but despite its problems it provides security of tenure for residents. While some households lack the financial means to change their housing position, others lack opportunity, and others still have no motive to change. Together these factors reinforce the increasingly siloed nature of housing tenure in Australia.

Home ownership remains the norm in Australia, with over 60 per cent of households purchasing or owning their housing outright, but the rate of home ownership has declined slowly but steadily over the past 20 years. The decline is primarily associated with newly forming households, which tend to be younger (Daley, Coates et al. 2017; Stone, Burke et al. 2013). Increasingly, the achievement of home ownership is undermined by housing price inflation, which requires a higher deposit and greater proportion of household income to service mortgage repayments (CoreLogic 2016).This means more households living in private rental housing for longer, with a third of renters now considered long-term, being more than 10 years (Stone, Burke et al. 2013).

Many low to moderate-income households now lack the means to achieve home ownership, but also face increased competition within the private rental sector (PRS) from higher income households, who spend longer periods in private rental in order to save a deposit for home purchase. The result is a reduction in the overall availability of affordable private rental stock for

low to moderate-income households not only due to *absolute supply shortages*, but also *availability shortages* (Hulse, Reynolds et al. 2015). A consequence is that many lower income households in the PRS are in housing stress (defined as paying more than 30% of their gross household income on rent). While homelessness has many causes, poverty and lack of affordable housing are implicated in the homelessness of an estimated 116,000 people on any given night in Australia (ABS 2018).

Faced with the precarity of private rental in Australia (Hulse and Saugeres 2008), those households in the lower two quintiles of income distribution also lack the opportunity to access social housing due to the dwindling number of units available (now less than 5% of housing nationally), and tight rationing of stock to those with high, multiple needs (Groenhart and Burke 2014). For those who are able to access social housing, their ability to choose the housing allocated to them is very limited. The price of obtaining social housing and thus housing security is thus being bound to a specific house and location, with little prospect of moving. Nonetheless, those living in social housing lack the motive to exit social housing into private rental because of the insecurity of tenure (Wiesel, Pawson et al. 2014) as well as the inability to pay (higher) market rents.

Meanwhile, the type of housing we live in is also changing. In 2016, one in five households lived in an apartment, compared with one in seven in 1991 (ABS 2017a). Apartment living is most associated with private rental, with a third of rental households living in higher density housing. A quarter of social housing tenants live in higher density housing (this rises to 40% in our major cities). Home owners, however, have not embraced higher density living; only 6 per cent of owner-occupied housing is in higher-density developments, in part due to the limited availability of good quality higher density housing in desirable locations. Meanwhile, the new apartment product created for investors is often highly generic, and of poor quality and design (Government of Victoria 2015). In short, most apartments are not a good value proposition for an owner-occupier (despite being cheaper than detached houses), and are concentrated in particular areas. For investors, however, rental income, capital gains and tax benefits make apartments appealing, fueling a market reliance on speculatively developed apartment product. The reluctance of owner-occupiers to embrace this product has implications for community support for urban consolidation policies (Randolph 2006; Woodcock, Dovey et al. 2011).

While the suburban backyard is highly valued at a cultural level, in many inner and middle ring suburbs it is rapidly disappearing. The renewal of these ageing suburbs presents the opportunity for urban intensification that also promotes environmental sustainability. However, the opportunity is being lost: these areas are undergoing significant but piecemeal intensification despite planning regulations intended to prevent ‘over-development’. Furthermore, development is often inadequately integrated with good transport and service access, community facilities and private and public open space (Bunker, Crommelin et al. 2017).

Shifting focus from housing supply to demand, estimates show an unmet need for affordable, accessible housing for 80,000–120,000 National Disability Insurance Scheme (NDIS) participants. With ageing a key driver of disability, our ageing population increases the need for more accessible housing and for modifications to existing housing. On the supply side, however, it remains impossible to estimate how many homes have accessibility features, due to the lack of a centralised data repository (Bridge 2005). At the same time, people with a disability are among the poorest in the community, as they are less likely to participate in the paid labour force (53.4% compared with 83.2%) (ABS 2015). This exacerbates the housing affordability pressures, and leads to people with a disability being over-represented among the homeless (Beer and Faulkner 2009).

Where housing and digital disruption intersects

The world of digital disruption may seem a long way from these well-established housing system issues of declining home ownership, longer tenure in private rental housing, the residualisation of the social housing system, the invisibility of private accessible housing, the challenges of sustainable urban renewal, and the speculative nature of new apartment development. Yet, as we have seen with Airbnb, technological interventions can facilitate rapid restructuring of markets, with both good and bad results. Similarly, online platforms like Juwai.com have facilitated foreign investment in Australian housing, which is also often publicly viewed as a contributor to housing price inflation (Rogers, Lee et al. 2015).

Governments have also taken some steps towards offering digital access to housing services, For example, Queensland's Digital1st strategy outlines the launch of the Housing Assist App (https://www.qld.gov.au/housing/renting/rent-assistance/housing-assist-qld-app). The App provides a digital portal for users to connect with services to assist with a Bond Loan or Rental Grant, a pathway for applying for the National Rental Affordability Scheme, and access to the Queensland Statewide Tenant Advice and Referral Service (QSTARS). Similarly, NSW Family and Community Services have developed an online portal known as Myhousing, which provides digital access to housing assistance services (https://www.facs.nsw.gov.au/myhousing). Data issues are also in the frame, with the need to optimise and share housing-related data raised by the Productivity Commission (2017). The Commission proposed that data on housing commencement, housing activity and affordability and social housing be included in accessible 'National Interest Datasets', to be managed as national assets (see Pettit, Liu et al. 2018 for further discussion).

In other respects, however, areas like social housing provision remain largely quarantined from the technological innovation that has fuelled the recent transformation of other markets. While there are many impediments to the adoption of new digital technologies in housing assistance, the challenges may be compounded by an understandable aversion to risk in an area long characterised by funding limitations. Evidence-based research has the potential to help to reduce the risks associated with adopting new digital strategies in housing provision and assistance. There is currently limited existing research on the specific implications of digital disruption for the housing sector, however, as the next section outlines.

1.3 Existing research

'Disruptive technologies' were defined by Christensen (1997) as innovations that redefine performance trajectories and prompt the failure of an industry's leading firms. Christensen's terminology has proven influential, and is now used more generally to refer to situations where technology disrupts existing practices, whether in an industry, organisation or market. In more practical terms, the broader concept of 'digital disruption' now refers to the combined impact of: more powerful computer chips; the Internet; the World Wide Web; broadband communications; programming and operating systems; and the cloud (Evans and Schmalensee 2016). Yet while there is a burgeoning body of literature discussing 'digital disruption' generally (e.g. Dawes 2009; Kenney, Rouvinen et al. 2015; Gans 2016), the literature on how new technologies are reshaping housing systems remains patchy.

One area that is receiving growing research attention is the impact of new platform-based matching markets, particularly short-term letting (STL) platforms like Airbnb. The research interest in STL covers a number of issues, including:

- the impact on housing supply and affordability (e.g. Wachsmuth, Kerrigan et al. 2017; Gurran and Phibbs 2017; Crommelin, Troy et al. 2018a)
- the amenity impacts on neighbours and neighbourhoods (e.g. Robertson 2016), and

- the impact on existing short-term accommodation providers like hotels and serviced apartments (e.g. Kaplan and Nadler 2015).

Beyond these assessments of impact, academics have also begun considering how policy makers and housing sector participants should respond to developments like Airbnb, examining various regulatory approaches (see Leshinsky and Schatz 2018 for an overview). These include full legalisation (Guttentag 2015), a focus on limiting noise and loss of amenity (Minifie 2016), or a model of transferable sharing rights using algorithms and rental data from STL platforms (Miller 2016). By contrast, planning and housing scholars have argued that with some revisions, existing zoning and residential development controls can minimise the negative impacts of STL (Gurran and Phibbs 2017), and even be used to impose limited or complete bans on STL in some circumstances (Lee 2016). As well as these conceptual debates, academics are also grappling with the challenges of STL enforcement. As cities worldwide have discovered, new regulations have limited benefits if enforcement is left to city authorities with tight budgets and limited data access (Leshinsky and Schatz 2018; on the unavailability of good data see Cox and Slee 2016).

While much of the research focus has been on STL platforms, some new research examines other emerging technologies with the potential to benefit households in accessing appropriate housing and related services in the private rental sector. Hulse, Martin et al. (2018) identify the growing use of digital technologies to advertise properties, take applications and make/accept offers of accommodation. For example, online property rental and sales portals realestate.com.au (REA) and domain.com.au (Domain), plus more specialised sites like rent.com.au (RNT) and flatmates.com.au, have largely supplanted print media advertising. These provide greater exposure for landlords/agents wanting to let properties, and more information (e.g. floor plans and neighbourhood attributes) for prospective renters (Hulse, Martin et al. 2018).This research also identifies digital technology platforms to streamline tenancy application processes (such as 1Form https://1form.com/), to organise property search and booking initial inspections (such as InspectRealEstate and Open for Inspection), and to redesign bond products like bond loans and alternative bond products (such as TrustBond and BondCover) (Hulse, Martin et al. 2018). This research also identified risks to consumers associated with the collection, aggregation and sharing of detailed consumer data, including privacy concerns, the exclusion of applicants on the basis of derived ratings, and the shift towards encouraging aspirant renters to bid against each other through applications such as Rentberry (see also Small 2017 on these risks). Other recent research has also highlighted the particular risks facing lower income households who are often reliant on social media and other informal digital channels for finding accommodation (Parkinson, James et al. 2018).

Beyond these examples of housing-specific research, there is also a body of work that highlights the indirect risks to housing security flowing from digital disruption. In particular, new technologies are driving the increasing casualisation of the labour force and the creation of what is known as the ‘gig’ economy, where individuals work on short-term engagements on a per-transaction basis (Allen 2015). Airtasker, Uber and Deliveroo are notable examples reshaping trades, transport and food industries. Tamvakologos and Cavanough (2016) and Warren (2016) make the important point that this move towards the gig economy creates an unstable workforce that has particularly detrimental impacts on vulnerable workers. Specifically, gig workers are often not protected by traditional labour regulations as they are engaged as franchisees or individual (sub)contractors, and generally work without protections such as paid leave, superannuation and compensation schemes. So while the added flexibility of gig economy work can be appealing, this work also creates significant uncertainty and insecurity (Aloisi 2016). This can impact vulnerable workers’ ability to keep up with housing and living costs and can potentially be prohibitive to accessing financial mechanisms such as home loans. While some platforms have addressed some of these issues (such as by providing discounted health insurance), significant concerns remain (see Dosen and Graham 2018). In the gig

economy, then, we see the potential for disruptive technology to have a broadly destabilising impact on current social and economic structures, with flow-on effects for housing markets.

While these areas of research focusing on the relationship between housing and digital disruption offer some valuable insights, the scope for new technologies to reshape the Australian housing system is far broader. This Inquiry examines this potential impact, identifying other areas of technological change that have the capacity to significantly reshape the housing system. The next section outlines the methods used for this examination (including a further literature review, reaching beyond the immediate housing/technology intersection discussed here).

1.4 Research methods

Three key research questions guided the research activities conducted under this Inquiry. They are:

- Which technologies are disrupting housing markets and assistance or are likely to in coming years?
- What are the most pressing risks and most likely rewards of technological disruption for the housing sector—housing providers, consumers and others?
- How should housing policy makers and practitioners respond to and engage with disruptive technologies efficiently and equitably?

Each of these three questions has now been investigated via a separate strand of the research program.

Research Question 1 has been addressed through a succinct review of the current state of play in the disruptive technology 'ecosystem', and an assessment of the relevance of emerging technologies to housing policy makers, providers and consumers. It involved an assessment of policy risks associated with current and likely future emerging technologies, and their potential impact on housing markets and assistance. This strand of the research was led by Professor Chris Pettit at the University of New South Wales (UNSW).

Research Question 2 has been addressed through an examination of the first wave impact of unplanned and initially unregulated technological disruption on housing opportunity in Australian private markets. This research strand has been led by Dr Laura Crommelin at UNSW. It involved a detailed examination of how short-term letting technology Airbnb has reshaped housing supply in Sydney and Melbourne, and the implications for private market participants. The findings provide an evidence-based contribution to the increasingly polarised debate over Airbnb's impact on housing markets, in which Airbnb is often held up as a proxy for all disruptive technologies.

Research Question 3 was a conceptual exploration of the future possibilities being created though technology-enabled market redesigns. Project C identified the technologies that provide the conditions required to reduce many long-standing frictions in markets, and applied understandings derived from two key economic concepts: market design, which is a process of creating rules and guiding market behaviour to create better market outcomes; and matching markets, the process of using market design to better match consumers and producers and/or policy design to market outcomes. The concepts are particularly relevant to sub-optimally functioning markets which, because of time lags, informational complexity, search costs etc., are not achieving their potential.

The findings from each strand has been synthesised in an AHURI Final Report (Pettit, Liu et al. 2018; Crommelin, Troy et al. 2018b; Sharam, Byford et al. 2018). All of these are available on-line via the AHURI website.[1]

Table 1 below outlines the methods used to address the three research questions in detail. Additional detail regarding these methods is available in the final report for each research strand (see Pettit, Liu et al. 2018: 12; Crommelin, Troy et al. 2018b: 8; Sharam, Byford et al. 2018: 13).

