Handbook of Research on Global Diffusion of Broadband Data Transmission

Yogesh K. Dwivedi
Swansea University, UK

Anastasia Papazafeiropoulou
Brunel University, UK

Jyoti Choudrie
University of Hertfordshire, UK

Volume II
Chapter XXXVII

Improving Health Services via Advanced ICT Networks

Peter Farr
Peter Farr Consultants, Australasia

Isabelle Ellis
Charles Darwin University, Australia

John Royle
Reliance Consulting Pty Ltd, Australia

ABSTRACT

This chapter describes an innovative broadband initiative that connects a group of general practices, medical specialists, hospitals, and other health providers in rural areas of Australia through a managed virtual private network. It provides secure connectivity for a variety of mission-critical healthcare delivery applications—for example, transmission of pathology and radiology test results direct to clinicians. The medical practices involved are small-medium enterprises (SMEs) and the key aspects of ICTs for them are the impact on costs, productivity, and customer service. The formal evaluation process examined the domains of appropriateness, efficiency, and cost-effectiveness. Being the first such health network of its kind in Australia, the project encountered challenges and, by overcoming these, has been guiding government policy in respect to e-health. Initially funded from March 2005 via a Commonwealth Government grant, the GoldHealth network moved into a sustainable mode in July 2006. This chapter provides insights into GoldHealth and should be a useful guide to any similar broadband network initiatives for the health sector elsewhere in the world.

INTRODUCTION

The term e-health has become widely prevalent since originating in the year 2000. The stakeholders considered to be the users or targets of e-health vary with a range of definitions. Some definitions emphasize applications for providers and organizations—particularly those stressing electronic data exchange for clinical and administrative purposes. Others emphasize provision of information, education, and services to consumers, including patients and “citizens.” A small number clearly identify e-health with consumer health informatics.

E-health is widely proposed to be a solution for the lack of medical and other healthcare specialists
in rural, remote, and outer metropolitan regions of many countries, including Australia. However, to realize the potential benefits, the infrastructure needed to provide many of the services requires sufficient bandwidth to allow transfer of large data files. Affordable broadband transmission is therefore seen as a key enabler and change agent for secure, functional, and equitable participation in e-health activities. Conversely, having broadband does not necessarily mean that health IT penetration will automatically follow (Farr, October 2006).

Exchanging highly sensitive personal and health information requires an acceptable legal and privacy framework that ensures that such information can be transferred securely to authorized users for approved purposes (National Health Information Management Advisory Council, 2001). This requires a secure broadband connection. Increasingly, healthcare providers are implementing a secure broadband connection to not only help improve their daily business processes, but to enable better collaboration in patient care, continuing professional education, and so forth. Although these challenges have been recognized for a relatively long period of time in the literature, there has been a huge diseconomy of scale when individuals, institutions, and medical practices have considered establishing electronic health information management systems, as, for example, in the Australian healthcare system where each institution and general practice operates separately.

Rural residents in Australia tend to have poorer health status and less access to health services (Simmons & Hsu-Hage, 2001). The cost of healthcare, the lack of choice, and the lack of access to health information is of concern to consumers (Bourke, 2001). It is also recognized that there is a difficulty in attracting and retaining medical, allied health, and nursing staff in rural hospitals, remote community health services, and so forth.

Against this background, the potential to improve access to healthcare has been used by governments as a vehicle to encourage adoption of broadband in urban, rural, and remote Australia. For example, in 2004, the “Broadband for Health” initiative funded broadband Internet access to general practices and Aboriginal Community Controlled Health Services across Australia. Despite the logical benefits of implementing e-health systems for rural and remote areas, there have been difficulties in diffusing these services.

A variety of change management models and methods have been proposed for implementing e-health, including: interaction design theory (Coiera, 2002); informatics, which has been the label put on sociotechnical systems design by a number of authors (Coeira, 2004; Hersch, 2002); and some more loosely put together frameworks such as that proposed by Kaur, Forducey, Smith, and Schneideman-Miller (2005) who propose that there are basic elements of organizational change, “strategy, structure, people and processes, all of which need to be addressed for a balanced approach to change.” Leonard (2004) points out that much of the research around implementing new technologies is “detailed and outline creative solutions and management theories, but have done little to facilitate the adoption of technology in healthcare.”

