Declaration Cover Sheet for Project Submission

SECTION 1 *Student to complete*

Name: Patrick King
Student ID: 14113970
Supervisor: Keith Maycock

SECTION 2 Confirmation of Authorship

The acceptance of your work is subject to your signature on the following declaration:

I confirm that I have read the College statement on plagiarism (summarised overleaf and printed in full in the Student Handbook) and that the work I have submitted for assessment is entirely my own work.

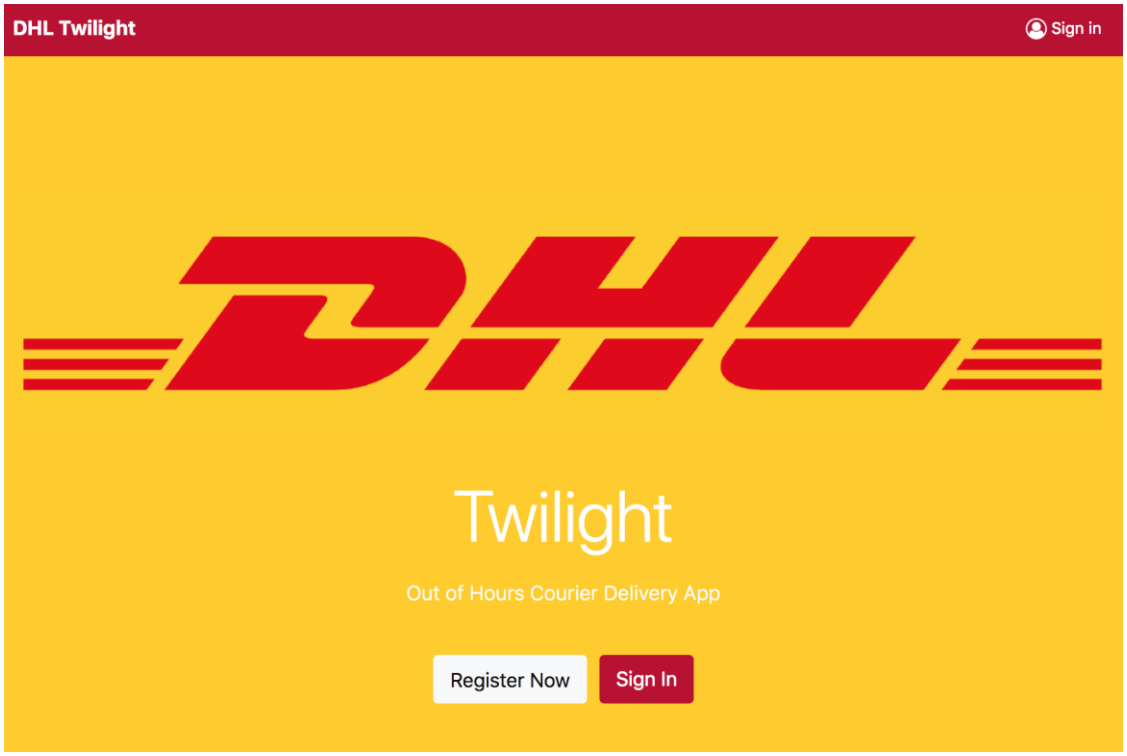
Signature: **Patrick King**_____ Date: 13/05/2018

National College of Ireland

BSc in Computing

2017/2018

Final Technical Report



Final Project submitted in fulfilment of the BSc in Computing at the National College of Ireland.

Patrick King
Student Number: 14113970

Supervised by Dr. Keith Maycock
May 2018

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Document Control

Revision History

Date	Version	Scope of Activity	Prepared	Reviewed	Approved
13/11/2017	1	Project Proposal	PK	X	X
23/11/2017	2	Requirements Spec	PK	X	X
29/11/2017	3	Technical Report	PK	X	X
13/05/2018	4	Final Technical Report	PK	X	X

Distribution List

Name	Title	Version
Keith Maycock	Project Supervisor	1
Keith Maycock	Project Supervisor	2
Keith Maycock	Project Supervisor	3
Keith Maycock	Project Supervisor	4

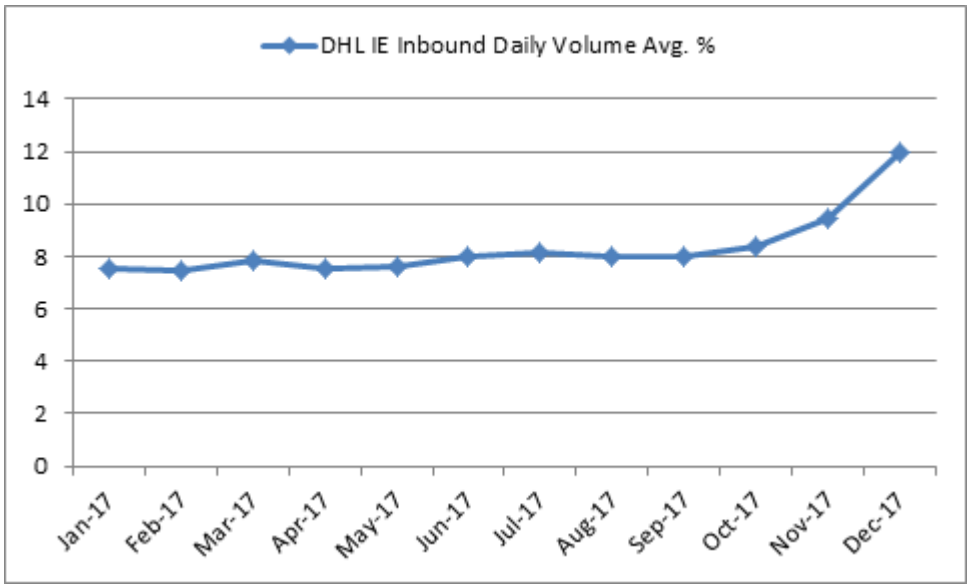
Related Documents

Title	Comments
DHL Twilight User Manual	Page 74
Project Proposal	Page 86
Mid-Point Technical Report	Page 107

Executive Summary

DHL Twilight is a cloud application to extend the delivery window for B2C (Business to Customer) deliveries during peak times so that shipments, where a failed delivery was made, can be re-arranged for a delivery outside of the normal working hours when the customer would be expected to be at home. As an employee working for DHL Express Ireland for over 5 years I was able to monitor courier reports, shipment volumes and have meetings with DHL Operation managers to understand the business case and requirements for the DHL Twilight cloud application. All reports and meetings with the DHL IE Operations management have confirmed year on year increases in deliveries to residential addresses (both in absolute terms and as a proportion of total deliveries) during peak periods including Black Friday weekend and Christmas.

DHL Operations provided a report breakdown of the total and percentage average daily inbound volume in to DHL Dublin HUB throughout 2017;



As confirmed the daily inbound volume significantly increased during the month of November and December, Black Friday/Cyber Monday weekend and Christmas holiday season. It is these peak periods that DHL Twilight is targeting to assist with the same day completed shipment delivery rate.

The DHL Twilight cloud application provides a scalable delivery platform to allow DHL employees the opportunity to assist with ad-hoc deliveries during these peak periods whilst

maintaining full transparency and traceability for the delivery status and reduce the workload on the couriers during peak seasons ensuring that their delivery routes are not impacted by having to re-attempt deliveries. The DHL Twilight cloud application is fully scalable across all platforms reducing the requirement for DHL scanners. This will in turn allow for cost savings on courier scanners and expand the network delivery times to fit that of the customer.

Introduction

The Final Technical Report details the business case and implementation of the cloud application, DHL Twilight, that was developed as part of a 4th Year Software Project at the National College of Ireland. The Final Technical Report will outline the background and requirements for the cloud application detailing the technical approach that was implemented for its delivery.

Background

I have been working for DHL Express Ireland for over 5 years in their Ecommerce & Customer Integration department. The department is located within the DHL Express Dublin HUB facility that is the central distribution centre in Ireland. Whilst working for DHL Express I have had the opportunity to look at the the business from both an internal perspective and external customer point of view. The Ecommerce department encourages Intrapreneralship and is always looking for ways to improve business processes and the customer experience. With this in mind I have kept a close eye on trends and areas where I believe innovation can improve our services. I noticed that during peak periods throughout the year e.g. Black Friday & Christmas when deliveries significantly increase that the demands on the couriers rose and the first time delivery rate was higher. This can be attributed to both the increase of B2C (Business to Customer) deliveries and customers not being at home when the courier call resulting in the delivery having to be rearranged and a second delivery attempt made. Often during these busy periods a call would be made to all staff to assist with local deliveries and these ad-hoc deliveries would not have the same traceability due to scanners not being available/used therefore completion scans would not take place. This reoccurring situation and loss of full traceability caused by ad-hoc deliveries is what triggered the idea of the out of hour's delivery cloud application, DHL Express Twilight.

Currently DHL Express offer timed delivery between the working hours of 9am-5pm with advanced delivery windows available at a premium, for example Express Pre 12 ensures a delivery will be made by 12pm the following working day. The lifecycle of a DHL Express shipment is fully transparent and traceable by the consignee by tracking their shipment using their dedicated AWB (Airway Bill) number. This AWB number is present on the shipment label on the package in the form of a unique 10 digit number and barcode

interpretation. It is this barcode that the courier scans using designated DHL courier scanners and selecting the relevant 'checkpoint' or status of the shipment. For example when a shipment is collected the courier scans the AWB barcode using their DHL scanner and selects 'Picked Up' from the menu option triggering the checkpoint update back in to the DHL network that is then visible against the AWB when tracked at www.dhl.ie. This process is replicated at all major events of the shipment journey i.e. 'With Courier' & 'Delivered'. A shipment is considered complete when it receives the final 'Delivered' scan at which point the consignee also signs the courier scanner to confirm POD (Proof of Delivery) that is also linked to the AWB.

Aims

The DHL Twilight cloud application provides a scalable delivery platform for ad-hoc deliveries to have full tracability for the last leg of the delivery and extend the delivery window for B2C deliveries during peak times so that shipments, where a failed delivery was made, can be re-arranged for a delivery outside of the normal working hours when the customer would be expected to be at home. This will reduce the workload on our couriers during peak seasons ensuring that their delivery routes are not impacted by having to re-attempt deliveries.

A brainstorming session was attended with DHL Ecommerce Management during the initiation stage of this project to help scope the concept and layout the approach(Appendix F, page 101). The vision for this application is to provide a more flexible and scalable solution to the current courier scanners allowing for cost savings and expanding the network delivery times to fit that of the customer.

Technologies

There were a number of applications, programming languages and tools specified within this document to develop DHL Twilight hosted on the AWS cloud environment to allow full scalability including;

- PHP - Hypertext Pre-processor
- SQL - Structured Query Language
- JS - Java Script
- JQuery - JavaScript Library

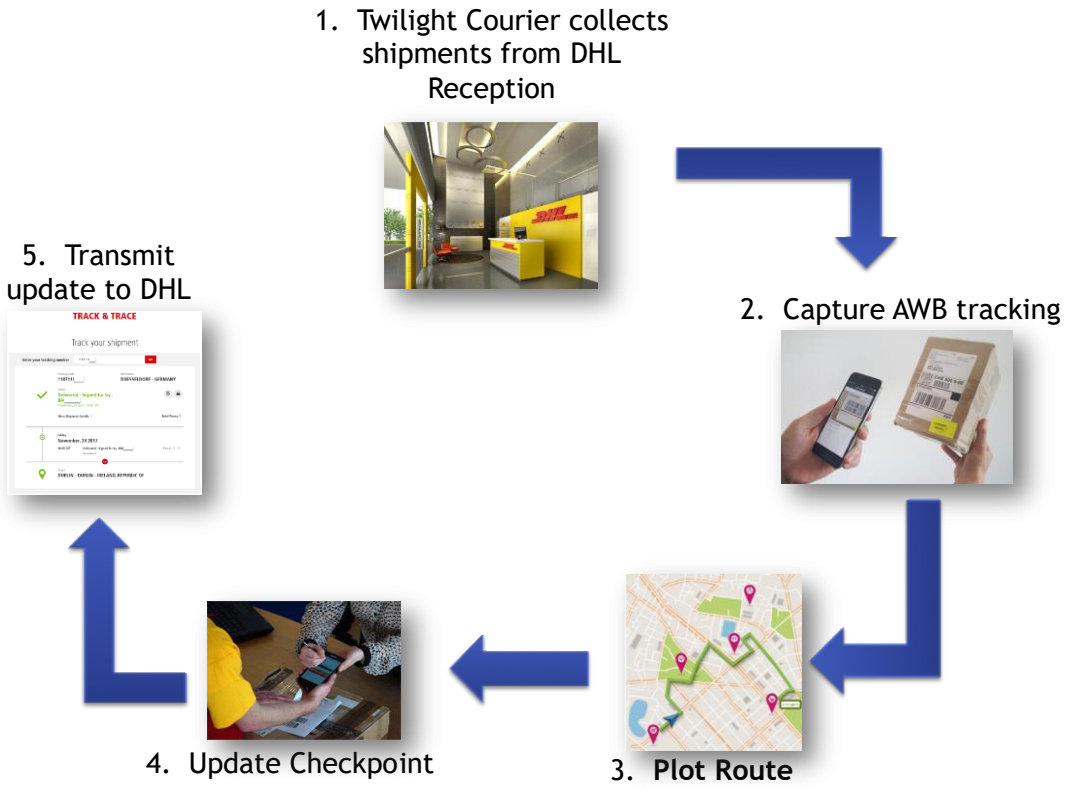
- HTML - Hyper Text Mark-up Language
- CSS - Cascading Style Sheet
- Bootstrap - HTML, CSS & JS Library
- AWS - Amazon Web Services
    - EC2
    - RDS (MySQL)
    - Route 53
    - Cloud9
- GitHUB - Online Repository
- Cloud9 - IDE Development Environment
- Google - Google Maps Waypoint API
- DCG - DHL Customer Gateway
- FTP - File Transfer Protocol
- SFTP - Secure File Transfer Protocol
- FileZilla - Cross Platform FTP Application

Structure

DHL Twilight provides a fully functioning cloud application, scalable across all platforms, allowing users to;

- Register with their DHL staff number
- login with their unique credentials,
- capture the AWB(Airwaybill) tracking number on a label,
- review the destination address,
- view an optimal route planner for their deliveries,
- update the status/checkpoint of each shipment
- assign POD / customer name to an AWB tracking number
- send updated tracking events to the DHL customer gateway (DCG)
- view user shipment history with advanced search filter
- view user profile

The DHL Twilight landing page displays an overview of the application and provides users the ability to log-in or register. Once a user is logged in to the cloud application they will have full access to all functions and visibility of their shipment history. The new delivery process begins with the user being able to capture the unique AWB(Airwaybill) tracking number present on all DHL Express labels, this retireves the shipment details including the consignee address. The application then calculates the optimal route for deliveries based on the address details for all shipments captured. The option to update the status of each shipment e.g. 'Delivered', 'Not Home' is provided including POD(customer Proof of Delivery) capture. The last part of the DHL Twilight shipment delivery cycle allowes users to transmit updates to DHL updating the Live Shipment status visible at www.dhl.ie.



System

User Requirements definition

The DHL Twilight cloud application has been designed to provide a platform to allow registered DHL Express staff/users to complete the shipment delivery process and view all completed shipments. All registered users will be granted access to required functionality by registering with their DHL Express staff number as their unique ID to provide security and traceability for all users. The future scope for the application is provide a secure log in for administration access to view and monitor user actions.

The DHL Twilight Application provides two different types of user with the Admisitrator user in scope for future development;

1. New User
    - **Unregistered** - User does not have a login
    - **View Home Page** – User has access to view the homepage
    - **Register Now** – User can register for an account

2. Registered User
    - **Login** – The registered user can access user account homepage
    - **New Shipments** – User can enter in new shipments & retrieve delivery address
    - **Plot Route** - User can view the optimal route plan for open deliveries deliveries
    - **Update Checkpoints** – The user can update checkpoints of pending shipments
    - **Capture Consignee Signature** – User can enter and assign POD / customer name to AWB
    - **Transmit checkpoint –** Transmit AWB checkpoint update to DHL
    - **View Shipment History** – User can view all completed shipments

3. Administrator User – Future Scope

- **Login** – Administrator has access to login to the administration side of the site with full privileges.
- **View all Shipments** – Administrator can view all shipments that have been entered by all users
- **View/Edit User Profile** – Administrator can view & edit all registered users profiles. This option is only available to the administrator to add a layer of security. Only the Administrator can edit user profiles and any user profile change requests must go through the Administrator.

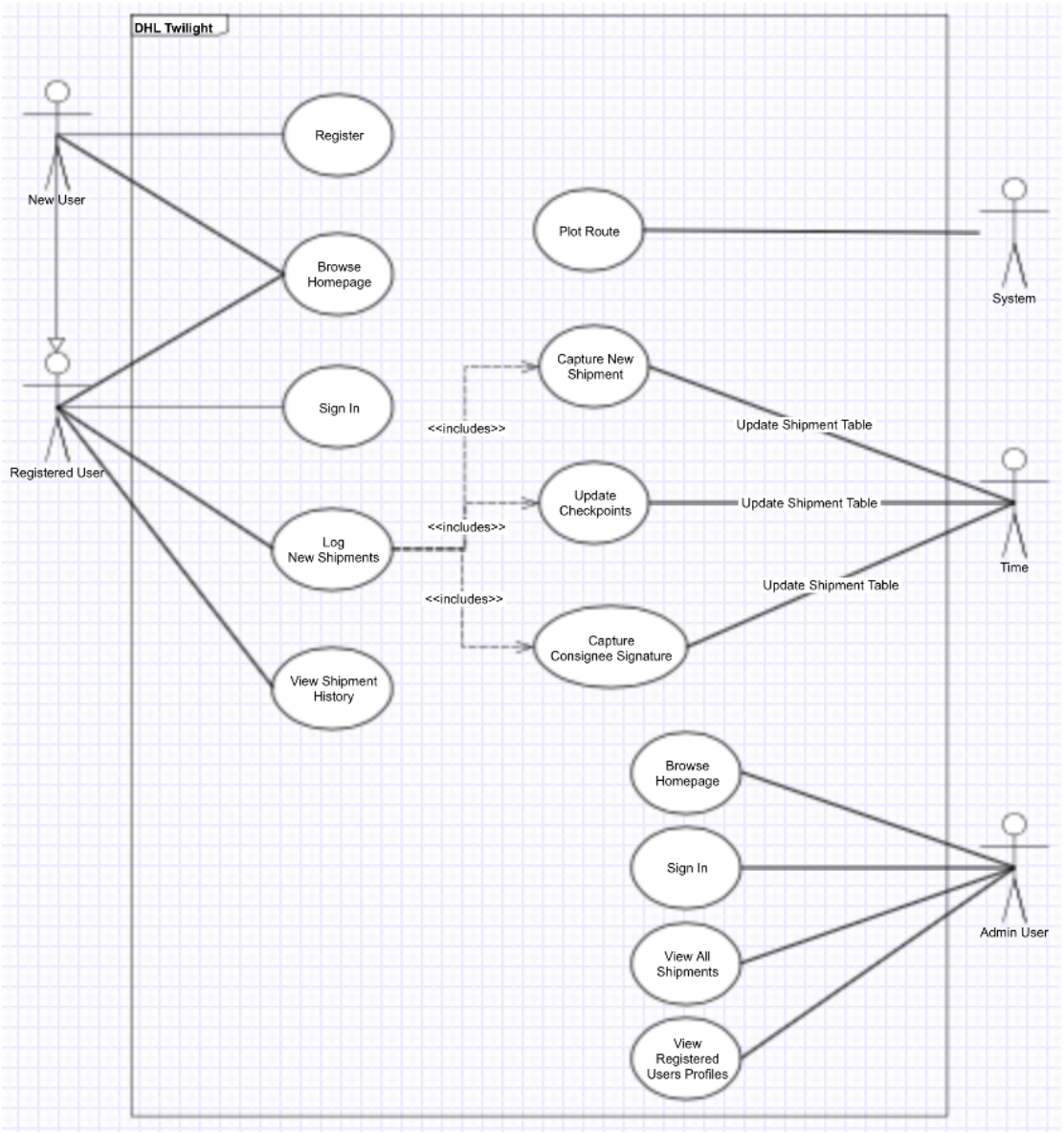
The Adiministrator User was originally scoped for the intial development of the DHL Twilight cloud application. All administrator tasks are currently handled by the system administrator for this release. The administrator user was considered surpluss to requirements until the application pulls orders directly from the DHL network. This has been marked for future development.

DHL Twilight is targeted at DHL Express employees only to comply with the security and integrity that the company requires for shipment courier delivery. All DHL Express employees undergo required training and certification as part of joining the company as well as a staff ID that are all required in order to register for the application. Based on the specific demographic that this application is targeted towards internal communication including links to the site will be used to provide maximum visibility to the target audience. The familiar official DHL colours, branding and functionality are specifically aimed at DHL Express employees providing security and clarity on its functionalities.

Functional Requirements

During the lifecycle of the DHL Twilight cloud application development the initial Project Proposal (Appendix F) and Technical Report (Appendix G) outlined the requirements in scope to deliver the application. The Technical Requirments Specification (Appendix G) presented at the Mid Point examination detailed that the DHL Twilight cloud appliaction use case consist of the following;

Use Case



Each defined user type detailed above has access to the following functionalities;

New Users

1. Register Now

Registered Users

2. Sign In
3. Capture Shipment/AWB number
4. Plot Route
5. Update Checkpoints
6. Capture Consignee Signature

7. View Shipment History

Administrators – Future Scope

8. Sign In
9. View all shipments
10. View/Edit Registered user profiles

Based on these functionalities the below 7 core requirement use cases are defined;

Requirement 1 – Register Now

Description & Priority

This provides 'new users' the ability to register with the application using their unique DHL Staff number and gain full access to the 'registered user' account landing page and functionalities.

Requirement 2 - Sign In

Description & Priority

This is the secondary function providing access to the 'Registered' and 'Administrator' users landing page and specific functionality. The 'Sign In' button is located in the centre of the main Home Page. This is listed as a priority 6 requirement.

Requirement 3 – Capture New Shipments

Description & Priority

Registered users can log new assigned shipments into the cloud application and retrieve destination address. This is a priority 1 function enabling registered users to log new shipments and begin the delivery cycle.

Requirement 4 – Plot Route

Description & Priority

This requirement plots the optimal route for all shipments captured and submitted ready for delivery. Based on the receiver address the system calculates the most efficient delivery route. This is listed as a priority 2 requirement.

Requirement 5 – Update Checkpoints

Description & Priority

This requirement allows the Registered User to select assigned AWB number and update its checkpoint. Once a shipment has been given a 'Delivered' or 'Not Home' checkpoint the shipment is considered complete. This is listed as a priority 3 requirement.

Requirement 6 – Capture Consignee Signature

Description & Priority

This requirement allows the registered used to capture the signature of the consignee to act as "Proof of Delivery" for the shipment. The signature captured is then linked to the AWB number. This is listed as a priority 4 requirement.

Requirement 7 – View Shipment History

Description & Priority

This requirement is provides the 'Registered' and 'Administrator' users visibility on shipments that have been completed. The Registered user only has privileges to view their own completed shipment history whereas the Administrator User can view all completed shipments for all users. This is listed as a priority 5 requirement.

**For a detailed breakdown of each use case please refer to the Mid Point Techical Report (Appendix G, pages 123-137).*

Core Functional Component – Optimal Route Planner

The core functional requirement for the DHL Twilight Cloud Application will be designing and implementing the route planner for the couriers' optimal route for deliveries. The application will display the AWB (Airwaybill) / tracking number of each shipment and the associated delivery address and calculate what route the courier is to take and display these within an embedded map. Extensive research was undertaken and a number of approaches for optimization and search algorithms considered. Genetic algorithms have been devised to tackle complex searches taking a "Survival of Fittest" Darwinian approach to finding the optimal result from 'n' number of possible solutions. Genetic Algorithms look to reduce the size of the search by randomly selecting sections of the graph search area and iterating through them until the optimal or "Fittest" result is found.

One GA considered was the 'Ant Colony' optimization (ACO) that bases its iterative search through graphs liken to that of an ant colony. (Aco-metaheuristic.org)

Non-Functional Requirements

The non-functional requirements outline the operation rather than behaviour of the system. The non-functional requirements in scope for the DHL Twilight cloud application are listed below;

Performance/Response time requirement

The response and performance times for the DHL Twilight will aim to replicate the standard levels deemed acceptable by users. Although there are not official "industry Standards" for this matrix the DHL Twilight will target all navigation and feature response times of around 0.3 seconds. This target is driven by projected initial base of 1000 users, the approximate number of DHL Express employees in the Dublin area. DHL Twilight will be hosted on the AWS EC2 cloud environment that will manage the performance/response times of the cloud application ensuring the resources are available to meet the required demand. This projected response time and number of users will need to be constantly monitored to ensure continued performance levels and relevant forecasting of usage.

Availability requirement

DHL Twilight can be accessed 24/7 by all user types. Although access and availability to the site is constant the peak usage periods will be between 17:00 and 23:00 GMT coinciding with the delivery window this application is targeting. Based on the recognised and forecasted spike in use of the DHL Twilight application it is important to host the application in an environment that can adjust to these demands and keep running costs down. The AWS EC2 cloud environment is targeted at this type of fluctuating usage time scaling servers to meet that of the applications demands at any given time.

Recover requirement

The DHL Twilight cloud application will have all running documents and scripts backed up in GitGub. On release to production the cloud application will be hosted on AWS

EC2 along with the SQL database. All physical and backup servers will be managed and maintained by AWS. In the event of any downtime to a required server the backup server will be initiated to ensure continued performance levels and recoverability of all secure data. DHL Twilights core functionality requires for data to be stored and written back to the DHL DCG gateway including all AWB numbers, checkpoint updates and PODs. Under data protection laws all information collected and used by the DHL Twilight application must be kept secure/private and fully recoverable and available to the individual on request (Dataprotection.ie)

Robustness requirement

The DHL Twilight cloud application underwent thorough testing to evaluate its robustness including stress testing to ensure that the site remains responsive and provides informative error handling messages to identify the root cause of any error encountered. Any errors encountered in the live environment the user will be advised to contact the site administrator and quote the error message displayed.

Security requirement

Security is a primary focus area in designing the DHL Twilight cloud application. As personal data is exchanged between servers it is vital to ensure that all connections and transfers are encrypted and secure. The main data transfer from the AWS live server to the DHL DCG gateway containing the AWB number and checkpoint will travel via an SFTP link. All data communications will be encrypted with SSL certs. The AWS EC2 cloud environment hosting the application will ensure the security and integrity of the site with malicious attempts to access the server side of the application being blocked/denied. Another major security concern is the registration of new users. The DHL Twilight application will be released initially to DHL Express employees in the Dublin area only. As part of the registration GUI form new users are required to provide their 4 digit DHL Express staff number, this staff number acts as a two way verification with all DHL Twilight users having to show their DHL Express badge (including staff number) on collection of any shipments that will be cross referenced against the database of registered users by the Administrator user to confirm identity. All shipments are logged against the registered user staff ID to provide full traceability. User passwords will be encrypted using the md5 hash function.

"Cloud security at AWS is the highest priority. As an AWS customer, you will benefit from a data center and network architecture built to meet the requirements of the most security-sensitive organizations. Amazon EC2 works in conjunction with Amazon VPC to provide security and robust networking functionality for your compute resources."
(Amazon Web Services)

Reliability requirement

Another advantage of hosting the DHL Twilight cloud application on AWS EC2 is that the management of the server reliability and backup is handled by AWS. AWS is the leader in the Cloud Service provider and has the infrastructure and support to ensure any down time of the site is either zero/minimal. A full end -to-end testing will be carried out within a test and live environment to ensure all functionality works as expected with no errors and without loops. The application will also undergo full UAT that will provide reports on user errors. It is vital that the application is fully functioning particularly during the peak delivery window, 17:00 – 23:00 GMT Monday – Friday. AWS EC2 environment will scale to meet usage demands on the system.

"Amazon EC2 offers a highly reliable environment where replacement instances can be rapidly and predictably commissioned. The service runs within Amazon's proven network infrastructure and data centers. The Amazon EC2 Service Level Agreement commitment is 99.95% availability for each Amazon EC2 Region." (Amazon Web Services)

Maintainability requirement

To ensure that the DHL Twilight application can be fully maintained and built upon it is essential that all code and functionality is captured and documented fully. All code and scripts that are created within the test environment will be fully commented during initial development and versions/updates to the application will be stored separately within GitHub forks. GitHub will supply a "living" code base environment including full comments on code and text on each release/version. On release to production the DHL Twilight application a fully detailed release guide will be created detailing all functionality of the application, code/ programming languages used and where to locate each segment. This document will be release based with any new update or release of the application requiring a new version of this document listing all new updates signed off by all

stakeholders. All support documentation and GitHub repositories will be available to all support staff and current and future developers.

Portability requirement

The DHL Twilight cloud application is based around users on the move, being able to use the application across all platforms is essential. The application will be designed to scale across all devices including Android and iOS mobile phones. Ensuring that the application functions are compatible and easy to use on smaller mobile devices will be of primary concern during development. Extensive UAT will be completed to ensure that all users can easily access all functionality required.

Extendibility requirement

The initial release of the DHL Twilight cloud application is targeted at DHL Express employees within the Dublin area only. Future scope for this application would see the application extend across a larger geographic to include all areas of Ireland. This would require further advancements to the registration process and administrators available at DHL Express sites across all access points. Further advancements to the current functionalities could include the ability to pull additional shipment detail on the AWB barcode scan including all address data. This would require further communications between the DHL Express in-house management systems and the DHL Twilight application; this in turn would push the need for extended secure communications and connections.

Reusability requirement

The reusability of code will be present across the application to inherit consistent views, functions and methods. The DHL Twilight cloud application will consist largely of user generated data that will all be stored and accessed through a database. Temporary PHP files will be used to retrieve and display unique user data on request. Reusing this retrieve PHP method will allow for code reusability to enable efficiency.

Resource utilization requirement

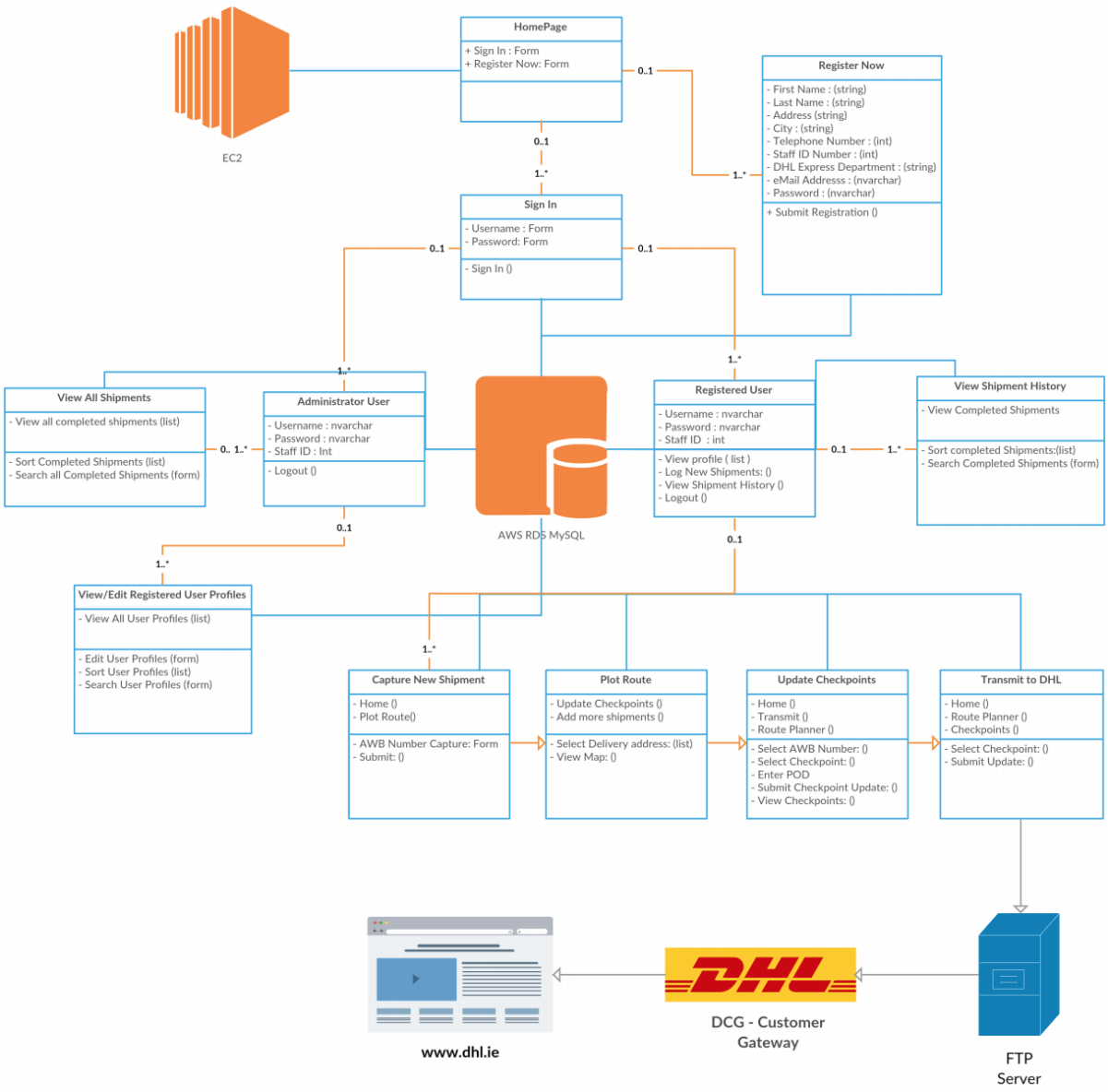
The DHL Twilight cloud application will be created and delivered by 1 developer in alignment with the project deliverables, timeframes and deadlines that have been laid out

within the Project proposal. The Project management will be monitored and controlled with the aid of a Gantt chart that was created to provide the developer a clear and structured approach to achieve all deliverables and the RTP within the specified timeframe.

