Session: 6W04

IP Video: Putting it All Together

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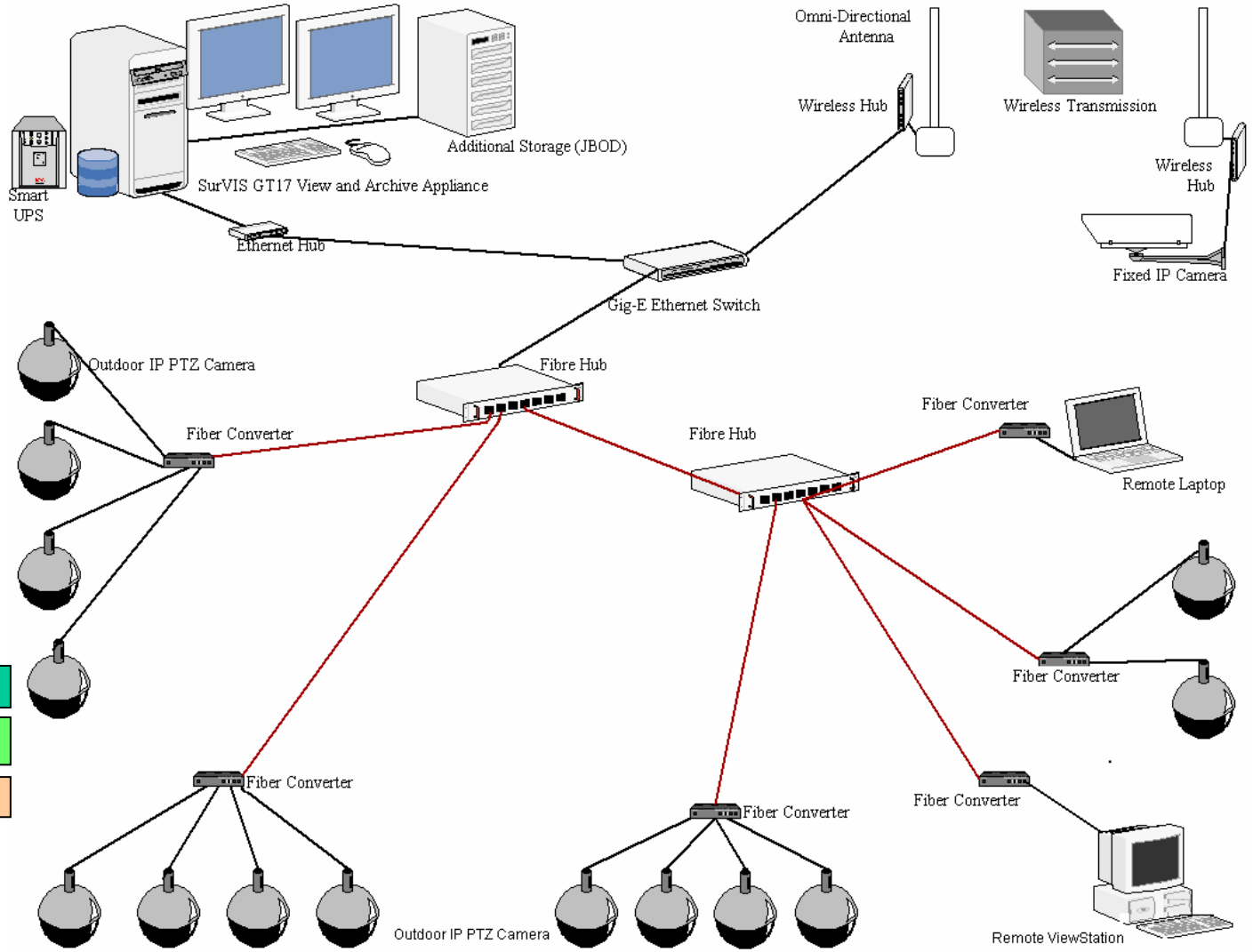
Agenda

- Overview
- Cameras
- Networking
- Software
- Network Video Recorder
- Case Study

