Optimize repeater & sDAS interconnectivity

Revision: 0.2 Draft

TRANSYSTEM INC.

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History

Revision	Change Note	Author	Date
0.1 Draft	Initial version	S.C. Yen	Dec. 2, 2016
0.2 Draft	Remove DAS GUI & wording For Java script: jdri_v1.3.0 (beginning version)	S.C. Yen	Dec. 21, 2016

Overview:

In the typical DAS application, HEU needs to be connected to mobile base station for better performance. However, it may be difficult to implement such architecture. In general, the DAS system is built by the neutral host owner, the mobile base station RF signal may need to be collected over the air, the specific architecture has been developed by added repeater. However, it needs to optimize for better system performance. This document described the criteria to build the system, and how to optimize the system.

Preparation:

To evaluate if DAS system can be built by receiving the over the air mobile radio signal is the preparation task, the system integrator shall measure the radio signal performance if good enough. When measure the radio signal performance, it needs to confirm that the signal quality is good enough, not only signal strength.

It had better to collect the operators' mobile network operation frequency spectrum for further performance adjustment/setting purpose for the region, this information will be set into repeater for better system performance.

- The following shows the classified for signal strength & signal quality:
  - 3G UMTS mobile network: the system integrator shall confirm **the signal quality (Ec/Io) shall be more than -10.**

RSSI	Signal Strength
>-70 dBm	Excellent
-70 to -85 dBm	Good
-86 to -100 dBm	Fair
<-100dBm	Poor

Ec/Io	Signal Quality
0 to -6	Excellent
-7 to -10	Good
-11 to -20	Fair to Poor

Note:
1. RSSI: Received Signal Strength Indicator
2. Ec/Io: Energy to Interference Ratio

  - 4G LTE mobile network: the system integrator shall confirm **the signal quality (SINR) shall be more than 0.**

RSRP	Signal Strength
>-90 dBm	Excellent
-90 to -105 dBm	Good
-106 to -120 dBm	Fair
<-120dBm	Poor

SINR	Signal Quality
> 10	Excellent
6 to 10	Good
0 to 5	Fair
< 0	Poor

Note:
1. RSRP: Reference Signal Received Power
2. SINR: Signal to Interference-plus-Noise Ratio

- The radio signal performance can be measured by specific mobile phone. The following information was captured based on Samsung Galaxy A710Y mobile phone in engineering mode (by dialing "＊＃０００１１＃", click "STACK 1", then "service mode"). The engineering mode for the other mobile phone model may need to have different engineering mode entering code, and the supported

information may not be sufficient. If the system integrator wants to use the other mobile phone model, the system integrator shall confirm if it can collect sufficient information for further usage.

- When the mobile phone is set at 3G UMTS mode, Ec/Io information can be captured as below. The system integrator shall confirm **the signal quality (Ec/Io) shall be more than -10.**

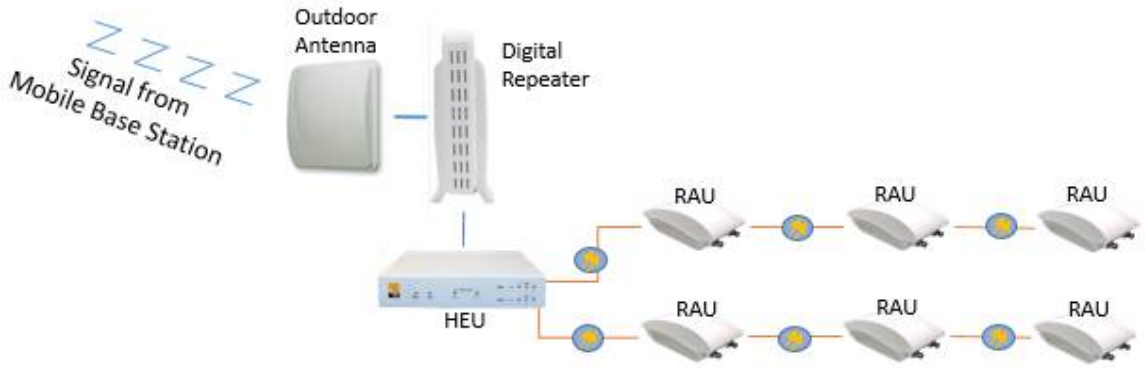
- When the mobile phone is set at 4G LTE mode: SINR information can be captured as below. The system integrator shall confirm **the signal quality (SINR) shall be more than 0.**

System Architecture

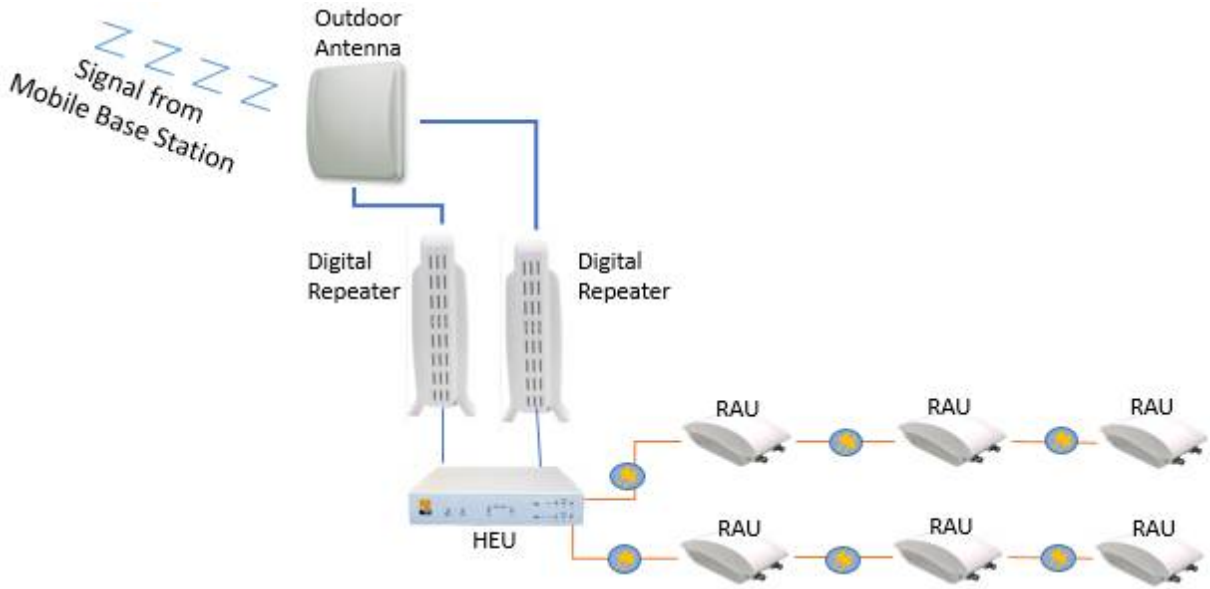
- The repeater is going to receive the mobile base station signal, and amplify the signal. HEU/RAU is going to distribute the mobile signal over optical fiber. There are 2 system architectures have been developed. The system integrator shall determine which architecture to be implemented. For 4G LTE mobile network, both architectures are possible to be implemented because of cost optimization, but the system performance will be degraded at least 50% or more.

