



# Charlotte Signal System Operations -Present and Future-

What does it mean for you?

December 13, 2006



# *Believe It or Not!*

- Whether you Plan, Design or Operate facilities for Cars, Pedestrians or Transit vehicles...
  - » You can benefit from a basic knowledge of signal systems.
- You can help us...
  - » Troubleshoot
  - » Public Education



# Outline

- Charlotte Signal Operations
- Five things you should know about signal system operations – the “real world”
- Retiming Program
- South Corridor LRT
- A look into the future...



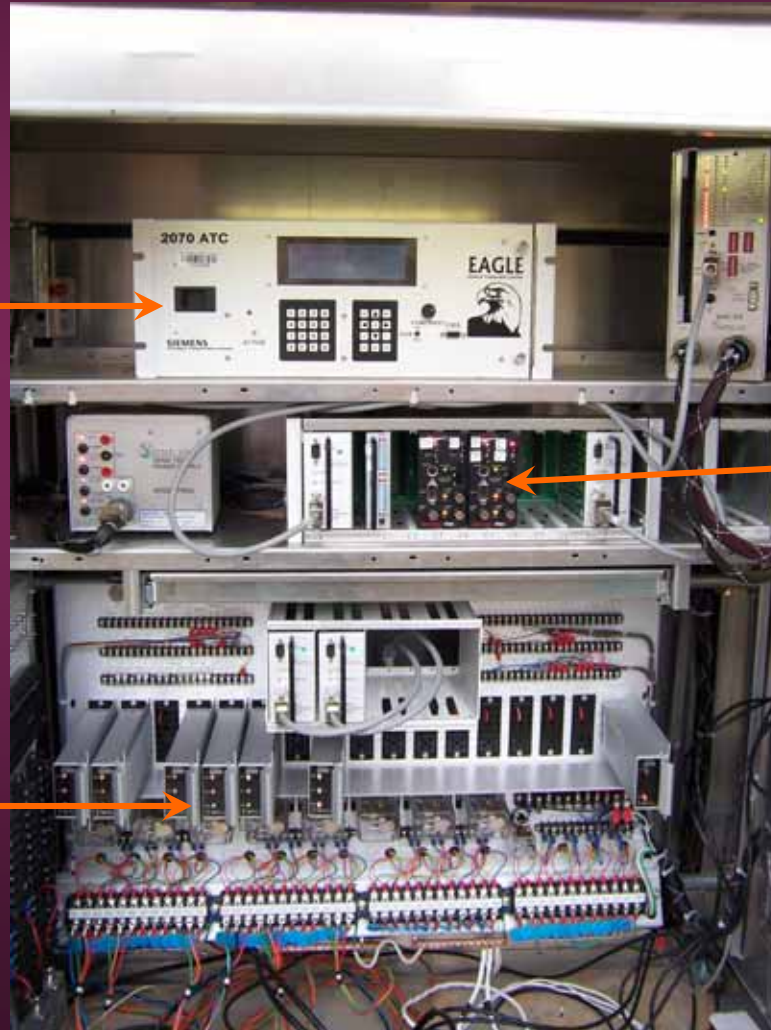
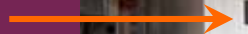
# Signal Controllers

- Modern signal controllers are basically a computer with traffic signal control software
- Input
  - » Traffic Data
  - » Timing Data
- Output
  - » When to display Red/Yellow/Green



# Controller Cabinet

**Controller**



**Detectors  
(input)**

**Load Switches  
(output)**





# Signal System

- A system of traffic signals controlled or managed from a central location
- Requires:
  - » “System” computer/software
  - » Ability to communicate with signals
- Common use is managing the synchronized operation of groups of signals
- Communication and monitoring improves troubleshooting and productivity

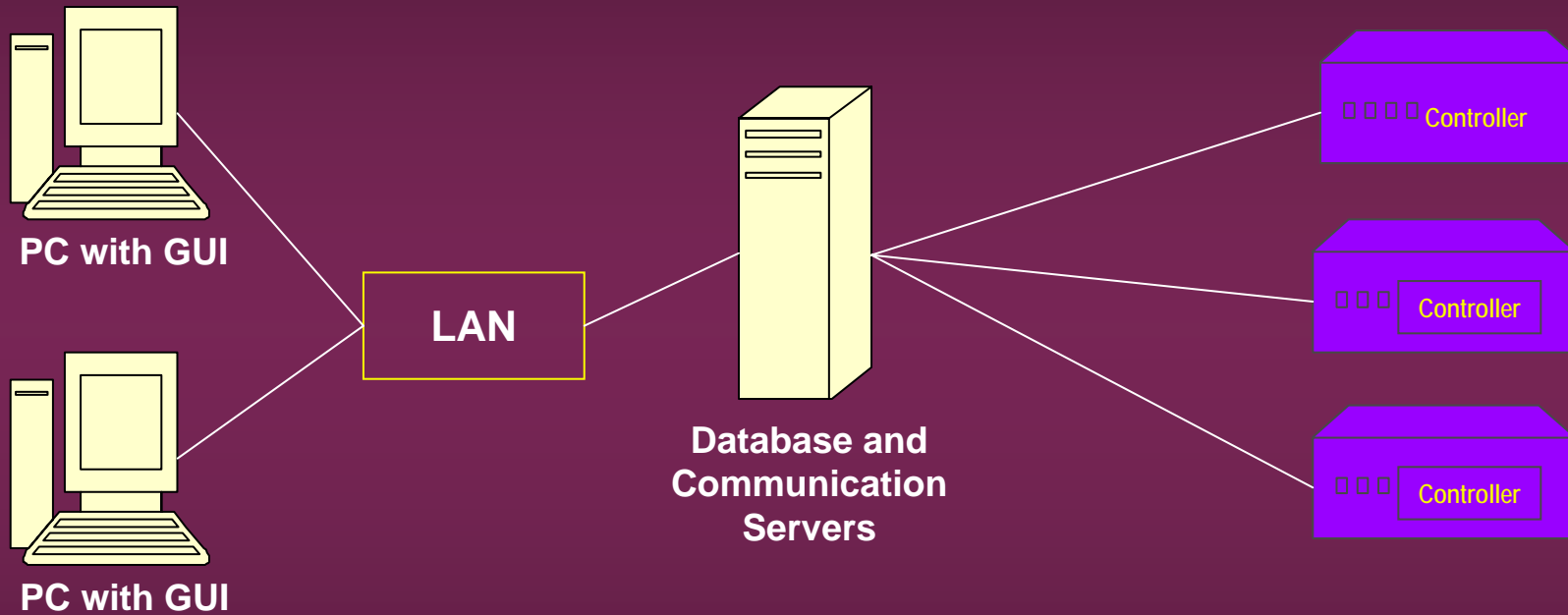


# By the Numbers

- CDOT operates and maintains almost 700 traffic signals
- 140 in CBD system
- 430 more in coordinated systems
  - » “hard-wired” and “time-based”
- Remote communication with 500



