The Collin County Community College District Convergence Laboratory

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Abstract

This paper presents and describes the novel next generation convergence lab located in the Engineering Technology (ET) Division at Collin County Community College District's (CCCCD) Preston Ridge Campus in Frisco, Texas. The laboratory currently features four (4) distinct "offices" integrated into a common environment: 1) Gigabit Ethernet 2) Wireless LANs 3) Private Branch Exchange (PBX) 4) SOHO (Small Office – Home Office). The transport layer has several broadband access technologies including ATM (Asynchronous Transfer Mode), SONET (Synchronous Optical Network), and DSL (Digital Subscriber Line).

The system architecture for each of the convergent offices is discussed in detail along with emphasis on the enabling technologies at the access level of service. A selection of data and call processing configurations and capabilities is presented, for example, wire and wireless, as well as other voice/data processing techniques utilizing ATM, IP, and DSL telecommunication facilities. The paper also describes how funding through a NSF Advanced Technological Education grant is providing a mechanism to support activities in the convergence lab consisting of project-oriented/case study research for members of the North Texas Regional Technology Consortium. Finally, the paper elaborates on issues associated with interoperability efforts and examples of how the convergence lab could be employed as a model for beta testing and system integration for small and medium-sized industry partners.

I. Introduction

Even though the much anticipated seamless convergence of voice and data services primarily facilitated by IP enabling technologies has not been fully realized, a telecommunications industry experiencing flux and the uncertain resolution of technical issues combine as a catalyst for the introduction and implementation of a convergence laboratory at Collin County Community College District. A precise definition of the concept of "convergence" is not necessary or even desirable, but two definitions are offered here that have been gleaned from various literature that closely coincides with the goals and objectives of Collin College's laboratory[1, 2, 3, 4, 5]:

- *Convergence is the blending or integration of voice, video, and data into a single but flexible global telecommunications network.*

- *Convergence is the merging together of products and capabilities of multiple vendors so that they provide the services the customer requires.*

The definitions are given as stand alone, separate descriptions of convergence, but a detailed consideration of the two reveal that they undeniably are interdependent within the current state of technological advancement. The ability of a diverse portfolio of media (voice, data, video, etc.) interacting seamlessly within a heterogeneous communications atmosphere and subsequently processed by end users with I/O devices manufactured by an array of vendors utilizing non-uniform standards is quickly exiting the novelty phase and becoming an expected requirement[1, 6, 7].

The genesis of the convergence lab began with a group of Collin College professors debating how to spend the final balance of existing grant monies and accrue the maximum utility for students. This discourse eventually led to an existing classroom being completely remodeled and retrofitted with leading edge broadband communications and networking components and systems. Significant benefits to students, college, community, and corporate partners are described below:

- Collin College curricula is the prime driver.
  - Hands-on experience not previously available.
  - Foster interdisciplinary collaboration.

- Industry participation in curricula development.
  - Industry beta test site for small/medium sized businesses.
  - Corporate seminars and demonstrations.

- Magnet for wider variety of industries.
  - Availability of a wider offering of sophisticated custom courses.
  - Timely and real-world preparation of students.

II. Curricula Enhancement

The convergence lab is still in its nascent phase of development, but the efficacy of an educational tool of this scope is already being discovered in our ET curricula design. The lab directly enhances the instruction of several courses in our telecommunications, electronics and computer networking programs. A partial listing of the disciplines and course offerings experiencing immediate impact predicated on convergence lab activities is listed below:

- Telecommunications Technology and Electronic Engineering Technology Courses.
  - Introduction to Telecommunications (EECT 1303).
  - Wireless Telephony Systems (EECT 2437).
  - Communication Circuits (EECT 2439).
  - Telecommunications Broadband Systems (EECT 1444).

- Digital Signal Processing (EECT 1448).
- Technical Programming (CETT 1431).

