Technology and Innovation in the NHS – Call for Views

Introduction:

This document constitutes the response from Tactical Wireless Ltd to the Call for Views from the Scottish Government concerning the topic of “Technology and Innovation in the NHS”.

From our experience working with NHS Highland, Tactical Wireless Ltd (TWL) recognises the scope, ambition and challenges embodied in the Scottish Government’s 2020 Vision document in the context of telehealth and digitally enabled health and social care practitioners: secure, reliable and resilient communications are essential.

Tactical Wireless Ltd (TWL) has developed Omni-Hub™, a universal sensor and communications hub that operates over a secure, private network, Omni-Hub.Net, to provide communications in remote and difficult areas. Omni-Hub™ integrates as many communications networks as are available, to maximise bandwidth availability, whilst using data, audio and video processing, to reduce bandwidth demand.

The original concept for TWL’s technology came from Satellite Applications Catapult (Catapult), from whom TWL secured a contract for benchtop prototypes, and was further developed with the aid of de minimis R&D funding from Highlands and Islands Enterprise (HIE). TWL continues to work with NHS Highland, conducting trials of Omni-Hub™ in the Highlands, to develop operational protocols and systems so that health and social care practitioners can make maximum use of the tools they have as well as advice from remote experts.

TWL is committed to building a manufacturing facility in the region, once sales at scale have been secured.

Details of the technology are shown in Annex 1.

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1 A route map to the 2020 vision for Health and social care, NHS Scotland
Medical challenges in the Highlands and Islands:

The problems associated with providing health and social care to all parts of the Region is beyond the scope of this document but it is well understood in NHS Highland and in the wider Scottish healthcare community. The Highlands and Islands are sparsely populated and require innovative solutions. A map of the Region, with healthcare locations, is shown below:\(^2\):

![Figure 1: Healthcare locations](image)

Health and social care practitioners already use smartphones and tablets to support their activities but the full capability of these tools is blunted or nullified where communications are poor or bandwidth is limited. As telehealth technologies and procedures are developed and put into operation, these communications tools will become more essential to ensure that data [audio, video and diagnostic] is available to experts who may be located 10’s or 100’s of miles away across rough terrain.

\(^2\) NHS Highland website
It is expected that fibre optic broadband will be available to much of the Highlands and Islands population, in due course, but this still leaves the problems of mobile connectivity and the substantial minority of the population, living in remote areas that will not benefit. Any solutions should, ideally, provide improved patient care at a lower cost. This means addressing the treatment of chronic illness, acute and emergency medicine, routine GP and outpatient requirements and social issues, particularly for aging and vulnerable individuals.

Healthcare Improvement Scotland supports the healthcare priorities of the Scottish Government, in particular those of NHS Scotland’s Healthcare Quality Strategy and the Scottish Government’s 2020 Vision. Its role includes issuing alerts to notify NHS Scotland of the publication of NICE Guidance and advise on its applicability to Scotland.

The solutions will be based on a range of technologies and processes but improved communications are a vital element of any solution. Many organisations are developing front-end medical devices and end-to-end software solutions but these require connectivity, in a wide range of scenarios, to make them effective. Omni-Hub™ can be the enabling technology that is a unique, integrated solution.

The overall approach is consistent with the requirements of the 2020 Vision as summarised in Figure 2:

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3 A route map to the 2020 vision for Health and social care, NHS Scotland

4 ibid
Even today, despite advances in the capabilities of communications systems over the past twenty years, resilient GPRS, 3G, 4G and Wi-Fi coverage is still patchy or non-existent in remote areas. This environment points to the need to provide something new in the business process of healthcare, to shift medical intervention from surgery and hospital out into the field, resulting in a lesser requirement for individuals to attend centres of expertise, and, critically, to enable timely and accurate intervention to acutely ill patients; both of these instances enabled via resilient and secure communications paths.

Considering the lack of general availability of terrestrial mobile systems, there is a compelling case for increased integration of satellite based communications (SATCOM) into the mix of communications to be used for patient related data transmission. However, simple reliance on satellite communications has a disadvantage in terms of cost; what is required is a highly usable communications system that can automatically choose between all communications paths depending both on what is available at a location, and the priority of the data being transmitted.