REFERENCE SITE OBJECTIVES

The primary objective of the Eastern Goldfields Regional Reference Site (EGRRS) was to test, measure, and demonstrate the benefits of healthcare providers working in rural and remote zones having access to high-speed, continuous, higher-quality broadband connectivity through which they may effectively and securely access a range of relevant information and communications applications, that is, e-health.

Prior to the EGRRS rollout in early 2005, the majority of medical participants had either no Internet connection or only dial-up Internet from their practice or home, and this would have been typical for medical practices in other regions of Australia at that date.

DEMAND AGGREGATION CONCEPT

The EGRRS broadband initiative provided a catalyst for organizations and individuals in the
Improving Health Services via Advanced ICT Networks

community to aggregate their demand for telecommunications services, potentially creating competition among providers and investment that will lead to greater sustainability and parity with metropolitan prices and conditions, hence supporting the Australian Government’s National Broadband agenda. EGRRS had strong support in advance from key stakeholders across the region including the Eastern Goldfields Medical Division of General Practice (EGMDGP), a large number of individual health service providers, and other local bodies including the City of Kalgoorlie-Boulder, the local Chamber of Commerce, and a number of mining companies.

The EGMDGP (http://www.egmdgp.com.au/) is one of 122 divisions of general practice in Australia. The EGMDGP was formed as a result of the Commonwealth Government’s General Practice Strategy developed in 1992. This has resulted in greater involvement of GPs in health policy, planning, and delivery of health services at the local and regional levels, working in collaboration with other health agencies and managing a range of health service programs.

Doctor members of the EGMDGP cover one of Australia’s largest regions (around the size of Texas), stretching from the town of Wiluna in the north to Esperance in the south, from the South Australian border in the east to Southern Cross in the west, with the city of Kalgoorlie-Boulder as the main center of administration. With a mix of metro-like, rural, as well as very remote geographies, the provision of quality health services is a challenging task. Prior to EGRRS, some key issues were:

- **Distance.** Due to the remoteness of healthcare practices in this region, communication of patient and medical information was infrequent and cumbersome between patients and health workers, as well as between healthcare practices themselves. Many patients in the region move regularly through communities and may see a number of different health practitioners for management of their healthcare. This causes a difficulty in establishing normal support structures for patients.

- **Cost.** Transport costs of medical equipment and patient visits in this region are high due to the great distances involved. Voice calls and fax alleviate some of the necessity of a direct visit, but when it comes to radiology images and other data that require large amounts of storage, direct communication is necessary, incurring a transmission cost.

- **Service levels.** There are less stable links between patients and GPs due to both the transient nature of the population and the turnover of doctors in the region. Digital patient records that are centrally stored in the doctor’s practices and easily accessible could greatly improve the continuity of patient care. However, due to the dispersed nature of healthcare workers in the region, coordination and advancement of the medical community as a whole is affected, with the participants in the healthcare supply chain (GPs, medical specialists, hospitals, pharmacies, etc.) operating independently of one another.

- **Security.** Healthcare practices need to be especially diligent about protecting confidential patient data. Compromized medical data can expose a practice to error-prone diagnoses, legal liability, and loss of confidence from the patient.

- **Consumer access to information.** Rising expectations of up-to-date and comprehensible medical/health information.

In 2004, the Australian Government’s Department of Health and Ageing (DoHA) invited telecommunications service providers to submit tenders for:

- The supply of EGRRS Broadband Services to participants in the EGRRS broadband initiative, to be paid for by DoHA for the Reference Site Period
- Provision of an EGRRS continuation plan under which participants may continue to acquire EGRRS broadband services for a further period of up to two years beyond the end of the reference site period at the same rates and on similar or better terms to
Improving Health Services via Advanced ICT Networks

those offered to DoHA for the reference site period.

