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EXPERIENCE

Program management

- Directed patent departments for software and wireless companies and defense contractors.
- Coordinated academic, government, and commercial partnerships for research and product development.
- Assembled industry and academic partners to work with defense and intelligence agencies to test and commercialize technologies that I invented.
- Principal Investigator and Project Manager for government contracts.

Technical expertise

- Inventor of over 150 U.S. and foreign patents, focusing on wireless and telecommunications networks.
- Co-authored dozens of journal articles, peer-reviewed conference papers, and a textbook on wireless technologies.
- Contributed to IEEE 802.16a standard, FCC rulings, and FAA spectrum management policies.
- Education and extensive expertise in physics, mathematics, and electrical engineering.
- Expertise in AI/ML, cryptography, digital signal processing, and information theory.

Patent prosecution

- Filed and/or prosecuted over 1000 U.S. and international patent applications.
- Experience in patent acquisitions, sales, licensing, prosecution, and litigation support.
- 20 years in a Director role advising on intellectual property matters for five different companies.
- 22 years guiding investors and industry leaders on patent valuations and patent assertion.
- Produced patent portfolios for technologies that cover commercial revenues of trillions of dollars per year.

EMPLOYMENT

Genghiscomm (1998-2023), Director Patent Prosecution

Beginning in the late-1990's, in coordination with its partners, Genghiscomm invested years and millions of dollars developing OFDM with suitable peak-to-average-power for mobile telecommunications. Through my direction in engineering, Genghiscomm produced and validated essential technologies for LTE/4G and 5G, without which today's cellular broadband data services would not be possible. Genghiscomm's patents are cited in over 4000 other patents. Some of the technologies first developed at Genghiscomm include:

- Carrier Interferometry
- Cooperative-MIMO
- Airborne Relays AI-based MIMO that exploits swarm intelligence
- Low-latency opportunistic device-to-device (D2D) communications
- Neural network linearization that improves AI learning
- Partial Update method for massive-MIMO and eigensystem adaptations
- Quantum-secure cryptography
- MIMO-based neutral host technologies
- Non-orthogonal multiple access (NOMA) waveforms for 5G IoT communications.

Department 13 (2016-2021), Director, Intellectual Property Strategist

Through my direction in technology development, patent acquisitions, exclusive licensing, and patent prosecution strategy, D13 controlled the majority of essential patents that cover $200B/year in products and services across several autonomous vehicle markets:

- Inventor of the most-cited patents in the counter-UAS field.
- Developed radio-protocol manipulation and electronic countermeasures.
- Developed perfectly secure key exchange by exploiting randomness and reciprocity in wireless channel state information.
- Developed counter-espionage technologies to defeat RF fingerprint and MAC ID tracking.

TensorComm, Inc. (2004-2007), Director Patent Prosecution
TensorComm developed digital signal processing solutions.

- Directed all phases of patent preparation and prosecution. Implemented intellectual property development policies. Managed other patent practitioners, consultants, interns, and outside counsel. Areas of expertise include CDMA, OFDM, MIMO, and advanced receivers. Built a portfolio of over 100 cases in two years.
- Analyzed patentability, validity, freedom to operate, and patent landscapes, and formulated strategies for protecting intellectual property using a combination of patents, copyrights, and trade secrets. Participated in engineering design and review.

CIAN Systems, Inc. (2002-2004), Technical consultant via Genghiscomm
CIAN Systems tested and commercialized technologies it licensed from Genghiscomm for WLAN, cellular, and satellite communications. .

- Implemented the first multi-Physical-Layer software-defined radio.
- Developed the first commercial OFDM-over-satellite technology.
- Implemented Coordinated Multipoint with Joint Processing, which is an essential part of LTE-Advanced and 5G networks.
- Field-tested the first Cloud Radio Access Network, which is now used to virtualize baseband processing in 5G networks.
- Field-tested Cooperative MIMO.
- Directed field tests and demonstrations of breakthrough WLAN, WWAN, and satellite communications.

