

A large iceberg floats in the middle of a calm, blue ocean under a clear sky. The iceberg is mostly submerged, with only a small, jagged peak visible above the water. The water is a deep blue, and the sky is a lighter blue with some wispy clouds.

THE FOLLOWING IS A WHITE PAPER ON:

**MAPPING TECHNICAL AND
OPERATIONAL CHALLENGES OF
MOBILE COMPUTING DEPLOYMENTS**

***USING TCO ANALYSIS TO IDENTIFY THE IDEAL MOBILE
COMPUTING SOLUTION FOR FRONTLINE WORKERS***

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Today's enterprises are continuing their transformation to highly fluid and distributed organizations where key decisions are being made at the point of interaction. Ultimately, the ability to improve employee decision-making speed and scalability at the edge of an organization is what is setting apart best-in-class operations. As a result, organizations are looking to mobile computing and wireless communications solutions to enable these real time remote transactions.

However, organizations are also frequently making these investment decisions with incomplete information or a general misunderstanding of the environments within which mobile technologies are being used. Coupled with the impact of today's tough economic climate and pressure to cut costs, this frequently translates into mobile workers being equipped with devices that do not map to their real-world requirements. The consequences can be severe, including higher ownership costs and, potentially, customer service lapses and even lost revenue. To avoid these missteps, VDC Research is proposing a fresh approach to how organizations evaluate mobile computing solutions for their mobile workers.

VDC Research believes that a model that focuses on the most powerful technical and operational cost drivers will provide customers with an accurate baseline from which they can make mobile and wireless investment decisions. A critical aspect of any successful TCO analysis needs to include the business elements of TCO. These include anticipated length of deployment and planned replacement cycles, failure rates and causes of failure, the opportunity cost of lost productivity—to name a few. Of equal importance to TCO is an analysis of the end user's needs based on their work flow and work environment. This will impact decisions on the appropriateness of a mobile platform in terms of form factor, functionality, connectivity and durability. Only through this kind of analysis can organizations determine which solutions will best serve the company.

I. IMPROVING MOBILE INVESTMENT DECISIONS THROUGH TCO ANALYSIS

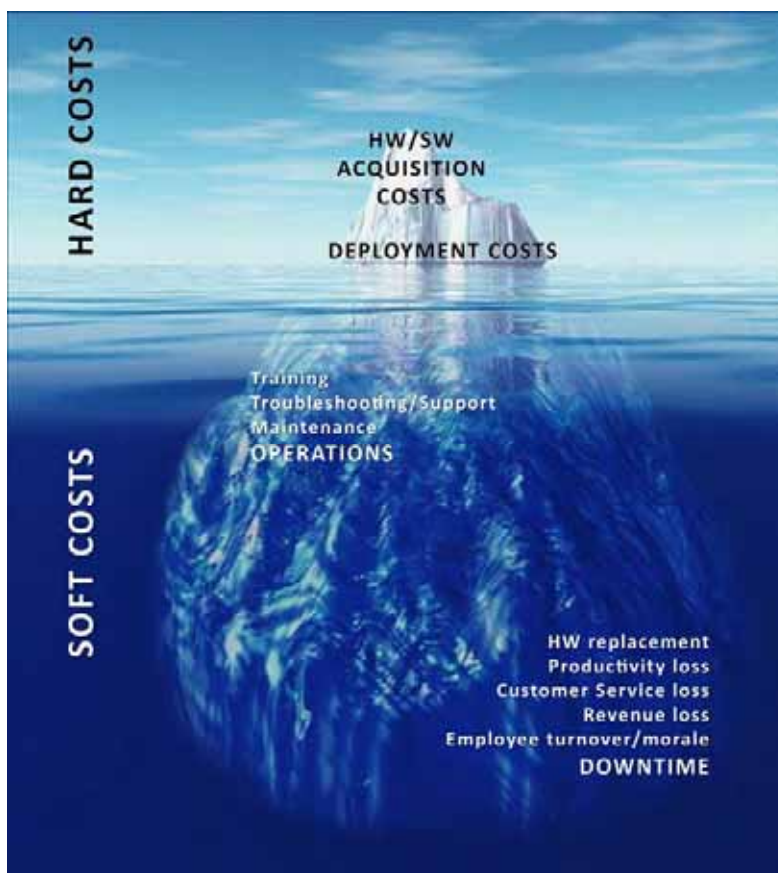
For nearly a decade, suppliers and users of both rugged and commercial grade mobile computing solutions have been debating the merits and limitations of both classes of solutions. TCO has often been upheld as the definitive metric by which the cost-effectiveness of any mobile computing solution can be measured. During that decade, however, definitions of every single dimension of the mobile computing market have changed.

