REACTION

Results and experiences from the project **REACTION**
Remote Accessibility to Diabetes Management and
Therapy in Operational Healthcare Networks

Online diabetes management and therapy in different healthcare settings

REACTION

The REACTION project - co-funded by the European Commission within the 7th Framework Programme in the area of Personal Health Systems under Grant Agreement No. 248590.

Project partners: Atos Research & Innovation (Coordinator - Spain), CNET Svenska AB (Sweden), DELTA (Denmark), Institut für Mikrotechnik (Germany), Foundation for Research and Technology Hellas (Greece), Fraunhofer SIT (Germany), Hellenic Telecommunications and Telematic Applications Company (Greece), In-JeT ApS (Denmark), Applied Logic Laboratory (Hungary), Medical University of Graz (Austria), Joanneum Research (Austria), Chorleywood Health Centre (UK), Brunel University (UK), Vrije Universiteit Brussel (Belgium) and BAYER Technology Services (Germany).

Welcome to the REACTION project

In this brochure you can read about the main results of the REACTION project which lasted from March 2010 to February 2014.

The main goal of REACTION was to investigate how information and communication technologies can support both patients and healthcare professionals in managing diabetes, by providing efficient and scalable tools that can be used in different healthcare contexts across Europe.

The result is an intelligent service platform for remote monitoring and therapy management, facilitating continuous and tight control of blood glucose levels and other vital signs, which are crucial for good diabetes management and insulin therapy.

Based on an iterative process of gathering user requirements, the REACTION platform and components have been designed, developed and integrated in two different health care environments: The in-hospital environment at the University of Graz in Austria with focus on monitoring and decision support to healthcare professionals, and the primary care environment at Chorleywood Health Centre in the UK with emphasis on management and therapy services to patients with diabetes.

In these contexts, REACTION has developed methods and tools to support patients and healthcare professionals in the day-by-day, as well as long-term management of diabetes.

Additionally, the project has made significant progress in the research on automatic glycaemic control, with the creation of a demonstrator platform integrating sensors and the insulin dosing algorithm developed in the project.

In the next pages you can read about the main results as well as 22 specific outcomes of the project.

Enjoy the reading
Lydia Montandon
Project Coordinator

EU Project Officer

The REACTION project is one example of how the EU works together with research & innovation communities to deliver concrete results that translate into affordable and quality health services to its citizens.

Financed under the 7th Framework Programme for Research and Technological Development (FP7), the REACTION project has in fact provided a tangible result for people suffering from diabetes: A platform for better diabetes management.

The project started in early 2010 under the coordination of Ms Lydia Montandon from Atos Research and Innovation, who in this endeavour has been backed by 14 other partners, representing 9 different countries, all with a strong expertise in the medical field and information technology. The platform has been field tested in two healthcare settings (Chorleywood Health Centre and Medical University of Graz), and has proved successful in providing better care to diabetes patients.

With two concrete achievements, namely the GlucoTab and the REACTION platform, there is no doubt that this project has delivered value to diabetes patients and healthcare professionals. If replicated at a larger scale, I believe these tools could produce a significant impact in healthcare delivery throughout Europe, and I can only encourage the project to transform these outcomes into exploitable products and services.

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www.ehealth2014.org

Highlights of REACTION

The REACTION project has resulted in a wide range of knowledge covering both technical, medical, clinical, organisational, cultural, social, market and legislative aspects.

The REACTION service platform for remote monitoring and therapy management was the central production environment for the deployment of REACTION applications. REACTION components have been assembled and integrated in different ways to address the needs of the different application environments.

The platform can be customised to different types of closed-loop applications and scenarios and is built on open and interoperable standards, utilising state-of-the-art solutions as far as possible.

From the clinical point of view, REACTION has resulted in medical methodologies, protocols and guidelines that prescribe the use of the technology to support decision making. Significant improvements in clinical outcomes were obtained both in the in-hospital and in the primary care environments:

In hospital, the use of a workflow and insulin dosing support system for glycaemic management had a positive impact on insulin dosing accuracy and this allowed keeping patients' glucose data in range. Nurses, as well as physicians felt that IT support improved their performance.

In the primary care setting, patients were able to use REACTION technology to monitor vital signs and communicate them to the healthcare centre. This made patients more aware of their condition and facilitated a more informed interchange with healthcare professionals concerning their therapy and behaviour.

