

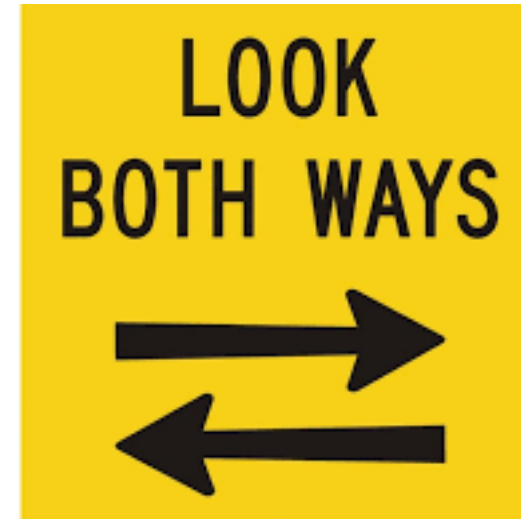
Update on Digital Pathology Scottish Association of Histotechnology

Dr Gareth Bryson
Head of Service for Pathology
National Clinical Lead for Digital Pathology
Greater Glasgow and Clyde

6th June 2019

Digital Pathology in Scotland

1. Review the Digital Pathology Pilot and share lessons learned
2. Look forward to what is next for GGC
3. Consider the landscape across Scotland



Aims of the Pilot

- Assess the technical impact of digitization and reliability of equipment
- Assess digital pathology in our NHS environment – particularly eHealth teams and IT infrastructure
- Collect some data to assist with building a business case
- Assess the feasibility of retraining in digital pathology for reporting
- Test some possible use cases
- A stepping stone to full digitization



The bones

- 1 Philips UFS Scanner
 - 8 Consultant users and workstations
 - Server and storage for 12 months
-
- Aim to validate all users, scan and report 10% of our work in 12 months

Achievements

- 7/8 consultants validated and using the system for most of their routine work
- 15597/140167 requests scanned – 11.1%
- 80000 slides scanned
- 100 TB data generated



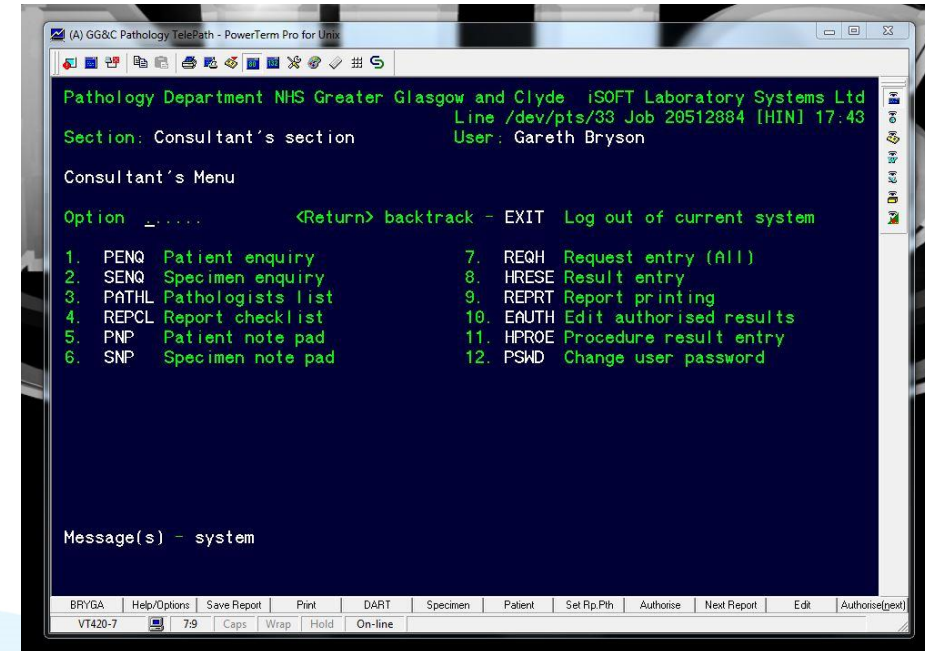
Lessons

- Integration
- eHealth
- Technical
- Equipment
- Data
- People



Integration

- IT integration to our existing systems is difficult
- Integration into lab systems is also difficult (especially in a pilot setting)



eHealth

- Very eHealth dependent
 - Server infrastructure
 - Local network speed (1GB connection)
 - Workstation builds
 - Peripherals
 - Responsibility for success



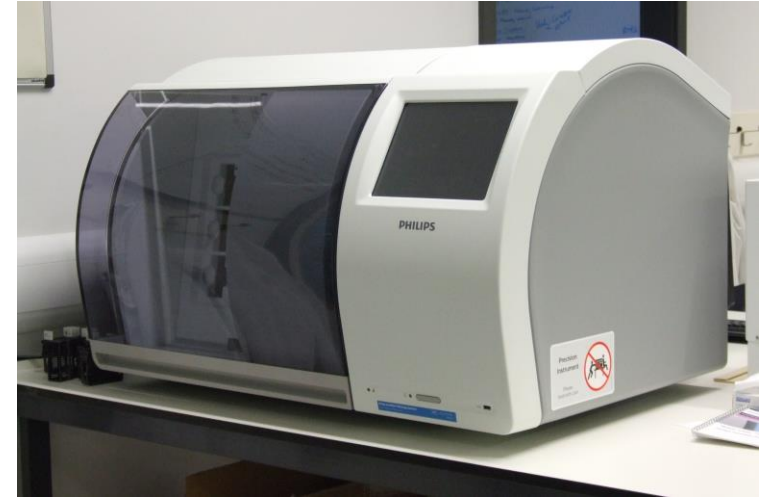
Technical

- Barcodes/tracking
- Extra step
- Quality
- Section thickness
- Cleanliness
- Workflow



Equipment

- Scanner
 - Reliable
 - Precision
 - Lens contamination
- Monitors
 - Number of pixels determines field of view
 - Minimum requirement is 27 inch 4MP
 - High luminance required (at least 300 cd/m²)
 - High quality essential to meet efficiencies



Data issues

- Ran out of data storage at 7 months
- Average image is 1.2 GB (estimate 650 MB)
- Data retention policy
- Image data storage
- Network speed, bandwidth and usage



Data retention policy

- How long to keep data
- In what format
- Layers/compression
- Accessibility
- Use for R+D
- Needs clinical leadership

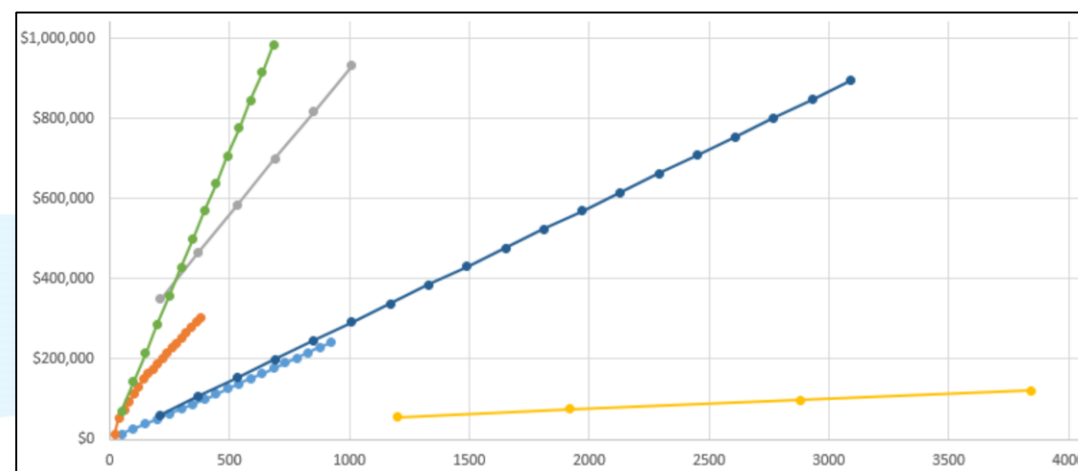
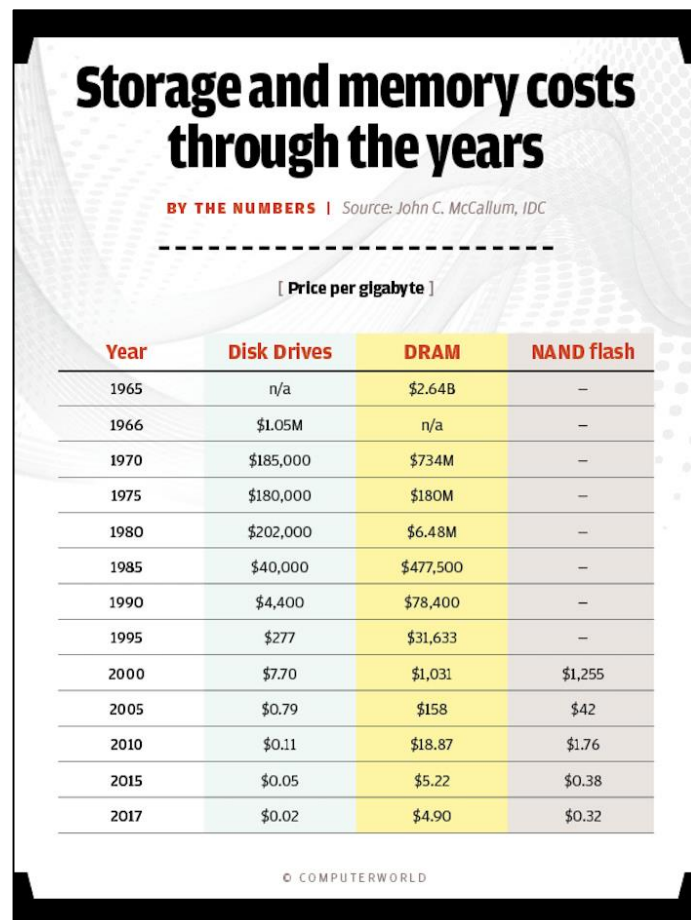


