



IBM Research

IBM Smart Surveillance System

Yingli Tian

Exploratory Computer Vision Group

IBM T. J. Watson Research Center

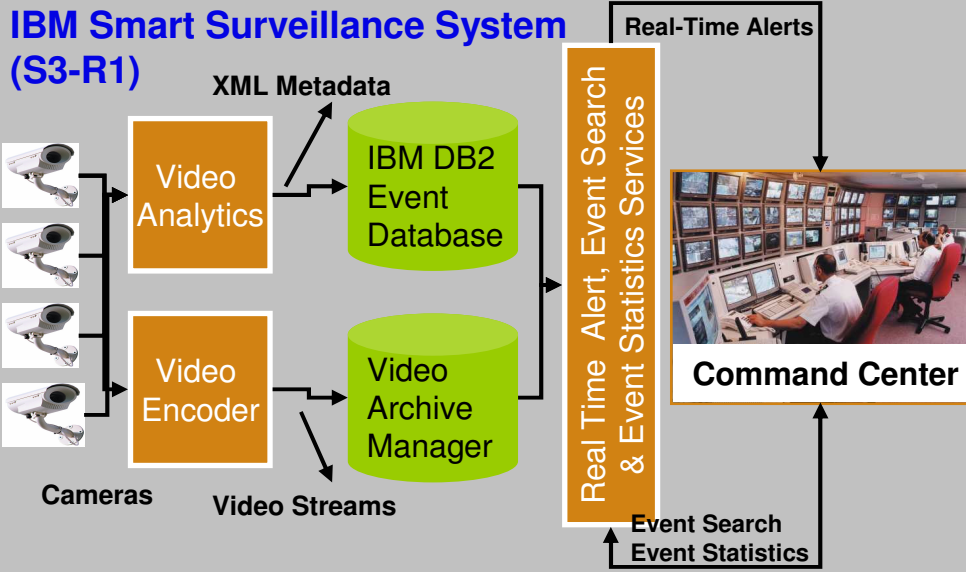
Yorktown Heights, NY

<http://www.research.ibm.com/peoplevision>

IBM Smart Surveillance System (S3-R1)

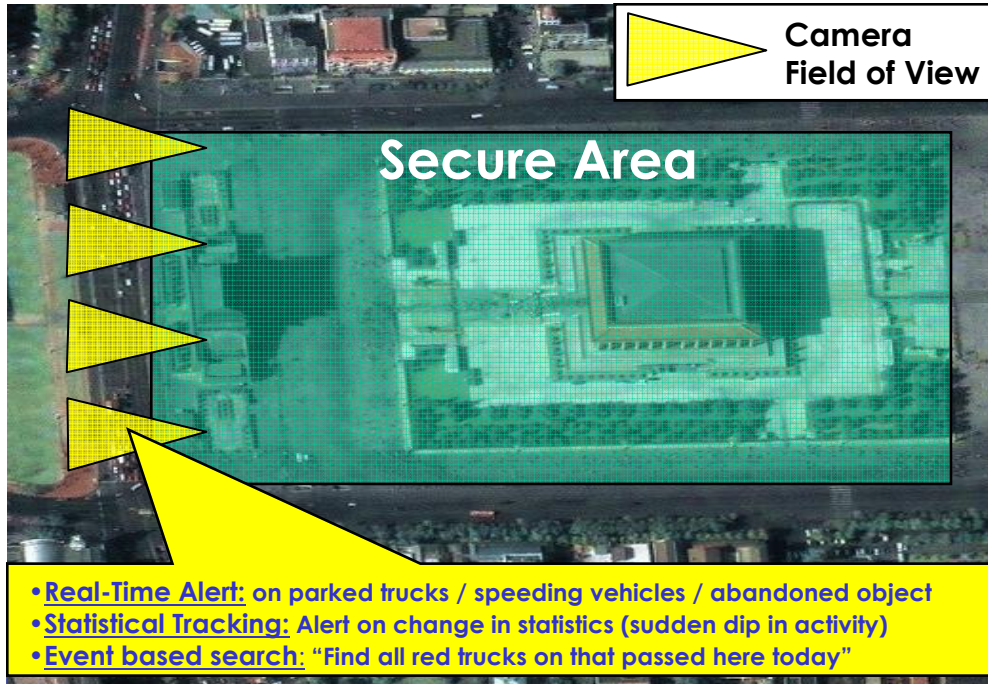
The world's first, event based, distributed smart surveillance system
www.research.ibm.com/peoplevision