Other project outcomes complement the main technological and clinical achievements and include:

Insight into the health market structure, technology trends, health reimbursement schemes and potential competitors of the REACTION elements.

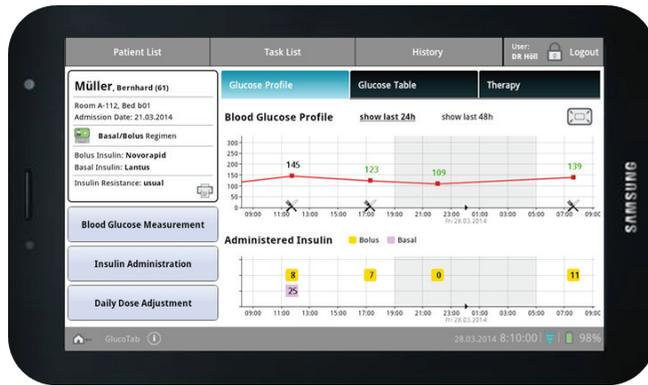**Social and cultural aspects impacting on user acceptance of technology for diabetes management.**

Overview of liability and privacy at EU level and legislation on medical confidentiality, privacy and liability in the countries where REACTION was trialled.

Most of the results are available to the public and can be downloaded from the REACTION website: www.reactionproject.eu

REACTION GlucoTab

The GlucoTab is a workflow and insulin dosing support system for glycaemic management of hospitalised patients with diabetes.

It implements a novel, mobile, tablet-based workflow support system for nurses and physicians at the ward which includes a validated basal/bolus insulin titration protocol (REACTION algorithm) to provide decision support for daily glucose management of patients with diabetes.

In REACTION the GlucoTab system was validated in two clinical trials involving a total of 129 patients. Results show a decrease of the mean blood glucose, no increase of hypoglycaemic events and a high user acceptance. The GlucoTab system was CE marked in November 2013 and can now be used in a clinical routine.

Contact
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Thomas Pieber: thomas.pieber@medunigraz.at

REACTION Nutrition App

The REACTION Nutrition App is a Smartphone app for entering nutrition information, providing access to and selection of nutrition-related data such as carbohydrates and calories.

The app exports data to a back-end server. It stores dietary information and weekly lists of meals and can export into the REACTION database using the Service Layer.

The Nutrition App can be used by system integrators to extend their eHealth solutions with possibilities of managing diet and nutrition data.

Contact
Peter Rosengren
peter.rosengren@cnet.se

REACTION Multi-Protocol Home Monitoring Gateway

The REACTION Multi-Protocol Home Monitoring Gateway is a software-based gateway running on a standard PC-platform with or without a user interface. It provides uniform access, connectivity, control and interfacing with medical and wellness devices.

The Gateway supports Continua® and other protocols and exports data to different back-ends. It is based on open standards but still offers support for commercially available medical devices and offers interoperability and flexibility for the customer to meet the requirements in many different scenarios.

Contact
Peter Rosengren: peter.rosengren@cnet.se

REACTION ZigBee Home Monitoring Platform

The platform is a mains plug mounted home gateway with ZigBee local wireless network and GPRS WAN sending data from ZigBee enabled sensors to a back-end database.

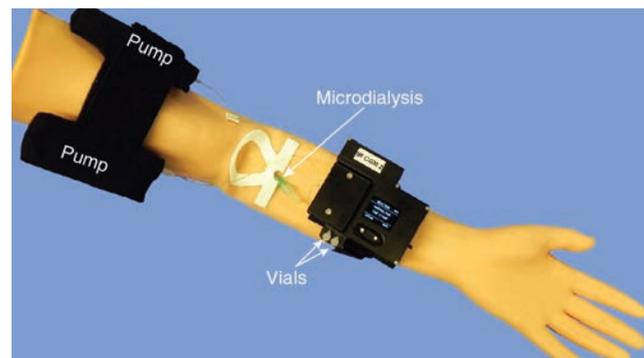Contact Malcolm Clarke: Malcolm.Clarke@brunel.ac.uk

REACTION Chip-based IR Glucose Sensor

The sensor is based on infrared difference absorption spectroscopy on perfusion solution in a disposable chip, attached to a non-disposable, wearable electronics and connected to a micro dialysis catheter.

Microdialysis is applied with medically approved dialysis catheters, fluidically connected to the disposable chip, containing the optical flow through cells for the perfusion solution and a reference liquid. In REACTION, the sensor was used for clinical evaluation of the optical measuring technique to avoid time consuming, pre-clinical and biocompatibility testing.

