CostQuest Associates (CQA)
Economic Research & Analysis

United States Cellular Corp.

Ongoing Support for Operations & Maintenance of Rural Mobile Networks

February 22, 2016

CostQuest Associates (CQA) Economic Research & Analysis

For further information or if there are any questions or concerns contact:
research@costquest.com

Table of Contents

Introduction

CostQuest presents this brief analytics paper, examining the cost structure of a rural wireless carrier, to inform the record with data and findings that can provide a foundation for an economically rational funding program for FCC's Mobility Fund Phase II. CostQuest's primary goal is to develop, through a series of internal, government-based, and proprietary data sources, a means to quantify the full financial picture of mobile wireless service in rural areas.

Whether Mobility Fund Phase II support is distributed via a model, a reverse auction as used in Auction 901, or a combination of both, the program will rely on both a "cost/financial model" and a "support model," either explicit or implicit. In a model distribution program, such as the CACM being used for Price Cap landline carriers, the cost/financial model identifies areas requiring funding and the potential funding requirements. In determining the model distribution, the CACM support model takes the costs and then applies policy decisions, such as not funding competitive areas, to arrive at the final disbursement amounts. In a reverse auction, the cost/financial model can help identify the potential size of the fund, the targeted areas, and potentially the reserve price. Additionally, for successful bidders, a cost/financial model typically forms the backbone of the bids submitted. On the support side for reverse auctions, the support model captures policy decisions that cover who is eligible, what areas are eligible, and the regulatory requirements imposed on fund recipients.

No matter how the ultimate fund is set up, understanding the cost/financial picture of rural area deployment is an important first step to developing a successful Mobility Fund Phase II program. As such, we provide a detailed view of the financial picture to serve a rural area with mobile wireless service.

Consumer Experience and the Importance of Maintaining Networks

For wireless carriers (just as for any telecommunication provider), the consumer experience determines the companies' ultimate level of success. In this world of mobility, consumer satisfaction is driven primarily by the consistency, quality, and reliability of voice and data coverage and throughput. Maintenance and operation (collectively referred to as "Opex") of the network (e.g., cell sites, switching, backhaul) is therefore paramount to the consumer experience and ultimately the provider's level of success. In more heavily populated areas, opex is less costly per subscriber and oftentimes offset by the revenues received from the larger available customer base (i.e., greater population density), although cell site rentals, backhaul and maintenance costs can be higher. In more rural locations, where opex cost per subscriber is often prohibitive, carriers may reach economic viability using explicit subsidies (universal service support) or implicit subsidies (transferring funds from profitable to unprofitable areas) (collectively, "Subsidies"). In such areas, insufficient funding causes carriers to cut back on the cell density, performance metrics, upgrades, functionality and maintenance, all of which are needed to make rural networks reasonably comparable in quality to those in urban areas. All of these factors mean the consumer experience can be quite different, especially if Subsidies are missing and/or reduced. In our

view, expanding the public record on the finances of rural deployment is critical to making the optimal policy choices.

Financials of a Rural Mobile Network

Through the Mobility Fund Phase I Auction, the FCC clearly recognized initial deployment costs as a hurdle to getting mobile service to rural areas. These costs were supported through the Auction's one-time infusion of funds – to the tune of $300 million - to serve 12.9%[1] of the eligible unserved road miles in the U.S. Deployment of facilities in these sparsely populated, varied-terrain areas is a financial challenge, and may have never happened without funding support. That being said, perhaps more of an economic challenge is operating and maintaining those networks over long periods of time.

In the following, we explore the financial picture of deploying and maintaining mobile wireless service in rural areas.

Financial Components

As a first step in identifying areas of the country that may require some type of external funding (e.g., Connect America Fund) to make mobile network deployment viable, it is necessary to understand the cost of mobile network deployments. For the purposes of this paper, we'll focus on three key cost categories: Initial Investment, Operations and Maintenance (hereafter referred to as "Opex"), and Maintenance/Replacement Investment (hereafter referred to as "Maintenance Capex"). This Maintenance Capex category of cost is often overlooked, but must be considered when attempting to identify the forward-looking costs and the funding needed to support those costs.

Initial Capex captures the upfront capital expenses required to build cell sites, increase switching capacity and the edge core that aggregates and manages traffic, provides functionalities to the end user, facilitates call completion and data packet handling, routing and billing, and more. The cell sites will include: towers, antennas, amplifiers, cabling, power, RAN electronics, shelters, transport electronics, and other miscellaneous gear deployed to meet expected traffic demands and user needs.

