I-Tel Dialer
Fault Tolerance

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Introduction and Background

The I-Tel Dialer product was installed at several customer sites throughout late 2003 and early 2004. The product satisfies a long-standing demand from the Quantrax installed customer base for an integrated dialer solution. Customer response has been overwhelmingly positive.

One of the key issues the Quantrax I-Tel team has learned a great deal about is what can occur when the dialer fails. A failure could be hardware or software related. Since the dialer is built on an Intel-based PC platform, it is a very complex machine with many components.

Initial dialer sales featured a very affordable PC platform. During implementation and deployment of these early sales, we asked ourselves "What will happen if the dialer PC goes down?" This is not as easy a question to answer as it would seem on first glance. We had to carefully look at how we define "goes down". We had to also consider support contract terms and internal Quantrax policies.

When we looked at an outage on the I-Tel dialer, we had to ask our customers: "What is your tolerance for an outage?" The answer was immediate and resounding: "We can NOT tolerate an outage on the dialer! It is critical to our core collection business." There are several different modes in which a dialer could be used. These include predictive dialing and inbound call management and routing. Predictive dialing results in significant gains in the number of calls placed and contacts made. As a result even a few hours of down time result in costly losses of revenue or the ability to keep commitments. Any disruption to inbound call routing could also have a serious impact in the collection industry where a person if often compensated based on account ownership, individual effort and results. With this in mind, we undertook a review of the engineering of the dialer hardware. Based on the findings, our current dialer platform offers an exceptional of fault tolerance at the hardware level.

What is Fault Tolerance?

"Fault tolerance" in the context of computer technology means exactly what you would expect. If a vendor says a computer is "Fault Tolerant", you would expect it to ***tolerate faults***, especially those caused by local outages. This bears some explanation. Since a modern computer is a very complex machine, fault tolerance in relation to hardware has to be focused on the major components, since it is unlikely that every piece of the machine will fail at once. In the case that every component fails at the same time, we generally use the term "catastrophic failure". This would be the case if your business was destroyed by fire, flood or some other natural disaster.

What Happens in a Catastrophic Failure?

To protect your business against catastrophic failure, you will require insurance. Depending on the operation, you may also have backup systems that can be quickly deployed to replace the damaged systems. (This area is commonly referred to as disaster recovery planning.) If your

offices are destroyed by fire, many more things than just the dialer will need your attention. You will need property insurance for the dialer and possibly business interruption insurance so you can be reimbursed for the loss of the dialer PC and for the possible loss of revenue.

Is It a Fault?

When we speak about the dialer PC, a ***fault*** is the failure of a component within the PC. This could be something as simple as a light on the front panel. It could be a cooling fan. It could be a more serious item such as a failing disk drive. Let us look at these situations.

Front Panel Light Goes Out

What is wrong with a light going out? Probably not much. Will the PC stop operating? No. Will the dialer stop making calls? No. Is this a ***fault***? No. Eventually we would obviously like to get the light repaired, but nothing has to stop or be changed for collection operations to continue.

Cooling Fan Stops

What is wrong with a fan stopping? Not much… at least right away. Will the PC stop operating? No. Will the dialer stop making calls? No. Is this a ***fault***? Yes. Eventually, the lack of a fan will result in the processor or a disk drive overheating and the PC will fail. This is more of a problem because we have less time to make the repair than we do when the front panel light goes out.

Disk Drive Crashes

What is wrong with a disk drive crash? This is pretty serious. Will the PC stop operating? Yes. Will the dialer stop making calls? Yes. Is this a ***fault****? Definitely*. We need to stop, make immediate repairs, reload system software, and recover any missing data before we can resume normal operations.

Classifying Faults

We have taken a look at three simplified scenarios. One was definitely not a fault. One resulted in a fault waiting to happen and the third was definitely a fault. How do we deal with these three situations?

Front Panel Light Goes Out: Not A Fault

In the case of the front panel light, probably nothing. You might not even notice if one of the lights on the front panel stopped blinking. If you did notice, you would probably call Quantrax and ask for some problem determination and diagnosis. We would probably recommend a service call, and depending on your service plan, help you schedule a visit from an authorized service technician. At an appropriate time, you would schedule an outage for the dialer and have the service technician visit at that time.

Cooling Fan Stops: Results In A Fault Waiting to Happen

When the cooling fan stops, we can anticipate that a failure will eventually occur. This is more urgent and once the problem has been diagnosed, you will need to schedule an outage at the earliest possible time to make sure the fan was repaired.

Disk Drive Crashes: Critical Fault

When a disk drive crashes, the PC stops working. The operating system stops working immediately and halts. Collectors can not work on the dialer until the disk drive is replaced, the operating system is re-installed, and data is recovered. Clearly this is a different category of problem than the other two examples.