- Despite network improvements, the problem is not just in the obvious areas such as Cornwall, the Highlands, East Anglia and Wales. At the end of 2015, only 37% of the land area of the UK was covered by 3G and 46% of the population by 4G.
- The need for telemedicine is understood but data transmission limits options in remote and rural areas.
- In any case, some medical devices have data transmission requirements of more than 3 Gbps compared to a typical broadband connection of 25 to 30 Mbps.

**TWL Experience to date:**

TWL is promoting its technology in several market sectors, which include:

- **Social and Medical care – chronic and acute.**
- Smarter Rural Communities.
- Logistics – Shipping Data Management.
- First Responders – Police, Fire, Ambulance, Bomb Disposal, HMCG, Mountain Rescue.
- Surveillance – covert and overt.
- Temporary Events – Sports etc.
- Critical National Infrastructure.
- Defence – Special Forces, Medical, Rapid Deployment.
- Remote agri- & aqua-culture.

TWL already has a presence in the Highlands and has demonstrated that it is able to make a substantial contribution, based on:

- TWL engineers have driven more than 50,000 miles in the Highlands and Islands Region, as part of the system development phase, measuring and recording cellular
and satellite connectivity thus enabling the appropriate system design. Consequently, TWL has a thorough understanding of the connectivity requirements and solutions to support healthcare projects. Cellular transmission of HD video is possible in most areas, given good antenna design and the bonding of multiple cellular streams. The use of L band satellite has been necessary on some occasions. For fixed installations, the use of KA and KU band satellite technology will add resilience and bandwidth. Omni-Hub™’s Video Management System (VMS), Crossfire, enables end users to limit the bandwidth requirement, which is vital as a cost management tool – transmission of what is needed rather than what is possible.

- To date, TWL has successfully conducted trials with Scottish Universities, HIE and NHS Highland. The details of the projects to date are:
  - **SURS** – Satellite Ultrasound for Rural Stroke working with the Centre for Rural Health, University of Aberdeen and Highlands and Islands Enterprise.
    - Research project to see if ultrasound can aid pre-hospital diagnosis of strokes – achieved 94.4% diagnostic quality from very remote locations, using cellular and BGAN (L-band satellite) both individually and together.
    - Ultrasound output of 3 Gbps but **diagnostic quality** was achieved using a < 500 kbps link – HD (1080p) quality.
    - Integrated solution, converting the ultrasound machine output to a series of electronically watermarked JPEG’s for store and forward and control of compression, frame rate and image resolution.
  - **Reducing Amputations in People with Diabetes (RAPID)** – working with the University of the Highlands and Islands, Highlands and Islands Enterprise, Satellite Applications Catapult and NHS Highland.
    - Aim is to provide remote consultations for diabetes patients and to reduce the need for patients to travel long distances across the Highlands and Islands.
    - Positive patient outcomes achieved from the work to date.
    - This is an example of a chronic illness - support to social and health workers in the field.
  - **Kent, Surrey and Sussex Air Ambulance Trust** – Joint development of a bespoke portable system for paramedics – successful 18 month evaluation complete and deployment is imminent on a new helicopter.
  - **Remote Highland Communities** – provision of connectivity from a GP in a remote area to his surgery, over a secure private network.
    - Omni-Hub™ installed in a GP surgery – Armadale Medical Centre.
• System bonds cellular, KA-band satellite and ADSL, to provide a resilient and secure broadband capability.

• Crossfire Server is installed, to enable video to be managed within the network.

• Lightweight, robust Hub issued for out-of-hours trials – ongoing – to enable nurses, doctors and other medical professionals to have a mobile, secure hotspot to support smart devices and to enable emails, voice over IP audio (VoIP), browser access and video transmission.

  o **Limitations** – trials to date have been limited by the need for full adoption of the technology by NHS Highland.

  ▪ In December 2016, initial trials by eHealth demonstrated the ability to securely access key databases over Omn-Hub.Net – these databases included but were not limited to Skystore, Adastra, Vision and ECS.

  ▪ In all trials to date the central hub of the system has been in TWL’s facility, with the NHS being provided with access. The central hub, for NHS purposes, has been simulated using an IPSec, secure VPN link to TWL. This has introduced a restriction, based on low bandwidth links within the NHS, that would not be there in a full installation.

