Smart Bases, Smart Decisions

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ABSTRACT

We are living in a time when virtually anything can be connected to the Internet: from smart clothing to autonomous driving to near real-time management of assets in agriculture, manufacturing, logistics, and more—the possibilities are endless. Among this connectedness, the smart cities trend continues to gain momentum. In November 2017, a real estate investment firm owned by Microsoft co-founder Bill Gates announced they purchased nearly 25,000 acres, approximately 45 minutes west of downtown Phoenix for $80 million for development into a smart community. [1] Similarly, Google's parent company, Alphabet, committed $50 million for a Toronto neighborhood development, AT&T is investing nearly $3 billion in the Atlanta area to enhance smart-city networks, and Saudi Arabia is forecasting a $500 billion investment in a mega-city spanning three countries intended to "push the boundaries of innovation." [2,3] A smart base may be able to take advantage of the same benefits anticipated for a smart city, with added military capabilities—mission assurance and mission command.

The Advent of the Internet of Things (IoT)

Technology is revolutionizing life, and it's not slowing down. In 1999, Kevin Ashton, an assistant brand manager at Procter & Gamble, delivered a presentation about wireless connectivity with an intriguing title: "Internet of Things." Sketching out a futuristic scenario where computers "knew everything there was to know about things as the network connected objects in the physical world to the Internet," Ashton predicted the IoT "has the potential to change the world, just as the Internet did. Maybe even more so." [4] Almost two decades later, the digital shift Ashton imagined is well underway. Organizations are using the IoT to glean new operational insights, grow revenues, reduce costs, and increase productivity.

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In the twentieth century, computers were brains without senses–they only knew what users told them. This was a huge limitation: there are many billion times more information in the world than people could type through a keyboard or scan with a barcode. On the other hand, automated and data-powered actions can process 55 trillion measurements per day, and make 1.3 million automated optimizations per day. Similarly, threat detection involved human-managed firewall monitoring and reactive threat responses to over 750 billion events per day. Data-powered actions enable analyzing up to 5,000 events per microsecond promoting a proactive self-healing network fabric. [5]

Today, because of the IoT, the number of interconnected sensors has exploded. It's only been a few years; however, this data transformation of networked sensors is already being taken for granted. [6] Figure 1, illustrates this remarkable transformation.

Edge intelligence advances this transformation as it pushes processing for data-intensive applications away from the core of the cloud to the edge of the network thereby realizing the real value of the IoT. This radical transformation from the cloud to the edge, 'edge intelligence,' will support trillions of sensors and billions of systems. It will treat data in motion differently from data at rest. By shifting intelligence from a core centralized cloud to a gateway at the edge of an organization's network, sense-making and near real-time decisions can be made closer to when they need to occur. This model reduces the impact on the network by having data crunching and analytics move closer to the edge, with smaller data streams forwarded to the cloud. Edge computing can also help solve latency challenges and enable organizations to take better advantage of opportunities leveraging a cloud computing architecture. Cities and military installstallations

would be prudent to prepare for disruptions in their business and military models. For example, during the last decade, there has been a change from the traditional software license model to the services model: software as a service, platform as a service, and infrastructure as a service. [7]

