

A Overview of VoIP and VoIP Projects

Reunion de Primavera

CUDI 2004

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Overview

- History of VoIP
- H.323
- SIP
- i911 Project
- The TAMU ITEC & Projects
- Internet2 VoIP Projects
- VNELab and WAES



What is VoIP?

- VoIP - (Voice over Internet Protocol)
- Commonly referred to as Internet telephony. It is a method of digitizing voice, encapsulating the digitized voice into packets and transmitting those packets over a packet switched IP network.



VoIP Protocols

- H.323
- SIP



H.323

- Definition: a multimedia standard that provides a foundation to transport voice, video and data communications in an IP based network.
- H.323 Zone
 - Collection of terminals, gateways, MCUs registered with a single gatekeeper.



H.323 Equipment

- Gatekeeper
 - Device that provides address translation
 - access control for H.323 terminals and gateways
 - manage bandwidth allocation
- Gateway
 - Device that connects H.323 voice network to non-H.323 voice network (SIP or PSTN)
 - Allows H.323 terminals to communication with non-H.323 terminals



H.323 Equipment

- MCU (multipoint control unit)
 - MC – multipoint cotroller
 - Routes call and control sgnaling to ensure endpoint compatibility
 - MP – multipoint processor
 - Switches, mixes and processes vice and vide streams to conferencing equipment

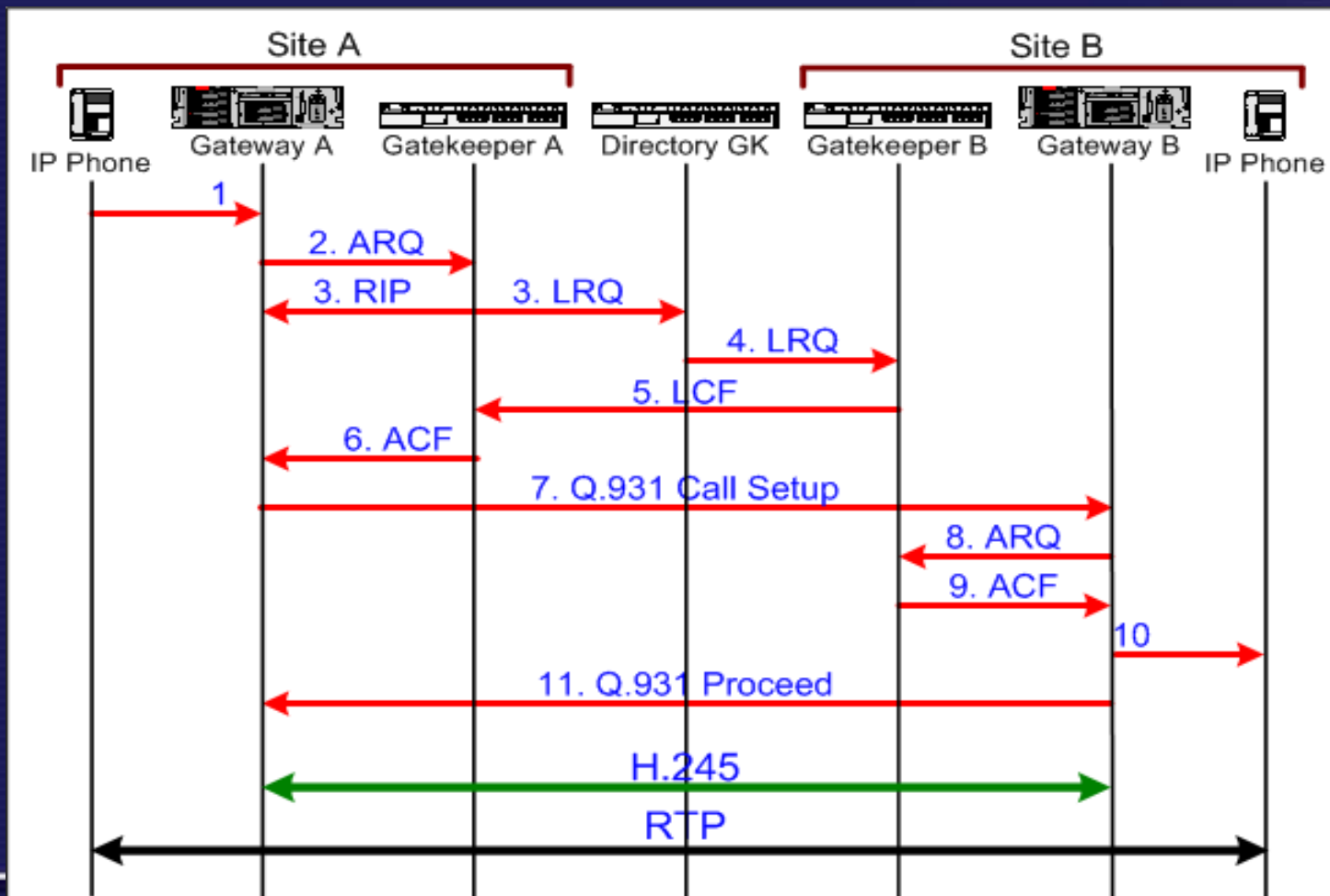


H.323 Equipment

- Terminal
 - An endpoint that supports 2-way streaming with another H.323 terminal or gateway
 - Originates and terminates calls



H.323 Call Setup via Gatekeepers



Session Initiated Protocol (SIP)

What is SIP?

- Text based Internet Protocol
- Resembles HTTP and SMTP
- Designed to set up a session between 2 endpoints
- Messages are sent in ASCII rather than encoded in binary



SIP - Network Elements

SIP's basic architecture is client/server in nature.

Main elements in a SIP network:

- User Agents
- Proxy Servers
- Redirect Servers
- Location Servers



SIP – User Agents

- User Agents: The endpoints in the SIP network, such as SIP phones. They function as either a client (UAC) when initiating requests, or a server (UAS) when responding to requests.



SIP – Proxy Servers

- Proxy Servers: Acts as both a server and a client for the purpose of making requests on behalf of other clients. Unlike User Agents, Proxy Servers do not initiate new SIP requests. A Proxy Server interprets, and, if necessary, rewrites a request message before forwarding it.



SIP – Redirect Servers

- SIP Redirect Servers: Provides the client with information about the next hop or hops that a message should take and then the client contacts the next hop server or UAS directly.



SIP – Location Servers

- SIP Location Servers: A server that accepts REGISTER requests, and processes requests from UACs for registration of their current location. A registrar is typically co-located with a proxy or redirect server and may offer location services.



SIP – Call Setup

SIP Methods:

- INVITE: User or service is being invited to participate in a session.
- ACK: Client has received a final response to an INVITE request.
- OPTIONS: Server being queried about capabilities.
- BYE: User Agent Client indicates to server to release the call.
- CANCEL: Cancels a pending request.
- REGISTER: Client registers address with a SIP server.