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Annex 1: The Omni-Hub™ technology

The Technology:
The solution to secure, reliable and resilient communications in remote and difficult areas depends on 2 issues:

- The environment – the connectivity and networks available.
- The application – the data rate required.

These factors can be represented by the following chart, Figure 3:

![Cost Effectiveness vs Operational Requirements Chart]

**Figure 3: Cost effectiveness vs operational requirements**

The quadrants can be described as:

- **Top Left:** the most difficult application in the most remote and poorly-connected area. An example might be the live transmission of scans from an ultrasound or other device. A raw ultrasound stream can be in the range 2-3 Gbps, well beyond the capability of any communications system. However, TWL has successfully transmitted live ultrasound over less than 500 kbps, at diagnostic quality. This requires in-field data processing and the use of multiple networks – 4 cellular plus optional satellite.

- **Top Right:** fewer communications channels may be required but data requirements still demand processing.

- **Bottom Left:** Data processing can be remote from the application but multiple channels are still required, to provide secure, resilient communications. TWL’s trials vehicles have successfully streamed video, albeit at lower frame rates, from most...
areas in the Highlands and it is estimated that 80-85% of the road network will allow video over cellular (based on TWL’s technology, rather than a cellular phone). Near 100% coverage can be achieved with the addition of a satellite option. The decision to use satellite or not is a function mission criticality.

- Bottom Right: TWL’s routing technology may be unnecessary but smart phones and tablets, on 4G/LTE, could still utilise TWL’s Omni-Hub.Net, to add security and network visibility, and Crossfire video processing, remotely located in the network. These options can be represented by the typical schematic shown at Figure 4:

**Figure 4: A typical Omni-Hub™ enabled system**

Key components of a successful communications system for remote areas include:

- Simultaneous use of multiple routes – cellular, satellite, ADSL, WiFi WAN – provides resilience, control of user operating costs and bandwidth.
- Antenna design – satellite & cellular.
- A long range WiFi hotspot around the unit.
- Data processing for large data requirements:
  - Compression algorithms.
– Video management systems to manage frame rate and resolution – transmit what is needed.

– The design of Omni-Hub.Net allows the user to locate Crossfire software anywhere in the network and to use Apps to access and control the operation. A remote user can use the Crossfire Camera App, configured to a server anywhere in the network, to stream images. Connection can be via an Omni-Hub™ hotspot or via an IPsec VPN to the central hub. A second user can log into the server and can view the Crossfire Camera or any other connected device, such as a medical scanner, from anywhere, again via an Omni-Hub™ hotspot or via an IPsec VPN to the central hub.

• A secure private network to allow access to any device, from within the network or via secure VPN.

• Multiple security levels, including IP networking, individual packet routing, secure VPN connections and encryption (AES 256).

• An integrated approach to provide users with a one-stop-shop solution. Solutions can be mobile (L-band satellite and cellular), nomadic (deployable KA-band and cellular) or fixed – see figure 5 below:

Figure 5: Scenarios

• Wide product range to provide the correct product for each application, based on end user requirements.
The system must also be able to accommodate software and hardware option, to include:

- Basic services:
  - Voice over IP, emails, messaging, video conferencing.
- Radio Messaging Systems.
- Server based Codec – Omni-Serve.
- Various video conferencing packages, including Jabber, VSee etc.
- Multiple specialist video inputs

**The art of what’s possible:**

Figure 6, below, shows a configuration in which a remotely located ultrasound scanner is linked to a specialist. The example is taken from the SURES (Satellite Ultrasound for Rural Stroke) programme in 2014/15, for which TWL won the Scottish Life Sciences Innovation Award in 2015.

In this case, volunteers were taken to remote areas of known poor connectivity and ultrasound data was acquired and transmitted to Raigmore Hospital. In this application a server based compression system (Omni-Serve) and Crossfire have to be located with the device. The raw output from the scanner can be up to 3 Gbps but can be transmitted at diagnostic quality at around 500 kbps and can be remotely viewed using Crossfire Apps.

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Figure 6: Remote ultrasound configuration