



PRIVATE NETWORKS



# Virtual private 5G brings connected intelligent healthcare to the patient journey at NUHS

Hybrid model delivers hospital-grade performance and secure care at home.

## Impact & statistics

- **Coverage on and off campus:** Virtual private 5G using a network slice provides hospital clinicians in Singapore’s National University Health System (NUHS) with guaranteed bandwidth and reliable performance and patients with secure remote care.
- **Transformative technology:** 40 staff have been trained in mixed reality (MR) and holographic 3D imaging, and 180 Extended Reality (XR)-assisted surgeries have been performed to date. Intra-operative guidance has reduced operating times by 10–30% on average across a variety of procedures (against a target of 10–15%).
- **Care at home:** NUHS@Home cares for more than 100 patients at any one time, saving hospital beds for critical needs.

### Challenge

Hospitals need consistent low-latency performance for applications like MR, autonomous robots and data-heavy clinical workflows, but must also meet stringent cybersecurity, governance and data-handling requirements, and support care beyond hospital walls with mobile teams, home monitoring and connected ambulances. Wi-Fi struggles to provide the combination of predictable, end-to-end service characteristics required for clinical-grade applications and secure care beyond campus, such as controlled QoS/priority, mobility and session continuity and SIM-based identity and segmentation.

### Solution

NUHS, Singtel and Ericsson deployed a virtual private 5G network delivering dedicated coverage and service-level agreements (SLAs) on campus while leveraging public infrastructure for wide-area reach. This enables XR-guided surgeries, remote proctoring and advanced care at home, and prepares NUHS for an “intelligent hospital” platform in the future. A combination of SIM-based provisioning (private DNN/APN) offers improved data security, and a secure-by-design 5G network provides data segregation between enterprise and consumer traffic.

The network slicing features were implemented for NUHS primarily for SLA differentiation and not for the implementation of the virtual private 5G network. Singtel and NUHS are exploring dedicating a 5G radio resource partition for in-hospital enterprise use cases as part of an enhanced network slicing capability.

Image © National University Health System (NUHS)

# From scans to surgery to home care: how 5G is transforming healthcare

NUHS is advancing XR Spatial AI using MR to improve surgical planning, intra-operative guidance, training and patient engagement, with ambitions to extend connectivity into non-clinical operations (A&E flow, bed management, facilities systems) and community care.

## Introduction

- **Background:** NUHS wanted a virtual private network that would support connected, integrated and intelligent hospital platforms and enable country-wide reach for services like hospital-at-home, connected ambulances and remote monitoring and proctoring.
- **Use case context:** Several use cases have been piloted or deployed, including 3-D hologram imaging for surgical planning, the use of XR devices for patient education and counselling, MR devices connected to the 5G network for image guidance during surgery, medication dispensing using robotics and NUHS@Home connectivity to support patients after discharge.
- **Technology rationale:** A hybrid model with a virtual 5G private network and a network slice provided both dedicated indoor coverage and country-wide reach for services like hospital-at-home, connected ambulances and remote monitoring and proctoring, which would be difficult with an on-campus-only “bubble”.
- **Objectives:** NUHS aims to build an integrated ecosystem with advanced connectivity at its core, creating a platform for the IoT environment and a network that is part of the AI fabric of the hospital. It does this by identifying use cases that create real value for patients and hospitals and integrating with existing hospital systems and healthcare practitioners.

## Challenges

- **Clinical-grade performance:** MR and imaging workflows require predictable throughput and low latency.
- **Security and governance:** Moving from trial to production requires end-to-end architecture security and compliance pathways.
- **Data handling and integration:** Early deployments of 5G networks in healthcare often run “parallel” to hospital intranet, with 5G data de-identified (no patient identifiers transmitted). Integrating electronic medical records safely is no trivial matter.
- **Device readiness:** Healthcare endpoint ecosystems are lagging; progress requires long-term, cross-industry learning and policy support. Some XR devices don't support 5G natively and are commonly deployed using 5G MiFi routers or 5G CPEs.

## Partnerships and ecosystem

Delivering holomedicine at scale requires a multi-partner model spanning connectivity, edge/cloud, devices, applications and governance.

### Key partners involved in this project

- **Singtel (mobile operator):** Provides the 5G service foundation (including the virtual private 5G slice) and the operational platform to extend secure connectivity beyond the hospital for mobile/community workflows.
- **Ericsson (network vendor):** Provides core 5G technology and engineering expertise to design and support the slice-based architecture and performance characteristics required for clinical-grade use cases.
- **Synapxe (health IT governance):** Reviews and approves end-to-end architecture and security controls as the pathway to deeper integration with hospital systems.
- **IMDA (public-sector enablement):** Supports live-environment trials and ecosystem development to accelerate validation and adoption of 5G healthcare innovations.
- **CSA (security assurance):** Supports security validation (including adversarial-style testing) to assess robustness and strengthen confidence in the deployment.



