In [4]:
```
import pandas as pd

df = pd.read_csv('RT_IOT2022.csv')
df.fillna(0)
df['Attack_type'].value_counts()
```

Out[4]:
```
Attack_type
DOS_SYN_Hping                 94659
Thing_Speak                    8108
ARP_poisioning                 7750
MQTT_Publish                   4146
NMAP_UDP_SCAN                  2590
NMAP_XMAS_TREE_SCAN            2010
NMAP_OS_DETECTION              2000
NMAP_TCP_scan                  1002
DDOS_Slowloris                  534
Wipro_bulb                      253
Metasploit_Brute_Force_SSH       37
NMAP_FIN_SCAN                    28
Name: count, dtype: int64
```

In [5]:
```
# creation of new data in order to keep the original and also to get the coloumns to use later on.
# renaming data so that the words look more better

data = df[['Attack_type',
           'proto',
           'service',
           'flow_SYN_flag_count',
           'flow_RST_flag_count',
           'fwd_PSH_flag_count',
          ]]

data.rename(columns={
           'proto': 'Protocol',
           'service': 'Service',
           'flow_SYN_flag_count': 'SYN_flag_count',
           'flow_RST_flag_count': 'RST_flag_count',
           'fwd_PSH_flag_count': 'PSH_flag_count'
            }, inplace=True)
```

```
C:\Users\TIPQC\AppData\Local\Temp\ipykernel_45112\268323312.py:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  data.rename(columns={
```

In [6]:
```
data['Attack_type'].value_counts()
```

Out[6]:
```
Attack_type
DOS_SYN_Hping                 94659
Thing_Speak                    8108
ARP_poisioning                 7750
MQTT_Publish                   4146
NMAP_UDP_SCAN                  2590
NMAP_XMAS_TREE_SCAN            2010
NMAP_OS_DETECTION              2000
NMAP_TCP_scan                  1002
DDOS_Slowloris                  534
Wipro_bulb                      253
Metasploit_Brute_Force_SSH       37
NMAP_FIN_SCAN                    28
Name: count, dtype: int64
```

What is the distribution of the Attack_type classes (normal vs. various attacks), and what percentage of the 123,117 instances does each class comprise?

In [7]:
```
# to check each names. i get the names of each attack type and i have placed it inside a list because i might use it
names = data.Attack_type.unique()[:12]
new_list = []
for i in names:
 new_list.append(i)

print(new_list)
```

```
['MQTT_Publish', 'Thing_Speak', 'Wipro_bulb', 'ARP_poisioning', 'DDOS_Slowloris', 'DOS_SYN_Hping', 'Metasploit_Brute_
Force_SSH', 'NMAP_FIN_SCAN', 'NMAP_OS_DETECTION', 'NMAP_TCP_scan', 'NMAP_UDP_SCAN', 'NMAP_XMAS_TREE_SCAN']
```

In [8]:
```
#checking of name
check_name = (data['Attack_type'] == 'Thing_Speak').sum()
check_name
```

Out[8]: 8108

In [9]:
```
# write the various and normal attack types into a seperate lists.
various = [
    'DOS_SYN_Hping',
    'ARP_poisioning',
    'NMAP_UDP_SCAN',
    'NMAP_XMAS_TREE_SCAN',
    'NMAP_OS_DETECTION',
    'NMAP_TCP_scan',
    'DDOS_Slowloris',
    'Metasploit_Brute_Force_SSH',
    'NMAP_FIN_SCAN'
]

normal = [
    'MQTT_Publish',
    'Thing_Speak',
    'Wipro_bulb'
]
```

In [10]:
```
# use of basic addition for loop of each name
v_count = 0
for i in various:
    v_add = (data['Attack_type'] == i ).sum()
    v_count = v_count + v_add

print(v_count)
```

```
110610
```

In [11]:
```
# i have only copied the last block of code since i always get error if i turned it into a function
n_count = 0
for i in normal:
    n_add = (data['Attack_type'] == i ).sum()
    n_count = n_count + n_add

print(n_count)
```

```
12507
```