Idris Communications, Inc. (2000-2002)
Vice President of Engineering (2000-2002)
Idris Communications commercialized technologies developed at Genghiscomm, and developed communications, radar, and cryptographic applications for U.S. government agencies.

- Principal Investigator for numerous contracts with NASA Ames, Air Force, Army, and other departments and agencies in the U.S. government.
- Research Director: Responsible for coordinating and directing research and commercialization partnerships with other defense contractors, government labs, and universities.
- Founding Member of IEEE 802.16a (Wi-MAX) standard group: Developed alliances among commercial and academic participants to promote the adoption of OFDM.

Granularity Information Architecture, Inc. (1998-2000),
Chief Database Architect

- Led object-oriented design for business systems development and multi-vendor/supplier e-commerce interfaces.
- Developed decision-support software in coordination with wireless communications and remote sensing for airport surface management.

Wyndemere, Inc. (1996-1998), Senior Systems Engineer

- Established consortium between commercial aviation and regulatory agencies to coordinate spectrum-management policies at airports.

Objective, Inc. (1995-1996), Software Development Manager

- Led software development team for business process engineering applications in aviation.

Genesis Telecom Inc. (1993-1995), Lead Telecom Engineer

- Built and field-tested the first MIMO-OFDM system in 1993 at University of Colorado

N.I.S.T. (1993-1994), Research Scientist

- Developed GPS satellite tracking software, authored papers on highly accurate computations of GPS satellite ephemerides.

QUALIFICATIONS

Registered to Practice before U.S.P.T.O, 1996 (Registered Patent Agent No. 40,170)
M.E., Electrical Engineering, University of Colorado, Boulder, CO
M.S., Physics, Colorado School of Mines, Golden, CO
B.S., Physics, Rensselaer Polytechnic Institute, Troy, NY

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Published Books

- **Multi-Carrier Technologies for Wireless Communication**
  Nassar, C.R.; Natarajan, B.; Wu, Z.; Wiegandt, D.A., Zekavat, S.A.; Shattil, S.
  Springer; 1st edition (November 1, 2001)

- **Enabling Technologies for 3G and Beyond (SPIE proceedings series)**
  Garg V.K.; Nassar C.R.; Shattil S.J.;
  Society of Photo Optical (November 2001)

Selected Journal Articles and Conference Papers

- **Innovative pulse shaping for high-performance wireless TDMA**
  Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Communications Letters, IEEE
  Volume 5, Issue 9, Sept. 2001 Page(s):372 – 374

- **High-performance MC-CDMA via carrier interferometry codes**
  Natarajan, B.; Nassar, C.R.; Shattil, S.; Michelini, M.; Wu, Z.;
  Vehicular Technology, IEEE Transactions on
  Volume 50, Issue 6, Nov. 2001 Page(s):1344 – 1353

- **Oscillating-beam smart antenna arrays and multicarrier systems: achieving transmit diversity, frequency diversity, and directionality**
  Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
  Vehicular Technology, IEEE Transactions on
  Volume 51, Issue 5, Sept. 2002 Page(s):1030 – 1039

- **Large set of CI spreading codes for high-capacity MC-CDMA**
  Natarajan, B.; Zhiqiang Wu; Nassar, C.R.; Shattil, S.;
  Communications, IEEE Transactions on
  Volume 52, Issue 11, Nov. 2004 Page(s):1862 – 1866

- **High-throughput high-performance TDMA through pseudo-orthogonal carrier interferometry pulse shaping**
  Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Wireless Communications, IEEE Transactions on
  Volume 3, Issue 3, May 2004 Page(s):689 – 694

- **CI/FSK: bandwidth-efficient multicarrier FSK for high performance, high throughput, and enhanced applicability**
  Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Communications, IEEE Transactions on
  Volume 52, Issue 3, March 2004 Page(s):362 – 367