Contact: Dr. Arun Hampapur
IBM T. J. Watson Research Center
19 Skyline Drive, Hawthorne, NY 10532
(914) 784-7440, arunh@us.ibm.com



Video camera based surveillance systems are key to acquiring intelligence in urban combat zones. Current systems provide raw image data leaving the intelligence gathering task to humans. Human monitoring of video is known to be ineffectual from an intelligence gathering perspective. The first generation of smart surveillance systems were limited to providing real time alarms to “pre-programmed” events. While real-time alarms are useful, the ability to search through event data and understand patterns of activity enables the adoption of new “security strategies & postures” in challenging urban environments. The IBM S3-R1 system is a platform for event-based surveillance. S3-R1 provides the following capabilities

- Real Time Alerts** including Motion Detection, Directional Motion, Abandoned Object, Object Removal & Camera Move/Blind: .
- Event Search** using Object Type, Size, Speed, Location, Color
- Automatic Face Capture & Statistical Event Tracking:**



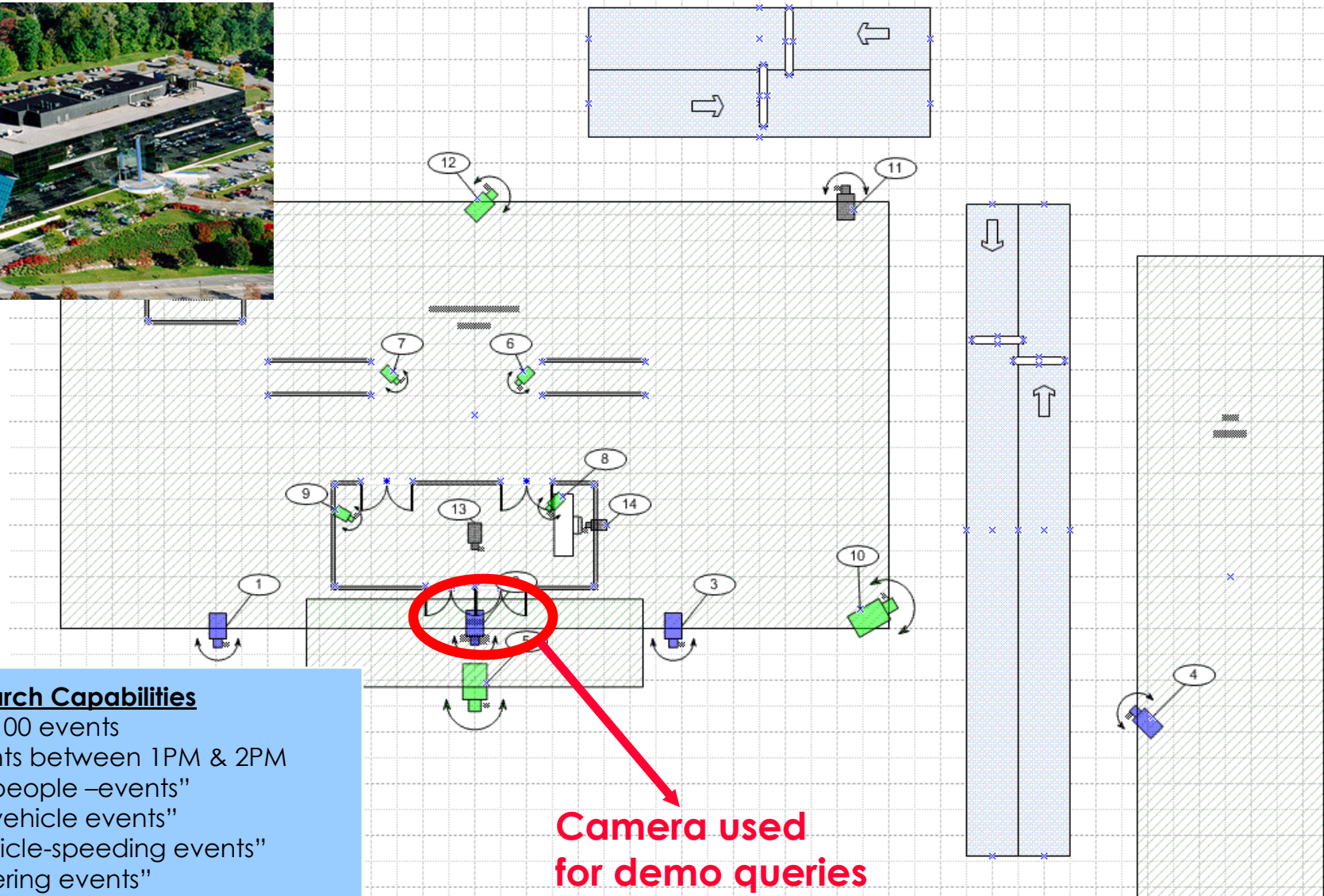
Application Scenarios While being able to provide real time alarms to “pre-programmed” events is useful, the ability to search through event data and understand patterns enables new “security strategies”.