Generic System Overview



CCD A/D

Compression

LAN I/P

Cameras

- A/D and compression occur at camera
- Many cameras have multiple compression options
- IP Cameras come with software which allows the user to view and set parameters for a single camera
- Camera bandwidth determined by resolution, frame rate and compression
- Two camera options: fixed and Pan/Tilt/Zoom (PTZ)
- Many camera manufacturers: several resolution levels

Cameras

- Camera selection and settings drive overall surveillance system performance requirements
- Camera Settings:
  - Resolution or image size
  - Images per second
  - Image quality: sharpness, brightness, hue…
  - Compression
  - Network configuration
  - Security
  - Alarms

Resolution

- Common image sizes in Common Intermediate Format
  - 320 x 240: 1 CIF
  - 640 x 480: 4 CIF
  - 1280 x 1024: 1.3 Mega Pixel or 17.1 CIF
  - 1600 x 1200: 2MP or 25 CIF

- Image file size depends on:
  - Resolution
  - Contents of image
  - Presence of motion
  - Compression

Resolution Example

NVR - DVR Image Comparison

Image File Size*

12KB

32KB

150KB to 275KB

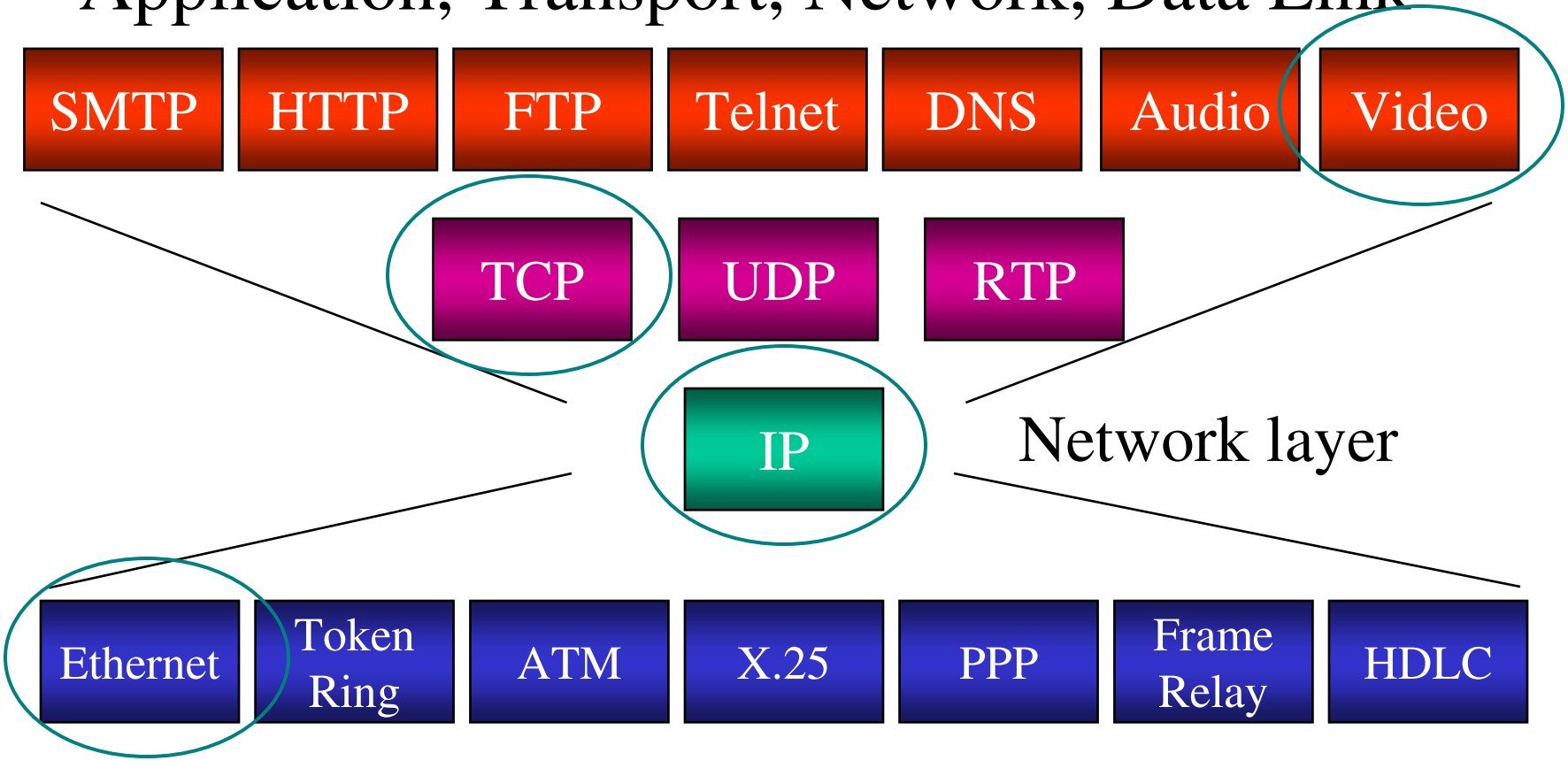
*MJEPG

Networking

- Ethernet:
  - A physical and data link layer (Layers 1 & 2) used to move data across a network. IEEE controlled/maintained standard: 802.3xx. MAC addresses reside at this layer.
  - Most widely deployed network interface
  - Synonymous with the term LAN (Local Area Network)
  - Transmit and receive across a single "pipe" – collisions occur
  - Copper (UTP) and Fiber interfaces defined. Copper distance limit spec'd at 100 meters
  - 2 main network speeds: 10/100 Mbps and 10/100/1000 Mbps (gigabit)
- TCP/IP:
  - Transmission Control Protocol (Transport Layer, 4) and Internet Protocol (Network Layer, 3) are used together to reliably send "packets" of data from one point in a network to another. TCP is an end-to-end protocol: encapsulation/decapsulation over network protocol on end systems. IP is throughout the internetwork: encapsulation/decapsulation over data link protocol at each hop

Protocol Layers

Application, Transport, Network, Data Link



Network Devices

Hub -A common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets

Switch - Short for port-switching hub, a special type of hub that forwards packets to the appropriate port based on the packet's address. Since switching hubs forward each packet only to the required port, they provide much better performance.

Router - A device that connects any number of LANs. Routers use headers and a forwarding table to determine where packets go, and they use ICMP to communicate with each other and configure the best route between any two hosts. Very little filtering of data is done through routers. Routers do not care about the type of data they handle.

