Understanding the Potential for Video Analytics to Support Traffic Management & Operations

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National Rural ITS Conference – Branson, MO
August 2014

ENTERPRISE Program

Program Goals

- Facilitate rapid progress in the development and deployment of ITS technologies
- Accelerate the systematic advancement of selected ITS projects

Members carry out ITS projects and activities including fundamental research, technology development, demonstration, standardization, and deployment.

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What is Video Analytics?

"Video Analytics" – Refers to the capability of analyzing video feeds to determine events that are not based on a single image

Commercially available Video Analytics systems ***process video streams*** from traffic cameras to:

- ***Collect Traffic Data***: Volumes (vehicle counts), speeds, & vehicle classifications
- ***Detect Incidents and Create Alerts***: Stopped/slow vehicles, wrong-way vehicles, wildlife, debris

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Why Use Video Analytics?

Challenges
• Difficult to monitor conditions in rural areas • Challenge for TMC operators to monitor multiple camera views simultaneously • Vehicles traveling the wrong way introduce safety hazard

Opportunities
• Utilize existing camera infrastructure • Potential to use Video Analytics for multiple purposes (traffic data collection, incident detection)

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Why Evaluate Video Analytics?

Project Goals

- Investigated potential of Video Analytics as a tool for:
  - Traffic data collection
  - Incident detection
  - Wrong-way vehicle detection
- "Proof of Concept" evaluation to understand current state of practice
  - How accurate? How effective? How useful?
  - Compared to traditional methods/technologies: Loop detectors, radar, reported incidents, visual observation
- Not a comparison of vendors' products

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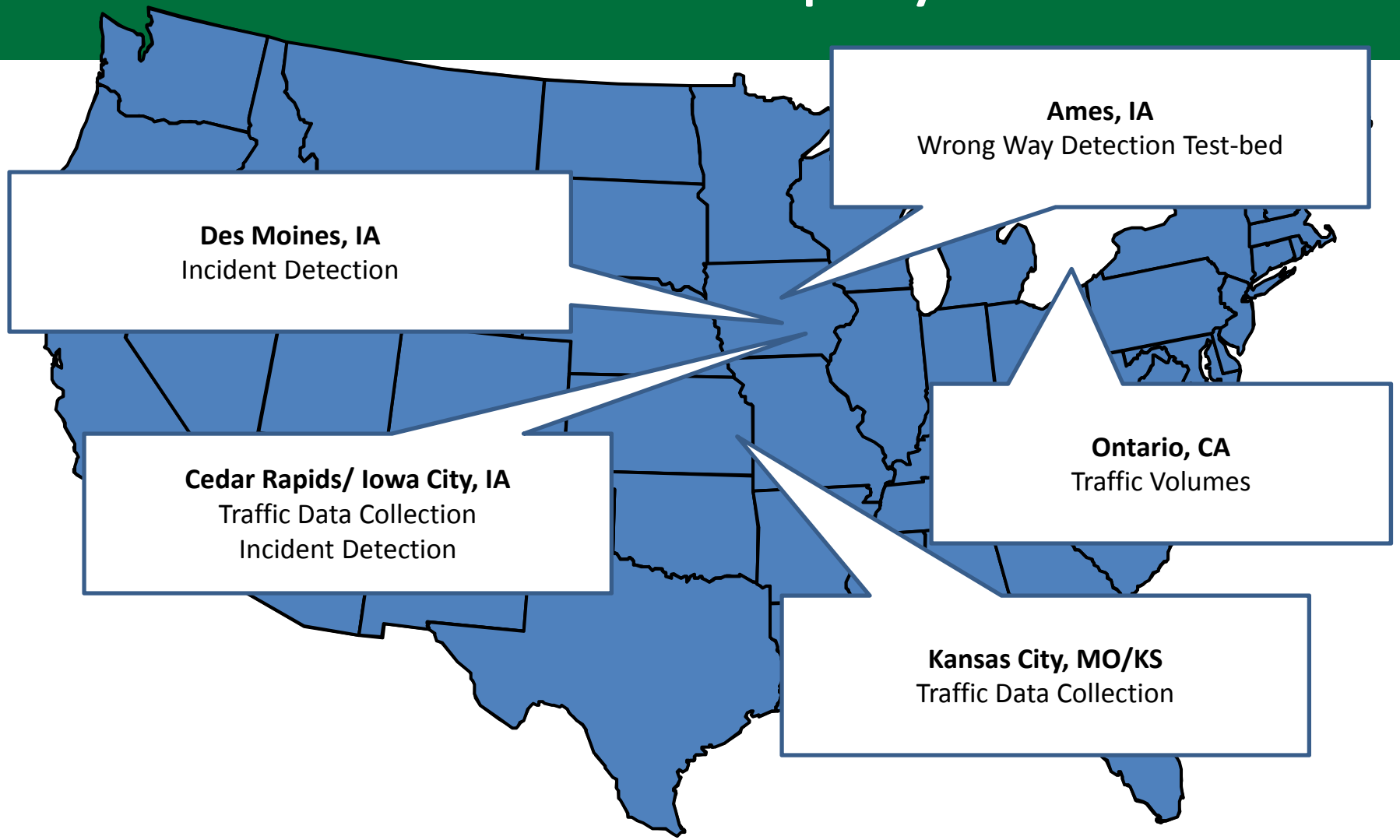
“Virtual Test Bed” Deployment Sites



