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Pratik Tarafdar

Doctoral student, IIM Calcutta, D. H. Road, Joka P.O., Kolkata 700 104, India

&

Debashis Saha

Professor, IIM Calcutta, Diamond Harbour Road, Joka P.O., Kolkata 700 104 India

Diamond Harbor Road, Joka, Kolkata 700104

INDIA

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Pratik Tarafdar*

Doctoral student, IIM Calcutta, D. H. Road, Joka P.O., Kolkata 700 104, India

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Debashis Saha

Professor, IIM Calcutta, Diamond Harbour Road, Joka P.O., Kolkata 700 104 India

Abstract

The rapid pace of adoption of ISMAC (*IoT, Social, Mobile, Analytics, and Cloud*) technologies within organizations make it essential to investigate the theoretical underpinnings prevailing behind the digitally-fueled organizational transformations. Thus, there is a heightened need for sensitizing business executives on various facets of the already happening digital disruptions caused by ISMAC because managing disruption is much more difficult than managing continuity. Hence, this article aims to enlighten them with the know-how of catching up with ISMAC innovations so that they are not left behind in the race for digital transformation. In particular, we seek to attend to the following questions: What is the role of ISMAC in facilitating a digital ecosystem around an organization? How do the interrelationships amongst the five pillars of ISMAC enrich the culture of ecosystem? Why and how should ISMAC strategy fit into overall IT strategy of the organization to achieve the transformation?

Keywords: Management of Computing and Information Systems, Smart Systems, Digital Disruption

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* Corresponding Author.: Pratik Tarafdar, pratikt15@iimcal.ac.in

Introduction

The interplay between the Internet of Things (IoT), social, mobile, analytics, and cloud (or, ISMAC in short) [1]–[6], along with other interrelated computing and communication paradigms as well, is shaping the next generation of enterprise IT systems that is capable of enriching the business manifold. Together ISMAC constitute a digital ecosystem of devices, products, middleware, applications, and services geared towards orchestrating closer ties not only between consumers and suppliers across the complete value chain [4]–[6] but also among the multiple entities involved in the related ecosystem. This digitally integrated ecosystem, referred to as *ISMAC ecosystem* in this article, is gradually fostering an environment that comprises a medley of internet-enabled tiny wireless sensors, data (both structured and unstructured) stored in cloud, analytics involving human cognition and deep learning algorithms, handheld mobile devices to access information, and social media to connect and share instantly. Consequently, ISMAC technologies that accelerate, mediate, and facilitate cyber-physical interactions on an unprecedented scale are increasingly becoming entrenched in the meaning-making systems of our social processes, thereby rendering themselves to *social machines* [7]. To stress on this unique role ISMAC ecosystem is playing in the shared economy, Paul Daugherty, the chief technology officer (CTO) of Accenture remarked:

“[...] as every business becomes a digital business, together they can effect change on a much bigger stage, collaborating to shape experiences, and outcomes, in ways never before possible. As a result, these leading enterprises are shaping a new economy — the We Economy.” (<https://www.forbes.com/sites/ciocentral/2015/03/09/the-rise-of-digital-ecosystems-in-the-we-economy/#3d4b95145514>)

The extant literature has defined an *ecosystem* as an open, loosely coupled, domain clustered, interactive, balanced, self-organizing, and agent based environment where inhabitants are proactive and reactive to their individual benefits while conserving the environment as a whole

