TA to Connectivity in the Western Balkans

EuropeAid/137850/IH/SER/MULTI

Sub-Project

Code: CONNECTA-TRA-INFR-MKD-DD-02
Area: Connectivity Transport Reform Measures

Review of the prepared project documentation for implementing Intelligent Transport System (ITS) along Road Corridor X in the former Yugoslav Republic of Macedonia

REVIEW REPORT (Final)

08 January 2019

MOTT MACDONALD CONNECTA CONSORTIUM

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	05/12/2018	Marios Domoxoudis (Road ITS Expert), Miroslav Petrovic (ICT)	Marios Miltiadou (PM)	Kostas Georgiou (TKE)	Draft Report
B	08/01/2019	Marios Miltiadou (PM)	Vesna Lazarevska (TM)	Chris Germanacos (TL)	Final Report

Information Class: EU Standard

Contents

List of Abbreviations

AO	Administrative Order
CEN	European Committee for Standardization
CNC	Core Network Corridor
CO	Country Office
CONNECTA	Technical Assistance to Connectivity in the Western Balkans
CONNECTA	The MMD led Consortium implementing Connecta
CRM	Connectivity Reform Measures
DG MOVE	Directorate-General for Mobility and Transport
DG NEAR	Directorate-General for Neighborhood and Enlargement Negotiations
DTL	Deputy Team Leader
EC	European Commission
EU	European Union
EUD	EU Delegation
FR	Final Report
FRAME	FRamework Architecture Made for Europe
IFI	International Financing Institution
IPA	Instrument for Pre-accession Assistance
IT/ ICT	Information – Communication Technologies
ITS	Intelligent Transport Systems
IR	Inception Report
KE	Key Expert
KoM	Kick-off-Meeting
MED	Mediterranean (corridor)
MKD/MK/MAC	the former Yugoslav Republic of Macedonia
MIS	Management Information System
MoM	Minutes of Meeting
MoTC/MoI/MoCTI	Ministry related to Transport and Infrastructure
NIPAC	National IPA Coordinator
NKE	Non-Key Expert
OEM	Orient East Mediterranean (corridor)
PM	Project Manager
QA	Quality Assurance
RFA	Request for Approval
SC	Steering Committee
SEE	South East Europe
SEETO	South East Europe Transport Observatory
SNKE	Senior Non-Key Expert
TA	Technical Assistance
TEN-T	Trans-European Network – Transport
TL	Team Leader
TM	Task Manager
ToR	Terms of Reference
V2I – I2V	Vehicle to Infrastructure (and vice versa)
VDR	Visual Data Recorder
WB6	Western Balkans 6 countries

1 SYNOPSIS

Project (sub-project) Title:	Review of the prepared project documentation for implementing Intelligent Transport System (ITS) along Road Corridor X in the former Yugoslav Republic of Macedonia (CONNECTA-TRA-CRM-REG-03)
Project Code:	EuropeAid/13785/IH/SER/MULTI
Area:	Connectivity Transport Reform Measures in WB6
Contracting Authority:	European Commission - DG NEAR
Main Beneficiary/Monitoring:	Ministry of Transport and Communications
End Beneficiaries:	the former Yugoslav Republic of Macedonia
Context:	National
Consultant:	CONNECTA Consortium (led by Mott MacDonald)
Administrative Order:	16 April 2018
Mobilisation of NKEs:	May 2018 (Kick-off Meeting on 30 May 2018)
Sub-Project Duration:	6 months (extended to 8 months, due to delay in provision of translated documentation)
Anticipated completion:	17 December 2018
Responsible Transport KE:	Kostas Georgiou

1.1 Project Scope

The aim of this CONNECTA sub-project was to review the project documentation for ITS implementation along road Corridor X (A1 highway Tabanovce – Bogorodica) and provide guidance for improving the project documentation in line with the EU technical, legal and institutional standards and requirements.

As per the Scope of Works (**SoW**), CONNECTA was assigned to:

- check adopted technical specifications for ITS design, before submission of draft documentation, if required.
- review the draft design documentation on its ITS technical parts (no civil engineering parts neither BoQ) and provide recommendations for adjustments and improvement (in line with EU Directives and standards) before design finalization and official review.

This report presents all the comments on the relevant documents and design reports as delivered, translated in English (except ToR of design, provided in national language).

1.2 Activities undertaken and main milestones

The kick-off meeting of the project was held in Skopje on May 30th 2018, in the Ministry of Transport and Communication (MoTC), where a common understanding on the scope of works and direct contact between beneficiary and involved parties (CONNECTA, design team) were established.

The list of deliverables and their submission dates are presented in the table below:

Table 1.2-1 Deliverables

Deliverable	Description	Delivery date
1. Report on specifications	Review of tender documents (ToR) regarding EU legal framework and specifications	**29 June 2018**
2. Technical Note on preliminary findings	Submission of interim review technical note (not foreseen by SoW)	**01 October 2018**
3. Draft Review Report	Review of design documents – presentation of findings of the assignment	**07 December 2018**
4. Final Report	Finalised version, taking into account any comments of the beneficiary	*17 December 2018 (anticipated)*

In brief:

For the scope of the project the design documents had to be obtained in English, official CONNECTA language (as EU-funded project). Immediately after project kick-off meeting, the CONNECTA team received the tender documents (ToR) for the system which is subject of review, containing technical specifications of desired system, in local language only. At the same time, CONNECTA received in hard copy working (draft) version of the project – design of the north (Skopje) control centre (partially translated in English and not in electronic format).

On June 29th 2018, CONNECTA submitted to the beneficiary the results of the review of the specifications, through a memo that aimed at confirming the CONNECTA team understanding of technical specifications and requirements and, at the same time, to provide comments on specifications and their consistency with EU Directives and standards, as per SoW. The input materials received at that time were mostly in local language. Since the project team did not have professional knowledge of the language (not required), it was requested from the beneficiaries (MoTC and Public Enterprise for State Roads - PESR) to point out if some elements from the specifications have not been understood and/or translated properly in English.

