CURRICULUM VITAE OF BHASKAR RAMAMURTHI

1. Name : Bhaskar Ramamurthi
2. Date of Birth : April 17, 1959
3. Leadership Positions Held :
   (i) Director
   Indian Institute of Technology, Madras (2011-2022)
   (ii) Professor
   Department of Electrical Engineering,
   IIT Madras
   (iii) Hon. Director
   Centre of Excellence in Wireless Technology
   IITM Research Park, Chennai 600 036
   (iv) Chairman
   IIT Madras Research Park (a sec 8 company) (2011-2022)
   (v) Chairman
   IITM Incubation Cell (a sec 8 company) (2011-2022)
   (vi) National Coordinator Indigenous 5G Test-Bed
   (vii) Chairman, Telecom Standards
   Development Society of India (2020-2022)
   (viii) Member, Telecom Regulatory Authority of India (2022-24)
   (ix) Director on the Board of Tejas Networks Ltd
   (x) former Director on the Board of Bharat Electronics Ltd.
4. Postal Address : Dept. of Electrical Enigneering
   Indian Institute of Technology, Madras
   Chennai 600 036
5. Email Address : bhaskar@iitm.ac.in
6. Employment :

S.No	Period	Company/Institute	Designation
1.	Dec.'84 – April'86	AT&T Bell Laboratories, New Jersey, USA	Post-Doctoral Member of Technical Staff
2.	June'86–Feb. '93	Indian Institute of Technology, Madras	Assistant Professor
3.	Feb.'93 – Dec '99	Indian Institute of Technology, Madras	Assoc. Professor
4.	Jan 2000 – till date	Indian Institute of Technology, Madras	Professor
5.	Jun 2005–Jul 2011	Indian Institute of Technology Madras	Dean (Planning)
6.	Sep 2011- Jan 2022	Indian Institute of Technology Madras	Director
7.	Jan 2022-June 2024	Indian Institute of Technology, Madras	Professor
8.	July 2024 -	Indian Institute of Technology, Madras	Professor Emeritus

8. Fields of Specialisation : Communications, Wireless Networks, Signal Processing

9. Academic Qualifications :

Degree	University	Year	Specialization
B.Tech	IIT Madras	1980	Electronics
M.S.	University of California, Santa Barbara	1982	Electrical & Computer Engg.
Ph.D.	University of California, Santa Barbara	1985	Electrical & Computer Engg.

10. Awards and Fellowships : Awarded University of California, **Regents Fellowship** for 1980-81 and 1981-82.

The paper titled "Perfect-Capture ALOHA for Local Radio Communications" selected for reprinting in IEEE Press book on ***Key Papers*** in Multiple Access Communications.

Fellowship of Indian National Academy of Engineering (**INAE**), 2000

Fellowship of the Institute of Electrical and Electronics Engineers (**IEEE**), 2015 for contributions to wireless technology in India

Honorary Fellow, RWTH Aachen, Germany

Vasvik Award for Electronic Sciences and Technology, 2000

Tamil Nadu Scientist Award 2003 for Engineering and Technology

US$250,000 Intel Curriculum Development Award for Software Radio Laboratory in 2002, one of only five such awards world-wide

IBM Faculty Award, 2009

Indian Semiconductor Association Lifetime Achievement **Technovisionary** Award 2011

ACCS-CDAC Foundation Award 2015 for "outstanding achievements in communications engineering and for stewardship in bridging the industry-academic cooperative research".

Indo-Australian Award for Meritorious Service, 2018-19

11. Publications : See Appendix I for a list of peer-reviewed journal and conference publications

12. Patents : 41 patents awarded till date (jointly with other inventors), of which 26 are Indian and 15 US patents (all filed from India). A further 31 Indian patents and 7 US patents are under filing/examination.
See Appendix II for details.

13. Research : Main research contributions are in the areas of Signal Compression, Wireless Physical layer techniques and algorithms, and Digital Signal Processing.

Key achievements:

- Among the first to determine the appropriate manner in which to apply the then newly-proposed signal compression technique called Vector Quantization to image compression (paper #4).
- Co-authored two of the early papers on indoor wireless communications, fifteen years before WiFi became a reality. One of these papers (#5) forms the basis for the first version of WiFi, and the other (#6) on random access was re-published as a key paper in a special IEEE publication of selected papers.
- First to propose with Sumam David "non-causal" block signal processing for speech signal compression (papers #13 and 17) in a manner similar to what was done later in DSL modems.
- Extended the idea of optimal sequence estimation in a receiver to the non-coherent case (paper #22).
- Articulated the role emerging technology was to play in the rapid expansion of telecom in India (paper #21).
- Co-authored the first practical solution for co-operative wireless transmission based on interference alignment (paper #29)
- Co-authored five papers on non-simultaneous two-way relaying, where the two directions of communication are not between the same nodes (papers #38-42), representing a significant improvement over simultaneous two-way relaying
- Proposed jointly with Ashok Jhunjhunwala an approach to provide uninterrupted 48V dc power to homes even in blackout situations
- Led the team in India that developed the Low Mobility Large Cell rural use case that is now mandatory for ITU IMT-2020 (5G), and also the special modulation format in the 5G standard to achieve the best performance for this use case
- Supervised seven doctoral theses, and twenty-three Masters' (M.S. by Research) theses (see Appendix IV for list of research scholars and thesis titles)

14. Product R&D : Engaged for the past 20 years in R&D for developing innovative wireless products for the Indian market, and in technical assistance to companies incubated for commercialization of these products.

Some significant contributions are -

- Principal Wireless System Architect and physical layer designer for *corDECT* Wireless Local Loop System and *Broadband corDECT* Wireless DSL System, widely deployed in India and 15 countries in the late '90*s*, to the extent of a million lines.
- Inventor of Variable Bitrate Modified-GSM voice compression algorithm for digital storage applications, employed in several cordless answering machines when they first appeared in the early '90*s*.
- Designer of *Digicom* Digital Communications Laboratory Trainer and *Benchmark* Software-Defined-Radio Trainer, used extensively by engineering colleges in India and abroad for the communications laboratory courses.
- Designer of the Radio Modems for a TDM-TDMA Rural Digital Telephone System, developed jointly with CDoT in early '90*s*. Was among the first commercial wireless high-speed modems to be developed in India.
- Consultant for 3G WCDMA and IEEE 802.11 Physical Layer Design teams in Indian Industry, when design-services industry in India first started getting into wireless PHY design.
- Inventor of the Multi-Level Adaptive Modulation Extension to the DECT standard that makes the Broadband corDECT system possible
- Co-inventor of the WiFi Rural Extension (WiFiRe) developed by IISc, IITB, and CEWiT
- Co-inventor of the Conjugate Data Repetition and associated Collision-Free Interlaced Pilots scheme in IEEE 802.16m standard
- Co-inventor of Indoor Personal Relays for Wireless Broadband Systems (EVDO, HSPA, WiMAX and LTE)
- Developer of a Software-Driven 4G wireless testbed on the IITM campus
- National Co-ordinator for an end-to-end 5G testbed being developed by eight national institutes.

See Appendix IV for details of projects and their funding levels

15. IPR, Technology Incubation, and Innovation Centres : One of three founding members of the **TeNeT (Telecommunications and Networking) Group** (www.tenet.res.in) of the EE and CSE Departments of IITM, now grown to 18 faculty members. The TeNeT group has incubated more than a dozen companies and developed products as diverse as wireless systems, data switches and routers, network management systems, smart thin clients for cloud computing, low-power ATMs, optical instruments, laboratory trainers, and IVR systems. Appendix V gives details of companies and

technologies incubated.

Founder and Hon. Director of the **Centre of Excellence in Wireless Technology (CEWiT) (www.cewit.org.in)** – a 50-member research centre in the IITM Research Park that conducts research related to IPR development for emerging wireless standards, in order to make Indian a global player in wireless technology. **Leading the effort to introduce Indian IPR into international standards**, with significant success during 2009-10 in the IEEE 802.16m standard. The Centre has had 33% of its funding from industry since inception. Among the significant achievements:

- Successfully patented and introduced an entire transmission mode in the IEEE 80.16m WiMAX standard

- Created the **Broadband Wireless Consortium of India (BWCI)**, a consortium of more than a dozen companies that support CEWiT and collaborate with it. BWCI evolved into the **Telecom Standards Development Society of India (TSDSI)**.

