

# **The Internet of Things (IOT), Big Data and B2B Digital Business Ecosystems**

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## **Abstract**

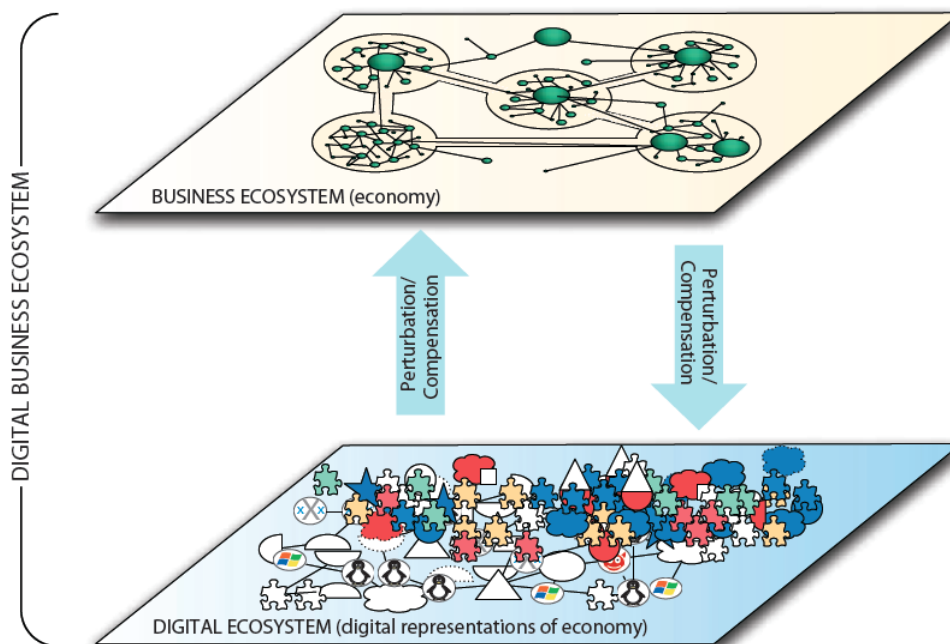
New digital business ecosystems (Nachira, et al 2007) are emerging mirroring business networks and information flows. At the base of these ecosystems are smart sensors that collect, receive and send real-time information through the Internet into a platform that underpins B2B information requirements and services. This collective of sensors – the ‘Internet of Things’ (IOT) – is expanding at an explosive Cambrian level with estimates connecting to the Internet varying wildly from Cisco’s official estimate of 1 billion at the end of 2012 to over 27 billion by 2020 (Varley 2013), compared to TSensors Summit (2013), estimates of over 10 billion sensors in 2013, growing to over 1 trillion sensors to be connected to the Internet by 2022! Sensors may be found in almost everything by 2020 and will generating huge streams of data – Big Data. Frameworks for defining and classifying big data are emerging including IBM’s (2014) four V’s framework (volume, variety, velocity and veracity). Marr (2015) added a 5<sup>th</sup> V to the IBM framework – value.

A B2B digital business ecosystem is outlined including real business value creation ecosystem and digital ecosystem with IOT, Big Data, and information services platform, layers – and interactions by B2B actors (human and increasingly becoming digital) to produce products, services, ideas and activities. Data science is emerging focusing on capture, curation, analysis and use of big data streams. Datafication includes big data and includes value creation (Norman, 2001; Lycett, 2013). The IOT underpinning B2B services was outlined by Sood & Pattinson (2013) and Big Data for B2B value creation by Johnston, Nickell, Liu & Gould (2014). Discussion on the emerging area of marketing data science (in a B2B context), B2B digital business ecosystems and how far they may go in terms of imitation or taking over of real value creation system is presented at the end of the paper.

## EMERGING BUSINESS AND DIGITAL BUSINESS ECOSYSTEMS

In the Second Machine Age almost everything will be digitised (Brynjolfsson, & McAfee 2014). Business actors, activities, resources – and the businesses themselves – will be digitised as much as is economically and practically possible.

