

Green & Sustainable Cities of the Future

By

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EXECUTIVE SUMMARY

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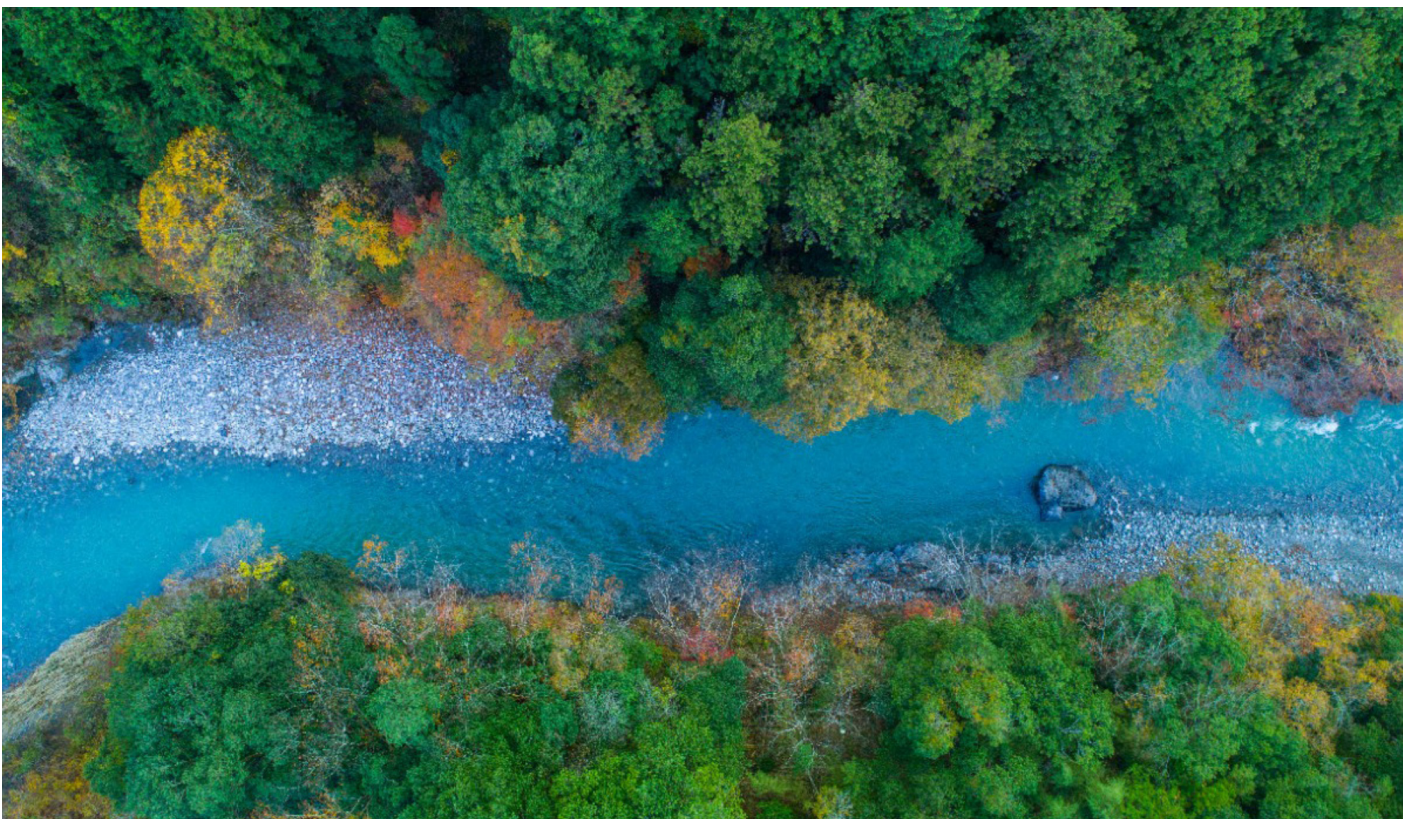
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Envision a carbon-negative urban environment, with a population consuming less than what is generated, from energy and water to consumer goods / household efficiency on through to efficient green buildings. Modern cities are becoming aware of the careful balance they must maintain between generating value for their citizens and maintaining environmentally sustainable operations, all while controlling their public sector spending. The Dell Technologies Digital Cities team is bringing transformative thinking to deliver citizen-centric outcomes, by leveraging the latest in cutting-edge technologies. Planning and prioritizing critical outcomes expected will be the foundation in their digital transformation journey.

