

Towards Temporal Dynamic Segmentation

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Presentation Outline



- ⌘ Introduction
- ⌘ Dynamic Segmentation Characterization
- ⌘ Classic Dynamic Segmentation Revisited
- ⌘ Segment Fundamentals
- ⌘ Illustration of Functional Specifications
- ⌘ Illustration of Real world temporal GIS-T applications (courtesy of Maricopa County Department of Transportation)

Introduction



⌘ Why there has been an abundance of LRS data models but limited temporal GIS-T implementations?

- the Lack of methodology to define as well as to handle feature segments in the temporal context

Dynamic Segmentation Characterization - Data Modeling

⌘ Feature-network Independence

- ☑ Feature data and network data are stored in separate tables or even on separate locations

⌘ Feature-feature Independence

- ☑ Each feature is stored in its own table

Dynamic Segmentation

Characterization - 2 Fun. Categories

⌘ Network Maintenance

- ☑ Build and maintain traversal (LRS) network, with which linearly referenced features can be associated.

⌘ Feature (Segment) Processing and Representation

- ☑ Geocoding
- ☑ Overlay
- ☑ Maintenance

Dynamic Segmentation Characterization - 3 Functions

⌘ Feature-network Geocoding Function

☑ As a result of feature-network independence

⌘ Feature Overlay Analysis Function

☑ As a result of feature-feature independence

⌘ Feature Maintenance Function

☑ Spatiality or spatiotemporality is decomposable

Road	From-mp	To-mp	Pavement type
Main St	0.0	1.5	Asphalt
Main St	1.5	2.8	PCC

Asphalt

Concrete



Road	From-mp	To-mp	Pavement type
Main St	0.0	15	Asphalt
Main St	1.5	1.9	PCC
Main St	1.9	2.4	Compsite
Main St	2.4	2.8	PCC

Asphalt

Composite

Concrete

Concrete



Classic Dynamic Segmentation Revisited



⌘ Feature (or Segment) Classifications

- ☒ Point feature & Linear feature

⌘ Temporal Assumptions

☒ Mapping function

- ☒ Feature data and target network share the temporal existence

☒ Overlay function

- ☒ Overlaying feature data to be overlaid share the temporal existence

☒ Maintenance function

- ☒ History data is irrelevant once replaced by the current data

Segment Definition (I)

⌘ What is a Segment

☑ A section of or a point on a road in a network at or during a given time, or an event or a feature associated with such a road section or road point at or during a given time.

⌘ A segment can be mapped in a Traversal-Time space

☑ Linear Period: pavement type

☑ Linear Instant: sweeping activities

☑ Point Period: traffic signs

☑ Point Instant: accidents

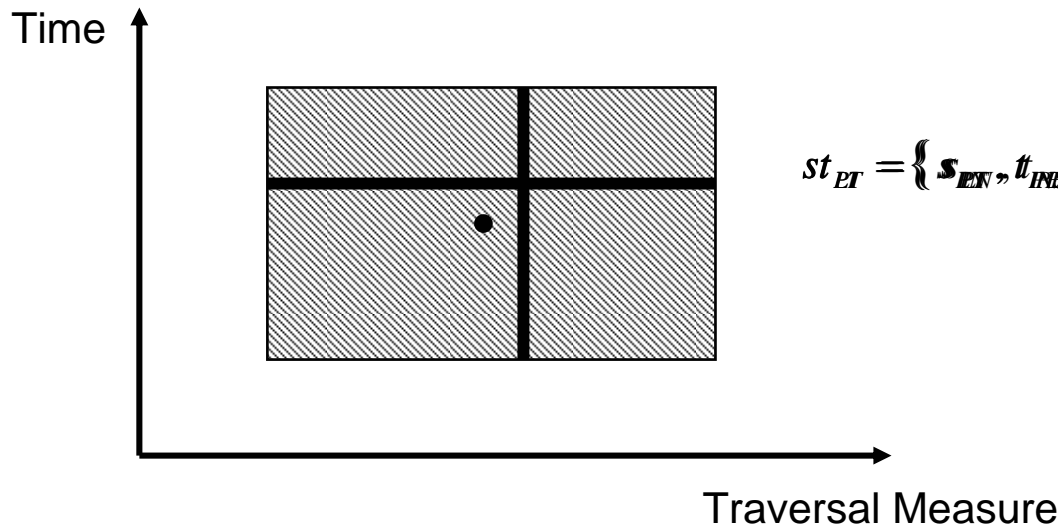
Segment Definitions (II)

