



EN 50155 / IEC 60571 Railway Embedded Controller & Remote IO



Application note TRDP communication over ETB

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RIOM & BRIO are Ethernet-based input/output controller designed to be embedded onboard rolling stock vehicles.

RIOM & BRIO are fully compliant with the EN50155 standard for railway systems.

This application note describes the implementation of TRDP communications in the TCMS. Following User Manuals for RIOM are available:

- ✓ User Manual "Hardware specifications" P_DOC_RIOM_001E
- ✓ User Manual "User's manual STRATON programming" P_DOC_RIOM_006E

Prerequisites

It is necessary that the user have technical knowledge in mechanical, electrical, and Ethernet networks for railway systems; following standards IEC61375-2-3, IEC61375-2-4 & IEC61375-2-5 are used for the network configuration and communication definition.

Safety instructions

Following symbols are used in this documentation in order to avoid user for potential risks:



Risk of personal injury or damage to the equipment.

Risk of an electrical hazard.

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Table of Contents

1.	. Introduction						
	1.1.	1.1. Hardware Description					
	1.2.	System	architecture	6			
2.	Svste	em impl	ementation	7			
	2.1.	Networ	k configuration	7			
	2.2.	RIOM p	rogramming Straton database	8			
		2.2.2.	Communication with the local ETBN:				
		2.2.4.	Communication with other consists				
	2.3.	DDS pr	ogramming				
	2.4.	System	test				
		2.4.1.	Consist 1 Leader state case	12			
		2.4.2.	Consist 3 Leader state case	12			
		2.4.3.	Straton Monitoring, Debugging & list view	12			
3.	Conc	lusion .		13			



1. Introduction

TRDP (Train Real-Time Data Protocol) is a new Ethernet communication protocol dedicated to TCMS (Train Control and Monitoring System) applications.

TRDP is defined in the IEC61375-2-3 standard: this standard specifies rules for the data exchange between consists in trains, in order to define a TCN (Train communication network) communication profile.

The objective of the communication profile is to ensure interoperability between consists of the trains with respect to the exchange of information.

This communication profile is adhered to the Ethernet Train Backbone (ETB) technology as defined in IEC 61375-2-5 standard. TRDP is also used in Ethernet Consist Network (ECN) technology as defined in IEC 61375-3-4 standard.

This application note describes TRDP communications over ETB and ECN networks.

TRDP is now available on all new Leroy Automation Ethernet devices designed for train.

1.1. Hardware Description

RIOM, acting as a VCU (Vehicle Control Unit), BRIO, acting as a remote IO, DDS (Driver Display Unit), Routers (ETBN: Ethernet Train Backbone Node) and Ethernet Switches () are units fully compliant with the EN50155 standard, and are designed to be integrated in embedded railway systems and subsystems.



Figure 2 : Leroy Automation RIOM



Figure 1 : Leroy Automation BRIO



Figure 3 : PIXY DDS



Figure 5 : VDS Ethernet Train Backbone Node



Figure 4 : VDS Consist Switch



1.2. System architecture

The system architecture is defined according to IEC61375-2-5 and IEC61375-3-4 standards.

The system described in this application note implements the following features:

- ETB line redundancy: redundant Ethernet line between each ETBN.
- 3 consists management: train inauguration process.
- Leader consist management: ECSC (ETB Control Service Client) & ECSP (ETB Control Service Provider) communication.
- TRDP communication: between RIOM (VCU) & ETBN (ETB Node), RIOM (VCU) & BRIO (remote IO).
- Process management (Doors) through the RIOM device
- DDS : monitoring of the Door & Speed process



Figure 6 : System architecture with 3 consists

To increase the ECN availability, the architecture can be improved: the architecture below includes for ECN1 the following features:

- ETB-ECN line redundancy: two Ethernet lines are available between the ETB and ECN1: ETBN1 & ETBN2 are in redundancy mode.
- ECN Ethernet redundancy: two consist switches (CSW1 & CSW2) are connected together with a redundant Ethernet line.
- VCU redundancy: two RIOM (VCU) in this consist are in redundancy mode.