- Computer Networking Technology Courses.
  - Fundamentals of Networking (ITNW 1325).
  - Installing and Administering Windows 2000 - Server (ITMC 1419).
  - Implementing and Administering Microsoft Windows 2000 (ITMC 1443).
  - Network Security (ITNW 2417).
  - Networking with TCP/IP (ITNW 2321).
  - Designing a Secure Microsoft Windows 2000 Network (ITMC 2433).

The primary beneficiaries, students, are offered an exponentially superior treatment of the topics in the courses above as instructors have the freedom to move away from the rudimentary charts and diagrams presentation of the relevant topics into a "real world" handling of these advanced subjects utilizing the convergence lab as the vehicle. In the wireless and networking disciplines, for example, the lab offers students the technical capability to design, configure, and test networks based on the IEEE 802.11b protocol within a "live" network. The lab also gives the student the opportunity to more fully realize the utility of topics and applications including optical networking, AFSK (Audio Frequency Shift Keying), and PSK (Phase Shift Keying) techniques. Generally speaking, curricula offered students in the higher education arena are subject to several "delays" in the system relative to course development, preparation for delivery, and timeliness and applicability to state-of-the-technology in business and industry. The advent of the convergence laboratory facilitates the student having the opportunity for exposure to hands-on activities tied directly to current technology or to the development of the next generation of products.

III. System Architecture

A detailed system baseline configuration of the laboratory is given in Figure 1. The central focus is the four (4) virtual offices listed below with some of their salient features and capabilities:

- Office A: Ethernet LAN.
  - Various configurations and topologies.
  - Fast/Gigabit Ethernet.
  - Voice/video over IP.
  - Multimedia applications.

- Office B: Wireless LAN.
  - LAN, Personal Information Machines (PIMs)/mobile terminals.
  - 2G, 2.5G, 3G, 4G, IR.
  - Voice/video over IP.

- Office C: PBX - Hybrid Telephony – Wired and Wireless.
  - Digital telephony, VoIP, wireless.

- Transmission, Signaling System 7 (SS7), ISDN, traffic engineering.
- Voice processing: voice mail, IVR, auto attendant.

- SOHO: Small Office/ Home Office.
  - Switch, wired, wireless.
  - Voice: analog, digital, over IP/DSL.
  - Streaming video, conferencing, entertainment over IP/DSL.
  - Bluetooth applications.
  - H.323/H.225/H.235.
  - POTS.

Access to the network is granted by several devices depending on the level and type of service[2, 4, 9]. However, the primary end user access tool is the PC – there are currently approximately twenty (20) Dell (Optiplex GX400) computers in the lab each equipped with Pentium 4 processors with an operating speed of 1.50 GHz. The computers have CD ROM drives with memory and disk capacity of 512 MB and over 40 Gbytes respectively. One of the desktops is being modeled to act as the Network Operating Center (NOC) for the group. Each workstation has a junction box that supports several flavors of connectivity including Ethernet, along with individual ports for single mode (SM) and multi-mode (MM) fiber optic. The twisted copper pair wiring at each desktop is high bandwidth capacity CAT 5 and CAT 6 cabling. Finally, the Dell's are equipped with wireless transceivers supported by IEEE 802.11b; the Infinity Project Technology Kit fitted with the advanced Texas Instruments digital signal processor is also installed in the lab[8]. A set of ten (10) laptop computers installed with wireless (802.11b) transceivers are also deployed in the data network. User access is also gained through the operation of several digital wired and wireless IP telephones manufactured by Nortel. A suite of call processing configurations are established in the database with the ability to originate/terminate calls in both wired and wireless fashion via IP, ATM, DSL, POTS, and IEEE 802.11b protocols and telecom facilities[9, 10, 11, 12, 13, 14]. Two servers manufactured by Dell (Poweredge 2500) are used to interconnect the workstations together in a LAN environment (see Figure 2).

