*Smart Homes*

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# introduction

‘In case you are wondering what ‘smart’ – as in ‘smart city’ or ‘smart home’ – means: Surveillance Marketed As Revolutionary Technology’.[[1]](#footnote-1)

Are smart home devices like vampires? … First, to feed their thirst for intelligent generation – that is, to be smart – smart devices must suck up data. Second, smart devices cannot enter the home unless invited. Thus, any claims of intrusion or invasion shall be met with an invocation of consent. According to some sources, vampires also could exert mind control over their victims.[[2]](#footnote-2)

Smart technologies are everywhere, including the home. Smart homes are part of the National Health Service’s Healthy New Towns programme, running since 2015.[[3]](#footnote-3) In 2016, the National House Building Council Foundation (NHBC Foundation) published a report, *The Connected Home: Designing and Building Technology into Today’s New Homes*,[[4]](#footnote-4) outlining methods of integrating smart technologies in new build homes. More specifically the 2017 Department for Business, Energy & Industrial Strategy (BEIS) Report: *Heat in Buildings: Boiler Plus*,[[5]](#footnote-5) set out a requirement for smart boilers (with problematic implications discussed below).[[6]](#footnote-6) In his first speech to the United Nations, the Prime Minister, the Rt Hon Boris Johnson MP, drew a typically florid picture ‘in the future, voice connectivity will be in every room and almost every object: your mattress will monitor your nightmares; your fridge will beep for more cheese.’[[7]](#footnote-7) This echoed the NHBC Foundation report’s reference to ‘fridges [that] … automatically order more milk’,[[8]](#footnote-8) a technological development at least two decades old,[[9]](#footnote-9) and rightly subject to comic critique.[[10]](#footnote-10) Most recently, a report for the Institute of Engineering and Technology on children’s views of the future showed ‘sentient homes’ to be top of the list.[[11]](#footnote-11)

There are numerous potential legal aspects of this evolution.[[12]](#footnote-12) There are obvious privacy implications,[[13]](#footnote-13) security risks,[[14]](#footnote-14) and various direct and indirect harms caused by malfunctioning or misused devices,[[15]](#footnote-15) including outward facing problems where smart objects can affect wider networks.[[16]](#footnote-16) A cautious welcome can thus be given to recent legislative proposals, which would enforce three security requirements: unique (non-default) passwords, a public point of contact for manufacturers of internet of things devices, and obligations on manufacturers to state the minimum length of time security updates will be provided.[[17]](#footnote-17)

However, despite a growing literature critiquing the extent to which smart objects can be controlled by third parties’ (invariably corporations) controlling software,[[18]](#footnote-18) there is very little available as to the impact of smart objects as part of a smart home. Smart goods have tangible aspects, but they rely on software which the material doctrine on fixtures cannot accommodate. Smart goods can project data around the house, giving rise to the possibility of virtual fixtures, ie fixtures which do not have individual tangible existence, but which are intrinsically connected to the tangible land. Smart homes may also have an income-generating function, through selling of data captured by smart objects or by the generation of products through 3-D printing (for example). The effects of smart technologies on the home, especially how they may lead to a technological creep which could restrict our capacity to make choices about our home, needs examination.

This chapter therefore considers the implications of smart homes, to try to avoid the dangers of path dependency resulting in analogue regulation of digital life,[[19]](#footnote-19) by identifying and addressing two interlinked issues generated by the possibilities of smart homes. First, how may the ‘smartness’ of things affect their status as a fixture? Second, to what extent do smart technologies impact on the formation of a ‘home’? Before that, it is necessary to try and understand what exactly is meant by the term ‘smart home’.

# SMART HOMES

The meaning of ‘smart home’ is unclear. The NHBC Foundation’s 2016 *Connected Home* report, as its name suggests, conflates connectivity with smart homes,[[20]](#footnote-20) but the two are not the same, as Finding and Taylor note:

it’s more than a home with a connection of smart devices, and it’s more than a connected home. In essence, a smart home, or smart house, is a home that incorporates one or more communications networks that connect its key electrical appliances and services and allows them to be remotely controlled, monitored and accessed by its inhabitants.[[21]](#footnote-21)

This description is generally sound, but its focus on the controllable, accessible and monitorable nature of technologies arguably misses a key component of smart objects, that is, responsiveness. Finding and Taylor also use the term ‘integrated’ – here it is suggested ‘embedded’ is more accurate. An alternative, brief (and admittedly tentative) definition of a smart home is suggested: residential houses (homes) that utilise technologies embedded into the physical structure, where such technologies are able to perform tasks (i) automatically; (ii) remotely; and (iii) responsively.[[22]](#footnote-22) It is worth examining this further.

The first point is that the focus of this definition, and this chapter, is on residential homes. The distinction is thus between smart homes and smart buildings, a division deliberately chosen to enable focused analysis of the concept or status of ‘home’. The second point is that the relevant technologies are ‘embedded’ into the physical structure. This issue of attachment seems resolvable through the fixtures doctrine. However, that doctrine is arguably only viable in an analogue context. The third point is the capacity of smart homes to perform tasks automatically, remotely, and responsively, the latter capacity being central.[[23]](#footnote-23) Without the capacity to act responsively, there is no true smart object or smart home.[[24]](#footnote-24) It is the ability to respond to changes in the environment (understood in a broad sense, thus including actions by humans and other objects) which distinguishes a smart object from something that is merely acting automatically or remotely. Conversely, automatic and remote performativity are not core to the notion of a smart home, but they remain of substantial importance. Should either be absent it would be difficult if not impossible to consider the home as ‘smart’. This third point is related to the first point, in that it impacts on what it means to have a smart home.

This chapter addresses a gap in the literature. Finding and Taylor’s brief outline is one of only a very small number of legal articles dealing with the notion of a smart home. A search (21 July 2020) for ‘smart home’ on Westlaw revealed around 22 results, of which short practitioner commentaries dominate. The sole substantive work appears to be Basarudin, Yeon and Yusoff’s 2018 article ‘Regulating smart home technology devices under Malaysian legal framework’, offering a useful overview of the nature of smart technology in the home, outlining the possible protection from Malaysian (and briefly, English) consumer law for defects, as well as privacy and security issues.[[25]](#footnote-25) They did not however deal with the issues discussed herein. Searching ‘smart home’ on SSRN (limited to the Law network) and HeinOnline also failed to reveal anything related to the current topic, with most articles focusing on privacy and security issues. This chapter illustrates the dangers of an uncritical application of the fixtures’ doctrine, and the status of home, in light of the problematic relationships between different rights holders of real, personal, and intangible property.

# FIXTURES: FROM DUMB THINGS TO SMART OBJECTS AND VIRTUAL FIXTURES, AND SMART HOMES

Delineating between goods and land helps us undertake a meaningful examination of what exactly land is, which aids our understanding of broader questions of economy and society. From a narrower perspective, such a delineation helps ascertain the value of land or other assets. However, land law’s general tendency to focus on financial aspects arguably restricts attempts to elucidate and build on land’s capacity to generate, support and express non-financial values,[[26]](#footnote-26) and this can be seen in the specific context of fixtures.

The law on fixtures, at first glance, appears straightforward, so it is perhaps unsurprising that *Megarry and Wade* devotes just ten pages to the topic,[[27]](#footnote-27) Whether something is a fixture or a fitting depends on the nature of the attachment to the land (and thus depending on the nature of the goods and the nature of the land itself).[[28]](#footnote-28) Something very heavy can be attached by virtue of its weight alone,[[29]](#footnote-29) whereas lighter objects will require some form of connection such as bolts or screws. At a general level the test is usually presented as depending on the degree and purpose of the annexation of goods to the land. It is also seemingly straightforward that any conveyance of land shall operate to convey the fixtures themselves.[[30]](#footnote-30) However, the doctrine is not as clear and coherent as it might appear.[[31]](#footnote-31) The development of the law on fixtures, with side-stepping to avoid difficulties posed by formalities vis-à-vis security rights over goods,[[32]](#footnote-32) means it remains heavily focused on protecting those with commercial interests in the land (as opposed to consumer interests, or those with interests in goods).[[33]](#footnote-33) Another difficulty is that goods necessarily attached in order to actually work properly, such as a computer controlled woodworking machine,[[34]](#footnote-34) ‘remain chattels, unless (perhaps) it can be shown to be installed for the permanent improvement of the premises.’[[35]](#footnote-35) The doubt suggested by the use of ‘perhaps’ is significant, given the centrality of intangible technology to smart homes. Can the analogue fixtures doctrine, reliant on tangible concepts of affixation, provide an appropriate legal mechanism for governing the development of smart homes?

