City of Jonesboro ARKANSAS

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Traffic Signal Coordination Plan

2/4/2013

Engineering Department

Table of Contents

1. Introduction

The City of Jonesboro currently has more than 80 signalized intersections with more being added each year. Most of these intersections are along major corridors, and the traffic signals have little or no coordination among them. Coordination is a strategic approach to synchronize signals so that vehicles move through a corridor more efficiently with reductions in travel time, delay, number of stops, and emissions.

The purpose of this plan is to establish a process by which each major signalized corridor within the city can be evaluated, and effective traffic signal timing and coordination plans can be implemented along these routes.

The process outlined in this plan will be applied to each major corridor with order of priority based on corridors with the largest Average Daily Traffic (ADT) values. Software programs such as Passer 5, Synchro and Tru-Traffic will be utilized to analyze traffic conditions, select the most efficient signal settings, and evaluate possible intersection modifications. A report will be generated for each corridor studied noting the overall reductions in travel time, delay, number of stops, and emissions. This report will also include, if applicable, a list of suggested improvements for each corridor that, if completed, will increase the efficiency of the corridor.

2. Traffic Signal Timing and Coordination Plan

2.1 Initial Work

2.1.1 Traffic Signal Communications

In order to effectively coordinate the city's traffic signals, the city has purchased and installed a central server with TACTICS Central Software. Communications from the TACTICS Central Server to each intersection have been established, except for 8 remaining locations. Communications are in the form of wireless remote and master radios. Communications to each intersection from the TACTICS Central Server provide for all the intersections to be referenced to one central clock, receive commands from the TACTICS Central Software, and allow for remote monitoring and uploading and downloading data.

The 8 intersections that do not have communications established at this time have limited line of sight with the existing master radio locations. Obstructions such as terrain, buildings, and trees are a factor and have to be taken into consideration. A communications study consisting of a path profile analysis and site visits will be required for each location. New master locations will be identified based on access to the city network and geographical location. An example of a path profile chart is depicted in Figure 1.

The below path profile is of the terrain between Highland Dr. at Harrisburg Rd. and a proposed master site located at Fire Station #4. This analysis is critical in determining the most efficient and effective means of communications.

Figure 1.

The current communications system consists of 900 MHz serial radios at each signal communicating with one of three master radio locations. The current master locations are located at:

- Greensboro Road Water Tower
- Craighead County 911 Center (410 W. Washington St.) – 1200 Baud Rate
- Craighead County 911 Center (410 W. Washington St.) – 1900 Baud Rate

Plans are underway to add a fourth master radio location at Fire Station #4 on Harrisburg Road. This location will have 900 MHz Serial communications installed on a seventy foot tower. Another master location will be added to a relocated 215 ft. tower that is going to be installed at the city's Strawfloor facility. We are also considering relocating the Greensboro Road radio to Fire Station #1 so that direct access to the city's network can be established.

2.2 Corridor Study

2.2.1 Data Collection

Accurate vehicle volume and vehicle speed data is critical to the traffic signal timing process. Vehicle volume data will be collected utilizing traffic signal controllers, hose counters, and radar detectors. The radar detectors (depicted in Figure 2) will also collect vehicle speed data. Data collection will be needed for each major segment between intersections due to variations in traffic volume and speed.

Turning movement counts will also be collected at key intersections. The locations where turning movement counts are collected will be selected based on their overall impact to the corridor. Many key operating settings of the corridor are usually dependent on one or two critical intersections.

The turning movement counts will be collected between the hours of 7:00 – 10:00 AM and 3:00 – 6:00 PM during average traffic conditions unless shorter time periods are justified. The roadway section where the hose counters are set up shall be a relatively straight and smooth section of roadway with free flowing traffic throughout the duration of the data collection session. Attention should be given to avoiding proximity to driveways and intersections. Traffic count and speed data will be used to document the directionality of traffic flow and will be entered into various computer models to simulate the corridor.

Figure 2.

2.2.2 Pre - Travel Time/Delay Study

Prior to making any changes to the corridor, a Travel Time/Delay Study will be performed utilizing Tru-Traffic software synchronized with a GPS unit. This study will document the existing travel conditions such as delay, travel time and number of stops. The initial data collected will be compared to data collected after timing and sequencing improvements have been made to the corridor to measure how the corridor was improved. Multiple "trips" through the corridor will be made during peak traffic conditions using a "floating car technique." During a trip the following data will be collected:

- Travel Time Between Intersections
- Cumulative Travel Time
- Delay Between Intersections
- Cumulative Delay
- Stopped Delay
- Cumulative Number of Stops in the Trip
- Speed
- Average Speed Between Intersections

Below is an example of a "trip" made from Stadium Blvd. at Parker Rd. to Stadium Blvd. at Aggie Rd. The vertical axis is speed and the horizontal axis is distance. Note that the vehicle made complete stops at Stadium at Hwy. 63 Southbound Ramp, Stadium at Highland, and Stadium at Nettleton Ave.