Image data storage

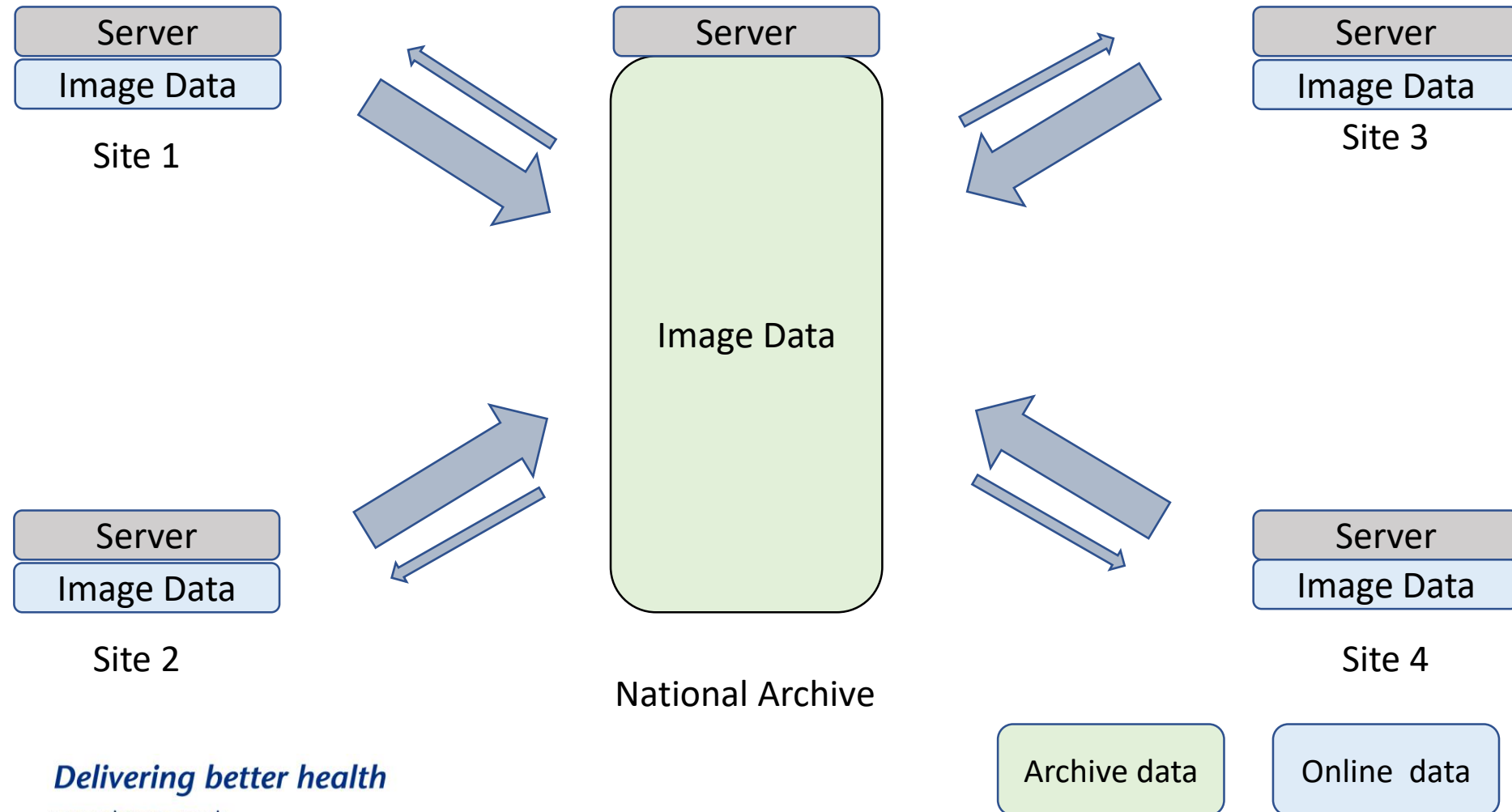
- Amount of data
- 1.2 GB per slide
- NHS Scotland circa 2.5 PB per year (for 10 years)
- Single national store or local storage
- Storage technology
 - Tape
 - Disk
 - Cloud



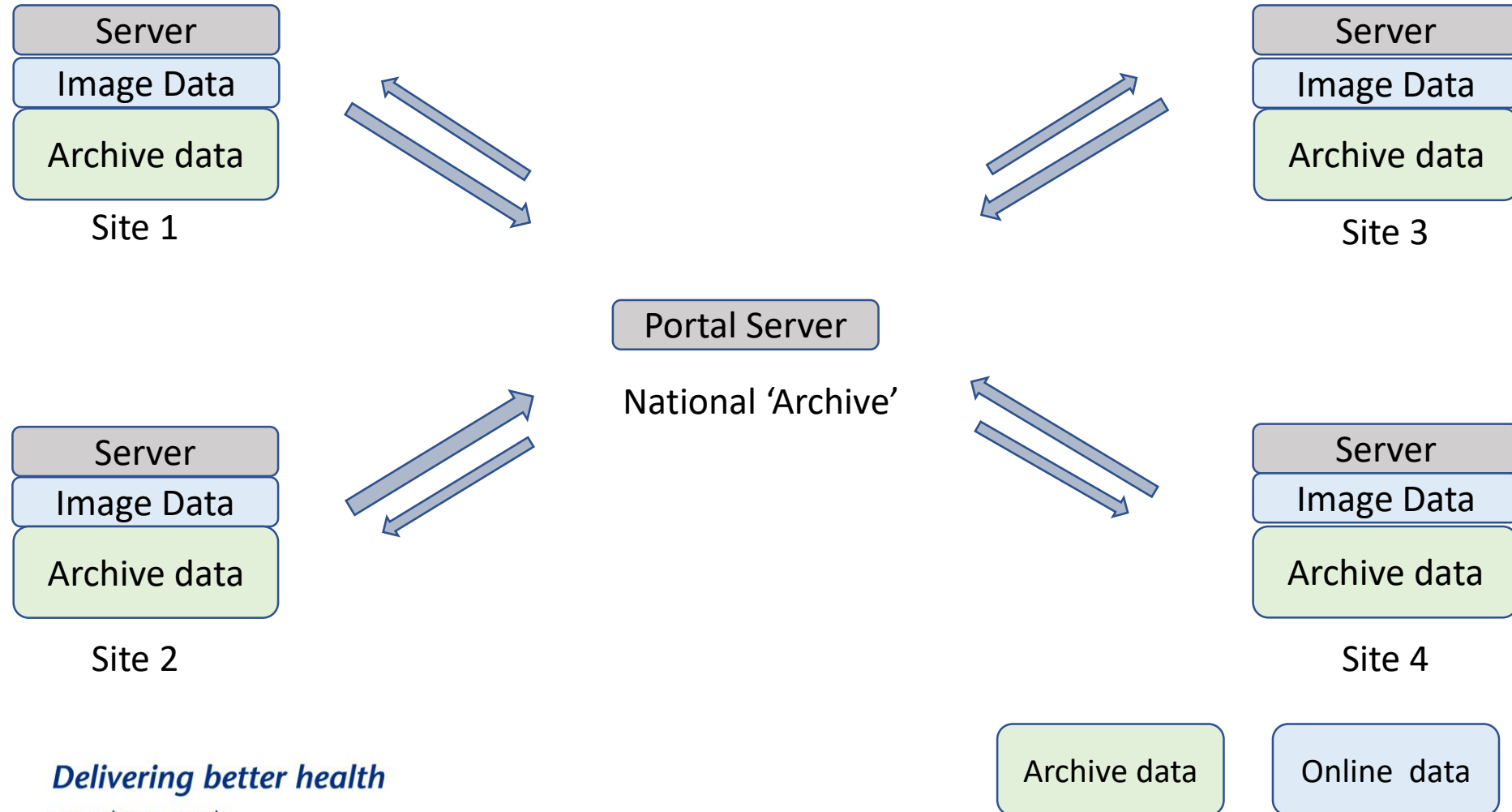
Image data storage



National data store – V1 - Centralised



National data store – V2 - Federated



Data store model comparison

Centralised

- Simplicity
- Security??
- Ease of migration/conversion
- Accessibility for research
- High impact on network infrastructure

Federated

- Lower network pressure (particularly upstream)
- Ease of accessibility of local data
- Data governance
- Scalable
- Less central control of quality
- More complicated access

People

- We consider that all pathologists can be retrained to digital for the majority of use cases (over 95%) with good system design
- Some will need more time and encouragement to adapt
- Transition will need to be phased
- Revealed enthusiasm and commitment from all levels of technical staff



Pilot Summary

- Overall success
- Some unpredicted challenges revealed
- Most issues resolved

The next phase

- UK Gov Life Science Strategy
- Innovate UK Competition
- June/July 2018

Delivering better health

www.nhsggc.org.uk

Blog

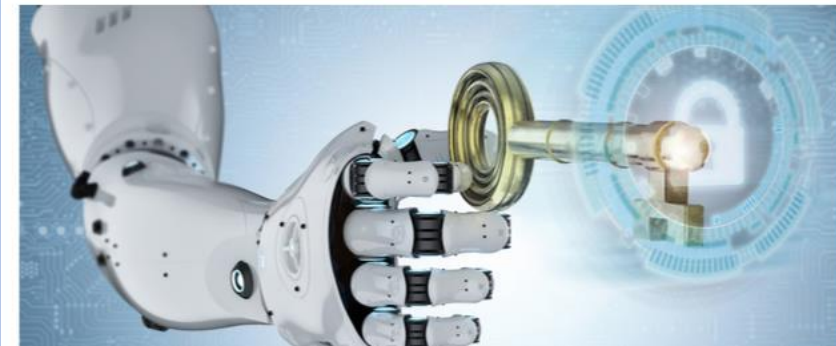
Innovate UK

Organisations: [Innovate UK](#)