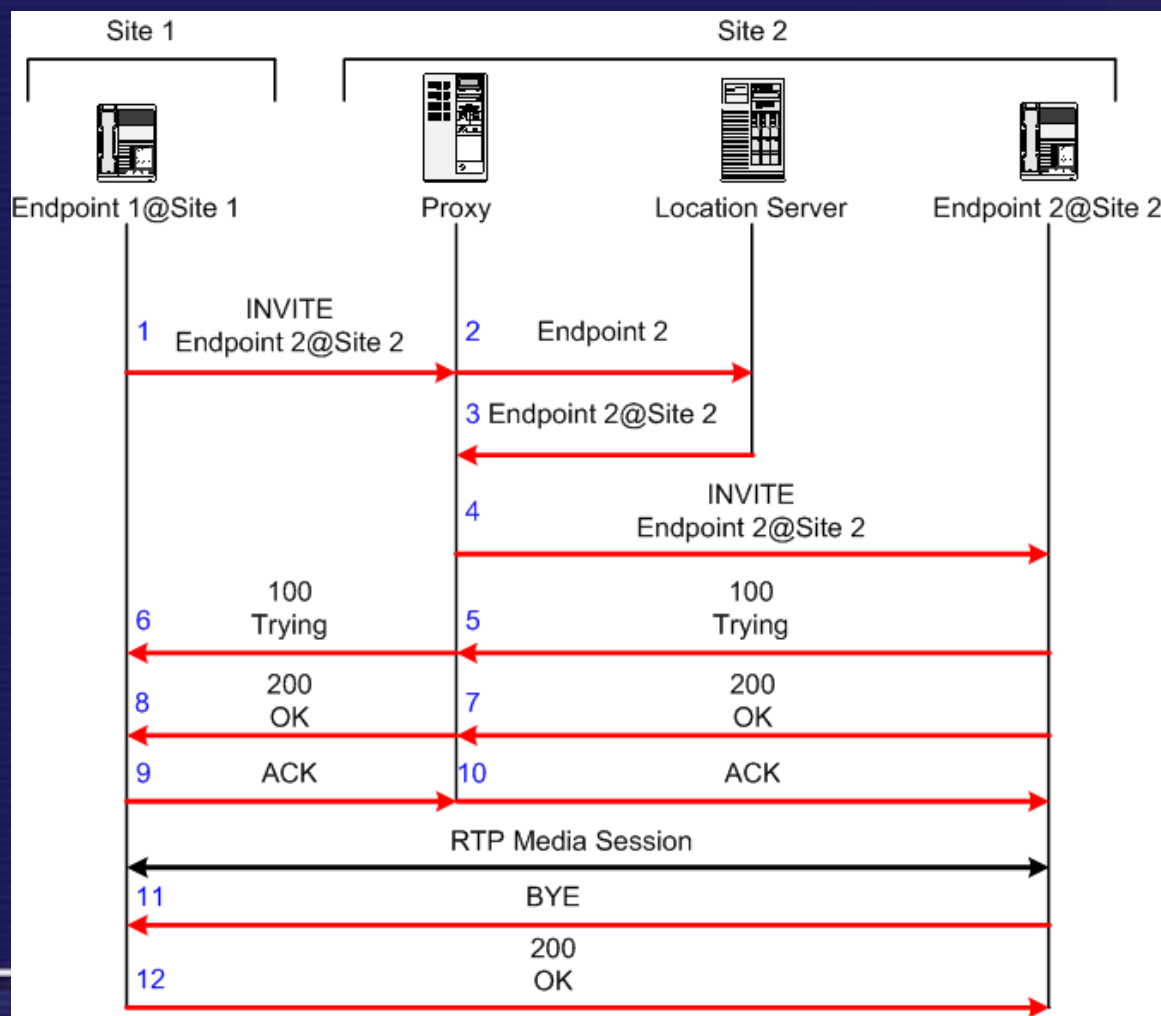
SIP – Responses

- SIP Responses

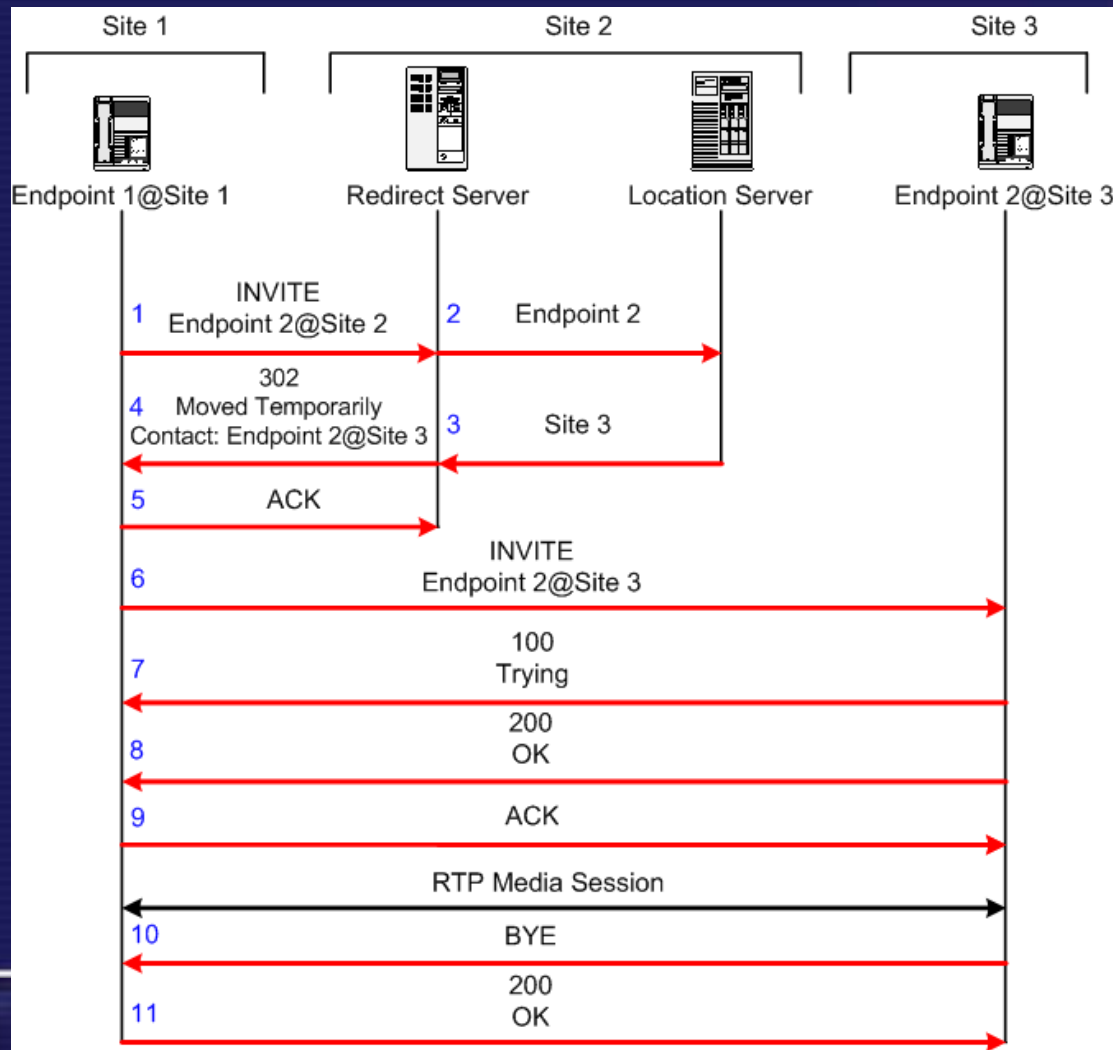
- 1XX Informational: Request received, continuing to process request.
- 2XX Success: Action successfully received, understood and accepted.
- 3XX Redirection: Further action required to complete request.
- 4XX Client Error: Request contains bad syntax or cannot be executed at server.
- 5XX Server Error: Server failed to execute an apparently valid request.
- 6XX Global Failure: Request cannot be executed at any server.



