POC Project for SBST on RC COMMS Training

- **Natural voice Chatbot prompts Teaching** - on Voice Protocol, Syntax, and Practice

OBJECTIVE

Develop a RC Comms Cloud-Based Trainer adopting LLM AI, so that :

- trainee can learn and practice to communicate efficiently using TETRA Hand Portable Radio, and
- trainees can develop correctly voice protocol and develop good habits and practices to follow the Rules and Procedures for radio comms in SBST Rail operating environment.

. . and effectively applied in much a self-learning manner.

APPROACH

SBST Rails usage of RC Comms over TETRA spans the entire company-wide operations and for the interest of conducting simulation training. It is therefore best to organise it in 3 principle groups; casually known as **talk-groups**; ie Operations, Station, and Engineering / Depot. As the the POC is suppose to lead-on to a full scope for training the operations staff from a complete newbie to full competency, in their respective area of ops, it will mean examining the full context of use cases, the learning progression, and the unique verbiages being applied and practiced in each of these talk-groups.

Organised into three principle Talk-groups		
Operation Control	**Station Control**	**Engineering Control**

In order to cover the full spectrum and continuum, it is hence proposed to adopt this **Framework** to build the Training System. But before that, the trainees will also need to be inducted in some form of theory; the syntax of RC comms, sentence structure, and use of catchphrases, abbreviations etc. These will be in the form of more traditional interactive teaching modules. The concept of this will be demonstrated a a slice of application in this POC, but the full functionality will only be developed at subsequent implementation phase.

To support this, the RC AI assisted Sim Learning and Practice (RC AI SLP, or in short '**RC-SLP'**) will be developed in this Proof of Concept (POC) along this lines, adopting this Framework;

	Operation Control	**Station Control**	**Engineering Control**
Call-signs & Personas in Control :	OCC (default), TC, etc..	SM (default), ASM, etc..	Depot (default), Engineering, etc..
Users group :	CSO (Default), TPO, etc.	CSO (Default), etc.	EPIC (default), Engineer, technician, etc.

I Basic Levels	Comms syntax, habits, practices, Check-out etc. (similar for all except call-signs)		
II Intermediate Level	Procedural routines in Train Operations	Station's Procedural routines	Engineering work routines coordination
III Advance Level	Known incident handling	Known incident handling	Known incident handling

This 3 x 3 matrix above, illustrates the progression of personnel being trained in each talk-group. The intent is not to make the communication training & practices across to be mutually exclusive, but rather is for individuals to master the Comms conducted in each operating scenario quickly base on their familiarity, and what they can easily identify with. Comms practices however in the RC-SLP can later evolve into a more multi-disciplinary conversational context, in as much as a human intelligence can be mimicked within the AI platform.

There is also a desire for SBST to conduct auditing functions within this 'System'. This need arises as a result of the requirement for SBST to submit a monthly audit report of 80 hours sample of comms transcript to LTA. To ensure that this function can be incorporated at implementation phase, a pilot run on the accuracy of the Voice-to-Text transcription will be done with todays state-of-the-art AI application, and an assessment on the practicality for converting them in a cost effectively manner, investigating on a bolt-on application to do the analysis of bad RC comms instances (errors or problems), attributing them to : a) wrong usage or improper call-signs, b) wrong RC protocol and verbiage and c) poor comms clarity, etc. Limitations that can be seen upfront at this stage can be the inability of AI to handle the transcription job 100% of the time, due to user's voice accents and speech itself. But although is not an issue with the SLP function, as it's intend is in correcting the trainee to speech, the 'Auditor's' role is to resolute between context problem vs clarity instances. And as for the latter, it will always transcribe base on its best 'understanding' of the audio be it completely fitting the context or not.

Deliverable Modules in RC Sim

A) **Teaching Portion** - RC Comms Theory (only in PILOT Phase) :

1. Explain semi-duplex comms and rules (examples, one person talk at a time, pause of 2 secs before another speaks, etc..)
2. Use of key-words and phrases, acronyms and abbreviations - a dictionary of them; verbalising and pronouncing them; and their application meaning.
3. Reading (pronouncing) of phonetics and numbers and time in a proper manner.
4. Introducing the different Operating Groups and established calls-signs - of users within (control stations, mobile control and different sets of users)
5. Learn sentence structure and syntax - show examples of forms and format.
6. Technical jargons and nomenclatures (specific to talk groups) - through reading and picture references

This will eventually an interactive video/audio multi-modality play-out; and scope may also be extended to the use of TETRA handset hardware.