Stadium Boulevard Northbound

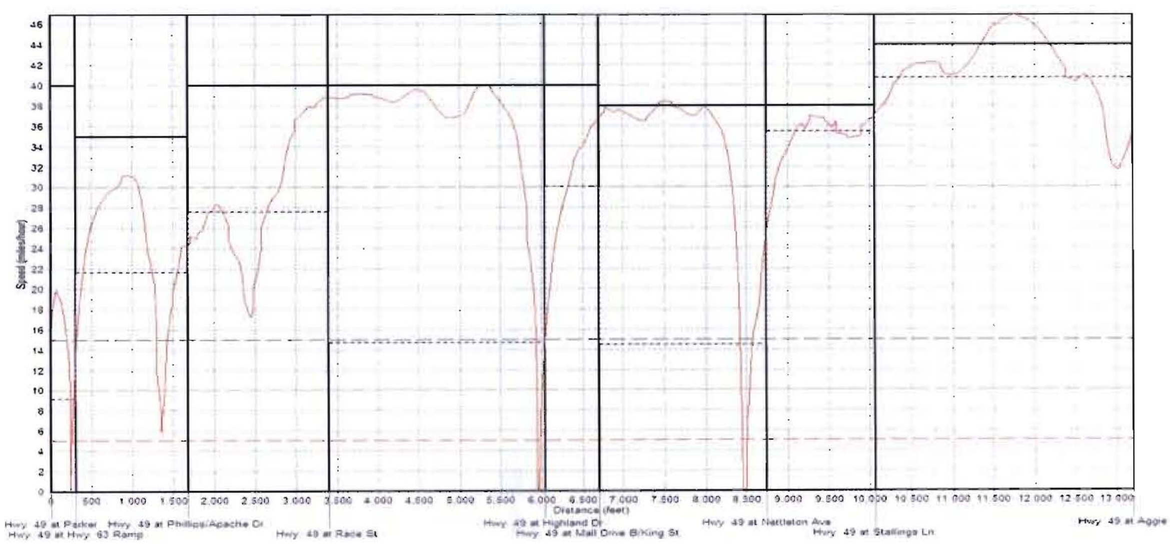

Figure 3.

2.2.3 Establish Basic Intersection Times

It is important that the basic intersection times be calculated prior to selecting a timing plan cycle length. These times include Minimum Green, Yellow, Red, Passage, Pedestrian Walk, and Pedestrian Clearance and are calculated utilizing the Federal Highway Administration's Traffic Signal Timing Manual as a guide. The formulas and definitions for calculating these times are as follows:

Minimum Green
Gq=3 + 2n
n=Dd/25
Dd=Distance between stop line and nearest upstream detector, ft

Yellow
Y = (t+((1.47*v)/(2(a+32.2*g)))
t=perception-reaction time to the onset of a yellow indication
v=approach speed
g=grade, with uphill positive and downhill negative
t-1.0s
a=10ft/s^2

Red
R=(W+Lv)/(1.47*v)
W=width "measured from the near-side stop line to the far edge of the last conflicting traffic lane"
Lv=20ft
V=approach speed

Passage
P=MAH-((Lv+Ld)/(1.47*Va))
MAH=maximum allowable headway
Va=average approach speed
Lv=length of vehicle
Ld=length of detection zone

Pedestrian Walk
High Pedestrian Volume Areas = 10 to 15 seconds
Typical Pedestrian Volume and Longer Cycle Length = 7 to 10 seconds
Typical Pedestrian Volume and shorter cycle Length = 7 seconds
Negligible Pedestrian Volume = 4 seconds

Pedestrian Clearance
PC = (Df-3.5)/3.5
Df = The distance of the travel-way from curb to curb

Minimum Green – A parameter that defines the shortest allowable duration of the green interval.

Yellow Clearance – The exclusive function of the yellow change interval shall be to warn traffic of an impending change in the right-of-way assignment.

Red Clearance – The yellow change interval should be followed by a red clearance interval to provide additional time before conflicting traffic movements, including pedestrians.

Passage – This parameter extends the green interval for each vehicle actuation up to the Maximum Green time.

Pedestrian Walk – This interval should provide pedestrians adequate time to perceive the WALK indication and depart the curb before the pedestrian clearance interval begins.