Digitisation of business networks, actors, activities, resources can be analysed using an ecosystems perspective. Exploring networks from an ecosystems perspective emerged early in the 21st century drawing on business, environmental, and digital perspectives. An environment ecosystem takes a holistic view of entities, activities and events mapped to a focal location, usually with a view to assessing environmental sustainability at the geographic location or in locations physically linked to it (e.g. linked by a river) . Similarly, an ecosystems perspective can be applied at an industry level to identify and map actors and activities. An ecosystems approach can be applied to mapping elements of information and communications (digital) technology into a platform – effectively a 'digital Business ecosystem'. The European Commission, Director General – Information Society and Media outlined definitions, policy and recommendations for development of digital business ecosystems incorporating real business ecosystems and digital ecosystems. (Nichira et al. 2007, p. 11). Figure 1 highlights components of a digital business ecosystem.



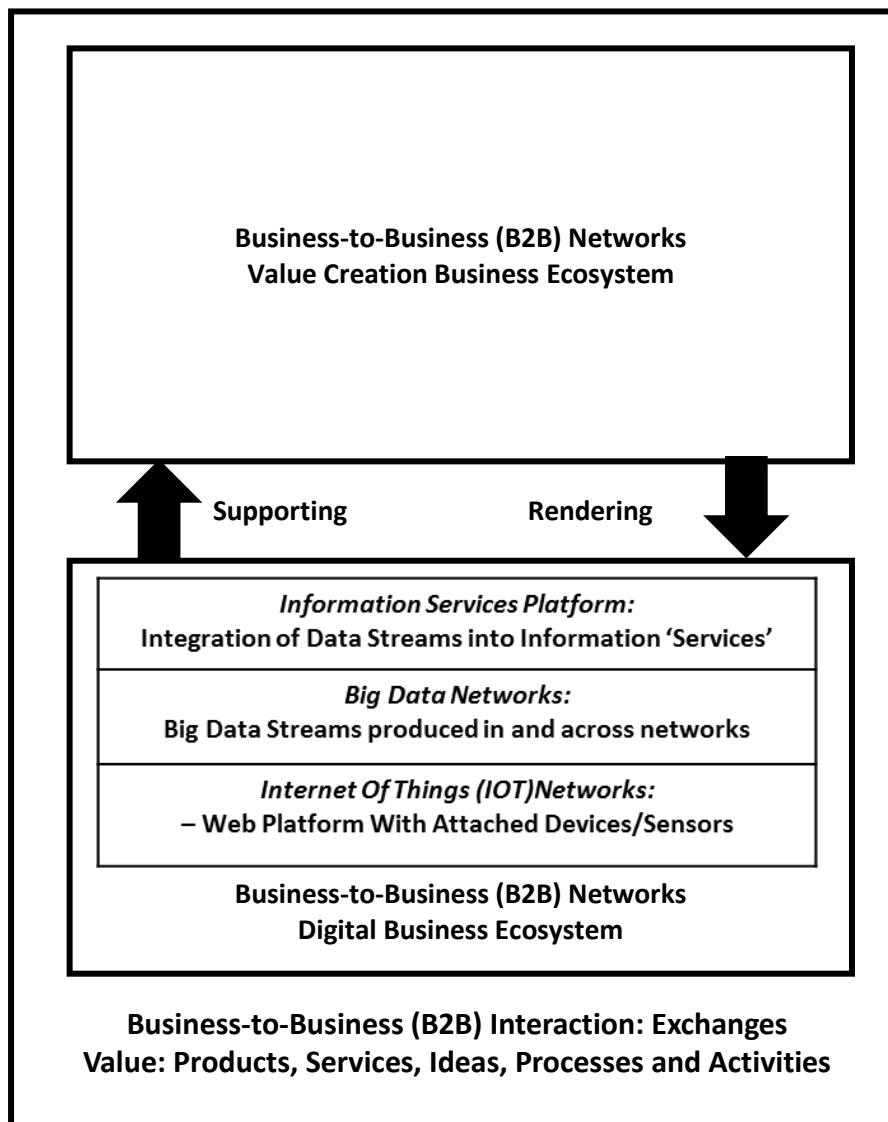
**Figure 1: Digital Business Ecosystem = Business Ecosystem + Digital Ecosystem (Nachira et al. 2007, p.11)**

The European Commission digital business ecosystem framework is a strong overall conceptualisation but refinement is required to reflect key challenges and themes for

business-to-business marketers and researchers, including the Internet of Things (IOT), Big Data, platforms, increasingly digital interactions and relevant supporting data science.

