# Network Systems Technician (NST)
## Competency Requirements

This Competency listing serves to identify the major knowledge, abilities, skills, and standards areas which the **Network Systems Technician (NST)** needs in order to perform the professional networking concepts and practices required for modern wired and wireless information technology. Examples of these include, but are not limited to installing, configuring, troubleshooting, optimizing, operating, upgrading, maintaining, disaster prevention and recovery in networks.

**Network Systems Technician (NST)** must be knowledgeable in the following technical areas:

### 1.0 Network Terminology

- 1.1 Define the functions of a computer network
  - 1.1.1 Explain how modern networks developed from telephone network systems, Integrated Services Digital Networks (ISDN)
- 1.2 Identify network types and terminology associated with:
  - 1.2.1 Local Area Networks (LANs)
  - 1.2.2 Virtual Local Area Networks (VLANs) to include:
    - 1.2.2.1 Virtual Private Networks (VPN)
  - 1.2.3 Wide Area Networks (WANs) to include:
    - 1.2.3.1 Value Added Networks (VANs) and VPNs
    - 1.2.3.2 Metropolitan Area Networks (MANs)
    - 1.2.3.3 Low Power Wide Area Networks (LPWAN)
- 1.3 Describe the fundamental terms and nomenclature for network topologies to include:
  - 1.3.1 Point-to-Point
  - 1.3.2 Bus
    - 1.3.2.1 Peripheral Component Interconnect (PCI) and PCI express (PCIe)
  - 1.3.3 Ring
  - 1.3.4 Star
  - 1.3.5 Hybrid
  - 1.3.6 Mesh
  - 1.3.7 Tree (Hierarchical)
- 1.4 Describe Network Services
  - 1.4.1 Explain the differences between peer-to-peer versus server-based networks
  - 1.4.2 Compare the different network infrastructures and services available:
    - 1.4.2.1 File sharing and file management
    - 1.4.2.2 Peripheral integration and sharing
    - 1.4.2.3 Email
    - 1.4.2.4 Remote Access Servers (RAS)
    - 1.4.2.5 Application servers
    - 1.4.2.6 Print Servers
- 1.5 Define the Open Systems Interconnection (OSI) model
  - 1.5.1 List and describe the configuration of the seven OSI model layers to include:
    - 1.5.1.1 Application Layer – layer 7
    - 1.5.1.2 Presentation Layer – layer 6
    - 1.5.1.3 Session Layer – layer 5
    - 1.5.1.4 Transport Layer – layer 4
    - 1.5.1.5 Network Layer – layer 3
    - 1.5.1.6 Data-Link Layer – layer 2
    - 1.5.1.7 Physical Layer – layer 1
  - 1.5.2 Briefly explain the function of each layer within the OSI model
  - 1.5.3 Explain the importance and protocols of the OSI model layers in network design
  - 1.5.4 Explain how protocol data units (PDU) are used in context with the OSI model layers

 