At the access or transport level of service, there are a number of devices and equipment that promote both broadband and feature rich quality of service (QoS). A Nortel Networks Transport Node provides optical carrier 12 (OC-12) rings in the long haul while supporting OC-3 drops. A DSL Integrated Multiple Access System (IMAS) 2300 is the backbone for symmetrical/asymmetrical (SDSL and ADSL) DSL deployment providing services for commercial and home end users. Nortel's Passport 7440 is the enabling technology for ATM, frame relay (FR), and SONET applications (see Figure 3). The ADTRAN Atlas 550 sometimes referred to as a "Central Office in a box" functions as an Integrated Access Device (IAD) where T1, Basic Rate Interface (BRI), and POTS lines can be terminated. Virtual Office C has a Private Branch Exchange (PBX); here, the Nortel Networks 1000 Business Communications Manager offers several useful features including automated attendant, unified messaging, voicemail, fax, and call center functionality. Future expansion at the broadband level envisions the addition of the Optera optical DWDM system manufactured by Nortel (see Figure 4).

IV. NSF Consortium and Interoperability Efforts

Collin County Community College District is the lead institution in a consortium (North Texas Regional Technology Consortium) including Richland College of the Dallas County Community College District, Grayson County College, North Central Texas College, The University of North Texas and business partner Texas Instruments (see Figure 5). Within this framework, the convergence lab is being used as a pilot test-bed for learning activities with the objective of developing a model for problem solving oriented teaching that can be advanced and reused within the consortium and throughout the region. To facilitate this goal, a new course in testing methodology will be developed that heavily leverages the capabilities of the convergence lab. This particular area is supported by a grant from the National Science Foundation Advanced Technological Education initiative. Additional equipment for the lab will be purchased through the grant to bring remote access to consortium members to fruition.

Another top priority for the convergence laboratory to consider is the critical issues emphasized by interoperability. The second definition of convergence stated above embodies the crux of the challenges and opportunities centered on interoperability. With a multiplicity of vendors implementing an array of products where standards are not necessarily uniform, the maintenance of a communications network that allows quality inter-exchange is not trivial. However, the convergence lab would be an excellent choice for small and medium-sized businesses to evaluate proof of concept in a quasi vendor neutral environment. The utility of the lab is certainly maximized with this type of corporate engagement as industry investigates avenues where meaningful and relevant relationships can be fostered within the educational community. An Industry Advisory Group (IAG) has already been formed and has injected significant impact in terms of lab focus and direction.

An example of a client scenario currently under consideration involves a startup company developing management platforms and control systems for SONET networks running on multiple vendor rings, switches, and add – drop multiplexers who are interested in the lab to create and model networks. The lab has sufficient LAN and MAN capabilities to simulate the connecting and sub-networking affiliated with the prime SONET rings; however, the client is required to provide the central databases and control equipment such as a Sun Solaris Workstation which is not available in the base lab configuration. The customer client will also supply appropriate traffic simulation in order to execute testing that generates reliable and valid statistical data.

Expected costs and logistics related issues to client partners and the lab are relative to the value(s) derived from testing, training, and demonstrating systems. Costs to either the lab or the client include hardware and software for infrastructure as well as test and data gathering instrumentation. A client heavily invested in preparation to commence testing or training expects to have dependable support from the lab. One model to protect the customer's investment is supplier 7 X 24 technical service on all lab equipment with next day part replacement and onsite presence of appropriate lab personnel to maintain and troubleshoot systems as required. The context here is that a professional *pro forma* is the only level of effort

and support that is acceptable to be afforded to the client. The critical issue is not the cost to use the lab, but the cost of delay and the jeopardizing of quality control that are the principal concern.

V. Conclusion

In summary, the convergence laboratory has several attractive attributes that are vital to the Engineering Technology Division at Collin County Community College: 1) The convergence lab is necessary and essential to revising and updating curricula for degrees and certificates. 2) The lab acts as a magnet for current and prospective students along with teachers covering many disciplines. 3) The lab will serve as a viable platform for industries and businesses to justify involvement with educational entities as a collaborative community joint effort.

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Biography

WAYNE A. JONES

Wayne A. Jones is currently an associate dean and professor at Collin County College in Frisco, Texas. He received the B.S. in Electrical Engineering from Southern University with Latin Honors before matriculating to L.S.U. and earning a M.S. degree in Electrical Engineering where his research focused on the semiconductor physics of III-V compounds. His thesis is titled "Emitter Size Effects in InAlGaAs/InGaAs Heterojunction Bipolar Transistors".