Contact Thomas Klotzbucher
Thomas.Klotzbuecher@imm.fraunhofer.de

REACTION Fibre-based IR Glucose Sensor

The sensor is based on IR difference absorption spectroscopy and is integrated into a micro-needle. The measurement principle is the same as with the chip-based sensor but by integration of the optical cells into a micro needle equipped with a semi-permeable membrane, no fluidic transport is required thereby not introducing any additional lag time.

In REACTION, the fibre-based sensors were used for laboratory in vitro experiments to demonstrate the concept of optical transmission cell integration into catheter needles.

Contact Thomas Klotzbucher,
Thomas.Klotzbuecher@imm.fraunhofer.de

REACTION Wireless Sensor (ePatch) for Heart Rate Monitoring

The ePatch is a miniaturised monitoring system applied to the skin surface with a skin friendly adhesive. The ePatch primarily records ECG but in REACTION the technology has been further developed towards the needs in diabetes treatment.

Activity sensors and wireless data communication using ZigBee or Bluetooth have been integrated, and the technology has been further developed and matured in general so it is reliable, easy to use and can be manufactured at affordable prices.

Contact Jens Branebjerg, jab@delta.dk

REACTION Patient Portal

The portal is a comprehensive diabetes data management system designed to enable sharing of information between clinicians and patients and supporting the patients in managing their diabetes.

The portal visualises captured patient measurements and other data, including lifestyle data such as activity and diet, care plans and educational content. It also facilitates manual entry of measurements in case of lost connectivity.

Contact Franco Chiarugi, chiarugi@ics.forth.gr

REACTION Clinical Portal

The portal is a software application to manage information collected from sensors, patient portal and care plan in order to provide clinical management of diabetes patients.

Contact Malcolm Clarke, Malcolm.Clarke@brunel.ac.uk

REACTION Primary Care Patient Monitoring Protocols

The protocols, workflow and risk stratification are used to support the management of patients with chronic diseases.

They support the clinician in the management of patients in a way that reduces the burden of reviewing patient data, identifying those patients at risk in order to support timely intervention.

Contact Russell Jones, russell.jones@brunel.ac.uk

REACTION Semantic Search Tool

The tool enables the user to search for information from databases. It strengthens the functions of the Short-Term Risk Management tool in finding heterogeneous patterns in the history of the actual patient, similar cases and relevant information materials.

Contact Tamas Gergely, gergely@all.hu

REACTION Notification Handler

The notification handler is a tool allowing professional staff to assign alerts/notifications based on patient data coming from the REACTION database.

The application allows the physicians to react ubiquitously to change in the patients' health state, perform pre-defined activities according to pre-programmed rules or through closed loops involving formal and informal carers and combine the orchestration of services with an underlying efficient networked-based event management solution.

Contact Blanca Jordan: blanca.jordan@atos.net and
Lydia Montandon: lydia.montandon@atos.net

PRODUCTS | MODELS

REACTION Long-Term Risk Models

General practitioners and endocrinologists can use the models to predict the occurrence of complications and adjust treatment, motivate compliance and facilitate behavioural and lifestyle changes.

The risk models provide: Statistical models for predicting the occurrence of diabetes complications; sets of risk factors of diabetes complications and Bayesian networks depicting the statistical relations among diabetes-related clinical parameters. All are implemented as Web-Service components.

Contact Franco Chiarugi, chiarugi@ics.forth.gr
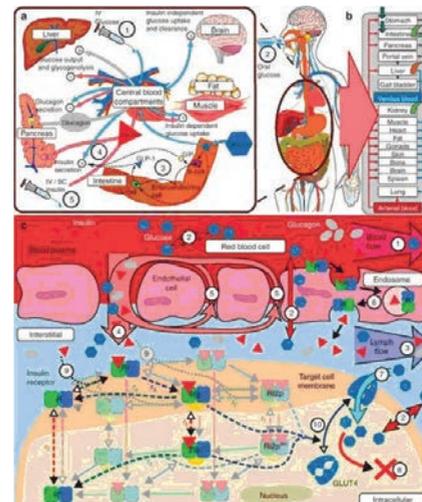
REACTION Short-Term Risk Management Tool

The tool is used to control the adjustment of the care plan in a cyclic process, based on a pattern management approach. It supports general healthcare services by analysing monitored data collected from different medical devices. The component contains several beneficial functions including data visualisation with intelligent, adaptive graphical display options; a daily profile with therapeutic data and statistical methods for data processing.

