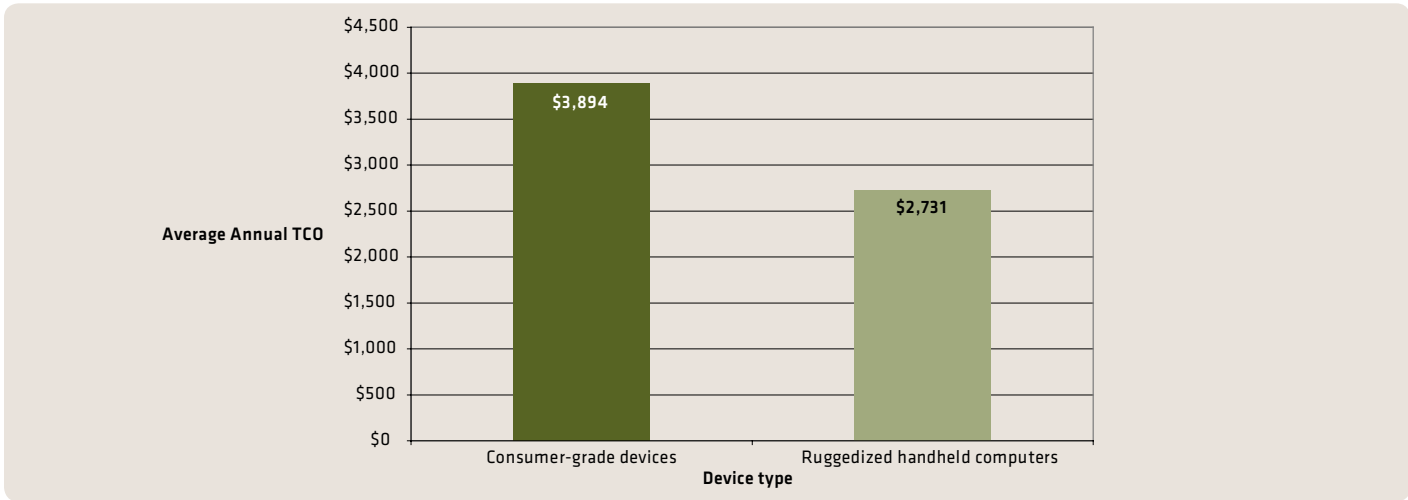


White paper

How Ruggedness Reduces TCO for Mobile Computers

General-purpose PDAs and ruggedized enterprise mobile computers are made for separate markets, are designed for different tasks, and also vary by their size, weight and materials. But the biggest difference between these device types is their total cost of ownership (TCO). Organizations can't afford to overlook this important difference in challenging times when all costs are under scrutiny and funds for new equipment are oftentimes limited. Despite their lower purchase price, smart phones and PDAs cost much more to own and operate than ruggedized mobile computers in service, delivery, retail, warehouse and manufacturing environments, according to independent research that studied mobile computer life cycles in these environments. In fact, the average annual TCO for consumer-oriented PDAs and smart phones used for business is 42.6 percent higher than that for enterprise-grade ruggedized handheld computers, as Figure 1 shows. Understanding TCO differences is essential to choosing the device that will provide the most value for mobile computing deployments.

Figure 1: Average TCO for Consumer-Grade and Enterprise Handheld Devices



Source: VDC Research Group.

TCO is a major differentiator among mobile devices, and as the chart above shows, ruggedness is a major variable that determines TCO. Reliability and length of service are the main reasons why. At one extreme, consumer-grade devices often don't last a year when deployed to support mobile enterprise operations. At the other end, ruggedized mobile computers routinely last four years or more even in challenging industrial environments. Calculating TCO isn't as simple as plotting the expected life cycles and replacement costs for different devices. Replacement costs only tell a small part of the TCO story because the purchase price of a device accounts for less than 30 percent of its total cost of ownership. Lost productivity when devices fail costs businesses more than the price to repair or replace them.