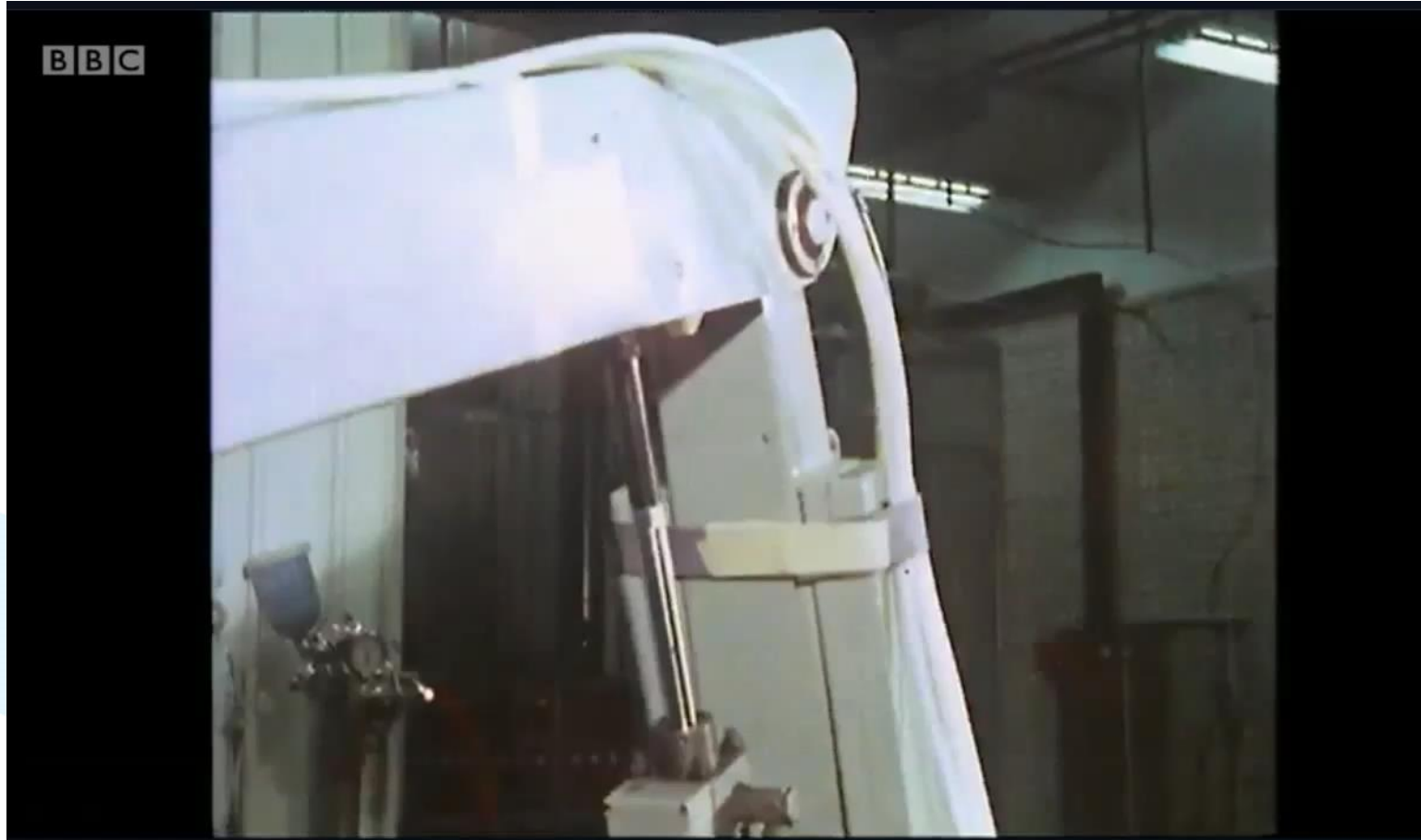
automating and digitising pathology

Unlocking the power of medical images with AI for patient benefit and economic growth

Dr Penny Wilson, 30 July 2018 - AI & Data Economy, artificial intelligence, Early Diagnosis & Precisions Medicines, Industrial strategy challenge fund, Leading edge healthcare, Precision medicine



Artificial Intelligence in healthcare isn't new

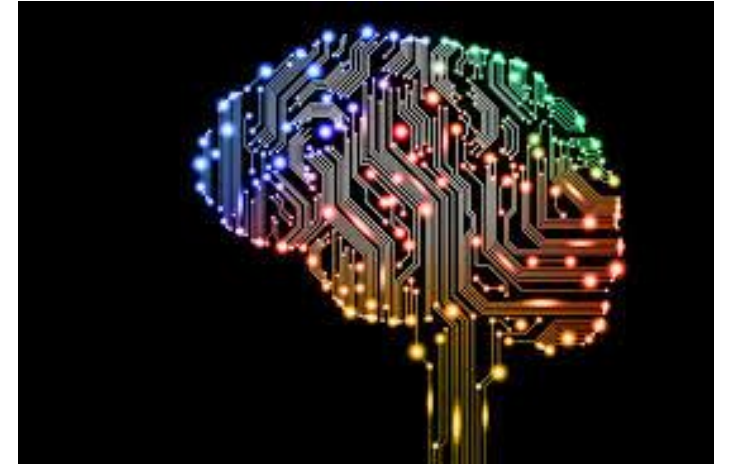


Delivering better health

www.nhsggc.org.uk

Joining up services to support the service, but...

- The concept of moving work to areas with spare capacity is flawed as **no** department has *spare* capacity
- Need for additional tools to significantly increase capacity
- The need for Artificial Intelligence



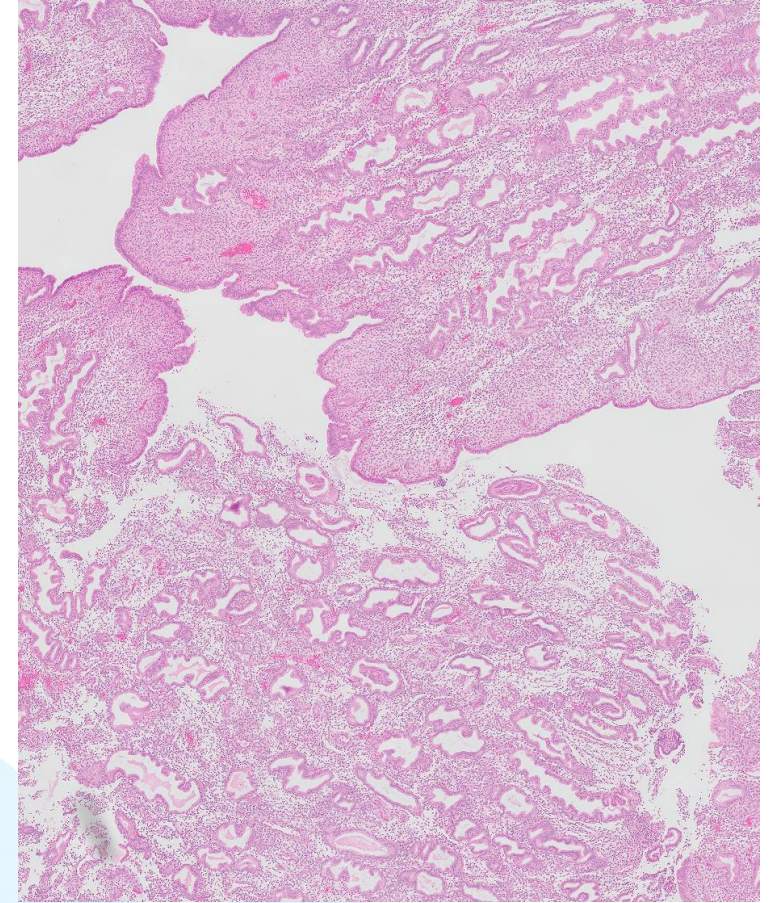
What Can Artificial Intelligence Do for Pathology?

1. Decrease demand
2. Replace the pathologist for simple tasks
3. Augment the pathologist for complex/difficult tasks

Need to do all three!