Force Protection: Understanding long term patterns of activity and the ability to search through events can help identify potential vulnerabilities.

Border Monitoring: While real-time alarms are useful, reacting to a large number of real time alarms is infeasible. Understanding patterns of violations for effective deployment of patrols is critical.

Large Scale Investigations: In large scale investigations like the Washington Sniper incident, the ability to sift through large numbers of surveillance video tapes to identify commonality is essential.

S3-R1 Pilot at IBM Research Facility in Hawthorne, NY



Event Search Capabilities

- Find last 100 events
- Find events between 1PM & 2PM
- Find all "people -events"
- Find all "vehicle events"
- Find "vehicle-speeding events"
- Find "loitering events"
- Find "events at-this-position in camera"
- Find "objects by size"
- Find "objects by color"

**Camera used
for demo queries**

Real-Time Alerts

- Person / vehicle in area
- Wrong direction motion
- Crowd / loiter detection
- Abandoned object
- Vehicle arrival / departure
- High speed objects
- Camera move / blind
- Removed object
- Virtual Perimeter Monitoring



S3-R1 Query Result: Find People Events

The screenshot displays the MILS Framework web application in a Microsoft Internet Explorer browser window. The browser's address bar shows the URL `http://localhost:9080/mils/master.html`. The application interface includes a navigation sidebar on the left with buttons for Home, Instant Alerts, Find People, Find Cars, Find Big Cars, People Stat, Car Stat, Region Search, Velocity Search, Time Search, and Duration Search. The main content area features a header titled "The last 100 moving Objects/Events." and a 4x6 grid of 24 video frames. Each frame shows an aerial view of a parking lot with magenta motion tracking lines overlaid on the scene, indicating the movement of objects. The browser's status bar at the bottom indicates "Slide 2 of 3", "Default Design", "English (U.S.)", and "Local intranet". The Windows taskbar at the very bottom shows the Start button, several open applications including "Arun Hampapur...", "Writeup", "Microsoft Power...", "MILS Framewor...", and "S3-R1-ShowCar...", along with system icons for network, volume, and battery (97%), and a clock showing 9:59 AM on Saturday, 10/9/2004.

S3-R1 Query Result: Find Car Events

MILS Framework - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Links

Address <http://localhost:9080/mils/master.html> Go

Google Search Web 52 blocked AutoFill Options

Powered by IBM MILS Framework

Home

Instant Alerts

Find People

Find Cars

Find Big Cars

People Stat

Car Stat

Region Search

Velocity Search

Time Search

Duration Search

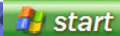
The last 100 moving Objects/Events.

Local intranet

Slide 1 of 2

Default Design

English (U.S.)



Address

Go

97%



9:56 AM

Saturday

10/9/2004

S3-R1 Query Result with linked Video Player

http://localhost:9080/mils/master.html

MILS Framework - Micro...

The last 100 mov

Home

ant Alerts

id People

nd Cars

I Big Cars

ople Stat

car Stat

on Search

city Search

ie Search

tion Search

Play Full Screen Pause

Stop

Elapsed : 107 dys 14:04:34:082 (hh:mm:ss:nnn)

script:showVideoPlayer("LaunchVideoPlayer?track_id=35231694061559")

Local intranet

Address

97%

10:04 AM Saturday 10/9/2004

Arun Hampa... Writeup Microsoft Po... MILS Framew... MILS Framew... untitled - Paint

Face Images Captured by SSE Face Engine

MILS Framework - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print Mail

Links QinetiQ My Yahoo! Yahoo! Bookmarks Yahoo! Yahoo! Mail

Address http://localhost:9080/mils/master.html

Google Search Web 310 blocked AutoFill Options

Search Web Mail My Yahoo! Games Shopping Personals LAUNCH Sign In

Powered by IBM MILS Framework

Home

























Instant Alerts

Find Faces

Advanced Search

Logout

The last 100 moving Objects/Events.