Figure 7 : System architecture with 2 consists, in



2. System implementation

2.1. Network configuration

VDS router & switches are configured with a PC software called "TTCMP Network Manager"; scripts are used in order to configure and enable the TCN and the TTDP (Train Topology Discovery Protocol) management.

Ethernet TCMS E	ETB TTCMP Network Designer			-	o ×			
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Dual-homed								
Host					~			
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Display								
IIII Host				Node commands				
Portable PC				Selected hode: ITBN-IC1				
Router/				1 configure interface vlan1 vrrp instance-id 1	^			
(ateway				3 configure interface viant vrip vrid 1				
треакег				4 configure ttdp consist etb total 2				
				5 configure ttdp consist etb position 1	~			
>VDS Rail Router				Set // Clear & Reset				
>VDS Rail Switch								
Cars Counled-	-Switch III DHCP option groups III Provisioning III Ethernet	t III Routing III OoS III Redundancy III III III VI ANs 33		🔶 💥 🐃 🔲 📴 Outline %				
	Name	Network	Netmask					
1	Default	10.0.0	255.255.192.0					
				- X X - X X				
				D:\doc_log\FabriquaTBN_REDUNDANCY1.ned Leroy1 Rev.	•			

Figure 8 : VDS TTCMP Network manager

User manuals are available on request.

Deployment of the configuration in a router or a switch and all verifications are performed using VDS virtual machine called "Konfstation". Once uploaded to a router or switch, the configuration is automatically deployed to all other routers or switches in the Consist.



Figure 9 : VDS Konfstation virtual machine



2.2. **RIOM programming**

The IDE used for programming the RIOM is the **Straton** software from Copa-Data: its main features are listed below:

- Processes programming in IEC61131-3 languages
- Networks configuration through a Fieldbus editor
- Real time monitoring tools for the projects debugging

The project developed for this application note is divided in several programs each managing a process:

- Redundancy management with the second RIOM: "REDUND" program
- TRDP communication: "TRDP" program calling sub-programs located in folder "TRDP FUNCTIONS"
 - \circ within the Local consist :
 - With remote IO : PD for the local process control
 - With the local ETBN: it is the VDS router (ECSP): standard TRDP PD and MD messages comID 100 to 131, for the train database, and the train leading control.
 - \circ through the ETB, with the other consists:
 - With the RIOM of each other consists, TRDP PD messages, for the train process control.
- DDS communication management : "UDP_management" program
- Doors management : "DOORS" program

