Dynamic Capabilities related to Converging Software Markets

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Abstract

Methodology for in the software development life cycle has rapidly evolved over the last couple decades. This evolution is related to strategies born in just-in-time manufacturing which reveal themselves through methods such as rapid application development, waterfall development, spiral development, agile development, and DevOps. Coupled with consumer and industry adoption of cloud-based technologies, software releases to consumers can happen minutes after code-commits. This environment breeds highly competitive firms, rapid and frequent new entrants, ever changing resource barriers, and a constant threat of replacement. To mitigate these risks the adoption of dynamic capabilities could improve firm success and assist in ensuring continued competitive advantages. This paper will suggest ways to enable this in an example market, identify possible weaknesses, and suggest further avenues for research. The outcome of this paper would be actionable initiatives a firm could implement and track to solidify their position or extend their position in changing and converging markets. An example of suggestions specific to a firm in the immutable infrastructure (or continuous configuration management) market to address a possible market convergence. Personal experience in this market will be incorporated.
## Abstract

### Introduction to competitive strategies
- Porter’s 5 forces primer
- Resource-based view primer
- Economics and strategy

### Dynamic Capabilities
- David Teece
- Additional literature on Dynamic Capabilities
- Shortfalls of Dynamic Capabilities

### Example Market - Continuous Configuration Management
- Focus Firms
- Opportunities and Adjacent Markets

### Strategy Considerations for example firms
- Strategy suggestions
- Possible hurdles

### Future Research

### References

### Table of Figures
Introduction to competitive strategies

In order to create a framework for implementing dynamic capabilities, multiple competitive strategy frameworks will be reviewed. These will be incorporated and covered for relevant aspects to the digital software industry. While many strategies exist to gain or extend competitive advantage, this list and suggestions are not meant to be exhaustive, but a starting point.

Porter’s 5 forces primer

A quick review of Porter’s five forces model will show key elements related to later strategy application. Porter’s five forces is often the starting point for any MBA student to understand industry and competition. Porter says “the essence of formulating competitive strategy is relating a company to its environment” and a “key aspect of the firm's environment is the industry or industries in which it competes” [1]. The pillars of his model in figure A below can be applied to all firm’s in every industry, and with a small amount of consideration anyone with basic experience would be be able to create a simple model for their industry.

![Figure A  Porter’s five forces](image-url)

Figure A  Porter’s five forces [1]
The software and digital industries that have emerged in a broadband-connected world have started to shift traditional implementations of this model. Generally speaking the “threat of substitutes is high in many [digital] industries since the switches costs are low and the buyer propensity to substitute is high” [2]. It follows then that the threat of entry will be high as barriers for entry would be low: “A digitally based business model requires far less capital and can bring large economies of scale” [2]. Historically, and often industry specific, Porter’s model would be valid for a year or years. However in the digital software realm updating or often recreating the model every quarter would not be a far fetched idea as the model would help inform, but perhaps not dictate strategy. The output of this model allow a firm to “identify its strengths and weaknesses relative to an industry” [1] as Porter says. However to relate to this particular industry I would add “at a specific point in time.” Nonetheless understanding the basics of this model should inform the implementation and development of dynamic capabilities.

The easiest to identify aspects would be the industry and the buyers, as most firms would have a grasps on this from experience and be able to detail to some degree of accuracy off the cuff. The suppliers bargaining power would be moderate to strong as colleges are producing and according to the US department of labor, the software developer market is growing much faster than average at 24%. The threat of new entrants is high as often customers and venture capital firms are looking for the next big idea, which coupled with low potential startup costs means this is one of the highest threats. This also leads to substitution, which can vary from software market to market. Substitutes can manifest themselves here as complete platform changes where a particular markets software or products are no longer applicable.