SIP – Typical Call Scenario for Proxy Mode



SIP – Typical Call Scenario for Redirect Mode



Speech Codec Comparison

• Codec	Type	Rate	Algorithmic	Delay(ms)
• G.711	A-Law / μ -Law	64	0	
• G.722	SB-ADPCM	64/ 56/ 48	0	
• G.723.1/	AMP-MLQ/ACELP*	6.3/ 5.3	37.5	
• G.726	ADPCM	16/ 24/ 32/ 40	0	
• G.727	Embedded ADPCM	16/ 24/ 32/ 40	0	
• G.728	LD-CELP	16	< 2	
• G.729	CS-ACELP	8	15	
• G.729	ACS-ACELP	8	15	
• G.729	BCS-ACELP*	8	15	
• G.729	ABCS-ACELP*	8	15	

Issues with VoIP

- Firewalls
- NAT
- QoS
- Network Testing



VoIP Issues – Firewalls

- A set of security mechanisms than an organization implements to prevent unsecured access from the outside world to its internal network.
- Typically work by blocking access of certain network protocols to specific ports.



VoIP Issues – NAT

- Helps protect the intranet from exposure to unwanted traffic by providing one single external address to remote users.
- Translates local intranet addresses into an external address.
- Remote users connect to this external address to connect to the local user, without actually knowing its local address.

Issues with Firewalls and NAT

- H.323 requires the use of specific static ports for RAS messages, and a number of dynamic ports for RTP.
- SIP has one port (5060) for SIP messages, as well as dynamic ports for RTP.
- For these protocols to pass the firewall, the specific static and the range of dynamic ports must be opened for all traffic.

Voice Over IP - the reasons that we have all heard!

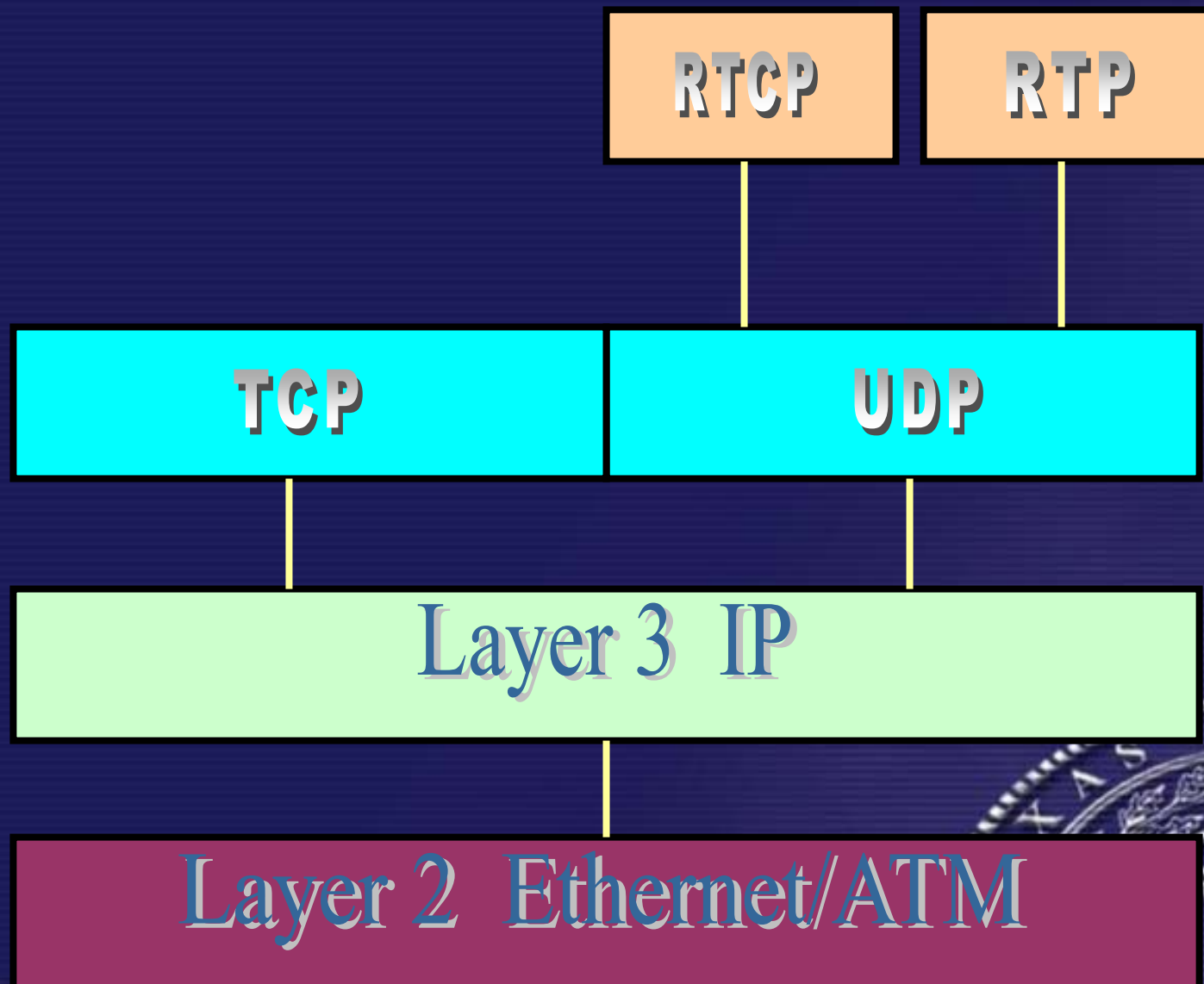
- Perception
 - It is cheaper to run just one network.
 - It is easier to integrate advanced technology when your phone is on the network (CTI).
 - If you don't do it someone else will.
- Reality
 - Convergence will occur some day so it is important that we build the required relationships now.



Voice over IP - the basics

- Most implementations use H.323 protocol
 - Same protocol that is used for IP video.
 - Uses TCP for call setup
 - Traffic is actually carried on RTP (Real Time Protocol) which runs on top of UDP (add drawing of protocol stack).





