SECTION 5

IT ARCHITECTURE & INFRASTRUCTURE FOUNDATION

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SECTION 5 ARCHITECTURE & INFRASTRUCTURE FOUNDATION

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

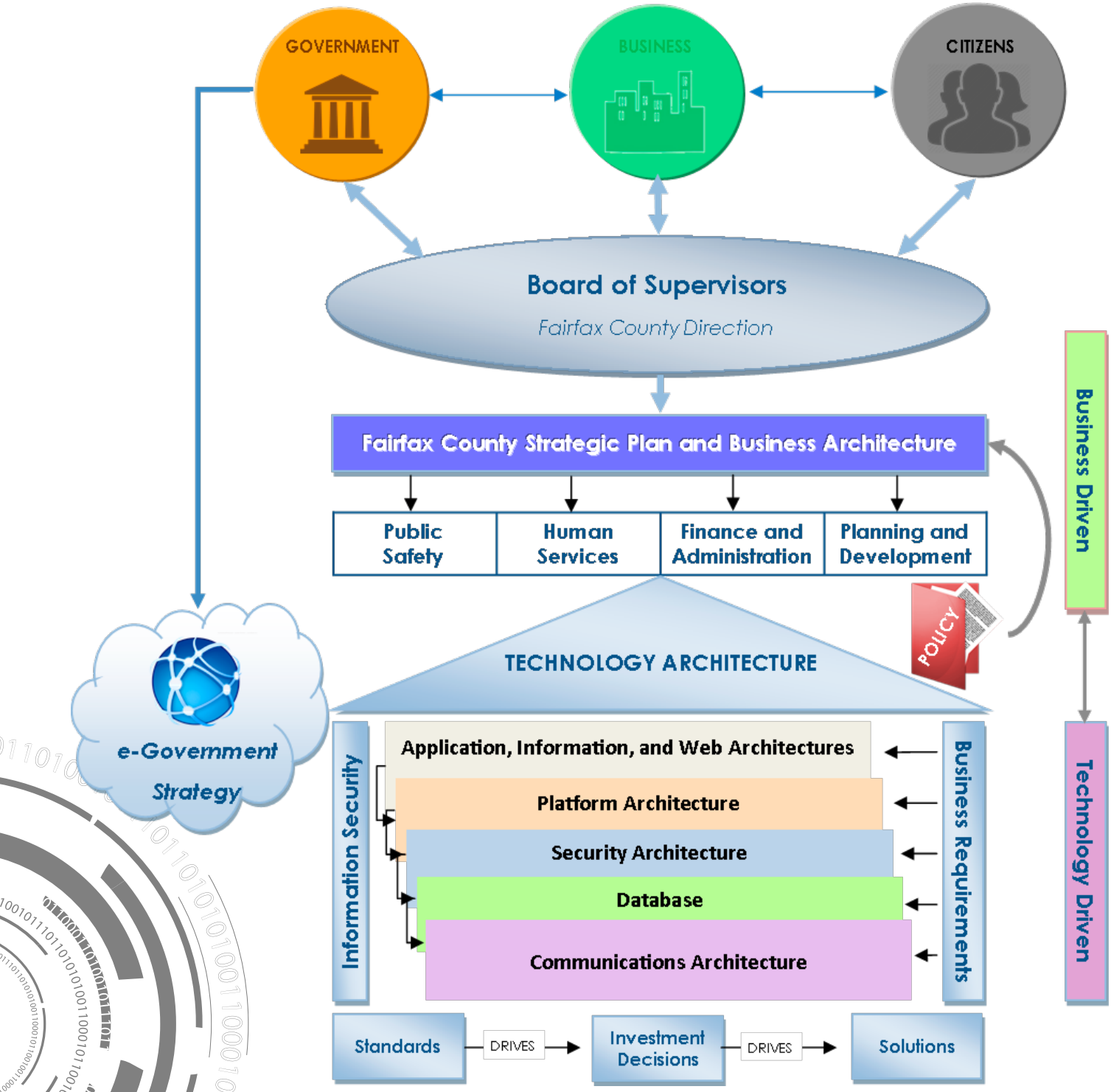
Enterprise Architecture Process Model

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: 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."*