Design and Architecture

The DHL Twilight cloud application is hosted on AWS EC2 cloud server providing the infrastructure and scalability to meet the usage demands. The application is centred around an AWS RDS(Relational Database Service) that provides user validation, data storage and read/write operations to enable all functionalities. The below system architecture diagram depicts the system and flow.

DHL Twilight System Architecture Diagram



As can be seen in the above system architecture the AWS RDS is central to infrastructure of the application. All user registration and sign in information is stored and validated through SQL queries to the RDS. The core functionalities within the application including shipment history, capture new shipment, optimal route planner, update checkpoints and capture POD all read and write to the database to provide a full repository of each users shipment delivery cycle. The shipment data stored in the database is then used to generate and send a file to the DHL gateway to process each shipment status and display on the live www.dhl.ie tracking website. This architecture was based upon the application requirements set out in the mid-point Technical Report (Appendix G) and the need for a central repository for storage and validation.

Cloud Provider - AWS

There were a number of considerations when deciding how to host the DHL Twilight cloud application. The coding and develpoment of the application was completed in house therefore it was the platform and services that were required by a cloud provider. The AWS EC2 cloud environment and AWS RDS were chosen as the main cloud services due to their standing as one of the leading providers in the market, the scalability models and the relative ease to implement along with comprehensive support documentation and agents. AWS provides free tier usage for its services that fit the DHL Twilight cloud application current requirements;

Service	Free Tier usage limit
RDS - Storage	20 GB-Mo
RDS - Instance	750 Hrs
EC2 - Linux	750 Hrs
EBS - Volumes	30 GB-Mo

The above shows the AWS services that were configured to host and run the DHL Twilight cloud application and the levels to which the application can run without cost. Exceeding these limits incurs usage costs however due to the current performance model for developing the DHL Twilight application these limits currently exceed requirement.

PAAS (Platform as a Service)

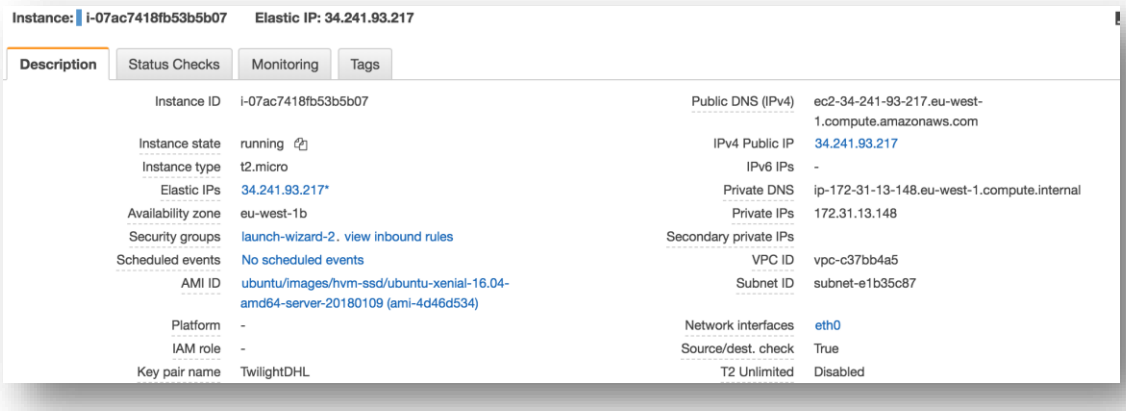
A PaaS (Platform as a Service) infratructure was chosen as the this model provided the infrastructure, server and services within a hosted scalable environment required to develop and run the DHL Twilight cloud application;

In House	AWS
Application	Runtimes
	Secutity & Integration
	Databases
	Servers
	Virtualisation
	Server HW
	Storage
	Networking

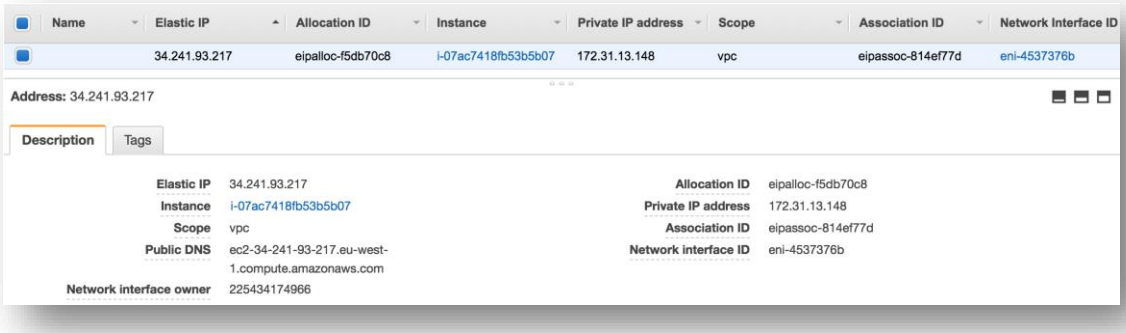
The above table outlines the management responsibilities within a PaaS environment with the application remaining in house and all other requirements outsourced to AWS.
Based on the system architecture a number of AWS services were required in order to build and host the DHL Twilight cloud application;

EC2 (Elastic Compute) Cloud Hosting Environment

AWS EC2 Public Cloud ownership model was adopted as this provided the scalability and flexibility that was required for the DHL Twilight application offering a free tier usage of 750hrs that exceeds requirements. If the requirement for additional usage is required this can be increased at an additional cost.

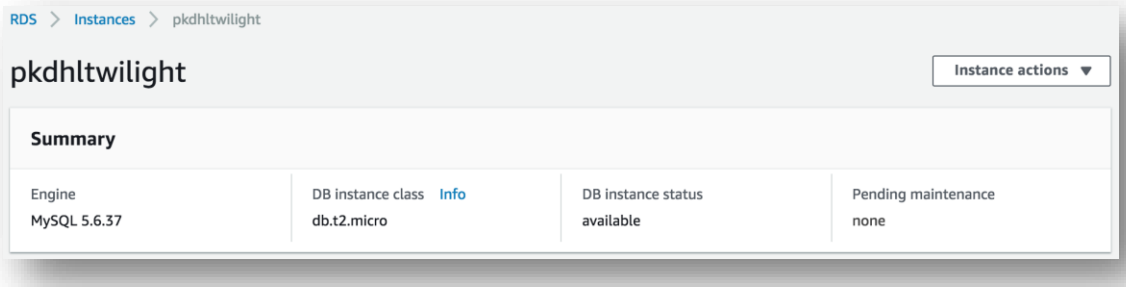


An Elastic IP address was created and assigned to my AWS account to enable dynamic IP assignment. Assigning an elastic IP allows for an EC2 instance to be start/stopped and remap the assigned IP to my AWS DNS;



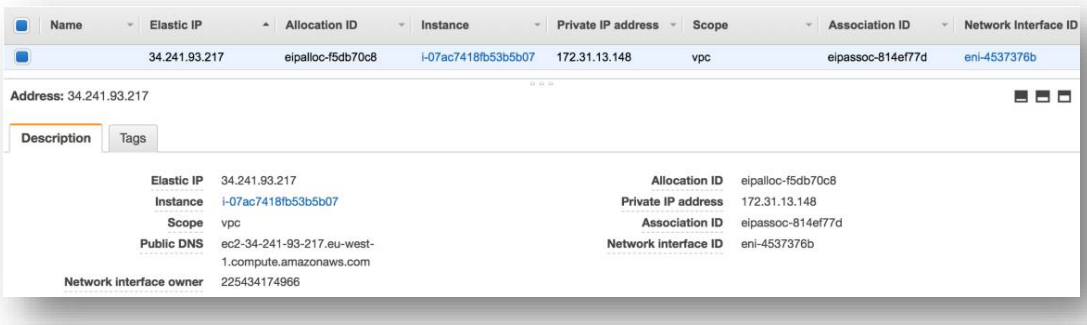
RDS (Relational Database Service) MySQL Instance

AWS RDS MySQL instance was configured to provide a cloud hosted DB and allows up to 20GB free storage and read/write access to DHL Twilight data.

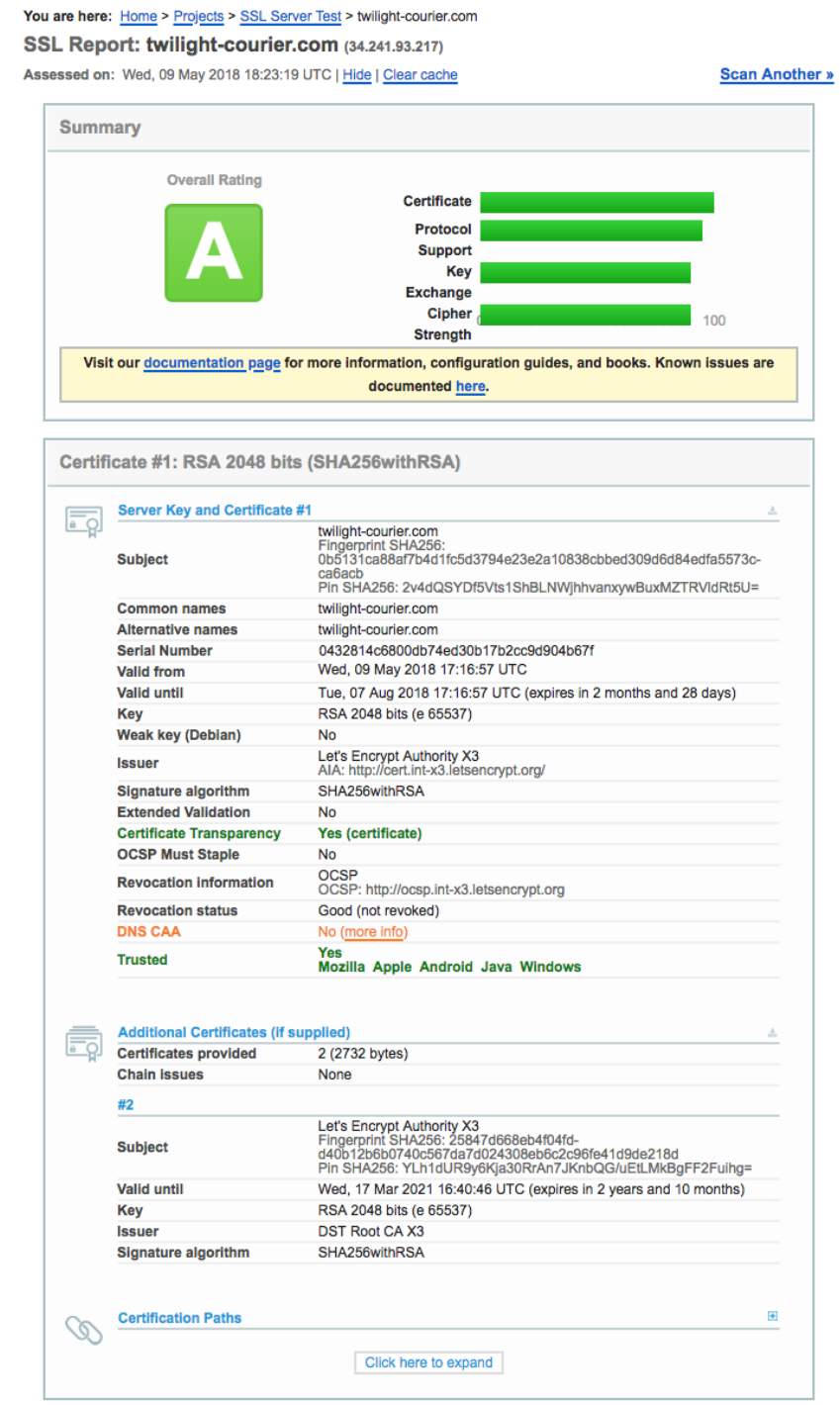


Route 53 – twilight-couier.com

AWS Route 53 is a scalable domain name system web service that allows end users to be routed to web applications. A unique DNS was purchased, [twilight-courier.com](), and assigned to the DHL Twilight cloud application hosted eleastic IP to provide a relevant hosted address for end users;



SSL Certification – twilight-courier.com



You are here: Home > Projects > SSL Server Test > twilight-courier.com

SSL Report: twilight-courier.com (34.241.93.217)

Assessed on: Wed, 09 May 2018 18:23:19 UTC | Hide | Clear cache

Scan Another »

Summary

Overall Rating

A

Certificate
Protocol Support
Key Exchange
Cipher Strength
100

Visit our documentation page for more information, configuration guides, and books. Known issues are documented here.

Certificate #1: RSA 2048 bits (SHA256withRSA)

Server Key and Certificate #1

Subject	twilight-courier.com Fingerprint SHA256: 0b5131ca88af7b4d1fc5d3794e23e2a10838cbbed309d6d84edfa5573c-ca6acb Pin SHA256: 2v4dQSYDf5Vts1ShBLNWjhhvanxywBuxMZTRVldRt5U=
Common names	twilight-courier.com
Alternative names	twilight-courier.com
Serial Number	0432814c6800db74ed30b17b2cc9d904b67f
Valid from	Wed, 09 May 2018 17:16:57 UTC
Valid until	Tue, 07 Aug 2018 17:16:57 UTC (expires in 2 months and 28 days)
Key	RSA 2048 bits (e 65537)
Weak key (Debian)	No
Issuer	Let's Encrypt Authority X3 AIA: http://cert.int-x3.letsencrypt.org/
Signature algorithm	SHA256withRSA
Extended Validation	No
Certificate Transparency	Yes (certificate)
OCSP Must Staple	No
Revocation information	OCSP OCSP: http://ocsp.int-x3.letsencrypt.org
Revocation status	Good (not revoked)
DNS CAA	No (more info)
Trusted	Yes Mozilla Apple Android Java Windows

Additional Certificates (if supplied)

Certificates provided	2 (2732 bytes)
Chain issues	None

#2

Subject	Let's Encrypt Authority X3 Fingerprint SHA256: 25847d668eb4f04fd-d40b12b6b0740c567da7d024308eb6c2c96fe41d9de218d Pin SHA256: YLh1dUR9y6Kja30RrAn7JKnbQG/uEtLMkBgFF2Fuihg=
Valid until	Wed, 17 Mar 2021 16:40:46 UTC (expires in 2 years and 10 months)
Key	RSA 2048 bits (e 65537)
Issuer	DST Root CA X3
Signature algorithm	SHA256withRSA

Certification Paths

Click here to expand

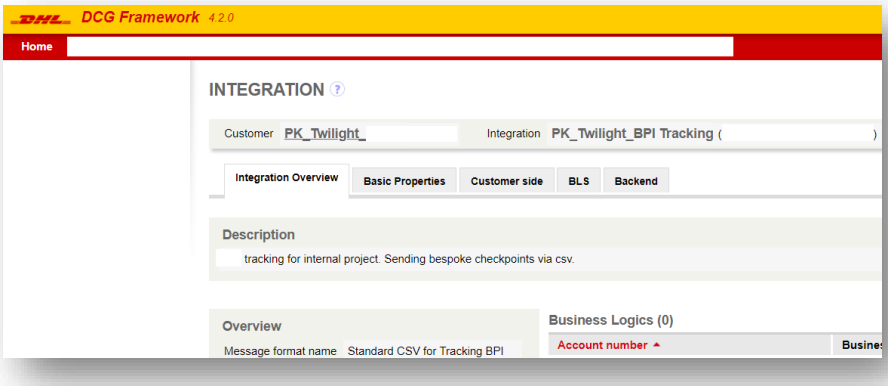
HTTPS – twilight-courier.com

HTTPS was enabled for the DHL Twilight Courier website obtaining a certificate through CertBot.eff.org;

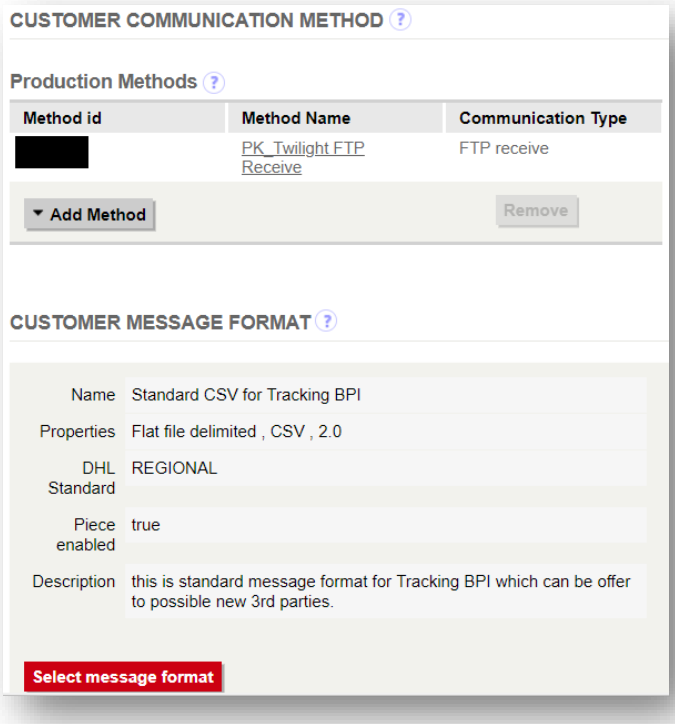
DHL DCG (DHL Customer Gateway)

The DHL Twilight cloud application is fully hosted on AWS to provide a platform and process data for all application functionalities. On completion of a shipment delivery and transmition of data to DHL the updated status of a shipment is then reflected on the tracking page through the main www.dhl.ie website. To achieve this the data that is captured from a shipment completed through DHL Twilight is transferred via an FTP server to DCG. An integration was configured within DCG and mapped to the shipment status update file generated from the DHL Twilight application. The DCG integration was configured to digest new files from the designated FTP file path and translate the shipment data and output results to the live www.dhl.ie tracking site. The DCG integration was configured to accept a standard CSV/.txt file from the DHL Twilight application containing the manadtory data required to identify the shipment, translate the data, feed in to the backend DHL systems and output the status update agianst the shipment number on the www.dhl.ie tracking site.

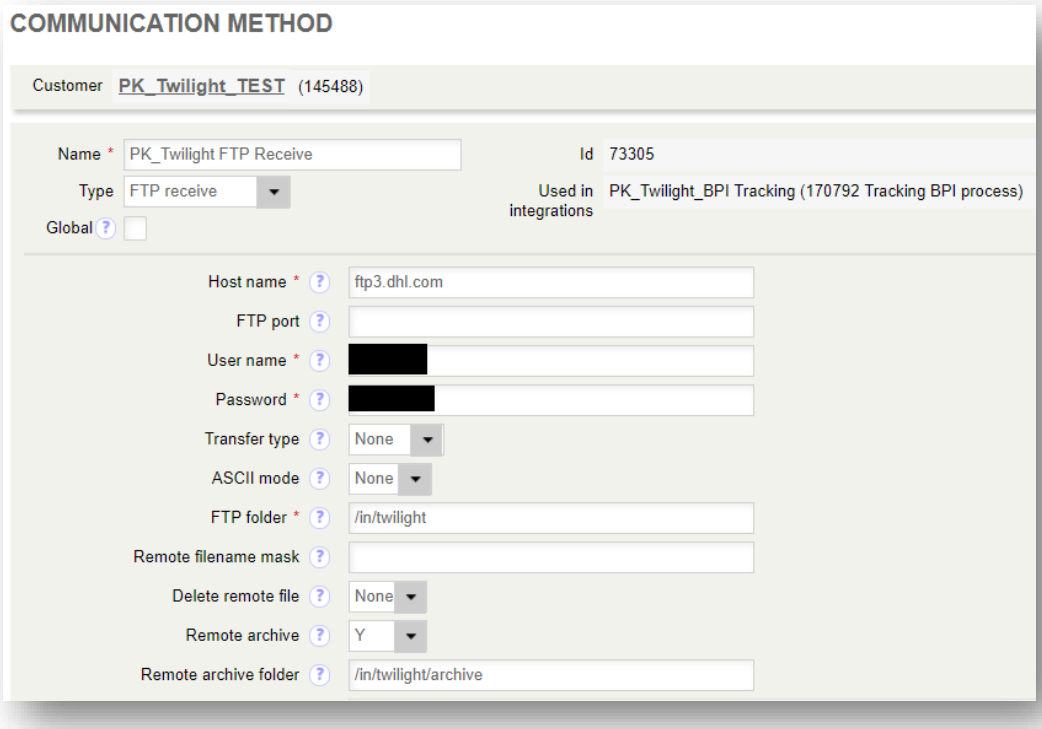
The PK_Twilight DCG Integration Profile was configured;



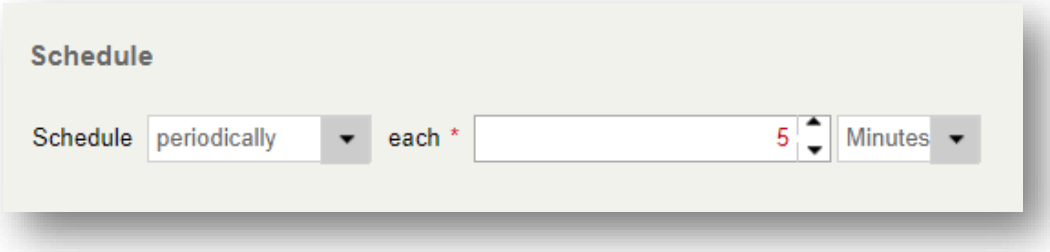
The message format selected from the pre-defined DHL tracking specification;



The communication and FTP server details defined for file retieval;



The FTP fetch scheduled to minimum periodical time of 5 minutes;



The DCG PK_Twilight integration was configured to accept csv/.txt files and mapped to successfully translate the below sample file structure;

Header;20180509;IntegrationID

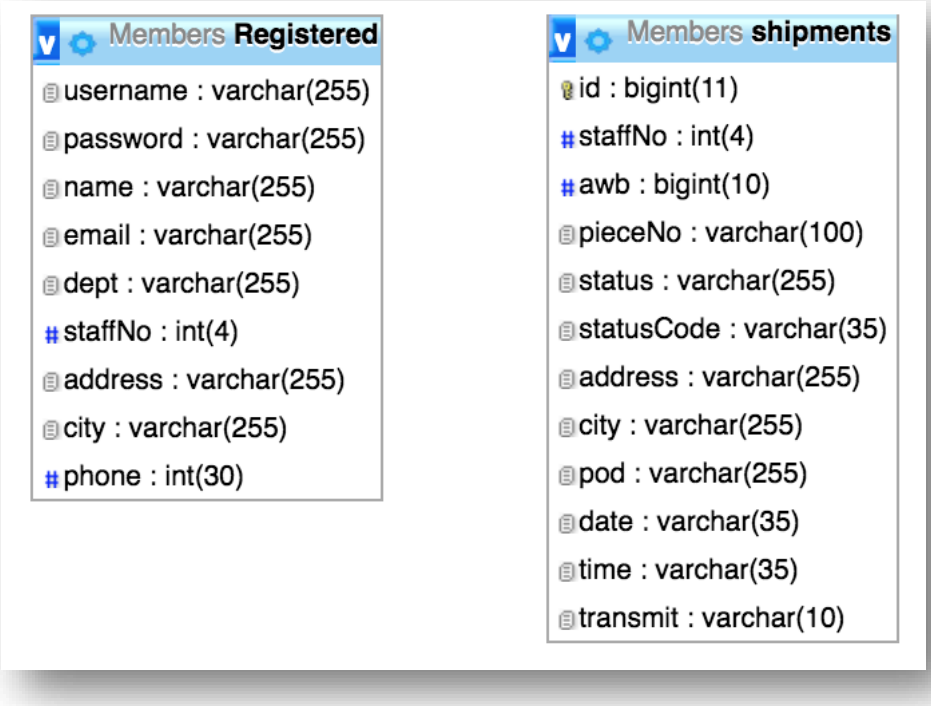
Detail;6;ServiceCode;Facility;20180509;215611;+01:00;AWB#;PieceID#;NH;POD;RouteCode;CycleCode

Trailer;6

Implementation

AWS RDS MySQL Design

The DHL Twilight cloud application revolves around a central cloud hosted database, 'Members', for storing and accessing data for users and shipments. The database was designed with these two requirements forming the tables. The 'Members' database tables are named 'Registered' and 'shipments' as per the below database structure diagram;



Each record within each table was assigned to relevant variables to handle the data assigned. The 'Registered' table was created to provide a repository of all registered users and their details. This table is referenced throughout the DHL Twilight application to validate user access and session mamangement. The second table, 'shipments' was created to act as a "Dummy" DHL shipment repository with shipments being imported to the table manually by the system administrator. This was a requirement due to the sensitivity and availability to the DHL network. DHL adhere to strict data protection regulations preventing accessibility to the Live shipment DB. After the mid-point Presentation feedback and discusstions with my Project Supervisor it was advised to create a "Dummy" DHL database storing test shipments to allow the DHL Twilight cloud application to fulfil all functions. The 'shipments' table provides the application to access shipment data whist

also performing required read/write operations against assigned shipments updating the status detail as the shipment delivery is completed.

Requirements Migration

User Registration

The user is navigated to the registration page and displayed with a form to capture all mandatory details including Email address and passwords to access the site. The Registration page was created using HTML/CSS for the look and styling and PHP to interact with the Members database to validate and write new entries to the 'Registered' table. All fields within the registration form are mandatory with validation controls being applied to 'Staff No.', 'Email' and 'Password'. The registration form validation is carried out using a series of PHP calls and references. The main registration page includes the 'server.php' & 'errors.php' files with data captured on the registration form posted to each of them;

The Registration file starts with the 'server.php' include that contains the connection to the Members DB;

```
<?php include('server.php') ?>
<!DOCTYPE html>
<html>
```

The form includes the 'errors.php' and captures the input from the user;

```
<h3 class="pb-3">Registration Form</h3>
<!--//Form fields captured and posted to "reg_user" -->
<form method="post" action="registration.php">
<?php include('errors.php'); ?>

<div class="form-group">
<label>Name</label>
<input type = "text" name="name" class="form-control" placeholder="Your name" value="<?php echo $name; ?>">
</div>

<div class="form-group"> <label>Address</label>
<input type="text" name="address" class="form-control" placeholder="Your home address" value="<?php echo $address; ?>">
</div>

<div class="form-group"> <label>City</label>
<input type="text" name="city" class="form-control" placeholder="Your City" value="<?php echo $city; ?>">
```

When the user clicks the 'Register' submit button on the form each field input is posted to 'reg_user';

```
    </div>

    <div class="form-group">
        <button type="submit" class="btn-primary" name="reg_user">Register</button>
    </div>
```

From the values caputured on the registration form the 'server.php' file validates each entry to ascertain whether the data is incomplete or is not unique. All fields are mandatory with 2 requiring unique value;

1. Staff No – This must be a unique DHL staff number and is checked against the current 'Registered' users within the 'Members' db.
2. Email – The email address must be unique as is used as 'username' to log into the application. The Email is checked against the current 'Registered' users within the 'Members' db.

```
$user_check_query = "SELECT * FROM Registered WHERE username='$username' OR staffNo='$staffNo' LIMIT 1";
$result = mysqli_query($db, $user_check_query);
$user = mysqli_fetch_assoc($result);

if ($user) { // if user exists
  if ($user['username'] === $username) {
    array_push($errors, "<p style='color:red'> *Username already exists</p>");
  }

  if ($user['staffNo'] === $staffNo) {
    array_push($errors, "<p style='color:red'> *Staff Number already registered</p>");
  }
}
```

The 'server.php' also checks to ensure that all fields are correctly filled and both passwords match;

```
// form validation: ensure that all manadatory fields are filled ...
// by adding (array_push()) corresponding error unto $errors array
if (empty($name)) { array_push($errors, "<p style='color:red'> *Name is required</p>"); }
if (empty($address)) { array_push($errors, "<p style='color:red'> *Address is required</p>"); }
if (empty($city)) { array_push($errors, "<p style='color:red'> *City is required</p>"); }
if (empty($phone)) { array_push($errors, "<p style='color:red'> *Phone Number is required</p>"); }
if (empty($dept)) { array_push($errors, "<p style='color:red'> *Department is required</p>"); }
if (empty($staffNo)) { array_push($errors, "<p style='color:red'> *Staff Number is required</p>"); }
if (empty($username)) { array_push($errors, "<p style='color:red'> *Email is required</p>"); }
if (empty($password_1)) { array_push($errors, "<p style='color:red'> *Password is required</p>"); }
if ($password_1 != $password_2) {
array_push($errors, "<p style='color:red'> *The two passwords do not match");
}
```

If any of the conditions for registration are not met then the form returns an error back to the user indicating that there are mandatory fields not complete or not unique. If all registration requirements are met when the user clicks on the 'Register' submit button then the new users details are written to the 'Registered' table.

Password Encryption

On successful registration of a new user all user details are written to the 'Registered' table within the 'Members' db. The password is encrypted using the MD5 hash function;

```
// Register the user if there are no errors in the form
if (count($errors) == 0) {
    $password = md5($password_1);//encrypt the password before saving in the database

    $query = "INSERT INTO Registered (name, address, city, phone, dept, staffNo, email, username, password)
          VALUES('$name', '$address', '$city', '$phone', '$dept', '$staffNo', '$email', '$username', '$password')";
```

username	password	name	dept	staffNo	address	city	phone
pat@test.com	7852341745c93238222a65a910d1dcc5	Patrick King	eCom	1234	0 Fairview Road, Fairview	Dublin	12345678

Capture New Shipments

Once logged into the DHL Twilight cloud application the user is presented with their landing page displaying all options available including 'New Shipments'. Clicking this option starts the Twilight courier delivery cycle and are first requested to 'Enter AWB'. An AWB is a unique 10 digit tracking number assigned to all shipments. The user obtains their assigned AWB from the packages that have been assigned to them by the DHL Twilight Administrator at the DHL Dublin HUB office. When the user enters the AWB number into the field and clicks 'Capture AWB' all associated information is returned from the 'shipments' table within the 'Members' db including the 'Status', 'Address' and 'City' and the users DHL Twiight staff number is assigned against the delivery. This feature is driven when the 'Capture Shipment' submit button is pressed, the AWB is referenced agaisnt the 'shipments' table and the users staff number assigned to the AWB only if the below requiremnets are met;

- The AWB number exisits within the ‘shipments’ table
- The AWB number is not assigned to another user, the ‘staffNo’ field is set to ‘0’
- The ‘status’ is ‘With Courier’

```
$sql = "UPDATE shipments SET staffNo = $staffNo WHERE awb = $AWB AND staffNo = '0'";
```

All captured shipments assigned to the user staff number are displayed to a table displaying all

```
$staffNo = $_SESSION['staffNo'];
$sql = "SELECT * FROM shipments WHERE status='With Courier' AND staffNo = $staffNo";
$result = mysqli_query($db, $sql) or die ("Bad Query:$sql");
```

```
<th>#</th>
<th>AWB Number</th>
<th>Shipment Status</th>
<th>Address</th>
<th>City</th>
</tr>
</tr>
</thead>
<tbody>
<?php
$num = 1;
while($row = mysqli_fetch_assoc($result)){
echo "<tr><td>".$num."</td>";
echo "<td>".$row['awb']."</td>";
echo "<td>".$row['status']."</td>";
echo "<td>".$row['address']."</td>";
echo "<td>".$row['city']."</td></tr>";
$num++;
}
?>
```

Route Planner / Google Maps WayPoint JS API

Following on from the ‘Capture Shipment’ feature the next part of the Twilight Couriers deliery cycle is the Optimal Route Planner. A number of techniques and search optimization/genetic algorithms were considered for generating the route planner based on the Travelling Salesmen problem including the ‘Ant colony optimization’ algorithm however after discussions with my Project Supervisor and extensive research the Google Maps Waypoint JavaScript API was considered to provide a solution to this requirement based around the same requirements in scope for delivering the optimal route based on time and distance. The Google Maps Waypoint API calculates the fastest route for up to

23 destinations and displays these to an interactive embedded Google Map. The Route Planner lists all current deliveries assigned to the users Staff Number and has a 'status' of 'With Courier'. These deliveries are then echoed to the Google Maps API Waypoint list.

