



Mobile Access North Yorkshire

D9.7 MANY CLOSURE REPORT

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Contents

1. Executive summary	2
2. Introduction	18
3. Description of what the project did	18
4. Description of the results	18
5. Impact of the results including Benefits	18
Methodology	12
Impact	18
6. Key learnings	18
7 Dissemination	22

1. Executive summary

This closure report summarises the highlights of the MANY project in the timeline from January 2020 through to closure in June 2022.

- Four main use cases were explored together with the further development of a technical delivery platform.
- Community Engagement was seen to be a cornerstone to the success of the project. A toolkit for this area, for use by others, has been developed.
- The project team used a variety of innovative solutions to overcome challenges in deploying the 5G networks.
- Despite the network going ‘live’ very late in the project, valuable results were collected.
- A series of key learnings is discussed - particularly around the importance of testing equipment with real end users and delivering use cases.

2. Introduction

The key objective of the MANY project has been to evaluate how 5G mobile communications can enhance life in rural areas, where currently, mobile networks are inadequate. Use cases were identified early on in the project as the best way to illustrate our hypothesis. We intended that the project would be use case driven, rather than technology driven. Our use cases involve:

- tourism; a Wizard Quest was created at Forbidden Corner to enhance the visitor experience;
- health and wellbeing; we collaborated with a medical practice in the area to evaluate video appointments between doctors and patients. In addition, we collaborated with Northumbria University to assess the effect of improved communications on the wellbeing of people who live in isolated rural areas.

- the monitoring of North Yorkshire County Council assets, specifically roads and bridges; such assets can be very quickly compromised and even destroyed in severe bad weather (as was the case in 2019). The use case was designed to provide a better ‘early warning system’ of impending issues.
- Mountain Rescue: we have tried to improve the Mission Critical Communications for the Swaledale Mountain Rescue Team. This has benefits for enhanced teamwork during a search. The project also demonstrated how through the use of enhanced communications and sensors, an injured person could be rescued from a mountain site in about half of the time without the communications.
- Helikite: in collaboration with York University, we have demonstrated how 5G technology can be utilised at temporary events such as festivals or sporting events, through the use of a helium filled balloon.

Enhanced communications in rural areas can positively affect many sectors and contribute significantly to bettering the social and business ‘fabric’ of rural communities. Our early discussions touched on the subject of retaining and attracting younger families in rural areas, which in turn helps to maintain schools and facilities in these areas.

Helping businesses and individuals to perform business transactions was also discussed, and with the advent of two-factor authentication for many transactions today, this became of even greater importance. Receiving an authorization text message to complete a transaction is very difficult in many of the remote valleys of North Yorkshire.

Safety also came to the forefront and we developed a use case focused on rescuing people from the more rural and inaccessible areas. Our trials were able to show how this intervention could have a significant effect on the health and wellbeing of the rescued patient.

And finally, and emanating from the previous 5GRIT program, we recognised the issue of loneliness and isolation in rural communities and how enhanced communications can give people a choice; those who wish to live in isolation, but who choose to communicate with family and friends, can do so. Those who prefer isolation can do so. Throughout this project we have stressed this aspect of choice and have taken great steps not to impose the communication technology where it was either not welcomed or simply not needed.

3. Description of what the project did

The project completed three main tasks:

1. **Community engagement:** to assess within the communities what the issues and challenges are due to the lack of communication and what they could do with better communication networks. We had intended to achieve this through a series of community events in the local areas, interactive discussion sessions and input from local residents. Due to the onset of COVID and the lockdown situation, we were unable to perform as many of these activities as planned. We adapted, however, and received a lot of the required information via telephone calls and remote participation at group events. It was very important for our project, and was

laid down at the very beginning, that our delivery would be consumer led, rather than technology driven.

2. **The technology**, of course, also played a major role in the project and a lot of time was spent procuring the appropriate software and hardware following the government decision not to allow Huawei equipment to be installed. Initially, we were in collaboration with Cablefree (<https://www.cablefree.net>), but this presented many challenges in on-time delivery and appropriate functionality of the relevant hard- and software. As a result, the project collaborated further with Mavenir (<https://www.mavenir.com>) to try and establish a functioning network. This was eventually achieved, but so late in the project that a three-month extension had to be secured to enable us to at least test some of the use cases.
3. **Use Cases:** as mentioned, we wanted the project to be use case driven and the lockdown situation - paradoxically - presented us with a lot of time to be able to discuss and formulate the right use cases for the region. We started with a list of personas we felt would best benefit from the intervention and tested our hypotheses with residents who matched these personas. By doing so, and with the lockdown situation forcing us to take our time, we were able to develop a short list of 5 main use cases we wished to develop.

These were:

- a. **Tourism:** Forbidden Corner (<https://www.theforbiddencorner.co.uk>) This popular tourist attraction near Leyburn receives over 100,000 visitors per year. The goal was to use 5G or enhanced wireless communication to improve the visitor experience by enabling them to upload photos and videos in real-time. By doing so, the intention was that through social media postings, new visitors will be attracted to the site. In addition, we hope that existing visitors will remain longer at the site and spend more per head at the location. The main focus was a newly created Wizard Quest where visitors can interact with beacons hidden along the trails. An innovative augmented reality app enables participants to gather rewards and create interactive images on their phones.
- b. **Health Care and Wellbeing:** we collaborated with Leyburn Medical Practice to devise a mobile network supported doctor/patient appointment system. This came very much into focus due to the pandemic, but had been a use case beforehand. Getting to a standard 10 minute appointment at the surgery could be a journey time of 4-6 hours (there and back) for those patients living rurally and unable to drive and, therefore, reliant on public transport. 'Simple' check-up appointments could now be performed via a video link.

In addition, we had previously investigated the link between isolation, loneliness and certain mental health issues. Our goal was to reduce loneliness for those isolated people living beyond the reach of the mobile networks by installing video linkage into their homes. They could then use this communication as and when they felt the need

to and of course, could be reached by family and friends who wanted to just ‘check-in’. Unfortunately, due to technical issues in the chosen area, we are unable to fully complete this use case ‘on the ground’. Instead, we collaborated with Northumbria University to “explore the experiences, challenges and opportunities of Mental Health Professionals/Practitioners using remote technology during Covid-19”.

- c. **Critical Asset Monitoring:** this was initially done for North Yorkshire County Council assets, such as key roads and bridges susceptible to damage during severe weather incidents. We installed water level sensors to collect data which can give the engineers an early warning system that a road or bridge incident might be imminent. This could enable adequate repairs to be carried out before a potential catastrophic failure. In the case of a bridge, it was estimated that a cost saving of approximately 50% could be achieved from this strategy. The cost of a bridge replacement can run into many millions of pounds so the potential cost saving is significant.

Later we included assets on the Tugill Estate (site of the Forbidden Corner) to monitor remotely the fluid levels in key fuel and water tanks on the site. This has enabled the office team to more efficiently order fuel and monitor water levels.

