CHABOT-LAS POSITAS

COMMUNITY COLLEGE DISTRICT

INFORMATION TECHNOLOGY PLAN

TOTAL COST OF OWNERSHIP

February 21, 2017

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1.0 INTRODUCTION

The Chabot-Las Positas Community College District is implementing a Total Cost of Ownership (TCO) process for both Facilities and Information Technology effective in February 2017. This is in response to the Accrediting Commission for Community and Junior Colleges (ACCJC) recommendation received in January 2016 which states that "the Colleges and District should update and integrate their long range facilities planning process to reflect the total cost of ownership projections of facilities and equipment". Both Facilities and Information Technology (IT) have developed a Total Cost of Ownership (TCO) Plan for their respective areas which will be included in the March 1, 2017 Follow-up Report to ACCJC.

Technology improvements are an integral part of the Facilities Master Plan. Therefore, technology equipment must follow the same TCO guidelines as Facilities. However, whereas Facilities looks at gross square footage for their buildings as part of the TCO analysis, the technology equipment requirements can vary substantially by building dependent on whether it is an office building or a student centric building with heavy technology. The technology equipment includes various categories of equipment to support new buildings, facility renovations, and refresh upgrade cycle for existing equipment in older buildings not under construction. Thus, the TCO for technology equipment is reviewed by the different equipment categories which vary in support levels. Information Technology utilized the TCO analysis methodology from the Gartner, Inc., who is a leading information technology research and advisory group, to determine how CLPCCD compares to the TCO recommendations. The Gartner model uses the IT Key Metrics Data (ITKMD) to calculate a price based on equipment type for infrastructure and operations with recommended staffing levels. The TCO life cycle encompasses all phases of the technology's usage from design, through procurement and deployment and through obsolescence.

Through the Measure B Bond program, Chabot-Las Positas Community College District (CLPCCD) has completed substantial improvements and growth in college facilities. The Information Technology improvements included upgrades to servers, desktop/laptop, audio-visual, network and cabling infrastructure. Where feasible, equipment support contracts for bond-funded equipment were also procured when available from vendors. The intent was to have a full-supported Information Technology infrastructure up to the end of 2017, and then the new Measure A would continue from where Measure B ended. For Measure B, CLPCCD District ITS and College Technology departments did follow the TCO model for hardware and software purchases, installation, training, and maintenance support, which will continue and be expanded where appropriate for the comprehensive Total Cost of Ownership process being implemented for Measure A. The technology departments coordinate all aspects of the technology equipment acquisition costs, including hidden costs through the full equipment life cycle as well as insurance and disposal of obsolete equipment. They are also responsible for all ongoing support costs.

While elements of the Total Cost of Ownership have been included in equipment discussions and decision-making for a number of years for the technology implementations related to the

Measure B bond program, a more formalized Total Cost of Ownership process will be instituted in the district's long range planning procedures for the new Measure A bond. The District Facilities Master Plan is the institutional long-range planning document that describes the results of the facilities planning process. The District Technology Plan addresses the technology aspects of facilities and equipment planning for the District and Colleges. The District Technology Plan is completed separately, but aligns with the Facilities Master Plan as well as the District Strategic Plan and the College Educational Master Plans. The District Technology Plan is developed from user inputs on the college and district technology requirements, in coordination with both Colleges' Technology Committees and the district-wide Technology Coordinating Committee. A new Technology plan will be developed in 2017, which will include Measure A bond projects and other Enterprise Technology initiatives. The current Technology Plans are posted on the district web site at http://www.clpccd.org/tech/TechnologyPlans.php.

For the Measure A bond, the Board Policy on Institutional Planning (BP 3250) has been revised to include Total Cost of Ownership in the implementation of the Facilities Master Plan. Related to the construction and maintenance of buildings is the ongoing operation and improvement of Information Technology equipment and services. In addition, a new Administrative Procedure AP3253 "Total Cost of Ownership" was created to define the total cost of ownership and its implementation.

For the TCO guidelines, technology equipment includes various categories of equipment. The Measure B bond provided funding for Information Technology improvements to servers (application systems), desktops/laptops, audio-visual (smart classrooms), network and cabling infrastructure (wired and wireless), and generators/UPS for data centers. While the Measure B Bond program was able to cover equipment and support including initial training, ongoing staffing and training costs were not included. As such, the expanded equipment and infrastructure provided through the Measure B Bond projects is being maintained by similar staffing levels and resources that have not changed since the start of Measure B in 2005. Staffing increases were not covered by the Measure B Bond, and the CLPCCD General Funds were not available to fund staffing increases due to budget constraints. Beginning in the 2016-2017 year, budget has been made available for a limited amount of staff augmentation in the CLPCCD District ITS and College Technology departments.

This document examines the industry approach for Total Cost of Ownership (TCO) for Information Technology systems and its application to CLPCCD District and College facilities. For TCO, CLPCCD will use the same model for Measure A as was used for Measure B. The TCO model did include hardware and software purchase costs, installation, initial training and maintenance, but it did not include staffing expansion costs. This document contains actions for ensuring that CLPCCD District and College Technology staff can acquire and maintain its resources as specified by Total Cost of Ownership recommendations for technology equipment. Staffing will be addressed as a critical part of effectively managing the total cost of ownership for the new Measure A technology improvements.

2.0 INFORMATION TECHNOLOGY TOTAL COST OF OWNERSHIP

In the Information Technology industry, Gartner, Inc. is regarded as a leading information technology research and advisory company. The Gartner Group (now Gartner, Inc.) originally introduced the concept of **Total Cost of Ownership (TCO)** in 1987. The Gartner Group also worked with the California Community Colleges Chancellor's office in 2000 to provide input for the Technology II Strategic Plan for 2000-2005.

Gartner defines total cost of ownership (TCO) for Information Technology (IT), as "…a comprehensive assessment of information technology (IT) or other costs across enterprise boundaries over time…including hardware and software acquisition, management and support, communications, end-user expenses and the opportunity cost of downtime, training and other productivity losses[1]". Total cost of ownership analysis attempts to define both the obvious costs for acquisition and ongoing support and the so-called "hidden" costs of ownership across the full ownership life or life cycle of the acquisition. The Gartner model uses the IT Key Metrics Data (ITKMD) to calculate a price for infrastructure and operations with recommended IT staffing levels. Gartner is the TCO model that was used to do an IT analysis to see how CLPCCD compares to the TCO recommendations including staffing.

In defining ownership life[2], CLPCCD ITS takes into account the following areas influencing the useful lifespan of IT systems:

- **Economic life**. - The number of years for which the IT system provides more value to CLPCCD than it costs to own, operate, and maintain. When ongoing costs exceed returns, the IT system is considered to be beyond its economic life.
- **Service life**. - The number of years the IT system is actually in service providing appropriate functionality and performance for the requirements at CLPCCD sites.
- **Depreciation life -** The number of years over which financial systems charge depreciation expense.

While the economic life may be a factor in which upgrades should be planned, the service life is more often the defining factor. CLPCDD District ITS and College Technology use the service life for determination of equipment life. In IT, discrete systems and technologies present different life cycles to analyze. For example, tablets and laptops exceed their service life in functionality and usefulness faster than Enterprise server systems. If a computer can no longer do the job needed by the staff, faculty or student, then upgrades are mandatory because the device has reached the end of its useful service life.

[1] Gartner IT Glossary 2016. http://www.gartner.com/it-glossary/total-cost-of-ownership-tco/
[2] Total Cost of Ownership TCO Explained, Business Encyclopedia, ISBN 978-1-929500-10-9. https://www.business-case-analysis.com/total-cost-of-ownership.html

Costs of ownership span beyond the procurement process itself. In the life cycle graphic shown, an IT system or technology requires different types of IT effort, as it moves from a new deployment to an aging service. The various phases include Planning, Procurement, Deployment, Management, Support and Disposition. Each phase requires IT to provide specific IT knowledge and task execution. The ongoing cost of ownership incorporates all expenses for staff, equipment and support to execute those tasks.

More specifically, the factors contributing to the Total Cost of Ownership for IT Technology include:[3]

Acquisition Costs - These are the costs that contribute to the original procurement of the technology:

- System Design: The new technology will require design by internal resources or external partners/consultants, which include the following tasks that could be iterative.
  - Analysis and inventory of the current environment's capabilities and limitations
  - Design of new environment
  - Research of the possible solutions
  - Documentation of solution, management presentation and approvals
  - Creation of the bill of materials for the new solution
- IT Hardware/Software Equipment: This can include:
  - Server hardware and software
  - Workstation hardware and software

[3] How to Determine TCO, ShoreTel, 2016. http://www.lantelligence.com/wp-content/uploads/2016/06/How-to_Determine-TCO-for-IP-Telephone-Systems.pdf

  - Network hardware and software
  - Warranties, ongoing hardware/software support and licenses
- Acquisition Process: In working with the procurement department, the following tasks would need to be executed:
  - Development of the bid package
  - Advertisement to potential bidders
  - Execution of the bid process/bidder management
  - Funding allocation or financing options
  - Ordering, receiving, inventorying and processing payment for the IT technology solution.
- System Implementation: This includes all tasks with bringing the new technology into production.
  - Equipment configuration
  - Migration from existing hardware and software platforms
  - Conversion of data from existing environment
  - Testing and functionality acceptance
  - Corrections to new environment as needed
  - Downtime during conversion to the new system.

