TCS990
Voice communication systems for ATC

Document history

History	Changes	Author	Reviewer	Date
Rev 1	First version	L.Blaauw	-	17-1-2011
Rev 2	Changed to the new style. Updated document.	T. de Ridder	W. van Eck	17-7-2016
Rev 3	12" size corrected into 12.1"	J. Smid	W. van Eck	21-11-2016
Rev 4	Added HDS990, TB990 and TRM990. Renamed MB990 to RCK990.	T. de Ridder	W. van Gulik	9-12-2016
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Rev 8	Updated MTBF numbers	T. de Ridder	J. Warnas	10-01-2018
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Rev 19	Added ATS-R2, and call interruption Added a couple of modules	T. de Ridder	D. Chaigneau	18-3-2022
Rev 20	Corrected headset title	D. Chaigneau		29-04-2022

Contents

1 Voice communications systems

The TCS990 is a non-blocking, redundant (the level of redundancy depends on the configuration), digital switch for all kinds of voice and data communications, such as radio, telephone, public address, intercom, voice logging, etc. Due to its modularity and flexibility, it can be easily adapted to every size, from small to large. The smallest configuration consists of 8 voice connections. In the maximum configuration, the system can support over 500 voice or data channels. The TCS990 VCCS provides continuous 24-hour, seven day a week operation. No single point of failure exists in areas of critical VCCS functionality to satisfy continuous operation. The TCS990 comprises generally out of commercial-off-the-shelf (COTS) items.

Since its introduction, the TCS990 has built up a solid basis founded on many installations and has proven to be extremely reliable, even in a non-redundant setup. The high flexibility of the design allows easy adjustment to customer requirements. All kinds of interfaces are supported, such as Ethernet (ED-137, SIP, SNMP), E1, ISDN, PABX (FXS, FXO), PSTN, 4 wire E&M and analogue leased lines with in-band signalling.

Some of the features of the TCS990 are:
- Intuitive touchscreen Controller Work Position (CWP)
- Distributed non-blocking digital voice and data switch
- Cost-effective flexibility through its HW and SW modularity (easy to meet end-user demands)
- A gateway of all kinds of voice communications, radio, telephone, intercom and PA
- Integration of long- and short-term voice logging and a versatile PBX
- Easy to configure and service by using CMS*pro*
- Inter-switch connectable
- Cross-channel coupling
- Integration of receiver diversity, simulcast (co-channel) and COOC(CLIMAX)

A typical TCS990 system is made of a digital voice switch, several types of operator consoles and remote control equipment. By means of thorough testing, modular software design and a field-proven real-time operating system, this reliable system meets all customer's needs. A very versatile control and monitoring system is available to change system settings and monitor the system. All events are logged and the system can send SNMP traps to make remote service possible.

