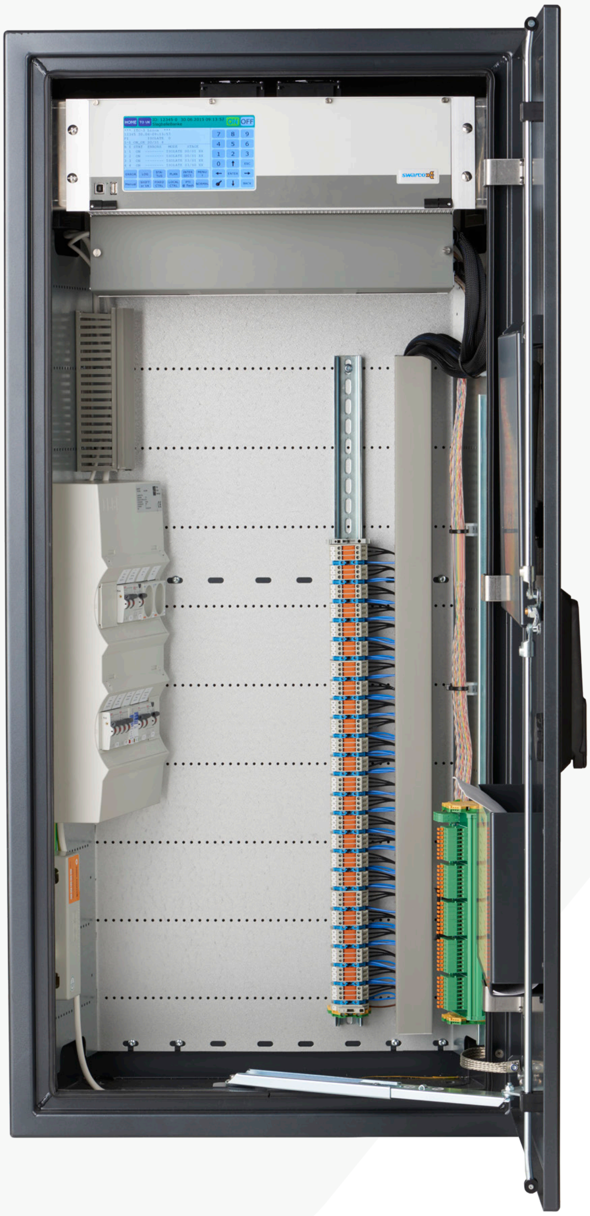
SWARCO

ITC-3 TRAFFIC CONTROLLER

BUILT FOR THE FUTURE



The Better Way. Every Day.

CONTENTS

We hereby have the pleasure to offer our new designed ITC-3 Traffic Controller together with our Swarco Cloud supervision and control software for your project

The ITC-3 controller is state of the art in its design, running a Linux based system on a modern and reliable ARM-based platform, with tight integration of dual safety CPUs and all required hardware to run an intersection in a single rack. The controller can be serviced through the built-in touch screen and web interface, and connects to a wide range of systems

The Hardware and Software platform used in ITC-3 makes it easy to upgrade for new innovations and this makes the ITC-3 controller future safe

Innovations that you find in the ITC-3 controller:

- Enhanced temperature range, ITC controllers are tested under all weather conditions from Artic to Equatorial environments
- Cost effective rack system with up to 24 signal groups in one single 19" rack
- VGA Touchscreen 800x480 makes it easy to maintenance and program the controller
- Innovative adaptive Traffic Algorithms calculates flow to capacity for every cycle and optimizes cycle time and green split for a single intersection or controls the right settings offset and split for a corridor
- ITC-PC Programming tool, Powerful 3D graphical programming tool makes it easy to configure the controller even with advanced adaptive programs
- ITC-Sim, Simulator that gives the opportunity to test and optimize controller programming directly on a PC with no need for extra Hardware
- SWARCO Cloud, an Easy to install and operate command and supervision system for ITC Traffic Controllers
- Web interface, can be used as supervision and control system or as a back-up system to easy service and maintenance the controller
- ITC controllers connects to the world's most common systems i.e. SCATS, SCOOT, ITAKA, NTCIP, Omnia
- C-ITS functionality, Newest innovation like TLA (Traffic Light Assistant, Time to Green and Time to Red) are already included in the ITC Firmware

CONTROLLER DESIGN

The ITC- 3 controller is, with its compact design and its many features, a controller designed to fulfil the requirements of the world market. The ITC-3 controller is based on a 19" rack solution with Main CPU / Safety CPUs / Signal Group cards.

The controller is delivered in three standard sizes:

- 6 signal groups, 16 internal loop detectors
- 12 signal groups
- 24 signal groups, 40 internal loop detectors

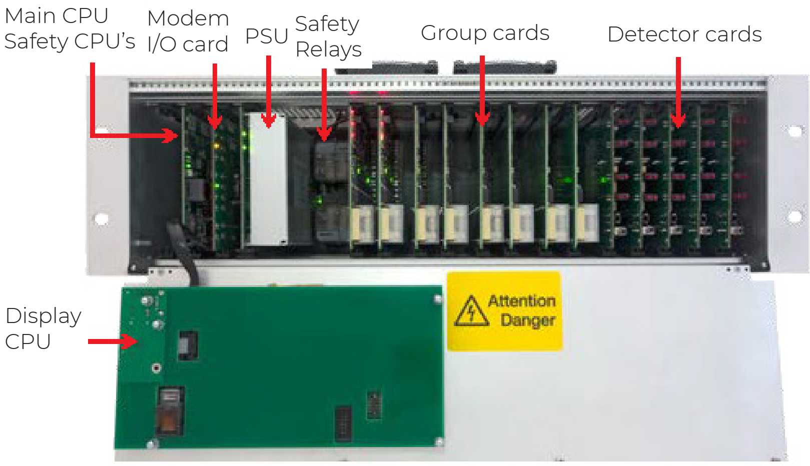
It is possible to have extra racks attached to the 24/40 model to increase the number of groups to a maximum of 64 groups.

The maximum number of inputs is 128 loop detector inputs, 128 digital inputs and 128 digital outputs.

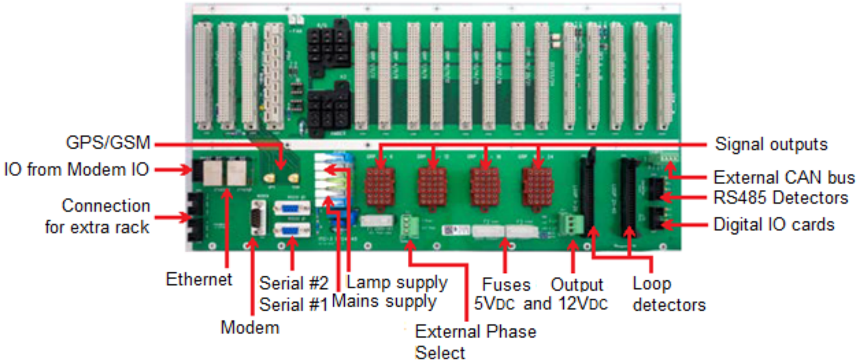
Rack Layout

The system architecture is kept the same across the different rack sizes, therefore all the cards are interchangeable between the different sized units so only one set of common spares is required.

