Chicago Transit Signal Priority Project

Presented by:

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Office of Emergency Management & Communication (OEMC)

Traffic Management Authority

City of Chicago

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Cooperative Effort

Funded thru Regional Transportation Authority (RTA) Regional Technical Assistance Program (RTAP).

- Chicago Transit Authority (CTA)
- City of Chicago Office of Emergency Management and Communication (OEMC) – Traffic Management Authority (TMA)
- Chicago Department of Transportation (CDOT)
- Chicago Department of Streets and Sanitation, Bureau of Electricity (BOE).

BOE

City of Chicago Traffic Statistics

- 3,800 miles of streets
- 26,000 intersections (approx)
- 2,900 + signalized intersections
- 24 signal interconnects (480 signals)
- 140,000 + traffic crashes per year (400 a day)
- Over a million estimated vehicles in the streets every day.

Chicago Transit Authority (CTA)

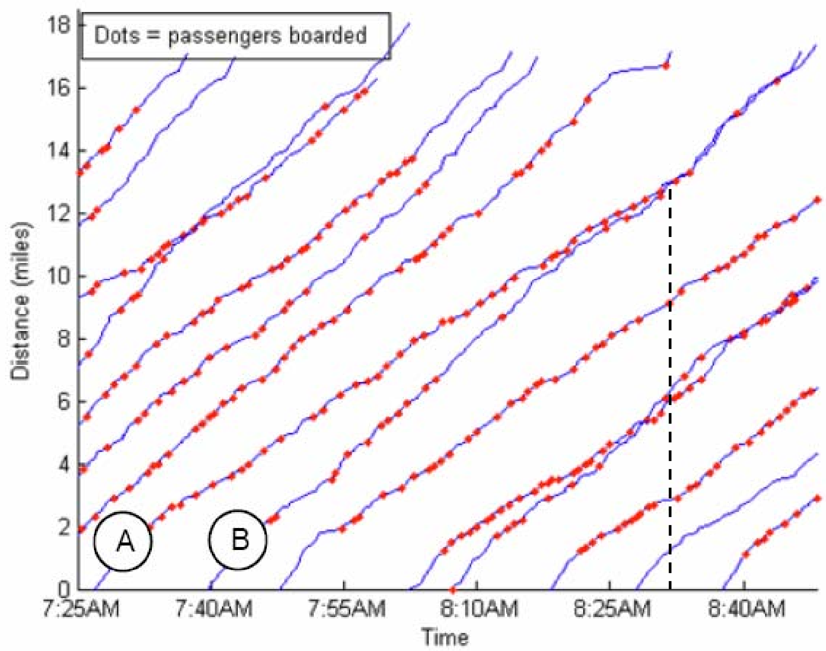
- Provides 24/7 bus and train service.
- Approximately one million average weekday customers
- 2,017 buses on 152 bus routes covering over 2,273 route miles.
- approximately 190,000 bus miles each day.

A Word on Bus Bunching

Bus bunching refers to two things: (1) a bus route having highly irregular service intervals, and (2) a classical theory for a causal model for irregular intervals, on the premise that a late bus tends to get later and later as it completes its run, while the bus following it tends to get earlier and earlier. (*Wikepedia.org*)

Classic Case: Oregon Study

Bus A started 15 minutes before Bus B.



After covering about 3/4th of the distance of the route Buses A & B are at the same location & Bus B is making fewer stops.

Time-space diagram of bus trajectories annotated with dots showing passenger boarding locations.

Source: Transit Performance Measurement and Arterial Travel Time Estimation Using Archived AVL Data. By: Mathew Berkow, John Chee, Robert L Bertini, and Christopher Monsere. ITE District 6 Annual Meeting, July 7, 2007. Portland, OR

Negative Effects of Bunching

- Poor Service
- Longer wait time
  - More passengers motivated to drive
- Increased congestion in the street
  - more pollution
  - increased fuel consumption

Project Goals

- The goal of the project is to facilitate faster movement of transit buses along a predefined corridor so as to avoid bus bunching.
- This will be achieved by providing traffic signal priority to CTA buses meeting specific conditions.