Hidden Acquisition Costs may include:

- Diminished Performance:
  - Old system performance issues before new system is brought online.
  - Conversion from manual processes which may result in work slowdowns or performance as the new system is being learned.
  - First day/week/month implementation issues that need to be corrected.
  - Functionality changes that make the new technology different or more difficult to use.
- Facility Improvements: These are changes that might be needed in order to accommodate the new technology.
  - Room/Floor space construction or refurbishment
  - HVAC/power improvements
  - Rack/cabinet changes or additions
  - Space reallocation or equipment rearrangement
  - Security costs: building locks, secure entry doors, CCTV, security staffing, electronic security (card readers, motion detectors, alerting to security personnel)
- Network Upgrades:
  - Additional copper/fiber cabling
  - Network ports and bandwidth increases required to support new equipment connections
  - Patching.
- Training:
  - Administrative and operational training for IT support staff.
  - End-user training on features, functions and operations of the technology.
- Insurance: Equipment damage/theft and replacement costs.
- Decommissioning: These are costs associated with the disposal of the old equipment.

- Recycle fees for disposal of old electronics. Environmental compliance reporting.
- Disassembly and transport fees of equipment
- Termination of support agreements/partnerships, including late termination fees or contract buy-outs

Ongoing Costs – These are costs associated with keeping the new technology running.

- System Maintenance:
  - Maintenance including backups, logfile analysis, storage restructuring, security procedures, and other tasks.
- System Upgrades:
  - Assessment of upgrades to enable performance enhancements or correct issues.
  - Design of expanded system.
  - Procurement of additional items such as software licenses, memory, disk, CPU expansion.
  - Configuration, testing and implementation
- User Changes:
  - Ongoing modifications of the technology to address changing user requirements
  - Application customization/additions
  - Password, access or location changes.
- System Management:
  - Daily/weekly/monthly management of each system is required to maintain peak performance
  - Identification of impending problems
  - Optimizing performance and operations.
- Staff Augmentation: hiring of additional staff or consultants to provide expertise required for new or advance systems deployment.
- Ongoing Training:
  - Administrative training for IT staff on new or modified processes and functionality.
  - Development and distribution of user training and updates.
- System Downtime: Scheduled or unscheduled downtime that creates a disruption of service to CLPCCD students and staff.
- Audit: Internal or external audit procedures for new technology.

IT systems are in a constant state of upgrade, change and improvement. Thus, IT equipment life cycles are typically shorter than other capital items, ranging from four to ten years, with extended life spans depending on the technology. The anticipated life cycle of CLPCCD Technology equipment is as follows:

- Desktop/laptop computers: 4 years
- Servers: 5-7 years
- Printers: 5 years
- Network equipment: 7-10 years
- Network cabling: 20-25 years

- Audio-Visual equipment: 7 years
- Telephony systems: 8-12 years
- UPS: 15-20 years
- Generator: 20-30 years

CLPCCD ITS and College Technology staffing assess equipment usefulness to determine life span. Innovative technology that does not exist in the industry as of yet will make the current equipment obsolete and will reduce the service life when available.

Coupling these items with the growth of IT systems made possible by the Measure B bond, CLPCCD ITS and College Technology departments have been presented with a significant impact to ongoing costs and a constant state of rapid change for the CLPCCD ITS staff.

To reduce TCO in IT organizations, a number of Best Practices have been identified, some of which include[4]:

- Stable IS Organization: A stable staff keeps deployments consistent and focused. CLPCCD ITS has been fortunate to maintain talented staff who have worked in the District for 10+ years. This provides a "braintrust" of experience to draw on for upgrades and new installations.
- Vendor Standardization: With vendor standardization, CLPCCD ITS can gain purchasing leverage and reduce incompatibility issues, support issues, administrative costs and have access to new technology for prototyping. For the Measure B Bond program, CLPCCD standardized on all IT equipment for switches, routers, network infrastructure, desktops/laptops, servers, audio-visual equipment and cabling. CLPCCD reviews the current standards annually to assess the new technology available to satisfy the college and district needs.
- Training: Professional training for CLPCCD ITS staff allows for confident knowledge in all support tasks ranging from planning new deployments to resolving end-user issues. Self-training performed as time permits may gain knowledge, but without a thorough and consistent understanding. Focused classes through vendor offerings reduce the net amount of time spent learning, and result in more effective implementation and troubleshooting. Formal training on vendor products is provided as part of the system implementation for both IT staff and user departments.

To quantify the ongoing cost of operations, Gartner has released a Total Cost of Infrastructure and Operations (TCIO) model in 2016[5]. This model addresses "Technology Domains" including Data Center, Networking, Client computing and Service Desk. Costs in each domain including operating and capital expenditures, generate an annualized TCIO.

[4] Reducing TCO in Higher Education: Best Practices. Gartner, 1999.
[5] Using Gartner's TCIO model to Optimize Costs, 2016. https://www.gartner.com/doc/3229020/using-gartners-tcio-model-optimize

In this document, the TCO for each of the following IT Systems will be examined in detail:

- Server technology, including Enterprise, standalone and blade servers, and their operating environments.
- Data Center facilities at Chabot, Las Positas and the District Office.
- Desktop computing environment, including PCs/Macs, laptops and tablets and their software.
- Network infrastructure, including wired and wireless data equipment and cabling plant.
- Audio-Visual technology, including smart classroom, conference room and lecture halls.
- Telephony systems, including telephone systems and voicemail.

Where applicable, TCIO models are applied and discussed for each technology.

CLPCCD ITS and College Technology departments have made operational and architecture choices to minimize the ongoing costs of ownership and better position the available staff to support the technology expansion and increased sophistication. The TCO approach for each specific area is documented in the following sections.

3.0 CLPCCD SERVERS

A key responsibility for CLPCCD ITS and College Technology staff is the ongoing operations and maintenance of application servers. Centralized server applications with near 99.99% uptime are mission-critical for the support of functions at the Colleges and the District. With ongoing changes in academic and student needs, there is a continued expansion for the deployment and support of administrative and instructional applications.

The expansion of servers and applications has presented an increasing workload for District and College Technology staff. CLPCCD has made several choices to optimize the way that servers are installed and maintained. These choices have lessened the cost of ongoing ownership and support.

College Application Servers

Prior to 2005, the server environment at CLPCCD sites was composed of many kinds of “home-grown” disparate systems, often assembled by hand, and maintained by in-house staff. This led to variations in performance and stability, a lack of interchangeability of parts, and a requirement for custom knowledge for maintenance and repair. Downtime was unpredictable because of the availability of parts and skills when a server failed. The College servers consisted of the following:

2005 College Server Statistics

Location	2005	Operating System
Chabot	11	Windows
Chabot	1	Linux
Chabot	3	MacOS
Chabot Totals	**15**	
Las Positas	6	Window
Las Positas	2	Linux
Las Positas	0	MacOS
LPC Totals	**8**	

As the number of servers continued to grow, the disparate hardware and operating environment led to an unacceptable support situation for mission-critical College and District applications.

At the beginning of the Measure B bond, a committee of District and College technical staff was formed to analyze and define a common approach for servers across CLPCCD locations. The following items were addressed:

- Establishment of Server Standards – One of the first tasks performed was the selection and establishment of a standard for server hardware. An assessment of the mainstream suppliers resulted in the selection of Hewlett-Packard servers for the hardware platform. Specific models of Hewlett-Packard (HP) DL servers were chosen, with standardized disk, memory and CPU.
- Acquisition of Support Contracts – Servers were purchased with supplier/manufacturer support. This increased the availability of parts, skilled technicians for repair and timeliness of repairs.

These decisions were key in improving the ongoing cost of ownership, through optimized CLPCCD maintenance efforts, less failures and faster return to operations than were previously possible. These approaches were effective in reducing the Total Cost of Ownership for acquisition and ongoing support costs, but did not address staffing support.

Early in the Measure B bond (2007), CLPCCD ITS and College Technology staff migrated the servers from the existing platforms and onto the standalone HP servers, thereby enabling a robust server environment. Since the life cycle of a server system is typically 5-7 years, a number of replacement migrations were undertaken from 2013-2015. This has allowed CLPCCD to also take advantage of recent technology migrations, including:

- Upgrades in disk technology from iSCSI to SSD storage, and individual disks per system to shared SAN arrays.
- Upgrades in backup technology for more reliable and efficient storage.
- Migration of server architecture from standalone servers to blade chassis systems.

- Change in server management environments from individual OS to VMWare/Hyper-V virtualized management running multiple OS instances.

