Organizations Preparing Organizations for the IoT

The Congruence of the IoT Meme

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***Abstract* — While the Internet of Things (IoT) has significant economic promise, an obstacle to its rapid adoption is the development of a shared understanding of capabilities and purpose. As the IoT concerns the transformation of everyday products, organizations that have limited expertise in computing and networking technologies still have the need to understand IoT possibilities. In addition, if these organizations collectively select a similar IoT strategic direction, more value will be created for society on the whole. Recognizing this dilemma, technical organizations are taking the initiative to enhance their clients and potential clients' IoT understanding as it relates to opportunities with their products. In this paper we model this interorganizational learning as it relates to reaching a consensus on IoT purpose and briefly identify real world practices that technical organizations are undertaking to facilitate this transformation.**

Keywords-Internet of Things, Interorganization Learning

I. Introduction

The Internet of Things (IoT) as a meme is increasingly drawing attention among organizations not only in the technology field but also among those organizations in less technical industries, such as clothing, retail, consumer product goods, and energy. The general understanding of the IoT is that it pertains to the connection of digitized products, with the specifics being intently scrutinized and explored. Prognosticators suggest a progression of IoT phases:

- (1) more context-sensitive processors in more things, (2) greater connection of these things and (3) the conceptualization of a holistic new entity [12]
- (1) better sensor technology, (2) growing data storage and (3) newly enabled real-time analysis [9]
- (1) improvement in object identity, (2) semi-autonomous actions (e.g., reminders) and (3) autonomous actions [9]
- (1) increases in sensors, (2) increases in machine-to-machine (M2M) data and (3) generation of savings [11]

While such predictions are not in direct conflict with one another, they each emphasize different aspects of the IoT. As different organizations pursue different aspects of the IoT, adoption may be impeded and value realized reduced as a result of the failure to leverage network externalities. Conversely, consistent purposing of the IoT across organizations will enhance the overall societal benefits. Consider a bike manufacturer and a shoe maker. If both focus on interconnectivity first, this may allow the bike and shoes products to communicate for the purpose of pacing of the owners or to avoid collisions. Or the two organizations could concentrate upon digitization of the products, with data tracking of duration and pace to track calories burned and progress to personal fitness goals. If both organizations do not perceive and pursue the same strategic IoT competencies, one is left with fewer connection options; if both choose the same option, they are both better off. That is to say, if both organizations chose to focus initially upon digitization, they benefit from secondary network externalities (e.g., a better educated public regarding digitization and the development of a technical labor force skilled in digitization). If both organizations choose to focus on interconnectivity, they both benefit from the interproduct synergy of each additional connected device.

Consequently, of central interest in the IoT evolution is the nature of the IoT meme that will be adopted by organizations that traditionally have not participated in

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the technology space, as the nature of this meme will influence product innovation choices, capital spending, and interorganizational network formation.

What impedes this exploration of purpose is that many organizations that may have significant IoT opportunities do not have the technical expertise in-house to examine these possibilities. While technical expertise can always be contracted, its integration with the product knowledge and history is a time-intensive, path-dependent effort. Consider the factors that allowed those organizations less familiar with the technology domain to nevertheless create a web presence in the early days of the commercialization of the Internet. Such organizations were able to leverage third party expertise to support commerce without immediately having to become expert in web technologies. While the methods of selling, delivery, and billing changed, the underlying product remained the same. The IoT on the other hand has significant product implications. Indeed, a reason for the recent General Motors choice to insource IT talent is the need to have internal technology experts who can provide the insight regarding automobile digital innovation [5, 6].

In addition to expertise, as the formation of the IoT will be iterative, with organizations informing and being informed at the same time of the nature of the IoT, an understanding of the adoption of strategic direction will be difficult. The awareness of this emergent interorganizational progression is more subtle than the technical knowledge yet the correct perception is critical for success.