Fault Tolerance 101: Redundancy

One key goal in the concept of fault tolerance is to avoid an extended outage and provide more time to continue operating your business. You want to make it to a day of the week or a time of the day when taking an outage does not impact your core operations. The impact of an outage varies depending on the type of business we would consider. In the collection business, lost time can not be recovered. You have limited hours in a day when it is possible and best to call a debtor. An outage during such a time will therefore have a direct impact on revenue. The loss can not be made up unlike in an application such as a manufacturing operation, where one could work a few extra hours at the end of the day and catch on lost time. Earlier in the discussion, we could see that a front panel light going out is not rally a fault. When the light goes out, there goes nothing different that you have to do or that the PC has to do to give you the time you need to get to a reasonable time for an outage.

What about the cooling fan? We decided that if it stops that eventually you would have a serious problem. What if there are ***two*** fans in the PC? The chances are *far lower* that *both* fans could stop simultaneously compared to the chances that one fan could stop. What if we put two fans in the dialer PC? Well, we do… in fact, we put *nine* in some of our dialer PCs. Clearly some are redundant. That is OK, though. The extra ones provide assurance that your PC will be able to continue operating normally until you are able to schedule an outage.

Redundancy is a key concept in fault tolerant computing systems like the I-Tel dialer. If you do not have redundancy of the key components inside the PC, you are at a substantial risk of an unscheduled outage. If that outage occurs at the wrong time, your business could be losing money because your collectors are not making a sufficient number of calls at the right time of the day.

Redundancy in the I-Tel Dialer

The I-Tel dialer has been engineered with redundancy for each of the major components. There are redundant cooling fans, redundant power supplies, redundant Ethernet ports…. even redundant mouse ports! We have analyzed every component and subsystem inside the dialer PC and we have engineered redundancy into every component that is important and where a fault could result in an unscheduled outage.

Advanced Fault Tolerance: RAID

What about the disk drive? We decided that if the disk drive crashes, it is a serious problem. On the down-side, making disk systems fault-tolerant is a real challenge. On the up-side, there is technology today that helps your system keep running in the case a disk crashes. This technology is called Redundant Arrays of Inexpensive Disks, or RAID. RAID technology has several variations. The primary variations in sue in modern computing system today RAID1 and RAID5. In RAID1, two disks are installed. Everything written to the first disk is written simultaneously to the second disk. This technique is also called *mirroring*. At first glance, this is a good thing. When the first disk crashes in a RAID1 implementation, though, the system still halts until you can remove the failed rive and move the mirrored drive into its place. There is still an unscheduled outage. Subsequently, when a new or repaired drive is available, there is another outage to install the mirror and make sure it is re-synchronized with the primary drive. That means more down time. Easier to schedule, but it is still down time. How much down time can you expect if you have a disk crash with a mirrored system? It could be as much as four hours. One may ask if mirroring is not a suitable option, because you can schedule the maintenance for a time when the system was not in use. The problem is that when one disk fails, you may be operating on a single disk. In this case, you should not delay the replacement of the failing disk. Based on the availability of a technician, this may mean that the outage should be taken during normal working hours! This could be a significant loss of productive time.

Another option is RAID5 technology. In RAID5, there is a minimum of three disks installed. In addition RAID5 does not write a mirror image of the data in the primary drive to the other two. In RAID5, data is written to the second and third drive such that, if the primary drive fails, the second and third disk drive can recover the data without stopping the system. RAID5 also results in DISK1 being a backup for DISK2 and DISK3. DISK 2 is a backup for DISK1 and DISK3. DISK3 is a back for DISK1 and DISK2. This means that two disk drives have to fail simultaneously for a "fault" to occur and stop operations. That is pretty unlikely. If you are monitoring your dialer PC and watching it, you will see an error message if a disk drive crashes. What do you have to do? Simply remove the failed drive, repair or replace it, and carry on *without stopping*. You can also have hot-swappable drives. These can be removed by anyone

without the risk of any damage to other components. Other solutions usually call for the services of a trained technician.

As with all solutions there are advantages and disadvantages. With I-Tel we will use RAID1 or RAID5. One of the better descriptions of RAID technology we have seen can be found at the following link - http://www.acnc.com/04_00.html

Beyond Fault Tolerance: Disaster Planning

Early on in this document, we looked at the possibility that your building could be flooded or that some other disaster could occur. This would, of course, result in a catastrophic failure of the dialer. What can you do to plan for that? There are a number of options. The first one to consider is a "hot spare". If you have conducted serious disaster recovery planning, you have looked at what it would take to get your business back up and running in the shortest possible time.

Quantrax will gladly consult with you on the benefits of configuring a second dialer to keep off-site as a "hot spare". It would likely be configured identically to the original dialer and would be available at (or near) your company's hot site if a disaster were to take place.

Summary

It should be clear by now, that Quantrax's key goals for engineering the dialer are:

- Keeping your business running continuously until you can schedule an outage
- Using redundant components inside the dialer PC to make sure that small problem do not cause big business interruptions
- Using advanced disk engineering to make sure that even the biggest problems do not cause interruptions

Quantrax has put a lot of thought into your business so you will not have to do so yourself. Once you consider a dialer system… any dialer system…you will realize that it will become a critical company resource. You need to have candid discussions with your vendor about what to do when a component inside the PC fails. We will be glad to discuss the advanced hardware and software features of the I-Tel dialer. We are proud to bring you the very best product we can and we will make sure you are comfortable with how it works… even when it doesn't.