In [12]:
```
# this block of code is for output and i also included percentage conversion.
v_per = 100 * v_count / data['Attack_type'].value_counts().sum()
n_per = 100 * n_count / data['Attack_type'].value_counts().sum()

print(f'Counts of normal attacks: {n_count} {n_per:.2f}%\nCounts of various attacks: {v_count} {v_per:.2f}%')
```

```
Counts of normal attacks: 12507 10.16%
Counts of various attacks: 110610 89.84%
```

In [13]:
```
#use of value_counts to count the values inside the column and then multiplied to 100 to output as standard numerical
attack_type_percentage = data['Attack_type'].value_counts(normalize= True) * 100

#use of apply with lambda to manipulate output as 2 decimals with a '%' string.
portions = attack_type_percentage.apply(lambda x: f'{x:.2f}%')
portions
```

Out[13]:
```
Attack_type
DOS_SYN_Hping                 76.89%
Thing_Speak                    6.59%
ARP_poisioning                 6.29%
MQTT_Publish                   3.37%
NMAP_UDP_SCAN                  2.10%
NMAP_XMAS_TREE_SCAN            1.63%
NMAP_OS_DETECTION              1.62%
NMAP_TCP_scan                  0.81%
DDOS_Slowloris                 0.43%
Wipro_bulb                     0.21%
Metasploit_Brute_Force_SSH     0.03%
NMAP_FIN_SCAN                  0.02%
Name: proportion, dtype: object
```

How do the categorical features proto (protocol) and service vary across different attack types and normal traffic patterns?

In [14]:
```
# recalling the new dataframe so I wont repeat scroll up too far back again and again.
data.head(3)
```

Out[14]:

	Attack_type	Protocol	Service	SYN_flag_count	RST_flag_count	PSH_flag_count
0	MQTT_Publish	tcp	mqtt	2	1	3
1	MQTT_Publish	tcp	mqtt	2	1	3
2	MQTT_Publish	tcp	mqtt	2	1	3

In [15]:
```
# checking unique existing values
data['Protocol'].unique()
```

Out[15]:
```
array(['tcp', 'udp', 'icmp'], dtype=object)
```

In [16]:
```
# checking unique existing values
data['Service'].unique()
```

Out[16]:
```
array(['mqtt', '-', 'http', 'dns', 'ntp', 'ssl', 'dhcp', 'irc', 'ssh',
       'radius'], dtype=object)
```

In [17]:
```
#storing the filtered data by the use of isin to get specific values. (top 3 common attack)

common = data[(df['Attack_type'].isin(['DOS_SYN_Hping','Thing_Speak','ARP_poisioning']))]
common
```

Out[17]:

	Attack_type	Protocol	Service	SYN_flag_count	RST_flag_count	PSH_flag_count
4146	Thing_Speak	tcp	http	2	0	2
4147	Thing_Speak	udp	dns	0	0	0
4148	Thing_Speak	tcp	http	2	0	2
4149	Thing_Speak	udp	dns	0	0	0
4150	Thing_Speak	tcp	http	2	0	2
...	...	...	...	...	...	...
115445	DOS_SYN_Hping	tcp	-	1	0	0
115446	DOS_SYN_Hping	tcp	-	1	0	0
115447	DOS_SYN_Hping	tcp	-	1	0	0
115448	DOS_SYN_Hping	tcp	-	1	0	0
115449	DOS_SYN_Hping	tcp	-	1	0	0

110517 rows × 6 columns

In [18]:

```
#storing the filtered data by the use of isin to get specific values. (uncommon attacks)

uncommon = data[(df['Attack_type'].isin([
          'MQTT_Publish',
          'NMAP_UDP_SCAN',
          'NMAP_XMAS_TREE_SCAN',
          'NMAP_OS_DETECTION',
          'NMAP_TCP_scan',
          'DDOS_Slowloris',
          'Wipro_bulb',
          'Metasploit_Brute_Force_SSH',
          'NMAP_FIN_SCAN'
]))]
uncommon
```

