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# KESSEL RUN: AN INNOVATION OPPORTUNITY FOR THE U.S. AIR FORCE


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# Kessel Run: An Innovation Opportunity for the U.S. Air Force

'Innovation' is a phenomenon observable through its impacts on the global economy, going beyond – but including – digital technologies. It has long been regarded as the engine that drives economic success at the organizational, regional, and national scale, but managing such innovation also matters for the public sector, including defense and security matters.

MIT defines innovation as the "process of taking ideas from inception to impact."[1] MIT's study of innovation in large organizations across the public and private sectors emphasizes the importance that leaders must place on building effective innovative behaviors as well as long-run capabilities for innovation in their organizations but also recognizes the challenges.

The recent focus on innovation by the U.S. Department of Defense (DoD) illustrates some of the ways in which a large, established public sector bureaucracy has fostered new innovation units.[2] It also highlights how the distinctive organizational cultures of these units can more effectively support key capabilities such as rapid experimentation, novel funding/contracting approaches, and alternative training/skills. 'Kessel Run', as one such organization, is a hybrid unit of the U.S. Air Force (USAF), combining acquisition and operations, established and then scaled to bring software solutions to the warfighter.

The story of Kessel Run allows us to explore the ways in which the U.S. Air Force responded to the contemporary demands of the digital economy, developing a capability for software innovation and building 'software factories' within the traditional structure of the U.S. Air Force. This paper is grounded in the development of 'Kessel Run' named after a feat from 'Star Wars.'[3] The U.S. Air Force's 'Kessel Run' was the first in a series of units linking the operational Air Force to software talent in the innovation economy which includes AF units, prime contractors, and smaller, more entrepreneurial start-ups. We focus on Kessel Run's approach to bridging the gap between the advanced capabilities of the American modern air force (aircraft, weapons, etc.) and the antiquated digital planning tools the U.S. Air Force generally has at its disposal.

***The goal of this Working Paper is to explore the major internal and external forces that allowed for the creation and subsequent hypergrowth of Kessel Run.***

This first requires a certain level of understanding of innovation theory and the history of U.S. Air Force software acquisitions.

## Innovation's challenges

[1] This Working Paper by Phil Budden and Fiona Murray - "An MIT Approach to Innovation" (2019) - is a good introduction: https://innovation.mit.edu/assets/BuddenMurray_An-MIT-Approach-to-Innovation2.pdf

[2] This MIT Working Paper on 'Defense Innovation' looks at the special challenges for innovation (and its units) in defense, both in the United States and further afield: https://innovation.mit.edu/assets/Defense-Innovation-Report.pdf

[3] In the 'Star wars' galaxy, the "Kessel Run" is a hyperspace route used by smugglers: flying the Millennium Falcon, Han Solo made this infamous run in about 12 parsecs. The founders of the U.S. Air Force's "Kessel Run", knowing that navigating digital transformation in the world's largest bureaucracy (i.e., the U.S. Department of Defense) would be treacherous, named their effort 'Kessel Run'.

While commonly considered to be at the heart of today's agile start-ups, innovation is also essential to large organizations. For such organizations, building internal innovation capabilities and an effective innovation system may require significant organizational change and leadership over the long term. This is as true for public sector organizations, which includes government agencies, as it is for private sector organizations. But the public sector — especially critical delivery agencies such as defense, security, health etc. — faces particular pressure for transformation to deliver new capabilities while at the same time being subject to the scrutiny of using public funding to undertake risky projects.[4]

Moreover, the public sector today often lacks the structures, incentives, networks and culture to deliver on ambitious innovation goals especially those that characterize today's digital economy compared to the more traditional industrial age where innovation was often focused on major projects.[5] What makes the public sector a particularly interesting setting in which to observe these innovation challenges is the ability to examine innovation activities, or lack thereof, over an extended period. In the private sector, competitive dynamics may drive stagnant organizations out of the marketplace.

In contrast, public sector organizations survive — typically due to a lack of competition, political insulation, and taxpayer funding — and are thus able to survive in spite of limited internal innovation capabilities. That makes it all the more interesting when a public sector organization as large as the DoD finds a way to build organizational units — such as 'Kessel Run,' the subject of this study — that deliver software capabilities, driving innovation at a pace that is more typically found in the private sector.

MIT has made a systematic study of innovation in different large organizations around the world — including in the public sector, security agencies, healthcare, universities, and global corporations — in order to develop an approach to innovation that allows us to assess particular organizational system challenges (and failure modes), identify characteristics of successful innovation units within the innovation system of large organizations, and articulate the benefits of working with external innovation ecosystems.