Table 1: Overview of research methods

Mapping the disruptive technology 'ecosystem'	
Method	**Details**
Literature review to identify and analyse key disruptive technologies.	Particular focus on how technologies can help to improve affordable housing supply; social housing stock management; social tenancy pathways; and data transparency.
Two **rapid co-design technology studios** for housing providers and policy makers to examine key technologies and assess pros/cons. The studios were designed to allow participants to engage with key technologies and test their potential to deliver efficiency gains and greater equity. Technologists were on hand to answer technical questions.	Conducted in September 2017 in Sydney and Melbourne, with 30 participants. Three case studies were used for the co-design technology studios: • infrastructure planning (including affordable housing) • social housing allocation and pathways, and • private market housing developments and legal information. Teams performed SWOT analysis of a case study, including feasibility/security concerns.
Assessing the impact of 'first wave' disruptive technology (Airbnb)	
Method	**Details**
Mapping Airbnb listings at small geographies (SA2), and comparison with census dwelling, demographic and rental affordability data **Network mapping** of multi-property hosts	AirDNA data sets mapped for Sydney and Melbourne (data current to end of March 2018) Mapping of rental bond data for Sydney and Melbourne (NSW data current to mid-2017; VIC data current to end of 2017) Mapping of 2016 census demographic data Multi-property hosts identified from AirDNA data—represented through dataviz

[1] Note also that some of the findings in this report reproduce selected material from these three reports directly.

Qualitative analysis of hosts' motivations and choices via an online survey, and in-depth host interviews	49 semi-structured interviews completed—29 with Sydney hosts and 20 with Melbourne hosts Online survey open 7 December 2017 to 31 May 2018—491 responses received
Review of policy responses from Australian and international jurisdictions Critical analysis of policy responses in the light of case study findings	Detailed analysis of policy responses for Sydney and Melbourne, plus 9 key overseas jurisdictions: • Amsterdam (The Netherlands) • Barcelona (Catalonia, Spain) • Berlin (Germany) • Hong Kong (Hong Kong SAR, China) • London (United Kingdom) • New York City (New York, United States) • Paris (France) • Phoenix (Arizona, United States) • San Francisco (California, United States)
Examining technology-enabled market design innovation	
Method	**Details**
Literature review to explain market design and related concepts	Literature covered includes market design and matching markets, and five case study areas: • swaps and transfers within social housing • accessible housing for sale/market rental • low cost private rental housing • the supply of new apartment for owner-occupation by modest to middle-income households, and • precinct level urban redevelopment.
Two **reiterative workshops** applied the lenses used by market designers to identify problems with current housing provision and assistance and constructed alternative market designs that would facilitate more effective outcomes.	Two workshops were held in Melbourne on 14 November 2017 and 19 February 2018. The workshops with the research team and policy makers and practitioners used a transdisciplinary method to approach the problem. Data collected informed the new market design propositions.

Source: Authors.

2 Findings: identifying the key technological changes in the housing sector

This chapter outlines the most significant technological changes identified by the research conducted for this Inquiry in regard to the provision of both market and non-market housing and housing assistance. The key technologies can be grouped into four main categories:

- matching market platforms, of which Airbnb is the most advanced housing example
- big data, open data and associated data infrastructure
- GIS-based tools, and
- blockchain.

This list is not definitive; indeed, there are other emerging disruptive technologies which have become increasingly prominent over the period that this Inquiry has been conducted, including artificial intelligence (machine learning) and sensor technology. However, the four categories above cover the key technologies that this Inquiry has identified as presenting a real and imminent likelihood of significantly reshaping the housing sector in the near term.

2.1 Matching market platforms

In the housing market, matching market platforms facilitating short-term letting (like Airbnb, Booking.com and HomeAway) are the most prominent technological disruption to date, with impacts which suggest the equitable distribution of private long-let market housing is under threat. However, matching market platforms for STL do in fact predate Airbnb (e.g. bed and breakfast brokerage services, and later Stayz). What the improved technology (and savvier marketing) provided by Airbnb has enabled is a vast expansion of the reach and popularity of these short-term letting matching markets. While this is a cause of concern with regard to private rental impacts, the improved performance of matching markets also offers significant opportunities in the housing sector, which are yet to be exploited.

2.1.1 What are matching market platforms?

Matching markets are markets in which agents (such as aspiring marriage partners) seek to be paired with someone or something, with the criteria for matching often highly specific and requiring reciprocity (Abdulkadiroglu 2013; Agarwal 2017). In this regard they are unlike commodity markets, where price plays the role of connecting buyers and sellers. The need to pair means in many matching markets finding a match can be very difficult and/or prohibitively expensive, with high search and transaction costs. For these reasons, many matching markets traditionally have not functioned well.

Thanks to new digital technologies, however, matching markets have been 'turbo-charged' (Evans and Schmalensee 2016), resulting in what Parker, Van Alstyne et al. (2016) describe as a 'platform revolution'.[2] A matching market platform is defined by Parker, Van Alstyne et al. (2016: 5) as:

[2] It is worth noting that the concept of a platform is itself a point of debate—for example, Gillespie (2010: 349) argues the meaning of 'platform' is subject to 'discursive positioning'. The least contested definition is *computational*, referring simply to the technical infrastructure involved.

> *a business based on enabling value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants.*

Intermediation via a platform involves *pulling* producers and consumers to the platform, *facilitating* interactions between them, and *matching* producers and consumers 'using information about each to connect them in ways they will find mutually rewarding' (Parker, Van Alstyne et al. 2016: 44). These platforms, or matchmakers, manage a *marketplace*.

The internet and associated technologies has proven a boon for matching market platforms. As the Productivity Commission (2016) notes, information asymmetries and transaction costs (including information transmission) have been reduced; and almost boundless data collection and processing enabled. This has fast made digital intermediaries and platforms ubiquitous, and some of the most transformative digital innovations to date. Uber, Paypal and Airbnb are the most high profile of the *entrepreneurial* matching market platforms, and each challenges a preexisting, lower-performing matching market platform (taxi companies, credit card providers and bed and breakfast brokerage services, respectively). Each is *entrepreneurial* because they compete in markets with other platforms. These are also examples of two-sided matching markets.

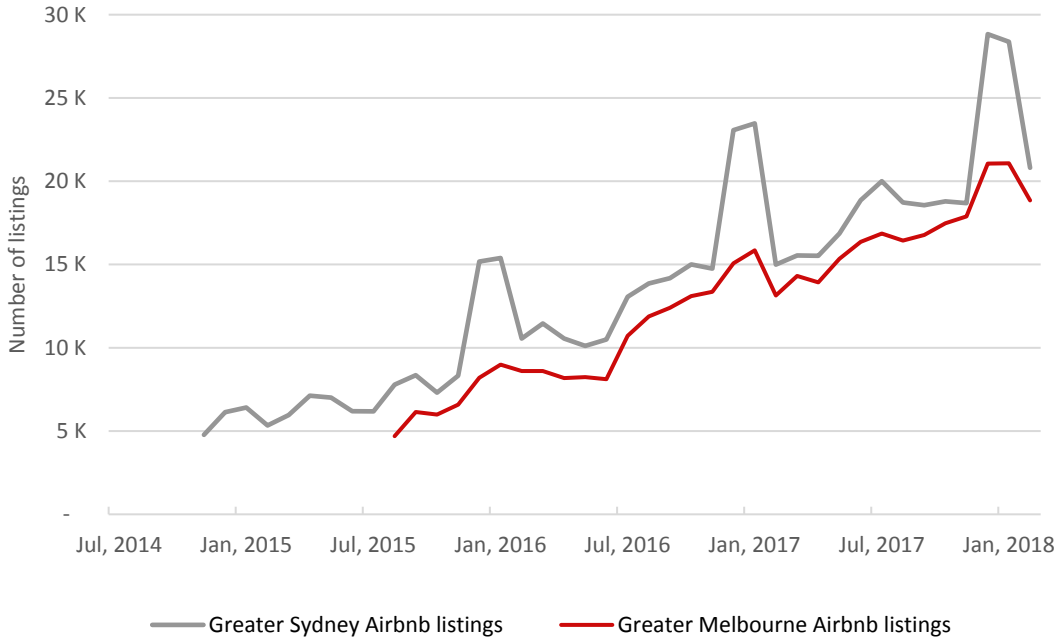
In one-sided matching markets, the market participants are all on the same side of the marketplace. Social housing allocations are one example, with tenants and the housing provider on the same side with the matching criteria determined by public policy. Some matching markets are not entrepreneurial. These are typically established by government or relevant authorities to facilitate matching in markets that are considered 'repugnant', that is, where monetary exchange is outlawed or socially unacceptable (Roth 2007). Kidney exchange is an example. In others, a single marketplace is considered efficient and can only be established by government or a relevant authority. Examples from the US include the National Residency Matching Program, allocation of university dormitory accommodation, and school choice. The focus in these matching markets has been the creation of new mechanisms to improve matching. In this regard they have been highly successful.

Governments have been at the forefront of promoting new and improved *non-entrepreneurial* matching markets, and technology, especially computing power and new algorithms, has been critical to this innovation. This expertise, however, has not typically been called upon to inform government responses to the entry of new *entrepreneurial* matchmakers. Equally, such knowledge could be brought to bear in assessing matching markets that do not function well, and where a new platform could be an appropriate policy response.

2.1.2 Matching markets in practice: the case of Airbnb

An example of how these pros and cons play out in practice is the phenomenal growth of short-term accommodation platforms like Airbnb. Airbnb is a matching market platform that connects hosts offering private rooms or entire residences with guests seeking short-term accommodation, for a commission. The company's stated goal is to '[leverage] technology to economically empower millions of people around the world to unlock and monetize their spaces, passions and talents to become hospitality entrepreneurs' (Airbnb, n.d.). Launched in 2008, after a decade in operation Airbnb claimed to have facilitated over 300 million guest arrivals in more than 5 million listings across 191 countries (Airbnb 2018). In the year to January 2018, Australian Airbnb hosts brought in over $978 million in revenue, from over 6 million guest arrivals (Tabakoff 2018). Airbnb's reach in Sydney and Melbourne is significant, and continuing to grow as shown in Figure 2 below:

Figure 2: Airbnb listings for Sydney and Melbourne (Aug 2015–Feb 2018)



Source: Crommelin, Troy et al. (2018b) based on analysis of AirDNA.co data

The global Airbnb business was valued at over $US 30 billion in May 2017 (Bort 2018). STL platforms like Airbnb also now support a sub-economy of service businesses offering everything from Airbnb house-cleaning, to property management, to analytics software (Gopal and Perlberg 2015; Coldwell 2016). The combined economic impact of these developments is significant—for example, Deloitte assessed Airbnb's economic contribution to Australia in 2015–2016 at $1.6b, of which $512m was in the state of New South Wales (Deloitte 2017).

According to Airbnb, the company's main interest is to allow home owners to share their property and their lifestyle, and to help middle-class residents to gain and retain a foothold in expensive housing markets (Hunt 2016). To this end, Airbnb describes itself as a 'home sharing' service that facilitates access to spare rooms and temporarily vacant homes. In line with this, the platform has been held up as an exemplar of the 'sharing economy', a somewhat nebulous term used to describe digital platforms that allow participants to easily share—or, more often, trade for money—excess capacity in assets and services (Benkler 2004). It is important to note, however, that hosts using STL to share their primary place of residence are engaging in economic activities long established in urban housing markets, from private boarding and lodging (O'Hanlon 2005) to share housing (Clark and Tuffin 2015). It is worth asking, therefore, why the STL facilitated by platforms like Airbnb is often portrayed as novel or innovative (see Schor 2014 and Crommelin, Troy et al. 2018a for further discussion).

But while precedents like private boarding and share houses involved relatively small-scale economic activity—in part restricted by high search costs—Airbnb has harnessed new peer-to-peer digital platforms to dramatically scale up house sharing and access a global market of millions. Airbnb has also facilitated other forms of short-term letting on a more significant scale, with entire properties now made permanently available via the platform. This constitutes a substantively different accommodation activity—the equivalent of providing serviced apartments or holiday rentals—which is more explicitly commercial in nature. It is this commercial activity which has been a particular concern with respect to housing affordability, as property owners are potentially incentivised to remove properties from the long-term rental market and convert them to STL instead.

As the Airbnb experience demonstrates, matching market platforms have the potential to dramatically reduce the search and transaction costs involved in housing provision of all kinds, including for longer term rentals. While Airbnb operates in the private housing market, these technological developments pave the way for digital platforms to become matchmakers across a host of market and non-market housing provision and housing assistance contexts. The economic and social savings are potentially significant. This new-found ability to match, however, also involves policy risks, which will be outlined in the next chapter.

2.2 Big data and data infrastructure

By definition, big data are 'large datasets, mined in bulk from modern electronic devices, that can be analysed to extract patterns of behaviour at both the macro and micro level' (Carrera 2016: 474). As Batty (2016) explains, the techniques used to analyse big data often differ from conventional methods, because of the unstructured format in which big data is typically received. Since data streams are often not collected for a specific end-use, new methods ('urban analytics') are needed to define its boundaries and link it to other datasets. Furthermore, as Goodspeed, Pelzer and Pettit (2018) note, visualisation is often required for communicating big data sets effectively, to allow the interpretation of patterns such as traffic movements or house sales volumes over time (see, for example, CityViz housing indicator).

A growing portion of government and market processes related to housing are now conducted via digital technologies. Large quantities of data are collected and stored in the process, creating reservoirs of information that could be used for automated decision-making in urban planning, utility provision, housing market analysis, housing assistance and more. However, much of this data exists in formats that make it incompatible for use in these other contexts. To address this issue, data workflow systems are software machines that make data from one system readable and useable by another system. A number of off-the-shelf packages (such as FME by Safe Software; https://www.safe.com/) perform this task, which can be run by someone with basic technical skills. Through these systems, heterogeneous data can be made compatible for use by different organisations. These systems are becoming central to interoperability, thus helping to facilitate automation.

Such automation may soon influence the provision of housing services in various ways. In the US, there are already examples of automated systems that coordinate between users and suppliers of housing services (Eubanks 2018). For instance, 'Coordinated Entry' and 'Homeless Management Information Systems' projects automate needs-based identification, assessment, referral and assistance for homeless persons. There are also a significant—and growing—number of automated decision-making systems in Australian administrative governance. Data61 at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) runs the 'Regulation as a Platform' project, which allows government entities to have legislation or policy documents translated into automated decision-making systems. Enabling legislation is generally required to allow the use of such automated decision-making tools, and has to date been introduced in:

- taxation (including systems to determine whether an individual is an employee or subcontractor)
- determinations for eligibility for social security, including military compensation
- determinations for child support and defining familial relationships between parties
- media content classification
- health records management
- mining royalty administration

- migration and visa decisions, and
- customs duties and importation permissions.

