The Smart State

Policy Exchange

Redesigning government in the era of intelligent services

Jonathan Dupont

Foreword by Francis Maude

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Acknowledgements

Contents

Executive Summary

Why Digital Matters

The Vision

- Imagine a government that was as efficient as an Amazon, as innovative as a Google and as well designed as an iPhone. Ever since the nineteenth century, our government has been run as a top down bureaucracy where Whitehall-knows-best. Digital technology offers the potential for a new kind of government in which the citizen is as an active and responsible user, directly in control of their public services, rather than a passive recipient of decisions mandated from the top. This in turn will allow us to create a more flexible, responsive and agile state.

- The technology exists to make this a reality today. However, future advances in AI, big data and machine learning look set to drastically magnify the opportunity. While many are worried about the potential impact of 'robots' taking the jobs, or excited about the potential for the 'Fourth Industrial Revolution' to boost productivity in the private sector, not enough people are thinking seriously about the potential to improve and reshape government over the next twenty years.

- The UK already enjoys a thriving GovTech ecosystem. In the future, the UK has the potential to become the leading world hub for the technology, working alongside our other strengths in FinTech and RegTech. While Brexit is creating understandable pressures on civil service capacity, if the state is to remain fiscally sustainable, the Government cannot afford to slow down its own progress on reform and digital transformation. Even more important than cost savings, however, is the potential for automation to create a true smarter state: responsive, intelligent and joined-up.

- According to the UN, the UK is already the number one digital government, but there is increasing concern that progress is stalling and that clear leadership is needed to ensures reforms are prioritised. In February 2017, the Government launched its new Government Transformation Strategy, centred around the vision that digital technology will allow us to transform the relationship between the citizen and the public sector.

- There are initial signs this vision is now being translated into action. As part of its new Industrial Strategy, the Government has pledged as its first Grand Challenge to "put the UK at the forefront

of the artificial intelligence and data revolution", and created a new GovTech Catalyst and £20 million fund to further develop the sector.

- The Government has the right ambition. However, to make it a reality will take more than just funding, and require a serious confrontation of the obstacles that in the past have stood in the way of digital government.

Digitalising government

- In the past, government productivity has lagged behind the private sector. Labour intensive public services are hard to automate or outsource, while government is the ultimate incumbent, blocking out new entrants. Without the power of competition, challenge and the price mechanism, the state finds it hard to allocate resources.
- Digital offers the chance to change this dynamic. Machine learning is as likely to be as powerful an enhancer of productivity in the public sector as in the private. At the same time, digital technology makes it much easier to measure performance, commoditise the benefits of scale and offer the user greater control and flexibility. While the public sector faces challenges not experienced by the private sector, such as a universal service obligation and legacy commitments, it also has its own advantages, such as access to sources of data nobody else enjoys.
- This future is already here. Initial digital tax and health accounts are already here, and by the end of the Parliament we will increasingly have moved from a 'read only' system, to a more interactive model, where citizens are able to input their own ongoing income or health data from wearables. Meanwhile, in the private sector, smartphone health subscription services can already close out the vast majority of GP enquiries at a fraction of the cost of the NHS, while machine leaning driven diagnosis can already beat many human consultants.

Can government ever get good at IT?

- Like many other major government projects, IT transformations have a record for going seriously over time and seriously over budget. Given the long and enduring record of disasters in government IT, it is tempting to adopt a position of learned helplessness. The memory of past disasters, from ID Cards to the more recent 'WannaCry' NHS hack, has left ministers and senior officials wary.
- Government doesn't always do badly at IT, especially compared to other large, incumbent bureaucracies in large companies. Over the last decade, the Government has released thousands of datasets, created street level crime maps, and turned the UK into a genuine world leader in open data.
- If Britain is to match the performance of the leading digital

companies in the private sector, it will have to overcome three challenges: legacy systems, ensuring data security in a way people can trust and breaking down the current top-down system that acts as a bottleneck, exacerbating skills shortages.

Why Digital Struggles

Turning government into a platform

- Across the private sector, the most successful companies are platforms. Rather than try and scale communication beyond a small team – and run into the inevitable bottlenecks of bureaucracy and internal politics – they restructure themselves from closed hierarchies into open, networked and digital platforms. Nowhere is the potential for a platform greater than within the Government itself, with digital technology offering the potential to finally fulfil the long standing vision of Open Public Services. Operating Government as an open platform means it can more effectively share data and connect citizens in a secure way to a wider range of new innovative providers and services.

- At present however, the Government is usually organised strictly by service, making it very hard for datasets to work together, or new players to break in and invent new ways of working. Government bodies have inherited rigid and fragmented data ownership models and are faced with the difficult task of attempting to modernise existing operating models.

- Organisational fragmentation in government comes hand-in-hand with a suite of siloed business components: disconnected data, siloed IT infrastructure and isolated pockets of IT and analytics skill-sets, all of which hinder the ability to create data-driven services.

Do people trust government with their data?

- In the wake of the Cambridge Analytica scandal and arrival of the EU's GDPR, concerns around trust, privacy and data security have grown substantially. Public attitudes towards data and privacy are far from straight forward, with many researchers pointing to the 'privacy paradox', with significant differences between what people say they value and how they behave. However, in many cases we have seen that the public is willing to share their data as long as they have trust in the organisation using it, there is a clear benefit for them, transparency over how their data is being and granular user controls allowing them to revoke access at any time.

- The UK already has a thriving cyber security industry, but will need to do substantially more to improve the security and privacy of government data. Loss of faith in government digital security, or one new major data breach, could set back the progress of digital government by years.

- New technology can be part of the answer, embedding in good practice and user ownership of their data. In the medium term, digital distributed ledgers are likely to have widespread applications in tax collection, benefit administration, land registries and health records, allowing to keep a secure and open record of who has accessed which bit of data and for what purpose.

- Technology by itself, however, will not be enough. As important, is ensuring that the user remains in control, with transparency over how their data is being used. Rather than Whitehall trying to make all the hard decisions, hiding away complexity, we should default to transparency, unless there are clear and provable harms. In the private sector, users are increasingly being given ever more granular control over which service has access to which source of their data, from their Facebook profile to their current location. There is no reason for the public sector to offer anything less, rather they should offer more.

Opening up Government

- Central Government will never be able to do everything by itself, have all the best ideas or recruit every talented programmer. Equally, it is naïve to expect all improvement to happen as a hobby project by an army of volunteers. If we are to unlock the potential for true disruption and new ideas, we need to ensure that sustainable business models exist for start-ups to earn a return and scale up their innovation. Part of being a true platform is ensuring the health of the wider supplier ecosystem.

- Traditionally, Government has struggled with early adopters. New programmes are generally expensive, risky and have uncertain impact – which is difficult to reconcile with universal, free-at-the-point-of-use services. Even those that do work demand that their users deal with the occasional bug or quirk as the kinks are worked out. Most public services are based on a principle of, at best, opt out, while innovative services work better as opt in.

- Outcomes based models like Payment By Results or Social Impact Bonds can provide suppliers with a sustainable business model, while maintaining an opt-in, free-at-the-point-of-use interface for the user. In the past, such models have struggled to build a solid evidence base of cost effectiveness, but big data offers us the potential for a much more accurate, real-time and nuanced view of their impact.

Policy

- How does the Government overcome these challenges and realise its vision of a truly Digital Government, putting the individual back in control? We suggest an ambitious, but achievable roadmap:

- **Structures**
  1. GDS should be given the medium term goal of creating a single Digital Government Account, putting the user firmly in control of who has access to their data and allowing them to opt in and out of new digital services.
  2. GDS should be moved from the Cabinet Office to DCMS, which would be given responsibility for leading on digital transformation of Government.
  3. The Government Chief Data Officer should work with GDS to manage a single, open roadmap of progress in digitalising core transactions and launching open APIs, allowing devolved administrations and third parties to interact better with central government and offer innovative new services.
  4. Each Department's annual update to their Single Departmental Plan should include an explicit account of their progress in implementing digital transformation, with GDS scoring them on their progress.
  5. The Government should trial new Payments by Results mechanisms, launching new social impact bonds in health, education and welfare allowing early adopter users to opt in to trial innovative new services.
  6. The Cabinet Office should create a new five year innovation lab centred on AI and Machine Learning.
  7. GDS, the new Centre for Data Ethics and the ICO should work together on a new set of 'privacy by default' principles for public sector organisations that handle data, including with regard to the technology they use.

- **Principles**
  Every major Government department, local Government institution or public sector body handling data should:
  1. Establish common principles for data collection and use to cover consent, retention, aggregation, anonymisation, disclosure, review, commercial data acquisition and supply, subject access and recourse.
  2. Establish a oversight framework for the use of data, data analytics and data sharing agreements.
  3. Engage with citizen groups to foster public trust and confidence, and to together understand how to maximise the opportunities from data.
  4. Establish guidelines for proportionate 'tiers of access' to data, hard coding these into the underlying systems.

- **Operations**

  From an operations perspective, every data handling body should seek to:

  1. Connect the data to establish a departmental data ecosystem.
  2. Define data quality metrics for completeness, accuracy and integrity.
  3. Establish audit and control of access principles: data registers, data catalogues, status checking and common data standards.
  4. Develop analytical capability by training officials in data science and recruiting where necessary.
  5. Adopt and develop appropriate data infrastructure.
  6. Organise data analytics into centralised, embedded or integrated teams, as appropriate.
  7. Enable agile data science through establishing appropriate operating models.
  8. Encourage the use of 'Lean' and 'Agile' techniques for advanced analytics.

Foreword

By Francis Maude

If you were to create government today, you would not build it around large, free standing Departments of State. Instead of a series of siloed hierarchies, you would structure it as a platform responding to the needs of the end user. Ministers and specialists would draw on a common pool of advice and functional expertise. Rather than every department having its own often overlapping or conflicting database, you would power it with a single core technology platform.

One reason is cost. Around the world, governments are facing the challenges of low growth, constrained budgets and rising expectations. Digital offers the opportunity to drive genuine efficiency improvements, rather than salami slicing budgets. In the short term, digital transactions can be 20 times cheaper than those over the phone and 50 times cheaper than face-to-face. In the long term, machine learning and AI offers the opportunity to automate or transform a significant proportion of the work government does.