[8]. Congruent to this concept, *business ecosystem* refers to the system of the loosely coupled network of suppliers, distributors, manufacturers, outsourcing firms, related products and services, consumers, technology providers, and other partner organizations [1]. They collaborate and cooperate to enrich the system environment, apart from focusing on the individual business dimensions. All these entities affect and/or are affected by the action of any single entity of the ecosystem. In this context, a *digital (business) ecosystem* refers to a business ecosystem enabled by digital technological capabilities, the successful implementation of which entails in operational excellence achieved through implementation of an efficient digital services backbone, and an effective organizational redesign [3]. The recent proliferation of ISMAC technologies has provided the necessary impetus to the companies to adapt to such digital ecosystems with a view to transforming their businesses. They are adopting a suitable digital strategy to incorporate the ISMAC ecosystem culture within the organization to engender rapid innovation and responsiveness to the constantly changing market conditions [3]. In fact, there are several examples of companies incorporating digital infrastructure and adopting digital goods and services enabled by their innovative ISMAC ecosystems to reshape the entire market or industry. Home Depot is providing its consumers with the convenience of transforming their house into a smart home with the ability to manage the automated and connected home products through Wink connected home ecosystem (<https://www.ovum.com/whitepaper-smart-2025-the-future/>). The digital applications and services comprising the home ecosystem necessitate its providers to embody the necessary digital drive into their business models too. Similarly, Philips approached Salesforce to build a digitally enabled healthcare ecosystem that will enhance the collaboration and communication among doctors and patients (<https://www.forbes.com/sites/ciocentral/2015/03/09/the-rise-of-digital-ecosystems-in-the-we-economy/#3d4b95145514>). In the automotive industry, Fiat is focusing towards connected cars through partnerships with companies such as TomTom, Reuters, Facebook and TuneIn. And the list goes on. But there comes the question – why only a few companies are able to do it? What happened to others?

Since the literature lacks in studies to apprehend the intricacies of the ISMAC ecosystem in parts as well as in whole, we intend to address in this article the foundation of ISMAC ecosystem through a systematic analysis of the five pillars of ISMAC and their significance towards building system of systems. The article is structured as follows. Section II explains in details the ISMAC ecosystem and its necessity in today's organization to stay competitive. Section III highlights the necessity of strategic alignment in the build-up to an ISMAC ecosystem. Section IV evaluates our propositions from the perspective of a CIO. Finally, the concluding section discusses the possible implications for managerial practices.

Interrelationship among ISMAC in an Ecosystem-like Model

Gartner introduced in 2014 the term “Nexus of Forces” (www.gartner.com/technology/research/nexus-of-forces/) to explain the mutual reinforcement of the four pillars of digital disruption, namely social, mobility, analytics and cloud (SMAC), that drive new business ecosystems. They envisioned that the nexus could invigorate the potential of IoT, and together their holistic interdependent trends would radically transform the way people and business relate to technology. Although these forces are disruptive on their own, collectively they are even more disruptive being capable of redefining industry boundaries and reshaping the competition, provided their nexus matures into a sustainable ecosystem (aka ISMAC ecosystem). Notably, we have added IoT in front of SMAC as the fifth pillar to coin the extended acronym ISMAC. To illustrate how ISMAC advancements are turning towards reality, we first consider the example of Google Home (www.google.com/home). The vision was first ideated by Philips who prognosticated the concept of *smart home* in 2009 in these terms [11]:

“Picture yourself relaxing at home on your couch. You are unwinding from a long day and want to play some music, but you are too exhausted to move. Instead, you say ‘Music, where are you?’ and hum your favorite slow tune. Lucky for you, your smart home

entertainment system understands your needs. Not only does it play the song you were humming, it dims the lights to provide a more relaxing environment for you.”

Unfortunately, the concept was much ahead of time about a decade ago, and that led to its unsuccessful realization by Philips. It is only through the harmonious interaction of the five pillars of ISMAC that Google was able to turn the vision into a real product in October 2016. Google Home – a smart, internet-connected virtual assistant – interacts seamlessly with smart devices (e.g., Chromecast, Nest, Philips Hue, etc), services from platforms, such as Google Play Music, YouTube, Wikipedia, and Social Media, and other internet sources for weather, traffic, commodity and energy prices, etc. in order to enable voice-activated features in it. Google also partnered with LG to devise smart appliances such as refrigerators, built with features like automatically switching to power saving mode if Nest detects such context. Google’s digital approaches are further proliferating to expand the smart home ecosystem to smart cities, as manifested by its self-driving cars.