- d. **Mountain Rescue - Mission critical Communications:** North Yorkshire is a favourite destination for ramblers and walkers due to the rugged nature of the terrain. Unfortunately, sometimes people fall and are injured such that they have to be rescued. The rugged terrain also means that often there is little or no mobile network in the area. Typically, mountain rescue teams will use their own radio networks to communicate with each other during a rescue mission. These can often be unreliable and have limitations. Our project has used enhanced communication technologies to improve the efficiency of the rescue teams as they work together to find and secure an injured person. Further, through the use of medical telemetry devices, we have been able to half the time taken to bring a person down a from the felltop. This is due to the ability to wirelessly transmit vital signs from the patient and monitor these without having to put the injured person down on the ground, thereby halting the rescue mission. This data can also be transmitted to the waiting medical services enabling them triage the situation more quickly in advance of the patient arriving at the ambulance.
- e. **Helikite:** the Helikite is a technical platform managed by our consortium partner York University. It is a helium filled balloon which can carry a communications platform up to a required height above a location where temporary communications may be required. This could be a sporting event (e.g. cycle race) or a music festival. Line of sight between handsets and the communication transmitter is key to performance. A communication platform above such a location will be able to reach many more people than if it were at ground level.

The communication was also used in an all terrain vehicle with our Mountain Rescue use case. This effectively increased the range and performance of the communications between the members of the rescue teams.

4. **Security:** we practised “security by design” wherever possible and introduced security aspects early on in use case and associated technology designs and discussions.

We identified three important risks to consider, over the course of the risk assessment process:

- A. Non-malicious (technology limitations): 5G fails and responders have to ‘daisy chain’, acting as a relay for mobile signal. This means less rescue support.
- B. Malicious (hacker): opportunistic attacks on the IP Multimedia Subsystem (IMS) services (SIP ctrl) hosted on the server underpinning the MC service.
- C. Non-malicious (human error): the responder team can still make mistakes that may expose data. E.g., installing an app on a spouse’s phone for convenience.

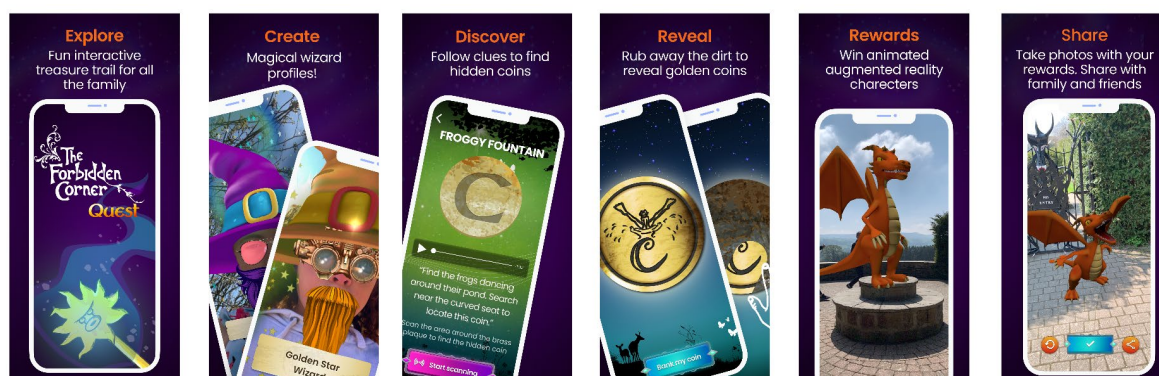
We discussed and implemented wherever possible mitigations against these risks.

In addition, we held a series of workshops specifically targeted at the security aspects of the use cases to ensure that as many risks as possible had been identified and mitigated.

4. Description of the results

Each use case has compiled a separate individual report going into all the results and findings in greater detail. The highlights for each are:

- a. **Tourism: Forbidden Corner;** Working together with the team at Forbidden Corner. We have successfully implemented an enhanced visitor experience centred on a ‘quest’ whereby visitors find hidden beacons along the trails which then interact with their phones. As a reward for ‘finding’ a beacon, an augmented reality feature appears via an app downloaded at the beginning of the trail. This enables special features such as animated creatures and wizardry to be incorporated into the visitors’ own photos.



Visitors are then able to share these experiences in real-time with friends and family, as well as on social media in general, thereby increasing the 'digital footprint' of the tourism attraction itself.

We have successfully tested this application with visitors and with students who performed a targeted assessment.

- b. **Health Care and Wellbeing:** we are only just beginning to collect the results of our intervention for these use cases. The Medical Centre in Leyburn consulted with us during the concept phase of the intervention. Unfortunately, towards the end of the project, the centre administrators were unable to find adequate time and resources to support our use case. Consequently, we had to regroup and we performed a targeted interview exercise with selected participants to simulate the experience of a doctor/patient interaction via a video link. The results were reported in a separate use case document 9.2,b.

The Wellbeing use case challenged us due to its location. We had originally intended to utilise the same location (Coverdale) where the other uses were planned, but we were unable to locate suitable participants in this area. A second area was chosen (Arkengarthdale) where North Yorkshire County Council health care workers had identified potential participants. Unfortunately, we were unable to install the required network masts in this area and could not carry out the use case.

To compensate, we collaborated with Northumbria University who conducted a research exercise to explore the experiences of mental health practitioners/professionals using digital technology working with children and families.

Data was collected via the use of semi structured interviews designed to elicit experiential data. Interview themes included: background information, general experiences of using digital technology in practice working with children and families, exploration of challenges using digital technology including therapeutic issues and issues of consistency of connectivity and quality of audio and visual technology, and perceived benefits and opportunities of future working using digital technology. In total 15 mental health practitioner/ professionals were interviewed, all had experience of working with children and families using digital technology.

The results have been reported separately, (Report D9.2,b-2) and the main points are these:

- i. Intermittent and breaking up of connectivity was identified as major challenge to communicating with patients.
- ii. mental healthcare practitioner/professionals stated that access to technology was a barrier to receiving digital healthcare. This was predominantly in

relation to access to technology by children and families incorporating access to broadband, and access to appropriate devices to use digital technology.

- iii. In addition, a lack of knowledge about technology and how to use it appropriately was identified as a barrier to adoption.
 - iv. Remote Working was seen as a challenge to the practitioners since the environment could, at times, be challenging with respect to privacy and connectivity. However, some positive benefits regarding working from home were also recorded.
 - v. A general poor knowledge level of 5G and its capabilities was seen as a barrier to adoption.
- c. **Critical Asset Monitoring:** we split this use case into two areas, which we will report on separately. The first focused on bridges and roads belonging to North Yorkshire County Council. These can be severely compromised during bad weather and some bridges even collapsed during the flooding of 2019.

Secondly, we installed fluid level sensors in various tanks at Tuppill Estate to monitor fluid - water and fuel - levels remotely.