## 2.0 Network Architecture – Wired and Wireless

- 2.1 Identify the network architecture's primary components and performance criteria for:
  - 2.1.1 servers
  - 2.1.2 workstations
  - 2.1.3 drives (HDD, SSD, Network, Hybrid)
  - 2.1.4 buses
  - 2.1.5 Central Processing Units (CPUs)
  - 2.1.6 memory
- 2.2 Compare wired Local Area Networks (LANs) and Wide Area Networks (WANs):
  - 2.2.1 Describe wired cabling and connectors in Ethernet networked systems to include:
    - 2.2.1.1 coaxial cable
    - 2.2.1.2 twisted pair
    - 2.2.1.3 optical fiber
  - 2.2.2 Explain application advantages of each of these cabling options
  - 2.2.3 Explain the function of Ethernet controllers, adapters, switches, routers, 'brouters' (bridge router) and access points
    - 2.2.3.1 Identify the purpose of a network interface controller (NIC)
      - 2.2.3.1.1 Ethernet Media Access Control (MAC) address
      - 2.2.3.1.2 Binding
    - 2.2.3.2 Identify the uses of dual network interfaces
  - 2.2.4 Explain how an Intranet is used
- 2.3 Recognize Wireless Local Area Networks (WLAN)
  - 2.3.1 Identify antenna technology and frequencies
    - 2.3.1.1 Explain Fresnel Zone transmitter/receiver technology
    - 2.3.1.2 Explain 'Reciprocity'
  - 2.3.2 Explain the use of Orthogonal Frequency Division Multiplexing (OFDM) used in High Performance Radio Local Area Networks (HIPERLAN)
  - 2.3.3 Identify and compare differing characteristics between HIPERLAN and 802.11 wireless interfaces
  - 2.3.4 Explain and list the general characteristics for 802.11a/b/g/n/ac/ax (WiFi 4/5/6)
    - 2.3.4.1 Identify how a Service Set Identifier (SSID) is used
  - 2.3.5 Identify network security protocols (WPA3, WPA2, WPA, and WEP)
- 2.4 Describe the wireless transport architecture identified as Bluetooth® (IEEE 802.15.1) technology
  - 2.4.1 Explain Spread Spectrum and the technique of Adaptive Frequency Hopping (AFH)
  - 2.4.2 Differentiate between frequency-hopping spread spectrum (FHSS) and direct-sequence spread spectrum (DSSS), a form of CDMA
- 2.5 Define internet connection sharing
  - 2.5.1 Explain the purpose of an 'ad-hoc network'
- 2.6 Define Broadband Network Communication
  - 2.6.1 Describe the term broadband network
  - 2.6.2 Explain the use of optical fiber in broadband technology
  - 2.6.3 Explain the operational and physical differences between Digital Subscriber Line (DSL) and 'cable'
  - 2.6.4 Define Multichannel Multipoint Distribution Service (MMDS)
    - 2.6.4.1 Explain the operational characteristics of a Local Multipoint Distribution Service (LMDS)
    - 2.6.4.2 Explain how DOCSIS+ key-management protocol is used within MMDS and LMDS
  - 2.6.5 Explain the difference between a copper-wired local loop and a wireless local loop (WLL)
    - 2.6.5.1 List the advantages of a WLL over a copper-wired local loop
    - 2.6.5.2 Describe the services offered through a WLL
  - 2.6.6 Describe how a broadband free-space optical system (FSO) has evolved into Optical Wireless Broadband (OWB)
    - 2.6.6.1 Describe the advantages of an FSO or OWB system over a closed broadband system
    - 2.6.6.2 Identify the bandwidth options provided by optical networks
    - 2.6.6.3 Describe what 'Media Converters' are and why they are needed

 

## 3.0 Network Configuration and Protocols - Wired and Wireless

- 3.1 Explain Internet addressing protocols, ports, standards, URLs and how network addressing works to include:
  - 3.1.1 Wide Area Network and TCP/IP assignments
    - 3.1.1.1 Describe the limitations of TCP/IP suite in a mobile network
  - 3.1.2 User Datagram Protocol (UDP)
    - 3.1.2.1 Layer 2 Tunneling Protocol (L2TP)
  - 3.1.3 Point-to-Point Protocol (PPP)
    - 3.1.3.1 Point-to-Point Tunneling Protocol (PPTP)
  - 3.1.4 ISP IP address assignment
    - 3.1.4.1 Simple Network Management Protocol (SNMP)
    - 3.1.4.2 Remote Monitor (RMON)
    - 3.1.4.3 IP Classes A thru E
    - 3.1.4.4 Subnet Masking
    - 3.1.4.5 Classless Inter-Domain Routing (CIDR)
  - 3.1.5 IPv4 using a 32-bit addressing
  - 3.1.6 IPv6 using a 128-bit addressing
    - 3.1.6.1 Explain the differences between IPv4 and IPv6
  - 3.1.7 Hyper Text Transfer Protocol (HTTP) web browsing, HTTPS (secure)
  - 3.1.8 Email Protocols
    - 3.1.8.1 Post Office Protocol 3 (POP3)
    - 3.1.8.2 Internet Message Access Protocol (IMAP)
    - 3.1.8.3 Simple Mail Transfer Protocol (SMTP)
    - 3.1.8.4 Multipurpose Internet Mail Extensions (MIME)
  - 3.1.9 Describe the Domain Naming Conventions (e.g.: .com, .org, .edu, etc.) managed by Internet Corporation for Assigned Names and Numbers (ICANN)
- 3.2 Identify additional Transport Layer Protocols and functions within a local area network (LAN):
  - 3.2.1 File Transfer Protocol (FTP)
    - 3.2.1.1 Explain the difference between Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)
    - 3.2.1.2 Differentiate between Server Message Block (SMB), Apple® Filing Protocol (AFP), and Network File System (NFS)
  - 3.2.2 Reverse Address Resolution Protocol (RARP)
  - 3.2.3 Describe the different types of wireless protocols:
    - 3.2.3.1 IEEE 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, 802.11ax
    - 3.2.3.2 Describe the move to Wi-Fi™ 4/5/6/6E
- 3.3 Explain network shared access configurations
  - 3.3.1 Explain how to configure and utilize an ad-hoc network
  - 3.3.2 Explain network access and ‘access method’ used by networks
  - 3.3.3 Explain the shared access technology involved with local area networking including:
    - 3.3.3.1 how to access ‘Homegroup Computers’, ‘Shared Folders’ and ‘Libraries’
  - 3.3.4 Explain the basics as to how devices gain access to and share the network by differentiating between:
    - 3.3.4.1 Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
    - 3.3.4.2 Carrier Sense Multiple Access/Collision Avoidance( CSMA/CA)
    - 3.3.4.3 Define the terms ‘Physical’ and ‘Virtual’ when used with carrier sense
    - 3.3.4.4 Define the terms ‘backoff’ and ‘wirespeed’ when used with CSMA/CD
    - 3.3.4.5 Token Ring MSAU
    - 3.3.4.6 Explain why CSMA/CD is not needed in modern Ethernet networking, but still in use with half duplex applications
- 3.4 Define the following terms:
  - 3.4.1 multiplexing
  - 3.4.2 demultiplexing
  - 3.4.3 bandwidth
  - 3.4.4 backbone links
- 3.5 Describe data rate measurement of a network connection

