



IT and Telecom
Consulting

Cellular RF Study Phase 2 Final Report

University of
British Columbia

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1 Executive Summary

Project Purpose

UBC is experiencing escalating requests for new cellular installations on campus and in the adjacent university neighbourhoods. TMC was engaged to conduct a study to determine existing and future coverage needs as well as how to better manage the application process and operation of existing cellular sites.

Phase 1

This study was undertaken in the second quarter of 2012 and is referred to as “Phase 1” of the larger project. The Phase 1 report was issued in August of 2012 and contained a series of recommendations and a suggested high-level implementation process.

Phase 2

In November of 2012, UBC issued a request for TMC to proceed with many of the Phase 1 recommendations. This report delivers the following results:

1. Agreement reached for new processes for ten internal procedures to improve the management of cellular antenna management.
2. An on-line cellular satisfaction survey has been completed.
3. Meetings have been held with carriers with the general result that the carriers will begin to deal with UBC as a municipality and share planning information on that basis. The carriers plan to meet with UBC in the coming months to finalize this new relationship.
4. Our goal of obtaining carrier field surveys was not successful so this objective is being fulfilled as part of the satisfaction survey.
5. A list of buildings and sites has been developed to identify them as YES, NO or MAYBE for future cellular installation potential. The list is a work-in-progress as UBC Facility Managers and UNA staff agree the suitability in each case. While this list was not developed with carriers, when complete, it can be shared with carriers as UBC develops a municipality-style relationship with each of them.
6. We have prepared a briefing on the future of cellular technology infrastructure and equipment and how new installations may be creatively incorporated into both the existing and future campus.
7. We have advised on the value of freestanding structures/monopoles on campus lands.



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8. We have also identified the next steps that UBC will need to undertake to conclude the restructuring of the cellular antenna management project.

2 Project Objectives

These objectives are based on the Phase 1 report.

1. Develop an implementation strategy that builds upon the recommendations in the original project work within the Cellular RF Study Final Report prepared by TMC IT and Telecom Consulting, dated August 10, 2012.
2. Employ the existing Steering Committee (with additional UBC departmental representation and external stakeholders (eg UNA) as needed) to facilitate discussions to achieve project objectives that include the procedural recommendations outlined in Sec. 6.1.2 of the Phase 1 report.
3. Assess cellular service satisfaction levels and needs by engaging and consulting faculty, staff, students and residents in a meaningful way.
4. Coordinate facilitated discussions between UBC, the UNA and cellular carriers to foster communication and understanding of mutual and individual needs in an effort to streamline application review processes and respond to future capacity needs. Topics to be discussed are to include but not limited to:
 - a. Criteria for siting future installations
 - b. General knowledge sharing on existing cell sites serving UBC
 - c. Opportunities for multiple carriers to share locations/sites
 - d. UBC's wireless and cellular carriers' anticipated future expansion plans
 - e. Sharing UBC's future development plans with carriers
 - f. Exploring opportunities to co-ordinate linkages between UBC's IT network and cellular service on UBC lands
 - g. Exploring the potential and demand for in-build systems
 - h. Piloting new and innovative cellular technology on campus
5. Undertake the following targeted field surveys to assess service reception levels and gaps on UBC lands: South Academic area north of 16th Avenue, Wesbrook Place neighbourhood, academic lands south of Wesbrook Place, Northeast academic area, Northwest academic area
6. In collaboration with carriers, assess, identify and tag, using established criteria, those buildings and sites that have future cellular installation potential and those that are not appropriate for cellular installations
7. Provide direction on the future of cellular technology infrastructure and equipment and how new installations may be creatively incorporated into both the existing and



future campus built environment Identify potential locations and evaluate the need for and advantages/disadvantages of freestanding structures/monopoles on campus lands



3 Project Results

3.1 *UBC Internal Procedures and Standards*

There were 10 separate issues that were identified in our Phase 1 work as “procedural”.

3.1.1 *Site Files and Compliance Certification*

The concern expressed in Phase 1 was that there are no “master files” with all records about a site; nor are there auditable records confirming that sites comply with codes, such as Safety Code 6 governing radio power levels where non-trained people have access.

Safety Code 6 compliance cannot be taken for granted and the legal liability for issues arising from non-compliance can fall on the landlord. This is not to say that the landlord is responsible for technical compliance – rather that the law would seem to expect the landlord to take positive steps to require that his tenants comply, and that those steps should be open to audit. If a single tenant is involved then it is usually sufficient for the landlord to assert in the contract that the tenant is responsible for safety compliance and to request, and maintain on file, the resulting certificate of compliance from the tenant.

The problem comes from sites with multiple tenants where there are multiple tenant agreements – as opposed to a single master agreement with sub-tenancy arrangements. With a single master tenant, who is allowed to sub-lease to other tenants, the compliance responsibility can be assigned under the master tenancy agreement. However with multiple separate agreements, each site can be in compliance on its own but the site as a whole can fail to comply. That is why many landlords sign only one master agreement and allow sub-leasing to other carriers – possibly with some revenue caveat to ensure that the landlord is remunerated for sub-lease arrangements.

Note: While TMC has certified engineering staff who are qualified to do Safety Code 6 measurements and to issue audit reports when required, being fully experienced in the technical matters on which the law is based is not sufficient for UBC’s requirements. Our interpretation of how the law applies is based on experience with other sites. Qualified legal counsel should be sought if clarification of legal matters is required.

Solution

In our Steering Group discussion, there was general agreement that the master version of all files should be in electronic format and that it should be filed in the central registry for ease of access by everyone.

Each project file will need to be closed and signed off. Documentation must be received to UBC’s satisfaction before the project file is closed. A deposit could be required as is done

for Record drawings or a “final completion holdback” could be built into the permitting process.

The documentation must be kept up to date once the initial work has been completed.

3.1.2 *Single Point of Contact*

The aim here is to replace the current system, where carriers deal directly with several departments, with a single point of contact. It is not intended that dealings between carriers, or their agents, and departments other than the primary contact point will be eliminated – rather that the first contact will always be via the primary contact so that the formal UBC process will be triggered in all cases. In this way, all interested departments will have the opportunity to become involved should they see the need and there will be no chance of a new project being missed by someone who was not told of the work. Going forward, all interested departments will register that interest and will be notified of all new work by the primary contact point. They could then choose whether they wish to have involvement in a given project.

Solution

There are some challenges since UBC has both neighbourhood residential (UNA) and institutional academic buildings. UBC buildings have UBC facility managers but buildings in the neighbourhoods within the jurisdiction of the UNA may not. Residential buildings within the neighbourhoods may be managed by Strata Councils, or may be rental buildings managed privately or by UBC Properties Trust through Village Gate Homes.

Karen Russell, Development Manager C&CP, was nominated as the first point of contact.

For the neighbourhoods, the agreements with Campus Planning are that cellular applications within the neighbourhood would be run through Calvin Cheung, UNA.. Residents in the UNA neighbourhoods within 30 meters of an application will be notified as per the Development Handbook.

3.1.3 *Signoff Checklist*

The intent was to create a uniform interface to represent UBC to the carrier organizations and to back that up with an internal structure that will allow all interested parties to have input. As part of defining that internal structure it is important to create a list of all departments that have a need to be involved.

Solution

It was agreed that all Steering Group members (RF Cellular Committee) will be on the contact checklist. The application will come to C&CP who will then distribute it online to

the Committee. Each contact will individually decide whether they need to be involved, or wish further information. Although the people involved are the same people who are on the Steering Group, the process should run independently of the committee meeting structure – it is not intended that routine applications will be presented at the periodic meetings.

Major installation applications will also be presented to the Development Review Committee. Members of the RF Cellular Committee could also attend and participate if they wished.

In the future, the carriers will become involved in the process much earlier and it is hoped that installations will be planned as part of the building design process for new buildings.

Although not within the remit of this project, IT systems use some of the same sites and there is interplay between the different RF systems. Going forward, IT should notify C&CP if they want to do any work on top of one of the buildings. It was noted that, following the public realm upgrades, there is a big push for external wireless coverage.

Rob MacDonald, Facility Manager, offered to assist with Safety Code 6 compliance testing by providing a contact person who is RF certified and can sign off and issue the latest certificate.

3.1.4 Option to Locate Equipment Indoors

A possible option to resolve site security issues might be to encourage the location of equipment indoors.

Solution

It was considered that security is not likely to be an issue at sites other than Henry Angus. As such it was not considered worthwhile looking at changes to other sites, although new building designs might consider indoor options for equipment location if that is useful to the carriers.

3.1.5 Henry Angus Access Rules

In Phase 1 it was noted that there are some site-specific new rules governing access to the Henry Angus installation. In the report it was recommended that these new rules should be incorporated into the standard contract rules governing acceptable behaviour at all sites.

Solution

It was agreed that these new rules should be incorporated into the standard contract rules when the new contract is written. For example, these rules could ensure that carriers would be notified of any service shutdowns on buildings that may affect the operation of their equipment.

3.1.6 Mandatory Site Sharing

It was suggested that the contract (license) wording should be amended to clearly indicate that site sharing is not just desirable but is mandatory wherever possible.

Solution

It was agreed that the wording should be changed when the new contract is written.

