Linux For Embedded Systems

For Arabs

Course 102:

Understanding Linux

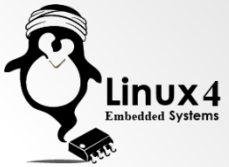
Ahmed ElArabawy

Linux4
Embedded Systems

Lecture 22:
Package Management

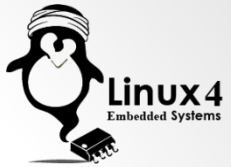
How to Install S/W in Linux ??

- **Build from the source code**
  - Need to download the software and compile it to generate the binaries/libraries
  - Usually, it is a straight forward task, and sometimes, there are a few tricks needed
  - In some cases, this is the only option (we only have the source)
  - Useful when installing non-official releases
  - Useful for installing on some embedded targets (non x86 Processor)
- **Install a pre-prepared Package**
  - The software may be pre-prepared in a package that is ready for installation
  - Only applicable to official releases
  - Packages depend on the used Linux distribution
    - Debian based distributions (like Ubuntu) they come in ***.deb***
    - Red Hat based distributions (like Fedora) they come in ***.rpm***



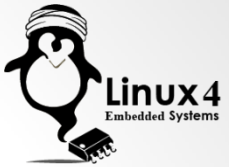
Build From the Source Code

Installing Software from the Source Code



- Download the source code
  - Simple download of a **zip** or **rar** file, then extract the source code
  - Download via some SW configuration tool (**svn**, **git**, …)
- Check the readme file that comes with the source code for the instructions to build and install the package
- The readme file should outline any adjustments needed to be done before building the source
- It should also outline any dependencies required for this code to run

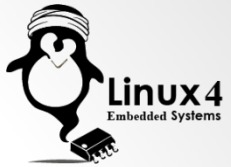
Using Software CM Tools



- Source code is normally maintained inside some Configuration Management Tool
- These tools are used to maintain changes, and revisions, and access by multiple users
- Most Common tools are **git**, **SVN** (Subversion)
- Other tools exist such as **Bazzar**, **Mercurial**, …etc
- Common sites for hosting source code for Open Source Projects,
  - **GitHub** (https://github.com/)
  - **Google Code** (https://code.google.com/)
- To download the source code from these tools, you will need special commands

```
$ git clone https://github.com/adafruit/Adafruit-Raspberry-Pi-Python-Code.git
$ svn checkout http://svn.wikimedia.org/svnroot/mediawiki/branches/REL1_23/phase3
```

Installing Software from the Source Code



- Typical steps are:
  - Perform any configuration changes
  - Go to the proper directory that contain the **Makefile**
  - For the configurations to take effect, run,

    $ make config
  - Build the code via,

    $ make
  - Install the binaries and libraries in the proper places in the tree hierarchy via,

    $ sudo make install
- Note:
  - To be able to perform these steps, you must have the tool-chain properly installed and setup
- The installed binary may still not run because it needs some **shared libraries** in its operation

So what are Shared Libraries ?

- Normally the program functionality are located in:
  - The program source code (functionality specific to this program)
  - Some pre-compiled Libraries (functionality that is used by multiple programs, such as printing, writing to files, …)
- Hence the program needs to be **linked** to some libraries to perform its task
  - This linking can be **Static** (during build time, the library is packed into the image of the binary of the program)
  - Or it can be **Dynamic** (At run time, the program is linked to the library)

Static versus Dynamic Linking

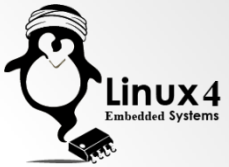
- **So why do we use Dynamic Linking ??**
  - To keep the binary image size smaller
  - Since multiple programs may be using the same library, it makes no sense to include it in each and every one of them
  - Also, as the different programs loaded in memory, they need less memory
  - Upgrade in functionality and bug fixing of the library does not require re-building of all the programs using this library