- When apply the system architecture for multi-carrier services, TSI's digital repeater is able to select which carrier's signal will be carried or not, and equalized each carrier's signal before sending to DAS system. This feature can optimize the system performance compared with other analog repeater.

  - SISO (Single Input Single Output): It is generally applied to 3G UMTS mobile network architecture, but also is possible to be implemented in 4G LTE mobile network architecture for cost optimized. Only one repeater is required to implement.



  - MIMO (Multi Input Multi Output): It is generally applied to 4G LTE mobile network architecture. 2 repeaters are required to implement.



System Setup procedure

To optimize the system performance, the optimization process shall be performed. TSI has developed the software to setup the system parameters according to the exactly environment, it includes digital repeater, HEU, and RAU parameters setting.

The following shows step by step setup procedure for optimized repeater and sDAS interconnectivity:

1. System Setup Preparation

It is possible to have multiple digital repeaters & HEU in the system, to minimize the setup effort, it is recommended to setup the system as the architecture shown as below figure.

- The setup of digital repeater shall be performed via USB interface, USB Hub shall be prepared to be connected among digital repeaters and notebook PC.
- The setup of HEU/RAU shall be performed via Ethernet interface, it is suggested PoE switch Hub to be prepared to be connected among HEU and notebook PC.
- The frequency spectrum information shall be collected, it is required to be setup in digital repeater in the beginning. the information also can be retrieved through mobile phone in engineering mode.

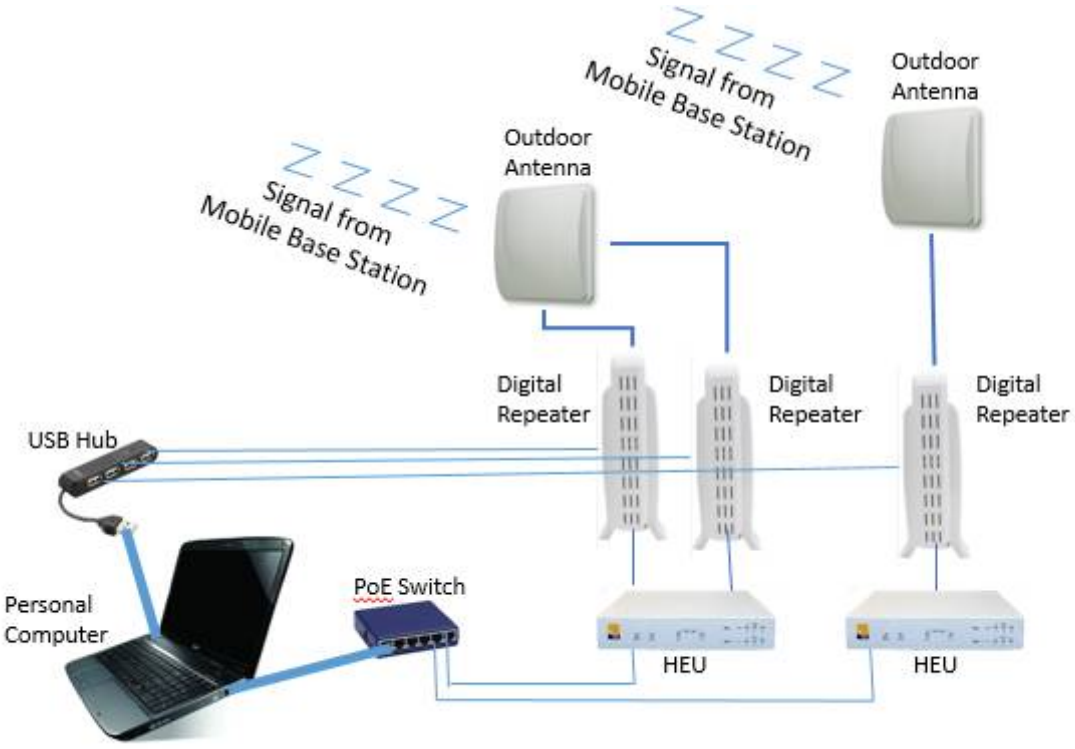
For example, Taiwan LTE operators' spectrum shows below,

	Band 3 (1800MHz)	Band 7 (FDD) (2600MHz)	Band 8 (900MHz)	Band 28 (700MHz)	Band 38 (TDD) (2600MHz)
ChungHwa Telecom	25MHz (C2, C5)	30MHz (D2, D4)	10MHz (B2)		
Taiwan Mobile	15MHz (C1)			15MHz (A4)	
FarEasTone	20MHz (C3, C4)	20MHz (D3)		10MHz (A2)	25Mhz (D5)
APTG			10Mhz (B3)	20MHz (A1, A3)	25Mhz (D6)
Taiwan Star		20Mhz (D1)	10Mhz (B1)		

Frequency	Uplink (MHz)	Downlink (MHz)	3GPP Planned
A1	703 ~ 713	758 ~ 768	Band 28
A2	713 ~ 723	768 ~ 778	
A3	723 ~ 733	778 ~ 788	
A4	733 ~ 748	788 ~ 803	
B1	885 ~ 895	930 ~ 940	Band 8
B2	895 ~ 905	940 ~ 950	
B3	905 ~ 915	950 ~ 960	
C1	1710 ~ 1725	1805 ~ 1820	Band 3
C2	1725 ~ 1735	1820 ~ 1830	
C3	1735 ~ 1745	1830 ~ 1840	
C4	1745 ~ 1755	1840 ~ 1850	
C5	1755 ~ 1770	1850 ~ 1865	
D1	2500 ~ 2520	2620 ~ 2640	Band 7
D2	2520 ~ 2540	2640 ~ 2660	
D3	2540 ~ 2560	2660 ~ 2680	
D4	2560 ~ 2570	2680 ~ 2690	