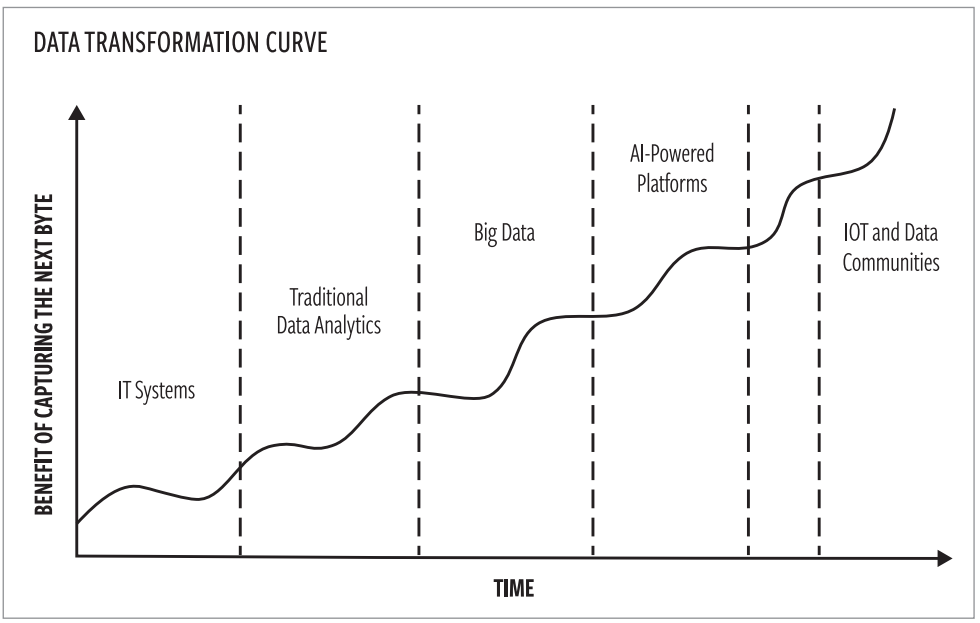

Figure 1. Benefit of capturing the next data byte over time

Furthermore, driven by the IoT, a new computing model is currently evolving, as shown in Figure 2. This extensive ecosystem of interconnected devices, operational tools, and facilities holds much promise for connecting people, processes, and assets in ways profoundly impacting how people live and work. IoT allows organizations to improve everything with data-powered insights.

The impact of this data-powered journey uses advanced analytics to translate vast amounts of collected, raw data into actionable intelligence that a city/base can use to improve the performance of its infrastructure and make long-term cost savings.

IoT Moves to the City

Cities are facing unprecedented challenges. The pace of urbanization is increasing exponentially. Every day, urban areas grow by almost 150,000 people, either due to migration or births. Between 2011 and 2050, the world's urban population is projected to rise by 72 percent (i.e., from 3.6 billion to 6.3 billion) and the population share in urban areas from 52 percent in 2011 to 67 percent in 2050. Additionally, the increased mobility of our societies has created intense competition between cities to attract skilled residents, companies, and organizations. [8]

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Furthermore, with this increased urbanization, the total number of machine-to-machine connections will grow from 5 billion in 2014 to 27 billion in 2024.[9] With this population density increase comes: increased crime, pedestrian safety, and aging infrastructure that cannot handle present population loads. According to America's Infrastructure 2017 report card, in the US there is an estimated $2.0 trillion needed by 2025 to correct infrastructure deficiencies.[10] Similarly, economic development a hot topic for politicians, will likely drive more connected/intelligent cities to attract established companies and perpetuate benefits to stimulate job growth and sustainability. To address these challenges, the concept of the smart city, the integration of technology with a strategic approach to sustainability, cost reduction, citizen well-being and economic development, has been conceived.

Smart cities are concentrating on a variety of supporting IoT devices in the following areas:

- **Public Safety:** the number one priority for many cities is public safety and the quality of life of their citizens. Using sensors and various smart-city technologies, city governments are implementing solutions to provide enhanced public safety to their constituents by delivering enhanced video surveillance at intersections, local parks, and other locations; installing sensors to alert authorities when suspicious activity takes place after hours; setting up license plate scanners embedded in video cameras to identify stolen vehicles; and mounting gunshot sensors on city light posts that immediately report the location of gunfire to first responders.
- **Infrastructure Monitoring:** city engineers stay remotely connected so they can monitor and measure changes within city structures

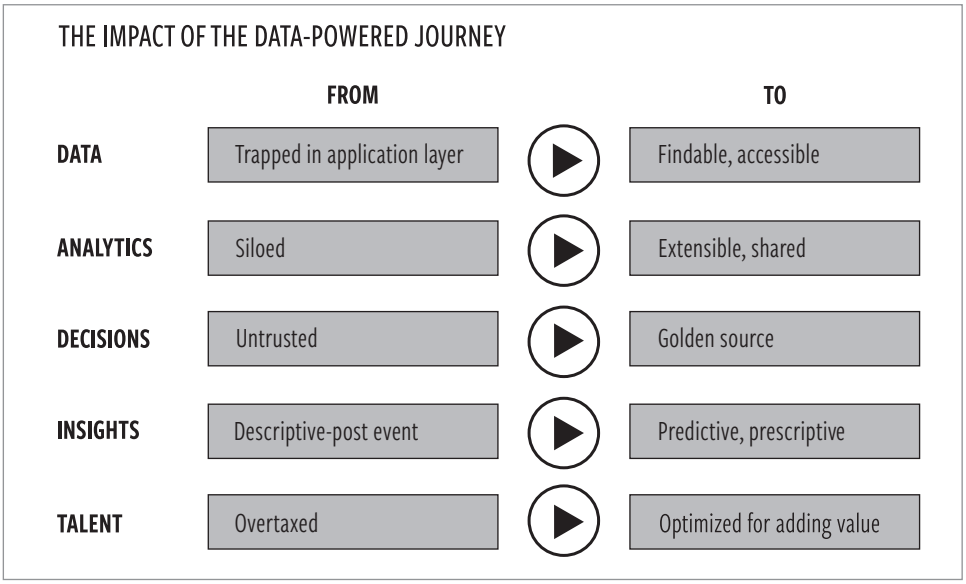

Figure 2. The data-powered journey

or earthworks. This includes an increase in efficiency and connectivity by utilizing connected lighting platforms with automated alerts to promote reductions in city-wide energy costs.

