



Computer Networks and Community Applications

Presentation by Air-Stream Wireless Incorporated
For CISA

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Overview

Networks provide a means of connecting two or more computers in order to share resources, such as files and printers, and for communication through websites, email, chat and video. The underlying systems used by computers to communicate, operate regardless of the medium in which they physically travel. Cables, telephone lines, radio signals and even infrared light beams, can be used to link computers in a network.

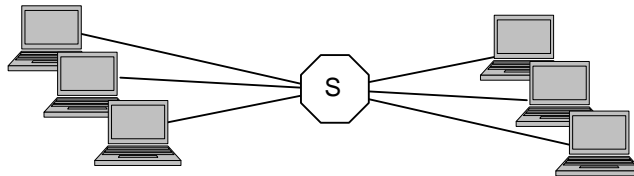
Physical Network Structure

Groups of computers can be connected in many different configurations.

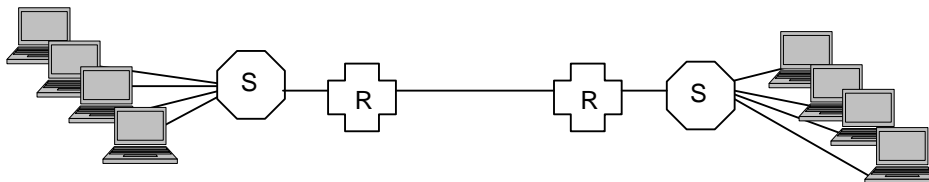
A simple **Local Area Network (LAN)** consists of a few computers, which are directly connected to each other. This allows for high-speed communication between the participating machines, but little flexibility for adding more clients. Networks like this are generally confined to a relatively small area, such as a home, business or office.



As more clients are added to the LAN, we require more efficient control of network traffic. This is achieved through the deployment of devices such as **Switches** and **Routers**. A network Switch (S) operates like a central hub through which several computers can communicate at high speed. Computers can send out network broadcasts to inform all other computers of their presence, and high-speed peer-to-peer communication is maintained.



Routers can be used to interconnect several LANs together, forming a **Wide Area Network (WAN)**. A Router (R) is used at each connection point between the LANs to control and monitor the passage of data.



The use of Routers allows confinement of network broadcasts to the Local Network only, instead of traversing the entire network, and reducing overall efficiency. The flow control and management of data as it traverses a physical network is known as **Routing**. Perhaps the best example of this network structure is the Internet, built upon these same principles; it is a worldwide collection of interconnected LANs and WANs.

Managing Networked Computers

Computers on a network communicate with each other using a special numbered addressing system. This is known as Internet Protocol (or IP). Each computer has a unique **IP Address**, which is four sets of numbers from 0-255, separated by a decimal point. This gives a total possible address space from 0.0.0.0 to 255.255.255.255. For example: 203.152.23.202 is an Internet IP Address.



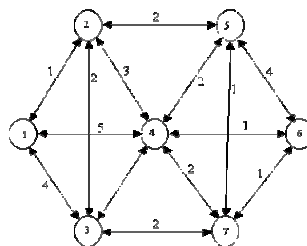
IP addresses can be grouped into smaller logical segments of the entire address space, which can then be assigned to computers in a LAN. Breaking up IP Address space into smaller sub-networks is known as **Sub-netting**. This allows for logical control of data between LANs, and maps well onto the physical network design outlined.

Managing Collections of Sub-Networks

When a **router** receives a packet of information (as it does thousands of times per second) it inspects the **IP Address** of that packet, and based on that, can make decisions on which physical path to send it through. This process is known as **routing** the packet.

Special software protocols have been created to support the routing of network traffic between sub-networks. These protocols operate with 'smart' algorithms that can adapt the flow of network traffic when problems occur. Protocols such as **Border Gateway Protocol (BGP)** and **Open Shortest Path First (OSPF)** are widely used across the Internet today.

The algorithms employed by these protocols provide great network stability ensuring that if one network connection is lost, the router can quickly adapt to send data through an alternate network path. Consequently, the greater the number of network connections that are available, the greater the reliability and bandwidth for its users.