GOVERNMENT
BUSINESS
CITIZENS
Board of Supervisors
Fairfax County Direction
Fairfax County Strategic Plan and Business Architecture
Public Safety
Human Services
Finance and Administration
Planning and Development
Business Driven
POLICY
TECHNOLOGY ARCHITECTURE
e-Government Strategy
Information Security
Application, Information, and Web Architectures
Platform Architecture
Security Architecture
Database
Communications Architecture
Business Requirements
Technology Driven
Standards
DRIVES
Investment Decisions
DRIVES
Solutions

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 (infrastructure), enables shared use of data, facilitates the reuse of components, and the rapid deployment of applications in response to changing business requirements. Application Architecture includes elements of technology architecture that converts business process to business intelligence to support the County's goal of delivering timely, efficient and cost effective services. The vast inventory of enterprise-wide and agency specific applications reside on open systems infrastructure environments including consolidated servers, 'cloud' services, desktop and/or mobile computer platforms. 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 and language environments that are adaptive in web-enabled and mobile models. 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 such as Web Services, XML, SOA and other contemporary methods, the County positions itself to take advantage of emerging opportunities offered by these as well as SaaS, mobile and cloud technologies. An exhaustive discussion is beyond the scope of this section; however, some examples of the County's application architecture and some recent developments are described here.

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 Methodology. These principles and techniques are used to keep the Systems Development Life Cycle Standards (SDLCS) current. 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 hot back-up. New applications will be built on the most supportable and promising platforms and an architectural framework based on the future of IT taking into consideration industry best practices and sustainable trends.

Development platforms such as .Net and standards such as XML and Web Services 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 .Net provide County developers with a robust and flexible development environment. Encapsulating both existing and new business logic into "Web 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. XML provides the common "glue" to hold together and provide consistent information across boundaries to facilitate data sharing among disparate platforms and systems. Enterprise Application Integration (EAI) products such as Microsoft BizTalk allow virtually unlimited ability to share, incorporate information and business processes from older, mainframe and client/server applications in to the new environment. A detailed "Architectural Framework" document has been developed, and is intended to be an organic document, flexible enough to reflect and incorporate rapid advances in information technology.

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 GIS tools (ArcGIS Online and GeoCortex) as well as desktop software such as ArcMap and ArcGIS Pro. Additionally, ArcGIS Server is a fundamental component that provides web map services that are used by all platforms serving GIS data. ArcMap has three levels of license usage for ArcGIS that the County uses. 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 view level is used by most users for creating maps and simple analysis of the County's geographic data sets. ArcGIS Pro is used by the most advanced users and offers integrated 3D capabilities to GIS software. It is the latest release of Esri's technology and will replace Arcmap completely by 2022.

ArcGIS Online, ArcGIS Portal and ArcGIS Enterprise (formerly ArcGIS Server) are components used to distribute highly customized GIS based applications through the Internet/Intranet. Additionally, GeoCortex is used for publishing medium to advanced level web 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 from Skyline, Inc. 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, including .NET framework, ASP.NET, .NET core, MVC and related technologies. The County primarily uses Microsoft BizTalk for integration of applications at the presentation, business logic, and data layers. Sometimes 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 times 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 Software Engineering technologies are incorporated into the Systems Development Life Cycle Standards (SDLCS) 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 and Skype for Business 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. Business Objects/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 E-mail and Office Suite is the standard for general productivity automation functions including Word, Excel, PowerPoint, Outlook and SharePoint. Microsoft Internet Explorer is the standard for Web browsing, and is implemented with the standard image. Microsoft Project and Visio are available via enterprise software provisioning or virtualized Citrix application delivery. Agencies may have other desktop-based software for special, unique requirements.

IT Service Desk Software – The IT Service Desk provides all County employees with a centralized portal for computer support using a web-based solution which us used to support the Service Desk function leveraging the ITIL framework. The Automatic Call Distribution (ACD) capability on the Avaya voice system is used to route calls. The IT Help Desk has a high percentage of first-call resolution.

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 1000 servers to an average target ratio of 60:1, a project that continues. Servers include UNIX (Sun Solaris) and HP UX, and Microsoft Windows /2008, 2012 R2. Over 14,000 PC's provide end-user access to County systems. Laptops, iPads, Blackberries, iPhones, Droids, and other tablets and mobile devices also support employee access to agency business systems. Workstations are standardized using Windows 8.1/Windows 10 operating systems.

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.

5.3.1 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, Citrix, and major business systems such as ERP, GIS, Tax systems, Human Services systems, Land Development and Public Works applications, Library, etc.

