



Canada Border
Services Agency

Agence des services
frontaliers du Canada

VAP / VAT: Video Analytics Platform and Testbed for testing and deploying Video Analytics

SPIE “Defense, Security, and Sensing” Conference
Track on Visual Analytics for Homeland Defense and Security
5 - 9 April 2010, Orlando

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Video Surveillance & Biometrics Section
Science and Engineering Directorate

The wordmark for Canada, featuring the word "Canada" in a serif font with a stylized maple leaf above the letter 'a'.

Canada

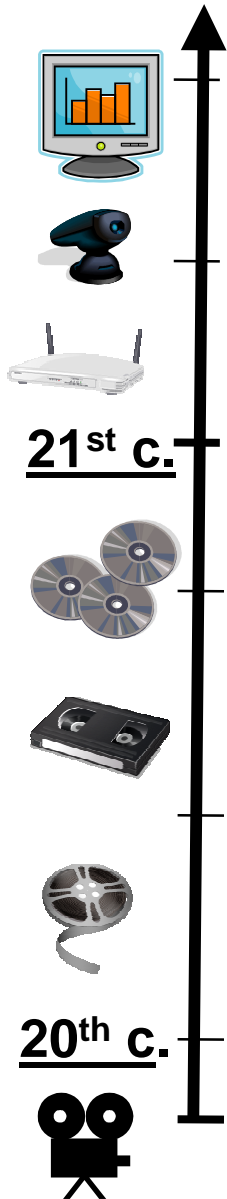
Outline



1. The evolution of Video Surveillance
 - What is Video Analytics (VA) and what it can do
 - ACE Surveillance™ pilot (2006-2008): results / lessons
 - VA Technology Readiness Level / Customization req.-d
2. VA deployment challenges and 3-Phase Roadmap
 - Introducing Video Surveillance & Biometrics Section
 - VAP /VAT concepts and architecture
 - EventCapture & EventBrowser: software & results
 - Doing VA evaluation (inc. FaceRec): metrics & demos
 - Running Pilots in the “Field”
3. Next steps



What is Video Analytics?



▪ **Video Analytics: Computational Analysis of Video Data and Extraction of Intelligence from Video. (aka Intelligent Video)**

▪ *Better quality, more affordable*

▪ **IP cameras**

▪ **Digital**

▪ **Analog**



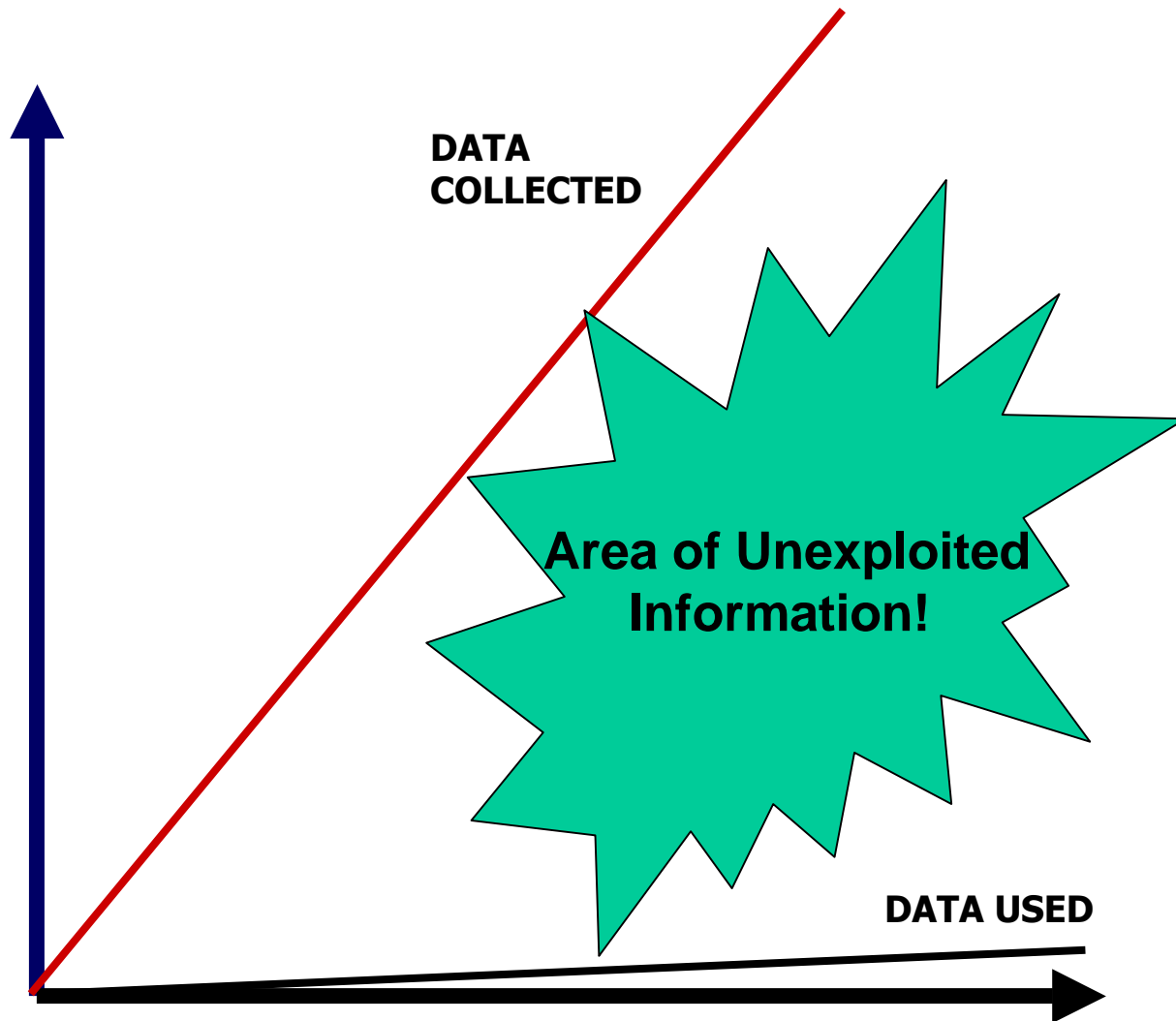
← Animated image example:

The entire 17:00- 24:00 activity is summarized into a few annotated snapshots.

➤ Video Technology (VT) of the 1990's was primarily concerned with video capture (Cameras and Recorders)

