

C. Edward Chow

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Education	Ph.D. in Computer Science	The University of Texas at Austin	1985
	M.A. in Computer Science	The University of Texas at Austin	1982
	B.S. in Electrical Engineering	National Taiwan University	1977

Experience

7/04-present	University of Colorado at Colorado Springs	Professor
7/09-12/11	University of Colorado at Colorado Springs	Associate Dean
8/08-7/09	University of Colorado at Colorado Springs	Interim Associate Dean
	<ul style="list-style-type: none">• Taught Programming Mobile Web (covers both iOS and Android), Software Security, Advanced System Security Designs, Distributed Networks, Fundamentals of Computer and Network Security, Advanced Internet and Web Systems, Multimedia Computing and Communications, Computer Communications, Computer Architecture, Web Systems and Electronic Commerce, Web Programming, and Principle of Computer Science courses. In charge of Master of Engineering in Information Assurance Program and PhD Security Program.• Exploring the network and protocol research issues in the areas of telecommunications and computer communications.	
10/02-7/03	University of Colorado at Colorado Spring	Interim El Pomar Chair
	<ul style="list-style-type: none">• Contribute to the activities of Research Development Center for the College of Engineering and Applied Sciences and organized the Cybersecurity Symposium with Dr. Ziemer.	
8/91 — 6/04	University of Colorado at Colorado Springs	Associate Professor
7/97, 99, 01, 03	Network Computing Lab, Fujitsu Laboratories, Kawasaki.	Visiting Scientist
6/94 - 8/94	IBM Network Application and Service Division.	Visiting Scientist
	<ul style="list-style-type: none">• Lead a testbed team to set up an interactive collaborative multimedia server and network testbed with FDDI and RS6000 servers.• Served as an acting manager and managed a team that designed collaborative business network services.• Designed/analyzed interactive multimedia networks and applications.• Provided expertise in network resource allocation, signaling, path finding, and protocol design.	
11/85 — 8/91	Bell Communications Research, Inc.	Member of Technical Staff
	<ul style="list-style-type: none">• Designed/developed path finding algorithms and connection management protocols for setting up multiparty multimedia connections in Gigabit ATM networks. Explored design issues in the con-	

nection management and the resource management for Gigabit ATM networks. Verified design solutions on an experimental broadband ATM network prototype. The ATM switching software and signal protocol software were written in C++.

- Coordinated the Fujitsu-Bellcore MICE-ISDN Network Interconnection Project which explored research issues in interconnecting ISDN, LAN, and Intelligent Networks, allowed multimedia document transfer and real-time multimedia share editing among terminals on different networks. Was responsible for
 - the design and implementation of an ISDN-LAN gateway,
 - the design and implementation of the multimedia communication software,
 - the design and implementation of the ISDN-IN interface and IN Service Logic,
 - the testing/modification of ISDN protocol implementation.
- Designed network services and communication protocols for an intelligent network testbed called MICE, which provided advanced network services such as the integrated voice+text mail, voice dialing, and retrieving email over voice line. Designed and evaluated methods and tools for telecommunications service creation environments. Implemented feature classification software based on KEE AI tools. Designed service editors with an advanced graphical interface to facilitate the creation and manipulation of intelligent network services.

6/82 — 11/85

The University of Texas at Austin

Research Assistant

- Developed a design methodology for constructing communication protocols.
- Designed a protocol programming environment called PROSPEC. It integrates methods of multi-phase protocol construction and protocol projections. The system provides a graphical interface to facilitate the application of these methods and creates an interactive environment for specifying, verifying and designing communication protocols. It has been used successfully to construct and verify versions of BSC, X.21, X.25, and telnet protocols.

Refereed Publications

1. Richard White, Aaron Burkhart, Randy George, Terrance Boulton and Edward Chow, “Towards a Comparable Cross-Sector Risk Analysis: RAMCAP Revisited,” Proceedings of Tenth IFIP WG 11.10 International Conference on Critical Infrastructure Protection, March 14-16, 2016.
2. Richard White, Aaron Burkhart, Terrance Boulton and Edward Chow, “Towards a Comparable Cross-Sector Risk Analysis: From RAMCAP to LIRA,” Proceedings of Tenth IFIP WG 11.10 International Conference on Critical Infrastructure Protection, March 14-16, 2016.
3. Amer Aljaedi and C. Edward Chow, “Elastic Edge Overlay Methods Using OpenFlow for Cloud Networks,” Proceedings of 13th International Conference on Information Technology : New Generations (ITNG 2016), April 2016.
4. Beulah Navamani, Chuan Yue, Xiaobo Zhou, C. Edward Chow, “An Analysis of the Virtual Machine Migration Incurred Security Problems in the Cloud,” Proceedings of The Third ASE International Conference on Cyber Security, Stanford, CA, USA, May 27-31, 2014.
5. Richard White, Terrance Boulton, and C. Edward Chow, “AVM: A Computational Asset Vulnerability Model for Strategic Protection of Critical Infrastructure,” published in International Conference on Critical Infrastructure Protection, Arlington, Virginia, USA. March 17-19, 2014. Full article published in International Journal of Critical Infrastructure Protection 7 (2014), pp. 167-177 DOI information: 10.1016/j.ijcip.2014.06.002.
<http://www.sciencedirect.com/science/article/pii/S1874548214000419>