Dell Technologies Digital Cities team is here to help minimize the time and effort required to successfully design and build a system of systems providing a “single pane-of-glass” perspective to fully integrate disparately functioning systems. It is like having a central nervous system for city leaders to monitor the pulse of the city by leveraging existing systems and improving data utilization to drive positive value for citizens. Planning for citizen outcomes becomes more intuitive for city leaders, planners and residents.

Dell Technologies Digital Cities team has a proven Smart City ecosystem of software solution partners and expert system integrators worldwide to effectively deliver on the promise of reducing a city’s carbon footprint while simultaneously giving citizens a greener and more sustainable urban environment in which to prosper and thrive. Our validated partner ecosystem solutions, in concert with Dell Technologies’ entire asset portfolio, ensures a modern, open, scalable, and adaptable infrastructure critical to successfully deliver green and sustainable citizen-centric outcomes both present and future.



CLIMATE CHANGE BACKGROUND OVERVIEW

Over the past 650,000 years, the Earth has gone through many cycles of climate change from glacial advancement to retreat, abruptly stopping about 12,000 years ago when the last ice age ended. This change marked the beginning of the modern climate era that we know today. Historically speaking, climate changes are due to solar energy received by the planet and solar activity that cause minute changes in the Earth's orbit. As the Earth continues to warm, it is becoming more and more evident that human activities over the past 100 years are the root cause of the current warming trend and are unparalleled in our planet's history.

Recent advances in sensors and data gathering technologies combined with satellites have breathed new life into scientists' efforts to study, understand, and continuously monitor the impact human civilization is having on Earth. The amount of data collected from the past few decades has begun to reveal the scale of the impact humans have on changing climate trends, including global temperature and levels of carbon dioxide, a natural heat-trapping greenhouse gas.

"Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that Earth's climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. This ancient, or paleoclimate, evidence reveals that current warming is occurring roughly ten times faster than the average rate of ice-age-recovery warming. Carbon dioxide from human activity is increasing more than 250 times faster than it did from natural sources after the last Ice Age."

(<http://climate.nasa.gov>)

