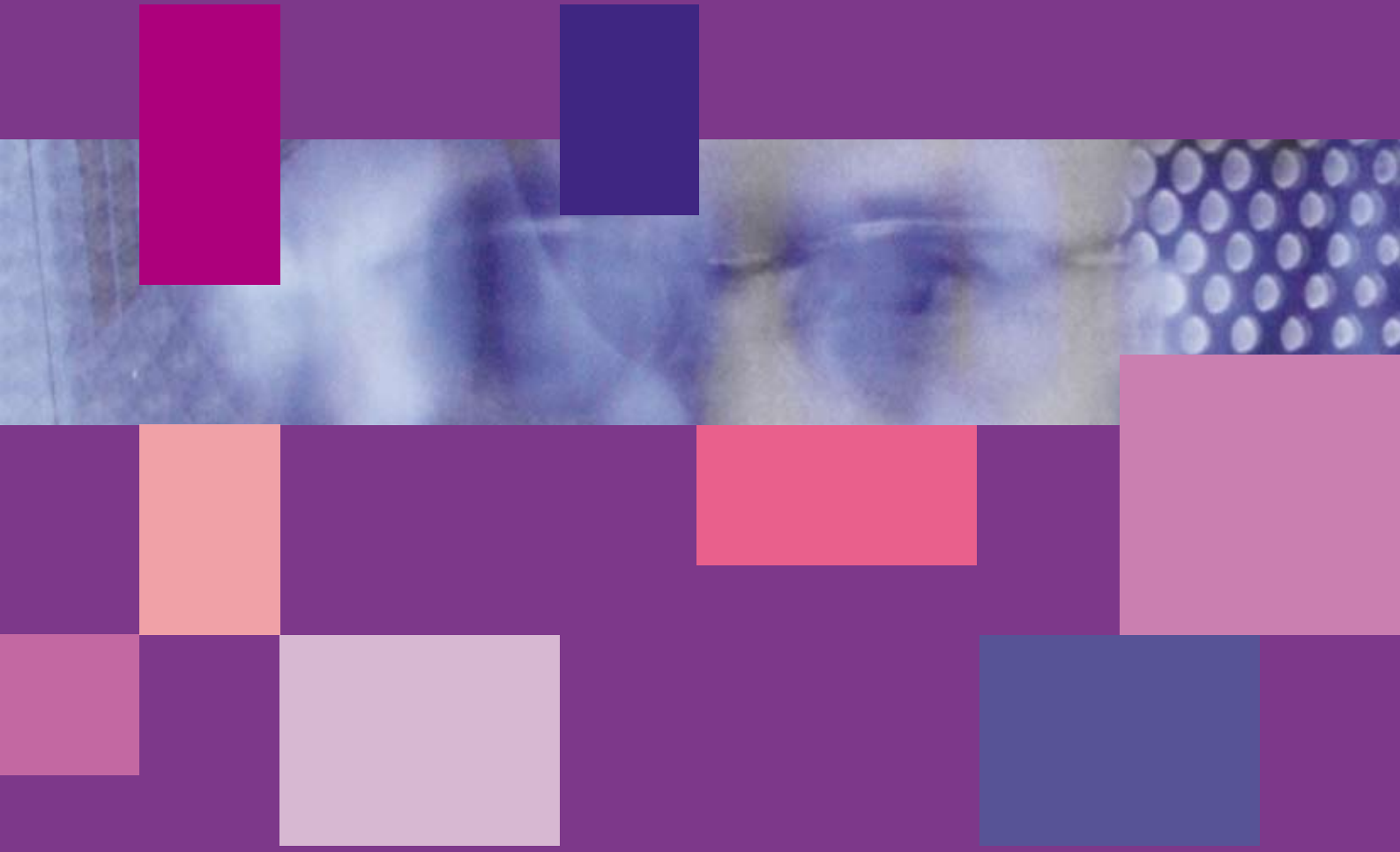


Technical
Guidelines
For IT Professionals



April 2006 – Number 1

Installing Linux

A study of installing Linux as an end-user
desktop/laptop operating system

Principia 

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Executive Summary

These NCC Technical Guidelines present a review of the practical installation of the Linux operating system for use on end-user desktops and laptops. It is of interest to anyone considering Linux as a desktop operating system or selecting a Linux distribution for personal or corporate use.

Several standard and widely available distributions of Linux were installed on both a desktop PC and a laptop and the experience captured in a systematic manner using an extensive score card.

The results reveal that installing the open source operating system Linux is typically not straightforward and can take several hours, whilst common incompatibilities with newer hardware are likely to frustrate the inexperienced installer. The consequence is that many of those wishing to trial Linux as an alternative to proprietary software are likely to abandon Linux adoption at the first hurdle.

The study identified significant differences between the distributions in terms of the experience of the installation. Generally this followed from the distributor's choice of installer software and components which are bundled with the Linux core to make up the distribution. In short, these distributions were developed for different types of user but this is not always clear. Improved presentation of distributions will ensure that users understand the differences between the distributions so that they can choose the right tool for the job.

Hardware vendors have a part to play in Linux achieving desktop readiness, particularly by providing access to the drivers. Similarly, the projects and companies which create the distributions could make greater efforts to ensure that the latest drivers are readily available.

These findings will not surprise many with prior Linux experience. Indeed anyone who has installed an operating system onto bare hardware is likely to have encountered difficulties of one kind or another. Many computer users never see such problems - they are provided with pre-installed and configured systems by manufacturers or their 'internal IT' colleagues. This study emulates those who have to DIY or provide installation support service for others.

A configured Linux machine is highly usable, however there are improvements to be made in terms of presentation and substance. The substantial improvements to be made are around support for new technologies and at the very least providing easily accessible information on which distribution and drivers support the hardware and technology.

The NCC tests provide a benchmark for the difficulties encountered by these technical teams, or by small organisations and individuals. The tests allow comparisons now and will enable progress to be charted.

1. Introduction

This technical guideline is based on a study initiated by the Society of IT Managers (SOCITM)^[1] Open Source Special Interest Group. The testing process was carried out by National Computing Centre (NCC)^[2] staff within the Open Source Academy (OSA)^[3] project.

The study was designed to assess the ease of installation and survey the basic functionality of the selected distributions. The functions were identified and agreed by SOCITM in discussion with NCC, and intended to cover many of the requirements of a public sector PC user. Similarly SOCITM also selected the trial distributions and specified the two hardware platforms.

These Guidelines are derived from the full lab study using a subset of the full results. The intention is to provide a more generalised interpretation of the findings. The data set on which this paper is based is available in the appendix.

2. The Study

This study provides a basic comparison of some of the major Linux distributions with an onus on desktop use. It is not designed to indicate how long installations would take in (for example) an ICT department, in which skills would be more developed than the average user and standard imaging would most likely be used to roll-out the installation.

'...of interest to anyone considering Linux as a desktop operating system or selecting a Linux distribution for personal or corporate use'

'This study provides a basic comparison of some of the major Linux distributions with an onus on desktop use'

The broad range of both hardware configurations and Linux distributions means that it is not feasible to study all possible cases. There are also many different contexts in which we use an operating system ranging from the non-technical home user to the PC support team managing a large computing estate, as well as the super-technical home user. This study chose to consider the time and effort required to install common 'out of the box' Linux distributions on standard desktop and laptop equipment.

