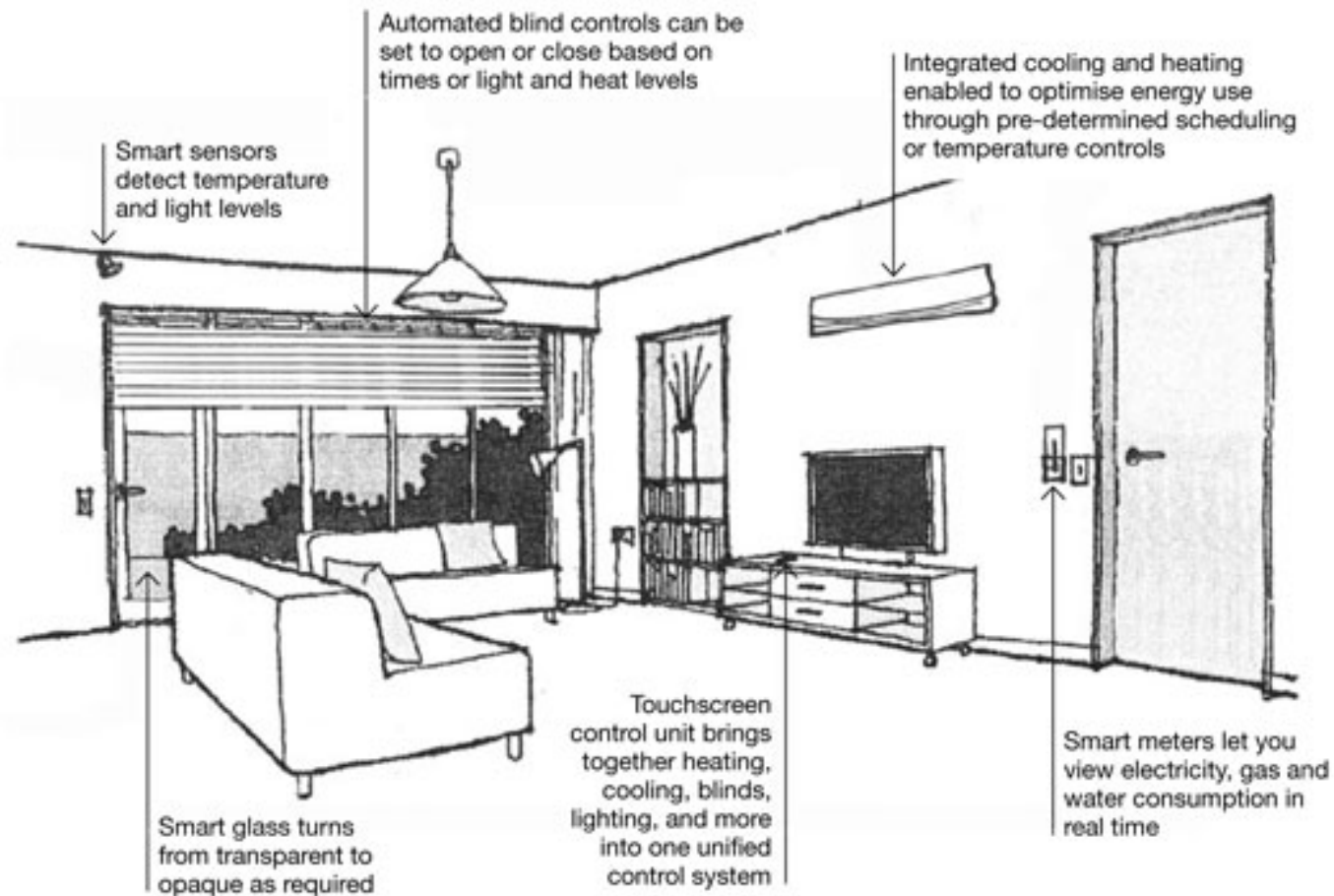# Be Lazy...