Courtesy of http://www.pcwebopedia.com

Bandwidth

- Bandwidth is the data rate expected to be pushed through the network
- When system bandwidth is expressed in CIF/sec there are 4 key factors:
  - Resolution (frame size) at each camera
  - Compression rate at each camera
  - Frame rate at each camera
  - Number of cameras
- A 24 camera system where all cameras are transmitting 20 fps and half the cameras are 1CIF and the other half are 4 CIF has a system bandwidth of 1200 CIF/sec
- Data bandwidth at NVR for same system is approx. 84.4Mbps
- Need to consider bandwidth for each wire

Networking: Design Considerations

- Given volume of data it is strongly recommended that the surveillance network be kept separate from the main network
- It is highly recommended that you develop a unique network scheme versus using default or dynamically assigned IP addresses – assign new ones to cameras. Defaults are usually are commonly 192.168.0.xxx.
- Calculate the bandwidth requirements for each leg or pipe of the network
- Rule of thumb: keep expected traffic on any one pipe to 60% or less of the speed rating of the pipe to avoid collision induces performance loss
- Do not connect hubs directly together.
- Use switches instead of hubs when possible
- Distributed or centralized topology? Camera distance from the switch location needs to be taken into account.

Software

- Software for an IP video system can be considered the core of the system. Standards Based software
- Key factors in selecting a software package are:
  - Efficiency
  - Scalability
  - Reliability
  - Flexibility

Software: Standards Based

- Advantages:
  - Open platform to allow for integration of other systems
    - Point Of Sale
    - Access Control
    - S.C.A.D.A. interfaces
    - Peripherals
    - Telemetry / GPS
    - More
  - Non reliant on proprietary interfaces

Software: Efficiency

- A software's efficiency speaks to:
- Camera Density
  - Cameras per NVR
  - Sustained frame rate
- Multi threaded vs. single threaded applications
  - Imagine a superhighway vs. a rural road
- Data management

Software: Scalability

- Is the software ready for the next step?
  - Site to site interaction
  - Remote users
  - Additional cameras / systems / users - what is the max?
- Feature set
  - What do you get?
  - Included or ala carte?
    - The system impact on cost / satisfaction & performance can be crucial
- Fit
  - Does the software fit the design philosophy?

