DIGITIZING GOVERNMENT
The Journey to Enacting a Digital Agenda

Citi GPS: Global Perspectives & Solutions
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The Journey to Enacting a Digital Agenda

Digital technologies — especially connectivity, big data, and artificial intelligence, among others, are transforming every facet of the economy. With public sector expenditure in most countries accounting for anywhere from one-third to two-thirds of gross domestic product (GDP), it has become an imperative for governments to actively drive digitization efforts.

Governments are beginning to play a key role in the digitization of their country’s economy which is impacting industry and citizens — digitizing government ministries, government services, and every interaction with society. While governments will have a more direct role in driving the transformation of government services, governments investing in building a digital infrastructure will be a key enabler for digitization of the economy as well as society. It will improve how citizens access public and private transportation, healthcare, education, and all of their financial transactions.

A strong digital economy requires a robust digital infrastructure, with digital money, payments, and identity being ubiquitous enablers required for the transformation of any industry or society.

Citi’s Digital Money Index, published annually since 2014, helps governments understand the readiness of their respective countries for usage of digital money. Each step made progressing towards digital money readiness can significantly enhance a nation’s ability to digitally transform its economy.

National digital identity systems are a foundational element of a robust digital economy and will deliver transparency and efficiency for citizens, government, and businesses. The ability of an individual to identify themselves and for governments/businesses to validate that identity is crucial for the effective functioning of a digital economy. Digital identity systems are also fraught with risks which require governments to play a key role providing sound regulation and oversight.

As countries and economies become digitized, governments must remain vigilant to cyber threats and have cyber risk mitigation strategies in place. Cyber resilience is a shared responsibility by all parties to ensure a high level of trust is embedded in every transaction between citizens and public sector entities. It will protect their data, help foster innovation and enable financial inclusion. Political and economic leaders play a critical role in ensuring public policy, regulation, and enforcement is in place to support integrity across the network.

Wherever governments are on their digital journey, by leveraging emerging technologies, they have a tremendous opportunity to deliver more efficient services while reducing costs and freeing up funds to reinvest in new digital infrastructure. This report concludes with several public policy recommendations we have seen governments make to put their digital agenda in motion.
The Journey to Digital
The Benefits of Moving to a Cashless Society

Digital money can:

1. Reduce cash handling
2. Increase consumer spending
3. Increase payment flows
4. Increase tax collections for governments
5. Redistribute world revenue pools

The Benefits of Moving to a Cashless Society

- **Consumer**: 220mm individuals enter formal economy and gain access to credit
- **Business**: $150bn increased consumer spending
- **Government**: $100bn in incremental tax
- **Government**: $100bn savings from reduced cash handling
- **Government**: $200bn savings with digital disbursements
ESTABLISHING A ROBUST NATIONAL DIGITAL IDENTITY SYSTEMS (NDIS) CAN PRODUCE SAVINGS FOR CITIZENS, GOVERNMENT, AND BUSINESSES.

BEYOND INVESTMENT IN INFRASTRUCTURE, GOVERNMENTS CAN TAKE THE FOLLOWING STEPS TO TRANSITION TOWARDS DIGITAL:

- Establish cross-agency collaboration and collaboration with the private sector
- Implement Digital Identity and National Identity programs
- Provide incentives for digital adoption (i.e. tax, VC support, and public-private funding)
- Encourage inter-governmental and intra-governmental collaboration
- Develop sandboxes, tech hubs, and accelerators

Key characteristics of successful NDIs:
- Trust
- Unique and Accurate Attributes
- Ability to Unbundle and Anonymity
- Security
- Interoperability
- Scalable and Secure Technology

Key Risks:
- Cyber attack
- Fraud
- Data privacy
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Moving Toward a Cashless Society

The adoption of digital money reduces the physical handling of cash, which in turn leads to a host of direct and indirect cost savings including: security, transport, theft, counterfeiting, processing payments, and the opportunity cost of accepting only cash. A study by Visa covering 100 cities suggests the average consumer spends 32 hours per year handling cash, including using automated teller machines (ATMs), writing/cashing checks, visiting banks, and paying bills. The cost of cash to businesses and government is even higher. But a city or society needs the right regulation, infrastructure, and solutions in place to move to digital money.

In January 2014, Citi along with Imperial College London launched a global survey called the Digital Money Index (link) to help understand: (1) the link between socio-economic outcomes and digital money adoption; and (2) what strategies a country’s government, policymakers, and companies could implement to increase digital money readiness and drive adoption. This study assumes there are four key pillars determining digital money readiness including government and market support, technology and financial infrastructure, presence of digital money solutions, and the propensity to adopt. Updated annually, of the 84 countries assessed in the 2019 index, 21 countries were deemed to be materially ready, 12 were in-transition, 32 were emerging while 19 were only at the incipient stage. In the index, the top five countries worldwide most ready for digital money adoption were Finland, Sweden, Norway, the U.S., and the U.K.

Being ‘materially ready’ for digital money does not guarantee a cashless society. Significant challenges with the mainstream adoption of digital money still exist. Even developed world economies lack solutions with compelling use cases/experience that solve critical customer pain-points to warrant a shift away from cash. A November 2017 study by the European Central Bank (ECB) for the euro area on how consumers pay at points-of-sale suggested cash was used for 79% of transactions by volume and 54% by value.

The emergence of digital ecosystems is key to adoption and is starting to solve for both the access and usage challenges. Mobility ecosystems such as ride-sharing apps have been successful in driving digital money adoption. In developed markets, where the necessary infrastructure was in place, ecosystem providers leveraged card rails to launch seamless checkout solutions. As the ecosystem evolves, players are enhancing convenience by accepting alternate payment solutions while improving the driver experience through real-time payouts and enhancing customer loyalty through cashback offers and rewards. As the ecosystem matures, these providers have launched their own mobile payment systems and have extended their wallet solutions beyond the primary use case to travel, restaurants etc.

The Benefits of Digital Money

Digitization is rapidly transforming industries, ecosystems, and economies and digital money has been a key enabler of this transformation. Businesses and governments have started to realize the importance of digital money and are embracing digital transactions, but could do a lot more to accelerate digital money readiness.

Digital technologies (smart devices, connectivity, cloud etc.) are enabling businesses to extend beyond traditional industry boundaries, and forge alliances across sectors to create completely new ecosystems. These ecosystems alter the business models of industries and influence a fundamental shift in consumer behavior. Ecosystems require a set of horizontal capabilities for success.
Digital payments are one such universal horizontal capability that is critical for the success of any ecosystem. Hence, businesses are naturally interested in the progress of readiness and adoption of digital money.

At the same time, new technology has opened up many possible futures for money that are rapidly gaining interest, especially as the fiat currency system faces criticism over its efficiency in supporting digital business models. Hence, governments around the world are investing in evolving the traditional batch payment systems by making them real-time to serve the digital world better.

The Benefits of Digital Money

Citi’s Digital Money Index report estimates that even a 10% increase in digital money readiness could help up to 220 million individuals enter the formal financial sector. As these 220 million individuals enter the formal financial sector, they will gain access to affordable credit, resulting in an increase in consumer spending to the tune of an estimated $150 billion, which could in-turn benefit businesses. In addition, businesses will also enjoy close to $100 billion savings per year from reduced cash handling costs. Put together, digitization of payments can lead to incremental flows to the tune of $1 trillion into the formal economy. With this, governments will see incremental tax collections likely in excess of $100 billion. The overall impact to the economy will therefore be substantial due to the multiplier effect.

The emergence of digital ecosystems could result in a redistribution of $60 trillion, approximately 30% of the world revenue pools in 2025. Our estimates at Citi suggest this redistribution of revenue pools towards digital ecosystems could result in an additional $15 trillion of payment flows being digitized by 2025.

Digital Money Readiness of Countries

Countries across the world have progressed on their digital money journey and this is reflected in the 5.5% improvement in the overall digital money readiness of countries measured in the index over the past five years. This positive shift is seen across clusters (leaders and laggards) indicating holistic progress.

However, countries across the board continue to face challenges in driving digital money readiness and adoption. For countries that are in the early stages of readiness, availability and accessibility of financial and communications infrastructure is the primary challenge, while for countries that are more advanced, they face challenges with the availability of appropriate digital money solutions and driving adoption.

These challenges are not insurmountable though, as indicated by 18 countries (20% of the index) that advanced clusters compared to their 2014 positions. These countries have managed the feat by addressing typical bottlenecks associated with their respective clusters. Countries in early stages that progressed have focused on developing their infrastructure and gaining progressive regulatory support; while countries that are slightly more mature, have focused on driving adoption.

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1 https://www.citibank.com/icg/sa/digital_symposium/digital_money_index/
What Can Businesses Do to Drive Readiness?

Businesses, especially the emerging digital ecosystems, can play a crucial role in driving readiness and adoption of digital money. These digital ecosystems can drive the adoption of, as well as benefit from, digital money adoption. If we look at the example of the mobility ecosystem, in markets where digital money infrastructure and capabilities exist, they have readily leveraged those capabilities to provide a superior payment and checkout experience to drive customer adoption of digital money solutions. On the other hand, in markets where infrastructure is lacking, the mobility ecosystem leaders have contributed to the development of the digital money infrastructure and capabilities, by providing connectivity solutions, bank accounts etc. to their drivers.

What Can Governments Do to Drive Readiness?

Beyond influencing the digitization of cash, emerging ecosystems also result in a fundamental shift in industry business models. Digitization is resulting in businesses going direct to consumers and shifting towards a services/experience-based business model. This shift will alter the role of many across all organizations and industries. For example, treasuries will now need to handle higher volumes of low-value payment and in near-real time. In addition, treasuries will also need to support exotic currencies and more complex reconciliations, as they deal with newer payment flows from emerging markets. Fiat currency systems need to rapidly evolve to address these new flows and expectations arising out of digital business models.

Governments naturally have a key role to play in the evolution of fiat currency systems that are more efficient/real time and 24x7 and are attuned to serve the digital world. Governments have an incentive to ensure robustness of fiat currency systems, driving toward a real-time and always-on payments infrastructure. Governments can also play an active role in creating an enabling environment for digital ecosystems and digital money solutions to flourish, and provide appropriate incentives to consumers and businesses for digital payments. It is also an imperative for governments to walk the talk by digitizing all its payouts and disbursements to begin with.
Why Mobile Money Matters

Mobile money is the technology that allows people to receive, store, and spend money using a mobile phone device. Thanks to a combination of simplicity, convenience, and safety mobile money uptake has grown at a rapid pace globally, and is fast becoming an alternative to bank accounts and payment services in several emerging and frontier markets. At the center of the payments transformation are Mobile Wallets (also known as digital wallets or E-wallets) that can hold a previously defined payment instrument (e.g., credit card details) or a digital equivalent of currency, and can be used to transfer money between two parties.

While the first widespread adoption of mobile money (starting with Kenya) was driven primarily by the need to cater for migrant remittances from cities to villages, today the sector has grown to play a much wider role in the economic and social transformations occurring across several (predominantly) emerging markets. Below we look at the key reasons why mobile money matters.

Financial and Social Inclusion

Access to financial services is a key part of the United Nation’s and World Bank’s Sustainable Development Goals. There are several emerging and frontier markets where access to banking services continues to lag but where mobile money has successfully stepped in to fill the void. One of the greatest success stories in mobile money over the past decade has been in Kenya, which was originally funded by the U.K. Government’s Department for International Development and scaled up by a joint venture between two mobile phone carriers in 2007.

As noted by economists Tavneet Suri and William Jack (“The long-run poverty and gender impacts of mobile money”, Science Magazine, 9 Dec 2016), mobile money in Kenya has led to “changes in financial behavior — in particular increased financial resilience and savings” and also impacted “labor market outcomes, such as occupational choice, especially for women, who moved out of agriculture and into business”. Suri and Jack conclude that the mobile money revolution has led to “a meaningful reduction of poverty in Kenya”.

Given the positive social impact of mobile money it is not surprising that among the first external investors in the leading mobile money player in Bangladesh, were the International Finance Corporation (IFC), a member of the World Bank Group, and the Bill & Melinda Gates Foundation. As the provider notes, “it has a special focus to …. achieve broader financial inclusion by providing services that are convenient, affordable and reliable.”

Improving Government Disbursement Efficiency

Mobile money can act as an important tool to reduce the scope of the informal grey economy and increase the use of non-cash means for transfer of funds. We have seen examples of this when ‘demonetization’ in India resulted in a sharp jump in the usage of mobile money payment channels due to the sudden withdrawal and replacement of high-value bank notes at the end of 2016 and early 2017.

Mobile money can also reduce waste/corruption in the direct disbursal of government funds whether salaries, subsidies, or other disbursements to the general population, cutting out rent-seeking intermediaries. For example, mobile money has been effectively used in Pakistan to distribute funds under government support programs such as the Benazir Income Support Programme (BISP) and in Kenya for disbursement of agricultural subsidies.
BISP is a flagship poverty alleviation program of the Government of Pakistan, aimed at providing a minimum income support package to the country’s most underprivileged families. Female recipients are provided with a monthly social welfare disbursement of about $2 per day for their households.

In conjunction with BISP, a Pakistani mobile payments company developed a solution that overcomes geographical and cultural as well as logistical barriers by bringing financial services to local corner shops using their point-of-sale terminals. Bringing financial services local enabled women to register and get their disbursements without having to travel to a bank or even requiring access to a phone.

In the words of Melinda Gates: “When the government deposits social welfare payments or other subsidies directly into women’s digital bank accounts, the impact is amazing. Women get decision making power in their homes … they invest in their families’ prosperity and help drive broader economic growth” (Banker Africa, July 2018).

Government-to-person (G2P) transfers are one to watch in terms of financial inclusion strategies and outcomes as governments move away from blanket subsidies towards targeted aid schemes. The total value of annual global mobile money bulk disbursements (primarily government-related) grew to over $12 billion according to the 2017 GSMA State of the Industry report.

India is another market where G2P transfers through mobile money accounts could help compensate for deficiencies in banking sector infrastructure. Recently introduced government regulations linking pensions and other welfare payments to bank account ownership have proved problematic in rural areas where branches and ATM penetration still lag, and hence a shift to disbursement through mobile money platforms could help alleviate some of these bottlenecks.

**Business Opportunity**

The number of mobile money users is large and growing rapidly, especially in Asia and Africa. Data from GSMA — the trade body of mobile network operators globally — estimates there were about 250 million mobile money users at the end of 2017, of which half were in Sub-Saharan Africa (120 million) and a third in South Asia (86 million). GSMA’s data includes only 7 million users for East Asia.

By our definition, we estimate there were around 800 million active mobile money users at the end of 2017 and this number is growing at a double-digit rate. We add Chinese mobile money wallets (as of year-end 2017 China had over 500 million active mobile money users) to the GSMA data and note India’s data may also not be fully captured in the GSMA data. In both China and India, mobile is driven by Internet companies versus being driven by telecom companies which is the norm in Sub-Saharan Africa.

The charts below set out the largest mobile money markets in the world based on estimated total number of active clients (see Figure 2) and transaction values (see Figure 3). By value of mobile money transactions, China dwarfs other markets. As a percentage of gross domestic product (GDP), China leads at about 110% followed by Kenya and Ghana (75%).
International Remittances

According to the World Bank, remittances to developing countries in 2019 were expected to touch $550 billion, or 0.7% of global GDP. While the former banking channels continue to represent a large part of the remittance chain, there are several other formats (e.g., currency exchanges) and informal channels that work in tandem in most economies.

Today, the top frontier and emerging market countries in terms of international personal remittances are India, Philippines, Nigeria, Pakistan, Mexico, and Bangladesh. When measured over GDP, the Philippines leads with inflows of over 10% of GDP, followed by Sri Lanka, Pakistan, Bangladesh, Vietnam, and Egypt.

Mobile money providers have rolled out services in many markets, hoping to build upon their lead in local person-to-person (P2P) transfers to capture a share of the international remittances business. Market shares remain mostly small though, and unlike P2P transfers or payments, in remittances they are facing a well-established industry (e.g., banks) which have expansive infrastructure in place. Banks with international branches or money exchanges with established relationships with overseas exchanges are therefore at an advantage. In addition, regulatory daily and monthly limits on withdrawals from mobile money accounts can prove problematic for larger transfers. Consumer behavior is also a drawback, as remittances tend to be immediately converted into cash upon arrival leaving little cash float to earn interest on, an issue in markets like Pakistan where cash withdrawals from agents are subsidized and mobile money merchant payments are still nascent.

Remittances to developing countries in 2019 were expected to touch $550 billion, or 0.7% of global GDP.

Mobile money providers are hoping to capture a share of the international remittances business.
National Digital Identities

Robust national digital identity systems (NDIs), if developed in an interoperable and scalable manner, could produce savings for citizens, governments, and businesses. The ability of an individual to prove that they are who they say they are is crucial to gaining access to a plethora of other services from healthcare to education, as well as being part of an efficient digital payments framework and cashless society. Equally there are risks around NDIs, which require sound regulation and oversight. This includes cybersecurity, data privacy, and fraud.

What are the key characteristics of a national digital identity?

