

SECTION 5

IT ARCHITECTURE &
INFRASTRUCTURE FOUNDATION

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5.1 ENTERPRISE ARCHITECTURE

This section identifies current information technology architecture elements in Fairfax County. The County's technology architecture is a tactical asset that defines technology components necessary to support business operations and the infrastructure required for implementation of technologies in response to the changing needs of government business and industry evolution. It is a multi-layered architecture that includes:

- Application and Data Architectures
- Platform Architecture
- Network Architecture
- Internet Architecture
- Security Architecture

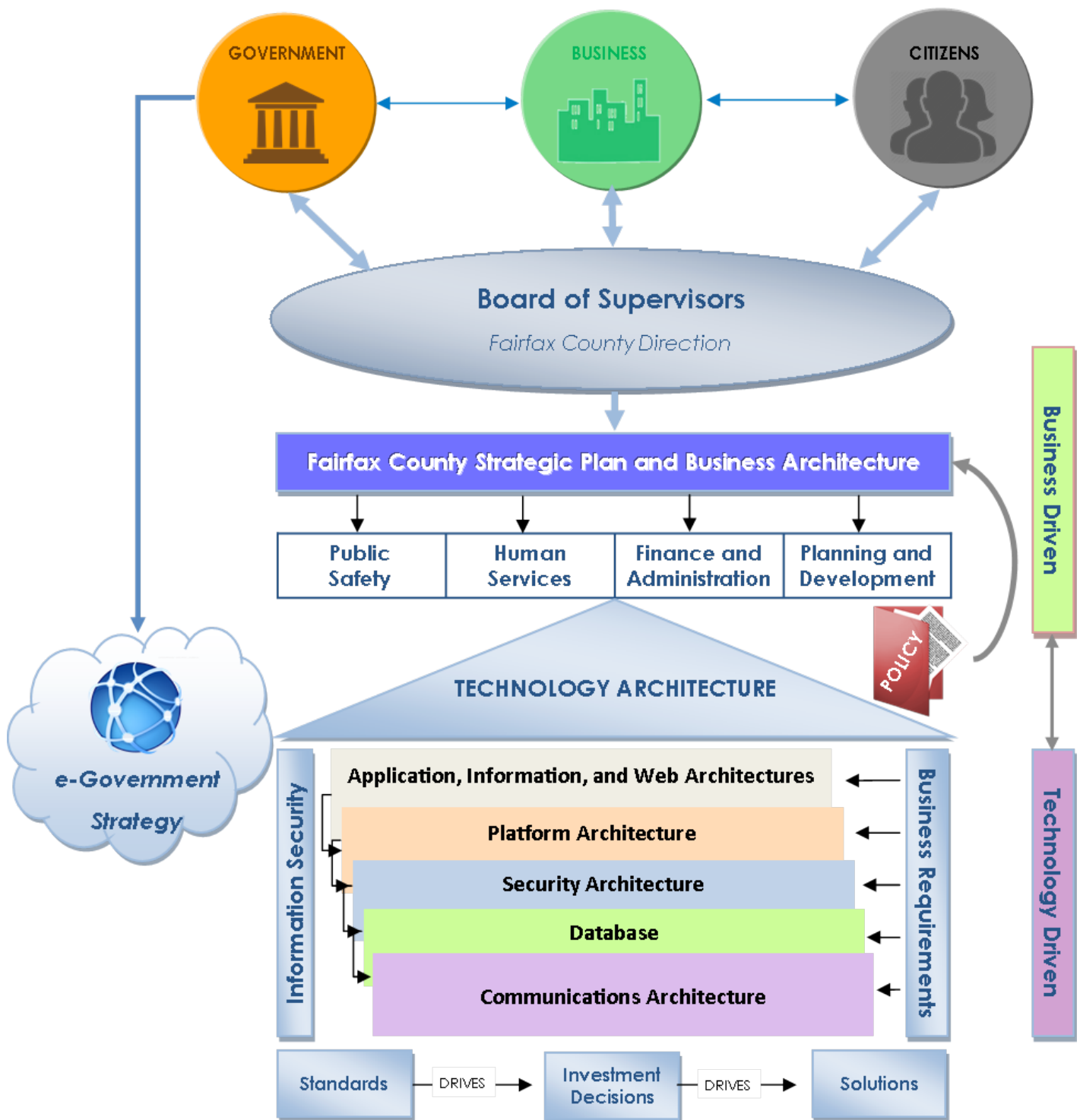
ENTERPRISE ARCHITECTURE PROCESS MODEL

Fairfax County adapted Enterprise Architecture (EA approach) as the blue print or road map by which specific technology solutions are developed. Architecture defines the manner in which technology is used to enable flexible business solutions which enable expansion and change as requirements evolve, technology is updated, or becomes obsolete. Architecture as a foundation and road map enables the County to establish open standards, assess the impact of new requirements and evolving technologies, and allow for the incorporation of new technologies as part of an updated blueprint that benefits other solutions. Enterprise Architecture improves the efficiency and effectiveness of technology investments by reducing functional and infrastructure redundancy, leveraging solutions and platforms, optimizing value, and promoting the sharing of knowledge and best practices across County government.

The Enterprise IT Architecture Process Model on the following page illustrates the inter-relationships between the County's IT architecture and business, and the iterative processes involved to ensure the development of an IT enterprise that is efficient, cost-effective, responsive and business driven. For the purposes of the County's model, the businesses have been grouped into four major functional areas as represented in the County's budget: Health and Human Services (HS), Public Safety (PS), Planning and Development (PD), and Finance & Revenue (F&R), inclusive of over 50 departments and agencies representing hundreds of unique and often times cross-agency services.

The model supports the following Mission Statement that directs the County's information technology activities, which remains valid. Every IT effort undertaken is framed and aligned with this mission statement:

"Delivery of quality and innovative information technology solutions for agencies and those doing business with Fairfax County Government."