Against that background, we have produced this study leveraging MIT's innovation framework to baseline the story of 'Kessel Run,' the U.S. Air Force's novel approach to software acquisition, which resulted in a hybrid acquisitions and internal software operations capable organization. In short, Kessel Run began acquiring and internally building software solutions using modern industry practices. Kessel Run adopted methods and practices that MIT refers to as stages of experimentation, including agile principles, user-centered design (UCD), lean product management, and DevOps.

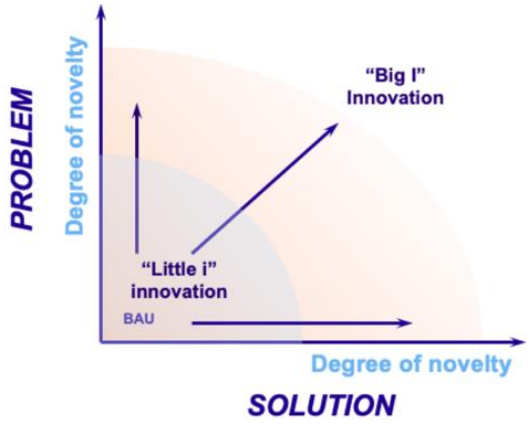
**MIT's approach to innovation**

Drawing from MIT's previous paper "The MIT Approach to Innovation" we argue that a useful working definition of *innovation* is simply the: "process of taking ideas from inception

[4] While a majority of ideas in the private sector do not actually make it from inception to impact, the pressure on government bodies like the DoD, given the scrutiny that comes with public funding, is to have a high success rate. Because of this expectation of near perfection, only the most mature innovation ventures in the government are supported.
[5] Consider, for example in the United States, the Hoover Dam, the moon landing, space flight, etc.

to impact".[6] As we have argued, MIT does not include the word 'technology' in its definition because innovation is something more than that, even if it harnesses it, especially digital technologies. By taking a *process* definition of innovation, with a trajectory that moves — albeit in a way that is often non-linear — from *inception* all the way through to *impact*, we go beyond a single moment of invention. This shifts attention from inventors (and invention) to a range of underlying capabilities, and emphasizes the role of a range of individuals, teams, units, and organizations — both in private and public sector enterprises.

Within any organizational context, an *idea* is a bridge (initially hypothetical) between a problem and a solution with *impact* going beyond profits, to include a variety of other outcomes such as environmental, social, medical, or security missions. In much common discourse on innovation, we find at least two distinct types of activities that are often raised, but need to be more clearly distinguished: these can be regarded as being on a spectrum, and best placed within a 'problem/solution' matrix (as below).




*MIT's Problem/Solution Matrix[7] (BAU stands for business as usual)*

First, there is formal 'Innovation' (with a capital 'I') meaning either the processes of taking novel science and technology (S&T) research and development (R&D) outputs (usually novel technological solutions to existing problems), or transformational innovations (matching novel solutions to novel problems), from inception through to impact: such impact is often described as being out on the frontier (or horizon) in the '10x' transformation category.

Second, there is a more modest form of 'innovation' covering the innovative adoption or adaptation of existing technologies, practices, and resulting capabilities, i.e., innovation with a little 'i' which would more typically provide 10% rather than 10x improvements in outcomes (or impact): this signifies a more widely applicable set of innovative behaviors seen in both private and public sector actors.

Software development is often an essential activity within both big 'I' and little 'i' innovation. There is a clear need to develop and deploy digital skills in such a way as to enhance outward-facing impact (e.g., delivering defense capabilities to the field through a

[6] This section draws heavily from the Working Paper by Phil Budden and Fiona Murray: "An MIT Approach to Innovation." https://innovation.mit.edu/assets/BuddenMurray_An-MIT-Approach-to-Innovation2.pdf

[7] Ibid

modern hybrid cloud infrastructure) as well as internal impact (e.g., using modern software development practices and tools). These impacts are an essential part of the innovation capability within any large public and private sector organization. And yet, the myriad of differences in skills, structures, incentives, networks, and culture have made it especially difficult for large public sector organizations, such as the military, to adopt contemporary software innovation capabilities.

A recent analysis found that more than 50% of respondents in large public sector organizations lacked confidence in their organization's ability to achieve successful IT transformation.[8] A similar number of respondents from a range of U.S. Government agencies felt that they were behind their peers. Of course, private sector enterprises also face challenges: effective software development capabilities are hard to establish in many large-scale, bureaucratic organizations.

These challenges are typically twofold: an organization's inability to 1) envision an innovation strategy that includes doing business in a new way and therefore creating novel value, and 2) create an internal innovation system that is able to support modern software capabilities, especially those delivered via cloud infrastructure and sophisticated software. One important difference, noted above, is that those in the private sector who fail to make change are liable to eventually be supplanted by more creative, leaner enterprises, while those in the public sector might continue regardless. Beyond obvious differences in competition that exist between the public and private sectors, there is also a perceived culture gap that often hinders the government's ability to unleash its substantial human capital to drive innovation.