Fabrizio Manfred Furuholmen

Beolink.org
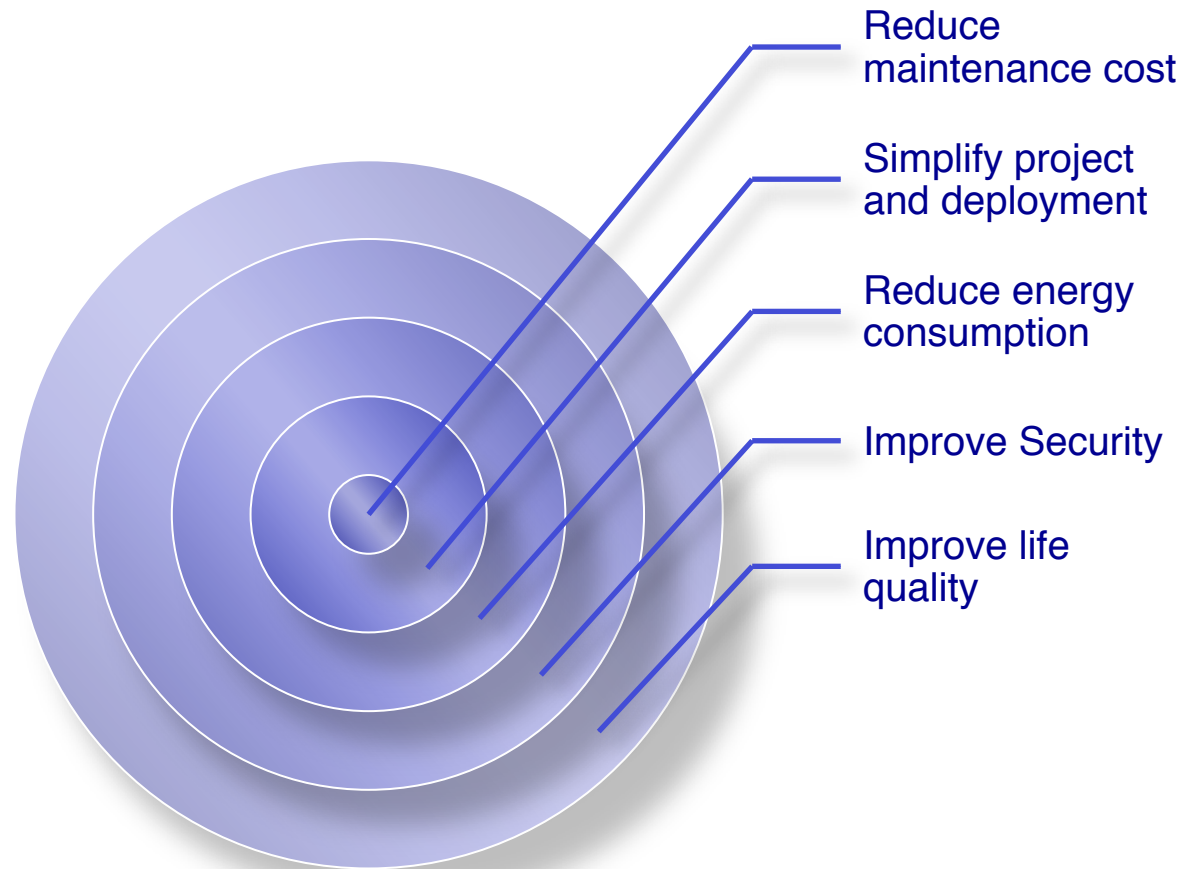
- Bringing the Future Home

- Hardware

- Software

  - Do it yourself
  - Entertainment with a little help from Linux

8/29/10

Do you have this House ?


Automated blind controls can be set to open or close based on times or light and heat levels

Integrated cooling and heating enabled to optimise energy use through pre-determined scheduling or temperature controls

Smart sensors detect temperature and light levels

Smart glass turns from transparent to opaque as required

Touchscreen control unit brings together heating, cooling, blinds, lighting, and more into one unified control system

Smart meters let you view electricity, gas and water consumption in real time

8/29/10

What can you expect from the house of the future ?

Reduce
maintenance cost

Simplify project
and deployment

Reduce energy
consumption

Improve Security

Improve life
quality

8/29/10

Improve life quality

- ☐ Control and coordination from everywhere
  - – Appliances
  - – Air Conditioning system / heating
  - – Lights
  - – Doors

- ☐ Automatic and Intelligent operations

- ☐ Magnetic fields reduction

8/29/10
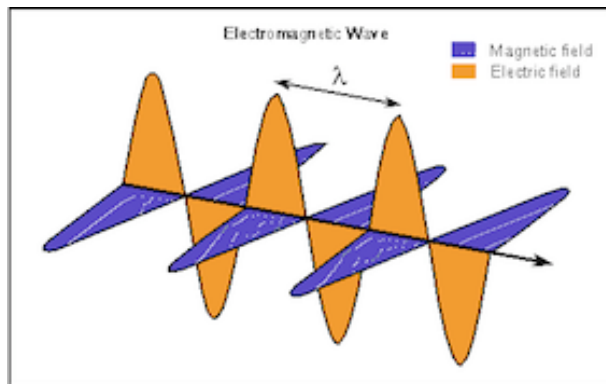
Improve Security

❑   Alarm on water/gas leak and fires

❑   Security, intrusion detection
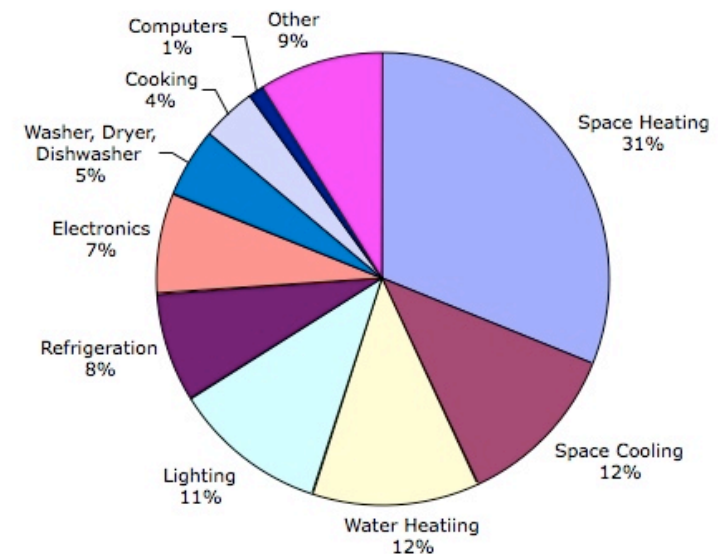
❑   Remote control, video control

Translation:
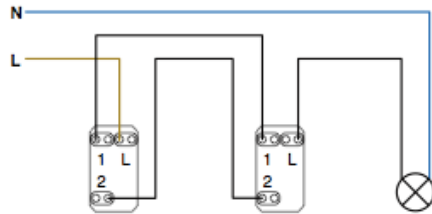 **Beware of Dog, its owner and all Family ..**

8/29/10

Energy Saving

❑ Keep the control of power consumption (coordination btw devices)

❑ Turn off all devices instead of standby

❑ Monitor human presence to control air condition or heating

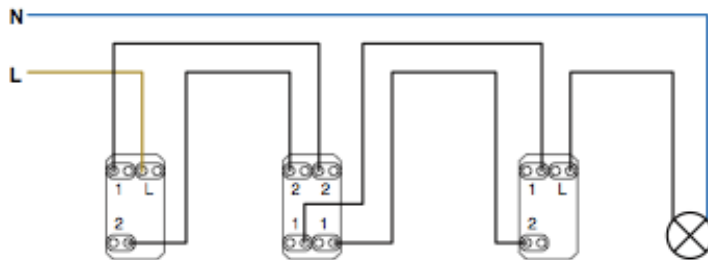❑ Constant Monitoring of light environment to control lights

Computers 1%
Other 9%
Cooking 4%
Washer, Dryer, Dishwasher 5%
Electronics 7%
Refrigeration 8%
Lighting 11%
Water Heatiing 12%
Space Cooling 12%
Space Heating 31%

Residential Energy Usage, 2006
National Academy of Sciences

8/29/10

Simplify installation and Administration

Traditional 2 switches

Traditional 3 switches

The LM12 receives and executes the command. The attached lamp will be dimmed or turned on/off.

Use a Marmitek Remote Control to give the command 'On', 'Off', 'Dim', or 'Bright'.

The TM13 transmits the command via the mains.

