



# Jack Brassil

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## Education

**Ph.D. Electrical & Computer Engineering**, *University of California, San Diego*.

Dissertation title: "Deflection Routing in Certain Regular Networks"

**M.Eng. Electrical Engineering**, *Cornell University*.

**B.S. Electrical Engineering**, *Polytechnic Institute of New York*.

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## Appointments

2018-present **Princeton University**, *Senior Director of Advanced CyberInfrastructure*, Office of VP of Information Technology, and *Senior Research Scholar*, Department of Computer Science.

- Develops campus strategy and leads creation of world class computing, networking and data science research infrastructure and instruments.

2015-2018 **National Science Foundation**, *Program Director*, *CISE/Division of Computer and Network Systems*, Alexandria, VA.

- Conceived and oversaw \$200M investments with over 275 Investigators in Computer Science and Engineering research programs, including the Network Technologies and Systems (NeTS) core program, Global Environment for Network Innovations (*GENI*), NSFCloud, and U.S. Ignite smart cities. Managing joint U.S. research partnerships with Japan, Brazil and the European Commission.

2015-2018 **Princeton University**, *Senior Scholar (on leave at NSF)*, Department of Computer Science.

1999-2015 **HP Laboratories**, *Distinguished Technologist & Program Manager*, *Networking & Mobility Laboratory*, Princeton, NJ and Palo Alto, CA.

- Led a research team creating, patenting and prototyping high-speed communications techniques for mobile wireless devices. Generated state-of-the art research contributions to location-based services, enterprise networks, cloud computing, privacy and security.

1991-1999 **Bell Laboratories**, *Member of Technical Staff*, *Communications Research Department*, Murray Hill, NJ.

- Principal Investigator researching computer networking architectures, protocols and applications.

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## Recognition & Honors

2018 **NSF Director's Award for Superior Accomplishment (co-recipient)**, for launching the *Platforms for Advanced Wireless Research (PAWR)* program.

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- 2012 **Best Paper Award**, *MobiSec 2012*, "Verifying the Location of a Mobile Device User".
- 2005 **IEEE Fellow**, *for contributions to computer networking, information hiding and privacy.*
- 1995 **R&D 100 Product Award**, *for most innovative R&D product in the emerging field of digital image watermarking and related electronic commerce technologies.*

## Keynote Lectures

- 2016 **Fourth IEEE Workshop on Hot Topics in Web Systems and Technologies**, *HotWeb 2016*, "Disruption at the Internet Edge".
- 2013 **22nd Intl. Conf. on Computer Communications and Networks**, *ICCN 2013*, "Locating Mobile Devices Indoors: Opportunities, Theory, and Practice".
- 2013 **Intl. Workshop on Cloud Computing and Information Security**, *CCIS 2013*, "Security and Privacy in the Mobile Cloud".

## Teaching

**Adjunct Professor**, *Rutgers University*, CS 352: Internet Protocols & Technology (1998).

**Research Advisor**, Mentor for 14 graduate and undergraduate research interns from institutions including UC Berkeley, Princeton Univ., MIT, Univ. of Illinois, George Mason, Columbia Univ., Univ. of Victoria, UC Irvine, Purdue Univ., Stanford Univ.

## Awards & Grants

**Principal Investigator**, *NSF-1934704, Workshop on Next Generation Cloud Research Infrastructure*, Convene research community to investigate future of cloud computing research infrastructure: Award – \$66,547 (2019).

**Principal Investigator**, *NSF-1923692, CloudJoin: Migrating CISE Computing Research Infrastructure to the Cloud*, Investigate novel architectures integrating campus research computing and commercial cloud platforms: Award – \$291,995 (2019).

**Principal Investigator**, *NSF GENI Program, InstGENI Project*, Completed deployment of compute server rack with OpenFlow-enabled network switches at 32 universities nationwide. Subcontractors: University of Utah, Northwestern University, PlanetWorks Inc.: Award – \$1.5 Mil. (2014).

**Co-Principal Investigator**, *DARPA Internet Control Plane Program, CHART Project*, Created and led a joint startup-academic team to develop flow-oriented internet architectures and protocols to improve TCP/IP quality-of-service on impaired networks. Subcontractors: Princeton University, UC Berkeley, UC Santa Barbara, George Mason University, Sparta Inc., Anagran Inc.: Award – \$6.4 Mil. (3 program phases, 2004-2008).