1.1 Schematic overview
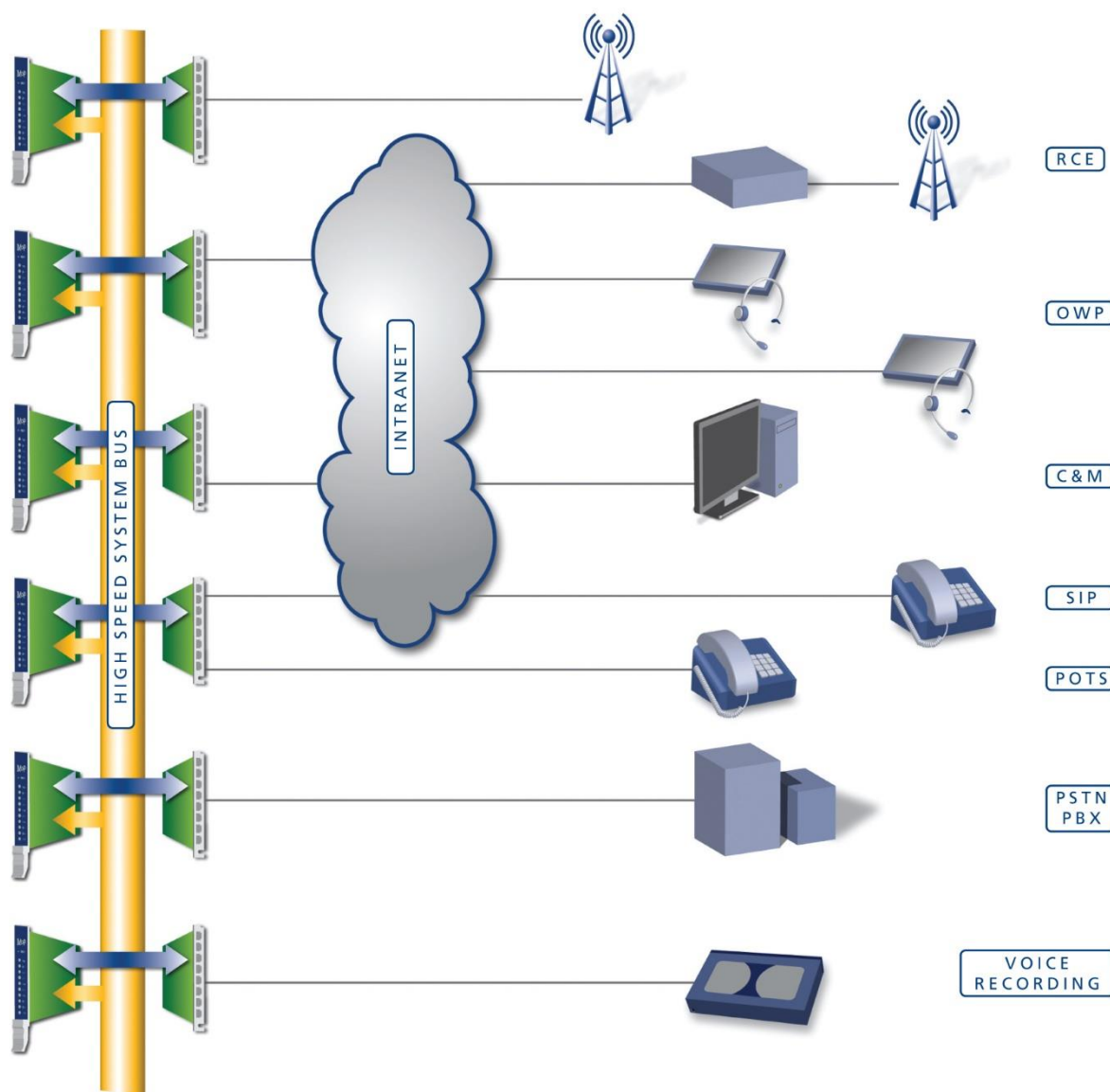
2 TCS990

2.1 Operating panels

The following operator panels are available for the TCS990. All operator panels hardly use energy and don't need a fan for cooling. The operator panels operate silently.

TBP990: Touchscreen operating panel 15"

The TBP990 is a 15-inch touchscreen console with a LED panel with a light output of 1000 CD/m2 and a wide viewing angle. With its built-in microphone, two speakers, volume control knobs and a PTT knob and optional handset, it is ideal for Traffic Operators.

TCP995: Touchscreen operating panel 12.1"

If the touchscreen needs to be built in an ATC desk the 12.1" version one of the choices. It uses the same basic electronic control board as all our touch units. The panel is equipped with an extra high light output of 1000CD/m^2 XGA touchscreen. Making it readable in places with high interior light conditions exists. The unit can be connected to an external headset plug unit ACU995 or the SBU995 speaker box.

TDP995: Touchscreen Operating panel 7"

This is an operator panel with a modern look. The TDP995 has an integrated 7 inch TFT touchscreen. The screen has a resolution of 800x480 pixels. De panel has a loudspeaker, two volume knobs and an integrated PTT button. Optionally a gooseneck can be placed. The console is connected via IP or E1 to the voice switch. At the rear, there is an extension connector to connect more audio modules.

STP995: Touchscreen operating panel 5.7"

The STP995 is a 5.7" version, it has the smallest size touchscreens. It can be built in a desk or in a standard Euro rack. For desktop use a special set is available. It uses the same basic electronic control board as the TBP990. The panel is equipped with a 550CD/m^2 VGA touchscreen. The unit can be mounted in a standard 19" rack or by VESA 100 mounting holes. It can be delivered with a permanently connected handset or with a handset with a plug. The panel has two volume knobs, a touch PTT button a speaker, an internal microphone and two fast on/off connectors.

At the rear, there is an extension connector to connect more audio modules like the SBU995 and the ACU995. The STP995 is provided with a second ethernet connector to support Dual LAN.

STB990: Bracket for STP995 on a desk

The STB990 is a bracket for placing an STP995 on a desk. In the picture, an STP995 is placed in the STB990.