Built into the DHL Twilight Route Planner is an optimised directional waypoint Google Maps Javascript API. This API provides an embedded Google Map, Waypoint panel and Route detail segment. To enable this configuration a Google Maps API key was obtained from the Google developemnt area. The configuration of the Google Maps Waypoint API was aided by the Google Maps WayPoint API developer guide providing documentation to implement. The standard plan available for free directions usage provides;

- 2,500 free requests per day, calculated as the sum of client-side and server-side queries; enable billing to access higher daily quotas, billed at $0.50 USD / 1000 additional requests, up to 100,000requests daily.
- Up to 23 waypoints per request, plus the origin and destination.
- 50 requests per second*, calculated as the sum of client-side and server-side queries. (Developers)

To implement the Google Maps Waypoint Javascript API the map and set variables for the start and end location were set as was the array pulling in the delivery addresses assigned to the Twilight courier from the 'shipments' table. The Twilight courier will always begin and end the delivery cycle at the DHL Dublin HUB office.

```
<div id="map"></div>
<div id="right-panel">
    <div>
        <b>Start:</b>
        <select id="start">
            <option value="DHL Express, Dublin Airport Logistics Park, St Margarets, Dublin, Ireland">DHL Express HUB, Dublin</option>
        </select>
        <br>
        <b>Delivery Points:</b>
        <br>
        <select multiple id="waypoints">
            <?php
            $nummaps = 1;
            while($rowmaps = mysqli_fetch_assoc($resultmaps)){
            echo '<option value="'.$rowmaps["address"].'">'.$rowmaps["address"].'</option>';
            $nummaps++;
              }
            ?>
        </select>
        <br>
        <b>End:</b>
        <select id="end">
            <option value="DHL Express, Dublin Airport Logistics Park, St Margarets, Dublin, Ireland">DHL Express, Dublin</option>
        </select>
        <br>
        <input type="submit" id="submit">
    </div>
    <!--<div id="directions-panel"></div>-->
</div>
```

The initiation of the map along with its default view were also defined with latitude/longtitude for Dublin and an event listener to the 'Submit' button;

```
<script>
    function initMap() {
        var directionsService = new google.maps.DirectionsService;
        var directionsDisplay = new google.maps.DirectionsRenderer;
        var map = new google.maps.Map(document.getElementById('map'), {
            zoom: 10,
            center: {
                lat: 53.350140,
                lng: -6.266155
            }
        });
        directionsDisplay.setMap(map);

        document.getElementById('submit').addEventListener('click', function() {
            calculateAndDisplayRoute(directionsService, directionsDisplay);
        });
    }
```

The next function added was to iterate through the 'waypoints' array to pull all present address information;

```
    function calculateAndDisplayRoute(directionsService, directionsDisplay) {
        var waypts = [];
        var checkboxArray = document.getElementById('waypoints');
        for (var i = 0; i < checkboxArray.length; i++) {
            if (checkboxArray.options[i].selected) {
                waypts.push({
                    location: checkboxArray[i].value,
                    stopover: true
                });
            }
        }
```

Finally the directionsService.Route is defined detailing the DirectionsRequest. Based on the standard plan implemented for this feature the below fields were included to provide required information to send the request;

- origin (required) specifies the start location from which to calculate directions.
- destination (required) specifies the end location to which to calculate directions.
- travelMode (required) specifies what mode of transport to use when calculating directions.
- **waypoints[]** (optional) specifies an array of DirectionsWaypoints. Waypoints alter a route by routing it through the specified location(s).
- **optimizeWaypoints** (optional) specifies that the route using the supplied waypoints may be optimized by rearranging the waypoints in a more efficient order. If true, the Directions service will return the reordered waypoints in a waypoint_order field. (Developers)

```
    directionsService.route({
        origin: document.getElementById('start').value,
        destination: document.getElementById('end').value,
        waypoints: waypts,
        optimizeWaypoints: true,
        travelMode: 'DRIVING'
    }, function(response, status) {
        if (status === 'OK') {
            directionsDisplay.setDirections(response);
            var route = response.routes[0];
            var summaryPanel = document.getElementById('directions-panel');
            summaryPanel.innerHTML = '';
            // For each route, display summary information.
            for (var i = 0; i < route.legs.length; i++) {
                var routeSegment = i + 1;
                summaryPanel.innerHTML += '<b>Route Segment: ' + routeSegment +
                    '</b><br>';
                summaryPanel.innerHTML += route.legs[i].start_address + ' to ';
                summaryPanel.innerHTML += route.legs[i].end_address + '<br>';
                summaryPanel.innerHTML += route.legs[i].distance.text + '<br><br>';
            }
        } else {
            window.alert('Directions request failed due to ' + status);
        }
    });
}
```

The above Google Maps Javascript implementation uses the 'Waypoints' direction request along with 'optimiseWaypoints'. Setting the 'optimiseWaypoints' = true optimises the route returned to provide the fastest route based on travel, distance and number of turns.

The implemented Google Maps Optimsed Waypoints API is an application of the travelling salesperson problem.

Update Checkpoint

The update checkpoint section allows the user to select the AWB, checkpoint and enter the customers POD(Proof of Delivery) name. The 'Select AWB' dropdown list displays all AWBs assigned to the users staff number with a 'With Courier' status;

```
$sql = "SELECT * FROM shipments WHERE status='With Courier' AND staffNo = $staffNo";
```

The 'Select Checkpoint' dropdown list displays two checkpoints applicable to the deliery attempt;

1. Delivered – The shipment was delivered successfully
2. Not Home – The customer was not available to receive deliver

The 'Capture POD' text box allows for the customer/DHL Twilight courier to enter the name of the recipient that took receipt of the delivery. The 'AWB' and 'Status' are mandatory leaving the 'POD Capture' optional depedning on whether the package was delivered.

Once all relevant options are selected the 'Udate Checkpoint' submit button assigns the 'AWB', 'Status' and 'POD' to the associated AWB number within the 'shipments' table. Based on these updates additional values are assigned against the AWBs within the 'shipments' table;

- Date & time stamps
- DHL CheckPoint Code
    - OK = Delivered
    - NH = Not Home
- Transmit Flag = Default value 'No'

```php
<?php
session_start();
// 1. Enter Database details
$db = mysqli_connect('localhost', 'patrickking25', '', 'Members');
date_default_timezone_set('Europe/Dublin');
$date = date('Ymd');
$time = date('His');

// echo $date['date'];

$AWB = (int)$_POST['awb'];
$status = $_POST['status'];
$pod = $_POST['pod'];
print_r($_POST);

if(!isset($_POST['status'])){

header('location: UpdateCheckpoint.php?message=empty');
echo close();
}

echo $checkpointStatus = $_POST['status'];
echo "<br>";

$sql = "UPDATE shipments SET pod = '$pod',status = '$checkpointStatus', date ='$date', time ='$time' WHERE awb = '$AWB'";
$sqlStatusOK = "UPDATE shipments SET statusCode = 'OK' WHERE status ='Delivered'";
$sqlStatusNH = "UPDATE shipments SET statusCode = 'NH' WHERE status ='Not Home'";
mysqli_query($db, $sql);
mysqli_query($db, $sqlStatusNH);
mysqli_query($db, $sqlDate);
mysqli_query($db, $sqlStatusOK) or die (header('location: https://dhltwilight-patrickking25.c9users.io/IndexHTML/UpdateCheckpoint.php?error=1'));

header('location: https://dhltwilight-patrickking25.c9users.io/IndexHTML/UpdateCheckpoint.php');

?>
```

id	staffNo	awb	pieceNo	status	statusCode	address	city	pod	date	time	transmit
45	4321	3333333333	JD01111111111113	Delivered	OK	, Northbrook Avenue, Ranelagh	Dublin	Ian Rush	20180505	174156	No
48	4321	6666666666	JD0111111111111116	Not Home	NH	, St James	Dublin	Jackie Moon	20180509	160326	No

After the AWB has been updated they are displayed in a table to confirm the updated status;

```php
<thead>
  <tr>
    <th>#</th>
    <th contenteditable="true">AWB</th>
    <th>Checkpoint</th>
    <th>POD</th>
    <th>Transmitted to DHL</th>
  </tr>
</thead>
<tbody>
  <?php
  $num = 1;
    while($row = mysqli_fetch_assoc($resultUpdates)){


    echo "<tr><td>".$num."</td>";
    echo "<td>".$row['awb']."</td>";
    echo "<td>".$row['status']."</td>";
    echo "<td>".$row['pod']."</td>";
    echo "<td>".$row['transmit']."</td>";
    $num++;

    }
  ?>
```

Transmit Checkpoint to DHL

The final part of the Twilight delivery cycle is to transmit the updated checkpoints to DHL. The transmission of AWB checkpoint data to DHL allows for the captured updates to be feed back to the DHL network and display the update live to the www.dhl.com tracking site providing tracking visibility to the customer and complete the shipment. The 'Transmit Update' section provides a dropdown list of all AWB numbers assigned to the users Staff Number with a status of either 'Not Home' or 'Delivered' and with the 'transmit' flag set to 'No'. The user can select an AWB and click on the 'Transmit to DHL' submit button, this triggers a PHP function that generates a local file, writes the relevant data and sends the file to an FTP server.

The first section of the PHP script is to update the 'shipments' table and set the 'transmit' flag to 'Yes' for the selected AWB, define the required fields from the 'shipments' table required to populate the transmit file, define the region date/time and the file naming format (date/time_AWB number);

```
$staffNo = $_SESSION['staffNo'];
$sql = "SELECT * FROM shipments WHERE staffNo = $staffNo AND awb = $awb";
$sqlTrans = "UPDATE shipments SET transmit ='Yes' WHERE awb = $awb";
$result = mysqli_query($db, $sql);
mysqli_query($db, $sqlTrans) or die ("Bad Query:$sql");

$id = "";
$pid = "";
$sc = "";
$pod = "";
$date = "";
$time = "";
while($row = mysqli_fetch_assoc($result)){
        $id =  $row['id'];
        $pid =   $row['pieceNo'];
        $sc = $row['statusCode'];
        $pod = $row['pod'];
        $date = $row['date'];
        $time = $row['time'];
    }


date_default_timezone_set('Europe/Dublin');
$date = date('Ymd');
$dateFile = date('Ymdhis_').$awb;
```

The f_open PHP function was used to create/open a file on the local directory assigned with the file format name (date/time_AWB) and write the specified data from the database or default values;

```
$myfile = fopen("testfile/$dateFile.txt", "w") or die("Unable to open file!");

$txt = "H;";
fwrite($myfile, $txt);
$txt = $date.";";
fwrite($myfile, $txt);
$txt = "PKTWILIGHT\n";
fwrite($myfile, $txt);
$txt = "D;";
fwrite($myfile, $txt);
$txt = $id.";";
fwrite($myfile, $txt);
$txt = "DUB;";
fwrite($myfile, $txt);
$txt = "GTW;";
fwrite($myfile, $txt);
$txt = $date.";";
fwrite($myfile, $txt);
$txt = $time.";";
fwrite($myfile, $txt);
$txt = "+01:00;";
fwrite($myfile, $txt);
$txt = $awb.";";
fwrite($myfile, $txt);
$txt = $pid.";";
fwrite($myfile, $txt);
$txt = $sc.";";
fwrite($myfile, $txt);
$txt = $pod.";";
fwrite($myfile, $txt);
$txt = "17S7;";
fwrite($myfile, $txt);
$txt = "A\n";
fwrite($myfile, $txt);
$txt = "T;";
fwrite($myfile, $txt);
$txt = $id."\n";
fwrite($myfile, $txt);
fclose($myfile);
```

Example file generated from this command;

Header;20180509;IntegrationID

Detail;6;ServiceCode;Facility;20180509;215611;+01:00;AWB#;PieceID#;NH;POD;RouteCode;CycleCode

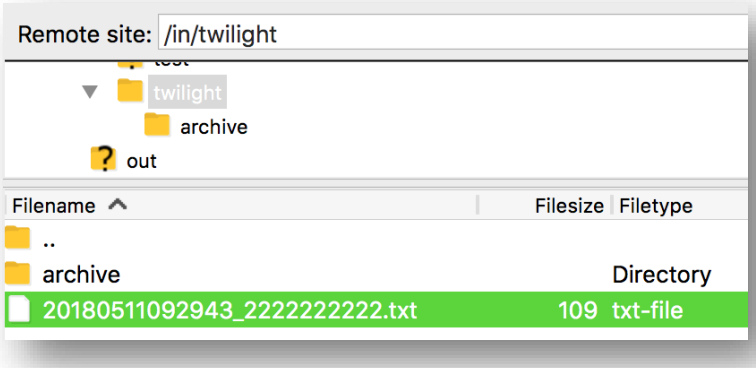
Trailer;6

Finally the ftp_put PHP function is used to connect to a server, locate the corresponding file that was created locally, rename the file (date/time_AWB) and send via FTP to the specified directory on the server;

```php
$ftp_server = "******.com";
$ftp_username = "******";
$ftp_userpass = "******";
$ftp_conn = ftp_connect($ftp_server) or die("Could not connect to $ftp_server");
$login = ftp_login($ftp_conn, $ftp_username, $ftp_userpass);
ftp_pasv($ftp_conn, true);

$file = "testfile/$dateFile.txt";


// // upload file
if (ftp_put($ftp_conn, "in/twilight/$dateFile.txt", $file, FTP_ASCII))
  {
  echo "Successfully uploaded $file.";
  }
else
  {
  echo "Error uploading $file.";
  }

// close connection
ftp_close($ftp_conn);
```

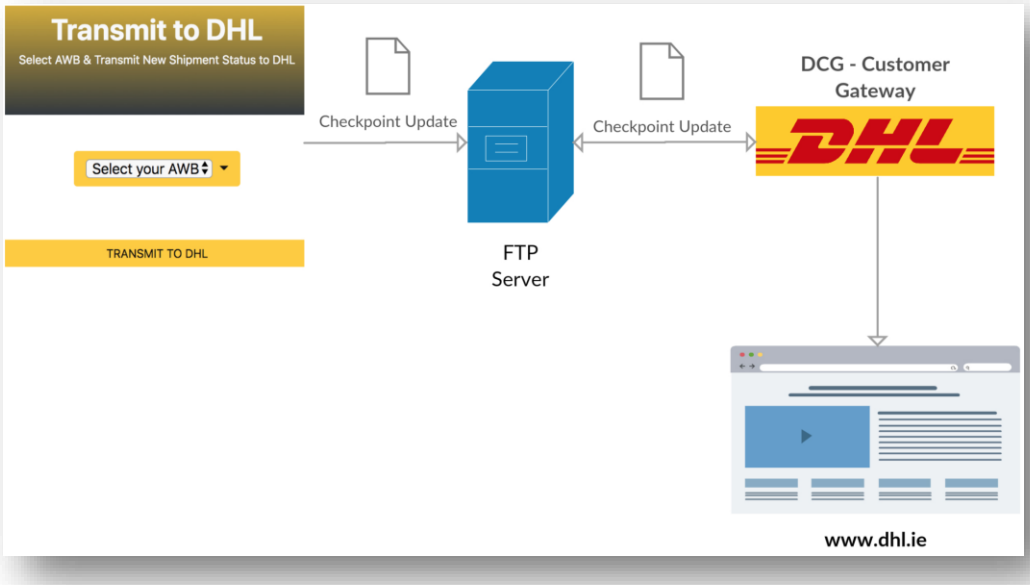
After the above functions have completed the user receives a confirmation message confirming that the data has successfully been transferred to DHL.

The file is now located at the desinated server directory;



DHL Customer GateWay(DCG) – Integration

An integration tracking feed was configured to fetch .txt files from the server directory containing the DHL Twilight checkpoint update files, translate the files and load into the DHL backend systems and network to provide tracking visibility for the completed shipments at www.dhl.com. This DHL tracking integration was set up on a 5 minute schedule to fetch files from the server directory, therefore every 5 minutes the integration would log in to the server and directory check for any new files take a copy of the file and move a copy to the 'archive' directory folder for future reference.



View History

Each registered user can view a full history list of all shipmenst assigned to their Staff Number throught the 'Shipment History' link on the users landing page. The shipment history table includes a reactive search functionaility allowing the user to filter their search based on the values entered into the search box. This functionality was achieved by using the datatables jQuery function;

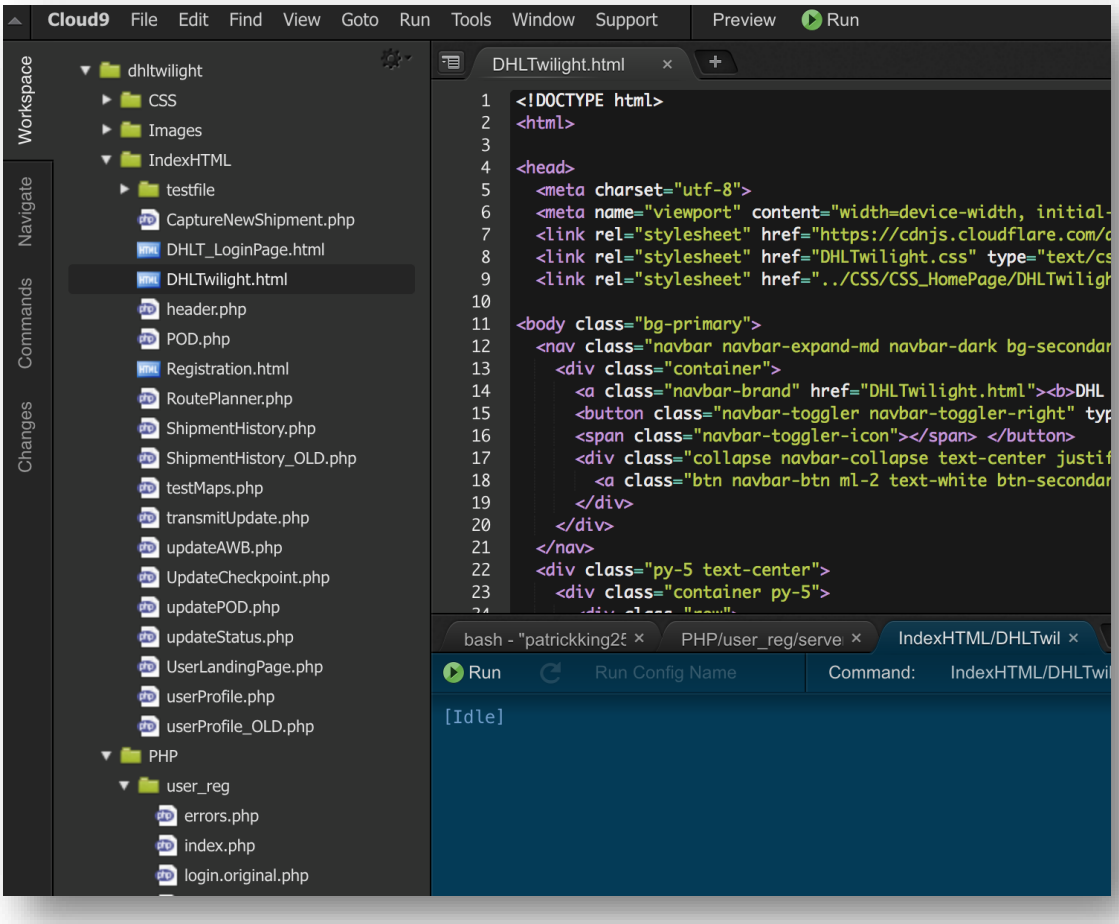
```
<script>
$(document).ready(function() {
    $('#example').DataTable( {
        "createdRow": function ( row, data, index ) {
            if ( data[5].replace(/[\$,]/g, '') * 1 > 150000 ) {
                $('td', row).eq(5).addClass('highlight');
            }
        }
    } );
} );
</script>
```

```
<div class="table-responsive">
<table id="example" class="display" style="width:100%">
        <thead>
            <tr>
                <th>AWB Number</th>
                <th>Status</th>
                <th>Delivery Address</th>
                <th>City</th>
                <th>POD</th>
                <th>Date</th>
            </tr>
        </thead>
            <tbody>
                <?php
                $num = 1;
                  while($row = mysqli_fetch_assoc($result)){
                  echo "<td>".$row['awb']."</td>";
                  echo "<td>".$row['status']."</td>";
                  echo "<td>".$row['address']."</td>";
                  echo "<td>".$row['city']."</td>";
                  echo "<td>".$row['pod']."</td>";
                  echo "<td>".$row['date']."</td></tr>";
                  $num++;
                  }
                ?>
            </tbody>
        </table>
        </div>

      <div class="row">
        <div class="col-md-12 p-3">
          <a class="btn btn-primary w-15" href="UserLandingPage.php">
            <b>Home</b>
          </a>
        </div>
      </div>
```

Environments

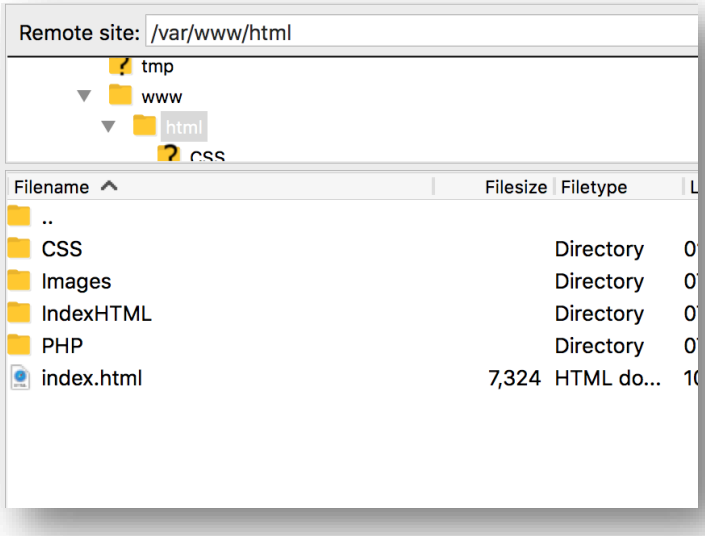
Development– Cloud9 IDE

The DHL Twilight cloud application was designed using the Cloud9 IDE as a development environment to where code & functionality could be written and tested. The DHL Twilight Cloud9 environment consisted of a project file structure to provide a clear and structured development;



Production – twilight-courier.com

Once code and functionality was successfully tested the application would be deployed to the Live AWS EC2 server (twilight-courier.com) via SFTP using the FileZilla FTP application;



To enable the transfer of files between the development Cloud9 environemnt and my Live EC2 server an SFTP connection was configured adhearing to AWS standards. To activate this secure transfer port 22 was enabled, a security key linked to my EC2 profile and inbound traffic allowed.

GitHUB repository

The DHL Twilight cloud application was fully backed up within the GitHUB repository to provide a full system recovery and version control during development. Please a link to the GitHUB repository used for the DHL Twilight project below;

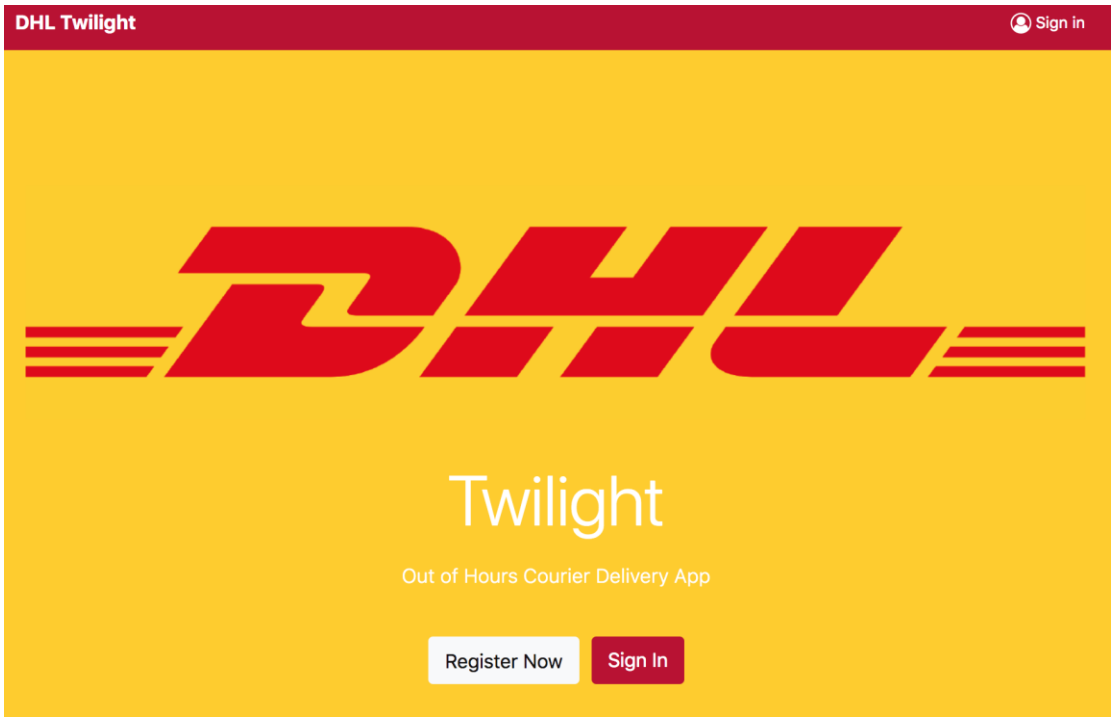
https://github.com/kinpat7/Twilight_SoftwareProject.git

GUI - Graphical User Interface

The DHL Twilight cloud application provides a platform for deliveries to be carried out after the standard courier operating hours. The application focuses around being able to record and update a shipment status up to and including the final 'Delivered' checkpoint. The GUI for the application uses the official DHL Express branding and colors that act as a consistent theme throughout navigating the application. A request to the DHL IE Marketing team was made and approved to use the DHL logo and colors throughout the application (Appendix C). The DHL Twilight application GUI provides a clear and easy to use interface from navigation to functionality. The application was developed to render across multiple platforms most importantly mobile devices. With this in mind the simple layout provides a smoother transition between platforms.

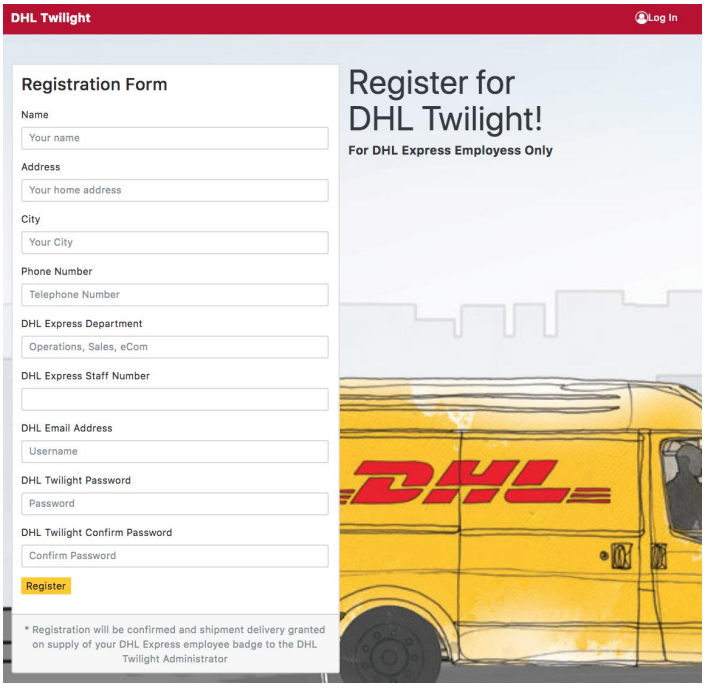
Home Page;

The Home Page for the cloud application provides a bold and clear overview of the application and its functionality. New Users can 'Register Now' or existing users can 'Sign In' using the buttons located in the centre of the page;



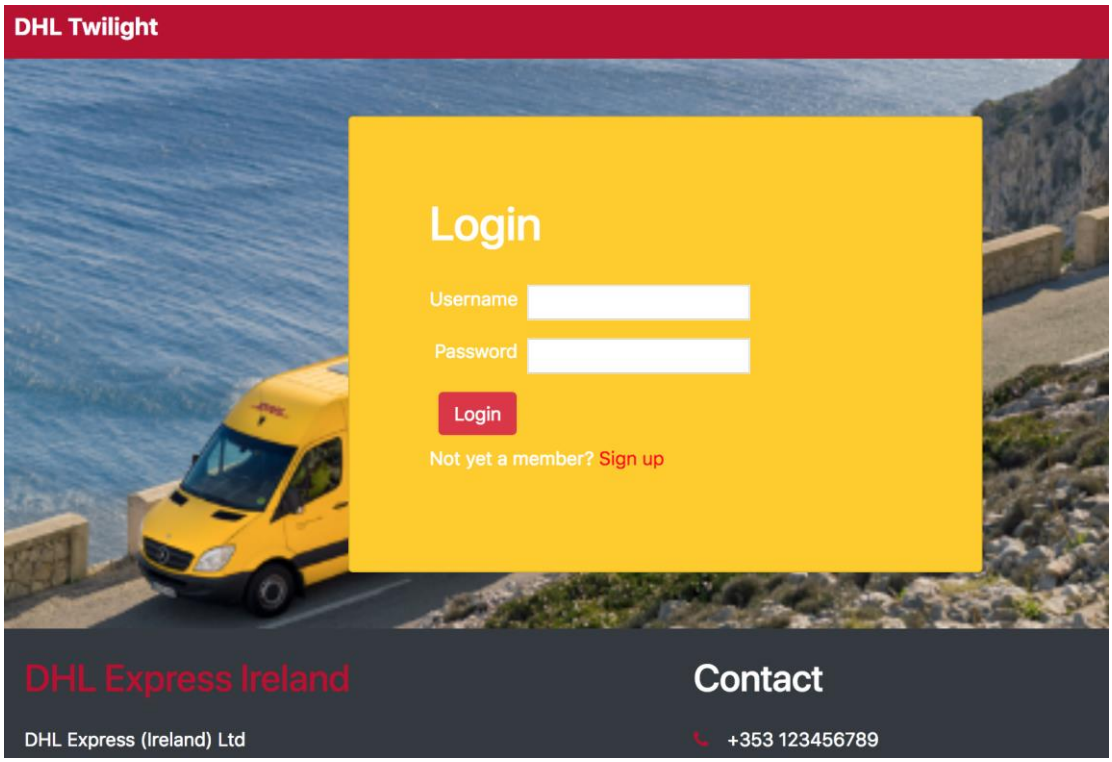
Registration

The registration form requires all fields to be completed including a unique Email address & 4 digit Staff Number.