The move to the blade/SAN technology with virtualized environments has been demonstrated to lessen the ongoing cost of support and maintenance in many ways[6]:

- Better resource use: Since virtualized servers share CPU/memory/disk, the hardware is more closely used to its maximum capacity, rather than in standalone servers where capacity may sit idle.
- Lower power consumption: Blade chasses support many servers with a consolidated power source, significantly reducing the number of 100v or 208v power connections and net power consumption by 20-40%.
- Faster server set up: Instead of a several week set up time for configuring, buying, receiving and setting up a new server, a virtualized server can be installed and working in a matter of hours.
- Easier recovery from failure: Management utilities provide automatic or administrator-initialized recovery from hardware/software failures. This moved servers across chasses and virtualized environments, so repairs on failing components can be done with a minimum of downtime.

College Technology has begun the migration to virtualized servers. Now supporting 30+ standalone servers, future purchases for Chabot funded by the Measure A bond will include blade/SANS architectures for applications compatible with a virtualized environment. LPC Technology similarly supports 22 servers and is planning to move towards blade/SANS architectures as part of their strategy to optimizing the LPC server environment.

2016 College Server Statistics

Location	Quantity	Operating System	Growth Factor from 2005	Growth % from 2005
Chabot	28	Windows		
Chabot	1	Linux		
Chabot	1	MacOS		
Chabot Totals	**30**		**2 times**	**200%**
Las Positas	19	Window		
Las Positas	2	Linux		
Las Positas	1	MacOS		
Las Positas Totals	**22**		**2.75 times**	**275%**

[6] 5 Reasons to Switch to Virtual Servers, University Business 2009 https://www.universitybusiness.com/article/5-reasons-switch-virtual-servers

District Servers

Like the College servers, the application server environment at CLPCCD District was composed of "home-grown" disparate systems, often assembled by hand, and maintained by in-house staff. Similar performance and stability issues occurred as was described above for the College servers. At the start of the Measure B Bond in 2005, the server distribution was:

2005 District Server Statistics

Location	Quantity	Operating System
District	6	AIX
District	2	Linux
District	18	NetWare
District	5	Windows 2000
District Totals	**31**	

For Enterprise applications, CLPCCD ITS has standardized on the Ellucian Banner application as the ERP system for CLPCCD. Running on IBM AIX servers, CLPCCD ITS has been able to leverage staff experience and knowledge to maintain efficient operations and execute substantial upgrades.

Initially housed in the Chabot Computer room, CLPCCD ITS procured a replacement IBM pSeries 570 systems in 2007. This system was configured with primary and failover hosts to increase the reliability and business continuity in the event of a failure of the primary server. The District Data Center was relocated to the Administrative Computer Room in the LPC IT Building in 2009, where these servers were provided with optimal power, HVAC and humidity control to ensure maximum uptime.

As the number of applications increased, the performance of the IBM p570 systems was exceeded. Within the standard server life cycle and as the technology advanced, new IBM S822 systems were procured in 2012.

CLPCCD District ITS was able to optimize the ongoing cost of ownership through the following methods:

- Staff Expertise – Leveraging the long-time, experienced staff, the knowledge base for deployment of these new systems was comprehensive and thorough.
- Standardized Hardware and Software – Each deployment of the CLPCCD Enterprise servers have been based on IBM hardware with AIX operating systems and Oracle databases. This immediately gives staff a familiarity and confidence for new implementations.

In the past two years, CLPCCD District ITS has begun the migration to blade/SANS hardware with virtualized servers, now supporting approximately 106 servers in virtual environments. An additional 30 standalone servers currently exist, many of which will be migrated to virtual.

Because of unique architectural requirement that prevent a virtualized instance, there will still be a few servers that will remain on standalone hardware.

The current distribution of servers for District applications is:

2016 District Server Statistics

Location	Quantity	Operating System	Growth Factor from 2005	Growth % from 2005
District	19	Enterprise		
District	22	UNIX (AIX)		
District	44	Linux		
District	51	Windows		
District Totals	**136**		**4.38 times**	**438%**

Cost of Ownership Calculations for Servers

The Gartner TCIO model calculates a price for infrastructure and operations based on IT staffing and investment levels, and technology cost and performance metrics. The price is derived from the Gartner's IT Key Metrics Data (ITKMD) which is refreshed annually and based on surveys and discussions with the customer base and industry sources.

Using the 2016 Gartner TCIO model, the ongoing costs for the servers maintained at the campuses are shown below. Refer to Appendix A for more description on how these calculations are derived:

Ongoing TCIO costs for CLPCCD Servers

Location	Number of Servers	TCIO per year
Chabot College	30	$182,944.00
Las Positas College	22	$133,848.00
District	136	$1,984,369.00
Total		**$2,301,161.00**

* TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), space, and other related costs.

4.0 CLPCCD Data Centers

Through new building construction and modernization provided by the Measure B bond, CLPCCD ITS has improved the Data Center environments at CLPCCD Sites. In 2005, the only space designated as a Computer Room was a small and crowded space in Building 300 at the

Chabot College campus. This housed the Enterprise Server system and some smaller District servers, but was inadequate for the targeted growth.

Likewise, in 2005 and earlier, College campus servers were distributed across various buildings, in department offices, classrooms and telecom rooms. This caused very inefficient operations since College Technology staff had to go to various locations on campus for operational tasks. Servers were dedicated to single functions/applications and leveraging compute resources was not possible. In addition, the computer environment was not well controlled leading to variations in operational temperatures and power fluctuations.

As a result of an analysis of space, resources and operational stability, a decision was made to build a new IT Building on the Las Positas campus. This building houses an Administrative Computer room for the District Enterprise servers and provides a dedicated computer room for the Las Positas servers. During the renovation of Building 300 at Chabot, the previous Computer Room was renovated to provide up-to-date Server room functionality for a centralized housing of the Chabot Campus servers.

TCO costs for the new IT Building and Data Center spaces include:

Acquisition Costs

- Design: architect and engineering services
- Build: construction costs
- Real Estate: LPC campus location, housing both District ITS and LPC Technology departments. Chabot campus location, housing limited District ITS and Chabot Technology Staff. District office location in Dublin, housing limited District ITS staff.

Ongoing Costs

- Data Center-specific Infrastructure maintenance and upgrades: Support contracts for specialized infrastructure including UPSes, ATS/Generator, HVAC/Chiller, Security and other custom mechanical/electrical components.
- Utilities: Power, water for operations, included as part of the campus building TCO.
- Building maintenance and upgrades: included as part of the campus building TCO.

With the centralized server room spaces, the ongoing maintenance and operations have become more efficient than previously. Reliability of operation has also improved with backup systems and power protection systems.

Large-scale UPSes (30kW+) and site Generators at both the LPC IT building and Chabot B300 server room now support centralized server rooms, providing more efficiency for power usage and improved uptime. Ongoing costs for these components include:

- Generator: fuel, ongoing preventative maintenance, repairs.
- UPS: ongoing preventative maintenance, repairs, battery replacement.

With regular maintenance, generators used for standby emergency power can last 20 to 30 years. UPS systems can last between 15 and 20 years.[7] Thorough and regular preventative maintenance programs are key to equipment longevity.

Cloud Hosting Model

While CLPCCD has largely deployed an in-house private hosting model, there is a perception of cost reduction as one of the primary benefits of adopting a cloud hosting model. In particular the comparison of capital expenses (TCO Acquisition costs) versus operational expenses (TCO Ongoing costs) often must be analyzed thoroughly in order to make the proper decision between outsourcing versus in-house solutions for each specific application.

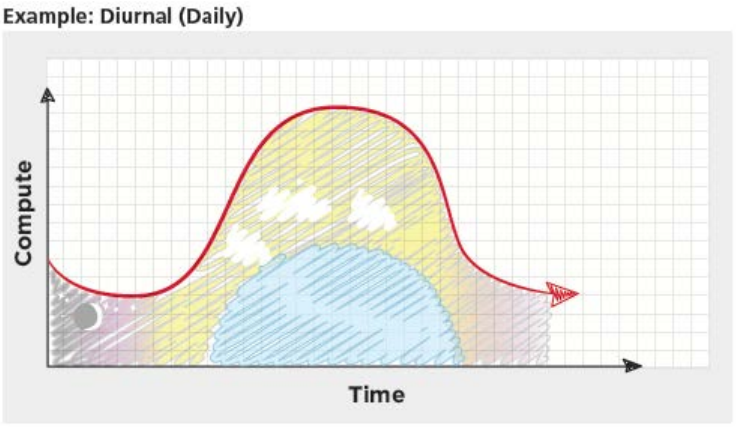
Application outsourcing can be of several models:

- IaaS – Infrastructure as a Service whereby the processing, storage, networks and other fundamental computing resources is provided by the hosting service and CLPCCD would deploy and run the custom applications for student and college support. CLPCCD would have control over selected processing, storage, deployed applications and some network components.
- PaaS – Platform as a Service whereby CLPCCD would deploy on a cloud infrastructure using services and tools provided by the hosting service, but not have management or control over the server infrastructure.
- SaaS – Software as a Service where CLPCCD uses the hosting service's applications running in the cloud.