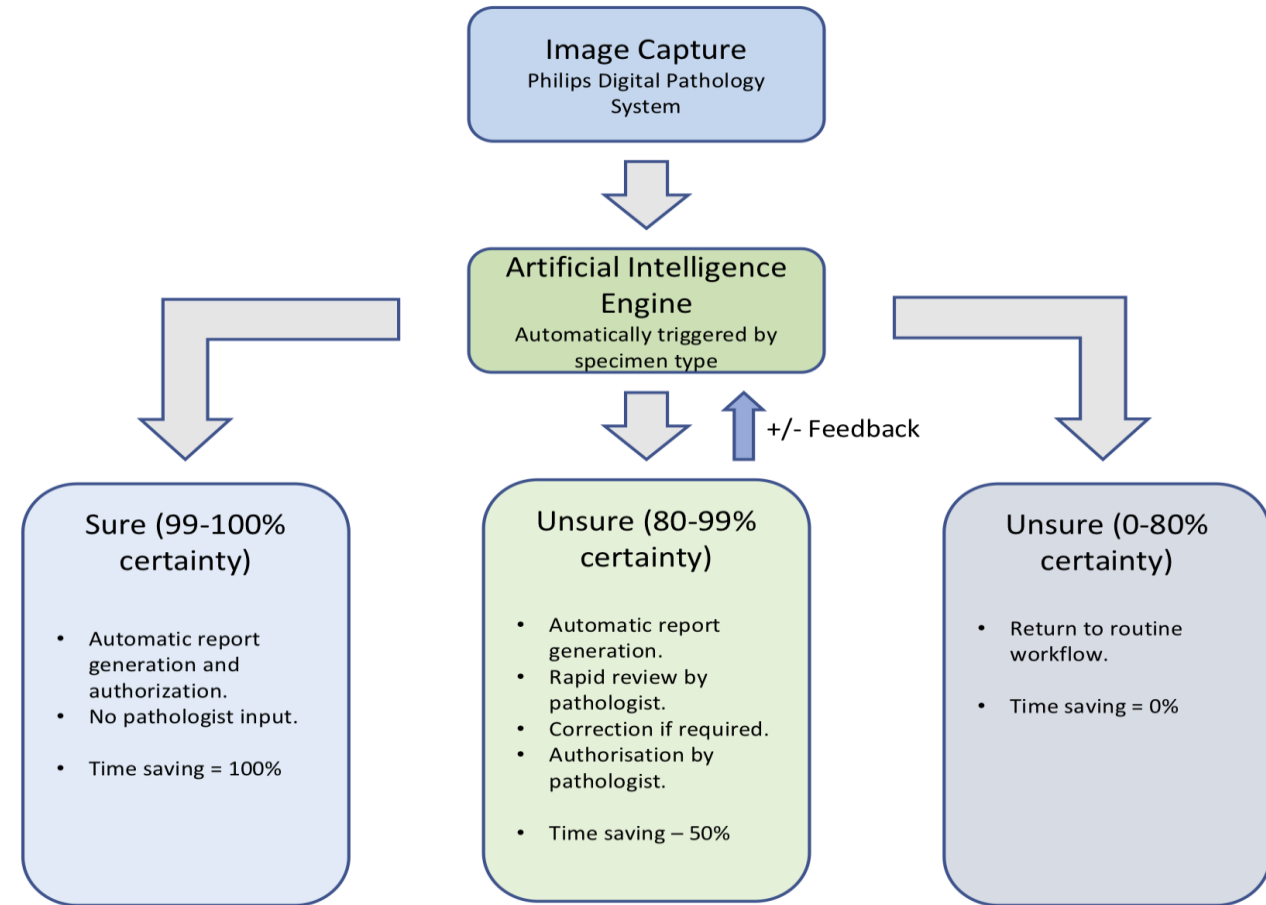
Decrease Demand

- Example – NHS GGC received 5786 Endometrial biopsies in 2017
 - 3% Malignant
 - 1.5% Atypical
 - 95% Benign
- Little benefit to the patient of pathology on these samples
- Use AI to identify the patients who can be safely not biopsied



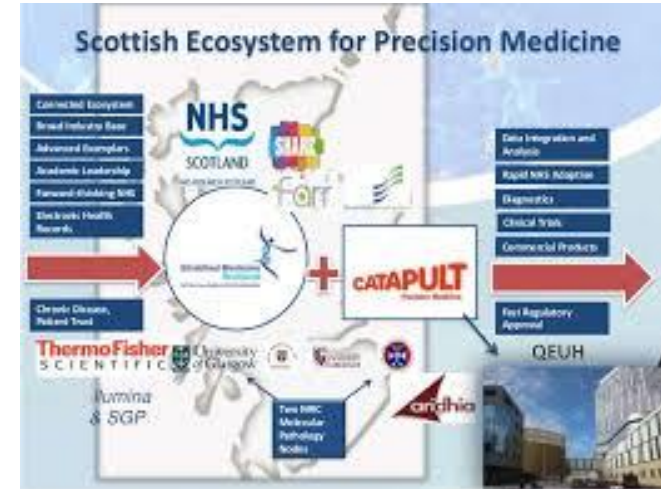
Replace the Pathologist for Simple Tasks

- Automated analysis of images
 - Normal colon
 - Normal duodenum
- Automated triage and escalation of suspicious images
- Automated report generation



Augment the Pathologist – Precision Diagnostics

- Image analysis
 - More reliable scoring/counting/measuring
 - ER/PR
 - Ki67
 - ICC/FISH
 - PDL1



Multi-stranded diagnostic data

1. Pathology
2. Radiology
3. Genomics
4. Transcriptomics
5. Proteomics

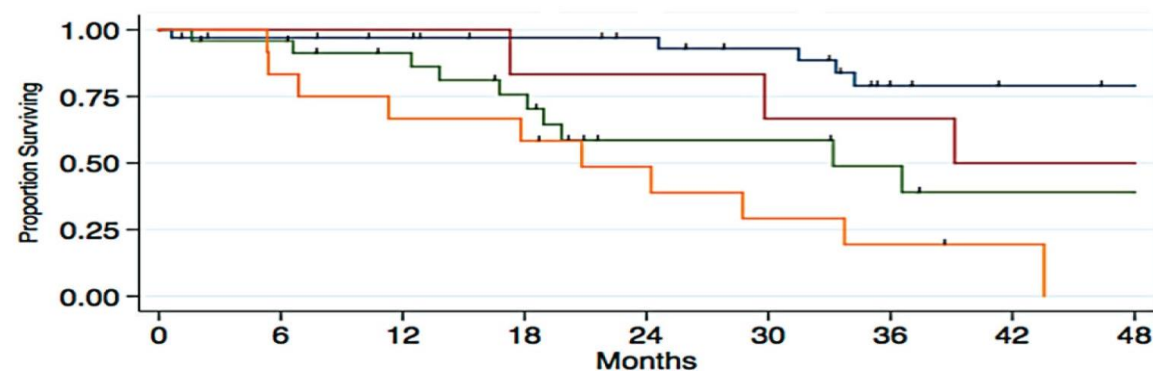
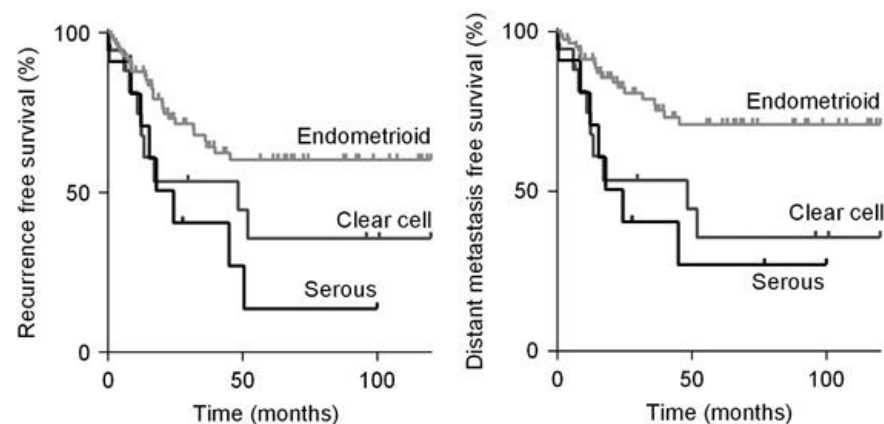


Shift in Focus from *Disciplines* to (*Precision*) *Diagnostics*

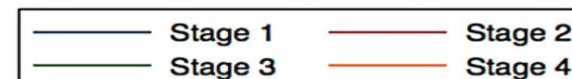
- What is the Gold Standard?
 - Pathology
 - Molecular profiling
 - Other



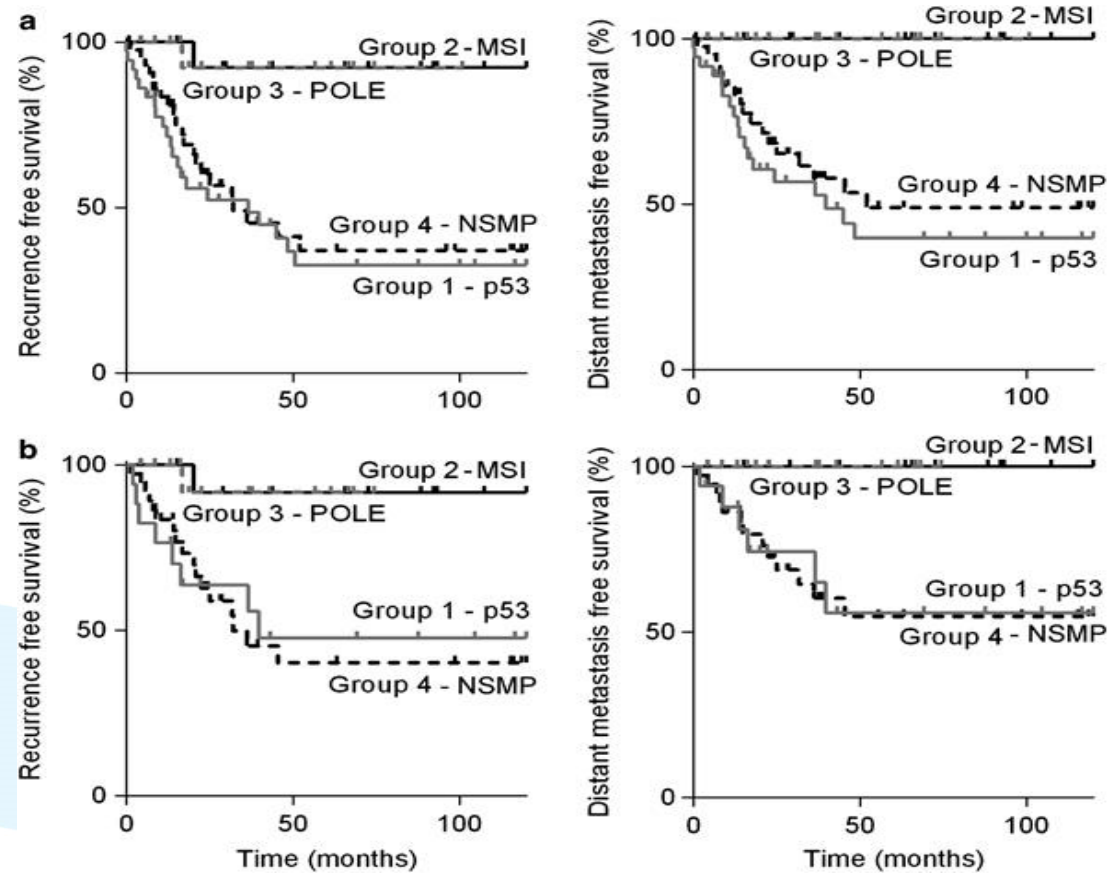
Endometrial cancer survival by type and stage



Number at risk									
Stage 1	34	31	29	26	24	21	13	11	10
Stage 2	6	6	6	5	5	4	4	3	3
Stage 3	24	22	18	14	7	7	5	3	3
Stage 4	12	10	8	7	5	3	2	1	0



Endometrial cancer survival by molecular subtype



The missing piece of the jigsaw

DATA

AI



Outcome as the Gold Standard

- Short term
 - Biopsy vs resection
- Medium term
 - Pathology vs response/recurrence
- Long term
 - Pathology vs survival

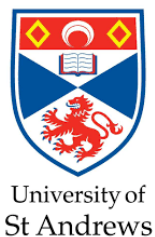


Digital Pathology

1. Digital pathology is a key method of adding key contextual and phenotypic information to the genomic and other omic data.
2. Pathology data items
3. Image information – as data

Future Diagnostics

- Integration of diverse data sources by AI
 - Pathology *Report* data
 - Pathology *pixel* data
 - Molecular data
 - Clinical data
 - Radiology data
- Use of machine learning to compare this integrated data to patient outcomes and identify patterns for predicting outcome of future patient cohorts.