3.1.7 Alternate Fee Options

The current process basically revolves around a series of license fees charged in the approval process. A more common remuneration process is for the carriers to be paid a smaller but recurring fee for the privilege of using a location. To the carriers this difference is significant because large up-front fees are considered part of the site capital cost whereas smaller recurring fees are considered a part of the site running cost.

Solution

This will be considered in discussions with Carriers and then presented back to the Steering Group.

3.1.8 Option for Higher Grade Power

It was considered as an option in Phase 1 that UBC might offer protected power (generator backed) as an added value feature.

Solution

The view was that this was not worth offering in current buildings because of the limited generator capacity but possibly worth considering for new buildings where the generator capacity could be sized appropriately.

3.1.9 Aesthetics Retrofit Options

One of the suggestions from Phase 1 was that consideration could be given to adding architectural features to building rooftops to disguise the visually intrusive antennae systems.

Solution

It was not considered to be worthwhile for existing buildings. Better to show the installations as is rather than disguise with building shrouding.

3.1.10 Aesthetics Design for New Buildings

The same suggestion as in the previous item was also offered for new building construction.



Solution

It was considered worthwhile investigating amendments to new building design in order to disguise rooftop antenna systems. New Building designers should be encouraged to work with the University Architect to anticipate cellular installations at the pre-design stage.

3.2 Cellular Service Satisfaction Assessment

To make most effective use of the project resources, TMC assisted UBC/C&CP with the development of a questionnaire format and C&CP conducted the web-based questionnaire advertising, management and analysis.

Solution

The questionnaire detail is shown in Appendix 1 – Cellular Service Web Questionnaire on page 22.

The on-line input closed on March 30th. The results are summarized in the Appendix on page 25.

Analysis of the results shows that the majority of problems relate to in-building coverage, with two specific buildings featuring strongly. This may be because those buildings are in low signal areas.

The results are, of course, highly subjective – as is the nature with this type of survey. It is not possible to infer any technical conclusions as to why specific results have been obtained – it may just be where people tend to prefer to use their phones most frequently. Whatever the technical reasons, it is clear that there is significant user dissatisfaction – sufficient to motivate people to take time to respond to a survey. That alone illustrates a perception of sub-standard service – and, in any service industry, user perceptions are every bit as important as factual problems.

The carriers are encouraged to take these results as a measure of user dissatisfaction that should help guide them in planning some remediation work. If, in turn, UBC and its user community could see that the reason for project “x” is to resolve the user identified problem “y” then the loop would be closed and the community would feel involved in the process – and possibly more welcoming to the solution.

3.3 Facilitate Discussions with Cellular Carriers

Many deficiencies with the relationship between the carriers and UBC had been identified in our Phase 1 report. The work in Phase 2 focussed on getting the carriers on board with identifying opportunities for change and starting on what was likely to be a long process of

improvement.

We held discussions with Telus, Rogers and Bell; and we also kept the other carriers aware of our discussions by e-mail. The Telus and Rogers discussions extended to in-person meetings. The initial concern was that TMC might be suggesting a new process where the carriers would be required to deal with TMC on behalf of UBC rather than being able to deal directly with UBC. When it was realized that this was not the case, the discussion began to make progress. It was identified by the carriers that UBC was really a lot more like a municipality or a small city than simply a landlord. The carriers have all had problems dealing with municipalities like landlords – for many of the same reasons identified in the UBC report.

Solution

The suggested solution that gained preliminary acceptance by Telus and Rogers was to look at possibly regarding UBC as a quasi-municipality. Because of the time required within the carrier organisations to process such a proposal and to produce suggestions as to how it will work, it is likely to be several weeks before firm ideas are available from them to work with. Current suggestions include a willingness to share medium and long term development plans on a two-way iterative basis – exactly like the Phase 1 report had suggested.

We find these embryonic ideas very encouraging and look forward to them maturing in the near future.

Two Valuable New Opportunities

A spin-off idea arose from the in-person discussions with the carriers and is related to the in-building service problems.

The carriers understand that many buildings do not have adequate coverage inside. The only solution in most cases is to install either repeater systems or micro-cell sites inside the buildings. It was explained by the carriers that, whilst most macro-cell sites (such as the main UBC rooftop sites) are financed by the revenue generated, and hence count as more of a current account cost than a capital project, in-building systems do not produce significant extra revenue – so such projects must compete for limited capital budgets.

In discussions around possible ways to “think outside the box” it was identified that the major cost component for in-building systems was the actual installation work. The equipment cost, particularly for simple repeater systems, is fairly low. Installation is not unlike what is already done at UBC for the Wi-Fi system, so it was suggested that the carriers might consider supplying the equipment at their expense for UBC to install as part of

ongoing electrical renovation work.

One further suggestion was raised – that UBC and the cellular industry might set up a formal research project to look into the idea and document it as a solution for much wider use.

3.4 Targeted Field Surveys

It had been hoped that the carriers would be willing to share their survey maps with UBC to help UBC work with its staff, students and residents (including the UNA) to identify areas of poor service that were not known as such to the carriers.

The problem stems from the fact that the carriers are aware of many areas where there are problems with inadequate coverage. Some have solutions in the pipeline, while others may affect such small numbers of users that no solution will be economic for some time. However there are many areas where service is inadequate but where the carriers think the opposite. Technically this is the difference between the theoretical models often used to map service and the practical reality with trees and the like that do not feature on digital maps. What UBC wants to do is to help fill in these gaps, which might identify some areas needing more urgent attention – supporting the anecdotal evidence coming from staff and students of many such locations on the UBC campus.

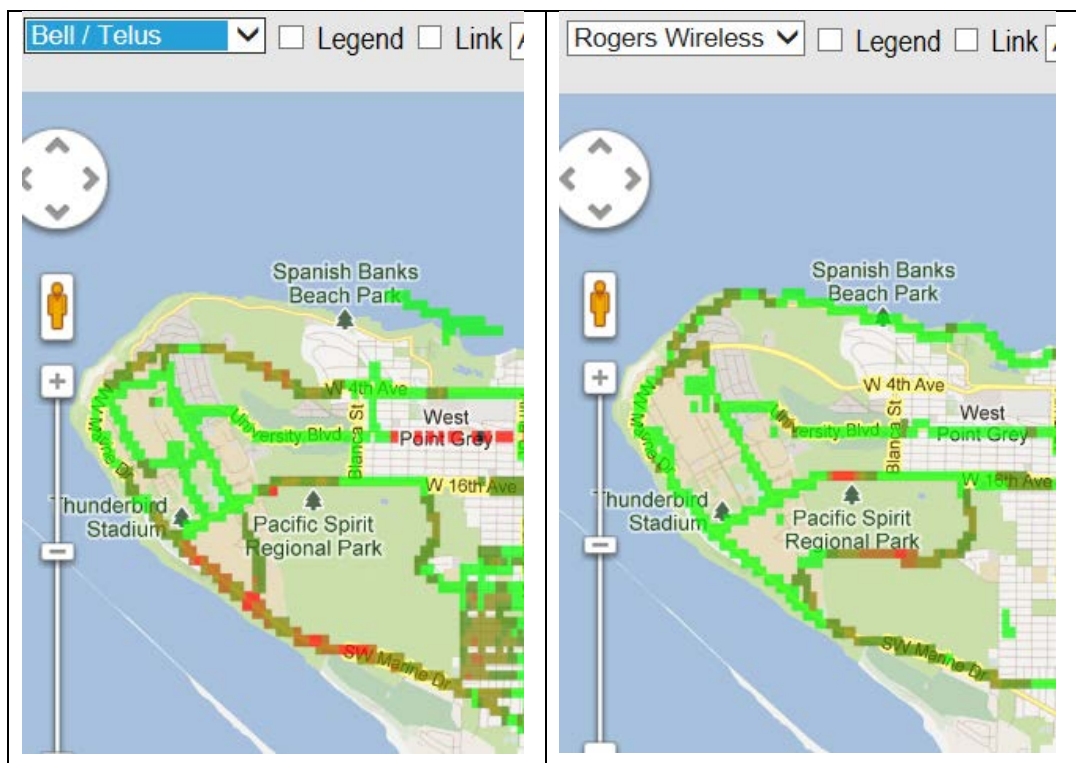
Unfortunately, the carriers do not feel that sharing their coverage maps would be worthwhile and our requests have been declined.

Solution

The questionnaire results will fulfill this need.

The carriers were introduced to the planned questionnaire process (covered in section 3.2 above). They were invited to add questions to the survey but none took up that offer. By way of this report, the survey results will be shared with the carriers as UBC's contribution to identifying some coverage problems that may not be currently understood by the carriers.

Additionally, our attention was drawn, by a resident of Wesbrook Village, to an interesting “crowdsourcing” application used to generate a coverage map based on input from thousands of cellular users – rather like the rudimentary survey we did in the north campus in Phase 1. Normalizing the data with a large population produces a more statistically valid result. The fact that such an application even exists shows that UBC is not alone in its concerns that the carriers may be unaware of many significant “holes” in their service.



The two images above show the site portrayal of service at UBC from the two main networks. It confirms the perception of problem areas on parts of Marine Drive to the north and northwest of the campus as well as the south campus area.