- **Why do we use Static Linking ??**
  - To remove dependencies (the program has everything it needs to run)
  - To make sure we are using a specific version of the library (to avoid conflicts)

How Does Dynamic Linking Happen

- When the program runs, the program binary is checked by the **Dynamic Linker** (***ld.so***)
- The Dynamic linker checks for dependencies on shared libraries
- It also tries to resolve these dependencies by locating the required libraries and linking it to the program binary
- If the Dynamic linker fails to find a library, the program fails to run
- **So, how does dynamic linker finds the required libraries ??**

Dynamic Linker Finds the Libraries,



Via Library Path Environment Variable:

- It checks the environment variable ***LD_LIBRARY_PATH***, which contain a list of directories (separated by a colon "**:**") that contain the libraries

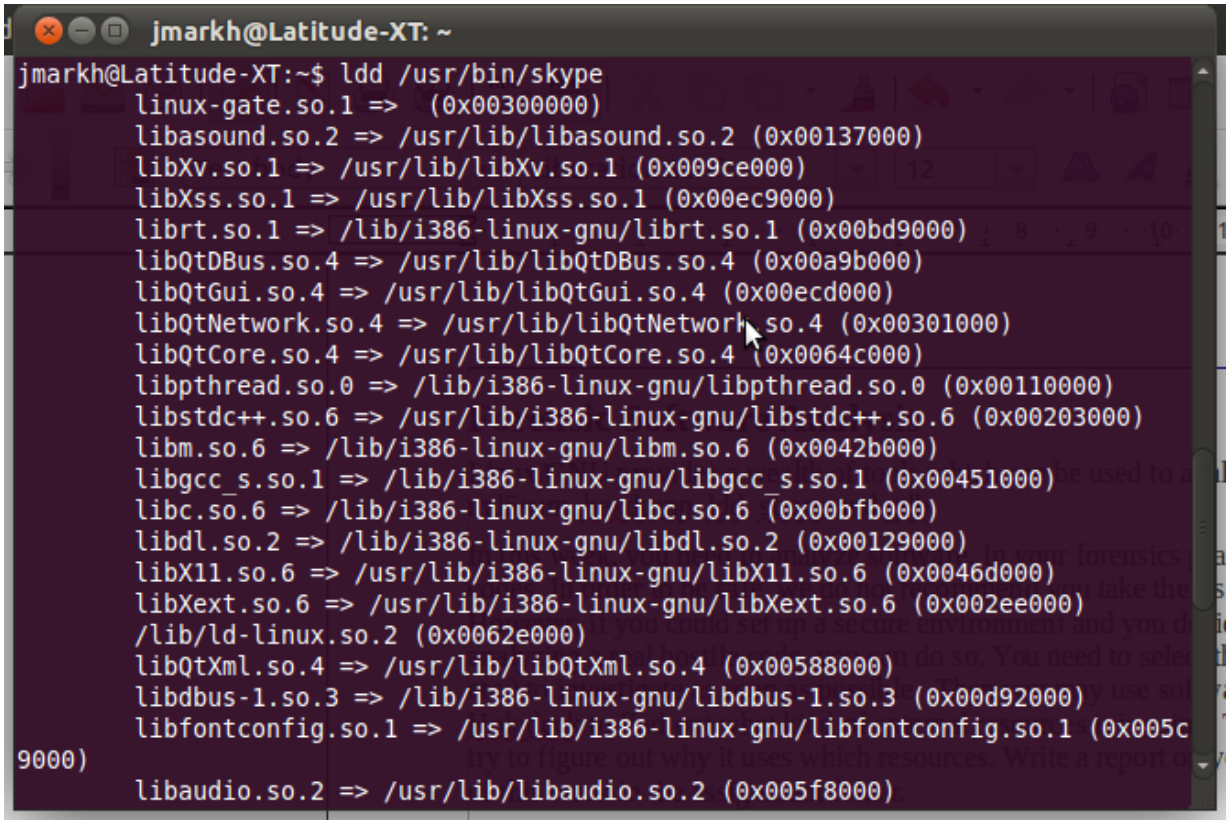
Via Dynamic Linker Cache

- The dynamic linker cache is a binary file (***/etc/ld.so.cache***)
- It contains an index of libraries and their locations
- It provides a fast method for the dynamic linker to find libraries in the specified directories
- To add a directory to the dynamic linker cache,
  - Add the directory path to the file ***/etc/ld.so.conf***
  - Run the utility ***ldconfig*** to generate the binary cache