- Led the first Indian team to participate in ITU's evaluation of 4G technologies (called IMT-A). This 50-member team was one among 13 from across the world, and included members from CEWiT, IITs and industry.

- Led the effort to propose and get accepted an entirely new requirement in ITU for 5G technologies called the **Low Mobility Large Cell** rural coverage requirement

- Led the effort at TSDSI to submit and win approval for an **Indian Radio Interface Technology for 5G** that improves on the global standard to provide enhanced rural coverage.

- Developed the **7-bit Indic language tables for SMS** and got them incorporated into the 3GPP standard.

- Chairman, **IITM Incubation Cell**, and Member, Gov. Council, of **Rural Technology and Business Incubator (www.rtbi.in)**, IIT Madras, Chennai. This incubator is one of its kind, with focus on technologies and business models for rural markets. Since such technologies and markets are totally new, the incubator provides extensive pre-incubation technology development and market exploration support. It leverages the ecosystem of the IIT Madras Research Park and the IITM faculty and laboratory facilities to enable entrepreneurs and innovators to explore and develop new ideas. A total of 200 companies have been incubated by the IITM Incubators.

- Member of the team that conceived the **IITM Research Park** and currently Chairman of its Board. It is the first of its kind in the country. The aim is to develop a model for enabling intense collaborative research and development involving faculty, industry personnel and students.

- Leading an 8-institute national team building India's first **end-to-end 5G testbed.**

16. Leadership of IIT Madras : As Director, leading the effort at IIT Madras to

- Increase the Ph.D graduation rate to 500 per year
- Increase research output and quality to take IITM into top-50 globally in engineering
- develop several revolutionary affordable technologies to address India's challenges in housing, power, EVs, water treatment, healthcare, and the use of AI in innovative ways
- create India's first university-based Research Park with 1M sq ft space
- raise donor funds of more than Rs 100 cr per annum
- build a satellite campus

17. Professional Activities at National Level : Co-founder and **National Co-ordinator** (2005-10) of the **Joint Telematics Group of the IITs and IISc.** The annual **National Conference on Communications (NCC)** (www.ncc.org.in) run by this Group, now in its 18th year, is acknowledged to be world-class and is archived by IEEE.

Member. Governing Council, Telecom Standards Development Society, India

Member National Frequency Allocation Plan Review Committee 2001, 2003

Member, TRAI Expert Committee on Quality of Service for VOIP Based International Long Distance Services, 2002

Member DoT Committee for Recommending Revised Subscriber Based Spectrum Allocation Criterion for Allocation of Spectrum in a Scientific and Practical Manner, 2007

Member, DoT committee for Allocation of Access Spectrum (GSM&CDMA) Spectrum and Pricing, 2008-2009.

Member, Inter-Ministerial Committee for Segregation of 2G and 3G Revenue and for Suggesting Annual Spectrum Charges for 3G Spectrum, 2008

Assisted TRAI on several occasions on technical issues related to wireless technology.

Chairman, MHRD Committee for MOOCs content for Swayam Platform

Member, MHRD Committee for National Ranking Framework

Member, MHRD Implementation Committee for GIAN and DST Apex Committee for VAJRA

Appendix I

List of Publications

A. Publications in Journals

1. M.A. Reddy, Bhaskar Ramamurthi, et.al., "An Active-Compensated Double-Integrator Filter without Matched Op-amps", Proc. IEEE, April, 1980. (DOI:10.1109/PROC.1980.11682)

2. K.R.K Rao, Bhaskar Ramamurthi, et.al., "A High-Quality Double-Integrator Building- Block for Active-Ladder Filters", IEEE Trans. On Circuits and Systems, December, 1981. (DOI: 10.1109/TCS.1981.1084938)

3. Bhaskar Ramamurthi and A. Gersho, "Non-Linear Space-Variant Post-Processing of Block Coded Images", IEEE Trans. on Acoustics, Speech & Signal Processing, Vol. ASSP-34, No. 5, pp 1258-1268, November, 1986. (DOI: 10.1109/TASSP.1986.1164961)

4. Bhaskar Ramamurthi and A. Gersho, "Classified Vector Quantization of Images", IEEE Trans. on Communications, Vol. Com-34, No. 11, pp 1105-1115, November, 1986. (DOI: 10.1109/TCOM.1986.1096468)

5. M. Kavehrad and Bhaskar Ramamurthi, "Direct-Sequence Spread Spectrum with DPSK Modulation and Diversity for Indoor Wireless Communications", IEEE Trans. on Communications, Vol. Com-35, No. 2, pp 224-236, February, 1987. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1096746)

6. Bhaskar Ramamurthi, A.A.M. Saleh, and D.J. Goodman, "Perfect-Capture ALOHA for Local Radio Communications", IEEE Trans. on Selected Areas in Communications, Vol. SAC-5, No. 5, pp 806-814, June, 1987. (DOI: 10.1109/JSAC.1987.1146592)

7. D.J. Goodman, Bhaskar Ramamurthi, et.al., "Packet Reservation Multiple Access for Local Wireless Communications", IEEE Trans. on Communication, Vol. 37, pp 885-890, 1989. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=31190)

8. S. Jegannathan and Bhaskar Ramamurthi, "An FFT-Based Algorithm for Reconstructing Inhomogeneous Circular Cylindrical Shells from Noisy Data", Sadhana, Vol. 15, pp 235-237, 1990. DOI: 10.1007/BF02812039

9. T.S. Nagabhushana and Bhaskar Ramamurthi, "A Fully Digital DPSK Burst Modem", Journal of IETE, Vol. 36, pp 397-405, 1990. DOI: 10.1080/03772063.1990.11436910

10. S. Jegannathan and Bhaskar Ramamurthi, "Scattering from a Circular Dielectric Cylindrical Shell: A Fast Algorithm", Electronic Letters, Vol. 26, No. 7, pp 484-485, March, 1990. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=50245

11. C.P. Mammen and Bhaskar Ramamurthi, "Vector Quantization for Compression of Multichannel ECG", IEEE Trans. on Biomedical Engg., No. 37, pp 821-825, September, 1990. (DOI: 10.1109/10.58592)

13. S. Jegannathan and Bhaskar Ramamurthi, "Diffraction-Tomography of Strongly-Scattering Infinite Cylindrical Objects of Arbitrary Cross-Sectional Shape", Journal of the Acoustical Society of America, October, 1990. (DOI: 10.1121/1.399674)

14. Sumam David. S and Bhaskar Ramamurthi, "Multiband-Excited Linear Predictive Coder with a Two-sided Short Term Predictor", Signal Processing, Vol. 25, No. 1, October, 1991.

(DOI: 10.1016/0165-1684(91)90039-L)

15. Mathew Thomas, Bhaskar Ramamurthi and Ashok Jhunjhunwala, "Design and Performance Evaluation of a Low Bit Ratio Packet Radio Network", Journal of IETE, Vol.39, No.5, pp 281-290, September – October, 1993. (DOI:10.1080/03772063.1993.11437135)

16. M.Archana Rao, B.Murgesh, Timothy A.Gonsalves, Ashok Jhunjhunwala, Bhaskar Ramamurthi, "A Reliable Fibre Optic Ring Network for Process Control", International Journal of Opto Electronics, Vol.8, No.4, pp 477-491, 1993. (http://www.scopus.com/inward/record.url?eid=2-s2.0-0027630129&partnerID=40&md5=857edbd5e346e0e4f88378fa5a27ead1)

17. Atul B.Mahamuni, Timothy A.Gonsalves, Bhaskar Ramamurthi, "Efficient Load Information Management for Load Sharing in Distributed Systems, Computer Networks Architecture and Applications", (C-13), 1993. http://www.scopus.com/inward/record.url?eid=2-s2.0-0027755735&partnerID=40&md5=f1291df5a1afb12a41ae24dfdc82c702

18. Sumam David. S and Bhaskar Ramamurthi, "Two-Sided Filters for Frame-Based Prediction", IEEE Trans. on ASSP, Vol. 39, pp 789-794, April, 1994. (DOI: 10.1109/78.80900)

19. Ashok Jhunjhunwala and Bhaskar Ramamurthi, "Wireless in Local Loop: Some Key Issues", IETE Technical Review, Vol. 12, No. 5&6, pp 309-314, September – December, 1995. (DOI: 10.1080/02564602.1995.11416547)

