

Carrier Equipment Failure Cost Analysis

A Study of Carrier Network Outage Costs Due to Equipment Failure

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Purpose:

The purpose of this study is to demonstrate a means to estimate direct and indirect costs from network outages attributable to equipment purchasing decisions made by telecommunications carriers. Furthermore, this study will establish a means to quantify a total cost of reliability which can be utilized to make better procurement decisions, i.e. when is it worth paying a higher capital cost to achieve reliable service?

This is needed due to the current tendency among telecommunications service providers (carriers) to make purchasing decisions strictly in terms of capital cash flow, and lowest comparative price. While carrier purchasing organizations are often very accomplished negotiators, their primary focus has been to optimize capital cash flow rather than understanding the full operational cost of deploying an equipment solution.

This effect is more marked in the newer carriers than the established incumbents. The incumbents, having mature organizational structures, understand the importance of reliability as a means to lower operational costs. The quality (reliability) standards promulgated by the incumbents are very stringent, and the incumbents pay increased costs for compliance to their standards. What do the incumbent carriers know that the newer carriers do not?

We maintain that the increased capital cost for significantly more reliable equipment is not a determining factor, when operating cost is factored into the evaluation, for moderate to large sized carrier organizations. This assertion will be tested in the following study.

There are many approaches to developing such an operations cost model and the single greatest determining factor of organizational size defines applicable methodologies. While a "time and motion" study would yield the most granular data, it is often not cost-justified when the goal is to make a procurement

decision between two choices of equipment providers. That type of goal supports the use of a higher level model designed to incorporate the various organizational models of the carrier community.

It became clear as we worked through the study, that the type of underlying capital equipment being discussed was not significant. We had focused on optical transport equipment, but the results are just as applicable for lower-ended equipment decisions such as those between fixed wireless, or copper-based transport equipment providers. The key element is that the capital equipment supports the acquisition/operation/maintenance of services revenue.

Background/Method:

In order to generate meaningful results, it is necessary to decide on a key independent variable, in this case expressed as service outage time due to equipment failure (often referred to as a “Priority 1 Trouble” by the carrier community). In concept it is reasonable to generalize this type of analysis to other types of failures such as degradation of service (Priority 2 Trouble) or scheduled maintenance (Priority 3 Trouble), but that is outside the scope of the current effort. The dependent variables are direct and indirect costs associated with the specific service outage event time.

A carrier’s total cost of outages (TCO) can be expressed over any period of time as:

$$TCO = \sum_{n=1 \text{ to total outages}} (\text{Direct Cost (n)} + \text{Indirect Costs (n)})$$

This study will focus on how to determine direct costs for one outage example and how this can easily be deployed by carriers to develop a TCO model.

Direct Cost:

Direct Costs are simple to identify by reviewing a carrier's organizational structure and their procedures for dealing with service outages. Other Direct Costs, such as equipment replacement, are not considered, due to the fact that carriers do not generally tolerate chronic equipment problems which require additional capital investment. In those circumstances, the supplier is generally forced to provide replacement parts under warranty or gratis in order to remain a supplier.

We will discuss a typical organizational and procedural framework, and what changes would need to be considered when customizing for a specific example. In concept, the longer the outage time interval, the larger the portion of an overall carrier organization that is involved. Figure 1 illustrates the overall concept.

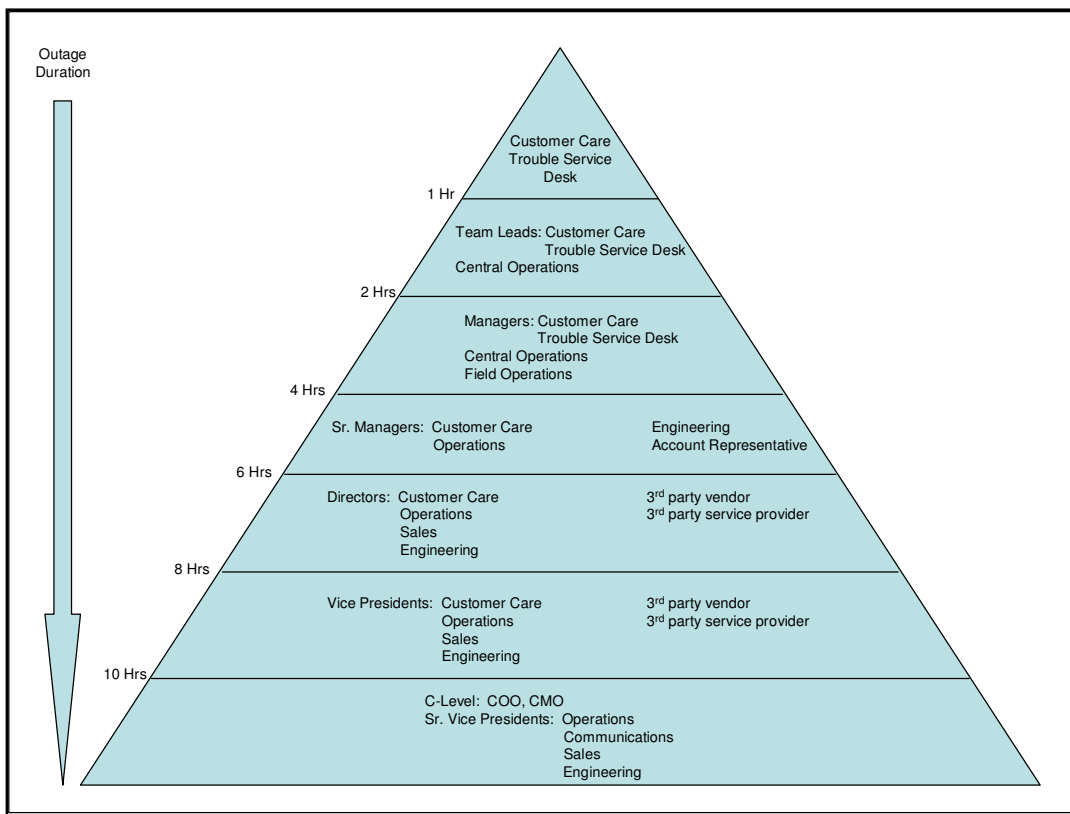


Figure 1: Organizational Engagement Due to an Outage

A short term outage (< 15 minutes) would involve a limited number of people within the carrier's organization such as network operations, customer care, and incident reporting which takes place on a periodic basis. More than 1 hour and other systems begin to be engaged, corresponding to an "escalation timescale" which varies from carrier to carrier. Depending on the importance of the link involved, an 8-10 hour outage will be something that the COO is aware of, although usually peripherally. The base of Figure 1 indicates that as outage time increases, the cost impact to the organization increases geometrically. The key method to reduce the cost of failure is to not experience it or, failing that, keep the duration short. Keeping the duration short is very difficult, and may not be an option for most operational models. Most outages caused by equipment failures exceed 4 hours.