ROBERT WRIGHT

Robert Wright is currently a professor at Collin County Community College District in Frisco, Texas. He is affectionately referred to as the "father" of the convergence lab for the initial concept and for the countless hours contributed to establishing the lab. He has many years of corporate experience with companies such as Nortel Networks and AT&T.

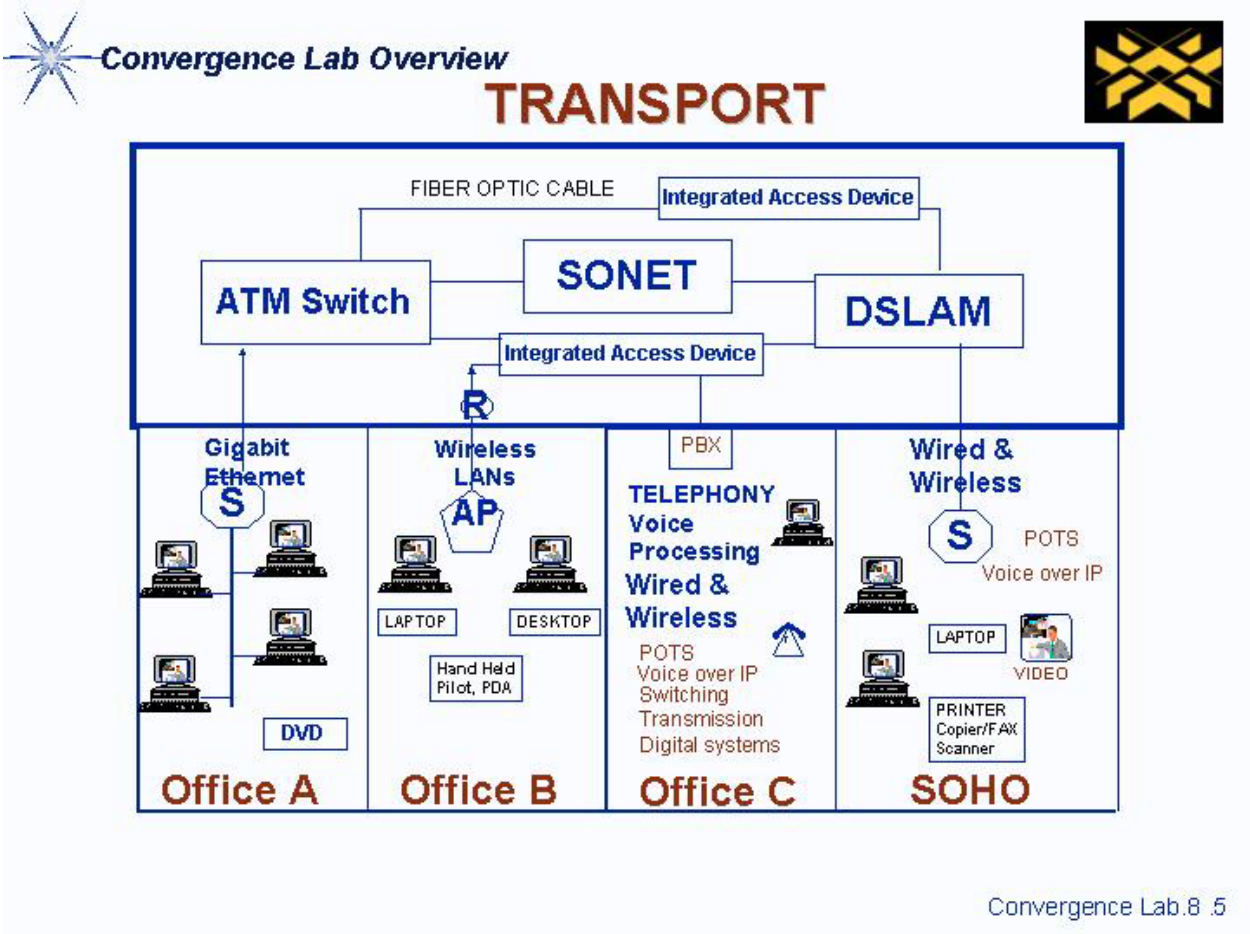

Figure 1: Convergence lab overview showing the transport layer and virtual offices.

