Axis Communications
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AXIS Network Cameras

Crisp quality images and live video over the Internet.

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Introduction

The Axis 2120 Network Camera is a camera with a built in Internet web server. The 2120 connect directly to a 10/100 MBit Ethernet network and live images are viewed directly from a web-browser. The 2120 Network Camera is a high-end version of the market leading Axis 2100 Network Camera. With up to 25/30 images/s, video motion detection, sturdy casing and DC-Iris, vari-focal lens the advanced and professional user of networked cameras will find the 2120 to fulfill the requirements of even the most demanding installation.

This paper describes what is under the hood of the Axis 2120 and how it works. For information on various applications, we refer you to read the Camera Applications document.

Why Networked Camera?

The Axis 2120 Network Camera is not to be confused with ordinary "webcams". It is a complete network camera with built-in features like motion detection and it attaches directly to a network providing live video with a frame rate of up to 30 (60Hz version for NTSC countries) or 25 (50Hz version for PAL countries) frames/second of high quality images. It is based on Linux and the standard TCP/IP protocol suite. Furthermore, it contains a web server and users can view live images remotely over the network, configure and manage the Network camera from a standard web browser, such as Netscape Navigator or Microsoft Internet Explorer. The camera can be monitored locally (intranet) or wherever desired in the world by taking advantage of the Internet. This ease of use and mobility in live remote video viewing is a quantum leap in terms of technology.

Networking using standards such as HTTP makes image gathering from applications very easy. The 2120 will, as its predecessors, be used in a multitude of applications ranging from remote monitoring systems to live Internet broadcasts of ski-slopes or other places of public interest to attract visitors to a web site.

Theory of Operation

The AXIS 2120 Network Camera is as a stand-alone camera, with a built in web server. In the basic mode of operation you use the URL of the camera to access the images and the internal web pages of the 2120. There is no need for a PC since the unit has its own IP address!

A snapshot or a video stream is triggered by the request from a browser. When an image is requested the snapshot taken by the camera, compressed into JPEG format and transmitted over the network back to the browser. Up to 30 (NTSC countries) or 25(PAL countries) frames/second can be transmitted to a single viewer. The actual frame rate received mostly depends on the speed of the viewing PC and network bandwidth.

Apart form the "passive web server" operation described above the 2120 is also able to act on pre-configured events to:

- Sequentially upload images using ftp at a certain frequency. This feature is mainly used for updating images on a remote web server at a low frame rate, for instance every 10 minutes.

- On external alarms. The external input can be connected to a doorbell and initiate e-mail transmission or storage of pre and post alarm images on an ftp server.

- Motion detection. The included motion detection functionality can cause "events" which initiates e-mail or ftp image transmission of images.

A web page Example:

Imagine that you want to add a live image of the street outside your office to your home page.

Once you have connected the AXIS 2120 to your Internet connected network, assigned it an IP address and maybe even a DNS name, then all you have to do is write an html page that includes the image directly from the 2120 and store it on your ordinary web server. Since the different parts of an

html page (images etc) can reside on different web servers the only thing you need to do is add the URL of the image directly to the web server inside the AXIS 2120.

Simply place the image URL where you want the image to appear on your home page. If your camera's name is cam.yourbusiness.com, then a simple html file like the example below is enough:

```
<HTML><HEAD><TITLE>Sample page</TITLE></HEAD>

<BODY><H1>Below an image from the Axis 2120 will appear</H1>

<IMG SRC="http://cam.yourbusiness.com/jpeg/default.jpg">

</BODY></HTML>
```

(For hints and tips for publishing images on an Internet web site, please visit: http://www.se.axis.com/products/cam_2100/livedemo.html)

Note: Advanced users can store their own html pages inside the 2120 flash file system. This is only for advanced users and html page design is not supported by Axis Communications.

Network, Modem and Internet Connectivity

The Axis 2120 is at its best when connected directly to an Ethernet network and assigned a public Internet address. This will allow you to take full advantage of the entire functionality inside the 2120, view images from anywhere on the Internet, trigger on motion and remotely store pre/post alarm images and much more.

However for maximum flexibility the Axis 2120 Network Camera is able to deliver live images over both 10/100 Mbit Ethernet as well as through an external modem. The main connectivity options are the following:

- Directly to an Ethernet network running TCP/IP. Where the camera is a web server on its own. You simply monitor what's going on in your web-browser. This is the recommended method of connection.

- Dial-up mode, where you attach an external modem to the serial port to have the camera dial-up to an ISP. The Axis 2120 can be set to connect when: motion is detected within the image, at certain intervals or triggered by external events (alarm sensors). After Internet connectivity has been established the 2120 can deliver snapshots via ftp or as e-mail attachments.

- Dial-in mode. You attach a modem to the serial port and can then dial in to the camera using a PC with modem and windows standard dial-up-networking. Images are then monitored as always, through your web-browser.

- Null- modem cable connection. The included Null- modem cable allows you to "dial-in" from a PC to your network camera without a network. This is mainly intended for installation and configuration at non-networked sites but can be used for viewing images when no network is available.