The 24/40 model is shown below as an example of how the different components fit together inside the rack.

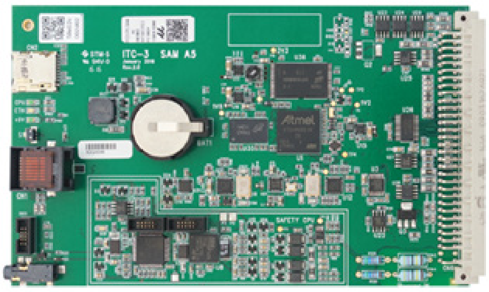


The connectors for external connections are all provided underneath the main rack for ease of maintenance as shown below.



Main CPU/Safety CPUs

The CPU card implements three micro-processors, the main processor for the ITC application running Linux and two safety processors. An on board real-time clock ensures stand-alone operation with an accuracy < 2ppm @25°C (calibrated).



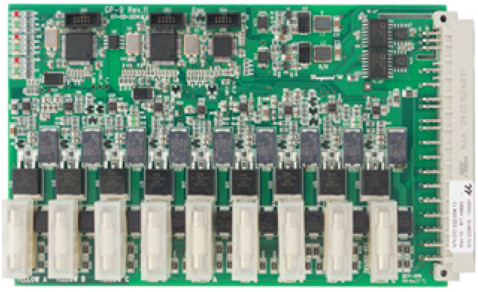
The integrated Safety CPUs monitor the following:

- Signal Conflicts
- Mains voltage
- Mains voltage dip
- Mains frequency
- Flash periods
- Plan cycles
- Signal state timings
- Lamp Minimum / Maximum loads

If any of these checks reveals a signal stage endangering the traffic, the safety relays will be switched off.

Group Card

The group card implements three signal groups, and has in total nine outputs, each fused by a 2A slow blow fuse. The outputs are used for red, amber, and green signals.

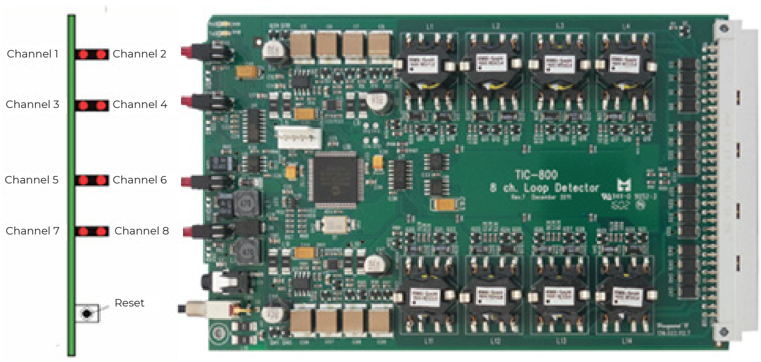


The group card has three micro-processors controlling and monitoring the signal outputs. Output voltages and currents are monitored. It has 12 LED indicators on the front indicating the signal group output status: red, yellow, green, and a blue for error indication.

The normal operation is for the 9 channels to be configured as red, amber and green, however the card can be configured with up to 4 outputs on the same group and of same colour. Also, each logical group has an auxiliary output that can be controlled by software for supplementary use. A logical group auxiliary output must be mapped to one of the 9 physical outputs on the group card.

TIC-800 Inductive Loop Detector Card

The TIC-800 detector controls eight inductive loops.



The detector is auto-tuning and scans the loops in two sections of four loops each with a response time of max 26 ms. Release time after detect state is 100ms. All parameters are downloaded from the main CPU. See ITC-3 Training Manual for details. Max loop feeder length is 300 m.

ITC-3-PSU-35 Power Supply

The power supply is a shielded unit complying with EN60950-1(ed2, am1, am2).

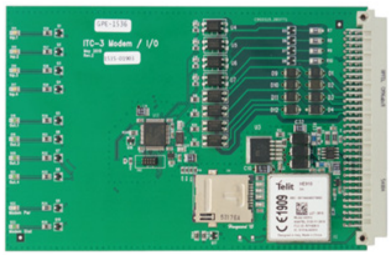
Power outputs are:

- + 5VDC
- +12VDC

Total power output for the standard unit is 30W. On the front there are two green LEDs indicators showing voltages +5V and +12V are OK.

Modem IO Card

The combined circuit board provides a standard modem interface together with GPS, four 24V input ports, and four output ports. The common terminals for the input, and output ports may be connected to either + or - of the power supply as suitable for the application.



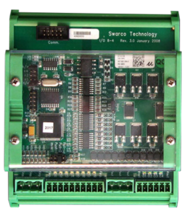
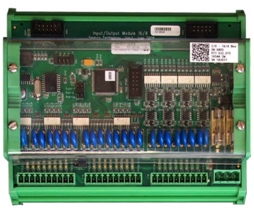
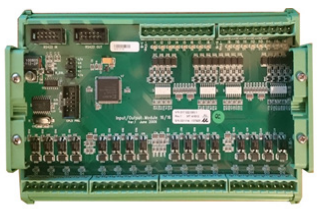
Digital IO Cards

The combined circuit board provides a standard modem interface together with GPS, four 24V input ports, and four output ports. The common terminals for the input, and output ports may be connected to either + or - of the power supply as suitable for the application.

There is a number of different versions of Digital input and ouput cards available for the ITC-3 controller:

- 8DI/4DO 8 Digital inputs and 4 Digital outputs
- 16DI/8DO – 16 Digital inputs and 8 Digital outputs
- 16DI/16DO – 16 Digital inputs and 16 Digital outputs
- 24 DI – 24 Digital inputs
- 24 DO – 24 Digital outputs

The digital IO cards are DIN rail mounted cards. The card is connected to the controller with a 10-Way ribbon cable from connector CN22 I/O (RS422) located on the right side of the rack. The next card is linked to the previous by the 10-Way Ribbon Cable the IN and OUT connection polarity is not important when daisy chaining the cards.