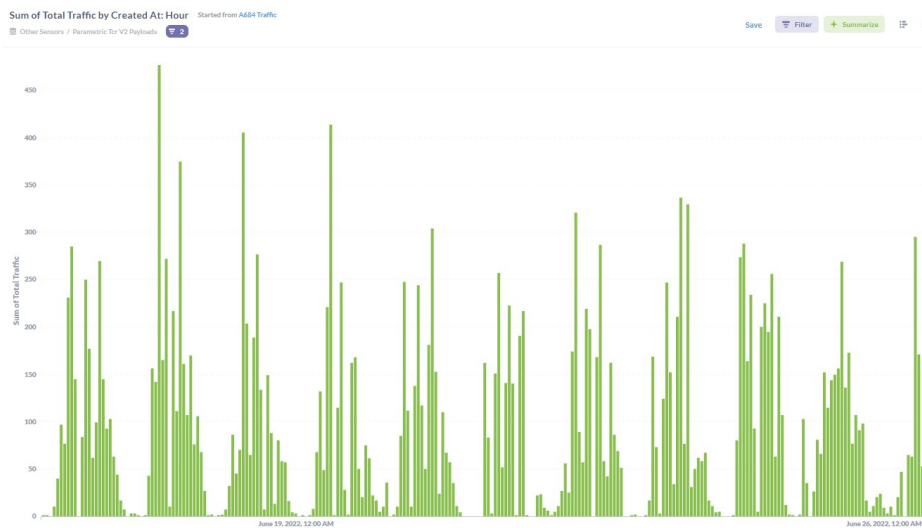


For the roads and bridges, we installed water level sensors. We had originally planned to install vibration sensors on some bridges, but technically, this became non-feasible. The water level sensors were deemed adequate to monitor the rising river levels from which the potential risk of flooding and damage could be assessed. The speed with which the water rises is also a key indicator for an early warning system.

Bridge sensor installation on the River Cover.

The initiative was eventually blended in with a wider NYCC program for the use of IoT devices on roads in the region. These are mainly for the monitoring of traffic congestion as well as to warn higher sided vehicles of low bridges. The warning signs could also indicate potential flooding ahead, thereby linking the two initiatives together, as the flood data would come from the MANY initiative.

The use of remote sensors was discussed with the respective departments within NYCC. Without remote data, members of these teams travel out to the most critical sites to assess the conditions. This, of course, takes both time and resources. In addition, the viewing is a subjective approach - experience is required to assess the conditions. The sensors provide hard data - a quantitative approach - which in turn supports the engineering teams to make data driven decisions and to back up their decisions with numbers and facts. It effectively diminishes a large part of the subjectivity in their decision making.



Sum of traffic passing LoRaWAN sensor by hour

d. **Tank Monitoring:** At the Tugill Estate, there are many fluid tanks containing water or fuel, which need to be monitored on a weekly basis. We installed sensors on a total of 19 tanks –

- 2 x Diesel (1 – red, 1 – white),
- 14 x Oil/Kerosene,
- 1 x Water
- 2 x LPG



It currently takes one person two hours to take readings from the tanks and these are checked weekly. This equates to 8 hours of staff time per month or about 96-100 hours per year. At £12 per hour, this equates to a 'saving' of £96 per month, or £1,152 - £1,248 annually. This is not a direct cost saving as the employee's time is not saved, but reallocated.

Additionally, through now being able to view the tank reading in one system, the administrative

staff are better able to collate ordering and benefit from both advanced ordering and volume discounts where available.

5. **Mission Critical Communications: Mountain Rescue;** We successfully trialed this initiative with the Swaledale Mountain Rescue Team (SMRT) and developed two sub use cases with them, following extensive discussions about their way of working.
 - a. The first concerned the improvement in efficiency of the rescue teams on a rescue mission. The breaking up of communications between team members can severely hinder the rescue attempt. The SMRT has measured dropped calls via the VPN inter-site links and estimated it impacts between 1 in 10 and 1 in 20 calls. On the trails we performed with the new technology, no dropped calls were recorded.
6. The second focused on the time taken to bring an injured person down from the accident site. Rescue teams have to monitor the health condition of the rescued person and they do this by stopping during the descent, placing the patient on the ground and taking vital sign measurements. SMRT casualty support is required to stop every 5 minutes for 2 minutes to check vital signs. A lift off the hill to a waiting vehicle or ambulance at a distance of around 1000 metres took approximately 30 minutes and involved 3 check stops.

We compared the simulated stretcher lift to the Land Rover drop off point without the need to stop. It was timed at just less than 15 minutes. This suggests a time saving of 50% and we can assume that this halving of the return time can be applied to the majority of rescue missions.

It is a well known fact that the quicker patients get into hospital, the better the chances are of recovery and the quicker that recovery is. Unfortunately, documentation concerning this hypothesis is largely confined to stroke and heart attack patients. There is very little data regarding the speed of recovery of patients who have been injured while walking or rambling. Our hypothesis however, follows a similar theme, in that we believe that the quicker a person can be recovered and placed into the care of medical experts, the better are the chances of recovery and the speedier that recovery will be.



The communication platform was carried in a University of York van.

Helikite: this was more of a technical demonstration than a use case, although we did combine the technical demonstrations with other use cases. Originally, we intended to use this application at temporary weekend events, such as Deer Shed festival or the Tour de Yorkshire cycle race. Unfortunately, due to the COVID lockdown, these events were cancelled. Consequently, we focused on optimising the communications platform for the helikite and then linked it in with the Mission Critical Use Case.

Although the helikite cannot be flown in high winds, the communication platform has been so designed that it can be carried in the back of an all terrain or four wheel drive vehicle. This we did and were able to demonstrate the value of the mobile platform for a rescue mission.