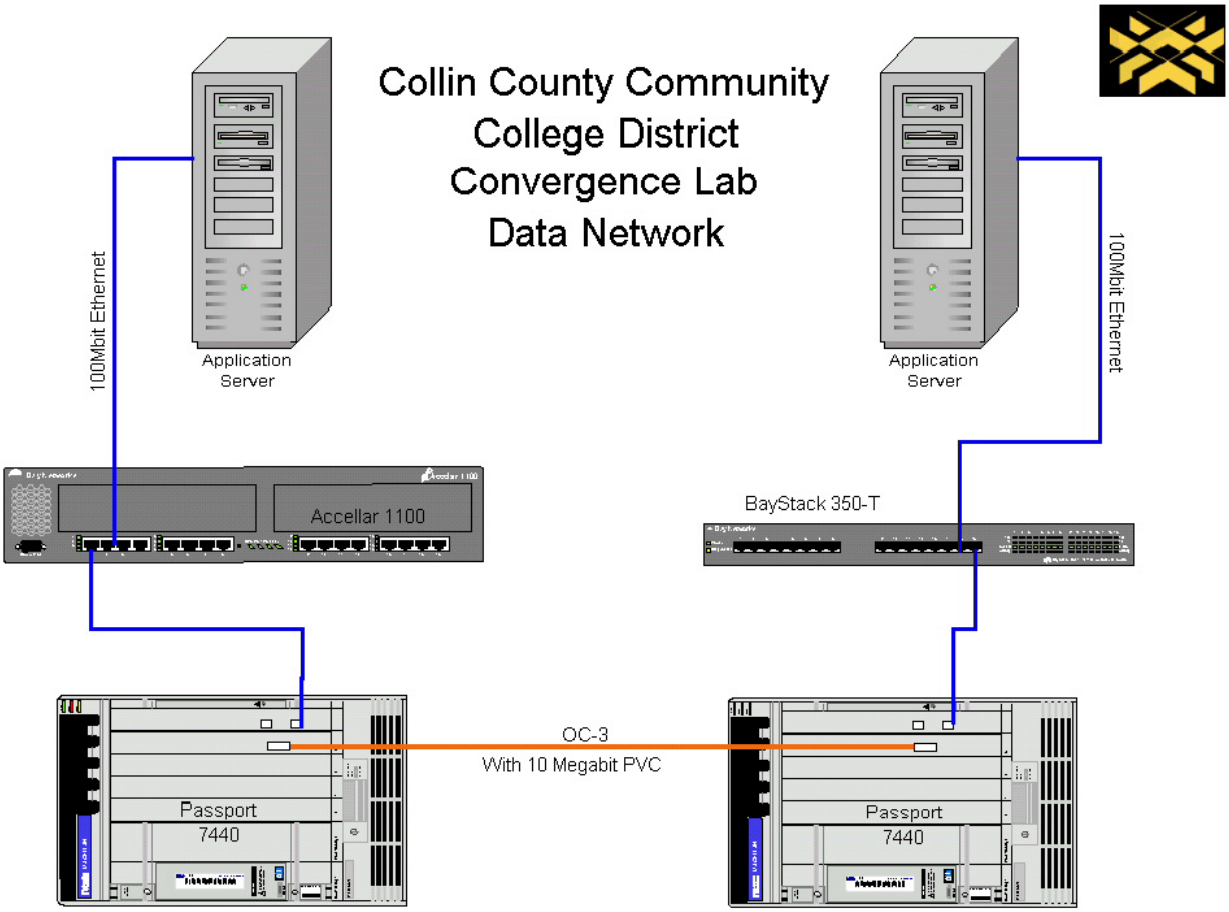

Figure 2: Convergence lab data network at the application server level.

