

Digital Transformation:
From Digital by Design to Digital by Default

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Abstract: The pace and scope of change is having a significant impact on nearly all organizations. The convergence of ‘as-a-service’ platforms, cloud computing and software defined infrastructure; analytics, cognitive technology and automation; and communication channels and mobility are accelerating exponentially and require companies, cities and even governments to adopt to remain relevant and competitive.

We begin with a brief introduction and background of the reasons driving exponential change in the current global economic environment, including disruption to industries and organizations as a result of digital transformation; the differences between the revenue, growth and productivity of digital and non-digital companies; and evolving challenges in current business models

We then undertake a literature, situational and environmental review of a number of organizations and associated methods, to determine what makes them successfully digital; with the intent to create a reference framework and recommended implementation plan that other traditional organizations can follow or implement to achieve similar results.

Our literature, situational and environmental review uncovers the strategic, organizational and foundational features that are common in the most successful digital organizations and industries. From a strategic and organizational perspective, this includes the adoption of new business models and methods for continuous service improvement and delivery. Underpinning this, the technical components include software defined infrastructure, ‘as-a-service’ platforms, microservices, application programming interfaces and increased use of cognitive technology.

Based on these consistent set of features, we propose an implementation and high-level plan specifically for the Government of Canada, but with minor changes can be adopted by other organizations, cities and even countries. We also present possible challenges to digital transformation and recommendations to address them.

Keywords: digital transformation, organization, strategy, application programming interface, platform based service, containers, DevOps

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1. Introduction and overview

We are in uncharted territory with respect to the overall economy: low productivity, an overall decline in manufacturing and exports but an increase in information exchange and value (from scarcity to abundance); unconventional monetary policy (low interest rates, quantitative easing without inflation), increased globalization and a focus on green energy; the rise of cognitive technologies and automation; the convergence of cloud services, data analytics and sensors; and a ‘war for talent’ occurring in the midst of overall low wages and shrinking job growth.

The response and impacts of these changes differ per country or region. For example, in Canada an over-dependence on commodity and resource exports detracted from the transformational changes that were underway in other countries, companies and regions. The global launch of digital natives (companies or employees digital from inception), digitally transformed ‘traditional’ organizations, or value-added digital services in traditional manufacturers based on platform architecture, have been occurring in some countries for five to ten years or more - a lifetime in the digital era. To create value through growth, we recommend Canadian governments, companies and other organizations adopt our digital reference framework that has been so successful for others.

As such our research contains the primary questions, which we answer throughout the paper:

What are the economic and competitive conditions associated with digital business models; are digitally transformed organizations successful?

What does digitalization actually mean? How can legacy companies transform to become digital (what are the organizational, strategic and technical conditions normally adopted to be digital)?

Does a reference framework exist, or can we create one, including recommendations and a plan that can be applied to traditional organizations, governments and cities to become digital?

1.1 Background

What does digitalization actually mean?

Being or becoming digital has different meanings for different organizations and people. We define digitalization to include the provision of products and services to consumers through electronic means; to use technology and platforms to create value across various industries

(disrupting incumbents or defending against unexpected entrants); to use new communication channels (social, mobile) and design methods to serve or leverage customers; and to reorganize to promote agility and create an innovation catalyst. Simply, becoming digital requires the creation of value at new frontiers and in the core business through the building of foundational capabilities (Dörner, 2015). For some digitalization concerns new channels and communication methods from a front-office perspective, and included aspects of previous IT related campaigns such as e-commerce and business process modernization. True digitalization also requires the recent convergence of various back-office components – cloud, containers, machine learning, continuous delivery, automation – which present exponential opportunities for first-mover organizations that adopt and succeed (Brynjolfsson, 2014, p. 8).

We use the term ‘digitalization’ when referring to digital transformation, and ‘digitization’ to refer to the specific conversion of data to digital from analog.

What are the economic and competitive conditions associated with digital business models; are digitally transformed organizations successful?

Becoming digital by design and then by default, as quickly as possible, is an absolute and undebatable requirement for most organizations; especially in Canada. Numerous reports and articles show how Canada has not retained its global leadership in e-government, research and development and innovation over the past decade due to the over-reliance on the commodity and the housing market (Fard, 2016), (Staurt, 2015), (Semeniuk, 2015). Even more unsettling, Canadian firms and organizations have unsubstantiated belief in preparedness while at the same time reporting challenges with the adoption of digital transformation, including inertia, accountability, available skilled workforce and education (Warburton, 2016), (ICTC, 2016), (Pileci, 2016).

The new ‘five forces’ of competition are increasingly digital for most organizations, regardless of location, strength, incumbent position, product or deliverable (see Figure 1).

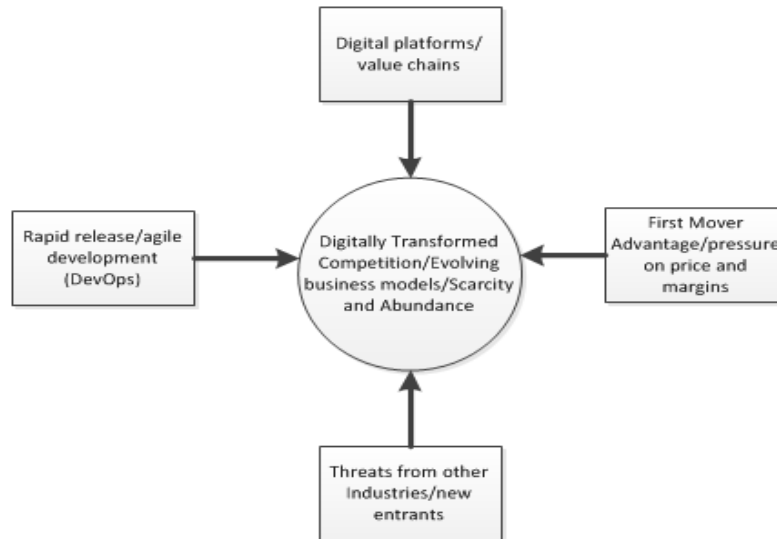


Figure 1: The new five forces, with input from (Oertel, 2015, p. 1) (Hirt, 2014, p 2-8)

Organizations now need to compete against others who produce a pipeline of monetized applications and consumer interfaces through continuous improvement and delivery; must unseat prime movers; and face competition from unexpected digital natives as well as legacy companies who are further along their digital transformation path.

An evaluation of a number of companies as defined by four categories (Table 1) show Revenue Generation, Profitability and Market Valuation are all higher for digital natives than traditional companies.

Dabblers – starting their transformation	Natives – digital natives/digitally transformed
Cherubs – under evaluation/consideration	Cautionary – risk averse or unconvinced

Table 1 Legend indicating the types of companies in each quadrant in the proceeding graphs

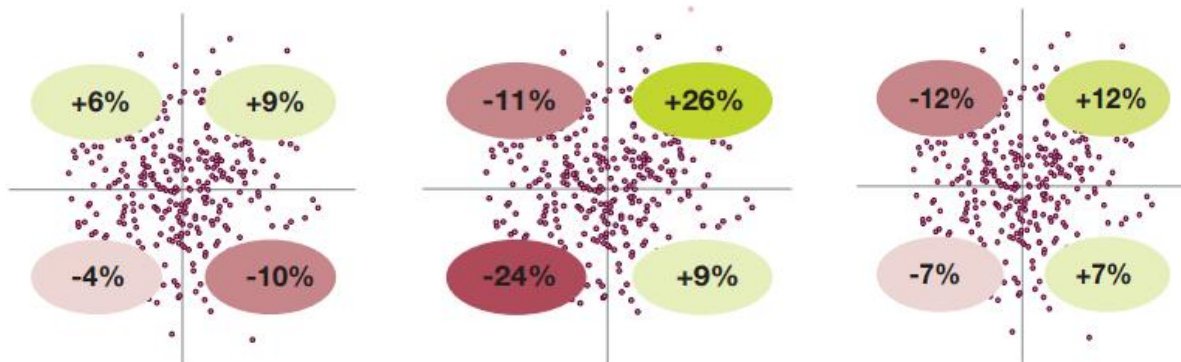


Figure 2: Revenue Generation; Profitability; and Market Valuation (Westerman, 2015, p. 7)

The digital natives exceed the others by a significant margin based on the same basket of indicators, such as revenue/employee for Revenue Generation; net profit for Profitability; and price/book ratio for Market Valuation (Westerman, 2015, p. 7). Other economic studies have similar conclusions: “...our survey shows that companies that lead their peers in categories related to strategy and investments that drive rapid ideation and reduced time to value also report superior financial results” (Deforest, 2016, p. 1). A few examples of digital natives or digitally transformed companies include the mobile messaging application (app) WhatsApp – that sold to Facebook for \$22 Billion with only 55 employees (Frier, 2014); SnapChat with 20 employees and a valuation of \$4 Billion (Whitman, 2016, p. 1); General Electric, Bosch, Uber, Amazon and others.

The strength of these digital companies is due in part to the network effects (or Metcalfe’s Law) as prime movers, where the value and utility of services increase exponentially as more people use or acquire it (see Figure 3). As product penetration increase, complimentary providers add value; thereby further increasing adoption through feedbacks (Hendler, 2007, p 1-2).

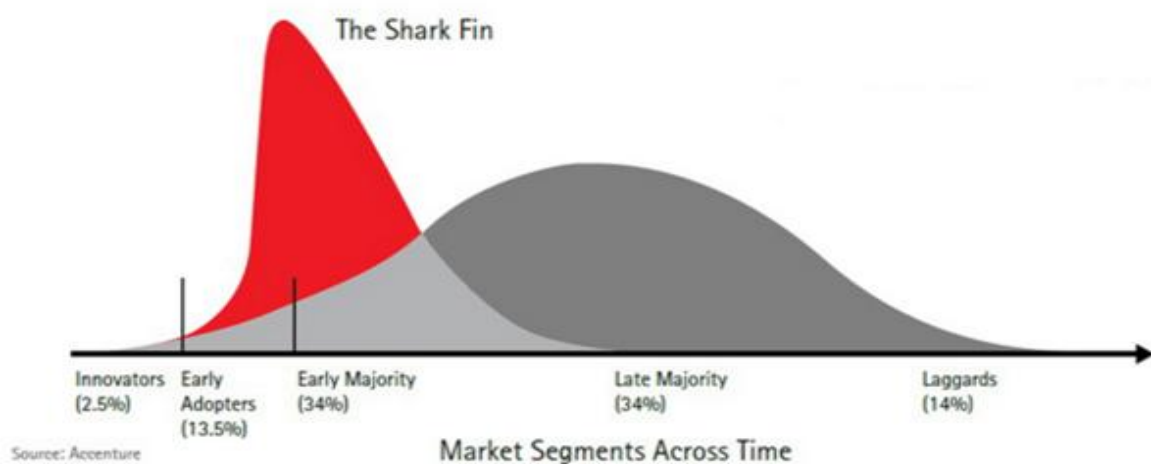


Figure 3: Technology adoption has an early majority (Oertel, 2015, p.1), (Downes, 2013, p. 5) Another common characteristic of digital companies is their adoption of external (public) clouds. For example, the previously mentioned SnapChat achieved a valuation of over \$4 Billion after only two years due in part to low infrastructure cost as it is hosted completely on Google Cloud as a ‘platform as a service’ (Whitman 2016, p. 3) (Russell, 2014).

2. Methods and Methodology

To determine what makes an organization truly digital, including the determination of a reference framework or digital quotient for digitalization, we perform a review of current literature and a situational or environmental analysis, including example and case studies, of successful digital companies.

The literature review includes an examination of relevant articles in business journals and publications, especially the Harvard Business Review, The Economist, Fortune, Forbes and the Wall Street Journal. Since digital transformation impacts most organizations we also include recommendations from consulting firms such as McKinsey, Deloitte, Gartner, Accenture and MIT Sloan.

We also rely heavily on technical journals such as the Internet Protocol Journal; standards from organization such as the International Telecommunication Union (ITU) and International Organization for Standardization (ISO); and more recently, the work of a number of ‘foundations’ that include vendors, academia and open source members, such as the [Cloud Native Computing Foundation](#) (CNCF), [OpenDaylight](#) (ODL) and [Open Network Operating System](#) (ONOS).

Since our project provides a framework and plan to digitalize governments, countries and economies, we also leverage progress in other jurisdictions such as [UK Government Digital Service](#) (GDS), US General Services Administration (including lean start-up [18F](#)), [Australia’s Digital Transformation Office](#) (DTO), [Germany’s Industrie 4.0](#), [Nesta](#) and the [Organisation for Economic Co-operation and Development](#) (OECD). Finally we leverage specific sources based on topic, such as Corporate Executive Board (CEB) for architecture and best practice insight.

Besides for traditional methods, my research included joining, ‘connecting to’, and/or following individuals and groups on a number of social platforms, including Twitter, LinkedIn and Facebook; subscribing to relevant vendor distribution lists; and interviews or online communication with thought leaders in this area. A word of note: presentation or consultation with vendors is solely limited to the illustration of concepts and is not meant to compare product capabilities or to recommend any particular vendor.

2.1 Digital Systems Triangle

How can legacy companies transform to become digital (what are the organizational, strategic and technical conditions normally adopted to be digital)?

Through our own observations and case analysis, review of recent literature and examination of successful digital natives we discover or determine the strategic, organizational and technical changes a legacy company should implement to become digital, which forms the basis for a complete reference framework. The following sections provide a response to the above question.

2.2 Strategic

Even though digitalization is a technical concept (and this is a technology research project), all successful digital transformation starts with organizational, cultural and process changes including the determination of strategic objectives and implementation of a digital strategy. At a high-level the objectives are very similar for most companies, cities and even governments; as well as the methods to achieve these objectives.

Environmental review show nearly all organizations leverage common technological themes when successfully implementing their digital agenda: social, mobile, analytics, cloud and internet of everything (SMACIE) (Kane, 2015, p. 5). From a strategic perspective, many digital natives begin their transformation by modifying their front-office or outbound channels that improve or replace contact centres in support of marketing, sales and customer experience – using social, mobile and cloud platforms (McManus, 2015, p. 3). This often includes marketing on social media (i.e. Twitter or Facebook); building external crowd-sourced user support teams and more recently; using natural language processing, insight and sentiment analysis to sort and classify data, such as using Text Analytics API's on Microsoft Azure (Microsoft, 2015, p.1) or IBM Watson natural language processing (NLP).