6. Richard White, Aaron M. Burkhart, C. Edward Chow, and Logan L. Maynard, "A Decision Support Tool for a Computational Unified Homeland Security Strategy," published in Proceedings of 8th Annual IFIP Working Group 11.10 International Conference on Critical Infrastructure Protection, Arlington, Virginia, USA. March 17-19, 2014, Full paper to be published in International Journal of Critical Infrastructure Protection October 2014.
7. Fahad Alsolami and C. Edward Chow. "N-Cloud: Improving Performance and Security in Cloud Storage." Proceedings of the 2013 IEEE 14th International conference on High Performance Switching and Routing. IEEE, 2013.
8. Philip Huu Huynh and C. Edward Chow, "Design and Analysis of Hybrid Wireless Mesh Networks for Smart Grids," *Proceedings of the International Computer Symposium ICS 2012*, Hualien, Taiwan, December 12-14, 2012, pp. 713-722.
9. C. Yue, G. William, C. Edward Chow, "Using Amazon EC2 in Computer and Network Security Lab Exercises: Design, Results, and Analysis," *Proceedings of 119th ASEE Annual Conference*, June 10-13, 2012.
10. F. Torres and C. Edward Chow, "Human Motion Similarity: a 3D Curve Shape Dissimilarity Approach", *Proceedings of CiComp 2010*, Baja California, Mexico, 11/2010.
11. F. Torres and C. Edward Chow, "A 3D Curves Chain Code Representation for the Analysis of Human Motion Similarity", *Proceedings of The 16th International Conference on Distributed Multimedia Systems (DMS'10)*, Oak Brook, Illinois 10/14-16/2010.
12. Brad Baker and C. Edward Chow, "HTEE: an HMAC based Tamper Evident Encryption," *Proceeding of Secrypt 2010 conference*, July 2010.
13. Murthy Andukuri and C. Edward Chow, "Efficient Asymmetric IPsec for Secure iSCSI," *Proceeding of Secrypt 2010 conference*, July 2010.
14. F. Torres, J. Knight, Y. Wang, J. Carollo, C. Edward Chow, S. Sudhansu, "Improve Rehabilitation and Patient Care with Lab Specification and Wireless Sensor Tracking," *Gait & Clinical Movement Analysis Society Conference*, GCMAS 2009.
15. Yu Cai and C. Edward Chow, "Algorithms for Selecting Multiple Mirror Sites for Parallel Download," *IJCSNS International Journal of Computer Science and Network Security*, Vol. 7 No. 10 pp. 273-278, 2007.
16. Xiaobo Zhou, Yu Cai, C. Edward Chow, "An Integrated Approach with Feedback Control for Robust Web QoS Design," *Computer Communications*, Vol. 29/16 pp 3158-3169, Oct. 2006.
17. Yu Cai and C. Edward Chow, "On path selection for multipath connection," *Proceeding of CISSE conference 2006*.
18. Ganesh Godavari and Edward Chow, "Secure Information Sharing Using Attribute Certificates and Role Based Access Cont," *Proceeding of 2005 International Conference on Secure and Management*, June 2005, pp. 269-276.
19. Xiaobo Zhou, Yu Cai, C. Edward Chow, and Marijke Augusteijn, "Two-tier Resource Allocation for Slowdown Differentiation on Cluster-based Servers," *Proceedings of the 34th IEEE International Conference on Parallel Processing (ICPP)*, IEEE Computer Society, pp. 31- 38, Oslo, Norway, June 2005.
20. Xiaobo Zhou, Yu Cai, Ganesh K. Godavari, C. Edward Chow, "An Adaptive Process Allocation Strategy for Proportional Responsiveness Differentiation on Web Servers," *Proceedings of IEEE International Conference on Web Services*, 6-9 July 2004. pp.142 – 149.
21. C. Edward Chow, Yu Cai, David Wilkinson and Ganesh Godavari, "Secure Collective Defense System," *Proceedings of GLOBECOM 2004*, Volume: 4, November 2004, pp. 2245 – 2249.
22. David Wilkinson, C. Edward Chow, and Yu Cai, "Enhanced Secure Dynamic DNS Update with Indirect Route," *Proceedings of fifth IEEE Systems, Man and Cybernetics Information Assurance*

Workshop 10-11, June 2004, pp. 335-341.

