



## Professor Ravi Sandhu

University of Texas at San Antonio

*Executive Director and Founder, Institute for Cyber Security*

*Lutcher Brown Endowed Chair in Cyber Security*

*Professor of Cyber Security (College of Science)*

*Professor of Comp. Sci., Elect. and Comp. Engg. and Info. Sys. (Courtesy Appointments)*

**Also Chief Scientist and Co-Founder, TriCipher**

## Contact

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## Degrees

Degree	Major	University	Year
Ph.D.	Computer Science	Rutgers University, New Jersey	1983
M.S.	Computer Science	Rutgers University, New Jersey	1980
M.Tech.	Computer Technology	Indian Institute of Technology, New Delhi	1976
B.Tech.	Electrical Engineering	Indian Institute of Technology, Bombay	1974

## Academic Career

- **Univ. of Texas at San Antonio**, 2007 onwards: Full Prof. and Endowed Chair (Cyber Security).
- **George Mason University**, 1995-2007: Full Prof., 1989-1995: Assoc. Prof. (Information Security).
- **Ohio State University**, 1983-1989: Assistant Professor, 1982-1983: Instructor (Computer Science).

## Career Focus and Goals

My career has focused on high impact research, practice and education in cyber security starting with my doctoral thesis. Effective cyber security requires science, engineering, business, policy and people skills. My goal is to instill this culture in the cyber-security discipline and provide leadership in all elements.

## Professional Recognition

- **Citations and Impact.** (Based on Google Scholar) 10,000+ citations. #1 and #2 papers in access control with 3000+ and 1800+ citations. My h-index is 46 (46 papers with 46 or more citations).
- **AAAS Fellow, 2008.** “For distinguished contributions to cyber security, including seminal role-based access control and usage control models, and for professional leadership in research journals and conferences.”
- **ACM SIGSAC Outstanding Contribution Award, 2008.**
- **IEEE Computer Society Technical Achievement Award, 2004.** “For outstanding and pioneering contributions to information security including innovation of the RBAC model and usage control.”
- **IEEE Fellow 2002.** “For contributions to the field of information and system security.”
- **ACM Fellow 2001.** “For technical contributions to the field of info. and system security, notably access control models and systems, and professional leadership in research journals and conferences.”
- **Best Paper Awards 1992 and 1998.** NIST/NSA National Computer Security Conference.

## Highly Cited Papers at Google Scholar Include Role-Based Access Control

- Role-Based Access Control Models, IEEE Comp., 29(2):38-47, 1996. 3000+ hits. #1 in access control.
- Proposed NIST Std. for RBAC. ACM TISSEC, 4(3):224-274, 2001. 1800+ hits. #2 in access control.
- The NIST Model for Role-Based Access Control. 5<sup>th</sup> ACM RBAC:47-63, 2000. 350+ hits.
- The ARBAC97 Model for Role-Based Admin. of Roles. ACM TISSEC, 2(1):105-135, 1999. 300+ hits.
- Configuring RBAC to Enforce MAC and DAC. ACM TISSEC, 3(2):85-106, 2000. 300+ hits.
- Role-Based Authorization Constraints Specification. ACM TISSEC, 3(4):207-226, 2000. 250+ hits
- Numerous others with 100+ hits.

## Usage Control

- The UCON<sub>ABC</sub> Usage Control Model, ACM TISSEC, 7(1):128-174, 2004. 150+ hits.

## Access Control Tutorials

- Access Control: Principles and Practice. IEEE Communications, 32(9): 40-48, 1994. 400+ hits.
- Lattice-Based Access Control Models. IEEE Computer, 26(11): 9-19, 1993. 350+ hits.

