U.S. Ubiquitous Mobility Study

Identification of and Estimated Initial Investments to Deploy Third Generation Mobile Broadband Networks in Unserved and Underserved Areas.

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Introduction

As communication evolves, our economy and our lifestyles are impacted. Transitioning from fixed to mobile services provides consumers greater safety, convenience, efficiency, and proximity. Transitioning from narrowband to broadband has brought access to information and services almost unimaginable a short time ago.

Clearly it isn't just our individual lives that are benefited by this transition. The growth of commerce and the economic well-being of the nation are improved. To maximize this economic impact all citizens should have the chance to participate. To accomplish this universal access, a key element is to promote ubiquitous wireless coverage and access to the kinds of advanced mobile wireless broadband services that most U.S. consumers now have available to them.

The two predominant third generation (3G) mobile wireless broadband technologies are Evolution Data Optimized ("EvDO") and High-Speed Downlink Packet Access ("HSDPA"). EvDO and HSDPA technologies provide consumers broadband quality connectivity to voice, data, and, increasingly, video services. CDMA carriers generally provide mobile wireless broadband access over EvDO networks, while GSM carriers provide mobile wireless broadband access over HSDPA networks. About half of America's mobile wireless subscribers receive service over CDMA networks and about 40% of America's mobile wireless subscribers receive service over GSM networks.

Unfortunately, these 3G mobile broadband technologies are not available to all U.S. consumers, especially those who reside, work, and travel in less dense, rural areas. The looming question then is: "what is the cost to provide ubiquitous 3G mobile broadband coverage"? The answer to this question will have considerable legal and policy implications – especially in the area of universal service.

To frame the concept of ubiquitous wireless and provide cost estimates, CostQuest Associates was commissioned by CTIA – The Wireless Association® - to study wireless coverage in the United States and to a) identify areas and population not served by 3G mobile broadband technologies, and b) estimate the up-front deployment costs to build a 3G wireless network to unserved and underserved areas.

To conduct the study, CostQuest collected coverage maps and tower locations. It then compared data to the road network where people live and commute. Partitioning up the country into cell site size lots, CostQuest was able to estimate the assets that would need to be deployed to achieve ubiquity.

CostQuest was not asked to estimate the substantial costs related to *maintaining* 3G networks or *providing* mobile wireless voice, data, and, increasingly, video *services*

on an on-going basis. Such operations and maintenance costs must be accounted for by carriers when they determine whether an area can be economically served on an ongoing basis.[1]

Below is a summary of the key findings of this study.

Summary of Findings

1) Approximately **23.2 Million U.S. residents** currently do not have access to 3G mobile broadband service at their primary place of residence.[2]

2) We estimate that approximately **42% of road miles** in the United States do not have access to 3G mobile broadband service.

3) The estimated investment needed to build out infrastructure to facilitate mobile broadband service ubiquitously is approximately **$22 billion.**

4) In order to achieve full 3G mobile broadband coverage, approximately **16,000 new towers** will need to be constructed and **55,000 existing towers** will need to be augmented with 3G technologies.

[1] The report also does not assess the cost of extending basic wireless voice networks.
[2] For this study residence is defined as the location of a census block in which a residence is enumerated according to the 2000 US Census. The population was then proportionally adjusted to equal the July 2006 county estimates.

Purpose and Uses

The purpose of this study is to frame a complicated factual question that underlies important universal service policy debates. This question is: what upfront investment is necessary to augment existing wireless infrastructure and / or build out new infrastructure to provide ubiquitous wireless broadband service?

This initial study frames the size of the deployment issue and sets out the next steps needed to address critical policy questions. Once these next steps are identified, it may be necessary to refine the cost, should there be a decision to publicly support the deployment. Further refinement would involve a more precise treatment of geographic and technological considerations, so that policy makers can be assured that policy and/or funding decisions are sound.

With this said, the assumptions included in our methodology present good high-level estimates of populations, roads, and total investment necessary to build-out meaningful Third Generation (3G) mobile wireless broadband capabilities.

This initial study is not an attempt at creating the actual final cost, the precise tower count or the bill of materials. Rather, the authors view this initial study as the first of many steps in accurately identifying locations investments and operating costs related to ubiquitous wireless broadband coverage. Policy makers, consumers, and carriers will determine, over time, the detailed input criteria for the development of the final costs and the resulting use of the values developed. Significantly, this study also does not include the cost of spectrum.

Equally important as developing the build out investment estimate, however, is developing a methodology to estimate the necessary costs to operate and maintain this ubiquitous network. These operations and maintenance costs are *not* included in this study. As such, the next logical step in this process would be to determine the costs associated with operations and maintenance of wireless networks in both existing areas and the areas identified in this study as requiring new plant. Much like the costs used in the current Universal Service mechanism (yet unique to the wireless industry), these costs would include the ongoing capital costs (depreciation, taxes, cost of money) associated with the network capital expenditures (land, buildings, radio/RF, switching and other accounts), spectrum costs, maintenance cost of the network, and the operating expenses related to serving the customer.

Methodology Fundamentals

As the purpose of this study was to understand the investment necessary to deploy ubiquitous wireless broadband services, several dimensions of data were necessary for every location within the United States. The section which follows will briefly discuss how these data were generated.

To study the cost of ubiquitous wireless broadband deployment, **two fundamental methodological definitions** had to be addressed:

1. **The goal of "ubiquitous 3G broadband service" had to be defined.** For the purpose of this analysis, ubiquitous broadband was defined in terms of the ability to receive both predominant types of 3G service at all studied locations. In other words, ubiquitous broadband service means the ability to receive 3G wireless broadband service in the technology evolution from both CDMA and GSM. If an area can now only receive one class of broadband technology, it was categorized as underserved and the network was augmented from existing infrastructure to allow the support of both technologies. If the area had neither 3G technology service, the area was categorized as unserved by 3G and the network was augmented with both technologies (and possibly a tower) to support the defined level of service.