CLPCCD has invested in SaaS options for selected vendor products for course management and other third party products that interface with Banner. Specific applications for Distance Learning were well provisioned using the SaaS model provided now by Blackboard, and in the future by Canvas. More recent progress to outsourcing College web services took advantage of the Microsoft Azure PaaS services and the Omni update SaaS software. Other enterprise cloud systems using the SaaS model include services for Counseling (Cranium Café), Student Learning Outcomes (Elumen) and Student Tutoring (Nettutor).

A benefit of cloud applications is the 24x7 access. Computer and application usage for CLPCCD Enterprise and college servers is typically daytime, with peaks when the college campuses are in session with classes and student activity.

[7] UPS Service Plans: How to Maximize Your Returns, Eaton, May 2010, Life Cycle Checklist, Eaton 2016



[8]

Round-the-clock access to applications as provided by a 24x7 hosting service is not as beneficial, since peak activity of CLPCCD access is usually at the same time each day.

CLPCCD ITS and College Technology departments maintain custom applications for the instruction and student administration. This reduces the possible options for the SaaS model. Ongoing staffing and training costs for either of the IaaS and PaaS models does not vary substantially with those of the in-house computing model. The cost of outsourcing for these applications would balance or outweigh the ongoing maintenance contracts in place for the CLPCCD in-house servers.

The specific outsourced applications described above, coupled with the in-house services available from the CLPCCD District ITS and College Technology servers provide an optimal operating environment for CLPCCD applications.

5.0 NETWORK CABLING AND EQUIPMENT INFRASTRUCTURE

CLPCCD District ITS is responsible for the network equipment and cabling infrastructure used for telecommunications at all CLPCCD sites.

Network Equipment

In 2005, at the beginning of the Measure B bond, the network infrastructure consisted of Cisco core routers and switches in the network core, and a minimal distribution of 10Mb unmanaged hubs throughout the buildings. While this was a very low-cost approach to implementing data connectivity, it provided limited performance and visibility into troubleshooting problems. The installed network ports were approximately:

[8] Cloud Economics, Rackspace 2012
`http://c1776742.cdn.cloudfiles.rackspacecloud.com/downloads/pdfs/WhitePaper_CloudEconomics.pdf

2005 Active Network Ports

Location	# of ports
Chabot	<1800
Las Positas	<1200
District	<48

Measure B bond expansion has grown connectivity of devices at each of the Chabot and Las Positas College campuses, plus additional connectivity at the District Office and Tri-Valley One-Stop (TVOS) sites in Dublin. In addition, the rollout of wireless technology, beginning in 2007, has increased the number of network users by approximately 2000 per day per campus. Network speeds have increased from a shared 10 Mbps transmission to 1Gbps transmission, with 10Gbps uplinks supported between buildings.

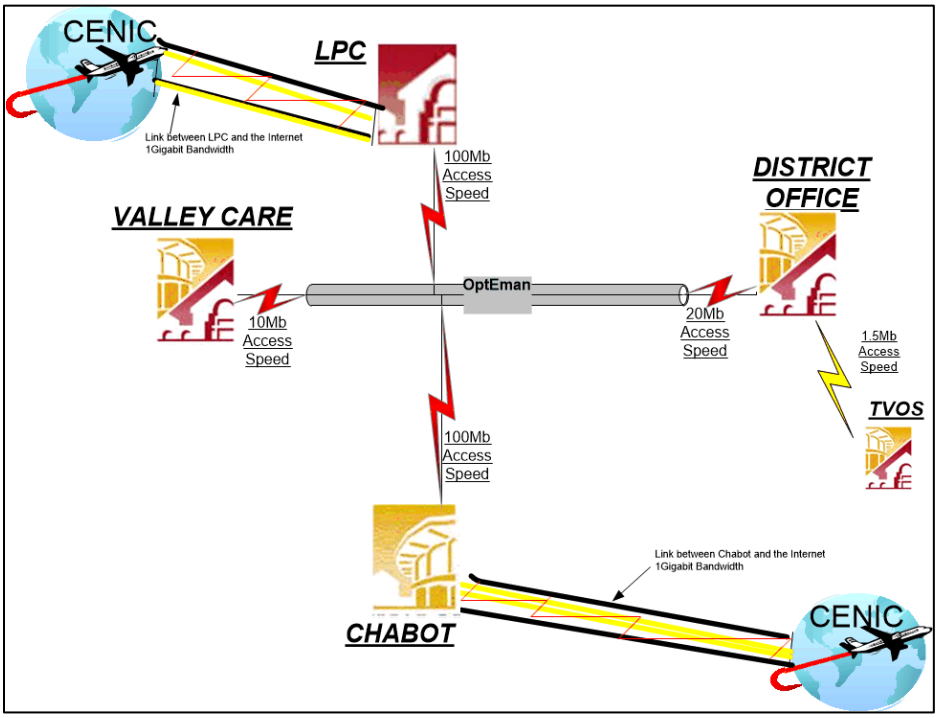
2016 Active Network Ports

Location	# of ports	Growth Factor from 2005	Growth % from 2005
Chabot	5520	3.06 times	306%
Las Positas	4720	3.93 times	3.93%
District	384	8 times	800%

CLPCCD ITS initially supported limited bandwidth site-to-site connectivity determined by the T-1 speed. As network activity increased at each site, CLPCCD ITS was able to incrementally add connections and redundancy to the WAN topology.

Connection	2005	2007	2016	Growth from 2005
Chabot to LPC	3 x T-1 (4.5 Mbps)		100 Mbps	22 times
Chabot to District	1 x T-1 (1.5 Mbps)	2 x T-1 (3 Mbps)	20 Mbps	13 times
District to LPC (redundant link to Chabot)	1 x T-1 (1.5 Mbps)		20 Mbps	13 times

In 2008, CLPCCD ITS upgraded the WAN router infrastructure to be able to support the AT&T OPT-E-MAN Ethernet service. These connections far exceed the bandwidth offered by multiple T-1 connections, with a simplicity of operation and upgrade.



CLPCCD District ITS maintains the network equipment operation using the equivalent of one full-time staff member. This has not increased since the 2005 and it is expected that another staff person will be added during the Measure A expansion. Through the following methods that increase operating efficiency, CLPCCD District ITS is able to achieve stable network operations and near 100% uptime:

- Cisco Equipment Standard – Using Cisco switching, routing and firewalls. Through the common IOS command set across equipment models, CLPCCD is able to leverage its staff knowledge for new deployments and ongoing operation of the network infrastructure.
- Standardized Configurations – CLPCCD District ITS has developed templates for each class of equipment. This includes base configuration, VLAN architecture, IP addressing, feature set deployment and cabling connectivity.
- 24x7 Monitoring – Using simple network management tools that actively probe and monitor equipment function, CLPCCD District ITS can be immediately alerted to unusual activity and outages, so restorative action can be quickly executed.
- Network Upgrades – Through the Measure B bond funding, CLPCCD has been able to procure equipment for network growth and to replace aging/obsolete equipment. This

keeps the network at the top of performance, with little day-to-day effort. Network equipment upgrades are necessary every 7-10 years to keep up with performance requirements. However, the actual replacement cycle may be accelerated and determined by security breaches or manufacturers' obsolescence schedules.

- Manufacturer Support – For the network core and high density equipment, CLPCCD District ITS has budgeted for Cisco SmartNet support. During troubleshooting and failure, this provides CLPCCD with up to 4 hour response time on equipment failure requiring replacements. Access to Cisco engineering resources as needed 24x7 is essential to restoring business continuity as quickly as possible.

Wireless Network

A completely separate network environment that was installed during the Measure B bond is the wireless infrastructure. At the beginning of the Measure B bond, wireless did not exist. CLPCCD ITS first began deployments of 802.11a/b/g infrastructure in 2009. This was upgraded in performance and functionality to the current 802.11n network in 2011.

Chabot: 118 access points in 39 buildings

LPC: 80 access points in 28 buildings

Wireless technology has continued to develop in areas of increased bandwidth, with the 802.11ac, Wave 2 version now readily available in the industry. The wireless significantly expands the network connectivity to Bring Your Own Device (BYOD) laptop, tablet and cellular devices, with 1000s more users. The CLPCCD staff who maintains the wired network also maintains the wireless connectivity. All of the wireless installations were new to the Bond Measure B since 2005, so the growth factor is also the current installation of 118 access points at Chabot and 80 access points at Las Positas.

