



TRANSFORMING CITIES FOR THE FUTURE

Cities are the foundational society constructs and core economic and innovation hubs of the world. As technology advances, the digital infrastructure becomes not only another utility delivered by cities, but the conduit to connect existing utilities and services together, and to deliver new and innovative ones. Digital cities are not about addressing a single use case or multiple ones in a siloed manner. Digital cities are about adopting a strategic direction towards making cities operate in an optimally efficient manner, making them safer, enabling them to offer services that enrich human quality of life, and making them pride themselves at being inclusive, offering economic and social enhancing opportunities for all.

At Dell Technologies, we have a vision that a Digital City can be accomplished by creating an open, data-rich and people-centric Digital City Platform that will foster innovation and accelerate the pace at which innovation is created in today's digital world. The world of technology will continue to evolve, and as a result, a Digital City Platform must be designed to continuously absorb and leverage these technological changes. A people-centric open data access platform should be based on open standards and built on a foundation that integrates solutions from a robust ecosystem of partners and open-source frameworks.

DIGITAL CITY = DIGITAL TRANSFORMATION OF CITY BUSINESS

A trusted and transparent city that leverages technology and policies to improve livability, sustainability, commerce, innovation, engagement, and enables positive outcomes for the community.



THE BUILDING BLOCKS OF A DIGITAL CITY

RESIDENTIAL AND OFFICE BUILDINGS

Buildings contribute to over a third of the greenhouse gas emissions in a city. Large building complexes support a population in a small area and thus put extra strain on resources. For instance, residential and office buildings which are often inefficient are the biggest consumers of electricity and water. Also buildings are vulnerable to natural and security threats, exposing a large population and assets to risk.

A smart building focuses on leveraging technology to efficiently manage resources and provide for an intelligent space that optimizes efficiency, comfort and safety to its tenants. For instance, Smart buildings equipped with environment controls will ensure efficient and smarter use of resources such as water and electricity reducing the environmental impact. Similarly, the use of sensors, video and other technologies can go a long way in reducing risk and increasing the security of its tenants.

Commercial buildings could save up to \$603 if investments in energy efficiency were ramped up by just 1-4%.

- American Council for Energy Efficiency

CITY RESOURCES MANAGEMENT

Cities and urban centers are constrained by the amount of natural resources available to them. In order to meet the raising demands of the growing population, the cities will need to find creative ways to manage their limited resources efficiently.

Digital Cities have adopted several approaches to address this problem, including the creation of awareness of usage and waste to citizens. For instance, smart meters provide real time energy usage to citizens. Re-cycling programs can also stretch the usage of the limited resources like in the instance of cities implementing rain water recycling, stormwater collection and desalination, to name a few.

All these programs leverage data to make better decisions to improve the management of limited natural resources with minimal impact to the environment.

Smart grids could result in nearly \$600 in direct bill savings for the average household per year.

- Smart Grid Consumer Collaborative



TRANSPORTATION AND URBAN MOBILITY

Large population growth results in a greater demand for transportation and mobility. The increase in the number of vehicles on the road is leading to traffic congestions, shortage of parking spaces, and pollution impacting the quality of life and productivity of citizens. Though city governments are investing on improving infrastructure and public transport systems, they are finding it hard to keep up with the growing demand.

With the adoption of automated tolling systems, intelligent traffic lights, and intelligent fleet management solutions, city officials can tackle these issues through better infrastructure management, reduced carbon footprints, and lower fleet maintenance costs.

Further, by developing custom applications, governments can provide citizens with enhanced public transportation services, and convenient parking systems.

Intelligent transport systems deployed in New Mexico have reduced traffic delays by 88%.

- U.S. Department of Transportation



HEALTH

With increased population density in urban centers, citizens are exposed to a rapid spread of diseases. Further, factors such as air and water pollution additionally impact the overall health of the community. The health and safety demands of the growing population are becoming a challenge as most cities are struggling to keep up.

