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David Lloyd Johnson
Director – Ammbr Research Labs – South Africa
Adjunct Senior Lecturer – University of Cape Town – South Africa

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Personal Details

Full Name	David Lloyd Johnson
Date of Birth	6th August 1972
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Linkedin page	http://www.linkedin.com/pub/david-johnson/14/2aa/171

Education

1991-1995: BSc Electronic Engineering, University of Cape Town
Distinction in final year thesis – Sound synthesis using Genetic Algorithms
Graduated December 1995

2003-2004: Honours Computer Engineering, University of Pretoria
Distinctions in Computer networks, Research methodology and Digital design (Distinction average)

2005-2007: Masters Computer Engineering, University of Pretoria
Topic: "Performance Analysis of mesh networks in indoor and outdoor wireless testbeds"
Graduated September 2008 with distinction

2008-2012: Masters Computer Science Department, University of California, Santa Barbara
Graduated June 2012: GPA average: 3.9 (max 4.0)

2008-2013: PhD Computer Science department, University of California, Santa Barbara
Topic "Re-architecting Internet access and wireless networks for developing regions"
Graduated March 2013

General Experience

1996 – 1999: CSIR – Icomtek - Information Delivery Software group (software engineer)

2000 – 2002: CSIR – Meraka Institute - various groups dealing with wireless connectivity (Telecommunications engineer)

2003 – 2005: CSIR – Meraka Institute – Mobile Platform technology (Technical group leader)

2005 – 2007: CSIR – Meraka Institute – Wireless Africa (Research leader)

2008 – 2013: University of California, Santa Barbara – Computer Science Department– Teaching assistant, Research assistant, PhD degree coursework and research

2013 – 2018: CSIR – Meraka Institute, Cape Town – Principal researcher in the Future Wireless Group, leading work on development of TV White Space technology and regulation, network measurements and broadband planning and policy.

2018 – Present: Ammbr Research Labs, South Africa – Director: Lead research for the South African branch of Ammbr Research Labs International (part of the Ammbrtech group). Lead work on combination of mesh networking, blockchain and TV White Space technology.

2014 – Present: UCT – Computer Science Department, Adjunct senior lecturer: Lead the Net4D research group supervising masters and PhD students and teach an honours course on networks in developing regions (Net4D)

I have 20 years experience in software and telecommunications engineering research and development with key skills in software design, RF engineering, radio planning, operating systems, programming in Linux and embedded environments, networking in rural areas, network traffic pattern analysis , mesh networks, Bluetooth, WiFi, OpenBTS and Open Cellular -based GSM, White space networks and telecommunications policy. I have taught and tutored various courses at universities in South Africa and the US over the past 12 years. I also have 12 years experience in leading small teams (up to 7 employees or students) of developers/researchers in cutting edge wireless technology projects and research.

Current Position and responsibilities

I am currently the director of Ammbr Research Labs (ARL) South Africa Pty (Ltd), part of the International Ammbrtech group of companies (http://ammbrtech.com). ARL is a research body that supports AmmbrTech product development and carries out research thought leadership and conceptualization by identifying or generating underpinning academic work in the field of decentralized systems and interpretation of key learning and impact of that work to others in the company. ARL South Africa will be carrying out research on TV white space, WiFi and advanced mesh technology and will also develop rapid prototypes in both lab and outdoor test bed environments in partnership with the international team carrying our product development of the Ammbr router hardware and firmware.

I also lead a research group, Networks for Development (Net4D) in the Computer Science Department of the University of Cape Town where I hold an adjunct senior lecturer position. I teach an honours course on Networking in Developing Regions and supervise PhD and Masters students that focus on wireless networking research with a specific focus on Dynamic Spectrum Access and TV White Space networks and localized cloud computing services.

Past Responsibilities

I have led various teams of researchers and developers since 2003. In 2003, I was appointed as a Technical group leader of the Mobile Platform Technology group to oversee the direction of various mobile technologies with a specific focus on applications for Bluetooth. During this period I led a team that developed various Bluetooth products including a Bluetooth heart rate tracker, a Bluetooth-based mortar firing system, a Bluetooth HF radio audio gateway and a Bluetooth assistive communication device.

In 2005, I began to focus on research related to wireless networking for rural areas with an

emphasis on wireless mesh networking. Students were appointed on a Studentship program and I was placed in charge of defining the research direction for this group as well as overseeing the students research. I acted as a research group leader for a group of approximately 7 students until 2008. During this period I helped define a three-year road map for the research team, assisted with topic identification for post graduate studies. completed the construction of an indoor 7x7 wireless mesh test bed (one of 3 such test beds in the world) and built the first rural wireless mesh network in South Africa in Peebles valley, a rural area near White river. These outputs were used for numerous research papers and blueprints for future wireless mesh networking work that are now part of current government-funded mesh networking projects such as Broadband For All (BB4All)[1].

In 2008, I was offered a scholarship to do a PhD in the USA at UCSB[2] in computer science with a group interested in wireless mesh networks and rural connectivity. I left in August, 2008 to begin my PhD studies at UCSB. During my tenure at UCSB, apart from my courses and research work, I was instrumental in helping establish a new research area in "ICT for development" in the MOMENT lab of the Computer Science department of UCSB . I was involved in writing funding proposals in this specific field. I contributed to Villagenet - A $1.2 million NSF proposal funded in 2010 and Immunet – a $100000 Bill and Millinda Gates foundation project. I also co-supervised 3 masters students and 2 PhD students in the research lab I was working in. My PhD degree was conferred in March 2013.

In 2013, I became the principal researcher in the Future Wireless Networks research group within the Telecommunications and Media group at CSIR Meraka institute. I led a team that developed cognitive radios and white space technology for rural developing/emerging regions. We developed and deployed a white space mesh networking router that supports heterogeneous radios in WiFi and TVWS for rural or urban township broadband access. We also carried out a number of TV White space trials to showcase the impact of TV White Space in South Africa to the Regulator and the Department of Communications. I also developed broadband plans for the National and provincial government, calculating optimal fibre expansion and wireless connectivity options to cover connectivity gaps in the country. In my final year at CSIR, I was involved in a study of spectrum and capacity requirements for the Wireless Open Access Network.

Publications

1995

- Honours Thesis: Final year Electronic Engineering thesis on <u>Sound synthesis using a genetic algorithm</u>

2004

- Conference paper: D.L. Johnson, <u>Hardware and software implications of creating Bluetooth Scatternet devices</u>, 2004 IEEE Africon conference

2005

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1 http://researchspace.csir.co.za/dspace/handle/10204/5446
2 UCSB is ranked 5th best research university in the world based on Mean normalized citation score and 7th best in the world based on the proportion of the publications to the top 10% most frequently cited. (http://www.leidenranking.com/ranking.aspx).