Reviewing Gartner's TCIO for networking, the cost estimates are typically based on the number of employees at a company. However, CLPCCD employees make up a fraction of the network usage, since student computer labs increase the number of connections significantly. Therefore, CLPCCD uses the number of connections to desktop PCs, which is a better representation of network usage. TCIO costs include:

Location	2016 Average TCIO/Unit/Year	Number of Active Connections *	TCIO per Year
Chabot	$100	2780	$278,000
Las Positas	$100	1,955	$195,550
District & TVOS	$100	200	$20,000
Total TCIO			**$493,550.00**

* Note that this is wired and wireless connectivity for CLPCCD-owned devices. BYOD devices are not included. TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), space, and other related costs.

Network Cabling

In 2005, the network cabling connectivity used multi-mode 62.5 fiber and Category 3 and Category 5 cabling, usually installed by CLPCCD M&O and ITS staff. This allowed a piecemeal growth of the network connectivity as cabling could be added in rooms in an ad hoc fashion. However, this also led to the usage of low-end cabling, small and inadequate IDFs located on shelves in custodial spaces and mechanical rooms and many troubleshooting and operational issues.

Beginning with the Measure B bond, CLPCCD District ITS created a Cabling Infrastructure Standard that has been used for the new and modernized building construction. This standard has provided the following:

- Consistency – With a defined set of design guidelines, engineers and designers were able to produce drawings that clearly defined cabling standards, IDF size, power and HVAC requirements and layouts. This resulted in the construction of robust cabling infrastructure that had a minimum of variations, and could easily be maintained by staff.
- High Performance - Based on Commscope Systimax Category 6A station cabling with single mode fiber backbones, this standard established a state-of-the-art cabling infrastructure. The life cycle of cabling infrastructure is expected to be 20-25 years. While Category 6A cabling was considered leading edge at the beginning of the Measure B bond construction in 2005, the TIA-4966 standard for Educational Institutions now embraces Category 6A as the cabling standard needed for 802.11ac and future wireless connections, DAS, POE+, AV solutions and other infrastructures that require high-performance (1Gb+) network connections. As such, this forward-looking approach has well served CLPCCD ITS in being able to support current and future technologies that were not even in design when CLPCCD did its first building renovations.

With the Measure A bond construction, the Cabling Standards will be updated as needed, and will continue to provide a robust, standard cabling infrastructure for CLPCCD buildings.

6.0 DESKTOP AND LAPTOP SYSTEMS

Maintenance and ongoing operation of the desktop and laptop computing environment is one of the most important functions of the Chabot and LPC Technology departments. The efficient operation of computer systems used for instruction, labs and department functions is key in making sure student instruction is high quality.

Prior to 2005, the desktop systems in use varied in CPU, disk, memory and manufacturer. PCs varied from Intel P2 through P4, using Windows XP operating systems. Apple G3/G4 systems were used for specific applications, and few laptops/tablets were present. Equipment was acquired through direct purchase or at the LPC campus, lease-to-own. Campuses and the District operated independently in their procurement processes. While attempts were made to

standardize, there was still a huge variance in hardware. Maintenance of failed systems consisted of in-house staff swapping components to restore the PC back to service. The installed base of computers is shown below:

Measure B Desktop/Laptop Growth

Location	2005	2016	Growth Factor from 2005	Growth % from 2005
Chabot	1600	2370	1.48 times	148%
Las Positas	1175	1955	1.66 times	166%
District	74	205	2.77 times	277%

As described for the servers, the committee of District and College technical staff defined a common approach for desktops across CLPCCD locations. The following items were addressed:

- Establishment of Desktop Standards – The selection and establishment of a standard for PC hardware enabled CLPCCD ITS and College Technology staff to provide a consistent functionality across the sites.
- Joint Bidding – Colleges and the District joined together in issuing bids that represented the multi-year purchasing requirements. Volume purchases resulted in more attractive pricing through larger discounts. CLPCCD also received custom service and delivery options through the dedicated supplier.
- Support Contracts – Desktops were purchased with supplier/manufacturer support. This increased the availability of parts, skilled technicians for repair and timeliness of repairs.
- 4-year life cycle –Assessing the bond funding, PC growth and viable service life, a 4-year life cycle was established at the beginning of the Measure B bond. In the years between 2005-2016, eleven (11) refreshes occurred, each refresh including 25% of the installed base of desktops/laptops.

These decisions were key in improving the ongoing cost of ownership, through optimized manageable equipment rollouts, effective maintenance efforts, less failures and faster return to operations than were previously possible. The current environment uses state-of-the-art HP or Apple PCs. Laptops and tablets are provisioned as dictated by purpose, and are primarily Microsoft Surface, HP laptop and Apple iPad devices.

Using Gartner's TCIO model for Client Computing, the following costs are calculated:

Site	2016 Average TCIO/per unit/per year	Number of Units	TCIO per Year
Chabot	$1,015	2370	$2,405,550
Las Positas	$1,015	1955	$1,984,325
District	$1,015	205	$208,075
Total			**$4,602,480.00**

* TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), space, and other related costs.

Note that these calculations do not differentiate between desktop and laptops. There is a higher degree of support required with laptops because the systems are prone to damage. Likewise the desktop count includes computer labs which have a static image, refreshed in between teaching sessions. These computer lab machines are more stable, but require more support between class sessions for refresh and reconfiguration. Balancing these inputs, the TCIO calculations shown above continue to use Gartner's standard model.

7.0 TELEPHONES

Through the Measure B bond, new construction and building growth at Chabot and Las Positas College have expanded the number of new classrooms, offices and staff. An increase in the connectivity requirements to the current telephone systems had paralleled this building growth, requiring the addition of telephone extensions, voicemail boxes and cabling. The Measure A bond will continue that growth.

At Chabot, a Fujitsu telephone system was in production at the start of the Measure B bond. This system was configured as two separate components, one housed in the main telephone room (MPOE) in Building 200, and the other located in the Building 1400 IDF. Since the Fujitsu systems were not expandable and nearing the end-of-life, in 2007, CLPCCD ITS and Chabot Technology worked with the current telephony maintenance organization, Altura CS, to implement a minimal upgrade whereby the Fujitsu systems were gatewayed to an Avaya Communications Manager S8300 system. This upgrade positioned Chabot to begin a gradual transition of the telephone services off the obsolete Fujitsu, and onto a current Avaya platform, and allowed deployment of Avaya telephone service to new buildings such as the IOB and CSSC. During the renovation of Building 1400 in 2011, the replacement of the Fujitsu system in the B1400 IDF, was performed. This upgraded the system in B200 to an S8500, and allowed the connectivity of Building 3500, 3400, 1400, 1600, 1700, 1800 and smaller buildings which had been connected to the old B1400 Fujitsu. The remaining Fujitsu system in B200 was also removed.

The District Office telephone system was linked to the Chabot Fujitsu system for voicemail. As Chabot gradually migrated off the Fujitsu system, it became clear that the District Office system similarly needed to be replaced. When the District Office moved to the current Dublin location in 2013, its Fujitsu system was decommissioned, and replaced with an Avaya S8300 system. While using separate calling through its own in/outbound PRI service, the District Office system currently connects to the Chabot system for voicemail storage.

Chabot and the District partner with Altura CS for ongoing maintenance, upgrades and configuration changes. Moves of the telephones from one office to another in the same building can be done by the Chabot or District staff.

Another District site, the Tri-Valley One STOP (TVOS) uses a Centrex system which is also completely independent of the other CLPCCD systems. Services are limited, and require a separate support contract with AT&T. An analysis will need to be performed to determine if the TVOS system can be connected to the District system in a cost-effective manner.

Many years ago, Las Positas purchased a Siemens HiCom 300 system, and at the start of the Measure B bond expansion, it was running at 50% of its capacity. This has been a discontinued product for Siemens for several years although support and refurbished parts have been available. The system is now expanded to its maximum capacity and a full system replacement will be done under the Measure A bond. LPC has a full-time telephone administrator who looks after onsite moves. For more complex system administration and configuration changes, this system is supported by an outside service organization, contracted as-needed basis.