Preemptions vs. Priority

- Preemption is typically provided to emergency vehicles and involves changing or extending traffic signal phase and is unconditional.

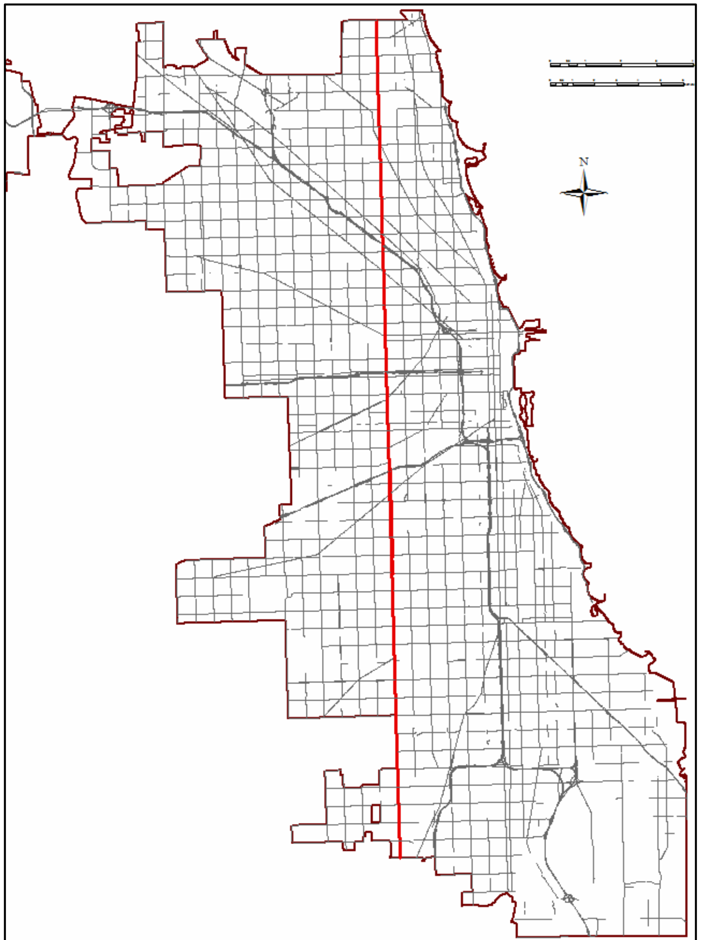
- Bus priority is typically considered a "*soft pre-emption*" because it is mostly concerned with advancing or extending the arterial green and is conditional.

Key To BRT Implementation

- The TSP project is considered a key step in the incremental approach to city wide implementation of Bus Rapid Transit (BRT) service.