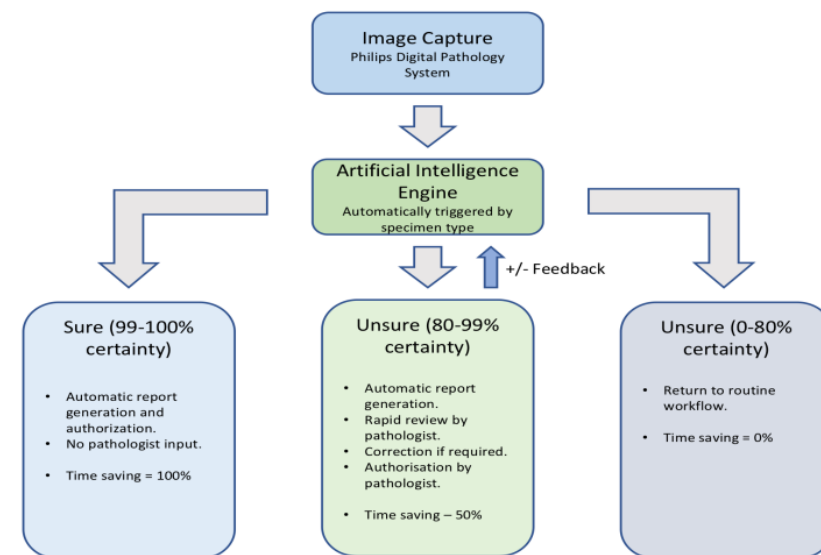
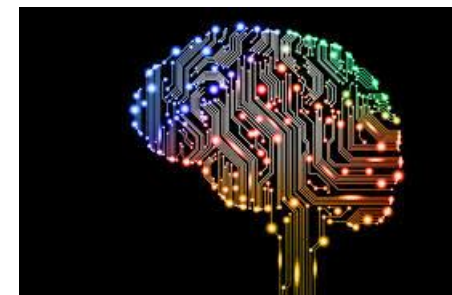
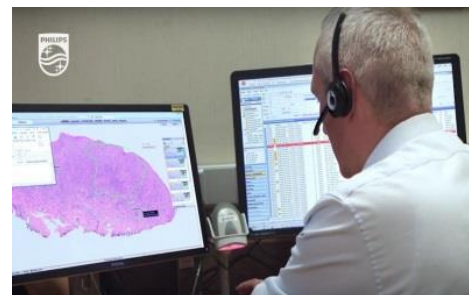


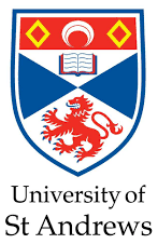
- Working with Academic and Industry partners to develop novel *Artificial Intelligence* tools.
- Improving accuracy and efficiency of tissue diagnostics by integrating computer image analysis, deep learning and NHS Pathologist expertise.
- Funded through the Industrial Strategy Challenge fund of

Innovate UK

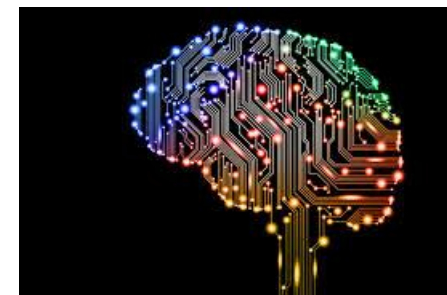
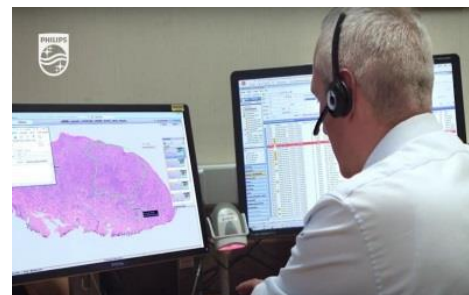
Delivering better health

www.nhsggc.org.uk





- Joint radiology and pathology consortium
 - Philips and Canon industry partners
 - £10 M Grant
 - £5.5 M Industrial contribution
 - NHS GGC Pathology £3.5 M
-
- Pathology is in 3 work packages (WP7, WP8 and WP9)



WP7 – Fully digitize NHS GGC Pathology



- Fully digitise NHS GGC Pathology over 18-24 months
- Equipment required
 - 5 UFS Scanners
 - 1 UVS Scanner
 - 70+ workstations and monitors
 - Data storage
 - Staff for transition



Delivering better health

www.nhsggc.org.uk

WP7 – Fully digitize NHS GGC Pathology



- Starts 12th June with delivery of 3 additional UFS scanners and 15 workstations
- Aim to be digitising 50% in the next 12 months
- Validating groups of pathologists from early autumn 2019
- Redesigning lab workflow and trying to go paperless

WP8 – Build a research ready data lake



- Working with Edinburgh Parallel Computing Centre and Glencoe Software to build a research ready data lake for UK SME businesses and academic institutions

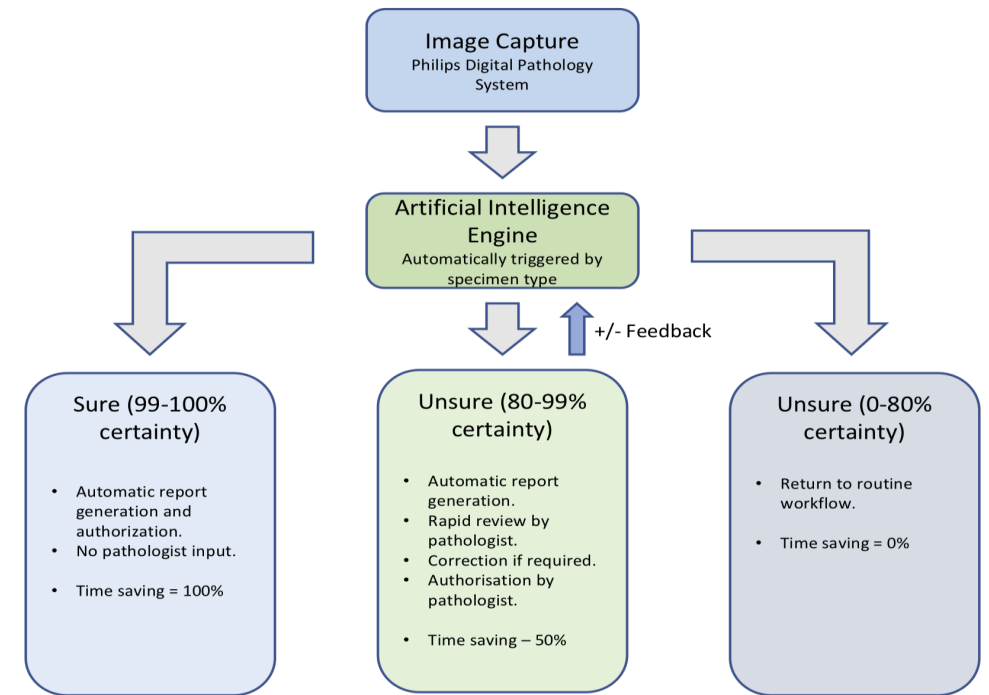


- Will be populated with data from NHS GGC initially
- NHS GGC image data also being shared with Philips

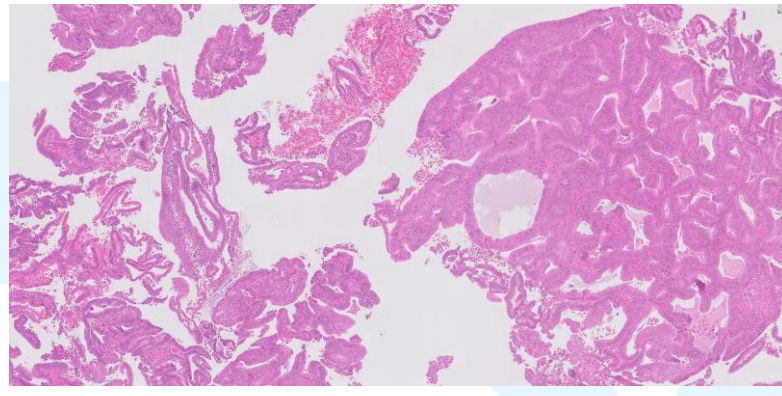
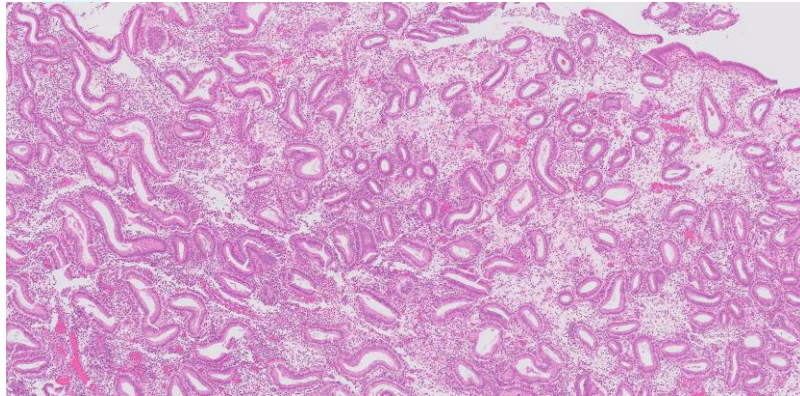
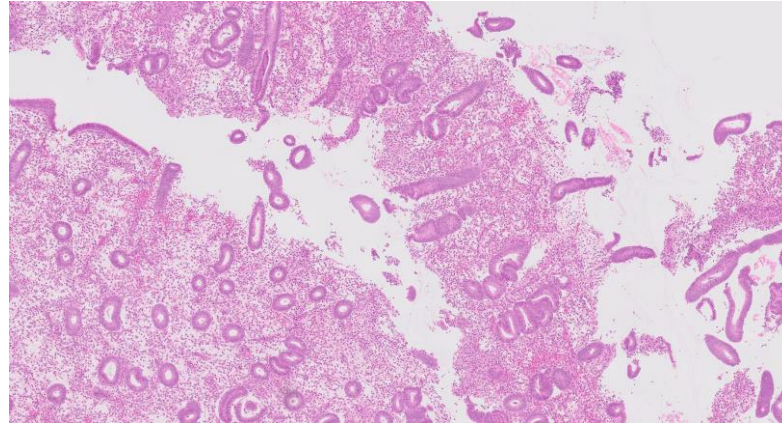
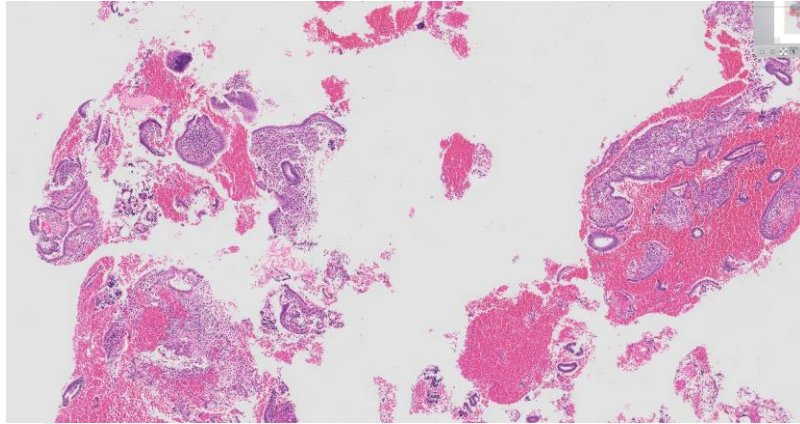
WP9 – Exemplar projects in Endometrial and Cervical Biopsies