Further information about the ITC-3 Controller Design can be found in the following manuals:
Appendix A, Manuals/ITC Manuals/ITC-3 Service Manual V1.8 EN.pdf
Appendix A, Manuals/ITC Manuals/ITC-3 Training Manual v1
Appendix A, Manuals/ITC Manuals/ITC3-UK Installation and Maintenance Handbook

CABINET DESIGN

Description:	Controller built into High Quality Sea Water Resistant aluminium cabinet with all needed plinths, fuses and electrical wiring
Dimensions:	H 1300 x W 900 x D 420 mm
Colour:	Light Grey, RAL Colour has to be specified
Weight:	80 Kg

SOFTWARE DESIGN

The combined circuit board provides a standard modem interface together with GPS, four 24V input
The ITC Traffic Controller is already adopted to a wide range of countries and specifications.

Coverage and adaptation
The ITC traffic algorithm is a full group logic-based controller. Each signal group can be controlled independently according to programming with respect to the defined safety configuration. Starting out as a Scandinavian Traffic Controller, the algorithm has been continuously improved and extended to meet the needs of the world market. As such the controller software is adapted to the requirements of more than 40 countries and can run a range of traffic control philosophies and systems.

The software connects to a wide range of supervision systems, with built in support for the following protocols:

- STCIP
- STREAMS
- RSMP
- 501
- KUN-Connect
- SPOT
- SOTU
- X-Link
- Swarco-Cloud (proprietary)
- IVERA
- UG-405
- UTMC
- NTCIP

It can be controlled by the following adaptive/external traffic systems:

- SCATS
- SCOOT/UTMC
- Artic
- ITAKA
- CCOL
- SPOT/UTOPIA

The software is developed with extendibility and adaptability in mind and can generally be integrated into any traffic control approach. The algorithm is guaranteed to fully run within a 100ms time slice, which is then the minimum control resolution. Safety features are handled directly in the safety CPUs by dedicated software, which can react in 20-200ms depending on the safety violation.

The main controller software consists of an ITC-Core, that handles hardware interfaces, safety features, and base algorithm. A range of software packages can connect through a fast binary interface internally and run traffic logic or supervise the operation.

Software development process

Software development follows an agile approach adapted to suit the somewhat special needs of safety critical software. The development processes are two-fold; one for non-safety critical software, and a slightly more strict process for the parts that fall under safety criticality.

All non-safety critical development goes through design, implementation, code review, encapsulated test, and finally passes the overall release tests before release. As the process is agile, any feature or bug fix that goes through the process can be sent back to earlier stages in case it doesn't pass the next stage.
Each feature is completely separated from other development during the development phase, and not included in the development version until it has undergone encapsulated test and code review. At that point it passes into the software package development branch, and further has to pass the release tests before being released to customers.

The non-safety critical process undergoes an internal retrospective audit in the software team after each release and optimizations and/or changes are implemented before next release cycle.

Software packages with safety-criticality have additional process steps. After the code review step, an additional code coverage test is inserted, and an impact analysis is done to determine if the changes have potential to trigger any regressions in other parts of the software.

Any possibly affected parts are re-tested before the changes can be merged into the development branch of the package.

Before starting release tests, a change analysis is done to determine the extent of 3rd party reassessment needed.

The processes and management of development are certified according to ISO 9001, 14001 and 18001, and re-audited yearly by an accredited 3rd party (Currently DNV).

The software process has been honed to move quickly and thoroughly into new philosophies and market requirements and has been proven to be very effective.

PROGRAMMING INTERFACE

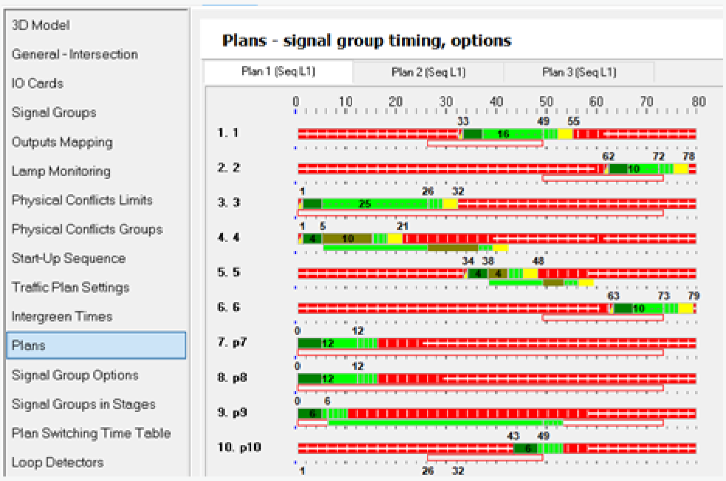
Advanced Traffic Controllers require advanced and user friendly programming interfaces. It is a way to allow the user to take best advantage of the solution and understand it well.

The ITC-PC software is a tool for preparing the ITC controller traffic configurations. It is the same software for uploading/downloading traffic configurations to/from the controller. The configuration as a collection of parameters can be also saved on the hard drive as .PTC, .PTC2 or .PTC3 file.

There are three modes for viewing and editing the configuration parameters: ”Advanced”, ”Quick Start View” and the ”3D mode”.

The advanced mode is based on tables containing all configuration parameters. For more information about programming in the Advanced mode please see:
Appendix A, Manuals/ITC Manuals/ITC-3 Programmers Manual.pdf

The Quick Start View mode is more graphical and simplifies the programming process for both advanced and new ITC programmers. The Quick Start View mode is a wizard that guides the user through the programming process step-by-step starting from base configuration settings to vehicle actuated and coordination settings.



The 3D View mode is an extension of the Quick Start View mode. This allows the user to draw a virtual model of the junction which then becomes the centre point of the configuration. It links all the configuration chapters (intersection layout, signal groups, detectors, timing settings and more) and provides reference to all typical traffic signal systems objects (signal groups, detectors, traffic lanes). Properties of individual elements can be then seen on a separate panels/windows triggered from the object list or directly from the 3D junction layout.

Specified objects (groups, detectors and more) can easily be dragged-and-dropped directly on the junction model during the junction model building process. A scalable background ensures further functionality related to traffic engineering and C-ITS areas:

- Traffic plans and structures design
- Intergreen times evaluation
- Printing junction documentation
- Producing the MAP/ITF file (part of the Spat/Map systems)

For further information about the functionality of the programming interface solution please see:

ADAPTIVE TRAFFIC ALGORITHM

The ITC controller has an adaptive algorithm for an isolated intersection and as well for a corridor that with a of a minimum detection system (only a stop line loop in each lane) has proven to give very good results.

The algorithms are called Smart Intersection and Smart Corridor.

Smart Intersection

Smart Intersection is an adaptive traffic control solution for an isolated intersection and is part of the adaptive solution for a co-ordinated system called Smart Corridor. It is designed to measure the level of service on an individual intersection and evaluate optimal cycle length and the green split in order to minimise the overall delays, number of stops, pollution and fuel consumption.

