National University Hospital

Rethinking Innovation in Healthcare

Truths, Challenges & Game-Changers

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Healthcare's 4th Industrial revolution

Parallels in the industrial revolution and the medical informatics evolution

Beyond the Headlines

Innovation is more complex and human than robots or AI

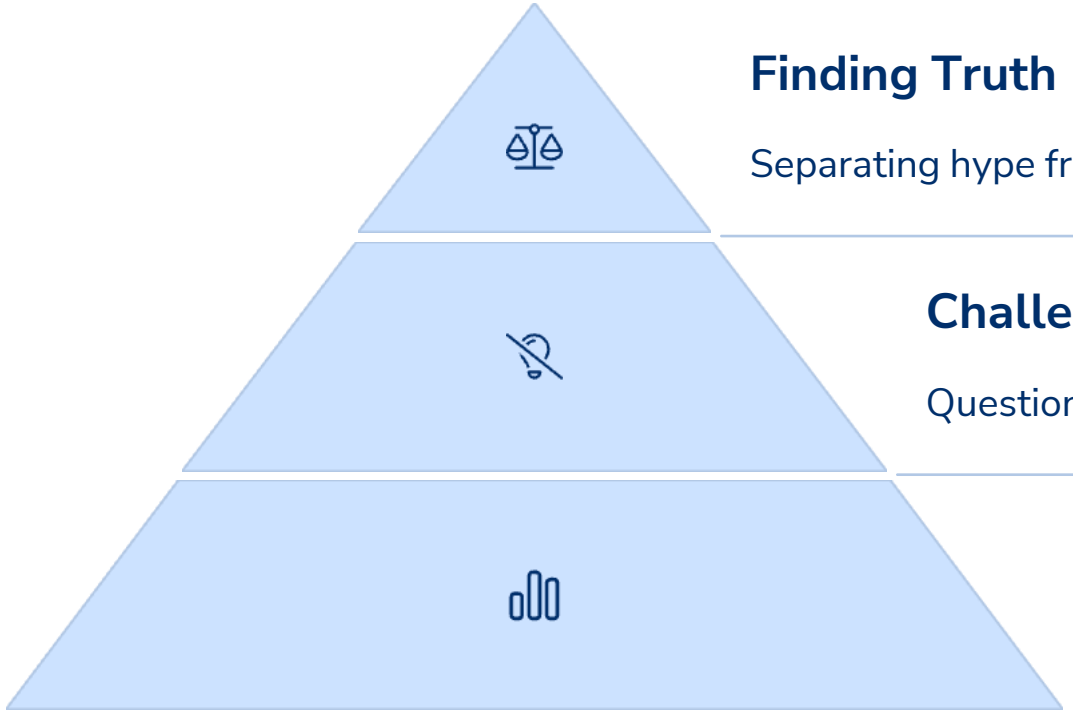
Reality Check

$240B invested, yet 70% of implementations fail

Our Focus

Distinguishing myths from realities in healthcare transformation

Myths vs. Realities



Finding Truth

Separating hype from impact

Challenging Assumptions

Questioning common innovation beliefs

Evidence-Based Approach

Using data to validate real solutions

Myth 1

Technology & Innovation Will Solve All Problems

Reality

Innovation Does Not Equate Progress

Viewpoint

November 2018

Machine Learning and Health Care Disparities in Dermatology

Adewole S. Adamson, MD, MPP[1,2]; Avery Smith, MS[3]

» Author Affiliations

JAMA Dermatol. 2018;154(11):1247-1248. doi:10.1001/jamadermatol.2018.2348

Machine Learning Website

Machine learning (ML), a form of artificial intelligence using computer algorithms, is often applied in ways we take for granted: Spotify to predict music that people may enjoy, Facebook to suggest friends to tag in photos, and Amazon to identify products to buy. Aside from these quotidian tasks, ML holds the promise of enhancing the delivery of quality health care.[1] Recently, ML has been used to create programs capable of distinguishing between images of benign and malignant moles with accuracy similar to that of board-certified dermatologists.[2] This technology could greatly assist dermatologists in diagnosing and treating skin diseases, thereby improving patient care. However, if not developed with inclusivity in mind, ML could exacerbate health care disparities in dermatology.

Reality

Pitfalls Still Exist

nature machine intelligence

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nature › nature machine intelligence › analyses › article

Analysis | Open access | Published: 15 March 2021

Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans

Michael Roberts ✉, Derek Driggs, Matthew Thorpe, Julian Gilbey, Michael Yeung, Stephan Ursprung, Angelica I. Aviles-Rivero, Christian Etmann, Cathal McCague, Lucian Beer, Jonathan R. Weir-McCall, Zhongzhao Teng, Effrossyni Gkrania-Klotsas, AIX-COVNET, James H. F. Rudd, Evis Sala & Carola-Bibiane Schönlieb

Nature Machine Intelligence **3**, 199–217 (2021) | Cite this article

101k Accesses | **605** Citations | **1207** Altmetric | Metrics

Data Quality & Bias

Rubbish In, Rubbish Out

AI is only as good as what we train it on

Rules of Traditional Statistical Analysis Apply

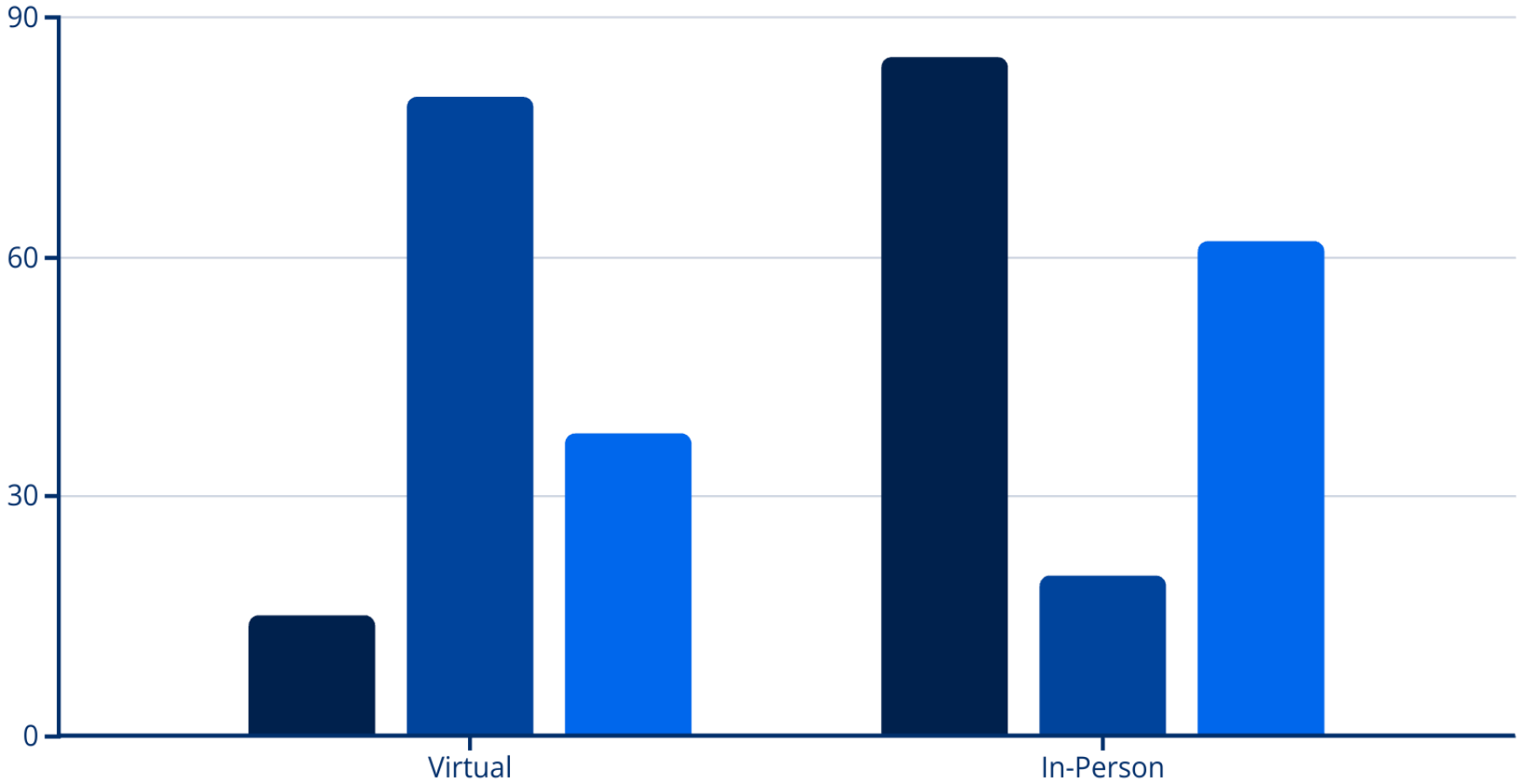
- Representative dataset
- Confounders
- Bias
- Data purity