As important as cost, however, is the opportunity to create truly modern public services, more convenient to use and responsive to individual needs. Government should be there to serve you, not the political needs of Ministers or the administrative convenience of mandarins. If you can bank from your smartphone, you should be able to check your tax return or the status of a prescription.

In order to power the most transformative kinds of digital government, we will need to maintain the public's trust in the handling of their data. That, in turn, requires digital government to be underpinned by clear principles, respecting individual privacy and remembering that ultimately power and control should rest with the citizen, not the state.

From 2010 to 2015, we showed that change is possible. In the course of a few short years, we built the Government Digital Service, closed more than 1500 websites creating the award-winning GOV.UK and embedded the principles of digital-by-default. In 2016, the UN ranked the UK as the world's leading e-government, with many other countries seeking to follow in our path. Not bad from the starting point of Britain being notorious worldwide as government IT car-crash central!

However, as this report warns, there are worrying signs that in recent years progress has slipped. Without constant pressure from the centre, the natural tendency in any large organisation is for individual departments to slip back into defensive isolation. Government as a Platform will

not happen without clear direction from the top. It is time to reboot. Government 2.0 is overdue.

Francis Maude, Baron Maude of Horsham, served over 25 years on the front bench in the House of Commons, including posts as Minister for the Cabinet Office and Paymaster-General, as well as Member of Parliament representing Horsham in Sussex, and then as Baron Maude of Horsham as Minister of State for Trade and Investment until April 2016.
As part of the 2010 Coalition Government drove forward numerous modernising reforms. He was responsible for the creation of the Government Digital Service, with the aim to consolidate internal IT and replace government websites with a single web hub.

Why Digital Matters

The Opportunity

"The business plans of the next 10,000 start-ups are easy to forecast," argues Kevin Kelly,[1] editor and widely respected futurist, "Take X and add AI." Silicon Valley, for one, is fully behind him. Google's CEO Sundar Pichai plans to shift his company from mobile-first to AI-first[2], Amazon CEO Jeff Bezos claims, "it's hard to overstate the impact IT's going to have on society over the next 20 years"[3] and Apple has been careful to position friendly articles boasting of its deep learning expertise.[4] If the personal computer was the engine of technological progress thirty years ago, the internet twenty, and the smartphone the last decade, machine learning is what technologists believe comes next.

While many are worried about the potential impact of robots taking jobs, or excited about the potential for a Fourth Industrial Revolution to boost productivity in the private sector, few are thinking seriously about the potential impact on government.

Imagine an NHS that was under the control of the patient, able to pre-emptively warn of a developing condition, and book a next day video consultation with a doctor. An education system, tailored to the different learning speeds and styles of each pupil, and freely available from childhood to retirement. An integrated tax and welfare system, making a serious dent in the annual £20 billion bill for fraud, or helping Britain's growing self-employed workforce smooth their income or save for retirement. Imagine a more targeted local government, able to identify far more precisely which buildings or streets are at risk of house fire, or a more motivated and fulfilled public sector, freed from the burden of hours of paperwork and busywork, and able to focus on real human connection.

Much of this is already possible in principle today, and in the coming decades it has the potential to become the norm.

In the following pages, we present what new technology can bring to Government and the benefits for citizens: for example, how data analytics coupled with machine-learning can improve and personalise almost any service you can think of; cutting waste, boosting productivity and transforming how we go about our day to day interactions with the government. With the help of several practical Case Studies, we illustrate the transformative power of data analytics that is already taking place.

In February 2017, the Government launched its new Government Transformation Strategy, with the vision that, "by harnessing digital to build and deliver services, the government can transform the relationship

1 "The three breakthroughs that have finally unleashed AI on the world", Kevin Kelly, *Wired*, 2014, http://www.wired.com/2014/10/future-of-artificial-intelligence/

2 "Inside Sundar Pichai's Plan To Put AI Everywhere", Miguel Helft, *Forbes*, 2016, http://www.forbes.com/sites/miguelhelft/2016/05/18/inside-sundar-pichais-plan-to-put-ai-everywhere/#5f380bfe3c31

3 "Jeff Bezos: Amazon Echo is just the 'beginning of a golden era'," Jillian D'Onfro, *Business Insider*, 2016, http://uk.businessinsider.com/jeff-bezos-code-conference-2016-5

4 "The ibrain is here – and it's already inside your phone," Steven Levy, 2016, https://backchannel.com/an-exclusive-look-at-how-ai-and-machine-learning-work-at-apple-8dbfb131932b#.qjeg1ipvp

SMART SOCIETY FOOTPRINT ANALYSIS
United Kingdom's Smart Society Footprint vs. The Global Benchmark

● ESTONIA ● ISRAEL ● NEW ZEALAND ● SOUTH KOREA ● UNITED KINGDOM
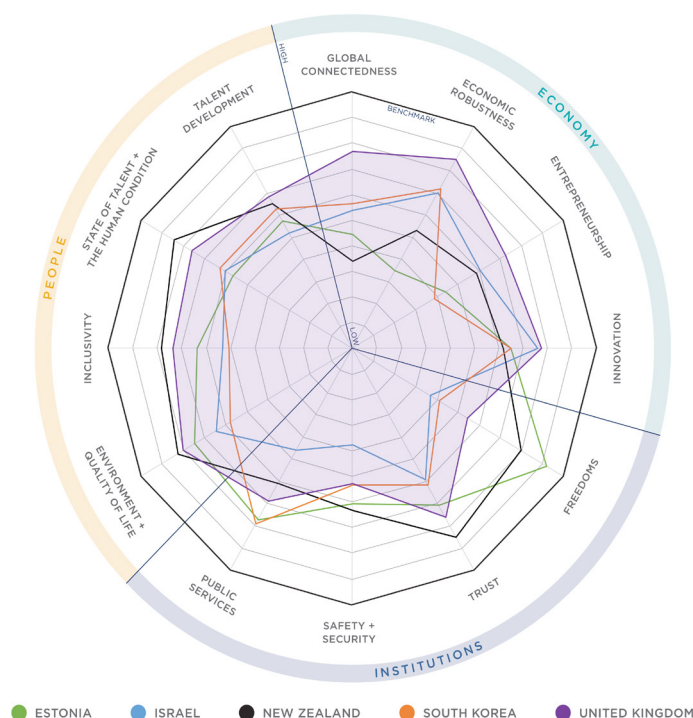
between citizen and state… The tools, techniques, technology and approaches of the internet age give us greater opportunities than ever before to help government: better understand what citizens need, assemble services more quickly and at lower cost [and] continuously improve services, based on data and evidence."[5]

At the same time, AI has increasingly become central to the Government's wider strategy. The Government's new Industrial Strategy chose as its first

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How data and machine learning can help Government

Tackling fraud using anomaly detection

- The last estimate from June 2013 reported fraud against the public sector to be £20.6 billion each year. Of this, it is estimated that central government might be losing £2.6 billion and local government £2.1 billion to fraud. A further £14.0 billion is estimated to be lost to tax fraud and vehicle excise fraud, and £1.9 billion to benefit and tax credit fraud."
- Machine learning techniques are the state-of-art fraud detection tools used by financial companies. From tax fraud to identity and benefit fraud, advanced analytics can help detect suspicious activity and enable organisations to reduce losses due to fraud.
- Anomaly detection for regulatory compliance. Regulators in financial services and healthcare could use predictive analytics to oversee compliance with rules and monitor for violations.

Improving services using predictive analytics

- Predictive hazard detection. The power of predictive analytics to target resources in an efficient way leads to cost-savings. For instance, using predictive analytics to identify properties at the highest risk of fire would result in efficient targeting of inspections, as well as improved safety outcomes.
- Predictive social care. Identifying vulnerable individuals through predictive analytics could help respond proactively in a range of services: from detecting troubled families to preventing homelessness and school truancy, advanced analytics can help tailor an appropriate response.
- Predictive analytics for crime detection. Predictive analytics could help detect crimes more efficiently, especially in areas where they are under-reported.
- Personalised and adaptive learning services, such as Isaac Physics, are using sophisticaed machine learning models to improve the effectiveness of their pedagogy for the one in four students that use the site who are studying physics in the UK. For example, they personalise the difficulty of questions that students receive to keep them engaged for longer.

Policy-making and pattern recognition

- Unsupervised learning can provide greater understanding of the challenge and guide better informed policy-making. For instance, unsupervised learning can inform better policy-making by identifying patterns in e.g. crime, court cases, or teacher behaviour. These patterns can guide specific policy interventions.

Recommendation engines

- Recommendations engines can save time and effort: for instance pre-filled tax forms help citizens have a much better experience when submitting tax returns.

Visualising data

- Departments and agencies should use service performance dashboards such as those on www.gov.uk/performance which currently show more than 800 different performance metrics across government.
- Crime Maps on police.uk is an example of a data visualisation project directed by a Government Department even prior to the establishment of GDS. Home Office publish an online map of crime data at the level of neighbourhoods (https://www.police.uk). The maps display granular monthly crime reports. Local residents, parents, teachers, local businesses and public service providers all benefit from granular neighbourhood safety information.

Grand Challenge to "put the UK at the forefront of the artificial intelligence and data revolution", while the 2017 Digital Strategy pledged to maintain the "UK government as a world leader in serving its citizens online." A new AI Sector Deal published in April 2018 saw the industry and public sector on £0.95 billion of funding for the sector, announcing the creation of a new AI Council and Office for Artificial Intelligence.

This is the right vision. However, it will not happen in the public sector without understanding what has stood in the way of digital transformation in the past, and what we will need to do differently to make it work. There is no physical reason why a digital government couldn't have as efficient a back-end as an Amazon, Google or Apple – but it will not happen by itself. Already, there are signs that central government is retreating from some of the ambition of the early days of GDS.

As the Government Transformation Strategy emphasises, transformation has to be as much about transforming services as building apps if it is to make a difference. The most innovative companies don't just create a new algorithm, but instead build a whole new business model, changing the way the market works. While much of the detail in the Transformation Strategy is sensible, it is unlikely to change the business model of government, or overcome the obstacles that have long stood in the way of structural transformation, such as legacy structures or concerns over data security. While this change is unlikely to happen overnight, the Government will need to do more to be ready to embrace truly transformative changes from 2020 on.

