Companies rely on IT to support nearly all aspects of their business. Employee productivity and customer satisfaction both depend on the availability and performance of mission critical applications, and these applications depend on the IT infrastructure running smoothly and efficiently.

Ensuring that IT resources meet the needs of your users requires more than just responding to problems. To keep your infrastructure running efficiently, you must obtain real-life data about the current status of your network, identify congestion and trouble spots before they affect users, and plan effectively for the future. These tasks are all part of capacity planning.

Capacity planning is a complex and critical part of managing IT resources. It helps you to use your current resources efficiently, evaluate trends in demand, and project future resource needs. Effective capacity planning allows you to:

- Reduce costs through the reduction or elimination of underused leased lines.
- Improve performance through identification of both overused and underused elements, and rebalancing of capacity with demand.
- Reduce server and network downtime by anticipating overloads before they occur, and ensuring adequate capacity is in place.
- Improve budget predictability by tracking trends and modeling the affects of new services or infrastructure, allowing you to avoid emergency purchases and ensure you get the best prices.

Using eHealth for Capacity Planning

This topic describes how eHealth can help you perform three major Capacity Planning activities:

- **Identifying Underutilized Resources** – Identifying existing devices or resources that are underused, resulting in unnecessary costs for leased lines and systems that are sitting idle.
- **Identifying Overutilized Resources** – Identifying existing devices or resources that are overused, resulting in performance degradation or penalty charges from overuse.
- **Planning Future Capacity Needs** – Projecting capacity needs based on current demand trends or anticipated business changes, allowing you to plan purchases and install upgrades as needed.
Case Study: Identifying Underused Leased Lines

A large financial company in the northwest United States operated 2000 branch offices, all of which connected to a centralized data center via high-speed leased lines. These branch offices were of varying sizes, ranging from small kiosks to large regional offices.

Since the company had grown quickly through mergers, the IT department managed a diverse network environment, containing everything from dialup modems to OC3 lines. Still, they operated a tight ship, with excellent configuration management and element naming conventions. They grouped their offices geographically, and their network management system told them that the network was operating efficiently.

In early 2005, the company spent several million dollars rolling out new applications along with higher bandwidth lines to support them. Despite the capacity upgrades, several branches complained of poor response time with the new applications. Performance in most locations was excellent however, and the network management system showed that bandwidth utilization was within acceptable levels for all groups.

The company installed eHealth to help them manage their diverse network environment. One of their first actions was to schedule a Daily Health Report to screen for overutilized and underutilized elements in their network.

Upon review of the Health Report, IT personnel immediately noticed several high speed lines identified in the Underused Elements Report, indicating that they were nearly unused 95% of the time. They then consulted the Bandwidth Utilization chart for one of the geographic groups (Figure 1), and saw that many lines were hardly used most of the time, while others exceeded 90% utilization.

Based on the eHealth reports, it became clear that since their groups were organized geographically, they contained mixed elements with widely different speeds. Although the group as a whole looked good, in fact some of these elements were operating at near peak capacity, while others were nearly unused.

By reallocating traffic from overused to underused lines, downgrading underutilized lines to slower speeds, and eliminating several unused T1 lines, the company was able to save nearly one million dollars in the first month alone, while improving overall performance.

The Bandwidth Utilization chart shows several leased lines that are underutilized (all green)
Identifying Underutilized Resources

Predicting the future is always difficult, especially in the business world. With IT departments striving to stay ahead of the demand curve, forecasts can sometimes prove inaccurate, leading to network interfaces, servers, or storage devices that are underused. In addition, frequent reorganizations and changes in business processes mean that resources that were once used heavily may now sit idle.

Whatever the cause, maintaining underutilized resources has one result – unnecessary costs. When high-bandwidth leased lines are underused, these costs can be especially significant.

eHealth provides an Underutilized Elements report that allows you to quickly identify elements that may be underutilized. You can then investigate the utilization of these elements using Health and Trend reports, and plan your options using the Capacity Trend What-If report. This process can yield significant results quickly, saving you money by cancelling unused leased lines, downgrading underused lines to less expensive options, or relocating demand from overused to underused WAN interfaces, disks, or systems.

