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**Symmetrifying Smart Home:  
Topological Power and the New  
Governmentality of the Internet of  
Things**

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**Abstract**

This paper investigates how the current domestic application of the Internet of Things (IoT), called “smart home,” changes the socio-phenomenological meaning of place-making. It describes a smart home as a topological continuum that could unfold lots of functional spaces—those optimized for a variety of predictable user behaviors and intentions, such as going to bed, working out, and energy-saving—according to how software applications redeploy its embedded sensors and actuators into certain algorithmic orders. This continuum once buried under people’s daily routines is constantly re-excavated in a smart home and re-differentiated into the new service domains of the IoT. This paper develops a topological framework to analyze the new form of media power behind this perpetual place-binding of smart spaces, which I term topological power. For this goal, it borrows Bernhard Riemann and Henri Poincaré’s mathematical thinking of manifold, or multiplicity, beneath the geometric structure of space.

**Keywords**

Internet of Things, smart home, topology, manifold, ontopower, risk society

**I. Introduction: Re-intensifying a (non-)smart home**

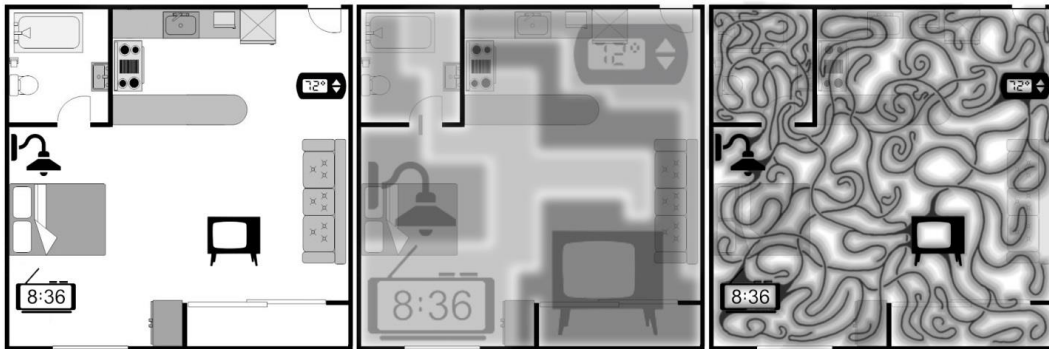
Small objects called social plugins, such buttons as Facebook’s “Like,” “Share,” “Send,” and “Quote,” are everywhere on the current Internet. Signifying how easily user participation can be done through one’s reflexive motor response of clicking, the visible surfaces of these objects also effectively conceal how proprietary the behavioral

data collected on the other side of the interfaces become as software companies use them to recommend certain contents or webpages customized to each user's preference. Embedded even outside of social network sites, their supposed optimization of one's personal web browsing experiences might also contribute to the ultimate ambition of the companies like Facebook to let their services filter and redisplay the entire Internet to their users. In this respect, the new fabric of the web or its network topology today is no longer woven through people's conscious decisions to click the hyperlinks that individual web designers created. "Beyond the hyperlink," the topology of each weighted edge of the web is now governed by machine learning's prediction of user preferences among all possible links it can generate (Gerlitz & Helmond, 2013: 1358).

If this object-oriented *place-binding* is what social plugins have secretly experimented with on the web under the banner of Web 2.0 and its myth of user participation (Scholz, 2008), the recent miniaturization of smart sensors, processors, and actuators (Crandall, 2010), or the things in the Internet of Things (IoT) suggests a topology of real-world objects as the new logic of spatialization applicable to any physical domains. In this case, optimized through these small machines embedded virtually in everything people interact with on a daily basis is their daily routines to manually manipulate these objects for everyday needs. And, as the current hype of the IoT and its domestic application imply, the fabric of a person's private life in a *smart home* is now woven through the ambient interoperations of smart objects that activate themselves or each other according to the IoT's algorithmic preemption of her emerging needs even before she recognizes them. In the following pages, I will develop a topological framework analyzing the new form of media power behind this IoT-driven transformation of human geography, but for now, to repurpose *topology* as a branch of mathematical thinking into a tool to describe this process of place-binding, let me start off with a simple thought experiment on a non-smart home, filled with several electronic devices, not yet digitally interconnected.

Say each device in this setting exerts its effect over a nearby area and can be redeployed anywhere insofar as it does not overlap another. A domain that each device's influence reaches could then be stretched and bent flexibly since they are rearrangeable in many improvised ways. Following the definition of topology as a study of the properties of

objects that “remain invariant under bending, stretching, or deforming transformations” (DeLanda, 2002: 25-6), this domestic space can be considered a topological object characterized not so much as a container for separable devices but as a continuum having flexible and unbreakable inner boundaries as its *topological invariants* that determine the scope of all possible interoperations of the devices (Figure 1). Each device in this conceptual space would then be *symmetrical* to any transformations the house undergoes in that it could operate invariantly in any position. (Note that the word symmetry here is used in its mathematical sense, meaning when an object or its property is invariant under a specific transformation the object undergoes. In this sense, symmetry is always symmetry *to* certain power that imposes transformations upon the object.)



