# QNX® for Automated X-Ray Inspection

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All Novus X-Ray system are completely self contained in terms of internal processing.  The primary image processing computer is an x86 Intel based computer, with all non-volatile information including the OS stored on flash (no hard disk).  The operating system is called QNX.

QNX has been found to be the most reliable operating system available for high speed, time-critical applications like X-ray inspection.  Because of the extreme volume of computationally intensive processing that must be done on each image before the next product is scanned, a deterministic  real-time operating system is needed in order to keep up with high product inspection rates.  Most new X-ray customers have never experienced a computer application that requires absolutely deterministic real-time behavior.  As a result they are unaware of the deficiencies of Windows operating systems in this regard.  Deterministic means that every time the computer performs the same steps using the same software modules, the execution takes the same amount of time and the results are available to other modules in the same order.  For common computer applications such as word processing, spreadsheets, or database applications, it does not matter whether every microscopic operation of the software is deterministic.  But for X-ray inspection, <u>determinism is absolutely necessary in order to guarantee that no product can pass through the inspection system without being inspected</u>.

Windows operating systems are not microscopically deterministic, cannot guarantee low latency on 100% of operations, and are thus not well suited for real-time applications.  Windows operating systems work on "average" latency, "average" timing, etc.  As a result, they will "usually" complete the inspection of each product before the next one arrives, but they cannot be guaranteed to <u>always</u> inspect <u>every</u> product that passes through the machine.  As a result, there is always a small but finite possibility that a product may pass through the machine uninspected.  Running faster computer hardware may reduce that possibility, but it can never be entirely eliminated because Windows operating systems are not deterministic: they cannot guarantee that the same operation takes the same amount of time, or even a specific maximum time on every

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iteration.  This problem with Windows systems can be observed as occasional pauses in screen updates or other interactions when they are performing intensive tasks.

Since QNX was designed from the ground up to be a deterministic, low latency, real-time operating system, it is not only far superior to Windows in X-ray inspection applications, but we can accurately say that QNX systems can be relied upon to inspect every product presented, whereas Windows systems cannot be trusted to do so.  It has been our experience that X-ray machines using Windows operating systems will always fail to inspect some small percentage of product passed through them, because the Windows operating system occasionally becomes unavailable while it performs some internal task that takes an unspecified amount of time, and a product may pass through the machine while the operating system is busy doing something else.  QNX does not suffer from this deficiency.

Furthermore, QNX, as it stands today, is the result of 20 years of continual refinement to remove all software bugs.  This is possible because the basic code architecture of QNX has never been changed.  In contrast, Windows operating systems are entirely rewritten every few years with huge volumes of new code, containing huge numbers of new bugs that must be discovered by customers and submitted for correction.  That is why Windows is continually releasing new "updates", "patches", "bug fixes", etc.  In contrast, QNX is stable, bug free, and trustworthy.   Perhaps this reliability does not matter much in traditional office computing or Information Systems, but it is absolutely critical in X-ray inspection systems.  <u>If the operating system cannot be trusted to be bug-free, then the inspection system cannot be trusted to always inspect every product passed through it</u>.

Windows operating systems are also notorious for "memory leaks" and "resource leaks", meaning that the system resources allocated to a software module are not always released after that module is done using them, and then are not available to other modules that need them. As a result, less and less system resources are available over time, causing Windows operating systems to run slower and slower until the user turns off the power and re-boots the system.  It has become the standard recommendation in the computer industry that Windows operating systems should be re-booted every day to prevent this problem from degrading system performance excessively.  In contrast, QNX systems are completely free from "memory leaks" and "resource leaks", making it possible for QNX systems to run continuously for many months without losing any performance.

Another problem that can jeopardize the reliable operation of an X-ray inspection system is direct connection to a factory network.  Because repeatable timing is

so crucial to assure that every product passing through the system is inspected without fail, any outside tasks from a network connection can cause unreliable inspections.  These outside tasks may be data requests that come in at uncontrolled times, or they may be software modules that are loaded onto the X-ray system from the factory network and then executed, thus changing the timing of the software execution in unknown and uncontrolled ways.  This is a recipe for disaster in critical applications like high speed product inspection.  For this reason, Novus X-Ray X-ray inspection systems are never connected directly to a factory network.  Instead, Novus X-Ray systems can be equipped with Remote Portal, a dedicated communications interface computer that protects the X-ray system from interfering tasks coming from a the factory network.

Because of the critical nature of X-ray inspection system operation, the user/customer must never interact with the operating system of the X-ray computer.  Any modification or addition to the files, programs, settings, or other data on the X-ray computer could change the timing of the system and thus make it impossible to assure that every product passing through the machine is properly inspected.  In order to prevent tampering, the X-ray computer is designed without a hard disc drive, and is programmed in such a way that the user/customer cannot access the operating system in any way at any time.  Eliminating the hard disk drive also improves the long-term reliability of an inspection system, as hard disk drives are known to have a much lower MTBF than other electronic components.

As a result of this embedded architecture, any consideration of operating system "ease of use" is irrelevant to Novus X-Ray machines because the user/customer is never permitted any access to the critical X-ray computer operating system.  Instead, Novus X-Ray systems can be equipped with an Remote Portal interface computer, running a standard Windows operating system, to provide the user/customer with access to all user level X-ray machine data and functions without jeopardizing reliable product inspections.   The QNX operating system is protected and embedded in hardware/firmware and thus is not available to the user/customer for any purpose.  The Windows based Remote Portal communications interface computer is the only point of user/customer data access permitted on Novus X-Ray systems.  All system log and product inspection data is also made available to any factory network connected to the Remote Portal computer.

The only software "ease of use" metric that applies to Novus X-Ray systems pertains to the HMI, which is designed to be extremely easy to use and intuitive to learn.  A direct comparison of the man-machine interactions afforded by Novus X-ray HMI design to that of competitors will prove that Novus X-Ray excels in true ease of use.

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