Software: Reliability

- Issue contention
  - Alerting
  - System “health monitoring”
  - Failover
  - Auto restarts
- Archive management
  - What level of control is available?
  - Multiple paths for storage needs

Software: Flexibility

- Installation
  - "Thick" and "Thin" client capability
  - Repeatability for settings / profiles
  - Granular control; cameras, servers, groups, motion, etc…
- Integration
  - Open to other interfaces
  - Able to empower unique camera features
- Operation
  - Ease of archived video retrieval
    - How fast? / How many ways can it be found?

Network Video Recorders

- The NVR is an Open Architecture Application Specific Computing Platform engineered for IP video performance – it is an enabler
- Main elements to consider when choosing an NVR for a specific application:
  - Video processing horsepower
    - Processor
    - Motherboard
    - RAM
    - Chipset
    - Peripherals
    - OS & Video Management S/W
  - Storage
    - RAID versus Non-RAID and RAID level
    - Simultaneous Read/Write capability to discs and RAID arrays
    - Capacity
  - Network Interface
  - Video Output
  - Footprint

Storage

- In addition to system bandwidth, storage is also dependent on :
  - Activity at each camera
- Keep in mind that quoted “raw” storage of a disc is not what is available after formatting and application overhead
- Drive types: IDE, SCSI, SATA (each have different performance)
- Three types of storage systems:
  - Direct Attach (DAS)
  - Network Attached (NAS)
  - Storage Area Network (SAN)