- **Trust**: “Cash is king”. What is intrinsically a piece of paper (or plastic) is trusted as a medium of payment because people trust the government and its central bank and the notes carry sufficient security features to make it difficult to counterfeit. Like cash, a digital ID should be issued by a national body like the government, and like cash the banks also have a role in maintaining that trust.

- **Attributes**: For an NDI to function in the provision of digital services/payments, the NDI must have sufficient information to identify the person uniquely and accurately. A person’s address may be part of the NDI information, but is not sufficient as an identity, unless there is a specific need for the location to be eligible to receive a service. However a person’s retina may be regarded as a unique identifier.

- **Unbundling and anonymity**: Because an NDI carries a lot of information about the individual, the other party who requests verification could in theory see a lot of personal information that is far beyond what he/she needs. Thus the NDI must be able to provide verification of only the data which is actually needed and no more. Furthermore the system must be able to provide verification without disclosing sensitive details of the individual.

- **Interoperability**: NDI also means that the identification can be used throughout the country (perhaps even internationally). And other forms of ID can be tied to the unique NDI. Today every individual possesses multiple digital IDs, including their mobile number, an e-mail address, perhaps a Facebook ID, and so on. Thus the digital IDs of today are very fragmented, each one only possessing certain pieces of information about the individual.

![Figure 4. Digital Identity Lifecycle & Key Roles](source: World Bank)

![Figure 5. ISO and eIDAS Authentication Levels](source: World Bank)
Security: Like cash, it is key that an NDI cannot be forged or that someone cannot pretend to be another individual. And like the security features on cash it is paramount that a person’s details cannot be hacked or misused. As recent events have shown, even large established social media companies can abuse an individual’s trust by misuse of their data. In the financial world, the hurdle for security is even higher when it comes to abiding by strict regulatory requirements for Know Your Client (KYC) and Anti Money Laundering (AML).

Technology: NDIs must be designed on robust and resilient technology and software to ensure scalability, ability to withstand cyber attacks, and have robust contingencies in the event of failure.

Estonia Case Study

Estonia is regarded as having the most highly-developed national ID card system in the world. More than a legal photo ID, the mandatory national card also provides digital access to all of Estonia’s secure e-services. In Estonia, every person can provide digital signatures using their ID-card, Mobile-ID, or Smart-ID, so they can safely identify themselves and use e-services.

The ID card is used for legal travel ID within the European Union, national health insurance, proof of ID when logging into bank accounts, for digital signatures, for i-voting, to check medical records, submit tax claims, and use e-prescriptions. The chip on the card carries embedded files, and using 2048-bit public key encryption, it can be used as definitive proof of ID in an electronics environment.

Mobile-ID allows people to use a mobile phone as a form of secure digital ID. Like the ID-card, it can be used to access secure e-services and digitally sign documents, but has the added advantage of not requiring a card reader. The user accesses the benefit by entering a Mobile-ID pin code into the phone.

Smart-ID is a new mobile app that works as an identification solution for anyone that does not have a SIM card in their smart device but needs to securely provide their online identity. As a convenient alternative to bank code cards, the user can log into a financial sector e-services site and confirm transactions and agreements.

X-Road is the backbone of e-Estonia, allowing the nation’s various public and private sector e-Service databases to link up. To ensure secure transfers, all outgoing data from X-Road is digitally signed and encrypted, and all incoming data is authenticated and logged.
Singapore’s National Digital Identity (NDI) Initiative

A digital identity system for Singapore residents and businesses to transact digitally with the government and private sector in a convenient and secure manner is expected to be operational in 2020 with widespread adoption by 2022.

- **SingPass and SingPass Mobile for Individuals:** SingPass is an authentication system launched in 2003 that provides individuals with access to over a hundred government services, such as filing taxes and performing Central Provident Fund (CPF) transactions. Depending on the sensitivity of the transaction, 2-step verification (2FA) could be required where users authenticate themselves using a code generated from their physical token or by entering the text message sent to their registered number. To make 2FA more convenient, SingPass Mobile was launched, which is an app allowing users to authenticate themselves via fingerprint, facial recognition, or passcode rather than having to bring along a physical token. As of February 2019, SingPass Mobile users numbered 190k. This not only creates opportunities in e-commerce where customers can scan a QR code on websites to verify themselves through SingPass Mobile, but also assists in-person transactions where a customer can similarly scan a QR code, allowing in some cases, instant services, since no further verification is necessary.

- **CorpPass for Businesses:** CorpPass is the equivalent of SingPass for businesses and since September 2018, businesses have been required to use CorpPass for transactions with government agencies. Such transactions include filing taxes or applying for business grants or trade licenses. Even before CorpPass was mandated as the only method for transacting with the government, it enjoyed wide acceptance since its launch in 2016 with a 90% adoption rate as of August 2018. CorpPass is well suited to the corporate structure allowing users to take on an appropriate CorpPass role which has permissions corresponding to the user’s seniority level. The separate nature of SingPass and CorpPass for personal and business transactions, respectively, allows clarity as to which identity is being used by an individual and also encourages greater privacy protection.

- **MyInfo:** Piloted in 2016 and rolled out in 2018, MyInfo is a digital personal data vault which carries personal information verified by the government and can be used to auto-fill data for both government and private sector online forms. This provides benefits for both the individual and businesses/government. The individual can fill up forms more quickly and conveniently, avoid the hassle of repeatedly keying in data, and circumvent accidental data entry errors. For the business/government agency, they can be sure that data received is accurate and would not need to verify supporting documents. Use cases for MyInfo include credit card sign-up for banks, applying for public housing and verification of identity on e-commerce customer-to-customer (C2C) platforms. Because the ownership of the data still belongs to the individual, the individual still has to explicitly provide consent to what data is used in each transaction, and will be able to keep track of their MyInfo usage history on the online portal. As of July 2019, 110 government services and 90 private sector services have adopted MyInfo. As of February 2019, 220k small & medium-sized enterprises (SMEs) have benefitted from MyInfo Business when they fill in forms at local banks.

- **NDI Developer and Partner Portal:** The portal gives developers and partners the ability to integrate with the Singapore NDI stack to create efficiencies and better experiences for customers. Developers and businesses can access a sandbox environment to experiment with prototypes and deliver solutions faster.
There are four levels within the portal that relate to increasingly complex NDI applications. To illustrate, the first level, ‘Trusted Data’ involves merchants seamlessly creating customer journeys by recognizing data from MyInfo is already authenticated, while the fourth level, ‘Trusted Services’, would involve advanced NDI services such as digital signing.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trusted Data</td>
<td>Merchants can create seamless customer journeys by obtaining information from MyInfo and potentially onboard clients instantly.</td>
</tr>
<tr>
<td>Trusted Identity</td>
<td>A National Certificate Authority (NCA) will issue unique digital certificates of identity to Singaporeans and permanent residents. This layer also includes a multi-tiered model where more risky transactions will need higher levels of authentication, e.g., biometric authentication.</td>
</tr>
<tr>
<td>Trusted Access</td>
<td>This layer supports an open ecosystem of federated Authentication Services Providers (ASPs) of which the government is operating one, though other ASPs can be operated by the private sector. A common trust framework will allow for the necessary legislation, cybersecurity standards, and technical references stipulating ecosystem interactions. Ultimately this is to allow previously protected domains (e.g., government agency, banks) a standardized way of access and interaction between each other through the common government digital identity.</td>
</tr>
<tr>
<td>Trusted Services</td>
<td>Trusted Services allows for use cases that emphasize a superior customer experience that is seamless, such as 1-click account registration and identity verification, as well as digital signing where customers can sign any document on any device.</td>
</tr>
</tbody>
</table>

Source: Smart Nation and Digital Government Office

India’s National Identity Project

Aadhaar, a 12 digit unique number assigned to every resident in India, has reached 90% penetration with >1.2 billion enrollments since inception in 2009.

IndiaStack allows private companies to build services on top of Aadhaar

Aadhaar, a 12 digit unique number assigned to every resident in India, has reached 90% penetration with >1.2 billion enrollments since inception in 2009. Given the data captured on every individual enrollment (mobile phone number, biometrics, photograph, and demographic details) and seeding of Aadhaar across several government services, it is increasingly serving as the basis for citizen interactions with the government across welfare programs (such as the LPG subsidy) as well as government services (e.g., income tax filing, pensions etc.).

IndiaStack: Technology Backbone for Everything Based on Aadhaar

The goal of IndiaStack is to create a technology backbone for a presence-less, paper-less, and cash-less economy. IndiaStack allows private companies to build services on top of Aadhaar. The key parts of the initiative include Aadhaar being used for identification, a Unified Payments Interface (UPI) allowing paperless payment, digital lockers allowing paperless documents, and an electronic ‘Know Your Client’ (eKYC) and digital signature which allows two or more parties to execute contracts over mobile.

- **Presence-less Identification:** Through mandatory seeding of Aadhaar details into income-tax records, mobile phone numbers, and other identification systems in use in India, the government now has the ability to link data records across systems (i.e., personal income tax, business tax, property records, big ticket consumer transactions etc.) which should help reduce tax evasion and increase the tax base.

- **Paper-less Authentication:** A 30-second fingerprint scan is set to replace a paper-intensive two-day process for verifying new customers. This is most extensively being used currently at financial services and telecom companies for customer onboarding. Aadhaar-enabled eKYC reduces direct customer onboarding costs by up to $4-5/person, enabling minimum ticket sizes to go down and participation rates to go up. India’s Supreme Court in a judgment on Aadhaar in September 2018 restricted private sector’s usage of Aadhaar. However, the government has subsequently tweaked rules/regulations in the
Aadhaar legislation to comply with Supreme Court judgment and enable private players to use Aadhaar for KYC authentication on voluntary basis.

- **Cashless Payments**: Aadhaar-enabled payment systems have led to improvements in disbursement efficiency for government welfare spends (e.g., Aadhaar-enabled direct benefit transfer of liquid petroleum gas (LPG) subsidies (e.g., PAHAL Yojana) directly into eligible subscriber accounts). McKinsey estimates total government benefits amount to ~28% of GDP and further integration of Aadhaar could generate up to $26 billion in value just from removing remaining ghost beneficiaries and leakage. Aadhaar could also be used to increase the tax base and reduce fraud with an estimated $23.5 billion in additional revenues to the government possible from these use cases. In addition to the PAHAL LPG subsidy, the government has launched accident & life insurance and pension schemes under Jan Dhan-Aadhaar-Mobile (JAM).

- **Data-sharing and Consent**: Sahmati is an account aggregator service compliant with IndiaStack, which enables transmission of encrypted personal financial data from provider to user via consent-based channels, such that the account aggregator itself has no access to the data. This service allows consumers to easily transmit relevant data to entities like lenders etc. reducing hassle and improving turnaround time.

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**Figure 8. IndiaStack**

<table>
<thead>
<tr>
<th>SUBSIDIES (DBT)</th>
<th>COMMERCE (GST)</th>
<th>BILLS (BBPS)</th>
<th>TOLLS (ETC)</th>
<th>OTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONSENT LAYER</strong></td>
<td>Provides a modern privacy enhanced framework for data sharing</td>
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<td></td>
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<tr>
<td><strong>CASHLESS LAYER</strong></td>
<td>Game changing electronic payment systems and transition to cashless economy</td>
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<tr>
<td><strong>PAPERLESS LAYER</strong></td>
<td>Rapidly growing base of paperless systems with billions of artifacts</td>
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<td></td>
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</tr>
<tr>
<td><strong>PRESENCE-LESS LAYER</strong></td>
<td>Unique digital biometric identity with open access of nearly a Billion users</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: ispirt
Digitization Helps to Drive Smart Cities

A study by GSMA and BCG identifies eight areas where smart city benefits are concentrated: environment, transport, safety, utilities, healthcare, communities, tourism & entertainment, and commerce. Smart cities that develop these areas to higher levels (i.e., from just using widely available technologies to adapting more cutting edge technologies) can reap greater rewards.

For a tangible idea of the size of the benefits when solutions are deployed at scale, BCG and GSMA estimate that for a city similar in size to Barcelona with 1.5 million inhabitants, there could be €90-€100 million ($100-$110m) of direct value and €250-€450 million ($275-$500m) of indirect value annually. The largest area of benefit could come from smart traffic management with €12-€22 million ($13-$24m) of direct value to citizens and €200-€350 million ($220-$285m) of indirect value as traffic light timing adapts to traffic conditions.
25 out of the 40 most populous cities are located in Asia

Smart Cities in an Asia Context

Smart cities as a phenomenon are important for Asia as a whole which provides an interesting growth angle. 25 out of the 40 of most populous cities, or 63%, are located in Asia. This creates stress on five particular areas: mobility, environment, utilities, safety, and services. Imagine how a mega-city with >10 million in population could be impeded with vehicle congestion. Healthcare in these large cities face greater stress given the far larger population base. Service reach of financial services could be limited given potentially low incomes and high cash handling costs. Effectiveness of law enforcement could be limited because of the sheer density. All of these issues could be more efficiently addressed with the move to smart cities.

Figure 10. Direct and Indirect Benefits for Specific Use Case when Deployed at Scale for a Smart City with 1.5m Population

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>BASELINE</th>
<th>SMART CITY INNOVATION</th>
<th>DIRECT</th>
<th>INDIRECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAFFIC MANAGEMENT</td>
<td>Timer-based traffic lights</td>
<td>Equipped with counting cameras; sequence adapted to traffic</td>
<td>€12-22M</td>
<td>€200-350M</td>
</tr>
<tr>
<td>SMART STREET LIGHTING</td>
<td>Timer-based LED lights</td>
<td>LED lights controlled with a multi-stage dimming scenario</td>
<td>€75M</td>
<td>17k T CO₂</td>
</tr>
<tr>
<td>SMART PARKING</td>
<td>Parking meters with manual registration &amp; surveying</td>
<td>Sensors detecting parked cars and system verifying if spot is paid</td>
<td>-€1M</td>
<td>€15-20M</td>
</tr>
<tr>
<td>SMART SURVEILLANCE</td>
<td>Dispersed street CCTV</td>
<td>Widespread, with image (activity and license plate) recognition; noise sensor to detect shots</td>
<td>-€55M</td>
<td>€8M</td>
</tr>
<tr>
<td>DIGITAL KIOSK</td>
<td>No infrastructure</td>
<td>Interactive digital billboards displaying ads and providing services</td>
<td>€30M</td>
<td>Citizen engagement, connectivity, etc.</td>
</tr>
<tr>
<td>SMART WATER MANAGEMENT</td>
<td>Analog water meters</td>
<td>Smart water meters frequently monitoring and sharing consumption</td>
<td>€16M</td>
<td>€16M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>€90-100M</td>
<td>€250-410M</td>
</tr>
</tbody>
</table>

Source: BCG, GSMA

Figure 11. Key Statistics on Asian Smart City Opportunities

- **63%** of the world’s 40 most populous cities are in Asia. These cities would have a greater urgency to raise efficiencies in order to maintain the quality of life.
- **40%** of the top 20 ranked Smart Cities are in Asia vs. 25% for the U.S. and 20% for Europe.
- **53%** of Asian companies see IoT as raising market competitiveness vs. 35% and 33% for the Americas and the EU, respectively.
- **36%** of Asian organizations have adopted IoT vs. 27% for the U.S. and 26% for Europe.
- **7%** of Asian organizations have more than 10k connected devices, trailing the U.S. (19%) and the EU (13%), indicating upside potential.
- **39%** of IoT shipments from 2017 through 2021 will be in Asia, making it the largest adopter of IoT needed for Smart City development.

Source: Gartner, Vodafone, Juniper Research
An additional ~70 million people are expected to live in urban areas in ASEAN (Association of Southeast Asian Nations) by 2025 driven not only by growth in city centers but also mid-sized cities, which house populations between 500,000 and 5 million. ASEAN views the development of smart cities as aligned with sustainable urbanization that would allow for the optimization of the benefits from urbanization while building resilience to the associated challenges. In 2018 the ASEAN Smart Cities Network (ASCN) was established with 26 participating cities as a platform to exchange best practices and solutions, in order to ultimately improve lives leveraging technology. Each ASCN country has identified two priority projects to focus on bringing these best practices and solutions to fruition. The projects have tended to focus on themes of environmental sustainability, waste management, safety and security, and urban mobility.