## **B2B BUSINESS ECOSYSTEMS – REAL AND DIGITAL**

To highlight key digitisation of business themes, the framework presented in Figure 2 continues to separate real business ecosystems from digital business systems i.e. Business-to-Business (B2B) Networks - Value Creation Business Ecosystem, and Business-to-Business (B2B) Networks - Digital Business Ecosystem.



**Figure 2: Business and Digital Business B2B Ecosystems**

The B2B digital business ecosystem contains three layers including:

- Internet Of Things (IOT) Networks
- Big Data Networks
- Information Services Platform

### **INTERNET OF THINGS (IOT) NETWORKS**

The Internet of Things (IOT) is a collective (network) of sensors connecting into the Internet – a Web platform underpinned devices through sensors each containing IP addresses. Smart sensors collect, and send real-time information through the Internet. The Internet of Things is expanding at an exponential rate with estimates connecting to the Internet varying wildly from Cisco’s official estimate of 1 billion at the end of 2012 to over 27 billion by 2020 (Varley 2013), compared to TSensors Summit (2013), estimates of over 10 billion sensors in 2013, growing to over 1 trillion sensors to be connected to the Internet by 2022! Sensors may be found in almost everything by 2020 and will be generating huge streams of data (big data).

### **BIG DATA NETWORKS**

Big Data Streams are produced in and across networks. Apart from the obvious observation that big data pertains to large streams of data, there is no formal agreed definition for ‘big data’. Gartner’s (2011) produced the Big Data ‘3 V’s’ model (Volume, Variety and Velocity) is reflected in Kitchin’s (2014) broader definition:

- Huge in volume, consisting of terabytes or petabytes of data
- High in velocity, being created in or near real-time
- Diverse in variety in type, being structured and unstructured in nature, and often temporally and spatially referenced
- Exhaustive in scope, striving to capture entire populations or systems (n=all), or at least much larger sample sizes than would be employed in traditional, small data studies
- Fine-grained in resolution, aiming to be as detailed as possible, and uniquely indexical in identification
- Relational in nature, containing common fields that enable the conjoining of different datasets
- Flexible, holding the traits of extensionality (can add new fields easily) and scales (can expand in size rapidly) (Kitchin, 2014, Ch. 4)

IBM’s (2014) Big Data Framework includes Volume (scale of data), Variety (different forms of data), Velocity (analysis and speed of streaming data) and Veracity (uncertainty of data). IBM plans to invest over \$US3 billion in a new ‘Internet of Things’ unit focused on developing the IOT platform and Big Data Management and Analytics (Clark, 2015). Marr (2015) added a 5<sup>th</sup> V to IBM’s Big Data Framework emphasizing that big data ultimately must contribute business value.

Table 1 outlines definitions and examples for the Five V’s of Big Data (Volume, Variety, Velocity, Veracity and Value).