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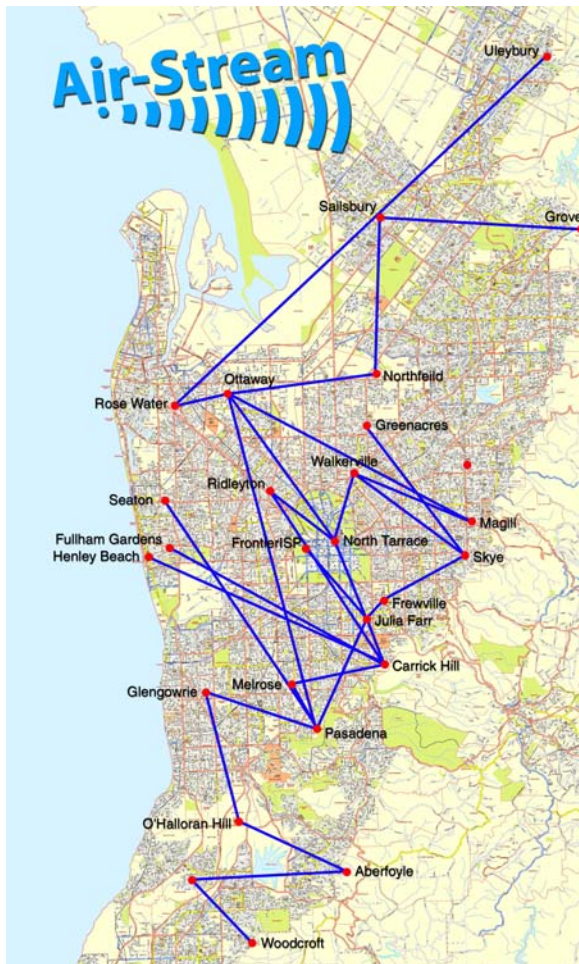
Air-Stream Wireless Incorporated

Until recently, interconnecting multiple computers over distances greater than a kilometre has required a significant infrastructure investment, for example overhead and underground cables, satellites and telephone exchanges.

However, the recent advent of low-cost wireless (radio) network equipment, and the availability of sophisticated Open Source Software, has created the opportunity to build large metropolitan and suburban networks that have the ability to grow to support many thousands of users.

Air-Stream is a not-for-profit community organisation, the first in South Australia to build such a Wide Area Network using these technologies. Our aim is to deploy a low-cost broadband infrastructure for **sharing localised information** such as websites, email, voice, video and other forms of communications.

The goal is not to be in competition with existing Internet Service Providers but rather to provide a low cost, community owned and operated infrastructure that runs in parallel, **complementing existing Internet services** by providing an alternate path for local 'last-mile' network traffic. Consequently, communications between users, local servers and other users within the community network bypass the Internet and avoid the costs of national and international Internet carriers.



Access Points within the Air-Stream Network
(Adelaide, South Australia)

Over the past few years, similar projects have been rapidly appearing in communities all over the world. Since Air-Stream's conception, groups of local community-minded people have been putting their heads and hands to work, creating the substantial network we enjoy today.

Currently, our membership includes IT professionals, engineers, community groups and enthusiasts, who are volunteering their time and resources to build and support this network.

Since its establishment in 2001, Air-Stream has pooled its skills and experience from members and other groups internationally to develop systems that in terms of cost and flexibility are outside the scope of commercial operations to deliver.

The network is growing rapidly and has now successfully backboned locations in many parts of Adelaide. Where Each site can support between 30 and 100 users, depending on equipment installed.

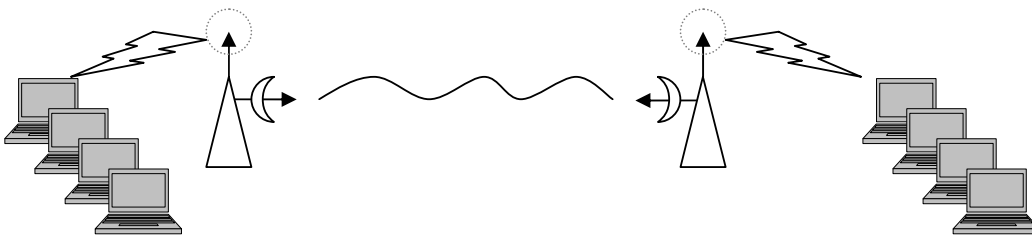
The Network Infrastructure

The technology deployed uses off-the-shelf low power microwave telemetry equipment and as such requires “line-of-sight” between each point where the distance is greater than 400 metres.

Nevertheless, due to the properties of microwaves it is easy to direct this signal into a narrow beam allowing networks to be established over much greater distances, sometimes in excess of 10km. Consequently, at each site where equipment is installed a mast is erected to provide the greatest access for users, wishing to connect and backbones to other similar Access Points.