- Conference paper: A. Smith, D.L. Johnson, Y.Kaka, <u>Initial research results on affordable community-owned information networks in South Africa</u>, 2005 Community Informatics Research Network (CIRN) conference

2006

- Conference paper: D.L. Johnson, Y. Kaka, J. Hay, <u>A new grid based test bed environment for carrying out ad-hoc networking experiments</u>, 2006 Southern African Telecommunications Networks and Applications Conference (SATNAC). (<u>Poster</u> for conference)

- Workshop poster: D.L. Johnson, <u>The quest to connect 450 million rural people in Africa</u>, 2006 Association for Progressive Communication workshop in London sponsored by the IDRC

2007

- Conference paper: D.L. Johnson, A. Lysko, <u>Overview of the Meraka wireless grid test bed for evaluation of ad-hoc routing protocols</u>, 2007 Southern African Telecommunications Networks and Applications Conference (SATNAC) (<u>Presentation</u> for conference)

- Journal paper: D.L. Johnson, A. Lysko, <u>Comparison Of MANET Routing Protocols Using A New Grid Based Test Bed Environment</u>, Special issue on "Advances in Wireless Mesh Networks" of the Journal of special issues on Mobility of Systems, Users, Data and Computing (MONET), Springer US

- Conference paper: D.L. Johnson, <u>Evaluation of a single radio rural mesh network in South Africa</u>, IEEE/ACM International Conference on Information and Communication Technologies and Development (ICTD2007) (<u>Poster</u> for conference)

2008

- Masters thesis: <u>Performance analysis of mesh networks in indoor and outdoor wireless testbeds</u>

- Conference paper: D.L. Johnson, C. Aichele, N.Ntlatlapa, <u>A simple pragmatic approach to mesh routing using BATMAN</u>, 2nd IFIP International Symposium on Wireless Communications and Information Technology in Developing Countries (WCITD'2008)

- Conference paper: D.L. Johnson, K. Roux, <u>Building rural wireless networks: Lessons learnt and future directions</u>, Wireless Networks and Systems for Developing Regions (WiNS-DR'2008)

- Conference paper: A.A. Lysko, D.L. Johnson, <u>A Numerical Study of Propagation Effects in a Wireless Mesh Test Bed</u>, The 6th WSEAS Int. Conf. on Applied Electromagnetics, Wireless and Optical Communications (Electroscience '08)

- Conference paper: T.O. Olwal, N. Ntlatlapa, Y. Hamam, F. Aron, B.J. Van Wyk, D.L. Johnson, <u>Transmission probability-based dynamic power control for multi-radio mesh networks</u>, 2008 Southern African Telecommunications Networks and Applications Conference (SATNAC)

2009

- Journal paper: D.L. Johnson, G.P. Hancke, <u>Comparison of two routing metrics in OLSR on a grid based mesh network</u>, Ad Hoc Networks, Elsevier

- Journal paper: A.A. Lysko, D.L. Johnson, <u>A Study of Propagation Effects in a Wireless Test Bed</u>, WSEAS Transactions on Communications

2010

- Conference paper: D.L. Johnson, E.M. Belding, K. Almeroth, G. van Stam, <u>Internet usage and performance analysis of a rural wireless network in Macha, Zambia,</u> 4th ACM Workshop on Networked Systems for Developing Regions (NSDR 2010)

- Conference paper: P.A.K. Acharya, D.L. Johnson, E.M. Belding, <u>Gateway-aware Routing for Wireless Mesh Networks,</u> 4th IEEE International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (MeshTech 2010)

2011

- Conference paper: D.L. Johnson, V. Pejovic, E.M. Belding, G. van Stam, <u>Traffic Characterization and Internet Usage in Rural Africa</u>, 20th International World Wide Web Conference (WWW 2011)

- Conference paper: M.T. Masonta, D.L. Johnson, M. Mzyece, <u>The White Space Opportunity in Southern Africa: Measurements with Meraka Cognitive Radio Platform</u>, 3rd International ICST Conference on e-Infrastructure and e-Services for Developing Countries (AFRICOMM)

2012

- Conference paper: D.L. Johnson, V. Pejovic, E.M. Belding, G. van Stam, <u>Network traffic locality in a rural African village</u>, IEEE/ACM International Conference on Information and Communication Technologies and Development (ICTD2012)

- Conference paper: A. Anand, V. Pejovic, E.M. Belding, D.L. Johnson, <u>VillageCell: Cost Effective Cellular Connectivity in Rural Areas</u>, IEEE/ACM International Conference on Information and Communication Technologies and Development (ICTD2012)

- Conference paper: D.L. Johnson, V. Pejovic, E.M. Belding, G. van Stam <u>VillageShare: Facilitating content generation and sharing in rural networks</u>, 2nd Annual Symposium on Computing for Development (ACMDEV2012)

- Journal paper: V. Pejovic, D. L. Johnson, M. Zheleva, E. M. Belding, L. Parks, and G. van Stam, <u>The Bandwidth Divide: Obstacles to Efficient Broadband Adoption in Rural Sub-Saharan Africa</u> International Journal of Communcation

- Conference paper: G. van Stam, D. L. Johnson, V. Pejovic, C. Mudenda, A. Sinzala, and D. van Greunen, <u>Constraints for Information and Communications Technologies implementation in rural Zambia</u> Africomm 2012

- Conference paper: A. Lysko , D.L. Johnson, M.O.R. Mofolo, <u>Significant Performance Improvement Obtained in a Wireless Mesh Network Using a BeamSwitching Antenna,</u>

2012 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: A. Nika, S. Dimopoulos, D.L. Johnson, E.M. Belding, Time-Shifting Traffic to Improve Utilization in Rural Area Network, Celebration of Women in Computing in Southern California (CWIC)

2013

- Conference paper: M. Zheleva, A. Paul, D.L. Johnson, and E.M. Belding, Kwiizya: Local cellular network services in remote areas, Mobisys'13

- Conference paper: C. Mudenda, D.L. Johnson, L. Parks, G. van Stam, Power Instability in Rural Zambia, Case Macha, Africomm 2013

- Conference paper: D.L. Johnson, E.M. Belding, C. Mudenda, Kwaabana: file sharing for rural networks, 4th Annual Symposium on Computing for Development (ACMDEV 2013)

- PhD thesis: Re-architecting Internet Access and Wireless Networks for Developing Regions, University of California, Santa Barbara (dissertation, defence presentation)

2014

- Conference paper: V. Pejovic, D.L. Johnson, M. Zheleva, E.M. Belding, and A.Lysko, VillageLink: Wide-area Wireless Coverage, 6th International Conference on Communications Systems and Networks (COMSNETS 2014)

- Conference paper: A. Lysko, M.T. Masonta, M.R.O. Mofolo, L. Mfupe, L. Montsi, D.L. Johnson, F. Mekuria, D.W. Ngwenya, N.S. Ntlatlapa, A. Hart, C. Harding, A. Lee, First large TV white spaces trial in South Africa: A brief overview, Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT), 2014

- Conference paper: S. Dlamini, M.T. Masonta, D.L. Johnson, Building an argument for Internet expansion in Dwesa - an under-serviced rural community in South Africa,International ICST Conference on e-Infrastructure and e-Services for Developing Countries (AFRICOMM 2014)

2015

- Book: A.K. Mishra, D.L. Johnson, White Space Communication: Advances, Developments and Engineering Challenges, Springer International Publishing, November 2014

- Book chapter: A. Lysko, M.T. Masonta, D.L. Johnson, The Television White Space Opportunity in Southern Africa: From Field Measurements to Quantifying White Spaces,White Space Communication. Springer International Publishing, 2014. pp. 75-116