- **Multi-Network Solutions:** the IoT revolution offers a wide-range of network options to customers that support connectivity from parking meters to farm equipment, and everything in between using a variety of the latest technologies such as cellular (LTE/4&5G); fiber; small cell; low power wide area networks; and satellite communications.
- **Logistics Management:** city logisticians can shift to condition-based maintenance to improve performance and reduce costs. Employ automation to enhance container visibility across the supply chain. Correspondingly, automated data can simplify orders and reduce emergency deliveries. Similarly, savings on fuel costs through route optimization, minimized idling, and keeping customers informed with real-time to vehicle locations can be realized.
- **Waste Management:** cities can install and connect sensors in their trash bins, allowing them to receive real-time capacity data to enhance their logistics and waste management efficiencies; thereby providing real-time volume reports to optimize collection routes versus scheduled routes. Likewise, improved monitoring of driver behavior and vehicle conditions; allows for reducing infraction risks and optimizing driver performance.

- **Water Management:** water usage and sustainability are critical factors to cities. Smart water management is an opportunity to not only conserve but preserve the water supply with advanced sensors to reduce waste. Sensors in the water supply can precisely locate and detect leaks before they become a major issue; allowing for more efficient maintenance and repair. Alerts can also inform an individual or business of abnormal water usage in real time.
- **Smart Cities Operations Center:** the Smart Cities Operation Center is a data visualization tool that integrates and aggregates various data points and outputs the data in an easy to digest format. The aggregated IoT data is then used by local utilities, chief information officers, and mayors, to track and improve issues and efficiencies in real-time.
- **Traffic Analytics:** traffic is one of the biggest pain points for cities, and a difficult quality of life indicator to improve. Sensors installed at intersections can identify and alert local municipalities of unexpected traffic or congestion, and dispatch responders quickly and efficiently. Traffic type (pedestrian, bicycle, vehicle) information can be collected in real time offering the city the opportunity to optimize ingress and egress routes for the various modes of transportation. Small business can utilize the traffic analytics data in determining the optimal location to build their next franchise.

These transformations will require radical changes in the way cities are run. Smart cities are necessary to reduce emissions and handle rapid urban growth. Rather than being an expense, smart technology integration can create considerable opportunities for added value in cities of the future. [11]

Evolution of Smart Bases

With the smart-cities movement gaining more traction, and the convergence of the IoT, the successes of smart-city initiatives may be directly applicable to military installations. This extrapolation and enthusiasm are further fueled as technology disruptors shift their focus to relevant smart-city innovations.

"Military Bases function as small cities," said Colonel Don Lewis, 42d Mission Support Group Commander, Maxwell Air Force Base. "We face a lot of the same challenges municipalities face. We're excited about opportunities to explore ways to enhance our operations, conserve limited resources, and stimulate new ideas to more creatively execute our missions through the power of IoT and network connected sensors," see Figure 3. [12]

A connected machine does not become "smart" from a single sensor, or modem, or network, or application alone. It is a combination of all of these pieces coming together that creates added intelligence. Smart bases are essentially the integration of networks with IoT components and data analytics to present users with situational intelligence or a common operating picture.

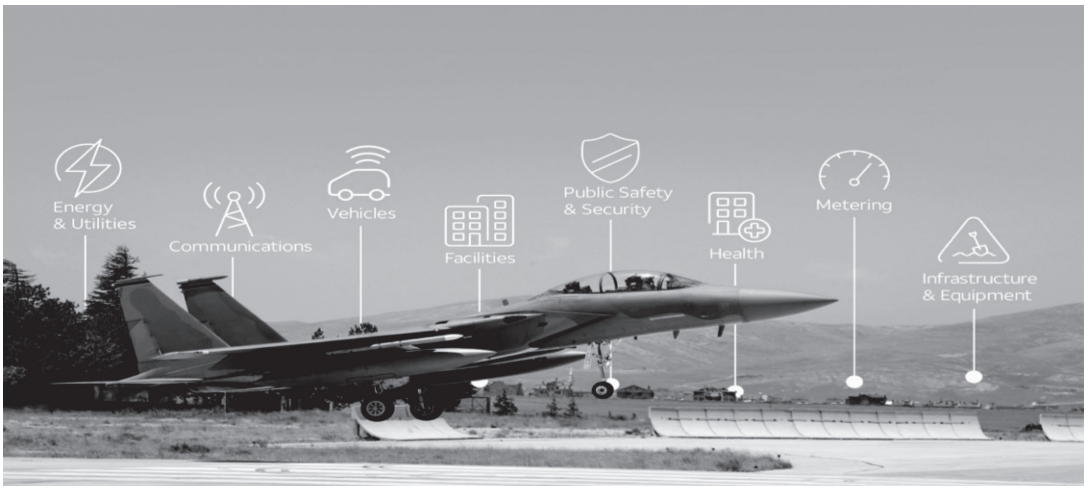

Figure 3. The power of IoT and connected sensors.

