

Institution: Lancaster University		
Unit of Assessment: 11 Computer Science and Informatics		
Title of case study: Transforming communities and enriching lives: broadband connectivity for rural areas in the UK and abroad		
Period when the underpinning research was undertaken: 2003 onwards		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Nicholas Race	Professor of Networked Systems	01/07/96 - present
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? N		
<p>1. Summary of the impact</p> <p>Research led by Professor Nicholas Race of Lancaster University has resulted in the creation of a rural community broadband network called B4RN (Broadband for the Rural North) that is leading the way on last-mile rural broadband coverage in the North West. Founded in 2013, this network is now a registered non-profit community benefit society and has witnessed exponential growth in recent years. From its origins in the small village of Wray, Lancashire, it now connects 7,000 properties in over 90 parishes, across an area of 3,500 square kilometres in the North West of England and beyond. It is a multi-million-pound community enterprise, comprising 2,300 shareholders, investments totalling over GBP5million (December 2020), and a net income of GBP2million in 2019/20. It now provides reliable and fast broadband to isolated rural communities across the UK, and has brought about a range of economic, social, educational and health benefits to local businesses, residents and communities.</p> <p>Its success has inspired similar models nationally and internationally, and it has been heralded by the UK government and European Union as a good-practice model for community empowerment and investment projects. From jobs to health and well-being to education to a newfound sense of 'belonging,' residents of these communities and those that serve them have reported that their lives have been 'transformed.'</p>		
<p>2. Underpinning research</p> <p>Deployment of broadband services in the UK in the early 2000s, delivered through a few large commercial organisations such as BT and Virgin Media, was naturally focused on areas of high population density offering the greatest commercial incentives. The resulting 'digital divide' between urban and rural meant that in cities and towns access to the Internet was fast and always-on, whereas in rural areas it was either impossible or extremely slow through dial-up connections, degrading both social communication and business advancement. Concerned about the impact on their community, the villagers of Wray (pop. 532, 2011), around 10 miles from Lancaster, approached the University to see if they could find a way to deliver Internet access to their area. This challenge needed a completely new approach, leading Professor Race to establish the Wray Broadband Project in 2003 to explore research issues and address key barriers around 'community broadband' that would ultimately empower such communities to build and operate their own networks.</p> <p>Over a 10-year period, Wray established itself as a 'living laboratory' for the exploration of technical and social challenges associated with building and operating community networks. Race's early research addressed issues with designing and building the underlying broadband network built on 'Wireless Mesh Network' (WMN) technology, a low-cost infrastructure through which devices could communicate and allow an Internet service to be shared more widely [3.2]. The community were supplied with a selection of wireless network 'meshboxes' that they would then organise as a community to deploy in households throughout the village in such a way that they could then communicate with one another to provide coverage across the village. One of the key findings of this initial deployment was to debunk the prevalent theory that WMNs were 'dynamically self-organized and self-configured'; Lancaster's analysis of the performance of the network showed that suboptimal choices in hardware placement and software-based gateway selection could result in erratic performance. However, in overcoming these initial challenges</p>		

Race's research empowered the community to expand the network coverage within Wray and conduct a second deployment into the neighbouring area of Wennington.

The phenomenal uptake in the use of the Wray community network would go on to highlight further issues around network capacity and security. In addressing the former, Race's research would establish the importance of symmetric network connections to enable future services, such as IPTV (Internet Protocol TV), which would be trialled within the village [3.5]. To address the latter, Race would investigate security issues within the community [3.4] and develop a lightweight intrusion detection system [3.3]. This was the first research to consider security from a community network perspective: the challenge being that these networks had limited resources, thereby ruling out commonly used deep packet inspection techniques.

Alongside the technical research contributions, the research in Wray uncovered important societal benefits as documented in Race's initial deployment paper [3.2]. One of the early findings was that the very *deployment* of the community network became a focus for the village, bringing residents together. The network would then go on to be used to support a range of new services [3.1], alongside supporting the villagers to live better lives: from the farming community registering cattle online, to villagers using web cameras to support elderly relatives. It would be these findings, alongside the technical contributions, that would highlight that not only is it possible for communities to *deploy* networks themselves but that these networks offered a range of societal benefits that continue to be relevant to this day.

The Wray project revealed the latent power and potential of communities working together to build their own network infrastructure [3.2]. This has proven fundamental to the creation and development of B4RN [5.1a and b].