Functional involvement creates direct costs to the organization. The cost to the carrier is the sum of paid time for involved employees (expressed in dollars per hour). Employees directly impacted by an outage generally come from functional organizations such as Operations (customer care, network management center, trouble service desk, central operations, and field operations), Engineering, Sales, Marketing, 3rd party vendors-service providers, and Executive Management. The sum of direct costs will be characterized by the term "Organization Direct Cost".

Organization Direct Cost will also include Service Level Agreement (SLA) credits associated with service outages, although usually these are fairly small in comparison to the other direct labor costs.

At this point, the savvy operations person may state that many of the functions that report up through Operations are to specifically support outages. While that is true on the surface, operational efficiency dictates a multiplexing approach to those personnel, i.e. they support more than just outages. An extension of that

logic dictates that time spent in excess of the allocation for outages represents a additional direct cost to the business in the form of overtime or need for additional personnel.

A common example would be the operations staff in a metropolitan area for a new carrier, whose primary job task is to perform new installations. When working an outage issue, the primary task fueling revenue growth (installations) is either not being done on-time or on-time through the use of additional resources at an additional cost.

Another objection might be that executive management isn't compensated by the hour and thus shouldn't be considered on an hourly basis. That also is true on the surface, however, time spent in the carrier executive suite managing an operations crisis takes executive resources away from more productive activities and represent a true cost to the firm. The model accounts for this cost because presumably executives are paid their salaries to add value in proportion to their compensation level. Executive time is the single biggest cost line item for a chronic outage problem within an organization.

To recap, in order to determine the Organization Direct Cost for a specific outage, we must sum the hourly costs associated with each functional role within the organization and any SLA service revenue credits that are attributed to the outage.

Determining Functional Role Costs:

The first task is to identify the impacted functional organizations. Most carriers have established procedures with escalation schedules which will provide most of the information needed. Figure 2 is a typical newer carrier process diagram which illustrates a good portion of the impacted groups.

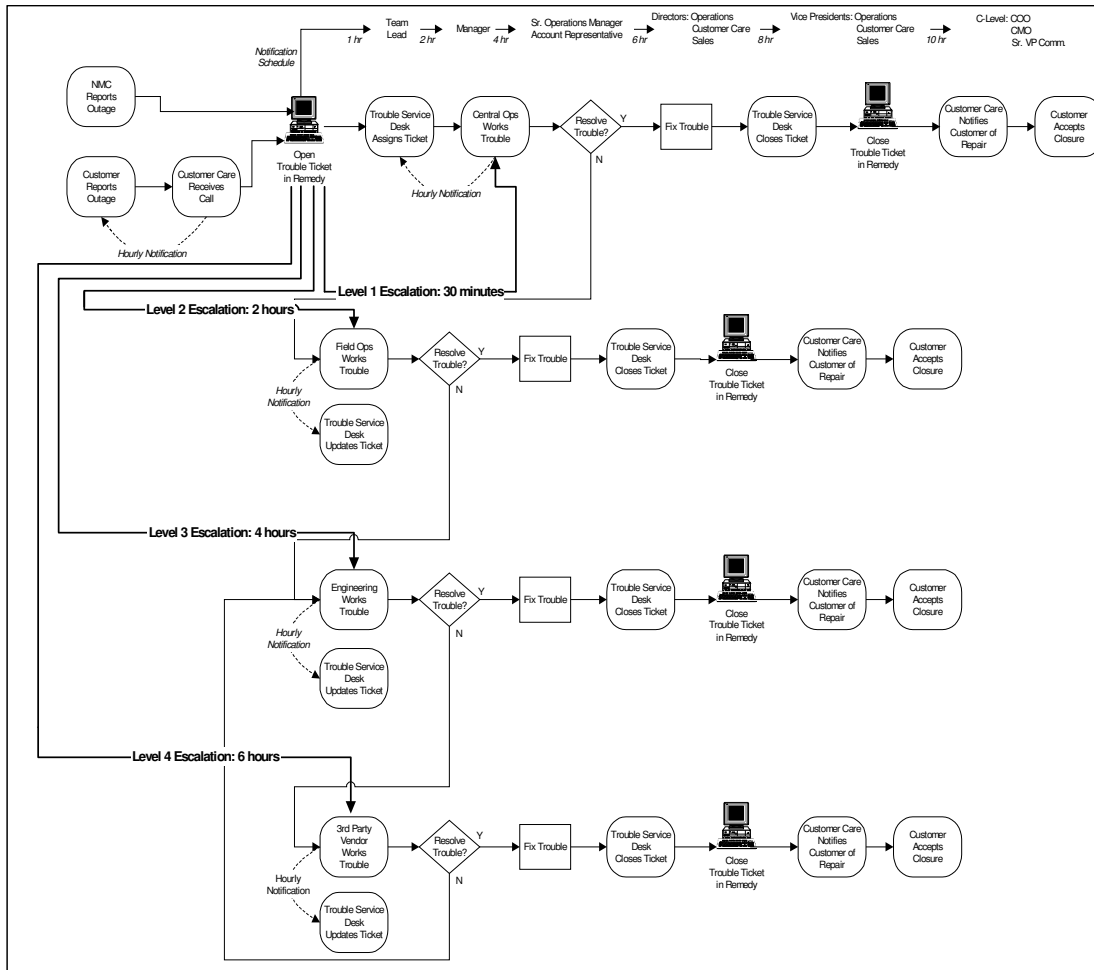


Figure 2: Typical Trouble Process Flow

The above seems fairly complex, until realizing that most carrier process flows are much more complex. This simple rendering illustrates the thought process used to identify the impacted organizations.