Mains

~ 230V 50Hz
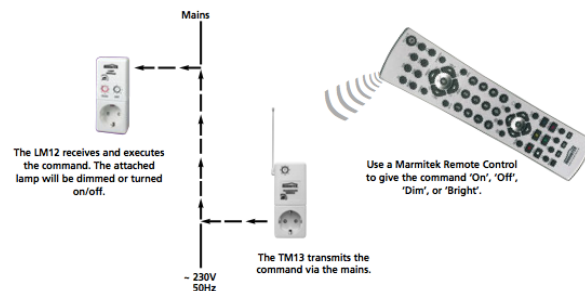
Domotic

❑ Single cable or no cable for control

❑ Change the system configuration as you want (programming)

8

Hotel rooms are reserved for only 50% of the time

❑ **Room booked but no one inside**

All the power sockets are off

Security system is on

Air conditioning/heating is set to fix value

❑ **Room booked with people inside**

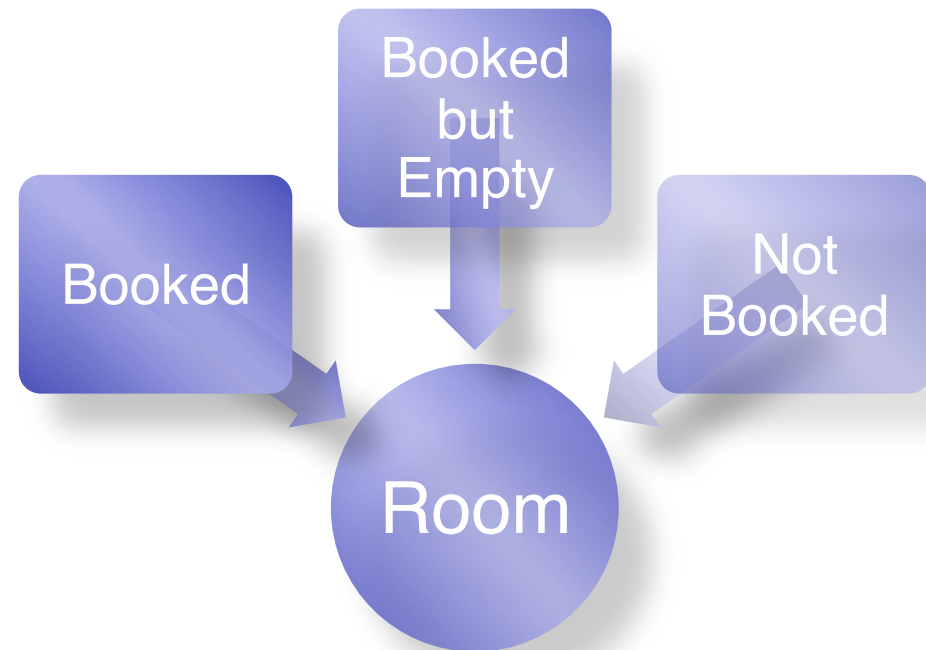Temperature defined by customers

Security system off

Power sockets on

Heating or Air conditioning turned off with open windows

❑ **Room not booked**

Security on

Power supply off

Temp set to fix Value (min)

Booked

Booked but Empty

Not Booked

Room

8/29/10

- ❑ **Sensors** are sensitive devices to light, temperature, radiation level and much more, which transmit a signal to a measuring or control instrument.

- ❑ **Actuators** receive command to turn on/off linear devices or set a specific value.

- ❑ **Controllers** receive input from sensors and send command to actuators. The action is based on fixed rules (cabled), PLC or computer.

- ❑ **Links:** The connection type btw elements for communication. You can find wireless , bus or cable wired.

8/29/10

Architecture

- ❑ **Centralized Architecture**: a centralized controller receives information of multiple sensors and, once processed, generates the opportune orders for the actuators.

- ❑ **Distributed Architecture:** all the intelligence of the system is distributed by all the modules that are sensors or actuators.

- ❑ **Mixed Architecture**: it has several small devices able to acquire and to process the information of multiple sensors and transmit them to the rest of devices distributed in the house.

8/29/10

PROTOCOLS

8/29/10

Standard ? No, Yes, Maybe ..Why not ?

- ❑ **X10** was developed in 1975 by Pico Electronic Glenrothes, Scotland, in order to allow remote control of home devices and appliances. It was the first general purpose domotics network technology and remain the most wide spread

- ❑ **INSTEON** is similar to the X10 standard, designed specifically to address the inner limitations in the X10, but also to incorporate backward compatility.

- ❑ **Z-Wave** is a *open* standard wireless communication protocol designed for home automation, specifically to remote control applications in residential and light environments.

- ❑ **KNX** standard is based upon more than 20 years of experience in the market, amongst others with predecessor systems to KNX: EIB, EHS and BatiBUS.

- ❑ **Digital Living Network Alliance (DLNA)** is a no profit collaborative trade organization including more than 250 member companies, it intends to solve the concerned problems in using digital media between different electronic devices.

8/29/10

❑ The story tells the developers of X10 tried 9 experiments that failed but at the tenth they cried out "AHA!" And thus experiment 10 or X10 was born.

❑ The X10 protocol defines a way for devices to send and receive short digital messages over existing electrical wiring.

❑ These messages contain an address and an action (such as "on", "off", or "dim").

❑ The address allows a transmitter (the controlling device) to target one or more receivers (connected to a lamp or other items to be controlled).

8/29/10

In the modern X10 implementation you will find :
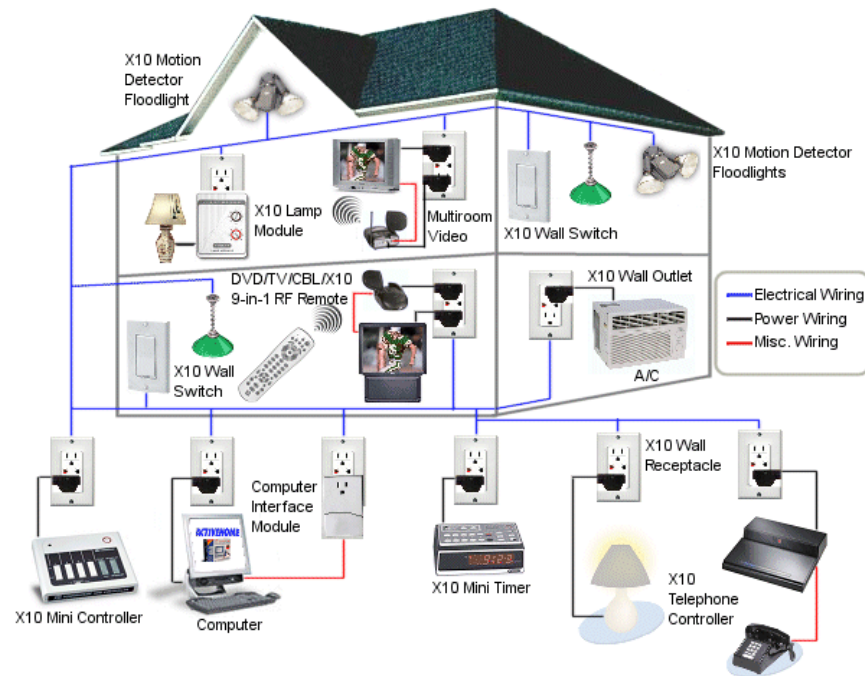
- **Modules**: these components will receive X-10 signals and will switch or dim the attached lamp or appliance.