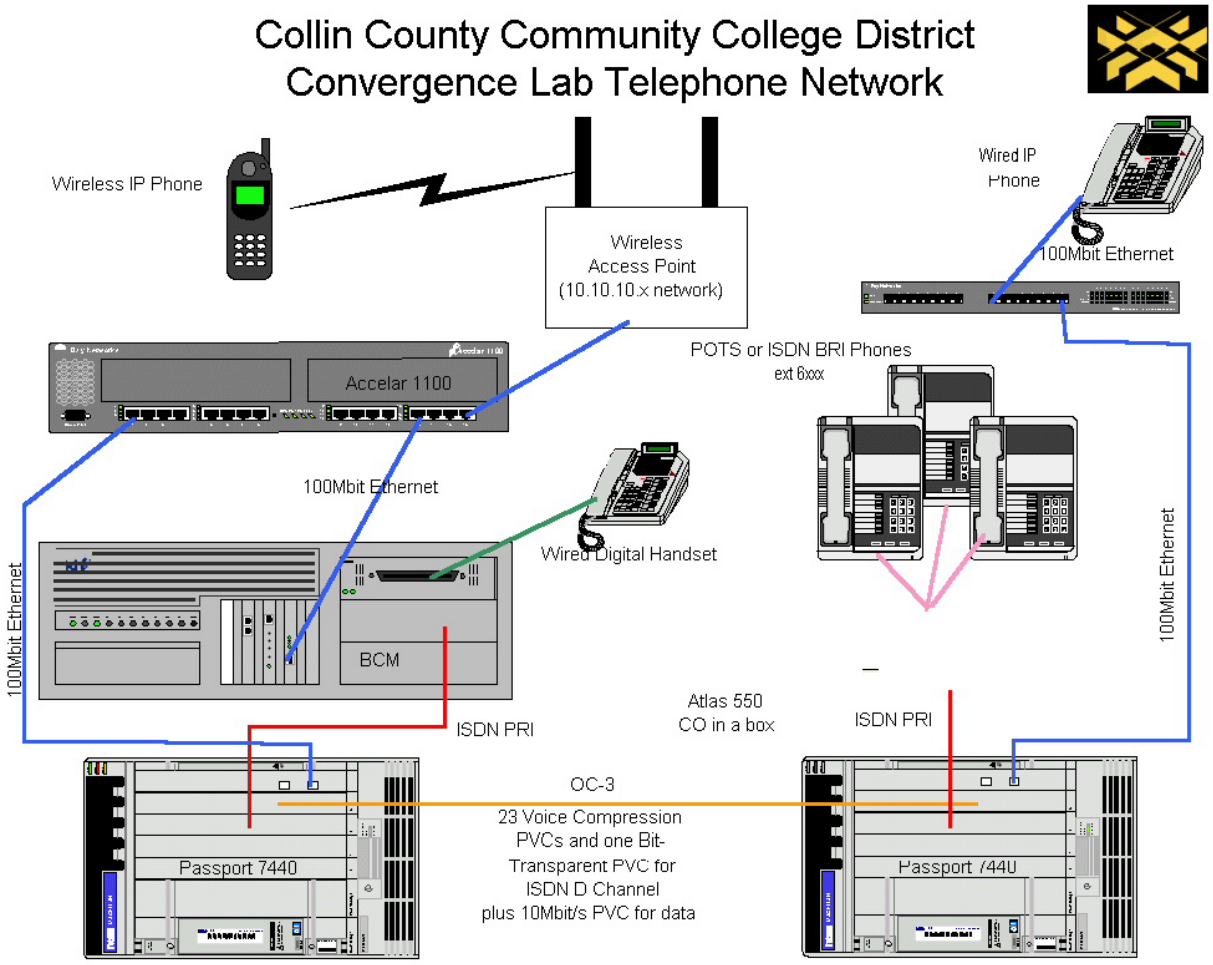

Figure 3: Convergence lab telephony network and the Passport 7440.

Figure 4: Future network expansion deploying the Optera 3400.