*Helikite trial at
Tupgill estate*



7. Impact of the results including Benefits

Methodology

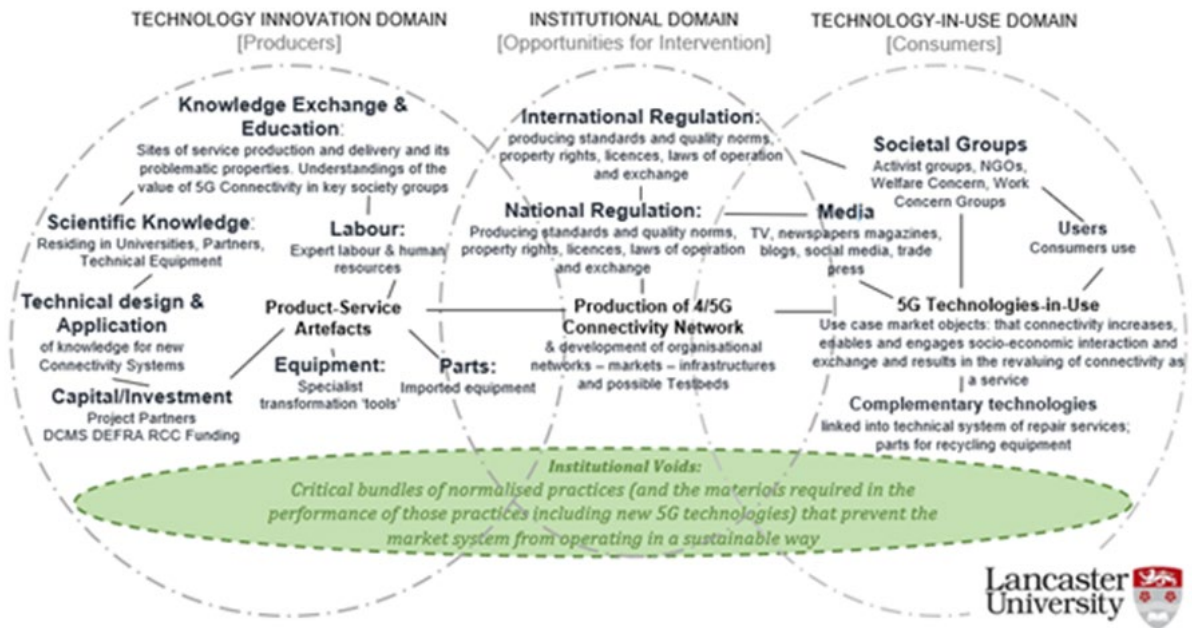
The MANY project aims to help rural communities achieve socio-economic flourishing through improved connectivity and provide a platform for *improved wellbeing, business innovation, and safety and resilience*.

We define ‘flourishing’ as improvements in wellbeing, business innovation and the safety and resilience of connected communities and use this as our overarching aim of our work. More specifically, we define improved wellbeing as reductions in self-perceived levels of harm, loneliness, and improvements in social connections and mental health; improved business innovation as improvements in practice that contribute to the business growth and/or improvements in productivity and/or (public) service offering (i.e. using a reduced resource for the same output); and improved safety and resilience as improvements in the timeliness and quality of information provided at critical decision-making junctures.

Described in theoretical terms, we worked across three domains of action - the technology innovation domain, the technology-in-use domain, and in the middle, the institutional domain, as illustrated in (Figure 1), across our four main use cases (excluding helikite). These domains show how we worked to connect people from different social worlds (used to working with different logics, and working

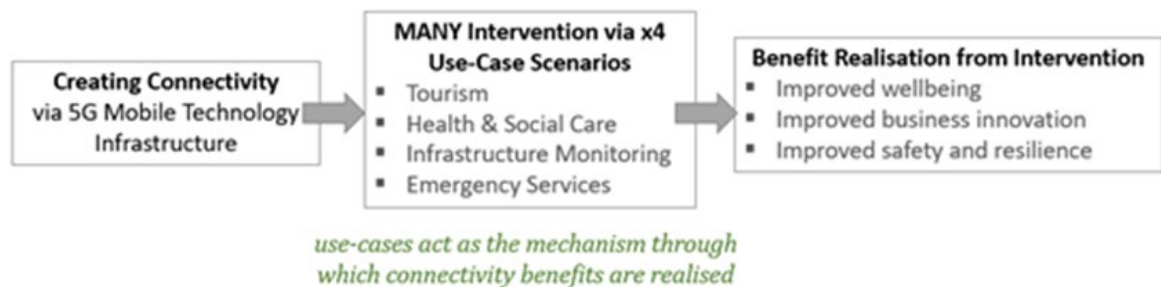
practices), to help them co-produce connectivity solutions that work in place: in a very rural community.

Figure 1: Market-Making Actors for 5G Use Cases: An Analytical Framework for 5G Across Three Domains.



Our core research question: *how is the provision of an enhanced communication network – based on 5G technology – improving the socio-economic lives of those living in previously disconnected communities?* is illustrated in Figure 2.

Figure 2. Benefit Realisation Mechanism for the MANY Project



In each of these use cases we are interested in the benefit realisation of 5G for both producers (including service providers) and consumers so the value of 5G to markets can more clearly be

understood. We wanted to know what the totality of benefits are across the use cases in a single place, to help us better understand how 5G infrastructures enable and support socio-economic flourishing in place.

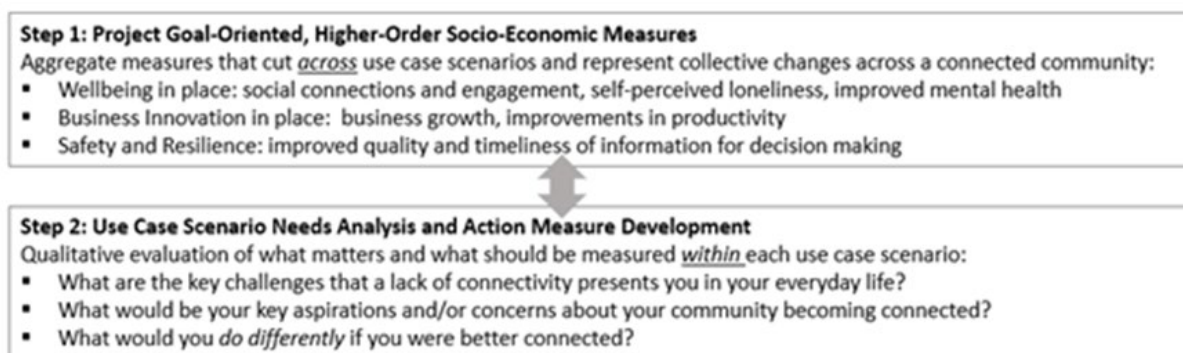
We adopted a three-step approach to develop an evaluation framework for the socio-economic impact of connectivity technology interventions designed to close the ‘digital divide’ and catalyse the flourishing of connected communities. We developed specific research questions for each use case scenario: *Tourism, Health & Social Care, Infrastructure Monitoring, and Emergency Services*. Below, we present one higher-order research question for each use case scenario. Higher-order questions reflect the research team’s observation that the MANY project needs to apply current understanding, analyse, synthesise, and evaluations of the North Yorkshire context. This is necessary to better understand what each use case scenario is a case of (cf. Ragin and Becker 1992), before we can develop ‘good’, targeted questions and measures. Targeted questions helped us to drill down into the key issues for each use case.

