



Liverpool 5G Create: Connecting Health and Social Care

Overview

January 2023



We have

- Created the largest 5G Stand Alone network at street level in Europe
- Supported UK industry and the technology ecosystem in tech diversification and in innovative technology
- Proved the effective performance of the network
- Built a positive reputation for technology innovation - including security devices, and collaborative working
- Fostered effective cross-sector collaboration
- Challenged OFCOM's thinking on what 5G is and can do – emboldened them to think about public services
- Shown that the concept of private 5G network for Civic use cases works
- Reduced the digital divide
- Had a successful impact on individuals and services
- Developed the project to meet social need
- Gained recognition for the project as one that disrupts business as usual in favour of the poorest in society
- Proved that the technology is available and can be deployed and used to support live public services and help deliver those services effectively
- Provided a pioneering pathway for other public sector organisations



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01 Who are we?



Background

The Liverpool 5G Create Connecting Health and Social Care project is the second DCMS 5G Testbed and Trials project awarded to the Liverpool 5G consortium and ran from September 2020 to September 2022.

The project builds on the previous Liverpool 5G Testbed delivered as part on the first phase of DCMS testbed and trials projects and completed in November 2019.

The project expanded the existing network in Kensington, Liverpool to incorporate cellular capability and create a Stand Alone 5G network for delivering public services. In addition to Health and Social Care use cases the project also covers education, providing connectivity to school children in their homes and school.

The consortium

The Liverpool 5G consortium was led by the University of Liverpool with partners Liverpool City Council, Blu Wireless Technology Ltd, Broadway Partners Ltd, Liverpool John Moores University, CGA Simulation Ltd, Docobo Ltd, NHS Liverpool Clinical Commissioning Group and Merseycare NHS Foundation Trust.

The project was managed and supported by the eHealth Cluster Ltd with further services supplied by Telet Research (NI) Ltd, AIMES Management Services Ltd and Real Wireless Ltd. In the final six months of the project Telet Research moved from being a subcontractor to the University of Liverpool to a full partner.



02 Why do it?



Our aim was to:

- Change people's lives by:
 - reducing digital poverty,
 - providing digital health, social care and education support where it's needed most
 - providing the technology for children to use at home to support their school work.
 - helping people with long-term health conditions live independently at home for longer
 - helping to reduce health inequalities
- Use our 5G supported health and social care technology to freeing up valuable health and social care resources and saving money
- Enable health and social care providers to offer robust, reliable digital health applications as an alternative to face-to-face interventions
- Create a safe, reliable and robust private 5G network with ubiquitous coverage across the network area
- Support the UK's Covid-19 recovery by enabling British built technology and innovation to thrive in a meaningful and sustainable way
- Create practical, affordable digital solutions to replace the analogue telehealth technologies which will be turned off in 2025
- Deliver a blueprint for using 5G networks to deliver public services.

03 What did we do?



During the project we:

- Deployed a private, stand-alone 5G network for delivering public services
- Built on the previous successful Liverpool 5G Testbed
- Used existing street furniture enabling a speedier roll-out than exclusively using full-fibre.
- Upgraded our existing network technology
- Used the latest, new to market, world-leading 5G technology
- Increased the physical area covered
- Trialed new-to-5G, and in some case entirely new, devices and apps in health and social care.
- Worked with key organisations from the NHS, the social care sector, local government, national government to develop the use of private networks in delivering public services.

Addressing needs

- The network is designed to provide tech enabled care and telehealth that is not available in the commercial market
- Connectivity is provided via Wi-Fi or cellular with no charge to the resident, meaning remote monitoring is available to all, even where there's no broadband
- Liverpool 5G manage access to the network by providing individuals with devices configured to the network
- Liverpool 5G bear the initial costs of deployment and maintenance – residents will not incur any usage costs
- Long term revenue costs are reduced for public bodies, such as NHS and local authorities, and can be offered to individuals
- Health services, care homes, supported living, and home care can access for free (or less than current costs), freeing up spend for frontline services.
- We provide a unique health, social care & education 'network-of-networks' that incorporates mmWave 60GHz mesh network, small cell radio technology.

Working with people

A range of products and services were tested:

Telehealth Monitoring via Docobo Devices – the Care Portal device is used by the patient, includes a built-in ECG monitor, and connects to Telehealth Hub staffed by nurses and HCAs.