- **Merging multicarrier CDMA and oscillating-beam smart antenna arrays: exploiting directionality, transmit diversity, and frequency diversity**
  Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
  Communications, IEEE Transactions on
  Volume 52, Issue 1, Jan 2004 Page(s):110 – 119

- **Combining multi-input single-output systems and multi-carrier systems: achieving transmit diversity, frequency diversity and directionality**

Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
Vehicular Technology Conference, 2002. VTC Spring 2002. IEEE 55th
Volume 3, 6-9 May 2002 Page(s):1353 - 1358 vol.3

- **Novel multi-carrier implementation of FSK for bandwidth efficient, high performance wireless systems**
  Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Communications, 2002. ICC 2002. IEEE International Conference on
  Volume 2, 28 April-2 May 2002 Page(s):872 - 876 vol.2

- **Merging DS-CDMA (with CI chip shapes) and oscillating-beam smart antenna arrays: exploiting transmit diversity, frequency diversity and directionality**
  Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
  Communications, 2002. ICC 2002. IEEE International Conference on
  Volume 2, 28 April-2 May 2002 Page(s):742 - 747 vol.2

- **Ultra wideband DS-CDMA via innovations in chip shaping**
  Zhiqiang Wu; Nassar, C.; Shattil, S.;
  Vehicular Technology Conference, 2001. VTC 2001 Fall. IEEE VTS 54th
  Volume 4, 7-11 Oct. 2001 Page(s):2470 - 2474 vol.4

- **Achieving directionality and transmit diversity via smart antenna pattern oscillation with a geometric-based stochastic channel model for coherence time evaluation**
  Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
  Radio and Wireless Conference, 2001. RAWCON 2001. IEEE
  19-22 Aug. 2001 Page(s):223 – 226

- **Enhanced Bluetooth and IEEE 802.11 (FH) via multi-carrier implementation of the physical layer**
  Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Broadband Communications for the Internet Era Symposium digest, 2001 IEEE Emerging Technologies Symposium on
  10-11 Sept. 2001 Page(s):129 – 133

- **The merger of a single oscillating-beam smart antenna and MC-CDMA: transmit diversity, frequency diversity and directionality**
  Zekavat, S.A.; Nassar, C.R.; Shattil, S.;
  Broadband Communications for the Internet Era Symposium digest, 2001 IEEE Emerging Technologies Symposium on
  10-11 Sept. 2001 Page(s):107 – 112

- **High-performance, high-capacity MC-CDMA via carrier interferometry**
  Zhiqiang Wu; Natarajan, B.; Nassar, C.R.; Shattil, S.;
  Personal, Indoor and Mobile Radio Communications, 2001 12th IEEE International Symposium on
  Volume 2, 30 Sept.-3 Oct. 2001 Page(s):G-11 - G-16 vol.2

- **Wireless communication system architecture and physical layer design for airport surface management**
  Zhiqiang Wu; Nassar, C.R.; Alagar, A.; Shattil, S.;
  Vehicular Technology Conference, 2000. IEEE VTS-Fall VTC 2000. 52nd
  Volume 4, 24-28 Sept. 2000 Page(s):1950 - 1955 vol.4

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- **Wireless communication system design for airport surface management .1. Airport ramp measurements at 5.8 GHz**
  Shattil, S.; Zhiqiang Wu; Alagay, A.; Nassar, C.R.;
  Communications, 2000. ICC 2000. 2000 IEEE International Conference on
  Volume 3, 18-22 June 2000 Page(s):1552 - 1557 vol.3

- **Array control systems for multicarrier protocols using a frequency-shifted feedback cavity**
  Shattil, S.; Nassar, C.R.;
  Radio and Wireless Conference, 1999. RAWCON 99. 1999 IEEE
  1-4 Aug. 1999 Page(s):215 – 218

- **Introduction of carrier interference to spread spectrum multiple access**
  Nassar, C.R.; Natarajan, B.; Shattil, S.;
  Wireless Communications and Systems, 1999 Emerging Technologies Symposium
  12-13 April 1999 Page(s):4.1 - 4.5

- **High data rate FSK via multi-carrier implementations for wireless personal area networks** B. Natarajan, Carl R. Nassar, and S. Shattil, *SPIE's ITCom 2002: Enabling Technologies for 3G and Beyond*, Boston, MA, July 29-Aug. 2, 2002.

