# Product Type: Centracs™

## Overview

*Centracs* is an Intelligent Transportation System (ITS) application that provides a centralized integrated platform for traffic signal system control, Closed-Circuit TV (CCTV) monitoring and control, information management, and graphical data display, and much more. *Centracs* uses client/server architecture and distributed processing to achieve a flexible and scalable design. System data processing is distributed across multiple servers and applications such that system functions are accomplished most effectively considering cost, communications implications, security, redundancy (back-up), and network interface capabilities. National and international protocol standards are used to ensure that the system can adapt to changes in technology and increase functionality over time with minimal impact on individual system components. Intelligent interface protocols are used for distribution of real-time data among workstations facilitating increased system performance and multi-user responsiveness.

Furthermore, *Centracs* is extremely modular and scalable because of its distributed processing architecture. High system performance can be maintained when the system is expanded, because system software processes can be distributed across various system processor components. The system software architecture does not require that a single central processor perform all real-time functions. This protects the agency's systems hardware/software investment and allows the system to be readily and incrementally expanded to handle any functions and features that are added at a later date.

As further described in the sections that follow, Graphical User Interface (GUI) techniques and graphical information system components are an integral part of *Centracs'* fundamental design. These elements form the basis of all user interactions with the system and its components, and are integrated using standard software tools and protocols.

*Centracs* is developed using the latest programming language and software development tools. Always keeping the end user's needs in mind, *Centracs* is designed to provide the greatest level of system flexibility and configurability. A standard, ODBC-compliant SQL database system (Microsoft® SQL Server) is used to store, retrieve, and maintain all system data and parameter files. System report and display presentations retrieve information from data stored in the database. Client (system user) workstations access network servers that perform traffic management, database management, and real-time traffic control and communications functions. *Centracs* interfaces to many different field devices and operates easily using any type of communications media, including twisted pair and leased line cable, wireless, and single or multi-mode fiber optic cable.

*Centracs* supports traffic signal controllers and other field devices that comply with the National Transportation Communications for ITS Protocol (NTCIP) protocol standards. Our total commitment to the NTCIP standard, and our continued intimate involvement with the standards development process, puts Econolite in a unique position to deliver a fully functional end-to-end communication system that can be maintained to the most current version of the standard. *Centracs* also supports non-NTCIP protocols, providing an upgrade path for users of *OASIS*™ (2070L controller software) and W4IKS (170-type controller software) controllers. Also, because of the open architecture of *Centracs*, other protocols and device types may be added in the future, if demand warrants the addition.

*Centracs'* system architecture provides for modular cost effective expansion. The architecture consists of three main hardware components: workstations, communications servers, and traffic control/database servers.

All connected traffic signal controllers are polled by a communication server connected to the *Centracs* Traffic Management System (TMS) local area network. *Centracs* servers currently support serial or Ethernet protocols (depending on communication media utilized) of individual local intersection controllers, or other devices, interconnected by multi-dropped twisted-pair wire, wireless, or fiber optic cable circuits.


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The typical *Centracs* interface to a local intersection, or channel of intersections, is as follows: a Communications Server computer is connected to a controller via the provided interconnects (serial or Ethernet). The system will support NTCIP versions of Econolite *ASC/2, ASC/2S, ASC/3* (1000, 2100 or RackMount) NEMA TS1/TS2 controllers, 2070 (L or LN) controllers running the Econolite *ASC/2070* or *OASIS* firmware, 170-type controllers running certain versions Wapiti Microsystems W4IKS firmware, or possibly any NTCIP 1202 compliant NEMA controller or 2070 software.

## General System Architecture

### *Local and Wide Area Network*

*Centracs* supports the concurrent use of multiple workstations (Rich Clients) over local, dial-up, and wide-area network connections. An optional secure Web browser (Thin clients) can be added to the system for remote access. The number of workstations that can be connected is only limited by the capacity of the network and the system servers, which can be scaled up if necessary. A password-based security system is used to log into the system and to ensure that unauthorized workstations that may be on the same network will not have access to the traffic system. Database integrity is also ensured through the use of jurisdictional access and user group permissions so that multiple operators cannot make simultaneous changes to the same intersection's database or access "other agency" databases.

*Centracs* also supports Center-to-Center (C2C) operation by using NTCIP C2C protocols through an optional C2C interface module. This provides the ability for a limited exchange of data across jurisdictional boundaries using standardized NTCIP C2C data objects. If two or more agencies are using *Centracs*, an optional Server-to-Server interface module is available, which allows a seamless coupling and full exchange of data between the systems.