At a time when the Civil Service is already stretched, it is understandable why radical digital transformation might seem like a low priority goal. Preparing for Brexit will require the UK to build and implement complicated new systems for, among other things, customs, agriculture and science funding. At the same time, the Government is still not finished with the process of fiscal retrenchment, a process that is likely to continue for many years to come if the current stagnation in productivity is not overcome.

Both challenges however, also present opportunities. Repatriated services will present a blank sheet of paper, and a chance to design and build digitally native services from the ground up. Digital is not a distraction from the goal of sustainably increasing government efficiency, but the best way of achieving it.

In this paper, we outline the essential components of the data transformation that the Government needs and explain how it must be connected with the broader strategic objectives of government departments and agencies. It is addressed to Government, but should also be of interest to any business or citizen who cares how their data is used and how they might benefit from more intelligent public services.

This paper explains the key components and the associated stages of a successful Data Transformation of a government department or agency. It is based on our work with Government on data science, but also on extensive conversations with senior officials in Government and those that have

	HMRC	DWP	Home Office	NHS	Local Authorities
Anomaly/fraud detection	Tax fraud	Benefit fraud	Identity; Visas; Crime	Infection outbreaks	Housing fraud
Predictive analytics	Forecasting, policy	Policy, employment schemes	Security, crime	Tools for clinicians	Proactive social care
Recommendation engine	Pre-filled tax forms	Vacancies for jobseekers	Pre-filled forms (eg passport, visa)	Pre-filled forms (eg organ/bone marrow donor)	Pre-filled forms (eg licence applications)

Data visualisation   Dashboards (eg www.gov.uk/performance)

recently left Government. These have included conversations with people at Number 10, House of Commons, Cabinet Office, GDS, HMRC, Home Office, Google, Google Deepmind, Facebook, Adobe, Nesta and many others.

The Future is Already Here

Why is Silicon Valley so excited by the potential of AI? This is not the first time hype over artificial intelligence has soared. Previous peaks in the 1970s, 1980s and 1990s were followed by rapid disappointment and collapses in funding, bringing about an 'AI winter'. Is this time any different?

Much of the increased attention in the popular press has been the result of a series of stark technological breakthroughs over the last decade, including:

- Better pattern recognition enabled by new algorithms and sources of data, allowing computers to achieve human level abilities in handwriting recognition, distinguishing objects in photos or medical diagnosis.
- Limited self-driving cars are already for sale, with full self-driving vehicles being tested in cities worldwide. While some commentators still claim that such vehicles will somehow fail at the last hurdle, this scepticism is not shared by those working closely on them.
- At a more conceptual level, machine learning continues to conquer new types of game, from teaching itself to play Atari computer games to beating a 9-dan professional player of the computationally difficult Go.

Lying behind these advances is a combination of cheap GPU enabled parallel processing, new deep learning methods, huge investment from the private sector, and most significantly, an avalanche of new data, harvested from the internet and smartphone revolutions.

Half of all data in human history was created in the last 10 months alone. More photos were taken yesterday than in the entirety of human history up to 2012. The increasing pace of data creation is spectacular, relentless and transformative.

The data revolution is intrinsically linked to the digital revolution. 80% of adults now have a smartphone, or 91% of 18-44 year olds – with the majority making sure to check it within 15 minutes of waking up and then going on to spend at least two hours a day online.[6] Ubiquitous access to the internet has allowed a rapid transition from offline real world services to digital services in a wide range of domains, leading to a huge expansion in the amount of data we all create. From Amazon to Uber and Airbnb, digital companies have become the primary solution for many of our daily transactions.

There have, however, been other significant technological shifts in the past. The arrival of the personal computer or the internet changed many aspects of the private economy and consumer experience, but ultimately barely touched the central model of government. Why should this time be any different?

Historically, the public sector has struggled to match the productivity increases of the private sector. Before the recent stagnation, long- run private sector productivity has generally increased by about 2% a year, while between 1997 and 2010, for example, public sector productivity was completely flat, with no increases at all.[7]

Three major 'headwinds' have made productivity improvements difficult:

- **Many government services have required skilled human workers operating locally, with little potential to automate, outsource or offshore.** In the economics terms, government services are 'non routine', meaning they couldn't be described by an algorithm, or workers outside your immediate supervision. It is much harder to automate a nurse than a worker on the assembly line.
- **Without the short feedback loop provided by user choice, market prices and provider competition, public services find it much harder to efficiently allocate resources.** In the private sector, competition is a strong driver of productivity increases, forcing inefficient providers to up their game or exit the market.[8]
- **The top-down model of government makes it hard to launch disruptive innovation, or test new initiatives.** In the private sector, the most radical innovations in business models or technology come from disruptive start-ups, scaling up experiments that have first been iterated and perfected at a small scale.

The reason the current machine learning and data revolution such a big deal is that potentially they can help on all three fronts:

- **Automation and AI will make public services increasingly less**

labour intensive. Machine learning and related technologies such as big data are set to vastly increase the range of tasks that can be considered 'routine', allow them to be automated, and triage away the easiest cases.

- **Digital measurement will reduce the feedback loop between inputs and outputs for individuals and the public sector collectively, allowing better, more effective public services as a whole.** Digital technology makes it much easier to frictionlessly measure performance, efficiency and user satisfaction without creating excessive paperwork. At the same time, it can provide greater flexibility, control and responsibility to the end user.
- **Digital back-ends commodify some of the advantages of scale, making it possible for teams that are smaller and closer to the front line to match the efficiency of big organisations.** In the private sector, cloud services allow new start-ups to scale up as fast as any multinational. Equally, centralised platforms for government allow a more nimble form of policy: diverse, data driven and disruptive.

When we think of the public sector workforce, we have a natural tendency to focus on those we encounter most often at the front end: a teacher at the blackboard or a nurse helping an elderly patient to bed. Neither seems likely to be automated any time soon.

In reality, however, the public sector workforce is much more diverse than this. Of the NHS England's 1.2 million staff, only around a quarter or 321,000 are nurses, and teachers make up less than half of the total workforce in schools. Much of the rest of the public sector workforce is made up of the 1 million people in 'public administration'. If you apply the same methodology that produced the famous Frey and Osborne estimate, which said that 35% of UK jobs are at high risk of automation over the next twenty years to the public sector, you discover that an almost identical 33% of jobs are likely to be automated.[9]

Significant disagreement remains over the extent to which future jobs really will be automated. Even if the specific 33% proportion proves to be an overestimate, what really matters for the long term sustainability of the public finances is the relative difference in the ease of automation – and there is little doubt that knowledge-focused machine learning is a much more relevant technology to the public sector than the automation of the production line.

But even if no automation happened whatsoever, digital would still be a big deal.

Data is the life-blood of digital services. It allows policymakers and those delivering public services to conduct far more sophisticated policy analysis than has ever been possible before. The benefits that we highlight in this report – things like reducing kidney disease deaths, reducing fires, reducing crime – are all made possible by linking different datasets, which allows those in Government to identify the true causes behind certain events. Once the causes of something are known, it is possible to design

9 Author calculation

more effective public policy and services to address them. For example, the McKinsey Global Institute estimates that a combination of adopting best practice and using big data to optimise care, could increase productivity within the healthcare system by up to 22% by 2025.

As important as data is for central government, it can be even more transformative for the end user. Ultimately, it is individual patients and parents who are best placed to benefit from and contribute to the success of innovative public services and big data. No amount of additional public funding can substitute for unhealthy eating, not getting enough exercise or skipping your homework. Closing the feedback loop between our individual choices and outcomes will make it easier for us to take the right long-term decision. Given that around 70% of the NHS's budget already goes to patients with long term chronic conditions, making best use of patient controlled data and data informed medicine will be critical for cost control going forward and improving outcomes for patients.

In healthcare, for example, the combination of wearables, digital medicine, smartphone apps and cheap genetic testing is creating a revolution in preventative medicine. A smartphone can monitor an individual's vitals 24/7, cross-referencing that data with everything else it knows about them. Over time, this level of data is going to become still more embedded and automatic than it already is, which combined with smart algorithms and knowledge about an person's pre-existing risks will allow people to identify problems like high blood pressure, or type 2 diabetes, before they become critical – and much more expensive to treat. No GP can match that.

This is not just a blue sky theory, but is already happening now through a range of innovations such as:

- **Patient controlled and app-based health subscription services**, like Babylon or Push Doctor. Babylon, costs the individual just £4.99 a month, yet estimates it can close out 85% of enquiries – saving the NHS an average of £45 for each GP consultation .
- **Machine-learning diagnosis systems** can already outperform many human consultants, while chat bots are available that replace triage services like NHS 111. Other innovative apps can help with earlier diagnosis of autism by having children play a game on an iPad, or diagnose genetic conditions simply using a photo of your face.
- **New types of near-zero marginal cost digital medicine.** Computerised cognitive behavioural therapy has been shown in randomised control trials to be as effective in many cases as human led therapy, leading to new products like Deep Health's Sleepio tool, designed to tackle insomnia.

In the NHS, the Health Secretary Jeremy Hunt has pledged that by the end of 2018, every patient in England will be able to use an app for the following: NHS 111, their healthcare record, booking a GP appointment, ordering repeat prescriptions, expressing their preferences for things like organ donation or

data sharing and accessing support for managing long-term conditions.[10]

More broadly, Public, a new GovTech funder and accelerator, has identified as many as 100 British GovTech firms, and argued that the UK has the potential to become a wold hub for the sector. They estimate that the current UK GovTech market is worth £6.6 bn, with the potential to expand to £20 bn by 2025.[11] Seeking to build on this, the Government's Industrial Strategy has pledged the creation of a new GovTech Catalyst and £20 m fund.

In the long run, an increasingly digital government is most likely inevitable. While it may have lagged behind the private sector, every part of the public sector eventually did get a website. Even if digital government in Britain stood completely still, eventually the difficult problems will be solved by other countries. If the NHS doesn't allow patients open digital access to their health record, a firm like Google or Apple will develop services that match the digital preferences of users.

But this would be a shame. Firstly, it would risk creating a two-tier health service, where the wealthy can afford the integrated digital approach, while everyone else is left behind using an analogue NHS. As important, government could end up needlessly wasting billions on inefficient processes, and potentially forfeit progress in areas like welfare, where sustainable private business models are always likely to be hard.