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Deployment Conditions

Tested in "Real World" Conditions

- Existing camera infrastructure
- Typical TMC practices and workflow

Conditions Not Controlled to Ensure Optimum Performance

- Camera settings & system configurations not always ideal for video processing (doing this could affect viewing ability)
- Normal panning/zooming of cameras
- TMC operations did not allow for constant monitoring and re-configuring of Video Analytics. Efforts made to adjust systems as much as practical.

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INCIDENT DETECTION

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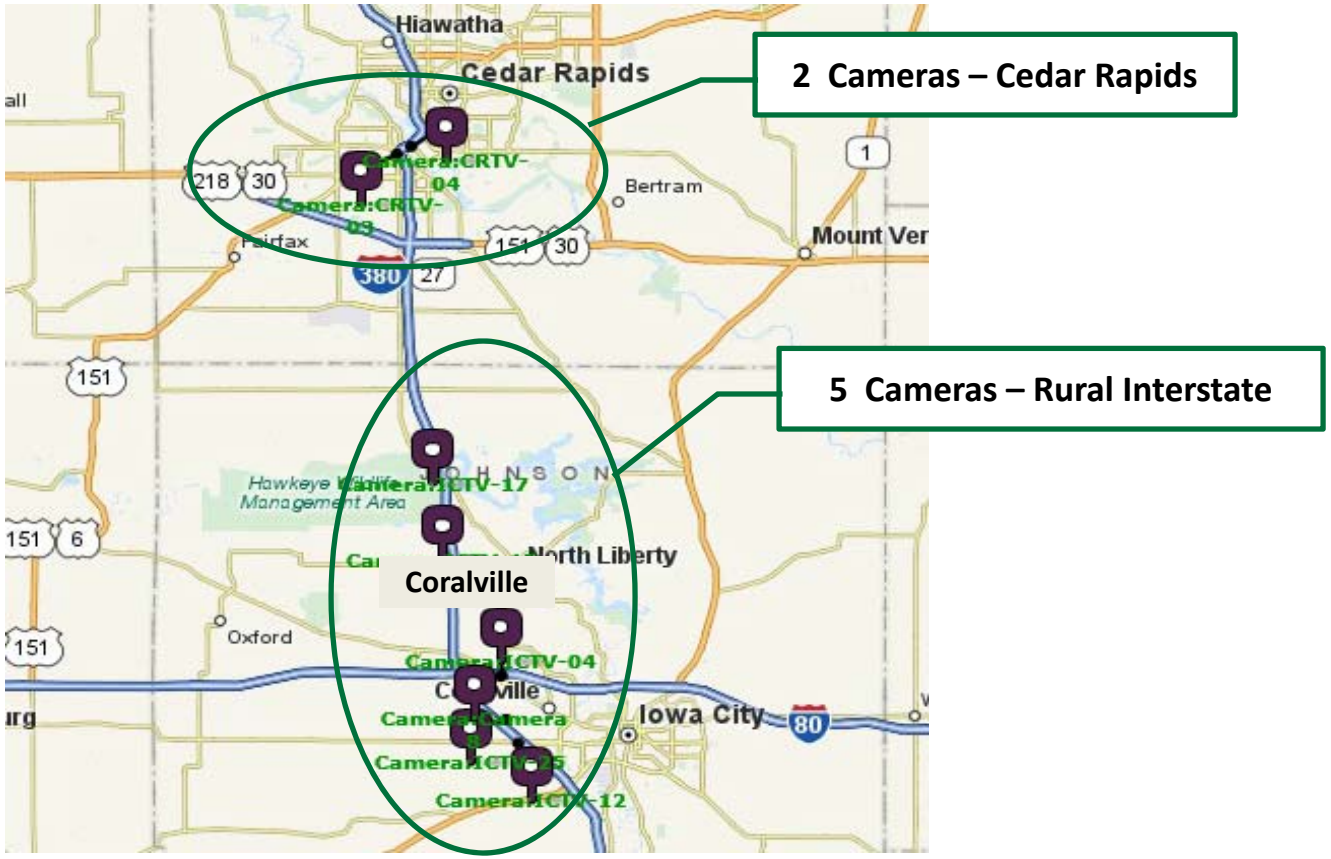
Incident Detection

