**ATM IN THE HOME – and – THE HOME AREA NETWORK.**

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**http://www.cl.cam.ac.uk/Research/SRG/HAN**

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## 1 Introduction

The cost of Asynchronous Transfer Mode technology is falling while its deployment is growing. Once regarded as a technology strictly for rates above 100 Mbps, ATM may now be considered for any networking scenario where multimedia and real-time are important. In this contribution, we look at a possible deployment path for ATM technology in the home and explain some of our practical work. These are both based on dumb ATM devices which can be built for low cost. The style of operation and method of control of these dumb devices uses the approach of the *ATM Warren* [1]. The Warren is a method of building low cost ATM devices and switches where the cost savings are achieved by using fixed VCI values in end stations and by using proxy control from a single processor, rather than local control processors in each device or switch.

## 2 Seeds for ATM Technology in the Home

We see three possible seeds for ATM Technology to be deployed in the home:

1. Residential Access networks are being built using ATM. This ATM is carried over a wide variety of links and media, including coax, UTP, xDSL, fibre and radio. Most of these media will be terminated in the home at an active *Homepoint* box. The Homepoint is the socket offered to the consumer on a network terminator (NT) unit at the point of entry to the home. It is the contractual boundary for the wide-area network service and the boundary between privately owned, domestic equipment and the service provider's equipment. The NT provides network protection and management functions, including electrical isolation, source-rate policing, admission control and tariffing support.

   The socket forming the Homepoint is under wide discussion, but one of the forms likely is ATM on UTP or Plastic Optical Fibre. The non-ATM contenders are Firewire and Ethernet. POTS may also be offered on the Homepoint. If the link from the Homepoint to the Set-Top Box is ATM, then, in the future, this link may easily be cut and a switch inserted to expand the network to other home devices.

2. A second source of seeding is *starter kits*. A starter kit is a collection of adaptors, a length of wire or plastic fibre and a domestic ATM switch. (Our project is the design

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of such starter kits, including the software and security architecture.) The adaptors may be fixed onto the rear of existing consumer goods to convert the sockets provided to a common ATM format. Adaptors are required for SCART, SVHS, SP-DIF, Line-level Audio, POTS, Infra-red, RS232, Midi, Firewire and others. Finally, a gateway module to a low-rate HAN, such as mains-borne signalling, is required. HiFi and home theatre addicts are likely to be good, early customers for this approach.

The idea of the starter kit is that a consumer will purchase the initial kit and perhaps some other bits and pieces, at a shop, and then take them home to install and thus form a HAN. It would be rather like installing a burglar alarm. The consumer need not know that he had an ATM network.

3. The final seed envisaged is that designers of consumer chips will place ATM macro-cells on their devices. We argue that a fixed-VCI, no signalling ATM interface has the same cost as any other type of digital I/O found on a consumer device.

## 3 Media and Line Rate: POF at 51 Mbps

Plastic optical fibre is surely the preferred cable media for the home. We have links working up to 50 metres using ATM25. The POF tranceivers are cheaper than UTP since transformer blocks are not neeed. Also there is no EMC/EMI problem. In addition, the fibre is cheap and can be cut and terminated by hand. Users can see daylight through an open fibre and can see the red light coming out of a driven fibre, so maintenance and polarity are intuitive.

Our current work uses a line rate of 25.6 Mbps. Within the ATM Forum we are defining a double-rate version of this for POF, giving 51.2 Mbps. We are in favour of using the higher rate, since the throughput of small, bus-based switches will handle this higher rate with nearly no cost penalty. Other parts of the system (end stations) have no cost penalty when the line rate is increased within the capabilities of CMOS technology (i.e. kept below about 100 MHz).

## 4 Practical Work

We have been busy building ATM devices for the home. These have been done by buying consumer goods and adding to or replacing the PCBs inside. Our current demo configuration is shown in figure 3. All components of the demo configuration are working in basic form and some 'lash-up' software exists to make the demo work. However, this software can only be used by loving experts and is certainly not the idiot-proof, self-configuring software needed for the home. Ongoing work is addressing this.

The Version 1 Warren Switch is a six port design with ATM25 on UTP using RJ45 connectors (figure 1). A handful have been built and are in use in Cambridge. This switch is a fully working, standards-compliant ATM switch, but which uses the Warren Control Protocol on a pair of dedicated VCIs, rather than having a processor inside it.

The demo configuration diagram does not show our new Warren Phones and the real configuration is actually a bit larger than that illustrated.