Full documentation translated in English was provided by the beneficiary to CONNECTA in two stages: on September 17th 2018 (Books 1, 2 and 3) and on October 5th 2018 (Books 4 and 5). Upon provision of the set of documents, the team identified some design issues that led to increased implementation and maintenance costs (CAPEX & OPEX) and immediately issued a technical note to the beneficiary, submitted on October 1st 2018.

This report includes all comments made in the technical notes submitted to the beneficiary, as well as all CONNECTA detailed comments on the design documents, namely:

- Book 1: ITS Traffic Design
- Book 2: Electrical Design
- Book 3: Traffic Information System
- Book 4: Civil Design for Steel Portal Frames Structure
- Book 5: Design Channels for Cables

1.3 The Team of Non-Key Experts (NKEs)

The team of the project consisted two Senior Experts on Road ITS and ICT and was coordinated by a Project Manager, in collaboration with the CONNECTA Transport Key-Expert and Deputy Team Leader.

Table 1.3-1 Team of NKEs

Position in RFA	Name	Category in Financial Proposal
1. Project Manager	Marios Miltiadou	SNKE
2. Roads ITS expert	Marios Domoxoudis	SNKE
3. ICT expert	Miroslav Petrovic	SNKE

2 REVIEW OF SPECIFICATIONS AND STANDARDS

Tender documentation is from July 2016 with the following project title: "Development of project documentation for main project for construction of information and communication system for ITS (intelligent transport system) traffic monitoring and control for M1, Highway A1."

Section II, Part 1 – Technical specifications of the tender documentation contains part titled "Laws and regulations" (ЗАКОНИ И ПРОПИСИ), where relevant local laws and regulations for this project are listed. Afterwards, the following formulation exists: "for those parts within the scope where no domestic regulations and instructions exists, contractor in agreement with client will apply valid directives and regulations of EU and Member States related to the project domain and which are applied for projects of transport systems on Pan-European Corridor".

Since, as the team was informed during the kick-off meeting, no local regulations regarding ITS exists at the moment, it was understood that such formulation of specification enables using recent versions of applicable EU directives, regulations and standards. In the last two years since the tender documentation was completed, several relevant regulations and directives have been adopted and entered into force. The same is valid for some standards and delegated regulations amending main directives. For the sake of completeness and clarity, hereby the most relevant EU acts have been listed. Therefore, CONNECTA recommends that the final project is aligned with the acts mentioned below:

Act	Description	Comments
Directive 2010/40/EU	Framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other transport modes	Mentioned
Directive 2004/54/EC	Minimum technical conditions for safety in tunnels	Mentioned in the project
Directive 2008/96/EC	Road Infrastructure Safety Management	No specific functionalities are described on Accident/Incident Information and Reports under Incident Management Section of the project
Directive 2007/2/EC	Establishment of spatial information infrastructure for integrated access to travel data	Not mentioned
Delegated Acts 305/2013 886/2013 885/2013 962/2015 2017/1926 2017/2380	Delegated Acts under Directive 2010/40/EU	Not mentioned
Directive 2016/1148/EU	Network Information Security (NIS)	Not mentioned. Required, since road operators provide an essential service under the directive
Regulation 2016/679/EU	General Data Protection Regulation (GDPR)	Not mentioned. Required, particularly due to video surveillance part of the project
Standard CEN 16157	DATEX II (adopted in MKD as MKTC CEN/TS 16157)	Not mentioned
Other CEN/TC 278 Standards		Not mentioned
EN 12966:2014	Variable message traffic signs (МКС EN 12966:2015)	

For the cases where there is no relevant EU-wide act, it was recommended to use standards and procedure of recognized international standard institutions or relevant national procedures of EU countries, as those listed in the technical specifications:

- Transport Research Board: Highway Capacity Manual (HCM), 2010
- ISO/TC 204 standards
- Bundesministeriums fuer Verkher, Bau und Stadtentwiklung (BMVBS):
  - Merkblatt fuer die Ausstattung von Verkhersrechnerzentralen un Unterzentralen (MARZ), 1999.
- Bundesanstalt fuer Strassenwessen (BASt):
  - Technical Supply Condition for Roadside Stations (TLS) 2002, 2012.
  - Guidelines for variable traffic sign installation (RWVA) 1997.
  - Guidelines for variable traffic sign (RWVZ) 1997.
  - Dynamic Signing with Integrated Congestion (dWiSTa) 2005.
- EU Easy way. Variable Message Signs Harmonisation, Specific Messages Recommended VMS – DG02, version 01-02-00, 2012.
- Oesterreichische Forschungsgemeinschaft fuer Strasse und Verkher (FSV):
  - Richtlinien RVS 9.261, RVS 9.262, RVS 9.282, RVS 09.02.41

However, in this case it was recommended to use the latest versions of above-mentioned standards, since the ones listed in the tender documents have newer versions, such as:

- Transport Research Board: Highway Capacity Manual HCM 2016.
- ISO 14813-1:2015 Intelligent transport systems -- Reference model architecture(s) for the ITS sector (MKC ISO 14813-1:2016)
- Bundesministeriums fuer Verkher, Bau und Stadtentwiklung (BMVBS):
  - Merkblatt fuer die Ausstattung von Verkhersrechnerzentralen un Unterzentralen (MARZ), 2018.

Finally, there are cases where standards listed from different organizations are covering the same area (such as variable traffic signs). But since MKD standard exists (MKC EN 12966:2015), being the same as EU standard holding the same number, this should have the priority over other sources.

3 DESIGN REVIEW

3.1 Main Findings – Concerns on Technical Approach

3.1.1 Communication Network Design

Industrial and Utility networks, traditionally dominated by SONET/SDH and other proprietary technologies, are migrating to Ethernet en masse. There are many reasons behind this migration.

Ethernet's simplicity, interoperability, and cost efficiencies bring tangible benefits.