Digital Cities leverage big data technologies to monitor the overall health of the community and proactively address any spread of diseases before it reaches an epidemic level. Also, these technologies help cities manage and plan resources better to become more efficient in meeting the demands. Mobile and social solutions help with connecting and engaging the citizens to educate and also provide health services remotely.

35%

of patients are misdiagnosed, often due to lack of access to patient records.

- GE Health Cloud



SAFETY AND DISASTER MANAGEMENT

This demographic boom, already very visible today in many parts of the world, comes with big challenges that could lead to chaos. Unless local governments, together with their communities, step up to the plate and work on innovative solutions.

How can we let cities grow while preserving, or even improving, quality of life for all citizens? Moreover, where can we combine urban development with sustainable working and living conditions?

Even where the population increase stays under control – like in most historic cities in the Western world – how can we keep the cities attractive, green and prosperous, both economically and culturally, while ensuring that urban areas are accessible and inhabited by a variety of income earners?

With smart policing strategies, Philadelphia's crime rate is at its lowest in 50 years.

- Smart Cities Council

WASTE MANAGEMENT

With the surge in population, there is also an alarming rise in the total volume of waste generated. This puts a major strain on city municipalities as they face rising costs of labour, increased dependence on diesel trucks and a shortage of landfills.

By collecting and analysing data from sensors in smart bins, municipalities can accordingly dispatch low or high capacity collection trucks. Further, city governments can enable collaboration by empowering citizens to report on areas that require more bins, or on faulty sensors.

50%

waste recycled by
Sweden's waste management
system and remaining devoted to
energy recovery
- Smart Cities Council

PUBLIC ADMINISTRATION AND SERVICES

Citizen trust and confidence is essential for a successful government. City governments are working towards greater open communication with their citizens, transparency, and seamless access to services. City governments can provide online access to records, and empower citizens with easier requests for services. Citizens can easily track requests, and communicate with local administrations using social media. In turn, governments can improve records management, increase efficiency, reduce costs, gain insights from the data collected, and use these insights to drive internal efficiencies.

Barcelona's Public information is available to everyone. This has enhanced the city's social and economic value and improved individuals' lives.

- BCN Smart City

INFORMATION SECURITY

As governments work towards moving their services to digital platforms, there is also an increase in privacy concerns regarding the safety of confidential government, citizen and business information. Privacy protection systems go hand-in-hand with the planning and building of digital cities, ensuring that citizen confidence is not diminished with issues related to personal information being misused or being accessed by unauthorised parties.

The Department of Homeland Security announced plans to invest \$50 million over five years for emergency response technologies for Smart Cities.

- DHS

TOURISM

In many cities, tourism accounts for a major portion of their revenue. As a result, city governments are increasingly looking for ways to attract more tourists. To do this, authorities look towards digital advertising and email campaigns targeted at potential visitors. However, there is an increasing need to gain insights and learn about potential tourists. Using social media and big data, governments can build databases on followers and create targeted campaigns with a view to increase the number of visitors.

The City of Gaudi is taking advantage of live data analytics and the IoT to keep its reputation as a top holiday destination.

- Journal of Destination Marketing & Management

ENERGY

Across nations, electric utilities are deploying smart meters to their residential and commercial customers as the basic building block of the Smart Grid. Smart meters offer a unique opportunity to learn customers' lifestyle and extract meaningful information to improve energy consumption. In order to optimize energy usage, Demand Response (DR) and Energy Efficiency (EE) programs are being promoted among citizens and large amount of electricity consumption information is analysed to reduce energy costs.

Smart Meters' sensors can perceive peak load problems and utilize automatic switching to divert or reduce power in strategic places.

- Department of Energy

SMART FACILITIES

ICT and Internet of Things (IoT) are enabling city governments to offer an array of enhanced services and facilities that improve the lives of their citizens while also providing the governments with a host of actionable insights to monitor and continuously improve the usability of these facilities.

For instance, apps could help drivers locate available parking spots in their vicinity, thereby reducing illegal parking, traffic congestion and pollution. Similarly, smart homes can help residents' efficiently reduce wastage of water, electricity and gas.