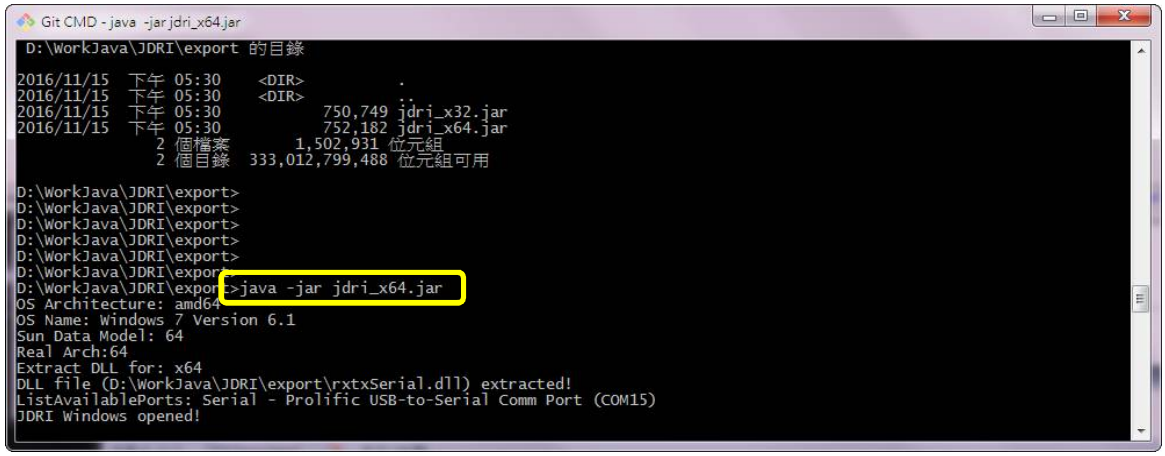
D5	2570 ~ 2595 (guard band: 2570 ~ 2575 included)	Band 38
D6	2595 ~ 2620 (guard band: 2615 ~ 2620 included)	Band 41

- Java runtime environment shall be setup in the notebook PC. The Java version shall be Version 8 update 111 or later version.
  - Required java script shows below, if you have no such script, please contact the technical support.
    - ✓ Jdri_x32.jar: for 32-bit Windows OS environment
    - ✓ Jdri_x64.jar: for 64-bit Windows OS environment



2. Run Java script

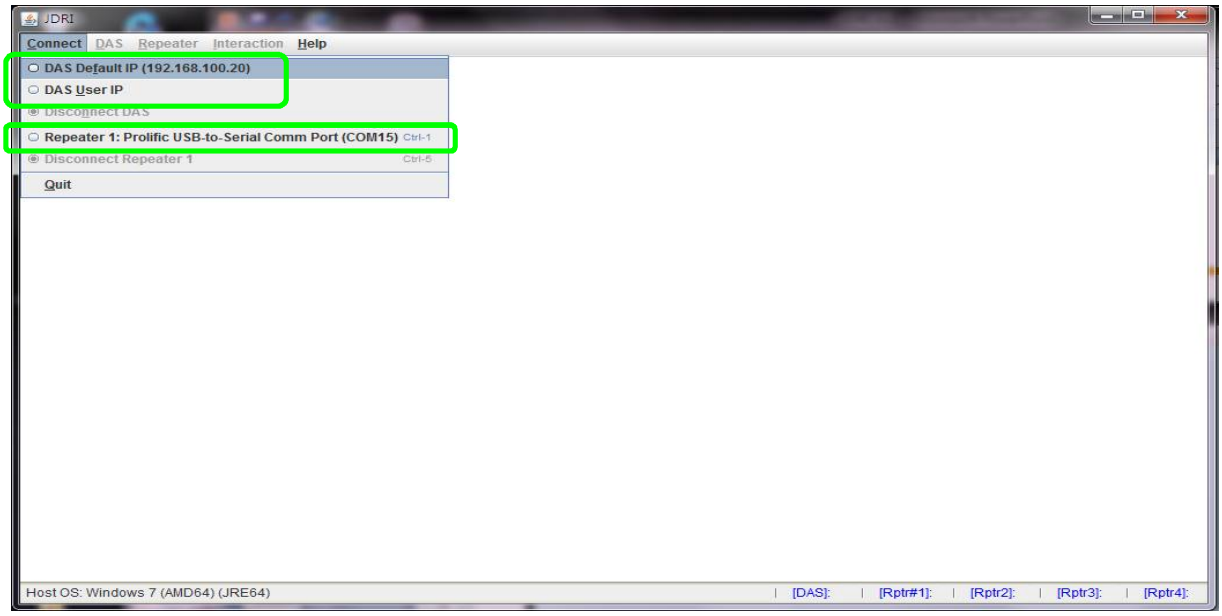
By command “java –jar jdri_x64.jar” or “java –jar jdri_x32.jar” to run Java script.



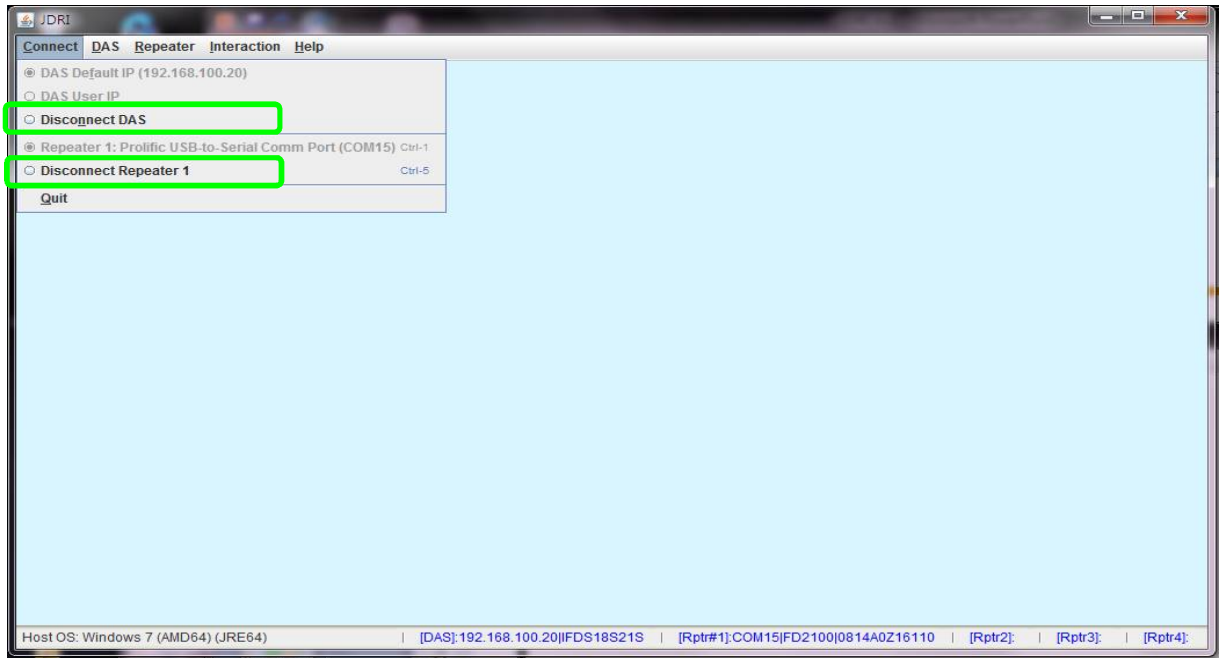
3. Connect/disconnect sDAS and repeater

The Java GUI will be presented as below when "java –jar jdri_x64.jar" or "java –jar jdri_x32.jar" is successful running.

