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*(c) 2020-2022 STTA / Wilko PA1WBU*  
*(c) 2020 Jim MOJIM (1<sup>st</sup> translation)*  
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## **Introduction**

This TETRA TMO Getting Started (GS) supplements the STTA DMO Getting Started. This TMO GS assumes that the information from the DMO GS has been read, understood and, if necessary, already set on the radio.

Just like the DMO GS, this GS is also limited to Motorola TETRA radios. Simply because the writer does not currently own TETRA radios from other manufacturers.

A small repeat from the DMO GS,

- The use of the CPS Lab mode is not without risks;
- Therefore, first make a full flash backup using Flash Report (refer to the DMO GS);
- If things should go wrong with the CPS Lab mode, that's a shame but it remains your own risk.

Some important TMO additions:

- The ISSI (the CCS7, or the "DMR ID" must be entered.  
Tetra TMO requires a unique ISSI, 2 radios with the same ISSI on a TMO network or Node ("repeater") will not work. Both radios will have problems in the network!
- The requirement for a unique ISSI also applies if a DMO-TMO gateway is used.

This GS has been intentionally kept concise and is limited to the basic settings needed to operate TETRA TMO within the service area of the STTA TMO node. There is much, much more to tweak according to your own taste.

The screenshots were created with CPS7.5 and are based on MTH800, MTM800 and MTP6650 radios. Depending on the radio model and the firmware used in the radio, it looks (slightly) different in CPS.

In addition to the full flash backup, always make full backups of the codeplugs. This ensures it will be possible to go back to the 'known good' version.

The TMO "repeater" is referred to in general as "the node". Another name for node is "BS" which stands for Base Station. Mobile and portable radios are called MS (Mobile Stations).

## **TMO Talkgroups and folders**

The first step is to create a TMO Folder in which the Talk Groups (TG) for a particular TMO network (in case of the STTA TMO environment, that network consists of a single TMO BS).

In the image below the default folder name has already been changed to STTA. The folder name is of course settable to your own preference..

TETRA has a 'strangler' as seen on some analogue amateur repeaters. This function prevents a single user from speaking 'endlessly' and thus occupying a TG. This also prevents a radio that hangs on its PTT switch.

The Transmission Timeout Timer (TTT) and the Transmission Timeout Warning Timer (TTWT) shown below are still at the standard (default) value of 60 and 50 seconds. It is useful to set the TTT to 300 seconds (which is also the maximum value), and the TTWT to 290 seconds. This means that 10 seconds before the timeout occurs and the call will be disconnected, a warning beep sounds which informs you that your transmission timeout will follow in 10 seconds. Setting the value to 0 will disable the strangler. Not really recommended.

	Name	Status	Parent Folder	Transmission Timeout Timer, sec	Transmission Timeout Warning Timer, sec	Number of Talkgroups in the Range	Receive Only
1	STTA	<input checked="" type="checkbox"/>		60	50	5	<input type="checkbox"/>
2		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
3		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
4		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
5		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
6		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
7		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
8		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
9		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
10		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
11		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
12		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
13		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
14		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>
15		<input type="checkbox"/>		0	0	0	<input type="checkbox"/>

The following image shows the standard set of 5 TG's as automatically generated by the CPS. Note that the TG's are already included in the default folder renamed to STTA in the previous step.

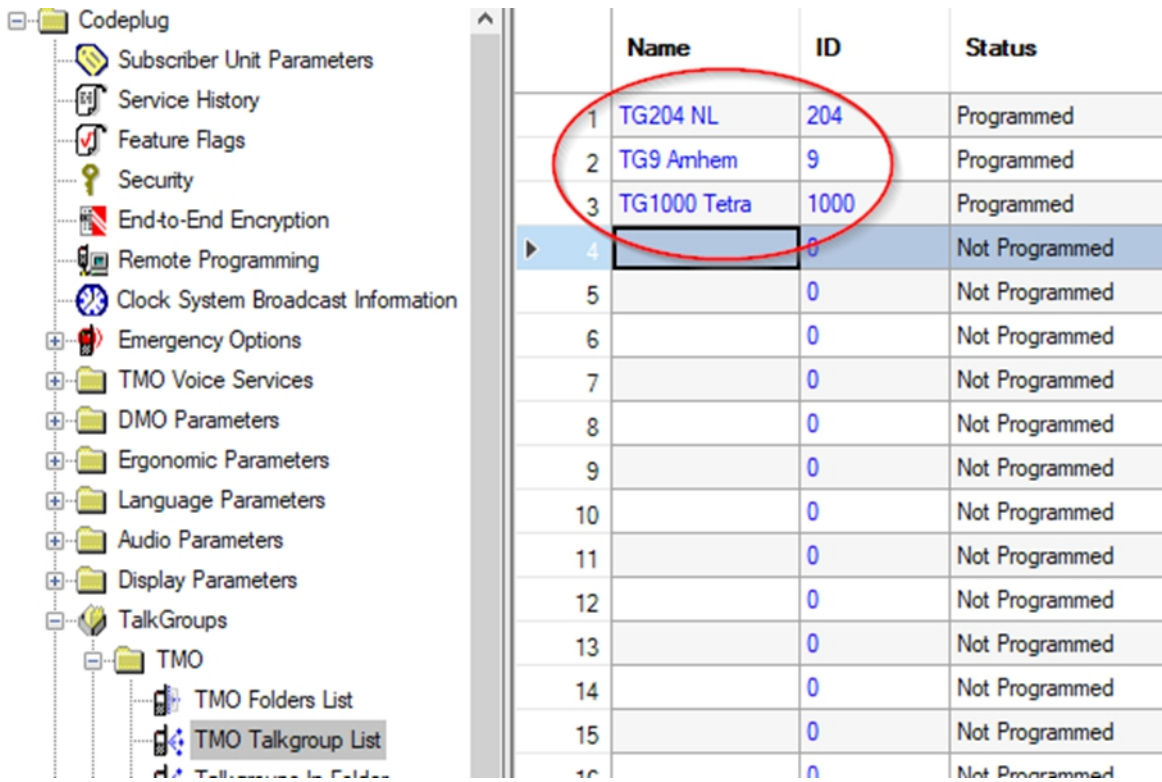
	Name	ID	Status	Default Folder	Announce Group
1	Motorola1	3000	Programmed	STTA	<input type="checkbox"/>
2	Motorola2	3001	Programmed	STTA	<input type="checkbox"/>
3	Motorola3	3002	Programmed	STTA	<input type="checkbox"/>
4	Motorola4	3003	Programmed	STTA	<input type="checkbox"/>
5	Motorola5	3004	Programmed	STTA	<input type="checkbox"/>
6		0	Not Programmed		<input type="checkbox"/>
7		0	Not Programmed		<input type="checkbox"/>
8		0	Not Programmed		<input type="checkbox"/>
9		0	Not Programmed		<input type="checkbox"/>
10		0	Not Programmed		<input type="checkbox"/>
11		0	Not Programmed		<input type="checkbox"/>
12		0	Not Programmed		<input type="checkbox"/>
13		0	Not Programmed		<input type="checkbox"/>
14		0	Not Programmed		<input type="checkbox"/>
15		0	Not Programmed		<input type="checkbox"/>