**Prior U.S. defense efforts at software innovation**

The military, with its strong tradition of command and control, is an organizational setting within which innovation — particularly the little 'i' innovation at the heart of digital transformation — is significant. In absence of direct data on digital transformation spending, R&D budgets can serve as an adequate proxy. With this in mind, defense spending is over 3% GDP for the United States, which accounts for about 40% of total worldwide defense spending. Additionally, R&D is around 8% of the aforementioned total U.S. defense spending, which translates to about $59 billion annually.[9] And yet, the past decade has been challenging for the DoD in the domain of digital innovation and software.

The need to develop software development capabilities in the military has been the subject of lengthy reports since the early 1980s. In 1982, a DoD joint service task force on software development report stated that:

> *"the necessary technology base and management practices cross Service lines and the problems are bigger than any individual Service initiatives currently address. A plan of action should be developed which embodies a broad and bold approach and which includes both academia and industry as willing participants."*[10]

[8] https://institutes.kpmg.us/government/articles/2019/public-sector-modernization.html
[9] https://www.defenseone.com/technology/2020/02/us-defense-rd-funding-falls-chinas-keeps-growing/163021/
[10] https://apps.dtic.mil/dtic/tr/fulltext/u2/a123449.pdf (page iii)

The report reinforces the notion that there are many difficulties facing the DoD in software. "These difficulties span the acquisition process, the development and support environment, characteristics of deployed software, and computer professional resources".[11] From the Task Force's conclusions we learn that: 1) the state of DoD software development is adversely affecting the military mission, 2) the problems in software are many and interrelated precluding a simple solution, and 3) DoD must take a leadership role in solving the problems in software and in averting the erosion of the technology base.

Five years later, in 1987, a report from the Defense Science Board (DSB) Task Force on military software suggested that the DoD should look for change of attitudes, policies, and practices concerning software acquisition: "the big problems are not technical. In spite of the substantial technical development needed in requirements-setting, metrics and measures, tools, etc., the Task Force is convinced that today's [1987's] major problems with military software development are not technical problems, but management problems."[12]

By 2000, the picture had changed little. The Defense Science Board (DSB) Task Force on Defense Software reviewed six major DoD-wide studies that had been performed on software development and acquisition since 1987 and found that "too often, programs lacked well thought-out, disciplined program management and/or software development processes. Meaningful cost, schedule, and requirements' baselines were lacking, which prevented any possibility of tracking progress against them."[13] The report also revealed statistics on software development performance (in the DoD and the commercial market): Only 16% of programs complete on budget and schedule, 31% are cancelled, and the remaining 53% cost 189% of their original estimates.[14]

For the U.S. Air Force in particular, a Report on System-of-Systems Engineering (SoSE) for Air Force Capability Development from 2005 found that the service:

> *"does not build all systems through a homogenous acquisition and development process, it does not use all systems in ways foretold at their inception, and not all systems find themselves used among predicted interface partners… For the U.S. Air Force, the challenges of building a system-of-systems are particularly important because many of the systems already developed can function as contributors to the performance of other systems. However, smooth and simple assembly of a system-of-systems is quite difficult for the DoD."*[15]

This research illustrates the struggle of the Air Force's predominantly waterfall acquisition methodology.[16] Its rigid, requirements-based approach often results in solutions and systems that do not meet their original intent, or are no longer fit for purpose. More 'agile'

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[11] https://apps.dtic.mil/dtic/tr/fulltext/u2/a123449.pdf (pages i and ii)
[12] Ibid (page 7)
[13] Ibid (page 19)
[14] https://www.projectsmart.co.uk/white-papers/chaos-report.pdf (page 7)
[15] https://www.dau.edu/cop/se/DAU%20Sponsored%20Documents/AF%20System%20of%20Systems.pdf (page iii)
[16] "The 'waterfall' model is often also referred to as the linear and sequential model, for the flow of activities in this model are rather linear and sequential as the name suggests." It stands in contrast to the newer 'agile' methods for software development. https://acqnotes.com/acqnote/careerfields/software-development-approaches

techniques are better designed for rapid software development.

