SCADA

EIS

Monitoring systems

IOS

Turnkey SW

InfoPanels

Servis

TechIS

GIS

ELVAC
SOLUTIONS

CMOS for Air Navigation Services of the Czech Republic

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CMOS FOR AIR NAVIGATION SERVICES OF THE CZECH REPUBLIC

SITUATION

The mission of ANS CR is to take part in the provision of cost effective, long-term sustainable aviation navigation services in an environment of evolving functional airspace blocks. In the dynamically evolving air transportation environment, its services are designed to meet the expectations of all users with regard to current and future demand at both the national level and that of the European ATM development context. ANS CR provide its services on the Prague, Ostrava – Mošnov, Brno – Tuřany a Karlovy Vary airports in the Czech Republic airspace. These localities by the international civil airports are part of the Prague FIR.

The basic purpose of providing ATM services is to ensure safety. For this reason, ANS CR aims to maintain or improve the safety level of provided services regardless of the air traffic volume. Safety is a priority for the company, which takes precedence over commercial, operational and other goals.

ANS CR has to strictly adhere to regulations and EUROCAE international standard for aviation.

In the 2015 the overall airspace movements has reached 750 000. The growth of the air traffic in the Czech airspace and is considered as one of the highest in the Europe. This, together with security is the main argument for building reliable and redundant monitoring system.

BUSINESS OBJECTIVES

Infrastructure monitoring and visualization is an essential part of successful ATM (Air Traffic Management) system operation. Therefore, every part of the ATM system has dedicated control and monitoring system. The downside is that it requires a lot of displays to visualize the data and puts additional requirement on the operators as every system has its own user interface. In order to improve efficiency and lower the operation and maintenance costs as the result of high security standards had ANS CR decided to implement system integrating all the ATM systems into one central system with unified user interface and data visualization. This central system is fully integrated with technical information system (TIS).

The system is built upon the CitectSCADA (www.citect.com) platform that is SCADA/HMI software for Windows. It allows implementing interface to control and monitor technological devices and processes. CitectSCADA is based on the extensible client server architecture and has built-in redundancy capabilities across the SCADA system. Openness of the system enables information exchange with other applications. Data are stored in the Microsoft SQL database using CitectSCADA Historian tool. Among other reasons CitectSCADA platform has been eventually selected for central control and monitoring system is that it has been deployed in over 50 000 industrial, automotive and energy applications worldwide.

CMOS SOLUTION

The preferred solution was implement custom software per ANS CR requirements and needs - **CMOS** (**C**entral **M**onitoring and c**O**ntrol **S**ystem). The mission of the CMOS project was to provide technicians with the overview of all the ATM systems with possibility to control and manage individual processes. ELVAC SOLUTIONS s.r.o (hereinafter as ELVAC) as the author of the CMOS is the Citect (Schneider Electric) integration partner in the Czech Republic and is certified by Civil Aviation Authority of the Czech Republic (http://www.caa.cz/).

Certificate CAA

**Citect Integration Partner**



The main CMOS tasks are:

- To build distributed system with graphical user interface
- To create unified user interface across all the controlled and monitored systems
- To provide access to all the information from all the ANS CR localities
- To distribute information to maintenance staff (ATSEP) and to controllers (ATCO)
- To improve integration with Technical Information System (TIS) that provides information for planning maintenance activities on ATM systems
- To automate technical processes of ATM systems
- To archive information about technological equipment, systems statuses and control actions

CMOS is built upon CitectSCADA platform and has all its benefits and features. CMOS runs under Windows operating system and all the data are stored in Microsoft SQL database.