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## Advisory Committees

**National Research Council**, *Board of Assessment for the National Institute of Standards and Technologies*, Appointed to a 5 year term (2001-5) overseeing NIST's Information Technologies Laboratory's research programs.

**National Science Foundation**, *Computer and Information Science & Engineering panelist* (2002, 2004, 2007, 2014), Office of CyberInfrastructure panelist (2005).

**National Research Council**, *Computer Science and Telecommunications Board*, Image and Instrument Integrity Planning Group; Technology for Copyright Protection (1995).

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## Service

**Community**, Judge, *Responsible Computer Science Challenge* (2019).

**Editorial**, Lead Guest Editor, *IEEE JSAC* issue on ATM LANs (1995).

**Professional Societies**, IEEE – Fellow; IEEE Communications Society – Member, Strategic Planning Committee (1996-97, 1998-99), Electronic Processes Committee (1994-95); ACM; ACM SIGCOMM Member.

**Recent Technical Program Committees**, SECON Fog Networking Workshop (2015); FIDC (2014); Usenix CSET (2012); ICST TridentCom (2012, 2010); ICDCS-SPCC (2011 - 2012); ACM SIGCOMM VISA Workshop (2009, 2010); ANCS (2009); Information Hiding (2006 - 2008); IEEE INFOCOM (2002); WiTMeMo (2006, 2007); UbiSec (2005); IEEE LANMAN (2002 - 2007), TPC Co-Chair (2002), Conference Co-Chair (2004), Steering Committee (2008 - 2017).

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## Patents

### Granted.

• Mobile Printers	US Pat. 10,369,781
• Mobile Printing	US Pat. 10,052,883
• Authenticating a User's Location in a Femtocell-based Network	US Pat. 9,408,025
• Mobile Device Location Authentication	US Pat. 9,049,817
• Tenant Isolation in a Multi-tenant Cloud System	US Pat. 8,909,053
• Assigning WAN Links to Subflows based on Link Characteristics	US Pat. 8,514,865
• Methods for Location Determination and Asserting Privacy	US Pat. 8,493,443
• Media Program Timing and Identity Delivery Method	US Pat. 7,530,086
• Dynamic Generation of a Networked Information Resource	US Pat. 7,370,077
• Local File Transfer	US Pat. 7,212,785
• Dynamic Bandwidth Allocation in a Reservation System	US Pat. 7,143,166
• Cooperative Networking Method and System	US Pat. 7,065,575
• High Rate Data Communications	US Pat. 6,950,668
• Advertisement Insertion in Real-Time IP Multicast	US Pat. 6,771,644
• Document Copying Deterrent Method	US Pat. 6,086,706
• Signal Quality Measurement	US Pat. 6,611,776
• Document Copying Deterrent Method Using Word Shifting	US Pat. 5,629,770

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## Publications

### Location Services

1. "Improving Indoor Positioning Accuracy with Dense, Cooperating Beacons," J. Brassil, *Intl. Conf. on Selected Topics in Mobile and Wireless Networking (MoWNet'14)*, Sept.. 2014.
2. "Indoor Positioning with an Enterprise Radio Access Network," J. Brassil, C. Pearson, L. Fuller, *11th Intl. Conf. on Mobile Systems and Pervasive Computing (MobiSPC 2014)*, Aug. 2014.
3. "Traffic Signature-Based Mobile Device Location Using Authentication," J. Brassil, P.K. Manadhata, R. Netravali, *IEEE Transactions on Mobile Computing*, vol. 13, pp. 2156-2169, 2014.
4. "Authenticating a Mobile Device's Location Using Voice Signatures," Jack Brassil, R. Netravali, Stuart Haber, Pratyusa Manadhata, Prasad Rao, *8th Intl. Conf. on Wireless and Mobile Computing, Networking and Communications (WiMob'2012)*, Barcelona, Spain, October 2012.
5. "Securing a Femtocell-based Location Service," J. Brassil, P.K. Manadhata, *Intl. Conference on Selected Topic in Mobile & Wireless Networking (ICOST 2012)*, July 2012.
6. "Verifying the Location of a Mobile Device User, J. Brassil, P.K. Manadhata, *Proc. of MobiSec 2012*, June 2012. (**Best Paper Award**)
7. "Proving the Location of a Mobile Device User," J. Brassil, P.K. Manadhata, *2012 Virginia Tech Wireless Symposium*, May, 2012.
8. "Femtocell-assisted Location Authentication (short paper)", R. Netravali, Jack Brassil, *18th IEEE Workshop on Local and Metropolitan Area Networks*, Chapel Hill, NC, October 2011.