This study does not address all issues. For example:

- Interface design
- Security
- Comparison with other non-Linux operating systems
- Long-term reliability

The test plan has been designed and published in full so that interested parties can extend their own testing to include these aspects of a desktop operating system.

Please note that, technically, Linux refers to just the kernel component of the distributions tested. What we are actually testing relies heavily on the use of individual software packages that are distributed with the Linux kernel^[4], such as desktop environments (GNOME^[5], KDE^[6] etc.), office suites (OpenOffice.org^[7]) and other such software. This is not an authoritative or exhaustive study of the Linux kernel or any specific software bundled with the Linux kernel. Due to the sheer volume of software available which purports to accomplish these tasks, testing each and every combination would be a huge task outside the scope of this study.

It should also be noted that Linux distributions are targeted at different markets. Ubuntu^[8] / Kubuntu^[9] for example aim to simply provide a basic desktop GNOME / KDE installation respectively that can be tweaked and configured post-install. In contrast, SuSe^[10] and Fedora^[11] provide much more control during the installation stage, the latter, in general, requiring more understanding on the users part. Novell Linux Desktop (NLD)^[12] is aimed mainly at the business desktop market. A comparison of the value of these different approaches to different user communities is again outside the context of this study in terms of scoring, although observations made were noted and commented upon^[13].

2.1 Test hardware specification

The test hardware used was as follows...

Desktop PC – Dell Optiplex SX270

- Intel Pentium 4 2.4Ghz
- 512Mb RAM
- 60Gb Hard disk
- Integrated Intel chipset (LAN / video etc.)
- 1 x Laptop – HP Compaq nx8220
- Intel Pentium 4 3.2GHz
- Intel Centrino Mobile Technology
- 512Mb RAM
- Mobile Intel 915PM Express chipset
- ATI Mobility Radeon X600 graphics controller with 128Mb video RAM
- 15.4-inch wide-screen display
- 80Gb Hard disk

2.2 Distributions tested

The following distributions were tested...

- Ubuntu Linux 5.10 (Breezy Badger)
- Kubuntu Linux 5.10 (Breezy Badger)
- SuSe Linux 10.0 (OSS)

- Fedora Core 4
- Novell Linux Desktop 9

2.3 Selection of distributions

The distributions were selected to represent the commonly available up-to-date^[14] distributions. Ubuntu and Kubuntu were selected to represent two different desktop environments, GNOME and KDE respectively. Fedora Core 4 (FC4) was selected as the main desktop offering from RedHat^[15]. SuSe and Novell Linux Desktop (NLD) are both Novell^[16] offerings.

There are many other distributions we could have considered for this. Debian Linux^[17], it was felt, is a very stable distribution, however the package versions in Debian’s stable branch are rather old in comparison to the selected offerings. While an argument can be made for testing Debian’s ‘unstable’ branch this was rejected as it is unlikely to be considered for business or organisational use. Ubuntu and Kubuntu are both modern Debian derivatives however, and retain the package system and many other similarities while providing stable, up-to-date packages. Gentoo Linux^[18] was not included in the study as the installation procedure is complex and source-based distribution requires a lot of time and effort. That is not to say that any of the omitted distributions should not be considered for desktop use, rather they are outside the scope of this study.

2.4 Conduct of tests

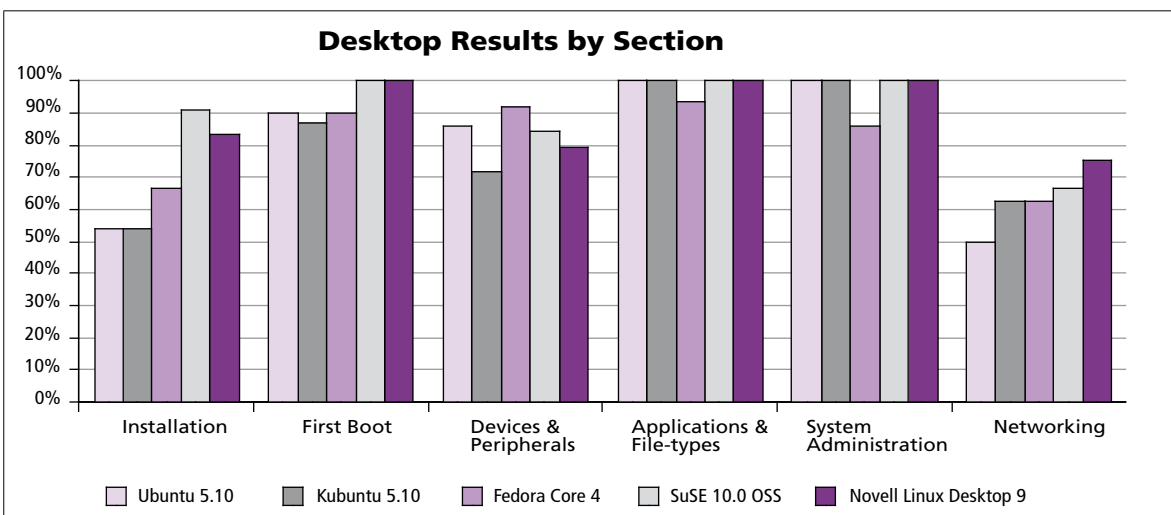
The tests were conducted in November and December 2005 at NCC’s offices in Manchester, UK. The person undertaking them had extensive experience with Linux and OS software. They were able to overcome some of the issues which arose, however this was only done to ensure that the problem was understood or to proceed with further tests. In these cases such skilled intervention was recorded and is reported on.

‘Ubuntu and Kubuntu are both modern Debian derivatives however, and retain the package system and many other similarities while providing stable, up-to-date packages