Thanks to open data, citizens in Barcelona can use the CityBikes app. Application that provides information about the city's biking system.

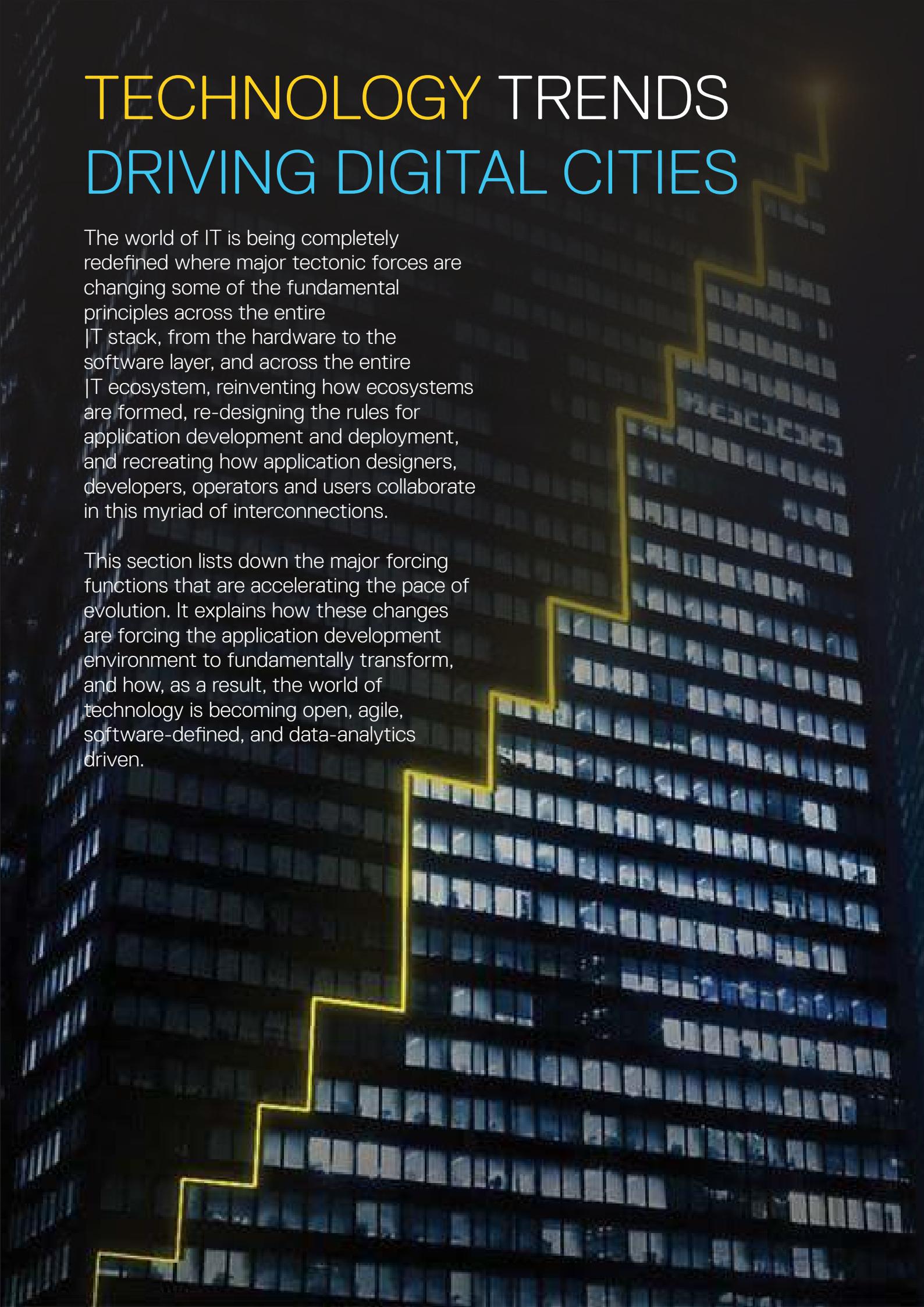
- BCN Smart City



TECHNOLOGY TRENDS DRIVING DIGITAL CITIES

The world of IT is being completely redefined where major tectonic forces are changing some of the fundamental principles across the entire IT stack, from the hardware to the software layer, and across the entire IT ecosystem, reinventing how ecosystems are formed, re-designing the rules for application development and deployment, and recreating how application designers, developers, operators and users collaborate in this myriad of interconnections.