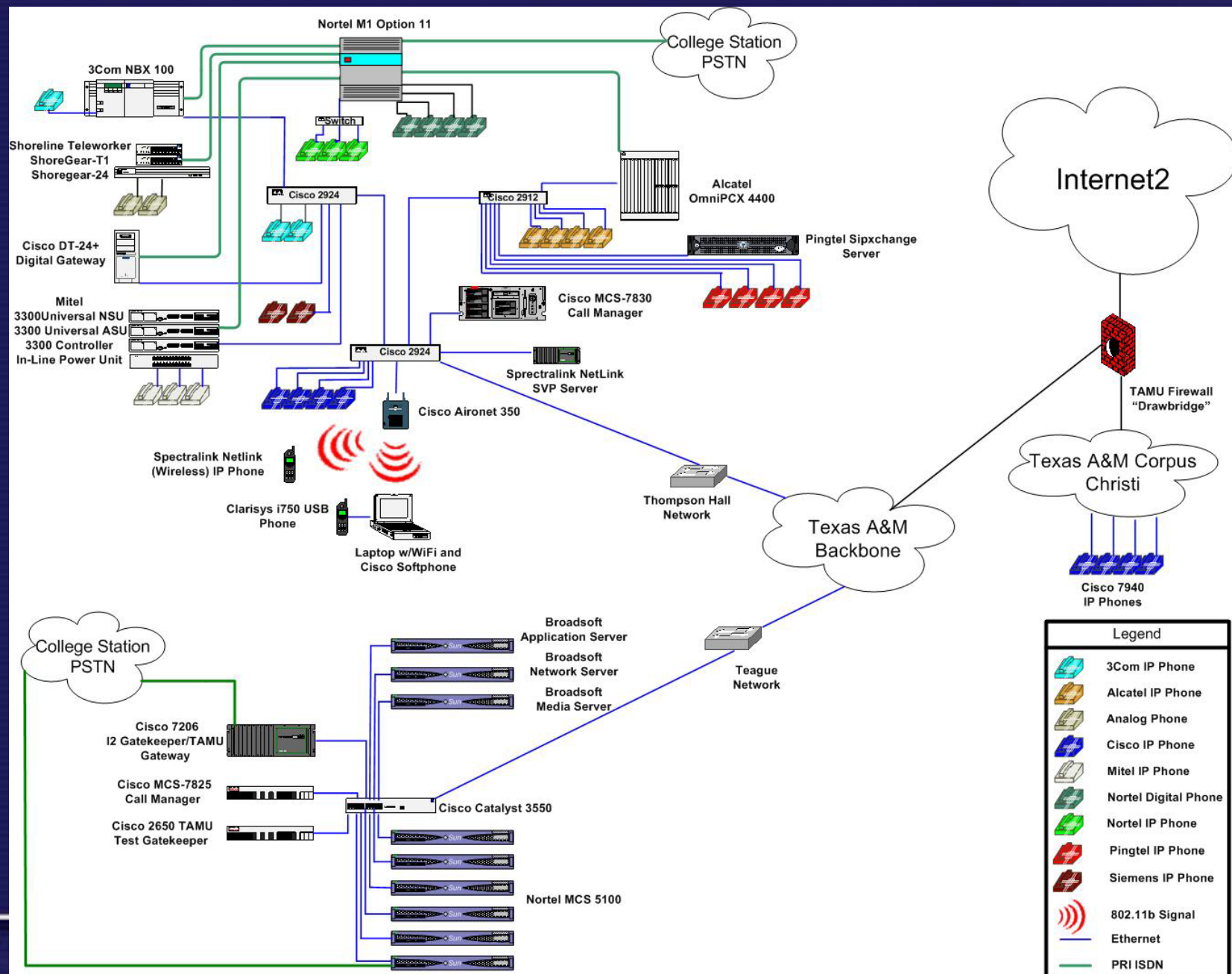
The TAMU ITEC



The TAMU ITEC

- The first Internet2 Technology Evaluation Center (ITEC) focused on Voice over IP.
- The TAMU ITEC will focus on VoIP security, assurance, and interoperability guiding the Internet2 community.





ITEC Projects

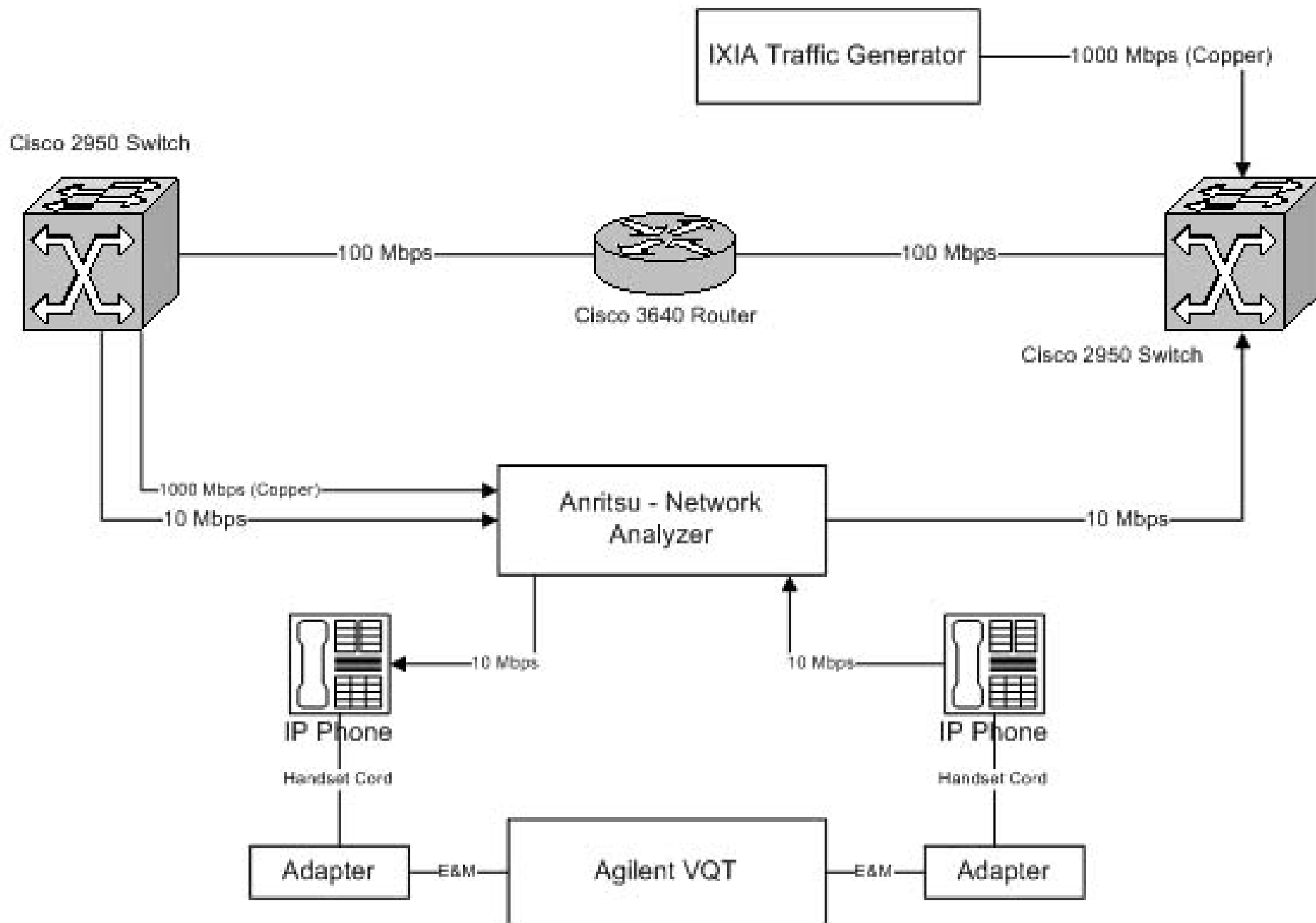
- **Network Impairment Test (SIP Codec Testing)**
- **Voice Disaster Recovery Initiative**
- **SIP Interoperability Testing**



ITEC Projects (*cont.*)

