Cartesian®

A BUSINESS GUIDE TO FIBER NETWORK EXPANSION

CONTENTS

INTRODUCTION

IMPROVING PROFITABILITY THROUGH EFFECTIVE FIBER NETWORK PLANNING

Network owners have a unique challenge in the communications industry: the deployment, operation and expansion of the networks that underpin the services we consume. This is a complex undertaking requiring significant investment and not without risk. Selecting the right deployment strategy and ensuring that the right resources and processes are in place is critical to keeping costs under control. But how does one go about selecting the right strategy, and what are the critical considerations that define a strategy as right?

In this eBook, we discuss how to approach the challenge of network planning and business case development. We share our experience on network planning best practice, network deployment options and cost estimation, and set out the key steps to build a comprehensive business case, including approaches to reduce cost and revenue risk.

CHAPTER 1

ASSESSING CUSTOMER DEMAND IN NETWORK PLANNING

Fiber network deployment is characterized by very high fixed costs (when rolling out the network) and relatively low marginal costs (when connecting customers to the network). As a result, fiber network business cases are very sensitive to the market share and rate of take-up. Accurately estimating the take rate is therefore critical to reducing investment risk.

To estimate residential consumer demand, you can use socioeconomic factors – such as education, income and occupation – and penetration of relevant products and services. For businesses and public sector organizations, use data such as industry sector, headcount, number of sites and revenue/budget, to indicate potential demand and willingness to pay. In both cases, consider the presence of competitive substitutes and the relative pricing of competing services.

With the demand data, you can construct a geographic revenue model which will identify potentially attractive areas for network deployment. Ideal areas are those that have unmet demand and limited competing infrastructure. Demand may be served directly (retail) and/or indirectly through wholesale channels depending on the desired go-to-market strategy. Here are five critical steps to consider in developing the revenue model:

1 - Research the Target Market

Conducting detailed market research will provide a deeper understanding of the local area's characteristics. This research should ideally capture the following data:

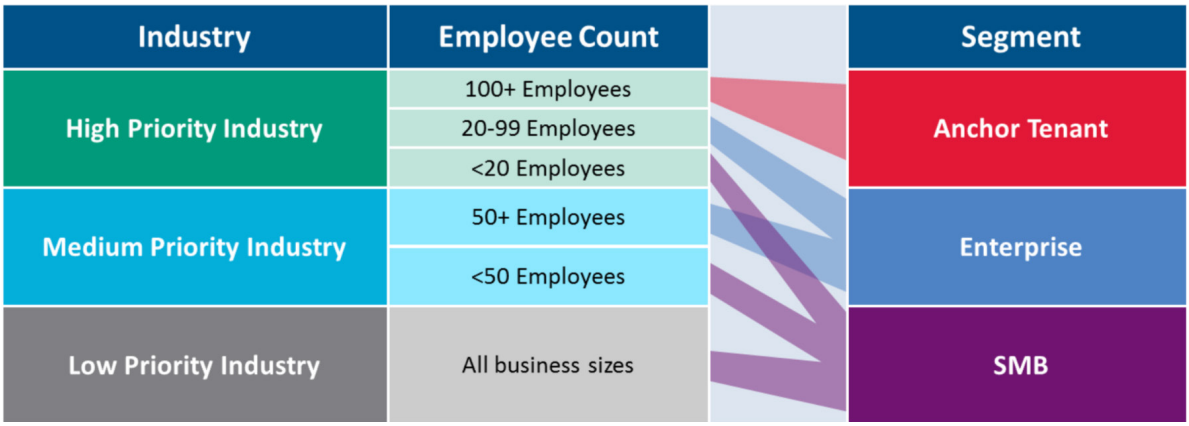
- Area benchmarks (e.g. premise types, broadband penetration, density)
- Residential profiles (e.g. income, household size, current penetration of broadband) by household
- Business profiles (e.g. industry sector, headcount, revenue) for each business
- Pricing benchmarks (e.g. regulated prices, competitor pricing)

Sources of information include public data published by government statistical services, marketing databases from specialist providers such as Dunn & Bradstreet and Experian, and bespoke primary research. Combining and analyzing data from multiple sources increases the reliability of inputs into the business case, such as addressable market size, ARPU and current penetration. For example, ARPU can be benchmarked based on internal metrics of ARPUs in other areas (if available), competitor pricing in the target area, or estimates based on consumer surveys or share of spend data.