Myth 2

Innovation Means Disruption

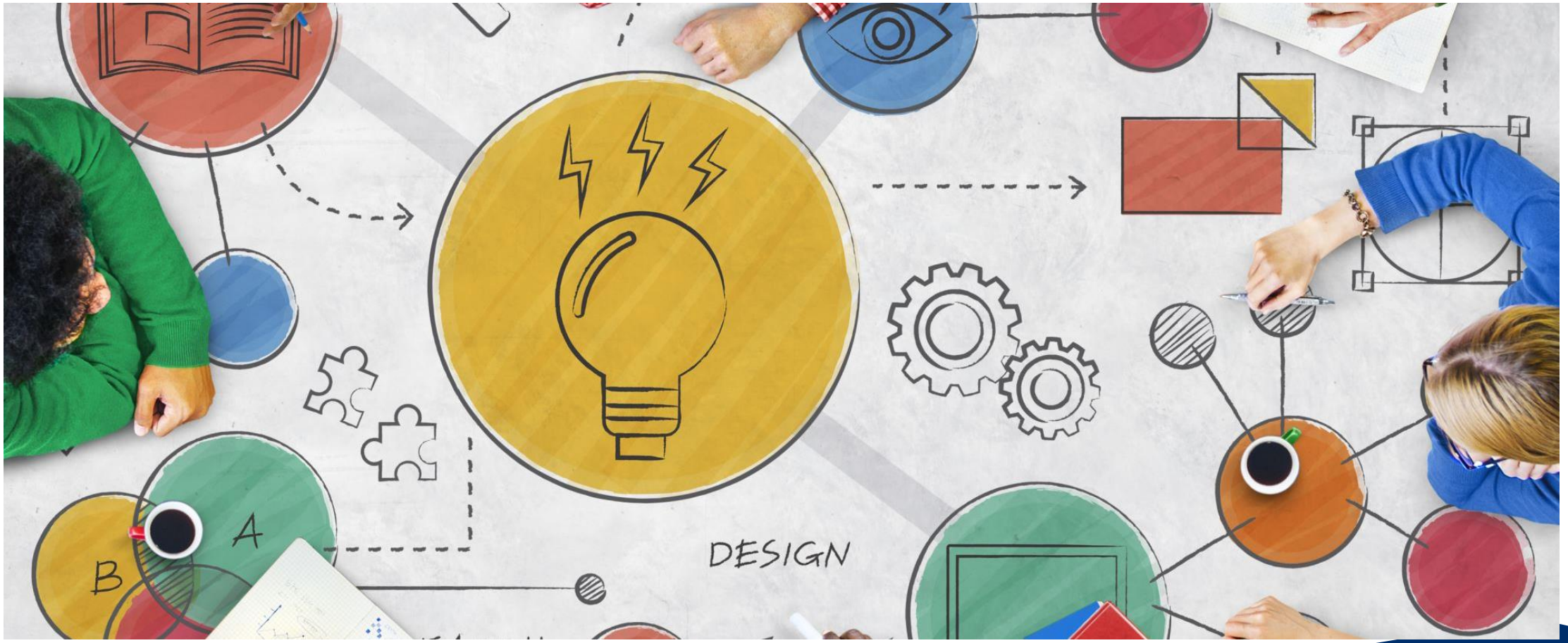
Reality

Kaiser Permanente Teleconsultation Program



Myth 3

Innovation Will Improve Wellbeing



Reality

Psychological & Social Impact

Tech Addiction

Constant Health Monitoring

Obsessive /Abussive use of Health Tracking Apps

Patient Anxiety

Doctor-Patient Relationship

Dr Google / Dr AI

Misinformation and Distrust

Medical Education

AI in Exams

Erosion of Core Knowledge

Diminishing Clinical Experience

Existential Crisis for Healthcare Workers?

Is it Real?

Potential replacement of healthcare workers

Most at risk

- Non-procedural clinical specialties
- Consultation roles
- Low-level physical tasks
- Certain simple procedures

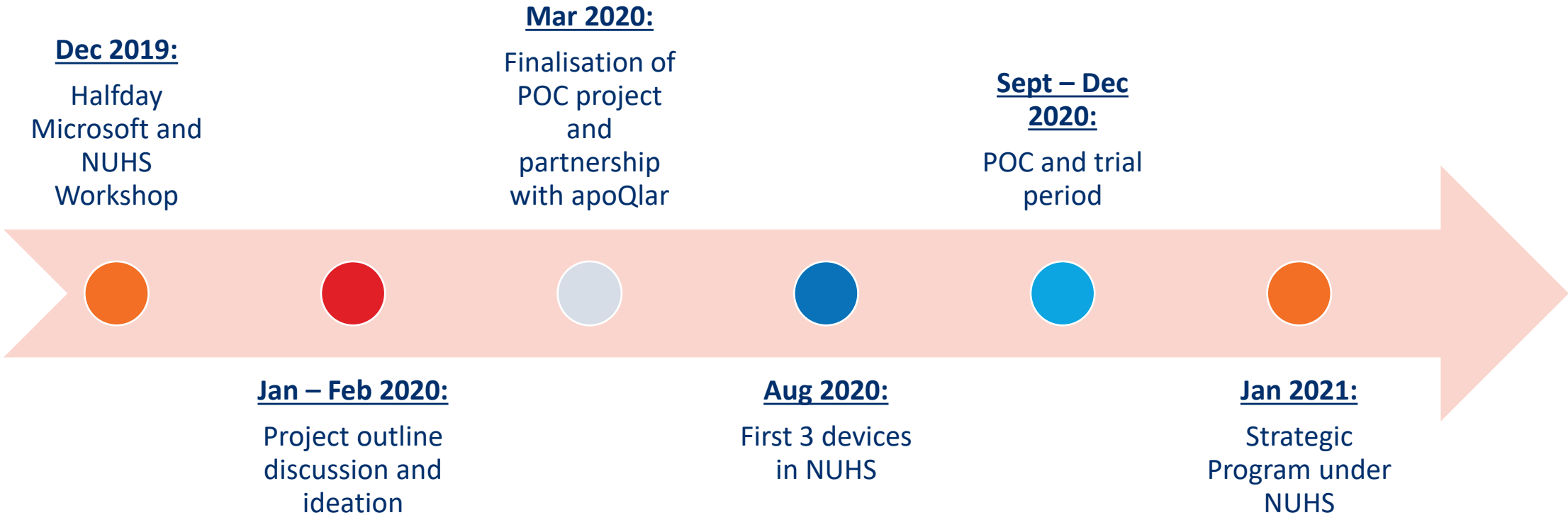
Our Own Lessons

NUHS Mixed Reality Program

- Leveraging on Mixed Reality
- Enhance clinical capabilities
- Improve clinician experience
- Improve patient outcomes