Getting TCO as low as possible requires organizations to deploy the devices that will lead to maximum reliability and productivity in their work environment. This white paper will help you do that, by documenting the relationship between ruggedness and TCO, showing how ruggedized devices add value for specific work processes and environments, identifying the key differences between ruggedized and non-ruggedized devices, and providing guidance to determine what degree of ruggedness is needed for different usage scenarios.

The TCO-Ruggedness Relationship

Ruggedized mobile computers provide superior value over common PDAs and smart phones in enterprise environments because they can be kept in service much longer. The longer life cycle more than offsets the higher initial purchase price by leveraging the initial investment over a longer time, and by producing lower repair and replacement expenses. It is not unusual for smart phones or PDAs to need to be replaced two or even three times before a ruggedized device would need to be replaced in the same environment. For example, a study¹ by VDC that compared the life cycles of ruggedized and non-rugged mobile computers used for enterprise operations found 38.5 percent

Terminal Terminology

Definitions of mobile computer categories and what makes devices rugged vary widely. This white paper refers to devices in general as being ruggedized (or rugged) or non-ruggedized (non-rugged), which makes a basic distinction between mass-market PDAs and smart phones and more specialized mobile computers developed for enterprise applications. There are important subsets within these general classifications, particularly for the ruggedized category, where there are major durability differences among devices.

When specific subsets and categories are referenced, this white paper follows the definitions established by VDC, which is the leading research firm specializing in mobile computing and data collection equipment used in industrial, distribution, retail and field service environments. VDC categorizes mobile computers within four ruggedness levels, and classifies smart phones separately. In order of ruggedness, VDC's categories are: consumer grade, durable, semi rugged and fully rugged. The first two categories plus smart phones are considered non-ruggedized, and the second two are considered ruggedized.

1 "Total Cost of Ownership (TCO) Models for Mobile Computing and Communications Platforms," VDC Research. July, 2007.

of commercial grade devices had been replaced within two years of being deployed, compared to 7.8 percent of ruggedized mobile computers, and after year three 82.6 percent of the original non-rugged devices had been replaced, compared to just 18.2 percent of ruggedized devices.

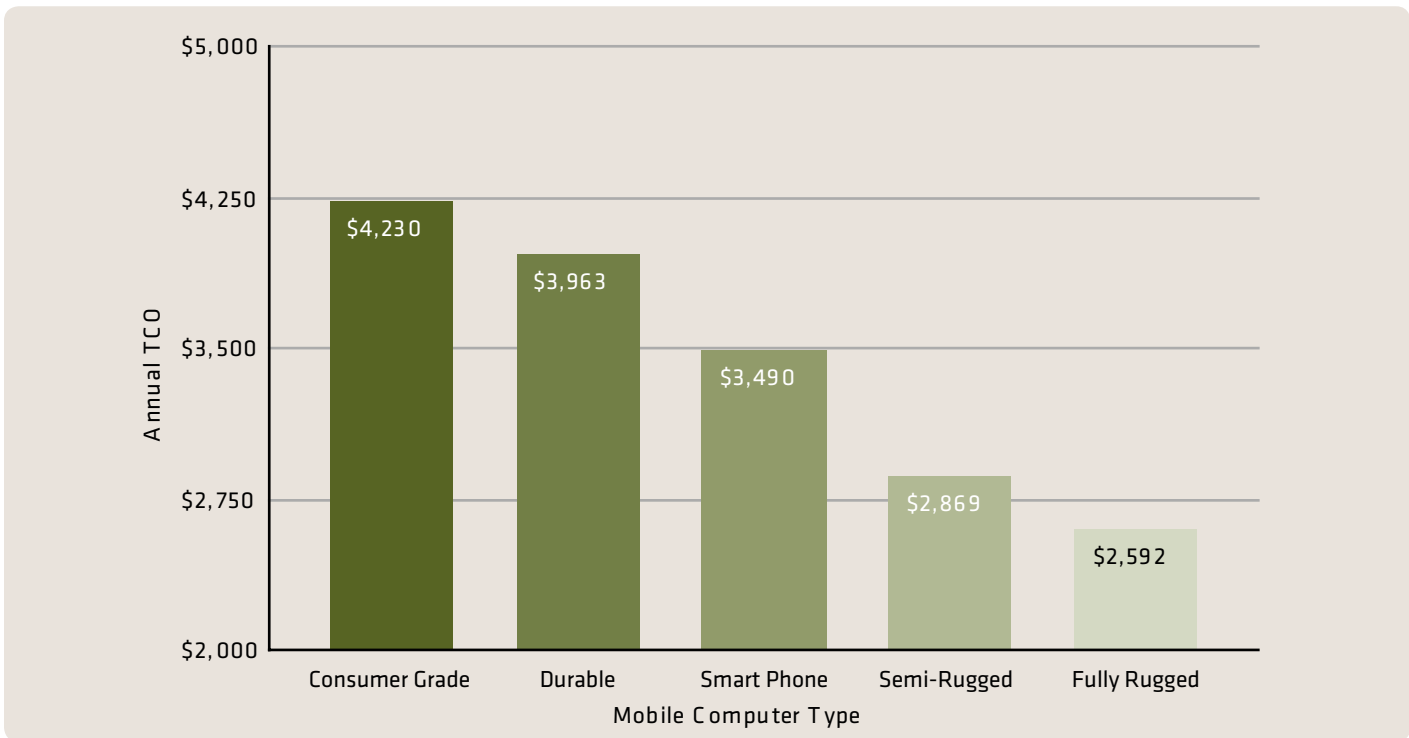
Figure 2: Percent of Installed Mobile Computers Replaced by Year