To elaborate further how Google is slowly maturing its ISMAC ecosystem, we begin from January 2014, when Google acquired Nest, a digital thermostat and smoke detector company. The move was a clear indication of Google’s intention in exploiting the opportunities for smart, connected homes [2]. A Nest thermostat consists of sensors and actuators that digitize the entire heating, ventilation and air conditioning (HVAC) process at home. Along with it, there are other products - Nest Protect, Nest Cam Indoor, and Nest Cam Outdoor too – all of which embed wireless **IoT** devices that are connected to Nest’s cloud (now part of Google **cloud**) to store aggregate data on real-time basis. After running necessary **analytics** (say on energy consumption data) within the cloud platform itself, Google shares the insights with utilities, which, in turn, act smartly (say by ameliorating the energy consumption thereby achieving greater efficiency overall). Google Home is also connected to smart **mobile** phones, other smart gadgets (e.g., TV, freeze, car, and garage opener), and **social** media such as Facebook, through various embedded applications. This inextricable interdependency among the five pillars of ISMAC (Figure 1), thus, clearly explains how the complementarity effect of the five components can comprehensively lead to an

ecosystem like Goggle Home. Figure 1 depicts that wireless and/or wired connectivity allows information to be exchanged among the smart devices in a generic production environment, interact with the mobile devices and social media, and enable some functionalities of the products outside the physical device in the cloud [10]. However, the analytical engine for the discovery of knowledge and insights are mostly embedded in the cloud, (sometimes it may reside partially in the end devices to perform edge computing).