Opex will include the cost to run and maintain the cell sites, edge core and network, manage traffic, support the customer, operate stores, handle billing, and other aspects of running a mobility company. The typical Opex costs for a mobile carrier can be broken down as follows: Customer Operations (CustOps), Roaming Expense (Roaming), Bad Debt, Sales and Marketing, Advertising, Network Operations

[1] One could infer from this that it would have taken at least $2.3 Billion to serve 100% of the eligible unserved road miles. However, this would appear to be a conservative lower bound since the $300 Million was awarded to the lower cost areas. Keep in mind, this value is simply the cost to expand service to currently unserved areas and does not include the support that may be required in currently served areas that were the result of prior USF funding.

(NetOp)[2], Cell Site Operations (CellSiteOp)[3], Handset Subsidies, and General and Administrative costs (G&A) which can include billing, IT departments, HR, etc.

Maintenance Capex captures the ongoing capital investments required to maintain a viable mobile network. Over time, new technologies and techniques to manage the network (e.g., Software Defined Networks) emerge, and demand changes (e.g., new devices, new applications, and dramatic growth in data traffic over the last number of years). Continual changes require ongoing network investments, covering items such as carrier augmentation, resectorization, deployment of each succeeding new generation of mobile technology (e.g., HSPA, HSPA+, LTE, LTE Advanced), power backup systems, shifts to Ethernet backhaul, and more. In addition, as with any capital deployment, there are equipment failures requiring capital for replacements.

All three of these cost categories, Initial Capex, Opex, and Maintenance Capex, must be considered by a carrier as they plan for initial deployment, maintaining deployment, and/or expanding deployment. Additionally, carriers must consider the often prohibitively high cost of fiber for backhaul in rural areas.

Differences in Costs of Maintaining Rural Networks versus Typical Networks

Operational and maintenance costs for wireless carriers in rural areas obviously can vary greatly from the costs in metro areas, just as they do for wireline carriers. Intuitively, it is more expensive to provide service, on a per subscriber basis, in less densely populated areas. Maintaining rural sites may also be more expensive as many of the utility and other services and amenities are not as readily available as they are in metropolitan areas. Rural sites are often in remote areas requiring more travel time to reach, via unpaved roads and varying topography; but, they require maintenance nevertheless and often times this expense is not economically feasible or commercially viable without the aid of Subsidy funding given the low number of subscribers using the rural site. Rural sites often require more expensive backhaul arrangements (higher leased line costs or a microwave investment amortization). Also, while collocation at most rural sites should cost less, it is more likely in the most rural areas and, certainly, the unserved rural areas that there will be few, or no opportunities to colocate on existing structures (likely resulting in increased tower capex amortization).

Universal Service Funding has historically supported service areas that are not commercially/economically viable. However, commercial viability, or the antithesis of it, can be difficult to quantify because legacy mobility funding is clouded with inter and intra-company cross subsidization. This makes the job of isolating true commercial viability in rural areas a difficult one.

It is clear that high initial investment is not the only barrier that keeps carriers from serving high-cost rural markets. Carriers look at the total expected net cash flows, including maintenance and other operating

[2] Network Operations costs include call and packet handling, 911 facilitation and other costs associated with the edge core and national network.
[3] Site Operations costs include tower lease, backhaul, utilities and cell site maintenance.

expenses, over an extended time period in deciding whether to extend/continue service in a given area. The less dense areas within markets are often left unserved or underserved because of the ongoing OPEX as much as for the high hurdle of Initial Capex. If Universal Service funding, cross-subsidization or other sources of support were not available, what areas would be deemed viable markets for a rational executive of a mobile carrier serving rural areas?

The Business Case

To examine the financial picture of deploying service in rural America, CostQuest constructed a financial model using a five year cash flow business case analysis. The model looked at the annual cash flow in (via revenues) and the annual cash flow out (via the three type of costs discussed above) over a five year period. The cash flow in each year was then discounted back to today's dollar value, what is typically referred to as the net present value or NPV. A positive NPV indicates economic viability while a negative NPV indicates the opposite.

In the model, inputs for initial capex, opex, and maintenance capex were derived from CostQuest's knowledge of the industry, proprietary financial data, public financial information, and other sources. Toggles were set to provide the discount rate, assumed take rates and ARPU (Average Revenue Per User[4]), and the term of the study. Finally, population counts within the serving footprint of typical cell sites were varied to provide an in-depth understanding of the economically viable breakpoints for deployment.