2. **The geographic scope of coverage had to be defined.** In the case of a wireless network this is a particularly complicated question. Because mobility is a fundamental characteristic of wireless coverage we felt it was important to both identify where population resides as well as how that population could move (e.g., roads). In other words, some combination of populated areas and paths for movement were necessary coverage targets for the ubiquitous wireless networks. We felt that road paths would capture both attributes: populated areas and paths for movement. As such, our target for coverage is road paths[3].

Methodology Steps

Once ubiquity was defined and the geographic scope of coverage was established, a number of processes needed to be developed in order to estimate investment. Ultimately, six technical steps ranging from geospatial to cost analysis were used:

1. **Coverage Data Analysis** - Data regarding current wireless deployment was identified, filtered and combined with other data sources. Along with the coverage pattern, the technology providing service was evaluated.

2. **Technology Isolation** - Those areas served by each of the wireless technologies were isolated.

3. **Asset Data Analysis** - Existing wireless assets (tower locations) were filtered and categorized in terms of the existing broadband coverage patterns and network protocols. These towers were then overlaid with the wireless coverage areas.

[3] The reader is cautioned to not infer that this coverage guarantees a specific quality of service. In other words, there is no guarantee of uniform in building or in car standard with this definition. The mobile wireless coverage used in this study does not assume that signal propagation is spread perfectly or even uniformly throughout the covered area. That is, the networks in the covered areas are continually optimized and improved for capacity growth by the carriers who own and manage them.

4. **Road and Population Analysis** - Using the coverage and asset information, the basic requirements for a ubiquitous network could then be estimated using road paths as the coverage target for network build out and estimated coverage areas as the unit of analysis.

5. **Coverage Analysis** - The entire U.S. was divided into areas approximating the area that could be served by a single tower in lower density areas. These cells were superimposed over the coverage and asset data. Those cells without any roads were dropped from any further analysis since there was no need for coverage. It was assumed that a new tower was needed in each of the remaining cells (those without any coverage), providing an estimated count of new tower sites that will be needed to fill out service coverage. In those cells with coverage from only one 3G technology (or only with voice coverage), the assumption was made that the existing towers within the grid cell would require augmentation.

6. **Investment Development** - Given the count of new sties and the count of towers requiring augmentation, both from the previous step, the investment required to deploy the wireless assets was developed.

Coverage Data Analysis

Coverage Basis Determination

In order to identify uncovered or unserved areas within the U.S., the study first identified the areas currently *covered* by a mobile wireless signal.

As a result of the complexities inherent in carrier coverage maps and in obtaining standard maps from each carrier, we elected to use a commercial coverage database which has been introduced in several regulatory proceedings[4]. For this study, American Roamer[5] provided coverage data for the top 5 wireless carriers by subscribership and 5 of the largest regional carriers[6]. The carriers included in this study represent over 97% of the wireless market share[7] and cover all 50 states, and the District of Columbia. Coverage for 3G services was derived from American

[4] See uses including http://www.psc.state.fl.us/utilities/telecomm/ETCWorkshop/Alltel.pdf - Showing multiple carrier coverage in Montana and South Dakota, see also Re: In the matter of the Federal-State Joint Board on Long-Term High-Cost Universal Service Reform, WC Docket 05-337, and CC Docket 96-45 (http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519534113)

[5] http://www.americanroamer.com/ - 5909 Shelby Oaks Drive, Suite 105 – Memphis, TN 38134

[6] Due to time and data acquisition constraints, coverage areas of smaller regional carriers were not included in the study. However, the coverage from these small regional carriers should not materially impact the results of the study.

[7] Market share was determined by using CTIA's estimate of total subscribership in the US, and applying market share numbers by carrier from Forrester Research (AT&T - 27.1%, Verizon – 26.3%, Sprint Nextel – 23.6%, T-Mobile – 11.1%). Alltel, Dobson, RCC, US Cellular, Alaska DigiTel, and Centennial Communications represent roughly a combined 9% market share. For purposes of completeness, we included in this analysis ACS's EvDO coverage in the State of Alaska.

Roamer's Coverage Right Advanced Services (2/2008)[8]. The geographic extent of non-3G coverage was based upon American Roamer's *Coverage Right (9/2007)* data product.

Technology Isolation

Coverage Protocol and Generation Scenarios

Given that both CDMA and GSM technologies are prevalent in the U.S. today and that the two platforms are not interoperable, coverage by the 3G evolution platforms for both types of networks will be necessary in order for all consumers to retain coverage in all areas.[9] Figure 1 below shows the generational technology protocols and research standards used for the two technologies.

