The Business Value of XP Embedded's Embedded Enabling Features (EEFs)

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Having been involved in a few XPe projects and conversations over the past couple years, I find that many companies choose XPe simply because it is a cheaper alternative to the full XP Pro licensing. Cost is an obvious choice, especially when you consider that you can even build a full XP Pro equivalent image from XPe.

Embedded systems are dedicated, single-purpose computers that are not a traditional laptop, mainframe, server, or desktop computer. Smart phones and PDAs are beginning to fit in this definition of an embedded system since they are general purpose devices as well. Embedded devices come in all shapes and sizes. Different media such as hard drives, flash, CD-ROM, network, etc. are all used to store the software that will run on the device. Special I/O is integrated into the device to control every thing from robotic arms to coin operated slot machines. There are also issues of field maintenance and support that are needed to be addressed in more high-end machines.

XP Pro could address some of these devices, but XP Embedded was designed to address the embedded market directly. XPe does so in two distinct ways. First and the most obvious is the fact that XPe is a componentized version of XP Pro, which in itself allows the developer to customize the OS to their device. Second, and the key to what makes XPe embedded, is the Embedded Enabling Features (EEFs). EEFs are understandable from a technical point of view, but the value that they bring to an embedded system is an important part of the system business proposition.

One of the main topics I try to drill home in my XPe classes and books is the concept of architecting the system. How the system performs and operates when it leaves production needs to be designed in at the beginning of the project. Features of security, serviceability, support, ease of use, etc. all need to be design in from the beginning. EEFs can help in these different areas. Technical people understand the link between EEFs and the different details of the project, but EEFs also need to be understood by the decision makers so they can best judge the life cycle of the project. Unfortunately, EEFs are not as visible nor understood in the decision making process so here we are going to look at the EEFs and the value they bring to a device.

1.1 Enhanced Write Filter (EWF)

The Enhanced Write Filter (EWF) is the key cornerstone to XP Embedded. Very simply, EWF protects a partition from direct writes and send the writes to another media or "overlay" as it is called, which could be either RAM or a disk partition. In effect, the partition looks read-writable, but the original files are not touched or changed since the writes are sent else where. As a result, EWF allows XPe to boot from different media such as flash and even read-only media, such as CD-ROM. EWF can also protect an OS boot partition from damage or corruption. Without EWF, XPe could not be considered an embedded operating system. Here is brief look at what EWF provides and addresses:

Servicing – Upgrading systems in the field could be performed as simply as replacing a CD-ROM or compact flash drive. EWF can be enabled and disabled programmatically so updates can be performed on systems with read/writable storage media.

Security – With a RAM overlay all writes are lost on a reboot, thus EWF offers some protection from viruses or tampering to the protected partition, which addresses concerns that customers have with Internet connected machines.

Reliability – Some flash drives wear out quickly over time, thus the boot partition protected with EWF protects the life of the flash device and saves on maintenance cost.

Here are some of the industries where EWF is used:

Device / Industry	Details
Casino Slot Machines	Gaming laws restrict the media that slot machines can use. As a result CD-ROM is the most popular boot media.
Thin Clients	Flash drives are the dominate boot media for the thin client market. EWF is used to protect the life of the flash media
Consumer Electronics	Combined with HORM (see next section), XPe can boot within 30 seconds which is desirable for consumer electronic devices. Consumers don't want to wait for their set top boxes to boot.
Test Equipment	Same as consumer Electronic devices. The desire is to have the test equipment boot quickly.
Any system that is booting from flash	Protecting the life a flash device that doesn't have wear-leveling technology.
Any system that is booting from read-only media	Manages the writes that would go to the boot media during the boot and system operation.