# Charlotte's "i 2" System



Scheduled Pattern Change Command  
Active TOD Schedule  
Controller Clock Synchronizing  
Stored Timing Parameters/Plans  
Communications Server

Active Timing Parameters/Plans  
TOD Schedule (backup)

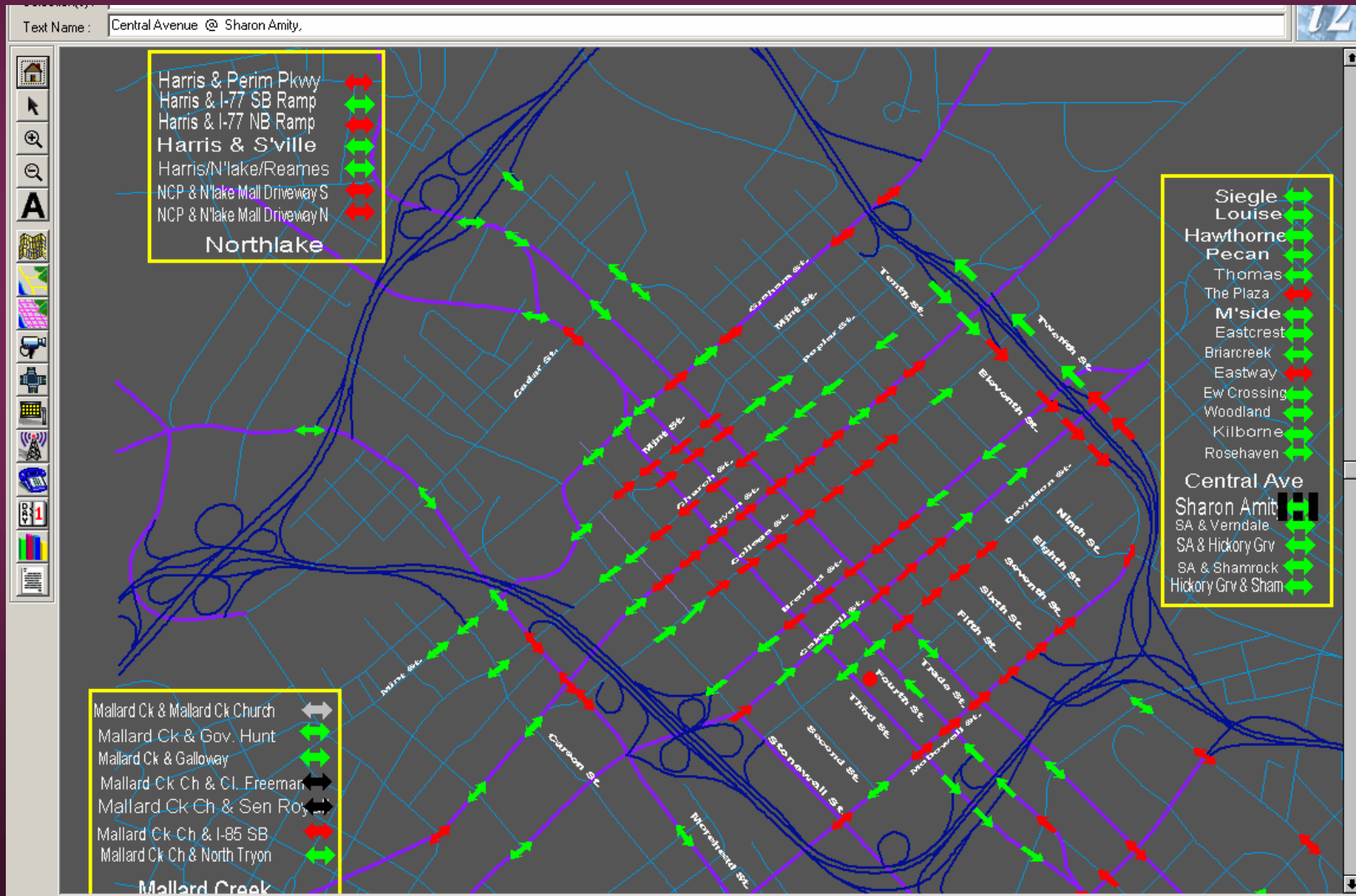


## *i* 2 Features

- “Umbrella” GUI design with support for multiple controller types
- Communications server
- Database server
- Distributed Intelligence



# i2 GUI






# i2 - Signal Monitoring

Signal 460: Central Avenue @ Sharon Amity

Options



Information | Timing | Alarms Detail | Peer

**Parent**  
SEC 202: ZON 2: SYS 1

**Controller Type**  
NextPhase 1.5

**Location**  
Central Avenue  
Sharon Amity

**IP Address**

**Agency**

Params Asset Info

	Phase							
	1	2	3	4	5	6	7	8
Actual	13G	42G	15G	14	13G	41G	26G	2
Programmed	23	50	23	54	19	54	34	43
ON	●	●	●	●	●	●	●	●
PED	●	●	●	●	●	●	●	●
CALL	●	●	●	●	●	●	●	●
PED CALL	●	●	●	●	●	●	●	●
NEXT	○	○	○	○	○	○	○	○