**Figure 1: Three topological isomorphs of a domestic space with flexible inner boundaries of devices**

However, most of the symmetries these devices have preserved would be broken soon as a person moves in and her daily routine—waking up, sitting at a table, having breakfast, reading something—redeploys them to the new niches. Under the influences of the homeowner, they can be functional only by being consistently engaged with a trajectory she draws to refresh her energy to begin and continue a day. This means the devices no longer remain the same under all possible stretching and bending of the continuum but symmetrical only to a linear transformation along the homeowner’s daily routine. As Manuel DeLanda says, “an undifferentiated *intensive space* (that is, a space defined by continuous intensive properties) progressively differentiates, eventually giving rise to *extensive structure*” (2002: 27, emphasis in original). Her singularity embeds a *line of force* or *attractor* within the continuum and makes “a large number of different trajectories, starting their evolution at very different places in the manifold, ... end up” being aligned “within the ‘sphere of influence’ of

the attractor” (15, 32). Despite the extensive structure that the space’s transformation eventually culminates in, this topological description at least conceptually preserves the undifferentiated continuum of the space insofar as it is still able to unfold lots of hidden functional states with the introduction of other attractors than the person’s daily routine. Topology repurposed as a means to describe the place-binding of domestic space in this way rediscovers its intensive proto-territory where manifold functional relations among the entities are still open to all possible re-deployments prior to any extensive structures.

This paper examines the smart electronic devices and their network called the Internet of Things as the technological attractor that re-intensifies this topological potential of domestic space, currently renamed *smart home*. Embedded with a multitude of sensors and actuators, a domestic interior in its most advanced form now is redefined as a topological continuum that could unfold potentially innumerable functional spaces in response to software applications’ constant redeployment of smart objects. In the first section of the paper, this continuum is discussed as not simply discovered under people’s everyday routines by ubiquitous sensors but cultivated by the new form of media power I term *topological power*, which, as the second section argues, constantly redifferentiates the continuum into the new service domains for its algorithmic governance. The following section then discusses Bernhard Riemann and Henri Poincaré’s mathematical thinking of *manifold*, or multiplicity, as a possible theoretical tool to describe this undifferentiated proto-territory of the IoT, from which the final two sections theorize the new logic of place-binding in smart home and the new technique of self-governance its smart residents internalize.

## 2. Topology in Culture

In the introduction to the special issue of *Theory, Culture & Society* on “Topologies of Culture,” Lury, Parisi, and Terranova discuss the recent interface culture, which they characterize as “a proliferation of surfaces that *behave topologically*,” as something originated from “20<sup>th</sup>-century developments in the gridding of time and space, the proliferation of registers, filing and listing systems, the making and remaking of categories, the identification of populations, and the invention of logistics” (2012: 8). Encompassing all these early computational modelings of the workplace, domestic

space, and social geography, and currently embedded in all of these human spaces, digital interfaces for the past decades have registered a variety of objects—from home/office appliances to consumer goods—to their heterogeneous networks. At the same time, the functional values of these objects have been re-categorized along with online activities of their users, whose quantified-selves have also been registered to the same interfaces as the collections of computable variables: from their demographic characters to the patterns of online behaviors. By topology, these authors suggest how the “lower level” principles of invariance or consistency” in human geography have changed as its subjects and objects have been relocated to the networked social platforms. While Euclidean axioms define objects as something invariant under such geometric transformations as “rotation, symmetry, scale and translation” and, in turn, define their movement as the “transmission of fixed forms in space and time,” the movement they topologically reconceptualize is expressed in the form of “the ordering of continuity” (6-7, 13), or, in my term, the bending and stretching of a continuum to make something invariant emerge from its folded surfaces. Suppose you are walking around a city with a GPS tracking augmented-reality app. Prior to any other representations of your engagement with the city, your physical displacement would be expressed as a linear transformation of a geo-data continuum along the trajectory of a data point representing your location. The graphical boundaries of urban objects would then appear in the app’s GUI as nearby Points of Interests (POI) only as the result of the software’s constant ordering and folding of the continuum into the changed data point. In the same way, your social profile would be constantly updated and improvised through the algorithmic comparison of your pathway across the POIs to what others draw (Lury & Day, 2019). The movement here is not about your displacement as the consequence of your motor intention ingrained in “pre-given territorial containers” (Allan, 2011: 286). Rather it expresses certain power that makes a place itself emerge from the continuum in which objects should be constantly re-included as those orderly changing under given deformations.

In this respect, the “becoming topological” of something entails the liquidation of “the rigidity of the distinction between inclusion and exclusion,” once determining the place of an object “based on essential properties, such as archetypes, values or norms, or regional location” (Lury et al., 2012: 5). Objective boundaries rethought as topological matters are instead under constant recreations through “different kinds of folding and

filtering” of the continuum (Mezzadra & Neilson, 2012: 60). Reconfigured as a continuum of multilevel relational data, the urban landscape also becomes an object with lots of embedded boundaries, which preserve the “excess” (Lury, 2009: 80) open to the software’s alternative ways of folding/filtering. In the recent discourses of human geography, topology has therefore been introduced as the term to describe these innovated lower-level principles for the movement of humans and nonhumans “in culture as a field of connectedness,” and their “inclusion and exclusion” along deformable boundaries (Lury et al., 2012: 5).

On the other hand, what I mean by *topological power* is a new form of power that capitalizes on this transformability of human geography converted into a digital continuum. This power mobilizes people’s speculations about hidden values and problems embedded in their material footings and exploits them as what justifies the expansion of its governance. In doing so, this power constantly re-differentiates the continuum into a multitude of problem-spaces, which can be managed optimally by its environmental sensors and actuators. There can be various conductors of topological power. Active users of self-tracking devices, such as early proponents of *quantified-self*, for instance, exercise this when they attempt to expand the scope of their self-governance by digging out some unknown computable problems from their everyday lives; a smartwatch, on the other hand, exercises its governance by asking the wearer to delegate this job to quantify herself without being a data analyst herself; governments and corporate actors could expand the scope of this data-mining of hidden problems to a whole city converted into big data. Even though the objects each conductor takes for its domain are stretched vastly from a body to a city, topology expresses their common logic for territorial expansion, never imaginable with the territoriality previously understood as a geometric extension. Space under topological power is transformed into a relational database with lots of unknown correlations. Claimed to be discovered sooner or later by embedded sensors and actuators, these correlations are indicative of hidden problems like unknown health issues or impending terrorisms detectable only by the pattern recognition algorithms of a smartwatch or smart city. As the rest of this paper demonstrates, the technological embodiment of topological power, such as the IoT, is, therefore, superior to other territorial actors based in a single extensive level of space since the number of objects

a topological actor could put under its governance is potentially unlimited as it could unfold hidden levels of space *ad infinitum*.