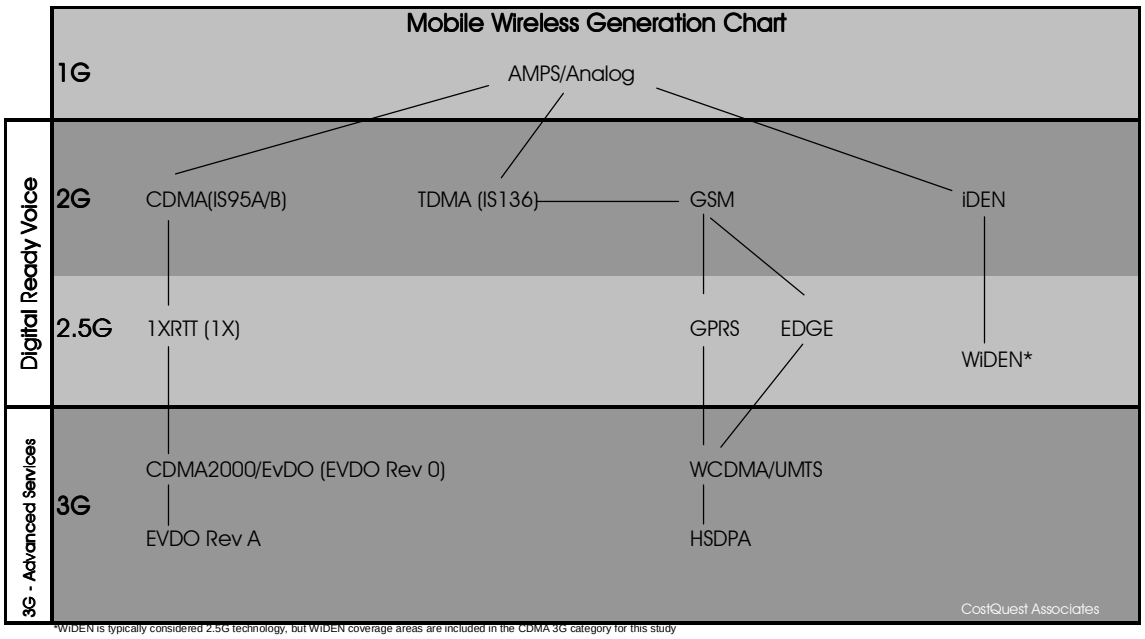


Figure 1—Mobile Wireless Technology Generation

Nationwide Build Out to 3G

As noted above, the study estimates the cost of building out the two predominant 3G evolution platforms to cover each eligible road segment in the US. In Figure 2 below, an example is provided showing the overlay of coverage on roads. Although not shown on this figure, 3G was further classed into areas with dual network providers or only a single provider.

[8] Coverage for ACS was digitized based upon marketing material available at http://www.acsalaska.com/NR/rdonlyres/64686B8E-9B6D-48B0-A365-CCF9E954EC4D/0/2007MobileBroadbandMaps.pdf

[9] This study utilizes current FCC broadband definitions.

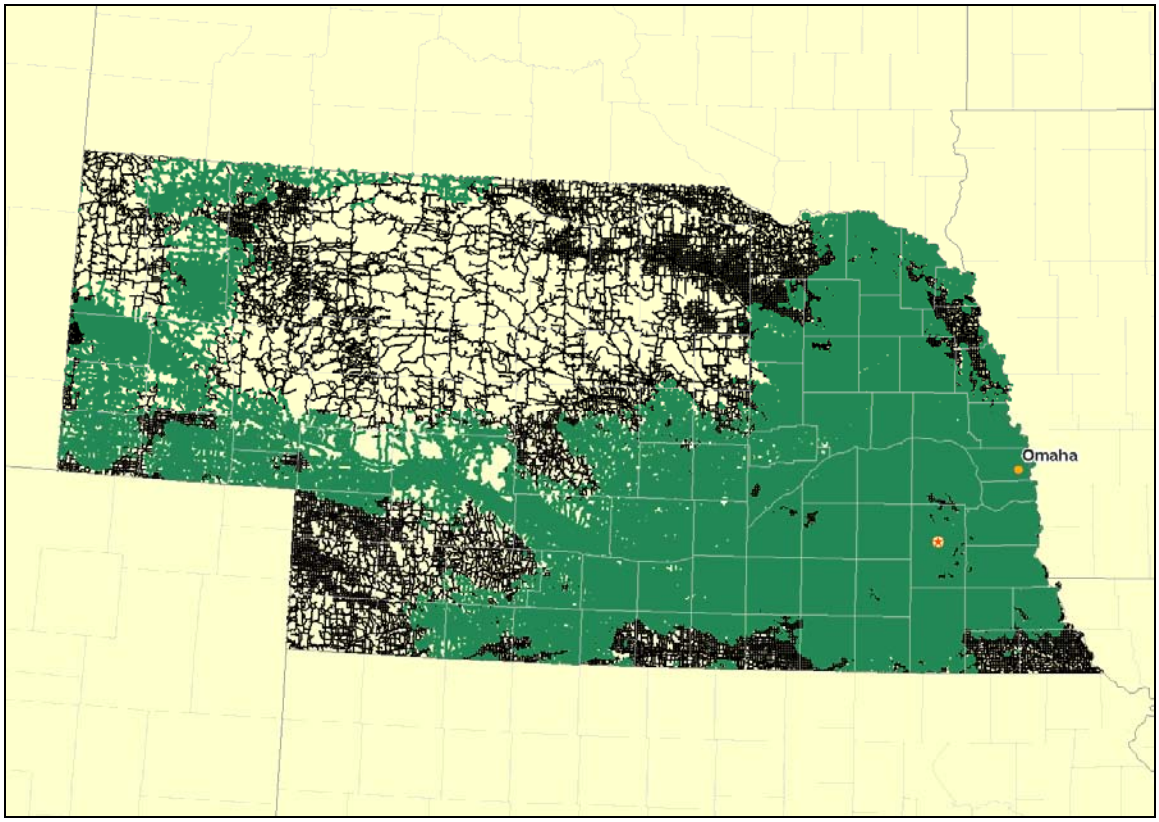


Figure 2—Overlay of 3G Coverage Maps on Road Network - Green-3G, Black-Uncovered by 3G

For those areas only receiving voice services, the study augments each cell with appropriate investment to provide ubiquitous 3G coverage. For those areas currently with no wireless service, the study augments each serving area with appropriate investment to build towers, antennas and backhaul to provide ubiquitous 3G coverage. Finally, in those areas where only one 3G technology is deployed, the study augments these serving areas with the appropriate investment to provide both 3G technologies.

Asset Data Analysis

Towers and Sites

For cells within 3G served areas, existing tower sites were used as the augmentation target. In these underserved areas it was reasoned that existing tower location information provides a better indicator of serving area engineering than does the 6mi tower radius. [10] Tower location information was obtained from Towersource.com[11].

[10] In some extremely high density cells, the number of towers considered for augmentations was capped at 16, since the tower records may capture repeaters. This cap of 16 provides a cell radius of ~0.8miles with roughly a 4 mi sub grid cell coverage area.
[11] Extracted April 2008.

Broadcast towers were removed from the data as well as duplicates and records outside of the area under study.