- Book chapter: V. Pejovic, D.L. Johnson, M. Zheleva, E.M. Belding, VillageLink: A Channel Allocation Technique for Wide-Area White Space Network, White Space Communication, Springer International Publishing, 2014, pp. 249-280

- Poster: M. Vigil, D. Johnson, E. Belding, <u>Localized Content for Village Schools</u>, Mobisys

2016

- Conference paper: A. Moret, A. Sathiaseelan, M. Zennaro, F. Dondon, E. Pietrosemoli, D.L. Johnson, <u>Open and Regionalised Spectrum Repositories for Emerging Countries</u>, GAIA Workshop 2016

- Conference paper: A. Phokeer, D.L. Johnson, M. Densmore, <u>Characterisation of mobile data usage in township communities</u>, 2016 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: N. Zlobinsky, D.L. Johnson, <u>A Channel Selection Algorithm for a TVWS mesh network</u>, 2016 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: R. Maliwatu, N. Zlobinsky, M. Densmore, D.L. Johnson, <u>A road map for wireless mesh routing with DSA</u>, 2016 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: A. Takyi, M. Densmore, D.L. Johnson, <u>Collaborative neighbour monitoring in TV white space networks</u>, 2016 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: M. Lamola, D.L. Johnson, A. Lysko, N. Zlobinsky, <u>TVWS devices Spectrum Mask Test and Analysis</u>, 2016 Southern African Telecommunications Networks and Applications Conference (SATNAC)

- Conference paper: A. Phokeer, A. Aina, D.L. Johnson, <u>DNS Lame delegations: A case-study of public reverse DNS records in the African Region</u>, Africomm 2016

- Conference paper: D.L. Johnson, G. van Stam, <u>The shortcomings of globalised Internet technology in Southern Africa</u>, Africomm 2016

- Conference paper: R. Maliwatu, A. Lysko, D.L. Johnson, S. Hadzic, <u>Exploring RSSI Dependency on Height in UHF for throughput optimisation</u>, Africomm 2016

- Conference paper: D.L. Johnson, N. Zlobinsky, A. Lysko, M. Lamola, S. Hadzic, R. Maliwatu, M. Densmore, <u>Head to head battle of TV White Space and WiFi for connecting developing regions</u>, Africomm 2016

- Conference paper: S. Hadzic, A. Phokeer, D.L. Johnson, <u>TownshipNet: A localized hybrid TVWS-WiFi and cloud services network</u>, 2016 IEEE International Symposium onTechnology and Society (ISTAS)

- Conference paper: R. Maliwatu, A. Lysko, D.L. Johnson, <u>Exploring RSSI Dependency on Height in UHF for throughput optimisation</u>, 3rd IEEE International Conference on Advances in Computing and Communication Engineering (ICACCE)

- Magazine: D.L. Johnson, C. Mikeka, <u>Malawi and South Africa pioneer unused TV frequencies for rural broadband</u>, IEEE Spectrum, September 2016

2017

- Conference paper: A.Takyi, M. Densmore, S. Hadzic, D.L. Johnson, Performance analysis of a collaborative DSA-based network with malicious nodes, Africomm 2017

Citations

Extracted from
http://scholar.google.co.za/citations?user=88B0Yj0AAAAJ&hl=en

Citation indices	All	Since 2012
Citations	998	681
h-index	15	13
i10-index	25	19

TITLE	CITED BY	YEAR
Simple pragmatic approach to mesh routing using BATMAN D Johnson, N Ntlatlapa, C Aichele	151	2008
Comparison of two routing metrics in OLSR on a grid based mesh network D Johnson, G Hancke Ad Hoc Networks 7 (2), 374-387	120	2009
VillageCell: Cost effective cellular connectivity in rural areas A Anand, V Pejovic, EM Belding, DL Johnson Proceedings of the Fifth International Conference on Information and …	67	2012
Evaluation of a single radio rural mesh network in South Africa D Johnson Information and Communication Technologies and Development, 2007. ICTD 2007 …	65	2007
Traffic characterization and internet usage in rural Africa DL Johnson, V Pejovic, EM Belding, G Van Stam Proceedings of the 20th international conference companion on World wide web …	60	2011
Internet usage and performance analysis of a rural wireless network in Macha, Zambia DL Johnson, EM Belding, K Almeroth, G van Stam Proceedings of the 4th ACM Workshop on Networked Systems for Developing …	50	2010
Broadband Adoption| The Bandwidth Divide: Obstacles to Efficient Broadband Adoption in Rural Sub-Saharan Africa V Pejovic, DL Johnson, M Zheleva, E Belding, L Parks, G van Stam International Journal of Communication 6, 25	44	2012
Network traffic locality in a rural African village DL Johnson, EM Belding, G Van Stam Proceedings of the fifth international conference on information and …	41	2012
The white space opportunity in Southern Africa: Measurements with Meraka cognitive radio platform MT Masonta, D Johnson, M Mzyece International Conference on e-Infrastructure and e-Services for Developing …	36	2011
Kwiizya: local cellular network services in remote areas M Zheleva, A Paul, DL Johnson, E Belding Proceeding of the 11th annual international conference on Mobile systems …	35	2013
Building rural wireless networks: Lessons learnt and future directions DL Johnson, K Roux Proceedings of the 2008 ACM workshop on Wireless networks and systems for …	33	2008
VillageShare: Facilitating content generation and sharing in rural networks DL Johnson, V Pejovic, EM Belding, G van Stam Proceedings of the 2nd ACM Symposium on Computing for Development, 7	32	2012
Comparison of MANET routing protocols using a scaled indoor wireless grid D Johnson, A Lysko Mobile Networks and Applications 13 (1-2), 82-96	25	2008
White Space Communication: advances, developments and engineering challenges AK Mishra, DL Johnson Springer	24	2014
Building a rural wireless mesh network D Johnson, K Matthee, D Sokoya, L Mboweni, A Makan, H Kotze Meraka Institute. African Advanced Institute for Information …	21	2007
First large TV white spaces trial in South Africa: A brief overview AA Lysko, MT Masonta, MRO Mofolo, L Mfupe, L Montsi, DL Johnson, ... Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT …	13	2014
FSL based estimation of white space availability in UHF TV bands in Bergvliet, South Africa AA Lysko, MT Masonta, DL Johnson, H Venter	13	2012
A study of propagation effects in a wireless test bed AA Lysko, DL Johnson WSEAS Transactions on Communications 7 (8), 857-871	13	2008
Hardware and software implications of creating Bluetooth Scatternet devices D Johnson AFRICON, 2004. 7th AFRICON Conference in Africa 1, 211-215	12	2004
Kwaabana: File sharing for rural networks DL Johnson, EM Belding, C Mudenda Proceedings of the 4th Annual Symposium on Computing for Development, 4	11	2013

Paper reviews

Between 2009 and 2017, I carried out 31 reviews in International conferences and journals. This included 6 International conferences (2 of which are top International conferences in the field – Mobicom and Sigcomm) and 3 highly-ranked peer reviewed journals (IEEE Transactions on Mobile Computing, ACM Transactions on Parallel and Distributed Systems and IEEE Communications magazine)

2009
- PC ExtremeCom 2009 – Technical Programme Committee member (4 papers)

2010
- Transactions on Mobile Computing 2010 (1 paper)