- Select sDAS IP for further setting
- Select repeater USB COM port for future setting

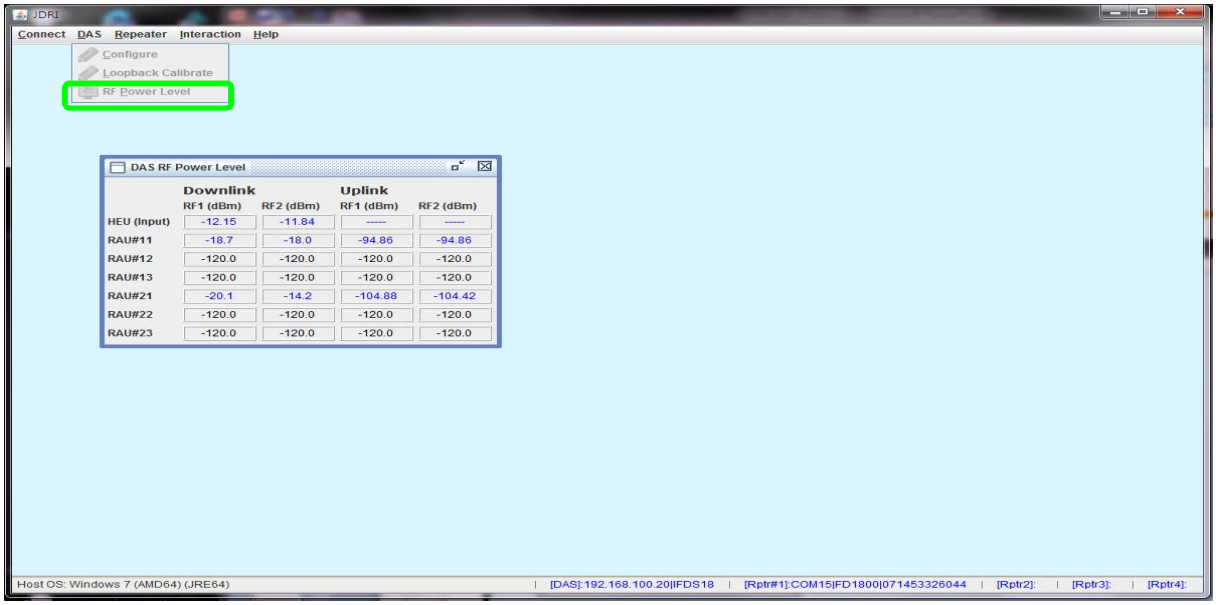


- Disconnect sDAS or repeater USB COM port can be executed by the menu below.



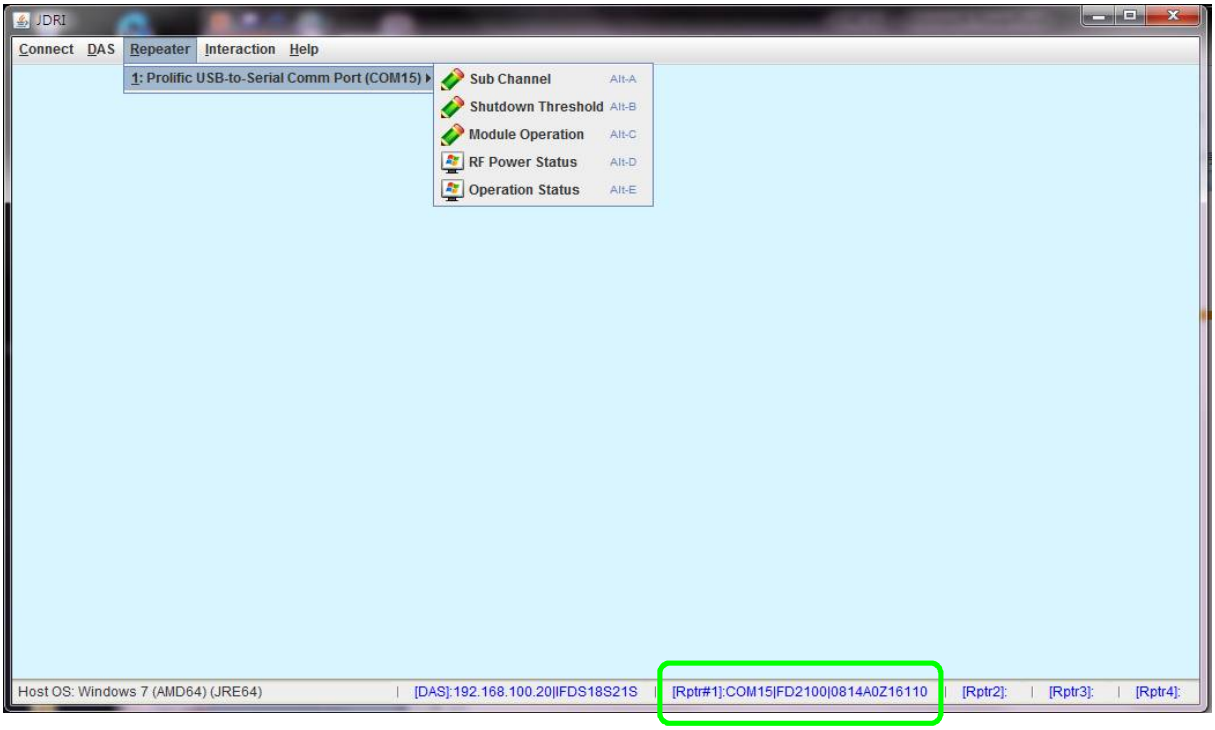
4. sDAS parameter Setup

- sDAS parameters shall be setup via web based GUI. However, through this interface, the parameters can be retrieved via this menu.