## Access Control Earlier Models

- Task-based Authorization Controls. 11<sup>th</sup> IFIP 11.3 Data and Application Sec.:262-275, 1997. 200+ hits.
- The Typed Access Matrix Model. 13<sup>th</sup> IEEE Security and Privacy (Oakland):122-136, 1992. 200+ hits.
- Toward a Multilevel Secure Relational Data Model, SIGMOD:50-59, 1991. 150+ hits.
- Transaction Control Expressions for Separation of Duties. 4<sup>th</sup> ACSAC:282-286, 1988. 100+ hits.
- The Schematic Protection Model, Journal of the ACM, 35(2):404-432, 1988. 100+ hits.
- Crypto. Implementation of a Tree Hierarchy for Access Control. IPL, 27(2):95-98, 1988. 100+ hits.

## Research Highlights

- **Statistics:** 180+ papers (with 50+ co-authors), 12 USA patents, 14 PhD graduates, 35+ research grants.
- **Sponsors:** include NSF, NSA, NRO, NRL, AFOSR, NIST, DARPA, ARDA, AFOSR, Sandia, State Dept., DOE, IRS, RADC, FAA, Intel, Northrop Grumman, Lockheed Martin, ITT, Verizon.
- **Ongoing research initiatives include:** PEI (policy, enforcement, implementation) layered models, Applications of the UCON usage control model, Innovative applications of modern trusted computing, Next-generation role-based access control, Security for the semantic web, Stealthy Botnet Detection, Security and Privacy for Social Networks, Web 2.0 Security, Secure Information Sharing.
- **Earlier research:** My research on RBAC has been instrumental in establishing it as the preferred form of access control, including its acceptance as an ANSI/NIST standard in 2004. My earlier research on numerous access control models remains influential and state-of-the-art.

## Professional Leadership Includes

- Founding Editor-in-Chief, ACM Transactions on Information & Systems Security (TISSEC), 1997-2004.
- Chairman, ACM Special Interest Group on Security Audit and Control (SIGSAC), 1995-2003.
- Security Editor, IEEE Internet Computing, 1998-2004.
- Conference Founder: ACM CCS (1993), ACM SACMAT (1995). Both very highly regarded.
- Conference Steering Committees: ACM CCS (1993-2003 Chair, 2003-2007 Member), ACM SACMAT (1995-2008 Chair), IEEE CSF (1992-2008 Member).
- Conference Program Chair: IEEE CSF (1991, 1992), ACM CCS (1993, 1994, 2002), ACM SACMAT (1995), ACSAC (1996), IFIP WG 11.3 (1996), ACM CSAW (2007).
- Conference General Chair: IEEE CSF (1993, 1994), ACM CCS (1996), ACM SACMAT (2001, 2002).

## Entrepreneurial and Consulting Career

- TriCipher Inc., 2000 onwards, Chief Scientist and Co-Founder
- Consultant to numerous organizations including: McAfee, Trusted Information Systems, National Institute of Standards and Technology, Verizon, SETA Corporation, Argonne National Laboratory, Singapore Management University, Northrop Grumman, Integrus Health.

## Teaching Career

- I was the principal architect for the MS and PhD in Information Security and Assurance at George Mason University, where I personally developed and taught the core courses and multiple electives.
- I have presented short courses, tutorials and invited lectures all over the world including Asia, Australia, Europe, North America and South America.

## Personal

- US Citizen since 1997. Born in India. Schooled at Doon School and IITs. Married with two sons.