	Year 1	Year 2	Year 3	Year 4	Year 5
Non-ruggedized	18.0%	38.5%	82.6%	96.8%	98.5%
Ruggedized	3.3%	7.8%	18.2%	55.4%	76.2%

Source: VDC Research Group

The study also found that TCO fell for every level of ruggedness (consumer grade, durable, semi-rugged and fully rugged), i.e., fully rugged devices cost the least to own, while consumer grade PDAs cost the most, as highlighted in Figure 3. The difference can be more than \$1,600 per device, per year.

Figure 3: TCO by Mobile Computer Ruggedness Level



Source: VDC Research Group

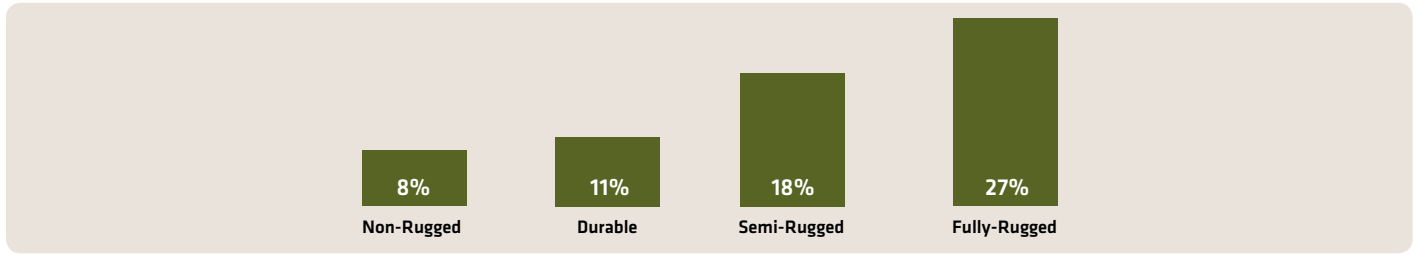
Ruggedized devices provide a TCO advantage because they have longer replacement cycles, and result in less breakdowns, repair expenses and lost productivity while they are in service. The average annual failure rates for non-ruggedized handheld computers is 38 percent, compared to just 11 percent for ruggedized models.² Companies typically plan to keep mobile computers for enterprise operations in service for 3¹/₂ years³, but as Figure 2 showed, less than one in five non-ruggedized models will survive that long. The longer mobile devices are exposed to working conditions, where drops are common, work takes place in hot and cold temperatures, equipment is exposed to rain, snow, dust and humidity, the more value rugged construction provides.