Login

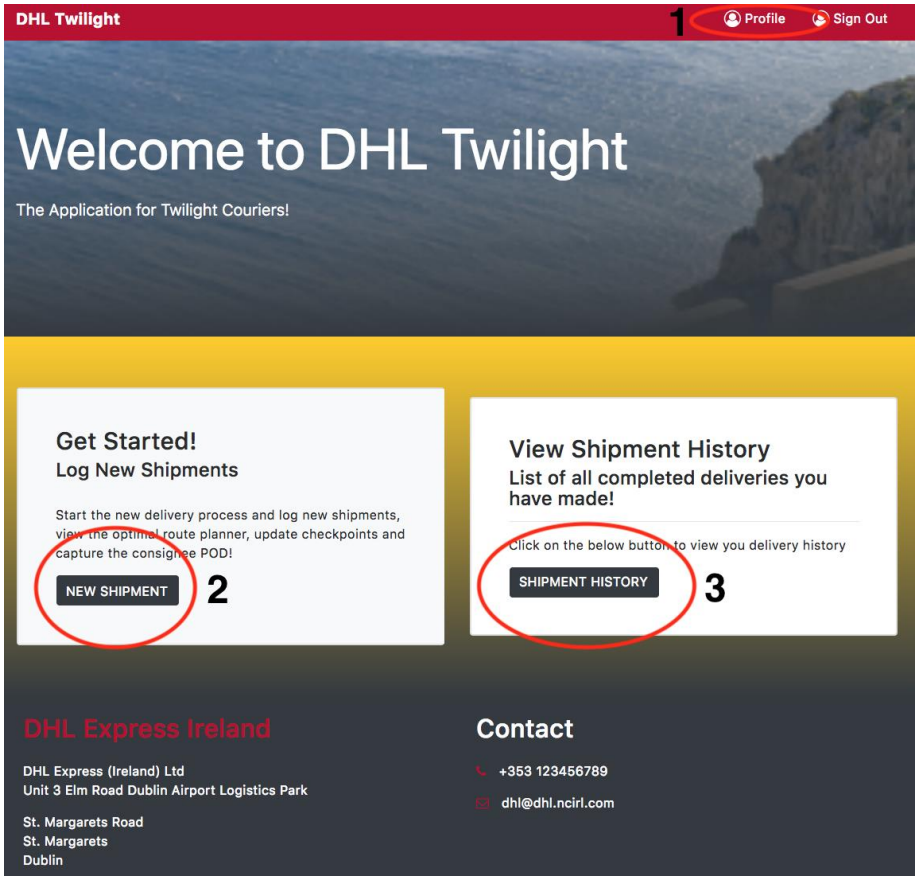
Once successfully registered the user will be redirected to the 'Login' page where they can login with their registered Email address and password;



User Landing Page

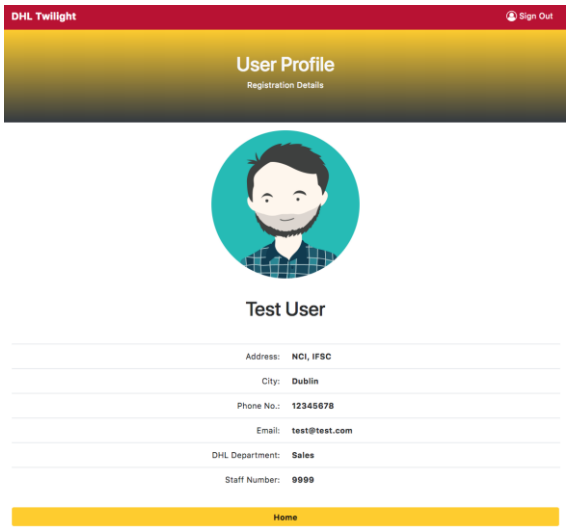
On successful login the user will automatically be redirected to their user landing page that provides the user with the options to;

1. View Profile
2. New Shipments
3. Shipment History



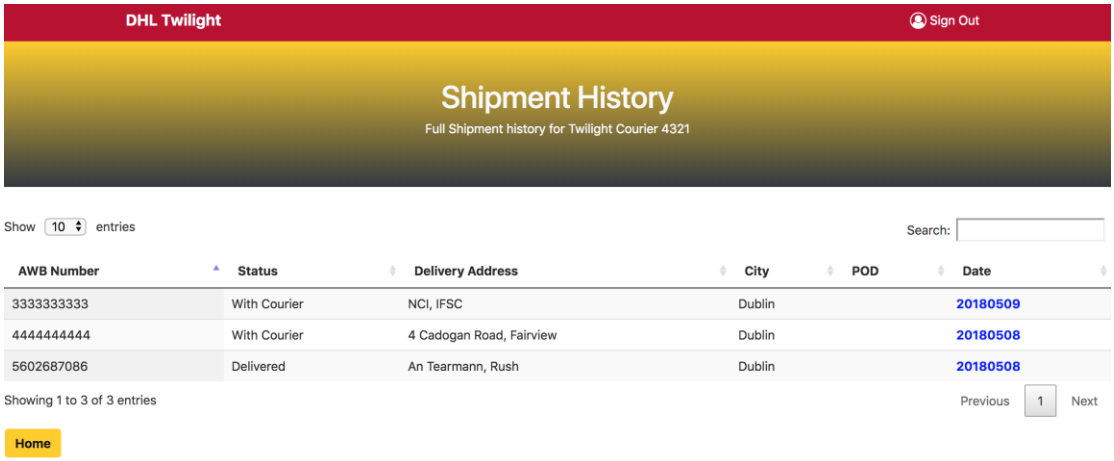
View Profile

The user profile page displays the user registration details in a clear and concise format;



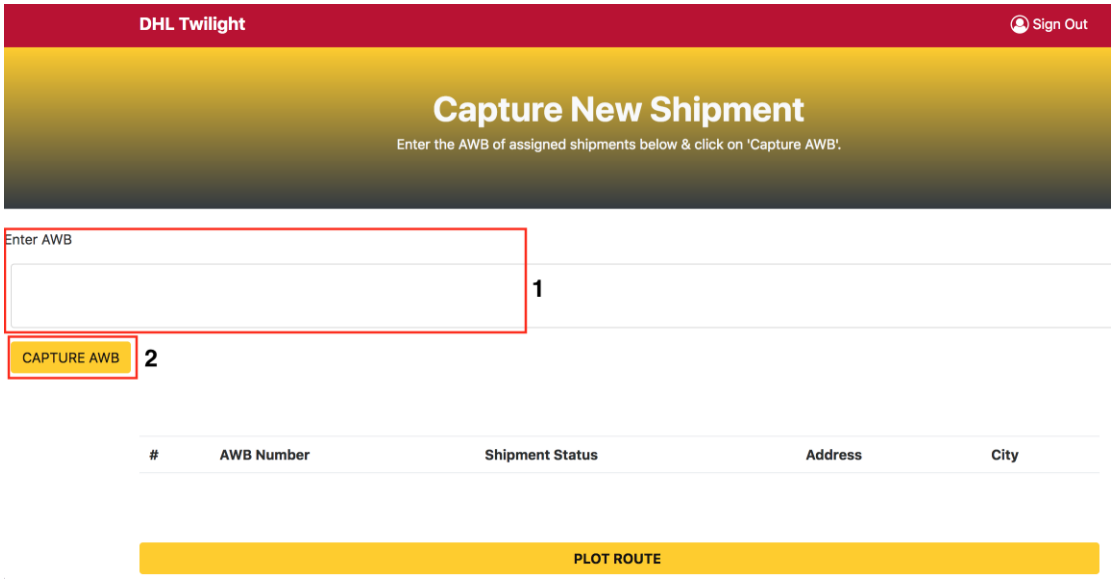
Shipment History

The shipment history page displays a full list of all complete and assigned shipments along with the date of last update and details. A responsive serach filter is built into the shipment history page to aid simple shipment retireval;



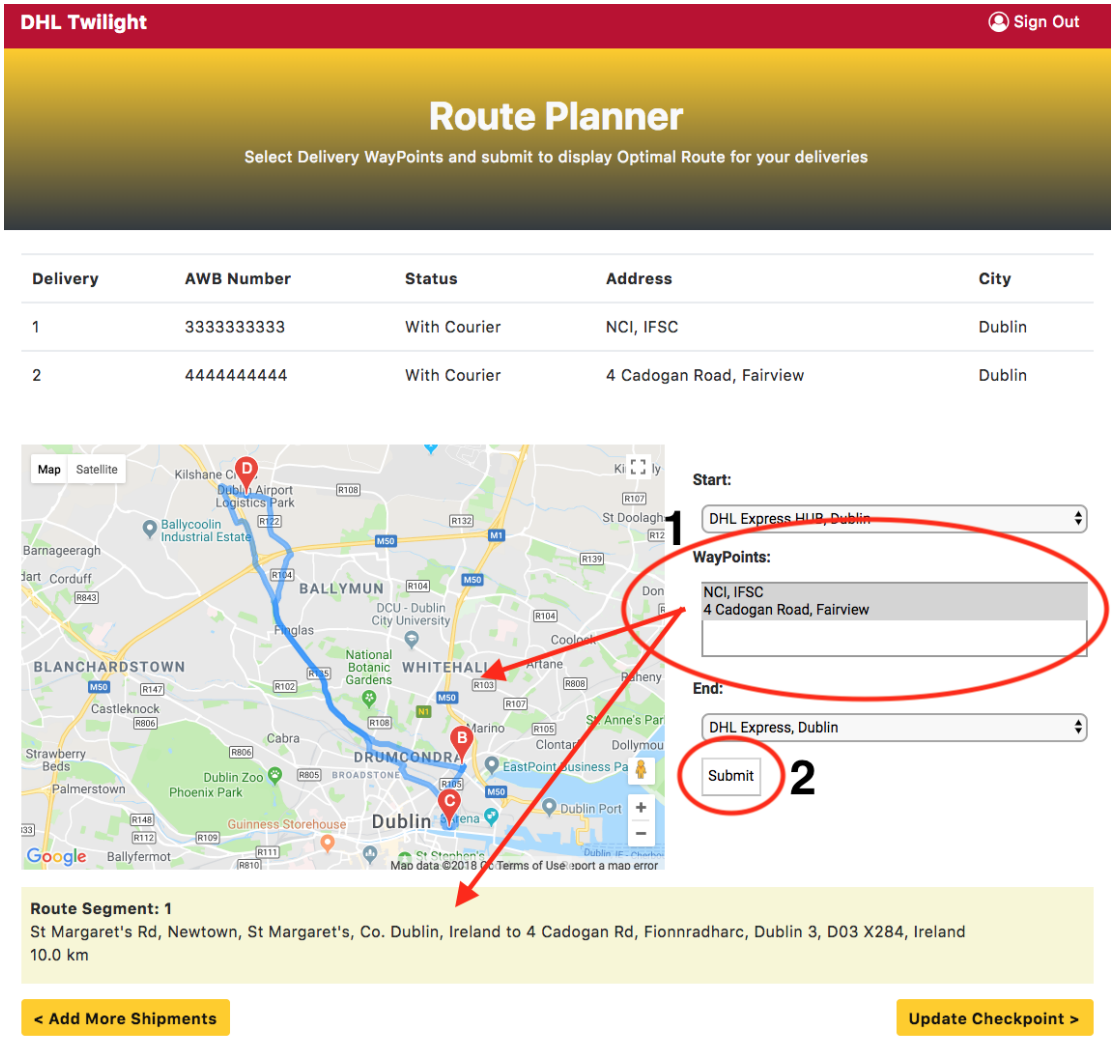
Capture Shipment

The capture shipment page allows users to assign AWB (AirWayBill / Shipment tracking numbers) to their account.



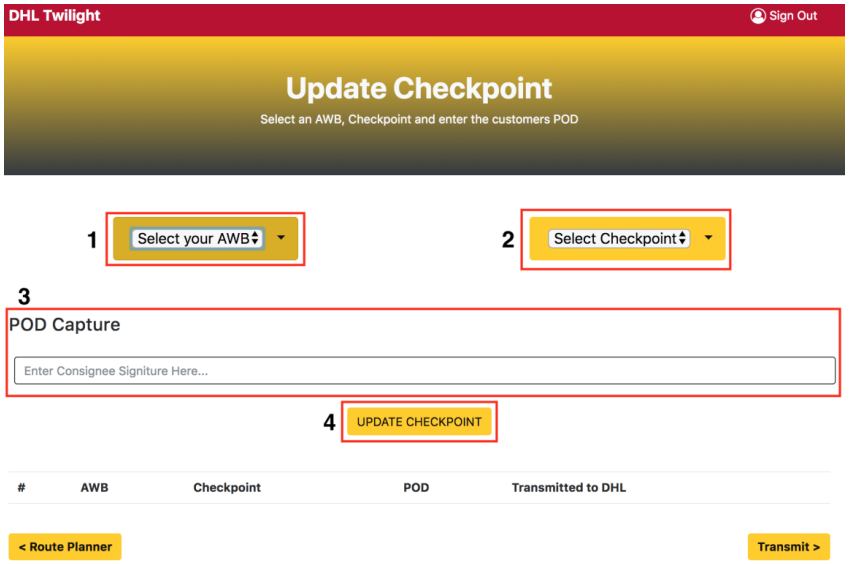
Plot Route

All captured shipments assigned to a users account and 'With Courier' status are dislayed. To display the optimal route for assigned deliveries the user can select all addresses within the 'Waypoints' panel located on the left of the Map(1).



Update Status

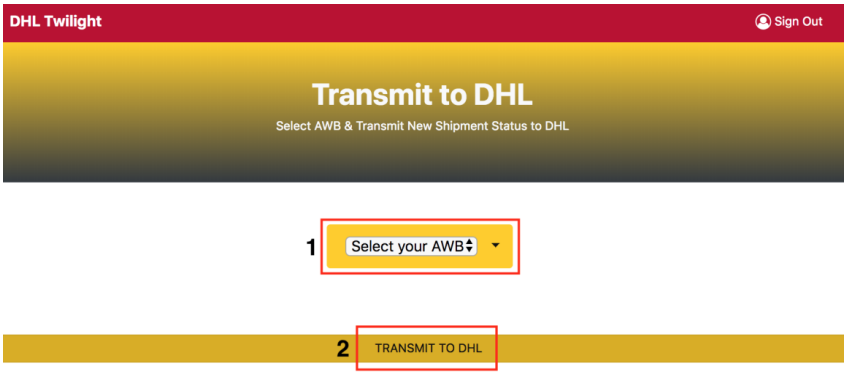
Allows users to update the delivery status of each AWB assigned to their account. All AWB numbers assigned to the user & have a status of 'With Courier' appear available in the 'Select AWB' dropdown and the default statuses 'Delivered' or 'Not Home' within the 'Select Checkpoint' dropdown.



Transmit to DHL

The final step to complete the DHL Twilight delivery process is transmit the new updates to DHL to appear on the Live www.dhl.com tracking page.

All shipments that have an updated status of 'Delivered' or 'Not Home' will appear available within the 'Select your AWB' dropdown'. The user can select the AWB they would like to send to DHL(1) and click on 'Transmit to DHL'(2) to send the update and complete the delivery;



Testing

During the final stages of development the DHL Twilight cloud application was put through a number of tests including UAT, Unit testing and Usability testing questionnaires to ensure the usability and functionality of the application was as expected and to aid further development. An iterative test methodolgy was applied to perform regular tests on the application code to ensure all functioanlity and scalability was as expected prior to releasing to the Live environment. The DHL twilight cloud application is for internal DHL employee use only therefore the volunteers participating were all members of the DHL IE Dublin HUB office.

Unit Testing

Iterative unit testing was performed throughout development ensuring all operations and functions were successful prior to migrating to the live envirnment by the developer. Addiotionally a series of full end to end unit tests was carried out by a DHL IE volunteer who tested all site functioanlities over 3 separate tests recording the results within the unit test plan provided marking each function as pass/fail providing comments when unexpected results returned;

	DHL Twilight UAT	
	Date	04/05/18
	Test Case #	1
	DHL Tester	Danny Bryan (DHL Express)

Test #	Test Case	Expected Result	Pass/Fail	Comments
1	Navigate to the *twilight-courier.com* homepage	DHL twilight Homepage is displayed	PASS	**Please enter details of failed test*
2	Click On Register Now	User is directed to the 'Registration' form	PASS	
3	Complete registration form without 'Name'	Error returned to user notifying that the 'Name' field is mandatory	PASS	
4	Complete registration form without 'Address'	Error returned to user notifying that the 'Address' field is mandatory	PASS	
5	Complete registration form without 'DHL Express Department'	Error returned to user notifying that the 'DHL Express Department' field is mandatory	PASS	
6	Complete registration form without 'DHL Express Staff Number'	Error returned to user notifying that the 'DHL Express Staff Number' field is mandatory	PASS	
7	Complete registration form without 'DHL eMail Address'	Error returned to user notifying that the 'DHL eMail Address' field is mandatory	FAIL	Email address not accepted
9	Complete registration form without 'DHL Twilight Password'	Error returned to user notifying that the 'DHL Twilight Password' field is mandatory	PASS	
10	Complete registration form with all mandatory fields complete	User successfully logs in and redirected to User Landing Page	FAIL	User credentials are not recognised on log in
11	Click on 'Sign Out'	User successfully signs out and is redirected to the DHL Twilight Home Page	PASS	
12	Click on 'Sign in'	User is redirected to the Sign in form	PASS	
13	Enter invalid email address	Error is displayed to user notifying that username/password is incorrect	PASS	
14	Enter invalid Password	Error is displayed to user notifying that username/password is incorrect	PASS	
15	Enter valid username & password	User successfully signs in and is redirected to the user landing page	PASS	
16	Click on 'Log New Shipments'	User is redirected to the 'Capure New Shipment' page	PASS	
17	Enter '1234567890' in 'Capture AWB' field & click 'Capture AWB'	AWB number and consignnee address displayed with status 'With Courier'	PASS	
18	Enter '2345678901' in 'Capture AWB' field & click 'Capture AWB'	AWB number and consignnee address displayed with status 'With Courier'	PASS	
19	Enter '3456789012' in 'Capture AWB' field & click 'Capture AWB'	AWB number and consignnee address displayed with status 'With Courier'	PASS	
20	Enter '4567890123' in 'Capture AWB' field & click 'Capture AWB'	AWB number and consignnee address displayed with status 'With Courier'	PASS	
21	Enter invalid AWB number '000'	AWB, address and status not found and not added to list below	PASS	
22	Click on 'Plot Route'	User is redirected to the 'Plot Route' page. All captured AWB numbers and addresses are displayed in list and Google Maps UI showing waypoints	PASS	
23	Click 'Add more shipments'	User is redirected back to the 'Capture New Shipment' page	PASS	
24	Enter '5678901234' in 'Capture AWB' field & click 'Capture AWB'	AWB number and consignnee address added to the list with status 'With Courier'	PASS	
25	Click 'Plot Route'	User is redirected to the 'Plot Route' page. New captured AWB number and address is added to the list and Google Maps UI waypoint	PASS	
26	Click 'Update Checkpoint'	User is redirected to the 'Update Checkpoint' page	PASS	
27	Select AWB '1234567890' from the 'Select AWB' dropdown list	AWB 1234567890 populates the 'Select AWB' dropdown box	PASS	
28	Select Delivered from the 'Select Checkpoint' dropdown list	Delievered' populates the Update Checkpoint dropdown box	PASS	

Unit Test Case 1 | Unti Test Case 2 | Unit Test Case 3 | Sheet2

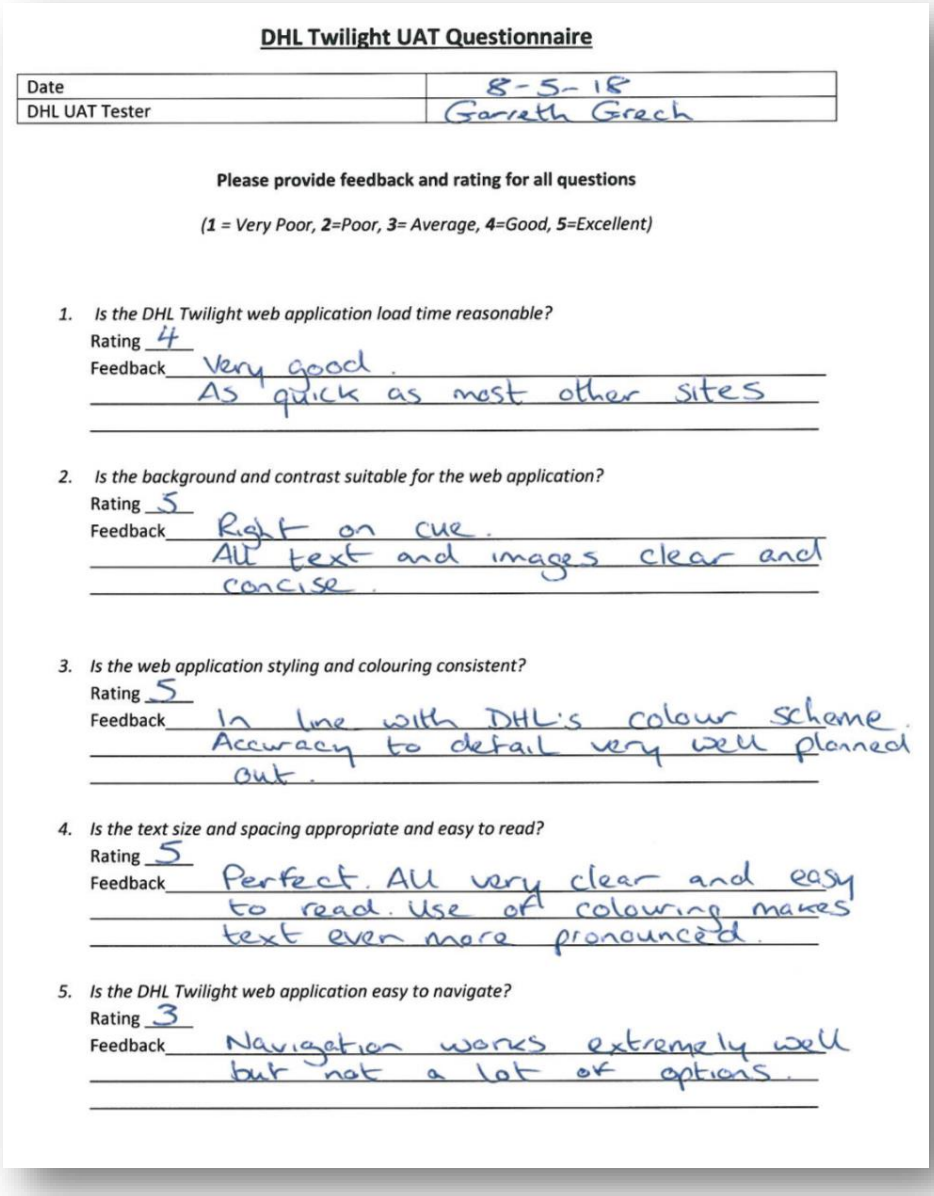
DHLTwilight_TestCases.xlsx

Based on the results from the unti test cases carried out by the DHL volunteer amendments and bug fixes were applied to the application.

Usability Testing

To test the usability of the DHL Twilight cloud application and assess the look, feel and business relvance two DHL IE volunteers participated in navigating through the application and completing a questionnaire to gauge user feedback;

Sample snapshot of questionnaire result;



DHL Twilight UAT Questionnaire

Date	8-5-18
DHL UAT Tester	Gareth Grech

Please provide feedback and rating for all questions

*(**1** = Very Poor, **2**=Poor, **3**= Average, **4**=Good, **5**=Excellent)*

1. *Is the DHL Twilight web application load time reasonable?*
   Rating 4
   Feedback Very good. As quick as most other sites

2. *Is the background and contrast suitable for the web application?*
   Rating 5
   Feedback Right on cue. All text and images clear and concise.

3. *Is the web application styling and colouring consistent?*
   Rating 5
   Feedback In line with DHL's colour scheme. Accuracy to detail very well planned out.

4. *Is the text size and spacing appropriate and easy to read?*
   Rating 5
   Feedback Perfect. All very clear and easy to read. Use of colouring makes text even more pronounced.

5. *Is the DHL Twilight web application easy to navigate?*
   Rating 3
   Feedback Navigation works extremely well but not a lot of options.

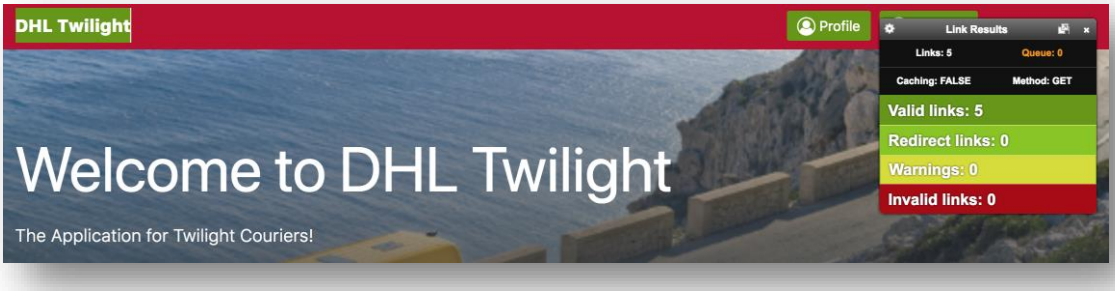
Please find the DHL IE volunteers fully completed Usability questioannires in Appendix A & B.

The questionnaires provided valuable feedback confirming the design, flow, features and usability to be suitable for the DHL Twilight application and purpose.

Check My Links

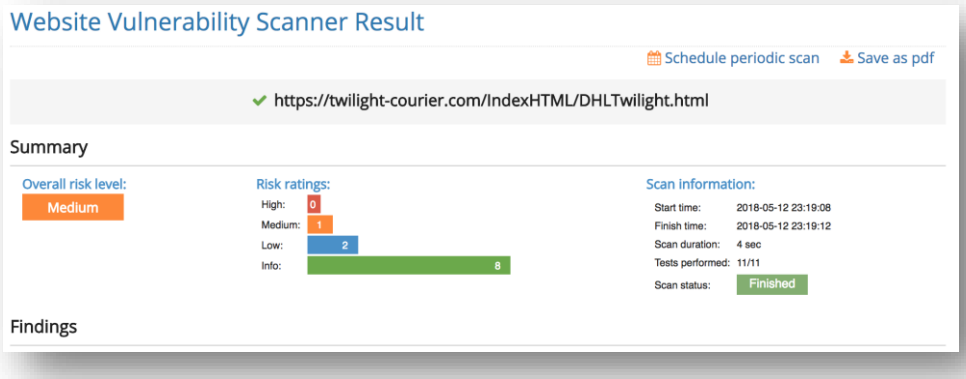
The Chrome plug 'Check My Link' provides a feature for checking all links on a web page. This application was used across all site pages returning a 100% valid link return ensuring that all links contained within the DHL Twilight cloud application are valid and accurately redirecting.

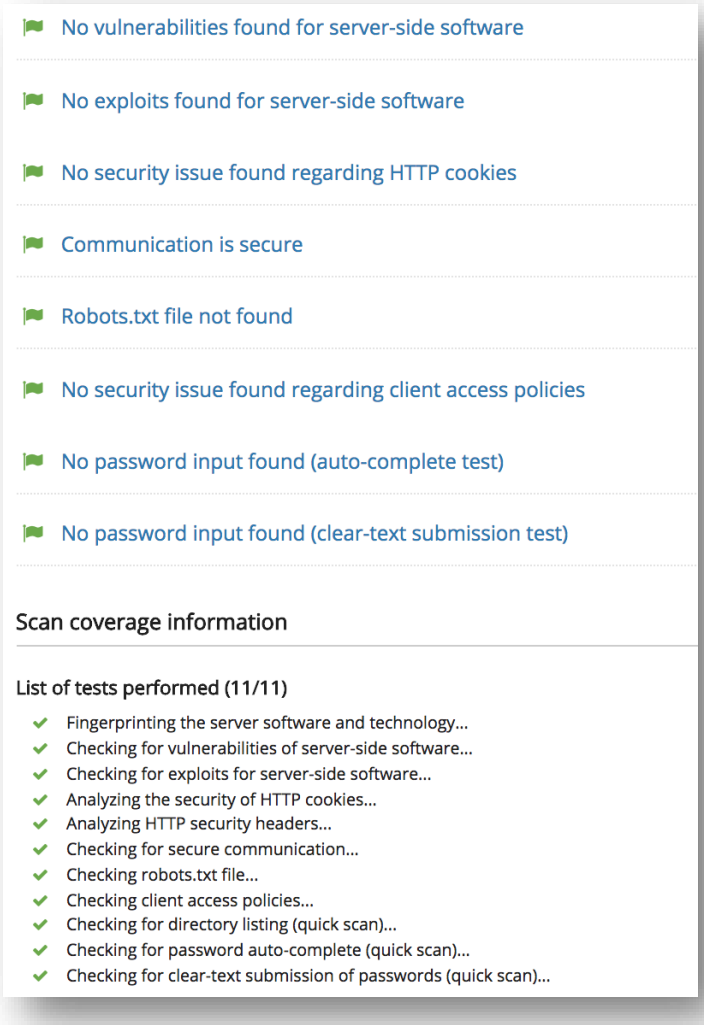
Example of Check My Links validating links on the User Landing Page;



Penetration Testing

Penetration testing was performd on the application using the Pentest-Tools.com website, https://pentest-tools.com/website-vulnerability-scanning/web-server-scanner?run. The Pentest-Tools.com ran a series of vulnerability scans against the application site to check for potential weaknesses;





The penetration testing confirmed that there were no major vulnerabilities with the website.

Evaluation

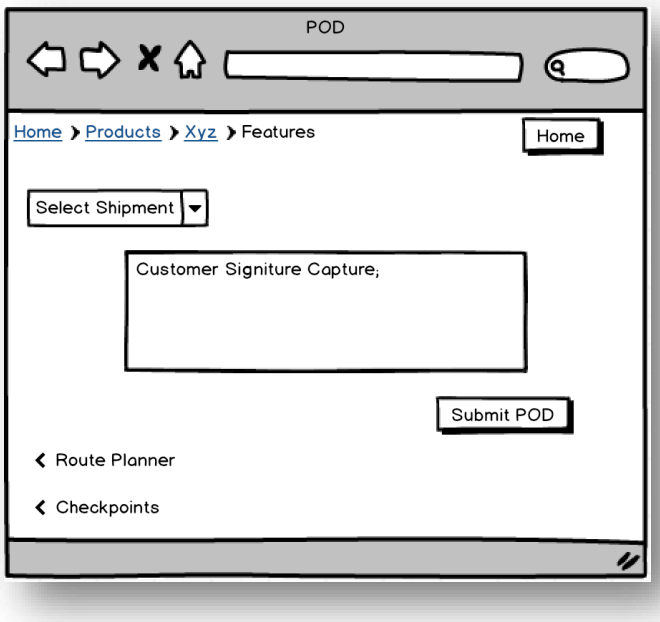
The DHL Twilight cloud application was delivered in accordance with the Project Proposal and Technical Requirements specifications. The intiation and planning stages of the DHL Twilight cloud application provided a firm foundation to develop a fully functioning application meeting all requirements and funtionality as expected and meeting deliverables. The GUI and site navigation delivered kept close to the GUI wireframes outlined during the Project Plan (Appendix F, pages 146-150) as did the required functional requirements detailed within the mid Point Technical Report Requirements specification(Appendix G, pages 120-137).

Challenges

During development a number of updates to the original application UI and funtional implementation were applied to provide a smoother user interface and the required functionality.

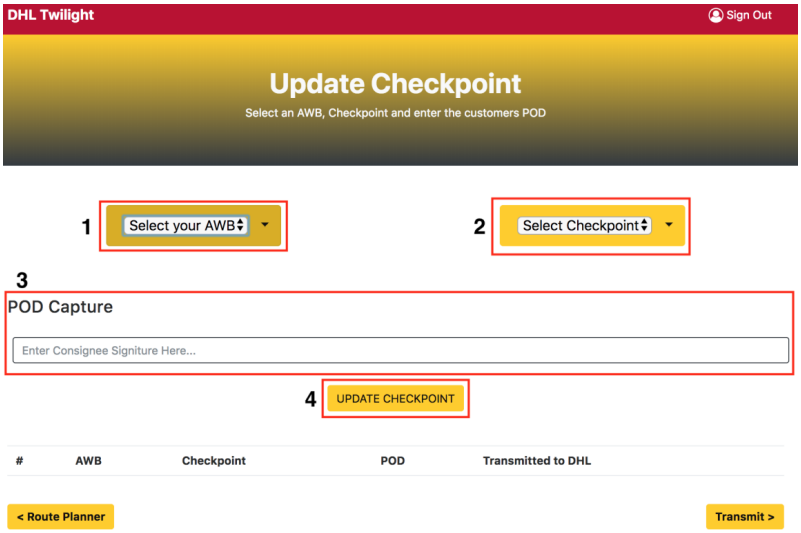
POD Capture

The original idea for capturing the customers name on receipt of delivery was to provide a separate page after the checkpoint update specifically entitled POD. This page would provide a text window for capturing the POD only and adding against the AWB (Appendix F, page 149).



After consideration and looking at the flow of the DHL Twilight delivery cycle it was decided that seperating the POD capture was uneccessary and over complicated the process. The POD capture logically is completed at the same stage as the checkpoint update therefore integrating the POD capture into the Checkpoint Update page provided the user an easier platform with which to perform all shipment updates at the same time rather than having to navigate back and forth through the application.

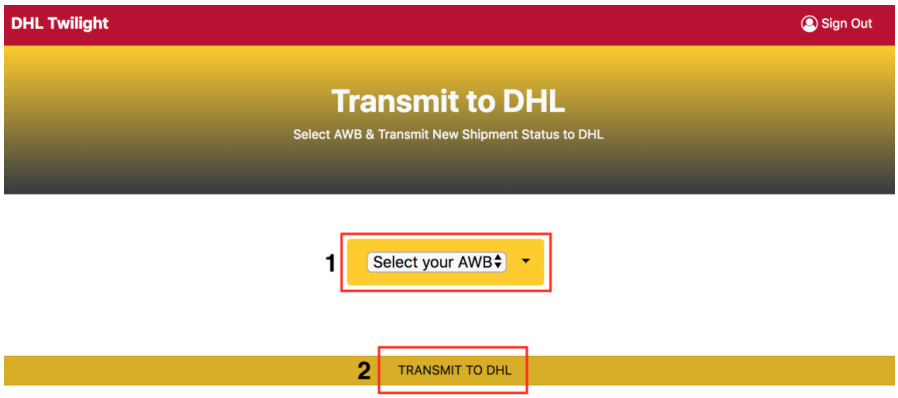
The final version of the DHL Twilight cloud application show the POD capture form embedded as part of theUpdate Checkpoint stage.



Transmit To DHL

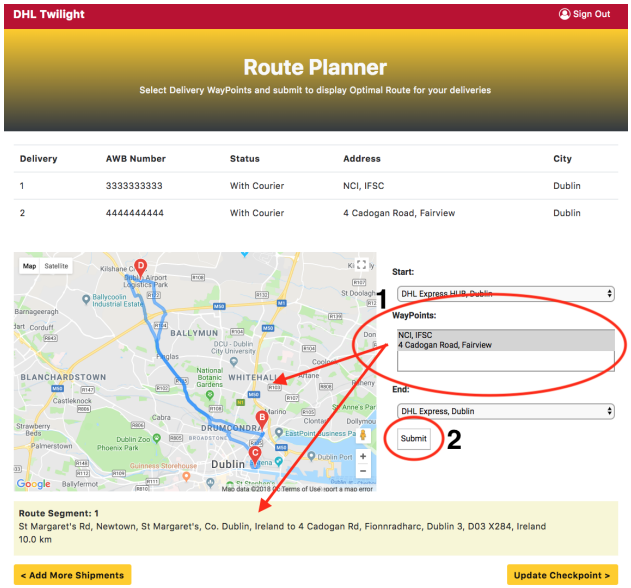
On completion of the DHL Twilight shipment delivery the data captured and updates need to be transferred back to the DHL network to provide live tracking visibility at the www.dhl.ie tracking website. In order to successfully transfer the data in the most efficient manner it was decided that an update of an AWB status should only be sent once to DHL containing all data rather than sending each update seperately.

To achieve this it was decided to add a final stage to the DHL Twilight application entitled 'Transmit to DHL'. This page allowed the user to select the AWB to complete and send the update to DHL containing delivery status, POD and date/time stamp of update. Prior to this addition the updates were planned to be sent individually to DHL during each step of the DHL Twilight delivery process, this would not have been feasible as the DHL DCG integration required all shipment data to successfully load the update in to the DHL network.



Route Planner

The implementation of the optimised route planner is a key component of the DHL Twilight cloud application providing users the optimal route to carrry out their deliveries. During project scope it was proposed that the travelling salesperson problem would be researched and a genetic algorithm developed to deliver an optimised route for deliveries based on randomising the search parmeters. After extensive research in to this area and studying the requirement for the DHL Twilight application the Google Maps Waypoint JS API is designed to tackle the travelling salesperson problem. It was therefore decided to implement the Google Maps Waypoint JS API configured to optimise the route for up to 23 locations based on Time and distance. Using the Google Maps Waypoint JS API enabled the Route Planner requirement to be fulfilled whilst providing the desired logic and UI.