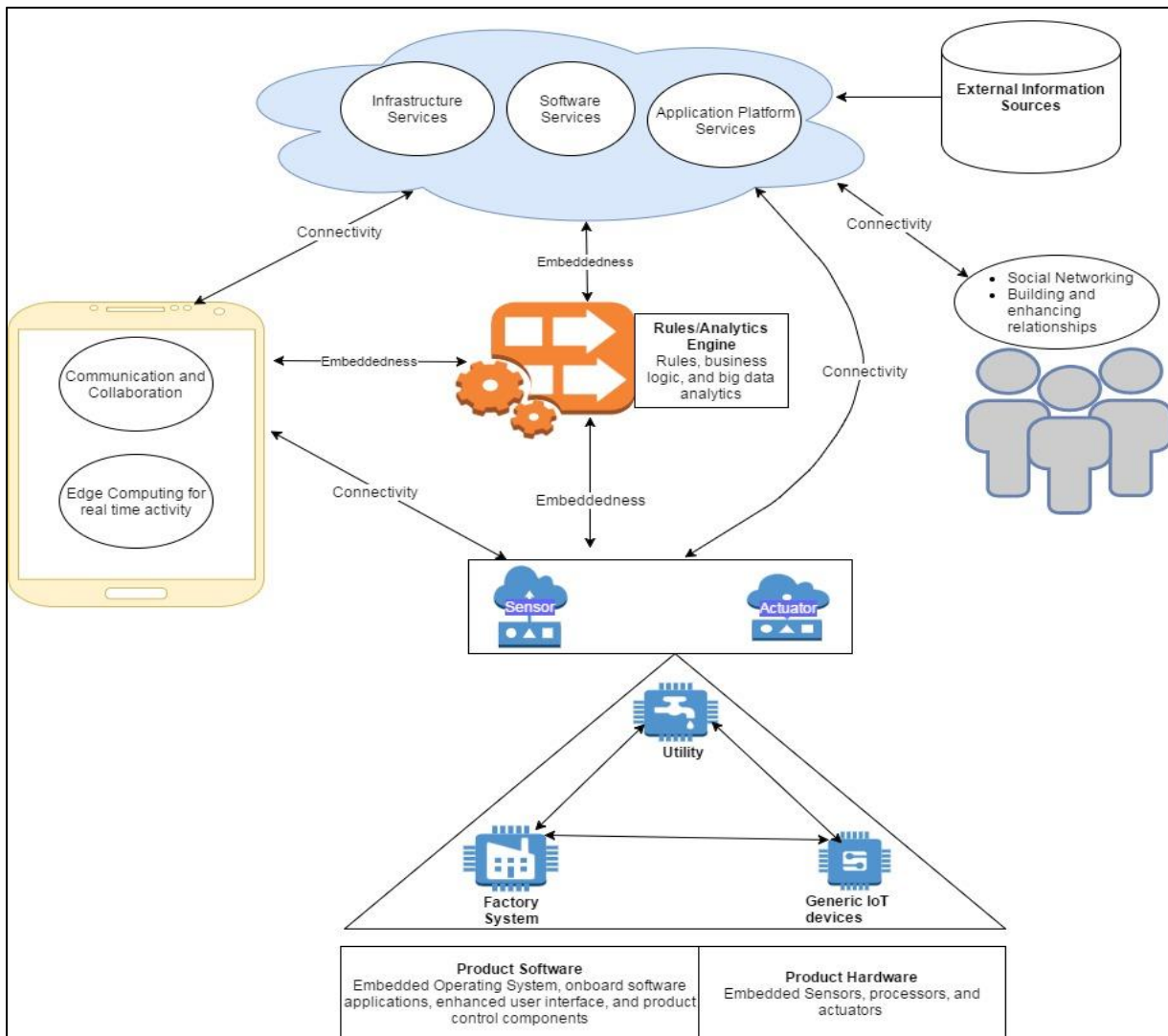


Figure 1: Interrelationships amongst the five pillars of ISMAC in an ecosystem

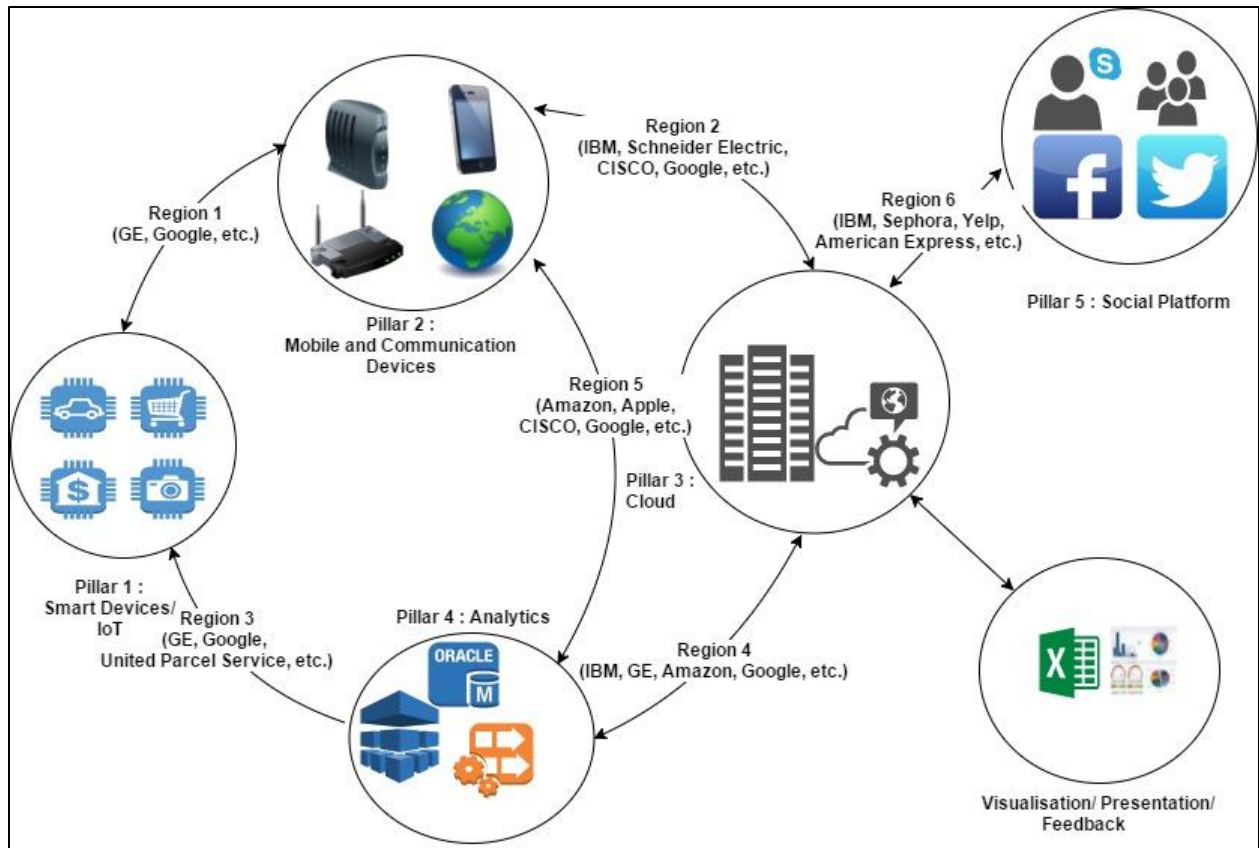


Figure 2: Example of some well-known IT companies operating in the ISMAC ecosystem