3. Results

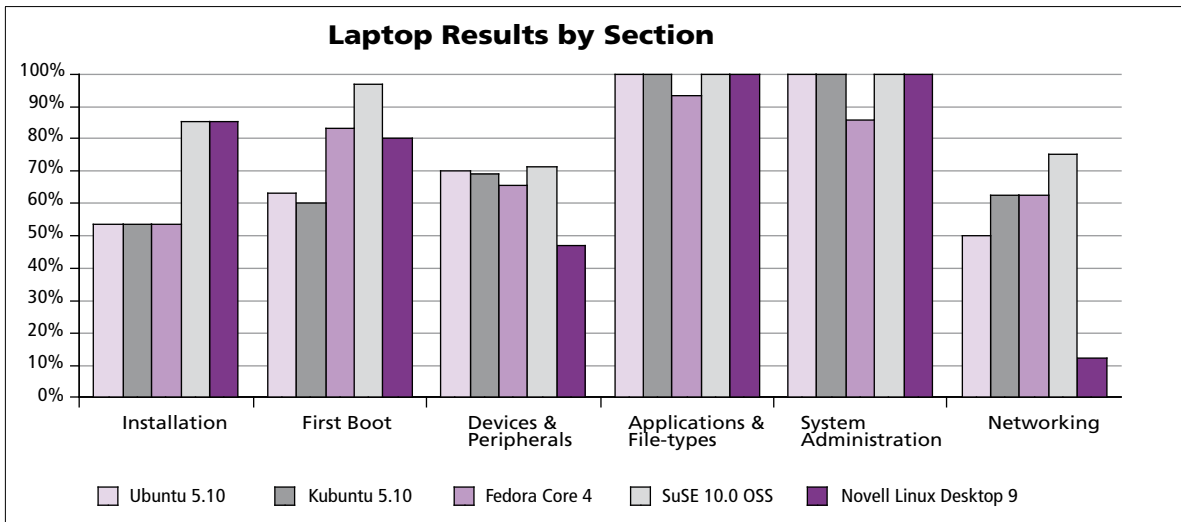
3.1 Desktop results

Desktop Results – By % of Maximum Available						
	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SuSE 10.0 OSS	Novell Linux Desktop 9	Average (Mean)
Installation	53.7%	53.7%	66.7%	90.7%	83.3%	69.6%
First Boot	90.0%	86.7%	90.0%	100.0%	100.0%	93.3%
Devices & Peripherals	85.7%	71.4%	92.1%	84.1%	79.4%	82.5%
Applications & File-types	100.0%	100.0%	93.3%	100.0%	100.0%	98.7%
System Administration	100.0%	100.0%	85.7%	100.0%	100.0%	97.1%
Networking	50.0%	62.5%	62.5%	66.7%	75.0%	63.3%
TOTAL As % Of Maximum Available	79.3%	76.4%	82.7%	90.3%	88.2%	83.4%
Rank	4	5	3	1	2	



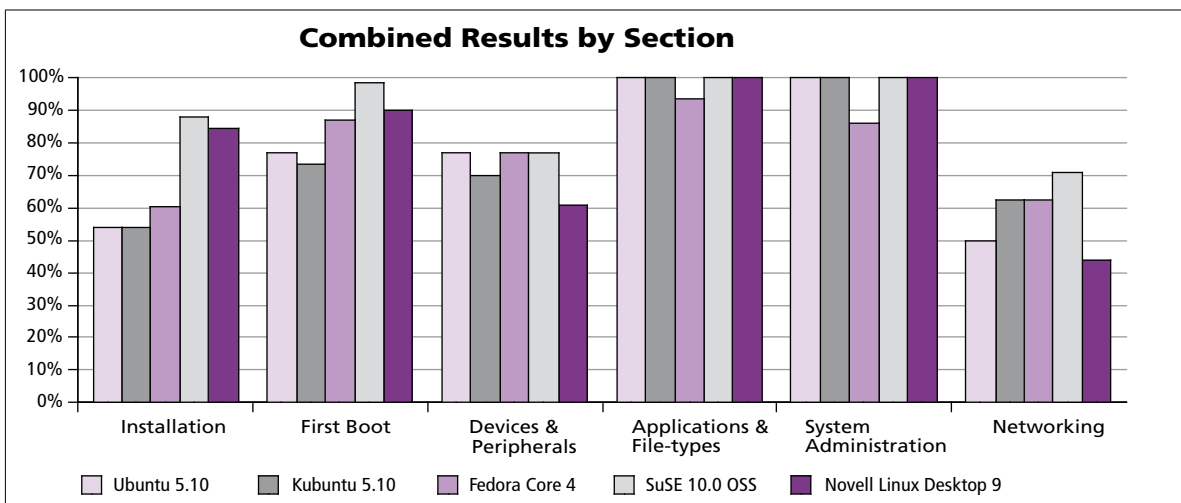
3.2 Laptop results

Laptop Results – By % of Maximum Available						
	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SuSE 10.0 OSS	Novell Linux Desktop 9	Average (Mean)
Installation	53.7%	53.7%	53.7%	85.2%	85.2%	66.3%
First Boot	63.3%	60.0%	83.3%	96.7%	80.0%	76.7%
Devices & Peripherals	70.1%	69.0%	65.5%	71.3%	47.1%	64.6%
Applications & File-types	100.0%	100.0%	93.3%	100.0%	100.0%	98.7%
System Administration	100.0%	100.0%	85.7%	100.0%	100.0%	97.1%
Networking	50.0%	62.5%	62.5%	75.0%	12.5%	52.5%
TOTAL As % Of Maximum Available	71.7%	72.0%	71.3%	84.7%	69.0%	73.7%
Rank	3	2	4	1	5	



3.3 Combined results

Combined Results – By % of Maximum Available						
	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SuSE 10.0 OSS	Novell Linux Desktop 9	Average (Mean)
Installation	53.7%	53.7%	60.2%	88.0%	84.3%	68.0%
First Boot	76.7%	73.3%	86.7%	98.3%	90.0%	85.0%
Devices & Peripherals	76.7%	70.0%	76.7%	76.7%	60.7%	72.1%
Applications & File-types	100.0%	100.0%	93.3%	100.0%	100.0%	98.7%
System Administration	100.0%	100.0%	85.7%	100.0%	100.0%	97.1%
Networking	50.0%	62.5%	62.5%	70.8%	43.8%	57.9%
TOTAL As % Of Maximum Available	80.1%	78.9%	81.6%	93.0%	83.1%	83.3%
Rank	4	5	3	1	2	



4. Detailed Observations

4.1 Fedora Core 4

Desktop & General

Fedora Core 4 installed in a very short space of time (40 mins) on the desktop PC. The DVD installation method meant that no disk-swapping was required and the installation could be carried out unattended. This is particularly useful for business or organisational installations as it means IT staff can move onto the next machine or work on other tasks.

During the 'post-install configuration' stage, the mouse became unresponsive and the on-screen progress bar appeared to stop at 50%. Eventually, after around 10 minutes, the installation continued, however some users may view this as a fault and reboot their machine.

The default Fedora interface is very polished and welcoming to the user. Fedora also provides excellent update functions by way of an update widget and automatic schedule. This takes responsibility away from the user to update their installation and allows them to concentrate on working.

One feature to note is the automatic installation of SELinux^[19] (security-enhanced Linux), which provides general support for role-based access control and multi-level security. Fedora is the only distribution tested that bundles SELinux by default.

Automatic mounting of USB keys and removable drives was successful. Icons were placed on the desktop which could be used to access removable drives efficiently.

Laptop

On first attempt, Fedora refused to install on the test laptop, complaining that insufficient space was available, despite being allocated the full hard-disk (80Gb) in a single standard ext3^[20] partition. Three attempts failed. On a fourth attempt the text-mode installation option was successful.

The WiFi interface failed to configure in Fedora despite two separate configuration applications (which could be confusing). We suspect this was down to the lack of an included firmware package for the WiFi card. No-doubt the drivers can be installed manually, however a first time user would not find this to be a trivial task due to the non-standard way in which vendors release their drivers. This is a side-effect of the fact that there are a number of different packaging systems used in distributions.

The addition of an external monitor was successful with Fedora, however the aspect ratio of the mirrored image was uncorrected, and the resolution unacceptable. It was not immediately apparent how to correct this without hand-editing complex configuration files and risking rendering the operating system unusable.

4.2 SuSe 10.0 (OSS Version)

Desktop & General

SuSe took a long time to install (2hrs 45 mins) in comparison with the other distributions tested, although it provided a great deal of configuration flexibility at install-time due to the inclusion of their exclusive YaSt^[21] installer. Disk-swapping meant that the installation needed constant attention. (SuSe 10.0 is also available as a DVD, although others have reported that the DVD installation also cannot be carried out unattended because the installer still asks for the individual disks, with success gained by simply pressing 'return'.)

