IoT, Cloud and Healthcare
Challenges and Opportunities

Arash Ghadar
Technical Director
Datalink Electronics

E: aghadar@datalink-electronics.co.uk
W: www.datalink-electronics.co.uk
T: 01509231023
Datalink Electronics

• Full Turn-Key provider of electronic devices and solutions
• Full life-cycle management
  – Feasibility study
  – Design and development
  – Prototyping
  – Verification and validation
  – Certification
  – Volume production
• Close links with universities
• Joint ventures, collaborations and grant funded projects
• QMS: ISO9001 and ISO13485 Medical Devices
• Industries: Medical, Oil & Gas, Instrumentation, Energy, Environmental, Food, ... Where safety and reliability is key
IoT: A network of uniquely identifiable devices with the ability to communicate independently over a network without human intervention.

Case Studies

- **Oil & Gas**: Valve leakage monitoring
- **Food**: Wifi Thermometer
- **Environmental**: Waste collection
- **Security**: Dynamic Signature Verification
- **Medical industry**: Glucose monitoring
Case Study – Valve Leakage Monitoring

• Ultrasonic sensor for detecting emergency valve failure.
• Local signal capture and conditioning.
• Use of cloud for complex signal processing algorithm and sensory data fusion.
• Guaranteed delivery of data is essential.
• Certain transmission delay can be tolerated. Real-time delivery is not required.
• Main processing is done remotely.
Case Study – WiFi Thermometer

- Used for measuring food temperature, for food safety.
- Use of cloud for data management, updates and interactions.
- Data is collected when requested.
- Data is transmitted when possible.
- Real-time data delivery is not required.
Case Study – Waste Management

• Ultrasonic sensor for detecting waste level in industrial bins.
• Local data analysis and depth measurement.
• Continuous monitoring
• Periodic data transmission.
• Real-time data delivery is not required.
• Use of cloud for route optimisation and customer behavioural analysis.
Case Study – Signature Verification

• Use of acoustic characteristics of signature for authentication.
• Retrieval of user signature template on demand
• Running the matching algorithm and sending commands to access control unit
• Use of cloud resources for storing users signature and identification.
• Access to cloud services on a timely fashion is essential
Case Study – Glucose Monitor

• Used as a class Ib medical device
• Non-invasive continuous monitoring
• Used by patients at home
• Data collection once every few seconds
• Data transmission once every few minutes
• Trend monitoring
• Data used for decision making
• Reliability of data is key
Case Studies – Key Points

• **Guaranteed Delivery:** Where safety and security matters, guaranteed data delivery and data integrity are key.

• **Timeliness:** Where immediate action is required, transmission of data in a timely fashion is essential.

• **Security:** Network security is a key factor in many applications, in particular medical or where user-identifiable data is being transmitted.
Healthcare Model

• **Primary Objectives**
  – Prevention
  – Treatment and Cure
  – Disease Management

• **Service Model**
  – Primary Care (GP, Dentist, Optician)
  – Secondary Care (Consultants – Psychology, Orthopedics)
  – Tertiary Care (Specialist care in hospital)
Tele Health

- **The Future of Healthcare**
  - Improved quality of life
  - Cost saving
- **Patient Monitoring**
  - Local vs remote analysis
  - Decision making vs decision support
  - Real-time vs on-demand
  - Time-critical vs non-time critical
- **Intervention**
  - Remote surgical operation
  - Drug prescription and administration
- **Contact, Advice and Education**
  - Video and audio, Text and voice call, Email
- **Assisted Living**
Medical Device Software

- **Compliance to ISO62304**
  - Software Life Cycle Processes
- **Compliance to ISO14971**
  - Risk Management Process
- **Software classification**
  - Broken down to items and units
  - Consider risk – no risk vs risk of a minor injury vs serious injury or death
- **Scope**
  - All processes, including data generation, communication, storage and integration
Continuous Monitoring – Use Cases

• **Home Care**
  – Chronic disease or long-term medical condition
  – Immediate professional attention is not needed