## Sponsored Research Grants

### Currently Active

1. A Systematic Defensive Framework for Combating Botnets  
Principal Investigator: Ravi Sandhu  
Sponsor: *Office of Naval Research*, 2009  
Partners: Purdue U., UT Dallas, Texas A&M, U. of Wisconsin
2. IAPD: A Framework for Integrated Adaptive and Proactive Defenses against Stealthy Botnets  
Principal Investigators: Shouhuai Xu and Ravi Sandhu  
Sponsor: *Air Force Office of Scientific Research*, 2009-2012  
Partners: Georgia Tech
3. AISL: Assured Information Sharing Life Cycle  
Principal Investigator: Ravi Sandhu  
Sponsor: *Air Force Office of Scientific Research, MURI*, 2008-2013  
Partners: U. of Maryland-BC, U. of Michigan, U. of Illinois-UC, Purdue U., UT Dallas
4. SNGuard: Securing Dynamic Online Social Networks  
Principal Investigator: Ravi Sandhu  
Sponsor: National Science Foundation, 2008-2012  
Partners: Penn. State Univ., Arizona State Univ., Univ. of North Carolina-Charlotte
5. Institute for Cyber Security Founding Grant  
Principal Investigator: Ravi Sandhu  
Sponsor: *State of Texas Emerging Technology Fund*, 2007-2010
6. STARS Grant for Establishing Institute for Cyber Security Laboratory  
Principal Investigator: Ravi Sandhu  
Sponsor: *UT System*, 2007-2008
7. Secure Knowledge Management: Models and Mechanisms  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Science Foundation*, 2005-2009
8. Deploying Secure Distributed Systems using LaGrande Technology: Models, Architectures and Protocols  
Principal Investigator: Ravi Sandhu  
Sponsor: *Intel Research Council*, 2004-2009

### Completed

9. Information Operations Across Infospheres  
Principal Investigator: Ravi Sandhu  
Sponsor: *Air Force Office of Scientific Research*, 2006-2008
10. Usage Control Models, Architectures and Mechanisms Based on Integrating Authorizations, Obligations and Conditions  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Science Foundation*, 2003-2006
11. Next Generation Authentication and Access Control for the FAA  
Principal Investigator: Ravi Sandhu  
Sponsor: *Federal Aviation Administration*, 2004-2005

12. Flexible Policy Models and Architectures for Client and Server-assured Document Access Controls  
Principal Investigator: Roshan Thomas, McAfee Research, Network Associates  
Investigator: Ravi Sandhu  
Sponsor: *Advanced Research and Development Agency, 2003-05*
13. Scalable Authorization in Distributed Systems  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Science Foundation, 1999-2002*
14. Sonora: Secure Metadata Models and Architectures  
Principal Investigator: Ravi Sandhu  
Co-Investigator: Larry Kerschberg  
Sponsor: *Northrop Grumman, 2001-2002*
15. Secure Objects  
Principal Investigator: Ravi Sandhu  
Co-Investigators: Larry Kerschberg and Edgar Sibley  
Sponsor: *National Reconnaissance Office and National Security Agency, 2000-2001*
16. Security and Containment Policy for the Attack Sensing, Warning and Response Laboratory  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency, 1999-2000*
17. Secure Role-Based Workflow Systems  
Principal Investigator: Ravi Sandhu  
Sponsor: *Naval Research Laboratory, 1999*
18. Control and Tracking of Information Dissemination  
Principal Investigator: Ravi Sandhu  
Sponsor: *Lockheed Martin, 1999*
19. Distributed Role-Based Access Control Models and Architectures  
Principal Investigator: Ravi Sandhu  
Sponsor: *Sandia National Laboratories, 1999*
20. Role-Based Access Control on the Web  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency, 1998-99*
21. Secure Remote Access  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency, 1998*
22. Agent-Based Systems  
Principal Investigators: Ravi Sandhu, Prasanta Bose, Elizabeth White  
Sponsor: *National Security Agency, 1998*
23. Multi-Layered Countermeasures to Vulnerabilities in Networked Systems  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency, 1996-97*
24. Role-Based Access Control: Phase II  
Principal Investigator: Ed Coyne, SETA Corporation  
Investigators: Ravi Sandhu, Charles Youman (SETA)  
Sponsor: *National Institute of Standards and Technology, 1995-97*

