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Reach Higher Ground

Connect America Fund Cost Modeling

Methodology and Approach

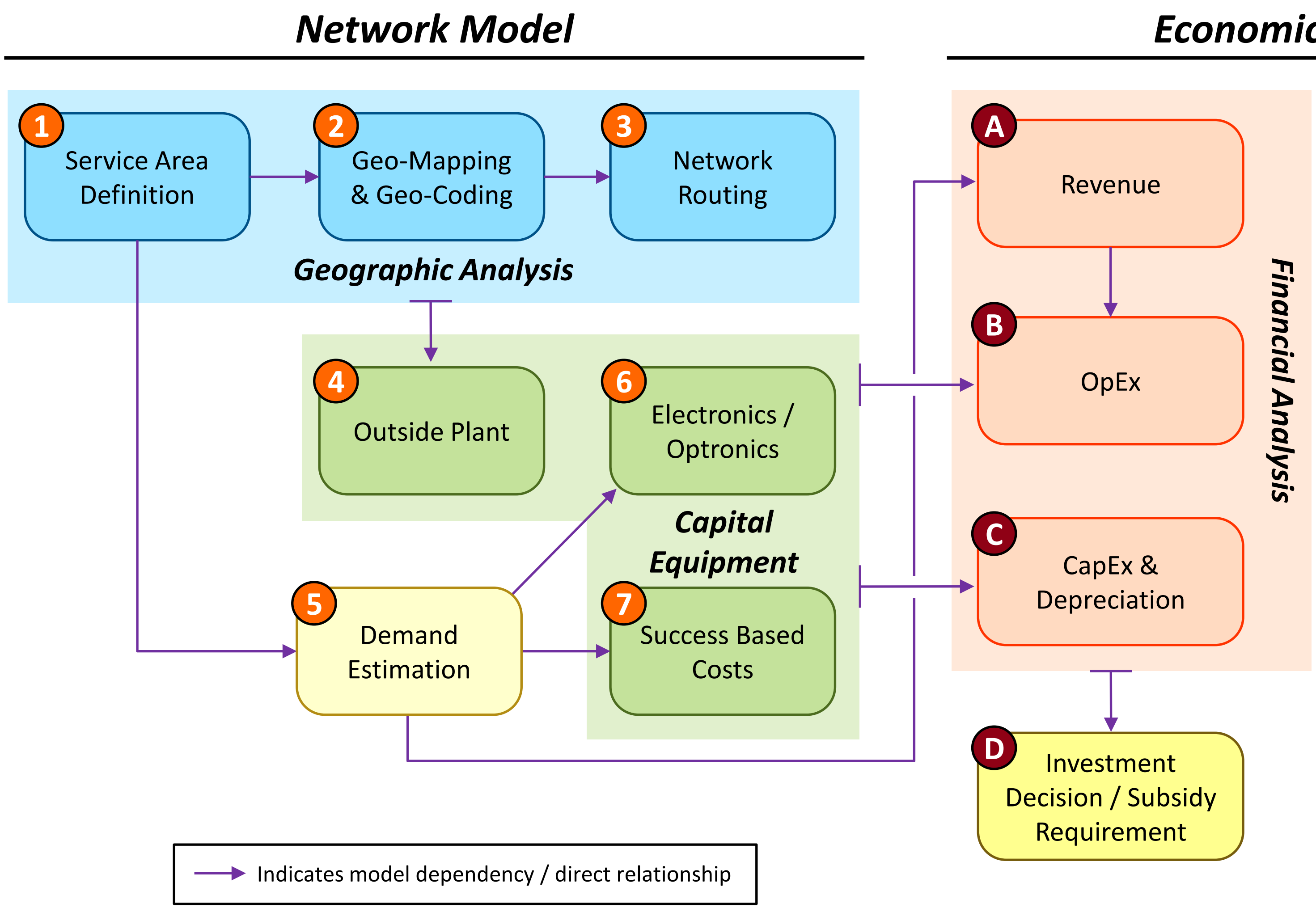
Prepared for: FEDERAL COMMUNICATIONS COMMISSION · USA ·

February 1, 2012

CSMG is filing this presentation in response to the FCC's public request for Connect America Fund cost model submissions

- CSMG is a focused strategy consultancy with significant expertise in developing communications cost models and in assessing the impacts of communications regulatory policy
- We are not submitting our rural broadband cost models as part of this proceeding but wish to provide more general input into the process to highlight some of the key issues we have identified as the FCC develops and adopts the Connect America Fund cost model
- This presentation summarizes some of the alternative approaches to developing any CAF model as currently envisioned, including structure, key model parameters and sensitivities
  - Any model that is designed to calculate the investment gap required to deploy broadband to unserved areas will be very sensitive to key assumptions
    - In many areas where revenues almost offset costs, small miscalculations can have large impacts on the size of this gap-driving disproportionate impact on investment decisions
  - We have identified some of the data sources, approaches, and assumptions that will have a significant impact on the results of the model, and which we think we will be critical to capture accurately, including:
    - Identification of unserved areas, capital equipment cost assumptions
    - Service adoption rates, operating expense assumptions
    - Depreciation approaches, investment decision thresholds
- Many of these assumptions can vary substantially in different situations, and we believe a robust dialogue will be critical as the CAF model is developed and adopted and view this presentation as a brief primer on the key analytical issues for participants in this process

CSMG's cost model methodology drives from detailed service area data and demand to network costs before calculating investment returns and subsidy requirements



- CSMG's view is that NPV analysis is most often used to make investment decisions, so our model, outputs, and discussion focus on this approach
- However, we recognize that there are alternative cost-based approaches that implicitly account for revenue and/or return on invested capital