Figure 2 captures schematically the complementary relationship amongst the examples of IT companies operating in each region (the list of companies is not exhaustive obviously) within the ISMAC ecosystem. The regions reflect the interaction between two or more pillars of ISMAC; for example, Region 1 defines the interaction between the Pillar 1 (IoT Devices) and Pillar 2 (Mobile and Communication Devices) which drives the digital transformation of various business processes of companies like GE, Google, etc. Also, the circular link comprising of Region 1, Region 3, and Region 5 define the broad region of interconnectedness between Pillar 1, Pillar 2, and Pillar 4. Companies seamlessly integrate these pillars to form a digital zone of business operations that transcends the existing interoperability of their business units to pull them to the arena of higher competitive advantage.

Business-IT-ISMAL alignment

Having discussed the ecosystem outlook substantiated by the waves of digital innovations, it is of utmost importance to note that the strategic alignment between the business and the digital developments in an organization should not be relinquished under any circumstances in its effort to overdrive ISMAC initiatives. In order to ride the crest of ongoing digital disruptions, organizations should comprehend such a digital strategy, in particular, the ISMAC strategy that is aligned to their business strategy. We explain it further below.

The triad of the factory system, utilities, and the generic IoT devices in Figure 1 manifest the conceptualizations of a System of System (SoS) [9], where a set of disparate product systems coordinate and optimize their operating environment. Since the dynamics of competition becomes pervasive, it intrudes into the boundaries of the connected equipment and related services that uplift the performance of the broader product system (or, SoS). For example, a smart home represents a system of numerous product systems including lighting, heating, ventilation, air conditioning, entertainment, and security. The overall system of these individual smart, connected products operates in tandem with the cloud system, the social media network, analytics and mobility solutions. The functional and tactical disparity between any two of these digital innovations could perturb the whole ISMAC ecosystem and can lead to implementation/execution failures. Therefore, the right digital strategy ideally should be an amalgamated cohort of IoT, social, mobile, analytics, and cloud strategies rather than individual silos of separate IoT strategy, social media strategy, mobility strategy, big data analytics strategy, and cloud strategy. To be more specific, ISMAC strategy itself does not resemble independent strategical positions segregated into five silos; rather it is one single plank taking into consideration of the cumulative effect of the five pillars and is subsumed by the overall IT strategy or digital strategy of the organization. Thus, on a cautionary note, one of the things that firms must keep in mind while considering the plethora of opportunities from ISMAC is that any intervention made through these technologies must necessarily not disturb the *Business-IT alignment* that exists in the organization [4].

To stay competitive, however, the digital transformation may require controlled decentralization of the in-house IT organization, while maintaining a strong centrally-standardized architecture [1], [4]. Also, while deploying the disruptive technologies like ISMAC, the business processes need to be refined, rationalized, and improved [4]. Therefore, building the ISMAC ecosystem requires the knowledge and management of the *complementarity effect* of the ISMAC technologies that drives value in the respective business. The impact of the ecosystem is not the mere sum of its constituents, rather it is the holistic impact emphasized by the close coupling of its constituent parts. The exploitation of this interconnectedness of the ISMAC capabilities and the organizational resources not only enhance the sustainability of the ecosystem [8] but also opens up new avenues for disruptive business models. For example, a fragmented industry can be transformed into a sustainable business ecosystem by the integrated application of ISMAC [5] in a holistic manner (e.g., Uber). Consequently, if we consider types of innovations to lie along a continuum, though the firms may be tempted to move more towards outside-in innovation, it must be noted that in order to seamlessly integrate the ISMAC related innovations within the existing enterprise IT strategy of the firm and to have sufficient control over the environment, the firms must still move towards inside-out innovation. This calls for the need to have a strong IT Governance committee that would monitor each of potential changes that could be brought in [12]. Having said that, an important pre-requisite for ISMAC to be successfully provisioned in this mode is that the firm must be willing to undergo multiple controlled shifts in strategy creation and strengthening the relationship between the firm and the environment [13]. GE's initiative to reinforce the loosely coupled network of suppliers, distributors, and developers of related products and services exemplifies such strategical initiatives. To strengthen its ecosystem, GE is investing in different types of partnerships. For example, the joint venture between GE Aviation and Accenture, Taleris signed the multibillion-dollar contract with Etihad Airways to enable predictive maintenance and suggest preventive approaches through software and analytical capabilities [10].