The expansion of topological power for the past decades has been driven by the proliferation of software interfaces embedded not only in the new urban landscape but also human skins under smart wearables and it has foregrounded lots of hidden correlations otherwise undetectable. On the other hand, the above thought experiment on the transformability of a non-smart home suggests another direction that topological power recently takes to access the underlying continuum of our everyday lives. The becoming topological of space in this domestic scenario is not achieved by its connection to the outside networks. It is rather intensified through the *manifold* regional interconnections of devices in the same sense with what the term *manifold* means in Riemannian differential geometry: a set of “multiply extended magnitudes ... susceptible of various metric relations,” in which “a [Euclidean] space constitutes only a special case of a triply extended magnitude” (Riemann, 2007: 23). Our not-yet-smart home is likewise topological as it is charged with lots of potential interoperations among the devices that could be susceptible to various functional relations if rewired properly to each other. As the technological solution to this quest for becoming topological of everyday life, the IoT embeds miniaturized “RFID and sensor technology” in domestic objects and lets them “observe, identify and understand the world” from their own data points and, in turn, transforms the space into a relational database (Ashton, 2009).

According to the International Telecommunication Union’s standardization report, the things in the IoT are enrolled to a new dimension called “Any THING communication,” distinguishable from two other dimensions of the ICTs in the past, namely “Any TIME communication” and “Any PLACE communication” (2012: 2). This new dimension for machine-to-machine communication provides smart objects with an ontological platform for their reciprocal presence without being necessarily used in human TIME and PLACE. This means, for realizing the IoT’s ideal of the “full use of things to offer services to all kinds of applications” (3), a smart home should first liberate its objects from their previous obligation to follow the instructions directly given by humans and let them communicate freely with each other about the space’s hidden relational problems. For instance, the state of the space not optimal yet

for predictable user behaviors, such as going to bed, can be communicated and optimized by the relevant applications, such as a sleep app to manage the interoperation of a smart thermometer, lighting, phone and watch.

A smart home topology in this scenario can be then roughly analyzed into three different conductors of power in negotiation. First, there is the homeowner, so interested in optimizing her lifestyle to the extent of speculating her daily routine as a continuum embedded with lots of efficiency problems. The smart home applications she purchased then function as technical conductors of topological power to unfold these invisible problems of her daily routine. On the other hand, the primary concern of a service provider, who owns big data gathered from its smart home subscribers, would be to data-mine a greater number of serviceable problems for the companies' further commodification of the smart home infrastructure.

### **3. Manifolds in the Internet of Things**

Kirstein (2016) suggests an architectural abstraction for expanding “the edge of the networks that make up the Internet” even to the not “IP-enabled” objects, such as the devices in our non-smart home scenario. According to him, a typical IoT system consists of two layers: *DeploymentNet*, or the physical lower layer for the actual enrollment of smart objects to a physical domain; and *ServiceNet*, or the upper software layer where the virtual objects as the algorithmic counterparts of the physical objects are abstractly defined for their deployment for the IoT applications. For the regional IoT infrastructure (such as a smart home with several smart devices) to be automatically operational for the applications in the software layer, the semantic technology called ontology also needs to intervene in the middle for “the alignment and matchmaking tasks ... to identify which smart entities that ‘live’ in the house are appropriate for the applications/services to function” (Kotis & Katasonov, 2012).

<sup>1</sup>Replacing a person's habitual deployment of objects for her daily routine, this machine-to-machine protocol enables the smart home to optimize itself to the predictable human needs. However, this technological optimization of space, which the homeowner may believe she delegated to the IoT to save the time she used to waste for walking around and manually turning on and off the devices, is not only to

fulfill her daily needs but the corporate conductor's commercial interest, namely constantly renewing the space's commodifiability.

For the person in the not-yet-smart setting, to live her daily routines is to transform her surroundings gradually into the figure symmetrical to her everyday practices. Along the multiple sensorimotor pathways from what physiologists call *reflex arc* to what phenomenologists call *intention arc* (Merleau-Ponty, 2005), any move she takes at home is followed by her somatic expectation on the transformation her move would bring in space. The actual perception succeeding her move would in turn confirm or update this expectation to prepare her future moves. In this sense, the person's living in her not-yet-smart home is topologically isomorphic to the process whereby a spatial continuum is folded by a set of biological sensors and motors interconnected through certain physiological pathways. As Ingold says, "places are formed through movement, when a movement *along* turns into a movement *around*" (2008: 1808); to put it differently, a place is unraveled as what the sensors perceive is aligned with how the motors routinely operate, and vice versa. Like the typical residents of modern buildings, whom Pink et al. call "directors of flows," this person improvises "the material configuration and atmosphere of [her] bedtime home as [she] move[s] through" the space for "switching the lights on and off, closing curtains, plugging in things to charge and setting up technologies to 'work' while [she is] asleep"; to make it "felt right" to her "bedtime routine" (2016: 86, 88).

