Linux For Embedded Systems

For Arabs

Cairo University
Computer Eng. Dept.
CMP445-Embedded Systems

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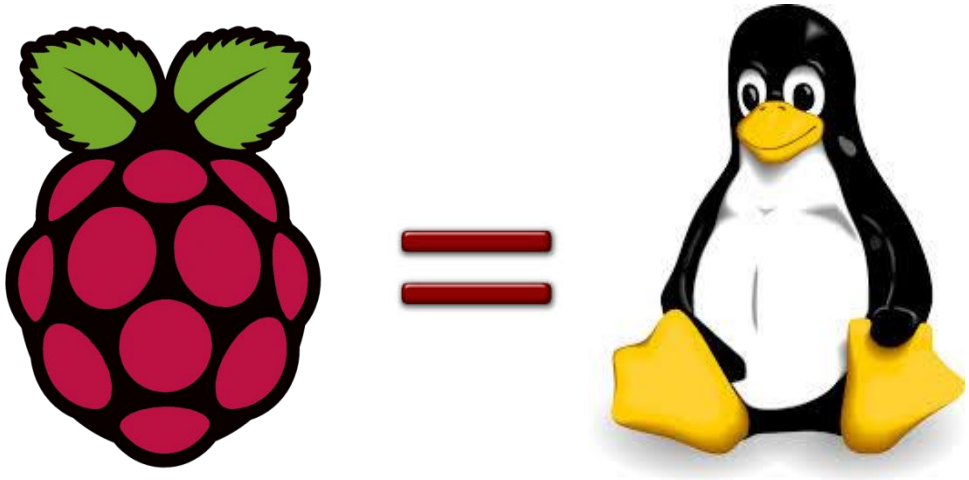
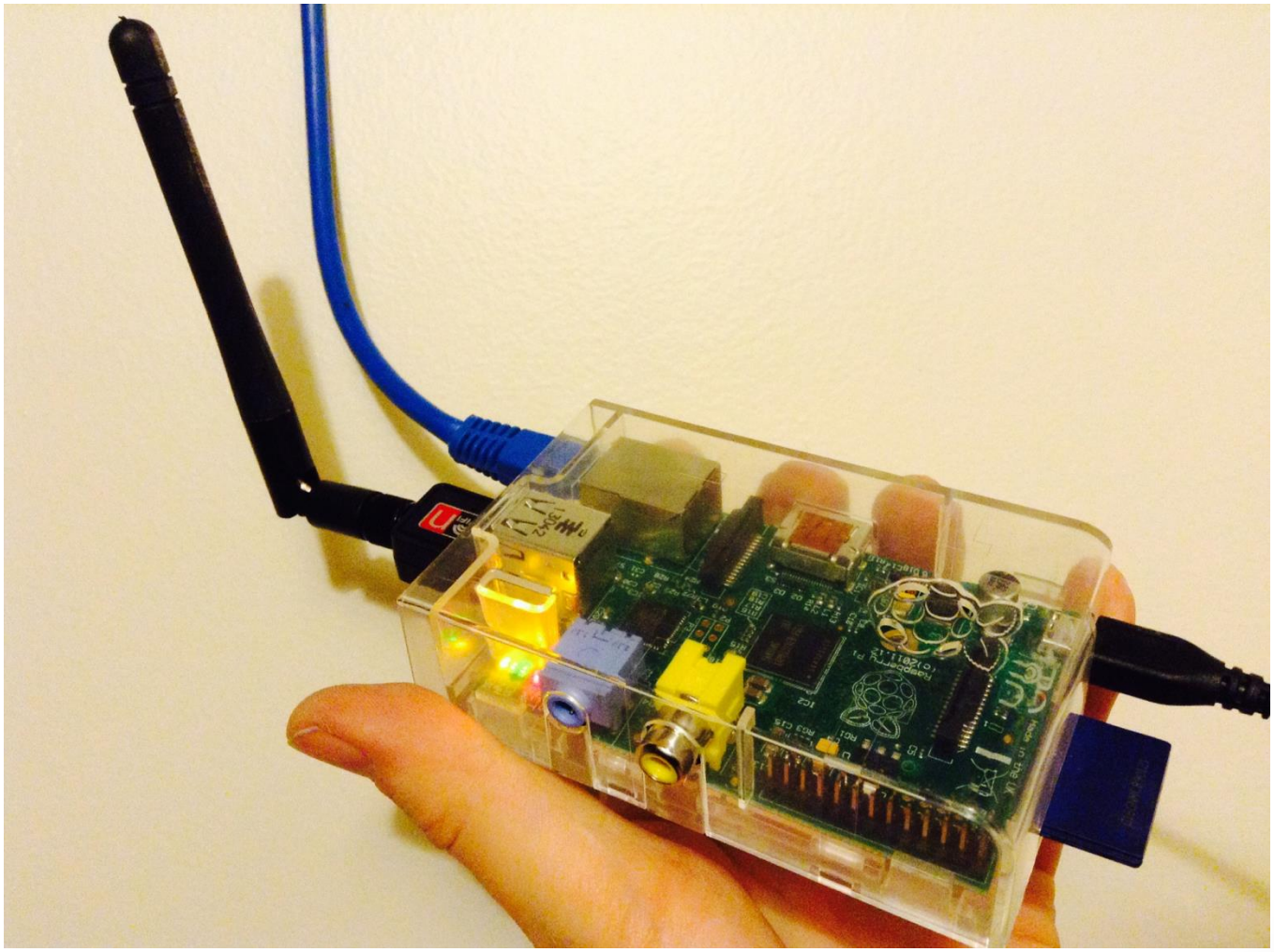