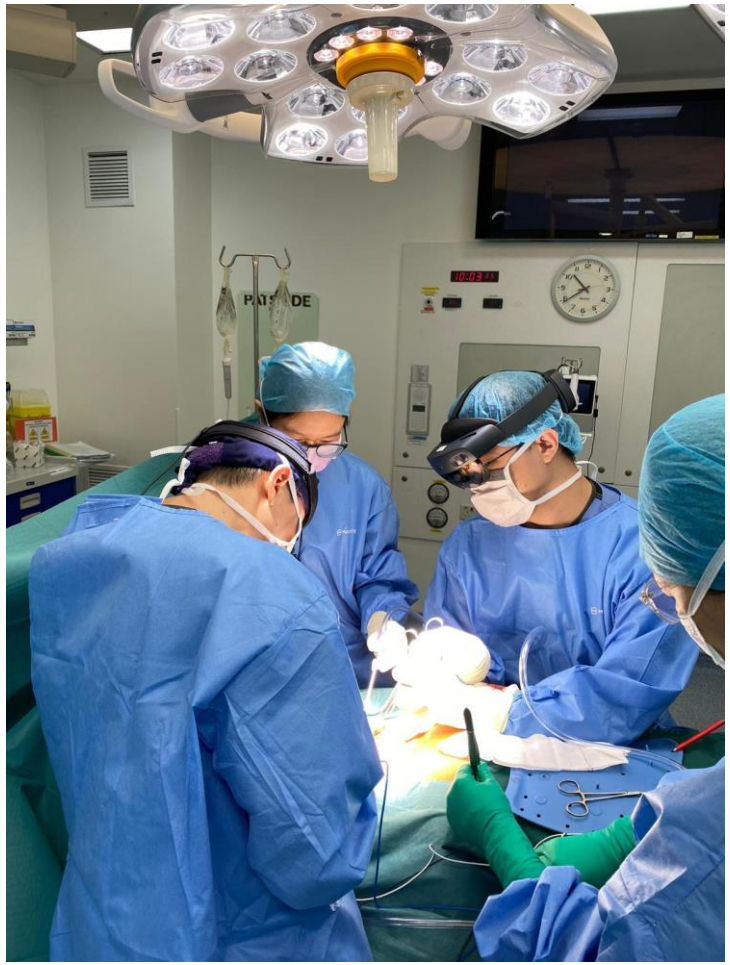
How it All Began

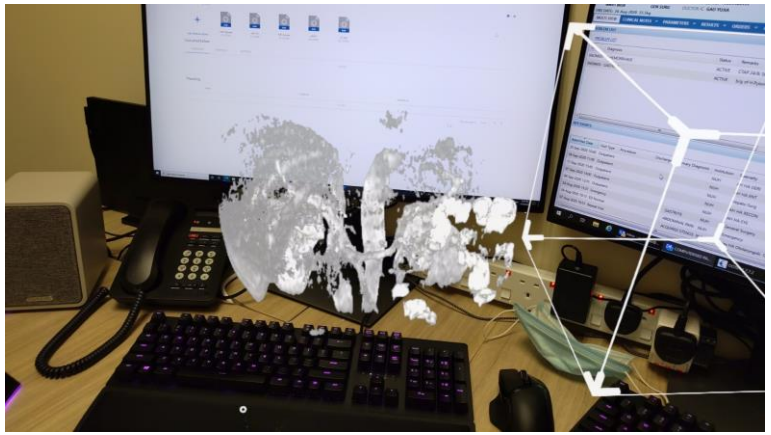
From Idea to Implementation



The Myth

Opportunity to change and disrupt the way we practice Medicine

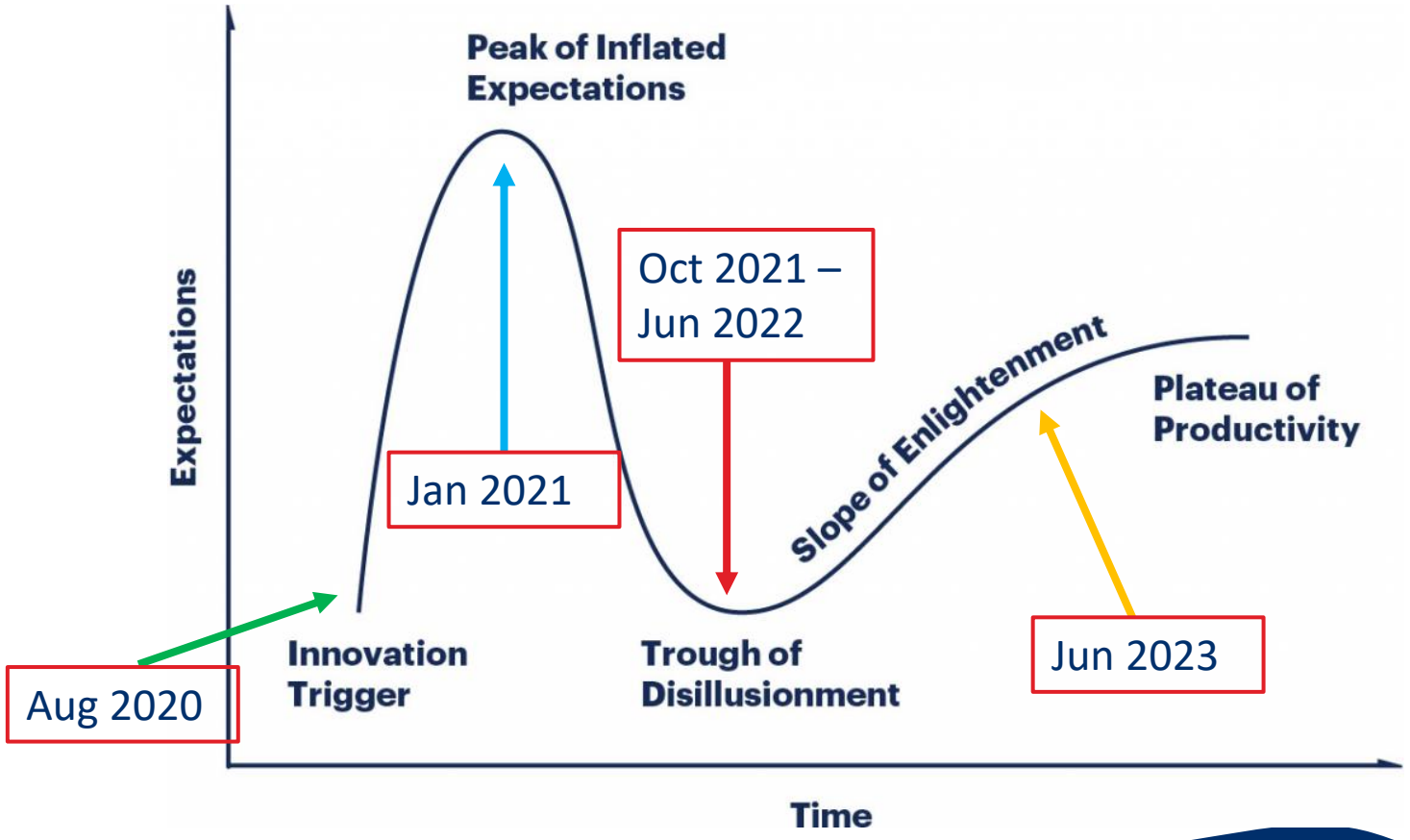




The Reality

Not That Straight Forward

- Gartner Curve
- Adoption Issues
- Implementation Hurdles
- Use Case Selection
- Loss of Interest



Breakthrough

How Do We Move

Breakthrough Integration Models

Keep the Important Things in Mind

Human-Centered Design

Starting with patient and provider needs

Evidence-Based Implementation

Building evaluation from day one

Ecosystem Collaboration

Breaking silos between stakeholders

Human-Centered Design

Staying Human in a Digital World

Article

19 minute read • 26 June 2023

Being human in a digital world: Questions to guide the internet's evolution

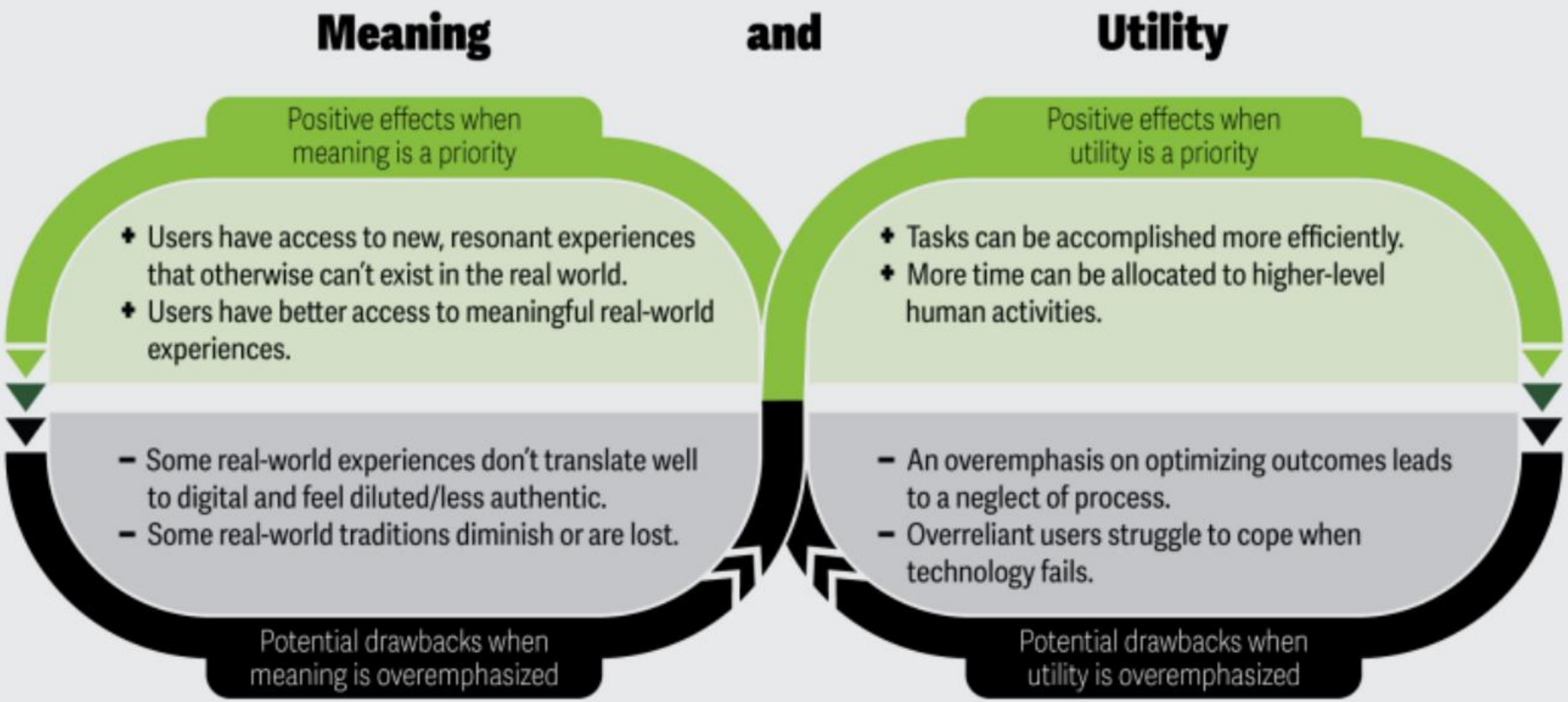
With growing calls to halt AI development and widespread cynicism over the metaverse, we need a framework for visionary businesses, regulators, and society to help shape the future of an internet that enhances, rather than supplants, our humanity

Duleesha Kulasooriya
Singapore

Michelle Khoo
Singapore

Michelle Tan
Singapore

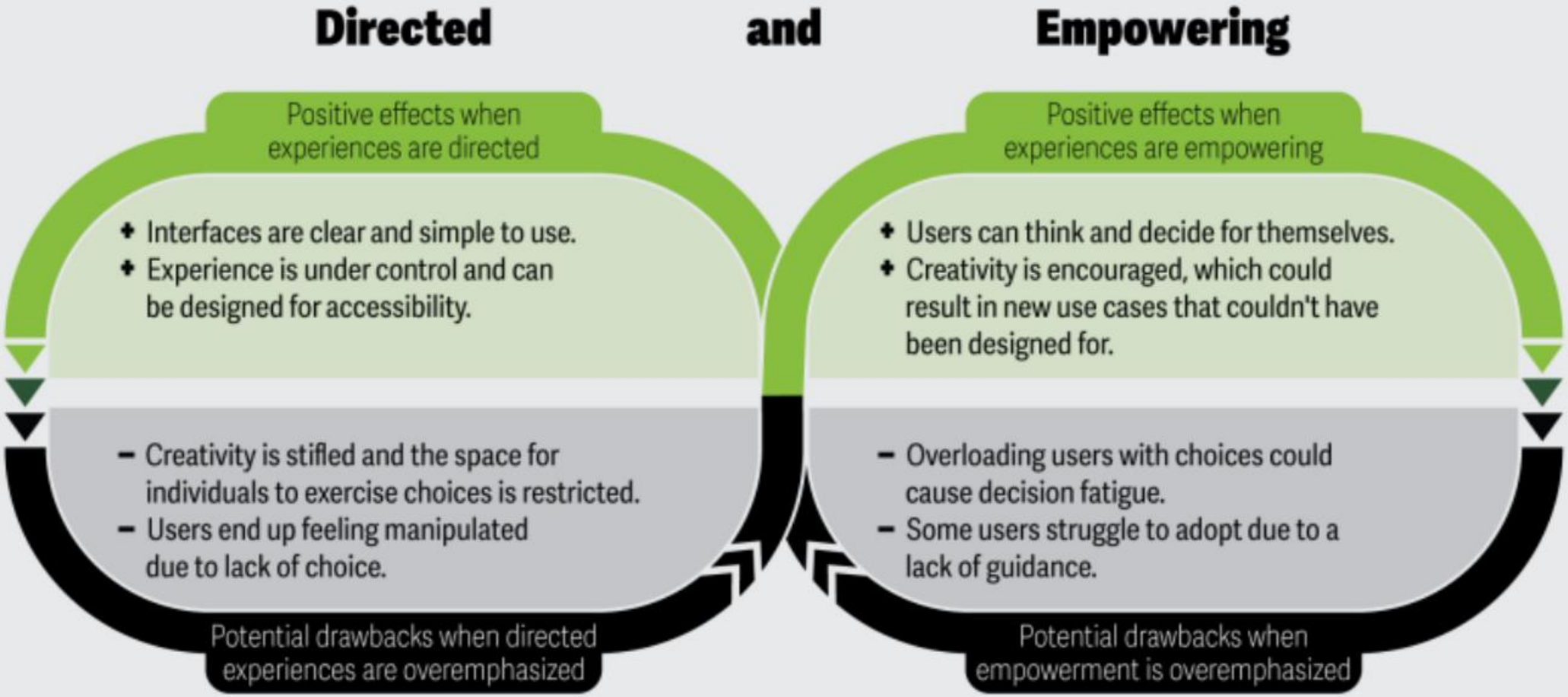
The next internet should serve users in deriving ...