The standard TG names have been renamed into the locally known TG names. The TG ID's can be adjusted to your own taste. As an example; 3 TG's have been devised as "STTA standard".

In general, the STTA TMO BS is not aware of the TG or TG ID's. This means that anyone can invent and use TG's and TG ID's themselves. Obviously, all stations must have programmed the relevant TG ID, otherwise it is not possible to communicate. There is no such thing as "VFO mode"

in Tetra. Using the default groups is certainly the best option.

The following screenshot shows where the adjustments must be entered.



	Name	ID	Status
1	TG204 NL	204	Programmed
2	TG9 Arnhem	9	Programmed
3	TG1000 Tetra	1000	Programmed
4		0	Not Programmed
5		0	Not Programmed
6		0	Not Programmed
7		0	Not Programmed
8		0	Not Programmed
9		0	Not Programmed
10		0	Not Programmed
11		0	Not Programmed
12		0	Not Programmed
13		0	Not Programmed
14		0	Not Programmed
15		0	Not Programmed
16		0	Not Programmed

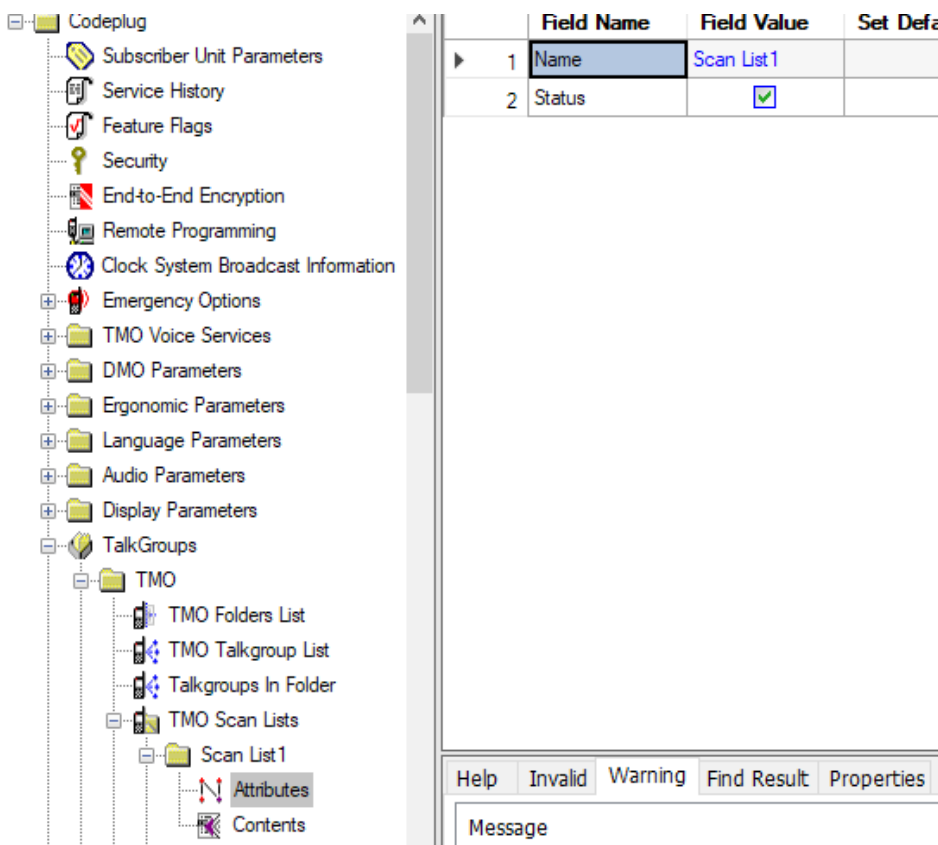
*Remark:* There can be 3 TGs active simultaneously on a node. There are 4 timeslots within the 25kHz bandwidth, 1 of them is permanently allocated to the MCCH, which is the Control Channel for 'housekeeping'. In professional TMO networks nodes with multiple base radios (BR) are sometimes used, that allows e.g. 7 simultaneous active TG using a BS with two BR.

*Remark:* some BS allow full duplex (FDX) private calls, which is exactly what you know well from using a telephone: simultaneous talking and listening, no PTT. This FDX mode requires two time slots. You have to enter the number of the party you want to talk to and press the green “telephone” button on your MS.

In the previous 2 steps, Talk Groups and, also a Talk Group Folder have been created. The last step is to place the TG’s in that folder. This of course is intended for large networks with many TG’s. Should ever a link be established between different TMO BS’s or TMO networks, it will become more interesting. For now, its usefulness is limited.

### Scan lists

TMO offers the possibility to let the radios "scan" TG’s in a list of predefined set TG's. The image below shows the standard scan list as CPS creates it.



The screenshot shows the CPS software interface. On the left is a tree view of the configuration structure. Under 'TalkGroups' > 'TMO' > 'TMO Scan Lists', 'Scan List 1' is selected. Below it are 'Attributes' and 'Contents'. On the right, a table shows the properties for 'Scan List 1':

	Field Name	Field Value	Set Defa
1	Name	Scan List 1	
2	Status	<input checked="" type="checkbox"/>	

At the bottom of the window, there are buttons for 'Help', 'Invalid', 'Warning', 'Find Result', and 'Properties', and a 'Message' field.