- Aim to use deep learning to build algorithms which can identify common patterns in endometrial and cervical biopsies
- Partnered with University of St Andrews
- For simple cases, significant proportion of pathologists time is generating and authorising the report



WP9 – Exemplar projects in Endometrial and Cervical Biopsies



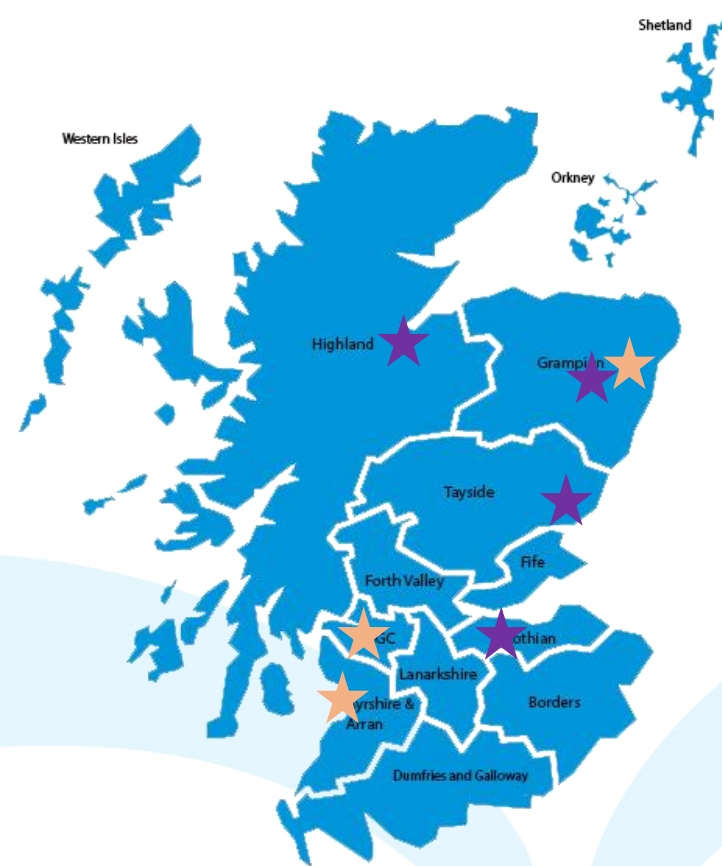
Delivering better health

www.nhsggc.org.uk

Scotland and the future

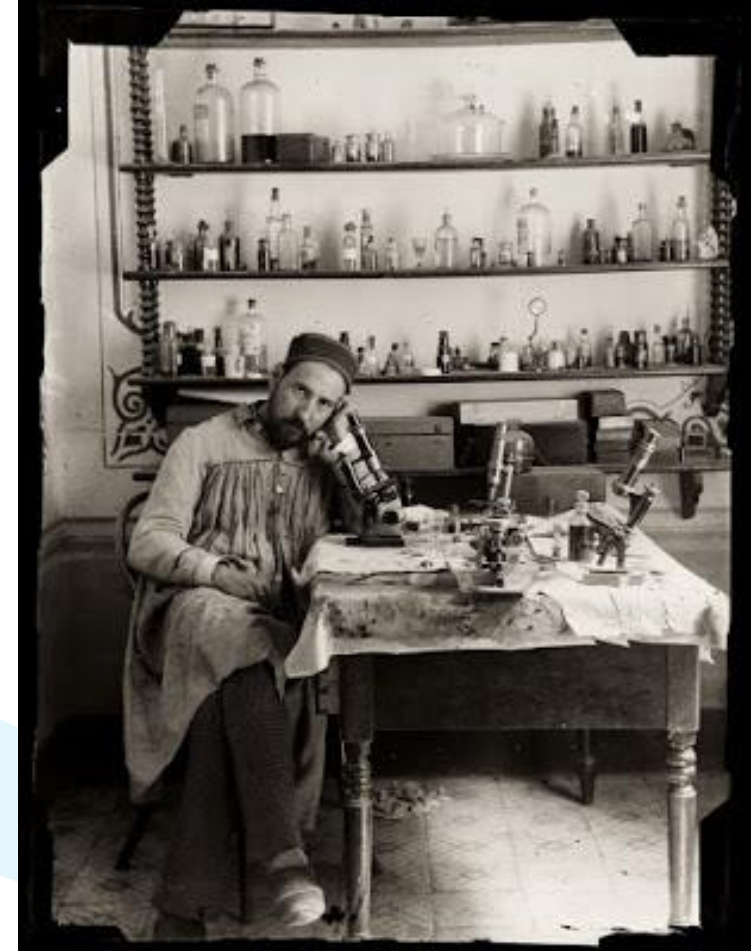
Where are we?

- Agreements for roll out in GGC and A&A
- Commitment in Grampian
- Pilots in North and Lothian

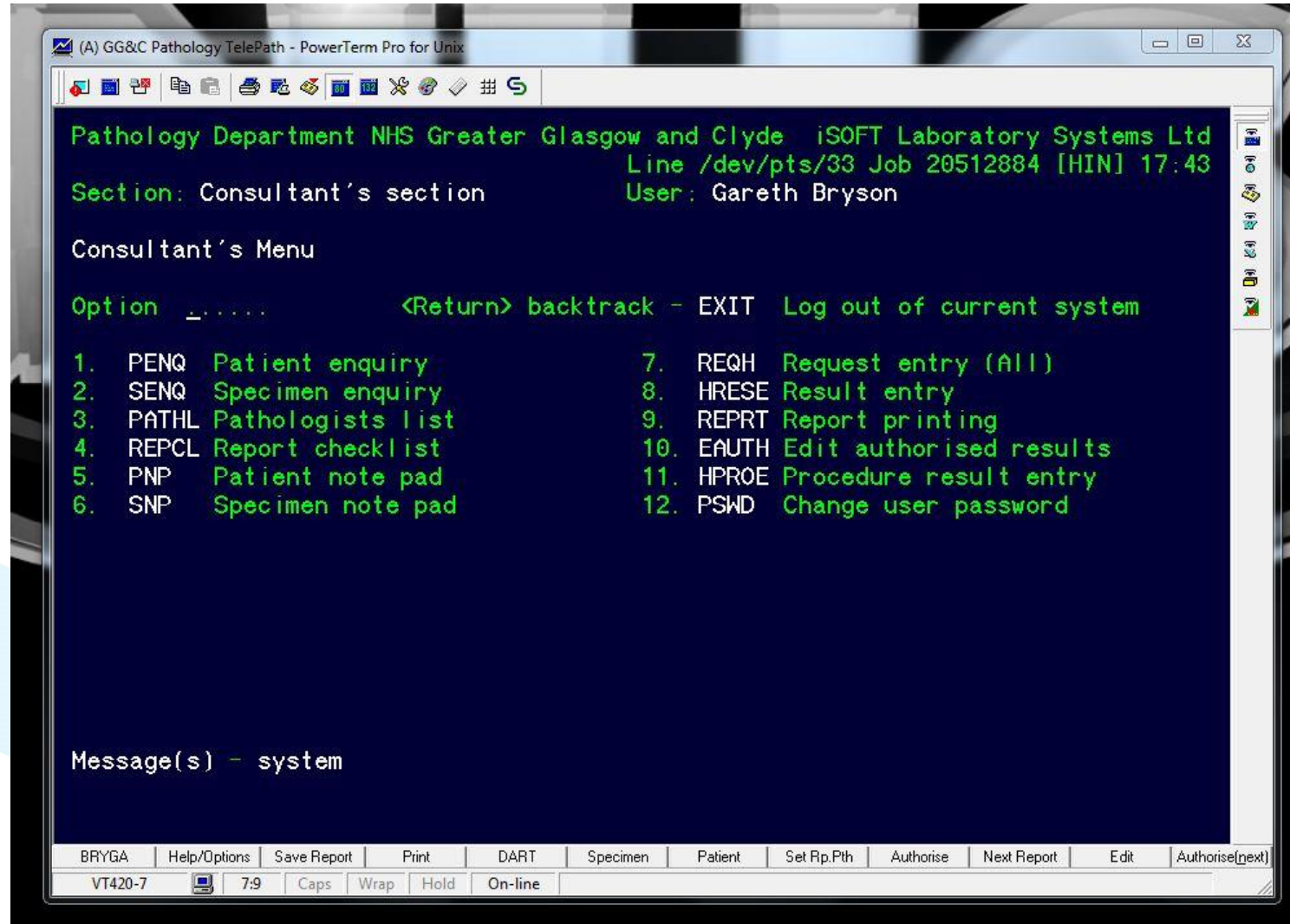


Closing the loop in pathology

- Significant investment in laboratories and equipment over the last 10 years
- Investment in IT infrastructure and information management systems is lagging behind
- Attempting to provide a 21st Century service with 20th Century IT