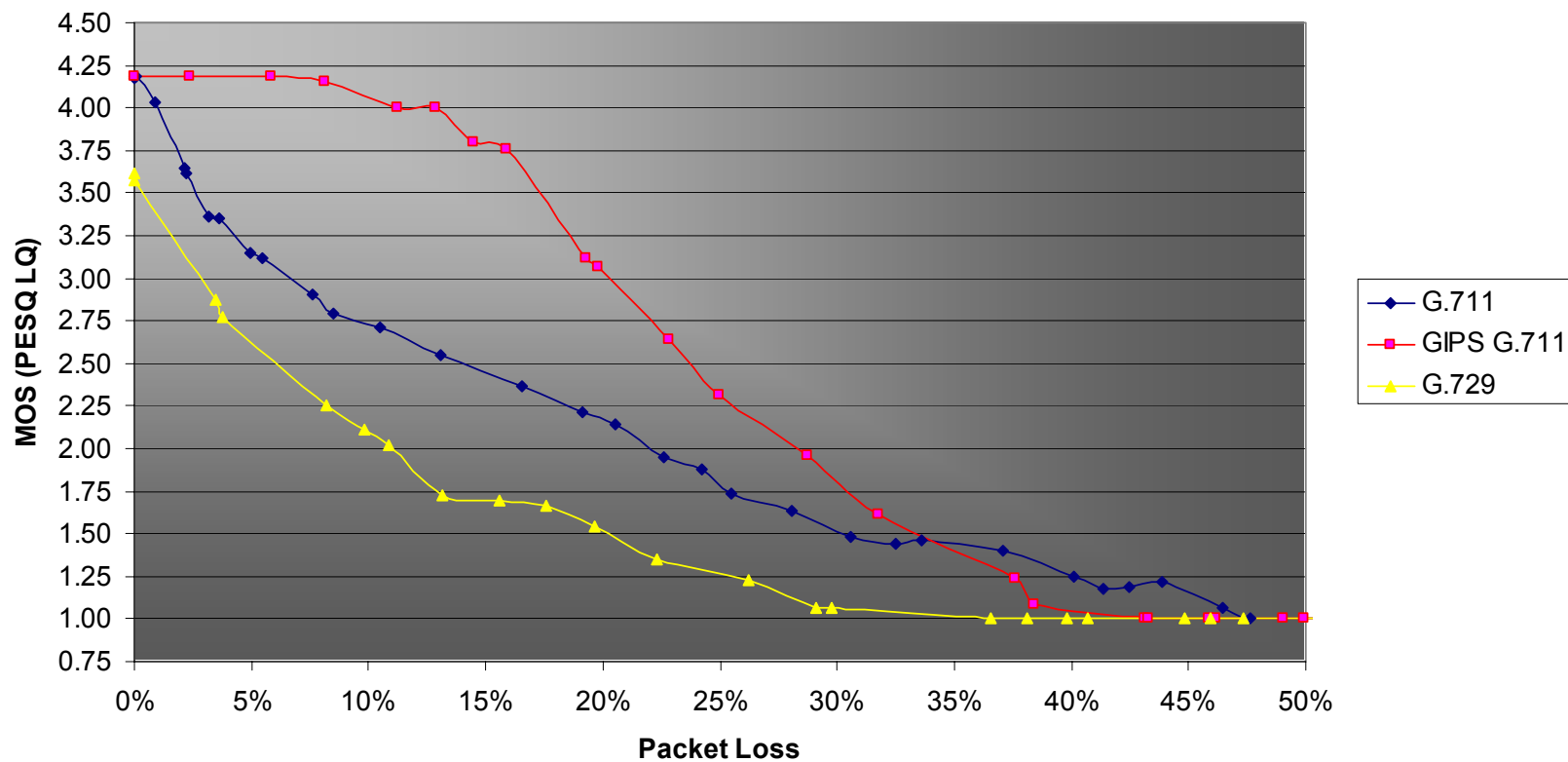
- **Network Impairment Test (NIT)-(SIP Codec Testing)**
 - The Network Impairment Project involves testing the efficiencies of various codecs when packet loss, latency and jitter are introduced within the network.
 - Findings of this project will be useful in that when a company migrates to Voice over IP, the company can incorporate the phone that uses the most efficient codec tailored to their network.





Pingtel Xpressa Results

Pingtel MOS (PESQ LQ)

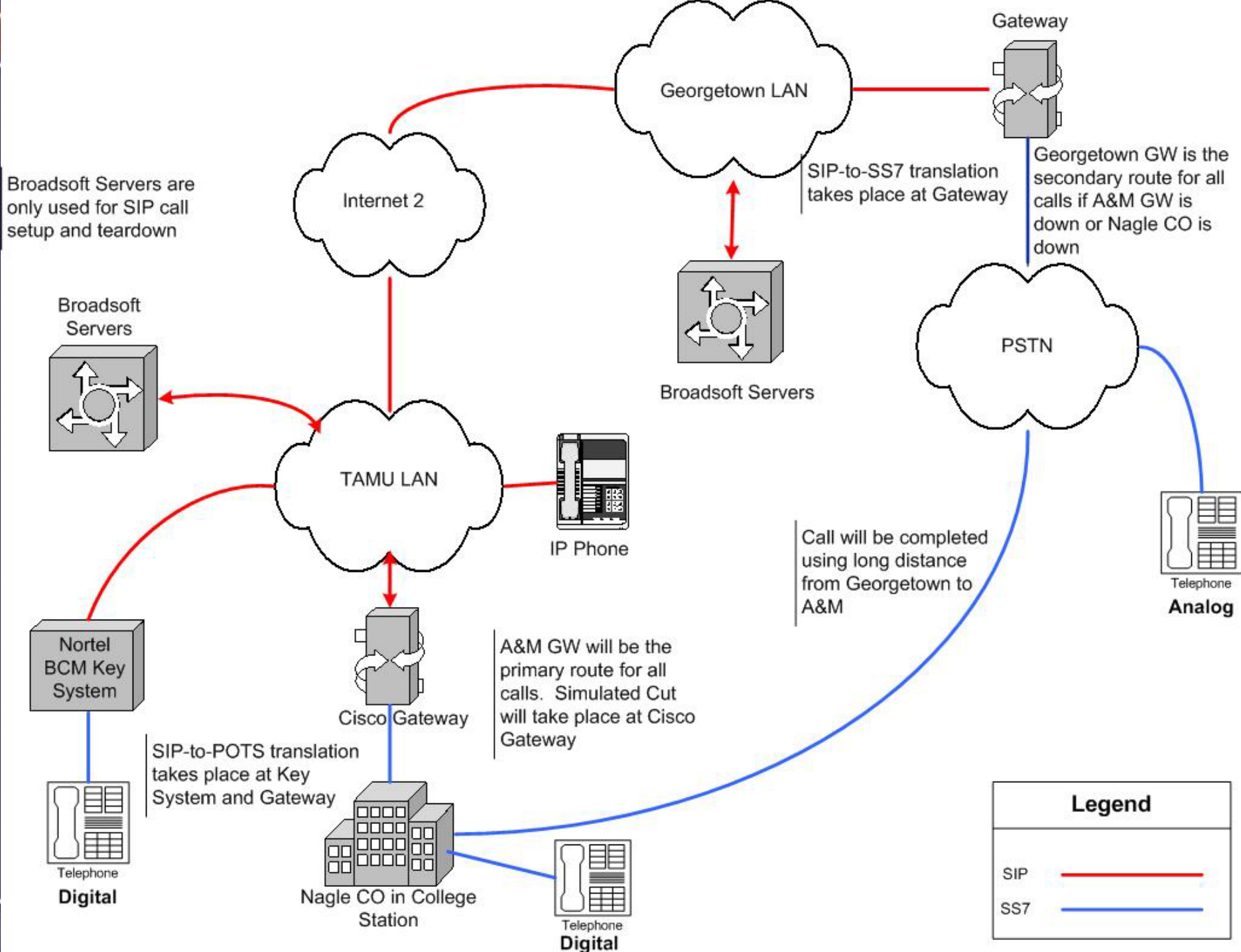


ITEC Projects (*cont.*)

- **Voice Disaster Recovery Infrastructure (VDRI)**

- To integrate a variety of networking elements to provide a failover system utilizing the signaling aspect of Session Initiation Protocol (SIP).
- This failover system will be available in case the connection to the Public Switched Telephone Network (PSTN) is interrupted.
- The system will be available for a defined number of lines, 100 access lines, utilizing regular analog and/or digital phones and also utilizing SIP based telephones.