**Resource-based view primer**

In addition to a traditional five forces model it is often helpful to change the perspective one is using to analyze their firm, and shift the focus from products to resources. This allows for a perspective shift from *what do I produce* to *what could I
produce. As Wernerfelt stated the view “...conjectured that this perspective would throw a different light on strategic options, especially those open to diversified firms” [3]. This particularly applies to markets such as this one where the threat of substitution and/or entrants is high combined with high buyer propensity to switch. The output of such an activity allows an economic slanted perspective, thus “specifying a resource profile for a firm, it is possible to find the optimal product-market activities.” [3]. This view renders more options and insights for firms where they do not compete in a monolithic market with little product diversity. It follows that using this theory as basis for strategy in a firm to create competitive advantage the emphasis is on creation of difficult-to-reproduce resources - “those (tangible and intangible) assets which are tied semipermanently to the firm” [3]. The intangible assets such as skill, unique process, employee trust, etc will play a role when implementing or structuring dynamic capabilities. “The creation of such resources is seen as entrepreneurship: strategic management consists of properly identifying the existence and quality of resources, and in building product-market positions” [4] could be realized as first-move advantages, resource-position barriers to entry, or exploiting an adjacent markets via substitution.

According to Barney in 1991 the focus initially with the resource-based view (RBV) is to gain sustained competitive advantage through valuable, rare, imperfectly imitable, and non-substitutable resources [10]. While this seems a perfectly normal strategy, it was conceived prior to the internet expansion, bubble, burst, and ultimate come back. Barney et al. conclude 10 years later in 2001 that it “seems to suggest that a "dynamic capabilities" perspective on competitive advantage contradicts the RBV, especially as it was developed in the 1991 special issue” [11]. The relationship of dynamic capabilities to RBV can be confirmed as “the ability to learn and the ability to change are likely to be among the most important capabilities that a firm can possess” [11].
Economics and strategy

Economics typically looks at markets as a whole or sets of firms when comparing, contrasting, or aggregating over time. When considering strategy it is most often done inside a firm, and each firm in a market could have wholly different strategies. Looking at the economics of the market you may find the outputs of the strategy, but their may not be an input factor. Economists would “argue that subunits should be measured on profit, they should transfer products, services, and capital to one another - at marginal cost” [4] inside the firm. This would create different dynamics and internal boundaries focusing more on existing positions with less flexibility for firm adoption of strategies. In the early 1990s this relationship was acknowledged as the fact that economics and microeconomics could inform strategy, and instances of failures were determined to be instances incorrect implementations as opposed to incorrect strategies [4]. In addition, research at this time had shown “sources of advantage has begun to point to organizational capabilities, rather than product-market positions or tactics, as the enduring sources of advantage” [4]. In that same article, Strategic Management and Economics [4] for which Teece was an author, he is foreshadowing dynamic capabilities as theory of strategy. It is interesting to note that economics and strategy are very much related, and often overlapping.

Dynamic Capabilities

David Teece

Dynamic capabilities was first codified by David Teece et al to not only define how to gain competitive advantages, but how to sustain and renew them. While many strategies exist and provide analytical methods of industry to gain or fortify competitive advantage, it is typically assumed that the process would repeat. Dynamic Capabilities
(DC) is focused primarily on markets of rapid change, where the goal is to “identify the dimensions of firm-specific capabilities that can be sources of advantage, and to explain how combinations of competences and resources can be developed, deployed, and protected” [6]. The roots of this theory stem from Porter’s model, where markets were modeled, strategies created from model, and actions follow. If taken at face value those models based on solely the resource-based view or Porter’s would erode over time. Generally speaking this would happen on a periodic basis, as most people in any industry and company today would have experience annualized updates. This model does not lend itself well to fast-paced markets, such as those of the software industry. Following the model of a market, the resource-based view allowed for capture of resources not limited to capital and equipment (and often protected with IP), but also staff, experience, and skills. Incorporating these models into identifying the processes firms use is the focus of DCs. When broken down, Teece defines dynamic as the “capacity to renew competences so as to achieve congruence with the changing business environment” and capabilities as “[role] of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies to match the requirements of a changing environment” [6]. Simplified it can he defines this as “the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” [6]. Following the initial publishing of his paper, he authored two key follow-on studies. The first focuses on micro-foundations, or applicable processes, in each of the sensing, seizing, and reconfiguring aspects of DC. The second addresses the entrepreneurial traits with constant change and seizure of opportunities.