➤ Today, VT is Video Capture + Video Analytics

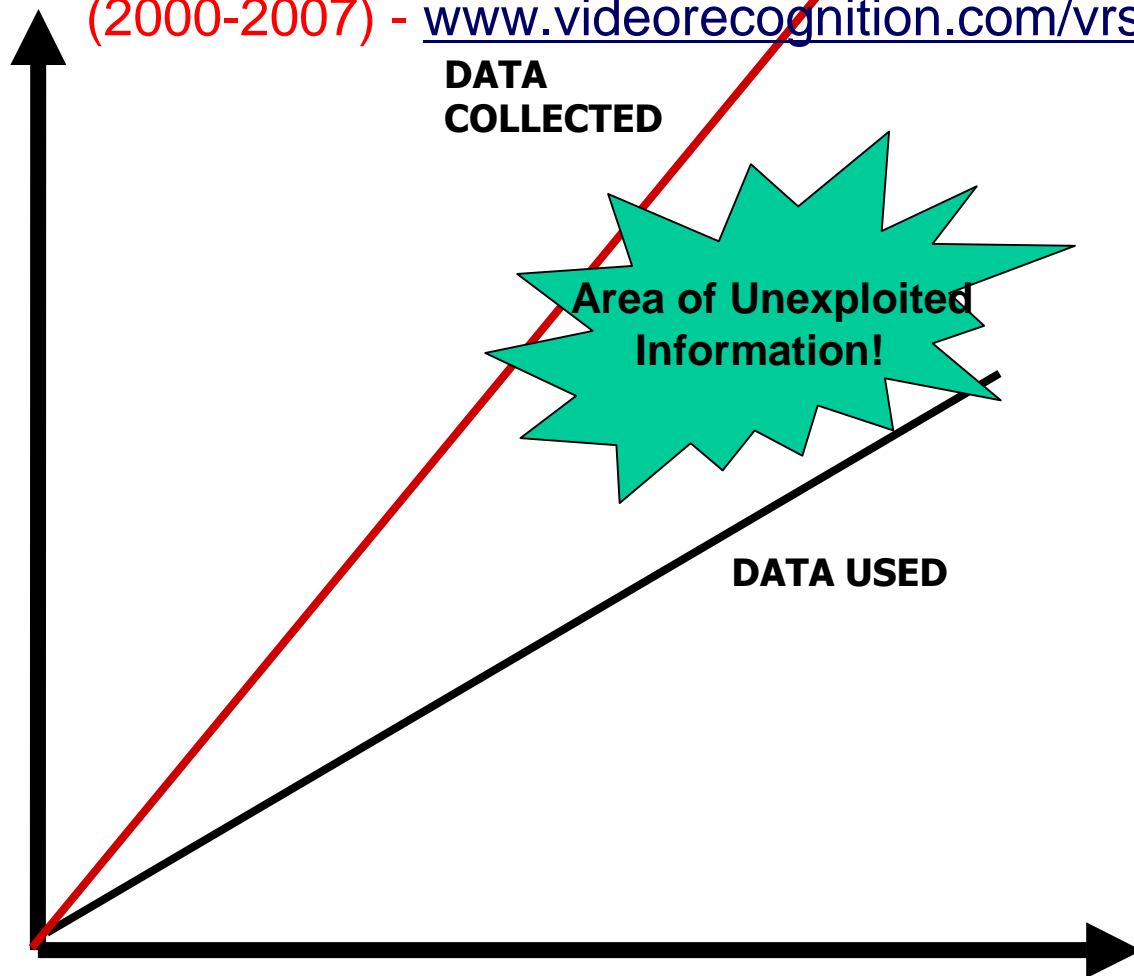
Without Video Analytics - as it is now



With Video Analytics - what we can do

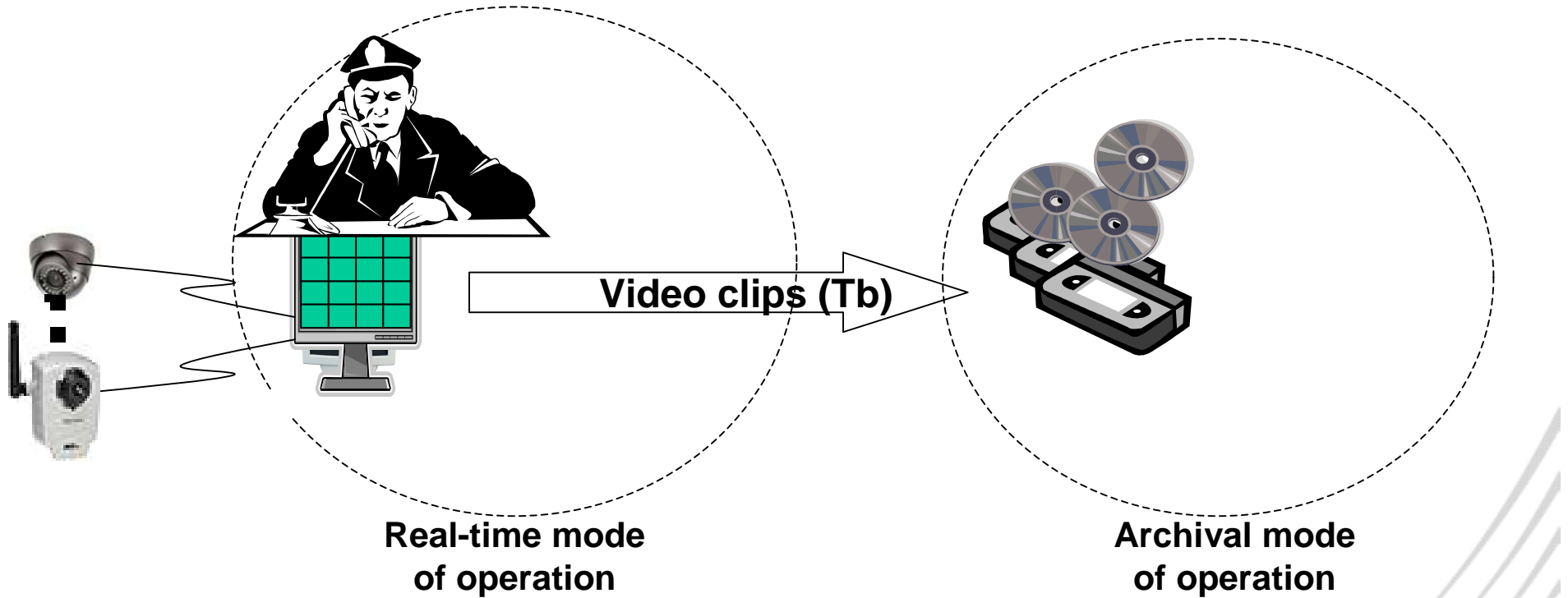


With ACE Surveillance™ software that we have developed within Video Recognition Systems project at National Research Council of Canada (2000-2007) - www.videorecognition.com/vrs.html



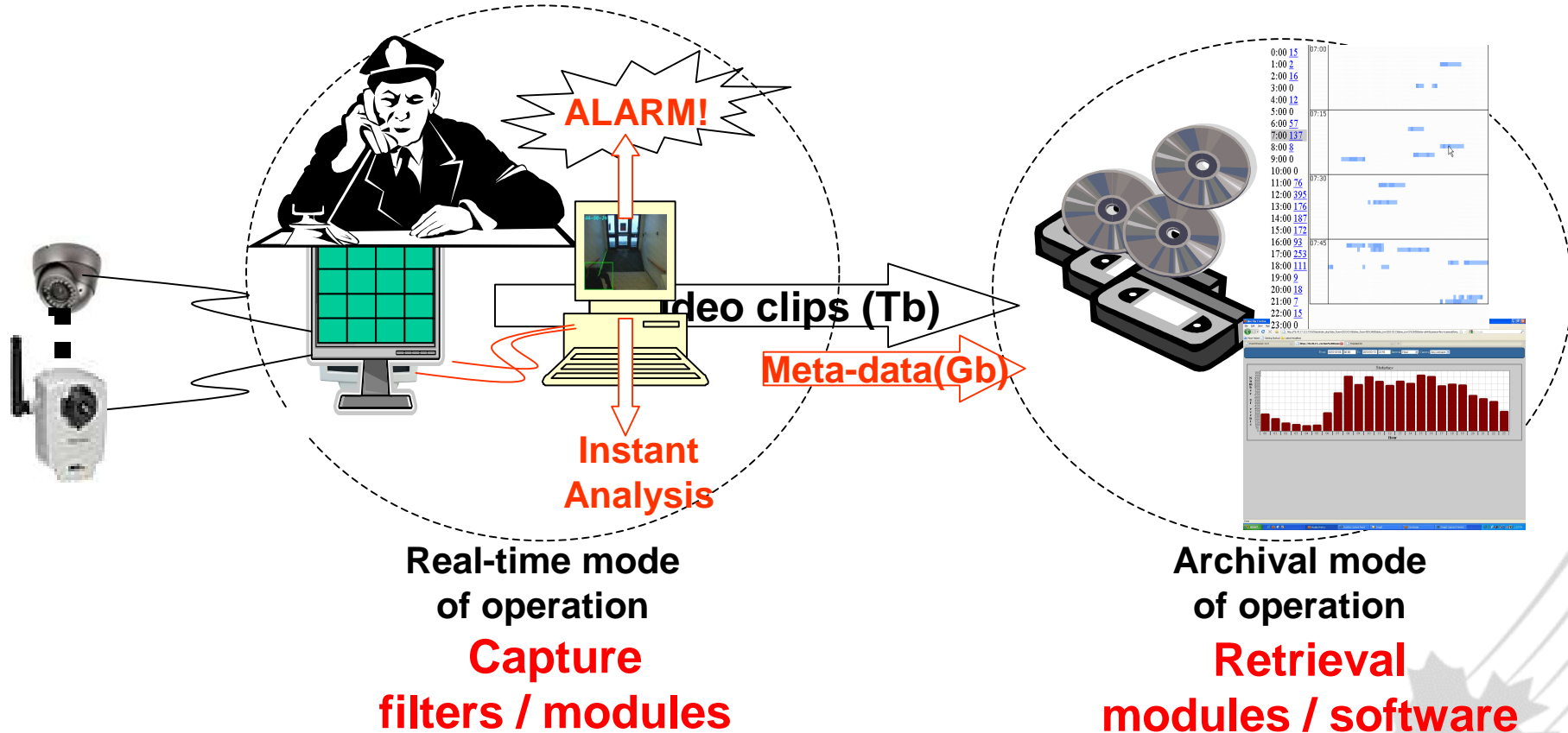
Monitoring Tasks Performed by Human (Status quo)