The County has standardized on VMWare for virtualization platform and consolidated over 800 physical servers to approximately 100 physical servers. Over 1,000 virtualized servers are run within these 100 physical servers. Virtualization in the SUN/Solaris environment in the form of zones has been implemented.

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 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, and mainframe emulation terminals. The Windows 7 OS is being transitioned to Windows 8.1 in FY 2016, and Windows Mobile, iPads, and Androids continue to be deployed based on business needs. In FY 2017 the County will start deploying Windows 10 operating system as a continuous modernization effort. Desktop and network printing is accomplished primarily through the County's enterprise Ricoh 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 backup 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 has a fundamental need to protect data and information, it is therefore, imperative that end users remain mindful of the location of their data so that DIT can better support backing up the data appropriately.

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. There are areas where a central service can provide the maximum benefit for the least cost, leveraging economies of scale.

These storage solutions should be available with ranges 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's 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 severs (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 saves the County money because of the built-in features such as de-duplication, which help to control the amount of storage needed for the counties growing server requirements.
- The new XIV storage provides the high volume input/output operations required by our 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 helps to support shrinking backup windows
- 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 component to the overall IT strategy of maintaining its successful deployment of cost-effective solutions that optimize business goals. The enterprise communications infrastructure includes voice and data technologies, as well as various network topologies, transmission services and protocols necessary to facilitate the interconnection of server platforms, intra-building and office networks (LANs), and inter-building and campus networks (WANs). The network is thus responsive and reliable for County business applications and allows for the uninterrupted flow of voice, data, and video information.

The plan and architecture take into account growth based on the needs of County agencies as programs expand for both intra and inter County connectivity. The core network for intra-County is supported

by the County's fiber I-Net, integrated with carrier lines for full coverage, back-up and redundancy for certain critical systems. The underlying infrastructure is able to support voice, data, and video, providing increased, cost-effective bandwidth potential, and improved output. The core fiber I-Net is a metropolitan fiber ring that connects over 400 County and schools facilities, with DIT supporting over 14,000 data ports and over 15,000 voice ports on the communications infrastructure.

Network technologies tend to refresh every 18-24 months, which creates additional challenges with respect to keeping network architecture and standards in line with evolving business requirements, information security and other support needs. Web-enabled applications and Internet tools such as Social Media have rapidly expanded; this coupled with business continuity have resulted in expansion from a single high capacity DS-3 for internet services to four high speed LAN based Internet connections from two diverse IPS. E-Government applications, streaming video, teleconferencing, and more integrated and complex applications drive the requirements for the County's communication infrastructure and its components, thus the communications infrastructure is flexible and designed for low-cost, incremental enhancement.

5.4.1 ENTERPRISE DATA COMMUNICATIONS NETWORK

The Fairfax County Government's Enterprise Data Communications Network serves as the data communications backbone that provides County wide access to information technology resources. All systems connected on the enterprise network are based on well-recognized, open standards; compliance with published standards is required for any network-connected device or system. The County standard network protocol is TCP/IP. Gigabit Ethernet is the standard LAN backbone speed in the County and 100 MBPS is the standard desktop speed. All platforms are interconnected via the enterprise network including PCs, servers, multi-function printer/scanner/copier device fleet, and the mainframe computer. Additionally, various wireless technologies are rapidly expanding throughout the County's network. The County currently uses commercial broadband wireless infrastructure to support wireless applications, data, images, live video to the field and mobile devices supporting primarily public safety responders. The ongoing strategy has allowed for the integration of the wireless and wire-line networks.

The Enterprise Wide Area Network (WAN) is built of two different architectures: I-Net or the Institutional Network, which utilizes the dark fiber provided to the County through the COX and Comcast Cable Franchise Agreements (see section 5.4.2 below). I-Net spans seven hub sites and two key resource centers; Massey Public Safety Campus and the Government Center. These sites are networked via a 10 gigabit DWDM fiber optic backbone. The I-Net DWDM backbone provides connectivity to 192 remote sites running a 1 Gigabit uplink from the backbone to the site. I-Net also employs MPLS (Multiprotocol Label Switching)/VRF (VPN Routing & Forwarding) to allow I-Net to service many types of diverse traffic whether it is enterprise, public access, public safety, or voice over IP. Through MPLS/VRF each type of traffic can be separated logically for security support, as in enterprise vs. public access, or prioritized in the case of voice traffic. Currently MPLS technology has allowed the County to support 20+ logical networks to flow across the I-Net backbone. I-Net has now positioned the County Data Communications Network to

respond quickly to the ever-changing technology needs of its customers. The remaining WAN sites are supported by the use of several technologies to include High-speed broadband VPN technology, ATM, and Transparent LAN Services based on user group and bandwidth needs.

