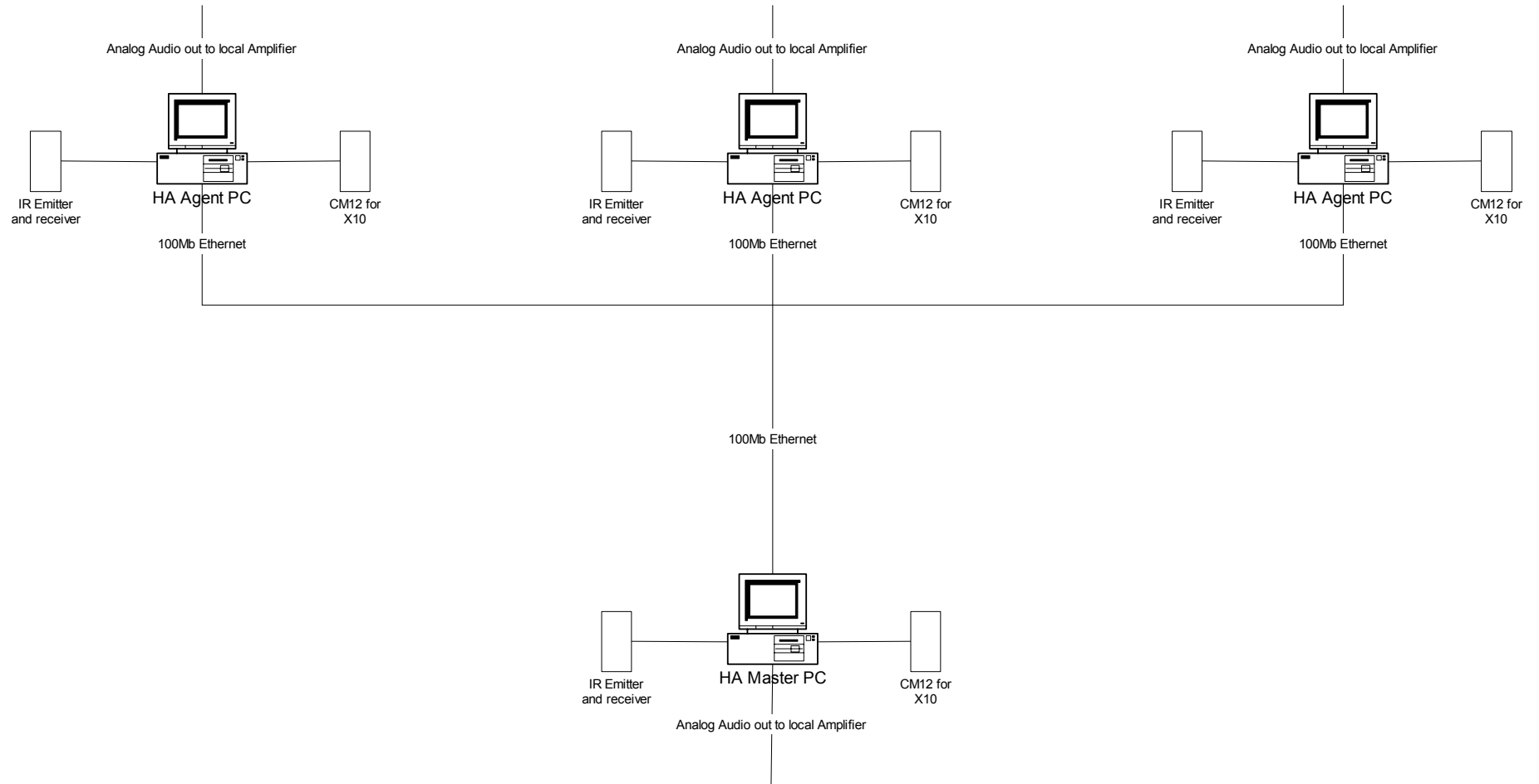


## Pauls distributed multi-master Home Automation Network Schematic



## Notes and key for schematic

The whole system is based on "Message passing" between zones. Raw data is never sent, only requests to a local agent responsible for a single zone. Therefore, there is only a requirement for a communications network between these agents. Individual carriers for IR, Music, Announcements, and voice recognition are not required. So, for example, if zone 2 is a bedroom, and I wish to turn on the bedroom TV to channel 6, then from wherever I am, I issue the appropriate command by whatever method is preferred (be that IR or voice command), The command is detected and decoded locally by the agent node in whatever room I am in, and a MESSAGE is then sent to the central controller via the communication network to tell it to turn on the TV in Zone 2 to channel 6. The master controller then issues a MESSAGE to the agent node in the bedroom, which obeys the message by issuing the appropriate IR commands from it's locally attached IR emitter. The master controller may of course additionally perform some logic checking before issuing the command to the destination agent, such as checking if the TV is already on, whether someone else is already in the room, and so on. All logic processing and intelligence is based in the master PC. All status tracking information is also held by the master node.