Two modes: a) real-time monitoring, b) post-event analysis



Monitoring Tasks Performed by Human & Software

Two modes: a) real-time monitoring, b) post-event analysis



Main condition - Open Architecture:

To be able to tap into (video signal) input and (data) output.

ACE Surveillance™ VA Pilot (2006-2008) [Gorodnichy, NATO-2008]

Indoor w/o sunlight, CCTV



Outdoor, wireless, eye-level



Outdoor, webcam, overview



Indoor with sunlight, CCTV

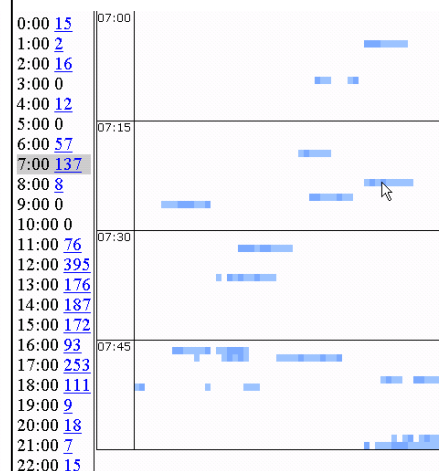
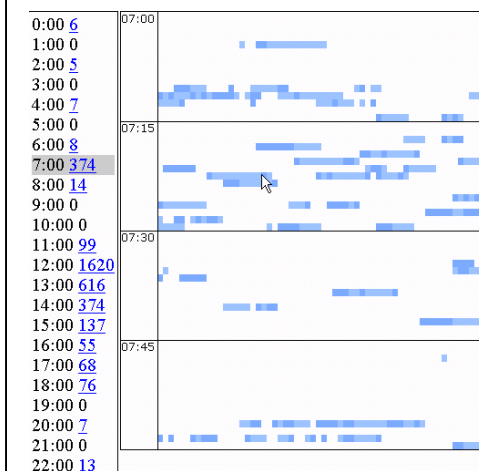
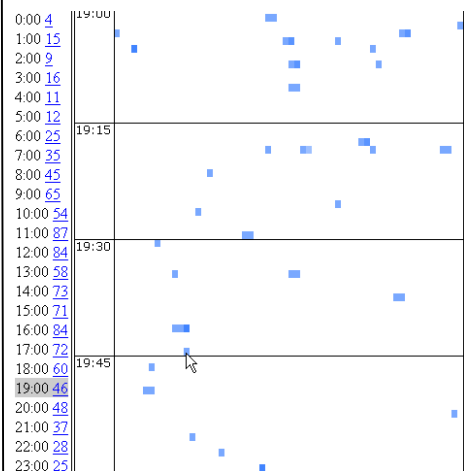
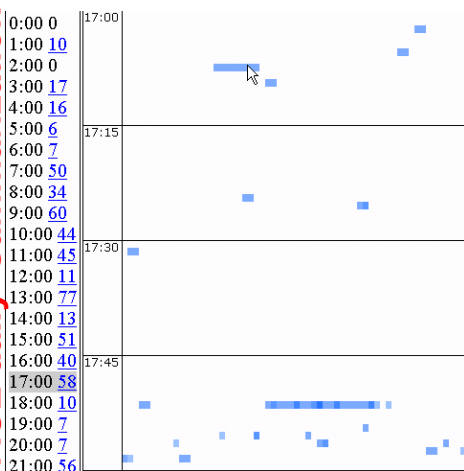


Camera / setup

Annotated CES



ACE daily summarization



VA deployment challenges & Road-map



Phase 1. Building Business, Infrastructure foundations; R&D capacity

- From Knowing the Art of Possible to Making it Possible
 - Dealing with Stereotypes / Misconceptions
 - Not to over-estimate or under-estimate what VA can do
 - Technology Readiness Level vs. Customization required

Phase 2. Developing VA solution: Technological Challenges

- R&D programming + Knowledge of Operational Tasks
- Dealing with “Closed Architectures”
- Selecting/Building a solution

Phase 3. Piloting & deploying the solution in the “field”

- Knowing Clients needs & Educating/Training the Client
- Customizing, stress-testing (in Mock-up and real setups)

What Video Analytics is NOT ?



- “Brightness change detection” marketed by industry as “motion-detection”, which is NOT.
- NOT a “Magic bullet”:
 - Just as with ANY image recognition (inc. Biometrics), there will be “False Hits” and “False Misses”.
 - ➔ However, their Rates can be minimized to acceptable for operational needs – by evaluation and customization.
- NO “one size fit all” solution (esp. in Non-cooperative scenarios)
 - Different VA codes required for each setup, environment, task.
 - ➔ However, experts may use the same library to write these codes.
- “High resolution / quality” do NOT assume “high intelligence”.
- It is NOT expensive with proper (unique) skills and planning.
 - In fact, it (significantly) reduces the entire cost operation, though the optimized equipment build-up and efficient data analysis.

Video Technology components / cost

1. Video Data Capture
2. Transfer
3. Storage
4. Protection and security

Technologically solved

- cameras
- encodes, decoders
- transmitters and receivers
- routers and multicast switches
- network video recorders
- storage media

5. Integration with other sensors / software
 - Motion, heat sensor, audio, Video Analytics
6. Video data management
 - Indexing, visualization, retrieval of data
 - Data = video + associated Meta-data (Annotations) obtained with Video Analytics
7. Video analytics for automation and filtering:
 - Real-time event detection / recognition
 - Analysis of archived video data

Being solved – requires exploring, evaluation, tuning (inc. RFI, Pilots)

Total cost = Hardware + Software/Programming/Testing
Video Analytics expertise minimizes the cost of both components.

Video Analytics Technology Readiness

- Traditionally performed by Humans, many of these Monitoring Tasks can now be facilitated with VA software