This section lists down the major forcing functions that are accelerating the pace of evolution. It explains how these changes are forcing the application development environment to fundamentally transform, and how, as a result, the world of technology is becoming open, agile, software-defined, and data-analytics driven.



MAJOR TECHNOLOGY TRENDS ARE ACCELERATING THE PACE OF EVOLUTION

The rapid pace of evolution technology in the last few decades can be attributed to some major technology trends that fuel each other and propel the acceleration of their own evolution:

- Cloud
- Mobile
- Big Data and Advanced Analytics
- Social
- Internet of Things (IoT)
- Blockchain

Major changes in the way innovation is being created in this century are fuelled by 3 major trends:

Democratization of Entrepreneurship

Democratization of Technology

Democratization of Innovation.

Cloud-native, Mobile Scale-out Applications:

Today's applications are built natively in the cloud and are designed to be scalable, run on any platform, and be accessed from any device.

The Merge of Development and Operations Environments:

The entire infrastructure-operations operating environment can now be virtualized and automated. In Software-defined data centers (SDDCs), processes are implemented through software and Application Program Interfaces (APIs), allowing for reduced inefficiencies and errors, improved performance between data center components, and consolidated operations across servers, storage, networking and security.

Applications Make No Assumptions on the Underlying Hardware:

Another fundamental shift introduced by cloud-native applications is the migration of availability and resilience features away from the underlying hardware into the application fabric itself. Cloud-native applications are designed to be scalable, self-managed, resilient, and data-rich.



Data-driven Innovation, Data-rich Platforms:

Organizations across the globe are already realizing the benefits of Big Data and Big Data analytics to raise productivity, create new opportunities, improve decision making and gain competitive advantage. Putting Big Data to work means transforming your infrastructure into a more flexible, distributed and open environment, as well as placing new tools into the hands of managers and citizens.

Rapid Release Cycles:

There are three major shifts in the way we develop and deploy applications, namely shortened time from idea to market, shortened time between releases, and constant or continuous release cycles. As a result, the time period for the introduction of new application functionality is reduced from years to a matter of hours.

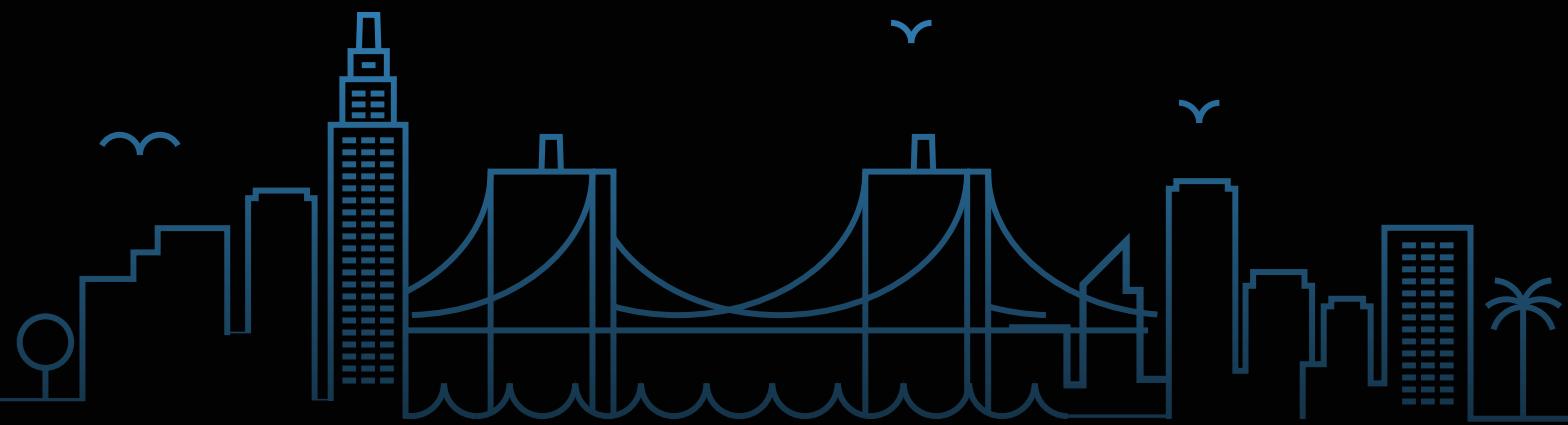
Software Enters the Era of Continuous Everything