ITEC Projects (cont.)

- **SIP Interoperability Testing**

- To evaluate SIP interoperability between various vendors SIP based instruments and other vendors SIP based servers.
- The goal is to document the level of interoperability. For features that are covered by an RFC we will test against RFC compliance.
- Desired features that are not yet covered under an RFC will be documented which will hopefully lead towards future work that will result in a more comprehensive feature set.



ITEC Facility

- Currently under construction
- Completion of ITEC is scheduled May 1, 2004



TAMU ITEC – Under Construction



TAMU ITEC Building



Future Projects

- Work with NC ITEC
 - Want a virtual extension/virtual lab between TAMU ITEC and NC ITEC



Internet2 Projects



Voice Disaster Recovery

- The Internet2 VoIP Disaster Recovery Working Group has been building a national system for telephony services utilizing Internet2's Abilene backbone network.
- Abilene provides a high capacity, extremely resilient data infrastructure that can offer an alternative pathway for communication in disaster scenarios.
- Internet telephony over Abilene can be used to supplement a university's circuit-switched telephone system to provide an increased level of voice survivability.

- Georgetown University has partnered with [BroadSoft](#), [PAETEC](#) Communications Inc., and the [Mid-Atlantic Crossroads](#) (MAX) to test and demonstrate an emergency IP voice service for Internet2 members.



- This initial design provides inbound and outbound disaster recovery voice service in the event of any of the following scenarios:
- Failure of a local phone service provider's Central Office
- Loss of TDM voice trunks
- Failure of a single BroadWorks node
- Failure of a single PaeTec Central Office
- Failure of a single PaeTec SIP gateway



SIP.edu

- The Internet2 SIP.edu project seeks to promote the convergence of voice and email identities, grow SIP-reachability within Internet2, and build a community of Internet2 schools that are developing and deploying SIP services.



SIP.edu (cont.)

- To implement SIP.edu, a participating enterprise initially makes all of its telephones and users reachable via SIP. This is done by integrating the legacy campus PBX and person directory using a SIP proxy server and a SIP-PRI gateway. Once this first step is taken, participants can begin to explore and implement other SIP services. While SIP.edu focuses primarily in voice communications, SIP is media-agnostic and can support video, text, and other media.

H.323 Testbed

- **This project has concluded.**

This project built a testbed for voice transmission over high-performance networks. A community of Internet2 member universities and international partner institutions peered their H.323 VoIP networks (largely Cisco CallManagers) to demonstrate the ability the ability of advanced networks to provide reliable, high-quality long-distance voice transport.



I911 Project



1911

- This project proposes a proof of concept demonstration to introduce a cost effective, standards based, distributed method for delivering emergency calls to ECC operators.
- The process moves the responsibility for reporting the location information to the end users system for Internet based calls.



1911 (cont.)

- This project seeks to develop, deploy, and demonstrate solutions for internet-based emergency services, build on emerging open standards, incorporate common off the shelf technology (COTS), and offers an unparalleled partnership of researchers, university network practitioners, operators of public safety answering points, and state governments.



911 Partners

- Columbia University
- Texas A&M University
- University of Virginia
- The State of Texas Commission on State Emergency Communications (CSEC)
- The State of Virginia Division of Public Safety Communications of the Virginia Information Technologies Agency (VITA)
- University Corporation for Advanced Internet Development (UCAID)
- Brazos County Texas E911 District
- City of College Station Texas
- National Emergency Number Association (NENA)
- Cisco Inc.
- Nortel Inc.





The Virtual Networking Lab (VNELab) at Texas A&M



Willis Marti
Associate Director for Network Services

Walt Magnussen, Ph.D.
Director for Telecommunications



Virtual Lab Overview

- Goal: Provide “hands-on” experience via remote access to real equipment/situations in protected environments
- Key Points:
 - Must support teaching pedagogy
 - Allow exercises over all network layers
 - Allow instructor flexibility to try different styles
 - Support Distance Education



Funding

- National Science Foundation
- Partially Funded by Marconi
- Texas A&M Vice President for Research
- Would like to extend funding on translations



VNELab Goals

- Allows students to access real communication equipment, without being physically present
- Accommodate large number of students
- Minimize administrative overhead
- Support distance learning
- Total access to every layer of software
 - design, development, modeling & measurement, debugging
- Solution: **Web Access Exercise System (WAES)**