Nowadays CMOS is composed of 8 redundant communication servers located on each airport and 2 redundant servers to process alarms, trends and reports. For remote access there are two dedicated terminal server. Current ASN CR data network is used for communication between servers and ATM systems.
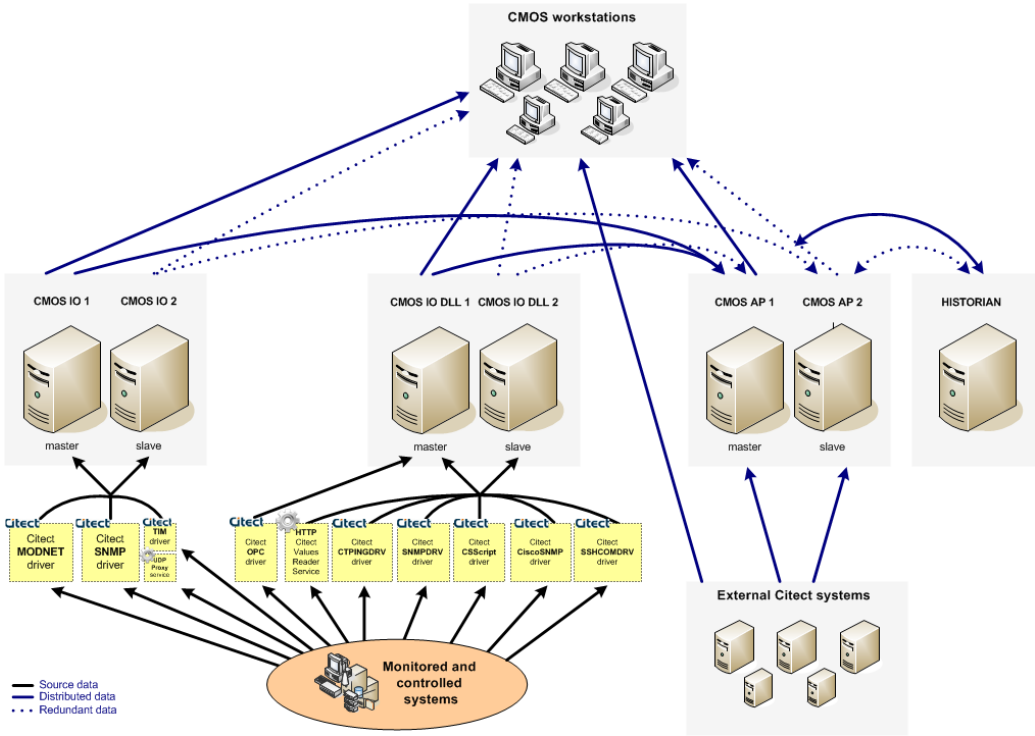
CMOS architecture based on CitectSCADA platform:
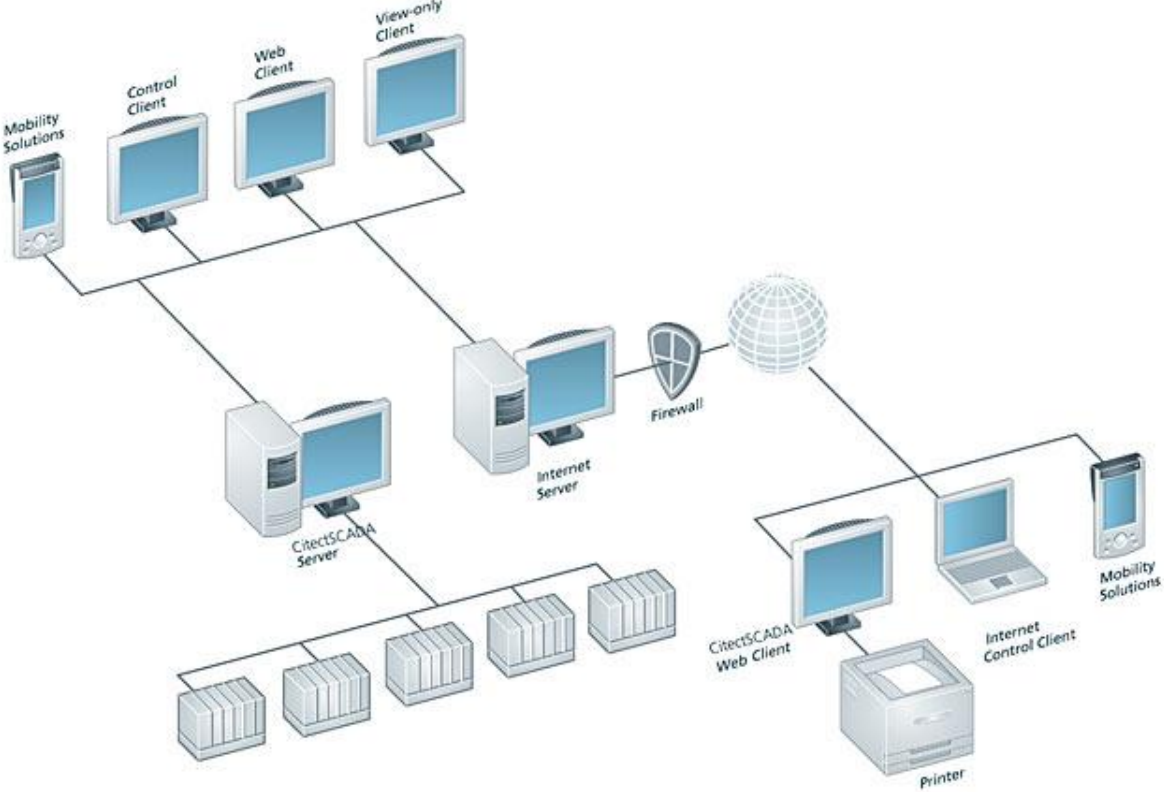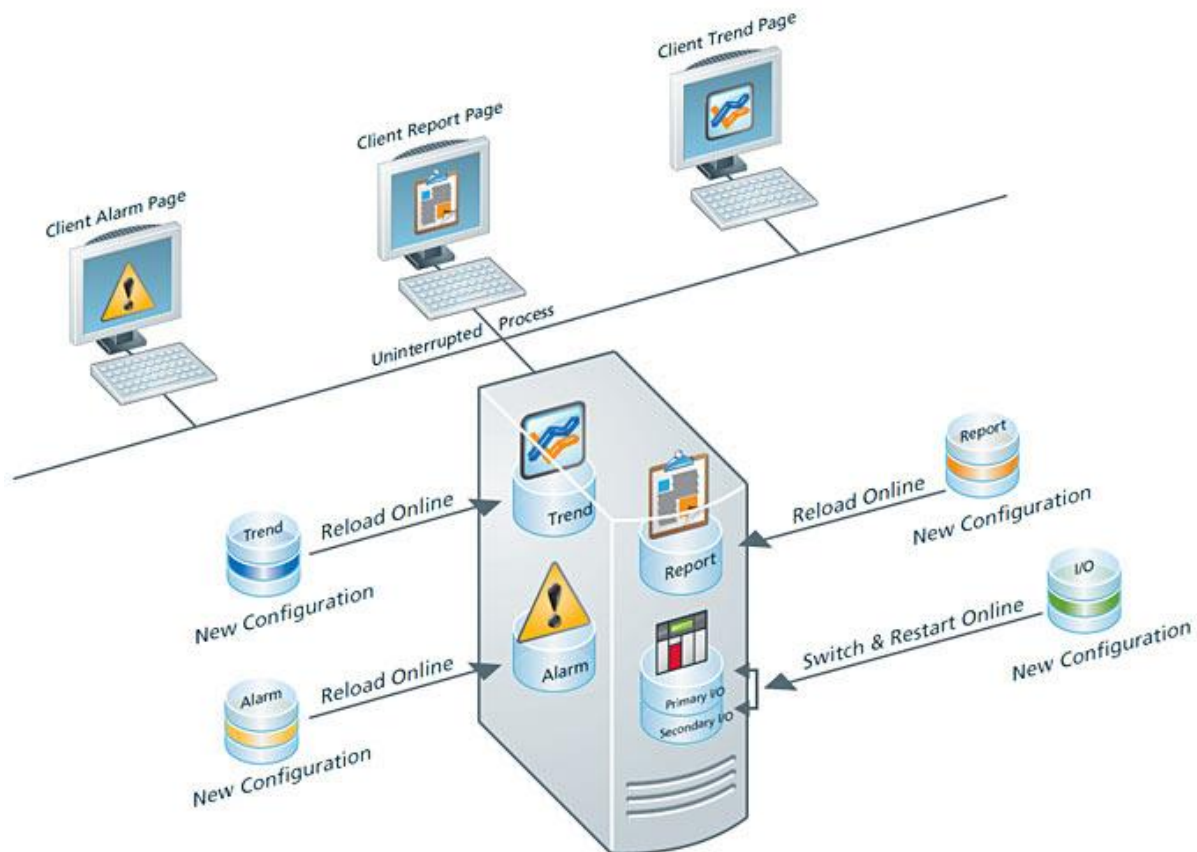
Interoperability (communication using different protocols and standards) is one of key EUROCAE requirement regarding operation security. As a result of this requirement every device used has some standard industry protocol implemented (OPC, SNMP, ICMP, HTTP, IEC, etc.) together with its proprietary protocols. CitectSCADA offers over 140 communication drivers (ICMP, SNMP, IEC 103, MODBUS, MODBUS NET, etc.) implementing said standards. Nonetheless, some of the older devices are kept at the airports for their reliability, accuracy or for historical or economical value but those devices have no standard protocol implemented. Since ELVAC has rich experience with implementing proprietary protocols into CitectSCADA drivers (whether communicating over serial, parallel or network line), there is no need to replace such device.