Automatic updates were also provided at install-time (of which there were many, including a kernel update), and this further increased the time needed. However, it should be noted that in distributions that don't contain this feature the user would be expected to update the operating system post-install anyway. The fact that the user has a fully up-to-date system upon first boot is a major plus in terms of security.

The default installation contained clean, sensible branding and a welcoming feel for the user, including attractive boot-splash screens which shield the non-technical user from kernel and boot messages that can be confusing.

The YaSt tool provides a simple method to get the machine 'up-to-scratch' upon first boot. It is well-integrated into the desktop environment.

'The default installation contained clean, sensible branding and a welcoming feel for the user, including attractive boot-splash screens which shield the user from kernel and boot messages that can be confusing to a non-technical user'

One surprise was that the default PDF reader was xpdf^[22] rather than one of the more modern applications such as gpdf^[23], kpdf^[24] or evince^[25]. The latter are better integrated into their respective desktop environments. (The commercial version of SuSe 10.0 bundles Adobe Acrobat for Linux^[26].)

An application crash was experienced when using nautilus^[27] (the GNOME desktop's file-manager application), to access SAMBA^[28] shares on a remote Microsoft Windows XP Pro machine. We were however successful in mounting the share from the command line. This would lead us to believe that this was an application problem and not a network problem. It should be noted however that a non-technical or first time user is unlikely to know how to mount a share from the command line, or indeed whether this is possible. In short, it is absolutely essential that GUI applications can complete the tasks they set out to achieve as no user should be banished to the command-line to complete a job which a GUI application purports to cover.

Laptop

Installation of SuSe was completed on the laptop in a much shorter time than the desktop. This is probably due to the newer hardware and therefore better CD-read and HD-read/write speeds.

The machine needed to boot without ACPI^[29] in order to reach the installation program. This was a simple procedure of passing the 'noacpi' option to the boot command-line. However, a non-technical user may not think to try this and presume SuSe does not work with their hardware. Upon installation, ACPI was enabled and working as expected and it was not necessary to pass the 'noacpi' option again.

Resolution of the Laptop screen upon first boot was not the native resolution of the LCD screen. Although it was acceptable in comparison with the other distributions tested. SuSe also succeeded in auto-configuring the ATI^[30] Radeon graphics card using the included open-source driver, while other distributions tested failed to do so and required the user to install this (or the 3rd party driver) manually. It is absolutely essential to major desktop Linux adoption that the user is presented with a usable desktop upon first-boot, even if the resolution is not to the best standard or colour depth is reduced. Installation of the 3rd party driver^[31] from ATI's website allowed the screen to operate at full native resolution, and enabled 3D acceleration, however this was not a simple task and involved installation manually via a shell script. This would have been much easier had an RPM^[32] package been made available from ATI.

We were unable to get the WiFi interface to work in SuSe, despite manually installing the proprietary drivers downloaded from the internet. The device appeared to be recognised but failed to connect to the out test access point.

The external monitor did work, however it only showed a mirrored image of the active desktop (as opposed to a second, usable screen). Use of the external monitor also required a restart of the Xorg Xserver^[33] (on top of which the GUI aspect of desktop sits). This was accomplished via a system reboot, which a non-technical or first time user may not have the inclination to try. Further configuration of the monitor was only available through hand-editing the Xserver configuration file. This is far too technical for the average desktop end-user and they would expect a GUI configuration tool.

4.3 Novell Linux Desktop

Desktop & General

Novell Linux Desktop (NLD) provides a very simple installation procedure requiring minimal user interaction. The dialog boxes presented are very friendly and easy to understand for a non-technical or first-time user. NLD provides an attractive boot-splash screen which also shows boot and kernel messages. This could be seen as confusing although, when presented as part of the boot-splash, is quite reassuring. NLD provides Adobe Acrobat as the default PDF viewer, in contrast to SuSe's default choice of xpdf which lacks functionality and isn't integrated into the modern desktop environments, KDE and GNOME, of which coincidentally, NLD provides a choice of both. It is worth mentioning that the inclusion of Adobe Acrobat is due to the commercial nature of NLD as a Linux distribution.

Automatic updates and install-time configuration are features provided by the inclusion of the YaSt installation engine. This means the machine is secure on first boot and requires very little in the way of post-install configuration.

On the whole, NLD provides a clean simple desktop which makes use of common applications. The installation is simple and interactive only where required, while more experienced users have the option to 'dive-in' further and make use of the power of YaSt.

Laptop

The auto-update feature failed to work during the laptop installation despite (seemingly) setting up the network interface. It was later discovered the network was in fact not set up.

lspci^[34] showed many devices as 'unknown device'. This is unacceptable as this only requires a small database of PCI ID's to be compiled into the kernel.

The display manager did not start on first boot in the native LCD resolution.

We were unable to setup the ethernet card in the laptop despite repeated attempts. Even after selecting the correct kernel module (unlikely to be known to non-technical users), the device failed to configure. The wireless adapter also failed to configure despite manually installing proprietary drivers available from the internet. Probing for the sound card failed and as such sound was unavailable. These tests were repeated three times for confirmation.

The external monitor would not work for desktop use, however when left unattended, it was noticed that the screensaver was running on the external monitor. Despite this, it was not possible to use the second monitor as part of the desktop.

Due to the failure of the network interface setup, it was not possible to test the networking questions.

In general, the hardware support provided by NLD was unacceptable as far as the test laptop was concerned.

4.4 Kubuntu 5.10

Desktop & General

Ubuntu and Kubuntu provide a very simple installation procedure which requires just a single CD and minimal dialogs, but unfortunately there is no graphical installer^[35]. This could be seen as positive in some respects as it is likely to be installable on a wide variety of hardware, however a text-mode installation may seem daunting to a non-technical or first-time Linux user. The simple install also means there is a lack of install-time setup for modems, ISDN and USB-ADSL adapters, although a standard ethernet LAN can be configured.

Ubuntu/Kubuntu provides no manual package selection during installation. Package selection can be tweaked post-install. It is also possible to install a 'server' setup, which provides no GUI and minimal package selection during installation.

Upon configuring the network, the operating system refused to set the default gateway except by reverting to the command-line. A non-technical or first-time user is unlikely to know how to do this and may find that they could not configure the network.

Auto-mounting of USB keys was problematic. An error message was displayed to suggest the USB key could not be mounted, however some investigative work showed the key was in fact mounted in a non-standard place and not immediately available to the user via the desktop.

Kubuntu's default terminal font was difficult to read. It was possible to change this but the default should be a standard font which is readable in most installations.

3D graphics acceleration was enabled by default and graphics were snappy and responsive. Some media formats such as OGG and WAV failed to play satisfactorily. Sound was produced, however it was 'choppy' and unlistenable.

'The installation is simple and interactive only where required, while more experienced users have the option to 'dive-in' further and make use of the power of YaSt'

'Ubuntu and Kubuntu provide a very simple installation procedure which requires just a single CD and minimal dialogs, but unfortunately there is no graphical installer'

Installation of browser plug-ins via the browser did not work. Getting these required extra package repositories and using Kubuntu's own package management system.

Laptop

The display manager did not start due to lack of auto-configuration for the ATI video card. Manually installing the drivers using Kubuntu's package management system (from the command-line) fixed the problem, although the Xserver configuration needed to be done by hand. This would most certainly put-off first time or non-technical users. Native resolution and 3D acceleration was available after installation of the drivers. On a positive note, it was very helpful that the drivers were available from the official Kubuntu repositories.