8. AUDIO-VISUAL TECHNOLOGY

In 2005, prior to the Measure B bond, College Technology staff provided Audio-Visual (AV) to classrooms on demand by pushing TVs, overhead projectors, VCRs and slide projectors on carts around to the classrooms as requested by the instructors. At the beginning of the Measure B bond, College Technology departments individually developed AV Technology standards for the "smart" classrooms at each campus. Beginning with the renovation of the first classrooms on each campus, the "smart" classroom was installed in every teaching room providing:

- Drop-down screens (3x4 or 9x10)
- Projectors (LED)
- Push-button SP input controllers using AV sources including document cameras, VCRs, and laptops
- Speakers
- Assisted listening devices

When buildings were constructed or modernized, AV designers were engaged as part of the architect and engineering team, to design the AV infrastructure and produce a set of drawings for the classroom construction. The construction projects included:

Year	Chabot Building	Rooms	LPC Building	Rooms
Pre-2008	B1300 B1500 B1600 B2000 B2100 B2200 B3100 B3900	2 classrooms 3 rooms 10 classrooms 2 classrooms 8 classrooms 5 classrooms 3 classrooms 14 classrooms	B2200 B800 B2500 PE	6 classrooms 8 classrooms 7 classrooms
2008	B900	5 classrooms	M&O	2 rooms
2009	B2200 Health B800 B3500	1 classroom 18 classroom 1 classroom	B2400 MD Aquatics	12 classrooms - none
2010	B700 CSSC B400 IOB B1900 Planet. B500	4 rooms 2 classrooms 2 classrooms 17 classrooms	B2300 CDC B4000 CCA B1900 IT B900	2 classroom 11 classrooms 1 room 1 classroom
2011			B400/500/600	13 classrooms
2012	B4000 B300 B1400/B1600	- none 14 classrooms 4 classrooms	B1800/1850 B1700	19 classrooms 1 room
2013	B1800 B2500, 2600, 2700, 2800, 2900 B3400 B1200	9 classrooms 12 classrooms 2 classrooms 5 classrooms	B1600 SSA	17 classrooms
2014	B1700	13 classrooms	B1310/1320 Temp 100	1 room 6 classrooms
2015	B100	5 classrooms	B2000	7 classrooms
2016			B700	2 classrooms
Totals		**161 classrooms**		**114 classrooms**

Throughout the span of the Measure B projects, the growth of smart classrooms has been:

Location	Pre-2008	2016	Growth Factor	Growth %
Chabot	47	161	2.46 times	246%
Las Positas	21	114	5.42 times	542%

The build-out of the new smart classrooms has been part of building modernization and new construction, using contractors for the installation and initial configurations to assist the College Technology staffs.

As buildings were completed, the “smart” classroom AV equipment introduced an additional level of technology sophistication to be supported by College Technology staff. In addition, the AV industry has matured and enhanced their products, and newer products have been installed in more recent building remodels. This results in a similar but heterogeneous set of equipment to be supported by College Technology staff.

The life cycle of AV equipment can be as long as 7 years, depending on the robustness of the hardware. Items that fail frequently are project bulbs and occasionally the projectors themselves. These require regular replacement for the classrooms to continue functioning. Even if equipment continues to function, AV technology is particularly susceptible to a short service life.

Ongoing support of the new AV technology was absorbed by College Technology departments. Limited training and documentation on the equipment was provided by AV contractors. College Technology staff was frequently in a position to figure out the functionality on their own, through on-the-job training. While the AV technology advanced the complexity significantly, the staffing and training in the College Technology departments did not change appreciably. For Measure A projects, there will be a focus on providing more comprehensive training at the initial installation, as well as for ongoing maintenance support.

Classrooms are demanding increased resolutions, digital technologies, support of new AV sources, and access to conferencing/collaborative tools so students can present and interact with the instructor during the lectures. AV Technology is moving towards an IT type of infrastructure with cabling, electronics, software and programming becoming increasingly similar to computer systems. Given the rising costs and the mission-critical nature of today's AV systems on campuses, utilizing a TCO approach is required.[9]

The Gartner TCIO studies do not include an assessment of Audio-Visual technologies or staffing. Industry standards for university/college level AV staffing vary. The complexity of the AV systems in the classrooms vary from simple projection to complex collaboration, video capture and conferencing tools.

In an AV survey conducted in 2014[10], the following items were compared: 1) school size, 2) AV technology sophistication and 3) number of AV classroom/conference rooms per school. A broad set of responses was received. The results of this survey were published in a number of online journals pertaining to educational support. While there was a wide variety of responses, the results of the survey indicate an average support ratio of one staff for 43 AV installations; with the room:staff ratios varying from 15:1 to 140:1. A variety of technical factors contributed to the staff levels, but the median of the survey showed a staffing ratio of 77 rooms per staff, which is the guideline utilized by CLPCCD for comparative purposes.

CLPCCD's AV staffing as shown below:

Location	No. of classrooms	Current No. of AV support staff at Colleges (daytime)
Chabot	161	2
Las Positas	114	2

[9] AV/IT Infrastructure Guidelines for Higher Education, Infocomm, 2014. https://www.infocomm.org/cps/rde/xbcr/infocomm/InfoComm_AVITHighEd_Dec14.pdf
[10] A Benchmark for AV Support Staff, Campus Technology, 2016. https://campustechnology.com/articles/2016/09/21/a-benchmark-for-av-support-staff.aspx

*LPC has an additional .5 part time staff for after-hours AV support for faculty.

For CLPCCD, the highest ratio is about 80 rooms per dedicated AV support staff. This is within the support range found in the median of 77 rooms per staff in the industry survey. CLPCCD also has the ability to leverage the desktop support staff if extensive AV support as needed.

Since much of the smart classroom technology is reaching or exceeding its useful life, a significant project for the Measure A bond will be to design and contract the refresh of the AV in the classrooms. College Technology departments will work with AV designers in establishing - new standards to refresh existing classrooms, and become the basis of design for Measure A building projects. This will put increasing pressure on College Technology staff as they work as designers while maintaining the current installations. For Measure A, the AV requirement will need increased staff at both colleges for support of new building construction and refreshes of existing AV equipment concurrently. However, it will also allow them to become more educated on the solutions for the next generation AV installations in advance of the production environment.

9. STAFFING

As mentioned in earlier sections of this document, staff expansion has not kept pace with growth of the IT infrastructure and servers. As such, the current staff provides "best effort" response for support and project rollouts.

Gartner's TCIO model provides staffing metrics that are calculated as part of the TCIO costs.

Resource	TCIO cost per year *	Staffing Cost Allocation	Average Annual Salary
Windows servers	$5,662	45%	$126,336
Linux Server	$8,454	50%	$142,335
Unix Server	$27,483	35%	$136,020
Storage	$2,009	26%	$131,836
Client Computing (Desktops)	$1,015	40%	$105,455
Data Network	$100	43%	$131,500
Voice Network	$622	37%	$122,529

* TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), space, and other related costs.

The details as to how the staffing proportion of TCIO are calculated are described in more detail in Appendix A. These calculations and data from peer California Colleges have been analyzed for applicability to CLPCCD. In all of the staff analyses documented below, the supervisor/management staff has not been included in the staff calculations.

College Staffing

Applying the Gartner TCIO for staffing to the College Technology departments, staffing levels for technology analysts can be calculated and compared to existing staffing levels at CLPCCD.

In addition, CLPCCD also reviewed the comparable colleges in the 2016 survey of California Community College Staffing level for desktop computer counts. The colleges in the survey with a similar count range for Chabot and LPC include Merced (275), Ohlone (228.7), Irvine Valley (236), Glendale (262.5), Cuesta (250) and Shasta (226.7) The average desktop count from the CCCD survey for the comparable colleges was 233, ranging from 226 to 275 units per IT Staff member. Prior to the Measure B Bond, the per unit ratio for Chabot was 266 and for LPC was 235, so in 2005 both colleges were within the CCCD range from the 2016 survey.

Location	TCIO cost per year *	Gartner Recommended Staff count	College Desktop/Server Staff Count
Chabot Desktop/Server	$2,405,550	9	4
LPC Desktop/Server	$1,984,325	7.5	3

* TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), building space, etc.

With the Measure B expansion, the 2016 current per unit support ratio at Chabot increased from 266 to 395 per IT staff. To lower support ratios to closer to the acceptable 266 unit ratio, the Chabot staff would need to increase staff beginning with an increase of three (3) staff. This begins to close the gap for the staffing level of nine (9) that is recommended by the Gartner TCIO model.

With the Measure B expansion at LPC, the LPC 2016 current desktop ratio increased from 235 units per IT staff to 355 units per IT staff. To lower support ratios to closer to the acceptable 266 unit ratio as Chabot, the staff for LPC would need to increase staff, beginning with an increase of two (2) staff. A .5 person staff increase is already in progress for additional evening/weekend support. This begins to close the gap for the staffing level of 7.5 that is recommended by the Gartner TCIO model.

Summarizing for support, both Chabot and LPC technology departments should be increased by three (3) staff at Chabot and two (2) staff at LPC to support the college desktop expansion already in place with the Measure B bond growth.

With Measure A bond, there will be increased computer labs and classroom technology. Significant refresh projects for the “smart” classrooms will also require College staff resources

during the design, installation and ongoing operations. Additional staff increases to support the Phase 1 (2017-2022) Measure projects are needed.

For the colleges, the server increase count was not as significant as the District server count since most of the Enterprise systems are centralized through the District servers that service all locations. For both colleges, the Gartner TCIO model staffing recommendations was .5 to .6 staff, which is a shared IT resource with desktop support staff. An additional .5 IT resource is expected to become warranted during the Measure A expansion when more virtualized servers with redundancy are added to the college server pool as has already been implemented at district locations.

Summarizing the College staffing increases for Desktop/Server:

Location	College Technology Staff Count	Proposed Growth for 2017-2018	Measure A Phase 1 Staff Increase
Chabot	4	+3	+2
LPC	3	+2.5*	+3

* Additional .5 staff head count increase is already in progress for off-hours support of one full-time staff.