Until now, ELVAC has developed and implemented 10 custom CitectSCADA drivers for CMOS:

- TIM – SDH system monitoring
- THALES –RCSE 443 (Remote Control and Status Equipment) monitoring and control
- RHODE&SCHWARZ GB2PP – RHODDE&SCHWARTZ 4200 radio station monitoring and control
- CISCOSNMP – custom driver for monitoring of CISCO network devices (Catalyst 2000, 3000 and 4000)
- SNMP – special SNMP driver for data discovery in dynamic SNMP tables
- SSH NETCONF – for router monitoring (i.e. Juniper router)
- PING – driver for network devices monitoring using ICMP protocol
- CSSCRIPT – allows scheduling and running CS script and its return value use as a property that can be used by CMOS (used for monitoring of services, ports or web pages' availability)
- RTU – monitoring and control of track navigation devices using ELVAC RTU devices
- AMS – processes and provides information to the parent system for monitoring III. CAT, accepts commands for navigation system. AMS system is product of TRANSCON ELECTRONIC SYSTEMS (www.transcon.cz) company

DATA VISUALIZATION IN CMOS

In CitectSCADA, data visualization is organized by so-called "maps" and at one moment there can be several maps displayed. Data sets (map definition) can be accessed from main navigation or using action buttons.

On the "Overview screen" are all the devices of monitored system displayed. The status of each device is displayed in unified way (color, icon, and highlight) across the CMOS. On the overview page the device status is aggregated (and visualized) from underlying devices' statuses. The idea behind this arrangement is that the overview screen will be displayed most of the time so the operators can have general overview of system(s) monitored.

For data presentation there was uniform concept adopted where each state is represented by its color:

PRIORITY	COLOR	NAME	DESCRIPTION
-		OK OFF	turned off, operational
		OK	operational
		MAINTENANCE	deliberately ignored (maintenance), operational
		UNKNOWN	inaccessible (lapses in communication)
		WARNING	warning
+		ALARM	inoperable

All the data and information can be accessed and displayed from workstations anywhere in the ANS CR data network. Access rights to different sets of information and action (device control) rights depends on actually signed in user. The screen (information and control) is then automatically configured based on current workstation location and currently signed in user.

The data from CMOS are displayed in the technical room using large (6x2 m) screen where all the monitored systems are displayed at once.

Maintenance

CMOS allows operators to set the Maintenance state on ATM system or its part (if possible). This state indicates that all events are deliberately ignored as there is maintenance ongoing. The maintenance can be set by authorized users only using the CMOS or automatically whenever maintenance activity is started in TIS (Technical Information System).

Active Alarms

Active alarms screen in CMOS is used visualize all events (warnings, alerts, failures, etc.) in the monitored system.

As for devices' states, the uniform color scheme was adopted for all alarms in CMOS as well.

- active unconfirmed – alarm has occurred, was not confirmed and event has not ended yet (red color)
- active confirmed – alarm has occurred, was confirmed but event has not ended yet (white color)
- inactive unconfirmed – alarm has occurred, was not confirmed but event has ended (yellow color)
- inactive confirmed - alarm has occurred, is confirmed and event has ended (grey color) – this type of alarm is then displayed only on the *summary alarm* screen (since is not active anymore)

Active alarms screen is filtered based on the context so when user opens active alarms screen from detail of some system, only alarms valid for that system are displayed. Additional type of alarm is disabled alarm (alarms from devices under maintenance, prohibited alarms) and is visible only to CMOS administrator.