2011
- Africon 2011 Technical Programme Committee member (5 papers)
- Mobicom 2011 (1 paper)

2012
- Mobicom 2012 (1 paper)

2013
- Sigcomm 2013 (3 papers)
- IST-Africa 2013 (1 paper)
- ACM Transactions on Parallel and Distributed Systems (1 paper)

2015
- ACM DEV 2015 (7 papers)

2016
- IEEE Communications magazine (3 papers)
- ACM DEV 2016 (5 papers)
- SATNAC (4 papers)

2017
- IEEE Communications magazine (1 papers)
- ACM SIGCHI (2 papers)
- ICTD (4 papers)
- SATNAC (2 papers)

2018
- ACM COMPASS (2 papers)

Technology demonstrators

2006: Massive mesh testbed (CSIR)
David Johnson

This demonstrator consists of a grid of wirelessly enabled computers in a 7x7 grid topology (spaced 700cm apart). The lab allows a researcher to carry out wireless experiments from anywhere in the world once the user has an account on the head-server of the lab. The lab currently uses attenuated WiFi to allow a researcher to simulate multi-hop links. The lab is completely flexible and allows any operating system to be loaded onto the nodes and easily changed by booting the entire operating system on every node from the head-server.

2006: Low cost mesh node (CSIR)
David Johnson

A Linksys-based wireless 802.11 router, embedded in a waterproof enclosure, ready to deploy in the field complete with custom designed firmware that is capable of IPv6 mesh routing (1st of its kind in the world). Units are deployed in the Pretoria Wireless network at 6 CSIR staff houses and the Mpumalanga Peebles Valley mesh network at 8 sites.

2006: Rural mesh testbed (CSIR)
David Johnson

An 8-node rural outdoor testbed covering approximately 30 square kilometers. The system has a server for providing localized services to the mesh as well as controlling the bandwidth of the clients. Full remote login is possible and researchers can use the system to run wireless networking experiments in a live system. Rural mesh testbed deployed in Peebles Valley near White River, Mpumalanga.

2007: Bluetooth heartrate monitor belt and software (CSIR)
David Johnson

A bluetooth-module coupled to a Polar heartrate pickup through some custom-built circuitry. This system fits into a belt worn by a sports person and sends their heartrate over 100m to a bluetooth recevier next to the field. The bluetooth receiver is connected to a PC running custom-built heart rate pickup software that can send a live heart rate video to a TV broadcaster. System was used in a live SuperSport 20/20 cricket match in 2007.

2009: Spectrum auction system (UCSB)
David Johnson
An online spectrum auction system, bridging the implementation gap
http://cs.ucsb.edu/~davidj/Files/spectrum_auction.pptx

Frequency bands have traditionally been allocated using a static long term allocation to primary users paying very high yearly license fees. Replacing this long term allocation with an online spectrum auction system which allows users to buy temporary access to spectrum can improve the efficiency and affordability of radio spectrum. Research on spectrum management and opportunistic spectrum access to date has been evaluated either through analytical analysis or through simulation with little implementation work in existence.

In this technology demonstrator, our wireless indoor grid-based test bed of 49 nodes is used to test a live online spectrum auction system. The auctions system is built using click

router software for packet exchange between a bidder and a spectrum broker. The broker relies on operators(bidders) to sense each other in order to construct a conflict graph and thereby allocate channels to operators which will not interfere with each other. To create a truthful conflict graph, reducing the power of operators that cannot see all other operators by 6 dB (halving their transmission range) was found to increase throughput by 30% due to decreased interference. The bidding system incurs a worst case overhead of 54 Kbps of bidding traffic if 1000 operators were supported with a bid interval of 10 minutes.

2011: Inexpensive radio frequency spectrum monitoring platform (CSIR)
David Johnson, Moshe Masonta, Albert Lysko,

The system was devised as a hardware and software package, including a software defined radio (SDR)
based receiver, control computer, signal processing software, software for presenting the data, and
software realizing localization of transmitters by multilateration. The SDR used was USRP2 module from Ettus Research LLC, USA. GNU Radio open source package was used to speed up programming of the system. The concept prototype operated in the ranges 89-108 MHz and from 400 MHz to 1 GHz (with different antennas), and can be readily expanded to cover 50 MHz to 2.9 GHz bands.

The purpose of developing the inexpensive radio frequency spectrum monitoring was dual. One goal was to prototype an inexpensive system capable of monitoring and sensing radio frequency spectrum, locating transmitters, and offering a good potential for portability. The potential users include regulators, wireless equipment operators and installers. The other goal was to demonstrate the technical capabilities of CSIR Meraka researchers, through the system developed, to the Independent Communication Authority of South Africa (ICASA), an important stakeholder of CSIR Meraka Institute.

2011: VillageShare
David Johnson, Veljko Pejovic, Elizabeth Belding, Gertjan van Stam

VillageShare: Facilitating content generation and sharing in rural networks
http://cs.ucsb.edu/~davidj/Files/villageshare_2012.pdf

While broadband Internet connectivity has reached a significant part of the world's population, those living in rural areas of the developing world suffer from poor Internet connectivity over slow long distance links, if they even have connectivity at all. While this has a general negative impact on Internet utilization, our surveys of users in rural communities show that the severest impact is in the area of content generation and sharing.

To this end we produced a technology demonstrator called VillageShare, an integrated time-delayed proxy server and content-sharing social media application utilizing Facebook and local cloud computing components. Through these components, VillageShare facilitates localization of traffic, protecting the bandwidth-limited Internet link from content shared between local users, and minimizes upload aborts by time-shifting large uploads to periods when the gateway link is under-utilized. We have deployed and evaluated the system in a rural village in Zambia.

2011: VillageCell
David Johnson, Arghadip Anand, V. Pejovic, Elizabeth Belding,

VillageCell: Cost Effective Cellular Connectivity in Rural Areas
http://cs.ucsb.edu/~davidj/Files/villagecell.pdf

Kwiizya: Local cellular network services in remote areas
http://cs.ucsb.edu/~davidj/Files/Kwiizya.pdf

Mobile telephony brings clear economic and social benefits to its users. As handsets have become more affordable, ownership has reached staggering numbers, even in the most remote areas of the world. However, network coverage is often lacking in low population densities and low income rural areas of the developing world, where big telecoms often refrain from deploying expensive infrastructure.

To solve this coverage gap, we developed VillageCell, a low-cost alternative to high-end cell phone networks. VillageCell relies on software defined radios and open-source solutions to provide free local and cheap long-distance communication for remote regions. Our architecture is simple and easy to deploy, yet robust and requires no modification to GSM handsets. The system has been evaluated in a lab to determine call quality metrics and the system capacity under a realistic rural-area network load. We have also deployed two VillageCell base stations in a rural village in Zambia and evaluated its performance.

2011: Cloud bursting system
David Johnson, Daniel Vucci
Auto-scaling and cloud bursting service for Eucalyptus
http://cs.ucsb.edu/~davidj/Files/autoscale.pdf

Rural regions in the world often have very limited access to broadband Internet and local powerful computing resources. Internet is usually provided by asymmetric satellite links with typically download speeds ranging from 256kbps to 512kbps. The link is often shared between many users in a village or Internet cafe and at peak-usage times the link becomes highly congested and often unusable. This causes many services, only available on the Internet, to become unavailable or too slow to use. However locally installed private cloud computing infrastructure could provide some valuable services such as speech technology to local residents even when the Internet link is congested or unavailable.