STRATON V10.0 - demo_red_trdp21.w5l		– 🗗 🗙
File Edit View Insert Project Tools Windo	low Help	
Workspace		
		Time
	n 2 rtrid(%IX0.1.15 OR DirectionCdButton): n 2 tritter TTDB OP TRAIN DIRECTORY STATUS INFO ************************************	DP ECSP CONTROL A
E POP	3 ftrig1(%IX0.1.15): 3 TTDE OF TRAIN DIRECTORY STATUS INFO ('grpAll.aVeb.lCst.lTrn', state,	
	4 ftrid2(DirectionCdButton); 4 etbTopoCnt, ownOpCstNo, ownTrnCstNo); nerva	PT POOL
Exception programs	5 ⊟ if rtrig1.0 then 5 LOCAL CONS.ownOpCstNo := ownOpCstNo;	RI BOOL
ponbedindex	2 6 DirectionCd := TRUE ; 2 6 LOCAL CONS.ownTrnCstNo := ownTrnCstNo;	BOOL
p punDivzero	sm 7 elsif ftrig1.Q OR ftrig2.Q then sm 7	BOOL
D pointer	8 DirectionCd := FALSE; 8 ⊟ (* ********************************	CONS CONSI
E potertup	9 L end_if; 9 L **********************************	TRDP
A Programs	<pre>ip 10 from the second sec</pre>	COD CTDING
COMMUNICATION	II (* Leading reg *)	JSP STRING.
P HMI	12 ftrig(41X).1.0 OK LeadingCaButton); 22 12 TRN.opcstcht := opTrnbir.opcstcht; SEND	MD_130 BOOL
A P TRDP	13 IFIGS(FIX.I.O.) 13 FIGS(FIX.O.) 14 EV(1) IFIGS(FIX.O.) 10 IFIGS(FIX.O.)	STATUS TRDP
TRDP (*TRDP PD & MD : comm	15 = 16129 (deading conductor), $15 = 16$	STATUS IRDP
TRDP_ECSP_CONTROL	16 LeadingCd := TRUE ; 16 TTDB TRAIN DIRECTORY INFO ('', URL ECSP, SEND MD 102, TrnDir);	Red USINI
T# TRDP_FDU_PREP	17 elsif ftrig3.g OR ftrig4.g then 17 E (* *********************************	
T# TRDP_FDU_TR	18 LeadingCd := FALSE; 18 18 18 18 18 18 18 18	rinbles
"# TRDP_TRAIN_PROCESS_ME.	19 Lend if; 19 TTDB_STATIC_CONSIST_INFO ('', URI_ECSP, SEND MD_104, TrnDir, cstInfo);	
A PROCESS	20 E if LOCAL_CONSIST.etbLeadState<>etbLeadS 20 E (* *********************************	value Type
A DOORS	21 etbleadState mem := LOCAL CONSIST.e 21 ***********************************	
E DOOR_MGT	22 if LOCAL CONSIST.etDLeadState >=9 t 22 TTDB TRAIN NETWORK DIRECTORY INFO (', URL ECSP, SEND MD 106, trnNetDir);	
E DOORS_MGT	23 LeadingConstitution := TKUE; 23 1 K	
DOORS_PROCESS (*DOORS .	24 EISTI DOCAL CONSIST. ECDEBADSIALE < 3 24 TTIB OF TOIN DIRECTORY TWO (". HET FROM STREET OF TOIN DIRECTORY TWO	
t DOORS_THAIN_MGT	26 end if: 26 (1 to the second se	
E CYCLE_MEASURE (*Cycle time me	27 - end if;	
Cycle_1ime	28 (* ECSP management *) 28 TON10((state.opTrnTopoCnt=0 OR opTrnDir.opCstCnt = 0 OR RESTART)AND SEND MD 110=F	
DATE_TIME	29 TRDP_ECSP_CONTROL (VCU_IP_ADDRESS, RES 29 TTDB_READ ('', URI_ECSP, SEND_MD_110, state, opTrnDir, trnNetDir);	
E STATES	30 (* Operational TRAIN function managemen 30 ⊟ if TON10.Q then	
	31 TRDP_TRAIN_PROCESS_MESSAGES (VCU_IP_AC 31 SEND_MD_110 := TRUE;	
HEDOND ("REDONDANCY MANA	32 RESTART := FALSE;	
VCU_ACTIVITY2 (-VCU state mach	33 ° end 11;	
Discosson of a statement of the		>
PROCESS_SIMULATION (PROCE		cks Spylist Define ENU
SPEED_SIMULATION	K ↔ K VCUI · TRAIN_VIEW_ETH3 VCUI · IO Drivers VCUI · TRDP CCSP_CONTROL	
D GRAPH_VIEW	Call tree 'D:\STRATON_PROJECTS\TCMS_DEMO\demo_red_trdp21\VCU1'	×
testi	E (All)	~
 Watch (for debugging) 	C	^
Cot Second	Cycle Time CYCLE MEASURE	
Soft Scope I		
	Cycle Time	
* TRAIN_VIEW_ETH3		
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Can Fieldhus Configurations	DOORS TRAIN MGT DOORS MGT DOOR MGT	
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I HOA		
Sa Clobal defines	DOORS PROCESS - DOORS TRAN MGT - DOORS MGT -	
and all the second seco		
	DOORS MGT	
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E Bit Fields	Inter Prese control of Californ Evening Californ Evening California Control California Control Alifornia Control	