Out[18]:

	Attack_type	Protocol	Service	SYN_flag_count	RST_flag_count	PSH_flag_count
0	MQTT_Publish	tcp	mqtt	2	1	3
1	MQTT_Publish	tcp	mqtt	2	1	3
2	MQTT_Publish	tcp	mqtt	2	1	3
3	MQTT_Publish	tcp	mqtt	2	1	3
4	MQTT_Publish	tcp	mqtt	2	1	3
...	...	...	...	...	...	...
123112	NMAP_XMAS_TREE_SCAN	tcp	-	0	1	1
123113	NMAP_XMAS_TREE_SCAN	tcp	-	0	1	1
123114	NMAP_XMAS_TREE_SCAN	tcp	-	0	1	1
123115	NMAP_XMAS_TREE_SCAN	tcp	-	0	1	1
123116	NMAP_XMAS_TREE_SCAN	tcp	-	0	1	1

12600 rows × 6 columns

In [19]:

```
'''
Using of groupby to filter the columns to display then followed by size function to count the values.
I used reset index in order to reformat the output as well as displaying the counts of each protocols and service use
'''

ps_counts = common.groupby(['Attack_type', 'Protocol', 'Service']).size().reset_index(name='count')
ps_counts

# it displays combinations
```

Out[19]:

	Attack_type	Protocol	Service	count
0	ARP_poisioning	icmp	-	8
1	ARP_poisioning	tcp	-	214
2	ARP_poisioning	tcp	dns	125
3	ARP_poisioning	tcp	http	129
4	ARP_poisioning	tcp	ssl	1459
5	ARP_poisioning	udp	-	324
6	ARP_poisioning	udp	dhcp	26
7	ARP_poisioning	udp	dns	5458
8	ARP_poisioning	udp	ntp	7
9	DOS_SYN_Hping	tcp	-	94659
10	Thing_Speak	icmp	-	45
11	Thing_Speak	tcp	-	14
12	Thing_Speak	tcp	dns	1
13	Thing_Speak	tcp	http	2667
14	Thing_Speak	tcp	ssl	1097
15	Thing_Speak	udp	-	92
16	Thing_Speak	udp	dhcp	14
17	Thing_Speak	udp	dns	4068
18	Thing_Speak	udp	ntp	110

In [20]:

```
#checking to see if some data were not read
ps_counts['count'].sum()
```

Out[20]: 110517

Which network flag counts (e.g., flow_SYN_flag_count, flow_RST_flag_count, fwd_PSH_flag_count) are most indicative of specific intrusion patterns?

In [21]:
```
# similar to the previous code but for the count of each flags in each top 3 common attack types.
f_counts = common.groupby('Attack_type')[['SYN_flag_count', 'RST_flag_count', 'PSH_flag_count']].sum().reset_index()
f_counts
```

Out[21]:

	Attack_type	SYN_flag_count	RST_flag_count	PSH_flag_count
0	ARP_poisioning	3786	1324	15142
1	DOS_SYN_Hping	94659	84969	0
2	Thing_Speak	7571	2046	8978

Visualization

In [22]:
```
import matplotlib.pyplot as plt
import numpy as np
```

In [28]:
```
# renaming of values inside the attack type of the newly created dataframe for top 3 common attack types

ex_top = common['Attack_type'].replace([
          'MQTT_Publish',
          'NMAP_UDP_SCAN',
          'NMAP_XMAS_TREE_SCAN',
          'NMAP_OS_DETECTION',
          'NMAP_TCP_scan',
          'DDOS_Slowloris',
          'Wipro_bulb',
          'Metasploit_Brute_Force_SSH',
          'NMAP_FIN_SCAN'
], 'Other',inplace=True)
```

```
C:\Users\TIPQC\AppData\Local\Temp\ipykernel_45112\1262206874.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  ex_top = common['Attack_type'].replace([
```