Plugging in the external monitor produced no output or response from the operating system. It is possible this could have been configured manually, however this would be outside the realms of a non-technical user's understanding and they could assume it simply 'doesn't work'.

4.5 Ubuntu 5.10

Desktop & General

A simple default interface is provided by the Ubuntu installation which uses the GNOME desktop environment. It is a very simple install procedure using a single CD and minimal dialogs. The absence of a graphical installer (as with Kubuntu) is positive in some respects as the distribution is likely to install on more systems, however this could also be negative as the first-time or non-technical user may find this daunting. It is very easy to install but there is a lack of flexibility in configuration. As with Kubuntu, there is a lack of set-up at install-time for modems, ISDN and USB-ADSL adapters. The lack of manual package selection during install meant that package selection can be tweaked only after installation.

Auto-mounting of devices is very slick with import dialogs for drives containing pictures etc. (unlike counterpart Kubuntu).

3D graphics acceleration was enabled by default.

As with Kubuntu, installation of browser plug-ins via the browser did not work. Getting these required extra package repositories and using Ubuntu's own package management system.

Laptop

As with Kubuntu:

The display manager did not start due to lack of auto-configuration for the ATI video card. Manually installing the drivers using Ubuntu's package management system (from the command-line) fixed the problem, however the Xserver configuration needed to be done by hand. This would most certainly put-off first time or non-technical users. Native resolution and 3D acceleration was available after installation of the drivers. On a positive note, it was very helpful that the drivers were available from the official Ubuntu repositories.

Plugging in the external monitor produced no output or response from the operating system. It is possible this could have been configured manually, however this would be outside the realms of a non-technical user's understanding, and they could assume it simply 'doesn't work'.

5. Discussion Points

5.1 General

The findings show that the differences between each of the target distributions are mainly dependant on the intended approach.

Ubuntu and Kubuntu, for instance, offer a simple 1 CD installation with no package management at the installation stage. This provides a quick install that can be largely unattended. System configuration and addition/removal of extra packages can be achieved after initial installation.

On the other hand, SuSe, Fedora and NLD offer a great deal of flexibility at the installation stage, providing manual package selection. For the SuSe/Novell distributions, this is largely thanks to the YaST software which provides a central configuration console for use during and after installation.

'The findings show that the differences between each of the target distributions are mainly dependant on the intended approach'

This does add time to the installation, however this is time saved upon first boot which, typically, would be used to configure and customise the system to an acceptable standard.

All of the distributions contain excellent automatic update mechanisms, which allow the user to stay up-to-date and secure with very little effort. Both SuSe and Novell Linux Desktop provide this feature at the installation stage, greatly adding to the security on first boot. However, this does mean that the installation can take quite a while. SuSe, for instance, contained over 100 updates.

Windows networking is an essential part of Linux use in a corporate environment as most organisations use some Windows-based file-sharing or authentication systems. All of the distributions can interoperate with Windows file-servers with correct configuration, however they did not meet all the criteria 'out-of-the-box'. This is certainly a potential stumbling block to adoption and improved auto-configuration would no doubt be welcomed.

5.2 Laptop

The laptop tests required us to explore the world of hardware and its interface with Linux. The popular HP Compaq nx8220 we used was a revealing choice as the drivers for both the ATI graphics card and the Intel WiFi adapter are only available as proprietary code. This meant none of the distributions tested actually supplied the drivers as part of their installation media. Installing the ATI driver manually was not a trivial task apart from on Ubuntu and Kubuntu, who package the 3rd party ATI driver and make it available via their repositories. It did however need to be installed from the command line as these two distributions failed to start the desktop environment using the open source ATI Radeon driver. All the other distributions succeeded in booting to the desktop environment using the freely available distributed open source driver, although default resolution was generally not up to scratch. Manual installation of the 3rd party drivers was laborious and required searching on the internet for assistance.

Connecting an external monitor showed mixed results, all being unsatisfactory in terms of user experience. The desktop environment needed restarting and, upon doing so, the resolution used for the external monitor was unsatisfactory. There were few or no configuration options available for multiple monitors on all of the distributions, although this can be configured by hand editing configuration files. It is unlikely that a non-technical user will be experienced enough to find this a trivial exercise.

With regards to the WiFi adapter, drivers were not available as part of the distributed packages. Even after installing the drivers manually, some distributions refused to connect to the test access point. This was mainly due to the non-standard installation method of the drivers, i.e. downloading and running a shell-script from the manufacturers web site. This point is increasingly important as use of wireless networks and mobile working becomes more commonplace. This would be a complete show-stopper for many.

5.3 Possibilities

The major difference between the desktop and laptop performance in the tests can be put down to hardware maturity. The Dell Optiplex SX270 desktop contains a standard Intel integrated chipset and on-board components and is around 18 months old. The HP Compaq nx8220 laptop is much newer, and uses cutting edge technology such as the latest ATI mobile video hardware and the Intel Centrino processor. Support for newer technologies can take a while to arrive in the Linux kernel because most manufacturers are primarily committed to providing Windows and/or Mac drivers which cater for the majority of the market they serve. Some hardware vendors produce Linux drivers, but often this is not with the support and help of the open source community. Others fail to provide any non-Windows drivers whatsoever, and any hope of a driver emerging rests on reverse-engineering on the part of Linux 'hackers'. These efforts are often successful, however it takes time to perfect and is not the most efficient method of driver production.

WPA WiFi encryption is a good example of newer technologies maturing. Support for WPA in Linux is limited to just a few wireless adapters and

'...manufacturers are primarily committed to providing Windows and/or Mac drivers which cater for the majority of the market they serve'

requires using a third-party piece of software called 'wpa-suplicant', which is still in active development. We could not make WPA encryption work 'out-of-the-box' for any of the distributions tested.

6. Conclusion

The experiences met while conducting this evaluation are similar to those encountered by many who try to install Linux, either for personal or professional use.

In general, support on older (desk PC) hardware was better than that of the newer (laptop) hardware. This is a significant observation for the non-technical individual selecting a hardware operating system combination to work with. It also means that installation can be more time consuming on the newer hardware, requiring more work in finding and getting drivers to work. Where a working laptop-based system is to be simply replicated across many identical machines, e.g. in a corporate environment, then this difficulty may be worth bearing should it arise - the cost is borne only once.

When hardware vendors provide only closed-source drivers for Linux, there is a need to package those drivers individually for each of the different distributions or package management systems. Similarly, the projects and companies which create the distributions could make greater efforts to ensure that the latest drivers are packaged, available and implementable through their own package management systems (as Ubuntu / Kubuntu have done with the ATI drivers).

In terms of graphical environment and desktop integration, once installed, each of the distributions scored well and were very usable in terms of accessing files and applications etc. The major differences between them are of no surprise if you know what to expect from each distribution's installation approach, e.g. a simple initial installation vs. a configurable set up of a comprehensive system, or the inclusion, or not, of proprietary drivers.

A configured Linux machine is highly usable, however we'd say there are improvements to be made in terms of presentation and substance. Improved presentation of distributions will ensure that users understand the differences between the distributions and choose the right tool for the job. Substantial improvements can be made in support for new technologies and, at the very least, providing easily accessible information on which distribution and drivers support which hardware technology. By and large this is not an issue for most Windows or Mac users unless they too are faced with a bare machine and a set of generic software disks. However, it's clearly significant for many existing, potential and/or frustrated Linux users.