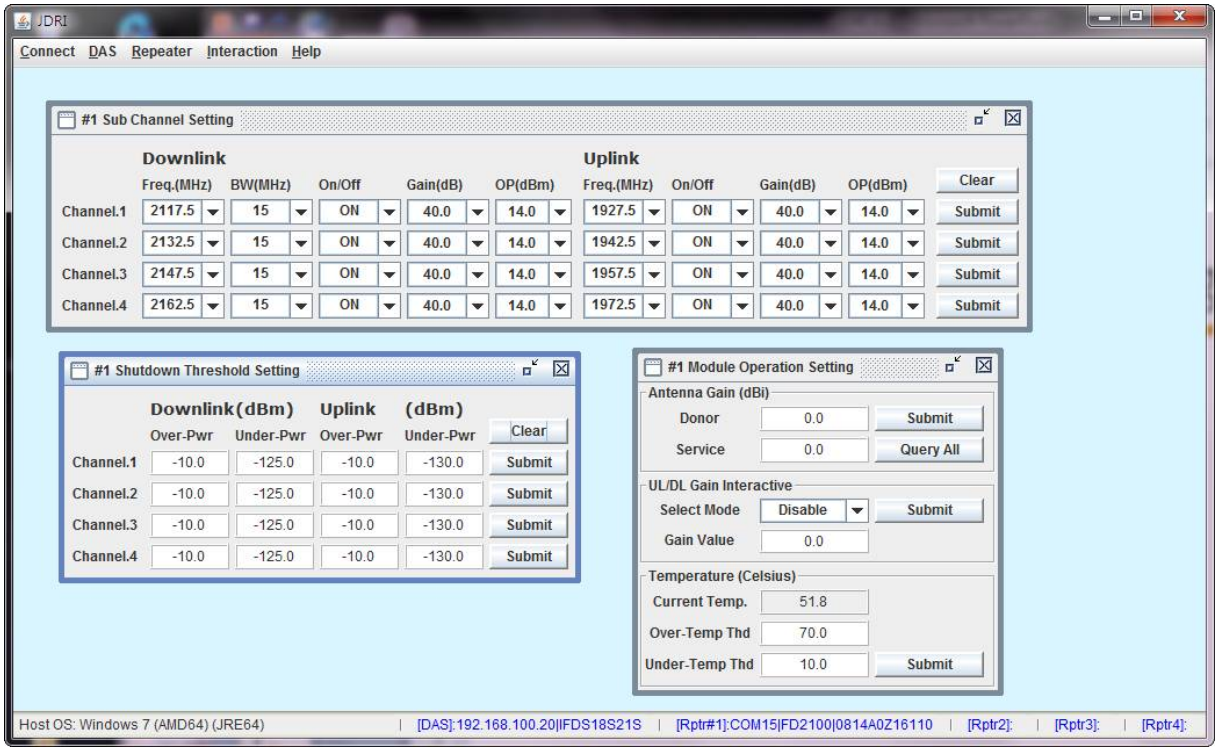
5. Repeater parameter setup:

- Repeater parameters setup can be performed via the following menu.
- Setup "Sub Channel Setting", the operator's channel frequency allocation info. if it has been well understood, or by mobile phone when running in engineering mode to collect the information.

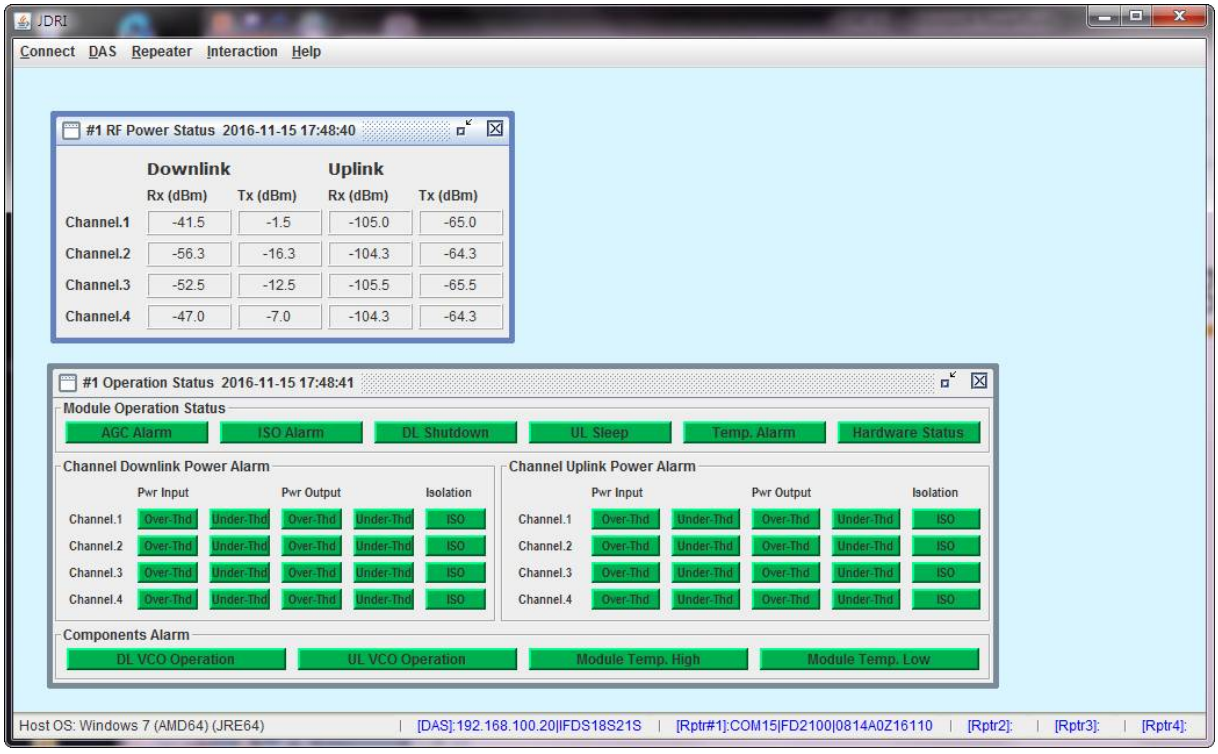


- "Sub Channel Setting": the information for the setting can be retrieved per operator's channel frequency allocation, or by mobile phone when running in engineering mode.
  - Frequency: the center frequency of the channel can be set; Downlink/Uplink center frequency will be automatically set.
  - Bandwidth (BW): the bandwidth of the center frequency of the channel can be set.
  - On/Off: the downlink/uplink channel can be turn on or off.
  - Gain (dB): the gain of the downlink/uplink channel can be set. It is suggested to set at system default, +40.0dB, in the beginning. However, it may be optimized by the Java script after interaction command.
  - OP (dBm): the maximum RF output power of the downlink/uplink channel can be set. It is suggested to set at system default, +11.0dBm, in the beginning. However, it may be optimized by the Java script.
  - "Submit": after the setting, click "Submit" button to perform.
  - "Clear": the exactly system setting will be retrieved and displayed.
- "Shutdown Threshold Setting":
  - Over Pwr. (Over power): when the repeater detected the RF input power of Downlink/Uplink over the setting threshold, the RF output power of Downlink/Uplink will be shutdown. The user can set the threshold as needed. However, it is suggested to leave at the system default setting.
  - Under Pwr. (Under power): when the repeater detected the RF input power of Downlink/Uplink lower than the setting threshold, the RF output power of Downlink/Uplink will be shutdown. The user can set the threshold as needed. However, it is suggested to leave at the system default setting.
  - "Submit": after the setting, click "Submit" button to perform.
  - "Clear": the exactly system setting will be retrieved and displayed.
- "Module Operation Setting":

  Please leave all parameters are in the system default.