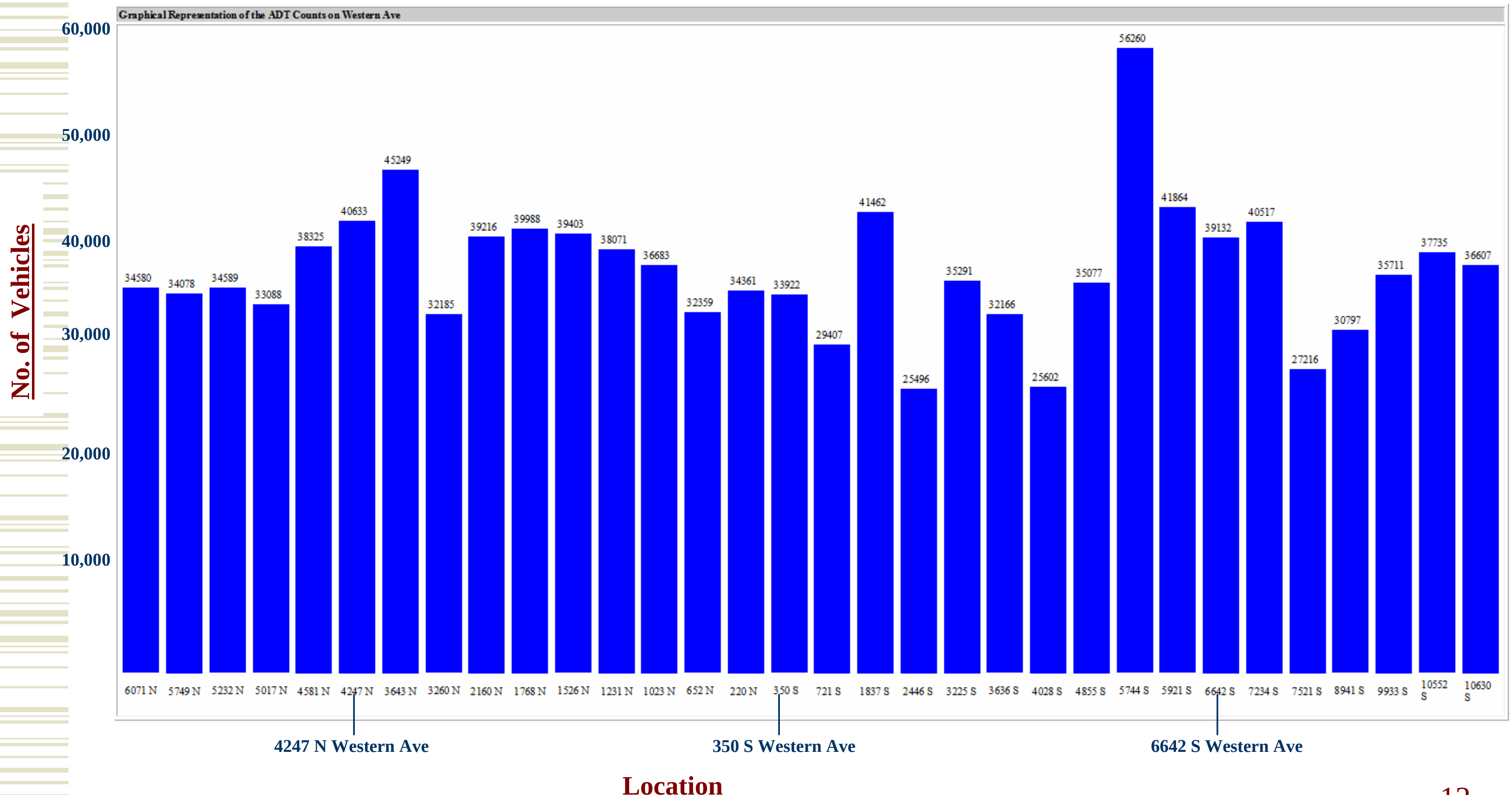
- The project will demonstrate the feasibility of TSP within a busy corridor, and build a local knowledge base for expanding coverage and optimizing the benefits of the system.

TSP Project Scope



- Pilot Project
- Along Western Avenue: One of the longest Streets in the City and one of the region's busiest transit corridors
- About 100 inter-connected signals on Western Ave.