Alongside these government-led developments, however, big data sets are also increasingly being created through the growing international movement towards 'open data' (Amorim, Castro et al. 2017). A long established example of such open data is the Australian Bureau of Statistics' (ABS) Census, an extremely rich data product which underpins a significant body of housing research and analytics, including this Inquiry. Unlike the Census, however, many new open access data sets are created through crowdsourcing initiatives. Perhaps the most notable is Wikipedia, which collates the collective wisdom of individuals who contribute their knowledge freely. With respect to mapping, the most comprehensive open data initiative is Open Street Map (OSM). OSM began in 2004 and is a collaborative mapping project with the goal of creating a free and editable map of the world. OSM is licensed under an open database license via the open data commons, and provides fairly comprehensive data for cities and regions across Australia. These tools provide opportunities for users without access to government or commercial datasets to also benefit from the big data movement.

2.3 Locational intelligence tools for urban planning

It has been widely quoted that '80 per cent of information is spatial in nature'. While this claim may be as much folklore as scientific fact (Dempsey 2012), it nonetheless captures the dramatic increase in the use of geographical information systems (GIS), first invented by Roger Tomilinson in the 1960s (Dempsey 2015). GIS can be defined as systems that support the management, analysis and mapping of spatial information.

The broad acceptance of GIS applications such as Google Maps is indicative of the accessibility, cultural normalisation and power of map-based tools. The use of spatial information has also grown within organisations, with the vast majority of large businesses now compiling and managing spatial data along with traditional business data. This growth in the spatial data industry has led to the creation of multiple bespoke, industry-specific locational intelligence systems.

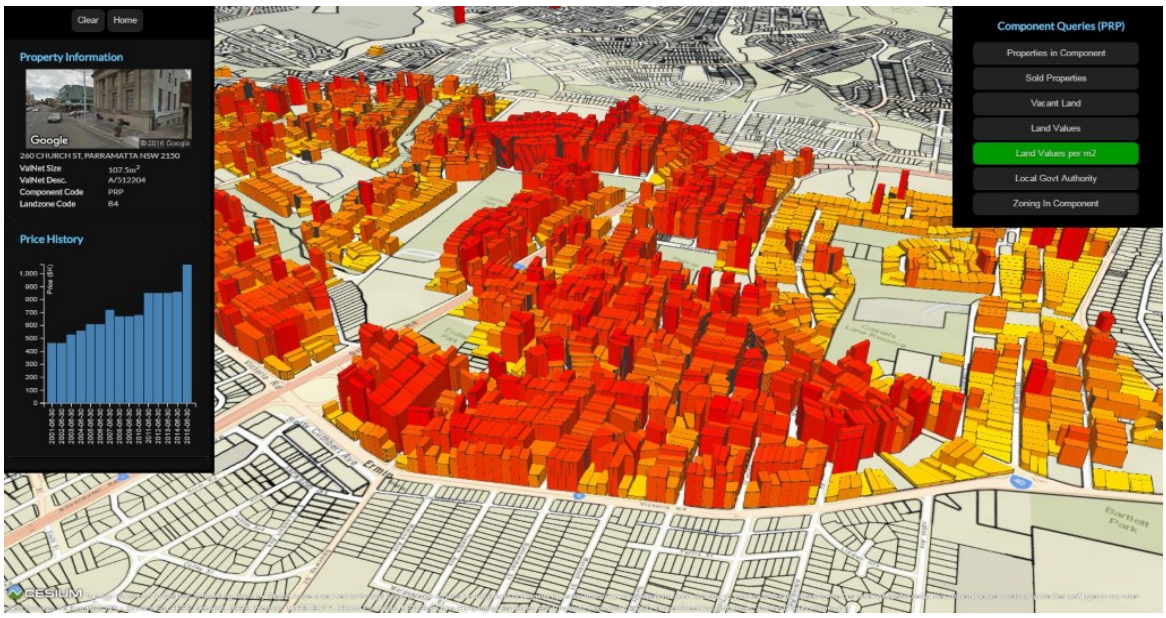
There are a number of foundational GIS systems with similar functionality, including the open source system QuantumGIS (QGIS), and the proprietary MapInfo (Pitney Bowes 2017) and ArcGIS (ESRI 2017a) (see Pettit, Liu et al. 2018 for more detailed descriptions). Each allows for data storage, geocoding, manipulating, overlaying and querying geospatial data, using a mix of open and closed data. The next level of spatial analysis lies in the development of bespoke tools, typically used for scenario modelling. These have to be constructed in part by a software developer and in part using existing technology. A final level of complexity is then introduced when the visualisation moves from 2D (maps) to 2.5D (extrusions on a map) and 3D (three-dimensional mesh models on a map). With these features, users are able to traverse the virtual landscape and the objects within a map, such as in Google Earth.

Meanwhile, attempts to reconcile the need for accessible urban and housing data have resulted in university-led portals, such as the Australian Urban Research and Infrastructure Network (AURIN). AURIN has been funded through the National Collaborative Research Infrastructure Strategy and provides access to over 3,500 datasets and 100 spatial statistical tools for analysing Australia's cities and regions (Sinnott, Bayliss et al. 2014; Pettit, Barton et al. 2015; Pettit, Tanton et al. 2017). The AURIN portal provides aggregate access to public and private sector datasets including property data from the Australian Property Monitor (APM), which has been used by academics in undertaking housing studies related to affordability (e.g. Pettit, Barton et al. 2015). AURIN also comprises an Application Program Interface (API) where industry, government and academics can access and integrate datasets into GIS and software packages.

A suite of university-developed, GIS-based Planning Support Systems (PSS) also now exist to perform various bespoke operations. These are gaining traction across Australia (Pettit, Bakelmun et al. 2017):

- **ENVISION** allows government planners to identify sites that will undergo transformative change and assess the future outcomes. These systems provide a greater understanding of changes in the urban fabric at a lot-by-lot level across an entire metropolitan area. ENVISION uses fine scale land and property valuation data to calculate a residential potential index, to identify areas most likely to be redeveloped in the near future (Trubka and Glackin 2016).
- **Envision Scenario Planner (ESP)** is a web-based 3D GIS platform to support fine scale urban precinct analytics. ESP's primary purpose is to facilitate collaborative decision-making of in-fill development in cities, intended to support redevelopment scenario preparation and exploration using 3D visualisations and performance assessment techniques (Trubka, Glackin et al. 2016).
- **Rapid Analytics Interactive Scenario Explorer (RAISE)** is a system that allows planners to assess the value uplift of housing based on the addition of new infrastructure. This system allows planners to have a fuller understanding of the incentives and potential revenues that can come from infrastructure investment, and assists with the development of strategic plans (see Figure 3 below; Lieske, van den Nouwelant et al. 2018).
- **What if?** is a GIS-based PSS developed to run future city scenarios driven by population and employment projections. What if? has been used across Australia (Pettit, Keysers et al. 2008; Pettit, Klosterman et al. 2013; Pettit, Klosterman et al. 2015) to forecast future housing growth based on planning and policy considerations. What if? is open source and can be used to model future land use scenarios anywhere in the world with available data (https://aurin.org.au/projects/portal-and-infrastructure/what-if/).

Figure 3: RAISE tool for exploring residential value uplift via new transport infrastructure



Source: Authors

2.4 Blockchain platforms and applications

The blockchain protocol, unlike internet protocol, enables the transfer of value without the need for intermediaries (Swan 2015; Tapscott and Tapscott 2016). A blockchain is a transaction

ledger that operates and updates simultaneously across a multitude of participating computers ('nodes', using peer-to-peer communication protocol). This distributed structure enhances data security as it cannot be attacked at a central point. Blockchain transactions are linked, verified and updated using cryptography. As a blockchain updates only when there is computational agreement from the network that a transaction has occurred, a value cannot be spent twice.

The blockchain economy—or 'cryptoeconomy'—is fundamentally different from the existing digital economy. While the web 2.0 economy has been characterised by centralising forces, with large companies handling transactions on users' behalf, the cryptoeconomy does not require the same market or government mechanisms for trusted transactions to be achieved. This creates the potential to do away with current processes of licensing, self-regulation and branding. Instead, peer-to-peer transactions, as well as direct, transparent incentives for participation, underpin the cryptoeconomy.

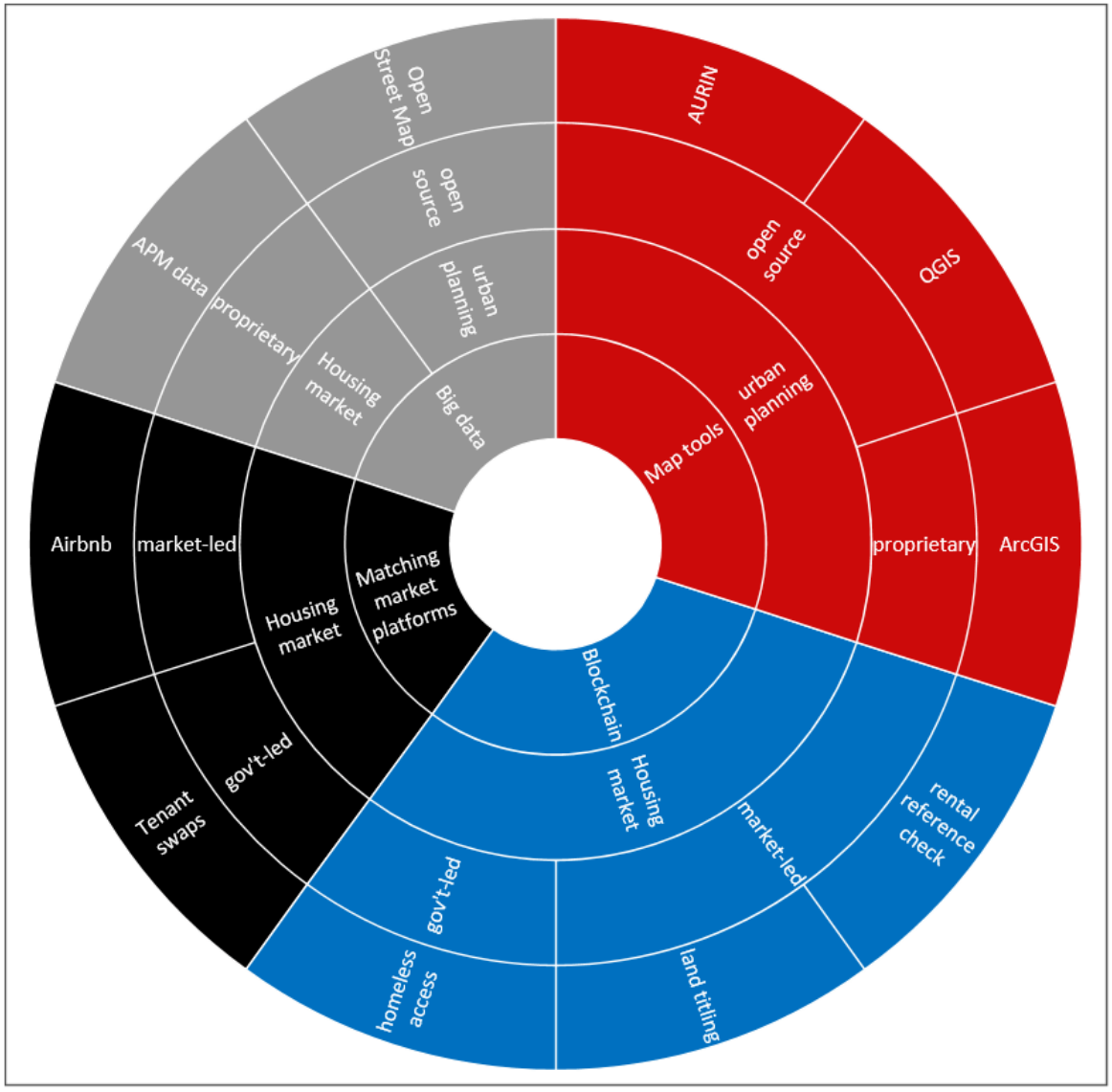
An early example of blockchain being used in a housing-related context is Power Ledger, which allows home owners to trade home-grown units of electricity known as Sparkz directly to their neighbours (i.e. peer-to-peer energy trading). The Sparkz are backed up by a blockchain platform known as Power tokens. Power Ledger has been successfully trialled with home owners in Busselton WA, demonstrating that those with solar panels could get a better return (https://powerledger.io/).

Blockchain technology also has the potential to create other efficiencies in the Australian housing system in the short term, including in land titling processes. This would involve the use of blockchain in the service of traditional governance functions like data registration and management. In the longer-term it may also bring about significant transformations in the housing sector by automating reference checking, access to property, and property or tenancy escrow. These potential transformations provoke questions around the new institutional dynamics that these technologies introduce, as well as their relationships with existing legal and governance structures (Reijers, O'Brolcháin and Haynes 2016; Yeung 2017).

2.5 Seeing technological disruption as an 'ecosystem'

Reflecting on the disruptions outlined above, it is clear that there is great complexity in the way technological change may reshape housing markets and housing provision. In an effort to synthesise this complexity, the chart in Figure 4 below identifies some shared features and contexts associated with these disruptions. The inner ring shows the four categories of disruption outlined above; the second ring identifies the broad context in which they primarily operate (housing markets or urban planning); the third ring shows the sub-context (i.e. whether they are primarily government-led or market-led initiatives), and the outer ring offers examples of the particular technologies involved. While this representation necessarily oversimplifies the drivers and impacts of these technological changes, it also helps to highlight some shared trends within the seemingly chaotic landscape of fast-moving technological disruption.

Figure 4: Housing Disruption Ecosystem



Source: Authors

The next chapter picks up on this theme, drawing out shared possibilities and challenges posed by these four categories of digital disruption.