	Name	Status	Network	Folder	O
	TG204 NL:204	Programmed	Any	STTA	
2	TG9 Amhem:9	Programmed	Any	STTA	
3	TG1000 Tetra:1000	Programmed	Any	STTA	
4		Not Programmed	Any	STTA	
5		Not Programmed	Any	STTA	

The name of the scan list can be changed as desired. So here the name has been changed to "STTA scan".

	Field Name	Field Value	Set Default
1	Name	STTA scan	
2	Status	<input checked="" type="checkbox"/>	

The scan list is subsequently filled with TG's at your own discretion, this can be seen in the following screenshot.

	Talkgroup	Prior
1	TG204 NL:204	low
2		
3		
4		
5		

If all 'standard' TG's are in the list, it looks like the screenshot below. There is also the option to indicate priorities in the Scan list, TG204 NL:204 is set to "high" as an example.

	Talkgroup	Priority
1	TG204 NL:204	high
2	TG9 Amhem:9	low
3	TG1000 Tetra:1000	low
4		

It is practical to program the scan list to be activated when the radio is switched on. That list is called the "active list". You can also choose another scan list via the menu in the radio.

	Field Name	Field Value	Set Default
▶ 1	Active List	1:STTA scan	Set Default
2	Scan Status	<input checked="" type="checkbox"/>	
3	User List Editing	<input checked="" type="checkbox"/>	
4	Priority Editing Enabled	<input checked="" type="checkbox"/>	
5	PTT Operation	Talk Back	Set Default
6	Presentation Mode	Force	Set Default
7	On/Off via MMI	<input checked="" type="checkbox"/>	
8	Block Group Enabled	<input type="checkbox"/>	
9	Priority Presentation Timer, msec	8000	Set Default
10	Scan Hold Timer, msec	5000	Set Default
11	Rx Hold Timer, msec	5000	Set Default
12	Scan On/Off over the Air	<input type="checkbox"/>	

It will be clear that multiple Scan Lists can be created. For now, not too useful for small-scale amateur use.

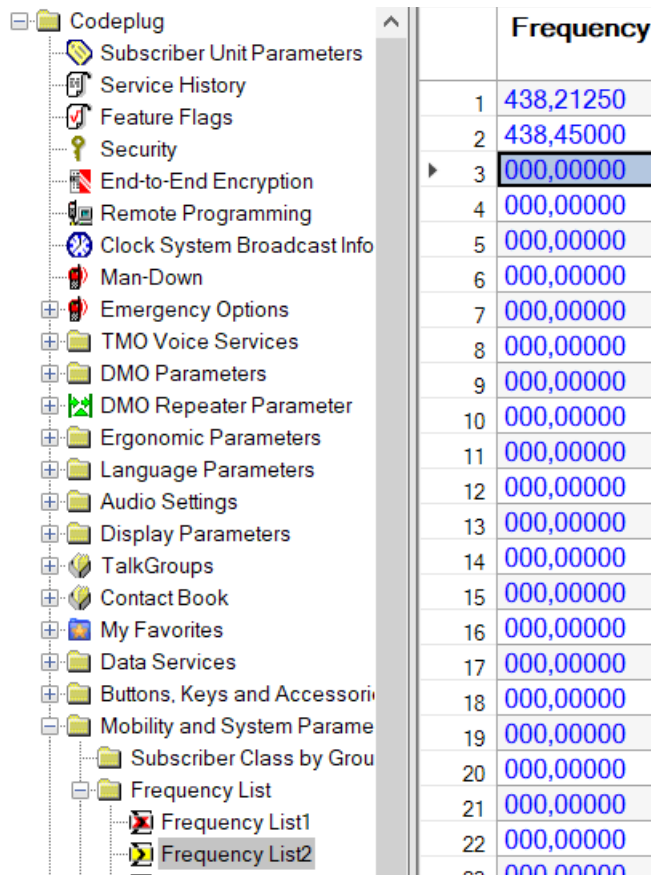
### Frequency lists

Obviously, it must still be ensured that the radios can find the the related STTA TMO BS frequency. This works very differently in TMO than with 'normal' radios or (DMO) repeaters. In fact, the TMO model is comparable to the way a GSM telephone network works.

There are four so-called Frequency lists in the Motorola TETRA radios:

- List 1: list with frequencies of the BS to which the radio has ever been connected  
(cannot be programmed, is read-only for the user)
- List 2: pre-programmed frequencies for 'known nodes'
- List 3: scan list 1
- List 4: scan list 2

Frequency scan lists are useful when there are multiple nodes operational. By scanning the frequencies based on List 3 and List 4, the radio can then find the nodes by itself. The larger the frequency range to be scanned, the longer it takes (which is logical of course) so for the Dutch nodes the QRG is simply "hardcoded" in List 2. This means that the radio quickly finds the node after switching on (provided it is within range of the radio of course).



	Frequency
1	438,21250
2	438,45000
3	000,00000
4	000,00000
5	000,00000
6	000,00000
7	000,00000
8	000,00000
9	000,00000
10	000,00000
11	000,00000
12	000,00000
13	000,00000
14	000,00000
15	000,00000
16	000,00000
17	000,00000
18	000,00000
19	000,00000
20	000,00000
21	000,00000
22	000,00000
23	000,00000

438.2125 is the transmit frequency of the PI1ANH BS, 438.450 is the transmit frequency of the PI6ZTM BS located in The Hague. Not in the screenshot is the future frequency for the PI1UTR BS in IJsselstein, near Utrecht. It is recommended to already enter that frequency 438.750 in the list.

The purple icons and the red box around the Frequency is how CPS indicates that there is something wrong with the entered values. In this case it is 'simple': the radio used was originally intended for the 380-430MHz band. The entered frequency of 438.2125 is therefore invalid. The solution for this follows below, stay tuned...

Please note: as long as there are errors in the codeplug according to CPS, the codeplug cannot be written to disk.

Scan lists are currently not used, they are also pretty pointless with just a couple of TMO nodes which have no overlapping coverage. They do, however, potentially slow down the registration of the radio in the 'network'. Experimenting with scan lists is of course fine, but fill in the correct start frequency and limit the number of channels to be scanned (Tetra channels are 25kHz wide by the way).