A dedicated Public Access Network was established in FY 2005. This network provides public access computers a various County locations to citizens of Fairfax County for access to County and Internet resources separate from the government Enterprise Network for security reasons. The Public Access Network includes all public libraries, community and recreation services sites, and select human services sites. The design provides for separate physical networks at each site while sharing the existing WAN/I-Net infrastructure and using logical separation on the WAN/I-Net. A firewall between the Enterprise Network and Public Access Network allows for County IT staff to manage the infrastructure down to the desktop for each site. This model will be the standard for any new facilities requiring both enterprise and public access.

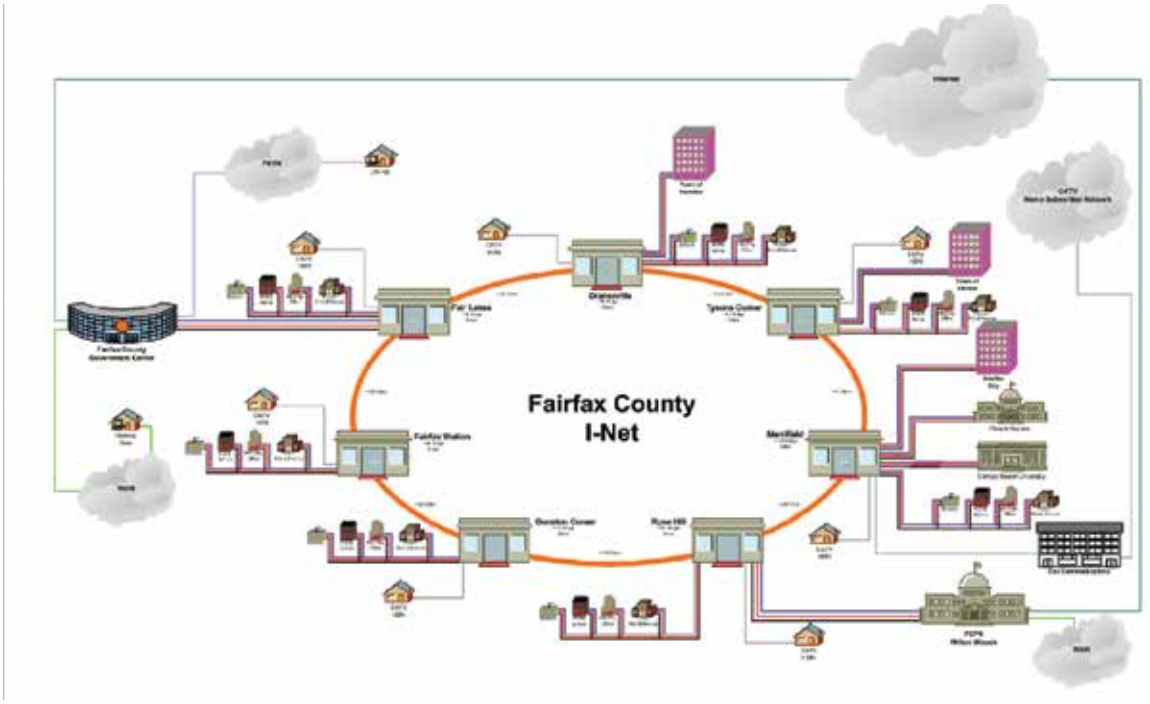
The County continues to implement wireless LANs and wireless data over commercial systems as required by business and operational requirements. The use of this technology is carefully evaluated to ensure all County data is protected from unauthorized access. Currently, non-broadcast SSID's, NAT and MAC address registration, and digital certificates are required to gain access to the private WLAN. VPN technology is employed to protect data over commercial services.

Network Management is supported on four platforms using Orion Solarwinds – Moniters I-Net infrastructure for up/down alerting and performance issues, and Verizon Managed Services – provides fault reporting of all ATM and I-Net sites. Fairfax County continues to migrate legacy carrier circuits to COX and other providers which provides better quality and cost.