These communication channels are often now implemented in consumer social media platforms (i.e. Facebook messenger); via browser based technology connected to a collaboration platform such as Spark or Slack; or through a mayday function on a corporate web site, such as on Amazon Prime using WebRTC. Traditional call centre functions, formerly provided through offshore call centers are now available via customer activated communication and collaboration tools (Schoeller, 2015, p.1). With the rise of dis-unified communication, consumers generally make use of a number of different communication apps and more recently 'bots', to find people, goods or services by their medium of choice. Communication through collaboration and

communication apps are expected to overtake those on social media for the first time this year (Messina, 2015, p.1).

The next level of digital strategy includes the modification of operations: we examine this theme more fully throughout the paper when discussing the redesign of information technology (IT) in Section 2.4. This includes changes in operations, risk and change management, architecture, and the adoption of infrastructure such as software defined networking, cloud and service or user design (McManus, 2015, p. 4).

A third strategic layer includes the evolution of products and services from a physical to a digital model. This includes the development of new business channels to create revenue (such as retail sales); the increased use of sensors and platform-based API's to create digital value from physical objects; improved product sales; and cloud-based platform analytics or supply chain data. Another example is simply new methods and markets that create value, such as on-line banking; ride and home sharing; digital health and entertainment (McManus, 2015, p. 4). We are also reaching the tipping point of early adoption and the creation of digital/physical partnerships in some industries, such as automobile, aircraft and utilities (Brown, W., 2016, p. 1) and the rise of automation, robotics and machine learning.

We recommend that companies, organizations and cities re-evaluate the 'five forces' from Figure 1 to determine how to implement new strategic objectives in a modified business plan. Appendix 1 contains a continued overview and recommendations of the new objectives and business models.

2.3 Organizational (Structural Reorganization)

Successful digitalization requires structural reorganization, redesigning workflows and operations to support a digital environment. In part, this is to ensure systems are not built to Conway's Law:

'Any organization that designs a system (defined broadly) will produce a design whose structure is a copy of the organization's communication structure' Melvin Conway (as cited in Haack, 2013)

Designing applications and systems based on hierarchical structures create monoliths, without the agility and time to market digital services now require. Our research shows

traditional organizations generally create a two-speed or dual mode Information Technology (IT) environment, where select resources are assigned to implement digital methods of working (transformative), with other employees supporting legacy environments (traditional). Some companies consider adding a separate innovation stream resulting in a tri-mode organization (Chandok, 2016, p. 3), though most digital organization can unlock value and embed innovation natively. As services, processes and applications move to the new environment, more and more employees move over as well, until a company is a predominately digital hybrid – “... the transformation toward digital is a continuous process of delivering new functionality” (Bossert, 2015, p. 4).

The implementation of dual-mode IT, and then a full organization, occurs by pulling resources out of the traditional hierarchy and creating teams surrounding a guiding coalition: of business leaders; security, network and cloud specialists; developers; multi-channel marketers; data scientists and analysts; and a host of others (Kotter, 2012, p. 7), (Bossert, 2015). In retail and other markets, these agile teams start with service design that produce and deploy applications quickly through various channels. We see this further when discussing rapid application development on top of cloud-based platforms and with the recent rise of bots, or automated interfaces between companies that make recommendations based on the content of communication (Constine, 2016). Figure 4 shows how organizations can build agile teams who rapidly design these new features, led by a guiding coalition.

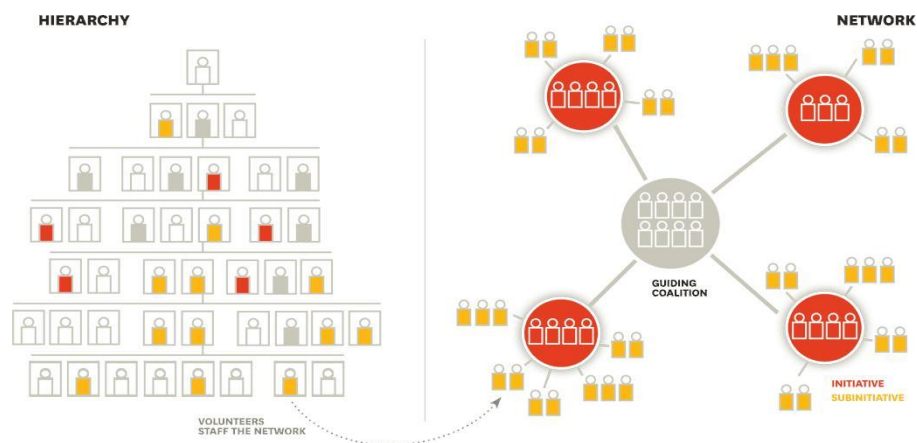


Figure 4: Hierarchy to Network (Kotter, 2012, p. 7)

As the IT environment stabilizes, the exercise repeats until the entire organization becomes digital, including marketing and support channels, service design, and application testing and deployment. This has its roots in the organizational ambidexterity of Tushman/O'Reilly: where organizations compete in their legacy environments as they transition to new markets requiring flexibility, autonomy and experimentation. The truly ambidextrous exhibit this flexibility through a continuous pipeline of new services and both incremental and disruptive innovation (Tushman, 1996, p.24). The new guiding coalition produces results normally found in the heavyweight cross-functional or matrix teams proposed by (Clark, 1992, p. 11); but are much more agile and flexible: forming, coalescing and disbanding as required.

For years, lowest cost and efficiency were the primary goals of IT service delivery in support of business value, which often meant out-sourcing key IT functions, a de-skilling workforce and the separation of Information Technology from strategic planning. But in this new age 'everything matters': quality, reliability, security, and time to market are all critical priorities required to gain or maintain a continuous prime-mover advantage (Andersson, 2014, p. 2). Bimodal IT becomes a business requirement, helping digital companies repeatedly cycle through new goods and services, with new partners and agile deployment that leaves unexpected incumbents wondering what had just happened to their business model or markets (McGrath, 2013, p. 5).

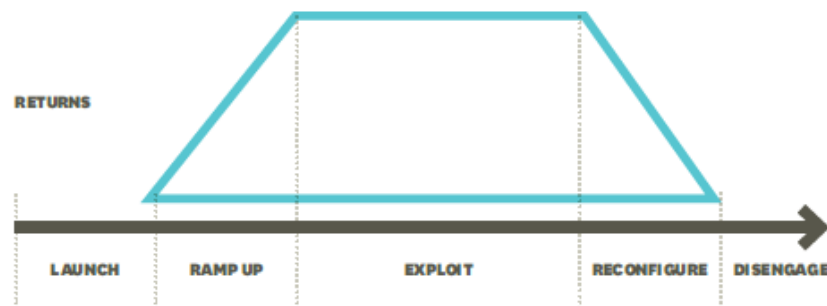


Figure 5: Stages of Transient Advantage (McGrath, 2013, p. 5)

Like feedbacks (or gifts that keep on giving) our analysis uncovers other significant benefits or impacts of digital transformation. Digital transformation creates the environment for architectural innovation in an organization – an innovation catalyst. Since value is created using digital platforms and continuous application delivery, new products and services can be added

simply and repeatedly without reconfiguring complementary assets, such as marketing, training or support structures, of an organization.

As well, digitally native employees are often considered millennials but in reality could be any person who leverages network effects and digital tools, design thinking and creativity are well suited to digital organizations. The rapid deployment of applications through DevOps keep employees engaged; and ‘microservices’ are well suited to ‘micro-assignments’ for freelancers or those participating in the gig, collaboration or sharing economy. Finally, the platforms themselves provide a marketplace for employers to hire staff for short-term engagements, for staff to collaborate and innovate from any location, and for companies to spin up the extra compute cycles required to meet demand.

2.3.1 Service Design

A common theme among digital organizations is their application design and development practices, especially in relation to Conway’s Law. Successful companies create services via applications that are pleasant and easy to use and solve client problems. These popular applications drive adoption; as well as create value and the feedback loops that strengthen prime-mover advantage. Regular updates containing new features, services and products increase the value of these apps, providing the transient advantage mentioned earlier. This successful pipeline begins with service design, sometimes called user, interactive or customer experience (UX/IX/CX). This involves teams that work with end users to prototype different features, location of buttons, screen size, etc. For example, retailers like Nordstrom, H&M and Zara test applications and services right in their stores, asking customers to make selections on physical mock-ups of proposed apps (Brown, T., 2015). Successful digital transformation and business model has allowed Nordstrom and others grow revenue over 50% in both its traditional and online channels (Ross, 2015, p. 3-4), at a time when Canadian retailers such as Danier Leather, Laura, Jacob, and Smart Set have been forced out of business (Wright, 2016).

To succeed in this arena, companies have focused their effort and design to be so compelling and personalized the user no longer considers comparison shopping or feature pricing. Examples abound: real estate agents with 3-D visual house walk-throughs, and a solar-panel company that not only provides estimated energy savings, but model overlay and google earth views of each potential customers home; references to other customers in the same neighbourhood; specific,

directed and personalized sales info; and an immediate sales contracts – all of which guide customers to a purchase and ensures they do not consider the competition (Edelman, 2015, p. 1-4).

Personalization creates loyalty loops, as shown in Figure 6. Appendix 2 examines service design and development further (Brown, T., 2015).

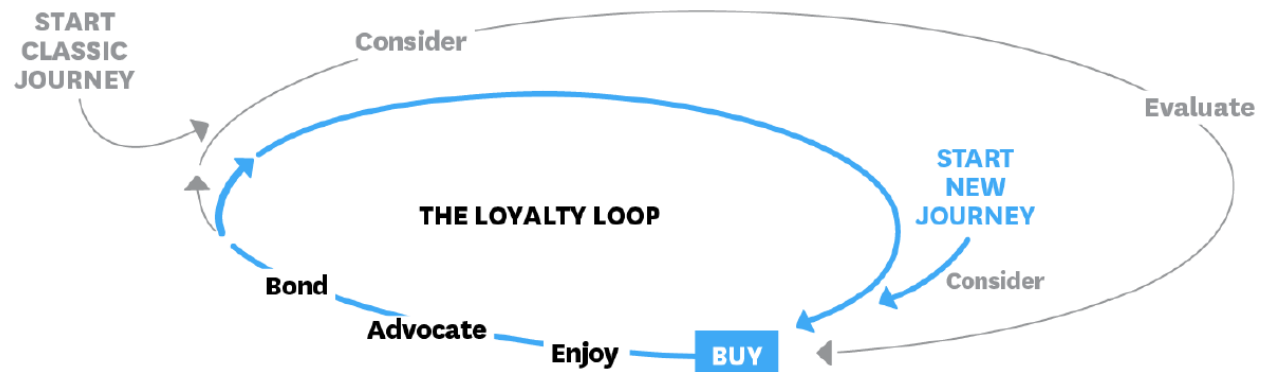


Figure 6: Streamlining the Decision Journey (Edelman, 2015, p. 4)

2.4 Technical

The digital in digital transformation is the result of an extraordinary convergence of technical factors. This includes the implementation of software defined infrastructure and network virtualization; clouds and platforms; service design and implementation through containers and microservices connected via application programming interfaces (API); and the adoption of sensors, data analytics and cognitive technology. This is sometimes considered ‘combinatorial innovation’, where the decomposition and recombination of technology creates new business models, competitive change and digital transformation (Varian, 2004). An important theme is the rise and use of open source software and components, both embedded in vendor products and available independently as a hybrid platform, such as OpenStack.

Digitally transformed companies are more inclined to run most IT components as software, such as software defined networks (SDN) and software-defined wide area networks (SD-WAN). And since ‘software is eating the world’ (Andreessen, 2011) this also includes software defined infrastructure (SDI) components, like storage (SDS), perimeter (SDP) and platforms that constitute a software defined data center (SDDC) (Bawa, 2015, p 1-4).

2.4.1 Software Defined Networking

From a customer, citizen or user perspective, the outcome of service design (2.2.1) requires connectivity from users and products to organizations and the platform-based cloud running the applications. In many cases this simply includes the cellular and broadband networks connecting homes and mobile devices to the internet. With the growing deployment of sensors in support of the industrial internet and the internet of everything, it also includes the machine to machine (M2M) communication from cloud edge to cloud-based platforms, which we discuss later.

From a sales, marketing or support perspective, this begins with the applications and front-office channels used by stakeholders – customers, citizens, employees – both inbound and outbound. To deploy digital services and product in an ecosystem that might require immediate scale in the hundreds of millions (i.e. new product release on hundreds of different devices) digital companies use SDN and network function virtualization (NFV) to connect staff (such as developers) to the services deployed in the cloud. This flexibility also reduces cost and addresses the unprecedented demand that first mover advantage produces and requires.

Like most technical topics, SDN/SD-WAN have a number of interpretations; and we define it to mean the management of paths between network switches and routers via templates or profiles, managed by a controller (or control plane) using the open source OpenFlow or more propriety OpFlex protocol. Above this, the application plane contains orchestration, elasticity and management tools. Through the open source standards, the control plane is able to manage and include hardware from various vendors agnostically; though, as often occurs, retaining vendor consistency often provides the full set of features and most benefit.

There are a number of benefits of SDN/SD-WAN that support digital transformation: 1) elastic service provisioning via policies or templates eliminates (reduces) configuration time and human effort and error, 2) using open source components reduces vendor lock-in, and 3) companies replace expensive and fixed data circuit contracts with internet (broadband), over which policies secure and route traffic when and where required, such as to private, public and hybrid clouds. This reduces costs, dynamically reroutes traffic around outages and allows for scalable bandwidth provisioning on-demand, as seen below (Varnum, 2015, p. 1).