Antiquated IT



System Challenges in Pathology

- Reliance of paper (ordering, lab worksheets)
- Reports are made up of multiple strands of information generated at distinct times across several days
- Difficult integration of voice recognition
- Need for structured data reports to improve quality and consistency

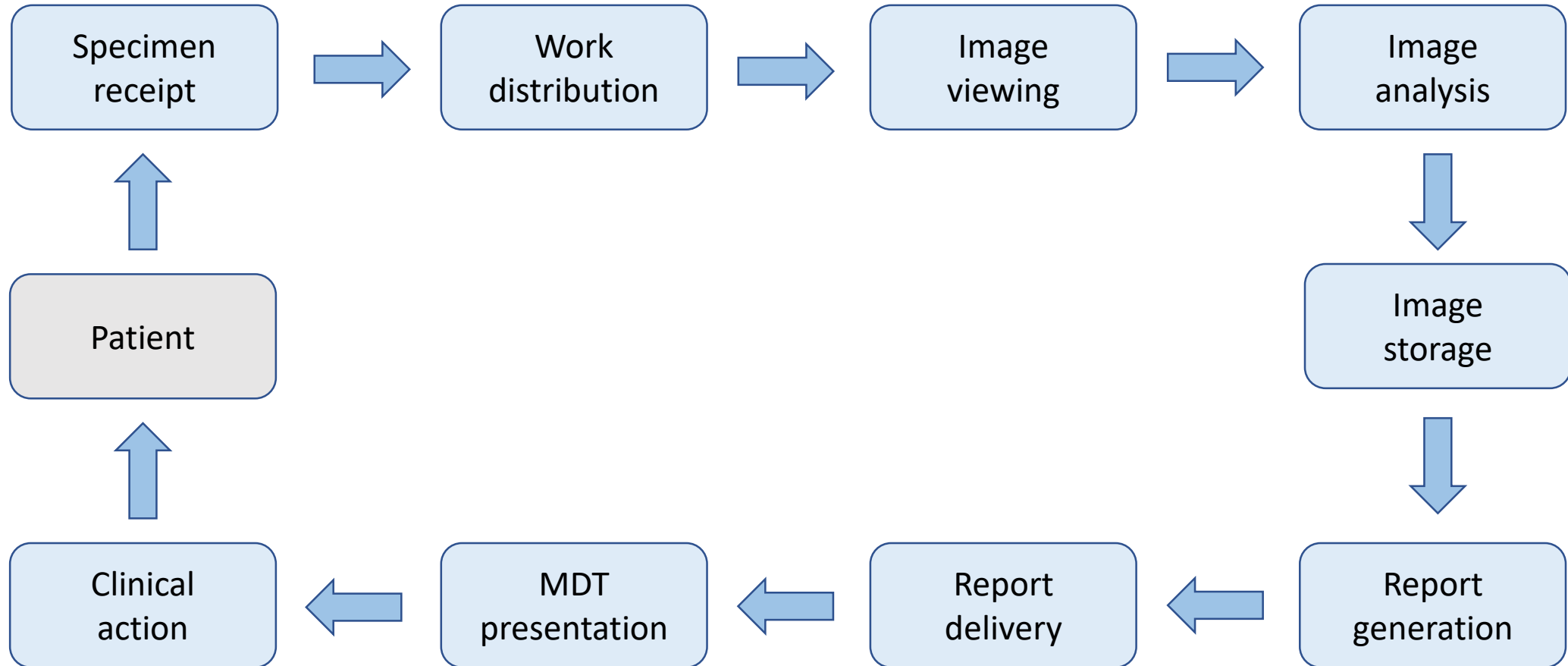


Innovate to turn these Challenges to an opportunity

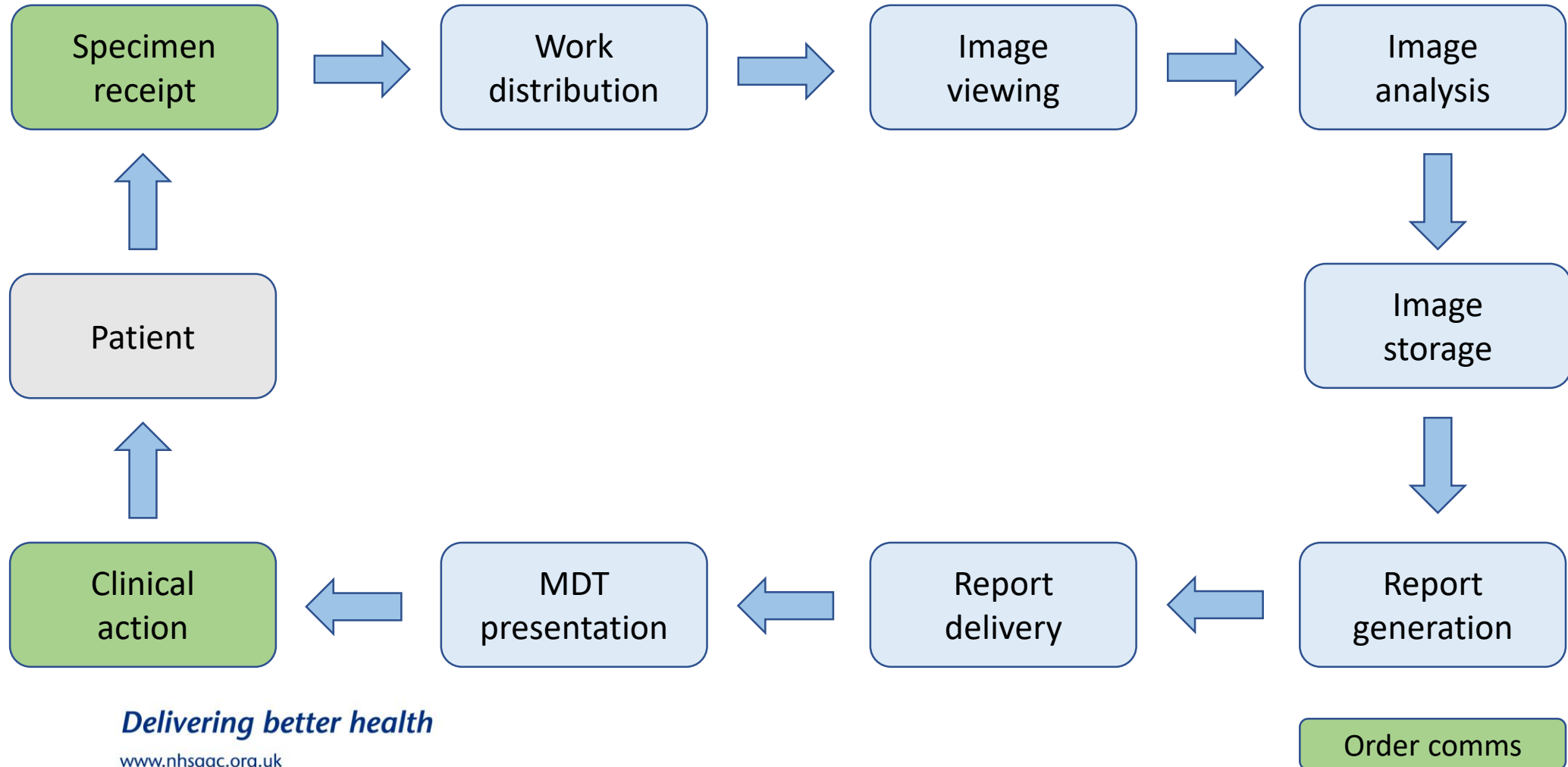


- Aim to solve many of our challenges by developing a (National) Reporting System for Pathology
- Use Digital Pathology Deployment as the lever for change