5.2 APPLICATION AND DATA ARCHITECTURE

Application architecture defines the design of and correlations among software programs and applications. The Architecture promotes common development and presentation standards, enables optimum system integration, provides opportunities for use of shared infrastructure environments, servers, storage and related tools, enables shared use of data, facilitates the reuse of components, and the rapid deployment of applications in response to changing business requirements. Cloud-native, software defined infrastructure, containerized applications, and continuous integration (CI)/continuous deployment (CD) based DevOps which provides new innovative opportunities for Application and Data Architecture are being implemented to support the County's goal of delivering timely, efficient and cost-effective services. The migration of enterprise-wide and agency specific applications, such as intranet portal and business processing/workflows are underway from on-premise infrastructure environments to efficient, geo-redundant, high availability and resilient cloud services. New applications and application enhancements are constantly evaluated, developed or acquired, and applied as older "legacy" applications retire, and as business organizations and related functions reorganize and/or have new needs.

For custom development efforts (when there are no commercial or open source applications that are appropriate for County business processes) our goal is to use industry standard application development tools that are adaptive in web-enabled and mobile. For commercial software solutions, the goal is to implement solutions developed using industry standards and avoid propriety software architecture to the extent possible; proprietary software is used only as a last resort. The application architecture also protects the County's investment in 'classic' systems by enabling enhancements for enhanced usability, improved use of information and data analytics, search and reporting and end user controls. In addition, by keeping abreast of emerging technologies the County positions itself to take advantage of emerging opportunities offered by these as well as SaaS, mobile and cloud technologies.

As the County balances determination among Commercial-Off-The-Shelf (COTS), in-house development and cloud/software subscription services for the diverse portfolio of agencies' business systems, the DIT framework for application development is applied. The framework incorporates Software Engineering, Information Architecture, and Application Development Lifecycle Management (ALM). They are used to keep the development life cycle standards current with an emphasis on customer satisfaction, agile response, iterative improvements, and operation excellence by using the principals and tools of DevOps. The resulting approach encompasses application life cycles for "cradle to grave"; that is, from the earliest stages of planning, through requirements and design, to implementation and post-implementation support, and continuous improvements. New applications will be built on the most supportable and stable platforms and an open architectural framework based on the IT's best practices, cloud-native infrastructure, open-source toolchains, and open industrial standards.

DevOps with Continuous Integration(CI)/Continuous Deployment (CD)/Continuous Security (CS) – Fairfax County's Application Lifecycle Management (ALM) is built on top of Azure DevOps Servers with version controls, code review workflows/ pull requests, requirement/bug/issue tracking, program management tools. The CI/CD/CS pipelines automatically build, test, deploy and secure application dependencies and resources while increasing the productivities, reducing integration errors, improve quality and agility from development to the end user. For any single line of code, it will be built by the build agent in a controlled secure environment, run through the standard set of tests and customized unit/integration tests, secured by role-based access control and network security policies, and deployed to the development, acceptance and staging environment for user testing. The dashboard shows the team's work backlogs, velocity to address the issues, and Kanban boards to manage

priorities and distribute loads among team members. Every change to the infrastructure and applications is documented, version controlled, peer reviewed, approved by CM, and deployed in a repeatable fashion. The application and its dependency are managed via containerization and build automatically as part of the CI/CD pipelines with the latest software updates and security patches. This ensures the long-term supportability and stability of the application as it evolves independently of its hosting/cloud environments. Software-based infrastructure and container-based application change management are critical to cloud-native application development and depend on mature, sound software engineering and change management processes for rapid responses to changing business needs and system loads.

Next Generation Web Farms on Kubernetes Clusters – Fairfax County is implementing next generation web server farms on Kubernetes clusters. Kubernetes is a powerful open-source system for running and orchestrating containerized applications across a cluster of machines. Instead of managing and caring individual web servers and applications, Kubernetes provides a standardized way to manage and coordinate applications for services while providing runtime abstractions and protections. It provides an easy way to spread the workload among geo-redundant, load-balanced, high available clusters while maintaining the underlying scheduling, patches, states, storage, and security policies. It allows several new use scenarios such as AB Testing, Canary Deployment, and seamless deployment with a high 24x7 service level.

Open and Service based Architecture – Development platforms such as cross platform .Net Core, open-source frameworks, toolchains, JSON standards are a key part of the strategy. The .Net platform provides the foundation for departmental and enterprise-wide applications and offers a stable application environment with more opportunity for componentization of business logic, sharing of common components, and the integration of business processes across application boundaries. Tools such as Visual Studio provides County developers with a robust and flexible development environment. Encapsulating both existing and new business logic into “services” provide the ability to expose business processes across organizational and application boundaries, within the County, other local jurisdictions, state, and federal government, as well as business partners.

Geographical Information System Applications (GIS) – The ArcGIS software suite provides high-end Geospatial technology, GIS tools, functionality, and presentation capability to the GIS user community. The software integrates visual or graphic data in the form of maps, with descriptive or attribute information from an organization’s internal databases. ArcGIS provides the tools for analysts to gain access, visualize, and query both graphic and tabular data for better analysis and decision-making. There are multiple levels of GIS software usage within the County. At a high level, there are both web-based GIS tools including (ArcGIS Online, ArcGIS Enterprise and Geocortex) as well as desktop software such as ArcGIS Desktop and ArcGIS Pro. ArcGIS Enterprise is a fundamental component of the County GIS that provides web map and feature data services that are used by all platforms consuming GIS data. There are three levels of licensing available of the desktop GIS software for both ArcGIS Desktop and ArcGIS Pro. The highest level, Advanced, is used by professional GIS analysts for sophisticated analysis and processes as well as multi-user editing. The standard level is used almost exclusively by data editors and publishers for maintaining enterprise wide GIS data sets. The Basic level is used by most users for creating maps and simple analysis of the County’s geographic data sets. ArcGIS Pro is the newest desktop GIS software from ESRI and will replace ArcGIS Desktop completely by 2022.