2 - Assess Retail Demand

Armed with data from the market research, you can then segment the retail market. Create segments by applying different assumptions (e.g. ARPU and penetration) to groups of potential subscribers who may have differing demand potential and needs. Additionally, tailor product and service propositions accordingly (e.g. for example, between residential, SMB and Enterprise customers). The diagram below illustrates a potential segmentation for business subscribers.

Figure 1.1 – Example Business Subscriber Segmentation



Using business 'firmographic' data, we can categorize industries in multiple dimensions. For example, IT-intensive industries can be prioritized, as firms in these sectors rely on telecoms to support business-critical processes. Employee count, company revenue, and number of sites can also be used to inform relative size of the demand (e.g. larger organizations will, on average, take more products than smaller ones).

Public sector organizations (e.g. government offices, hospitals and education establishments) are often suitable as anchor tenants as they provide a stable revenue base to underpin the business case for that area. These anchor tenants are also more likely to enter long-term contracts and are often easier to get planning and build permission from. Large, high priority enterprises may also be suitable anchor tenants depending on their needs.

3 - Evaluate the Wholesale Case

It is critical that wholesale opportunities are at least considered when developing the business case. Given the relatively low marginal cost of connecting additional customers to the network, network operators can greatly benefit from a wholesale product even when offered to retail competitors. Acquiring these wholesale customers, however, requires a carefully crafted wholesale proposition. Wholesale customers will weigh the pros and cons of working with a new supplier, considering several factors as shown in the table.

Figure 1.2 – Considerations When Working with a New Supplier

Network Coverage	Determines the size of the addressable market and hence the scale of any benefits
Operational Costs	Potential operational cost savings due to difference between current wholesale product provider's costs and cost of new option; could be used to improve margin or to discount retail prices
Switching Costs	Investment in new systems and processes for address matching, order handling, fault management, and billing
Customer Impact	Potential loss of customers through higher churn during migration to the new network
Product Quality	Potential to command higher revenues or share due to superior product, which is dependent on demographics and affordability within the retail CSPs target market
Wholesale Competition	The ability of the existing supplier to respond in terms of pricing or proposition, potentially constrained by regulation
Retail Competition	Whether the CSP will be able to compete effectively with other CSPs on the same network

If wholesale service revenues are included in the business case, then the incremental costs of offering wholesale must also be accounted for. This will include investment in wholesale systems and processes, and any additional headcount to service wholesale customers. The business case should also consider the direct cost of migrating new customers to the platform, and any indirect costs arising from subscriber churn as a result.

4 - Forecast Take-Up and Migration

In the business case, you will need to make assumptions on the share of subscribers that will be won within the network footprint, usually based either on fair-share or national market share (if applicable). However, even the most attractive proposition in the market will take time to build a subscriber base, as customers research, assess and commit to their purchasing decisions.

Hence, your business case must also consider the rate of take-up, e.g. the speed at which customers migrate from competitor offers.

In mature markets, most residential customers will be won through churn. The business case can therefore estimate the share of churners that will be acquired. Consideration should be given to minimum contract terms, as consumers are unlikely to switch whilst 'in contract' if they are liable for early termination charges (ETCs). This gives their current provider some time to react and adjust prices and propositions to protect their base.

Acquisition of subscribers through wholesale channels will follow a different profile to retail. A wholesale customer may choose to actively migrate their existing base to the new network, or may decide to only use it to serve new adds. An active migration strategy has the potential to rapidly grow the number of subscribers on the network, but carries the risk of churn if it is not properly managed.

Figure 1.3 – Take-Up and Migration

5 - Develop the Revenue Model

With a view of the addressable market size, potential revenues by segment, and estimated penetration over time for retail and/or wholesale channels, you can now build a comprehensive revenue model. This model will forecast revenue growth over time, considering the network deployment plan, but independent of the deployment costs. To offer the most value in decision-making, scenarios should be analyzed to determine the impact of roll-out timelines, propositions offered, competitor responses, and whether to offer a wholesale product.

However, to estimate the actual revenues for the business case, the CSP will need to decide which areas it can profitably serve. A revenue model alone cannot help a CSP do this – no matter how attractive an area is from a revenue perspective. What else, then, is required to decide which areas to build out to? A cost model provides this crucial missing input to assessing profitability. However, with it comes the need to consider deployment methods and network topology. We explore these next.

CHAPTER 2

FACTORING DEPLOYMENT METHODS INTO NETWORK PLANNING

Whether embarking on a brand-new fiber deployment, expanding an existing footprint to reach more homes and businesses, or extending the fiber footprint to support other applications such as mobile backhaul, you must carefully assess the network deployment options available to minimize costs, and maximize profitability.