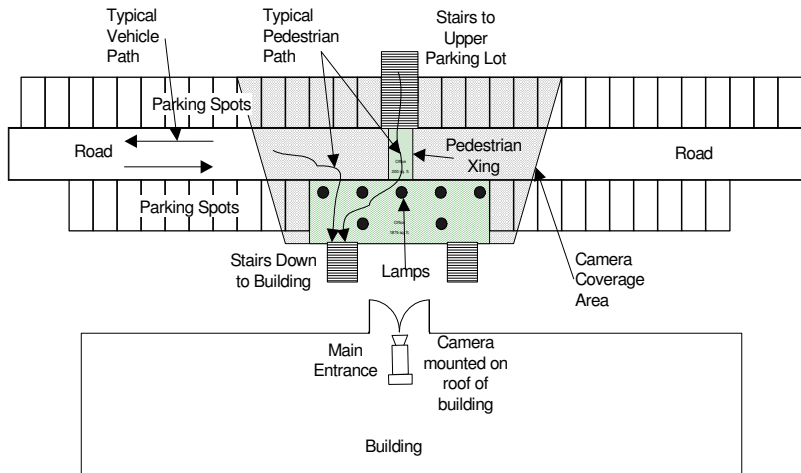
 10:39:24 10-07-2004	 10:37:42 10-07-2004	 10:37:39 10-07-2004	 10:36:05 10-07-2004	 10:35:41 10-07-2004	 10:35:41 10-07-2004
 10:35:38 10-07-2004	 10:32:40 10-07-2004	 10:31:58 10-07-2004	 10:27:10 10-07-2004	 10:26:16 10-07-2004	 10:26:15 10-07-2004
 10:18:55 10-07-2004	 10:18:29 10-07-2004	 10:13:12 10-07-2004	 10:08:40 10-07-2004	 10:03:52 10-07-2004	 10:02:43 10-07-2004
 10:01:43 10-07-2004	 09:59:19 10-07-2004	 09:57:14 10-07-2004	 09:56:30 10-07-2004	 09:56:08 10-07-2004	 09:54:00 10-07-2004

Local intranet Security Tools

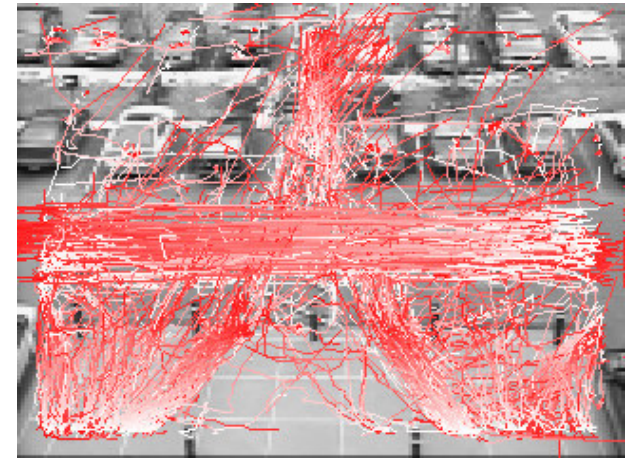
start Address Go 100%

6:20 PM Thursday

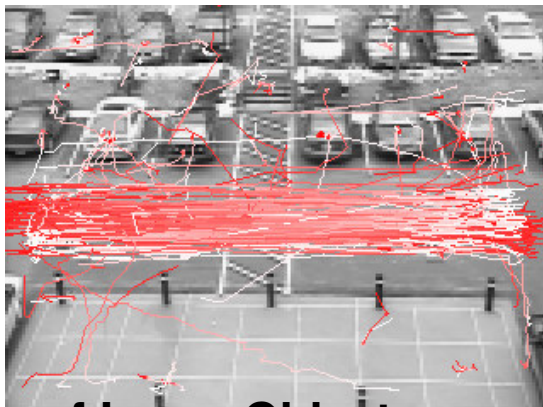
Long Term Monitoring Results – for 24 hours



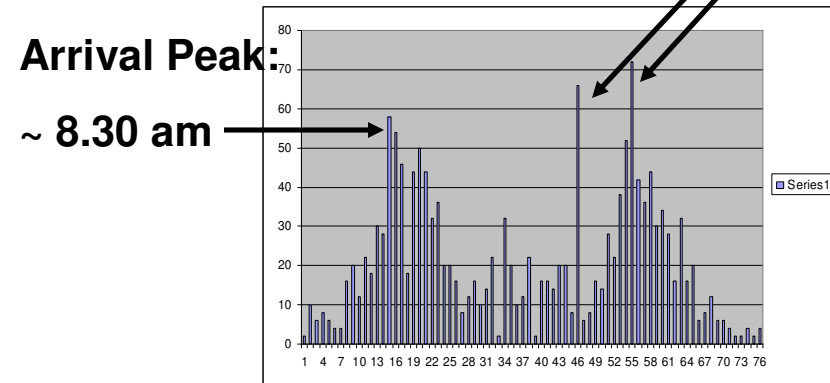
Hawthorne1 Deployment Scenario for Camera #2