**Table 1: Big Data: The Five V's – Definitions and Examples**

<b>VOLUME</b>	<p><b>Scale of Data. Amount of Data generated every second (IBM 2014; Marr, 2015)</b></p> <ul style="list-style-type: none"> <li>On Facebook 10 billion messages are sent per day, the like button is clicked 4.5 billion times and 350 million new pictures are uploaded every day. (Marr, 2015)</li> <li>All the data generated in the world between the beginning of time and the year 2000, is now the same amount now generated every minute (Marr, 2015)</li> <li>2.5 quintillion bytes (2.3 Trillion gigabytes) of data were created per day in 2014 (IBM, 2014)</li> <li>40 zettabytes (43 trillion gigabytes) of data will be created by 2020 – 300 times the amount in 2005 (IBM, 2014)</li> <li>Most US companies store at least 100 terabytes (100,000) gigabytes of data (IBM, 2014)</li> </ul>
<b>VELOCITY</b>	<p><b>Speed: of new data is generated; and of data moving around networks (Marr, 2015)</b></p> <ul style="list-style-type: none"> <li>The New York Stock Exchange creates at least 1TB of trading information each trading session – and that figure is increasing exponentially with faster trading systems (IBM, 2014)</li> <li>The Internet of Things will enable 2.5 connections per person on each by 2016. Cars now have over 100 sensors that can be connected to the internet (IBM, 2014). In 2013 IEEE published 802.11p standards for wireless access in vehicular environments (WAVE) to support Intelligent Transport Systems (ITS). Widespread Roll-out of 802.11p systems in new cars is expected from 2016 (IEEE, 2013)</li> </ul>
<b>VARIETY</b>	<p><b>Different types or forms of data in use (IBM, 2014)</b></p> <ul style="list-style-type: none"> <li>Structured data (tables, relational databases) mixing with unstructured data (messages, social media conversations, photos, sensor data, video or voice recordings). (Marr, 2015)</li> <li>80 percent of the world's data is now unstructured (Marr, 2015), including in 2014, 400 million tweets per day, more than 4 billion hours of YouTube video per month, more than 30 billion Facebook Content items per month, and more than 420 million tweets per day, wearable/mobile health/fitness monitors (IBM, 2014)</li> </ul>
<b>VERACITY</b>	<p><b>Uncertainty of data. Messiness or untrustworthiness of data (IBM, 2014; Marr, 2015)</b></p> <ul style="list-style-type: none"> <li>Poor Data Quality costs the US Economy around \$1 trillion per year (IBM, 2014)</li> <li>1 in 3 business leaders don't trust the information that they use to make decisions (IBM, 2014)</li> </ul>
<b>VALUE</b>	<p><b>Ability to turn data into business value (Marr, 2015)</b></p> <ul style="list-style-type: none"> <li>To better understand and serve customers: e.g. recommendations made by Amazon or Netflix. (Marr, 2015)</li> <li>Process optimization: e.g. Uber is able to predict demand, dynamically price journeys and send the closest driver to the customers. (Marr, 2015)</li> <li>health care improvements: Government agencies predicting flu outbreaks and track theming them in real time; pharmaceutical companies using big data analytics to fast-track drug development. (Marr, 2015)</li> <li>Security: Government and law enforcement agencies using big data to foil terrorist attacks and detect cyber-crime. (Marr, 2015)</li> <li>Sports performance improvements: Sensors in balls, cameras on the pitch and GPS trackers on their clothes allow athletes to analyze and improve their performance. (Marr, 2015)</li> </ul>

Sources: Extracted and adapted from IBM (2014) and Marr (2015)

Big data streams may be structured or unstructured – but have to be ‘curated’ in preparation for further analysis and use. Curation includes setting up data structures, repositories, defined streams and repurposing. Curation may occur either in the Big Data Networks or Information Services Platform

### **INFORMATION SERVICES PLATFORM**

Big data streams are integrated into information ‘services’. Web 2.0 views the Web as a platform with activities as services. Applications, conversations, businesses packaging web-based information, and web-based recommendations and decision-making can all be viewed as services (O’Reilly, 2007; Pattinson, 2014). Cloud computing approximates both to the overall three layered B2B digital business ecosystem and as set of business services (Grossman, 2009) at the Information services platform level.