In [29]:
```
common
```

Out[29]:

	Attack_type	Protocol	Service	SYN_flag_count	RST_flag_count	PSH_flag_count
4146	Thing_Speak	tcp	http	2	0	2
4147	Thing_Speak	udp	dns	0	0	0
4148	Thing_Speak	tcp	http	2	0	2
4149	Thing_Speak	udp	dns	0	0	0
4150	Thing_Speak	tcp	http	2	0	2
...	...	...	...	...	...	...
115445	DOS_SYN_Hping	tcp	-	1	0	0
115446	DOS_SYN_Hping	tcp	-	1	0	0
115447	DOS_SYN_Hping	tcp	-	1	0	0
115448	DOS_SYN_Hping	tcp	-	1	0	0
115449	DOS_SYN_Hping	tcp	-	1	0	0

110517 rows × 6 columns

In [30]:
```
pd.DataFrame({'Attack_type': 'Other', 'count': [int(uncommon['Attack_type'].count())]}).reset_index()
```

Out[30]:

	index	Attack_type	count
0	0	Other	12600

In [31]:
```
# combining of values since the newly created data of top 3 common attack types and the excluded got seperated
top_percentage = common['Attack_type'].value_counts().reset_index()
top_percentage = pd.concat([top_percentage, pd.DataFrame({'Attack_type': 'Other', 'count': [int(uncommon['Attack_type
top_percentage
```

Out[31]:

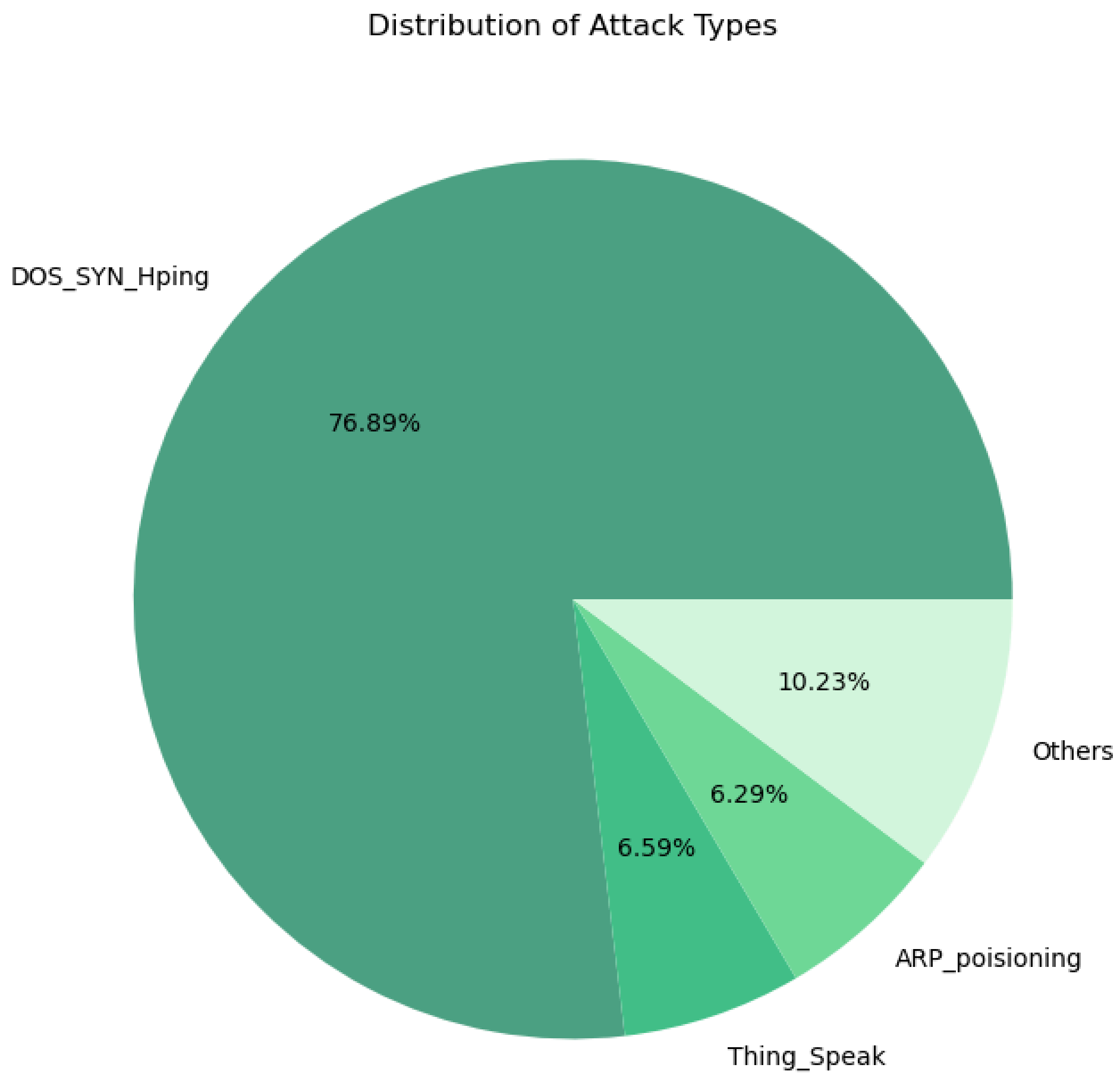
	level_0	Attack_type	count	index
0	0	DOS_SYN_Hping	94659	NaN
1	1	Thing_Speak	8108	NaN
2	2	ARP_poisioning	7750	NaN
3	0	Other	12600	0.0