- **Controllers**: these components will transmit X-10 signals and thus will control the modules

- **Transmitters**: wireless components like remotes. The signals of these components will be received by a controller with the transceiver functionality.

- **Transceiver**: these components will translate the signals into X- 10 signals on the power line.

8/29/10

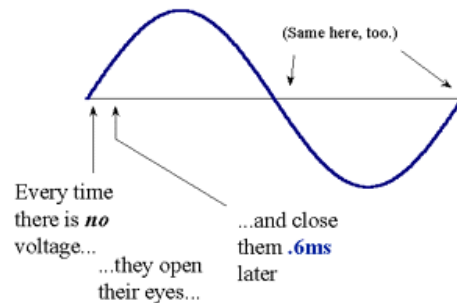**Receivers "sense" the 0° point and then look for signal in a small window only .6 milli-seconds in duration.**

(Same here, too.)

Every time
there is *no*
voltage...   ...and close
them **.6ms**
...they open   later
their eyes...

Figure 2

A standard X-10 transmitter "*should*" routinely send the address data **twice**.

2   4   5   2   4   5

Number Code   Start Code

Letter Code   Letter Code

Start Code   Number Code

Each eleven cycles (one start code, one letter code and one function code) is known as a "*frame*".
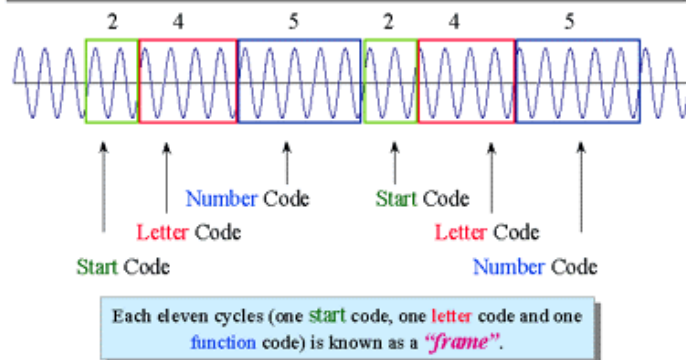
Figure 7

- ❑ The X-10 communication is based on the "injection" of high-frequency signals (120 kHz) on the 220Vac network, representing binary signals (1 or 0).

- ❑ The signal is inserted immediately after the passage through the origin of the sine wave of 50Hz, with a maximum delay of 200 microseconds. This special feature is used by receivers to know when to listen to the line.

- ❑ The signal is sent through the electric energy network to the X-10 receivers connected to the network.

List of X-10 commands

Code	Function	Description
0 0 0 0	All Units Off	Switch off all devices with the house code indicated in the message
0 0 0 1	All Lights On	Switches on all lighting devices (with the ability to control brightness)
0 0 1 0	On	Switches on a device
0 0 1 1	Off	Switches off a device
0 1 0 0	Dim	Reduces the light intensity
0 1 0 1	Bright	Increases the light intensity
0 1 1 1	Extended Code	Extension code
1 0 0 0	Hail Request	Requests a response from the device(s)
1 0 0 1	Hail Acknowledge	Response to the previous command
1 0 1 x	Pré-Set Dim	Allows the selection of two predefined levels of light intensity
1 1 0 0	Extended Data	Additional data (followed by 8 bytes)
1 1 0 1	Satus is On	Response to the Status Request indicating that the device is switched on
1 1 1 0	Status is Off	Response indicating that the device is switched off
1 1 1 1	Status Request	Request requiring the status of a device

8/29/10

You Can

☐ **Build by yourself**
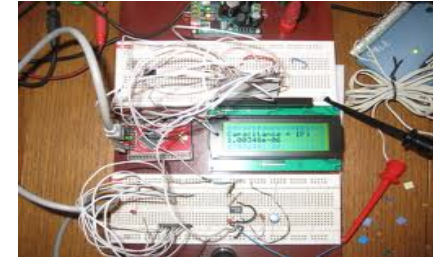
☐ **Buy a Kit**

☐ **Buy a very low price**

INSTEON is mainly an improvement of X10 standard

Dual-mesh network: The "dual" part of the network combines wireless radio frequency (RF) with the home's existing electrical wiring capabilities

Reliable network: Every message is confirmed once received, and if any errors are detected, the message is automatically resent (payload encrypted).

Faster: X10 is about 60 bps (about 1 command/sec), Insteon is between 1K bps to 2K (4800 bps?).

Address: large address space (64k devices)

X10 Compatibility: X10 and Insteon can coexist and hybrid devices can send and receive both signals