A network with managed Quality of Service was sought that could handle all potential applications as well as providing essential security and privacy required by the specified health community. The successful tenderer for the network was IP Systems Pty Ltd http://www.ipsystems.com.au/industry_health_award.html.

**Links Between the Reference Site and Other Australian Government Initiatives**

The reference site formed a part of the DoHA’s *Broadband for Health* program which draws together a number of government initiatives including the Access to Broadband Technology Initiative, to support whole-of-sector broadband connectivity. The *Broadband for Health Program* is a $60 million Australian Government program to provide broadband Internet access to GPs and aboriginal community controlled health services nationwide. The program is a key component of the Australian Government’s revised HealthConnect implementation strategy and represents DoHA’s contribution to the national broadband strategy managed by the Department of Communications, Information Technology, and the Arts. HealthConnect aims to allow healthcare providers to securely transfer clinical information such as electronic referrals, hospital discharge summary reports, prescriptions, imaging and pathology requests, and results, and aims to create shared electronic health record repositories, guided by the iterations of National E-Health Transition Authority (NeHTA) with regards to standards and specifications for interoperability.

**SCOPE OF THE PROJECT**

The physical locations of EGRRS participants were linked together by a *Virtual Private Network*, with different forms of technology (optical fiber, DSL, and satellite) providing the link from each site into the core network.

The participants in the project comprised approximately 81 sites made up of 22 medical practices (health points) and 39 home points in rural Western Australia. Also involved were the EGMDGP offices at Kalgoorlie and Esperance, the Kalgoorlie and Esperance Hospitals, a pathology laboratory, a radiology service, three Kalgoorlie-Boulder pharmacies, a University Rural Clinical School, and the Royal Flying Doctor Service.

The scope of the project included these “Core” applications: Fast Internet access (at the surgery and at doctors’ homes) for medical information and other purposes, secure e-mail (at the surgery and at doctors’ homes), access to Medicare Online Claiming; VOIP telephony (both entry level and full IP telephony), desktop videoconferencing and boardroom videoconferencing, remote after hours access from home or a hospital to the surgery practice management system, and other applications residing on each practice’s server.

Also included were additional medical applications which broadly fell into four categories: (1) online education and peer support, (2) clinical therapeutic guidelines, resources and information services, (3) clinical applications, and (4) new technologies and small business tools relevant to healthcare providers.

**INDEPENDENT EVALUATION**

For the formal evaluation, DOHA appointed a multidisciplinary team led by Peter Farr Consultants Australasia. Their task was to thoroughly examine three domains: efficiency, cost-effectiveness and appropriateness, and the ability of the network to be replicated elsewhere. The methodology used was a pragmatic or “mixed methods” methodology, involving the collection and analysis of extensive quantitative and qualitative data. Relevant information for the evaluation was obtained from a very wide range of sources over a period of 16 months.

The use of controlled test scenarios was an innovative method used in the evaluation. Volun-
Improving Health Services via Advanced ICT Networks

teer doctors participated in realistic exercises that provided contextual use of the various e-health technologies. This enabled the doctors to envision the future, and consider how various technologies could be adapted or appropriated (Carroll, 2002). Examples included desktop videoconferencing and e-mailing images and other attachments. (The scenarios used related to dermatology and obstetrics cases). The test scenarios also served to help technically test the technology infrastructure and its appropriateness.

Recognizing that the gains or losses that might accrue from the reference site are likely to vary according to the intended target or user, the nature of the application, and the specific technological configuration that is used, a three-dimensional model linking health work, users and target groups, and technologies was developed and is depicted in Figure 1.

The executive summary of the project evaluation is available—see Department of Health and Ageing (2007a), together with a write up of the lessons learnt—see Department of Health and Ageing (2007b).