5.4.2 INSTITUTIONAL NETWORK (I-NET)

The County's network backbone (I-Net) is the primary infrastructure interconnecting sites for the enterprise communications network, supporting both the County government and Fairfax County public schools. The I-Net was provided through the Cable Franchise Agreements with COX Communications-Northern Virginia and Comcast of Virginia. Fairfax County's I-Net is one of the largest and most complex local government networks in operation. This carrier-class network comprised of over 4,000 km of single mode fiber (SMF), in a ring, hub and spoke topology. There are seven Hub sites that are redundantly connected in a ring. The fiber optic infrastructure enables the County enhanced capabilities for transporting data, voice and video. The I-Net provides services such as high speed data, Voice over IP (VoIP), broadcast video, video conferencing, streaming video, and distance learning. The network has several origination points, and facilities for controlling the switching and routing of data, voice and video signals among all participating sites.

Although broadband service is available through local telecommunication companies, it comes at a significant price, a loss of flexibility, and for some services, only limited availability. The I-Net provides



Fairfax County I-Net Map

bandwidth that is virtually "unlimited" while meeting the County's present and future communication requirements. The I-Net is the "super highway" for the County's internal video, voice and data communications. The virtually "unlimited" bandwidth potential 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. The ultimate goal of converged voice, data and video technologies will be facilitated through I-Net. The I-Net can also serve as the back-haul for the County's wireless broadband initiative for public safety (See section 5.4.3).

The I-Net Video Network is a scalable integrated 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 applications. The I-Net video network transport has two distinct communication links: Coarse Wave Division Multiplexing (CWDM) is the transport technology that 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.

The County participates in the I-Interconnect in the National Capital Region (NCR-Net). Fairfax County has five direct interconnect. NCRnet is a foundational; interoperable communications infrastructure utility for local government first responders and emergency support functions with neighboring jurisdictions and Fairfax County DIT manages the NCRnet program, engineering and operations for the region.

5.4.3 MOBILE DATA NETWORK

To support operations of the various public safety agencies, the County will be transitioning Commercial Wireless Broadband service to the First Responder Nationwide Public Safety Broadband network, FirstNet with a dedicated secure core and priority and preemption service for public safety to improve mobile data activated AT&T and Verizon Commercial Wireless Broadband service 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 (MCT). Both 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 and 'green' IT, a major component of the enterprise technology infrastructure includes Enterprise mobile device management (MDM) that has been incorporated into the enterprise network and platform enabling infrastructure. MDM allows the usage of smart-phones, and tablets to include Apple, and Android (for example). With the County having a mature 'private' enterprise cloud, this technology has been adopted and integrated with the enterprise network. Air Watch is being utilized for the Mobile Device Management (MDM) architecture.

5.4.4 VOICE COMMUNICATIONS NETWORK

The County's 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. DIT implemented Session Initiation Protocol (SIP) Trunking to further reduce the cost of the connection to the carrier network. DIT is implementing Skype for Business as a flexible, secure and very cost effective alternative to the Avaya enterprise platform. The Avaya system will be converted to (SIP) offering an end-to-end IP based broadband communications environment and eliminating the need for hardware on site.

The voice system design will move the two main Fairfax County government sites – the Massey Campus and the Government Center Campus - as the "core" into the County's virtual server environment at the Government Center Campus and at the disaster recovery site adding higher availability outside the county. 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 also a highly fault tolerant network. Avaya collaboration applications, such as the Call Center Elite 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.

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.

5.4.5 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. 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 is lacking in 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 as reliable for critical communications. This project is to provide redundancy to improve the reliability and disaster recovery capabilities of Public Safety system, and retire the legacy Public Service system.

Currently, all but Fairfax County Public Schools, Solid Waste and the Department of Transportation have moved their communications over to a commercially available Push-To-Talk (PTT) platform from the Public Service system. Plans have been made by each agency to facilitate the transition to Push-To-Talk. While the transitions are taking place, interoperable communications have still been maintained through the use of Radio over Internet Protocol (RoIP) and Inter Sub-System Interface (ISSI). Once the transitions have been finalized, interoperable communications will be maintained through the ISSI connection and the Public Service system will be decommissioned.

County staff also serves as Regional Coordinator for the entire National Capitol Region's assure regional radio interoperability.

Fairfax County continues to leverage FirstNet capabilities and since each agency within Fairfax County has an Emergency Service Function (ESF), efforts have been made to transition PTT users over to FirstNet as Extended Primary Users. This classification allows for the 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 have currently been working towards migrating their cellular phone users over to FirstNet.

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, technologies and guidelines for public access, and requirements for conducting on-line business with County agencies, state agencies and outside entities. To meet the demand of changing times, recognizing mobile technology is key to communications; the County's e-Government program has taken the initiative (m-Government) to provide mobile access that enables greater interaction and service delivery such as mobile device-compatible web access and applications.

