

# Advances in Video-based Vehicle Identification for AETC

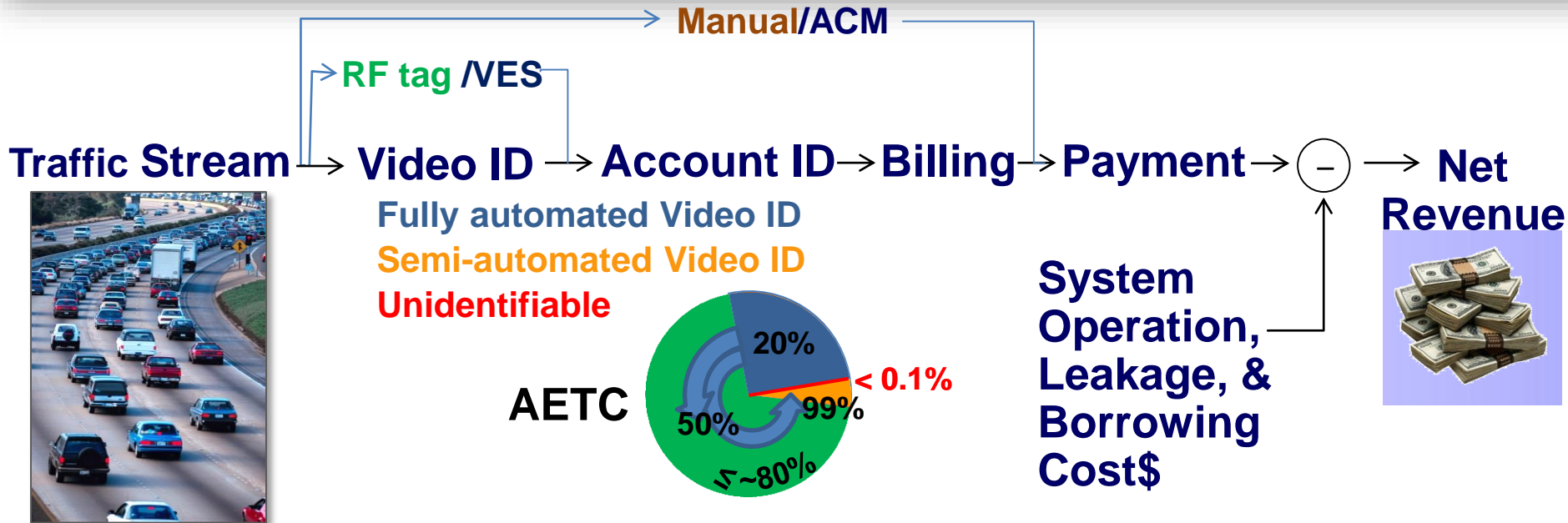
James Alves

[jalves@dacolian.com](mailto:jalves@dacolian.com)