- Smart Intersection is a software package in the controller logic that can be applied to optimise maximum green times for signal groups and/or signal stages, as well as the signal cycle length.
- The optimisation is based on a continuous measurement of saturation flow using detectors placed directly after the stop line for targeted signal groups.
- Not all signal groups or stages need to be chosen for optimisation in Smart Intersection.
- The aim of Smart Intersection is to maintain a" useful" allocation of green time and to reduce or increase the cycle length time in accordance with prevailing levels of traffic demand. This means that ineffective green time is minimised (e.g. not maintained for late vehicle passages) and that the system adapts to the traffic situation.

It is an innovative approach having such a powerful adaptive traffic control logic build in the controller's software. It allows adaptive operations locally without a need for the central level. This is a way to reduce the licensing and infrastructure costs but also simplify the installation and maintenance procedures.

User-friendly and intuitive programming user interface is an additional strength. An advanced programming tool with the 3D junction layout makes the advanced traffic control solution easy to implement and understand for the traffic engineers.

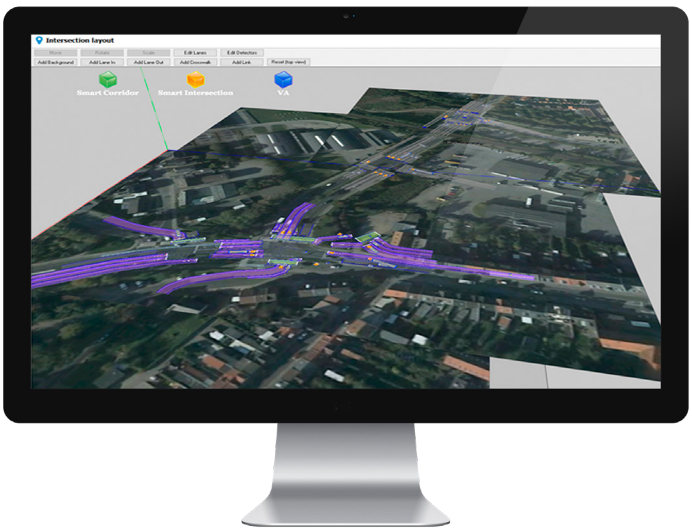
Smart Corridor

Smart Corridor is an adaptive dedicated traffic control solution for co-ordinated signalized corridors. It is a software package that decides optimum cycle length for a whole corridor and supports individual junctions with the cycle split estimation. With the Smart Corridor the cycle change and split is applied gradually in order to always maintain the coordination path. The rule can also deal with another intersection some distance away which shall run a different cycle length at some point of the cycle change transition.

Together with the Smart Intersections reporting evaluated performance factors from each individual junction, the traffic algorithm can decide either to fully support the coordination path or resolve some oversaturation problems measured on some intersection's side roads or left turn movements.

The variety of different options makes the solution very modular. It is the user that can decide level of adaptiveness on the individual junction and the individual junction impact on the traffic control strategy for a whole corridor.

As with Smart Intersection the Smart Corridor programming process is also supported with the 3D drawing features visualising the whole corridor and also each individual system objects (detection zones, signal groups, push buttons). The Smart Intersection and Smart Corridor user interface is specially designed to make the advanced traffic solution easy to implement.



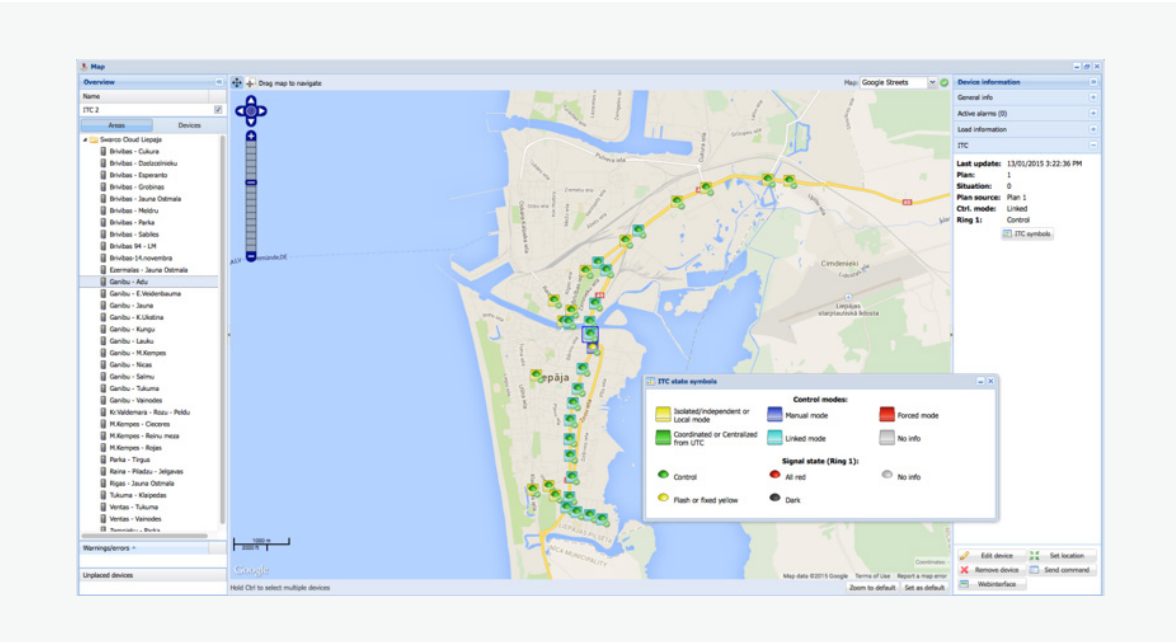
SWARCO CLOUD

SWARCO Cloud is a monitor and control system developed by Swarco Technology.

By drawing on three decades of experience in the field of traffic control, Swarco Cloud is designed as a simple and efficient way to survey connected devices, alerting about alarms and giving means to access the devices directly through the service without complicated network setup.