GOVERNANCE

It was never considered feasible for a regional health information network of the scale of EGRRS to operate informally. Accordingly, the overall governance structure in place during the EGRRS project period comprised (Peel, 2006):

- DoHA (the sponsor and funder), working cooperatively with the EGMDGP, EGRRS advisory committee, and EGRRS stakeholder reference group
- The network contractor (IP Systems)
- The evaluator (Peter Farr Consultants Australasia).

Figure 1. Three-dimensional model for the reference site evaluation
NETWORK SOLUTION

The technology foundation of the reference site was the Cisco Medical Grade Network which is designed to meet the rigorous security and performance requirements of healthcare organizations. The Cisco Medical Grade Network can be tailored to suit all types of healthcare organizations, from large scale hospitals to the smallest rural healthcare practice. Utilizing cutting edge network technology, a robust and scalable network infrastructure can be built to support various medical and applications (Cisco, 2005).

For EGRRS, the network consisted of a mix of Cisco routers and switches deployed over more than 80 sites across the region. For IP telephony, a mixture of Cisco IP phones and Cisco analogue telephone adapters were deployed at medical practices and the EGMDGP (Cisco, 2005).

Network Rollout

IP Systems installed the majority of the network points in March-April 2005, the endpoint broadband connections using a mix of optical fiber and DSL from a carrier (Telstra) and two-way satellite from PanAmSat. IP Systems installed its own Cisco routers in Kalgoorlie so that the group of sites in the Eastern Goldfields could be routed to its national backbone network. In this phase, on-site training was conducted in regard to Internet, e-mail, IP telephony, role of the help desk, and so forth. In Phase 2, IP Systems connected in further sites and revisited the Phase 1 sites for refresher training and addressing specific problems and issues. The EGRRS project team considered that using the staged approach to rollout of network and applications would give time for users to develop skills for each type of technology or application prior to the next “new thing” being deployed.

A network schematic is shown in Figure 2.

ADDITIONAL MEDICAL APPLICATIONS

The value of broadband is principally in two things—the first that it is “always on,” and second,
via the convenient/quick/cheap access it gives to relevant content and relevant applications. The suite of additional e-health applications that formed part of EGRRS addresses the latter consideration and was vital in increasing the “value proposition” for GoldHealth. Through an expression of interest process the EGMDGP invited software vendors, education institutions, and other interested parties to propose applications to be hosted on the network. A list of “additional” applications was selected and implemented. Training and support was provided by the suppliers of the additional applications and the EGMDGP project staff. The GoldHealth Additional Applications portal was launched at the end of October 2005, the rationale being that an applications portal would assist the participants in seamlessly accessing the whole range of applications (Farr, October 2006).

HEALTHCARE VALUE

The DoHA is quoted (Cisco, 2005) as being very optimistic in advance of the rollout about the potential benefits that the reference site could provide:

"Broadband is a key enabler for e-health applications such as HealthConnect, a system of electronic health records with cross-jurisdictional support in Australia. This type of cutting edge technology has not been experienced by participants in the past. Participants are gradually increasing their knowledge of the technology and potential for associated applications. As people become more aware of the capacity of the infrastructure, there are many ideas coming forward from the participants themselves to innovate the way they currently communicate."

At its core, the EGRRS aimed to bridge the geographical distances that separate healthcare practices within the large area. The ability to transmit digital data at high speeds across such distances vastly improves the ability of the healthcare practitioner to share information and receive peer support. Participants in the reference site were able to use e-mail, access the Internet at broadband speeds, and make voice calls via IP telephony. Sites had the ability to access clinical and educational information directly from the source, thus keeping themselves up-to-date with best practices.

Additionally, they were able to:

- Receive radiology and pathology reports electronically
- Transmit clinical images electronically to specialists for review
- Transmit and receive specialist reports without the need for scanning
- Connect to the Medicare Online Claiming to access services such as insurance and benefits information, claims, and processing, as well as immunization and organ donor registry lookups.

Through the various channels of communication available on the network, collaboration between sites was made easier, fostering a sense of community among the caregivers. As an additional benefit, this can also contribute to the ability to retain and attract more healthcare workers to the region.