20. Bhaskar Ramamurthi, K.Giridhar and M.A.Srinivas, "DSP-based Digital FM Demodulation for GMSK Signals", Sadhana, Vol.21, Part I, pp 101-112, February, 1996. (http://link.springer.com/article/10.1007/BF02781791#page-1)

21. K.Vasudevan, K.Giridhar and Bhaskar Ramamurthi, "Efficient Viterbi Algorithm for Signals with ISI", pp 629, Electronics Letters, Vol.34, No.7, 2 April, 1998. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=673760)

22. Ashok Jhunjhunwala, Bhaskar Ramamurthi, Timothy A.Gonsalves, "The Role of Technology in Telecom Expansion in India", IEEE Communication Magazine, Vol.36, No.11, pp 88-94, November, 1998. (DOI: 10.1109/35.733480)

23. K.Vasudevan, K.Giridhar and Bhaskar Ramamurthi, "Non-Coherent Detection of Multilevel Signals in Frequency Non-selective Fading Channels", Signal Processing Journal, Elsevier Science Publishers, Vol. 78, Issue 2, pp 159-176, October, 1999. (DOI: 10.1016/S0165-1684(99)00057-2)

24. K.Vasudevan, K.Giridhar, and Bhaskar Ramamurthi, "Efficient Suboptimal Detectors Based on Linear Prediction for Rayleigh Flat Fading Channels," Signal Processing Journal, Elsevier Science Publishers, Vol. 81, Issue 4, pp 819-828, April 2001. (DOI: 10.1016/S0165-1684(00)00250-4)

25. C. Vijayalakshmi, Devendra Jalihal, Bhaskar Ramamurthi, "Capacity of High Density Macro Cellular Wireless Local Loop System Based on Dynamic Channel Selection", IETE Journal of Research, Vol. 49, No. 6, pp 411-422, Nov-Dec 2003. (DOI:10.1080/03772063.2003.11416365)

26. Rohit Budhiraja and Bhaskar Ramamurthi, "Efficient Low Bit-Rate Low Latency Channelisation in DECT", EURASIP Journal on Wireless Communications and Networking, vol. 2006. (DOI: 10.1155/WCN/2006/54148)

27. Krishna Paul, Anitha Varghese, Anurag Kumar, Sridhar Iyer, and Bhaskar Ramamurthi, "WIFIRE Rural Area Broadband Access Using the WiFi PHY and a Multisector TDD MAC", IEEE Communications, Vol.45, No.1, pp.111-119, Jan.2007. (DOI: 10.1109/MCOM.2007.284546)

28. Bhaskar Ramamurthi, "Broadband Wireless Technology for Rural India", Indian Journal of Radio & Space Physics, Vol.36, June 2007, pp. 168-171. (http://nopr.niscair.res.in/bitstream/123456789/2849/1/IJRSP%2036(3)%20168-171.pdf)

29. Ashok Jhunjhunwala, David Koilpillai and Bhaskar Ramamurthi, "Broadband to Empower Rural India", IETE Technical Review, Vol.24, No.4, July-August 2007, pp 195-201. (http://www.rtbi.in/Ashok/rural_link1.html)

30. V. Nagarajan and B. Ramamurthi, "Distributed Co-operative Procoder Selection for Interference Alignment," IEEE Trans. On Vehicular Tech., vol. 59, no. 9, Nov 2010 (DOI:10.1109/TVT.2010.2068569)

31. Vinosh Babu James J., Bhaskar Ramamurthi and Venkatraman Ganesh, "Distributed Co-operative Precoding with Power Control for Cellular Systems with Correlated Antennas at the Receiver," Eurasip Journal on Advances in Signal Processing, vol. 2011. (DOI:10.1155/2011/706212)

32. Rohit Budhiraja, Bhaskar Ramamurthi, Babu Naarayan and A. Oredope, "End-to-End India UK Transnational Wireless Testbed", ICTACT Journal on Commun. Tech., Special Issue on Next Genl. Wireless Netw. And App., May 2011. (10.21917/ijct.2011.0045)

33. Vinosh Babu James J and Bhaskar Ramamurthi, "Distributed Cooperative Precoding with SINR-Based Co-Channel User Grouping for Enhanced Cell Edge Performance", IEEE Transactions on Wireless Communications, Vol.10, No.9, pp 2896-2907, 2011. (DOI:10.1109/TWC.2011.072511.100562)

34. Sendilramkumar Devar, K.S. Karthik, Bhaskar Ramamurthi and R. David Koilpillai, "Downlink Throughput Enhancement of a Cellular Network using Two-Hop User-Deployable Indoor Relays", IEEE Journal on Selected Areas in Communications, Vol.31, No.8, pp 1607-1617, 2013. (DOI:10.1109/JSAC.2013.130822)

35. Rohit Budhiraja, Karthik KS and Bhaskar Ramamurthi, "Linear Precoders for Non-Regenerative Asymmetric Two-way Relaying in Cellular Systems", IEEE Transactions on Wireless Communications, Vol.13, No.9, pp 5002-5014, 2014. (DOI: 10.1109/TWC.2014.2327962)

36. Karthik KS and Bhaskar Ramamurthi, "A Two-Hop AF Relaying Scheme With Interference Suppression at the Relay", IEEE Transactions on Vehicular Technology, 09/2014; Vol.63, No.7, pp 3469-3474, 2014. (DOI:10.1109/TVT.2013.2295854)

37. J. Vinosh Babu James, Bhaskar Ramamurthi, "Distributed Cooperative Precoding in Cellular Systems", IEEE Communications Letters, Vol.18, No.7, July 2014. (10.1109/LCOMM.2014.2327968)

38. Rohit Budhiraja and Bhaskar Ramamurthi, "Joint Precoder and Receiver Design for AF Non-Simultaneous Two-way MIMO Relaying", IEEE Transactions on Wireless Communications, Vol.14, No.6, pp 2942-2955, 2015. (DOI:10.1109/TWC.2015.2398434)

39. Rohit Budhiraja and Bhaskar Ramamurthi, "Multiuser Two-Way Nonregenerative MIMO Relaying With Nonconcurrent Traffic", IEEE Transactions on Vehicular Technology, Vol.64, No.7, pp3268-3273, 2015. (DOI:10.1109/TVT.2014.2348574)

40. Rohit Budhiraja and Bhaskar Ramamurthi, "Joint Transceiver Design for Non-Concurrent MIMO Two-way AF Relaying", IEEE Wireless Communication Letters, Vol.4, No.5, pp 497-500, 2015. (DOI:10.1109/LWC.2015.2446971)

41. Rohit Budhiraja and Bhaskar Ramamurthi, "Joint Transceiver Design for QoS-constrained MIMO Two-Way Non-Regenerative Relaying using Geometric Programming", IEEE Transactions on Wireless Communications, Vol.15, No.5, pp. 3453-3465 (DOI: 10.1109/TWC.2016.2521733)

42. Rohit Budhiraja and Bhaskar Ramamurthi, Transceiver Design for Nonconcurrent Two-Way MIMO AF Relaying With QoS Guarantees, IEEE Transactions on Vehicular Technology, 2016, Vol.65, No.12, pp 9651-9661 (DOI: 10.1109/TVT.2016.2522095)

B. Publications in Conferences

1. Bhaskar Ramamurthi and A. Gersho, "Image Coding Using Vector Quantization", Proc. IEEE International Conference on Acoustics, Speech and Signal Processing, April, 1982.

2. Bhaskar Ramamurthi and A. Gersho, "Image Coding Using Segmented Codebooks", Picture Coding Symposium, March, 1983, Davis.

3. Bhaskar Ramamurthi and A. Gersho, "Low-Rate Image Coding Using Vector Quantization", IEEE Global Communications Conference Record, November, 1983.