Figure 12. Priority Projects of Selected ASCN Pilot Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Country</th>
<th>Priority projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jakarta</td>
<td>Indonesia</td>
<td>Oke Otrip (integrated payment card for public transport), OK-OCE (One District One Centre of Entrepreneurship)</td>
</tr>
<tr>
<td>Kuala Lumpur</td>
<td>Malaysia</td>
<td>KL Urban Observatory, Sustainable Municipal Solid Waste Management</td>
</tr>
<tr>
<td>Phuket</td>
<td>Thailand</td>
<td>City Data Platform, Phuket Eagle Eyes (CCTV Coverage)</td>
</tr>
<tr>
<td>Hanoi</td>
<td>Vietnam</td>
<td>Intelligent Operations Center, Intelligent Transportation (e.g. I-Parking, E-tickets for Public Transportation, Online Vehicle Registration)</td>
</tr>
<tr>
<td>Phnom Penh</td>
<td>Cambodia</td>
<td>Smart Public Spaces, Improving Efficiency of Public Bus Service</td>
</tr>
<tr>
<td>Singapore</td>
<td>Singapore</td>
<td>E-Payments, National Digital Identity (NDI)</td>
</tr>
</tbody>
</table>

Source: ASEAN
A Case Study on Singapore

Using Technology to Meet the Challenges of Urbanization

The global trend towards urbanization continues unabated: In 2018 the United Nations estimated 55.3% of the world’s population live in urban areas with this number projected to rise to 60% by 2030 and to 68% by 2050. Asia dominates this trend, as 25 of the 40 most populous cities are in Asia, as well as the most number of mega cities (>10m population). Urbanization provides opportunities for individual prosperity but also immense challenges that materially affect economic efficiency and quality of life, as well as putting an immense strain on scarce resources, and in turn the cost of living.

Although Singapore’s 5.7 million population lies well below the definition of a megacity, it is one of the highest population-density countries in the world, and faces unique challenges around absolute resource constraints, with a land area of 722 sq. km (less than half the size of London), of which two-thirds is used for water catchment, and yet imported water still supplies up to 60% of Singapore’s water needs. Similarly Singapore relies on imports for 90% of its food needs. And Singapore’s population is aging, with the government indicating the number of Singaporeans aged 20 to 64 is projected to peak at 2.2 million around 2020.

Smart cities use information and communication technologies (ICT) to help overcome the economic pain points of urban living to improve their inhabitants’ quality of life. In its latest iteration, technology will be almost invisibly embedded into citizen’s daily lives. The Internet of Things (IoT), a multitude of devices connected by wireless networks, LTE (and eventually 5G), plus leaps in cloud-enabled computing power, promises to generate terabytes of real time data that can be analyzed by AI to improve a city’s operational efficiency as well as using predictive techniques for optimal resource allocation. Digital transformation and technology, while a valuable enabler, goes hand-in-hand with long-term strategic planning and government-led cultural change to reap the full benefits for a city’s inhabitants. The precise goals of a Smart City framework will vary according to a city’s individual pain points and needs.

Singapore’s Smart Nation initiatives

Singapore’s Smart Nation initiative focuses on six broad areas: (1) Strategic National Projects; (2) Urban Living; (3) Transport; (4) Health; (5) Digital Government Services; and (6) Start-Ups and Businesses. Underlying these initiatives are plans to develop the three pillars of a smart city, which are a digital economy, a digital government, and a digital society.

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5 https://www.straitstimes.com/politics/parliament-no-major-changes-expected-to-immigration-policy-josephine-teo
Figure 13. Singapore – Smart Nation Initiatives

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic National Projects</td>
<td>National Digital Identity, E-Payments, Smart Nation Sensor Platform, Smart Urban Mobility, Moments of Life, and CODEX</td>
</tr>
<tr>
<td>Urban Living</td>
<td>Automated Meter Reading (AMR) Trial, Drones to Survey Dengue Hotspots, myENV app, OneService App, Planning for Our People and Businesses, Smart Elderly Alert System, Smart Towns, Virtual Singapore.</td>
</tr>
<tr>
<td>Transport</td>
<td>Autonomous Vehicles, Contactless fare payment for public transport, On-demand shuttle, Open Data &amp; Analytics for Urban Transportation, Spearheading research in standards for self-driving vehicles (SDVs)</td>
</tr>
<tr>
<td>Health</td>
<td>Assistive Technology and Robotics in Healthcare, HealthHub, National Steps Challenge &amp; the Healthy 365 app, TeleHealth</td>
</tr>
<tr>
<td>Digital Government Services</td>
<td>Business Grants Portal &amp; LicenceOne, CentEx, HDB Resale Portal, Moments of Life, Multilingual Digital Services, OpenCerts, Parents Gateway</td>
</tr>
<tr>
<td>Startups And Businesses</td>
<td>CorpPass, Data Innovation Programme Office (DIPO), FinTech Sandbox, Networked Trade Platform (NTP), Punggol Digital District</td>
</tr>
</tbody>
</table>

Source: Smart Nation Singapore (link)

Figure 14. Smart Nation Singapore — Serving Citizens and Businesses Better Through Technology

Source: Smart Nation Singapore (February 2019),

E-payments and a Drive Towards a Cashless Society

Singapore began its journey towards creating a national e-payments infrastructure in 2014 with the launch of FAST (Fast and Secure Transfers), Singapore’s national real-time payment system, to facilitate direct real-time transfers between consumers and businesses across different banks, and enhance convenience and efficiency for citizens and businesses, with the long term goal of achieving a cashless society.
E-payments has seen robust growth in recent years and FAST has been the key driver of this while the use of GIRO, a legacy batch-based direct debit system used by the banks, has remained relatively stagnant. In the second half of 2018 FAST grew to take a 29% share of payment volume (vs. 21% in the second half of 2017) and a 10% share of payment value (vs. 7%). In the same period, check payments fell to 22% by volume (vs. 27% in the second half of 2017) and 54% by value (vs. 58%). Though these trends augur well, check payments are clearly still frequently used, especially for big ticket items. Businesses, in particular small & medium-sized enterprises (SMEs) running on the same payment processes now as they have in the past, continue to use checks.

Cash continues to be readily used for small ticket items especially in hawker centers and neighborhood shops, where vendors (perhaps by choice) do not support any e-payment methods. Consumers may also exhibit inertia because they haven’t found any real problems with the existing payment methods. In a PayPal survey, 54% alluded to this as the primary reason for not using new payment methods. Another important hurdle is lack of interoperability. Until one ubiquitous cashless payment method exists that can be used almost everywhere, consumers by necessity will require cash. In Singapore, there are numerous silos of payment methods that can only be used for specific use cases, though Singapore’s Smart Nation plans are well on the way to changing this.

The initiatives discussed below do not reinvent the core infrastructure but rather, they drive adoption by improving the payment experience and improved interoperability and efficiency.
PayNow: Launched in July 2017, PayNow allows instant peer-to-peer (P2P) payments by entering the recipient’s mobile number. PayNow leverages upon the nation’s existing FAST network, and new users have to log in to register their mobile number into the PayNow database in order to receive funds. As FAST is a network connecting banks, access to PayNow is limited to the banks’ mobile wallets, mobile app, and online platforms. In August 2018, PayNow Corporate was launched. Instead of a phone number, companies with PayNow Corporate can receive funds through their unique entity number (UEN). Companies can use PayNow Corporate to pay other companies without needing to keep track of various account numbers which can get complicated with multiple suppliers. Furthermore, small and temporary stalls would be able to easily receive payments via mobile phone, providing mobility for such businesses. PayNow has also been adopted by a few government bodies such as the Central Provident Fund (CPF), and other G2C use cases are being considered. More recently, PayNow has seen some adoption for use also in consumer-to-business (C2B) payments. For instance, OCBC Bank tied up with Republic Polytechnic in July 2019 to allow students to pay tuition fees via PayNow.

SGQR standard unifies payment acceptance: Singapore Quick Response Code (SGQR) was launched in September 2018 and is a single QR code that can accept multiple payment methods including domestic and international e-payment schemes, e-wallets, and banks. With SGQR, various payment schemes can be accepted using just one QR code at the merchant, with the payment resolution still completed on each separate payment rail. By using SGQR, merchants need not maintain multiple QR codes provided by different payment schemes and may even be able to avoid a point-of-sale (POS) terminal set-up, which can be costly and physically cumbersome to maintain. Typically, merchants using the SGQR would not need to fork out additional costs. Merchants can select which forms of payments they wish to accept and this would be reflected on the SGQR label so customers are aware which apps they can use to scan the label. As of July 2019: SGQR has integrated nine international payment schemes, seven banking payment schemes, 32 wallets/acquirers and four government agencies.

NETS unified payments system focuses on hawker stalls: NETS is Singapore’s national debit card scheme, owned and operated by the local banks since 1985, and in many ways was Singapore’s first move towards e-payments. In September 2018 NETS was first appointed by Enterprise Singapore to develop a single unified system for e-payments at hawker centers (open air food centers), industrial canteens, and coffee shops around Singapore. Hawker centers are of special interest in the cashless drive as Singaporeans dine at hawker centers 40% of the time and use cash for these transactions 70% of the time. The unified system would permit interoperable payments by e-wallets like Singtel Dash and Grab, transport stored value contactless cards such as EZ-Link, and also credit/debit card schemes. In terms of format, hawker stalls can set up a payment terminal or display an SGQR. Payment terminals are provided free of charge for the first three years with NETS. As of June 2019, NETS has launched the unified e-payment system at 500 out of 12,000 hawker stalls in Singapore, and aims to launch at 200 coffee shops, 25 hawker centers and 20 industrial canteens (total ~2,300 stalls) by September 2020.

Figure 17. PayNow: Three Step Payments

1. Login
2. Enter mobile or NRIC/FIN number and amount
3. Confirm and Send

Source: PayNow

Figure 18. SGQR Example

Source: MAS
-- **SimplyGo for public transport**: SimplyGo provides public transport gantries the ability to accept payments from a wider range of payment methods. Previously, commuters could only use EZ-Link transport stored value contactless cards (launched back in 2001) to pay at gantries. Under SimplyGo commuters would no longer need to carry an additional (EZ-Link) card, but just their regular bank card or NFC-enabled phone that they use for purchases. Billing would also be consolidated on the same payment bill where commuters could review their travel expenses together with their other expenses. SimplyGo was first piloted with Mastercard in December 2018 which saw 26 million transactions made from 100,000 users. The plan for 2019 is to expand this to Visa and NETS cards.

-- **Progressive regulations and non-bank access**: Progressive regulations aim to create a conducive environment for innovation and competition in payment services, while still ensuring that risks around payments are controlled. The Payment Services Bill, finalized in November 2018, streamlined previous regulations regarding payments, and instituted a modular and activity-based risk management regime allowing payment companies to perform risk management commensurate to their level of risk. The modularity of the system gives smaller companies the opportunity to compete without being unnecessarily burdened by stifling regulatory or compliance costs. In 2019, the Monetary Authority of Singapore (MAS) also announced that it would extend FAST access to non-bank players, therefore levelling the playing field and liberalizing payment services, while potentially increasing interoperability.

**Smart Nation Sensor Platform**

Systematic use of sensors in an IoT nation-wide platform generates real-time data which can be analyzed and modeled to improve urban planning, build more responsive and reliable public transport, and improve public security. Governments can be more proactive in public service provisions and enhance the quality of urban living. At the home level, more vulnerable members of society (the elderly and the very young) can be helped by the use of smart sensors:

- **Lamppost-as-a-Platform (LaaP)**: The existing 95,000 lamp posts in Singapore make for an already well placed network throughout the country. These lampposts will be fitted with sensors and cameras to capture crowd data as well as environmental data (air quality, rainfall and water level). The data will then be analyzed using artificial intelligence (AI) and other methods to gain better insights for policymaking and also possibly improve services. Crowd data, for instance, can inform better urban planning while a visual sensor that could detect a collision could result in faster response times for emergency services. The lamp posts would also be replaced with LED lamps by 2022 which are 25% more energy efficient and have a lifespan of 20 years, therefore reducing energy and maintenance costs. The LED lamps can also be remote-controlled so that the lamps can adapt their lighting intensity to weather conditions.

- **Smart apartment**: In 2016, the Housing & Development Board (HDB) began smart home trials in 3,200 apartments in Yuhua where there were improvements to utilities management and elderly care. Building upon the experience, HDB plans to launch its first smart town of 1,400 units in Punggol Northshore Residences in 2020 with smart infrastructure that would be built-in at the outset. With Punggol and future smart homes, HDB highlights a five-pronged approach.
– **Smart Living:** entails benefits within the home that would enhance residents’ quality of life. In terms of enhanced appliances, HDBs will come equipped with smart power sockets and high-tech distribution boards which allow integration with smart appliances. The Home Energy Management System (HEMS) and Home Water Management System (WMS) can help to increase energy efficiency and reduce the utility bill. A trial in Punggol in 2013 indicated energy consumption savings of 20%. The Elderly Monitoring System can help residents take care of the elderly with a peace of mind.

– **Smart Estate:** Extending smart capabilities further from just the unit, technology can be deployed to allow for energy efficiency and waste optimization for the estate.

– **Smart Environment:** Various estates linked by sensors can create a ‘smart environment’ that collects data that informs decisions. Data collected can lead to a wide range of solutions such as smart fans, and data will also be eventually shared publicly.

– **Smart Planning & Smart Community:** HDB uses complex planning tools and computer simulations in town planning. This has been utilized for carpark planning, wind flow, solar panel installation and amenity placement.

Figure 19. Smart Use Cases in a Smart-enabled HDB Home

<table>
<thead>
<tr>
<th>Smart Aspect</th>
<th>Applications and Benefits</th>
</tr>
</thead>
</table>
| Smart Living                  | - Appliance: Smart infrastructure can help to add intelligence to appliances connected to the power source. For instance, residents can control the lights through their app. With a smart door lock, home owners can open the door remotely for visitors should they not be at home, and can open the door without keys via their fingerprint.  
  - HEMS & WMS: With smart energy and water meters, residents will be able to monitor the consumption of both electricity and water for their households through an app, and therefore be able to adjust their consumption accordingly. HEMS also allows tracking of each household appliance for households to optimize electrical use.  
  - Elderly Monitoring System: Sensors and cameras can help to monitor the movement of the elderly in the flat; sensors can provide an alert when there is also no motion for an extended period of time, for instance, deployed in the bathroom where a person might have fallen or become unconscious. Panic buttons that the elderly at home can use to alarm their caretakers on an app. |

| Smart Estate                  | - Smart lighting: Sensors attached to lighting in the estate can adjust the luminosity based on human traffic. When human traffic is low, human luminosity can be reduced by up to 30% which could help to reduce energy usage by up to 40%.  
  - Smart pneumatic waste conveyance system: The automated waste collection system uses underground vacuum-type pipes to move waste into sealed containers which are then periodically picked up by trucks informed by sensors which monitor the volume of waste.  
  - SolarNova Program and Solar panel sensors: The SolarNova program involves aggregating the government’s demand for solar panels across its various agencies and accelerating their deployment. In the HDB set-up, sensors can monitor solar panel efficiency and when they should be cleaned and maintained. HDB plans to install 220 MWp of solar panels in 5,500 HDB blocks as part of Singapore’s broader plan to generate 350 MWp of solar power by 2020. |

| Smart Environment             | - Environment monitoring and smart fans: This involves setting up a network of sensors, effectively linking up estates into a larger ‘smart environment’. The sensors can capture environmental data (e.g., temperature, humidity) in real time which can lead to various applications to improve the environment, such as fans which speed can adapt to those factors.  
  - Data and decisions: Data from the sensors can also be used for decision making. For instance, in Punggol Northshore, HDB will use human traffic data to inform where to build community networking spaces and place amenities. Such data can have wider applications, such as for future town planning. HDB is also working with Starhub and two tech firms to launch an open data platform which the private sector can potentially use for innovation and to solve environmental problems. |

| Smart Planning & Smart Community | - Complex system modeling tools: The tool, used to plan Punggol Northshore’s sustainability features, helps HDB to achieve sustainability goals as cost effectively as possible. These tools are complex and often produce simulations for planners to achieve optimization. This has various applications. Planners can design better carparks to improve ventilation and maximize the use of natural light to reduce electricity costs. Smart carparks can also optimize for usage by allowing more parking spaces when season parking residents are more likely to be out. Wind flow simulations help inform planners where buildings should face to optimize ventilation, while similarly planners will be able to place solar panels and greenery at spots with high temperatures. Planners can also use footfall and sun shade data to select where would be the best place to place amenities and locations for community bonding. Analytics and open data can help engage residents for co-creation. |

Source: HDB, Smart Nation and Digital Government Office
Smart Urban Mobility

Transport efficiency is a key focus in land-constrained Singapore’s smart nation push. A more dynamic transport congestion planning system would allow the government to better manage traffic flow across the island and across peak and non-peak usage. Projects such as on demand bus services and eventually autonomous transport has been laid out. In the long term there is a vision of a ‘car-lite’ Singapore, with safer road and perhaps with a lower carbon footprint. In the near-term however, we see improvements forthcoming soon on the way road users utilize their vehicles.

- **Electronic road pricing system:** Under the current electronic road pricing system launched in 1998, vehicles driving through a designated area were charged based on time of day and based on the principle of congestion charging using gantries and near field communication (NFC) technology. While the system remains effective as it shaped usage behavior based on pricing, it was broadly static in nature as it didn’t have the ability to influence and spread road usage to improve traffic flow. Vehicle drivers were not able to use information effectively with the in-vehicle units providing no information outside of the charges and cash card balance.

- **Government-led change:** The Singapore government announced a tender for a new electronic road pricing (ERP) system to be implemented by 2020. It had opened a bid in 2016 and had since awarded the contract to a consortium led by Singtel’s NCS subsidiary and Mitsubishi Heavy Industries.