At the information services layer the term ‘digitisation’ becomes fairly stretched. A basic definition of digitisation is on converting technology and the information associated with it into binary readable and usage form. Digitisation as a macro meta-global perspective covers the digitisation of almost everything, of the global economy. Dorner & Edelman (2015) views ‘digital’ as using digital technology to create new value in new markets, new value in core businesses and developing fast and agile enterprises. The emerging term ‘datafication’ offers further interesting insights into managing datastreams through three layers of a B2B Digital Business ecosystem including:

- Datafication is where a phenomenon is put in a quantified format so that it be tabulated and analysed - to datafy (Strong, 2015, Ch. 1)
- Datafication has to date largely been focused on physical domains but is rapidly diffusing through human behaviour (Strong, 2015, Ch. 1)
- Datafication is a sensemaking process for value creation (Lycett, 2013, p. 382)

Value creation based on density out of dematerialisation and liquification was outlined by Normann (2001), compared and applied to Service-Dominant Logic (Michel, Vargo & Lusch, 2008) and extended to datafication by Lycett (2013). Dematerialisation and liquification enables identification and unbundling (or re-bundling) of data-based (datafied) value to produce density in the form of (re)combinations of resources, mobilised for a particular context, at a given time and place (Lycett, 2013). Lycett links datafication for value creation directly with SD-logic.

Value creation expressed as digital business services can be identified and datafied through Service-Oriented Architecture (SOA) (Schroth & Janner 2007) i.e. through the information Services Platform. Sood and Pattinson (2013) outlined IOT driven B2B Services based on business services developed using social media using datastreams out the IOT, including 3D printing networks, freight messaging networks, open B2B innovation networks, and Google Earth B2B applications..

### **WELCOME TO B2B MARKETING DATA SCIENCE**

Although now more formalised in terms of definitions and projects, big data streams are not new. Preparation of large data streams and sets for analysis and e-research emerged in the first decade of the 21<sup>st</sup> century; large financial market data streams go back to at least the late 1980's. Bell (Adapted by Hey, Tansley & Tolle 2007) presented a fourth science paradigm based on data exploration (the previous three paradigms were empirical, theoretical, and computational). Data science focuses on Data Capture, Curation and Analysis. Data scientists focus on Integration/fusion of computer/information scientists with discipline experts, software engineers, digital librarians and curators. Big data streams have to be prepared into structures, repositories, new and revised streams and often repurposed

Data science can no longer be left to specialists in computing science but has to be managed within specific disciplines and activities. Science, health, education, manufacturing and fabrication, and business are all developing specific principles, standards and decision-making capabilities for curating, analysing and using big data streams.

According to Manyika et al (2011) at McKinsey Research, "The United States alone faces a shortage of 140,000 to 190,000 people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of big data." Businesses, large and small, are racing to recruit data scientists to curate, analyse and use data internally, in B2B and B2C contexts. In 2014/15, 'marketing data scientist' appeared alongside marketing technologist as a job title focused on marketing data streams (Wright, 2015; Afshar, 2014). B2B marketing activities, actors, teams and networks will include marketing data scientists.

Datafying businesses using a data science perspective is complex and throws up several challenges including accuracy and relevance; search or (re)search; and capturing human-behaviour driven information

#### **BIG DATA ACCURACY AND RELEVANCE**

The fourth V of big data – veracity – expressed through accuracy and relevance is especially challenging for businesses facing tough competition, relentless innovation and cost pressure. Capturing, and curating clean and accurate data streams especially for customer is already difficult and expensive; applying ever-advancing analysis approaches to these streams adds more time and cost. Automating and sinking consistent analytics applications down into the IOT level of a digital business ecosystem can lower big data management costs – but not necessarily time and expense associated with B2B actor and management decision-making, without further training or development or changes in relevant skills and competencies.

#### **SEARCH OR (RE)SEARCH**

Data science favours a discovery-driven view of knowledge creation and sharing. Semantic learning applications (such as used in Google and Amazon search and recommendation systems) look for real-time patterns linking them back to stored previous search patterns – and then recommendations. Martin's innovation knowledge funnel perspective for managing innovation information offers a flow sequence for search through discovery using discovery to heuristics to algorithm to action. Discoveries are initially expressed as Stories in the form of scenarios, stories, and

events, then reduced to usable heuristics, which in turn may be stored as cases or directly programmed as algorithms. Outputs may be shared offline or incorporated into collaborative information platforms. A continuous version of the innovation knowledge funnel closes the loop with previous actions updated for new discoveries.