Road and Population Analysis

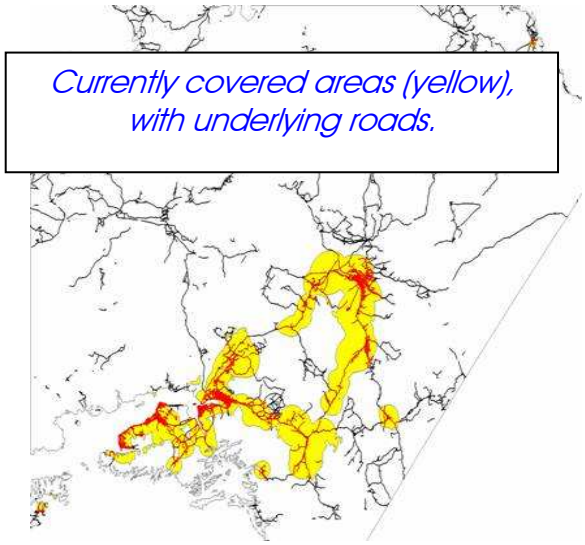
Coverage Demand Identification

Population

While not a direct unit of analysis for the development of augmentation costs, population was studied to determine the counts of potential subscribers who are in 3G unserved areas. Population data were derived from US Census 2000, SF1 population counts at the census block level. The population was then proportionally adjusted to the July 2006 county estimates. Population was allocated based upon the amount of livable road side[12] feet in that census block within each covered service territory.

Roads

TIGER 2006 First Edition roads were used as targets for where the population lives and routes for mobility. Roads were also used to allocate the census population data into the appropriate grid cells. Eligible road types were determined based upon the Census Feature Classification Code (CFCC). Vehicular trails, forest service roads, Ferry Crossings and other special paths and trails were excluded from the study[13].



Currently covered areas (yellow), with underlying roads.

To allocate population a subset of the eligible road segments were used to establish where people likely live. In other words, certain road classes such as limited access interstate highways were included in the coverage analysis portion of this study, but were excluded from calculations which allocated population within a census block.

Identifying Features of Interest

For this study isolating the population, roads, existing tower assets and extent of coverage by technology was necessary. This was accomplished by using a Geographic Information System (GIS)[14].

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[12] As a road may represent a different census block on its left side and right side, the side feet of roads were used as the population allocators—not the centerline distance.

[13] If any of these additional roads and trails were included in the analysis, there would be considerably more road miles to cover.

[14] ESRI, ArcView, 9.2 Build 1420

A geoprocessing model was used to identify road segments which were not covered by a 3G technology. The geoprocessing model effectively analyzed each eligible road segment and recorded the amount of that segment intersecting each 3G covered area.

Using the geoprocessing model, five classes of eligible roads were developed. The first class was all possible eligible road segments. The second segment class included roads covered by only voice technology. The third class was road segments covered by both a CDMA (EvDO) and GSM (HSDPA) class of 3G broadband service. The fourth class was a segment covered by only GSM (HSDPA) based 3G. The fifth class was a segment covered only by CDMA (EvDO) based 3G.

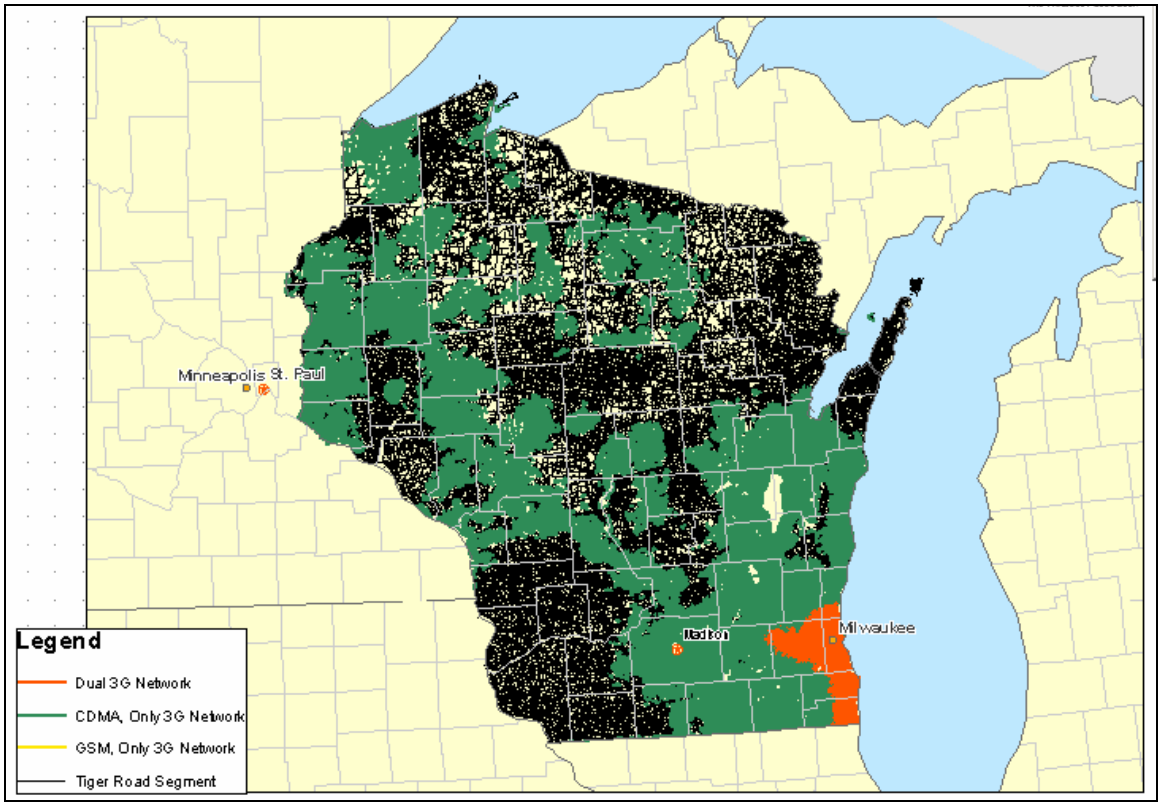

Figure 3–Categories of Road Segments: Green- Only CDMA based 3G, Black-Uncovered by 3G, Red-Covered by both a GSM and CDMA based 3G network.