This input was shared with the carriers but it is not seen as sufficiently accurate to be of serious use in network planning. Regrettably this misses the point that user perception of poor service is every bit as important as real poor service. Whatever the cause, a response is deserved.

3.5 Assess, Identify and Tag those Buildings and Sites for Future Cellular Potential

The aim here was to produce a list of UBC buildings annotated with yes/perhaps/no descriptor tags – recognizing that some buildings are not suitable for cell sites and applications would simply waste a lot of time. The development of this “no-go” list could potentially include tagging some buildings as “already approved” – leading to the idea of a red/yellow/green tagging system.

The need for this was illustrated by a recent application process where a cell site was planned for one building, only to be turned down. The resubmitted proposal for a different



building was also turned down and the process will continue to waste time for the carrier's agent and for UBC trying to find a match.

Solution

UBC Facility Managers and the UNA are working on deciding which buildings are or are not suitable candidates for Cellular Base Stations. A list has been produced and is included as Appendix 2 – Building Suitability List on page 28 of this report.

Note: *This list is currently being prepared by UBC Campus and Community Planning in consultation with building users and facility managers.*

3.6 Provide Direction on the Future of Cellular Technology

Rather than include a lengthy passage in this subsection of the report, we have included a customized TMC technology review as section 4 on page 17. This is our evaluation of how technology developments are likely to affect UBC and its relationship with service providers, including its own Wi-Fi service.

3.7 Assessment of Need and Value of Freestanding Structures/Monopole

This question initially arose out of a coverage issue at the TRIUMF site. The staff there have been getting increasingly frustrated at the lack of acknowledgement of poor service in the area and had proposed an independent third party solution. The proposal involved a faux tree structure to support the cellular antennae at a proposed new cell site to serve the TRIUMF location.

Our concern is over the process and the lack of buy-in from the carriers. There is little point in building a structure with the best of intentions if the carriers decline to use it – and indications are that the carriers currently do not perceive the location as a problem.

We took the opportunity to visit the area and meet the staff concerned. There are a number of issues that are going to affect cell service – primarily to do with the location being both in a forested area and below the horizon for the campus cell sites.

Firstly the carriers need convincing that there is a coverage issue to be solved. Then options need to be considered, for which the faux tree may well be one.

However the suggested location may not solve the problem – being in with the trees that may be part of the reason for poor signals and also being on the side of the building with the most dense walls. A better location may well be in front of the building – but these discussions are for the carriers to consider after they accept that coverage at TRIUMF needs



improving.

The faux tree idea certainly has merit. It has been used by Bell in Ontario to satisfy the need for visual screening. We like the idea and agree that it may offer a visually appealing way of siting additional cell sites around the UBC campus. Whether the 3rd party ownership idea is the best way, or is even workable at UBC, is not possible to say at present. However we recommend that it is discussed with the carriers as a potential partnership solution for at least some locations on the campus.

Solution

We suggest that both the TRIUMF site and the faux tree idea are tabled at the upcoming discussions with the carriers, as noted in section 3.3 above.



4 How Evolution of Wireless Technology will affect UBC – TMC’s Vision

Telecommunications technology is evolving and will radically change over the coming years. There are two aspects to the evolution of telecommunications technology relevant to this project. Firstly there is evolution in the field of telecommunications networks – how information is moved from place to place. We refer to this as the “Transport Layer” and it encompasses cellular networks, voice data and text, wi-fi networks and traditional hard-wired networks, including cable television networks and telephone company landline networks. Secondly there is what the end user sees – which is the application interface, like internet browsers, email, voice calls etc. We refer to this as the “Service Layer”.

Typically, commentators look at the development of physical technology – the “tangible stuff”. It is easy to get excited about new cellular data speeds or ways of delivering TV signals over optical/DSL services in competition with Cable. However that misses the point that the “service” is what really matters to the paying end user – the TV programs or the Facebook application. Cellular service providers see “cellular” as a “service” and frequently miss the point that it is not a service but rather is a delivery mechanism for services, which could equally use a different transport layer mechanism.

There used to be a time when making a voice call implied having a wireline telephone at both ends. Now one end can be cellular and the other end a port on a Cable TV network. The “service” to the user looks and feels like a telephone service but it may well have been delivered entirely on networks that have nothing to do with wireline telephony.

To see the two perspectives more clearly we will look separately at the Transport Layer and the Service Layer – remembering that the two used to be one and the same before technological competition changed the playing field. Finally we will take a look at where all this is taking us.

4.1 *The Transport Layer*

Cellular

Cellular services began as an evolution of radio-telephone services – all of which were based on the need to make and receive voice calls on the move. Early services were entirely analog in nature. Modern services are entirely digital – a move initially made to gain more capacity in the very finite radio spectrum available.

Initially this move to digital paralleled the move of landline phone networks to digital and the cellular specification was very similar to its landline cousin. In both cases, the communications channel could be used for data (circuit switched data) or fax or voice –

although most users only saw only the voice use.

The change from the original digital service to an IP-based network (packet-switched data) allowed the network to operate rather like a mobile version of the Internet. Indeed, with gateways to the public Internet, that is exactly what it became. The biggest limitation has always been speed, because the mobile channel has to balance speed and distance. With cell sizes quite large, speeds were quite slow. By the time cellular data had struggled up to a 64Kbit/s channel, the landline equivalent was well into the Mbit/s range. Cost was another negative because the bandwidth used was billed on a cost recovery basis and costs were much higher than using existing wireline systems.

As cell sizes reduced, thanks to traffic growth, the data speeds could increase. New technology played a similar role and now we have significantly higher data speeds – at least in urban areas.

The down side in this technological wonder is that the network topology was designed around large cells and infrequent inter-cell hand-off. Users can move from cell to cell and hold an IP session just like they hold voice calls while moving. The overhead to achieve this reduces the capacity of the cellular data network compared to other ways (like Wi-Fi) of serving wireless data.

Wi-Fi

In contrast, Wi-Fi systems are very efficient at serving large numbers of users in a small area. At the London Olympic Games, British Telecom used Wi-Fi systems to serve the needs of 10s of thousands of users crammed into the many venues – something that would have been impossible to achieve using cellular data technology at any reasonable speed. Again, there is a down side. Users of Wi-Fi systems need to stay in range of the Access Point (AP) used to set up the IP session – because inter-AP roaming is not supported.

Going forward, Wi-Fi is moving to address the need to roam between APs and next generation Wi-Fi systems will allow full roaming without dropping calls. Currently, a single Wi-Fi network can support inter-AP roaming to a limited extent – allowing users to move around areas like an airport or a campus site. However moving from Starbucks along the street using the municipality's free Wi-Fi service and going into Tim Hortons is not possible without re-establishing the IP-layer connection repeatedly.

Converged Networking

The next big step for both Wi-Fi and Cellular data networks will be to follow the model recently pioneered in Europe and to support authentication and hand-off between not only different APs but also different networks.

In Europe, it recently became possible to take a standard high speed internet service

provided by the local telco, with a Wi-Fi router giving the usual wireless internet service and sign an agreement with the telco to allow public use of the “private” network. Doing this can leverage lower rental costs from the telco and can also, in a domestic scenario, allow a user to roam onto other telco-supported networks at no cost – opening up a vast pool of such “shared Wi-Fi” systems to participants.

More than that, the latest technology cellphones will freely roam onto Wi-Fi when available. Household cordless phones are also Wi-Fi compatible and can be taken outside the home and used on any Wi-Fi service – effectively providing the transport layer for a service that is remarkably similar to cellular in feature set.

4.2 The Service Layer

Whilst many users are “tech” literate and are genuinely interested in the supporting technology, others simply see the service. ‘It’s a phone – who cares how it works as long as it makes calls’.

Nowadays, if you dial a phone number, your call could terminate on a cellular phone, an IP terminal on a Cable TV service, a computer running Skype, a tablet PC or even a satellite terminal on some remote part of the ocean. It is a “service” and the “transport technology” used to provide it is largely irrelevant (as long as it works).

Service providers (Wi-Fi as well as Cellular) are fond of stating that their networks are providing services that “their” users need. That is not entirely true. Firstly the users only associate with a carrier for convenience – as a means to an end. Secondly the users actually use a number of services, which in turn use one or other of the carriers to link back to servers to satisfy the user need. The distinction is that the user interfaces to the service not to the network. A student in class has a need for access to services – perhaps a library. Conventionally some students will use a tablet with a cellular modem, while others will use one with Wi-Fi. Some students could, if the transport layer existed, use an infra-red link to a ceiling mounted transceiver. The nature of the link is not important – it is the service that matters. When we focus on the service and become agnostic to the transport technology then we start to design a composite multi-modal network using technology that is appropriate in all cases. We might have infra-red systems in classrooms or areas sensitive to RF energy, Bluetooth gateways for desktop use, Wi-Fi in other heavily populated areas (particularly in-building) and cellular outdoors where distances are greater. If the future tablet computers have interfaces to all network technology then the user could not care which technology is used as long as they have access to the service required.

It is interesting to look at the screen of a modern “smart phone”. It is full of icons or tiles that represent “applications” – or tasks that the phone may be required to do. Just one of these icons is really related to the concept of a “phone”. The rest relate mainly to games

and ways of using the CPU power in the gadget.