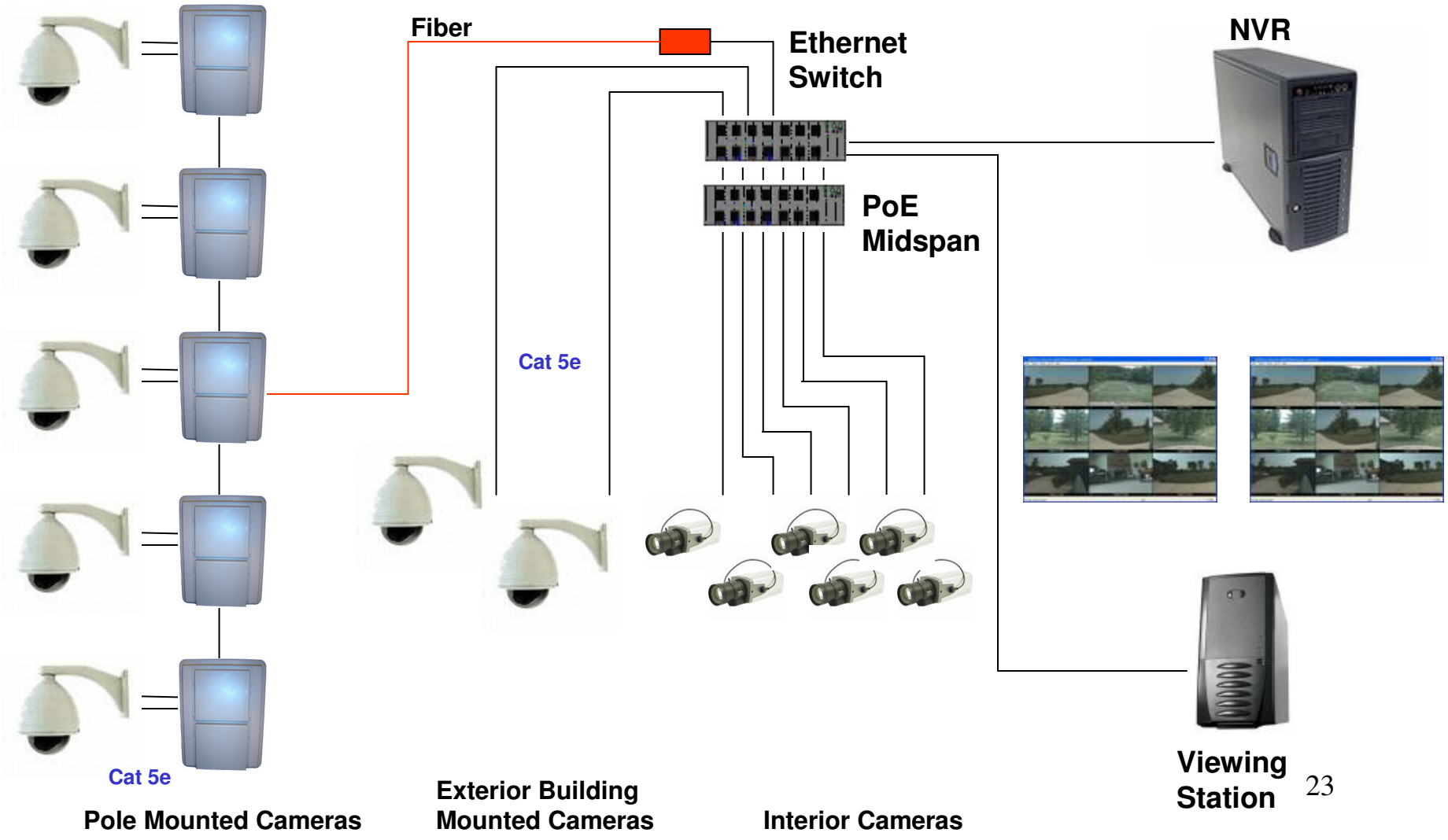
Case Study

- New sports complex – Phase 1
- 6 court gymnasium, commercial kitchen and exterior
- Customer expectations: visibility to the entire site but not “Fort Knox”
- Build in expansion capability for Phase 2

Case Study: Cameras

- 10 cameras mounted to 5 poles (2 cams/dome) in parking lot: 640 x 480 @ 15 fps
- 2 cameras mounted to one corner (1 cam/dome) of building exterior: 640 x 480 @ 15 fps
- 4 cameras mounted in gymnasium in bullet enclosures: 640 x 480 @ 15 fps
- 2 cameras mounted in commercial kitchen in ceiling domes: 320 x 240 @ 15 fps
- Total bandwidth: 64.32 Mbps

Case Study: Topology



Case Study: Network

- 2 Fiber media converters/switches
- 4 4-port Ethernet switches in NEMA boxes on 4 poles
- 1 16-port managed gigabit Ethernet switch
- 1 8-port PoE mid-span injector
- Fiber run from server room to middle pole of parking lot
- Cat5e connections for each camera connected to switch located within a NEMA enclosure (along with 24VAC power for dome heater/blower) at each pole
- Each pole switch ties back to fiber switch

Case Study

- Surveillance System: Software
  - Enterprise class video management package
  - Licensed by camera MAC address
  - Ease of installation and video retrival
  - Easy to add new cameras (Phase 2)

- Surveillance System: NVR
  - Total video processing requirement of 990 CIF/sec
  - Dual Core Processor
  - 2TB of raw storage – at least 4 days
  - Separate viewing station

Summary

- An “IP video” surveillance system consists of 4 interlocking elements:
  - Cameras
  - Network topology
  - Management Software
  - Hardware: NVR
- An Ethernet/TCP/IP network allows you to mix and match physical transmission, camera types and setting, power infrastructure (through PoE) and software functions and capabilities
- “IP Video” is not just for large enterprise installations

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- Backup and additional Info

OSI Protocol stack

7	Application		*Mail, Web, etc.*
6	Presentation		
5	Session		
4	Transport	**TCP/UDP**	*End to end reliability*
3	Network	**IP**	*Forwarding (best-effort)*
2	Data Link		*Framing, delivery*
1	Physical		*Raw signal*