In setting up the business case, we used the following inputs:

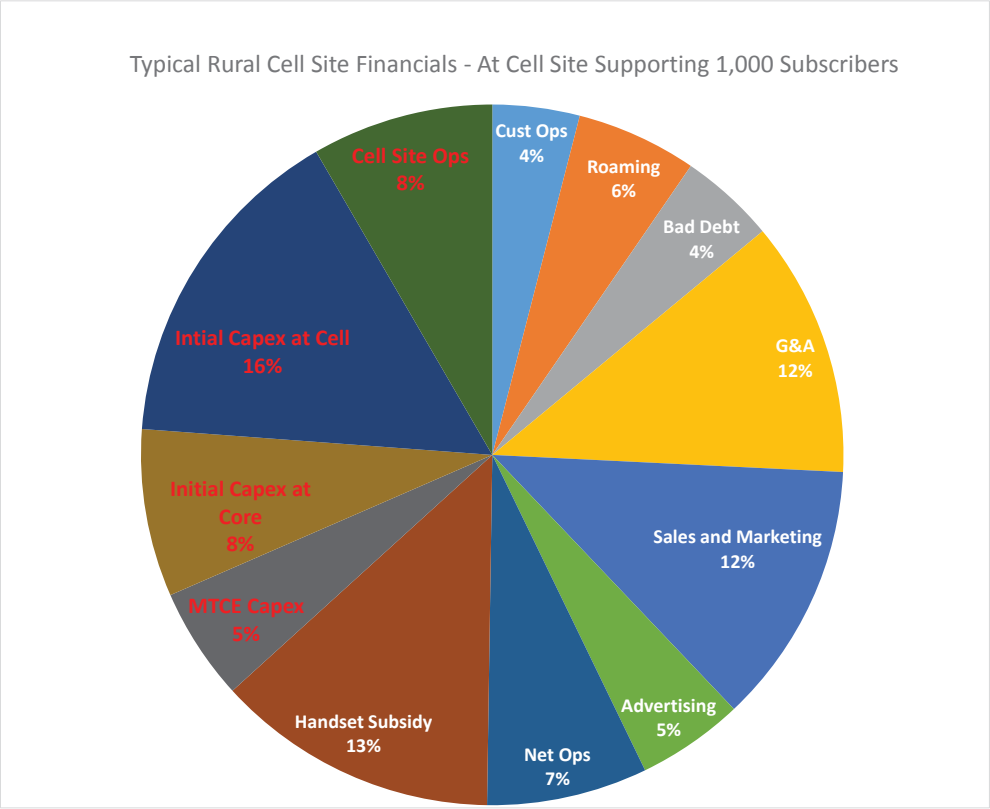
- Monthly ARPU: $56.21
  - Value excludes USF and ETC derived revenue
  - Value includes roaming revenue
- Monthly Subscriber operational costs: $35.68
- Monthly Handset Subsidy and Inventory costs: $9.24
- Monthly Cell Site operational costs: $4,662.44
- Initial cell site capex: $290,000.00
- Initial core capex: $145,000.00 (unitized to per cell site)
- Maintenance capex: 42% of initial capex over 5 years

[4] While there are a number of ways to attribute revenue to cell sites, for the modeling purposes in this paper we attributed the revenue of users to their home base cell site.

Business Case Results

1,000 Subscriber Snapshot

From the five year business case model, an example of the carrier cost breakdown for a cell site supporting 1,000 subscribers is shown in the chart below.[5] The components shown in red represent costs associated with deploying and maintaining the cell site.