Average Daily Traffic on Western Ave



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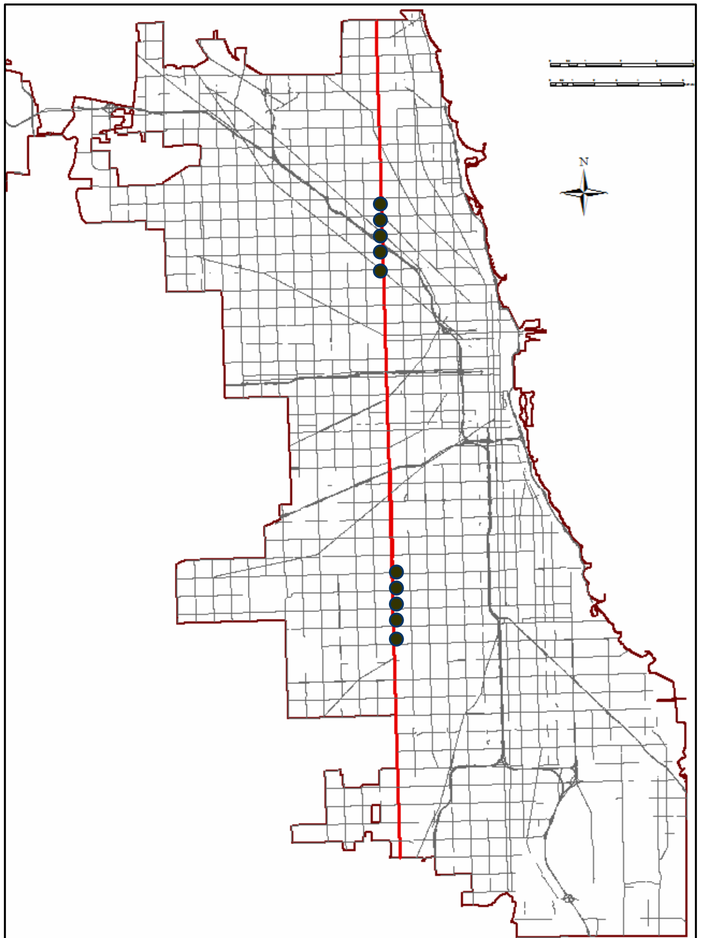
Project Scope (cont.)



TSP to be implemented in up to 10 intersections along Western Ave

- 5 on the north side of the City
- 5 on the south side of the City

6 month evaluation period

- If found successful expand to more streets and intersections.