Overlap

Time	A	B	C	D
	8			

Special Functions

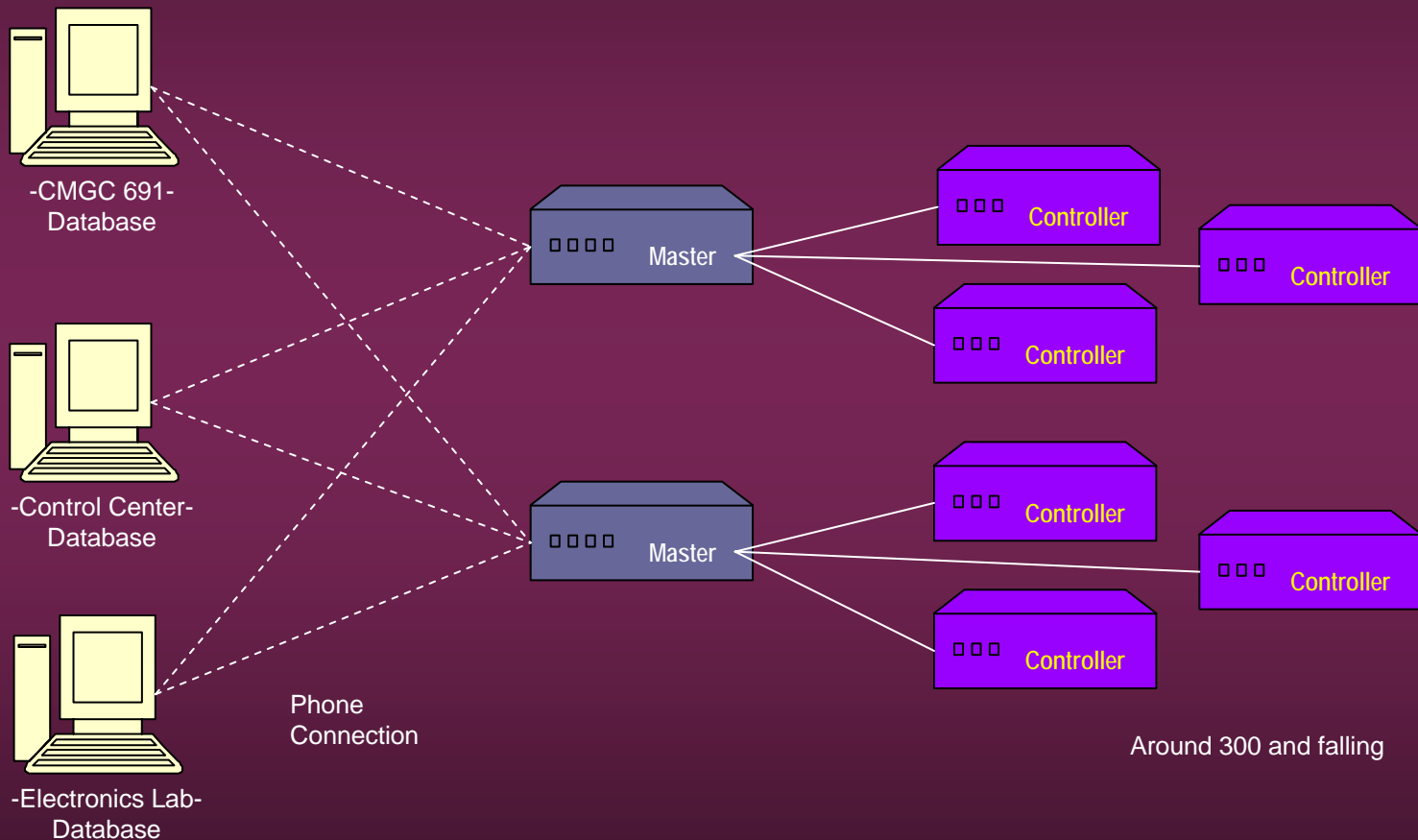
1 ●	5 ●
2 ●	6 ●
3 ●	7 ●
4 ●	8 ●

Preempt/Priority

1 Not Active	5 Not Active	9 Unknown
--------------	--------------	-----------



# Traconet



User Interface Application  
Stored Timing Parameters/Plans  
Independent Workstations/Databases

Scheduled Pattern Change Command  
Active TOD schedule  
Controller Clock Synchronizing  
Manual Pattern Assignment  
Communication Interface with Locals

Active Timing Parameters/Plans  
TOD Schedule (backup)



# Five “Real World” Things

- Actuated operation and detection
- Synchronization – Fact vs. Fiction
- Capacity – Theory vs. Reality
- Impacts of 24/7/365
- Electromechanical Devices – They Fail