Coverage Analysis

Cells and Coverage

As described in the Assumptions and Calculations discussion at the end of this section, a 6 mile serving radius was used to represent the reach of a tower site in

lower density areas[15]. This 6 mile serving radius equated to a 8.48 x 8.48 grid cell[16]. Once the road segments were classed by the served network technology, they were then classed within each cell[17].

The amount of road centerline feet covered by each network protocol within a grid cell was then used to determine whether 3G augmentation would be required[18] and the type of augmentation. Grid cells with no road feet covered by an existing 3G or voice technology required a full site deployment (e.g., tower, antenna, backhaul, etc.). In these areas, a single site was assumed sufficient to serve the entire cell.

Grid cells covered by only voice based technologies (i.e., no current 3G deployment) were identified as areas that required upgrades to both 3G technologies. In contrast to the unserved areas, these grid cells only required upgrade equipment – augmentation - rather than the equipment needed to fit out a full tower site. In these areas, it was also assumed that a single tower site could be deployed with 3G equipment to serve the entire area.

The final types of areas analyzed were those that were partially covered with 3G services.[19] In those grid cells where both technologies were deployed, no investment was necessary. However, in those grids with only one 3G technology, the underserved area was augmented so that existing tower sites within that area were augmented to make both 3G technologies available. Unlike the unserved 3G areas, we augmented a percentage of the actual tower count within the grid cell[20], since the actual tower count provided the actual cell sizing criteria in higher density areas – rather than our estimated 6 mile based grid cell.

Investment Development

As mentioned in the introduction, this study was commissioned to identify only the initial capital investment of deploying ubiquitous wireless broadband coverage across the nation. As such, these estimates are not comparable to other Universal Service cost estimates, since such mechanisms represent the average monthly or annual costs of providing service, including capital costs and operations and maintenance costs. This study also did not attempt to include the costs of spectrum, which are often significant.

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[15] We assumed that in lower density areas, distance from the tower was the key limitation on design. As density increases (i.e., users), both traffic and distance can limit the service area of a tower.
[16] This size cell was used as it is the smallest square which can bound a 6mi radius tower serving area.
[17] There we approximately 50,000 grid cells in the study covering more than 39 million road segments.
[18] For purposes of the study, augmentation was triggered when more than ½ mile of roads within a grid cell was found to be uncovered.
[19] As a conservative approach, a cell partially covered by a 3G technology was considered fully served by the specific 3G technology.
[20] For purposes of the study, we assumed that 40% of the towers (minimum of 1) within a 3G grid would need to be augmented to provide service for the currently non-deployed 3G technology. The 40% was derived from an assumption that ½ of the towers were required for each technology. We reduced our ½ assumption to account for concerns that the tower data may contain non-tower sites such as repeaters.

Direct and Indirect Capital Investment Estimates

For those areas already served by both a CDMA (EvDO) and GSM (HSDPA) based 3G technologies, no additional investment was needed. By-in-large, fully deployed 3G areas reside in counties with population density greater than 100 people per square mile. To put that into perspective, the FCC has reported that 79% of the U.S. population lives in non-rural counties representing no more than 14% of the geographic area of the United States.[21]

For those areas that are currently unserved by any wireless service, the grid cell analysis provided the total counts of tower sites that need to be deployed. This count of tower sites was multiplied by the costs for a full site deployment for both technologies. This full site deployment cost includes the base station, tower, antenna, site acquisition, microwave backhaul, etc.

For those areas where a tower exists but service coverage has to be augmented to provide full 3G level service, the grid cell analysis provides the count of towers where the technologies need to be deployed. Based on the deployment requirements, the tower count was then multiplied by the required augmentation costs, which include all upgrade components required at the site.

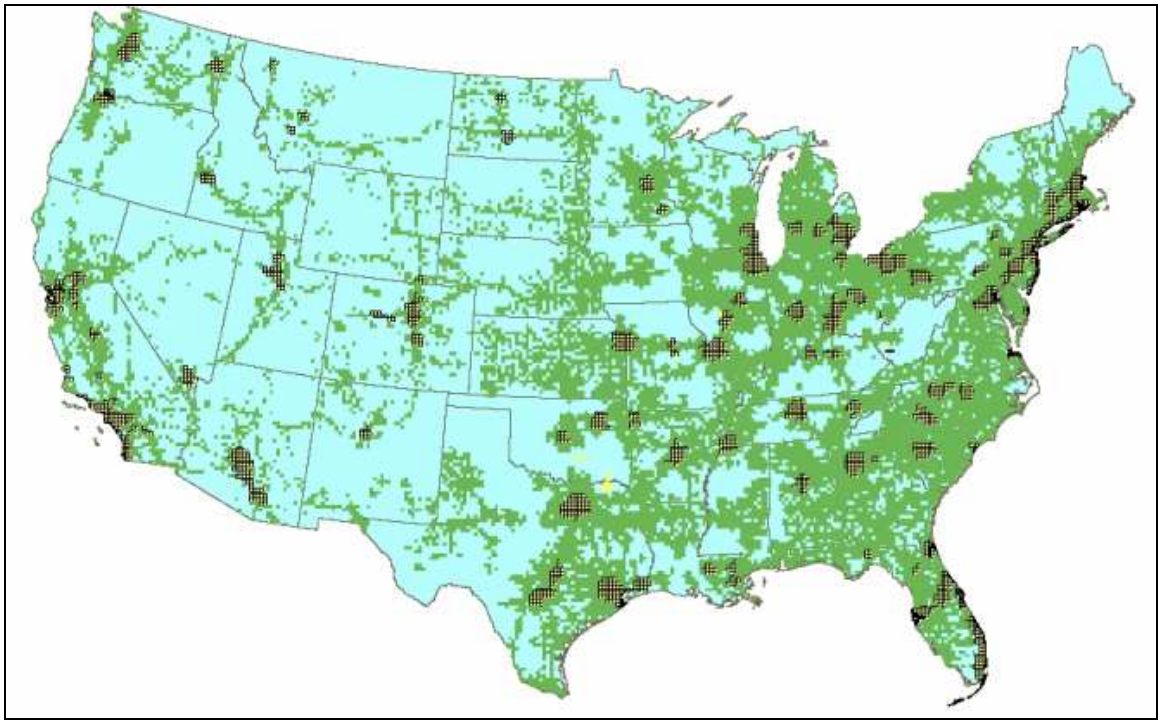

Figure 4-Areas needing augmentation to dual 3G networks (green requires only GSM based 3G, yellow requires only CDMA based 3G)

[21] See Annual Report and Analysis on the Competitive Market Conditions With Respect to Commercial Mobile Services, WT Docket No. 07-71, FCC 08-28 (rel. Feb. 4, 2008), at para 37.