 

- 3.6 Define data transmission protocols to include:
  - 3.6.1 synchronous
  - 3.6.2 asynchronous
  - 3.6.3 explain a Universal Asynchronous Receiver – Transmitter (UART)
  - 3.6.4 half-duplex and full-duplex
- 3.7 Explain the characteristics and features of network connecting to include:
  - 3.7.1 client/server - domain
  - 3.7.2 peer-to-peer - home
- 3.8 Describe the structures, formats, fields, filtering and standards of:
  - 3.8.1 packets – RTP/RTTP, VOIP, UDP
  - 3.8.2 frames
  - 3.8.3 messages
  - 3.8.4 datagrams (User Datagram Protocol - UDP)
  - 3.8.5 bits
    - 3.8.5.1 Explain how Error Correction Codes (ECC) algorithms work
  - 3.8.6 segments
- 3.9 Describe the difference between switching:
  - 3.9.1 circuits
  - 3.9.2 packets
- 3.10 Explain how to configure the different types of wired networks
  - 3.10.1 Determine the proper use of wired cabling for different applications
  - 3.10.2 Explain how to connect:
    - 3.10.2.1 T1/T3/OC3 data multiplexers
    - 3.10.2.2 Matrix switches
    - 3.10.2.3 Voice/Video Over IP
- 3.11 Explain how repeaters/Wi-Fi™ extenders function and how they are used in networks
  - 3.11.1 Explain how MESH networks use repeaters
    - 3.11.1.1 Identify Mesh network topologies
- 3.12 Describe the legacy networking connectivity of:
  - 3.12.1 modem access technology
    - 3.12.1.1 differentiate between fiber, cable and DSL modems
  - 3.12.2 dedicated circuits to include:
    - 3.12.2.1 Asynchronous Digital Subscriber Line (ADSL)
    - 3.12.2.2 Digital telecommunication carrierT1/E1 (Transmission System)
      - 3.12.2.2.1 ATM Transmission (Asynchronous Transfer Mode)
    - 3.12.2.3 Multiprotocol Label Switching (MPLS)
- 3.13 Define the basic theory of operation and deployment purposes of:
  - 3.13.1 gateways
  - 3.13.2 routers
    - 3.13.2.1 Explain routing/routed/non-routable protocols
    - 3.13.2.2 Explain the characteristics and functions of a mobile IP router
- 3.14 Explain the functions of:
  - 3.14.1 switch
  - 3.14.2 repeater
  - 3.14.3 bridge
- 3.15 Describe wireless connections to include:
  - 3.15.1 Bluetooth® (IEEE 802.15.1) networks
  - 3.15.2 WLANs, MiWi™, Z-Wave® and Zigbee wireless networks
    - 3.15.2.1 Explain how Z-Wave® and Zigbee smart hubs work
- 3.16 Identify and establish criteria for using wireless and portable wireless devices in networks
  - 3.16.1 Explain how to program an IP-networked device onto a LAN
- 3.17 Explain the benefits of using combination networks

 