4. A. Gersho and Bhaskar Ramamurthi, et.al., "Fast Searching Algorithms for Vector Quantization and Pattern Matching", Proc. IEEE International Conference on Acoustics, Speech and Signal Processing, March, 1984. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1172352)

5. Bhaskar Ramamurthi and A. Gersho, "Edge-Oriented Spatial Filtering of Images with Application to the Post-Processing of Vector-Quantized Images", Proc. IEEE International Conference on Acoustics, Speech and Signal Processing, March, 1984. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1172667)

6. Bhaskar Ramamurthi and A. Gersho, "Image Vector Quantization with a Perceptually-Based Cell Classifier", Proc. IEEE International Conference on Acoustics, Speech and Signal Processing, March, 1984. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1172636)

7. Sumam David. S and Bhaskar Ramamurthi, "Two-Sided Filters for Frame-Based Prediction", Workshop on Speech & Signal Processing at TIFR, November, 1988. (DOI: 10.1109/78.80900)

8. G.A. Sudheer and Bhaskar Ramamurthi, "A Spread Spectrum Wireless LAN for Multipath Fading Environments", Proc. of Indo-US Workshop on Systems and Signal Processing, 1988, Oxford and IBH, Pub.

9. D.J. Goodman, Bhaskar Ramamurthi,et.al., "Packet Reservation Multiple Access for Local Wireless Communications", IEEE International Conference on Vehicular Technology, 1988, Philadelphia, USA. (DOI: 10.1109/VETEC.1988.195449)

10. C.P. Mammen and Bhaskar Ramamurthi, "Vector Quantization for Compression of Multichannel ECG", Proc. of Workshop on Signal Processing, Communication &

Networking, July, 1990, Bangalore. (DOI: 10.1109/10.58592)

11. Bhaskar Ramamurthi, "Wireless Networks; IETE Seminar on "Telematics in the Year 2000", December, 1990, Madras.

12. Mathew Thomas, Ashok Jhunjhunwala and Bhaskar Ramamurthi, "A Low-Bit Rate Data Networks", IETE Seminar on Telematics in the year 2000, December, 1990, Madras.

13. Dr.Bhaskar Ramamurthi, "Trends in Speech Coding", IETE 34th Technical Convention, 7-8 September, 1991, Bangalore.

14. A. Jawahar and Bhaskar Ramamurthi, "High-Speed DSP-Based DQPSK Burst Modem for TDM/TDMA System", Conference on Signal Processing and Communications, Indian Institute of Science, January, 1993, Bangalore.

15. Sumam David. S and Bhaskar Ramamurthi, "Multi-Band Excited Speech Coder", Conference on Signal Processing and Communications, Indian Institute of Science, January, 1993, Bangalore.

16. C.P.Mammen and Bhaskar Ramamurthi, "Cellular CDMA System with Packet Voice", Recent Advances in Signal Processing & Communication" 18-20 January, 1993, Indian Institute of Science, Bangalore.

17. A.Mahamuni, Timothy A.Gonsalves and Bhaskar Ramamurthi, "Efficient Load Information Management for Load Sharing in Distributed Systems", in IFIP Transaction (C-13), 1993 (http://dblp.org/rec/html/conf/networks/MahamuniGR92).

18. Bhaskar Ramamurthi, "Wireless in Indian Telecom Network", Infocom‟94, December, 1994, Bombay. C. Mathiazhagan and Bhaskar Ramamurthi, "DECT-Based Wireless in Local Loop System", International Conference on Personal Wireless Communications, Indian Institute of Science, December, 1994, Bangalore.

19. C. Mathiazhagan and Bhaskar Ramamurthi, "DECT-Based Wireless in Local Loop System", International Conference on Personal Wireless Communications, Indian Institute of Sciences, December 1994, Bangalore

20. K. Giridhar, M.A. Srinivas and Bhaskar Ramamurthi, "DSP-Based Digital FM Demodulation for GMSK Signals", SPCOM‟95, Indian Institute Science, 9-12 August, 1995, Bangalore.

21. K.Vasudevan and Bhaskar Ramamurthi, "DSP-based Algorithms for Voiceband Modems", SPCOM‟95, 9-12 August, 1995, Indian Institute of Science, Bangalore.

22. Ashok Jhunjhunwala and Bhaskar Ramamurthi, "Wireless in Local Loop, "Some Key Issues" IETE Annual Technical Convention, October 1995, Pune.

23. K.Giridhar, K.Vasudevan and Bhaskar Ramamurthi, "Split-Trellis Viterbi Decoder; A Computationally Efficient Technique for MLSE", National Conference on Communications (NCC-96), pp 59-62, February, 1996, Bombay.

24. M. Kavehrad and Bhaskar Ramamurthi, "Direct-Sequence Spread Spectrum with DPSK Modulation and Diversity for Indoor Wireless Communications", IEEE International Conference on Communications, June, 1996, Toronto, Canada. DOI: 10.1109/TCOM.1987.1096746

25. C.P.Mammen and Bhaskar Ramamurthi, "VPE-LPC:A Variable Bit-Rate Speech Coder", National Conference on Communications (NCC-97), pp.51, 31 January – 2 February, 1997, Indian Institute of Technology, Madras.

26. K.Vasudevan, K.Giridhar and Bhaskar Ramamurthi, "Nyquist-Rate Detection of CPM Signals Using the Viterbi Algorithm", National Conference on Communications (NCC- 97), pp.85, 31 January – 2 February, 1997, Indian Institute of Technology, Madras.

home.iitk.ac.in/~vasu/nc970.pdf

27. Abhay Joshi and Bhaskar Ramamurthi, “Adaptive Data Detection of ISI Channels”, National Conference on Communications (NCC-97), pp 191, 31 January – 2 February, 1997, Indian Institute of Technology, Madras.

28. Vasudev Nambakkam, Devendra Jalihal and Bhaskar Ramamurthi, “Statistical Multiplexing with Variable Rate Embedded Coding for Voice Circuit Multiplication”, National Conference on Communications (NCC-97), pp 208, 31 January – 2 February, 1997, Indian Institute of Technology, Madras.

29. C.P. Mammen and B. Ramamurthi, “Capacity enhancement in digital cellular systems using variable bitrate speech coding”, 'Towards the Knowledge Millennium' - IEEE International Conference on Communications, 1997. (http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=609979&tag=1)

30. K.Vasudevan, K.Giridhar and Bhaskar Ramamurthi, “Non-Coherent Sequence Estimation of Multilevel Signals in Slowly Fading Channels”, National Conference on Communications (NCC-98), 29-31 Jan. 1998, Indian Instt. of Science, Bangalore.

31. K.Vasudevan, K.Giridhar and Bhaskar Ramamurthi, “DSP-based Non-Coherent Detectors for Multilevel Signals in Flat Fading Channels”, Proc. Of the IEEE, International Conference on Universal Personal Communication, October, 1998, Florence, Italy. (DOI: 10.1109/ICUPC.1998.733706)

32. K.Rama Sudha Mohan and Bhaskar Ramamurthi, “A DSP-based DTMF Detector for Universal Application”, National Conference on Communications (NCC-99), 29-31 January, 1999, Kharagpur.

33. R.Ravikumar, G.V.Rangaraj, and Bhaskar Ramamurthi, “Internet Access on corDECT WLL”, National Conference on Communications (NCC-99), 29-31 January, 1999, Kharagpur.

34. Vijayalakshmi Chetlapalli, Devendra Jalihal and Bhaskar Ramamurthi, "Capacity of High Density Macro Cellular Wireless Local Loop System based on Dynamic Channel Selection", National Conference on Communications (NCC-99), 29-31 January, 1999, Kharagpur

35. R.Sivan, Ashok Jhunjhunwala, Bhaskar Ramamurthi, "Relay Base Station for DECT Based Wireless in Local Loop to Serve Sparse Rural Areas". International Conference on Personal Wireless Communications (ICPWC'99), 17-19th February 1999, Jaipur, India http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=759647

36. K. Vasudevan, K. Giridhar, and Bhaskar Ramamurthi, “Differential Detection of Multi-Level Signals in Frequency Non-Selective Rayleigh Fading Channels with Diversity”, IEEE International Conference on Personal Wireless Communications (ICPWC'99), 17- 19th February 1999, Jaipur, India (DOI: 10.1109/ICPWC.1999.759613)

37. Bhaskar Ramamurthi, "Telcom Expansion in India: Low Cost Access is the Key", Symposium on Advanced Technologies, Central Research Laboratory, 16-19th November 1999, Bangalore.