Costs used in the study were based on input from 4 wireless carriers. The cost inputs reflect the various buying power of providers, ranging in size from national carriers to smaller regional carriers.

Estimates on secondary capital were also included in the study by multiplying the tower and augmentation costs by a factor. These secondary investments include switching, motor vehicles, furniture, tools, etc. The factor applied only represents the secondary capital investment related to the initial build-out for unserved and underserved areas.

Spectrum costs were not included in this study. The substantial costs associated with acquiring spectrum should be considered for further studies.

Assumptions and Inputs

Engineering Parameters

Given that this is an exercise in determining a national cost estimate to provide ubiquitous 3G wireless broadband coverage as opposed to specific site by site engineering, standard GSM/HSDPA and CDMA/EvDO deployment parameters, engineering, and costs were considered sufficient.

If site specific costs are of interest (as we recommend in the next steps to refine this study), details related to network deployment at each site, such as tower height, topography, frequency and handsets used would be required.

Signal Propagation Radius

Notwithstanding all the variables that go into planning a broadband wireless network, reasonable averages were determined so that the study could estimate total network assets needed to cover a given area. Depending on the frequency and technology used, between 4 and 7 miles of propagation radius will give a customer in-car and in-building signal in an average deployment.[22] As such, we selected 6 miles as the signal radius used to determine the reach of a tower or site in this study.

Other Engineering Parameters

- Maximum customers per site/tower were assumed to fall between 2,000 and 2,500 customers based on 60 mErlang per subscriber.
- Maximum propagation radius for any deployment would be no more than 22 miles. However, given our grid cells and their assumed signal radius, no main road was greater than roughly 6 miles from a tower.
- The analysis assumes the use of existing, deployed spectrum including Cellular, PCS, SMR, and AWS-1 bands.

Cost Development Assumptions

Cost estimates for direct (e.g., tower) and secondary (e.g., motor vehicles) capital investment were derived from requests to providers and from CostQuest's work in the wireless industry and are meant to serve as a broad average for deployment of new network equipment.

Tower/Site Cost Estimates

Full site deployment, which includes the base station, tower, antenna, site acquisition, microwave backhaul, etc., are estimated to be $650,000 per site for either CDMA/EvDO or GSM/HSDPA based 3G deployments. For dual mode sites, the cost of the site was $865,000.

[22] Dr. Shawn Ziglari, President and CEO, eXpert Wireless Solutions, Inc. (http://www.expertwireless.com)

For those areas where a tower exists but service has to be augmented to provide 3G level service, augmentation costs including all upgrade components required at the site are estimated to be $105,000 for GSM/HSDPA augmentation, $80,000 for CDMA/EvDO augmentation, and $185,000 for dual mode augmentation.

Spectrum

Spectrum costs were **not** included in this study. The substantial costs associated with acquiring spectrum should be considered for further studies.

Secondary Capital Estimates

Secondary capital, including switching, motor vehicles, furniture, tools, etc., is estimated to be 5% of the direct site investment. This represents only the secondary capital investment related to the initial build-out for unserved and underserved areas.

Up Front Capital Study Limitation

This study does not estimate costs related to maintaining the networks or providing service. Additional analysis would need to be performed to identify capital and operating costs related to maintenance, optimization (coverage and capacity adjustments for changing market conditions), and the general service and administrative costs associated with such networks.

Ubiquitous Wireless Broadband Study Results

3G Coverage

Population and Roads

Based on our study methodology for 3G coverage and the data that was used, roughly 23.2 Million U.S. residents currently have no access to advanced wireless broadband service at their place of residence. While roughly 2.5 million road miles do not fall within any 3G coverage area.

The map below (Figure 5) shows areas currently served by 3G services. There is no distinction at this scale for underserved 3G areas.

The map in Figure 6 shows the road coverage within the state of Washington broken out by: Dual Technology 3G network, CDMA/EvDO only, GSM/HSDPA only and unserved. Figure 7 is a table showing unserved roads, geographic area, and population by state.