### Cloud/Data Center Networking

1. "Performance Isolation in Network and Computing Systems with Multiple Inputs," J. Brassil, *Journal of Communications: Special Issue on Advances in Communications & Networking*, vol.7, No. 1, 2012.
2. "Analyzing Flow Isolation in Shared Resource Systems", J. Brassil, *Proc. IEEE Int. Conference on Computer Communications and Networks (ICCCN'11)*, Maui, HI, August 2011.
3. "Automating Network Monitoring on Experimental Testbeds", M. Golightly, J. Brassil, *USENIX Security Workshop on Cyber Security Experimentation and Test (CSET'11)*, San Francisco, August 2011.
4. "Physical Layer Network Isolation in Multi-Tenant Clouds", J. Brassil, *ICDCS 2010 Workshop on Security & Privacy in Cloud Computing (SPCC'10)*, Genoa, Italy, June 2010.

### Wireless Networking

1. "Towards Mobile Handheld Imaging Devices," S.M. Iftekarul Alam, J. Brassil, *ACM HotMobile'16*, St. Augustine, FL, Feb. 2016.
2. "Managing Large Scale, Ultra-Dense Beacon Deployments in Smart Campuses," M. Wang, J. Brassil, *IEEE INFOCOM'15 Smart Cities and Urban Informatics Workshop*, Hong Kong, May 2015.
3. "Aggregating Bandwidth for Multi-homed Mobile Collaborative Communities," P. Sharma, S.J. Lee, J. T. Brassil, K. Shin, *IEEE Transactions on Mobile Computing*, vol.6, no.3, March 2007.
4. "Improving Aggregated Channel Performance through Decentralized Channel Monitoring," P. Sharma, S.J. Lee, J. T. Brassil, K. Shin, *Computer Networks*, vol. 50, no. 11 August 2006, pp. 1675-1691.
5. "Handheld Routers: Intelligent Bandwidth Aggregation for Mobile Collaborative Communities", P. Sharma, S.J. Lee, J. T. Brassil, K. Shin, *BroadNets 2004*, San Jose, CA, Oct 2004, pp. 345-356.
6. "Distributed Channel Monitoring for Wireless Bandwidth Aggregation", P. Sharma, S.J. Lee, J. Brassil, K. Shin, *Proceedings of Networking 2004*, Springer-Verlag, Athens, Greece, pp. 345-356,

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May 2004.