Seeing 5G adoption as a long-term game plan; we need both public and private collaboration.

Sheng-Ann Yu, Singtel

Figure 1

## Architecture at a glance

Source: NUHS



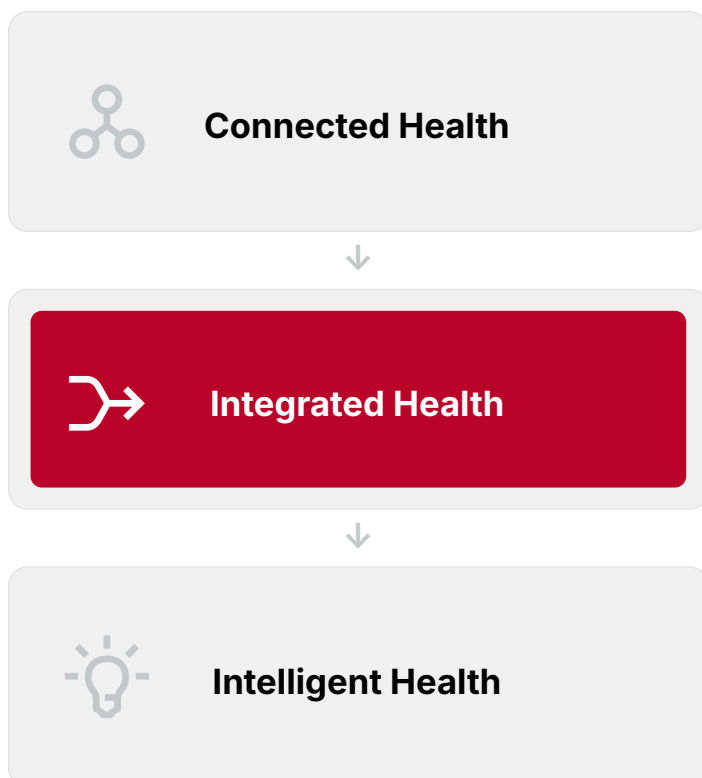
In some ways, connected health is a concept of the past. We are now at the stage of integrated health, which creates a single platform for data harmonisation and patient care coordination. The future lies in intelligent health, where AI not only integrates data but helps make sense of it, automating responses to improve patient care and operational efficiency.

The strategy of NUHS is to build an integrated ecosystem with advanced connectivity at its core, forming the platform for the IoT environment and having the network itself as part of the AI fabric of the hospital.

Figure 2

## Development evolution

Source: NUHS



## Key use cases

The following use cases have been piloted or deployed:

- **Emergency/difficult venepuncture support:** Point-of-care superficial vein identification via MR devices is an early patient touchpoint for patients with difficult venous access. The AI inference service is hosted in a Singtel data centre and accessed via the NUHS virtual private 5G network, with the 5G core providing secure connectivity, traffic steering and QoS.
- **Imaging for surgical planning:** After a scan, images are uploaded to MR devices and rendered into 3D holograms.
- **Patient education and counselling:** Surgeons can use XR devices to explain procedures using patient-specific visualisations.
- **Intra-operative guidance and theatre IoT:** On the day of surgery, clinicians wear MR devices connected to the 5G network for image guidance, while UVC ceiling lamps are controlled over 5G for continuous disinfection, enabling greater use of the operating theatre. 11 lamps are connected to one control platform, and in future will be integrated into a hospital-wide IoT dashboard for monitoring and control across operating theatres.
- **Pharmacy logistics using robotics:** On discharge day, robots fetch patient medications from the central pharmacy and bring them to the ward. “Last-mile” dispensing remains nurse-led today using access-controlled compartments. QR/identity concepts are under consideration for the future.
- **NUHS@Home connectivity:** After discharge, patients are handed over to NUHS@Home teams who are equipped with tablets using enterprise SIM cards on the private virtual 5G network. The use of enterprise SIMs supports tighter policy and security control (e.g. segregated access and managed connectivity) aligned with clinical workflows.

## Impact and benefits

- **Clinical adoption and surgery time:** 180 XR-assisted surgeries have been performed to date. Intra-operative guidance has delivered reported reductions in operating time of 10–30% on average – up to 60 minutes – across a number of procedures, improving patient outcomes such as faster recovery, lower risk of complications and the need for hospital re-admission.
- **Theatre IoT control:** 11 UVC lamps connected to a single control platform over 5G enables continuous disinfection and increased theatre use.
- **Care at home:** NUHS@Home cares for more than 100 patients at home at a time, monitoring them remotely and saving hospital beds for critical needs.
- **Connectivity:** NUHS@Home mobile teams improved connectivity for voice/video after transitioning from commercial SIMs to enterprise network access.
- **Robotics and theatre IoT:** Connectivity can support discharge flow and theatre use through automation and monitoring, enabling clinicians to devote more time to their patients and contributing to a high-reliability environment.