Innovation

"Innovation can be defined simply as a "new idea, device or method"

(Merriam-webster.com, 2018)

"Innovation is often also viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs."

(Maranville, 1992)

The DHL Twilight cloud application was designed to meet the business defined market need, to develop a new method of addressing a growing business problem. It provides a scalable courier delivery platform to enable ad-hoc shipment delivery and relay the shipment status back to the live DHL network without the need, and extra cost, of supplying DHL scanners to each part time DHL Twilight courier. Identifying a real life businnes need and impementing a solution that enables all DHL employees to assist the delivery of packages past the standard DHL opertaing hours and adhance the DHL

delivery network. The DHL Twilight cloud application fulfils its requirements in both providing this platform fully scalable across multiple platforms and providing full shipment tracability/visibility.

Completeness

The DHL Twilight cloud application was completed in full providing all functionality as outlined within the Project Proposal and Technical Report. The full end to end process was delivered allowing a scalable platform to allow DHL Twilight couriers to;

- Register with their DHL staff number
- login with their unique credentials,
- capture the AWB(Airwaybill) tracking number on a label,
- review the destination address,
- view an optimal route planner for their deliveries,
- update the status/checkpoint of each shipment
- assign POD / customer name to AWB tracking number
- send updated tracking events to DHL customer gateway (DCG)
- view user shipment history with advanced search filter
- view user profile

Difficulty

There were many technologies used and challenges to deliver the DHL Twilight cloud application. Identifying the business need and scoping the initial concept required thorough investigation, planning and meetings with DHL Operations management to ensure all requirements were captured and the methodologies that would be required to deliver the application. During implementation a number of challeneges and detailed developments were required to enable a clear platform and a logically sound process flow through the delivery cycle. A number of core functional requirements were delivered including;

- Suitable Cloud Hosting Environment
- Secure Login

- Relevent data storage and retrieval
- Optimised Route Planner
- DHL DCG Integration
- Live DHL www.dhl.ie tracking updates

All the above functionalities form the basis of the DHL Twilight cloud application providing significant technological and logical challeneges.

System Evolution

The DHL Twilight applications initial development is scaled for DHL Express employees within the Dublin area in Ireland only. This release of the application and its controlled environment will provide the foundations for layering complexity to the current build to further its geographic reach. The next step for the application would be to roll out to further DHL Express Ireland Hubs in a phased approach with a view to have the application available to all DHL employees across Ireland.

Additional features in scope for future development of the DHL Twilight application are;

- Barcode scanner to capture the AWB number
- Digital signiture capture to allow customer signiture to device
- Integration with DHL customer DB. Allow customer data to be pulled directly from the DHL network. On scan of the AWB barcode the address information is also read.
- All checkpoints. Adding additional checkpoints to the application allowing for the potential to complete end to end pickup-delivery
- Expanding the network to customers allowing ad-hoc collections. Adding an interactive map to display all registered DHL Twilight couriers and their current location. Customers can request a collection from one of the roaming DHL Twilight couriers.

Based on the above potential evolution areas there are a number of directions the application can grow towards. The application could be kept in house for employee use only and therefore building on the existing functionality to capture all requirements of a full shipment collection-delivery lifecycle. This would allow for the application to be rolled out across all couriers, both daytime and Twilight, replacing the current scanners that are used with a unit cost of approximately €1,500.
An alternative and more innovative route would be to expand the application to the outside market allowing customer access to view an interactive map showing all available DHL Twilight couriers locations and arranging for ad-hoc collections directly with the Twilight courier. This would be coupled with extending the DHL Twilight courier application to register the couriers "active" GPS location and receive incoming requests for collections to accept or decline.

All the above future evolutions for the application are feasible but the initial release of the DHL Twilight application within a controlled limited environment will provide vital information on the functionality and current model.

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Appendices

Appendix A – Usability Questionnaire 1

DHL Twilight UAT Questionnaire

Date	8-5-18
DHL UAT Tester	Garreth Grech

Please provide feedback and rating for all questions

*(**1** = Very Poor, **2**=Poor, **3**= Average, **4**=Good, **5**=Excellent)*

1. *Is the DHL Twilight web application load time reasonable?*
   Rating 4
   Feedback Very good. As quick as most other sites

2. *Is the background and contrast suitable for the web application?*
   Rating 5
   Feedback Right on cue. All text and images clear and concise.

3. *Is the web application styling and colouring consistent?*
   Rating 5
   Feedback In line with DHL's colour scheme. Accuracy to detail very well planned out.

4. *Is the text size and spacing appropriate and easy to read?*
   Rating 5
   Feedback Perfect. All very clear and easy to read. Use of colouring makes text even more pronounced.

5. *Is the DHL Twilight web application easy to navigate?*
   Rating 3
   Feedback Navigation works extremely well but not a lot of options.

6. *Are the DHL Company logos clear and well positioned?*
   Rating 5
   Feedback Perfect. Page Layout is finished to a high standard.

7. *Does the landing page provide adequate and concise information about the web application and its functionalities?*
   Rating 4
   Feedback Could have a little more information.

8. *Are all menus and labels clearly defined and easily navigated?*
   Rating 4
   Feedback Yes though not to many on homepage.

9. *Is the Company logo and homepage easily accessed?*
   Rating 5
   Feedback Yes.
   Even through the DHL Twilight button home page can be reached from all locations

10. *Are all links well located and accurately labelled?*
    Rating 4
    Feedback Yes.
    There could be more though on the homepage.

11. *Are all HTML page titles are relevant?*
    Rating 5
    Feedback Yes.
    Each page has clear displays of the HTML reference.

12. *Was the registration form easy and simple to complete?*
    Rating 4
    Feedback Yes though did have a couple of issues with password entry.

13. *Was it easy and clear to navigate forward and back through the Log New Shipments process?*
Rating 4
Feedback Very easy and straight forward.

14. *Does the Google Maps API provide accurate and detailed directions to all the captured AWB shipment delivery addresses?*
Rating 5
Feedback Excellent. Pin point accuracy Route planner works brilliantly

15. *Is the Google Maps API adequately sized and directions clearly visible?*
Rating 5
Feedback Yes. All locations easily visible and directions concise

16. *Would you recommend the DHL Twilight web application to other DHL employees?*
Rating 5
Feedback Yes. Great tool which works well in the real world!!

17. *What rating would you give the DHL Twilight web application overall?*
Rating 5
Feedback Overall it does exactly what its supposed do and looks sleek.

18. *Is there anything that you believe is missing from the DHL Twilight web application?*
Rating 4
Feedback Only thing would be some more links to other DHL tools / applications.

Signed Gareth Greech
Print Name GARRETH GREECH Date: 8-5-18

Appendix B – Usability Questionnaire 2

DHL Twilight UAT Questionnaire

Date	**09/05/2018**
DHL UAT Tester	**Danny Bryan**

Please provide feedback and rating for all questions
*(**1** = Very Poor, **2**=Poor, **3**= Average, **4**=Good, **5**=Excellent)*

1. *Is the DHL Twilight web application load time reasonable?*
   Rating _5___
   Feedback: web page loaded as expected
   _____
   _____
   _____

2. *Is the background and contrast suitable for the web application?*
   Rating _5___
   Feedback: good contrast and use of colour. Images using correct ratio on both mobile and web app.
   _____
   _____
   _____

3. *Is the web application styling and colouring consistent?*
   Rating __4___
   Feedback: colours are consistent images are not, but they are good use of the images..
   _____
   _____
   _____

4. *Is the text size and spacing appropriate and easy to read?*
   Rating __5___
   Feedback_very good use of text as it is consistent in colour, font and size.
   _____
   _____
   _____

5. *Is the DHL Twilight web application easy to navigate?*
   Rating __4___
   Feedback_____
   _____
   _____

6. *Are the DHL Company logos clear and well positioned?*
   Rating _5___

Feedback: yes well positioned and good ratio.

_____
_____
_____

7. *Does the landing page provide adequate and concise information about the web application and its functionalities?*

   Rating __4___
   Feedback: yes but it required a scroll before reading. Landing image should be slightly smaller in this case.

   _____
   _____
   _____

8. *Are all menus and labels clearly defined and easily navigated?*

   Rating __5___
   Feedback: yes I cannot see any other wording needed for these labels.

   _____
   _____
   _____

9. *Is the Company logo and homepage easily accessed?*

   Rating __5___
   Feedback: as above, yes all logos and homepages are clearly defined.

   _____
   _____
   _____

10. *Are all links well located and accurately labelled?*

    Rating __3___
    Feedback: within the Capture new shipment screen some button styles / Drop down menus are different to the rest

    _____
    _____
    _____

11. *Are all HTML page titles are relevant?*

    Rating __5___
    Feedback: yes all webpage names make sense for navigation

    _____
    _____
    _____

12. *Was the registration form easy and simple to complete?*

    Rating __5___
    Feedback: yes only relevant info was captured.

    _____
    _____
    _____

13. *Was it easy and clear to navigate forward and back through the Log New Shipments process?*
    Rating __3__
    Feedback: no if capture AWB did not work it would not provide an error and you would need to use the back button in the browser.
    _____
    _____
    _____

14. *Does the Google Maps API provide accurate and detailed directions to all the captured AWB shipment delivery addresses?*
    Rating __5__
    Feedback: yes correct pin point was returned as per the address provided.
    _____
    _____
    _____

15. *Is the Google Maps API adequately sized and directions clearly visible?*
    Rating __4__
    Feedback: when multiple addresses are in waypoint box it would be difficult for a user to understand they need to click ctrl and down to select many options.
    _____
    _____
    _____

16. *Would you recommend the DHL Twilight web application to other DHL employees?*
    Rating __5__
    Feedback: yes overall it is a good app with a great concept behind it.
    _____
    _____
    _____

17. *What rating would you give the DHL Twilight web application overall?*
    Rating __4.5__
    Feedback: overall it is a good app minor tweeks would give it a 5. No showstoppers.
    _____
    _____
    _____

18. *Is there anything that you believe is missing from the DHL Twilight web application?*
    Rating ____
    Feedback: no, the app does as expected.
    _____
    _____
    _____

Signed_____
Print Name: DANNY BRYAN _____ Date: 10.05.2018 _____

Appendix C – DHL IE Marketing Approval

From: Ciara Hynes (DHL IE) **Sent:** Friday 1 December 2017 15:58 **To:** Patrick King (DHL IE) **Subject:** RE: College Project

No problem, as it is only an internal college project this is grand Pat

Ciara

From: Patrick King (DHL IE) **Sent:** 01 December 2017 15:13 **To:** Ciara Hynes (DHL IE) **Subject:** RE: College Project

The web app is just a concept idea that will be mimicking some of the functions performed by a courier scanner, updating checkpoints and plotting routes. Looking to use the DHL logo and the red & yellow colours for the colour theme throughout the site, so background etc.

Patrick

From: Ciara Hynes (DHL IE) **Sent:** Friday 1 December 2017 15:08 **To:** Patrick King (DHL IE) **Subject:** RE: College Project

Hi Pat,

What would the web application be? Did you want to use the logo or just colours?

Thanks
Ciara

From: Patrick King (DHL IE) **Sent:** 01 December 2017 09:41 **To:** Ciara Hynes (DHL IE) **Subject:** College Project

Hi Ciara,

For my 4th Year College project I am creating a Web Application and I want to use DHL branding and colours etc. This is for my college project only and not for release, is it ok to use DHL branding/colours?

Regards
Patrick King

Appendix D – Supervisor Meetings

From: Keith Maycock
Sent: 29 January 2018 17:52:26
To: Bruno Guedes; Nuth Sirikitiwannakul; Patrick King; Deniss Strods
Subject: Re: Meeting software project

Hi Guys,

I hope you enjoyed the Christmas break. I would like to meet you this Thursday evening at 5pm if possible at NCI. I will send out a room location as soon as you get back to me with your availability.

Thanks,

Keith

Dr Keith Maycock,

Lecturer 2,
School of Computing,
National College of Ireland.

From: Keith Maycock
Sent: 31 January 2018 16:22
To: Nuth Sirikitiwannakul; Bruno Guedes
Cc: Deniss Strods; Patrick King
Subject: Re: Meeting software project

Hi Guys,

Apologies but we need to move our meeting back until next Tuesday the 6th of February at 5pm. I hope this suits.

Can you mail me back to make sure I know that you have received the change in date.

Kind Regards,

Keith

Dr Keith Maycock,

Lecturer 2,
School of Computing,
National College of Ireland.

From: Keith Maycock
Sent: 31 January 2018 09:17:12
To: Nuth Sirikitiwannakul; Bruno Guedes
Cc: Deniss Strods; Patrick King
Subject: Re: Meeting software project

Hi Guys,

Thanks for your responses. The meeting will just be held in my office from 5. As you are arriving at slightly different times I can use this to have a deep look at your individual progress.

Patrick, I will be scheduling a regular meeting for every second week on Tuesday evenings to make sure that we keep in regular contact.

Thanks Guys,

Kind Regards,

Keith

Dr Keith Maycock,

Lecturer 2,
School of Computing,
National College of Ireland.

Accepted: Final Year Projects

PK Patrick King
Tue 06/03, 11:09
Keith Maycock

Reply all

When: Tue 13/03/2018 17:00 - 18:30
Where: 3.15

Patrick King has accepted this event

Sent Items

National College of Ireland

BSc in Computing

2017/2018

User Manual

Submitted in fulfilment of the BSc in Computing at the National College of Ireland.

Patrick King

Student Number: 14113970

Supervised by Dr. Keith Maycock

May 2018

Table of Contents

Introduction

This document provides a user manual to guide users through the DHL Twlight application, how to access and perform all site functionalities.

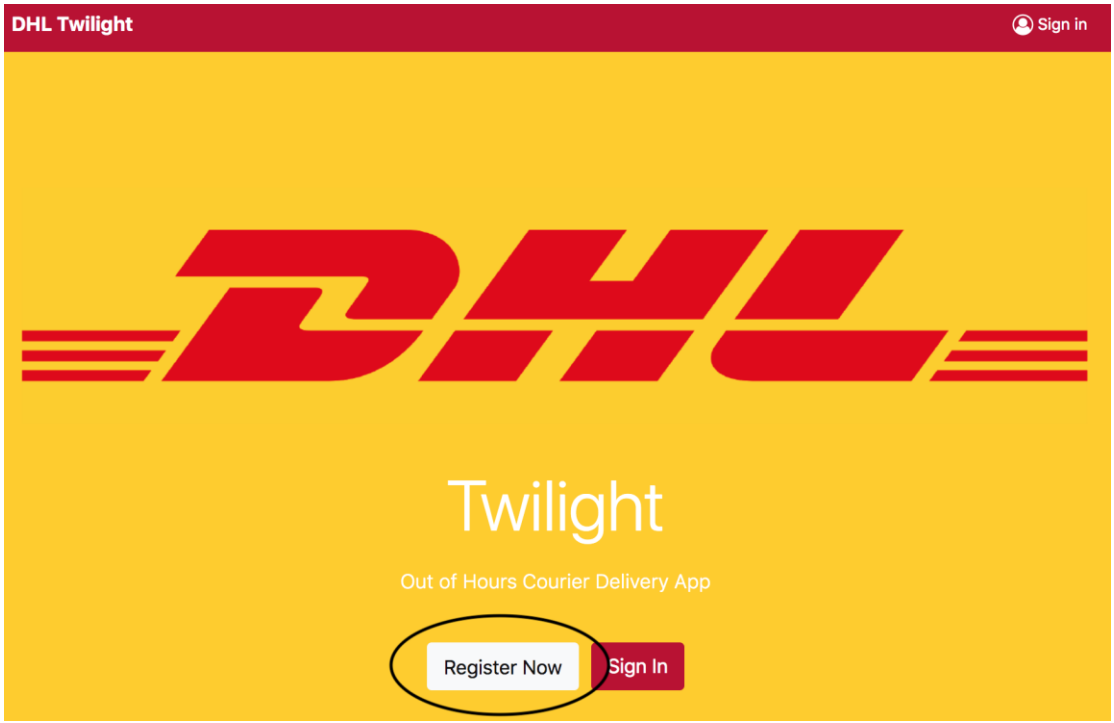
DHL Twilight URL

The DHL Twilight cloud application can accessed through the below URL;

Twilight-courier.com

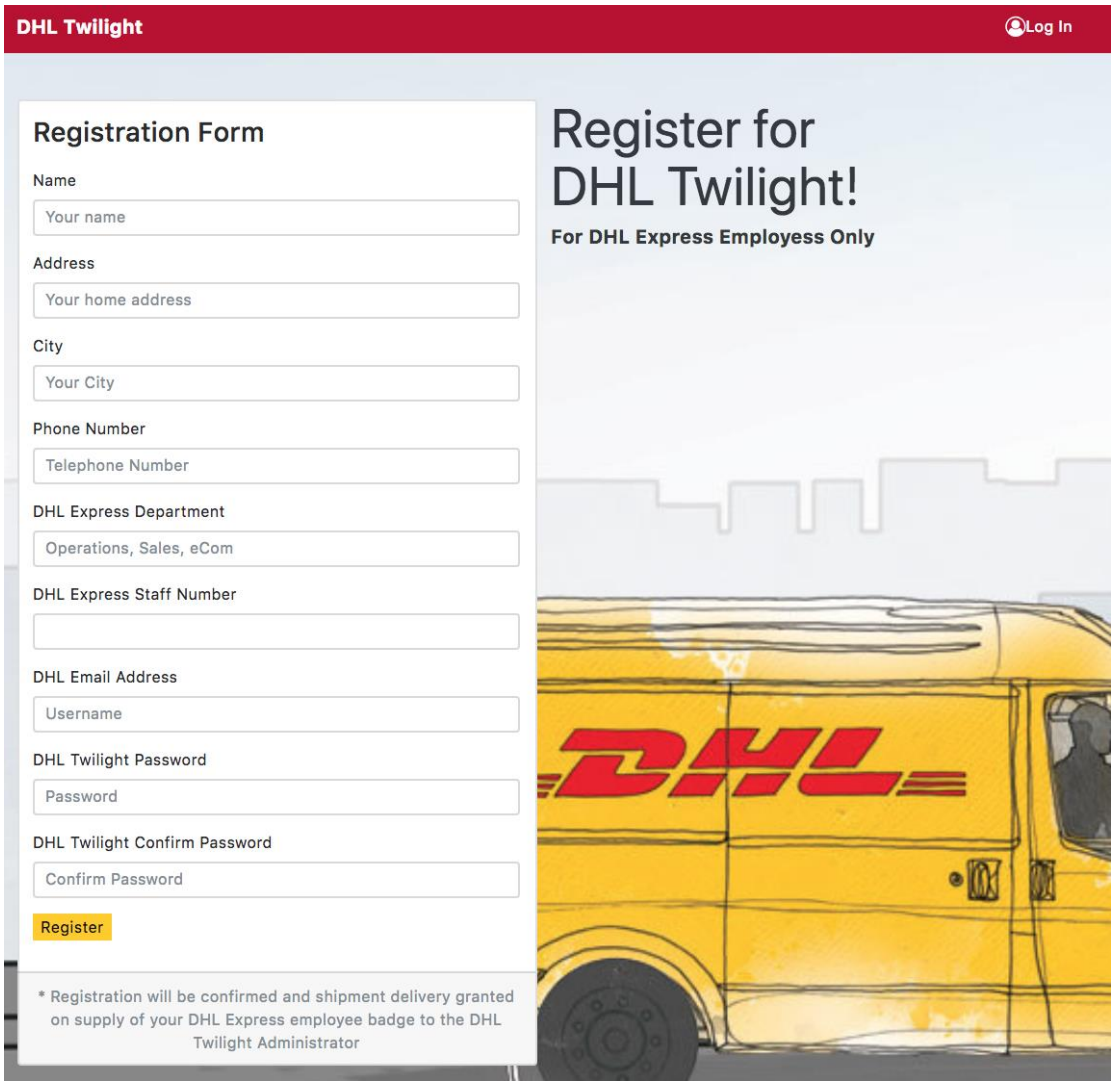
DHL Twilight HomePage

The DHL Twilight Homepage provides a summary of the application and entry points to register or sign in. New users should click on the 'Register Now' button located in the centre of the homepage;



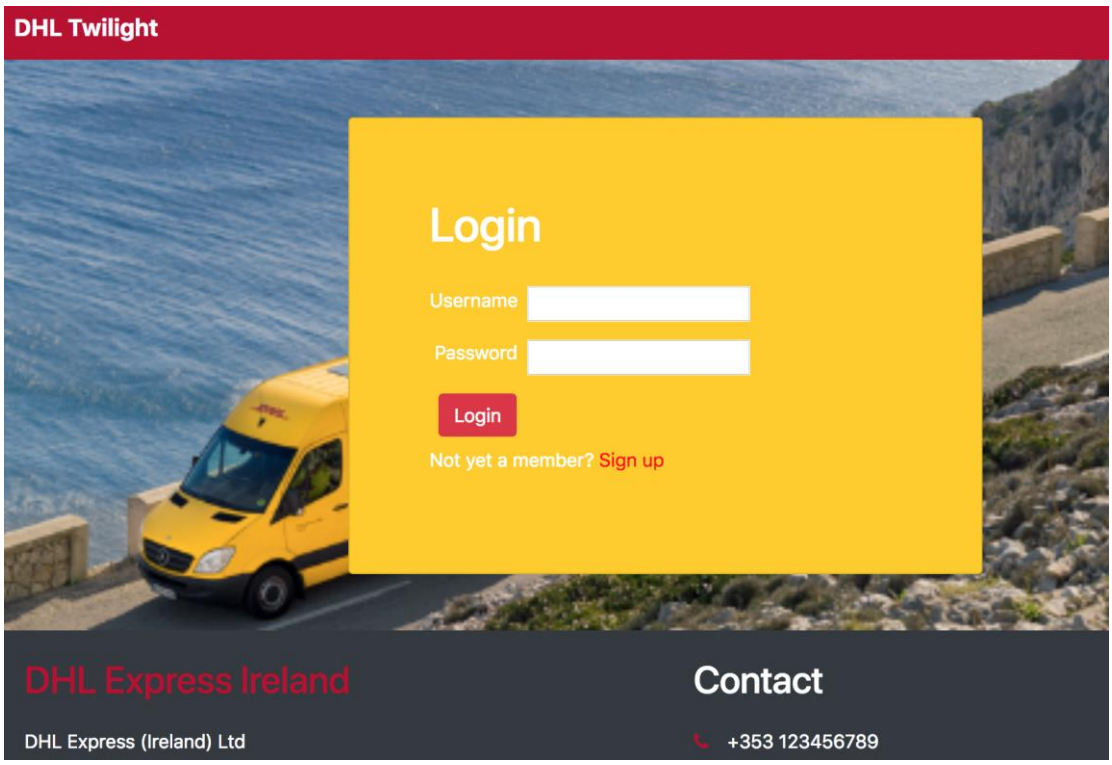
Registration

The registration form requires all fields to be completed including a unique Email address & 4 digit Staff Number (for testing purposes any 4 digit number not assigned can be used). Once all fields are complete please click on 'Register' to complete registration and be directed to the LogIn page;



Login

Once successfully registered you will be redirected to the 'Login' page where youo can enter your registered Email address and password;



*If you do not wish to register you can use the test credentials already setup;

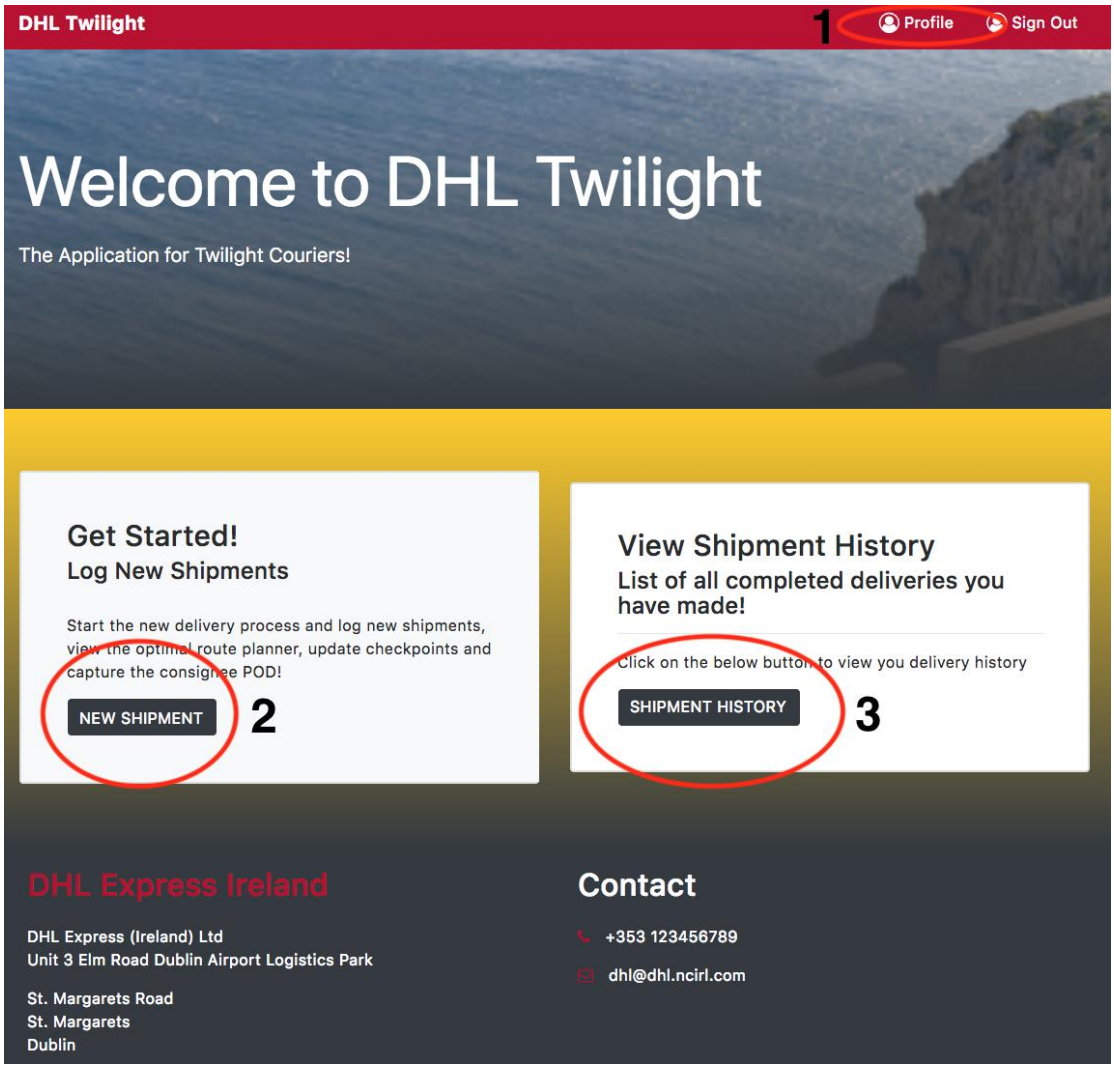
Username = test@test.com

Password = test

User Landing Page

On successful login you will automatically redirected to your user landing page that provides the user with the options to;

4. View Profile
5. **New Shipments**
6. Shipment History



2. New Shipment

To begin the Twilight Courier delivery click on 'New Shipment' to be directed to the first step, 'Capture Shipment'.

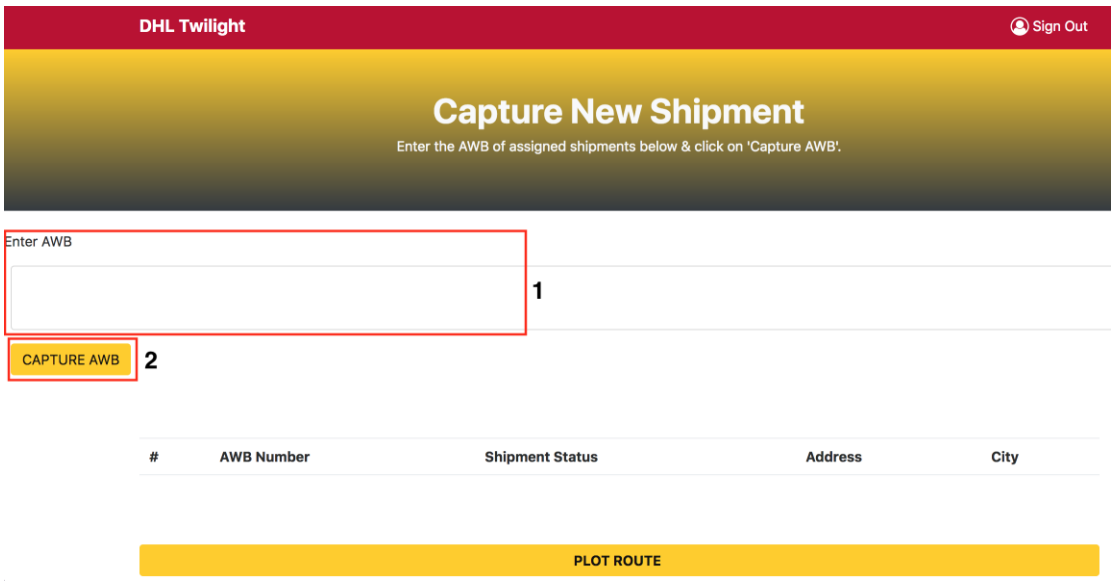
Capture Shipment

The capture shipment page allows users to assign AWB (AirWayBill / Shipment tracking numbers) to their account.

For testing purposes please use at least one of the below Live DHL test AWB numbers;

1. 1596613476
2. 1596613480
3. 1596613491
4. 1596613502
5. 1596613513
6. 1596613524
7. 1596613535
8. 1596613546
9. 1596613550
10. 1596613561

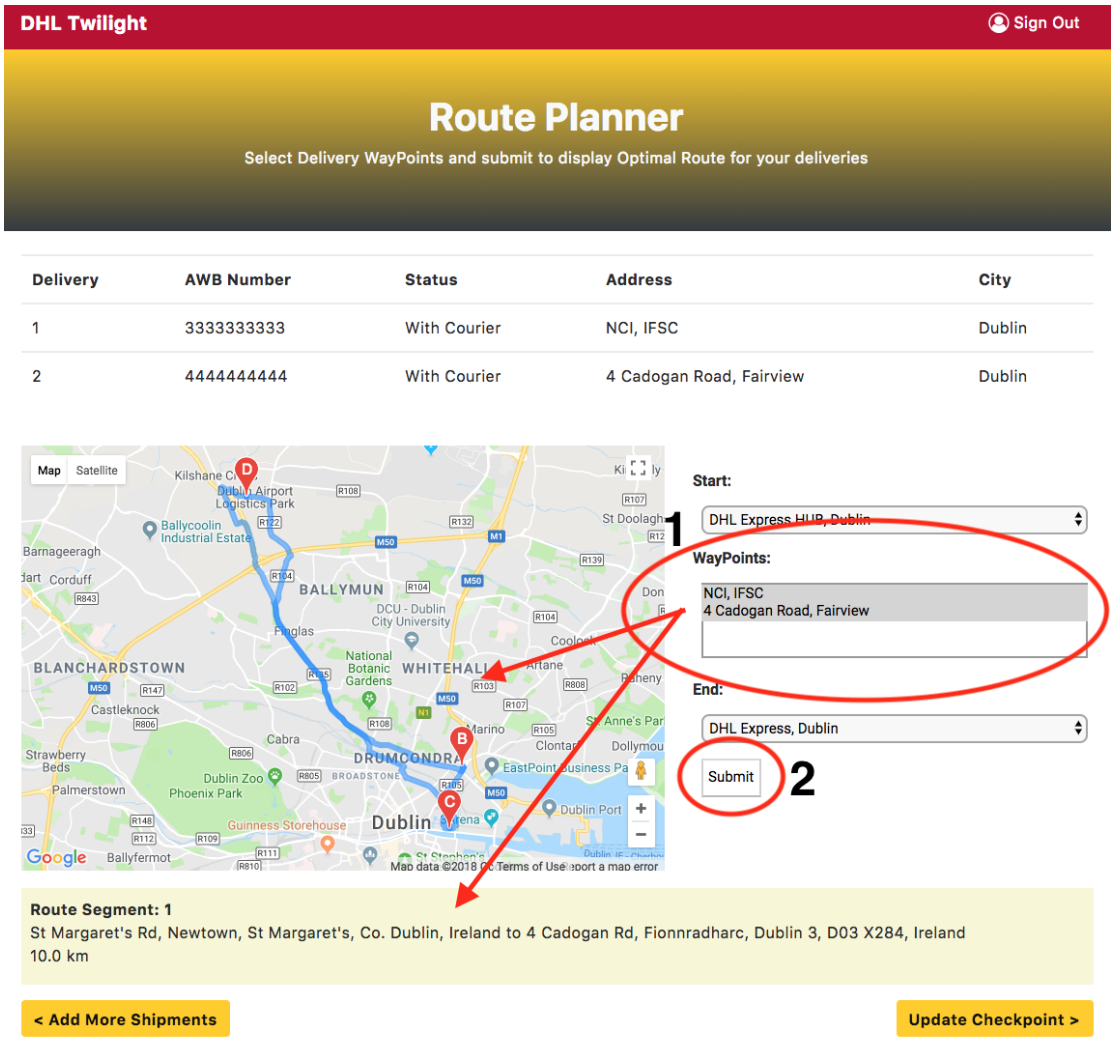
Enter each of the above AWB numbers one at a time in to the 'Enter AWB' text box(1) and click 'Capture AWB'(2) to assign AWB to your account;



Once you have captured all AWB numbers please click on 'Plot Route' to navigate to the next step.