ArcGIS Online, and ArcGIS Enterprise (portal for ArcGIS, ArcGIS Server) are platforms used to distribute highly customized GIS based applications through the Internet/Intranet. Additionally, Geocortex is used for publishing medium to advanced level web-based GIS applications. Internet based mapping capabilities are incorporated as appropriate for augmenting and delivering County services. Web maps and web mapping services are also integrated into business specific applications for public and

internal government access via the WEB. The County also uses Terra Explorer to serve out 3D data to both internal and external customers. See Section 2 for more information about GIS strategy.

5.2.1 THE APPLICATION TOOLS

Application tools are information technology components used to develop and support application functions. Application tools include the support systems required to enable work planning and communications.

Programming/Development Tools – New applications under development use programming languages and tools following industry recommended standards. This approach continues as web-based applications are developed, or as Commercial-Off-The-Shelf (COTS) systems or Cloud and SaaS applications are implemented. Industry standard application life-cycle methodologies are employed to define, develop and implement new systems. Expert system technology is used to incorporate complex rule based functionality into systems. New developments use full stack Microsoft technology, and/or open-source frameworks, toolchains, and cloud infrastructure, including .NET framework, ASP.NET, .NET core, MVC and related technologies. Visual Studio Code and Live Share are used for code level collaboration and container development. Pull request and code review workflows are used to ensure the high quality of code merged into the project codebase. JAVA is used depending on a specific systems' architecture and anticipated integration with other systems that use JAVA. SAP ABAP is the development language for the County's ERP system.

Since often there are no viable COTS or SaaS solutions available that meet County agencies' unique governmental business needs and related statutory requirements, software development remains relevant, thus application lifecycle management (ALM) and DevOps are incorporated into the development life cycle to provide a disciplined and consistent development approach.

The County also supports OpenText/LaserFische/REAMS imaging solutions that have been in place for many years for smaller image archival and retrieval needs in some agencies. The County and Courts use the Commonwealth of Virginia's capabilities for certain court case records.

Collaboration Tools – The County uses Microsoft SharePoint Online and Teams which includes instant messaging and web conferencing. Additionally, the County uses other video conferencing and web conferencing tools to support collaborative communications.

Database Management Systems (DBMS) – The County uses several database management platforms to support its business applications. Oracle and Microsoft SQL Server are the County's databases standards. Currently most of the Oracle and SQL databases on standard COTS development architectures are consolidated for greater cost efficiency, supportability and performance. The County IT standards call for complex, Internet-accessible or high access databases to use Microsoft SQL Server or Oracle, as appropriate. There are also "fat client" and web-based agency specific applications that are maintained separately by agencies. The standard for small agency applications is Microsoft SQL Server as the database.

Data Analytics and Business Intelligence – The County's portfolio currently contains several products used for reporting, analytic, and decision support. SQL Reporting Services is the preferred reporting tool for application development. PowerBI, Crystal Reports, SAS, SQL Reporting Services and MarkLogic are also currently supported tools for reporting, and basic ad-hoc query. The County utilizes Microsoft PowerBI for data analytics and KPI dashboards. Fairfax County's strategy is to provide shared enterprise capability and infrastructure for reporting, query, transparency and decision support. As standards are defined

for the County's enterprise solution(s), the portfolio will be rationalized into fewer products over time. This approach enables DIT to continue to modernize the existing systems portfolio while creating economies of scale for improved interoperability, search, dashboards and cost control.

Desktop Office Automation/Workstation Software – Microsoft's Office 365 is the standard for general productivity automation functions including Word, Excel, PowerPoint, Teams, Outlook, and SharePoint. Microsoft Chromium is the standard for Web browsing and is implemented with the standard image. Agencies may have other desktop-based software for special, unique requirements.

IT Service Desk Software – The IT Service Desk (ServiceNow) provides all County employees with a centralized portal for computer support using a web-based solution which is used to support the Service Desk function leveraging the ITIL framework. The IT Help Desk has a high percentage of first-call resolution.

The County supports over 1,000 State and other non-County Windows workstations hardware devices.

In FY 2015, the County implemented near-real time, active/passive solution for the systems in the County's DIT Data Center using a third party off-site facility.

The following paragraphs describe the major features of the County's platform architecture.

5.3 PLATFORM ARCHITECTURE

Platform architecture defines the technical components of the infrastructure including server and client platforms, middleware, operating systems and interfaces supported, as well as other software tools and equipment used to operate applications. With the County's server consolidation and virtualization effort in FY 2011, Fairfax County's platform architecture was reduced from over 1700 physical servers to 40 servers leveraging our virtualization application that is a 42:1 ratio, and the project continues. Servers include Nutanix Servers, UNIX (Sun Solaris) and Microsoft Cloud based servers. We are currently upgrading all Microsoft Windows Servers to 2016, and 2019 versions. Over 15,000 PC's/laptops provide end-user access to County systems. iPads, iPhones, Androids, and other mobile devices also support employee access to agency business systems. Workstations are standardized using Windows 10 operating systems.

5.3.1 PLATFORMS

LAN-based Network Servers – Fairfax County's enterprise server environment uses Intel and Unix-based servers. Enterprise-class server technology Cisco blade technology, Dell, SUN and HP-UX servers for robust, high availability applications support the County's enterprise infrastructure applications such as Exchange, Active Directory, SQL, Oracle, Zscaler, and Citrix, and major business systems such as ERP, GIS, Tax systems, Public Safety, Health and Human Services systems, Land Development and Public Works applications, Library, etc.

Desktop PCs, Workstations and Peripherals – DIT prescribes hardware platforms and desktop applications standards as well as procurement vehicles to optimize support and cost. Workstations (PCs) are replaced in accordance with the County's five year PC Replacement Program cycle using adopted standards bundled with the MS Office Suite. The PC Replacement strategy applies to all agencies and provides the County economies of scale as well as a more robust, effective support environment.