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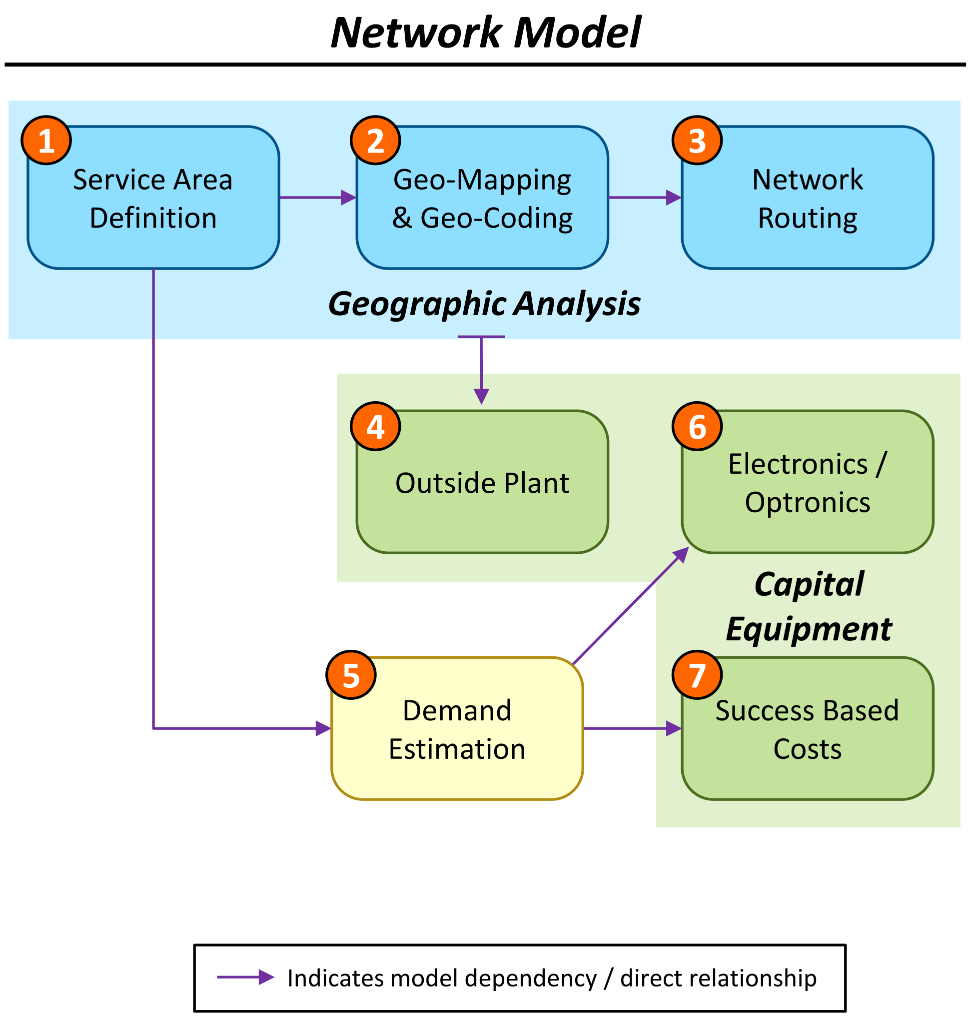
The network model focuses on the costs of building a network based on geographic and demand inputs of unserved areas



Category	Definition
1 Service Area Definition	Determine which geographic areas do not have access to speeds of 4 Mbps/1 today and 6 Mbps/1.5 in five years
2 Geo-Mapping & Geo-Coding	Map census blocks to service territories (geo-map) and place households and businesses at specific locations on the map (geo-code)
3 Network Routing	Create a model of the physical network required to reach new service locations
4 Outside Plant	Based on the linear distance of network established in Step 3, determine the cost of deploying outside plant
5 Demand Estimation	Forecast expected level of service uptake, services taken, service pricing, and usage levels
6 Electronics / Optronics	Using the technology type and physical network model built in Step 3 and demand estimates from Step 5, determine the required electronics / optronics costs
7 Success Based Costs	Based on the number of homes that take service from Step 5, determine the cost of the drop cable, labor, and customer premise equipment (CPE)

Each step of building a network model has multiple approaches with different limitations that can lead to a range of potential outcomes

	Category	Approaches
1	Service Area Definition	• National Broadband Map / SBI • Proximity to existing infrastructure • Other data sources / processes
2	Geo-Mapping & Geo-Coding	• GIS techniques to overlay Census blocks on service territories
3	Network Routing	• Minimum distance routing along actual road segments • Regression analysis based on geographic archetypes, e.g. rural, suburban, urban
4	Outside Plant	• Detailed and variable costs based on specific plant type, terrain, etc. attributes of service territory • Generalized per foot averages varied applied to high-level characterizations of service territory, e.g. urban, suburban, rural
5	Demand Estimation	• Mathematical models of penetration ramp • Adjustments for demographics, competition • Constant assumed take rate
6	Electronics / Optronics	• Capacity-dimensioned network to determine number of nodes and required demand-determined equipment and shared equipment
7	Success Based Costs	• Success-based costing using estimates of average HH frontage, lot dimensions, and market-based costs for CPE