Ruggedized devices do not provide a TCO advantage in Year 1 of the deployment, because of their higher purchase price. Figure 4 shows the percentage of TCO represented by the purchase price. It is highest for the ruggedized categories, which are the most expensive to buy upfront.

² "Total Cost of Ownership (TCO) Models for Mobile Computing and Communications Platforms," VDC Research, July, 2007.

³ Ibid.

Figure 4: Hardware Cost as a Percent of TCO for Different Device Types



Source: VDC Research Group

Working conditions, replacement cycles, failure rates and purchase prices are among the many factors that determine TCO and differentiate it among mobile devices. The following sections provide insight into these variables so businesses can gain a better understanding of their TCO considerations and ruggedness needs.

What Accounts for TCO

The costs associated with mobile computers that are easiest to identify -- purchase price, maintenance contracts, etc. -- account for only a small portion of total cost of ownership. "Soft costs," such as support time, lost productivity, and device maintenance account for a much higher percentage of TCO. Soft costs are not only much greater than hard costs, but they vary considerably by device type, accounting for about 65 percent of the total cost of ownership for fully rugged devices, to 87 percent for consumer grade PDAs, as the data in Figure 5 shows.

Figure 5: Annual Hard Cost & Soft Costs for Handheld/PDA Computers

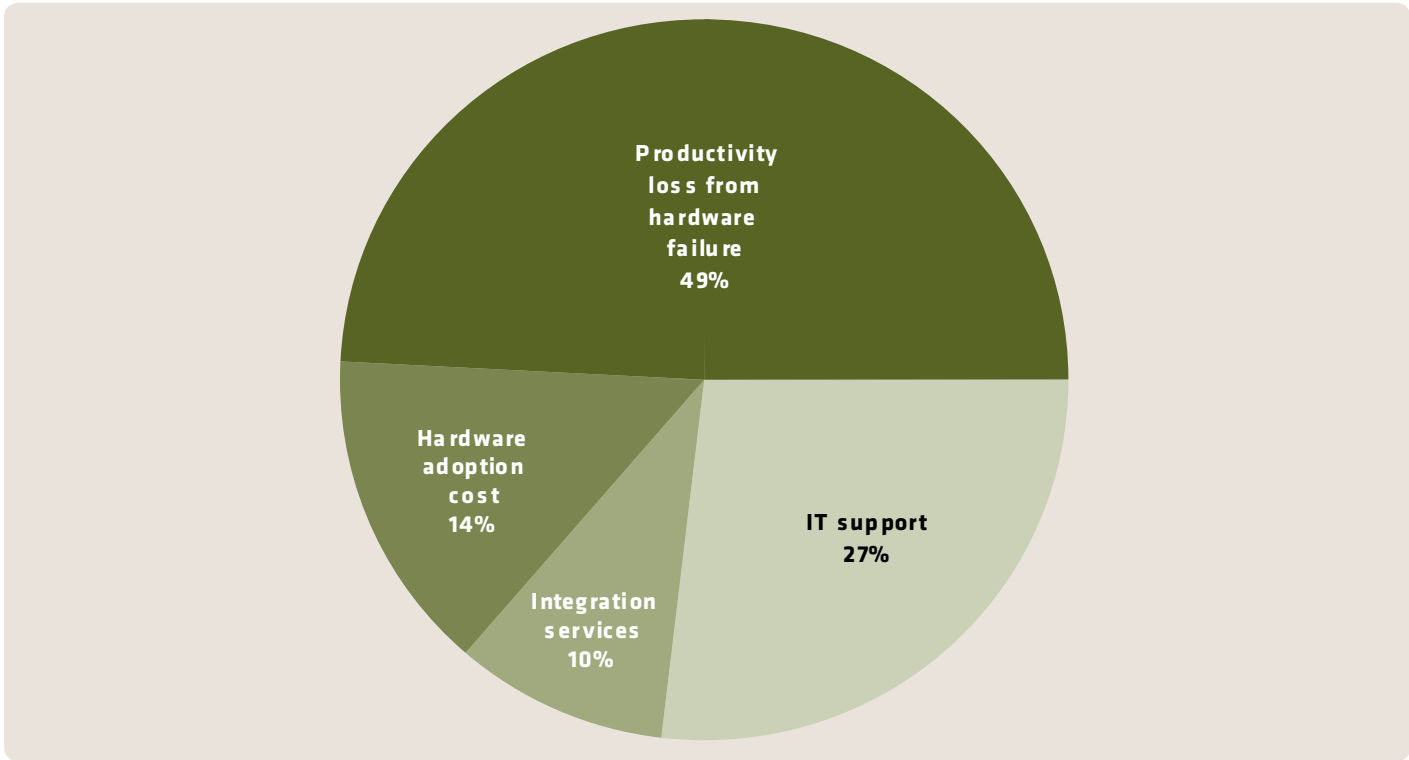
Device Type	Hard Costs	Soft Costs	Total TCO
Consumer Grade	\$472	\$3,758	\$4,230
Durable	\$654	\$3,309	\$3,963
Smart Phone	\$943	\$2,547	\$3,490
Consumer device average	\$690	\$3,205	\$3,895
Semi Rugged	\$863	\$2,005	\$2,868
Fully Rugged	\$895	\$1,697	\$2,592
Ruggedized device average	\$879	\$1,851	\$2,730