So, too, have the definitions of TCO. With all these moving parts, it is nearly impossible for users to be confident in the accuracy of their TCO modeling during their evaluation or deployment. In this challenging business climate, now is no time to make the wrong investment decision based on flawed TCO modeling. It is critical that users find and use a simple, reliable TCO model.

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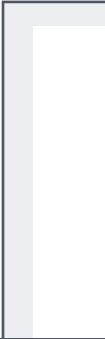
To determine "true" TCO, it is imperative to consult both hard (direct) and soft (indirect) costs. Hard costs consist of hardware and software costs, including depreciation charged for capital expenditures, as well as salaries and benefits. Soft costs are more difficult to determine and include expenses associated with operating and maintaining any mobile solution. Downtime costs, including any productivity loss and lost revenue streams, factor in here. VDC's research shows that over 70% of the cost of owning a mobility solution can come after the initial purchase. This underscores the significance of taking a long term view during the initial selection process.

Figure A
Total Cost of Ownership



Understanding soft costs and being able to marry the best possible mobile computer with the target user and application is ultimately what will set apart mobility innovators and enable companies to fully leverage mobility investments as a true competitive advantage.

Understanding soft costs and being able to marry the best possible mobile computer with the target user and application is ultimately what will set apart mobility innovators and enable companies to fully leverage mobility investments as a true competitive advantage. However, organizations looking to cut expenditures will frequently opt for lower cost mobile computing hardware. In many cases this means the use of a non-rugged mobile computer for applications that are better served by rugged devices. The subsequent high frequency of hardware failures in many of these deployments, many supporting mission-critical applications, significantly impacts operational effectiveness. According to VDC's most recent research, annual mobile computer failure rates exceeding 30% are not uncommon.



VDC's TCO analysis of mobile computing deployments demonstrates that there is a correlation between increasing ruggedness and decreased cost over the life of the deployment where there are hazards within the deployment environment that can cause failure.

VDC's TCO analysis of mobile computing deployments demonstrates that there is a correlation between increasing ruggedness and decreased cost over the life of the deployment where there are hazards within the deployment environment that can cause failure. In order to make appropriate investment decisions, organizations should map device specifications to the potential hazards in the deployment environment. Conditions as diverse as in-vehicle vibration and exposure to extreme temperatures and/or humidity, to the drops and spills experience by frequent travelers, all influence the performance of mobile investments in the field.

One frequently overlooked yet essential step in the mobile computing solution evaluation process is segmenting target users by usage environment and job requirements and prescribing the best possible mobile computing solution to fit their needs. It is imperative to balance the user, application, deployment environment and—perhaps most importantly—the mission criticality of the applications.

II. THE EVOLUTION OF RUGGED MOBILE COMPUTING

Use of mobile computing continues to extend beyond basic e-mail and PIMS application to more integral business applications that can significantly heighten operational efficiencies. VDC estimates the total number of mobile workers to have reached 80 million in the United States in 2008.

This increasingly mobile workforce heightens the need for effective and appropriate mobile computing and communications solutions. Consider, for instance, mobile solutions that, through real time connectivity, allow Direct Store Delivery operations to redirect trucks to fulfill same-day orders. Sealed mobile solutions that can be disinfected for use in a laboratory permit researchers to directly enter data into the computer system, eliminating the paper-to-computer data chain. Mobile CRM platforms let field sales agents access vastly more information than they were ever able to carry on paper into their clients.

Mobile computing extends the enterprise, allowing end users to achieve new levels of efficiency and accuracy in their work. Because mobile solutions have become deeply etched into the operations of the mobile workforce, a failed device has a direct effect on worker productivity, customer service, and, ultimately, revenue. This increasing importance of mobility has impacted investment philosophies, driving a new model of how we think about computers, environments, and operators.