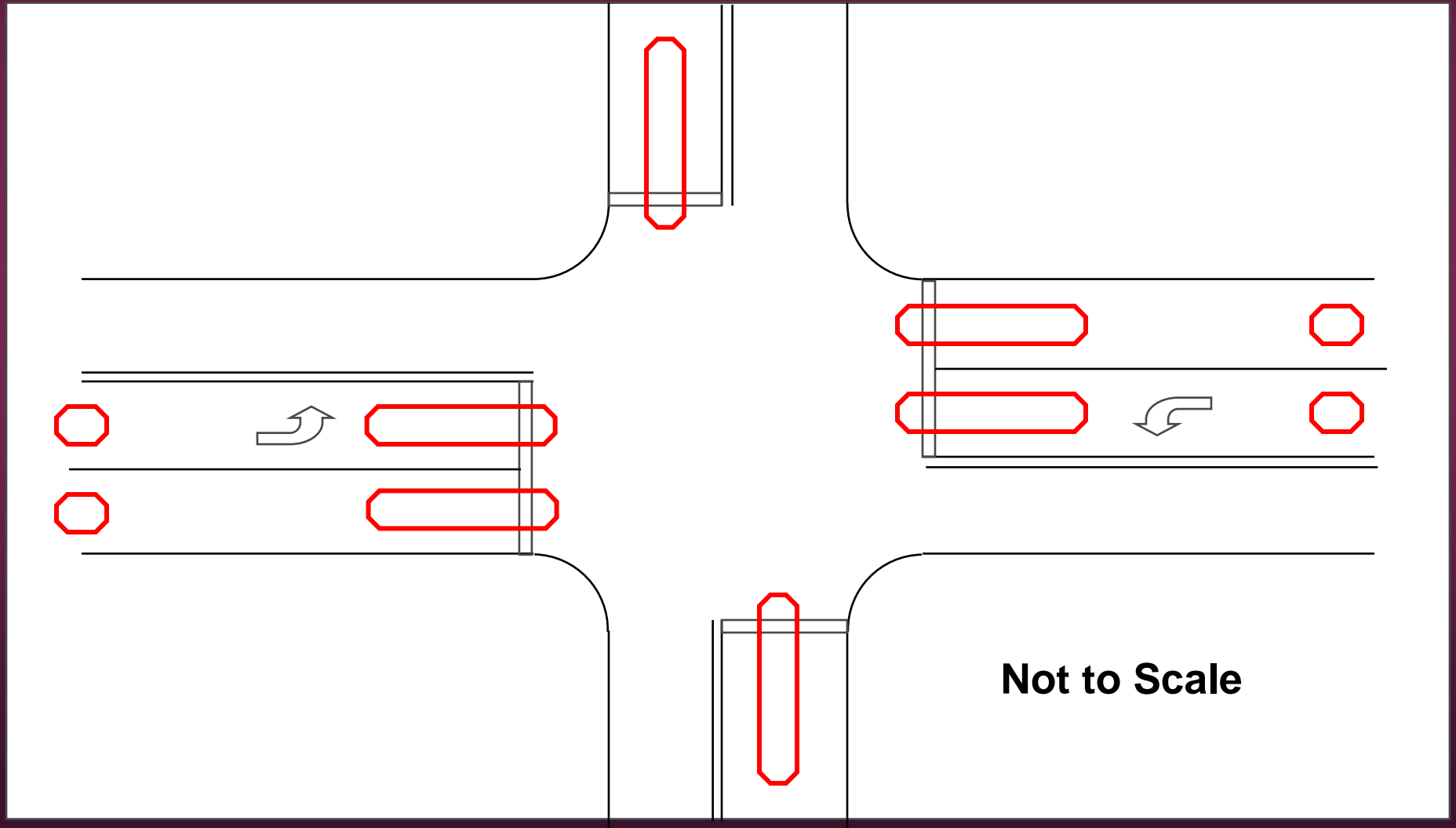


# Detection - Loops

- A loop of wire installed in the pavement, connected to a detection device in the controller cabinet. The detection device senses changes in the inductance of the wire loop caused by large metal object.



# Traffic Signal Loops



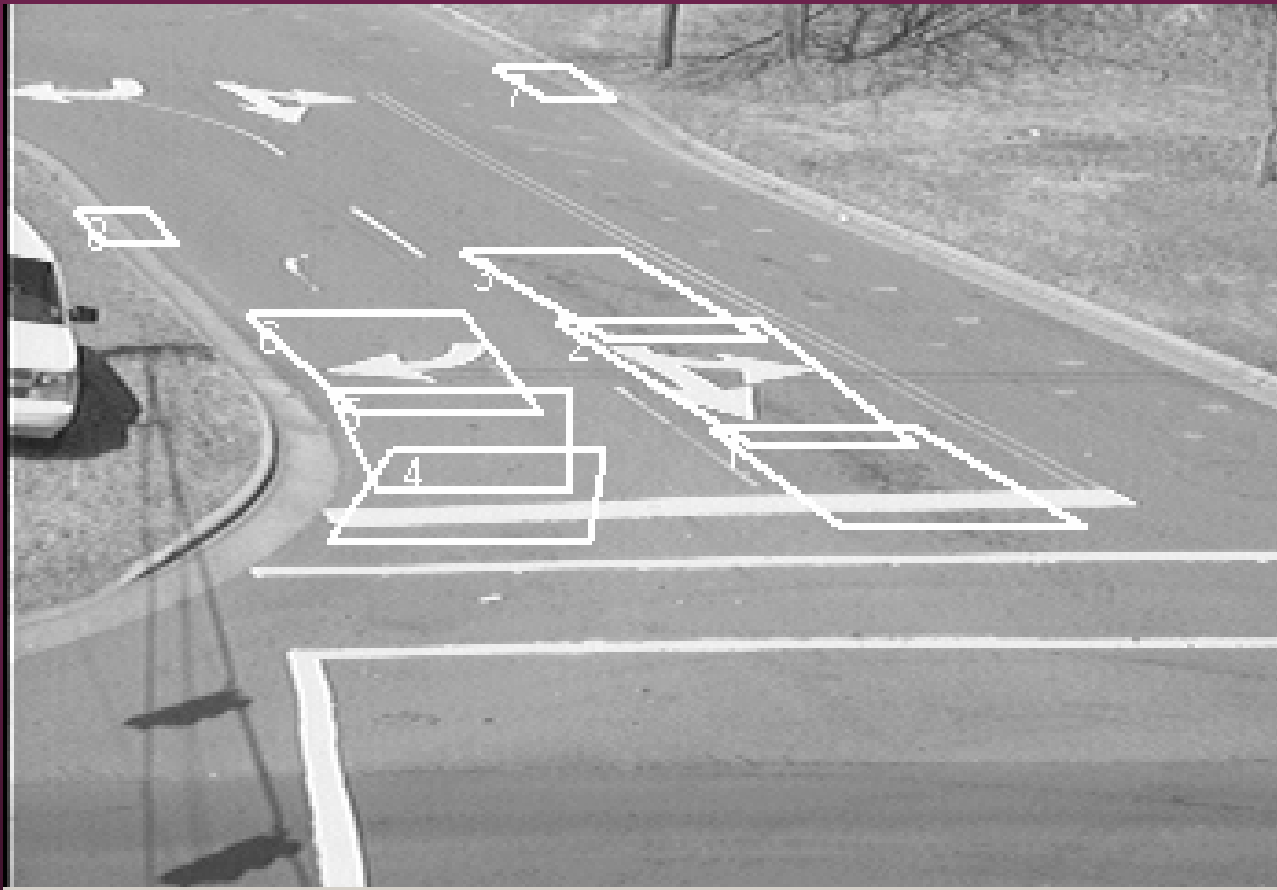


# Video Detection





# Virtual Loops





# Signals – Video Detection

- Advantages

- » Eliminate sawcuts, lane closures
- » Less intrusive, no easements required
- » No long “lead ins”
- » Use with any pavement

- Disadvantages

- » Weather sensitivity
- » Sun impacts
- » Darkness impacts



# Actuated Operation

- No fixed green time – rather, a range or window
- Minimum green, then additional green based on vehicle presence (put another way, termination when vehicles served)
- Setting extension timer – probability of early termination weighed against needs of other phases
- “Free” operation – no wasted green time, lowest cycle length for conditions, almost every vehicle stops



# Synchronization

- “The property of a signal system that allows all lights along my route to be green all of the time.”  
- Joe Citizen



## Synchronization (Take 2)

- Creating consistent and cyclical timing relationships between signals, to create consistent flow patterns and operations that are beneficial to the users.
- By lay-person, usually associated with “green bands” or “progression” along arterials.
- Other operational goals often more critical, influencing capacity, safety.