There are a few that relate to data (the browser and e-mail client obviously) and a few that fall into the personal office category (reminders, calendars etc) – and a small but growing number of intelligent apps that give us a peek into the future. These include maps that use GPS and other network-based location features to establish where you are. The maps are updated online over the data network (Wi-Fi if available or Cellular if not) and overlaid with live traffic data to allow the app to compute a best route to take. Each segment of that description uses one or other transport layers to do its job but the user interaction is with the app not with the communications technology.

At UBC, an app is being developed that knows the campus layout and can link with student timetables to show a student where to go for the next class. At YVR airport they are working on an app that can translate a stored electronic boarding pass into guidance to the gate – based on using the Wi-Fi network as an internal location service so that the phone “knows” where you are in order to guide you where to go. In both cases the telecom technology is there and is essential – but is effectively invisible to the user.

4.3 The Future

This new focus on “services” is starting to look at not only what users need to do but also how the service should be presented and how it should link to other services. We are starting to see clickable links on web pages that launch other services to make calls to service technicians, launch video conferences, create shared desktop environments etc. This will continue to evolve.

We only need to look to Science Fiction to see that many visions of the future do not require users to manually authenticate or accept terms and conditions ad nauseam. Captain Kirk just needed to tap his comm badge and the “comm system” accepted his spoken command to connect him with his ship.

Currently, Cellular and Wi-Fi services compete for the same user base and provide support for the same services. Campus Wi-Fi provides more controlled security – but properly designed cellular could do the same and could provide a direct gateway to UBC IT services for registered UBC users. Equally, UBC Wi-Fi could provide data capacity for cellular users – particularly inside buildings where cellular penetration is limited. Competition is good when it encourages diversification and reduction in costs. However the cost of in-building cellular coverage is high and the cost of wide area Wi-Fi is high.

We see a better future where both technologies compete in the mid ground and help each other where one is better suited to support services than the other.

5 Next Steps

The original aims of the project have largely been met. With the exception of the carrier interface, all the issues are within UBC's control and are well in hand. Work does, however, need to continue on several of the items.

The carriers are coming on board with the ideas developed and are starting to add value to the process – which is good news. However the process has only just begun and it is not possible to say with any confidence that it will deliver what is required. As a result, we recommend that close monitoring of this aspect is needed over the next few months.

The new ideas with regard to in-building services are encouraging and need further development. It is quite likely that one or both of these ideas will mature to solve some of the coverage problems experienced around the campus.

Recommendation 1

Monitor the ongoing development of the ideas being advanced by the carriers.

Recommendation 2

Set up small projects to explore the new ideas for in-building services.

Recommendation 3

Create the planned new contract.

Recommendation 4

Create the new application paperwork.

Recommendation 5

Establish a process for including cellular planning steps in the planning process for new buildings.

Recommendation 6

Update the buildings list and share it with carriers for comment.

Recommendation 7

Continue with the cellular satisfaction survey so that it will collect input over a longer period of time.

6 Appendix 1 – Cellular Service Web Questionnaire

The following is the set of questions posed on the survey. Respondents are given the opportunity to give up to four problem locations in one survey but are encouraged to repeat the process if more locations need to be included.

Who is your cellphone provider?

- Rogers (includes Fido + Chatr)
- Bell (includes Virgin + Solo)
- Wind Mobile
- Mobilicity
- Telus (includes Koodo)
- Other, please specify...

Where are you experiencing cellular reception difficulties?

- Indoor
- Outdoor
- Both

Section A. Indoor Cellular Reception Difficulties

Please select the building where you are experiencing difficulties indoors on the UBC Campus OR UNA Neighbourhood and which floor from the lists below.

Building Name

[UBC Academic - select from list] - Abdul Ladha Science Student Centre | Acadia Community Centre | Acadia House | Acadia Park Highrise | Acadia Residence | Acadia Row Housing | Allard Hall (Law) | Ambulance Station | Anthropology and Sociology | Aquatic Centre | Aquatic Ecosystems Research Laboratory (AERL) | Asian Center | Auditorium | Auditorium Annex | Barn Daycare | Beaty Biodiversity Centre | Belkin Art Gallery | Berwick Memorial Centre | Binning Studios | Bioenergy Research and Demonstration Facility (BRDF) | Biological Sciences | Biomedical Research Centre | Bookstore | Botanical Gardens Pavilion | Brimacombe | Brock Hall | Buchanan A-E | Buchanan Tower | C&CP | Cecil Green Park | Centre for Interactive Research on Sustainability (CIRS) | Chan Centre | Cheeze Factory | Chemical and Biological Engineering | Chemistry A-E | Child Care Services | Civil and Mechanical Engineering (CEME) | CK Choi | Clock Tower | Coal & Mineral Processing Lab | Continuing Studies | Cunningham | David Lam | Strangway, David | Detwiller Pavilion | DH Copp | Donald Rix | Doug Mitchell Thunderbird Sports Centre | Earth and Ocean Sciences (EOS) | Earth Sciences Building (ESB) | Earthquake Engineering Research Facility | EDC, Wayne and



William White | Empire Pool | Fairview Crescent Residence | Fire Hall | First Nations Longhouse | Food, Nutrition and Health (FNH) | Forest Sciences Centre | FP Innovations - Feric | FP Innovations - Forintek | Frank Forward | Fraser Hall | Fraser River Parkade | Fraternity Village | Fred Kaiser | Frederic Wood Theatre | Friedman | Gage Residence | Gas Gun Facility | General Services Administration Building (GSAB) | Geography | Gerald McGavin | Green College | Health Sciences Parkade | Hebb Theatre | Hennings | Henry Angus | Hillel House | Horticulture | Hugh Dempster Pavilion | ICICS/CS | International House | Iona Building | IRC | Irving K. Barber Learning Centre | Jack Bell | JB Macdonald | John Owen Pavilion | Kenny | Keremeos Court | Klinck, Leonard | Koerner Library | Landscape Architecture | Lasserre | Life Sciences Centre | Liu Institute for Global Issues | Lower Mall Research Station | Macleod | MacMillan | Main Substation | Marine Drive Residence | Mary Bollert Hall | Math | MBA House | Medical Sciences Block | MFA Studios | Michael Smith Laboratories | Museum of Anthropology (MoA) | Music Building | Nitobe Gardens | Norman Keevil | Norman Mackenzie House | North Parkade | NRC Institute- Fuel Cell Innovation | Old Administration | Old Barn Community Centre | Orchard House | Osborne Gym | Oyama Court | Panhellenic Sorority House | Paprican | Pharmaceutical Sciences | Place Vanier Residence | Plant Science Field Station | Point Grey Apartments | Ponderosa Annex A-G | Ponderosa Centre | Power House | Public Safety | Pulp and Paper Centre | Purdy Pavilion | Ritsumeikan | Rose Garden Parkade | Rugby Pavilion | SC Warehouse | Scarfe, Neville | Sedgewick Library | Sing Tao | Somerset, Dorothy | Sopron House | SPPH | St. John's College | Student Recreation Centre (SRC) | Student Union Building (SUB) | Swing Space | TEF3 | Tennis Centre | Theatre-Flim Production | Thunderbird Parkade | Thunderbird Residence | Thunderbird Stadium | Totem Field Studios | Totem Park Residence | TRIUMF | Triumph House | University Centre, Leon and Thea Koerner | University Services Building (USB) | War Memorial Gym | Wesbrook Building | West Mall Annex | West Parkade | Woodward Library

[or UNA Neighbourhoods – Select from list] - Argyll House East | Argyll House West | Azalea House - Faculty/Staff Housing A | Balmoral | Bristol | Carey Centre | Cascara House - Faculty/Staff Housing C | Chancellor Hall | Chancellor House | Chatham | Clement's Green | Coast | Corus | Crescent West | Dahlia House - Faculty/Staff Housing D | Epiphany Chapel | Esse Townhouses | Folio | Gardenia House - Faculty/Staff Housing D | Granite Terrace | Greenwood Commons | Hawthorn Green | Journey | Keenleyside | Larkspur House - Faculty/Staff Housing F | Legacy | Logan Lane | Magnolia House - Faculty/Staff Housing | MBA House | Mews | Nine on the Park | Old Barn Community Centre | Pacific | Pathways | Promontory | Reflections | Regency | Sage | Sandringham



| Save-On-Foods | Sitka | Somerville House | Spirit | Spirit Park Apartments | St. Andrews Hall Residence | St. James | St. Mark's College | Stirling House | Stratford | Sumac House - Faculty/Staff Housing B | Tamark House - Faculty/Staff Housing E | Tapestry | Thames Court | Ultima | University Hill Secondary | Wesbrook Tower | West Hampstead | Westchester | Westpoint | Wyndham Hall | Yu.

Floor [Select from list] - 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18

If the building name is not listed above, please specify the building name or address below (e.g. Buchanan A or 1866 Main Mall) and the floor number:

What difficulties are you having in the building you selected? (Please select all that apply)

- Difficulty with voice calls
- Difficulty with data service
- Difficulty with text messaging
- No service

Section B. Outdoor Cellular Reception Difficulties

Please specify the location where you are experiencing difficulties outdoors by including nearby landmarks, road names or intersection, or the name of the nearest building or park/public outdoor space.

