General

The project time was 1.9.2015 – 31.8.2018. It was run by four organizations: VLL, the University of Umeå, South Ostrobothnia Health Technology Development Center (EPTEK) and the University of Vaasa. VLL has been acting as a lead partner of the project.

Project consisted of five work packets (WP leader in parenthesis); WP1: Communication (VLL), WP2: Project Lead (VLL), WP3: Establishment of the Center (EPTEK), WP4: Courses and Training (UMU) and WP5: Evaluation and Sustainability (UV).

Project personnel in the University of Vaasa

Following persons have been working in NTC project during the project time in the University of Vaasa:

Abdelmageed Shaima
Elsanhoury Mahmoud
Eltahawy Bahaa
Hänninen Petri
Madetoja Markus
Sandell (née Fernandez Gualdron) Lina Maria
Seppälä Hanne
Mantere Timo
Virrankoski Reino

Hanne Seppälä is working as Assistant in the Finance and Project Administration at the University of Vaasa. Professor Timo Mantere is a head of the Department of Computer Science in UV. Reino Virrankoski was a Development Manager in UV and the principal investigator of the UV part of the project until he moved to new job on 1.5.2018. During the rest of the project time, Mantere was the PI of UV part. The rest of the persons mentioned above have been working as Project Researchers in NTC.

Project Activities by the University of Vaasa

University of Vaasa contributed to different work packages of the NTC project as follows:

WP1: Communication

NTC project team in the University of Vaasa participated to different meetings related to the project execution, and the planning of the project website and Facebook site, and contributed with these activities.

As a part of the European Cooperation Day on 2016, NTC was promoted in Seinäjoki and UV team participated to this promoting. On 16.3.2017, UV team organized a seminar about healthcare digitalization at the University of Vaasa jointly with Elisa, which was one of the industrial collaborators in the NTC project. On 15.2.2018, Shaima Abdelmageed participated to Women with
Impact seminar in Vaasa. In her presentation she used NTC as an example about women’s role in technology

**WP2: Project Lead**

This WP was under VLL responsibility. UV team participated to joint meetings to exchange knowledge and to brainstorm and work with the ideas.

**WP3: Establishment of the Center**

Project ICT group took care of most of the planning and discussion related to NTC physical node. Shaima Abdelmageed was UV representative in the ICT group. Other UV team members took part of the ICT group meetings when there was something related to their work under discussion.

Shaima Abdelmageed has been working with the remote heart rate monitoring and the utilization of low-quality sensor data for that purpose. In this context low-quality refers to typical challenges that exist in the utilization of sensor data, which is collected wirelessly by using relatively cheap sensors. These challenges include noise, missing packets, erroneous measurements, time-varying transmission delays etc. She also worked with the wireframes to build up the NTC portal (so-called virtual node).

Bahaa Eltahawy has been working with activity monitoring systems and security. He made an investigation about the feasibility of Sigfox and LoRa network technologies for this purpose. He also made a survey about the exiting commercial activity monitoring systems, and made a suggestion about the best ones for assisted living (Appendix 1). Then he investigated suitable cloud services and the requirements in terms of security related to the collection of big data in eHealth.

Lina-Maria Sandelin has been working with Small Data Garden’s lotts sensor nodes. These nodes have been used with drone and their use for activity monitoring has also been considered. She also made a survey about the existing sensors that would be suitable to use with Small Data Garden node for presence and activity monitoring purposes (Appendix 2).

Petri Hänninen and Markus Madetoja have been working with the drones and drone-integrated sensor systems. In the context of eHealth, the drones can be used in rescue and accident situations. In the case of accident, the pictures and the video stream provided by the drone can be utilized for situational awareness to rapidly figure out the situation in the accident area, form the operational picture and plan the actions and medical preparation accordingly. The drone can also carry sensor nodes and deploy them to the accident area to figure out the spread of the chemical leak, fire or some other phenomena. Related to the rescue operations, the drone can be utilized e.g. to seek persons who are lost because they suffer from memory disorder. They can also provide a rapid way to send first-aid help to people in remote locations.

The used drone was GeoDrone X4L multicopter by VideoDrone Finland Oy. It was equipped with Sony α6300 camera. In addition to camera, a node dropper device to carry and deploy lotts sensor nodes was developed and integrated with the drone jointly with Small Data Garden.