How much knowledge can be created and managed through a relatively real-time search-dominant approach as against a more reflective theory-driven research strategy is open for debate. Where knowledge can be routinized and standardised then search strategies may be preferred. A key here is what knowledge 'creation' constitutes – imitation, or real original creation?

### **CAPTURING HUMAN-BEHAVIOUR DRIVEN INFORMATION**

B2B marketing flows such as sales negotiations and conversations are unstructured and challenging to capture as data streams and curate for structured analysis, storage and use. Advances in ethnographic methods including video analysis are assisting with setting up scenarios, stories, cases and some circumstances heuristics. However, typically sales conversations are not recorded (video or audio) so there may be not be big enough data streams to actually prepare and to analyse.

Resistance to explicating embedded knowledge regarded as offering advantage or power to an individual (such as a key account manager's key contact's list or details) will also hinder data collection. Cost, confidentiality, privacy and information power issues will continue to constrain capture of B2B human-behaviour driven information – although proliferation and extensive use of 'endlessly-on' mobile devices may turn small-talk big data streams.

### **B2B DIGITAL BUSINESS ECOSYSTEMS – BEYOND THE IMITATION GAME?**

The B2B digital business ecosystem interacts with the real value creation ecosystems through support and 'rendering'. The digital business ecosystem mainly supports the real business ecosystem. Advancing digitisation and datafication sees increasing rendering of routinized non-creative activities, resources and even actors into the digital business ecosystem. Activities and resources that do not pass the Turing or Lovelace Tests of creating new ideas can be imitated, digitised and datafied (Turing, 1950; Bringsjord, Bello, & Ferrucci, 2001; Marks, 2014).

Relentless innovation in digital technology combined with advances from social computing to behavioural or cognitive computing are pushing the frontiers of human imitation such that many routine activities are passed down into lower layers of the digital business ecosystem. Digital fabrication systems complete most of the processes in producing computer chips. Selected analytics and cloud-based software is now incorporated in chipsets for mobile smart devices (Qualcomm, 2015).

The IOT layer will transform not just network but B2B actors, resources and actions. The IOT will shift activities to less human actors through digitisation and automation of activities into events and processes. However, B2B data streams out of the IOT and

their associated services will become valuable resources – in some cases more valuable than basic offerings from a human supplier.

On the other hand, the IOT will increase the size of the actor network as new and different partners – sometimes from industries or areas that the businesses are not used to dealing with – join focal dyad providing knowledge, services and digital or datafying capabilities required by key businesses in the network. Ford's investment into developing its Silicon Valley Research and Innovation Centre in Silicon is an example of acquiring digital technology knowledge through networks previously outside the focus of an automotive company (Davies, 2015).

'Imitation' of actors, resources and activities will be driven as much economically and practically possible down to the IOT level of the digital business ecosystem.

Just how far will 'imitation' go through digitisation and datafication? The second machine age or the fifth technological age of Information and Telecommunications will see digitisation of as much as is practically or economically feasible over the next five to fifteen years (Perez 2010; Pattinson 2014). Digital business ecosystems may be able to match or even take over most business value creation ecosystems within that time period, if such actors, actions, resources, events and processes are digitally imitate-able. Isaacson (2014) does not see digital technology relacing humans from an artificial intelligence perspective, preferring an 'augmented human intellect' perspective drawing on cognitive systems where humans and machines collaborate to product results (Isaacson. 2014, p.445)

We believe that human actors will continue to develop creatively producing new and original ideas which will be discernible within real business creation ecosystems – but the time and level of translation for imitation and completion by the digital business co-creation part of the ecosystem may be short. Such co-creation will rely on robust and consistent ecosystems. Real business value creation ecosystems are remarkably adaptive and resilient – but the IOT underlying platform plus all five V's (Volume, Variety, Velocity, Veracity and Value) associated with big data, and the information service platform will as they grow quickly remain sufficiently robust, usable and secure for business use.

How much of your B2B activities and research (or 'search') will be rendered digitally?

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