In this case, we will develop functional role costs for the following impacted organizations:

- Customer Care
- Network Management Center
- Trouble Service Desk
- Central & Field Operations
- Engineering

- Sales & Marketing
- Executive Management

The example for this study is conservative in that it does not include other functional areas of the carrier such as Finance & Accounting, IT, Human Resources which would also see an impact as a result of a severe outage, although the impacts would be harder to quantify. Many times 3rd party vendors and service providers will play a support role, and we have incorporated that into the Central & Field Operations assumptions. In the cases where the services provided by the carrier are regulated, additional costly work by the Legal and Regulatory Affairs organizations would be required. In this case, we assume that the services provided are data-oriented and not regulated, for simplicity of analysis.

The amount of functional role hours will vary depending on the length of the outage. For example, an impact coefficient can be determined for each functional role, for use in determining cost of an outage. The impact coefficient is determined by the number of hours charged per hour of outage. If Customer Care involves 3 people for 15 minutes on a one hour outage, the impact coefficient would be 0.75. The activity profile for each functional segment will generate a impact coefficient function based on time duration of outage. An example for network management center technicians is shown in Figure 3. This does not include the impact of network management center management, which has its own activity profile. In this case, when experiencing a 4 hour outage, the impact coefficient would be 1.60 for this functional category.

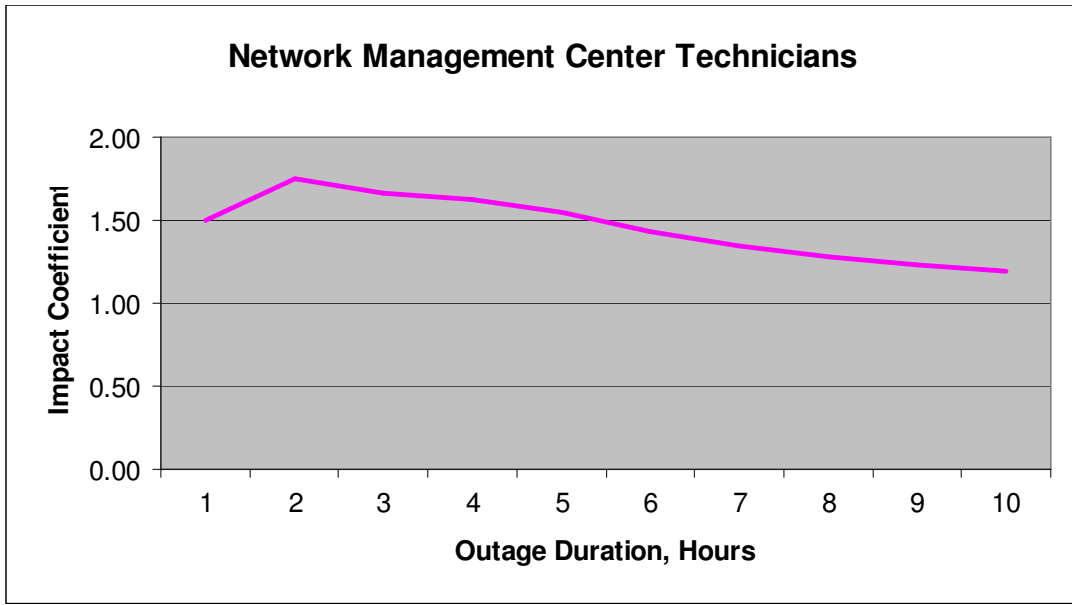


Figure 3: Sample Activity Profile

The cost summation for the Network Management Center would thus be the following, for a given outage duration (t):

$$\text{Network Management Center (c)} = \text{Technician (ic}_T \cdot t) + \text{Team Lead (ic}_{TL} \cdot t) + \text{Senior Manager (ic}_{SM} \cdot t) + \text{Director (ic}_D \cdot t)$$

Each identified functional area has a similar cost summation formula and forms the basis for the total functional role cost equation:

$$\begin{aligned} \text{Functional Role Cost (FC)} = & \text{Customer Care (c)} + \text{Network Management Center (c)} + \text{Trouble Service Desk (c)} + \\ & \text{Central \& Field Operations (c)} + \text{Engineering (c)} + \text{Sales \& Marketing (c)} + \\ & \text{Executive Management (c)} \end{aligned}$$

Each functional operation identified in the earlier process evaluation will have its own Activity Profile which varies according to the organizational structure of the target firm as well as the established escalation processes. The example presented in this study, uses a typical profile for a newer carrier. A time-and-motion study would be required to benchmark the applicable Activity Profiles, if applying this model to a specific carrier. The resulting tool would be very accurate in predicting operational costs due to failures.

Determining SLA Credits:

SLA credits can be a significant direct cost element when the outage is severe, exceeding 4 hours for example. Most carriers limit their exposure for smaller outages to some small percentage of the monthly recurring service charges. For the purposes of our example, we will assume that the carrier provides a 10% credit against monthly service charges for outages which exceed 4 hours. Actual amounts vary, but can be easily incorporated into the overall model results with the carrier's actual SLA commitments.

Indirect Costs:

Indirect costs are more subjective to model and are associated with opportunity costs, such as the carrier's inability to generate future revenue. The indirect costs which are discussed herein are delayed revenue, lost future revenue from existing customers, and brand damage.

Delayed revenue refers to the service installations which are put off in order to address the needs of an outage, and is fairly quantifiable. If you view each service provided as a separate financial case, delaying revenue generation increases costs and reduces the profitability of the opportunity.

Lost future revenue from existing customers is subjective, but it seems basically clear that customers who have suffered through a severe outage or a poor outage record with a carrier are less likely to award additional business to that carrier. Or if they do, they require a substantial discount under what they would normally have paid for the service. Either way, carrier profitability is affected adversely.