Sensory vest –

Haptic shirt to allow care home residents to receive remote hugs from family, reducing isolation and loneliness in care homes



5G WAN Pilot for NHS Sites

– providing 5G connectivity to NHS sites for public access and clinical use. This reduces costs of a fibre-delivered WAN network and provides low latency, high bandwidth, secure WAN network for ongoing increase in digital clinical services.

Education – Providing connectivity and Chrome Books for pupils at home in Kensington



Vitalerter – Sensor for under a care home bed that monitors the vital signs. Using AI, it notifies staff when the resident is about to get out of bed, reducing the number of falls.



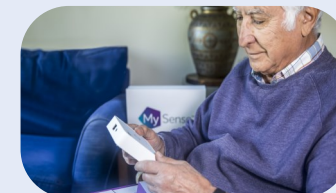
Chill Panda – A playful, interactive app which helps children manage their anxiety. It uses a built in AI driven recommendation engine to create personalized anxiety reduction content for users.

Pressure Ulcer Management System – Mobile technology which uses AI imaging techniques and emerging camera technologies to categorise pressure ulcers remotely and send high-quality images to practitioners for diagnosis

Urine Monitoring Unit

– Uses optical technique to detect infections in urine, and transmits ultra-resolution images to GP surgeries for analysis - performs at the same high level as current standard tests in NHS

MySense – A new range of telecare equipment, which uses AI to monitor nutrition, hydration, independence, and activity via IoT (Internet of Things) sensors around the home, and alerts support networks to any changes in behaviour or deterioration



Publicising the project:

- Mentioned in over 85 press and media articles.
- Radio interviews with BBC Merseyside (2) and BBC Wales
- Took part in over 58 events and dissemination activities
- Liverpool 5G website: 8503 visitors & 23038 individual visits
- Held two successful dissemination and information events:
 - Liverpool 5G Showcase - audience 195
 - Use Case Demonstration Event, attended by DCMS, L5G and supplier representatives. Video produced

Award Nominations/Shortlist

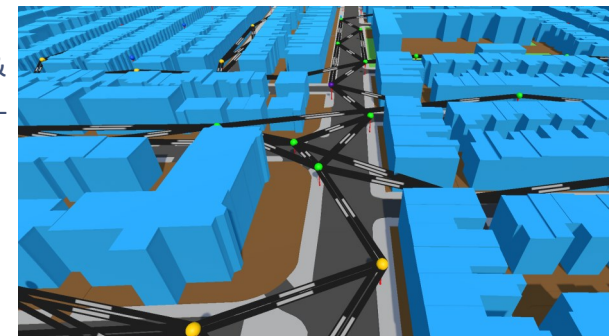
- Prolific North Tech Entrepreneur of the Year Award (Rosemary Kay, Liverpool 5G Project Director)
- Maximum Citizen Impact & Reach at UK's 5G Showcase Awards
- Digital Leader of the Year (Ann Williams, Health & Social Care Authority, Liverpool 5G)
- Most potentially disruptive business model, 5G Week Award

Award Wins

- Best Individual Contribution (Ann Williams, Health & Social Care Authority, Liverpool 5G), at UK's 5G Showcase Awards
- 5G Innovation of the Year (Liverpool 5G planning tool, CGA Simulation) at DigiLeaders100 Awards.
- Connecting People Award, at Cambridge Wireless' Technology and Innovation Awards.
- Tech for Good' award at the 2021 Prolific North Tech Awards.

Where are we now?

- The network is designed to provide tech enabled care and telehealth that is not available in the commercial market
- The improved SLA allows the safe use of tech enabled care and telehealth devices by managing the network and knowing where all the vulnerable adults are.
- Connectivity is provided via Wi-Fi or cellular with no charge to the resident, meaning remote monitoring is available to all, even where there's no broadband,
- Residents have access to civic services, breaking down the digital divide.
- Liverpool 5G bear the initial costs, and with ubiquitous coverage long term revenue costs are reduced for public bodies, and can be offered to individuals
- Health services, care homes, supported living, and home care can access for free (or less than current costs), freeing up spend for frontline services.
- This is a unique health, social care & education 'network-of-networks' that incorporates mmWave 60GHz mesh network,



04 What were the Benefits?



Benefits for Business and Development

- **Increased investment in R&D and business investment**
 - Additional funds spent on R&D due to the funded project was a total of £1,530,232
 - Third party investment attracted: £950,000
- **Increased technology development**
 - 80% of the products reported on during the project showed an increase in TRL level
 - 60% reached their target TRL level by the end of the project
- **New and Improved 5G-capable health technology products**
 - New features of the Docobo telehealth system were developed: a fully integrated video consultation system plus further developments to take advantage of the wider bandwidth and low latency.
 - CGA Simulation refined their Chill Panda app, updated software installation and connection protocols, and identified new hardware that will work with the product
 - LJMU created a decision support tool was developed which standardised pressure ulcer categorisation using AI modelling techniques.