## From Smart Objects to Smart Homes: A First Glance at Flawed Regulation

The necessary interconnectedness of objects, people, and environment generates novel techno-social environments.[[36]](#footnote-36) Some smart objects straddle a boundary between goods and realty, as they may only be a valuable (or even viable) product when connected to (or contextualised by) realty.[[37]](#footnote-37) Amazon has developed a number of smart objects that sit at this boundary, such as a cat-flap that prevents cats carrying prey from entering,[[38]](#footnote-38) a doorbell security system that can and does log its interactions,[[39]](#footnote-39) a seemingly different system which enables third person couriers to open doors for deliveries,[[40]](#footnote-40) as well injecting its Alexa system into a swathe of other things. There are of course various other general home hubs such as that from Google, or more focused systems such as Centrica’s Hive.[[41]](#footnote-41) Other types of smart objects worth thinking of in this context might include robotic vacuum cleaners,[[42]](#footnote-42) and even robotic furniture.[[43]](#footnote-43)

Going beyond smart objects that need to be located within a house to be worthwhile, it is possible to conceive of smart homes where technologies are actually built into the structure. Smart objects can be easily inserted into the fabric of the building at the outset,[[44]](#footnote-44) whilst retrofitting even large smart objects, such as battery walls,[[45]](#footnote-45) is also possible. Given proposals that would require all new homes to be built with car charging points have been made,[[46]](#footnote-46) and developments in the field of battery technology,[[47]](#footnote-47) there will be a clear impact on housing development.[[48]](#footnote-48) A further illustration concerns photovoltaic power generation. Technological developments are driving a shift away from the classic solar panel, attached onto a roof, to sprayable or paintable materials.[[49]](#footnote-49) Additionally, smart plugs which provide connectivity between smart objects clearly exist on a fuzzy boundary between fixture and fitting (and certainly sit neatly between the battery-wall and car-charger examples).[[50]](#footnote-50)

However, these examples fail to provide any coherent meaning to the term ‘smart home’, and potential legal difficulties can be identified. A particularly sharp example is drawn from the trade magazine for registered gas engineers, with an opinion piece from Dean Jepson, the managing director of a company dealing in heating and smart home appliances, arguing that the relevant part of the Building Regulations concerning heating (known as Boiler Plus) is flawed.[[51]](#footnote-51) Boiler Plus started in April 2018 and set out new standards in efficiency, and also involved the novel requirement for timers and room thermostats. There have been difficulties with these regulations though, which ‘lies in the simply – yet wholly misleading – definition of a smart thermostat under Part L of the Building Regulations.’[[52]](#footnote-52) Smart thermostats are required under Boiler Plus for new installations of combination boilers, but ‘Part L’s definition of a smart thermostat is one that does NOT require remote control or internet connectivity.’[[53]](#footnote-53) This apparently led to a ‘trade war’ with ‘unscrupulous manufacturers’ using this regulative error to sell seemingly compliant but otherwise non-connected, dumb equipment of limited practical value.[[54]](#footnote-54) Jepson wondered ‘who will compensate’ customers that had purchased and installed seemingly compliant (under the old flawed regime) goods in the event that the anticipated review by BEIS altered the definition of ‘smart’.[[55]](#footnote-55) BEIS said they would review Boiler Plus in April 2019; this does not yet appear to have occurred, though there has been a clarification that the Boiler Plus standards are mandatory without the option to opt-out.[[56]](#footnote-56)

The requirement for smart boilers draws from the Domestic Building Services Compliance Guide (DBSCG),[[57]](#footnote-57) which states that for replacement combination boilers, a ‘smart thermostat with automation and optimisation’ is a potential required measure.[[58]](#footnote-58) The term ‘smart’ is not defined, but automation and optimisation are. Automation is ‘a control function which automatically adjusts time and temperature settings based on occupancy detection and/or stored data from user adjustments over time’. Optimisation means ‘a control function which starts the boiler operation at the optimum time to achieve the set point temperature at the start of the occupancy period.’[[59]](#footnote-59) The Heating & Hotwater Industry Council’s (HHIC) guidance on Boiler Plus,[[60]](#footnote-60) drawing from the BEIS *Heat in Buildings* policy document of 2017 which outlined the Boiler Plus scheme,[[61]](#footnote-61) noted ‘there is no widely accepted definition of what ‘smart’ entails.’ Nevertheless, whilst the potentially confusing nature of smart controls was highlighted by respondents to the *Heat in Buildings* consultation,[[62]](#footnote-62) the requirement for ‘smart controls with automation and optimisation functions’ was deemed acceptable.[[63]](#footnote-63) The *Heat in Buildings* report defined smart thermostats as ‘products that let consumers remotely control their home temperature via a tablet, smartphone or desktop’.[[64]](#footnote-64) A device which is both automatic and optimizing in accordance with these meanings is, for the purposes of this area of regulation, a smart thermostat.[[65]](#footnote-65) Although there is no specific requirement for connectivity, there is the implied connectivity through reference to operation via smartphones and so on, which Jepson rightly noted is at best contradictory.[[66]](#footnote-66) The weight placed on the concepts of automation and optimisation is considerable. Whilst automation by itself cannot really be considered ‘smart’, it might be that optimisation could provide some useful grounds. On this point it is worth comparing the DBSCG definition given above,[[67]](#footnote-67) with that provided by the BEIS *Heat in Building: Boiler Plus* report that preceded it: ‘Optimisation means the device calculates how long it takes the property to reach the desired comfort level, and times the system’s operation to minimise the amount of work it has to do. Usually it also modulates the output of the boiler in a similar way to load compensation, so as little fuel as possible is consumed.’[[68]](#footnote-68) Compared to the DBSCG definition, this comes closer to the notion of responsiveness that arguably is central to ‘smartness’. This discrepancy generates substantial questions as to whether the requirement for smart boilers is merely semantic as opposed to substantive.

In April 2018 following introduction of the Boiler Plus regime, BEIS issued an FAQ document,[[69]](#footnote-69) explaining the limited definition of smart thermostat in the DBSCG:

BEIS considers smart thermostats to be products that let consumers remotely control their home temperature via a tablet, smartphone or desktop for greater control over the central heating system. The wording of the [DBSCG] does not reiterate this description, as there is no one definition of smart technology that is accepted by all. However, there is a common understanding amongst consumers and traders of what it means for a product to be smart. This generally requires some form of wider connectivity, potentially over the internet, and the Boiler Plus policy document is in line with this interpretation.[[70]](#footnote-70)

It also states the following about the definition of automation:

The term ‘automation’ is used in different ways across smart industries. A broad interpretation can be applied to Boiler Plus, and ‘stored data from user adjustments’ includes user preferences that have been entered manually. Some smart controls monitor and learn preferences, rather than relying on manual input. It is important to understand that in this context the device must be smart, irrespective of whether user preferences are entered manually or automatically, and must include optimisation, as defined in the 2018 amendments.[[71]](#footnote-71)

The best that can be said about this is that those who sell ‘smart’ boilers or thermostats, and those that buy such things, will at least have something that might connect to the internet and can select an optimum time to turn on the heat.[[72]](#footnote-72) Whilst it seems clear that there are difficulties in ascertaining the meaning of ‘smart’, and ‘smart homes’ must remain an allusive concept to some extent, it is possible to frame smart objects as distinct from other, dumb, objects.

## Smart objects/homes should not be treated the same as dumb goods/homes

Smart objects are different because they contain software. However, while all smart objects contain software, not all objects that contain software will be smart. Smart objects require software acting autonomously based on its own interpretation of data measured or received by the said object. What ‘interpretation’ or ‘autonomous’ might mean, is a fascinating question, but perhaps best left to the philosophers (and/or software engineers), at least in the context of this chapter. This chapter is not about what smart software is; indeed, the meaning of software per se remains unclear.[[73]](#footnote-73) Rather, is the presence of smart software enough to distinguish between smart objects and dumb goods, for the purposes of thinking about fixtures and fittings within a smart home? The first stage of this task is to consider the nature and impact of software when embedded in tangible things.

The presence of software in goods creates problems as between IP rights holders and others with interests in the goods. While contractual mechanisms can help delineate rights and obligations, such relationships only have personal effect; it is with IP law that we begin to see the generation of some sort of proprietary form to this ‘ownership’. The capacity of IP rights holders to control smart goods, by virtue of IP rights over the software, has been subject to some critique,[[74]](#footnote-74) especially as courts refuse to extend principles of first sale or exhaustion to digital assets.[[75]](#footnote-75) Nevertheless, IP rights holders may simply move to controlling goods via contract and licensing,[[76]](#footnote-76) or by application of trade secrecy protection,[[77]](#footnote-77) rather than IP law per se, notwithstanding the formal limitations of personal obligations. Theoretically, contract bargaining would lead to a relationship or agreement that meets both parties’ expectations. However, well-known problems with unequal bargaining power, and the psychological reality that default settings are ‘sticky’ and are invariable left alone,[[78]](#footnote-78) (going beyond the issues covered by the forthcoming legislation concerning default passwords),[[79]](#footnote-79) means that even if there is a fair agreement, what may matter more is the inability to vary that relationship in the event of circumstantial and contextual variation in the future.

The impact of IP rights holders on smart homes could cause problems. Two brief illustrations suffice. First, there are numerous instances of smart objects effectively being ‘bricked’ (that is, an object is reduced to the functionality of a brick due to the absence of working software),[[80]](#footnote-80) sometimes for quite deliberate purposes,[[81]](#footnote-81) though sometimes ordinary error has this effect with potentially harmful results.[[82]](#footnote-82) Second, there is the increasing tendency towards access being determined on a running basis, with subscription outweighing ownership.[[83]](#footnote-83) Moreover, goods with software which require permanent rather than intermittent access may be transferred for use but without title or ownership also flowing, or with a strong buy-back or recapture mechanism.[[84]](#footnote-84) Digitalisation therefore provides the supplier with capacity to monitor, and possibly even control or shut down the asset.[[85]](#footnote-85)

An orthodox reading and application of fixtures doctrine shows that third party agreements as to ownership of goods cannot survive accession of the goods to the realty. This was clearly indicated by the fate of the third-party boiler supplier in both *Holland v Hodgson*,[[86]](#footnote-86) and *Melluish v BMI (No 3) Ltd*.[[87]](#footnote-87) Regardless of whether such cases actually do tell us anything about what a fixture is,[[88]](#footnote-88) it is suggested that the difference generated by the presence of software in smart objects and thus smart homes is sufficient to justify a move away from the analogue fixtures doctrine. There is simply no functional (or, even, non-functional) equivalent to the role of software in analogue goods and housing. Software’s necessity in smart objects/homes is further compounded by the inevitability that such software will change over time. This will occur by virtue of a number of factors of digitalisation, such as (1) upgrading, often without any real choice on the part of the user of the smart object, and (2) the nature of smart software as being responsive, autonomous and remotely variable means that the operative capacity of a smart object can change by virtue not just of the user’s choices, but by the choices of third parties and possibly, given the growth in forms of AI within smart objects, in ways that may not even be understandable (the black box problem).[[89]](#footnote-89) Another problem concerns the potential for virtual fixtures, which will be considered before the possibility of using the doctrine of tenant’s fixtures as a workaround for some of these issues.