38. Hema A.Murthy. Timothy A.Gonsalves, Bindu Madhavi, Kamini Gupta, Ashok Jhunjhunwala, and Bhaskar Ramamurthi, "CygPlan: An Installation Planner for Telecom Access Networks", National Conference on Communications (NCC-2000), 28- 30 January 2000, Delhi.

39. P.R.Goundan, Ashok Jhunjhunwala, and Bhaskar Ramamurthi, "Use of Existing Copper Cable and Optical Fibre in the Railway Network to Provide Telecom Services in Small Towns", National Conference on Communications (NCC-2000), 28-30 January 2000, Delhi

40. K.Ramasudha Mohan and Bhaskar Ramamurthi, "A DSP-based Reed Solomon Coder for DECT Applications", National Conference on Communications (NCC-2000), 28-30 January 2000, Delhi

41. V.Suresh and Bhaskar Ramamurthi, "A Fast-locking Frequency Synthesizer for Multi-carrier TDMA Applications", National Conference on Communications (NCC-2000), 28-30 January 2000, Delhi

42. Mathew P.Joseph, Devendra Jalihal, and Bhaskar Ramamurthi, "DSP Algorithms for a 15-Channel On-board Satellite Transmultiplexer and Receiver", National Conference on Communications (NCC-2000), 28-30 January 2000, Delhi.

43. K.Vasudevan, K.Giridhar, and B.Ramamurthi, "Efficient suboptimum detectors based on linear prediction in Rayleigh flat-fading channels", International Conference on Communications, Control, and Signal Processing in the Next Millennium, Bangalore, India, July 2000. (DOI: 10.1016/S0165-1684(00)00250-4)

44. S. Mohammed Rabeek, Ashok Jhunjhunwala, and Bhaskar Ramamurthi, "Internet Access in corDECT Multiwallset," Proc. of the National Conference on Communications, 2001, pp. 13-17. https://getinfo.de/en/search/id/BLCP%3ACN042719730/

45. Valli Madhavi, Devendra Jalihal, K. Giridhar, and Bhaskar Ramamurthi, "High-Speed DECT-Based Internet Download System", Proc. of the National Conference on Communications, 2001, pp. 47-51.

46. A. Kotilingaiah Setty, Bhaskar Ramamurthi, and Devendra Jalihal, "IP-PX: A Wireless Local Loop System for Small Communities", Proc. of the National Conference on Communications, 2001, pp. 370-374.

47. Vasudha Raman, Bhaskar Ramamurthi, and K. Giridhar, "Lossless Data Compression for the Internet Connection in corDECT", Proc. of the National Conference on Communications, 2001, pp. 375-379.

48. N. Hitesh, G. Ramesh Kumar, Bhaskar Ramamurthi and K. Giridhar, "Receiver for 3G DECT Physical Layer", Proc. of the Nat. Conf. On Communications, Mumbai, 2002. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.17.2727&rep=rep1&type=pdf

49. N. Hitesh, Rohit Budhiraja, and Bhaskar Ramamurthi,"Backward Compatible Software FM Demodulator for 3G DECT Receiver", Proc. of the Nat. Conf. On Communications, Mumbai, 2002.

50. Hema A. Murthy, T.A. Gonsalves, Bhaskar Ramamurthi, K. Balamurugan, Shubha Augustine, and Ch. Vijayalakshmi, "Cygplan – An Installation Planning Tool", Proc. of the Nat. Conf. On Communications, Mumbai, 2002.

51. Sundar Krishnaraj and Bhaskar Ramamurthi, "Efficient Channel Utilisation for Internet Calls in Wireless Access Systems", Proc. of the Nat. Conf. On Communications, Mumbai, 2002.

52. Rohit Budhiraja and Bhaskar Ramamurthi, "Modified DECT 3G Physical Layer with Improved Multi-Rate Capability", NCC-2003, Madras, Jan 31-Feb 2, 2003. www.ncc.org.in/download.php?f=NCC2003/G-5.pdf

53. Vinosh Babu James, Bhaskar Ramamurthi and K. Giridhar, Controlling array gain using partial channel feedback in linearly decodable codes, Proc. of WWRF-15, France, Dec 2005.

54. A. S. Mohan Vamsi, Andrew Thangaraj, Bhaskar Ramamurthi, "HARQ Schemes using LDPC codes with Diversity-Combining,", Natl. Conf. on Communications, NCC2007. http://www.ncc.org.in/download.php?f=NCC2007/4.1.5.pdf

55. Vinosh Babu James, Bhaskar Ramamurthi, "A Two-Antenna Two-Tone Space- Frequency Code Using Reduced Channel Feedback", Proceedings of IEEE SPAWC- 2k7, Helsinki, Finland, June 2007. DOI 10.1109/SPAWC.2007.4401338

56. Vinosh Babu James and Bhaskar Ramamurthi, Performance Evaluation of Two 2 x 1 MIMO OFDMA Schemes in a Multi-cellular Environment, Proc. of WWRF-18, Finland, June 2007

57. Vinosh Babu James, Bhaskar Ramamurthi, et. al., Array-Gain Enhancement in 4 × 2 Coordinate Interleaved Spatial Multiplexing Proc. of WWRF-19, Chennai, Nov 2007 (http://www.wwrf.ch/files/wwrf/content/files/publications/libraries/Library19.pdf)

58. Bhaskar Ramamurthi, Next-Generation Wireless System Architectures with Optical- Fiber Backhaul, (invited) First International Workshop on Software Radio Technology, Beijing, 2008

59. A. R. Venkatesh, Bhaskar Ramamurthi and K. Giridhar, "Analysis of Novel Low Complexity Direct-Sequence Spread Spectrum Receiver", NCC 2009, January 16-18, IIT Guwahati. (http://www.ncc.org.in/download.php?f=NCC2009/Q3_2.pdf)

60. Bhaskar Ramamurthi, Cutting Edge at the Cell Edge: Mitigating Co-Channel Interference in Emerging Broadband Wireless Systems (invited), First International Conference on Communications Systems and Networks, Bangalore, 2009 (DOI: 10.1109/COMSNETS.2009.4808881)

61. Kiran Kuchi, R Vinod, M K Dileep, M S Padmanabhan, Dhivagar, J Klutto Milleth, Bhaskar Ramamurthi, K Giridhar: Interference Mitigation using Conjugate Data Repetition, Proc. IEEE International Conference on Communications, June 2009. (DOI: 10.1109/ICC.2009.5199093)

62. F. Diehm, P. Marsch, B. Ramamurthi and G. Fettweis, "A Low-Complexity Algorithm for Uplink Scheduling in Cooperative Cellular Networks with a Capacity-Constrained Backhaul Infrastructure", Proceedings of the IEEE Global Communications Conference (GLOBECOM'09), Hawaii, USA, 2009. (DOI: 10.1109/GLOCOM.2009.5425374)

63. J. Vinosh Babu James, B. Ramamurthi and V. Ganesh, "An Algorithm for Distributed Cooperative Precoder Selection in a Cellular Network", Proc. of Natl. Conf. on Communications, NCC-2010, Chennai, Jan 2010. (DOI: 10.1109/NCC.2010.5430220)

64. Adetola Oredope, Mehrdad Dianati, Barry G. Evans, Rohit Budhiraja and Bhaskar Ramamurthi, "Deploying IP Multimedia Subsystem (IMS) Services over Next Generation Networks (NGNs): The IU-ATC Integrated Test Bed", Testbeds and Research Infrastructures. Development of Networks and Communities - 6th International ICST Conference, TridentCom 2010, Berlin, Germany, May 18-20, 2010, Revised Selected Papers. (DOI: 10.1007/978-3-642-17851-1_71)

65. N. Vinoth, A Ayyar, B. Ramamurthi, and K. Giridhar, "Robust LLR-Aided Low feedback Precoding for Intereference Alignment," Proc. Of National Conf. on Communications, NCC 2010, Chennai, 2010. (DOI: 10.1109/NCC.2010.5430223)

66. K. S. Karthik and Bhaskar Ramamurthi, Prediction of SINR Improvement with a Directional Antenna in a Cellular System, Nat‟l. Conf. on Communications, NCC 2011, Bangalore. (DOI: 10.1109/NCC.2011.5734716)

67. Hemanth Acharya, Sivakishore Reddy Yerrapareddy, Kiran Kuchi, Bhaskar Ramamurthi, "Unitary Precoders for CQI Reliability in Closed Loop MU-MIMO OFDM Systems", Proc. Nat‟l. Conf. on Communications, Jan 2011, Bangalore. (http://toc.proceedings.com/10927webtoc.pdf)