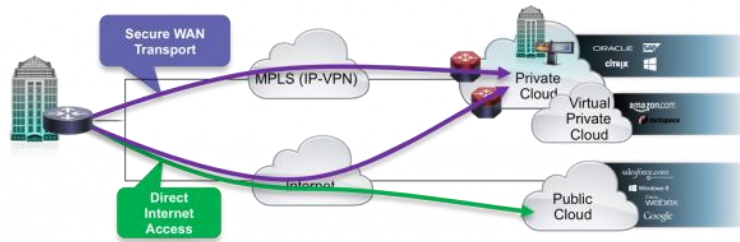


Figure 7: Application Centric WAN to the cloud (Varnum, 2015, p. 1)

Currently there are a number of complementary standards bodies or foundations working in the SDN space, including the open source [OpenDaylight](#) project (including other open source components such as [Open Contrail](#)); or the co-opetitor [Open Network Operating System](#) (ONOS). Appendix 3 contains further details on SDN/SD-WAN as it relates to business transformation.

2.4.2 Cloud

Our evaluation shows that a common theme throughout digitally transformed companies is the use of various types of cloud platform services for scalability, availability, cost and feature set. The economics and value proposition of cloud computing are well documented, and we focus on the various types of clouds and platforms. Clouds are either:

- Private: Cloud infrastructure operated for an individual organization or company, hosted internally or externally.
- Public: Cloud services provided over a network which is open for public use.
- Hybrid: A cloud infrastructure combination made up of both private and public resources (Cloudyn, 2014, p.3)

The different types of clouds also provide different functionality, especially public and hybrid clouds. Until recently private clouds were mostly corporate data centers running products requiring traditional management techniques such as VMWare vSphere/ESX, Microsoft Hyper-V, or flavours of a Unix-based virtual platform. Due to a world-wide developer network and contributions from ‘foundations’ recent updates to [OpenStack](#) now provides considerable cloud-based compute, storage, networking, firewall and even telephony functions that drives many of the world’s most used online services, such as PayPal. Finally, Microsoft’s recent release of Microsoft Azure Stack connects to and contains all the functionality of publicly available Microsoft Azure, including credential management, thus building a hybrid cloud (Kjerland, 2016, p.1).

With public-like cloud features such as orchestration, elasticity and the rise of containers, private and hybrid clouds are making a comeback, increasing the importance of SDN for policy or application based routing and rapid deployment (Bartoletti, 2016). Private/hybrid clouds also support the data residency requirements based on policy or regulation, such as keeping data in Canada to avoid the US Patriot Act – which allows the US Government to intercept communications and retain ownership of stored information (Banks, 2012, p.1). Depending on the classification or sensitivity of the data, some organizations may be obligated to keep data local - on-site or within geographic boundaries.

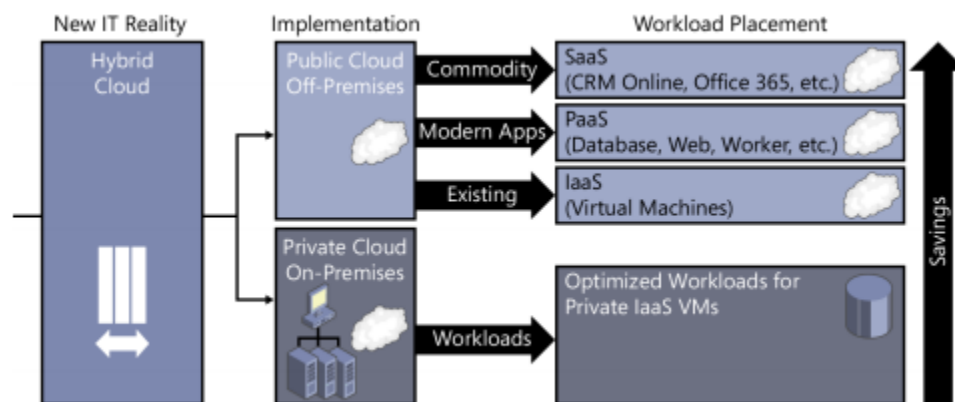


Figure 8: Hybrid Cloud (Briggs, 2016, p.20)

But it is public clouds and the rise of platforms that our analysis has shown is having the greatest impact on business models, core competencies and the theories of business, allowing unexpected threats to disrupt an incumbent company; or conversely creating a billion dollar valuation (unicorn) from two-dozen coders and a first to market app.

Initially, clouds provided basic infrastructure as a service (IaaS), such as storage, computing, redundancy and high availability. Just as critical, they were less expensive and could be provisioned with more speed and scale than IT organizations could do themselves (Bawa, 2015, p. 1). [Amazon Web Services](#), [Microsoft Azure](#) or [Google Cloud](#) were early frontrunners in this space, and continue to increase respective percentages of overall revenue year-over-year. More importantly, they also provided the platforms that digital start-up's and other companies leveraged to also scale their prime-mover advantage (Weinberger, 2015, p. 1).

Cloud adoption has recently gone mainstream for many organizations as they embrace cloud economics (CAPEX to OPEX) and mitigate security issues relating to the release of corporate data through cloud access security brokers (CASB). Moreover, our literature review show public

clouds are built are engineered for availability, resiliency and recovery, such as Google's Site Reliability Engineering team (Perry, n.d.), (Underwood, n.d.). For digital organizations that are built entirely in the public cloud, and for most other traditional or transitional companies going forward, the value of public clouds far outweighs the risks.

As cloud adoption increased, so did the evolution of public cloud services and features. Cloud companies began to offer applications as part of their models, creating Software as a Service (SaaS), such as Microsoft O365 and popular communication platforms such as Slack, Spark, Asana and others. Besides for ease of provisioning and cost, SaaS also created feedbacks in other areas, increasing the flexibility of virtual teams and reinforcing the value of digital models. Built upon the SaaS model, cloud-based companies then began to provide Platforms as a Service (PaaS), including application PaaS (aPaaS) or application enablement platforms (AEP); and integration PaaS (iPaaS) or hybrid integration platform (HIP). One popular aPaaS example is Salesforce.com, originally used for client relationship management; it now allows businesses to build customer-centred business processes for marketing, sales, customer service and business analytics (Salesforce 1, 2016). A strong contender in the iPaaS/HIP space, Mulesoft provides security and API integration connectivity for cloud-based, mobile and on premise resources (Pezzini, 2015), (Thompson, 2014).

We do contend organizations and governments must continue to evaluate their information holdings and privacy requirements, especially in the context of international rules such as the US Patriot Act (Banks, 2012, p.1) in order to meet regulations and citizen expectations.

2.4.3 Application platforms and Application Programming Interfaces

The rise of the application platform has provided completely new models for business and has far-reaching consequences in nearly all industries. Platforms such as Salesforce improve services and create value through the creation of custom applications and more recently 'bots' and 'chat-bots' such as 'Assist' in Facebook Messenger (Constine, 2016) based on the requirements and user experience gathered from service design:

"Platform services include the tools, technology, and APIs designed for developers to build custom apps" (Salesforce 2, 2016, p. 6)

API's are generally open interfaces from one service to another, allowing the exchange of information through coding methods, and often based on *Representational State Transfer* or REST (Fielding, 2000). For example, PayPal publishes its API style guide making it easier for

partners to create services that use PayPal. As often seen in the digital world, PPaaS (PayPal as a Service) protects PayPal's prime-mover advantage and creates value through network effects (Leblanc, 2015, p. 1). Figure 9 maps the journey from service to consumer via RESTful API's:

“APIs are the building blocks of the digital economy. They make existing capabilities fungible, so that it is possible to use them in new ways, quickly and easily, thereby spurring innovation and new value creation.” Laura Merling, VP Ecosystems and Solutions AT&T (as cited in Willmott, 2013, p. 13)

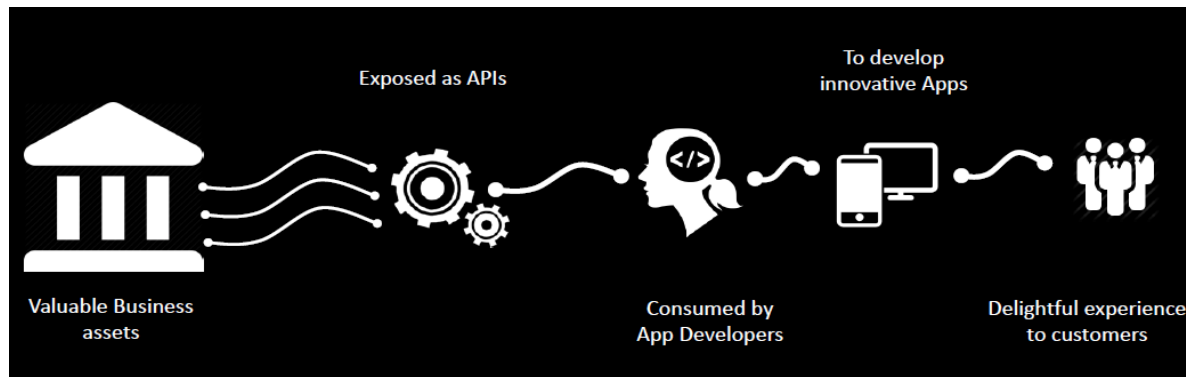


Figure 9: API Economy Value Chain (Bhatia, 2015, p. 7)

Even more remarkable, exponential development in cognitive technology is now available to all businesses via API's through platform clouds. [IBM Watson Analytics](#), [Microsoft Azure Machine Learning](#), [Google Prediction API](#) and [Amazon Web Services Machine Learning](#) allow organizations to build cognition and deep analytics into their applications, products and processes. IBM Watson Analytics currently provides 28 cloud-based API's, such as regression, binary classification, concept tagging and sentiment analysis. Similar machine learning algorithms are also available from Microsoft, Google and Amazon (Microsoft, 2014), (Watson Services, 2015). Application developers then leverage API's to create programs using the languages 'R' or 'Python' to present and analyze the vast amounts of structured and unstructured data now being collected.

Experience also show the prime-mover impact of digital transformation impacts market in other ways as well. Millions of consumers use deep or machine learning through entertainment and retail platforms such as Apple iTunes and Amazon Prime; though the personal assistants of Amazon Alexia, Microsoft Cortana or Apple Siri; or through search engines such as Google and Microsoft Bing. Machine Learning also feed into the rising automation of physical and increasingly cognitive activity, including driving, manufacturing and creative thinking. We already see the resulting impact on overall levels of employment, wages and talent in most

economies. Overall, jobs and wages are on the decline in most countries, even in Canada with a devalued currency; and white collar employment in many industries is now also considered at risk from cognitive learning and automation, reducing the traditional middle class (The Economist, 2016). Ensuring our reference framework acknowledges and then adapts to these changes will help respond to current economic challenges.

2.4.4 Industrial Internet/4th Industrial Revolution

Building upon the platform model is the rise of the ‘industrial internet’, and since the recent World Economic Forum held in Davos, the 4th Industrial Revolution. The industrial internet began as “...sensors and actuators embedded in physical objects—from roadways to pacemakers—are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet” (Chiu, 2010, p. 1). Now it includes digital platforms from traditionally physical manufacturers such as General Electric (GE Predix), PTC (ThingWORX), Bosch; as well as Amazon, Google, Microsoft and others; that create value by increasing the efficiency of equipment, tools, and infrastructure; and their maintenance and management (Press, 2013, p. 1), (Schwab, 2016).

The total value of and impact to the business models and value chains created by machine to machine (M2M) communication, sensors and data analytics have been well documented by international organizations such as the Organisation for Economic Co-operation and Development, World Economic Forum and others; as well as businesses such as Cisco and GE (Bradley, 2013), (Annunziata, 2012), (Annunziata, 2015), (Barnes, 2013).

For many traditional manufacturers, this also represents a transition from a product to service business model, and the changes this requires. For example, rather than simply mortgages, banks partner with realtors to complete the home acquisition, or a manufacturer selling ‘runtime’ rather than engines (Annunziata, 2012).

2.5 Application Design and Development

Our analysis show organizations are creating better customer and citizen journeys through service design and user experience, leading to improvements in the visual features of apps, customized marketing, and convenient delivery methods (i.e. order online, pick up in store) for front-office components. This value increases as application programming interfaces (API’s)

allow this to be extended across a wide-range of complementary companies, further improving the customer experience and creating value.

From a coding perspective, this is enabled by platforms and developers reviving the concept of containers and the deployment of microservices. Containers are isolated, portable environments containing all required libraries and dependencies that support microservices, or applications written as small blocks of code and interconnected via API's (Cacciatore, 2015, p. 3). They can be created in one environment and deployed to another, providing continuous delivery of new services (value) and providing a catalyst for architectural innovation.

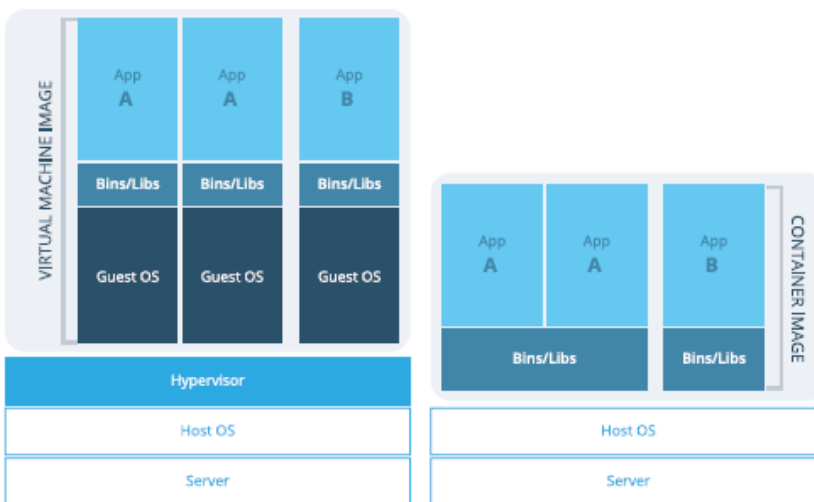


Figure 10: Virtual machines vs. Containers (Cacciatore, 2015, p. 3)

The use of containers and new application design also promotes a change in application development. Traditional development methods like waterfall now take too long, cause analysis paralysis, and create a mismatch between business requirements and delivered product. Organizations adopting an agile methodology are able to incorporate new system requirements late in the process, deliver code early and often, and bring functional experts and software developers together on a single team (Lundqvist & Olesen, 2016, p. 4). Figure 23 in Appendix 2 compares waterfall and agile development methodologies, and Figure 10 compares traditional virtual machines with containers.