*Annual TCO based on five-year deployment; average of all usage environments.

Source: VDC Research Group

The difference between hard costs and soft costs shows why product comparisons and TCO evaluations should not be based primarily on mobile computer list prices and other hard costs. Soft costs have a much greater impact on total cost of ownership than hardware acquisition costs, which account for only eight to 27 percent of TCO. By comparison, a single soft cost -- lost productivity due to failed devices -- accounts for 49 percent of the five-year TCO for mobile devices (see Figure 6). Addressing this variable presents the best opportunity for organizations to keep costs under control and maximize the value of the mobile computing investment. The chart below provides guidance as to where organizations should focus their efforts.

Figure 6: What Accounts for TCO for Mobile Devices



Source: VDC Research Group

Mobile computers cost the most not when they're purchased or replaced, but when they fail. Downtime is the leading contributor to TCO. Device failure is the leading cause of downtime, and can be mitigated by the design and features of the mobile computer. As noted, failure rates for non-ruggedized devices is 38 percent, which is 3.5 times higher than the 11 percent rate for ruggedized devices. Just as with TCO, mobile computer failure rates correlate directly to ruggedness levels.

Productivity

Mobile workers lose an average of 75 minutes each time their mobile devices fail according to VDC's research. This leads to lost revenue in field sales and service operations, production delays and potentially missed shipments in plants and distribution centers, shelf replenishment and customer service problems in retail, and potential overtime in all environments to make up for the lost work time. These negative implications are noted in its 2007 TCO report:

*"Device failure remains a critical issue for mobile computers with annual failure rates often exceeding 30 percent. With many mobile computers supporting mission-critical applications, the impact of failure on customer service, internal productivity, employee morale and ultimately lost revenues can be significant. Equipping mobile workers with the most appropriate device based on application and environment - and not upfront adoption cost - is absolutely critical."*⁴

Here are some scenarios that illustrate the business impact when devices fail in various operations.

Field Service: Imagine a service technician pulls up to a job site and drops his smart phone into a puddle as he gets out of the van. Because of the resulting device failure, the technician can't consult previous maintenance records stored in the device, and must record all work performed and parts used on paper, rather than entering it into a mobile software application. The manual data entry means that service call and all those that follow it that day will take a few extra minutes to complete, which may add up to enough time to cause the technician to be late for his last appointment, or require him to reschedule it for the next day.