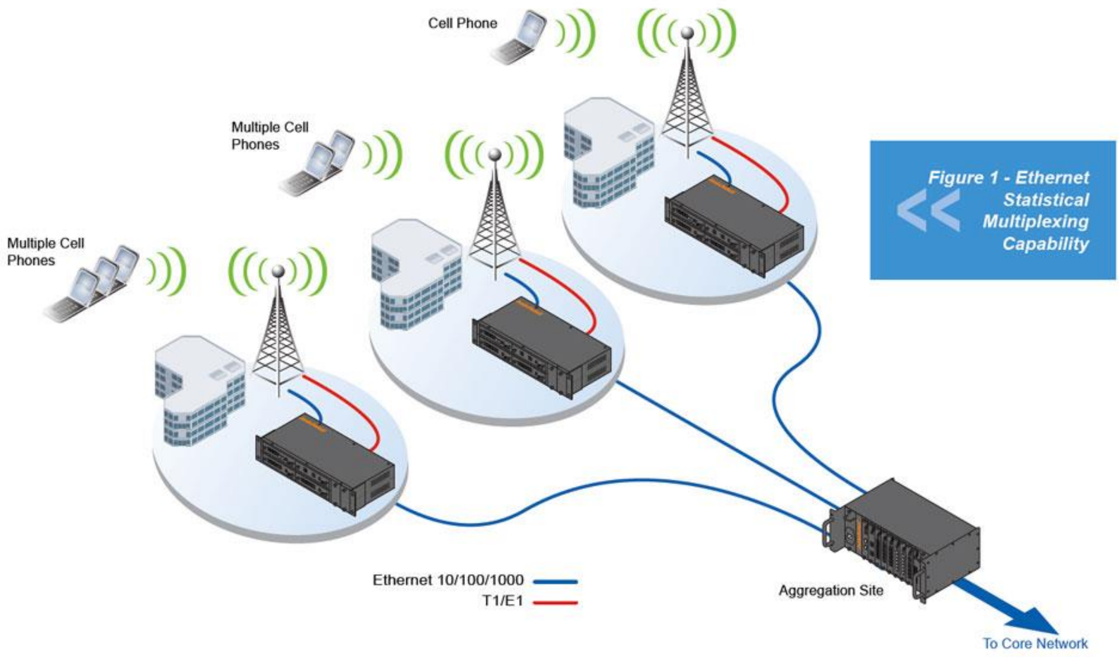


Figure 1 - Ethernet Statistical Multiplexing Capability

Recent Ethernet standardization efforts have focused on improving Quality of Service (QoS) and Operation Administration and Management (OAM). As a result, Ethernet addressed some weaknesses and now provides strengths previously only associated with SONET/SDH.

For example, Ethernet's real time (deterministic) capabilities are now comparable to SONET/SDH for virtually every application including Smart Grid, SCADA, and tele-protection relay communications in critical network applications.

SONET/SDH networks are designed to use fixed bandwidth circuits, which contribute to overall complexity and operation inefficiencies. In short, SONET/SDH bandwidth allocation is rigid; Ethernet is flexible.

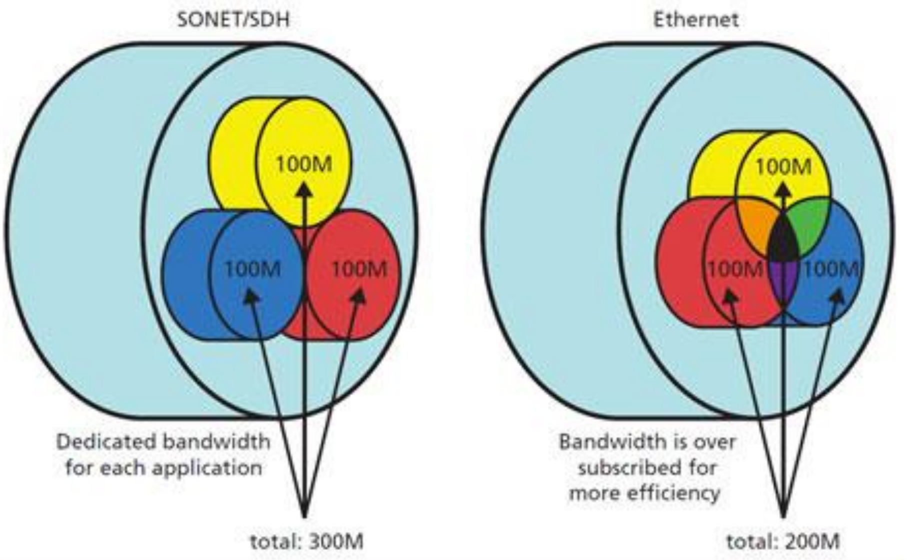


Figure 2 - Bandwidth Efficiency Comparison

Ethernet is a connectionless packet technology that inherently supports statistical multiplexing. Ethernet-based backhaul transport can easily accommodate data increases with a much smaller incremental increase of backbone bandwidth through the proper use of over-subscription and statistical multiplexing. Industrial Ethernet layer 2 switches can be deployed in several applications to increase overall bandwidth efficiency including:

1. Terminating T1/E1 circuits over Ethernet at the cell sites takes advantage of Ethernet's statistical multiplexing capabilities to reduce bandwidth needs for backhaul.
2. Using Ethernet switches instead of SONET/SDH ADMs at the aggregation points to reduce overall Capital Expenditure (CAPEX) as well as Operational Expenditure (OPEX).