STORING AND ARCHIVING DATA

Data are stored and archived for further processing using CitectSCADA Historian. The historian collects all changes in the process tag values, as well as alarm activity, from each control system. Each change is saved with a timestamp and quality stamp. The data can then be used for reporting, analysis and presentation (i.e. web pages).

CitectSCADA historian data can be used or further system analysis in order to increase reliability and security of systems monitored.

ATM SYSTEMS CONTROL

AMT systems from CMOS can be controlled by operators using pointing device. Controlling workplaces may be independent on each other or can transfer control to each other so that only one workplace is controlling the system at any time and others are blocked.

Control transfer is then based on the operators' communication and agreement. The controlling operator renounces the control and that is visualized in the system then different operator can take over the control of the device (that is again visualized in the system).

This functionality is again limited to user rights and location of workplace.

CMOS FUNCTIONS

The main functions of CMOS implementation in ANS CR are:

- monitoring and control of the native RCMS for individual ATM systems
- availability monitoring of physical or virtual servers, workstations, UPS, network switches, printers, IP cameras, etc.
- service and port availability monitoring (WEB, FTP, DNS, etc.)
- data retrieval from PLC or sensors (temperature, humidity, etc.)
- email and SMS notifications for operators if certain alarm is activated

CMOS Attributes

- **Extensibility** – the change in the scale of monitored system or adding new one is carried out by verified and repeatable development process and it takes from days to weeks (depending on the system) to deliver.
- **Flexibility** – client server architecture ensures excellent performance and fast responses.
- **Scalability** – I/O servers, trend and alarm servers supports multiprocessing and can be ran on different physical servers.
- **Reliability** – the system has full, hot standby configuration and I/O devices redundancy integrated.
- **Security** – Different access levels to data and controls. Two client levels – read only and control.
- **Data quality** – real-time data with quality stamp ("false" alarm elimination).
- **Sustainability** – CitectSCADA full support and ELVAC 24/7 SLA support.
- **Interoperability** and other IS – the CMOS supports interconnection using ODBC, OPC, DDE, SQL, and CTAPI. CMOS tightly cooperates with TIS system when technicians log into his or her shift and takes responsibility of individual ATM system.

CMOS LICENSING

- CMOS license model is derived from CitectSCADA licensing
- CitectSCADA is licensed per number of workstations currently connected to CitectSCADA system (not the overall count of the workstations with CitectSCADA installed)
- Is based on the number of "points" (analog or digital variable that is read from I/O device)
- There 75, 150, 500, 1500, 5000, 15000 points licenses and unlimited license.
- Different licenses are needed for client station and server. Client station licenses are divided to read-only license and control license.
- Hardware (USB key) and software licenses are supported.