For the reasons outlined, it is useful to uncheck the box for Full band scan and to set the number of channels to be scanned in Frequency List 3 to, for example, 40. Note: Not all firmware versions provide this Full band scan check mark.

- Feature Flags
- Security
- End-to-End Encryption
- Remote Programming
- Clock System Broadcast Information
- Man-Down
- Emergency Options
- TMO Voice Services
- DMO Parameters
- DMO Repeater Parameter
- Ergonomic Parameters
- Language Parameters
- Audio Settings
- Display Parameters
- TalkGroups
- Contact Book
- My Favorites
- Data Services
- Buttons, Keys and Accessories
- Mobility and System Parameters
  - Subscriber Class by Group
  - Frequency List
  - Home Location Areas
  - Networks
  - Mobility Parameters**
  - TXI Parameters
  - Randomization on Service Level

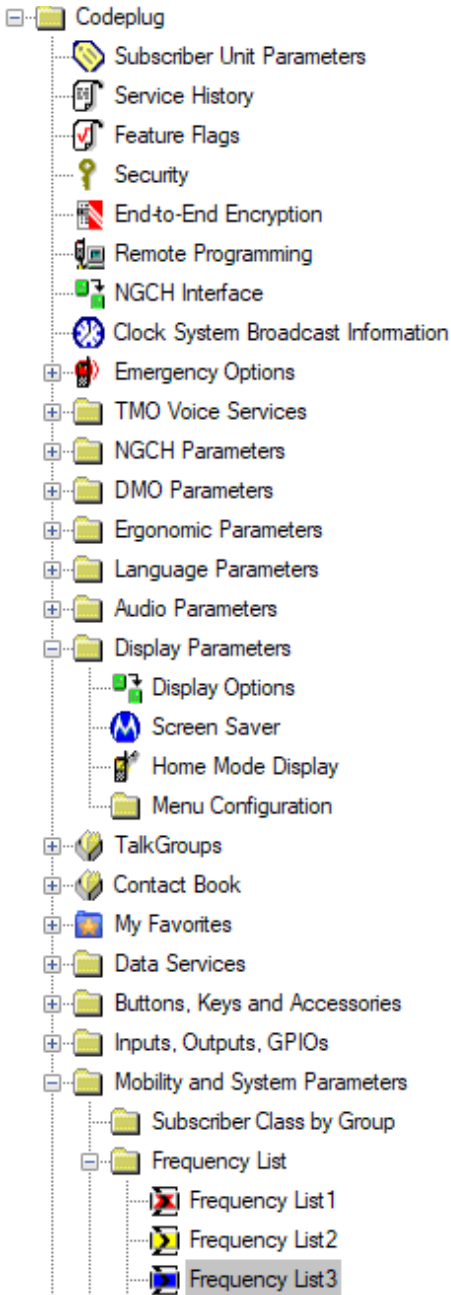
	Field Name	Field Value	Set Default
12	Common SCCH Allocation Number (MS_SCCH)	0	
13	Overwrite MSCCH over the Air	<input checked="" type="checkbox"/>	
14	Minor Congestion Timeout	3	
15	Major Congestion Timeout	15	
16	Maximum RF Transmit Level	Class 3	Set Default
17	Randomization Congestion Timer, sec	20	
18	Cell No Longer Congested Timeout, min	10	
19	Avoid Registration on Link Failure Timeout, sec	1	Set Default
20	Max Time out of Serving Cell	30	Set Default
▶ 21	Full Band Scan	<input checked="" type="checkbox"/>	
22	RF Power Class Selected	Hi RF Power	Set Default
23	HIGH Power Activation upon Entering DMO	<input checked="" type="checkbox"/>	
24	LOW Power Activation upon Entering TMO	<input type="checkbox"/>	
25	SIM Card Network Alias		
26	Non-relinquishable Cells Ranked Worse	<input type="checkbox"/>	
27	Remove Cells after Failed Scanning	<input type="checkbox"/>	
28	Scrambling Vector for Colour Code 0	Add MNI	Set Default
29	Minimum Signal Strength Threshold	0	Set Default
30	Duplex Space Table[0]	10	Set Default
31	Duplex Space Table[1]	7	Set Default
32	Duplex Space Table[2]	0	Set Default

Help Invalid Warning Find Result Properties

Mobility and System Parameters -> Mobility Parameters -> Full Band Scan

The scan list start frequency must be set, plus the number of channels to scan. As already mentioned: do not use a large number of channels, that will only make the scan slow. By default, the number of channels is set at 400.





	Field Name	Field Value	Set Default
▶ 1	First Frequency to Scan	438.00000	Set Default
2	Number of Frequencies	40	Set Default

### Address extension

Tetra TMO follows the convention within the Dutch amateur TETRA community to use the (official) MCC or Mobile Country Code. For the Netherlands this is 204. Furthermore, every Tetra network has a Mobile Network Code (MNC). The NL amateurs use 7373.

*Just so you know:* the commercial Entropia network also uses MCC 204, the same applies to C2000 for the Dutch Emergency Services. Each network has its own unique MNC.

- Codeplug
  - Subscriber Unit Parameters
  - Service History
  - Feature Flags
  - Security
    - End-to-End Encryption
    - Remote Programming
    - Clock System Broadcast Information
  - Emergency Options
  - TMO Voice Services
  - DMO Parameters
  - Ergonomic Parameters
  - Language Parameters
  - Audio Parameters
  - Display Parameters
  - TalkGroups
  - Contact Book
  - My Favorites
  - Data Services
  - Buttons, Keys and Accessories
  - Mobility and System Parameters
    - Subscriber Class by Group
    - Frequency List
      - Frequency List1
      - Frequency List2
      - Frequency List3
      - Frequency List4
    - Home Location Areas
    - Address Extension

	Country Code	Network Code	Alias
1	204	7373	HamNL
2	0	0	
3	0	0	
4	0	0	
5	0	0	
6	0	0	
7	0	0	
8	0	0	
9	0	0	
10	0	0	
11	0	0	
12	0	0	
13	0	0	
14	0	0	
15	0	0	
16	0	0	
17	0	0	
18	0	0	
19	0	0	
20	0	0	
21	0	0	
22	0	0	
23	0	0	

Help Invalid Warning Find Result Properties

### Authentication

TMO has facilities to ensure that the TMO network and the radio must (mutually) authenticate. This facility, usually in combination with encryption, can prevent a 'foreign' radio from connecting to a TMO network. Long story short: for amateur use authentication should be disabled, as shown in the screenshot below. Having authentication enabled will give rise to strange effects: the radio at first appears to connect correctly to the BS and then suddenly reports „No service“. Ask me how I know..