B) **RC SLP** (which is the POC's core) :

Partitioned to 3 Different Comms Talk-group - a) Station Manager Control, b) Engineering Control, c) OCC. Hence, at the User App Landing Page, these selection will be featured. (Different AI persona with its designated Avatar will be adopted for each Controller/Control Centre).

Trainees will be able to select and progress themselves through each level of Practices:

I. Basic levels -
Initial check in, comms check etc.., simple tasks like asking permission and check-out (with proper and right call-signs).

II. Intermediate level -
Standard work routines and contextual rules programmed in AI (RAM will know, as it will be provided the practices; wait time, and responding to request for pause etc..); That Ram is able to play out the requirements and expectations.

III. Advance level (POC this will be sampled) -
AI will randomly select from pre-loaded storyboard (each pre-written with the help of SME) for the context of a simulated play-out, example is there is a mini incident of a train defect in AM mode, and it overshoot the PSD. There is an expected unfolding of events and sequence and hence, how parties involved (OCC and CSO) will respond.

Scope of POC

The SLP Trainer is constructed for the trainee to conduct RC comms with the AI Chat Bot through a smart phone application. Different scenarios are created along with the other dialogue parties, one at a time, taking on different persona, and driven by AI in the respective talk-group. It assumes and takes on the identity at the moment the user or trainee choses the lesson plan / scenario. The AI will follow the voice protocol and practices as it has 'learnt', and thereby prompt the trainees to do likewise.

The SLP will developed in the perspective of "Users"

	Operation Control	Station Control	Engineering Control
Call-signs & Personas of Control :	OCC (default) TC, etc..	SM (default), ASM, etc..	Depot 01 (default), etc..
Users identified :	CSO and TPO	CSO	EPIC
I Basic Levels	Complete	Complete	Complete

II Intermediate Level	4 to 5 routines (should be sufficient)	2 routines (sampling)	1 routine (sampling)
III Advance Level	1 incident (sampling storyboard)	1 incident (sampling storyboard)	

General Rules for the SLP Trainer

Although the POC is not covering the 'Teaching of Theory', all the **General Rules in RC Comms** will have to be embodied into the SLP Trainer :

1. All parties must identify themselves with discrete call-sign (structure).
2. Parties involved must practice 2-way, half-duplex communication; ie. only one party speaks at a time, and pause for 2 seconds before the other can speak.
3. All messages must be clear, concise and to the point. Both the recipients and the caller must understand the messages correctly, and make clarification if required.
4. When using the radio for communications, standard radio protocol (voice procedure) must be used and strictly adhered to at all times.
5. All radio voice messages must be in English and the use of expletives is prohibited.
6. Only use acronyms as authorised by SBST in the comms manual are to be used.
7. Radio comms are performed only on a **need basis**. Particularly for Technical and Operations coordinations, and should not be used for social or personal matters.
8. Radio check is used as a way of checking in when user first 'enters' a new talk group (switch channel). This is particularly important in situation; example, where a CSO switch over from talk group 3700 to 3701 with mainline intending to communicate with the Traffic Controller, when the train is at the Reception Track.
9. All radio voice messages concerning safety critical work including manual train movement control must include the use of "Read Back" message.
10. A radio message for an individual manual train movement must be sent to one addressee only. The Read Back protocol must be applied to ensure critical action is clearly understood.
11. Misuse of 'emergency calls' including the emergency call function, on radio sets is prohibited.
12. Staff performing train driving or manning duty shall register his radio number with the DTC, TC or duty SM (if control has been delegated to the station) by performing a radio check and establishing radio contact before commencing train movement into the depot ATO area, into and on the mainline.
13. When making initial contacts with Control, User has to identify himself (his own call-sign), and addressing the receiver or control, and then state the purpose of the call.

All these along with the other rules and relevant terminologies will also be captured and applied as the 'Right Habits' and 'Rules' for the SLP **portion**. This allows the AI Bot to persistently making the voice comms corrections to 'train' the user in the cause of Comms Dialogue.