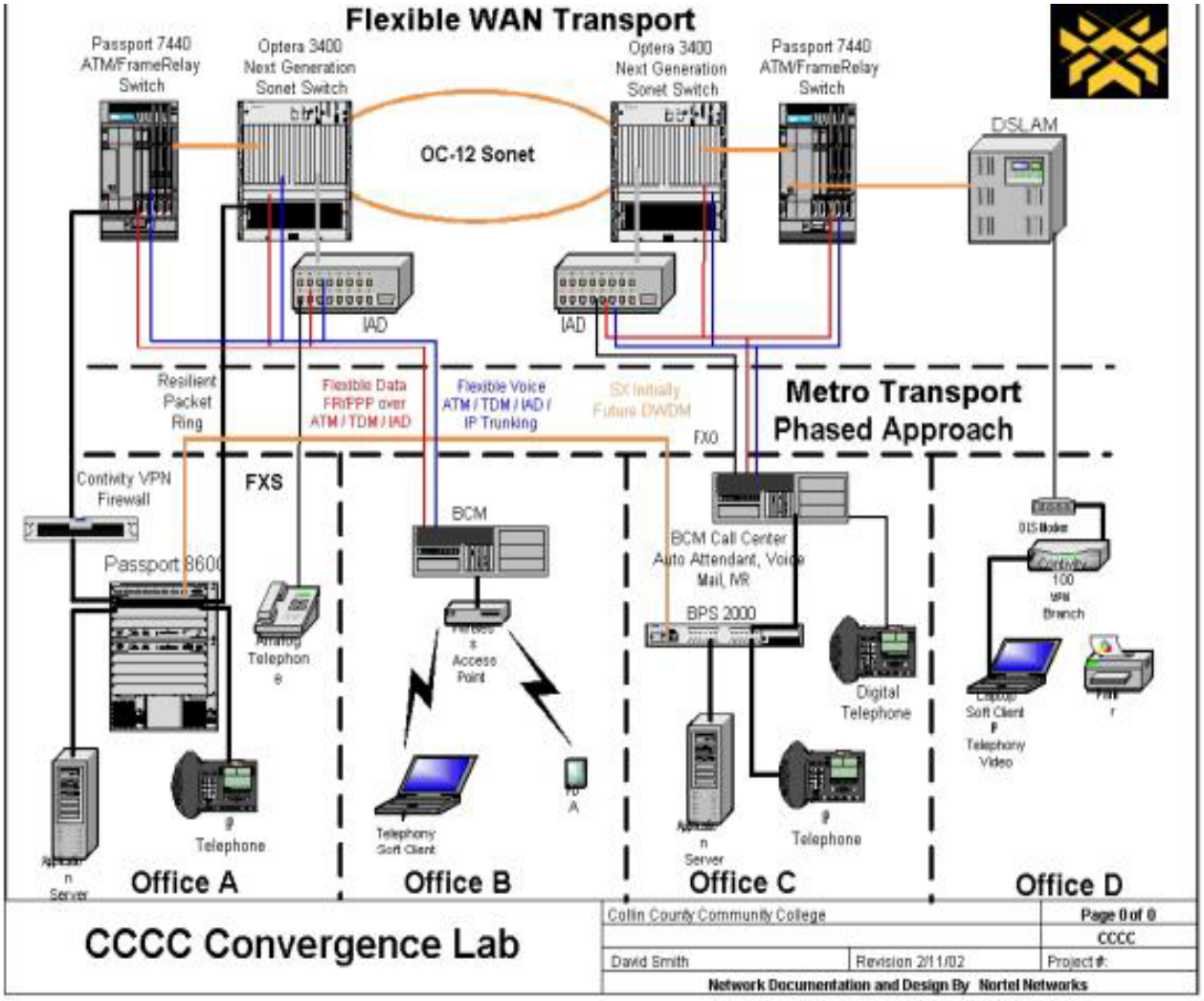

Figure 5: Convergence lab with members of the North Texas Regional Technology Consortium (Compliments of Shawn Stewart – Public Relations, CCCCD).