$$t_{PER} = \{ [t_i, t_j] \mid t_i, t_j \in \text{dom}(T), t_i \leq t_j \}$$

$$t_{INS} = \{ t_i \mid t_i \in \text{dom}(T) \}$$

$$s_{LN} = \{ v, [m_i^v, m_j^v] \mid v \in \text{dom}(V), m_i^v, m_j^v \in \text{dom}(M^v), m_i^v \leq m_j^v \}$$

$$s_{PT} = \{ v, m^v \mid v \in \text{dom}(V), m^v \in \text{dom}(M^v) \}$$



$$st_{ET} = \{ s_{EN}, t_{INSR} \mid s_{EN} \in \text{dom}(S_{EN}), t_{INSR} \in \text{dom}(T_{INSR}) \}$$

Segment Topology

1-D Segment Relationships

Relationship	Disjoint	Meet	Overlap	Cover	Graphic Relationship	Relationship
Disjoint						
Meet						
Overlap						
Cover						
Equal						
Contain						

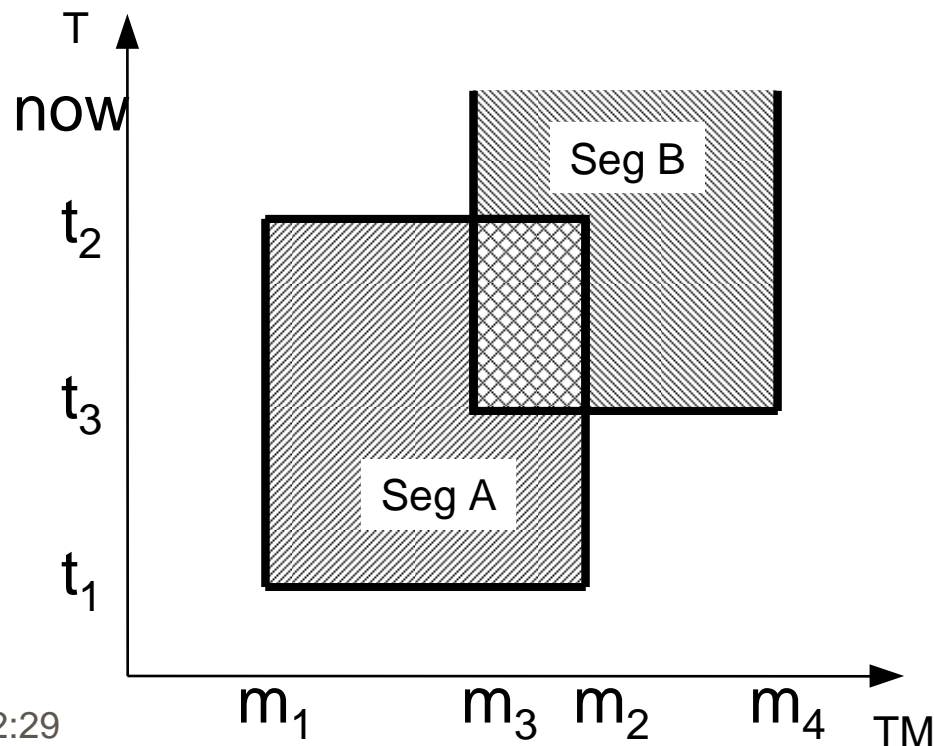
Basic Segment Operations

⌘ The set operations construct the basic segment operations

⌘ Set Intersection

⌘ Set Difference

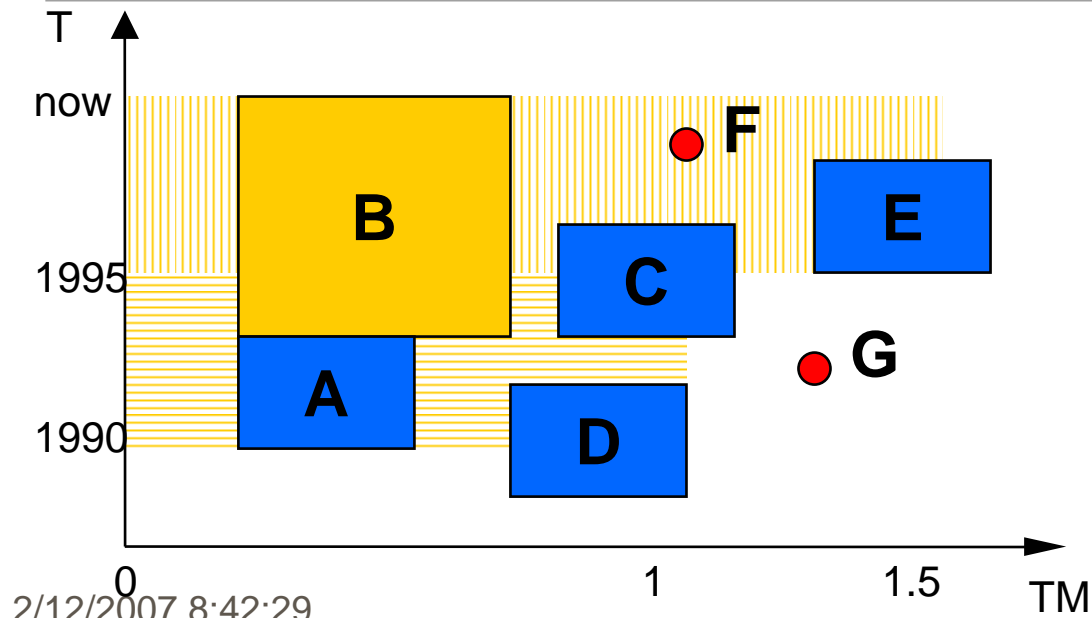
⌘ Set Union



$A \ominus B$

Function Illustration - Segment Geocoding

Configuration	State	Example
Mappable	Single map	A, F
	Multiple map	B
Partially mappable	Single map	D, F
	Multiple map	C
un-mappable	NA	G