23. C. Edward Chow, Paul J. Fong, and Ganesh Godavari, "An Exercise in Constructing Secure Mobile Ad hoc Network (SMANET)," *Proceedings of The 18th International Conference on Advanced Information Networking and Applications*, Volume: 2, March 29-31, 2004, pp. 436 – 438.
24. Kenneth H. Wenker and C. Edward Chow, "Analysis and Evaluation of an XML Database," *Proceedings of IASTED Conference on Communications, Internet, & Information Technology*, Scottsdale, AZ, on November 17-19, 2003.
25. Angela Cearns and C. Edward Chow, "A2D2: Design of an Autonomous Anti-DDoS (A2D2) Network," *Proceedings of IASTED Conference on Applied Informatics*, February 2003.
26. C. Edward Chow, Ganesh Godavari, and Yu Cai, "LSWS: Linux-based Secure Web Switch," *Proceedings of IASTED Conference on Applied Informatics*, February 2003.
27. C. Edward Chow and Chandra Prakash, "Enhance Features and Performance of a Linux-based Content Switch," *IASTED Conference on Applied Informatics*, February 2003.
28. C. Edward Chow and Indira Semwal, "Web Load Balancing Through More Accurate Server Report," *Proceeding of 2nd International Conference of Parallel and Distributed Computing, Applications, and Technologies*, July-9-11 2001, Taipei, Taiwan, pp.117-124..
29. C. Edward Chow and Weihong Wang, "The Design and Implementation of Linux LVS-based Content Switch", *Proceeding of 2nd International Conference of Parallel and Distributed Computing, Applications, and Technologies*, July-9-11 2001,, Taipei, Taiwan, pp. 204-211.
30. C. Edward Chow, Ganesh Godavari, and Jianhua Xie, "Content Switch Rules and their Conflict Detection," *Proceeding of 2nd International Conference of Parallel and Distributed Computing, Applications, and Technologies*, July-9-11 2001, Taipei, Taiwan, pp. 325-330.
31. J. He, C. Edward Chow, Jihui Yang‡ and Takafumi Chujo, "An algorithm for the measurement of available bandwidth," *Proc. IEEE ICN'01*, July 2001.
32. C. Edward Chow, Jingsha He and Tomohiko Taniguchi, "NetLobars: A Simulation System for Web System Design and Evaluation," *Proceedings of ICC'99*, Tokyo, Japan, , Sept. 14-16.
33. C. Edward Chow and Hedlind E. Jonas, "POCAT: Power Control and Channel assignment Tool for Wireless Networks," *1999 IEEE International Performance, Computer, and Communications Conference*, Feb. 10-12, 1999.
34. C. Edward Chow and Anders Hansmats, "Design and Analysis of One Prong Network Restoration Algorithms," *1999 IEEE International Performance, Computer, and Communications Conference*, Feb. 10-12, 1999.
35. Hekki Julkuen and C. Edward Chow, "Enhance Network Security with Dynamic Packet Filter," *Proceeding of International Conference on Computer Communications and Networks*, Oct. 12-15, 1998, pp. 165-168.
36. C.-H. E. Chow and Dianne Ouderkerk, "Path-based two prong network restoration algorithm," *Proceedings of IASTED applied Modeling and Simulation Conference*, July 27-31, 1997, Banff, CA.
37. C.-H. E. Chow, David Yule, "Performance and Analysis of Nearest Neighbor Network Restoration Algorithms," *Proceedings of IASTED/ISMM International Conference on Modeling and Simulation*, pp. 335-338, Pittsburgh, April 25-27, 1996.
38. C.-H. E. Chow, J. Bicknell, and S. Syed, "Performance Analysis of Fast Link Restoration Algorithms," *International Journal of Communication Systems*, Vol. 8, pp. 325-345, 1995.
39. C.-H. E. Chow, "Resource Allocation for Multiparty Connections," *Journal of Systems and Software*, 1995. Also appeared as *UCCS Tech Report EAS-CS-92-1*, January 1992.
40. C.-H. E. Chow, J. Bicknell, S. McCaughey, and V. Narasimhan, "NETRESTORE: A Simulation

System for the Design and Analysis of Network Restoration Approaches,” to be published in *Journal of Computer and Software Engineering*. Also appeared as *UCCS Tech Report EAS-CS-93-6*, August 1993.