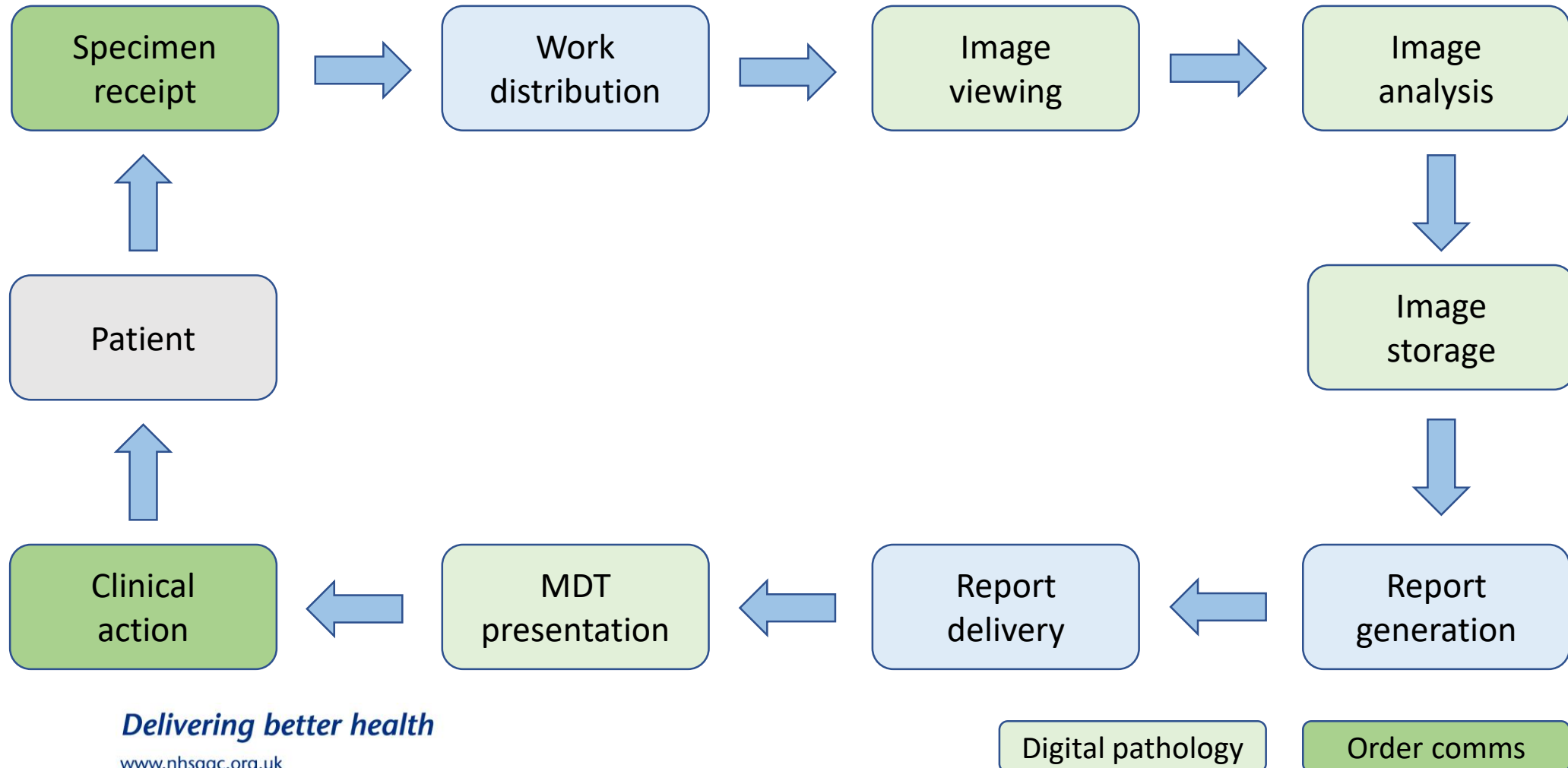
Closing the loop in pathology



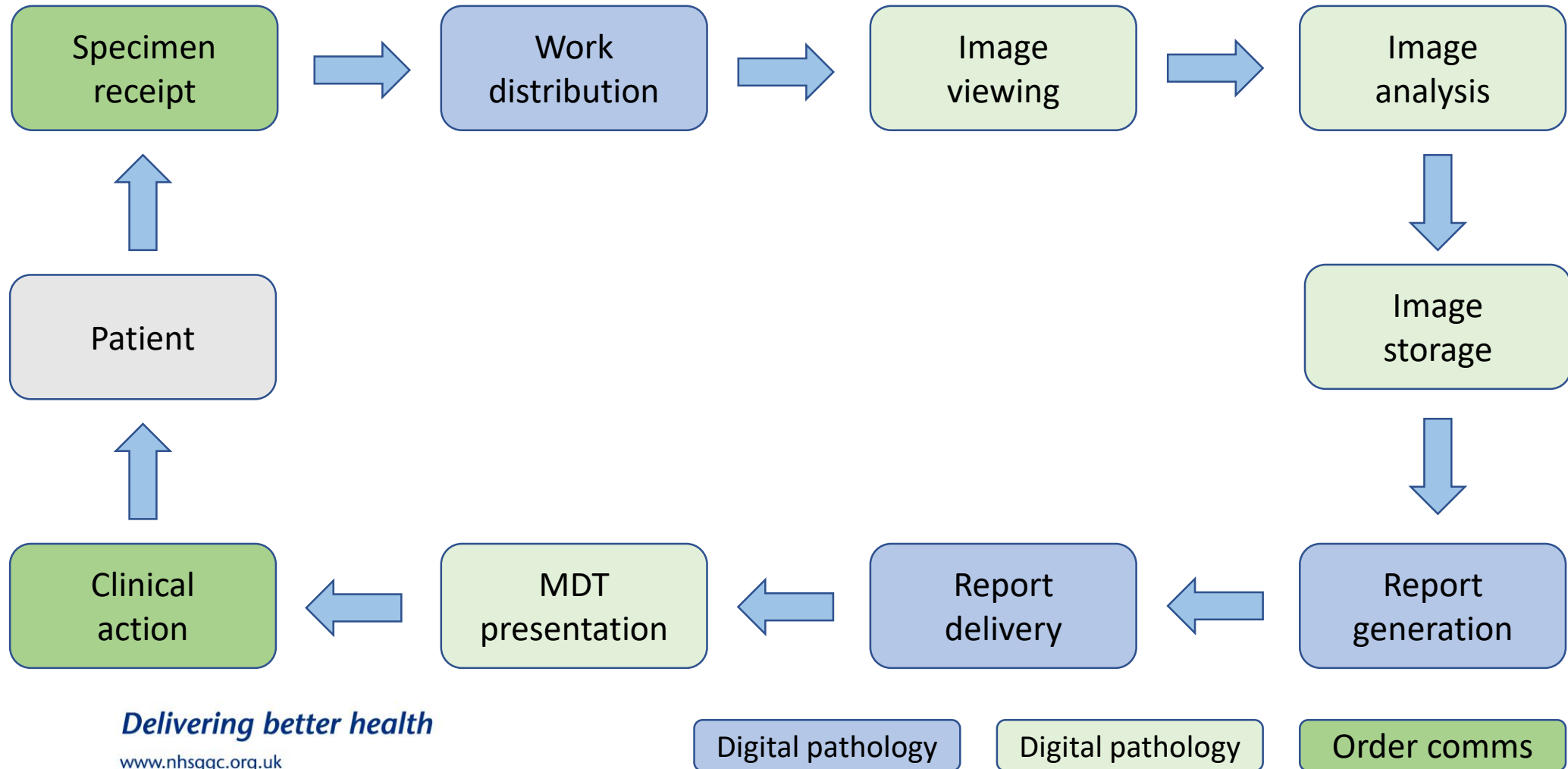
Closing the loop in pathology

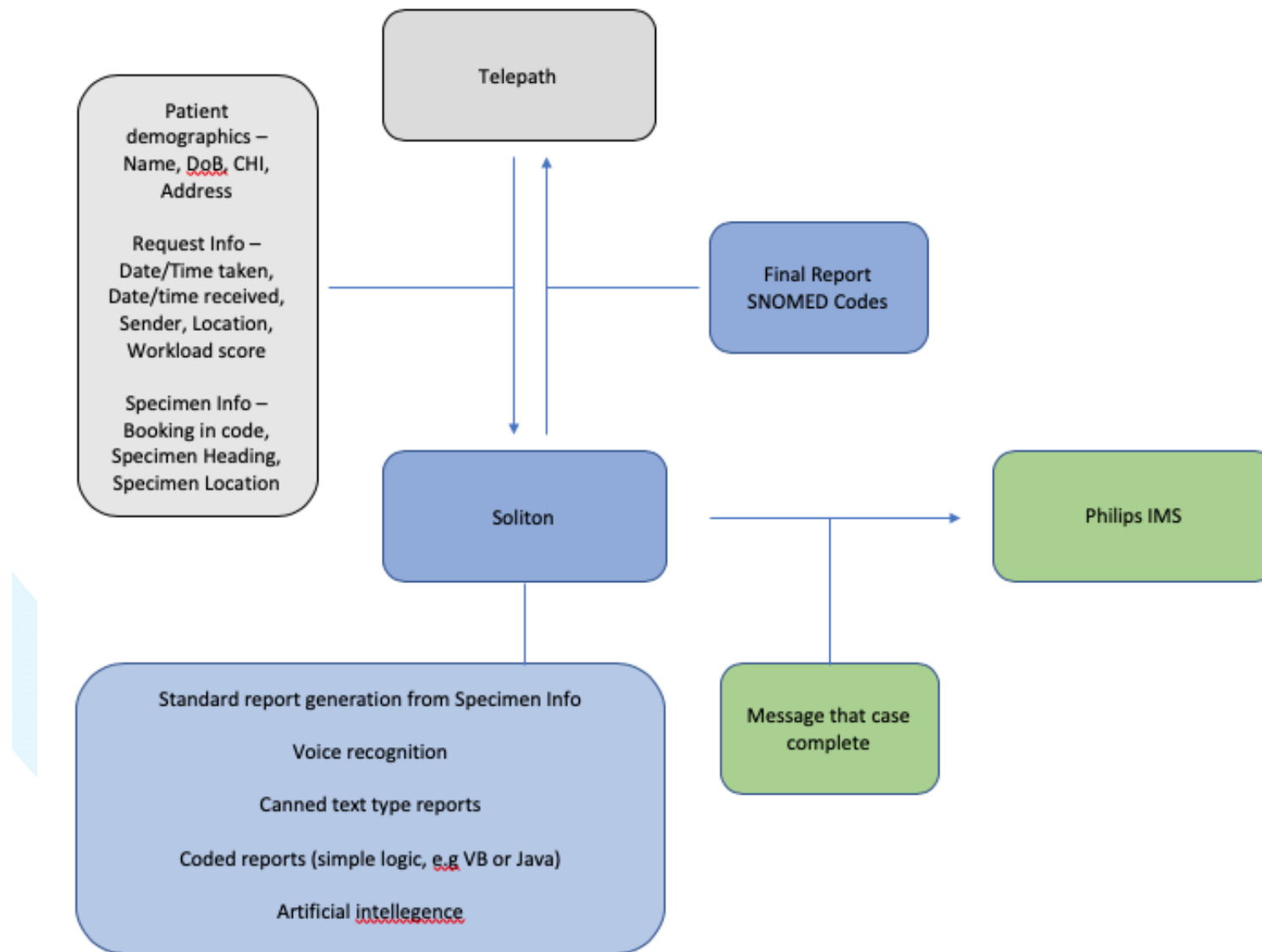


Closing the loop in pathology



Closing the loop in pathology





Thank you