

A person in a dark suit and white shirt is holding a glowing blue globe of the Earth. The globe is surrounded by several white and blue orbital lines, suggesting a global network or data flow. The background is a blurred white and blue gradient.

IoT, Cloud and Healthcare Challenges and Opportunities

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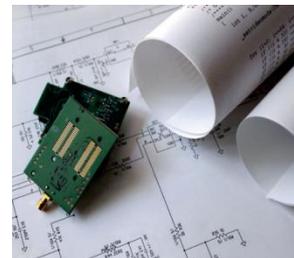
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Datalink Electronics

- **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 reliability is key

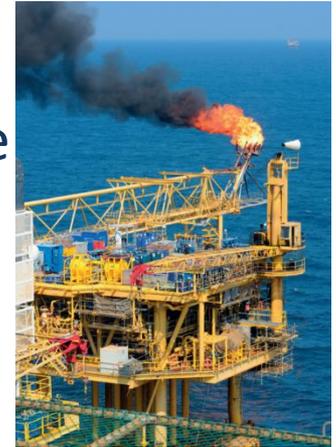


and



Internet of Things (IoT)

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 IIb 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



Cloud-Based Point of Care Technology

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

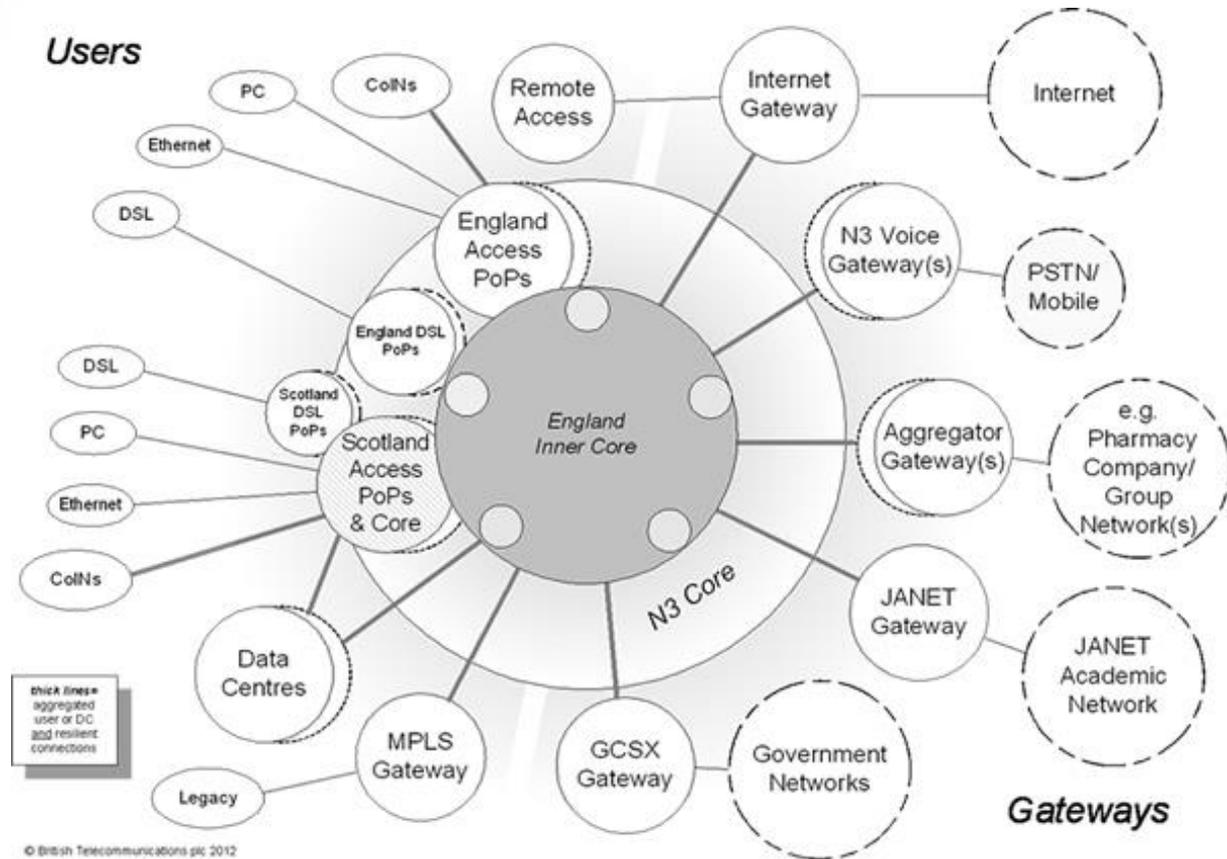
- **Timeliness**
 - Limitation for use in time-critical applications
- **Quality of Network Connection**
 - Quality of connection
 - Data integrity
- **Cyber Security and User Data Protection**
 - Privacy and compliance with HIPPA
 - Prospect of malicious hacking
 - Two factor authentication
- **Certification**
 - 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



United 4 Health

- **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



IoT, Cloud and Telehealth – Messages

- **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.