3 Findings: identifying the opportunities and threats these technologies present

This chapter explores whether the technological changes outlined in Chapter 2 represent opportunities or threats to the equitable and efficient provision of both market and non-market housing and housing assistance. As a helpful overview, key points from the following discussion are also summarised in a table in Appendix 1.

3.1 Matching market platforms: opportunities

The research undertaken for this Inquiry demonstrates that technology offers the opportunity to improve the performance of many housing matching markets. The adoption of matching market platforms is a means by which governments can harness efficiencies to deliver better social, economic and environmental outcomes. In particular, the research revealed the potential for change that could:

- provide greater housing choice to social housing tenants and better stock utilisation
- create a national inventory of accessible housing, and marketplace for accessible housing, providing the means for people living with disability to discover accessible market housing
- increase the access by the lowest income households to the lowest-cost private rental housing at relatively little public cost
- improve the affordability, quality and supply of new apartments for owner-occupation, and
- provide the coordination required to facilitate the renewal of greyfield suburbs.

3.1.1 Opportunities for non-market housing matching

Social housing swaps and transfers

Swaps (or mutual exchange) refers to the ability of social tenants to swap their houses with other social housing tenants. Transfers occur when a tenant seeks to leave a property and is rehoused in a vacant property. In Australia, swaps and transfers are a neglected policy area, with tenant mobility typically restricted. This poor tenant mobility creates significant costs; in the UK, for example, the cost to government has been estimated at £542 million per annum (Gulliver 2010).

While it has traditionally been difficult for tenants to find another tenant willing to swap, an algorithm known as a ‘top trading cycle’ can now find multiple matches by identifying sequences of swaps known as ‘chains’ (Sharam, Byford et al. 2018). This enables a larger number of swaps to occur. House swap platforms in the UK (often owned by social landlord consortiums) use chain letting as a key means of enabling tenant mobility. A platform or application provides the interface between tenants and housing providers, while a computer runs the algorithm, with swaps conducted in ‘rounds’. The inclusion of community housing providers (CHPs) changes the market from a one-sided matching market to a two-sided matching market.

Facilitating mobility among tenants who wish to move improves their opportunities for employment and education, and promotes better connection with services and their families (Family Mosaic 2017; Gulliver 2010). Another key benefit of mobility is better stock utilisation and asset management, as tenants’ dwelling choices provide a demand signal for dwelling type and location. However, a recurring issue with any matching platform is the release and sharing of data across agencies to make such platforms rigorous, reliable and up-to-date. Furthermore, improving swaps provides little benefit to those still waiting for housing, unless positive inducements to move (such as rent holidays) can be used to free up under-utilised dwellings.

3.1.2 Opportunities for market housing provision

Accessible housing for sale or market rental

Currently no Australian program tracks the stock of accessible housing, a problem first identified by Bridge (2005). Accessible housing for private rental or purchase is therefore difficult to discover, as modifications are not typically advertised due to the negative impact of many accessibility features on property values (Imrie 2005). Some proportion of accessible housing is converted to mainstream housing, and some accessible housing is occupied by people without a disability. The loss of accessible housing and lack of availability undermines voluntary standards for accessible housing.

Government could promote the discoverability of accessible housing through mandating reporting by owners of accessible rental properties (Sharam, Byford et al. 2018). This would be a vital step in the creation of a national inventory of accessible housing, which, in turn, is necessary for understanding stock quantities and the effectiveness of measures to increase this stock. The inventory could form the basis for a new reiteration of the Victorian-based *Housing Hub*, an online service that matches accessible properties and people living with a disability.

Addressing the lack of available low-cost private rental housing for low-income households

Many households in the lowest two income quintiles attempt to match to private rental housing that is affordable to them, only to find that it is unavailable as a result of occupancy by higher-income groups (Hulse, Reynolds et al. 2015). This mismatch results in housing stress and an increase in informal living arrangements, with higher risk of homelessness. In addition, matching sometimes fails because of issues such as discrimination.

Facilitating matches of affordable stock to corresponding income groups could be an inexpensive public policy intervention (Sharam, Byford et al. 2018). The National Rental Affordability Scheme and Commonwealth Rent Assistance programs are examples of existing policy interventions aimed at aiding matching in the PRS (although the latter is rather indirect and makes little use of digital technology). Governments could support a brokerage service operating via a digital platform to head lease existing low-cost private rental housing, effectively quarantining some of this stock for the exclusive use of low-income households (see also Parkinson, James et al. 2018). For low-income tenants, this brokerage service could operate something like Airbnb: membership could entail the right to 'book' an available property, rather than apply for it as is customary for private rental (Sharam, Byford et al. 2018).

The degree of government subsidy would be minimal, covering administration only: households are simply reallocated from a higher-cost market rent to a lower-cost rent if they wish to move. These households would receive no additional subsidies (although if the scheme were extended to those currently squeezed out of the PRS into informal housing arrangements, some degree of on-going subsidy may be required).

New apartments for owner-occupation by modest to middle-income households

Developers of new apartments often have difficulty finding matches (i.e. presales). Investors are relatively easier to find than aspiring owner-occupiers and are less concerned with amenity, resulting in apartment product that is orientated to investors rather than owner-occupiers. Aspiring owner-occupiers with low to middle incomes therefore find it very difficult to match to apartment product that is both affordable and of decent quality and design.

Investors are inclined to renege on presale contracts if property prices decline between precontracting and settlement, and developers are able to void contracts or change designs (Sharam, Bryant et al. 2015). Investor matches are therefore unstable in that they are inclined to un-match or 'unravel'. The inability of developers to address this 'settlement risk' means their

profit margins must be significantly higher than would otherwise be the case. This has implications for both cost and supply of new apartments.

Provision of quality, affordable product for owner-occupation would result in buyers who present a far lower risk of settlement failure. Reduction in settlement risk enables more favourable financing terms providing the opportunity to deliver a price discount (Sharam, Moran et al. 2018). In competitive markets the savings created by these new financing terms would be passed through to buyers, but the oligopolistic nature of the speculative development industry (Coiacetto 2009; Dong, Sing et al. 2006; Ong, Jam et al. 2003) precludes this.

The rise of matching market platforms suggests that the issue of finding aspiring owner-occupiers can be addressed relatively easily. The experience of Nightingale Housing Ltd (http://nightingalehousing.org/), a profit-for-purpose housing developer in Melbourne, in attracting buyers points to the Internet as a key tool for resolving the matching problem and the delivery of quality and a discount to market price as central to resolving settlement risk (Sharam, Byford et al. 2018). In short, a new 'structure of provision' (Ball 1986) is emerging, but it relies on competition to speculative developers. This competition currently takes the form of nascent profit-for-purpose developers such as Nightingale, and DIY development syndicates (or deliberative developers) such as Property Collectives (http://propertycollectives.com.au/) and Green Fabric (http://greenfabric.com.au). It could also include the not-for-profit community housing sector. Economic theory suggests that these types of developers could, if able to gain sufficient market share, compel speculative developers to share the financial benefits of improved matching with buyers. The Assemble model (http://assemblecommunities.com), also in Melbourne, suggests that some speculative developers are sufficiently concerned about housing affordability that they may change their business model even without direct competition.

Government could support the establishment of a matching market platform to connect aspiring owner-occupiers with such developers who are willing to share the financial benefits of improved matching with buyers. Government support could include financial guarantees or preferential access to surplus government-owned land for deliberative, profit-for-purpose and non-profit developers.

Precinct-level urban redevelopment

Australia's well-located, low-density 'greyfield' suburbs built between the 1950s and 1980s are now being targeted for the provision of new, sustainable housing supply (Newton, Murray et al. 2011). Reaggregation of fragmented land parcels in these areas to enable precinct level redevelopment would deliver environmental, social and economic benefits. However, aggregation of lots is challenging because of the complexity of coordinating multiple landowners. The high transaction costs involved deter private developers, and reduce the return on investment when public agencies undertake renewal projects. This coordination role could now be filled more efficiently and cost-effectively by a new digital platform.

A citywide matching market platform could be established by a government agency as a permanent intermediary, to facilitate matches between people, land and opportunities. The process would deliver more options to existing landowners and provide them with a more active role in instigating change, as well as a greater share of the benefits. Many existing landowners would retain property ownership, although this property would be different from their original holding. There are also risks in this type of arrangement, however, including undue pressure on owners who do not want to participate (as precinct level redevelopment relies on participation by all land owners in the precinct). Nonetheless, a citywide platform could provide a transparent mechanism for managing engagement with these stakeholders over a long period.

Setting up a platform of this kind would require a different administrative framework than for a single, limited redevelopment site. Linking the platform with locational intelligence tools like ESP and AURIN could help to provide some necessary insights, including housing redevelopment

potential (see 2.3 above for details). Data accessibility and interoperability would be key to ensuring this is possible, thus reinforcing how open data and data infrastructure play a pivotal role in enabling matching markets and urban analytical tools to support the housing sector.

3.2 Matching markets: threats

Housing matching markets already exist, but most do not function well. The entry of new matching market platforms responds to the inefficiencies of preexisting matchmakers. Typically, this takes the forms of reducing transaction costs and frictions that impede transactions. This benefits all market participants. In order to be successful the platforms need to establish 'thick' markets, with more than enough participants on both sides of the market to make good matches. In theory, this should make the platforms more sensitive to the needs of those it is seeking to attract and retain as market participants (Evans and Schmalensee 2016).

These benefits are significant, but there is also potential cause for concern related to the growth of matching market platforms. These fall into four main categories:

- The first issue is the potential for negative spillover impacts, with the conversion of long-let housing to STL a prominent example (this is detailed more below).
- The second is the tendency to monopoly. The need for thickness in matching markets drives consolidation of platforms, and in time there is often only a duopoly (as, for example, with the major online property platforms in Australia, Domain and REA). This is primarily an issue for competition regulators to monitor.
- The third issue arises where the characteristics of certain housing consumers may mean finding matches will be difficult, regardless of technology to aid searching. Certain consumers may engage in behaviours that result in ratings that mean matching becomes difficult (Uber drivers, for example, decline to pick up passengers with low ratings). In terms of housing, these may be vulnerable people who require assistance. Government intervention may be necessary to increase the opportunity for matching. In the absence of an adequate supply of low-cost housing stock, for example, financial subsidies will provide the means for low-income households to match to housing stock that is available, but which would otherwise be too expensive. Some platform operators, particularly not-for-profits, may also be well-placed to work with government to support vulnerable housing consumers to overcome these barriers.
- Fourth, absent adequate monitoring and regulation, there is a risk of inequities arising, as the kinds of individualised connections facilitated by matching market platforms can in practice be most accessible to and helpful for those with power, education and know-how, with adverse equity potential for others. This risk should be considered when policies are developed, such as through government support to ensure access to platforms, and for support from intermediaries and advocates where required. Similarly, there is an important role for government to play in regulating platforms to support equitable access to powerful data analytics tools.
- Privacy and consumer protection. Matching market platforms collect and aggregate data which they may onsell to others, for example as a means of upselling products related to housing such as insurance products. This raises issues of privacy and consumer protection which need to be addressed.

3.2.1 Spillover effects in practice—STL platforms

While matching market platforms present an opportunity to harness efficiencies to provide better social and affordable housing outcomes, Airbnb offers a cautionary tale about the disruptive impact of allowing new entrepreneurial matching market platforms to operate unregulated in the

private housing market. While primarily designed to 'disrupt' the commercial accommodation market, Airbnb has had significant spillover effects in another market entirely—the market for long-term residential housing. Concerns about the prospect that Airbnb and similar STL platforms are facilitating a shift in supply from long-term private rental to short-stay accommodation have been much discussed (see Gurran and Phibbs 2017). Quantifying the extent of the threat to private rental supply and affordability has proven challenging, however, not least because of the lack of reliable Airbnb listing data available.

In addition, the nature of the market disruption caused by STL is complex. While Airbnb promotes itself as facilitating 'house sharing', our analysis suggests that the site facilitates a significant amount of activity which is best considered as commercial STL. We draw the distinction as follows:

- **House sharing** includes advertising part of a house (a private or shared room) or a whole house for a small portion of the year (up to 90 days). These uses suggest that the property is otherwise meeting someone's permanent housing needs.
- **Commercial short-term lets** means properties permanently offered for short-term rental, thus preventing their use as long-term housing. This includes properties available or booked for more than 90 days per year, and those where the host has multiple listings.

For Sydney, the listing data suggests that about a quarter of Airbnb activity in late 2016 consisted of commercial letting (see Crommelin, Troy et al 2018a); this has now increased to almost 30 per cent (see Table 2 and Table 3 below). While still the minority of listings, there is evidence from other jurisdictions (e.g. Wachsmuth, Kerrigan et al. 2017) that these full-time listings make up a larger proportion of Airbnb's income, relative to listing numbers. This is not surprising given that Airbnb's model involves taking a percentage of all rental fees charged.

Table 2: Airbnb listings by type for Sydney, March 2018

	Total	Proportion
Commercial let	6,697	29%
House sharing	16,424	71%
Total lets	23,121	100%

Source: Crommelin, Troy et al. 2018b, based on analysis of AirDNA.co data

Table 3: Airbnb listings by type for Melbourne, March 2018

	Total	Proportion
Commercial let	8,310	44%
House sharing	10,528	56%
Total lets	18,838	100%

Source: Crommelin, Troy et al. 2018b, based on analysis of AirDNA.co data

The prospect that Airbnb has removed over 6,000 properties from the Sydney long-term rental market and over 8,000 in Melbourne is concerning. On top of this, some house sharing listings might otherwise provide long-term accommodation for house-mates or lodgers, meaning that these tables likely understate the full extent of Airbnb's impact.

What this data also doesn't reveal is how these properties were being used prior to being listed on Airbnb, and how they might be used in future if STL were restricted. According to Airbnb, many of their listings represent previously under-utilised housing capacity (e.g. spare rooms, holiday houses, or vacant investment properties). However, the Inquiry research findings suggest STL platforms like Airbnb are reshaping housing opportunity in private markets in Sydney and Melbourne in two ways: through direct affordability impacts in localised areas, and by influencing housing beliefs and behaviour more broadly (see Crommelin, Troy et al. 2018b for the full analysis underpinning these findings).