A significant development to meet the emerging needs of today's mobile workers has been the evolution of rugged mobile computing and emergence of various classes of ruggedness or durability depending on a user's needs. Once associated with high adoption costs, significant bulk and weight and lagging several generations behind in terms of computing performance, these solutions have evolved considerably.

Advancements in the technology around ruggedness have led to the creation of smaller, lighter devices. In addition, today's offerings incorporate most of the current standards-based components and frequently lead with the integration of next generation functionality such as wireless communications. Finally, recognizing the limitations of two defined categories of commercial-grade and rugged, vendors have expanded the levels of ruggedness to map better to various workforce requirements. Categories now include:

- **Commercial-grade:** The most common type of enterprise notebook, commercial-grade, indicates no official rugged specifications. Commercial-grade notebooks provide levels of consistency and support that consumer grade devices do not strive to match. The production of these units is usually outsourced to an OEM to keep costs low.
- **Business Rugged:** These notebooks generally feature no official specifications (although some do map to existing standards for rugged notebooks), but in recognition of the increasing importance of durability, vendors have created solutions with specialized/metal casing, shock-mounted hard drives, spill-proof keyboards, other reinforcements to protect against drops and spills and integrated mobile broadband radios. The result is a blended platform that features a premium price point that can survive semi-hazardous, non-carpeted environments.
- **Semi-Rugged:** The traditional semi-rugged notebook is not designed for use in severe conditions but features some of the reinforcements of ruggedness such as metal casing, spill resistance and sealed ports, daylight viewing technology, and shock absorption reinforcement such as rubberized bumpers and internal dampers.
- **Fully Rugged:** Created for the most hazardous environments, these notebooks feature a specification of IP-54 or greater, comply with relevant MIL-STD-810F environmental tests and are constructed with the most sophisticated technologies for antenna pass-throughs, casing and reinforcements. These systems are often UL-1604 certified, allowing them to be used in hazardous environments such as oil and gas. A sub category of fully rugged is ultra-rugged computers (at least IP-64, fully sealed with MIL-STD-461E specification).

Highly mobile workers operating outside of the carpeted office space who support applications deemed mission critical to business operations should consider some level of a rugged device.

Frankly, a majority of office bound users are served best by the commercial-grade device. Yet, segments of the enterprise space could experience cost savings by adopting a higher degree of ruggedness. Highly mobile workers operating outside of the carpeted office space who support applications deemed mission critical to business operations should consider some level of a rugged device. A TCO analysis, conducted to properly account for the operational costs of mobile computing, can help quantify the cost benefits.

III. SEGMENTING MOBILE WORKERS

When it comes to determining the optimal mobile computer, many evaluators underestimate the risks associated with the deployment environment. This fault is most common among first time adopters of mobility who fail to consider device durability and deploy solutions without consideration of the soft costs. According to VDC Research, of respondents who deployed solutions to non-carpeted environments, 37.8% deployed commercial-grade solutions. Of this group, 61.7% did not evaluate semi-rugged or fully rugged solutions. However, and perhaps most interestingly, most users of rugged or durable/business rugged mobile solutions initially adopted commercial grade hardware. In other words, having experienced the pain of high rates of failure, they took a more proactive approach with subsequent deployments.

"The customers who go with a rugged solution are typically those who have deployed commercial-grade solutions in the past and experienced the soft costs of downed equipment, continuous upgrades, etc."

– Tier I Wireless Carrier

As the various levels of ruggedness and protection have evolved so are the users who frequently rely on mobile computing solutions to support their workflows. This large user base – over 80 million mobile workers in the United States alone – ranges from campus mobile workers (corridor warriors, to road warriors and mobile field workers. Mobile computers used by these professionals are, to varying degrees, exposed to a variety of environmental conditions. In addition, a non-deskbound workforce is simply more prone to mishaps. If equipped with the wrong device, the impact of failure and subsequent downtime can be significant.