There are three steps to the process of identifying underused resources:

1. Identifying Underutilized Resources
2. Confirming Underutilization
3. Addressing Underutilized Resources

Identifying Underutilized Resources

To identify underutilized resources in your network, schedule the Underutilized Elements report to run as part of a daily Health report.

You can schedule this report to run at periodic intervals (weekly or monthly) depending on your specific needs. When you first install eHealth, run it weekly to identify resources that are not being used. After this initial period, you can run it less frequently (monthly or quarterly) to identify usage changes in your network.

Since the Underutilized Elements report looks at data from the past 8 days, you should schedule the report to run on Sunday so that you get data for an entire business week.

Depending on how your network is used, you can edit the service profile so the report includes data from only certain days or times, to eliminate periods of low network usage such as nights or weekends.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Element Name</th>
<th>Speed</th>
<th>Utilization Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5734-ATM00</td>
<td>56.2 ATM/WAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
<tr>
<td>2</td>
<td>5734-ATM00</td>
<td>56.2 ATM/WAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
<tr>
<td>3</td>
<td>5734-ATM00</td>
<td>56.2 ATM/WAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
<tr>
<td>4</td>
<td>5734-LIC 1.13</td>
<td>56.2 Gigabit LAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
<tr>
<td>5</td>
<td>5734-LIC 1.13</td>
<td>56.2 Gigabit LAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
<tr>
<td>6</td>
<td>5734-ATM00</td>
<td>56.2 ATM/WAN</td>
<td>Underutilized Link, 99.00% of the baseline below 10% utilization (On)</td>
</tr>
</tbody>
</table>

Figure 2. Underutilized Elements Report

The Underutilized Elements report lists elements that meet the following criteria for the past 8 days:

- Never reached 50% utilization
- Did not reach 10% utilization more than 5% of the time

Use the Underutilized Elements report to locate leased lines, routers, switches, and systems that have underutilized bandwidth, CPU capacity, memory, or disk space. For example, Figure 2 shows several high-speed OC-3 lines that have very low usage and should be investigated further.

When you run an Underutilized Elements report for only LAN/WAN elements, the elements are sorted first by speed (since faster WAN links are more expensive), then by the percentage of time they were underutilized.

Confirming Underutilization

Once you identify network elements that may be underutilized, analyze the purpose of each element and run reports to confirm that it is really being underused.

Before going further, review any unused network links to determine if they are backups. Since backups are used only when the primary fails, they often have no usage.

If a candidate element is not a backup, confirm that it has been underutilized for at least a month by running a monthly Health Report.
Select Element Detail in the Health Report, and examine the Bandwidth Utilization chart (Figure 3).

The Bandwidth Utilization chart shows the load on each of the network interfaces over the report period. Usage percentage is color-coded, showing the percentage of time the interface was in each usage range. Gray bars in the chart represent lines that have not been used at all, while no color indicates that no data was collected.

For example, in Figure 3 the bar for Helium 5734 is completely gray, indicating it had no usage during the month. Several other bars, such as Helium 7839, Miami, and Atlanta are all dark green, indicating they never exceeded 10% usage. All of these interfaces appear underutilized.

Click the bar for the element you suspect is underused to run a Bandwidth Trend Report (Figure 4).

The Bandwidth Trend Report shows the utilization for that element for the same time period as the Health Report. Examine the chart for constant underuse, or for a sudden decrease in usage due to network reconfiguration. For example, the element shown in Figure 4 never exceeded 3.5% utilization last month, indicating that it is underused.

When you confirm that a resource is underutilized, establish a report trail to document evidence of low usage. In addition to weekly and monthly Health Reports, you can run a Service Customer Service Level report for longer term (quarterly or yearly) bandwidth utilization data. The Service Customer report also contains the Daily Bandwidth Utilization chart, which provides a detailed picture of daily usage.

**Addressing Underutilized Resources**

Once you have documented the underused resource, address the issue by:

- Eliminating unused lines
- Downgrading underused lines
- Rerouting traffic to the underused line.

**Eliminating Unused Lines.** If a leased line is completely unused and does not serve as a backup, you can eliminate it and save the monthly cost of the line.

**Downgrading Underused High-Speed Lines.**

When high-speed leased lines are underused, you can often save money by downgrading the capacity of the link. This solution is effective when the link is a fractional T1, frame relay circuit, or ATM channel, but may not be practical if you have to change technologies or run new cable.