25. Task-based Authorizations: A New Paradigm for Access Control  
Principal Investigator: Roshan Thomas, Odyssey Research Associates  
Investigator: Ravi Sandhu  
Sponsor: *Defense Advanced Research Projects Agency*, 1995-97
26. A Pragmatic Approach to the Design and Analysis of Composite Secure Systems  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1994-97
27. Design of Multilevel Secure Relational Databases  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1994-96
28. Role-Based Access Control: Phase I  
Principal Investigator: Hal Feinstein, SETA Corporation  
Investigators: Ravi Sandhu, Ed Coyne (SETA), Charles Youman (SETA)  
Sponsor: *National Institute of Standards and Technology*, 1994
29. Architectures for Type-Based Distributed Access Control  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1993-96
30. Privacy Models and Policies  
Principal Investigator: Andrew Sage, George Mason University  
Investigators: Ravi Sandhu, Sushil Jajodia and Paul Lehner  
Sponsor: *Internal Revenue Service*, Tax Systems Modernization Institute, 1995
31. Derivation, Modeling, and Analysis of Access Control Systems  
Principal Investigators: Ravi Sandhu and Paul Ammann  
Sponsor: *National Science Foundation*, 1992-95
32. Unified Security Models for Confidentiality and Integrity  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1992-94
33. Foundations of Multilevel Secure Object-Oriented Databases  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1992-94
34. Polyinstantiation in Multilevel Relations  
Principal Investigator: Sushil Jajodia  
Co-Principal Investigator: Ravi Sandhu  
Sponsor: *Rome Air Development Center*, Department of Defense, 1992
35. Models, Mechanisms and Methods for Integrity Policies  
Principal Investigator: Ravi Sandhu  
Sponsor: *National Security Agency*, 1989-92
36. Analysis of Updates of Multilevel Relations  
Principal Investigator: Sushil Jajodia  
Co-Principal Investigator: Ravi Sandhu  
Sponsor: *Rome Air Development Center*, Department of Defense, 1990-91

## PhD Advisees

1. Venkata Bhamidipati, *Architectures and Models for Administration of User-Role Assignment in Role Based Access Control*, Fall 2008. (Co-advisor: Daniel Menasce.)
2. Zhixiong Zhang, *Scalable Role and Organization Based Access Control and Its Administration*, GMU, Spring 2008. (Co-advisor: Daniel Menasce.)
3. Xinwen Zhang, *Formal Model and Analysis of Usage Control*, GMU, Summer 2006. (Co-advisor: Francesco Parisi-Presicce.)
4. Mohammad Abdullah Al-Kahtani, *A Family of Models for Rule-Based User-Role Assignment*, GMU, Spring 2004.
5. Jaehong Park, *Usage Control: A Unified Framework for Next Generation Access Control*, GMU, Summer 2003.
6. Ezedin Barka, *Framework for Role-Based Delegation Models*, GMU, Summer 2002.
7. Pete Epstein, *Engineering of Role/Permission Assignments*, GMU, Spring 2002.
8. Qamar Munawer, *Administrative Models for Role-Based Access Control*, GMU, Spring 2000.
9. Gail-Joon Ahn, *The RCL 2000 Language for Role-Based Authorization Constraints*, GMU, Fall 1999.
10. Joon Park, *Secure Attribute Services on the Web*, GMU, Summer 1999.
11. Phillip Hyland, *Concentric Supervision of Security Applications: An Assurance Methodology*, GMU, Spring 1999.
12. Tarik Himdi, *A Scalable Extended DGSA Scheme for Confidential Data Sharing in Multi-Domain Organizations*, GMU, Spring 1998.
13. Srinivas Ganta, *Expressive Power of Access Control Models Based on Propagation of Rights*, GMU, Summer 1996.
14. Roshan Thomas, *Supporting Secure and Efficient Write-Up in High-Assurance Multilevel Object-Based Computing*, GMU, Summer 1994.