The use of IP telephony allowed on-net voice calls to be made at a reduced cost compared with conventional telephony. Since IP calls travel as digital data along the high-speed network, quality and fidelity is kept at a high level using QoS. Staff members from any of the sites are able to make voice calls without incurring any long distance charges. With the VPN, staff members who move between sites had a convenient way to stay connected. Routine technical maintenance and support could also be done remotely, thus saving the time and cost of physical travel.

Video conferencing has also provided healthcare practitioners within the region the ability to conduct and receive training remotely. A government spokesperson is quoted in a publicly available case study (Cisco, 2005) as saying:

"For the most part, many of the health professionals involved in the project are minimal users of IT. There are some advanced users, or 'champions,' which are important people in terms of creating acceptability and understanding of the technology. Desktop videoconferencing capability will enable a practitioner to conduct remote consultations,
undertake education, and attend professional meetings without the need to travel.”

One important aspect of EGRRS is its ability to scale incrementally to future growth. Additional hardware and software can be added without the need for a drastic reconfiguration. Hence, this network becomes the seed from which further expansion and added services can be incorporated in the future. Additional applications which may be explored include backup services and disaster recovery—potentially important for small-medium enterprises (SMEs).

DISCUSSION

Overall, the project’s findings confirm the knowledge gained from research into similar projects involving the integration of new technologies. Broadly, the research suggests that diffusion of new technologies generally follows an “S” shape over time, with low take-up in the early months/years, then an increase in the rate of take-up, when network effects start to become significant and apparent to the group of people for whom the technology is intended. This is consistent with the innovation adoption curve of Rogers (1995).

Leonard (2004) has reported that once the decision to adopt a technology has been made, regardless of the industry, the amount of work required by the business increases until the new system is working effectively. How much the workload increases, and how long this effect lasts, has been linked to five critical success factors:

1. The amount of resistance to change and experience in using technology
2. The amount of training before and during the transition
3. The amount of buy-in, or contribution from stakeholder groups
4. The level of effective reporting on outcome measures during and after implementation
5. The level of effectiveness in dealing with “breaks” (i.e., setbacks)

An aspect that was certainly to be considered beneficial was the development of stronger relationships between participants (and with the EGMDGP) during the course of the project through project-related activities and events, including camaraderie-building social events.

Members of the project visited participants many times which generally involved extensive travel. They also made a big effort to balance work priorities with social activities for the project. This balance is important in service delivery for health networks, and should not be underestimated.

The major technical hurdles encountered were the technical problems affecting IP telephones and the satellite connected services.

An aspect that did not reach initial expectations for practitioners in rural and remote areas was on-net videoconferencing. Along with the voice over IP, this technology required the implementation of quality of service, which comes at a cost.

Training and support also were issues, compounded by staff turnover at medical practices. Limitations also arose from the relatively low level of ICT confidence of many participants at the commencement of the project.

The executive summary of the project evaluation is available—see Department of Health and Ageing (2007a), together with a write up of the lessons learnt—see Department of Health and Ageing (2007b).

SUSTAINABILITY

The initial set-up funding included both capital funding to establish the GoldHealth VPN and its associated services as well as the operational funding and support for a sufficient period to enable EGRRS to reach a viable level of operation and service. Funding of the project by DoHA finished as scheduled in June 2006.

Farr and Papandrea (2006) have found that the various factors that contribute to sustainability for community ICT facilities can be grouped into these three key interdependent dimensions:
Improving Health Services via Advanced ICT Networks

Figure 3. Diagrammatic representation of the sustainability model for community ICT facilities

- Financial resources
- Community empowerment and socio-economic impact
- Efficient operations and support systems

The interrelationship between these three key dimensions is illustrated in Figure 3.

Each of these three dimensions is critical to the viability of a managed health network. Also, because of the interrelationship between the dimensions, insufficient attention to any one of them will be likely to have an adverse impact on the other two.