Included among the core mobile user segments are:

- **Field-based harsh:** Field-based computing is perhaps the roughest on the device due to the need for the computer to be used both inside and outside the vehicle. Therefore along with all the specifications against vibration, temperature, humidity, and altitude, mobile devices for field based computing in harsh environments need to be built to withstand wet and particulate laden environments, including dust, sand, dirt, snow, ice, and rain. Finally, the solutions need to be built to withstand potential long falls to a variety of surfaces. Solutions deployed to these environments are typically classified as fully rugged solutions. Common adopters include the military, utilities, marine and trucking industries.
- **In-vehicle:** Devices are exposed to a variety of hazards within the vehicle including vibration, dust, humidity, temperature, thermal shock, and altitude. The areas where vehicles are driven is one of the largest factors determining the degree of ruggedness for the device. In the case of off-road driving, devices can experience shock equal to a drop to concrete. Mounts for solutions also need to be ruggedized depending on the environmental demands. Common adopters of in-vehicle computers include police, utility workers, and the military.

- **Field-based moderate:** The hazards of the field based moderate environment align with field based harsh. Devices need to be designed to resist vibration, temperature, humidity, and altitude, along with wet and particulate laden environments. Yet, the degree of protection does not need to be as robust as conditions are less harsh. Vehicles are typically driven on smooth paved roads. Mobile workers will often choose not to work outside during extremely harsh weather conditions. Granted the solutions are still highly mobile, requiring strong protections against normal wear and tear, drops, and liquid. Key industries that deploy solutions to field based moderate environments include field sales, field service, professional services, trucking, DSD, and mail/courier.
- **Road warrior:** Currently most road warriors use their devices primarily in carpeted office areas except for during transit. As a result, commercial-grade devices are the most commonly adopted platform. Integration of more durable components such as spill-proof keyboards and some form of hard drive protection received favorable reception from this community which is resulting in adoption of more business-rugged or durable mobile computing solutions.
- **Campus:** Organizations that work in areas of tiled floors or concrete often demand more active workloads (namely not desk work). Devices need to be protected against shock to concrete or tiled floors from arm level. Depending on the environment, specifications may need to be specialized to withstand exposure to industry specific hazards. For instance, healthcare facilities require solutions that can be disinfected to prevent the spread of germs. Warehousing operations often require solutions that can withstand cold temperatures for use in freezer environments. Industries covered in this category include healthcare, manufacturing, warehousing, and retail.
- **Healthcare:** In reaction to a lack of a “perfect” platform, hospitals have mainly adopted commercial-grade devices, stapling them to carts to prevent falls and enhance the ergonomics. Recently, increasing adoption of more sophisticated applications, such as e-prescribing and prescription verification, is demanding that computers be further integrated into the workflow. Subsequently, demand for truly mobile platforms is on the rise. To meet this new trend, vendors developed Mobile Clinical Assistants (MCAs) such as Panasonic’s Toughbook H1, which is a tablet featuring rugged construction, disinfectable casing, and a competitive price point. Currently, MCAs have received favorable reception from the medical community, especially for the ability to disinfect, and are starting to be used in full scale deployments at hospitals. Indicators point to the MCA category as a successful new form factor due to the creation of platforms consisting of the distinct set of ruggedness and ergonomic features demanded by the healthcare environment.

“The ability to disinfect is huge. We have done-in our keyboards trying to apply just a little disinfectant to stop the spread of viruses”

– IT evaluator for a homecare service provider organization

Figure B
Mapping Users, Environments, and Mobile Requirements

← Fully Rugged Semi-Rugged Business Rugged Commercial Grade →						
Field-Harsh	Vehicle-Based	Field-Moderate	Road Warrior	Campus-Non Carpeted	Office, Deskbound	Environments
Military Industrial Field Service DHS/FEMA Mining	Public Safety Trucking Utilities Telco	Field Service Insurance Healthcare	Field Sales Mobile Professional Home Healthcare Professional	Healthcare Education Campus Mobile	Enterprise OEM	Users
Drop (>3') Water Protection Temp./Humidity Vibration Sun Viewing	Vibration Dust Drop (>3') Temp./Humidity Sun Viewing	Drop (1-3') Temp./Humidity Spill Sun viewing Int. WWAN Specialty (Disinfect)	Drop (1-2.5') Temp./Humidity Spill Int. WWAN	Drop (1-3') Water Specialty	NA	Requirements

Figure B summarizes each environment in terms of their core users and application environments and the level of protection required in their mobile computers. Although VDC is not explicitly recommending rugged or business rugged/durable solutions for the vast majority of today's mobile computing users, the high failure rates associated with many mobile computing deployments suggests that there is a large number of users equipped with an inappropriate solution. The consequences of these deployments are substantially higher ownership costs, poor customer service performance and lost revenue.