Why is the smart-base concept important to the U.S. Department of Defense (DoD)? Installing and integrating network-connected sensors into the everyday operations of a military installation will drive efficiencies, feed and automate analytics, bolster anti-terrorism and force protection measures, and improve processes. Typical base-level shortfalls that smart bases may remedy are increased safety and security, lower operating costs, resiliency, and infrastructure and energy efficiencies.[13,14,15] While these can be massive benefits for each functional community (finance, logistics, operations, etc.), greater and less-often discussed non-tangible benefits are increased mission assurance and mission command through enhanced, holistic sense-making, and situational awareness.

However, legacy bases today are for the most part not "smart-enabled" because they are not optimized for IoT and data analytics and this causes inefficiencies. Moreover, bases are frequently stifled by lack of manpower and budgetary constraints as well.

Call to Action

The job of securing the nation, although noble, is dirty; the operation of military facilities continues to consume enormous quantities of energy and fresh water and generates considerable amounts of waste.[16] Until recently, military infrastructures and services have been developed, operated, maintained and funded separately in their cylinders of excellence. This silo architecture has impeded the horizontal linking necessary to bring efficiencies, mission assurance, and military command. Consequently, as organizations inevitably move into the brave new world of the IoT to address these challenges, it may be easy to feel overwhelmed by the scope and complexity of the fast-materializing IoT era. Individuals and organizations can begin to reduce this complexity by understanding

the solution domain they are operating in, the target application they are addressing, and the potential solutions available within the IoT ecosystem, as shown in Table 1. These are the types of possible IoT solutions every commander should ask his or her team about when implementing smart-base solutions.

SOLUTION DOMAIN	TARGET APPLICATIONS	POTENTIAL SOLUTIONS
Energy & Utilities	Smart Lighting Smart Metering Sensor Automation Water/Waste Management	◆ Wireless Transport ◆ LED Lighting ◆ Smart Meters ◆ Water/Gas Leak Detection ◆ Advanced Metering Infrastructure
Transportation	Traffic Management Vehicle Fleet Management Smart Parking Base Transit Supply Chain	◆ Wireless Transport ◆ Traffic Sensors ◆ Real Time Parking Info Available to Base ◆ RFID Tagging
Military Personnel Engagement	DoD & Public Wi-Fi Base/Post Info Apps e-Governance	◆ DoD, Public Wi-Fi Hotspots ◆ Base Apps for Reporting Issues, Searching Policies
Infrastructure	Smart Facilities Base/Post Services	◆ Wireless Transport ◆ Buildings, Structural Sensors
Safety & Security	Surveillance Communications Cybersecurity Hospital Capacity Tracking Fire/Noise Detection Emergency Management	◆ Wireless Transport ◆ Video Cameras ◆ Intrusion Detection Sensors ◆ Threat Intelligence Sensors ◆ Tele-Health ◆ Wearable Devices

Table 1. IoT Solution Domains

The IoT and smart-base era is just beginning, and many aspects of securing it remains a work in progress. Organizations in every industry are already reaping the benefits of IoT implementations. By approaching the IoT strategically, and with security at the core of every connected device, military installations can begin to capture new value through the smart-base concept—while keeping potential risks in check.

Furthermore, using the DoD Mission Assurance Strategy (May 2012) pillars as a guide, strategically approach IoT implementation by using pillar one (Identify and Prioritize Critical Missions, Functions, and Supporting Assets) to guide IoT funding priorities and then utilize the IoT data and information to enable pillar three (Use Risk-Informed Decision Making to Optimize Risk Management Solutions).

While implementation of intelligent-edge devices enabling a smart-base construct may seem overwhelming, man has forever pushed himself to the limits trying to achieve the impossible. Daedalus and Icarus were imprisoned together in the Labyrinth on the Isle of Crete; they escaped on wings fashioned by Daedalus from feathers and wax. But Icarus flew too close to the sun, melting his wings, and he fell to his death in the Aegean Sea as his father sagely flew to freedom. Myth though it may be, the story of Daedalus and Icarus illustrates "the power of man has no limits" but also that this power should be employed very carefully. By weaving smart technologies at the edge into our military bases, smart decisions may be made, enabling enhanced mission assurance and military command.

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