There is a "Role" within the HA network of "Master HA Controller". This is the PC that actually executes HA events, arbitrates between other HA machines on the LAN, sends X10 commands to X10 devices, maintains status tracking information, and performs any logic processing within the system. This role would normally be held by the dedicated HA Master PC (the one at the bottom in the diagram). HOWEVER, the "Master Role" is portable, and can be assumed by any of the HA zone agent PC's on the LAN, if the full-time master is unavailable. (Read crashed!)

The mechanism for this is based on broadcasts from whichever machine is currently the master. The master PC will broadcast an "I'm alive" signal, (either on the LAN or by X10) to ALL other HA PC's every 5 minutes. This broadcast will be sent twice, 30 seconds apart, in case transient conditions prevent it being received by one or more agents. There will be NO acknowledgement by the agents of receipt of the broadcast. Upon receipt of the broadcast, each agent will reset a timer event, which is set for 6 minutes, back to zero. Thus, as long as the master PC is operational, the agent's timers will never expire, (they should always be reset with 1 minute remaining) and the event will never fire. However, should the master PC cease sending the signal, ALL the agents' timers will expire, and an event will fire on each of them as a result. The event that fires on the agents will be an "election" to determine which one of them should assume the master role. The election will be weighted by assigned priorities given (by me) to each agent PC, based on the order I determine I want the master role to move about in. So in the example in the diagram, the full-time dedicated master PC would be assigned priority 1, the next most powerful PC would be assigned priority 2 and so on. In this way the master role moves about in a predictable fashion. Note that the role only moves as a result of a machine failing, and so in theory at least should never need to be reassigned more than once. However, the

mechanism allows for any number of PC's to fail, and whichever remain will always elect a master between them. The election is a collaborative process between the active PC's, so each machine will know at all times which is the current master, which one has which priority, who wins the election, and so on. It is not possible for two PC's to simultaneously decide to become masters.

Following the election, when one of the Agent HA PC's has been assigned to be the new master, it will reconfigure itself as required. This may involve a reboot into a new config, or perhaps just unloading one config file, and reloading another with the master config settings in it. – this will be dependant on the HA client-server software in use.

Each HA Agent PC is a discrete HA “zone” controller. – IE one per room typically. It is equipped with an IR emitter for local control of IR equipment in that room (zone), an IR receiver for relaying IR commands back to the master controller PC, a soundcard, connected to a local amplifier within that room, a TV-out graphics card, connected to a local TV, and finally an X10 interface. Note that the agent's X10 interface is provided purely for use when (and if) that PC assumes the master role. X10 is ONLY sent out to X10 devices by the master controller PC. Therefore it would *probably* be OK to dispense with all but 2 of the X10 interfaces, on the machines with priority 1 and 2.

Each agent PC provides the following facilities to its zone:

- Whole house Audio
- Whole House Text-to-Speech announcements
- Whole house two-way Infrared control
- Whole house voice recognition via a local microphone

All of these are processed locally, and communicated between stations in the HA network via messages over the 100MB Ethernet ONLY. – Meaning that the only cable requirement for each zone for all of the above facilities is a single CAT5. Raw AV signals are never sent between zones! – Only TCP/IP communications!

This will be explained in greater detail below:

### **Whole house Audio without Audio cables!**

Each agent PC will have a soundcard connected to a local amplifier in that room, for audio output. Whole house Audio will be fed to that zone by a copy of WinAMP running on the agent PC, which take audio from either the MP3 Jukebox machine situated elsewhere on the LAN, (for independent zone listening), OR from a streaming Audio server also running on another PC on the LAN. (For synchronised whole-house listening). There can be multiple streaming channels available within the house. Note that is not necessary to provide whole-house FM radio or TV audio by this means, as each zone will have it's own FM receiver and television locally. However, it would also be possible to connect to Internet streaming channels via the proxy server

situated on the LAN with either dial-up or permanent Internet access. In this way, a multi-zone amplifier, and numerous speaker cables are not required.