Teece develops DC’s more fully by identifying processes and routines that align with the three primary components of DCs - called microfoundations - in a paper in 2007. Each can be considered a stand-alone trait that could be identified in almost any firm. Sensing is the beginning, and “most emerging trajectories are hard to discern. Sensing (and shaping) new opportunities is very much a scanning, creation, learning, and interpretive activity” [7]. This function can typically vary within firms, and heavily
depends on access to and the flow of information and experience. Microfoundations here are related to research and development efforts, hypothesis testing, competition monitoring, identification of changes in customer markets and segments, among others. Following identification (sensing) of an opportunity, it must be seized through “through new products, processes, or services” [7]. While many strategies and business practices can fall into this category, Teece identifies foundations here related to where to invest, when to invest, and how much to invest - any miscalculation here could lead to lost opportunities, negative return on capital, or even firm failure. These microfoundations include business models, product and service architectures and platforms, as well as identifying the boundaries and limits to the firm.

The third related paper by Teece focuses on the entrepreneurial aspects inherent to DCs came out in 2012. The descriptions of the processes and frameworks that comprise DCs could just as easily be applied to the personality and traits of successful entrepreneurs - either as individuals or leading fortune 100 firms. He relates that certain aspects of capabilities “may be based on the skills and knowledge of one or a few executives rather than on organizational routines” [8]. Any experience in a firm will provide evidence of this assertion most quickly in sensing aspects and those related to information access. To a large extent success with DCs can be related to firm culture, to “how employees have worked together” [8], as well as how projects are identified and selected. Teece’s thesis here is that executive and management levels will need access to entrepreneurial-based skills - not only those that help “find new and better ways of putting things together” but those that are capable of also “getting things started” [8]. To this end, these skills are not limited to start-ups or garage inventors, but to larger firms as well, considering larger firms will have “the organizational and technological slack to repetitively evaluate potential opportunities” [8] easier than those with less slack resources.
Additional literature on Dynamic Capabilities

In 2014 a systematic literature review related to DC published papers was published by Taina Eriksson at the Turku School of Economics, Finland. Her groundbreaking summary of existing literature where the term “dynamic capability/capabilities” occurred title, abstract, or keywords. While many articles would reference DCs only title or passing, criteria for the review required a discussion of DCs in the conclusion or findings section. Her method, discussed in much greater detail in her paper [9] shows the rising popularity and body of work related to DCs in the published findings per year shown in the figure below:

![Figure B: DC articles used in Eriksson review [8]](image)

While the body of work related to furthering the evolution of DCs can easily been seen following an upward projection, the referencing to DCs is growing even faster. Her review focused on “four knowledge processes”: accumulation, integration, utilisation and reconfiguration.

The accumulation of knowledge - of information - is a requirement to accurate sensing. Eriksson’s reviews of empirical studies confirmed the requirement that “that
both internal and external sources of knowledge are vital for DCs” [8]. The general conclusion is that a “variety of collaborative arrangements can be adopted” [8] and would pose different challenges for firms of different sizes - yet all rely heavily on the managers role.

While knowledge for knowledge’s sake is noble, not integrating that with the existing body of knowledge at a firm and thus utilising it, access to accumulation of it would be fruitless. Her findings build upon Teece’s initial assertions and confirm that not only does integration of knowledge provide pathways to new knowledge, but integration of both internal and external sources better fostered resource positioning. Utilisation is closely related with integration, and her findings also backup.

Reconfiguration, essentially starting the process over from new perspective proves to be equally vital to a complete DC process. Repeated recombination of resources, experience, and knowledge was found to lead to new abilities to sense, which in turn can lead to sustained competitive advantages. “Organisational proactivity” was also confirmed to be a key element in finding new ways to address market needs, furthering the entrepreneurial nature of DC processes [9].

While the review of what comprises a DC appears to confirm Teece’s assumptions in the late 1990s, the confirmation of microfoundations, or as Eriksson refers to them antecedents were also covered. Apart from the typical flexibility, collaboration, and diversity or resources, she found the influence in DCs can come from individual contributors as well as management or executives.

A final note on a majority of literature that covers DCs from an empirical perspective is that they generally are connected with positive outcomes. This can lead to a binary result as either a firm has DC or does not - the firm either was able to gain or sustain competitive advantages over a given time or it was not. This is covered more in the next section.