The multicopter has 4 rotors in X-configuration. Flight time can be maximum 66 minutes depending on payload, weather and other conditions. Copter has analog videolink to the screen which is mounted on top of the copter remote controller. Videolink is directly attached to still camera so it
can be used to view real-time video stream from the camera and also to check some flight parameters, for example altitude. Copter battery voltage level and copter location in GPS coordinates are also transmitted from the multicopter to the remote controller.

GeoDrone X4L has a mounting space and connectors for payload, which can be camera, gas sensing unit, node dropper etc. Camera can be almost any kind of camera, which is suitable for drone and does not exceed drone’s maximum takeoff weight. The usual still camera, video camera, thermographic camera and multispectral camera can all be used.

Two test scenarios were made with GeoDrone X4L multicopter. In first scenario, Sony α6300 still camera was used. Camera was mounted on 2-axis gimbal, which stabilizes the image. Some still images and video were collected. This is the most usual use case for multicopter system. Because of the videolink type, only camera viewfinder image was transmitted in real time to the ground. Images and video were saved to the onboard Secure Digital memory card. The saved files were transferred after the copter landed. However, there are alternative ways to build the communication link from the multicopter to the ground so that everything can be transmitted in real time, if needed. If the communication link supports multi-video streaming, it would also allow the simultaneous use of video and thermographic cameras, which would be beneficial in many cases.

In the second test scenario, GeoDrone X4L multicopter was equipped with the developed node dropping device. Iotsu sensor nodes were deployed by using the drone to the pre-defined locations to form a wireless sensor network. These locations were set by using VideoDrone’s flight planner software. We managed to deploy all nodes into correct coordinates. Depending on the type of the communication technology, the nodes can either transmit the data they measure directly to user location, or the nodes can store the data, and the drone can visit time to time to read the buffered data from the nodes.

**WP4: Courses and Training**

Shaima Abdelmageed planned and lectured a new course: “E-Health: Concepts and Applications (5 ECTS”. The course was lectured as Communications and Systems Engineering Seminar on Autumn 2016 in the University of Vaasa. After the course, a feedback was systematically collected and analyzed. That information was utilized to update the course content and some material about drones, UAVs and their utilization in emergency and rescue situations was also added. The course is going to become part of the ICAT program syllabus in the University of Vaasa, and it will be lectured (most probably) in every second year in the future.

Shaima Abdelmageed also visited University of Umeå, and participated to the E-Health course that was planned and lectured there as a part of this WP4 activities.

In addition to communication activities (see WP1), the healthcare digitalization seminar that was organized jointly by Elisa and the University of Vaasa on 16.3.2017 in Vaasa, can also be considered as an example of such training, that can be offered in the context of NTC.

**WP5: Evaluation and Sustainability**

This WP was led by the University of Vaasa. There were three main entities in this WP: NTC Advisory Board, NTC Demo Scenarios and the development of the sustainability model for NTC.
Advisory Board consisted of the representatives of stakeholders and project partners. Based on the project partner proposals, the project executive group decided the persons who were invited to the Advisory Board. The Advisory Board worked as a discussion and expertise forum regarding the center technical development, user experience evaluation and business model development. It provided a forum to brainstorm the ideas related to project execution, and to receive feedback and comments about them from the stakeholders and collaborators. This was an important form of the continuous evaluation during the project proceeding.

Since there were two countries participating to the project, the Advisory Board had the same number of representatives from Finland and Sweden. The Finnish part of the Advisory Board had its first meeting in September 2017 and the second one in December 2017. A joint Advisory Board meeting (Finnish and Swedish part) took place in Umeå in Spring 2018.

A couple of piloting and demo scenarios were first defined jointly with other project partners so that every partner suggested some scenarios which were then jointly discussed further. Then the selected scenarios were carried out to technically validate the center facilities and to collect feedback from the users.

NTC project built up the Nordic Telemedicine Center, which is going to continue its operation after the project. To enable a successful continuation, a model how to sustain the center is needed. This model must include the legal form of the center (company, association, public organization etc.) as well as the business model and strategy of the center.

Mahmoud Elsanhoury made a business investigation study about NTC by using business model canvas. The main results are documented as his Master’s Thesis “Business Investigation Study for the Nordic Telemedicine Center using Business Model Canvas and Monte Carlo Simulation” (University of Vaasa, 2018).

Based on his work, Mahmoud Elsanhoury made also a report that can be considered as a preliminary sustainability model of NTC. This report is attached as an Appendix 3 into this document.

**Appendices**

Appendix 1: Commercial activity monitoring systems

Appendix 2: Motion & Position sensors

Appendix 3: The Nordic Telemedicine Center Business Model Canvas