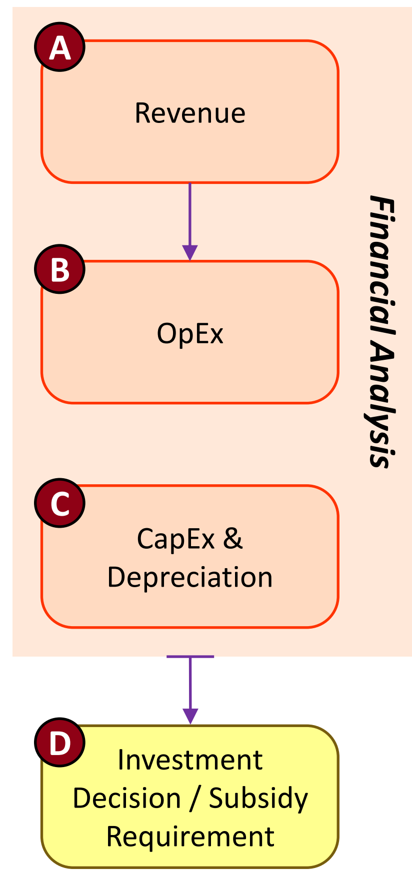
Limitations

- Data availability
- Data accuracy
- Unique characteristics of specific study areas
- Differences between cost estimates and actual costs
- Unpredictable technological improvements and developments
- Inherent uncertainty in forecasting service uptake

The economic model takes inputs from the network model to establish the investment decision and the support required to deploy broadband in unserved areas

	Category	Definition
A	Revenue	• Amount of incremental revenue an operator could expect to generate if it invests in a network build-out
B	OpEx	• Costs associated with operating and maintaining the network and servicing customers
C	CapEx & Depreciation	• Network deployment costs • Cost recovery of capital investments through return on capital and depreciation
D	Investment Decision / Subsidy Requirement	• Ultimate determination of economic viability of network investment project • Calculation of investment gap that would have to be filled to enable build

Economic Model



The economic model may produce a broad range of outputs depending on demand estimates, expense calculations, depreciation method, and NPV inputs

	Category	Approaches	Limitations / Input Sensitivity
A	Revenue	• Total revenue associated with network build • Incremental revenue from network build	• Operators make investment decisions based on incremental costs and revenue, so including all revenue might overstate an operator's ability to recoup costs • Revenue forecasts are sensitive to demand and ARPU estimates • Different service types / levels
B	OpEx	• OpEx calculation – Operator benchmarks as % of revenue, CapEx, etc. – Unit build-up of OpEx based on real world operational parameters – Relationship between plant type in service (CapEx) and operational costs	• OpEx can vary significantly by operator based on scale of operator, mix of network technologies, network density, terrain of service territory, demographics of subscriber base, usage levels, etc. • Cost model may choose to include or exclude certain operating and overhead costs
C	CapEx & Depreciation	• Accounting depreciation • Economic depreciation • Historical Cost Accounting (HCA) • Current Cost Accounting (CCA) • Annuity method • Tilted annuity method • Adjusted tilted annuity method • Others	• Historical cost methods do not adjust for changes in value of assets • Depreciation methods that try to tie asset depreciation with income generation may differ from methods used for operators' financial accounts • Annuity methods are very sensitive to economic lives and expected price trends of assets
D	Investment Decision / Subsidy Requirement	• Net present value • Return on invested capital • Market-determined cost thresholds	• NPV is sensitive to terminal growth rate, discount rate • Return on capital approaches make simplifying assumption that capital investments will necessarily generate a return, but in practice returns are dependent on real world demand and revenue • Using cost thresholds may ignore dynamics that make broadband or the presence of competition feasible in unprofitable areas

- Network Model
- Economic Model

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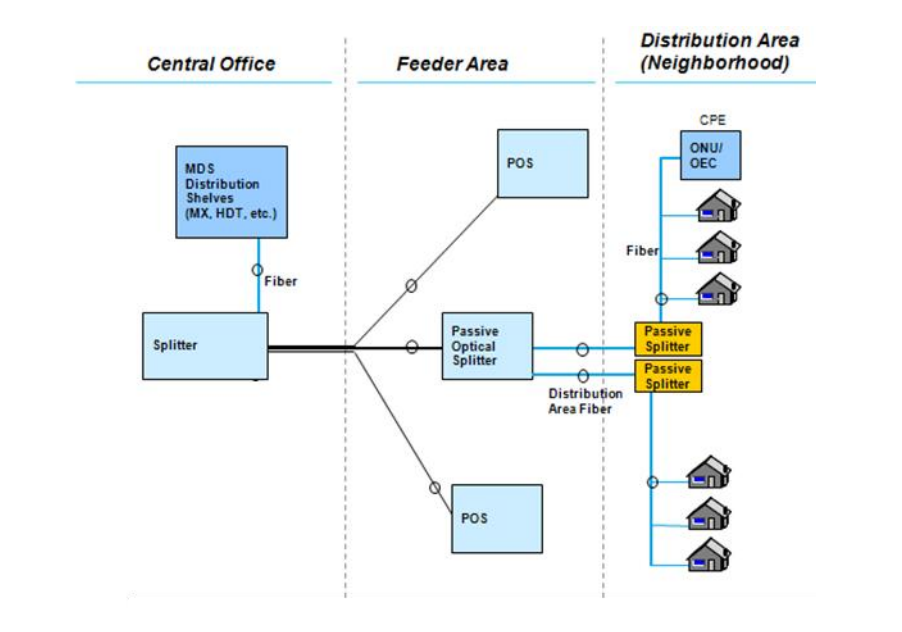
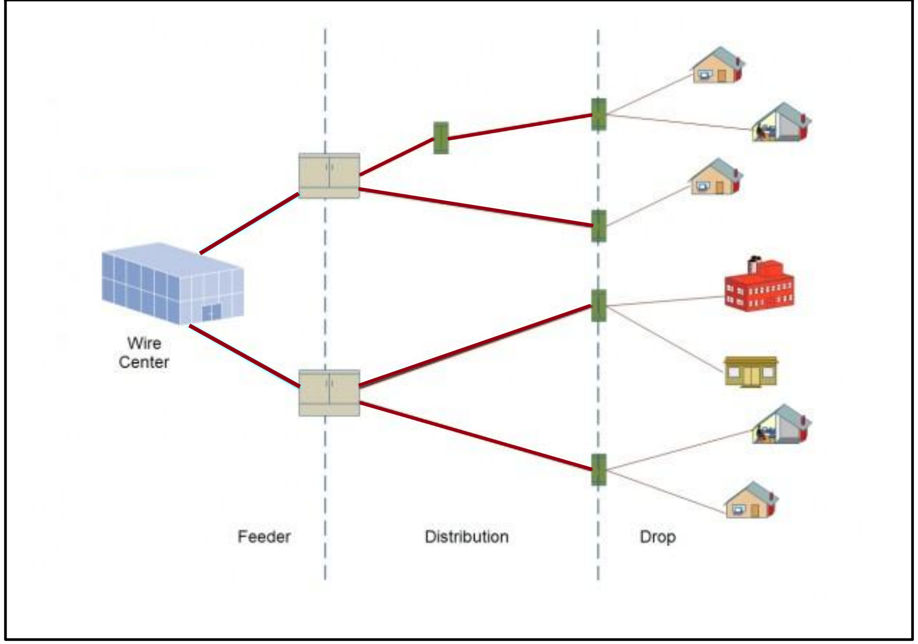
CSMG has built models of rural FTTH and xDSL deployments to estimate the sensitivity of investment case outcomes to model assumptions