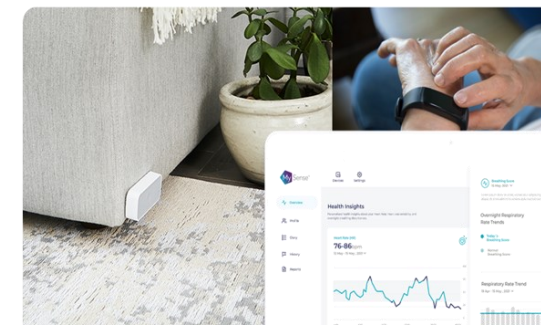
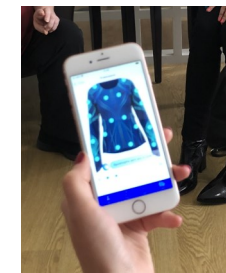
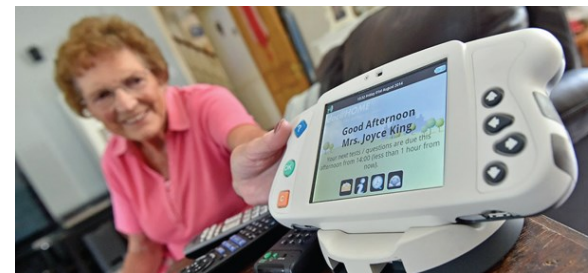
Benefits for Health Services

- **Improved connectivity for services and individuals**
 - The Liverpool CCG 5G WAN Pilot for NHS sites showed that the Liverpool 5G network had Increased speed and reliability, with less jitter, lower latency, and lower round-trip time.
- **Improved Health and Care services**
 - New Clinical Care Pathway question sets were developed by Docobo and Mersey Care
 - New features added to the Docobo monitoring system to form the basis of future new and more effective services, enhancing the Mersey Care offer.
- **Reduced costs to Health and Social Care services**
 - Liverpool CCG 5G Wan Pilot reduced connectivity cost of GP sites, with a yearly per surgery saving of £2,026. Applied to 86 surgeries in Liverpool, this could be an annual cost saving of £174,236
 - Vitalerter monitoring showed a reduction in falls and the number of nightly turns needed for cre home residents, leading to potential annual saving of £7,737 per user per year, after costs.
 - Using the CuteCircuit Hug Vest showed an average 19% decrease in estimated costs, saving £841 per user over the trial
 - Those using MySense Telehealth monitoring reported a reduction of days spent in hospital, leading to average annual cost saving of £63 per user

Benefits for Individuals

- **Better health and wellbeing outcomes for individuals**
 - Vitalerter monitoring showed a reduced number of turns were needed for each patient, allowing them to get undisturbed sleet, leading to better health
 - Service users using the CuteCircuit Sensory Vest had a 64% decrease in those who said that they often or sometimes felt lonely
 - MySense Telehealth monitoring users showed an increase in reported wellbeing and in increase in feeling safe
 - Users of MySense Telehealth monitoring reported a 40% reduction in the annual number of days spent in hospital
 - Video consultation was developed by Docobo was demonstrated to give good quality video consultation over the Wireless L5G network, improving the patient experience
- **Decreased poverty and stress for local residents in one of the poorest wards in the country**
 - Liverpool Council Education offer – families of pupils using the network incurred no additional data or connectivity costs
 - MySense telehealth monitoring users had improved wellbeing, leading to increased social value of £1,800 per user, which represents additional money the average individual would need to improve their wellbeing over the trial period.

