# CHAPTER 19: CENTRAL CONTROL SYSTEMS

## 19.1 INTRODUCTION

1 A central traffic control system co-ordinates and controls the operation of a network of signal junctions and crossings. The objective of such a system in the first place is to improve the efficiency of traffic flow, but it also has a secondary objective of managing the signalised system itself.

2 Central control systems utilise a central computer (or master controller) for controlling the signal network. Such a system consists of two main components:

(a) An instation located at a control centre and/or a control room. The instation equipment comprises traffic computers, computer peripherals, software and instation data transmission equipment.

(b) Outstations located at various local controllers under the control of the central system. Outstation equipment comprises outstation data transmission equipment connected to, or integral within, the local traffic signal controller, traffic detectors and other items of street equipment such as variable message signs.

3 Central control systems can vary in complexity from the relatively simple systems, to the most complex of systems. In its simplest form, the central computer may purely monitor the performance of on-street equipment. The more complex systems have facilities to update signal plans at a local controller, possibly in response to traffic demand.

## 19.2 CONTROL CENTRES AND ROOMS

1 A control centre is provided to accommodate the central computer system as well as control equipment for data communications. It also provides for manual operations and intervention of the control system.

2 The control room is typically equipped with control consoles and a dynamic wall map. This map can either be physically constructed, or can be a computer-projected image. The map takes the form of a simplified map of the street network under control, showing the location of signalised junctions and crossings. The operational state of each signal is indicated on the map.

3 A control room can also be equipped with a closed circuit television system (CCTV) which is used for manual monitoring of traffic. The operator may implement signal plans based on events observed on the television monitors.

## 19.3 CENTRAL CONTROL COMPUTERS

### 19.3.1 Computers and equipment

1 Depending on the number of signals controlled, one or more instation computers may be required. The configuration will depend on:

(a) The number of intersections restricted by the software or equipment (dependent on the supplier).

(b) The maximum number of signal controllers that should be controlled by one computer. A guideline is about 200 signal controllers.

(c) The control strategy followed.

2 It may be desirable to use a computer system whereby one computer acts as a Traffic Management Computer and one or more Traffic Control Computers provide the signal control functions. Alternatively, different computers may provide the same function, which has the advantage that in the event of a computer failure a standby facility exists.

3 Other peripheral computer equipment would typically include:

(a) Control console for accessing the computers.

(b) Log printer(s).

(c) Storage device for regular data backup.

(d) Additional hard disk drive for data storage e.g. traffic counts, fault logs etc.

(e) Dial-in modem enabling remote access to the system. For improved security a dial-in/dial-back facility can be specified whereby the authorised dial-back numbers are specified.

(f) A “roving terminal” which allows communication with the control system by on-street personnel via a cellular telephone link (if such a facility is available).

(g) Wall display map or alternatively an overhead projection device.

4 The central control computer should be capable of running unattended and be fully operational for 24 hours per day, throughout the year. The number of system parameters and commands required to take the system off- and online should be a minimum.

5 The control computer should be relatively fast and be able to perform all tasks as and when required. The system should be capable of operating with all junctions on minimum cycle times with no obvious or apparent degradation in performance or speed of response.

6 Providers of central control systems normally supply all of the system software required for the maintenance and operation of such systems. Some systems, however, may require the use of additional software developed by a third party. Traffic adaptive and responsive systems, in particular, may require such third-party software at additional cost.

### 19.3.2 User interface

1 The central control system should preferably be operated in a multi-tasking operating system, if possible with a graphical user interface. Significant benefits can be achieved if the system can also handle graphics and diagrams.

2 The system terminal should typically be able to display and dynamically update information such as the following for a selected signal controller or other items of street equipment:
   (a) Current date, day of the week, and time.
   (b) Equipment identification number, equipment type and other references.
   (c) The current mode of control.
   (d) The current plan number, cycle length, stages (including omitted stages), offset times, minimum and maximum green and intergreen times as well as times of scheduled plan changes.
   (e) Control and reply messages dynamically updated in real time.
   (f) Details of current faults as well as fault summaries per sub-region, region and total.

3 Efficiency can be improved if systems have the facility to display progression diagrams. It should be possible to display such diagrams in either “live update” mode with the diagram driven by stage green reply data from the controllers, or “predictive” mode, whereby a prediction of the effect of a selected set of plan timings is displayed without those timings being implemented.

### 19.3.3 System log

1 The central control system should have the capacity to store all system log data output for at least five years. A backup of such data should also be kept.

2 The disc system log would normally contain the following information:
   (a) All messages output by the system.
   (b) All implemented operator commands which affect the system.
   (c) All operator comments.
   (d) All generated fault messages.
   (e) All operator recorded faults.

3 All messages should be dated and time stamped, while operator commands and comments should include the identity of the operator initiating the command or the comment.