### Virtual fixtures

Immersive technologies such as virtual reality (VR) and augmented reality (AR) have attracted considerable recent interest.[[90]](#footnote-90) Their applicability ‘will be a ubiquitous part of our lives just like electricity …. [and] will completely disrupt the way we conduct our lives … it cannot be dismissed as just a topic for fiction.’[[91]](#footnote-91) Whilst immersive technology ‘is a multidiscipline multi-labelled and massively confusing collection of technologies, applications, and opportunities’,[[92]](#footnote-92) the key is that both AR and VR overlay digital ‘things’ onto the material world. Thus, AR ‘mixes the completely real with the simulated or synthetic and projects images and information in the wearer’s line of vision’,[[93]](#footnote-93) whilst VR takes this a step further by generating an entire virtual world.[[94]](#footnote-94)

Despite the volumes of legal literature on law and augmented and/or virtual reality (A/VR),[[95]](#footnote-95) none examine the implications for fixtures. There are works examining property in virtual worlds,[[96]](#footnote-96) but this is not the same as the problems here, which deal with the combination between reality and A/VR. So even while Fairfield’s path-breaking 2012 article ‘Mixed Reality: How the Laws of Virtual Worlds Govern Everyday Life’ provides some excellent illustrations of the wide variety of issues concerning A/VR, he only briefly comments about the impact on real property, addressing the clash between IP holders and others and the danger of corporate control.[[97]](#footnote-97) There is virtually nothing looking at the issue of A/VR from the perspective of English land law, especially regarding fixtures. What can be suggested then?

A simple delineation cannot be drawn between the material world of fixtures and the immaterial world of digital images. Pointing out that A/VR merely involves the projection of light to generate images either overlaying or completely obscuring material things might work, but only to an extent.[[98]](#footnote-98) Ignoring the issue of whether the projectors themselves are embedded into a home, combining light-projections with other forms of energy projection, specifically the technology of haptics, can generate something like a material object.[[99]](#footnote-99) The capacity to give light-projections some effect of presence, to the extent that they can be ‘touched’ or ‘felt’, raises questions about the potential role of virtual fixtures within smart homes.[[100]](#footnote-100)

Consider two recent situations. First, the dispute over the ownership of a Francis Bacon statue.[[101]](#footnote-101) There the court determined that the sculpture was, despite its weight, and despite arguments that the aesthetics of its location showed it to be part of the land, removed without damage to the land and thus was a chattel. Second, in October 2017 it was reported that the artist Jeff Koons had collaborated with Snapchat to produce a number of digital copies of his famous Balloon Dog sculpture. These copies would be viewable via Snapchat, by means of an AR imposition onto the material world via a smart phone. Swiftly after this, the AR sculpture was digitally vandalised, by another artist Sebastien Errazuriz, as a protest against ‘augmented reality corporate invasion’ of city spaces.[[102]](#footnote-102) Consider now the possibility of an AR object that was equipped with haptic technology, such that it could be ‘touched’. This AR object could be made to be essentially connected to the land itself. It could either be geo-locked by technological means,[[103]](#footnote-103) or it could be projected by technologies embedded into a structure. Furthermore, it could be that the projection is specifically designed for that geographical context, or even more specifically, to particular individuals.[[104]](#footnote-104) It is difficult to see this as anything other than analogous to the argumentation used in discussing the Bacon statue (and indeed in fixtures jurisprudence generally) – fixation to the land, difficulties of removal, specific value within a particular geographic context.

This sort of embedded smart, virtual, technology will have value in a commercial and technical context as well,[[105]](#footnote-105) but it will also be extended into smart homes. Given the need to recognise the contemporary techno-social reality and likely future developments, encapsulating A/VR within the fixtures doctrine through analogy could entrap the law within path-dependency. Given how the fixtures doctrine provides an easy way for third party lenders against the realty the capacity to overreach prior interest-holders in goods and the problems of appending a commercialised doctrine to residential homes,[[106]](#footnote-106) this might not be appropriate. Instead, it is suggested that a special form of protection for smart homes, which in turn might cover A/VR technologies, would be preferable. Such an approach would need to be grounded on a coherent distinction, not between tangibles and intangibles, but between smart objects and dumb goods (and thus between smart homes and dumb homes).

### Tenant’s fixtures

English law initially distinguished between tenants and freeholders vis-à-vis fixtures. The story of tenant’s fixtures is fascinating, but economy prevents a wider examination. Instead the aim is simply to note that English law has been able to deal with new forms of goods-building relationships, in order to meet policy justifications concerning trade and industry. If a tenant attached certain types of objects to the land, they were entitled to remove them before or at (or just after) the expiry of the term.[[107]](#footnote-107) These objects were goods connected to the tenant’s occupation or trade; things such as dying vats or a furnace.[[108]](#footnote-108) The justifications given were clear. It was ‘in favour of trade and to encourage industry’,[[109]](#footnote-109) and for ‘publick benefit and convenience’.[[110]](#footnote-110) Luther’s excellent examination of this area shows how by the seventeenth century trade fixtures were removable (though not without some doubt) whilst it took until the mid-eighteenth century before domestic and ornamental goods could be removed by tenants.[[111]](#footnote-111) This distinction was not entirely definitive as a rule of law, and by the end of the nineteenth century it had essentially disintegrated, with tenants and mortgagors being treated the same ie the goods became part of the land and thus available to creditors with interests in the land.[[112]](#footnote-112) This tightening of the doctrine meant that the relative freedom of tenants (and notably also third parties who had interests in the tenant’s fixtures[[113]](#footnote-113)) disappeared. One difference remains, concerning the terms of the different agreements. Whilst a tenancy needs to exclude or modify the tenant’s right to remove fixtures,[[114]](#footnote-114) if land is mortgaged then fixtures pass to the mortgagee without more.[[115]](#footnote-115) However, given the prevalence of residential mortgages, should we retain a doctrinal position which was clearly developed as a means of protecting mortgagees of realty against claims by third-party financiers of goods in commercial contexts, or should we allow the homeowner greater freedom to utilise novel technologies which blend into (or onto) the realty?

There are two interconnected reasons why smart homes should be treated differently. The first is that some smart objects will be income generating, and a parallel can be drawn with the justification for discrete treatment for such sorts of assets given for tenant’s fixtures. The second is that the limitation of the tenant’s rights, and the approach taken to mortgagees, was at least partly an exercise in information cost management, and that aspect is being made obsolete.

The justification for special protection (from the operation of the fixtures doctrine) for tenant’s fixtures essentially rested on those objects being income-generating assets. Such assets were protected from being automatically treated as part of the land, providing the user (and third-party suppliers) the option of removal of the asset. Though this area of law is quite ossified, with fragmented doctrinal remnants, it does provide a foundation for justifying protecting income-generating assets as distinct types of objects within the fixture and fittings firmament. Smart homes are likely to be income-generating. This could be in the form of generating valuable data about how the house itself is used. A less ephemeral form of income generation may come from smart houses producing and selling objects, perhaps through an embedded 3-D printer.[[116]](#footnote-116) Treating such assets as being distinct and thus presumptively excluded from any mortgagee’s claim would generate a space for sellers of such smart objects to retain security, thus enabling the development of a market for financing such transactions. There will also need to be acknowledgement that there is whole group of actors involved who have not before had such an interaction with real property: those holding IP rights over the software that makes everything smart.[[117]](#footnote-117) Relationships at the edge of property rights can be notoriously difficult to structure, as evidenced by Hunter’s work on solar panel installations,[[118]](#footnote-118) and the inevitable introduction of IP rights holders into smart home/object relationships may thus be seen as problematic. A major difficulty, possibly the most practically significant, for those who hold interests in assets are the information costs of monitoring and where necessary controlling those assets.[[119]](#footnote-119) Yet the nature of smart technology is such that those with the capacity via software to identify and control the use of an asset can do so at a very low cost. The problem thus is not likely to be one where the interest holder is unaware or unable to protect their interest, but instead where the interest holder is very able to exercise power over their assets. This means that the problem here is more likely to be having to deal with the exercise of power over smart objects and smart homes by those whose identity is unclear. This thus becomes clear as an issue of protecting third parties (such as, but not exclusively, future purchasers). But it is also clear that the justification for the fixtures doctrine is weakened.

One underlying reason for the approach taken with mortgages and fixtures in the nineteenth century was in order to avoid difficulties arising from the bills of sale regime that existed for security over personal property. This was effectively an exercise in reducing information costs. Mortgagees of real property could take security over land which would at the same time encompass fixed goods, but without having to comply with the notification requirements of the bills of sale regime. However, there has been fundamental changes since then, notably the increase in residential mortgages, along with developments at a doctrinal and technical level providing foundations for cheaper and quicker asset registration regimes. This makes the reasoning underlying the Victorian fixtures doctrine less persuasive when applied to contemporary situations, and even less so for near-future scenarios involving smart homes.