(Please use cardinal points (N-S-E-W) whenever possible and approximate distances in meters or feet to best describe your outdoor location.)

What difficulties are you having outdoors? (Please select all that apply)

- Difficulty with voice calls
- Difficulty with data service
- Difficulty with text messaging
- No service

Are you experiencing cellular reception difficulties in additional locations on campus?

- Yes
- No



6.1 Results

| Number of Surveys | |
|-------------------|------------|
| Complete | 113 |
| Incomplete | 42 |
| Total | 155 |

| Cellular Provider | |
|--------------------------------|------------|
| Telus (includes Koodo) | 45 |
| Rogers (includes Fido + Chatr) | 31 |
| Bell (includes Virgin + Solo) | 12 |
| Mobilicity | 9 |
| Wind Mobile | 14 |
| Other, please specify... | 2 |
| Blank | 31 |
| Total | 144 |

| Location | |
|--------------|------------|
| Indoor | 76 |
| Blank | 32 |
| Both | 29 |
| Outdoor | 5 |
| Total | 142 |

| Difficulty | Indoor | Outdoor |
|----------------|------------|-----------|
| No service | 108 | 28 |
| Voice calls | 87 | 25 |
| Data Service | 78 | 20 |
| Text messaging | 71 | 16 |
| Total | 344 | 89 |



Summary for Completed Surveys by Location - Indoor

| Building Name | |
|--|----|
| ICICS/CS | 26 |
| Marine Drive Residence | 11 |
| Henry Angus | 9 |
| Totem Park Residence | 9 |
| Student Union Building (SUB) | 6 |
| Botanical Gardens Pavilion | 5 |
| Koerner Library | 5 |
| Forest Sciences Centre | 4 |
| Larkspur House - Faculty/Staff Housing | 4 |
| Allard Hall (Law) | 3 |
| C&CP | 3 |
| Dahlia House - Faculty/Staff Housing | 3 |
| Hugh Dempster Pavilion | 3 |
| Irving K. Barber Learning Centre | 3 |
| Keenleyside | 3 |
| Old Barn Community Centre | 3 |
| Beaty Biodiversity Centre | 2 |
| Buchanan Tower | 2 |
| Cecil Green Park | 2 |
| Civil and Mechanical Eng (CEME) | 2 |
| Klinck, Leonard | 2 |
| Legacy | 2 |
| Life Sciences Centre | 2 |
| Sage | 2 |
| Tapestry | 2 |
| TRIUMF | 2 |
| AMS | 1 |
| Balmoral | 1 |
| Buchanan A-E | 1 |

| Building Name | |
|--|------------|
| Chan Centre | 1 |
| Chancellor Hall | 1 |
| CK Choi | 1 |
| Coast | 1 |
| Earth and Ocean Sciences (EOS) | 1 |
| Esse Townhouses | 1 |
| Gardenia House - Faculty/Staff Housing | 1 |
| Green College | 1 |
| Iona Building | 1 |
| IRC | 1 |
| Kenny | 1 |
| MacMillan | 1 |
| MBA House | 1 |
| NRC Institute- Fuel Cell Innovation | 1 |
| Osborne Gym | 1 |
| Pacific | 1 |
| Scarfe, Neville | 1 |
| Sitka | 1 |
| Somerset | 1 |
| Stirling House | 1 |
| Strangway, David | 1 |
| Thunderbird Parkade | 1 |
| UBC Hospital - Koerner Pavilion | 1 |
| University Centre, Koerner House | 1 |
| University Hill Secondary | 1 |
| University Services Building (USB) | 1 |
| Wesbrook Tower | 1 |
| Westpoint | 1 |
| Grand Total | 151 |



Summary for Completed Surveys by Location – Outdoor

| Outdoor Locations | |
|--|-----------|
| Areas around Marine Drive Building 6 | 2 |
| In and around Agronomy Road, Thunderbird Boulevard | 2 |
| On SW Marine Drive between 16th and 41 st | 2 |
| Spotty coverage throughout UBC Botanical Garden, Nitobe Memorial Garden and the Botanical Garden Nursery. | 2 |
| 3396 shrum lane, specifically inside the Mozart school of music. | 1 |
| 6360 Larkin Drive | 1 |
| 6804 SW Marine Drive -main parking lot ... most places on site | 1 |
| Along NW marine drive between east mall and university blvd | 1 |
| Along Wesbrook Mall in the vicinity of Norman MacKenzie Square is very poor. The north-west corner of NMS has some reception, but closer to Wesbrook or to Blenz is no reception. | 1 |
| Around the ICICS and CEME Buildings | 1 |
| Bus route along Pacific Spirit Park | 1 |
| Bus stop on thunderbird blvd and wesbrook mall. | 1 |
| Chancellor blvd by Uel and 4 ave | 1 |
| East of Wesbrook Mall on 16th. Dead spot. | 1 |
| Green college | 1 |
| I don't get service inside the ICICS/CS building. Have to go out and wait a few minutes before I can use my phone. | 1 |
| I don't get very much reception anywhere on Marine Drive. My service also cuts in and out as I move between Main Mall and Lower Mall in the vicinity of Koerner Library and Ponderosa Annex. I experience service interruptions on the B-Line ride into campus | 1 |
| In the road way between ICCS x wing and the Dempster building. | 1 |
| Marine Drive near Wesbrook Mall and the Research neighbourhood | 1 |
| Most of Wesbrook Village has dead zones for Telus. The farther south I go, the worse it gets. | 1 |
| mostly around agronomy and main mall occasionally in the SUB and random areas | 1 |
| NE corner of Theology Mall and Iona Drive | 1 |
| On marine | 1 |
| On way to Thunderbird stadium from Icics/cs | 1 |
| open space around EOS and scarfe building | 1 |
| Outside of ICICS/CS | 1 |
| Pacific Spirit Park, and roads leading through to Campus | 1 |
| south campus and a dead spot on 16th just east of Wesbrook Mall | 1 |
| South campus Recycling and compost area and Lower Mall Research building #22 | 1 |
| SW Marine Drive - where it goes through the forest South-East of UBC | 1 |
| SW Marine Drive area has a big zone of non-coverage, from where 16th ave road ends, all the way along to the 41/SW Marine Drive Fork. | 1 |
| SW Marine Drive, going through Pacific Spirit Park en route to 41st | 1 |
| The balconies on the south and north side of my townhouse have not been reliable for voice calls. | 1 |
| Throughout the west of SW Marine Drive section of the Botanical Garden, where it is heavily treed. | 1 |
| UBC Botanical Garden, west of Reception Centre/Campbell Building | 1 |
| Wesbrook Village has horrid cell reception for Telus customers. I had to get a landline because I don't get cell service in my apartment. | 1 |
| Grand Total | 40 |



7 Appendix 2 – Building Suitability List

Where buildings have been evaluated as to their suitability for hosting a cellular base station, the building ID numbers in the following list have been highlighted with red or green. The red highlights indicate that a building is not suitable for future cellular antenna development. The green highlights indicate that a building is suitable for future cellular antenna development. If a building ID is not highlighted then no decision has been made yet.

| BL_ID | NAME |
|-------|--|
| 011 | Acadia Community Centre |
| 013 | Kids Club |
| 017 | Old Administration Building |
| 018 | General Services Administration Building |
| 019 | Bioenergy Research and Demonstration Facility |
| 020 | The Brimacombe Building |
| 021 | Landscape Architecture Annex |
| 022 | Lower Mall Research Station |
| 023 | Henry Angus Building |
| 026 | Henry Angus Building Addition |
| 028 | Frederic Lasserre Building |
| 029 | Campus & Community Planning 2 |
| 034 | Aquatic Centre |
| 036 | Theatre-Film Production Building |
| 044 | Auditorium |
| 045 | Auditorium Annex Offices A |
| 046 | Asian Centre |
| 048 | Anthropology and Sociology Building |
| 051 | The Barn |
| 052 | Fraser River Parkade |
| 057 | Centre for Comparative Medicine |
| 064 | Biological Sciences Building |
| 065 | Biological Sciences Building - West Wing |
| 066 | Biological Sciences Building - North Wing |
| 068 | Biological Sciences Building - South Wing |
| 069 | Biological Sciences Building - Workshop |
| 070 | Biological Sciences - Paper Recycling/Flammable Storage Facility |
| 076 | Botanical Gardens Scholars' Retreat |
| 078 | Botanical Gardens - Lunchroom |
| 079 | Botanical Gardens - Greenhouse and Workshop |
| 081 | Bookstore |
| 082 | Botanical Gardens - Greenhouse, Alpine Garden |