Access Points

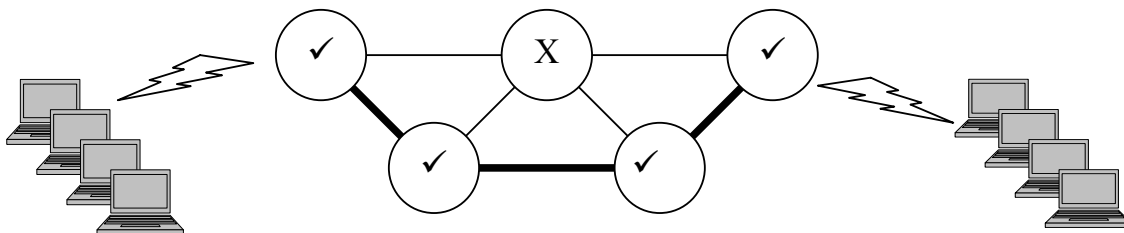
Omni-directional antennae and 802.11 compliant radio equipment is installed at each site, providing wireless access to the surrounding area. Users connect to the network with similar radio equipment and directional antennae. Each Access Point may support around 30 users or network groups at a time and as many as 4 Access Points can be located in the same location. Highly directional one-to-one connections called backbones are also installed between Access Points, to provide a dedicated bandwidth pipe and allow network traffic to be routed over multiple paths.



Inter Network Routing

Proper use of sub-netting (breaking a network up logically into smaller networks) and routing (methods used to efficiently pass traffic between subnets) within a large network can be used to improve performance and redundancy.

Air-Stream's network design and structure has been carefully planned and tested over the past few years, resulting in a refined network model that suits the technology well. South Australia has been segmented into logical areas allowing networks within these areas to be allocated proper sub-networks, which support our routing protocols. The Air-Stream network utilises dynamic routing protocols such as BGP to ensure maximum connectivity at all times.





Pictured above is a common Access Point installation supporting four wireless links and a local Ethernet connection. Similar dedicated servers are found at all installation sites, running dynamic routing protocols, and supporting two or more Backbones to other Access Points in the network.

These hardware configurations provide us with the ability to interconnect several small sub-networks, and as the number of Access Points increases, so too does the network's reliability, bandwidth and the number of users that can connect to it.

Network Security

Wireless Networks operate in the same way as the Internet, so precautions should be taken to protect computers or LANs connected to it. This can be done on several levels, and as the network is tightly managed, it employs a number of security measures, such as:

- Access Point telemetry equipment can be encrypted providing security between the Users and an Access Point.
- Users may firewall and protect their computers using the same tools and applications available for the Internet.
- Being a routed network, each AP manages its own subnet and traffic between each host can be highly controlled.
- Users may also deploy encrypted VPN (Virtual Private Networks) as another layer, providing additional layer of security.



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Benefits for Community Organisations

Wireless networks provide a cost-effective way to **share resources** between multiple business sites. For example, file servers and databases can be centralised, and by linking each site via a wireless network, access to common information is made possible from each of an organisations outlets.

This opens opportunities for **remote technical support**, where IT technicians are not always available on site, and even makes it possible for staff members to access work information from their homes.

Sharing a single high-speed connection between offices, using wireless technologies, can greatly **reduce cost of Internet access** and allow for the provisioning of one extremely fast single connection, rather than several slower ones. Email and other communication channels can be greatly improved by keeping all local data on the wireless network, rather than sending information out through the Internet Service Provider and back.

Internet telephony (Voice Over IP) provides a means of circumventing some of the costs associated with the local landline service. Using compression systems similar to that of mobile phone networks, carriage of several voice conversations over the Internet, or a wireless network such as Air-Stream, is quite possible. Several businesses are already benefiting from free voice communications.

Supporting the Community Network

Until this stage, the ever-increasing group of Air-Stream members has provided funding for the network Infrastructure, both through membership fees, hardware donations, roof space, and the time taken to develop software and build wireless devices for deployment. However, there are several ways other community organisations can provide support.

An important pre-requisite for building effective wireless networks are suitable locations to house the telemetry equipment. Because the technology depends heavily on line-of-sight connectivity, **elevated mounting platforms** for antennae, such as **rooftops** and **masts**, are ideal locations for wireless transmitters.

Hardware contributions, for example through funding of shared telemetry equipment, are an ideal way of getting local business involved in the community, while at the same time reaping some of the benefits outlined above.

Local business and community groups are capable of **providing community-rich content**, such as web pages, portal sites, newsgroups etc, which in turn helps to promote their goals and community presence.

Actively promoting the Air-Stream network to other organisations as a beneficial **community resource**, and helping others come to terms with understanding the technology and concepts involved. This helps to attract like-minded people, with both technical and non-technical backgrounds, broadening the skill set available within the group.