Direct affordability impacts

The findings suggest that STL platforms like Airbnb are probably not significantly worsening rental affordability at the metropolitan scale, given that commercial Airbnb listings represent between 1–2 per cent of total rental stock in both cities. However, the findings also suggest that these platforms are having an impact on the availability of rental properties in high-demand inner city areas with significant tourism appeal. More specifically:

- In Sydney, the eastern beaches suburbs, Darlinghurst and Manly, have been the focus of Airbnb activity, which accounts for between 11.2 per cent and 14.8 per cent of rental housing stock.
- In Melbourne, central Melbourne, Docklands, Southbank, Fitzroy and St Kilda have been the focus of Airbnb listings, which account for between 8.6 per cent and 15.3 per cent of rental housing stock.

In these areas, two main factors—decreasing bond lodgement rates, and increasing levels of property vacancy—point to the likelihood that STL is removing properties from the long-term rental (LTR) market, thereby contributing to increasing unaffordability in the PRS. The impacts of Airbnb on rental supply in these areas have somewhat been offset by substantial dwelling growth in Melbourne, and large numbers of dwellings that are otherwise outside of long-term housing supply, such as unoccupied dwellings. Nonetheless, the findings suggest that STL is contributing to the challenges already confronted by long-term renters in these local markets. While the city-wide affordability impact may be limited, those seeking long-term housing will face a market that is at best more complex and uncertain, and may also be moderately less affordable in some local areas.

Influence on housing behaviours and beliefs

Beyond the direct market impacts already outlined, the findings also suggest that the rise of STL is likely to reshape Australian housing markets by influencing how we think about and deal with property. The research suggests two main elements to this shift: more fluid housing markets, and financialised attitudes towards housing.

First, the findings suggest that the rise of STL platforms is contributing to private housing markets becoming more fluid and uncertain, with increasingly diverse uses of housing, and property holders moving regularly between STL and LTR. STL platforms provide a new form of financial opportunity for those who already have housing wealth, which adds greater flexibility to the way their housing assets can be exploited. At the same time, however, hosting may provide new opportunities for aspiring market entrants to get a foothold in areas they could otherwise not afford. Ultimately, while hosts' financial and housing circumstances are diverse, the findings do indicate that many hosts have converted properties from LTR to STL. However, some indicated these will likely return to LTR over time, due to the greater workload, declining profitability and seasonal variability of STL. Overall, the findings reinforce the conclusion that STL is contributing to greater fluidity of property use, where the competing benefits of different monetisation strategies are regularly weighed up. This fluidity is likely to come at the expense of certainty for prospective tenants and owners, for whom long-term housing may be more difficult

to secure, particularly in areas where peak period STL prices are high. This adds another factor to the mix of issues already reducing the likelihood that the market will provide a steady and sufficient supply of affordable long-term housing, for both rental and ownership.

Second, the research findings suggest that STL platforms have contributed to a cultural shift: the expansion of financially-focused attitudes towards housing beyond those already involved in housing investment. Two main findings support this conclusion:

- The large majority of hosts were motivated to use STL by the financial benefits and, in most cases, to provide discretionary income rather than to cover essential housing needs.
- Many hosts were now factoring hosting into their thinking about future property choices.

By providing more flexible options for monetising housing assets, STL platforms have attracted new participants to the practice of providing commercial accommodation. While many hosts may not be earning significant incomes, hosting is nonetheless reshaping their perceptions of the value of their housing. STL therefore seems likely to have a cultural impact as well as an economic one—and one which may ultimately drive further accumulation of housing wealth by already housing-rich market participants, potentially contributing to greater inequality over time.

On the other hand, there is also the potential for the rise in STL to shed new light on aspects of our housing markets that have not been broadly recognised and debated. In particular, the high number of Airbnb listings in desirable neighbourhoods in both Sydney and Melbourne can be seen as an amplification of an existing distortion in these housing sub-markets, namely a significant stock of vacant properties. In these areas, STL listings appear to overlap with a large amount of housing stock that is not ordinarily part of the long-term housing market, as it is neither owner-occupied nor made available for LTR. In doing so, STL listing patterns offer a new perspective on this longstanding issue in Australia's urban housing markets—the underutilisation of housing held primarily for speculative gain. In other words, STL platforms like Airbnb seem to have tapped into a capacity in our existing housing stock that might be turned towards improving access and affordability, but which on present policy settings is not.

Overall, the Inquiry research findings suggest that Airbnb is disrupting to the private housing market in Sydney and Melbourne. While it presents an opportunity to existing participants, by allowing them to further monetise their housing assets, it poses a threat to those seeking to enter the market. Although certainly not the only reason for the increasing price of private rental in Sydney and Melbourne, the findings suggest that Airbnb is contributing to making these markets more inaccessible, thus increasing the inequitable nature of housing opportunity in Australia's largest cities.

These findings highlight the need for considered, informed regulation of matching market platforms, which focuses on the nature of the economic activity occurring and its impacts, not simply the technology involved. The challenges to implementing such regulation will be discussed further in the next chapter.

3.3 Big data: opportunities

While the possible applications of big data are extensive, three key opportunities stand out as examples of how it may facilitate more efficient and informed planning decisions:

- **Data swap-shops:** The push for open data access has seen the development of digital 'marketplaces' or data swap-shops like data.gov, data.vic and data.nsw, which are clearinghouses for a wide range of government data. Though they currently contain limited information, there is great potential for these clearinghouses to act as the centralised repository for all government data. In combination with data workflow systems, this could

mitigate duplication and provide access to those who need the information, facilitating more informed planning and housing-related decisions.

- **Semantic analysis:** this is another novel but incredibly powerful development, particularly in the areas of law and policy where the discourse is the data. This method of data extraction is based on machine learning algorithms, which are arguably at the point where reading and interpreting statutory land use regulations is becoming redundant (Psyllidis, Bozzon et al. 2015). Capacity now exists for digital systems to do initial assessments of planning proposals, particularly for smaller endeavours. This could vastly improve the efficiencies of the planning process, and facilitate faster approvals for new housing developments.
- **Richer data assets:** Machine learning and advanced spatial modelling techniques are being applied on remotely sensed imagery acquired through satellites and airborne sensors in aircraft (including drones). Such modelling is resulting in higher resolution datasets across our cities. For example, the Public Sector Mapping Agency (PSMA) has developed Geoscape, a national data product that includes the building footprints and heights of every property across Australia's urban landscape. Geoscape also includes tree canopy and other attributes such as roof material. Such rich, fine-scale data products offer the potential to better inform urban analytics platforms such as RAISE. Machine learning algorithms are also being applied to imagery such as Google Streetview to capture fine scale property and neighbourhood information, which will no doubt underpin the next generation of urban analytic platforms.

By making more informed planning systems easier, these developments also have the potential to help facilitate more efficient and equitable housing markets, and subsequently support more nuanced housing assistance programs.

3.4 Big data: threats

Key threats associated with the development of big data sets and associated data infrastructure relate to commercialisation, privacy and complexity.

3.4.1 Commercialisation

While the commercialisation of data is not new, the increase in digital transactions, combined with the richness in how big data can inform consumer behaviour, means that operating without this information is now a significant disadvantage. This has led to the growth of specialist data firms and exchange platforms such as DataRepublic, many of which generate privately-owned and highly-commercialisable datasets. Examples include the Australian Property Monitor (APM) housing dataset, which includes historical and contextual data of all property sales in Australia; the Experian Mosaic dataset, which has real and modelled consumption data for each Australian household, and of course Google's vast data store on personal consumption practices and location (among other things). Many firms are also now collecting big data captured through smart phones and web transaction histories. This includes data from the telecommunication companies such as Optus, which has set up DataSpark, and Telstra, which has set up LocationInsight, which provides information on people's location and mobility patterns across Australia. Credit card companies are also now in the data business, with Mastercard releasing its Retail Insights data platform, providing ABS-level access to consumer expenditure across the city.

As Inquiry research participants explained, the data industry is seen to be developing too quickly for government regulations and policies to catch up, and private industry is far more flexible in adapting to these changes. In many cases, commercial enterprises offer better quality

and more complete data than government can, as a government participant explained (see Pettit, Liu et al. 2018):

> *Google and other organisations have … huge data on almost everything … They were working with us, but then they pulled their data because we were using it for free. They are going to be monetising their data…They are collecting traffic data, where the bathrooms are, the congestion spots. They can already probably provide better info than governments ... Data aggregation is the new anti-trust. Things are moving too fast for governments to respond to. Google has aggregated their data, that's why they are powerful.*

However, as these firms make their income from the sale and analysis of these datasets, acquiring them for government or research use is often not viable, due to the prohibitive cost (although occasionally special licences are granted for research; see Davison, Legacy et al. 2013 for an example). While open data initiatives help to counter this commercialisation, it is not a complete solution. For example, OSM is useful for many urban applications, including street network analysis. However, it does not currently include as rich a source of urban data as some commercial offerings; for example, the attribution of building footprints and height is incomplete across much of the built environment in Australia. By contrast, commercial offerings such as PSMA's Geoscape product include detailed urban data for every address across Australia.

3.4.2 Privacy

There is also increasing concern about the risks to people's privacy with commercial data exchanges. This has been most spectacularly highlighted by the Facebook Cambridge Analytica debacle, where more than 87 million people reportedly had their personal information exposed through data scraping (ABC 2018). Currently, state agencies and larger private entities are limited in terms of how they deal with data, due to federal and state data protection legislation (e.g. the *Privacy Act 1999* (Cth) and the *Privacy and Data Protection Act 2014* (Vic)). These statutory regimes impose rules on the collection, processing and distribution of data when that data is 'personal information'. Although the definition is contentious, 'personal information' can broadly be understood as data that identifies or can be used to identify a person (see Pettit, Liu et al. 2018 for further discussion). It is likely that the majority of data collected and shared by housing and associated services concerning clients would be personal information and governed by data protection law, thus potentially limiting its use. It is less clear that general data about use of services that did not necessarily include identifying information, or had been de-identified, would be considered personal information. Questions such as this need to be resolved, however, and protections put in place to ensure the use of such information does not create inadvertent privacy risks. The surveillance possibilities of any highly connected data intensive environment are confronting, and any system of data openness will require measures to ensure the protection of individuals. In response to such concerns, the Office for the Australian Information Commission recently released its guide to data analytics and the Australian Privacy Principles. This includes guidelines for working with big data, data matching, deidentification of data and understanding data analytic techniques such as artificial intelligence and machine learning (OAIC 2018).

3.4.3 Complexity and inaccuracy

As big data sets and the systems built on them become more advanced, they also become more complex, providing less opportunity for human oversight or review. At present, existing decision-making systems used by government are typically of limited sophistication. They generally fall into the category of 'expert system', whereby legislation or policy documents are translated into algorithmic decision trees (or flow charts). Their potentially damaging limitations were very visible in the Centrelink 'RoboDebt' scandal (Terzis 2018). Despite such risks, these systems are increasing in scope, sophistication, and use. Their use in determining the provision

of housing services and assistance seems very feasible. As these systems adopt more machine learning functionality, they also become more complex and difficult to regulate. Nevertheless, it is increasingly likely that automated systems will be further deployed in various social welfare programs, including systems that establish eligibility and priority for social housing and other housing-related services. While this could improve the efficiency of these systems, there is also a real risk of increasing inequity as a result, particularly through the decreased capacity to take individual circumstances into account. The 'RoboDebt' scandal highlights the importance of instituting speedy and reliable processes for appeals and checks on decisions, in addition to open and transparent data.

3.5 Locational intelligence tools: opportunities

While urban planners have long used GIS to support planning decisions, technological advancements now mean more complex modelling can be used to more accurately predict final outcomes (e.g. Lotteau, Yepez-Salmon et al. 2015). With the maturing of open source GIS software packages such as QGIS in recent years, we are now seeing the democratisation of powerful location intelligence and mapping tools, with greater uptake across government, industry and the community sector. For example, AURIN, ENVISION, ESP, RAISE and What if? are all built using opensource GIS software, and are now being used to support planning and housing redevelopment decisions. Currently, ESP is actively being used in the City of Maroondah in Melbourne and Blacktown City Council in Sydney. In both instances this precinct redesign tool is being applied in greyfield areas to assist councils and communities in the collaborative redevelopment of sustainable and affordable housing options.

3.6 Locational intelligence tools: threats

3.6.1 Commercialisation and complexity

As previously noted, the costs of installing and maintaining proprietary GIS software solutions can be prohibitive. Software licensing can cost hundreds of thousands of dollars per year for multiple GIS extensions and seats across an organisation. Fortunately, the maturing of open-source GIS solutions described above is starting to address this issue.

Another barrier to the uptake of GIS is the skills required to use this software, as significant training is needed to develop the expertise to perform spatial analysis and produce high quality maps and other visual outputs. Combined with high software costs, this need for expertise means many councils and agencies continue to operate simple GIS systems, or subcontract access to third party urban analytics providers in the commercial sector. Russo, Lanzilotti et al. (2018) provide an overview of the educational barriers for planners and decision-makers in this regard. New programs designed to train the next generation of urban and housing decision-makers in GIS and analytics platforms may help address these barriers (see, for example, the Master of City Analytics program at UNSW).

3.6.2 Legacy hardware and software administration restrictions

Technical limitations (such as outdated hardware) can also present barriers for governments and NFPs seeking to employ GIS and urban analytics software packages. Overcoming these limitations further adds to the cost associated with these tools. It is also common policy for government agencies and large organisations to restrict access to both desktop and cloud-based platforms, such as when an organisation's internal ICT Department locks administration rights and won't allow untested software to be installed, or only supports old versions of software. The same problem arises with cloud-based software systems that can only be

accessed via old versions of internet browsers incapable of running the latest GIS or urban analytics platforms, or if certain URLs are blocked from within an organisation.