On the other hand, the IoT's optimization of a smart home is not for stabilizing it into a single "right" level because its stability is bad news for the service provider, meaning no more problems embedded for the company's data-mining. Stability in a smart home should rather be a transitory equilibrium about to be broken by the new problems the updated application soon excavates. As Kitchin and Dodge (2011: 71) illustrate with the term "code/space," in a smart home, "*space is constantly brought into being as an incomplete solution to an ongoing relational problem*" that can be termed the *maximum optimization of space*. And for this bringing-forth of more optimal space to be repeated over and again, the physical continuum of a smart home should be full of small relational problems to a variety of predictable user behaviors, such as its state not-yet-optimal-enough for sleeping, doing exercise, or watching TV, which can be optimized further by each different application. Unlike the spatial continuum of a not-yet-smart

home setting, which was folded through the physiologically hardwired *sensorimotor arcs*, the continuum of a smart home, under multiple *sensor-actuator arcs*, is not detained within just a single level of optimality. Instead, its IoT system needs to keep the continuum intensive enough to be de/re-territorialized by different sets of smart objects for different applications. The two-layered structure of the IoT in this commercial concern is, therefore, the product of the strategic design decision to guarantee the IoT's intensive penetration all the way down into lurking problems. While its lower layer for the maximum interoperability of smart objects intensifies the space with lots of relational problems, the upper software layer gradually identifies and commodifies them into its serviceable domains. For instance, Lanzeni observed in a citizen-sensing environment project that the problem of knowing the real cause of air pollution was always engaged with some "other environmental elements" that the current deployment of environmental sensors could not detect. These other elements' withdrawals from the grip of current software solutions were, however, still expected to "become tangible" and "bring [the participants] closer to understanding what was causing the pollution" as the project could redeploy the sensors by "improving firmware or to move to a different technology" (2016: 55-6, 60). In other words, the smart future where all these environmental elements have been optimized was imagined to be already embedded in the material bottom but not just unfolded yet through a proper software application in the high (Ahn, 2019a).

As Dourish and Bell say, "the proximate future vision" of ubiquitous computing has spurred the "dramatic transformations of technological infrastructure" for the last three decades from Mark Weiser's early research at Xerox PARC in the 1990s to the recent IoT (2011: 24-5). And, in the topological framework roughly sketched above, this future vision is now reinterpretable as more than just the rhetoric of Silicon Valley on its "future infinitely postponed" (25). In-between the intensive lower layer and the abstract upper layer of a smart home, the most optimal future for our smart life is inevitably postponed infinitely because it would stay lurking in the underlying continuum until the software applications unfold all of its problematic hidden levels and, more importantly, because this continuum would always be abundant with hidden problems.

## 4. Riemannian and Poincaréan theories of symmetrical space

At the heart of the current hype of the IoT is therefore a sort of topological speculation about the multiplicity enfolded in our physical reality. And, for the IoT's expansion of its service domains to be sustainable even after everything is already replaced by smart objects, this multiplicity should continue unraveling its hidden measurable features through the multiple "cuts" the wireless sensors and actuators constantly inscribe on its continuum (Poincaré, 1913: 54). With regard to this resourceful multiplicity, this section discusses Bernhard Riemann's mathematical concept of *manifold* and Henri Poincaré's group theory and how they theorize the cause, or attractor, behind implicit sensors and motors that function in their mathematical imaginations to cut through to the hidden geometries of the manifold.

In the essay on a *manifold* "at the foundation of geometry," Riemann explains how a surface with constant curvature, or a geometric plane, could be unfolded from this conceptual space of *multiply extended magnitudes*. He first assumes that for measurement in the most basic sense to be possible, a length of the line should be independent of its position no matter where it is superposed to be compared with other lengths. He then contrives heuristically an anonymous "one," who (or which) passes from one magnitude to another to transport "the line element  $ds$ " as an infinitesimal yardstick to define "metric relations of which a manifold ... is susceptible." As this mathematical *cursor* moves across a manifold, he argues, the nearby magnitudes it passes through are gradually localized into the points fixed by the homogeneous Pythagorean distance function. And, consequently, it concretizes one embedded level of the manifold, on which any configurations "distinguished by a mark or a boundary" the cursor draws appear symmetrical to the group of geometric transformations, such as displacements and rotations (Riemann, 2007: 24, 26).

In this heuristic explanation, Riemann's differential geometry suggests a mathematical actor that folds the magnitudes infinitely close to its trajectory into the geometric theorem at the expense of breaking all other relations the manifold once preserved. Even though he did not explicitly mention anything about the motoricity of his yardstick, its simple operation to superpose the line element ( $ds$ ) upon other magnitudes already assumed the elementary capacity of movement the yardstick

should have. And this motoricity delivering the smallest measure all over the manifold was the attractor that Riemann introduced to unfold a single stable level of measurability from the intensive space imagined by the non-Euclidean geometries in the nineteenth century and thus to rewire it with the Cartesian coordinate.

On the other hand, the substitute Poincaré suggested for this purely mathematical attractor in Riemannian geometry was a simple biological being capable of sensing and moving in a physical environment of multiply extended intensities. In his physiological and phenomenological explanation on the origin of geometry, what appears invariant enough to replace Riemann's hypothetical yardstick is an elementary correlation between two types of state changes this biological cursor undergoes as moving around the continuum of intensities. First, there could be the changes aroused from its sensors "independent[ly] of will" by something that hits its surfaces. On the other hand, there could also be the changes "voluntary and accompanied by muscular sensations," indicating nothing outside but whether and how activated certain muscles are within its body (121). An eye, for instance, can be thought of as an intersection for these two types of changes to be intermingled. Say it moves to the right and left as the manifestation of a motor volition that activates certain muscles. The metric relation between the external sensations that have passed through the retina during this motor activity would then be, for now, measurable by the amounts of coincident muscular sensations. (E.g. a red spot on the right could be certain muscular sensations away from a blue spot on the left.) And if there was no other motor apparatus activated during this brief experience, these voluntary muscular sensations would be enough to unfold specific spatial relations invariant under the continuum's repeated distortions through the eye movements whereas all the other parts of the continuum would withdraw to the background. For the physiological system that is multiply extended to its intensive environments through its sensors and motors also multiply interconnected along certain sensorimotor pathways, these elementary sensations can be alternative to the Riemannian line element, not hypothetically given any longer, but experientially emergent in this case. According to the trajectory this body draws, the surrounding manifold would eventually bifurcate into a phenomenological space; not so much a transcendental form but just a set of magnitudes that appears to be invariant or orderly changing under (in other words, symmetrical to) *a group of transformations* the hardwired sensors and motors of this biological cursor apply to its intensive surroundings.

