K.S.Rangasamy College of Arts & Science

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i SHARE
it is power

Monthly Magazine

Department Of Computer Science UG

Ishare

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Editorial

We would like to wholeheartedly thank our honorable Chairman, Secretary, Executive Director and Principal for their continuous encouragement and constant support for bringing out the magazine. We profoundly thank our Head of the Department for encouraging and motivating us to lead the magazine a successful one right from the beginning. Ishare serves as a platform for updating and enhancing upcoming technologies in Information and Communication. We are grateful to all the contributors to this magazine so far. The magazine has been sent to almost 60 Institutions in and around Tamilnadu. So far we have received feedbacks and appreciations from various Institutions.

We would be very pleased to receive your feedbacks. Please send your feedbacks to ishare@ksrcas.edu

By,

Editorial Board

CONTENT

HUB OF KNOWLEDGE

1. LINUX SERVER HARDENING SECURITY TIPS

Securing your Linux server is important to protect your data, intellectual property, and time, from the hands of crackers (hackers). The system administrator is responsible for security Linux box.

Linux Server Hardening Checklist and Tips

The following instructions assume that you are using CentOS/RHEL or Ubuntu/Debian based Linux distribution.

1: Encrypt Data Communication

All data transmitted over a network is open to monitoring. **Encrypt transmitted data whenever possible** with password or using keys / certificates.

1. Use scp, ssh, rsync, or sftp for file transfer. You can also mount remote server file system or your own home directory using special sshfs and fuse tools.

2. GnuPG allows encrypting and signing your data and communication, features a versatile key management system as well as access modules for all kind of public key directories.

3. Fugu is a graphical frontend to the command line Secure File Transfer application (SFTP). SFTP is similar to FTP, but unlike

FTP, the entire session is encrypted, meaning no passwords are sent in clear text form, and is thus much less vulnerable to third-party interception. Another option is FileZilla - a cross-platform client that supports FTP, FTP over SSL/TLS (FTPS), and SSH File Transfer Protocol (SFTP).

4. OpenVPN is a cost-effective, lightweight SSL VPN.

5. Lighttpd SSL (Secure Server Layer) Https Configuration And Installation

6. Apache SSL (Secure Server Layer) Https (mod_ssl) Configuration And Installation

1.1: Avoid Using FTP, Telnet, And Rlogin / Rsh Services

Under most network configurations, user names, passwords, FTP / telnet / rsh commands and transferred files can be captured by anyone on the same network using a packet sniffer. The common solution to this problem is to use either OpenSSH , SFTP, or FTPS (FTP over SSL), which adds SSL or TLS encryption to FTP. Type the following command to delete NIS, rsh and other outdated service:

yum erase inetd xinetd ypserv tftp-server telnet-server rsh-serve

2: Minimize Software to Minimize Vulnerability

Avoid installing unnecessary software to avoid vulnerabilities in software. Use the RPM package manager such as yum or apt-get and/or

dpkg to review all installed set of software packages on a system. Delete all unwanted packages.

yum list installed

yum list packageName

yum remove packageName

OR

dpkg --list

dpkg --info packageName

apt-get remove packageName

3: One Network Service Per System or VM Instance

Run different network services on separate servers or VM instance. This limits the number of other services that can be compromised. For example, if an attacker able to successfully exploit software such as Apache flow, he / she will get an access to entire server including other services such as MySQL, e-mail server and so on.

4: Keep Linux Kernel and Software Up to Date

Applying security patches is an important part of maintaining Linux server. Linux provides all necessary tools to keep your system updated, and also allows for easy upgrades between versions. All security update should be reviewed and applied as soon as possible.

Again, use the RPM package manager such as yum and/or apt-get and/or dpkg to apply all security updates.

yum update
OR

apt-get update && apt-get upgrade

You can configure Red hat / CentOS / Fedora Linux to send yum package update notification via email. Another option is to apply all security updates via a cron job. Under Debian / Ubuntu Linux you can use apticron to send security notifications.

5: Use Linux Security Extensions

Linux comes with various security patches which can be used to guard against misconfigured or compromised programs. If possible use SELinux and other Linux security extensions to enforce limitations on network and other programs. For example, SELinux provides a variety of security policies for Linux kernel.

5.1: SELinux

SELinux provides a flexible Mandatory Access Control (MAC). Under standard Linux Discretionary Access Control (DAC), an application or process running as a user (UID or SUID) has the user's permissions to objects such as files, sockets, and other processes.

Running a MAC kernel protects the system from malicious or flawed applications that can damage or destroy the system.

6: User Accounts and Strong Password Policy

Use the useradd / usermod commands to create and maintain user accounts. Make sure you have a good and strong password policy. For example, a good password includes at least 8 characters long and mixture of alphabets, number, special character, upper & lower alphabets etc. Most important pick a password you can remember. Use tools such as "John the ripper" to find out weak users passwords on your server. Configure pam_cracklib.so to enforce the password policy.

6.1: Password Aging

The chage command changes the number of days between password changes and the date of the last password change. This information is used by the system to determine when a user must change his/her password. The /etc/login.defs file defines the site-specific configuration for the shadow password suite including password aging configuration. To disable password aging, enter: chage -M 99999 userName

To get password expiration information, enter:

chage -l username

Finally, you can also edit the /etc/shadow file in the following fields:

{userName}:{password}:{lastpasswdchanged}:{Minimum_days}:{Maximum_days}:{Warn}:{Inactive}:{Expire}:

Where,

1. **Minimum_days**: The minimum number of days required between password changes i.e. the number of days left before the user is allowed to change his/her password.
2. **Maximum_days**: The maximum number of days the password is valid (after that user is forced to change his/her password).
3. **Warn** : The number of days before password is to expire that user is warned that his/her password must be changed.
4. **Expire** : Days since Jan 1, 1970 that account is disabled i.e. an absolute date specifying when the login may no longer be used.

6.2: Restricting Use of Previous Passwords

You can prevent all users from using or reuse same old passwords under Linux. The pam_unix module parameter remember can be used to configure the number of previous passwords that cannot be reused.

6.3: Locking User Accounts After Login Failures

Under Linux you can use the faillog command to display faillog records or to set login failure limits. faillog formats the contents of the

failure log from /var/log/faillog database / log file. It also can be used for maintains failure counters and limits.To see failed login attempts, enter:

faillog

To unlock an account after login failures, run:

faillog -r -u userName

Note you can use passwd command to lock and unlock accounts:

lock account

passwd -l userName

unlock account

passwd -u userName

6.4: How Do I Verify No Accounts Have Empty Passwords?

Type the following command

awk -F: '($2 == "") {print}' /etc/shadow

Lock all empty password accounts:

passwd -l accountName

6.5: Make Sure No Non-Root Accounts Have UID Set To 0

Only root account have UID 0 with full permissions to access the system. Type the following command to display all accounts with UID set to 0:

awk -F: '($3 == "0") {print}' /etc/passwd

You should only see one line as follows:

root:x:0:0:root:/root:/bin/bash

If you see other lines, delete them or make sure other accounts are authorized by you to use UID 0.