### Core Networking

1. "The CHART System: A High-Performance, FairTransport Architecture Based on Explicit-Rate Signaling," J. Brassil, R. McGeer, R. Rajagopalan, P. Sharma, P. Yalagandula, S. Banerjee, D.P. Reed, S.-J. Lee, A. Bavier, L. Peterson, L. Roberts, A. Henderson, B. Khorram, S. Zhang, S. Sohn, B.L. Mark, C. Heiter, J. Spies, N. Watts, *ACM SIGOPS Operating Systems Review*, vol. 43, no. 1, pp. 26-35, Jan. 2009.
2. "Network Integrated Transparent TCP Accelerator," J.-K. Lee, P. Sharma, J. Tourrilhes, R. McGeer, J. Brassil, A. Bavier, *Proceedings of AINA 2010*, April 2010.
3. "The Case for Service Overlays (Position Paper)," J.T. Brassil, B. Mark, R. McGeer, S. Schwab, P. Sharma, P. Yalagandula, *Proc. IEEE Int. Conference on Computer Communications and Networks (ICCCN'09)*, San Francisco, CA, 2009.
4. "Networking Technologies in the Developing World", M.E. Fiuczynski, R. McGeer, J.T. Brassil, L.L. Peterson, D.P. Reed, *Proceedings of the Sixth International Conference on Creating, Connecting and Collaborating through Computing*, January 2008.
5. "Improving VPN Performance over Multiple Access Links", J. Brassil, R. McGeer, R. Rajagopalan, A. Bavier, L. Roberts, B. Mark, S. Schwab Broadnets 2008, London UK, 2008.
6. "Performance of an Adaptive Routing Overlay Under Dynamic Link Impairments", B. Mark, S. Zhang, J. Brassil, et al., *Proceedings of Milcom'07*, Orlando FL, 2007.
7. "Networking Technologies in the Developing World", M.E. Fiuczynski, R. McGeer, J.T. Brassil, L.L. Peterson, D.P. Reed, *Proceedings of the Sixth International Conference on Creating, Connecting and Collaborating through Computing*, January 2008.
8. "NATALIE: An Adaptive, Network-Aware Traffic Equalizer", Y. He, J. Brassil, *IEEE International Conference on Communications (ICC'07)*, Glasgow UK, June 2007.
9. "Congestion-triggered Multipath Routing based on Shortest Path Information", S. Sohn, B.L. Mark, J.T. Brassil, *Proc. IEEE Int. Conference on Computer Communications and Networks (ICCCN'06)*, Arlington, VA, pp. 191-196, Oct. 2006.
10. "The CHART System: Architecture and Performance," J. Brassil, R. McGeer, N. Watts, S. Banerjee, P. Sharma, P. Yalagandula, D. Reed, *HP TechCon'07*, San Antonio TX, April 2007.
11. "Multi-path Routing Overlays: Opportunities and Problems," J. Brassil, A. Bavier, B. Mark, *DARPA Workshop on Routing Protocols and Management*, Arlington VA, 2007.
12. "Increasing TCP Throughput with an Enhanced Internet Control Plane", A. Bavier, et al, *Milcom 2006*, Washington DC, October 2006.
13. "GENI Component Reference Design", J. Brassil (Ed.), *GENI Design Document GDD-06-13*, October 2006.
14. "Performance Characterization of Traffic Equalizers on Heterogeneous Communication Links", J. Li, J. Brassil, *Proceedings of QShine'06*, Waterloo CA, August 2006.
15. "An Empirical Study of Bonded Heterogeneous Access Links," J. T. Brassil, *14th IEEE Workshop on Local & Metropolitan Area Networks (LANMAN 2005)*, Crete, September 2005.
16. "Strict Peak Rate Enforcement at the ATM Network Entry Point," J. T. Brassil, *The 31st Allerton Conf. on Communication, Control and Computing*, Univ. of Illinois, September, 1993, pp. 197-206.
17. "The Manhattan Street Network: A High Performance, Highly Reliable Metropolitan Area Network," J. T. Brassil, A. K. Choudhury, N. F. Maxemchuk, *Computer Networks and ISDN Systems*, vol. 26, 6-8, March, 1994, pp. 841-858.
18. "Peak Rate Regulation Maintains Service Quality in ATM LAN/WAN Integration," J. Brassil,

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- Proceedings of IEEE INFOCOM'94*, vol. 2, Toronto, June, 1994, pp. 902-909.
19. "Overcoming Reservation Latency in an ATM PON," J. Brassil, *Proceedings of IEEE Globecom'99*, pp. 1155-1161, December 1999.
  20. "Nonuniform Traffic in the Manhattan Street Network," J. T. Brassil and R. L. Cruz, *Proceedings of ICC'91*, vol. 3, pp. 1647-1651, June, 1991. Reprinted in *Performance Evaluation of High-Speed Switching Fabrics and Networks*, T. Robertazzi (Ed.), IEEE Press, 1992.
  21. "Nonuniform Traffic in the Manhattan Street Network," J. T. Brassil and R. L. Cruz, *Performance Evaluation*, vol. 25, pp. 233-242, 1996.
  22. "ATM LANs: Implementation and Experience with an Emerging Technology," J. Brassil, V. Frost, I. Leslie, B. Lyles, Guest Editors, *IEEE Journal on Selected Areas in Communications*, vol. 13 no. 4, May 1995, pp. 617-619.
  23. "Broadband Networks Using Combined Trunk Group and Deflection Routing," J. T. Brassil and R. L. Cruz, *Proceedings of the 25th Annual Conference on Information Sciences and Systems*, Johns Hopkins University, pp. 935-940, March, 1991.
  24. "Bounds on Maximum Delay in Networks with Deflection Routing," J. T. Brassil and R. L. Cruz, *IEEE Transactions on Parallel and Distributed Systems*, vol 6, no 7, July 1995, pp. 724-732.
  25. "Bounds on Maximum Delay in Networks with Deflection Routing," J. T. Brassil and R. L. Cruz, *Proceedings of the 29th Allerton Conference on Communication, Control and Computing*, July, 1991.
  26. "Deflection Routing in Certain Regular Networks," J. T. Brassil, *Ph.D. Dissertation*, University of California, 1991.