### **Whole House Voice recognition**

Each agent PC has a locally connected microphone, suitably positioned within the zone. Each agent PC also runs its own instance of a VR engine, and performs all VR processing locally. Voice commands are decoded by the agent PC, and the RESULTANT COMMAND is forwarded to the Master HA controller PC as a network message, for interpretation and action. Again, the only communication back to the master PC is via 100MB Ethernet. Once the decoded command data is received by the master PC it acts upon it as necessary.

### **Whole House Text To Speech (TTS)**

As stated above each agent PC has its' own soundcard connected to a local Amplifier. Each agent PC also runs its' own instance of a TTS engine. The input to the TTS engine comes from the Master controller PC as a network message. In other words each agent PC speaks to its' zone on behalf of the master. In this way, no speaker wires need to be run all over the house from the master machine. The local agent PC has full control over the software mixer for the soundcard, meaning that there is no problem in having multiple sources, such as the abovementioned whole-house audio, and TTS announcements simultaneously being output to the amplifier. All mixing, source selection, and source volume control is performed by the agent PC. Indeed, this makes it easy to implement facilities like music mute when announcements are spoken.

### **Whole House two-way Infrared**

Each Agent PC has a locally connected IR emitter and receiver. Received IR is decoded locally into a command string, and the RESULTANT COMMAND is relayed back to the master PC (as a network message) for execution. Once again, it can be seen that the only communication between zones is via 100mb Ethernet. The reverse process allows the master controller PC to issue IR commands to be sent to any zone for transmission by the local agent PC. The IR command is sent across the LAN as a command string, which is received by the agent PC, converted to IR, and sent out of the local IR emitter. In other words, the local agent PC transmits IR signals to its' zone on behalf of the master PC. In this way, the need for IR distribution amplifiers/splitters and relays is removed.

### **Input to the system**

In every zone there is both an IR receiver and a microphone, connected to the zone's agent PC. Therefore each of these is a means for issuing commands to the system. However, I would further envisage that the local agent PC should be directly accessible via a cordless keyboard/mouse combination. This would presumably be IR in preference to RF, due to the requirement to

use several of them in a relatively small area (one per room). This would be provided by standard off-the-shelf IR PC keyboards used in place of the normal corded keyboard.

### **Output from the system**

TTS may be used to confirm event actions, and obviously simple observation will confirm that lights have (or haven't) come on. However, I would envisage that the local Agent PC would also provide a feedback interface to the user via its normal screen display, which in this system will be connected to a local TV in the room. It will employ a custom interface designed specifically for a low-resolution TV display (IE use large fonts & buttons etc). It will provide both an input interface (IE onscreen buttons to initiate actions) and a status feedback display.

This will also allow each PC to be utilised fully, by also providing web browsing, and games.

### **Other points**

Every PC in the system will also run a flavour of remote control software, such as VNC or PC-Anywhere etc. which will enable it to be taken over from any other PC on the LAN (subject to permissions of course!) to enable me to troubleshoot/check etc remote agent PC's without having to get off my Arse and go to the room in question.

Every PC will be powered through an X10 appliance module, to enable it to be remotely (and automatically) "bounced" should it prove necessary to do so. (And if it's running any flavour of Windows, that's quite likely!)

Most (if not all) of the local zone agent PC's will be concealed from view. They will likely be slimline desktop style cases, hidden behind furniture kickplates (in that bit of dead space you always get at the bottom of a wardrobe or drawer unit), or in floor voids etc. Access will obviously be required from time to time for upgrades and stuff though, so they can't be totally unreachable!

Although redundancy of the basic HA features has been designed in to the system by the multi-master message passing nature of its configuration, certain additional functions will be placed solely at the central controller PC, such as digital and analogue IO, and Caller ID. It is simply not practicable to provide redundancy for these features because of the cost of providing multiple IO controllers (such as Homevision's or Ocelots, etc.), although, in the case of Caller-ID, it may be possible. Because of this, in the event of failure of the central controller, one of the other machines will take over the X10, IR, TTS, and VR functions of the system, but certain facilities will inevitably be unavailable until the master machine is restored. (Which, incidentally, will trigger an election within a few minutes of it coming back online!)