7: Disable root Login

Never ever login as root user. You should use sudo to execute root level commands as and when required. sudo does greatly enhances the security of the system without sharing root password with other users and admins. sudo provides simple auditing and tracking features too.

8: Physical Server Security

You must protect Linux servers physical console access. Configure the BIOS and disable the booting from external devices such as DVDs / CDs / USB pen. Set BIOS and grub boot loader password to protect these settings. All production boxes must be locked in IDCs (Internet Data Center) and all persons must pass some sort of security checks before accessing your server.

9: Disable Unwanted Services

Disable all unnecessary services and daemons (services that runs in the background). You need to remove all unwanted services from the system start-up. Type the following command to list all services which are started at boot time in run level # 3:

chkconfig --list | grep '3:on'

To disable service, enter:

service serviceName stop

chkconfig serviceName off

9.1: Find Listening Network Ports

Use the following command to list all open ports and associated programs:

netstat -tulpn

OR

nmap -sT -O localhost

nmap -sT -O server.example.com

Use iptables to close open ports or stop all unwanted network services using above service and chkconfig commands.

10: Delete X Windows

X Windows on server is not required. There is no reason to run X Windows on your dedicated mail and Apache web server. You can disable and remove X Windows to improve server security and performance. Edit /etc/inittab and set run level to 3. Finally, remove X Windows system, enter:

yum groupremove "X Window System"

2. COOL OPEN SOURCE SOFTWARES

simpleinvoices

It is a web based invoicing system. It helps me to create quick and nice looking invoices without having to set up too many services on server. All you have to do is install the SimpleInvoices software, enter a biller, a customer details and go creating invoices. You can easily track your finances; send invoices as PDF's and more. It is **the best invoicing set up** for independent IT consultancy business.
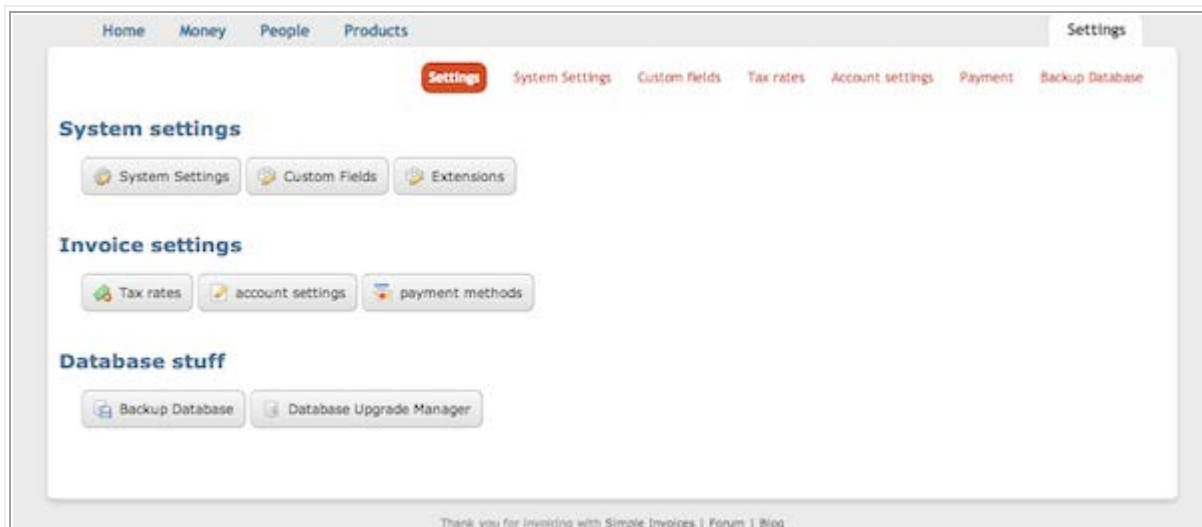
Operating system : Linux/Unix-like/Windows/OSX
Purpose : Invoicing system

Targets : Sole traders/Small business owners
License : Observium License
Similar apps : BambooInvoice - another invoicing software intended for small businesses and independent contractors

❧ *FileZilla - sftp/ftp client for noobs*

This is **a perfect open-source FTP, FTP over SSL/TLS (FTPS) and SSH File Transfer Protocol (SFTP) client** for Windows, Mac OS X and GNU/Linux. It has the following features that new users might find useful:

1. Drag & drop support
2. Tabbed user interface
3. File transfer queue and bookmarks
4. Remote file editing and remote file search
5. SOCKS5 and FTP-Proxy support
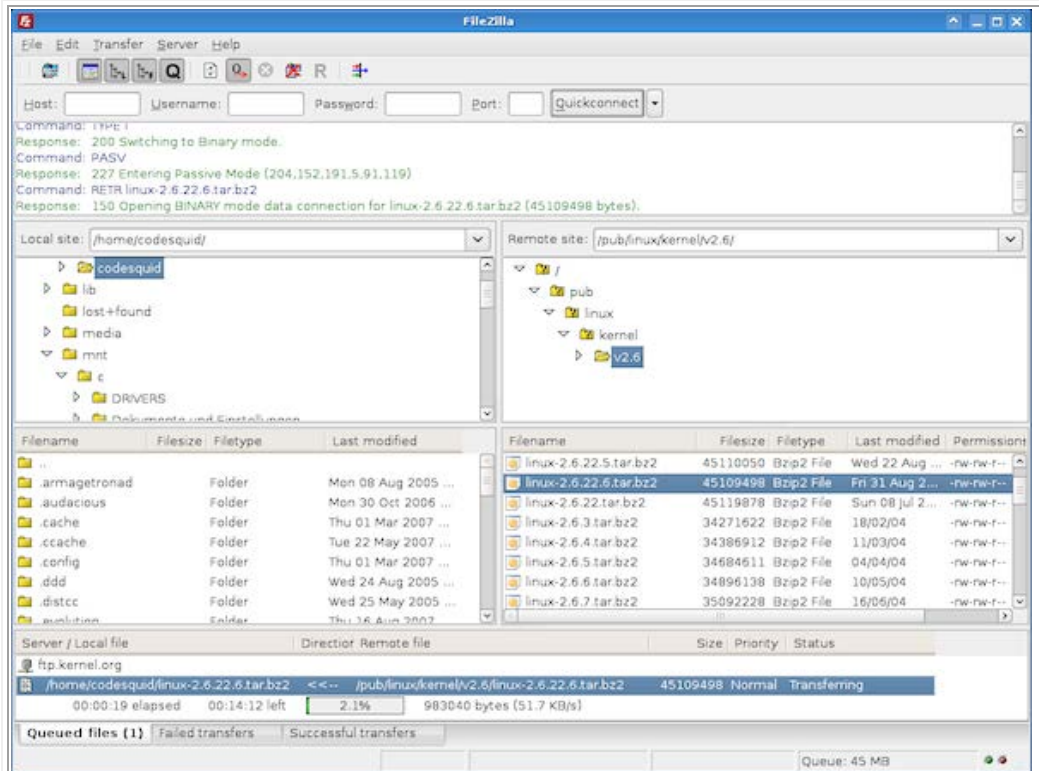
Operating system : Cross-platform
Purpose : FTP client

❧ *WinSCP - Easily transfer file using scp*

It is an open source free SFTP client and FTP client for Windows. Its main function is the secure file transfer between local and server under your control. Most new MS-Windows user find **WinSCP an easier to use as compare to putty and friends**.