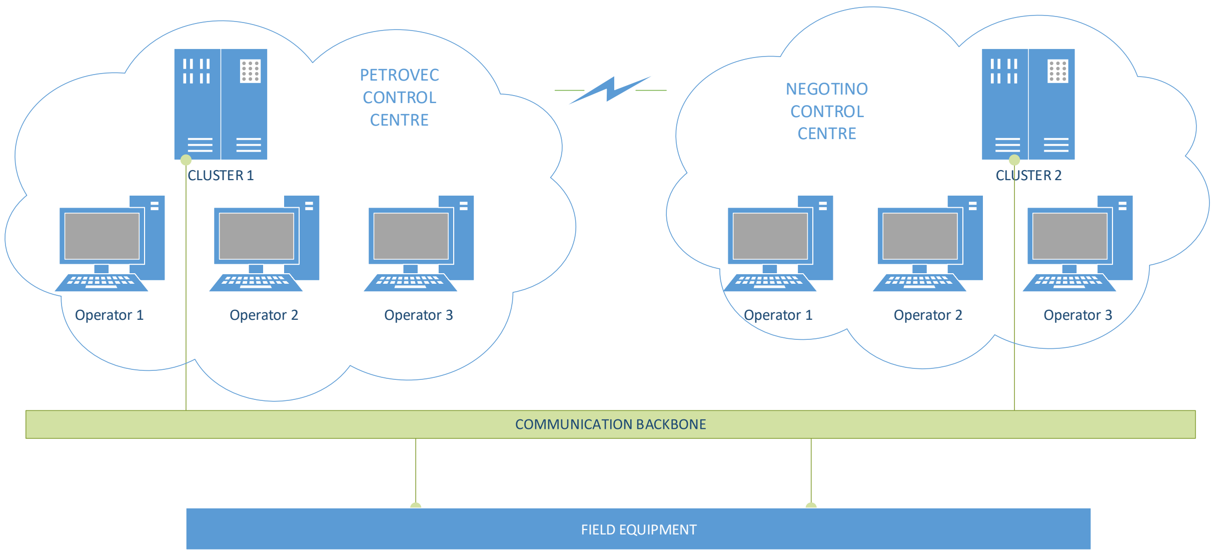
In addition, operational and maintenance costs (OPEX) are also lower for Ethernet. Compared to the complicated hierarchies of SONET/SDH based systems, Ethernet reduces operational expenses by eliminating unnecessary hardware layers. This is a huge benefit because it significantly lowers the skill level (and related costs) required for installation, maintenance and troubleshooting.

Thus, the use of layer 2 and 3 (as appropriate) Ethernet switches, instead of SDH nodes, is strongly recommended, since Ethernet is less expensive than SONET/SDH in terms of initial equipment costs, ongoing maintenance and provisioning. Moreover, the complicated technical nature of SONET/SDH networks typically requires several highly trained personnel for ongoing system configuration and maintenance. Ethernet networks, on the other hand, can be configured and maintained by fewer Ethernet-trained personnel.

Finally, from the CONNECTA team's understanding of the ToR provided in national language is that the requirement is to use Ethernet over optical network with minimum speed of 1 Gb/s (section 2.4.5.2). The project does not include calculation about bandwidth needs for the required equipment and services, to justify that enough bandwidth with spare capacities for future expansion and future services is planned. This calculation is very important in terms of foreseen additional ITS services. Moreover, recent EU Commission initiative - Digital Agenda for the Western Balkans with investment in broadband connectivity supported by World Bank and WBIF might have impact on this project, as it promotes sharing of unused digital infrastructure capacities among public enterprises.

3.1.2 Disaster Recovery

Disaster recovery and central system redundancy is of paramount importance in case of hardware and/or network failures in order to maintain system availability and motorway operations to high levels.



Redundancy should exist in two levels, local and remote. Local redundancy implies that within each control centre, servers are redundant (cluster mode). So, when a hardware or software component fails, automatically another hot-standby server within the same cluster takes over.

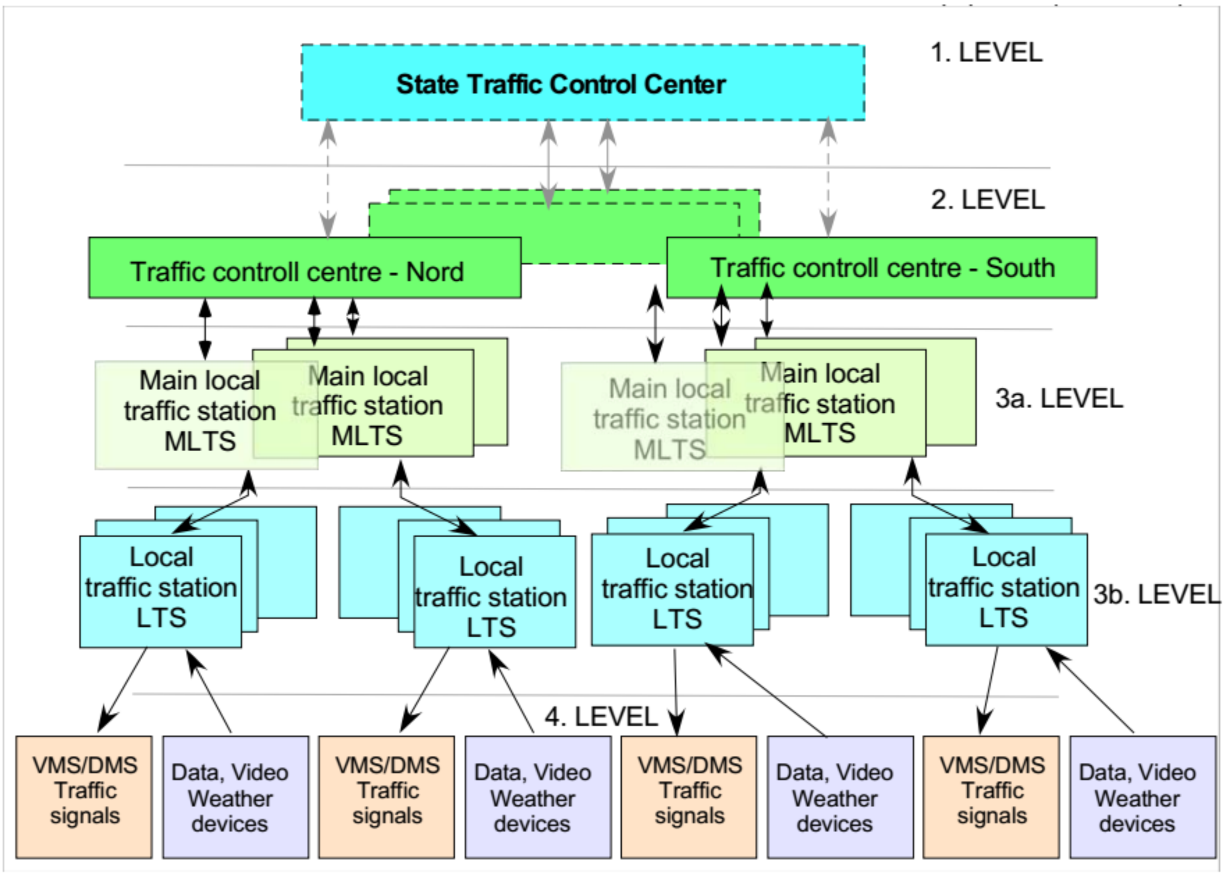
Remote redundancy is between the two control centres in cases of disaster (e.g. earthquake, fire, etc). In such case, operations of the whole motorway are handled from one control centre.