3.6.3 Data access and licensing

Having good quality data is critical when performing systematic analysis to inform housing policy, which is necessarily sensitive to spatial context. GIS and urban analytics software requires access to good quality data in order to perform queries and provide meaningful results. The quality of data across Australian urban areas varies significantly, and there are different access policies across jurisdictions. Some data is openly available, such as ABS Census data. Other datasets (e.g. bond data) do not exist in some jurisdictions, are not regularly updated, or are only available as costly commercial products. Another issue is that agencies might not be able to share their data even though they paid for the initial data capture, due to data procurement procedures. For example, a number of NSW councils have subcontracted 3D models for their LGA, but due to licensing restrictions are not permitted to share this with other organisations. Such data silos can lead to interior analysis of the housing sector and barriers to replicating methods and testing results to ensure quality. These obstacles can in turn provide a barrier to innovation.

3.7 Blockchain: opportunities

3.7.1 Efficiencies in property rights management

The Australian housing system currently relies on information stored within public sector infrastructures. Property rights are recorded in carefully maintained ledgers of dealings (including the Torrens system of land registration), which underpin ownership and enable the enforcement of rights. This ‘stack’ of data, physical servers, and regulation (Bratton 2016) reduces uncertainty in housing markets and enables credit systems to operate. Commercial intermediaries including real estate agents and banks use these records and contribute additional layers of information, brokerage and financial instruments, which may not be transparent to consumers or policy makers.

While the internet has enabled greater efficiency in some housing-related processes (such as online real estate and mortgage advertising as well as online transactions—i.e. Property Exchange Australia [PEXA]), it has not fundamentally changed the ledger of transactions or its management. Internet protocol is not equipped to transfer value in a trusted fashion. As a result, bureaucracies, banks, lawyers and estate agents still provide the institutional arrangements required to make property ownership possible, including the enforcement of transactions and the granting of exclusive use, as well as transferability and inheritability. Data is managed in central repositories and protected against security breaches at significant public expense.

A significant question is the extent to which blockchain can reduce market friction and the regulatory burden of these housing-related purposes. Disruptions in the housing system may occur due to reduced transaction costs from the automation of bureaucratic and banking processes. In economic theory, complex evolving systems typically move from centralised to decentralised systems (Coase 1960); centralisation enables enforcement, but also comes with costs (e.g. corruption, inflation, security costs). Decentralisation occurs when the costs of centralisation rise and the costs of decentralisation fall, often due to technological progress (Davidson, de Filippi et al. 2018). In the case of blockchain, efficiencies achieved in land registries, for instance, might also enable complex title arrangements for co-ownership to evolve, possibilities that are currently not pursued due to onerous administrative requirements. This has implications for new models to generate affordable housing, such as community land trusts, and some Indigenous housing models.

Multiple international jurisdictions are now experimenting with blockchain-based solutions for registering and transacting in land ownership (van Erp 2017). A number of nation states have experimented with putting land titles onto blockchain platforms, as have some US states (see Pettit, Liu et al 2018 for more details). Beyond reducing the costs of maintaining legacy land registry records, these initiatives also underpin other so-called 'proptech' innovations.[3] For instance, establishing a global market for peer-to-peer property sales and leasing requires trusted records of when a purchase has occurred.

The most promising of these applications are those that address a lack of trust in governing institutions, or address the possibility of fraud. The former application is most relevant in the development context, the latter in Deed-based property systems, where there is no central register verifying property ownership. However, the Australian Torrens system already offers a secure, trusted and relatively efficient mechanism for managing ownership of real property. It is therefore difficult to see applications for a blockchain-based real register taking off, despite the additional efficiencies it may bring. Instead, the research findings suggest that blockchain platforms are better suited to the recording of new categories of information (not otherwise recorded on titles). This might include limitations on land use, such as restrictive covenants, or limitations on selling land for profit (as used in innovative private housing developments like Nightingale Housing). It could also be information relevant for leasing, such as maintenance records. Ideally, this land use and title information would also link directly to cadastral systems.

3.7.2 Efficiencies in private rental management

In the private housing market context, blockchain is also being used to develop a range of property-related applications. Automated property transaction platforms require that those rights are encoded on a blockchain (Fairfield 2015), as well as systems capable of automating contract obligations under arrangements such as leases, licenses and short-term rentals. For example, 'smart tenancy products' are being developed that can hold bonds in escrow, automate rental payments, and manage maintenance workflows (Egbertsen, Hardeman et al. 2016). There is also interest in using the technology for listing services that include incentive mechanisms for supplying information about listed properties. A potential barrier to uptake is the relatively small portfolios managed by real estate agents in Australia and the historically low uptake of technological innovation in rental property management, although there are signs that this is changing (Hulse, Martin et al. 2018).

The findings also suggest there is interest in using blockchain to address what some research participants described as a 'broken' market for residential tenancies. This could involve more transparency and information symmetry between owners, agents and tenants, as well as disintermediating leasing (i.e. removing real estate agents) and directly connecting owners and tenants. Participants also expressed interest in the use of 'smart contracts'[4] as an escrow system for private rental bonds (despite being contrary to law in most Australian jurisdictions).

If integrated with IoT technologies, smart contracts can also be deployed to manage access rights to properties. The German company Slok.it, for example, is developing blockchain-based IoT systems, including web-enabled locks, that can provide access to properties according to coded conditions. The company hopes to extend these systems to include numerous web-enabled objects. These objects can have their own 'identities' that interact with a blockchain,

[3] 'Proptech' is commonly-used shorthand for property technology.

[4] 'Smart contracts' involve the use of Turing-complete programming languages to write programs that can be uploaded on a blockchain. These software agents can perform transactions between parties on the triggering of certain conditions without intermediaries. Parties pay crypto-tokens into the contract, which holds them until an event or condition triggers their distribution.

meaning secure machine-to-machine transactions may soon extend and transform what we currently think of as the sharing economy more generally.

3.7.3 Incentivising investment

Nascent models of property asset fragmentation may also become commonplace as blockchain technology evolves, creating greater liquidity in property. A number of blockchain companies are creating tokens that represent fractions of a property (including Propy, Atlant, Pangea and LAToken), allowing an owner to sell tokens to multiple investors. Some platforms are building in smart contracts whereby any rental dividends are automatically paid to token holders. For example, Blockchain start-up Pangea claims to be tokenising $100 million worth of real estate assets in the US, as well as in Germany and Dubai. Australian company BrickX allows investors to buy 'bricks' representing a fraction of a property it owns (see also Bricklane in the UK).

The main difference between existing Real Estate Investment Trusts (REITs) and blockchain property tokenisation (other than fees) is that it gives the buyer complete control over their purchases, as opposed to relying on the decisions of a portfolio manager. Those holding property would be able to do so using the same 'wallet' technologies that are used for other crypto-assets. Tokenisation of property, therefore, accords with a blockchain economy in which users of platforms have control over their assets, as well as easily accessible and secure data. While such strategies to increase liquidity may help some smaller investors to invest in real estate for the first time, there are also risks; a particular concern is whether such investors have the information and skills to make financially prudent decisions. Uptake of these tools and underlying business models also risks fueling further housing price inflation in places like Australia, as the next section will discuss. Nonetheless, some blockchain companies are marketing their business model using social equity arguments, claiming the platform provides an entry point into the property market for those who cannot afford an entire property. In addition, it might provide tenants with a means to own a share in the property they live in—a seemingly mutual benefit that would incentivise good behaviour among tenants and owners as the tenants would receive some return if the property is sold.

3.7.4 Transparency in property development

Property development may be transformed by transparency in supply-chains during the contracting and building process. Companies such as Bitrent are promoting blockchain as a means of crowdfunding development and attracting smaller investors, while providing investors with real-time information on the construction process to support investment decisions.

3.8 Blockchain: threats

At present, there have not been significant risks identified with the use of blockchain. The need for significant computing power presents an environmental concern, and blockchain's potential to facilitate greater liquidity in property markets will likely benefit some socio economic groups disproportionately, as argued in works on intergenerational transfers and equity (e.g. Barrett, Cigdem et al. 2015). Perhaps more pressing at this stage, however, is the question of whether blockchain is actually a useful innovation in the housing context.

Most of the blockchain use cases outlined above seek to reduce transactions costs, such as by eliminating the fees associated with purchasing property through smart contracts. At least for now, they do not signify a major change in how property is bought and sold. For instance, start-ups facilitating fragmented ownership in property, or crowdsourcing funding for construction projects, will still need to comply with Australian corporate legislation. Systems of property products or interests represented by tokens might constitute managed investment schemes or share issuances, which require significant compliance with securities regulations. To legitimately

sell tokens representing equity in a property, an owner would need to establish a REIT and keep a register of token owners.[5]

At the same time, home reversion schemes already provide some level of liquidity, by providing home owners with the option of selling part of their equity and forgoing future profits on that share of the property. Co-ownership of property is also possible without blockchain via Tenants in Common legal agreements. Timeshare arrangements are also a financial product that has enabled shared property ownership, along with rights to occupy that property under agreed terms. Equity release (including reverse mortgages) and timeshare products have attracted scrutiny from consumer organisations such as Choice, as well as regulatory agencies (ASIC 2005; de Silva, Sinclair et al. 2016). Similarly, Blockchain securities are already being scrutinised and regulated in many countries, including Australia.

However, the promise of blockchain is that by simplifying the processes involved in selling property, or portions of property, shifts might occur even without substantial regulatory change. While this may benefit some investors, it also raises significant concerns given the underlying characteristics of Australian housing markets. Fractional investment permits a larger number of investors to make far smaller investments, creating a serious risk of fueling house price inflation, and potentially driving greater turnover as investors seek to withdraw their investment. This could lock more people out of home ownership and in turn add further pressure in the PRS.

[5] International experiments seem to be conforming to these requirements: for example, Pangea is working with a REIT to offer tokens in its projects.

4 What do policy makers need to be better prepared for digital disruption?

As the findings outlined in Chapter 3 demonstrate, disruptive technologies present many opportunities for improved efficiency and flexibility in the way both private housing markets and housing assistance mechanisms operate. They also present significant opportunities for more informed decision-making by government, particularly in housing provision and urban planning more broadly. However, as the case study of Airbnb demonstrates, allowing the introduction of disruptive technologies without government oversight risks making private housing markets more inequitable. Furthermore, the review above also highlights a number of other key challenges posed by disruptive technologies that regulators will need to tackle. Of particular note are risks associated with privacy, commercialisation, and a lack of transparency.

The key question for discussion in this Inquiry was how policy makers and regulators can best address these risks, while not inhibiting the exploitation of the opportunities new technologies present. This section suggests some developments that are needed to ensure policy makers effectively manage and take advantage of the likely disruptions identified in this research. In addition, a brief overview of regulatory responses to Airbnb to date is provided, to highlight some possible policy frameworks available to regulators grappling with this challenge.

While the dramatic growth and negative impacts of short-term letting platforms like Airbnb seemingly caught policy makers unawares, it is now clear that they need to be more proactive in preparing for this kind of disruption in future. The research findings suggest a number of required developments in this regard.

4.1 More agile and critical policy responses

Given the increasing digitisation of services and products and the wave of digital disruption that is reshaping housing markets and cities, there is a need for more critical and agile policy setting and review processes. This is to ensure that negative impacts are mitigated early and the positive potential of such technologies is realised, both for the housing sector and society at large.

To date, there has been a paucity of policy and regulations designed to support the use of digital planning tools and data-driven approaches in the formulation of housing and planning policies. Only recently are national plans and recommendations now developing in the context of smart cities, technical disruptions, data ecosystems and state-based regulation. In 2016 the Australian Government published its Smart Cities Plan, the only national plan currently available pertaining to cities. A number of councils have followed suit in developing Smart City strategies (e.g. Newcastle City Council). Yet even with such plans in place, government struggles to keep up with the pace of technological advancements and disruptions. As the example of Airbnb demonstrated, Australian governments have been slow to respond to disruptions to the housing market relative to overseas jurisdictions. In part, this seems to reflect the lack of an underlying strategic housing policy, as well as a desire to be seen as embracing the new digital 'collaborative economy'. The responses to Airbnb also seem to reflect a lack of clarity around which parts of government would lead the regulatory response. Together, these issues meant governments in NSW and Victoria found themselves 'on the back foot' in responding to public concern about the impact of STL platforms.

The lessons learned from the Airbnb case, as well as feedback from policy makers involved in this Inquiry, point to two key changes that governments could make to help ensure they respond more proactively and productively to future technological changes. These are adopting more critical perspectives on the changes occurring via disruptive technologies, and adopting tools to

allow more agile policy responses. More broadly, they point to the need to understand 'private renting' as comprising a variety of renting options facilitated by technological innovation and ranging from the very short term to the longer term, from informal to formal, and including a variety of matching arrangements. This has been described as fragmentation (see Parkinson, James et al. 2018).

More critical policy responses

While fostering a cultural shift towards embracing the opportunities that technology offers is important, it is essential that this does not occur to the detriment of adopting critical perspectives. Instead, policy makers need to be equipped to understand the nature and the potential impact of new digital technologies in a way that is both enthusiastic and critical.

A key lesson from the Inquiry research on Airbnb is that when it comes to entrepreneurial disruptions, policy makers should focus on understanding *the impact* of the technology, as well as the technology itself. While Airbnb is undoubtedly a technological advancement, ultimately it facilitates an economic activity that has long existed—a combination of lodging, holiday rental and serviced apartment rental. In other words, sharing the excess capacity in housing assets is not a new form of economic activity; what has changed, rather, is that new technologies have fundamentally changed the *scale* and speed of this activity. It is the economic activity that should be the focus of regulation, not simply the platform through which it is facilitated. A more critical response of this kind will help to ensure that activities arising due to technological advancement are not unfairly advantaged (or disadvantaged) simply because of their technological underpinnings.

Similarly, in circumstances where big data is harnessed for policy analysis and development, it is important that this data is combined with other types of knowledge, including practice knowledge, consumer experience and early warning indicators. As a result of privatisation and contracting out, government policy knowledge is now increasingly divorced from implementation. While evidence gained from big data is valuable, it is insufficient on its own to justify policy change. Not only are the other sources mentioned above important, but so are processes of dialogue and negotiation to develop a more comprehensive policy understanding.