- Codeplug
  - Subscriber Unit Parameters
  - Service History
  - Feature Flags
  - Security
  - End-to-End Encryption

	Field Name	Field Value
1	MS Authentication	<input type="checkbox"/>
2	MS Mutual Authentication	<input type="checkbox"/>
3	Mandatory Mutual Authentication	<input type="checkbox"/>



## **Lab mode**

The use of CPS lab, or depot, mode is necessary for radios that cannot work without adjustments between 430 and 440MHz in terms of frequency range. The duplex settings have to be adjusted in lab mode. The default duplex shift of 10MHz for the 400MHz Tetra band is obviously not suitable for amateur use in the 10MHz wide 70cm band.

**The need to make adjustments in the lab mode typically applies to the older radio models.**

Newer models Motorola radios are wideband, up to 470MHz. For those radios, the use of lab / depot mode is *not* necessary. Do not use lab mode for new radio models as this can harm the settings. Later in this GS-document the duplex adjustment for the new radio models will be discussed. This can be done without the use of the lab mode.

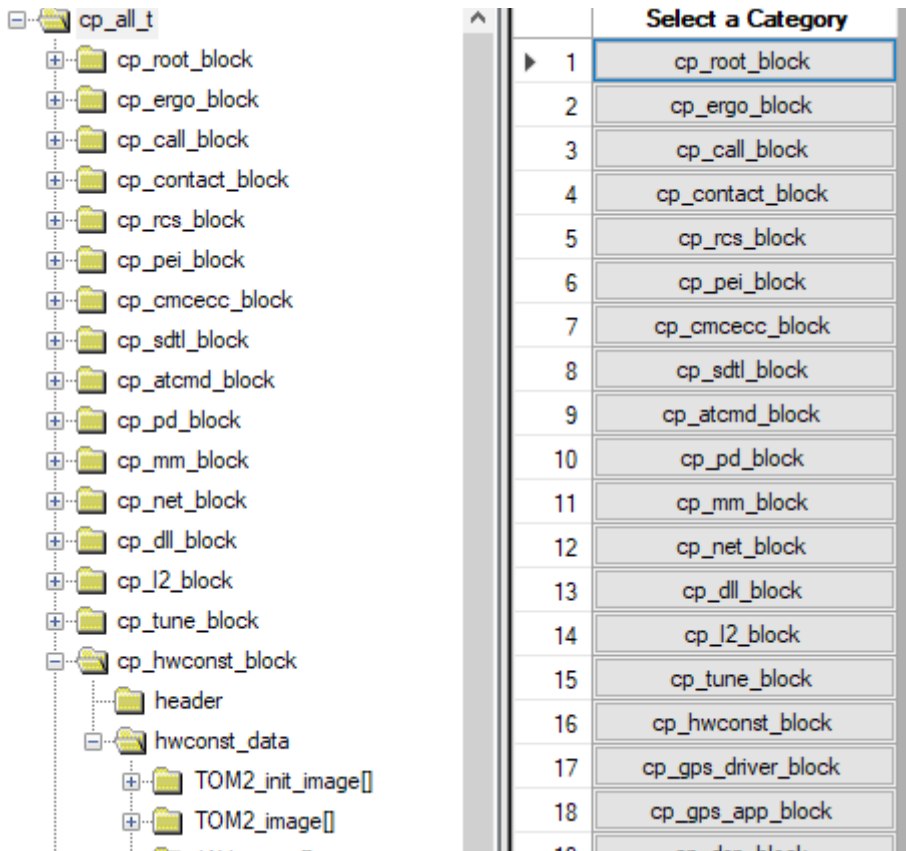
*Remark:* Older radio models can be expanded up to 440MHz, but they were not designed for it. Reception sensitivity is less, certainly higher up in the 70cm amateur band, than modern wide band radios.

Selecting CPS Lab Mode is described in the DMO GS document. The next part assumes you have already set the lab mode to its decimal display.

## **How to adjust *hwconst\_block***

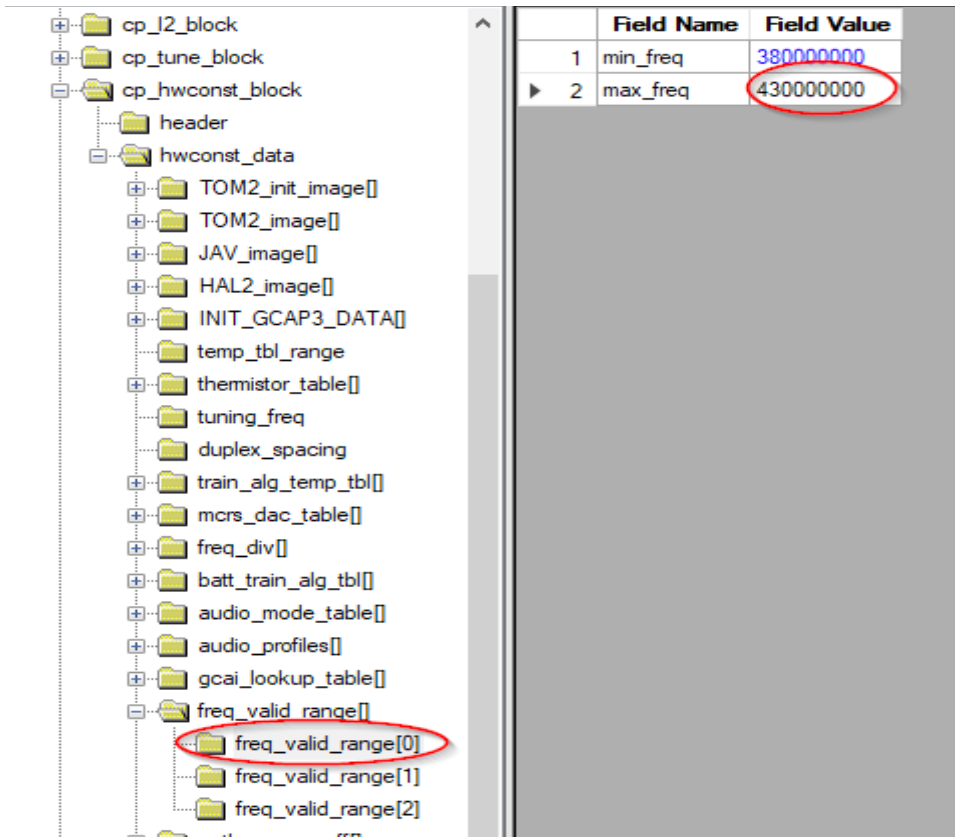
In order for the radios to work in the amateur band, it is, as mentioned, necessary to increase the maximum frequency range that is considered valid to 440MHz. This is done by adjusting some *hwconst\_block* values.