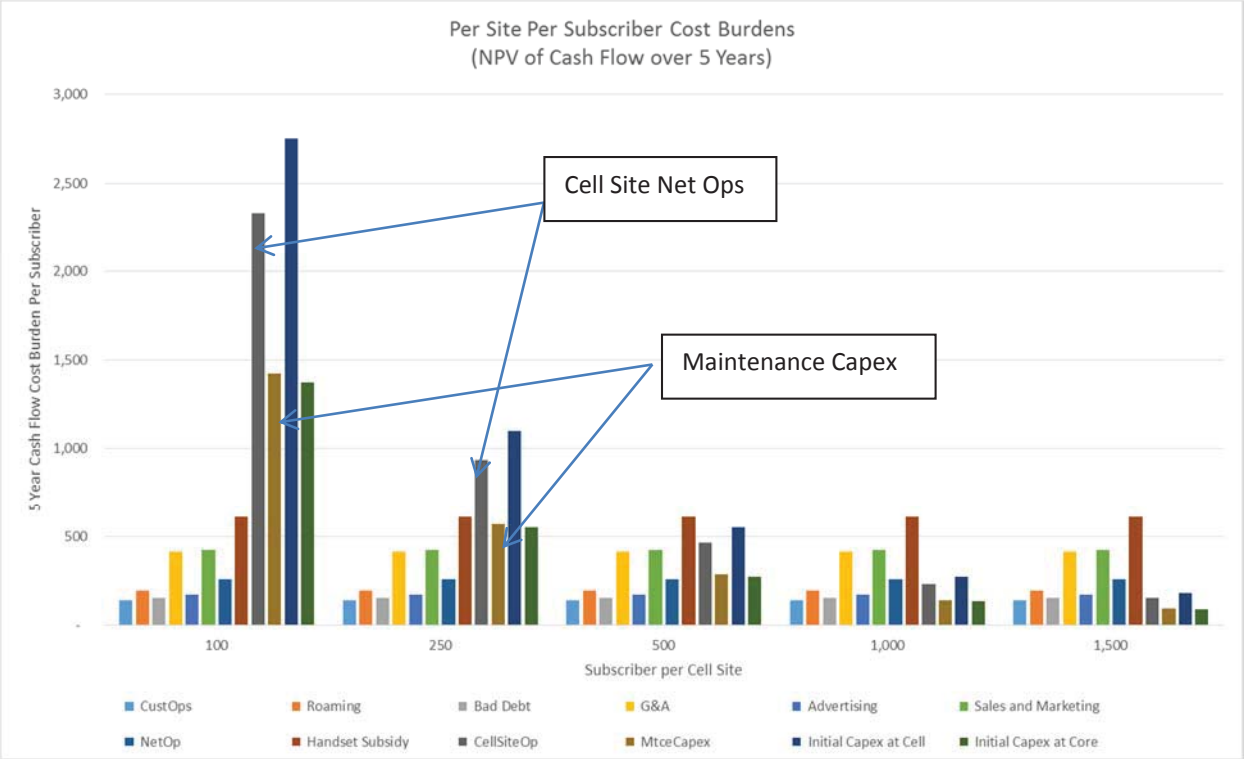
While much of the cost displayed above is driven by subscriber counts (i.e., volume sensitive to subscribers), a sizeable portion of the costs, those noted in red text, are fixed costs associated with the cell site. Consider the cell site, the backhaul costs, the power consumption, and cell site maintenance. All of these costs are relatively fixed once the cell site is in place. As long as the carrier can "amortize" these fixed costs over enough subscribers, the site, or a collection of sites in a community or even the company, can be economically viable. The issue that arises in rural America is that the subscriber counts

[5] These costs are based on a 5 year business case for a typical site supporting 1,000 subscribers.

served by a typical cell site can be insufficient for a carrier to defray these fixed costs. As such, the expected or realized financial loss may warrant subsidization through government funding programs.[6]

Impact of Supported Subscriber Counts

Using the financial model, we can examine the impact of the fixed costs of cell site deployment and maintenance. In the chart below, the cash flow analysis shows there is a clear per subscriber cost advantage to placing sites in dense areas, not just for the benefit in the multiples or ARPU, but for the spreading of the initial cell site and switch capex costs across many subscribers. It also highlights the impact of Cell Site operations costs and Maintenance Capex, which are the 2nd and 3rd highest costs for sites with 250 subscribers, next to the initial capex deployment. While this recognition of density issues could go without saying, we feel it's important to inform the record as to the extent of the differences between the assumed subscriber density tiers.



