# GigE Camera Technology for Pulp and Paper - Operational Advantages

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ECS Uptime by Design
Event Capture Systems, Inc.

**Capture • Process • Display**

## Operational Advantages of an ECS GigE Event Capture System

### Key words

- Analog cameras with signal sent via coaxial cable
- Digital Ethernet backbone with GigE cameras
- Frame grabbers and other specialized processing hardware
- Total Cost of Ownership
- Console/Capture computer architecture vs. Server Farm
- Single Point of Failure
- Maintenance, upgrade path and system uptime

### Summary

Cameras installed along the paper machine to record web breaks for later review to help determine break cause have been used since the mid 90's and are now commonplace in every grade of paper manufacture. As these systems are computer based the mill has to evaluate when the technology should be replaced by newer and more advanced components. This paper reviews the concepts of upgrading an analog system in three major categories (1) interface cabinet, (2) paper machine components, (3) signal backbone.

### Analog Based Systems

The majority of camera systems installed from mid 1990 through the following decade use analog cameras with coaxial cable transmission to a central location (computer room) where the signal is digitized and buffered on a hard drive or RAM. This analog standard (NTSC – National Television System Committee - http://en.wikipedia.org/wiki/NTSC) was developed in the 1950's and the low cost and high availability of components have made this the choice for camera based security and monitoring systems. As compared to newer technologies these systems have the following limitations:

- Resolution
  At 60 images per second NTSC cameras are limited to 240 lines of resolution (by 640 lines wide). This is considered half VGA resolution.
- Requires specialized hardware – limited to no repair and upgrade path
  The camera information must be digitized by frame grabber hardware before buffering. Repairing or upgrading specialized hardware in dated computers is either not possible or cost prohibitive.
- Single Point of Failure – Capture and Console Architecture
  Most analog based systems have computers that digitize the information (capture computers with frame grabbers) and one computer per system that runs the user interface and other global system features (console computer). Because these computers have specialized hardware to perform these tasks (frame grabbers in the capture computer) a failure in the console computer can bring the entire system down as a capture computer cannot be configured 'on the run' to process the information required for the console computer.
- Signal loss on coax cable
  The analog camera signal degrades over distance and will pick-up EMI (electromagnetic interference) from the paper mill environment. Coaxial cable shielding also supports unwanted ground looping from camera location to interface cabinet. Line filters can be used but causes resolution loss due to increased signal attenuation.
- Frame rate
  Most analog based systems are limited to 60 pictures per second. 120 frames per second is also available but the resulting video quality from these analog cameras can be poor.
- Total Cost of Ownership
  Over system life the downtime of analog systems generally increases (more parts fail) and the repair/diagnostic becomes more time consuming and expensive. Camera system downtime may result in further production losses on the paper machine.
- Multiple spare parts required
  In many cases utilizing different cameras (higher frame rate, color vs. black and white) requires a different frame grabber. If different cameras are used, the mill must allocate spare parts for different capture units and also for the console computer.
- Limitation of software features
  Camera systems used in break analysis today are no longer limited to the reactive approach of simply viewing break video 'after the fact'. Newer systems that process higher resolution images with more powerful processors can provide not only better break images but also several advanced features outlined below.

### Digital Based Systems

Recently a new camera transmission standard has emerged that does not have many of the limitations of NTSC (analog) and other digital standards (Camera Link, Firewire) - it's called GigE. (http://en.wikipedia.org/wiki/Gigabit_Ethernet and http://www.machinevisiononline.org/public/articles/index.cfm?cat=167). The technology sends the camera information as an Ethernet digital signal from camera to processing computers. In this case the camera is GigE compliant with an RJ45 port. Coaxial cable is replaced by UTP (unshielded twisted pair – see www.belden.com or http://en.wikipedia.org/wiki/Twisted_Pair) or fiber optic. Systems that use this architecture have the following advantages:

- Higher resolution
  Camera enclosure cleanliness, shutter speed, depth of

**Digital Based Systems -** *continued*

field, contrast and light quality are all important concepts for any system (analog or digital). However, there is no limitation of the resolution (lines and width of video signal) that the GigE camera can provide. Currently standard GigE camera used in pulp and paper output VGA resolution (twice that of analog) to XVGA (5 times greater camera resolution than analog). Mega pixel cameras (including HDTV) are available but the current frame rate (as low as 10 pictures per second), sensitivity and cost remove them as alternatives. These will be viable alternatives in the future.

- No specialized hardware
  The camera information is presented as a digital signal. No frame grabbers are required. As a result – the computers contain no specialized hardware. The computer components are limited to standard readily available parts – motherboard, processor, hard drive, chassis, power supply and fan. All of the processing of the camera signal is done via software. Upgrading to the next camera platform (higher resolution) only requires the retrofit of standard computer hardware – motherboard and processor.
- No single point of failure
  The system is designed as a 'server farm'. There is no console and no capture design. In the digital architecture – all computers are the same. Each computer is its own independent unit and can run a standalone (capture and review) version of the software. If one unit should fail any other unit can take the processing load of the failed computer.
- One spare part
  Since all of the computers are the same – only one spare computer is needed for the entire system.
- One computer per camera to multiple cameras per computer
  One to four cameras can be connected to a computer
- Cost effective upgrade path
  From above 'The computer components are limited to standard readily available parts – motherboard, processor, hard drive, chassis, power supply and fan. All of the processing of the camera signal is done via software. Upgrading to the next camera platform (higher resolution) only requires the retrofit of standard computer hardware – motherboard and processor.'
- Lossless camera signal transmission
  The Ethernet signal is lossless between points. Many cable manufactures (Belden – www.belden.com) manufacture special CAT 6 and other UTP cabling that is designed for noisy industrial environments.
- Pre-molded cables
  The cable ends exposed on the camera enclosure (Ethernet signal) all use pre-molded cables sets to a junction box. Conduit is used from the junction box to the interface cabinet. No field terminations are used at exposed points – this protects the digital backbone and ensures reliability over time.
- Extended warrantee on hard drives
  A ghosting procedure allows for easy replacement of hard drives with hard drive warrantees up to five (5) years.
- Low cost of repair
  No specialized hardware – repairs and parts are not required to match key hardware components. Any Windows compatible hardware can be used for repair or upgrade.
- Wireless technology can be used for any camera
- Backward compatibility to legacy analog based systems
  All ECS systems are GigE based but can be fitted with analog to GigE converters to utilize existing analog camera video inputs. Later upgrade to GigE cameras only requires the removal of the analog to GigE converter. This typically results in higher video quality from (1) lower compression used in the ECS capture program and (2) the analog to digital converting chip in the converting module (Pleora) is a higher quality chip than most traditional analog frame grabbers
- Advanced Software features – a general overview includes:
  - Hands free viewing – system opens all cameras to synchronized break point
  - Extended video buffer – 24 hours
  - Video Scanning of the entire video buffer
  - Improved operator interface with intuitive controls – see ECS™ white paper '*Ease of Use – The Critical Details*'
  - Terminal Services –the system can be controlled by any computer on the mill network
  - Interface with PI and other OPC compliant servers. The system can have an OPC server on specific playback computers for unlimited conductivity to other mill systems
  - Advanced grayscale and image processing
  - Multiple beam web inspection with classification and roll map
  - Seamless integration to existing web inspection systems
  - 100% image processing on all images (every frame) include edge defect detection with VGA or higher native signal resolution
  - Integration of event capture to web inspection in single window interface (storyboard display)
  - SQL Library Database
  - Excel export from Library with customized Macros - http://office.microsoft.com/en-us/excel/