Finding the Required Libraries (The ldd Command)

$ ldd <program>

- This command lists the required libraries (along with their location) for this program
- M



Managing the Dynamic Linker Cache File (The ldconfig Command)

$ ldconfig

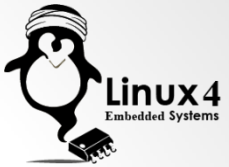
$ ldconfig <Library Directories>

- This command is used to display contents, or build the Dynamic Linker Cache file (***/etc/ld.so.cache***)
- To display the cache contents

  $ ldconfig -p
- To build the cache from the ***/etc/ld.so.conf*** file (in addition to ***/lib*** and ***/usr/lib***)

  $ ldconfig
- To build the cache as above, with the addition of /usr/local/lib,

  $ ldconfig /usr/local/lib

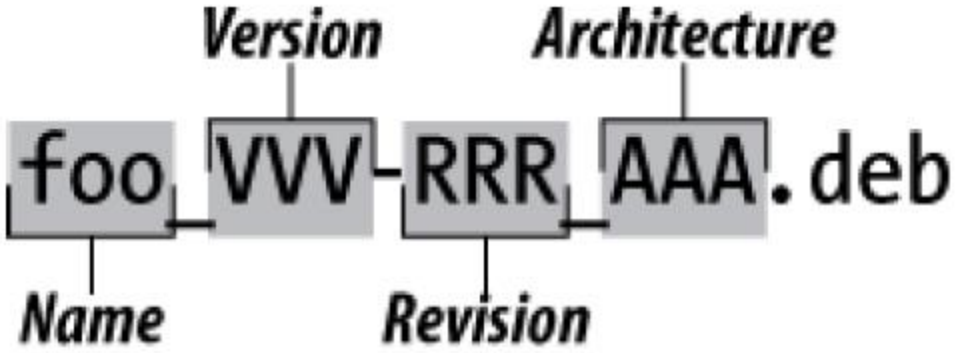


Using a Pre-prepared Software Package

Software Packages

- A Software Package is an archive of files that contains,
  - The binary files to be installed (previously built)
  - Any configuration files needed for the application
  - Meta data about the package (including a list of dependencies)
  - Pre/post installation scripts
- Packages are available,
  - Individually on internal sites (a package file with extension ***.deb*** or ***.rpm***)
  - Among a group within common repositories (collection of packages)
- Tools and package format is dependent on the Linux distribution (we will focus on Debian based distributions)

Debian Package File Name Format



- The package name normally contains words separated by hyphens
- The package version is normally composed of 3 numbers separated by dots, in the format **major.minor.patch**
- The Architecture is normally to state what kind of processor this package is targeting
- Examples are

  gedit-common_3.10.4-0ubuntu4_i386.deb

  gnome-user-guide_3.8.2-1_all.deb

  Libfile-copy-recursive-perl_0.38-1_all.deb

How to Install a .deb Package File (dpkg Command)

$ dpkg -i <package file>

$ dpkg -r <package name>

- To install .deb file, we use the tool ***dpkg***
- If we have a package named "my-package", and it has the package file name **my-package_1.8.0_i386.deb**
- If we download the package file, we can install it as follows,

  $ sudo dpkg -i my-package_1.8.0_i386.deb
- If we later decide to un-install the package, we do,

  $ sudo dpkg -r my-package

Showing Package Information

- To list all installed packages
  $ dpkg --list

- To show all files inside a package
  $ dpkg -L <package name>

- To determine if a package is installed or not
  $ dpkg --status <package name>

- To find out which package installed a certain file
  $ dpkg --search <file name>

- Note that dpkg keeps its information in files in the directory ***/var/lib/dpkg***
- For example,
  /var/lib/dpkg/available List of available packages
  /var/lib/dpkg/status Status of packages (installed, marked for removal,..)