Lecture 8:
The Pi as a Linux Box

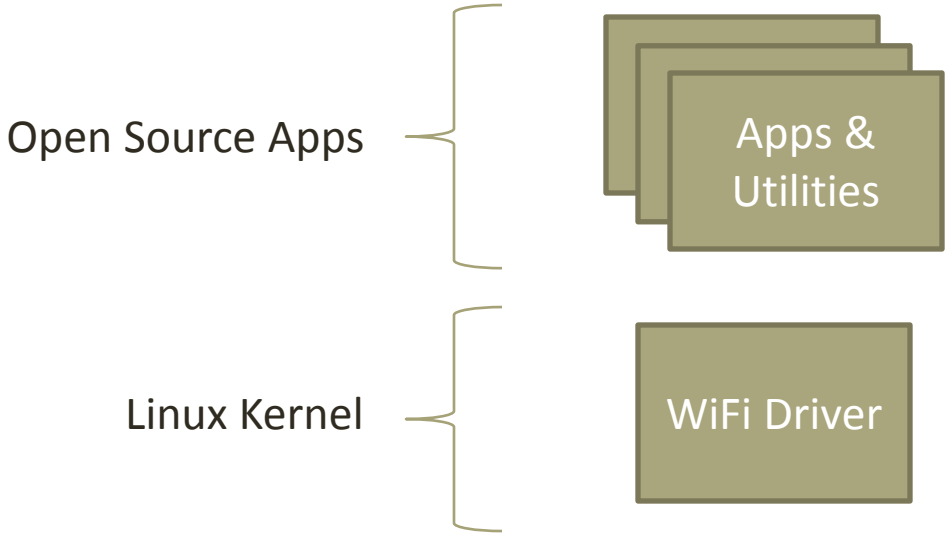
Embedded System

- Some people only think of embedded system projects as hardware interfacing projects
- This is not an accurate perception
- A lot of embedded systems are pure software projects (or with minimal hardware interfacing capability)
- This lecture aims to change this perception by exploring some of the software dominated embedded system projects
- Here comes the power of Linux, since Linux has a huge library of software packages that can be used as building block in a highly capable embedded system
- This is one of the main reasons, a lot of embedded systems use Linux as their preferred operating System
- In this lecture we will go in some examples of using the Raspberry Pi an a Hardware Interfacing-Free projects