Even though containers and microservices are currently only used in 8% percent of companies (Bartoletti, Feb 10, 2016) most people rely on them every day - a typical Google search can use up to 70 microservices (Miller, 2015). Containers are available via open source platforms including [Docker](#), [LCX](#) and [runC](#) and can run on a host of public cloud platforms,

including [AWS](#), [Microsoft Azure](#) or [Google Cloud IBM Bluemix](#), [Pivotal Cloud Foundry](#), [Apcera Platform](#) and [OpenShift](#) (Juneja, 2016, p.1). With each component managed separately in discrete portions, large IT coding projects are now occurring on-time and with less risk.

Since technology always seems to be progressing, scaled-down containers are now being introduced and supported via cloud platforms. Unikernels combine the application code with only the operating system components that are necessary, creating microservices that can be deployed to IOE sensors and other hardware (Marks, 2016, p.1).

There have been other recent features or technical advances that support the ‘perfect storm’ of underpinning services for organizations pursuing digital adoption. Management tools are improving cloud based services, driven by standards such as the [Topology and Orchestration Specification for Cloud Applications](#) (TOSCA) that provides consistency between cloud deployments (Katsaros, 2013, p. 1). The [Cloud Native Computing Foundation](#) (CNCF), comprised of industry giants such as Cisco, Google and IBM, are also building and recommending standards at the orchestration, security, integration and services layer. This includes *Mantl*, *Terraform* as well as other tools we see in Section 2.5 (Williams, 2016).

New products, such as API gateways NGINX and HAPROXY, provide load balancing for some of the world’s busiest websites and are available as open source from [Docker](#) as a container. Advancements in credential management and transactional services include OAuth/Oauth2 (Brail, 2012) and http2 (Ludin, 2012) respectively, which provide efficient mechanisms to build and secure inter-application communication. Many cloud services also provide directory integration for hybrid deployments, such as identity management between corporate active directories, Azure Stack and Microsoft Azure. This allows organizations to better share user data and credentials between platforms for both consumer and corporations hoping to leverage the cloud.

2.6 DevOps

Section 2.2 indicates the requirement for organizations to switch to a bimodal (or two-speed) IT organization to support legacy services while transforming digitally. When this occurs the ‘digital’ portions of the IT organization adhere to a fairly recent organizational design/methodology called DevOps (Developer Operations). Much like the waterfall method of

application development, traditional application deployment is tedious when occurring in hierarchical organizations constrained by process (Figure 11).

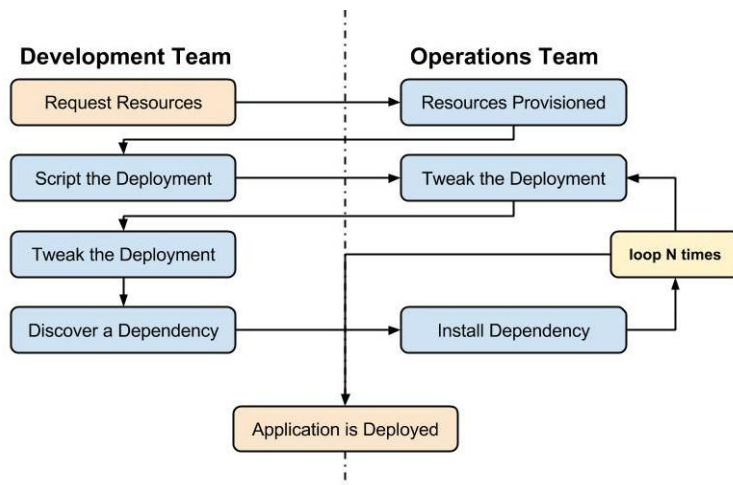


Figure 11: Traditional Application Deployment (Matthias, 2015, p. 22)

Container deployments are much simpler than traditional methods: development teams build their applications including dependencies, run it in development and test environments, and then ship the bundle to production, using a continuous delivery mechanism such as Docker, LCX or runC (Matthias, 2015, p.24). As applications scale up, DevOps take advantage of deployment tools such as Docker Compose, Swarm and Machine; Jenkins; Kubernetes or Spinnaker for orchestration; and Mesos/Marathon for scheduling (Cacciatore, 2015, p. 5), (Grillet, 2016).

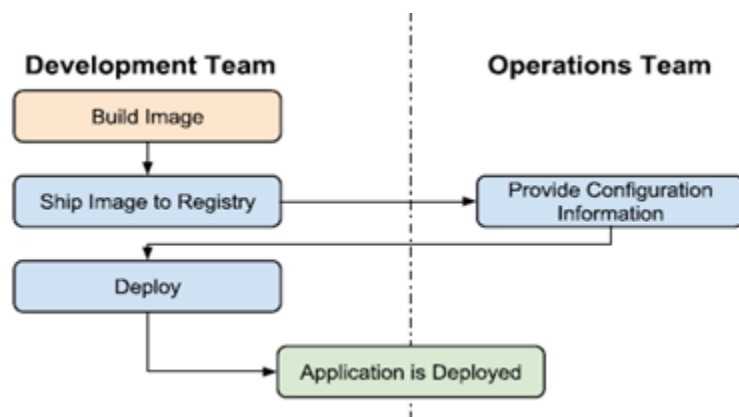


Figure 12: DevOps workflow using a Container Registry. (Matthias, 2015, p.23)

2.7 Business Mechanics

Platforms services, realigned IT, and the ease of application deployment also encourage new methods for change, risk and operations management. Digital organizations requiring certain skills now use virtual employees from anywhere in the world though existing collaborative

platforms. This builds employee engagement and helps address the skills gap for certain roles, such as developers and data scientists.

2.7.1 Application Testing and Deployment

In digital organizations, basic service requests from users, such as extra storage or compute, occur automatically through pre-defined rules mapped to account credentials and software defined templates and policies. Automated provisioning and continuous delivery has prompted the adoption of new deployment methods available to digital organizations. In the age of work-fast/learn-fast, A/B testing, and blue-green and canary deployments have become the distribution methods of choice for organizations that need to constantly improve their services and applications (Stine, 2015).

A/B testing is used to validate specific portions of an application, such as the user interface, for popularity and usability. Blue-green and canary deployments are techniques for releasing applications while reducing the impact of unforeseen issues causing downtime (Posta, 2015). In the Figure below, digital organizations deploy changes to the ‘blue’ environment, while keeping the ‘green’ available and functioning. In canary deployments, updates occur to one node at a time, increasing as application functionality is verified. Safe and continuous delivery builds trust in the deployment team, which no longer requires monolithic change management processes.

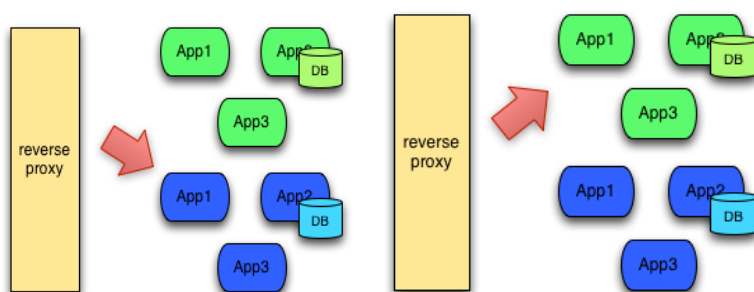


Figure 13: Blue-green deployment (Posta, 2015)

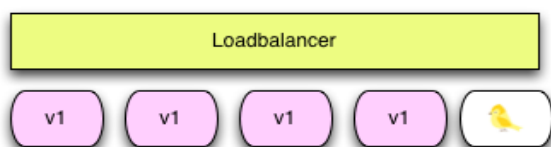


Figure 14: Canary deployment (Posta, 2015)

2.7.2 Risk Management

We also recognize that the increase in connectivity, multichannel media and digital value chains introduce new types of risks which now also need to be addressed, including information intensity and the rise of platforms and sensors. Analytics mean companies now collect and manage more data with increase risks in cyber security and customer data privacy. The extended enterprise now also creates potential risks, where vendors, suppliers, contractors, agents and resellers are all interconnected due to the digital value chain (CEB, 2014, p. 1).



Figure 15: Increased connectivity increases potential risk (CEB, 2014, p.2).

These risks can be mitigated by the use of software defined policies and pre-built and approved security enclaves in the cloud, leveraging recent updates to identity and transactional services for authentication and data integrity (i.e. OAuth2 and eventually blockchain). Application of new standards including Committee of Sponsoring Organizations of the Treadway Commission (COSO) Principle 11 (Rose, 2014), Executive Board's Principle 12 for Risk Management and ISO 15504 (Shah, 2014, p. 57), now manage IT risk as an important component of the business model.

Finally organizations now need to strike the right balance between risk aversion risk appetite; focus on value-driven outcomes and not only compliancy; include employees, software and systems in their mitigation of risk; and begin to leverage cognitive technology platforms to evaluate risk (HBR, 2015, p. 2-6), (CEB, 2014).

2.7.3 Operations Management

Changes in the service delivery models based on platform architecture, various cloud services and continuous application delivery also produce new methods and tools for operational management. Development teams write and deploy microservices on production architecture

following the DevOps model. A similar model is now being applied to network and cloud operations (NetOps). Labeled Zero-touch Orchestration Operations and Management (ZOOM), NetOps for network operations include the automatic provision of services using policies or runbooks, allowing companies to scale and provide new services quickly. Principles enabling both DevOps and NetOps include: collaboration, continuous delivery, testing and monitoring, automation and automated management interfaces (Metzler, 2015, p. 8-10).

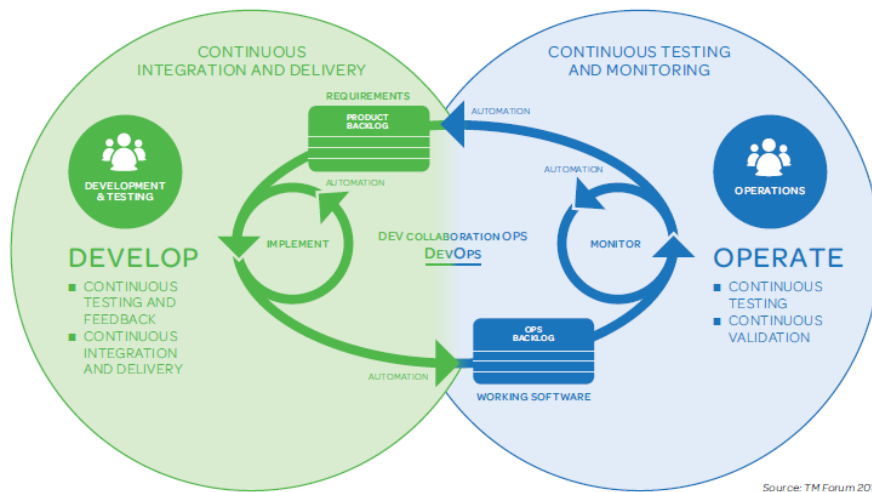


Figure 16: Applying DevOps to NetOps (Metzler, 2015, p. 9)

Standards bodies and Foundations such as The Internet Engineering Task Force (IETF), European Telecommunications Standards Institute (ETSI) and Open Networking Foundation (ONF) are also working on new management models, such as Management and Orchestration (MANO) and Network Function Virtualization Operational Support Systems (OSS) (Ersue, 2013, p. 2-12).

2.8 Case Study - Netflix

Our literature and environmental review examines the functions and activities that organizations have adopted to become digital, supported by specific examples such as Zara, SnapChat and WhatsApp. Another example of an organization that has become digital by design, and whose digital business model disrupted the physical retail presence of an entire industry, is Netflix.

Originally a DVD mail order company when founded in 1997, Netflix has since adopted many features considered digital (or found in a digital organization). In 2006, they used machine learning to improve customer recommendation accuracy by analysing what people had already

watched; and launched online streaming to include personalized viewing recommendations in 2007. Besides for the misstep in 2011 with the temporary launch of Qwikster as an attempt to split off their mail-order business, Netflix have increased customer base and revenue fairly consistently for the last 10 years. This is partly due to the implementation of progressive features and original content, starting with the acclaimed House of Cards, that now compete directly with mainstream television empires (Contreras, 2015, p. 3-6).

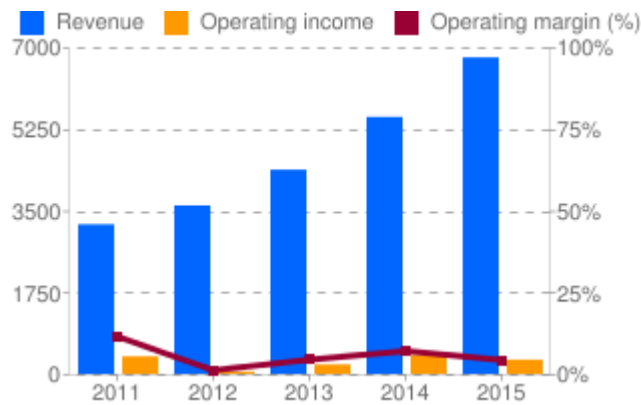


Figure 17: Netflix revenue growth (Google Finance, 2016)

Organizationally, it has a modern corporate and human resource culture that includes flexible holiday and parental schedules; that allow employees to work on projects that interest them and suits their capability; and includes the consistent staff engagement when making corporate decisions (Arkadin, 2015, p. 5, 8-9).

After an outage at an internal data center in 2008, Netflix decided to move content delivery to Amazon Cloud Services (AWS). Throughout the transition, exceptional growth in both number of paying consumers and their viewing times have been met by dynamic and elastic provisioning through AWS, allowing Netflix to expand to 130 countries using Amazon's global data centers (Izrailevsky, 2016, p.1).