IV. THE IMPACT OF TCO: BEHIND THE NUMBERS

TCO is not a standard measurement implemented in mobile deployment evaluations. According to VDC end user data, only 31.6% of respondents performed a TCO analysis during their most recent mobile computing deployment. Key reasons for the lack of TCO analysis is the expense, mistrust of outsider assessment, and lack of justification.

However, the core idea behind TCO – to measure direct and indirect costs of an investment over time to determine its viability – is a sound and useful business concept. Having a full view of the cost of a mobile computing deployment over its lifetime provides insight into the type of solution that needs to be deployed. In particular, TCO analysis can show the significance in cost of mobile device failure.

One of the most compelling aspects of this solution is the availability of a Web-based reporting tool and supporting analytic engine that makes information regarding what's happening on the retail floor available to other locations, including participating trading partners, providing a platform for item-level intelligence:

VDC defines TCO to include the following components:

- **Hard costs (Deployment costs):** hardware, accessories, software, implementation, and training costs
- **Soft costs (Operational costs):** productivity loss, opportunity loss, and IT support, costs of repairs and replacement parts

One of the most striking misunderstandings in TCO is how little hard costs actually matter in the total cost of the deployment, yet price remains the leading product selection criteria among end users.

Easily quantified through supplier estimates, a majority of TCO analyses overly rely on hard costs. In fact, hard costs for a commercial-grade notebook only account for 18% of the deployment's TCO over a five year period. One of the most striking misunderstandings in TCO is how little hard costs actually matter in the total cost of the deployment, yet price remains the leading product selection criteria among end users.

Exhibit I-1 TCO Comparison Over Five Years				
	Fully Rugged Notebook	Rugged Notebook	Business-Rugged Notebook	Consumer Grade Notebook
Hard/Deployment Costs	34.0%	29.2%	20.8%	18.2%
Soft/Operational Costs	66.0%	70.8%	79.2%	81.8%

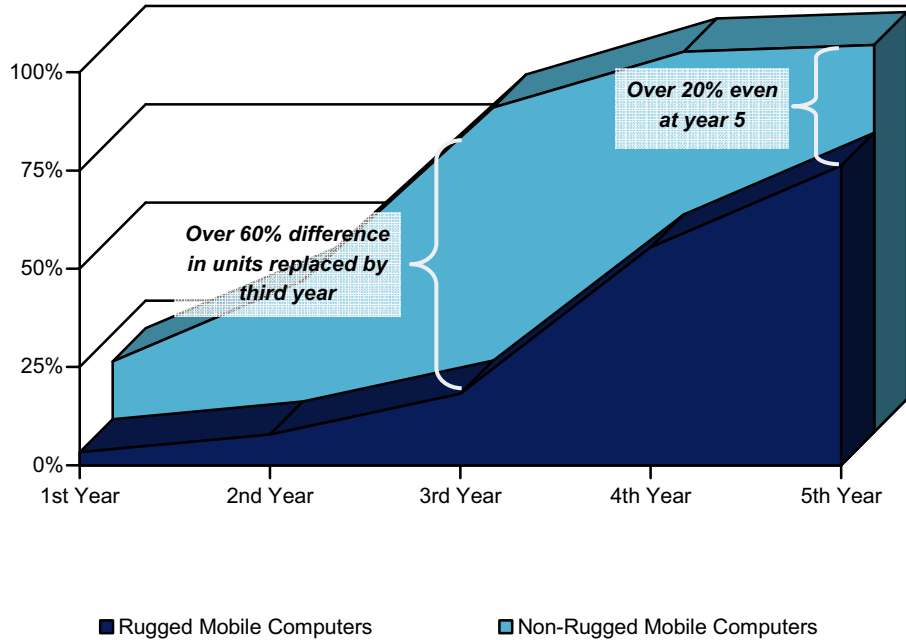
Soft costs make up the bulk of TCO and the greatest expenses in soft costs relate to lost productivity, IT expenses, and opportunity cost when a device fails. Annual device failures for non-rugged hardware can exceed 30%. This is a staggering figure considering that each percentage point of failure results in an increase of almost 5% in the mobile computing indirect or soft costs.