This technology demonstrator solves the problem of optimally using local computing resources by providing a mechanism to auto scale services to demand on a local cloud computing platform. We provide a flexible auto scaling framework for Eucalyptus which is able to start and stop virtual machine instances based on CPU, memory or disk demand. We also provide a mechanism to allow traffic to be offloaded to a public cloud (Amazon EC2) in the case where local resources are exhausted or not available.

2012: Smart antenna system (CSIR)
Albert Lysko, Mofolo Mofolo, David Johnson

The remotely controlled beamswitching array antenna with low power consumption and control software compose a subsystem for a wireless communication system. This subsystem is intended for improving the throughput, reliability, reconfigurability and functionality of

wireless networks, including rural energy-constrained wireless mesh networks (WMN) applications. The main challenges addressed include the need for reliability via robustness to an isolated network node failure, high throughput suitable for multimedia, long communication range, and power efficiency to accommodate unreliable rural energy supply.

The antenna can offer a significant throughput improvement in presence of interference. The near-real world laboratory tests showed more than 10 times improvement compared to an omnidirectionally radiating antenna. This is achieved by using directional properties of the antenna, otherwise achievable only with the use of a fixed directional antenna. The antenna designed is capable of switching between an omnidirectional mode, similar to traditionally used dipole/monopole antennas, and several directional beams. The latter mode permits the antenna to focus the beam, reach further distances, and switch between different links, e.g. in the case of network node failure. In addition, the advantage of focussing the energy with a directional beam, reduces both the interference and its affects, thus improving the reliability, as compared to a fixed high gain antenna.

2016: White Space Mesh Node (CSIR)
David Johnson, Albert Lysko, Natasha Zlobinsky,

The White Space Mesh Node (WSMN) makes use of hybrid set of radios (TV White Space and WiFi radios), to provide a wireless backhaul mesh network as well as a local WiFi access networks. The WSMN makes use of a channel allocation algorithm that combines a Geo-Location Spectrum Database (GLSD) as well as spectrum sensing (using a low cost built-in spectrum analyzer) to select an optimal TV white space channel to operate on. The mesh protocol makes use of an intelligent link metric to switch between a 5GHz WiFi radio link and the TVWS link for optimal routing of traffic.

The White Space Mesh Node grew out of the success of the CSIR HPN (a high performance mesh node for providing broadband access in poorly connected areas in South Africa). The motivation was that the addition of TV spectrum radios would provide better coverage and radio propagation than the HPN in areas where topology or foliage or structures would have led to extra mesh nodes to provide a link and hence additional cost.

2016: Programmable Network Interface Unit (CSIR)
David Johnson, Carel Kruger, Ronel Smith

The Programmable Network Interface Unit (PNIU) is visualised as a "black box" that once introduced into a network has the ability to adapt to the network service and functional requirement as it evolves. The concept has its origin in the need to have functionality in the health connectivity reference network which can firstly be used to monitor the various service providers and secondly be flexible enough to adapt to the migration over time of the network from the current public internet-like network to a future more secure government network (or parts thereof). The PNIU could also form the basis of a monitoring and measurement tool for SA Connect.

The PNIU is a low cost, robust, highly configurable edge device with a strong network management and monitoring capability. The PNIU is low cost as it uses a generic low cost router platform re-programmed with enhanced architecture and software. It is a robust and highly configureable edge device with a strong network management and monitoring capability typically associated with much higher priced products.

2017: TVWS test and measurement laboratory TD (CSIR)
Albert Lysko, Mofolo Mofolo, Ntsibane Ntlatlapa, Fisseha Mekuria, Moshe Masonta, Luzango Mfupe, Kobus Roux, David Johnson

This technology demonstrator (TD) submission overviews a television white spaces (TVWS) laboratory setup including the setups devised/produced and methodology developed for laboratory testing of television white space (TVWS) devices. The submission also reviews how this set of processes and technology are able to reliably determine operational limits and detect faults in TVWS devices. This information is critical when deploying these devices in wireless networks where interference to primary users and the devices themselves needs to be controlled and performance needs to be maximized.

The regulations require that any radio technology is carefully tested prior to operation. TVWS is a new and highly complex and integrated technology which permits sharing of radio frequency spectrum dynamically, without causing interference to existing/primary users. It promises significant (up to 16 times, as compared to 2.4 GHz WiFi) reduction in costs for both infrastructure and licensing, with predicted long term economic impact in tens to hundreds of billions of Rands.

Popular media

2007: BBC Click: Programme on Peebles valley mesh

2008: SABC Knock knock III Episode 3:documentary on the Cantenna
https://www.youtube.com/watch?v=Wm-qy88fjQM&list=UURC8aeiRU6AA5S6wak7U2AA

2008: CSIR Science Scope March 2008: Simulating a wireless solution for rural areas
http://www.csir.co.za/enews/2008_mar/pdfs/ScienceScope_platforms.pdf

2011: UCSB newspaper "Daily Nexus": article on Zambian VillageNet project
http://dailynexus.com/2011-11-14/internet-rural-african-life/

2011: UCSB Convergence magazine article on Zambian VillageNet project
http://convergence.ucsb.edu/article/bridging-digital-divide

2012: IEEE Spectrum Magazine article by D.L. Johnson, C. Mikeka, "Malawi and South Africa pioneer unused TV frequencies for rural broadband", IEEE Spectrum, September 2016
http://spectrum.ieee.org/telecom/internet/malawi-and-south-africa-pioneer-unused-tv-frequencies-for-rural-broadband

Invited talks

- 2004: National: Guest lecture on Bluetooth for post-graduate course on network security at University of Pretoria
- 2004: National: Guest lecture on Bluetooth for wireless symposium at Tshwane University of Technology
- 2004: National: Guest lecture on WiFi for wireless symposium at Tshwane University of Technology
- 2007: Califronia - Nokia USA, UCSB, UCSC, UCDavis: A presentation tour of California on the South African Wireless Africa programme on mesh networking
- 2008: Wireless community linkup: presentation on overview of mesh networking to Meraka to Wireless User Groups.
- 2009: National: Investing In ICTs For Emerging Markets Summit (couldn't present due to being in the USA)
- 2011: California - UCSB: Presentation to undergraduates on Engineering for Social Change
- 2013: Malawi – Africomm: Presentation of White Space communication - current research and trials and future outlook for Africa.
- 2015: London – ACMDEV, Presentation on TV White Spaces in South Africa,

External examiner or Research rating review

- 2008: Masters Thesis by Kevin Duff at Rhodes University
- 2008-2013: Examiner for a number of undergraduate computer science courses at UCSB
- 2014: Reviewed National Research Foundation application for a research rating in Computer Science
- 2015: PhD Thesis: Performance evaluation of Low Cost Smart Mesh Networks

Student supervision and mentoring

- 2005-2008: Co-supervised 4 masters students and 2 PhD students registered at South African universities while leading the Wireless Africa research programme
- 2008-2012: Co-supervised 3 masters students registered at University of California, Santa Barbara while completing my PhD at UCSB
- 2015-2017: Supervising 4 PhD students, 1 Masters student on TV White space mesh networks, mobile phone data usage and localized clouds at UCT. I also hired a Post-Doc at UCT to work on TV white spaces and channel selection strategies.