- **Improved learning, engagement and life chances for pupils**
 - As part of the Liverpool Council Education offer, 49% of pupils at Phoenix Primary School identified as not being connected were connected, enabling pupils to access education from home, and engage more fully with education



MySense™

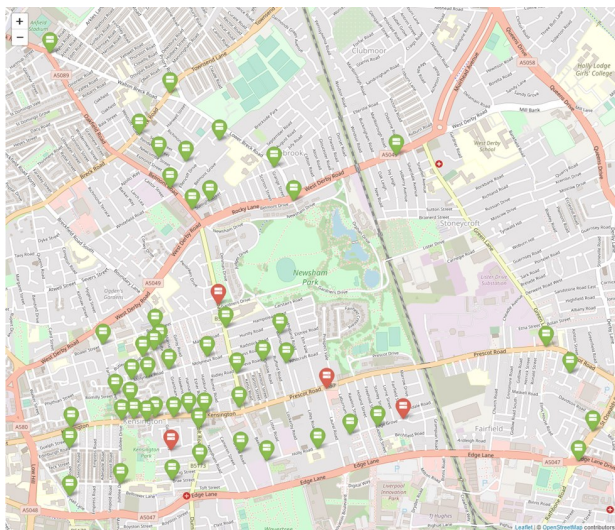
05 What about the technology?



Building the Network

The network provides:

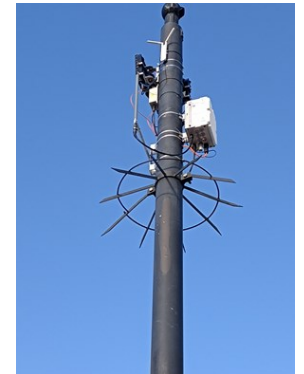
- coverage from 56 active small cells within and around Kensington and Fairfield (see map below),
- back-haul to these and fixed sites was provided via 24 fibre points of presence,
- 101 intermediate mmWave sites on lamp-posts,
- connections to 5 buildings by mmWave,
- a connection to 1 building by fibre to the premises (which then hosts a small cell),
- a street-level WiFi network around the Phoenix school catchment.



This phase deployed:

- 138 'DN101' single mmWave nodes and
- 57 'DN201' bidirectional nodes.

A small number of nodes from the previous project continue to provide service at two buildings where rework was impractical or inappropriate for the objectives of this phase.



The mobile network Core functions are co-located at the AIMES data-centre on dedicated hardware. A subscription-based dynamic web filter provides protection from inappropriate material and transfer of material from malicious sites. A redundant cluster of Virtual Machines provides a platform for the mmWave network management, forensic and configuration tools, the WiFi management system and the network's global availability monitoring tool (PRTG). Service usage monitoring is implemented within the data-centre's existing infrastructure with granularity to individual connections if required.

Back-haul from the field sites is aggregated at a pair of intelligent switches close to Hunter Street which also support per-port monitoring.



Approach to security

The project was largely based on established technology – with mature and often verified security. As such, our focus was on the inherent risks that we created by rolling out the project and operating as a connectivity provider.

- The security of data as it transits the L5G network
- The security of services or devices that use the L5G network
- Managing and mitigating threats to the L5G network for the areas that we can control

We took a secure-by-design approach throughout and a secure-by-default approach wherever possible.

Overall, the project aimed to work towards:

- Developing an ‘appropriate’ security governance framework that protected and secured the network without stifling innovation or development.
- Understanding the requirements for working with diverse partners in a secure and controlled manner to run a stable, secure and resilient network.
- Developing new draft policies and procedures to ensure that security is taken into account
- Focusing on security and design during the project but also prioritising security in relation to configuration, management and monitoring.

Research and Development

The team from the School of Computer Science and Mathematics, Liverpool John Moores University (LJMU) modelled the use case application traffic requirements and worked with partners to develop end-to-end traffic management models and algorithms across the Radio Access Network (RAN) and mmWave mesh core. They published their findings in [Modelling and Analysis of Performance Characteristics in a 60 Ghz 802.11ad Wireless Mesh Backhaul Network for an Urban 5G Deployment](#).

CGA Simulation designed and developed a 5G mmWave Network Planning Tool - a decision support assistant and 3D mapping environment with a dynamic digital test-and-trail-sphere to optimise the access and utilisation of a 5G network. Features added during this phase of the project include:

- extension and enhancement of the original map using a combination of Ordnance Survey and OpenStreetMap data.
- functionality of new hardware e.g. Telet boxes
- More features and usability to the dashboard and visual display
- the ability to visualise Wi-Fi reach in the simulation.