"Evaluators struggle to wrap their head around the soft costs of mobile solutions"

- GM, Mobile Computing System Integrator

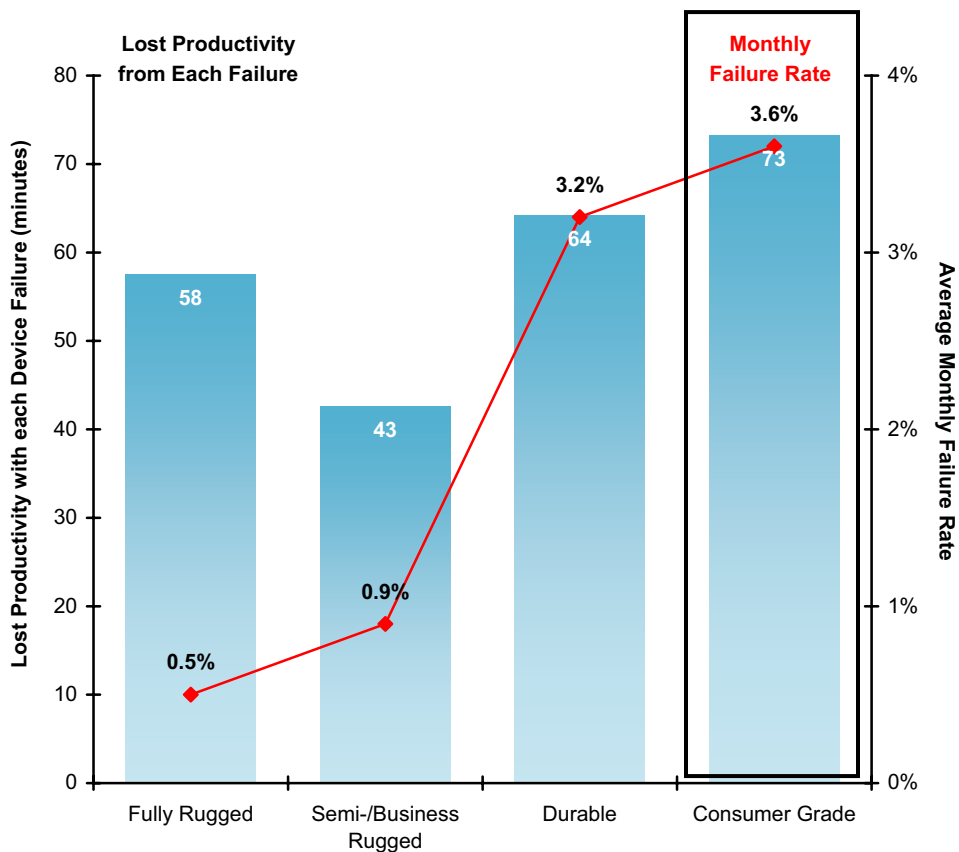
According to VDC end-user research, the leading causes of device failure are dropping the device and water liquid exposure, two relatively common experiences. Furthermore, failure rates of non-rugged mobile computers in many of the previously described user environments exceeded 20%.

Figure C
Cumulative Mobile Replacement Cycles by Platform



Rugged mobile computers are replaced far less often than commercial-grade devices. While it is expected that commercial-grade solutions have a shorter life span than rugged mobile computers, a higher amount of commercial-grade failures leads to early replacement, rather than repair. These costs start to replicate in various ways that continue to increase the TCO for commercial units.

Figure D
Notebook Failures and Lost Productivity:
Field Mobility Solutions



Rate of failures and impact on productivity from each failure are significantly higher for consumer grade offerings.