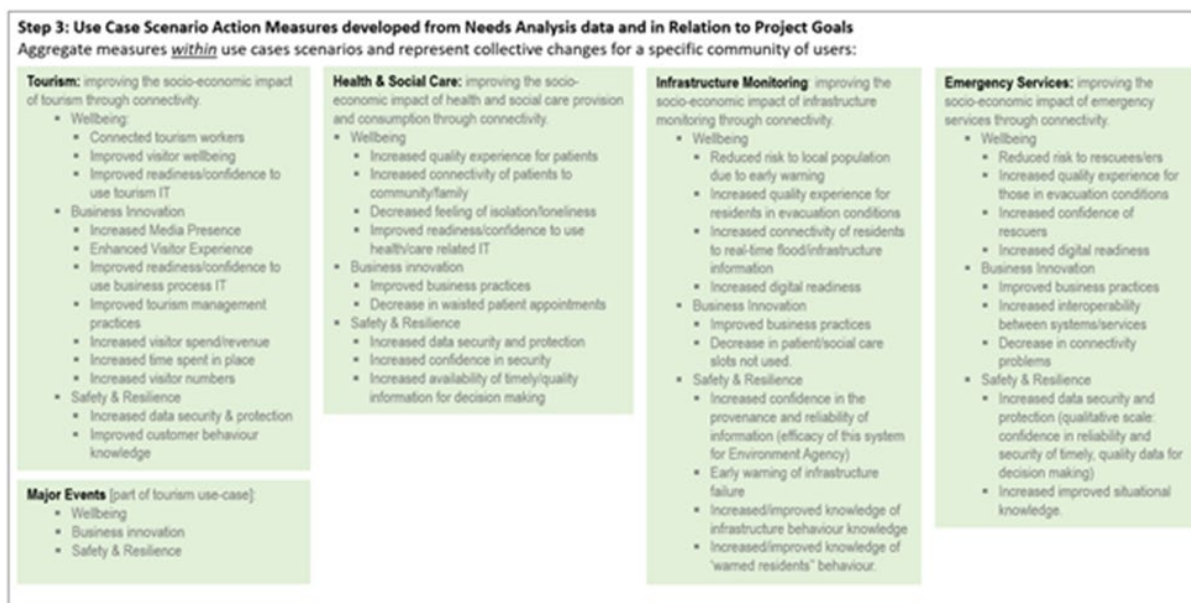
Our four higher-order questions thus represent the core objectives driving our initial, exploratory research phase, and are as follows:

1. How does enhanced connectivity increase the socio-economic impact of **tourism**?
2. How does enhanced connectivity increase the socio-economic impact of **Health and Social Care**?
3. How does enhanced connectivity increase the socio-economic impact of **infrastructure monitoring**?
4. How does enhanced connectivity improve the security, resilience and reach for **emergency services**?

We proposed an evaluation framework designed for multiple levels of analysis and both cross case and within case analysis (Figure 2), in a three-step approach to evaluation and action measurement.

Figure 3: Socio-Economic Impact Evaluative Framework for Connected Communities





Our three-step approach was designed to identify higher-order measures for *our cross-case* evaluation, and ‘good’ targeted questions and measures to allow in-depth *within case* evaluation of each use case scenario, and for each core stakeholder group participating in the use-case intervention. By co-developing ‘good’ measures, working with and using data from research participants, we aimed to make ‘good’ actionable measures that can be used in our practice to change the practices of others; the practices this project aims to catalyse. We see our three-step approach as simultaneous and iterative in the development of the evaluation framework and see our work to arrive at good measures for each use-case scenario as ongoing.

Section four of our report *D5.1* presents the research we undertook in relation to steps one and two of the evaluation framework. Section five of report *D5.1* and reports *D5.8* and *D5.8 Update* present activities as part of the process of good measurement development (step three of the evaluation framework) including quantitative, published ‘*state of the nation*’ statistics and qualitative interviews undertaken and used to develop and further conceptualise each of MANY’s four use cases. Quantitative measures set out to provide an objective, benchmarked indication of increased or decreased activity or output (e.g. number of hits on a website, increased patient numbers handled in a day). Qualitative measures set out to provide a more subjective, benchmarked indication of experience or emotion (e.g. feel less lonely, feeling more confident).

Below is an example of how LUMS went about developing benchmarks that fit with our overall objective of wanting to look at aggregate measures of *business innovation*, *wellbeing*, and *safety and resilience*. In the instance of the health and social care use case the benchmarks were agreed as follows:

- The **business innovation** benchmark relates to how GP video consultations improve productivity of GP appointments. If the MANY project can help the GP surgery manage its appointment services more efficiently, savings could be made by the GP surgery.

- The **wellbeing** benchmark relates to seeing an increase of GP video consultations with the Coverdale community (and associated improvement in digital skills) and reduction in the possibility of exposure to cross infection.
- The **safety and resilience** benchmark relates to reduced cost of travel and time for patients travelling to the GP and avoidance of missed appointments due to lack of public transport alternatives.

Table 1 shows the current state of play in relation to *state of the nation* statistics that are already in public domain and policy and produced and published by reputable bodies. Pre-existing statistics or ‘facts’ are presented in relation to the benchmarks outlined for this use case to set a context for the importance and relevance of the benchmark measure that is being adopted for each use case (and here for the health and social care use case specifically). Further details of developing benchmarks for this use case are available in the appendices at the end of this report.

Table 1: Benefits realisation for Health & Social Care use case

Benefits Realisation	State of Nation	Our Setting (benchmark)	Post intervention
Business Innovation	BMJ Open: Average GP consultation time in UK 9.22 minutes.	Average <u>time</u> for booking, confirming and delivering health/social consultations during July/August 2018/19; 2019/20; GP Practice 7 minutes	
Well-being	BMA survey of GPs found 88% want greater use of remote consultations (BMA 2020) Covid-19 causing increases in anxiety levels (ONS, 2020) associated with exposure risk.	Average number of video consultations on the area during July/August 2018/19; 2019/20 currently zero (0) Reduced exposure to infection risk: current exposure 60 people per day	

<p>Safety & Resilience</p>	<p>Average journey time in England to GP is 8.6 mins, and to hospital is 19.6 mins (Department of Transport, 2017)</p>	<p>Reduced cost of travel and time for patient. No public transport available in the area.</p> <p>Local GP: 9 miles each way Own Car @ £0.45pm time 20 min £8.10 return. Taxi: £34 return</p> <p>Hospital: 49 miles each way Own Car @ £0.45pm time 1 hour 25 min. Plus £5 parking = £49 return Taxi: £ 162 return</p> <p>Source: https://www.nidirect.gov.uk/articles/taxi-fares</p>	
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It is important to highlight here how in the later stages of the MANY project the evaluation and benefits realisation of the use cases was undertaken more directly by the Use Case leads and the project managers working on the MANY project, particularly in relation to economising the benefits. This shows when it came to valuing and realising the benefits of the use cases, a three-way activity took place between academia, practitioners and through policy to enable completion of the benefits realisation to take place. The final evaluation and benefits realisation measures are included in the final benefits realisation spreadsheet.