CMOS SCREENSHOTS

Data network monitoring example
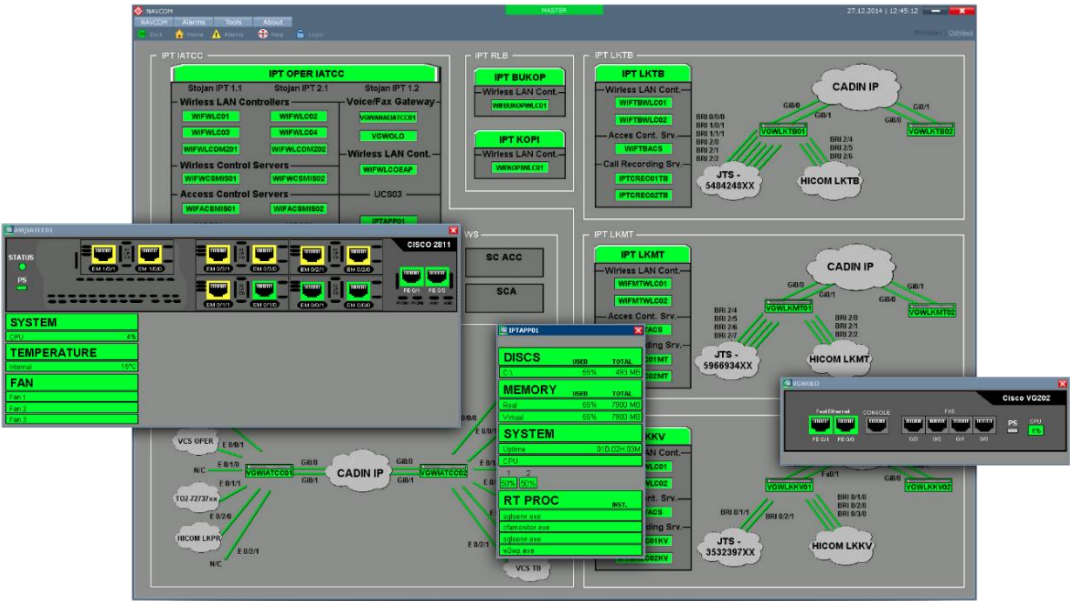
ATM system monitoring example
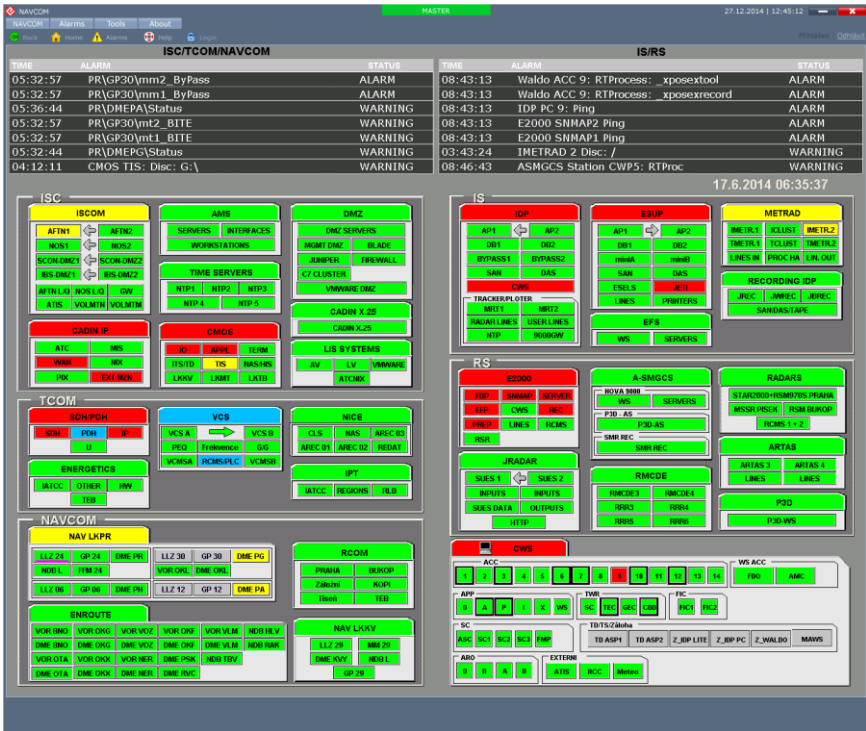
Navigation system monitoring example

BENEFITS

The decision to implement CMOS system was made not only the system is able to fulfill all requirements ANS CR had but as well as requirements that apply for all systems in aviation.

- Nonstop monitoring
- Security
- Redundancy
- Scalability
- Data visibility – access the data from anywhere within organization
- ATM system overview
- Reduction of displays in the technical rooms
- Unified data presentation for locations and systems
- More than 100 000 monitored values
- More than 80 000 alarms
- More than 90 sub-systems (NAVSYS, AMS, ESUP, METRAD, etc.) and still counting
- More than 15 standard and proprietary protocols already in use (SNMP, ICMP, etc.) that can be further extended.
- Possibility to extend the system beyond initial requirements

The ELVAC Company facilitate the supervision of individual for air traffic control systems and enabled the creation of a central monitoring and control system for all ANS CR systems.

CMOS = unified user interface for control and monitoring of ATM systems.

TECHNOLOGIES USED

- CitectSCADA
- Microsoft SQL Server
- Microsoft .NET
- CitectSCADA Historian
- CTAPI

TECHNICAL INFORMATION SYSTEM (TIS)

TIS is also product of the ELVAC Company and together with CMOS system is a core tool for ANS CR technicians to work with. Every technician has two displays where one is dedicated to CMOS system and one to TIS. TIS processes and evaluates the real time data from CMOS or entered manually and provides processed information back to users. Its concept is to provide support to technicians in technical room, to technical supervisors or to administrators of individual ATM systems. Moreover, TIS supports digital signing of documents thus can fully replace paper journals.