A possible approach is to build on the conceptual foundation of registration. Hunter’s interesting examination of the socio-legal nature of the lease, in the context of solar panels, indicated that solar panels were being retrofitted onto properties, using leases (of the airspace) as the relevant legal mechanism. She suggested this enabled the lease to be registered and thus bind future owners.[[120]](#footnote-120) Digital technological advances, along with nano-technologies, are providing mechanisms which enable granular surveillance of things. Whilst it may be somewhat futuristic to envisage such an expansive registry that could cover not just the current data found in the Land Registry, but other information about the contents of a home, its smart objects and possible third party interests, it is merely a computational, rather than conceptual, difficulty that we face here.[[121]](#footnote-121)

What could be suggested in light of possible wide-scale registration capacity qua smart objects and virtual fixtures, is the idea of providing for specific details about such assets to be recorded in the land register. Such a move would provide clarity as to the status of such assets. The ownership interests held by third parties would be identifiable. This would help protect those who acquire smart homes. It would also have the benefit of dismantling a core normative argument in favour of a strict application of the principle that goods attached to land become part of the land (that is, such an approach provides clarity for third parties dealing with the land because it reduces the scope of potentially relevant interest-holders to just those holding interests in the land).[[122]](#footnote-122)

# THE STATUS OF ‘HOME’ IN THE DIGITAL FUTURE

The considerable literature dealing with the concept of ‘home’ prevents in-depth review.[[123]](#footnote-123) However, there is a strong (though arguably not overwhelming) claim that the law’s financialised perspective of housing and homeownership fails to account for a broader, non-financial, concept of ‘home’.[[124]](#footnote-124) Nevertheless, the combined roles of the home (using Fox’s classic categorisation of financial investment, a structure for shelter, territory and self-identity, as well as a social and cultural unit),[[125]](#footnote-125) renders ‘home’ as ‘our society’s most familiar, important, and emotionally freighted manifestation of property’.[[126]](#footnote-126)

According to Fennell, property is ‘an inherently sticky institution that carries forward the forms and shapes that worked best in resolving resource dilemmas in the past.’[[127]](#footnote-127) Two particular ‘resource dilemmas’ are worth identifying. First, that the development of a ‘home’ concept is connected to increased acquisition of goods.[[128]](#footnote-128) Second, despite a shift away from home-working (the putting-out system of industry) and the rise of importance of out-house working (in factories and the like) following the Industrial Revolution, and the development of a gendered notion of ‘home’,[[129]](#footnote-129) ‘in reality the home was never, and could never be, a non-commercial private space.’[[130]](#footnote-130) The reality of the continuing commercial and public nature of ‘home’ is partly due to the commercialisation of home ownership noted above, and also due to the intertwining of rights and obligations in the form of what Fennell calls the ‘unbounded home’.[[131]](#footnote-131) A ‘home means … much more than a structure’, because it is ‘an amorphous resource that overflows parcel boundaries. It is both porous and ambient’.[[132]](#footnote-132) This approach can be combined with sociological and anthropological evidence that the ‘home’ concepts depends heavily on individual relationships with personal property,[[133]](#footnote-133) that goods often attain a more significant role in the inheritance process than real property,[[134]](#footnote-134) and that goods may begin to take on a significant role as a depository of meaning in fluid home situations (renting, moving).[[135]](#footnote-135) The construction of a ‘home’ concept thus depends on external (neighbour) factors (as per Fennell’s analysis) and also on the effects of goods as constitutive of personality and home-ness, which together indicate the potential impact of smart objects on the ‘home’.

The ‘porous and ambient’ nature of the home is further reflected in the fact that ‘technology dissolves into our surroundings until only the user interface remains perceivable by users.’[[136]](#footnote-136) Indeed, the aim of making smart objects disappear into the background is often core to technological development in this field.[[137]](#footnote-137) At the same time, we must consider the enmeshment of technologies (where the plural is vital);[[138]](#footnote-138) an entangling and capturing effect. The distinction between integration and enmeshment is useful to explain the relationships between the so-called ‘big five’ tech companies: Apple, Microsoft, Facebook, Alphabet, and Amazon. Each organisation can integrate with each other. For example, one can access Facebook using Google on a Mac. However, these organisations also aim to enmesh users within their own corporate digital eco-system. Life may be great within a particular eco-system. However, exiting the eco-system can be problematic, as you will necessarily enter a different eco-system.[[139]](#footnote-139) The recent announcement by Apple, Google and Amazon that they will be starting to work together to make smart home objects interoperable suggests that whilst problems of rivalrous non-interoperability may be reduced,[[140]](#footnote-140) this is only reducing the barriers to multiple-enmeshment between different forms of corporate digital eco-systems, which already have massive volumes of data and control over users.[[141]](#footnote-141) Arguably this may just be form of decentralisation and recentralisation of corporate interests. This has been recognised in the dynamic and fluid world of digital (IP) interests,[[142]](#footnote-142) but much less so in the conservative world of land law and fixtures.

By examining ‘the techno-social system running behind the scenes’ that the extent of control can be seen.[[143]](#footnote-143) Zhao has recently provided an excellent overview of these issues:

Characterized by *digitalization*, *connectedness*, *smartization*, and *automation* in the context of IoTs, our home and home life have been changed in fundamental ways: from physical space to hybrid space and mixed reality, from a solely private space to half-public space, and from dwelling to smart living.[[144]](#footnote-144)

He suggests that ‘the inviolability of the home and home protection should cover not only the home’s physical space, but also its virtual and hybrid space, helping residents regain their control of home.’[[145]](#footnote-145) He proposes a new concept, ‘Home 2.0’, which ‘protects virtual spaces co-existing within the physical space of home. This best coordinates the two different spaces anchoring the new [Home Virtual Space] to the traditional home’s location in the physical world [but not those virtual spaces outside the home, such as cloud servers]’.[[146]](#footnote-146) Zhao’s analysis is sound, but he is more concerned with the issues of intrusion into the home, and data-flows out of the home. This chapter, by contrast, emphasises the goods/house relationship, and the issues surrounding the control of smart goods and how such issues factor into the debate about ownership and control of smart homes.

Frischmann and Selinger identify a ‘creep’ effect of such techno-social change, combining (1) contracting creep, (2) surveillance creep, and (3) nudge creep.[[147]](#footnote-147) The ‘human-computer interface from websites to apps to smart TVs to smart homes and beyond’ will creep along in a gradual manner,[[148]](#footnote-148) as a result of the increased contractualisation of interaction via the ubiquity of the click-wrap standard form contractual licences at the heart of any digital transaction, along with the enhanced surveillance possibilities generated by the digitalisation of life and the potential for nudging human behaviour through digital practices and information. Although such agreements are not necessarily intrinsically bad, developments of ‘smart techno-social environments’ enable execution of what Frischmann and Selinger identify as ‘the normative agenda … optimal efficiency, productivity, and happiness.’[[149]](#footnote-149) Such agendas invariably prescribe and constrain human activity, reducing the viability of differing perspectives on the meaning and validity of happiness, production and efficiency. More profoundly, novel techno-social environments in areas where there has been up to now the capacity, or freedom, to be offline – ‘to be free from systemic, environmentally architected human engineering’[[150]](#footnote-150) – might result in the inability to express individual identity.

By creating smart homes, we necessarily invite corporate control and commercial mediation of our relationships and individual stories through our chosen forms of use and interaction with technologies. We also enforce such use and interaction on our dependants (children; parents; pets) and friends. And ‘in doing so, we leash ourselves.’[[151]](#footnote-151) This leash is contractual. In order to interact in any meaningful sense in the modern world – that is, a world of consumption – individuals must contract, and the contracts they enter into will invariably be standard form contracts that are realistically impervious to negotiation. This in turn raises difficult questions about whether, in such circumstances, individuals are exercising any meaningful autonomy.[[152]](#footnote-152) Whilst our necessarily interdependent lives render contingent our ‘autonomy’,[[153]](#footnote-153) technological developments increasingly infringe upon aspects of our lives in novel ways. Where our actions, choices and outcomes were once not so determined by pre-existing, pre-programmed potentialities, now our tastes, preferences, and beliefs will be affected (and effected, even), in ‘*constrictive environments*’,[[154]](#footnote-154) resulting in humans becoming ‘accustomed to being nudged, conditioned, and, more broadly, engineered to behave like simple stimulus-response machines.’[[155]](#footnote-155) In this context, our notion of ‘home’ will be constrained increasingly, by virtue of the restrictions on how we use and access smart home facilities. These restrictions can prevent certain types of use or access, or possibly worse, enforce use or access. Our smart homes may be alterable without our control, knowledge or even understanding, and they may be able to influence our behaviour.

# CONCLUSIONS

Smart objects, connecting with a residence which may itself contain prefabricated or later added technologies, can result in a smart home. However, the specific meaning of ‘smart home’ is unclear, and this lack of clarity could be problematic if replicated in legislation (as shown by the building regulations requirements for smart boilers). Additionally, the blunt, tangible, delineation between fixtures and fittings, drawn in the pre-digital era and for purposes quite unconnected to the actual connections of goods and realty, cannot properly account for the digitalised imbrication of thing, land, software and data. The possibility of virtual fixtures compounds this problem. There could be value drawn from how English law provided a special regime for tenant’s fixtures. In a future where smart homes may well be sources of production, either of tangible things or of valuable data, as a result of embedded smart technologies, the need to provide protection and the possibility of a registry of smart objects to deal with such problems was suggested.

The technological changes discussed herein might result in a need to reconceptualise what is meant by a ‘home’. We choose to interact with smart objects, and smart homes, but our choices will be limited, both in our initial choices and our future choices. And as smart homes become prevalent, our capacity to make initial choices will reduce, but will have to continually (especially due to the tyranny of the upgrade) ask ourselves what sort of access we want or can afford. We will also have to deal with third parties. These are choices for the future, but not necessarily choices that can be made again in the future. This is how a technological ‘creep’ might restrict how we can express ourselves within our future smart homes.

1. \*Reader, York Law School, University of York.