Advanced Internet Access functionality.
The AXIS 2120 Network Camera is built with local LAN, high speed Internet services such as DSL well as low cost (modem) connectivity in mind. The ideal solution is, if you have a high-speed Internet service that provides you with several external static IP addresses. If this is the case, you can assign one of these IP addresses to your camera, and it will be fully accessible via the Internet.

Since Internet connectivity services are continually evolving and sometimes have regional differences there are a few things that you should keep in mind:

DYNAMIC IP ADDRESSES.
Most Internet Service Providers only give you 1 external IP address and in most cases this is a dynamic IP address (DHCP). In a dynamic IP address environment such as dial-up over modem or on a DHCP network the 2120 will receive a new address every time it connects or when the lease of the IP address expires. The dynamic IP address is not a problem if images are to be transmitted via e-mail or ftp, however if you would like to have access directly to the web server inside the AXIS 2120 and view truly live images the IP address is unknown.

The AXIS 2120 does however have a great feature, it is able to send the newly received IP address via e-mail, upload an html page with a link to the current IP address or deliver the current IP address as a CGI parameter to a script on a web server. These features allow you to always have the latest IP address available and you can go directly to your 2120 and view truly live images.

SINGLE IP ADDRESS.
Even if you have an Internet service, which only assigns you one IP address and you use this IP address for your PC you still have a few options:

Use the Windows 2000 NAT-feature (Network Address Translation) or a program such as Wingate (for Win 95/98), which allows you to have multiple Ethernet cards in your PC. You will then let one port go to the Internet and the other for your internal "private" network. The 2120 will in this setup be able to upload images to an external ftp-server at for instance your ISP or send images via e-mail.

A better solution is to get a small router/firewall that provides the NAT functionality. There are several such on the market today and this gives you the independence of the PC, which may be switched off or hanging…

If the public IP address provided by your ISP is static and your NAT unit provides "port mapping" functionality you may configure your NAT unit to bypass requests on a specific TCP port to the IP address of your 2120 and port 80. This will give you access to live images from the 2120 as if the 2120 was connected directly to the Internet.

PROPRIETARY OR UNUSUAL CONNECTION OR AUTHENTICATION PROTOCOLS.
Some ISP's' have implemented their own or are using uncommon connection protocols and procedures. The best way to avoid these providers is to make sure that they support connection from a wide variety of operating systems without installation of any special software.

BLOCKED INBOUND HTTP REQUESTS.
Some ISP's are blocking incoming access from the Internet. This means that you are unable to have a web server accessible from the Internet. If your ISP has imposed this limitation to its users I

recommend you discuss this matter with them, they will in most cases enable you to get the desired access by assigning you to a different service level.

Image and Video file format

Still images
The Axis 2120 generates hardware compressed JPEG images in the JPEG File Interchange Format (JFIF). As JPEG is natively supported by web-browsers these images can be viewed and easily be included in your web pages.

JPEG images can be fetched using HTTP (web browser) or FTP, the 2120 is when configured to act on alarms and transmit JPEG images to an ftp server over FTP and via SMTP (e-mail).

5 levels of compression are available. Important to know is that the file size of a JPEG compressed image depends on the actual content of the image. Images containing much detail will generate larger files. Image quality is controlled through the level of compression. High compression yields small files while low compression maintains high image quality at the expense of larger files. The tables below contain average file size, derived from real life tests.

Resolution	Compression level		
	Low	Medium	High
704 x 576 (50 Hz)	52kb	34kb	20kb
352 x 288 (50 Hz)	12kb	8kb	4kb
704x480 (60 Hz)	36kb	22kb	13kb
352x240 (60 Hz)	8kb	4kb	3kb

Note: 50 Hz in PAL countries up, 60 Hz in NTSC countries.

Video
The live video format is server push of JPEG images. In server push, an HTTP connection is held open for an indefinite period of time or until the client interrupts the connection. Server push is accomplished by using a variant of the MIME message format "multipart/mixed", which lets a single message (or HTTP response) contain many data items (JPEG images).

Server push has native support in Netscape Navigator 3,4 & 5. Internet Explorer will automatically download an ActiveX component from the 2120; other browsers may view live video through a Java applet.

WHY MOTION JPEG?
A common question regarding the choice of video format is why we do not use MPEG or H-261 instead, since this would use less bandwidth then Motion JPEG. The answer is obvious when considering a security surveillance system:

Top priority of a surveillance system is to always have high quality on the images that are transmitted and stored when something occurs in the image it is desired to have optimal quality on moving objects like people or cars.

H-261 is aimed at video conferencing systems and is focused on providing images fast with low latency; MPEG is mainly aimed at compressing motion pictures onto a CD or DVD. In order to achieve their objectives something must be sacrificed, image quality and in particular the quality of moving objects is sacrificed. H-261 and MPEG will in have high quality on the background and non-moving objects but will reduce quality on the person who quickly ran past the camera.