## USA Patents

1. *Laddered Authentication Security Using Split Key Asymmetric Cryptography*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,447,903. November 4, 2008. (Continuation of 7,069,435.)
2. *Authentication Protocol Using a Multi-Factor Asymmetric Key Pair*. Ravi Sandhu, Brett Schoppert, Ravi Ganesan, Mihir Bellare and Colin deSa. USA Patent 7,386,720. June 10, 2008.
3. *System and Apparatus for Storage and Transfer of Secure Data on Web*. Ravi Sandhu and Joon Park. USA Patent 7,293,098. November 6, 2007. (Continuation of 6,985,953.)
4. *Method and System for Authorizing Generation of Asymmetric Crypto-Keys*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,149,310. December 12, 2006.
5. *System and Method for Authentication in a Crypto-System Utilizing Symmetric and Asymmetric Crypto-Keys*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,069,435. June 27, 2006.
6. *System and Method for Generation and Use of Asymmetric Crypto-Keys Each Having a Public Portion and Multiple Private Portions*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,065,642. June 20, 2006.
7. *One Time Password Entry to Access Multiple Network Sites*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,055,032. May 30, 2006.
8. *Secure Communications Network With User Control of Authenticated Personal Information Provided to Network Entities*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 7,017,041. March 21, 2006.
9. *System and Apparatus for Storage and Transfer of Secure Data on Web*. Ravi Sandhu and Joon Park. USA Patent 6,985,953. January 10, 2006.
10. *A System and Method for Crypto-key Generation and Use in Cryptosystem*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 6,970,562. November 29, 2005.
11. *High Security Cryptosystem*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 6,940,980. September 6, 2005.
12. *A System and Method for Password Throttling*. Ravi Sandhu, Colin deSa and Karuna Ganesan. USA Patent 6,883,095. April 19, 2005.

## INVITED LECTURES, KEYNOTES, SEMINARS, INCLUDE

1. *Group-Centric Information Sharing*  
Keynote lecture at 4th ICST-Create-Net International Conference on Collaborative Computing: Networking, Applications and Worksharing, Orlando, Florida, Nov. 14, 2008.
2. *Trusted Computing Models*  
Keynote lecture at 2nd IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing (SUTC), Taichung, Taiwan, June 11-13, 2008.
3. *The ASCAA Principles for Access Control Interpreted for Collaboration Systems*  
Invited lecture at Workshop on Collaboration and Security (COLSEC) held at the 2008 International Symposium on Collaborative Technologies and Systems (CTS), Irvine, California, May 19-23, 2008.
4. *Access Control and Semantic Web Technologies*  
Invited lecture at Secure Semantic Web Workshop held at the 24<sup>th</sup> International Conference on Data Engineering (ICDE), Cancun, México, April 7-12, 2008.
5. *The ASCAA Principles for Next-Generation Role-Based Access Control*  
Keynote lecture at 3<sup>rd</sup> IEEE International Conference on Availability, Reliability and Security (ARES), Barcelona, Spain, March 4-7, 2008.
6. *The Secure Information Sharing Problem and Solution Approaches*  
Invited seminar at Center for Education and Research in Information Assurance and Security (CERIAS) at Purdue University, West Lafayette, Indiana, September 27, 2006.
7. *Secure Information Sharing Enabled by Trusted Computing and PEI Models*  
Keynote lecture at 1<sup>st</sup> ACM Symposium on Information, Computer, and Communication Security (AsiaCCS), Taipei, Taiwan, March 21-24, 2006.
8. *Cyber-Identity, Authority and Trust in an Uncertain World*  
Keynote lecture at 6<sup>th</sup> Brazilian Symposium on Computer and Information Security (SSI), November 9-12, 2004.
9. *A Perspective on Graphs and Access Control Models*  
Keynote lecture at 2<sup>nd</sup> International Conference on Graph Transformation (ICGT), Rome, Italy, September 28-October 2, 2004.
10. *Cyber-Identity, Authority and Trust in an Uncertain World*  
Invited plenary lecture at 1<sup>st</sup> Secure Knowledge Management Workshop, Buffalo, New York, September 23-24, 2004.
11. *Future Directions in Role-Based Access Control Models*  
Keynote lecture at 1<sup>st</sup> International Conference on Mathematical Methods, Models and Architectures for Computer Networks Security, Saint Petersburg, Russia, May 21-23, 2001.
12. *Access Control: The Neglected Frontier*  
Keynote lecture at 1<sup>st</sup> Australasian Conference on Information Security and Privacy, Wollongong, NSW, Australia, June 23-26, 1996.
13. *Leader, People-to-People Information Security Delegation to China*  
Beijing, Guangzhou, Shanghai, Hong Kong, May 17–June 1, 1996.