Last but not least, the Motorway Operator may need for management purposes (e.g. staffing) to operate the entire network from one location. Thus, **the system must enable both control centres to be able to monitor and operate the entire system**.

All the above are not mentioned or even implied in the project documentation, thus <u>CONNECTA deems necessary to include such provisions/ functionality</u>.

3.1.3 System Architecture

In the design document (pages 19-20 of Book 1), Level 3a and Level 3b are described. According to the state of good practice, the functionality of MLTS and LTS devices can be easily implemented in the server level unless deemed critical and autonomous scenarios are run locally (see diagram below).



Since this is not our case, Level 3a and Level 3b devices (LTS & MLTS) can be omitted, providing less complexity and reliability (e.g. if one MLTS unit loses communication, everything below that unit will become unavailable), lower implementation cost (less CAPEX) and lower operational/maintenance cost (less OPEX). Field devices can be required to have an Ethernet interface that will enable the central system to communicate directly with them.

For equipment that an LTS unit is required, such as inductive loops, the LTS can either remain or specify an alternative to inductive loops (such as LIDAR radars) with Ethernet interface. Note that inductive loops have low MTBF (often repairs – high maintenance efforts) and they are prone to damages during winter maintenance (they are damaged by the snow plows) and need often replacement.

Concluding, **for less complexity, higher availability and reduced investments and operational & maintenance costs, it is strongly recommended to**:

1. Disregard Level 3a and 3b.
2. Specify Ethernet interface for all field devices in order to communicate directly with the Central System.
3. Examine alternatives to inductive loops (e.g. LIDAR).

3.2 Detailed Comments on Design

The table below presents the full list of the comments of CONNECTA team, considering all the above concerns. Comments have been marked for their respective status as presented in the following table.

Type of Comment		Assessment	
G	General	**CN**	Correction necessary
M	Mistake	**CE**	Correction expected
U	Understanding.	**+**	Major
P	Proposal	**-**	Minor

Below is the list of the comments on the design documents that were presented to CONNECTA as final.

N°	Reference (e.g. Art, §)	Type/ Assess	Reviewer's Comments, Questions, Proposals
1.	Book 1, Chapter 4.1, page 18	G/CN	Each control centre should be able to monitor, manage, control the whole stretch of the motorway, including the tunnels.
2.	Book 1, Chapter 4.1, page 18	G/CE	Interface with the tunnel SCADA system is not specified and tunnel scenarios not considered.
3.	Book 1, Chapter 4, page 18	M/CN+	ISO 14813-1:2007 has been withdrawn and substituted with ISO 14813-1:2015. Make necessary corrections and amendments to the whole of the document, if necessary, in order to be compliant to the valid current version of the standard.
4.	Book 1, Chapter 4.2, page 19	P/CE+	3a and 3b levels are not necessary and it is recommended omitting them. They just add complexity, extra point of failures and significantly increase installation and maintenance costs. Equipment can be directly accessed/ integrated over Ethernet. Thus, equipment must all have ethernet interface. Amend accordingly next chapters and Books
5.	Book 1, Chapter 4.2, page 20	G/CN+	Each TCC should be able to control and operate all equipment and act as a disaster recovery site of the other TCC. Amend accordingly next chapters and Books.
6.	Book 1, Chapter 4.4, page 22	P/CE+	Provide functional description of all tasks of the TCC, listed. For example, what are the manual operation options? Elaborate in detail. Also provide UI mockups and data/ action flow diagrams. See also comments 2 and 3, above.
7.	Book 1, Chapter 6, Page 30	M/CE+	Traffic data collection is not specified in detail (e.g. how many categories shall be measured?). It is assumed that inductive loops are proposed. Inductive loops have significant fault rates, are not accurate and can be damaged during winter maintenance operations. Lidar radars should be considered, since they are non-invasive, have better performance and lower maintenance costs. Moreover, not all field equipment is described/ specified, or UI related functionality is described. Missing equipment is: 1. SOS phones. CONNECTA team recommends VoIP SOS phones with dual (Ethernet and GSM) interfaces. 2. Disaster recovery and Redundancy (see Chapter 3.1 of this report)