41. C.-J. Wang, H. Y. Zhou, C.-H. E. Chow, “Automatic Network Restoration using Two-Level Associative Memories,” *Proceedings of IEEE 1994 International Conference on Neural Networks* in Orlando Florida, June 1994, pp. 3565-3570.
42. C.-H. E. Chow, S. McCaughey, and S. Syed, “RREACT: A Distributed Protocol for Rapid Restoration of Active Communication Trunks,” *Proceedings of 2nd IEEE Network Management and Control Workshop*, pp. 391-406, Sept. 21-23, 1993. Full version of the paper submitted to the *IEEE-Communications Journal*. Also appeared as *UCCS Tech Report EAS-CS-92-18*, November 1992.
43. C.-H. E. Chow, V. Narasimhan, and S. Syed, “Analysis of Centralized Network Restoration,” *Proceedings of 2nd International Conference on Computer Communications and Networks*, June 28-30, 1993, San Diego.
44. J. Bicknell, C.-H. E. Chow, and S. Syed, “Performance Analysis of Fast Distributed Network Restoration Algorithms,” *Proceedings of GLOBECOM '93*, Nov. 29-Dec.2, 1993, Houston, Texas.
45. M. Huang, I. T. Frisch, and C.-H. E. Chow, “Connection Control Protocols in Broadband Networks,” *Proceedings of 2nd IEEE Network Management and Control Workshop*, Sept. 21-23, 1993.
46. C.-H. E. Chow, J. Bicknell, S. McCaughey, and S. Syed, “A Fast Distributed Network Restoration Algorithm,” *Proceedings of 12th International Phoenix Conference on Computers and Communications*, pp. 261-267, Scottsdale, Arizona, March 24-26, 1993.
47. M. Huang, I. T. Frisch, C.-H. E. Chow, H. Bussey, “Nondistributed Multiparty Connection Establishment For Broadband Networks,” *Proceedings of 1992 IEEE International Conference on Communications*, pp. 1392-1396, 1992.
48. Minfa Huang, Frisch, I.T., Ching-Hua Cho, Bussey, H, “Two Multiparty Connection Establishment Procedures For Broadband ISDN,” *Network Operations and Management Symposium, 1992. NOMS '92. Networks Without Bounds., IEEE 1992 , Volume: 2 , 1992 Page(s): 373 -382*.
49. C.-H. E. Chow, “Resource Allocation Protocol for Multiparty Connections in Broadband Networks,” *Proceedings of 3rd International IFIF WG6.1/6.4 Workshop on Protocol for High Speed Networks*, pp.121-132, Stockholm, May 13-15, 1992.
50. C.-H. Chow, “On Multicast Path Finding Algorithms,” *Proceedings of INFOCOM'91*, pp. 1274-1283, Miami, Florida, April 7-11, 1991.
51. C.-H. Chow, “Protocol Issues In Interconnecting ISDN, IN and LAN,” *Proceedings of 1990 TEN-CON Conference on Computer and Communication systems*, pp. 610-617, Hong Kong, Sept. 24-27 1990.
52. C.-H. Chow, M. Adachi, D. Nelson, “Achieving Multimedia Communications On A Heterogeneous Network,” *Journal of Selected Areas in Communications*, Vol. 8, No. 3, pp. 348-359, April, 1990.
53. T. F. Bowen, C.-H. Chow, F. S. Dworak, N. D. Griffeth, G. Herman, Y. J. Lin, “Feature Interaction in Telecommunications,” *Proceedings of 7th International Conference on Software Engineering for Telecommunication Switching Systems*, pp. 59-62, Bournemouth, U.K., July 1989.
54. C.-H. Chow, M. Adachi, D. Nelson, “Multimedia Communications On A Heterogeneous Network,” *Proceedings of 22nd Hawaii International Conference On System Sciences*, pp. 829-837, Jan. 1989.
55. C.-H. Chow, David A. Braun, and M. Adachi, “Interconnecting ISDN With IN And LAN,” *Proceedings of 2nd National UNIX System Information Networking Group Conference*, Denver, Colorado, Sept. 19-21, 1988.
56. C.-H. Chow, S. S. Lam, “PROSPEC: An Interactive Programming Environment for Designing and

Verifying Communication Protocols,” *IEEE Trans. on Software Engineering*, Vol. 14, No. 3, pp. 327-338, March 1988.