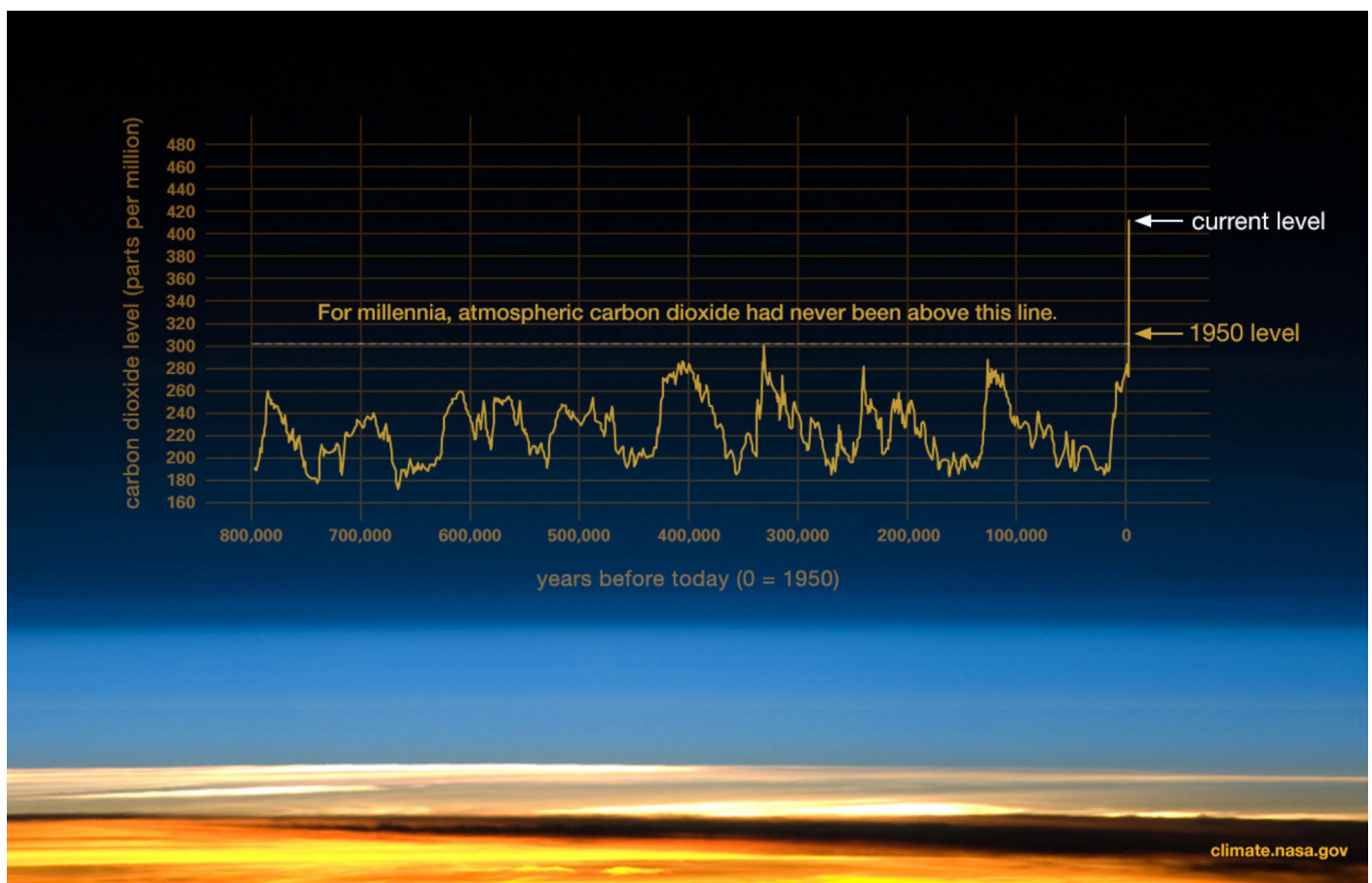


Diagram 1 (Source: <https://climate.nasa.gov/evidence/>)



IMPLICATION FOR CITIES: CHALLENGES AND OPPORTUNITIES

Estimates suggest that cities are responsible for 75 percent of global CO₂ emissions, with transport and buildings being among the largest contributors (<https://www.unep.org/>). As most urban activities are tied to increases in greenhouse gas emissions, this unprecedented climate change is driven in large part by the rapid global urbanization over the past half century.

The acceleration of temperature increase is driving extreme weather scenarios across the globe with effects that extend well beyond the mostly urbanized world population. Considering the implications for countries dealing with continued urbanization, unforeseen events like the frequency of hurricanes, typhoons, floods, epidemics, droughts leading to fires, bringing immense cost implications to urban planning. Citizen health, security, and basic services (power, water, etc.) coupled with critical infrastructure and rapid urbanization are the primary contributing factors affecting climate change.

“Only with a coordinated approach and action at the global, regional, national, and local levels, can success be achieved. It is essential, therefore, to make cities an integral part of the solution in fighting climate change. Many cities are already doing a lot by using renewable energy sources, cleaner production techniques and regulations or incentives to limit industrial emissions. Cutting emissions will also

reduce local pollution from industries and transport, thus improving urban air quality and the health of city dwellers. (<https://www.unep.org/>).