Tracks of all objects over a 24 hours
Departure Peak: ~ 3.30 pm & 5.30pm



Paths of Large Objects over a 24 hour period

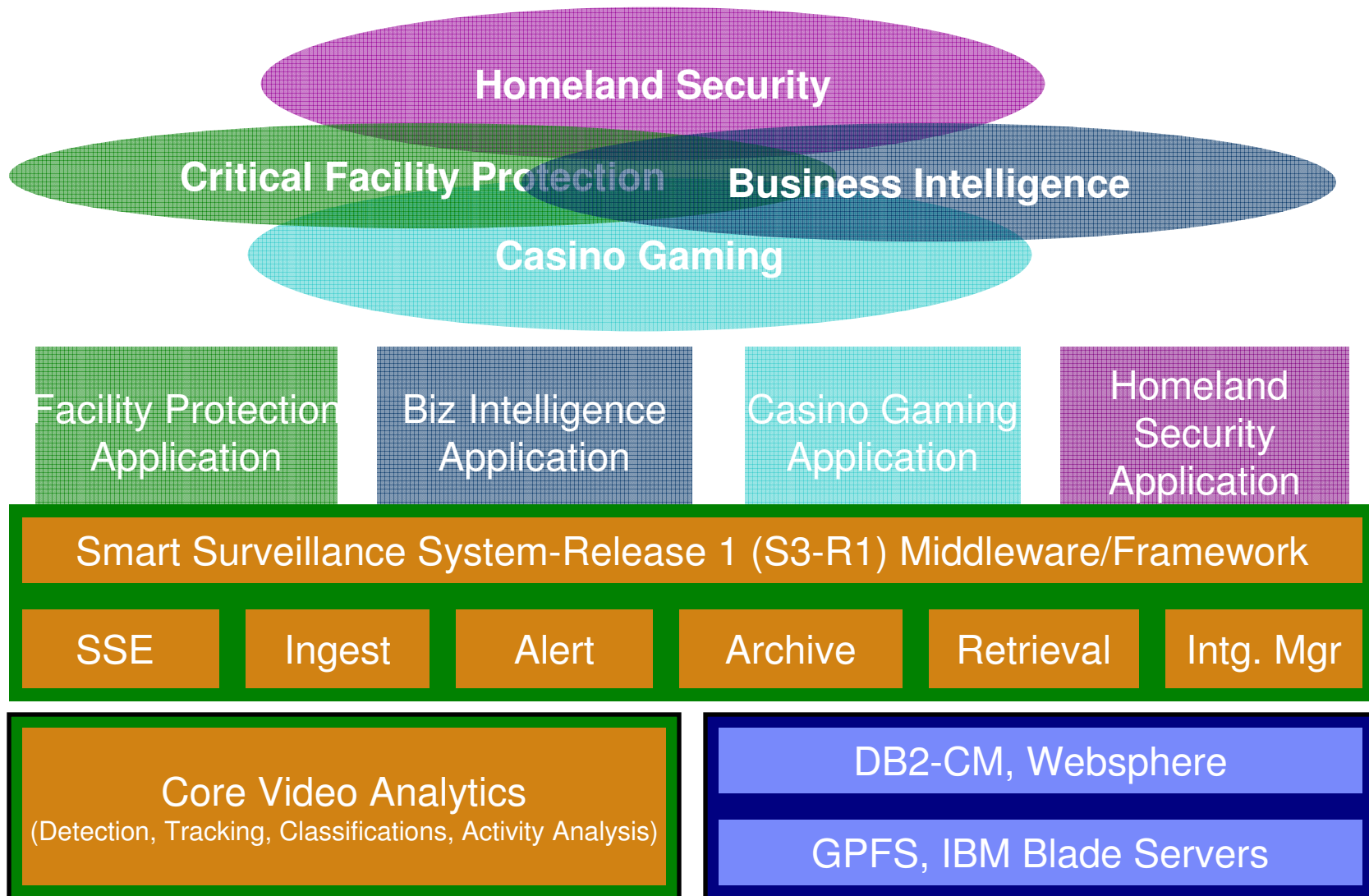


Arrival & Departure Distribution of people into Hawthorne 1

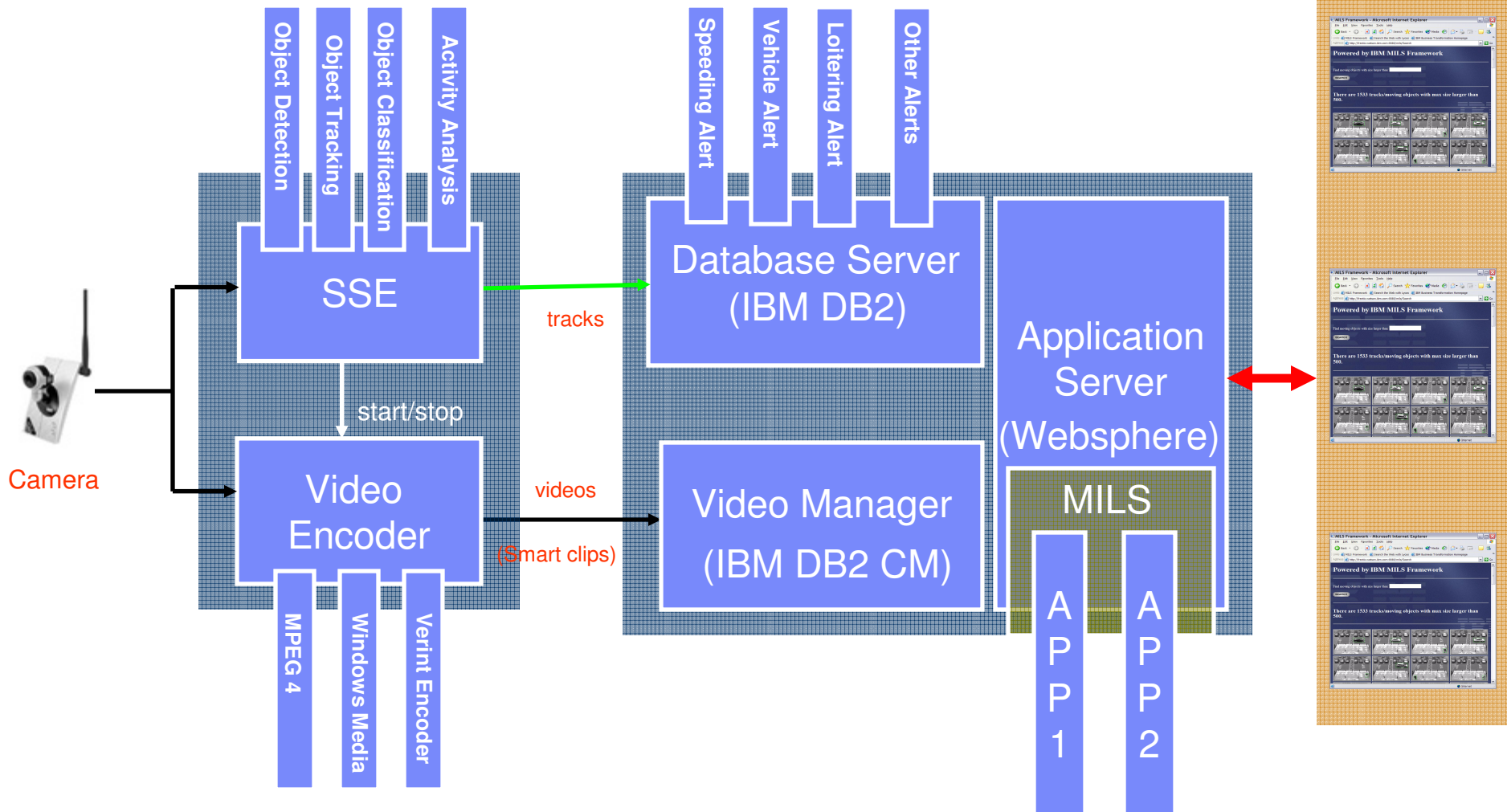
Applications of Smart Surveillance

- Security Applications
 - Airports/Critical Facility
 - Borders.
 - Embassies & Bases
 - Enterprise Security
 - Schools
- Retail Applications
 - Banking
 - Loss Prevention
 - CRM – people counting, demographics, shopping patterns
- Manufacturing
 - Safety Applications.
 - Operations – Time & Motion.
- Transportation
 - Safety – railways.
 - Congestion monitoring
- Health Care.
 - Elder Care facilities.
 - Home Monitoring.
- Sports
 - Player tracking.
- Gaming
 - Casinos