Manual data entry also increases the chances that not all service performed or materials used will be recorded (field service software applications prompt operators to enter job codes and part numbers, and create alerts if data is missing), which results in missed billing opportunities. Recording activity on paper in the field creates a requirement at the office to transcribe the information and enter it into customer records and billing systems, introducing more opportunities for errors and delays. The errors and expenses associated with paper-based field service operations have been well documented. Best-in-class field service operators are twice as likely as other firms

4 Ibid.

to issue rugged mobile computers to their field staff, and their technicians are 18 percent more productive.⁵ Mobile computing initiatives in field service produced an average 7.3 percent reduction in overtime pay, and service-level agreement (SLA) compliance improved an average of 23 percent.⁶

The high cost of lost productivity in field service is reflected in the wide disparity in TCO among different device types used for these operations. VDC found rugged devices provide the lowest TCO in field service environments, and consumer-grade PDAs have the highest, at \$5,082 annually, which is more than \$2,300 higher than for some ruggedized models.⁷

Retail: Consider a store associate who is responsible for helping customers with their shopping and restocking shelves throughout the shift. A wireless handheld computer enables them to answer customer questions about whether items in specific sizes or colors are in the back room, inventory available at other stores and expected delivery dates. If the handheld computer isn't working, the clerk has to leave the customer and walk to the back room, office or POS area to check available inventory, which reduces productivity, results in lower customer service and increases the risk the customer will leave without making a purchase or placing an order. In another scenario, if inventory management or shelf replenishment activities are slowed down because of equipment trouble, the store may be at increased risk of out-of-stocks or may have to pay overtime to keep shelves stocked. These outcomes impact the bottom line and underscore the value of reliability. TCO in the retail environment ranges from \$4,162 for consumer-grade PDAs to \$2,511 for fully rugged handheld computers.

Production & Distribution: Ruggedized computers are almost always used in manufacturing and warehouse environments, because reliability is of utmost importance there. Tight production schedules and delivery windows mean companies can't afford productivity slips. If mobile computers fail, order picking operations can fall behind, threatening on-time delivery and complete orders. Companies can usually meet commitments by authorizing overtime, but doing so can severely reduce profitability for the order. Ruggedness is extremely valuable in production and distribution because of the work environments. TCO for consumer-grade devices is extremely high, up to \$4,998 in manufacturing, which is 1.8 times higher than for fully rugged models (\$2,791).

Lost productivity is responsible for nearly half of the total cost of ownership for mobile devices, and a variety of other factors account for the other half. Some of the differences between ruggedized and non-ruggedized devices that have important TCO considerations include software and IT support issues, ease of use, power management and administrative control. These issues are highlighted below.

Software & Support

As the data presented in this paper shows, consumer-oriented smart phones and PDAs don't last long in enterprise environments. However, they often have an even shorter lifespan within the manufacturer's product lineup. Products are often discontinued or refreshed after only six to eight months as new features are added. This doesn't present a problem for individual consumers, who typically only use one device at a time, but can be a major problem for IT administrators who are responsible for managing hundreds or even thousands of mobile devices. Support personnel need to maintain consistency in the operating systems, extensions and features in their device populations, and need access to replacement parts and devices. Figure 5 shows that IT support contributes 26.8 percent to TCO, which is the second-highest category. IT support is considered a soft cost. Soft costs for smart phones and non-ruggedized PDAs averages \$3,205 (Figure 5), which is nearly double the \$1,851 for ruggedized devices. Software issues are an important reason for the difference.

Enterprise-class devices with Microsoft operating systems (Windows CE, Windows Mobile and PocketPC) also give businesses the benefit of a stable, large and competitive software development community. Businesses have a broad choice of solution providers, packaged software applications and development tools that support rugged Windows-based devices, which provides the benefits of competition and flexibility. Windows-based mobile computers also support terminal emulation and other features that are advantageous for enterprise deployments.

Gartner highlighted the advantage of using Microsoft operating systems in its assessment of handheld computers:

"Gartner recommends that clients deploying applications on a ruggedized device primarily consider only Windows platforms to reduce project risk.... Other OS options represent a high degree of risk for buyers because of the small number of vendors producing those products. Gartner sees Research In Motion's BlackBerry OS in limited deployment using standard smartphone hardware in field service, CRM and hospitality for non ruggedized devices."⁸

Ease of Use

Like their operating systems, ruggedized mobile devices are designed for business use. Smart phones and PDAs were developed primarily for communications and contact management. They are not optimized for entering data (via keypad, touchscreen, bar code scanning, imaging or other peripherals), navigating enterprise applications, or interfacing to back-end systems.