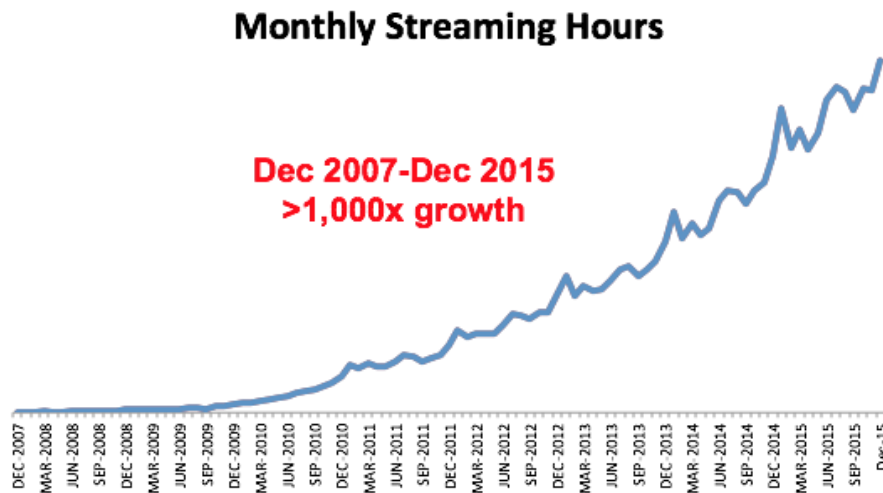


Figure 18: Netflix overall growth (Izrailevsky, 2016)

The data center migration, completed in January 2016, took longer than expected but provided unplanned benefits. Operational (streaming) costs dropped significantly due to economies of scale, and the ability to dynamically grow and shrink capacity to meet demand as required. The cloud also provided highly reliable services through redundant components and ‘graceful degradation’ in the architecture, tested originally by what Netflix called the ‘Simian Army’, and has since evolved to Failure Injection Testing (FIT) and chaos engineering (Izrailevsky, 2016, p. 1)

The ‘Simian Army’ comprises of tools that randomly disabled or disrupted production instances to verify customer availability. Labeled simians or monkeys, such as Chaos, Latency, and Conformity, they performed tests looking for failures in currently running services (Tseitlin, 2011, p. 1). This has since evolved to Failure Injection Testing or ‘failure as a service’ that includes the intentional failure of a location or service. Finding and remedying errors this way ensures platform robustness and resiliency, and creates an antifragile programming culture (Bryant, 2015, p. 1). FIT is now included in Netflix’ discipline of Chaos Engineering: “the discipline of experimenting on a distributed system in order to build confidence in the system’s capability to withstand turbulent conditions in production” (Avarm, 2015, p. 1).

Rather than forklift systems and applications from legacy datacenters to the AWS (which would simply have transferred the problems and limitations to the cloud) Netflix adopted a digital first or cloud-native approach, requiring the redesign of the original monolithic content distribution app to hundreds of microservices (Izrailevsky, 2016, p. 1).

To displace the ‘organizational’ and ‘technical’ debt of the previous monolithic architecture, to permit innovation, and to scale services in ways previously impossible, Netflix implemented continuous delivery pipelines for its microservices via DevOps, canary deployments and the container delivery platform *Spinnaker* (Evans, 2015, p. 40). This allows the continuous update of the services that push content via API’s and containers, from distributed clouds to the 800 different types of devices running the Netflix app; and which allowed Netflix to expand its market to 130 countries at the click of a single button. Even more amazing, Netflix has open-sourced the platforms it has built and released them on [GitHub](#) so other organizations can adopt and deploy in their environments as well (Bryant, 2016, p. 1).

This brief case shows how Netflix has adopted digital or cloud-native processes, allowing it to grow customer base and scale, thereby increasing revenue. We also see how Netflix relates or reacts to the digital competitive forces in Figure 1. For example, it must defend against disruption from competitors such as Crave TV and Amazon Prime to retain its prime mover role; it constantly changes its business model with new services and original content; and it deploys these new services and content via a continuous delivery pipeline through DevOps.

3. Framework for Implementation

Does a reference framework exist, or can we create one, including recommendations and a plan that can be applied to traditional organizations, governments and cities to become digital?

3.1 Proposed Framework

The literature and environmental review, including industry examples and our case study of Netflix provides the basis of a framework that most organization can adopt to become digital.

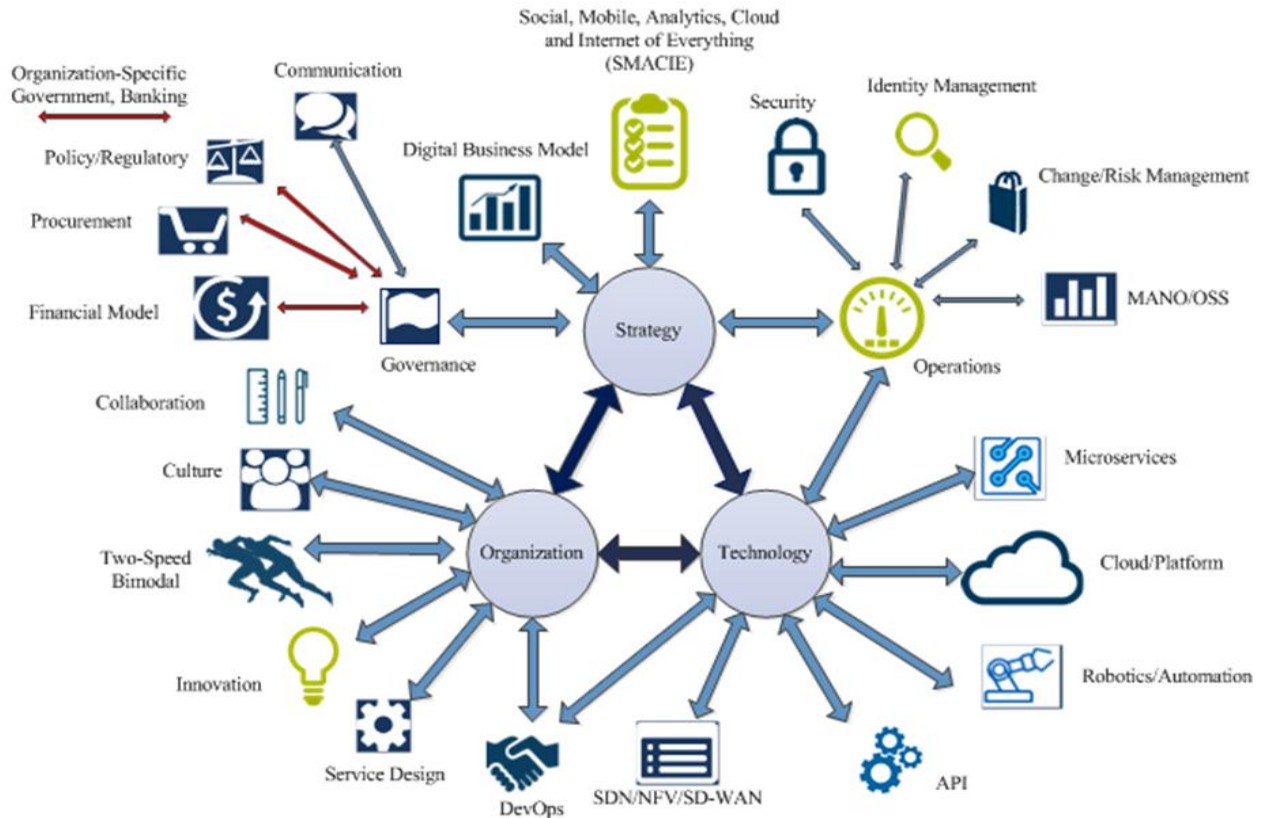


Figure 19: Reference Framework for becoming Digital

Based on the common information systems triangle of strategy, technology and organization (Pearlson, 2013, p.24), digitally transformed organizations exhibit, have implemented or contain many (most) of the features in Figure 19 and Appendix 4. From a strategy perspective, digital natives adopt aspects of SMACIE to various degrees (fully, partially); adopt new business models following an updated '5 forces': seek and retain prime mover advantage, disrupt or counter disruption, utilize digital platforms, and realign operations to be more agile and lean. While all organizations must communicate a transformation vision and implement via good

governance, banks, governments, health care and others must also ensure it aligns with legal, regulatory and/or financial requirements.

An absolute requirement of successful digital transformation is organizational realignment. Companies need to promote and adopt agile and lean start-up methodology, starting from a bimodal IT perspective and extending to the entire organization. As companies become digital, the business model, processes products and services become digital as well, requiring technology and technical support. The culture of the organization begins to change as the development and operations team work together with the continuous delivery of applications, content and services. This new methods of collaboration are supported by virtual teams, using coding (i.e. via Github) and deployment (i.e. Spinnaker, Jenkins, Swarm, Kubernetes) platforms, which permits ‘work-fast/fail-fast’ innovation embedded in the regular deployment process. Finally, this agile methodology suits the open talent and employee engagement function of digital natives, including millennials and Generation Z, ensuring digitally enabled companies retains the best workforce in the upcoming war for talent.

Central to our framework is the technical requirements of being or becoming digital. At a high level, digital transformation includes increased cloud adoption, but this is much more than the forklift of current services to an IaaS cloud. True transformation includes the adoption of application platforms (aPaaS or via API’s to specific clouds) where possible and the use of DevOps, containers and microservices for the continuous delivery of content, services and products. As seen, companies support these new business processes (since business models are now fundamentally digital in many organizations) through bimodal IT and agile risk, change and operations management. In this new world, cyber-security, data protection and residency, encryption and authentication are now strategic objectives to be considered at the executive level.

3.1 Application of Framework

Our framework can now be used to create a roadmap or blueprint for digital re-mastering that can be adopted by various industries, cities, governments and even countries. Though we include industry specific examples when required, we present a blueprint with recommendations that the Government of Canada can consider for becoming digital.

Much like our future organization, our blueprint is bimodal. To address such a large scope and to show early wins, we quickly determine a small item of commonality amongst a number of departments or within the mandate of a service broker (such as Shared Services Canada) to digitalize; and a small team of required resources to design, create, deploy and support the chosen service. This proof of concept could be a simple outbound service requiring a mobile app and dynamic web page, also providing updates via a digital communication channel such as Twitter (potentially automated using a machine language API or bot). Our initial app would distribute unclassified data to avoid security issues and be very light but useful, validating the organizational and technical structure and producing a minimum viable capability (MVC). Potential examples include combining weather data from Environment Canada and sensor data from buoys to give mariners sea conditions based on location; wait times at a border crossing; or a modification of some other of the current [mobile](#) and [social](#) front office channels.

Lean start-ups and other smaller organizations may be able to implement a digital transformation by simply repeating the above proof of concept for each product or service it sells or manages. However, to digitalize a large organization like the Government of Canada (and by extension Canada itself) we begin the significant series of events while our quick win/learn fast proof of concept is underway.

We begin by appointing a senior executive to lead a ‘Government as a Platform’ (GaaP) or ‘Digitalizing Canada’ initiative, to be the human ‘flak jacket’ supported by a top executive (ideally the Prime Minister). The lead builds a guiding coalition of executives from various departments and agencies, including provincial, municipal, non-profit and external companies, similar to the example in Flanders (Vanderbeken, 2015). The criticality warrants the creation of a digital transformation office (DTO) reporting to the Treasury Board of Canada Secretariat (TBS), with a close relationship to the Chief Information Officer Branch (CIOB), Shared Services Canada (SSC), Innovation, Science and Economic Development (ISED) and other Department and agencies; as long as our primary goal remains speed of execution. With the correct background and skill set, the guiding coalition members are assigned to lead certain major topics or themes. Each lead assembles a team of digitally-native champions or experts below them to produce roadmaps that are focused on the major themes of digital transformation, based on our framework; other jurisdictions such as the UK and US; and other reference

architectures such as the ‘Digital Ecosystem Reference Architecture’ for Smart Cities (McCovey, 2016, p.1).

Fortunately for Canada, other governments have already started to implement digital programs and are much further along their journey, allowing us to avoid pitfalls and collect adoption principles. For example, Flanders built a guiding coalition assigned to tasks or themes to implement their ‘*Flanders Radical Digital Program 2015 – 2020*’. Built using digital platforms, this program permits sharing between levels of government and an ‘ask it only once’ methodology, which creates efficiency and improves value to citizens (Vanderbeken, 2015). Even more recently, Australia and UK have signed an agreement to collaborate on digital transformation (Agbonlahor, 2016), something Canada should pursue.

We validate our themes by leveraging the work of other jurisdictions. Some of these themes now include:

1. Search for commonalities across departments (Thompson, M., February 2015)
2. Departmental specific Mandate
3. Policy, Governance and Procurement
4. Organizational Restructuring and Employee Engagement
5. Aging IT Infrastructure and application inventory
6. Security, Privacy and User authentication
7. Technology, Platform and Cloud Enablement

The guiding coalition members are expected to resolve issues and provide an implementation roadmap for the themes within 60 days, ensuring an aggressive installation schedule. A high-level work breakdown schedule can be found in Appendix 4, and high-level iterations of digital government in Appendix 5.

3.1.1 Commonalities

In the Whitehall parliamentary experience, departmental outcomes are considered ‘bespoke’ products and services. As well as typical shared services functions (human resources, finance, and information technology) we look for and extract commonalities amongst the departments, such as identity services, external transactions, external communication, operational support (fleet and building maintenance), business registration and regulation, taxes and revenue collection amongst others. Implementing our digital framework also provides the venue to create

and present common services, such as Open Government, shared labs and improved collaboration.

By applying our reference framework, we create new models for those services between departments, including overlapping services with provincial and municipal organizations. By using API's, containers and PaaS, we present common services to citizens across the entire Government of Canada, such as the single collection of identity and registers (health, taxation, travel, business registration, various licences) and open structured and unstructured data. Underpinning functions, such as security, are implemented throughout our themes (Thompson, M., 2015, p.1), (Vanderbeken, 2015). We recognize some of the challenges and address them throughout our implementation, such as the realignment of budgets, authority and responsibility, and dismantling the silo's that exist between departments. An initial high-level iteration of digital government can be found in Appendix 5.

Shared services organizations, such as Shared Services Canada (SSC), are ideally situated to be the broker of back-office digital platforms, while Services Canada and partner departments continue to digitalize front-office and outbound communication channels.