Cities cover less than 3% of the world’s surface, but host more than 50% of global population, consume more than 78% of global energy, and are the source for more than 70% of all greenhouse gas emissions. (<https://www.smartcitiesworld.net/>).

These principal factors will drive current state as well as future planning for cities, around green energy and sustainable urban living, as we dive into how to confront and even reverse climate change. While it is self-evident climate change cannot be rectified in the short term, having the vast number data points integrated into a common framework allows city administrators and urban designers to think more creatively building a better future. The principle objective must always be to help our planet achieve carbon neutrality and eventually planetary carbon normalcy by reducing the human impact on climate change.



NEXT GENERATION GREEN AND SUSTAINABLE CITIES

City leaders, government agencies, and urban planners are envisioning how to digitally transform urban landscapes and systems in order to address the challenges brought on by climate change. Their transformative visions are set to deliver citizen-centric outcomes, leveraging the latest in cutting-edge technologies to achieving a greener and more sustainable environment. Technology innovations are the driving force altering the way cities of the future are being planned at the foundation to manage climate impact and achieving carbon-neutral to carbon-negative state, driving economic growth, and human progress. Discerning and adapting to primary trends critical to transformation will unquestionably lead cities to these outcomes:

- mainstream digitally native citizens
- autonomous mobility
- critical infrastructure overhaul.

While addressing the key challenges cities face from climate change may seem overwhelming, it is necessary for planners to begin by categorizing and prioritizing the areas where success will have the greatest impact in the shortest amount of time. The diagram below shows four areas which are central indicators of where cities should focus and improve the efficiency parameters promised by digital transformation, making them greener and more sustainable.

City planners should focus on these four key areas, which have the highest potential to reduce their cities' carbon footprints:

Energy

Water

Buildings and Infrastructure

Environment Resilience

ENERGY	WATER & WASTEWATER	BUILDINGS & INFRASTRUCTURE	ENVIRONMENT & RESILIENCE
SMART GRID (DISTRIBUTION)	ADVANCED WATER & WASTEWATER NETWORK	SMART BUILDINGS	CRITICAL INFRASTRUCTURE SAFETY & DISASTER MANAGEMENT
DISTRIBUTED ENERGY SYSTEMS	ADVANCED METERING INFRASTRUCTURE	SMART STREET LIGHTING	WASTE MANAGEMENT
ENERGY MANAGEMENT & DEMAND RESPONSE			POPULATION MONITORING

Source: Market model developed by Harbor Research in Sep 2020 in collaboration with intel

A primary objective for city planners today is reducing a city's contribution to climate change. Being aware that sustainability outcomes are broad and diverse, cities must plan and prioritize goals of the underlying urban ecosystem to deliver these complex and interdependent outcomes. Thus, a strong case for cities to undertake a more integrated and a holistic approach to plan the digital transformation to enable these outcomes.

Dell Technologies Digital Cities team has developed its methodology to deliver these outcomes in a focused solution-centric approach. Clearly smart buildings and energy segments present the largest opportunity for cities and governments to make a difference in the most expeditious way. Concentrating on smart buildings and smart campuses stands out as a priority as they have the highest potential to deliver climate change reductions. The existing ecosystems and subsystems in place are fragmented and lack cohesion. These systems are vertically disparate in nature, thus creating an integration layer as a foundation is key to delivering a "System of Systems" platform connecting cities with real-time situational awareness and predictive modeling.

There is a significant synergy with the other Digital City campus scale solutions such as Safe Campus and Thermal Edge Screening, enabling leaders to determine the larger impact on society through integrated solutions.