Plot Route

All captured shipments assigned to your account and 'With Courier' status are dislayed. To display the optimal route for your deliveries please select all addresses within the 'Waypoints' panel located on the left of the Map(1). For selecting multiple addresses please hold down ctrl/cmd and click each address then click submit(2) to display the optimal route for assigned selected deliveries and the Route Segment detailing each waypoint route by text ;

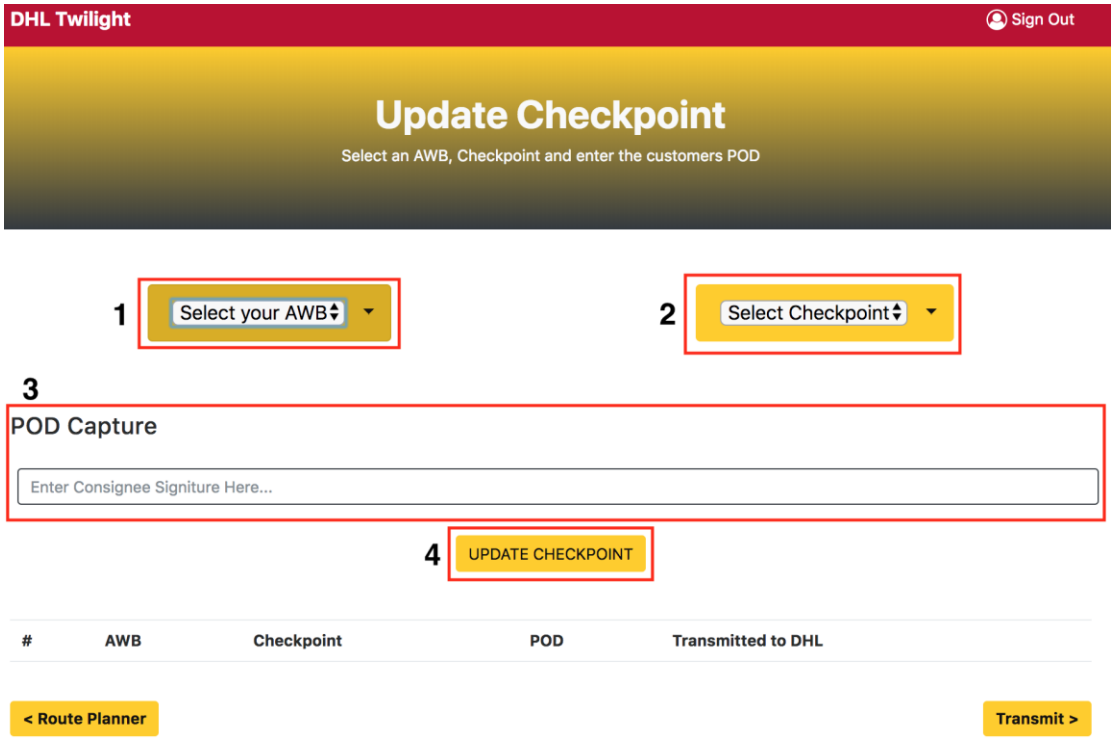


Once you have reviewed the Optimal Route for deliveries please click on 'Update Checkpoint'.

Update Status

Allows users to update the delivery status of each AWB assigned to their account. All AWB numbers assigned to the user & have a status of 'With Courier' appear available in the 'Select AWB' dropdown and the default statuses 'Delivered' or 'Not Home' within the 'Select Checkpoint' dropdown.

To update an AWB status select the AWB from the 'Select AWB' dropdown(1), the new checkpoint from 'Select Checkpoint' dropdown(2) and enter the name of the customer who took receipt of the shipment into the 'Capture POD' text box(3). Please note the 'Capture POD' is only required for AWBs that have been delivered. Finally click on 'Update Checkpoint' to submit the AWB delivery status.



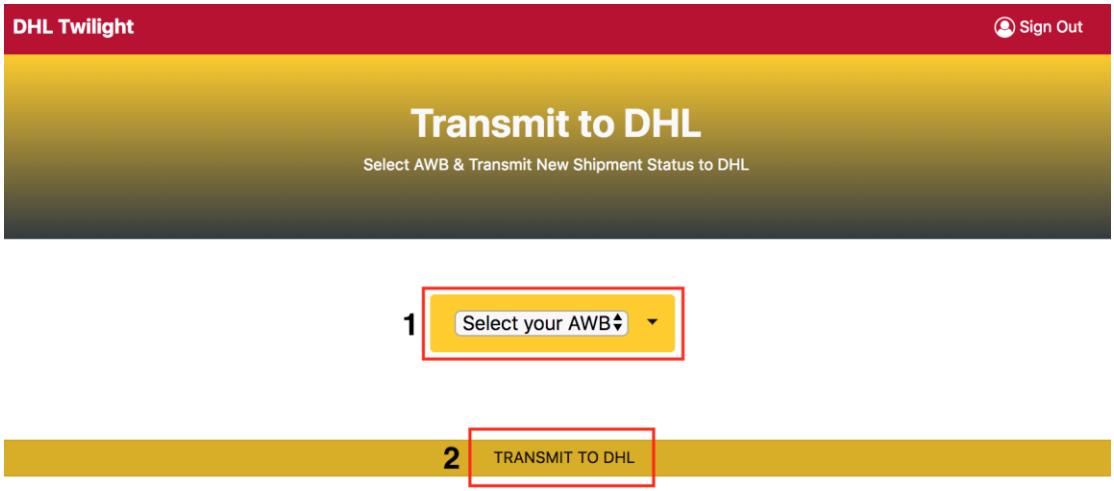
Once the AWB has been updated the AWB and new status will be displayed below with a default value of 'No' for "Transmitted to DHL'.

To complete the DHL Twilight delivery cycle please click on the 'Transmit' button.

Transmit to DHL

The final step to complete the DHL Twilight delivery process is transmit the new updates to DHL to appear on the Live www.dhl.com tracking page.

All shipments that have an updated status of 'Delivered' or 'Not Home' will appear available within the 'Select your AWB' dropdown'. Select the AWB you would like to send to DHL(1) and click on 'Transmit to DHL'(2) to send the update and complete the delivery;



Track your shipment at www.dhl.ie

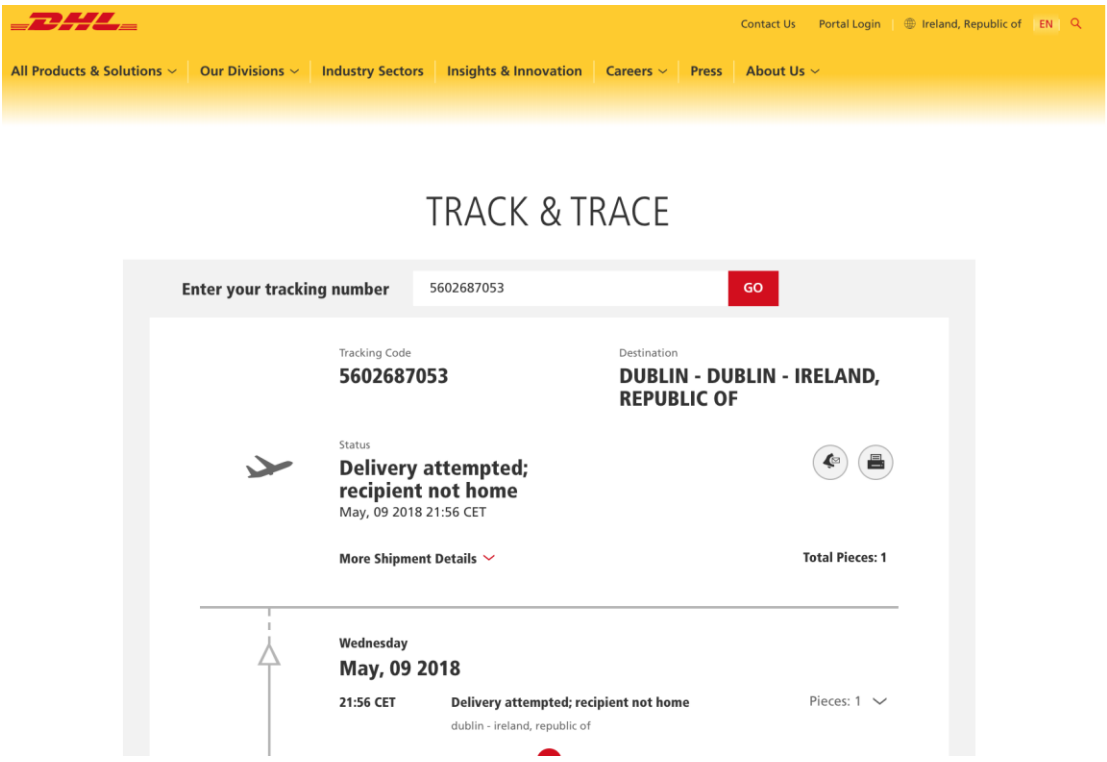
Once the above Twilight delivery process steps have been completed and the AWB status update Transmitted to DHL customers can view the new delivery status of their shipment on the Live www.dhl.ie website;

To track a shipment please click on the below link;

https://www.logistics.dhl/ie-en/home/tracking.html

Enter the AWB number of a recently completed DHL Twilight Delivery to display the latest updates;

Eg.



Project Proposal

Final Project submitted in partial fulfillment of the BSc in Computing at the National College of Ireland.

Patrick King
Student No: 14113970
Supervised by Dr. Keith Maycock
October 2017

Table of Contents

Introduction

This document provides an in-depth analysis of my final year software project. It details the proposal of an application along with the methods, techniques and project plan to meet all requirements. The document is comprised of the following sections;

- **Objectives:**
  A summary of the Software Project objectives including the concept and business case.

- **Background:**
  Detailing the origin of the application idea and how it will be used within the industry.

- **Technical Approach:**
  The technical approach that will be required to develop and deliver the proposed application.

- **Special Resources Required:**
  All special resources that will be referenced and implemented to assist development of the application.

- **Project Plan:**
  The deadlines and deliverables throughout the lifecycle of the project are captured and managed through a Gantt chart methodology.

- **Technical Details:**
  Outlining how the application will be delivered, the tools, applications and languages in scope.

- **Evaluation:**
  Summary of the project including expectations, challenges and how they will be approached.

Objectives

This project aims to address a current gap in the part time deliveries at DHL Express[1]. The objectives of the project are to create a suitable application to enable DHL Express courier deliveries outside of the standard 9-5pm operating hours. This will enable part time employment opportunities to DHL Express employees to deliver packages within the Dublin area between the hours of 5-10pm Monday-Friday, outside of current standard delivery hours.
The 3 main objectives in scope to deliver this project are;

1. Create a responsive application,
2. Implement the travelling Salesman algorithm for an optimal route planner,
3. Host the application on a scalable Cloud (Paas) environment.

The application works by capturing checkpoints of a shipment that would normally require a DHL Express courier scanner. These checkpoints are what provide the customer and DHL Express full transparency of the status of all shipments, for example a courier scans the barcode on the label of a package when they first collect it triggering a 'Picked Up' checkpoint. Deliveries outside the standard operating hours will be made possible by using this application as it will allow the user to type/scan the tracking number of the package into the application and select all relevant checkpoints of the delivery journey, from 'Picked Up' to 'Delivered'. The application will also provide a digital signature capture feature that will allow the consignee to sign as proof of delivery. All these checkpoints will be sent back to the DHL gateway where they will be available to view at the DHL Express website. To enable the distribution of X number of goods to X number of locations by the "out of hours" courier the application will provide a route planner plotting the optimal path, this functionality will be made available by implemented the travelling salesman algorithm that will be used to calculate the path. The application will be hosted on a Cloud infrastructure to meet the usage demands.

[1] http://www.dhl.ie/en/about_us/company_portrait.html

On completion of this application I will be looking to pilot its release with DHL Express Ireland employees with a view to optimize all courier delivery routes and first time delivery rates as well as an improved customer experience, offering home deliveries at a more convenient time.

Background

I have been working for DHL Express Ireland for 5 years in their ecommerce & Customer Integration department. The department is located within the DHL Express Dublin HUB facility that is the central distribution centre in Ireland. Whilst working for DHL Express I have been exposed to all sides of the business from both an internal and external customer point of view. The ecommerce department encourages Intrapreneralship and we are always looking for ways to improve business processes and our customer experience. With this in mind I have been keeping a close eye on trends and areas where I believe innovation can improve our services. I noticed that during peak periods throughout the year e.g. Black Friday & Christmas when deliveries significantly increase that the strain on the couriers and the first time delivery rate were affected. This can be attributed to both the increase of B2C (Business to Customer) deliveries and customers not being at home when the courier calls resulting in the delivery having to be rearranged and a second delivery attempt made. Often during these busy periods a call would be made to all staff to assist with local deliveries and these ad-hoc deliveries would not have the same traceability due to scanners not be available/used therefore completion scans would not take place. This reoccurring situation and loss of full traceability caused by ad-hoc deliveries is what triggered the idea of the out of hour's delivery application, DHL Express Twilight.

Currently DHL Express offer timed delivery between the working hours of 9am-5pm with advanced delivery windows available at a premium for example Express Pre 12 ensures a delivery will be made by 12pm the following working day. The lifecycle of a DHL Express shipment is fully transparent and traceable by the consignee by tracking their shipment using their dedicated AWB (Airway Bill) number. This AWB number is present on the shipment label on the package in the form of a unique 10 digit number and barcode interpretation. It is the barcode that the courier scans using designated DHL courier scanners and selecting the relevant 'checkpoint' or status of the shipment. For example when a shipment is collected the courier scans the AWB barcode using their DHL scanner and selects 'Picked Up' from the menu option triggering the checkpoint update back in to the DHL network that is then visible against the AWB when tracked. This process is

replicated at all major events of the package journey i.e. 'With Courier' & 'Delivered'. A shipment is considered complete when it receives the final 'Delivered' scan at which point the consignee also digitally signs the courier scanner to confirm POD (Proof of Delivery) that is also linked to the AWB.

The application aims to extend the delivery window for B2C deliveries during peak times so that shipments, where a failed delivery was made, can be re-arranged for a delivery outside of the normal working hours when the customer would be expected to be at home. This will reduce the workload on our couriers during peak seasons ensuring that their delivery routes are not impacted by having to re-attempt deliveries.

A brainstorming session was completed during the initiation stage of this project to help scope the concept and layout the approach (see Appendix 1). The vision for this application is to provide a more flexible and scalable solution to the current courier scanners allowing for cost savings and expanding the network delivery times to fit that of the customer.

Technical Approach

The first stage of this project will be to fully scope all functional & non-functional requirements. These requirements will then form the basis of a comprehensive Requirement Specification detailing full functionality of the application. During the initiation of this project and brainstorming sessions it was decided that the application would be delivered as a Web Application to provide ease of deployment and scalability across all major platforms. Implementation will start with creating the front end/GUI of the application that will be hosted on a Cloud (PaaS) environment. This will provide the adequate server scalability to meet the fluctuating demand on the application during usage periods. A database will then be setup and linked to the application to provide data management of all registered users, shipments & captured checkpoints. To communicate the checkpoints and digital signature back to DHL the database entries will be read and sent by either XML messages to the DHL server or alternatively a delimited text file via SFTP. The route planner will be creating by implementing the travelling salesman algorithm to plot the optimal path for all deliveries.

Special resources required

To implement the DHL Express application a number of sources will be used to aide its development. Research and deployment of AWS services will be delivered utilizing toolkits and deployment guides direct from AWS Documentation. The travelling Salesman algorithm will be implemented to assist plotting out the logic and functionality of the travelling courier route planner using online sources. I will be looking to implement a barcode scanner to read the AWB number from each shipment label that is collected by the courier and a digital signature capture form for the consignees on confirmation of delivery both of which I will be researching available software and implementation techniques from online sources. In order to conform to the appropriate requirements from DHL Express for returning shipment data I will be reviewing the API, Web Service/Toolkits and schemas to ensure data is sent in the correct format and to the correct server.

In order to compile a full and comprehensive picture of the existing DHL Express Ireland process and when/where the application can be most effective I will be researching DHL Express Ireland shipment data including volumes, delivery success rate and peak delivery periods. This will also include reports and surveys undertaken by DHL Express Ireland Operational management.

To complete full UAT I will require 10 volunteers to test the application and functionalities providing reports and feedback.

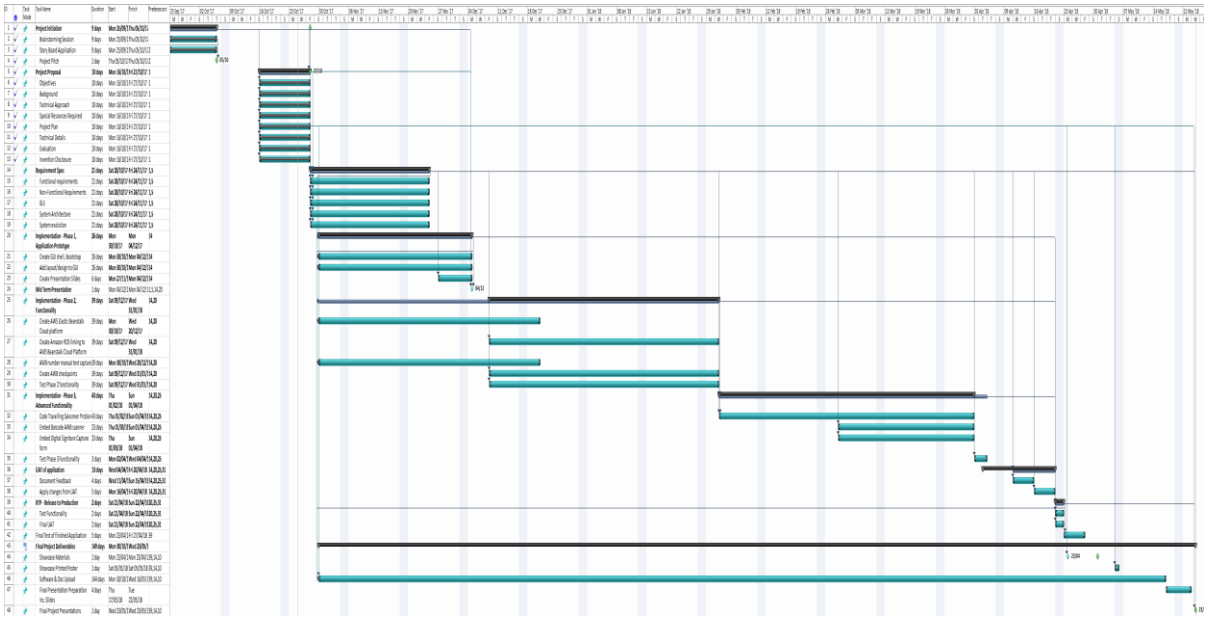
Project Plan

A Gantt chart has been designed to assist with the project management of the application. The Gantt chart details all deliverables and milestones of the project to provide a structured and clear approach to be taken. The Gantt chart is based around 10 key milestones;

1. Project Initiation
2. Project Proposal
3. Requirement Spec
4. Implementation - Phase 1, Application Prototype
5. Mid Term Presentation
6. Implementation - Phase 2, Functionality
7. Implementation - Phase 3, Advanced Functionality
8. UAT of DHL Moon App
9. RTP - Release to Production
10. Final Project Deliverables

Each milestone consists of subset tasks that have been given timelines for delivery and predecessors that enable the next phase to commence.

Gantt chart Overview;



Task breakdown;

	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource
1		**Project Initiation**	**9 days**	**Mon 25/09/17**	**Thu 05/10/17**		
2		Brainstorming Session	9 days	Mon 25/09/17	Thu 05/10/17		
3		Story Board Application	9 days	Mon 25/09/17	Thu 05/10/17	2	
4		Project Pitch	1 day	Thu 05/10/17	Thu 05/10/17	2	
5		**Project Proposal**	**10 days**	**Mon 16/10/17**	**Fri 27/10/17**	**1**	
6		Objectives	10 days	Mon 16/10/17	Fri 27/10/17	1	
7		Background	10 days	Mon 16/10/17	Fri 27/10/17	1	
8		Technical Approach	10 days	Mon 16/10/17	Fri 27/10/17	1	
9		Special Resources Required	10 days	Mon 16/10/17	Fri 27/10/17	1	
10		Project Plan	10 days	Mon 16/10/17	Fri 27/10/17	1	
11		Technical Details	10 days	Mon 16/10/17	Fri 27/10/17	1	
12		Evaluation	10 days	Mon 16/10/17	Fri 27/10/17	1	
13		Invention Disclosure	10 days	Mon 16/10/17	Fri 27/10/17	1	
14		**Requirement Spec**	**21 days**	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
15		Functional requirements	21 days	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
16		Non-Functional Requirements	21 days	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
17		GUI	21 days	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
18		System Architecture	21 days	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
19		System evolution	21 days	**Sat 28/10/17**	**Fri 24/11/17**	**1,5**	
20		**Implementation - Phase 1, Application Prototype**	**26 days**	**Mon 30/10/17**	**Mon 04/12/17**	**14**	
21		Create GUI shell, Bootstrap	26 days	**Mon 30/10/17**	**Mon 04/12/17**	**14**	
22		Add layout/design to GUI	26 days	**Mon 30/10/17**	**Mon 04/12/17**	**14**	
23		Create Presentation Slides	6 days	**Mon 27/11/17**	**Mon 04/12/17**	**14**	
24		**Mid Term Presentation**	1 day	Mon 04/12/17	Mon 04/12/17	1,5,14,20	
25		**Implementation - Phase 2, Functionality**	**39 days**	**Sat 09/12/17**	**Wed 31/01/18**	**14,20**	
26		Create AWS Elastic Beanstalk Cloud platform	39 days	**Mon 30/10/17**	**Wed 20/12/17**	**14,20**	
27		Create Amazon RDS linking to AWS Beanstalk Cloud Platform	39 days	**Sat 09/12/17**	**Wed 31/01/18**	**14,20**	
28		AWB number manual text capture	39 days	**Mon 30/10/17**	**Wed 20/12/17**	**14,20**	
29		Create AWB checkpoints	39 days	**Sat 09/12/17**	**Wed 31/01/18**	**14,20**	
30		Test Phase 2 functionality	39 days	**Sat 09/12/17**	**Wed 31/01/18**	**14,20**	
31		**Implementation - Phase 3, Advanced Functionality**	**43 days**	**Thu 01/02/18**	**Sun 01/04/18**	**14,20,25**	
32		Code Travelling Salesmen Problem	43 days	**Thu 01/02/18**	**Sun 01/04/18**	**14,20,25**	
33		Embed Barcode AWB scanner	23 days	**Thu 01/03/18**	**Sun 01/04/18**	**14,20,25**	
34		Embed Digital Signiture Capture form	23 days	**Thu 01/03/18**	**Sun 01/04/18**	**14,20,25**	
35		Test Phase 3 Functionality	3 days	**Mon 02/04/18**	**Wed 04/04/18**	**14,20,25**	
36		**UAT of application**	**13 days**	**Wed 04/04/18**	**Fri 20/04/18**	**14,20,25,31**	
37		Document Feedback	4 days	**Wed 11/04/18**	**Sun 15/04/18**	**14,20,25,31**	
38		Apply changes from UAT	5 days	**Mon 16/04/18**	**Fri 20/04/18**	**14,20,25,31**	
39		**RTP - Release to Production**	**2 days**	**Sat 21/04/18**	**Sun 22/04/18**	**20,25,31**	
40		Test Functionality	2 days	**Sat 21/04/18**	**Sun 22/04/18**	**20,25,31**	
41		Final UAT	2 days	**Sat 21/04/18**	**Sun 22/04/18**	**20,25,31**	
42		Final Test of finished Application	5 days	Mon 23/04/18	Fri 27/04/18	39	
43		**Final Project Deliverables**	**149 days**	**Mon 30/10/17**	**Wed 23/05/18**		
44		Showcase Materials	1 day	Mon 23/04/18	Mon 23/04/18	39,14,10	
45		Showcase Printed Poster	1 day	Sat 05/05/18	Sat 05/05/18	39,14,10	
46		Software & Doc Upload	144 days	Mon 30/10/17	Wed 16/05/18	39,14,10	
47		Final Presentation Preparation inc. Slides	4 days	Thu 17/05/18	Tue 22/05/18		
48		Final Project Presentations	1 day	Wed 23/05/18	Wed 23/05/18	39,14,10	

Error! No topic specified.

In conjunction with the Gantt chart monthly project journals will be kept and submitted outlining deliverables met, challenges, achievements and next steps to provide visibility on project progress. GitHub will also be used as a repository for storing the application code enabling collaboration, backup and fall back (should it be required). GitHub will also act as another project monitor to track code 'commits' to keep track and report on progress.

Technical Details

After the initiation stage of the project is complete, with the accompanying in-depth Requirement Specification, the implementation of the application will commence with a phased approach. This will begin with creating the front end web application including basic functionality. The first phase will be used to demonstrate and showcase the application at the Mid-Term Software Project presentation. Phase 2 of the implementation will look to enhance the functionality of the application consisting of setting up an AWS Elastic Beanstalk (Paas) instance and linked Amazon RDS database for the backend of the application. Adding the AWB capture, checkpoint capture and signature capture field allowing basic testing of the core functionality of the application by capturing AWB numbers and customer signatures manually by text and writing them back to the database and then on to the DHL gateway.

Phase 3 will consist of layering the functionality of the application to automate the existing functionality via a barcode reader, digital signature capture and implementing the travelling Salesman algorithm to provide an optimal courier route planner.

For my application the following tools, applications and languages are in scope;

- Bootstrap
- AWS Elastic Beanstalk
- Amazon RDS
- HTML
- CSS
- JS
- JQuery
- PHP
- SQL
- GitHub

Evaluation

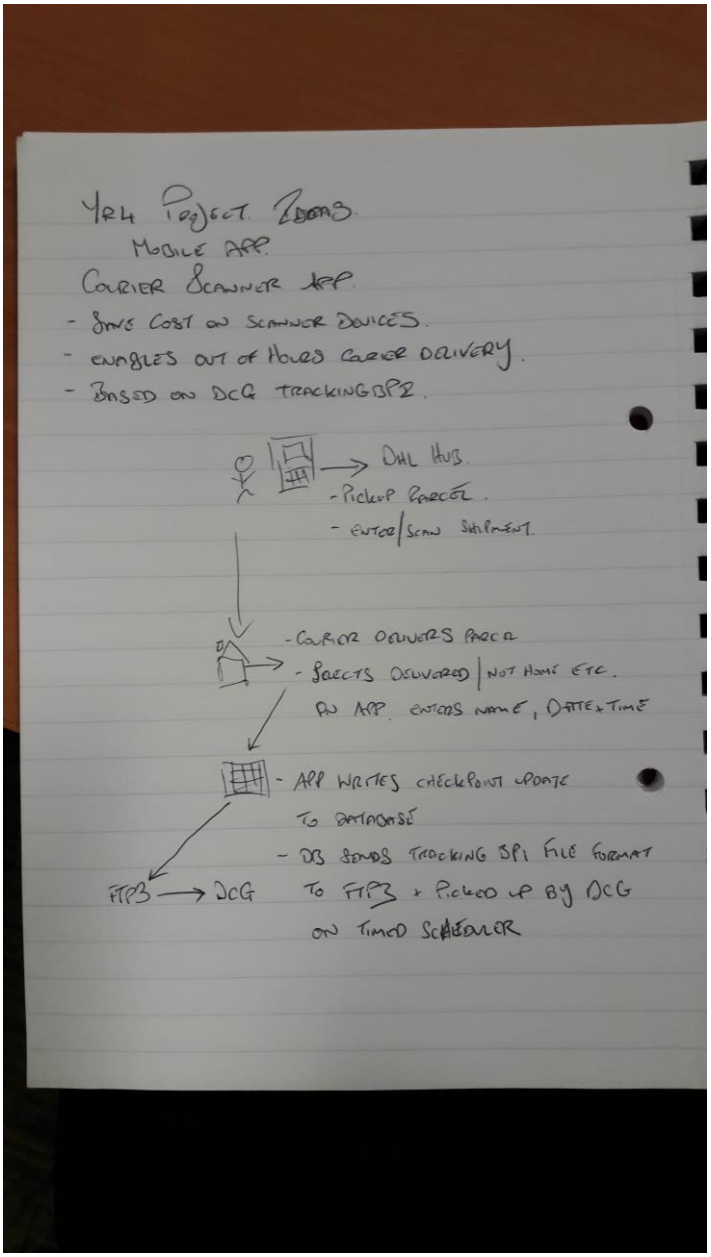
The application will be developed and ready for UAT one month prior to the final deliverable. This will provide adequate time to embark on a series of UATs to ensure that all functionalities are working correctly and within the scope. All UAT cases will be captured through questionnaires, testing plans and reports to gauge user response and bugs identified. Further tests will be carried out with real test shipments from the DHL Express network and monitoring the performance of the application and expected traceability of the shipments. A range of platforms will be used to fully test the application including Android and iOS.
There are a number of components that will be implemented to deliver the final DHL Express application including;

- Travelling Salesmen Algorithm
- Barcode Scanner
- Digital Signature Capture
- AWS deployment

These components will drive the complexity and ensure that the application is as user friendly and as efficient as possible whist enabling the core operations to flow seamlessly.

Appendix

1. Initial Project brainstorming session – Notes;



Monthly Journals

Reflective Journal – September 2017

Student name: Patrick King

Programme: BSc in Computing (Evening)

Month: September 2017

My Achievements

September saw the return to NCI to commence our 4th year. As part of our final year of the BSc in Computing we are required to complete a Software Project. During the summer I had a number of brainstorming sessions and came up with an idea for my Project. An application to enable courier deliveries between 5-10pm, outside of the standard operating window. In September I prepared my pitch of the idea ready to deliver to 3 NCI supervisors in September. I drafted up the background and concept as per the below;

My Software Project Pitch;

I work for DHL Express within their eCommerce team and after noticing trends during busy periods e.g. Christmas, Black Friday etc. and the constantly striving to improve our customer experience and successful deliveries I came up with a DHL Android app that I am calling "Twilight". This app is focused on enabling an out of hours delivery service with DHL Express. This service is targeting deliveries to customers between the hours of 6-9pm and enables any certified "couriers" to have access to the application and start delivering! Certified couriers will be assigned all deliveries at the DHL Dublin HUB where they will be assigned shipments by a DHL agent. The out of hours courier will enter/scan all shipment tracking numbers into their app to register the shipment as picked up and assigned to their unique courier ID. On delivery the courier will select the AWB number and confirm delivery. All of these checkpoints are stored in a database and then feedback to DHL for full transparency to DHL and the customer on the shipment status. There is currently nothing like this on the market with DHL Express and I believe that future scope for this concept could see it move into replacing the current courier scanner units.

My Reflection

I believe the project is innovative, has a place in the market and meets the requirements of the project. My next steps will be to present my pitch to 3 NCI supervisors on the 6th October where the idea will be either approved or rejected. I will also be assigned my supervisor for the Software Project.

Software Project Pitch

Date of Meeting: 6th October 2017, 17:40

Reflective Journal – October 2017

Student name: Patrick King

Programme: BSc in Computing (Evening)

Month: October 2017

My Achievements

After being assigned my Project supervisor, Keith Maycock, we arranged meeting to outline my software project idea and the best way to approach it. It was decided that I would change from building a Mobile application to a web application due to past experience in web development and the ease to scale the application across all platforms. Also discussed was the implementation of the travelling salesman algorithm to provide an optimal route planner in to the application for each user. To coincide with my 4th Specialisation, Cloud Computing, I will also be hosting the web application on a cloud platform, AWS.

Once the above details of the project had been discussed I began creating the Project Proposal document to outline the concept, functionalities and methods that would be used to build the application. The project proposal was submitted within the given deadline.

My Reflection

In completing the project proposal I ran a number of draft copies by my supervisor who provided feedback suggesting the format and styling to use as well including an introduction to the document to ensure that it was correctly laid out and read well. I found the input from my supervisor very helpful and informative to correct gramatical and styling that I previously was unaware of.

Next steps are to begin creating the Requirement Specification and building the prototype of the application ready for the mid term presentations in December.

Supervisor Meetings

Date of Meeting: 19th October 2017, 17:30

Items discussed: Project overview, platforms and methods in scope. Project proposal deliverable.

Action Items: Requirement Specification & Prototype

Reflective Journal – November 2017

Student name: Patrick King

Programme: BSc in Computing (Evening)

Month: November 2017

My Achievements

During the month of November I worked on and completed the Requirement Specification report detailing the functional and non-functional requirements of the DHL Twilight cloud application. This specification also included Use Case, Class diagrams and GUI wireframes depicting the flow of the application. The final draft of the Requirement specification was shown to my Supervisor, Keith Maycock, who reviewed the document with me during a scheduled meeting. Keith provided me with advice and recommendations breaking down the document and detailing additional parts that should be added including further descriptions on the main functional requirement, the route planner.

After submitting the Requirement specification I then commenced creating the Technical Report required for the Mid Term presentation in December. The technical report combines the Project Proposal and Requirement Spec to one master document. This document was also completed and uploaded within timeframes outlined and including the additions recommended by my Project Supervisor.

In preparation for the Mid Term presentation I will be working on the slides and prototype required for demonstration and focusing on my presentation pitch.