14. *Pacific Rim Information Security Seminars*  
Professional seminars in Sydney, Canberra (Australia), Singapore, Kuala Lumpur (Malaysia), Wellington (New Zealand), May 25–June 10 and November 2–18, 1995.

## PUBLICATIONS

### Journal Publications

1. Xinwen Zhang, Masayuki Nakae, Michael Covington and Ravi Sandhu, “Toward a Usage-Based Security Framework for Collaborative Computing Systems.” *ACM Transactions on Information and System Security*, Volume 11, Number 1, Article 3, Feb. 2008, pages 1-36.
2. David Ferraiolo, Rick Kuhn and Ravi Sandhu, “RBAC Standard Rationale: Comments on “A Critique of the ANSI Standard on Role-Based Access Control”.” *IEEE Security & Privacy*, Volume 5, Number 6, Nov.-Dec. 2007, pages 51-53.
3. Sejong Oh, Ravi Sandhu and Xinwen Zhang, “An Effective Role Administration Model Using Organization Structure.” *ACM Transactions on Information and System Security*, Volume 9, Number 2, May 2006, pages 113-137.
4. Elisa Bertino, Latifur Khan, Ravi Sandhu and Bhavani Thuraisingham, “Secure Knowledge Management: Confidentiality, Trust, and Privacy.” *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans*, Volume 36, Number 3, May 2006, pages 429-438.
5. Ravi Sandhu, Xinwen Zhang, Kumar Ranganathan and Michael J. Covington, “Client-side Access Control Enforcement Using Trusted Computing and PEI Models.” *Journal of High Speed Networks*, Volume 15, Number 3, 2006, Pages 229-245 (Special issue on Managing security policies: Modeling, verification and configuration).
6. Xinwen Zhang, Francesco Parisi-Prisicce, Ravi Sandhu and Jaehong Park, “Formal Model and Policy Specification of Usage Control.” *ACM Transactions on Information and System Security*, Volume 8, Number 4, November 2005, pages 351-387.
7. Xinwen Zhang, Songqing Chen, and Ravi Sandhu, “Enhancing Data Authenticity and Integrity in P2P Systems.” *IEEE Internet Computing*, Volume 9, Number 6, November-December 2005, pages 42-49.
8. Elisa Bertino and Ravi Sandhu. “Database Security-Concepts, Approaches, and Challenges.” *IEEE Transactions on Dependable and Secure Computing*, Volume 2, Number 1, March 2005, pages 2-19.
9. Jaehong Park and Ravi Sandhu. “The UCON<sub>ABC</sub> Usage Control Model.” *ACM Transactions on Information and System Security*, Volume 7, Number 1, February 2004, pages 128-174.
10. Ravi Sandhu, “Good-Enough Security: Toward a Pragmatic Business-Driven Discipline .” *IEEE Internet Computing*, Volume 7, Number 1, January-February 2003, pages 66-68.
11. David F. Ferraiolo, Ravi Sandhu, Serban Gavrila, D. Richard Kuhn and Ramaswamy Chandramouli. “Proposed NIST Standard for Role-Based Access Control.” *ACM Transactions on Information and System Security*, Volume 4, Number 3, August 2001, pages 224-274.
12. Joon Park, Ravi Sandhu and Gail-Joon Ahn. “Role-Based Access Control on the Web.” *ACM Transactions on Information and System Security*, Volume 4, Number 1, February 2001, pages 37-71.
13. Gail-Joon Ahn and Ravi Sandhu. “Decentralized User Group Assignment in Windows NT.” *Journal of Systems and Software*, Volume 56, Issue 1, February 2001, pages 39-49.