CURRENT CHALLENGES IN OPERATING BUILDINGS MORE EFFICIENTLY

The challenge of the existing ecosystem of verticalized solutions in the smart building / campus market segment presents another opportunity for Dell Technologies Digital Cities approach to creating a more efficient and sustainable energy consumer within a city's boundaries. Fragmented ecosystems like multiple building management systems, building automation systems, facilities management systems, video management systems etc., create multiple islands of data sets yet lack the cohesive nature of a fully integrated system with a single-pane-of-glass view.

Developers and building owners/operators often have difficulty maximizing building efficiency, particularly using artificial intelligence and machine learning, due to several common gaps:

- limited ability to connect disparate data sets
- difficulty prioritizing and managing service requests
- lack of comparative, diagnostic, and predictive capabilities.

With buildings accounting for more than 40% of a city's energy consumed, those potential gains are significant both financially as well as ecologically.

Having multiple teams running independently in silos, buildings don't leverage the available data, leaving advanced technologies unavailable for modernizing building and campus level operations. By using the complete data sets available and establishing known thresholds and baselines on building performance, operators can perform comparative analyses. This allows them to identify inefficiencies in energy usage faster and with greater detail.

CREATING INTEGRATED SMART BUILDINGS / CAMPUS BENEFITS



Dell Technologies Digital Cities team has best-of-breed partners providing campus and building level holistic management systems, bringing to market the capabilities of integrating and operationalizing the way buildings/campuses operate. This new and unique approach provides clear benefits on a city's journey to becoming green and sustainable. Optimizing energy consumption based on tenant occupancy levels, building administrators can make intelligent use of data collected and apply best practices to the entire campus.

Artificial intelligence-based predictive maintenance helps to ensure all major systems within a building or campus operate at peak efficiency. There are significant reductions in the number of emergency maintenance situations when system performance levels are continuously monitored and maintained.

Buildings become adaptive and can automatically generate their own service/maintenance requests based on health status of connected sensors and devices, resulting in continuous system uptime. Further machine learning and artificial intelligence algorithms evolve and adapt as the number and behavior of occupants change. Other facets like temperature and lighting are kept to optimum levels. Tenant well-being is improved with air quality monitoring.