The AI team from School of Computer Science and Mathematics, LJMU created a decision support tool which standardised pressure ulcer categorisation using AI modeling techniques, and published their research - [Pressure Ulcer Categorisation using Deep Learning: A Clinical Trial to Evaluate Model Performance](#)



Key points we learned from the project

1. Innovating at the very forefront of technological development needs flexibility and access to the right skills when needed

No matter how well planned at the beginning, working at the bleeding edge of technology innovation will always generate unknown challenges.

To deploy the 5G small cells the project benefited from the skills and proactive working relationships of technology partners, who worked collaboratively with the vendors and software suppliers to not only identify issues but also resolve them and provide a real world application to prove the performance of the devices.

Where skills needed to deploy devices was beyond the scope of installers, additional development engineering support was brought in through the project managers. This approach was possible due to the range of skills available, capacity and commitment of the partners.

Flexibility in the approach is needed from both partners and funders in order to achieve the project outcomes. Having a flexible resource base and the capacity to deploy additional skills as required is essential.

2. Bring the full range of key stakeholders onboard and maintain links throughout the project, even when stakeholders change

We saw many changes in the public bodies we were working with, such as the formation of Integrated Care Systems (ICSs) and the integration of NHSX with NHS England. Change and restructuring of public bodies is inevitable over a two year project, but keeping the links established with key individuals is essential.

By setting up an Advisory Group at the beginning of the project, which included representatives from local authorities, NHS trusts, UK5G and NHSX, we were able to keep members updated and involved in facilitating wider connections.

The Liverpool 5G project was based on live services being delivered in the community. To support this we worked with the full “stakeholder chain” including patients, their families, equipment providers, health professionals and commissioners of services.

As a result of these links, at the end of the project, the majority of the use cases intend to continue running.



Key points we learned from the project

3. With a wide mix of partners, partner priorities and resourcing levels will change over time

A key strength on the project has been the wide range of partners involved. The Liverpool 5G Create project has only been possible due to the mix of partners involved. Partners have come from industry, academia, local authority and NHS. The project brought together this full range of perspectives to both deploy and apply the network.

It has been challenging to coordinate such a wide range of partners but without this approach we could not progress from the technical implementation to the actual adoption of the private network approach for delivering public services.

Flexibility in approach has been key. Public sector partners have seen unprecedented challenges during the pandemic. However, the need for providing connectivity at home and the impact of digital poverty has become much more widely recognised.

The overall project Technical Authority role moved from Blu Wireless to Telet Research within the first few months of the project. Inevitably, over the two year period of the project, investment priorities within key private sector partners have changed and it has not been possible to get the level of resourcing required, but with a flexible approach we have managed to achieve the project objectives.

4. Technology innovation is relatively easy compared to the adoption of innovation within public services

We managed to achieve the deployment of the largest 5G Stand Alone street level network in Europe, but continue to work on a business plan that will enable the public sector to deliver public services over a private network at scale.

Through the use cases and the cost model we have been able to demonstrate that the objectives of our business plan are being met, however there are numerous challenges in developing a Green Book business case to access public sector funding.

The innovative approach of using a private network to deliver public services does not fit neatly into a single public body or local strategic priorities, it cuts across many. This makes it difficult to identify one Senior Responsible Officer to make decisions on the approach to the business case.

At the end of the project we are a lot clearer on the approach needed in the business case but still need to gain full support for a wider roll out. Essentially, we are ahead of our time and the market for devices needs to develop further with unit prices decreasing.



The Business Model

We have the opportunity to:

- Explore the business case for expanding the civic network within priority areas in the Liverpool City Region
- Build a circular economy, where public services fund the network and residents get the benefit
- Increase the Social Impact across the LCR through:
 - Giving more school children connectivity at home
 - Increasing access to digital Health and Social Care services at home
 - Introduce wider applications in Housing, Transport and Smart City initiatives onto the network
 - Research how developing the network can maximise LCR assets, e.g. LCR Fibre, Civic Data Trust.

Supporting the existing network

As the DCMS funded project comes to a close the project partners plan to keep the network operational and continue the existing use cases where applicable while we continue to work on the business case.

Further investment will be needed, and we will be looking at future investment opportunities and building on international interest.

We also intend to use the network for continuing research purposes. Both Liverpool John Moores University and the University of Liverpool plan to use the network for ongoing research project.