Operating system : MS-Windows
Purpose : SFTP/FTP client

ೞ *XAMPP - Easily write and test Apache+MySQL+PHP/Perl apps on desktop*

They can easily setup Apache, MySQL, PHP/Perl to deploy and write an application on their own desktop. No need to install virtual machine and Linux server. Just focus on development and skip real server management job to pros.
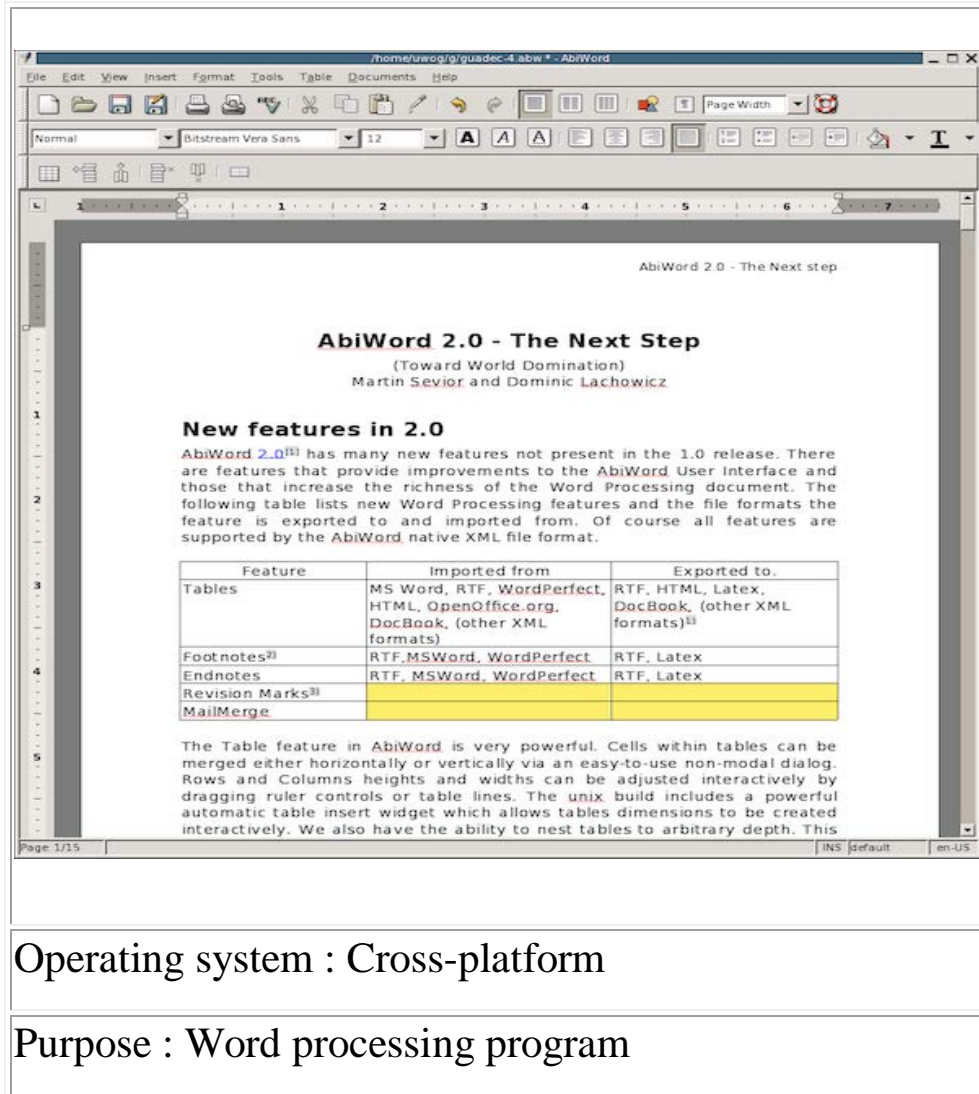
Operating system : Cross-platform
Purpose : Apache distribution for desktop user/developers.

ೞ *Abiword - A nice little word processor*

Many users only use 2% of the features of a program like Microsoft Word. No need to spend money or time on Microsoft Word. Uses of Abiword:

1. Easy to use and not bloated as OO.org.
2. Small size word processor i.e. it loads very fast on my old computer.
3. I can read and write OpenOffice.org documents, Microsoft Word documents, WordPerfect documents, Rich Text Format documents, HTML web pages and more.
4. Abiword is tightly integrated with the AbiCollab.net web service, which lets you store documents online, allows easy document

sharing with your friends, and performs format conversions on the fly.

Operating system : Cross-platform

Purpose : Word processing program

☙ *{less}: The dynamic stylesheet language*

LESS extends CSS with dynamic behavior such as variables, mixins, operations and functions. LESS can run on the client-side and server-side or can be compiled into plain CSS.

```
// LESS                                    /* Compiled CSS */

@color: #4D926F;                           #header {
                                               color: #4D926F;
#header {                                  }
  color: @color;                           h2 {
}                                              color: #4D926F;
h2 {                                       }
  color: @color;
}
```

Operating system : Cross-platform

Purpose : Web developers

❧ *Cinnamon*

Cinnamon is a GTK+ based desktop environment and a fork of the GNOME Shell. It was initially developed by Linux Mint. It offers a user interface with the following features that I needed most:

1. **A movable pane**l equipped with a main menu, launchers, a window list and the system tray
2. Various **extensions and applets**
3. **Cinnamon makes GNOME3 a useful** desktop

Operating system : Linux

Purpose : Desktop user

ও *Tmux*

Tmux is terminal multiplexers for Unix-like platforms. tmux offers several advantages over GNU/screen:

1. Vi or emacs key layouts

2. Multiple paste options

3. Secure code base

4. An option to limit the window size and more.

Operating system : Linux/Unix-like
Purpose : Terminal multiplexer

✑ *Artica - Full SMTP/Mail/Proxy server Appliance in 10 minutes*

It is simple and straightforward software that offers the following features:

1. Proxy server Appliance
2. SMTP server Appliances
3. Mail server Appliances
4. NAS server Appliance
5. Web based management
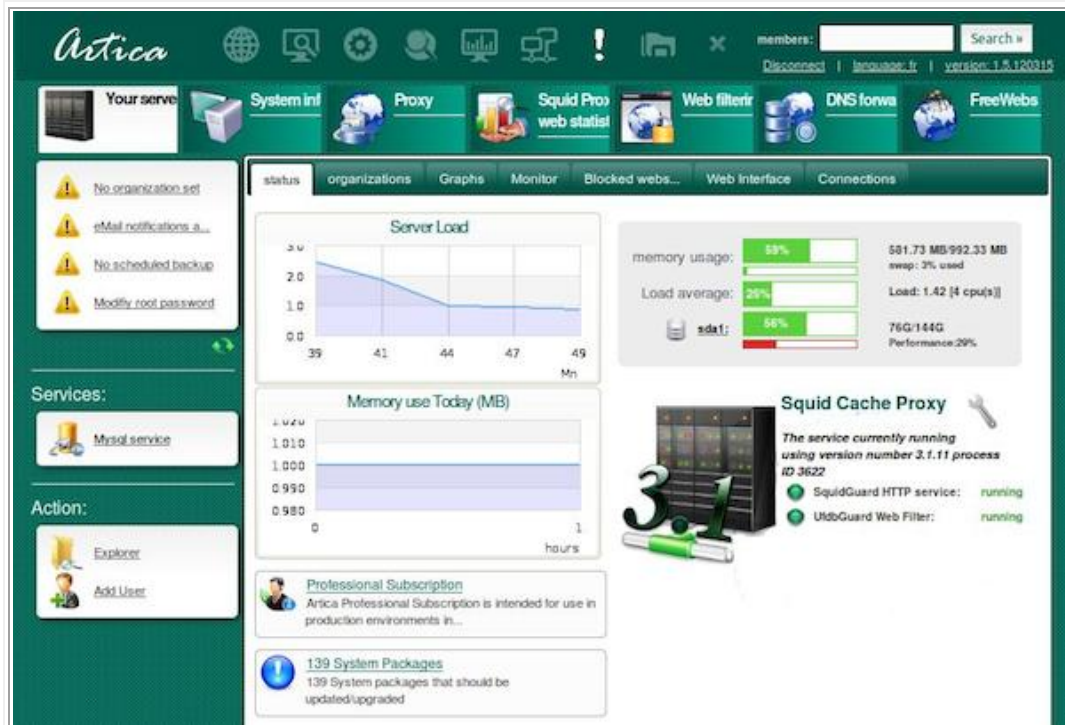
Operating system : Linux
Purpose : Turn normal server into appliances

ଔ *Zentyal small business server*

Zentyal is a **full-featured Linux server for small and medium businesses** that you can set up in less than 30 minutes. It is a **drop-in replacement for Microsoft Small Business Server and Microsoft Exchange Server**. It is easy to use software. Zentyal is based on Ubuntu and it can be installed either from Ubuntu repositories or from Zentyal's own installer.

Operating system : Linux
Purpose : Office server

❦ *Ack-grep - a source code search tool for programmers*

ack-grep is a grep like tool, optimized for programmers. This tool isn't aimed to "search all text files". It is specifically created to search source code trees, not trees of text files. It searches entire trees by default while ignoring Subversion, Git and other VCS directories and other files that aren't your source code.

Operating system : Cross-platform
Purpose : Search source trees

❧ *ditaa - DIagrams Through Ascii Art*

ditaa is a small command-line utility, that can **convert diagrams drawn using ascii art**, into proper bitmap graphics. I use this tool all the time **to draw diagrams and forwarding** them via email or chat session.

```
+---------+     +-------+     +-------+
|         | --+ ditaa +-->  |       |
|  Text   |     +-------+    |diagram|
|Document |     |!magic!|    |       |
|    {d}  |     |       |    |       |
+---+-----+     +-------+    +-------+
    :                            ^
    |          Lots of work      |
    +----------------------------+
```

After conversion using ditaa, the above file becomes:

Operating system : Cross-platform
Purpose : Convert diagrams drawn using ascii art
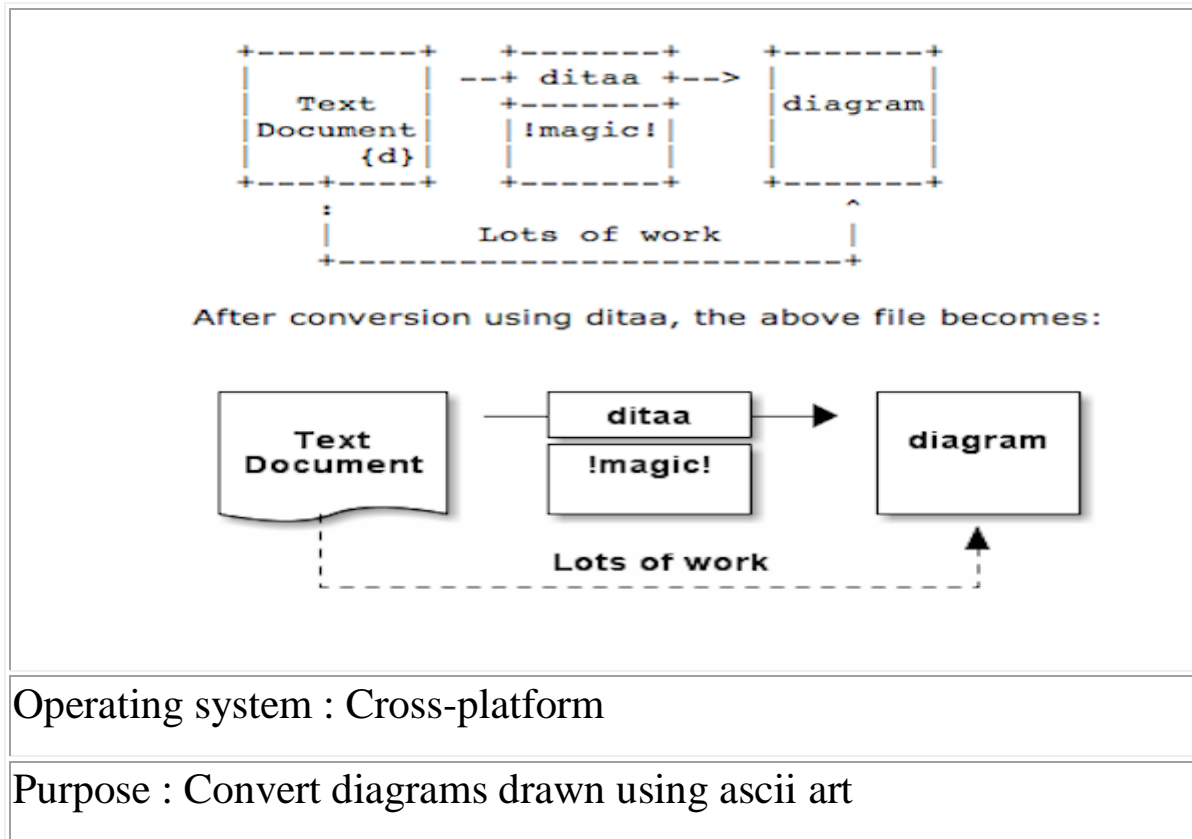
❧ *GNU parallel*