My Reflection

In creating the technical reports required for the software project mid term presentation I believe that I have been able to fully research and detail how the application will be developed and the approaches I will take. This has been very useful in laying foundations and ensuring a clear and structured approach will be taken. Regular meetings with my Project Supervisor have been very beneficial and he has provided valuable feedback and advice as to how to structure the required documents.

Due to the workload required for the mid term deliverables time management was required to ensure I allocated enough time to meet the deadlines.

Intended Changes

After the mid-term presentations I will be focusing on the next stage of the Software Project and development of the application. This will include setting up and configuring the AWS EC2 cloud environment and adding functionality to the application.

Supervisor Meetings

Date of Meeting 1: 23/11/2017
Items discussed: Requirement Specification
Action Items: Supervisor to Review the draft of the Requirement Specification

Date of Meeting 2: 25/11/2017
Items discussed: Requirement Specification – Final Draft
Action Items: Supervisor provided feedback and recommendations for the final Requirement specification deliverable.

National College of Ireland

BSc in Computing

2017/2018

Technical Report

Final Project submitted in partial fulfilment of the BSc in Computing at the National College of Ireland.

Patrick King
Student Number: 14113970

Supervised by Dr. Keith Maycock
November 2017

Table of Contents

Document Control

Revision History

Date	Version	Scope of Activity	Prepared	Reviewed	Approved
13/11/2017	1	Project Proposal	PK	X	X
23/11/2017	2	Requirements Spec	PK	X	X
29/11/2017	3	Technical Report	PK	X	X

Distribution List

Name	Title	Version
Keith Maycock	Project Supervisor	1
Keith Maycock	Project Supervisor	2
Keith Maycock	Project Supervisor	3

Related Documents

Title	Comments
Use Case Model	Page 14
Class Diagram	Page 35
Wireframes	Page 38
Gantt Chart	Page 56
Initial Project Brainstorm	Page 61

Executive Summary

DHL Twilight is a cloud application to extend the delivery window for B2C (Business to Customer) deliveries during peak times so that shipments, where a failed delivery was made, can be re-arranged for a delivery outside of the normal working hours when the customer would be expected to be at home. As an employee working for DHL Express Ireland for 5 years I was able to monitor courier reports, shipment volumes and have meetings with Operation managers to understand the business case and requirement for the DHL Twilight cloud application. All reports and meetings have confirmed substantial increase in deliveries to residential addresses during peak periods including Black Friday weekend and Christmas. It is these peak periods that DHL Twilight is initially targeting to assist with the same day completed shipment delivery rate.

This cloud application will aim to reduce the workload on the couriers during peak seasons ensuring that their delivery routes are not impacted by having to re-attempt deliveries. DHL Twilight will provide a cloud application for part-time couriers to maintain full transparency and traceability on ad-hoc deliveries made outside of the normal delivery hours without the requirement of a courier scanner. This will in turn allow for cost savings on courier scanners and expand the network delivery times to fit that of the customer.

Introduction

This technical report details the cloud application, DHL Twilight that will be developed as part of a 4th Year Software Project. The Technical Report will outline the background and aim of the cloud application detailing the technical approach that will be implemented for its delivery.

Background

I have been working for DHL Express Ireland for 5 years in their ecommerce & Customer Integration department. The department is located within the DHL Express Dublin HUB facility that is the central distribution centre in Ireland. Whilst working for DHL Express I have been exposed to all sides of the business from both an internal and external customer point of view. The ecommerce department encourages Intrapreneralship and we are always looking for ways to improve business processes and our customer experience. With this in mind I have been keeping a close eye on trends and areas where I believe innovation can improve our services. I noticed that during peak periods throughout the year e.g. Black Friday & Christmas when deliveries significantly increase that the strain on the couriers and the first time delivery rate were affected. This can be attributed to both the increase of B2C (Business to Customer) deliveries and customers not being at home when the courier calls resulting in the delivery having to be rearranged and a second delivery attempt made. Often during these busy periods a call would be made to all staff to assist with local deliveries and these ad-hoc deliveries would not have the same traceability due to scanners not be available/used therefore completion scans would not take place. This reoccurring situation and loss of full traceability caused by ad-hoc deliveries is what triggered the idea of the out of hour's delivery application, DHL Express Twilight.

Currently DHL Express offer timed delivery between the working hours of 9am-5pm with advanced delivery windows available at a premium for example Express Pre 12 ensures a delivery will be made by 12pm the following working day. The lifecycle of a DHL Express shipment is fully transparent and traceable by the consignee by tracking their shipment using their dedicated AWB (Airway Bill)

number. This AWB number is present on the shipment label on the package in the form of a unique 10 digit number and barcode interpretation. It is the barcode that the courier scans using designated DHL courier scanners and selecting the relevant 'checkpoint' or status of the shipment. For example when a shipment is collected the courier scans the AWB barcode using their DHL scanner and selects 'Picked Up' from the menu option triggering the checkpoint update back in to the DHL network that is then visible against the AWB when tracked. This process is replicated at all major events of the package journey i.e. 'With Courier' & 'Delivered'. A shipment is considered complete when it receives the final 'Delivered' scan at which point the consignee also digitally signs the courier scanner to confirm POD (Proof of Delivery) that is also linked to the AWB.

Aims

The DHL Twilight cloud application aims to extend the delivery window for B2C deliveries during peak times so that shipments, where a failed delivery was made, can be re-arranged for a delivery outside of the normal working hours when the customer would be expected to be at home. This will reduce the workload on our couriers during peak seasons ensuring that their delivery routes are not impacted by having to re-attempt deliveries.

A brainstorming session was completed during the initiation stage of this project to help scope the concept and layout the approach. The vision for this application is to provide a more flexible and scalable solution to the current courier scanners allowing for cost savings and expanding the network delivery times to fit that of the customer.

Technologies

There are a number of applications, programming languages and tools specified within this document to build DHL Twilight hosted on the AWS cloud environment to allow full scalability including;

- PHP - Hypertext Pre-processor
- SQL - Structured Query Language
- JS - Java Script

- JQuery - JavaScript Library
- XML - Extensible Mark-up Language
- HTML - Hyper Text Mark-up Language
- AWS - Amazon Web Services
- RDS - Relational Database Service
- DCG - DHL Customer Gateway
- SFTP - Secure File Transfer Protocol

Structure

DHL Twilight aims to deliver a fully functioning cloud application, scalable across all platforms, allowing users to;

- login with their unique credentials,
- scan the AWB(Airwaybill) tracking number on a label,
- enter the destination address,
- view an optimal route planner for their deliveries,
- Update the status/checkpoint of each shipment.

The DHL Twilight landing page will display an overview of the application and provide users the ability to log-in or register. Once a user is logged in to the cloud application they will have full access to all functions and visibility on their shipment history. The new delivery process begins with the user being able to capture new shipment details including the AWB(Airwaybill) tracking number with a barcode reader being embedded into the application configured to read barcode symbology Code 128 used on all DHL Express labels. The application also calculates the optimal route for deliveries based on the address details for all shipments captured. A number of techniques and search optimisation/genetic algorithms were researched to develop the route planner including the 'Ant colony optimisation' algorithm. After discussions with my Project Supervisor it was decided that the 'Travelling Salesman' algorithm would be implemented to solve and provide the fastest/optimal route for all given addresses. The option to

update the status of each shipment e.g. 'Out for delivery', 'Delivered' will be based on database lookups and lists to update each shipment. The last part of the shipment delivery cycle will be to capture the consignee signature through an electronic form located on the POD page.

System

User Requirements definition

The DHL Twilight cloud application is to be designed to provide a platform to allow registered users to complete the shipments delivery process and view all completed shipments. All registered users will be granted access to required functionality by registering using their DHL Express staff number as their unique ID to provide security and traceability for all users. The application must also provide a secure log in for administration access to view and monitor user actions. From initial analysis, DHL Twilight will require three different types of user;

4. New User
    - **Unregistered** - User does not have a login
    - **View Home Page** – User has access to view the homepage
    - **Register Now** – User can register for an account

5. Registered User
    - **Login** – The registered user can access user account homepage
    - **Add Shipments** – User can scan in new shipments & enter delivery address
    - **Plot Route** - User can view the optimal route plan for their deliveries
    - **Update Checkpoints** – The user can update checkpoints of pending shipments
    - **Capture Consignee Signature** – User can access the POD function to capture consignee signature
    - **View Shipment History** – User can view all completed shipments

6. Administrator User
    - **Login** – Administrator has access to login to the administration side of the site with full privileges.

- **View all Shipments** – Administrator can view all shipments that have been entered by all users
- **View/Edit User Profile** – Administrator can view & edit all registered users profiles. This option is only available to the administrator to add a layer of security. Only the Administrator can edit user profiles and any user profile change requests must go through the Administrator.

DHL Twilight is targeted at DHL Express employees only to comply with the security and integrity that the company requires for shipment courier delivery. All DHL Express employees undergo required training and certification as part of joining the company as well as a staff ID that are all required in order to register for the application. Based on the specific demographic that this application is targeted towards internal communication including links to the site will be used to provide maximum visibility to the target audience. The familiar official DHL colours, branding and functionality are specifically aimed at DHL Express employees providing security and clarity on its functionalities.

Requirements Specification

The DHL Twilight cloud application is built around a central Home page that provides an overview of the application, its functionality and an access point for registered users to log in or new users to Register Now. The homepage will be designed with ease of use in mind to provide users with a clear understanding as to its purpose and how to register or login. Based on the demographic of the target users, DHL Express employees, this will be displayed to the user by adopting the official DHL branded colour scheme that will remain consistent throughout navigation to all areas of the site including complimentary imagery and descriptions. All DHL images & branding have been approved by the DHL Marketing team to use on the DHL Twilight cloud application. The requirements for registered users of the site is to be able to quickly and easily add new shipments, view their optimal route, update checkpoints and capture the customer signature. All of these functions are familiar to DHL Express staff

however the application will ensure all these functionalities are clearly displayed and quick to navigate.

Functional requirements

DHL Twilight will be designed consisting of 7 core functionalities across all the recognised types of users, 'New User', 'Registered User' and 'Administrator'. The cloud application will be built around a central database that will be used to store all user account and shipment details accessed in real time to provide read/write processes to enable user functionalities and access. The application will be hosted in a cloud environment on AWS to allow required ease of scalability to meet the application fluctuating usage demands. Implementing programming PHP, SQL, Java, JS, JQuery and XML languages will enable the application to access and communicate all required calls and data. The complexity of calculating the optimal route planner will be solved implementing the 'Travelling Salesman' algorithm.

Core Functional Component – Traveling Salesman Algorithm

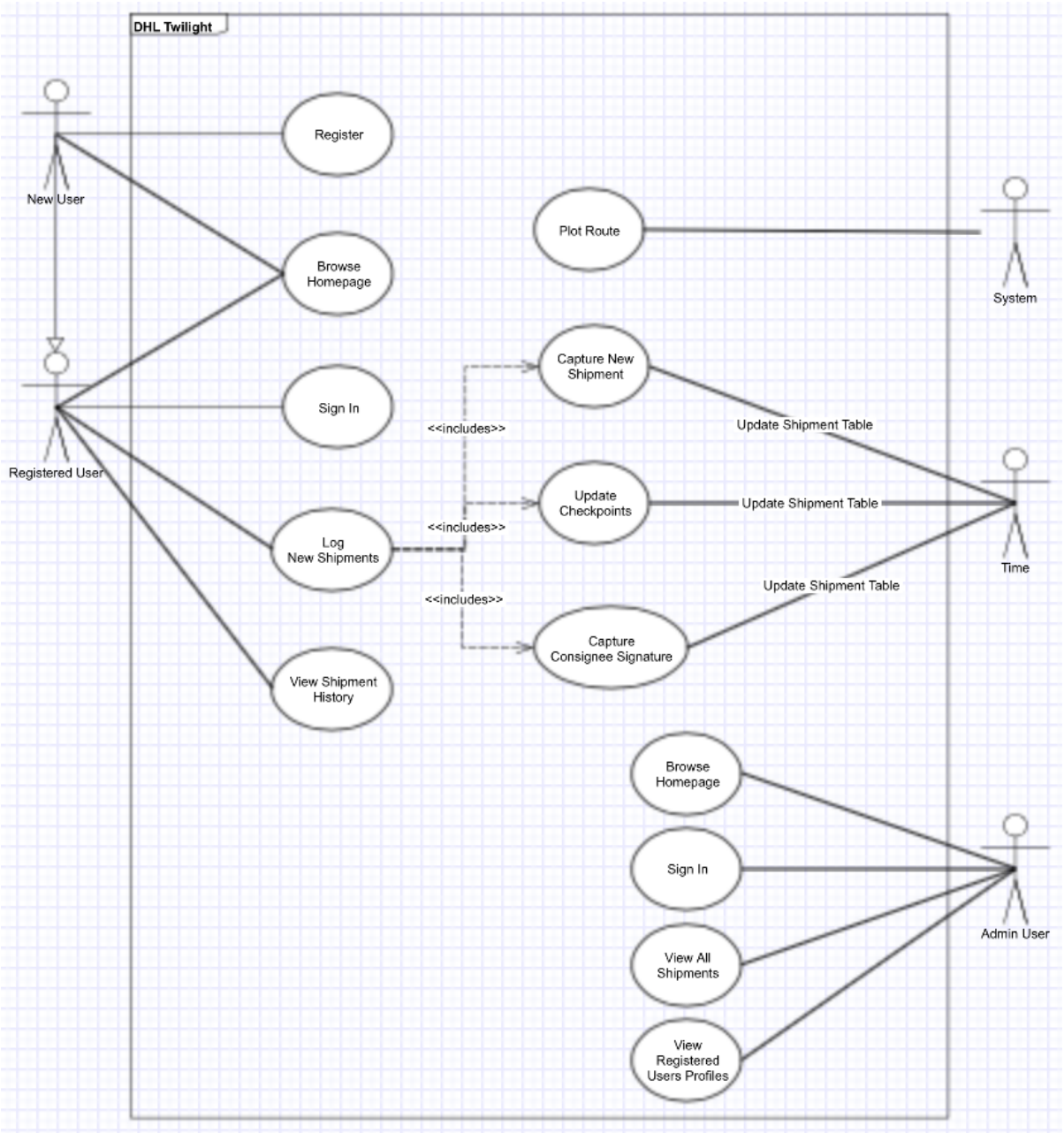
The core functional requirement for the DHL Twilight Cloud Application will be designing and implementing the route planner for the couriers optimal route for deliveries. The application will take the inputs from the user from the 'Capture New Shipments' page that detail the AWB(Airwaybill) / tracking number of each shipment and the associated delivery address. On submission of these addresses the system will calculate what route the courier is to take and display these to the 'Route Planner' page. This is the most complex problem that the application will look to solve. Extensive research was undertaken and a number of approaches for optimization and search algorithms considered. Genetic algorithms have been devised to tackle complex searches taking a "Survival of Fittest" Darwinian approach to finding the optimal result from 'n' number of possible solutions. Genetic Algorithms look to reduce the size of the search by randomly selecting sections of the graph search area and iterating through them until the optimal or "Fittest" result is found. One GA considered was the 'Ant Colony' optimization

(ACO) that bases its iterative search through graphs liken to that of an ant colony. (Aco-metaheuristic.org)

After discussions with my Supervisor on how best to tackle this problem it was decided that the 'Travelling Salesman' algorithm, would be implemented. The travelling salesman algorithm is based upon determining the optimal route travelling between 'n' number of cities. Taking the roads/nodes connecting cities and applying a weight to these nodes it will then iterate through and determine the optimal route based on the evaluation of weight of nodes. (Math.uwaterloo.ca)

Use Case Model

The below Use Case Model outlines all the types of users in scope and how they interact with the DHL Twilight application functions.



Each defined user type detailed above has access to the following functionalities;

New Users

11. Register Now

Registered Users

12. Sign In
13. Capture Shipment/AWB number
14. Plot Route
15. Update Checkpoints
16. Capture Consignee Signature
17. View Shipment History

Administrators

18. Sign In
19. View all shipments
20. View/Edit Registered user profiles

Based on these functionalities the below 7 core requirement use cases are defined;

Requirement 1 – Register Now

Description & Priority

This provides 'new users' the ability to register with the application using their unique DHL Staff number and gain full access to the 'registered user' account landing page and functionalities.

Use Case – 1. Register Now –New User

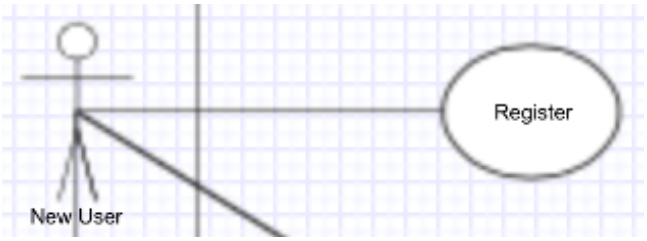
Scope

This use case provides users a GUI form to complete registration with the application and generate their unique login credentials. This is listed as a priority 7 requirement.

Description

This use case describes how new users can register with the site and generate their unique login credentials.

Use Case Diagram



Flow Description

Precondition

System is idle on the application home page awaiting user input.

Activation

This use case starts when the user clicks on the 'Register Now' button located in the centre of the main home page.

Main flow

1. The system displays a form to the user with mandatory data fields to be populated to complete registration
2. The 'New User' enters all mandatory data fields
3. The system checks user input against database to validate unique user credentials.
4. On validation of details the users registration is confirmed and access to the 'Registered Users' account landing page granted/displayed.

Alternate flow

A1 : User credentials already signed in

1. The user credentials are already logged into the system as a 'registered user', the system displays an information window advising user they are already registered.
2. The 'Registered User' is directed back to the home page and prompted to 'Sign In'

Exceptional flow

E1 : Missing Mandatory Registration information

1. The user has entered details into the registration form but has not completed one or more of the mandatory data fields
2. A warning dialog box is displayed to the user advising that 1 or more mandatory data fields are not complete
3. The use case continues at position 2 of the main flow

Termination

The system confirms registration and grants the user access to the 'Registered Users' account landing page and functionality.

Post condition

The system goes into a wait state

Requirement 2 - Sign In

Description & Priority

This is the secondary function providing access to the 'Registered' and 'Administrator' users landing page and specific functionality. The 'Sign In' button is located in the centre of the main Home Page. This is listed as a priority 6 requirement.

Use Case –2. Sign In

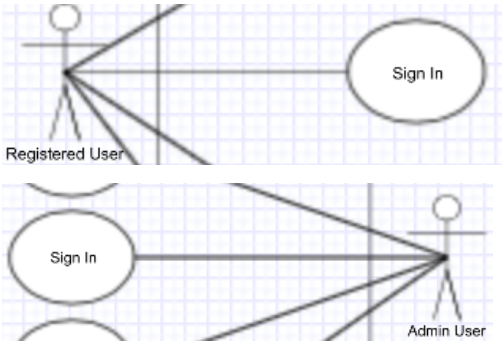
Scope

This use case provides all users a GUI form to gain access to their landing page

Description

This use case describes how 'Registered' and 'Administrator' users can access their account landing page and functionalities of the site.

Use Case Diagram



Flow Description

Precondition

System is idle on cloud application home page awaiting user input

Activation

This use case starts when a user clicks on the Sign In button located in the centre of the Home Page.

Main flow

1. The system displays a login GUI form and asks the user to enter their username & password
2. The 'Registered User' enters unique username & password into GUI form
3. The system checks user input against database to validate user credentials and account privileges
4. On validation of login credentials the user is granted access to their account landing page and associated level of functionality and access

Alternate flow

A1 : User Already logged in

1. The system recognises user credentials and notifies user that they are already logged in
2. The user is directed to their account landing page with access to the site functionalities

Exceptional flow

E1 : Incorrect / Unrecognised log in credentials entered

1. The system checks users log in credentials against database and rejects incorrect/unknown entry
2. The user is notified and requested to re-enter the correct credentials
3. The use case continues at position 6 of the main flow

Termination

The system allows access to the users' account landing page and functionality

Post condition

The system goes into a wait state

Requirement 3 – Capture New Shipments

Description & Priority

Registered users can log new assigned shipments into the cloud application and enter destination address. This is a priority 1 function enabling registered users to log new shipments and begin the delivery cycle.

Use Case – 3. Capture New Shipments

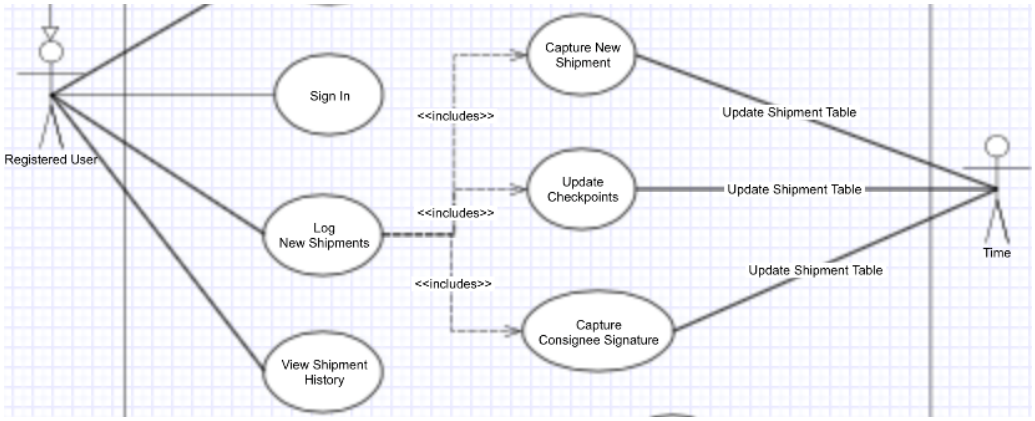
Scope

The scope of this use case is to provide registered users a GUI to capture new assigned shipments into the application

Description

This use case describes the start of the delivery cycle where 'Registered users' can capture/log new assigned shipments into the application ready for delivery.

Use Case Diagram



Flow Description

Precondition

The 'Registered Users' account landing page displays button to providing access to the 'Capture New Shipment' function.

Activation

This use case starts when a Registered User is logged in.

Main flow

1. Registered User clicks on the 'Capture New Shipment' button on their account landing page
2. The 'Capture New Shipment' page is displayed with AWB box
3. The Registered User clicks on the AWB number box to initiate the Barcode scanner reader
4. The Registered User scans the AWB barcode on the shipment label
5. The AWB number of the shipment is populated in the AWB box on the 'Capture New shipment' page.
6. The 'Registered User' selects submit to confirm AWB number and add to shipment list.
7. The option to manually enter the consignee address provided against the AWB number in the shipment list.

Alternate flow

A1 : Manual Entry of AWB number

1. The 'Registered User' selects manual AWB number entry
2. The 'Registered User' manual types in the AWB number into the AWB Box
3. The use case returns to position 5 in the Main Flow

Exceptional flow

E1 : Incorrect AWB number captured

1. The 'Registered User' scans the incorrect AWB number
2. The 'Registered User' selects Manual AWB Entry
3. The use case returns to position A2.

Termination

The system displays list of all shipment AWB numbers submitted.

Post condition

The system goes into a wait state

Requirement 4 – Plot Route

Description & Priority

This requirement plots the optimal route for all shipments captured and submitted ready for delivery. Based on the address entered in the Shipment list the system calculates the most efficient delivery route. This is listed as a priority 2 requirement.

Use Case – 4. Plot Route

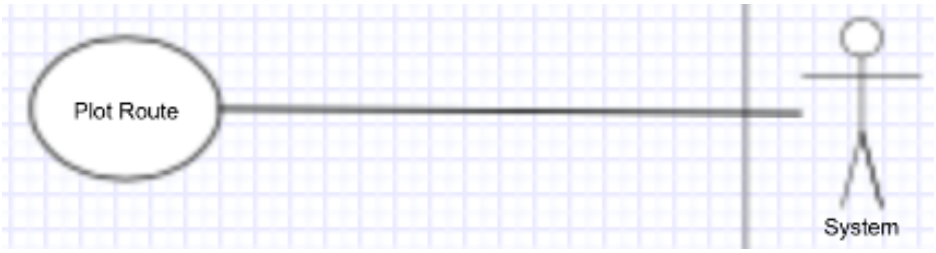
Scope

The scope of this use case is to provide 'Registered Users' with a GUI displaying the optimal route for delivering the assigned shipments.

Description

This use case describes how the 'Registered user' accesses the 'Plot Route' GUI within the cloud application.

Use Case Diagram



Flow Description

Precondition

System is idle on the 'Log New Shipments' page

Activation

This use case starts when the 'registered user' clicks on the 'Plot Route' button located on the 'Log New Shipments' page

Main flow

1. The 'Registered User' clicks on the 'Plot Route' button
2. The system assesses all delivery addresses against all shipments captured
3. The 'Plot Route' page is displayed listing the order of addresses in which the deliveries should take place and a Google Map plugin

Alternate flow

A1 : Addresses are not recognised/validated

1. The system is unable to determine the location of address entered
2. The AWB numbers with un-processed addresses will be added to bottom of route list marked as "Unknown"
3. The use case continues at position 3 of the main flow

Exceptional flow

E1 : **Registered User selects 'Home'**

1. The user selects the 'Home' button on the 'Log New Shipments' page
2. All AWB numbers and addresses are saved and the user is redirected back to their account landing page

Termination

The system displays optimal route of all deliveries to the Plot Route page.

Post condition

The system goes into a wait state

Requirement 5 – Update Checkpoints

Description & Priority

This requirement is provides the Registered User to select assigned AWB number and update its checkpoint. Once a shipment has been given a 'Delivered' checkpoint the shipment is considered complete. This is listed as a priority 3 requirement.

Use Case – 5. Update Checkpoints

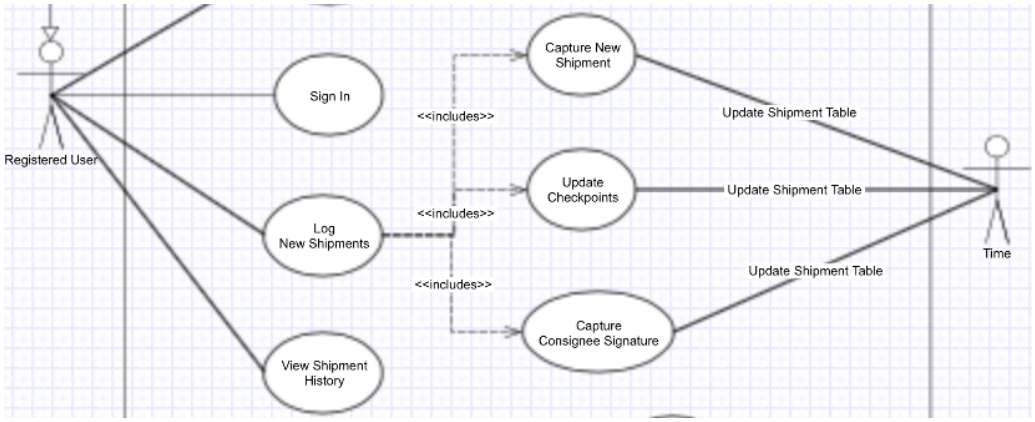
Scope

The scope of this use case is to provide the registered user the ability to select all AWB numbers that are assigned and update its checkpoint.

Description

This use case describes how the 'Registered User' can select the AWB number from a drop down list and updates its checkpoint by selecting from a predefined category.

Use Case Diagram



Flow Description

Precondition

System idle on the 'Plot Route' web page awaiting user input

Activation

This use case starts when a registered user clicks on the 'Update Checkpoint' button located on the Plot Route web page

Main flow

1. The 'Registered User' clicks on the 'Update Checkpoint' button
2. The 'Update Checkpoint' GUI is displayed
3. The 'Registered User' selects the AWB number they wish to update from a combo box list
4. The 'Registered User' selects the appropriate checkpoint from the predefined 'Select Checkpoint' combo box list
5. The AWB number is moved to the appropriate list displaying their checkpoints.

Alternate flow

A1 : User Returns to the Plot Route Page

1. The 'Registered user' clicks on the Route Planner button
2. The 'Registered User' is re-directed back to the previous page displaying the optimal delivery route

Exceptional flow

E1 : Registered User select 'Home'.

1. The user selects the 'Home' button on the 'Update Checkpoints' page
2. All AWB numbers and checkpoints are saved and the user is redirected back to their account landing page

Termination

The system displays AWB numbers and status of checkpoints to the 'Update Checkpoint' page.

Post condition

The system goes into a wait state

Requirement 6 – Capture Consignee Signature

Description & Priority

This requirement allows the registered used to capture the signature of the consignee to act as "Proof of Delivery" for the shipment. The signature captured is then linked to the AWB number. This is listed as a priority 4 requirement.

Use Case – 6. Capture Consignee Signature

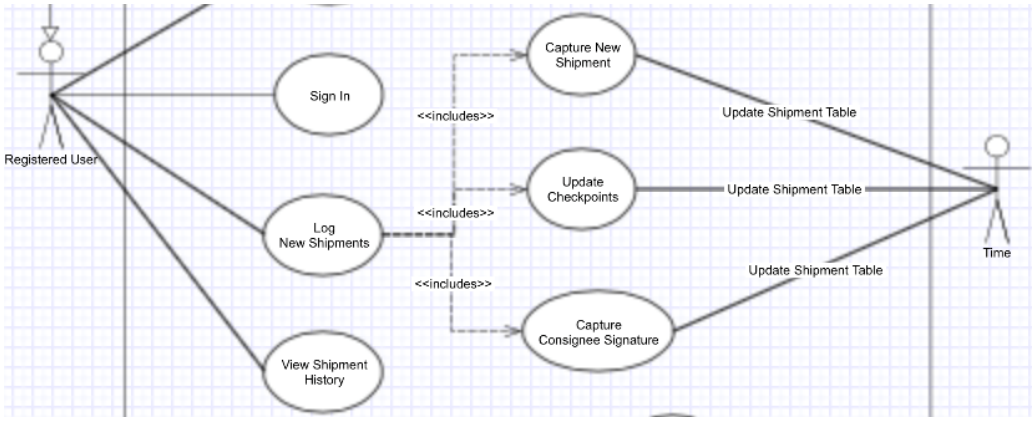
Scope

The scope of this use case is to provide the Registered User a GUI with a signature capture element to enable the consignee to electronically add their signature as Proof of Delivery.

Description

This use case describes how the 'Registered User' can access the 'POD' web page and electronic signature element.

Use Case Diagram



Flow Description

Precondition

System idle on the 'Update Checkpoint' web page awaiting user input

Activation

This use case starts when a registered user clicks on the 'POD' button located on the 'Update Checkpoint' web page

Main flow

1. The 'Registered User' clicks on the 'POD' button
2. The 'POD' GUI is displayed including electronic signature box
3. The 'Registered User' clicks on the electronic signature box to activate the signature capture listener
4. The consignee signs within the signature capture box
5. The consignee selects confirm signature

Alternate flow

A1 : Manually enter the Signature

1. The 'Registered user' clicks on the manually capture signature button
2. The customer full name is entered manually into the capture signature box
3. The consignee selects confirm signature

Exceptional flow

E1 : Electronic Signature not recognised

1. The consignee signature is not captured electronically
2. The 'Registered User' select the enter manually button
3. Consignee enters full name manually in to signature capture box

Termination

The system displays a message confirming the signature has been submitted to the 'POD' page.

Post condition

The system goes into a wait state

Requirement 7 – View Shipment History

Description & Priority

This requirement is provides the 'Registered' and 'Administrator' users visibility on shipments that have been completed. The Registered user only has privileges to view their own completed shipment history whereas the Administrator User can view all completed shipments for all users. This is listed as a priority 5 requirement.

Use Case – 7. View Shipment History

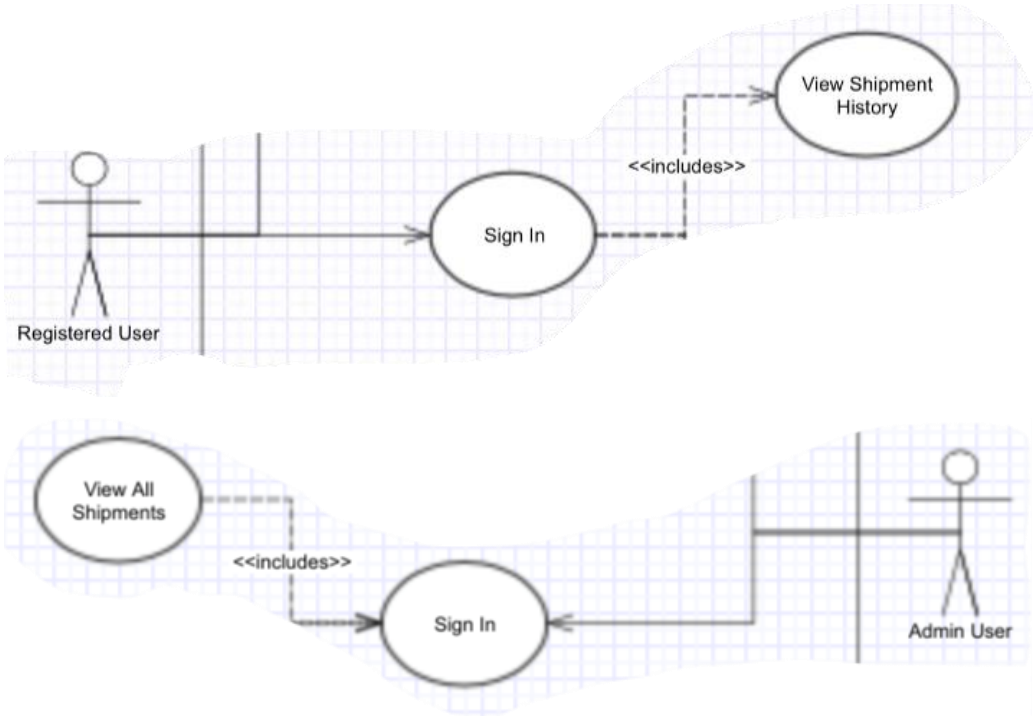
Scope

The scope of this use case is to provide the 'Registered' and 'Administrator' user access to view completed shipments in accordance with their account privileges.