Other evaluative measures used in the project included TRLs (technology readiness levels[i]) agreed between the MANY project and DCMS project managers. As the name implies, these levels indicate the level of readiness of the proposed technology at the start of the project and the target TRL at the end of the project, showing the expected time the technology will come to market with and without the MANY project intervention. For example, virtual video calls as part of the health and social care use care:

TRL at start of project – TRL 5 – technology (technology validated in relevant environment)

TRL at end of project – TRL 8 – technology (system complete and qualified)

Expected time to market without funding – 2026

Target time to market - 2022

[i] Technology readiness levels [h2020-wp1415-annex-g-trl_en.pdf \(europa.eu\)](https://ec.europa.eu/euro-iss/technology-readiness-levels-h2020-wp1415-annex-g-trl_en.pdf)

Impact

The impact of our intervention has been varied and almost everywhere positive. Some benefits are easier to measure than others. For example, an increase in revenues is potentially trackable and measurable, whereas the effects of an increase in wellbeing in a small rural population is very difficult to measure and track. The **Health and Wellbeing** use case was the hardest use case to measure. For the medical appointments by video, we were able to demonstrate that a significant time saving could be achieved by patients not having to travel to the surgery. In rural areas, with poor and sporadic public transport, a visit for a routine ten-minute doctor's appointment can take up to 6 hours or longer, due to the timings and frequency of public transport. In many rural areas, elderly and infirm patients rely heavily on family and friends to transport them to appointments. These are 'hidden' costs and a saving cannot be measured accurately.

With the recent cost-of-living crisis, and with some elderly rural pensioners not having much money or pension income, a saving in transport costs can be vital. Many elderly women in particular who have lived in a rural setting all their life, may have worked locally and for little income and, therefore, may not have a significant pension income. A trip to town to see the doctor can be a significant cost element.

6. Key learnings

There are inevitable challenges working on projects of this size and the development of an evaluative framework that shifts action.

Issues raised with the process of using a benefits realisation framework include:

Benefits realisation as transitional objects

We felt forced to put in metrics before we had even spoken to any of the stakeholders, for example the number of people we wanted to connect, or the perceived value of the connectivity. In other words, it is difficult to pre-specify what the project is able to deliver, leading to stakeholders effectively operating in an 'imaginary world' to complete KPIs and metrics. However, while much fewer people have ended up connected, we could say this limitation represents a market experiment with real opportunity for scale up. As one project stakeholder said:

"you start out with a number of perceived benefits, you realise a number of actual deliverables [through use case development]. Only then can you report what the beneficiaries have actually achieved in their own minds that provides maximum benefit to them."

Theoretically, a lesson learned through this process is the need to develop and establish frameworks that hold in place ambiguities that allow for experimentation and discovery while providing a clear pathway for project development. For example, it is important to acknowledge the importance of the benefits realisation, by not looking at the benefits as final or static, but to look at them as transitional objects, that enable us to illustrate benefits in a more holistic, less restrictive way.

Community engagement central to market experiments

Speaking and engaging with stakeholders and community members is central to market experiments. We undertook this approach by using the Responsible Research and Innovation (RRI) framework as an evaluative tool (Owen, Macnaghten, & Stilgoe, 2012), to inform the MANY project’s actions as they worked to put in the right digital ‘future proof’ infrastructures for a very rural community. The RRI framework is constituted through four core principles: *inclusion* of the “right” forms of knowledge and expertise – such as scientists, business practitioners, policy-makers and community groups – and their *anticipation, responsiveness* and *reflexivity* throughout the innovation process. Used to organise the co-development and implementation of a practical, Grand Challenge problem-solution, we used the RRI framework in the production, circulation and consumption of multiple forms of distributed knowledge in the research and innovation process (cf. Stilgoe, Owen, & Macnaghten, 2013). In other words, we used the RRI framework to govern how the MANY project is performed in practice (Kuhlmann & Rip, 2018) - see figure below:

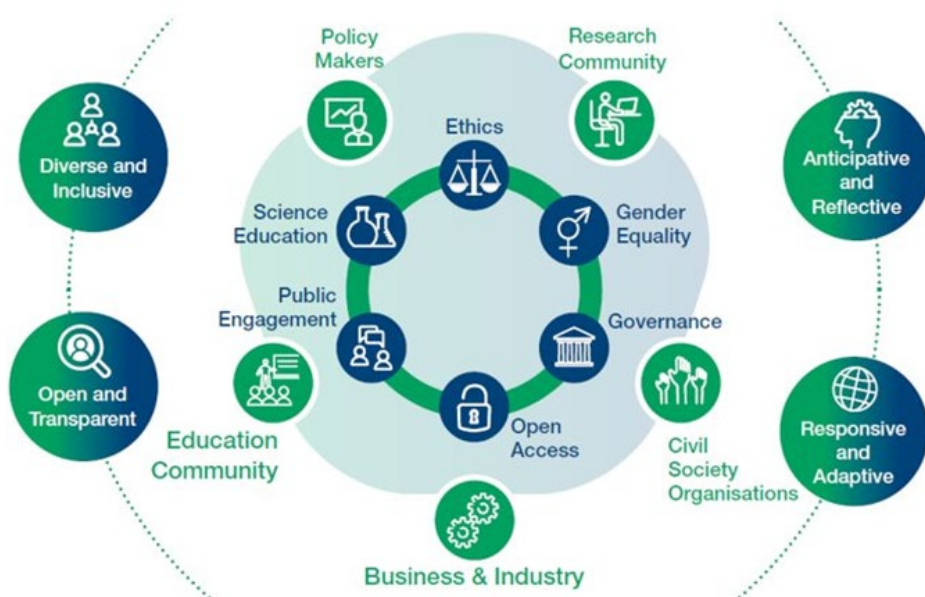


Figure 4: The Responsible Research and Innovation Framework

Taking this approach, we learned that community engagement transforms how projects are made valuable to communities. More specifically, we learned the importance of inclusivity and the need to capture multiple and often contradictory voices of citizens at the heart of the MANY project. Community engagement is not a straightforward process, so we identified four principles to help inform best practice: engage early and often, be transparent, inclusive, open, and honest – and a variety of methods to develop an understanding of everyday rural community life, the entanglement of peoples lived experience of home, work, business, community, and connectivity technologies. An inclusive approach to community engagement helped the project develop an in-depth understanding

of how rural communities value connectivity technologies both socially and economically and brought to light key community concerns about the possible introduction of new digital infrastructures.

This in turn enabled us to develop a community engagement tool-kit. We used social science insights as key learnings from the MANY project. We have shared the community engagement tool-kit with DCMS and other 5G and digital connectivity stakeholders. See Appendix 1 for a copy of the tool-kit (this is also available as a pdf). The community engagement tool-kit summarises three key research findings revealed through the evaluation of the project:

- working with the community
- generating joined-up thinking
- setting up for knowledge exchange

Below is a summary of the best practice learnings:

Best Practice Learning: Doing Community Inclusion Well

Our study revealed the importance of working with the community and in foregrounding community voices in the project. We identify four key principles that we think will help a project team do community inclusion, well:

1) Engage early and often. By contacting community members early on in the project (through community engagement events and Parish Council meetings, through a dedicated project website, newsletter, mailings, and social media), we raised awareness of the project within the community. We advocate the continued regular engagement throughout the life of a project to involve the community as the project evolves and develops;

2) Be transparent. By clearly articulating the aim of the project, sharing insights and developments across the project and with the community, we generated a mechanism for the community to raise concerns and ask questions, and have them addressed. We were transparent about the project unknowns (e.g. exactly which communities would be connected; exactly what technologies would be used), and shared our learning and progress with the community as our understanding of the technologies and the socio-political landscape grew.