Britain is genuinely a world leader in digital Government, with the UK coming top in the UN's 2016 rankings of e-government – with the creation of Gov.uk and the efficiency savings achieved by digital transformation specifically referenced as setting an example for other countries.[12] Looking forward, there is real interest in some parts of Government about the possibilities of digital and machine learning. But at present this enthusiasm is largely confined to Number 10 and specialist project teams within Departments and the Cabinet Office.

To the extent that data and AI are understood, too many think of these things as being the preserve of those that work on digital projects. In Government, attaching the word "digital" to a function or team usually means it is for "someone else". But data science and AI can be so transformative in the way public services are delivered, that they should be at the heart of politicians' and civil servants' deliberations over the future of government and the next stages of public sector reform.

Even more fundamentally, many people simply lack confidence that anything like this will ever happen. Even if it is physically possible, past experience suggests that governments simply don't do IT projects very well. While Amazon or Google might be able to take full advantage of the transformative power of AI, we are much less sure about Whitehall.

Can Government ever get good at IT?

Given the long and enduring record of disasters in government IT projects, it is tempting to adopt a position of learned helplessness. Nobody wants to create the next NHS National Programme for IT (a £10 billion write-down) or BBC Digital Medium Initiative (fortunately, only £98 million

10 *Health Secretary challenges NHS to deliver digital services nationwide,* Department of Health, 12 September 2017, https://www.gov.uk/government/news/health-secretary-challenges-nhs-to-deliver-digital-services-nationwide

11 State of the UK GovTech Market, Public, 2017, http://www.public.io/wp-content/uploads/2017/07/Public_GovTech_market.pdf

12 United Nations E-Government Survey 2016, http://workspace.unpan.org/sites/Internet/Documents/UNPAN96407.pdf

lost). Even the Obama administration, famed for the sophistication of its digital campaigning, ultimately proved unable to smoothly launch the website for its signature policy initiative, Healthcare.gov.

Internationally, major government IT projects seem to have only a slightly better reputation for delays and cost overruns, than nuclear power stations or airport runways. More systematically, Flyvbjerg (2005) found out using a database of 258 transport projects, that 90% seriously overran, with no evidence that forecasts are improving. There is little reason to believe that projects in other areas such as energy, defence or, most relevantly, IT are any better.[13] A third of the projects in the Government's Major Portfolio that are supposed to deliver in the next five years, are currently rated as red or amber-red.[14]

Not unreasonably from the perspective of politicians who take the public blame for mistakes, the memory of disasters involving personal data, from ID Cards to CDs being left on trains, has left ministers and senior officials wary. The unfortunate result is an intense frustration involved in accessing data held within, let alone across, organisational boundaries.

All that said, the Government doesn't always do badly at IT – especially compared to other large, incumbent bureaucracies in large companies Over the last decade, the Government has released thousands of datasets, created street level crime maps, and launched digital tax accounts for every individual and small business. The UK is genuinely a world leader in this, with the independent Open Data Barometer putting Britain at the top for all three of its measures: readiness, implementation and impact.[15] Over the next five years, progress is also expected to continue with the roll-out of the Pensions Dashboard, Universal Credit and Real Time Information, as well as better online integration and patient access to health records.

Beyond the success in opening up data, and the internationally admired Government Digital Service (GDS), the HMRC roadmap for extending digital tax accounts seems to be on track; TfL maintains one of the world's most sophisticated systems for open data and payments; G-Cloud and the digital marketplace have helped open up public sector procurement to SMEs.

Neither is sophisticated digital government a theoretical abstraction, that exists nowhere in the world. Estonia already operates a mass e-identity system which acts as the heart of a secure decentralised digital infrastructure, allowing citizens to digitally identify themselves, vote, complete tax returns, upload wills, obtain a prescription, set up a business or sign a contract. Their eKool system allows parents to instantly see grades, homework and class attendance, with plans to use distributed ledger technology to secure over a million health records, giving patients the power to authorise and have complete transparency over exactly who accessed their data.

At heart of heart of Estonia's data architecture is a system called the "X-Road", connecting together databases across departments and agencies. All the digital services in Estonian government that rely on more than one database use X-Road, avoiding the need to make copies of databases, or mandate the establishment of a centralised data owner/controller. This tool can be used to search across and write to multiple data-bases, as well as

13 *Underestimating Costs in Public Works Projects*, Bent Flyvbjerg, Mette Skamris Holm, and Søren Buhl, 2002, http://flyvbjerg.plan.aau.dk/JAPAASPUBLISHED.pdf

14 *Delivering major projects in government: a briefing for the Committee of Public Accounts*, NAO, 2016, https://www.nao.org.uk/report/delivering-major-projects-in-government-a-briefing-for-the-committee-of-public-accounts/

15 ODB Global Report Third Edition, World Wide Web Foundation, 2015

transmit large amounts of data in a secure way. Over 170 databases are offered through X-Road, and over 2000 services rely on it.

Nevertheless, there is a still long, long way to go before we have anything like what you might describe as a truly digital government in Britain. While in the long term the Public Sector Efficiency Group identities technology and data as the route with the most potential for savings, so far it has made a near negligible contribution. Of the efficiency savings the Government gave details on in the last Parliament, just 1.4% came from digital.[16]

Why has Britain struggled to replicate the success of an Estonia – and what fundamental problems do we need to solve if we are to make a difference in the future?

Three stand out:

- **Legacy systems and service design**

   In Britain, we are still surrounded by many legacy contracts, databases and systems. Vast parts of the government apparatus still run on paper, while at present, many of the datasets held by different Departments are not just overlapping, but contradictory.[17] Over the last Parliament, GDS transformed 20 exemplar transactions to 'digital by default'[18], but Government as a whole is made up of over 700 such services.

   The problem is as much about culture and internal politics, as it is to do with data specifications. It is not just that IT systems often refuse to talk to each other. As with most older legacy organisations, Government has inevitable problems with size, turf wars, broken communication and inflexible regulation. If you created a government today, it is not clear you would build it around the siloed departments that we have now.

- **Data security and user trust**

   No security system is perfect. Even the most sophisticated technological defences can often be routed around with the right social hack, or old fashioned deception. Government is not the only organisation to struggle with data security, and over the last few years, many large corporates, from Sony to TalkTalk, have found themselves subject to catastrophic data breaches. The recent chaos caused by WannaCry ransomware in the NHS suggests that there is still a long way to go in terms of ensuring basic security and government must make this a priority.

   Nevertheless, enabling truly revolutionary data driven improvements will require the boundaries between the datasets held by users and the state to become more porous. New technologies like distributed ledgers or differential privacy can play a key part in this, baking in best practice from the design level. As important, however, will be giving users a sense of transparent ownership over their data, making sure they are both in control and can experience direct benefits. If your phone is to constantly

16 Government unveils £14.3 billion of savings for 2013 to 2014, Cabinet Office, 2014, https://www.gov.uk/government/news/government-unveils-143-billion-of-savings-for-2013-to-2014

17 *Open data*: Matt Hancock speech, Cabinet Office, 2015 https://www.gov.uk/government/speeches/open-data-matt-hancock-speech

18 https://www.gov.uk/transformation

record your health statistics, that data belongs to you – not the government.

- **Skills and top-down control**
  The first challenge is the lack of appropriate tooling and advanced analytical skills needed in Government. While many organisations in the private sector are grappling with the same issue, the problem is particularly acute in the public sector, who will always struggle to match the pay and freedom offered by firms in what is one of today's most profitable sectors. This need not be a deal breaker the sense of mission offered by the public sector can to some extent offset the monetary disparity – but it does make implementation harder.

  As important, will be to take full advantage of the skills that already exist in the private sector. Central Government does not need to build everything itself, but instead set the standards and create a welcoming environment for a more open and porous public sector. New, more agile firms should have the opportunity to break in and disrupt old ways of doing things.

  In the next chapter, we will look more deeply at what Government should do to meet these challenges.

Why Digital Struggles

The Problem with Communication

"Communication is a sign of dysfunction." As reported in Brad Stone's book *The Everything Store*, an early meeting saw Amazon CEO Jeff Bezos espouse a now infamous, counterintuitive view: "It means people aren't working together in a close, organic way. We should be trying to figure out a way for teams to communicate less with each other, not more." In later speeches, Bezos would go on to expand this philosophy, arguing that "A hierarchy isn't responsive enough to change."

Ever since, Amazon has been structured into small, modularised ten people or less, known as 'two pizza teams'. Interaction between the teams happens strictly through standardised channels, such as APIs that can later be opened up just as easily to third party developers as other internal teams. No group has to wait for permission and buy in from the whole company to try something out.

One striking feature of today's tech giants is their ability to almost instantly roll out and ramp up massive new projects, going from zero to millions of users in a matter of weeks, if not days. By contrast, seven years later, Universal Credit is progressing slower than expected. While this pace is partly cultural, it is even more fundamentally technological and organisational. Tech giants like Amazon are not nimble by accident, but because they have purposely designed themselves to be that way.

Across the private sector, many of today's most successful companies are platforms. Driven by the near zero marginal costs of digital, both modern tech giants and old corporates are turning themselves from closed, hierarchical bureaucracies into open, networked and digital platforms. AirBnB, Amazon, Google, eBay, Facebook and Uber all drive their value not just from their internal talent, but acting as a two-sided market that connects customers with a large network of providers. Accenture argues that the top 15 platform companies now account for $2.6 trillion of market ecentralized , and lists among the companies adopting platform strategies: Fiat, Kaiser Permanente, Disney, Goldman Sachs and Philips Healthcare.[19] The Center for Global Enterprise went even further, identifying a global list of 176 platform companies worth $4.3 trillion.[20]

Nowhere is the potential for an open platform greater than within the Government itself. Digital technology offers the potentially to finally fulfil the long standing vision of truly Open Public Services. As Tim O'Reilly first argued back in 2010, Government as a Platform offers the possibility of a more innovative, experimental and participatory state.[21] The vision

19 *Platform Economy: Technology-driven business model innovation from the outside in*, Accenture, 2016, https://www.accenture.com/fr-fr/_acnmedia/PDF-2/Accenture-Platform-Economy-Technology-Vision-2016-france.pdf

20 *The Rise of the Platform Enterprise: A Global Survey*, Peter C. Evans & Annabelle Gawer, The Center for Global Enterprise, 2016, https://thecge.net/wp-content/uploads/2016/01/PDF-WEB-Platform-Survey_01_12.pdf

21 *Government As A Platform*, Tim O'Reilly, http://chimera.labs.oreilly.com/books/1234000000774/ch02.html#I_sect12_d1e2456

for Government as a Platform is to learn from Silicon Valley, and build a similarly nimble, decentralized and open infrastructure, allowing small teams to experiment with new ideas and diverse methods. Rather than try and rebuild everything at once, new digital initiatives can be built in a much more agile, evolutionary process. Projects can be scaled up after they have been shown to work, and not before..