Hardware, Firmware and Cloud support

The computer system requirements this POC Project for an operation training chatbot is based on the anticipated complexity and flexibility desired, the technologies and

frameworks also caters to the possible desire of upscaling the immediate validation deployment. Henceforth the proposed support and hardware specifications:

a. Development Machine - for development purposes, a standard desktop computer with a core i7 processor and 32GB RAM with a solid-state drive (SSD), with Windows 11 OS, is good for overall performance. As the chatbot involves training large language models (LLM), a computer with a dedicated NVIDIA GPU, such as those from the GeForce GTX can significantly accelerate the training process.
b. Development Tools - depending on the final decision the final development carries us to, we will for the moment us such service provider that taps on the texting LLM such as Chat GPT. We are unlikely needing to use such specific Python programming tools and code editor for POC.
c. Internet Connection - only a reliable and reasonably fast internet connection is suffice since, it is for internal training deployment. And for POC it is intended to be hosted on cloud platform, the requirements will however may differ subsequently in final deployment. Also, there is no need for web-based interface, at the moment.
d. Text Editors or integrated development environment (IDE) may be a crucial interfaces for future development, and it has to match the programming language.

The Trainer is constructed for the trainee to conduct RC comms with the AI Chat Bot through a smart phone application. Different scenarios are created along with the other dialogue party having different persona being driven by AI in the respective talk-group. The UI and UX provides for the identity at the moment the user/trainee choses the lesson / scenario. The AI will follow the voice protocol and practices and thereby allowing the trainees to be prompted to do likewise.

Practice Portion - levels of practices defined :

Three different levels of Practice Training cuts across and are similar for all the 3 talk-groups. Throughout, the SLP will make 'corrections' of the trainer dialogue is as illustrated ..

Player (TPO)	Chatbot AI (as OCC), resolute and prompts
Unrecognisable chatter [fails to identify himself]	Station unknown, Mainline 01 here, please identify/ say call-sign, Over
Mainline 01 . .	Station unknown, Mainline 01 here, please identify/ say call-sign, Over
Mainline 01, TPO 'George'	TPO George, Mainline 01 here, please use proper Voice Protocol, says 'Over' after you are finish. Over
Mainline 01, TPO 'George', I am at Station 'twenty' over.	TPO George, Mainline 01 here, please use proper Numerical Phonetics, Over.
Mainline 01, TPO 'George' I need to recognise	TPO George, Mainline 01 here, please use proper Phonetics, Over.

Basic Level Practice :

This level of Practice Training cuts across, and are similar for all the 3 talk-groups, except that the call-signs and message context are slightly different. Mainly to *practice what is being 'learnt'* in the earlier 'Teaching Module'.

GOOD Comms PRACTICES and HABITS :

Basic Comms Syntax and Sentence structure in RC comms:

A) **Making a Group Call (only by control centre, not individuals)**, Sender start by saying:
<Receiver's Call Sign> this is <Sender's Call Sign>, <Message . . >, over
<Car 45> this is <Mainline 01>, <Message . . >, over

B) **Individuals establishing a Call**
Receiver's Radio call alert sounded, Receiver respond just by saying:
<Receiver's Call Sign>, send, over
<Car 45>, send, over

C) **Subsequent Radio messages** between the receiver and sender should just start with your own call sign; and finally ending the last with 'out'.
<Your own Call Sign> < …Your Message… >, over
<Car 45>, <Message . . >, over

D) **Leaving Radio comms** b sender should just ending with 'over and out'.
<Your own Call Sign> < …Your Message… >, over

<Car 45>, <Message . . >, over and out.

When talking:

- Maintain a natural rhythm
- Keep a constant speed, slightly slower than in normal conversation
- Speak every word clearly, do not let the voice fade away & do not shout.
- Use a higher pitch tone to allow better transmission.

Guides for User for good RC Comms:

Specify upfront - **Purpose of call** (example - "Asking / Request" for permission for entering track)

Example of clear purpose:

Doing maintenance, repair, search for item
Respond to rescue a train
Following orders or instruction (with authority from ..)

If too vague? Or incomplete details for normal deployment, AI agent taking on Control Centre persona, will prompt TPO to ask :

When? .. specific time, or minutes from present time
Where ? Present location ?
Number of personnel?
Reason for ..

Other Voice Protocol and Practices:

Not to be too apologetic, and disband with excessive nicety (such as "please, can you?" "how great if you can ..", etc), Otherwise Control will initiate, 'Over and Out' to terminate recurring counter acknowledgement.

Response by Control (control centre persona):

Must also follow similarly follow proper voice protocol,
And always stands to be corrected,
Lead the dialogue in each (intended) scenario. Example: In specific scenario, such as seeking entrance for Track Access; **OCC has to also follow though** to provide (after he is satisfied, and ready to grant authorisation):

TOA number xxxx, and state:
Time limit (period in minutes, or up to a specific time)
Method of Track Access Protection (Standing Train Protection, .. etc)
Lastly, make reminder to TPO to update progress.