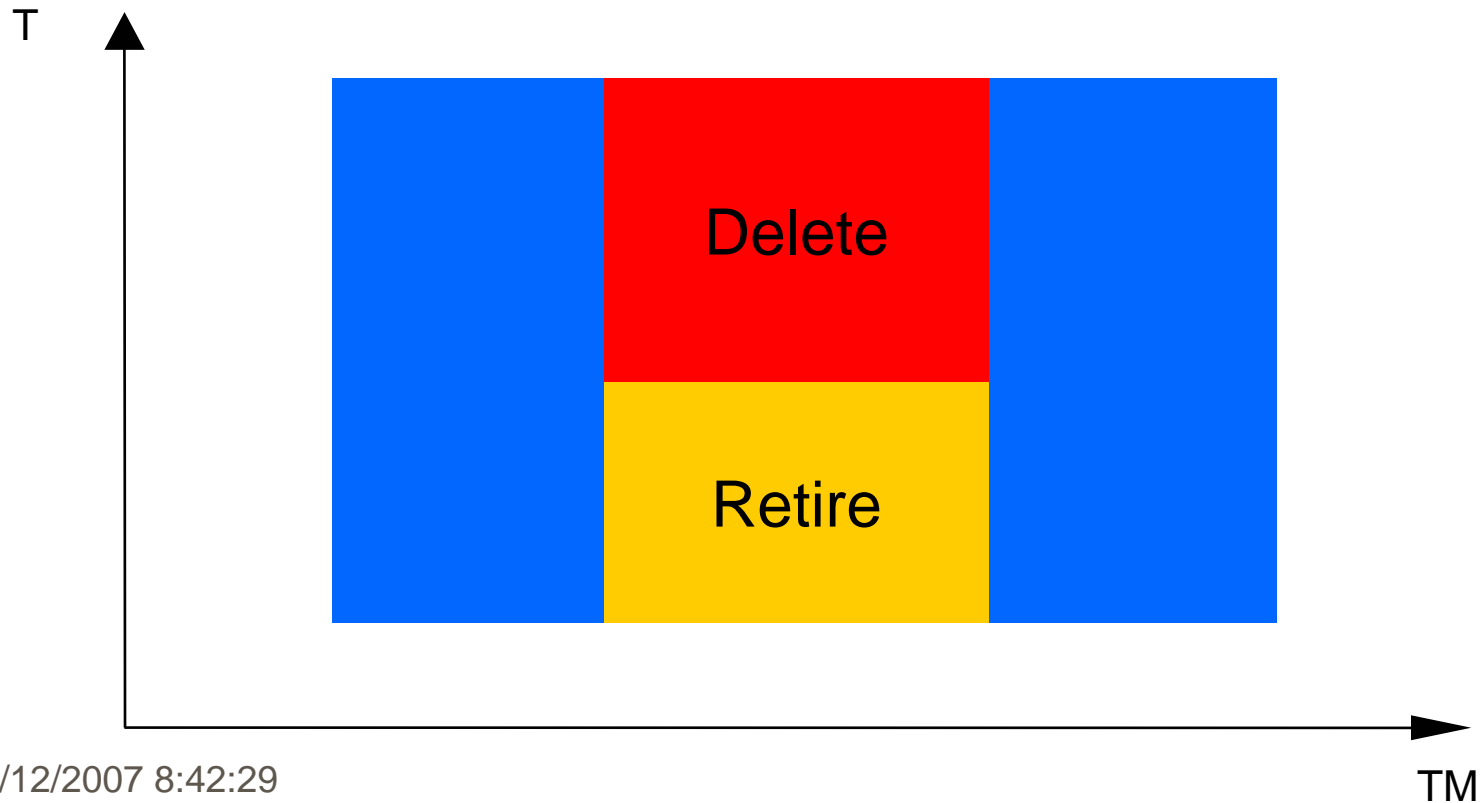


G: Collision occurred on Main St at 1.3 mi. on July 13th 1992.