Megapixel Product Overview

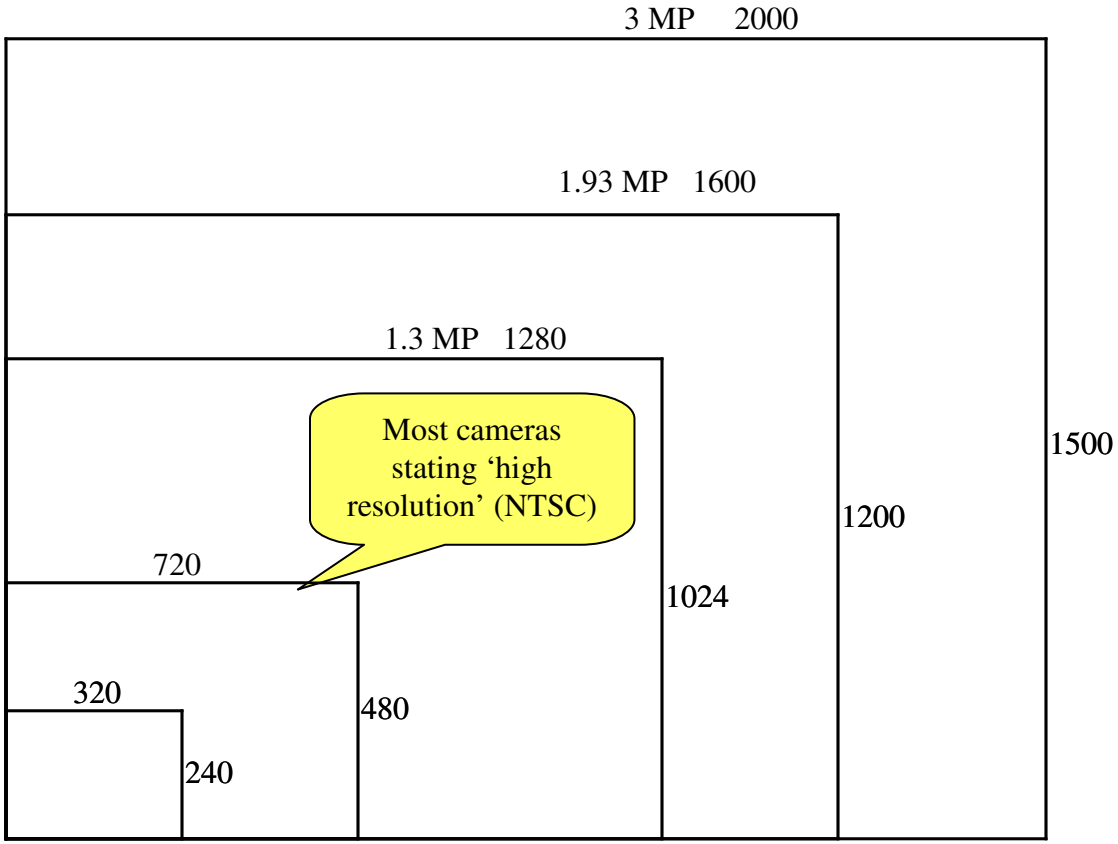
DIFFERENTIATORS

- **Megapixel** resolution
  - ***image detail*** (digital zoom) is more important for evidence gathering than ***framerate***
  - Interlaced analogue video is 50+ year-old capture/display technology.
  - Resolutions from VGA to 11 megapixel
- **Use** of CCD and CMOS image sensors.
- **Image quality**
  - On-board processing (gamma, sharpening, colour correction)
  - On-board auto-control (AWB, AEC/AGC with 4 algorithms, framerate/quality throttling)

"Standard" FEATURES

- Security tasks (set ROI, privacy zones, motion or input alarms, FTP images, email notify, passwords, persistent settings, self-test/watchdog)
- Field upgrades to firmware.