14. Gail-Joon Ahn and Ravi Sandhu. "Role-Based Authorization Constraints Specification." *ACM Transactions on Information and System Security*, Volume 3, Number 4, November 2000, pages 207-226.
15. Joon Park and Ravi Sandhu, "Secure Cookies on the Web." *IEEE Internet Computing*, Volume 4, Number 4, July 2000, pages 36-45.
16. Sylvia Osborn, Ravi Sandhu and Qamar Munawer. "Configuring Role-Based Access Control to Enforce Mandatory and Discretionary Access Control Policies." *ACM Transactions on Information and System Security*, Volume 3, Number 2, May 2000, pages 85-106.
17. Ravi Sandhu, Venkata Bhamidipati and Qamar Munawer. "The ARBAC97 Model for Role-Based Administration of Roles." *ACM Transactions on Information and System Security*, Volume 2, Number 1, February 1999, pages 105-135.
18. Ravi Sandhu and Venkata Bhamidipati, "Role-Based Administration of User-Role Assignment: The URA97 Model and its Oracle Implementation." *Journal of Computer Security*, Volume 7, 1999, pages 317-342.
19. Gail-Joon Ahn and Ravi Sandhu, "Towards Role-Based Administration in Network Information Services." *Journal of Network and Computer Applications*, Volume 22, Number 3, July 1999, pages 199-213.
20. Ravi Sandhu and Fang Chen. "The Multilevel Relational Data Model." *ACM Transactions on Information and System Security*, Volume 1, Number 1, November 1998, pages 93-132.
21. Ravi Sandhu, Edward Coyne, Hal Feinstein and Charles Youman, "Role-Based Access Control Models." *IEEE Computer*, Volume 29, Number 2, February 1996, pages 38-47.
22. Ravi Sandhu and Pierangela Samarati, "Authentication, Access Control and Audit." *ACM Computing Surveys*, 50th anniversary commemorative issue, Volume 28, Number 1, March 1996, pages 241-243.
23. Roshan Thomas and Ravi Sandhu, "A Secure Trusted Subject Architecture for Multilevel Object-Oriented Databases." *IEEE Transactions on Knowledge and Data Engineering*, Volume 8, Number 1, February 1996, pages 16-31.
24. Ravi Sandhu and Pierangela Samarati, "Access Control: Principles and Practice." *IEEE Communications*, Volume 32, Number 9, September 1994, pages 40-48.
25. Ravi Sandhu, "Lattice-Based Access Control Models." *IEEE Computer*, Volume 26, Number 11, November 1993, pages 9-19. **Cover Article.**
26. Roshan Thomas and Ravi Sandhu, "A Kernelized Architecture for Multilevel Secure Object-Oriented Databases Supporting Write-Up." *Journal of Computer Security*, Volume 2, Number 3, 1993, pages 231-275.
27. Ravi Sandhu and Gurpreet Suri, "A Distributed Capability-Based Architecture for the Transform Model." *Computers & Security*, Volume 12, Number 3, May 1993, pages 285-303.
28. Paul Ammann and Ravi Sandhu, "The Extended Schematic Protection Model." *Journal of Computer Security*, Volume 1, Number 4, 1992, pages 335-383.
29. Ravi Sandhu, "Lattice-Based Enforcement of Chinese Walls." *Computers & Security*, Volume 11, Number 8, December 1992, pages 753-763.
30. Ravi Sandhu and Sushil Jajodia, "Eliminating Polyinstantiation Securely." *Computers & Security*, Volume 11, Number 6, October 1992, pages 547-562.