1997 and 1992.

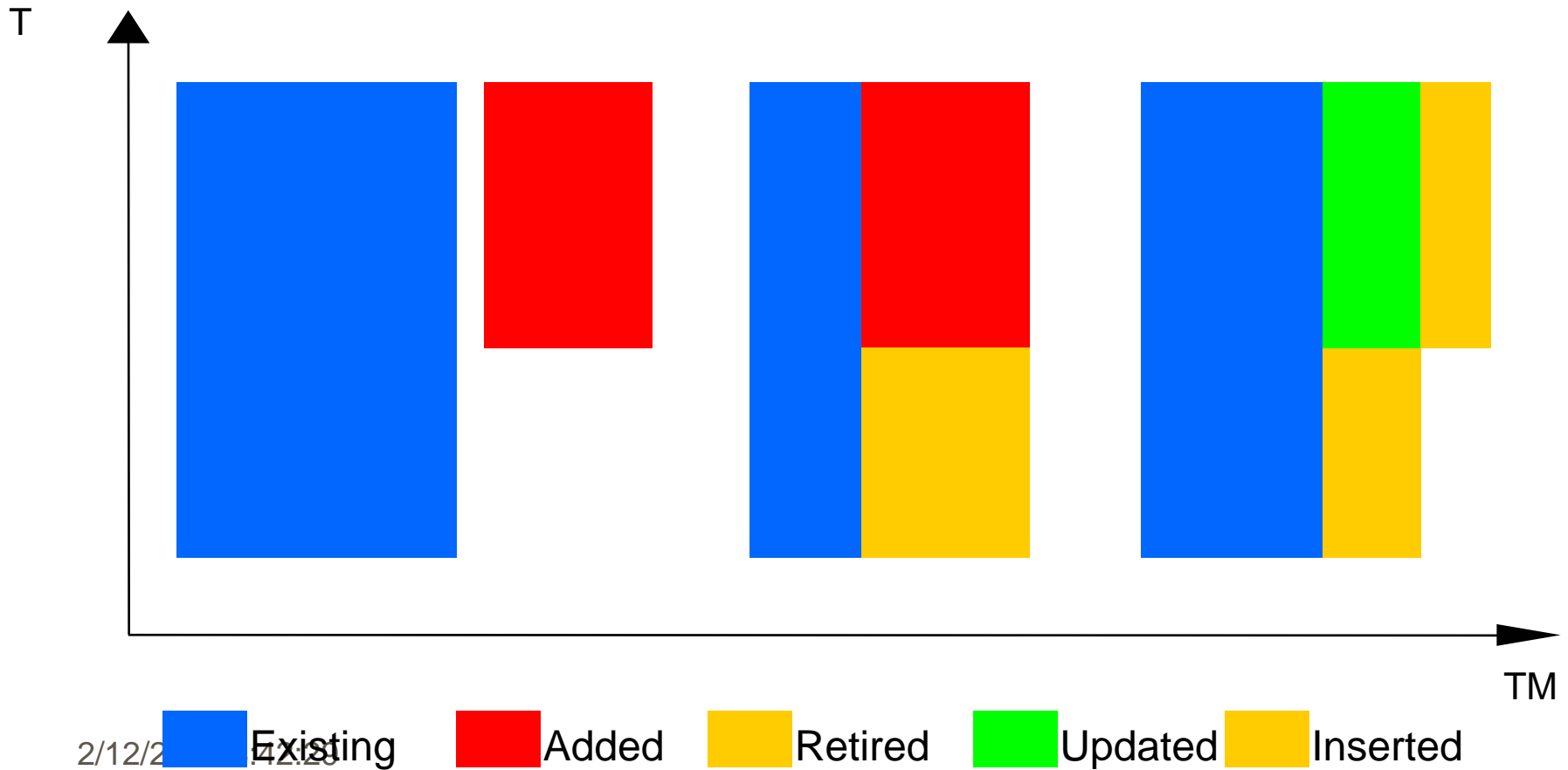
Function Illustration - Segment Maintenance (I)

