

2021鐵道紀錄裝置技術研討會

# 臺鐵列車紀錄裝置

110年11月10日 臺鐵局機務處



- 壹、臺鐵列車紀錄裝置種類與現況
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- 參、ATP資料紀錄
- 肆、無線電通話紀錄
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# 壹、臺鐵列車紀錄裝置種類與現況

- 臺鐵車輛型式眾多(傾斜列車、電聯車、電力機車、柴電機車、柴聯車等23種)，隨著引進時間與製造商之不同，紀錄裝置亦不同。
- 現有之紀錄裝置可分為4種
  - 列車控制監視系統(TCMS)
  - 列車自動防護系統 ( ATP )
  - 無線電語音錄音
  - 影像紀錄

# 貳、列車控制監視系統(TCMS)

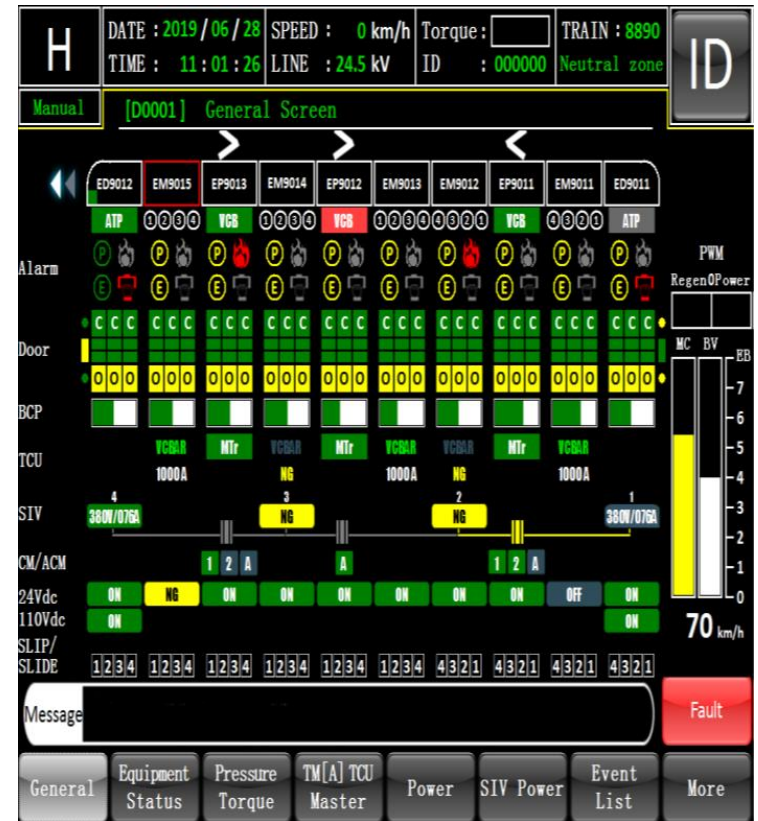
- 列車控制監視系統(Train Control and Monitoring System, TCMS)之主要目的，係將列車相關訊息以圖形化方式提供給駕駛員，以提升駕駛員的情境感知能力(situational awareness)。
- 臺鐵局早期引進的車輛並無TCMS裝置。
- TCMS除提供列車資訊給司機員外，亦紀錄列車相關狀態
  - 基於事件之紀錄(Event-Based Recording)
  - 連續紀錄(Continuous Recording)
- P-P/EMU600/TEMU1000(太魯閣號)僅提供事件紀錄

# 貳、列車控制監視系統(TCMS)

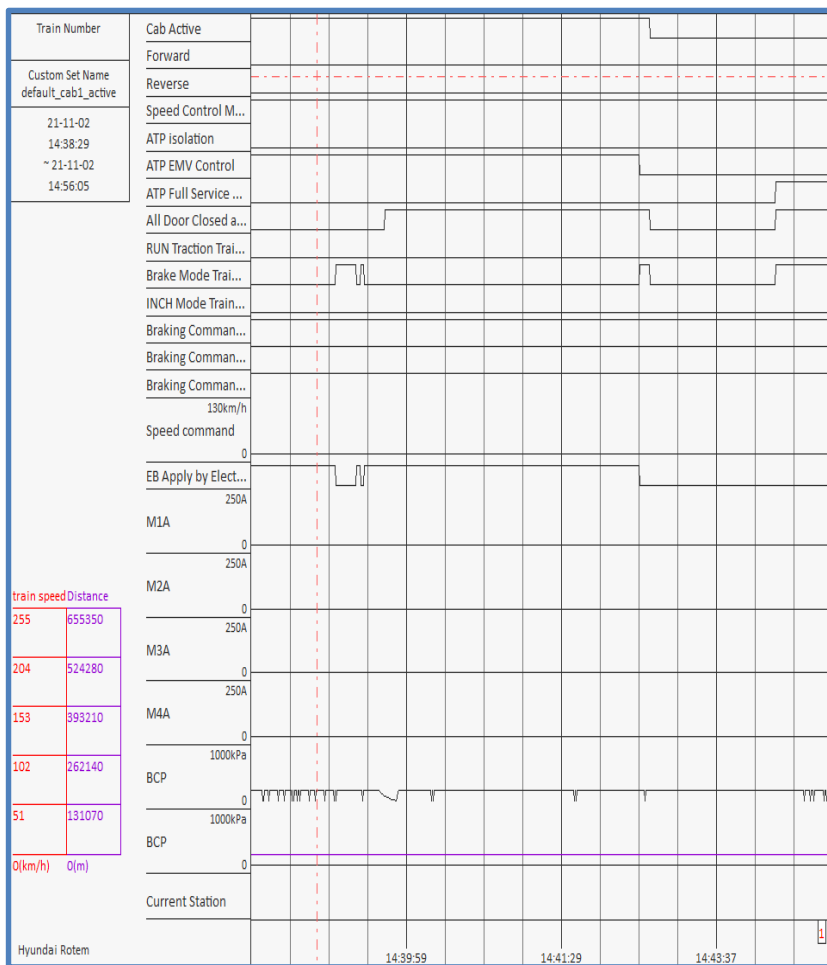
## EMU900電聯車 TCMS介紹



- EMU900 通勤電聯車之機電核心系統由東芝提供，TCMS則由韓國樂鐵 (Rotem)提供
- EMU 900 TCMS同時具備事件紀錄(故障、異常)與列車相關數據之連續紀錄等能力(列車位置、煞車、電門、電車線電壓、、、、)