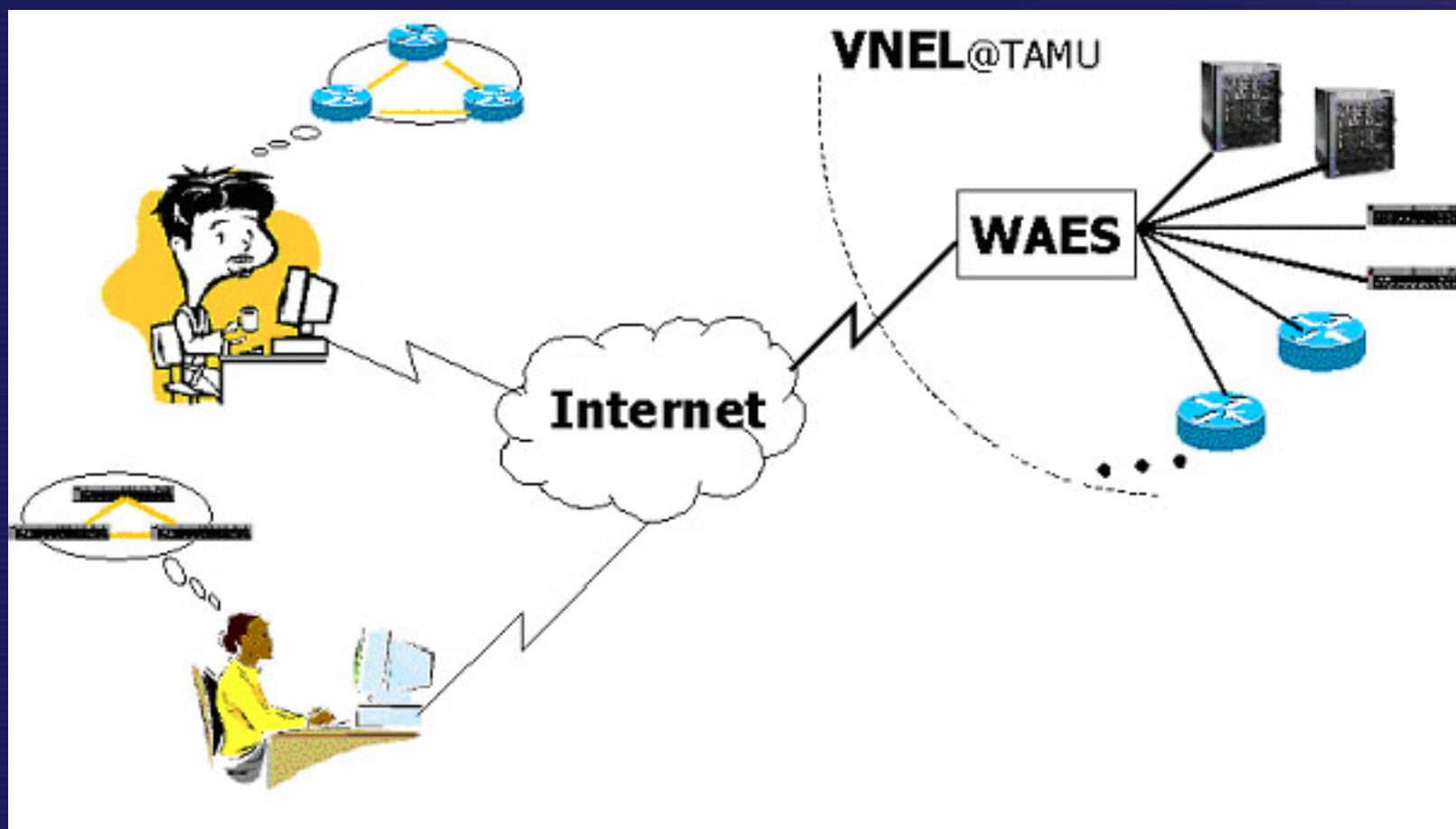


Other Solutions

- Major commercial products provide only lecture-based distance learning programs (or so-called course-ware programs) e.g.,
 - Web CT
 - Black Board
- Some companies provide laboratory-based distance learning programs, e.g.,
 - Mentorlabs.com
 - Mislabs.com
 - R1r2.com
- However, they are not appropriate as distance
- learning programs for college and universities
 - Scheduling
 - Grades and Assignments
 - Potential for guided learning



Basic Idea



WAES

- WAES is an experiment providing and user behavior controlling system. It provides the capacity for the users to remotely conduct their experiments. At the meantime, it controls the behavior of the users during an experiment session.
- WAES is an experiment grading assistant system. It can log the actions and results of the experiments to assist the instructor to do grading. Furthermore it can intelligently evaluate the result of some simple experiments and do grading automatically.
- WAES is an experiment schedulable system, which allows the users to schedule their experiment time under experiment valid period.

WAES (cont.)

- WAES is an experiment oriented management system. It helps to manage and maintain users' personal information, experiment materials and resources etc.
- WAES is an experiment design assistant system. It provides the possibility that the instructors can design and submit their experiments remotely.
- WAES is a modular distributed system. All of its modules can be integrated in single or multiple machines and multiple copies of the same module can be activated in different machines the different places currently. The properties of the distributing let the system have scalability, reliability and performance balancing attributes.



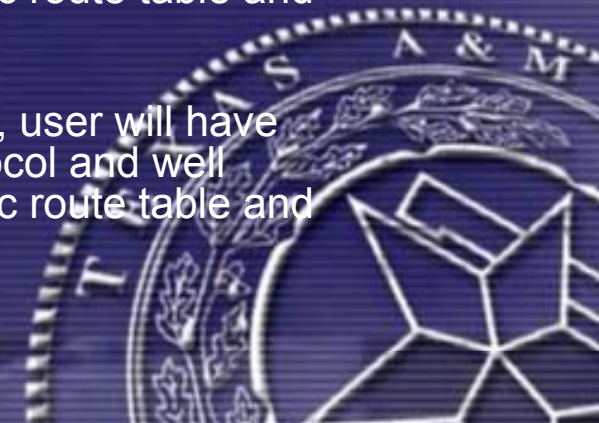
WAES (cont.)

- WAES is a performance guarantee system. Besides the experiment devices, the network bandwidth and the server machines' capacity are also considered limited resource by the system. The system will evaluate the current utilization of the resources before it admits a new experiment request.
- WAES is a multi-session and multi-user experiment system. A user can apply and run multiple different experiments at the same. Furthermore multi-users can real-timely collaborate to complete the same experiment. These properties let the system more flexible and friendly.



Sample Exercises

- **Configure PVC and LAN Emulation:** Through this exercise, user will have experience of network configuration on Marconi ATM switches. In this exercise, users are required to create PVC connections between the ATM switches and to create VC connections between the ATM switches through configuring ATM LAN emulation (ELAN).
- **Configure RIP Routing Protocol:** Through this exercise, user will have experience of network configuration on RIP routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol.
- **Configure OSPF routing protocol:** Through this exercise, user will have experience of network configuration on OSPF routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol OSPF.
- **Configure BGP routing protocol:** Through this exercise, user will have experience of network configuration on BGP routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol BGP.



Workshop

- NSF Grant for Universities in Mexico to offer WAES access



International Collaboration

- Mexico
 - Universidad Nacional Autónoma de México
 - Universidad Autónoma del Estado de Hidalgo
 - University of Tamaulipas
 - Baja
- Would like to add more international partners in Latin America





User Name

Password

Login

Reset

[Forgot your password?](#)



Our users:

[Texas A&M University, USA](#)

[Universidad Autónoma del Estado de Hidalgo, Mexico](#)

[Universidad Nacional Autónoma de México, Mexico](#)

Web Access Exercise System (WAES) is a trusted Network Engineering Education System.

WAES provides hands-on network engineering training with facilities capable of demonstrating ideas and concepts. Easy web based user interface. Anytime and anywhere you can start your exercise.

Want a hands-on network engineering training? **WAES is your solution.** To See how and what **WAES** can do for you, you can download and watch the demo video or review the sample exercises below. [Download demo.](#)

Sample Exercises:

➤ **Configure PVC and LAN Emulation:** Through this exercise, user will have experience of network configuration on Marconi ATM switches. In this exercise, users are required to create PVC connections between the ATM switches and to create VC connections between the ATM switches through configuring ATM LAN emulation (ELAN). [More info](#)

➤ **Configure RIP Routing Protocol:** Through this exercise, user will have experience of network configuration on RIP routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol. [More info](#)

➤ **Configure OSPF routing protocol:** Through this exercise, user will have experience of network configuration on OSPF routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol OSPF. [More info](#)

➤ **Configure BGP routing protocol:** Through this exercise, user will have experience of network configuration on BGP routing protocol and well understanding of routing behavior through setting up static route table and dynamic routing protocol BGP. [More info](#)

Nombre de
Usuario

Contraseña

Entrar

Borrar

[Olvidó su contraseña?](#)



Nuestros Usuarios:

[Texas A&M University, USA](#)

[Universidad Autónoma del Estado de Hidalgo, Mexico](#)

[Universidad Nacional Autónoma de México, Mexico](#)

El sistema de ejercicios por acceso Web (Web Access Exercise System - WAES) es un sistema seguro para capacitación en Ingeniería de redes.

WAES provee entrenamiento práctico en ingeniería de redes con funcionalidades que, además, demuestran ideas y conceptos. Posee una sencilla interfase de usuario. Usted puede iniciar sus ejercicios en cualquier momento y en cualquier lugar.