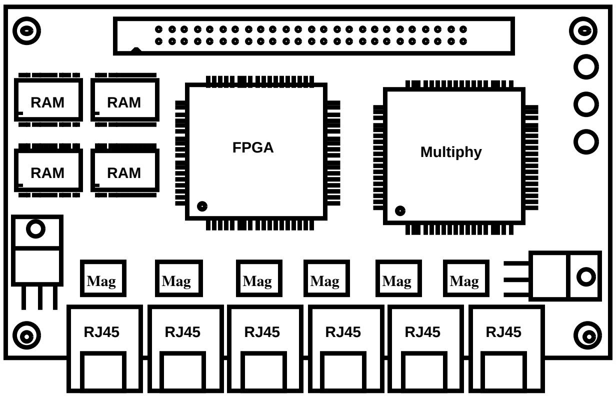


Figure 1: Structure of Warren Switch Version 1

We have built four Warren Microphones. These generate a stream of cells when switched on and the routing table in the switch is used for on/off control. A future version would include encryption or another security feature.
Two CD players are operational with internal ATM25 interfaces. The ATM25 interface carries audio and bi-directional infra-red.
Several Audio input/output units (HiFi Adaptors) have been built. These can be attached to a standard consumer HiFi on the tape return loop, or else included as modules inside active loudspeakers. Note the daisy chain facility of the speakers, where each one provides a 'through' socket to build stereo or surround systems.
The initial infra-red (IR) gateway design is complete. Several have been made, but they only currently support consumer IR protocols an not IRDS. However, all popular IR protocols are supported by the untis. The units perform lossless compression and decompression of the IR sequence and send the compressed form over the ATM network to an application provider.
An initial design of the Warren Phone is complete and ten have been made. These consist of our own ATM PCB placed inside a good-looking, production case donated by GeeMark Ltd. These phones support hands-free operation and should cost little more than an equivalent POTS phone in production. They support 8 Khz A or Mu-law encoding over AAL-1 and CD quality (mono) audio.

## 5 Video

Our plans for Video are to emphasise Motion-JPEG. M-JPEG can be compressed and decompressed without much effort and is convenient to handle and process. We are designing a single chip which includes M-JPEG and the simple fixed-VCI ATM interface that is all that is needed using the Warren approach.
We have built some LCD panels with integral ATM framestore. These currently have 224x160 by 8 bits per pixel and have a fixed colour map. Arriving ATM cells each contain a tile of pixels and a description of the shape and position of the tile. A revised version will have dynamic colour map, TV output and JPEG decoding. This could be the world's dumbest and cheapest set-top box! In the long term, we would prefer to see the

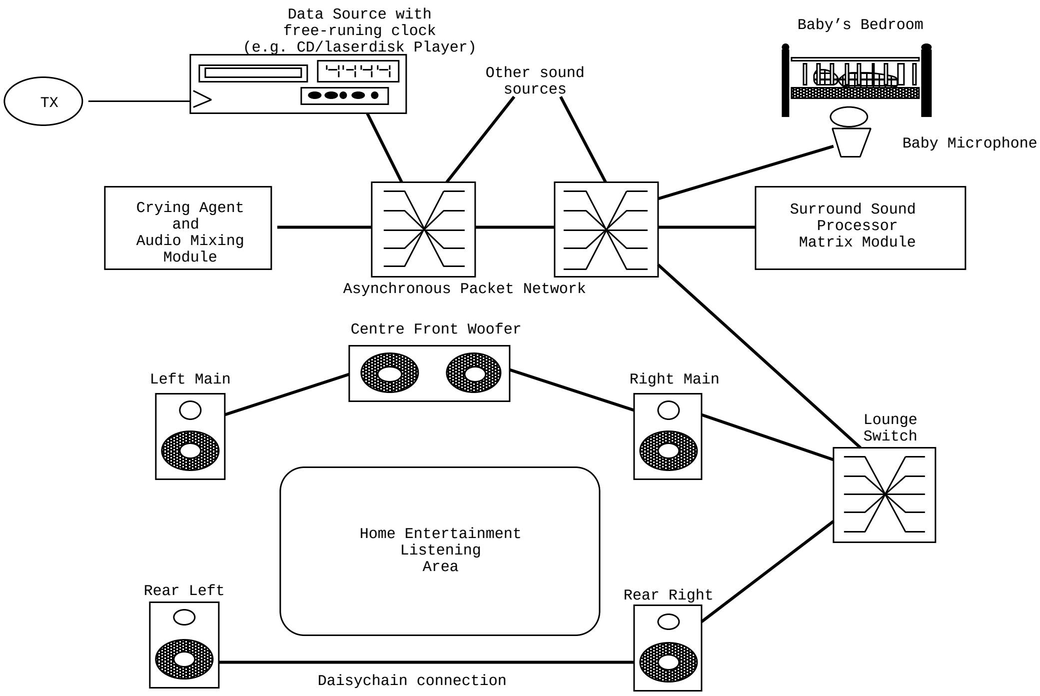


Figure 2: Audio components of a baby monitor and surround-sound system

**electronics placed inside a small module integral with a SCART connector to be mounted off the back of a TV, or even better, for the module to be placed inside a production TV set.**