⁵ "Complex Service Work: Scheduling Technicians, Crews and Physical Resources," Aberdeen Group, May 2008.

⁶ Ibid.

⁷ All data on TCO for specific environments is from "Total Cost of Ownership (TCO) Models for Mobile Computing and Communications Platforms," VDC Research, July, 2007.

⁸ "MarketScope for the 'Ruggedized' Handheld-Computer Market," Gartner, Inc., December 2008.

In many cases, functionality that is built into ruggedized devices must be added to consumer-grade PDAs through peripherals, which introduces another potential failure point. Separate bar code scanners and other peripherals are more prone to damage than integrated models, and also burden the user with another device to carry and maintain. Failure rates for peripherals are higher than those of ruggedized mobile computers, so adding peripherals increases the risk of downtime.

Power Management

Integrated peripherals also make more efficient use of battery power, which is a critical success factor in any mobile computing application. Wireless communications, bar code scanning and portable printing all place an additional burden on batteries. Mobile devices designed for these activities have power management advantages that can help ensure batteries will last the length of the shift, even when peripherals are heavily used.

Recharge time is an important consideration. High-volume operations may not provide the opportunity to recharge batteries during the day, except perhaps during a lunch break. In this situation, a battery that can be fully recharged quickly would be highly advantageous. An investment in this feature would add to the purchase price, but would quickly be recovered by preventing productivity losses from dead batteries. For remote mobile workers without access to recharging capabilities, dead batteries could represent a lost day of work. Issuing spare batteries could prevent the problem, but at a high cost.

Device Management & Control

Because they are designed for large deployments (rather than for sale to individual consumers) ruggedized mobile computer often have built-in support for enterprise management and security systems. Features that streamline provisioning and deployment, enable remote, no-touch troubleshooting and configuration changes, and otherwise allow proactive management are extremely valuable because they save administrative support time and improve device uptime -- which are the two leading contributors to TCO. In VDC's words:

"A powerful resource to control the costs associated with device failure and solution upgrades, MDM [mobile device management] software lowers incidence of repair, 'no trouble found' tickets and the need for spare devices. Investments in MDM have successfully improved the networking ability for line of business applications and customer relationship management. Ultimately, MDM decreases workforce downtime and variable costs across an enterprise's entire mobile fleet."⁹

Remote management is especially important for mobile devices deployed for field service, delivery and other off-premise operations because workers do not have ready access to spare equipment. Productivity losses can be very high if devices or applications lock up in those environments. Therefore, there is strong value for the ability of IT support staff to remotely troubleshoot devices, so they can be returned to service without having to be returned to a central service location. Some mobile management systems even predict when batteries will fail, so replacements can be installed proactively. Mobile management systems can also lock down devices to prevent unauthorized data transfer and prevent non-business Web browsing, phone calls and e-mailing.

What Makes Rugged Computers Rugged

Consumer grade PDAs and smart phones are designed for "curb appeal," to attract buyers with their sleek look, while ruggedized versions are designed to keep working even if they're dropped. Ruggedized devices are designed for durability, and as such, their average annual failure rates are three and a half times lower than non-ruggedized models (11 percent compared to 38 percent).

Ruggedness and reliability result from many factors, including the computer housing, added protection, screen material, keypad type, I/O ports and more. These features protect computers from the damage and conditions common to industrial work environments. There are various independent ratings and certifications that are used to designate ruggedness and resistance to environmental factors (e.g., moisture and dust).

Internationally recognized ratings and certifications are very helpful for evaluating and comparing mobile devices because they result from standardized testing that is repeatable. Manufacturers' specifications and claims carry less credibility, because they can result from proprietary testing methods that favor the manufacturer's own devices and do not allow objective, side-by-side comparisons to others. For example, a manufacturer may say its mobile computer is "rugged" or "drop resistant," but there is no objective, widely accepted definition of what these terms mean. On the other hand, if for example a device is MIL-STD 810G compliant, it has been tested and certified to conform with the U.S. Department of Defense Military Standard (MIL-STD) 810G, which requires that devices remain operable when landing on any face, edge or corner to a "non-yielding" surface such as steel or concrete.