# Progression

- The concept of getting through many consecutive signals without stopping, in rush hours, is mostly fantasy.
  - » Two-way demands
  - » Platoon dispersion
- “Progression Opportunity” – after getting through signal green, arrive at next signal on green (better yet, don’t stop)



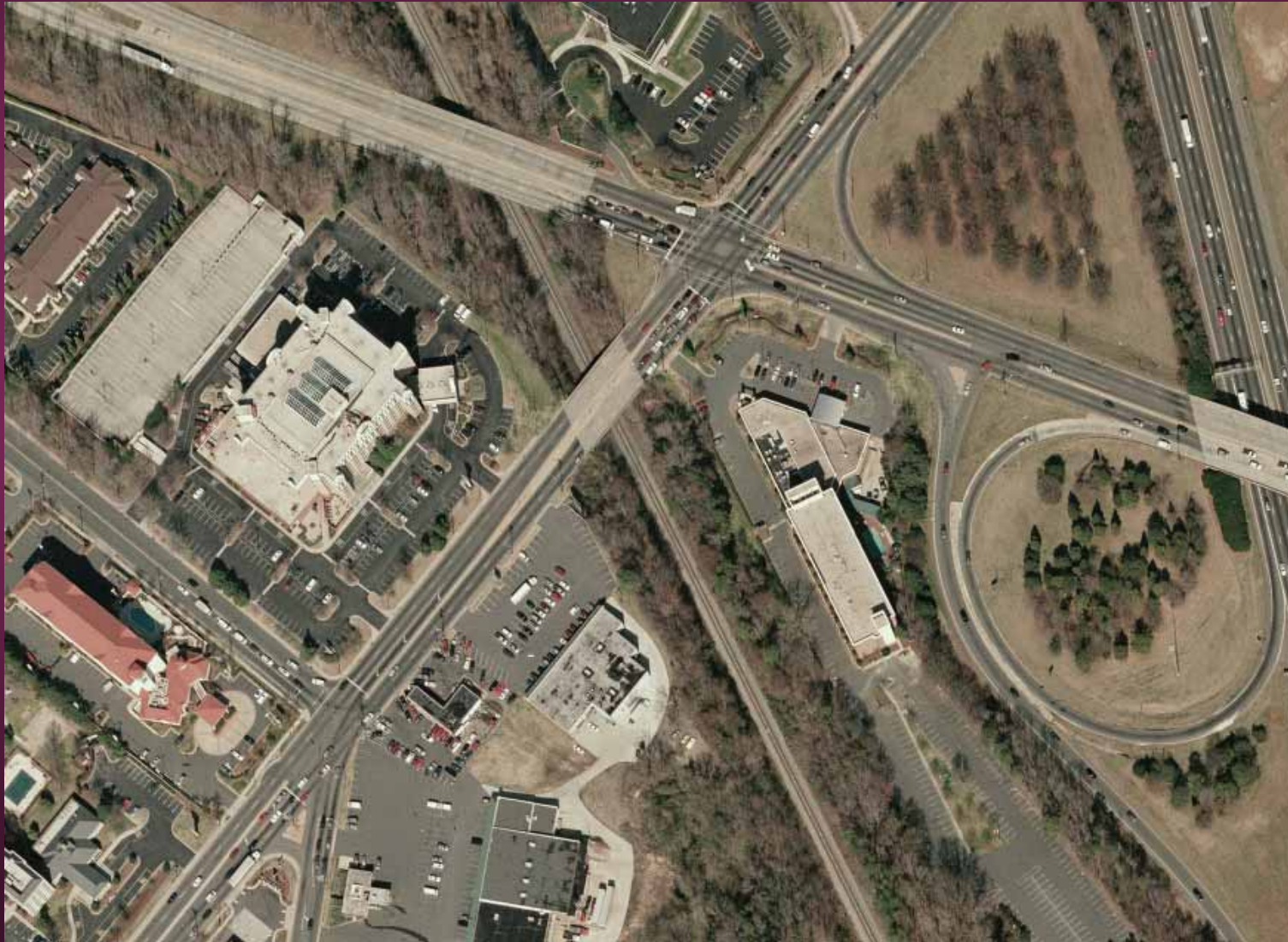
# Progression “Philosophy”

- Where coordination is established, provide Progression Opportunities in a manner that will, on average, reduce trip times, fuel consumption and emissions
  - » weighted toward higher volumes and flow patterns that take advantage
- Avoid “bad progression”



# Space Management

- Got a green light, but no place to go?
- Unsignalized movements hampered by queues?
- S. Tryon at Woodlawn/BGP and Yorkmont/Nations Ford
- 4<sup>th</sup> St. at I-277 SB off-ramp/3<sup>rd</sup> St. Connector/Courthouse Deck





# Capacity Protection

- Traffic signals that are in close proximity to each other can impact the arrival or departure of traffic in such a way that potential capacity is “lost”.
- Quality of flow through a green signal can result in “lost” capacity



# Capacity Reducers

- Green blockage
- Green starvation

Coordination Related

- Sluggish flow
- Platoon “gaps”
- Lane blockages

Other Factors



## Side Note: Impact of Cycle Length

- Longer cycle lengths may not provide additional capacity as a result of these “capacity reducers”
- Shorter cycle lengths result in shorter queues, which may help with “space management”