| BL_ID | NAME |
|-------|--|
| 083 | Michael Smith Laboratories |
| 088 | Botanical Gardens Area |
| 090 | Botanical Gardens - Workshop |
| 091 | Botanical Garden - Garden Pavilion |
| 094 | Botanical Gardens Workshop (Trailer) |
| 097 | Botanical Garden Centre - Gate House and Shop-In-The-Garden |
| 098 | Botanical Garden Centre - Campbell Building |
| 099 | Botanical Garden Centre - Reception and Education Centre |
| 100 | Botanical Garden Centre - Lookout Tower |
| 112 | Brock Hall - West Wing |
| 113 | Brock Hall Annex |
| 120 | Buchanan Tower |
| 130 | Chan Centre for The Performing Arts |
| 132 | Chemistry D Block, Centre Wing |
| 136 | Chemistry E Block, North Wing |
| 137 | In-Vessel Composting Facility |
| 138 | Environmental Services Facility - Solvent & Silver Recovery Lab |
| 139 | Environmental Services Facility - Office |
| 140 | Chemistry Storage |
| 141 | Environmental Services Facility - Solvent Storage Area |
| 142 | Environmental Services Facility - Chemical Waste Processing & Storage Building |
| 143 | Environmental Services Facility - Pcb Equipment Storage Containers |
| 144 | Chemistry C Block, East Wing |
| 148 | Chemistry B Block, South Wing |
| 152 | Faculty Staff Housing - Building A |
| 153 | Faculty Staff Housing - Building B |
| 154 | Faculty Staff Housing - Building C |
| 155 | Child Care Services Administration Building |
| 160 | Continuing Studies Building |
| 164 | Hugh Dempster Pavilion |
| 165 | Institute for Computing, Information and Cognitive Systems / Computer Science Institute for Computing, Information and Cognitive Systems / Computer Science |
| 166 | Addition |
| 180 | Rodney Graham Millennium Sculpture Pavillion |
| 182 | Ladner Clock Tower |
| 184 | Coal and Mineral Processing Laboratory |
| 192 | Ponderosa Centre |
| 198 | J. B. Macdonald Building |
| 199 | David Strangway Building |
| 200 | Child Care Services - Building 1 |
| 201 | Child Care Services - Building 2 |
| 202 | Child Care Services - Building 3 |



| BL_ID | NAME |
|-------|--|
| 203 | Child Care Services - Building 4 |
| 204 | Child Care Services - Building 5 |
| 205 | Child Care Services Building 1 |
| 206 | Child Care Services Building 2 |
| 207 | Child Care Services Building 3 |
| 212 | Sing Tao Building |
| 225 | Earth Sciences Building |
| 232 | Neville Scarfe Building - Lecture Block |
| 233 | Neville Scarfe Building - Teacher Education Office |
| 234 | Neville Scarfe Building - Library |
| 300 | Chemical & Biological Engineering Building |
| 301 | Wayne and William White Engineering Design Centre |
| 305 | Earthquake Engineering Research Facility |
| 306 | Civil and Mechanical Engineering Building |
| 307 | Civil and Mechanical Engineering Laboratories |
| 308 | The Leonard S. Klinck Building |
| 309 | Civil and Mechanical Engineering Structures Lab |
| 310 | Engineering Student Centre |
| 312 | Macleod Building |
| 313 | The Fred Kaiser Building |
| 314 | Beaty Biodiversity Centre |
| 316 | Aquatic Ecosystems Research Laboratory |
| 320 | Dorothy Somerset Studios |
| 324 | B.C. Binning Studios |
| 337 | First Nations Longhouse |
| 344 | Leon and Thea Koerner University Centre |
| 345 | Peter Wall Institute for Advanced Studies |
| 353 | Forest Sciences Centre |
| 372 | Fp Innovations - Forintek Western Research Facility |
| 373 | Fp Innovations - Feric - Forest Engineering Research Institute of Canada |
| 376 | Frederic Wood Theatre |
| 380 | Old Fire Hall |
| 385 | Wood Products Laboratory |
| 386 | H. R. Macmillan Building |
| 387 | Forestry Green House |
| 389 | Forestry Field House South Campus |
| 394 | Gas Gun Facility |
| 401 | Geography Building |
| 402 | Earth and Ocean Sciences - Main |
| 403 | Earth and Ocean Sciences - South |
| 408 | Thea Koerner House |
| 409 | Thea Koerner House Addition |



| BL_ID | NAME |
|-------|--|
| 412 | Green College - Graham House, Green Commons, Coach House - Building D |
| 413 | Green College - Building A North |
| 414 | Green College - Kitchen / Laundry |
| 415 | Green College - Building A South |
| 416 | Green College - Building B East |
| 417 | Green College - Building E |
| 418 | Green College - Administration -Building F |
| 419 | Green College - Principal's Residence - Building C |
| 420 | Cecil Green Park House |
| 421 | Cecil Green Park Coach House |
| 422 | Cecil Green Park Squash Court |
| 428 | War Memorial Gymnasium |
| 429 | Empire Pool |
| 430 | Robert F. Osborne Centre - Unit 1 |
| 431 | Robert F. Osborne Centre - Unit 2 |
| 432 | UBC Tennis Centre |
| 433 | UBC Tennis Centre (New) |
| 434 | Gerald McGavin UBC Rugby Centre |
| 436 | Haida House |
| 440 | Mortuary House |
| 445 | Hillel House - The Diamond Foundation Centre for Jewish Campus Life |
| 447 | Chemistry A Block, Chemistry Physics Building |
| 449 | Food, Nutrition and Health Building |
| 451 | Sopron House |
| 456 | Horticulture Building |
| 458 | Donald Rix Building |
| 461 | Biomedical Research Centre |
| 462 | Purdy Pavilion |
| 463 | Koerner Pavilion |
| 465 | Djavad Mowafaghian Centre for Brain Health |
| 467 | Health Sciences Parkade |
| 468 | Acute Care Unit Patient Park |
| 470 | Environmental Services Facility - Incinerator |
| 472 | International House |
| 473 | P. A. Woodward Instructional Resources Centre |
| 475 | P. A. Woodward Instructional Resources Centre Lecture Theatre Addition |
| 476 | Japanese Tea House - Nitobe Gardens |
| 478 | C. K. Choi Building for The Institute of Asian Research |
| 482 | Allard Hall |
| 490 | David Lam Management Research Centre |
| 496 | Liu Institute for Global Issues |
| 500 | Hampton Place Lot 1 - Sandringham |



| BL_ID | NAME |
|-------|---|
| 501 | Hampton Place Lot 2 - West Hampstead |
| 502 | Hampton Place Lot 3 - Thames Court |
| 503 | Hampton Place Lot 4 - St. James |
| 504 | Hampton Place Lot 5 - The Chatham |
| 505 | Hampton Place Lot 6 - The Bristol |
| 507 | Hampton Place Lot 8 - The Regency |
| 508 | Hampton Place Lot 9 - The Balmoral |
| 509 | Hampton Place Lot 10 - Pemberley |
| 511 | Engineering High Head Room Laboratory |
| 513 | School of Population & Public Health |
| 515 | Sedgewick Library |
| 516 | Irving K. Barber Learning Centre |
| 517 | Cheeze Factory Engineering Undergraduate Society |
| 518 | Mathematics Building |
| 519 | Mathematics Annex |
| 521 | District Energy Centre |
| 526 | D.H. Copp Building Addition 2 |
| 527 | Pharmaceutical Sciences Building |
| 528 | Rose Garden Parkade |
| 529 | Life Sciences Centre |
| 534 | Triumpf House |
| 536 | Woodward Library |
| 537 | Detwiller Pavilion 1 |
| 538 | |
| 539 | Ambulance Station |
| 543 | Vanier Pump Station |
| 544 | Place Vanier Residence - Gordon Shrum Common Block |
| 548 | Place Vanier Residence - Kootenay House |
| 549 | |
| 550 | Sitka |
| 551 | Thunderbird Parkade |
| 552 | Place Vanier Residence - Okanagan House |
| 553 | Fraser Hall - Student Rental Housing |
| 556 | Place Vanier Residence - Robson House |
| 560 | Place Vanier Residence - Sherwood Lett House |
| 562 | Frank Forward Building |
| 565 | Totem Park Residence - Kwakiutl House/Shuswap House |
| 566 | Totem Park Residence - Qelexen House |
| 567 | Totem Park Residence - Hemelesem House |
| 568 | Morris and Helen Belkin Art Gallery |
| 569 | Gerald McGavin Building |
| 570 | Museum of Anthropology |



| BL_ID | NAME |
|-------|---|
| 575 | Music Building |
| 579 | Labor Hut - South Campus |
| 584 | Spirit - Adera |
| 585 | UBC Research Ponds |
| 586 | Faculty Staff Housing - Building F |
| 587 | Keenleyside |
| 590 | Nrc Institute for Machinery Research |
| 591 | Nrc Institute for Fuel Cell Innovation |
| 594 | Wesbrook Residential Tower |
| 595 | Sage Townhouses |
| 595 | Sage Tower |
| 596 | Academy |
| 599 | Wesbrook Discovery Centre |
| 605 | Crescent West |
| 605 | Crescent West Block 2 |
| 605 | Crescent West Block 1 |
| 605 | Crescent West Block 3 |
| 605 | Crescent West Block 6 |
| 605 | Crescent West Block 7 |
| 605 | Crescent West Block 5 |
| 606 | Technology Enterprise Facility 3 (Tef3) |
| 612 | Paprican Building |
| 614 | Mary Bollert Hall |
| 616 | Westchester Townhouses |
| 617 | Faculty Staff Housing - Building D |
| 618 | Hawthorn Green |
| 619 | Journey |
| 620 | Logan Lane Townhouses |
| 621 | Clement's Green |
| 622 | Somerset |
| 623 | Reflections |
| 624 | George Cunningham Building Addition (Pharmaceutical Sciences) |
| 625 | George Cunningham Building (Pharmaceutical Sciences) |
| 626 | Promontory Tower |
| 627 | Old Barn Community Centre |
| 628 | Nine On The Park |
| 629 | Faculty Staff Housing - Building E |
| 630 | Legacy Apartments |
| 633 | Centre for Interactive Research in Sustainability [CIRS] |
| 635 | St. John Hospice |
| 638 | South Campus Warehouse |
| 641 | University Services Building |