In summary, this study has revealed differences between some of the most popular Linux distributions in use. It has identified areas where Linux could improve its public image through a better explanation of the target market and the required skill levels. It has also shown where the practical adoption of Linux could be improved, notably through better integration with hardware supply chains.

7. What Next?

7.1 The current situation

We have created a comprehensive test plan and a body of test results for several Linux distributions as the basis of a desktop/laptop operating system. The information and data in this report is a subset of the full report at <http://www.opensourceacademy.gov.uk>.

7.2 How can I use this to do my own testing?

The test-plan is openly available so that others can use it to extend our work. If you require copies in electronic formats please contact us at linuxtrials@ncc.co.uk. We'd like to hear about any useful extensions to the test-plan and any results of testing you'd offer for sharing via our website. Please send full details of the tests and results to linuxtrials@ncc.co.uk and, subject to moderation, we'll add your information to the set. We'll agree to any changes in content or presentation with you before publication and you will

'A configured Linux machine is highly usable, however there are improvements to be made in terms of presentation and substance'

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Any published additions provided by the community will also be licensed as such. NCC is responsible for the base report, original test-plan and their provided results. Additions to the data are the responsibility of those who submit them. We are happy to host these free of charge, however we advise you keep your own backups.

We look forward to hearing from you to both continue and extend the scope of this work.

1 INSTALLATION

Test	Description	Scoring	Maximum	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SUSE 10.0 OSS	Novell Linux Desktop 9	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SUSE 10.0 OSS	Novell Linux Desktop 9	Ubuntu 5.10	Kubuntu 5.10	Fedora Core 4	SUSE 10.0 OSS	Novell Linux Desktop 9	
Boot-time control	Is there any level of boot control? i.e. Disable devices, install 3rd party modules etc.	0 1 2 3	3	2	2	3	1	1	2	2	3	1	1	2	2	3	1	1	3
Language & Locale	Is the interface language selectable during installation?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Are language changes activated immediately?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Is there keymap selection during installation?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Are keymap changes activated immediately?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Graphical Installation	Is there a GUI installer? Is this successful in running?	0 1 2 3	3	0	0	3	3	3	0	0	3	3	3	0	0	0	3	3	3
Network Configuration	Is an acceptable resolution used for install? (applies to text / graphical, points scale relative to hardware)	0 1 2 3	3	1	1	0	3	2	1	1	0	3	3	1	1	0	3	3	3
	To what extent is network configurable? Consider DSL / ISDN / Modem / WIFI etc.	0 1 2 3	3	1	1	1	3	3	1	1	1	3	3	1	1	1	3	3	3
HD Partitioning	Is a default partitioning scheme selectable e.g. for a new machine?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Package Selection	Is it possible to customise partitioning? To what extent?	0 1 2 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Is manual package selection available?	0 3	3	0	0	3	3	3	0	0	3	3	3	0	0	3	3	3	3
Desktop Environment Selection	Is there an option to choose Desktop Environment / Window Manager?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
On-line Update	Is it possible to update package list and / or patch system during install procedure?	0 3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	3
User Configuration & Authentication	Did this identify updates and install or identify lack of updates and continue? (Both score)	0 3	3	0	0	0	3	0	0	0	0	3	0	0	0	0	3	0	0
	Is the user able to configure authentication mechanisms (NIS / LDAP etc.) at install?	0 3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	3
Boot-loader Configuration	Is it possible to test these settings during the install?	0 3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Is it possible to configure users during the install?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Errors & Info	To what extent can the boot-loader be configured? Consider kernel parameters, time-out, password protection etc.	0 1 2 3	3	1	1	2	3	3	1	1	2	3	3	1	1	2	3	3	3
	Were there any errors and / or warnings during install?	$-\infty < x \leq 0$ x=	0	0	0	0	0	0	0	0	0	0	0	0	0	-4	-3	0	0
TOTALS	What were these due to?	n/a	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Needed to boot w/o FB + had to use text installer	Needed to boot without ACPI	n/a	n/a
	What is the installation media? e.g. single CD + net install, Set of CD's (specify #), single DVD etc.	n/a	0	1xCD	1xCD	1xDVD	5xCD	3xCD	1xCD	1xCD	1xDVD	5xCD	3xCD	1xCD	1xCD	1xDVD	5xCD	3xCD	3xCD
	What package system does this distribution use? e.g. RPM, DEB, source, binary archive.	n/a	0	DEB	DEB	RPM	RPM	RPM	DEB	DEB	RPM	RPM	RPM	DEB	DEB	RPM	RPM	RPM	RPM
	Which DE / WM was selected? KDE, GNOME, XFCE etc.	n/a	0	GNOME ONLY	GNOME ONLY	GNOME	KDE	GNOME	GNOME ONLY	GNOME ONLY	GNOME	KDE	GNOME	GNOME ONLY	GNOME ONLY	BOTH	GNOME	GNOME	KDE
How long did the installation take (approx.)?	n/a	0	1 hr 20 mins	1 hr 10 mins	40 mins	2 hrs 45 mins	50 mins	1 hr 10 mins	1 hr 10 mins	45 mins	1hr 45 mins	1hr 45 mins	1 hr	1 hr 10 mins	45 mins	1hr 45 mins	1hr 45 mins	1 hr	
Points Scored	54	54	29	29	36	49	45	29	29	29	36	49	45	29	29	36	49	45	46
As % Of Maximum Possible			53.7%	53.7%	66.7%	90.7%	83.3%	53.7%	53.7%	53.7%	66.7%	90.7%	83.3%	53.7%	53.7%	66.7%	90.7%	83.3%	85.2%

3 DEVICES & PERIPHERALS

Networking (Ethernet)	Does the network auto configure when the machine was booted with Ethernet plugged in and with a DHCP server available on the local LAN?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	
	Is it possible to configure Ethernet networking to use a static IP address? Check that changes are applied and work etc.	0 3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	0
	How easy is it to change the Ethernet configuration? Consider amount of dialogs, clutter, descriptive language used.	0 1 2 3	3	3	2	3	3	3	3	2	2	3	3	2	3	3	3	3	3
Wireless Networking (WIFI)	Does the WIFI auto configure when the machine was booted in range of a network and with a DHCP server available on the local LAN?	0 3	3	Laptop Only										0	0	0	0	0	
	Is it possible to configure the WIFI network by selecting an AP and using both DHCP and Static IP addressing?	0 3	3																0
	Does connecting to an AP using WEP encryption work?	0 3	3																
Sound & Video	Is there a facility to browse for WIFI networks?	0 3	3																0
	How easy is it to change the WIFI configuration? Consider amount of dialogs, clutter, descriptive language used, available options etc.	0 1 2 3	3																0
	Is the sound-card previously detected / selected during install recognised and initiated?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
USB	Is there relevant GUI tools to configure the sound-card? e.g. mixer, record-source selection etc. To what extent is it configurable using the installed tools?	0 1 2 3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Is 3D acceleration enabled?	0 3	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	0
	Is hot-plug enabled for USB keyboards? i.e. Can a USB keyboard simply be plugged in and used?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Removable Drives	Is hot-plug enabled for USB mice? i.e. Can a USB mouse simply be plugged in and used?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	If you plug a USB key / stick in, does the OS recognise it and allow it to be used?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	If you plug in a digital camera (USB), is the device mounted and browseable?	0 3	3	0	0	3	3	3	3	0	0	3	3	3	3	3	3	3	0
Removable Drives	Upon inserting a data CD, was the CD automatically mounted and browseable?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Upon inserting a data DVD, was the DVD automatically mounted and browseable?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Was an audio CD recognised?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3 DEVICES & PERIPHERALS (continued)