# 24/7/365 Operations

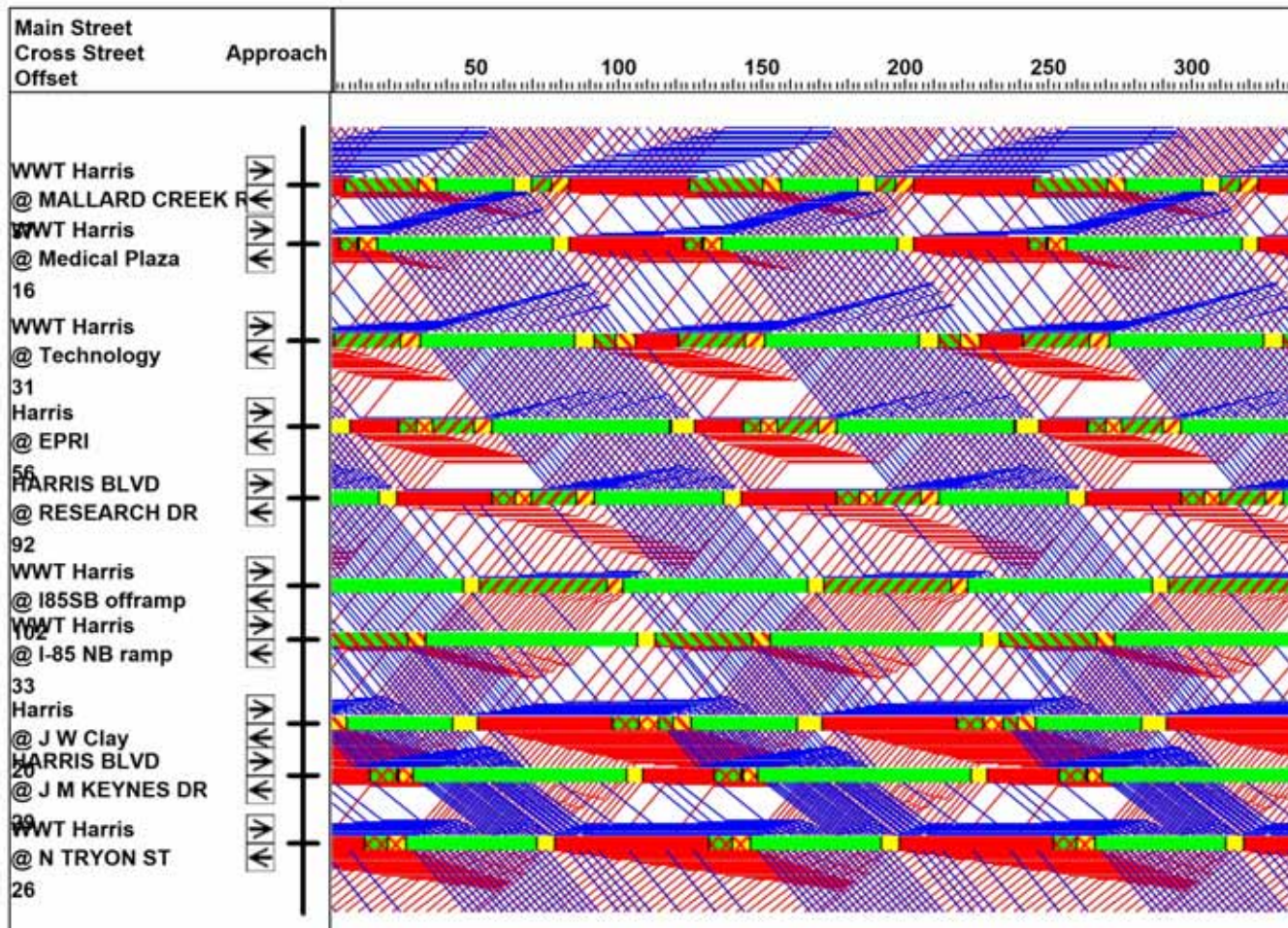
- 24

- » Time-space relationships “float” in coordinated/actuated operation
- » Pattern transitions
- » Volume fluctuations
- » Pedestrian actuations
- » To be free, or not to be free
- » Schools
- » Train, transit preemption



# Time-Space Diagram

Harris/Clay/Tryon System #32





# 24/7/365 Operations

- 24

- » Time-space relationships “float” in coordinated/actuated operation
- » Pattern transitions
- » Volume fluctuations
- » Pedestrian actuations
- » To be free, or not to be free
- » Schools
- » Train, transit preemption



# 24/7/365 Operations

- 7

- » Weekends
- » Volume fluctuations

- 365

- » Volume fluctuations
- » Holidays
- » Special Events
- » Incidents
- » Emergency Preemption



# Equipment Failures

- Detection
  - » Performance degradation
  - » Temporary adjustments
- Communications
  - » Possible performance impacts
  - » Troubleshooting
- Need to consider fault tolerance in timing design



# Signal Retiming Program

- Incorporate USDG Goals
- Evaluate and re-time all signals every two years
- New signals
  - » Larger “scope of work” when in systems
- Intersection Deficiency Identification (Vehicular Traffic)

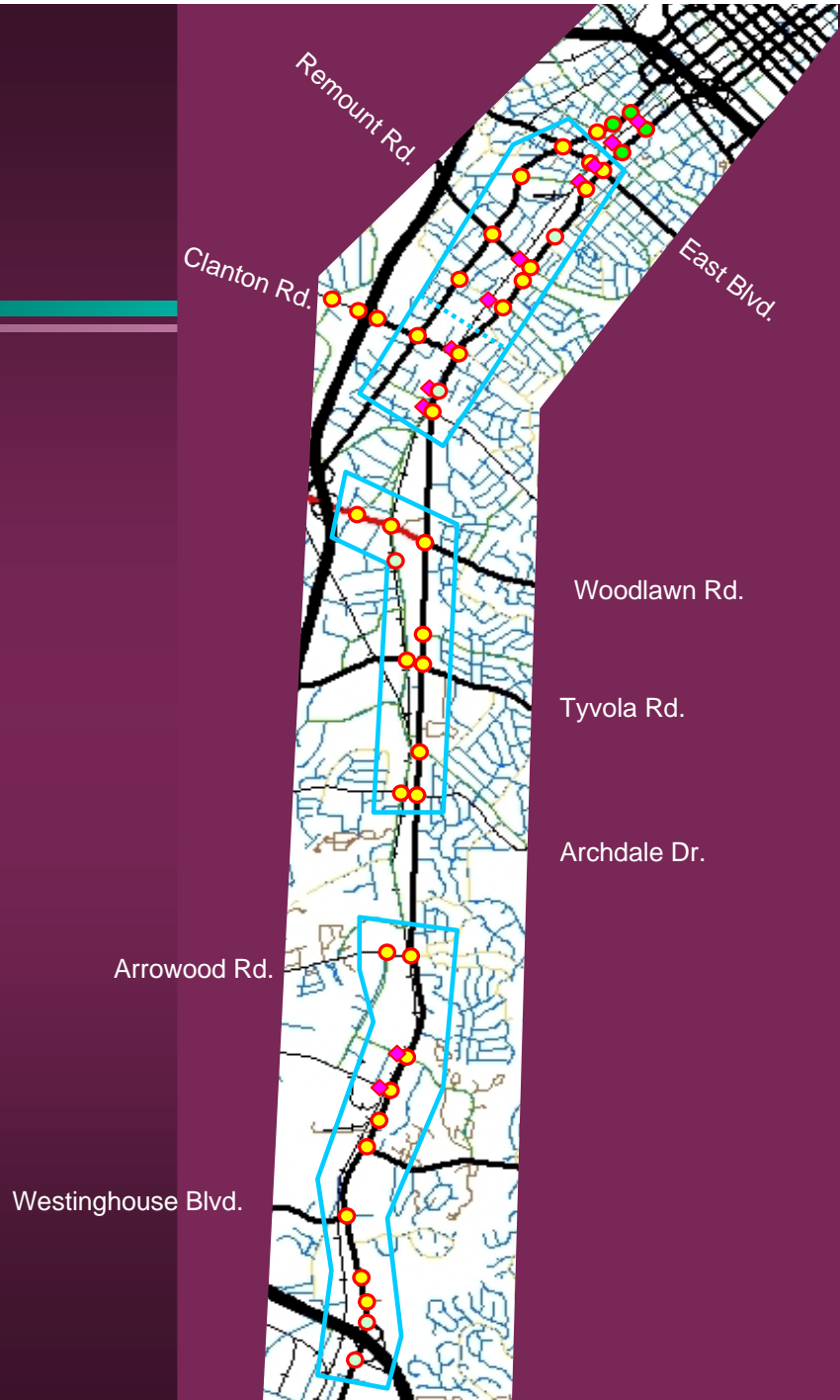


# CDOT Signal Systems Staff

- Art Stegall – ITS Coordinator
- Cecilia Doman
- Martin Kinnamon
- Tammy Drozd
- Beth Boswell
- Joe Rayano
- Signal Timing and Intersection Deficiency Identification
- Evaluate new signal/phase requests
- Troubleshoot and address equipment failures
- System software support
- Operate CTMC



