The Ruckus Q710 is an indoor, ceiling or wall-mounted LTE Access Point for CBRS. Q710 offers the highest CBRS capacity available in an attractive, Enterprise-friendly design.

About the tasks/projects

Goal assigned to me was to make the process of reading FAPI (femto application platform interface) protocol message between two APs easy.

The first task for that was to convert Packet Capture file of wireshark tool in human readable file formats ie. Text or CSV(comma separated values) or JSON.

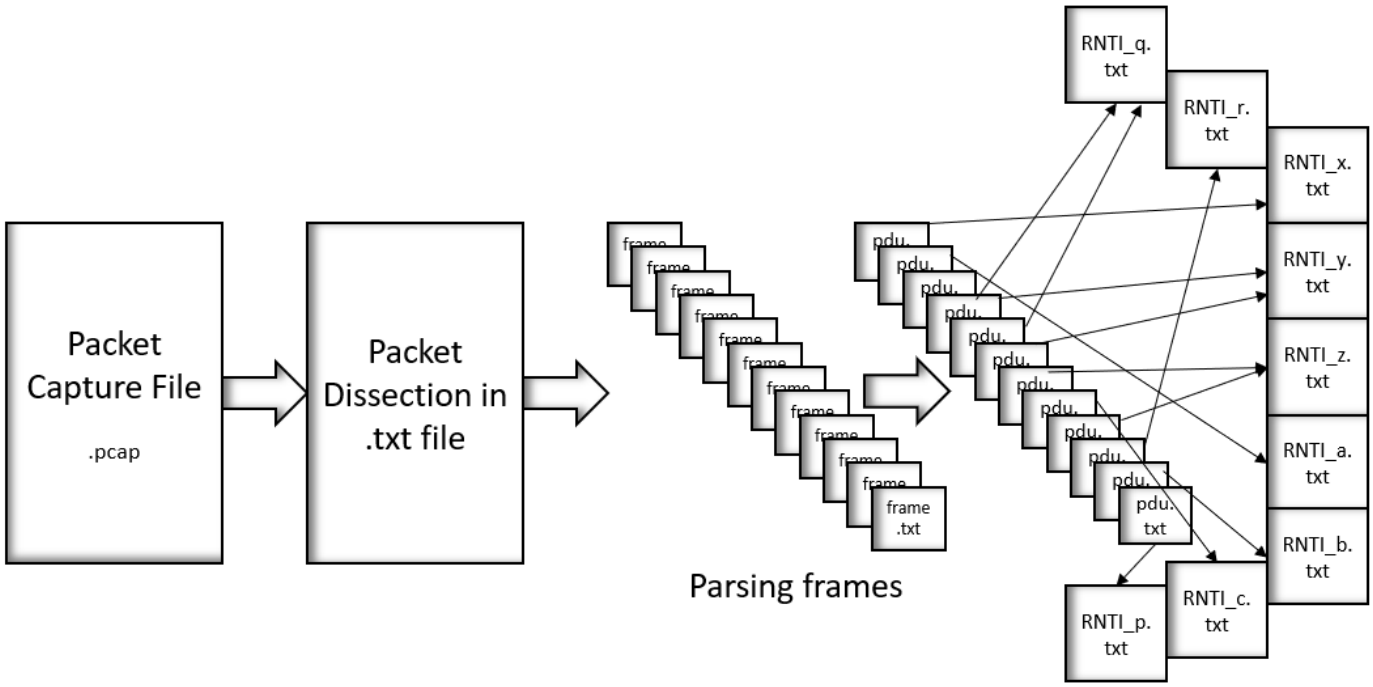
Below attached is the screenshot of FAPI protocol captured using wireshark.

```
⊞ Frame 90: 501 bytes on wire (4008 bits), 501 bytes captured (4008 bits)
⊞ Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
⊞ Internet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
⊞ User Datagram Protocol, Src Port: 0 (0), Dst Port: 65535 (65535)
⊞ PI-E Header
⊟ Message Header
    Type: FAPI_E_UL_CONFIG_REQ (0x81)
    Vend. Length: 0
    Length: 433
⊟ Message Data (FAPI_E_UL_CONFIG_REQ)
  ⊟ SFN/SF: 0x2342
      0010 0011 0100 .... = Frame: 564
      .... .... .... 0010 = Sub-frame: 2
    Length: 433
    No of PDUs: 10
    RACH Freq. Resources: 0
    SRS Present: Not Present
  ⊟ PDU[0]: (UCI_SR_HARQ)
      PDU Type: UCI_SR_HARQ (7)
      PDU Size: 48
    ⊟ UE_INFO
      ⊟ Rel 8
          Handle: 0x01b4f3bd
          RNTI: 79
      ⊟ Rel 11
          Virtual cell ID enabled flag: 0
          nPUCCH Identity: 0
      ⊟ Rel 13
          UE type: non LC/CE UE (0)
          Empty symbols due to re-tuning: 0
          Total num of repetitions: 1
          Repetition num: 1
    ⊟ UCI_SR Info
```

We can see that under message data section of FAPI message, under PDUs we get a specific value named RNTI which represent one user connected to the AP. The goal was to aggregate all FAPI message for a particular RNTI in plain text file.