For Poincaré, the attractor that unfolds a geometric structure embedded in a manifold is this voluntary action of a physiological system that accompanies certain muscular sensations, or what current neuroscience calls *proprioception*, which enables “the sensory cortices to predict specifically how the actions to be taken will change the relations of the eyes, nose, ears, and fingers to the world” (Freeman, 2000: 33). He also knew that the “sensible space” this biological being inhabits is not three-dimensional *a priori* but possible to be folded into “as many [degrees] as there are nerve-fibers” (Poincaré, 2007: 132). A manifold for him was thus characterized by its feature capable of being bound by as many local sensorimotor pathways as any possible observing systems, but inexhaustible by any of them. Inferred from this feature is that underlying intensities of physical reality are embedded with lots of hidden levels that can be unfolded separately by different attractors, but never unfolded all together. Geometry for Poincaré was, therefore, just one unraveled order out of these manifold others, and its appearance as a single stable level was what expresses the operation of the anthropomorphic sensorimotor pathways, which put a person’s phenomenological world under the “maximum grip” the person holds on a certain embedded order of the intensities (Freeman, 2000: 120-1).

In Poincaréan group theory, *symmetry* attains a new ontological meaning besides an object’s invariance under a subject’s observation or manipulation since it now refers to the emergence of the subject-object boundary itself from a continuum under transformation. Symmetry is an event whereby a group of sensors and motors is interconnected along *an arc*, through which the folded inside of the continuum achieves a stable grip on an embedded level of the outside. In this respect, symmetry is akin to what Karen Barad describes by the term *agenial cut*: “topological dynamics of enfolding whereby the spacetime-matter manifold is enfolded into itself” whereby “the marking of the ‘measuring agencies’ by the ‘measured object’” emerges (2007: 140, 177). This cut is where a continuum is folded in two and differentiated into the symmetrical inside and outside. Therefore, it is prior to any boundaries of the observer/observed, toucher/touched drawn on the continuum. As the cause that makes the cut, an attractor does not belong to either of two poles of the symmetry, namely subject/object or system/environment. Its power topologically thought is rather described as a continuum’s fluctuation to make a fold on its own surface, from which something invariant comes to the fore, or bifurcates, as an object. This movement is

both material and discursive in that what the unfolded space presents is not only the objects' invariant boundaries but the group of transformations to which their *objectness* is defined to be symmetrical. Riemann's infinitesimal yardstick is one instance of this power as it folds a mathematical manifold into a *measurable space* under the maximum grip of the Pythagorean Theorem. Poincaré's *group of transformations* is another and it folds an intensive continuum into a *livable space* on which a phenomenological subject, like our homeowner, would have the maximum grip with her routine sensorimotor responses. And, the IoT is the latest example of this attractor as its wireless sensor and actuator network constantly refold the underlying continuum of a smart home to multiply its optimal grip of *serviceable and marketable spaces* for its perpetual market penetration.

## 5. Two types of power in manifolds

*Symmetry* has been used in media studies as the term to describe the equal right or mutual accessibility assigned *bilaterally* to both sides of the interaction, such as human/nonhuman and subject/object, especially since its appropriation of actor-network theory's *principle of symmetry*. However, in the term's functioning as the convenient gesture of reciprocity formally given to "all the elements that go to make up a heterogeneous network, whether these elements are devices, natural forces, or social groups" (Law, 2012: 124), often overlooked has been that, even for actor-network theory, symmetry has never been just descriptive of the relation between pre-existing actors; but expressive of a certain power which draws some *invariant responses* from undefined entities, such as Latour's microbes (1984), to make them reappear as the reproducible objects and thus mobilizable. Emphasizing these power dynamics concealed in the term's common usage, the symmetry re-conceptualized in the last section, on the other hand, suggests another way to think of the meaning of reciprocity. Prior to any bifurcations of such pairs of subject/object, observer/observed, or system/environment, symmetry now means an ontological event, or what Barad calls *intra-action* (2007), whereby a continuum folds an arbitrary subject boundary along its incurved arc, around which something invariant would then appear as objects.<sup>2</sup>

There can be two types of power that govern this emergence of objective spaces from a manifold. Exemplified by Riemannian bifurcation of mathematical space and