Brand damage is also subjective. Carriers spend millions of marketing dollars to establish and promote the company's brand positioning in the marketplace. Whenever a serious outage takes place and becomes public knowledge, the carrier is judged by the marketplace, which impacts the carrier branding effort. In fact, some of the more amusing anecdotes in the industry involve outage-impacted customers lampooning carrier branding material.

Since the indirect costs are difficult to quantify in a general fashion without controversy, this study examines the various kinds of direct costs to a carrier who experiences an equipment failure outage. However, given enough primary information regarding a carrier's branding expenditures, account churn, installation backlog, and customer behavior demographics could enable a fairly accurate economic analysis of indirect costs. In general, the direct cost analysis alone is sufficient to make better total-cost-of-ownership procurement decisions, but it should be considered a low conservative estimate without the indirect cost elements.

Economic Analysis:

Using these concepts, we examine a specific example of an upcoming procurement for a newer carrier (NewTelco).

The sales team of equipment provider A, who we will call OR Networks (Optical Reliable), has been losing recent optical transport equipment procurements at NewTelco to a competitor EdgeTech Optical. The procurement team at NewTelco has advised the OR sales team that the losses were due to a combination of higher price and older technology. This is discouraging news by any definition.

After a year of losing orders to EdgeTech, OR starts to hear NewTelco personnel talking about a large number of significant service outages (greater than 4 hours)

with EdgeTech Optical equipment. But NewTelco, to date, has not used a total cost of ownership approach to procurement.

The OR Networks sales manager realizes that there is something to work with in this situation. Their company is built on providing reliable equipment, in fact, NewTelco had over 1000 units of OR Networks equipment installed and operating. The OR Sales manager reviews the records and discovers that not one equipment failure had occurred on any of the OR Networks equipment for the whole of the year. He has to find a way to show NewTelco that sometimes a proven, reliable, equipment design is worth some additional capital cost. Furthermore, that markedly different reliability experience will favor the more reliable solution if total cost of ownership is considered during the procurement cycle.

The current procurement scenario details are provided below.

	EdgeTech	OR Networks
1. Equipment Price	\$120,000	\$160,000
2. Reliability Commitment (%)	99.999	99.999
3. Actual Performance last 12 months (%)	?	100.00

At first glance, it looks as though OR Networks cannot overcome the 25% price differential, but the sales team decided to try and quantify the NewTelco total cost of ownership to help make their case as the lowest cost provider.

One obstacle that had to be overcome, is that carriers are very reluctant to provide much actual information regarding the performance of other suppliers. So the method of obtaining the information would have to be indirect. Using the generic trouble process contained in this study, and the known data about the performance of their own equipment, OR Networks can construct a compelling argument, hopefully, why their equipment should be purchased.

The first step was to create activity profiles for each functional organization within NewTelco which is engaged during equipment failures. This could be done by asking NewTelco to identify those groups, or to use the generic sample process.

The following functional groups are identified, with group job classifications.

Functional Group	Job Classifications
Network Management Center	Technicians Team Lead Senior Manager
Customer Care	Associates Team Lead Senior Manager Director
Trouble Desk	Associates Team Lead Senior Manager
Operations (Field & Central)	Technicians Managers Director
Engineering (Field & Central)	Technicians Managers Director
Marketing & Sales	Account Managers Directors
Executive Management	Vice Presidents, COO, CEO

For each of the job classifications a separate activity profile is constructed, and are included for reference as appendices to this study. The job classification activity profiles yield an Impact Coefficient for each outage length. But since NewTelco won't tell OR Networks about EdgeTech's past failures, OR Networks has to provide an easy method for NewTelco (who knows about the past failures) to apply a total cost of ownership for the new procurement.

The OR Networks sales team puts together an analysis tool which can be demonstrated to the NewTelco procurement team in realtime. The tool embeds what OR Networks knows about the bid process, a generic cost model for operations outage costs and their own reliability metrics. The tool interface is shown below as Figure 4.

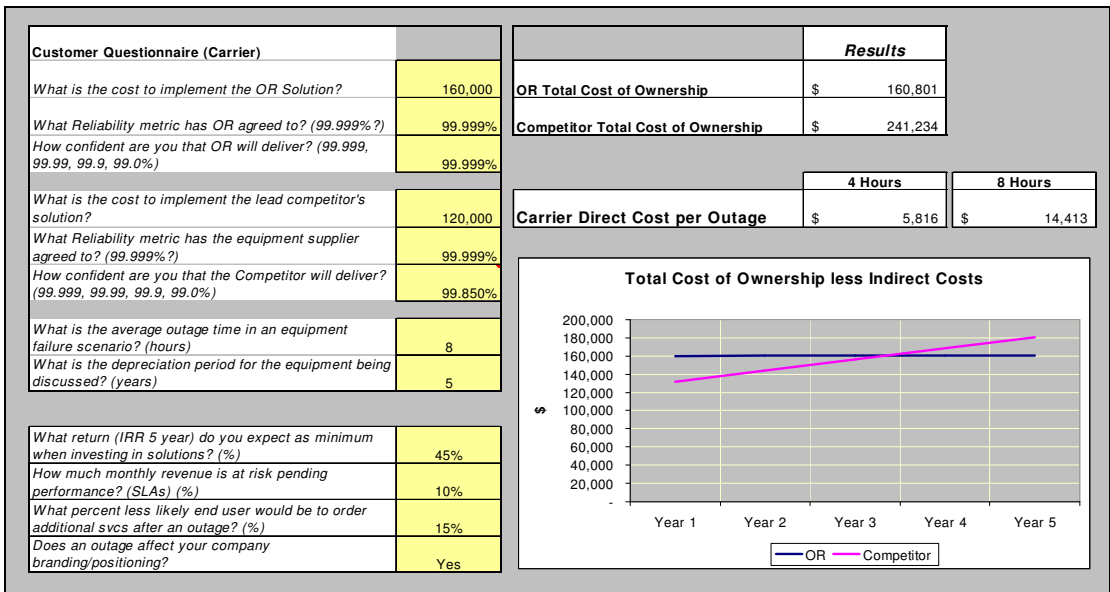


Figure 4: Carrier Total Cost of Ownership Tool Interface

This allows the OR Networks team to sit down with the key people at NewTelco and walk through the analysis. Every piece of data until the sixth question (How confident are you that the competitor will deliver?) is freely available. In context, the sales team should suggest percentage examples and review the realtime results update on the tool interface. A confidence level of 99.818% corresponds

to an expectation of 2, eight hour outages per year. In fairness to EdgeTech, it is unlikely to have many more than that, so the team could suggest something between 1, eight hour outage (99.910%) and the above 2 outage scenario. If EdgeTech's results were worse than that, the costs suffered by NewTelco would not ever justify buying EdgeTech equipment. (one 24 hour outage per year (99.727%) yields a total cost figure of \$290,479 for EdgeTech) The level specified by the NewTelco team was 99.85%.