More agile policy responses

A second key point of discussion among policy makers involved in the Inquiry focused on how governments—not traditionally 'nimble' organisations—can best deal with the rapid pace of technological change. During this discussion, participants noted that there are good reasons why government often takes time to respond to change. The issue is not simply that government is a 'clunky' institution; rather, the time taken reflects the genuine complexity of the landscape government has to navigate, and the broad range of stakeholders involved. In addition, participants noted the need to factor the parliamentary process into decision-making timelines, which can be a drag on response times. It is important to acknowledge these realities in developing strategies for government to respond to technological disruption, so that the strategies are realistic and achievable. Simply expecting government to become significantly more 'nimble', in the way of start-ups or other commercial operators, is likely to lead to failure.

With this in mind, Inquiry participants suggested that while government is unlikely to be well placed to predict or pre-empt technological change, it can do some *higher level thinking* about how it might respond to technologies in different contexts. By developing some key principles and strategic steps—a technological change response 'playbook'—housing policy makers will be better placed to respond proactively and productively to the next change that occurs. Such a playbook would outline not only the pros and cons of different potential regulatory responses, but also steps to manage the early phases of technological change, when the impact is unclear.

This playbook could include a set of key principles such as the following:

1. Undertake regular environmental scanning to identify new and emerging technologies with the potential to impact housing markets and housing assistance programs. Agencies responsible for housing, consumer affairs/fair trading and industry development could jointly undertake this type of scanning on a regular basis, reporting to relevant CEOs and Ministers.
2. Ensure risk assessments are systematic, use best practice principles, and factor in both the upside and downside of technical disruptions. Such assessments need to be focused on the broad *impacts* of the technology, not simply the innovation itself, and be ongoing (as is now needed for tracking the impact of new STL regulations and market responses).
3. Consider co-production/co-design approaches in developing responses to technological disruption, involving key actors from across the community, industry and technology firms (e.g. online property portals, market monitoring companies and specialist rental matching platforms).
4. Examine the potential for smart, performance-based (rather than prescriptive) regulation, that can minimise the negative impacts of disruptive technologies, while also harnessing benefits. This may include an assessment of such regulation in other policy domains and jurisdictions, and how this could be applied to housing policy and housing assistance. Such a review may take a form similar to the international STL regulation review (see Chapter 5 of Crommelin, Troy et al. 2018b).
5. Be particularly attentive to privacy and consumer protection as an important underlying principle in considering regulatory responses, e.g. noting the particular importance of these considerations in areas such as domestic and family violence and rehousing of ex-prisoners, as well as more general concerns.
6. Being responsive to new technologies requires continuous education to equip the organisation to deal with new disruptive technologies through regular workforce training. This includes both specific training in new technologies relevant to housing and housing assistance, as well as broader competency-based training for policy makers and practitioners.
7. Work towards developing an organisational culture that is open to technical innovation. One way to do this is through undertaking pilots in low-risk contexts, which can then be scaled up (while noting that there are often legislative and other constraints on governments in terms of treating people in different situations in the same way).
8. Learn from other sectors outside of the housing and planning domains and be familiar with examples of and responses to digital disruption in different fields, as well as learning from other housing organisations locally and internationally. To be effective, this would require some mediation by inhouse policy and research staff to customise it for the housing context.
9. Ensure the longer-term risks associated with government divesting itself of data assets and management systems are well assessed; these are increasingly valuable assets in a digital age, and private entities may limit future access. For example, such assessments should apply to key digital data on market activity such as rental bond lodgement records, and stamp duty records for house sales prior to on-selling to commercial entities.
10. Develop strategies to bring expertise from across government departments together, to provide a joined-up approach to responding to and generating technologically-driven change in housing policy and assistance in the context of other related domains.

As Inquiry panellists noted, traditional housing regulation has been a blend of regulatory economics, environmental impact management and social policy. These approaches, however, may limit the benefits the housing sector can gain from digital disruption. To reap greater

rewards will require governments to go beyond simply responding to digital disruption and to actually harness it. For example, one panellist suggested moving to regulatory approaches that

> *encourage companies, either through commercial opportunity, incentives or penalties, to augment their products to deliver government and community objectives, not just customer objectives.*

Such an approach may be foreign to those regulators who have traditionally regulated to minimise negative impacts rather than realise benefits (although possibly more familiar to economic regulators). Driving a change of this kind would require a significant shift in regulatory strategy, to introduce a government-led reform agenda that seeds investment to guide industry to create public value (e.g. some form of urban innovation commission model).

Another possibility to facilitate the adaptation of regulations to an era of technological disruption is co-production—a method of collaboration designed to yield greater value (Humphreys and Grayson 2008). Several platforms are already working with regulatory bodies to respond to issues such as unequal access (e.g. the AskIzzy platform) and data privacy (see Cheung 2013; Berthold and Wacks 2003). When co-production principles are applied to public services, services can be developed with the involvement of citizens, community organisations and other affected stakeholders (Alford 1998). ICT advances have made it easier to receive stakeholder input (Humphreys and Grayson 2008) and this field is advancing quickly. Co-production techniques may also assist in building a dialogue that genuinely represents the concerns of citizens, whose motivations for housing and related transport choices will provide valuable information for planners. This approach can also be used to create new data streams that provide decision-makers with more useful, potentially real-time feedback in addition to improving citizen attitudes (Needham 2007). Needham (2007) recommends workshops as one way to facilitate co-production; she also cautions that they may not necessarily work if there is a lack of trust between citizens and decision-makers.

However, achieving significant shifts in regulatory approaches like those proposed here would require cultural change within government, away from a risk-minimisation focus. Such change is never easy, and the complex and justifiably risk-averse nature of governments as public institutions makes such change particularly challenging. In some cases, a first step may be to re-engage with risk not as a binary concept, but as a multifaceted assessment process, which actively acknowledges how failing to take risks can also result in poor outcomes. This is particularly true in respect to technological change. To this end, the Productivity Commission (2016: 102) offers some useful guiding principles in its proposed risk assessment approach, concluding (p.130) that '[t]he public service role should be about identifying the risk factors and risk tolerance levels around new technologies, not about trying to eliminate all risk'.

A potential impediment to embracing risk in this way is that it requires relinquishing control, which our Inquiry panellists noted can be very uncomfortable for government. A number of our panellists noted that the fear of making mistakes is a significant cultural barrier in government, as nobody wants to bear the potential political blowback. This puts government at odds with technology start-up culture, much of which embodies a ‘fail fast, fail often’ approach designed to foster innovation and experimentation. While a complete cultural shift towards entrepreneurial-style decision-making is neither achievable or advisable,[6] there is clearly room for government to become somewhat less risk averse in their response to technological change.

One suggestion from panellists for overcoming this cultural barrier was for governments to pick a small number of policy areas where mistakes are unlikely to prove career-ending for the

[6] Indeed, there have been some very valid critiques of this mantra (e.g. Pontefract (2018), who argues instead for a focus on ‘calmly and intelligently iterating’).

officials involved, and use these areas to pilot a more rapid response/higher risk approach to managing technological change (while noting the possible legislative barriers to this in some areas). There is some evidence to suggest that such approaches can be successfully implemented within government, despite the barriers presented by risk-averse organisational culture (Productivity Commission 2016: 131). Such approaches can also have broader benefits beyond the pilot project area itself, if learnings about the benefits and challenges of undertaking such pilot projects within government are shared broadly. Once the benefits of the piloted approaches become clear, it will become easier to upscale or roll out similarly technology-driven approaches in more sensitive policy areas. At the same time, a pilot-based approach of this kind may also better equip policy makers to predict the unintended consequences of technological change. This is a skill that panel members suggested has not been a strength of government in the past, and which contributes to risk aversion in subsequent cases.

4.2 Integrated and well-resourced data assets and infrastructure

What is paramount for the realisation of many disruptive technologies is the ability to access fine scale data, whether it be property information or personal information. In an era of open and real-time data, we are on a trajectory to make accessible new data assets that could support further smart city application development. The housing system is a key component in this transformation process. Housing-focused digital platforms like AskIzzy, Wattblock and Powledger, provide good examples of what is possible when data is made accessible.

While much work has been done in opening up property data assets across governments, significant work is still required on data standards, interoperability and data sharing across government, industry and the non-profit sectors. There are, however, institutional and structural blockages in terms of policy, infrastructure, finance, data quality and legal considerations. Data quality is of particular concern. One Inquiry panellist argued that usable, comparable, accurate data is the fundamental building block for all technological development, and that without ‘data maturity’ little progress would be achieved. In other words, when it comes to technological disruption, 'you’re only as good as your data'.

Providing access to de-identified data for public good, such as research, can help to highlight improvements required to ensure quality in administrative data, as well as new opportunities to benefit from existing data assets. As the Productivity Commission (2017: 2) notes, '[t]he substantive argument for making data more available is that opportunities to use it are largely unknown until the data sources themselves are better known, and until data users have been able to undertake discovery of data'. Providing access to researchers for the purposes of exploration and optimisation avoids many of the risks associated with providing government data to commercial operators. Such arrangements already exist in the housing context (e.g. https://cityfutures.be.unsw.edu.au/research/projects/national-strata-data-analysis/) and can incorporate confidentiality restrictions on storage and sharing of data, as needed. The ‘Five Safes Framework’, already adopted by a number of Australian government agencies including the Australian Bureau of Statistics, provides key principles for achieving a balance between data sharing and data security (ABS 2017b) in such arrangements.

Meanwhile, we are now seeing increased momentum in industry to acquire and value-add to existing government data assets. These commercial data assets offer potentially significant benefits for both government and the non-profit sector, including CHPs. However, because it can be costly to purchase, such commercial data is often not fully used. Governments need to be more proactive and forward-thinking in negotiating (or regulating) access to such datasets for the benefit of their constituents, particularly in circumstances where they build on existing government assets, and where users cannot afford the commercial rates charged. Similarly, the research has found there are barriers to technology uptake in certain sectors due to software licensing costs, which exacerbate existing limitations based on what software is supported.

Also in the area of data, there are opportunities for policy to support better two-way flows between contributors and collators. For example, housing providers might already provide data to government agencies, but rarely receive access back in the form of aggregated or value-added data products created across government agencies. Identifying opportunities to support these kinds of exchanges will help to facilitate better data collection and aggregation outcomes.

4.3 Data and privacy protection policies

A key tension raised by the push towards open data is the risk of compromising personal data. This could result in many negative outcomes including identity theft, inequitable treatment (by both government and business), and violations of civil rights and freedoms including discrimination and exclusion from housing. Indeed, the use and protection of personal data is of critical concern even where datasets are not open source.

Furthermore, inadequate systems in this regard can provide a roadblock to innovation. For example, in the context of social housing allocation, some research participants expressed a desire for a common waitlist-type vacancy listing—already in place in the private rental sector—so that potential social tenants may be better matched with available properties not managed by their existing provider (or their immediate professional network). If the decision were made to facilitate this, state level policies and client and property management databases would need to be updated to allow for the creation and sharing of such real-time vacancy listings. Protocols would also need to be developed to ensure data security—potentially with the assistance of blockchain technologies—of both the applicants and the providers.

Currently, state agencies and private entities are limited in terms of how they deal with data through federal and state data protection legislation, which is yet to catch up with the evolving nature of emerging technologies and the data that they create, access, manipulate etc. This is on top of many datasets being kept in organisational silos under cloaks of commercial-in-confidence. In addition, privacy legislation is fragmented across the country, making it complicated to implement technology projects with privacy implications at the national level. The growing importance of data in how both society and government operate justifies a reconsideration of how these regimes are structured, and what they are designed to achieve. One possibility for reform proposed by a panellist would be to shift away from a focus on protecting privacy towards a focus on ensuring meaningful informed consent from participants. Given the controversy that often arises around what constitutes ‘informed’ consent and protection of privacy (see, for example, the ‘opt out’ system for electronic MyHealth records), this approach may ultimately pose too great a risk to personal privacy and security in some circumstances. Nonetheless, exploring a paradigm shift of this kind does offer a different perspective from which to consider what privacy restrictions are ultimately aiming to achieve, and how well equipped they are to do so.

Finally, another panellist highlighted the benefits for government of decentralisation of data concentrations and data centres in certain circumstances. This can enhance the security of data assets, by ensuring they are not all stored in a single location. While this data management model could incentivise the development of more Local Government Area-level data sets (which can offer planners different insights to metro-level data), it would be essential that standards and procedures are in place to ensure locally-produced data can also be integrated into aggregated datasets, and that personal information is de-identified.

4.4 Policy frameworks to enable digital transparency

As well as policy frameworks to ensure data interoperability, the process of embracing technological disruption will require governments to develop policy frameworks to ensure data

transparency. Currently, platforms and applications are often opaque in their design, leaving citizens unaware of how decisions are made. To address this, policies and procedures that enable open source software are recommended. Open source software facilitates transparency as to how governments are using technology, by allowing review and critique by third parties.

Similarly, where proprietary solutions are used, or commercial third-parties engaged to provide digital solutions for government, there is a critical need for policies and procedures to allow external review of the processes, algorithms and datasets being used. As the Inquiry research on Airbnb demonstrates (Crommelin, Troy et al. 2018b), a lack of public access to data regarding major technological change can significantly undermine efforts to develop appropriate and effective regulatory responses. One solution may be the adoption of 'notificatory' regulatory tools, which require either providers or users to notify government of key details regarding the use of a technology, to enable ongoing monitoring and analysis.