Serving on steering committees and TPCs

- Sweden: ExtremeCom 2009 Technical programme committee
- France: Mobile and Wireless Networks Security (MWNS) 2009.
- Zambia: Africon 2011 - co-organized a special session on cognitive radio at Africon 2011, the first research forum on the topic in Africa – two of the papers submitted to the session received "the best paper" award at Africon 2011
- London: ACMDEV Technical Programme Committee 2015
- Cotonou, Benin: Africomm Steering committee 2015
- Addis Ababa, Ethiopia: Africon Technical Programme Committee 2015
- ACMDEV Technical Programme Committee 2016
- GAIA workshop Technical Programme Committee 2016
- ICTD Technical Programme Committee 2017
- ACM COMPASS Technical Programme Committee 2018

Contributing to standards

- Contributing author for IETF Global Access to the Internet for All Internet Draft, http://www.ietf.org/id/draft-manyfolks-gaia-community-networks-02.txt

Influencing trends in R&D and policy at a national level (South Africa)

Between 2004 and 2007, I was a key initiator of wireless mesh networking research and development in Meraka and amongst other SA Universities. My early research and trials and experiments with mesh networking protocols eventually became part of the mesh networking devices that are used in many national level projects such as the BB4All project. Through our studentship programme with Tshane University of Technology, University of Johannesburg, Rhodes University, University of Zululand and University of Pretoria, I was able guide many students on mesh networking topics and provide research leadership for University programmes around the country interested in mesh network research; many of these programs continue today.

Between 2013 and 2015 I was a key contributor to the broadband expansion strategies in South Africa for the Eastern Cape province and for the country as a whole. My role was to come up with innovative ways to expand fibre and wireless networks to all public facilities (schools, clinics, libraries etc.) in the country to match the National Broadband targets, where all public facilities are connected by 2020.

In 2016 I wrote a position document, "Dynamic Spectrum Access Innovation to lower the cost of Access" for the Parliaments Portfolio Committee on Telecommunications and Postal Services in response to a call for submissions on the Cost to Communicate in South Africa[3].

In 2017 I led the development of a spectrum and capacity model for a study on high demand spectrum in the Wireless Open Access Network for the Department of Telecommunications and Postal Services.

Leading formation of R&D strategies

In 2007, I oversaw the development of a 3 year research and development road map for wireless mesh networking research that was be undertaken by researchers and developers in the Wireless Africa programme of Meraka. In 2012 I developed the strategy for a new research group, "Cognitive Radios for Emerging Regions" in the Networks and Media competency area of Meraka.

At UCSB I contributed much of the technical content for a large $1.2 million multidisciplinary research grant that spanned computer science and media studies. I also played a key leadership role in providing a bridge between UCSB and a trial rural network in Zambia – facilitating the complex interplay of culture and technology in the project.

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3 https://people.cs.uct.ac.za/~djohnson/Files/DSA_parliament.pdf

Teaching experience

Visiting lectures given at South African Universities

- **2004**: Bluetooth lecture for post-graduate course on network security at University of Pretoria
- **2004**: Bluetooth lecture for wireless symposium at Tshwane University of Technology
- **2004**: Wifi lecture for wireless symposium at Tshwane University of Technology

Course presented at Meraka Institute

- **2005**: uClinux (embedded linux) course
    - Day 1: Survey of embedded operating systems - why uClinux, The uclinux environment - the directory structure
    - Day 2: Using the configuration tools for the kernel and user applications, Adding user application to uClinux
    - Day 3: The cross compiling tool chain (gcc, as, ld, objdump, objcopy), Memory architecture of the arm7tdmi processor - configuring uclinux for the arm
    - Day 4: To "Boot loader" or not to "Boot loader, Hardware access and device drivers
    - Day 5: Debugging applications with gdb, Downloading applications to the development kit using JTAG

- **2007**: How to build a Mesh network - Training for Linknet Zambia - DIY guide on which training was based is available here.

- **2009**: Indoor massive mesh network and Click router tutorial
    - Day 1: Learning the massive mesh lab toolset
    - Day 2: The click modular router

- **2011**: 8 week course on Unix C/++ programming
    - Week 1: C: Formatting output, constants, functions, scope
    - Week 2: C: Compile, link and make, C pointers
    - Week 3: C: Parameter passing, allocating memory, pointers to pointers and arrays of pointers
    - Week 4: C: Line input and output, structures and unions, library functions
    - Week 5: C++: Namespace, new constants, casting, default function arguments, reference variables,
    - Week 6: C++: Dynamic memory Formatting, Arrays, C++ structures, Classes
    - Week 7: C++: Constructors, Destructors, 'this' object
    - Week 8: C++: Inheritance, Static members, Friends, exceptions, function overloading, operator overloading

Courses presented at University of Cape Town

- **2015**: 3rd quarter honours course on Networking for Development:

    - This course will introduced students to the challenges of building computer networks in developing regions and worked through novel networking solutions used over the past decade to overcome these challenges. The content involved:

- Framing the problem of Networks in developing regions (Constraints in developing regions (Environmental, infrastructural constraints, regulatory, cultural, economic, political, language, technical)

- Connectivity options for developing region (Wireless Mesh networks, TV white spaces, community GSM networks, delay tolerant networks)

- Network performance, Traffic analysis and network maintenance in developing regions

- Network architecture options for developing regions (networks acceleration techniques, smart caching, co-located sharing)

- Case studies of design, usage and performance of networks in developing regions (BB4All project, VillageTelco project)

- **2016**: 2nd quarter honours course on Networking for Development:

Teaching assistant for at UCSB. *(This involves, giving tutorials, marking assignments and answering student questions during allocated office hours)*

- **Fall 2008: CS12**: Programming Methods in C: Introduction to the UNIX system, C programming language, and data structures. Topics include: introduction to the UNIX system, C shell and shell scripts; UNIX file system and utilities; stacks, queues, lists, and trees

- **Spring 2009: CS130A**: Data Structures and Algorithms I: The study of data structures and their applications. Correctness proofs and techniques for the design of correct programs. Internal and external searching. Hashing and height balanced trees. Analysis of sorting algorithms. Memory management. Graph traversal techniques and their applications

- **Fall 2009: CS60**: Introduction to C, C++, and UNIX: Advanced topics in object-oriented computing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging; recent advances in design and development tools, practices, libraries, and operating system support.

- **Spring 2010: CS40**: Introduction to the theoretical underpinnings of computer science. Topics include propositional predicate logic, set theory, functions and relations, counting, mathematical induction and recursion (generating functions).