### *Communications*

Typically, the user's console (workstation) reads data from the database on the Core (file/application) Server, which is populated in real-time directly from the communications server, which in turn can be configured to communicate via Ethernet (UDP/IP) communications or serially (RS-232) to each controller or field device. *Centracs* can support fiber optics (multi or single mode), twisted pair, leased lines, and wireless communication modems. Serial based media typically support a communications data rate of 9600 to 19,200 bps; Ethernet supports up to 100mbps. Direct full-time interconnect is typically required to connect the communications server computer to the local intersections in the field. However, *Centracs* is designed to be capable of communicating via dial-up (standard telephone connection) for remote intersection control. Communication server and communications channel capacity will vary based on the interconnect type deployed. However, Communication Server Computer(s) are designed to support a minimum of 250 devices serially (more are possible via Ethernet), permitting *Centracs* to manage additional devices each time a communication server computer is added.

### *Communications Server*

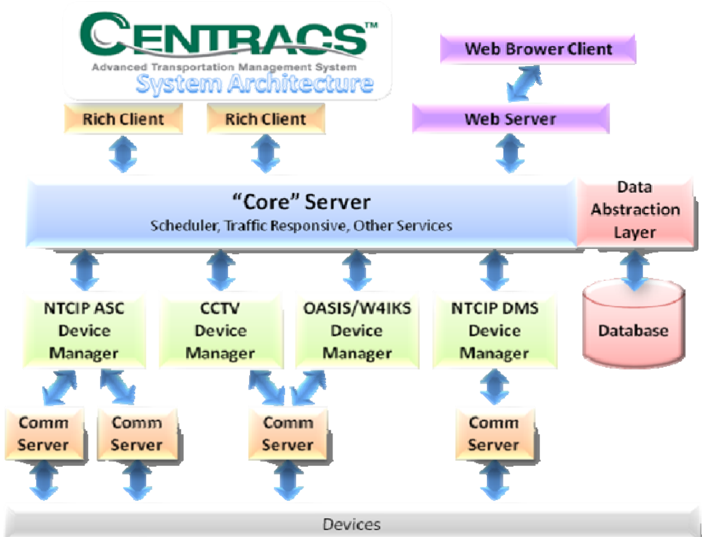
The *Centracs* Communications Server handles all system communications. The Communications Server supports NTCIP protocols to Econolite *ASC/2, ASC/2S, ASC/3* (1000, 2100 or *RackMount*) NEMA TS1/TS2 controllers, 2070 (L or LN) controllers running the Econolite *ASC/2070*, or non-NTCIP controllers such as 2070's with *OASIS* firmware and 170-type controllers running certain versions Wapiti Microsystems W4IKS firmware. Other NTCIP 1202-compliant NEMA controllers or 2070 software may be added in the future. The communication process uses a polled-response type of communications to the intersection controllers. The Communications Server software handles all of the low level communications functions necessary to interface with the various field controllers for traffic signal control, status monitoring and data upload/download. Low-level functions include device polling, message input/output buffering, message sequencing and prioritization of tasks, error checking/correction, data filtering, and short-term data storage. This distributed processing architecture in the system relieves the traffic application/file server from performing these processing-intensive tasks and also prevents these functions from becoming a bottleneck on the local area network.

### *Device Managers*

*Centracs* utilizes Device Managers to exchange data between the core applications (device programming, displays, reports) and the Communications Server. Device Managers (software modules) isolate the knowledge of specific device types into separate executable applications, allowing for modularity and scalability. Device Managers can be configured to communicate with a single Communications Server or multiple Communications Servers. Conversely, multiple Device Managers can also interface with a single Communications Server.

### *Core Applications*

*Centracs* utilizes a Core File and Application Server to perform and manage devices and user interfaces. All data displayed or entered on local workstations is managed by the Core Server, directing all data to Device Managers, a Center-to-Center interface, Server-to-Server interface or directly to the SQL database through a Data Abstraction Layer. For further system efficiency and scalability of operation, the SQL database manager can and should be run on a separate computer.




## Asset (Device) Database Management

All devices used on *Centracs* are configured into the system database using menu selections, dialog boxes, and other object oriented functions. Individual devices can be added or deleted from the system using object-oriented functionality. Each new device, with all the appropriate properties and configurations, can be added to the system in a matter of minutes.

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If device databases (traffic controllers) are required to control and operate these devices, the databases allow users to create new assets from a default database, modify existing databases, upload and download databases to devices, and print, email, or export the databases.   Device databases are specific to each device and are designed with user friendly graphical interfaces.

## Graphical User Interface

The *Centracs* GUI utilizes Microsoft's Windows Presentation Foundation (WPF) technology as the basis for the user interface guidelines, distinguishing it from older Windows GUI window and control mechanisms. *Centracs* uses "container" technology, allowing users complete customization of individual workstations.