## 4.0 Network Services and Operations

- 4.1 Describe using Windows® server-based platform utilities to include:
  - 4.1.1 User and group accounts
    - 4.1.1.1 access levels
    - 4.1.1.2 access protected shares
    - 4.1.1.3 access permissions
  - 4.1.2 Identify the similarities/differences between file serving/sharing storage area network (SAN), network attached storage (NAS) and 'Server Message Block 3' (SMB3)
  - 4.1.3 Explain multitasking
- 4.2 Describe 'as a service' IaaS versus PaaS versus SaaS and how cloud configurations fit into them
  - 4.2.1 Identify the advantages and disadvantages of cloud-based IaaS over in-house Redundant Array of Independent Disks (RAID) Arrays for data storage
- 4.3 Describe security level access terminology
- 4.4 Explain how to utilize network administration tools contained in Windows® server-based platforms, Windows® Credential Manager
  - 4.4.1 Describe password use Windows®, Certificate-based, and Generic
- 4.5 Define the theory and classifications of signaling
- 4.6 Explain the use and function for network drivers:
  - 4.6.1 Open Data-link Interface (ODI)
  - 4.6.2 Network Driver Interface Specification (NDIS)
- 4.7 Describe the difference between transmission paths versus protocols
- 4.8 Describe the Simple Network Management Protocol (SNMP) framework and its three parts: SNMP manager, SNMP agent and MIB
- 4.9 Differentiate between analog and digital communications techniques
- 4.10 Explain the basics of broadband and baseband transmission protocols
- 4.11 Define characteristics of signaling in digital communications
- 4.12 Describe use and functions of Channel Service Unit / Data Service Unit (CSU/DSUs)
- 4.13 Explain how to setup software and hardware sharing utilities on a network
  - 4.13.1 Quality of Service (QoS)
- 4.14 Describe the file systems used by network operating systems, NAS and RAID
- 4.15 Explain how file integrity is maintained when multiple users are accessing the same files
- 4.16 Describe the purposes of network services available with:
  - 4.16.1 Windows® Internet Naming Service (WINS)
  - 4.16.2 Dynamic Host Configuration Protocol (DHCP)
  - 4.16.3 Domain Name System (DNS)
  - 4.16.4 Network Address Translation (NAT)
- 4.17 Explain other basic network performance and monitoring tools contained within:
  - 4.17.1 Windows® server-based platforms
  - 4.17.2 Linux
  - 4.17.3 OS X (Apple®)
- 4.18 Identify protocol stacks native to each network operating system
- 4.19 Describe the essential file structures used in 'booting'
- 4.20 Explain the criteria and procedure for setting up separate hard disk partitions for different operating systems
- 4.21 Define the basic administration and cybersecurity control features of network operating systems:
  - 4.21.1 firewall
  - 4.21.2 proxy servers
  - 4.21.3 DeMilitarized Zone (DMZ)

## 5.0 Diagnostics, Equipment, Tools and Troubleshooting

- 5.1 Describe the main tools available within network operating systems that can be used to measure network performance as it relates to accounting and auditing
- 5.2 Troubleshooting TCP/IP using utility commands and their switches
  - 5.2.1 Describe the three modes of Ping to Verify and test connectivity (ICMP, UDP, TCP)
  - 5.2.2 IPCONFIG - displays the current TCP/IP configuration and information on 98/NT/2000
  - 5.2.3 TRACERT (Windows®) or TRACEROUTE - displays the path a packet takes to a destination host computer

 

- 5.2.4 NETSTAT - displays the TCP/IP protocol sessions, connections and open port connection information
- 5.2.5 NBTSTAT - displays a list of NetBIOS computer names that have been resolved to IP addresses
- 5.2.6 ROUTE - displays or modifies the local routing table
- 5.2.7 ARP - displays the cache of locally resolved IP addresses to Media Access Control (MAC) addresses

5.3 Describe the common causes and symptoms of network 'bottlenecks'

5.4 Explain how the following test equipment works:

- 5.4.1 time domain reflectometers (TDRs)
- 5.4.2 oscilloscopes
- 5.4.3 network analyzers
- 5.4.4 software-based network monitors
- 5.4.5 simple network cable tester
- 5.4.6 network cable certifiers

5.5 Explain the criteria for selection of an uninterrupted power supply (UPS) and/or redundant power supply (RPS)

## 6.0 Network Security

6.1 Identify key points required for a typical network enterprise disaster plan

6.2 Describe network security tools and procedures to:

- 6.2.1 safeguard against virus attacks
- 6.2.2 monitor activities

6.3 Identify backup tools used in safeguarding critical resources to include:

- 6.3.1 software
- 6.3.2 hardware

6.4 Describe Domain Name System (DNS) attack mitigations to include:

- 6.4.1 Denial of Service (DoS)
- 6.4.2 Distributed Denial of Service (DDoS)
- 6.4.3 Define a 'botnet'