TIS is custom developed for ANS CR with regards of following functions:

- "Technical logbook in Electronic form".
- Issues and registers Operating Instructions – Operating instructions are all linked to specific system or device so when determining system status, Instructions are displayed along with other information about the system.
- Issues and registers Operating Information for all TIS users.
- Keeps record of ATC system failures – connected with technical logbook entries to have overview all activities from the failure start to its elimination.
- Keeps records of and defines regular maintenance plans of ATM systems.
- Evidence of implementation of CAA flight verification and their validity.
- Evidence of valid certificates and system Approval for use in ATM.
- Conclusive acquaintance with new information.
- Evidence of tasks from meetings
- Email notifications
- Etc.

TIS MAIN FEATURES

- Is replacement of standard paper journals used on supervision centers
   o Supports electronic document signing
- Is complement to CMOS
   o Processes and evaluates real time data from CMOS and automatically creates failures reports
   o Provides the information about user rights to CMOS system
   o Provides information about ongoing maintenance activities on system (no alarms are reported in CMOS)
- All processed data are presented back to users in more readable form.
- Provides management means to control, monitor and assign tasks
- Provides data for internal or external audit
- Allows preventive maintenance planning
- Users can be notified using email or SMS about different types of events on systems.
- Supports workflow to manage different aspect of every day work.

TIS ILLUSTRATION SCREENS

TIS USERS

Nowadays is TIS used by more than 200 users in different roles:

- Workers in technical rooms (ATSEP staff) (H24 supervision)
- System supervisors
- System administrators
- Management
- Quality and audit department
- External subjects

TECHNOLOGIES USED

- Microsoft SQL Server 2008+
- Database replication (4 localities – Praha, Brno, Ostrava, Karlovy Vary)
- Microsoft .NET Framework 4.0
- IIS – web client
- IOS, Android (mobile client)
- CTAPI

ABBREVIATIONS

A

AMS	Airport Monitoring System TRANSCON
ANS CR	Air Navigation Services of the Czech Republic
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSEP	Air Traffic Safety Electronics Personnel

B, C, Č

CADIN IP	Private data network of ANS CR
CitectSCADA	Monitoring software HMI / SCADA (http://www.citect.com/)
Client-Server	Software architecture
CMOS	Central Monitoring and cOntrol System

H

HMI	Human machine interface
HW	Hardware

I

IATCC Praha	Integrated Air Traffic Control Center
I/O	Input / Output
IP	Internet protocol

J, K, L

LAN	Local area network
LKKV	Karlovy Vary airport
LKMT	Ostrava - Mošnov airport
LKPR	Praha – Ruzyně airport
LKTB	Brno airport
LVP/LVTO	Low Visibility Procedures / Low Visibility Take Off

N

NAVCOM	Control and monitoring system for RCMS NAVCOM
NAVSYS LKPR	Control and monitoring system for RCMS NAVSYS
NTP	Network Time Protocol

O

ODBC	Open Database Connectivity
OLE DB	Object Linking and Embedding, Database

R, Ř

RCMS	Remote control and monitoring system
RCOM LKPR	Radio communication control and monitoring
RTU	Remote Terminal
R&S	Rohde & Schwarz - Praha, s.r.o.

ANS CR	Air Navigation Services of the Czech Republic

S

SCADA	Control and visualization monitoring system
SNMP	Simple Network Management Protocol
SW	Software

T

TCP	Transmission control protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TIS	Technical Information System
TS	Technical Hall
TWR	Control tower

U

ÚCL	CAA CR - CIVIL AVIATION AUTHORITY Czech Republic (http://www.caa.cz)
UPS	Uninterruptible Power Supply/Source

CMOS for Air Navigation Services of the Czech Republic
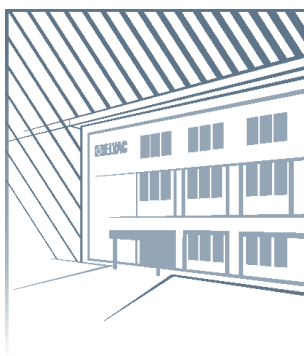
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