Clicking open *cp\_hwconst\_block* and then *hwconst\_data* yields the image below:



The *freq\_valid\_range [0]* must be 'stretched' to 440MHz, the maximum frequency.

Pay close attention to the number of 0's (zero's), CPS checks nothing to little with regard to the values entered in lab mode! Incorrect values can result in a completely malfunctioning radio (hence those backups...). The next screenshot shows the parameter to be adjusted.



	Field Name	Field Value
1	min_freq	380000000
2	max_freq	430000000

After adjustment it will look like the following image.



- [-] cp\_l2\_block
- [-] cp\_tune\_block
- [-] cp\_hwconst\_block
  - [-] header
  - [-] hwconst\_data
    - [+] TOM2\_init\_image[]
    - [+] TOM2\_image[]
    - [+] JAV\_image[]
    - [+] HAL2\_image[]
    - [+] INIT\_GCAP3\_DATA[]
    - temp\_tbl\_range
    - [+] themistor\_table[]
    - tuning\_freq
    - duplex\_spacing
    - [+] train\_alg\_temp\_tbl[]
    - [+] mcrcs\_dac\_table[]
    - [+] freq\_div[]
    - [+] batt\_train\_alg\_tbl[]
    - [+] audio\_mode\_table[]
    - [+] audio\_profiles[]
    - [+] gcai\_lookup\_table[]
    - [-] freq\_valid\_range[]
      - freq\_valid\_range[0]

	Field Name	Field Value
1	min_freq	380000000
2	max_freq	440000000

## Adjustment of the duplex\_space table in cp\_net\_block

In contrast to TETRA DMO (such as the 'old' P11ANH repeater), TETRA TMO uses duplex frequencies. The P11ANH TMO node of the STTA transmits 7MHz higher in the band than where it receives. The duplex shift is therefore 7MHz for the P11ANH TMO node.

Without making it too complicated: the node broadcasts information that informs the radios on which frequency the node is receiving. This is a single 8 bit value. Thus, the information transmitted is not the actual receiving frequency or offset from the transmission frequency, but a single number. That number is translated by the radios into the duplex value by means of a pre-programmed table lookup. The standard values and how this works are described in the ETSI TETRA standards.

Unfortunately, there is an error in the standard codeplugs which proves tricky with the STTA node: in the space (line 1) in the table for the 400MHz band where according to the ETSI standard, it should say 7MHz instead it says 45MHz.

That 45MHz value should be changed to 7MHz. The 45MHz setting is only intended to be used for the 800/900MHz TETRA band. See also the following table from the ETSI documentation. Because the professional TMO users all use 10MHz duplex shift, the incorrect 45MHz has probably never been a problem.

## 6 Duplex spacing

The duplex spacing values are defined without any mathematical rule. The duplex spacing shall be reference/base frequency dependent as defined in table 2. The 0,000 MHz duplex value may be needed for direct mode operation and is included here for completeness.

Table 2: Duplex spacing as function of the reference/base frequency

Frequency band	Base/reference frequency	Duplex spacing information element value (next row) and corresponding duplex spacing (other rows; in MHz)							
		000 <sub>2</sub>	001 <sub>2</sub>	010 <sub>2</sub>	011 <sub>2</sub>	100 <sub>2</sub>	101 <sub>2</sub>	110 <sub>2</sub>	111 <sub>2</sub>
0000 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
0001 <sub>2</sub>	100 MHz	1,6	4,5	0	note 1	note 1	note 1	note 1	note 1
0010 <sub>2</sub>	200 MHz	10	note 1	0	note 1	note 1	note 1	note 1	note 1
0011 <sub>2</sub>	300 MHz	10	note 1	0	8, (see note 2)	18, (see note 2)	note 1	note 1	note 1
0100 <sub>2</sub>	400 MHz	10	7, (see note 2)	0	8, (see note 2)	5 (see note 2)	note 1	note 1	note 1
0101 <sub>2</sub>	500 MHz	10	note 1	0	note 1	note 1	note 1	note 1	note 1
0110 <sub>2</sub>	600 MHz	10	note 1	0	note 1	30, (see note 2)	note 1	note 1	note 1
0111 <sub>2</sub>	700 MHz	note 1	note 1	0	note 1	30, (see note 2)	note 1	note 1	note 1
1000 <sub>2</sub>	800 MHz	note 1	45	0	18, (see note 2)	note 1	note 1	note 1	note 1
1001 <sub>2</sub>	900 MHz	note 1	45	0	18, (see note 2)	39, (see note 2)	note 1	note 1	note 1
1010 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
1011 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
1100 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
1101 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
1110 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1
1111 <sub>2</sub>	note 1	note 1	note 1	0	note 1	note 1	note 1	note 1	note 1

NOTE 1: The value is reserved for future standardization.  
NOTE 2: These values are intended to be used only outside Europe.