County PCs are used for office productivity software, enterprise e-mail and client software, Internet/Web access software. The Windows 8.1 OS transitioned to Windows 10 in FY 2020, and Windows Mobile, iPads, and Androids continue to be deployed based on business needs. Desktop and network printing is accomplished primarily through the County's enterprise multi-function copier/printer/scan/fax machine fleet. Agencies also use stand-alone desktop or work-group printers, and special use machines, i.e., plotters, etc.

5.3.2 STORAGE AREA NETWORK

A critical and required element of County IT operations is the management and storage of County data. Storage management provides capacity, timely access, and protection for the County's most important asset, its records and information. Storage management is also one of the most challenging aspects of IT operations. For each new day, County users and County agencies have data that is multiplying at an astronomical rate. Most County data is stored and backed up electronically. This may include customer and agency data, partner data, financial records, analytics, and more. Critical data must be protected and recoverable if it becomes inaccessible to the users. Each Fairfax County government end user needs to protect data and information, it is therefore, imperative that end users remain mindful of the location of their data for better support.

DIT is focused on delivering a multi-level storage infrastructure, based on a low-cost foundation, which provides a set of storage solutions for the most common needs across the County's computing environment. These are areas where a central service can provide the maximum benefit for the least cost, leveraging economies of scale.

These storage solutions are available within a range of pricing, security, reliability, and availability that can be matched to the requirements of the data being stored. DIT's Storage Management Service provides Fairfax County with a centralized and secured storage platform to retain and store County data. It is DIT's mission to ensure Storage Area Network (SAN) service is scalable, redundant and cost effective.

Fairfax County implemented its first Storage Area Network (SAN) in 2002. This enabled data storage in a centralized location, with redundancy and failover, mitigating the risk of data loss due to hardware failure. Data from all servers (mainframe, UNIX, and INTEL) now coexist on the same disk subsystem. In 2006, the County refreshed the enterprise disk arrays and fabric with EMC DMX-3 disks and Cisco fabric, which has since then been retired. As a replacement for these retired storage infrastructure components, the County implemented NetApp and IBM XIV storage systems, which positions the County for future growth and the ability to meet strategic initiatives for Data Lifecycle Management. The total data storage requirement has grown from 394 gigabytes in 1998 to the current total of over 3.4 petabytes. The primary storage environments are NetApps and IBM XIV.

Storage Management requirements addressed by the Storage Area Network (SAN) are:

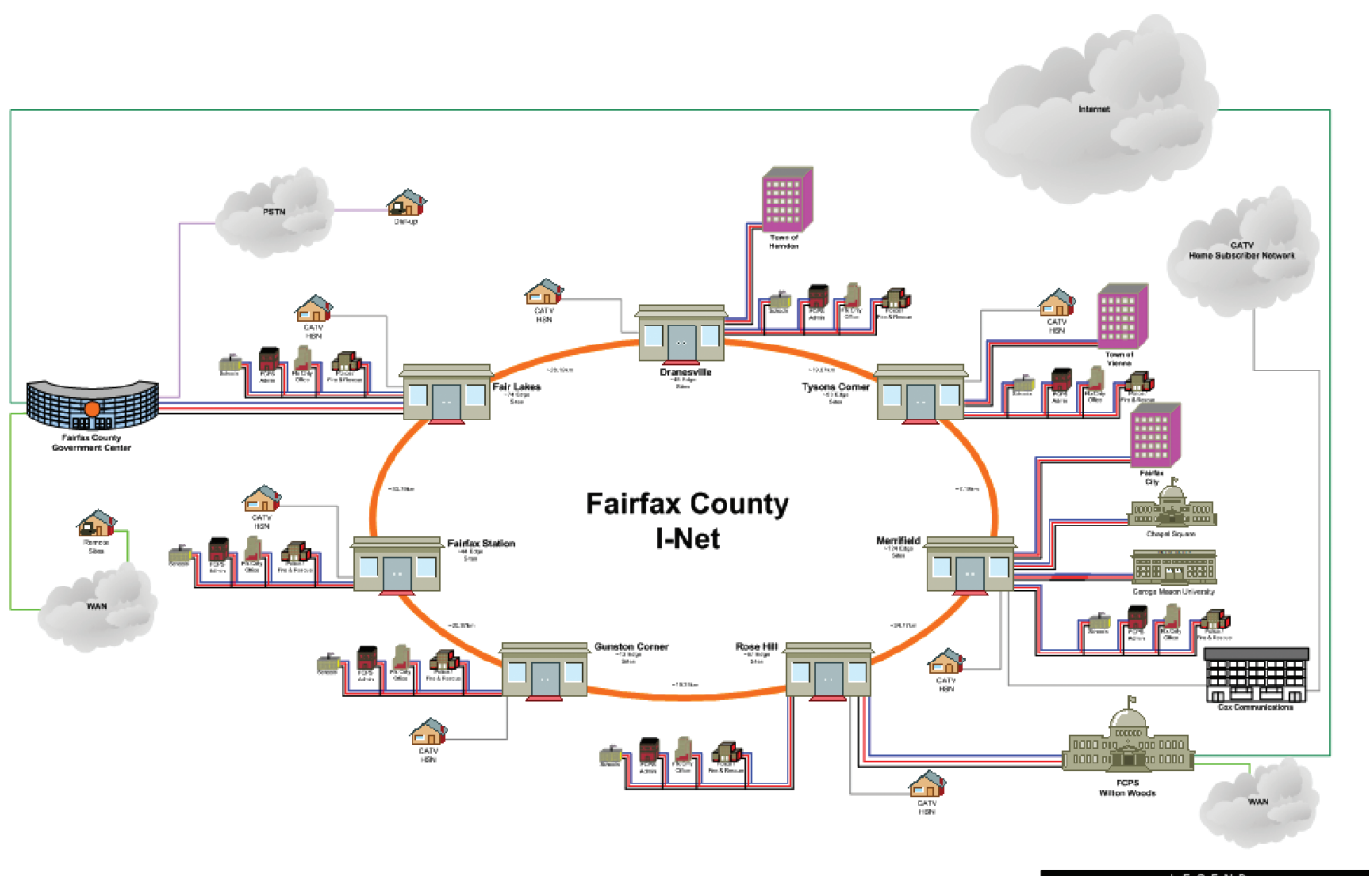
- Scalable storage capacity that allows users to increase storage as needed.
- Modular, adaptive architectures which allow users to deploy storage in a variety of centralized and distributed environments with re-deployment capabilities as needed.
- Highly available architectures to minimize/prevent downtime.
- The storage solutions provide a range of cost savings. Using NetApps for virtualization standard storage platform is cost effective because of built-in features such as de-duplication, which help to control the storage needed for the County's growing server requirements.