Cedar Rapids - Rural Deployment

7 cameras instrumented - 2 vendors



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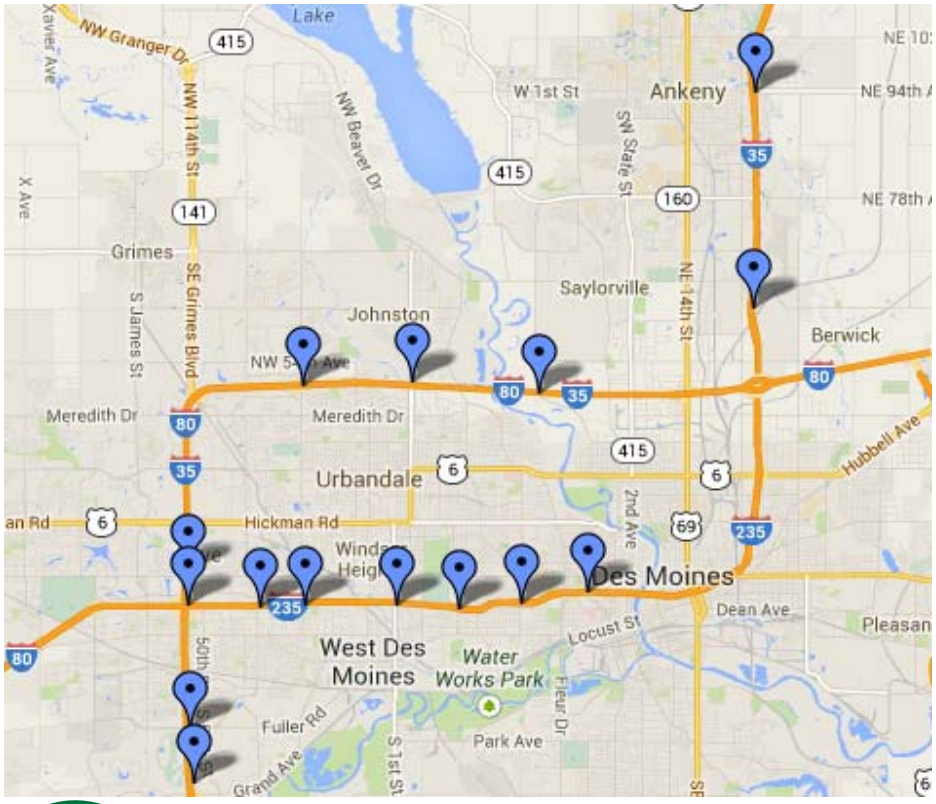
Incident Detection