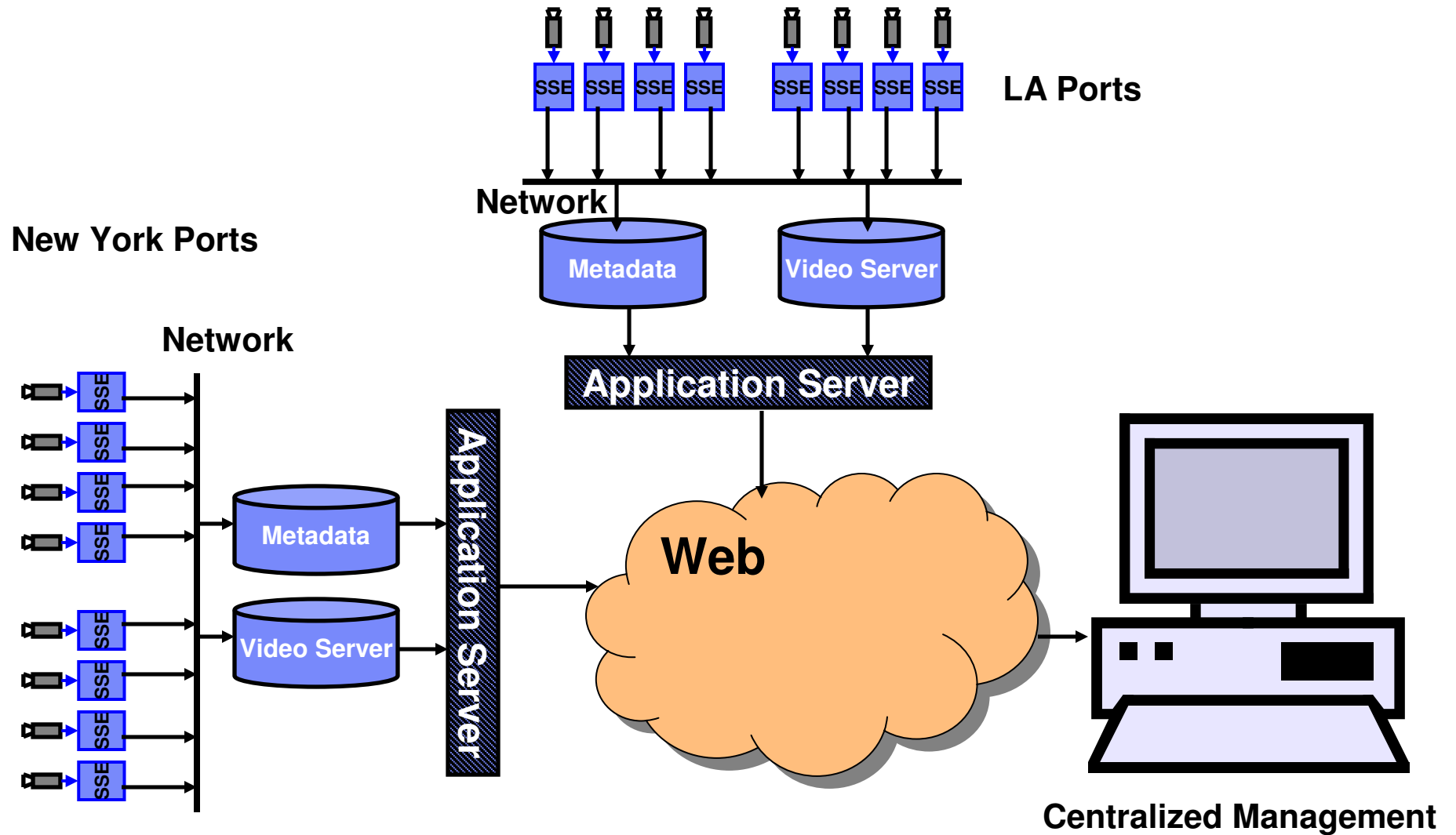
Smart Surveillance Middleware



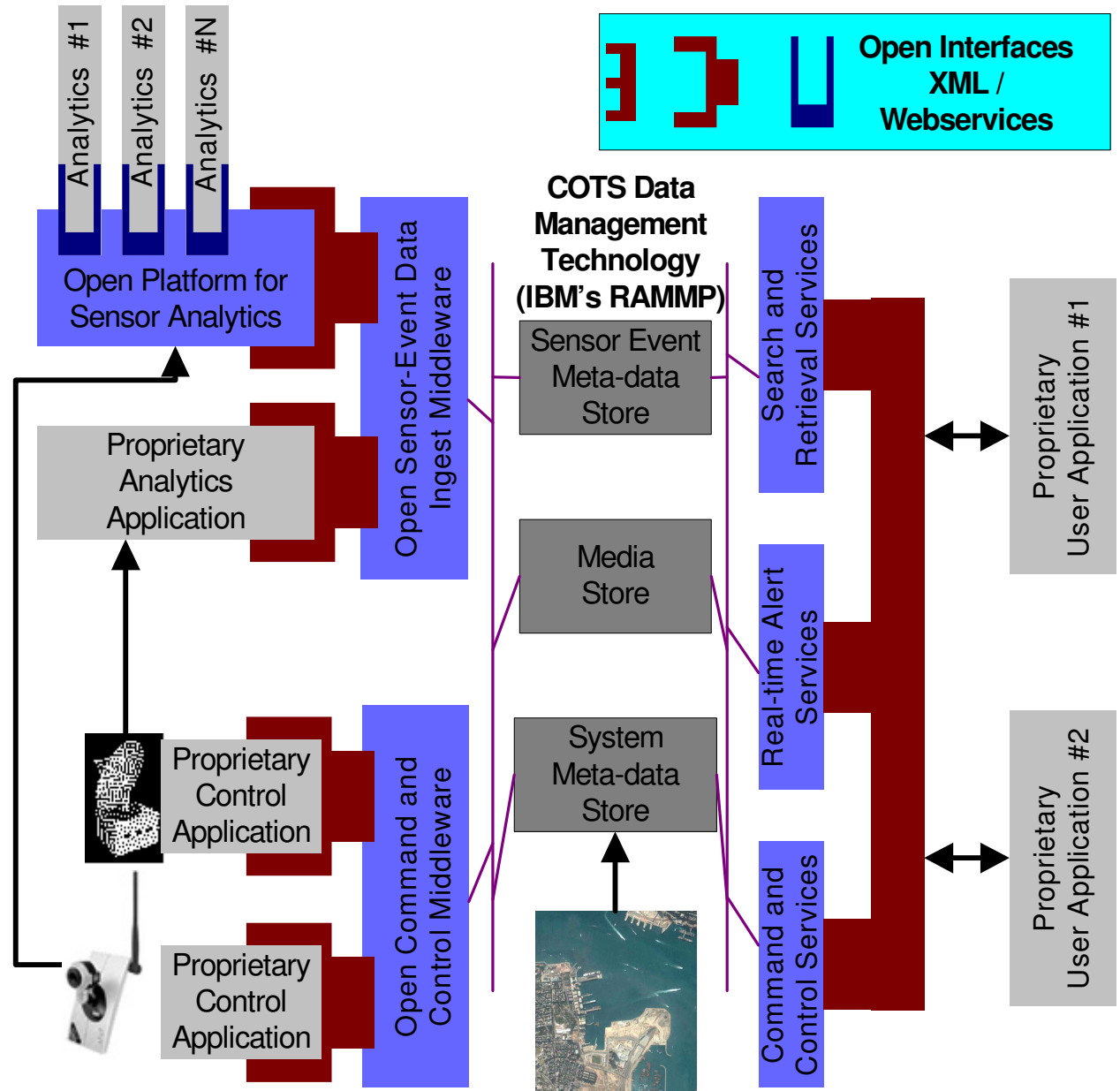
Open Architecture for Smart Surveillance



Distributed Smart Surveillance



Open Architecture for Sensor Analytics



System Requirements for S3-R1

- Analytics Server— handles 4 video streams (320x240)
 - Single Processor 2.8Ghz+ Intel Pentium
 - 1 GB Ram, 160GB Hard disk
 - 4 Channel Frame Grabber Card—Osprey
- Database / Analytics Server – handles up to 24 cameras
 - Dual Processor System 2.8GHz+ Pentium
 - 2GB Ram, 160GB Hard disk
- Video Encoding and Storage.
 - Partner Systems.
- Ongoing Scalability Work
 - Re-architect SSE and port to DSP's
 - Backend scalability testing

Competitive Analysis

Dimension	IBM Research	Other Vendors
Video Analytics	=	=
Advanced Analytics	+	-
Event Data Management	+++	--
User Interfaces	--	++
System Architecture	++	--
Accuracy	=	=
Performance (Speed)	=	=
Backend Scalability	++	--

+ Advantage

= Similar Capabilities

- Behind