### Internet Streaming Media

1. "Large-Scale Personalized Video Streaming with Program Insertion Proxies," J. Brassil, T. Kim, *IEEE Communications Magazine*, vol. 42, no. 8, August 2004.
2. "Smoothing Coarse-Grain Rate Increases to Improve Streaming Media Service Quality," J. T. Brassil, *Proceedings of the 38th Annual Conference on Information Sciences and Systems*, Princeton University, March 2004.
3. "Dynamic Program Insertion in High Quality Video over IP", T. Kim, J. T. Brassil, *Proceedings of the 13th International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV'03)*, Monterey CA, June 2003.
4. Structuring Internet Media Streams with Cueing Protocols," J. T. Brassil, H. Schulzrinne, *IEEE/ACM Transactions on Networking*, vol. 10, no. 4, August 2002, pp. 466-476.
5. "CDNs for Personal Broadcasting and Individualized Reception", S. Banerjee, J. Brassil, A. Dalal, E. Perry, P. Sharma, A. Thomas, *Proceedings of the 7th International Workshop on Web Content Caching and Distribution*, Boulder CO, June 2002.
6. "RTP Payload Format for Program Cues," J. Brassil, H. Schulzrinne, *IETF Audio-Video Transport Working Group*, November 2000.
7. "Enhancing Internet Streaming Media with Cueing Protocols," J. T. Brassil, H. Schulzrinne, *Proceedings of IEEE Infocom'01*, April, 2001. **Best paper award nominee** (top 5 of 830 submissions).
8. "Program Insertion in Real-Time IP Multicasts", J. T. Brassil, S. Garg, H. Schulzrinne, *ACM Computer Communication Review*, vol. 29, no. 2, pp. 49-68, April 1999.
9. "Active Network Error Recovery for Continuous Media Applications", J. Brassil, *SPIE Symposium on the Performance and Control of Network Systems*, vol. 3231, November 1997, pp. 196-207.

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## Privacy

1. "Technical Challenges in Location-Aware Video Surveillance Privacy", Jack Brassil, *Protecting Privacy in Video Surveillance*, Senior, Andrew (Ed.), Springer, 2009, ISBN: 978-1-84882-300-6.
2. "Using Mobile Communications to Assert Privacy from Video Surveillance", J. Brassil, *Proceedings of the First Workshop on Security in Systems and Networks (IPDPS 2005)*, Denver CO, April 2005.

## Information Hiding

1. "Tracing the Source of a Shredded Document," J. Brassil, *Proceedings of the Fifth Workshop on Information Hiding*, Springer-Verlag Lecture Notes on Computer Science, Amsterdam, October 2002.
2. "Copyright Protection for the Electronic Distribution of Text Documents," J. T. Brassil, S. Low, N. F. Maxemchuk, *Proceedings of the IEEE (Invited Paper)*, vol. 87. no. 7, pp. 1181-1196, July 1999.
3. "SEPTEMBER: Secure Electronic Publishing Trial", J. Brassil, A. Choudhury, D. Kristol, A. Lapone, S. Low, N. Maxemchuk, L. O'Gorman, *IEEE Communications Magazine*, vol. 34, no. 5, May 1996, pp. 48-55.
4. "Electronic Marking and Identification Techniques to Discourage Document Copying," J. Brassil, S. Low, N. Maxemchuk, L. O'Gorman, *IEEE Journal on Selected Areas in Communications*, vol. 13 no. 8, October 1995, pp. 1495-1504.
5. "Watermarking Document Images with Bounding Box Expansion," J. Brassil, L. O'Gorman, *Proceedings of the First Workshop on Information Hiding*, Springer-Verlag, Cambridge University, May 1996.
6. "Internet Access to IEEE Journals: The SEPTEMBER Trial," H. Schulzrinne, A.K. Choudhury, J. Brassil, *Proceedings of Documents in Public Networks – Applications and Experiences*, Darmstadt, Germany, November 1995.
7. "Hiding Information in Document Images," J. Brassil, S. Low, N. Maxemchuk, L. O'Gorman, *Proceedings of the 29th Annual Conference on Information Sciences and Systems*, Johns Hopkins University, March 1995, pp 482-489.
8. "Document Marking and Identification using both Line and Word Shifting," S. Low, N. Maxemchuk, J. Brassil, L. O'Gorman, *Proceedings of IEEE INFOCOM'95*, Boston MA, April, 1995.
9. "Marking Text Features of Document Images to Deter Illicit Dissemination", J. T. Brassil, S. Low, N. F. Maxemchuk, L. O'Gorman, *Intl. Conf. on Pattern Recognition*, Haifa, Israel, Oct., 1994.
10. "Marking of Document Images with Codewords to Deter Illicit Dissemination," J. Brassil, S. Low, N. Maxemchuk, L. O'Gorman, *Proceedings of the Third Annual Symposium on Document Analysis and Information Retrieval*, Las Vegas, NV, April, 1994.
11. "Electronic Marking and Identification Techniques to Discourage Document Copying," J. Brassil, S. Low, N. Maxemchuk, L. O'Gorman, *Proceedings of IEEE INFOCOM'94*, vol. 3, Toronto, June, 1994, pp. 1278-1287.