The dominant component of network deployment is the civil works: regardless of the geography, digging the roads and laying ducts and fiber cables is the most expensive and time-consuming part of the project (some estimates put it as high as 80% of the overall cost[1]). For this reason, CSPs are increasingly using existing shared infrastructure access where possible.

Shared Infrastructure Access: Pros and Cons

Shared infrastructure access includes access to existing ducts, poles and dark fiber. Reuse of these existing passive assets allows CSPs to avoid the high upfront cost of new construction.

The cost benefits of using third-party infrastructure are potentially very large. As an example, some CSPs in Western Europe are known to achieve savings of up to 80% in their Cost Per Premises Passed (CPPP) when re-using ducts from the telecom incumbent compared to new build.

Unless there are strategic reasons for you to fully own its network, shared infrastructure access will increasingly be considered as part of the mix. However, using third-party infrastructure is not without its issues – we highlight four of these below.

1 - Availability of infrastructure varies greatly by geography

Incumbent CSP infrastructure is often the most convenient in terms of location, as it is most likely to have high capillary networks covering the last and middle mile. However, access typically requires regulatory intervention and this may place limits on the scope of use. Obligations on access to ducts and poles are quite common, whereas obligations on dark fiber are less widespread.

Alternative options include other CSPs or utility companies (e.g. gas, electricity, sewers[2]). However, the infrastructure of the latter tends to be less dense, e.g. gas utilities are typically good for backhaul, but not dense enough to cover the last mile.

Even if infrastructure access is nominally available, the condition of ducts and/or poles may preclude shared use. Telecom ducts may be congested, silted up with mud, or partially collapsed.

[1] CSMG (Cartesian) report for Ofcom: "Economics of Shared Infrastructure Access", February 2010

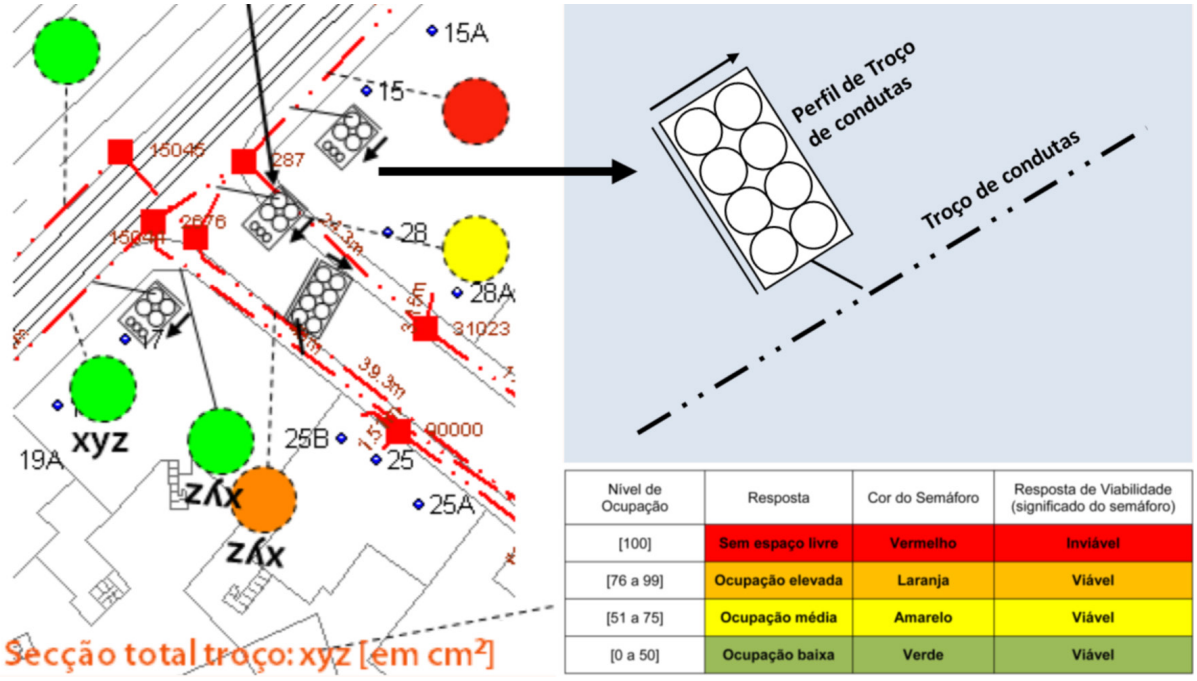
[2] In Paris, infrastructure access in the sewer system has been very successful for reasons including the excellent condition and easy accessibility of the infrastructure, the amount of capacity available, appropriate pricing, and by the difficulty in obtaining permission for street works

2 - Lack of access to accurate, high-quality records adds risk and delay

Use of third-party infrastructure requires access to up-to-date information on the available routes, handover points, spare capacity, and status.