31. Ravi Sandhu, "Undecidability of Safety for the Schematic Protection Model with Cyclic Creates." *Journal of Computer and System Sciences*, Volume 44, Number 1, February 1992, pages 141-159.
32. Ravi Sandhu, "Expressive Power of the Schematic Protection Model." *Journal of Computer Security*, Volume 1, Number 1, 1992, pages 59-98.
33. Ravi Sandhu and Sushil Jajodia, "Integrity Principles and Mechanisms in Database Management Systems." *Computers & Security*, Volume 10, Number 5, August 1991, pages 413-427.
34. Ravi Sandhu, "Recognizing Immediacy in an NTree and its Application to Protection Groups." *IEEE Transactions on Software Engineering*, Volume 15, Number 12, December 1989, pages 1518-1525.
35. Ravi Sandhu, "The Demand Operation in the Schematic Protection Model." *Information Processing Letters*, Volume 32, Number 4, September 1989, pages 213-219.
36. Ravi Sandhu, "The Reflected Tree Hierarchy for Protection and Sharing." *Information Processing Letters*, Volume 30, Number 1, January 1989, pages 21-26.
37. Ravi Sandhu, "Nested Categories for Access Control." *Computers & Security*, Volume 7, Number 6, December 1988, pages 599-605.
38. Ravi Sandhu, "The NTree: A Two Dimension Partial Order for Protection Groups." *ACM Transactions on Computer Systems*, Volume 6, Number 2, May 1988, pages 197-222.
39. Ravi Sandhu, "The Schematic Protection Model: Its Definition and Analysis for Acyclic Attenuating Schemes." *Journal of the ACM*, Volume 35, Number 2, April 1988, pages 404-432.
40. Ravi Sandhu, "Cryptographic Implementation of a Tree Hierarchy for Access Control." *Information Processing Letters*, Volume 27, Number 2, February 1988, pages 95-98.

## Publications in Collections

41. Zhixiong Zhang, Xinwen Zhang, and Ravi Sandhu, "Towards a Scalable Role and Organization Based Access Control Model with Decentralized Security Administration." *Handbook of Research on Social and Organizational Liabilities in Information Security*, edited by M. Gupta and R. Sharman, IGI Global, pages 94-117, 2009.
42. Munir Majdalawieh, Francesco Parisi-Presicce and Ravi Sandhu, "RBAC Model for SCADA." *Innovative Algorithms and Techniques in Automation, Industrial Electronics and Telecommunications*, Springer, pages 329-335, 2007.
43. Ravi Sandhu, "Role-Based Access Control." *Advances in Computers*, Volume 46, (M. Zelkowitz editor), Academic Press, pages 237-286, 1998.
44. Ravi Sandhu and Pierangela Samarati, "Authentication, Access Control and Intrusion Detection." In *The Computer Science and Engineering Handbook*, CRC Press, 1997, pages 1929-1948.
45. Ravi Sandhu and Sushil Jajodia, "Integrity Mechanisms in Database Management Systems." In *Information Security: An Integrated Collection of Essays, Volume 1*, (Abrams, M.A., Podell, H.J. and Jajodia, S., editors), IEEE Computer Society Press, 1994, pages 617-634.

46. Sushil Jajodia and Ravi Sandhu, "Toward A Multilevel Secure Relational Data Model." In *Information Security: An Integrated Collection of Essays, Volume 1*, (Abrams, M.A., Podell, H.J. and Jajodia, S., editors), IEEE Computer Society Press, 1994, pages 460-492.
47. Sushil Jajodia, Ravi Sandhu and Barbara Blaustein, "Solutions to the Polyinstantiation Problem." In *Information Security: An Integrated Collection of Essays, Volume 1*, (Abrams, M.A., Podell, H.J. and Jajodia, S., editors), IEEE Computer Society Press, 1994, pages 493-529.
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52. Ram Krishnan, Ravi Sandhu, Jianwei Niu and William Winsborough, "Formal Models for Group-Centric Secure Information Sharing." *Proc. 14<sup>th</sup> ACM Symposium on Access Control Models and Technologies (SACMAT)*, Stresa, Italy, June 3-5, 2009, to appear.
53. Ravi Sandhu, "The PEI Framework for Application-Centric Security." *Proc. 1<sup>st</sup> International Workshop on Security and Communication Networks (IWSCN)*, Trondheim, Norway, May 20-22, 2009, to appear. **Invited Lecture.**
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55. Justin Leonard, Shouhuai Xu, and Ravi Sandhu, "A First Step Towards Characterizing Stealthy Botnets." *Proc. of 4<sup>th</sup> International Conference on Availability, Reliability and Security (ARES)*, Fukuoka Institute of Technology, Fukuoka, Japan, March 16- 19, 2009, pages 106-113.
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