The features available to a user in the Swarco Cloud system in order to:

- Get an overview of the controllers in the system
- Get immediate information about a controller in the system
- Obtain more in-depth information about a controller
- See and export special data from a controller
- Send commands to a controller
- Access the controller web interface directly

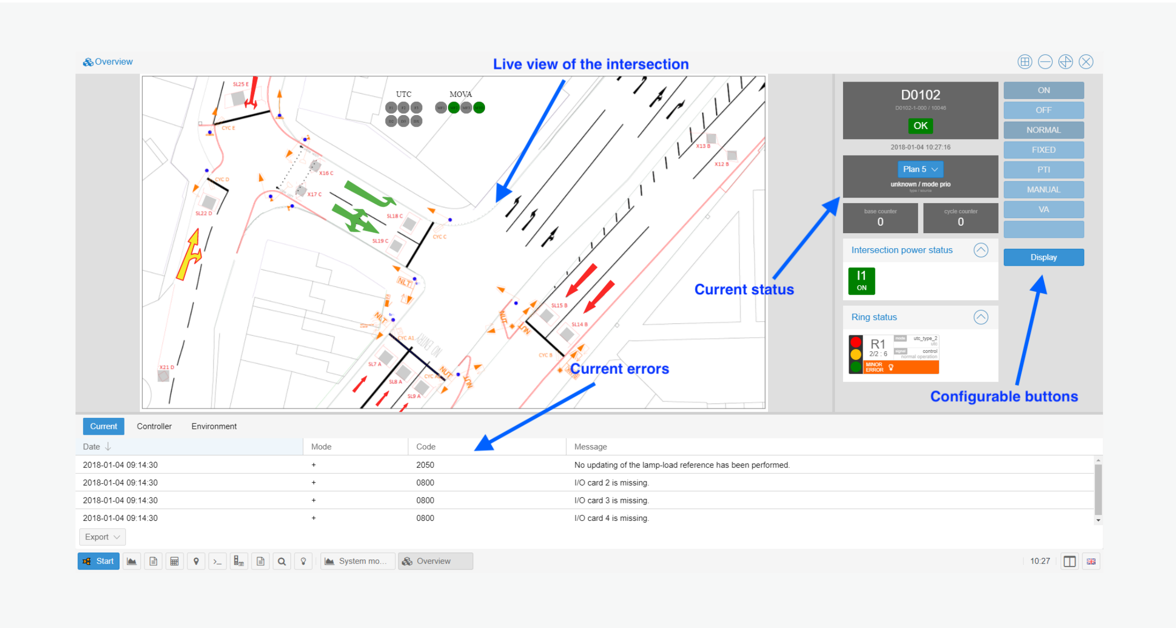


ITC WEB INTERFACE

ITC controllers is based on the Linux platform and has a built in Web server that can be used by field engineers to get an overview of the operation, status and errors in the intersection.

Overview

Get a quick overview of the current status of the intersection, including group status, current errors, and a configurable set of buttons to influence the controller.

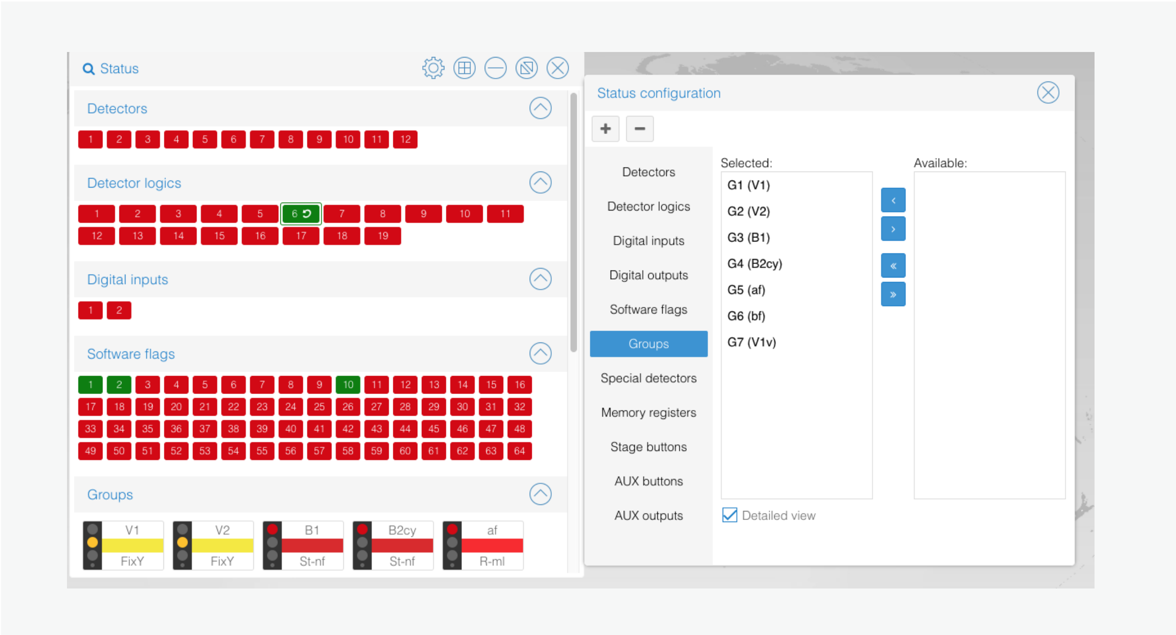


Stripes

See real-time or historical view of groups and detectors.

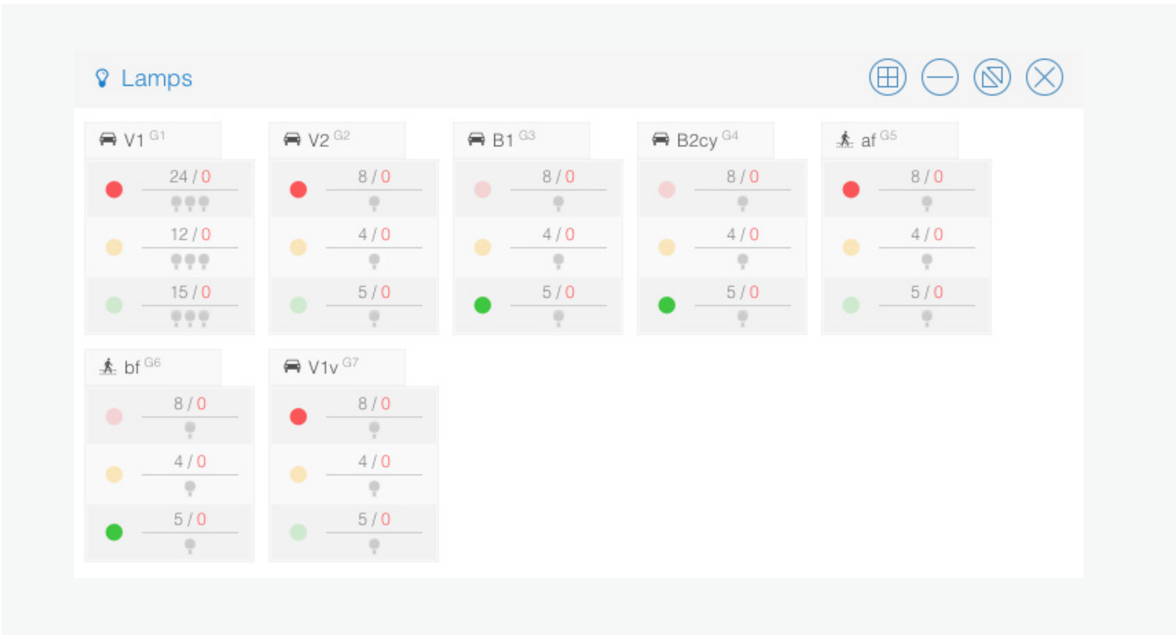
Status

See complete status of traffic algorithm elements in the controller, fully configurable.