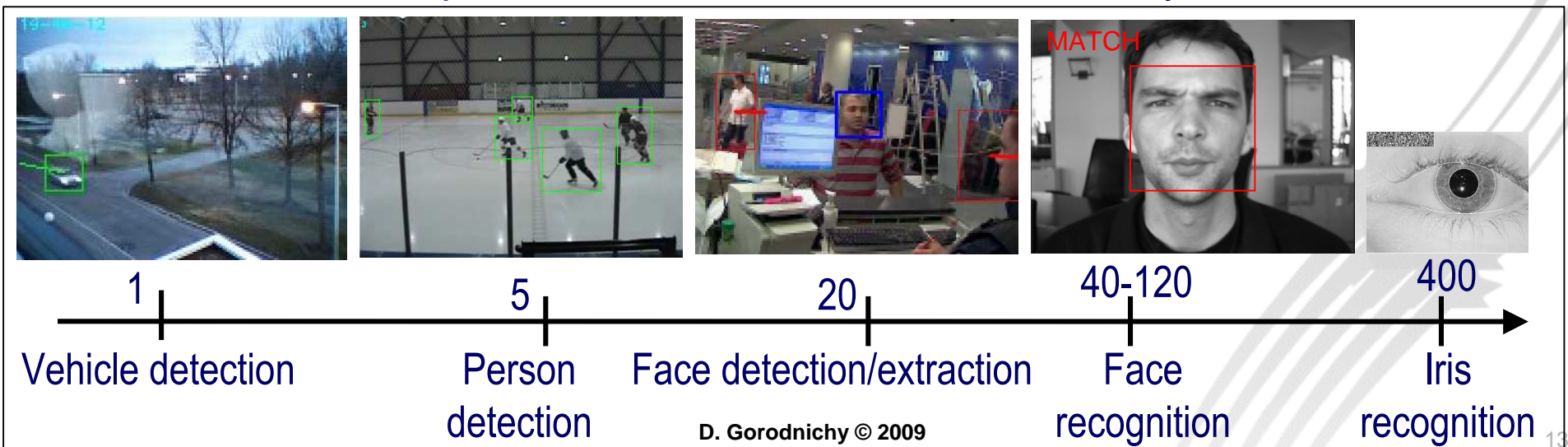
TYPE 1: Real-time monitoring tasks	Customization, testing req.-d	Technical readiness
1* - "Face extraction/tagging"	Little	5
2* - "Wrong direction detection (Run-away alarm)"	Little	5
3 - "Loitering alarm"	Major	4
4 - "Object-left behind or abundant object alarm"	Major	4
5 - "Tripwire (trespassing) alarm"	Little	5
6 - Other events (door opening, car parking etc) alarm	Major	4
General Tracking / Detection of people in multiple streams	-	1
TYPE 2: Post-Event (Archival) monitoring tasks		
1 - Summary of detected events & statistics (trends)	Little - Medium	5
2 - Searching for a object/person in stored streams	Little - Major	5
General Summary / Search in unstructured environment	-	1
Special case tasks		
LPR (License Plate Recognition)	None	5
Face Recognition	Little-Medium	1-4

5 – ready, 4 – requires Evaluation only, 3/2– requires further Refining/Exploration, 1 – not yet ready

Building R&D Capacity

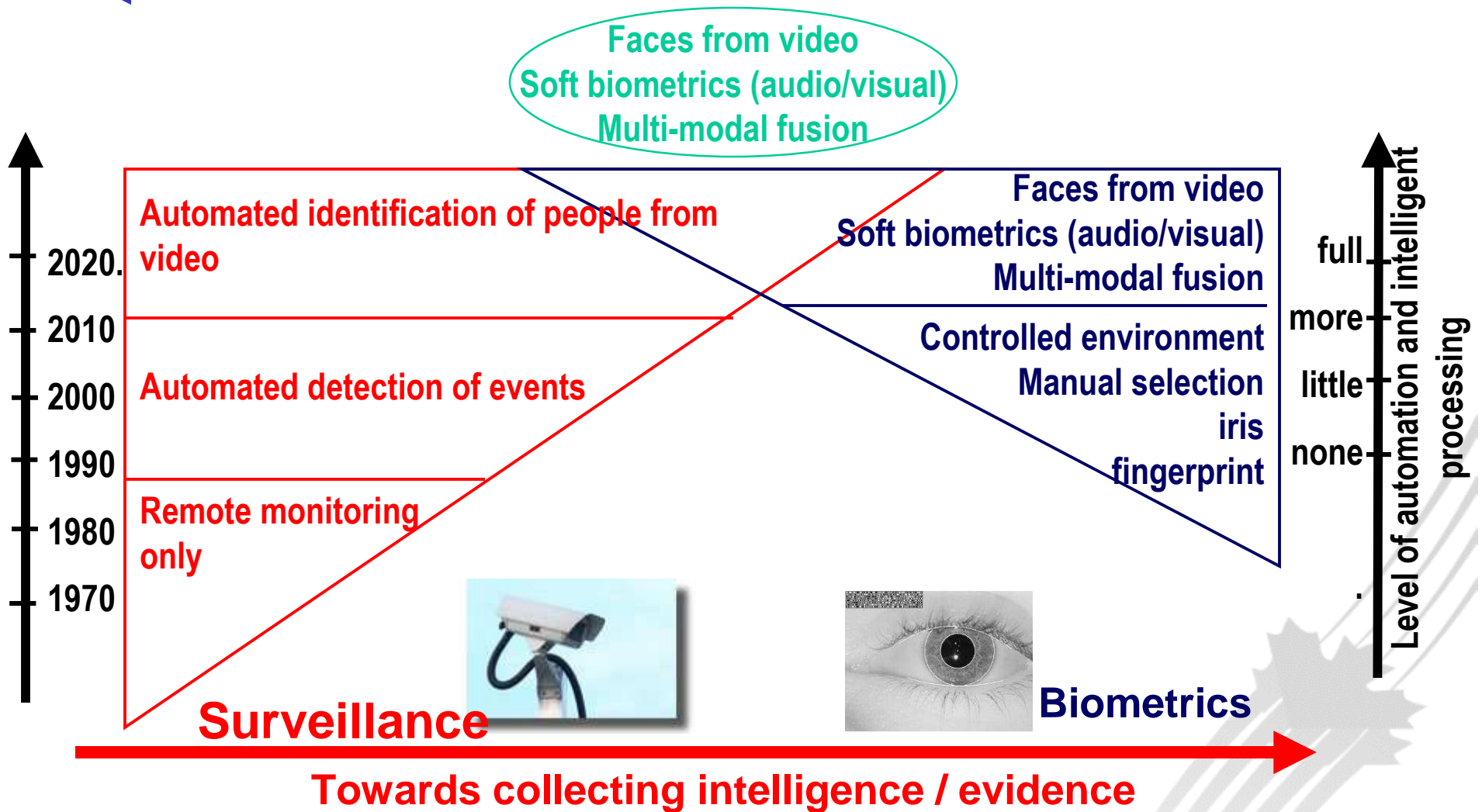


- Best synergy and impact is achieved by treating Video Surveillance together with Biometrics.
 - ... because most Biometrics are image-based.
 - Same unique set of skills:
IP: Image Processing (CompSci) & PR: Pattern Recognition (Math).
 - Face Recognition – where Biometrics meets Surveillance.
- VSB Section consolidated all IP & PR expertise in one place
 - To support both CBSA portfolios: in Biometrics and Video Surveillance
 - To become the prime GoC R&D center in Video Analytics & Biometrics



Evolution of Video Surveillance & Biometrics

Towards more collectable, unconstrained environments



Three foci of our R&D work:



Our objective: **To find what is possible and the best**

- **in Video Analytics, Biometrics, Face Recognition**
- **for LAND and AIRPORT Points of Entry (POE)**

to be in a position to build solutions to CBSA & OGD.

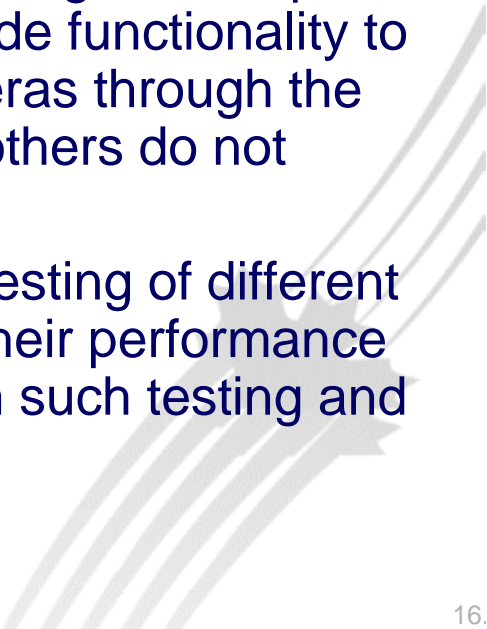
- Focus 1: Evaluation of Market Solutions
- Focus 2: In-house R&D
- Focus 3: Live Tests/Pilots in the Field

See also:

- “C-BET: Comprehensive Biometric Evaluation Toolkit” in SPIE Biometric Technology for Human Identification track – today at 4pm
- Federal Dept’s workshops on Video Technology for National Security (VT4NS) - www.videorecognition.com/vt4ns

Building VA Solution: Technical challenges



1. Different tasks and scenarios require different VA codes to be written, and the customization of the VA codes can be properly done only by a Video Recognition expert, which in many cases is not available in an operation-driven agency. At the same time, VA customization requires strong knowledge of operational tasks as well as constant communication with the involved regions. As a result, a solution coming from outside is often very expensive and in many cases not reliable.
 2. IP-cameras, which are now extensively replacing analog cameras, contain vendor-specific coding/encoding mechanisms, and getting a video-feed from these cameras requires customization in programming codes specific to each vendor. Furthermore, while some vendors provide functionality to perform direct capture of the video-feed from their cameras through the use of a dedicated SDK (Open Architecture cameras), others do not (Closed Architecture cameras).
 3. Selecting a good (or the best) VA product requires the testing of different products for the purpose of measuring and comparing their performance for a given task. Most agencies cannot afford to perform such testing and have to fully rely on the vendors' claims instead.
- 

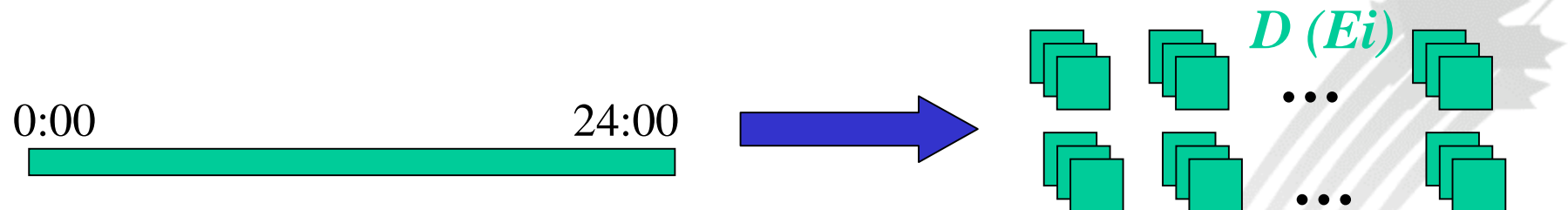
VAP / VAT definitions & concepts

Definition: Event of interest (E_i) is an instance when certain conditions related to what is observed in video are met.

Definition: Details of interest $D\{I_a, M_0, \{I_j\}, \{M_j\}\}$ (E_i) is set of static images & associated metadata (annotations) extracted and saved from video when an *Event of Interest* happens

- one image with annotation (I_a) is chosen to represent the Event

VAP task: To replace a continuous video-stream with a list of Details $\{D_j\}$ that can be efficiently browsed and analyzed – by using a Video Analytic module that operates on the video-stream.