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

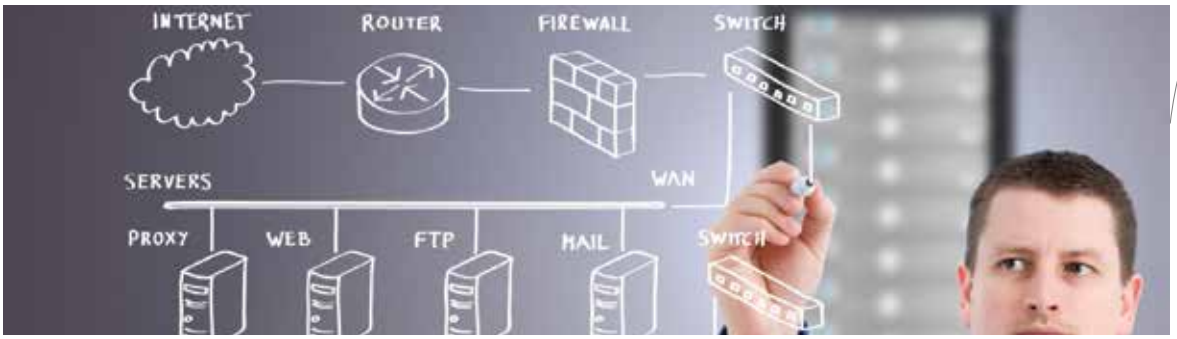
- **High Speed Connection to the Internet** – The County's fractional DS-3 connections to the Internet provide internet access for County staff as well as outside access to the County's Web server(s) to residents, business, and others via the Internet.
- **Public Access Web Farm** – The County's Public Access Web Server 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.

- **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. Integrated with a SharePoint web farm, it also provides a platform for County employees to collaborate on documents and projects electronically.

- **Mobile Web Farm** – The Mobile Web Farm provides mobile phone users with information made available by County agencies via Web Content Management systems in a mobile device-friendly format, thus allowing citizens to obtain information and conduct e-service transaction via mobile devices. The mobile web farm also enables County developers to continuously develop more web-based mobile applications to transition the County from 'e'-government to 'm'-government. The Mobile Farm is built on top of Public Access Web Farm, therefore retains the same capabilities of high availability, high fault tolerance, and high bandwidth throughput. The Mobile Farm not only enables citizens to view the County's website on their mobile phone web browsers, but also delivers contents to County's native mobile applications including County's iPhone native application published in AppStore, and Android native application published in Google Play. The architecture of the Mobile Farm is designed in such a flexible way that allows the farm to keep up with the ever growing numbers and varieties of mobile devices constantly released into the market, and as a result always ensure the contents is rendered properly for various mobile devices.

- **iPhone Application Infrastructure** – iPhone Application, for release into Apple's App Stores, allows iPhone users to access County's web contents and interact with various County e-services. SDK environment, iPhone 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 are to ensure confidentiality of information, integrity of data, systems and operations, technical compliance with legal mandates such as HIPAA and 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 secure network architecture is best described as a defense-in-depth approach to network security design, to include a method of secure network segmentation. In this architecture, modular infrastructure building blocks are deployed to better shield important resources within the network.

The "SAFE" network 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. Each group is protected by its own physical firewall, with firewall policies tailored to each specific business area. This strategy has optimized firewall performance and limited risk exposure to each business group.

- The E-Commerce business group supports all public facing web services providing access to County resources for both citizen and business.
- The Internet business group is used to control County employee access to the internet and allow for content and virus scanning.
- The Partners business group allows for connections to external "Trusted Partners" to include Fairfax County Public Schools, Fairfax County Water Authority, Commonwealth of Virginia (State Police, State Health, Department of Social Services, Supreme Court of Virginia, Department of Juvenile Justice, and State Board of Elections) as well as public safety connections for several adjoining jurisdictions.
- The Emergency Operations group was established to secure the Emergency Operations Center providing IT resources to the Department of Emergency Operations.
- The Public Access network was built for the Libraries and Community and Recreation Services.

Remote access via VPN and Citrix 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. 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.