68. Sunil Kaimaletu, Rajet Krishnan, Sheetal Kalyani, Nadeem Akhtar and Bhaskar

Ramamurthi, "Cognitive Interference Management in Heterogeneous Femto-Macro Cell Networks", Proc. Of IEEE Int"l Conf. on Communications, June 2011, Kyoto, Japan. (DOI: 10.1109/icc.2011.5962617)

69. Prasanth Karunakaran, Padmanabhan Madampu Suryasarman, Vinod Ramaswamy, Kiran Kuchi, Deviraj Klutto Milleth Jeniston and Bhaskar Ramamurthi, "On pilot design for interference limited OFDM systems", 8th International Symposium on Wireless Communication Systems, ISWCS 2011, Aachen, Germany, November 6-9, 2011. (DOI: 10.1109/ISWCS.2011.6125413)

70. Sriram Narayanamurthy, Sneharaj Ramdaspalli, Ashok Jhunjhunwala and Bhaskar Ramamurthi, "Rural base station powering", National Conference on Communications (NCC), 3-5 Feb.2012. (DOI: 10.1109/NCC.2012.6176834)

71. Karthik KS and Bhaskar Ramamurthi. "Impact of reduced antenna spacing on the post-processing SINR of interference rejection combining in cellular downlink receivers", National Conference on Communications (NCC), 15-17 Feb. 2013. (DOI: 10.1109/NCC.2013.6487931)

72. Rohit Budhiraja and Bhaskar Ramamurthi, "Precoder design for asymmetric two-way AF shared relay", National Conference on Communications (NCC), 15-17 Feb.2013. (DOI: 10.1109/NCC.2013.6487900)

73. R. Budhiraja, K.S. Karthik and B. Ramamurthi, "Precoder design for asymmetric multi-user two-way AF relaying in cellular systems", IEEE International Conference on Communications (ICC), 9-13 June 2013. (DOI: 10.1109/ICC.2013.6655542)

74. K.S. Karthik and B. Ramamurthi, "Downlink throughput enhancement of an OFDMA cellular system with closed-access indoor relays", IEEE 14th Workshop on Signal Processing Advances in Wireless Communications (SPAWC), 16-19 June 2013. (DOI: 10.1109/SPAWC.2013.6612070)

75. Ashok Jhunjhunwala, Bhaskar Ramamurthi, Krishna Vasudevan, Lakshmi N, Uma Rajesh, "Un-interrupted DC Power from Grid without storage – will it rid India of power-cuts?", DC Micro-Grid Conference, Charleston, USA March31 – April 1, 2014.

76. Rohit Budhiraja and Bhaskar Ramamurthi, "Diagonalized two-way MIMO AF relaying for non-simultaneous traffic in cellular systems", Proc. IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), Toronto, Canada, Jun. 2014, pp. 1–5.

77. Ashok Jhunjhunwala, Janani Rangarajan, Bhaskar Ramamurthi and Uma Rajesh, "Why decentralised solar deployment can be a game changer in India", IEEE Photovoltaic Specialists Conference, Denver, USA, Jun. 2014.

78. Rohit Budhiraja and Bhaskar Ramamurthi, "Two-way MIMO DF relaying for non-simultaneous traffic in cellular systems", International Conference on Signal Processing and Communications (SPCOM), 22-25 July 2014, pp.1-6 (DOI: 10.1109/SPCOM.2014.6984005)

79. Kishore Prahlad and Bhaskar Ramamurthi, "Design and implementation of a Multi-Terminal Channel Emulator on LTE TestBed", Twenty First National Conference on Communications (NCC), Feb.27-Marc.1 2015, pp.1-6 (DOI: 10.1109/NCC.2015.7084853)

80. Ashok Jhunjhunwala, Lakshmi Narasamma, Krishna Vasudevan, Bhaskar Ramamurthi, Prabhjot Kaur, "Decentralized solar dc power and smart load management to enable 24 x 7 power for Indian homes", Activities on Smart city Workshop in Asia, Institute of Electrical Engineering of Japan (IEEJ) March 31, 2015. Pg: 39- 42.

81. Ashok Jhunjhunwala, Krishna Vasudevan, Lakshmi Narasamma and Bhaskar Ramamurthi, "Technological and deployment challenges and user-response to uninterrupted DC (UDC)

deployment in Indian homes", IEEE First International Conference on DC Microgrids (ICDCM), 7-10 June, 2015, pp.38-42 (DOI: 10.1109/ICDCM.2015.7152006)

82. Vikram Singh, Abhijit Masal, Klutto Milleth, and Bhaskar Ramamurthi, "High Precision Positioning Using Multi-Cell Massive MIMO System for 5G and Beyond", IEEE 32nd Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 2021.

APPENDIX II

LIST OF INVENTIONS/CO-INVENTIONS OF PROF. BHASKAR RAMAMURTHI

Patents Granted

Sl. No	Title	Patent Number	Patented at
1.	Direct-In-Diallers for Decadic-Pulsing Telephone System	173914 & 173916	IPO
2.	A Long Range DECT System	333/MAS/97	IPO
3.	A Long Range Relay Base DECT System	332/MAS/97	IPO
4.	A Broad Band wireless communication system	492/CHE/2006	IPO
5.	Multi Antenna cellular broadband wireless communication system with interference mitigation	298/CHE/2007	IPO
6.	Inter-Cell Interference Mitigation using Limited Feedback in Cellular Networks	355/CHE/2008	IPO
7.	Interference Suppression OFDMA and SC-FDMA Systems	1685/CHE/2008	IPO
8.	Methods to Time-Frequency Multiplex Pilot and Data in OFDMA Systems	1493/CHE/2008	IPO
9.	Quasi Orthogonal Pilot Design	1511/CHE/2008	IPO
10.	Interference Mitigation Enhancement Using Conjugate Symbol Repetition and Phase Randomization	1461/CHE/2008	IPO
11.	Enhancements to a CDMA system to support in-band personal indoor relays	2815/CHE/2010	IPO
12.	Method and system for single Transmission and Reception	1211/CHENP/2011	IPO
13.	Precoding for multiple transmission streams in multiple antenna systems	357/CHENP/2011	IPO
14.	Pilot aided Data Transmission and Reception with Interference Mitigation in Wireless Systems	6122/CHENP/2011	IPO
15.	Cognitive interference management in wireless networks with relays; macro cells; micro cells; pico cells and femto cells	7213/CHENP/2011	IPO
16.	Precoding for Single transmission streams in multiple antenna	373/CHENP/2011	IPO
17.	An ordered Reduced Set Successive Detector For Low Complexity; Quasi-ML MIMO Detection	227/CHE/2012	IPO
18.	Interference Cancelling Block Modulation	8665/CHENP/2012	IPO

19.	Indoor Personal Relay	10755/CHENP/2012	IPO
20.	Interference management for a distributed spatial network	9732/CHENP/2013	IPO
21.	Method for efficient Uplink-Downlink configuration hopping for interference mitigation	4388/CHE/2013	IPO
22.	Resource Sharing of eNode-B to support Multiple Operators in LTE	4410/CHE/2014	IPO
23.	An open-loop multiple-user MIMO method for OFDM based communication system	2468/CHE/2015	IPO
24.	Methods and systems of 2-D virtual sectorization using beam steering	3728/CHE/2015	IPO
25.	Relaying Using D2D Capable Terminals in LTE	1895/CHE/2015	IPO
26.	Method and system for Spectrally Efficient Channel State Information Estimation using In-band Full Duplex Communication	3692/CHE/2015	IPO
27.	Inter-Cell Interference Mitigation using Limited Feedback in Cellular Networks	12/867,461	USPTO
28.	Interference Mitigation Enhancement Using Conjugate Symbol Repetition and Phase Randomization	12/999,826	USPTO
29.	Precoding for Single Transmission streams in Multiple antenna systems	12/999,894, 14/734,634 (divisional)	USPTO
30.	Precoding for Multiple transmission streams in multiple antenna systems	12/999,941	USPTO
31.	Pilot Aided Data Transmission And Reception With Interference Mitigation In Wireless Systems	13/254,849	USPTO
32.	Cognitive Interference Management In Wireless Networks With Relays; Macro Cells; Micro Cells; Pico Cells And Femto Cells	13/257,667, 14/661,746(divisional)	USPTO
33.	Interference Cancelling Block Modulation	13/640,036	USPTO
34.	Indoor Personal Relay	13/699,641, 14/700, 916	USPTO
35.	An Ordered Reduced Set Successive Detector For Low Complexity; Quasi-ML MIMO Detection	13/745,018	USPTO
36.	Interference Management For A Distributed Spatial Network	14/116,341	USPTO
37.	Method for dual connectivity of device in heterogeneous network using in-band full duplex radio	15/211,443	USPTO
38.	An open-loop multiple-user MIMO method for	15/152,392	USPTO

	OFDM based communication system		
39.	Methods and systems of 2-D virtual sectorization using beam steering	15/204,477	USPTO
40.	OFDMA apparatus and method thereof For Performing OFDM based communication in wireless communication system	15/614,326	USPTO
41.	Method For Beam Steering In Multiple-Input Multiple-Output System	16/153,739 (Continuation-in-part of 15/204,477)	USPTO

In addition, 31 Indian patent applications and 7 US patent applications are under filing / examination.