The world is facing a fundamental shift on how technology-driven and software-driven innovation is introduced and adopted. The technology world is entering the era where continuous is the new tempo, an era where:

- Continuous integration drives the integration of components on an on-demand and on-availability basis.
- Continuous iteration allows application developers to constantly modify, add code, test, deploy, analyse effectiveness of changes, and enter the cycle again without delays.
- Continuous deployment enables application upgrades to happen on a continuous basis without the user being affected or noticing the changes.
- Continuous innovation introduces novel ways of accomplishing any task

On Open Data and Open Software:

Implicit in a definition of Open Anything is the notion of sharing, transparency and accountability. Making data more “liquid” has the potential to unlock economic value through improved efficiency, making possible new products, services and markets, and creating value for individual citizens.



DIGITAL CITY PLATFORM OF THE FUTURE

The Dell Technologies Strategically Aligned Businesses define a Digital City as a city that has three strategic characteristics:

- 1** **Instrumented**
Enabling the measurement of as many aspects as possible of the city and of its people, in a secure, seamless and non-invasive manner
- 2** **Interconnected**
Enabling the movement and fusion of the data in real-time or near-real-time, ensuring the availability of the data where and when respond, adjust and adapt to life-events as needed.
- 3** **Intelligent**
Enabling insights of the data to be harvested and shared, allowing a city and its people to they occur.

The Dell EMC Alliance shares the view that the concept and vision of a Digital City can only be achieved through the creation of an open, data-rich and people-centric Digital City Platform that fosters innovation and accelerates the pace at which innovation is created in today's digital world.





The Dell Technologies vision stems from the following facts:

- A Digital City platform must be designed to dynamically and continuously absorb and enable technology evolution
- The platform must support people-centric solutions and open data access
- Bespoke solutions will be required for smart infrastructures and services
- Digital Cities must deliver a simpler life by optimizing around its resources, people and data
- The needs of its people must be gauged through deeper insights using advanced analytics
- Resources must be efficiently and optimally allocated

The focus on designing a Digital City Platform also centres around how a robust ecosystem of partners can be brought together to constantly and continuously collaborate and innovate. This ecosystem can only achieve sustainability when it includes multiple commitments:

- From the Public Sector ensuring long term demand; from Academia to educate and engage the upcoming generations
- From the Private Sector, demonstrating financial and market viability

Smart people transform cities into Digital Cities. In order to hear and meet the needs of its people, the Digital City Platforms of the future must transcend silos, in order to provide a cohesive view of its environment.

In order to deliver on the promise of a Digital City, Digital City Platforms must exploit the momentum that is being created in the world of Information Technology (IT) to not only expand the Instrumentation and interconnectivity of the city and of its people, but to also accelerate the level of intelligence that is applied to the framework. This intelligence is translated into value by delivering innovative service to its people and by optimizing the use of its resources.



DIGITAL CITY PLATFORM

This section discusses how the Open, Agile, Software-Defined, and Data Analytics driven properties of the emerging IT world enable the Digital City Platform of the future. Specifically, we describe the design, need, use case and economic considerations for Digital City Platform solutions.

AN OPEN DIGITAL CITY PLATFORM

An open IT world affects the design of a Digital City Platform in several ways, including:

OPEN DATA By making data open for the public, citizens are empowered to participate in government decisions pertaining to their daily affairs and are able to assist the government with tackling municipal challenges using crowd sourcing.