Relevant Project experience listed chronologically

1996:Software metrics	Built a software metric analysis tool
1997-1998:Investment Process Tool	Designed and Rolled out a 3 tier Client/Server Financial Application to allow Corporate to manage their government funding more effectively
1998:Production Planning	Created software to optimise production planning in Sawmills using linear

	programming
1999:Radio coverage measurements	Carried out Radio Coverage Measurement and planning work for 3rd Cellular Operator equipment suppliers (Lucent and Nokia) and for a SCADA systems in South Africa
1999:MTN measurement vehicle software	Designed and implemented a Measurement Vehicle software system for use in CSIR's radio coverage vehicle and 2nd Cellular Operator's vehicle
1999: Low altitude communication platforms	Assisted in the feasibility study of using a low altitude communications platform in South Africa.
1999:Baby monitoring RF tags	Involved in embedded programming for RF tags and control software for a RF track and trace system
2000:Language interpretation call center	Assisted in technical study of Call Centre technology for a language interpretation service
2000:Vodacom spectral efficiency study	Designed Spectral efficiency measurement methodology and Analysed Spectral efficiency and Capacity of the 1st cellular network operator in South Africa and compared this with other operators in Europe for use in a court case to obtain a license to operate in the GSM1800 band.
2000:GSM heart rate monitoring	Designed a remote heart rate monitoring system using a GSM modem, a Polar heart rate pickup and a micro-controller.
2000-2001:Bluetooth mortar firing system	Designed an embedded multiple slave Bluetooth radio network for controlling a mortar firing system. Cambridge Silicon Radio Bluetooth radio modules were used using Bluelab 2.0.
2000:Bluetooth HF radio audio gateway	Built a bluetooth audio gateway for an HF radio to enable voice communications to a standard commercial bluetooth headset
2001:Bluetooth voting system	Wrote the concept for a bluetooth voting system which allows 255 keypad devices to wirelessly connect and send a keypress to a Central PC
2000:2001Bluetooth access point	Designed a bluetooth access point using an open source embedded operating system (uC-linux some experience in eCos), open source bluetooth stack (AXIS), ARM7TDMI microprocessor,

	CSR bluetooth module and Linux Gnu toolchain.
2001:GSM tracking system for skiing and cycling	Designed a tracking system for tracking outdoor adventure sports using a GSM modem, a GPS and a micro-controller. Implemented the entire embedded C code for the micro-controller to respond to SMS requests and other inputs. This was used for the Argus cycle tour in 2001
2001:Cricket Bluetooth heart rate monitoring	Designed a heartrate over Bluetooth system which was used by the Supersport for the 20/20 cricket series in April 2004
2002:Dumelang (assistive communication device)	Contributed to the Bluetooth component of an augmentative communication device for the speech impaired.
2002:Bluetooth and WiFi course	Presented courses on Bluetooth and WiFi at Tshwane University of Technology, University of Pretoria and a Telecommunications workshop
2003:WiFi security project	This project aimed at attempting to hack into WiFi-based wireless networks and Bluetooth-enabled phones and also look at mechanisms to protect the network. I was particularly involved in a solution for a laptop which shut itself down if a wireless network was activated without proper authorization.
2003:Embedded linux course	Presented a 3 day course on uClinux, an embedded linux operating system, to CSIR staff.
2004-2008:Government research project on seeding critical mass research in wireless networking – Wireless Africa	Helped define and manage research activities for a 3 year research project around building a critical mass research group around wireless networking.
2004-2007:First mile first inch project	Providing technical leadership for a mesh networking sub-project in an IDRC funded project called the "First Mile First Inch" projects which looks at sustainable connectivity solutions for rural areas around Africa.
2004-2007:Community owned wireless networking testbeds	Developed and installed a wireless mesh testbed network across Pretoria East to test various ipv6-based mesh networking protocols and applications. Installed a Africa's first rural wireless mesh testbed in Peebles valley near white river in Mpumalanga with the view of this eventually becoming a self-sustaining

	network.
2006-2007:Indoor massive mesh	Developed a 7x7 grid indoor wireless grid for carrying out mesh networking protocol benchmarks. This includes building netboot kernels, setting up boot up scripts and various perl scrips to run wireless experiments and designing the lab architecture which allowed full remote control of all 49 wireless-enabled computers.
2006: Ipv6 network conversion on experimental city mesh network	Wrote embedded code on OpenWRT (Linux-based) Linksys wireless routers to enable Ipv6 to run on an experiential city wireless mesh network. This included tasks like setting up Auto IP configuration scripts, Ipv4 over Ipv6 tunneling.
2007:Bandwidth management tool	Wrote a bandwidth management tool for a Linksys WRT54G which allows mesh gateway provider sub-cap each user on the network. This is especially useful when connecting a mesh to an expensive Internet connection using satellite in a rural area.
2007:Strategic Resource Programme funding proposal on energy efficient mesh networks	Together with 2 other senior researchers, wrote a R6 million Rand research proposal on how build energy efficiency into wireless mesh networks. This includes everything from smart antennas to improved mesh routing protocols.
2007: 3 year research and development road map for Mesh networking	Using a series of strategy sessions I led a process to develop a road map for all the future mesh networking research and development in the Wireless Africa Research and Development group in Meraka over a 3 year period.
2007: DIY mesh network guide	Based on experiences in deploying mesh networks in rural regions, we wrote a DIY guide on installing and operating mesh networks for other communities around the world to use. The book was published online using a creative commons license. Many users from around the world have commented on its usefulness and provided valuable feedback.
2008: Gateway aware routing extension to BATMAN mesh protocol	As part of a UCSB course project, extensions were added to the popular BATMAN mesh protocol

2009: Spectrum auction system	As part of a UCSB course project, I built a micro spectrum auctioning concept for accessing wireless spectrum on a short-term basis.
2009: Music coach for smart phones	Music coaching software developed for a Nokia smart phone which does pitch and rhythm recognition in order to evaluate a musical performance of a musician – the code is available online on google code.
2010-2011: Rural network traffic analysis	Carried out network traffic analysis of a rural network providing Internet to 300 users in Macha, Zambia. This included URL analysis, mesh network performance, diurnal network patterns and network anomalies such as time-outs. This work was published in 2 conference papers and 1 journal paper.
2011: Locality of Interest and instant message topic extraction in rural networks	Analyzed the degree of local traffic in a rural network in Macha, Zambia. Making use of Facebook Online social network traffic, the amount of instant message traffic sent between two local users was extracted as well the the degree locally generated images shared between local users. Data mining techniques were also used to extract topics in instant message conversations. This work was published in 1 conference paper and 1 journal paper.
2010: NSF proposal on VillageNet (Funded in 2011)	Helped write technical sections of a $1.2 million NSF proposal called VillageNet on networking solutions for rural regions. The project consisted of 3 component sub-projects: VillageLink, a white space network for rural regions, VillageCell, A local low-cost GSM solution, and VillageShare. an application that facilitates local file sharing amongst local users.
2010: Inexpensive spectrum monitoring platform	Made use of low-cost Ettus USRP software-defined radios to build an inexpensive spectrum monitoring system. This was submitted and accepted as a CSIR technology demonstrator in December 2010.
2011: White space Spectrum scans in USA and Southern Africa	Making use of the inexpensive spectrum monitoring platform, spectrum scans in urban and rural areas of California as well as urban and rural areas of South Africa and Zambia where carried out to check the amount of available white space