3.1.2 Departmental specific Mandate

The Government of Canada also has influence, authority or responsibility in a significant number of areas with a direct impact on digital transformation. We recommend departments examine their mandate and strategic objectives as they relate to a digital agenda. Besides for omni-channel digital communication, some of the many examples and the responsible department include:

- Digital records and wearables for e-health (Health Canada);
- Investment and creation of digital cloud-incubators and research labs using private and open source components, such as OpenStack (ISED)
- Providing digital recommendations for start-ups and entrepreneurs (ISED)
- A pivot from 'red seal' to investing in technical and digital education, including coding in required languages (R, Python), data analytics, and cloud support (ISED)
- Working with industry, trade unions, non-profits and others on a shift towards digital transformation, similar to other countries (The Economist, 2015) (ISED)

- Increased telecom competition, sale and investment in spectrum and broadband respectively (ISED)
- Improved reliability, safety and security from sensor data for various departments and business models such as pipelines, marine traffic, aerial and financial regulations (Multiple Departments)

The strategic, technical and organizational digital realignment permits the conditions for embedded innovation within and across the Government of Canada, creating seemingly limitless opportunities for improved citizen-based services, efficiencies, and new opportunities in these unconventional economic times.

Departments should also implement regulations that encourage digital adoption or other new services. Few of the many examples include the use of drones; health and wearables; safety and occupational regulations concerning robots and humans; national and international trade arrangements; regulatory requirements concerning additive manufacturing (3-D printing) and machine learning (legal, medical, driverless cars).

3.1.3 Policy, Governance and Procurement

There is a number of policy and governance challenges that must be addressed before the Government of Canada can proceed with true digital transformation. Starting with a platform-first mentality, the team lead for this theme should engage the Treasury Board Secretariat to determine a cloud model based on location and data classification and clarifying allowed options for public, private and hybrid clouds. The outcome could be a cloud security and monitoring standard for partners and Shared Services Canada, based on the United States Federal Risk and Authorization Management Program ([FedRAMP](#)).

From a security perspective this team lead would work with the Communications Security Establishment to determine and validate cloud security policies, such as an enhanced IT Security Bulletin 105, again similar to the Defense Information Systems Agency (DISA) cloud 5 certification for FedRAMP high baseline security requirements (Lyngaas, 2015, p 1). This would permit automatic service and accreditation for applications built to certain specifications and locations, permitting their transfer to cloud-based infrastructure and use without considerable service or application authorization delay.

We set guidelines for the approval of technology spending, including limits to duration and price ceilings for monolithic outsourced contracts, following GDS' technology code of practice:

- *no IT contract will be allowed over £100 million in value*
- *there will be no automatic contract extensions; the government won't extend existing contracts unless there is a compelling case*
- *new [cloud] hosting contracts will not last for more than 2 years (GDS, 2016)*

There are a number of procurement vehicles or standing offers required, such as data networking, broadband or internet access, and short-term right-skill acquisition, which could all be based on the GDS technology code of practice.

As well, trade agreements or partnerships should be reviewed to minimize the impact on cloud vendors based on location.

3.1.4 Organizational Restructuring and Employee Engagement

Our environmental scan has shown that organizational restructuring is one of the most important aspects of digital transformation. The implementation of DevOps, bimodal IT and business teams change the culture and structure of departments, flattening the hierarchy, improving collaboration and enabling innovation. Specifically this requires involvement, engagement and communication with employees, retooling staff with the correct skillset to succeed in digital organizations, engaging public sector unions, and submitting the required Order-in-Council for any structural changes. Some current examples of this already occurring include 'red-tape reduction' exercises, the expanded use of internal collaboration platforms, the gradual increase in virtual teams and the rise of 'micro-missions' in the Public Service.

3.1.5 Security, Privacy and User authentication

We adopt the security policies from section 3.2.3 concerning security and data classification, and, following the GDS model, create a roadmap to design a digital identity and authentication method. This includes working with provincial and municipal organizations to engage or leverage required components, including the *Digital Identification and Authentication Council of Canada* working on the deployment of digital certificates to citizens and organizations (Hamilton, 2015, p.3); and *Canada's Digital Interchange*, working "...to develop a secure, scalable service to facilitate information sharing across jurisdictions" (Charette, 2015, p.1). We examine various security products from vendors, recent developments in authentication (OAuth2 and blockchain) and policy templates when using software defined networks.

3.1.6 Aging IT Infrastructure and application design

The team assigned to examine the Auditor General's report on the replacement of aging IT infrastructure determines which applications to redesign and move to a cloud native topology. Out of the 16,000 IT systems delivering departmental mandates, 2,100 are considered mission-critical and 533 are at risk. Of the 533, 130 directly support service delivery to citizens or Canadian businesses and become our priorities for redesign and migration to the private, public or hybrid platforms (Treasury Board Secretariat, June 25, 2012). We analyze each of the 130 programs to determine if they are good candidates to transform using service design, continuous delivery/continuous improvement and a DevOps methodology. A high-level outline can be found in Appendix 6.

Once again we adopt the codes of practice and framework from other governments who are further along their digital transition, including 18F (part of the US General Services Administration), UK GDS and GOV.UK and the significant value-add progress that has occurred in Flanders, Estonia, Denmark, Australia and Singapore.

3.1.7 Technology, Platform and Cloud Enablement

Given the diversity of our requirements, scope and delay in our journey to the cloud we begin with parallel request for information (RFI) or request for proposals (RFP) for the various services and product we require, such as platform services, network hardware and software and open talent. We also ensure teams reporting to the guiding coalition are familiar with the development and deployment tools and methodology required in cloud native and DevOps environments, and are open to new initiatives.

The literature and situational review provides the basis of our technical reference framework, which we follow when procuring or building (depending on data classification) a new cloud based architecture. The steps, tools and platforms have been introduced throughout the project, with specific procurement vehicles and implementation details available per platform. Coincidentally, AWS and Microsoft Azure clouds are currently being built in Canada, providing the local platforms required to minimize the risk associated with the US Patriot Act; as well as innovation labs from Cisco, Google and other companies (Dingman, 2016).

Besides for leveraging the work of other governments, we also leverage specific consultancy firms with a proven record and experience in digital transformation, as well as other available frequency distribution and predictability models (Wardley, 2015).

3.2 Challenges and Remediation

We address a small number of the challenges and risks associated with digital transformation.

3.2.1 Cultural and Institutional Reform

“I hoped the system would have had more capacity for institutional reform than it has.”

Mike Bracken (as cited in Glick, 2015)

Such significant strategic, organizational and technical changes will also include challenges related to acceptance and implementation. One of the first and most difficult hurdles to overcome is the appetite for cultural and institutional reform. As seen when Mike Bracken left GDS last year, constantly having to sell the vision, show value, and negotiate funding every budget cycle and change of government becomes a demotivating use of effort and resources (Glick, 2015). This can be remedied in part with acceptance of long-term vision, strong and stable leadership and acceptance of false starts during the learning and implementation cycle.

3.2.2 Leading Change and Momentum

As well, such change transformations requires the constant adherence to a timetable, milestones, communication strategy and attention to momentum and employee motivation (Syriatowicz, 2015). We implement some of the past lessons from Kotter once again to lead change during transformation efforts (Kotter, 1995).

3.2.3 Talent and process

Related to employee motivation and culture, the data scientists, development and back-office skills and processes required in a digitally transformed organization are not common in the public service. Digital companies pay high premiums for employees with talent and experience in service design, data analysis, coding for containers, and DevOps; and current government outsourcing models have de-skilled staff in some areas. To remedy we encourage the federal service to launch training programs in the required skill sets and/or encourage employees to take

time to learn new skills in their current environments (via webinar's and massive open online courses or MOOC's).

We extend this theme to Innovation, Science and Economic Development (ISED), recommending they work with trade schools, colleges and industries to increase training in the skills required for digital transformation and digital natives. As seen, this includes coding, training in container and cloud orchestration tools and data analytics; much of which is available via open source (such as Openstack). Specifically this might include helping those recently in the oil industry to learn the skills required to support Service Design and M2M communication that will be paramount in the oil industry going forward (Pilięci, 2016). We also recommend ISED and the regional development agencies work with local business and industry to implement the connected components of the 4th Industrial revolution in Canadian industry while we still have the opportunity (Sniderman, 2016), (Stuart, 2015), (The Economist, 2015), (Barnes, 2013).

“You must be this tall to use microservices” (Fowler, 2014)

Supporting our reference framework we also encourage process changes supporting service design, DevOps, NetOps (NoOps), continuous delivery and a host of other features of digital natives. For example, microservices require new DevOps skills and cause operational duplication, distribution complexity and service re-composition challenges that must be addressed before adopting containers successfully (Wootton, 2014).

3.2.4 ‘Always in motion is the future’ (Lucas, 1980)

Reports from independent groups and various organizations all show the economic and resiliency value of digital transformation in the current environment. However, the rate and breadth of change occurring in most industries, the evolution of technology, machine learning and robotics, and unconventional economic environment, together make strategic planning and predicting the future very tenuous. Our recommendations include the impact and likelihood of possible future events based on a review the work of futurists, including (Kurzweil, 2016), (Urban, 2015), (Frey, 2016), (Wardley, 2015) and others. Besides for technology, climate change and post-capitalism, other social, economic and political events are shaping the future and making it harder to decipher. As such we recommend organizations examine their own strategic plan and theory of business with the intent to reinvent themselves before the

competition, circumstances, austerity measures or a revolution does it for them in an uncontrolled fashion. By ‘destroying your business’ organizations are better able to take control and map their future, in effect, ‘a future that has already happened’ (Pearlson, 2012, p.31-32).

We also acknowledge the impact digitalization has on the determination of Gross Domestic Product (GDP). Traditional GDP is simply value produced based on time (hours worked) but does not include the value and utility of digital products, which are abundant and often freely available online; or the sharing or digital economy available via online platforms.

This is related to recent discussions on a renewal of the social contract, universal basic wage distribution and the possibility of a post-capitalist society. Part of the uncertainty is due to the difficulty in foreseeing the potential impact of robotics and automation on future employment prospects. Futurists and others have mixed opinions on whether robots and automation will replace humans, augment them or cause a transformation in employment. As a pragmatic optimist, organizations (governments, cities) have to encourage human-robot augmentation, in part through the adoption of digital transformation, smart cities and smart government.

4. Conclusion and recommendations

A review of the environment and literature and presentation of a reference framework has answered the questions in our introduction; and show the significant impact digitalization is having on corporate business model and the delivery of products and services to consumers and citizens. We begin the examination of the digital components now required in most strategies and strategic objectives and the necessity for organizational change – including the adoption two-speed or bimodal IT and service design, DevOps, continuous delivery of applications, and other components. The organizational changes now support new digitally enabling technical architectures, such as the ‘software-defined everything’ (network, perimeter, policy); cloud-native designs; the adoption of containers, microservices and API’s; improved digital identity and security; continuous improvement; and agile operations management (including risk and change).

Our embedded examples and case study of Netflix show how the application of a digital systems triangle disrupted a traditional industry and continues to defend against disruption and increase revenue. We see examples in the press daily of companies adopting digital business models and the underpinning technical requirements, such as the Spanish group BBVA buying financial technical start-up Holvi (Meyer, 2016) and Goldman Sachs’ recent patents with blockchain (Hughes, 2015) and the migration of 90% of its applications to microservices and Docker (Rosenbush, 2016).

The reference framework can be implemented by most organizations, governments or even countries to provide products and services consumers and citizens now expect, to build resiliency and defend against disruption in unconventional economic times and to adopt the features and functions that successful organizations (digitally-native unicorns) have implemented to reach and retain their prime-mover advantage.

The application of our framework executes the recommendations that digitalize a Whitehall-based government. This begins with the implementation of the digital systems triangle – strategy, organization and technology, leveraging the progress of the [UK GDS](#), US GSA (and [18F](#)), [Australia’s Digital Transformation Office](#) (DTO), [Germany’s Industrie 4.0](#), and the work of many other jurisdictions. This includes the determination of commonalities across departments and departmental specific items; impacts and changes to policy, governance and

procurement; organizational restructuring and employee engagement; addressing the aging IT infrastructure issue and creating an application inventory; creating and using net methods to manage security, privacy and user authentication; and the application/implementation of the correct technology including platform and cloud enablement.

Specific recommendations that underpin the digitalization of Canada, related to all levels of government and industry, include: network and platform clouds to be considered digital infrastructure when determining Infrastructure investments; manufacturing and commodity assistance to include the enablement of platforms, sensors and connectivity (allow them to compete globally with other industries, to improve efficiency and safety, etc); federal government support provinces and municipalities with the determination and adoption of Smart Cities and green technology; expansion of services and competition in the Telecom market related to sensor connectivity and standards; the continued emphasis on adopting diversity, including cognitive diversity; and the support of digital incubators in industry and universities, and the immediate adoption of training programs in Industry 4.0 areas, including service design, physical-digital interaction, robotics, platform and container development, data science, analysis and digital transformation.

'Impossible to see the future is' (Lucas, 1980)

The exponential changes occurring in machine learning, automation and technology, and the socio-economic environment as a whole, make it even harder to predict the future than before. However, we are confident the implementation of a digital framework, based on the literature and environmental review, provide governments and organizations, industries and even countries the methods to create value and build resiliency regardless of the challenges ahead. Given other regions and institutions seem to be further along than Canada, our only other recommendation would be launch our digital transformation as quickly as possible to minimize opportunity lost and provide the best chances of success.

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6. Appendix 1 – Era of Digital Business

An overview of changes in business models: the era of digital business.