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Intersection Selection Criteria

- Where an express bus stop exists, and if either northbound, southbound or both stops are expected to become far-side stops when the project is implemented.
- Will have the least effect on the cross traffic.

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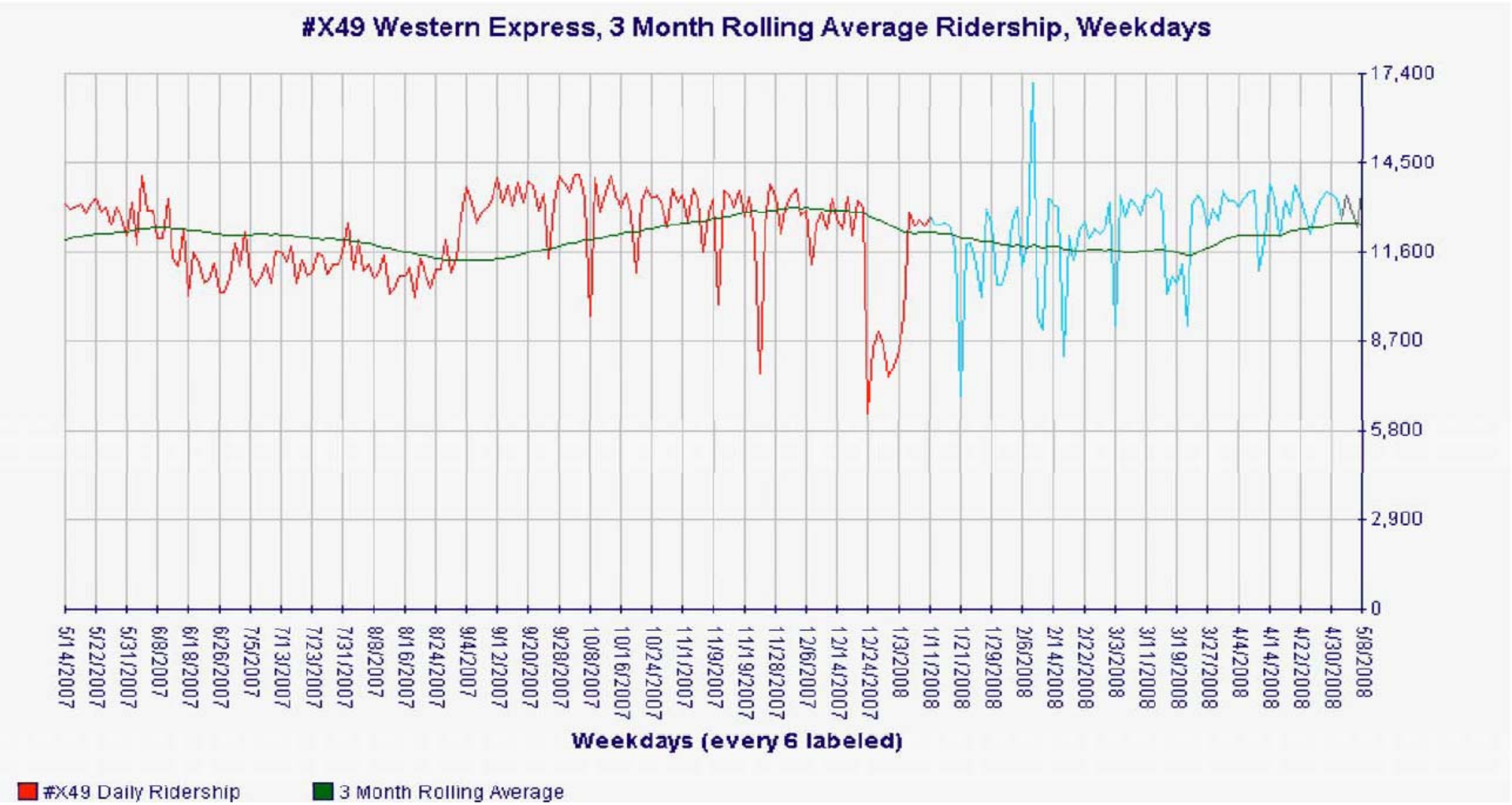
X49 Western Ave Express