The AXIS 2120 Network Camera will transmit every single image with a known and predefined image quality regardless of the amount of motion within the image. When bandwidth is insufficient for full frame rate the number of images transmitted will be reduced but each and every actually transmitted will have the same high quality.

The AXIS 2120 could have been designed to generate an MPEG stream. However, most viewers in the PC environment do not support live never-ending streams of MPEG, only fixed length MPEG files. The addition of MPEG support in the future is a possible enhancement, but today it would not offer a better solution.

MULTIPLE SIMULTANIOUS ACCESS
Multiple accesses are the added bonus of using Motion JPEG. The AXIS 2120 is able to provide each viewer with the best video quality his or her network connection makes possible. The AIXS 2120 can provide a local network user with full frame rate video at the same time as a user on a slow modem connection receives one image/s. The images received will always be of the same high quality.

The AXIS 2120 is specified to support up to 10 simultaneous viewers of live video. The actual number of simultaneous viewers may in real life be higher then 10 since it depends on available bandwidth and the memory available for TCP buffering in the 2120.

MOTION DETECTION
The AXIS 2120 Network Camera has a built in motion detection feature. This can be used to issue an alarm when motion is detected. In most cases it can replace a PIR sensor. The motion detection algorithm can in simple terms be described to look in the image for changes that are larger than a certain configured threshold, when this is passed it may trigger a certain event, such as uploading pre-post alarm images, sending an email e t c.

EDIT YOUR OWN HOMEPAGES
The AXIS 2120 Network Camera supports upload of custom web pages. You are not required to have the factory equipped homepages, but can use your AXIS 2120 to host your own small website! The maximum amount of storage of homepages is roughly 2 Mbyte.

CONFIGUARBLE MAXIMUM BANDWIDTH USAGE
The AXIS 2120 Network Camera only uses network bandwidth when it actively transmits images. This happens when someone is watching or the Axis 2120 stores alarm images remotely. Most applications only have a few network cameras running simultaneously, this enables real life installations to contain hundred's of cameras connected on one single Ethernet network.

However video over networks requires bandwidth and in production networks environments it is often desired to limit the bandwidth allowed for video transmission. The AXIS 2120 is equipped with a configurable maximum bandwidth limitation to prevent network saturation. The bandwidth usage depends on image content, compression level and resolution. "Normal" bandwidth usage for a single video connection at high frame rates is about 1.5-2,0 Mbit/s.

Administration

All administration is done using a standard web browser. The user is guided through the entire configuration by assisting "wizards".

Installation

The AXIS 2120 can be installed and configured in two different ways:

- Over a LAN where it is assigned an IP address using the two commands "arp" and "ping" or with the Axis IP installer (software downloadable for free from the Axis web site)

- With the supplied null-modem cable and dial-up networking (non-network installation).

Software:

The AXIS 2120 is running embedded Linux as its operating system, together with a Flash based file system (JFFS). This means that own HTML pages may be uploaded, direct access to configuration files and special applications can be created.

- Embedded Linux

- Boa web server

- JFFS for storage of web pages

- PHP3 as a scripting language (to be added in coming release)

- Mechanism for handling DHCP dynamic IP address

Hardware:

The AXIS 2120 has been equipped with an abundance of hardware, considering that it is an embedded device. Hardware JPEG compression support by the ARTPEC-1 chip delivering up to 30 frames/second. In conjunction ETRAX-100 processor that delivers 100 MIPS of raw performance, as well as driving the 10/100 Mbit/s network. The ARTPEC-1 and the ETRAX-100 are both Axis in-house developed chips.

- 16 Mbyte RAM (up to 8 Mbyte available for pre/post alarm image storage)

- 4 Mbyte FLASH. (up to 2 MB available for user designed html files)

- ARTPEC-1 compression chip. This Axis designed image compression chip is the video engine of the 2120 that enables it to generate optimally compressed quality images at high speed.

- ETRAX-100, 32 bit RISC, 100 MIPS CPU.

- Camera. The camera part of the 2120, is a high performance digital, 24-bit color camera with a 1/3" Sony super HAD interlaced CCD. It includes back light compensation, automatic AGC, automatic and fixed white balance, electronic shutter: 1/50s [1/60] _ 1/10000s. Illumination range with the provided DC-Iris lens is 1 to 200 000 Lux with F 1.0, if the lens is changed to a

fixed iris lens it will be about 1 to 5 000 Lux. The camera part of the AXIS 2120 will come in two flavors. This is due to the differences in electrical frequencies used in various countries the two predominant are 60 Hz (USA) and 50Hz (Europe).

Operating Environment

The AXIS 2120 Network Camera is equipped with a sturdy metal casing and a DC-Iris lens that will protect the CCD from exposure to very strong light. It is however still recommended to avoid aiming the AXIS 2120 directly into extremely bright objects like the sun, since prolonged exposure to very strong light may harm the CCD image sensor.

If used outdoors or in other harsh environments it is required to use a, for the environment appropriate, casing. The AXIS 2120 will fit into most standard medium sized outdoor casings. Casing can be purchased through many of our resellers as well as from CCTV and security resellers.