Only For North America at the moment

8/29/10

8/29/10
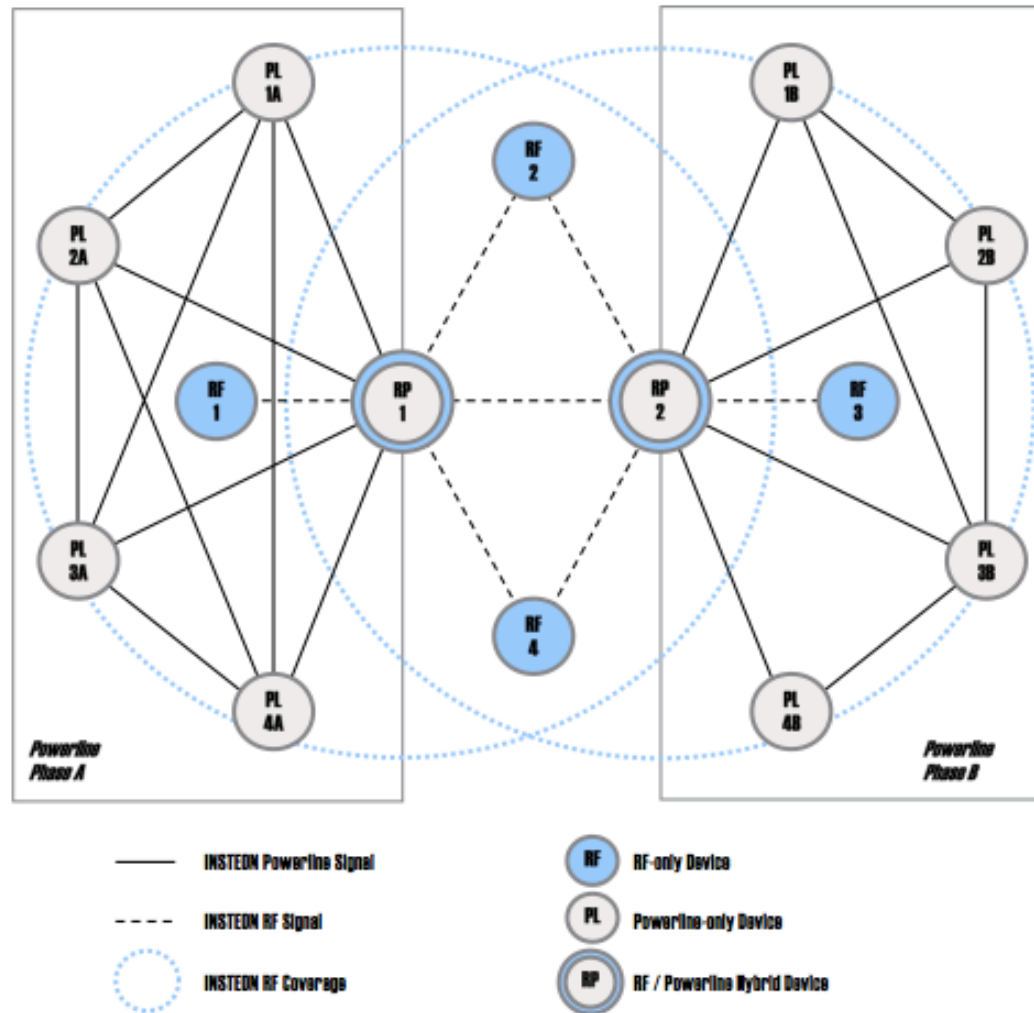
Z-Wave is a proprietary wireless communications protocol

❑ is a low-power wireless technology designed specifically for remote control applications. Unlike Wi-FI and other 802.11 wireless LAN systems it is designed for high bandwidth data flow with low overhead command

❑ is a mesh networking technology where each node or device on the network is capable of sending and receiving control commands and use intermediate nodes to route around household obstacles or radio dead spots that might occur in the home

Z-Wave Alliance is a consortium of leading independent manufacturers who have agreed to build wireless home control products based on the Zensys' Z-Wave open standard.

8/29/10

Z-Wave is not a multi-vector broadcast system. Instead, it is designed based on a highly efficient source routing algorithm. Therefore, typical problems associated with flooding are irrelevant for Z-Wave.

There are two main types of devices defined in Z-Wave protocol: controllers and slaves. Controllers are able to initiate transmission as well as hold all the smarts related to network routings. Slaves, on the other hand, are just end devices with general-purpose input output

Network topology and routing table
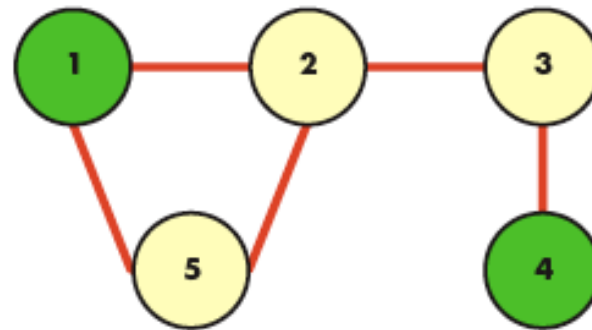
	1	2	3	4	5	6
1	0	1	0	0	1	0
2	1	0	1	0	1	0
3	0	1	0	1	0	0
4	0	0	1	0	0	0
5	1	1	0	0	0	0
6	0	0	0	0	0	0

Source: courtesy of Zensys

Figure 3

http://www.zwaveworld.com/zwavedemo.php
http://www.drdobbs.com/embedded-systems/193104353

8/29/10

is based on the UPnP A/V architecture.

As written in [UPNPForum03], *"UPnP™ technology defines an architecture for pervasive peer-to-peer network connectivity of intelligent appliances, wireless devices, and PCs of all form factors. It is designed to bring easy-to-use, flexible, standards-based connectivity to ad-hoc or unmanaged networks whether in the home, in a small business, public spaces, or attached to the Internet. UPnP technology provides a distributed, open networking architecture that leverages TCP/IP and the Web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices."*

Characteristics

- ❑ **Media and device independence**
- ❑ **User Interface control**
- ❑ **Operating systems and programming language independence**
- ❑ **Extensibility**

8/29/10

Protocol components:

- ❑ **Address,** the process by which a UPnP device assigns itself an address is known within the UPnP Device Architecture as "AutoIP"

- ❑ **Discovery,** the SSDP allows that device to advertise its services to control points on the network.

- ❑ **Description,** the description includes a list of any embedded devices or services, as well as URLs for control, eventing, and presentation.

- ❑ **Control,** function calls interface (RPC), for device control

- ❑ **Event notification,** the service publishes updates by sending event messages.

- ❑ **Presentation**, allow a user to control the device and/or view device status.

"Transport" used : IP/TCP/UDP/SSDP/GENA/SOAP

There are UPNP specs also for networking, home automation, printer and scanner

KNX Association is the creator and owner of the KNX technology

KNX is the only global standard for home and building control with:

- ❑ A single, manufacturer independent design and commissioning tool (ETS).
- ❑ A complete set of supported communication media (TP, PL, RF and IP).
- ❑ A complete set of supported configuration modes (system and easy mode)

KNX is approved as:

- ❑ European Standard (CENELEC EN 50090 and CEN EN 13321-1).
- ❑ International Standard (ISO/IEC 14543-3).
- ❑ Chinese Standard (GB/Z 20965).US Standard (ANSI/ ASHRAE 135).

The last Olympic games were based on KNX !

8/29/10

SOFTWARE

8/29/10

HEYU

It is a text-based console program for remotely controlling lights and appliances in the home or office.

Characteristics

- ❑ Transmit and receive any X10 signal supported by the CM11A and other devices like Oregon

- ❑ Monitor and/or log all X10 signals on the power line.

- ❑ Maintain a record of the state (On, Off, Dim level) of modules based on received or transmitted X10 signals.