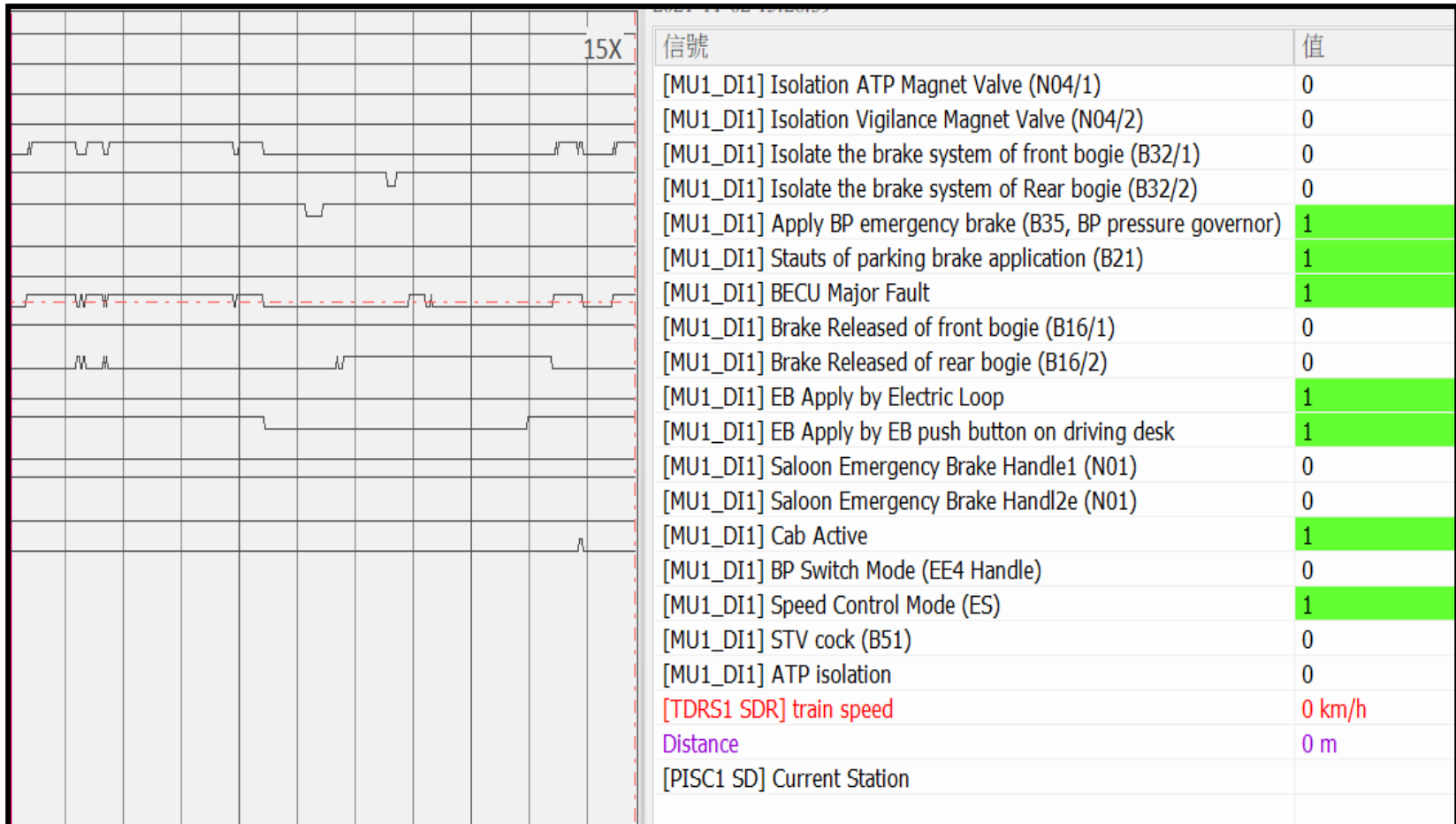
# 一、列車相關參數之監視與紀錄(1)



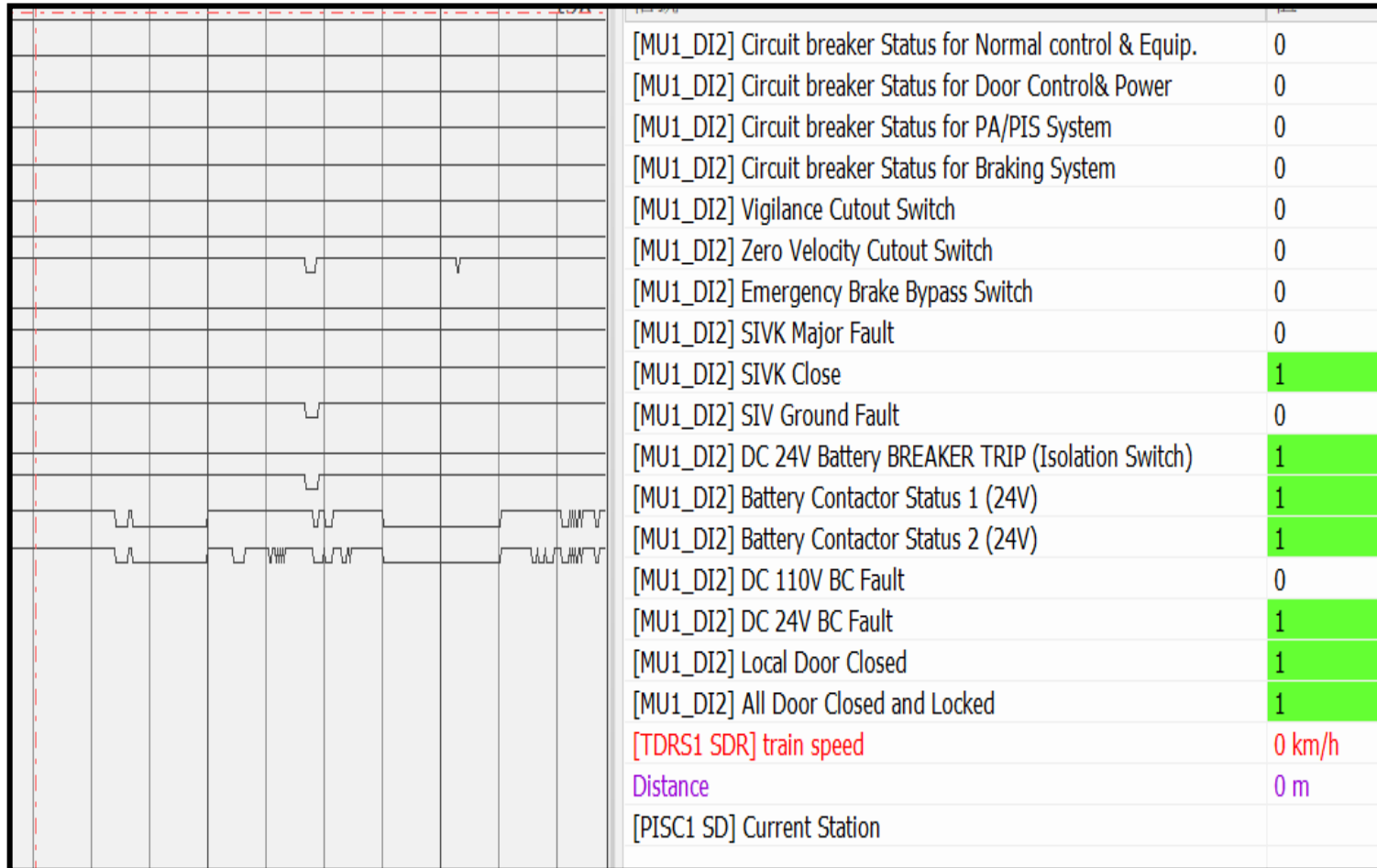
信號	值
[MU1_DI1] Cab Active	0
[MU1_DI4] Forward	0
[MU1_DI4] Reverse	0
[MU1_DI1] Speed Control Mode (ES)	1
[MU1_DI1] ATP isolation	0
[MU1_DI3] ATP EMV Control	0
[MU1_DI4] ATP Full Service Brake Application	0
[MU1_DI2] All Door Closed and Locked	1
[MU1_DI4] RUN Traction Trainline	0
[MU1_DI4] Brake Mode Trainline	1
[MU1_DI4] INCH Mode Trainline	0
[MU1_DI4] Braking Command 1	1
[MU1_DI4] Braking Command 2	1
[MU1_DI4] Braking Command 3	1
[TCU1_SDR] Speed command	0 km/h
[MU1_DI1] EB Apply by Electric Loop	0
[TCU1_SD] M1A	0 A
[TCU1_SD] M2A	0 A
[TCU1_SD] M3A	0 A
[TCU1_SD] M4A	0 A
[BECU1_SD] BCP	0 kPa
[BECU2_SD] BCP	0 kPa
[TDRS1_SDR] train speed	0 km/h
Distance	0 m
[PISC1_SD] Current Station	