 E Morozov, *Twitter* (1 February 2016, 01:45), cited by T Timm, ‘The government just admitted it will use smart home devices for spying’ (*The Guardian*, 9 February 2016) [www.theguardian.com/commentisfree/2016/feb/09/internet-of-things-smart-devices-spying-surveillance-us-government](http://www.theguardian.com/commentisfree/2016/feb/09/internet-of-things-smart-devices-spying-surveillance-us-government). [↑](#footnote-ref-1)
2. B Frischmann and E Selinger, *Re-Engineering Humanity* (Cambridge, Cambridge University Press 2018) 133 fn 8. [↑](#footnote-ref-2)
3. NHS England, ‘Putting Health into Place: Principles 4 – 8 Design, Deliver and Manage’ (2 September 2019) [www.england.nhs.uk/ourwork/innovation/healthy-new-towns/](http://www.england.nhs.uk/ourwork/innovation/healthy-new-towns/) 38. [↑](#footnote-ref-3)
4. NHBC Foundation, *The Connected Home: Designing and Building Technology into Today’s New Homes (NF67)* (25 January 2016) [www.nhbcfoundation.org/publication/the-connected-home/](http://www.nhbcfoundation.org/publication/the-connected-home/). [↑](#footnote-ref-4)
5. BEIS, ‘Heat in Building: Boiler Plus’ (October 2017) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651853/Boiler_Plus_final_policy_and_consultation_response.pdf>. [↑](#footnote-ref-5)
6. Text following n 50. [↑](#footnote-ref-6)
7. G Russell, ‘Pink-eyed terminators and limbless chickens: Boris Johnson’s UN speech in quotes’ (*The Guardian*,25 September 2019) [www.theguardian.com/politics/2019/sep/25/pink-eyed-terminators-and-limbless-chickens-boris-johnsons-un-speech-in-quotes](http://www.theguardian.com/politics/2019/sep/25/pink-eyed-terminators-and-limbless-chickens-boris-johnsons-un-speech-in-quotes). [↑](#footnote-ref-7)
8. NHBC Foundation, *The Connected Home* (n 4) at 1. [↑](#footnote-ref-8)
9. R McKie, ‘Remote control your home with phone-a-fridge device’ (*The Observer*, 6 October 2002) [www.theguardian.com/uk/2002/oct/06/mobilephones.japan](http://www.theguardian.com/uk/2002/oct/06/mobilephones.japan). [↑](#footnote-ref-9)
10. P Palka, ‘How to Write a Law and Technology Paper?’ (30 November 2018) <<https://przemyslaw.technology/2018/11/30/how-to-write-a-law-and-technology-paper/>> accessed 26 November 2020. [↑](#footnote-ref-10)
11. BD Johnson, ‘Virtually Reality: How children’s imagination today will shape tomorrow’ (July 2020) [www.engineer-a-better-world.org/media/2829/iet-eabw-vision-report.pdf](http://www.engineer-a-better-world.org/media/2829/iet-eabw-vision-report.pdf). [↑](#footnote-ref-11)
12. NHBC Foundation, *The Connected Home* (n 4) 23: ‘The emergence of the connected home is evolutionary rather than revolutionary, but even the present-day demand for smart devices is turning what were recently considered luxuries into fundamental expectations for many families.’ [↑](#footnote-ref-12)
13. J Chen, L Edwards, L Urquhart, and D McAuley, ‘Who Is Responsible for Data Processing in Smart Homes? Reconsidering Joint Controllership and the Household Exemption’ (2020) *International Data Privacy Law* (forthcoming) <https://doi.org/10.1093/idpl/ipaa011>. There is a wealth of US literature on privacy in the smart home: see, eg: G Bronshteyn, ‘Searching the Smart Home’ (2020) 72 *Stanford Law Review* 455. [↑](#footnote-ref-13)
14. S Piasecki, L Urquhart and D McAuley, ‘Defence Against Dark Artefacts: An Analysis of the Assumptions Underpinning Smart Home Cybersecurity Standards’ (3 October 2019) [https://ssrn.com/abstract=3463799](https://ssrn.com/abstract%3D3463799). [↑](#footnote-ref-14)
15. BBC News, ‘Smart home gadgets in domestic abuse warning’ (*BBC News*, 9 July 2018) [www.bbc.co.uk/news/technology-44765830](http://www.bbc.co.uk/news/technology-44765830); Lara K, ‘Families are LOCKED OUT of or INSIDE their homes as Yale “smart” security app crashes leaving dozens stranded’ (*MailOnline*, 12 October 2018) [www.dailymail.co.uk/news/article-6268379/People-locked-houses-Yale-smart-security-crashes.html](http://www.dailymail.co.uk/news/article-6268379/People-locked-houses-Yale-smart-security-crashes.html); BBC News, ‘Gadgets can be hacked to produce “dangerous” sounds, says researcher’ (*BBC News*, 11 August 2019) [www.bbc.co.uk/news/technology-49291665](http://www.bbc.co.uk/news/technology-49291665). [↑](#footnote-ref-15)
16. CJ Barnes, ‘Smart Home Alone: The World’s Gateway to More Efficient Use of Energy and Mayhem’ (2017) 5 *Louisiana State University Journal of Energy Law & Resources* 365; S Thomas, ‘Law, Smart Technology, and Circular Economy: All Watched over by Machines of Loving Grace?’ (2018) 10 *Law, Innovation and Technology* 230, 243-244. [↑](#footnote-ref-16)
17. Department for Digital, Culture, Media & Sport, ‘Government response to the Regulatory proposals for consumer Internet of Things (IoT) security consultation’ (3 February 2020). A call for views is currently open: Department for Digital, Culture, Media & Sport, ‘Proposals for regulating consumer smart product cyber security - call for views’ (26 July 2020) [www.gov.uk/government/publications/proposals-for-regulating-consumer-smart-product-cyber-security-call-for-views/proposals-for-regulating-consumer-smart-product-cyber-security-call-for-views](http://www.gov.uk/government/publications/proposals-for-regulating-consumer-smart-product-cyber-security-call-for-views/proposals-for-regulating-consumer-smart-product-cyber-security-call-for-views). [↑](#footnote-ref-17)
18. MS Van Houweling, ‘The New Servitudes’ (2008) 96 *Georgetown Law Journal* 885; C Mulligan, ‘Personal Property Servitudes on the Internet of Things’ (2016) 50 *Georgia Law Review* 1121; JAT Fairfield, *Owned: Property, Privacy and the New Digital Serfdom* (Cambridge, Cambridge University Press, 2017); A Perzanowski and J Schultz, *The End of Ownership: Personal Property in the Digital Economy* (London, MIT Press, 2017); P Chapdelaine, *Copyright User Rights: Contracts and the Erosion of Property* (Oxford, Oxford University Press, 2017); NB Banta, ‘Property Interests in Digital Assets: The Rise of Digital Feudalism’ (2017) 38 *Cardozo Law Review* 1099; C Mulligan, ‘Licenses and the Property/Contract Interface’ (2018) 93 *Indiana Law Journal* 1073; Thomas (n 16); R Crootof, ‘The Internet of Torts: Expanding Civil Liability Standards to Address Corporate Remote Interference’ (2019) 69 *Duke Law Journal* 583; CJ Hoofnagle, A Kesari and A Perzanowski, ‘The Tethered Economy’ (2019) 87 *George Washington Law Review* 783. [↑](#footnote-ref-18)
19. Frischmann and Selinger (n 2) at 41 (path dependency); M Hildebrandt, *Smart Technologies and the End(s) of Law* (Cheltenham, Edward Elgar, 2015) ch 3. [↑](#footnote-ref-19)
20. NHBC Foundation, *The Connected Home* (n 4) at 1. [↑](#footnote-ref-20)
21. M Finding and M Taylor, ‘Smart homes’ (2016) 22 (6) *Computer and Technology Law Review* 147, 147. [↑](#footnote-ref-21)