Figure 11: Straton IDE



2.2.1. Straton database

Straton allows defining variables, arrays, and structures: all the structures defined in IEC61375-2-3 are defined in the Straton library "TRDP", used by the RIOM project:



Figure 12: Straton TRDP structures definition

2.2.2. Communication with remote IO within the local consist

TRDP communication programming is available through the Straton fieldbus editor:

	[D:\STRATON_PROJECTS\TCMS_DEMO\demo_red_trdp21\VCU1 - Drivers E/S]			
	A 📲 TRDP	^	Nom	Valeur
2	🔺 🏯 Telegrams		nom	RIOM1
	⊿ 📲 RIOM1		Туре	Process Data
э.	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[0].OPEN = FALSE		Com ID	1100
1	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[0].CLOSED = TRUE		Mode	Subscribe
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[0].LOCKED = TRUE		Payload lenght	32
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[0].FAULT = FALSE		Source URI	
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[0].POSITION = 70		Destination URI	10.0.0.30
l	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[1].OPEN = FALSE		PD Periodicity (us)	50000
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[1].CLOSED = TRUE		Redundancy group identif	0
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[1].LOCKED = TRUE		PD Timeout (us)	500000
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[1].FAULT = FALSE		PD Timeout Behaviour	DEFAULT
•	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[1].POSITION = 70		Quality of Service	5
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[2].OPEN = FALSE			
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[2].CLOSED = TRUE			
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[2].LOCKED = TRUE			
	LOCAL_CONSIST.VEHICLE[0].DOORS_LEFT.DOOR[2].FAULT = FALSE			
_				

Figure 13: Straton fieldbus editor

2.2.3. Communication with the local ETBN:

A specific sub program "TRDP_ESCP_CONTROL" manages the communication with the ECSP (ETB Control Service Provider) that is provided by the ETBN:

(* ECSP management *) TRDP_ECSP_CONTROL (VCU_IP_ADDRESS, Restart, DirectionCd, LeadingCd, LOCAL_CONSIST, opTrainDir, TRN);

The RIOM act as the ECSC (ETB Control Service Client).

This sub program manages the following MD and PD:

- PD ComID 100: TTDB_OP_TRAIN_DIRECTORY_STATUS_INFO
- MD ComID 101: TTDB_OP_TRAIN_DIRECTORY_INFO
- MD ComID 110 & 111: TTDB_READ_COMPLETE_REPLY
- PD comID 120: ECSP control telegram
- PD comID 121: ECSP status telegram
- MD comID 122: ECSP confirmation/correction telegram
- MD comID 123: ECSP confirmation/correction reply data

The complete TTDB will then be acquired by the RIOM with message ComID 111.



The ECSP control telegram allows to change the state of the local consist, from follower state to Leader state.

2.2.4. Communication with other consists

The RIOM, VCU in Leader consist, will send PD command messages to other VCU in follower consists, as defined in IEC 61375-2-4:



Figure 14 : communication with other consists

A specific sub program "TRDP_TRAIN_PROCESS_MESSAGES" manages all PD messages over the ETB: those PD messages depend on the local consist state, follower or leader: Those PD are managed dynamically at each TTDB change detection.

Each VCU in follower consist sends its function states to the VCU in leader consist.

The VCU in leader consist sends the function commands to each VCU in follower consist.



Figure 15: Function Data Unit definition

FDUs are automatically managed in the "TRDP_TRAIN_PROCESS_MESSAGES" sub program.