3. References to the research

- 3.1. Probing Communities: Study of a Village Photo Display. **Taylor, N., Cheverst, K., Fitton, D., Race, N., Rouncefield, M., and Graham, C.,** *OZCHI '07 Proceedings of the 19th Australasian conference on Computer-Human Interaction: Entertaining User Interfaces*. 2007. p. 17-24. DOI: 10.1145/1324892.1324896
- 3.2. Deploying rural community wireless mesh networks. / **Ishmael, J., Bury, S.,** Pezaros, D., and **Race, N.,** *IEEE Internet Computing*, Vol. 12, No. 4, (07.2008), p. 22-29. DOI: 10.1109/MIC.2008.76
- 3.3. OpenLIDS: a lightweight intrusion detection system for wireless mesh networks. Hugelshofer, F., Smith, P., Hutchison, D., and **Race, N.,** *Proceedings of the 15th Annual International Conference on Mobile Computing and Networking (MobiCom 2009)*. New York: ACM, (2009) pp. 309-320. DOI: 10.1145/1614320.1614355
- 3.4. Designing for social interaction with mundane technologies: issues of security and trust. **Bury, Sa., Ishmael, J., Race, N.,** Smith, P., *Personal and Ubiquitous Computing*, Vol. 14, No. 3, 04.2010, p. 227-236. DOI: 10.1007/s00779-009-0257-0
- 3.5. P2P-Based IPTV Services: Design, Deployment, and QoE Measurement. **Mu, Mu, Ishmael, J., Knowles, W., Rouncefield, M., Race, N., Stuart, M., Wright, G.,** *IEEE Transactions on Multimedia*, Vol. 14, No. 6, (01.12.2012), pp. 1515-1527. DOI: 10.1109/TMM.2012.2217119

Grants:

- [G.1] Towards Robust Attack Detection in Wireless Mesh Networks, EPSRC, EP/F038496/1, November 2007 – March 2008, GBP20,906
- [G.2] P2P-Next, EU FP7, January 2008 – April 2012, GBP832,468
- [G.3] DART: Digital Advanced Rural Testbed, Technology Strategy Board, GBP14,000
- [G.4] Telling Tales of Engagement: The Wray Broadband Project, June 2012 – March 2013, GBP10,000

4. Details of the impact

Lancaster's research led to the first wireless broadband service to a UK rural village in 2003, and the first high-speed broadband service to the same village, in 2010. The Wray Broadband Project went on to achieve significant attention (**BBC, Countryfile, One Show, and the Guardian**) and recognition (**Queen's Anniversary Prize, EPSRC Telling Tales of Engagement Prize**). The impact has gone beyond internet connectivity for homes and farms in the rural North West of England, to cover thousands of properties across extended areas of England, Northern Ireland, and Wales, and has been imitated in other regions and countries,

nationally and internationally. As Barry Forde MBE, CEO of B4RN has said of the contribution made by the Wray project to the early conception and subsequent success of B4RN: *“The research carried out by Lancaster University within Wray showed how communities could deploy technology in such a way that they were no longer dependent upon public assets for the realisation of broadband services. It also, critically, demonstrated the importance of community engagement and mobilisation – these were the differentiators that enabled connectivity to become affordable. This was a step change. For the first time, the Wray Broadband Project revealed how communities could be empowered to share, install and manage their own network infrastructure”* [5.1a]. While co-founder, activist and volunteer, Chris Condor MBE, has stated that *“None of this (B4RN’s success) would have been possible without Professor Race and his team whose research developed the underpinning ethos of community involvement that B4RN relies upon, as well as investigating possible technologies to use”* [5.1b].

4.1 Impact on rural communities in the North West of England B4RN and the expansion of community network provision

Adapting the lessons learned in the Wray project, Barry Forde, Chris Condor, and a small team of volunteers began to expand this community-orientated approach to neighbouring villages and localities in Lancashire and West Yorkshire, and in 2013, registered B4RN (Broadband for the Rural North) as a company with the goal of achieving better connectivity for hundreds of communities and thousands of homes. As Barry Forde describes: *“B4RN emerged organically from the learning that was embodied in the Wray project which had opened our eyes to the latent power and potential of communities working together to build, operate and own their own networks. We also learned that the only way to deliver future proof technology at scale was by fibre”* [5.1a]. Following their 1,000th property connection in 2015, they received a visit from **HRH The Prince of Wales** and subsequently **both directors received MBEs in the 2015 Queen’s Birthday Honours**.

The B4RN network has proven to be not only innovative, but also a commercially sustainable business model for the implementation of enhanced broadband connectivity for areas and communities deemed outside the margins for profitability and accessibility by large internet providers. 2013 was the first year B4RN made significant impact, when it connected its first 300 properties, since then it has continued to grow exponentially. [5.4b] By the end of February 2019, for example, the B4RN network had expanded to **79 parish** communities covering **nearly 1,800 km²** with **5,300 connected properties**. On average, each community has achieved a **65% uptake** with the total number increasing at the rate of around **150 new connections per month**. By the close of 2020, B4RN’s coverage had expanded to over **90 parishes**, covering an estimated **3,500 km²**, and connecting **7,000 properties** in total. Local communities have invested a total of **GBP5million** in B4RN’s shares and loans, with over **2,300 shareholders** in B4RN, **60 members of staff** and boasts a **net income of GBP2million** [5.1a]. Their aim is to reach another 13,000 properties by 2021, to increase their footprint to 25,000 properties, and by 2025 to increase that footprint to over 100,000 properties with an annual turnover of GBP9-12million [5.2] and [5.1a].