- **How does the new ERP 2.0 work?:** Instead of using gantries with NFC technology, the new system will use cameras, satellite, and mobile networks in conjunction with one another to track the vehicles embedded with new GPS/LTE-based in-unit devices. The new system however will be far more dynamic in nature compared to the current system and better use information to its advantage. Instead of a static, NFC-based in-vehicle unit which can only execute payment functions, the new system will be able to communicate two ways between the central computer system and the in-vehicle unit to better utilize information. For instance, the system, via its various sensors may be able to sense vehicle build-up in specific areas on a real-time basis. The system can then recommend remedial actions and dynamically divert traffic with push levers such as changing the road pricing structure across the congested roads or pull levers by informing the users of the traffic situation via the in-vehicle devices.
This better use of information would allow reduced time wasted in traffic as well as improve the environmental impact with less pollution. Road charging and traffic rules enforcement could be more dynamic as well.

- The system can automatically recognize a car parked in a designated public parking area and charge the user accordingly based on the actual time spent in that area, removing the need for on-site payments and clunky coupon or app use.

- Enforcement of road rules would be far easier. Speeding for instance can be easily recognized without the need for traditional fixed location speed cameras with the analytics provided by GPS/mobile data. Fines can be sent to the relevant party automatically with the identifiable in-vehicle unit. This would help influence compliance to the rules.

- Road charging could also be more efficient as road use could be tracked more accurately. This grants the government the ability to charge users properly based on their road use.

- Usage could be influenced. Using data and analytics, the system could influence road usage behavior by altering the charging system across time and area.

**Figure 22. ERP 2.0 System**

Connectivity everywhere: Based on the expected framework for ERP 2.0, we should see far greater connectivity needs for the sector. Sensors throughout the island will need to be connected and this can be done via fiber or 5G. All these sensors and in-vehicle units will need to connect to a mobile network and as such it creates a potential source of revenue for the telco, equipment suppliers and platform providers. We note that the opportunity is not linked to the connectivity platform alone. The creation of the system itself was partly enabled by a telco based on their ~S$556 million (~$400m) contract to build the platform.
Self-driving vehicles and vehicles on demand: Singapore has launched autonomous vehicle trails with the first self-driving vehicle approved for public road testing in July 2015. Multiple parties have started project trials with universities and companies collaborating on various autonomous vehicle projects. Test tracks have been developed and the government is simultaneously working on testing, regulation formulation, and city planning in order to introduce a cohesive smart mobility offer.

Certain areas such as the Nanyang Technological University (NTU) campus are targeted to introduce driverless routes on its roads in 2019. For instance, in March 2019, NTU and Volvo began to test an autonomous bus on its campus. Off-peak driverless buses are expected to ply some residential areas by 2022. These vehicles are to be equipped not only with GPS and sensors but with communications capabilities as well with WiFi, 4G, and eventually 5G connectivity in place to improve service delivery and safety.

Social benefits of autonomous vehicles: Once autonomous vehicles are fully rolled out, efficiencies are expected to be seen with less congestion and a greater sharing of assets across users thereby reducing the need for individual vehicles. On-demand sharing and more efficient logistics platforms are expected to spread. This will have other tangential benefits such as reduced road congestion, lower pollution and better parking space optimization.

Singapore pivoting into electric cars?: One electric vehicle manufacturer from the U.K. is building a dedicated electric vehicle manufacturing division in Singapore, due for completion in 2020 with the goal of rolling out its first model by 2021. Singapore has played a significant role in the company’s development since 2007, where a growing engineering team are developing high-speed digital motors. Singapore’s Economic Development Board is in talks with other potential manufacturers of green vehicles also to be based in Singapore.

Moments of Life Initiative

The Moments of Life app provides seamless, convenient, and personalized experiences for citizens as they consume government services and information throughout their lives, through a single platform. Rather than interacting with multiple systems, users can use the app to access multiple services at once.

Key services for different life moments: The app has various bundled services for key life points for citizens. Some key examples: (1) birth registration service: parents can register for their child’s birth, apply for the government “Baby Bonus” grant and library membership at the same time through a single application on the app. Since Moments of Life was released in June 2018, over 6,000 parents have used this service; (2) children’s health information: Using SingPass to login, parents can access records of completed immunizations and track what upcoming medical appointments are to come; and (3) search for preschools: through the app, parents would be able to search for preschools, view information and indicate interest for their children’s enrollment.

Development of additional services: Moments of Life has taken a proactive approach in incorporating the feedback of citizens in the design of the app, as was the case for the addition of the child library feature. In 2019, private hospitals were on-boarded for parents there to perform electronic birth registration, while the Parents’ Gateway was launched, which is a one-stop portal for the school and parents to communicate. On the roadmap for 2019 are more services for active ageing and end of life matters, and additional services for families with young children.
CODEX & Cybersecurity

Core Operations Development Environment and eXchange (CODEX) is a digital services platform for the government and was added as the sixth strategic Smart Nation project in late 2018. This relates to the fundamental re-engineering of the government for more efficient and cost-effective e-service construction.

- **Structure and benefits:** The base of CODEX is a data infrastructure across the government with common data standards and formats that will facilitate sharing across the agencies, which will avoid data being siloed. In the middle of CODEX is the Singapore Government Technology Stack (SGTS). The stack uses Infrastructure-as-a-Service (IaaS) by shifting less sensitive systems and data onto the commercial cloud which can provide scalability and reliability. More sensitive systems and data can instead be on the government’s own private cloud. The middleware is built of software services including application programming interfaces (APIs) and analytic tools that can result in agility through quick prototyping, deployment, testing and monitoring. Within the SGTS is also a library of reusable common micro-services that can be amalgamated to form new applications. With a library of micro-services, various government agencies can build applications such as the network device interface (NDI) while avoiding duplication.

- **Approach to cybersecurity:** The SG digital stack takes a ‘security-by-design’ approach to cybersecurity, minimizing system vulnerabilities by taking security concerns into account during software development. With Singapore as a whole including the banking and payment systems becoming more digital, more is at risk from cyberattacks. Indeed, all forms of cyber threats have increased totaling 6,179 cases in 2018 (2017: 5,351) and comprising 18.6% of total crimes (2017: 16.6%). One of the more prominent cases was in June 2018 when Singapore’s largest healthcare institution was subject to a cyberattack and personal data of 1.5 million patients were stolen.

- **Additional measures to strengthen cyber resilience:** The MAS’ Technology Risk Management Guidelines seek to provide guidelines to financial institutions’ technology risk management and cyber security practices. These guidelines cover various aspects of technological risk, including system availability, disaster recovery, data backup management and payment card security. In September 2018, the MAS issued a consultation paper to augment cyber resilience of these IT systems, and requires financial institution to implement six cyber security measures: (1) address system security flaws in a timely manner; (2) establish and implement robust security for systems; (3) deploy security devices to secure system connections; (4) install anti-virus software to mitigate the risk of malware infection; (5) restrict the use of system administrator accounts that can modify system configurations; and (6) strengthen user authentication for system administrator accounts on critical systems.
Three Pillars Underpinning a Smart Nation

To support Singapore’s Smart Nation goals, the three pillars of the economy, society, and government need to be digital and mutually reinforce each other. The government has launched plans to transform each of these pillars.

Digital Economy

A digital economy is one with new-age digital ecosystems formed from new businesses and business models, but existing business models could prosper by increasing productivity and finding new opportunities with technology. Singapore aims to digitalize its economy using a three-pronged approach.

- **Accelerate**: Accelerate digitalization of existing industries thereby increasing productivity and efficiency and potentially discovering new revenue streams. In 2017, 23 Industry Transformation Maps (ITMs) were rolled out that entail specific industry digitalization plans. For SMEs, the SMEs Go Digital programs specifically target SMEs and provide advice and solutions.

- **Compete**: Create new integrated ecosystems to compete. As digitalization blurs sector boundaries and new digital platforms become channels of distribution, businesses need to innovate and create synergistic ecosystems to remain competitive. The Open Innovation Platform (OIP) allows businesses to post problems on which solution providers can then ideate. Thus far, OIP has 54 challenges and 3,200 solution providers competing for S$1.6 million ($1.2m) of prize money.

- **Transform**: Other than digitalizing and creating ecosystems, this regards developing novel digital businesses, which may in turn also create growth for the wider digital economy.

Digital Government

Digitalization of government will be a key pillar of Singapore’s public services transformation, as laid out in the Digital Government Blueprint. This will require building common digital and data platforms for the whole of government, with reliable, resilient and secure systems. This entails transforming the government’s technology infrastructure using micro-services, operate more nimbly and provide quicker time-to-delivery. The government will also use cloud computing and invest in technologies such as AI. This blueprint should help deliver a transformed digital government.

- **Two principles — ‘digital to the core, serving with heart’**: The Singapore government aims to be digital “to the core” — reconstructing its core infrastructure, building efficient business processes and leveraging data and connectivity to provide high quality digital services with a personal touch

- **Three main stakeholders — citizens, businesses, and public officers**: For Singapore citizens and businesses, the government aims to create easy-to-use seamless digital services that are device agnostic. Furthermore, these services should be secure and reliable while also relevant to their needs. For public officers, the goals are for digitally-enabled workplaces which use data, technology, and high quality internal corporate services to be more productive. The government is upskilling public officers with data science and AI capabilities and intends to grow the talent pool for technology.
**Six-fold strategy to building a digital government:** (1) integrating services around citizens (including the “Moments of Life” initiative) and business needs; (2) strengthening integration between policy, operations and technology (through the appointment of Chief Digital Strategy officers and Chief Information Officers); (3) building common digital and data platforms (to reduce the time and effort needed to introduce new digital services); (4) operating reliable, resilient, and secure systems (with a clear cybersecurity strategy); (5) raising digital capabilities to pursue innovation (establishing a Center of Excellence or CentEx growing expertise and nurturing manpower); and (6) co-creating with citizens and businesses and facilitating adoption of technology.

**Six broad KPIs:** The government will hold itself to a set of key performance indicators (KPIs) to be met by 2023: (1) stakeholder satisfaction (measured via survey); (2) end-to-end digital options (for example filing income tax returns is fully digital); (3) end-to-end digital transactions (a move to full e-payments); (4) digital capabilities (all public officers must have basic digital literacy and a high number trained in data analytics and data science); (5) transformative digital projects; (6) use of AI, data, and data analytics (all Ministry families to have at least one AI project for service delivery or policy making).

### Figure 27. Singapore’s Digital Government Goals by 2023

<table>
<thead>
<tr>
<th>Key Performance Indicators</th>
<th>Sub-goals</th>
<th>2023 Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder satisfaction</td>
<td>Citizen satisfaction with digital services as measured via survey</td>
<td>75%-80% to rate very satisfied</td>
</tr>
<tr>
<td>End-to-end digital options</td>
<td>Services that offer e-payment options (both inbound and outbound)</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Services that are pre-filled with government-verified data</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Services requiring wet ink signatures that offer digital options</td>
<td>100%</td>
</tr>
<tr>
<td>End-to-end digital transactions</td>
<td>Percentage of transactions completed digitally from end-to-end</td>
<td>90%-95%*</td>
</tr>
<tr>
<td></td>
<td>Percentage of payments (both inbound and outbound) that are completed via e-payments</td>
<td>100%*</td>
</tr>
<tr>
<td>Digital capabilities</td>
<td>Number of public officers with basic digital literacy</td>
<td>All public officers</td>
</tr>
<tr>
<td></td>
<td>Number of public officers trained in data analytics and data science</td>
<td>20,000</td>
</tr>
<tr>
<td>Transformative digital projects</td>
<td>Number of transformative digital projects</td>
<td>30-50</td>
</tr>
<tr>
<td>AI, data and data analytics</td>
<td>Percentage of Ministry families that use AI for service delivery or policy making</td>
<td>All Ministry families to have ≥1AI project</td>
</tr>
<tr>
<td></td>
<td>Number of high-impact data analytics projects</td>
<td>2 projects per Ministry family/year,</td>
</tr>
<tr>
<td></td>
<td>Core data fields to be stored in machine readable format and to be transmittable by APIs</td>
<td>10 cross-agency projects/year,</td>
</tr>
<tr>
<td></td>
<td>Time required to fuse data for cross-agency projects</td>
<td>90%-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;10 days to share data</td>
</tr>
</tbody>
</table>

*Note: excluding those that cannot be met due to legislation or certain segments of the population (i.e., those with disabilities) that are unable to use or access digital tools.

Source: Smart Nation and Digital Government Office

### Digital Government Services – Selected Initiatives

**Integrated government services:** Corporates who need to maintain licenses can utilize the LicenceOne which brings license applications across government agencies into one portal. By 2019, over 200 licenses will be available on LicenceOne. Launched in 2017, the Business Grants Portal brings government grants into one place, allowing businesses to use their CorpPass account to find, apply and manage their grant applications. By 2019 it is planned that 80% of government grants will be available on the Business Grants Portal. Integrated and simpler government services apply to consumers as well. Introduced in January 2018, consumers can use the HDB Resale Portal to buy a resale public housing unit and benefit from a 50% reduction of transaction time, possibly completing a transaction in just eight weeks.
The HDB Resale Portal also makes transactions easier with eligibility checks for housing transactions, grants and concessionary loans combined within the portal, so consumers would no longer need to visit different portals.

- **Building technical expertise and exploring emerging technologies:** The government will build an in-house reserve of deep technical skills within Centre of Excellence (CentEx) which can be called upon quickly when opportunities arise. Such capabilities include data science and AI, IoT, cybersecurity, and GeoSpecial. CentEx can also be expanded into emerging areas of technology such as robotics, VR/AR and blockchain. At present, one example of building deep expertise and exploring use cases is with smart glasses. GovTech’s Video Analytics (VA) team has been piloting projects focusing on remote assistance and facial recognition. For instance, with smart glasses, on-site engineers working on train maintenance can tap on remote assistance to access additional help to solve more complex problems.

- **Moments of Life:** As previously discussed, the Moments of Life app aims to provide seamless, convenient and personalized experiences for citizens as they consume government services and information throughout their lives, through a single platform. Rather than interacting with multiple systems, users can use Moments of Life to access multiple related services at once.

- **OpenCerts:** OpenCerts is a blockchain-based platform offering an easy and reliable way to issue and validate academic certificates that are tamper-resistant. Built on open source and standards, educational institutions can easily create digital versions of every academic certificate that has been or will be issued, and publish them on a public ledger. Students receive their academic certificates and transcripts as a digital file that can be easily viewed, shared, and verified internationally.

- **Adopting agile methodology and technology:** The Adaptive Digital Workplace Program (ADWP) aims to boost the efficiency of public officers and instill a new, agile way of working. Through the adoption of commercial cloud and software-as-a-service (SaaS) tools such as Microsoft 365, public officers can work anytime and anywhere using just their mobile phones. Agencies have set up co-working spaces and can provide technical support for visiting public officers. The ADWP is supported by infrastructure that ensures secure intranet and internet access and the plan is to roll out ADWP from July 2019 over three years. Similar to the ADWP, the Ministry of Manpower’s Mobile i-Occupational Safety Health System (iOSH) gives site inspectors the ability to immediately key in findings without returning to the office thereby reducing time spent on tasks such as data entry, scanning and uploading of work. These initiatives will result in a government that is quicker, more efficient but still secure.

- **Partnering and co-creating solutions with businesses:** For 2019 the government has an ICT procurement budget of S$2.5-S$2.7 billion with more than 80% of this open to SMEs which means the government can engage a wide spectrum of businesses rather than just top-tier corporates. To engage businesses more deeply and not just purchase from them, the government is exploring three new partnership models.

  - **Crowdsourcing:** The government can lead hackathons and collect ideas while simultaneously conducting procurement, versus the previous approach where the government has performed these activities separately. A combined approach could aid speed to market and increase efficiency.
– **Co-developing with partners**: This entails a longer-term paradigm where businesses which are able to meet the government’s needs can continue to co-develop more projects and could even take over selected operations. Indeed, the government intends to adopt this approach in the development of three selected sections of the NDI project, which are certificate authority, biometrics and fraud analytics.

– **Dynamic contracting**: In contrast to the traditional approach which is to give multi-year contracts to companies, the government would instead adopt dynamic contracting for bulk orders. This is somewhat similar in spirit to the agile approach. The government can flexibly add new requirements to the existing panel of suppliers or add new suppliers. The benefits of such an approach are that the business and government collaborate, and products and services can be updated to stay relevant till the end of the contract.

### Digital Society

The Digital Readiness Blueprint aims to ensure digital inclusion, promote digital literacy and encourage widespread digital adoption.

- **Digital Access**: At the most basic level, residents need to have the means to be digital. The government has identified four key basic digital enablers as (1) a mobile device with a network connection; (2) Internet access, (3) a bank account with card facility; and (4) a national digital identity. Efforts are aimed toward these four enablers in an inclusive manner. For instance, computers and tablets are subsidized for households with low income while the MAS is working to ensure that bank accounts are free for those who otherwise cannot afford it (i.e., without fall-below fees). The Info-Communications Media Development Authority (IMDA) also launched the Enable IT program in 2014 which promotes the awareness and adoption of assistive technologies for people with disabilities.

