SCATS Adaptive Traffic System

TRB Adaptive Traffic Control Workshop
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Session 1 - Principles
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SCATS - Objectives

- Minimize Stops (light traffic),
- Minimize delay (heavy traffic), and
- Minimize travel time.

By selecting the most appropriate:
- Cycle Length,
- Splits (that is the phase, or green, splits), and
- Links (or Offsets)
SCATS Degree of Saturation

$$DS = \frac{[\text{green} - (\text{unused green})]}{\text{green}}$$

- Green is the available phase time
- Unused green is space time greater than or less than the saturation space time. i.e.
  - Total space time from controller, LESS
  - Number of spaces (from the controller) times the standard space time at maximum flow
- Unused green is a measure of efficiency (zero at saturation flow, +ve undersat, -ve oversat).
SCATS Degree of Saturation

$DS = \frac{[green-(unused\ green)]}{available\ green}$

- Standard space time at maximum flow is **self calibrated** daily
- DS is the ratio of efficiently used phase time to available phase time,
- DS can be >100% i.e. during oversaturation the used green can be negative - vehicles are closer than standard space time at maximum flow.
SCATS Car Equivalent Flow - VK

- Derived from DS and the lane saturation flow for each lane,
- VK = DS x green time x vehicles per second at maximum flow
- Independent of vehicle types in traffic stream,
- Allows valid comparisons of competing flows for offset selection.
SCATS Data Smoothing and Damping

- DS and VK are used as weighted averages usually over three cycles,
- SCATS uses smoothing, damping (i.e. reducing the gain of feedback control loops) and hysteresis extensively,
- It is the calibration of these techniques over years of experience that is the key to effective performance.
SCATS - Cycle Length

- User defined equilibrium DS values are used to determine the relationships between measured DS and CL.
- The relationships are used to select a target CL toward which the actual CL moves.
- Objective is to keep CL below user defined limits.
SCATS - Cycle Length

• CL normally moves toward the target by up to +/- 6 seconds.

• CL can change by up to 9 seconds where the target for the last two cycles was > 6 seconds. (allows response to steep change in demand).

• Subsystems at low CL can move to several “Stopper” CL’s based on flow per cycle parameters, not DS. (i.e. provides for step change).
SCATS - Split Plan

- Minimum delay for intersection when DS of competing approaches is equal = Equisat.

- All possible split plans examined each cycle to determine the most “equisat” plan for the next cycle, i.e. minimal delay
SCATS Offset Selection

• Offset plans are selected by comparing traffic flows on the links,

• Directional Bias values are entered for each of four plans for each link

• The weighted three-cycle average volumes (VKs) are multiplied by the DB’s and the results summed for each plan,

• The plan with the highest sum receives the vote.
SCATS Coordination

• Sub-systems = one or more intersections only one of which is “critical” i.e. requires dynamic split selection,

• All cycle length and split plan voting is carried out at the critical intersection,

• CL and Splits at “minor” intersections in the sub-system are controlled by the critical intersection.
SCATS Coordination

• Sub-systems can “marry” to achieve coordination using a separate set of offsets,
• “Married” sub-systems have the same CL,
• “Marriage” and “Divorce” is controlled through voting based on CL and volume and occurs automatically.
SCATS - Coordination Cycle Length

- CL for a “married” set of subsystems is a compromise.
- Delay increases rapidly for CL below Co (optimum CL)
- Exact CL not critical as long as not less than Co
SCATS Phasing Flexibility

- SCATS has seven Stages, A to G,
- Compatible phases (signal groups or displays) grouped into STAGES,
- Signal Group control provided within stages for conditional overlaps, green arrow vs ped. control etc.,
- Stages can be introduced in any order and any undemanded stage can be skipped.
SCATS Measures of Effectiveness

• Only surrogate MOEs available from system:
  – SCATS Degree of Saturation DS
  – VO/VK (actual/calculated vehicles during green)
  – 5 or 15 minute counts system wide.

• MOEs should be measured independently:
  – SCATS in Sydney is equipped with ANTTS (Automatic Network Travel Time Subsystem- link travel times from 4000 taxicabs collected and analyzed continuously).
SCATS and Oversaturation

• SCATS DS can be >100% i.e. oversaturated,
• “Stretch effect” i.e. all stages share extra CL up to a limit CL.
• After limit CL the coordination stage gets all the extra CL (i.e. a move away from equisat),
SCATS and Oversaturation
Illustration of the Stretch effect
SCATS Priority Systems

At the controller -

• Nine prioritized preemption inputs with preemption display, ending overlaps and return stage selectable.

At a system level -

• Route Preemption Control (RPC) System provides automatic emergency route control from a single input (e.g. fire station pushbutton),
SCATS Arterial/Network Capability

- Offset plans can be arranged for arterial or network use,
- Arterial plans are set up as: low CL, Direction 1, “Business Peak” and Direction 2,
- For a network the offset plans are independent for use on multiple coordination routes.
- Coordination decisions are not constrained by simple inbound vs outbound arguments.
SCATS Arterial/Network Capability

• Links and offsets in a grid are automatically selected for the heavily trafficked routes,

• All possible links will be operating,

• Links operating will be those with the greatest flow.
End

Thank You