Indirect and direct cost of failure and replacement include:

- Higher turnover of commercial-grade notebook models. Within a typical year, this results in organizations managing a mixed deployment, adding costs related to maintaining multiple versions of hardware.
- Replacements that result in mixed deployments create need for the worker to learn the configuration of new hardware. Also it requires time and often frustration for IT staff to support two or three versions of hardware in troubleshooting and purchasing software solutions that work across units.
- Devices bought at subsidized prices at the initial deployment (typically a commercial-grade business model) are no long subsidized for replacement, greatly increasing the purchase price.
- In the event of a device failure, the worker is forced out of commission from their normal operations. Workers then waste time troubleshooting and bringing the device back to the IT department.

- There is also the unknown of what the worker could have achieved if they were fully productive. These opportunity costs vary depending on industry.
- Beyond costs to fix problems, IT departments burdened with fixing devices spend less time managing and improving the IT infrastructure.
- Soft losses include less implementation of preventative IT actions and less time to find better solutions that could improve worker efficiency.
- Wireless communication failure causes the worker to spend time reconnecting their solution, reloading programs, and reentering data. Session persistence is necessary for efficient work.
- Wireless communication failure also causes a break in the stream of information for backend dispatch systems. Because many make adjustments based on real time information, this defeats many of the efficiencies these solutions were designed to achieve.

In current recessionary times, VDC recognizes that organizations are looking to streamline investments to gain the most bang for the buck. However, ruggedness should not be viewed as a 'luxury-item' that can be forsaken. By preventing the burgeoning costs of failure, rugged solutions more than make up for their price tag within a five year period.

By preventing the burgeoning costs of failure, rugged solutions more than make up for their price tag within a five year period.

Exhibit I-2
Annual TCO Comparison for Notebook Computers:
Field Mobility Solutions

	ANNUALIZED COSTS		
	FULLY RUGGED	SEMI-RUGGED	DURABLE
	NOTEBOOK	NOTEBOOK	NOTEBOOK
Hard Costs - Deployment Costs	\$1,207.7	\$978.3	\$851.2
Soft Costs - Operational Costs	\$1,738.3	\$2,264.2	\$3,717.4
Total Cost of Ownership	\$2,946.0	\$3,242.5	\$4,568.5

* Assuming a 4 year replacement for fully and semi-rugged notebooks and a 2.5 year replacement for durable and consumer-grade notebooks

V. PERFORMING AN ACCURATE TCO ANALYSIS

A TCO model that takes into account the soft costs (i.e. productivity, IT expenses, and opportunity loss of failed mobile computers) will provide organizations with a more accurate baseline from which they can make mobile and wireless investment decisions. While this trend is not new, the recession is adding a new level of significance to optimizing every penny.

While slimmer IT budgets will tempt evaluators to pick solutions with the lower price tag, often organizations will end up spending significantly more on downgraded solutions over time. Organizations looking to deploy mobile computers outside the office space with operational-critical or even high value, applications will want to consider a higher grade of ruggedness through the lens of a TCO analysis.

Such a TCO analysis must quantify the differences between rugged and commercial-grade solutions. They must also take into account the increasing cost of lost productivity and IT support due to further integration of mobile computing into core operations and company image. Through such a metric, organizations can determine the solution which will best serve the company and cost the least over the life of the deployment.

ABOUT VDC RESEARCH GROUP

VDC Research Group (VDC) is a technology market research and strategy consulting firm that advises clients in a number of technology markets including: Automatic Identification and Data Collection, Embedded Hardware and Systems, Embedded Software and Tools, Industrial Automation and Control, Mobile and Wireless, and Power Conversion and Control. Using rigorous primary research and analysis techniques, the firm helps its clients identify, plan for, and capitalize on current and emerging market opportunities. We strive to deliver exceptional value to our clients by leveraging the considerable technical, operational, educational and professional experience of our research and consulting staff. During our nearly four decades of ongoing operation, we have had the pleasure of serving most of the world's leading technology companies, many high-profile start-ups, and numerous blue-chip early and later stage investors. Our products and services consist of research reports, annual research programs, and custom research and consulting services. Founded in 1971, the firm is located in the Boston area. Please visit our Web site at www.vdcresearch.com to learn more.

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