- **Digital Literacy**: This entails basic digital skills that would enable residents to effectively leverage technology. Users should be able to register and transact with government applications, understand how to communicate online (chatting apps and e-mail), know how to perform transactions, and crucially apply cybersecurity best practices. Various efforts exist which seek to promote digital literacy at schools. For instance, the Media Literacy Council uses public education content and school visits to promote the safe use of technology. For 2018’s campaign, the Council focused on disinformation as a key risk.

- **Digital Participation**: Residents who adopt technology can achieve a better quality of life, eventually resulting in connected communities where new content, products and services can be created. In this vertical, the government emphasizes the need for businesses to commit to participate in technology, both for their employees and also their users. One private sector initiative is HourVillage, a social enterprise where people help each other through performing skills, services, and errands for time credit. Simultaneously, the government is also creating digital initiatives that seek to foster meaningful community participation. Within the Smart Nation initiative itself is Tech Kaki, which is a platform for citizens to provide feedback to the government and participate in product development.
A Case Study on India

India’s ranking in the United Nations e-governance survey has risen from 119th in 2010 to 96th in the 2018 rankings. During this period, India: (1) launched its ‘Digital India’ (2015) e-governance program; (2) scaled its new digital identity system (Aadhaar; 2009-onwards) to 1.2 billion+ enrollees; and (3) accelerated the adoption of low-cost digital payment systems (UPI, RuPay).

These three programs, which we discuss in detail, will continue to be key to India’s transition into a digitally empowered knowledge economy, in our view. Apart from the near universal adoption of the Aadhaar digital identity system, we think the recent upsurge in mobile broadband penetration (>500mn users forecast in 2020 vs <200mn in 2016) will be instrumental foundation stones in this transformation.

Objectives of India’s Digitalized Government

The goals of India’s government efforts to digitize have in recent years evolved to have the following key objectives:

- To establish India’s e-governance infrastructure on a common technology/data platform versus erstwhile standalone systems to have better overall impact.
- To utilize India’s new digital ID, Aadhaar, to improve targeting of government spends on social welfare, reduce corruption, and accelerate financial inclusion.
- Leverage private sector innovation to further deepen financial inclusion.

Why ‘Digital India’?

Since the late 1990s, the Indian government has initiated a number of projects which aim to adopt e-governance and improve citizen services (e.g., online railway ticketing, e-filing income taxes, digitizing land records etc.). While a number of these projects have been successfully launched, the early implementations were mostly standalone systems with limited interoperability, thereby limiting their overall impact. In response, India launched a ‘Digital India’ program in 2015 to enable universal adoption of e-governance across/throughout the government machinery.

Holistic Approach to Digitizing Government

The ‘Digital India’ program aims to not only digitize government services but also to enable universal access (digital literacy and physical infrastructure). Overall, there are nine broad pillars of the Digital India initiative encompassing: (1) physical infrastructure (broadband highways, universal access to mobile connectivity); (2) government service delivery (e-Governance, Information for All etc.); and (3) universal digital literacy. Further, the Digital India program also provides for public-private partnerships to implement e-governance projects (several live examples including Passport service and the GSTN network).

The program covers multiple government ministries, and is being coordinated by the Department of Electronics and Information Technology (DeitY). The government has created Chief Information Officer (CIO) desks in 10 key Ministries to coordinate/facilitate implementation of various e-governance projects.
### Figure 28. Nine Pillars of Digital India

<table>
<thead>
<tr>
<th>Pillar</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadband Highways</td>
<td>Covers 3 sub components: (1) broadband for all; (2) rural, broadband for all; and (3) urban and National Information Infrastructure</td>
</tr>
<tr>
<td>Universal Access to Mobile Connectivity</td>
<td>Two subcomponents: (1) Common service centers (CSCs) and (2) Post Offices as multi-service centers</td>
</tr>
<tr>
<td>Public Internet Access Program</td>
<td>Guiding principles are form simplification, online applications/tracking, online repositories, integration of services, and platforms</td>
</tr>
<tr>
<td>e-Governance: Reforming Government through Technology</td>
<td>Transforming the delivery of services to ensure enhancement in productivity and competitiveness</td>
</tr>
<tr>
<td>Information for All</td>
<td>Open Data platform, Social Media Engagement and Online Messaging</td>
</tr>
<tr>
<td>Electronics Manufacturing</td>
<td>Focuses on promoting electronics manufacturing in the country with the target of NET ZERO Imports by 2020</td>
</tr>
<tr>
<td>IT for Jobs</td>
<td>Focus on providing training to youth in the skills required for availing employment opportunities in the IT/ITES sector</td>
</tr>
<tr>
<td>Early Harvest Programs</td>
<td>Projects to be implemented within short timeline like IT Platform for messages, Biometric attendance, Secure email with Government etc.</td>
</tr>
</tbody>
</table>

Source: DigitalIndia.Gov.In

### Figure 29. Government Initiatives to Build Physical Infrastructure for Digital India

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BharatNet</td>
<td>Project to establish, manage, and operate the National Optical Fiber Network aimed at providing broadband data connectivity to 250k gram panchayats (grass root self-governance systems of India), covering 625k villages</td>
<td>More than 135k gram panchayats have been connected through optical fiber; with equipment installed in 120k 64TB/month of data carried</td>
</tr>
<tr>
<td>Smart Cities Mission</td>
<td>Creation of 108 smart cities: the project involves city improvement/renewal/extension projects involving housing, transport infrastructure, e-governance, and smart infrastructure solutions and services. To be implemented by a 50:50 JV of state government and local bodies with Government of India supporting with Rs1bn/year in financing for five years</td>
<td>As per Smart Cities Mission, 100 proposals have been approved so far, potentially impacting an urban population base of nearly 100 million with a total cost outlay of Rs2 trillion</td>
</tr>
<tr>
<td>Common Service Centers</td>
<td>CSCs are access points for delivery of public utility services, social welfare schemes etc. to citizens in rural and remote parts of the country</td>
<td>Over 370k CSCs established across the country; India has ~650k villages</td>
</tr>
<tr>
<td>Universal Access to Mobile</td>
<td>Aim to provide mobile access to &gt;50k villages with no mobile coverage</td>
<td>As of August 2018, 43k villages had no mobile coverage</td>
</tr>
<tr>
<td>Public Wi-Fi hotspots</td>
<td>Creation of public Wi-Fi hotspots</td>
<td>Wi-Fi hotspots set up at 1,000 railway stations across India – estimated usage at 20mn+/month</td>
</tr>
<tr>
<td>National Cyber Coordination Center</td>
<td>A center to safeguard India’s cyberspace against threats</td>
<td>Phase-I operational</td>
</tr>
<tr>
<td>Digitization of Post Offices</td>
<td>Centralized data centers, networking of all post offices, and enabling digital payment capabilities</td>
<td>India Post has signed up with TCS to digitalize 150k Post Offices &amp; Create the world’s biggest ePostal network.</td>
</tr>
</tbody>
</table>

Source: Deloitte

### Digitizing Governance: National e-Governance Plan 2.0 (e-Kranti)

A major shortcoming of India’s older e-governance plan was a lack of integration amongst government data/technology platforms and low degree of government process re-engineering. The e-Kranti program aims to both create new e-governance projects and revamp existing projects to follow key principles designed to ensure inter-operability, process transformation, ease of use and deployment of accessibility enabling technologies (e.g., cloud, mobile etc.). Figure 30 highlights key principles to which all new and existing e-governance projects across ministries (state and local) must adhere.
Figure 30. Key Principles of National E-Governance Strategy 2.0 (e-Kranti)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation and not Translation</td>
<td>All projects must involve transformation in quality, quantity, and manner of service delivery plus significant enhancement in productivity and competitiveness</td>
</tr>
<tr>
<td>Integrated Services and not Individual Services</td>
<td>A common middleware and integration of back-end processes and processing systems</td>
</tr>
<tr>
<td>Government Process Re-engineering</td>
<td>To mandate government process re-engineering as a mandatory first step in all new projects</td>
</tr>
<tr>
<td>ICT Infrastructure on Demand</td>
<td>Government departments should be provided with connectivity, cloud, and mobile platforms on demand. National Information Infrastructure (NII) is in advanced stage of project formulation to aid this</td>
</tr>
<tr>
<td>Cloud by Default</td>
<td>To leverage cloud technologies; government cloud shall be the default and will store all sensitive information from all government departments</td>
</tr>
<tr>
<td>Mobile First</td>
<td>All applications to be designed/redesigned to enable mobile service delivery</td>
</tr>
<tr>
<td>Fast Track Approvals</td>
<td>To establish fast track approval process for mission mode (priority) projects</td>
</tr>
<tr>
<td>Mandating Standards and Protocols</td>
<td>Use of e-governance standards and protocols as notified by DeitY</td>
</tr>
<tr>
<td>Language Localization</td>
<td>All information and services to be provided in Indian languages</td>
</tr>
<tr>
<td>Security and Electronic Data Preservation</td>
<td>National Cyber Security Policy 2013 notified by DeitY to be followed for all online applications and e-services</td>
</tr>
</tbody>
</table>

Source: DigitalIndia.gov.in

Figure 31. Total Number of e-Services Offered by Central/State Governments

Source: etaal.gov.in

Figure 32. Electronic Transactions Under e-Governance Projects are Surging

Source: etaal.gov.in

Figure 33. Projects Under e-Kranti Span Across Government Functions

<table>
<thead>
<tr>
<th>Central</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking</td>
<td>India Portal</td>
</tr>
<tr>
<td>Insurance</td>
<td>NSDG</td>
</tr>
<tr>
<td>Income Tax</td>
<td>CSC</td>
</tr>
<tr>
<td>Central Excise</td>
<td>Financial Inclusion</td>
</tr>
<tr>
<td>MCA 21</td>
<td>E-Trade</td>
</tr>
<tr>
<td>Pensions</td>
<td>E-courts</td>
</tr>
<tr>
<td>Passport</td>
<td>E-Procurement</td>
</tr>
<tr>
<td>National ID/UID</td>
<td>E-Biz</td>
</tr>
<tr>
<td>Immigration/Visa</td>
<td>NGIS</td>
</tr>
<tr>
<td>E-office</td>
<td>Road and Highway Information</td>
</tr>
<tr>
<td>Posts</td>
<td>Social Benefits</td>
</tr>
<tr>
<td>Central Armed Paramilitary</td>
<td>Urban Governance</td>
</tr>
<tr>
<td>Forces</td>
<td></td>
</tr>
<tr>
<td>e-Bhasha</td>
<td>CCTNS</td>
</tr>
<tr>
<td>NMEICT</td>
<td>Agriculture 2.0</td>
</tr>
<tr>
<td>e-Sansad</td>
<td>e-Vidhaan</td>
</tr>
<tr>
<td></td>
<td>Rural Development</td>
</tr>
<tr>
<td></td>
<td>Women and Child Development</td>
</tr>
</tbody>
</table>

Note: Dark Grey – live projects Light Grey – Partially live projects Blue – Under implementation or under design & development or in design-stage projects

Source: DigitalIndia.Gov.In

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Aadhaar & Financial Inclusion

Aadhaar is the central plank of Indian government’s financial inclusion project titled JAM (Jan Dhan (bank account for everyone) – Aadhaar (identity) – Mobile (digital payments)) which aims to reduce fraud/leakages and improve targeting in government spending on social welfare.

JAM Trinity is Digital India’s Most Prominent Flagbearer

‘JAM’ essentially enables direct transfer welfare subsidies into bank accounts, replacing an extant system that relied on a complex intermediary system prone to leakages/corruption and poor targeting. The three prongs of ‘JAM’ addressed identifying beneficiaries, reaching them, and enabling beneficiary accessibility to their due from the government. To date, India has seeded >80% of public benefits disbursement accounts with Aadhaar. Over time, Aadhaar should translate into a step change for financial inclusion in India, facilitating formal lending penetration (including digital lending), and greater financialization of savings.

Figure 34. India’s Digital ID System, Aadhaar, has ~90% Penetration with 1.2 Billion Enrollments to Date

Figure 35. Aadhaar Monthly Activity Trends Indicate Increasingly Widespread Usage

Figure 36. Jan Dhan Accounts Opened and Corresponding Savings Deposit Trends

Figure 37. RuPay Cards Issued to PMJDY Beneficiaries
The launch of UPI by the government resulted in the roll out of interoperable payment services and led to an acceleration of payment services in India.

Democratizing Digital Payments

The launch of UPI by the government entity, National Payments Corporation of India (NPCI) resulted in the roll out of interoperable payment services in India, contributing to an acceleration in the adoption of digital payments across merchants and consumers. UPI is a bank-to-bank electronic transfer facility which identifies recipients via a virtual payment address. The system powers multiple bank accounts into a single mobile application, merging several banking features, seamless fund routing, and merchant payments into one offering.

NPCI also launched RuPay – India’s indigenous card system that is designed to lower the cost of digital payments and support financial inclusion initiatives. RuPay was started in 2012 and as of August 2019 has issued 500 million+ cards issued by 1,100 issuing and acquiring banks with more 1.2 billion transactions on the network.

UPI and RuPay systems, both created by a government entity (NPCI), are leading systems facilitating the penetration of digital payments in India by achieving lower cost of transaction, focusing on inter-operability, and setting an enabling eco-system for fin-tech companies especially in payments and online lending space. The opportunity space is huge — Deloitte estimates the credit gap in the micro and SME segment may be as much as $150 billion+ (total credit demand of $250 billion versus bank credit supply of $100 billion).

<table>
<thead>
<tr>
<th>Number of DBT Schemes</th>
<th>FY14</th>
<th>FY15</th>
<th>FY16</th>
<th>FY17</th>
<th>FY18</th>
<th>FY19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Funds Transferred (Rs bn)</td>
<td>74</td>
<td>389</td>
<td>619</td>
<td>747</td>
<td>1,909</td>
<td>3,298</td>
</tr>
<tr>
<td>Eligible Beneficiaries (mn)</td>
<td>108</td>
<td>228</td>
<td>312</td>
<td>357</td>
<td>1,240</td>
<td>1,292</td>
</tr>
</tbody>
</table>

Source: dbtbharat.gov.in

**Figure 38. Direct Benefit Transfers (DBT) of State Welfare Spending has Grown Rapidly**

<table>
<thead>
<tr>
<th></th>
<th>FY14</th>
<th>FY15</th>
<th>FY16</th>
<th>FY17</th>
<th>FY18</th>
<th>FY19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of DBT Schemes</td>
<td>28</td>
<td>34</td>
<td>59</td>
<td>142</td>
<td>437</td>
<td>440</td>
</tr>
<tr>
<td>Total Funds Transferred (Rs bn)</td>
<td>74</td>
<td>389</td>
<td>619</td>
<td>747</td>
<td>1,909</td>
<td>3,298</td>
</tr>
<tr>
<td>Eligible Beneficiaries (mn)</td>
<td>108</td>
<td>228</td>
<td>312</td>
<td>357</td>
<td>1,240</td>
<td>1,292</td>
</tr>
</tbody>
</table>

Source: dbtbharat.gov.in

**Figure 39. India – Percent of Payment Transactions (by Volume) Done Through Mobile Banking and Mobile Wallets**

**Figure 40. UPI Transactions Have Surged Since Inception in FY17**

Note: (1) Total transactions excludes use of debit/credit cards at ATMs; (2) mobile banking data from Jul’17 includes only individual/corporate payments initiated, processed and authorized using mobile; (3) PPI comprises mostly of m-wallets, but also includes prepaid payment cards.

Source: RBI
Digital Governance Beyond Citizen-Centric Services

Beyond digital identity and attendant objectives of financial inclusion, there is massive scope for integrating digital capabilities throughout government machinery including in its internal processes (i.e. government process re-engineering) and to enable government to establish infrastructure to support commerce.

Instances of such deployment include: (1) the government e-marketplace for all government procurements from private sector; (2) Andhra Pradesh government’s Single Desk Portal which acts as a one-stop portal for all government approvals in for businesses – enabling sharp improvement in ‘ease of doing business’ and 3) the public digital infrastructure, eNaM, which is an agricultural marketplace that enables online agri-commodities trading between farmers and traders. Other examples include initiatives like Krishidoot and eHospital etc. (See Figure 41).