STP995 P3: Touchscreen operating panel 5.7"

The STP995 P3 are wider versions of the STP995, especially for placing in a P3 rack. The electronics inside are almost identical to the electronics of the STP995. The STP995 P3 comes in red for use in an EVCS system.

SVP995: Small Vertical Panel 5.7"

The SVP995 is a vertical variant of the STP995. The electronics inside are almost identical to the electronics of the STP. The SVP is equipped with an internal wide input DC/DC converter. When the STP is too wide to fit in the location, the SVP can be used. The SVP also comes in red for use in an EVCS system. The SVP995 is provided with a second ethernet connector to support Dual LAN.

SVS995: Four radio EVCS panel

The SVS995 is an addition to the wide range of consoles MEP is offering. This modern and low-cost console is ideal for desktop use in small systems that require a compact solution. It supports up to four radios, analogue, IP connected ED137 or any mix of the two. Because it can be powered via Power Over Ethernet (POE) only a single wire is needed to connect and power this console for ED137 radios. The product is backwards compatible to the SVS990 for the analogue radio connections.

2.2 Display accessories

ACU995: Audio connection unit

This unit connects to the TCP or STP touchscreen units. It has three LEMO sockets on the front for headset or handset connection. The left plug is for the mentor. This audio device has the highest priority and will overrule the audio coming from other audio devices. The unit can be placed under or built in the desk.

ADB995: Audio Distribution Box

The ABD995 is the solution to ease installation of the operator positions that MEP offers. The ADB995 speeds up installation by simplifying wiring the D-SUB 25 to the different peripherals installed around the console such as speaker boxes, handset, fist microphones, foot bar, voice logging and the ACU995 headset extension.

HNDsetPTTLemo : Handset with PTT and Lemo connector

The HNDsetPTTLemo is a K-style handset with integrated PTT button. It comes with a cable defined in TCS_connections_rev48_final.pdf, a 10 pins LEMO connector, which can be connected directly into the STP995 or via a conversion cable to the ADB995.

HNDsetPTTRJ12 : Handset with PTT and RJ12 connector

The HNDsetPTTRJ12 is a K-style handset with integrated PTT button. It comes with a cable defined in TCS_connections_rev48_final.pdf, the RJ12 connector, which can be connected directly into the TDP995, KHS995 or via an extension cable to the ADB995

CRA995: Cradle

The CRA995 is a cradle for the MEP handset. .The cradle is designed to be mounted on a vertical surface and has an integrated switch that is used to detect whether the handset is placed on the hook.

SBU995: Speaker box

This speaker box always features a speaker and has options to feature either one or two volume knobs. A pre-amplified gooseneck microphone can also be added.
The SBU995 comes in three variations, a desktop version and two rack-mounted variants that support 3U 19" rack and P3 rack.

PEI000: Handheld microphone

The Peiker hand microphone is an electret microphone which can connected to the MEP system via the ADB995. The microphone includes a PTT button and a durable spiral cable for long use. The hand microphone comes with a LEMO connector (default: FGG.2B.310.CYBD52Z). The rugged chrome housing ensures long durability and easy use. Including with this microphone is a HV5 mount

PEI000: Desktop microphone

The Peiker desktop microphone is an unidirectional noise cancelling electret microphone on a stand. It connects to the MEP system / console via the ADB995. The microphone includes a PTT button and an anti-slip base.

The PEI000 Desktop microphone includes the cable, with a standard length of 2 metre.

Footswtich: Foot Switch

The foot switch is a General purpose momentary foot switch. It incorporates a non-slip base pad and footpad. Sealed to IP40. The foot switch is an extended foot switch which has been designed to incorporate two non-latching foot switches connected in parallel. These switches have been constructed from steel and are extremely reliable. This light duty foot switch has SPST N/O contacts and is black and grey in colour.

Epos Headset: HME 27 ATC/C3 300 ohm

The HME27 ATC/C3 300 ohm is a dual earpiece noise-cancelling premium headset. It boosts concentration in the control room with a comfortable headset that delivers uncompromising communication and situational awareness. The noise-cancelling microphone reduces ambient noise to improve speech intelligibility for your listener. Meaning you can be heard even in noisy, dynamic working environments

2.3 System cards

The TCS990 is built from the following system parts.

