WHAT'S IN IT FOR US?
WHOSE PROBLEMS ARE 5G EMPOWERED SOLUTIONS ADDRESSING IN THE CASE OF CONGENITAL HEART DISEASE?

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Ewout Brandsma & Natasja Leurs

Telenor
Philips

5G HEALTH AQUACULTURE AND TRANSPORT VALIDATION TRIALS
Outline

1. Use case motivation & assessment
2. Methodology for judging functionality and usability
3. The need for 5G and the 5G-HEART testing facilities
4. Conclusions
Use case motivation & assessment
Congenital Heart Disease (CHD):
- Serious heart defect(s) present from birth (early fetal development)
- Structural abnormalities (ventricles, valves, major vessels in/out, …)
- Prevents effective pumping or reduces amount of oxygen in blood
- Of all children, 0.8% are born with a CHD
- Fetal screening has only 50% detection rate
- Early detection, diagnosis and treatment is essential, and ultrasound plays a key role
PCHD patient journey

Screening / Diagnosis (w. ultrasound)
Heart team meeting
Surgery planning
Surgery execution
Recovery monitoring
Transfer & Recovery Monitoring (w. ultrasound)

Local hospital:
remote hospital: (OUS)

Patient
Local cardiologist / pediatrician
PCHD expert with medical team
Newborn Congenital Heart Disease dilemma: High urgency – lots of risks

Two realistic current alternatives used for diagnoses

1. Baby transported
   → Expert do US and assess

2. Local (poor) images of US screen
   → Send to expert
   → Expert inspect images and assess

Current pains and risks
- Death: to live or die
- Long term effects – whole life
- Transportation harmful
- Condition aggravation

Over/under diagnoses
- Death/no recovery
- Long term effects – whole life
- Privacy violated

Future ultrasound solution
- Local and high quality CHD detection

Source: Minutes Oslo 2020-01-29 D3.1
Many roles and stakeholders: different pains points and benefits

- **Beneficiary**
  - Patient – baby
  - Parent

- **Executer**
  - Remote expert
  - Local pediatrician / cardiologist
  - Local/central technicians

- **Customer**
  - Hospital management
  - Hospital IT
  - Expert center (OUS)
  - Local authorities/hospital
  - Government

- **Provider**
  - Health tech supplier (Philips)
  - Network service provider (Telenor)

- **Regulator**
  - Infection control authorities
  - Data protection
Business model: customer different from user & several providers involved

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Provisioning of solution

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Remote expert, Henrik: we could increase probability for short and long term health effect for the baby, the family, and local community

‘I am Henrik, a paediatric cardiologist at OUS. For me, one major pain point is getting sufficient ultrasound images to diagnose new born babies with severe heart disease in local hospitals, with as little risk as possible for the baby.

When in doubt, we may have to transport them to OUS at high risk of condition aggravation, and even death, or we are basing our diagnoses on images of US scanning sent to my mobile phone. The images are both illegal and poor, and lead to under- and over diagnosing.

If we could offer remotely assisted ultrasound for babies, we could decrease complications and increase probability of short and long term health effects for the baby, the family and local community.'

We could observe success through number of babies being sufficiently diagnosed earlier in their treatment cycles. We could also observe success through other use of remotely supervised ultrasound. Finally, we could observe fewer unapproved images on experts’ mobiles.
Methodology for judging usability and functionality
Partnering along the value chain

Mobile ecosystem (network vendors, operators)  
fit-for-purpose 5G networks

Medical solution partners  
meaningful innovation

Clinical partners (hospitals, ambulance services)
Agile development with key stakeholders

Understand workflow & shortcomings (stakeholder workshop) → Develop prototype & UX experiment → Perform UX experiment with stakeholders → Extract learnings from experiments
Concept 1: Basic 2D video

Local hospital, anywhere in Norway

Local doctor

Baby on table

Probe

2D camera(s)

EPIQ (Philips US)

Oslo University hospital (OUS)

Computer

Remote expert

Live US images

Live US control

Audio

Video of probe
Concept 2: 3D Mixed reality

Local hospital, anywhere in Norway

- Hololens 2
- Local doctor
- Baby on table
- 3D camera(s)