In the absence of adequate technological transparency, there is also a significant risk that social, cultural and political biases may become embedded in technological processes, whether deliberately or inadvertently. The recent evidence of racial bias affecting the options available to Airbnb guests is instructive in this regard (Edelman, Luca et al. 2016). Research on implicit bias highlights how easily such biases can shape decision-making (Payne, Neimi et al. 2018); this extends to decision-making about technological design and processes, particularly where the complexity of the product is likely to prevent such biases from being easily identified (Spielkamp 2017). Unless systems are put in place to protect against bias being built into technological tools, this risk adds further support to concerns regarding the suitability of automation technologies if applied to services for vulnerable groups such as social housing tenants. Strategies to combat this issue could include technological skills training for project managers, to ensure they understand the back-end development of new systems serving vulnerable groups; implicit bias training for technology staff and contractors; and requirements that key assumptions underpinning technology and modelling be made transparent.

4.5 Upskilling of policy makers and regulators

The research also uncovered an identified skills gap in both government and industry being equipped to work with new emerging digital technologies. There are significant limitations in the internal capacity of housing agencies and organisations to afford regular upgrades and training to ensure staff can operate constantly changing systems. This results in an uneven market where entities with the financial means to invest flourish (e.g. large private sector companies), while others lag behind (e.g. CHPs). This potentially compromises the quality of decision-making and housing assistance client outcomes. Clients themselves differ in their capacity to engage with technology-based market matching platforms as they navigate their access to housing (Parkinson, James et al. 2018). Upskilling of policy makers and government employees will reduce the need to outsource key data management tasks, thus minimising the risk of government being left without the capacity to adequately manage its own digital needs.

Some of the technologies described in this paper—blockchain, digital planning tools, automation—are at an early stage of development. While these are already showing promise in influencing the provision of housing products and improving the efficiency of management, their real impacts may only be realised after key financial and legal issues are resolved, and when upskilling has been addressed. Policy makers also need to consider the impacts of emerging technologies not directly related to housing services, such as Uber and Deliveroo, which can destabilise vulnerable groups' financial positions through 'gig'-based engagements. This can have lasting impacts on individuals' ability to sustain tenancies, access housing loans, and cover living costs, and may subsequently have far broader effects than any technological and policy interventions anticipate.

Embracing digital disruption would also involve policy makers developing a new economic literacy concerning matching markets, as well as improved technological skills. As Parker, Van Alstyne et al. (2016) and Evans and Schmalensee (2016) suggest, understanding of matching markets by entrepreneurs has often been intuitive, rather than the result of putting theory into practice. Government, on the other hand, has been at the forefront of developing certain matching markets, bringing together theorists and practitioners. But these efforts are siloed, with the learnings failing to permeate more broadly through government. There needs to be investment in the intellectual capacity to reimagine a whole swath of service provision and markets, to position government as leaders and facilitators of positive technological change, rather than being reactive and ill-equipped to respond.

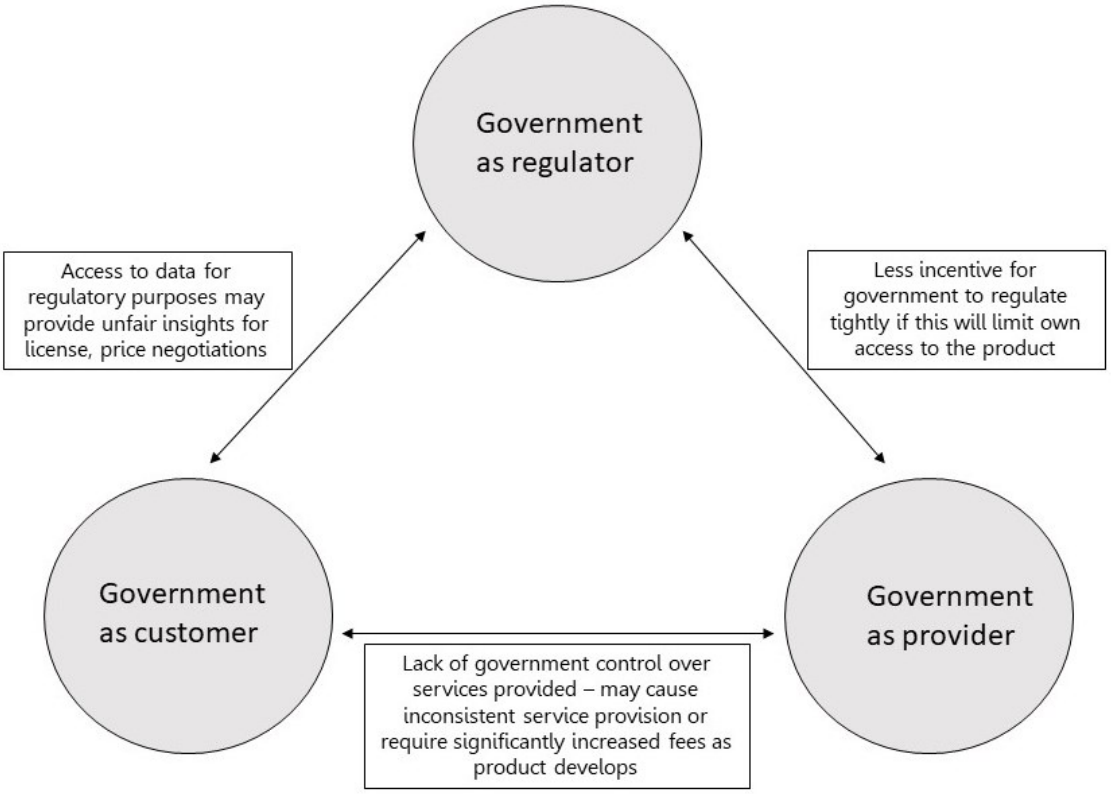
4.6 Strategies to manage relationships with corporate providers

The increase in digital transactions, combined with the capability to inform consumer behaviour, creates market advantages for those who can access the data. This has led to an increase in specialist data firms able to offer better quality and more complete data. There are, however, pressing concerns over recent sales of government data sets and data stores such as land title registries to the private sector, allowing private companies to profit on public data records and limit access to other potential users with a paywall. The risks associated with such strategies will only increase as the value of data continues to grow, and government may find itself increasingly hampered by past decisions to divest data assets and management systems. Such decisions may also constrain research by universities and non-profit organisations, who are in a good position to test the data and provide independent interpretations not based on commercial considerations.

Furthermore, as government embraces new digital technologies, it will increasingly find itself in the challenging position of being simultaneously customer (of a technology firm), provider (of a digital service using the technology firm's software, data or platform), and regulator of transactions taking place via the digital technology. There are inherent tensions in these multiple roles, particularly between the roles of regulator and provider (see Figure 5 below).

A panellist suggested one possibility for mitigating these tensions was to explore the potential for NFPs in the housing sphere to act as intermediaries between government and the corporate sector, or even as alternative providers to government. The potential effectiveness of such arrangements reflects the trust that many NFPs have built up with government and the community, and the fact that they are often smaller, more nimble organisations. As a result, NFPs may be viewed as a more trustworthy and efficient option than outsourcing to the corporate sector. Of course, these assumptions would need to be tested.

Figure 5: Tensions in government role re technology



Source: Authors.

4.7 Regulation to prevent market-based discrimination

Last (but not least), government needs to be aware of the increasing ability of market providers to use data to take an actuarial approach to risk in markets. In essential service markets, low-income, vulnerable households may be at risk of being subject to higher fees and charges, assuming they can access services at all (see Sharam 2007; Hulse, Martin et al 2018; Parkinson, James et al. 2018). Residential tenancy databases are an example of how a low credit-score can contribute to exclusion from services. The risk of bias being built into such actuarial assessments by market providers is also significant (see the related discussion at 4.4 above). Regulators should consider whether imposing transparency or oversight requirements in these market contexts can help to minimise the likelihood of such inequities arising.

The actuarial approach is currently being used to create a market where one did not previously exist. Fintech products such as Trustbond and Snug offer households deemed a good credit risk the opportunity to pay non-refundable cheap insurance instead of paying a bond. The credit rating includes assessment of the tenant's social media postings. Tenants not considered a good credit risk will not be able to purchase such insurance, and will need to provide a bond (Hulse, Martin et al 2018). In Sharam's (2007) terminology, these tenants will be residualised in a provider of last resort scheme, paying the highest price in the market. A further effect of these products will be declining revenue from interest on bonds held in trust by governments. These bond funds are currently used to support a range of measures supporting rental housing, and in Victoria, these funds increasingly support construction of new social housing.

The traditional solution for insurance is to pool the risks, so that low-risk customers pay for those who make a call on the insurance, and every attempt is made to exclude those who are

likely to be a risk. The latter concern is precisely why public insurance developed (Medicare is an example), with universality enabling the cross-subsidy that is a key feature. Market-driven products like Trustbond, however, are likely to undermine the capacity of government programs to provide the cross-subsidies required to make such schemes viable.

5 Final remarks and next steps

While we now live in an era of big data, cryptocurrencies, and digital matching market platforms, adoption of digital technologies and data-driven solutions to support the housing sector remains a slow process. This Inquiry has identified significant opportunities to improve and modernise parts of the housing system through policies that embrace and support the development, testing and adoption of technological tools and data-driven solutions.

However, a proactive government response does not mean simply adopting a hands-off, deregulatory response to technological disruption in the housing sector. As the example of STL has shown, a laissez-faire approach can mean a risk of new technologies exacerbating existing affordability and exclusion issues in our housing system. For vulnerable communities, particularly, it is essential to consider whether technological disruptions will cause more harm than good. Governments must develop appropriate regulations and policies to ensure that technological interventions will not drive further social inequality.

To help governments do this, this report proposes that as a first step, housing agencies and organisations prepare a 'playbook' of key strategic steps for responding more proactively and productively to technological change. This document should set out key principles and priorities that need to underpin any response to new technologies. It could also identify potential short-term strategies to manage the immediate response to a disruptive technological change, as well as options for regulatory responses in the medium-term, and longer-term cultural changes to equip the organisation to respond more effectively and efficiently in future.

Of critical concern is the assurance of data accuracy, security and oversight. Housing is often people's most valuable asset, and the housing sector must ensure that related data is secure, as misuse can have significant short and long term consequences. Governments also need to affirm that technological advancement does not mean that critical information is only made available to those with financial means to access it. This includes ensuring ongoing access to deidentified data for organisations like universities and non-profits, which provide essential oversight and analysis of the housing sector. These roles will only become more important in the light of the increasing complexity that accompanies technological disruption.

If these key challenges are tackled effectively, the digital revolution presents many opportunities for government to use emerging technologies such as digital planning tools, matching market platforms and housing-related big data sets to address growing social inequities in housing opportunity, affordability and security.

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Appendix 1: Table of threats and opportunities

	What?	Technology	Market	Barriers	Policy Intervention	Outcome
Threat	Airbnb	Platform	Matching market for private housing short-term lets	none	Regulation required to minimise disruption to private rental markets through reduction of available stock	Reduced availability of private rental stock (both entire and shared properties); reduced amenity for strata residents where significant short-term letting exists
Threat	TrustBond	Big data	Credit rating service for private landlords/ insurance substitution for bond payment	Permit private landlords to avoid tenants who are not credit worthy. Permits credit worthy tenants to buy insurance rather than pay a bond.	The response in other markets has been to ignore exclusion or exploitation, and to allow key essential services by monopoly suppliers through the creation of provider-of-last-resort schemes (e.g., universal services provisions that tend to guarantee service but at a non-competitive rate).	Tenants who are not credit worthy are likely to be excluded from the mainstream PRS and will rely more than ever on social housing and marginal housing types. Bond loan schemes will see a substantial fall in interest earned as credit worthy tenants abandon payment of bonds in favour of cheaper insurance
Opportunity	Social housing swaps and transfers	Platform	Matching market for swaps and transfers to promote tenant mobility	Lack of policy support	Design and implementation of program including mechanism design	Savings likely hundreds of millions of dollars through improved tenant and tenant families' health, tenant employment participation, asset protection, reduced crime
Opportunity	Housing Hub	Platform	Matching market for accessible housing for sale or private rental	Poor discoverability of accessible housing	Support expansion of existing Hub	Creation of inventory of accessible stock; reduced loss of accessible stock; increased access to accessible stock for rental or purchase.

What?	Technology	Market	Barriers	Policy Intervention	Outcome
			Lack of accessible housing inventory Loss of accessible housing		Provision of information to market for the development of accessible stock
Private rental housing	Platform	Head lease/Brokerage scheme to allocate affordable private rental stock to lowest income households	Requires shallow subsidy	State governments required as implementation agency to set target for number of dwellings. Administration by community agencies.	Reduction in housing stress
New quality apartment supply for modest/middle-income households	Platform	Matching market for presales. Deliberative development.	Oligopolistic private development industry unlikely to pass on savings	Government support the establishment of a matching market platform Government surplus land offered to deliberative developers Stamp duties and GST reform to support deliberative developers.	Provision of well-designed, quality apartments for purchase at 15–30% discount to market price
Urban renewal	Platform	Matching market for city-wide coordination of greyfield renewal	Signification transaction costs prevent individual developers from undertaking greyfields renewal	Government design and implementation required	Permits discovery of interested landowners and their preferences. Permits value sharing. Enables identification of localities that are ‘ready-to-go’ permitting sequencing of projects and infrastructure planning.

What?	Technology	Market	Barriers	Policy Intervention	Outcome
					Cost-effective mechanism for managing engagement over a long period.
Blockchain	Distributed transaction ledger	Property rights management; private rental; property development	Significant computing power required	Critical assessment of whether outcomes with blockchain actually improve current (robust) systems	Reduced fraud; more efficient private rental management systems; greater investment in housing development through new investment models
Big data and data infrastructure	Open source datasets; automated systems; data swap shops; semantic analysis	Government housing data management; urban planning	Cost of commercial data sets; limited development of open source datasets	Policies to ensure transparency of automated systems; privacy protection; data integrity checks	More efficient, data-driven government decision-making; e.g. automated preliminary review of development applications
Locational intelligence tools	GIS-based visualisation tools (e.g. Envision; RAISE)	Urban planning (both commercial and government)	Cost of commercial tools; relatively nascent university-led developments	Greater funding and support for development of tools for government use	Improved urban planning outcomes through visualisation and prediction of likely impact of planning decisions

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