Several additional questions help define the carrier's specific needs. In the case of the average outage time, most will not know or won't want to say if they do know. The reason it is important is related to the amount of their organization that is engaged on an outage. Below in Figure 5, the cost per hour of outage varies significantly to reflect that effect.

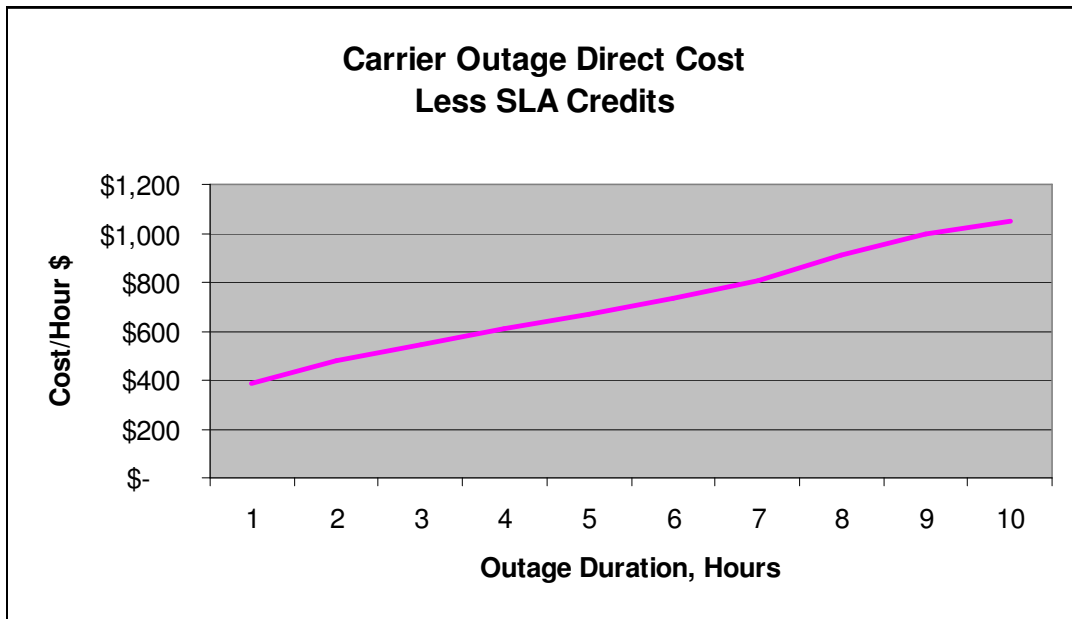


Figure 5: Carrier Outage Activity Profile

The depreciation period question is important to help determine the amount that SLA credits (to their enduser) impacts the carrier, as well as establish the evaluation lifetime for the equipment. That combined with the Internal Rate of Return (IRR) will help estimate what level revenue is being impacted when

experiencing an outage. IRR combined with the maximum equipment cost can conservatively estimate the revenue expected by the carrier. The reason it is conservative is that carriers calculate the IRR from the free cash flow metric and we are using it here at the Revenue from Operations level. All of the additional costs associated with the carrier balance sheet are not considered, hence the revenue requirement is much higher, and most important, more significant to lose under an outage scenario.

Another indirect question, addressing the maximum SLA credit percentages, allows the model to identify additional direct costs associated with SLA credits. The final two questions do not have a direct impact on the results generated by the model. They are posed to generate the understanding that the model is conservative and that these costs should also be considered if the direct costs are not a clear cut indicator.

Results:

In this case, the OR Networks total cost of ownership is \$160,801, based on the expectation that the OR Networks will generate very few, if any, outages. The corresponding result for EdgeTech is \$241,234, based on the expectation that their equipment will result in one eight hour outage per year over the lifetime of the equipment.

The graph display on the tool interface depicts the relative cost of ownership for five years of equipment life. As the OR sales and NewTelco procurement teams work together to refine the results, the graph defines the OR-EdgeTech comparison in realtime. As an added metric, two indicators are also provided for cost of a 4 hour outage and 8 hour outage. Most carriers that have seen these figures immediately state that they are low. If that is the case, and we believe it is, the results around reliability are even more skewed in favor of reliable solutions.

Conclusion:

Carriers, especially newer ones, are struggling in today's business climate to vault the cash flow positive benchmark. One of the means they have used to date has been the classic low-price equipment choice schema. If they recognized the cost of equipment outages to their operations, it would help them make better equipment procurement decisions which support their financial goals as a business.

Network reliability is the single most significant metric governing the carrier business model. Improving the network reliability in ways which make sense (i.e. actually lower the total cost of ownership) will enable carriers to significantly improve their reputation and subsequent profitability.

Arbitor, Inc. considers the Reliability Total Cost model as an important building block for the future carrier and enterprise telecommunications marketplace. We are helping to create that market by supporting companies who stand to benefit from the definition of reliability metrics in easily understood economic terms. We help promote a more thorough understanding of network infrastructure & technology by reduction to measurable economic principles which can be put into practice.