- The new XIV storage provides the high volume input/output operations required by the County's high volume database and email systems.
- Higher levels of performance to support the ever-growing volume of online data.
- Higher performance backup and restore operations using snapshot technology.
- The ability to share data across the enterprise rather than building "islands of data."
- Easy to use, centralized management tools that allow hardware and data to be distributed.

5.4 NETWORK ARCHITECTURE

The County views a strong, viable communications infrastructure as a vital to the overall IT strategy of maintaining its successful deployment of cost-effective solutions that optimize business goals. The County's enterprise network architecture is built upon its' dedicated fiber optic infrastructure coupled with various carrier provider services to enable secure, reliable, and robust communications throughout the County's enterprise data network.

The overall architecture of this network is complex but designed to be agile in providing secure, responsive, reliable and cost-effective carrier class services of voice, video, and data while meeting the business and technology requirements of the 53 county agencies, multiple public safety groups, neighboring jurisdictions and the visitors of the public.



Fairfax County I-Net Map

5.4.1 INSTITUTIONAL NETWORK (I-NET)

The County's I-Net is a "super highway" of dedicated fiber optic infrastructure serving as the foundation of the County's enterprise network providing the "on ramps" to the 400+ Fairfax County Government and Public Schools locations. The I-Net was originally provided and continues to be maintained through the Cable Franchise Agreements. The I-Net is comprised of over 4,000 km of Single Mode Fiber (SMF), in a ring, hub and spoke topology. This private fiber optic infrastructure enables the enterprise network to virtually scale "unlimited" bandwidth provisioning as demand continues for higher speed data for services such as Voice over IP (VoIP), broadcast video, video conferencing, streaming video, collaboration and distance learning. Fairfax County's I-Net is one of the largest and most complex private local government network infrastructures in operation.

The fiber optic plant is digitally documented within a geographical cable plant documentation system with real-time monitoring and alerting. This system enables the County to track the fiber assets that are in use and those that are available for onboarding new locations at lower costs. In addition, the system provides immediate insight to the health of the fiber and in the event of a damage it alerts staff with near precise GPS location coordinate of the damage by which increases the mean time for repair.

Although broadband service is available through telecommunication companies, these come at a monthly recurring cost, provider network dependency as well as loss of flexibility and insight. The virtually "unlimited" bandwidth capabilities provided by the I-Net allows the County to amortize its cost over the life of the I-Net with an overall long-term operating cost savings.

5.4.2 ENTERPRISE DATA COMMUNICATIONS NETWORK

Fairfax County's Enterprise Data Communications Network is the communications backbone providing county-wide access to the Internet and County resources. Internet services are provided from 3 ISPs utilizing 4 redundant high-speed connections strategically homed at 3 diverse County key resource locations. All systems connected on the enterprise network are monitored 24x7x365 with alerting and are based on well-recognized, open standards; compliance with published standards is required for any network-connected device or system.

The wired LAN backbones are gigabit delivering 100Mbps to the interconnected 14,000+ County managed devices. (PCs, servers, multi-function printer/scanner/copier device fleet, the mainframe and wireless access points). In addition, LAN services include secure public network access at various County locations such as libraries and recreational centers for visiting citizens to access Internet resources.

The wireless LAN (WLAN) is available in most County buildings serving Wi-Fi public access to visitors and secure access to County staff. The larger facilities have been upgraded from 802.11n to 802.11ac. As other facilities' equipment ages they will be outfitted with 802.11ac or possibly even 802.11ax (Wifi-6).

The Wide Area Network (WAN) is delivered via carrier provider services at locations without County I-Net fiber. The WAN services provided at these locations are either high-speed broadband layered with secure VPN technology or Transparent LAN Services (TLS).

The Metropolitan Area Network (MAN) is also referred to as the I-Net. The network core of the I-Net consists of 7 hub sites networked via a resilient 10 gigabit DWDM mesh backbone. Each of the 200+ locations outfitted with fiber are provided

1GB WAN links utilizing MPLS (Multiprotocol Label Switching)/VRF (VPN Routing & Forwarding) enabling secure prioritized communications of multiple logical networks (enterprise, public access, public safety, or voice over IP).

5.4.3 MOBILE DATA NETWORK

To support operations of the various public safety agencies, the County is transitioning from Commercial Wireless Broadband service to FirstNet, the First Responder Nationwide Public Safety Broadband network that has a dedicated secure core and provides priority and preemption service for public safety; providing for high availability and additional spectrum to support public safety. Use of mobile data provided by AT&T and Verizon Commercial Wireless Broadband service was implemented in 2007 to allow the response vehicles of the Police, Fire and Rescue, and Sheriff's departments to access the County's Computer-Aided Dispatch (CAD) system, the Law Enforcement Incident Management system, and various databases maintained by the Commonwealth of Virginia and Federal law enforcement. This Public Safety system consists of more than 1500 Mobile Computer Terminals (MCTs). Both commercial carriers are used to support a growing portfolio of mobile applications including Public Works and Environmental Services, Zoning, Health Department, and various Human Services agencies consisting of a user base of over 1,000 mobile devices.