可即時監看並連續紀錄

# 一、列車相關參數之監視與紀錄(2)

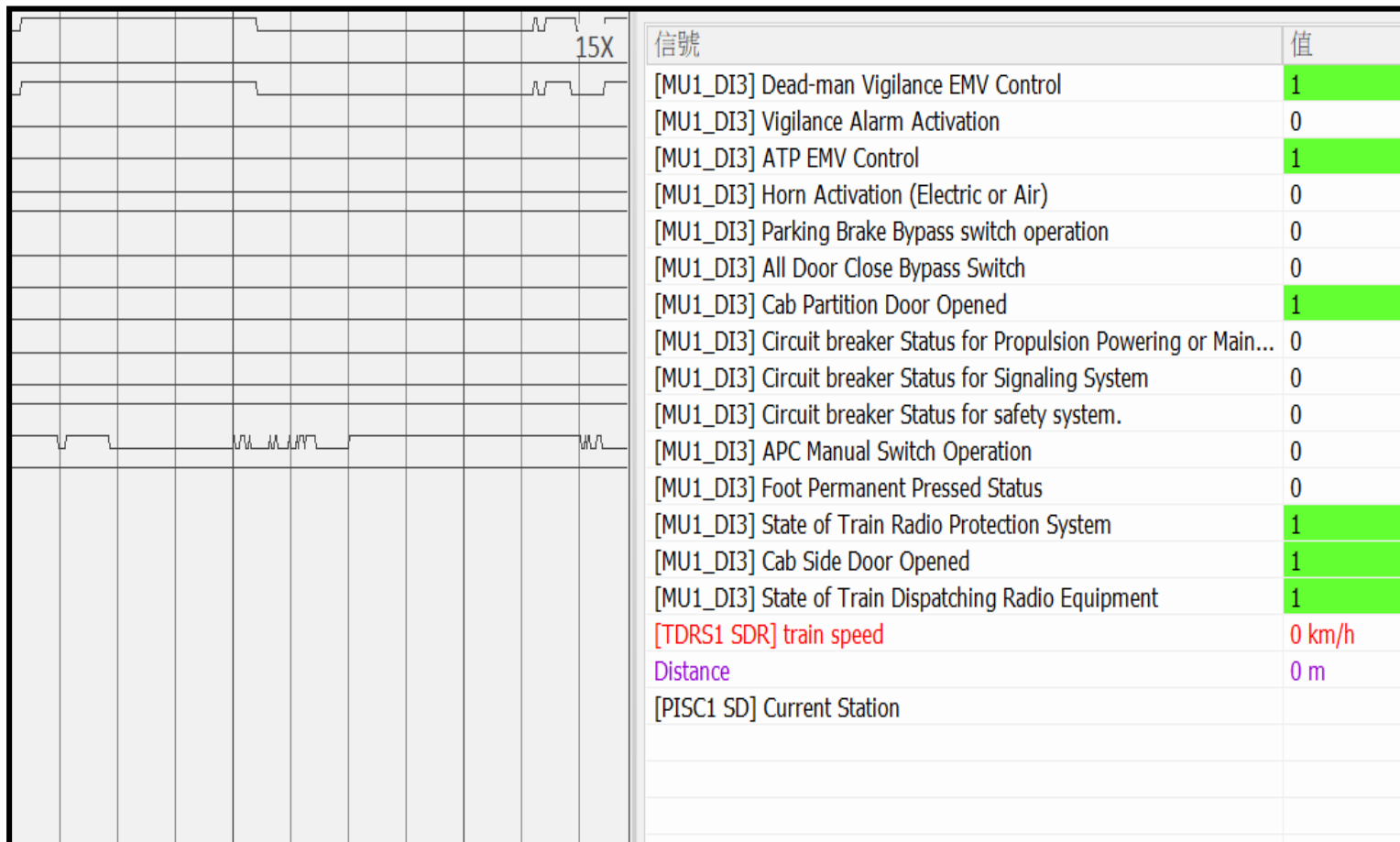


# 一、列車相關參數之監視與紀錄(3)












# 一、列車相關參數之監視與紀錄(4)



# 一、列車相關參數之監視與紀錄(5)

NO.	項目	單位	顯示	監視	紀錄	備註
	[DCU4(R3) SD] Door close command from LDCP		0			
	[DCU4(R3) SD] Door open command from LDCP		0			
	[DCU4(R3) SD] Emergency handle activated		0			
	[DCU4(R3) SD] Obstacle Detection Status		0			
	[DCU4(R3) SD] Fault Present		0			
	[DCU4(R3) SD] Door Fully Open		0			
	[DCU4(R3) SD] Door Isolation		0			
	[DCU4(R3) SD] Door not Closed Status		0			
	[DCU4(R3) SD] Zero velocity status		1			
	[DCU4(R3) SD] Static output Failure		0			
	[DCU4(R3) SD] Internal Network Communication Failure		0			
	[DCU4(R3) SD] DLSL failure		0			
	[DCU4(R3) SD] DLSR failure		0			
	[DCU4(R3) SD] Door motor circuit failure		0			
	[DCU4(R3) SD] DCU minor failure		0			
	[DCU4(R3) SD] DCU Major failure		0			
	[DCU4(R3) SD] Door Closing Time Exceeded		0			
	[DCU4(R3) SD] Door Opening Time Exceeded		0			
	[DCU4(R3) SD] High Door Motor Current Level		0			
	[DCU4(R3) SD] Door failed to open because obstruction		0			
	[DCU4(R3) SD] Door failed to close because obstruction		0			
	[DCU4(R3) SD] Door failed to lock		0			