1.2 Hibernate Once, Resume Many (HORM)

Hibernating an XP/XPe system means simply saving the state of the machine by copying all the contents of RAM to the drive. You have to provide enough free space on the drive to support the amount of RAM in the system for the hibernate process to be successful. When the hibernated system boots, all contents are copied back into RAM and the system is restored to the saved state at the time of hibernation within seconds. Restoring from hibernation is the fastest boot method available for XPe. Hibernation is very helpful with laptops, where battery life is concerned, but combined with XPe's EWF, the ability to hibernate the system allows you to develop devices that will boot to the same state over and over again within a very short period of time. The combination of EWF and hibernation is called Hibernate Once, Resume Many (HORM). Typically hibernation is reset when the system is restored so the system will not reboot through hibernation again. Part of configuring a HORM XPe image, is to write the saved hibernation files to the boot media. EWF blocks the changes made to the key hibernation files, thus when the system is power cycled, the OS always boots from hibernation to the same saved state.

Here are some of the industries where HORM is used:

Device / Industry	Details
Consumer Electronics	Combined with EWF, XPe can boot within 30 seconds which is desirable for consumer electronic devices. Consumers don't want to wait for their set top boxes to boot.
Test Equipment	Same as consumer Electronic devices. The desire is to have the test equipment boot quickly.
Systems that use Compact Flash as boot media	Speed is import, and CF is slow. HORM can be used if the CF card is large enough to hold the hibernation file.

1.3 Boot from Solid State Media: CD-ROM with El-Torito or Flash

You typically see XP boot from a hard drive, but embedded systems require a more robust boot media solution. Flash is the most popular media for XPe and Compact Flash (CF) in particular, because it is readily available. The drawback to CF cards is the limited erase cycles that eventually wear out the flash over time, but the life of the device can be extended with XPe's EWF protecting the boot partition of the flash. XPe can also boot from IDE Flash disks and USB flash disks with special drivers.

XPe can be made to boot from a CD-ROM with the help of the El-Torito driver and EWF. An El-Torito boot disk is incorruptible and easily upgradeable as we discussed earlier.

Here are some of the industries where Solid State Media is used:

Device / Industry	Details
Transportation	Flash is a desired media to withstand shock and vibration
Slot Machines	Different gaming regulation forces OEM's to build slot machines with no local storage and no way to modify the game. CD-ROM has been the media of choice for slot machines.

1.4 Headless/Message Box Intercept (MBI)

Some systems don't require a graphical user interface. XPe can run headless without a video card, keyboard or mouse, and there is the ability to connect a video card, keyboard, or mouse to a "headless" system to perform some basic servicing if required.

System messages can still appear even if the system doesn't have a video card. XPe features Message Box Intercept (MBI), which will intercept these system messages and provide appropriate responses so valuable CPU and memory resources are not consumed. MBI will make sure that a process is not stalled waiting for a Message Box response that will never come. The messages themselves can be logged for later servicing. MBI is ideal for systems that are headless, where users are not attending the device or public machines where the user might not understand the message.

Here are some of the industries where MBI is used:

Device / Industry	Details
Kiosks / Terminals	Message Box Intercept is ideal for public devices such as airline ticketing kiosks, where the user has no concept of addressing a system message.
Routers	High end routers can use the headless features and be accessed remotely over a network connection for servicing.

1.5 Remote Boot

XPe can be remotely booted over the network and run in RAM on a target device. The system will require more RAM for the image and working memory, but it will not require a disk. The OS is downloaded from a PXE server, which makes it easy to upgrade all remotely booted systems by

replacing a single image on a server. Remote Boot also saves cost on hardware and servicing since the image resides on the back end service and isn't changed by the user.

Remote Booting was originally intended for Point of Sale or Service markets, but the solution has found its way into other markets since upgrading the image is very simple.

Here are some of the industries where Remote Boot is used:

Device / Industry	Details
Point of Sale or Service	Remote downloading of the image to cash register machines
Gaming Industry	Download video games from a central server to generic hardware on the arcade floor.
Kiosks	Terminals can have absolutely no local storage. Shopping malls / airports with various Kiosks throughout the complex
Thin Clients	PXE boot is supported by a variety of Thin Client hardware manufacturers
Banking Terminals	Secure systems with no local storage of critical information

1.6 SMS/SUS/DUA

System Management Server (SMS), Windows System Update Services (SUS), and Device Update Agent (DUA) all address servicing the system when deployed in the field. These three servicing solution address incremental updates and can be handled remotely without having a service technician attend each station. SMS and SUS allow XPe devices to be connected and managed in a large enterprise network. SMS allows for custom updates to be pushed down to the device. SUS permits Microsoft updates to be pushed down to the device. Both SMS and SUS are mutually exclusive of one another.