<table>
<thead>
<tr>
<th>Initiative</th>
<th>What It Is</th>
<th>How It Works</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-Hospital</td>
<td>Enables patients to register, book appointments, pay fee, and avail diagnostic reports in premier medical government institutes.</td>
<td>e-Hospital runs an online registration system for connecting various hospitals to citizens through Aadhaar based online registration and appointment system</td>
<td>The service allows citizens to access any government hospital online for making appointments; 322 hospitals provide the service nationwide; 120mn patient registrations since inception and additions at a 6mn/month+ pace and 100k+/month online appointments made</td>
</tr>
<tr>
<td>eNaM</td>
<td>National Agriculture market is a Pan-India electronic trading portal which seeks to network existing APMCs (offline agricultural produce markets) and other market yards to create a unified national market for agri commodities</td>
<td>The common e-market platform will be deployable across the 585 regulated APMCs; it will also provide allocation to each APMC for purchase of related hardware. States are required to undertake mandatory reforms in their respective APMC acts</td>
<td>585 markets across 16 states and 2 UT have been integrated with eNaM 300+ of the 585 APMCs are now doing online trade. More than 16mn farmers are using the service</td>
</tr>
<tr>
<td>SDP</td>
<td>Andhra Pradesh governments portal to assist businesses in obtaining clearances and approvals to establish and operate businesses.</td>
<td>The platform provides 75 business specific services (land records, environmental registrations, permits etc.) online with provisions for online tracking and payments of taxes and bills.</td>
<td>Total transactions on the platform reached Rs170bn ($2.5bn) in FY19. It has also led to a sharp reduction in lead time in government procurements, per a World Bank study</td>
</tr>
<tr>
<td>eGeM</td>
<td>Government’s online procurement platform. The marketplace offers more than a million products and around 15 services and hosts 280k+ sellers and counts 27x government organizations as clients.</td>
<td>The common e-stop portal for all government approvals in for businesses – enabling sharp improvement in ‘ease of doing business’ and 3) the public digital infrastructure, eNaM, which is an agricultural marketplace that enables online agri-commodities trading between farmers and traders. Other examples include initiatives like Krishidoot and eHospital etc. (See Figure 41).</td>
<td></td>
</tr>
</tbody>
</table>

Source: Government of India, World Bank, Deloitte, Government of Andhra Pradesh, Media

Public Private Partnerships (PPP) could enable the government to set up a solid technological backbone to support the roll out of various initiatives.

More PPPs Key to Digital India

Public Private Partnerships (PPP) could enable the government to set up a solid technological backbone to support the roll out of various initiatives. As demonstrated by the role of private sector in realizing ‘universal access’ of digital services by deepening penetration LTE mobile broadband, private sector could play a key role in the government’s plan to roll out more digital solutions for citizens. Indeed, over the past decade, several projects implemented under the PPP route (case studies below) highlight the potential for private sector to assist the government in translating its vision of ‘Digital India’ into reality.

Case Study#1: Re-imagined Passport Services across India

Under India’s national e-governance plan, a private Indian company provided a technology platform for passport services that enabled a public private partnership model for passport services — the private company manages the overall physical and technical infrastructure and operations while the government retains the sovereign functions.
The project was successful — it reduced fraud and time delays, increased transparency and drastically reduced the time taken to handle passport applications. The success of this project has paved the way for other government departments to follow a similar process.

As per a Government of India study, 77 passport centers were rolled out, 90 million records from legacy systems were migrated and 40,000k+ applicants are now handled daily.

**Case Study#2: Income Tax Filing System**

The Income Tax Department of India needed a comprehensive software system for e-filing, processing, and refunding income tax returns. A private Indian company partnered with the government to set up an IT-CPC, a centralized processing center for all IT-related processes where all the filed returns were directed, validated, scanned, digitized, processed, and printed.

Impact: As of July 2019, more than 87 million users were registered for e-filing services and more than 67 million returns filed electronically in full year 2019.

**Case Study#3: Curbing Tax Evasion through Big Data Analytics**

‘Project Insight’ aims to use big data analytics to glean data from multiple sources (social media accounts, flight data, address) to create taxpayer profiles and deduce mismatches between spending pattern and income tax declarations. This project will be aided by the mandatory linking of PAN cards (identification system used for taxation) with Aadhaar IDs (given Aadhaar-enabled eKYC is increasingly being used across services). This project will make use of IT and data analytics tools to identify evasion cases and make enforcement actions.

Context: Improving tax compliance is a key goal for the government of India — an aim that was part of the driver for the demonetization exercise conducted in November 2016. The size of black/underground economy in India was estimated to be 23% of GDP by World Bank prior to demonetization in late 2016.

**Case Study#4: Reimagining Postal Services**

The Department of Posts partnered with a private Indian enterprise in a multi-year digital core program which has transformed the Department of Posts into a new-age digital hub offering smart mail and innovative value-added services.

Among the achievements of the offering:

- Connected network of 150,000 post offices makes it the largest ePostal network in the world.
- A point-of-Sale solution from the private entity was rolled out across 80,000 PoS Terminals; among the largest such implementations in the world.
- Unique 130,000 hand-held devices used by ‘Gramin Dak Sevaks’ (rural postmen) to provide postal, banking, and insurance services in remote, off-grid villages.
Case Study#5: GSTN Network

GSTN is a non-government non-profit company set up to provide IT infrastructure and services to central and state governments and tax payers for implementation of India’s GST indirect tax regime. Built by a private Indian company, GSTN is a complex IT project that integrated the entire indirect tax system of all India’s states and the central governments and provided a uniform online interface to taxpayers and other stakeholders.

While the network has frequently thrown up some challenges since going live in June 2017 – not surprising given the complexity of the extant federal system it replaced, it has nevertheless on-boarded 12.3 million registered tax payers; processed 324 million tax returns and Rs18 trillion ($250bn) in payments through the portal in the last two years. Further, it processes more than 2 million returns/day.

Government’s Role in Burgeoning Privacy Debate

The Indian government has introduced a number of new digital platforms to further its goal of financial inclusion through the widespread adoption of low-cost digital finance. The new digital platforms include India’s digital identity system (Aadhaar), various payment systems (UPI, RuPay, even Bharat QR) and technology platform (IndiaStack) which provides services to businesses/governments to utilize the existing digital infrastructure to create new services. The social benefit promise of these solutions is apparent — financial inclusion — by solving for identity, authentication and payments quicker and cheaper than before. Indeed, India has become one of the hotbeds for fin-tech innovation across sub-sectors in financial services, most prominently in payments, lending, insurance etc.

Given the data centricity of most of these solutions and their ability to gather and analyze unprecedented volumes of data about individuals, they have warranted privacy concerns.

India’s ‘data protection law, is currently in draft stage (Personal Data Protection Bill, 2018) but is expected to be passed in the parliament this year. The bill, whose mandate is “to ensure growth of the digital economy while keeping personal data of citizens secure and protected”, is expected to create a legal regime for how data can be shared, stored and used in India.
A Case Study on Dubai

Dubai has pursued an ambitious plan to use technology as a means to transform the city for a number of years. Over the past two decades, the government started with e-Gov and Dubai Internet City initiatives in 2000, followed more recently by the SmartGov initiative (2013), Smart Dubai Initiative (2014) and in 2016, Smart Dubai, the government office charged with driving Dubai’s citywide smart transformation.

The Smart Dubai initiative was founded following the vision of His Highness Sheikh Mohammad bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai. Dr. Aisha Bint Buti Bin Bisher is Director General of the Smart Dubai Office, the government entity entrusted with Dubai’s city-wide smart transformation.

Figure 42. Dubai’s Digitalization Journey Over the Last Two Decades

Note: # SD2021 (Smart Dubai 2021) is a five-year strategy that aims to transform the Emirate of Dubai into a leading global smart city.
Source: Smart Dubai

Six Strategic Objectives

The Smart Dubai 2021 strategy spans six city dimensions of smart living, smart economy, smart governance, smart mobility, smart environment, and smart people. To achieve this impact, six strategic objectives have been mapped to these dimensions and will be implemented by various city entities, both public and private. These include:

1. **Smart liveable and resilient city** by achieving full ICT enablement of critical infrastructure, improving city connectedness and nurturing collaboration among various stakeholders in the Emirate.

2. **Globally competitive economy powered by disruptive technologies** to transform strategic economic sectors and transition towards a circular economy that fosters reuse/sharing of economic assets and resources.
3. **Interconnected society with easily accessible social services** by streamlining social, cultural, education and healthcare experiences in the Emirate that help improve individuals' quality of life.

4. **Smooth transport driven by autonomous and shared mobility solutions** that help boost the use of public and shared transportation means to reduce time spent and traffic congestion.

5. **Clean environment enabled by cutting edge ICT innovations** to ensure sustainability of the Emirate's resources. Digitally transform utilities, manufacturing, transportation, and waste treatment sectors.

6. **Digital, lean connected government** by providing 100% eligible public services through digital channels. The strategy aims for a paperless, cashless government.

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**Figure 43. Smart Dubai 2021 Goal KPI's**

- **95% Happiness meter**
- **100% of eligible data shared / made open**
- **90% City connectivity**
- **100% of eligible shared solutions & services adopted**
- **100% of internal operations digitally enabled and paperless end-to-end**
- **100% of experiences digitally enabled and paperless End-to-End**
- **100% compliance of applicable smart related policies & shared services**
- **TBD Digital maturity Index**
- **TBD Cashless city index**

Source: Smart Dubai

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**Paperless Government**

The Smart Dubai strategy seeks to transform the Dubai government into a fully digital organization, eliminating the use of paper altogether by 2021 via a government-wide effort to leverage technology such as IoT, data, artificial intelligence, and blockchain. The strategy is estimated to help eliminate over 1 billion pieces of paper used for government transactions each year, translating to savings of about AED900 million ($245 million) annually for the government.

In February 2018, the government launched the first phase of the Dubai Paperless Strategy, working with six government entities — Dubai Police, Dubai Electricity and Water Authority, Roads and Transport Authority, Department of Economic Development, Dubai Land Department, and the Department of Tourism and Commerce Marketing.

Below are some of the prominent initiatives by Smart Dubai as it continues to work towards digital transformation:
1. UAE Pass and Digital Identity

The UAE Pass, launched in 2018, is a national digital identity platform for the UAE that allows users to access government services by federal or local government entities through a simple smartphone-based authentication. The project is expected to strengthen government cooperation at a federal level, developing an integrated system of government and private sector services.

Further, the UAE Pass is also set to roll out a digital signature feature which will allow users to digitally and remotely sign documents using their smartphone, eliminating the need for anyone to physically visit an office to process paperwork.

Financial institutions in the Emirate are also preparing to integrate the UAE Pass, accepting it as a new authentication system. This will enable users to open bank accounts, complete financial transactions, and upload documents using the digital authentication system.

2. DubaiNow

DubaiNow is a unified Dubai government services platform that allows residents to complete most of their daily government needs digitally, through the web or via a smartphone. The app covers 12 different categories, namely security and justice, transportation, payments and bills, visas and residency, motor vehicles, health, business and employment, education, housing, and Islam, among others.

Since its launch in February 2015, the DubaiNow application has processed 7.5 million transactions, worth AED3.8 billion ($1 billion) and houses over 70 government and private sector services from 32 participating entities.

In February 2019, the government announced the completion of phase one of its Dubai Paperless Strategy, announcing two fully digital and paperless customer journeys on the DubaiNow platform. These revolve around (1) driving a vehicle in Dubai; and (2) relocating a new house in the Emirate.

Simultaneously, phase two of the Dubai Paperless Strategy was also launched, which included four new customer journeys. In this phase, eight government entities have been directed to begin implementing the Dubai Paperless Strategy. These include Dubai Courts, Dubai Municipality, Dubai Public Prosecution, Knowledge and Human Development Authority, Dubai Health Authority, Community Development Authority, Dubai Airports, and Dubai Customs.

Emerging Technologies

Smart Dubai is also working on a number of emerging technologies to further its cause on transforming Dubai. These include apps and services such as Rashid, Blockchain, Dubai Pulse, Dubai Careers, and Smart Employees amongst others.

Rashid: The City’s Virtual Assistant

Smart Dubai has developed an AI-powered advisor, called Rashid, leveraging the IBM Watson Assistant service. The chatbot is capable of aggregating information from various government and private databases in the Emirate, to answer questions about living and working in Dubai. Rashid is aimed at enabling users to gather information on topics ranging from starting business, to transportation, licensing, visas and residency, passports and certificates attestation, entertainment, shopping and more.
Dubai Blockchain Strategy

Smart Dubai has established a roadmap for the introduction of blockchain technology for Dubai and the creation of an open platform to share technology with cities across the globe. The objectives for enabling blockchain are multifold: (1) use blockchain in all applicable government services; (2) create and enable a blockchain ecosystem for startups and business; and (3) become a global thought leader by piloting cross-border blockchain cases. Based on Smart Dubai estimates, adopting blockchain will help unlock benefits of about AED5.5 billion ($1.5 billion) annually in document processing alone.

In 2018, Smart Dubai integrated blockchain technology into its retail payments smartphone app DubaiPay. Notably, DubaiPay aggregates payments for over 40 government and non-government entities, collecting payments worth AED15.8 billion ($4.3 billion) across 10.4 million transactions in 2018. Blockchain integration helped bring real-time reconciliation and settlement of transactions between government entities, banks, and financial institutions thereby eliminating the need for physical reconciliations, which took up to 45 days.

**Interview with Zeina El Kaissi of Smart Dubai**

Zeina El Kaissi is the Chief Digital Director at the Smart Dubai Office, the government office charged with facilitating Dubai’s city-wide smart transformation. She has over 12 years of experience holding strategic roles in both public and private sectors.

Prior to this, she worked as a Senior Consultant at The Executive Office of HH Sheikh Mohammed Bin Rashid Al Maktoum, Prime Minister of the UAE, and led city-wide projects aimed at increasing the quality of life of Dubai residents and the economic competitiveness of the city regionally and globally.

**What is Smart Dubai? What are the use cases?**

Smart Dubai is basically a city planner for digitization to drive initiatives from the private and government sector with the aim for mass adoption by UAE residents. Smart Dubai has been live for four years now. Interestingly, we have aggregators or platform services for almost everything from flight/hotel bookings and food delivery to movie tickets etc. but we still have multiple apps/websites to access government services like, gas, electricity, water, buying or leasing a house, checking, and paying fines.
Smart Dubai aims to bring 100% of government services under one roof. Any UAE resident holding the UAEPass app can get on-boarded through various channels (banks, service stations, kiosks). Smart Dubai will let you buy/sell your car, issue a government certified rental agreement to both landlord and tenant that could be digitally signed, find a house if you move to the UAE, register your new car, buy insurance, as well as pay for fines, school fees, and utility bills.

Using Smart Dubai, you can also apply for your family's residency and check your children's education invoices and updates via their profile which are all linked to the parent's profile.

Have any quantification of savings achieved by these initiatives?

Yes, of all the government departments we have on-boarded onto the platform, in the last year we have saved about one-third of the paper usage and we aim to go paperless in all government transactions by 2021. With this initiative, we aim to save 130,000 trees annually. This translates to saving of about AED900 million ($245 million) for the government annually, after all initiatives come into full force.

What is your mandate with emerging technology such as AI or blockchain?

As humans, we get into social life by speaking first and not typing. My kids look things up not by typing their question into Google but instead by asking Siri about it. “Hey, Siri …?” Smart Dubai has leveraged IBM Watson to build an intelligent agent called Rashid and you can ask Rashid questions similar to how my kids speaks to Siri.

For example, Rashid can guide people through the entire process of setting up a new business, whether it is a coffee shop or an accounting firm. Rashid is capable of conversing in natural language, and provides a single point of contact to navigate the bureaucracy.

I think Rashid is still a baby as it only knows about 77,000 topics and we are teaching him more. It is live in English right now but learning Arabic as well and we should go live in Arabic soon. If you were to ask me what it will look like 5-10 years from now, we plan to scale this up significantly and let Rashid solve more intricate questions that are thrown at it.

On your second point regarding blockchain, initially when blockchain gained market attention due to cryptocurrencies, we had a few private sector players using it and it was certainly not at a government level. At this point, we thought blockchain could propel our journey at being a one-stop shop and help us reach Government 2.0.

We used blockchain to ease the process of sharing data amongst network members consisting of different government departments. For example, we used to take 40 days to reconcile all the payments we received on the app, but by using blockchain we can now reconcile on a real time basis.
Digitalization of Sectors

Transportation

The world spent $1.15 trillion on transportation infrastructure in 2013. With rapidly aging infrastructure in developed markets and growing populations in emerging markets, infrastructure investment in the future could rise as much as 5% out to 2025, according to PwC. Part of that infrastructure spend is on digital solutions ranging from mobility-as-a-service, ride-hailing, and connected vehicles, to smart parking, digital payments, and traffic management.

Demographics is a key issue in transport policy as populations age and as they migrate towards cities. The provision of data-based transport services will create greater value add, as will plans to upgrade regional public transport and on-demand logistics services, the use of APIs for data coordination, and the study of platform creation. Mobility-as-a-Service (MaaS) can transcend current individual transport modes. By integrating search, reservation, and payment across a range of services including trains, buses, and car sharing for example, public transport could potentially be made more efficient and more productive.

Autonomous Vehicle Networks

The combination of advancements in artificial intelligence, connectivity, computing power, and electrification — the Car of the Future — is expected to change mobility as we know it. Autonomous vehicles are transforming the ‘car’ into a network which can be used on demand or through a subscription. The catalyst for this major industry change and the formation of strategic networks is the development of level-4 driverless cars, i.e. vehicles that are highly automated and can operate without human input or oversight under select conditions. We expect these level-4 vehicles to roll out in a specific domain — initially in urban environments on specific routes and during specific times/weather conditions or be in a particular radius within a city or pre-defined routes operating as shuttles or other services.