Source: Deloitte analysis.

Deloitte. Insights | deloitte.com/insights.com

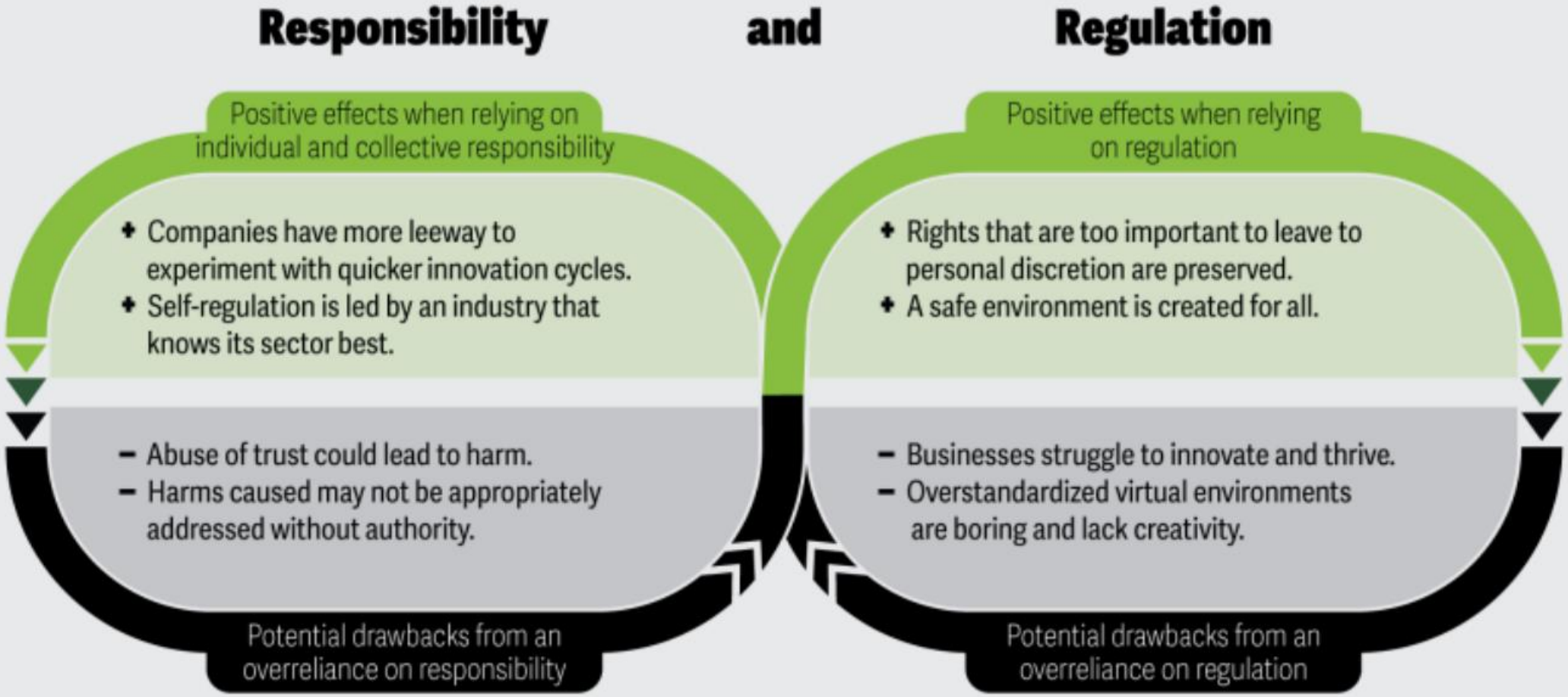
Experiences on the next internet should be ...



Source: Deloitte analysis.

Deloitte. Insights | deloitte.com/insights.com

Governance of the next internet should rely on ...

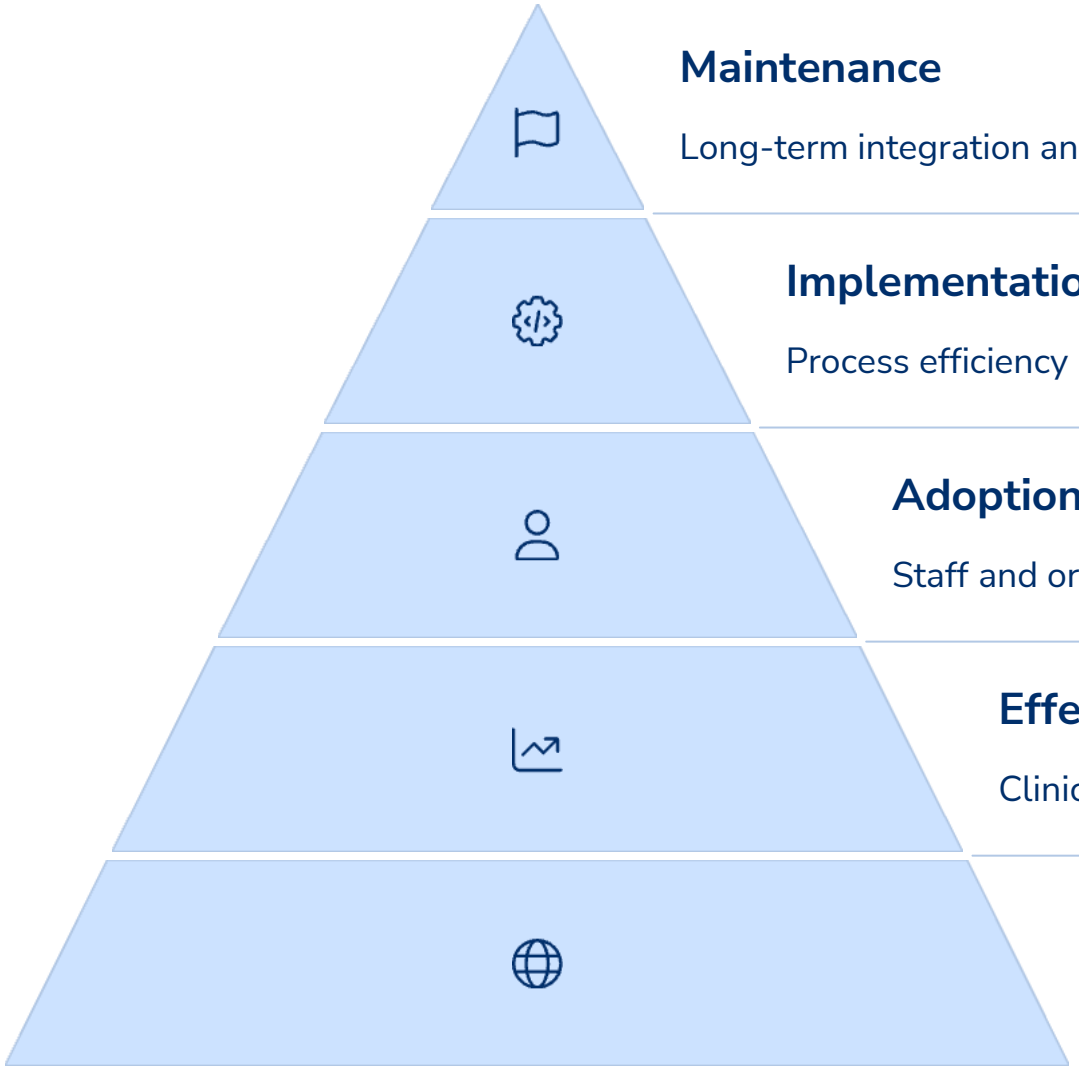


Source: Deloitte analysis.

Ecosystem Collaboration

Find the Right Partners

Evidence-Based Implementation



Maintenance

Long-term integration and sustainability

Implementation

Process efficiency and fidelity

Adoption

Staff and organizational uptake

Effectiveness

Clinical and operational outcomes

Reach

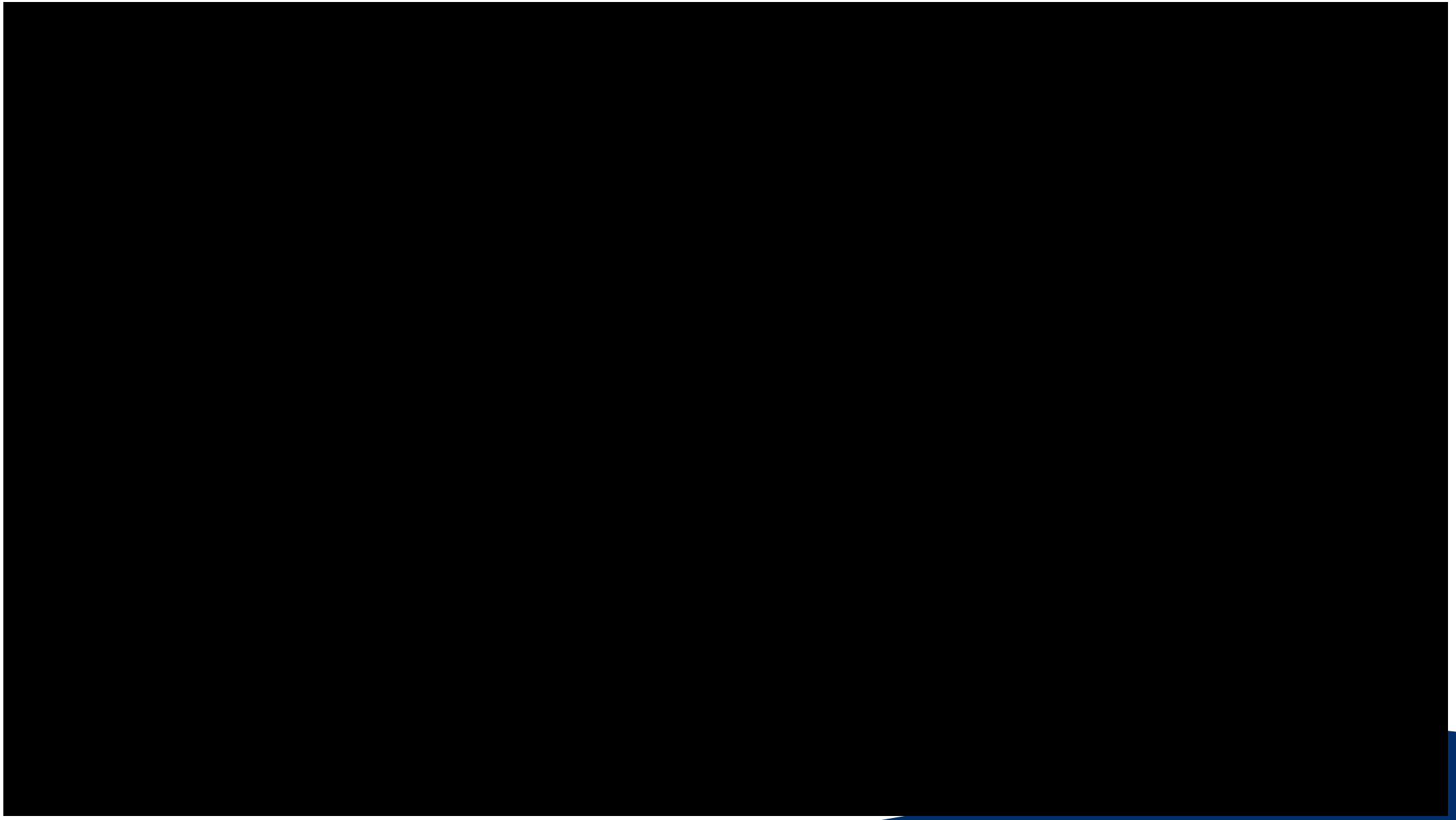
Patient population impact

How Did We Fair?