Local Printers	Does the machine respond to a USB inkjet printer being plugged in?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
	Can the printer be configured for different paper sizes, colours etc.? To what extent?	0 1 2 3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	How easy is it to change printer configuration and settings?	0 1 2 3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2
	Are drivers available either in the package system or on the Internet?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Does the machine respond to a consumer laser printer being plugged in?	0 3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Can the printer be configured for different paper sizes, colours etc.? To what extent?	0 1 2 3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	How easy is it to change printer configuration and settings?	0 1 2 3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2
	Are drivers available either in the package system or on the Internet?	0 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Does the machine respond to an external (DCC) monitor being plugged into it?	0 3	3																
	Does the monitor start in the desired resolution?	0 3	3																
	IF NO TO ANY OF THE ABOVE – was the external monitor configurable?	0 3	3																
	Does the external monitor automatically display a new, or mirrored session?	n/a	0																
	In what way does the machine respond to a hot-plugged USB inkjet printer?	n/a	0	Add Printer Wizard	Add Printer Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard	Printer Config Wizard
	In what way does the machine respond to a hot-plugged laser printer (parallel)?	n/a	0	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
What driver is being used for Ethernet?	n/a	0	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	e1000	
What driver is being used for WIFI?	n/a	0		Laptop Only															
What driver is being used for sound?	n/a	0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	snd_intel8x0	
What driver is being used for video?	n/a	0	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	Intel i810	ati / fg1rx	ati / fg1rx	ati / fg1rx	ati / fg1rx	ati / fg1rx	ati / fg1rx	
Were there any errors and / or warnings during any of the tests in this section?	$-\infty < x \leq 0$ x=	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
What were these due to?	n/a	0	n/a	Failure to configure ethernet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
TOTALS	Points Scored	63	87	54	45	58	53	50	61	60	57	62	60	61	60	60	60	41	
	As % Of Maximum Possible			85.7%	71.4%	92.1%	84.1%	79.8%	70.1%	69.0%	65.5%	71.3%	69.0%	70.1%	69.0%	69.0%	69.0%	47.1%	

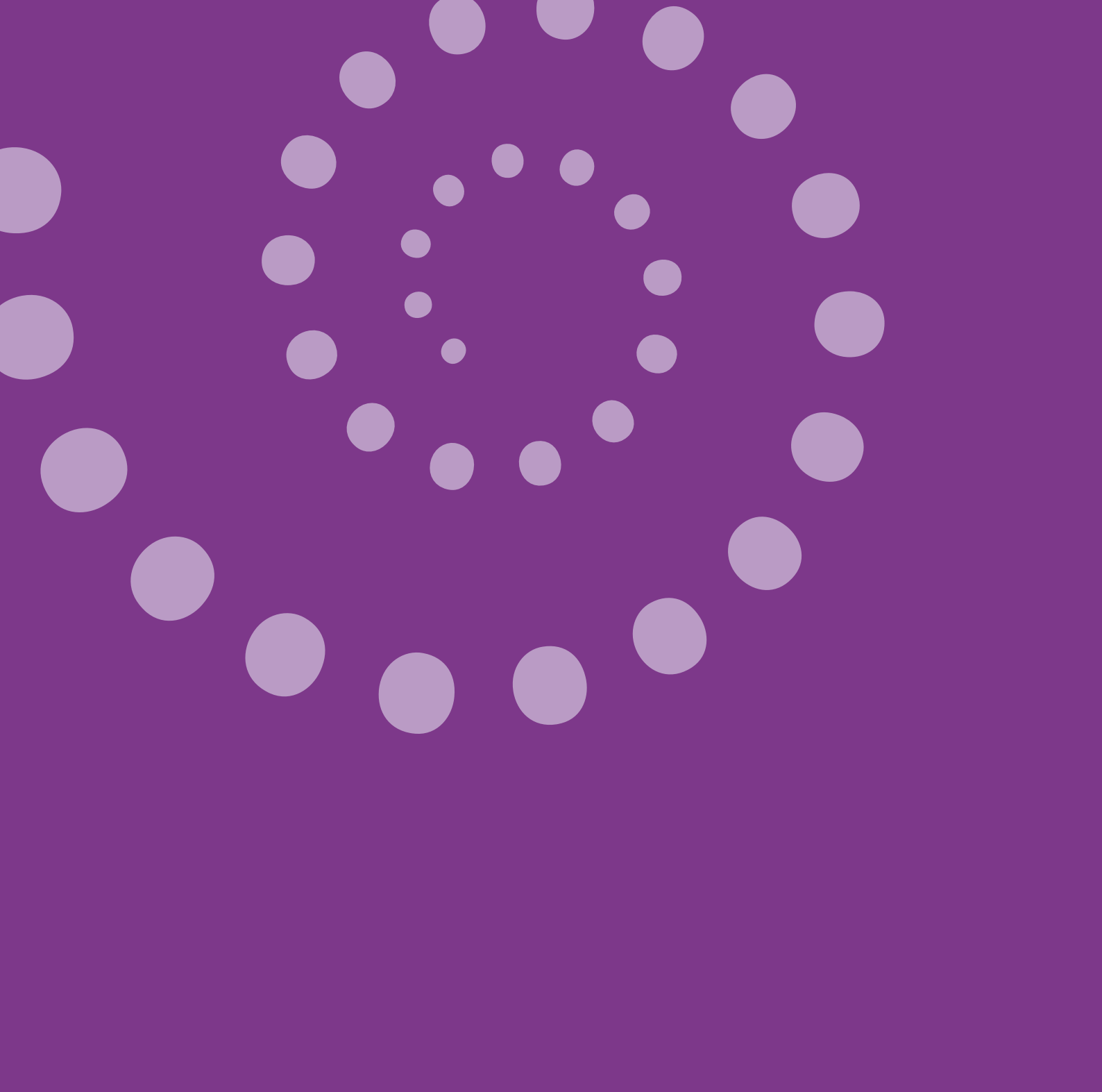
4 APPLICATIONS & FILE-TYPES														
Office Applications	Did all office applications install correctly? Check Ooo.org or koffice appropriately.	0	3	3	3	3	3	3	3	3	3	3	3	3
	Did a PDF reader install correctly? Check evince, gpdf, xpdf Adobe Acrobat etc.	0	3	3	3	3	3	3	3	3	3	3	3	3
	Do office applications provide full support for dictionaries in the selected language?	0	3	3	3	0	3	3	3	3	3	0	3	3
	File Manager Integration													
	Check the following (open from file manager, must be able to open and edit)													
	Ms-Word (.doc)	0	3	3	3	3	3	3	3	3	3	3	3	3
	Ms-Excel (.xls)	0	3	3	3	3	3	3	3	3	3	3	3	3
	Ms-Powerpoint	0	3	3	3	3	3	3	3	3	3	3	3	3
	HTML	0	3	3	3	3	3	3	3	3	3	3	3	3
	JPEG	0	3	3	3	3	3	3	3	3	3	3	3	3
Browser Integration	GIF	0	3	3	3	3	3	3	3	3	3	3	3	3
	TXT	0	3	3	3	3	3	3	3	3	3	3	3	3
	BMP	0	3	3	3	3	3	3	3	3	3	3	3	3
	OGG	0	3	3	3	3	3	3	3	3	3	3	3	3
	WAV	0	3	3	3	3	3	3	3	3	3	3	3	3
	Does the default browser provide a PDF plug-in by default?	0	3	3	3	3	3	3	3	3	3	3	3	3
	Are missing browser plug-ins installable either via the browser or package system?	0	3	3	3	3	3	3	3	3	3	3	3	3
	Which office suite was used?	n/a	0	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 1.1	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 2.0	OpenOffice.org 1.1	OpenOffice.org 1.1
	Which application was used to open PDF?	n/a	0	evince	kpdf	evince	kpdf	evince	xpdf	evince	evince	evince	xpdf	Adobe Acrobat
	Were there any errors and / or warnings during any of the tests in this section?	$-\infty < x \leq 0$	0	0	0	0	0	0	0	0	0	0	0	0
ERRORS & INFO	What were these due to?	n/a	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	Maximum for section	45	45	45	42	45	45	45	45	45	42	45	45	
	As % Of Maximum Possible	24	100.0%	100.0%	93.3%	100.0%	100.0%	100.0%	100.0%	100.0%	93.33%	100.0%	100.0%	
TOTALS	Maximum for section	468	12	15	15	16	18	18	16	15	15	18	18	
	As % Of Maximum Possible		50.0%	62.5%	62.5%	66.7%	75.0%	75.0%	66.7%	62.5%	62.5%	75.0%	75.0%	