Practices in RC Voice Comms:

Structured communication practices:

Order of Phraseology :

Start with call in the Party, followed by one-self
End with "over"

Keep conversation clear and brief, and practice affirmation and confirmation

Make relevant reminders:

Proceed with caution.
Notify once operation/work is complete.

Adopt Common Catch Phrases / Words (List B) :
Negative, Positive, Wilco, Roger, go-ahead, copy that
Say again, Affirmative, at location / position
Request additional time, extension, use as TOA

Trade specific and standard terminologies (example List A1 for Operations) :
Referrals: such as OCC, TPO,
Situations: Train disruption, trespassing, intrusions, SPAD, inclement weather, equipment malfunction, track damage.

In the half-Duplex (one way communication - means at anyone time), only one person can talk, Parties will also need to practice 2 sec spacing and speak only the other party says; “over” or “out”.

Hence, it is important to say OVER or OUT after parties have finished talking so that other radio users in the Talk Group can start their own radio conversation.

- OVER means you had completed your message transmission and now your counterparty can start his message transmission to you.
- OUT in a Group Call setting (Open Channel) means you had completed your radio conversation with your intended counterparty, now other radio users in this Talk Group can use it to made radio call to others in the same Talk Group.
- OUT in an Individual Call setting means you had completed your message transmission to your intended counterparty, the radio conversation is completed no further reply is required, radio conversation had ended.

‘Read Back Message’ practice is specifically important to ensure that a message has been correctly understood and received, and has to be applied in all these situations:

1. Safety situation
2. Protection arrangements
3. Possession & worksite boundaries
4. Change of vehicle operation modes; between AM, CM or RM
5. Movements of vehicles
6. Position of switch eg: Normal or Reverse
7. OCS status ON/OFF

Intermediate level Training

The voice comms habits and practices in the 'Basic Level' will be snowballed to this phase as well. But the 'practice', again in this level is divided into the 3 talk-groups will be be listed and ordered by the selection of different SOPs, and / randomised standardised processes and work sequences as below. There are also arranged in the 3 principal talk-groups for the purpose of this Training.

Operations

Seeking permission for Track Access (during traffic hours)
Seeking permission for Track Access (during traffic hours)
Moving Locomotive onto tracks

Station Control

Validating Authorisation for Access
Arrangements for Visits
Closure of stations / entrances
etc..

Depot / Engineering

P-way maintenance
etc..

An example of Intermediate Level Practices:

Specific Sequences of Comms with OCC (Track Access) : Sequence of events (varies and depends on Track protection methods) :
[after obtaining TOA]

- Move to platform, and board the right assigned train,
- Make way to enter restricted area,
- Entering track,
- Report start of work (provide regular update)
- Report work complete
- Report leaving track
- Report giving up (surrendering) TOA

Advance level Training

This level of practice incorporates situation relevancy in event, incidents or emergencies. And these are incorporated through storyboards provided for each scenarios. These written scenarios and multiple variations of it will be uploaded into the AI Model for guiding the sequence of response being led by the AI Bot in the SLP:

Examples :

Operations Situations:
SPAD,
Inclement weather,
etc ..

Station Control Situations:
Train disruption,
Trespassing,
Intrusions,
etc ..

Depot / Engineering Situations:
Track damage.
Point machine malfunction,
etc ..

There are also other matters involving work practices arrangements tied to each of the incidents or events that will drive the play-out of the different scenarios in both Intermediate and Advance Level.

WORK PRACTICES for Intermediate and Advance Level Training :

Take note :

BESIDES CALL-SIGNS, each Tetra device do have an individual device code, a four digit ID, and Each Comms Group has an individual Comms Group four digit ID.

Although there is Group Call function, in the respective channel ID groups, group call function ("Open Channel" communication) on 3701 and 3702 can be used for broadcasting and by 'Control' for instances such as :

- Release of the Last Train by stations
- Managing an event or delay
- Incident or Emergency

In the event of an incident, one Control Centre in a talk group (eg. OCC) may instruct parties directly involved in handling the incident to switch to another talk group, such as the Incident Management channel 3703 or 3704 for radio communications during the Initial Response and Evacuation phase.

This Incident Management channel may also be used by the EPIC / AEIC and staff from the respective Engineering disciplines during the Investigation and Recovery phase for communications between themselves and the IO.

During the incident management, all personnel should minimise use of the radio to avoid network overloading.