District Staffing

At the District level, the server count is significantly higher, leading to the following staffing calculations:

Resource	TCIO cost per year *	Gartner Recommended Staff count	District Staff Count
Desktops	$208,075	.78	1
Windows Server	$288,762	1	.75
Linux Server	$371,976	1.3	1
AIX Server	$1,126,803	3	1
Storage	$184,828	.4	.25
Networking	$493,550	1.6	1
District Total		**8.08**	**5**

* TCIO annual cost includes costs for staffing, operations, facilities costs (power/HVAC), building space, and related costs.

For the District, staffing for desktop support went from .5 person to one (1) person to support 205 desktops since the Measure B bond expansion. No additional staffing increases are needed for the district support of desktops.

With the expansion of servers during the Measure B bond technology improvements, the primary increase was in the District servers which went from 31 to 136 servers, due to the increase in new application systems, Enterprise servers and redundant servers to maximize system availability. With this substantial increase in systems and servers, the Gartner TCIO model recommends 5.7 IT staff required, which is an increase of three (3) IT staff members for Enterprise systems/servers.

The network growth resulting from Measure B includes 1) expanding the services for students and staff , 2) increasing the available bandwidth and 3) an increase in network ports by a factor of three to eight times depending on the site. In all three locations, the total port count has increased from 3,048 to 10,624, which is 3.5 times the network capability. The Gartner TCIO model recommends at least 1.6 staffing compared to the current 1.0 staff for network support. Thus, due to the anticipated expansion under the new Measure A Bond, an increase of one (1) network staff is recommended to maintain the network for 24x7 coverage.

10.0 SUMMARY OF TOTAL COST OF OWNERSHIP AT CLPCCD

Through the Measure B Bond program, the Information Technology infrastructure at Chabot-Las Positas Community College District (CLPCCD) has grown substantially. The Information Technology improvements included upgrades to servers, desktop/laptop, audio-visual, wired and wireless networking and cabling infrastructure. Likewise, the Total Cost of Ownership for the expanded infrastructure has been significant.

CLPCCD did take actions to handle TCO for the Measure B expansion to reduce TCO costs and achieve productivity gains. CLPCCD District ITS and College Technology departments have been able to accommodate the infrastructure and TCO growth through a number of operational approaches:

- Vendor Standardization: With vendor standardization, CLPCCD District ITS reduced incompatibility issues, support issues, administrative costs and have access to new technology for prototyping. For the Measure B Bond program, CLPCCD standardized on all IT equipment for switches, routers, network infrastructure, desktops/laptops, servers, audio-visual equipment and cabling. With vendor standardization, CLPCCD also gained purchasing leverage, which resulted in attractive pricing from partners who worked with CLPCCD for a successful infrastructure implementation.
- Product Selection – CLPCCD District ITS and College Technology staff analyzed and selected products that would provide the greatest performance and life cycle. This includes Hewlett-Packard and IBM servers, Hewlett-Packard desktops, Cisco networking hardware and Commscope SYSTIMAX Category 6A cabling standards. This has allowed CLPCCD to extend the longevity of the equipment and maximize its investment of Measure B funds.
- Multi-year Support Contracts with Vendors for Maintenance – Servers, desktops and network equipment were purchased with supplier/manufacturer support. This increased the availability of parts, skilled technicians for repair and timeliness of repairs. Where available, support contracts were purchased to the end of 2017 at the end of Measure B.
- Stable IS Organization: CLPCCD ITS has been fortunate to maintain talented staff, many of whom have worked in the District for 10+ years. Leveraging the long-time, experienced staff, the knowledge base for deployment of new systems was comprehensive and thorough. A stable staff kept deployments consistent and focused.

CLPCCD did replace technology equipment in accordance with the unit's service life in order to ensure that the support costs does not exceed the value of the equipment, thus reducing overall TCO costs. Desktop refreshes were completed on a 4-year cycle with 25% of the desktops being replaced annually with a total of 11 refreshes completed from 2005-2016. For Windows/Linux Servers, equipment replacements were done twice during the duration of Measure B in 2007 and

2014. For the Banner Enterprise AIX servers, replacements were also done twice during the duration of Measure B in 2007 and 2012. Network equipment refreshes were completed four times during Measure B in 2006, 2009, 2012, and 2014. The wireless network rollout had no refreshes during Measure B since all the installations were new, but CLPCCD will do a total replacement of wireless with the new technology available under Measure A.

While CLPCCD District ITS and College Technology departments have been very successful in the approaches documented above, the TCO impact has not been addressed in areas of staff levels and training. Supported by Gartner TCIO analysis and peer California Community colleges, the following staff expansion is required to support the ***current*** infrastructure acquired through the Measure B bond projects to satisfy the gap for TCO staffing:

Staffing Expansion for Servers, Desktops, AV and Networking

Location	Actual Staff Count	Gartner Recommended Staff Count	Proposed Growth for 2017-2018
Chabot	6	9	+3
Las Positas	5.5	7.5	+2.5
District	5	8	+3

* For LPC, additional .5 staff head count increase is already in progress for off-hours support of one full-time staff.

In addition to the staff expansion, appropriate training is required to ensure effectiveness of support to staff and students. Estimated costs of these staffing increases is provided using the Gartner TCIO salary estimates and summarized in the next section, IT Action Plan.

As the Measure A projects occur, CLPCCD plans to leverage the successful approaches for equipment selection, deployment and support. Further analysis of staffing levels must be performed on a regular basis to ensure there is adequate technology support to implement the new Measure A Bond projects as additional technology expansions continue. Some of the new Measure A initiatives that will require additional staffing include: a redesign of the wireless network at the colleges and district, distributed antenna system (DAS) to improve cell phone coverage internal to buildings, cell tower installations with key providers for external coverage outside the buildings, a total refresh of all the AV smart classroom configurations, and replacement/upgrades of the telephone systems.

11.0 INFORMATION TECHNOLOGY (IT) ACTION PLAN

Information Technology projects include the Measure A bond building modernization projects and other district wide Enterprise technology initiatives. This includes the development of an updated district-wide Technology Plan that addresses the technology aspects of facilities and equipment planning and aligns with the Facilities Master Plan, the College Educational Master Plans, and the District Strategic Plan. The Technology Plan will be expanded to include ongoing review of the Total Cost of Ownership (TCO), with annual adjustments incorporated as needed to ensure that TCO costs are addressed appropriately. In coordination with the College and District Technology committees, the existing equipment and application functionality will be assessed periodically, and there will be an ongoing review of IT systems/infrastructure and the relevant TCO to ensure that systems are performing in the best manner to satisfy the College requirements.

The following TCO areas will be reviewed:

- Acquisition Costs: An analysis of industry equipment directions will indicate if new acquisitions will provide enhanced functionality and service offerings to College staff and students while taking advantage of more attractive acquisition costs.
- Hidden Costs: As equipment changes, hidden costs for facility and resource use may be modified to more optimally use building resources for better operating costs.
- Ongoing Costs: Increased maintenance costs for existing, aging equipment may drive changes sooner than equipment service or life cycle would normally demand.

All factors affecting TCO cost impacts for CLPCCD Information Technology will be regularly assessed for the optimal environment for CLPCCD users.

Key items addressed in Phase 1 of the Measure A projects will include:

- Follow guidelines for the TCO IT model for Acquisitions and Ongoing Support as was done for Measure B.
- Upgrade of campus data and cellular wireless networking. This project will replace the current infrastructure with the 802.11ac Wave 2 technology, allowing for high-bandwidth and more pervasive data connectivity on campus. Distributed Antenna System (DAS) technology will be deployed to enhance cellular reception within buildings, in conjunction with carrier tower transmission outside of the buildings.
- Addition of equipment to support Facilities Master Plan: As buildings are modernized or renovated, new desktop/laptops and network infrastructure will be procured and deployed.
- Ongoing replacements for equipment life cycle and end of service life. Using the four-year life cycle, refreshes each year will replace 25% of the installed desktop/laptop equipment. Additional equipment needed for the building modernizations will be rolled

into the four-year life cycle refreshes. Network and server expansion and replacements will be designed and procured as needed.

- Ongoing support with multi-year vendor maintenance. To provide quick problem resolution and return-to-service, support contracts for equipment will provide expertise for quick problem resolution and efficiency of operations for CLPCCD District ITS and College Technology staff.
- Replacement of Help Desk software. To provide enhanced service to the user community, new Help Desk software will be implemented, providing a searchable knowledge base to assist with rapid problem resolution.
- Staff additions to reach Gartner and peer California Community Colleges staffing ratios. The recommendation provided in the chart below projects the additional growth as needed to meet the current year 2017-2018 to address the gap resulting from the Measure B expansion projects followed by the Phase 1 of Measure A projects which covers the first five years to 2022.