## Lessons learned

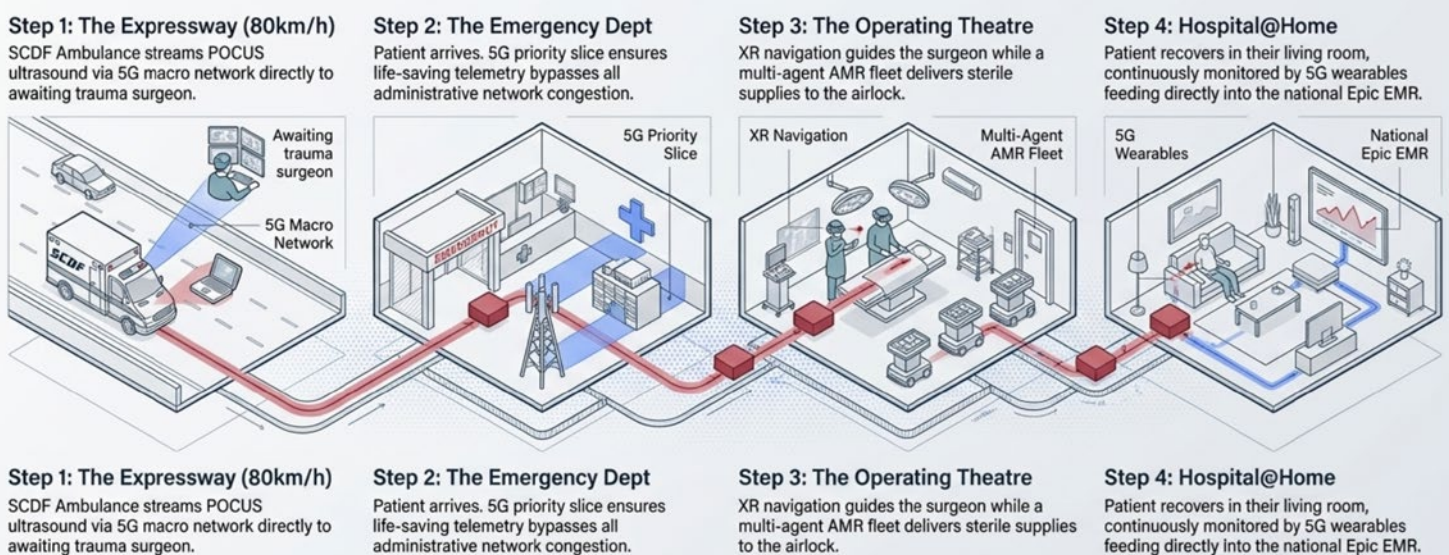
- A “virtual private” model scales the care pathway: Slice-based private service characteristics inside the hospital plus macro reach for mobile teams, home monitoring and connected ambulances.
- **Security and governance are key:** Moving from unlicensed Wi-Fi to licensed 5G was driven heavily by security and governance, in addition to performance requirements.
- **Edge and slicing make MR clinically usable:** Measured throughput and latency support high-resolution 3D imaging and real-time guidance.
- **Ecosystem maturity (especially device availability) determines the pace:** Healthcare adoption requires long-term planning, cross-industry learning and ecosystem alignment, not a single, short-term business case.

As NUHS moves towards an intelligent hospital platform, its partnership with the GSMA Foundry supports a clear pathway to scaling innovation beyond pilots into deployable models. Through this collaboration, NUHS works within a global ecosystem of mobile operators, technology partners and healthcare organisations seeking to co-develop and validate 5G- and AI-enabled solutions in real-world settings. This helps to ensure that insights from proven use cases are not confined to a single deployment but evolve into scalable approaches aligned with operational healthcare needs and capable of wider adoption across health systems.

Figure 3

### The network is the hospital: A continuous digital care journey

Source: NUHS





## Future plans

Over the next two to three years, NUHS will scale 5G from pilots to production-grade infrastructure supporting clinical operations, hospital-at-home, AI-enabled care and building management. Coverage will expand across critical care areas, wards and ambulatory spaces, with 5G standalone (SA) capabilities including network slicing, deterministic latency and secure network APIs.

This will support proven use cases (XR-assisted surgery, remote consultation, robotics and IoT), accelerate Hospital-at-Home and virtual wards, and enable new applications such as positioning, sensing and digital twins.