- In the following sections, we will show relative sensitivities of economic model outputs based on a hypothetical rural town

FTTH Deployment



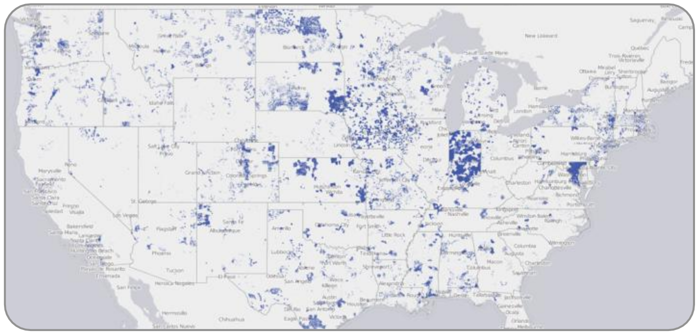
xDSL Deployment



Source: CSMG analysis

There are a variety of potential sources that can be used to identify unserved areas

Potential Approaches and Limitations

	Description	Commentary
National Broadband Map	• Use the National Broadband Map data to identify areas with actual speeds lower than 4 Mbps/1 	• Represents an evolving picture of availability which may under/over report broadband availability in different jurisdictions due to varied collection methodologies and reporting errors • Map data has improved with the first update in September 2011, which included service availability data from an additional 81 providers • While the National Broadband Map does not specifically report availability of 4 Mbps/1, per FCC 11-161 the reported data is sufficient for use as a proxy for the availability of 4 Mbps/1
Existing Infrastructure	Use databases of cable and DSL infrastructure to estimate bandwidths **Cable** • Warren Media – includes franchise boundaries & network capabilities • Determine # of HUs within franchise boundaries **DSL** • Using LERG database, identify all COs and RTs and draw radii to define served areas based on length of copper loop • Determine # of HUs that are not within the established distance from the CO / RT	• Potential issues with cable databases include, exclusion of smaller MSOs and assumption that all houses in franchise areas are covered with best available service • Assumptions must be made about the existence of two-way plant to enable broadband • DSL analysis would have to make assumptions about which LEC COs and RTs are DSL-capable • Radius approach may under/overstate coverage depending on actual linear distance from node

Source: NTIA

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Standard GIS data and geo-coding techniques using publicly available sources offer reasonable approximations of service locations

- GIS experts we interviewed cite typical location geo-coding error levels between 5% and 10%
- Other proprietary mapping sources could have lower error rates but may not be available or be cost prohibitive to license

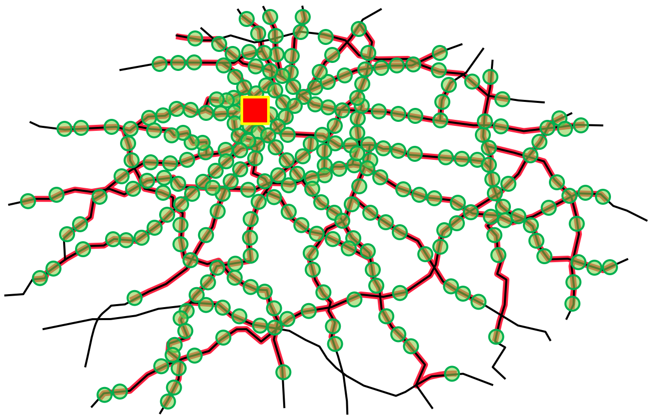
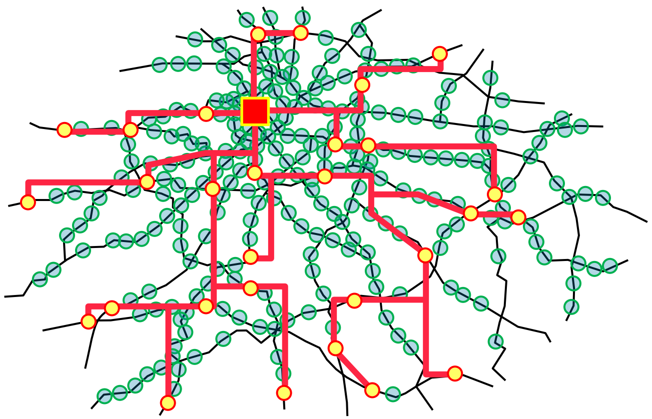
Existing Approaches