N°	Reference (e.g. Art, §)	Type/ Assess	Reviewer's Comments, Questions, Proposals
8.	Book 1, Chapter 6.2.4, Page 46	M/CE+	Chapter 5 seems incomplete. Software client UI of operator should be specified in detail. Provide mockups and functionality. Minimum functionality includes: 1. monitor and control of all field devices of the whole motorway, including tunnels 2. Incident response logging and data entry according to Motorway Incident Management state of practice and operations manuals. 3. Traffic Management plans and tunnel scenario execution 4. AVL for incident response vehicles 5. Interface to third party systems (eCall) 6. Control Centre to control centre interface 7. V2I interface
9.	Book 1, Chapter 6.2.4, Page 46	M/CE+	VMS signs should be EN 12966:2014 certified. EN 12966:2007 mentioned is obsolete. Moreover, CONNECTA team does not find justification for mentioning Croatian Safety Regulations: *Declaration of Conformity with Croatian Safety Regulations for electronic devices provided by the producer must be substantiated by test reports carried out by authorized laboratories in Macedonia or EU countries and made for a group of products: light variable signs of the same technology as the signs from the list of expenses.*
10.	Book 1, Chapter 6.3.1, Page 49	P/CE	Putting the cabinet in 5m height is not necessary. It is not good for maintenance and makes the connection to road sensors difficult. The cabinet can be put on the ground level and necessary sensors (e.g. wind direction, etc.) can be put in a smaller pole.
11.	Book 1, Chapter 6.4, Page 49	P/CE+	NVR is not specified. The Video system should have an NVR where all videos will be recorded for a specified maximum period of time. For this, also a disk space calculation should be provided, taking into account that specific alarm videos concerning accidents may be required to be recorded and stored permanently. NVRs can be located in the tunnel and the two control centres and managed by both control centres from Operator's UI.
12.	Book 1, Chapter 6.4.2, Page 50	P/CE+	As also mentioned in 5.4.1, AID cameras are fixed (no PTZ or zoom). For monitoring and surveillance PTZ cameras are needed. As it is presented in this chapter one may think there is one camera for both applications. The location and BoQs of each camera type should also be provided.
13.	Book 1, Chapter 6.4.3, Page 52	P/CE+	Provide bandwidth calculations for the total AID cameras of the project and design the network accordingly. To reduce bandwidth needs, the video network should be multicast and QoS enabled.
14.	Book 1, Chapter 6.4.4, Page 52	P/CE+	See above comment. Network switches should be suitable for such an application.

N°	Reference (e.g. Art, §)	Type/ Assess	Reviewer's Comments, Questions, Proposals
15.	Book 1, Chapter 6.4.5 Page 53	P/CE+	List of incidents and alarm types the AID system can detect and provide, should be specified. Indicative list regarding tunnels: smoke, fallen object, pedestrian, stopped vehicle, slow moving vehicle, wrong way vehicle. Also, the maximum false alarm rate (FAR) should be specified. AID cameras should overlap one another, and 100% coverage of the tunnels must be achieved. See also comment #1. Where is the AID video card going to be installed in case of a hardware video card AID system? This should also be specified.
16.	Book 1, Appendix	G/CE+	Barriers, guardrails should be EN 1317 certified.
17.	Book 2, Chapter 1 Page 3	P/CE+	SDH network should be disregarded and instead an Ethernet network to be specified. Also see Chapter 3.1 of this report.
18.	Book 2, Chapter 1.4, Page 9	M/CE+	The CONNECTA team does not find justification to make this equipment vendor specific by listing the device model from specific vendor: SparkLight ADM-16 (https://www.iskra.eu/en/Iskra-Optical-Transmission/ADM-16-SparkLight/). Refrain from being vendor specific.
19.	Book 2, Chapter 2, Page 24	M/CE+	Disaster recovery and central system redundancy is of paramount importance in case of hardware and/or network failures in order to maintain system availability and motorway operations to high levels. Add “System Redundancy” chapter where system redundancy is specified. See also Chapter 3.1 of this report. NMS requirements and functional description is missing. System Architecture and topology is missing. Server/Cluster hardware requirements are missing (per control centre). Cluster VMs should be defined. Also, network storage requirements are missing. Provide storage needs calculation taking into account all cameras (including AID) and a maximum video retention interval (e.g. 45 days) Server/Cluster software requirements are missing. The CONNECTA team recommends Linux clustering solutions (KVM, RedHat)
20.	Book 2, Chapter 3, Page 25	M/CE+	The CONNECTA team recommends VoIP SOS phones with dual (Ethernet and GSM) interfaces. This will reduce to reduce overall Capital Expenditure (CAPEX) as well as Operational Expenditure (OPEX). Ethernet VoIP interface should be the main emergency phone interface and in case of a network issue, the GSM interface to be used.
21.	Book 2, Chapter 5, Page 37	M/CE+	Apart from calculations related to electrical parameters (insulation, protection, voltage drop, etc.), calculation about network bandwidth required is missing. This is mandatory to exist, to be sure that bandwidth is enough for the equipment planned to be installed and that there is enough spare capacity for future use. Surge protection for all field devices and cabinets should also be included.

N°	Reference (e.g. Art, §)	Type/ Assess	Reviewer's Comments, Questions, Proposals
22.	Book 3, Chapter 1.2, Page 10	P/CE+	In integrated protocols, include Datex II. Include tunnel management in control center tasks. Tunnel management is missing completely. Add accordingly.
23.	Book 3, Chapter 1.2.1, Page 13		*“The user application’s Administrator can define specifying settings, together with specific rights, for each user of the System. User rights can be customized for individual users as well as for a group of users the individual user is a member of “.* To be altered as: *“The user application’s Administrator can define system settings, together with specific rights, for each user of the System. User rights can be customized for individual users as well as for a group of users the individual user is a member of and for any system function, equipment and equipment type “.*
24.	Book 3, Chapter 5.11.1, Page 78	M/CE+	Video Wall specified is deemed not sufficient. Video wall specification should take into account the total number of cameras installed, the number of operators (staff) and the number of simultaneous incidents that can be processed. Also, an alarm area for AID alarms to be displayed (including tunnels) should be specified. The above requirements will determine the architectural requirements for the control room. The layout provided is deemed inadequate by the CONNECTA team. Provide a control room layout with dimensions, depicting also operator ergonomics and field of view of the video wall, taking into account a new video wall layout.
25.	Book 3, Chapter 6, Page 83	P/CE+	Cluster hardware requirements should be based on calculations. Storage requirements should be based on calculations (see comment 19). All calculations to be presented in Appendix.
26.	Book 5, Chapter 2	P/CE+	ToR (in local language) mentions existence of project for main fiber cable for South Sector and in book 5, Section 2 it is mentioned that cable channel on section Demir Kapija – Smokvica will be used for this project. The CONNECTA team thinks it is necessary to include in this project relevant details of construction of existing cable (duct) as well as connections of new cable channels with the existing one.

4 BASIC CONCLUSIONS

CONNECTA completed this TA assignment, having stressed some serious concerns that constitute major design deficiency:

1. Communication Network Design; SDH network is proposed in the design, instead of an Ethernet network.
2. Disaster recovery and system redundancy; No disaster recovery or redundancy between the two control centres is specified in the design.
3. System Architecture; Levels 3a and 3b are considered unnecessary, as they provide extra complexity and an extra point of failure, which could be avoided if the field devices (VMS, DMS, ERTs, etc.) are specified with an Ethernet interface. Thus, field devices can be accessed directly by the central system.