DMI990: Digital Matrix Interface

This is the general system card. All interface cards are linked to this card type. The system card has the following specifications: 300Mhz Digital Signal processor with 8 Mbyte SDRAM and 8 Mbyte Flash ROM. 300Kgate Field Programmable Gate Array and a redundant Low Voltage Differential Signalling system bus. Two serial telecom busses, four UART/SDLC controllers, 16 system and 16 user I/O's a 16 bits expansion bus and 10 LED signals. A reset button is available on the front and can be configured to reset the single card or the whole system

LLI990: Local Line Interface

The card can be used to create analogue and digital connections in the voice switch. This card supports four analogue connections with integrated line signalling or 4 wire with E&M signalling. The card can hold four expansion modules, these expansion modules can be used to support a wide variety of (digital) line types. The radios can be connected locally or remotely.

LBI990: Local Battery Interface

The local battery interface is used for direct connection to a subscriber on a non-amplified direct line. The card supports up to four lines and can work with a ring in ring out or with ITU Q8 or AC15 signalling. The card has multiple line voltage and ring generators to avoid a single point of failure.

LPI990: Local Phantom Interface

The local phantom interface is used for connecting a base-station which uses phantom voltages for keying and or squelch. Per LPI990 four base-stations can be connected. The transmitter and the receiver can be individually selected for the phantom mode.
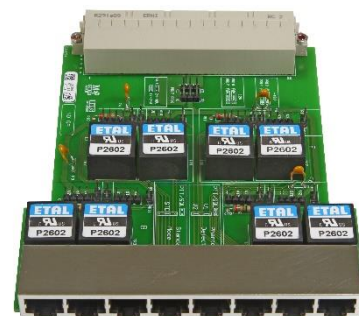
RCK990: 3HE Rack

This is the rack for the system cards. The power supply (or supplies), the system and the interface cards are inserted into the rack. The RCK990 can accommodate two power supplies and 16 system and interface cards. Several racks can be linked to each other using a simple single flat cable. With a maximum of 4 racks. A power line sensor module monitors both power supplies and measures the ambient temperature. The system can be supplied with two 230VAC or two 18-75VDC or a mix of these two types.

PWR995: Power Supply

The PWR995 is a wide input range AC/DC 100 Watt power supply, 85 – 264 VAC (48-63 Hz). It can be used in conjunction with the DCS990 (DC/DC) direct current supply. One unit is sufficient to power a complete rack. Dual, redundant supplies are used to increase system reliability. Both supplies are monitored by the system.

DCS990: Direct Current Supply

The DCS990 is a wide input range 18-57V DC/DC 100W power supply. It can be used in conjunction with the PWR995 (AC/DC) power supply. One unit is sufficient to power a complete rack. Dual supplies are used to increase system reliability. Both supplies are monitored by the system.
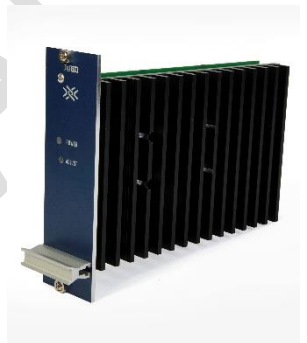
2.4   Extension modules

The following extension modules can be used in the system.

ADM990: Asynchronous Data Module

The ADM990 contains an RS232 serial port.
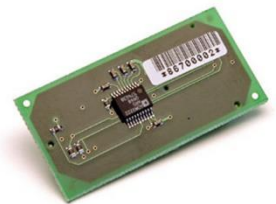
BSM990: Best signal Module

The BSM990 contains four analogue DC input ports for radio signal strength measurements (RSSI) and, a connection for GPS data from the GPM990. This module is used in Best Signal systems (Diversity) and simulcast / Climax (CCOC) systems.

DAM990: Direct Access arrangement Module

This card supports analogue connections to PBX or PSTN switches. It is used to facilitate links from the public or business network to the voice communication switch.

EIM990: External input Module

The EIM990 contains 8 non isolated input ports. The alarm or functions of these inputs can be configured in CMSpro.

EIM990: External input Module

The EOM990 contains 8 open collector output ports. These output ports are suitable for levels up to 24 Volts. The alarm or functions of these outputs can be configured in CMSpro.

GPM990: GPS Module

The GPM990 contains four analogue DC input ports for RSSI measurements; two coax connectors support an active GPS antenna and a reference output for the transmitter. This module is used to supports Climax / Simulcast, with Best Signal Selection.