Additionally, the research noted that the U.S. Air Force's traditional processes are functioning as a barrier to entry for innovation:

> *"For any innovation there are usually barriers to overcome. In the case of the proposed SoSE methodology, the first barrier is tradition. The incorporation of experimentation venues for refining requirements and for accelerating product fielding runs counter to the existing culture. It is, therefore, important for the bureaucracy to not resist the idea of becoming involved in creating and facilitating the new concept."*[17]

This particular point speaks to the struggle of driving innovation through the 'frozen middle' created by the bureaucracy of requirements, planning, and budget programing functions.[18]

**A new DoD approach**

In 2016, the Federal Advisory Committee Act founded the Defense Innovation Board (DIB) as part of its work to build a more modern set of innovation capabilities, including modern software development. This organization would assist the then-Secretary of Defense Ash Carter and senior DoD members in assessing emerging technologies and innovation that could be implemented in the military.[19] In addition, each of the services (Army, Navy, Air Force, Marine Corps) sought to expand its own innovation capabilities.

In the U.S. Air Force, the gap in software innovation coupled with an aging IT infrastructure sat uncomfortably beside the tradition of cutting-edge solutions based on hardware-centric innovation capabilities (e.g., strategic reconnaissance (1946-72), precision attack (1990-1999) and most recently, persistent intelligence, surveillance, and reconnaissance (ISR) via unmanned aerial vehicles (UAVs) and satellites).

A 2016 RAND study on U.S. Air Force innovation questioned whether the service was sufficiently innovative and what it would need to do to be more innovative in the future. It emphasized the fact that successful USAF innovation was often born out of decentralized operational units (and individuals) rather than top-down doctrine or decisions. The approach to different types of projects identified by the RAND study is illustrative of the ways in which large public sector organizations may have distinctive approaches to little 'i' versus big 'I' innovation. "Headquarters Air Force and major commands often seek 'long-cycle innovation' by developing new technologies and platforms over many years. Operational units engage in 'immediate adaptation' as they adjust tactics and techniques on a sortie-by-sortie basis."[20] Neither of these approaches, however, is necessarily one that lends itself to digital, software innovation. This begs the question: how does the Air Force overcome this software innovation challenge?

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[17] https://www.dau.edu/cop/se/DAU%20Sponsored%20Documents/AF%20System%20of%20Systems.pdf (page 62)
[18] https://warontherocks.com/2018/08/some-modest-proposals-for-defense-department-requirements-reform/
[19] https://innovation.defense.gov/About1/
[20] https://www.rand.org/content/dam/rand/pubs/research_reports/RR1200/RR1207/RAND_RR1207.pdf (p. viii)

## U.S. Air Forces Central Command (AFCENT)

The spark that allowed Kessel Run to begin confronting *that* challenge can largely be attributed to the existence of a champion stakeholder — the United States Air Forces Central Command (AFCENT) and its commander, Lieutenant General Jeffrey Harrigian. Their support chartered and empowered Kessel Run to work directly with operational users. At the same time, Kessel Run provided AFCENT and its personnel with access to modern software development capabilities. But the story of its emergence and survival is important in shaping our understanding of how to drive innovation — especially the little 'i' innovation associated with software capabilities — in the public sector.

AFCENT is part of the U.S. Central Command (CENTCOM), which covers the Middle East (including Egypt), Central Asia and parts of Southern Asia (excluding India). As such, AFCENT is responsible for all air operations, independently or together with a coalition of partners, and supports national goals and security interests in 20 areas of responsibility around Asia, the Persian Gulf, and Africa. According to the latest AFCENT public report on Airpower Statistics in Iraq and Syria alone, AFCENT operated ~40k sorties (a sortie is a mission/flight of an individual aircraft): ~14k manned strike aircraft sorties in which ~4,700 weapons were released, ~13k intelligence, surveillance and reconnaissance (ISR) sorties, ~7k airlift and airdrop sorties, and ~7k tanker (refueling) sorties that provided ~45k aircraft refueling operations in the air.[21] Due to its high operational tempo and area of responsibility, AFCENT's responsibilities consist of missions that require deep planning capabilities (route planning, air refueling, etc.), a high level of command and control, and the coordination of air operations with coalition air forces. Considering the volume of missions, planning tools have a high impact on the efficiency and quality of operations.

## The 'Gonkulator' and AFCENT's air war against ISIS

In 2016, AFCENT was executing multiple air operations against the 'Islamic State of Iraq and Syria' (ISIS) in Iraq.[22] During a tour in the Central Command's Combined Air Operations Center (CAOC)[23] in Qatar, the Defense Innovation Board (DIB) with Chairman Eric Schmidt (the then-executive chairman of Alphabet, Inc.) was surprised to see that these critical aerial refueling operations were being planned manually on a physical whiteboard.