For instance, in the UK, the telecoms regulator Ofcom has been working with industry and Openreach to improve access to its ducts and poles (DPA). The new Openreach online mapping tool provides the location of the passive infrastructure and duct spare capacity.[3]

Figure 2.1 – Example Digital Map Tool



Nível de Ocupação	Resposta	Cor do Semáforo	Resposta de Viabilidade (significado do semáforo)
[100]	Sem espaço livre	Vermelho	Inviável
[76 a 99]	Ocupação elevada	Laranja	Viável
[51 a 75]	Ocupação média	Amarelo	Viável
[0 a 50]	Ocupação baixa	Verde	Viável

Source: MEO – Serviços de Comunicações e Multimédia, S.A

3 - Operational processes need to be fit for purpose: simple, clear and scalable

Process quality is another key success factor. Access seekers should look for clear, well-documented processes for all lifecycle stages: planning, deployment and repair. Examples include identifying and fixing duct blockages; flexibility to deviate from plans where necessary; and, SLAs for response and resolution.

4 - Pricing is a make or break issue

The importance of pricing can be seen in the development of infrastructure access in Paris. CSPs have been using the city sewers for business fiber services since the 1990s. However, it wasn't until 2006, when price cuts were introduced, that consumer-focused CSPs embarked on large-scale, residential network builds.

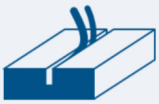
Self-build: Using a mix of Construction Methods

Even with a preference for third-party passive infrastructure, there will inevitably be segments of the network that need to be built.

Several methods and techniques are available to construct buried networks, with different cost points and surface suitability. CSPs that adopt a range of techniques can select the most appropriate for each given situation. Below, we summarize the pros and cons of the five most common techniques.

[3] Before this upgrade, CSPs had to request printed maps displaying the 3rd party infrastructure. This was seen as a contributing factor to the low take-up since launch.

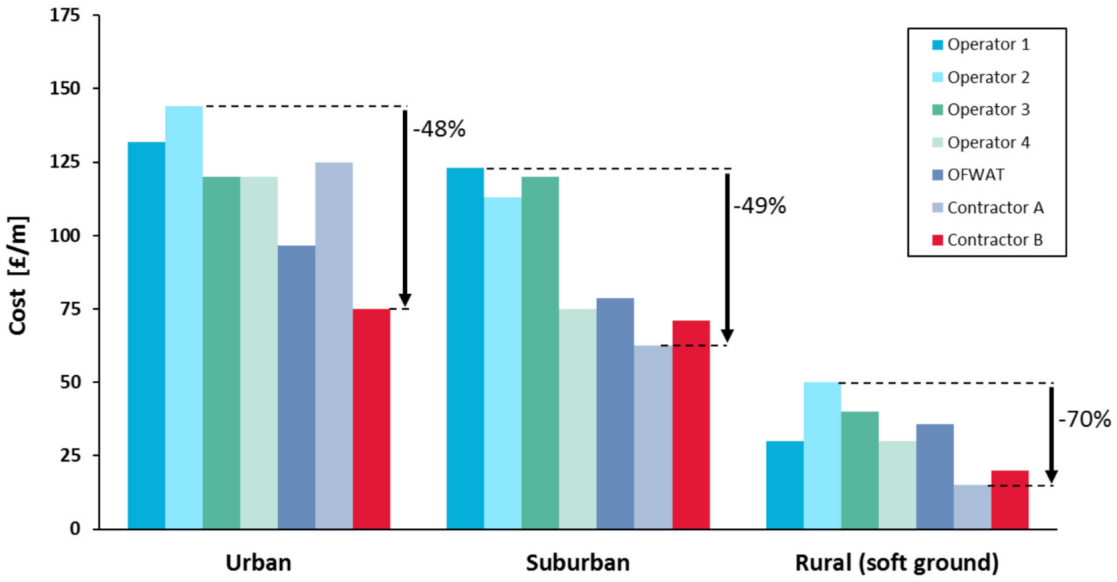
Figure 2.2 – Buried Network Construction Techniques

Traditional Open Trenching	Slot Trenching	Vacuum Excavation	Directional Drilling / Moles	Impact Moles
				
Invasive method, most cost effective in soft ground; manual digging required for buried obstacles	Lower cost, shallow depth option suitable for some surface types; up to 5x faster than traditional	Alternative to mechanical/manual digging; doesn't disturb buried cabling, pipes and roots	Allows precision network routing under obstacles, e.g. motorways, railways and rivers	Lower precision sub-surface technique, suitable, for example, a final drop under a residential garden

With access to a range of techniques and conditions, costs can vary significantly between builds. The chart below shows the research commissioned by Ofcom in 2010, showing a wide range of costs for open trenching for various geotypes in the UK.