CIO's perspective

The digital leaders in the digital age should possess the skills to realize the strategy, and not the technology, to integrate the digital maturity within the culture of an organization [14]. CIOs must have the vision of a clear ISMAC strategy to drive the transformation of a digitally maturing organization. They should be poised with the cognitive skills to set a coherent digital strategy in alignment with the business and effectively communicate to the employees. With the fourth industrial revolution (Industry 4.0) involving cyber-physical systems flourishing at a rapid pace, the CIOs have the onus to push for a digital business model that drive culture change through effective change management. The culture conducive to the digital environment involves fostering innovation, encouraging risk taking appetite, developing collaborative work environments, facilitating interoperability between machines, devices, sensors, and people, managing avalanche of data, and enabling decentralized decision making by the cyber-physical systems [14]. Therefore, in order to inculcate a digital culture within the organization, CIOs can no longer strategize from the perspective of a single enterprise; rather they need to think through their partners, the value chain, and the evolving ISMAC ecosystem, holistically to curb ad-hocism. It is about transforming the industry, enriching the ecosystem, markets, and marketplaces. Since the ISMAC components are the change agents for the digital transformation, CIOs need also to ensure that ISMAC strategy overcomes the implementation failures due to inability to accommodate the change in mindsets and processes within the organization.

The ISMAC ecosystem will make the data culture prevalent within the digitally maturing organizations. The practice of data-driven decision-making is predominantly becoming the aspirational initiative of the Industry 4.0. Traditionally, the responsibility of data lies with the CIO and the specific business units that own and consume the data. However, in this ISMAC era, a new role of chief data officer (CDO) is emerging to understand the data and information value above parochial interests [12]. CDOs are supposed to tackle data strategy and governance, which include

data quality, and data ownership. Such welcome transformation in the different facets of organizational structure reassures the maturity of the leadership to connect the abstract concepts of the ISMAC ecosystem to tangible business outcomes.

Conclusion

Through this article, we establish an understanding of the five disruptive technologies that are rapidly transforming the industry standards and redefining industry boundaries. The era of ISMAC has the potential to alter the trajectory of business innovation and economic growth. The companies incapable of embracing this larger opportunity will eventually cease to compete and will face “Digital Darwinism”. The ISMAC effect has already been paralleled to the third wave of IT that has incorporated newer product and process dimensions ([https://www.capgemini.com/resource-file-access/resource/pdf/Digital Transformation A Road-Map for Billion-Dollar Organizations.pdf](https://www.capgemini.com/resource-file-access/resource/pdf/Digital_Transformation_A_Road-Map_for_Billion-Dollar_Organizations.pdf)). We try to reflect on the contribution of each of the five pillars of ISMAC in the process of development of a digitized ecosystem. The cumulative effect of ISMAC ecosystem on industry structure will depend on the interrelationships of constituent elements of ISMAC that make the ecosystem tightly coupled and connected. According to Porter [10], the elements of ISMAC ecosystem and their interrelationships have the ability to shift the five forces that shape the industry competition: the bargaining power of buyers, the bargaining power of suppliers, the threat of new entrants, the threat of substitute products or services, and the nature and intensity of rivalry among existing competitors. It is important to comprehend these paradigm shifts in the light of disruptive technologies before defining a competitive overall strategic positioning for the company. Moreover, the adoption of ecosystem idea drives the appropriate strategic alliances, which have been observed in the example of Google Home cited earlier. Therefore, companies that aspire to attain market leadership in this era of digital ubiquity will concentrate on the valuable and scalable businesses for themselves and their ecosystem

partners. Such companies will eventually drive not only the value chain but also the ecosystem, and be termed as ‘ecosystem drivers’.

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