Building a Pi Based WiFi Access Point



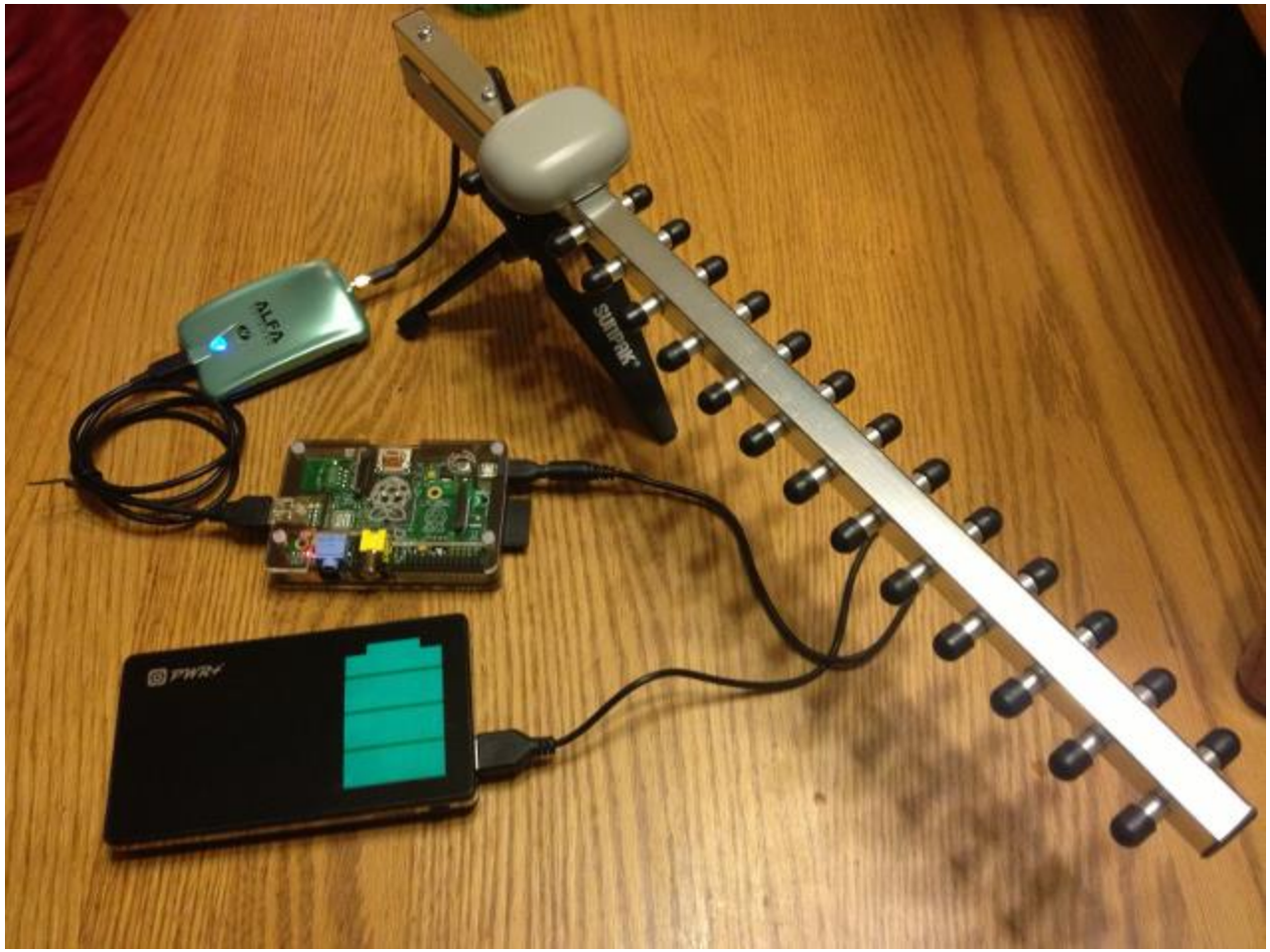
Building a Pi Based WiFi Access Point



Building a Pi Based WiFi Access Point

- We can use the Raspberry Pi board to build a WiFi Access Point
  - Some WiFi chipset can be configured to provide AP functionality
  - Also, the Linux kernel has strong support for different WiFi modes of operation
  - All we need is to install and configure user plane apps that will enable us to switch the Pi into a fully functional WiFi AP
- Why do we need to build that,
  - Extend the WiFi coverage
    - But keep in mind that the Pi will be less cost effective, and less powerful than commercial products
  - Learning purposes
    - To learn more about WiFi, its modes of operation, configuration parameters, and its software components
  - Build a special featured access point such as more security, special firewall, adding anonymity (onion server)
    - A lot of libraries and applications provide a lot of functionality, so you can customize your own WiFi AP
  - Hack the AP software to test new functionality and features
    - All user plane applications are open source with a lot of community support, so you can develop your own features
    - The WiFi drivers running in the Linux Kernel are also open source, so you can also hack it
    - Linux provides a well documented API to enable developers to connect to the different components of the WiFi System
  - Build a product where the WiFi AP support is just one part of it
    - I will leave this to your imagination