To enhance the County's goals for mobility, telework, operational cost efficiency, Continuity of Operations Planning, and environmental stewardship 'green' IT, a major component of the enterprise technology infrastructure includes Enterprise Mobile Device Management (MDM) has been incorporated into the enterprise network and platform infrastructure. MDM allows use of smart-phones, and tablets including Apple and Android (for example). Given the County's mature 'private' enterprise cloud, this technology was adopted and integrated with the enterprise network. Air Watch is utilized for the Mobile Device Management (MDM) architecture, however efforts are in process to transition to Microsoft Intune as the principle MDM solution for the County.

5.4.4 I-NET VIDEO NETWORK

The I-Net Video Network is a private scalable integrated radio frequency (RF) video transport system which provides a high quality image delivery system with scalable bandwidth, capacity, and growth potential for future Fairfax County Government and Fairfax County Public School broadcast television needs. The I-Net video network transport has two distinct communication links: Coarse Wave Division Multiplexing (CWDM) is the transport technology which provides forward and reverse transport for I-Net enabled County facilities. The forward (downstream) transport provides select cable TV operator channels and local origination content produced by the County's Video Production facilities for services such as distance learning. Each I-Net enabled facility is equipped to transmit reverse (upstream) video to the County's Video production facility for processing.

5.4.5 VOICE COMMUNICATIONS NETWORK

The County's current voice telecommunications architecture is the Avaya enterprise-wide VoIP capable platform. The solution uses the latest technology that includes VoIP/SIP and the County's fiber-optic network for connecting County facilities. Using the County's fiber backbone (I-Net) greatly reduces the total costs of providing telecommunications services. The evolution of the Avaya communications platform on a fully integrated broadband network synchronizes and leverages communications capabilities, security and will help meet the present and future IT and County agencies' business needs to complement cost

saving advantage of using the I-Net for calls between locations. Session Initiation Protocol (SIP) Trunking was initiated to further reduce the cost of the connection to the carrier network. DIT is currently in the process of upgrading the existing Avaya PBX platform to a full IP-based, converged solution. By upgrading to the Avaya PodFX solution, which is a vendor supported platform that utilizes virtual machine (VM) environments, the footprint of Avaya equipment Countywide will be significantly reduced.

DIT is in the process of transitioning from Skype for Business to Microsoft Teams (Teams). As a direct response to the COVID-19 pandemic, the vast majority of the Fairfax County workforce was transitioned nearly instantaneously to a remote workforce. As such, the PBX functionality is being added to the Teams platform. This added functionality will provide the opportunity to remove a significant amount of legacy telephone equipment from the desks of County personnel. This reduction of equipment will also reduce the overall cost of ownership and direct support for those devices. Teams provides the necessary flexibility and functionality to support a geographically decentralized workforce through the use of a secure messaging platform, video conferencing, and collaboration solution.

The voice system design will move the two main Fairfax County government sites – the Courthouse Complex and the Government Center Campus - as the “core” into the new “Pods” that are in an active-active state, thus ensuring failover that is transparent to the end user. A streamlined dialing plan has enabled more efficiency and less cost for agencies that have a geographically dispersed footprint. The Core + Edge configuration has yielded much tighter voice communication integration between locations and highly fault tolerant network. Avaya collaboration applications, such as the Call Center Elite/1X Agent application, allow agencies to have call center agents geographically dispersed across the County, yet they appear as a single work group from a citizen facing standpoint. This has been heavily utilized in the Continuity of Government during the COVID-19 pandemic where the majority of County employees are teleworking from remote locations.

The system architecture is also integrated with a new Call Management System (CMS) solution from Avaya. This solution’s capability greatly improves the collection of necessary statistics used by Contact Center Managers to evaluate the County’s responsiveness to citizens and constituents. Microsoft Teams will also be utilized as a direct replacement for some of the call centers as many of the features that are part of the Avaya solution can be transitioned to the Teams environment.

Additional efforts are being made to incorporate conference calling onto Teams. While this transition is in its early stages, a number of early successes can be tied to the response to the COVID-19 pandemic and it has been demonstrated that Teams is a viable solution for the County’s teleconferencing needs.

5.4.6 PUBLIC SERVICE AND PUBLIC SAFETY RADIO NETWORKS

The County has two 800 MHz radio systems; the Public Safety system on newer technology supporting all the public safety responder agencies and the Public Service system, a legacy 800 MHz radio system serving the general government agencies and Fairfax County Public Schools. The Public Safety Radio system was initially upgraded in FY 2014 to the new P25 digital/IP technology (this system is supported in the DIT Operating part of the E911 - Fund). Further upgrades and enhancements were made in FY 2017 and 2018 to replace the dispatch consoles in the primary and secondary Public Safety Answering Points (PSAPs) for Fairfax County and upgraded the PSAPs for Fairfax City, and the Towns of Herndon and Vienna. Additional console replacements for the Office of Emergency Management and the Sheriff’s Office were also completed. A Geographic Prime Site and Dynamic System Resiliency (DSR) enhancement was also implemented to provide an additional level of hardening and

resiliency to the public safety radio system that allows for full functionality should the main prime site fail to operate. The Public Safety system underwent two system upgrades in FY 2017 and again in FY 2018 to bring it in line with other National Capitol Regional radio systems. Plans are in place to undergo another upgrade of the Public Safety Radio System in FY 2021, which will continue to keep the radio system at the appropriate system operating level within the NCR. In FY 2021, the Public Safety Radio System will also receive an added ASTRO Stand Alone Repeater (ASR) site in the McLean area to address a historically poor radio frequency (RF) coverage area due to topography. This new site will provide better communications for public safety personnel operating in the field. The Public Service system is over 15 years old and is using proprietary technology developed in the 1990's and based on the older circuit-switched analog technology which lacks sufficient call processing capacity to meet current end user requirements, and has high maintenance costs. At the end of 2018, the manufacturer (Motorola) declared it would no longer support it, thus the system must be decommissioned as it can no longer be reliable for critical communications.