MIL standards (MIL-STD) and Ingress Protection (IP) ratings are among the most important and widely used measures of mobile computer ruggedness. IP ratings are defined by International Electrotechnical Commission (IEC) standards to provide a measure of how well devices are sealed against dirt and moisture. Ratings are typically expressed by the letters "IP" followed by two numbers. The first number indicates the level the device is protected against particles, and the second digit is the protection against water. For example a mobile computer rated IP54 has level five particle protection, which means dust deposits may form on the unit but will not effect performance, and level four water protection, which means the device can function when splashed or exposed to low-pressure spray. The higher the number, the greater the protection. An IP 64 device is considered dust tight and can be exposed to splashing water.

9 "Mobile Computing TCO Models: Secure a Strategic Competitive Advantage During the Recession," VDC Research Group, May 2009.

There are multiple MIL-STDs that deal with various areas of performance. In 2008 the U.S. DoD updated MIL-STD-810F, which had been in place since 2000, with MIL-STD-810G, which has more challenging vibration testing. MIL-STD-810G devices are rated to withstand multiple drops to concrete when landing on any face, side or corner.

Ratings aren't the only thing that make a device rugged -- design, materials and features do too. One of the reasons ruggedized computers cost more is because they have more durable, longer-lasting components. For example, ruggedized computers may be housed in a metal frame to provide strong protection, while the housing for consumer-grade devices may be motivated more by cost. Other important features that impact ruggedness include keypads, screens, I/O ports, peripheral support and temperature resistance. Some of the most important considerations are highlighted below.

Keypads can be fully sealed so dirt, dust and liquids can't penetrate the gaps between keys and cause damage to the computer. For added durability, legends can be etched (rather than printed) so keys remain legible after millions of uses. Rugged computer makers often offer customers a choice of keypad configuration, which can enhance ease of use.

Screen damage is a leading source of repairs to mobile devices, so models with scratch-resistant screens are advantageous. Specialty screens can also remain readable in bright sunlight, and those sealed against moisture don't fog over when workers move among different temperatures (for example when unloading a refrigerated foods truck at a sunny dock door on a warm day).

How the computer interacts with peripheral services also has an impact on reliability and TCO. Integrated features or services are more rugged and reliable than separate peripheral components. For example, a scan engine integrated with the handheld computer takes advantage of the computer's ruggedized housing, drop protection and warranty coverage, while replacing the need for a separate, handheld scanner. Similarly, integrated radios, are less prone to damage than those that stick out of card slots.

Conclusion

Many factors determine the TCO of mobile computers, but none are more important than longevity and reliability. The length of time devices can be kept in service, and the uptime they provide during their life cycle, determines the value and ROI they provide. Independent data shows that longevity goes up with each level of ruggedness, and TCO goes down. Ruggedized devices cost more, but the additional spend is worthwhile because it extends and protects the mobile computing investment for months and years beyond the time when non-ruggedized devices would need to be replaced.

The value of ruggedness is clear, but whether or not a device is rugged and suited for a particular work environment can be harder to determine. Third-party ratings and certifications provided much-needed clarity and objectivity about ruggedness claims. To select the devices that are most appropriate for their workers and will provide superior TCO, organizations must evaluate their work environment and then specify the relevant ratings and features they need. Deploying devices to environments for which they are not suited, or changing business processes to accommodate device limitations, will ultimately limit the benefits mobile automation will provide.

Intermec offers a complete range of mobile computers to meet enterprise needs. We have been developing ruggedized mobile computers and data collection equipment for more than 40 years and have successfully integrated hundreds of thousands of devices into demanding industrial, warehouse, field service, delivery, logistics, retail and other environments. Intermec mobile computers are rugged enough for years of service in challenging environments and are flexible enough to support new peripherals, software applications and business processes as they are developed.

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