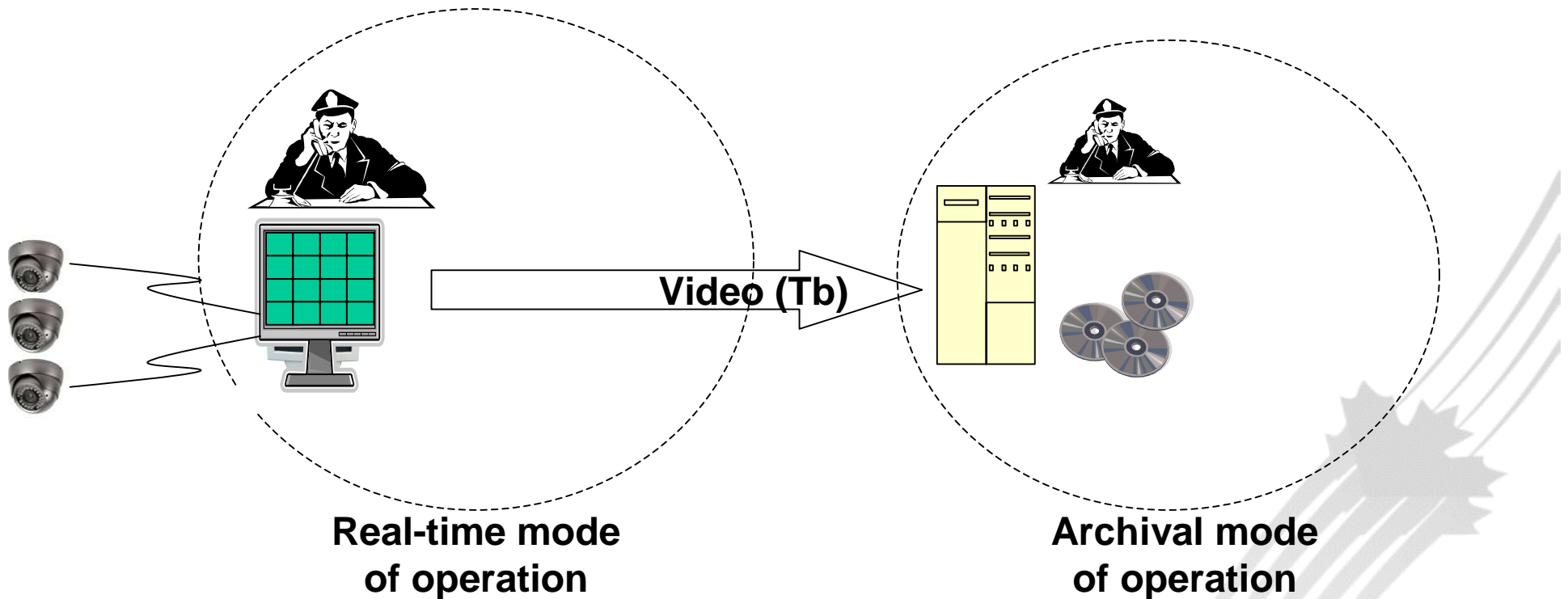


VAP / VAT Architecture

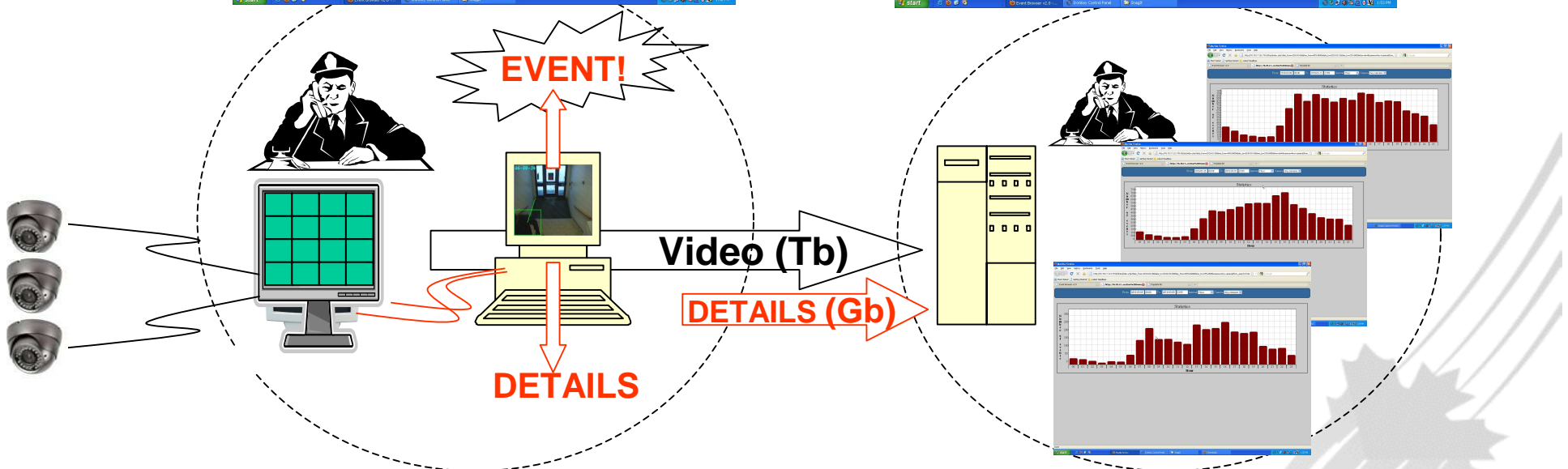
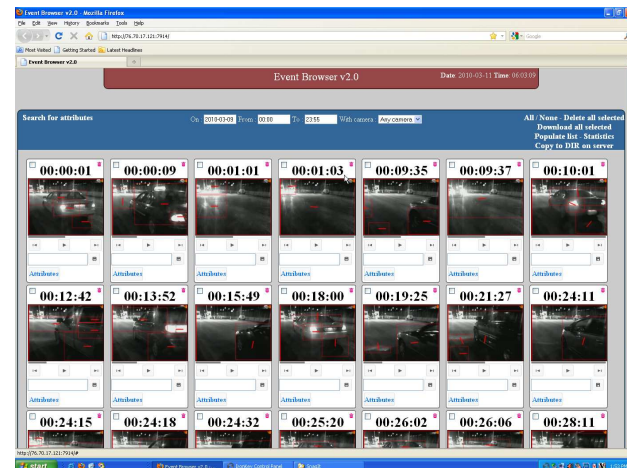
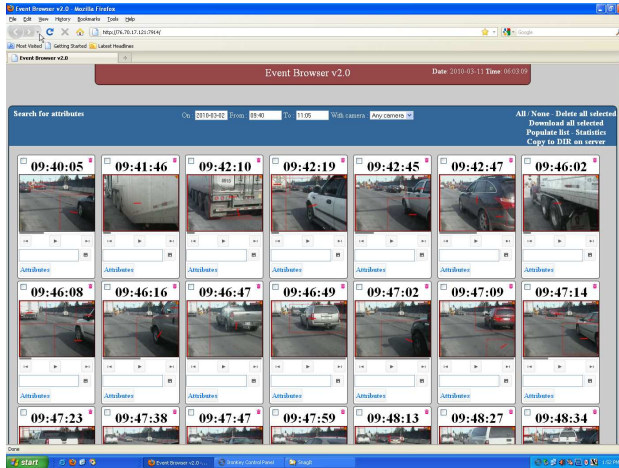


Consists of two components:

- EventCapture: uses VA to detect *Event* and extract *Details*
- EventBrowser: Convert *Details* into searchable web-applet



VAP / VAT Architecture



Real-time mode
of operation

Archival mode
of operation

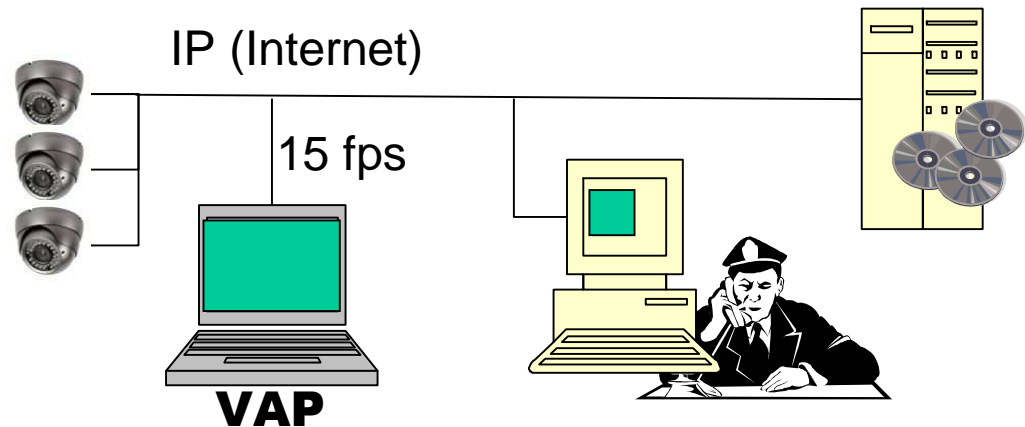
VAP / VAT: EventCapture + EventBrowser

Tapping into Closed & Open Architecture

Open Architecture

- Allows to directly access the video-feed
- Allows to control the video-feed quality/size

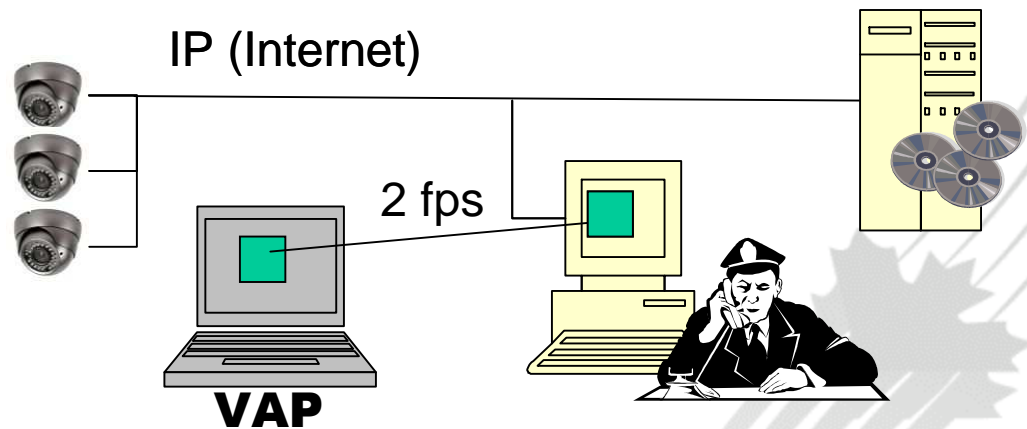
→ VAP *IPCamCapture*



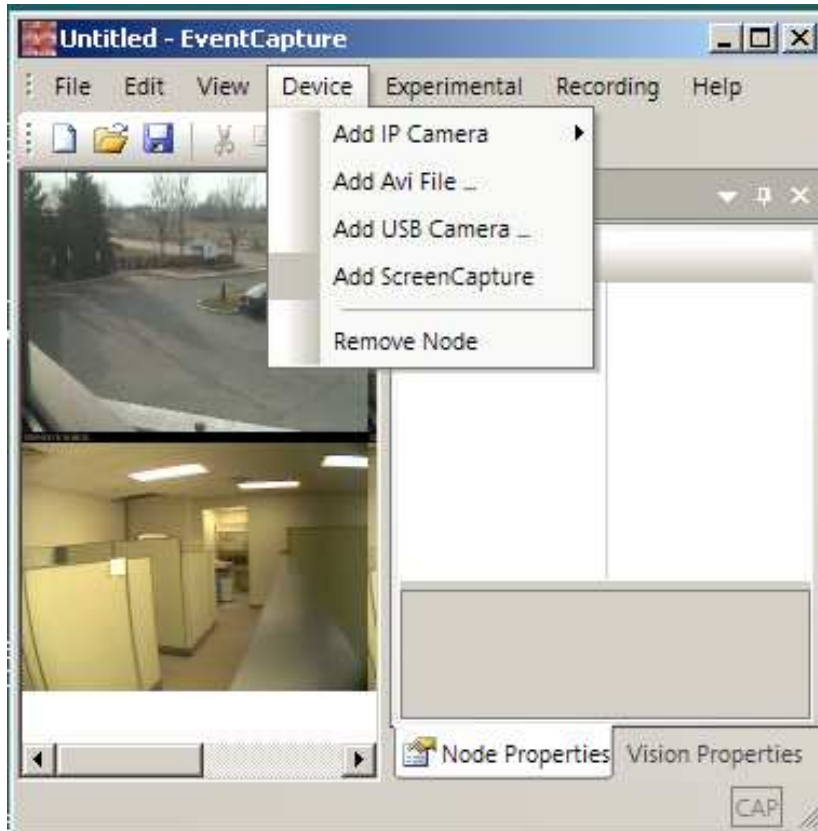
Closed Architecture

- Does not ...
- Does not ...