Great…. So What is the Catch ??

- As we have shown, the dpkg tool takes care of installing a package file
- However, there is a problem,
  - A lot of packages have **dependencies**, for package A to work, package B with a specific revision must be installed
  - The user needs to know the dependencies and perform the required pre-requisites before installing the desired package
  - This makes the process too complicated and very error prune
- We need a high level tool that takes care of dependency resolution
  - It should be able to query for the required dependencies
  - Then it should perform the needed installations
  - Then it installs the desired package
  - All of this in a transparent way without user intervention
- This resulted in the tool "Advanced Packaging Tool" or ***apt***

What is “apt”

- “apt” is a set of high level tools for installing software packages in Debian based Linux distributions
- It is composed of several tools,

  $ apt-get

  $ apt-cache
- It hides a lot of details from the user,
  - User does not need to download the package file
  - User does not even need to know the package file name, or release number
  - All user needs to know is the “package name”
  - User does not need to know about the package dependencies, or do anything to satisfy for them
  - All is done for the user in a transparent way

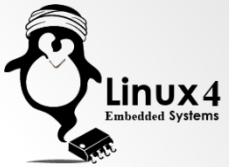
Installing Packages using apt (apt-get install Command)

- To install a certain program or library, all you need is to know the name of the package that contains it
- If you don't know it, you can find the package name via some web search
- Then use the command:

  $ sudo apt-get install <package name>

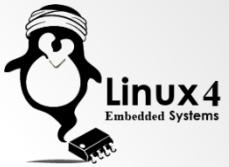
- The **apt** tool then performs all the necessary steps
- This includes,
  - It identifies the latest version for the package to be installed
  - It identifies any pre-requisites for the package (along with the needed version number of each of them)
  - It calculates how much disk space needed for the installation of the package
  - It prompts the user to approve the installation before it is done
  - If user approve the installation, the tool downloads all the needed files from the internet if not available locally on the machine
  - Then the installation procedure is performed
- So how does **apt** does all of that ???