Appendix III

Research Scholars supervised by Prof. Bhaskar Ramamurthi

	Student Name	Title	Year	Degree
1.	G.A. Sudheer	A Spread-Spectrum Wireless Lan For Indoor Communications	July 1989	Master of Science
2.	C.P.Mammen	Vector Quantization for Compression of Multichannel ECG	November 1989	Master of Science
3.	S. Jeganathan	Fast-Fourier-Transform-Based Algorithms for Scattering and inverse scattering from circular cylindrical shells	May 1991	Doctor of Philosophy
4.	N. Sanjay	Digital FM Modem With Periodic Synchronisation for a TDM/TDMA System	April 1991	Master of Science
5.	S. Sumam David	Two-Sided Linear Prediction: Theory and application to speech coding	August 1991	Doctor of Philosophy
6.	M.G. Syed Sadaqathullah	Digital FM Modem for a TDM/TDMA System	June 1992	Master of Science
7.	A. Siva Kumar	Rate-Adaptive Digital Communications over the Twisted-pair channel	May 1996	Master of Science
8.	Vasudev Nambakam	Statistical Multiplexer for Variable Bit-Rate Voice Signals	March 1997	Master of Science
9.	K. Rajesh	Design and Development of a Radio Transceiver for DECT	January 1998	Master of Science
10.	Ch. Vijayalakshmi	Capacity of High Density Macro Cellular Wireless Local Loop System Based on Dynamic Channel Selection	August 1998	Master of Science
11.	Sivan.R	Analysis and Design of Relay Base Station for DECT WLL	October 1998	Master of Science
12.	C.P. Mammen	Capacity Enhancement in Digital Cellular Systems Using Variable Bitrate Speech Coding	May 1998	Doctor of Philosophy
13.	K. Vasudevan	Efficient Non-coherent Detectors for Multilevel Signals in Fading Channels	August 1999	Doctor of Philosophy
14.	S. Maruthi Nayagam	Analysis, Design and Development of a Base Station Distributor (BSD) For DECT WLL	June 1999	Master of Science
15.	V. Suresh	Design of a Fast-Locking Synthesizer for Multi-Carrier TDMA Systems	February 2000	Master of Science
16.	K. Rama Sudha Mohan	An Efficient DSP Based Implementation of Reed Solomon Codec for CorDECT WLL System	June 2000	Master of Science
17.	N. Hithesh	Design of a Transceiver for 3G DECT Physical Layer	August 2002	Master of Science
18.	K. Sundar	Efficient Channel Utilisation for Internet calls in a Wireless Local Loop System	February 2002	Master of Science
19.	Vasudha Raman	Lossless Data Compression for Internet	February	Master of

		Traffic and Its Application To corDECT WLL System	2002	Science
20.	Rohit Budhiraja	Efficient Low Bit Rate Channelisation in DECT using Sub-bands	March 2004	Master of Science
21.	M.P. Harish Prabhu	Enhanced DECT Physical Layer with Multi-Level GFSK Modulation	March 2006	Master of Science
22.	Andalam Satya Mohan Vamsi	Low-Density Parity-Check Codes for channels with Feedback: Retransmission Schemes	June 2007	Master of Science
23.	Eswar Goda	An ALL-IP Version of the Broadband corDECT Wireless Access System	September 2007	Master of Science
24.	Fabien Diehm	On the Impact of Scheduling on the Performance of Multi-Cell Cooperative Detection in a Cellular Network with a Constrained Backhaul	January 2009	Master of Science
25.	Niju Abraham	Design of a Cost-Effective Wireless Terminal with a Split-Architecture	June 2009	Master of Science
26.	N. Vinoth	Distributed Cooperative Precoder Selection for Interference Alignment	April 2010	Master of Science
27.	J. Vinosh Babu James	Cooperative Precoder Selection for Spectrally Efficient Communications in Cellular Wireless Systems	June 2012	Doctor of Philosophy
28.	K.S. Karthik	User Deployed Indoor Relays in Cellular Systems	July 2014	Doctor of Philosophy
29.	Rohit Budhiraja	Precoder and Receiver Designs for MIMO Non-Simultaneous Two-way Relaying	July 2015	Doctor of Philosophy
30.	P. Kishore	Design and Implementation of a Multi-Terminal Channel Emulator for LTE Testbed	July 2015	Master of Science

APPENDIX IV

List of R&D Projects co-ordinated individually and jointly by Prof. Bhaskar Ramamurthi

(projects in italics are government sponsored, rest are industry-sponsored)

Sl. No.	Title of the Project	Duration	Sponsoring Agency	Value in lakhs (Rs.), R-Royalty
1.	Development of TDM TDMA system for Rural Communication Radio Systems	1988-92	TRC / Centre for Development of Telematics, Bangalore	45.735
2.	A versatile Fibre Optic Time Division Multiplexed Voice and Data Network	1989-91	Electronics Corporation of India Limited, Hyderabad	5
3.	Wireless Multi-access Messaging	1989-91	Intelligent Commn. Equipment Pvt Ltd.,	2.6

Sl. No.	Title of the Project	Duration	Sponsoring Agency	Value in lakhs (Rs.), R-Royalty
	System		Hyderabad	
4.	Development of Drop and Insert PCM equipment	1989-91	Indian Telephone Industries, Naini	2.5
5.	Development of EKB with LCD Display	1990	Hindustan Teleprinters Limited, Madras	1
6.	Development of EKB Concentrator	1990	Hindustan Teleprinters Limited, Madras	1
7.	Fibre Optic Communication Educator	1990	Benchmark Systems, Madras	R
8.	Telephone Sharing System	1990-91	Innovation Commn. systems, Hyderabad	1.4+R
9.	Development of Digital Communication Educator Kit	1990-91	Universal Instruments, Bangalore	0.75+R
10.	Fibre Optic Based Double Ring Telemetry system	1991-92	Instrumentation Limited, Kota	5.5
11.	Operator Console for EPABX	1991-92	W.S.Industries (India) P. Ltd., Bangalore	1.25
12.	Portable Telephone Tester	1991-92	Telematics Systems Ltd.	0.75
13.	G732 Compatible Mux with Drop and Insert capability	1991-93	W.S.Industries (India) P.Ltd., Bangalore	3.25
14.	Failsafe Signal multiplexer Systems for Railways	1991-93	Crompton Greaves Ltd., New Delhi	5.5
15.	Development Of A Dsp Board	1992	Bay Talktec P Ltd	0.20
16.	Simulation Study of High Quality Wideband Audio Compression Techniques	1992	Indchem Research & Development Laboratory, Madras	8.00
17.	Integra S Ql Based Software Development	1992-93	Grasim Industries	1.00
18.	Proposal For Development Of Pc Based Ethernet Bridge	1992-93	Multi-Media Incorporated	1.00
19.	Ethernet Driver And Monitor Two S Co Unix	1992-93	Zenith Computers Limited	0.40
20.	Development Of R 111 Compatible Multiplexer For ... Transmission	1992-93	United Communications Limited	2.50
21.	DSP Based PLCC System	1992-93	W.S.Electronics, Bangalore	4
22.	Development of a Neuron-Based Distributed Control SCADA System	1992-95	Alacrity Electronics, Madras	15
23.	6 Channel ADPCM Mux with D&I for Railways and 60 Channel ADPCM Transcoder	1993-94	W.S.Telesystems, Bangalore	7.5 + R