Erikssons synthesis summarizes what comprises a DC very well and can be seen in the figure below:
Shortfalls of Dynamic Capabilities

Dynamic capabilities is not without imperfections. The first and most obvious of which is the tautological aspect - if you are dynamically capable you will have achieved competitive advantage, and if you have competitive advantage you must be dynamically capable [12]. Some of the relevant criticisms of DCs will be introduced to add perspective.

In order to employ any business strategies, selections must be made that lead to actions - there will always be a tradeoff and hindsight will always be 20-20. Firms will always seek “only those actions patterns that appear to be meaningful to itself [12]. However “selectivity leads to potential blind spots, and to uncertainty” [12] whether you are deciding what meal to prepare for dinner or where you engineering teams should focus their development efforts. The physiological aspect of perspective leads to a level of naivete and thus “uncritical in a certain way,” which the only real way to overcome is external observation or “another frame of reference” [12].

Complexity leads to a need to simplify, which leads to a level of uncertainty. The free flow of information and the globalization of the internet means all markets have a
level of complexity that did not exist just a couple decades ago. To comprehend markets simplification efforts are required, and the “management of uncertainty through simplification opens the possibility for failure” [12].

Other possible complications with dynamic capabilities exist and are covered extensively in other fields. These include, but are not limited to, inertia within an organization, dependencies or “strategic lock-ins”, past resource commitments, or even luck. It can be asserted that the “concept of dynamic capabilities represents an ideal end to a continuum rather than an empirically observable phenomenon” [12]. The notion that these concepts exist are enough for application to a industry.

**Example Market - Continuous Configuration Management**

If searching for market information on continuous configuration management (CCM), or sometimes call continuous configuration automation (CCA), typically represent a specific set of software tools for automating and managing various infrastructure or operating system configuration. Ranges in market capitalization and growth rates vary widely depending on which elements are incorporated in the term “infrastructure” and can range from 100s of millions to billions by 2025 and beyond. For the sake of argument here we will assume the market capitalization is “valuable enough” and growing, and thus we will review select firms that compete in that space. The specific tools associated with this space will largely not be covered as they will be part of the product portfolio a firm represents. Personal experience in this market has shown that if a prospect is evaluating two tools for configuration management, and one manages “security and vulnerability” better and another manages “network infrastructure” better, they may choose one tool for that job, but typically not both due to overlap. To that end, firms do have strengths and weaknesses in subsets of these areas, which for the purposes here will not be discussed as separate markets. These include aspects such as cloud
migration, network [only] automation, or storage automation. The configuration management tools can be defined as elemental configuration automation, automating the configuration of an element of infrastructure. They are often part of a larger prospect initiative into DevOps or other agile-related management practices. Firms in that initiative will typically be building out a tool chain which will comprise of various tools that typically fall into categories such as plan, code, build, test, deploy, monitor. The CCA market generally focuses on the deploy piece, with elements in test and monitor.

**Focus Firms**

The primary existing firms in this space are Puppet, Chef, and Ansible. Puppet was founded in 2005 and is just over 500 employees headquartered in Portland Oregon. Chef was founded in 2008 and is between 200 and 500 employees headquartered in Seattle Washington. Ansible was founded in 2013 and was headquartered in Durham North Carolina. Ansible was acquired by Red Hat, a public company, in late 2015 and thus statistics are not separable from the parent company. Puppet and Chef are private companies. Each of these companies products compete directly in the CCA market. Other players can be considered in this space but are omitted due to direct application and vendor/platform lock-in. The results of the Forrester Wave report for Configuration management shows the players in the market:
Opportunities and Adjacent Markets

In 2014 Gartner found that most of its customers “do not have formal centralized configuration management” [14] and this can lead to risks associated with over budget projects, projects or products delivered late, or missed capitalization opportunities due to other failures or timing in the value chain they provide customers. “Traditional firms isolate the technology organization from the broader business” [17] which is more aligned with “a world in which competitors and customers were stable, static, and predictable” [17]. Gartner has found that many businesses “hit a wall in their digital business strategy” and thus need to transform to a culture that “morphs toward a digital business” [15]. They also suggest reorienting technology strategies by “stop investing in the technology areas that do not provide differentiation” [15] where “data centers are part of technical debt” [15] and differentiation will not come from replication legacy functionality in the cloud” [15]. DevOps is largely focused on speed, where speed is only valuable if it is successful. The benefit of “improving application delivery com when
customer experience consistent improvement in the solutions they use” [17] meaning firms with DevOps methods have improved customer satisfaction. The trends in DevOps are not new, and the below table from the 2017 State of the DevOps report shows a shift in focus from speed to stability in the most recent polling.