Building a Pi-Based WiFi Sniffer



Building a Pi-Based WiFi Sniffer

- Most WiFi chips can run in Monitor mode, which is a mode that it reads all traffic in the wireless channel
- This enables us to use the Raspberry Pi board to build a device to sniff the WiFi wireless link
- You can detect ongoing traffic, and management messages on your network
- You can also increase your detection coverage using a ***Cantenna***
- Why do we need that,
  - Learn more about WiFi Networks and how they communicate
  - Debugging a problem in WiFi Networks
  - Having this feature as part of a broader functionality
- Can this tool be a way to spy on user communication on the network
  - No, most of user traffic is encrypted and hence, you will not be able to spy on other people traffic
  - Actually, user traffic is more secure on the wireless link than on the wired link
  - So think positive, you can do a lot of useful products without invading other people privacy

Need a WiFi Antenna ??
Use a Cantenna

Building a Pi-Based Media Center

Building a Pi-Based Media Center

- A lot of people use the Raspberry Pi board as a Media Center
  - Low power
  - Inexpensive
  - Small foot-print
- The Raspberry Pi comes with a GPU Core that is capable of offloading the ARM core from a lot of processing needed for video decoding
- That enables the Pi to handle HD quality videos
- You can use the Pi to play videos via streaming from YouTube, Netflix, …
- Or, you can play stored videos on the SD card, USB Flash, or USB Hard-disk
- Keep in mind, in these projects, you may need to change the split of the Pi memory between the ARM core and the GPU
  - Default is 64 MB for the GPU and the rest for the ARM Core
  - You may need to give more memory to the GPU since it is performing a lot of processing for video decoding
- There are special Pi distribution for that purpose (such as ***RaspMC*** & ***OpenElec***)

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documentation.

Shop

RASPBIAN

Debian Wheezy

Version: December 2014
Release date: 2014-12-24
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PIDORA

Fedora Remix

Version: 20
Release date: 2014-07-24
More info +

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OPENELEC

An XBMC Media Centre

Version: 4.0.5
Release date: 2014-06-14
More info +

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RASPBMC

An XBMC Media Centre

Version: November 2014
Release date: 2014-11-24
More info +

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Building a Pi-Based MP3 Player