Of course, government has its own challenges not faced by a social media network or shopping site. The costs from 'moving fast and break things' can be much greater, as the Government often either has a universal service obligation or simply morally cannot leave anybody behind. While tech giants can close down failing products overnight, there are often good reasons why we seek greater stability from public services. A serious data loss in a Hollywood studio is bad; a serious data loss in HMRC would be catastrophic.

That does not mean that government cannot be aplatform, but it does mean that progress may inherently be slower and more evolutionary, always ensuring that data security is never compromised.

While Government as a Platform is a much broader concept than its usual technological interpretation – it includes being open just as much to welfare charities as to app designers – a modern digital backend is a prerequisite for making it a success, enabling the open, secure exchange of information within and without Government. While it may never achieve the nuance of face-to-face judgment, shared formal data is what allows the different parts of an organisation, market or society to work together – especially in areas where talking and direct human interactions don't fully scale.

We often think of a government as a single agent: as if Theresa May, or at most a team of 23 Cabinet ministers, was personally responsible for everything it did. But in reality, the Government is enormously complex: a collective effort of 45 departments, 390 agencies and public bodies, 5,500 organisations, 5.3 million workers and 64.6 million residents. There is no way to think of this but as a complex ecosystem with decision making, power and responsibility, widely distributed across many different levels.

At present, the Government is usually organised by service, with areas like education or health organised into separate departments. This separation makes it very hard for datasets to work together - but the quality of machine learning and AI is almost completely dependent on the quality, volume and integration of data.

In practice, government has struggled to link together services, when they are not completely new. Verify, one of the three flagship components of Government as Platform, intended to provide a single mechanism for identity assurance, but has yet to persuade HMRC to adopt it, as they argue it does not meet their needs.

The most successful data-driven companies of our day did not exist 20 years ago. Their leadership had the benefit of beginning with a blank screen, never having to grapple with legacy organisational boundaries and a fragmented data ownership structure. By contrast, Government bodies have inherited rigid and fragmented data ownership models and are faced

with a far more difficult task of modernising existing operating models.

Back in the 1980s, the so-called New Public Management era saw the decentralisation of government services through the creation of government agencies. As the private sector embraced outsourcing as a boon of efficiency, the public sector too embraced its own form of outsourcing of services to specific agencies. One result of this decentralisation is that the data is now scattered across numerous agencies, with each agency owning datasets relating to the services they provide.

Organisational fragmentation comes hand-in-hand with a suite of siloed business components: disconnected data, siloed IT infrastructure and isolated pockets of IT and analytics skill-sets, all of which hinder the ability to create data-driven services.

Handling siloed data is not just inefficient and creates higher costs, but can lead to significant cracks in service provision. For instance, Local Authorities have valuable local knowledge: they know their neighbourhoods, the demographics, the local issues and challenges. However, there is often very little actual data sharing and coordination between different Local Authorities, negatively impacting the people living on a boundary.

Joining up data is not just about reducing costs, however. By joining up datasets, we significantly expand the ability of smart, automated public services to predict, triage and get ahead of problems. Many public services and priorities, from lifelong learning to troubled families, are inherently cross departmental. The current division of responsibilities means departments can end up duplicating services, working at cross purposes, or simply fail to recognise what is going on – whereas a shared, canonical dataset reinforces joined working.

The level of senior awareness and leadership that will be necessary to transform our national information infrastructure is only just emerging, as departments begin to appoint Chief Data Officers. However this transformation unfolds, it will inevitably involve every part of the organisation. This is not a job for the IT department, but will reach into the heart of policy making and operational leadership.

Do people trust government with their data?

In order to create truly interactive public services, we will need not just the read-only access to data pursued so far, but the ability to write, edit and mash it up. Increasingly, users will not just be the passive audience for data, but the generators of it.

All patients already have access to their summary care record, and by the end of the year they will have access to integrated app for medical records, repeat prescriptions, booking a GP appointment and NHS 111. By the end of the Parliament it is expected they will both be able to add their own comments and link data from wearables such as a Fitbit or Apple Watch. HMRC has now launched digital tax accounts for both individuals and businesses, but it is only from next year that taxpayers will be able to directly feed in information on additional sources of income, with the APIs for third party integration to be gradually built out over the rest of the Parliament.

As data capture and utilisation becomes more personalised and more obvious, increased concerns about trust, privacy and data security are inevitable. The ongoing Cambridge Analytica scandal and the arrival of the EU's new GDPR for data protection have refocused attention on data security and privacy. Given the current weak level of safeguards built at a fundamental technological or institutional level, the public is not wrong to worry about the potential for their data to be leaked or misused.

Lack of trust has already affected progress in digitalising government. The NHS's flagship Care.data system was designed to link together anonymised data about patients into a single database to allow better research, an objective supported by nearly everyone. Nevertheless, misgivings over privacy around its launch led to widespread concern by over 700,000 patients,[22] with 41% of GPs surveyed saying they intended to opt out.[23] The programme ultimately was put on pause, and after the Caldicott Review on data security and consent, cancelled altogether.

One complicating factor in Britain has been the political desire not to create the digital equivalent of an ID card, with all its perceived civil liberties implications. The 2017 Government Transformation Strategy confirms that the Government has no plans to create a national identity database.

In practice, this debate is increasingly esoteric: Government already has a fairly centralised form of identity, based around National Insurance numbers, while even if other databases are kept theoretically separate, with the right infrastructure in place, digital makes it fairly trivial to link them up. Maintaining separate logins for national insurance, tax, your driving licence and the NHS is more security theatre than a real defence.

Overall, public attitudes towards data and privacy are far from straight forward, with public beliefs pragmatic, dependent on how much they trust the brand in question and what they can expect to receive in return. Many researchers have complained of 'privacy paradox', in which consumer behaviour does not match expressed attitudes – relatively small incentives can lead to users willing to disclose fairly significant amounts of data.[24] If they see the benefits and think the data will be used for their own good, many are increasingly willing to share the details of our social life on Facebook, track our exercise regime through a FitBit or even put an always-on smart speaker microphone in the lounge.

Similarly, polling suggests that the public as whole is not nearly as against the principle of sharing data as it is sometime portrayed, provided there is a clear benefit and that transparent security measures give them trust and control Ongoing polling for DMA suggests that consumers are increasingly more comfortable ideologically with the idea of sharing their data, with 40% claiming trust in the organisation as the most important factor in deciding whether to share information, 70% saying they would be happy to share data in return for a direct financial reward or discount and only 24% completely unwilling to provide personal information.[25] On the other hand, polling by TRUSTe finds growing concern over online privacy (92% in 2014), falling trust in online businesses (51%) and 54% saying they want clear procedures for how to remove personal information.[26] Polling

22 "NHS overriding 700,000 patient opt-outs to GP data being shared", Alex Matthews-King, *Pulse*, 5 May 2015

23 "Over 40% of GPs intend to opt themselves out of care.data scheme", Nigel Praities, *Pulse*, 24 January 2014

24 *The Digital Privacy Paradox: Small Money, Small Costs, Small Talk*, Susan Athey, Christian Catalini and Catherine Tucker, 2018

25 *Data privacy: what the consumer really thinks*, dma, June 2015

26 2015 TRUSTe UK Consumer Confidence Index, https://www.truste.com/resources/privacy-research/uk-consumer-confidence-index-2015/

for Big Brother Watch found that 78% of respondents were concerned about online privacy, with 46% believing consumers were being harmed by data collection – but on the other hand 75% also said they would not be willing to pay anything at all for currently free services like Google or Facebook, suggesting that their concerns are not that fundamental.[27]

Public services are fortunate in that the public seem more willing to give them the benefit of the doubt, with 41% telling IPSOS Mori they highly trust their GP, 36% the NHS, and 28% the police – compared to 13% for online retailers, 10% supermarkets and 4% the press. However, if you ask how much they trust 'the British Government' compared to a specific service, trust falls to 13% - demonstrating just how important it is to be clear with the public over how and why government wants to use their data. In total, 44% thought the risks outweighed the benefits of joining up public data (compared to 33% in favour) – although a majority were in favour if additional safeguards such as anonymisation, opt-outs and strict controls on access were introduced.[28]

One potential technological route to data security is the use of blockchain or distributed ledger technology, as pioneered in digital crypto currencies like Bitcoin. Blockchains use peer-to-peer cryptography to create a shared permanent record of who has done what, ensuring both security and privacy, while remaining open to third parties and with transparency over what has changed. Sir Mark Walport, the Government's former Chief Scientific Advisor, has argued that distributed ledgers have "the potential to redefine the relationship between government and the citizen in terms of data sharing, transparency and trust."[29] In the future, digital distributed ledgers are likely to have widespread applications in tax collection, benefit administration, land registries and health records.

This technology is already relatively developed. Blockchains are already in use in Estonia as part of its digital identity system, while back in Britain, Google's DeepMind, arguably the the world's leading machine learning company, is developing a new project called Verifiable Data Audit for its Health services. Under this system, a secure record will be kept every time a piece of private health information is accessed – and as important, what is then done with it.[30]

While better technology can help significantly with data security, it is not a silver bullet. It cannot prevent social hacks, or attacks that come as the result of out of date software, as in the case of NHS and the WannaCry virus. As with all digital transformation, redesigning services to use technology with security principles built in from the ground up and from end to end, matters as much as the technology. In recent years, the Government has invested £1.9 bn in cyber security, established a National Cyber Security Centre and promised to strengthen cyber security standards for government and public services.