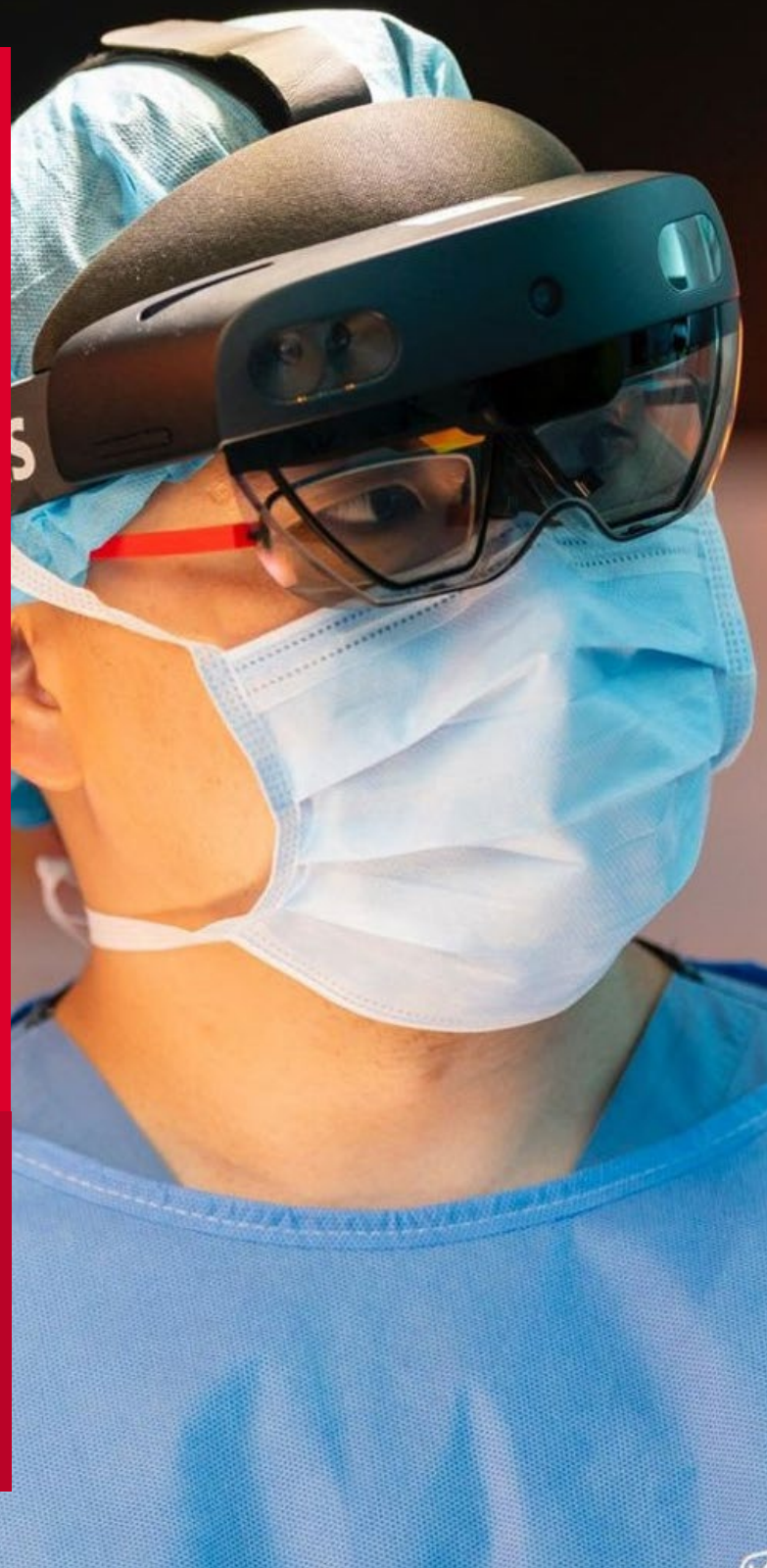
A key near-term milestone is integrating systems that began as parallel trials. Once approved, clinicians will securely connect, including remotely, to exchange data with EMR (Electronic Medical Record) via cloud/government infrastructure. NUHS and Synapxe are also working to integrate 5G-connected devices in EMR, enabling bidirectional data transmission and establishing a blueprint for future healthcare integration.

NUHS will position 5G as the connectivity layer for edge cloud and AI, enabling secure data flows between devices, clinical systems and analytics platforms. This structured approach combines clinical validation, IT integration and operational governance to deliver measurable improvements in patient outcomes, staff productivity and system resilience.

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As we move towards a more connected world, networks will no longer be just an information conduit. Advanced networks will form the core AI fabric on which services are built on, and bring us another step closer towards true connected-intelligence

Dr Yujia Gao



**GSMA**

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