- CTA provides both local and limited stop bus service along the Western Avenue corridor.

- Since its introduction in 1999, the X49 Western Ave Express service has provided faster service by limiting stops to approximately every half-mile.

X49 Ridership Graph



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Many Possible Implementation Methodologies

- Traditional transit priority systems use an on-street sensor system to detect the vehicle's arrival and priority is given to all transit vehicles.

- Newer systems use Global Positioning System (GPS) on the vehicle that transmits its location to the central computer, which then activates pre-emption based on stored knowledge of the transit schedule.

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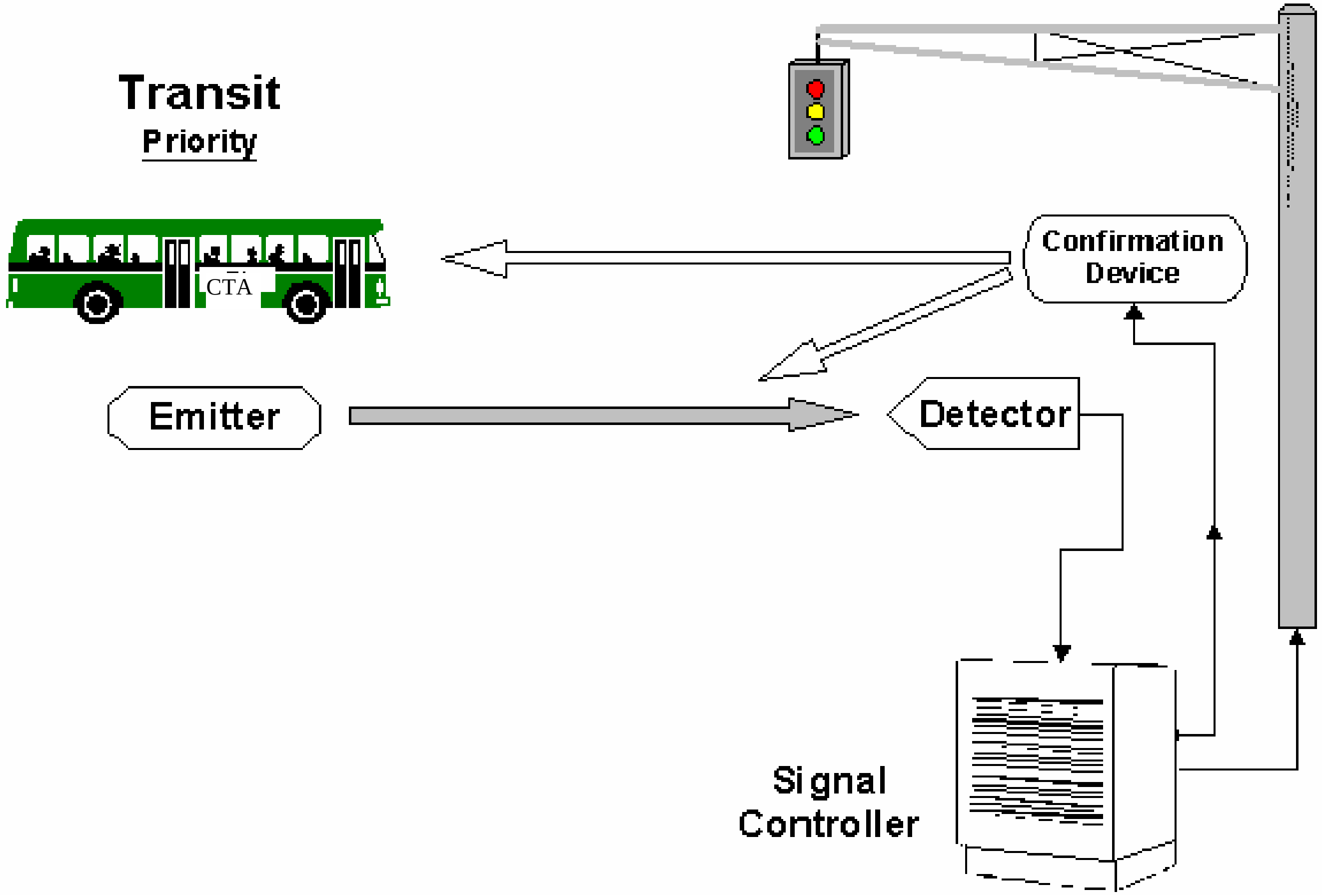
Chicago Approach

- Implementation similar to that of a low priority preemption.
- Buses operating on the X49 route will be equipped with infrared emitters that will allow selected traffic signals to detect oncoming buses. Equipment on the signal mast arm will communicate to the signal controller to process the priority requests.

Four Step Process

1. The intelligence on the bus will determine if a TSP request should be made.
2. Devices on the bus will communicate with the signal controller as the bus nears the intersection.
3. A phase selector on the controller will determine whether signal priority should be granted.
4. If the signal is on green phase, it will continue to be on green until the bus clears the intersection or if the signal is on red phase, borrow any available time from the cross street green phase.

Conceptual Diagram



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Step 1 – Intelligence on the Bus

- Automated Passenger Counter (APC) and Automated Vehicle Locator (AVL) equipments on the bus determines how late the bus is running and the passenger load of the bus.

  AVL utilizes GPS on the bus to determine location and adherence to schedule.

- Only buses that have a minimum passenger load (configurable) or is behind schedule by a minimum amount of time (configurable) will make TSP requests.
- AVL Software will automatically make the TSP request.

Step 2 – Communication Between Bus & Signal Controller

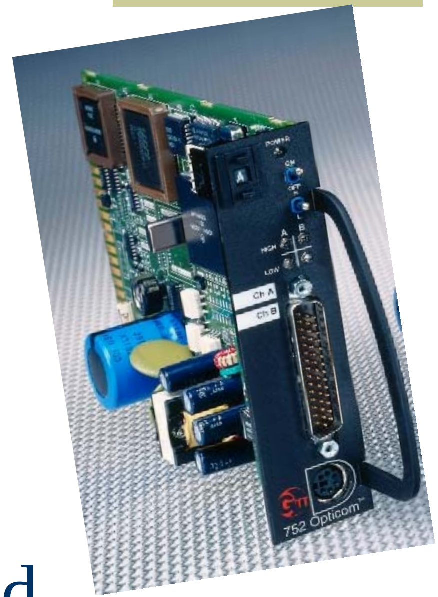
Bus fitted with infrared emitter.