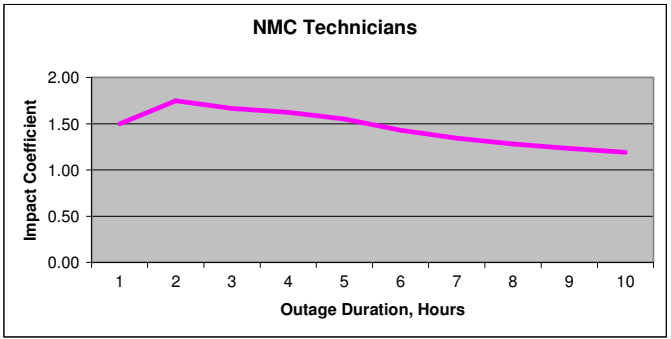
*Dan Kalin is a Senior Consultant for the Telecommunications Practice for **Arbitor, Inc.** He brings over 20 years of management, consulting and engineering experience in the telecommunications, aerospace and nuclear power industries from organizations such as Dresser Industries, Lockheed Martin, and Worldspace. Most recently, Mr. Kalin served as Senior Broadband Product Manager for XO Communications, Inc. where he developed and launched the XO Gigabit Ethernet product line in more than 60 markets nationwide. Dan can be contacted at DKalin@Arbitor.com.*

*John Mullan is Vice President of the Telecommunications Practice for **Arbitor, Inc.** and his 16 years in the industry spans from CLEC to IXC to ILEC to International Carrier. He has proven success for managing Telecom and Internet products. His expertise includes business analysis, market research, market plan development, product finance, product management, product marketing, sales channel development, network design & engineering, and network security.*

Appendix A: Outage Activity Profiles

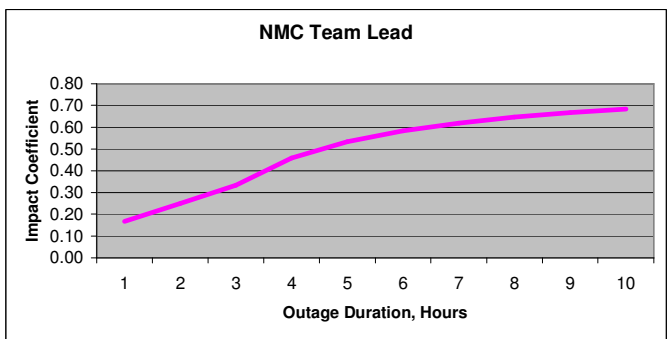
NMC Technicians
\$

Outage, Hours	IC
1	1.50
2	1.75
3	1.67
4	1.63
5	1.55
6	1.43
7	1.35
8	1.28
9	1.23
10	1.19



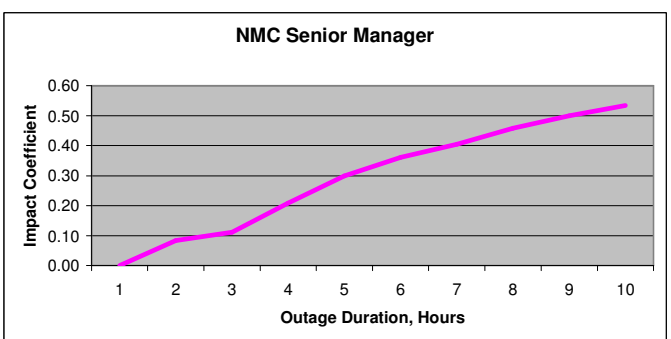
NMC Team Lead
\$

Outage, Hours	IC
1	0.17
2	0.25
3	0.33
4	0.46
5	0.53
6	0.58
7	0.62
8	0.65
9	0.67
10	0.68



NMC Senior Manager
\$

Outage, Hours	IC
1	0.00
2	0.08
3	0.11
4	0.21
5	0.30
6	0.36
7	0.40
8	0.46
9	0.50
10	0.53

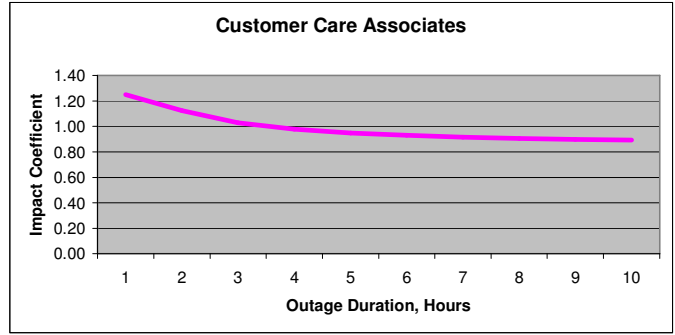


Appendix A: Outage Activity Profiles

Care Associates
\$

17.30

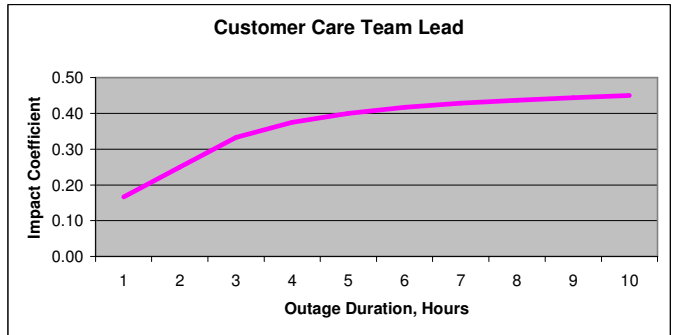
Outage, Hours	IC
1	1.25
2	1.13
3	1.03
4	0.98
5	0.95
6	0.93
7	0.92
8	0.91
9	0.90
10	0.89



Care Team Lead
\$

32.45

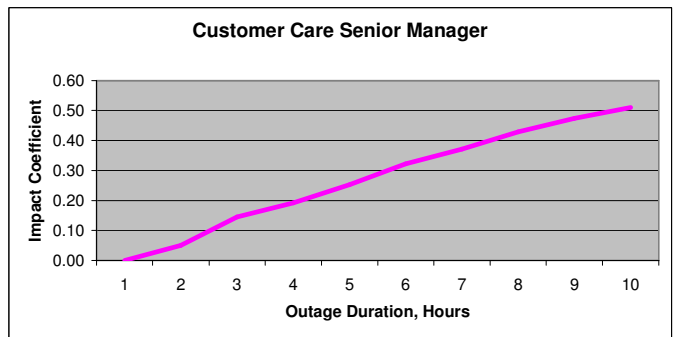
Outage, Hours	IC
1	0.17
2	0.25
3	0.33
4	0.38
5	0.40
6	0.42
7	0.43
8	0.44
9	0.44
10	0.45