Desea tener un entrenamiento practico en ingeniería de redes? **WAES es su solución.** Para ver lo que WAES puede hacer por usted, usted puede descargar y mirar el video de demostración o revisar los ejercicios de ejemplo de abajo. [Descargar demostración.](#)

Ejercicios de Ejemplo:

➤ **Configuración de PVC (circuito virtual permanente) y Emulación de LAN:** A lo largo de este ejercicio, el usuario adquirirá experiencia configurando redes en switches ATM Marconi. En este ejercicio, se requiere que el usuario cree conexiones PVC entre switches ATM, también, debe crear circuitos virtuales entre switches ATM mediante la configuración emulación de LAN (ELAN) sobre ATM. [Mas información](#)

➤ **Configuración de Protocolo de enrutamiento RIP:** A lo largo de este ejercicio, el usuario adquirirá experiencia en configuración de redes con el protocolo de enrutamiento RIP. También podrá entender el comportamiento del enrutamiento mediante la configuración de tablas de rutas estáticas y del protocolo de enrutamiento dinámico. [Mas información](#)

➤ **Configuración de Protocolo de enrutamiento OSPF:** A lo largo de este ejercicio, el usuario adquirirá experiencia en configuración de redes usando el protocolo de enrutamiento OSPF. También podrá entender el comportamiento del enrutamiento mediante la configuración de tablas de rutas estáticas y del protocolo de enrutamiento dinámico OSPF. [Mas información](#)

➤ **Configuración de Protocolo de enrutamiento BGP:** A lo largo de este ejercicio, el usuario adquirirá experiencia en configuración de redes usando el protocolo de enrutamiento BGP. También podrá entender el comportamiento del enrutamiento mediante la configuración de tablas de rutas estáticas y del protocolo de enrutamiento dinámico BGP. [Mas Información](#)

Future Projects

- More exercises
 - VLAN / Ethernet Exercise
 - Allow students to create cross switch VLANs
 - Very basic, but necessary
 - Simple static routing exercise
 - IPv6 Exercise
 - Cutting edge protocol
 - QoS / Rate-Shaping
 - Voice and Video Policy
- VoIP Configurations
 - Proxy
 - Gatekeeper
 - Gateway



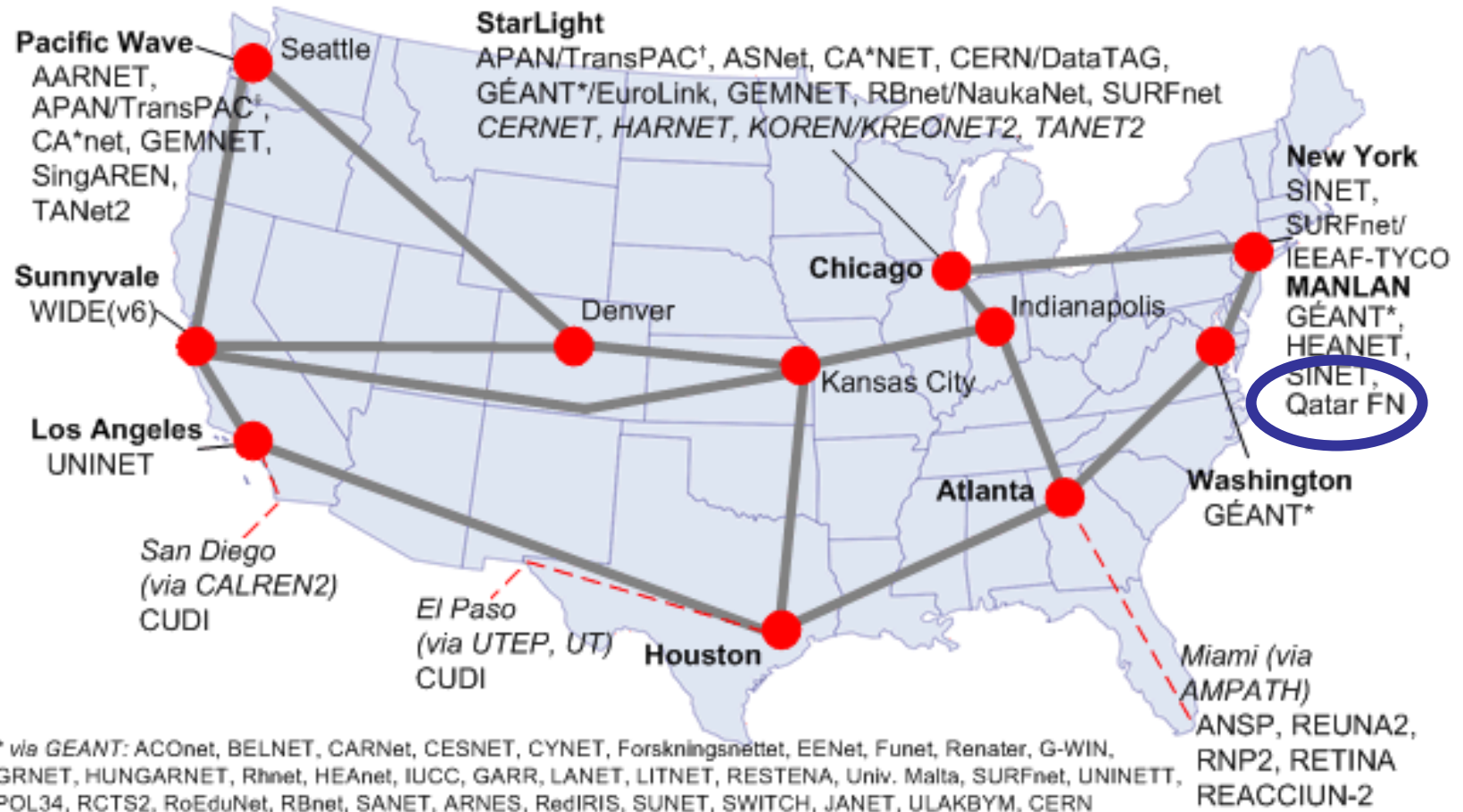
Texas A&M-Doha, Qatar

- Utilizing OC-3 link from Qatar to New York
 - Four US Universities in Qatar work with Qatar Foundation to attain International Peering agreement.
 - Dual OC-3 connections to New York
 - Abilene peered from there





Abilene International Peering



* via GEANT: AConet, BELNET, CARNet, CESNET, CYNET, Forskningsnettet, EENet, Funet, Renater, G-WIN, GRNET, HUNGARNET, Rhnet, HEAnet, IUCC, GARR, LANET, LITNET, RESTENA, Univ. Malta, SURFnet, UNINETT, POL34, RCTS2, RoEduNet, RBnet, SANET, ARNES, RedIRIS, SUNET, SWITCH, JANET, ULAKBYM, CERN

[†] via APAN/TransPAC: WIDE/JGN, IMnet, CERNet/CSTnet/NSFCNET, KOREN/KREONET2, PREGINET, SingAREN, TANET2, ThaiSARN

Texas A&M-Nairobi Kenya

- Texas A&M University is using Satellite firm to provide high-speed Internet access to one site in Nairobi, Kenya.
- Seven or eight more countries anticipated
- Texas A&M will use the connection primarily for Internet browsing and occasional use of a two-way video teleconferencing application as well as an SMS gateway used to report cattle market information.



Two Service Level Options/Pricing

- **Option 1**

C-Band Service, Data Rate Receive/Transmit (Kbps)	768/256
\$2,995 Monthly, Billed Quarterly	\$ 8,985/quarterly
Satellite modem and 5W Radio	\$ 14,500/One-time Charge
Shipping & Handling (to USA address)	\$ 500 estimate
Installation price	\$Customer responsible*

Two Service Level Options/Pricing

- Option 2

C-Band Service, Data Rate Receive/Transmit (Kbps)	768/384
\$3,390 Monthly, Billed Quarterly	\$ 10,170/quarterly
Satellite modem and 5W Radio	\$ 14,500/One-time Charge
Shipping & Handling (to USA address)	\$ 500 estimate
Installation price	\$Customer responsible*

Conclusion

- The VNELab provides several opportunities for remote collaboration.
- Projects such as VoIP and VNElab only exist because of networks like CUDI. It is the enabler
- International Opportunities abound!



Questions



Thank You

- Visit us on the web
- Site includes
 - Information on VoIP project information
 - VoIP Help documentation
 - Project results

<http://itec.tamu.edu>