- ❑ Execute scripts or commands based on received or transmitted X10 power line or RF signals and the recorded states of modules.

- ❑ Upload schedules of timed events and macros to the CM11A memory for operation without a computer.

8/29/10

Heyu

Configure
/etc/heyu/x10.conf port, rooms / devices definitions

Run the Server
/etc/init.d/heyu start (or something like that)

Store Scheduling in CM11

macro lamp1_on 0 on lamp1
macro lamp1_off 15 off lamp1
timer smtwtf. 01/01-12/31 18:00 01:00 lamp1_on lamp1_off

Event Monitoring

SCRIPT C1 off anysrc :: play ssb.wav; heyu turn tv_set off
SCRIPT A1 address anysrc :: mysound.sh volumeup
SCRIPT A2 address anysrc :: mysound.sh volumedown

8/29/10

Command Line

heyu2 on HU : turn on HU

heyu2 off HU : turn off

heyu2 dim HU <level> set dimmer to level   (1-22)

heyu2 bright HU <level>: set bright to level(1-22)

heyu2 lightson H: turn on all lights in the H house-code

heyu2 lightsoff H : turn off all lights in the H house-code

heyu2 allon H: turn on all devices with H house code

heyu2 alloff H: turn off all devices with H house code

heyu2 turn HU <cmd>: switch status to   onlofflupldown

heyu2 preset HU <level>: default set level (1-32)

heyu2 status HU: device status

heyu2 kill_all_hc: turn off all devices

8/29/10

Web Interface

MisterHouse

It is an open source home automation program. It's fun, it's free, and it's entirely geeky. Written in Perl, it fires events based on time, web, socket, voice and serial data. It runs on Windows XX and on most Unix based platforms, including MAC OSX

Characteristics:

❑ Executes actions based on voice input, time of day, file data, serial port data, and socket data.

❑ Reads/writes internet mail, http, and ftp files unattended.

❑ Sends/receive instant messages using AIM, MSN, or Jabber

❑ Uses Voice XML to interface to tellme.com

❑ Reads MS Outlook, Unix ical, or the built in Organizer calendar for event reminders and VCR programming

❑ Control of RoboSapien, ESRA, and ER1 robots.

❑ Use simple menu templates to generate menus for LCD, VXML

❑ Support X10, EIB, UPB, Insteon and Z-Wave protocols

8/29/10

Perl program

```
$fountain = new X10_Item 'B1';

set $fountain ON if time_now '6:00 PM';

$movement_sensor = new Serial_Item 'XA2', 'stair';

play(file => 'stairs_creek*.wav') if state_now $movement_sensor eq 'stair';

$v_bedroom_curtain = new Voice_Cmd '[open,close] the bedroom curtains';

 curtain('bedroom', $state) if $state = said $v_bedroom_curtain;
```

8/29/10

Graphical User Interfaces
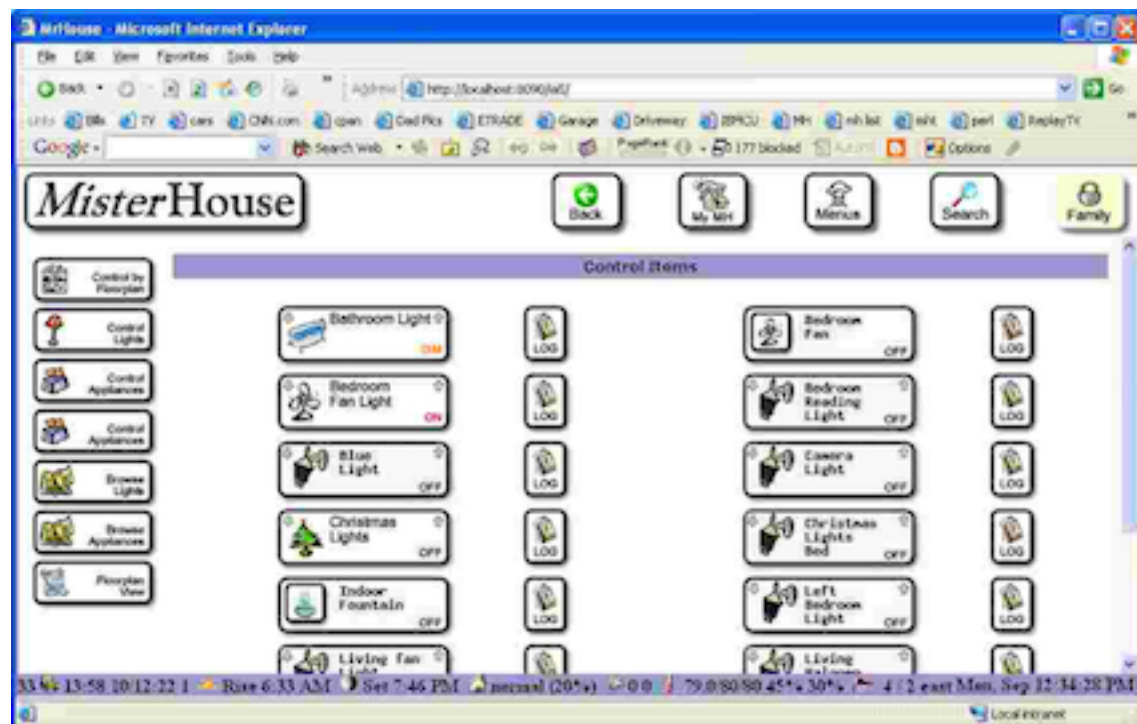
Linux Media Center Edition (LinuxMCE)

It is a free open source software platform to allow a computer to act as a HTPC, personal video recorder and home automation system.

Main Components

❑ **Media,** media store, video recorder, tv tuner

❑ **Climate,** heating and air conditioning control

❑ **Security,** intrusion detection and video alarm

❑ **Lighting,** lights control and devices control

❑ **Telecom,** pbx and video conference

Functionality	Platform
Operating System	Kubuntu
TV/PVR	MythTV
Media Playback	Xine/mplayer
Telephony	Asterisk
Home Automation	LinuxMCE
Surveillance camera recording	Motion

8/29/10

Architecture

❑ **The Core** - The computer that acts as the "server" for LinuxMCE. It is responsible for coordinating all the other components and managing your network.

❑ **Directors** - The computers that are connected to your TVs and allow you to view your media.. Any system that is to be used as a Media Director (pay attention to graphic card).