→ VAP *ScreenCapture*

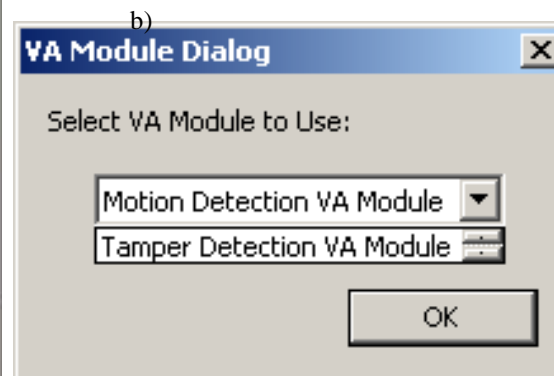


VAP EventCapture



Three steps:

1. Adding video-stream
2. Selecting VA module
3. Configuring VA module

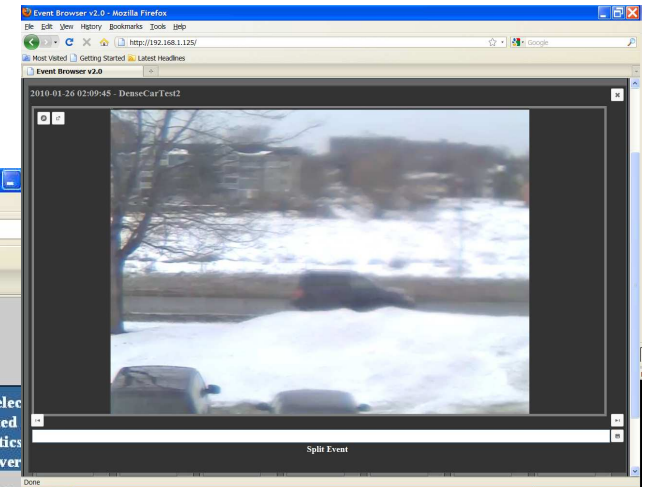
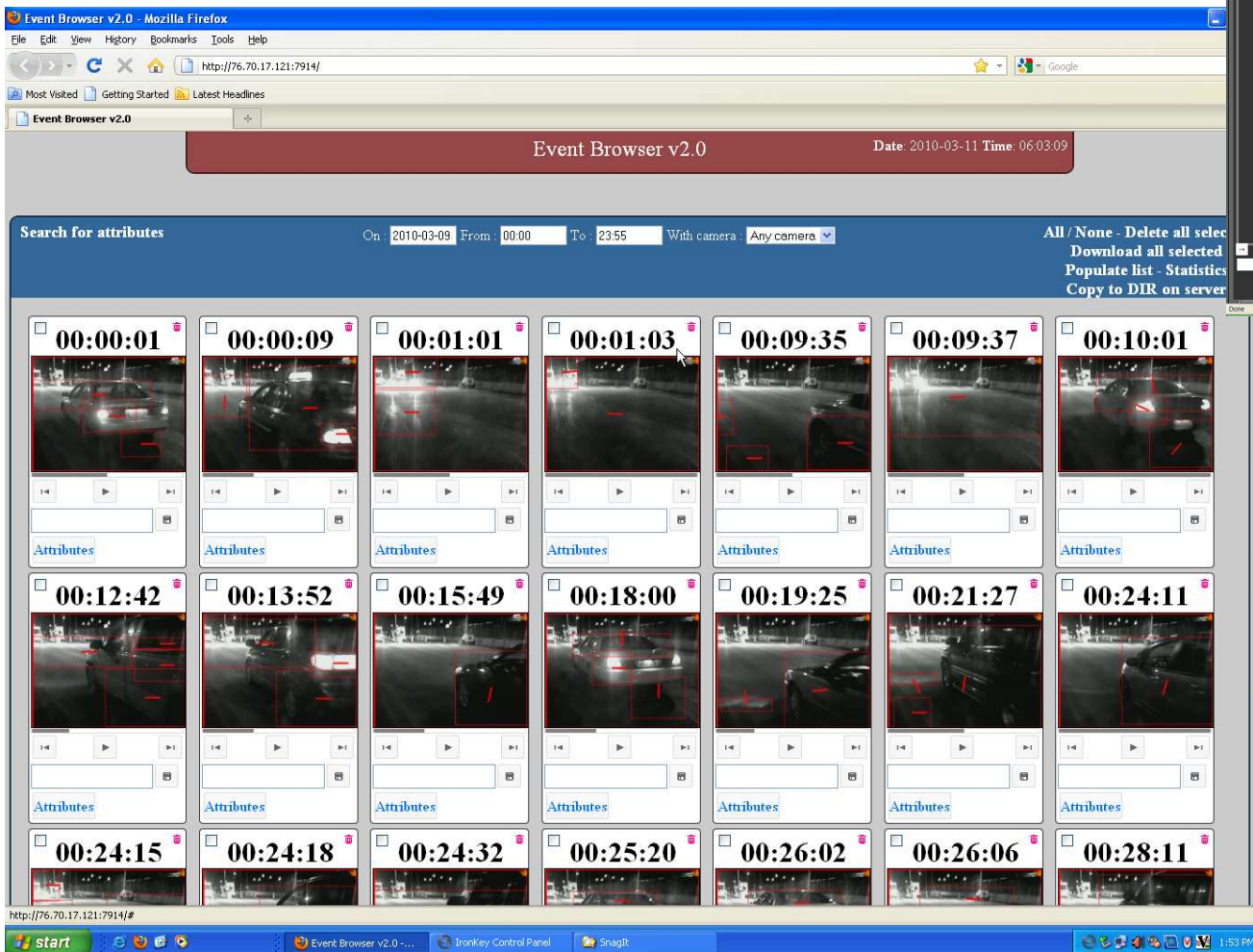


Vision Properties	
Image capturing ...	No
Threshold non-ze...	20
Threshold non-ze...	5
Detect Faces	No
Save image direct...	
View Resolution	160x120
Num images per ...	50
Num frames betw...	1
Image save meth...	Middle Images
Save thumbnail i...	Yes
Source To Save	All
Pre-Event Buffer S...	0

```
frame = Source->geCurrentFrame() // Obtain frame I(t)
VAModule->processFrame(frame) // Process I(t) and update the VA knowledge
if VAModule->eventConditionsMet()
    E++ // internal variables triggered an event
    VAModule->saveDetails() // All snapshots and metadata saved
```