57. C.-H. Chow, Herman, G. E., and C. A. Riley, “Coping With Complexity: Service Specification For A Network Services Testbed,” *Proceedings of 1988 International Zurich Seminar On Digital Communications*, pp. 13-20, ETH Zurich, Switzerland, March 8-10, 1988.
58. C.-H. Chow and Ming-Yee Lai, “DBINS: A Database Testbed for Intelligent Network Services,” *Proceedings of 1987 Bellcore Database Symposium*, pp. 47-54, Somerset NJ, September 15-16, 1987.
59. C.-H. Chow, “GCCP: A Structure Editor for Generating Network Services,” *Proceedings of 2nd International Conference on Human-Computer Interaction*, Honolulu, Hawaii, August 10-15, 1987.
60. Robert W. Root and C.-H. Chow, “Multi-Mode Interaction In a Telecommunications Testbed: A Case of Memory Dialing,” *Proceedings of 2nd International Conference on Human-Computer Interaction*, Honolulu, Hawaii, August 10-15, 1987.
61. C.-H. Chow, “Using PROSPEC to Design and Verify Communication Protocols,” *Proceedings of GLOBECOM’86*, pp. 86-91, Houston, Texas, December 1-4, 1986.
62. C.-H. Chow, “Interactive Verification and Construction of Communication Protocols in PROSPEC,” *Proceedings of INFOCOM’86*, pp. 67-75, Miami, Florida, March, 1986.
63. C.-H. Chow, M. G. Gouda and S. S. Lam, “A Discipline for Constructing Multi-phase Communication Protocols,” *ACM Transactions on Computer Systems*, pp. 315-343, Vol. 3, No. 4, November 1985.
64. C.-H. Chow, M. G. Gouda and S. S. Lam, “An Exercise in Constructing Multi-phase Communication Protocols,” *Proceedings of ACM SIGCOMM’84 Symposium on Communication Architectures and Protocols*, pp. 41-47, Montreal, June 1984.
65. M. G. Gouda, C.-H. Chow and S. S. Lam, “Detecting Livelocks in Networks of Communicating Finite State Machines,” *Proceedings of the 4th IFIP Workshop on Protocol Specification, Testing and Verification*, Mt. Pocono, PA, June 1984, pp. 47-56.
66. Ching-Hua Chow, Mohamed G. Gouda, Simon S. Lam: “On Constructing Multi-Phase Communication Protocols,” *Proceedings of the 4th IFIP Workshop on Protocol Specification, Testing and Verification*, Mt. Pocono, PA, June 1984, pp. 57-68.

Non-Refereed Publications

1. C. Edward Chow, "Wireless Sensor Network Application in Rehab and Nursing Home," *Conference on Digital Human Body Motion Research and Trends*, pp. 26-29, March 27, 2007.
2. C. Edward Chow, Robert Rogers, Xiaolong He, and Frank Watson, “Wireless Information Network Planning” (*CASI-TR-00-04*). Final report of a CASI FY99 Technology Transfer Grant. Fort Collins, CO: Colorado Advanced Software Institute. (Omnipoint Corporation - Collaborating Company), 83 pages. To be submitted to Wireless Networks. <http://cs.uccs.edu/~chow/casi/doc/winplan.doc>
3. C. Edward Chow, Heidi McClure, and Jonas Hedlind, “RACEWIN: Resource Allocation and Admission Control Evaluator for Wireless Information Networks,” (*CASI-TR-98-02*). Final report of a CASI FY97 Technology Transfer Grant. Fort Collins, CO: Colorado Advanced Software Institute. (US West Advanced Technologies - Collaborating Company). 85 pages. To be submitted to Wireless Networks. <http://cs.uccs.edu/~chow/casi/doc/racewin.pdf>
4. C. Edward Chow and Heidi McClure, “UTMOST: A User Traffic Modeling Tool for Wireless Information Networks”, UCCS Technical Report EAS-CS-97-1, 1997. To be submitted to AINA

2004.

5. Chow, C. E. and Albert M. Schaffer, "ATMROS: A Network Design System for ATM Network Optimization and Traffic Management," (CASI-TR-97-02). Final report of a CASI FY96 Technology Transfer Grant. Fort Collins, CO: Colorado Advanced Software Institute. (US West Advanced Technologies - Collaborating Company). <http://cs.uccs.edu/~chow/casi/doc/atmros.pdf>
6. C. Edward Chow and Dianne Ouderkirk, "NETSIM: A Network Simulation System for the Design and Analysis of Network Survival Techniques" (CASI-TR-96-04). Final report of a CASI FY95 Technology Transfer Grant. Fort Collins, CO: Colorado Advanced Software Institute. (US West Advanced Technologies - Collaborating Company) <http://cs.uccs.edu/~chow/casi/doc/netsim.pdf>
7. C. Edward Chow, "User Guide of NETRESTORE2.0: A Network Restoration Evaluation system," 1995.
8. C.-H. Chow, "A Discipline for Verification and Modular Construction of Communication Protocols," *Ph.D. Dissertation*, University of Texas at Austin, December 1985.

Patent Application Submitted

Wen-Tze Wu, Chun-Yi Chai, C. Edward Chow, "Method and apparatus for web server cluster architecture based on the transformation and distribution of web documents."

NSF Award

\$333,347 for the project entitled "A Security-Integrated Computer Science Curriculum for Intensive Capacity Building." 9/1/2014-8/31/2017 Dr. Chuan Yue as PI, iaobo Zhou, C. Edward Chow, Terrance E. Boulton as Co-PI.