Human-Centered Care

Use Case as our Core

Planning for Graft Reduction



Rib Tumour Localisation and Excision

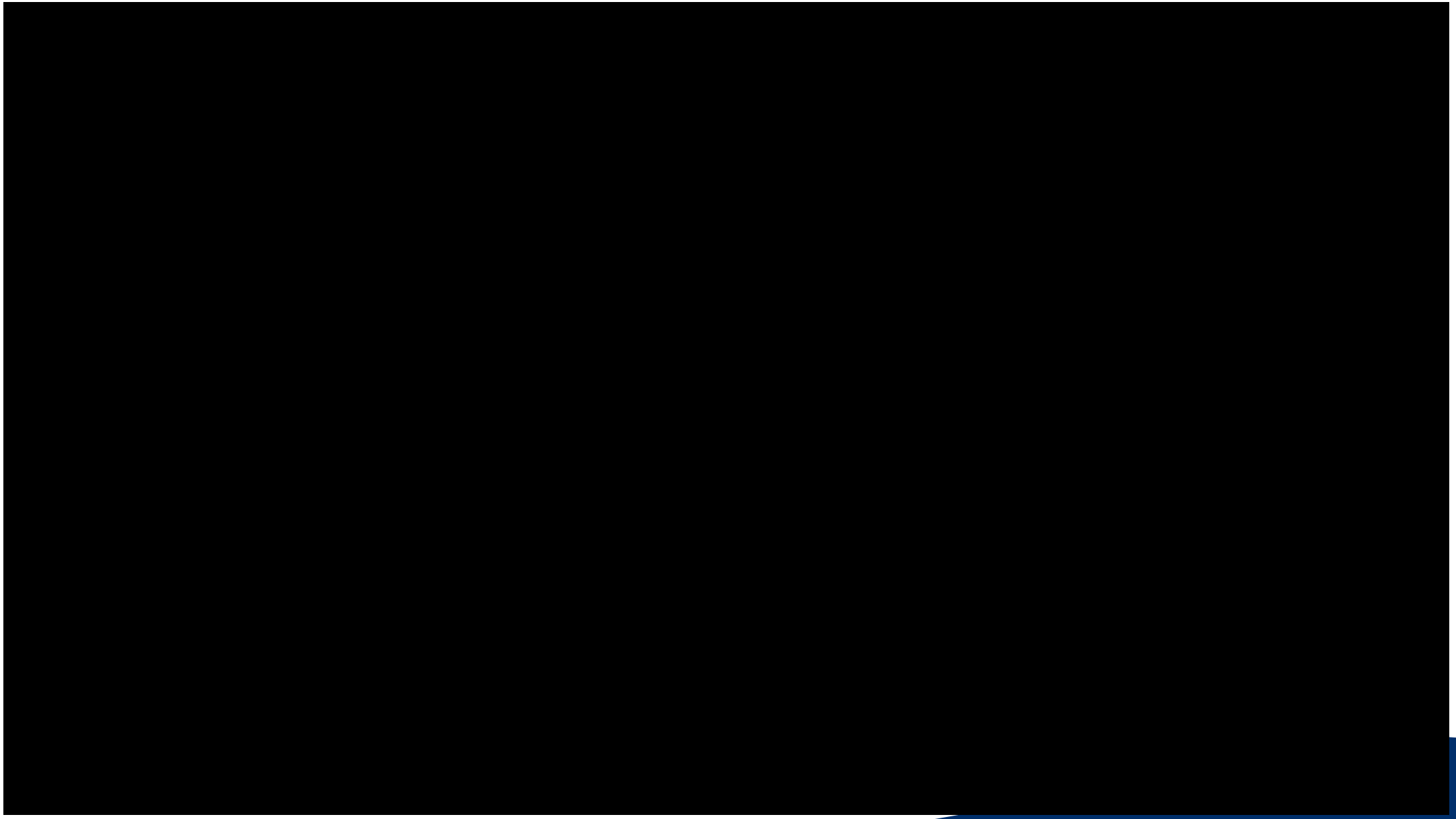
NUHS
National University Health System

Holomedicine: The use of mixed reality device to aid clinician in thoracic surgery

Dr Lowell Leow[1], Dr Zachery Yeo[2], Ng Kian Wei[2], Elaine Tan Ying Zhen[2], Guo Qinfeng[2], Hugh Tay Keng Lian[2], Adrian Hwang Jian Tay[2], A/Prof Ngiam Kee Yuan[2], Marcus Ong Ming Wei[2], A/Prof John Tam[1], Dr Gao Yujia[2]

1. Department of Cardiac, Thoracic and Vascular Surgery, National University Heart Centre, Singapore
2. Department of biomedical informatics, National University Health System