(619) 523-9220

Dacolian USA / Q-free

# Q-free is a leading supplier of Automation Tools for free-flow Tolling

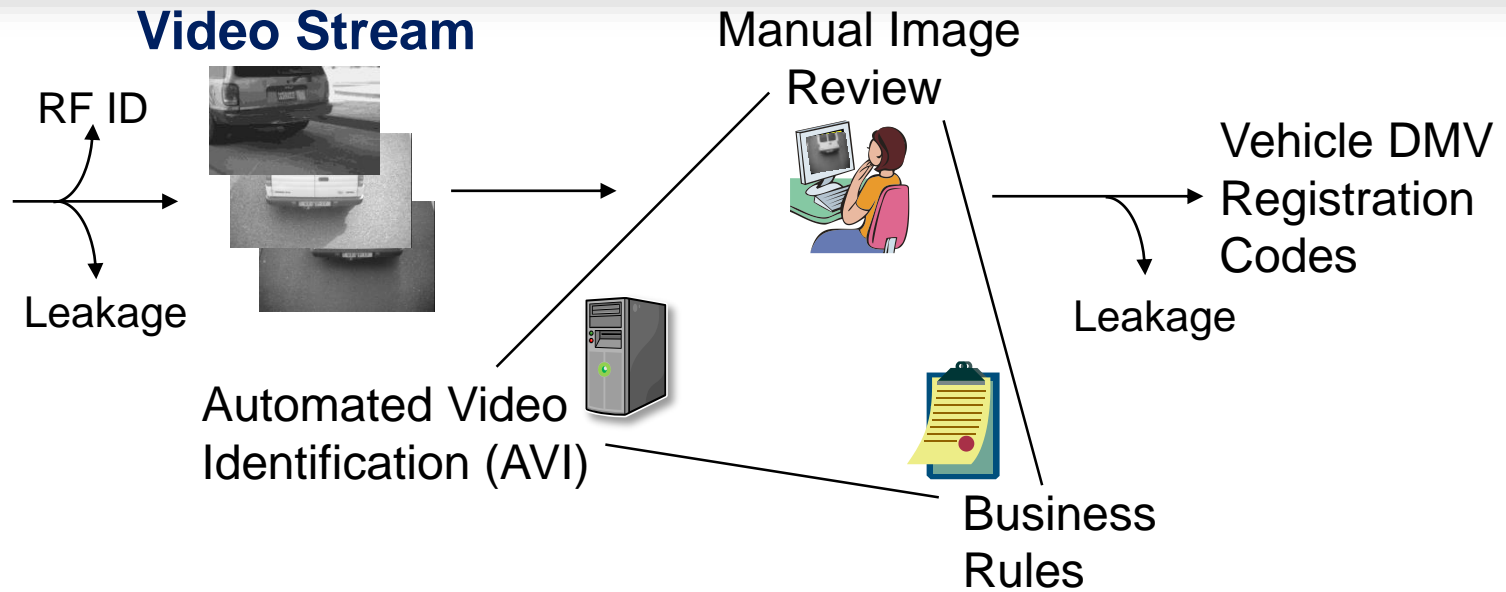


AETC requires very high rates of accurate automated vehicle identification and low leakage

- Advanced camera systems and installation procedures are ensuring reliable high image quality to maximize automation and minimize leakage
- Improvements in image processing techniques have enabled accurate identification of multiple State plates, Plate Types, and stacked plate characters
- Intelligent integration of image processing , display tools, human reviewers and self-learning systems has dramatically reduced video transaction costs

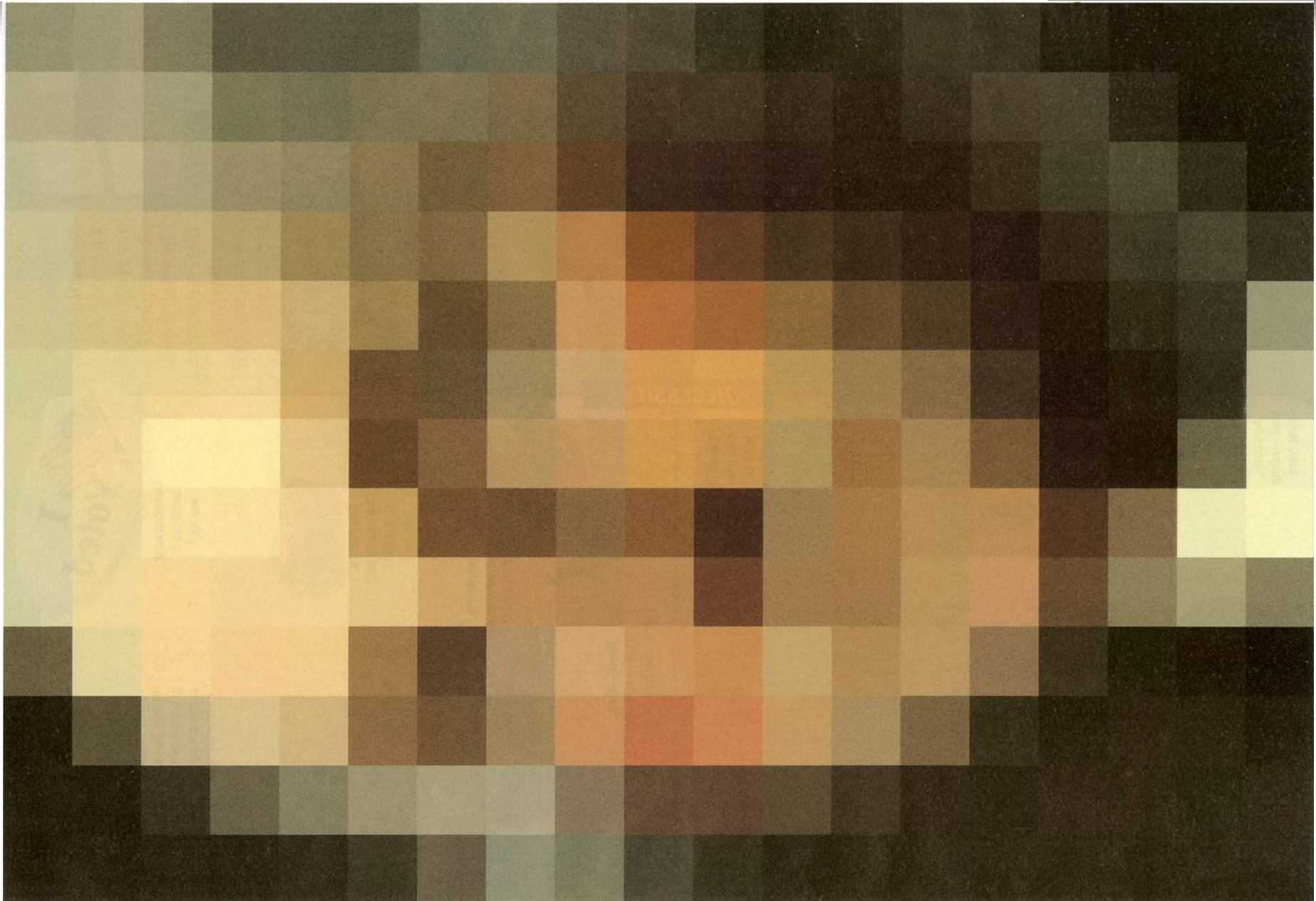
# Video Identification Systems Integrate both Machine and Human Reading