Megapixel IP camera Resolutions



Megapixel digital zoom – active IR night vision example

NTSC vs Megapixel
5X Digital Zoom

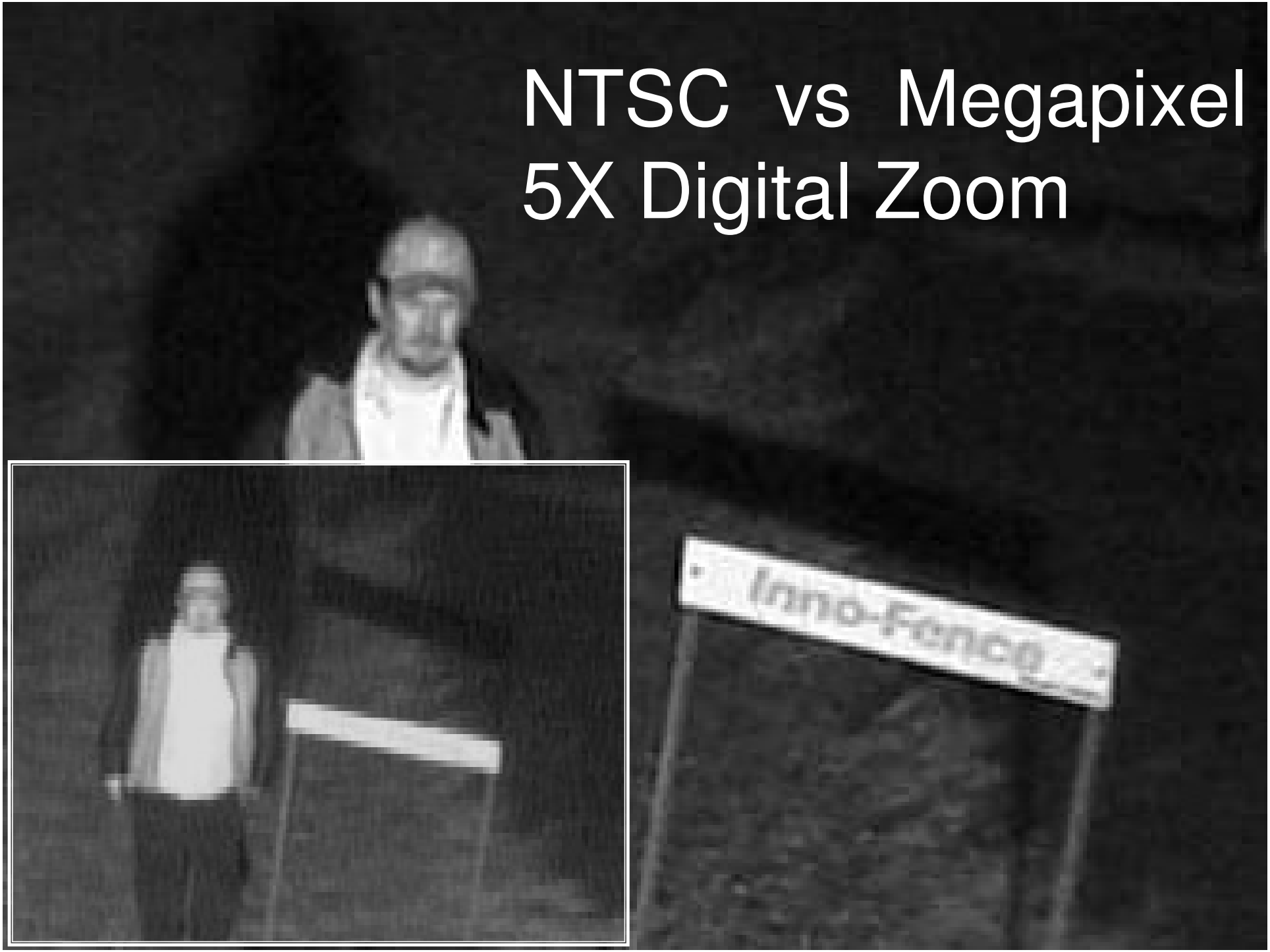


Image Capture - Sensors

CMOS - Complementary Metal Oxide Semiconductor

CCD - Charge Coupled Device

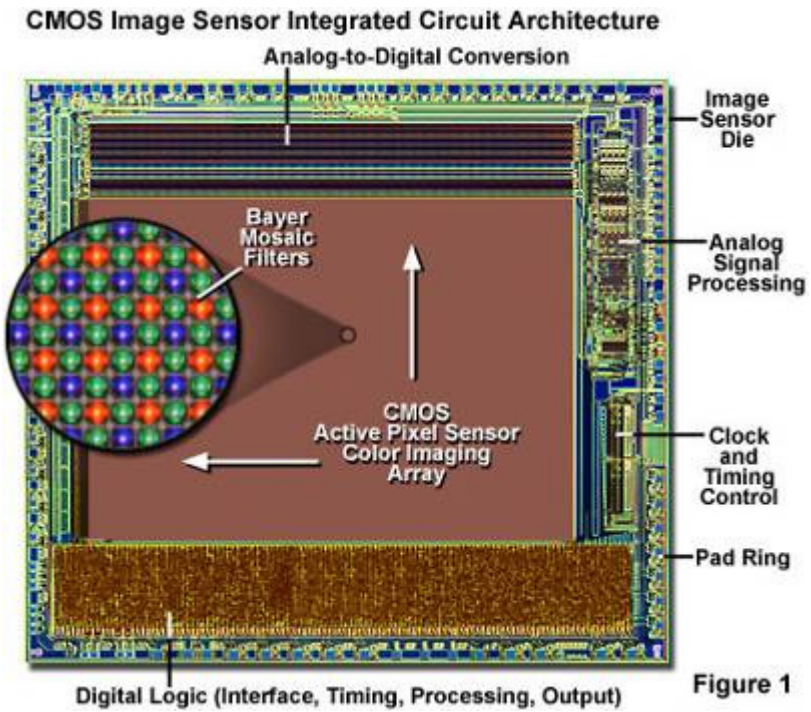


Figure 1

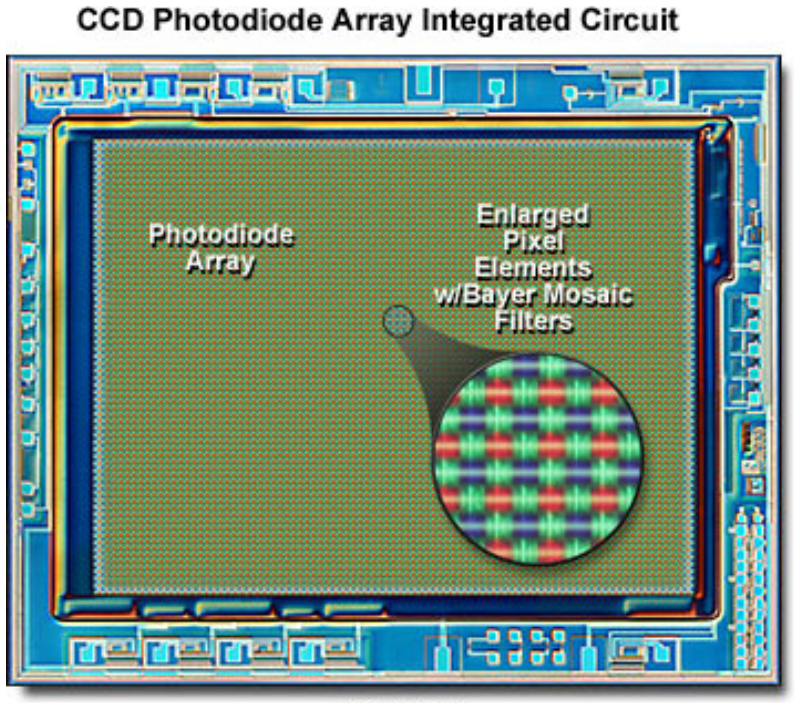


Figure 2

CMOS and CCD Image Sensors

CMOS

- a.k.a Active Pixel Sensors (APS), photodiode + transistors in each pixel
- High-volume, high-yield, low cost
- Generally lower image quality
- Usually rolling shutter
- Higher levels of integration (On-board functions)
  - on-chip clock generation
  - double-sampling for column-to-column noise
  - on-chip analog-to-digital conversion
  - on-chip gain
- Higher clock speed
- Anti-blooming
- Can read out a portion of the image sensor (region of interest – ROI).
- Lower power consumption.

CCD

- Photodiode array, with analog charge transfer row by row then serially one column at a time
- Lengthy custom process, lower volume, lower yield, higher cost
- Higher image quality
- Usually global shutter – can stop motion
- More sensitive to light
- Lower noise
- Higher uniformity
- Superior electronic shuttering, with little fill-factor compromise
- Need external drive circuitry and gain, with high power consumption.