Contact Tamas Gergely, gergely@all.hu

REACTION Glucose-Insulin-Glucagon Model

The model describes the pharmacokinetics of glucose, insulin and glucagon via a detailed mechanistic description of administration, distribution and elimination as well as pharmacodynamic interactions of the three substances. The description includes processes such as blood flows relevant for distribution on the whole-body level or glucose transporters in different organs as well as insulin receptor binding and downstream events. The model was established using very diverse data and validated on a clinical dataset capturing the blood plasma dynamics of the three substances. It is a multi-scale model for diabetes with a high level of physiological detail, demonstrating strong predictive capabilities.

Contact Stephan Schaller, stephan.schaller@bayer.com

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REACTION Closed-Loop Algorithm

The algorithm can provide insulin dose suggestions based on frequent glucose measurements (intravenous or subcutaneous) to improve glycaemic control.

The algorithm relies on the mechanistic Glucose-Insulin-Glucagon model as a core for model predictive control that is further embedded into a PID-based off-set control for prediction error correction. Automatic glucose control (i.e. artificial pancreas systems) especially for type 1 diabetes patients promises improved glycaemic control and consequently decreased long-term side-effects of the disease. In addition, it can ease the burden of manual self-therapy for patients.

Contact Stephan Schaller, stephan.schaller@bayer.com

SOFTWARE INFRASTRUCTURE

The REACTION Database

The database is specifically designed and implemented to take into account the data requests of different REACTION components. The database is built in SQL server 2008 and the data are managed by the Store Procedures which are managed by the Web - Services.

Contact Malcolm Clarke, Malcolm.Clarke@brunel.ac.uk

REACTION Platform Server Backend

The server back-end is software running on a back-end server on top of one or more databases. It processes incoming observations from various gateways and provides functionality for defining and executing monitoring rules and related actions such as SMS notifications. The software also provides functionality for defining and executing service orchestrations and event processing and management. A layer of Web-Services provides a high level Service Layer for applications to access and process patient and monitoring data.

Contact Peter Rosengren, peter.rosengren@cnet.se

REACTION DCK

The REACTION DCK is a developer toolkit to enable integration of medical devices into eHealth applications. The toolkit includes APIs, extensible middleware objects for device connectivity and testing tools for protocol compliance. Using the REACTION DCK, the developers will increase their efficiency and be able to quickly deliver new eHealth solutions to their customers.

Contact Peter Rosengren, peter.rosengren@cnet.se

REACTION SMS Notification Component

The component is a software infrastructure for the delivery of SMS notifications.

It provides advanced and targeted alerts and notifications to the end users with the use of an instant communication method, the Short Messaging System, which is available to mobile users over GSM networks. The key issues for this service are the advanced user profiling and the cognitive techniques which can be used in order to dynamically compose and send alert and notification messages to the end users of the REACTION platform, depending on their particular personal profile and attributes (carers or patients).

Contact Manolis Stratakis, stratakis@forthnetgroup.gr

REACTION Network Monitoring Service for Mobile Devices

The service is a Java library for remotely monitoring/managing mobile devices using the Simple Network Management Protocol.

The main objective of the Network Management System in REACTION is to utilise a Network Monitoring Infrastructure which supports network wide measurement data collection and analysis; identifies end-to-end performance bottlenecks in network paths; discovers network attacks and evaluates internet traffic characteristics on an ongoing basis.