## AETC Traffic Stream



- AVI software from Q-free automates the bulk of each day's vehicle identification tasks (low error rate and multi-State ID are major features)
- Human reviewers minimize toll collection leakage by reading the lower percentage of plate styles/conditions that AVI cannot accurately read
- Business rules are designed to minimize false identifications by trapping AVI and human errors while enabling maximum automation
- Video ID system design is key to AETC success (Synergy)

# Human vision sees details that are not explicitly present in image data



# Machine Vision requires image data that mathematically contains the information sought

- For a Human, a video image is a trigger that sets off a highly complex perceptual experience that is not at all well understood computationally

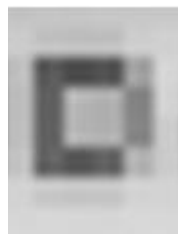
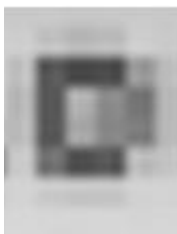
“There’s more to the picture you see than the image that meets your eye”

- For a Machine, mathematical definitions of information drive the evidence collection techniques employed to automate identification of human defined concepts such as plate characters, State, or Plate Type

- For machines to read plates, character information must be captured with enough fidelity (image resolution and sharpness) to enable its computational extraction from the clutter/noise in the image data

“A computer can’t see any more than what the image data contains”

- Fine print such as State Names, Plate Type prefixes/suffixes, or more than 2 vertically stacked characters, are often not sufficiently resolved to make them machine readable, even though humans can identify such poorly resolved print



→ FL  
SHERF00000

# AETC needs ALPR to output a Plate's full DMV Registration Code

## PLATE READING

Requires separating plate symbols from background  
(typically all characters that must be read have the same State chosen color)

Then ignoring all symbols not part of the DMV code

State Name

(unresolved small print often obscured)

Stickers

Authentication marks

Plate Background/Type Info

(State chosen Logos/Graphics/Scenic's/Colors  
Special Symbols/Small Print)

## PLATE TYPE INFERENCE

(Evidence of Plate Type text, graphics, or coloration)

→ CCI IC64CE MA  
conf 756

## STATE ID INFERENCE

(Evidence of State text/symbols, character font, spacing, syntax, & plate coloration)

- DMV registration codes must be well understood by the reader (human or machine)
- Reading a plate requires deciding what to ignore as much as what to pay attention to
- Consistent high image sharpness of discriminating details required for accurate State ID
- State (or Plate-Type) must be inferred using multiple clues since individual pieces of evidence are often not well resolved, consistently visible, or conclusive on their own

MDNY  
RR

# Pattern Matching Techniques help Automate difficult to ALPR Plates

Image with Low Conf ALPR Read



DMV Registration Code  
**NG 8000 FL**

Associated together in a Database of previously reviewed images

Matches previously stored Fingerprint

Image Fingerprint



Fingerprint uniquely characterizes plate/vehicle information and its similarity to other Fingerprints can be mathematical computed

- Unlike ALPR, Fingerprints do not need to differentiate characters from clutter
- Pattern Matching is used when key portions of the DMV Code information are:
  - Not readily separable from a scenic/graphic backgrounds
  - Not well resolved (when small text is a primary indicator of the DMV Registration)
  - Partially obscured, damaged, or distorted
  - Unconstrained or rarely seen syntax (personalized plates, organizational plates)
  - Plate Types (In or Out-of-State) that the ALPR was not trained to read

# Q-free helps deliver the most accurate multi-State AVI available in North Am

- 2-State performance (11189 human readable transactions, spanned days/nights, multiple sites, rain/clear weather/sky)

ALPR trained to read **93.5%** of traffic stream plates

19.9% ALPR reject rate at an error rate of 0.107%

73.6% fully automated by ALPR alone

~35% ALPR rejects read by Fingerprinting

**83% of readable traffic through AVI**



*Sharp imagery and Color information are vital to success of many-State AVI*

- 11-State performance (20655 human readable transactions, spanned days & nights, ORT & Lane sites, rain/clear weather/sky)

ALPR trained to read **97%** of traffic stream plates

13.6% ALPR reject rate at an error rate of 0.99%

83.8% fully automated by ALPR alone

38% ALPR rejects read by Fingerprinting

**90% of readable traffic through AVI**





# Parting Thoughts

- **High Resolution color cameras are a superior choice for AETC in North America**  

Color information provides a wealth of computationally simple to manipulate image data that facilitates character isolation, improved multi-State/Plate-Type ID, & the cost has come way down
- **Performance of ALPR is extremely dependent on image information quality, camera set-up and maintenance**  

Imperative that video images reliably capture the information details required to ensure both high automation and high accuracy rates required by AETC
- **Intelligent combination of ALPR and Fingerprinting significantly increases the variety of plate styles/conditions that can be automated**