Depending on your usage patterns and the technology of the link, you may also be able to downgrade just one direction of the link, and have different speeds in each direction.

Before downgrading a high-speed line, run a Capacity Trend What-If report to visualize the effect of lowered capacity, and determine the optimal capacity of the new line. For example, Figure 5 shows that if capacity were reduced to 10% of the current bandwidth, utilization would have reached about 35% last month. Therefore, a less expensive line would still accommodate the current traffic.
Relocating Demand to the Underused Line.
If you have overused lines in the same location, or multiple underused lines that can be consolidated, it may make sense to reroute network traffic to an underused line.

If you don’t have other traffic from the same location, you may also use a link more efficiently by:
- Relocating local servers to a central site, increasing traffic over the underused line and lowering costs through server consolidation.
- Aggregating traffic from several small local links to a regional center, then using one shared high-speed link to the central site.

When relocating demand to an underused line, run a Capacity Trend What-If report (Figure 5) to visualize the effect of added demand to the target resource.

Making the Case. Once you have determined what capacity changes to make, calculate the potential monthly savings from eliminated lines and the difference in cost between existing lines and new downgraded lines. Then calculate the cost of changing service (both service provider fees and internal costs).

When you have determined your costs and potential savings, calculate the Return on Investment (ROI) of making changes:

\[ \text{ROI} = \frac{\text{switching costs}}{\text{monthly savings}} \]
Identifying Overutilized Resources

As businesses grow, the demand on network elements can often stress their capacity. When network elements become overutilized, response time slows down and users experience problems connecting to network services. The result can be lost productivity and unhappy customers. If the overutilized resource is a leased line, it can also cost your business a substantial amount in overage charges.

eHealth’s capacity planning tools can help you identify overutilized resources before they start causing problems. By examining a single Health Report each week, you can identify network elements that are reaching their capacity. You can then consult other reports to analyze problems, and solve the issues before they become fires for your IT team. This allows you to use IT resources more efficiently, prevent unnecessary costs for your business, and ensure that your end users receive optimal performance.

There are three steps to the process of identifying underused resources:
- Identifying Overutilized Resources
- Confirming Overutilization
- Addressing Overutilized Resources

Identifying Overutilized Resources

To identify overutilized resources in your network, schedule a weekly Health report to run on Sunday, so that you get data for an entire business week.

Review the Exceptions Summary Report in the Exceptions section of the Health report (Figure 6).

Figure 6. Exceptions Summary Report

The Exceptions Summary report identifies elements that have experienced unusual events or whose resources are consistently inadequate for the demand on them. The elements are ranked by exception points, so that those elements experiencing the worst problems are listed first.

Note any elements in the report that list Utilization Health Index or Congestion Health Index in the Leading Exception column. These elements are experiencing high volume and may be overutilized.

For example, in Figure 6, the Frame Relay link to the Virginia office is listed first, and has Utilization Health Index as its leading exception. This link is likely overutilized and should be investigated further.

Confirming Overutilized Resources

Once you identify network elements that may be overutilized, go to the Situations to Watch chart in the Summary section of the Health report.

Figure 7. Situations to Watch Chart

The Situations to Watch chart identifies elements that are predicted to exceed, reach, or come close to reaching their trend thresholds. The chart shows you how close each element is to its threshold, how fast utilization is growing, and how long until demand exceeds capacity.

Review the elements listed in the chart, looking for those that have exceeded their threshold or are growing fast enough to soon reach it. For example, the first element in Figure 7 (Virginia) has already exceeded its threshold for 2 days, while the next two are predicted to reach threshold in the next week. All of these are likely to be overutilized elements. Demand on the final two elements listed is increasing, but both are still at less than 20% capacity, and do not represent a problem.

Select Element Detail in the Health Report, and examine the Bandwidth Utilization chart for the elements you suspect to be overutilized (Figure 8).

Figure 8. Bandwidth Utilization Chart

The Bandwidth Utilization chart shows the percentage of time each element was in each usage range. Generally, purple and red colors indicate an overutilized resource. Purple indicates greater than 100% utilization, meaning that the element is probably a leased line exceeding its contracted bandwidth, and therefore incurring overage charges.