The technology organizations that are directing resources towards the support and development of the IoT recognize that apart from the technical issues, a key challenge for IoT adoption is their ability to enhance their customers' understanding of how organizations can best participate in the IoT opportunities. So in addition to specific product initiatives, these technical organizations are now actively seeking to educate their partners and potential partners on the possibilities, limitations, and issues of the IoT to facilitate IoT initiatives.

In the following section we review research regarding interorganizational learning in the context of IoT meme adoption. We then introduce a simulation of the transfer of IoT memes from a technical organization to less technical organizations. Next, we identify real world efforts highlighted in the model. We end with a discussion for how such real world efforts can be enhanced as informed by the model.

II. Interorganizational Learning

Communities of practice (CoP) have been described as informal groups of workers within or across organizations that share a common expertise and an interest in improving upon that expertise [13]. Such an entity is distinguished from formal work teams in that the desired CoP outcome is improved expertise rather than a deliverable or product; in addition, CoP members voluntarily participate. These two properties – growth of knowledge and voluntary participation – can be said to characterize the IoT setting described in the introduction. This is not to say there are not formal efforts underway both within and across organizations to teach technical aspects of the IoT, but the IoT framing of purpose and capability will not be formed on the basis of an understanding of the technical learning of processing power or understanding of the aspects of the ZigBee network.

In contrast, to set strategic directions at this early stage of the IoT, the less formal influence and education provided by the technical organizations to less technical organizations is more prevalent than formal contractual arrangements. Thus the emergent understanding of the IoT purposing can be thought of as a CoP, with the learning that occurs as the identification of the IoT emphasizing the properties of:

- interconnectedness: The IoT as nervous systems [10]
- digitization: The programmable world [12], ambient intelligence and brilliant machines [7]
- omnipresent: Pervasive digitization

Given the dichotomy between more technical and less technical organizations, the first challenge for the latter set of CoP members is absorptive capacity, defined as the ability to integrate new knowledge based upon an understanding of the basic concepts and terms of the domain under consideration [3]. For the pervasive digitization meme to emerge, less technical organizations need to understand how chipsets may be embedded into everyday devices, what data collection opportunities are possible, and how such information can be stored and retrieved. Each of these steps requires some technical understanding before an overall "big picture" of opportunity can emerge. Similarly, for the nervous system meme to take hold, less technical organizations must to some degree be able to incorporate into their learning the distinctions between network standards options.

A similar CoP learning barrier concerns cultural differences [2] between the technical and less technical organizations. Learning opportunities among CoP members may be between organizations that have no prior cooperative history; e.g., a shoe company had little reason to work with a chip manufacturer in the past. Communication differences such as the extensive use of acronyms by the technical organization, the comfort level in virtual communication, and the expectation for the pace of change in technical products are all distinct cultural experiences that may cause communication difficulties.

The absorptive capacity and cultural challenges may benefit from the recognition of an authoritative participant, in this case, the technical organization. While the literal communication difficulties remain, the negotiation of power regarding the adoption of practices is diminished. The other CoP members benefit from the recognition that the technical organization is the primary source of learning while at the same time the non-technical organizations are sharing the perspectives of their industry through which the CoP collectively achieves a cohesive IoT framing. In addition to being the authoritative member (conceptually, the member whose mental models of the IoT changes relatively less), the technical organizations could be modeled as the dominant CoP actors. In other words, in addition to being perceived as "right" the technical organization's influence is disproportionate relative to its size of degree of CoP membership.

To more completely understand the IoT CoP, in addition to an understanding of the CoP member types (i.e., most expert), the CoP learning processes must also be considered. The processes for organizational learning and knowledge creation typically begin with some form of socialization [4, 8] among the actors, a process less formal and innate for a CoP. The subsequent processes are more formal activities such as articulation and internalization that may fall outside the scope of a CoP. Through this process the learning among the different member types occurs.

The model introduced in the next section seeks to simulate this socialization via repeated trials among the two actors types (more and less technical expertise, the former recognized as expert), where actors have initial distinct IoT memes that will evolve through socialization.