IPM990: Ethernet Module

The IPM990 module can be placed on an LLI990 slot to create an IP connection to the card. Only a single IPM990 is needed to support IP for all functions on a card. The IPM990 supports a 10 / 100Mbit IEE.802.3 network with a TCP/IP protocol stack using UTP connection. This module is the successor of the ETM990 module.

IPM142: Ethernet Module

The IPM142 module can be placed on an LLI990 slot to create an IP connection to the card. Only a single IPM142 is needed to support IP for all functions on a card. The IPM142 has two physical interfaces for redundancy purposes. A failure of a single LAN interface on the IPM142 has no effect on the functional operation, when redundancy is completely configured. The IPM142 supports a 10 / 100Mbit IEE.802.3 network with a TCP/IP protocol stack using UTP connection.

LSM995: Last Call Module

The LSM995 is the successor of the LCM990. This solid-state disk module has the capability to record a minimum of 24 hours for two streams voice channelsdata. The LSM995 has reserved memory for twelve pre-recorded messages. These messages can be played on predefined channels and time. The module is placed inside the operating panel.

MDM990: Multi-Drop Module

The MDM990 has two isolated RS485 ports. It is used to connect multiple devices on a single line. These can be remotely controlled radios or time display units.

PLS990: Power Line Sensor

The PLS990 monitors the supply voltages of the system. It also checks the temperature. The PLS is placed in the CVS990 and in the MB990. When the PLS is placed in the CVS990, it will also control the fan when the temperature becomes high.

PRM990: Primary Rate Module

The PRM990 is a 2Mbit E1 connection in compliance with ITU G.703 / G.704. This module cannot be used in conjunction with other digital line modules.

PLM995: Primary rate, Last call Module

This card is a combination of the PRM990 and LCM990 modules, to be placed within a CWP. It cannot be used on a LLI990.
It supports a 2Mbit E1 connection in compliance with ITU G.703 / G.704.
The PLM995 has a solid-state disk. It has the capability to record four hours of voice data. The module records all radio voice communication from the operator position. The LCM has reserved memory for twelve pre-recorded messages. These messages can be played on predefined channels and time. The module is placed inside the touch screen panel

RTM990: Real-Time Module

The RTM990 module is a clock module used to generate accurate local time. This time is used for time stamping system messages.

SCM995: Subscriber line interface Circuit Module

This card supports the connection of eight analogue telephone sets for central battery installation. The card can be programmed for different national requirements on various line implementations. The card also supports long and short lines and can handle DTMF signalling.

SDM990: Synchronous Data Module

The SDM990 two independent RS422 links.

TRM990: Terminator module

The TRM990 is used to terminate the internal bus of the system. Per system two TRM990 modules are needed. They are placed inside the RCK990.
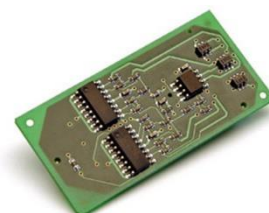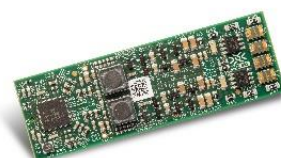
2.5   System description

2.5.1   Central Equipment

A typical voice switch is constructed out of a number of DMI990/LLI990 cards with the appropriate expansion modules placed in a 19" system rack (MB990). Every system uses at least one duo card as a server. The design of the DMI/LLI990 duo card is based on distributed processor/switch technology and can be used in a fully redundant set-up. This assures a system with an extremely high availability figure. The system can be equipped with two controlled power supplies to overcome sleeping errors.

Two or more central equipment in different locations can be connected to each other. For the operator, it looks like one big system. This involves all kinds of operational benefits, like centralized control and/or backup facilities.

The cards are in the central equipment are hot-swappable. So it is possible to replace certain parts or to expand the system, without turning the system completely off. If the system reboots for any reason, it will automatically start without manual action and continue communication.

2.5.2   Digital lines

The system can use E1 or IP for the communication with the touchscreens or remote sites. The VCCS is made following the CAP670 and Euro control procurement guidelines. The system supports the EUROCAE ED-137 VoIP specification.