# 一、列車相關參數之監視與紀錄(6)

號碼	時間	Catenary Voltage	Converter Input Current	Converter Output Voltage	Inverter Output Voltage	Inverter Output Current
 <all>	 <all>	 <all>	 <all>	 <all>	 <all>	 <all>
1	10:35:31 (...)	0 A	0 A	0 V	0 V	0 A
2	10:35:31 (...)	27000 A	18 A	768 V	436 V	8 A
3	10:35:31 (...)	27000 A	18 A	800 V	436 V	12 A
4	10:35:31 (...)	27000 A	18 A	784 V	436 V	8 A
5	10:35:31 (...)	27000 A	18 A	792 V	436 V	8 A
6	10:35:31 (...)	27000 A	18 A	784 V	436 V	8 A
7	10:35:31 (...)	27000 A	18 A	792 V	436 V	4 A
8	10:35:31 (...)	27000 A	18 A	800 V	436 V	12 A
9	10:35:31 (...)	27000 A	18 A	800 V	436 V	8 A
10	10:35:31 (...)	27000 A	18 A	792 V	436 V	8 A
11	10:35:31 (...)	27000 A	18 A	784 V	436 V	12 A
12	10:35:31 (...)	27000 A	18 A	792 V	436 V	8 A
13	10:35:31 (...)	27000 A	18 A	792 V	436 V	8 A

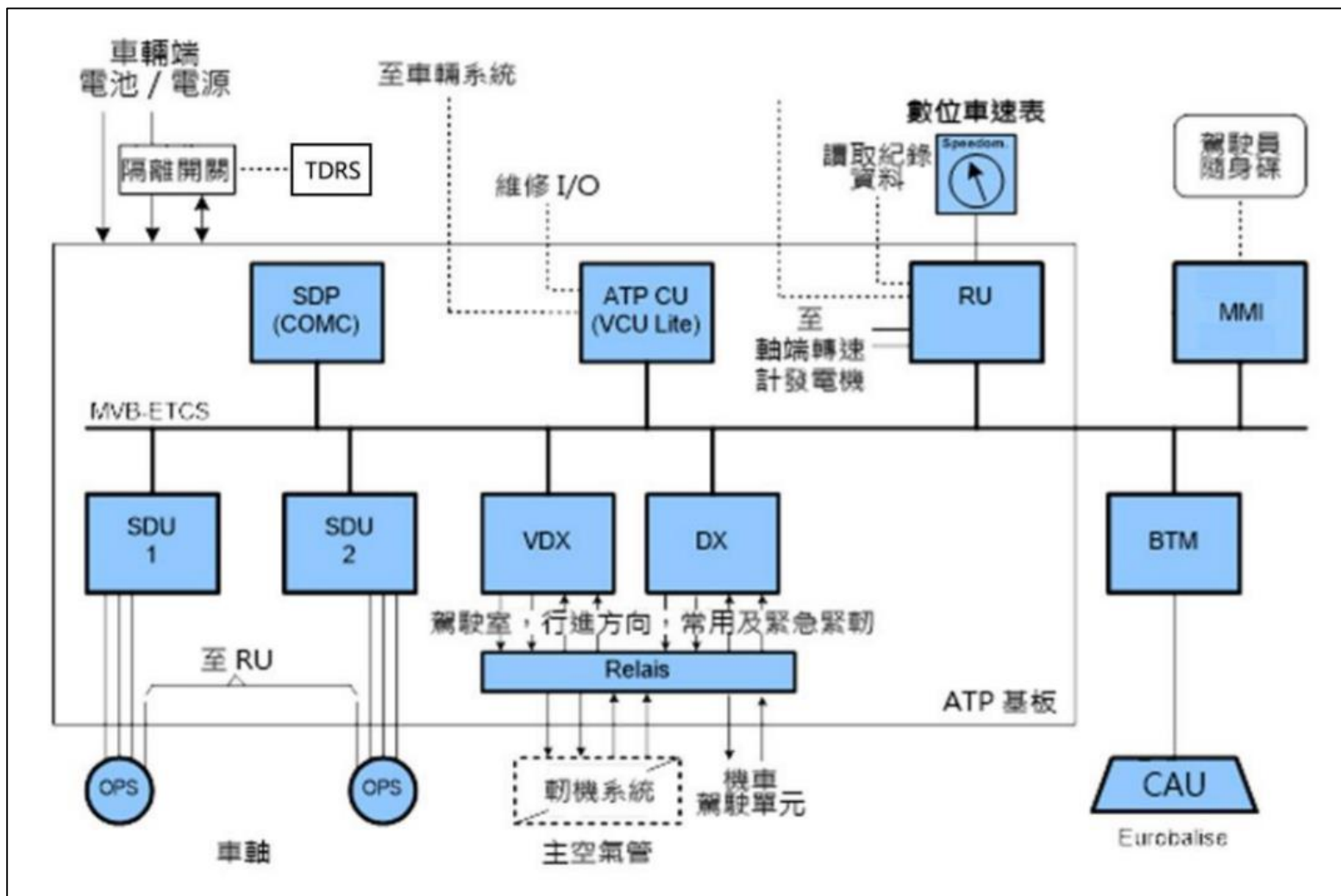
## 二、故障與異常紀錄

1	車門開啟無法出力
2	不鬆軔無法出力
3	緊急緊軔無法出力
4	停留軔機未鬆軔無法出力
5	5組軔機系統故障無法出力
6	MR壓力過低(7.5bar)無法出力
7	PWM故障無法出力
8	
9	
10	
11	ATP緊急緊軔作用
12	ATP全緊軔作動
13	ATP隔離開關已隔離
14	ATP電磁閥隔離
15	腳踏警醒緊急緊軔作用
16	腳踏警醒電磁閥隔離
17	警醒警報啟動(5秒)
18	警醒警報啟動(60秒)
19	自動軔機緊急緊軔作用