Examine the chart to see how often a suspected element was overutilized during the course of the week. Some elements may show consistently high demand (like Virginia in Figure 8), but since demand varies over
time, most elements will show significant periods of low usage. Depending on your network activity, an element may even have no usage at certain times (overnight for example), but still be overutilized because demand exceeds capacity at peak times.

For example, the Vermont line in Figure 8 shows no usage a third of the time (possibly overnight), and is under 20% usage most of the time. However, since it exceeds 100% utilization at peak demand, it could be incurring overage charges, and therefore be considered overutilized.

To obtain more details about an element’s performance, create an At-a-Glance report by right-clicking on that element in the Bandwidth Utilization chart (Figure 9).

Figure 9. At-a-Glance Report

Review the Bandwidth Utilization charts in the At-a-Glance report to see how frequently the element was overused, and during what time periods. The element in Figure 9, for example, was around 50% utilization most of the week, but peaked near 100% several times. Depending on your business needs, an element that reaches its capacity for only one hour per week may be acceptable, or that one hour of overutilization could be a critical problem.

Review the other charts in the At-a-Glance report for any anomalies, including high error rates or signs of congestion (FECNs, BECNs, discards). Use this information to determine the conditions that might be affecting the element, including:

- Insufficient capacity.
- Inefficient or misconfigured applications consuming excessive bandwidth.
- Too many or too few stations overloading a WAN link.
- A highly repeated or bridged domain that should be routed.

Once you have confirmed that a resource is overutilized, establish a report trail to document evidence of high usage. In addition to the reports described above, you can select specific elements in the Exceptions Summary Report and Situations to Watch chart to run detail reports for those elements. You can also run Bandwidth Trend reports on specific elements to show the long-term utilization of a resource.

Addressing Overutilized Resources

Once you have documented the overutilized resource, address the issue by:

- Upgrading the element to a higher capacity.
- Relocating demand to other resources.
- Adding additional elements to share the workload.

Finally, run Capacity Trend What-If reports to visualize the effects of higher capacity or lower demand on the overutilized element, and determine the optimal capacity of any new resources (Figure 10).

Figure 10. Capacity Trend What-If Report

For example, Figure 10 shows that by increasing the capacity of the Virginia line by 50%, peak utilization is reduced to about 60% of capacity. This capacity should be sufficient to meet expected demand.
Planning Future Capacity Changes

Effectively managing IT resources requires more than just identifying elements that are overutilized today. You must also project future capacity needs to identify when demand could exceed capacity.

Predicting the future may be difficult, but it is at the heart of capacity planning. Maintaining the performance of your mission-critical applications requires addressing capacity issues proactively, by tracking current network and server usage, accurately projecting future capacity needs, and adding or reconfiguring capacity before service to users is affected.

eHealth provides capacity planning tools that enable you to analyze the behavior of your resources under varying conditions, and predict where and when you’ll need to add capacity. eHealth reports make capacity planning easier and more accurate by helping you:

- Predict where and when you need to make capacity upgrades based on historical trends.
- Analyze future capacity based on hypothetical changes that you plan to make or on expectations of growth.

With eHealth reports, you can plan capital expenses for IT upgrades and forecast how your current usage might be affected by changes in capacity, demand, or both.

There are three steps to the process of projecting capacity changes:

- Identifying Potential Capacity Changes
- Analyzing Capacity Trends
- Addressing Capacity Changes

Identifying Potential Capacity Changes

To help predict which elements are approaching their capacity, schedule a weekly Health report to run on Sunday, so that you get data for an entire business week.

Examine the Situations to Watch chart in the Summary section of the Health report (Figure 11). The Situations to Watch chart shows the top 10 elements (network interfaces, CPUs, disk partitions) that are nearing their capacity. The chart shows you how close each element is to its threshold, how fast utilization is growing, and how long until demand exceeds capacity.

Figure 11. Situations to Watch Chart

Figure 11 shows several user partitions that are nearing their thresholds. In the Days To Threshold column, System-Orange shows 0, meaning that utilization has reached the Trend threshold. System-Green, shows 20 days to threshold, and System-Pink shows Increasing, indicating utilization is growing, but will not reach threshold for a long period of time.

Each of the systems at or near its threshold merits further investigation. For example, System-Orange could already be overutilized, or it could be a system partition designed to operate near capacity. System-Green, on the other hand, is 20 days from meeting its threshold, but could be a good candidate for upgrade if it is showing a steady increase in demand.