❑ **Orbiters** - Small devices used as advanced remote controls. Some possible devices include:

    ❑ Bluetooth mobile phones (with OBEX capabilities)
    ❑ Nokia Internet tablets (N770/800/810)
    ❑ Windows PCs
    ❑ Any device with a web browser

8/29/10

8/29/10

MiCasaVerde is a Z-wave controller based on appliance with Linux embedded

❑ **Simple setup**

❑ **Control any z-wave devices**

❑ **Control from everywhere**

❑ **Wifi and internet router**

More info:
http://www.linuxjournal.com/issue/181

8/29/10

```bash
#!/bin/bash
# This file is named "lights" and is placed in
# lights in the house  biglamp="12",  smalllamp="13" , desklamp="14" tv="16"
#   masterbedroom="17"
# All of the lights in the house
lights="12 13 14 16 17"
function turnlight() {
     if [ "${2}" = "on" ];  then        # Turn the light on
             curl \         "http://vera:3451/messagesend?from=1&to=${1}&type=1&id=192"
     else       # Turn the light off
             curl \         "http://vera:3451/messagesend?from=1&to=${1}&type=1&id=193"
     fi
}
if [ "${1}" = "on" ] || [ "${1}" = "off" ]; then
      for light in ${lights}; do
              turnlight ${light} ${1}
     done
else
     echo "Usage:"
    echo "   \"${0} on\" to turn all lights on"
    echo "   \"${0} off\" to turn all lights off"
     exit
fi
exit 0
```
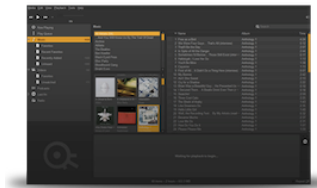
8/29/10

Common UPnP Software.

UPnP AV media servers provide a service to UPnP AV client devices.

The devices, called control points, can browse the media content of the server and request the media server to deliver a file to the control point for playback.

8/29/10

Coherence is not a simple media server, but it starts from a new idea of gateway and aggregator.

It provides media files to numerous UPnP devices, that can instantly be used.
It acts as a gateway to online resources, or to expose the media-db of some applications. Others enable controllable media playback for instance via GStreamer.

Coherence

8/29/10
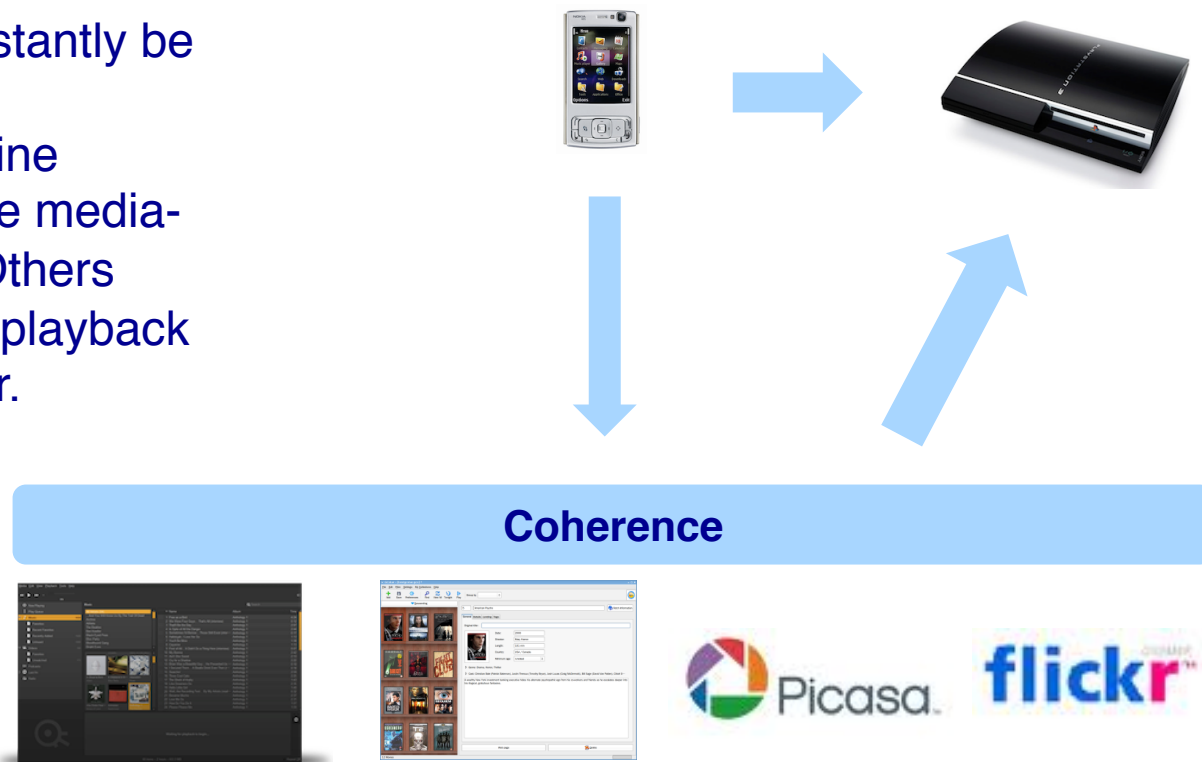
# Coherence is divided into three main parts:

❑ **Core**

The core of Coherence provides a implementation of UPnP communication components like SSDP, MSEARCH client ..

❑ **Devices**

Devices are the implementation of UPnP services (like media server, render). Device are linked to the core by their respective services.

❑ **Device backends**

The backends are the worm-holes out of the UPnP universe into other worlds: file-systems, audio/video hardware and some User Interfaces.

40
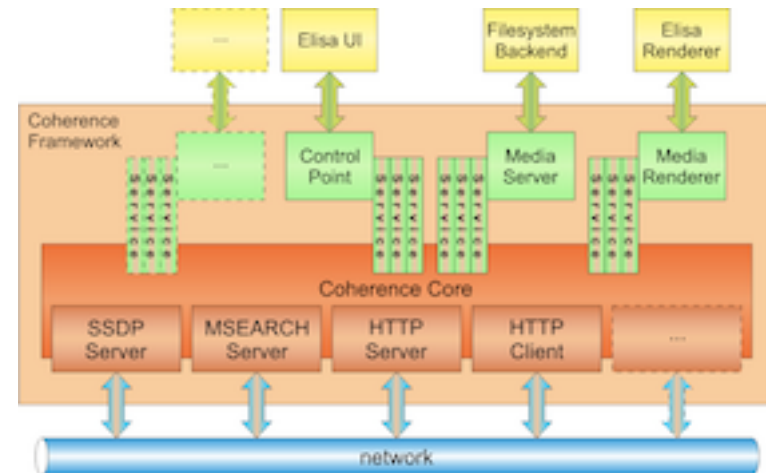
Backends

- ❑ Ampache
- ❑ Apple Trailers
- ❑ Axis Cam
- ❑ BBC
- ❑ DVBD
- ❑ Elisa Media Player
- ❑ Flickr
- ❑ File System
- ❑ Gallery2
- ❑ iRadio
- ❑ Last.FM
- ❑ Lolcats
- ❑ Media Database
- ❑ Picasa Web Albums
- ❑ Playlist
- ❑ SWR3
- ❑ Ted
- ❑ Tracker
- ❑ Many other in beta
- ❑ **Write your own Backend !!**