Building a Pi-Based Internet Radio

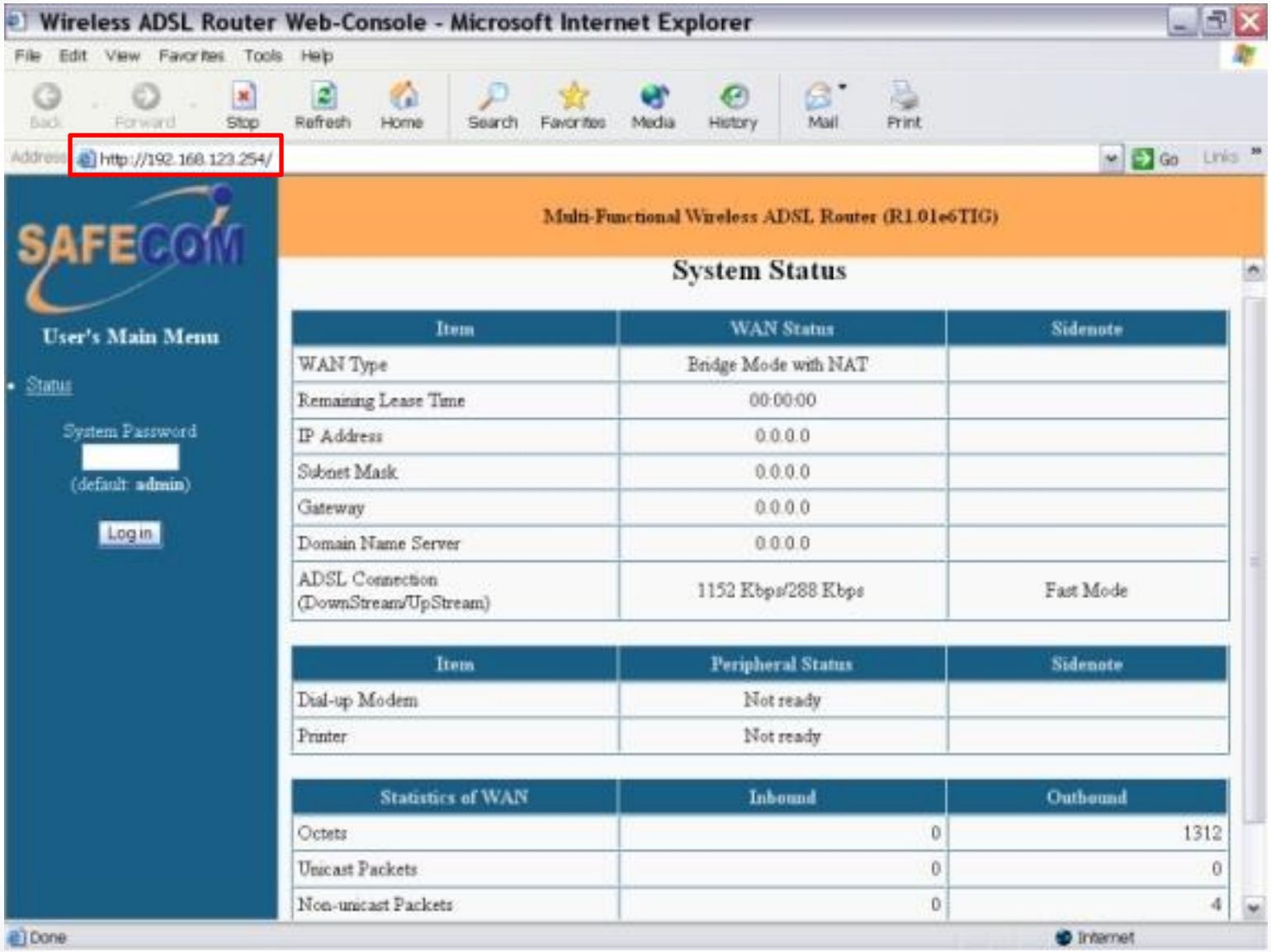
Building a Pi-Based Torrent Downloader

Building a Pi-Based Torrent Downloader

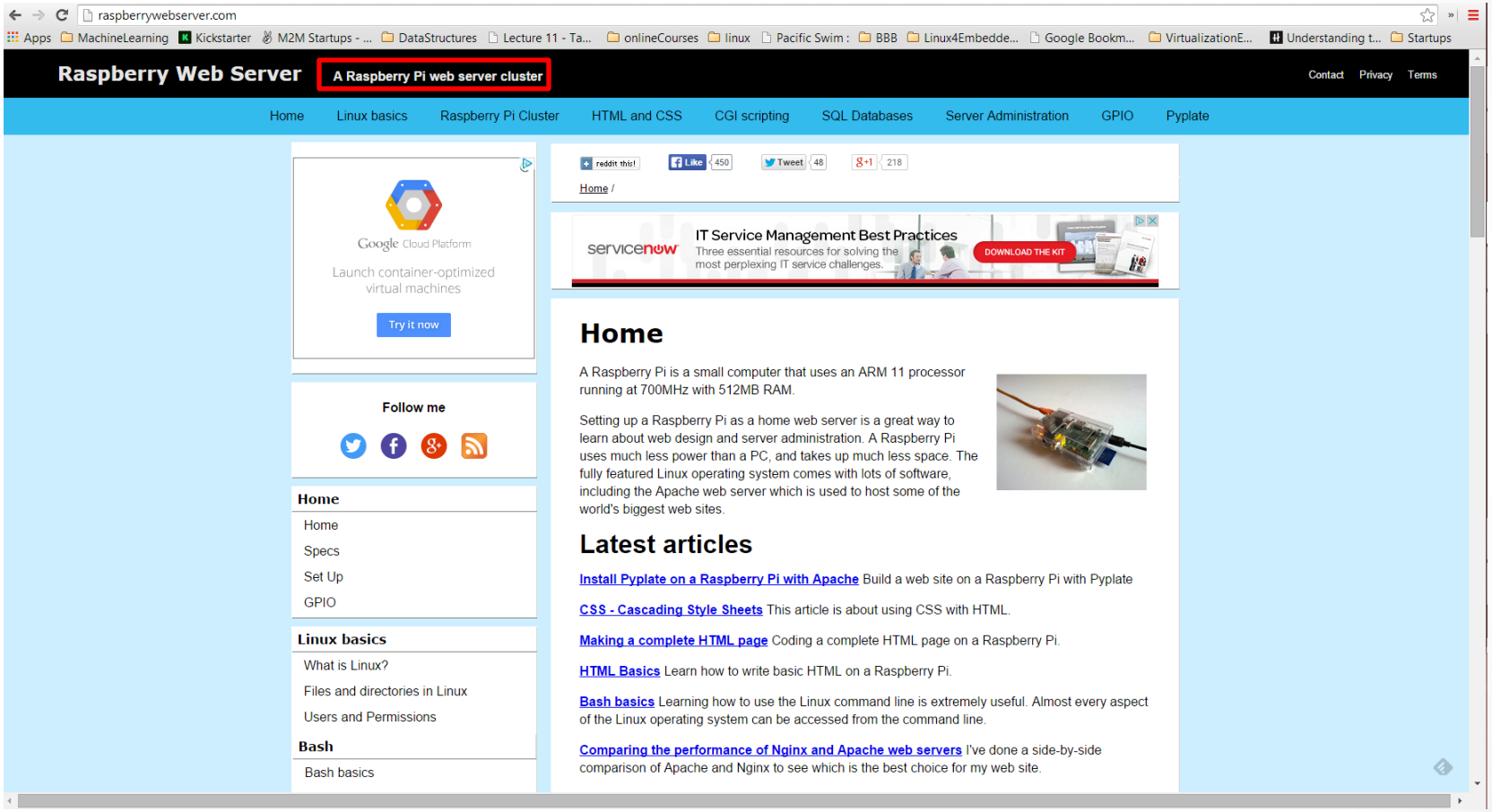
- Torrent downloading needs a lot of time online
- You can not keep your computer on and connected to the internet for long periods of time
  - Waste of power
  - Waste of resources (your computer will be left on for this purpose)
- Instead, you can build inexpensive, low power, small size device as your device to collect your files from the internet
- You can use the same device to share content with others
  - Device always on
  - Isolation between your private files and shared files

Building a Pi-Based Home Web Server

- When people think of web servers, they think of big computers and not embedded systems
- So, why would you consider building a webserver on the Pi
- A lot of people are using the Pi as their way for their personal web servers
  - Low power
  - Low cost
  - Small size
- This can be used either internally, or even exposed to public
- Of course this can not be used with high traffic websites, but suitable for special purposes where traffic is not huge
- It can be used as an interface to a Pi based product such as a home automation system
- Most commercial embedded projects use a webserver for their management interface (such as routers, WiFi Access Points, …)
- There are CMS (Content Management Systems) that were tested successfully on the Raspberry Pi (such as Pyplate)


Wireless ADSL Router Web-Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites Media History Mail Print
Address http://192.168.123.254/
Go Links
SAFECOM
User's Main Menu
Status
System Password
(default: admin)
Log in
Multi-Functional Wireless ADSL Router (R1.01e6TIG)
System Status
Item | WAN Status | Sidenote
WAN Type | Bridge Mode with NAT |
Remaining Lease Time | 00:00:00 |
IP Address | 0.0.0.0 |
Subnet Mask | 0.0.0.0 |
Gateway | 0.0.0.0 |
Domain Name Server | 0.0.0.0 |
ADSL Connection (DownStream/UpStream) | 1152 Kbps/288 Kbps | Fast Mode
Item | Peripheral Status | Sidenote
Dial-up Modem | Not ready |
Printer | Not ready |
Statistics of WAN | Inbound | Outbound
Octets | 0 | 1312
Unicast Packets | 0 | 0
Non-unicast Packets | 0 | 4
Done
Internet