Currently, all but Fairfax County Public Schools and the Department of Transportation have moved their communications from the Public Service System to a commercially available Push-To-Talk (PTT) platform. In FY 2021 the Department of Transportation is migrating to a VoIP communications platform for the transit bus fleet also agencies have made plans to transition to Push-to-Talk; during this period interoperable communications will be maintained using Radio over Internet Protocol (RoIP) and Inter Sub-System Interface (ISSI). Once the transitions are finalized, interoperable communications will be maintained through the ISSI connection and the Public Service system will be decommissioned. County staff also serve as the Regional Coordinator for the entire National Capitol Region's ID management program to ensure regional radio interoperability.

Fairfax County continues to leverage FirstNet capabilities and since each agency within Fairfax County has an Emergency Support Function (ESF), efforts have been made to transition PTT users over to FirstNet as Extended Primary Users. This classification allows users of FirstNet to receive the benefit of priority and preemption over the standard commercial user, thus preventing the commercial users from causing reduction in bandwidth consumption and impacting FirstNet subscribers. Public Safety agencies are working towards migrating their cellular phone users over to FirstNet.

5.4.7 NATIONAL CAPITAL REGION NETWORK (NCR-NET)

NCR-Net is a high-speed carrier class network interconnected over local jurisdiction's existing fiber optic network infrastructure delivering secure interoperable communications and resource sharing to all first responders and public safety agencies within the MFCOG jurisdictions. The County is a major participant in the NCR-Net providing five County managed and monitored interjurisdictional interconnects.

5.5 INTERNET ARCHITECTURE

Fairfax County's Internet architecture supports the County's E-Government program which utilizes emerging Web technologies to make County services and information readily accessible and available to the public, with interactive services to conduct business (e.g., pay taxes, apply for permits, etc.), and searchable access to data (real estate assessments, Human Services resources, etc.). The E-Government architecture defines the standards, guidelines, technologies, development tools, templates, and governance for public access, and requirements for conducting on-line business with county agencies, state agencies and outside entities. Recognizing mobile technology and cloud computing are key to promote digital transformation, the County's

E-Government program has taken the initiative to provide expansive mobile access and cloud-native computing platforms that enables greater interaction and service delivery.

The County's internet architecture is comprised of the following:

- **High Speed Connection to the Internet** – The County's multiple 10GB connections to the Internet provide internet access for County staff as well as outside access to the County's Web server(s) to residents, business, and others via the Internet.
- **Public Access Web Farm** – The County's Public Access Web Server farm provides internet users with a vast amount of information made available by various agencies. The Web server can be viewed as an "on-line service counter" where residents and others may obtain information related to services, licenses, taxes, recreation, court filings, etc. The Web farm acts as the distribution or collection point for information obtained from or provided to enterprise databases via "Application Servers". The Farm is designed to contain multiple web servers distributed in different locations to provide high availability, high fault tolerance, and high bandwidth throughput capabilities. The architecture is designed in such a flexible way so that the farm can easily scale out to meet constituents' needs in the event of sudden increase of web traffic. It intends to consolidate public facing web applications throughout the agencies in the County, which would eliminate the needs to set up separate servers for each web application and as a result leads to significant cost-savings. As the County becomes more digitized each day, more and more County's services and information are transformed into web applications and added to our public access web farm to serve citizens with gradual integration of more cloud resources for better performance, higher availability, and more robust services
- **Intranet Web Farm** – The County's Intranet (FairfaxNet) Web farm provides a portal to access County information and applications for agency and employee use. The Intranet Farm provides a platform allowing County employees and administrators to manage back-end data for the large number of public facing web application. The farm is integrated with Microsoft SharePoint Online cloud service for content management, page publishing, project collaboration and document management. It is the County's business processing platform for digital forms and workflows supporting many aspects of the daily operations. It also hosts a large number of web applications from various agencies and projects.
- **Mobile Application Infrastructure** – iPhone Application, iOS as well as Android versions, allows mobile users to access County's web contents and interact with various County e-services. SDK environment, application template, standards, and App Store distribution channel have been developed to further enable the County to provide m-government services. The architecture is designed in a flexible way that would enable developers from other County agencies to develop their own modules separately. These modules would later be added to the original package to ensure the app would continuously grow and improve with contributions from the entire community of developers.



- **Interfaces** – The County’s application servers and enterprise databases provide the link that allows access to data residing in a wide array of sources. The interfaces make it possible to access data from virtually all of the County databases: Oracle, SQL, and MS Access. The interfaces are comprised of “Application Program Interfaces” (APIs), Open Database Connectivity (ODBC), Service Oriented Architecture (SOA), and other standards that enable the access layer of the web architecture.

5.6 CYBER SECURITY ARCHITECTURE

The Information Security Office defines and enforces the security standards and policies necessary to protect the County’s information assets and technology infrastructure. IT Security continues to be a fundamental component of the County’s enterprise architecture and e-Government strategy. The security architecture fuses best practice security principles with a hardware and software infrastructure, supported by policies, plans, and procedures. This layered architecture is designed to provide an appropriate level of protection for all County information processing resources, regardless of platform, and includes incorporation of industry best practices to yield an overall reduction in risk.

The objectives of the information security program is to ensure confidentiality of information, integrity of data, systems and operations, technical compliance with legal mandates such as Health Insurance Portability and Accountability Act (HIPAA) and Payment Card Industry (PCI), privacy and availability of information processing resources. The information security program utilizes a multi-faceted approach to meet these objectives, an approach that includes threat reduction techniques, technology and management solutions, and the vigorous implementation of awareness activities. The basic elements of identification, authentication, authorization, access control, and monitoring of information processing activities are employed throughout the enterprise.