Research Projects:

Homeland Security Research

- Drinking Water Resilience Project, sponsored by Oak Ridge National Labs and Department of Homeland Security Science and Technology, \$225,000 grant with Drs. Richard White, Terry Boulton, 10/2015-9/2016.
- RAMCAP Review and Enhancement, sponsored by Oak Ridge National Labs and Department of Homeland Security Science and Technology, \$90,000 grant with PIs: Drs. Richard White, Terry Boulton, 10/2014-9/2015.

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Network/Web System Research

work on content switch, network simulation, network resource placement, network/web load balancing, policy-based networking, and Internet network measurement.

Specific projects:

- Neuroguide— Design a secure web system for neuro evaluation result interpretation, working with Dr. Sara Qualls and her graduate research assistant, sponsored by Peak Aging with \$7,452, 3-

9/2008.

- Online E-commerce System Project— Design online trading information web site, sponsored by Internet Business Skills, \$8,280, 1-5/2007.
- **Advanced Content Switch Design**—A research and development project , with \$220,516 grant from Computer Communication Lab, ITRI, 11/2000-2/2003. Design and implement advanced content switches with two variants based Linux-LVS and Intel IXP1200 Network Processor with flexible rules for configuring the content switch as firewall, fault-tolerant cluster, network load balancer, virus detector and filter, and advanced storage systems. Focus on efficient content switching rule matching algorithms, conflict detection in rules, new protocols for improving TCP delay binding, network bandwidth measurement, server load measurement, and load balancing algorithms.
A Linux LVS-based Content Switch called LCS version 0.2 was released 5/31/2001.
- **Internet Network Research**-\$25,000 gift from Fujitsu Lab of America, 4/2002.
- **WIPE**-Wireless Rogue Traffic Prevention and Detection Study, sponsored by ITT, \$23,752, 6-9/2001. A joint project with Dr. Mark Wickert of ECE Department.
- **NetLobars**—a Java-based network simulator for evaluating web/network system performance, analyzing policy-based networking systems, designing network load balancing algorithm and protocols, detecting bottlenecks, and suggesting efficient network resource placement.
- **Uprobe**—a cooperative Internet network measurement project.
- **Walrus**—a wide area load balancing resource utilization study project which creates a testbed by connecting collaborative sites world-wide for server load balancing and Internet network measurement studies. The testbed enables participating sites to design and deploy network load balancing and measurement protocols, and to benchmark virtual server performance.

Network Security Research

Specific projects:

- **Proximity Based Encryption**— Research on techniques/tools for protecting data based on proximity relations, sponsored by a gift from Northrop Grumman with \$70,000, 11/2014-12/2015.
- **SDD: Secure Discovery Delivery** — Principal Investigator of an \$11,500, E-Government Project funded by Statewide Internet Portal Authority (SIPA) and sponsored by 4th District Attorney Office, Colorado, 2-7/2012.
- **XL-CITR: Accelerated Learning for Cyber Insider Threat Reduction** — Principal Investigator with Terry Boulton. \$29,000 is UCCS portion, sponsored by Tier-one, AFRL-OSD-SBIR, \$90,000.00, 2/2009-8/2009. Phase II Small Business Innovative Research (SBIR) award on XL-CITR (Accelerated Learning for Cyber Insider Threat Reduction) with Tier 1 Performance Solutions, by As Co-PI Edward Chow with Terry Boulton., AFRL/OSD, \$750,000.00
- **Making Secure Information Sharing Easy and A Reality** — Principal Investigator for the \$10,000.00 grant sponsored by University of Colorado Technology Transfer Office/Proof-of-Concept Grant (POCg), 1/1/2006-5/31/2006. Develop software for providing secure information access to network services IIS web servers based on attribute certificate and role-based access control. Extend Microsoft Active Directory (AD) with attribute certificate support and design

access control engine for IIS that queries AD for role information contained in attribute certificate.