The chart shows that even within a single geotype, costs can vary widely. Drivers include surface type, choice of method, contract size (volume discounts), and ancillary costs such as construction permits and traffic management.

Figure 2.3 – Open Trenching Costs for Different Geotypes



Source: Cartesian, Ofcom

CHAPTER 3

STRATEGIC NETWORK PLANNING AND GEOSPATIAL ANALYSIS

Strategic network planning identifies and quantifies the optimal network routes – those which minimize cost and maximize return on investment.

Ten years ago, this decision-making would have been time consuming and incomplete. However, it is now possible to analyze vast quantities of geospatial data to plan and optimize network deployments of any scale.

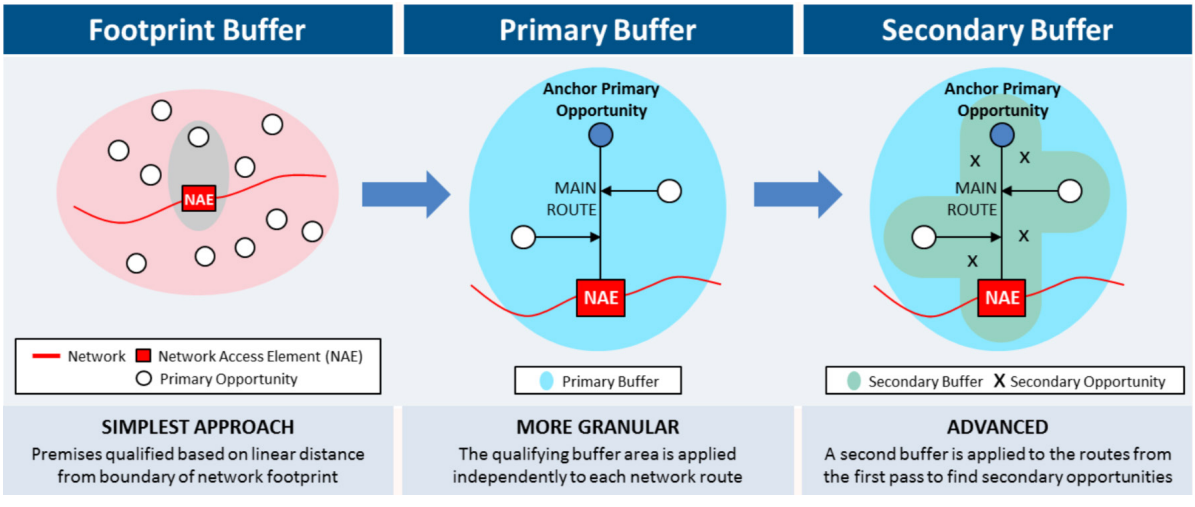
Sophisticated analytical methods enable entire countries to be analyzed in a matter of hours, dramatically reducing the time required to estimate construction costs. Proprietary and open source tools exist that allow multiple data sets to be overlaid, enabling more accurate modeling of network routes and costs.

As explained above, CSPs construct their networks using self-build, third-party infrastructure, and often a combination of both. Analyzing the optimal network topology for these deployments can consider:

- Route of existing passive network (e.g. cabinets, ducts) and capacity information (for existing network, if applicable)
- Location of serviceable (and unserviceable, if applicable) premises
- Location of available third-party passive infrastructure (e.g. ducts, poles, dark fiber)
- Surface type (e.g. verge, asphalt, pavements)
- Freeholder and leaseholder information (for right of ways)