8/29/10
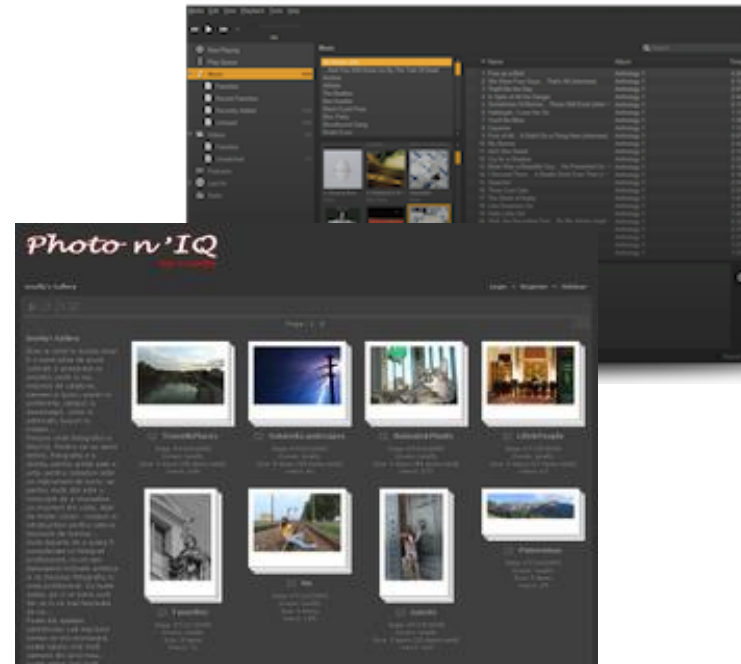
What can you do now ?

Otherwise ..

Bang Olufsen home automation (beoLiving)

8/29/10

Main protocols

- ❑ **X10** simple, cheap and good for hobbies
- ❑ **Insteon** much better, but only for North America
- ❑ **Z-wave** quite good and stable (I don't like wireless)
- ❑ **KNX** robust and world wide standard, for professional use (expensive)
- ❑ **Upnp** not much home automation, but you can find everywhere in multimedia devices

Others protocols:

- ❑ ONE-NET
- ❑ ZigBee
- ❑ ...

Home Automation

If you plan to build a complete home automation keep in mind there are thousands of "professional" solutions, sometimes are very good and better than open source solutions (and expensive), but often worse (less flexible, limited or not true home automation)

Name	Links
Home automation	www.linuxha.com
X10	http://kbase.x10.com/wiki/Main_Page
INSTEON comparison	http://www.insteon.net/about-whitepapers.html
Z-wave Alliance	http://www.z-wavealliance.org/modules/AllianceStart/
knx	http://www.knx.org/
Zigbee	http://www.zigbee.org/
Articles on Dr. Dobbs Embedded	http://www.drdobbs.com/

8/29/10

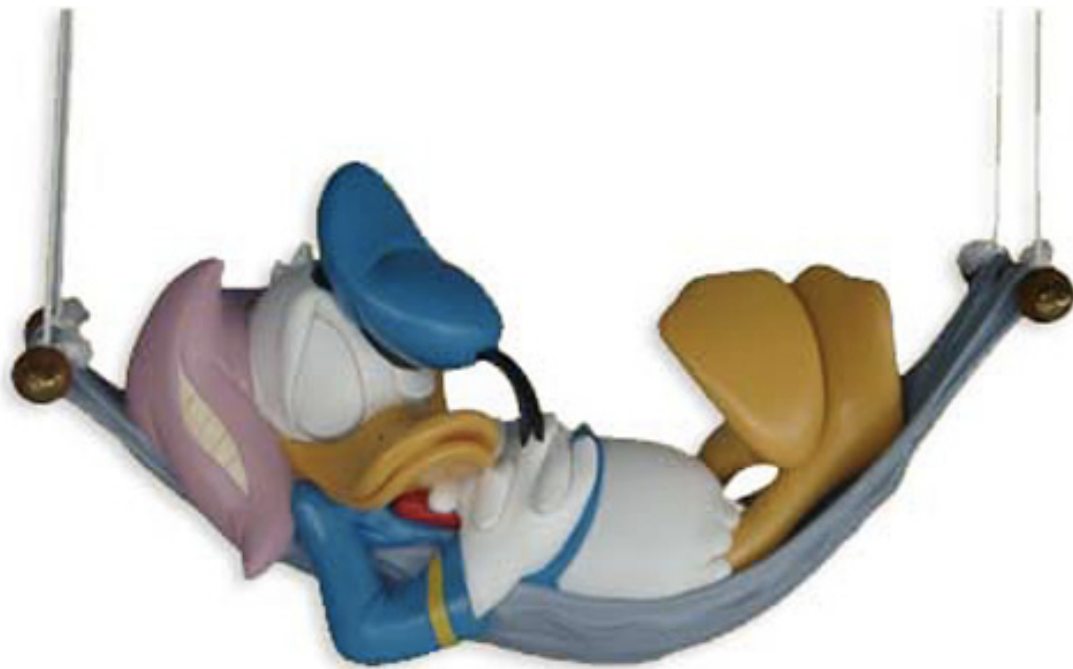# XVII European AFS meeting 2010
PILSEN - CZECH REPUBLIC
September 13-15

Who should attend:

- Everyone interested in deploying a globally accessible file system
- Everyone interested in learning more about real world usage of Kerberos authentication in single realm and federated single sign-on environments
- Everyone who wants to share their knowledge and experience with other members of the AFS and Kerberos communities
- Everyone who wants to find out the latest developments affecting AFS and Kerberos

More Info: http://afs2010.civ.zcu.cz/

8/29/10

Thank you

Beolink.org