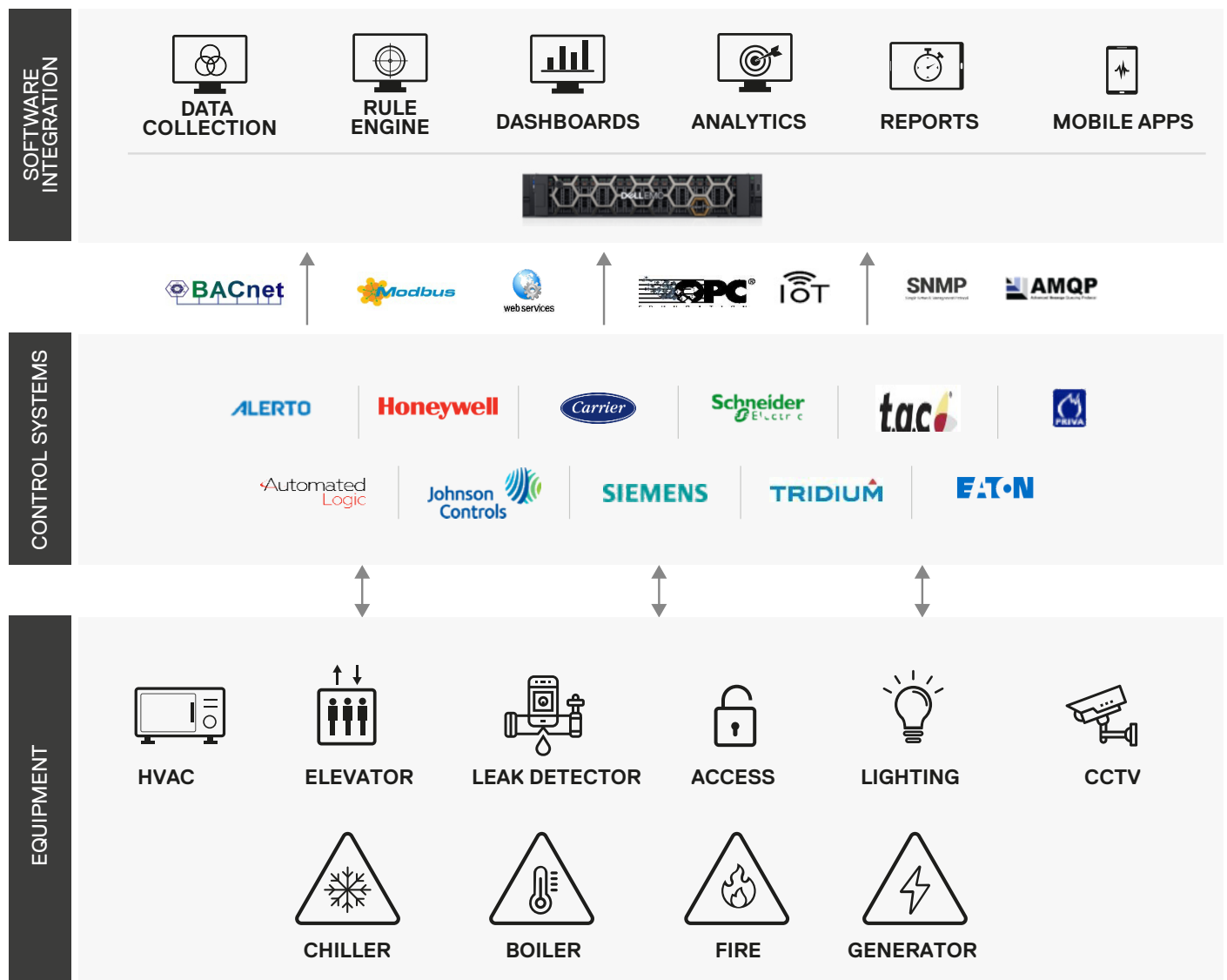
Predictive maintenance and automated work order management may be integrated with service desk and maintenance systems. Finally, safety and access control have improved monitoring and tracking, keeping tenants safe and secure throughout the time spent in the buildings.

SMART BUILDINGS & CAMPUS: ARCHITECTURE



Below is a representative architecture of smart building solutions. Various equipment within a building such as HVAC systems, elevators, chiller plants, and occupancy sensors would be connected to controllers. The controllers can be from multiple vendors i.e. Siemens, JCI, Honeywell, etc.

The smart building software then connects to the same controllers via various protocols or it may connect directly to the building equipment itself. Having all this data collected, processed, and analyzed helps with generating relevant dashboards and reports.