For systems that are not connected to an enterprise network, XPe comes with DUA, which is a simple, generic, incremental update solution. All updates are custom and created with a basic instruction command set. DUA is a small service that doesn't impact the system performance, and can be scheduled to run any time during a 7 day week.

Here are some of the industries where SMS/SUS/DUA is used:

Device / Industry	Details
Network Printers	High-end network printers that everyone connects to in the network can take advantage of SMS and SUS
Headless devices	DUA is ideal for systems that are isolated or headless.
Any Embedded Device	Field upgrades are an important part of every embedded device.

1.7 Remote Management

SMS, SUS, and DUA help with software updates, but true servicing and maintenance sometime goes beyond updating the device. The cost for servicing a device needs to be factored into the total cost of the machine, thus servicing is a key issue that must be addressed during development. Like Windows XP Pro, XPe device comes with the tools to access a device remotely, typically this means over a network via TCP/IP. The available remote management tools for remote accessing an XPe device are: Telnet services, FTP Server, Remote Desktop,

Windows Management Instrumentation (WMI), and SNMP. Also, there are many custom solutions available on the market that provides access over modem or serial ports.

Servicing can be a profit center if the infrastructure and the features are in the device. The remote management features allow a service center access to a system over the Internet, intranet, or other remote means and provide support.

Here are some of the industries where Remote Management is used:

Device / Industry	Details
Headless Devices	Sometime the only way to access a headless device is via remote management
Routers	Manage the router either over serial or TCP/IP
Any Embedded Device	Field upgrades are an important part of every embedded device.

1.8 Language Packs for MUI

Multilanguage User Interface (MUI) supported on XPe provides a cost effective means for Multilanguage deployment of embedded systems. If the operating system were localized (non-MUI), the developer would have to generate a separate operating system release for each language supported. This would require a distinct process of design, integrations test, packaging, release management, and maintenance for each localized release. Any updates would also have to be managed independently for each localized language build. Using MUI language components, however, a single operating system configuration can be built, tested, packaged, released and maintained which can be dynamically switched to support the required languages.

Having a single configuration for world-wide distribution can be a big cost savings for both development and maintenance.

Here are some of the industries where Language Packs are used:

Device / Industry	Details
Any Embedded Device	Any embedded device targeted for multi-country release and Multilanguage support.

1.9 Power Management Control Library

Power management control features of shutdown, restart, standby, and hibernate can be accessed and controlled through the Power Management API. Even if the standard Start menu interface is not provided, a custom shell or application can gain access to these power management features. Power management is a critical issue with portable, battery powered, embedded devices. Proper power management can significantly extend the battery life of portable devices.

Device / Industry	Details
Any Portable Embedded Device	Any embedded device that totally or in part runs on battery power can benefit from power management.

1.10 MinLogon

Microsoft Windows XP Professional on booting requires a user to logon to the system, for many consumer devices, a logon is not required or desired. MinIogon removes the logon feature and provides a faster boot method for XP Embedded. Consumer electronic manufactures, kiosks, and some standalone test equipment benefit from this fast startup feature.

Device / Industry	Details
Consumer Electronics	Looking for a fast boot without a logon. - Settop box, internet enabled TVs
Kiosks / Terminals	Fast boot, no networking required
Test Equipment	Fast boot, no or minimal networking required

1.11 Summary

We have looked at the different Embedded Enabling Features (EEF's) and seen how individually they address specific market needs. The EEF's address many of the many concepts that going into creating an embedded device: management, updates, boot media, security, and deeply embedded requirements. All of these individual issues add to the cost and support of a device. The EEFs provide solutions to help minimize these costs. In short, the price for the tools and licensing make XPe an attractive choice, but it is the EEFs that bring the real value to producing a successful embedded device.