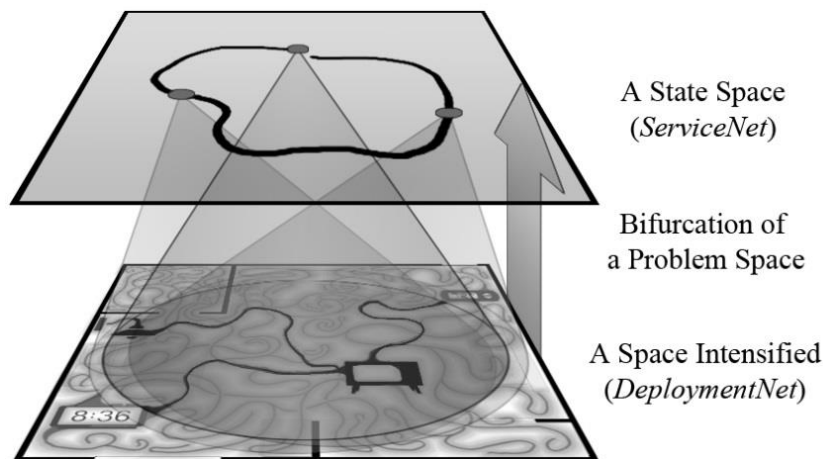
Poincaréan phenomenological space, the first type of power is operating as its fold tends to be hardwired to maintain its current grip on a single level of the manifold. Like the eye swaying from side to side, the fold in this case would move *along* the continuum and then move *around* only for enrolling what it has just passed through as the objects re-traceable by its registered or habituated motor operations. On the other hand, another type of power, which the earlier section mentioned as truly topological and thus always better than human eyes at governing unknown problems, tends to constantly re-wire its fold to update its current grip to a different level every moment. In this case, the fold would move around to the initial point only to initiate each new move-along to the undiscovered territories of the space. While the feature of a manifold the first type seeks out is its single symmetrical level bound by the routinized sensorimotor responses, the second type does not concern with identifying the most stable level but constantly re-deploying its wireless sensors and motors to examine all the “nested set of vector fields related to each other by symmetry-breaking bifurcations” (DeLanda, 2002: 32).

With regard to how the first type of power operates within a social domain, it can be shortly mentioned how Brian Massumi analyzes Foucauldian *governmentality* into two alternating techniques to fold “the [social] continuum ‘that lies between the organic and the biological, between body and population’” (2015: 24). According to him, this neo-liberal approach to optimize individual freedom within the ever-changing acceptable limit is still relying on the “disciplinary power” for its function to enable everything it “passes through” such as “bodies, gestures, discourses, and desires to be identified and constituted as something individual” (Foucault, 2003: 29-30). However, the symmetry of this level of “the spatial distribution of individual bodies” (242) under the maximum grip of local disciplinary apparatuses is shortly broken as the “regulatory biopower” re-bifurcates the continuum into a population: the “phenomena that are aleatory and unpredictable when taken in themselves or individually, but which, at the collective level, display constants” to its demographic apparatuses of “forecasts, statistical estimates, and overall measures” (243, 246). Foucauldian governmentality in this sense forms “a correctional reuptake mechanism for emergent normative variation” (Massumi, 2015: 25), which constantly updates the acceptable limit of individual behaviors from the changing statistical regularity; as Stephen Collier (2009: 93) argues as to Foucault’s lectures on security, territory, and population, this

mechanism also implements “a topology of power” as it transforms the social continuum into “a problem space to be analyzed by tracing the recombinatorial processes through which techniques and technologies are reworked and redeployed.” And, in our concern with the technique that governs individual devices in a domestic setting, this form of geographical governmentality is still noteworthy as topologically isomorphic to how our homeowner transformed her space by manually redeploying the devices to their new niches, whose collective interoperations would correspond to the constants in her daily routines, such as her regular needs and desires.

On the other hand, the second type of power is distinguishable by its tendency to unfold more symmetries hidden in the continuum no matter how symmetry-breaking an attempt to find a new one is to the others already discovered. It does not seek out a limited set of constants to detain the continuum’s dynamics in a single or two-coupled level of geometry or individual-population. Instead, the power is now concerned with drawing a whole *state-space* for the continuum to pass through in its recurrent differentiations from one state to another, constantly updating its optimal grip from one hidden level to another. This type of power is appearing in the middle of the two layers of a smart home as the software applications, downloaded and executed in its upper layer, also tend to redeploy smart objects below constantly into each new sensor-actuator arc to unfold a hidden marketable level of the space (Figure 2). For instance, in an existing smart solution to “the wellness of an elderly living alone,” a set of smart objects, including a room heater, toaster, microwave, TV, bed, and chair, is deployed by an algorithm that calculates the “wellness parameters,” the measure for space’s engagement with a person’s health-related routine (Suryadevara et al., 2013). On the other hand, the same set of objects can be re-deployed in other applications to calculate other parameters, such as the measures of space’s engagement with energy-consuming routine (Moreno et al., 2014), calorie-burning routine (Helal et al., 2009), and so forth. As the semantic protocol to define possible interoperations of these nonhuman actors in a smart home, the IoT ontology in the middle, in this respect, represents a different form of governmentality, and its optimization of the space for the most liveable condition does not pertain to reducing it to a population of the objects interoperating within the statistical regularity of the homeowner’s daily routines. Alexa Routines, sets of actions Alexa-powered smart appliances perform as the preemptive substitutes of the physical routines of the homeowner to optimize an

Amazon-built smart home to a variety of goals it predicts from verbal or behavioral cues, for instance, are inexhaustible in their customizability neither because she is the reservoir of insatiable needs nor of the new gadgets she would purchase in the future. It is rather because these objects are subject to the constant recombination and redeployment to detect some still unresolved uneasiness always remaining in her “*Good Morning Routine*,” “*Start my Day Routine*,” “*Screen Time Routine*,” “*Good Night Routine*,” and so forth (Amazon, n.d., “Alexa Routines”). The machine-to-machine protocol of the IoT is in this sense designed to maximize the possible ways for the smart objects to interoperate under the assumptions that there always remain some unknown problems and that the hidden parameters to measure, or to commodify, these problems can be identified through the constant reassemblage of the objects’ intensive interoperations.<sup>3</sup> Re-stirring the space once hardwired by the everyday routines of the homeowner, and exploring all the problematic levels its resumed re-differentiation could pass through, this new technique for space-binding, in turn, transforms the smart home into a continuum, or a nested set of problems related to each other by symmetry-breaking bifurcations.