The local USAF team was using Excel spreadsheets to input relevant data and then copying the data to a whiteboard using dry erase markers and magnets to organize the information and plan missions for the day. This was an 8-hour process for 6 people and, if any of the data changed during the day or was even partially erased accidentally, they would have to erase the whole whiteboard (see below) and start again from the beginning. [24]

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[21] For 2019: https://www.afcent.af.mil/About/Airpower-Summaries/

[22] https://airman.dodlive.mil/2018/11/05/changing-the-story/

[23] The Combined Air Operations Center (CAOC) provides command and control of air power throughout Iraq, Syria, Afghanistan, and other nations in the U.S. Air Forces Central Command region.

[24] https://airman.dodlive.mil/2018/11/05/changing-the-story/

*The whiteboard on which tanker refueling operations used to be planned. [Photo: courtesy of U.S. Air Force]*

USAF Colonel Mike Drowley, AFCENT Chief of Staff, explained: "We got the missions for the day, figured out what targets needed to be hit, and how much fuel was needed, who needed the fuel, and when they needed it." During the tour, Schmidt asked one of the Combined Air Operations Center (CAOC) commanders what his biggest concern was, expecting to learn more about ongoing attacks and missions, yet he received a different answer, "Well, frankly….I don't want them to erase my whiteboard."[25]

The process typically started when an Airman (nick-named the 'Gonker') input data into the spreadsheet called the 'Gonkulator,' while the 'Planner' organized magnets and plastic laminated cards on the whiteboard to calculate how much fuel each aircraft would have. These were the planning tools being used by the world's leading 21st century military. For the past decade and a half, the United States had been involved in military missions in the region and had been wasting millions of dollars in man hours and fuel due to calculation inaccuracies. Methods and systems being used such as the 'Gonkulator' were resulting in limited operation abilities, wasted fuel, and endless wasted hours of human work.

Although the CAOC had 'modern' software, it had not been upgraded for more than 20 years. In 2006, Lockheed Martin had received a $589 million contract to improve and transform the technology used by more than 20 AOCs globally. Initial work on an upgrade began, yet in 2013 the Air Force opened a new tender ('AOC 10.2') for the remainder of the work and Lockheed chose not to bid. Instead, the contract went to a different defense 'prime', Northrop Grumman.

By 2017, Northrop's costs had doubled, from $374 million to $745 million, and the solution was still running years behind schedule.[26] At the time of the DIB visit, the future of this critical software project was unknown, and had no sign of success or timeframe for implementation in the near future.

[25] https://www.fastcompany.com/40588729/the-air-force-learned-to-code-and-saved-the-pentagon-millions
[26] https://www.fastcompany.com/40588729/the-air-force-learned-to-code-and-saved-the-pentagon-millions;

**Key industry partnership**

One member of the now famous 2016 CAOC trip made by the DIB was Raj Shah, a former USAF F-16 pilot and then Managing Director of the Pentagon's new 'Defense Innovation Unit – Experimental' (DIUx).[27]

Founded in 2015, DIUx (now just DIU without the x) is an organization focused exclusively on fielding and scaling commercial technology across the U.S. military to help solve critical problems, and the whiteboard planning tool was exactly one of those problems. DIUx's course of action was to locate innovative private-sector companies to help produce fast solutions to DoD problems; Pivotal Inc. was one of these companies. Backed by Dell EMC and VMWare, Pivotal (acquired by VMware in 2019) helps organizations and companies improve their software development via their platform and enablement services that propel smart and simple application development.[28]

Immediately after the visit to the CAOC in Qatar, DIUx connected Pivotal with an Air Force product team and directed them to focus their efforts on the tanker planning tool the DIB had just witnessed. Shah and others were confident that if the DIUx team sent their team of software engineers, product managers, and designers, together with Pivotal experts, to work side by side with Air Force personnel, they would be able to deliver a solution within months.[29] The joint team of Pivotal employees and USAF Airmen then flew to Qatar to sit together with the CAOC operators in order to create a new tool.

Less than four months later, the solution – named 'Jigsaw' – was in production.[30] This new tanker planning software changed the manual 'Gonkulator' process — 6 people using magnets and a whiteboard and 8 hours of work — into a simple touch-screen interface. The new technology instantly improved operations by taking only one person 3 hours to complete. The Air Force was able to use fewer aircraft saving money and fuel every day. "The efficiencies it had created was saving about 400,000 to 500,000 pounds of fuel each week and they were accomplishing their missions with one less refueling aircraft. This saved the Air Force $750,000 to $1 million every week."[31]

Within a few weeks, the sum of money saved covered the costs for both the development process and the initial enablement sessions needed to implement it. The powerful combination of significant savings alongside seemingly simple and rapid software development, for a problem that was easily explained, highlights the power of so-called little 'i' innovation to actually drive significant change. It has also served as a key touchpoint in explaining the power of such software innovation to naysayers.