Insert, Update, Delete



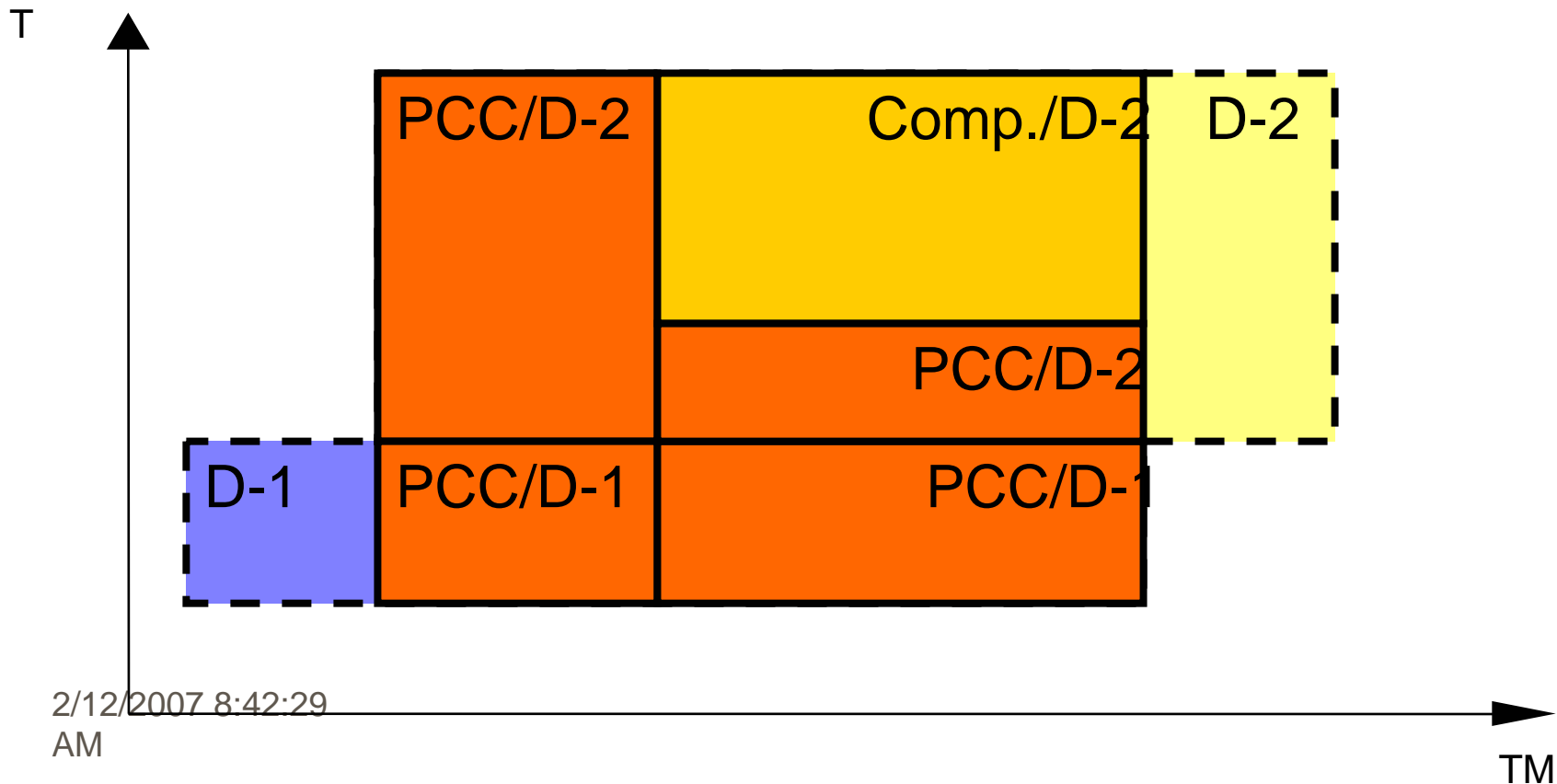
Function Illustration - Segment Maintenance (II)