2.5.3   Operator voice control panels

The TCS990 supports a wide variety of control panels to meet the system requirements for each type of telecom market segment. The most advanced version is the TBP990/ TCP995/STP995 touchscreens. It can be delivered as a 5.7" or 12.1" built-in panel or as a 15" desktop. All new panels are equipped with LED lighting for long life and the reduction of hazardous substances. On every panel, the controller has the option to adjust the backlight of the panel to the preferred brightness. The high brightness with adjust functionality makes the panels usable in very bright and in quite dark environments. The audio levels are user adjustable but hearable when set at minimum All electronics are integrated into one unit with minimal wiring. Connections are available for headset, handset and external microphone/speakers at the rear. The panel is equipped with low power electronics. No forced ventilation is required, therefore no noise is generated. The operation is intuitive and works with tab pages and pictograms to minimize the number of operator actions. The panel combines the operation of radio and telephone functions in one device. It is connected to the switch by E1 or TCP/IP Ethernet. The unit must be powered by an external 12VDC supply. The TBP/TCP/STP manual is available on request.

2.5.4   Audio on the voice control panels

The audio in the panels is completely configurable to the requirements of the customer. Per audio channel (radio traffic, radio monitor, telephone, ringtones etc.) the minimum, maximum and routing can be configured. Which audio should be audible on which speaker is also completely configurable. If required it is possible to change the audio configuration per role.

2.5.5   User interface / HMI

The user interface of the control panels is completely configurable from CMSpro. The size, font, colour of every button can be changed to the needs of the customer. With this, a dedicated configuration can be created for specific customers or roles. There will be no unnecessary buttons or space because only the used functions will be placed on the user interface.

The error status of radio buttons and Direct Access telephone buttons is shown in the button itself if there is an automatically detected problem. The status of the complete

system, with the latest error messages, is also available on the control panel. A cleaning/maintenance button is available with a maximum enable time of 30 seconds.

2.5.6 Roles

In the system, roles can be added, configured and deleted, on the fly, without the need of reset(s). Per control panel, one or more roles can be assigned. This can be preconfigured or can be done during operation, either from the control panel itself or via CMSpro. Per role, the audio, allowed functions, radio channels, telephony options and user interface can be configured. Via CMSpro the currently assigned roles can be monitored.

2.5.7 Receivers/transmitters

The Receivers/transmitters are connected through a 4 wire E&M connection. The audio levels (300 – 3400 Hz.) are from -20 to +6 dBm into 600 Ohm, levels can be adjusted in 1.5 DB steps. The E&M PTT/SQL signalling is controlled by a Photo-couplers. Type I, II, IV and V of E&M signalling is supported. If desired, the receiver/transmitters can be placed apart. Remote control equipment is available for different types of lines.

Radio capabilities
- Best Signal Selection (Diversity)
- Cross-coupling Duplex
- Cross-coupling Simplex (VHF/UHF one way, only received VHF audio relayed to ground TX frequency on UHF)
- Climax / Simulcast (AM)
- Frequency selection
- A/B set
- ZVEI-II
- 24 hrs messaging
- Sticky PTT button detection plus CWP PTT disabling (optional setting in the database)
- Air traffic specific
  - Off Air sidetone
  - Local sidetone
  - 'Local / Off Air sidetone'
    - The sidetone is generated locally, but it will be turned off if there is no reception.
- Maritime specific
  - DSC
  - NAVTEX
  - Maritime ATIS
  - Cochannel / Simulcast (FM)

2.5.8 CMSpro

The TCS990 switch is configured and monitored using the (Control and Monitoring System) CMS*pro* tool. CMS*pro* is a web server application for Linux or Windows 7 / Windows 10 running on standard PC's. Its architecture enables multiple user access with different authorization levels. If a VPN connection is provided, remote control and monitoring are possible. The system supports the entire product line, even the radio equipment when fitted to a data connection. New firmware releases can be uploaded to all TCS990 range equipment. Because CMSpro is web-based the system is easy to learn and is very user-friendly. SNMP v2 is supported for remote monitoring of the VCCS system by standard network management tools. The system supports the standard NTP time protocol. It will automatically update the time on the system logging and the touchscreen if an NTP server is available. Automatic or manual backups can easily be created of the complete system configuration and optional including all log files. The CMSpro manual is available on request.

2.5.9 Integrated radio monitoring

Depending on the transmitters and receivers used, remote service is available. Most of the internal parameter settings of the connected transmitters and receivers can be changed with the control and monitoring tool CMS*pro*. The status of the connected radios is constantly monitored giving a direct presentation of the availability of the radios. Remote monitoring is available for Park Air T6, R6 and Jotron TR-7750, TA7650, RA7203 and all ED137 compliant radios. Other types of radios can be added if desired. If no monitoring via digital communication is possible, an alarm input on the VCCS per radio can be used to monitor the status of the radio.