3) Be inclusive. We used multiple engagement platforms to be inclusive. Not all our participants were comfortable enough to talk at Parish Council meetings, some felt concerned about doing a research interview, some only wanted to engage with us via email or via the project website and telephone number. Some were unable to engage in interviews or Parish Council meetings via video conferencing due to poor connectivity but were able to engage via their landline. We also provided updates and reports to community residents via post.

4) Be open and honest. By working with the community and highlighting the challenges involved and typically experienced in such a project, we gradually built trust through transparency. We shared insights of the implications of working on a project during a global pandemic, working with multiple partners, finding suitable methods to communicate with the community without relying solely on digital communication. We did this through traditional mail shots and a continuous open

communication channel through the project website and telephone number and acknowledging this is a testbed and trial and so mistakes will inevitably happen.

Best Practice Learning: Putting Joined-Up Thinking in Place

Our study revealed the value and opportunities to join-up thinking across projects and communities in a single place or site of intervention. We identify five key principles that we think will help a project team develop a joined-up thinking approach in place:

1) Develop a peripheral vision. Developing peripheral vision will help situate your project within the specific place and community you want to impact. First, identify the key people that have a potential interest in your project. These people are beyond the boundaries of the project, and often occupy key roles in your community. Next, ask them to share their local knowledge and help you develop a place centred approach to your project. Engaging with key community members, local NGOs and other organisations of interest to your community will generate new enquiries and conversation that enable you to unfold new, innovative action plans. Coordinating your plans with interested external parties will open up new opportunities for collective action, further supporting socio-economic flourishing in place;

2) Make transparent the different social worlds and institutional logics that are at play in the project. By recognizing the value of each form of expertise and different interests that are brought together in a complex digital infrastructure project, expansive learning can be generated. This requires identifying the different worlds and directing project team members' differences between them, the logics that operate within each, and how these logics might bring key groups to reach certain kinds of conclusion. The key idea behind this principle is that from understanding comes compromise and innovative ways forward;

3) Reflect and understand tensions within a place. Developing a more holistic understanding of place, and the tensions between the different stakeholders and actors engaged in that place, offers the foundations for reflective and reflexive conversations about the project's innovative next steps. By building key points of reflection into your project, local, situated knowledge can be used to unfold what the project becomes, what it delivers and the benefits it realises.

4) Anticipate differences and question your assumptions. As part of the reflexive process, projects should seek to anticipate and continuously question their assumptions about what they know, and what they think other key stakeholders in place know. This is a difficult and engaging process, but represents a key aspect of putting RRI into practice.

5) Develop mechanisms to resolve tensions. We used social science enquiry to put in place project mechanisms that would drive join-up thinking and to use this to overcome and resolve tensions in a place. Many university-based researchers are interested in supporting these kinds of projects. Include researcher time in your project proposal and enrol expert knowledge activism and intervention. Alternatively you could develop a project brief and assign responsibility to a project member to do this work and to evidence how it feeds into unfolding project plans, as the project progresses.

Best Practice Learning: Running Complex Projects in Place

This study revealed the valuable role and practices of knowledge activism within the project, with key project stakeholders. We identify three key principles of knowledge activism to help project leads and project group members identify and repair institutional voids that emerge as their project unfolds:

1) Allocate the role of knowledge activist and boundary spanner to one or two project members; By identifying and making clear to all project group members who your knowledge activists are, the purpose of their role and how they will work. Knowledge activists provoke change by sharing and connecting knowledge. Having project members understand this role will help your knowledge activist do their job, and help the project to develop and prosper by providing an important mechanism for joining-up thinking and knowledge exchange. Celebrating positive outcomes that result from this role as the project unfolds can also be important to demonstrate the value of it to those you are trying to enrol in its activities;

2) Be open to where the boundaries are in the project. Boundaries usually emerge as projects progress, stopping the dynamic flow of information across different elements of a complex project. Boundaries typically emerge when different experts work together in a new setting. It is important that project members do not make assumptions about where boundaries are, but rather look out for the emergence of boundaries. Boundaries may be inter-organisational or between groups of experts that use different technical language or logics to make judgements. Project tensions tend to emerge at boundaries;

3) Create knowledge sharing mechanisms within the project and lead knowledge sharing activities. Your project needs you to put in place knowledge sharing mechanisms and activities to support effective knowledge activism. Project meetings, smaller inter-organisational meetings, collaborative events with other projects - conferences, workshops, seminars - are all mechanisms for knowledge activism and knowledge sharing. Make sure that your knowledge sharing activities emerge from the coordinated efforts of project members: get people involved and advocate knowledge sharing through inter-organisational meetings.

7. Dissemination

Our objective for dissemination of the project's aims were two-fold:

- To maximise reach of 5G as a solution in supporting rural lives and livelihoods
- To maximise reach of the findings of MANY to industry stakeholders by showcasing innovative work nationally and internationally of project and partners

The following text comments on highlights and metrics for our dissemination activities.

Headlines

- Over 400 million reach across all communications. This has included 23 events, 36 press cuts, 4 broadcast pieces (including BBC Click), 39 industry blogs and just under 4,000 attendees at events hosted by or, where MANY were involved
- Press has included hyperlocal, regional, national and international coverage highlighting how 5G can support rural lives

- 28% of attendees at events heard direct from MANY via speaker roles
- Our newsletter had an average of a 65% open rate
- 44 members of the community had an active role in the project (15%)
- Sentiment changed from being cautious to supportive. This included the MRT team publicly supporting the project, residents highlighting the benefits of the technology and acting as advocates within the community. We saw an increase in awareness of the project outside of North Yorkshire and across other rural areas which increased the numbers attending the final event
- Industry sentiment included being seen at the forefront of engagement and working with and for community's as well as other rural stakeholders highlighting the county as at the forefront of emerging technology, supporting our priority of placing North Yorkshire as a digitally enabled county and included being used as case studies by DCMS in APPG meetings on loneliness

Final outcomes

- A successful 5G Fixed Wireless Access deployment in a very rural area which will be rolled out through the Superfast North Yorkshire project, as part of Quickline's commercial projects. This has proved that 5G can support rural communities.
- Commercialised element of Mountain Rescue communications technology with ongoing conversation with 4 Mount Rescue Teams across the North of England.
- Community toolkit to engage local people with 5G deployments has received interest from several Local Authorities.
- NYCC project Smart Places has been driven forward by the learnings of MANY and allow the County to be placed further as a innovative county which is better connecting its residents, businesses and visitors
- NYCC are now rural thought leaders and are regularly contacted by other LAs to support smart places strategies.