4 The system should provide a command log that will allow the system to be restarted after a computer fault, system restart or reboot, or a power failure. The purpose of the command log is to automatically return all instation and outstation equipment to the same method of control and operational state prior to the restart.

## 19.4 OUTSTATION CONTROL

1 Outstations are controlled by the central control system by means of a communication system in which a control message is transmitted to each outstation. Outstations should be able to respond to and implement the commands.

2 The most basic facility that can be provided is that of remote monitoring of the operation of outstations with the purpose of ensuring the correct functioning of on-street equipment. *Remote Monitoring Systems* (RMS) should at least provide for the following facilities:
   (a) Fault monitoring of outstations by requesting and receiving data on faults detected at local controllers (such as signal lamps and transmission errors).
   (b) Synchronisation of timing equipment at local controllers.

3 In addition to the above facilities, it is preferable that provision should also be made to at least download signal plans to local controllers and to interrogate the local controllers on signal plans currently in operation.

4 In more advanced adaptive and traffic responsive control systems, outstations should also be able to return traffic data collected at vehicle detectors. Such data may include the following:
   (a) An indication that there is a demand for a particular stage or the presence of a queue at a queue detector.
   (b) Data collected at a traffic counting detector.
   (c) The presence of an emergency and other vehicle priority signals.

5 Some advance systems also have additional facilities for the control of variable message signs from the central system. Such variable message signs can be used in traffic management systems such as parking area control.

## 19.5 COMMUNICATIONS

1 Data transmission between in- and outstations can be achieved by various means. The most common method is by means of leased Public Switched Telephone Network (PSTN) lines (although some authorities do have private data transmission networks). It is also possible to utilise the GSM (Global System for Mobile Communication) network for this purpose.

2 Each outstation utilises a modem to communicate with the central control system. Each controller effectively has its own allocated number (similar to a telephone number). The cost of providing such communication could therefore be high and is an important factor in the provision of a central control system.

3 Traffic responsive systems may require a permanent communication link to all outstations. The cost of such communication could be prohibitively high, requiring thorough consideration when such systems are considered for implementation.

4 Fixed time traffic control systems do not require transmission of large amounts of data. Such systems therefore have the advantage that a permanent communication link is not required, thus avoiding potentially high communication costs. Dial-up facilities are used to institute communications only when (and for as long as) required.

5 All equipment connected to the PSTN or GSM network must be approved by the operator of the network. It is important that written confirmation of such approval is obtained.

6 A problem that is often experienced is that data transmission protocols are in many instances proprietary, prohibiting or complicating the connection between different makes of equipment. Some protocols also carry copyrights and care must be taken to ensure that the copyrights are not infringed. In order to address the problem of different data transmission protocols, it is necessary to prescribe standardised protocols. At the time of writing this manual, some countries have started developing such standards, but no such standards were available for use in South Africa.

## 19.6 SIGNAL TIMING PLANS

1 The basic function of the central control system is to either implement signal timing plans, or to adjust a current timing plan.

2 The system should provide for the following types of plans (given from highest to lowest priority):

(a) Temporary plans

(i) Emergency signal plans (highest priority).

(ii) Fixed time plan imposed by manual request from a computer console.

(b) Permanent plans

(i) Traffic adaptive or responsive plans updated based on collected traffic data.

(ii) Fixed time plans selected according to a timetable.

3 Requests for a plan change should be served in order of priority. When a request for a plan is received, it will only be serviced if the current plan was requested from a source of lower priority. When multiple requests occur from the same source level, the latest request will be served.

4 To prevent a temporary plan from being implemented over a too long period, provision should be made for the system to make an alarm after some time. One method is to give an alarm at the next plan change time.

5 A temporary plan can be implemented by specifying user-defined start and termination times. Provision should, however, be made to cancel such plans prior to, or during these times. It must be possible to cancel a temporary plan at any time by manual intervention.

6 The introduction, implementation and cancellation of all plans should be recorded in the system log and a suitable message output to the logging printer.

## 19.7 EMERGENCY SIGNAL PLANS

1 The provision of emergency plans is one of the important benefits of a centrally controlled system. Such plans are provided as an aid to emergency vehicles. The signal timings required to assist such vehicles are commonly referred to as “green waves” and do not form part of the signal plans.

2 Green wave plans can be developed as standard signal plans, except that co-ordination would normally only be provided in one direction. A greater proportion of available green time would also be provided on the emergency route. Where necessary, turning phases would also be provided.

3 Provision should be made for a variety of green wave plans, between various origins and destinations.

4 Emergency plans should be implemented for a predetermined period of between 5 to 10 minutes, although provision can be made to manually extend this period.

5 When an emergency green wave plan has timed out, the system should revert to the signal plan that would have been running if the green wave had not been introduced. The time at which a green wave plan is introduced and removed as well as the green wave plan number should be output on the log printer in the control centre.