Life Changing Application



Ecosystem Collaboration

Found our Soulmates

NUHS Hybrid Architecture

Project Daedalus

National University Hospital

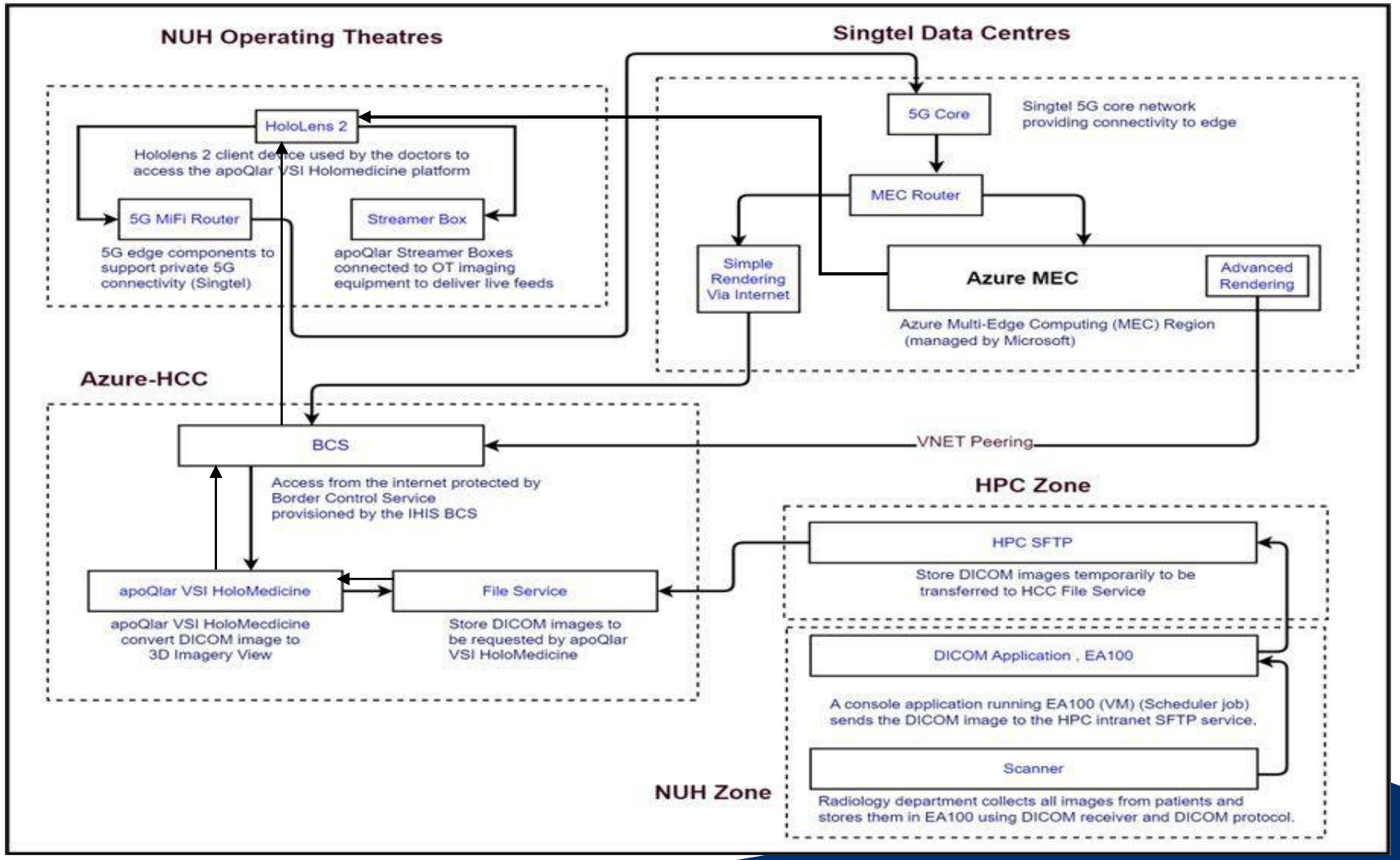
Singtel

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

ERICSSON

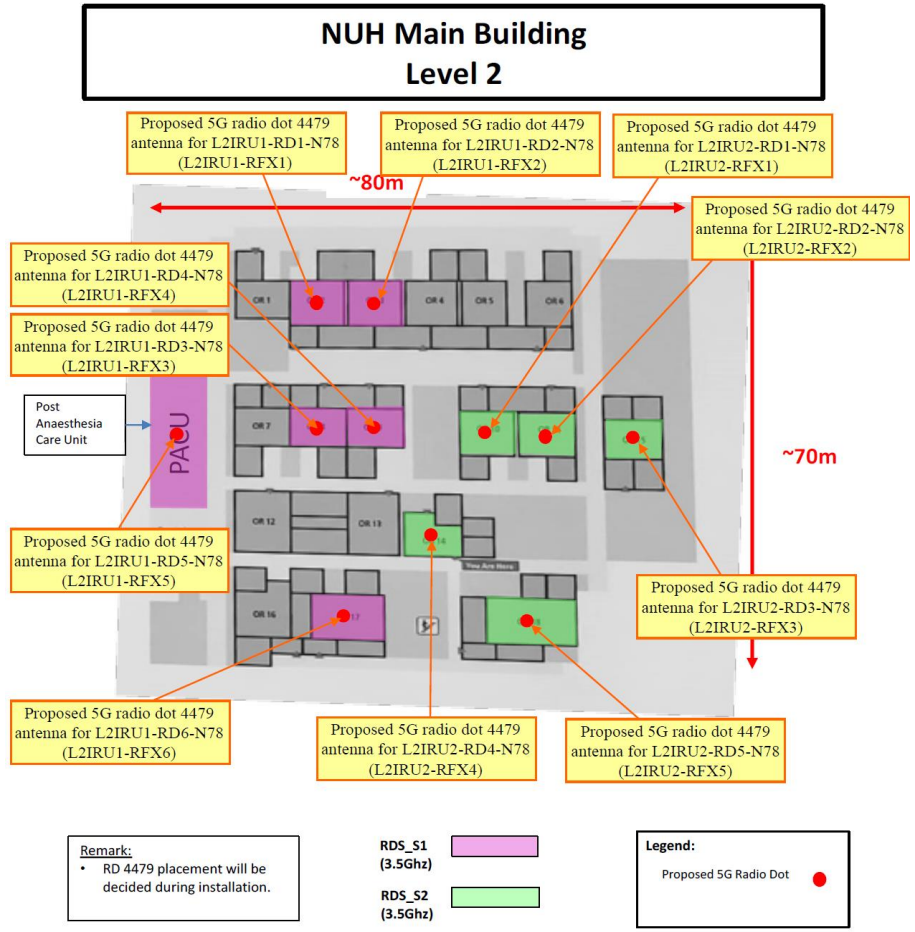
Microsoft

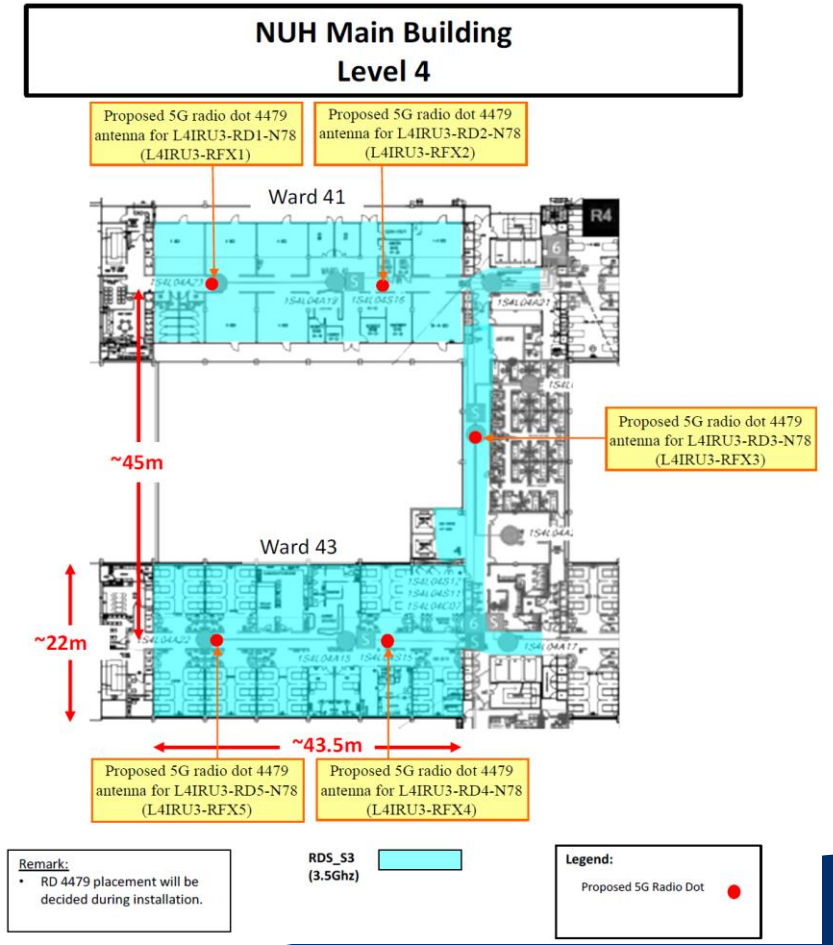
apoQlar

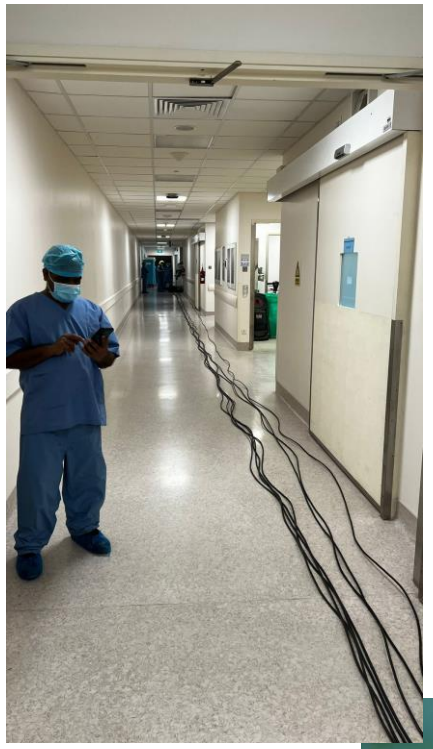


Dedicated Indoor 5G Network

Dedicated Service with no Public Interference







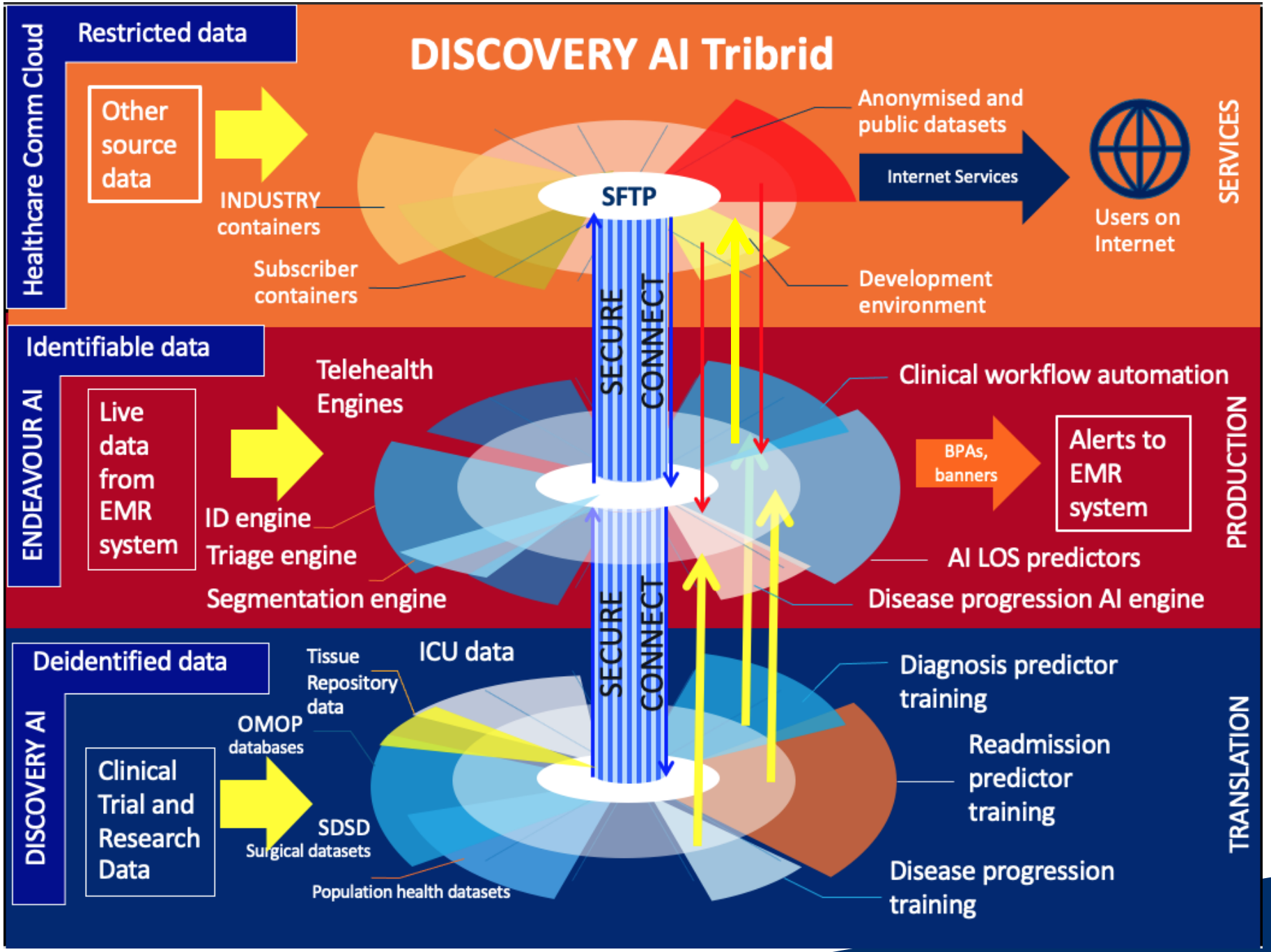
Evidence-Based Implementation

Found our Data

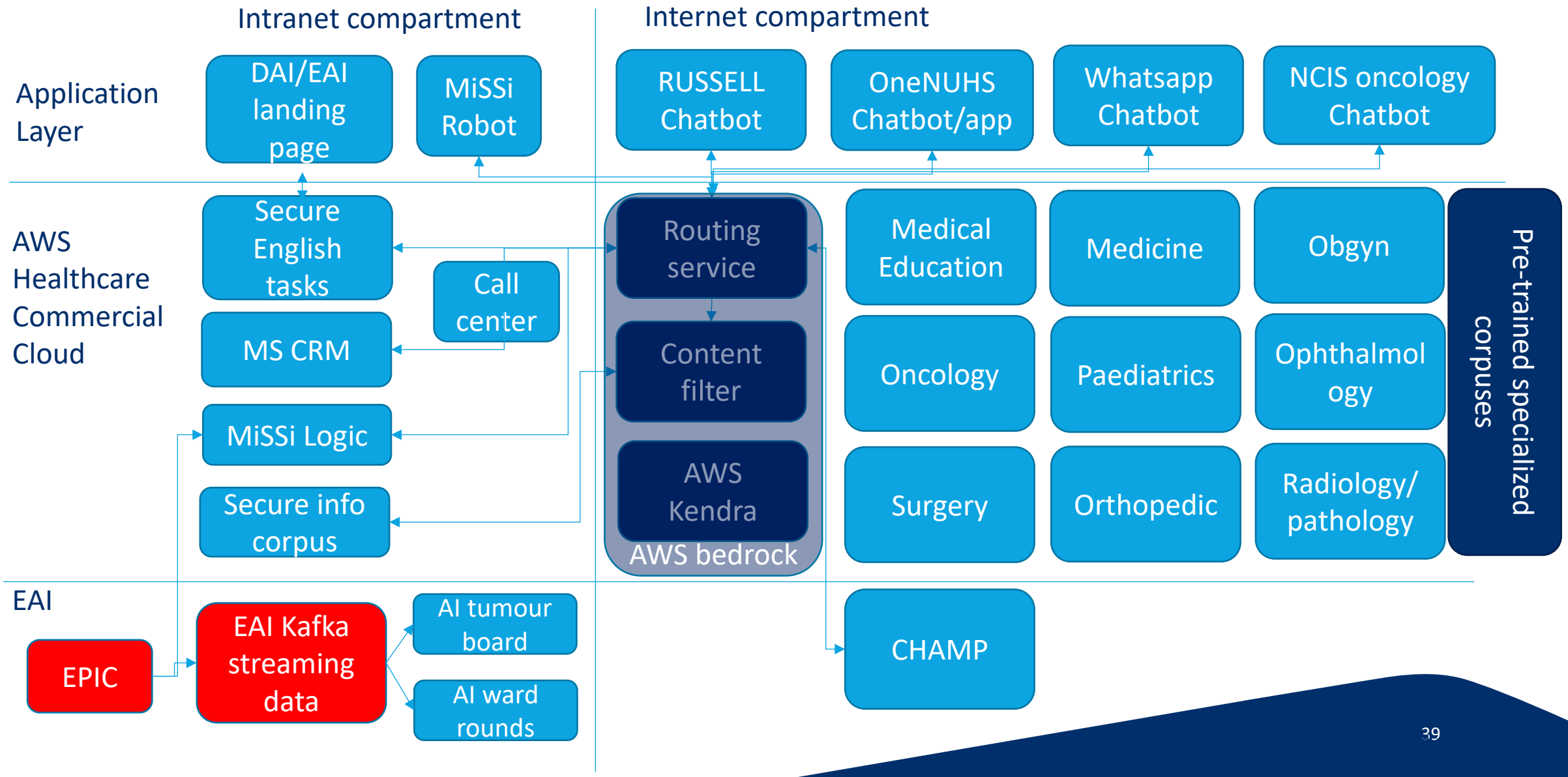
Where is the Evidence?

Following the Numbers

KPI	Target	Outcome
Commercial Deployment and Operationalisation	For system sign-off and deployment before end of project term	NUH 5G network signed-off and operational since November 2023. Met target expectations
Professional Training	30 staff to be trained in the use of Holomedicine and Mixed Reality in clinical and training use cases	40 staff have been trained till date. Exceeded target expectations