Software Repository



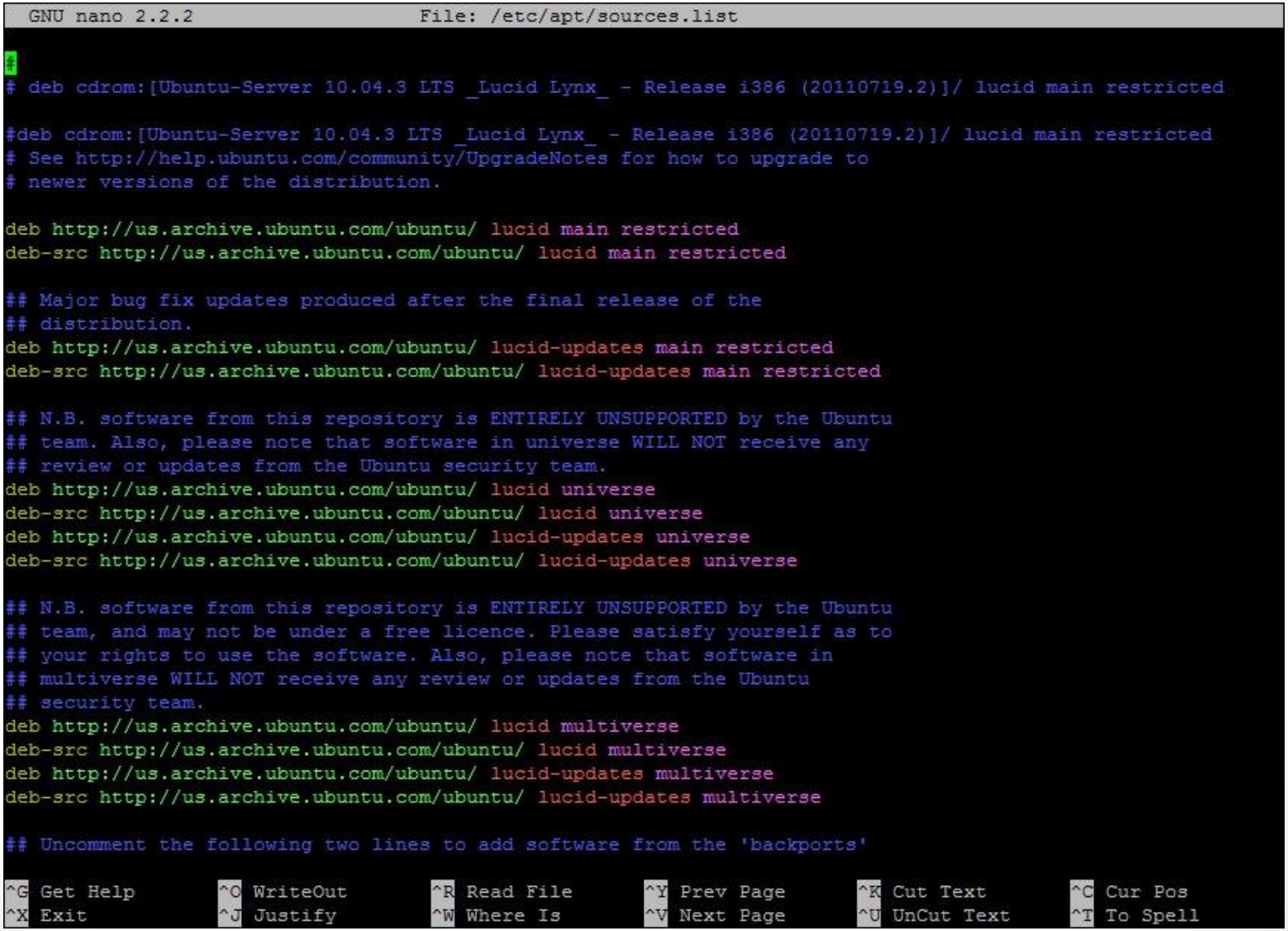
- Normally package files are not stored isolated
- Packages are grouped in big archives called **“Package Repositories”**
- A repository is a collection of packages along with some index file to organize them
- The ***apt*** tool keeps track of which repositories to search for the desired package
- This is done via a configuration file **/etc/apt/sources.list**
- This configuration file contains a list of the URLs for the servers containing the different repositories to search for packages

Example: Repositories for Ubuntu



- Ubuntu for example comes with a set of repositories
- The URLs of the mirror servers containing those repos are listed in **/etc/apt/sources.list**
- Software packages in Ubuntu repositories are divided into 4 categories,
  - **Main:** Contain open-source free packages supported by ubuntu, and comes installed with the distribution
  - **Restricted:** Contain proprietary software needed by Ubuntu. This include hardware drivers which does not have an open-source replacement
  - **Universe:** Contain all available open source software. Not supported by Ubuntu
  - **Multiverse:** Contain proprietary software that is not supported by Ubuntu (install on your own responsibility)

/etc/apt/sources.list



/etc/apt/sources.list

- The apt tools use this file to identify the list of repositories to search for software packages
- User can add/remove repositories by editing this file
- The file contains a list of lines
  - Starting with **deb** means these are binary packages
  - Starting with **deb-src** means that these are a source code packages (useful for developers)
  - Following the URI for the repository,
    - Name of the distribution
    - Available components (main, restricted, universe, multiverse,….)
- Note:
  - To find out the name of the Distribution Release use the command,