GNU parallel is a shell tool for executing jobs in parallel using one or more computers. If you like xargs command, try GNU/parallel utility. It can run command/script/job on all available CPU's or on multiple computers.

| Operating system : Cross-platform (Perl) |
| Purpose : Execute shell scripts/jobs in parallel |
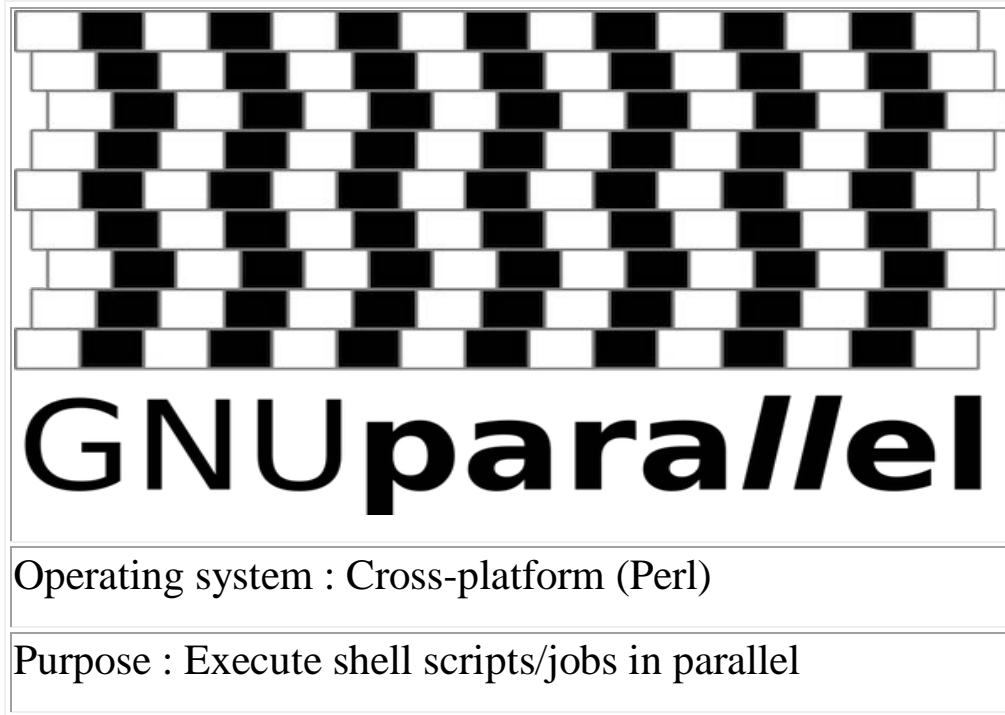
❧ *luckyBackup data back-up and synchronization tool*

luckyBackup is an application for data back-up and synchronization powered by the rsync tool. It is simple to use, fast, safe, reliable and fully customizable backup software.
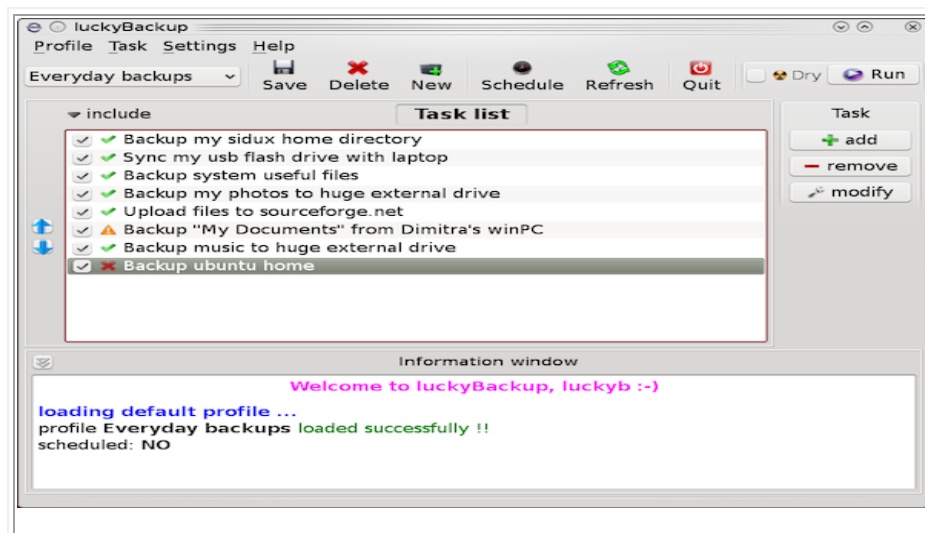
Operating system : Linux/Unix-like
Purpose : Desktop backup

❧ *OpenShot video editor*

OpenShot Video Editor is a free and open-source non-linear video editing software package for Linux. I use this tool to create videos for my youtube channel. It is a stable, free, and friendly to use video editor on Linux.
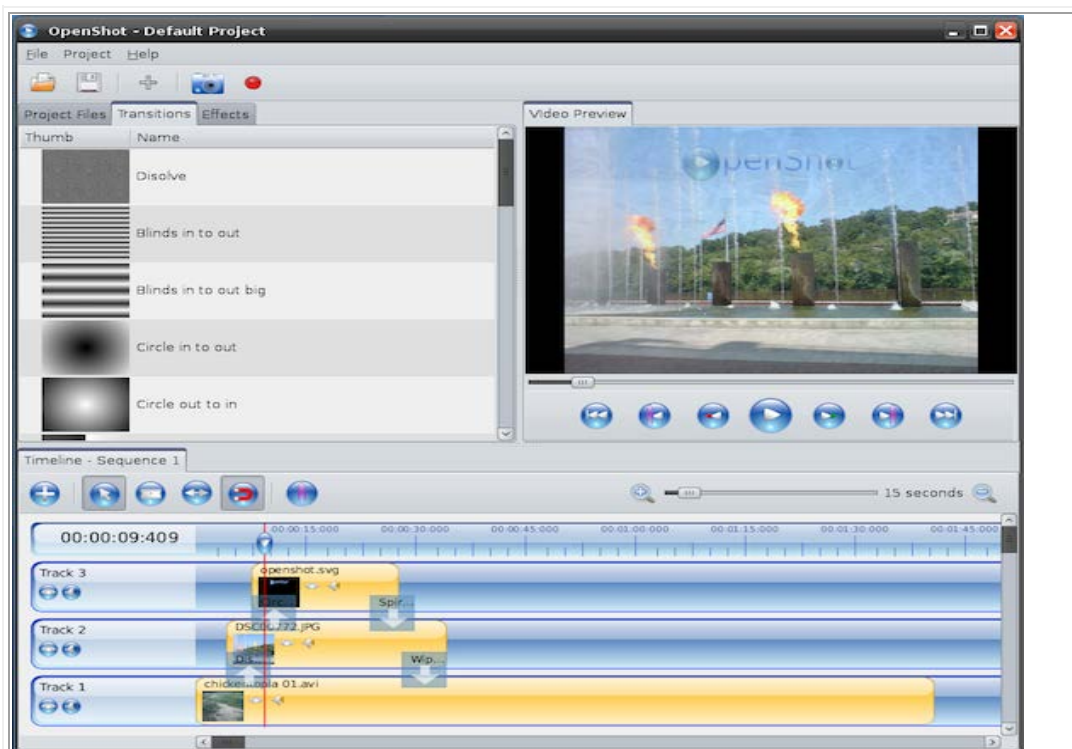
Operating system : Linux
Purpose : Video editing