In this project, the following functions are managed: External doors, Driving and brake controls, and Interior lighting equipment. Function Id and SubId are compliant with UIC556.

```
(******** FDU PREPARATION FOR SENDING COMMANDS TO FOLLOWER CONSISTS ********)
// Doors management
// Left Doors
FDU_SEND_LEADER[0].Header.FunctionId := 16#92 ; // External doors
FDU_SEND_LEADER[0].Header.FunctionSubId := 0 ; // External doors
FDU_SEND_LEADER[0].Header.ChannelId := 0;
FDU_SEND_LEADER[0].Header.InstanceInfo := 1;// Left Doors
FDU_SEND_LEADER[0].Header.ControlInfo := 0; //
FDU_SEND_LEADER[0].Header.LifeSign := LifeSign;
FDU_SEND_LEADER[0].Header.DataLength := 3; //
FDU_SEND_LEADER[0].DataSet[0] := ANY_TO_USINT(TRN.CONSIST[CST_INDEX].DOORS_LEFT.CD_LOCK);
FDU_SEND_LEADER[0].DataSet[1] := ANY_TO_USINT(TRN.CONSIST[CST_INDEX].DOORS_LEFT.CD_CLOSE);
FDU_SEND_LEADER[0].DataSet[2] := ANY_TO_USINT(TRN.CONSIST[CST_INDEX].DOORS_LEFT.CD_OPEN);
```



2.3. DDS programming

The PIXY touch screen is programed with PIXY PAD software: it allows to define screens, configure the communication and to program action on events.

Ethernet communication is only with the VCU within the consist.



Figure 17 : PIXY PAD software



Event/Action editor:

Figure 18: Pixy PAD event/action editor



2.4. System test

At startup, after inauguration step, all consists are enumerated and in the Follower state.

2.4.1. Consist 1 Leader state case

VCU in consist 1 sends a Leader request to the local ETBN in order to change the local consist state from Follower to Leader.

Result: Consist 1 becomes Leader and consist 2 & 3 remain as Followers: all the train programmed functions are driven by the VCU in Consist 1: Doors commands, Traction commands, Light commands.

VCU in consist 1 sends a Follower request to the local ETBN: Consist 1 returns to the Follower state.

2.4.2. Consist 3 Leader state case

VCU in consist 3 sends a Leader request to the local ETBN in order to change the local consist state from Follower to Leader.

Result: Consist 2 becomes Leader and consist 1 & 2 remain as Followers: all the train programmed functions are driven by the VCU in Consist 3: Doors commands, Traction commands, Light commands.

VCU in consist 3 sends a Follower request to the local ETBN: Consist 3 returns to the Follower state.

2.4.3. Straton Monitoring, Debugging & list view

Straton in "Online" mode allows to animate any edition view with real values defined in the Straton project:

Straton graphic views allow to define process animated views:



Figure 19: STRATON Graphic View



Straton programs are animated with variable real values; for structured text programs, real values are inserted dynamically next to each variable name:

I 田田 (日本) (日本) (日本) (日本) (日本) (日本) (日本) (日本)	1 Ⅲ 盂 特 ② ② 差 動 [① 浩 <mark>伊 RUN - + + + 特</mark> 結合 # 考 ②		
Workspace	sess [D:STRATON_PROJECTS\TCMS_DEMOIdemo_red_trdp21\VCU1 - TRDP]		
VCU1 [RUN]	at 1 (* Direction reg *)	Value Type	Dm.
Exception programs	2 rtrig1(%IX0.1.15 OR DirectionCdButton FALSE);	TRDP (*TRDP PD & MD : communication with	h ECSP*)
1 = pOnBadindex	3 ftrigl(%IX0.1.15);	DirectionCd FALSE BOO	L
1 # pOeDivZero	4 ftrig2(DirectionCdButton PALSE);	DirectionCdButton FALSE BOO	
ReStuDown	= 5 H if FAISE rtrigl.Q FAISE then	etbLeadState mem 5 USIN	п
P oStatup	6 Directioned Mist := TRUE ;	frig1 F TR	UG
A De Programs	an 7 leisif ftrigi.g Miss OR ftrig2.g Miss then	frig2 F_TR	uG
A COMMUNICATION	8 Directioned rates := FALSE;	frig3 E TB	UG
E HH	s - end 11	frind F TB	IIG
	11 (I Leading reg 1)	LeadingCd FALSE BOO	
TODE CTEOR FO & MD - communication of	12 rtrig2(hIX) - 0 R LeadingCdButton Dist);	LeadingCdBuffon FALSE BOO	
** TEDR ECSP CONTROL	13 ftrig3(%IX0.1.0);	PESTART TRUE BOOK	
** TECH FOULDEED	14 ftrig4(LeadingCdButton (ALSE);	driat P TE	ale ale
TETER FULTE	15 E if FALSE rtrig2.0 FALSE then	drin? P TE	ao
RATEDO TEAM DECORES ARESAGES	16 LeadingCd FALSE := TRUE ;	 Clobal variables 	40
	17 elsif ftrig3.g FALSE OR ftrig4.g FALSE then	HMIL ALIVE TRUE BOOL	
	18 LeadingCd FALSE := FALSE;	HAIL2 ALIVE FALSE BOOK	-
R DOOR MOT	19 - end if;	HALLSOCK1 22 DINT	
R poope wat	20 D 11 PAUSE LOCAL CONSIST. etc. LeadState 5 <>etc. etc. and 5 then	LOCAL CONSIST	CICT
R DOODS DROCESS ADOODS PROCESS	21 etbleadstate_mem 5 := LOCAL_CONSIST.etbleadstate 5;	coTrainDir TRDE	P OP TRAIN DIRECTORY
THE DOORS TRAIN NOT	23 LeadingCollection 21/20 := 7018/	TDDP statistics TDDP	D statistics
P OVIE NEASURE AD do free manufacture	24 elsif LOCAL CONSIST.etbleadState 5 <9 then	indi _sadates	
D Orbe Time	25 LeadingCdButton TALSE := FALSE:	A A MARKET	
DATE THE	26 end if:		
E STATES	27 - end_if:	Y Name Value Type	Dm. Description
	28 (* ECSF management *)	A TRN TRAN	<u>^</u>
PLEASED IND ADED INDIANCY MANAGEMENTS	29 TRDP_ECSP_CONTROL (VCU_IP_ADDRESS '10.0.0.10', RESTART TRUE, DirectionCd FALSE, LeadingCd FALSE, LOCAL_CONSIS	JeedingDir 0 USINT	
BVCL ACTNTV25/CListen machine activity	30 (* Operational TRAIN function management *)	opCstDxt 3 USINT	
	31 TRDP_TRAIN_PROCESS_MESSAGES (VCU_IP_ADDRESS_10.0.0.10', RESTART_TROE, VCU_LOCAL.ACTIVE_TROE, LOCAL_CONSIST,	.CONSIST_POLLOWER 1 DINT	
THE PARATION		.CONSIST_FOLLOWER 2 DINT	
D DDOCERS, Shi I ATION //DDOCERS (inclusion)		 CONSIST CONSIST 	T [0.7]
Se SPEED SMILLATION		NEHICLE_NUMBER 3 DINT	
D ODADH VEW		MEHICLE_LEADER 2 DINT	
Deat		MEHICLE VEHICLE	E [0.15]
Wetch (for debugging)		FCT TRAN	FUN
P DATE THE VEW		P LOCAL_CONSIST CONSIST	
Col Cronal		a optramDir THDP_C	3P_T
TDAIN		version 256 UINT	
TDAIN VEW ETHI		otold 0 USINT	identification o
TOOP TOOP		.opTmDrient 1 USINT	operational tra
The Initial values		opCetCet 3 USINT	nember of co
Enithus Configurations		 opCstList TRDP_C 	OP_C [0.15] dynamic oper
Contractor Comparation		v opVeNCnt 3 USINT	nember of veh v
Contrary comparison		 Blocks Spylist Define ENUM 	

Figure 20 : Straton program online view

Straton spy lists allow spying the real value of any Straton variable:

E	Name	Value	Description
	✓ opTrainDir		~
BL	version	256	
	etbld	0	identification of the ETB the train directory computed for: 0 = ETB0 (operational network): 1 = ETB1 (multimedia network): 2 = ETB2 (
	.opTmOrient	1	operational train orientation ; '00'B = unknown ; '01'B = same as train direction ; '10'B = inverse to train direction
	.opCstCnt	3	number of consists in train (163)
	▶ .opCstList		dynamic operational consist list ordered list starting with opCstNo = 1
	.opVehCnt	3	number of vehicles in train (163)
	∡ .op∀ehList		dynamic operational vehicle list ordered list starting with opVehNo = 1
	⊿ .opVehList[0]		dynamic operational vehicle list ordered list starting with opVehNo = 1
	.vehld	'312\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00	unique vehicle identifier
	.opVehNo	1	operational vehicle sequence number in train value range: 163
	.isLead	1	vehicle is leading (ANTIVALENT8)
	.leadDir	0	vehicle leading direction: 0 = not relevant; 1 = leading direction 1; 2 = leading direction 2
	.tmVehNo	1	vehicle sequence number within the train with vehicle 01 being the first vehicle in ETB reference direction 1 as defined in IEC 61375
	.vehOrient	1	vehicle orientation: 10°B = not known (corrected vehicle); 101°B = same as operational train direction; 10°B = inverse to operational tra
	.ownOpCstNo	1	operational consist number the vehicle belongs to
	∡ .opVehList[1]		dynamic operational vehicle list ordered list starting with opVehNo = 1
	.vehld	'314\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00\$00	unique vehicle identifier
	.opVehNo	2	operational vehicle sequence number in train value range: 1_63
	isLead	1	vehicle is leading (ANTIVALENT8)
	.leadDir	0	vehicle leading direction: 0 = not relevant: 1 = leading direction 1; 2 = leading direction 2
	.tmVehNo	2	vehicle sequence number within the train with vehicle 01 being the first vehicle in ETB reference direction 1 as defined in IEC 61375
	.vehOrient	1	vehicle orientation: 'U'B = not known (corrected vehicle); 'UI'B = same as operational train direction; 'U'B = inverse to operational tra
	.ownOpCstNo	2	operational consist number the vehicle belongs to
	 .opVehList[2] 		dynamic operational vehicle list ordered list starting with opVehNo = 1
	wenid	.319200200200200200200200200200200200200.	unique vehicle identitier
	.opvehNo	3	operational venicle sequence number in train value range: 1_b3
	.isLead	2	venicie is leading (AN IVALEN IS)
	.ieadUir	1	venice reading arrection: U = not relevant; I = reading direction (; z = reading arrection z
	whOrient	1	venice sequence number within the roam with venice of being the inst venice in ETD reference direction 1 as defined in EC 613/5"
	ouroOpCotNo.	2	vertice oremation, or b - individual consistence vertices, or b - same as operational rain direction, to b - inverse to operational rain, paratriage consistence or publick beloage to
	b op/oblict[3]	J	dynamic onerational vehicle list ordered list starting with onV/abble = 1
	 obsemanal 		dynamic operational venicle ist ordered list starting with up venicue = 1

Figure 21: Straton Spy list view

3. Conclusion

This application note shows that it is possible to control a complete train from any VCU with the TRDP communication protocol.

This application note shows also the use of several redundancy systems at different levels: Ethernet line redundancy (ETB and ECN level), Ethernet train node redundancy, VCU redundancy, Remote IO redundancy, in order to provide a high level of system availability.



Appendix: Table of Figures

Figure 1. Lower Automation DIOM	F
Figure 1 : Leroy Automation RIOM	5
Figure 3 : PIXY DDS	5
Figure 5 : VDS Consist Switch	5
Figure 4 : VDS Ethernet Train Backbone Node	5
Figure 6 : System architecture with 3 consists	6
Figure 7 : System architecture with 2 consists, in	6
Figure 8 : VDS TTCMP Network manager	7
Figure 9 : VDS Konfstation virtual machine	7
Figure 10: STRATON programming IDE	8
Figure 11: Straton IDE	8
Figure 12: Straton TRDP structures definition	9
Figure 13: Straton fieldbus editor	9
Figure 14 : communication with other consists1	0
Figure 15: Function Data Unit definition1	0
Figure 16: Function Data Unit application1	0
Figure 17 : PIXY PAD software	1
Figure 18: Pixy PAD event/action editor1	1
Figure 19: STRATON Graphic View1	2
Figure 20 : Straton program online view1	3
Figure 21: Straton Spy list view1	3