Also note the number of 0's (zerro's) in the duplex tables here. According to a reliable source there  
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are standard code plugs that contain, for example, 700000. 700kHz is obviously not something that will work. You can search for that one missing 0 for a long time..The duplex offset showing 45MHz in slot 1 and the 10MHz in slot 7 you must change:

	Field Name	Field Value
1	freq_band_table	Expand
▶ 2	duplex_space_table	Collapse
3		0 10000000
4		1 45000000
5		2 0
6		3 10000000
7		4 10000000
8		5 10000000
9		6 10000000
10		7 10000000
11	channel_offset	Expand
12	DMO_duplex_space_table	Expand
13	spare	Expand

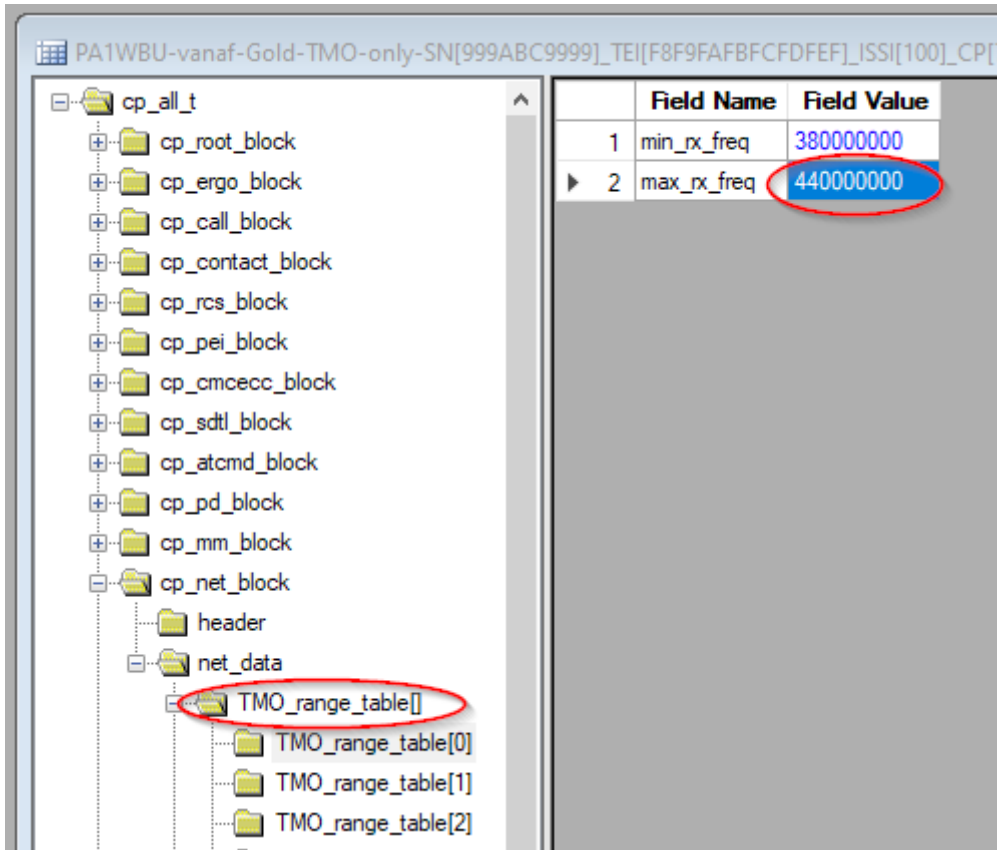
The correct duplex offset set to **7MHz** (7000000) in slot 1 (for PI1ANH), and **7.6MHz** (for PI6ZTM) in slot 7.

	Field Name	Field Value
1	freq_band_table	Expand
2	duplex_space_table	Collapse
3		0 10000000
4		1 7000000
5		2 0
6		3 10000000
7		4 10000000
8		5 10000000
9		6 10000000
10		7 7600000
▶ 11	channel_offset	Expand
12	DMO_duplex_space_table	Expand
13	spare	Expand

### **Adjustment of the upper reception frequency table in cp\_net\_block**

Next step, under *net\_data* and then *TMO\_range\_table* in the *TMO\_range\_table [0]* line, the maximum allowed receive frequency must be adjusted from 430MHz to 440MHz. Refer to the screenshot hereunder.





## Programming the radio

If the radio had to be modified via lab mode, the radio must be programmed with *Write Entire Codeplug*. So not with *Write radio*. This is necessary to put the parameters that were adjusted in lab mode into the radio. *Write radio* doesn't do that.

All radios that did not require changes via lab mode simply have to be programmed with *Write radio*, do not use the *Write entire codeplug* command.

## Adjustment of the duplex offset for modern radios

Modern radios are all those models that do not require the frequency range adjustments and the duplex offset settings via lab mode.

They already work 'from the factory' up to (at least) 440MHz and allow the adjustment of the duplex values in the regular CPS, thus without using the lab mode.

The screenshot below shows what the duplex table looks like on a MTP6650.

Remark 1: For these radios, the values in the duplex table are in Mhz. With the older radios, the values which has to be changed via lab mode are in Hz.

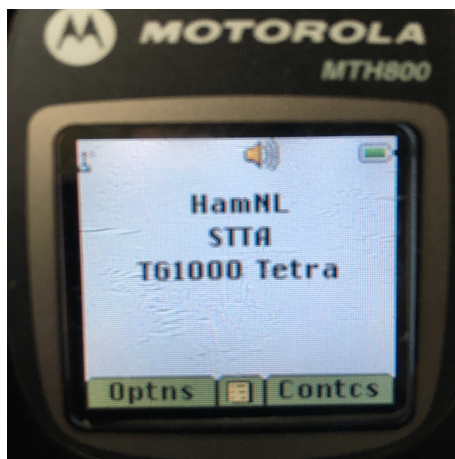
Remark 2: The 7.6MHz offset listed in the table (line 37) is intended for use with a German amateur TMO BS. Be aware that different duplex offsets are used. This is depending on the network and the country the network is used in. Check this before you travel and want to use your radio there. Even better: bring a laptop with CPS on it and a programming cable..