**Figure 2: an intensive space and a problem space**

Understood as a manifold, smart home, therefore, redefines the meaning of domestic space. It is no longer something lived by and organized through a person’s habitual sensorimotor activities. It should rather be constantly re-differentiated into each specific “problem space,” in which a particular “set of operators” are temporarily aligned with a certain IoT application to convert “a set of [problematic] *initial* states” of the space into “a set of *goal* states” (Newell, 1980: 5, emphasis in original). A person

cannot govern these problems optimally not because there are too many of them, but because she cannot live all different levels simultaneously. The smart objects thus do not need to be symmetrical to the context of the homeowner's direct uses of them. For the larger number of smart objects to be interoperable enough to foreground all the hidden parameters of the space, they should be symmetrical to the microscopic perturbations of the continuum each other's operation arouses.

## 6. Ontopower

As early as the 1950s, American architect Charles Eames anticipated that the future architectures would approach their new state of the art “based on handling and relating of an impossible number of factors.” His early vision for cybernetic architecture however required the architects to take huge responsibility to control “the effect of and affect on many simultaneous factors” because these humans were the only experts “to use such a tool” that “could make possible the inclusion of more factors—and could make calculable the possible results of relationships between combinations of factors” (Halpern, 2014: 134). About a half-century later, Mark Weiser in the 1990s suggested *ubiquitous computing* as this kind of tool to integrate a manifold of human and machine-generated databases into one's home and office. However, what the ubicomp's slogan of “calm technology” promised was not to enable humans to process all computational elements simultaneously, but to liberate them from their previous responsibility for multitasking, namely to symmetrify lots of technical objects simultaneously to their conscious goals (Weiser & Brown, 1997). Finally, in our still coming age of calm technology, we witness that the withdrawals of smart devices into our intensified peripheries are furthered by the corporate conductors of topological power, making every human problem potentially symmetrical to and thus reappearing to respond regularly to their smart applications. The state-space the IoT lays over our intensified smart home redefines these problems as what we cannot access since they are too dispersed and embedded, but we still need to pay for their algorithmic and preemptive solutions.

The market potential of smart home is, therefore, proportional to the number of problems assumed to hide in its intensive space. To justify the IoT's interventions, these problems must remain undistinguishable until their urgency is detected by each

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software application. Under this commercial necessity, smart home can be defined as what Massumi calls a “crisis-incubating environment,” where the crises are concealed in the forms asymmetrical to a Poincaréan observer, or our homeowner, who could recognize the problems only too late after the crises already disturb the symmetries of her daily routines. And what the recent smart home applications and other regional smart environments incubate foremost as this sort of crisis is hidden inefficiency issues in people’s everyday lives, such as unnecessary energy wastes (Moreno et al., 2014). No longer merely being a problem of one’s bad habit, the inefficiency is now embedded in the imperceptible fluctuations of space that her non-conscious behaviors precipitate. “The preemptive power” of the software layer thus needs to be always ready to “counter the event-driving force of accident if it catches it in the before of incipience” (Massumi, 2015: 40); in other words, “if Alexa has a hunch that you’re away from home or everyone has gone to bed, she can proactively turn off lights and adjust the thermostat to your preferred sleeping temperature,” preemptively acting “on her hunches without having to ask” (Amazon, n.d., “Alexa Smart Home”). As Massumi says, the power in this sort is environmental as it “alters the life environment’s conditions of emergence,” but it is different from how biopower detains a continuum within “a territory, grasped from the angle of its actually providing livable conditions for an existing biological being” (40). It also goes deeper than how *environmentality*, the concept Foucault shortly mentioned in his lectures on biopolitics but left not fully explained (2008), is recently revisited as the power that influences “the ‘rules of the game’ through the modulation and regulation of environments” to optimize people’s ways of life with the maximum degree of freedom (Gabrys, 2014: 35) or that expands Skinnerian “behavioral techniques” to the techniques of “environmental psychology” for “managing and controlling affordances” of the environments (Hörl, 2018: 160). While this Foucaultian environment is still till to be optimally graspable by our biological sensors and motors, or our behavioral minds that reorganize them into reflexive sensorimotor activities, a manifold the topological power intervenes in is rather “a prototerritory tensed with a compelling excess of potential which renders it strictly *unlivable*” or ungraspable for humans (40): the multiplicity of hidden levels that a society of smart objects in an ideal IoT ontology assumes to unravel one by one through their intensive interoperations. Tensed with this ungraspable multiplicity and unlimited interoperability of smart objects, the IoT’s

crisis-incubating materiality also cultivates its smart futures, which could be brought into reality as proper sets of smart objects eventually discover the hidden parameters for each unknown problem. Massumi uses the term *ontopower* for this topological power distinguishable from Foucaultian biopower. And, as he exemplifies with the battlefields of modern warfare against “the proteiform ‘terrorism’” (11) and Howe (2019) suggests in the case of Iceland’s glaciers with “environmental precarities,” this power works for any “continuum in space/time/matter” with excessive orders, asymmetrical to the “human-centered” sensing practices, but symmetrical to the sensing practices of “other-than-human entities” (Gabrys, 2016). As the domestic counterpart to these post-9/11 battlefields and Anthropocenic environments, smart home also incubates its own problems asymmetrical to our everyday sensorimotor activities.