Oslo University hospital (OUS)

- Hololens 2
- EPIQ (Philips US)
- Remote expert
- Probe

Flow:
- Live US images
- Live US control
- Audio
- 3D video of baby & probe
- 3D video of probe
- Computer
Experimental setup (concept 1)

Room at Telenor, Oslo (represents local hospital)
- Participant 1
  - Phantom
  - Probe
  - EPIQ (Philips US)
  - 2D camera(s)

Room at Telenor, Oslo (represents OUS)
- Participant 2
- Computer
- Live US images
- Live US control
- Audio
- Video of probe

Observer 1 = facilitator
Observer 2
**Experimental setup (concept 1) – COVID proof**

- **Local hospital, anywhere in Norway**
  - Participant 1
  - Phantom
  - Probe
  - 2D camera(s)

- **Oslo University hospital (OUS)**
  - Live US images
  - Live US control
  - Audio
  - Video of probe
  - Computer
  - Participant 2

- **Room at Philips, Eindhoven**
  - EPIQ (Philips US)

- **Contact**
  - Observer 1 = facilitator
  - Observer 2

- **Audio, Video of participants, Screen-grabbing (includes live US images and probe video)**
The need for 5G and the 5G-HEART testing facilities
Why 5G?

- High bandwidth (3D mixed reality) > 50 Mb/s
- Short latency (real-time cooperation) < 20 ms
- High reliability & availability (critically ill patient) > 99.9%
The 5G facilities in Norway

### 5G NR setup

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<th>Non-Standalone (NSA), option 3</th>
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<td>LTE anchor:</td>
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<td>• Band 1: 2.1 GHz FDD</td>
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<tr>
<td>• BW: 80 MHz</td>
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<td>5G NR antenna</td>
<td>64T64R active beamforming antenna</td>
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<td>4T4R RRU and passive antenna</td>
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### 5G Core

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<th>Cloud platform</th>
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<td>Ericsson Virtual EPC</td>
<td>Nokia Central NFVI and VIM</td>
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### Connecting to 5G-VINNI, phase 1

- **5G NR setup**
  - **RAN architecture**: Non-Standalone (NSA), option 3
  - **Carrier frequency and bandwidth**:
    - **LTE anchor**:
      - Band 1: 2.1 GHz FDD
      - BW: 5 MHz
    - **5G NR**:
      - Band n78: 3.6 GHz TDD
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  - **5G NR antenna**: 64T64R active beamforming antenna
  - **LTE antenna**: 4T4R RRU and passive antenna

- **LTE Carrier frequency and bandwidth**:
  - **LTE anchor**:
    - Band 1: 2.1 GHz FDD
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    - Band n78: 3.6 GHz TDD
    - BW: 80 MHz

- **5G NR antenna**: 64T64R active beamforming antenna
- **LTE antenna**: 4T4R RRU and passive antenna

### 5G-VINNI Norway Facility Slices Phase 1

- **eMBB slice**
  - MME-1
  - SGW-PGW-1
  - PCRF-1
  - HSS-FE-1
  - CUDB-1
  - CUDB-2
  - Prov.

- **mMTC slice**
  - MME-2
  - SGW-PGW-2
  - PCRF-2
  - HSS-FE-2
  - CUDB-3
  - CUDB-4

- **URLLC slice**
  - MME-3
  - SGW-PGW-3 CP
  - SGW-PGW-4 UP
  - PCRF-2
  - HSS-FE-2
  - CUDB-3
  - CUDB-4
Conclusions
Conclusions

Ultrasound essential in diagnosis & follow-up of newborns’ congenital heart disease

Lack of skills in local hospital affects quality of images & diagnosis

Real-time cooperation with remote expert could address this problem

Motivation

Method

Explored stakeholders and their pain points

Planning for iterative user experience experiments involving stakeholders
  * “Basic 2D video”
  * “3D Mixed reality”

Subsequently envision testing on 5G facilities in Norway
THANK YOU FOR YOUR ATTENTION

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