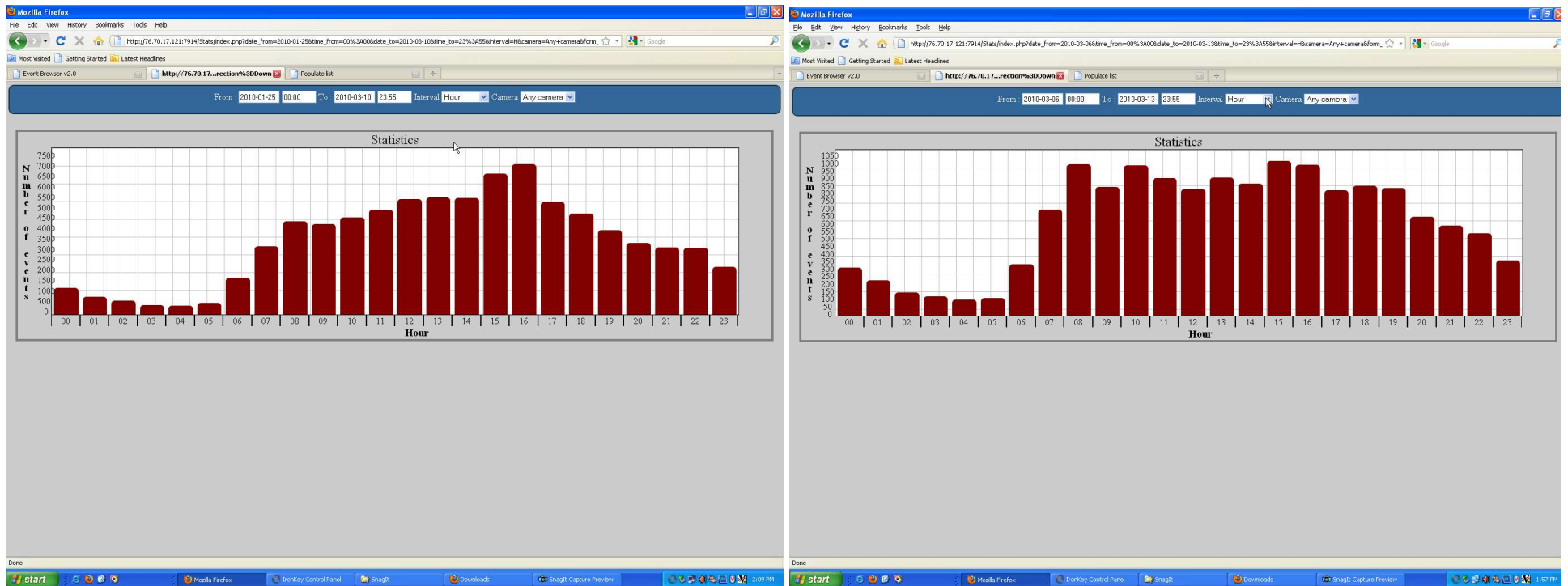
VAP EventBrowser

- All Events displayed represented by Thumbnails
- Each Event can be expanded
- Event can be viewed by attributes



Using VAP/NAT for VA evaluation (Cntd)

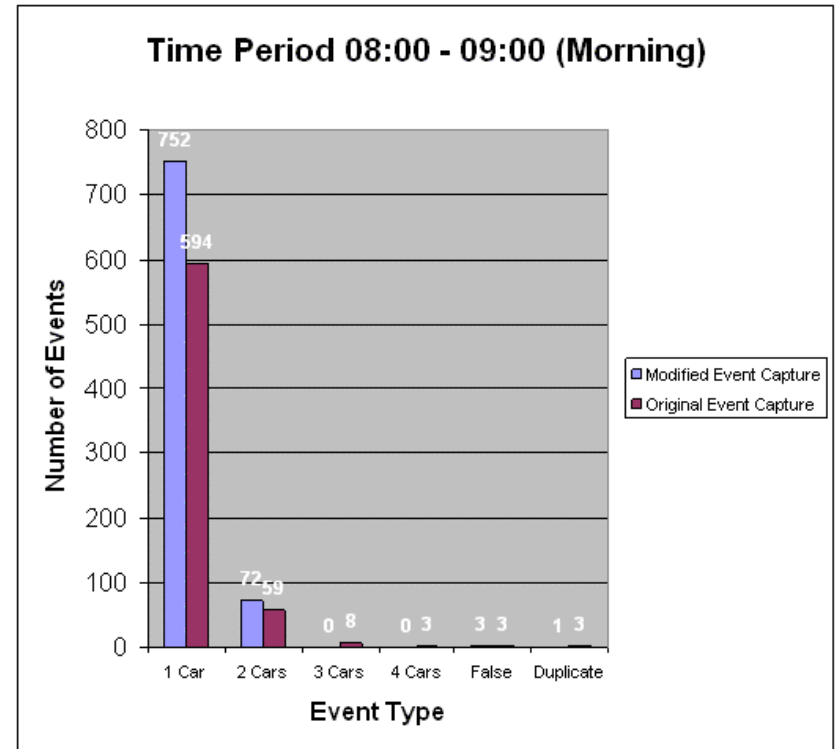
- Comparing VA-based solutions to one another
 - Using *EventBrowser* statistics module



Using VAP/NAT for VA evaluation

➤ Comparing VA-based solution to Manual screening:

- Count Vehicles in 24/7 out-door settings.



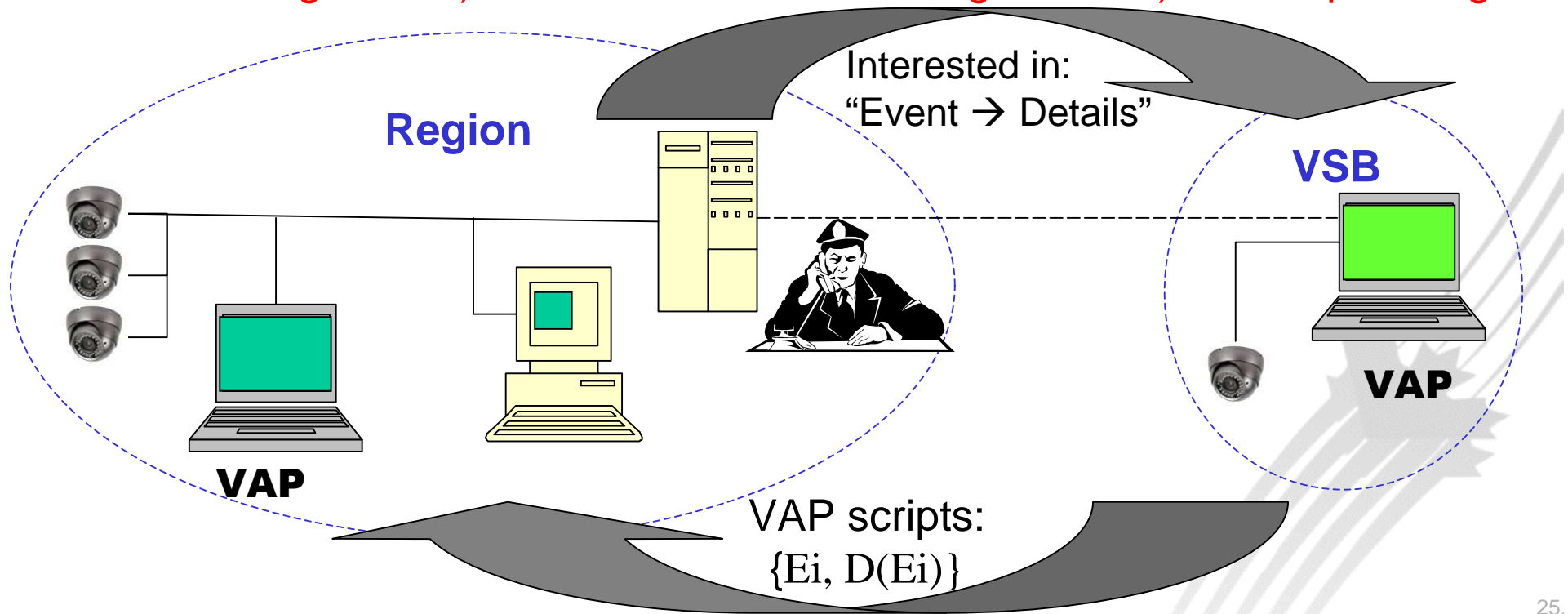
	VAS	MS	Difference	Percentage ¹
Total Events	98	105	7	6.67
Left	51	53	2	3.77
Right	47	52	5	9.62
Time (mins)	30	360	330	91.67

Business model: Client \leftrightarrow VSB



Once VAP is installed in the region:

- Client sends a request: describing what “EVENT” and “DETAILS” they want to detect (in plain English language)
- VSB provides a VA solution (in VAP script language):
 1. a) in-house built or b) by customizing a 3rd-party VA code (via SDK)
 2. + testing: with a) actual video-feed from regions or b) mock-up settings



Conclusions and Next Steps:



- Deploying VA in operations is shown to be possible
 - Without disruption to normal workflow
 - Cost-effective
 - Objectively measured performance improvement
- Methodological approach for selecting/testing VA is described
- In the 3-Phase Road-map for successful VA deployment
 - We have passed Phase 1 (Capacity) and Phase 2 (Solutions)
 - Moving into Phase 3 (Pilots & Outreach)
- Enables Testing of Face Recognition with existing CCTV video
- Next VT4NS workshop (June 3, 2010) themes:
 - “Deploying Video Analytics”, and “Faces in Video”.

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