6.5 Explain the Secure Socket Layer (SSL) in network cybersecurity

6.6 Explain the purpose for wireless encryption keys

- 6.6.1 Robust Security Networks IEEE 802.11i
  - 6.6.1.1 Temporal Key Integrity Protocol (TKIP)
  - 6.6.1.2 Counter Mode with Cipher Block Chaining Message Authentication Code Protocol (CCMP)
- 6.6.2 Advanced Encryption Standard (AES)

6.7 Define Remote Authentication Dial In User Service (RADIUS) protocol

6.8 Describe IEEE 802.1x and the Extensible Authentication Protocol (EAP)

6.9 Describe wireless network security protocols (WPA3, WPA2, WPA, replacing WEP)

## 7.0 Networking and Industry Standards

7.1 Describe OSI model configuration in network architectures based upon ISO/IEC 7498-1 standard

- 7.1.1 Explain function standards and protocol standards at each level of the OSI model
  - 7.1.1.1 Application layer 7: WWW browsers, NFS, SNMP, HTTP, HTTPS, FTP
  - 7.1.1.2 Presentation layer 6: ASCII, EBCDIC, TIFF, GIF, PICT, JPEG, MPEG, MIDI, PNG
  - 7.1.1.3 Session layer 5: NFS, NIS, RPC, SQL
  - 7.1.1.4 Transport layer 4: SPX, TCP/IP, UDP
  - 7.1.1.5 Network layer 3: Apple® Talk DDP, IP, IPX
  - 7.1.1.6 Data-Link layer 2: ITU-T G.hn, PPP, ANSI FDDI, Token Ring
  - 7.1.1.7 Physical layer 1: Parallel SCSI, Ethernet, FDDI, RJ45, ITU-T, V.35, V.24, IEEE 802.11, Bluetooth® (IEEE 802.15.1), IEEE 802.15.4 wireless

7.2 Interpret names and acronyms for network standards organizations:

- 7.2.1 International Organization for Standardization (ISO®)
- 7.2.2 American National Standards Institute (ANSI)
- 7.2.3 Information Technology Industry Council (ITI)
- 7.2.4 National Committee for Information Technology (NCITS)
- 7.2.5 National Telecommunications and Information Administration (NTIA)

 

- 7.2.6 Institute of Electrical and Electronics Engineers (IEEE)
- 7.2.7 Telecommunications Industry Alliance (TIA®)
- 7.2.8 Cellular Telecommunications & Internet Association (CTIA™)
- 7.2.9 International Telecommunication Union- Telecommunication Standardization Sector (ITU-T)
- 7.2.10 European Telecommunications Standards Institute (ETSI)
- 7.2.11 Internet Engineering Task Force (IETF®) - voluntary internet standards
- 7.2.12 National Fire Protection Association (NFPA®)

7.3 Define Network Shared Access Standards
- 7.3.1 Explain the standards for all LANs to include:
  - 7.3.1.1 Types of Ethernet media
    - 7.3.1.1.1 Ethernet
    - 7.3.1.1.2 Fast Ethernet
    - 7.3.1.1.3 Gigabit Ethernet
  - 7.3.1.2 Explain the utilization and define 10/100/1000 Base specifications
  - 7.3.1.3 IEEE 802.x standards
- 7.3.2 Explain the content and identity of IEEE 802.3 Ethernet standards
  - 7.3.2.1 Describe cable termination standards for:
    - 7.3.2.1.1 coaxial cable
    - 7.3.2.1.2 twisted pair, UTP/STP
    - 7.3.2.1.3 optical fiber
  - 7.3.2.2 Understand the differences in the collection of IEEE 802.3 standards defining the physical layer and the data-link layer of wired Ethernet
- 7.3.3 Describe the features of WLAN standards 802.11(xx)
  - 7.3.3.1 Explain 802.11 simplification to Wi-Fi™ 4, 5, and 6
- 7.3.4 Differentiate between 802.3 and 802.11 standards (known as Wi-Fi™ 4/5/6/6E)
- 7.3.5 Explain the basic features of the IEEE 802.15.x standard for WPANs to include:
  - 7.3.5.1 Bluetooth® managed by Bluetooth® Special Interest Group (BSIG) - 802.15.1
  - 7.3.5.2 MiWi™, Zigbee managed by Connectivity Standards Alliance (formerly Zigbee Alliance) – 802.15.4
- 7.3.6 Explain the basic features of IEEE 802.16x standard for WiMAX