III. Simulation

We model the CoP interactions through which a coherent, emergent IoT meme may emerge via a cultural diffusion simulation [1] under the observation that the learning in this context is less of the nature of objective knowledge and closer to subjective interpretation. In other words, to some degree the CoP learning that occurs concerns the emergence and adoption of an analogy (e.g., IoT as nervous system) which can be better modeled through a cultural diffusion model than through an information contagion or diffusion model. The model thus represents acceptance as opposed to simply information transfer.

The model examines the convergence of culture across actors when actors differ in culture and have opportunities to interact with a subset of the overall set of actors. Based upon the similarity between the actors as defined by the identical values of traits, the actors may influence other actors to adopt still another trait and thus become still more similar.

We extended this simulation to reflect the existence of an authoritative actor by fixing the initial randomized trait values of the authoritative actor. Dominance is the disproportional influence as modeled by establishing multiple authoritative actors at time 0.

Three versions of the simulation were conducted (modifications to the original model can be found in the Appendix), each run ten times, with each run having ten periods and each period producing 200 interactions of 25 actors. Using the model's original defaults, each actor has five traits each of which can take ten values. In our context, there may be five conceptualizations of IoT potential (as digitized product, as communicating with near field devices, etc.) each with a specific set of values (a digitized product may server as data collector, data collector and aggregator, collector and aggregator and communicator, etc.).

The extensions of the model were introduced to determine whether the authoritative, dominant actor improved the degree of consensus through which the value of network externalities may be better captured or whether the interactions were less stable and thus less susceptible to the influence of a dominant actor. In short, is the best we can hope for is an unmanaged emergence of a consistent IoT meme or will the technical organizations facilitate this emergence?

The simulation results were that the congruence rose 20% to 39.6% under the dominant, authoritative actor model. To the degree that a statistical test adds any information above and beyond the simulations, this increase is statistically significant at the .001 level of significance. The results of this simulation are consistent with the efficacy of proactive management of the technical organizations in educating less technical organizations regarding the IoT capabilities.

IV. Implementation

The socialization practices abstractly modeled in the simulation are in fact prevalent in practice. Technical organizations are actively arranging opportunities to educate partners and potential partners on how the conceptualize the IoT. The socialization processes, consistent with the process models of learning introduced earlier, are not formal arrangements and practices between organizations but rather, consistent with the CoP construct, less formal opportunities to engage. Specific socialization processes include requests for meetings, symposiums, conferences, and targeted published materials.

V. Discussion

The simulation can be enhanced in a number of manners to more closely match practice. Enhancements include the assignment of costs to interact with other actors, with increasing costs based on distance (measured in terms of similarity of traits). Competition between technical organizations that have different IoT meme payoffs would also add a more realistic dimension to the simulation. A changing trait of innovation can be introduced to the simulation to reflect exogenous technical shocks. Finally, a measure of the benefits of adoption from similar IoT memes could be measured against the loss of value from impeding innovation lost in the convergence of IoT perception.

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VI. Appendix

Authoritative, Dominant Actor

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'*** KTS CHANGE: Do not change actors 3,3 OR (serves as the authoritative actor)*********
            If (ix = 3 And iy = 3) Then ‘ do not alter
              Else
'*** KTS CHANGE: Actor 3,2 and actor 3,4 set to actor 3,3 (serves as the dominant actors)*********
        For bit = 1 To bitmax
          culture(3, 2, bit) = culture(3, 3, bit)
          culture(3, 4, bit) = culture(3, 3, bit)
        Next bit
'*** KTS CHANGE: Do not change actors 3,2 OR 3,3 OR 3,4 (serves as the dominant, authoritative actor)*********
            If (ix = 3 And iy = 3) Or (ix = 3 And iy = 2) Or (ix = 3 And iy = 4) Then ‘ do not alter
              Else
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