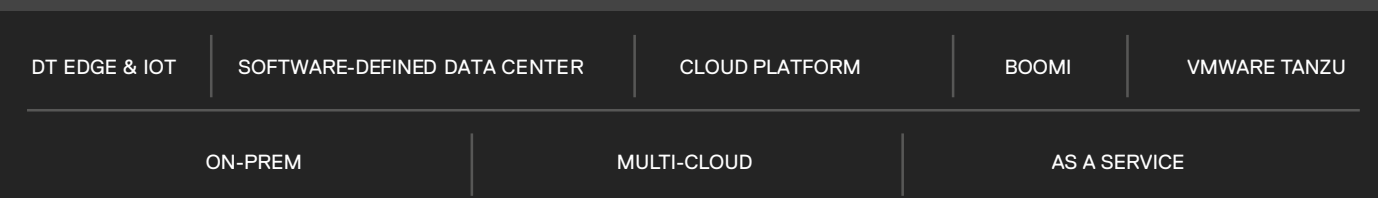
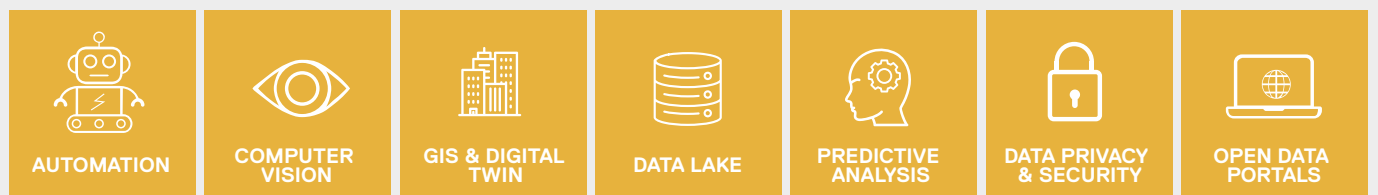
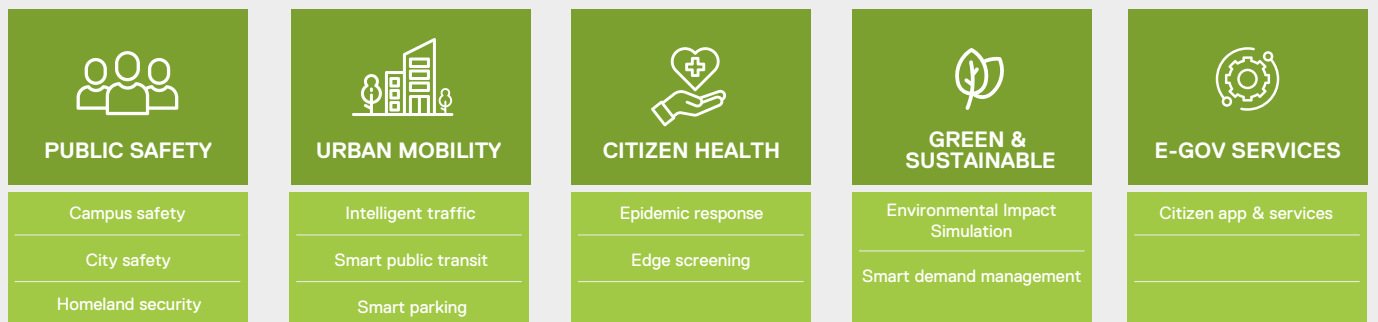
THE DELL TECHNOLOGIES DIGITAL CITY APPROACH - ACCELERATED ARCHITECTURE

Enabling this next generation architecture, leveraging an integrated operations center at its core, begins with detailing a design based on the below architecture. The framework must be open, intelligent, and capable of dynamic scaling as technology, building/campus needs, and tenant needs continuously evolve. Creating a comprehensive multi-cloud, software-defined, modern, application-centric data center architecture capable of ingesting many vertical sub systems, into a common data lake for automation, prediction, and analysis, while ensuring














mission critical systems are always operational.

Using a common data pool to store and process data for automation, prediction, and analysis, while maintaining complete cyber security is at the forefront of the design. Given that applications and other devices are delivering continuous data streams, the need for the system to be designed with a microservices-oriented architecture will also be essential.

DIGITAL CITIES ARE THE CONVERGENCE OF KEY NEXT-GEN TECHNOLOGIES



Dell Technologies has a wide infrastructure portfolio including industry-leading compute and storage platforms

STORAGE		SERVER	DATA PROTECTION	CONVERGED	HYPERCONVERGED
					
PowerMax	PowerStore	PowerEdge	PowerEdge DD		
					
PowerScale	PowerFlex	PowerEdge MX	PowerProtect Recovery Solution	VxBlock	PowerFlex Integrated System
					
		PowerEdge	PowerProtect DP		VxRail
CLIENT			DATA & APPS	CLOUD	SERVICES

Dell Technologies Green and Sustainable Customer Ready Solutions are enabled by Dell Technologies Infrastructure for Compute, Storage and Networking resources. Additionally, the hyper-converged solutions available are purpose-built for demanding workloads.



ACCELERATING DIGITAL CITIES OF THE FUTURE

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