22. *cf* Piasecki, Urquhart and McAuley, ‘Defence Against Dark Artefacts’ (n 14) at 2, citing D Mocrii, Y Chen and P Musilek, ‘IoT-Based Smart Homes: A Review of System Architecture, Software, Communications, Privacy and Security’ (2018) 1-2 *Internet of Things* 81, 81 (in turn citing M Raisul Alam, M Bin Ibne Reaz, and M Aluaddin Mohd Ali, ‘A Review of Smart Homes – Past, Present, and Future’ (2012) 42 *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)* 1190): ‘a contemporary application of ubiquitous computing that incorporates intelligence into dwellings management and operation for “comfort, healthcare, safety, security, and energy conservation”’. [↑](#footnote-ref-22)
23. *cf* B Zhao, ‘Unraveling Home Protection in the IoT Age: Smart Living, Mixed Reality, and Home 2.0’ (2020) 21 *Columbia Science & Technology Law Review* 1, 10: ‘homes equipped with a range of inter-connected sensors, systems, and devices that can be automated, monitored and controlled through, for instance, a computer or smartphone from both inside and outside the home.’ Note the absence of responsiveness. [↑](#footnote-ref-23)
24. *cf* Piasecki, Urquhart and McAuley, ‘Defence Against Dark Artefacts’ (n 14) at 2 (citing Mocrii, Chen and Musilek, ‘IoT-based smart homes’ (n 22) at 83: ‘It is only when all data about the environment is collectively stored and analyzed, patterns extracted, and decisions made without the user’s intervention, that an environment can be called smart.’ [↑](#footnote-ref-24)
25. N Ashikin Basarudin, A Laili Yeon and Z Mohamed Yusoff, ‘Regulating Smart Home Technology Devices under Malaysian Legal Framework’ (2018) 44 *Commonwealth Law Bulletin* 607. [↑](#footnote-ref-25)
26. L Fox, *Conceptualising Home: Theories, Laws and Policies* (Oxford, Hart Publishing, 2007). [↑](#footnote-ref-26)
27. S Bridge, E Cooke and M Dixon, *Megarry and Wade: The Law of Real Property*,9th edn (London, Sweet & Maxwell, 2019) ch 22. [↑](#footnote-ref-27)
28. *Elitestone Ltd v Morris* [1997] 1 WLR 687; *cf* P Luther, ‘The Foundations of *Elitestone*’ (2008) 28 *Legal Studies* 574. [↑](#footnote-ref-28)
29. *Elitestone* (n 28) (a chalet); *London Borough of Tower Hamlets v London Borough of Bromley* [2015] EWHC 1954 (Ch) (a bronze sculpture); *Dill v Secretary of State for Housing, Communities and Local Government* [2020] UKSC 20 (lead urns). [↑](#footnote-ref-29)
30. Law of Property Act 1925, s 62. [↑](#footnote-ref-30)
31. S Thomas, ‘Mortgages, Fixtures, Fittings and Security over Personal Property’ (2015) 66 *Northern Ireland Legal Quarterly* 343. [↑](#footnote-ref-31)
32. *Holland v Hodgson* (1872) LR 7 CP 328. [↑](#footnote-ref-32)
33. *Melluish v BMI (No 3) Ltd* [1996] AC 454; *Elitestone* (n 28). See generally: Thomas, ‘Mortgages, Fixtures, Fittings and Security over Personal Property’ (n 31). [↑](#footnote-ref-33)
34. *Fahstone Ltd v Biesse Grup UK Ltd* [2015] EWHC 3650 (TCC). [↑](#footnote-ref-34)
35. Bridge, Cooke and Dixon, *Megarry and Wade* (n 27) at [22-010]. [↑](#footnote-ref-35)
36. Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 133. [↑](#footnote-ref-36)
37. J Wakefield, ‘Amazon gets closer to getting Alexa everywhere’ (*BBC News*, 20 November 2019) [www.bbc.co.uk/news/technology-50392077](http://www.bbc.co.uk/news/technology-50392077) quoting Amazon’s AI division’s chief scientist Rohit Prasad: ‘tech needs to get better at contextual reasoning’; Byron Spice, ‘Sound and vibrations let smart devices know where they are’ (*Futurity*, 23 October 2018) [www.futurity.org/smart-devices-awareness-1894522/](http://www.futurity.org/smart-devices-awareness-1894522/). [↑](#footnote-ref-37)
38. L Kelion, ‘Cat flap uses AI to punish pet’s killer instincts’ (*BBC News*, 1 July 2019) [www.bbc.co.uk/news/technology-48825761](http://www.bbc.co.uk/news/technology-48825761). [↑](#footnote-ref-38)
39. L Kelion, ‘Amazon’s Ring logs every doorbell press and app action’ (*BBC News*,4 March 2020) [www.bbc.co.uk/news/technology-51709247](http://www.bbc.co.uk/news/technology-51709247). [↑](#footnote-ref-39)
40. The Guardian, ‘Amazon Key system will allow delivery drivers to unlock customers’ doors’ (*The Guardian*, 25 October 2017) [www.theguardian.com/technology/2017/oct/25/amazon-key-system-will-allow-delivery-drivers-to-unlock-customers-doors](http://www.theguardian.com/technology/2017/oct/25/amazon-key-system-will-allow-delivery-drivers-to-unlock-customers-doors). [↑](#footnote-ref-40)
41. Jillian Ambrose, ‘How “smart homes” and price caps drained Centrica’s power’ *The Guardian* (03 August 2019) [www.theguardian.com/business/2019/aug/03/centrica-smart-homes-price-caps-drained-its-power-iain-conn](http://www.theguardian.com/business/2019/aug/03/centrica-smart-homes-price-caps-drained-its-power-iain-conn) (smart home business was a fifth of that predicted). [↑](#footnote-ref-41)
42. Crootof, ‘The Internet of Torts’ (n 18) at 598, citing M Astor, ‘Your Roomba May Be Mapping Your Home, Collecting Data That Could Be Shared’ (New York Times, 25 July 2017) [www.nytimes.com/2017/07/25/technology/roombairobot-data-privacy.html?\_r=0](http://www.nytimes.com/2017/07/25/technology/roombairobot-data-privacy.html?_r=0); J Vincent, ‘Google Wants to Improve Your Smart Home with iRobot’s Room Maps’ (*The Verge*,31 October 2018) <https://www.theverge.com/2018/10/31/18041876/google-irobot-smart-home-spatial-data-mapping-collaboration>. [↑](#footnote-ref-42)
43. Paul Sewers (*Venture Beat*, 5 September 2019) [venturebeat.com/2019/09/05/alphabets-sidewalk-labs-leads-20-million-round-into-oris-robotic-furniture-for-small-spaces/](https://venturebeat.com/2019/09/05/alphabets-sidewalk-labs-leads-20-million-round-into-oris-robotic-furniture-for-small-spaces/). [↑](#footnote-ref-43)
44. NHBC Foundation, *The Connected Home* (n 4) at 12 (in-wall and in-ceiling speakers). [↑](#footnote-ref-44)
45. Such as the Tesla Powerwall: [www.tesla.com/en\_GB/powerwall](http://www.tesla.com/en_GB/powerwall). [↑](#footnote-ref-45)
46. BBC News, ‘Electric cars: Charge points could be requirement in new build homes’ (*BBC News*, 9 July 2018) [www.bbc.co.uk/news/uk-44759150](http://www.bbc.co.uk/news/uk-44759150). [↑](#footnote-ref-46)
47. J Rowlatt, ‘How Elon Musk aims to revolutionise battery technology’ (*BBC News*,17 June 2020) https://www.bbc.co.uk/news/business-53067009. [↑](#footnote-ref-47)
48. E Wollacott, ‘How your home could generate, store and sell energy’ (*BBC News*, 26 June 2018) <https://www.bbc.co.uk/news/business-44540726>. [↑](#footnote-ref-48)
49. ‘Perovskite Solar’ [www.perovskite-info.com/perovskite-solar](http://www.perovskite-info.com/perovskite-solar); P Belton, ‘A breakthrough approaches for solar power’ (*BBC News*, 1 May 2020) [www.bbc.co.uk/news/business-51799503](http://www.bbc.co.uk/news/business-51799503). [↑](#footnote-ref-49)
50. R Jones, ‘Best smart plugs 2020: add app and Alexa control to any socket’ (*T3.com*, 27 July 2020)[www.t3.com/features/best-smart-plugs](http://www.t3.com/features/best-smart-plugs). [↑](#footnote-ref-50)
51. D Jepson, ‘Boiler Plus isn’t so smart after all’ (2019) 118 *Registered Gas Engineer* 42. The article was published online in October 2018: <http://registeredgasengineer.co.uk/boiler-plus-isnt-so-smart-after-all/>. [↑](#footnote-ref-51)
52. ibid. [↑](#footnote-ref-52)
53. ibid. [↑](#footnote-ref-53)
54. ibid. [↑](#footnote-ref-54)
55. ibid. [↑](#footnote-ref-55)
56. BEIS, ‘Clarification on the Boiler Plus regulations for installers

