iBorrow Technical Report
(Wireless Environment)

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1 Introduction

This report documents the technical aspects relating to the wireless element of the iBorrow project. It summarises the design considerations, constraints, solutions, implementation and significant issues that were encountered during the various phases of the project. The following timeline indicates the key milestones during the project.

iBorrow Project – Wireless Timeline	
2008	
September	iBorrow project commences
November	Augustine House high level data points for access point positions and numbers agreed
December	Wireless technology selection made
2009	
January	Wireless budget shortfall in Augustine House project identified
February	RFQ for Professional Services and wireless solution components
March	Additional funding for Augustine House wireless agreed
April	RFQ best and final offers
May	Wireless solution procured
July	Pre-staging and commissioning of WCS, MSE and WLAN controllers
August	Access points installed Wireless service commissioned Location data extraction tests completed
September	Training Wireless service operational
October	Augustine House opening Wireless location data collected

2 Design considerations and constraints

2.1 Augustine House

First and foremost the iBorrow project needed to integrate with the Augustine House project. Which was to deliver approximately 12,000m^2 of open plan space to be used as a Library and Student Services Centre. Integrating with this project brought about the following challenges:

- How would Radio Frequencies (RF) behave in a building design that featured two main structures containing four storeys, interconnected by walkways covered by a glass-roofed atrium.
- Each main structure (East and West Wings) featured thirty concrete piles that run the full height of the building.
- Building design featured bare ceilings in places and conventional suspended ceiling in others.
- Building data infrastructure was to be served by five LAN Rooms, two in each of the main wings (East and West) and one serving the multipurpose hall. Each LAN Room in each main wing would distribute cabling to the floor it was on and to the adjacent one.

2.2 Existing University wireless solution

The existing University wireless solution could not provide any real time tracking capabilities that were a requirement for this project: it was five years old and due for a technology review.

The University is a member of the Medway Consortium (along with University of Kent and University of Greenwich), which provides a wireless solution which covers the buildings of all three institutions on the Medway Campus. This wireless solution is also under review and the findings of the iBorrow project have provided valuable information about the suitability of the chosen solution.

The existing wireless service is based on Cisco technology and as such a good knowledge base in Cisco wireless technology has been established within the Support Teams. In addition, both the Medway Consortium and its member institutions all use Cisco-based wireless solutions at their campuses.

2.3 Wireless service

The wireless service must continue to deliver the Janet Roaming Service[1].

It must be capable of supporting multiple broadcast service set identifiers (SSIDs).

It must be capable of delivering sufficient bandwidth per client to enable both the use of the iBorrow self-loan laptops and to deliver the relevant content via thin-client technology, in addition to allowing conventional use of the service.

It must allow fast roaming to allow users, particularly those using iBorrow laptops, to move freely within the building whilst maintaining their session.

It must deliver a Real Time Location System (RTLS) to enable the tracking and reporting of the use of iBorrow laptops within the building.

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[1] http://www.ja.net/services/authentication-and-authorisation/janet-roaming.html

3 Solution

The solution implemented consisted of the following components at a combined cost of £106K including VAT @ 15%:

3.1 Management

- WLAN controllers (WLC) – Manage the thin access points
  4 x Cisco WLC4402 each licensed to manage 50 access points

- WCS Server – Centralised management of the WLAN controllers and access points
  1 x Cisco WCS licensed for 150 access points running on a Virtualised RedHat Linux 5.0 Enterprise server 32-bit (VM resources allocated for WCS standard server specification[2])

3.2 Wireless access points

- 120 x Cisco 1242AG-LWAPP
- 240 x Cisco 2.4Ghz, 2.2dBi Dipole Antenna
- 240 x Cisco 5Ghz, 3.5dBi Dipole Antenna

3.3 Real Time Location System

- MSE – To allow real time location data to be gathered and exported to other systems
  1 x Cisco 3350 Mobility Services Engine appliance
  1 x Context aware engine client license for 3000 clients

3.4 Professional Services

- Design
- RF Survey
- Installation
- Commissioning
- Training

3.5 Maintenance

- 4 x 8x5xNBD on site WLC4402
- 1 x 8x5xNBD on site MSE 3350
- 1 x software support on WCS
- 1 x software support on Context aware engine

[2] http://www.cisco.com/en/US/prod/collateral/wireless/ps5755/ps6301/ps6305/product_data_sheet0900aecd802570d0.html

4 Technical issues

The main technical issues that arose are summarized below:

4.1 Design

Due to the advanced build schedule, it was necessary to make some design choices fairly quickly so they could be approved and incorporated into the scheme of works by the architects and Mechanical & Electrical and delivered by the data cabling contractor. The main issues to tackle were:

- access point positioning
- establishing data cabling routes to the access point positions
- access point mounting options
- capacity planning and technology selection.

Access point positioning was the first and biggest single issue encountered. This had a knock-on effect on numbers, mounting options and routing the data cabling. It was decided that the concrete piles could be significant RF obstacles and, in conjunction with there being few options for mounting access points directly on the bare ceiling or in ceiling voids and a severe shortage of partition walls, the conclusion was reached that the access points would be mounted on the piles directly at high level. It was also necessary to plan the data outlet provision before deciding which wireless technology solution would be used and therefore how many access points would be required. Agreement was reached to over provision the number of data outlets and therefore create a degree of flexibility in the wireless design. This allowed the planning and optimisation of data cabling routes to commence. It also essentially future-proofed the building in terms of wireless provisioning, which should allow significant changes in both wireless technology but, more fundamentally, coping with the re-purposing of the open planned space into enclosed areas should that ever occur.