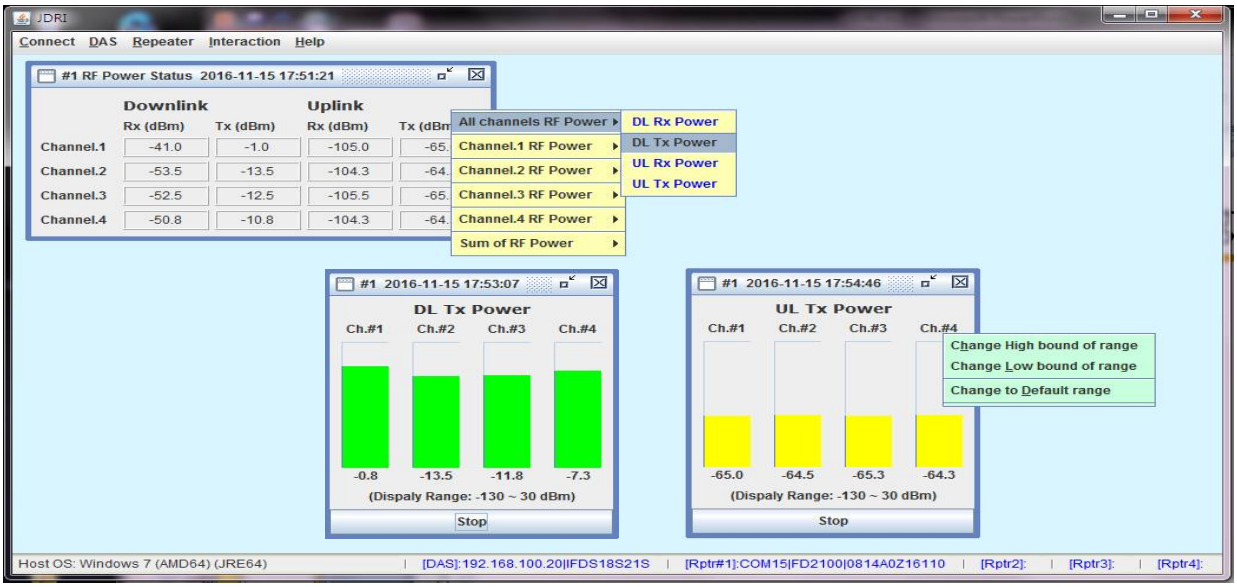


- "RF power status": after "Sub Channel Setting", the received/transmitted RF power of the repeater can be retrieved.
- "Operation Status": after "Sub Channel Setting", "Shutdown Threshold Setting", & "Module Operation Setting", the received/transmitted RF power of the repeater can be retrieved.



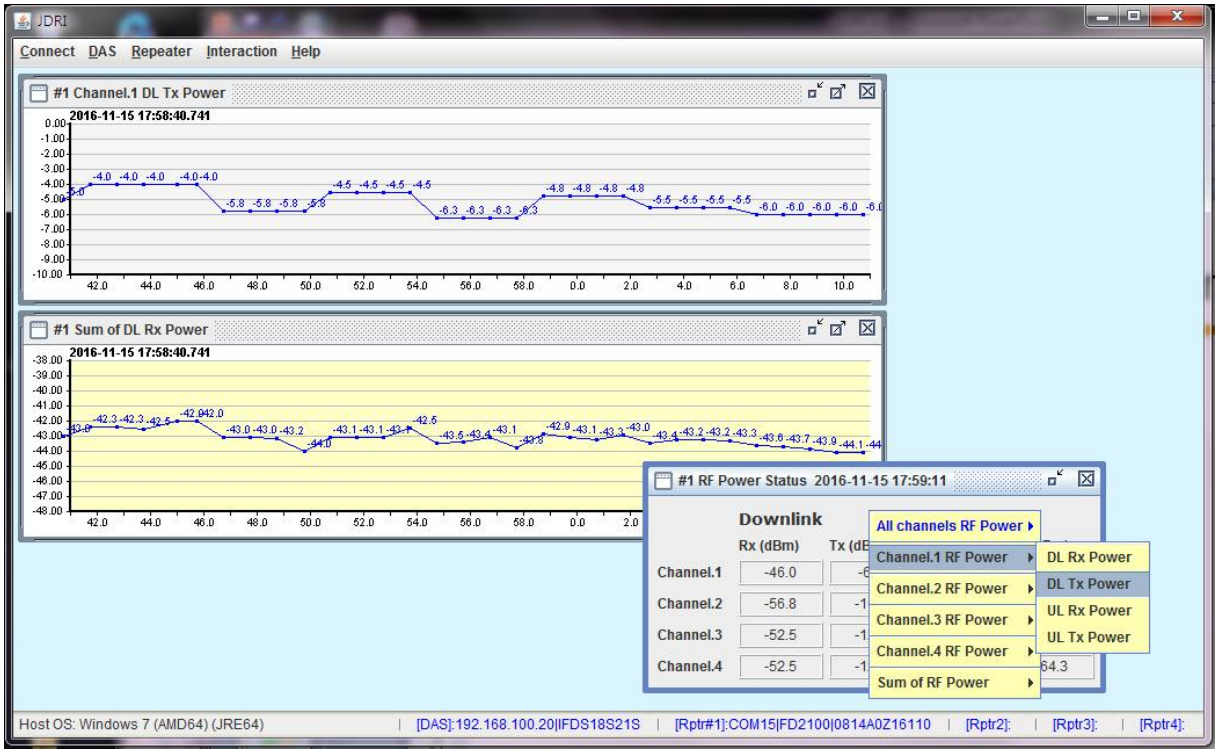
6. Outdoor Antenna Alignment

For better system performance, the outdoor antenna shall have the best alignment with the mobile base station. It is suggested that the installation person can adjust the outdoor antenna alignment and monitor "DL RX power" or "DL TX power" until all the channel in the highest power.



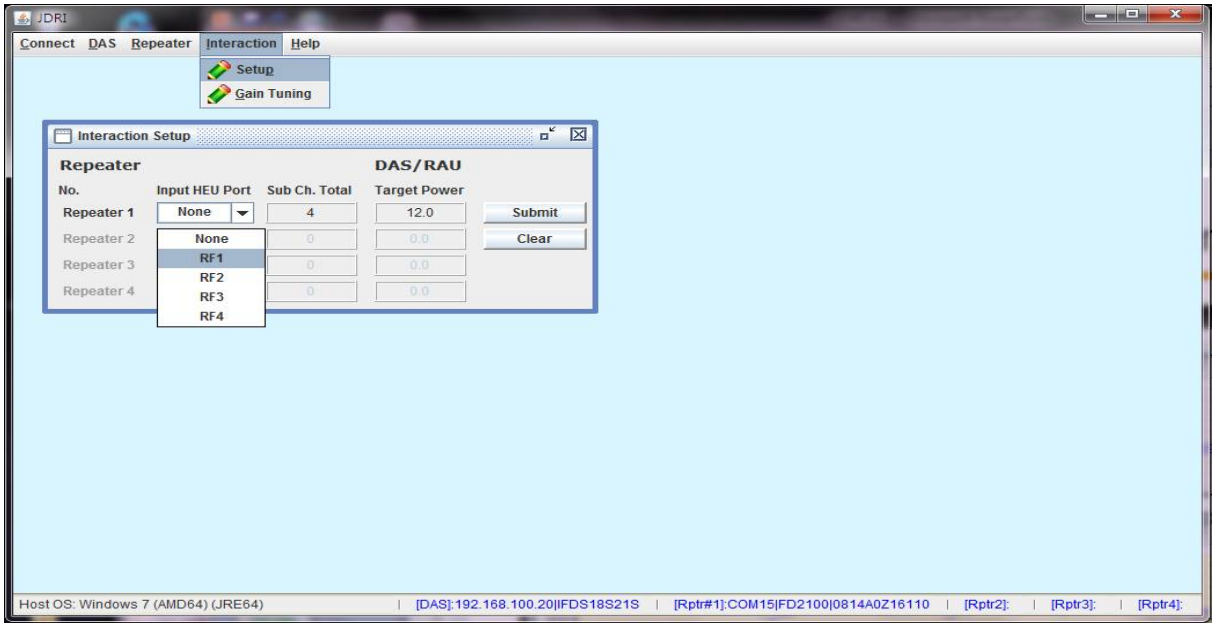
Besides, the other DL/UL TX/RX power can be monitored through the following operation:

- "DL RX power" windows can click "RF power status" windows, and select "All channels RF Power", then "DL RX power" for all channels status. The individual channel also can be retrieved accordingly.
- "DL TX power" windows can click "RF power status" windows, and select "All channels RF Power", then "DL TX power" for all channels status. The individual channel also can be retrieved accordingly.
- "UL RX power" windows can click "RF power status" windows, and select "All channels RF Power", then "UL RX power" for all channels status. The individual channel also can be retrieved accordingly.
- "UL TX power" windows can click "RF power status" windows, and select "All channels RF Power", then "UL TX power" for all channels status. The individual channel also can be retrieved accordingly.


JDRI
Connect DAS Repeater Interaction Help
#1 Channel.1 DL Tx Power
2016-11-15 17:58:40.741
#1 Sum of DL Rx Power
2016-11-15 17:58:40.741
#1 RF Power Status 2016-11-15 17:59:11
Downlink
Rx (dBm)
Channel.1 -46.0
Channel.2 -56.8
Channel.3 -52.5
Channel.4 -52.5
All channels RF Power
Channel.1 RF Power
Channel.2 RF Power
Channel.3 RF Power
Channel.4 RF Power
Sum of RF Power
DL Rx Power
DL Tx Power
UL Rx Power
UL Tx Power
Host OS: Windows 7 (AMD64) (JRE64)
[DAS]:192.168.100.20|IFDS18S21S
[Rptr#1]:COM15|FD2100|0814A0Z16110
[Rptr2]:
[Rptr3]:
[Rptr4]:

7. Interaction Gain Tuning Setup:

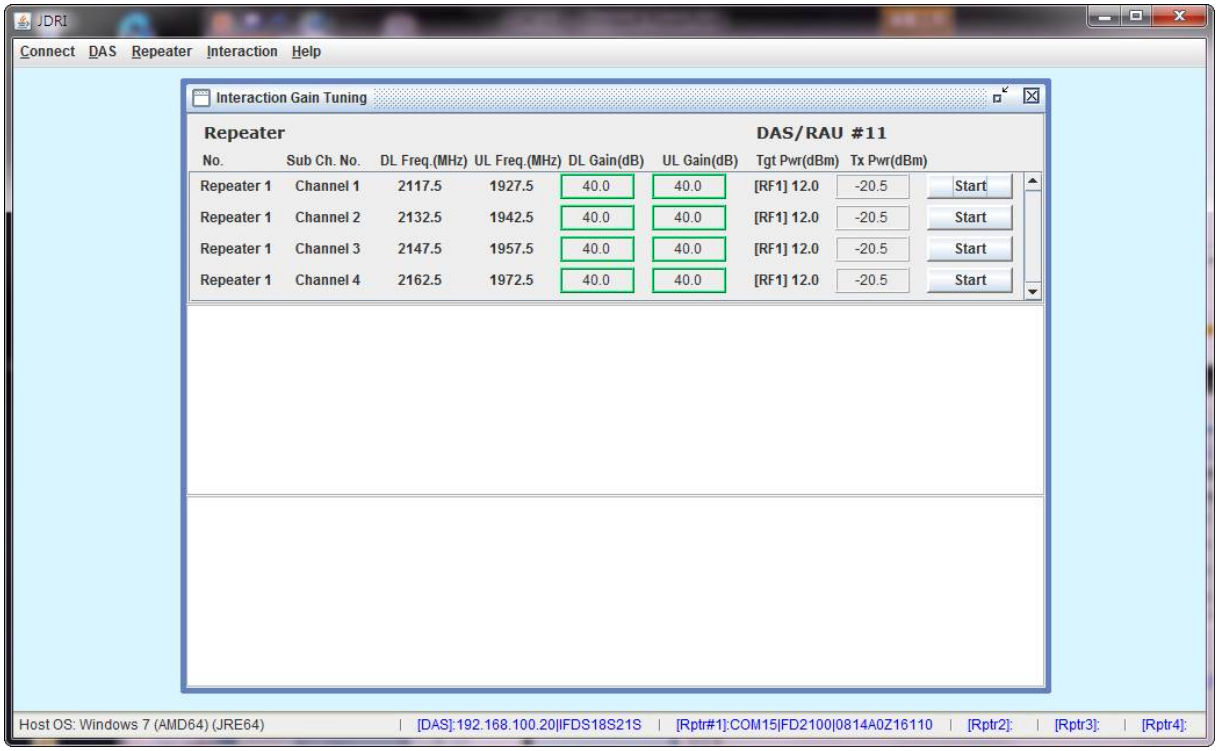
Once repeater and sDAS parameter has been corrected setup, the installation person can setup the interaction target by “Interaction” ➔ “Setup”.