These concerns have been timely provided to the Beneficiary, and, along with the detailed comments provided in this report, should be addressed by the Designer.

The designer has already acknowledged the importance of some of the concerns expressed by CONNECTA (reply received on 30.10.2018, Appendix A of this report) and shall take them to take into account in the documentation finalisation, along with the comments to be received by the official independent reviewer of the design.

APPENDICES

APPENDIX A: DESIGNER'S REPLY ON INITIAL CONCERNS EXPRESSED BY CONNECTA

Бр.

Скопје, 30.10.2018г.

До: **Министерство за транспорт и врски на РМ**
Сектор за Европска Унија
Одделение за ИПА Мониторинг
ул. Даме Груев бр. 6, 1000 Скопје

Предмет: Допис со одговори на забелешки на проектна документација

Врска: Договор за изработка на проектна документација за ИТС систем за коридор X, наш број (1002-1376/2 од 02.11.2016г.), Ваш број (18-9298/14 од 02.11.2016г.)

Почитувани,

Во прилог на овој допис Ви испраќаме одговори на забелешките на проектната документација за ИТС систем за коридор X испратени од страна на консултантот CONNECTA.

Со почит,

Координатор на проект

м-р Дарко Трајаноски, дипл.ел.инж.

Dear colleagues,

We submit you responses to EU Consultants' Objections from technical note on Corridor X ITS design review prepared by CONNECTA from 01.10.2018.

Replay to Objection (Communication Network Design)

We completely accept the Objection and the suggestion to set up the Ethernet instead of the SDH communication network.

The Ethernet network for highway systems can be of the "star" or of the "ring" topology. We chose the "star" topology.

Concerning the communication equipment (switches) in TCC and at the highway route the high quality with long MTBF will be applied. By checking the cable distance and chocking we shall choose the adequate Ethernet optical transducers with the maximum allowed attenuation in order it be taken into account at performing.

Related to this we will elaborate a specification and a cost estimate.

Replay to Objection (Disaster Recovery)

We partially accept the Objection.

Objection on Redundancy

By the Project servers working in the Cluster Mode in each TCC are planned, which means that within TCC redundancy is set up. We will check descriptions, block diagrams and technical specifications and complete them if they are possibly defective.

Explanation:

Local redundancy at the TCC level is provided by server equipment installing into the Hyper-V Cluster configuration and by installing the program equipment at virtual servers within the Hyper-V Cluster environment.
Redundancy of the integral traffic system is implemented by usage of virtual servers in the Windows redundant environment by installing a logical application server on both physical servers.
To make a load distribution and provide maintenance flexibility the integrated transport system's modules will be distributed and grouped into the following virtual serves as a minimum:

- Integrated Traffic System Server,
- Database and Reporting System Server.

Windows software must be configured to continuously monitor the load and the status of virtual servers on both physical servers. If one of instances becomes unavailable the Cluster Service must redistribute the virtual server to another physical server without any virtual server functionality disorder.

In a part of technical descriptions Books 1 and 3 explanations of redundancy method within TCC shall be supplemented, as well as checking and technical specifications.

Functional redundancy at the System level

By the Project the possibility of managing the entire length of the highway from one center is not anticipated due to many objects, a lot of operational monitoring and management tasks along 220 kilometers long route.

In the Project Task there is no requirement referring to the proposal of the functional redundancy (a proposal to introduce the possibility of overtaking TCC operational tasks of traffic management and control "dropped" for any reason).

Also, TCC premises, anticipated by Investor and taken over by Project Manger ("Skopje" and "Negotino" TCCs) are of minimal size and insufficient for such extensions.

By the Project it is planned (due to many objects, complexity of objects and climate diversity) that in case of communication interruption with TCC each interrupted object automatically switches to a local mode of work. Also, such mode of working allows each object under construction to be put into a local work before finishing the construction of the entire system.

By the Project communication and data exchange between two Centers via DATEX-II Protocols are designed, which is the standard for the real traffic data about roadway conditions.

Explanation:

At the moment of such an atypical situation (earthquake, fire etc.) a large number of management (operational) tasks can cause a disturbance within an operating center. In addition, in these moments the coordinated and other state-level services (police, fire brigades, army etc.) or Center for Crisis Situations must be involved. The solution represents the Main Traffic Control center (MNCC) of the state level. Such centers have been formed in EU countries, too. Such center was formed in Croatia (the level 1) and it coordinates work of all operational TCCs (the level 2), but it does not take over the operational conduction of the highway route traffic; it collects data on the highway route, coordinates the work of neighboring TCC in contact zones. MTCC exchanges data on the current state on highways in Croatia with such centers in the surroundings (Slovenia, Italy and Austria) via Datex II.

However, the problem occurs when there are different concessionaires which do not accept their system in any situation can be managed by someone else. (The reason is the possibility of access to financial data).

The functional redundancy at the System level is achieved by implementation of the backup control center at a separate location. To provide that in case of major breakdown at any control center (TCC) the backup control center could take over the function of the main control center, the communication and server equipment and the software at the backup center must ensure the following:

- Permanent access to the main communication network that connects all external elements of the traffic information system,
- Continuous and automatic "mirror" of the main traffic information system database,
- Complete copy of the configuration and the software for traffic information system, just like in the main control center.

These requirements to a great extent increase the investment (premises, communication infrastructure, equipment, personnel).

Replay to Objection (System Architecture)

ITS consists of several hierarchically structured functional levels and each functional level has assigned some specific tasks.
On the Functional Levels Diagram the Level 1 is indicated (the Main Center at the state level - MTCC) from which the work of all TCCs is monitored (the Level2). Its basic function is coordination, control and optimization of all TCCs of the Level 2, as well as coordination with other state-level services, in cases of atypical situations (earthquake, fire etc.).