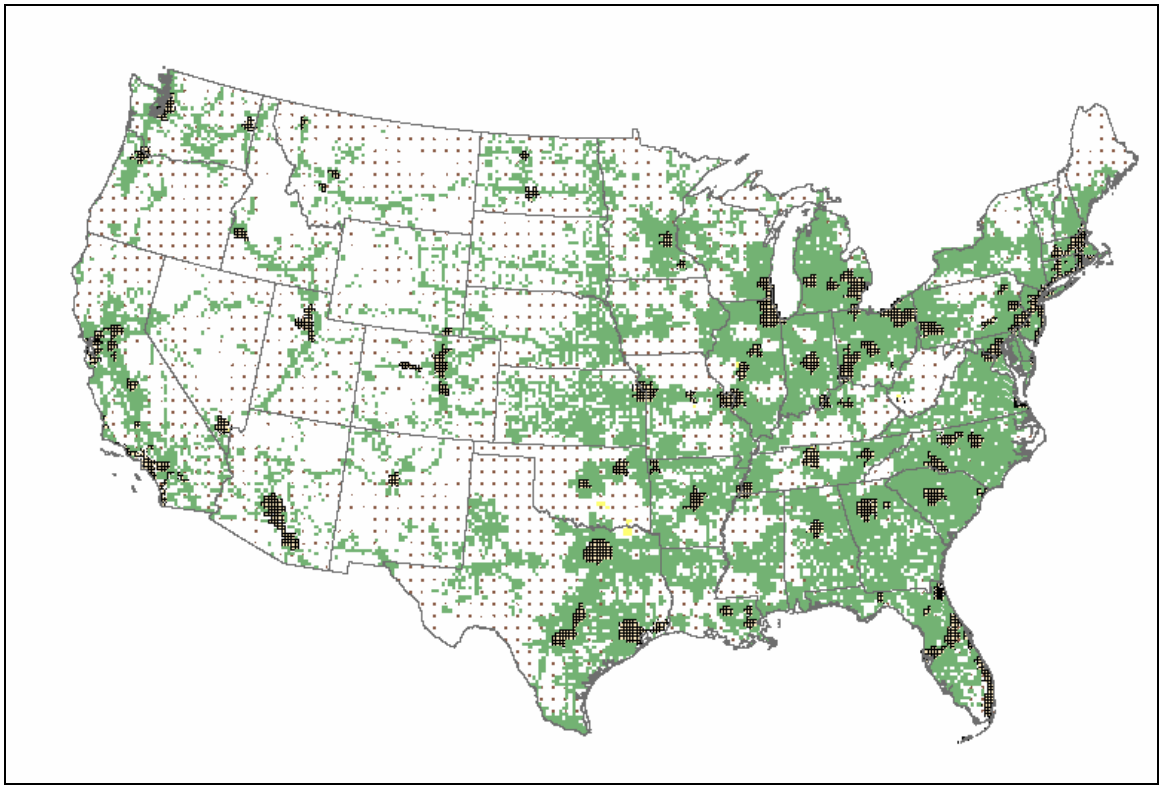

Figure 5 – National 3G Coverage Map (white areas are unserved)

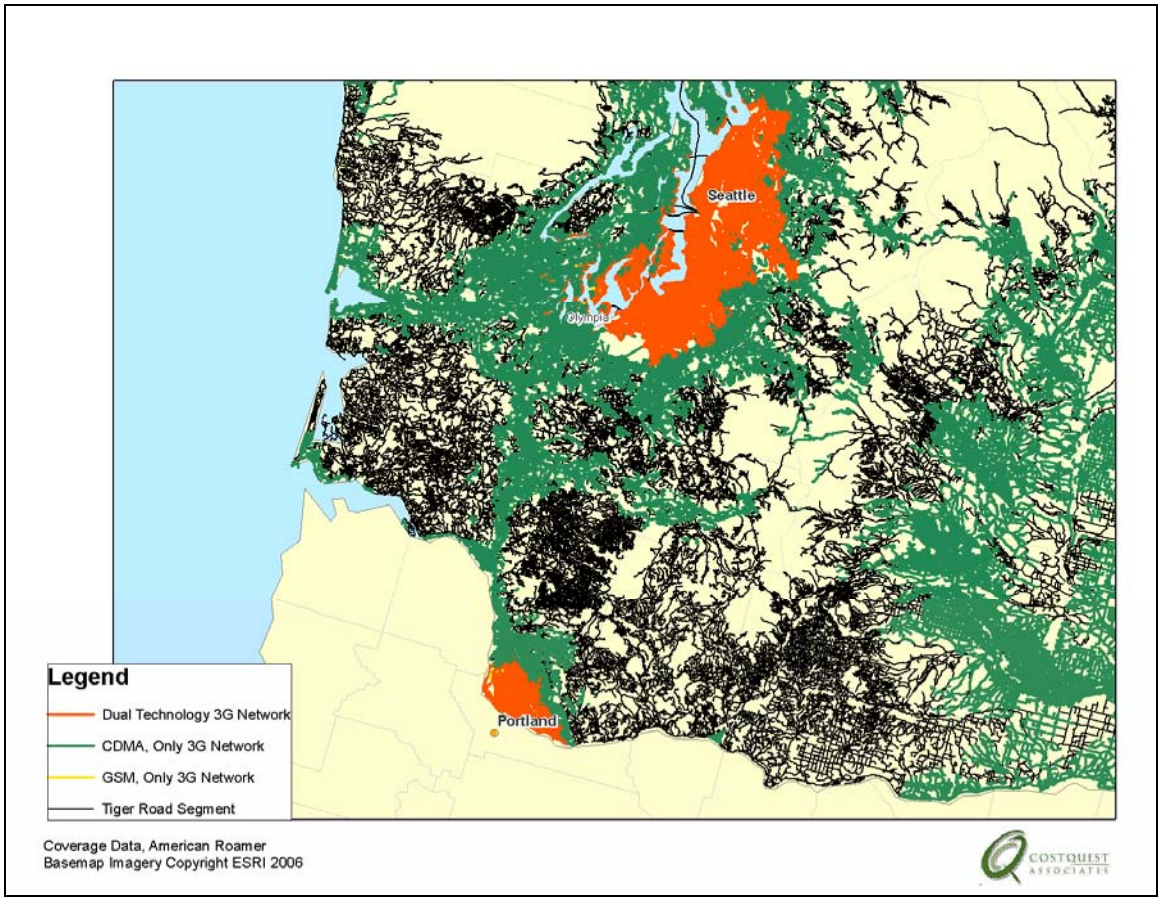

Figure 6 – Example of 3G Road Coverage (light-yellow areas are unserved by any 3G technology)

Note: In a second, accompanying document to this study is a map for each of the States and the District of Columbia.