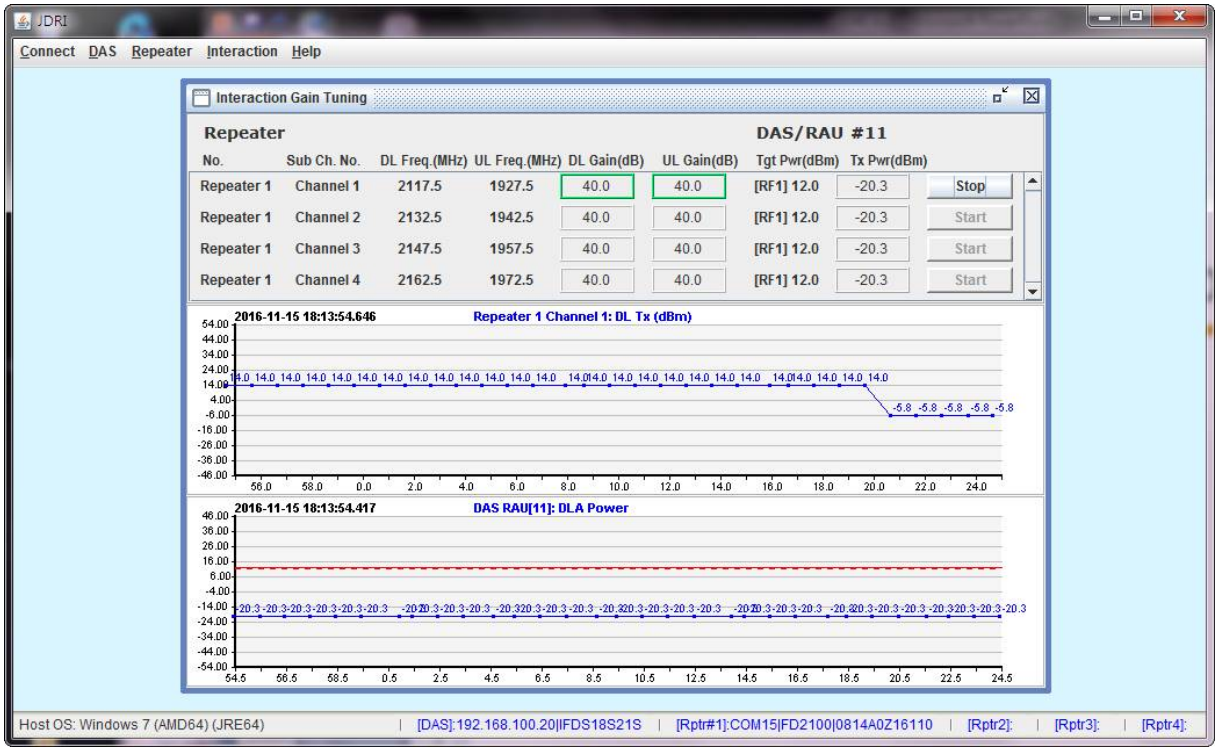
- Input HEU Port: select RF port of HEU to be setup. This option is going to setup the RF port of HEU which connected w/ the repeater. Only one HEU supported in the version, jdri_v1.3.0.
- “Sub Ch. Total”: setup the total number of sub channel
- “Target Power”: setup the target RF output power of RAU.
- “Submit”: after the setting, click “Submit” button to perform.
- “Clear”: the exactly system setting will be retrieved and displayed.

8. Interaction Gain Tuning

Once Interaction gain tuning parameter has been corrected setup, the installation person can enable the interaction gain tuning by "Interaction" ➔ "gain tuning". Then, the Java script will show the current setup and target parameters as below.

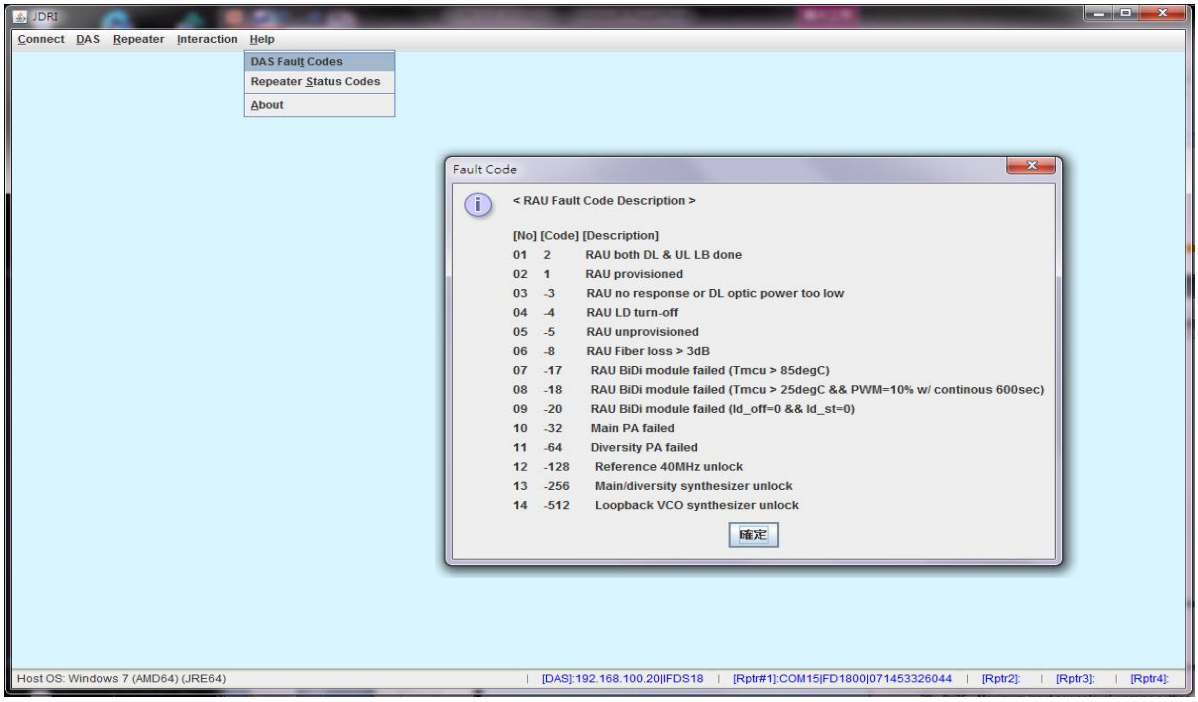


- Click "Start" button per each sub channel, the Java script automatically setup both repeater/sDAS parameters for better system performance. The GUI of this Java script will show the output power and setting relationship as below figure.
- Once exactly TX power of RAU is stable, click "Stop" button.
- All the sub channel shall be setup individually.


JDRI
Connect DAS Repeater Interaction Help
Interaction Gain Tuning
Repeater
DAS/RAU #11
No. Sub Ch. No. DL Freq.(MHz) UL Freq.(MHz) DL Gain(dB) UL Gain(dB) Tgt Pwr(dBm) Tx Pwr(dBm)
Repeater 1 Channel 1 2117.5 1927.5 40.0 40.0 [RF1] 12.0 -20.3 Stop
Repeater 1 Channel 2 2132.5 1942.5 40.0 40.0 [RF1] 12.0 -20.3 Start
Repeater 1 Channel 3 2147.5 1957.5 40.0 40.0 [RF1] 12.0 -20.3 Start
Repeater 1 Channel 4 2162.5 1972.5 40.0 40.0 [RF1] 12.0 -20.3 Start
2016-11-15 18:13:54.646
Repeater 1 Channel 1: DL Tx (dBm)
2016-11-15 18:13:54.417
DAS RAU[11]: DLA Power
Host OS: Windows 7 (AMD64) (JRE64)
[DAS]:192.168.100.20|IFDS18S21S
[Rptr#1]:COM15|FD2100|0814A0Z16110
[Rptr2]:
[Rptr3]:
[Rptr4]:

9. sDAS Error Code

Click “Help” ➔ “DAS fault Codes” for understanding the description of the error code.



10. Repeater Error Code

Click “Help” ➔ “Repeater Status Codes” for understanding the description of the error code.