7.4 Explain the features of basic optical standards

7.5 Describe Fiber Distributed Data Interface (FDDI) procedure and capability

7.6 Explain the Synchronous Optical Network (SONET) hierarchy in North America
- 7.6.1 Explain Synchronous Digital Hierarchy (SDH) outside N.A.
- 7.6.2 Describe Optical Transport Network (OTN) standards defined by ITU-T

7.7 Define the advanced Small Computer System Interface (SCSI) standards used in high-end server systems.

7.8 Explain the limitations of the hard disk drive standards:
- 7.8.1 Advanced Technology Attachment (ATA)
- 7.8.2 Serial Advanced Technology Attachment (SATA)
- 7.8.3 Integrated Drive Electronics (IDE)
- 7.8.4 SATA to Peripheral Component Interconnect express (PCIe)

## End of Network Systems Technician Competencies

 

**Find An ETA Test Site:** https://www.etai.org/test_sites.html

## Suggested Additional Resource and Study Material:

**As with most networking systems, you will find details and information on Websites:** ieee.org; networkcomputing.com; cisco.com; pcworld.com; cnet.com; computerworld.com; pcmag.com; Bluetooth Special Interest Group (SIG); consumerreports.org; maximumpc.com; infoworld.com; microsoft.com; itunes.apple.com; csa-iot.org; rmroberts.com; darrilgibson.com; professormesser.com; youtube.com; and many, many other websites.

**Guide to Designing and Implementing Local and Wide Area Networks, 3E**; Michael J. Palmer, PhD and Bruce Sinclair; ISBN 978-0619216115; Course Technology; 2015; 250 pgs.

**NST Research Document.pdf;** Tcat Houser, RESIma, CST, NST; Self-published 2015; 90 pgs.; Available at www.etai.org or by calling 1-800-288-3824

**Microsoft Windows Networking Essentials;** Darril Gibson; ISBN 978-1118016855; Sybex; 2011; softcover; 368 pgs.

**Cabling, part 1: LAN Networks and Cabling Systems, 5E;** Andrew Oliviero; ISBN 978-1118848289; Sybex; 2014; softcover; 608 pgs.

**CCNET Study Guide, 2E;** Todd Lammle; ISBN 978-1118749685; Sybex; 2013; softcover; 744 pgs.

**Upgrading and Repairing Networks, 5th Ed.;** Scott Mueller, Terry Ogletree, Mark Soper; ISBN 978-0789735300; Que Publishing; 2006; softcover; 1200 pgs.

**Designing and Building Enterprise DMZs;** Hal Flynn; ISBN 978-1597491006; Syngress; 2006; softcover; 714 pgs.

## NST Committee Subject Matter Expert Advisory Board:

| | |
|---|---|
| Agard, Rich, RESIma | ragard@septa.org |
| Andrew Bonica, (CST, FOT, NCT, FO)I | andrew.bonica@gmail.com |
| Chuck Brooks, (RESI) | chuck@eitprep.com |
| Joshua Copeland, ITS, NST, CST | jdcopeland@gmail.com |
| Debra Cruickshank, FOI, FOT | debcruic@gmail.com |
| Joe Farkas, CETsr | |
| Mike Goshen, ITS, NST, CST | goshen@michaelgoshen.com |
| J.B. Groves,III, ITS, CST, NST,+ more | jbgroves@wcjc.edu |
| Davanan Harry, (CET) | davananh@yahoo.com |
| Eric Ingram, FOT, CETsr | eingram2@brandman.edu |
| Lazim Khan, (CNST) | lazimkhan@gmail.com |
| Ed Kirkpatrick, PVI, CSS | ekirkpatrick@etai.org |
| Tim Kirschbaum, NST, CST, CSS, (FOT) | kirschbaumt@hotmail.com |
| Brian Klier, | brian.klier@gmail.com |
| Dr. Ron Milione, CETma | ronmilione@yahoo.com |
| Rick Pinkava, (CST) | rpinkava@cvccworks.edu |
| Antonio Russell, (NST, CST) | arussell901@gmail.com |
| Tracy Sparks, NST, CSS, MCP, MTA | tsparks@etai.org |
| Rodolfo Veloz Perez, CETmsF, CETmsIT | Rodolfo@brainamics.net |

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