Care Senior Manager
\$

50.40

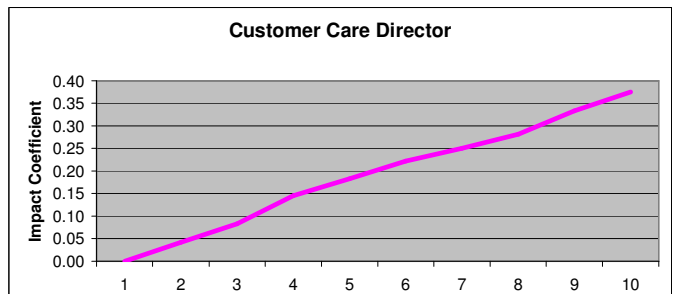
Outage, Hours	IC
1	0.00
2	0.05
3	0.14
4	0.19
5	0.25
6	0.32
7	0.37
8	0.43
9	0.47
10	0.51



Care Director
\$

80.50

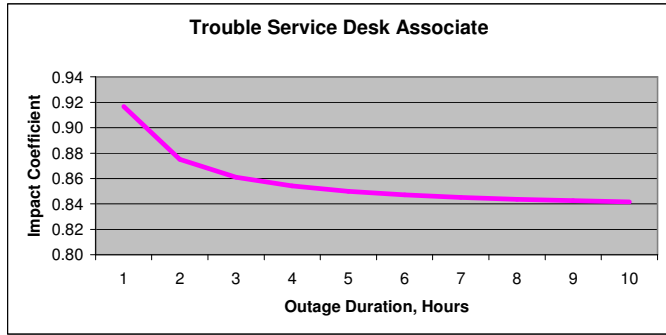
Outage, Hours	IC
1	0.00
2	0.04
3	0.08
4	0.15
5	0.18
6	0.22
7	0.25
8	0.28
9	0.33
10	0.38



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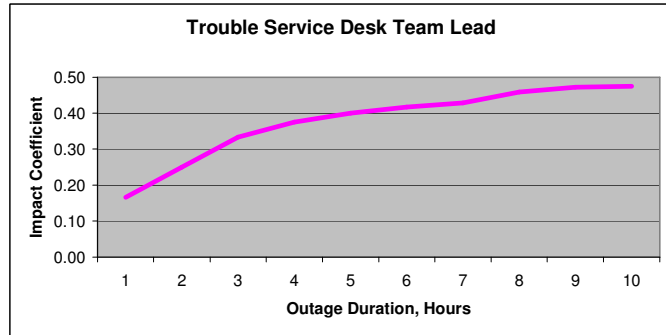
Trouble Desk Associates
\$ 17.30

Outage, Hours	IC
1	0.92
2	0.88
3	0.86
4	0.85
5	0.85
6	0.85
7	0.85
8	0.84
9	0.84
10	0.84



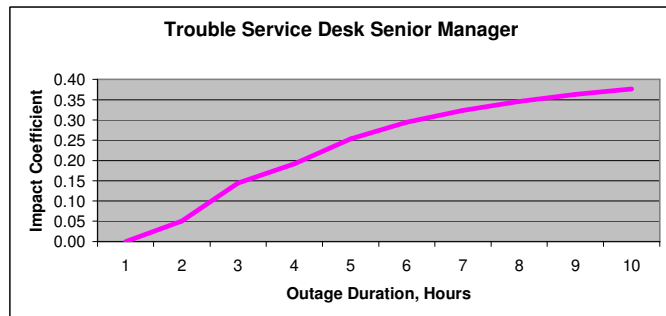
Trouble Desk Team Lead
\$ 32.45

Outage, Hours	IC
1	0.17
2	0.25
3	0.33
4	0.38
5	0.40
6	0.42
7	0.43
8	0.46
9	0.47
10	0.48



Trouble Desk Senior Manager
\$ 50.40

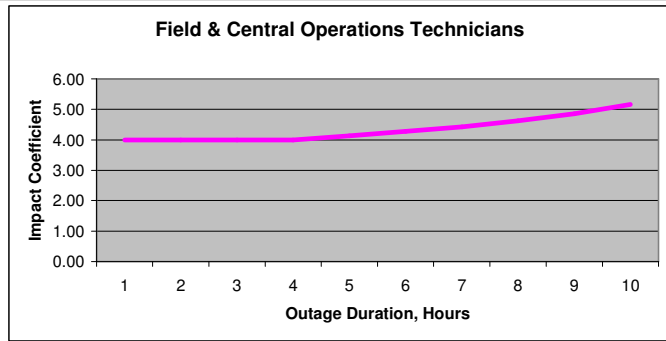
Outage, Hours	IC
1	0.00
2	0.05
3	0.14
4	0.19
5	0.25
6	0.29
7	0.32
8	0.35
9	0.36
10	0.38



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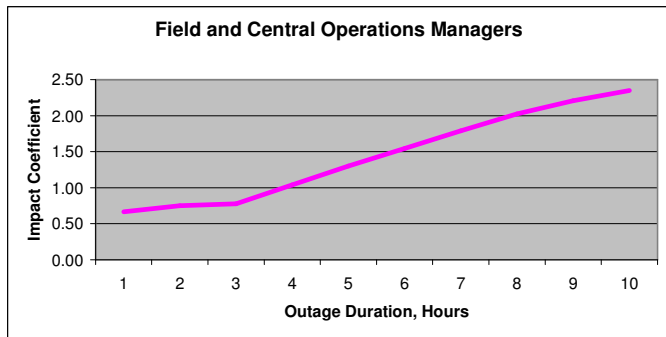
Operations Technicians
\$ 37.50

Outage, Hours	IC
1	4.00
2	4.00
3	4.00
4	4.00
5	4.13
6	4.28
7	4.43
8	4.63
9	4.85
10	5.17