<table>
<thead>
<tr>
<th>IT performance metrics</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployment frequency</td>
<td>200x more frequent</td>
<td>46x more frequent</td>
</tr>
<tr>
<td>Lead time for changes</td>
<td>2.55x faster</td>
<td>440x faster</td>
</tr>
<tr>
<td>Mean time to recover (MTTR)</td>
<td>24x faster</td>
<td>96x faster</td>
</tr>
<tr>
<td>Change failure rate</td>
<td>3x lower (1/3 as likely)</td>
<td>5x lower (1/5 as likely)</td>
</tr>
</tbody>
</table>

Figure E [19]

The Gartner Hype Cycle for Hybrid Infrastructure Services shows “Immutable Infrastructure” as part of the Innovation Trigger segment, which the above firms would belong. This brings intro frame a holistic view of technologies and methods, and while all could thus technically be considered adjacent markets in the sense that they are involved in infrastructure management, there are few key players. The first key adjacent market is the Serverless Infrastructure as this could represent a substitution threat to traditional CCA products which rely on managing infrastructure. Serverless means firm focus on software release, which means a heavy investment in application release automation (ARA, other terms can include continuous delivery release automation CDRA). Forrester believes “elemental configuration management tools will converge will CDRA” [13]. The change in markets such as hybrid cloud, PaaS, and IaaS will also represent changes for the CCA market.
The opportunities that result from these analysts reveal that there will be significant changes seen with both immutable infrastructure (where CCA tools live) and serverless infrastructure. Other cloud-based services such as hybrid cloud computing and private cloud computing along with platform-as-a-service and infrastructure-as-a-service will evolve more over time, and these represent possible consumption markets of CCA tooling. With this knowledge we will suggest strategy considerations for a firm in the immutable infrastructure category.
Strategy Considerations for example firms

An aside: As stated in the abstract, full disclosure necessitates I state that I work at of the representative companies mentioned above and thus have experience and access to information in this market.

Having met with a a senior vice-president of strategy at one of the representative firms, the response when asked “what is your strategy” more more along the lines of laughter than sentences that represents something actionable. While there is undoubtedly a strategy at each firm personal experience such as this can back some initial strategy suggestions. These include:

- **Codification of corporate strategy** Have a documented strategy
- **Accessibility to strategy** Once codified provide access to employees
- **Draw parallels from strategy to individual contributor** Provide access to how individuals can contribute

Strategy suggestions

Dynamic capabilities “are often combinations of simpler capabilities and the routines related to them” [9] and thus elements may already exist in most firms under a different guise. Incorporating DCs into core firm strategy would be an ideal way to improve chances of competitive advantages in these markets and shine light on possible markets that might not have seemed accessible. In the instance where CCA and CDRA/ARA markets will converge DCs will give a unique advantage to current players in the market. Implementing a DC framework would be a four step process.

The first step would be develop high level DC framework incorporating processes in the sensing, seizing, and reconfiguring areas from the perspective of a generic
corporate strategy. This step would be rather straightforward and incorporate existing knowledge from DC literature, external resources such as analyst reports or executive knowledge. Creating this strategy framework and providing access to all employees would benefit the firm to ensure all levels of staff comprehend and understand that the strategy is more than “beat competitor X.”

The second step would be to populate and customize this framework with existing processes that may exist internally to the firm. This would involve interviews with different departments and/or work units to understand process that exist. The focus here should be on the three overarching steps in a DC - sensing, seizing, and reconfiguring. Once categorized this could reveal various levels of maturity in these skills and provide a general direction of focus.

The third step would be to develop a system of ranking each process (or antecedent) in these categories based on this given firm. This processes would be the most difficult, but in general the iterative process would be “how well do we …” for each of the processes identified in step two. The process should also be incorporated to any new process developed going forward.