- **Improved Fourier Transforms for Multi-carrier Processing**, S. Shattil, C. Nassar; Conference on Emerging Technologies for Future Generation Wireless Communications, Boston, MA, July 29-30, 2002.

- **Smart antenna spatial sweeping for combined directionality and transmit diversity**, S. A. Zekavat, Carl R. Nassar, and S. Shattil, *Journal of Communications and Networks: Special Issue on Adaptive Antennas for Wireless Communications*, Vol. 2, No. 4, Dec. 2000, pp.325-330.

- **Improved fast Fourier transform implementation based on orthogonal carrier processing**, S. Shattil and Carl R. Nassar, *SPIE's ITCom 2002: Enabling Technologies for 3G and Beyond*, Boston, MA, July 29-Aug. 2, 2002.

- **Merging oscillating beam smart antenna arrays and wideband multi-carrier CDMA: exploiting transmit diversity, frequency diversity and directionality**, S.A. Zekavat, Carl R. Nassar, and S. Shattil, *International Conference on Third Generation Wireless and Beyond*, San Francisco, CA, May 28-31, 2002, pp. 435-440.

- **Geometric-based stochastic channel model for adaptive antennas with oscillating beam patterns** S.A. Zekavat, Carl R. Nassar, and S. Shattil, *IEEE International Symposium on Personal, Indoor, and Radio Communications PIMRC01,* San Diego, CA, Sept. 30-Oct.3, 2001, pp. 130-134.

- **Next generation high performance DS-CDMA via carrier interferometry**, Z. Wu, Carl R. Nassar, and S. Shattil, *The 12th Annual International Conference on Wireless Communications WIRELESS2001*, Calgary, Alberta, July 9-11, 2001, pp. 564-569.

- **Chip shaping advances for high capacity DS-CDMA**, Z. Wu, Carl R. Nassar, and S. Shattil, *2001 International Conference on Third Generation Wireless and Beyond*, San Francisco, CA, May 30-June 2, 2001, pp. 928-932.

- **Combined directionality and transmit diversity via smart antenna spatial sweeping**, S.A. Zekevat, Carl R. Nassar, and S. Shattil, *Allerton Conference on Communications, Control, and Computing*, Champaign-Urbana, Illinois, Oct. 4-6, 2000, pp. 203-211.

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- **Throughput enhancement in TDMA through carrier interferometry pulse shaping**, B. Natarajan, C.R. Nassar, and S. Shattil, *IEEE Vehicular Technology Conference VTC2000,* Boston, MA, Sept. 24-28, 2000, pp. 1799-1803.

- **Exploiting frequency diversity in TDMA through carrier interfometry**, B. Natarajan, Carl R. Nassar, and S. Shattil, *The 12th Annual International Conference on Wireless Communications WIRELESS2000*, Calgary, Alberta, Canada, July 10-12, 2000, pp. 469-476.

- **Secret Key Generation Rate With Power Allocation in Relay-Based LTE-A Networks**, Kan Chen; Natarajan, B.B.; Shattil, S., in *IEEE Transactions on Information Forensics and Security,* vol.10, no.11, pp.2424-2434, Nov. 2015.

- **Relay based secret key generation in LTE-A**, K. Chen, B. Natarajan and S. Shattil, Proceedings of *IEEE CNS Workshop on Physical layer methods for wireless security*, San Francisco, October 2014.

Conference Chair, *Enabling Wireless Technologies for 4G and Beyond*
Chairs: Carl R. Nassar, CSU and Steve Shattil, Idris Communications
Date: Aug. 19-24, 2001
Where: Denver, CO
Organization: SPIE (ITCom 2001)

Founding Member of IEEE 802.16a (Wi-MAX)