Most *Centracs* items (i.e. display, report, function, control, etc.) can be placed in any number of "containers", providing users with immediate access to the most frequently referenced items.  *Centracs* graphics display and control features are integrated into a single user workstation interface.  Any system function or control, such as system maps, intersection displays, status reports and data entry dialogs, can be simultaneously displayed on the graphics display, and can also utilize Windows multiple monitor mode, allowing users to expand "container" windows across many monitors.

All *Centracs* system actions are immediately visible in real-time on graphical and/or text-based status displays. Unlike the GUIs of many traditional traffic management systems that separate operator control and text reporting functions from graphics display functions, the *Centracs* GUI integrates these operations, allowing operators to freely move between contexts in an intuitive point and click manner.

*Centracs* workstations use an advanced map-based GUI.  Each workstation user is presented with an on-screen map of the system area as the main user interface with the system.  GIS-based maps (in their natural form) are required for real-time display of data.  Dynamic icons on the map indicate the type, status, and location of each active field device.  The user can specify how icons are to appear and change based on status information.  The map zooms and scrolls to show more or less detail for specific areas.  The user can also click on any device icon(s) to bring up separate, more detailed displays or reports associated with that field device.  Examples of detailed on-screen displays for one or more devices include: intersection displays, live video feed (with IP based CCTV cameras), event logs, historical status data, user-set parameters, etc.  Extensive use is made of graphics and colors to assist in interpretation of information presented to the user.

The graphics map plays a role as a system device selection palate enabling the operator to make a selection by pointing to a particular object (i.e. controller, CCTV camera, or other optional ITS components).  When such a system object is selected, an object window or control panel and/or status window can be requested for display in a separate window or "container."  If the proper access control privileges are granted, the operator may also exercise control of the device through graphical control panels.

## Traffic Signal Management and Control

In addition to control and monitoring displays and dialogs, formatted data entry screens provide users with the ability to store and edit parameter data for various system elements.  For example, traffic controller data screens allow easy editing of local controller parameters and provide a mechanism for facilitating the uploading and downloading of these parameters to/from local controllers in the field.  During system operation, user alerts are issued through the GUI, using an alert indicator on the tool bar and a separate alert window that can be placed in a "container" for continual display.




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The main display offers a toolbar near the top border that contains menus and other controls for configuring "container" windows, setting session parameters, or invoking another action or activity that affects the entire session. Actions supported by and pertaining to a single window, or "container" are invoked through that window's action bar or controlled internally to the window itself.

*Centracs* provides many ITS functions, of which Traffic Signal Management and Control is one of the primary applications. *Centracs* delivers a powerful management tool for engineers, providing intersection database management, flexible centralized scheduling of events, detailed system, intersection, detector, and efficiency reports, alarm paging and emailing, and powerful analysis tools, such as system detector "link" displays, Time-Space diagrams, Split Monitor graphs, Synchro™ Interface, etc.

### *Traffic Signal Monitor*

The Intersection Status Display window provides a standardized display that can be used to represent any intersection configuration. The display provides graphic representations for up to 16 phases (red, yellow, and green indications), 16 pedestrian movements (Hand and Man symbols), 16 overlaps (red, yellow, and green indications), up to 32 detectors and Status symbols such as Communication Failure, Preemption, Coordinator Alarm, Detector Fault, and Cabinet Flash. An integrated graphics editor provides user-friendly controls by which, symbols are placed on the display to represent each of the desired movements, detectors, and status indicators.

Custom graphics can also be provided with the system. These graphics are typically based on either an aerial photograph of the intersection or an actual CAD-type drawing. The resulting graphic display accurately indicates the intersection geometry, lane configuration and other important elements. As with the template-based graphics, symbols are placed to represent each of the desired movements, detectors, and status indicators specifically for the desired intersection.

### *Traffic Signal Control Modes*

The *Centracs* main server computer(s) provides for system-wide signal database control, communications, coordination, and continuous monitoring of system performance from the central location. The system is designed for unattended operations 24 hours per day, seven days a week, without requiring an operator to be logged on. The central facility has the capacity for continuously monitoring and exercising plan selection control for all controllers and/or other devices. The central system monitors the operation of all field devices and automatically reports detected failures and malfunctions. With requisite licensing and interface equipment, any number of workstations (desktops or laptops) may be attached to the *Centracs* network, each having the capability of performing various functions including:

- Traffic control and management functions
- Historical data analysis
- Traffic engineering operations analysis

Intersections may be configured in any number of control sections each running traffic responsive, time-of-day, or manually selected timing plans.