This project does not process the Level 1, but in future Investor will have to develop the Level 1, that is common in EU countries.

Explanation of Objection to Levels 3a and 3b (MLTS and LTS)

The functional level 3 is the level of all Local Stations as components for data entry, data release, switching and work control of all executive bodies (VMS, DMS, ERT etc.).
Local devices (MLTS and LTS) are identical and of the same level, they have a direct connection (the management and the control once) with the traffic control unit in TCC.

In case of connection interruption with the TCC for any reason, the Project is designed so that one of LTS devices takes over the execution bodies' management at the local level. The device is designated as MLTS and contains logic of the local management that is limited to executive bodies in a zone of the controlled object. The reason is to prevent possible emergence of contradictory messages on executive bodies and to set, based on local data, pre-defined messages on executive bodies.

Furthermore, MLTS and LTS due to their design do not require specific units such as inductive loops and can take over any other type of vehicles detections (for example LIDAR).

To avoid any ambiguity we will redesign a display of functional levels on the diagram.

We do not accept Objection that Level 3 is unnecessary

- The Level 3 is neither additional complexity nor additional fault point.
- The Level 3 does not raise the price of investment; even in case of the Level 3 absence, for each executive body on a roadway it is necessary to provide a unit for power supply and protection of executive organs, connection fields of the communication part between executive bodies and TCC, which makes approximately 80-85% of the Level 3 investment.
- The Level 3 is the standardized technical condition.

Defining technical conditions is a very demanding and sensitive part of designing if there are no generally accepted conditions; this is the main reason of introducing standardized technical conditions.

Existence of the market and technical conditions for delivery are two basic prerequisites for creating a competitive relationship between equipment producers.
This fact led to the development of “TLS” guidelines that do not favorite any equipment but define the unique technical conditions for the equipment functioning as a separate unit and in harmony with other traffic equipment as a reliable functional unit on a roadway.

Are there any other standards or guidelines related to this field and can they be realized by strict implementation:

- Compatibility at all levels of the system,
- Sufficient level of technical delivery conditions defining,
- Possibility of upgrading and installing into the installed system,
- Relevant competition that provides enough information to different suppliers, in order to be able to evaluate their offers uniquely.

The only EU standards partially related to this area are the following:

- *ISO 14827-1 Transport Information and Control Systems (Data Interfaces between Centers for Transport Information and Control Systems – Part 1: Message Definition Requirements and Part 2: DATEX-ASN)*

The standard sets frameworks for data protocol implementation (DATEX-COBRA etc.) only between various high level information systems. The standard does not deal with a particular realization of the Traffic System and System parts.

- *ISO 14813-1 Transport Information and Control Systems (Reference Model Architecture(s) for the **T**ransport **I**nformation and **C**ontrol **S**ystems (TICS) Sector –Part 1*

This standard defines basic TICS products, services and possible services users. The standard does not deal with a particular realization of the Traffic System and System Parts

- *ISO 14813-5 Transport Information and Control Systems (Architecture(s) for the **T**ransport **I**nformation and **C**ontrol **S**ystems (TICS) Sector – Part 5*

The standard defines the most comprehensive terms for TICS designing; they are designed at the abstract level and are not a particular template for the Traffic System construction.

Upon the above mentioned it is clear that at the EU level there is no standardized model for construction or operational realization of the transport system. For realization of this particular system the designer chose the existing model that is used in the EU countries (Germany, Austria, Switzerland, Croatia, Hungary, Slovenia etc.), i.e. Technische Lieferbedinung fuer Streckenstation 2012, Germany „TLS“.

These delivery conditions do not have to be the “TLS”, but reasons of TLS complexity and details would be reasons of complexity and details of any other technical delivery conditions; the only difference is that TLS model has been confirmed in practice and applied in developed countries of the EU.

Apart from the above mentioned TLS model is also:

- Applicable to this specific Traffic System and made in a form of particular and clear technical conditions that fully and precisely define all relevant technical parameters related to the System construction,
- Validated (tried, tested, reliable),
- Adapted to traffic and made primarily for traffic purposes,
- It is not against the law regulations,
- It does not in any way contradict the accepted EU standards and anticipate EU Standards and Regulations that the Republic of Macedonia will for certain adopt.

TLS does not impose any characteristics of a device or equipment that may significantly affect their cost (for example high or medium time between failures, special mechanical performances, choice of expensive electronic components or devices, special quality of performance). It also in any way does not determine technology for realization of requirements (for example possible mistakes that PLC devices can also work in accordance with TLS).

One of basic reasons why TLS is made is the need to achieve 100% horizontal and vertical compatibility, the ability of connection with new generations of devices, equipment and installations and a possibility of upgrading.

It is important to emphasize that concerning the traffic system the most critical moment is the response speed in critical situations.

The concept of solving critical situations according to TLS is based on local work (which allows the response speed within 1 sec, regardless of the communication medium and according to TCC.

The system's speed of response (reaction) to the command from TCC depends solely on data transfer technology that is not limited by TLS. According to TLS data are transmitted in real time without any restrictions.

According to TLS data can be transmitted at the highest possible technological speeds, in a way enabling the complete implementation of today's widely applied TCP/IP protocol.

TLS completely defines all relevant situations and data related to traffic events through appropriate functional groups; there are no longer any obstacles for all the systems related to monitoring and traffic management to be unified according to TLS, irrespective of applied technologies, devices, network communication protocols.

Based on all above mentioned we do not accept the proposal that the Traffic Control Center in TCC communicates directly with field devices.

Replay to Objection on inductive loop implementation

We agree with the Objection and accept the proposal of the consultant.
Related to this we shall set up in the Project a solution with the proposed non-invasive detection.

We will delete inductive loops from the Project and make a reconfiguration of the detection:

1. At the main route (on VMS portals), an overhead combination of doppler radars, ultrasound and passive infrared, (Xtrail),
2. At entrance-exit ramps, a side-fare radar for covering 1-4 zones/lanes (RTMS).

An also, related to the above mentioned we will make corrections in the documentation, technical description, technical specifications and cost estimate.

Regards,