OPEN PLATFORM empower Digital Cities to accommodate diverse technology solutions across public sector domains, making the nature of governments' enterprise architecture into a more flexible and open plug-and-play model.

OPEN SOFTWARE Making the internals of the source code available gives a tremendous amount of visibility into the inner workings of the software technology used, adding an element of trust and transparency to the relationship among members of the ecosystem.

AN AGILE DIGITAL CITY PLATFORM

An agile IT world affects the design of a Digital City Platform in several ways:

Platform as a Service (PaaS) Based Marketplace

An agile application development approach can significantly shorten the time required to market Innovative services and products.

Agile Platform Architecture

An agile platform architecture enables governments to promptly adjust their processes and operations to address municipal challenges effectively.



A SOFTWARE-DEFINED DIGITAL CITY PLATFORM

A Software-defined IT world affects the design of a Digital City Platform in several ways

Scalability

The scalable nature of software-defined platforms provides the capacity to flexibly accommodate the growth in data consumption that is associated with the growth in urbanization and subsequently the use of services and data from both public and private networks

Economic Viability

A software-defined platform improves the return of technology investments via optimal use of IT assets while also decreasing the costs of IT operations and maintenance.

A DATA ANALYTICS DRIVEN DIGITAL CITY PLATFORM

A data analytics-driven IT world affects the design of a Digital City Platform, in what it enables, and supports a broad spectrum of analytical frameworks, including:

- Real-Time Analytics
- Near Real-Time or Interactive Analytics
- Batch Analytics

A data analytics-driven IT world enables Digital City platforms to store any type of data, analyse it, and to view and use it when needed, and through any device.

The benefits of a data analytics-driven approach include:

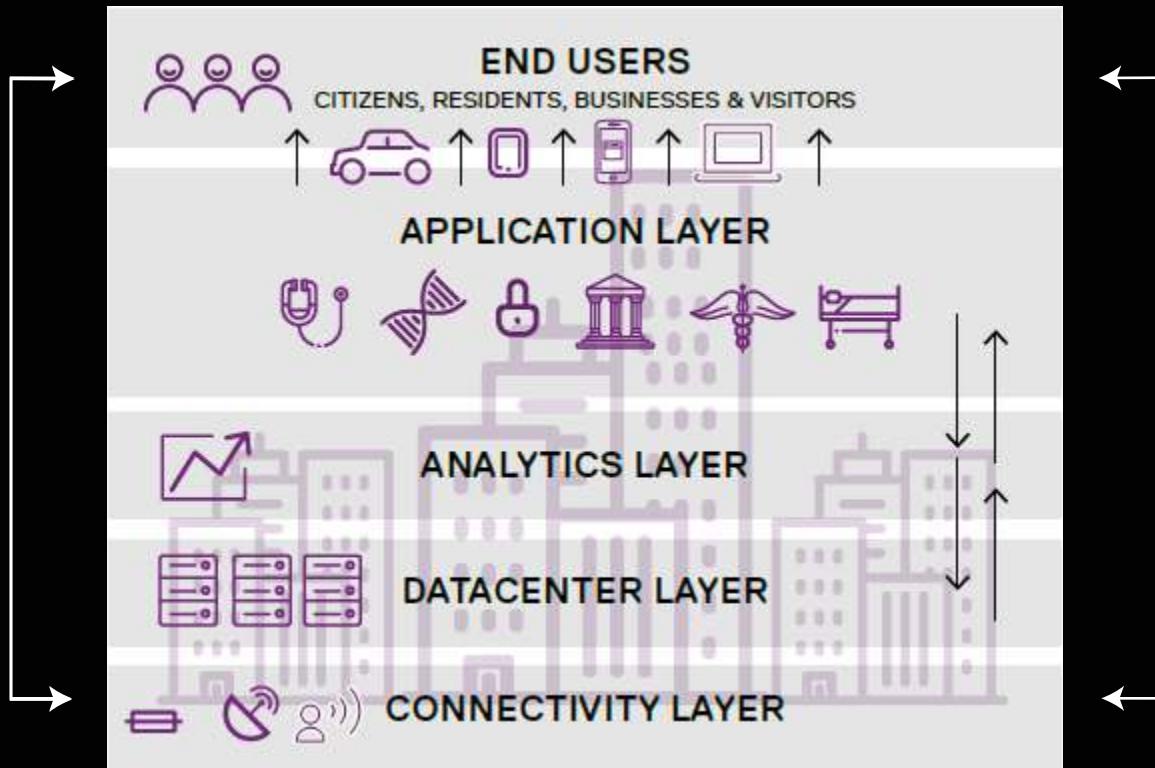
Data analytics-driven allocation of resources