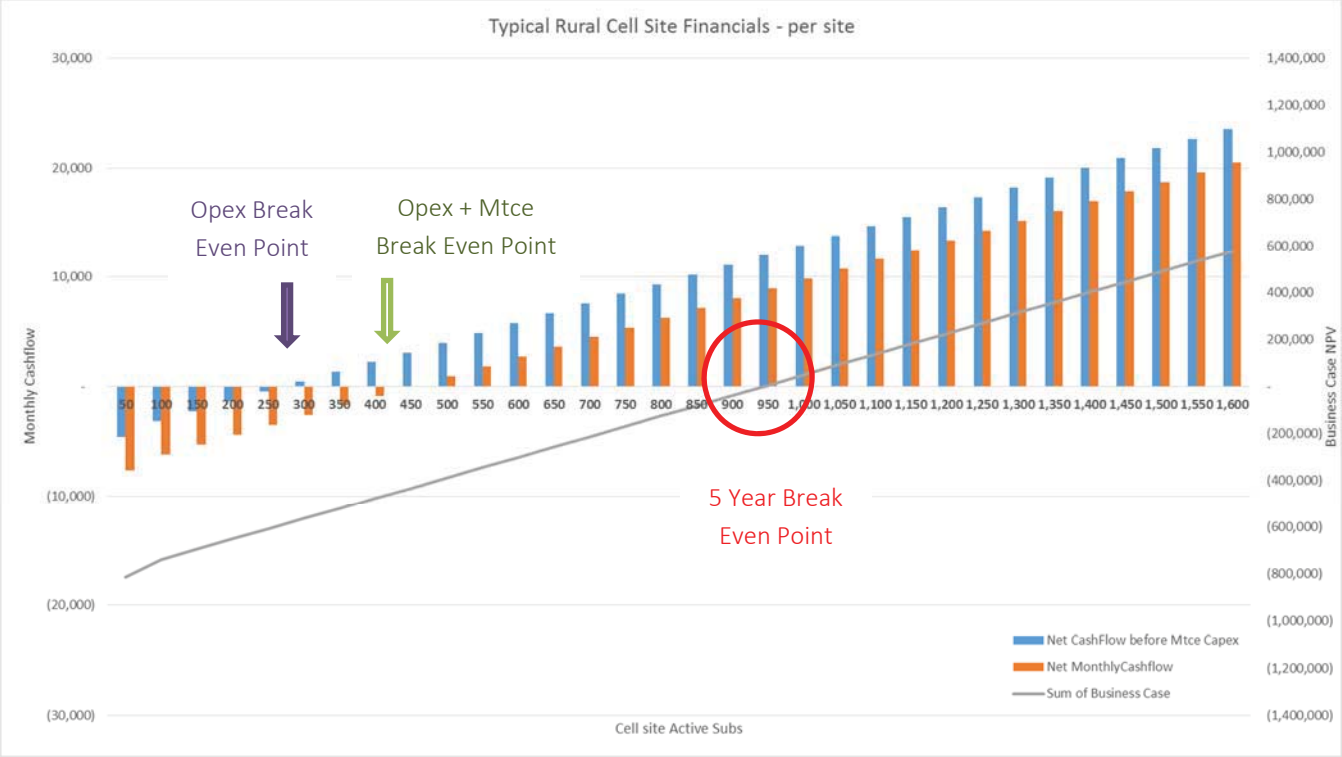
Economic Viability

A second step in the business case analysis, and perhaps more informative, is when the Cash Flow Analysis is drawn out to its conclusion to see the Net Present Value of the expected cash flows over the

[6] In our financial model, we recognize both roaming revenue and roaming expense. However, our values represent an average and do not capture the early industry phenomenon of deploying sites solely for the roaming revenue. With industry consolidation these types of sites have been largely absorbed into the larger carriers.

length of the expected business case.[7] The point at which a typical mobile carrier breaks even on the scale of *total number of active subscribers per tower* is perhaps the most salient figure.

Our analysis, using the same inputs, shows that, in order to see a positive present value of net cash flow on a tower over the five year period, the typical carrier would need to have, on average, approximately 900 active subscribers associated with the cell site. You can also see that the monthly cashflow Opex breakeven (defined as monthly levelized revenue minus the monthly levelized operational costs) is close to 275 subscribers and the monthly cashflow Opex plus Maintenance Capex breakeven (defined as monthly levelized revenue minus both the monthly levelized operational costs and the maintenance capex) is around 450 subscribers. Note that the analysis assumes the active subscriber counts represent the levelized value over the five year business case.[8]