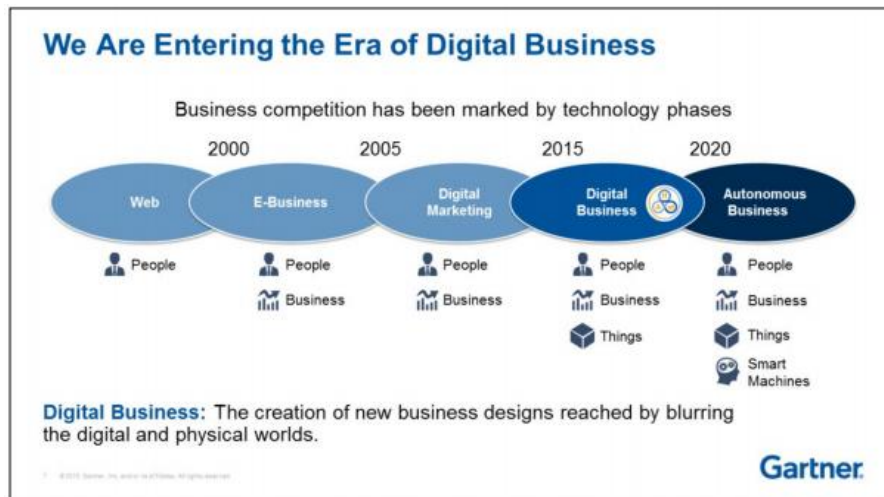


Figure 20: Era of Digital Business (Nag, 2015, p. 7)

Companies achieve valuation of a billion dollars (Unicorns) at a much quicker rate over the last decade, as a result of the prime-mover advantage and the rise of the customer's mobility.

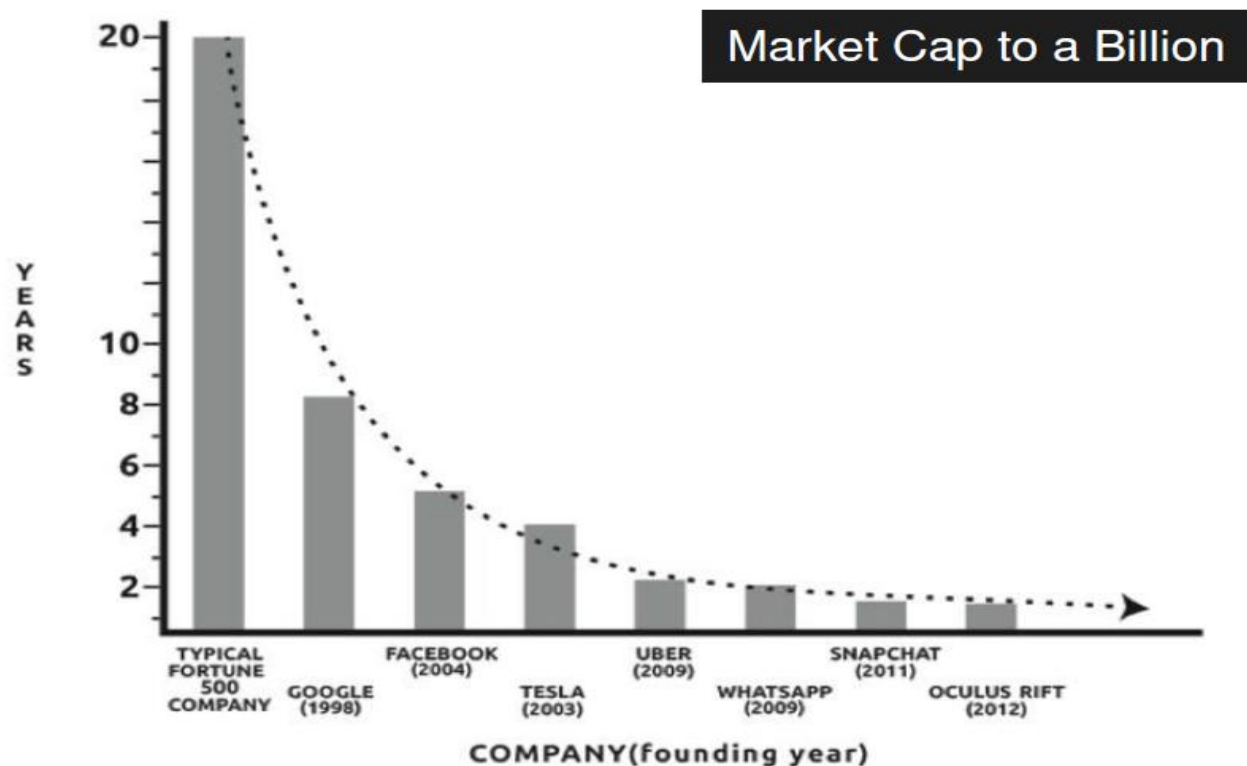


Figure 21: Market Cap of the Unicorns (Ismail, 2014, p. 6)

7. Appendix 2 - Application and service design

Modern applications are based on service design and international standards, such as ISO 9241-11 (1998), which defines usability as an outcome; ISO TR 18529, the “...specification, assessment and improvement of the human-centred processes in system development and operation” (ISO 13407, 2006, p. 1); and human centered design process (Spillers, 2008, p. 8):

1. Get to know the users
2. Analyze user tasks and goals
3. Establish usability requirements
4. Prototype some design ideas
5. Usability test the concepts
6. Repeat as necessary (Spillers, 2008, p. 8)

Alternate UX checklists are available from other cloud developers as well, such as [Outlast](#). We present design tools for different modalities, especially mobile and tablets whose usage has grown exponentially since 2008.

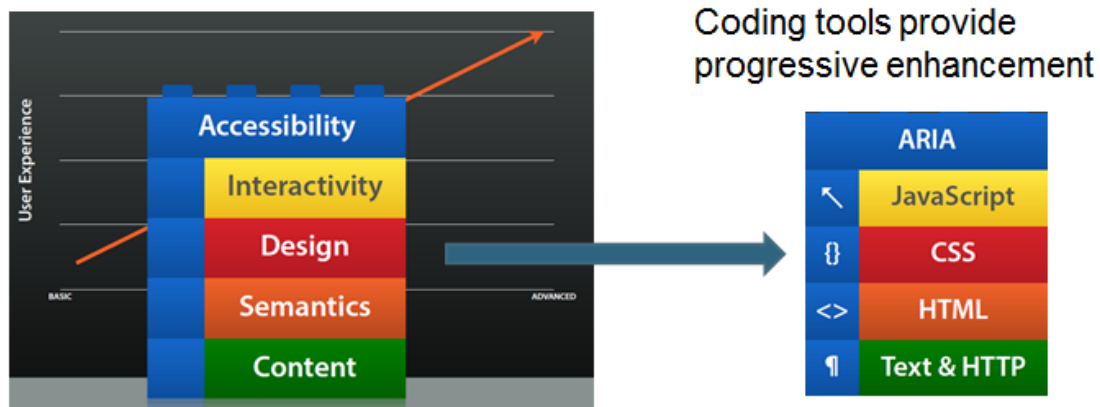


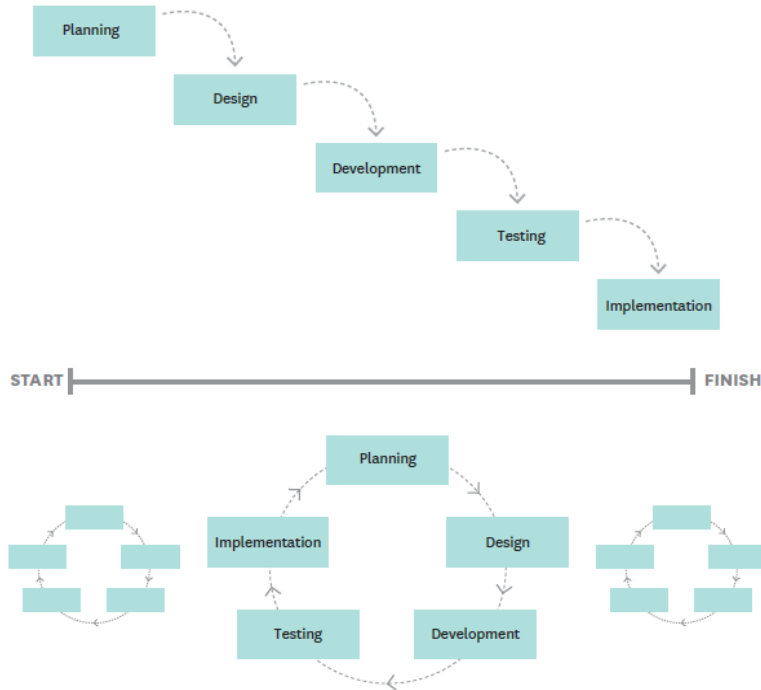
Figure 22: User Experience (Gustafson, 2015, p.39-44)

Agile versus waterfall development for continuous delivery; which reduces risk, cost and time for application updates versus big bang releases.

AGILE VS. TRADITIONAL WATERFALL DEVELOPMENT

WATERFALL

Sequential development process where all required activities in the preceding phases is complete



AGILE

Software development method based on iterative and incremental development encouraging rapid and flexible responses to change

Figure 23: Agile vs Waterfall Application development (Atlassian, 2015, p. 3)

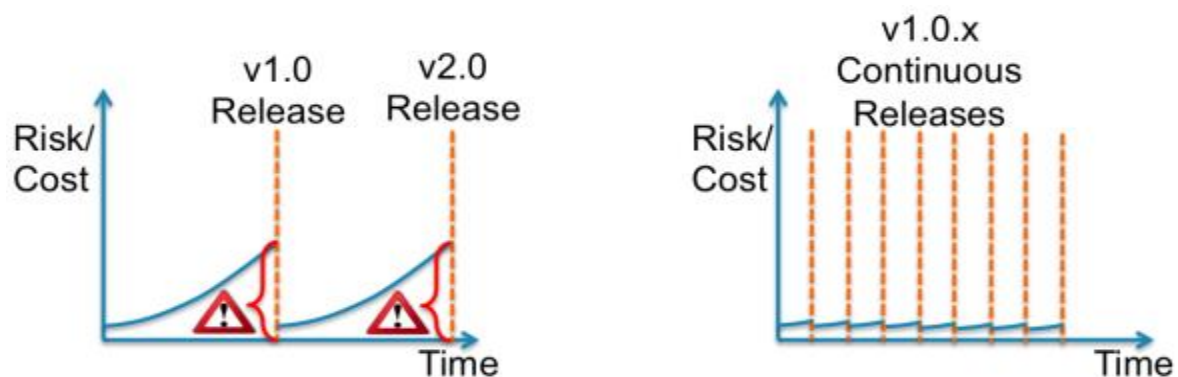


Figure 24: Continuous Delivery and Improvement (Cloudbees, 2015, p. 5)

8. Appendix 3 – Technical considerations of SDN

Rather than be disrupted most incumbent network resellers also provide full SDN/SD-WAN suites. Cisco Systems provide routers and Application Policy Infrastructure Controllers through their Application Centric Infrastructure (ACI) and Intelligent wide area network (IWAN) units. Juniper provides Contrail SDN controllers in support of Openstack, and Northstar for their native product line; and F5, Big Switch, Velocloud and others provide SD-WAN products and services through various mechanisms, including control planes offered as a cloud service.

Software defined network virtualization also occurs in the data center core. In a traditional data center, server virtualization such as VMWare ESX/vSphere and Cisco Unified Computing Platform (UCS) environment run virtual switches and firewalls (VMWare, 2014) or SDN ready Cisco Nexus 9000 or Juniper MX series switches. Cisco, Juniper and others provide elastic network provisioning that allows organizations to deploy and access various cloud models now critical for digital transformation.

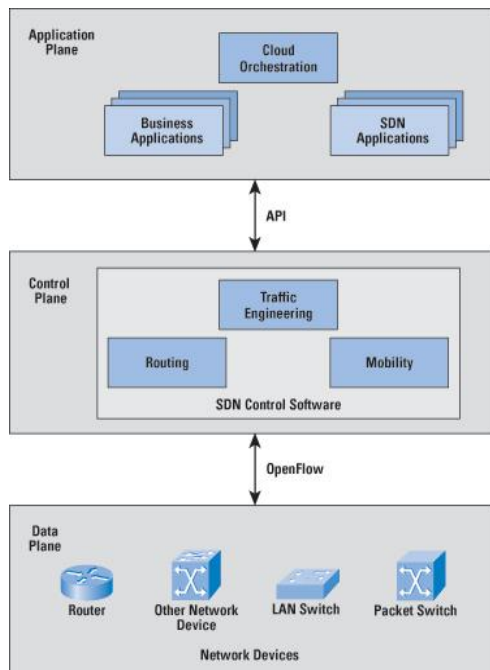


Figure 25: SDN Architecture (Stallings, 2013, p.1-4)

Enable Digital Business Transformation

with Application Policy for Agility, Security, Automation, Visibility, Scale



Figure 26: How SDN enables business transformation (Petty, 2016)

9. Appendix 4 – Reference Framework

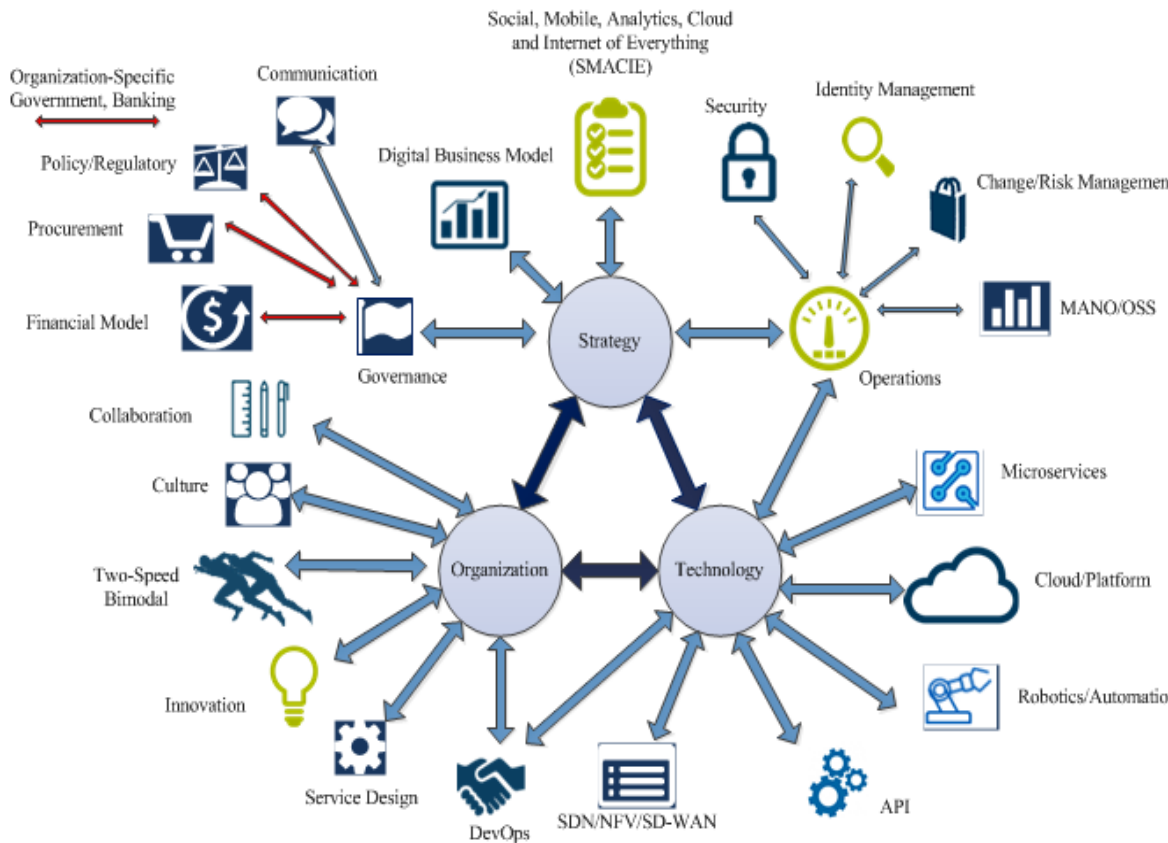


Figure 27: Reference Framework for becoming Digital

Our Reference Framework for becoming digital begins with the Digital Systems Triangle: Strategy, Organization and Technology.