3. DCIM FOLDER

Every camera — whether it's a dedicated digital camera or the Camera app on Android or iPhone — places the photos in a DCIM folder. DCIM stands for "Digital Camera Images."

The DCIM folder and its layout come from DCF, a standard created back in 2003. DCF is so valuable because it provides a standard layout.

DCF is a specification created by JEITA, the Japan Electronics and Information Technology Industries Association. It's technically standard CP-3461, and you can dig up the arcane standards document and read it online. The first version of this standard was issued in 2003, and it was last updated in 2010.

The DCF specification lists many different requirements with a goal to guarantee interoperability. The file system of appropriately formatted devices — for example, an SD card plugged into a digital camera — must be FAT12, FAT16, FAT32, or exFAT. Media with 2 GB or larger of space must be formatted with FAT32 or exFAT. The goal is for digital cameras and their memory cards to be compatible with each other.

The DCIM Directory and Its Subfolders

Among other things, the DCF specification mandates that a digital camera must store its photos in a "DCIM" directory. DCIM stands for "Digital Camera Images."

The DCIM directory can — and usually does — contain multiple subdirectories. The subdirectories each consist of a unique three-digit number — from 100 to 999 — and five alphanumeric characters. The alphanumeric characters aren't important, and each camera maker is free to choose their own.

For example, Apple is lucky enough to have a five-digit name, so their code is APPLE. On an iPhone, the DCIM directory contains folders like "100APPLE," "101APPLE," and so on.
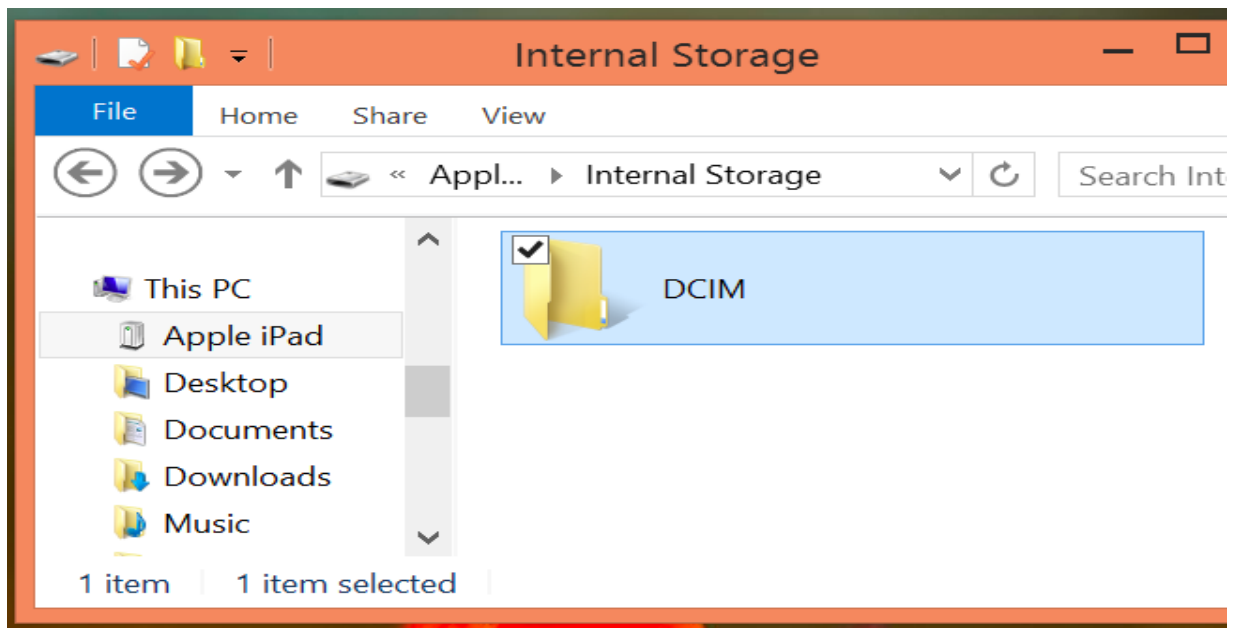
Inside each subdirectory are the image files themselves, which represent the photos you take. Each image file's name starts with a four-digit alphanumeric code — which can be anything the camera maker wants — followed by a four digit number.

For example, you'll often see files named DSC_0001.jpg, DSC_0002.jpg, and so on. The code doesn't really matter, but it's consistent to ensure the photos you take are displayed in the order you took them.

For example, the layout will look something like:

DCIM

- 100ANDRO
  - DCF_0001.JPG

- o DCF_0002.JPG

- o DCF_0003.WAV

- 101ANDRO

- 102ANDRO
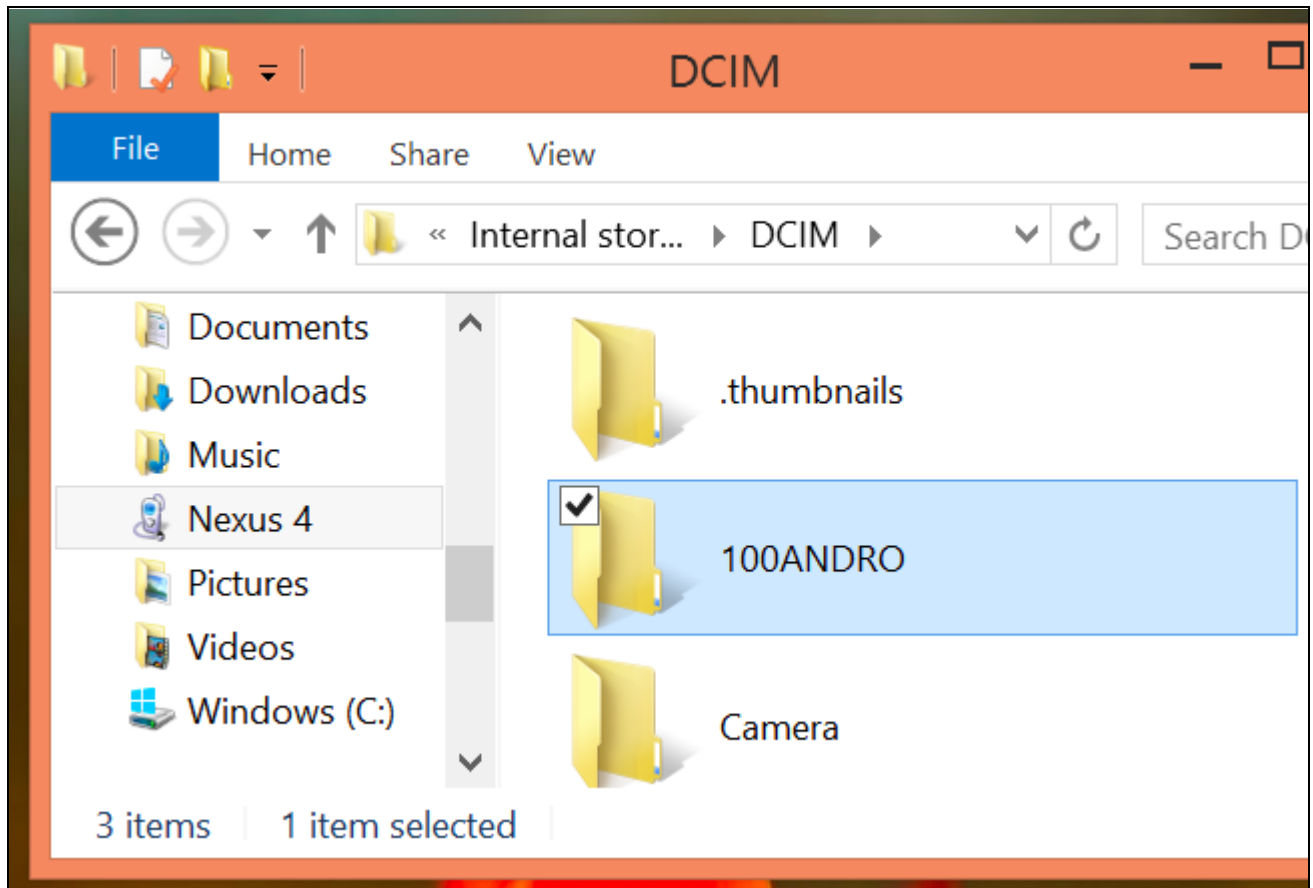
You may also see .THM files that represent the metadata for files other than JPG images. For example, let's say you took a video with your digital camera and it was stored as a .MP4 file. You'll see a DSC_0001.MP4 file and a DSC_0001.THM file. The MP4 file is the video itself, while the .THM file contains a thumbnail and other

metadata. This is used by the camera to display information about the video without loading it.

4. PRESENTATION TOOLS

(Continuation with previous issue)

authorPOINT Lite

Shareware

authorPOINTTM Lite Free PowerPoint to Flash Converter for PPS, PPT to SWF. You can share your presentations online on the web through authorPOINT Lite, by uploading to authorSTREAM, a free online presentation sharing platform, and to WiZiQ, a free online education platform. authorPOINT Lite is Microsoft Windows Vista compatible and Microsoft Office 2007 compatible.

Adobe Encore CS3

Shareware

Create DVDs, Blu-ray Discs, and SWF files that reflect your best work. Packed with a rich set of creative tools, Adobe Encore CS3 helps you create striking DVD and Blu-ray Disc titles and interactive web-based tours for film, business, training, events, and more.

AutoRun Design Specialty

Shareware

AutoRun Design Specialtyis a more powerful visual tool to create professional autorun (autoplay) interfaces and presentations for your CD/DVDs. It is the easiest way to create, edit professional autorun (autoplay) interface and generate autorun files for CD/DVDs in a WYSIWYG environment, just click, point, place and test (preview).

ComponentOne VS FlexGridPro

Shareware

ComponentOne VSFlexGrid™ Pro makes customizing the display and presentation of dynamic data easier than ever! With a full range of features, you can quickly build flexible, robust front-ends for database applications. Customize the grid's display and presentation with a host of new ways to display, edit, format, organize, summarize, and print tabular data.

Microsoft PowerPoint

Commercial

Create attention-grabbing slides quickly, collaborate with team members on your presentations, and share them live or online.

SesamTV Media Center

Shareware

SesamTV Media Center is free friendly multimedia-player software designed to help you create your own digital home.

RealPlayer Plus

Commercial

RealPlayer Plus is the perfect choice when you need to: Burn your videos to DVD and watch on TV with your friends and family. Transfer videos to your iPod and watch them wherever you go. RealPlayer lets you download YouTube videos with one mouse click - works on thousands of other video sites, too.

AutoRun Typhoon

Shareware

AutoRun Typhoon is a Multimedia Presentation tool that integrates Menus, Web Sites, PDF files, PowerPoint presentations, videos, slideshows. You can create your own templates or select from a large number of templates and choose from a dozen objects to add to your Menu, including Buttons.

ImageToAVI

Shareware

ImageToAVI will quickly convert a list of image/picture files into an AVI video. That video can then be loaded into your favorite DVD

authoring program and burned to disc. Just imagine, your entire family photo collection converted to everlasting 1's and 0's.

Photo Snap

Shareware

Photo Snap is an image and multimedia viewer that helps you quickly locate, edit, print, send and receive pictures over the Internet. You can add 3D text and geometric shapes to your pictures, convert between various image formats, play audio and video files.

Proteus VX

Freeware

The Proteus VX is a professional desktop sound module based on the Proteus sound modules and Emulator samplers. It has got features like Phase Locked Stereo signal path, Up to 192 kHz sample rate, 54 different filter types including multi-pole resonant filters, phasers, flangers, vocal filters and multi-parameter morphing filters, etc. Proteus VX is now available as a freeware.

Momento

Freeware

Momento is a lightweight and powerful application that enables you to preserve your favorite photo memories in a photo book. The

program also allows you to design greeting cards, calendars, diaries notables and gift vouchers. You can use the built in designed templates or create your own styles.

Easy WebTV & Radio

Shareware

This is the best internet, television and radio software in the world. With this software you can play hundreds of games with easy webTV and radio built in games function, from old school classics to brand new titles. This easy webTV and radio deliver outstanding streaming television, radio and other media is now directly to your PC or Laptop.

Photo SlideShow Maker

Freeware

Turn digital photos into your own SlideShow! Photo SlideShow Maker helps to make SlideShow quickly with accompanied music and various transition effects. As a result you can get a standalone executable (.exe) file with music, images inside.