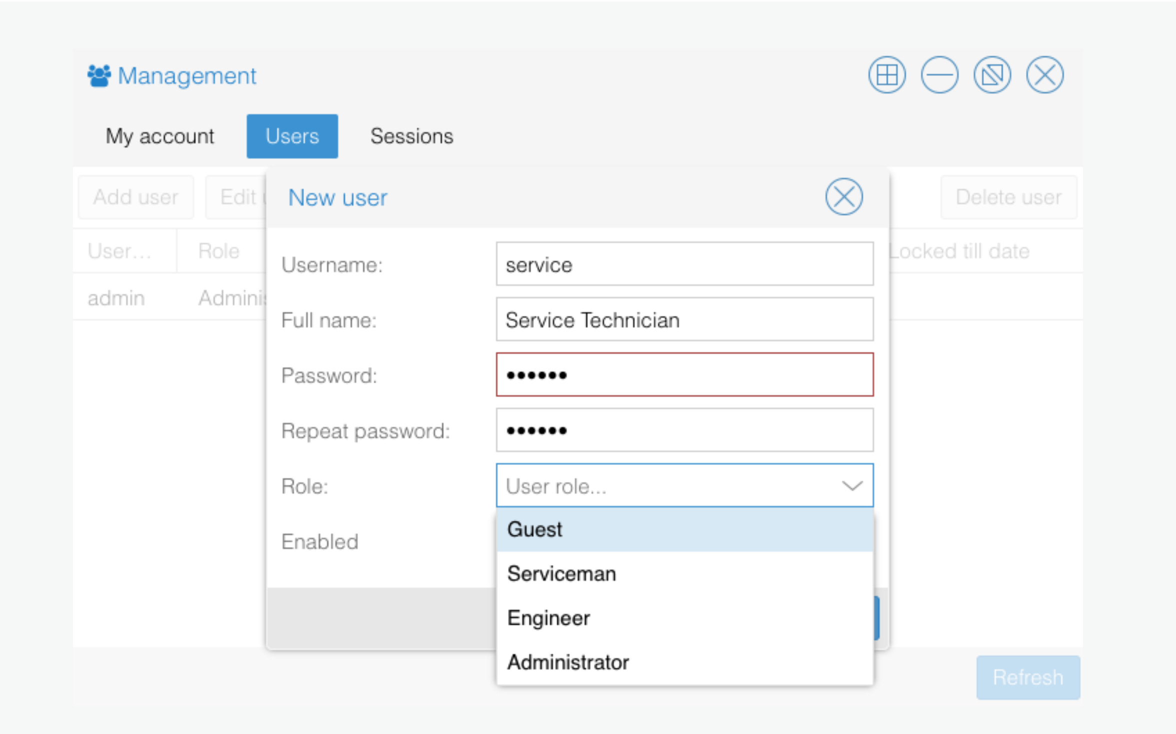
Lamp supervision

Get a quick overview of all lamp measurements and warning/error levels.



User and rights management

Complete control of users and 4 user rights levels.



INSTALLATION, SERVICE AND MAINTENANCE

The ITC-3 controller is built with installation, service and maintenance in mind. The controller is designed in a manner that reduces maintenance man-hours and technical qualification requirements for servicing common and critical controller faults.

The following documentation is provided to demonstrate the processes for undertaking common service, operational and maintenance activities required for the controller. Included is a regular schedule of preventative maintenance tasks for the controller hardware.

Installation

See the ITC3-UK Installation and Maintenance Handbook, Section 9 on page 26 for installation details.

Example Basic Service Functions

Examples from ITC-3 Service manual v1.8, Section 6 page 54 onwards:

- Setting Time/date
- Learning and monitoring of lamp loads
- Lamp Testing

Examples from ITC-3 Training manual v1, Section 4 page 26 onwards:

- Confirming Firmware and Configuration Details
- Controller basics (date, time and timezone)
- Verifying detection, inputs and outputs
- Verifying correct group outputs and flash testing
- Learning and verifying lamp loads
- Lamp faults and correspondence monitoring

Operational Functions

See the ITC3-UK Installation and Maintenance Handbook, Section 9 on page 26 for installation details.

Example Basic Service Functions

- **Error and Diagnostics**
  - ITC-3 Service manual
    - Section 4.4 page 40
    - Section 5 page 44 onwards
    - Section 6.7 page 59
  - ITC-3 Training manual, Section 5.1, page 51
- **Status monitoring of signals, detectors, inputs and outputs**
  - ITC-3 Service manual
    - Section 4.3 starting at page 34
    - Section 6.9 starting at page 61
  - ITC-3 Training manual
    - Section 4, page 26
- **Configuration management**
  - ITC-3 Service manual
    - Section 4.6, page 42
  - ITC-3 Training manual
    - Section 5.6, page 83

Administration and monitoring tasks may also be undertaken using the simple web interface provided by the controller.

Administrative tasks include:
- General Settings
- User account management
- Network Settings
- Package management for add on features such as communication protocols
- System Monitor

Monitoring tasks include
- Overview of controller status including all current and historical fault logs
- Status monitoring of signals, detectors, inputs and outputs
- Stripes view of signals and detectors (live and historical views available)
- Display panel
- Terminal / console access

Scheduled maintenance

Refer to the ITC-3 Service manual, The ITC-3 controller has an expected lifetime of not less than 10 years. During this period no components are required to be exchanged preventively. However a routine check should be done once a year. A maintenance check list, with recommended check procedures, is provided in the Service Manual ITC-3 Service Manual V1.8 EN.

The SWARCO ITC-3 Training Manual is available and this covers a range of topics tailored to the service engineer:

- Controller Interrogation Methods
- Hardware Overview for Hardware not currently in the Service Manual
- Installation Procedures
- Maintenance Procedures

Reactive maintenance

The ITC-3 is a highly modular traffic signal controller that uses a rack and bus based frame into which modules are inserted. There are also additional modules that are DIN rail mountable, connected to the main rack via ribbon cables. All connectors are located for ease of maintenance at the bottom of the rack behind a protective cover. Power and data are distributed on the backplane to support easy replacement which results in the task of replacement taking in the order of a few minutes.