Description

This use case describes how the 'Registered' and 'Administrator' user can access their shipment history and view all their shipments and status'

Use Case Diagram



Flow Description

Precondition

System idle on the users account landing page awaiting user input

Activation

This use case starts when a user clicks on the 'Shipment History' button located on the users' account landing page.

Main flow

1. The user clicks on the 'Shipment History' button
2. The 'Shipment History' GUI is displayed
3. The Registered User can view a full breakdown of all their shipments that have a completed checkpoint, 'Delivered' or 'Not Home'
4. The Administrator user can view all shipments that have been completed for all users.

Alternate flow

A1 : User can filter shipment history list

1. The user clicks on a table heading

2. The shipment history list then sorts itself into Ascending/Descending order of the selected heading

Exceptional flow

E1 : User select 'Home'.

1. The user selects the 'Home' button on the 'Shipment History' page
2. The user is redirected back to their account landing page

Termination

The system displays all completed shipments in accordance with their account privileges to a list on the 'Shipment History' web page.

Post condition

The system goes into a wait state

Non-Functional Requirements

The non-functional requirements outline the operation rather than behaviour of the system. The non-functional requirements in scope for the DHL Twilight cloud application are listed below;

Performance/Response time requirement

The response and performance times for the DHL Twilight will aim to replicate the standard levels deemed acceptable by users. Although there are not official "industry Standards" for this matrix the DHL Twilight will target all navigation and feature response times of around 0.3 seconds. This target is driven by projected initial base of 1000 users, the approximate number of DHL Express employees in the Dublin area. DHL Twilight will be hosted on the AWS EC2 cloud environment that will manage the performance/response times of the cloud application ensuring the resources are available to meet the required demand. This projected response time and number of users will need to be constantly monitored to ensure continued performance levels and relevant forecasting of usage.

Availability requirement

DHL Twilight can be accessed 24/7 by all user types. Although access and availability to the site is constant the peak usage periods will be between 17:00 and 23:00 GMT coinciding with the delivery window this application is targeting. Based on the recognised and forecasted spike in use of the DHL Twilight application it is important to host the application in an environment that can adjust to these demands and keep running costs down. The AWS EC2 cloud environment is targeted at this type of fluctuating usage time scaling servers to meet that of the applications demands at any given time.

Recover requirement

The DHL Twilight cloud application will have all running documents and scripts backed up in GitGub. On release to production the cloud application will be hosted on AWS EC2 along with the SQL database. All physical and backup servers will be

managed and maintained by AWS. In the event of any downtime to a required server the backup server will be initiated to ensure continued performance levels and recoverability of all secure data. DHL Twilights core functionality requires for data to be stored and written back to the DHL DCG gateway including all AWB numbers, checkpoint updates and PODs. Under data protection laws all information collected and used by the DHL Twilight application must be kept secure/private and fully recoverable and available to the individual on request (Dataprotection.ie)

Robustness requirement

The DHL Twilight cloud application will undergo thorough testing to evaluate its robustness including stress testing to ensure that the site remains responsive and provides informative error handling messages to identify the root cause of any error encountered. Any errors encountered in the live environment the user will be advised to contact the site administrator and quote the error message displayed.

Security requirement

Security is a primary focus area in designing the DHL Twilight cloud application. As personal data is exchanged between servers it is vital to ensure that all connections and transfers are encrypted and secure. The main data transfer from the SQL database to the DHL DCG gateway containing the AWB number and checkpoint will travel via an SFTP link. All data communications will be encrypted with SSL certs being configured closer to the application release. The AWS EC2 cloud environment hosting the application will ensure the security and integrity of the site with malicious attempts to access the server side of the application being blocked/denied.

Another major security concern is the registration of new users. The DHL Twilight application will be released initially to DHL Express employees in the Dublin area only. As part of the registration GUI form new users are required to provide their 4 digit DHL Express staff number, this staff number acts as a two way verification with all DHL Twilight users having to show their DHL Express badge (including staff number) on collection of any shipments that will be cross referenced against

the database of registered users by the Administrator user to confirm identity. All shipments are logged against the registered user staff ID to provide full traceability. User passwords will have to adhere to minimum requirements including length, case sensitivity and special characters to ensure the complexity of each and every password.

"Cloud security at AWS is the highest priority. As an AWS customer, you will benefit from a data center and network architecture built to meet the requirements of the most security-sensitive organizations. Amazon EC2 works in conjunction with Amazon VPC to provide security and robust networking functionality for your compute resources."
(Amazon Web Services)

Reliability requirement

Another advantage of hosting the DHL Twilight cloud application on AWS EC2 is that the management of the server reliability and backup is handled by AWS. AWS is the leader in the Cloud Service provider and has the infrastructure and support to ensure any down time of the site is either zero/minimal. A full end-to-end testing will be carried out within a test and live environment to ensure all functionality works as expected with no errors and without loops. The application will also undergo full UAT that will provide reports on user errors. It is vital that the application is fully functioning particularly during the peak delivery window, 17:00 – 23:00 GMT Monday – Friday. AWS EC2 environment will scale to meet usage demands on the system.

"Amazon EC2 offers a highly reliable environment where replacement instances can be rapidly and predictably commissioned. The service runs within Amazon's proven network infrastructure and data centers. The Amazon EC2 Service Level Agreement commitment is 99.95% availability for each Amazon EC2 Region." (Amazon Web Services)

Maintainability requirement

To ensure that the DHL Twilight application can be fully maintained and built upon it is essential that all code and functionality is captured and documented fully. All code and scripts that are created within the test environment will be fully commented during initial development and versions/updates to the application will be stored separately within GitHub forks. GitHub will supply a "living" code base environment including full comments on code and text on each release/version. On release to production the DHL Twilight application a fully detailed release guide will be created detailing all functionality of the application, code/ programming languages used and where to locate each segment. This document will be release based with any new update or release of the application requiring a new version of this document listing all new updates signed off by all stakeholders. All support documentation and GitHub repositories will be available to all support staff and current and future developers.

Portability requirement

The DHL Twilight cloud application is based around users on the move, being able to use the application across all platforms is essential. The application will be designed to scale across all devices including Android and iOS mobile phones. Ensuring that the application functions are compatible and easy to use on smaller mobile devices will be of primary concern during development. Extensive UAT will be completed to ensure that all users can easily access all functionality required.

Extendibility requirement

The initial release of the DHL Twilight cloud application is targeted at DHL Express employees within the Dublin area only. Future scope for this application would see the application extend across a larger geographic to include all areas of Ireland. This would require further advancements to the registration process and administrators available at DHL Express sites across all access points. Further advancements to the current functionalities could include the ability to pull additional shipment detail on the AWB barcode scan including all address data.

This would require further communications between the DHL Express in-house management systems and the DHL Twilight application; this in turn would push the need for extended secure communications and connections.

Reusability requirement

The reusability of code will be present across the application to inherit consistent views, functions and methods. The DHL Twilight cloud application will consist largely of user generated data that will all be stored and accessed through a database. Temporary PHP files will be used to retrieve and display unique user data on request. Reusing this retrieve PHP method will allow for code reusability to enable efficiency.

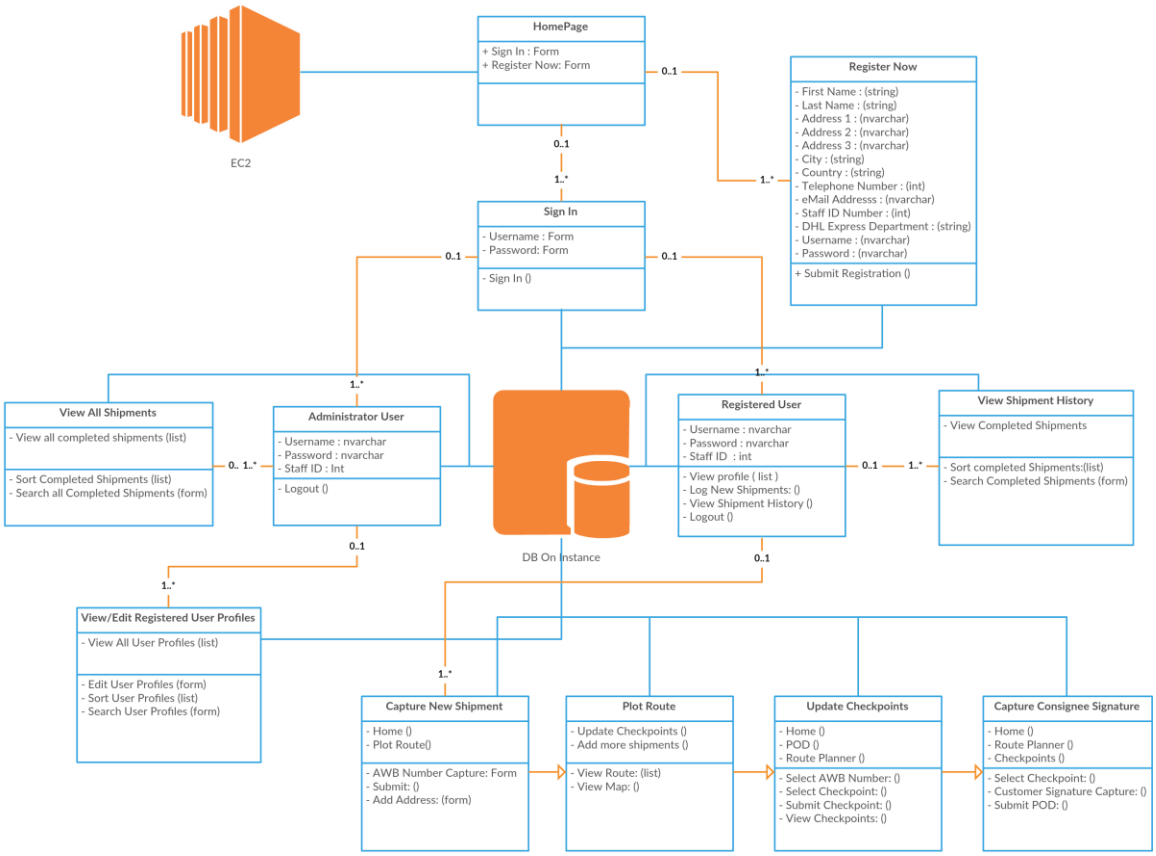
Resource utilization requirement

The DHL Twilight cloud application will be created and delivered by 1 developer in alignment with the project deliverables, timeframes and deadlines that have been laid out within the Project proposal. The Project management will be monitored and controlled with the aid of a Gantt chart that was created to provide the developer a clear and structured approach to achieve all deliverables and the RTP within the specified timeframe.

Design and Architecture

The DHL Twilight cloud application will be hosted on the AWS EC2 cloud server providing the infrastructure and scalability to meet the usage demands. The application will be centred around an AWS RDS(Relational Database Service) that will provide user validation, data storage and read/write operations to enable all functionalities. The below Class diagram depicts the system architecture and flow.

DHL Twilight Class Diagram



As can be seen in the above class diagram the AWS RDS is central to infrastructure of the application. All user registration and sign in information is stored and validated through calls to the RDS. The core functionalities within the application including shipment history, capture new shipment, plot route, update checkpoints and capture consignee signature all read and write to the database to provide a full repository of each users shipment delivery cycle. The shipment data stored in

the database is then used to build and send a file to the DHL gateway to process each shipment status.

This architecture was decided upon based on application requirements and the need for a central repository for referencing and validation. The AWS EC2 cloud environment and AWS RDS were chosen as the cloud providers due to their standing as one of the leading providers in the market, the scalability models and the relative ease to implement along with comprehensive support documentation and agents.

Implementation

The DHL Twilight cloud application will be designed with updates/backups being pushed to the GitHuB repository. The application will be hosted on the AWS EC2 cloud servers providing the infrastructure and managed services scaling to meet usage demands. An SQL database will be created within AWS EC2 environment to provide the central data storage that is required for all functionality of the application to run with read/write requests. Data stored in the SQL database will be used to form the checkpoint file that is pushed periodically to the DHL DCG gateway via SFTP.

The cloud application layout, GUI, buttons, forms and design will be built within the Cloud9 IDE providing a structured environment to develop using all programming languages in scope.

To implement the DHL Express application a number of sources will be used to aide its development. Research and deployment of AWS services will be delivered utilizing toolkits and deployment guides direct from AWS Documentation. The travelling Salesman algorithm will be implemented to assist plotting out the logic and functionality of the travelling courier route planner using online sources. I will be looking to implement a barcode scanner to read the AWB number from each shipment label that is collected by the courier and a digital signature capture form for the consignees on confirmation of delivery both of which I will be researching available software and implementation techniques from online sources. In order to conform to the appropriate requirements from DHL Express for returning shipment data I will be reviewing the API, Web Service/Toolkits and schemas to ensure data is sent in the correct format and to the correct server.

In order to compile a full and comprehensive picture of the existing DHL Express Ireland process and when/where the application can be most effective I will be researching DHL Express Ireland shipment data including volumes, delivery success rate and peak delivery periods. This will also include reports and surveys undertaken by DHL Express Ireland Operational management.

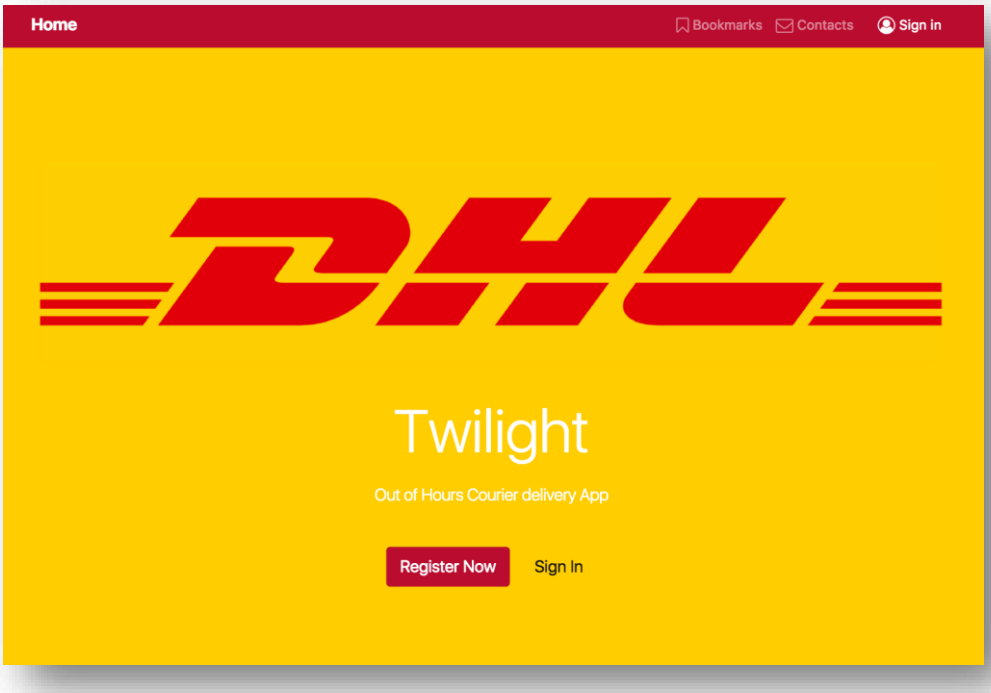
GUI - Graphical User Interface

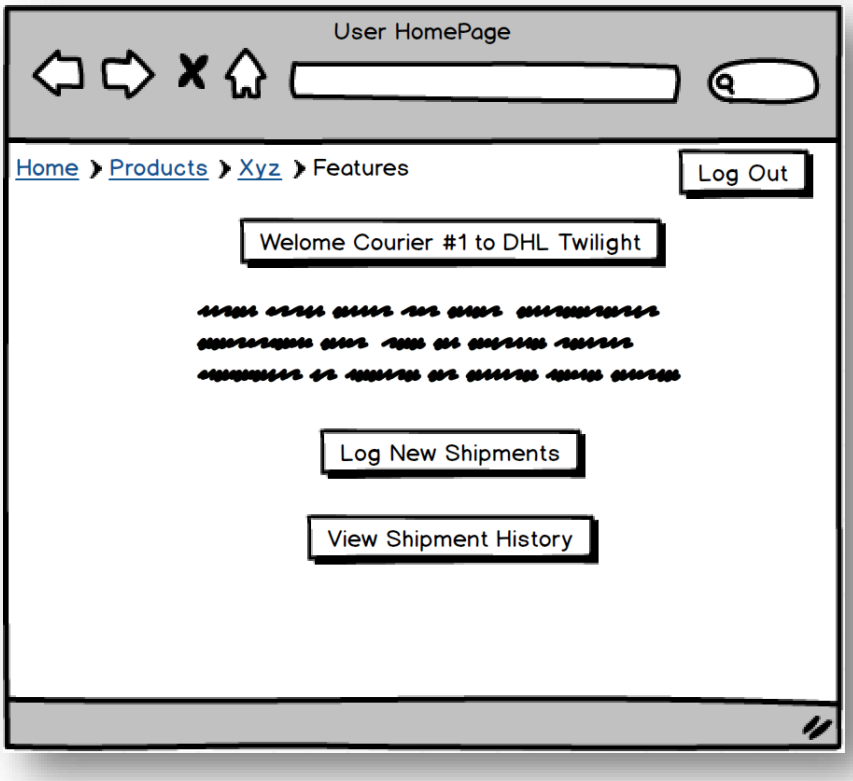
The DHL Twilight cloud application provides a platform for deliveries to be carried out after the standard courier operating hours. The application focuses around being able to record and update a shipment status up to and including the final 'Delivered' checkpoint. The GUI for the application uses the official DHL Express branding and colours that act as a consistent theme throughout navigating the application. The DHL Twilight application GIU aims to provide a clear and easy to use interface from navigation to functionality. The application is required to render across multiple platforms most importantly mobile devices. With this in mind the simple layout provides a smoother transition between platforms.

Wireframes and mockups have been created to provide a clear template for the developer to base the application design.

Home Page

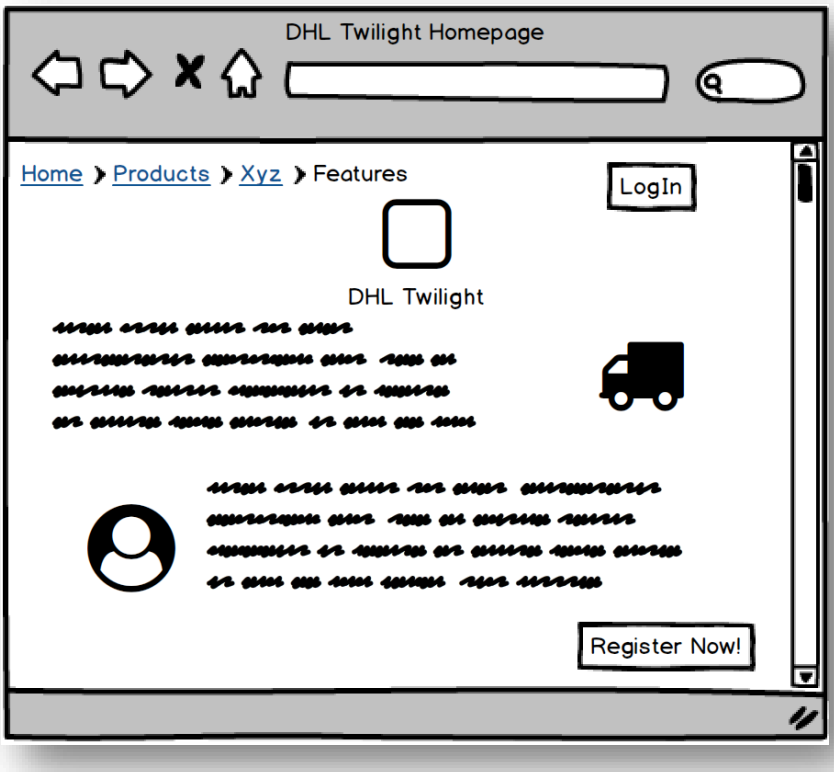
The Home Page for the cloud application provides a bold and clear overview of the application and its functionality. New Users can 'Register Now' or existing users can 'Sign In' using the buttons located in the centre of the page;


Home
Bookmarks
Contacts
Sign in
Twilight
Out of Hours Courier delivery App
Register Now
Sign In



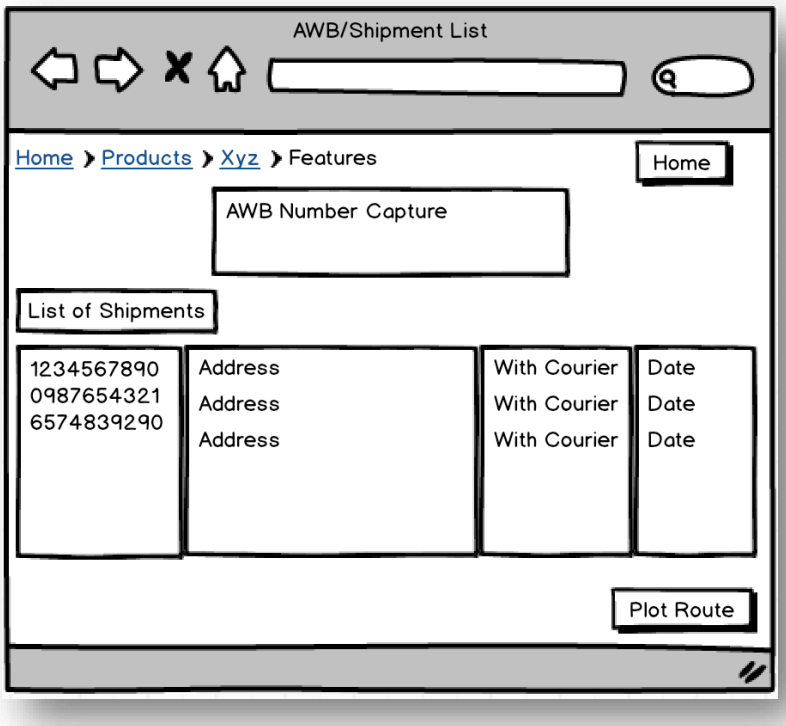
Registered User – Account Home Page

Once a Registered user is signed in they are automatically directed to their account home page that displays a welcome message and provide buttons for the user to 'Log New Shipments', 'View Shipment History' or 'Log Out';



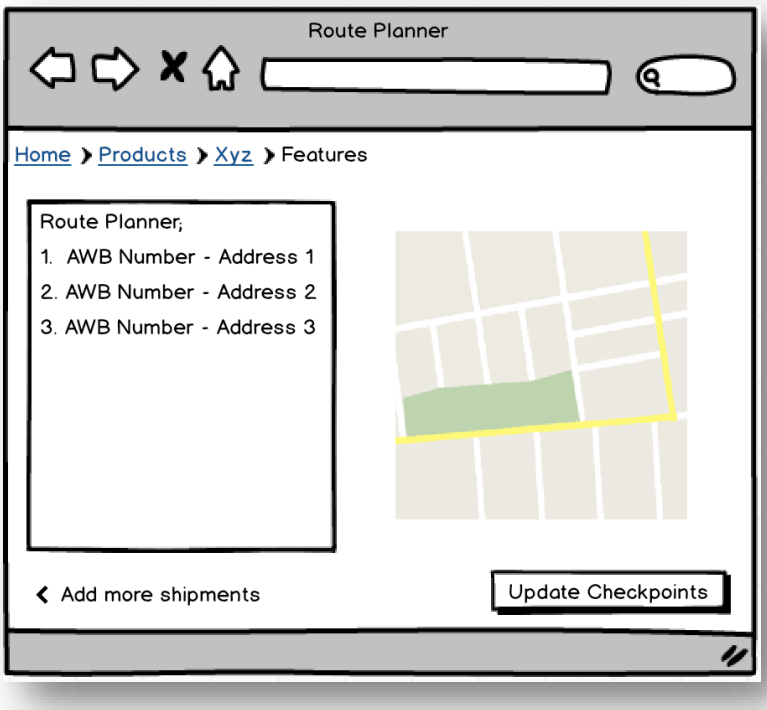
Capture New Shipments

This begins the delivery process cycle, this page allows users to scan/manually enter the AWB number of each shipment assigned to them by DHL Express for delivery. Once an AWB number is captured it is placed into the shipment list where the corresponding address can be entered;



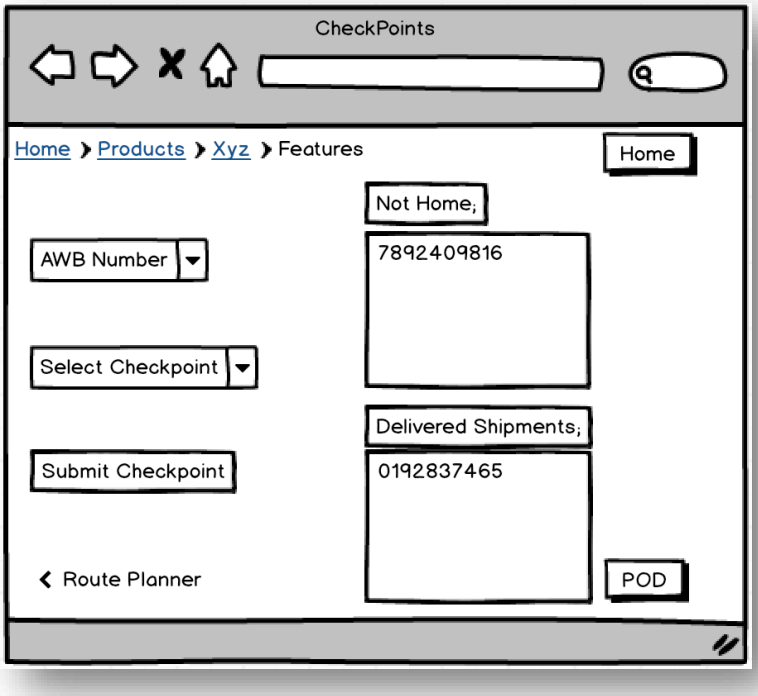
Plot Route / Route Planner

Once all shipments have been captured and the 'Plot Route' button pressed the application calculates the optimal delivery route based on the addresses for each shipment and are listed and displayed in delivery order;



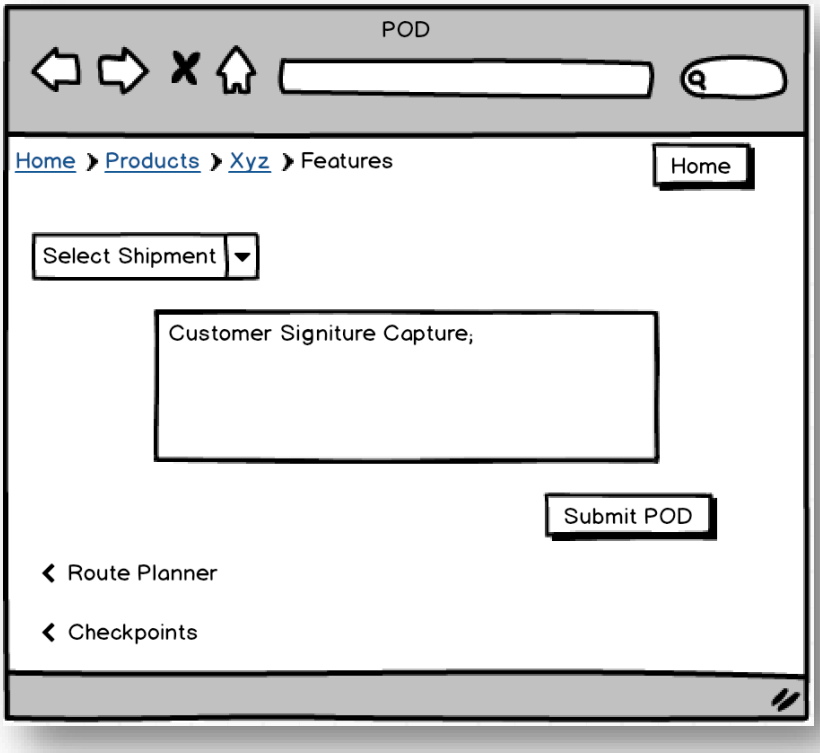
Update Checkpoint

Once a shipment has been delivered to the consignee the user can select the AWB number from the list, select the relevant checkpoint and submit this update. A summary of the checkpoints submitted that day are visible in tables on the right of page;



POD / Consignee Signature Capture

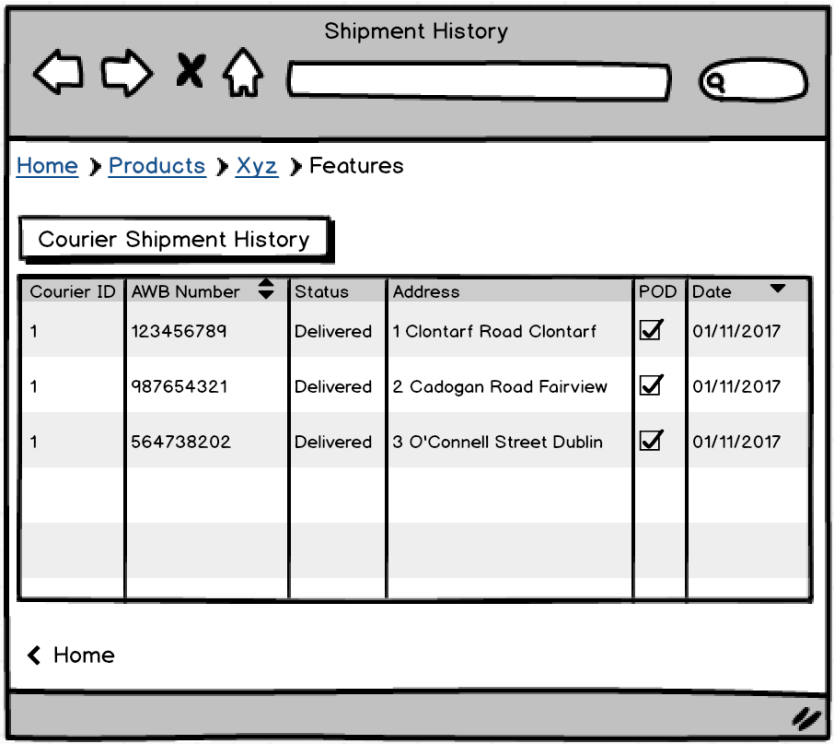
Once the AWB number has had a 'Delivered' checkpoint submitted that AWB number will be available to select from the list within the POD screen and a consignee signature captured;



View Shipment History

Each user can access and view their own completed shipment history from their account

homepage. The shipment history will display all relevant data captured from the shipment delivery that are linked to the user Staff ID numbers;



Testing

As part of the project plan designed in the project proposal using a Gantt chart, testing of the application will take place 1 month prior to the final deliverable. Testing will include full end to end testing of the cloud application by the developer. This will include all functionality and connections to the Cloud environment, database and DHL customer gateway to ensure the data flow reaches all end points and provides adequate traceability. The application will also undergo "stress testing" loading the application with volumes out of scope to ensure that it can handle the extensive load and that the AWS EC2 Cloud environment is able to scale to meet required demand as expected.

Customer Testing

Once full end to end testing is completed by the developer successfully the DHL Twilight cloud application will be released to 10 DHL Express employees who have volunteered to complete UAT. Questionnaires and testing reports will be provided to each volunteer detailing all test cases to be carried out and provide feedback.

Evaluation

On completion of the DHL Twilight application and full end to end developer testing the application will be passed to DHL Express volunteers to complete UAT. Based on the UAT feedback the application and performance will be evaluated and any changes and updates applied in preparation of the final DHL Twilight cloud application deliverable.

System Evolution

The DHL Twilight applications initial release is targeting DHL Express employees within the Dublin area in Ireland only. This version of the application and its controlled environment will provide the foundations for layering complexity to the current build to further its geographic reach. The next step for the application would be to roll out to further DHL Express Ireland Hubs in a phased approach with a view to have the application available to all DHL employees across Ireland. Additional features in scope for the DHL Twilight application are;

- Additional Data Feed. On scan of the AWB barcode the address information is also read.
- All checkpoints. Adding additional checkpoints to the application allowing for the potential to complete end to end pickup-delivery
- Expanding the network to customers allowing ad-hoc collections. Adding an interactive map to display all registered DHL Twilight couriers and their current location. Customers can request a collection from one of the roaming DHL Twilight couriers.

Based on the above potential evolution areas there are a number of directions the application can grow towards. The application could be kept in house for employee use only and therefore building on the existing functionality to capture all requirements of a full shipment collection-delivery lifecycle. This would allow for the application to be rolled out across all couriers, both daytime and Twilight, replacing the current scanners that are used with a unit cost of approximately €1,500.

An alternative and more innovative route would be to expand the application to the outside market allowing customer access to view an interactive map showing all available DHL Twilight couriers locations and arranging for ad-hoc collections. This would be coupled with extending the DHL Twilight courier application to register the couriers “active” GPS location and receive incoming requests for collections to accept or decline.

All the above future evolutions for the application are feasible but the initial release and trialling of the DHL Twilight application within a controlled limited environment will provide vital information on the functionality and current model.

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