For that, this assignment was divided in 3 major parts. (as shown in below attached picture)

1. First to parse all frames in different files from one capture file
2. Then parse PDUs from each frame
3. Look for RNTI in the PDU files and copy it in the respective RNTI file.



The python code was developed for this process which is attached below:

```
import re
from shutil import copyfile


def line_numbers(file_path, word_list):

    with open(file_path, 'r') as f:
        results = {word:[] for word in word_list}
        for num, line in enumerate(f, start=0):
            for word in word_list:
                if word in line:
                    results[word].append(num)
    return results


mylines=[]
with open("input1.txt",'rt') as myfile:
    for myline in myfile:
        mylines.append(myline)




import os

def get_block_range (filename, lookupValue):
    if not os.path.getsize(filename):
        return None, 0

    with open(filename, 'r') as file:
        lookup_position = None

        for num, line in enumerate(file, 1):
            if lookup_position is None and lookupValue in line:
                lookup_position = num
        return lookup_position, num


var1 = get_block_range("input1.txt",'')
word = ['Frame ']
results = line_numbers('input1.txt',word)
for word,lines in results.items():
    linum =(','.join(map(str,lines)))

linum = linum.split(',')
```

```
linum = linum.split(',')


i=0
j=0
lastpt=0
for i in range(0,len(linum)):
    firstpt=int(linum[i])
    try:
        lastpt=int(linum[i+1])
    except IndexError:
        lastpt=int(var1[1])
    for j in range(firstpt,lastpt):
        print(mylines[j],file=open("Frames/FRAME_NO_"+str(i)+".txt","a+"))

for i in range(0,len(linum)):
    q=0
    j=0
    l=0
    p=0
    Linnum=[]
    linesww=[]
    rntistring=[]
    lastlines=[]
    framestring=[]
    pdustring=[]
    var3=get_block_range("Frames/FRAME_NO_"+str(i)+".txt",'')
    with open("Frames/FRAME_NO_"+str(i)+".txt",'rt') as fileww:
        for lineww in fileww:
            linesww.append(lineww)
    with open("Frames/FRAME_NO_"+str(i)+".txt",'r+') as file:
        for linnum,line in enumerate(file,0):
            if '    PDU[' in line:
                Linnum.append(linnum)
                q+=1
    for j in range(0,int(q)):
        added_done=0
        firstpoint=int(Linnum[j])
        try:
            lastpoint=int(Linnum[j+1])
        except IndexError:
            lastpoint=int(var3[1])
        for k in range(firstpoint,lastpoint):
            if added_done == 0:
                added_done=1
                with open("Frames/FRAME_NO_"+str(i)+".txt",'r+') as filewww:
                    for l in range(int(var3[0])-1,Linnum[0]):
                        framestring=linesww[l]
                        print('\n'.join([p for p in framestring.split('\n') if len(p) > 0]),file=open("PDUs/PDU_"+str(j)+"_OF
            pdustring=linesww[k]
            print('\n'.join([p for p in pdustring.split('\n') if len(p) > 0]),file=open("PDUs/PDU_"+str(j)+"_OF_FRAME_"+str(i
            file.close()
        var4=0
        var4=get_block_range("PDUs/PDU_"+str(j)+"_OF_FRAME_"+str(i)+".txt",'')
        with open("PDUs/PDU_"+str(j)+"_OF_FRAME_"+str(i)+".txt","r+") as lastfile:
            for lastlinenum,lastline in enumerate(lastfile,0):
                if '            RNTI: ' in lastline:
                    rntistring=lastline
                    w=0
                    w=int(re.search(r'\d+',rntistring).group())
                    #print(w)
                    oldfile=open("PDUs/PDU_"+str(j)+"_OF_FRAME_"+str(i)+".txt","r+")
                    newfile=open("RNTIs/RNTI_"+str(w)+".txt",'a+')
                    newfile.write(oldfile.read())
                    oldfile.close()
                    newfile.close()
```

The above shown code gives results as such:

The output to parse frames is as such:

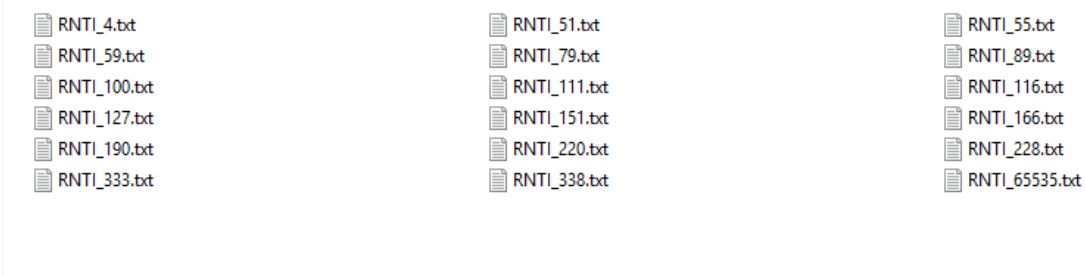
FRAME_NO_0.txt	FRAME_NO_23.txt	FRAME_NO_46.txt	FRAME_NO_69.txt	FRAME_NO_92.txt	FRAME_NO_115.txt	FRAME
FRAME_NO_1.txt	FRAME_NO_24.txt	FRAME_NO_47.txt	FRAME_NO_70.txt	FRAME_NO_93.txt	FRAME_NO_116.txt	FRAME
FRAME_NO_2.txt	FRAME_NO_25.txt	FRAME_NO_48.txt	FRAME_NO_71.txt	FRAME_NO_94.txt	FRAME_NO_117.txt	FRAME
FRAME_NO_3.txt	FRAME_NO_26.txt	FRAME_NO_49.txt	FRAME_NO_72.txt	FRAME_NO_95.txt	FRAME_NO_118.txt	FRAME
FRAME_NO_4.txt	FRAME_NO_27.txt	FRAME_NO_50.txt	FRAME_NO_73.txt	FRAME_NO_96.txt	FRAME_NO_119.txt	FRAME
FRAME_NO_5.txt	FRAME_NO_28.txt	FRAME_NO_51.txt	FRAME_NO_74.txt	FRAME_NO_97.txt	FRAME_NO_120.txt	FRAME
FRAME_NO_6.txt	FRAME_NO_29.txt	FRAME_NO_52.txt	FRAME_NO_75.txt	FRAME_NO_98.txt	FRAME_NO_121.txt	FRAME
FRAME_NO_7.txt	FRAME_NO_30.txt	FRAME_NO_53.txt	FRAME_NO_76.txt	FRAME_NO_99.txt	FRAME_NO_122.txt	FRAME
FRAME_NO_8.txt	FRAME_NO_31.txt	FRAME_NO_54.txt	FRAME_NO_77.txt	FRAME_NO_100.txt	FRAME_NO_123.txt	FRAME
FRAME_NO_9.txt	FRAME_NO_32.txt	FRAME_NO_55.txt	FRAME_NO_78.txt	FRAME_NO_101.txt	FRAME_NO_124.txt	FRAME
FRAME_NO_10.txt	FRAME_NO_33.txt	FRAME_NO_56.txt	FRAME_NO_79.txt	FRAME_NO_102.txt	FRAME_NO_125.txt	FRAME
FRAME_NO_11.txt	FRAME_NO_34.txt	FRAME_NO_57.txt	FRAME_NO_80.txt	FRAME_NO_103.txt	FRAME_NO_126.txt	FRAME
FRAME_NO_12.txt	FRAME_NO_35.txt	FRAME_NO_58.txt	FRAME_NO_81.txt	FRAME_NO_104.txt	FRAME_NO_127.txt	FRAME
FRAME_NO_13.txt	FRAME_NO_36.txt	FRAME_NO_59.txt	FRAME_NO_82.txt	FRAME_NO_105.txt	FRAME_NO_128.txt	FRAME
FRAME_NO_14.txt	FRAME_NO_37.txt	FRAME_NO_60.txt	FRAME_NO_83.txt	FRAME_NO_106.txt	FRAME_NO_129.txt	FRAME
FRAME_NO_15.txt	FRAME_NO_38.txt	FRAME_NO_61.txt	FRAME_NO_84.txt	FRAME_NO_107.txt	FRAME_NO_130.txt	FRAME
FRAME_NO_16.txt	FRAME_NO_39.txt	FRAME_NO_62.txt	FRAME_NO_85.txt	FRAME_NO_108.txt	FRAME_NO_131.txt	FRAME
FRAME_NO_17.txt	FRAME_NO_40.txt	FRAME_NO_63.txt	FRAME_NO_86.txt	FRAME_NO_109.txt	FRAME_NO_132.txt	FRAME
FRAME_NO_18.txt	FRAME_NO_41.txt	FRAME_NO_64.txt	FRAME_NO_87.txt	FRAME_NO_110.txt	FRAME_NO_133.txt	FRAME
FRAME_NO_19.txt	FRAME_NO_42.txt	FRAME_NO_65.txt	FRAME_NO_88.txt	FRAME_NO_111.txt	FRAME_NO_134.txt	FRAME
FRAME_NO_20.txt	FRAME_NO_43.txt	FRAME_NO_66.txt	FRAME_NO_89.txt	FRAME_NO_112.txt	FRAME_NO_135.txt	FRAME
FRAME_NO_21.txt	FRAME_NO_44.txt	FRAME_NO_67.txt	FRAME_NO_90.txt	FRAME_NO_113.txt	FRAME_NO_136.txt	FRAME