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[27] https://airman.dodlive.mil/2018/11/05/changing-the-story/

[28] https://www.airforce-technology.com/features/pivotal-innovative-partnership-saves-big-us-air-force-fuel-costs/

[29] https://airman.dodlive.mil/2018/11/05/changing-the-story/

[30] Jigsaw's deployment to a production environment was only made possible by the fact that the National Geospatial-Intelligence Agency's (NGA) GEOINT Services platform was approved on a classified environment. NGA played a critical role in supporting Kessel Run's application deployment until the unit had its own accredited platform.

[31] https://airman.dodlive.mil/2018/11/05/changing-the-story/

**Creating 'Kessel Run'**

DIUx and Pivotal's success in creating Jigsaw became the proof of concept the Air Force Life Cycle Management Center (AFLCMC)[32] needed to adopt a different way of developing and delivering software. This success, combined with the failed attempts to upgrade the Air Operations Center through traditional acquisitions processes, became the impetus to build an ongoing agile software development program called Kessel Run.[33]

The path from being a small, DIUx team to establishing AFLCMC's Kessel Run — which at the time primarily consisted of the Air Operations Center (AOC) program office[34] — was enabled by a combination of good timing and creative thinkers in positions of power and influence. The opportune timing for innovation to take root came in July of 2017 with the Air Force's cancellation of the 'AOC 10.2' modernization contract with Northrop (which had long called for upgrades to the technology used to plan and conduct air operations, to include mid-air refueling). After applauding the Air Force's decision, the late Senator John McCain lamented

> *"At the same time, it is unfortunate that the Air Force had already spent more than half a billion dollars over the last ten years on the AOC 10.2 upgrade, and yet the program has not delivered any meaningful capability. Even more unfortunately, this program is only one example of the Department's troubling record on software-intensive systems."*[35]

The old, waterfall system had proven faulty for software-intensive programs. It was time for significant change. The fortuitous relationship between Kessel Run and AFCENT broke the mold. It enabled end-users to reach into the innovation ecosystem of software development teams and agile acquisitions that often lies beyond the traditional capabilities of the military.

**Kessel Run becomes a 'DevOps'[36] organization**

The year 2017 was a turning point, creating the right conditions for DIUx's small team to partner with AFLCMC to introduce the AOC Pathfinder. "The AOC Pathfinder approach implement[ed] industry best practices by allowing airmen to communicate software needs directly to the developers throughout the life of the system, creating valuable feedback and

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[32] The Air Force Life Cycle Management Center (AFLCMC) is one of six centers reporting to the Air Force Materiel Command. Led by a 3-star general officer, AFLCMC is charged with life cycle management of Air Force weapon systems from their inception to retirement.

[33] https://airman.dodlive.mil/2018/11/05/changing-the-story/

[34] The Air Operations Center (AOC) program office is charged with stewarding the lifecycle of the AOC enterprise. An AOC provides tactical and operational control of air forces. A Combined Air Operations Center (CAOC) is a subset of an AOC that is multinational, hence the word 'Combined.' In terms of function, there is no difference between an AOC and a CAOC. For clarity, Kessel Run is also known as AFLCMC - Detachment 12, its more formal but less commonly used name.

[35] https://www.defensenews.com/air/2017/07/13/air-force-cancels-air-operations-center-10-2-contract-starts-new-pathfinder-effort/

[36] 'DevOps' is a set of practices that combines software development and IT operations. DevOps is sometimes referred to as DevSecOps when focused on 'security' to emphasize the difference. http://radar.oreilly.com/2014/06/revisiting-what-is-devops.html

learning for the development team and users, and shrinking release cycles from years to weeks."[37]

By structuring their innovation activities around short, clear cycles of experimentation that take user requests, provide a statement of needs, develop code and then test those solutions — i.e., a cycle of experimentation and evaluation, Kessel Run was building the scaffold for a modern software innovation capability, proficient at undertaking cycles of little 'i' innovation that together would create significant value.

One factor that inhibits the speed and ability to do continuous software delivery in traditional acquisitions is the time between requirement identification and contract award.[38] Additionally, any changes in the original contract scope would drive a contract modification, further delaying the execution of new work. In this model, the operational environment would have likely changed by the time the software product was delivered, therefore rendering the product less relevant.

Kessel Run made a deliberate decision to own the technical baseline, empowering the government with increased responsiveness and decreased cost. The comparative advantage in government-led software delivery is the ability to sense and respond to a dynamic operational environment where user needs (novel and existing) are constantly changing. Furthermore, this approach gives the government full ownership over the intellectual property (IP), and thus infinite use of that IP across the government.[39] Both of these advantages, government-led and government-owned, increase the efficacy of recognizing and curtailing licensing and sustainment costs.