## Distributed Systems, Algorithms and Protocols

1. "Content Services Network: Architecture & Protocols," W. Y. Ma, B. Shen, J. T. Brassil, *Proceedings of the 6th International Workshop on Web Caching and Content Distribution*, June, 2001.
2. "A Two Phase Auction Algorithm for Highly Asymmetric Assignment Problems", N. Cohen, J. Brassil, *Proceedings of the 34th Allerton Conference on Communication, Control and Computing*, Univ. of Illinois, October 1996, pp. 447-456.

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3. "A Parallel Pruning Technique for Highly Asymmetric Assignment Problems", N. Cohen and J. Brassil, *IEEE Transactions on Parallel and Distributed Systems*, vol. 11, no. 6, pp. 550-558, June 2000.

#### NSF Solicitations

1. "Computer and Network Systems (CNS): Core Programs," J. Brassil, D Fisher, M. Ghosh, S. Khan, S. Kundu, M. McClure, M. Mutka, A. Von Lehmen, *NSF 18-569*, 2018.
2. "Smart and Connected Health (SCH)," W. Nilsen, et al, *NSF 18-541*, 2018.
3. "NSF/VMware Partnership on Edge Computing Data Infrastructure (ECDI)," N. Amla, J. Brassil, D. Fisher, M. McClure, *NSF 18-540*, 2018.
4. "US-EU Internet Core & Edge Technologies (ICE-T)," J. Brassil, M. Ghosh, *NSF 18-535*, 2018.
5. "Campus CyberInfrastructure (CC\*)," K. Thompson, A. Nikolich, J. Brassil, *NSF 18-508*, 2018.
6. "Japan-US Network Opportunity 2 (JUNO)," A. Von Lehmen, J. Brassil, *NSF 17-586*, 2017.
7. "FutureCloud Phase 2 (by invitation)," J. Brassil, *CloudLab Phase II, Chameleon Phase II*, 2017.
8. "Computer and Network Systems (CNS): Core Programs," J. Brassil, D Fisher, S. Khan, M. McClure, T. Nandagopal, Y. Solihan, A. Von Lehmen, *NSF 17-570*, 2017.
9. "Tomorrow's Internet Project Office (TIPOFF)," J. Brassil, K. Thompson, *NSF 17-540*, 2017.
10. "NSF/VMware Partnership on Software Defined Infrastructure as a Foundation for Clean-Slate Computing Security (SDI-CSCS)," N. Amla, J. Brassil, D. Fisher, M. McClure, G. Singh, *NSF 16-582*, 2016.
11. "Campus CyberInfrastructure (CC\*)," K. Thompson, A. Walton, J. Brassil, E. Walker, S.K. Prasad, A. Nikolich, R. Chadduck, *NSF 16-567*, 2016.
12. "Platforms for Advanced Wireless Research (PAWR): Establishing the PAWR Project Office (PPO) (PAWR/PPO)," T. Nandagopal, J. Brassil, *NSF 16-585*, 2016.
13. "Computer and Network Systems (CNS): Core Programs," J. Brassil, D Fisher, W. Lou, M. McClure, T. Nandagopal, G. Singh, Y. Solihan, *NSF 16-579*, 2016.
14. "Smart and Connected Health (SCH)," W. Nilsen, et al, *NSF 16-601*, 2016.
15. "US Ignite," J. Brassil, B. Kramer, W. Nilsen, *NSF 16-553*, 2016.
16. "Optics and Photonics (OP)," V. Roytburd, et al, *NSF PD 5102*, 2015.

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