State	Population Unserved by Mobile 3G	Percent Road Miles Unserved by Mobile 3G	Percent Geographic Area Unserved by Mobile 3G
Alabama	535,125	21%	30%
Alaska	315,189	87%	98%
Arizona	214,013	62%	80%
Arkansas	225,894	27%	35%
California	715,985	36%	61%
Colorado	258,632	59%	76%
Connecticut	87,180	3%	5%
Delaware	7,438	2%	6%
District of Columbia	-	0%	0%
Florida	198,026	8%	22%
Georgia	334,086	15%	21%
Hawaii	128,830	27%	57%
Idaho	132,337	67%	83%
Illinois	705,239	22%	29%
Indiana	546,519	13%	16%
Iowa	1,082,406	59%	63%
Kansas	169,390	38%	45%
Kentucky	1,318,302	53%	60%
Louisiana	725,254	31%	44%
Maine	467,162	65%	83%
Maryland	229,120	10%	18%
Massachusetts	123,016	5%	10%
Michigan	404,429	21%	58%
Minnesota	777,478	53%	67%
Mississippi	887,855	47%	50%
Missouri	993,593	45%	56%
Montana	185,195	82%	90%
Nebraska	149,068	47%	65%
Nevada	61,956	76%	90%
New Hampshire	295,936	23%	39%
New Jersey	90,975	1%	3%
New Mexico	260,473	74%	86%
New York	978,061	24%	44%
North Carolina	523,997	15%	20%
North Dakota	88,808	66%	71%
Ohio	578,357	11%	21%
Oklahoma	1,101,262	66%	73%
Oregon	537,055	74%	86%
Pennsylvania	1,354,928	25%	36%
Rhode Island	14,234	1%	1%
South Carolina	42,678	3%	5%
South Dakota	82,086	64%	76%
Tennessee	840,015	28%	37%
Texas	1,427,567	46%	59%
Utah	47,821	66%	84%
Vermont	112,006	52%	60%
Virginia	421,832	16%	22%
Washington	285,138	47%	65%
West Virginia	1,083,017	77%	84%
Wisconsin	912,652	41%	58%
Wyoming	96,006	80%	86%
Total	**23,153,618**	**42%**	**68%**

Figure 7 – Unserved 3G Population, Roads, and Area by State[23]

[23] Due to rounding Washington DC shows as entirely covered area but there is a small amount of uncovered population.

Initial 3G Investment Estimate

We estimate that it will require roughly $22 Billion of upfront capital to deploy ubiquitous wireless broadband coverage, via 3G technologies, in the U.S. Below is a summary of findings related to the investment estimates.

- Nearly a third of the investment necessary for bringing 3G broadband ubiquity to the U.S. is for augmentation of existing site locations

- States with lower population density require more new site investment rather than augmentation of existing network assets. More than 90% of the estimated investment for Alaska, Idaho, Montana, Nevada, and Wyoming is Greenfield or new site investment.

- Ten states represent nearly 50% of the estimated investment needed for ubiquitous 3G wireless service in the U.S.

Below is a table (Figure 8) showing total estimated investment needed and a count of estimated sites and augmentations.

State	Est. Count of New Sites	Est. Count of Augmentation of Existing Sites	Est. Investment
Alabama	130	2,068	$ 351,445,500
Alaska	1,678	440	$ 1,602,373,500
Arizona	913	640	$ 919,842,000
Arkansas	176	1,151	$ 291,201,750
California	769	2,182	$ 975,969,750
Colorado	815	620	$ 821,598,750
Connecticut	4	201	$ 25,793,250
Delaware	3	110	$ 14,852,250
District of Columbia	-	-	$ -
Florida	151	2,010	$ 361,100,250
Georgia	135	2,467	$ 396,448,500
Hawaii	51	135	$ 63,388,500
Idaho	726	473	$ 720,189,750
Illinois	87	1,565	$ 260,442,000
Indiana	52	1,477	$ 211,664,250
Iowa	103	1,282	$ 263,282,250
Kansas	327	1,355	$ 457,558,500
Kentucky	117	791	$ 209,013,000
Louisiana	94	1,543	$ 267,671,250
Maine	151	542	$ 216,305,250
Maryland	18	411	$ 62,921,250
Massachusetts	19	282	$ 48,683,250
Michigan	187	1,762	$ 377,711,250
Minnesota	341	1,211	$ 473,550,000
Mississippi	125	1,348	$ 276,512,250
Missouri	147	1,484	$ 324,350,250
Montana	1,252	691	$ 1,245,147,750
Nebraska	344	1,113	$ 457,742,250
Nevada	1,012	463	$ 986,658,750
New Hampshire	31	264	$ 58,605,750
New Jersey	10	265	$ 38,298,750
New Mexico	890	824	$ 934,048,500
New York	205	1,555	$ 363,090,000
North Carolina	107	2,007	$ 321,226,500
North Dakota	509	498	$ 528,207,750
Ohio	50	1,557	$ 220,095,750
Oklahoma	121	1,260	$ 290,865,750
Oregon	373	1,159	$ 522,501,000
Pennsylvania	148	1,427	$ 295,695,750
Rhode Island	1	7	$ 1,680,000
South Carolina	26	1,801	$ 222,174,750
South Dakota	553	541	$ 575,851,500
Tennessee	94	1,374	$ 244,823,250
Texas	930	5,719	$ 1,567,933,500
Utah	626	476	$ 639,103,500
Vermont	66	85	$ 69,987,750
Virginia	105	1,609	$ 274,018,500
Washington	387	937	$ 468,825,000
West Virginia	142	387	$ 180,180,000
Wisconsin	171	1,314	$ 317,651,250
Wyoming	929	309	$ 882,703,500
Total	**16,413**	**55,275**	**$ 21,721,680,750**

Figure 8 – Estimated 3G Investment by State

About CostQuest

CostQuest Associates develops solutions related to costs, pricing, business management, and regulatory analysis. CostQuest's recent projects include Broadband Network Modeling, Forward Looking Cost Models, Profitability Analysis, Regulatory Compliance Consultation and Regulatory Advocacy Support.

CostQuest is a world-wide leader in Universal Service Fund modeling and policy analysis. CostQuest developed models to support USF with the FCC (US) and for foreign governments including Australia, New Zealand, and Hong Kong. CostQuest has written policy analysis papers on modeling, reverse auctions, 10th circuit issues, and various other USF related issues.

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