• **Hospital**
  – Short-term critical condition or a life-threatening condition
  – Immediate professional attention may be required
Point of Care (PoC) Testing, diagnosis and intervention (drug delivery) at the point of care

- PoC devices are moving to home care setting
- Require robust connection to the network of professionals, either AI or humans
- Require a degree of autonomy and local decision making, depending on the associated risk
- Distributed cloud computing is not always necessary
PoC Data Flow

• **Medical Device**
  – Generation at the point of care
  – Translation to electronic health record
  – Transfer to a certified data centre

• **N3-Certified Data Centre**
  – Storage (SNOMED format)
  – Retrieval (Authentication)
  – Processing (running app on cloud)

• **Professional Use**
  – Presentation to clinicians
  – Decision Support
Challenges

• **Timeliness**
  – Limitation for use in time-critical applications

• **Quality of Network Connection**
  – Quality of connection
  – Data integrity

• **Cyber Security and User Data Protection**
  – Privacy and compliance with HIPPA
  – Prospect of malicious hacking
  – Two factor authentication

• **Certification**
  – Complex, covering all aspects of data flow
  – Time consuming and expensive
  – Applies to software updates and security patches
NHS Network – N3

• National network for NHS
• Largest private network in the world, 51K connection points, 1.3M users
• 58 Points of Presence (POP) in England, and 5 in Scotland
• Used by all care layers
• All external communications to go through this network
• All connections need to be N3 certified
NHS Network – N3 Structure
N3 Network Access

- Accredited N3 aggregators
- Store patient data for and behalf of the NHS
- Remote N3 access
  - Two factor authentication
  - Secure internet tunnel
  - Information Governance Statement of Compliance, adherence to ISO27001
  - Create token for hardware, software and smart devices
- N3 certified data centre for data and apps
Case Study – Diabetes Management

• **Diagnosis**
  – Gathering evidence using structured glucose measurement
  – Remote decision making by professionals

• **Monitoring**
  – Continuous glucose monitoring
  – Remote analysis by professionals

• **Treatment**
  – Long term treatment by remote prescription of drugs, diet, and exercise
  – Short term treatment for insulin injection based on local instant decision making or remote long planned schedule
Diabetes Management – State of Industry

State of Industry (by Glooko)
Case Study – Glucose Monitoring

• **Characteristics**
  – Local measurement and decision making
  – Remote data collection, monitoring and diagnosis

• **Variety**
  – Numerous glucose monitors
  – Various means of data collection and connectivity
  – The majority provide non-medical apps

• **Lack of a Ubiquitous Platform**
  – Data generation
  – Data communication and storage
    • The majority email data to the clinic
    • Some use SMS technology to send data
    • Some manually upload data to a cloud-based account
  – Data presentation and analysis
- **Europe-Wide Tele Healthcare Project**
  - 13 countries, including Scotland (Coordinator), Wales, Germany, France, ...
  - Universal telemedicine platform
- **Scope – 3 Main Chronic Diseases in EU**
  - Diabetes
  - Chronic Obstructive Pulmonary Disease (COPD)
  - Congestive Heart Failure (CHF)
- **Diabetes Study**
  - “My Diabetes My Way” programme run by NHS Scotland
  - Data collection and presentation by Diasend
  - Covering medication, life style and complications
• **Telehealth is the future of healthcare.**
• **Healthcare cost** can be reduced and patient care improved.
• **Security and data protection** restrict and complicate integration of public cloud into care models.
• **Reliable timely data delivery** over internet have limited the use of IoT to long-term chronic diseases.
• **Complex N3 access** and limited number of providers have increased time to market for new products.
• **Certification challenges** are applicable to the whole data flow and is a major obstacle in the use of cloud.
• **Safety** is a key factor in a medical system, which can’t be compromised.
• **Dedicated focused networks** is the answer by major companies to tackle this issue. There is a huge potential for other players to create a universal telehealth platform for chronic diseases.