	spectrum in these areas. This work was published in 1 conference paper.
2011: VillageShare (deployed in 2012)	VillageShare was developed to facilitate content sharing between local users without using the slow, expensive Internet gateway. The system was built using a Facebook component and a local cloud computing platform. This system was deployed and tested in Macha, Zambia in July 2012. This work was published in 2 conference papers.
2011: VillageLink	An extension to the 802.22 white space protocol was developed to enable white space radios to make use of channel sounding across the white space frequency range to check the effect of the environment on the channel at different TV frequencies as well as the degree of interference between white space radios. Gibbs sampling was used to allocate channels which maximize the quality of the channel to clients but minimize the interference between white space base stations. This work was published in 1 conference paper.
2011: Indoor cognitive radio test bed	A set of 4 USRP software defined radios and associated PC with GnuRadio software were configured and deployed in the Meraka building and UCSB. These two test beds were identical which allowed researchers to easily collaborate between South Africa and the USA.
2011: Outdoor cognitive radio test bed	USRP radios were connected to standard TV antennas and a 3km link was built between the CSIR and a home in the East of Pretoria. This link was used to test various channel sounding ideas and digital communication building blocks that form part of VillageLink.
2011: Auto-scaling and cloud bursting service	An extension to Eucalyptus – a local cloud hosting service – was built to automatically instantiate new virtual machines when thresholds are reached on specific resources such as memory or CPU usage. Once all local resources are used up, the auto-scaling engine can instantiate VM instances on the Amazon EC2 commercial service.
2012: VillageCell (deployed in 2012)	VillageCell enables free low-cost local cellular access for rural villages. It makes

	use of an open source GSM stack – OpenBTS as well as an open source switch – called FreeSwitch. A instant message to SMS extension was added to these exisiting building blocks. Two base stations interconnected with an exisiting WiFi network were deployed in Macha, Zambia in July 2012. This work was published in 2 conference papers.
2013: Smart antenna for mesh networks	Contributed to developing a set of mesh networking experiments to test the performance of a WiFi smart antenna for mesh networks. The output of this project was a technology demonstrator: Submitted and accepted as a technology demonstrator in March
2014-16: White Space High Performance Mesh Node	The White Space Mesh Node (WSMN) makes use of hybrid set of radios (TV White Space and WiFi radios), to provide a wireless backhaul mesh network as well as a local WiFi access networks. The WSMN makes use of a combination of a Geo-location Spectrum Database (GLSD) as well as spectrum sensing (using a low cost built-in spectrum analyzer) to select an optimal TV white space channel to operate on. The mesh protocol makes use of a link metric to switch between a 5GHz WiFi radio link and the TVWS link for optimal routing of traffic.
2014-15: Eastern Cape broadband plan	Wrote portion of the broadband plan which summarizes the current state of broadband in the province using GIS maps. Wrote algorithms to calculate optimal fibre routes to provide broadband connectivity to public facilities in the Eastern Cape province. Wrote conversion routines that converted raw Geo-referenced, statistical census data and raster maps into GIS shapefile format.
2015-16: Programmable Network Interface Unit	The PNIU is a low cost, robust, highly configurable edge device with a strong network management and monitoring capability typically associated with much higher priced products. The PNIU is low cost as it uses a generic low cost router platform re-programmed with enhanced architecture and software.

2016: TV White Space regulation	Contributed to the development of a draft position paper on TV White Space regulation in South Africa. My contribution involved analysing industries technical and legal concerns and providing rebuttals to arguments against the use of TV white spaces.
2017: Wireless Open Access Network	Developed models to calculate total and average user capacity for LTE-A in the 700,800,2600 MHz bands if all available spectrum is used. Also developed models to calculate spectrum required in these bands to meet SA connect 2020 and 2030 targets. Recommendations with a number of scenarios where written up in a report to Department of Telecommunications and Postal Services.
2018: Low cost spectrum analyzer	Developed a low cost outdoor pole-mounted spectrum analyser using a raspberry PI and a LimeSDR to remotely monitor spectrum from 100 kHz to 3.8 GHz. The device is remotely controllable using MQTT and sends back scans to a central server at regulator intervals.

Training History

Courses taken after Undergraduate degree

Private courses

1998

- C++ and object oriented programming course

Courses for Masters at University of Pretoria

2003:

- ERS280: Software Management and economics

2004:

- ERN270: Computer Networks
- ENA732: Research Methodology

2005:

- ERV780: Advanced Microprocessor system design

Courses for PhD at UCSB

Fall 2008:

- CS276: Advanced Topics in Networking
  - *Project: Devising a gateway location metric for B.A.T.M.A.N in rural areas*
- CS279: Advanced Topics in Security
- CS595n: Seminar on social computing
  - Talk: Reflection on ICT projects in rural areas
- CS501: Techniques of Computer Science Teaching:

Spring 2009:

- CS270F: Cognitive wirelss networking, strategy, economics and social behaviors
  - *Project: An online spectrum auction system, bridging the implementation gap*
- CS230: Approximations, NP-Completeness and Algorithms

Fall 2009:

- CS225: Information Theory
  - *Final paper: Network Information theory for a multi-node network*
- CS290I: Multimodal Interaction on Mobile Computing Platforms
  - Project: Musiccoach - Realtime evaluation of music performance
    - Final paper
    - Final presentation
    - Code

Winter 2010:

- CS290F: Networking for Multimedia
  - Project: Internet usage and performance analysis of a rural wireless network in Macha, Zambia

Spring 2011:

- CS290D: Advanced Data Mining Techniques
  - *Final project: Instant Message locality and topic extraction in rural networks*

Fall 2011:

- CS290C: Virtualization and Cloud Computing Technologies
  - Project presentation: Auto-scaling and cloud bursting service for Eucalyptus

Skills Inventory

Keywords: Mesh networking, rural networks, cloud computing, embedded programming, software defined radios, TV white spaces, GIS, digital communication, RF engineering

Leadership skills	Managing small research/development teams (< 8 staff/students) Road mapping workshops Leading research/development projects (University / CSIR)

Operating Systems (Strongest skills and preferred OS shown in bold)	Embedded operating systems (uclinux, ECos, **OpenWRT**) DOS Windows XP,2000/98/95 Windows CE Mac OS **Linux** FreeBSD
Database Management Systems	Oracle MySQL
Cloud Computing	Eucalyptus Amazon EC2
Programming Languages	Apple][Applesoft Basic (Back in the 80s) 6502 machine language (Back in the 80s) Visual Basic C/C++ (mostly Gnu C/C++ for Linux but historically Borland C++) Qt graphics development PIC C Perl scripting Shell scripting Python
Packaged Application Software	Orcad circuit board layout tool Radio mobile radio planning tool Matlab mathematical modeling tool Eucalyptus cloud computing software GnuRadio for software defined radios
GIS Software	ArcGis Grass Python for GIS
Simulation tools	NS2 network simulator Omnet++ network simulator Click network protocol/routing tool
Communication protocols	GSM (SMS, GPRS, AT command sets) Bluetooth (taught courses on Bluetooth) WiFi (802.11 a/b/g/n) TV White spaces/ Cognitive radios TCP/IP networking Mesh/ad-hoc networking protocols (Masters on mesh networks)

RF engineering	Radio propagation prediction Building software that interfaces with scientific instruments Software defined radio with Gnuradio on USRPs

Hobbies and interests

Windsurfing, Mountain Biking, Rock climbing, Hiking, Photography, Making movies - especially comedies, Music (Playing various instruments Piano, Cello, pennywhistles, recorders, melodicas), Landscaping, Building and house restoration, Vintage computers, Community owned wireless networks, Collecting and restoring old cars – especially Volkswagens.