and consumers’ [www.gov.uk/government/groups/heat-in-buildings](http://www.gov.uk/government/groups/heat-in-buildings). [↑](#footnote-ref-56)
57. HM Government, Domestic Building Services Compliance Guide (2013, incorporating 2018 amendments) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697525/DBSCG_secure.pdf>. [↑](#footnote-ref-57)
58. ibid 19: specifically, combination boilers must have one of the following: flue gas heat recovery; weather compensation; load compensation; smart thermostat with automation and optimisation. See also Heating & Hotwater Industry Council, ‘Installer Guide: Boiler Plus additional guidance’(2018) [www.hhic.org.uk/uploads/5B1E75E44B78C.pdf](http://www.hhic.org.uk/uploads/5B1E75E44B78C.pdf). [↑](#footnote-ref-58)
59. DBSCG(n 57) at 14. [↑](#footnote-ref-59)
60. HHIC, ‘Installer Guide’ (n 58). At 5, it is said this description of optimisation ‘implies a learning capability to meet this definition.’ [↑](#footnote-ref-60)
61. BEIS, ‘Heat in Building: Boiler Plus’ (n 5). [↑](#footnote-ref-61)
62. ibid 7 [1.8]; 12 [2.21]. For specific responses, see Annex A. [↑](#footnote-ref-62)
63. ibid 10 [2.9]. [↑](#footnote-ref-63)
64. ibid 12 [2.19]. [↑](#footnote-ref-64)
65. BEIS, ‘Heat in Building: Boiler Plus’ (n 5) at 12 [2.19]. [↑](#footnote-ref-65)
66. Jepson, ‘Boiler Plus isn’t so smart after all’ (n 51). [↑](#footnote-ref-66)
67. Text accompanying n 59. [↑](#footnote-ref-67)
68. BEIS, ‘Heat in Building: Boiler Plus’(n 5) at 12 [2.19]. [↑](#footnote-ref-68)
69. BEIS, ‘Boiler Plus: new standards for domestic boiler installations from April 2018: Frequently Asked Questions’ (April 2018). [↑](#footnote-ref-69)
70. ibid Q17. [↑](#footnote-ref-70)
71. ibid Q15. [↑](#footnote-ref-71)
72. For a US analysis, see T Francis, ‘Note - Adopting Building Code Standards to Incorporate Smart Home Technology’ (2019) 28 *Southern California Review of Law & Social Justice* 555. [↑](#footnote-ref-72)
73. *Computer Associates UK Ltd v The Software Incubator Ltd* [2018] EWCA Civ 518, appealed as UKSC 2018/0090, referred to the CJEU as Case C-410/19 *The Software Incubator* (is software “goods” for the purposes of the Commercial Agents Directive 86/653/EEC?). [↑](#footnote-ref-73)
74. See: n 18. [↑](#footnote-ref-74)
75. *Nederlands Uitgeversverbond and Groep Algemene Uitgevers v Tom Kabinet Internet BV and others* [2019] Case C-263-18. [↑](#footnote-ref-75)
76. Thomas, ‘Law, smart technology, and circular economy’ (n 16) at 255-260 (examining the impact of *Impression Products, Inc v Lexmark International, Inc* 581 US\_\_ (2017); 137 S Ct 1523). [↑](#footnote-ref-76)
77. C Sappa, ‘What Does Trade Secrecy Have to Do with the Interconnection-Based Paradigm of the Internet of Things?’ (2018) 40 *European Intellectual Property Review* 518, 519. [↑](#footnote-ref-77)
78. *cf* Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 20. [↑](#footnote-ref-78)
79. See: n 14. [↑](#footnote-ref-79)
80. J Peters, ‘Google will replace Home devices bricked due to the latest firmware update’ (*The Verge*, 24 October 2019) [www.theverge.com/platform/amp/2019/10/24/20931201/google-home-mini-bricking-firmware-update-replace-out-of-warranty](http://www.theverge.com/platform/amp/2019/10/24/20931201/google-home-mini-bricking-firmware-update-replace-out-of-warranty). [↑](#footnote-ref-80)
81. BBC News, ‘Sonos in bricked speaker “recycling” row’ (*BBC News*,31 December 2019) [www.bbc.co.uk/news/technology-50948868](http://www.bbc.co.uk/news/technology-50948868). [↑](#footnote-ref-81)
82. BBC News, ‘Pets “go hungry” after smart feeder goes offline’ (*BBC News*, 25 February 2020) [www.bbc.co.uk/news/technology-51628795](http://www.bbc.co.uk/news/technology-51628795). [↑](#footnote-ref-82)
83. M Savage, ‘How subscription is replacing ownership’ (*BBC News*, 5 March 2019) [www.bbc.co.uk/news/entertainment-arts-47445271](http://www.bbc.co.uk/news/entertainment-arts-47445271). [↑](#footnote-ref-83)
84. C Fox, ‘BT to charge people £50 for keeping old wi-fi routers’ (*BBC News*, 29 January 2020) [www.bbc.co.uk/news/technology-51294395](http://www.bbc.co.uk/news/technology-51294395). [↑](#footnote-ref-84)
85. This could occur through a form of enforced obsolescence: Hilary Osbourne, ‘Smart appliances may not be worth money in long run, warns Which?’ (*The Guardian*, 8 June 2020) [www.theguardian.com/technology/2020/jun/08/smart-appliances-may-not-be-worth-money-in-long-run-warns-which](http://www.theguardian.com/technology/2020/jun/08/smart-appliances-may-not-be-worth-money-in-long-run-warns-which). [↑](#footnote-ref-85)
86. *Holland v Hodgson* (1872) LR 7 CP 328. [↑](#footnote-ref-86)
87. *Melluish v BMI (No 3) Ltd* [1996] AC 454. [↑](#footnote-ref-87)
88. Thomas, ‘Mortgages, fixtures, fittings and security over personal property’ (n 31). [↑](#footnote-ref-88)
89. F Pasquale, *The Black Box Society: The Secret Algorithms That Control Money and Information* (London, Harvard University Press, 2015); A Deeks, ‘The Judicial Demand for Explainable Artificial Intelligence’ (2019) 119 *Columbia Law Review* 1829; A Zuckerman, ‘Artificial intelligence – Implications for the Legal Profession, Adversarial Process and Rule of Law’ (2020) 136 *LQR* 427, 436. [↑](#footnote-ref-89)
90. In the media: M Wall, ‘Conjuring designs from thin air in a virtual world’ (*BBC News,* 14 May 2019) [www.bbc.co.uk/news/business-48199905](http://www.bbc.co.uk/news/business-48199905); BBC News, ‘University of Northampton “virtual sculptures” a UK first’ (*BBC News*, 6 October 2019) [www.bbc.co.uk/news/uk-england-northamptonshire-49775393](http://www.bbc.co.uk/news/uk-england-northamptonshire-49775393); and in academia: G Yadin, ‘Virtual Reality Exceptionalism’ (2018) 20 *Vanderbilt Journal of Entertainment & Technology Law* 839, 859 citing JAT Fairfield, ‘Mixed Reality: How the Laws of Virtual Worlds Govern Everyday Life’ (2012) 27 *Berkeley Technology Law Journal* 55, 59-60 (noting the existence of hundreds of articles on laws *within* virtual worlds, but not on how real world doctrine may be (ab-)used to deal with mixed reality). [↑](#footnote-ref-90)
91. J Peddie, *Augmented Reality: Where We Will All Live* (Cham, Switzerland, Springer, 2017) 4. [↑](#footnote-ref-91)
92. ibid 9. [↑](#footnote-ref-92)
93. ibid 2. [↑](#footnote-ref-93)
94. ibid 24. [↑](#footnote-ref-94)
95. The main analytical targets are crime, torts and IP. See generally: MA Lemley and E Volokh, ‘Law, Virtual Reality, and Augmented Reality’ (2018) 166 *University of Pennsylvania Law Review* 1051; W Barfield and MJ Blitz (eds), *Research Handbook on the Law of Virtual and Augmented Reality* (Cheltenham, Elgar, 2018). [↑](#footnote-ref-95)
96. See, eg: P Palka, ‘Virtual Property: Towards a General Theory’ (PhD thesis, European University Institute 2017); W Erlank, ‘Law and Property in Virtual Worlds’ in Barfield and Blitz, *Law of Virtual and Augmented Reality* (n 95) at 636-661. [↑](#footnote-ref-96)
97. Fairfield, ‘Mixed Reality’ (n 90) at 97-101. [↑](#footnote-ref-97)
98. *cp* ME Brady, ‘Property and Projection’ (2020) 133 *Harvard Law Review* 1144. [↑](#footnote-ref-98)
99. M Smith, ‘How you could control your world with just your fingertips’ (*BBC News*, 1 March 2019) [www.bbc.co.uk/news/business-47400209](http://www.bbc.co.uk/news/business-47400209); Ian Sample, ‘Hologram-like device animates objects using ultrasound waves’ (*The Guardian*,13 November 2019) [www.theguardian.com/technology/2019/nov/13/hologram-like-device-animates-objects-using-ultrasound-waves](http://www.theguardian.com/technology/2019/nov/13/hologram-like-device-animates-objects-using-ultrasound-waves). [↑](#footnote-ref-99)
100. A slightly different analytical approach is provided by Zhao, ‘Unraveling Home Protection’ (n 23) at 12-14, distinguishing simulations and ontological reproductions, and a hybrid space. He conceptualises these changes as generative of a Home Virtual Space and a mixed reality where ‘physical and digital objects and entities co-exist and interact with each other at a higher level in real time’. [↑](#footnote-ref-100)
101. *Tower Hamlets* (n 29); M Iljadica, ‘Is a Sculpture “Land”? *London Borough of Tower Hamlets v London Borough of Bromley* [2015] EWHC 1954 (Ch)’ [2016] *Conveyancer and Property Lawyer* 242. See also *Dill* (n 29). [↑](#footnote-ref-101)
102. BBC News, ‘Artist “vandalises” Snapchat’s AR Balloon Dog Sculpture’ (*BBC News*,6 October 2017) [www.bbc.co.uk/news/technology-41524550](http://www.bbc.co.uk/news/technology-41524550). See further S Smith, ‘Comment: Copyright and Reality’ (2018-2019) 167 *University of Pennsylvania Law Review* 1269, 1315 fn 223; M DeGeurin, ‘Internet Artists Invaded the MoMA With a Guerrilla Augmented Reality Exhibit’ (*Motherboard*,5 March 2018) [motherboard.vice.com/en\_us/article/8xd3mg/moma-augmented-reality-exhibit-jackson-pollock-were-from-the-internet](https://motherboard.vice.com/en_us/article/8xd3mg/moma-augmented-reality-exhibit-jackson-pollock-were-from-the-internet) (artists used AR technology to display their work over those of Jackson Pollock). [↑](#footnote-ref-102)
103. Such as Pokemon Go: <https://pokemongolive.com/en/>. [↑](#footnote-ref-103)
104. Technology embedded within the wall could identify specific people: see, eg: S Fernandez, ‘WiFi system identifies people through walls by their walk’ (*Futurity*, 1 October 2019) [www.futurity.org/wifi-video-identification-through-walls-2173442/](http://www.futurity.org/wifi-video-identification-through-walls-2173442/). [↑](#footnote-ref-104)