| BL_ID | NAME |
|-------|---|
| 643 | Campus & Community Planning 1 |
| 645 | M.F.A. Studios |
| 646 | Plant Operations Exterior Storage Shed |
| 652 | Hennings Building |
| 654 | Abdul Ladha Science Student Centre |
| 656 | Hebb Building |
| 666 | Plant Science Field Station |
| 667 | Plant Science Garage |
| 668 | Totem Field Studios |
| 669 | Stores Road Annex |
| 670 | Plant Science Field Building |
| 673 | Thunderbird Park |
| 674 | Logan Field Kiosk |
| 678 | Telus Hub |
| 686 | Wesbrook Village - Office / Bank |
| 687 | Wesbrook Village - Save-On-Foods / Granite Terrace Apartments |
| 689 | Mews |
| 690 | Granite Terrace III |
| 694 | MBA House |
| 695 | Yu |
| 699 | Pacific - Adera |
| 705 | Sail 1 |
| 706 | Ultima |
| 707 | Sail 2 |
| 713 | Magnolia House - Building 1 |
| 724 | Power House |
| 725 | Power House - Meter Station |
| 726 | Power House - Oil Storage Facility |
| 728 | Norman Mackenzie House (President's Residence) |
| 730 | Ponderosa Annex H |
| 732 | Douglas Kenny Building |
| 745 | Ritsumeikan-UBC House |
| 747 | Pulp and Paper Centre |
| 750 | Jack Bell Building for The School of Social Work |
| 760 | Rugby Pavilion |
| 763 | South Campus Telecommunication Hub Site |
| 765 | South Campus Substation - Switching Station 12kv |
| 766 | Material Recovery Facility |
| 767 | Staging Research Centre |
| 768 | Building Operations - Nursery |
| 771 | Point Grey Apartments (Osoyoos Housing) |
| 774 | Student Recreation Centre |



| BL_ID | NAME |
|-------|---|
| 780 | Thunderbird Residence - Building A1 |
| 781 | Thunderbird Residence - Building A2 |
| 782 | Thunderbird Residence - Building B2 |
| 783 | Thunderbird Residence - Building B1 |
| 784 | Thunderbird Residence - Building C1 |
| 785 | Thunderbird Stadium |
| 789 | Main Substation |
| 790 | Student Union Building (Sub) |
| 792 | North Parkade |
| 795 | New Student Union Building |
| 797 | Alumni Building |
| 802 | Vancouver School of Theology - Chancellor Building - Chapel of Epiphany |
| 804 | Carey Theological College |
| 806 | Carey Theological College Addition |
| 807 | Carey Centre |
| 808 | Esse (Townhouses) |
| 810 | Argyll House East |
| 818 | Stirling House |
| 819 | Axis |
| 823 | Chancellor Hall (Townhouses) |
| 824 | Chancellor Hall (Apartments) |
| 825 | Folio Apartment Building |
| 826 | Folio Townhomes |
| 828 | St. Mark's College |
| 829 | St. Mark's College Chapel |
| 830 | Chancellor House (Apartments) |
| 833 | Chancellor Row (Duplex) - 1 |
| 834 | Chancellor Row (Duplex) - 2 |
| 835 | Chancellor Row (Duplex) - 3 |
| 836 | Vancouver School of Theology - Iona Building |
| 837 | Argyll House West |
| 838 | Somerville House |
| 839 | Corus Apartment Building |
| 841 | Westpoint |
| 843 | TRIUMF - Stores Building |
| 845 | Ariel Building |
| 846 | Biological Archive Centre |
| 847 | Isac 1 - Isotope Separator Accelerator (Triumf) |
| 850 | Triumf - Workshop Building |
| 852 | Public Safety Building |
| 853 | Triumf - Accelerator and Experimental Building |
| 854 | Triumf - Offices, Laboratory & Workshops |



| BL_ID | NAME |
|--------|---|
| 855 | John Owen Pavilion and Allan McGavin Sports Medicine Centre |
| 858 | Berwick Memorial Centre |
| 859 | John Owen Pavilion Annex |
| 860 | Athletics Washroom Facilities |
| 864 | Wesbrook Building |
| 866 | Orchard House |
| 867 | Wesbrook Building Annex |
| 868 | Doug Mitchell Thunderbird Sports Centre |
| 873 | Ponderosa Office Annex G |
| 874 | Walter H. Gage Residence - Apartments |
| 880 | Anthropology and Sociology Building - Mary Murrin Hall |
| 898 | Vanier Korea House |
| 900 | West Parkade |
| 901 | West Mall Swing Space Building |
| 902 | Place Vanier - Tec De Monterrey |
| 903 | Audain Art Centre |
| 904 | Ponderosa Hub Phase I - West |
| 918 | Panhellenic Sorority House |
| 921 | Fraternity Village - House - 1 |
| 922 | Fraternity Village - House - 2 |
| 924 | Fraternity Village - House - 4 |
| 925 | Fraternity Village - House - 5 |
| 926 | Fraternity Village - House - 6 |
| 927 | Fraternity Village - House - 7 |
| 928 | Fraternity Village - House - 8 |
| 002-1 | Acadia Park Highrise |
| 007-00 | Fairview Crescent Student Housing - Parking Lot |
| 007-01 | Fairview Crescent Student Housing - Unit 1 |
| 007-02 | Fairview Crescent Student Housing - Unit 2 |
| 007-03 | Fairview Crescent Student Housing - Unit 3 |
| 007-04 | Fairview Crescent Student Housing - Unit 4 |
| 007-05 | Fairview Crescent Student Housing - Unit 5 |
| 007-06 | Fairview Crescent Student Housing - Unit 6 |
| 007-07 | Fairview Crescent Student Housing - Unit 7 |
| 007-08 | Fairview Crescent Student Housing - Unit 8 |
| 007-09 | Fairview Crescent Student Housing - Unit 9 |
| 007-10 | Fairview Crescent Student Housing - Unit 10 |
| 007-11 | Fairview Crescent Student Housing - Unit 11 |
| 007-12 | Fairview Crescent Student Housing - Unit 12 |
| 007-13 | Fairview Crescent Student Housing - Unit 13 |
| 007-14 | Fairview Crescent Student Housing - Unit 14 |
| 007-15 | Fairview Crescent Student Housing - Unit 15 |



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| 007-16 | Fairview Crescent Student Housing - Unit 16 |
| 007-17 | Fairview Crescent Student Housing - Unit 17 |
| 007-18 | Fairview Crescent Student Housing - Unit 18 |
| 007-19 | Fairview Crescent Student Housing - Unit 19 |
| 007-20 | Fairview Crescent Student Housing - Unit 20 |
| 007-21 | Fairview Crescent Student Housing - Unit 21 |
| 007-22 | Fairview Crescent Student Housing - Unit 22 |
| 007-23 | Fairview Crescent Student Housing - Unit 23 |
| 007-24 | Fairview Crescent Student Housing - Unit 24 |
| 007-25 | Fairview Crescent Student Housing - Unit 25 |
| 007-26 | Fairview Crescent Student Housing - Unit 26 |
| 007-27 | Fairview Crescent Student Housing - Unit 27 |
| 007-28 | Fairview Crescent Student Housing - Unit 28 |
| 007-29 | Fairview Crescent Student Housing - Unit 29 |
| 007-30 | Fairview Crescent Student Housing - Unit 30 |
| 007-31 | Fairview Crescent Student Housing - Unit 31 |
| 007-32 | Fairview Crescent Student Housing - Unit 32 |
| 007-33 | Fairview Crescent Student Housing - Unit 33 |
| 007-34 | Fairview Crescent Student Housing - Unit 34 |
| 007-35 | Fairview Crescent Student Housing - Unit 35 |
| 009-01 | Acadia Family Housing Phase II - Unit 1 |
| 009-02 | Acadia Family Housing Phase II - Unit 2 |
| 009-03 | Acadia Family Housing Phase II - Unit 3 |
| 009-04 | Acadia Family Housing Phase II - Unit 4 |
| 009-05 | Acadia Family Housing Phase II - Unit 5 |
| 009-06 | Acadia Family Housing Phase II - Unit 6 |
| 009-07 | Acadia Family Housing Phase II - Unit 7 |
| 009-08 | Acadia Family Housing Phase II - Unit 8 |
| 009-09 | Acadia Family Housing Phase II - Unit 9 |
| 009-10 | Acadia Family Housing Phase II - Unit 10 |
| 009-11 | Acadia Family Housing Phase II - Unit 11 |
| 009-12 | Acadia Family Housing Phase II - Unit 12 |
| 009-13 | Acadia Family Housing Phase II - Unit 13 |
| 009-14 | Acadia Family Housing Phase II - Unit 14 |
| 009-15 | Acadia Family Housing Phase II - Unit 15 |
| 009-16 | Acadia Family Housing Phase II - Unit 16 |
| 009-17 | Acadia Family Housing Phase II - Unit 17 |
| 009-18 | Acadia Family Housing Phase II - Unit 18 |
| 009-19 | Acadia Family Housing Phase II - Unit 19 |
| 009-20 | Acadia Family Housing Phase II - Unit 20 |
| 009-21 | Acadia Family Housing Phase II - Unit 21 |
| 009-22 | Acadia Family Housing Phase II - Unit 22 |