The fourth step would be to identify gaps in these processes and develop a path to close those gaps. As discussed earlier DCs are closely related to entrepreneurial actions. Developing internal programs with a entrepreneurial focus would benefit multiple processes simultaneously. Typically the components of DCs from the literature reviews are also focused around knowledge gathering and integration. Having both of these themes in mind when developing plans could ensure high output from the process.

A real-world example of how this above plan could benefit a firm can be seen in the CCA and ARA market example. Puppet acquired a company Distelli in 2017, which represents a CCA company acquiring an ARA company. This seems like a very straightforward strategy - if markets would merge and present new opportunities and capital is available, acquire another company. The simple merging of two companies who are successful in their respective markets does not dictate that they will then extend
that success. The DC strategy presented above however is wholly applicable in the success and output of such a merge. Having processes to sense, seize, and reconfigure post merger might not directly determine success or failure, but will undoubtedly include the degree of success that would be attained. Once could also argue something similar occurred with Red Hat’s acquisition of Ansible, however due to the size number of markets Red Hat competes in, an analysis of this would be more complex than this paper covers.

**Possible hurdles**

The largest weaknesses related to DCs is related to the intangibility of them and their tautology. Determining how to overcome this to some extent measure them will be largest hurdle. Individual components can typically be measured, such as how many new products release, product iterations or success, knowledge integration through IP, etc. Through the course of research for this paper there did appear to be a gap in studies in measuring DCs, and this spearheading an academic theory in the business world without tangible and verifiable metrics may be a hard internal sell.

Size and scope of a market and firm will also play a part in the success or completeness of a DC initiative. If a firm is too large and diverse with various business units it will be more difficult to codify and internalize knowledge, harder to pivot to seize new opportunities, and more complex when configuring as redundancies could exist. Similar problems would exist in small firms and startups, although one could argue startups by nature are performing DCs. However DC successes may be related only to competitive advantages achieved, as noted in the shortfalls section earlier.

There are not many, if any, business success stories as a result of a DC initiative process being created and implemented, which makes adaptation and understanding less accessible to everyone. Based on the literature and components of a DC, it would be easy to retrospectively ascribe DC-like strategies to companies, but showing they were born and based on DC literature would not be possible. Mark Twain can be quoted saying
“There is no such thing as a new idea. It is impossible. We simply take a lot of old ideas and put them into a sort of mental kaleidoscope. We give them a turn and they make new and curious combinations. We keep on turning and making new combinations indefinitely; but they are the same old pieces of colored glass that have been in use through all the ages.” This abstraction can easily be assigned to DCs, and thus brushed aside as a focus area, thus reducing the possibility for future research.

## Future Research

Research is on an upward trajectory for dynamic capabilities as shown in this paper. Similar to DevOps DCs rely on information flow and trust as well as incorporation of that information (reconfiguration) to truly be successful and differentiated. While trust specifically can be considered a portion of social antecedents, it may perhaps be weighted differently. Empirical studies on specific antecedents and their relative weight to dynamic capabilities and its success could be explored.

When considering the VRIN criteria for the RBV of the firm, some elements such as trust could be argued as omitted from the list since it is duplicatable at every firm even though it is difficult. How would addressing the types of resources that are boundary resources to today’s definition of dynamic capabilities can effect them would shed more light on elements of DCs other than strict knowledge incorporation processes.

Considering the explosion of rapid development processes and methods and their application in the software industry, there is a gap in the correlation to DCs and some of these feedback methods such as DevOps or Agile. In some cases they could be considered a DC in and of themselves with sensing, feedback, and incorporation, however incorporating firm and business level processes with DevOps could shed new light on optimization and application.

Finally there may be a relationship between DCs and emerging markets or firms. To what extent DCs could accelerate or increase competitive advantage specific to
mergers would be an interesting relationship to explore. While there are some papers that exist from the last few years that address this topic, there exist more space for development.
References


**Table of Figures**


B. “Articles published references Dynamic Capabilities by year” [8]

C. “General structure of Dynamic Capabilities” [8]

D. “Results of the Forrester Wave” [13]


F. “Gartner Hype Cycle for Hybrid Infrastructure Services 2017” [18]