Inputs: Planning and Content Creation

METRIC	ONLINE / OFFLINE	ACTIVITY	MEASUREMENT
Total spend to date	Both	Aggregate total spend so far	£65,000
Content creation	Both	Infographics, videos etc	25 videos 5 x factsheets

Volume of press releases	Offline	No of press releases sent out	7
Volume of SM releases	Online	No of releases to owned social media channels	300 - twitter

Outputs: What the activity delivered and audience reached

METRIC	ONLINE / OFFLINE	ACTIVITY	MEASUREMENT
Estimate total reach	Both	Aggregate audience reach	400,085,952 (does not include all press reach)
Events	Both	Volume of events	3 x digital leaders 2 x 5G World 1 x 5G Showcase 1 x Connected North 2 x Community event 2 x online community event 8 x parish council meetings 1 x end of project event 1 x Open RAN Europe 1 x 5G Safety in place 1 x Lifting the lid on 5G safety 1 X discussion event Total = 23
Volume of coverage	Both	# exposures	36 x press cuts (up to June 2022) + 8 x sponsored content 4 x broadcasts (break local/national) BBC Click, BBC National news, Look North x 2 4 x Tech UK 31 x UK5G (blogs/ articles) 1 x Lancaster University Mgnt School article 2 x Rural Services Network blogs – website/ newsletter 2 x CLA North – newsletter 21 x Internal articles Total = 106
Estimated total reach (the total number of people available to reach)	Online	Launch Comms - Coverdale Sponsored content – digital champion	<ul style="list-style-type: none"> ● UK Authority ● Richmondshire Today ● Telecompaper ● Northern Echo ● Government Computing ● Richmondshire Today

		<p>MANY hears experiences</p> <p>Planning</p> <p>Forbidden Corner</p> <p>5G Supports MRT</p> <p>Go live/ Forbidden Corner case study</p> <p>5G Showcase – Quickline</p> <p>Newsletter</p> <p>Internal articles</p>	<ul style="list-style-type: none"> ● Northern Echo ● Northern Echo ● Richmondshire Today ● BBC National News ● Richmondshire Today ● The Stray Ferret ● Gazette Herald ● Northern Echo ● Richmondshire Today ● North Yorks CC ● UK5G ● Darlington and Stockton Times ● York Press ● Look North ● BBC News/ website ● BBC Click ● BBC Parliament ● UK5G ● Richmondshire Today ● Harrogate Advertiser ● York Press ● Yahoo ● Tech Tribune France ● Daily Advent ● Communicatistama (Italian) ● Tech Register ● Business Fast ● Yorkshire Post ● Richmondshire Today ● Hull Press ● 80,419 (LUMS an MANY online, printed copies, NYNow) ● 15,000 audience
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			Over 400,000,000 reach across local, national and international channels
Events	Both	Attendees	600: 5G Showcase event 300: Digital Leaders 100: 5G World 900: Connected North 185: Community events 65: MANY end of project 10: Parish Council 127: 5GTT Collaboration event 1680: Open RAN 23: LUMS Discussion event 75: 5G in place Total = 3,995 attendees
Social media	Online	Owned channels/ Partner channels Twitter LinkedIn	52,492 Reach 29,020 Reach Total – 81,512

Outtakes: Responses to content

METRIC	ONLINE / OFFLINE		MEASUREMENT
Social media	Online	Impressions Video views	137,190 impressions from owned channel only 1,145 views
Website	Online	Page views Users Referrals (Social, email, other)	20,500 (Website and Intranet) 6,214 1,141
Events		Interactions at events (speakers/stands)	Connected North – 200 5G Showcase – 100 x 2 sessions 127 viewers for OpenRAN 185 - Community event (online and physical) 300- DL

			65 – End of project event 11 – Discussion event 75 – RSN Digital connectivity event Total - 1088 (28%)
Partner channels Lancaster University Mgmt School MANY NY Now	Online	Open Rates/ Impressions	LUMS - 45% open rate/ 43 clicks - 1,993 impressions MANY – 68% open rate NY Now - 1300 clicks Tech UK – 510 views

Outcomes: The result of the activity (engage with the project; understand the benefits of 5G/ digital connectivity to rural areas/ advocate the project)

METRIC	ONLINE / OFFLINE		MEASUREMENT
Involvement		Registered triallists	40 x residents triallist plus 2 x business (Forbidden Corner and The Saddle Rooms) 1 x GP practice 1 x Mountain Rescue team 3 x other areas of NY requesting to be part of the project 11 x Emergency Service groups interested in being involved in the technology
Sentiment – North Yorkshire residents	Either	Degree to which the message has been positively or negatively received	<p>Comments <i>SMRT refused to take part in any public promotion and now is publicly supporting the project and 5G</i></p> <p>Great project to be part of – SMRT</p> <p>SMRT – Advocate <i>Yesterday a few team members braved the elements to work with the BBC film crews looking at the testing we have been doing on</i></p>

			<p><i>some exciting new 5g mobile technology</i></p> <p>SMRT – Advocate <i>Today was a demonstration of rescue relevant data (video, Drone footage, Medical data & communications) being streamed live via a standalone 5G base station and then on to the internet via satellite.</i></p> <p><i>We need 5G in Rosedale, Hillam, Braidley</i></p> <p><i>I've heard about the great stuff which is happening in North Yorkshire</i></p> <p><i>'We're going to have to introduce this technology'</i></p> <p><i>'5G projects findings – how it is being used in a visitor environment in a rural location – attractions, events and IOT aspects around Wi-Fi, footfall and parking data to support decisions'</i></p>
<p>Sentiment – industry</p>	<p>Either</p>	<p>Comments</p>	<p>What a masterclass in emerging tech/ IoT implementation in Local Government 🤖 Inspiring stuff! @northyorksc</p> <p>mobileaccessNY on Twitter: "Thank you @schulite - understanding how people use tech and what is needed for an area to truly engage with tech is so important in order to #levelup" / Twitter</p> <p>Informative event for MANY findings</p>

			<p>Extraordinary approach to the rural economy through digitalisation. Bravo UK</p> <p>Stakeholder engagement is so important.</p> <p>MANY is setting the bar high on engagement work</p> <p>Mentions in DCMS Minister address to APPG for Loneliness</p>
<p>Project outcome</p>			<ul style="list-style-type: none"> ● Extension of project – March 22 ● Discussion of new project post end of project ● Community toolkit discussions with DCMS ● Engagement in Centre for Thriving Places commissioned research ● Commercialised tech for Mountain Rescue teams ● 10 residents connected. Commercialised network available to over 300 residents. 15 x residents have requested access but are just outside of the coverage area but will be picked up by SFNY ● Network to be deployed across North Yorkshire as part of SFNY ● Driven the Smart Places project forward with learnings linking into NYCC digital strategy

			<ul style="list-style-type: none">● NYCC speaking at Connected Britain. Contacts made with other LA to discuss smart places strategies/ DCMS conversations re. evidence based data.● Continued contact with BBC Click
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