All these files have particular one frame in it which has different FAPI messages.

These frames now get separated on the bases of PDUs, which is attached below:

PDU_0_OF_FRAME_989.txt	PDU_0_OF_FRAME_1012.txt	PDU_0_OF_FRAME_1035.txt	PDU_0_OF_FRAME_1058.txt	PDU_1_OF_FRAME_6.txt	PDU_1_OF_
PDU_0_OF_FRAME_990.txt	PDU_0_OF_FRAME_1013.txt	PDU_0_OF_FRAME_1036.txt	PDU_0_OF_FRAME_1059.txt	PDU_1_OF_FRAME_7.txt	PDU_1_OF_
PDU_0_OF_FRAME_991.txt	PDU_0_OF_FRAME_1014.txt	PDU_0_OF_FRAME_1037.txt	PDU_0_OF_FRAME_1060.txt	PDU_1_OF_FRAME_8.txt	PDU_1_OF_
PDU_0_OF_FRAME_992.txt	PDU_0_OF_FRAME_1015.txt	PDU_0_OF_FRAME_1038.txt	PDU_0_OF_FRAME_1061.txt	PDU_1_OF_FRAME_9.txt	PDU_1_OF_
PDU_0_OF_FRAME_993.txt	PDU_0_OF_FRAME_1016.txt	PDU_0_OF_FRAME_1039.txt	PDU_0_OF_FRAME_1062.txt	PDU_1_OF_FRAME_10.txt	PDU_1_OF_
PDU_0_OF_FRAME_994.txt	PDU_0_OF_FRAME_1017.txt	PDU_0_OF_FRAME_1040.txt	PDU_0_OF_FRAME_1063.txt	PDU_1_OF_FRAME_11.txt	PDU_1_OF_
PDU_0_OF_FRAME_995.txt	PDU_0_OF_FRAME_1018.txt	PDU_0_OF_FRAME_1041.txt	PDU_0_OF_FRAME_1064.txt	PDU_1_OF_FRAME_12.txt	PDU_1_OF_
PDU_0_OF_FRAME_996.txt	PDU_0_OF_FRAME_1019.txt	PDU_0_OF_FRAME_1042.txt	PDU_0_OF_FRAME_1065.txt	PDU_1_OF_FRAME_13.txt	PDU_1_OF_
PDU_0_OF_FRAME_997.txt	PDU_0_OF_FRAME_1020.txt	PDU_0_OF_FRAME_1043.txt	PDU_0_OF_FRAME_1066.txt	PDU_1_OF_FRAME_14.txt	PDU_1_OF_
PDU_0_OF_FRAME_998.txt	PDU_0_OF_FRAME_1021.txt	PDU_0_OF_FRAME_1044.txt	PDU_0_OF_FRAME_1067.txt	PDU_1_OF_FRAME_15.txt	PDU_1_OF_
PDU_0_OF_FRAME_999.txt	PDU_0_OF_FRAME_1022.txt	PDU_0_OF_FRAME_1045.txt	PDU_0_OF_FRAME_1068.txt	PDU_1_OF_FRAME_16.txt	PDU_1_OF_
PDU_0_OF_FRAME_1000.txt	PDU_0_OF_FRAME_1023.txt	PDU_0_OF_FRAME_1046.txt	PDU_0_OF_FRAME_1069.txt	PDU_1_OF_FRAME_17.txt	PDU_1_OF_
PDU_0_OF_FRAME_1001.txt	PDU_0_OF_FRAME_1024.txt	PDU_0_OF_FRAME_1047.txt	PDU_0_OF_FRAME_1070.txt	PDU_1_OF_FRAME_18.txt	PDU_1_OF_
PDU_0_OF_FRAME_1002.txt	PDU_0_OF_FRAME_1025.txt	PDU_0_OF_FRAME_1048.txt	PDU_0_OF_FRAME_1071.txt	PDU_1_OF_FRAME_19.txt	PDU_1_OF_
PDU_0_OF_FRAME_1003.txt	PDU_0_OF_FRAME_1026.txt	PDU_0_OF_FRAME_1049.txt	PDU_0_OF_FRAME_1072.txt	PDU_1_OF_FRAME_20.txt	PDU_1_OF_
PDU_0_OF_FRAME_1004.txt	PDU_0_OF_FRAME_1027.txt	PDU_0_OF_FRAME_1050.txt	PDU_0_OF_FRAME_1073.txt	PDU_1_OF_FRAME_21.txt	PDU_1_OF_
PDU_0_OF_FRAME_1005.txt	PDU_0_OF_FRAME_1028.txt	PDU_0_OF_FRAME_1051.txt	PDU_0_OF_FRAME_1074.txt	PDU_1_OF_FRAME_22.txt	PDU_1_OF_
PDU_0_OF_FRAME_1006.txt	PDU_0_OF_FRAME_1029.txt	PDU_0_OF_FRAME_1052.txt	PDU_1_OF_FRAME_0.txt	PDU_1_OF_FRAME_23.txt	PDU_1_OF_
PDU_0_OF_FRAME_1007.txt	PDU_0_OF_FRAME_1030.txt	PDU_0_OF_FRAME_1053.txt	PDU_1_OF_FRAME_1.txt	PDU_1_OF_FRAME_24.txt	PDU_1_OF_
PDU_0_OF_FRAME_1008.txt	PDU_0_OF_FRAME_1031.txt	PDU_0_OF_FRAME_1054.txt	PDU_1_OF_FRAME_2.txt	PDU_1_OF_FRAME_25.txt	PDU_1_OF_
PDU_0_OF_FRAME_1009.txt	PDU_0_OF_FRAME_1032.txt	PDU_0_OF_FRAME_1055.txt	PDU_1_OF_FRAME_3.txt	PDU_1_OF_FRAME_26.txt	PDU_1_OF_
PDU_0_OF_FRAME_1010.txt	PDU_0_OF_FRAME_1033.txt	PDU_0_OF_FRAME_1056.txt	PDU_1_OF_FRAME_4.txt	PDU_1_OF_FRAME_27.txt	PDU_1_OF_