Des Moines Deployment – Urban / Suburban

15 cameras instrumented – 1 vendor

(Approx. 12% of Des Moines freeway network "coverage" with Video Analytics)



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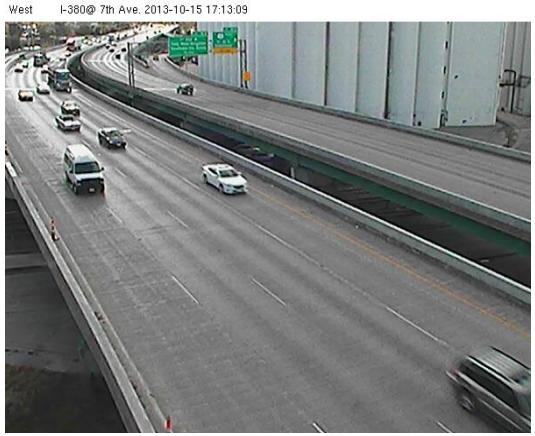
Incident Detection

Variation in Camera Views (examples)



Incident Types Detected by Video Analytics

- Stopped Vehicle / Debris in Road
- Slow Traffic / Congestion
- Pedestrian
- Wrong-Way Vehicle

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Incident Detection

Results:

Highest Level of Performance
Stopped Vehicle / Debris: 72% alerts validated, 23% not validated, 5% unable to determine (81 alerts during a 44-day period) **Stopped Vehicle / Debris – Remove False alarms from Object in View:** 0% “false alarms” (26 alerts during a 21-day period) **Slow Vehicle/Congestion:** 30% alerts validated, 33% not validated, 37% unable to determine (1111 alerts during a 44-day period) **Pedestrian in Road:** None observed **Wrong-Way Vehicle Movements:** None observed

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Incident Detection

Results

Factors that Impacted Performance
• Objects in the field of view • Weather events / moisture on camera lens • Headlight glare on roadway during nighttime lighting conditions
Factors that Did Not Appear to Impact Performance
• Camera position (zoom level, angle to roadway) • Inaccurate configuration of Video Analytics to roadway lanes (e.g. camera panning) 

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Incident Detection

Comparison of Detection Alerts to Agency Reported Incidents

- It is likely that Video Analytics detected a number of incidents that were not observed by agency staff, indicating that Video Analytics can be an effective tool for supplementing existing mechanisms to alert operators
- Strategic selection of camera locations along a coverage area will optimize usefulness of Video Analytics

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TRAFFIC DATA COLLECTION:

Iowa/Kansas City Deployments

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Traffic Data Collection

Traffic Data Types:

- Volumes (Vehicle Counts)
- Average Speeds
- Vehicle Classifications

Classification Categories from Video Analytics	Corresponding FHWA Classifications
Motorcycles	Classifications 1
Cars	Classifications 2-3
Small Trucks	Classifications 4-7
Large Trucks	Classifications 8-13

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Traffic Data Collection

<u>Analysis Approach</u>

- Data collected in 15-minute increments
- Video analytics outputs compared to outputs from DOT detectors (loops and radar)
- Absolute Percent Difference (Abs % Diff) Calculation:
  - Calculate 15 min. period difference from DOT data
  - Convert it to absolute difference (remove any '-')
  - Compute Percent Difference
  - Result is Abs % Diff.
- Caveat: Night-time traffic is often very low volumes. Abs % Diff. is not as meaningful

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Traffic Data Collection

Results : Highest Level of Performance (All results shown are average % Diff for one week)	
Traffic Volumes: • Day: 9% Avg. % Diff. *(carries reasonable expectation of repeatability)* • Night: 17% Avg. % Diff. (***Does not*** carry reasonable expectation of repeatability)	**Vehicle Speeds:** • Day: 2% Avg. % Diff *(carries reasonable expectation of repeatability)* • Night: 6% Avg. % Diff *(carries reasonable expectation of repeatability)*
Vehicle Classifications: • "Motorcycles" (FHWA Classification 1): Avg. % Diff of 24% at night • "Cars" (FHWA Classifications 2-3): Avg. % Diff of 13% daytime • "Small Trucks" (FHWA Classifications 4-7): Avg. % Diff of 44% daytime • "Large Trucks" (FHWA Classifications 8-13): Avg. % Diff. of 23% daytime	