The Information Security program follows a Defense in Depth and slow transformation to Zero Trust approach to detect and stop threats where data moves inside and outside the network. Defense in Depth adds multiple controls, enforcement and monitoring points that creates layers of security to slow down attackers as it adds intricate defenses from the perimeter all the way to the protected resources. Zero Trust security is a practice that no user, app, device is automatically trusted even in a trusted network. These elements must pass safety checks and authentication using technologies such as Identity Access Management, Multi Factor Authentication, encryption, analytics, endpoint security and so on before gaining access to parts of the network. Users are only given specific access entitlements to effectively do their jobs, nothing more and nothing less. This approach drastically minimizes the attack surface and security risks from breaches and data exfiltration.

The County’s rising adoption and use of Cloud-based services plays another big role to securing user data as they move between untrusted to trusted networks. In this architecture, modular infrastructure building blocks are deployed to better shield important resources within the network. The Next Generation Cyber architecture was developed and deployed to divide the network perimeter into the following five business groups: E-Commerce, Internet Access, Partners, Emergency Operations, and Public Access.

The County’s modern data center is rapidly evolving and has a robust Server Virtualization infrastructure. The traditional approach to data-center network security uses strong perimeter-based defense and does not address protection inside the perimeter where server to server communications are not controlled. Lateral spread of threats is the new risk. Part of a Zero Trust model is Micro-segmentation.

We are living in unprecedented times of pandemics and natural calamities. Organizations are now forced to work remotely, with a majority of employees teleworking. Fairfax County is well prepared and positioned to securely support remote access given NextGen Security solutions implemented proactively by the Cybersecurity program. The use of Software Defined Perimeter technologies is another Zero Trust Authentication scheme for more granular enforcement based on identity, user centric access control, device inspection check approach ensures that users are only authorized to access specific subset of applications and systems in all areas of the network whether internal or external Cloud hosted Fairfax services. Remote access via secure VPN services provides access to the County's enterprise network resources for telecommuters, vendors, remote access users or business travelers, as well as several small Fairfax County offices. Security for remote access is managed through a Remote Access Server using security tokens and PIN numbers for two factor authentication. Additionally, DIT implemented a mobile device management and security solution which can address the challenges of data loss prevention and security on mobile devices, such as tablets and smartphones, which may access County data from remote networks.

The County uses identity management modules to provide a software platform of shared services that includes reduced sign-on, authentication management (to validate who you are), and entitlement management (to authorize what you are allowed to do on the site) for web-based applications. Expansion of secure identity management capabilities will continue to provide a secure access and an end-user authentication platform for internal and external users.

Intrusion Detection System (IDS) detects intrusions within the network, and the Intrusion Prevention Systems (IPS) primary function is prevention rather than detection. IPS devices can proactively prevent intrusions by detecting signs of an intrusion and/or detecting an actual intrusion attempt. IPS provides capacity to perform real-time analysis of Intrusion attempts to determine if sensitive data, systems or network devices are being attacked or if a breach of confidentiality, integrity, or availability has occurred. The primary objective of Intrusion Prevention is to reduce damage and isolate/ contain malicious traffic. With the large quantities of log and alarm data generated by firewalls and sensors, a specialized application to support the role of correlation and alerting has also been implemented. The IPS solution conducts a comprehensive threat assessment and allows for quick identification of credible threats to the organization in order to facilitate expedited response and containment of intrusions and malicious activity.

Mandates such as HIPAA and the Payment Card Industry Data Security Standard (PCI-DSS) have increased system monitoring and policy enforcement requirements. IT security awareness programs and activities have been implemented to affect a culture change for all employees. Through security conscious employees, realization of the return on investment in security technologies can be leveraged further as the overall risk to data and systems is reduced.

Fairfax County Government is dedicated to the protection of its IT assets and the data/information in its custody, as well as ensuring that no unauthorized access or use of such data/information occurs. Fairfax County currently maintains a robust vulnerability and risk management program to continuously assess and validate our organization's security posture and to ensure compliance with Federal, Commonwealth, and industry regulation and best practices. In addition, DIT has invested in advanced technologies such as Data Loss Prevention and next-generation application-layer firewalls and endpoint protection to meet the evolving threats to hosted and cloud-based applications and resources.

Fairfax County's Next Generation Security Program, a blend of cutting edge detection and prevention technologies, secure network and systems architecture, awareness outreach activities, continuous monitoring through security event correlation



and assessments has been nationally recognized by the National Association of Counties (NACo), and received the Virginia Governor's Technology Award in 2014 and the CSO50 Award for 2016. In addition, Michael Dent, the CISO of Fairfax County, won the 2015 ISE North America Executive Award for the Public Sector for the development of a County-wide comprehensive IT security risk and privacy program; he was also awarded the Cyber Security Leader of the Year by StateScoop News organization in 2019.

5.7 COMPLIANCE ARCHITECTURE

As a public entity in the Commonwealth of Virginia, Fairfax County government must comply with the provisions of the Virginia Public Records Act and other applicable statutes and regulations that govern the lifecycle, accessibility, and/or disposal of public records, produced or maintained by its departments and offices. The steady transition to managed repositories and applications with functionality that provides controls and capabilities for identifying, organizing disclosing, storing, and disposing of both record and non-record digital objects within and across lines of business supports complying the county's public-record keeping responsibilities. Current and planned investments in application integrations and tiered storage offerings will reduce duplication and costs while still enabling access to retired content and institutional knowledge as needed. Machine-learning applications will further enhance the county's ability to assess and implement needed actions across vast quantities of public records, allowing their business value and compliance requirements to inform storage, recovery, and availability needs and priorities.