# 參、ATP紀錄資料概況

- 臺鐵局各型動力車皆安裝 Bombardier (Alstom)公司提供之 EBI Cab2000，屬 ERTMS/ETCS Level 1。
- EBI Cab2000 ATP提供數種紀錄供故障查修與司機員駕駛行為考核
  - RU log :位置、車速、加速率、減速率、SB/EB、號誌狀況、設備運作狀況、感應子(balise)狀況
  - AE log : 設備運作狀況、感應子狀況
  - 目前RU log 之解讀需透過Bombardier的維護工具
  - AE log 為文字檔，無須特殊工具

# 一、ATP基本架構



# 二、RU紀錄資料

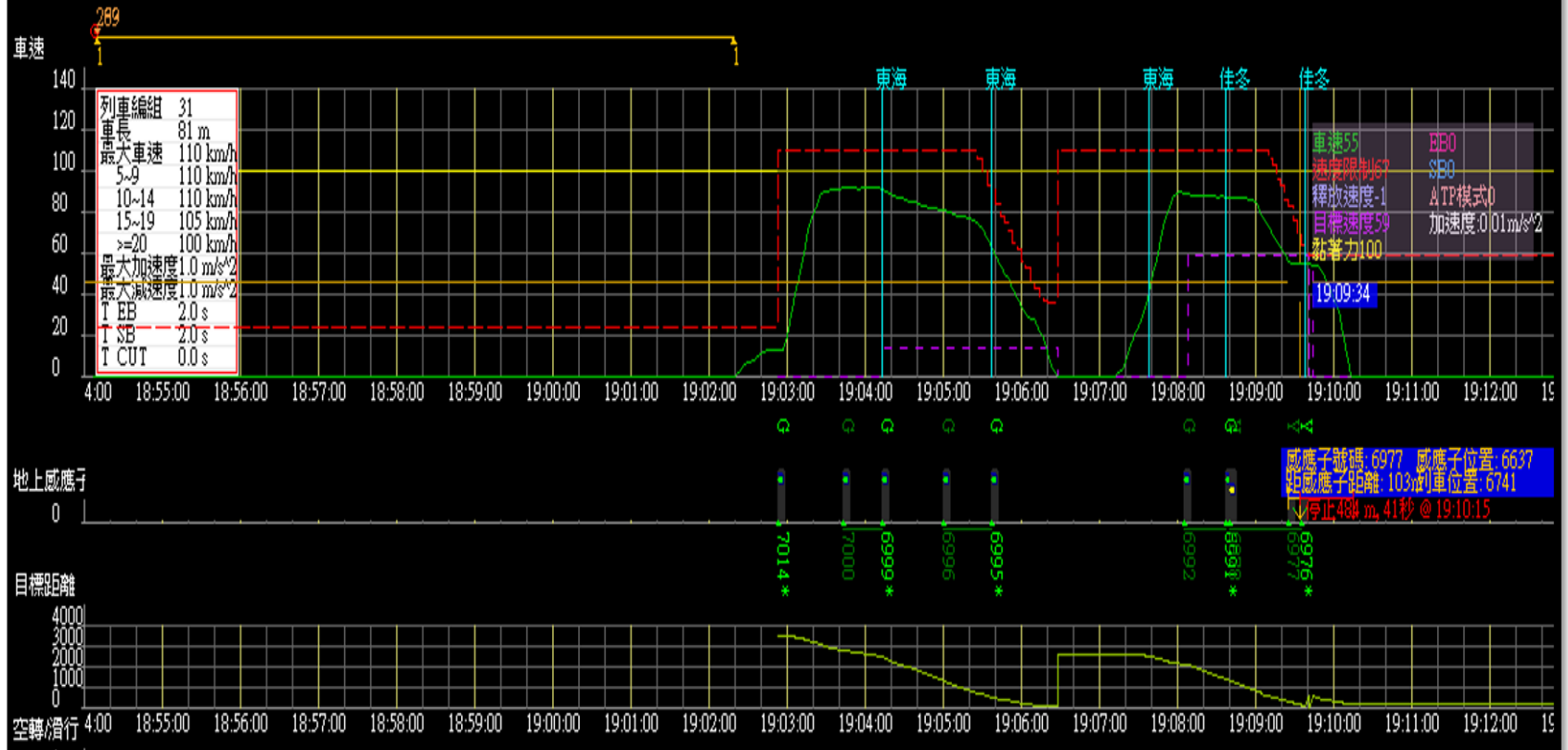
## (一)司機員ID、工作班、車次、車號

台灣鐵路管理局 列車自動防護系統

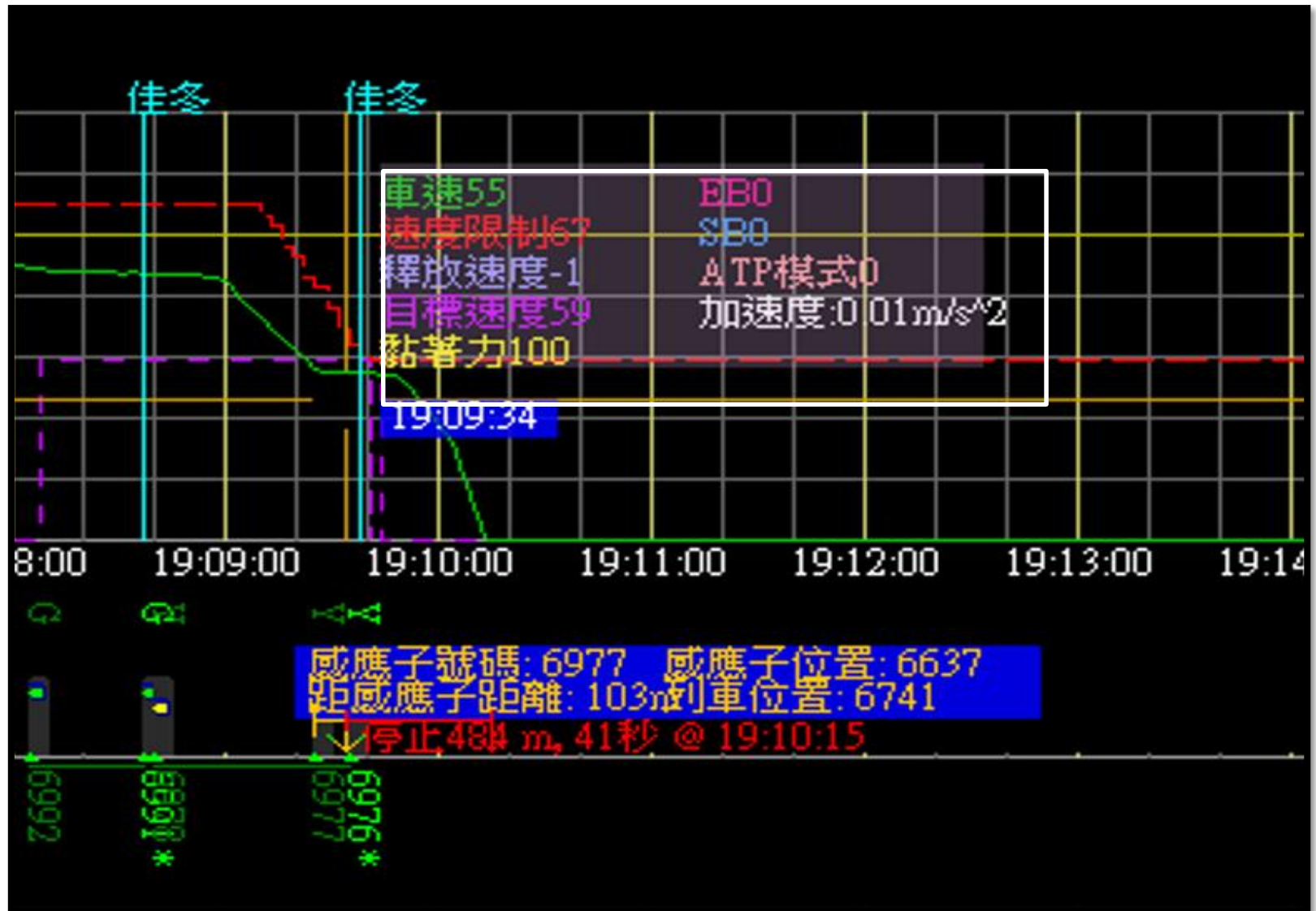
車速表

司機員代號 651380(劉子賢)  
日期(yyy/MM/dd) 2021/08/09  
工作班 00000863  
車次 003084  
動力車號碼 C0575

開始時間 2021/08/09 18:53:57  
結束時間 2021/08/09 20:34:08

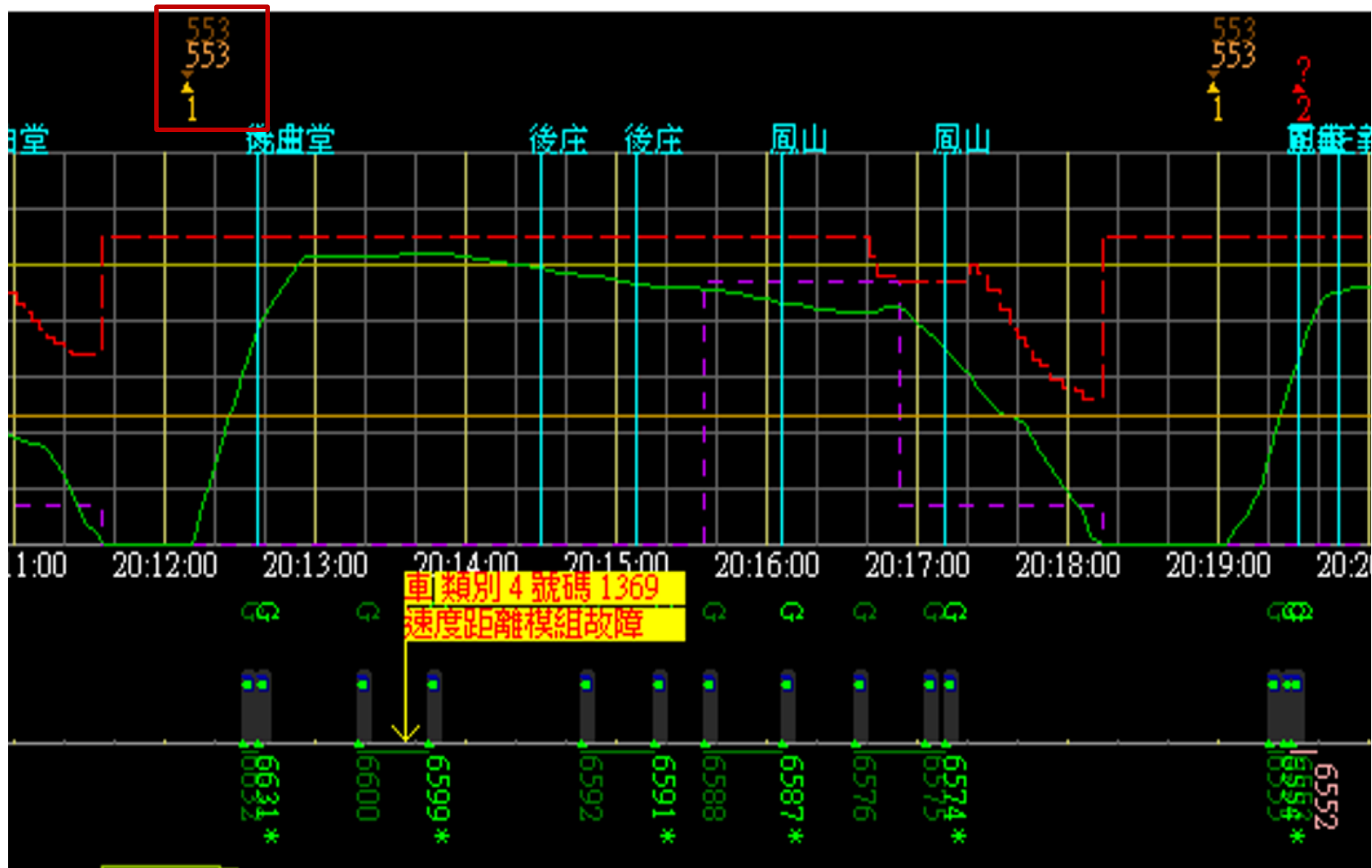


## (二) 列車車速、位置、限速、號誌、加減速





# (三)故障紀錄



# 三、AE紀錄資料

## (一)車輛相關參數

```
RTS_Mon-> read_imp
```

### INSTALLATION PARAMETERS

Engine identity	683031	(ID nr)
No of installed BTM:s	1	(nr)
Cab 1 antenna offset	125	(dm)
Cab 2 antenna offset	150	(dm)
No of installed MMI:s	1	(nr)
SB configuration	2	(config)
SB feedback time	30	(100 ms)
EB feedback time	10	(100 ms)
Target SB margin	50	(100 ms)
Pulse rate for tacho 1	100	(pulse/revolution)
Pulse rate for tacho 2	100	(pulse/revolution)
Pulse rate for Doppler	0	(pulse/km)
Doppler pulse limit low	0	(km/h)
Doppler pulse limit high	0	(km/h)
Sensor configuration	4	(config)
Data edit enable	57286	(config)