The Gartner model for TCIO estimated costs are based on industry-wide average costs, and are used to determine staffing ratio levels for maintaining a stable and reliable technology environment. CLPCCD adopted this model for the TCO analysis for Informational Technology. These staffing recommendations are shown in the following chart:

Location	Actual Staff Count	Recommended Staff Count	Proposed Growth for 2017-2018	Future Growth for Measure A Phase 1
Chabot	6	9	+3	+2
Las Positas	5.5	7.5	+2.5 *	+3
District	5	8	+3	+1

* For LPC, additional .5 staff head count increase is already in progress for off-hours support of one full-time staff.

Using the Gartner TCIO estimates, the following staffing costs would apply.

Resource	2017-2018 Staff Increases	2017-2018 Estimated Costs for Staffing Growth	Measure A Phase 1 Staff Increases	Measure A Phase 1 Estimated Costs for Staffing Growth
Chabot (Desktop, Server, AV)	3	$337,246	2	$210,910
LPC (Desktop, Server, AV)	2	$210,910	3	$337,246
District (Server, Enterprise, Networking	3	$393,856	1	$126,336
Totals		**$1,005,180**		**$674,492**

In summary, as implemented for Measure B, CLPCCD District ITS and College Technology will continue to follow and enhance the guidelines for Acquisition and Ongoing support described by the Total Cost of Ownership (TCO) for Information Technology (IT) to provide high-performing technology solutions for staff and students.

APPENDIX A

CALCULATING ANNUAL TCIO FOR CLPCCD INFORMATION TECHNOLOGY

Each year Gartner develops a new Total Cost of Infrastructure and Operations (TCIO) report based its Information Technology Key Metrics Data (ITKMD). ITKMD is part of the Gartner Benchmark Analytics range of solutions, and offers macro level and platform-level looks at Gartner's global database of comprehensive cost and performance measures. The annually published ITKMD reports contain relevant database averages and other statistics from a subset of metrics and prescriptive engagements available through Gartner Benchmark Analytics. ITKMD consists of more than 2,000 IT cost and performance statistics.

In 2015, Gartner collected ITKMD from over 2,000 enterprises worldwide. The data collected through 2015 formed the basis of the 2016 ITKMD series of reports. ITKMD provides immediate access to authoritative data on IT staffing and investment levels, as well as key technology cost and performance metrics. ITKMD is multilevel: from macrostatistics (such as IT expenditures/employee) to platform-level statistics. These metrics support improved budget and investment decisions with regard to the changing environments of business and IT. ITKMD is collected year-round through direct fact finding in benchmarking and consulting engagements, and through surveys of the Gartner customers and at Gartner events, in addition to surveys of non-Gartner-based customers.

The Gartner model for TCIO estimated costs include both the IT operating costs and Facility building operating costs to support the equipment. This includes costs for IT staffing, IT operations, facilities operating costs (power/HVAC), space, and other related costs. These estimated costs are based on industry-wide average costs, and are used to determine staffing ratio levels for maintaining a stable and reliable technology environment. CLPCCD adopted this model for the TCO analysis for Informational Technology.

Gartner’s TCIO model from 2016 assigns the costs as shown on the following table:

Gartner Costs per Platform (Categories of Equipment)

Platform	Unit	2016 Average TCIO/Unit/Year
Windows Server	No. of OS instances (installed)	$5,662
Linux Server	No. of OS instances (installed)	$8,454
UNIX Server	No. of OS instances (installed)	$27,483
Storage	No. of TB (raw configured)	$2,009
LAN	No. of ports (active)	$100
Voice Network	No. of users	$622
Client Computing	No. of end-user devices	$1,015

These values have been used to quantify funding costs for the CLPCCD District and College Technology TCIO.

Note that the total TCIO for a system at CLPCCD would include the years of service available from that system. The anticipated "service life" of CLPCCD technology equipment is as follows:

- Desktop/laptop computers: 4 years
- Servers: 5-7 years
- Printers: 5 years
- Network equipment: 7-10 years
- Network cabling: 20-25 years
- Audio-Visual equipment: 7 years
- Telephony systems: 8-12 years
- UPS: 15-20 years
- Generator: 20-30 years

CLPCCD ITS and College Technology staffing assess equipment usefulness to determine life span. Innovative technology that does not exist in the industry as of yet will make the current equipment obsolete and will reduce the service life when available.

TCIO calculations shown below are an **annual cost** based on Gartner's model.

Chabot College Servers

Chabot College has 30 servers, divided up as: twenty-eight (28) Windows servers and two (2) Linux servers. As such, the TCIO for those servers is:

Platform	2016 Average TCIO/Unit/Year	Quantity	Net Cost
Windows Server	$5,662	28	$158,536
Linux Server	$8,454	2	$16,908
LAN ports	$100	75	$7,500
Total TCIO			**$182,944.00**

Las Positas College Servers

Las Positas College has 22 servers, configured as: twenty (20) Windows servers and two (2) Linux servers. As such, the TCIO for those servers is:

Platform	2016 Average TCIO/Unit/Year	Quantity	Net Cost
Windows Server	$5,662	20	$113,240
Linux Server	$8,454	2	$16,908
LAN ports	$100	37	$3,700
Total TCIO			**$133,848**

District Servers

The TCIO for the Enterprise Banner server, application servers directly related to Banner access and general servers for email and web services is:

Platform	2016 Average TCIO/Unit/Year	Quantity	Net Cost
UNIX (AIX)	$27,483	41	$1,126,803
Linux Servers	$8,454	44	$371,976
Windows Servers	$5,662	51	$288,762
Storage (TB)	$2,009	92	$184,828
LAN ports	$100	120	$12,000
Total TCIO			**$1,984,369.00**

Network Infrastructure

Local Area Network (LAN) connections in the Data Center are already included in the Server TCIO cost model. Using the Gartner mode for Data Networks, the following TCIO calculations apply:

Platform	2016 Average TCIO/Unit/Year	Number of Active Connections *	Net Cost
Chabot	$100	2780	$278,000
Las Positas	$100	1,955	$195,500
District & TVOS	$100	200	$20,000
Total TCIO			**$493,500.00**

* Based on 2016 campus desktop and laptop counts. Does not include BYOD wireless users.

Staffing TCIO Calculations

Garner surveys the industry and compiles specific data on staffing levels and costs. These are documented as part of the ITKMD Toolkit, which is published annually. Key metrics are shown below:

Resource	TCIO cost per year	Staffing Cost Allocation	Average Annual Salary
Windows servers	$5,662	45%	$126,336
Linux Server	$8,454	50%	$142,335
Unix Server	$27,483	35%	$136,020
Storage	$2,009	26%	$131,836
Client Computing (Desktops)	$1,015	40%	$105,455
Data Network	$100	43%	$131,500
Voice Network	$622	37%	$122,529

Applying the Gartner recommendations to CLPCCD, the staffing requirements are calculated using the following formula:

$$\text{Net Staffing} = \frac{[\text{Platform 2016 Average TCIO/Unit/Year} * \text{No. of Units} * \% \text{ TCIO cost}]}{[\text{Salary}]}$$

Chabot College

Platform	2016 Average TCIO/Unit/Year	No of Units	Salary	% TCIO cost	Net Staffing Recommended
Desktop/Server	$1,015	2370	$105,445	40	9

Las Positas College

Platform	2016 Average TCIO/Unit/Year	No. of Units	Salary	% TCIO cost	Net Staffing Recommended
Desktop/Server	$1,015	1955	$105,445	40	7.5

CLPCCD District

Platform	TCIO cost per year	Gartner Recommended Staff count	Actual District Staff Count
Desktops	$208,075	.78	.1
Windows Server	$288,762	1	.75
Linux Server	$371,976	1.3	1
AIX Server	$1,126,803	3	1
Storage	$184,828	.4	.25
Networking	$493,550	1.6	1
District Systems/Servers Total		**8.08**	**5**

APPENDIX B

SURVEY OF CALIFORNIA COMMUNITY COLLEGE STAFFING LEVELS

A request was made to peer groups at Community Colleges in California in 2016 to share the staffing levels for desktop and server administration. The data in the chart was reviewed by CLPCCD to compare staffing levels for computer and server support to other comparable colleges.

The following data was received:

No.	College	No. Of Techs	No. of Computers	No. of Servers
1	Santa Rosa Junior College	22	3500	150
2	Merced Community College	7	1925	190
3	Ohlone CCD	11	2059	170
4	Long Beach	10	4200	250
5	Irvine Valley	5.5	1300	110
6	Glendale	8	2100	125
7	Fresno	11	3300	111
8	El Camino	8 Computer Support Techs, 3 Help Desk Techs, 1 Lab support tech.	3200	150
i9	Cuesta	5	2000	130

No.	College	No. Of Techs	No. of Computers	No. of Servers
10	Shasta	7	1589	227
11	Siskiyous	3	380	30
12	Southwestern	18	4000	180
13	Chabot	6	2370	30
13	Las Positas	5.5	1955	22
13	CLPCCD District	4	205	136