Ulrich Beck said in the 1980s that “the ‘logic’ of risk production” would replace the “logic of wealth production” in late capitalism where the risk distribution, not the wealth, becomes the most urgent problem for the still ongoing project of modernization (1992: 12). Under the “conditions of ‘scarcity society,’” the technoscience as the engine of modernization was, he says, for “opening the gates to hidden sources of social wealth.” On the other hand, under the condition of a risk society where “for many people problems of ‘overweight’ take the place of hunger,” the issue for this technoscientific monetization is no longer “obvious scarcity” but invisible side effects of modernization, such as harmful chemicals and pollutants, which “escape perception and are localized in the sphere of physical and chemical formulas” (20-21). These threats, detached from “any possibility of perception,” are “not only transmitted by science, but in the strict sense are scientifically constituted” (162). Modernization’s self-referential turn to its own side effects, or modernization risks, has formed a vicious cycle of self-intensification, which has constantly generated new side effects no matter how many solutions have been accumulated to the known problems so far. The “insatiable demands long sought by economists” have in this sense been discovered from our inexhaustible concerns over the life-threatening side effects in the technoscientific second nature while the welfare states of the West have claimed that material demands from the first nature, such as hunger and basic needs, have almost been sated and satisfied (23).

As the local demonstration of this risk-cultivating second nature, smart home however suggests that some of the urgent problems hidden in our not-enough modernized ways of life are still rooted in the first nature of our biological self. In this new domestic space characterized by its capacity to monitor its own energy and resource consumption, our biological needs as much as the sociocultural are revealed to have never been satisfied *optimally* by the consumerism of the past century insofar as our self-recognition of desires and consumer skill to arrange the objects in hand to fulfill these desires has always entailed inevitable delays and inefficiencies. Unlike Beck's expectation, the fields of science that have been the most enthusiastic about embedding their "*shunting yards* of problems" (179), or a web of scientific measures for each different problem, might be, in this sense, neither chemistry nor environmental science but the studies on the too-human-inefficiencies in our biological first nature, such as behavioral economics (Nadler & McGuigan, 2018). In a smart home, the IoT replaces these shunting yards of behavioral sciences with its algorithmic sensor-actuator arcs and integrates each unfolded thread of the problem into its new service domains.

## **7. Conclusion: Self-knowledge and self-symmetrification**

If the ultimate goal of smart home is to make it prepared for any problems lurking in a person's everyday life, what should be symmetrified first to the IoT's algorithmic preemption would be the person's intentional being. Her *quantified-self* could then be a topological solution for this. As the digital shadow of a person's everyday practice, quantified-self suggests that the presences of human "bodies, minds, and daily lives" in smart environments are translatable into the imperceptible perturbations within databases collected through "various self-tracking tools and applications, including emotion trackers, food trackers, and pedometers" (Ruckenstein, 2017: 402). Like other topological matters, these human-caused perturbations enfold various levels that signify her "wants, needs, and goals ... individual diversity in areas such as sleeping, eating, drinking, or exercising" (411). However, occurring as *nonconscious* processes in the first place, these problems would remain just fluctuations within a physiological continuum of her body (or brain) until they appear, at best several milliseconds of *missing time* later, to be something (un)conscious to her self-understanding (Hansen, 2015: 90; Hayles, 2017). If it is true that her intention is not the cause of her agency,

but the consequence of lots of distributed actors in a smart home, these too-human milliseconds of delays in self-understanding would be already long enough to make an intensive continuum of her body—yet to be bound by her consciousness—feel like a crisis that needs to be preempted by the IoT. Given the inefficiency embedded in this delay of human consciousness, her smart home should be under the control of the IoT applications to make it always and already optimal for her imminent intentions and desires. Even before she finds she wants to go to bed, the environment should be symmetrified to the actions to come by dimming the light and warming the room. In short, the homeowner needs to have a sort of open-mindedness as a new technique of self-management, which can be called *self-symmetrification*: to render one's nonconscious more connectable to various smart devices better than humans at managing the most optimal state of their neurophysiology.

The smart homeowner now rediscovers herself not symmetrical to her self-understanding, but as a host of manifold vital signals tracked by smart devices' "power of countless observations of small incidents of change—incidents that used to vanish without a trace." However, contrary to how the early proponents of quantified-self once willfully "delegated" the practice of "data-gathering" and "record-keeping" "to a host of simple Web apps," her movements in a smart home are more silently tracked by the ubiquitous sensors that quantify "every facet of life, from sleep to mood to pain, 24/7/365" (Wolf, 2009). She is no longer a *director of flows*, but a *source of flows*, and if the continuous optimization of her everyday life the smart home promises is proportional to the number of connections she has with the ubiquitous sensors and actuators, the only rational decision left to her is not to symmetrify the devices to her everyday uses, but symmetrify herself to every new device.

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## Notes

- <sup>1</sup> This stratified structure is also typical in other IoT-based systems. For instance, IBM's blueprint for a smart city analyzes its structure into the bottom layer of instrumentation "made up of sensors, actuators, programmable logic controllers and distributed intelligent sensors" and the top layer of intelligence for "urban software applications" with the mediation of the middle layer for interconnection (Sadowski & Bendor, 2019: 551).
- <sup>2</sup> For the fold as what illustrates or diagrammatizes the inscription of the subjectivity for audiences within the machine assemblages of the current media culture, see Ahn, 2019b.
- <sup>3</sup> Thomas Gruber (1991) suggests *ontology* as an engineering term for "knowledge-level protocols" between different intelligent systems, each of which has its own peculiar "symbolic-level" representations. According to him, the role of ontology is not so much to organize a globally shared theory on the environments to which each system's inner representation needs to adjust, but to provide machines with the language to maximize their interoperability by allowing them to translate an output of a system to the input for another no matter how incompatible their symbolic insides are to each other.

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