Firewall technology is used as the main perimeter defense with all access from the Internet routed through the County's system of firewalls. In addition, the County configures broad network traffic filtering and selective routing at firewalls provisioned nearest to the County's Internet peering points, reserving more granular filtering and routing for network traffic transiting to the internal network connection. Classic authentication for each internal user is based upon a unique UserID (also called a sign-or log-on) combined with a unique, strong password. To improve the secure access and authentication to web-based applications and backend servers, the County has implemented an identity management platform that positions DIT to leverage the security architecture framework well into the future. 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. The products also provide a secure reverse proxy solution that passes requests to enterprise backend content servers, and returns resources to the requesting client, thus allowing for a practical solution for the protection of internal assets. With Identity Management in place, the County can manage user profiles for both internal staff and public access, making personalized e-Government a reality. Expansion of secure identity management capabilities will continue in order 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 lag 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.

As the key aspect of the IT Security strategy, the County employs a private/public network model. Sensitive and critical assets are located on the private portion(s) of the network while information and services available for public use are located on the public segment(s). CITRIX, VPN, Web Access and other remote access technologies are available for remote users. Each of these services requires a personal

security token and LDAP-based authentication for access, otherwise known as two-factor authentication. Remote access is approved at the same level as if the user were physically at their work site. Identification and authentication, access control, and auditing functions are performed on the specific platforms using the capabilities inherent in the appropriate operating system. 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 activities have been implemented to effect 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.

The Fairfax County Government is dedicated to the protection of its IT assets and the data/information in its charge, 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 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.

5.7 Technical Architecture Standards

The Department of Information Technology establishes, updates, and retires technical standards throughout the year to ensure alignment, consistency, and modernization in the selection and design of business solutions across the County.

A platform is established as a standard through a governance process. This approach enables DIT to define and develop a portfolio of technology solutions that can be effectively managed and supported given available resources. Typically, projects in the concept stage come before DIT's **Architectural Review Board (ARB)** to discuss the technical approach and business objectives. Where the concept relies on new products or non-standard configurations, the details are assessed to establish general conformity to enterprise objectives. The ARB may steer the solution back to conformance, or it may authorize the use of a new product or configuration by granting a waiver. The ARB may alternatively recommend that the new product replace an existing standard, or that it be added to the list of supported standards. When DIT's executive management approves a recommendation, the standards are updated accordingly. Once adopted, the new product and its former standard, if any, are further classified as emerging (new), current (established), twilight (becoming obsolete), or sunset (referring from support as of a known date).

When a standard is established, it indicates that the designated technology will be supported by DIT as applicable, and that the selection is in alignment with broader IT goals, objectives, and strategic direction. In some cases, a standard may be adopted in advance of procurement or deployment, to provide strategic direction for emerging business needs. Adoption of a standard is not intended to convey endorsement for, or recommendation against, any specific product.

Declaration of a standard product(s) indicates DIT's strongest recommendation for selection of the available product(s) over any alternatives that may be similar or comparable. Generally, any solutions that will rely on the systems enterprise infrastructure, connect to the network, or depend upon DIT support must be fully conforming. Agencies using or selecting non-standard solutions may apply to the Architectural Review Board for a waiver on the basis of business needs and justification.

Standards are essential to sound cost controls in software licensing and maintenance, hardware, services, training, and integration. Having fewer platforms in use enables allocated resources to better support the information systems under management. Agencies are encouraged to invite DIT members to participate in selection and technical advisory committees for the Request for Proposal (RFP) process. DIT and its ARB should be consulted in advance of an RFP, to help explain technical alternatives and develop the proposal language to support conformance with existing and emerging standards.

The standards shown here do not represent a comprehensive view of all the products in use across the County. The list is intended to convey the primary standards for the major solutions to be supported by DIT and/or delivered with DIT resources.

Revised July 2019

FAIRFAX COUNTY INFORMATION TECHNOLOGY ARCHITECTURE

PLATFORM ARCHITECTURE: END USER SOFTWARE

Component	Environment
Operating System	Windows 10
Word Processor	Microsoft Office 365
Spreadsheets	Microsoft Office 365
Presentations	Microsoft Office 365
Database	Microsoft Office 365
E-Mail Client	Microsoft Office 365
Project Management	Microsoft Project Professional (latest release)
Graphics	Microsoft Visio Professional (latest release)
Web Browser	Microsoft Internet Explorer – IE11, Microsoft Edge
Antivirus	Cylance & Symantec AntiVirus (latest version) for Workstations and Servers
Patch Management	Microsoft System Center Configuration Manager (SCCM) 2016
Mainframe Terminal Emulation	Blue Zone
Thin Client Access	Citrix Xenapp 7.12 (latest version)
Other	Must be approved for Business Unit standard image/requirements