To quickly follow up with these situations, click the element name to run a Situations to Watch detail report for the partition (Figure 12).

Figure 12. Situations to Watch Detail Report

Examine the trend line to see how quickly the trend is approaching the threshold. If the line is rising at a steady rate (as in Figure 12), consider adjusting capacity by increasing the size of the partition, deleting unneeded directories and files, or buying a new system.
Analyzing Capacity Trends

After identifying potential upgrade candidates, run Capacity Projection and Capacity Provisioning reports to forecast volume changes over the upcoming weeks and months, and predict when elements need to be upgraded.

The Capacity Projection report forecasts how the capacity of a particular variable (partition utilization, for example) will change in the future. You can run the report based on peak, average, or percentile capacity values. eHealth measures the predicted capacity values against a threshold you specify, and displays those elements predicted to exceed the threshold (Figure 13).

<table>
<thead>
<tr>
<th>Partition Capacity Projection</th>
<th>Threshold</th>
<th>Weekly Average</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element Name</td>
<td>Value</td>
<td>Actual</td>
<td>30 Days</td>
</tr>
<tr>
<td>System-Orange</td>
<td>90.0%</td>
<td>96.9%</td>
<td>98.6%</td>
</tr>
<tr>
<td>System-Green</td>
<td>90.0%</td>
<td>92.9%</td>
<td>93.0%</td>
</tr>
<tr>
<td>System-Purple</td>
<td>90.0%</td>
<td>41.1%</td>
<td>41.3%</td>
</tr>
<tr>
<td>System-White</td>
<td>90.0%</td>
<td>71.6%</td>
<td>70.6%</td>
</tr>
<tr>
<td>System-Black</td>
<td>90.0%</td>
<td>45.7%</td>
<td>45.9%</td>
</tr>
</tbody>
</table>

Figure 13. Capacity Projection Report

Figure 13 displays the percentage of partition capacity that will be consumed on each element at 30 days, 90 days, and nine months into the future. You can see that demand on System-Orange is near threshold, but not increasing very much. Demand on System-Purple however, is quickly increasing and will soon exceed capacity. System-Purple, therefore, may be in greatest need of upgrade.

To project exactly when these elements will need to be upgraded, run a Capacity Provisioning report. The Capacity Provisioning report compares projected capacity values against an upgrade threshold, and displays those elements predicted to exceed the threshold, along with the number of days until an upgrade is required (Figure 14).

Like the Capacity Projection report, you can run this report based on peak, average, or percentile capacity values. You can set both the upgrade threshold and an upgrade lead-time window through the eHealth console.

Adjust capacity and demand factors to see the effect on your resources.

<table>
<thead>
<tr>
<th>Capacity Provisioning 20-90 Day Lead-time, 90% Upgrade Point</th>
<th>Daily Average</th>
<th>Days to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element Name</td>
<td>Actual</td>
<td>Upgrade</td>
</tr>
<tr>
<td>System-Orange</td>
<td>32.1%</td>
<td>30.00</td>
</tr>
<tr>
<td>System-Purple</td>
<td>41.2%</td>
<td>30.00</td>
</tr>
<tr>
<td>System-Black</td>
<td>40.0%</td>
<td>26.00</td>
</tr>
</tbody>
</table>

Figure 14. Capacity Provisioning Report

Figure 14 shows elements that are predicted to meet a 90% capacity upgrade point within the next 20 to 90 days. System-Green is most in need of upgrade, and should be addressed in the next 20 days.

Addressing Capacity Changes

When you predict changes in demand, or identify elements that need to be upgraded based on current usage trends, run a What-If Capacity Trend report to analyze potential solutions.

The What-If Capacity Trend report shows how resources perform as your infrastructure changes and grows. These reports allow you to leverage historical data to predict future patterns, model changes in capacity or demand, and see the effect on resources (Figure 15).

Using the report, you can determine whether an existing resource can support anticipated changes and, if not, how much capacity must be added. You can also illustrate potential problems so that you can justify requests for new equipment or upgrades.

For example, Figure 15 shows that by doubling CPU capacity, demand on the server will be well under the trend threshold of 80%, even with a 50% increase in demand.