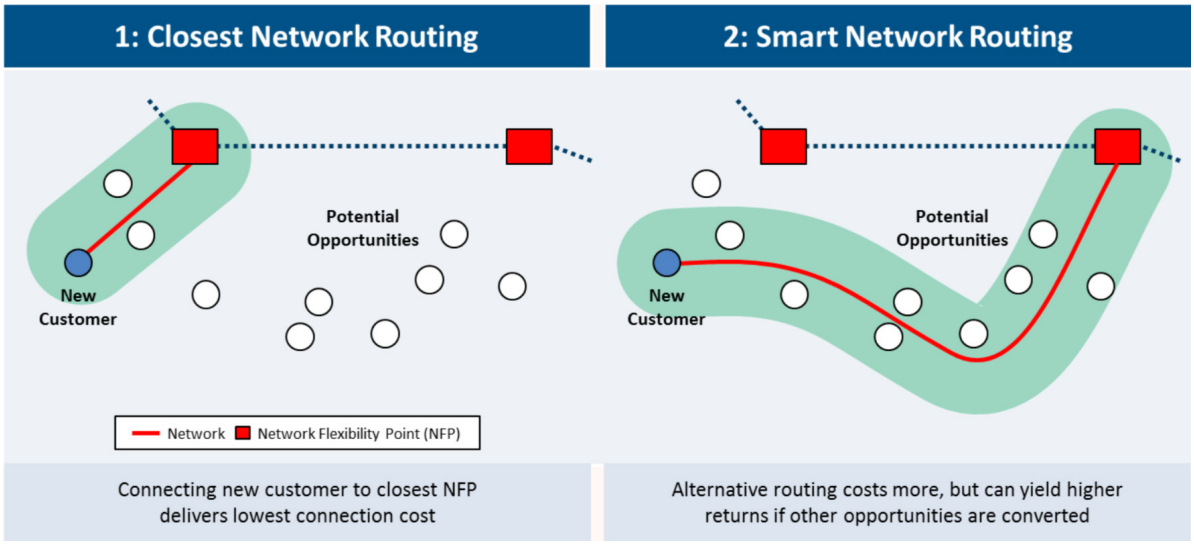
Analytical techniques can also be employed to identify potential customers close to an existing network footprint, or within reach of a new network extension. The figure below illustrates how increasing sophistication can be applied in identifying viable targets, with three alternative buffer zones: Footprint, Primary and Secondary.

Figure 3.1 – Buffer Zones Used to Identify Potential Customers



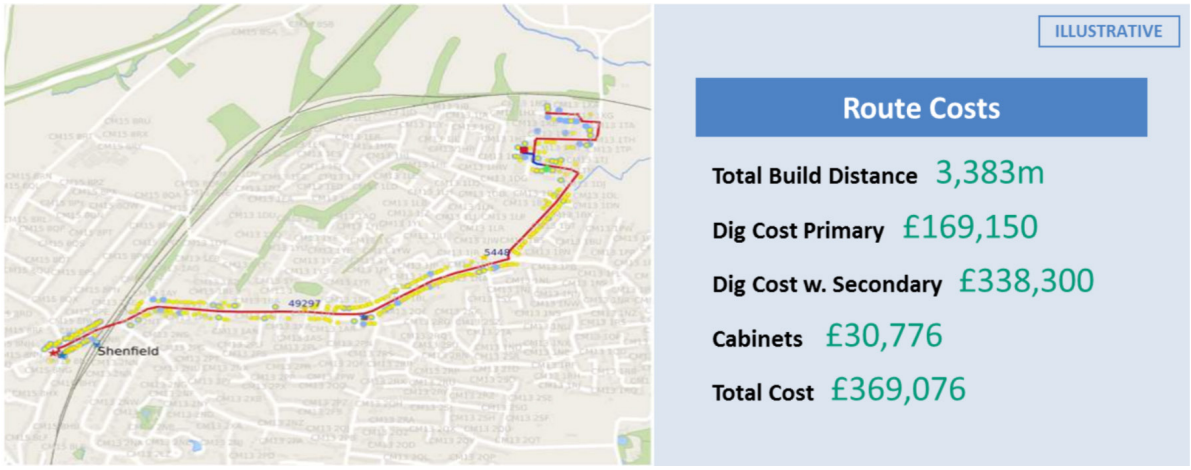
Once the opportunities are identified, we can use the same tools to automate the discovery of optimum network routes, for example using Minimum Spanning Tree or Dijkstra's shortest path algorithm. Following on from the example above, in Figure 3.2 are two approaches to route the anchor opportunity to the network: 1) routing to the closest network element and, 2) routing to any network element within an agreed maximum distance of the anchor opportunity.

Figure 3.2 – Approaches to Route the Anchor Opportunity to the Network



Once the route discovery is complete, the build effort and cost can be estimated. Figure 3.3 shows an example of the build costs of a route, splitting by primary and secondary build costs.