Data cable routing had to satisfy the aesthetic aspects the architect was tasked with delivering and the M&E requirements to minimise and manage the number of cabling routes. It was agreed, for both aesthetic reasons and cabling distance limitations, to route the cable at high level. This then required planning of concrete slab penetration points to create a path onto the adjacent sub-floor cabling basket work and then onto the associated LAN rooms. This was no mean feat to achieve considering that construction was already into its eighth month and first fix was only six months away.

Mounting options became the next issue, due to the concrete piles being circular and off-limits as far as drilling into them. Industrial strapping provided a solution for the majority of positions where the piles where free from glass windows or partitions. However, a small number of locations, did encounter this limitation, where floor-to-ceiling glass windows were flush against the piles. However, these problem areas occurred where suspended ceiling was in place, thereby allowing custom made floating brackets to be used to allow the Wireless Access Points to be mounted at the same relative vertical position on the piles. With both the strapping and floating brackets options an element of future proofing and fine-tuning of WAP positioning on the piles became available.

Four questions were asked to ascertain capacity planning and technology selection:

1. Which technology should we use?
2. How many access points are needed to service the Clients?
3. How many access points are needed to reasonably calculate the position of a client within the building?
4. How many access points can we afford?

From a technology perspective, several factors determined the choice:

- Location tracking was only available in thin access point solutions
- 802.11n was in draft, so no guarantee that solution would be certified once 802.11n was ratified.
- The existing wireless service provided 802.11a/b/g, so selecting a solution based on the 802.11n draft specification would create disparate service provision across the University and could force an accelerated adoption requiring significant unplanned investment
- 802.11n may require further investment on edge to core connections considering the potential for concurrent users within the building and factoring the effect of roaming connections
- Edge switching was not capable of supporting 802.11at POE+ requirements of available 802.11n access points
- Thin client technology did not need the bandwidth capabilities that 8011.n could potentially provide.

A theoretical capacity planning exercise was carried out that used information, such as Microsoft's RDP Performance White Paper[3], observed behaviour of our existing wireless service and some assumptions based on the design and function of the areas within the building. This provided information about the numbers of access points that were required for coverage and location information.

4.2 Implementation and configuration

The WCS software was not compatible with our desired choice of a 64-bit operating system, thus a 32-bit OS was used. CPU and memory requirements were met by VMWare ESX infrastructure and the 200GB storage requirements were met by allocation from a SAN.

It was decided not to deploy WCS in a high-availability (active-passive) design, despite there being no additional WCS licensing cost. The service could be restored relatively quickly from backup should the need arise. If the wireless solution were to expand to the entire University and the support aspects of the WCS became critical to the business, this could be reviewed.

Key aspects of the WCS configuration included: controller templates, access point templates and map configuration.

Custom physical and virtual interface configuration were required on each controller, but thereafter controller templates could be easily generated by configuring a single controller and importing the configuration directly into templates via the WCS. These templates could then be applied to several controllers from the WCS.

Access point templates were used to assign controller membership, access point role (Local or Monitor mode) and define the backup and tertiary controllers for the access point. It is important to note that access point controller membership does not fail-back after the outage of a WLAN controller. In addition without specifying backup and tertiary controllers access points will broadcast or query a specific domain name to search for available controllers to manage it. This could have an impact on roaming and the subsequent client session path through the network. Templates can be created to apply controller membership and can be scheduled to run periodically to mitigate this. The process of renaming access points could only be done via the WLAN controllers through the web

[3] http://download.microsoft.com/download/4/d/9/4d9ae285-3431-4335-a86e-969e7a146d1b/RDP_Performance_WhitePaper.docx

interface individually or via command line. The naming process was onerous, but can prove invaluable for support later on. Further exploration of automatic or scripted access point naming would be highly desirable for large scale greenfield deployments.

The MSE was relatively straightforward to pre-stage. Once communication was established with the WCS, the WCS could then be used to manage and configured the MSE. Difficulty arose with gaining access to the MSE API resources and documentation. Assistance from the Cisco developers helped us move forward and thereafter the Data Management Working Group gained an understanding of their element.

Maps were generally straight forward, although a bug was encountered whilst attempting to import a type of CAD file which caused the WCS to crash. Aside from noticing the web interface becoming unresponsive, there would need to be specific service monitoring of the WCS to detect and report any service problems. At the time of writing, integration to our monitoring systems is still pending.

Although various co-ordinate based location systems could be used, it was decided that querying the MSE via API for known MAC address (iBorrow laptop) and returning a defined coverage area, would be the simplest method of tracking and reporting on clients. Data would not be gathered for iBorrow laptops that were not located (detected) within the defined coverage areas.

Creating a calibration model and performing calibration steps has proved extremely problematic. Issues have been encountered with Vista, mixing autonomous and managed access points on the same map and non-Cisco wireless network cards. It is strongly recommended that if professional services are used it will be well worth the cost of including system calibration in their remit.

Figure1 below gives a brief summary of the wireless installation. Elements not shown in the diagram that are relevant include:

- All access points, WLAN controller management interfaces and WLAN controller AP manager interfaces are on the same subnet.
- All access points are allocated IP’s (statically assigned) via DHCP.
- Wireless client networks are configured to failover between the physical WLAN controller interfaces.
- Lower data rates (1Mbps, 2Mbps, 5.5Mbps) where disabled in the WLAN configuration.
- Dynamic RRM is used throughout.
- WLAN controller DHCP proxying is used for client IP assignment.

Figure 1 - Wireless Topology Overview