However, while maintaining the highest standards and doing better on cyber security is essential, retaining public trust will be as much about political choices and maintaining user control as better algorithms. The public do not just fear that their data will be stolen, but often distrust

27 *Big Brother Watch – Online Privacy*, ComRes, March 2015, http://www.comres.co.uk/wp-content/uploads/2015/03/Big-Brother-Watch_UK-Tables_9-March-2015.pdf

28 *Public attitudes to the use and sharing of their data*, Research for the Royal Statistical Society by Ipsos MORI, July 2014, https://www.ipsos-mori.com/researchpublications/researcharchive/3422/New-research-finds-data-trust-deficit-with-lessons-for-policymakers.aspx

29 "NHS urged to adopt bitcoin database technology", Robert Cookson, *Financial Times*, January 19 2016

30 Trust, confidence and Verifiable Data Audit, DeepMind, 2017, https://deepmind.com/blog/trust-confidence-verifiable-data-audit/

what the state itself plans to do with it. The most recent Caldecott Review recommended a new opt out model for healthcare, in which patients would be able to opt out of personal confidential data being used beyond their own direct care.[31]

This is not a bad principle to extend out across the public sector. However, a simple binary in or out decision is likely to become increasingly clumsy as the range and breadth of potential data grows. While we might be prepared to opt in to sharing the last thirty days of activity or heart rate data with our GP, that does not mean we want that data to be shared back with HMRC, let alone sold externally. At the same time, without more transparency over what data is being used for what, there is a risk that the decision is being made under little more than pre existing prejudices.

In short, to create a truly integrated but secure system, we will need much more sophisticated systems of control. Rather than Whitehall-knows-best, trying to hide away all complexity, we should move towards an open transparent system that puts the user fully in control.

In the private sector, users are increasingly being given ever more granular control over which services has access to which source of their data, from their Facebook profile to their current location. There is no reason for the public sector to offer anything less, rather they should do more.

Free

Much of the internet is free. Inspired by the success of non-commercial crowdsourced projects like Wikipedia or Linux, many idealists hoped that the power of a more activist digital citizenry would be enough to transform government.

For the most part, 'wiki Government' has been a disappointment. Opening up vast numbers of datasets has created some useful transit apps, but has not really changed the work of the Department for Transport. Despite being pointed to as the 'Californication' of Government[32] and receiving over 30,000 submissions, the model of the crowdsourced Red Tape Challenge has yet to be widely replicated.

The petition.parliament.uk service, guaranteeing any contribution with more than 100,000 signatures is considered for debate, has yet to reshape democracy. FOIs have proved more a tool for embarrassing politicians than truly opening up the workings of government. A volunteer attempt to save the NHS £100 mn a year in licensing costs by developing a secure open source OS, NHSbuntu, was met only with legal demands to stop using the government's trademark, despite claims that NHS leadership wanted to engage with the project.[33]

Perhaps partly as a result, the Government's current digital initiatives are much more modest, and mostly focussed inwards. The Cabinet Office's drive for 'Government as a Platform' largely keeps things in house, mostly focused on creating common tools and datasets internally, rather than opening up the public services to third parties. Local government has largely been excluded from the conversation, while HMRC and the Department for Health have been left to look after themselves.

31 *Review of Data Security, Consent and Opt-Outs*, National Data Guardian for Health and Care, 2016 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/535024/data-security-review.PDF

32 *The 'Californication' of Government? Crowdsourcing and the Red Tape Challenge*, Martin Lodge and Kai Wegrich, November 2012

33 https://www.theregister.co.uk/2018/01/18/nhs_buntu_trademark_cease_and_desist/

Technology creates the opportunity for a more experimental, innovative and bottom-up public sector. Once the underlying digital system is fully in place, local authorities or job centres could test crucial variables, such as the taper rates or work allowance payments in Universal Credit, to learn their real impact on work incentives. Digital tax accounts could integrate with your bank account or an employment coach to encourage greater saving or help you build your skills. Integrated health records could pull in data from your wearable device or gym, or allow users to set their own commitment contracts..

But none of this will happen if public and private institutions can't develop a sustainable business model. We are unlikely to be able develop digital Government for free, or rely solely on a volunteer hobby economy. Wikipedia, it turns out, isn't a suitable model for the whole economy. Many types of products can't be created by billions of small edits in a spare hour here or there, but instead require the kind of sustained, focussed attention that only a full time job or a whole company can provide.

So far, Government has not been a very good steward of its platform. Like many companies, it has suffered from a 'build it and they will come' laissez faire delusion. While many technological products of the last ten years have come with their own API or app store, only a vanishing few contain much that acts as more than a gimmick. The most successful platforms have popular 'killer' apps, incentives for key partners, highlight their best offerings and offer a fair share of revenue for everyone. TV companies prioritise exclusive content, shopping malls their anchor clients, supermarkets their best selling brands.

While the Government has done a good job of encouraging a more diverse procurement ecosystem through initiatives such as G-Cloud, it has done much less well in the user facing space. Even putting funding to one side, public and overladen institutions like the NHS are inevitably risk averse, especially for ideas that can't promise to save money within the next budgeting period. Despite being strong supporters of the NHS, some healthtech firms have found themselves having to move from London to San Francisco, as they have struggled to make their business models work under the British system.

The great advantage of an open platform system is that most services are rarely one size fits all – and this is doubly true when it comes to innovation. Early adopters aren't like everyone else and help develop innovative ideas into stable products.

Traditionally, government has struggled with early adopters. New services are generally expensive, risky and with uncertain impact. Even those that do work demand that their users deal with the occasional bug or quirk as the kinks are worked out. Most public services are based on a principle of, at best, opt out, while innovative services work best as opt in.

Being too open to each and every new idea in the public sector risks drastically inflating costs - while being too cautious could lead to innovation being a privilege of the rich. As digital technology inevitable places more control and better options in the hands of the user, the pressures pushing

us towards an undesirable two tier system are only going to grow.

The current binary division between public and private services already struggles. We know that two of the most powerful drivers of a long, healthy life are regular exercise and strong relationships - but that doesn't mean that government should pay for everyone's yoga class or their social life. Many future goods, especially in the digital space, are likely to fall into this blurred area between the public and private sector.

In some places, we can avoid this tension by subsiding those on low incomes, using market prices to ration overuse. In others, as a point of principle we want to maintain 'free at point of use' – but how can we ensure that remains sustainable as the boundaries between necessity and luxury become more fluid?

One is the increased use of outcomes based models. Rather than pay providers up front, we compensate them after they have already delivered the outcomes we want. For the user, the service remains opt-in and free at the point of use, while as long as the provider's product works, they can enjoy a more sustainable business model and lower barriers to entry than the vagaries of public sector commissioning.

The UK is already a world leader in outcome-based models like Payments By Results (PBR) and Social Impact Bonds, with the NAO estimating they now account for over £15 billion of public spending.[34] They have been used extensively in welfare-to-work, offender rehabilitation and international aid. Social Investment Bonds, a subset of PBR, allow private investors to make a return by injecting capital into new and typically unproven methods of service delivery – with the government only itself paying for the outcomes achieved. The UK launched the world's first Social Impact Bond at Peterborough Prison in 2010, which based on the data released so far seems to have to led to an 8.4% reduction in reconviction. Social impact bonds are now rapidly gaining in popularity across the world and are being used in diverse ways to lower unemployment, fund preschool and boost adoption rates.[35]

However, somewhat ironically, PBR models as a whole currently have only a weak evidence base on actually delivering results, with the NAO warning of the difficulty in designing contracts that deliver appropriate incentives and monitoring. In March 2016, the Cabinet Office announced the creation of a new Government Outcomes Lab to spread best practice and better understand where outcome based models are likely to be most effective.

The challenge with all PBR models is the difficulty in proving or measuring the counterfactual. How do you know the good outcome really was the result of the intervention, rather than chance, reversion to the mean or some external factor?

This, however, is exactly the sort of problem that the spread of big data and machine learning can help with. Government should stand ready to take opportunity of more sophisticated forms of measurement to enable new outcome based business models. Over time, PBR systems should evolve from their current relatively bureaucratic form to much more digital

34 *Outcome-based payment schemes: government's use of payment by results*, NAO, 2015, https://www.nao.org.uk/report/outcome-based-payment-schemes-governments-use-of-payment-by-results/

35 *The payment by results Social Impact Bond pilot at HMP Peterborough: final process evaluation report*, Emma Disley, Chris Giacomantonio, Kristy Kruithof and Megan Sim, Ministry of Justice, 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/486512/social-impact-bond-pilot-peterborough-report.pdf

and less proscribed forms. This would allow much more permissionless innovation in the public sector and enable early adopters to opt into new programmes rather than have it forced upon them.

In welfare, for example, machine learning could make it much easier to identify the claimants with the hardest or most complex needs earlier and more accurately, enabling better incentives for work providers who take on the toughest cases. If healthcare providers can demonstrate their service or app delivers measurably improved biomarkers, such as lower blood pressure or cholesterol, than current NHS tariffs, they should be partially reimbursed – creating a win:win:win for patient, company and government. If an online MOOC or training course run by a private provider can help the unemployed learn new skills and gain employment, it is not unreasonable they should be able to claim back out of the adult skills budget.

This kind of digitally enabled business model has the potential to enable central Government to draw on the best ideas and talents, wherever they are found – and in the process, create a much more agile, flexible and innovative public sector.

DATA TRANSFORMATION JOURNEY
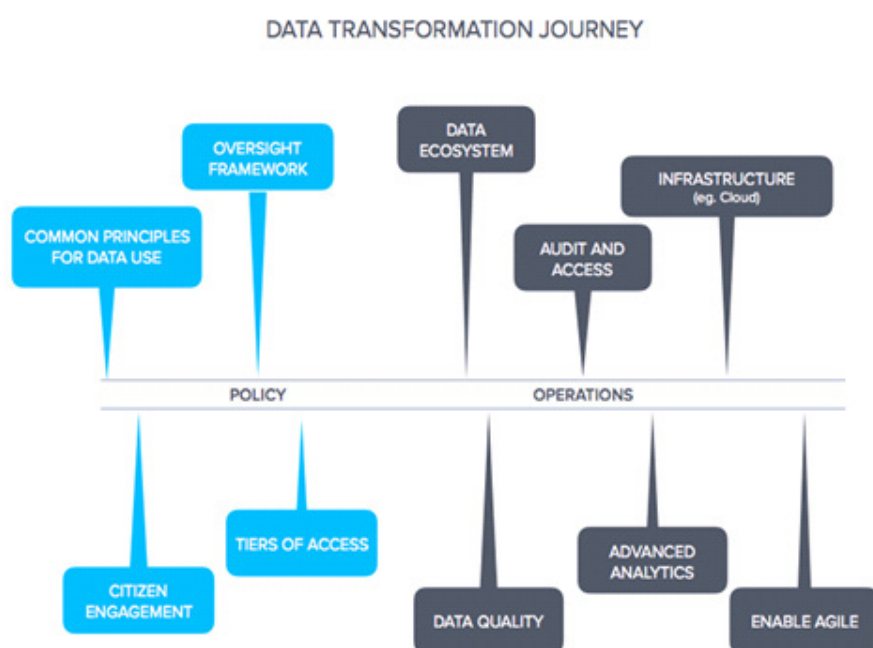
Policy

How does the Government overcome these challenges and realise the vision set out at the start of this report? How can it make the most of the opportunities presented by Artificial Intelligence and data science? In this section, we set out a route map with a list of practical ideas to help Government achieve its vision of digital transformation.