Figure 3.3 – Example Route Build Costs



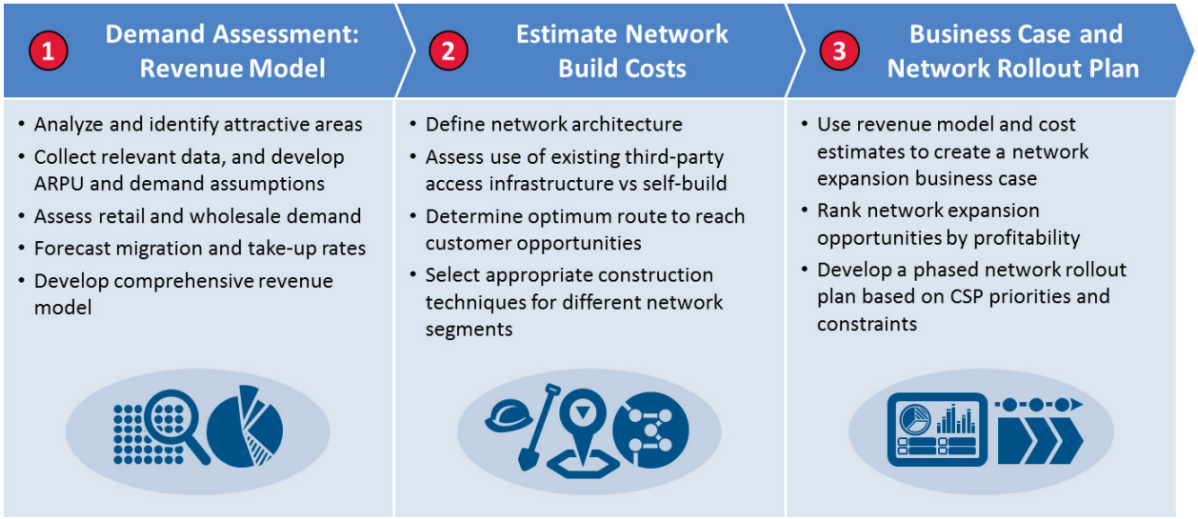
With all this information put together, we can understand the potential costs associated with deploying network in different areas.

CHAPTER 4

BUILDING THE NETWORK EXPANSION BUSINESS CASE

Network investments carry a high degree of risk due to the large sunk costs involved. Managing this risk is critical, both during planning and execution. A well-structured business case is an essential tool to help understand and manage risk during the planning stage. In this section, we discuss the main components of a network expansion business case which you can use for strategic planning decisions.

Figure 4.1 – Building a Network Expansion Business Case: High-Level Steps

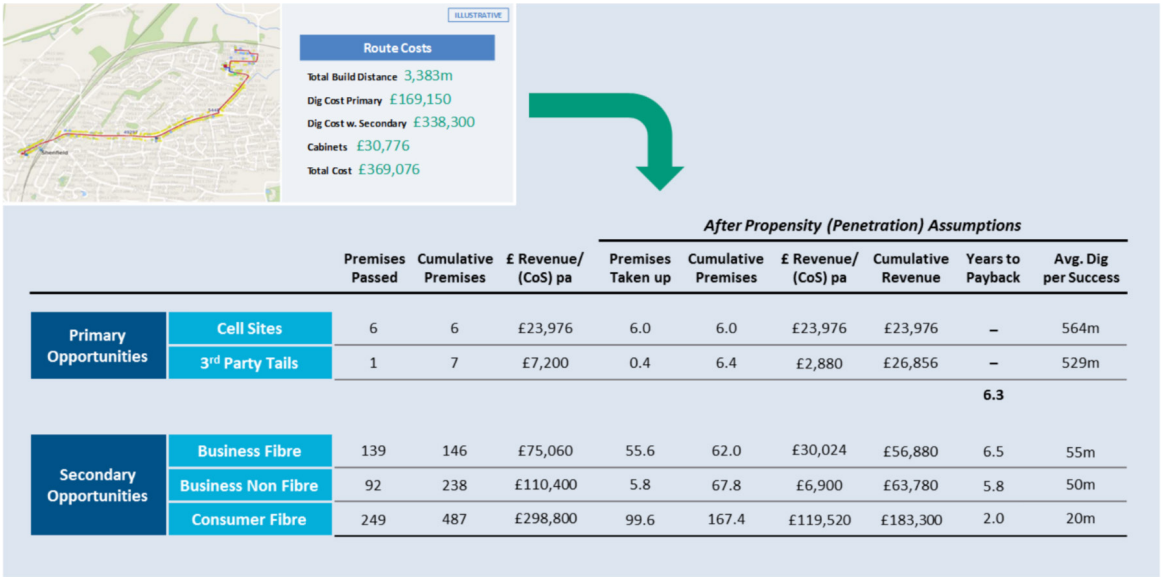


A network deployment business case needs to consider expected revenue (Chapter 1) and deployment cost (Chapter 2) for each of the target areas. Combining these inputs with variable costs for subscriber acquisition and in-life support will give a cashflow forecast for each area allowing the relative profitability to be assessed.