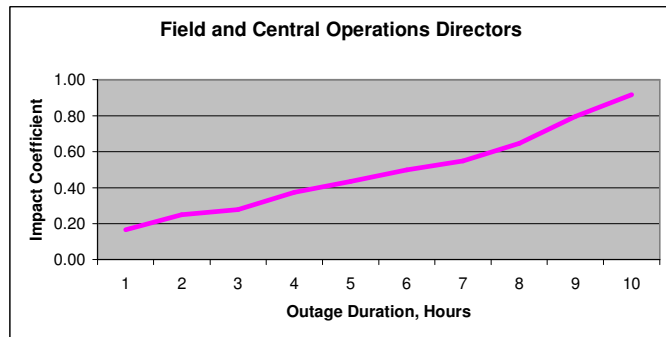
Operations Managers
\$ 50.00

Outage, Hours	IC
1	0.67
2	0.75
3	0.78
4	1.04
5	1.30
6	1.54
7	1.79
8	2.03
9	2.21
10	2.35



Operations Directors
\$ 75.00

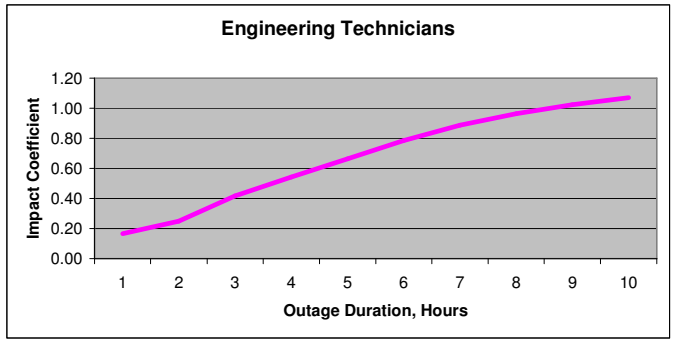
Outage, Hours	IC
1	0.17
2	0.25
3	0.28
4	0.38
5	0.43
6	0.50
7	0.55
8	0.65
9	0.80
10	0.92



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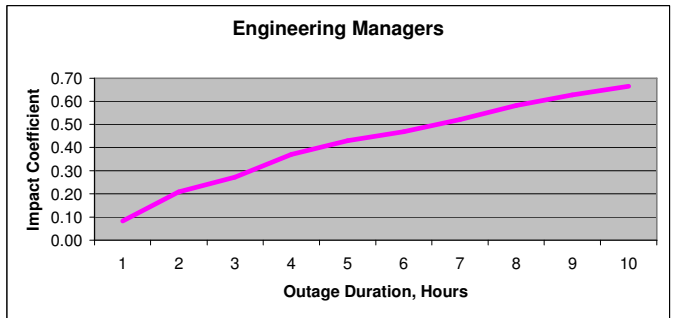
Engineering Technicians
\$ 40.00

Outage, Hours	IC
1	0.17
2	0.25
3	0.42
4	0.54
5	0.66
6	0.78
7	0.89
8	0.96
9	1.02
10	1.07



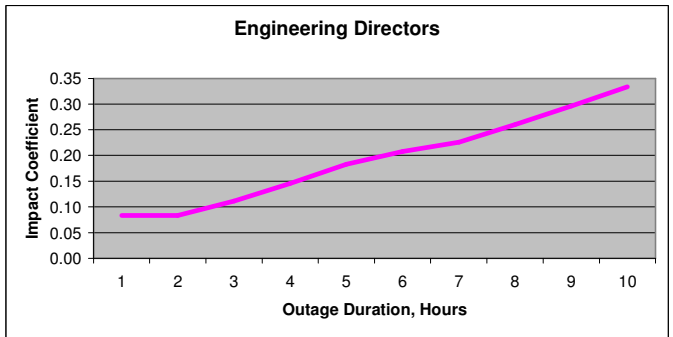
Engineering Managers
\$ 50.00

Outage, Hours	IC
1	0.08
2	0.21
3	0.27
4	0.37
5	0.43
6	0.47
7	0.52
8	0.58
9	0.63
10	0.67



Engineering Directors
\$ 75.00

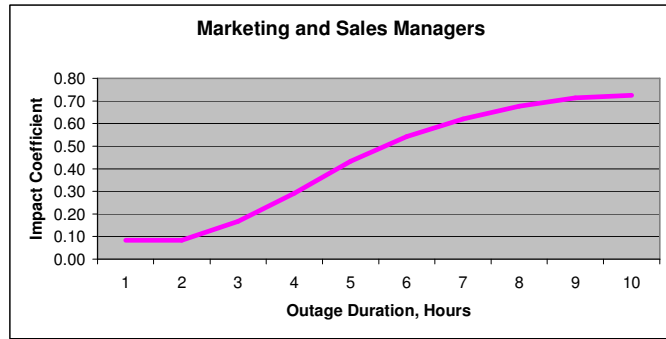
Outage, Hours	IC
1	0.08
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6	0.21
7	0.23
8	0.26
9	0.30
10	0.33



Appendix A: Outage Activity Profiles

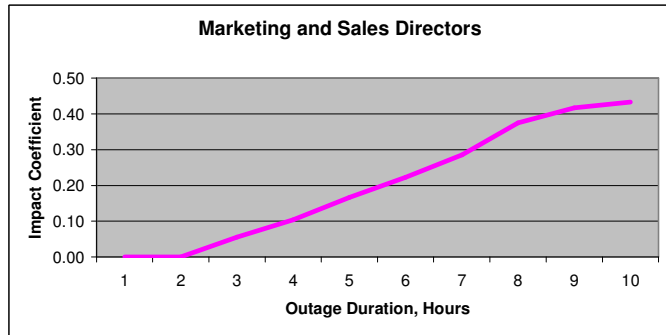
Marketing & Sales Managers
\$ 57.50

Outage, Hours	IC
1	0.08
2	0.08
3	0.17
4	0.29
5	0.43
6	0.54
7	0.62
8	0.68
9	0.71
10	0.73



Marketing and Sales Directors
\$ 80.00

Outage, Hours	IC
1	0.00
2	0.00
3	0.06
4	0.10
5	0.17
6	0.22
7	0.29
8	0.38
9	0.42
10	0.43



Executive Management
\$ 144.20

Outage, Hours	IC
1	0.08
2	0.08
3	0.19
4	0.29
5	0.38
6	0.50
7	0.74
8	1.15
9	1.39
10	1.47