Reduction in Surgical Time	Reduction in surgical time of 10-15% compared to standard practice	1. Thoracic surgery: 30-45 minutes reduction in operating time (16-25% reduction) 2. Paediatric Liver Transplant: 45-60 minutes reduction in operating time (8-10% reduction) 3. Laparoscopic Adrenal Surgery: 45-60 minutes reduction in surgical time (30-40% reduction)

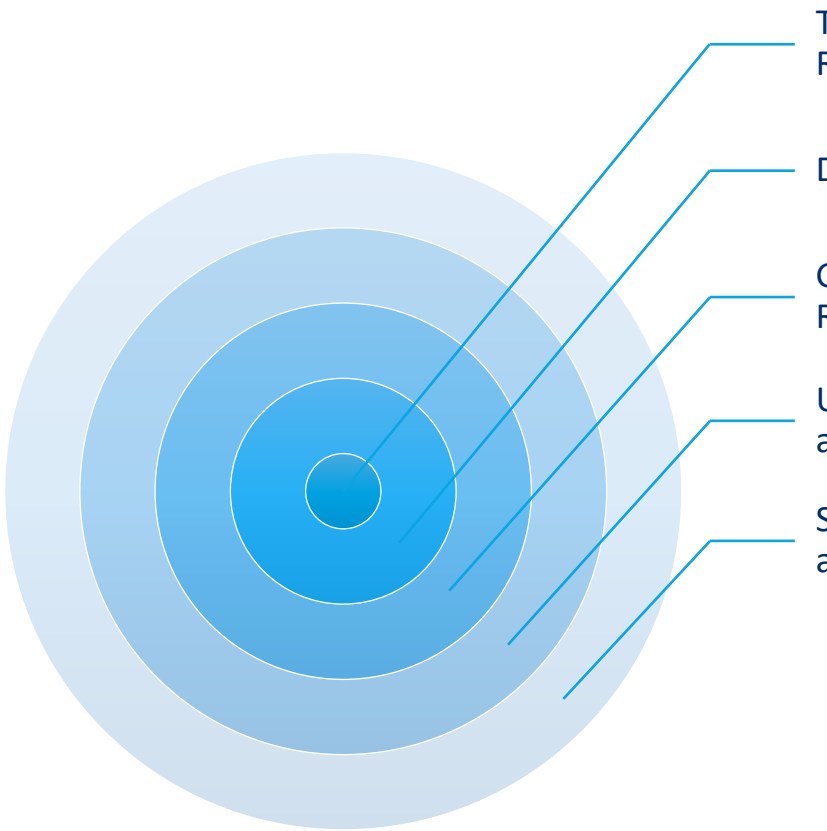

DISCOVERY AI Tribrid
Healthcare Comm Cloud
Restricted data
Other source data
INDUSTRY containers
Subscriber containers
SFTP
Anonymised and public datasets
Internet Services
Users on Internet
Development environment
SERVICES
Identifiable data
ENDEAVOUR AI
Live data from EMR system
Telehealth Engines
ID engine
Triage engine
Segmentation engine
SECURE CONNECT
Clinical workflow automation
BPAs, banners
Alerts to EMR system
AI LOS predictors
Disease progression AI engine
PRODUCTION
Deidentified data
DISCOVERY AI
Clinical Trial and Research Data
Tissue Repository data
OMOP databases
SDSD Surgical datasets
Population health datasets
ICU data
SECURE CONNECT
Diagnosis predictor training
Readmission predictor training
Disease progression training
TRANSLATION