Commentary

- Road segments are mapped to Census Block areas, and then houses are randomly assigned to locations along road segments in their respective Census Blocks
- Availability of address data and random placement of housing units along road segments may somewhat limit accuracy of geo-coding at the most granular level
- In some cases, houses are placed in the incorrect Census Block, which could lead to incorrect estimates of the unserved

Network routing modeling can be performed using actual road segments or through approximation techniques

Potential Approaches and Limitations

	Description		Commentary
Road Segment Routing	• Using actual road segments, the feeder and distribution network is constructed building out from the CO to homes using a least linear distance technique and adjusting for shared network segments		• Techniques such as Dijkstra's algorithm, which can calculate shortest path tree using actual road segments offer a good approximation of network design and routing • May not take into account certain types of road segments that are unlikely to be "buildable," such as federal highways, major divided highways, access ramps, traffic circles, and special purpose roads used for agriculture or emergency routes
Rectilinear Network Design	• Housing units are grouped to form clusters • A grid approximating a road network is then overlaid on clusters and network routes are drawn to connect all clusters to main feeder arteries that emanate in straight lines, often at right angles, from the CO		• This approach works well in cities and other areas with grid-like road systems, and has the advantage of not requiring data on actual road segments • This routing methodology may underestimate the costs of building a network, as the straight lines that represent network routes are often the shortest distance between two points, not the actual distance of a real world build

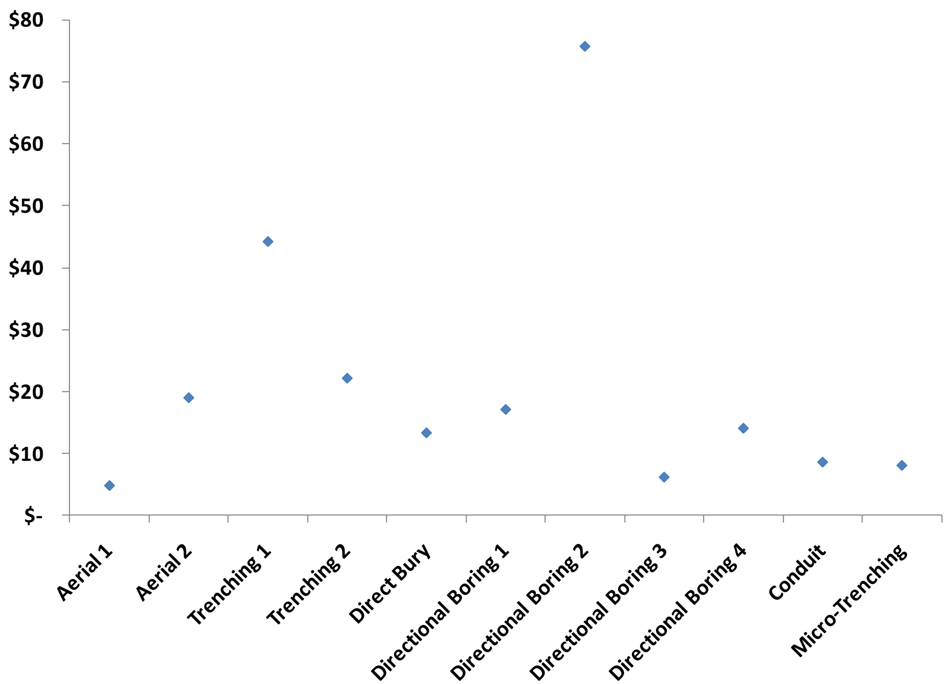
In estimating outside plant costs, cost per foot can be applied to linear distance estimates or costs can be estimated based on other data like population density

Potential Approaches and Limitations

	Description	Commentary
Linear Distance	• The network routing process produces outputs of linear distances between the nearest node, e.g. CO, remote terminal, and service locations • Assumptions about plant type (aerial vs. buried), terrain, and network density are taken into account • Costs per distance unit (typically per foot) are applied to the linear distance estimation to determine total outside plant costs	• Linear distance approaches provide a level of precision that produces realistic estimates of deployment costs • However, the number of variables that affect the cost per foot to deploy outside plant make it difficult to achieve precision at a geographically granular level
Cost Relationships	• Using empirical data, it is possible to establish a relationship between geographic area density metrics, such as housing units per square mile, and average cost to pass a housing unit in the area	• According to a study done by the Nebraska Rural Independent Companies, area density explains 71% of the variation in cost per location ($R^2 = .71$), making area density a fairly predictive measure of cost to pass • A reasonable approach when the marginal benefit of improved precision is minimal • However, a significant amount of the variation of costs still cannot be explained by density

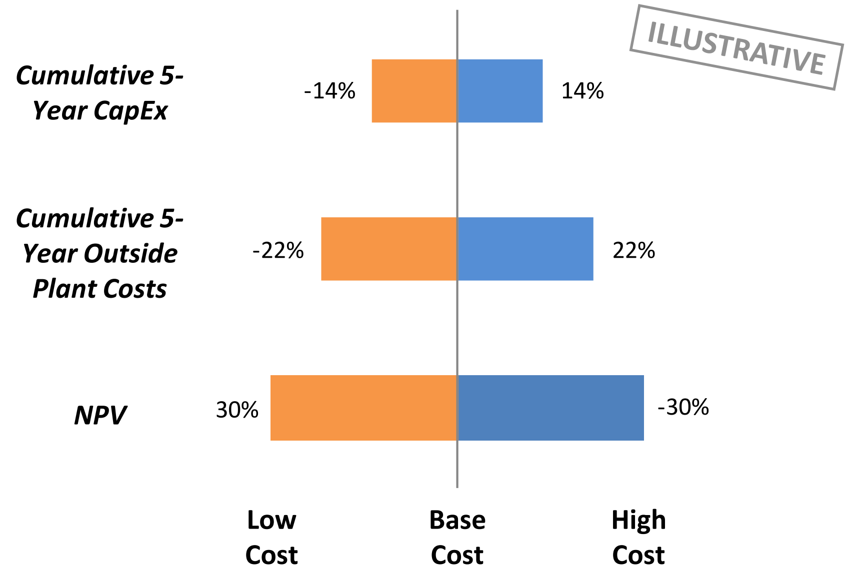
Network costs are highly sensitive to estimates of outside plant deployment costs, which can vary widely depending on the specific geography being modeled

Cost per Foot Estimates[1]



1. Cost estimates are from public sources from the years 2008-2010. Data points are intended to illustrate cost variance, but may not reflect true costs today.