PLATFORM ARCHITECTURE:

END USER HARDWARE

Component	Desktops	Laptops	Tablets
Power	Single	Single	Single
CPU	Intel Quad Core i7 -8700, 4.6GHz Optiplex 5060	Intel Core i5-6300, 2.7 GHz E5450	i5-7300 (3M Cache, up to 3.50 GHz
Disk Configuration	250 GB, SATA Drive	250 GB, SSD Drive	256 GB SSD
Disk Configuration	500 GB, SATA drive	320 GB, SSD Drive	320 GB SSD
Media Drive	16X DVD R/W combo drive	None	None
Memory	8 GB, Non-ECC DDR4, 2 DIMMS	8 GB, DDR4	16 GB
Monitor	23" Economic, Flat Panel, DVI/VGA	14" Wide Screen WXGA+ LCD Panel	12.3" Full HD (1920 x 1080) IPS (400 NITS)
Video Card	Integrated Graphics DP/DP/VGA w/DP-to-DVI Adapter	Intel® HD Graphics 4000	Intel HD Graphics 4000
Interface Card(S)	Ethernet 10/100/ 1000 Base-T	Built-in 10/100/1000 GB Ethernet card	None – 3rd Party USB to Ethernet
Wireless	N/A	Intel Centrino Advanced N 6205 802.11a/b/g/n	Intel Centrino Advanced N 6235 802.11 a/b/g/n
Operating System	Windows 10	Windows 10	Windows 10
File System	NTFS	NTFS	NTFS
Maintenance	5 Year on-site, next business day	5 Year on-site, next business day	3 Year on-site, next business day
Additional Hardware Requirements	Sound bar not included	Port replicator, external mouse, keyboard and monitor if used as desktop, Security Lock	Keyboard, and Port replicator

PLATFORM ARCHITECTURE STANDARDS:

HAND HELD MOBILE DEVICES

Component	Environment
Platform/Devices	Syclo iOS (iPhone, and iPads) Androids phones and tablets

PLATFORM ARCHITECTURE: SERVER STANDARDS

General Server Standards: Servers needs are determined based on many factors, including utilization of existing infrastructure, requirements of planned projects, and the availability of specific funding for new equipment. Some platforms will share components and others will not, depending upon the unique circumstances for each project and product. Sharing and re-use are promoted when feasible. The County's goal is to provide a homogeneous environment to streamline support and maximize resources, using virtual environment and consolidated server farms supporting many applications.

PLATFORM ARCHITECTURE: GENERAL SERVERS

Component	Environment
Operating System	Microsoft Windows Server 2016 Enterprise Edition; Solaris (latest release); z/OS 1.4
Thin Client Access	Citrix Xenapp 7.12 (latest version)
Hardware	Intel (Windows); SPARC(UNIX); HP UX; IBM Z-Series (Mainframe)
Backup	Symantec Net BackUp z/OS DFSMS Net App snap shots
Storage	IBM XIV (SAN) INFINIDAT NetApps (NAS)
E-Mail	Office 365 L-Soft LISTSERV
Web/Application Servers	Preferred: Microsoft Internet Information Server – IIS10 Apache Web server (if required by COTS package) Tomcat (if required by COTS package) JBOSS BEA Systems WebLogic Microsoft BizTalk Web Methods Oracle Application Server 11g
Configuration/Change Management	ServiceNow

PLATFORM ARCHITECTURE:

ENTERPRISE SOLUTION PLATFORMS

Platform	Current Standards
Report Writing: Departmental Reporting Needs	Business Objects Crystal Reports Microsoft SQL Reporting
Statistical Analysis	SAS
Enterprise Reporting Business Intelligence	SAP/BOBJ
Document Scanning/Imaging	OpenText
Web Content Management	Drupal
Web Search Engine	Google
Survey Instrument Software	SNAP 10 Professional (w/Scanning module)
Correspondence Tracking	Microsoft Dynamics / Intranet Quorum
CRM	Microsoft Dynamics
IT Services Management	ServiceNow
GIS	ArcGIS 10.6.1& Extensions ArcGIS Pro 2.3.1 ArcGIS Server 10.6.1 ArcPad 8 OnPoint 6.2 Electronic Field Study 2.7
ERP	SAP core; ESS, MSS portal
Voice Communications	Avaya Virtual SIP & Skype for BusinessG700s Servers