    $ lsb_release -sc
  - Examples:
    - Ubuntu 14.04 has the name TRUSTY TAHR (or **TRUSTY**)
    - Ubuntu 12.04 has the name PRECISE PANGOLIN (or **PRECISE**)

Modifying /etc/apt/sources.list

- You can modify the file by opening it in a text editor

  $ sudo vi /etc/apt/sources.list

  - Then add any new repositories
  - Comment out or remove any obsolete repositories
- But it is recommended, to use this command to add a repository to the file (to avoid corrupting the file)

  $ sudo add-apt-repository "<line to be added to the file>"

  - Example

  $ sudo add-apt-repository "deb http://us.archive.ubuntu.com/ubuntu/ precise universe"

- However, note that, editing the file does not result immediately in changes taking effect, you will need to update the apt database of packages

Updating the package database (apt-get update Command)

$ apt-get update

- This command causes ***apt***, to rebuild its package database
- It goes into the ***/etc/apt/sources.list***
  - Queries each repository for the packages it contain
  - For each package, get,
    - Latest release number
    - Size
    - Dependency list
- Then it builds its internal database with this info
- When it is required to perform an installation, ***apt*** refers to its internal database
- Accordingly, it is advisable to perform an update every now and then to make sure we are using the latest set of packages
- Also, we need to perform an update, whenever the list of repos is changed

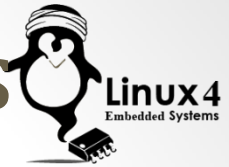
Upgrading the Installed Packages (apt-get upgrade Command)

$ apt-get upgrade

- This command
  - Checks the apt internal database
  - Compares the installed packages release numbers with the ones in the database
  - If any of the installed packages is outdated, it will install the newer version
  - If the newer version has a new dependency or conflict, it will not upgrade it (no new dependency is installed)
- Note that, since this command uses the ***apt*** internal database, it is advisable to refresh it before calling the command
- This is done via calling

  $ sudo apt-get update

Upgrading the Installed Packages (apt-get dist-upgrade Command)



$ apt-get dist-upgrade

- This command is similar to

  $ apt-get upgrade

- The only difference is that if dist-upgrade finds out that the new version of the installed package requires a new dependency, or no longer need a specific dependency, it will install/remove the modified dependencies
- This means, that some packages will be installed or removed as a result of upgrading the installed packages
- If you need to know what action needs to be taken before it is actually taken, use this command first,

  $ sudo apt-get check

  - This will Perform an update, then performs a diagnostic for the broken dependencies

Un-Installing Packages

- To Un-Install a package, and keeping the Configuration files (for future re-installation)

  $ sudo apt-get remove <package name>

- To Un-Install a package, and remove the Configuration files

  $ sudo apt-get purge <package name>

- To remove packages that are no longer needed (they were installed as dependencies but no longer needed)

  $ sudo apt-get autoremove

Getting Package Information

- To search packages for a keyword

  $ apt-cache search <keyword>

- To get info about a specific package

  $ apt-cache show <package name>

  - Information include version, size, dependencies, conflicts

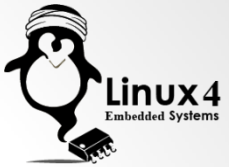
- To get the list of all installed packages

  $ apt-cache pkgnames

- To get the policy of the package … main, universe,….

  $ apt-cache policy <package name>

The Package Archive /var/cache/apt/archives



- This folder is used by the ***apt*** tool as a cache for the package files
- When installing a package, apt downloads the package file in this directory
- Accordingly, and since the package files are big in size, to save disk space, we sometimes need to delete these files

$ sudo apt-get autoclean

- Removes the .deb files for packages from ***/var/cache/apt/archives*** that are no longer needed

$ sudo apt-get clean

- Removes all .deb files from ***/var/cache/apt/archives***
- This may be undesirable, since some of the packages will need to be re-downloaded when you need to install them

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