- **Techniques and Tools for Supporting Secure Information Sharing and Collaborative Work**— Principal Investigator for the \$39,948 grant sponsored from an AFSOR sub-award from Network Information and Space Security Center, 02/01/2004 – 07/31/2004.
- **Improving Measurable Performance Under Cyber Threats by Information Fusion with Flexible Admission Control** — Co-Principal Investigator for the \$73,275 grant from an AFSOR sub-award from Network Information and Space Security Center, 06/01/2004 – 05/31/2005.
- **Networked Radio for Sensor Applications** — Co-Principal Investigator for the \$ 9,964.02 ARMY SBIR Phase 1 award grant with Q-Dot, 05/01/2004 – 06/30/2004.
- **Evaluating a Cluster-based Server Platform in Support of Intelligence/Information Fusion and On Integrating System Support for Intelligence/Information Fusion** — Co-Principal Investigator for the \$17,010 grant from an AFSOR sub-award from Network Information and Space Security Center grant, 02/01/2004 – 07/31/2004.
- **Secure Information Sharing** — Principal Investigator for the \$6,000 grant from an AFSOR sub-award from Network Information and Space Security Center grant, 02/01/2004 – 05/31/2004.
- **FRSN (First Responder Sensor Network)** — Principal Investigator for the \$8,440 grant sponsored by Network Information Space Security Center (NISSC), 9-12/2003. Develop software, protocols and deployment tools of wireless sensor networks for first responders. Design interface for interconnecting Mobil Ad hoc Network and wireless sensor networks.
- **DegradedDDoSDefense (Admission Control and Adaptive Resource Management for Defending Degrading DDoS Attacks)** — Co-Principal Investigator for the \$8,440 grant sponsored by NISSC, 9-12/2003. Design an effective admission control mechanism with an adaptive resource management mechanism at the server side to defend emerging degrading DDoS attacks.
- **SCOLD (Secure COLlective Internet Defense** — Principal Investigator for the \$10,000 grant sponsored by NISSC, 6-8/2003. Explored the concept of intrusion tolerance where the clients can be told to reroute traffic indirectly through a set of proxy servers and alternate gateways to the server of a site being attacked by DDoS. New secure DNS protocols were developed where the coordinator can update DNS server with new entries with a set of proxy server for indirect routes. A preliminary implementation of the system based on IP-tunnels was developed.
- **SMANET (Secure Mobile Ad hoc NETWORKS)** — Principal Investigator for the \$7,500 grant sponsored by NISSC, 6-8/2003. Developed secure AODV routing update protocol and explored how to use integrated firewall and IDS for access control, intrusion detection and handling.
- **SGFR (Secure Groupware for First Responders)** — Principal Investigator for the \$10,000 grant sponsored by NISSC, 6-8/2003; It is a joint project with Dr. Chip Benight of Psychology Department where we also explore approaches for estimating the stress level of first responders. Developed framework for enhancing collaborative applications such as instant messaging systems and video conference/monitoring with security, effectiveness, and capability. Integrated Jabber

instant messaging system with efficient Keystone secure group communication protocols with group key distribution and rekeying based on optimal key-tree and FEC concept. A prototype secure group chat was implemented.

- **A2D2 (Autonomous Anti-DDoS)**—A adaptive network security testbed for evaluating/improving firewall and intrusion detection systems and for the design of integrated network security systems that can tolerate intrusion.
- **CViprs**—Computer Virus Infection/Propagation Research System or CVIPRS. Here we investigate the design of secure runtime and programming environment for studying the virus and network worm. Explore the use of UML (User Mode Linux) and VMWare for such environment.
- **WINS (Wireless Network Security)**—Created a 802.11a/b dual band wireless security network testbed for improving wireless LAN security. Develop network software for supporting multiple paths that increase the performance, reliability, and security of the wireless networks. Improve end-to-end available bandwidth measurement techniques in wireless networks .

Human Motion Tracking System for Improving Rehab

Specific Projects:

- International Cooperation on Human Motion Tracking and Reasoning (Phase I), Tapei National University of Art, 11/1/2006 to 3/31/2007, \$10,000.00, Principal Investigator. Write proposal and project report, organize workshop, coordinate visits of Drs. Semwal and Chow to TNUA to discuss future project topics and present research results. Arrange visits to Olympic Center and Denver Children Hospital.
- International Cooperation on Human Movement Analysis (Phase II), Taipei National University of Art, 11/19/2007-3/31/2008, \$17,000.00, Principal Investigator. Coordinate the human motion track and reasoning research project to improve rehab patient care that involves TNUA, Denver Children Hospital, and UCCS. Lead the UCCS group to improve Laban animation software and design new software/sensor tracking system for rehab. See HTMR wiki site <http://athena.uccs.edu/~hmtr/present.pptx>
- TNUA Phase III: Human Motion Tracking and Reasoning. Evaluating smarting rotating exercise chairs and Enhancing LabanDancer Software. 2/1/2009-6/30/2009, TNUA, \$23,000.00.

Network Restoration and Survivability

Specific projects:

- **Inter-Exchange Carrier Network Restoration Project**—Principal Investigator for the \$83,745 MCI research grant, 6/92-12/93. Awarded a US patent #5,495,471 on two prong based fast distributed network restoration approach.
- **Digital Cross Connect Restoration Architecture (DRA) Study Project**—Principal Investigator for the \$44,444 MCI research grant, 6/95-8/96. A US patent#5,748,611 awarded 5/5/98 on distributed network restoration method based on conservative bandwidth request and selective forward.
- **Network Survivability Project**—Principal Investigator for the \$29,214 CASI technology transfer grant with US West as industrial collaborator.