IntroCreator

Shareware

IntroCreator makes it incredibly easy to create self-running multimedia presentations of your products, company or business activities from sound, image and text elements. A player is included for

playing the created presentations. The player can be reproduced without restrictions and will run immediately on all Win32 systems (Win95...XP) without having to be installed.

Ovation

Shareware

This program enhances the look of slides generated by Microsoft Power Point through the use of themes, called "PowerLooks", gentle motion, high-resolution text, and dynamic TV-style transitions. It is also possible to use Ovation´s built-in presentation tools to generate special slides that will be inserted in the presentation (Walk In, Walk Out, Heading, Subheading, and Intermission).

CD Autorun Creator

Shareware

Create professional autorun programs for your CD, DVD or USB flash drive. CD Autorun Creator offers fast and efficient way of building autorun programs. You can build your own autoruns within few minutes. All you have to do is import your favorite media files such as MP3s and photos in CD Autorun Creator, set command buttons, splash and exit screens, set effects etc.

Media Show Pro

Media Show Pro creates presentation in stand-alone .EXE file. Using a clean-looking, intuitive interface, you select pictures from any combination of folders on your system. The program allows to use beautiful transition effects and background music.

Snazzi PVR Pro

Freeware

Experience a first true 10-foot User Interface like a remote-controllable TV and manage your collection for Videos, Photos and Music besides watching & Recording TV. All these features make SnaZio*, a best companion for your Media Center Edition. Bring Digital TV Entertainment to your Windows Media Center Edition 2005

MASH

Bring your Desktop to Life with Microsoft Agent Animated Talking Characters in 11 Languages! Easily record and playback entertaining character presentations by simply dragging characters around the screen and directing what they say and do.

Microsoft Office Live Meeting

Commercial

Microsoft Office Live Meeting is an online collaboration and Web conferencing service that empowers business people to conduct real-time, interactive presentations and meetings over the Internet. Live

Meeting is the first fully hosted service within the new Microsoft Office System, which is scheduled to launch next month and is delivered by PlaceWare Inc., a wholly owned subsidiary of Microsoft. Live Meeting is a major upgrade to PlaceWare's Conference Center and offers an easy and intuitive Windows-based interface with powerful new presentation, scheduling and administration features. Live Meeting offers a native-based desktop console that follows familiar conventions of Windows-based software, making it easy to learn and use, and provides more flexible controls for meeting presenters. The new service also delivers rich, full-screen viewing options for meeting participants and feedback tools such as chat and a question/answer manager to make online meetings more engaging and productive. Subscribers also receive powerful scheduling and administration tools, and the option of customizing the service to include their own branding.

MDI Viewer

Shareware

MDI is a proprietary format - the specifications have not been made public by Microsoft, and MDI files can only be produced or read by certain Microsoft software, in particular the Microsoft Office Document Imaging (MODI) module included in Microsoft Office 2003 and later versions.

Acoolsoft PPT to Video Pro

Shareware

Acoolsoft PPT to Video Pro allows you to convert your PowerPoint presentations to video files. You can convert one or more files at the same time, and set the video settings and playback options with just few steps. There supported formats are PPTX, PPT, PPSX, and PPS. The output format selection is very easy.

PPT To Flash Catalog Professional

 Shareware

PPT to Flash Catalog Pro is a all-in-one solution page turning catalog software which can make PowerPoint flip and create page-flipping PowerPoint catalog with various multimedia object such as video, flash, audio, sound etc. What's more, it has strong edit functions include adding link, photos slide and so on.

Slideshow Magic

Demo

Easily add an audio track to the entire slideshow, or add smaller audio clips for each segment. Include transitions with varying durations between slides, and even insert customizable titles. Features: - Complete UTF-8 support; - Cross-platform compatible file format; - Frame titles; - Audio track; - Sound effects.

Tourweaver Professional Edition

Shareware

Tourweaver is a program for creating virtual tours. It supports flash player engine, Google maps, etc. The pro. version support more features such as 3D objects, online Youtube video, and Popup window. You can publish the results as Flash VR, HTML 5, *.exe, and *.swf files.

muvee photoFamily stylePack

Commercial

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5. COUNTING PEOPLE WITH WIFI

Our approach can estimate the number of people walking in an area, based on only the received power measurements of a WiFi link,'

said Mostofi, a professor of electrical and computer engineering. This approach does not require people to carry WiFi-enabled telecommunications devices for them to be counted, Mostofi emphasized.

To accomplish this feat of people-counting, the researchers put two WiFi cards at opposite ends of a target area, a roughly 70-square-meter space. Using only the received power measurements of the link between the two cards, their approach can estimate the number of people walking in that area. So far, they have successfully tested with up to and including nine people in both indoor and outdoor settings. The findings of Mostofi's research group are scheduled for publication in the *Institute of Electrical and Electronics Engineers Journal* on selected areas in Communications' special issue on location-awareness for radios and networks.

'This is about counting walking people, which is very challenging,' said Mostofi. 'Counting this many people in such a small area with only WiFi power measurements of one link is a hard problem, and the main motivation for this work.'

This people-counting method relies in large part on the changes of the received wireless signal, according to the researchers. The presence of people attenuates the signal in the direct line of sight between the WiFi cards if a person crosses the line of sight, and human bodies also

scatter the signal -- resulting in a phenomenon called multi-path fading -- when they are not in the direct line of sight path. By developing a probabilistic mathematical framework based on these two key phenomena, the researchers have then proposed a way of estimating the number of people walking in the space.

With the near-ubiquity of WiFi in many settings, the researchers' findings have the potential for many diverse applications. For instance, the ability to estimate the number of people in a given space could be used in smart homes and buildings, so air conditioning and heating could be adjusted according to the level of occupancy. 'Stores can benefit from counting the number of shoppers for better business planning,' noted Mostofi.

Security and search-and-rescue operations could also take advantage of occupancy estimation. Previous work in the research lab involved imaging stationary objects/humans through walls with WiFi signals, and Mostofi plans to eventually bring the two projects together in the future.
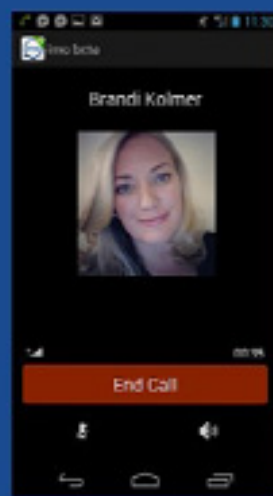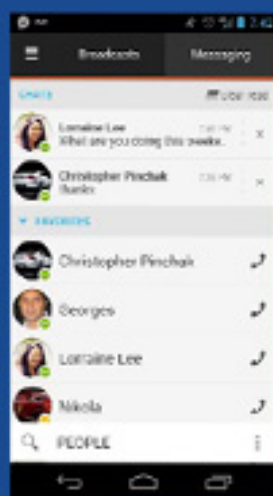
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