2.5.10 Intercom

Intercom is a standard feature of the Touch control panel. All connected control panels are listed in the (DA) work field.

2.5.11 Software distribution

All system parts and cards can be uploaded with new firmware via the control and monitoring system. All system cards hold the same firmware image. The same cards are used throughout the whole system. Only one spare is needed which supports all system functions. The system will automatically detect firmware releases and will update the older firmware if permitted by the system engineer.

2.5.12 Handset connection

The STP panel has two connectors on the front for headset and handset connection. The STP will show which audio device is selected. If no headset or handset is connected to the touch panel the internal microphone is selected. External audio units like SBU, ADB and ACU can be connected to the unit to expand connectivity.

2.5.13 Headset connection

The STP panel has two connectors on the front for headset and handset connection. The STP will show which audio device is selected. If no headset or handset is connected to the touch panel the internal microphone is selected. External audio units like ADB and ACU can be connected to the unit to expand connectivity.

2.5.14 External audio connection

The STP has a connection for external audio (Loudspeaker, volume knobs and optional microphone). One speaker is integrated into the STP995 panel.

2.5.15 Integrated PABX

The TCS990 switch has an integrated PABX (300 – 3400 Hz.). This PABX can handle several kinds of telephone lines (CB FXO/FXS, LB RiRo, ATS-R2, ISDN and SIP). Calls to and from the switch can be handled by the STP panel.

2.5.16 PABX capabilities

- Answer call
- Logging of all incoming and outgoing calls
- Call queue (handling order determined by the user(s))
- Hold
- Call transfer
- Group call
- Group hunt
- Crash call
- Direct access keys
- Manual dial
- Short dial

- Last number redial
- Call forwarding
- Conference calls
- Priority calls
- Call intrusion
- Call interruption (for selective line types)
- Instantaneous access
- Position monitoring
- Merge calls
- Mute
- Phone to radio connect (VOX operated PTT)
- Common and personal phone book
- Caller ID
- Auto answer
- On Channel Intercom

2.5.17 Remote control equipment

Radios can be connected locally and remotely. For remote connection, there are three units available. The CLI990 is a euro size system card for connecting one radio. If more than one radio has to be connected on one location a CVS990 is used. The CVS can be equipped with four system cards and connect up to 16 radios. A CRU995 can be used to connect up to four radios to a remote.

2.5.18 RoHS compliance

All system parts have been produced following the RoHS guidelines (Reduction of Hazardous Substances). The used TFT LCD screen is illuminated by LED's instead of CFL lamps, hereby increasing its lifetime and banishing mercury.

2.5.19 Power supplies

Most system parts are powered with auto-ranging 98-264 VAC power supplies using standard continental sockets and/or by 18-75VDC power supplies using 4 pole XLR type connectors. The maximum power consumption of the switch is 50W per rack. The system can be powered by two AC, two DC or an AC and DC supply.
The 5.7" panel is powered by a 230VAC / 18-75VDC supply unit. It connects to the operator panel by 9 pins sub D connectors.
The power for E&M signalling can be derived from the internal 12 VDC or from an external 48V power supply connected to the 4 pole XLR type connector.

2.5.20 Signal levels

All audio connections can be adjusted from -20 to +6 dBm signal level in a 600 Ohm impedance.
The levels can be adjusted in 1.5 dB steps by the CMS*pro* system.

2.5.21 Voice logging

Analogue ports are available to connect a voice logger. Al type of connections can be connected to the voice logger. The voice logger can be connected analogue or via IP (RTP or ED-137).

2.5.22 Connections

All analogue and digital ports use standard RJ45/RJ48 plugs. This allows for cost-effective and reliable connections that can be used with industry-standard patch panels.

2.5.23 Extendibility

By installing up to four racks the system can be extended up to 500 non-blocking audio connections.

2.5.24 Upgradable

Because the Small VCCS is built out of the same components as the standard VCCS systems, it is flexible, scalable, and modular The VCCS can easily be upgraded with other functionalities. All system cards/units are field upgradable by the Control & monitoring software CMSpro.