In addition to area-specific costs, the overall business case should consider central costs. Depending on whether this is a new entrant case or expansion of an existing network, central costs may include core network costs, advertising, OSS/BSS systems and SG&A.

With a comprehensive view of the estimated costs and revenues, a CSP can then assess the attractiveness of different expansion opportunities. There are several options to measure financial attractiveness, including net present value (NPV), internal rate of return (IRR), payback period, peak-funding requirement, total cost as well as network-specific metrics such as cost per premises passed (CPPP) and cost per premises connection (CPCC).

Figure 4.2 – Financial Attractiveness Analysis of a Network Route



					After Propensity (Penetration) Assumptions					
		Premises Passed	Cumulative Premises	£ Revenue/ (CoS) pa	Premises Taken up	Cumulative Premises	£ Revenue/ (CoS) pa	Cumulative Revenue	Years to Payback	Avg. Dig per Success
Primary Opportunities	Cell Sites	6	6	£23,976	6.0	6.0	£23,976	£23,976	–	564m
	3rd Party Tails	1	7	£7,200	0.4	6.4	£2,880	£26,856	–	529m
									6.3	
Secondary Opportunities	Business Fibre	139	146	£75,060	55.6	62.0	£30,024	£56,880	6.5	55m
	Business Non Fibre	92	238	£110,400	5.8	67.8	£6,900	£63,780	5.8	50m
	Consumer Fibre	249	487	£298,800	99.6	167.4	£119,520	£183,300	2.0	20m

None is 'right' nor 'wrong'. Using a combination of metrics will provide alternative perspectives on the viability of an investment, tailored to your appetite for financial risk. The figure below shows an example of financial analysis for our example network route segment.

Equipped with this information, you can then rank the potential opportunities by attractiveness and, using a set of financial constraints and thresholds, define a phased network rollout program. In doing so, you will balance short-term tactical targets and longer-term strategic goals. As an example, CSPs will often expand to the best opportunities first, so that they can maximize and bring forward cash generated from the first customers (e.g. anchor tenants), which can then be used to help fund the following rollout phases.

In some instances, balancing the short-term and long-term goals might mean building in areas that may not seem so attractive *a priori*: a stronger market positioning, first-mover advantage, or specific coverage objectives might prove enough justification over isolated financial metrics.

CONCLUSION

In this eBook, we set out important considerations of the strategic network planning process, from demand assessment through to the preparation of the business case. Key conclusions to take away are:

- Managing risk is critical, both during planning and execution. A well-structured business case is an essential tool to help understand and manage risk during the planning stage.
- There are multiple KPIs to measure financial attractiveness, e.g. NPV, IRR, TCO, CPPP, etc. Using a combination of them will provide a rounded view of the profile of an investment.
- Estimation of revenues involves the assessment of retail and/or wholesale demand for product and services. Ideal areas are those that have limited infrastructure-based competition, but sufficient demand to generate a return.
- In mature markets, most residential customers will be won through churn: assessing the speed at which customers can be gained from competitors is key to building a realistic business case.
- Civil works is the most critical aspect of any network expansion program, as it represents the largest cost item, with some estimates putting it as high as 80% of the overall costs.
- Third-party passive infrastructure can reduce the network build costs, but be aware of its limitations. For instance, availability and capillarity of infrastructure varies greatly by geography and by type of provider. Success will also depend on access to high-quality records, a simple operational process and proportionate pricing.
- Adopt a range of construction and fiber deployment techniques to best fit each situation: each method has different sweet spots and cost implications.
- Use geospatial analysis to accurately identify network routes which minimize the costs and maximize return on investment. The more information you can analyze, the more effective the network planning will be.

Our world is transforming. Every day, communications technology creates new opportunities to connect. Always on the move, this world is as complex as it is exciting – just keeping up is a full-time job. To truly succeed, you need to go further. By making this world simpler and smarter, Cartesian can make this happen.

We are passionate about problem solving, figuring things out, seeing things from a different angle and cutting through the complexities of the industry. We not only provide the right solutions, but also the answers that push our clients forward. And by doing this we help organizations transform – themselves, the industry and the wider world.

Ours is a world of opportunity. Combining analytics, technology and industry experience, we can help you succeed in it – faster.

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