Network Planning/Management

work on network resource placement, bottleneck detection, resource allocation—for connections with special resources such as video mixing and protocol converter, codec, and bandwidth

constraints; high speed networking—ATM, HIPPI, and gigabit networks, routing/path finding algorithms (including multicasting).

Specific projects:

- **ATMROS: A Network Design System for Network Optimization and Traffic Management of ATM Networks**—Principal Investigator for the \$31,859 CASI research grant, sponsored by US West. Developed tools for visualizing and characterizing LAN traffic and suggesting ATM cell rates.
- **RACEWIN: Resource and Admission Control Evaluator for Wireless Information Networks**—Principal Investigator for the \$35,215 CASI research grant, sponsored by US West, 7/96-9/97. Developing Java-based Traffic Modeling/Simulation tool and discrete event simulation based tool for PCS cell size determination and efficient designs of hand-off and admission control procedures.
- **WINPLAN: Wireless Information Networks Planning Project**—Principal Investigator for the with \$35,260 grant from CASI, sponsored by Omnipoint, 7/98-9/99. Provide Java-based software tools that read GIS terrain and highway data, display them and antenna location selection in VRML, and provide 3D mobile traffic data for wireless network resource allocation.
- **DPF: Dynamic Packet Filter**—Designed and implemented a dynamic packet filter on LINUX for firewall study.
- **RAS**—A Generalized Network Resource Allocation Prototype.
- **CANDARE**—Computer-Aided Network Design & Analysis Research Environment containing C++ classes for resource allocation, path finding, and graphical user interface.

Network Services

Research issues in upper layer protocols, architectures, and applications, multimedia communications

group-based multimedia applications—distance learning systems, computer conference systems, service creation and validation. Specific projects:

- **NICE—NAPLPS-based Integrated Communication Environment for Education**, sponsored by Sencenbaugh Research Trust Fund.
- **Java-based Sharedraw—Real-time Computer Conference Tool** (text+graphic) with conference management floor control such as revoke or suspend a user for a certain time period. It is being extended to include audio and video.

Protocol Engineering

Methods and algorithms for improving the correctness, reliability, and performance of communication protocols. Protocol Specification, Validation, Synthesis, and Testing, Internetworking, Protocol Conversion, and Document Architecture Conversion. Specific projects:

- **PDE—Protocol Development Environment** based on PROSPEC and including protocol testing and code generation tools

Online Cyber Security Course Development Project

- Developed online courseware on modern OS Security for CMU Software Engineering Institute, through a \$19,349 grant from JMark Services, 2/13-5/24/2013. Include viewgraphs, hand-on

virtual machine based exercises and short video demos on key OS security concepts for both Windows 2012 server and Linux.

Recognitions

Patent

US patent#5,748,611 awarded 5/5/98 for inventing distributed network restoration method based on conservative bandwidth request and selective forward. <http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=/netahtml/srchnum.htm&r=1&f=G&l=50&s1=5,748,611.WKU.&OS=PN/5,748,611&RS=PN/5,748,611>

US patent # 5,495,471, awarded 2/27/96 for inventing fast distributed network restoration based on a two-prong approach. <http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=/netahtml/srchnum.htm&r=1&f=G&l=50&s1=5,495,471.WKU.&OS=PN/5,495,471&RS=PN/5,495,471>

Award

2003 College of Engineering & Applied Science Outstanding Research Award
2001 CU Colorado Springs, Teaching with Technologies Award
1997 CASI Exemplary Research Award
1994 College of Engineering & Applied Science Outstanding Teaching Award
1993 College of Engineering & Applied Science Outstanding Teaching Award

Other Teaching Experience

- Taught communication software training courses at Pacific Bell and Bellcore. Covered the topics of signaling protocols, broadband switching software, C++ object-oriented language, class libraries, InterViews graphic package, object-oriented database, and C++ programming environments.
- Invited lecturer for a research seminar and intense short course sponsored by the Center of Telecommunication Research at National Chiao Tung University on high speed networks/protocols, protocol engineering, network interconnection, intelligent networks, and multimedia communications.

Consulting

Offered short courses on content switching to CCL 7/2002 and Agere 2/2003.
Offered short courses on ATM network and software design at HP Colorado Springs Division.
Offered short courses on Network Restoration Techniques at MCI Richardson, Texas.
Provided network design consultation to Network Planning Laboratory, Taipei.

Operating Systems and Programming Languages

- Operating systems: Linux (Fedora Core, Redhat), Windows (2012, 2008, 8, 7, XP), VxWork, Solaris, iOS, Android.
- Programming languages: C, C++, C#, Objective-C, Java, Perl, Php, VBasic.
- Web-Systems and Language: Apache, IIS, Web clusters, LVS, CGI scripts (Perl/PHP),

Javascript, Web Services, JQuery, JQuery Mobile.

- Cloud Systems: Amazon AWS, VMWare.