Emitters send a distinct optical signal.

Signal Mast arm equipped with an infrared receiver.

- Line of Sight required.
- A configurable level of intensity of signal received from the bus (i.e. proximity) can determine how far away from the signal a priority request will be accepted.
- Receiver will communicate to a phase selector on the controller at the base.

Step 3 – Intelligence on the Controller



- Phase selector accepts or rejects TSP request depending on the when (configurable period)priority was granted last at that intersection.

- Current plan is for only one TSP granted every 10 minutes.
- Headway average is about 10 minutes for the X49 route during peek hours.

Step 4 – Hold Green or Borrow Time from Cross Street

- If the signal is on green phase, the phase selector holds the green for up to a configurable minimum seconds or until bus clears the intersection
- If the signal is on red phase, the phase selector will try to get any available time (after walk, don't walk) from the cross street green.
- A conformation light on the mast arm indicates to the driver that the TSP request has been granted.
- If the receiver no longer receives a signal from the bus (i.e. bus clears the intersection) the phase selector automatically drops the TSP hold.

Select Vehicles to be Equipped with TSP

For the pilot project, 30 vehicles will be equipped with optical emitters.

25 buses will be utilized for the initial X49 service, and 5 buses will be used as spare.

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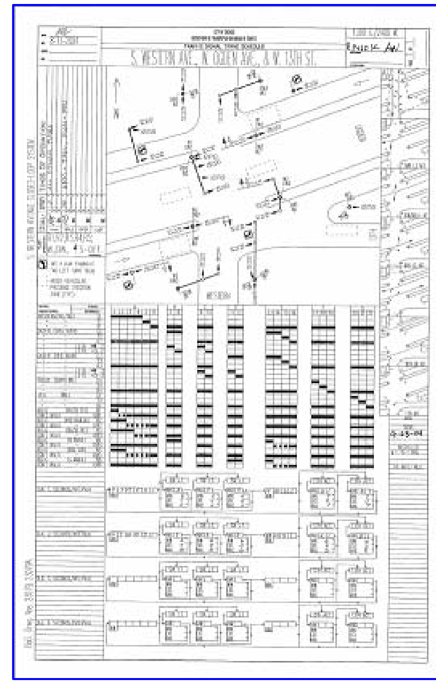
Design and Deployment Oversight

Consultant is engaged to do:

- Before and After study
- Signal Optimization
- Technical Advice
- System Design
- Set Benchmark
- Develop Strategies



Best Practices

- Get all agencies onboard initially
- Many technologies available.
  - Compatibility with existing traffic signal controllers and bus infrastructure is key
  - Infra red equipment takes-up the minimum amount of space in the signal controller and on bus and it is easy to install.
- Not all buses require priority
- Not all intersections have to be equipped with TSP:
  - Intersections with far side bus stops are preferred.
- Pilot project before city-wide deployment.

Benchmarks

Studies conducted elsewhere have shown:

- 9% reduction in travel time (AC Transit, Oakland, CA)
- 23% modal shift from auto to transit (TansLink, Vancouver, BC)
- 19% reduction in travel time variability, Avoided need for one additional bus (TriMet, Portland, OR)
- $14.2 M/Year economic benefit to general public (Pierce Transit, Tacoma, WA)

Source: *Transit Signal Priority (TSP): A Planning and Implementation Handbook, May 2005* (http://www.itsa.org/itsa/files/pdf/TSPHandbook2005.pdf)

Challenges

- Inter Governmental Agreements (IGA)
- Adhering to stakeholder objectives
- Selecting Appropriate Technology
  - Finding a technology that adds the minimum overhead to the buses already fitted with an array of devices.
  - Interface between AVL and Emitter and software upgrade
- Maintenance responsibilities.

Next Steps….

- Finalize Inter Governmental Agreements
- Approval by CTA Board & City Council
- Develop/Modify AVL software
- Signal System Optimization
- Driver training
- Go live
- Phase II- Expand scope and tie the project with the BRT (Bus Rapid Transit) network recently funded by USDOT Congestion Relief Grant.

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