105. [dynamicland.org/](file:///C%3A%5CUsers%5CSean%5CDocuments%5CLaw%5CResearch%5CCurrent%20Research%5CSmart%20Homes%20and%20Virtual%20Fixtures%5Cdynamicland.org%5C), discussed at Dominic Cummings, ‘On the referendum #33: High performance government, “cognitive technologies”, M Nielsen, B Victor, & “Seeing Rooms”’ (26 July 2019) [dominiccummings.com/2019/06/26/on-the-referendum-33-high-performance-government-cognitive-technologies-michael-nielsen-bret-victor-seeing-rooms/](file:///C%3A%5CUsers%5CSean%5CDocuments%5CLaw%5CResearch%5CCurrent%20Research%5CSmart%20Homes%20and%20Virtual%20Fixtures%5C%3Cdominiccummings.com%5C2019%5C06%5C26%5Con-the-referendum-33-high-performance-government-cognitive-technologies-michael-nielsen-bret-victor-seeing-rooms%5C). [↑](#footnote-ref-105)
106. Thomas, ‘Mortgages, Fixtures, Fittings and Security over Personal Property’ (n 31). [↑](#footnote-ref-106)
107. J Baker, *The Oxford History of the Laws of England: volume VI 1483–1558* (Oxford, Oxford University Press, 2003) 735–38; P Luther, ‘Fixtures and Chattels: A Question of More or Less’ (2004) 24 *OJLS* 597, 600-605; Bridge, Cooke and Dixon, *Megarry and Wade* (n 27) at [22-012]-[22-018]. [↑](#footnote-ref-107)
108. Luther, ‘Fixtures and Chattels’ (n 107) at 602. [↑](#footnote-ref-108)
109. *Poole’s Case* (1703) 1 Salk 368, 91 ER 320 (Holt CJ). [↑](#footnote-ref-109)
110. *Lawton v Lawton* (1743) 3 Atk 13, 15, 26 ER 811, 812 (Lord Hardwicke). [↑](#footnote-ref-110)
111. Luther, ‘Fixtures and Chattels’ (n 107) at 602-606; G Kodilinye, ‘Time for Removal of Tenant’s Fixtures’ [1987] *Conveyancer and Property Lawyer* 253. [↑](#footnote-ref-111)
112. *Southport and West Lancashire Banking Co v Thompson* (1887) LR 37 ChD 64. See also *Reynolds v Ashby* [1904] AC 466, 473 (Lord Lindley). [↑](#footnote-ref-112)
113. cp Kodilinye, ‘Time for Removal of Tenant’s Fixtures’ (n 111) at 262-263 citing *Saint v Pillay* (1875) LR 10 Exch 137. [↑](#footnote-ref-113)
114. *Peel Land and Property (Ports No 3) Ltd v T S Sheerness Steel (Ports No 3) Ltd* [2014] EWCA Civ 100. [↑](#footnote-ref-114)
115. Bridge, Cooke and Dixon, *Megarry and Wade* (n 27) at [22-022]. [↑](#footnote-ref-115)
116. The possible combination of additive manufacturing of houses (Dinusha Mendis and others, *The Intellectual Property Implications of the Development of Industrial 3D Printing* (Brussels, European Commission 2020) 240-244) and self-repairing objects (D Boffey, ‘Robot, heal thyself: scientists develop self-repairing machines’ (*The Guardian*,7 August 2019) [www.theguardian.com/technology/2019/aug/07/robot-heal-thyself-scientists-develop-self-repairing-machines](http://www.theguardian.com/technology/2019/aug/07/robot-heal-thyself-scientists-develop-self-repairing-machines) may lead to smart homes that can self-repair, the implications of which shall have to be left to another time. [↑](#footnote-ref-116)
117. See, in the context of 3D printing alone, D Mendis, M Lemley, and M Rimmer (eds), *3D Printing and Beyond: Intellectual Property and Regulation* (Cheltenham, Elgar 2019); Mendis and others, *Intellectual Property Implications of 3D Printing* (n 116). [↑](#footnote-ref-117)
118. C Hunter, ‘Solar Panels, Homeowners and Leases: The Lease as a Socio-Legal Object’ in D Cowan and D Wincott (eds), *Exploring the “Legal” in Socio-Legal Studies* (Basingstoke, Palgrave Macmillan, 2015) 137-155. [↑](#footnote-ref-118)
119. HE Smith, ‘Property as the Law of Things’ (2012) 125 *Harvard Law Review* 1691. [↑](#footnote-ref-119)
120. Hunter, ‘Solar Panels’ (n 118) at 148. [↑](#footnote-ref-120)
121. For a similar perspective: CG Bradley, ‘Disrupting Secured Transactions’ (2019) 56 *Houston Law Review* 965 (tracking and location technology is in use and should thus, be utilised for registration purposes). [↑](#footnote-ref-121)
122. *Ellis v Glover and Hobson Ltd* [1908] 1 KB 388, 397 (Fletcher Moulton LJ): no implied permission for a third-party financier to remove trade machinery from mortgaged land, even though this gave rise to the possibility of fraud, because of the difficulties faced by third parties in ascertaining the existence of a mortgage over land. [↑](#footnote-ref-122)
123. See generally: Fox, *Conceptualising Home* (n 26); L Fox O’Mahony and JA Sweeney, *The Idea of Home in Law: Displacement and Dispossession* (Farnham, Ashgate, 2011). *cp* SM Stern, ‘Residential Protectionism and the Legal Mythology of Home’ (2008-2009) 107 *Michigan Law Review* 1093. [↑](#footnote-ref-123)
124. Fox, *Conceptualising Home* (n 26) at 24. [↑](#footnote-ref-124)
125. ibid, ch 4. See also LA Fennell, *The Unbounded Home: Property Values Beyond Property Lines* (New Haven, Yale University Press, 2009) 180-87. [↑](#footnote-ref-125)
126. Fennell, *The Unbounded Home* (n 125) at 1. [↑](#footnote-ref-126)
127. ibid 10. [↑](#footnote-ref-127)
128. J Flanders, *The Making of Home* (London, Atlantic Books 2014) ch 1. [↑](#footnote-ref-128)
129. ibid 96-98. See also at 166: by the nineteenth century ‘a house without a woman was a house, not a home’. [↑](#footnote-ref-129)
130. ibid 101. [↑](#footnote-ref-130)
131. Fennell, *The Unbounded Home* (n 125) 4-5. [↑](#footnote-ref-131)
132. ibid 25. [↑](#footnote-ref-132)
133. See, eg: Thomas, ‘Mortgages, Fixtures, Fittings and Security over Personal Property’ (n 31) 364; Flanders, *The Making of Home* (n 128); D Miller (ed), *Home Possessions: Material Culture Behind Closed Doors* (Oxford, Berg 2001) 1; N Gregson, *Living With Things: Ridding, Accommodation, Dwelling* (Wantage, Sean Kingston Publishing 2007). [↑](#footnote-ref-133)
134. N Cahn and A Ziettlow, ‘“Making Things Fair”: An Empirical Study of How People Approach the Wealth Transmission System’ (2015) 22 *Elder Law Journal* 325, 341. [↑](#footnote-ref-134)
135. J-S Marcoux, ‘The Refurbishment of Memory’ in Miller, *Home Possessions* (n 133) at 69, 70-71, 84. [↑](#footnote-ref-135)
136. JJA Shaw, ‘From Homo Economicus to Homo Roboticus: An Exploration of the Transformative Impact of the Technological Imaginary’ (2015) 11 *International Journal of Law in Context* 245, 256. [↑](#footnote-ref-136)
137. O Wainwright, ‘Drunken droids and solar-powered shirts: what the smarthome will look like’ (*The Guardian*, 9 May 2018) [www.theguardian.com/artanddesign/2018/may/09/solar-powered-shirts-drunken-droids-smarthome-future-starts-here](http://www.theguardian.com/artanddesign/2018/may/09/solar-powered-shirts-drunken-droids-smarthome-future-starts-here) quoting Ivy Ross, head of design at Google’s hardware division: ‘It’s more about how to make the technology blend into your home. Our ultimate goal is to make it disappear.’ [↑](#footnote-ref-137)
138. N Carr, ‘Foreword’, in Frischmann and Selinger, *Re-Engineering Humanity* (n 2) xi: ‘a proliferation of networked objects, machines, and appliances in our homes and workplaces is enmeshing us still further in a computerized environment designed to respond automatically to our needs.’ [↑](#footnote-ref-138)
139. A Greenfield, *Radical Technologies: The Design of Everyday Life* (London, Verso 2017) 10-11, 17: ‘interlocking mesh of technical, financial, legal and operational arrangement that constitutes a contemporary device and service ecosystem … that we implicate ourselves in from the moment we purchase’; Hoofnagle, Kesari and Perzanowski, ‘The Tethered Economy’ (n 18) at 847: in smart homes, choosing one or another system could lead to ‘tightly tethered ecosystems’. [↑](#footnote-ref-139)
140. BBC News, ‘Apple, Google and Amazon decide to “play nice” over smart home tech’ (*BBC News*,18 December 2019) [www.bbc.co.uk/news/technology-50842062](http://www.bbc.co.uk/news/technology-50842062). [↑](#footnote-ref-140)
141. L Kelion, ‘Why Amazon knows so much about you’ (*BBC News*, 24 February 2020) [www.bbc.co.uk/news/extra/CLQYZENMBI/amazon-data](http://www.bbc.co.uk/news/extra/CLQYZENMBI/amazon-data). [↑](#footnote-ref-141)
142. D Desai, ‘The New Steam: On Digitization, Decentralisation, and Disruption’ (2014) 65 *Hastings Law Journal* 1469. [↑](#footnote-ref-142)
143. Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 20. [↑](#footnote-ref-143)
144. Zhao, ‘Unraveling home protection’ (n 23) at 3. [↑](#footnote-ref-144)
145. ibid 4. [↑](#footnote-ref-145)
146. ibid 35. [↑](#footnote-ref-146)
147. Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 67 n 40: their concern, as here, is with the interaction between the different types of creep. See also B-J Koops, ‘The Concept of Function Creep’ (2021) 13 Law, Innovation and Technology(forthcoming) [https://ssrn.com/abstract=3547903](https://ssrn.com/abstract%3D3547903). [↑](#footnote-ref-147)
148. Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 80. [↑](#footnote-ref-148)
149. ibid 103. [↑](#footnote-ref-149)
150. ibid 124. [↑](#footnote-ref-150)
151. ibid 10. [↑](#footnote-ref-151)
152. ibid 62, 65. See generally MS Gal, ‘Algorithmic Challenges to Autonomous Choice’ (2018) 25 *Michigan Technology and Law Review* 59. [↑](#footnote-ref-152)
153. Cp JE Cohen, ‘Examined Lives: Informational Privacy and the Subject as Object’ (2000) 52 *Stanford Law Review* 1373, 1424. [↑](#footnote-ref-153)
154. Frischmann and Selinger, *Re-Engineering Humanity* (n 2) at 228. [↑](#footnote-ref-154)
155. ibid 78. [↑](#footnote-ref-155)