Pedestrian Clearance – This interval follows the walk interval. The pedestrian clearance interval should be sufficient to allow a pedestrian crossing the crosswalk who left the curb or shoulder at the end of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.

2.2.4 Design Corridor Models

The traffic data collected will be used to model the corridor. Modeling software such as Passer 5, Synchro and Tru-Traffic will be used. These models analyze hundreds of different sequences and determine the most efficient cycle length, offsets, split times and phasing configurations for the corridor. The culmination of these settings for specific traffic conditions is called a timing plan. A time-space diagram will be generated for each timing plan. Time space diagrams are visual representations of each individual timing plan. An example is provided as Figure 4, the red vertical lines represent the time the major street is stopped, and the gray bands represent the "time tunnels" or "green bands" through the coordinated system.

Time-Space Diagram of Stadium Blvd.

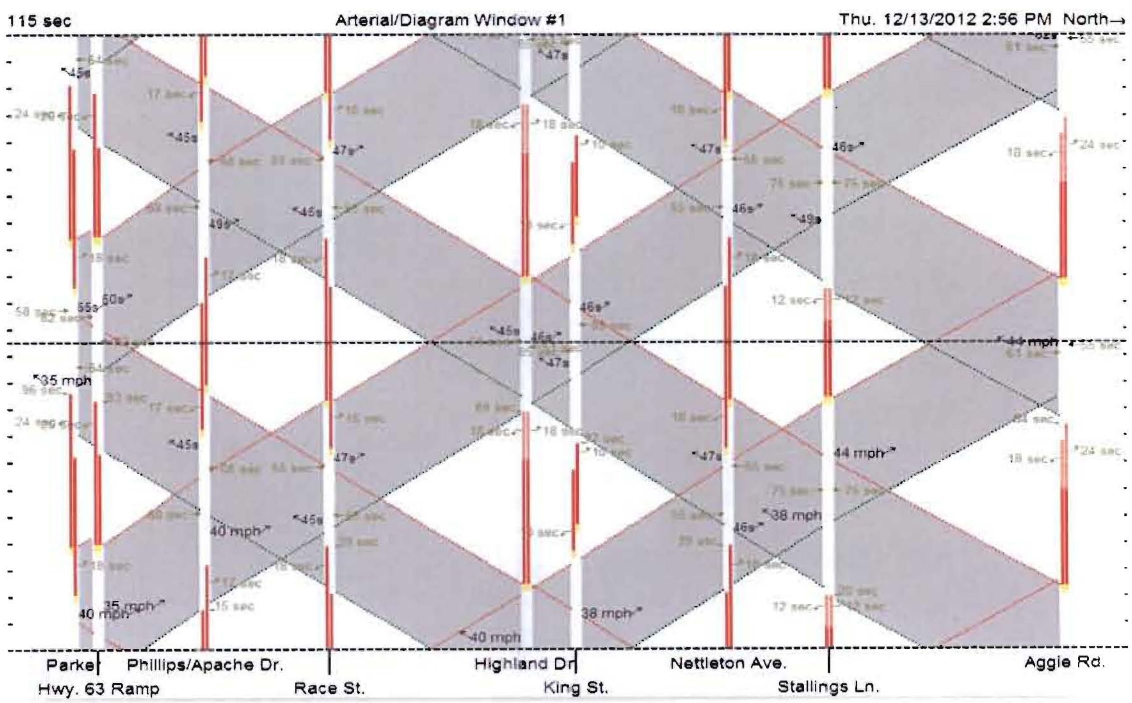

Figure 4.

Typically four to five different plans will need to be generated for a corridor: A.M. Peak, Noon, P.M. Peak, Off Peak, and weekend traffic. It is not uncommon to have a special timing plan designed for the Christmas season or special events. The schedule for when these plans are enabled is called a Time of Day Schedule. The TACTICS Central Server will be programmed to broadcast specific timing plans to the local intersections based on the Time of Day Schedule developed during this coordination process.

2.2.5 Phasing Modifications

During the modeling process, key locations may be identified in which phasing modifications are needed to increase the green bands of the timing plan. The most common phasing modification is the installation of 4-section signal heads to allow for a flashing yellow arrow configured left turn phase. This configuration is required by the Manual of Uniform Traffic Control Devices (MUTCD) when Lead-Lag left turns are used. Studies have shown that 70% of traffic signals require Lead-Lag configured left turn phasing for optimal corridor green band time. A permit issued by the State Highway and Transportation Department is required prior to implementing intersection phase modifications on state routes. Modifications to traffic signal cabinet and left turn signal displays will also be required in most applications.