Sensitivity to Outside Plant Deployment Costs



- Cumulative 5-Year CapEx includes outside plant, network equipment, and final drop
- Outside plant costs include network and labor

Source: Cook Report, BREAD, SHLB Coalition, CSMG analysis

In addition to linear distance estimations, the type of construction and the costs associated with that plant type will vary across study areas

Plant Type Determining Factors

Pole Availability / Access	• Hanging cable from utility poles is generally cheaper than burying cable, so availability of utility poles is typically the first gate used to determine plant type
Conduit Availability	• In areas where there is room to pull fiber/copper through existing conduits construction costs may be avoided
Soil Texture	• Areas with rocky soils and other dense soils could have higher construction costs
Bedrock Percentage	• Areas where bedrock is less than 36" (common depth of buried cable) below soil typically require labor intensive cutting or boring

Outside Plant Cost Drivers

Market Labor Rates	• Labor tends to be the single largest component of build costs, and labor rates can vary by market
Make Ready Costs	• Moving wires and equipment on a pole requires coordination efforts with the utility and the time required to do so can vary significantly, translating to variable costs across markets
Pole Attach & Conduit Rates	• The service provider incurs costs to attach cable to poles or access to conduits not owned by the service provider
Rights of Way	• Laying cable along or across roads, train tracks, bridges, etc. will drive incremental costs
Weather	• Ground freezing could lead to a shortened construction season and potential interruptions in construction • Areas with frequent rainfall could have construction delays that lead to higher costs
Wetlands	• Areas with poor drainage might require additional construction approvals and specialized techniques

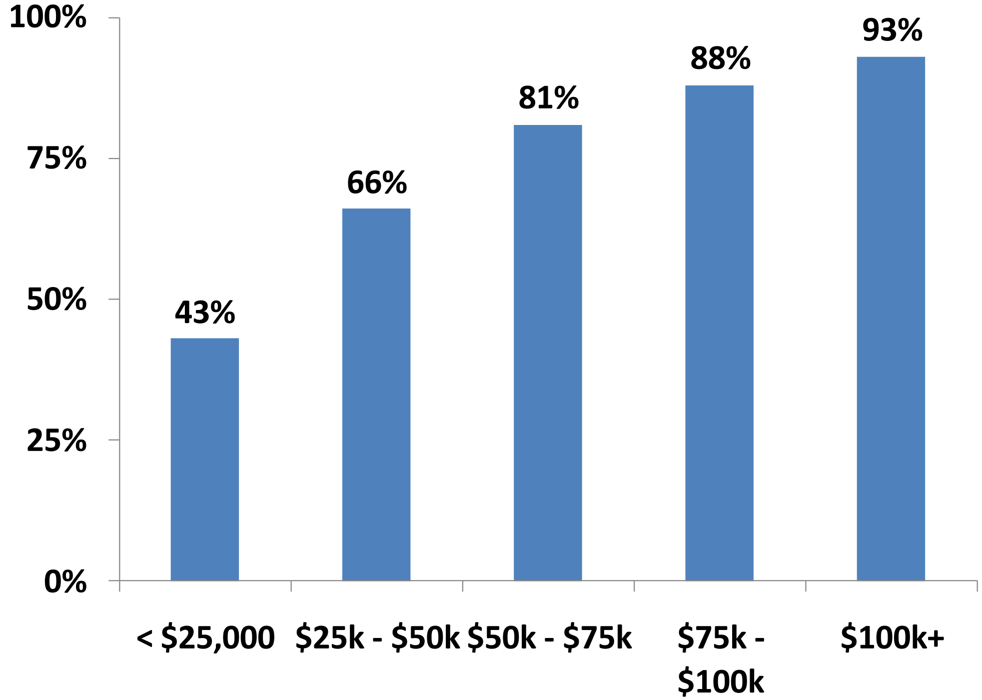
Not all of these factors will always have consequential impacts on network deployment costs, but are additional considerations for evaluating granular geographic areas

Source: Nebraska Rural Independent Companies, CSMG analysis

Different areas of the country are going to have different end state penetration levels depending on the demographics of the area

- Penetration rates drive success-based costs and impact subsidy requirements in specific areas