Topology & Segment Maintenance Operations



Function Illustration - Segment Overlay

⌘ Pavement Type overlays on Maintenance District



MCDOT RoadRunner (I) - Attribute Interface

Operation Roadrunner - [Attribute View]

File Edit View Window Help

Route Attribute Time

County Routes All Routes

Route: 96

Route-based Attribute-based

Reset Reset All Apply

Routes		
route_desc	Community	begin_date
96th Ave		1/1/1901
96th Dr		1/1/1901
96th PI	Mesa	1/1/1901
96th St	Mesa	1/1/1901

Cross References on 96th PI		
Cross Reference	Measure	Address
Flossmoor Ave	0	1199
Frito Ave	547	0
96th PI (Cul-De-Sac)	974	0
Sunland Ave	1217	999
Edgewood Ave	1817	901
Pueblo Ave	2468	799
Coralbell Ave	3786	599
Broadway Rd	5109	401

BASE			
base_type_desc	base_depth_measure	route_desc	from_referer
Aggregate Base Course	6	96th Ave	
Aggregate Base Course	6	96th Ave	
Aggregate Base Course	6	96th Dr	
Aggregate Base Course	6	96th Dr	
Aggregate Base Course	6	96th PI	
Aggregate Base Course	4	96th PI	
Aggregate Base Course	6	96th PI	
Aggregate Base Course	6	96th PI	
Aggregate Base Course	6	96th PI	
Aggregate Base Course	7	96th PI	
Aggregate Base Course	6	96th PI	

Map View Port

Draw a rectangle as the desired area to zoom in

MCDOT RoadRunner (II) - Overlay Reporting

The screenshot displays the 'Operation Roadrunner - [Attribute View]' application window. The interface is divided into several sections:

- Left Panel:** Contains navigation and filter options. The 'Route' tab is active, showing 'County Routes' selected. The 'Route' field contains 'meeker'. Below are 'From Ref' and 'To Ref' dropdown menus. At the bottom, 'Route-based' is selected, with 'Reset', 'Reset All', and 'Apply' buttons.
- Top Center Table (Routes):**

route_desc	Co
Meeker Blvd	
Meeker Blvd (Right Frontage Road)	
- Top Right Table (Cross References on Meeker Blvd):**

Cross Reference	Measure	Address
R H Johnson Blvd	5263	0
Pyracantha Dr	7048	0
Echo Mesa Dr	7496	13729
Medallion Ct	7692	13703
Creekwood Ct	7990	13677
Wintergreen Dr	8286	13651
Autumn Ct	8596	13625
Spring Meadow Dr	8911	13599
135th Ave (Left	9270	0
135th Ave	9287	13365
134th Wy	9633	13363
134th Dr	10472	0
- Bottom Left Table (BASE SURFACE on Meeker Blvd):**

base_depth_measure	base_type_desc	surface_depth
12	Aggregate Base Course	2
9	Aggregate Base Course	2
6	Aggregate Base Course	2
8	Aggregate Base Course	2
- Bottom Right (Map View Port):** A map window showing a street network with a blue line indicating the selected route. It includes navigation icons and a text prompt: 'Draw a rectangle as the desired area to zoom in'.

MCDOT RoadRunner (III) - Where was the collision? - 1/2

The screenshot displays the 'Operation Roadrunner - [Attribute View]' application window. The interface is divided into several panes:

- Left Pane:** Contains navigation and filter options. The 'Route' tab is active. It includes checkboxes for 'Current Only' (checked) and 'Observe Date' (unchecked). Below these are radio buttons for 'Route-based' (selected) and 'Attribute-based'. At the bottom of this pane is an 'ACCIDENT' icon.
- Top Middle Pane (Routes):** A table listing routes for Maricopa St.

route_desc	Community	begin_date	end_date
Maricopa St	Gila Bend	1/2/80	
Maricopa St		1/1/1901	
- Top Right Pane (Cross References on Maricopa St):** A table listing cross-referenced streets and their measures.