At the end of this transformation, we think the auto market will be characterized by:

1. Urban driverless RoboTaxi autonomous vehicle networks (mobility-on-demand, or rideshare, combined with micro-mobility solutions) operating mainly in urban and some urban/suburban areas. Once these networks are established, the eventual modes of transport could include much more than autonomous vehicles — i.e., e-scooters and ‘flying taxis’.

2. Autonomous vehicle subscriptions are driverless-capable cars that you subscribe to in order to combine the best attributes of personal ownership with the benefits or shared autonomous vehicles.

3. At some point, the RoboTaxi and autonomous vehicle subscriber distinction will narrow as networks seek to provide integrated solutions.

This last phase — the integrated mobility network — is expected to evolve sometime after 2030. We believe the most important asset of this phase won’t be the forms of mobility that are connected to it, but will be the network itself. The connected cars in the network are always connected to the Internet and have communication capabilities. Sensors in the vehicles are able to monitor the condition of the vehicle as well as traffic conditions and vehicles can communicate with other vehicles and with information infrastructure via networks.
Data is Key

As vehicles become more connected, the by-product is a tremendous amount of data. The data that is generated by these interactions can be used by government and planners to increase efficiency within the area. Capturing, analyzing, and applying this data to real-world issues is a key ingredient to drive mobility solutions. Data provided by connected cars on traffic conditions can guide city planners with infrastructure decisions while payment information from mass transit can help identify congestion zones and facilitate service changes as well as update information websites to alert riders of service status. Something as simple as noticing a bottleneck of traffic on a given morning, cross-referencing that information with sanitation department records and using the combined information to shift the time of city garbage pick-up or shift the trucks to a different route, can have a meaningful result. Changing the length of traffic signals at different points during the day to alleviate congestion can become the cornerstone of a traffic policy. With mobility-as-a-service, data on ridership can be used to introduce payment incentives to direct riders to the least congested modes of transportation. What these examples have in common is they increase the well-being of residents while also helping government entities make better and more well-informed decisions.

NY City Transit Goes Digital with OMNY

On May 31, 2019, NY City’s Metropolitan Transportation Authority (MTA) rolled out One Metro New York (or OMNY) in 16 of subway stations in Manhattan and on buses in Staten Island. OMNY is a digital tap-to-pay system where riders can tap their contactless bank cards or mobile wallet app on their smartphone against a sensor pad at the turnstiles to pay their fare. By 2023, OMNY is expected to replace the current MetroCard which allows customers to electronically load fares onto a thin plastic card. The tap-to-pay technology is expected to launch across the entire subway and bus system by the end of 2020 and eventually expand to suburban commuter train lines.

The new system has positive benefits for customers as the sensors have the ability to accept 30 fares per minute which should speed up turnstile lines especially during rush hour. Time would also be saved by people not having to stand in line to reload their MetroCards. Despite the initial cost of $540 million to install, OMNY is expected to reduce costs for the MTA by significantly reducing the dispensing of fare media, will streamline fare calculation, and phase out 20-year old equipment that is more costly to maintain each year.

In the short term, the system upgrade is primarily about increasing efficiency and modernization. But in the longer term, the digital nature of the new system will allow for greater opportunities. One possibility suggested by the Tri-State Transportation Campaign is to use fare data to help guarantee riders pay a fair price. The system will be sophisticated enough to count how many times a rider visits the MTA within a clear time span using single-ride tickets, and can stop charging them when they’ve hit a capped limit. This would avoid charging the poorest mass transit riders the most as these riders primarily use single-use tickets vs. longer-term unlimited pass benefits which are discounted per ride but have larger upfront costs. Data collection can also lead to enhanced service information which helps with congestion and allows riders to adjust their trip decisions based on current traffic.

Healthcare

Digitizing Helps Manage Cost and Accelerate Innovation

Global healthcare spending is expected to increase to over $18 trillion worldwide by 2050, according to the World Bank. This equates to almost 9% of global GDP by 2040 and varies greatly across different countries. The U.S. continues to spend more on healthcare at almost 17% of GDP in 2016.

As healthcare becomes more digitalized, it is expected to also generate a tremendous amount of data. By 2020 more than 2,310 exabytes of healthcare data is projected to be produced, up from 153 exabytes in 2013, creating a broad playing field for opportunities in these robust data sets. At the same time, rising costs in healthcare, an aging population, and a shortage of clinicians all create a need to monetize this data and bend the cost curve.

We view opportunities in big data, artificial intelligence, and machine learning as the natural progression of healthcare’s newly formed data stores, with McKinsey estimating these innovations could reduce healthcare spend by $300 billion to $450 billion.

The biggest organized push towards digitalization in the U.S. was the shift to Electronic Health Records (EHRs). Although EHRs existed prior to 2009 the majority of sector growth was spurred by government intervention, with an approximately 60 point uptick in penetration rates driven by the enactment in 2009 of the HITECH Act’s Meaningful Use program. The HITECH Act created financial incentives for provider adoption of EHRs, with the hope that electronifying healthcare data would help bend the ever growing cost curve for healthcare spend in the U.S. In effect, ‘you can’t manage what you can’t measure’ — so the first step from the government was a mandated measurement rollout.

With EHR adoption now nearly universal (96% of hospitals and 87% of physicians reported usage of a certified EHR in 2015), the focus in healthcare is to manage costs by driving actionable insights from the information captured. This should fulfill the government objective of managing healthcare costs.

The first wave of healthcare data utilization is with healthcare information technology (IT) players cross-selling value-added solutions (often driven by their data stores) into their client bases. On the data-driven side, these solutions tend towards analytics and population health.

Population health, or pop health, solutions entail quality/cost monitoring and management tools and all that goes with it — including data clean up, care coordination, patient communication/engagement, and patient education. Pop health solutions can also include rudimentary predictive analytics tools, such as the evolution of a patient along the risk curve, but these tools tend to be early days compared to enterprise-facing big data solutions.

Specialized analytics applications, particularly around patient and supply chain cost, have been another key use of the new healthcare data stores. Unlike the predictive enterprise big data analytics solutions today, these applications tend to be more backwards looking to help healthcare providers monitor and manage trends.
Ways that AI & Machine Learning are Being Used in Healthcare

While we believe we are still in the early stages of widespread big data applications within healthcare, some solutions are already in use today. We document a few of these use cases below.

- **Radiology/Medical Imaging**: Certain functions in healthcare, like radiologists, are considered "good" once they have a certain level of experience seeing cases. However, a human can never see as many cases as an electronic database, making this an ideal application for big data/AI. Given a large enough store of electronified x-rays, the interpretation of an x-ray becomes a search problem, with a big data solution functioning as a search engine for the diagnosis.

- **Predictive Risk from Retinal Imaging**: The retina offers a snapshot of a patient’s vascular system, but this data is often under-utilized as it is siloed within ophthalmology practice EHRs. Recent machine learning applications have leveraged this information to predict the risk of heart disease, with early trials showing a higher accuracy rating compared to the trial’s clinician evaluations. Although this solution has yet to be used in a clinical setting, we view this as a near-term opportunity that will create a quicker, easier, and lower friction (no blood test required) solution for evaluating a patient’s cardiovascular risk.

- **Claims Processing**: Early applications of machine learning and natural language processing are currently being used to reduce cost within the payments integrity and claims processing vertical. Traditional claims processing is a labor intensive solution, entailing a clinician reviewing a complex claims document that often encompasses dozens of pages. With the use of robotic process automation (RPA) and natural language processing (NLP), payers are able to highlight the areas of significance within the claims document and increase the findings rate for errors without increasing headcount.

- **Care Management Support**: Barriers in healthcare can extend beyond the core condition and treatment, such as access to care, transportation, and readmissions risk.
  - Transportation is one of the largest barriers to care: low-income, elderly, and disabled patients miss ~24 million appointments annually due to insufficient access to transportation. Further, no-show appointments due to transportation barriers alone represent ~$40 billion in avoidable downstream costs and ~$4 billion in lost revenue for doctors.
  - Today, predictive analytics models can highlight patients at a higher risk of encountering transportation barriers by utilizing a patient’s socioeconomic data. For example, socioeconomic data might show that patients in a certain zip code are unlikely to have a car, alerting the care team to make arrangements for follow-up appointment transportation following a discharge thus lowering downstream costs.
  - Reducing readmissions is another focus of care management support teams, with predictive models aiding in the allocation of people, process, and technology resources. Beyond allocation, these predictive analytics can also assist a care team in time management, such as the frequency and intensity of follow-ups based on a patient’s projected degree of risk.
Machine-to-machine (M2M) in healthcare is rapidly evolving as a potential economic alternative to cater to rising demand in patient care.

According to the U.S. National Health Council, more than 40% of the U.S. population is affected by chronic illness such as cardiovascular disease, cancer, and diabetes and may require continuous monitoring. Machine-to-machine (M2M) in healthcare is rapidly evolving as a potential economic alternative to cater to rising demand in patient care.

Remote monitoring of patients with the help of sensors with an embedded wireless device can allow medical practitioners to keep track of the health of patients who are out of the hospital. With sensors such as Medical Area Body Networks (MBANs) monitoring patient health conditions remotely and continuously, medical care providers can be given early warnings to changes in their patient’s health and could allow for real-time interventions. Extension of clinical environments into a patient’s home through remote monitoring could also help to prevent costly admissions to hospitals. This incentivizes individuals as well as insurance companies to drive the adoption of the service as a means to manage costs.

We see a multi-pronged push for M2M in healthcare services in order to build with scale and bring in cost effectiveness to meet the rising demand as well as rising healthcare burden. We see these services increasingly being pushed by various stakeholders in healthcare services such as healthcare providers, governments, and insurance companies. In the U.S., the Federal Communications Commission (FCC) has approved the allocation of 40 MHz of spectrum in 2.3 GHz band for a medical body area network (MBAN) and expects to save an estimated $2,000-$12,000 per patient through remote monitoring of vital health conditions.
Many economic studies have indicated there is a close correlation between education and economic growth. Education is a crucial social resource. In most countries basic education is seen as a right — governments are duty bound to provide education, while individuals are often required by law to attend education up to a certain age or level. Education also plays a key role in improving economic well-being. Many economic studies have indicated there is a close correlation between education and economic growth. The OECD estimate that “if a country is able to attain literacy scores 1% higher than the international average, it will achieve higher levels of labor productivity and gross domestic product (GDP) per capita that are 2.5% and 1.5% higher, respectively, than those of other countries.” Education increases the skilled human capital inherent in the workforce, improves the innovative capacity of an economy, and facilitates the diffusion of important knowledge.

Governments have become widely responsible for ensuring the adequate provision of education. On average in OECD countries, government spend on educational institutions is equal to 4.5% of GDP. On a per capita basis, the U.S. spends the most money on education ($3,400 per capita), followed closely by the U.K. ($3,200 per capita) versus countries like India and China which spend $84 and $450, respectively. However, it is important to note that capital spending for education is not the answer to everything — a country can reach the same quality of education by spending more efficiently on education.

In our Citi GPS report Education: Back to Basics, we noted there is limited correlation between education spend per student and education outcomes (as defined by PISA — a score that ranks scholastic performance of 15-year olds across the globe) for countries who already spend a significant amount on education. However, revisiting PISA in the context of broadband speeds, one can see that there is a strong relationship between higher Internet speeds and education outcomes across a sample size of about 60 countries. An argument could be made that wealthy countries generally spend more on all forms of infrastructure — including communications and education — and thus one (communications infrastructure) doesn’t necessarily cause the other (education infrastructure).

This is true to an extent, although, as highlighted in Figure 46, even when we focus exclusively on countries that already have a relatively high spend on education, we note that there is a reasonable relationship between the quality of Internet and the quality of education outcomes. For example South Korea, which has the fourth highest PISA score, has all of its schools connected by high-speed broadband. In contrast, in the U.S., which has the 21st best PISA score, only 37% of schools have adequate broadband for digital learning. One way to think about this is the better the Internet infrastructure, the higher the scope to effectively deploy educational technology, or EdTech resources.

The outliers here — relatively low PISA despite high broadband for example — could potentially be explained by the way technology has typically been used in education; as a means to automate and support existing practices rather than as a tool to transform the learning process.

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While it is not hard to imagine the benefit to developing countries from EdTech, even developed countries, some of which are witnessing diminishing marginal returns from their incremental education spend, could improve their quality of education through effective deployment of technology.

Figure 46. Average Internet Speed and Average PISA Score for 57 Countries

Source: OECD, Akamai

Figure 47. Average Internet Speed and Average PISA Score for Countries with High Education Spend per Student

Source: OECD Education at a Glance (2016), Akamai

The real opportunity lies in redesigning educational processes.

However using technology for the sole purpose of improving the current system at the margin might throw up underwhelming results. The real opportunity lies in redesigning educational processes. BCG recommends a closed loop — an integrated instructional system wherein clear objectives are established, a curriculum is designed to meet those objectives, instructors teach the curriculum in a compelling fashion, frequent assessments are used to spot problems and intervene as necessary, and finally outcomes are monitored carefully to modify and improve the closed loop for future students.

Figure 48. Closed Loop Instructional System

Source: BCG
As an example, this could involve clearly identifying supporting digital resources while designing the curriculum, adopting blended techniques while delivering instruction, online assessment and data on skill mastery can be linked to a personalized learning plan with immediate intervention when learning gaps are identified, and progress is continuously tracked through the learning plan.

Thus technology can play a role in transforming each segment of the education process including content creation, distribution, and learning management. The greater prevalence of mobile devices is increasing the number of access points to e-learning while simultaneously the inability of physical infrastructure to keep up with the rapid growth in students worldwide, and stagnating student outcomes are driving greater adoption of EdTech. EdTechXGlobal estimates that the global EdTech market will grow at a compound annual growth rate of 17% to $252 billion by 2020.

### Mobile Learning

M-learning, or mobile learning, involves the use of mobile technology to enable learning anytime and anywhere. M-learning can help facilitate access, creation, collaboration, and also management of the entire education process. The global M-learning market is estimated to register a compound annual growth rate of 11% and to reach $14.5 billion by 2019. Along with the proliferation of mobile devices, growth is likely to be driven by the following factors:

- Several developing countries have low personal computer (PC) penetration, but high mobile subscription rates. According to Ambient Insight, 67 of the 119 countries analyzed by it had mobile Internet access rates higher than PC access. Several of these countries are likely to skip developing their PC infrastructure in favor of mobile devices.

- Mobile learning Value Added Services, wherein the mobile network operators license content from third parties and sell a subscription-based product directly to consumers, is growing at a rapid pace. In 2013, one Brazilian telecom combined all of its mobile learning products into one subscription and marketed it directly to consumers. The service gained six million active users in a span of two years.

- Education apps are likely to register a 28% growth rate between 2016 and 2020. The three dominant types of mobile learning apps are language learning, early childhood learning, and brain teasers.

- The rise of smartphone-enabled virtual reality apps.
Technology to Enable IoT and Digitalization

Technologists have long predicted that a wide array of devices would one day be connected to the Internet, or that vast sensor networks would be deployed to track data or monitor various conditions. That Internet of Things (IoT) reality hasn’t yet come to pass for a variety of reasons, including the cost and size of the chipset required as well as the ability for networks to handle the sheer size of many connected devices on a per site basis. This may stem, in part, from the fact that the wireless standards took different use cases into account as they pushed for better spectral efficiency and higher speeds.

Devices cannot interact and communicate with each other to drive efficiencies if there is no inter-connection. For IoT to work in assisting smart city initiatives there needs to be a sufficient telco network layer to perform the connectivity to the relevant platform and applications. Telecoms are thus the thread which connects all the pieces together.

Telecom companies have invested in Low Power Wide Area Network (LPWA) Solutions such as NB-IOT, LORA or SIGFOX solutions. The common denominator between these solutions/technologies is that they present a cost effective and efficient option for telecom companies to service the IoT space and for potential IoT users to afford the modules on a broad-based basis. These networks allow efficient long-range, low power, low bit rate options to be used on easy-to-afford and long-lasting IoT devices. LPWA network solutions include a category of wireless communication technologies that are designed to support IoT deployments. Massive scale IoT projects have specific connectivity needs which may not be serviced by traditional networks. LPWA networks and devices typically exhibit the following characteristics:

- **Long lifespans in the field:** devices are often deployed without reliable/continuous access to power. Batteries must last for the lifetime of the device — up to a decade or more.

- **Strong coverage over large areas:** The network connection must offer strong penetration and reach.

- **Massive scale, at low cost:** The device and connectivity cost must be low and networks must be able to support high density of devices while guaranteeing quality of service.

- **Low bandwidth:** Devices may often send only a few bytes of data each day.

These use cases don’t need to support voice or even duplex data transmission. A LPWA device should last for 10 years in the field, connect as far as 10km from the cell sites, and cost well under $10, when transmitting down to 10s of bytes per hour. Each cell or base station should be able to support more than 10k devices at the same time.