The ITC-3 Training Manual covers the field replacement of components at Section 5.5. Table 20 has detailed guides for replacing, personnel required and time to fix. This time to fix is slightly variable as the time taken to board out an intersection with out of order boards (if the signals are required to be switched off) depends on the size of the junction and number of approaches.

Field Replaceable Units:

Field replaceable units are divided into three categories:

- Items located inside the controller rack (including the rack itself)
- DIN mounted controller modules within the controller cabinet.
- Ancillary equipment forming part of the cabinet architecture.

The following page details this hardware giving a time estimate for replacement, including any depot preparation time before hand which will reduce time take on street.

Rack mounted hardware consists of:

- **Aux IO Modem Card - not more than 5 minutes to replace card. No configuration necessary**
    - Table 20 page 70
- **Secondary CPU Card - not more than 5 minutes to replace card and reload any necessary software.**
    - Table 20 page 71
- **Main CPU/Safety CPU Card - not more than 5 minutes to replace card, 10 minutes to load correct firmware and config using test rig in depot.**
    - Table 20 page 72
- **12V/V PSU unit - not more than 5 minutes to replace unit.**
    - Table 20 page 73
- **Backplane ID daughterboard - not more than 10 minutes to replace.**
    - Table 20 page 76
- **9 Channel Group Cards (Lamp switch card) - not more than 5 minutes to replace.**
    - Table 20 page 74
- **Individual Aspect Supply Fuses (9 per group card) - not more than 5 minutes to replace.**
    - Table 20 page 75
- **Lamp Relays - not more than 10 minutes to replace both.**
    - Table 20 page 77
- **8 Channel Detector Cards - not more than 5 minutes to replace.**
    - Table 20 page 78
- **Display CPU/Touchscreen - Swap entire front panel as one assembly, not more than 5 minutes to replace.**
    - Table 20 Page 81
- **Entire rack - this can be replaced in as little as 15 minutes.**
    - Table 20 Page 82

Available DIN mounted controller modules within the cabinet have been designed with serviceability in mind, and all connections to them are either IDC ribbon connections or screw terminals that detach from their header making swapping of modules very quick to undertake. Available modules are:

- **I/O Cards (IO16-16, IO 16-8 or IO-8-4) - Not more than 5 minutes to replace**
    - Table 20 page 79
- **Regulatory Sign Monitor Card - Not more than 15 minutes to replace**
    - Table 20 page 80

Ancillary equipment in the controller cabinet supporting controller operation are listed as follows:

- **The cabinet is provided with a Mains AC Switchboard as part of the sub-assembly.**
    - ITC-3 Service Manual Section 1.41, page 11.

Diagnostic Tools

The ITC-3 has a number of diagnostic tools including an LCD touch screen available on the front of the controller. This can be used to interrogate and diagnose the operation of the controller and all necessary modules and as well to test the communications links.

In addition, via the use of a laptop other diagnostic software can be used to test and or update any internal software systems.

The ITC controller comes furthermore with advanced simulator tools and interface to VISSIM. The ITC-3 Training Manual covers controller interrogation methods in Section 2. Please see this section for more detail. The options are:

- Touch display
    - Status icons for detection, group status, fault display, configuration management and hardware/software versions.
    - Status/Programming interface for viewing configuration parameters, and providing monitoring of all detection, I/O, group behaviour, modes, fault information etc.
- Engineering Terminal
    - Handset commands for common tasks, status info, configuration view/change etc.
- Web Interface (requires laptop)
    - Comprehensive suite of tools for management, overview, monitoring the controller.
- ITC Console (another terminal)
    - A more advanced tool for viewing and changing configuration parameters
- Simple Swarco Shell
    - An advanced Linux shell for controller administration tasks.

The ITC-PC User Manual provides information on programming of the controller but also using a debugger tool to view the configuration operation on the laptop. This can be used in conjunction with simulation tools such as VISSIM to analyse how the controller configuration will perform in different situations.

APPROVAL DOCUMENTS

The ITC-3 Traffic Controller complies with the European regulations for Traffic Controllers, and has been tested accredited according relevant safety and environmental standards as listed below. The European traffic standards specifies international standards for Environmental, EMC and Electrical safety testing.

The safety design of the ITC-3 is compliant with IEC 61508 "Functional Safety" SIL 3. This means that all measurement circuits and safety processors are redundant forming two safety channels with mutual diagnostics.

STANDARD	NAME	COMMENT	ACCREDITED TESTING
EN50556	Road traffic signal systems	Specifies the IEC60068 series	DELTA/FORCE
EN12675	Traffic signal controllers / Functional safety requirements		DELTA/FORCE
EN50293	Road traffic signal systems / Electromagnetic compatibility	Specifies the IEC61000 series for EMC testing	DELTA/FORCE
IEC 60950-1	Information technology / safety		DEKRA

The processes and management of development are certified according to ISO 9001, 14001 and 18001, and re-audited yearly by an accredited 3rd party (Currently DNV).

SWARCO Technology's production and development are ISO certified to the following standards

- ISO 9 001 Quality Management
- ISO 14 001 Environmental management
- OHSAS 18 001 Occupational Health & Safety Advisory Services

REFERENCES / TESTIMONIALS

The ITC-3 Controller is state of the art and a controller developed for the world market installed in more than 50 countries.

Selected references last 5 years, ITC controllers:

Country	Company	ITC-controllers
Colombia	Smart Mobility & Security	340
Denmark	SWARCO Denmark	735
Estonia	IB Foor	98
Finland	SWARCO Finland	425
Ghana	Signals & Controllers	207
Poland	ZIR-SSR	2.117
India	Trafitek	60
Ireland	Elmore Group	311
Israel	IPI Power and Control	500
Latvia	Lucidus	277
Lithuania	UAB Eismo Valdymo Sistemos	102
Netherlands	SWARCO Netherlands	473
Norway	SWARCO Norway	387
Russia	STROY INVEST	1.150
Sweden	SWARCO Sweden	772
Thailand	Wang Tong Union Company	24
UAE Emirates	Tamas Group	166
United Kingdom	Motus Traffic	748
United Kingdom	Telent	1.800
Uruguay	Ciemsa	515
Vietnam	FPT Information System	190
Total		**11.397**