### DEFAULT TRAIN DATA

NC train	17	(category)
Max train length	31	(10 m)
Max train speed	110	(km/h)
SB deceleration	55	(cm/s <sup>2</sup> )
EB deceleration	65	(cm/s <sup>2</sup> )
SB delay	40	(100 ms)
EB delay	30	(100 ms)
Cut off traction	3	(100 ms)
Max acceleration	100	(cm/s <sup>2</sup> )
Max deceleration	150	(cm/s <sup>2</sup> )
Max train speed grad5	105	(km/h)
Max train speed grad10	100	(km/h)
Max train speed grad15	95	(km/h)
Max train speed grad20	90	(km/h)

### MAINTENANCE PARAMETERS

Wheel size for tacho 1	860	(mm)
Wheel size for tacho 2	860	(mm)
Max wheel size error	20	(0.1 mm)

### LEVEL 2 INSTALLATION PARAMETERS

Tilting category	0	(nr)
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# 三、AE紀錄資料

## (二)地上感應子(balise)故障

```
79 21-09-03 10:35:57;307 FID:ws_b_link_su LID: 761 TID:SMGM_LogTask  
004359205 ATP A 120C R Link reaction No Reaction  
  
80 21-09-03 10:35:57;306 FID:ws_a_link_su LID: 1389 TID:SMGM_LogTask  
004359204 ATP A 1DE4 D Reported faulty balise group ID to MMI  
  
81 21-09-03 10:35:57;305 FID:ws_a_link_su LID: 1378 TID:SMGM_LogTask  
004359203 ATP A 1002 D 7652 1001080990 1001086050 1001086030 Expected b  
ali  
  
82 21-09-03 10:35:57;303 FID:ws_a_link_su LID: 1588 TID:SMGM_LogTask  
004359201 ATP A 100D R link reaction no reaction  
  
83 21-09-03 10:35:56;308 FID:wi_b_balise LID: 564 TID:SMGM_LogTask  
004357956 ATP A 3FFC D Reported faulty balise group ID to MMI  
  
Hit any key to continue or ESC to stop ...  
  
84 21-09-03 10:35:56;219 FID:ih_b_euro_il LID: 900 TID:SMGM_LogTask  
004357948 ATP A 3FFC D Reported faulty balise group ID to MMI  
  
85 21-09-03 10:35:56;217 FID:ih_b_euro_il LID: 840 TID:SMGM_LogTask  
004357941 ATP A 32B0 D dead LEU or LEU cable broken  
  
86 21-09-03 10:35:56;216 FID:ih_a_euro_il LID: 565 TID:SMGM_LogTask  
004357937 ATP A 3FFC D Reported faulty balise group ID to MMI.  
  
87 21-09-03 10:35:56;215 FID:ih_a_euro_il LID: 501 TID:SMGM_LogTask  
004357936 ATP A 306A D LEU dead or LEU cable broken  
  
88 21-09-03 09:49:35;640 FID: LID: 0 TID:SMGM_LogTask  
000000000 VDX1 S C016E03C00000000000000000000000000000000000000000  
  
89 21-09-03 09:45:09;078 FID: LID: 0 TID:SMGM_LogTask  
000000000 VDX1 S C014E03A00000000000000000000000000000000000000000
```

# 三、AE紀錄資料

## (三)繼電器(relay)故障

```
156 21-09-01 08:58:06;683 FID:sm_a_psa.cpp LID: 358 TID:SMGM_LogTask
    000038090      PM S SMA0302

157 21-09-01 08:58:06;682 FID:um_unit_manu LID: 434 TID:SMGM_LogTask
    000038204      ATP S UM2002 2 log message(s) from master lost

158 21-09-01 08:58:06;181 FID:ba_applicati LID: 389 TID:SMGM_LogTask
    000000000      ATP A 1.35.2_t ATPCU 1.35.2_tra: Initialised and started

159 21-09-01 08:58:05;668 FID: bs_main.cpp LID: 268 TID:t_startup
    TBSW 3.9.2 (Sep 27 2012): Initialised and started

160 21-08-31 22:20:47;861 FID:tiuh_b_in.cp LID: 1067 TID:SMGM_LogTask
    014522898      ATP A 2A07 S IN_B VDX FS port invalid

Hit any key to continue or ESC to stop ...

161 21-08-31 22:20:47;860 FID:tiuh_b_in.cp LID: 1048 TID:SMGM_LogTask
    014522892      ATP A 2A06 S IN_B VDX HR2 port invalid

162 21-08-31 22:20:47;859 FID:tiuh_b_in.cp LID: 1029 TID:SMGM_LogTask
    014522890      ATP A 2A05 S IN_B VDX HR1 port invalid

163 21-08-31 22:20:47;857 FID:tiuh_a_in.cp LID: 211 TID:SMGM_LogTask
    014522889      ATP A 2800 S VDX FS port invalid.

164 21-08-31 22:20:47;856 FID:tiuh_a_in.cp LID: 206 TID:SMGM_LogTask
    014522888      ATP A 2801 S VDX HR1 port invalid.

165 21-08-31 22:20:47;855 FID:tiuh_a_in.cp LID: 201 TID:SMGM_LogTask
    014522887      ATP A 2805 S VDX HR2 port invalid.

166 21-08-31 22:20:47;853 FID:sm_a_sysmgr. LID: 580 TID:SMGM_LogTask
    014522690      PM S SMA0114

167 21-08-31 21:19:52;866 FID:tr_b_wheelwe LID: 696 TID:SMGM_LogTask
    010867601      ATP A 0675 D Speed variance too high for measuring WWC
```