5 SYSTEM ADMINISTRATION												
System Tools	Is there a GUI tool to administer user / group accounts?	0	3	3	3	3	3	3	3	3	3	3
	Is there a GUI tool to manage disk partitioning?	0	3	3	3	0	3	3	3	3	0	3
	Is there a GUI tool to handle boot-up behaviour? (run-levels)	0	3	3	3	3	3	3	3	3	3	3
	Is there a GUI tool to monitor system performance? (CPU / disk / memory usage)	0	3	3	3	3	3	3	3	3	3	3
	Is there a tool to add / update software on the system?	0	3	3	3	3	3	3	3	3	3	3
Errors & Info	How easy is it to use the software update tool?	0	1	2	3	3	3	3	3	3	3	3
	Is there an automatic update tool for software?	0	3	3	3	3	3	3	3	3	3	3
	Were there any errors and / or warnings during any of the tests in this section?	$-\infty < x \leq 0$	0	0	0	0	0	0	0	0	0	0
	What were these due to?	n/a	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Maximum for section	21	21	21	18	21	21	21	21	21	18	21
TOTALS	As % Of Maximum Possible	100.0%	100.0%	85.7%	100.0%	100.0%	100.0%	100.0%	100.0%	85.7%	100.0%	

6 NETWORKING												
Windows Networking	Are you able to mount a remote SMB share from the CLI, using the mount command?	0	3	0	0	0	3	3	3	0	0	3
	Can you browse Windows network shares?	0	3	0	3	0	0	0	0	0	0	0
	Can you use Windows networked printers without configuration?	0	3	0	0	0	0	0	0	0	0	0
	IF NO TO ABOVE, can this be configured?	0	3	3	3	3	3	3	3	3	3	3
	Were you able to successfully share a folder out which could be accessed by Windows clients?	0	3	0	0	3	3	3	0	0	3	0
	Were you able to mount a remote SAMBA share from a Unix / Linux machine?	0	3	3	3	3	3	3	3	3	3	0
	Were you able to create a SAMBA share and access it from a remote Unix / Linux machine?	0	3	3	3	3	3	3	3	3	3	0
	Do groupware applications support LDAP lookups?	0	3	3	3	3	3	3	3	3	3	3
	Were there any errors and / or warnings during any of the tests in this section?	$-\infty < x \leq 0$	0	0	0	0	-2	0	0	0	0	0
	What were these due to?	n/a	0	n/a	n/a	n/a	File-manager crash when browsing windows shares	n/a	n/a	n/a	n/a	n/a
TOTALS	Maximum for section	24	24	12	15	15	16	18	12	15	18	

References

1. <http://www.socitm.gov.uk>
2. <http://www.ncc.co.uk>
3. <http://www.opensourceacademy.gov.uk>
4. <http://www.kernel.org>
5. <http://www.gnome.org>
6. <http://www.kde.org>
7. <http://www.openoffice.org>
8. <http://www.ubuntu.com>
9. <http://www.kubuntu.org>
10. <http://en.opensuse.org>
11. <http://fedora.redhat.com>
12. <http://www.novell.com/products/desktop/>
13. There are a number of potential adaptations to this study. For example, to consult the wider open source user community on the design of the test-plan, to consult end users who have limited or non-existent experience in using open source software, and to extend the test to include some of the lesser known up-and-coming distributions possibly including more of the commercial offerings. As the whole test-plan on which this paper is based is made available, parties wishing to extend the study can and are encouraged to do so.
14. As at December 2005
15. <http://www.redhat.com>
16. <http://www.novell.com>
17. <http://www.debian.org>
18. <http://www.gentoo.org>
19. <http://www.nsa.gov/selinux/>
20. ext3 is a journaling filesystem for Linux. For more information, please see the FAQ at <http://batleth.sapientisat.org/projects/FAQs/ext3-faq.html>
21. YaSt – Yet Another Setup Tool was recently released under a GPL license and there are efforts to bring YaSt to other (non-Novell) distributions.
22. <http://www.foolabs.com/xpdf/>
23. <http://www.purl.org/NET/gpdf/>
24. <http://kpdf.kde.org/>
25. <http://www.gnome.org/projects/evince/>
26. <http://www.adobe.com/support/downloads/acrunix.htm>
27. <http://www.gnome.org/projects/nautilus/>
28. SAMBA is GPL licensed software which provides SMB / CIFS compatibility with Microsoft Windows. Please see <http://www.samba.org> for more information.
29. ACPI – Advanced Configuration & Power Interface. The ACPI specification can be found at <http://www.acpi.info/spec.htm>
30. <http://www.ati.com>
31. <https://support.ati.com/ics/support/default.asp?deptID=894&task=knowledge&folderID=27>
32. RPM – RedHat Package Manager – A package management framework developed by RedHat (<http://www.redhat.com>) and adopted by a number of Linux distributions.
33. The desktop environment (GNOME / KDE etc) runs on-top of the Xserver. There are a number of different Xservers for use with the Linux kernel, of which Xorg is currently the most popular. More details on Xorg can be found at <http://www.x.org>
34. 'lspci' is part of the pci-utils package and is a simple command-line based program to list devices in the system on the PCI bus. The pci-utils also provides the PCI ID database. More information on pci-utils and the PCI ID database can be found at <http://atrey.karlin.mff.cuni.cz/~mj/pciutils.shtml>
35. For the next release of Ubuntu / Kubuntu, there are plans to include a graphical installation engine, which should be available around May 2006.





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