Broadband Penetration by Household Income



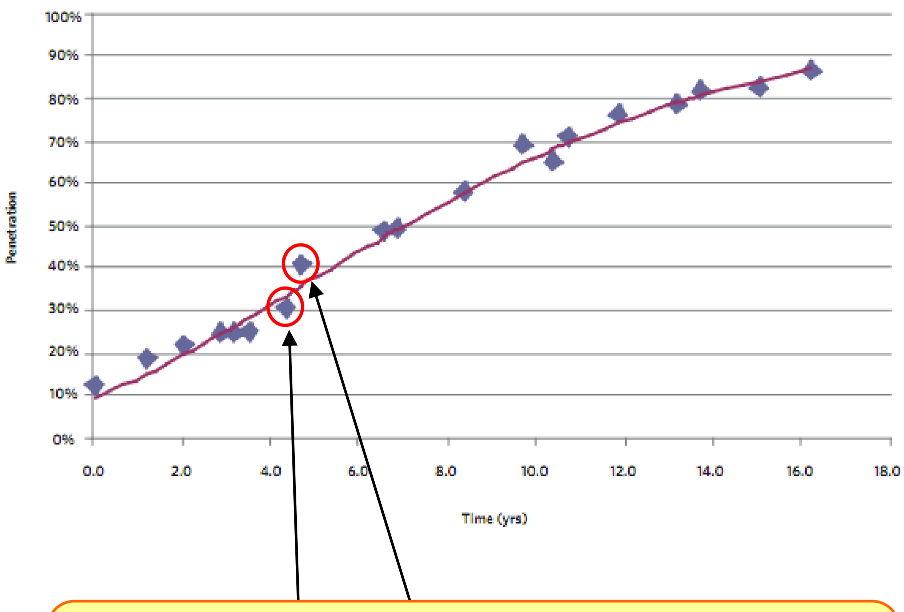
Other Demographic Variables

- Rurality
- Education level attained
- Householder race
- Householder age
- Presence of school-age children

Source: “Exploring the Digital Nation – Computer and Internet Use at Home”, ESA and NTIA, November 2011

Differences in actual end-of-forecast uptake rates can cause variance in costs and investment gaps in demand models

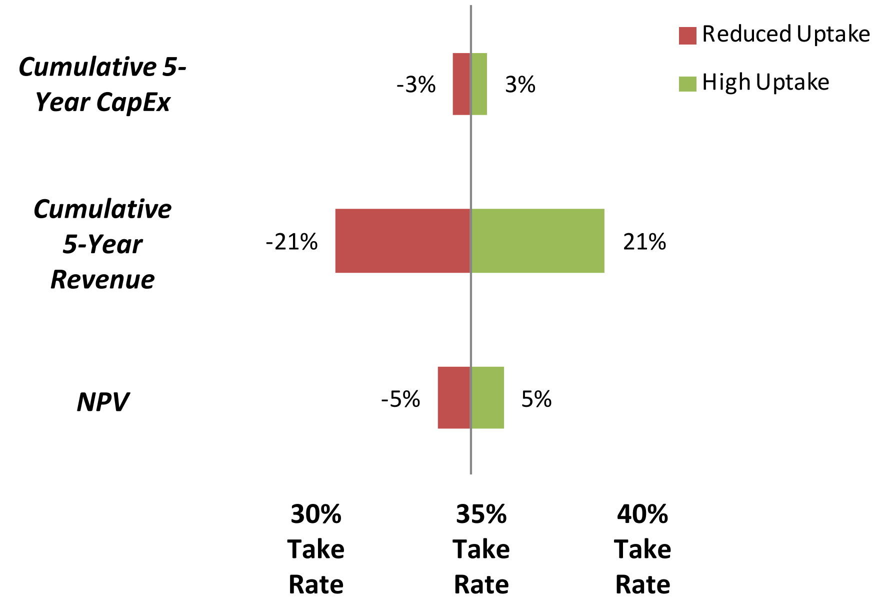
National Broadband Plan Demand Model



- Two empirical data points at about 4.5 years following initial service offering indicate penetrate rates of approximately 40% and 30%
- This suggests that not all variation in penetration rates in different markets can be explained by the ascribed model

Sensitivity to Uptake

ILLUSTRATIVE



- An operator's business case is sensitive to demand / service uptake
- Service uptake impacts both cost and revenue
- As a result, calculated support may differ from an operator's business case

Source: FCC National Broadband Plan, CSMG analysis

Success-based costs can vary significantly based on equipment type, local zoning, building access, and type of service location (house, MDU, commercial, etc.)

Success-Based Cost Elements

Category	Element	Description & Variability
Final Drop	**Fiber / Copper**	• Cable cost is fairly predictable and constant • Lot frontage or home placement on lot can be highly variable, especially in rural areas
	Labor	• Market-specific rates • Depends on number of hours actually required • Work slowdowns could increase costs
Customer Premise Equipment	**ONT / OEC** *(if applicable)*	• Optimal network terminal pricing is known and has limited variability
	Modem & Other In-Home Equipment	• Type of unit depends on services taken and network technology deployed
	Connections and Cabling	• Includes ODF, patchcord, Y branching unit, end cap and connectors, and other miscellaneous hardware

Cost to connect can vary by as much as $200 per location on average

Source: CSMG analysis

- Network Model
- Economic Model

Techniques for modeling operating expense range from using operator benchmarks to doing unit build-ups of various cost centers

Potential Approaches and Limitations

	Description	Commentary
Operator Benchmarks	• Use publicly available data on operators' operating expenses, including the network operations, general & administrative, marketing, and customer support costs as benchmarks for use in cost model • Determine appropriate benchmarks to apply to model, such as OpEx as % of revenue, as % of CapEx, per subscriber, etc., for each expense category • Adjust or use variable benchmarks based on the type and size of the modeled service provider, plant type mix, network architecture, and characteristics of the service territory	• This type of cost benchmarking has the advantages of being easier to apply and verifiable in aggregate due to the public sourcing • Backward looking nature of operator benchmarks may cause inaccuracy in a forward looking model • Likely to be more accurate in the aggregate, but may lack precision across different sizes of service providers and at granular geographies
Unit-Driven OpEx	• Identify all incremental network elements, support staff, and activities associated with the new network build • For each, ascribe unit level cost assumptions, such as # of units required, operating time, power requirements, salaries, monthly maintenance costs, etc. using engineering assumptions • Determine incremental costs from sales, marketing, and administrative support of operating the new network • Adjust assumptions based on attributes of service provider and market • Scale cost assumptions for the size and requirements of the modeled network	• Has the benefit of being similar to how an operator would budget costs • Makes OpEx detail more transparent and easier to identify cost drivers • Scaling mechanism is more natural than using % benchmarks, which is particularly important in rural markets where operators are more likely to be sub-scale • More time intensive to apply and requires a broader set of assumptions across a number of cost categories