## 6 Combining and Processing Agents

**Apart from reducing the number of different wires in the home, one motivation for having a HAN is reuse of peripheral devices between applications. For instance the same loudspeakers could be used for TV, HiFi, handsfree phone, baby monitor and doorbell. In additon, the same technique allows someone wearing headphones to continue to interact with all of the surrounding audio devices. In order to combine these streams, one could either send multiple streams to an output device and make the device mix, but this would complicate the device immensely. Instead, we prefer to have one or two hardware units on the network which act as agents to perform these mixing and other related functions. The related functions of crying detection and surround sound decoding are illustrated in figure 2. Another network agent needed when we concentrate on M-JPEG will convert from external MPEG sources to M-JPEG.**

## 7 Conclusion

**It is inevitable that a Home Area Network standard capable of voice and video as well as data will emerge. There are good reasons for this to be an ATM network. One of**

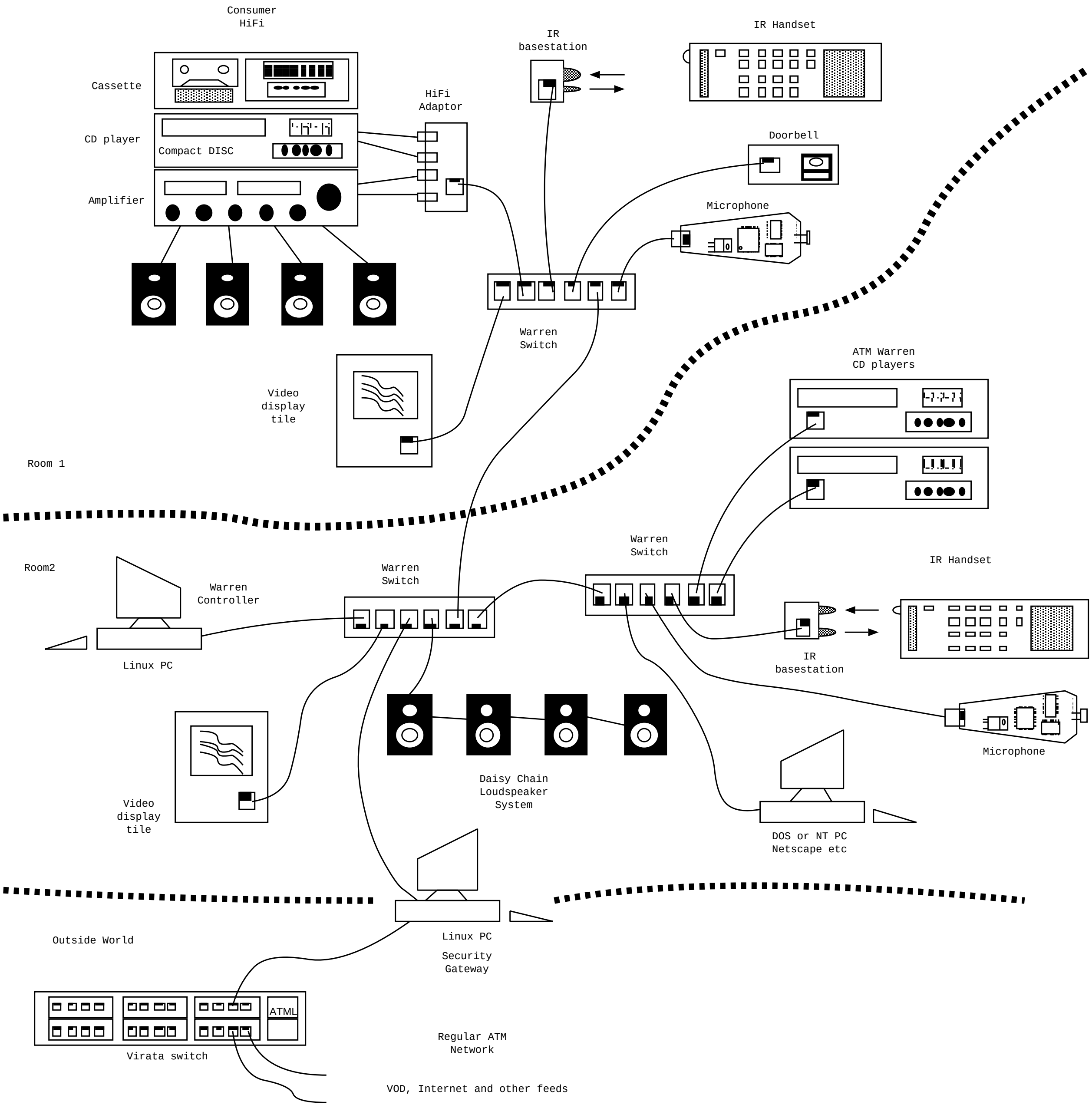


Figure 3: Current Demo Configuration

**the original motivations for ATM networks was low gate-count and ease of implementation in hardware: we have proved that an ATM network is indeed low-cost if designed appropriately.**

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**References**

**[1] See http://www.cl.cam.ac.uk/Research/SRG/HAN**