*Centracs* continuously transmits and receives status data from each intersection via communications media. In addition, data parameter upload, download, and time/date communications requests are supported on a periodic request-driven basis.

*Centracs* distributes actual low-level traffic signal control responsibilities to the local intersection controller. Maintenance of coordination is handled locally and only requires that timing plan parameters be available at the




controller and that controller firmware keeps an accurate time base. Local time base clocks are synchronized with the central system periodically via regularly scheduled time/date update communications functions.

When operating under centrally selected Traffic Responsive (TR), Time-of-Day (TOD) or Manual mode (MM), the communications system transfers to the local controller a plan number which specifies the selected plan of operation required for that controller. Under TOD Local mode (Plan 0), plan selection is handled locally by each controller's resident TOD/DOW (Day-of-Week) schedule.

Monitoring of local controller operations for malfunctions is performed continuously by the central system for all controllers communicating with the central system (regardless of current plan selection mode).

A minimum of 48 locally stored coordination-timing plans (per the TS2 Standard, the Econolite *ASC/2* Series controllers provide 64 coordination plans; *ASC/3* Series controllers provide 120 coordination plans) can be supported at each local controller through NTCIP commands. Each plan consists of a cycle length, offset, and a split set. Timing plans also implement phase omits, phase calls, special function outputs, and phasing sequences as established by a local controller's plan based on parameter settings. Free, Flash, and local Time-Based Coordination (TBC) control plans can also be commanded by a plan input.

System control modes are established and maintained by the system based on operator command, time of day schedule, and equipment status monitoring. Modes can be implemented at four levels: System, Section, Subsection, and Controller. In addition, Groups allow for flexible grouping and control of various, multiple device types.

Within *Centracs*, intersection control mode priorities are as follows (from highest to lowest priority):

- Manual Override (MAN)
- Time-of-Day/Day-of-Week (TOD/DOW)
- Traffic Responsive (TR)
- Local Default Control Mode (LOC)

Within each of these control mode priorities, an additional level of priority is set, based upon area control modes. Each intersection (or other ITS device) can be set up in one of 4 area types, with the following priority (from highest to lowest priority):

- Intersection – consists of single intersections or device
- Group – consists of multiple sections and/or intersections and/or devices
- Section – consists of multiple intersections and/or devices
- System- consists of all intersections and devices

Programmed Free and Flash operations are selected by invoking special plan numbers corresponding to these operations. MAN plan selection can be implemented on a System, Section, Group, or Intersection basis. Intersection Controller Manual Override selection(s) take precedence over Group-based selections, which in turn take precedence over Section or System-wide selections. It is possible for the operator to set independent termination time frame(s) for MAN mode selections at any level.

Local controllers will always fall back to a designated local TOD (Local) mode when not being commanded into one of the other system control modes by the central. The controller will also fall back to this mode should the desired mode be TR and insufficient detector data is available to run in TR mode and no other central mode is available. The local TOD mode will cause the controller to be in the Free State or to operate in a locally determined TOD/DOW plan depending on the local controller parameter settings.

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*Group, Section and System Control*

Controllers, and other ITS devices, are assigned optionally to Sections for plan implementation of traffic responsive, time-of-day, and manual control. In addition, central flash can be commanded on a group (combination individual devices and sections), sectional or system-wide basis. Intersections may be configured in any number of control sections each running traffic responsive, time-of-day or manually selected timing plans. All Control Sections operating on a common cycle length are automatically synchronized by virtue of the fact that they are referenced to the same master cycle timer.

*System Time Reference Synchronization*

The communications server functions periodically synchronize (user settable value) the local time clocks in each of the controllers they support. The server computer clocks are synchronized with each other using a standard protocol, Network Time Protocol (NTP). The workstation clocks can also be synchronized using this protocol. An internet time source is typically included as part of the system hardware to allow all system clocks to be referenced to a traceable time source.

The cycle-reference time used by traffic controllers is a function of the traffic controller software. Per the TS2 standard, the beginning of main street green is defined as the local zero point.

## Optional Synchro™ Interface Module

The system shall support an interface to the Synchro signal timing software, by Trafficware®, Ltd. Trafficware develops and markets software for Transportation Engineers. Synchro is the transportation industry's leading software application used in modeling traffic flow and optimizing traffic signal timing. This interface module provides the ability to transfer Econolite controller phase and coordination data to/from Synchro.

The module provides the ability to save controller phasing and timing data, and detector data, in the Universal Traffic Data Format (UTDF). Once saved in this format, the data can be exported to and opened in the Synchro application for off-line analysis and optimization.

The module also provides the ability to import Synchro timing plan data saved in the UTDF format back into the native Econolite controller format for use within the system.