2.5.25 Firmware

The firmware is written in C and uses an object-oriented approach. The system is set up in layers. The inner layer is the real-time kernel, this nucleus is responsible for all system calls, interrupts and scheduling. It is based on one of the most robust versions in the market for our DSP platform. The second layer consists of system drivers, handling all control with specific hardware. The third layer handles all system traffic and control. The outer layer is the user application layer. This structure makes it easy to make user-specific additions.

2.5.26 Built-In Test

The TCS990 internally executes tests to ensure the system works as expected. These Built-in Test (BIT) run continuously, so the problem is detected instantly:
- Internal system data and audio communication
- IP data line communications
- E1 digital data communication
- Radio functionality (as far as possible, depending on the type of radio, type of connection with radio)
- Digital telephone lines.
- Power supplies

An alarm will be set, if any of the automatically detected problems arise. If an error occurs and the system can automatically reroute, this will be done.

For digital lines, all data inputs are checked for integrity and validity. Configurations are checked on the reload of the configuration.

2.6   Reliability

Reliability and long life are key issues in the design philosophy of the entire product range. Built on new technologies the switch has been designed to be a highly integrated system using few components. All components have been selected with care to have low power usage and withstand the ageing and will be available over a long period. As a design practice, no components are stressed more than 70% of their maximum listed value (most much lower, <50%). All components have been selected from suppliers that are best of the breed and have their focus on that specific product range. The system has built-in redundancy in the system bus and can be equipped with a dual server and power supply to exclude single points of failures. In the case of dual power supplies, both are measured to exclude sleeping errors. All external telecom lines are guarded constantly. Reliability data is calculated based on the Bellcore BT standard. We have added a table with the MTBF figures of the most used cards and modules. In the last column, we have added the actual MTBF figures measured on operational systems. We have made an assumption that the first line of service will be carried out by the ANSP. We have calculated the availability with an estimated repair time of 2 hours.

2.6.1   MTBF data

The data below is updated to 1 January 2022. This data contains the most used system components.

Component	MTBF hours calculated*10^6	Field data MTBF hours *10^6
DMI990	1,6	15,7
LLI990	2,0	29,9
IPM990	11,4	16,8
TRM990	66,0	**27,1
RCK990	0,6	15,2
PWR995	0,9	1,0
SCM995	11,4	***0,7
DAM990	6,6	28,8
PRM990	7,0	26,9
TBP990	0,1	1,6
STP995	0,7	1,6
SVS990	0,6	0,7
SVS995	0,7	**0,4
TCP990	0,1	0,6
TCP995	0,1	0,2
TDP995	0,1	1,8

** no failures, not enough field data yet for valid prognoses.
*** not enough field data yet for valid prognoses.

The following formulas are used to calculate the availability figures.

B_e = (MTBF-MTTR)/ MTBF
B_d = (B_e/ (B_e + (1- B_e) (1- B_e))
MTBF=10^9/FIT

B_e = availability one unit
B_d = availability double unit
MTBF = Mean Time Between Failures
MTTR = Mean Time To Repair. We have used a 2 hour repair time for this calculation.

Availability of DMI/LLI = (10.3 10^6-2)/ 10.3 10^6 =99,99998%
For a double (server card) DMI/LLI the value will be 1.

Availability of one channel =(10.3 10^6-2)/ 10.3 10^6 =99,99998%. (local connected transmitter/receiver)
Availability operator voice panel (TBP990 used as example) = (1.6 10^6-2)/ 1.6 10^6=99,99988%

2.7   Documentation

All systems are fully configured and tested before shipment, all screens, text and documentation will be in the English language, the documentation will be as softcopy and on request as a hardcopy.

The system at a minimum will be accompanied by the following documentation:
- System drawing (As-built)
- Overview of the system parts
- Maintenance manual
- Manual for the STP995 touchscreen panel (5.7" version)
- Manual for the Control & Monitoring System CMS*pro*.
- Led signalling and switch settings
- Connection information

- Troubleshooting
- Training syllabus
- Block diagrams
- FAT Document

2.8 Environment

Operational temperature main system   -20°C to 75°C
Operational temperature control panels   -10°C to 50°C
Humidity   5% to 95% non-condensing
Storage temperature main system   -20° to 85°C
Storage temperature control panels   -20° to 60°C
Emission   EN55022
                                         EN61000-3-2 / 3-3 / 4-2 / 4-3 / 4-4 / 4-5 / 4-6 4-11
Immunity   EN55024
Safety   EN60950