It is the nature of ICT projects that there are economies of scale via aggregation and other means. If there are too few active participants over a very dispersed area, it will probably be uneconomic to offer or maintain a sophisticated service in the EGRRS style.

THE FUTURE

With respect to “testing” and “demonstrating” the benefits, this is an ongoing activity for GoldHealth which is the name the EGRRS project was carried forward under from July 2006. The great majority of participants signed up from July 2006 to continue with a network connection (IP Systems, 2006; Steigmund, 2006). Continuity of governance arrangements has occurred as a result of putting in place in July of 2006 a GoldHealth advisory committee and a stakeholders reference group.

Specific impacts of EGRRS on contemporaneous policy considerations or decisions include the aspect that the project has helped to inform the general development of change management around e-health. There are a number of specific outcomes that DoHA is believed to have taken forward from a policy perspective as a result of this project, including the Security Awareness and Conformance Report for the Broadband for Health program, the managed health network grants which have been significantly informed by the EGRRS experience, especially considerations of change management and governance of such projects (Peel, 2006). Wider issues around broadband infrastructure and access for the health sector, especially in remote areas, have also been informed by this project and are being followed through at the national broadband policy level.

The local division of general practice was well received by participants that it is now able to be sustained as a viable network under the name of GoldHealth,” said the CEO of the EGMDGP. “The GPs and practices throughout the region have embraced the concept and recognized that there are significant benefits. Just as importantly, GPs throughout the region have realized that e-health is a part of the future of medicine and primary
Improving Health Services via Advanced ICT Networks

care and GoldHealth is at the forefront of it” (IP Systems, 2006).

It is considered that health communities are needed from which lessons can be learned in terms of standards generally and in particular those needed for electronic pharmaceutical prescriptions, hospital discharge summaries, a standard e-health record, and interoperability issues. The Eastern Goldfields health provider community is ideally placed to provide such a reference point. A central agency that can support network users is also a key success factor in projects of this nature and this involvement, when at a detailed level rather than just a bystander role, can help to inform policy.

CONCLUSION

The establishment of managed health networks in rural and remote communities reflects the pursuit of the social policy objective of providing healthcare providers and clients with access to ICT services that are indispensable to their well-being at reasonable and affordable prices. Evidence from EGRRS shows that such a managed health network can cut down a feeling of isolation and “falling on the wrong side of the digital divide.” It can lead to the development of many new skills along with long-term employment opportunities, economic development, and a greater ability to cope with change.

The medical practices and pharmacies involved in EGRRS are SMEs and key aspects of ICTs for them from a project of this nature are the impact on costs, productivity, and customer service. EGRRS has proven that a VPN can be created to suit the majority of a wide range of healthcare service providers. The network has been leveraged to deliver applications in a meaningful tailored and flexible way that can continue to grow with the changing needs of the participants and the network. Partly from this evidence, GoldHealth was a joint winner of the “Best Regional Communications Solution” at the Australian Telecommunications Users Group 2006 awards.

Funding of the project by DoHA finished in June 2006 and, on a self-standing basis, the great majority of health point sites continued as part of the GoldHealth network beginning in July of 2006.

The managed VPN which is well bedded down enables the local division of general practice to have control, to decide who can be part of the network. It also controls the applications that are made available, and can broker the commercial conditions between the service providers and the participants.

REFERENCES


Department of Health and Ageing. (2007b). Eastern goldfields regional reference site devel-


KEY TERMS

Virtual Private Network (VPN): A hybrid network that includes both public and private facilities. The user leases a bundle of circuits and configures the VPN on an as-needed basis so that some traffic travels on the private leased network and some travels on the common carrier’s public network.

E-Health: An emerging field in the intersection of medical informatics, public health, and business, referring to health services and information delivered or enhanced through the Internet and related technologies.

Technology Diffusion Curve: The innovation adoption curve of Rogers is a model that classifies adopters of innovations into various categories based on the idea that certain individuals are inevitably more open to adaptation than others. It is also called diffusion of innovations theory.