30	Duplex Space Table[0]	10	Set Default
31	Duplex Space Table[1]	7	Set Default
32	Duplex Space Table[2]	0	Set Default
33	Duplex Space Table[3]	10	Set Default
34	Duplex Space Table[4]	10	Set Default
35	Duplex Space Table[5]	10	Set Default
36	Duplex Space Table[6]	10	Set Default
37	Duplex Space Table[7]	7.6	Set Default
38	N210	4	Set Default
39	Power up Network	Last	Set Default
40	Mode switch Network	Last	Set Default
41	Any Network Selection	All	Set Default
42	Any Network Action	Search	Set Default
43	Locked Preferred Network Search Depth	List 1+2	Set Default
44	Dynamic Preferred Network Search Depth	List 1+2	Set Default

### Testing

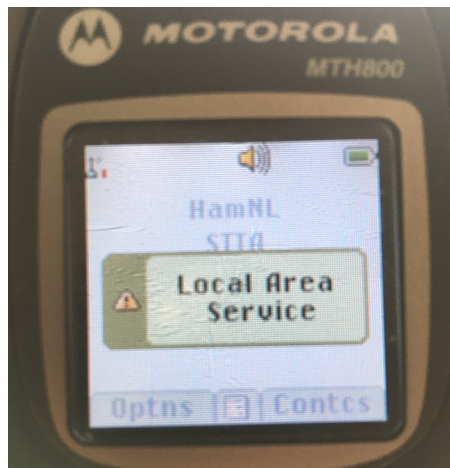
After programming the radio, the big moment has arrived: testing can take place!

If everything went well and there is sufficient signal strength both *from* and *to* the TMO BS, it will look like the screenshot below. And the radio has successfully registered on the BS!



TG1000 Tetra is selected. HamNL corresponds to what is included in the Address Extension (read: MCC 204 and MNC 7373). STTA is the selected Folder, containing the TG's.

The following may periodically appear on the display.



This indicates that the TMO BS is not connected to an underlying network that interconnects multiple nodes. It is therefore a warning that the connected BS forms, as it were, an isolated island within a larger network. Such a network is called a SwMI. Island operation is basically not normal for Tetra TMO. After all, TMO is Trunked Mode Operation, normally within a larger SwMI network. The consequence of Local Area Service is that accessibility of other stations (for example a police control room) is not guaranteed. Only stations connected to the same BS can reach each other.

In the case of amateur TMO, there is generally only 1 BS in radio range. This warning is therefore irrelevant. The LST (Local Site Trunking) status as Motorola calls it, is broadcast by the BS.

The default setting on Motorola radios is to provide both an audio signal and a message on the display when the radio is connected to an LST node.

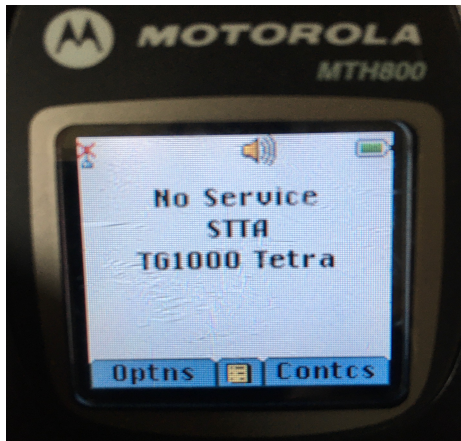
The screenshot below shows which setting controls the LST notification.

	Field Name	Field Value	Set Default
	1 Test Mode	<input type="checkbox"/>	
	2 Ring Style	British	Set Default
	3 Speaker Phone	<input checked="" type="checkbox"/>	
	4 Range Scroll Type	Scroll To Next Folder	Set Default
	5 Energy Economy Mode via MMI	<input type="checkbox"/>	
	6 Group Call Notification during Menu Viewing	<input type="checkbox"/>	
	7 Returning to Browser after Losing Focus	<input checked="" type="checkbox"/>	
	8 Low Battery Indication Threshold	Low	Set Default
	9 Idle Screen Configuration	Network	
	10 Power On Battery Insertion	<input checked="" type="checkbox"/>	
	▶ 11 LST Notification	Both	Set Default
	12 Show Temporary Address	<input type="checkbox"/>	

The LST notification can be disabled in the codeplug as indicated below (not possible for all radios, by the way)

	Field Name	Field Value	Set Default
1	Test Mode	<input type="checkbox"/>	
2	Speaker Phone	<input checked="" type="checkbox"/>	
3	Range Scroll Type	Scroll Stay In Folder	Set Default
4	Energy Economy Mode via MMI	<input checked="" type="checkbox"/>	
5	Group Call Notification during Menu Viewing	<input checked="" type="checkbox"/>	
6	Returning to Browser after Losing Focus	<input checked="" type="checkbox"/>	
7	Low Battery Indication Threshold	Low	Set Default
8	Power On Battery Insertion	<input checked="" type="checkbox"/>	
9	LED Brightness in Charge Only	1	Set Default
10	LED Brightness	3	Set Default
▶ 11	LST Notification	No	Set Default
12	Show Temporary Address	<input type="checkbox"/>	
13	Audio Notification when Speech Permission Withdrawn Enabled	<input checked="" type="checkbox"/>	
14	Visual Notification when Speech Permission Withdrawn Enabled	<input checked="" type="checkbox"/>	

It is considerably less pleasant (understatement) if the following appears on the display after you completed the programming.



"No service" might have one or more of the following reasons:

- An error in the programming of the duplex setting;
- An error in frequency list 2;
- An error in the maximum reception frequency (usually detected by CPS);
- Not enough signal strength received by your own radio ("no coverage" in GSM terms). The solution is usually to find a place with better coverage or a change of the antenna;
- The local radio is 'deaf': there is enough signal in itself, but the radio in question is insensitive. This can be due to unsuccessful experiments with lab mode changes.

Prepare for lengthy and frustrating bug searches. Reception strength can be verified by listening with an analog receiver on the downlink frequency used by the BS;

- adequate reception of the signal transmitted by the node, but the signal transmitted by the local radio (this *uplink* signal is necessary to register with the node) is not sufficiently received by the node for whatever reason to make the registration successful.

The reason could be, for example, because a Tetra portable usually has very limited RF power. A portable radio is 1, 1.8 or best case 3W. MTM mobile radios are 3W (MTM800,



MTM800E, MTM5200) or 10W (MTM5400, MTM5400). Tetra was designed for 'many' and relatively 'small' cells. Radio amateurs want to use large cells due to lack of TMO node hardware, as well as limited availability of repeater sites and frequencies. The solution is to improve the signal strength, both for the signal the BS receives and the signal the MS receives. Think of a better antenna or a better location (not close to or in buildings but on an open field).

- The nature of TDMA as used in Tetra limits the maximum distance between MS and BS. The timing parameters used in TMO make the maximum distance 58km, regardless how strong the RF signal is;
- ....

Debugging this kind of problems can be a fun and educational task. Good luck!