2.2.6 Timing Plan Implementation and Fine Tuning

Once the timing plans are designed, each individual plan will be loaded into the corresponding traffic signal controller. This will be done remotely through the TACTICS central server. Approximately 150 time, mode, and sequence settings per controller will be programmed remotely.

Once these settings are enabled in the field and the timing plan is in operation, the timing plans will be fine tuned. During this process, Tru-Traffic software synchronized with a GPS unit will be utilized to test the green bands. Typically offset or split times will then be adjusted by 1 to 5%.

2.2.7 Post - Travel Time/Delay Study

In order to measure the overall results of retiming, a second travel time/delay study will be conducted after all adjustments have been made. This study will be conducted in the same manner as the Pre-Travel Time/Delay Study.

2.2.8 Traffic Improvement Projects

Key improvements that will improve the efficiency of a corridor may be identified during the traffic signal timing, coordination and modeling process. A list of such improvement projects will be generated for each corridor as applicable. The projects will be prioritized based on the expected reduction in travel time delay, stops, and emissions. To this end, the software program Synchro will be utilized to model each corridor on a micro level. Figure 5 is an example of a micro model of an intersection. Different configurations will be analyzed and compared to ensure that the improvements proposed are effective.

Figure 5.

2.2.9 Report

A report will be compiled for each corridor once the study is complete. The report will address the following items:

- Communications methods, modifications and future recommendations
- Traffic data, including vehicular volume and speed for each link
- Timing plan settings, including cycle length and time of day settings
- The reductions in Travel Time Between Intersections, Cumulative Travel Time, Delay Between Intersections, Cumulative Delay, Stopped Delay, Cumulative Number of Stops in the Trip, Speed, and Average Speed Between Intersections will be documented.
- Key recommended improvements to the corridor will be identified and prioritized.

3. Order of Work

3.1 Plan Implementation

This plan is to be implemented based on Average Daily Traffic (ADT) volumes along corridors. Corridors with the greatest ADT volume will be addressed first and the next highest corridor next. Below is a list of corridors with their corresponding ADT values.

Corridor	ADT
Stadium Boulevard	37000 ADT
Caraway Road	32000 ADT
Johnson Avenue	21000 ADT
Southwest Drive	21000 ADT
Highland Drive	19000 ADT
Nettleton Avenue	13000 ADT
Harrisburg Road	10000 ADT
Downtown Grid	8000 ADT

3.2 Key Intersections

1. Stadium Boulevard/East Johnson Ave. (Highway 49/Highway 1)
    - East Johnson Ave at Clinton School Rd.
    - East Johnson Ave. at NEA Baptist
    - East Johnson Ave. at Airport Rd (Hwy. 351)
    - East Johnson Ave. at N Old Greensboro Rd. (Hwy. 351)
    - Stadium Blvd. (Hwy. 49) at East Johnson (U.S. 63B)
    - Stadium Blvd. (Hwy. 49) at Aggie Rd.
    - Stadium Blvd. (Hwy. 49) at Stallings Ln.
    - Stadium Blvd. (Hwy. 49) at Nettleton Ave.
    - Stadium Blvd. (Hwy. 49) at King St./Mall Drive B
    - Stadium Blvd. (Hwy. 49) at Highland Dr. (Hwy. 18)
    - Stadium Blvd. (Hwy. 49) at Race St.
    - Stadium Blvd. (Hwy. 49) at Phillips Dr./Apache Dr.
    - Stadium Blvd. (Hwy. 1) at Joe N Martin Expy. (U.S. 63 EBOR)
    - Stadium Blvd. (Hwy. 1) at Parker Rd.
    - Stadium Blvd. (Hwy. 1) at Fox Meadow Ln.

2. Caraway Road
    - Caraway Rd. at Matthews Ave.
    - Caraway Rd. at Nettleton Ave.
    - Caraway Rd. at Wilkins Ave./Forrest Home Rd.
    - Caraway Rd. at Highland Dr.
    - Caraway Rd. at Race St.
    - Caraway Rd. at Phillips Dr.
    - Caraway Rd. at Joe N Martin Expy. (U.S. 63 EBOR)
    - Caraway Rd. at Parker Rd.

3. Johnson Avenue (Highway 63B)
    - East Johnson Ave. (Hwy. 63B) at Stadium Blvd. (Hwy. 49)
    - East Johnson Ave. (Hwy. 63B) at University Loop East
    - East Johnson Ave. (Hwy. 63B) at Caraway Rd.
    - East Johnson Ave. (Hwy. 63B) at University Loop West
    - East Johnson Ave. (Hwy. 63B) at Patrick St.
    - East Johnson Ave. (Hwy. 63B) at Fisher St.
    - East Johnson Ave. (Hwy. 63B) at Bridge St.
    - East Johnson Ave. (Hwy. 63B) at Main St. (Hwy. 141)
    - East Johnson Ave. (Hwy. 63B) at Culberhouse St
    - East Johnson Ave. (Hwy. 63B) at Gee St.