For the more complex solutions for smart cities, fixed networks, 4G or soon 5G can be used as well outside of LPWA. Simply put, some smart city applications will be more network intensive and this means LPWA solutions would not be wholly sufficient.
More intensive smart city IoT cases may require 5G technology

5G may be required for some of the more intensive smart city IoT use cases. The advantage of 5G doesn’t lie with speed alone (5G is 10x the speed of LTE by using more spectrum blocks more efficiently) — it also allows ultra-low latency (1 millisecond or just 10% of that of LTE) and the ability to host up to a million devices per square kilometer at the same time (10x more devices vs. LTE). The ability to host a vast multitude of devices while at the same time offering ultra-low latency should help push the development of IoT needed for smart cities and more efficient industrial activity.

More advanced IoT devices could be better supported by 5G networks

The eventual explosion of more advanced IoT devices could be better supported by 5G networks. Factory robotics, security/delivery drones, and logistics networks for instance could be better facilitated with 5G services. Autonomous vehicle connections can be done on 5G allowing for almost zero latency situational awareness.

5G is important for the effective roll out of autonomous vehicles

5G would allow for the autonomous vehicles to act in a more informed and coordinated manner with ultra-low latency touchpoints across vehicles allowing for vehicle-to-vehicle connectivity. Autonomous delivery trucks with embedded connectivity would allow for real-time fleet and product tracking. While most of the basic driving functions can be orchestrated on a sensor level, embedding 5G into the system grants a heightened level of efficiency, security, and safety. Real-time traffic re-routing for instance can be performed with vehicles being aware of surrounding conditions. A vehicle sensing an errant pedestrian in its vicinity can instantly communicate with nearby vehicles, triggering beyond sight situational awareness and in doing so, elevate public safety. Beyond the safety element, this improved situational awareness could also drive cost efficiencies by helping plan/divert travel routes based on real-time traffic conditions.

Greater availability of 5G should allow for increased IoT usage for smart cities. It will help improve mobile computing in the cloud at high speeds and connectivity while decreasing latency (allowing for mission critical services like autonomous driving and smart grids), enhance upload speeds for augmented reality/virtual reality, and expand the scale of mobile IoT.
Cyber Risk

Today’s world is one of increasingly networked systems and reliance on interdependence for social connection and business operations. These rapid communication channels span globally and are growing exponentially with a majority of the population now conducting interactions and transactions in cyberspace. While new technology has provided new communications pathways, it has also revealed exploitable vulnerabilities embedded in the hardware and software used to construct and operate these pathways and exposed the people who use them.

Governments around the world face threats regularly ranging from the possibility of civil unrest and economic uncertainty to natural catastrophe and war. Most recently, cyber risk has entered as a mainstream threat with multiple countries targeted by cyber attacks for both espionage and competitive advantage. The rise of state-backed actors and cyber as a political weapon, as well as highly organized and sophisticated criminals, increases the risk that governments and critical infrastructure are targeted. This in turn has forced governments to move from a more defensive position on cyber to one that is more focused on offensive capabilities.

Cyber threats at the government level are similar to those faced by corporates and individuals, including:

- Threats to critical infrastructure;
- Theft of data, including the theft of trade secrets; and
- Threats of financial loss.

And the actors who are behind the cyber attacks are also similar:

- Nation state actors who conduct espionage to steal intellectual property and collect intelligence considered vital to advancing national interests;
- Organized criminals who are focused on monetary gains or obtaining personal identifiable information (PII) through techniques such as phishing, social engineering, malware, ransomware, and denial-of-service attacks.
- Issue motivated groups and individuals with personal grievances, including hacktivists and individuals causing a nuisance, who are attempting to draw attention to themselves and their causes.
- Insiders who use local tools and their knowledge of the internal network to steal, damage, or commit fraud.

As more and more government services are offered online, the threat of disruptions to government systems from a cyber attack increases, while at the same time, concerns over privacy issues for citizens also increase. There is a constant trade-off between keeping private information secure and creating a system for government services that is easy to use and delivers services broadly.

Financial transaction systems are exploited at multiple levels, and even the introduction of authentication services on transactions to reduce point-of-sale fraud and smartcard data skimming in the consumer sector, has not reduced the rate of innovation in cyber criminal financial theft.
What Needs to be Done to Address Cyber Concerns?

Each country addresses the threat of cyber attack in its own way. However, according to the UN’s ITU 2017 Global Security Survey, 50% of countries have no cyber strategy in place. This obviously may have changed in the two years since the survey, given the speed at which the world of cyber has changed. In the last few years, many countries have set up national cyber centers which aim to protect critical services from cyber attacks, manage major cybersecurity incidents, and improve security through technological improvement and advice to corporates and citizens. There is also collaboration between national governments on cyber to identify and publicly share available tools used by threat actors in the hopes of limiting their effectiveness.

Cyber is a ‘borderless’ issue, requiring a combination of inter- and intra-sector and country collaboration as well as public-private partnerships (PPP) to combat it. However, a strategic approach is required to move this collaboration beyond law enforcement, intelligence agency, and information security ‘circles of trust’ that exist today, which predominantly focus on operational and tactical threat information sharing. For the public sector, particularly regulators, ensuring a common understanding of cyber risk offers the opportunity to deepen the effectiveness and alignment of regulatory frameworks across borders, and avoid regulatory arbitrage, fragmentation, and diverging assessments of the same cyber risk management capabilities. Two areas of public-private partnership which inform and help the maturing of the global architecture of cyber regulatory systems and good cyber security standards including information sharing models and cyber threat exercising:

- Information sharing models have existed for decades in some form or another, there has been great progress in developing awareness and increasing membership in these groups. The groups tend to be sector-specific (e.g., financial services) and include both public and private entities that share information about physical and cyber security threats to help protect critical infrastructure.

- Cyber threat exercising is critical to ensuring the safety and well-being of private firms and their employees as well as supporting clients in times of need should they experience an operational disruption. In the exercise, clear and timely communication flows are established between the private firm and public entities. Doing these exercises with the public sector aids in the development of risk strategies as regulators, government and law enforcement are involved.

Emerging Technology Solutions

With the extreme growth in volumes of data and increased capacity to store large amounts of data, the next logical step is to analyze the data to further an organization’s goal, including cyber defense capabilities. As government service models are evolving, so too is the threat landscape, creating a need for new tools and technologies to support objectives while reducing the risk of exploitation. With existing cyber threats growing at an unprecedented pace, there is a need to use artificial intelligence and machine learning capabilities to keep pace in improving our cyber security posture. According to AV-TEST, since 2010 there has been an increase in the number of malware types to around 800 million.

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The application of artificial intelligence can enable traditional antivirus products to learn how malware morphs to avoid detection so that the antivirus detection algorithms can be appropriately updated at the same speed.

Other emerging technologies include:

- **Machine learning (ML):** ML enables analysis of large amounts of data, and the ability to recognize and label unknown patterns. Deep learning techniques within the ML domain mine the vast quantity of data to identify threat activity and anomalous activities, which could provide real-time indicators of malicious activity.

- **Natural Language Processing (NLP):** NLP reads and understands the context of a given text which gives the capability to detect and analyze threats which lead to the execution of an appropriate response strategy.

- **Biometric Technologies:** Identification, authentication, and authorization of resources are a critical component of cyber defense. Biometrics use unique physical characteristics of human beings like iris patterns, fingerprints, voice, face, etc., for identification and authentication. The ability to personalize authentication and use human features that currently are difficult to fraudulently replicate, provides an enhanced authentication capability. Behavioral biometrics identifies people by how they do what they do, instead of what they are, what they know, or what they have. This technology is being used to detect fraud, and malware in real time.

- **Blockchain/Distributed Ledger Technology (DLT):** DLT provides a distributed network and potentially a solution to trust, which is a fundamental challenge of technology solutions. Blockchain technology is currently being explored for potential use in preventing fraud and data theft.
Conclusion – Recommendations to Policymakers

The development of new technologies, platforms, and ways of integrating different service providers is revolutionizing all aspects of society, commerce, and the economy from smart cities to healthcare and payments. Technological innovation can improve the client experience and the efficiency of firms in developing and developed markets — improving competition in markets and consumer choice. It also advances financial inclusion and literacy by extending the reach of governments and firms, and the mechanism for delivering information.

Innovation is offering new opportunities to expand access to credit, reduce fraud, strengthen cyber security, transform social services, and support new forms of digital money.

Digital technology provides both challenges and opportunities — opportunities in the many benefits outlined in this report and challenges as assets and ‘Value at Risk’ in today’s world are trust, data, and access to data. Public and private sectors are now custodians of digital identities. Balancing data privacy and cyber security with the data gathering and analysis of smart city devices will take time to evolve and this can only happen through a strong and secure Information Technology infrastructure, having transparent, collaborative dialogue and inter-government exchanges of lessons learned.

A bigger challenge is presented in the very nature of decommissioning legacy technology or infrastructure — or at the very least, configuring it to be compatible to interface with new technology, systems, or processes. This will require substantial and long-term investment. For example, Sweden\(^\text{10}\) the second most prolific technology hub in the world on a per capita basis (with companies producing $6.3 billion in revenue per million people, compared to Silicon Valley’s $8.1 billion per capita) achieved this status through early and substantial public investments in digital infrastructure. As early as the 1990s, the Swedish government subsidized household purchases of personal computers, enabling a rapid upskilling of IT/digital skills and literacy. The government also provided funding in rural areas, and largely subsidized elsewhere speedy fiber-optic broadband, to which more than 60% of the country has access to. This investment has paid off and Sweden now has the third-highest average Internet speed in the world and fourth-highest superfast broadband.

Another example of practical innovation, in addition to the examples of Singapore, Pakistan, India, and Estonia that were discussed earlier, is Peru. In 2014, Peru embarked on a process to implement a mandatory e-invoicing reform program, with the aim of reducing the use of paper and other legacy costs. The policy change strengthened tax compliance, streamlined the tax collection process through the use of electronic invoicing and eased reconcilement by allowing for the automatic transfer of billing information between firms and the tax authority.

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To make this possible, Peru enacted legislation including certification requirements. They also leveraged international standards to ensure easier integration with trading partners in the European Union as well as APEC (Asia-Pacific Economic Cooperation) countries. This will reduce the risk of crime and overhead costs, and increase both efficiency and improve the taxpayer experience.

Governments need to ensure that innovation and digitization priorities are practical and in line with technologies that are scalable and can be supported by a regulatory framework. Distributed ledger technology (DLT) (or often referred to as blockchain) remains at an early stage of development and deployment. Despite significant market activity and investment in the last few years, this technology is yet to show a scaled and transformative application. One reason for its slow progression to date is that in most cases challengers are trying to fit a blockchain solution into every industry’s problem versus trying to find the best solution for each unique problem. Cryptocurrencies are currently impractical for real world applications to support underlying commercial settlement, and can add systematic imbalance to the whole financial system due to unregulated, speculative trading and intense volatility. Further, central bank digital currencies (CBDC), while interesting as a concept, will have a fundamental impact on today’s commercial banking model and will have practical implementation challenges that will present a variety of risks. For most central banks, a market driven large-scale basic payment infrastructure upgrade (e.g., Instant Payments) is a higher, short to medium term priority. Regulatory modernization needs to be balanced and be mindful that it should allow both incumbents and newcomers the same ability to innovate safely.

It will be essential to adopt an ‘activity-based’ approach to evaluate potential from new innovation without sacrificing the quality of checks and balances in the system. Policymakers should focus on transforming existing and integrated payment infrastructure (such as Instant Payments, enhanced messaging, 24x7 RTGS, etc.) with supportive regulatory technology (RegTech) for financial inclusion, and implement a consistent, ‘best practice’ approach to the deployment of Instant Payment requirements within each country while avoiding local customization. This will have a much larger impact on improvements on the global payments landscape and it will preserve the structural integrity already in place.

**Beyond Infrastructure: Other Important Steps on the Digital Journey**

- **Cross Agency Collaboration & Collaboration with the Private Sector:** A practical starting point for governments would be to conduct a mapping of how each country’s public sector agencies — from Government Ministries to regulators, development banks, and Central Banks — are engaged in activities aimed at enabling innovation. Harnessing synergies will be a powerful amplifier, and will also aid private sector firms in navigating the public sector landscape to ensure they can apply for, and utilize the most relevant support in their country.

  - For each innovative ‘topic’, for example crypto currencies or blockchain, putting together a government ‘directory’ which describes, for each country which services each public sector agency (i.e., ministries of finance, foreign affairs, transport, health etc.), central bank, regulator (capital market, banking), AML/CFT authority) does what (i.e., prohibit, explicitly regulate, interpret and apply existing general framework, monitor) and for which policy objectives (i.e., financial stability, customer protection, market integrity, AML/CFT).
More roundtables with the private sector (firms of all sizes) could help identify and prioritize shared issues. Further, partnering with the private sector and/or cross-agency would help develop local accelerator and incubation programs, as well as create opportunities for developers to travel and learn from other countries.

Dialogue and partnership with global banks who have a clear digital vision and strategy can also bring learning and best practices to governments. Banks are very focused on making innovation mainstream through design thinking and co-creation. This process is led by global innovation labs and other talent development initiatives. These techniques and approaches can be very relevant for the public sector as well.

- **Attracting Investment**: The need exists for centralized sites that house information on types of funding and investment, export opportunities, and composition of the local market. A single website providing educational materials or links to other information sites would aid innovators. To build on this, a platform enabling the supply side to better connect to the demand side will improve collaboration and the ease of doing business, as well as foster inclusiveness.

  Countries will need to respectively explore how the regulatory and tax framework may need to evolve to facilitate innovation, as these often create barriers. Introducing new products for export requires upfront investment in new technology and capital. Government policy that supports and incentivizes investment supporting exporters is key and supportive trade policy can also influence innovation.

- **Bankruptcy Laws**: Bankruptcy rules that allow firms to restructure their debts and obligations easily, for example in limiting discharge periods, is another important area to review. In Europe, these laws can inhibit innovation but newer business models are being developed as half of Europeans say they would not start a business because of fear of failure. This fear is connected to the substantial costs associated with failure in many member states and a series of protracted liquidation processes when early restructuring could have saved a business.\(^\text{11}\)

- **Common Templates, Taxonomies and Methodologies**: Ensuring that all public sector agencies within a country adopt the same common, minimum standards and controls is critical to facilitating digitization and more secure, sustainable products. A common foundation of risk assessment and management (focusing on data protection and cyber security) will also help improve public sector innovation and risk management. A framework that identifies, links, and prioritizes the various types of threats and potential harm would be valuable, particularly if it can be easily understood by large and small businesses, public bodies, regulators, and individuals. A common framework could then enable the development of sector or activity-specific risk management tools.

Digital Identity and National Identity

- A National Digital Identity scheme is a core foundational element that supports many digital capabilities and secures digital transactions with constituents, citizens and business. Examples include Malaysia’s MyKad identity card which can be used as a driving license, ATM card, e-wallet, and loyalty card and Pakistan’s national ID card, operated by National Database and Registration Authority (NADRA). This has enabled initiatives such as EasyPaisa, which, when integrated with the NADRA ID card, became a smartcard (from 2012 onwards) as part of the National Financial Inclusion Strategy.

Incentives

- Government policy that provides tax and funding incentives can help pave the way for private sector entities to engage with the public sector to accelerate digital service coming on line. The Australian government published draft legislation to incentivize investors to support early-stage FinTech startups with ‘high-growth potential’. They are proposing amendments to the Tax Incentive for Early Stage (Angel) Investors, as well as the Venture Capital Limited Partnership (VCLP) and Early Stage Venture Capital Limited Partnership (ESVCLP) regimes, that will allow eligible investors to invest in early-stage companies with finance or insurance activities as their predominant activities. The Monetary Authority of Singapore (MAS) announced a number of new incentives specifically designed to attract venture capital (VC) investment into their local technology ecosystem, including proposing to simplify the authorization and regulatory requirements for VC managers to enable them to operate more nimbly in supporting start-ups in Singapore and the region.

Inter-Governmental and Intra-Governmental Collaboration

- We have seen success with the creation of inter and intra government forums to drive collaboration between departments and across borders. Australia’s Mobile Digital ID and the federal Digital Transformation Agency (DTA) is partnering with Australia Post to integrate their mobile Digital ID with the Commonwealth’s Digital Identity Framework, which uses a variety of other digital documents from various government departments for authentication. In Singapore the National KYC utility is working with the Ministry of Finance on projects such as decentralized recordkeeping in trade finance supported by FSTI scheme. Another example is Smart Nation and the Digital Government Office (SNDGO) developing a Moments of Life initiative that is an intergovernmental framework that bundles government services and information.

We are greatly encouraged by the public sector focus on digitization in many countries around the globe and anticipate many new opportunities for increased efficiency, transparency and security as technologies such as 5G, the internet of things and distributed ledger technology become more mainstream. These new capabilities are accelerating the pace of change. We are seeing many governments starting to harness these new technologies to help improve their economies and the quality of life for their constituents. We hope you have found the content of this report to be of value and look forward to the opportunity to further discussing how Citi can engage with and support you on your digital journey. We will continue to share lessons learned and perspectives on seizing the opportunities technology and digitization has to offer.
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