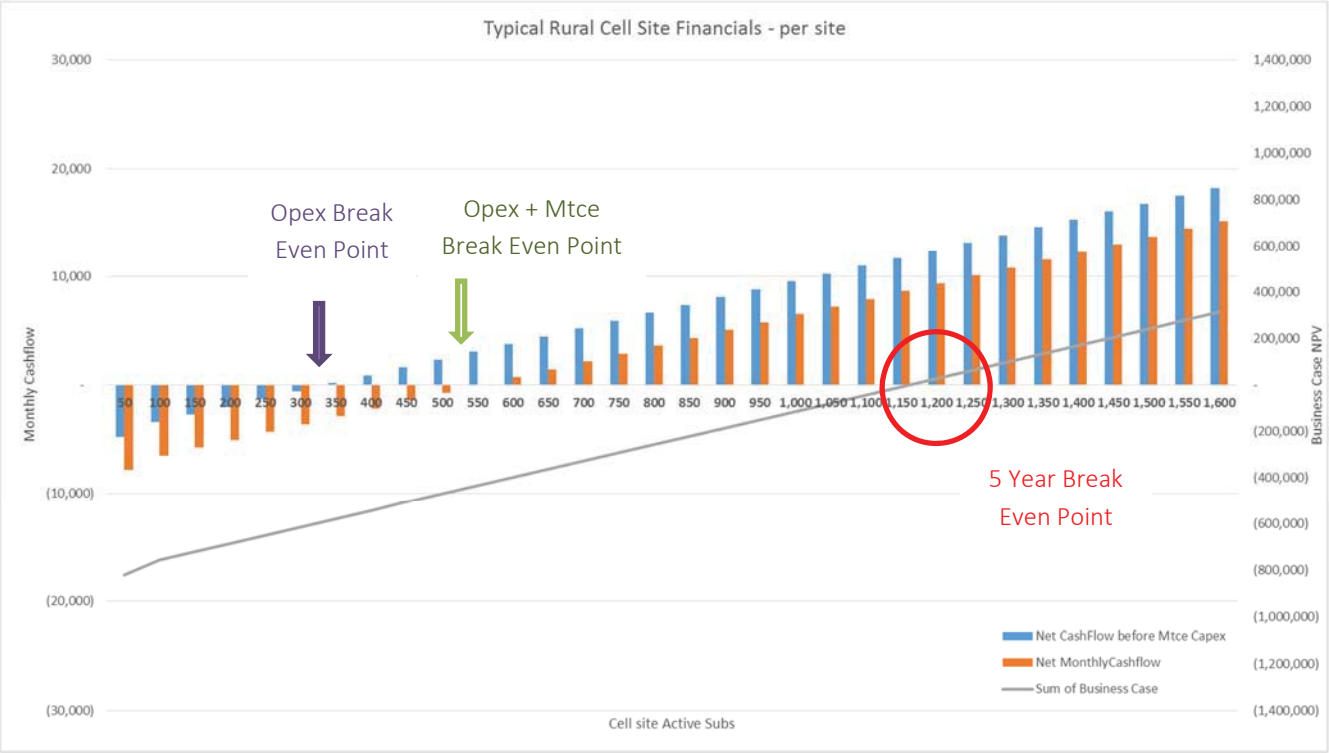


Impact of ARPU

The chart above is based on a static set of input assumptions noted earlier. It is important to understand the impact of changes in assumptions. Looking at sensitivities, if we adjust the ARPU down just 6.5%, to $52.50 (potentially the value selected as the benchmark, or the result of competition on the ARPU values into the future), we see the picture changes quite a bit. The five year business case NPV breakeven jumps

[7] We use 5 years in this paper to line up with the expected duration of the Mobility Phase II funding.
[8] For new sites, subscriber adoption typically increases over time. As such, the 5 year, end period count of active subscribers will be higher than the levelized value presented above.

to around 1,200 average active subscribers per cell site, the Opex breakeven increases to ~350 subscribers, and the Opex plus Maintenance Capex breakeven increases to ~550 subscribers.



Impact of Take Rate

A key driver in the business case noted above is the count of subscribers associated with a cell site. In effect, the greater the number of subscribers a carrier can sign up in an area in which the subscribers live, work and travel, the more viable a cell site (or community) deployment in that area becomes. As such, the effective take rate a carrier can achieve in an area is key to the business case, and ultimately to the determination of where funding is required in order to make the area economically viable to a carrier.

Economic Viability and Fund Sizing

As shown above in the financial modeling, the viability of an area is driven by the number of subscribers one can obtain, the expected ARPU, the Initial Capex, the opex, and the Maintenance Capex. In simple terms, when the CEO of a mobile company looks to expand/maintain service in an area, he/she will review the business case. If the business case does not warrant sufficient returns (with solid assumptions), then the service area will not be expanded or, conversely, service will be terminated. And, as pricing competition heats up, the pressure to understand where the economically unviable areas are, and how to address them will become vital.