NUHS Production LLM Architecture



Hurdles and Limitations

Translating from Bench to Bedside



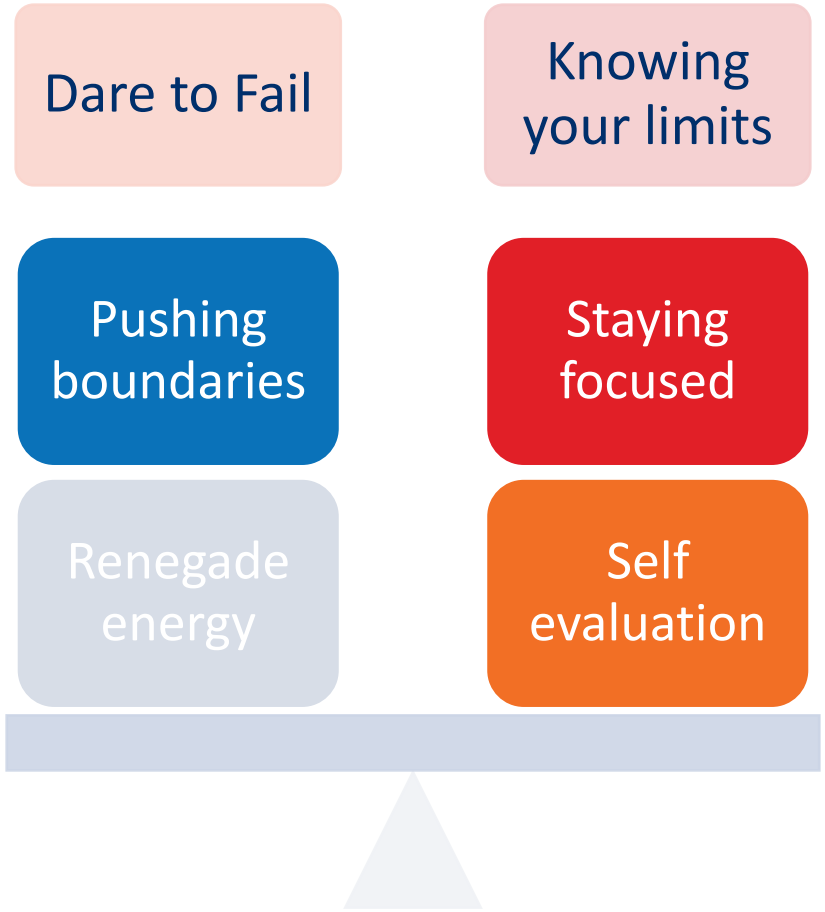
Lessons Learnt

Growing Pains

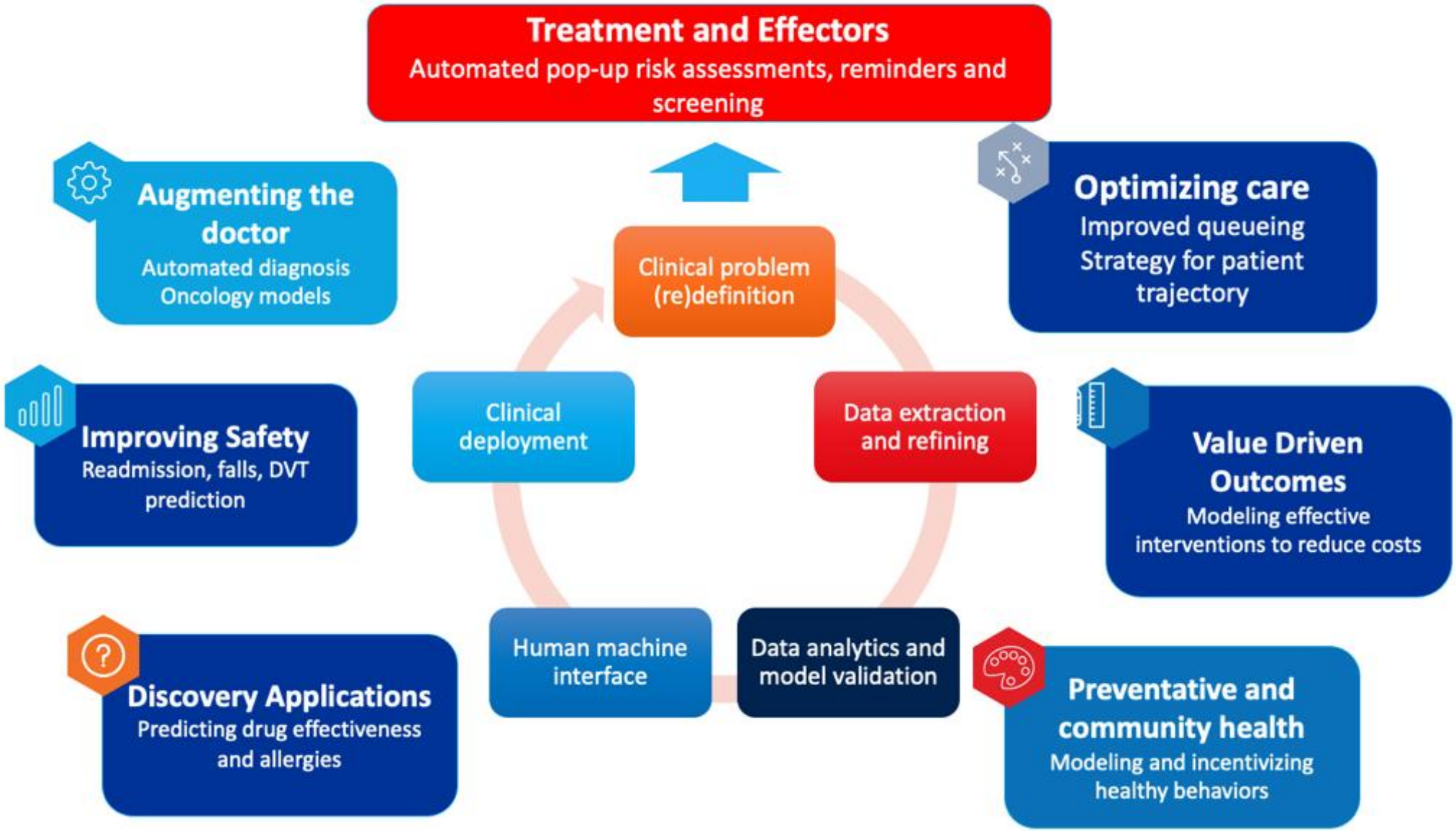
1. Choose your use cases wisely
2. Keep ethical considerations in mind
3. Explore every opportunity
4. Always open your doors, but be cautious of who you let in
5. Be prepared to make costly mistakes
6. Be prepared to be dismissed / ridiculed
7. Keep the original motivation in mind

Lessons Learnt

Dare to Fail?



Clinical AI Development Process and Functional Domains



Stakeholder Ecosystem

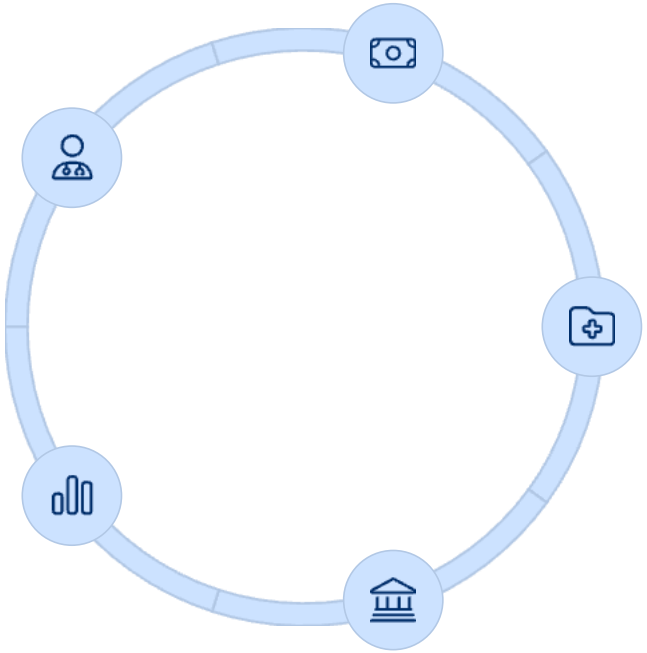
Understand and Evaluate

Providers

63% burnout rates post-pandemic

Investors

Shift to sustainable business models



Payers

$4.3T US healthcare spending (19.7% GDP)

Patients

Increasing demand for digital solutions

Regulators

Country and Region Specific

The Path Forward

Practical Steps

Value Alignment

Economic, clinical, and operational value within 24 months

Implementation Science

CFIR framework with champions at every level

Patient-Centered Outcomes

Beyond clinical: quality of life, access, experience

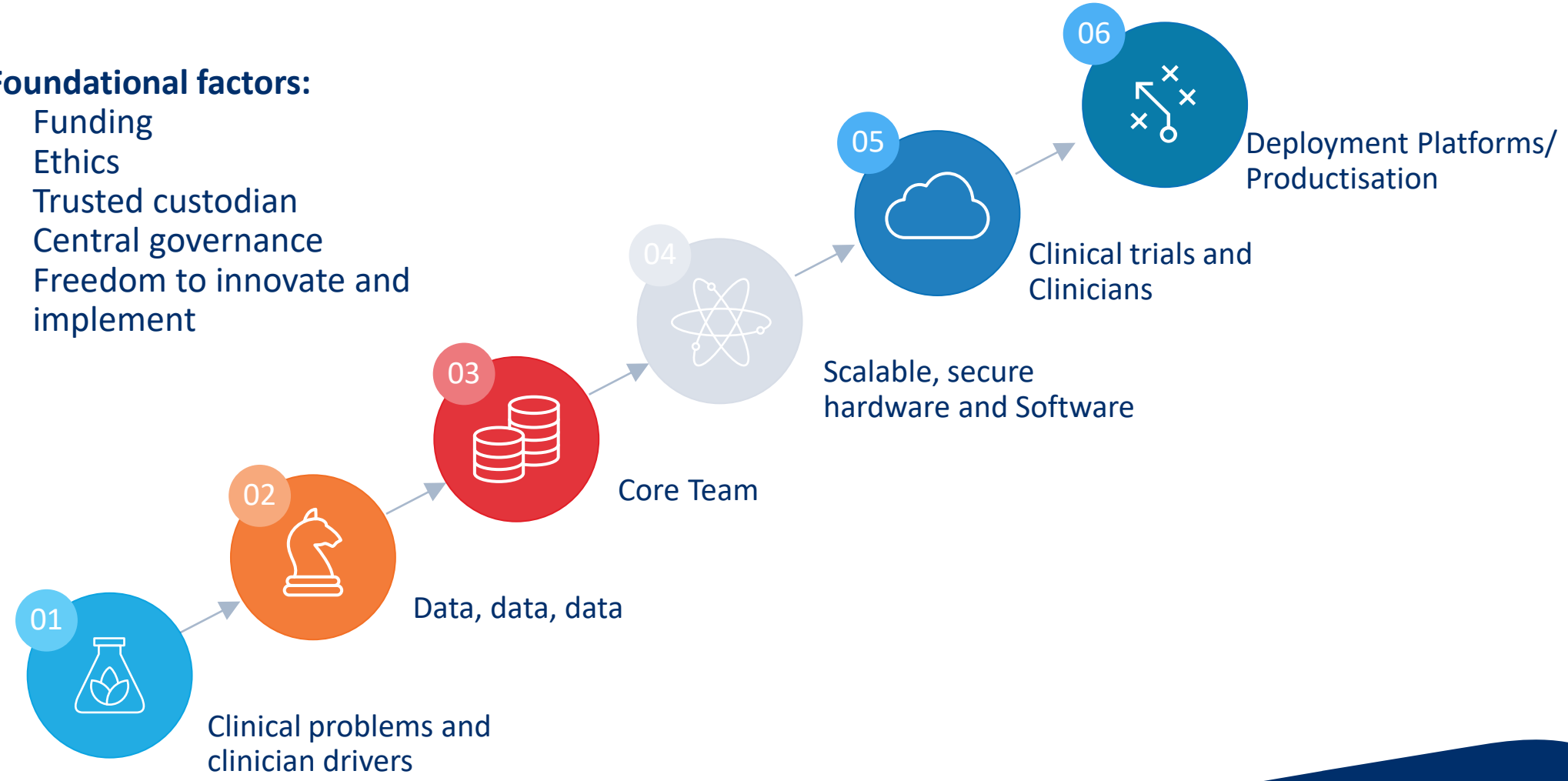
Next Steps

Assess readiness, build cross-functional teams, create safe spaces

Healthcare Innovation Success Factors

Foundational factors:

- Funding
- Ethics
- Trusted custodian
- Central governance
- Freedom to innovate and implement



'Do Not Fear Failure, But Be Afraid of Not Having The Opportunity to Succeed'

Thank you.

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Ng Teng Fong General Hospital
Alexandra Hospital
Jurong Community Hospital
National University Polyclinics
Jurong Medical Centre
National University Cancer Institute Singapore
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