Anables seamless data sharing between the public and private sectors and empowers the Digital City to take a data-driven approach towards strategic, tactical, and operational challenges.

Data analytics-driven people-focused apps

Empower people to make smarter choices in their day-to-day lives and subsequently improve their standard of living.

LAYERED APPROACH TO BUILDING A DIGITAL CITY



The picture above depicts the layered approach to building a digital city platform where each layer is capable of scaling up or down to dynamically accommodate the demands of a city. The following decoupled layers form the core of the digital city platform ecosystem:

- 1 Connectivity layer:** Includes the ICT backbone for the city that enables a connected ecosystem responsible for the capture, aggregation and transport of data via a broad set of protocols and networks. Data acquisition can happen across a broad set of end points from sensors in embedded devices, to Internet of Things (IoT) monitors and data collectors, to connectors into existing enterprise databases, to social media broadcasts, and more.
- 2 Data Center Layer:** Delivering the Infrastructure as a Service (IaaS) layer, as well as the Management and Orchestration Layer (M&O) of a Software-Defined Data Center (SDDC) which can support all the workload demands of digital city application and can also scale seamlessly as per the needs of the city.
- 3 Analytics Layer:** Delivering the data platform to store and analyze data through an analytics framework enabling big data processing and machine learning to derive actionable insights from the data collected.
- 4 Application Layer:** Delivering the Application platform for the city to host all the end user applications on a common management framework thereby making it easier and faster to develop, deploy and maintain the suite of applications that drive the digital city.