In order to execute the DevOps model of having short release cycles, Kessel Run had to overcome the significant hurdle of gaining an Authority To Operate (ATO) for each release. An ATO is the accreditation of sound cybersecurity practices, code base, and interfaces. Program offices traditionally use security as a stage gate for an ATO to ensure everything that is delivered to an end user is complete, a practice contrary to modern software development where there is no such thing as a finished product. This model clearly hinders an organization's ability to deliver software with speed and at scale.

Thus, Kessel Run began to lobby corporate Air Force Leaders to approve a 'continuous Authority To Operate' (c-ATO). A 'c-ATO' is enabled by rigorous automated security scanning, release pipelines, and initial deep assessments of the processes and technology employed by each new Kessel Run product team. In the Spring of 2018, after significant conversation, Air Force Leadership bought in and awarded Kessel Run the DoD's first c-ATO, which ultimately unleashed Kessel Run to fully embrace DevOps.[40]

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[37] https://www.defensenews.com/air/2017/07/13/air-force-cancels-air-operations-center-10-2-contract-starts-new-pathfinder-effort/

[38] In the case of the AOC 10.2 modernization effort, that time lag was 6 years.

[39] "The cost of sustaining DoD's weapon system software is estimated to be at least $15 billion over the next 5 years, but DoD may not know the full costs. Some of DoD's systems have incomplete cost data, which could make it harder to ensure that DoD has the necessary resources available." https://www.gao.gov/products/gao-19-173

[40] https://www.c4isrnet.com/it-networks/2019/01/14/how-the-air-forces-new-software-team-is-proving-its-worth/

Due to this c-ATO and the innovative support of Air Force corporate leadership, the members of Kessel Run could now focus on continuously delivering valuable software directly to their users. The initial AOC Pathfinder effort planted seeds for what would become a 'strangler pattern' approach. To begin deprecating legacy systems, the people who comprised the Pathfinder team — military members, government civilians, and contractors — expanded the scope of their innovation activities into different parts of the problem set. After a year, the AOC Pathfinder had shown good promise delivering value leveraging commercial software practices and Kessel Run, as we know it today, was born. [41]

In his statement to the House Armed Service Committee in 2018, Eric Schmidt (chair of the DIB) described Kessel Run as:

> *"a project run out of the Air Force Life Cycle Management Center to modernize the Air Operations Center, with DIUx's support, whereby over 70 Airmen have recently undergone training through a partnership with a company, Pivotal Labs, to learn software and app development in a genuine agile software development environment. It is DoD's version of a Software Factory. Kessel Run has already saved vast sums of money that would otherwise have been spent through the traditional acquisition process. Cycle time that may have extended years are accomplished in weeks."*

In May of 2018, AFLCMC and Kessel Run opened a downtown Boston software lab named the 'Kessel Run Experimentation Lab' (KREL). This location created cognitive and physical separation from the Air Force's traditional acquisitions construct. The entire space created a more collaborative environment within which to bring top software talent into government. A senior Kessel Run leader described this effort: "Collaboration is easier in an open facility like this…because workers in the same area can solve problems quickly and not rely on emails and phone calls, which is the traditional way the Air Force tackles such problems."[42]

With the establishment of KREL proper came new challenges. With more people and resources, Kessel Run moved beyond mid-air refueling and started to explore other problem spaces. Given their increased risk tolerance and willingness to try new things, AFCENT continued to be the ideal customer.[43] As some of those efforts proved to be successful, other members of the Air Force began to take notice and desired better capability at their AOCs as well.

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[41] "Instead of the all-in, risky battle to a cut-off date, an alternative agile approach is to observe the current application and create an application alongside the old application that gradually replaces it. This approach provides for a progressive plan that also reframes the problem, reducing the risk that is associated with a cut-over approach. It also provides value back to the business by enabling an earlier delivery of new features and replacing old features until you have a mature application that can replace the old one." https://www.ibm.com/garage/method/practices/code/chunking-strategy-strangler-pattern/

[42] https://www.c4isrnet.com/it-networks/2019/01/14/how-the-air-forces-new-software-team-is-proving-its-worth/

[43] https://www.foxnews.com/tech/us-military-teams-up-with-silicon-valley-to-revolutionize-the-battlefield

**Next Steps: Scaling Kessel Run**

While initially the customer base was focused on AFCENT and therefore CAOC requirements, Kessel Run's experiment grew into the full scope of responsibility for the entire AOC enterprise.[44] Therefore, the challenge became: how do you continue to sufficiently support your initial customer while also fulfilling an Air Force mandate to expand?