We start by looking at the big picture structural changes Government needs to make to unblock the obstacles currently standing in the way of digital government: legacy structures and overly siloed departments; citizens' fears about how their data is being used; an overly top-down structure that makes it hard for disruptive innovators to break in and offer people better public services.

We next move on to the details of how organisations across the public sector can put this into practice. The organisational journey to data maturity requires coordinating many different elements of change. For instance, the development of technical capabilities need to occur alongside the establishment of appropriate policies and oversight arrangements. This section explains – as simply and practically as we can - the necessary components of data transformation for any Government department or agency. While the focus is on government, common principles mean that it can also benefit a private sector or third sector organisation embarking on a similar data transformation journey.

Structures

1 GDS should be given the medium term goal of creating a single Digital Government Account, putting the user firmly in control of their data and digital services.

The bringing together of over 300 separate websites into the single Gov. uk over the course of 2014 was widely – and rightly – recognised as a significant early success for the nascent Government Digital Service.

However, since its creation, Gov.uk has not continued to evolve fast enough, and remains largely organised around the needs of Whitehall departments.

Both information and individual services remain siloed and hard to find, with little attempt to provide clarity over who has access to what data. The site remains optimised for desktop computers, rather than smartphones,. There is still no app for either iOS or Android. While the decision to initially prioritise a responsive website over native apps was understandable in 2013, today most other organisations have recognised

the need to go where the user is and provide a customised native experience. Most critically the site and content is static, one size fits all, with next to no customisation options for the end user.

Other nations have copied Gov.uk, but we should continue to evolve rather than rest on our laurels.

Compare Gov.uk to a modern web service like Google, Facebook, Microsoft or Amazon, where:

- Home pages dynamically alter to meet the needs of the users, surfacing relevant services and de-emphasising the irrelevant
- Citizens can interact however suits them best, from keyboard and mouse through to touch, voice or chat bot
- APIs allow third parties to extend and build on core competencies, meaning users can patch together different services in the best way for them
- Internal services work together through a consistent data layer – the user is never asked to enter the same information twice, while settings and notifications are collated into a single coherent user interface
- Both internal and external access to data is fully transparent, with the user able to revoke or adjust that access at any point from an easy to access control panel

The principle for the future should be that wherever possible the user should be in control, not Whitehall.

You should be in charge of your data, the central conduit through which different parts of the sector link up and work together. In the future, this citizen controlled government could unlock a radically different type of state: much more flexible, customisable and automated, allowing the user to opt in to new innovations offered by government and third party providers.

As importantly, a single Government Digital Account could act as a powerful tool to break the current Whitehall monopoly of top-down control. As a platform owner, the Government's principle advantage is in setting core standards and ensuring security and privacy, not providing every function itself. In different areas, such as digital tax or personal health accounts, different parts of the Government are moving forward. A single digital government account, however, would force different parts of the government to work together, enable transparency over data use and act as a point of entry for new services.

Over the next three years, GDS should explore the creation of a single digital government account, that would:

- Show which government services you are using and which you can opt into, such as new telemedicine GP services, tax smoothing for Gig Economy workers or lifelong learning MOOCs for adult education and skills training

- Present much more transparent information back to the citizen on the performance of their local public services, or monitored delivery roadmaps and metrics connected to Single Departmental Plans at the national level
- Present coherent APIs allowing third parties to integrate their own services or design their own front end to offer an alternative user experience
- Give you visibility over who has access to what data and allow the user to extend or revoke this where appropriate
- Provide a single point of focus to drive common standards on the backend

A single Digital Government Account would not bring about full digital transformation by itself – but it could act as a vital gateway.

2 GDS should be moved from the Cabinet Office to DCMS, which would be given responsibility for leading on digital transformation of Government.

While DCMS leads on the UK's overall Digital Strategy, GDS currently remains largely under the departmental leadership of the Cabinet Office. This divide adds organisational complexity, diffuses accountability and slows the overall progress of transformation. Given the Cabinet Office's many other responsibilities, it often runs the risk of being distracted from the long term work required for digital transformation.

Bringing all of GDS together into DCMS would help create a more coherent Department for Digital and Culture, able to focus on all aspects of digital transformation across the public and private sector. Over time, DCMS should also take full leadership of projects it currently shares with BEIS, such as the AI Council or Sector Deal. Given the increasing digitalisation of the media and shared issues around free speech, there is liking to be increasing crossover between digital and culture - while in the long run, sport could potentially be moved to the DfH as part of Sport England's new Active Nation strategy.

3 The Government Chief Data Officer should work with GDS to manage a single, open roadmap of progress in digitalising core transactions and launching open APIs, allowing devolved administrations and third parties to interact better with central government.

The Government should continue to standardise and open up more data, making greater use of common standards rather than in-house solutions to build Government as a Platform. Central Government will never be able nor should it aim to hold all the data itself.Instead, it should focus on creating and defining common standards that will make it much easier for the systems that include thousands of local schools, GPs and council services to talk with each other or be compared.

There is, however, sometimes considerable reluctance by individual

departments to open up their data or processes. Sometimes this is for very good reasons, with unedited raw data likely to give a misleading impression or endanger personal privacy. In other cases, however, there is a suspicion that Departments are trying to hide from the inevitable uncomfortableness that greater openness brings.

A centralised roadmap would help provide greater transparency over the ongoing evolution of plans – allowing Departments to remain agile and not be too locked down to a rigid timeline, while still maintaining some pressure for continued, ongoing progress.

4 Each Department's annual update to their Single Departmental Plan should include an explicit account of their progress in implementing digital transformation, with GDS scoring them on their progress.

In theory, Departments are supposed to update their Single Departmental Plans (SDPs) every April, giving greater transparency over their progress towards inmeeting core objectives. In practice, SDPs currently provide very little true transparency, and the updates offer even less information.

In future, annual updates to SDPs should provide an explicit explanation of what steps have been taken to meet core objectives and reasons given for when plans have had to be delayed or changed. GDS should be asked to provide their own feedback on the progress of each department, and like the Major Projects Authority, provide a green-amber-red rating on progress.

At the same time, the Government should commission an independent review to benchmark current progress in opening-up data, with a follow-up review two years later to check progress. If progress has not been sufficient at that point, the Government should explore the creation of a fully independent digital standards watchdog, on the OBR or NAO model.

Ultimately, it is citizens, not departments, who own official data.

5 The Government should trial new Payments by Results mechanisms, launching new social impact bonds in health, education and welfare allowing early adopter users to opt into new approaches.

In health, the Government could launch a series of kitemarks, allowing users to identify which apps, technologies and services have been independently verified for effectiveness and safety. In education, it should commission a review into opening up and providing new forms of credentials, making it easier for new entrants to demonstrate the quality of their courses or exams.

6 The Cabinet Office should create a new five year innovation lab centred on AI and Machine Learning.

In the long run, trained data scientists should be embedded across the public sector, combining subject knowledge and technical expertise. In the short term, however, Government Innovation Labs or 'skunkworks

organisations' can help build up expertise and critical mass, catalysing a new policy agenda, before their new expertise is dispersed across the public sector as a whole.

Building on the precedent of the Behavioural Insights Team and Government Digital Service in the last Parliament, the Cabinet Office should launch a new focussed vehicle to build and apply machine learning skills across the public sector. GDS itself is largely busy with building the backend for Government as Platform, while a dedicated body could experiment with more forward looking and experimental applications. After five years, the organisation could either be disbanded, or spun off as a mutual.

7 GDS, the new Centre for Data Ethics and the ICO should work together on a new set of 'privacy by default' best practice principles for public sector organisations that handle data.

The Government it has indicated that it intends to stay aligned with the EU's General Data Protection Regulation (GDPR), which includes several new fundamental rights for individuals, for data access, erasure and portability. For organisations, it designates several new responsibilities, including a requirement for systems to be designed to incorporate data protection by design and by default.

These are the right principles. Wherever possible and proportionate, user control of their data should be baked in at a technological level, security should be ensured through end-to-end encryption and organisations should make of anonymisation technologies such as end-to-encryption or differential privacy to combine the beneits of big data and individual conidentiality. Where this is not possible, bodies should set on clear internal rules, and ensure there are legal consequences for those break them.

GDPR, however, is much less specific about how their principles should be applied in practice. While it is understand that the regulation was designed in a way not to be outdated by changing technology, this also means that many companies are suffering from significant ambiguity over how GDPR will affect them.

The public sector should be an example of best practice in transparent individual data control and access - but at present, is often significantly more opaque with how data is user than many private companies. The introduction of a single digital government account presents one opportunity to change this - and at the same time, the public sector should use GDPR as a catalyst to improve its wider practices.

Given that this is a fast moving field, both technologically and legally, there is a role for central Government to provide regularly updated advice on best practice.

This should include:

- Available technologies to maintain user control or anonymise individual data.
- Best principles in service design and operations. (We discuss mor on this below.)

- Under what circumstances opt-in or opt-out models are likely to be most appropriate.
- Examples of good practice in other countries or organisations that the UK should learn from.

Policy

Thinking about how Central and Local Government and other public sector bodies should approach the task of how to make the most of data science in AI, we recommend the following principles:

1 Establish common principles for data collection and use to cover consent, retention, aggregation, anonymisation, disclosure, review, commercial data acquisition and supply, subject access and recourse.

These principles will be consistent with existing legal requirements for necessity, proportionality, foreseeability and timeliness.