Determining recovery of capital investments and depreciation charges can be performed using a number of different methods

Cost Base & Depreciation Methodologies

Historical Cost Accounting (HCA)	Method under which the net book value of an asset is calculated using its actual cost of acquisition and adjusted for depreciation; examples: straight line, declining balance
Current Cost Accounting (CCA)	Similar to HCA, but asset prices are re-assessed each year, so net book value is adjusted for both depreciation and the replacement cost of a modern equivalent asset (MEA)
Accounting Depreciation	Systematic allocation of long-lived capital investments over the useful life of an asset to recover
Economic Depreciation	Period-by-period change in the market value of an asset, defined by the present value of the income that the asset is expected to generate over the remainder of its useful life
Annuity Method	Method that annualizes capital investments by calculating a an annuity comprised of both a return on capital, e.g. WACC, IRR, and a return of capital, i.e. depreciation charge
Tilted Annuity Method	Applies a "tilt" to the annuity method to adjust for changing asset prices in the market
Adjusted Tilted Annuity Method	Similar to the tilted annuity method, but adjusts for levels of output that evolve over time, e.g., the penetration ramp of a FTTH deployment

Considerations

- The economic or operational lives of network assets may differ from those assumed in financial accounts, which could have ramifications for free cash flow and NPV calculations
- Economic depreciation techniques attempt to adjust for this by tying asset depreciation with its output, i.e. revenue, over time
  - Different methods can be used depending on whether demand / output levels are stable or evolving
- It is sometimes appropriate to consider both the effects of 'wear and tear' on network assets and declines in economic value due to technological advancements
- Certain approaches require knowledge or estimation of economic lives and expected price trends of network elements, which may be difficult to quantify or forecast

Investment profiles of network builds are sensitive to discount and terminal growth rate assumptions

- At higher terminal growth rates, the terminal value represents a significant portion of the NPV

"Baseline" Scenario NPV Sensitivity

PV of Cash Flows

WACC:	6.0%	8.0%	10.0%	12.0%	14.0%

PV of Terminal Value

	WACC:	6.0%	8.0%	10.0%	12.0%	14.0%
Terminal Growth Rates	1.0%					
	2.0%					
	3.0%					
	4.0%					
	5.0%					

Total Present Value

	WACC:	6.0%	8.0%	10.0%	12.0%	14.0%
Terminal Growth Rates	1.0%					
	2.0%					
	3.0%					
	4.0%					
	5.0%					

Most Negative → Most Positive

Source: CSMG analysis

CSMG is the strategy and business consulting division of TMNG Global; together we offer a comprehensive portfolio of professional services and solutions to the global telecom, media and technology industries

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- Growth & Business Transformation
- Go-to-Market Strategy
- Customer & Revenue Management
- Ecosystem & Business Model Evolution
- Improving Effectiveness & Optimization
- Corporate Strategic Planning
- Regulatory / Litigation Expert Support
- Deal Development

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CSMG provides strategic advisory and consulting services ranging from market assessment and strategic planning to business model and costing analysis

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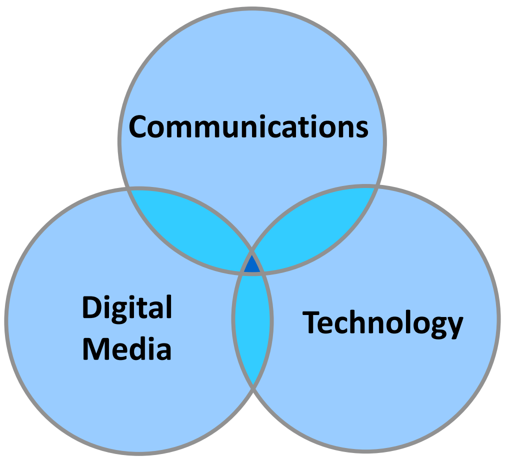

- Industry Focus
  - We are specialists, focusing exclusively on the communications, digital media, and technology industries
- Advisory Services Expertise
  - Growth & Business Transformation
  - Go-to-Market Strategy
  - Customer & Revenue Management
  - Ecosystem & Business Model Evolution
  - Improving Effectiveness & Optimization
  - Corporate Strategic Planning
  - Regulatory / Litigation Expert Support
  - Deal Development
- Global Presence
  - Working with clients across all continents
  - Boston and London offices
- Track Record
  - 20+ years of successfully serving the TMT industry
  - Extensive global client roster, including service providers, technology companies, investment sector, digital media, market influencers, regulators, and enterprises

CSMG has assessed the impacts of regulatory policy in a variety of topical areas for clients in many countries

Mobile Termination Rates

- LRIC model development
- Model assumption validation
- MTR methodology analysis

Wholesale Access

- Economics of separation of access
- Regulatory implications of wholesale services
- International case studies

Wireless Policy

- Mobile spectrum auctions
- Spectrum refarming
- Spectrum reuse and service migration

NGA Policy

- NGA business case
- Economics of sub-loop unbundling
- OSS interfaces for wholesale NGA

4G Mobile Policy

- Benefits of enabled services and applications
- Mobile network economics

Passive Infrastructure Access

- Cost modelling of alternative options
- International duct access case studies
- Consultation support

Rural Broadband

- Rural wireless business case
- Rural broadband network options and economics
- Cost modeling

Consumer Benefits

- Impact of new trends on service providers
- Competitive assessment of broadband providers in context of HDTV delivery

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