The problem was further compounded by the fact that mid-air refueling and some of the other successful applications only supported a small portion of the entire air tasking cycle.[45] That is, at this point in Kessel Run's journey, they only had confronted a thin thread of the air tasking cycle value stream. So, an additional question became: how do you complete the entire value stream for the air tasking cycle? The answer to both — expanding user base and completing the value stream — was to scale.

Since 2017, Kessel Run has expanded its scope significantly, supported by a growing number of product teams. Today, Kessel Run includes more than just the AOC program office. Kessel Run encompasses what was the former Targeting and GEOINT program office, supports the F-35 joint program office and F-22 special program office, and enables others, via its all-domain common platform (ADCP) and enterprise other transaction authority (OTA). This growth brought with it competing stakeholders, increased problem complexity, and a susceptibility to scope creep.

A scaled Kessel Run would allow the Air Force to leverage government-led, continuous software delivery that would truly enable dynamic air campaign management, changing fundamentally the way air command and control is conducted.[46] In order to do so, Kessel Run had to rapidly increase the footprint of its organization. While hypergrowth is exciting, maintaining the 'magic' that allowed Kessel Run to excel at the beginning required a different set of ingredients to successfully scale. Effectively scaling a DevOps organization is far from easy but became the necessary challenge Kessel Run had to face and continued to face today.

Thus, the Kessel Run example has inspired members of the DoD to ask how *could* and how *should* they work differently — at scale — inside the world's largest bureaucracy.

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[44] The AOC enterprise consists of 20+ AOCs globally. The mandate of the AOC program office is to support the entire enterprise.

[45] The joint air tasking cycle consists of six stages…[it] is time-dependent, built around finite time periods to plan, prepare for, and conduct joint air operations. There are set suspenses for product inputs and outputs for each stage of the joint air tasking cycle. https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_30.pdf

[46] The legacy air tasking cycle, as referenced in [47], is limited by human-to-human interaction due to segmented value streams. This segmentation is partially the result of slow 'idea to impact' cycles that are typical in the traditional software requirements and acquisition processes of the U.S. Government.

**Conclusion**

Software development capabilities are essential in today's innovation economy. These capabilities frequently form the basis of new innovative solutions that can transform the approach to problems within large organizations (and shape their products and services). Software is also the basis of many of the 10% innovative approaches that organizations seek across much of their portfolio.

Even the private sector struggles to develop and maintain software capabilities due to the difficulties they pose to organizational design, politics, and culture. This struggle is compounded for the public sector as a result of similar but often more intractable constraints on organizational structure, cultural norms, and complex networks of power.

As such, the story of the U.S. Air Force's Kessel Run — which went from an idea to a scaled DevOps organization with impact — is worthy of study in detail, as the insights are relevant far beyond this specific case. The outlines of its story may be familiar to others – in the private sector as well as the public sector – where promised digital transformation may not have delivered the results that those at the front line need. As such, there may be analogues to the 'gonkulator' system, which represent practical but inefficient 'hacks' to meet the day's operational needs, while long-term transformation efforts – in this case with a series of defence prime contractors – fail to deliver, despite years of effort and millions of dollars spent.

In the end, this is a story with multiple stakeholders – senior outsiders, including Eric Schmidt (DIB), who question the way things are still being done; tech-savvy insiders, including Raj Shah (DIUx), who see a path to a solution; an entrepreneurial firm (Pivotal) that delivers the solution in a short time-frame; the staff in the organization (in this case the U.S. Air Force) who work in new ways alongside the entrepreneurial firm; the leaders of the organization, including Lt Gen Harrigian (AFCENT), who provide the demand and the senior 'air cover' for the experiment; and the the middle-management that carefully builds on the proof of concept into the wider corporate system. The ultimate impact can be much greater than the initial 'proof of concept' experiment might have suggested.

The story of 'Kessel Run' is also about how tackling one small operational element (in this case refuelling as part of wider air operations) can introduce innovation – even if only of a little 'i' type – and expose an organization to new ways of doing things, changing the organization, its staff and its 'culture'. The many uses of terms related to Star Wars is only one of the most visible elements of the effort to create a distinctive, creative and more tech-savvy culture.

The notion of an organizational culture is especially important, and a subsequent Working Paper will look at Kessel Run through MIT's 'three lenses' approach[47], as a way to identify some of the more hidden elements of the story above. Without a deeper understanding of the 'why' behind Kessel Run's new way of working, efforts to replicate its success elsewhere (in the U.S. and other militaries, but also others in the public and private sector) could prove less effective, and possibly futile.

[47] MIT's 'three lenses' approach: https://innovation.mit.edu/assets/BuddenMurray_MIT-3-lenses-and-innovation.pdf