Sl. No.	Title of the Project	Duration	Sponsoring Agency	Value in lakhs (Rs.), R-Royalty
24.	Development of New DSP Based Products	1993-94	Analog Devices, USA	7.88
25.	Design & Development of Bedside ECG Monitor	1993-94	Siemens, Madras	6
26.	Ethernet Twisted Pair Remote Bridge	1993-94	Citi Bank, Madras	2.5
27.	Digital Telephone Answering Machine	1994-97	Analog Devices, USA	1.88
28.	*Fibre Optics Railway Signaling and Communication System*	*1993-96*	*Department of Electronics, New Delhi*	*17*
29.	Two Port Local and Remote Ethernet Bridge	1995-96	Excellent Computers, Madras	R
30.	Digital Pair Gain System	1995-96	ITI Bangalore & Crompton Greaves Ltd., Bangalore	16+R
31.	ISDN Interface for Paradigm Exchange	1996-97	Tata Telecom, Gandhinagar	9
32.	E1 Circuit Multiplier	1996-97	Shyam Telecom, New Delhi	1.5
33.	Video Telephony Over Internet	1996-98	Objected Oriented Programming Services, Madras	15
34.	Development of ISDN Terminals	1996-98	Tata Telecom, Gandhinagar	4
35.	Co-Channel Signal Recovery	1997-98	Ericsson Inc., USA	7
36.	Design of LanFone System	1998-2000	BPL Telecom, Bangalore	5.5
37.	*Simulation Study of Multi-Carrier Satcom Modem*	*1998-2000*	*ISRO, Ahmedabad*	*4*
38.	*Telematics*	*1986-2002*	*Ministry of HRD*	*75*
39.	Fibre in Local Loop	1997-2003	HFCL, New Delhi	39
40.	Digital Internet Access System (DIAS)	1998-2003	ARM, Hyderabad, Shyam Telecom, HFCL, New Delhi	65.0 + R
41.	Wireless in Local Loop	1994-2003	Analog Devices, USA, Westel Wireless, Bangalore, Crompton Greaves, Bangalore, ECIL, Hyderabad, Shyam Telecom, New Delhi	1000
42.	Computer Networking Activity	1995-2003	Acacia Networks, USA	130 + R
43.	Retainer Consultancy	2000-01	RELIANCE TELECOM LIMITED	1.80
44.	Wireless Network Planning and Management	2001-02	Bonsai Networks India Pvt. Ltd.,	10.00
45.	Digital internet access system (DIAS)	2001-03	Shyam Telecom Ltd	20.00

Sl. No.	Title of the Project	Duration	Sponsoring Agency	Value in lakhs (Rs.), R-Royalty
46.	Cygplan Access Network Planner	2001-04	NILGIRI NETWORKS	1.00
47.	Transmit Diversity Research	2002-2003	Bharat Electronics Ltd.	7
48.	*Modernisation of electrical engineering lab in communication system*	*2002-04*	*Ministry of Human Resource and Development*	*6.00*
49.	A Peer-to-Peer 802.11b based Mesh Network for Rural Communities	2002-2007	Media Lab Asia, Mumbai	48
50.	3G WCDMA Physical Layer Design	2001-02	Sasken Communication Technologies Ltd., Bangalore	0.84
51.	IEEE 802.11 Physical Layer Design	2002-	Wipro Infotech, Bangalore	1.2
52.	ADI-IITM DSP Learning Centre	2001-2004	Analog Devices Inc. USA	10
53.	Intel Software Radio Laboratory	2002-2009	Intel Technologies, USA	115.2
54.	Retainer Consultancy for Redpine Signals, Inc.	2003-03	Redpine Signals, Inc. - Hyderabad	0.60
55.	Retainer Consultancy	2003-04	Tata Elxi Ltd.	0.40
56.	PLDs for access devices	2003-05	Media Labs Asia	46.00
57.	*Design of Satellite Modems and Transcoders for Sparse Area Communication System*	*2003-2009*	*ISRO, Ahmedabad*	*159.85*
58.	Infrastructure Technology	2004-07	Interdisciplinery Research Projects, IIT Madras	100.00
59.	Development of Wireless Systems	2004-2010	Midas Communication Technology	60
60.	Next-Generation (4G) Wireless Technology Research – awarded to CEWiT	2005-2014	DIT and consortium of industry (BWCI) in 2:1 ratio	2400
61.	Nokia bridging the world	2007-08	Nokia Research Center	5.78
62.	Study of software defined radio with WiMaX and LTE base-band in a combo terminal	2007-11	NXP Semiconductors India Pvt. Ltd	36.80
63.	*End-to-End UK-India Trans-national wireless Test Bed (IUAATC)*	*2009-2013*	*DST*	*142.6*
64.	IBM Faculty Award - 2008	2009-14	IBM CORPORATION , USA	4.90
65.	PCM telemetry project design and testing	2011	Encompass Electronics Pvt. Ltd.	1.10
66.	Technical advice for setting up a Solar PV power plan	2011-13	CCCL Infrastructure Ltd.,	12.50
67.	*Relays for Fourth Generation Broadband Networks*	*2011-2014*	*DIT*	*60*

Sl. No.	Title of the Project	Duration	Sponsoring Agency	Value in lakhs (Rs.), R-Royalty
68.	Robust Estimation	2011-15	Renesas Mobile Europe	6.78
69.	Sustainable Communication Infrastructure (Information Network for Natural Disaster Mitigation and Recovery (DISANET))	2011-16	Japan International Co-operation Agency	486.00
70.	*Proof of concept for project UDC*	*2013-16*	*Ministry of Human Resource and Development*	*400.00*
71.	*Solar powered air conditioners and desert air-coolers*	*2013-16*	*Department of Science & Technology*	*63.39*
72.	*Centre of Excellence for Decentralized Power Systems*	*2013-18*	*Ministry of Human Resource and Development*	*2000.00*
73.	Decentralized solar PV power for commercial buildings	2013-18	Indo-US Science & Technology Forum	135.00
74.	*Education through information and communication technology using Direct-to-Home (DTH)*	*2014-18*	*Ministry of Human Resource and Development*	*10500.00*
75.	*Statistical estimation of electromagnetic radiation using large data analysis of cellphone signal levels*	*2015-17*	*Department of Science & Technology*	*81.01*
76.	*Development of Indigenous end-to-end 5G Test Bed*	*2018-21*	*Department of Telecommunications*	*23800.00*

Appendix V

Incubated Companies whose technologies were substantially influenced by Prof. Bhaskar Ramamurthi

1. **Midas Communications Technologies:** the company was founded in 1994 to develop the first affordable wireless local loop system in India. The first product was launched in 1997, and a million lines were installed in India and more than a dozen countries. The entire technology development was driven by Prof. Bhaskar Ramamurthi, with many firsts in the wireless domain. It was probably the first SDR based commercial system, with the micro base station and terminal being entirely software defined, and remotely re-programmable. It was also the first WLL system to provide an IP port for always-on broadband connectivity, first at 70 kbps and then at 256 kbps.

2. **Banyan Networks:** the company was set up to enable DSL-like connectivity using ISDN Physical layer even on cables that were not good enough to support DSL. The company went on the develop DSLAM and optical transport solutions and was merged with Midas.

3. **Novatium:** the first company to develop a cloud-based thin client solution that provides a PC-like service without the cost and hassles of a desktop. The company has now launched services in several countries, and has attracted investment from a global telecom major.

4. **Vortex:** the company built India's first low-cost and energy-efficient ATM, and has successfully deployed it in large numbers for a leading Indian bank and several other banks. No other ATM can run entirely on solar power and with a modest power requirement.

5. **N-Logue Communications:** the company that took Internet access for the first time to India's rural areas using wireless broadband technology and set up Internet cafes for the public

6. **Tejas Networks Ltd:** the company that became a global supplier of optical network equipment to telecom and Internet service providers and then followed up with 4G and 5G Radio Access Networks. Company went public in 2018 and is currently executing a 100,000 site 4G/5G network for one of the India's leading service providers.