4. Southwest Drive (Highway 18/Highway 18)
    - Southwest Dr. (Hwy. 18) at Highland Dr.
    - Southwest Dr. (Hwy. 18) at Culberhouse St.
    - Southwest Dr. (Hwy. 18) at Alexander Dr.
    - Southwest Dr. (Hwy. 18) at Parker Rd.
    - Southwest Dr. (Hwy. 18) at Keller's Chapel Rd.

5. Highland Drive (Hwy. 18)
    - Highland Dr. (Hwy. 18) at Nestle Rd.
    - Highland Dr. (Hwy. 18) at Commerce Dr.
    - Highland Dr. (Hwy. 18) at Industrial Dr.
    - Highland Dr. (Hwy. 18) at Nettleton Ave. (Hwy. 463)
    - Highland Dr. (Hwy. 18) at Mall Drive D
    - Highland Dr. (Hwy. 18) at Brazos St.
    - Highland Dr. (Hwy. 18) at Highland Dr.
    - Highland Dr. (Hwy. 18) at Bittle St./Fair Park Blvd.
    - Highland Dr. (Hwy. 18) at Caraway Rd.
    - Highland Dr. (Hwy. 18) at Browns Ln.
    - Highland Dr. (Hwy. 18) at Rains St.
    - Highland Dr. (Hwy. 18) at Harrisburg Rd. (Hwy. 1)
    - Highland Dr. (Hwy. 18) at Southwest Dr./Main St.

6. Nettleton Avenue
    - Nettleton Ave. at Rains St.
    - Nettleton Ave. at Church St.
    - Nettleton Ave. at Main St.
    - Nettleton Ave. at Flint St.
    - Nettleton Ave. at Nettleton Cr.
    - Matthews Ave. at Gee St.
    - Washington Ave. at Gee St.

7. Harrisburg Road (Highway 1B)
    - Harrisburg Rd. (Hwy. 1B) at Windover Rd.
    - Harrisburg Rd. (Hwy. 1B) at Future WBOR
    - Harrisburg Rd. (Hwy. 1B) at Parker Rd.

8. Downtown Grid
    - Main St. at College Ave.
    - Main St. at Nettleton Ave.
    - Main St. at Cherry Ave.
    - Main St. at Oak Ave.
    - Main St. at Matthews Ave.
    - Main St. at Washington Ave.
    - Main St. at Huntington Ave.
    - Main St. at Cate Ave.
    - Main St. at Johnson Ave. (U.S. 63B)
    - Union St. at Huntington Ave.
    - Union St. at Washington Ave.
    - Union St. at Matthews Ave.
    - Matthews Ave. at Church St.
    - Washington St. at Church St.
    - Washington St. at Flint St.
    - Matthews Ave. at Flint St.

3.3 Work Timeline

We estimate the above process will require a minimum of one working week per intersection. Larger corridors with 6 or more signalized intersections may require more time due to their complexity. Approximately 150 settings per traffic signal will be analyzed and programmed. Therefore, coordination along Stadium Boulevard will be comprised of 2,250 individual settings. Below is an estimated timeline to complete the traffic signal coordination and retiming process along each major corridor:

Corridor	Estimated Timeline
Stadium Boulevard	20 Weeks
Caraway Road	10 Weeks
Johnson Avenue	13 Weeks
Southwest Drive	5 Weeks
Highland Drive	18 Weeks
Nettleton Avenue	5 Weeks
Harrisburg Road	3 Weeks
Downtown Grid	18 Weeks

3.3.1 Reevaluate Corridors

The Federal Highway Administration's "Traffic Signal Timing Manual" suggests traffic signal timing and coordination should be reviewed every three to five years and more often if there are significant changes in traffic volumes or roadway conditions. This frequency of signal retiming is particularly important for jurisdictions or localized areas within a jurisdiction in which land use changes lead to rapid changes in traffic patterns. Key to the ability to identify the right frequency for signal timing updates is a proactive monitoring program consisting of regular traffic counts and travel delay studies. Citizen complaints should also be considered in the reevaluation process. Other factors such as the addition of a new traffic signal adjacent to existing signals will require an analysis of the immediate area and may even require an analysis of the entire corridor.

CORRIDOR STUDY FLOW CHART