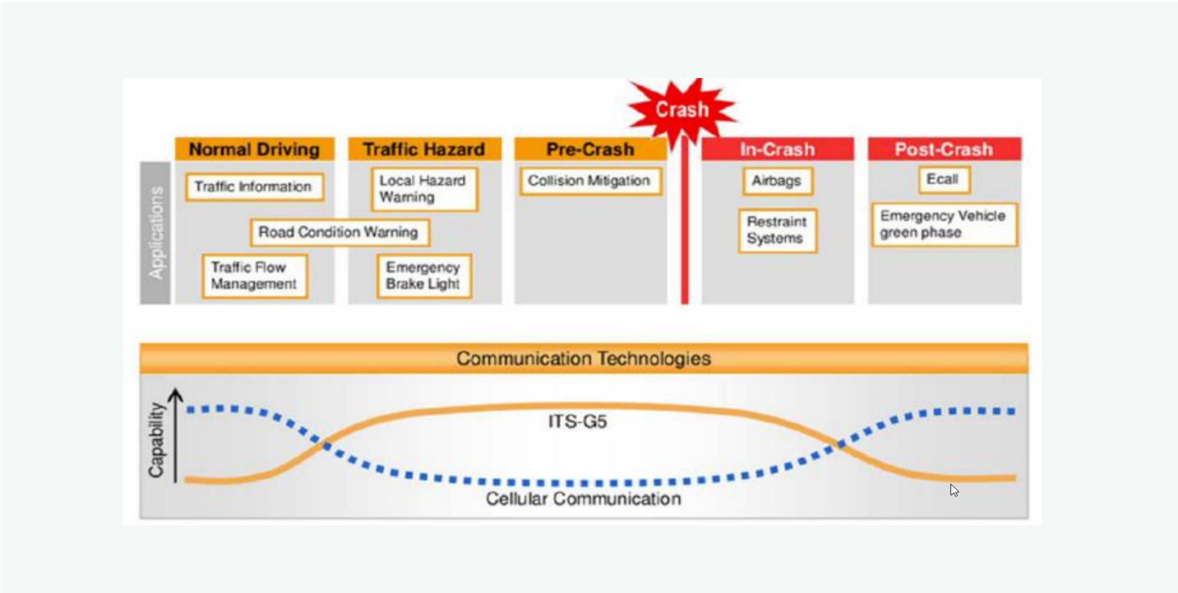
INNOVATION

C-ITS

Cooperative ITS is a greatly emerging field. Swarco has drawn its competences in traffic together to be able to offer great integration in its products. The ITC-3 comes by default with C-ITS/C2X support and integration into the traffic algorithm is constantly evolving. By working together with authorities, automakers and suppliers, the ITC-3 is on the forefront of this innovation.

Numerous trends, ranging from connected automated vehicles (CAV) to the Internet of Things (IoT) passing by Mobility-as-a-Service (MaaS), are likely to come together to create drastic changes in mobility systems over the next 5 to 10 years. These changes will have important impacts on the way we monitor and control traffic in cities. The future of urban traffic management is CAME: Connected, Automated, Multimodal and Environmentally-conscious. Connected and Automated vehicles are inevitably on the way and technology is evolving fast. Today we face the dispute between two major technologies: DSRC (ITS-G5 or WAVE) and cellular technology (V-LTE/5G). Differences in terms of reliability, safety and delays appear to decrease more and more, but still the winner is missing.

The proposed solution has been designed to accommodate both scenarios and to achieve an implementation which is independent of the communication technology related to specific use cases. The most suitable access technologies (DSRC or cellular) will be derived from the use cases (safety-related or comfort application), the appropriate communication method (broadcast vs. point-to-point) and the type of addressing (IP or geographically). Vehicles could then select the appropriate access technology based on performance indicators. Alternatively, mobile devices could be used in vehicles not equipped with DSRC technology.



The solution focuses on the application stack mainly and the ability to generate and process C-ITS messages independently from the chosen communication mean and equipment manufacturer.

Swarco has extensive experience in this field based on our participation in many projects in Europe and North America. We are active partners with a leading role in the “C-ITS corridor program” involving three European countries (Netherlands, Germany, Austria) and as SPAT/MAP data supplier for a major OEM in North America.

As a result, Swarco has developed several software modules, like the Central ITS Station (C-ITS-S), that are part of the enhanced solution to support new cooperative services.

The following is a non-exhaustive list of already supported Use Cases:

Intersection Safety (ISS) based on signal, phasing, timing and map data (SPAT/MAP), In-vehicles Signage (IVI), Roadworks Warning (RWW), Probe Vehicles Data (PVD) and other Decentralized Environmental Notification Messages (DENM).

The ISS use case will provide information on traffic-light status and a geographical representation of the vicinity of the traffic light. The use case description is based on the most promising possibilities to use SPAT/MAP based information in specific use cases, namely for the use cases:

- Vehicle Speed optimisation approaching an intersection, based on signal status
- Traffic Signal priority for emergency vehicles or public transport
- Fast pre-emption of traffic due to traffic light signal change (red to green)
- Prevention of red light violation

The collection of anonymised information from mobile ITS stations (PVD data) will enlarge the information base for traffic management decisions. Until now there is no standard or data format specified for PVD. For this reason, a method for collecting possible data from vehicles, based on the already existing Cooperative Awareness Message (CAM), as specified by [ETSI 302 637-2]. This method is called CAM Aggregation and includes:

- Vehicle data (type, speed, location, accelerations etc.)
- System state (e.g. ESP, ABS if provided by the OEM)
- Priority request
- Emergency vehicles status (e.g. siren in use)

This data is used to calculate travel times and origin-destination matrices.

IVI, RWW and more in general DENM are used to inform drivers about:
- Current speed policy/advices and other relevant (hazard) information which are shown on dynamic traffic signs using the In-Vehicle Information
- Road works ahead, their relevant parameters and associated obstructions (e.g. closed lanes)
- Other ATMS generated information like general traffic conditions, rerouting suggestions and queue warnings.

The challenge of bringing this new environment and its hugely enriched, expanded and complementing data set into the traffic management centre is carefully addressed with a modular service-oriented system architecture and a robust and scalable data fusion engine. The data fusion engine particularly is designed in such a way to be able to scale along with the penetration of both Road Side Units (C-ITS-R) and Connected Vehicles.

Moreover, best practices in system design have been applied to guarantee, for instance, loosely-coupled components to be replaced with alternative implementations that provide same services. The effort made is amply repaid by the enormous potential that these data have in terms of optimization and traffic control measures. Especially, the switch from human driven to driverless cars will have a major impact on classical traffic flow modelling as traffic analysis, planning, control, and generally transport management are strongly based on it. For the ITC controller we have developed TLA (Traffic Light Assistant) and this functionality is now a part of the ITC core it is developed as a cooperation between Swarco, Volvo and Norwegian Road Authorities, and it serves the purpose to provide drivers with “Time to Green-Time to Red” information to optimize the traffic. Trondheim is one of the first Nordic cities to test the new TLA function where the application was deployed on 48 intersections, Volvo cars and an app system.