# South Corridor Traffic Signals

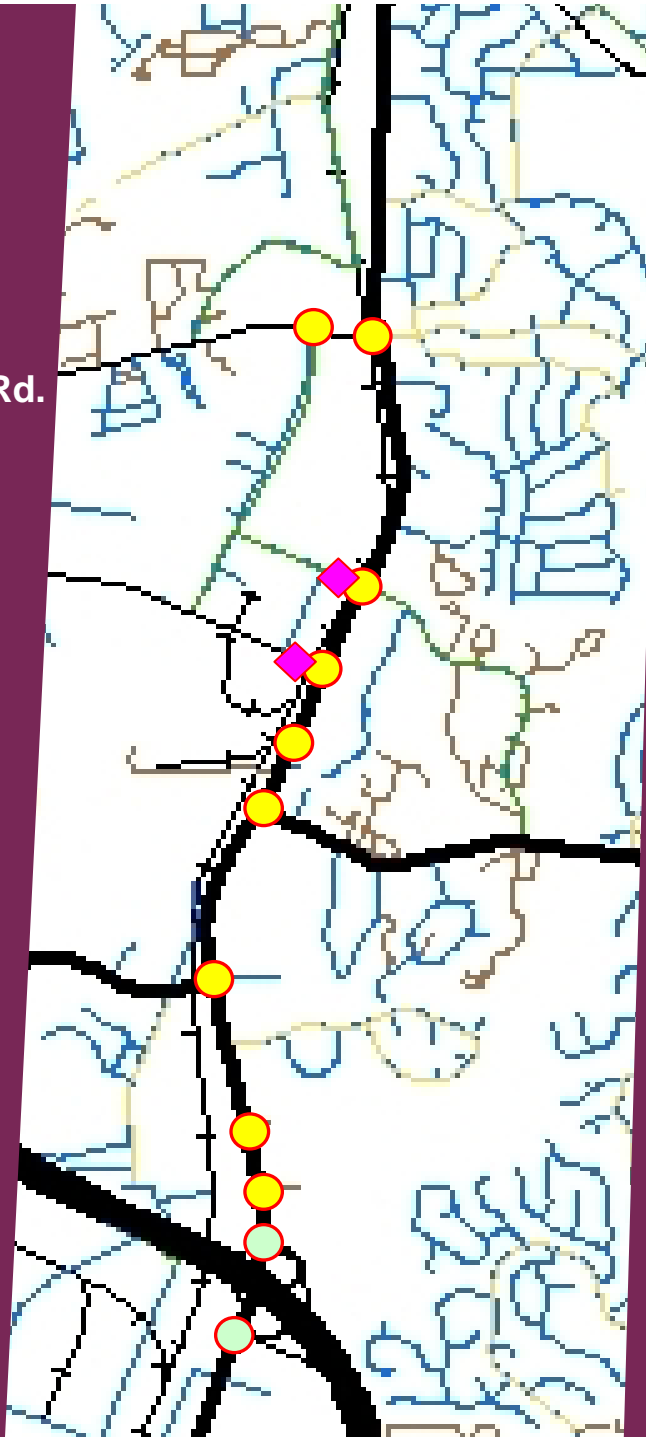


- ◆ LRT Grade Crossing
- Existing South Corridor Signal
- New Signal
- Existing CBD System Signal
- Potential Timing Section



Arrowood Rd.

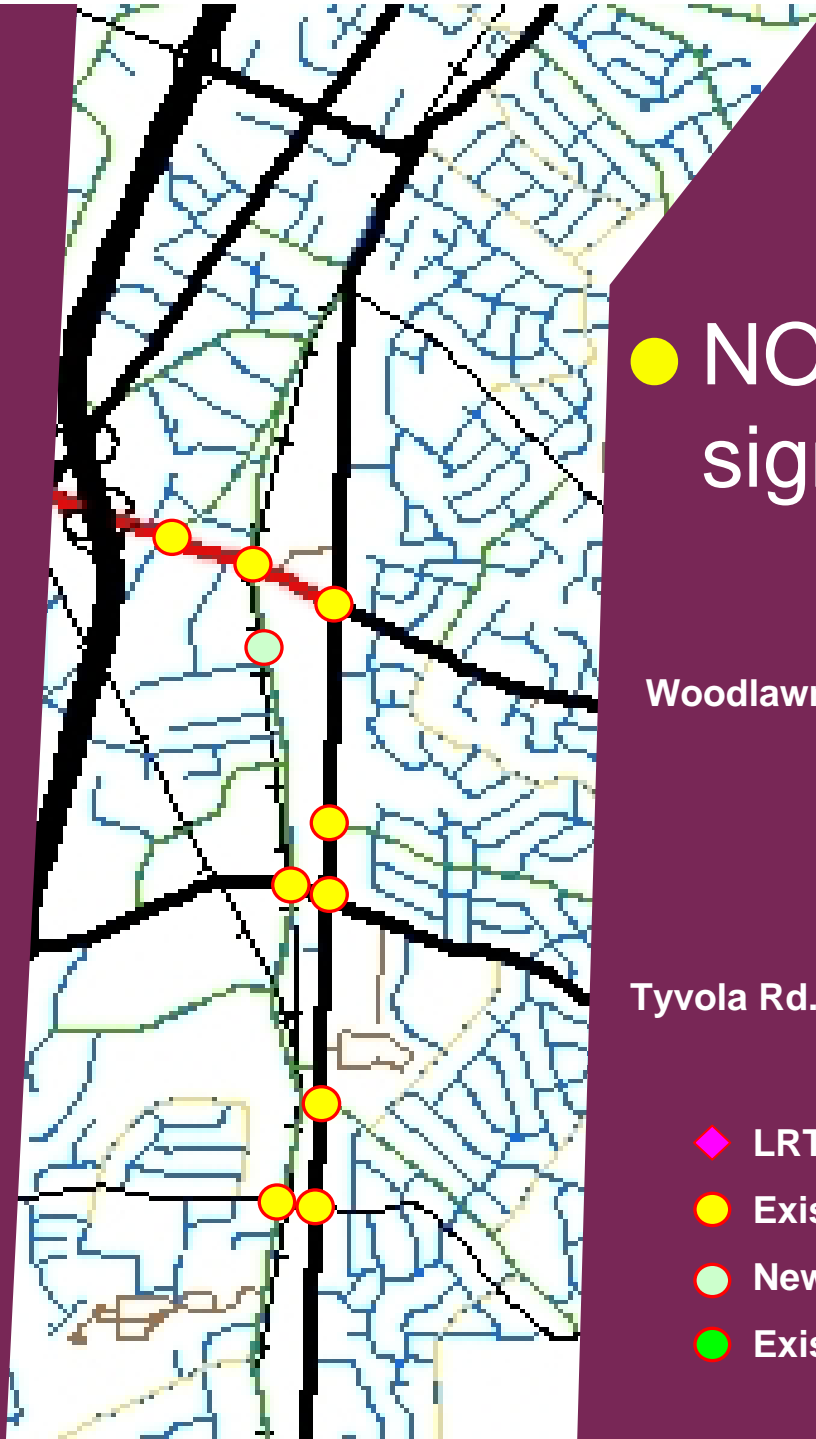
Westinghouse Blvd.