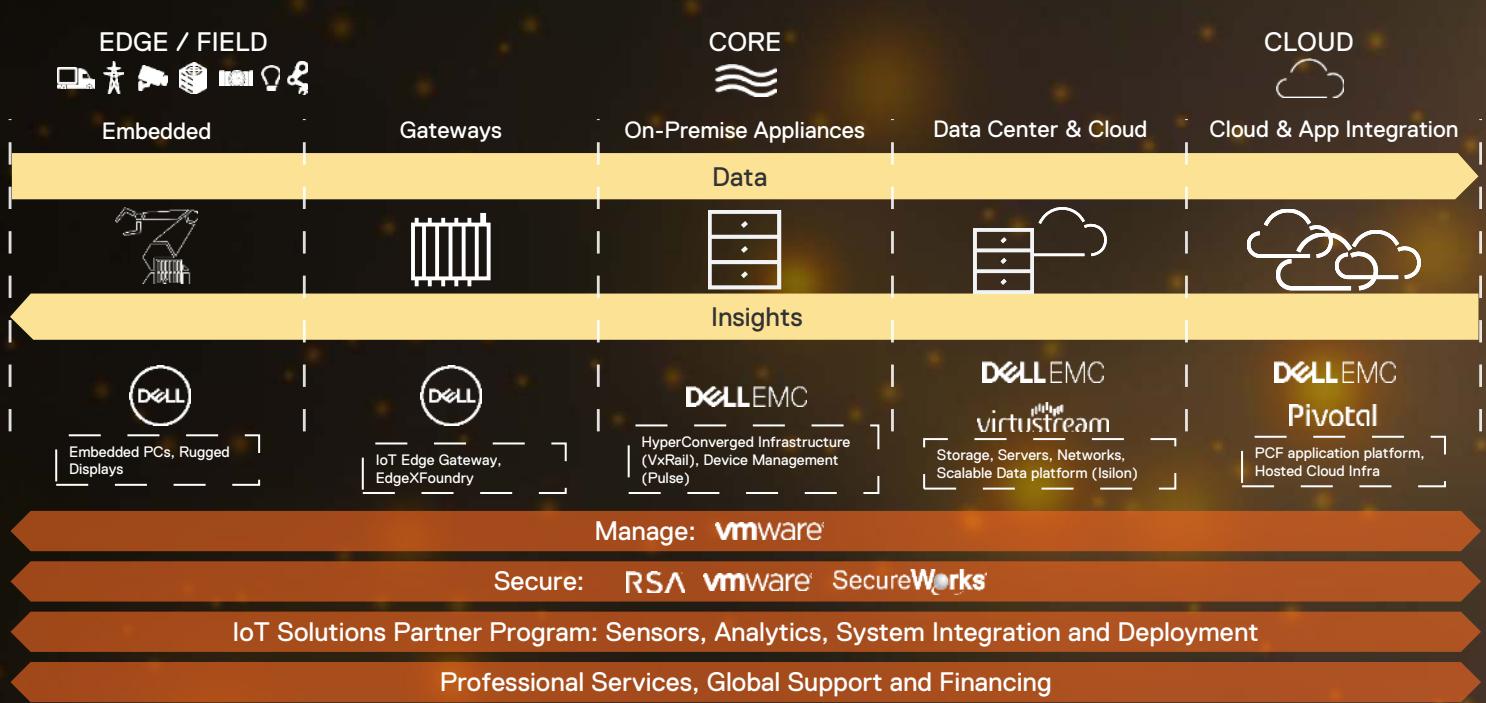


IoT IN DIGITAL CITIES

Internet of Things (IoT) has become an integral part of digital cities to make them more intelligent and self-reliant. Employing IoT gives the ability to connect devices at different places and access them from one location and also enables the development of a number of applications that make use of potentially enormous amount and variety of data generated by these resources to provide new services to citizens, companies, and public administrations.

The Dell Digital cities architecture enables all such IoT use cases to be implemented end to end using a cutting edge distributed IoT architecture with hyper convergence at the Edge layer and also enables edge analytics.

The picture below outlines the fact that Dell Technologies is in a position to deliver IoT solutions with products and solutions portfolios across the IoT Continuum.



Summary

Digital Cities present an opportunity to federate and correlate information from across the services and facilities within a City, with public and social data, to enhance the lives of both residents and visitors. Digital City Platforms of the future must capitalize on the emerging trends of the IT world and embrace its new shape and form, offering:

Open Data Platforms to promote collaborative development, to engage citizens and stakeholders to effectively use their data, and to create an innovation-enabled ecosystem that will drive city growth.

Agile Systems to promote greater communication between the government and citizens, understand the behaviours and needs of the citizens, and make governance more responsive and adaptive.

A Software-defined Architecture and Approach to promote citizen-centric optimisation of the city by delivering innovative, leading edge infrastructure, and personalised applications and services.

A Data—driven Approach to enable citizens to make well-informed and well-educated decisions, and to live happier.

Digital City ICT leveraging the DT family alignment



Award-winning customized solutions offering innovative devices and services designed for the way people work

Pivotal

Leading the intersection of Big Data, PaaS and agile development leveraging data on one cloud-independent platform

SecureWorks

Elite and trusted intelligence that strengthens security and reduces risk in a dynamic landscape

DELL
Technologies

Dell Boomi

The leading EDI – API – MDM Cloud enabled software suite

virtustream

The leading enterprise-class cloud software and solution provider

DELL EMC

The foundation to transform your data center with industry-leading servers, storage and converged infrastructure

RSA

The premier provider of security, risk and compliance solutions solving your most complex challenges

vmware

The most trusted virtualization for desktop, data center and applications. Mobile device security. VDI.

DELL Technologies