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| 009-23 | Acadia Family Housing Phase II - Unit 23 |
| 009-24 | Acadia Family Housing Phase II - Unit 24 |
| 009-25 | Acadia Family Housing Phase II - Unit 25 |
| 009-26 | Acadia Family Housing Phase II - Unit 26 |
| 010-01 | Acadia Family Housing Phase III - Unit 1 |
| 010-02 | Acadia Family Housing Phase III - Unit 2 |
| 010-03 | Acadia Family Housing Phase III - Unit 3 |
| 010-04 | Acadia Family Housing Phase III - Unit 4 |
| 010-05 | Acadia Family Housing Phase III - Unit 5 |
| 010-06 | Acadia Family Housing Phase III - Unit 6 |
| 010-07 | Acadia Family Housing Phase III - Unit 7 |
| 010-08 | Acadia Family Housing Phase III - Unit 8 |
| 010-09 | Acadia Family Housing Phase III - Unit 9 |
| 010-10 | Acadia Family Housing Phase III - Unit 10 |
| 014-1 | Acadia Faculty Row Housing - Unit 1 |
| 014-2 | Acadia Faculty Row Housing - Unit 2 |
| 014-3 | Acadia Faculty Row Housing - Unit 3 |
| 023-1 | Henry Angus Building Classroom Addition |
| 024-3 | Research Station Annex 3 |
| 024-5 | Lower Mall Header House |
| 024-6 | Research Station Annex 6 |
| 036-1 | Theatre-Film Production Building Annex |
| 069-1 | Biological Sciences Building - Workshop - Addition 1 |
| 069-2 | Biological Sciences Building - Workshop - Addition 2 |
| 071-1 | Botany Greenhouse 1 |
| 071-2 | Botany Greenhouse 2 |
| 077-1 | Botanical Gardens - Greenhouse |
| 077-2 | Botanical Gardens - Shade House |
| 081-2 | Networks of Centres of Excellence |
| 112-1 | Brock Hall - East Wing |
| 121-1 | Buchanan Building Block A |
| 121-2 | Buchanan Building Block B |
| 121-3 | Buchanan Building Block C |
| 122-1 | Buchanan Building Block D |
| 122-2 | Buchanan Building Block E |
| 184-1 | Norman Keevil |
| 240-1 | Neville Scarfe Building - Classroom Block |
| 240-2 | Neville Scarfe Building - Office Block |
| 308-1 | The Leonard S. Klinck Building Addition |
| 344-1 | Leon and Thea Koerner University Centre Addition 1 |
| 376-1 | Frederic Wood Theatre Addition |
| 377-1 | Marine Drive Residence - Simon K.Y. Lee Hku-UBC House |



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| 377-2 | Marine Drive Residence - Building #2 |
| 377-3 | Marine Drive Residence - Building #3 |
| 377-4 | Marine Drive Residence - Building #4 |
| 377-5 | Marine Drive Residence - Building #5 |
| 377-6 | Marine Drive Residence - Building #6 |
| 449-1 | Food, Nutrition and Health Building - Addition |
| 450-1 | Acadia House - 2700 |
| 450-2 | Acadia House - 2710 |
| 450-3 | Acadia House - 2720 |
| 490-1 | White Spot Restaurant in David Lam Management Research Centre |
| 490-2 | David Lam Learning Centre |
| 506-1 | Hampton Place Lot 7-1 - The Stratford |
| 506-2 | Hampton Place Lot 7-2 - Wyndham Hall |
| 515-1 | Walter C. Koerner Library |
| 523-1 | D.H. Copp Building |
| 523-2 | Friedman Building |
| 523-3 | Medical Sciences Block C |
| 525-1 | D.H. Copp Building Addition |
| 525-2 | Friedman Building Addition |
| 525-3 | Medical Sciences Block C Addition |
| 536-1 | Woodward Library Addition |
| 537-1 | Detwiller Pavilion 2 |
| 540-1 | Totem Park Residence - Coquihala Common Block/Magda's Convenience Store |
| 540-2 | Totem Park Residence - Haida House/Salish House |
| 540-3 | Totem Park Residence - Dene House/Nootka House |
| 545-1 | Place Vanier Residence - Cariboo House |
| 545-2 | Place Vanier Residence - Tweedsmuir House |
| 554-1-7 | Greenwood Commons - Rental Housing |
| 570-1 | Koerner Gallery |
| 588-1 | Pathways I (West) |
| 588-2 | Pathways II (East) |
| 590-1 | School Addition |
| 593-1 | Tapestry At Wesbrook Village, UBC - North Building |
| 593-2 | Tapestry At Wesbrook Village, UBC - South Building |
| 652-1 | Hennings Building Penthouse Addition |
| 668-1 | Totem Field Studios Addition |
| 713-1 | Dahlia House - Building 2 |
| 724-1 | Power House - Addition 1 |
| 724-2 | Power House - Addition 2 |
| 724-3 | Power House - Addition 3 |
| 728-1 | Norman Mackenzie House (President's Residence - Garage) |
| 770-1 | Spirit Park Apartments - 2705 |



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| 770-2 | Spirit Park Apartments - 2715 |
| 770-3 | Spirit Park Apartments - 2725 |
| 780-1 | Thunderbird Residence - Building A4 |
| 781-1 | Thunderbird Residence - Building A3 |
| 782-1 | Thunderbird Residence - Building B3 |
| 782-A | Thunderbird Residence - Building B2 Store |
| 783-1 | Thunderbird Residence - Building B4 |
| 784-1 | Thunderbird Residence - Building C2 |
| 789-1 | Main Substation Addition |
| 790-1 | Student Union Building (Sub) - Addition 1 |
| 790-2 | Student Union Building (Sub) - Addition 2 |
| 817-1 | St. Andrew's Hall Residence - Block A - Ross House & Mclean Block |
| 817-2 | St. Andrew's Hall Residence - Block B - Walker House |
| 817-3 | St. Andrew's Hall Residence - Block C - Lennox House |
| 817-4 | St. Andrew's Hall Residence - Block A Addition |
| 822-1 | St. John's College Phase 1 |
| 822-2 | St. John's College Phase 1 |
| 822-3 | St. John's College |
| 825-1 | Folio Cityhomes I |
| 825-2 | Folio Cityhomes II |
| 827-1 | Folio Duplex 1 |
| 827-2 | Folio Duplex 2 |
| 827-3 | Folio Duplex 3 |
| 827-4 | Folio Duplex 4 |
| 827-5 | St. Mark's Duplex 5 |
| 827-6 | St. Mark's Duplex 6 |
| 827-7 | St. Mark's Duplex 7 |
| 827-8 | St. Mark's Duplex 8 |
| 830-1 | Chancellor House Cityhomes |
| 830-2 | Townhouse Attached To Chancellor House - 2 |
| 830-3 | Townhouse Attached To Chancellor House - 3 |
| 830-4 | Townhouse Attached To Chancellor House - 4 |
| 831-1 | Coast Duplex 1 |
| 831-2 | Coast Duplex 2 |
| 831-3 | Coast Duplex 3 |
| 831-4 | Coast Duplex 4 |
| 831-5 | Coast Duplex 5 |
| 832-1 | Coast Apartment West |
| 832-2 | Coast Apartment East |
| 832-3 | Coast Townhouses |
| 847-1 | Isac 2 - Isotope Separator Accelerator Addition (Triumf) |
| 855-1 | John Owen Pavilion and Allan McGavin Sports Medicine Centre - Addition |



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| 863-1 | West Mall Annex |
| 863-2 | Auditorium Annex Offices B |
| 865-1 | Ponderosa Office Annex A |
| 865-2 | Ponderosa Office Annex B |
| 865-3 | Ponderosa Office Annex C |
| 869-1 | Walter H. Gage Residence - Common Block |
| 869-2 | Walter H. Gage Residence - South Tower |
| 869-3 | Walter H. Gage Residence - North Tower |
| 871-2 | Ponderosa Office Annex E |
| 871-3 | Ponderosa Office Annex F |
| 872-1 | Walter H. Gage Residence - East Tower |
| 872-2 | Walter H. Gage Residence - Court |
| 876-1 | Anthropology and Sociology Building - Isabel Macinnes Hall |
| 876-2 | Anthropology and Sociology Building - Anne Wesbrook Hall |
| 896-1 | Place Vanier Residence - Dorothy Mawdsley House |
| 896-2 | Place Vanier Residence - Margaret Mackenzie House |
| 896-3 | Place Vanier Residence - Phyllis Ross House |
| 896-4 | Place Vanier Residence - Aldyen Hamber House |