Strategy includes a reimagining of digital business models, SMACIE, operations and governance.

Organizational realignment requires updates to collaboration, service design, bimodal and DevOps teams, innovation catalysts and culture.

Technology changes include the adoption of cloud-native platforms, such as private, public and hybrid; microservices and API's; updates to Operations and DevOps; SDN; robotics/machine learning and automation.

Figure 28 contains an example work breakdown schedule for implementing our reference framework for becoming digital. We acknowledge some tasks and subtasks are not included here.

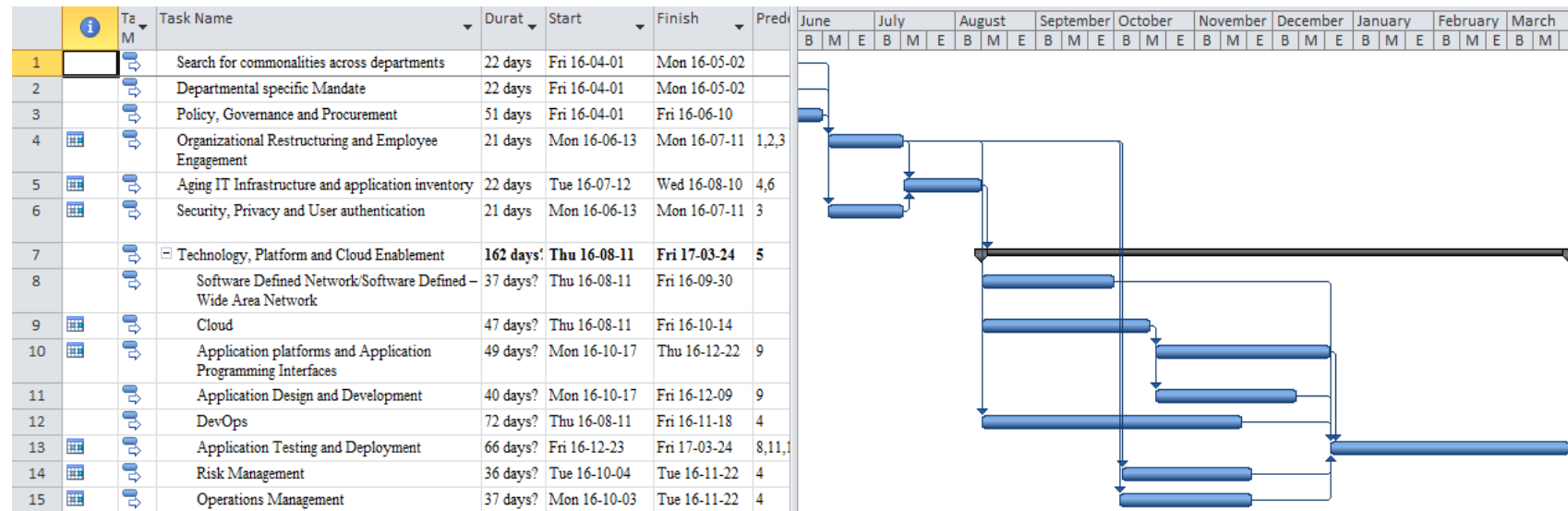


Figure 28: High level work breakdown schedule (reengage and repeat)

10. Appendix 5 – Digital Government

New Flemish Government Coalition 2014 - 2019

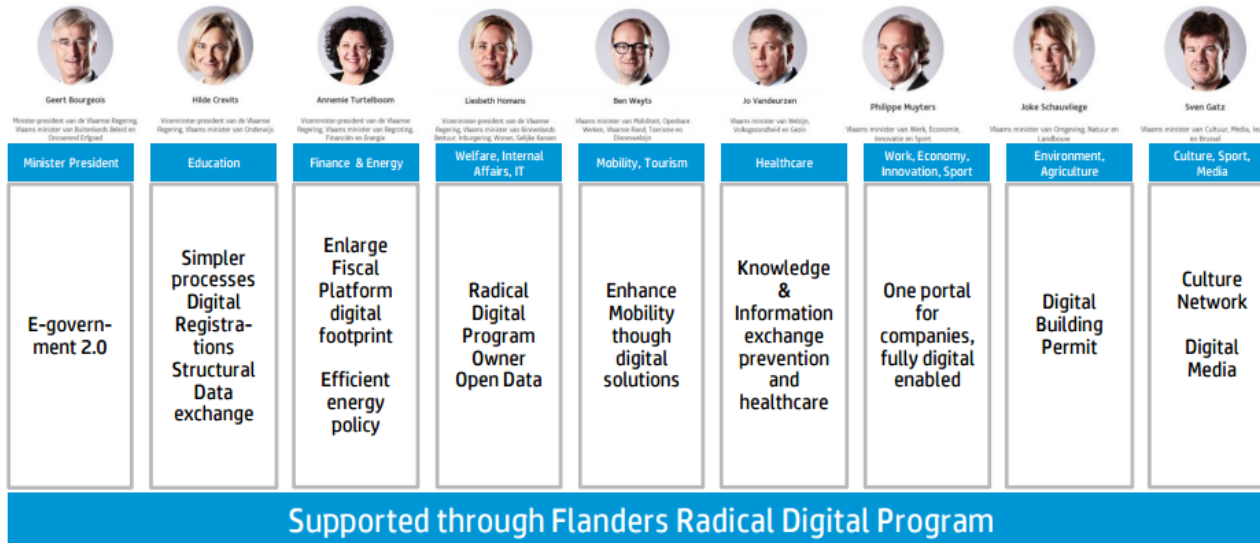


Figure 29: Example Coalition: Flemish Government Coalition 2014 - 2019

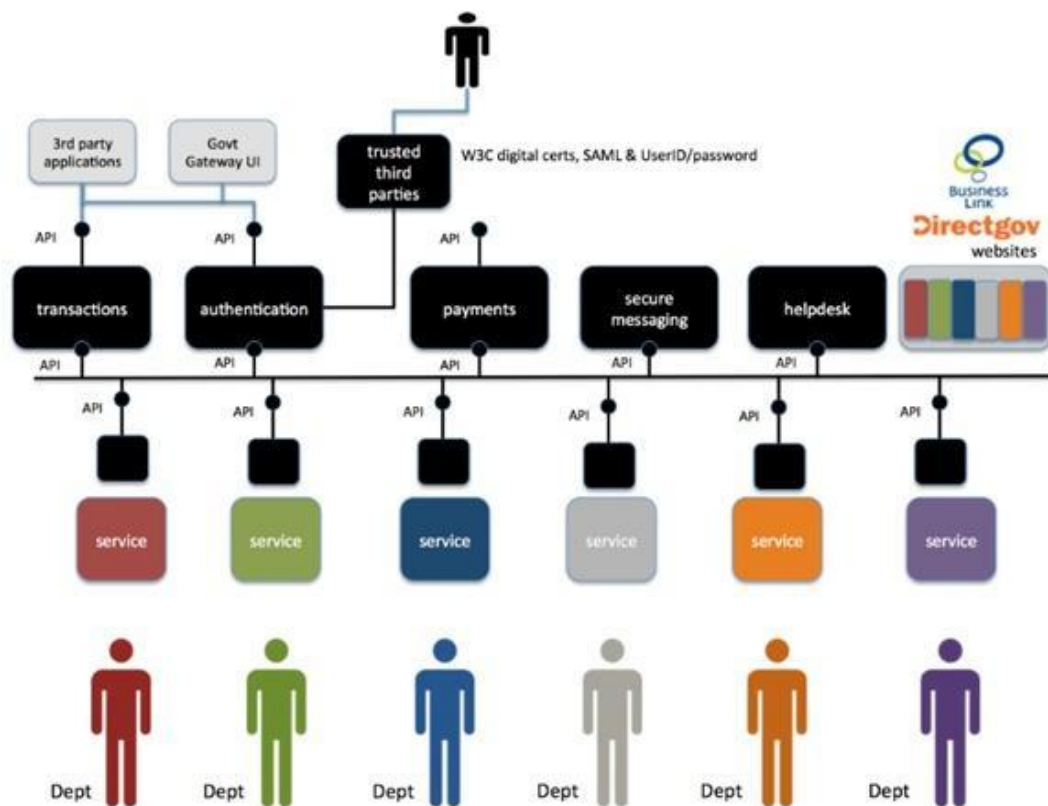


Figure 30: High-level overview (Fishenden, March 6, 2015)

As part of the digital systems triangle, organizational and strategic changes are a critical part of the digitalizing government. Numerous articles show how government as a platform require a reconfiguration of departments/agencies and how services are provided; but also how governments and agencies are creating value and providing significant services at a reduced cost (Thompson, M., February 12, 2015), (Lundqvist, M. & Olesen, PB, 2016), (Brown, A., Fishenden, J. & Thompson, M., November 2014).

11. Appendix 6 – Strangling the Monolith

Best Practices when deciding to migrate from a monolith to microservices and containers:

“...if your application / service has good separation of code, configuration, and data, installs cleanly,..., and features a clean communication paradigm – it does make sense to break the application up / allocate one service per container” (Scott, 2016).

Begin migrating supporting or periphery services for larger applications, such as DNS and authentication.

Traditional vs. Microservice application and delivery

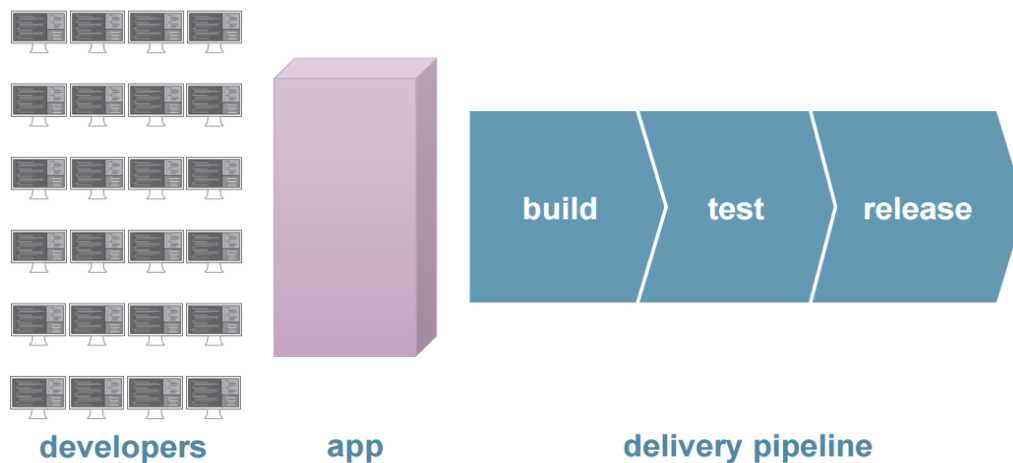


Figure 31: Monolith development lifecycle (Munns, 2015, p.11)

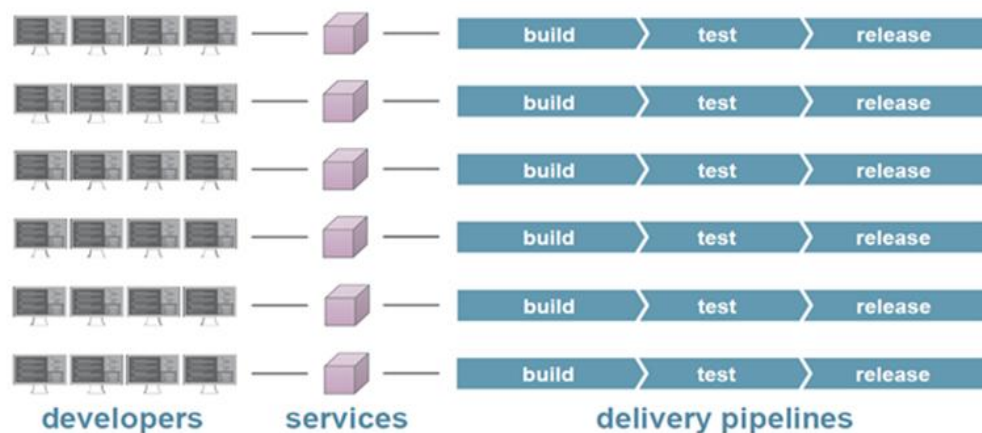


Figure 32: Microservice development lifecycle (Munns, 2015, p. 27)