Sharon Road West

● 2 at-grade/signal crossings

- ◆ LRT Grade Crossing
- Existing South Corridor Signal
- New Signal
- Existing CBD System Signal



Archdale Dr.

● NO at-grade /  
signal crossings

Woodlawn Rd.

Tyvola Rd.

- ◆ LRT Grade Crossing
- Existing South Corridor Signal
- New Signal
- Existing CBD System Signal



- 9 at-grade/signal crossings

Clanton Rd.

Remount Rd.

East Blvd.

- ◆ LRT Grade Crossing
- Existing South Corridor Signal
- New Signal
- Existing CBD System Signal





# Clanton/South





# Where are we headed?

- Maximize Use of Roadway System
  - » Fiber Communication
  - » New Traffic Signal Controllers
  - » Traffic Surveillance Cameras
  - » Traveler Information



# Video Traffic Surveillance

- Closed-Circuit TV

**Spectra IV. Get More With Four.**

- Industry-Leading 35X Optical Zoom Lens
- 540 TV Lines of Resolution
- .00018 Lux Sensitivity
- 128X Wide Dynamic Range
- Electronic Image Stabilization
- Integrated Event Scheduler



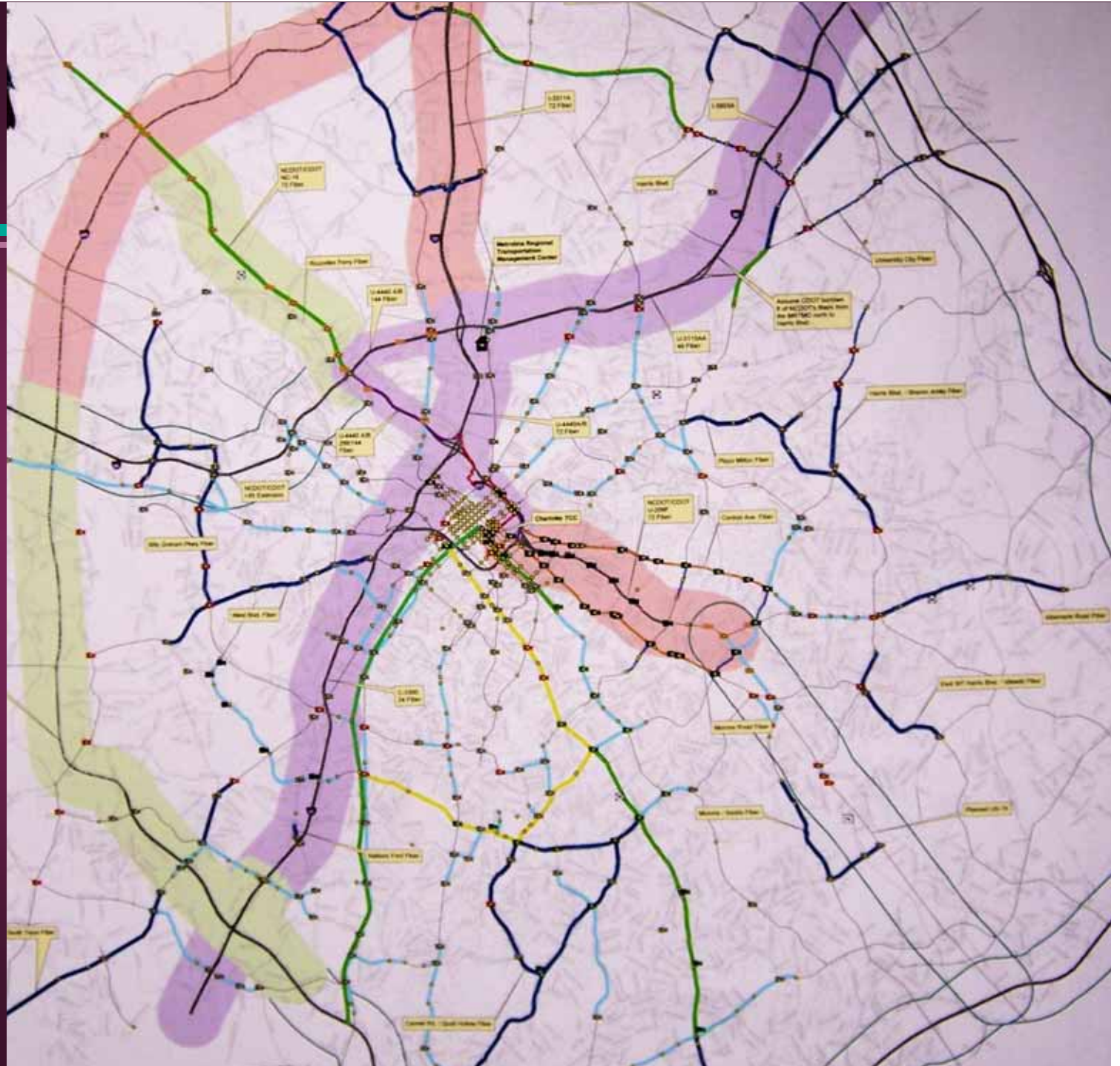


# CTMC





# Plan for Fiber & Cameras





# Thank You!

- Let us know if we can help!
- Let us know if you think you've seen something not working properly.



**Swamp Kings**  
Florida Dominates UCLA;  
Wins First National Title





Eat 'em up Gators, eat 'em up!