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Traffic Data Collection

Results

Factors that Impacted Performance
• Low light / dark conditions • Camera position (proximity to traffic, zoomed out, angled to roadway) • Weather events that reduce image quality • Inaccurate configuration of video analytics to roadway lanes • Camera settings (e.g. shutter speed, max gain)
Factors that Did Not Appear to Impact Performance
• Position of camera relative to direction of traffic (e.g. counting headlights vs. tail lights at night)

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TRAFFIC DATA COLLECTION:

Ontario Ministry of Transportation (MTO) Deployment

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Traffic Data: MTO Deployment

MTO Deployment – Focus on Volumes

- 13 cameras instrumented at 4 Locations
- Data collected in 15-minute periods
- Video recorded for 1 week at each camera, sent to video analytics vendor for processing
- Manual counts conducted for comparison
- Manual counts compared to video analytics data outputs to compute percent error

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Traffic Data: MTO Deployment

Results:

Type of Comparison	Configuration/ Setting	% Error
Time of Day	Day[1]	9.1%
	Night	7.9%
Camera Angle	Side	9.4%
	Overhead	6.5%
Camera Type	Axis	7.5%
	Cohu	9.6%

[1] 'Day' analysis was PM peak (16:30-17:30)

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Traffic Data: MTO Deployment

Results:

1. Camera based counting system is appropriate if:
   - Overall Accuracy within 10% is acceptable
   - Vehicle Classification is not critical

2. Camera based counting system may not be suitable if:
   - Counts are to be conducted in work zones or areas with high stop-and-go traffic
   - Accuracy within 5% is required
   - Vehicle Classification is needed
   - Night-time accuracy is important

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Traffic Data: MTO Deployment

Lessons Learned:

1. Engage in discussions early with camera vendors
2. Standard definition cameras are actually better
3. Ambient light surrounding cameras should be taken into consideration for camera locations

Next Steps:

MTO will be undertaking additional data collection assignments utilizing video analytics beginning this fall and continuing through next summer

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WRONG-WAY VEHICLE DETECTION

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Wrong-Way Vehicle Detection

Controlled Test: Nov. 2013 in Ames, IA

- 3 vendors/technologies at 3 separate freeway ramps
- Ramp closures to test various conditions
- Detections conveyed via email, web interface, or on-site computer interface
- Recorded “detection” or “non-detection”

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Wrong-Way Vehicle Detection

Highest Level of Performance Achieved
Daytime Test: 100% detection for 12 test drives **Nighttime Test:** 83% detection for 12 test drives
Factors that Impacted Detection Rate
Nighttime / Low Light Conditions Slow Speeds
Factors that Did Not Appear to Impact Detection Rate
Color/Size of Vehicle Lane Position (consistent position, shoulder, and/or weaving)

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EVALUATION FINDINGS

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Evaluation Findings

State of Practice for Video Analytics is ready to meet many agency needs.

- Dedicated and/or fixed cameras may be warranted, especially for traffic data collection
- Video Analytics may not serve all purposes simultaneously (e.g. a camera used for incident detection may not be optimal for traffic data collection)
- Important to follow vendor guidelines for camera selection, position, zoom level, etc.
- Recognize significant human component involved. Operator resources are required to monitor system settings and re-configure as needed.

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Acknowledgements & Project Contact

Final Report: To be published - September 2014

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Participating Agencies

- Iowa DOT
- KC Scout/Missouri DOT
- Ministry of Transportation of Ontario

Participating Vendors

- DRS Technologies, Inc.
- Iteris, Inc.
- Peek Traffic Corporation
- TrafficVision
- VideoIQ

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