4.2 Empowering communities and improving lives

The enhanced internet provision and community-orientated approach, pioneered by Race and colleagues through their research, has led to significant impact on communities and individuals that may not otherwise have happened, given the neglect of isolated rural areas by successive governments and internet providers. The benefits have been wide-ranging: to the economy, to education, to health and well-being, and to society.

Economic benefits and commercial opportunities: Enhanced internet speeds have benefited local businesses and made rural communities a more attractive place for investment. Cllr Stewart Young, Leader of Cumbria County Council, commented: *“Groups such as B4RN are playing a vital role supporting business and residents in rural communities to gain access to high-speed, affordable and reliable digital connectivity”* [5.4b]. B4RN enabled a seamless switch to homeworking in March 2020, but even before, its overall benefit to those who work whilst living in rural communities was apparent. A publisher and events promoter commented: *“Thanks to a fast broadband connection I have moved my whole network on to a Cloud based server. This is not only much faster and saves many hours of waiting for downloads, uploads, and connections, but it allows for the digital distribution of products, and sharing of folders, which is*

more secure, more efficient, and more convenient. B4RN has transformed our business” [5.3]. Traditional rural businesses have also benefitted. A locum veterinary surgeon cited the advantages of being able to upload and download information without buffering and at lightning speed. *“Veterinary telemedicine is in its infancy. Now we have a B4RN connection, online triage with photos/videos and advice is going to be feasible and possible.”* A local milkman stated, *“The internet (B4RN) has been fast and reliable, which the old connection wasn’t, and this has helped massively with keeping up with the changing needs of our customers.”* Small village shops have long been under threat and a shop owner commented that B4RN had enabled them to maintain contact with staff and customers and crucially to develop online sales and keep an income stream during COVID-19 restrictions [5.3].

Education: Improved speed and reliability of Internet access enables learning across the lifespan and is particularly beneficial for school-aged children. In April 2020, a partnership between B4RN and Zykel Communications brought ultra-fast broadband to 21 primary schools in the rural north of England [5.4c] enabling them to make use of the latest education technology and software, whilst teachers and students complete work online, attend virtual events, seminars, and workshops, and make use of cloud-based resources for the first time. This proved invaluable during the COVID-19 pandemic; one parent stated that without B4RN, online schooling would have been impossible during 2020. *“Our B4RN connection was activated part way through lock down, prior to this my son wasn’t able to complete his maths tasks as the internet connection was too slow, his teacher was having to screenshot the questions and email them over to me so I could print them off. Since then, they have given my son online video literacy lessons to follow also, we physically would not have been able to do these on the previous connection.”* A teacher added: *“Having a flawless connection has meant online lessons are much less stressful, downloading work and uploading resources has been seamless and some of the material is enormous!” [5.3]*

Health and Well-being: A strong factor in the initial desire to improve internet connectivity was the need to improve the provision of health and social services, making use of video calls, online prescriptions, and access to online information, which helped support the work of community health professionals. Commenting on the B4RN connection, a clinical lead for intensive care stated. *“It has allowed us to work at home when appropriate but still maintain good quality work and information from patient records and particularly scans (which are data heavy) as well as important remote meetings with colleagues locally, nationally and internationally in ensuring the best clinical advice, management and latest information for managing COVID and other conditions. It has been so important to us that we had access to the most up to date publications and research mostly only accessible online and with fast, reliable access” [5.3].*

Social cohesion: Access to better internet has helped improve social cohesion in rural areas, particularly for those who struggle with mobility or who live in remote locations. Vulnerable people are able to remain in touch with loved ones, neighbours, care workers and public services. The process of implementing B4RN reinvigorated and regenerated communities, alleviating loneliness and isolation, as its deployment depends on leveraging a community effort to make it affordable. Volunteers must acquire the skills to map the proposed coverage area, secure permissions to access neighbour’s land and create trenches to lay the plastic ducting, which holds fibre-optic cabling. Community fundraising drives, ‘dig days’, splicing and fusing sessions are an essential requirement. One volunteer said: *“We didn’t just build the network; we own it and the core of volunteers working around each B4RN community champion quickly become local heroes. It has brought life and engagement back to our community. We know everyone again.”* She goes on to state that *“the main benefit is not really gigabit speeds. It is the community” [5.4a].* In response to COVID-19, B4RN facilitated the formation of volunteer support networks in isolated rural locations where help might otherwise have been very difficult to access. In Clapham, for example, a remote rural village with an elderly population in the Forest of Bowland, enhanced connectivity enabled the formation of ‘Clapham Cobra,’ a volunteer emergency response initiative mitigating the negative effects of isolation by sharing information, delivering supplies, and checking on vulnerable residents [5.4a].