Cross Reference	Measure
Martin Ave	405
Capitol Ave	615
Cleveland Ave	970
St Louis Ave	1382
Barnes Ave	1572
- Bottom Middle Pane (ACCIDENT on Maricopa St):** A table listing accident records.

accident_number	accident_severity_desc	on_date	collision_object
9405570	Property Damage	5/15/95 2:28:00 PM	Vehicle
9213471	Property Damage	5/15/81 2:28:00 PM	Vehicle
9401953	Injury	5/15/80 2:28:00 PM	Parked Car
9407884	Property Damage	5/15/82 2:28:00 PM	Vehicle
9213807	Property Damage	5/15/96 2:28:00 PM	Other
- Bottom Right Pane (Map View Port):** A map showing a street grid. 'Martin Ave' is highlighted in yellow. A black dot is visible on the map, likely representing the location of the collision.

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MCDOT RoadRunner (IV) - Where was the collision? - 2/2

The screenshot displays the 'Operation Roadrunner - [Attribute View]' application window. The interface is divided into several sections:

- Top Panel:** Includes a menu bar (File, Edit, View, Window, Help) and a toolbar with various icons.
- Left Panel:** Contains filter options for 'Route', 'Attribute', and 'Time'. It includes checkboxes for 'Current Only' and 'Observe Date' (set to 01/01/1979). Below these are radio buttons for 'Route-based' (selected) and 'Attribute-based', along with 'Reset', 'Reset All', and 'Apply' buttons.
- Routes Table:** A table with columns 'route_desc', 'Community', and 'b'. The selected row is 'Maricopa St' in the 'Gila Bend' community.
- Cross References on Maricopa St Table:** A table with columns 'Cross Reference', 'Measure', and 'Address'. The selected row is 'Cleveland Ave' at measure 646.
- ACCIDENT on Maricopa St Table:** A table with columns 'accident_number', 'accident_severity_desc', 'vehicle_action_desc', and 'collision_object'. The selected row is accident number 9111572, categorized as 'Injury' with a 'Misc' vehicle action and 'Pedestrian' collision object.
- Map View Port:** A small map window showing a street grid with 'Maricopa St' highlighted in yellow. It includes navigation controls and a 'Base Type' dropdown set to 'Aggregate Base Course'.

MCDOT RoadRunner (V) - Segment Maintenance

Operation Roadrunner - [Attribute View]

File Edit View Window Help

Route Attribute Time

Item: surface_type_cd
Operator: =
Value:
 Valid Only
 Route-based Attribute-based
Reset Reset All Apply

Routes			Cross Reference	
route_desc	Community	b	Cross Refer	
98th Ave		1	Royal O.	
98th Dr		1	Cedar D	
98th Pl	Mesa	1	Forreste	
98th St	Mesa	1	Emberw	
98th Wy	Mesa	1	Branding	
			Hawthor	
			Redwoo	
			Teakwo	

Map View Port

Draw a rectangle as th

SURFACE: 98th Ave							
surface_type_desc	end_da	from_reference_desc	from_offset_me	to_reference_desc	to_offset_measu	from_offset_n	
Asphaltic Concrete		Beginning Of Pavement	0	Pebble Beach Dr	0		
Asphaltic Concrete		Santa Fe Dr	0	Royal Oak Rd	100		
Asphaltic Concrete		Santa Fe Dr	0	Thunderbird Blvd	0		
Asphaltic Rubber		Royal Oak Rd	100	Redwood Dr	100	N	
Asphaltic Concrete	4/15/01	Royal Oak Rd	100	Redwood Dr	100	N	
Asphaltic Concrete		Redwood Dr	100	Thunderbird Blvd	0	S	
Asphaltic Concrete		Beginning Of Pavement	0	Bolivar Dr	0		
Asphaltic Concrete		Pleasant Valley Rd	0	End Of Pavement	0		
Asphaltic Concrete		Amber Tr	0	Palmeras Dr	0		
Asphaltic Concrete		Spanish Moss Ln	0	End Of Pavement	0		

Archive Control Inventory SHOULDER STRUCTURE SURFACE Right of Way Traffic

2/12/2007 8:12 AM

2/12/2007 8
AM