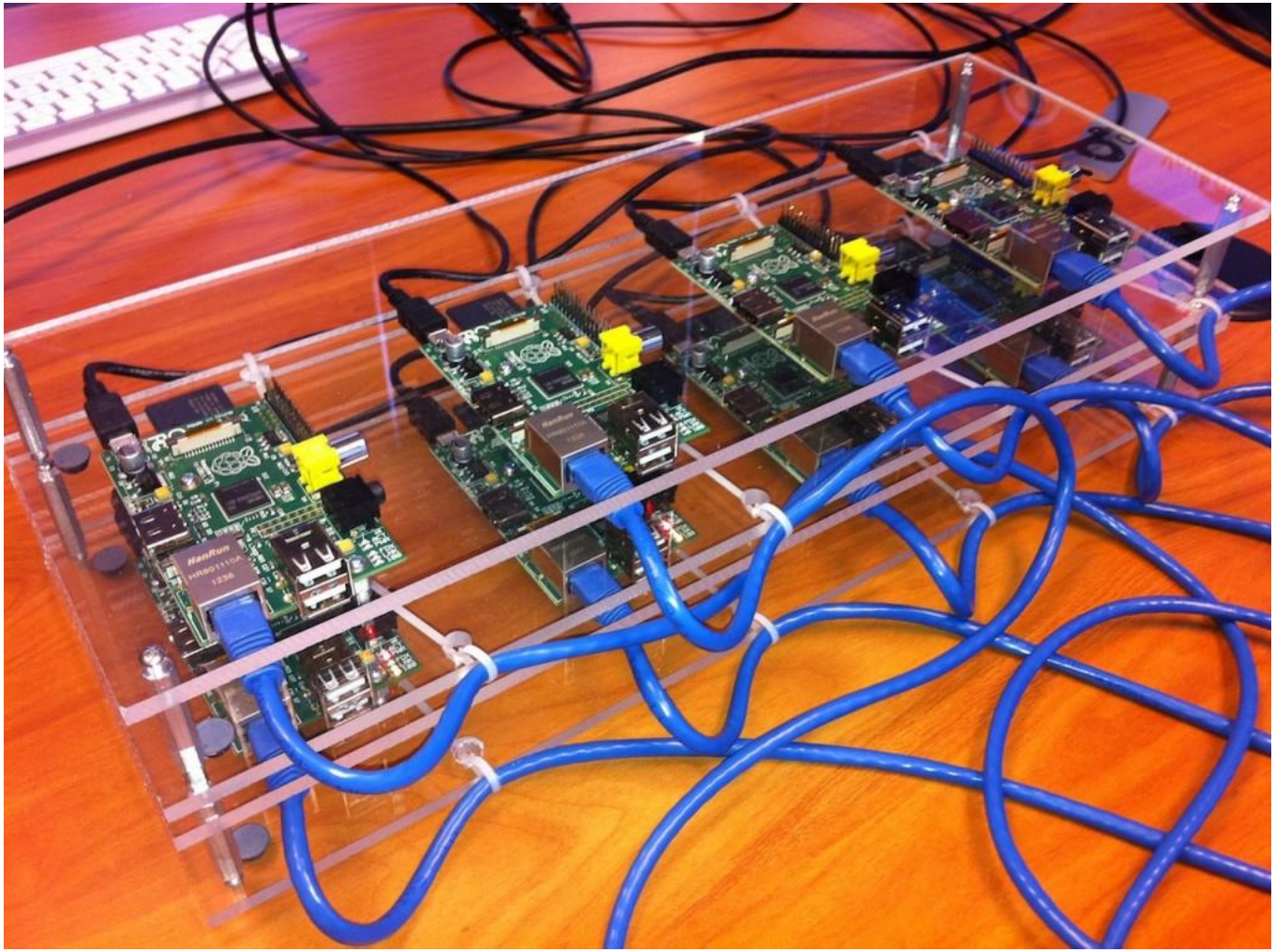
http://raspberrywebserver.com/



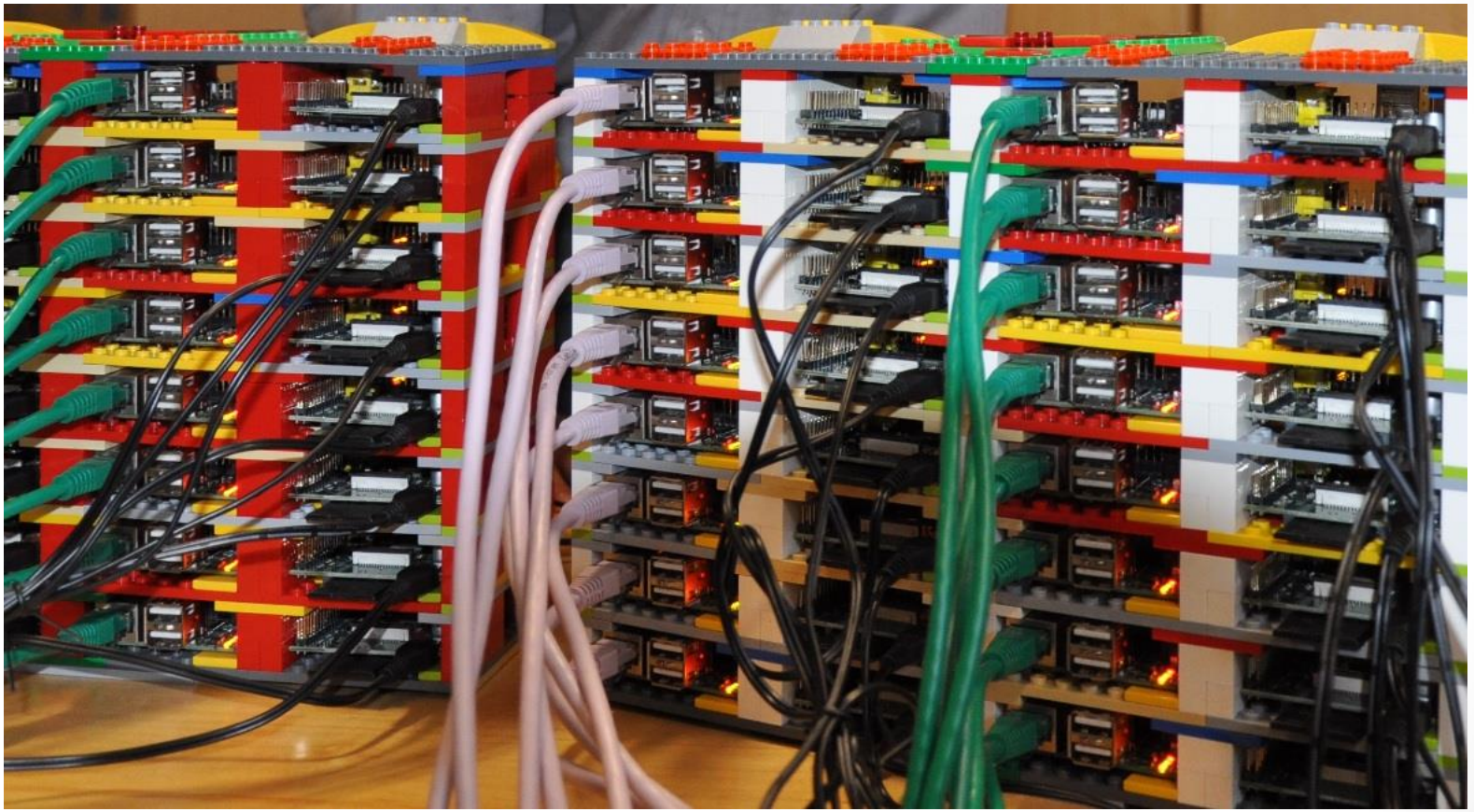
Building a Pi Cluster

- A lot of projects will be limited by the power of the Raspberry Pi processor
- We can combine multiple Pi's to do this job
- One example is the webserver used for
  http://raspberrywebserver.com/
- Keep in mind, that not all functionality can use the power of a clustered system
- Also, there is some messaging overhead that is associated with clusters that may make some applications not suitable for clusters

Pi-Cluster



Pi-Cluster



And a lot more ….

Things to Keep in mind

- Although the Raspberry Pi is capable of all of these projects, its processing capacity may put a limitation on its serious use in real products
- We can push these limits by,
  - Using Raspberry Pi Model 2 (Much more powerful than Model 1)
  - Overclocking the Pi
  - Make use of the power of the GPU
  - Redistribute memory between the ARM core and the GPU
  - Build a Pi Cluster
- The Pi is built mainly for learning purposes, there are other boards in the market that has more processing power and can perform better than the Pi
- These boards may have stronger ARM cores or multiple cores
- Also there are boards in the market that are more cost effective than the Pi
- So, learn with the Pi, and consider other boards when you want to build a commercial product

Linux 4 Embedded Systems

http://Linux4EmbeddedSystems.com