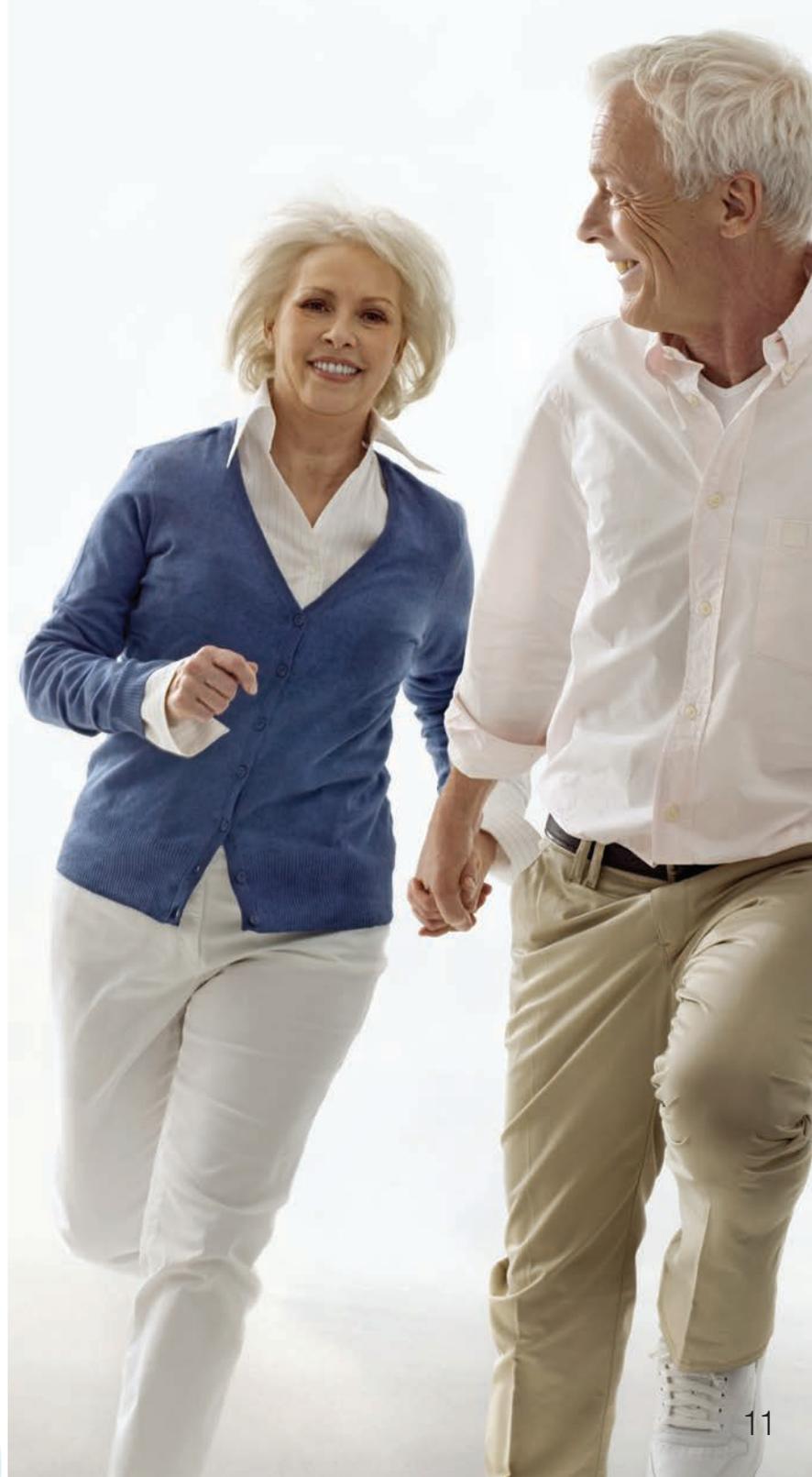Contact Manolis Stratakis, stratakis@forthnetgroup.gr

REACTION Security Environment

The REACTION Security Environment is a framework for securing communication between Android devices and Web-Services and managing user information.

The security environment controls access to Web-Services based on roles and security tokens (e.g., identity certificates) which are validated and managed.

The security service for Android devices (SSA) developed in REACTION runs on any Android device and is a system-wide service providing easily accessible and secure communication from a mobile device to a server. It can be employed by any SSA-aware app running on the same device. Developers of networked applications simply connect their Android app to the security service and will then be offered an easy-to-use API for making web service calls. The SSA has built-in identity management which can be configured by administrators so that different identities can be used for different services.

Contact Matthias Enzmann, info@sit.fraunhofer.de

Results from the REACTION project

Remote Accessibility to Diabetes Management and Therapy in Operational Healthcare Networks

The purpose of the REACTION project was to develop an integrated approach to improved management of diabetes, facilitating continuous and tight control of blood glucose levels and other vital signs, which are crucial for good diabetes management and insulin therapy.

With this overall objective in mind, the project aimed at developing a service platform that would integrate tools and applications allowing remote monitoring and therapy management of people with diabetes.

Applicable for the different healthcare regimes across Europe, the ultimate goal was to offer monitoring and decision making support to healthcare professionals as well as management and therapy services to diabetes patients.

For further information about the project, please visit www.reactionproject. eu or contact Project Coordinator Lydia Montandon: lydia.montandon@atos.net