4.3 Impact on rural communities nationally and internationally

Many other local authorities who are developing local high-speed broadband plans have adopted or replicated the B4RN model. Forde and Condor have acted as consultants on many of

these [5.4a and b] B4RN's series of "show and tell days" offered interested communities the chance to visit B4RN and gain an insight into the technical and practical hurdles that were first highlighted in the Wray Project. Thanks to this knowledge exchange, B4RN has gone on to inspire and train other projects. In addition to parishes in Cumbria, Lancashire and North Yorkshire, the B4RN model has now been adopted in the East of England in South Norfolk (B4SN) [5.5] with a further project underway at East Rushton, Nr, Norwich (BB4ER) [5.6]. There are ongoing projects in Cheshire (B4RN Cheshire) with plans to employ permanent staff; in Surrey (B4SH) [5.7]; Northumberland (B4AV); Derbyshire (Hucklow Net) [5.8]; and, in rural Nottinghamshire (F4RN) [5.9]. In 2017, following a visit to B4RN, a member of the Northern Ireland Assembly stated: "*the Broadband for Northern Ireland (B4RNI) project wishes to pursue that model [B4RN]*" [5.10]. In Scotland, the B4RN model was adopted by Balquhider Community Broadband (2017) to bring connectivity to a remote area in the Trossachs [5.11].

4.4 Impact on national and international rural broadband policy and provision

Since 2014, B4RN has been considered 'the fastest rural broadband service in the world' and has been influential in both UK and international rural broadband policy. As part of the UK Government's Industrial Strategy and drive to provide world-class digital connectivity across the country, B4RN was cited in a national infrastructure review (2018) to support greater investment in future telecoms infrastructure as an example of a "*new and innovative business model*" and highlighted as an example of a "*community led fibre deployment model*" [5.12]. In a recent parliamentary debate (2020), the Parliamentary Under-Secretary of State for Digital, Culture, Media and Sport, Matt Warman, stated that B4RN "*does really great work and has been doing so for a number of years. It has a huge amount of expertise that I hope we can learn from when it comes to working across the country*" [5.13]. Internationally, the European Commission has highlighted B4RN as an example of best practice in 2020 in its policy document *The Broadband Handbook*. This publication is part of the European Commission's comprehensive [Action Plan for Rural Broadband](#) aiming to bring better broadband to rural areas of the EU [5.14].

5. Sources to corroborate the impact

- 5.1. **Letters from B4RN:** a) Barry Forde MBE, Chief Executive Officer and Co-founder of B4RN (December, 2020); b) Chris Condor MBE, volunteer, activist, and co-founder of B4RN (November, 2020).
- 5.2. **B4RN company website** corroborates number of connected properties, jobs created and shareholder information - <https://b4rn.org.uk/about-us/> (accessed December 2020)
- 5.3. **Responses to feedback survey** conducted by B4RN showing impact on local communities (can be provided by request)
- 5.4. **News Media:** a) Independent: [Digital DIY: The superfast internet network built by locals in the Yorkshire Dales](#) (July 2020); b) Westmorland Gazette: [Vital B4RN funding for struggling rural areas has been welcomed by Furness councillor](#) (July 2020); c) Total Telecom: [Zyxel Communications Partners with B4RN to Bring High-Speed Internet to Rural UK Schools](#) (April 2020)
- 5.5. **B4SN website link** (accessed December 2019) corroborating influence of B4RN
- 5.6. **Secretary of Broadband for East Rushton** campaign website (BB4ER). (2017: accessed 29 November 2019 see pdf copy for version referencing B4RN directly).
- 5.7. **B4SH website link** where they state: '*We have modelled ourselves on the highly successful Broadband for the Rural North (B4RN).*' (accessed January 2021)
- 5.8. **Case study on Hucklow Net by local business** highlighting influence of B4RN (2014).
- 5.9. **Business Plan for Fibre for Rural Nottinghamshire** (F4RN) showing aspiration to join network (December 2015).
- 5.10. **Proposal made to All Northern Ireland Assembly by William Irwin MP:** [link](#) p.4 (2017).
- 5.11. **Balquhider Community Broadband** corroborating influence of B4RN (2017: accessed January 2021).
- 5.12. **Future Telecoms Infrastructure Review** (July 2018).
- 5.13. **Statement from Matt Warman MP** during a Parliamentary debate, indicating significance of B4RN as a model for implementation of rural broadband nationally (January 2020).
- 5.14. **The Broadband Handbook:** 'Facing the challenges of broadband deployment in rural and remote areas' *Shaping Europe's digital future* (April 2020).