Project Nocturne: Project Initiation Document

# Introduction

This document is intended to detail an approach for the development of Project Nocturne. At the present time, this is foreseen to be comprised of two distinct segments: one, the development of a bed pad which contains a sensor. The second segment involves the creation of applications for smartphones (iPhone, Blackberry, Android).

# Sample Use Case

A 97 year old woman living in a middle sized town in Northern England, experiences a fall while using the bathroom on a weekday evening. The only outward sign to her neighbours that anything might be wrong is the fact that she has left her living room light on: as she values her independence and cannot afford the cost of an expensive monitoring system, she is reliant on her neighbours noticing this anomaly in order to get timely assistance.

“Project Nocturne” intends to address this issue via the following means: the woman in question does have a smart phone. A pad attached to her bed will transmit status updates to the smart phone via Bluetooth at regular intervals; the phone, detecting an anomalous pattern, will notify designated individuals with a complementary application that this individual is not in bed. This will enable those on her designated list to first attempt to contact her to ensure she’s all right; if there is no response, the appropriate authorities can be alerted.

A second iteration of this use case involves a carer who has multiple individuals to monitor; this individual would need an app that can keep tabs on multiple sensors.

This approach is low cost, as it relies upon technologies, e.g. a smartphone, which increasing numbers possess, even in countries which are not yet fully industrialised. Furthermore, the sensor will not require a battery change for lengthy periods; the present target is one battery change per annum.

# The Bed Pad

At the present time, the preferred technology for developing the bed pad portion is a Bluetooth Low Energy single-chip solution has demonstrated with the Texas Instruments CC2541 SensorTag Development Kit. More information about this kit can be obtained here:

<http://www.ti.com/tool/cc2541dk-sensor>

The bed pad provides a convenient and non-obtrusive method for determining whether the person is in bed. The bed pad provides a contact closure (closed switch) when the person is in bed and an open contact (open switch) when the person is out of bed. This is a simple requirement but is critical for the success of the project. Failure in either state will produce false alarms and diminish the usefulness of the system. There are several manufacturers of bed pads and the bed pad sensor electronics should be designed to interface to as many as possible.

The bed pads are passive devices which only require current to sense the state of the contact. This allows the electronics to “test” the state of the contact with a very low duty cycle to conserve battery life. The radio transmitter only transmits changes of state on the bed pad (or possibly on a regular but infrequent basis) to conserve battery life.

A leading example of such a bed pad is:

* Secure bed pad 12x30, Male phone plug 2.5 mm dia, 11.5 overall length, 7.5 mm barrel length - [www.padalarm.com](http://www.padalarm.com)

## The Implementation

The Bluetooth Low Energy technology is an ideal solution as it offers -

* Fast connect times
* Short message packets
* Wide acceptance with smart phone manufacturers

The Bed Pad Sensor is designed to act as a Peripheral Device (BLE Slave). The smart phone can be used to emulate any Bluetooth low energy behaviour but in this application it is acting as a Central Device (BLE Master). The smart phone (central) runs the app and is ready to discover the bed pad sensor. This allows the bed pad sensor to remain “off” until it is ready to report the bed pad state.

When the bed pad sensor is ready to report, the bed pad sensor goes into a discoverable state. This will turn advertisements on; making the device discoverable for 30 seconds (this value is defined in the Specification of the Bluetooth System). Once the connection process with the smart phone completes and the state of the bed pad is transmitted, the bed pad sensor disconnects and returns to the standby state. The bed pad sensor is not discoverable until the next scheduled reporting period.

IAR Embedded Workbench for 8051 development environment is required in order to make changes to the bed pad sensor firmware.

**Texas Instruments *Bluetooth* Low Energy Software Installer**

(The software installer is available for download at **www.ti.com/ble-stack**)

* Texas Instruments *Bluetooth*® Low Energy Software Developer’s Guide (SWRU271)
* TI BLE Vendor Specific HCI Reference Guide
* Texas Instruments BLE Sample Applications Guide (SWRU297)

***Bluetooth* Special Interest Group (SIG)**

* *Specification of the Bluetooth System*, Covered Core Package version: 4.0 (30-June-2010)

**https://www.bluetooth.org/technical/specifications/adopted.htm**

# The Application

There are three foreseen applications. Two are for the first iteration:

* A “sending” App
* A “single receiver” App

The sending app is attuned to the bed pad; it contains the logic whereby a determination as to an anomalous event has occurred. It also determines a list of “receivers” for the status updates.

The single receiver app is attuned to a sending app and processes messages and alerts.

These apps should work across 2G, 3G and WiFi connections.

The third foreseen app is a “multiple receiver” App; this will enable nurses, carers, doctors and other personnel to receive updates from multiple “sending” apps. This development will take place following the successful development of the first two.

## Basic App Functions

Subscribe - user provides email, cell phone number, and name on App and clicks "subscribe", the server sends a message to the email address for verification. This can be a special URL that opens up the app to set up the UUID in the app.

Connect - user inputs another user's email address to connect with them; other user must verify that this is ok.

Status updates - Patient app sends status updates to server; server sends push notifications to caregiver (receiver) apps.

For the single-app case, a setup view will be required that indicates whether this app is for a patient, a caregiver, or both. In the case of people looking out for each other it is likely been nomenclature will be required for "patient" and "caregiver".

## Server Side Development All the apps will require the backing of server side development as direct peer to peer communication presents technical challenges which can best be solved by the presence of a centralised server.

## Approach

The iPhone app will be developed first, followed by ports to Blackberry and Android phones. Server side development will need to happen alongside the first app.

A decision on encryption will be required early in the development of the project: if only basic security is required, a UUID approach will suffice. If not, there will need to be encryption for all data associated with the applications.

# Recruitment Needs

The hardware team requires the following:

* Engineers familiar with low power Bluetooth sensors
* Engineers familiar with the firmware in TI sensor tags.

The software team requires the following:

* Android App developer.
* Blackberry App developer
* Server-side developer for phone applications
* User interface designer
* Usability consultant