# 三、AE紀錄資料

## (四)BTM(Balise Transmission Module)故障

```
25 21-10-16 09:22:19;186 FID:bt_b_supervi LID: 1052 TID:SMGM_LogTask
000057543 ATP A 1E1F R BTM1: Telepowering Command and Status mismatch

26 21-10-16 09:22:18;686 FID:bt_a_supervi LID: 1767 TID:SMGM_LogTask
000057042 ATP A 1CD5 R BT A Supervisor: Cmd-Sts mismatch: telepow BTM C
abA

27 21-10-16 09:22:18;186 FID:bt_b_supervi LID: 1052 TID:SMGM_LogTask
000056543 ATP A 1E1F R BTM1: Telepowering Command and Status mismatch

Hit any key to continue or ESC to stop ...

28 21-10-16 09:22:17;686 FID:bt_a_supervi LID: 1767 TID:SMGM_LogTask
000056042 ATP A 1CD5 R BT A Supervisor: Cmd-Sts mismatch: telepow BTM C
abA

29 21-10-16 09:22:17;186 FID:bt_b_supervi LID: 1052 TID:SMGM_LogTask
000055543 ATP A 1E1F R BTM1: Telepowering Command and Status mismatch

30 21-10-16 09:22:16;686 FID:bt_a_supervi LID: 1767 TID:SMGM_LogTask
000055041 ATP A 1CD5 R BT A Supervisor: Cmd-Sts mismatch: telepow BTM C
abA

31 21-10-16 09:22:16;186 FID:bt_b_supervi LID: 1052 TID:SMGM_LogTask
000054543 ATP A 1E1F R BTM1: Telepowering Command and Status mismatch

32 21-10-16 09:22:15;686 FID:bt_a_supervi LID: 1767 TID:SMGM_LogTask
000054041 ATP A 1CD5 R BT A Supervisor: Cmd-Sts mismatch: telepow BTM C
abA

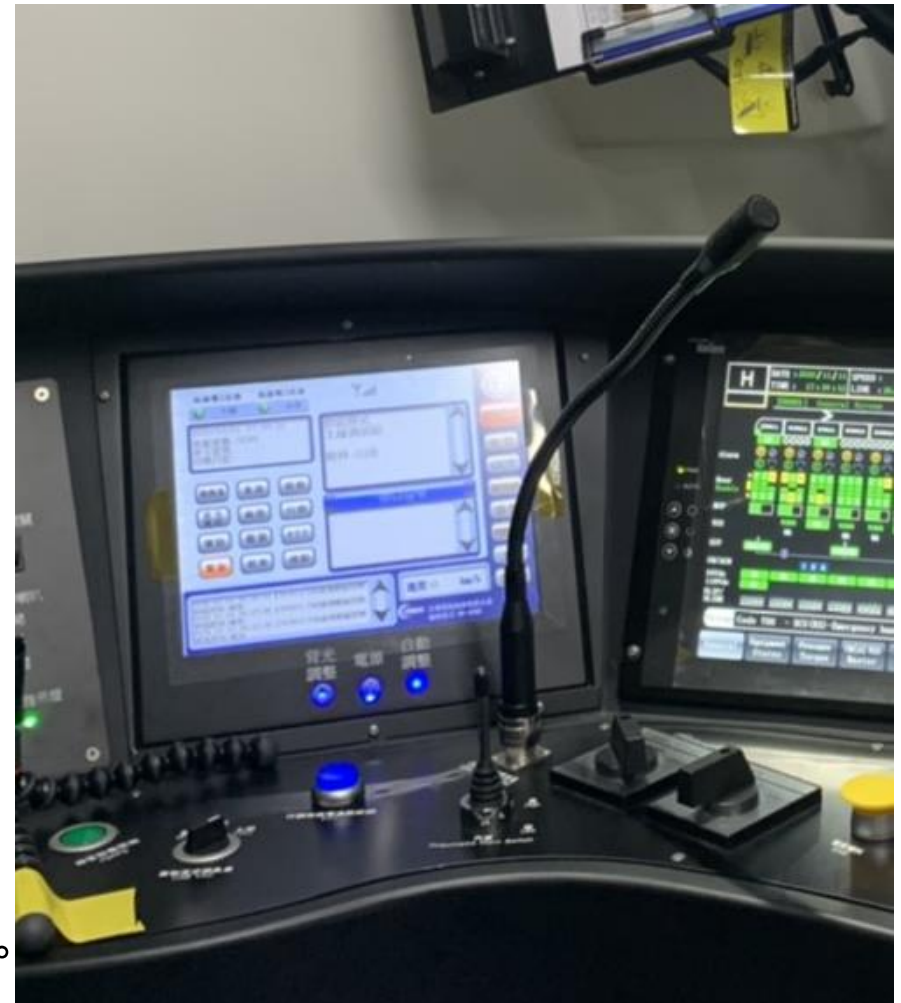
33 21-10-16 09:22:15;185 FID:bt_b_supervi LID: 1052 TID:SMGM_LogTask
000053543 ATP A 1E1F R BTM1: Telepowering Command and Status mismatch

34 21-10-16 09:22:14;685 FID:bt_a_supervi LID: 1767 TID:SMGM_LogTask
000053040 ATP A 1CD5 R BT A Supervisor: Cmd-Sts mismatch: telepow BTM C
```

# 肆、無線電紀錄



- 行車調度無線電系統(簡稱行調無線電)，為臺鐵列車與行控中心間之主要通訊模組。
- 司機員與調度員間之通話皆會記錄於台北之綜合調度所。



# 伍、影像紀錄



行車紀錄器影像



集電弓影像

- 行車紀錄器影像與集電弓影像，因受限於SD卡容量關係，目前約可保存7天

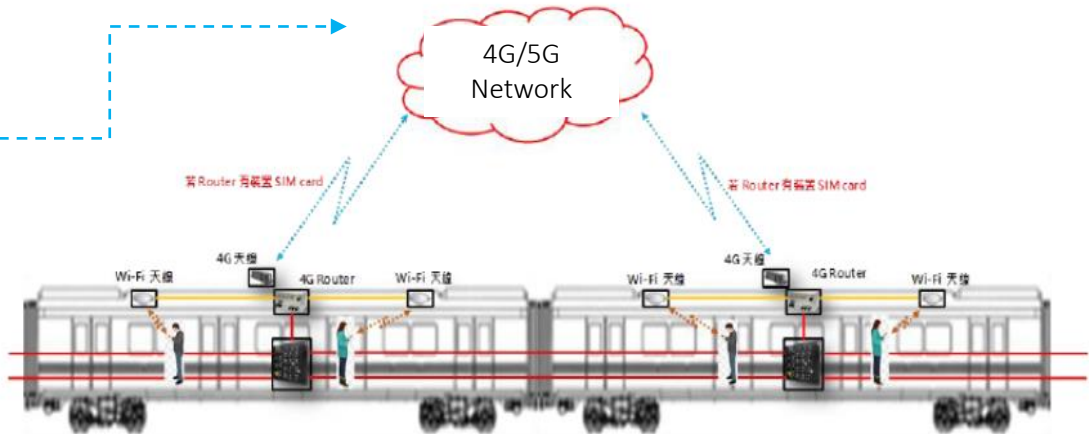


# 陸、未來精進方向

台鐵智慧雲平台



電信商基地台



控制中心/各機務單位

- ✓ 利用4G/5G通信，即時監看TCMS畫面，協助司機員處理故障，減少故障處理時間。
- ✓ 遠端備份列車相關數據，建置大數據庫。利用數據庫資料及AI技術，分析車輛相關參數，預測模組壽命，優化保養週期。
- ✓ 利用5G大頻寬特性，將影像資料備份於雲端，免去找車及等待車輛入庫時間，提升檢修效率



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