And the final output will be like:



Now this RNTI files have the information like message header + PDU which has that particular RNTI in it.

Which looks as follows:

```
Frame 7: 237 bytes on wire (1896 bits), 237 bytes captured (1896 bits)
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
User Datagram Protocol, Src Port: 0 (0), Dst Port: 65535 (65535)
Message Header
    Type: FAPI_E_HARQ_IND (0x85)
    Vend. Length: 60
    Length: 109
Message Data (FAPI_E_HARQ_IND)
    SFN/SF: 0x2328
        0010 0011 0010 .... = Frame: 562
        .... .... .... 1000 = Sub-frame: 8
    No of HARQ PDUs: 7
    PDU[0]
        RX UE_INFO
            Handle: 0x3ce7f180
            RNTI: 127
        ACK/NACK Mode: Format 4 (3)
        No of ACK/NACKs: 4
            HARQ_TB_0 : ACK (1)
            HARQ_TB_1 : ACK (1)
            HARQ_TB_2 : ACK (1)
            HARQ_TB_3 : NACK (2)
        UL CQI Info
            UL_CQI [dB]: 12
            Channel: PUSCH (1)
Frame 10: 1192 bytes on wire (9536 bits), 1192 bytes captured (9536 bits)
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
nternet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
User Datagram Protocol, Src Port: 0 (0), Dst Port: 65535 (65535)
Message Header
    Type: FAPI_E_DL_CONFIG_REQ (0x80)
    Vend. Length: 0
    Length: 1124
Message Data (FAPI_E_DL_CONFIG_REQ)
    SFN/SF: 0x2331
        0010 0011 0011 .... = Frame: 563
        .... .... .... 0001 = Sub-frame: 1
    Length: 1124
    No of PDCCH Symbols: 2
    No of DCI PDUs: 7
    No of PDUs: 20
    No of PDSCH RNTIs: 7
    PCFICH Boost: 0
    PDU[12]: (DL DCI, RNTI = 127)
        PDU Type: DCI_DL_PDU (0)
        PDU Size: 55
        Rel 8
            DCI Format: 1A (1)
            CCE Index: 42
            Aggregation Level: 2
            RNTI: 127
```