These policies will guide specific decisions about:

- when and how to combine different databases within a single organisation
- whether and how to support citizen access to their own record to ensure greater transparency
- whether and how to support citizen access to decisions about themselves arising from automated decision systems (e.g. algorithms)
- how long to retain citizen information
- how to address third party access to government raw or processed data or data analytics output (e.g. algorithmic model parameters)

In addition, there should be a policy relating to the use of open data currently published as part of transparency.

Consent and retention

Each organisation should establish a consent policy on collecting and retaining data. In contrast to most private sector organisations, consent is not always required for government organisations seeking to collect personal data. Nevertheless, a department may choose to maximise the opportunity to secure the informal consent of data subjects to beconsistent across all of the areas of their business.

Aggregation and anonymisation

Data protection law does not apply to data rendered anonymous in such a way that the data subject is no longer identifiable. Fewer legal restrictions apply to anonymised data.

The anonymisation of personal data is possible and can improve operations and efficiency in a privacy-friendly way. 'Anonymised data' refers to data that does not itself identify any individual and that is unlikely

to allow any individual to be identified through its combination with other data.

The Data Protection Act does not require anonymisation to be completely risk free – an organisation is mandated to mitigate the risk of identification until it is remote.

The goal of data transformation is to establish a robust and consistent approach across the department or agency towards aggregation and anonymisation. This is not straightforward, as the case of de-anonymisation of Netflix user data in 2007 illustrates. In some cases, specific differential privacy techniques could be required.

Disclosure and review

Policies should also specify when organisations are allowed to disclose data to any third parties, as well as how often data should be internally reviewed for accuracy and relevance.

Third party data acquisition and supply

Policies should establish a robust and consistent approach for providing and potentially charging third parties for access to the data within an organisation's own systems.

Subject access and recourse

Policies on subject access should clarify how an individual can see a copy of the information an organisation holds about them. However, the right of access goes further than this and an individual can also request to find out whether any personal data is being processed, the reasons for processing and any sharing with third parties.

An individual may in many cases also be entitled to receive information about the reasoning behind any automated decisions, such as a computer-generated decision to grant a visa, offer or withdrawal of credit and similar.

Data transformation will establish a set of consistent principles defining how this legal right should be discharged within a given department or agency (automatic online access such as 'View my driving license' vs manual postal request).

2 Establish an oversight framework for the use of data, data analytics and data sharing agreements.

Most departments and agencies already have a data oversight framework in place, specifying roles such as: data owner, data controller and data processor in line with the ICO ('Information Commissioner Office') requirements. However, the oversight framework for the use of data analytics is still in a nascent state since oversight panels tend to be too junior, with unclear duties and limited resources to steward the data. For instance, a data oversight panel may find that data quality is poor, but it may not have the power or resources to make any improvements.

Data analytics could lead to actions which do not align with the broader mission of the organisation (regarding ethics for example), but this may not

always be visible without an appropriate data analytics oversight function. Equally important, is the possibility of malicious threats which could compromise the organisation through cyberattacks on the analytic capability.

A data analytics oversight framework is responsible for ensuring the appropriate use of data analytics within the organisation (relating to e.g. proportionality and necessity). Ethics panels at universities have been established for the consideration of ethical issues arising from research that involves human participants and personal data and provide a good model for the type of oversight function in government departments. Additionally, external governance structures may be necessary in some cases.

3 Engage with citizen groups to foster public trust and confidence, and to ensure that the opportunities from data are clearly understood.

While establishing the legality for the use of data and data analytics may in itself be unquestionable, establishing the legitimacy of such uses could be less straightforward. Engaging with citizen groups in order to ensure legitimacy as well as to foster public trust and confidence should be a necessary component of establishing a well-functioning data analytics capability.

4 Establish guidelines for proportionate 'tiers of access' to data, hard coding these into the underlying systems.

Even though data should be fully connected across the organisation, full democratisation of access to data within a government department is not feasible. Instead, 'rules' should be established for the type of database access granted to staff, based on role, business unit and seniority, underpinned by technology.

Operations

What should that mean from an operational perspective? Here are some suggestions:

1 Connect the data to establish a departmental data ecosystem.

Isolated data is a lot less valuable than joined-up integrated data.

While the government should fully safeguard civil liberties though the existing privacy legal frameworks, the existing data already collected by the government services should be used in a way that creates better citizen outcomes. Government departments and Local Authorities maintain innumerable databases which have no way of talking to each other.

The most feasible technical implementation of the link between databases is likely to vary, but mandating APIs to be built alongside every newly established database is likely to be a good starting point. In addition to this, a set of existing databases will also need APIs in order to integrate them into the data ecosystem.

Focus should be first on joining up databases which will give actionable outcomes. Great data analytics comes from focusing on areas which have existing data that allow asking an insightful question, the answer to which will lead to an actionable outcome. Therefore, focusing on actionable

outcomes is generally a good starting point in prioritising the data integration journey.

2 Define data quality metrics for completeness, accuracy and integrity.

Scoring the existing data for quality would enable different business units to quickly determine whether the data is of sufficient quality for the desired applications and display the quality metrics through dashboards to enable quick decision-making.

3 Establish audit and control of access principles.

a) Establish data registers that are simple to connect to. Data registers are authoritative canonical lists of information. Avoid the need for bulk access or making copies of databases when building multiple digital services.

b) Establish a single data catalogue across the organisation.

c) Use status checking to minimise information transfer. Provide yes/no answers to common questions rather than record values.

d) Establish common data standards to ensure comparability of data within different systems. Specifically, this may require the creation of unique reference numbers. Connecting databases is technically difficult if there are no unique reference numbers for data fields. For instance, a unique property reference number (UPRN) for all addressable properties across the UK is an enabler for connecting databases related to properties. It would be useful to create unique identifiers for different entities that government databases repeatedly reference.

4 Develop analytical capability.

Chief Data Officer roles will be increasingly necessary to ensure clear leadership and accountability for the data and analytics capability. A CDO should be a senior leader with a seat on the Operating Committee. Alternatively, this role could be combined in one Board level leadership post responsible or Digital/Data and Technology. A CDO would be accountable for implementing data integration operations, for auditing and improving data collection practices as well as designing and running advanced analytics capabilities.

At the operational level, a core analytical capability should be developed in-house. This is typically done by implementing a quick, easy and visible proof of concept analytical projects independently of the wider transformational effort, in order to:

a) win stakeholder support
b) test existing analytical capability
c) create the analytical roadmap consisting of a sequence of analytical projects which incrementally lead to increased efficiency and service quality

Figuring out the best places to invest in data integration needs to take into account three things: what are the impactful questions, which data is accessible and what answers will lead to actionable outcomes.

There should always be razor sharp focus on actionable outcomes coming out of developing advanced analytics, so that the upfront costs are soon recovered. Failing to focus on actionable outcomes could lead to data analytics projects which answer interesting questions but which ultimately do not affect anything that the government does - these sorts of blue sky initiatives should be avoided in a disciplined manner, so as not to jeopardise the wider goal by loosing the support of front-line workers and service managers.

5 Adopt appropriate data infrastructure.

Scalable computer processing power and storage are key to a successful transition to a 'data mature' organisation. Whether this scalability is achieved through accessing commercial cloud providers or establishing own data centres, it is necessary to enable data analytics teams to efficiently access significant storage and computing capability.

6 Organise data analytics into centralised, embedded or integrated teams, as appropriate.

The advantage of establishing a centralised data analytics team is the concentration of analytical knowledge and talent in one team, with clear career path progression and the opportunity to develop deep technical expertise. The weakness of this approach is the isolation of analytics from the front-line.

Embedded data scientists work in front-line operations for a period of time while a particular project is underway. They still report to a data science manager in a centralised unit and their career progression occurs within the data science function. The advantage of this approach is that it enables the data scientist to gain deep insight into the business particularities and informs the development of an analytical toolkit in a way that is most useful and relevant for the front-line worker. A potential weakness of this approach is the fragmentation of technical and business expertise among the analytics staff.

Integrated data scientists are permanently placed in front-line operations and are responsible for ensuring that any part of the operations has full analytical support and capability. They report to the service/product manager and their career progression occurs within the product/service team. The advantage of this approach is the availability of advanced analytical insight at every stage of the front-line lifecycle. The potential weakness is fragmented technical knowledge and a reduced capacity for developing deep technical expertise.

7 Enable agile data science through establishing appropriate operating models.

DataOps is a Silicon Valley term that describes the collaboration between a product team, data team and IT in an integrated functional model. It is fundamentally about breaking down silos that exist between business units in order to create a continually evolving, agile and integrated delivery unit.

8 Use 'Lean' and 'Agile' for advanced analytics.

Lead suggests that the best way to get the most value out of an organisation is by following these principles: build a minimum viable product, deploy continuously, use A/B testing and fail fast. While this model is decidedly inappropriate for sensitive services (e.g. national security, health services), there is a vast range of government operations that could benefit from this approach.

The 'agile' methodology falls broadly under the Lean framework. It refers to segmenting the workload into small portions and receiving continuous feedback, evaluation and updates. 'Agile' project management stands in contrast to the 'waterfall' project management approach which mandates the existence of an upfront plan outlining the timeline, deliverables and outcomes at the start of the project. Conceptually, the agile approach allows for better outcomes through continuous feedback, learning, updating and pivoting.

Finally, autonomous working and flat management structures are a boon for Millennials according to sentiment research, and should be considered as part of the incentive structure to win top graduate analytical talent. Leading private sector organisations have seen a steady shift in recent years in organisational structures away from hierarchical towards flatter management structures. Flatter teams tend to be able to respond faster to real-time feedback and they tend to empower the front-line worker to use their judgement based on real-time information, resulting in more agile ways of working overall . This, however, needs to be balanced with a traditional hierarchical structure in order to retain clear accountability.

The UK should become a global hub for 'GovTech', with digital technology offering the chance to transform the relationship between the state and the citizen, and create a more efficient, responsive and innovative state, says a new Policy Exchange report Smart State. Like today's leading companies, Government should be structured as a platform and centred around the needs of the individual, rather than the legacy structures of government departments. Whilst the UK is already a world leader in open data, the government needs to overcome the challenges of legacy systems, maintaining user trust on data security and skills shortages to realise the full potential of digital government. As the private sector works to respond to the EU's GDPR regulations and recent personal data scandals, the Government should be setting an example of what true user control and 'privacy by design' looks like.