In [32]:
```
labels = ['DOS_SYN_Hping',
          'Thing_Speak',
          'ARP_poisioning',
          'Others',
         ]

sizes = top_percentage['count']

fig, ax = plt.subplots(figsize = (10,8))
ax.pie(sizes, colors=['#4FA486','#44C28A', '#6FD89A', '#D4F8DE'], labels=labels, autopct='%1.2f%%')

plt.title('Distribution of Attack Types')
plt.show()
```

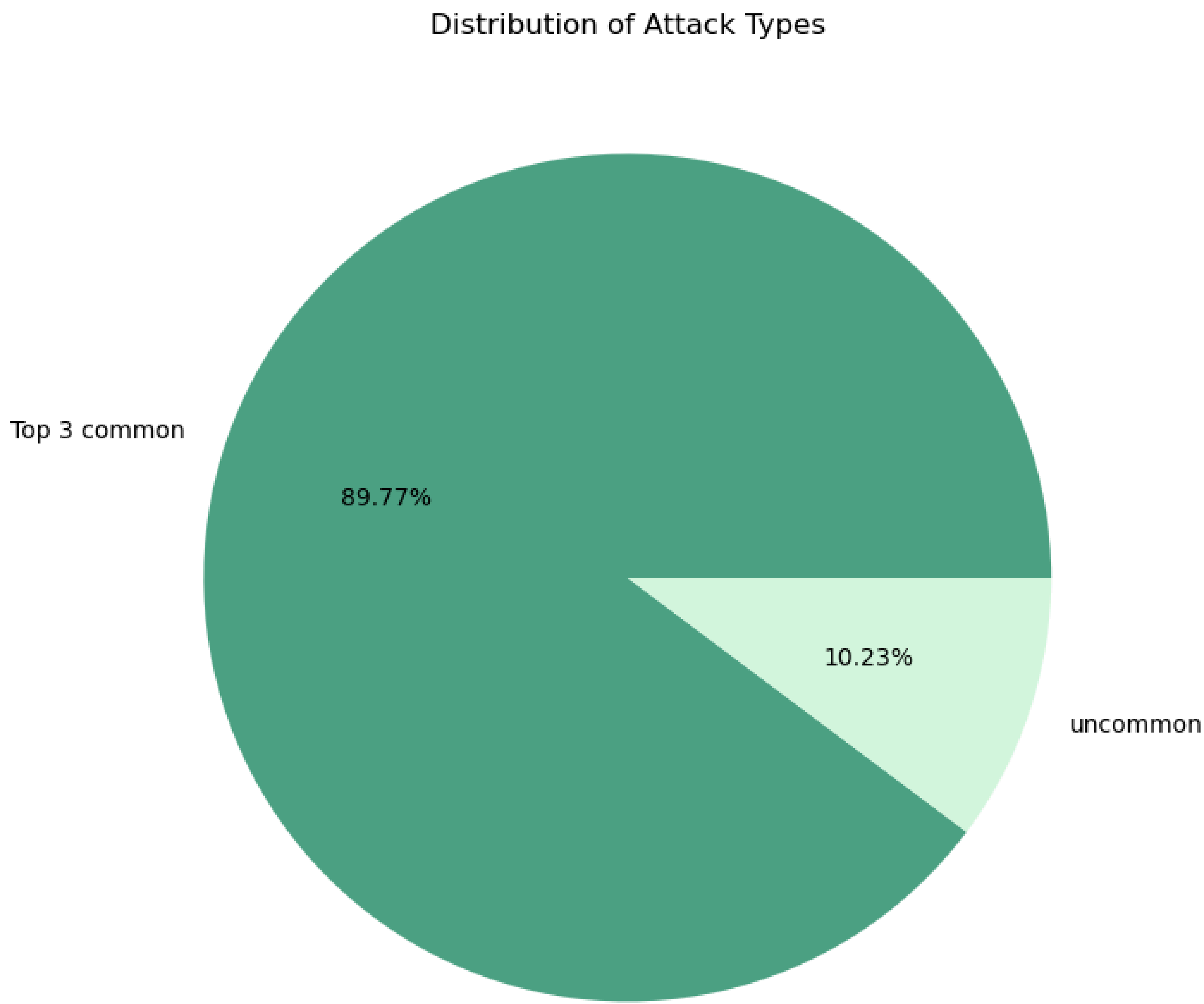


In [33]:
```
labels = ['Top 3 common','uncommon']
```

```
sizes = [common.Attack_type.count(), uncommon.Attack_type.count()]

fig, ax = plt.subplots(figsize = (10,8))
ax.pie(sizes, colors=['#4FA486', '#D4F8DE'], labels=labels, autopct='%1.2f%%')

plt.title('Distribution of Attack Types')
plt.show()
```



In [34]:
```
f_counts
```

Out[34]:

	Attack_type	SYN_flag_count	RST_flag_count	PSH_flag_count
0	ARP_poisioning	3786	1324	15142
1	DOS_SYN_Hping	94659	84969	0
2	Thing_Speak	7571	2046	8978

In [35]:

```
# initialize reusable variable
attack = f_counts['Attack_type']
syn_flag = f_counts['SYN_flag_count']
rst_flag = f_counts['RST_flag_count']
psh_flag = f_counts['PSH_flag_count']
```

In [36]:

```
#use of fig and ax as a variable for subplots in order to customize the desired output and to prevent overlapping tex

fig, ax = plt.subplots(1, 3, figsize=(12, 6))

# SYN Plot
ax[0].bar(attack, syn_flag, color='#4FA486')
ax[0].set_title('Synchronize Flag Counts')
ax[0].set_xlabel('Attack Type')
ax[0].set_ylabel('Counts')
ax[0].tick_params(axis='x', rotation=45, labelsize=10)

# RST Plot
ax[1].bar(attack, rst_flag, color='#4FA486')
ax[1].set_title('Reset Flag Counts')
ax[1].set_xlabel('Attack Type')
ax[1].set_ylabel('Counts')
ax[1].tick_params(axis='x', rotation=45, labelsize=10)

# PSH Plot
ax[2].bar(attack, psh_flag, color='#4FA486')
ax[2].set_title('Push Flag Counts')
ax[2].set_xlabel('Attack Type')
ax[2].set_ylabel('Counts')
ax[2].tick_params(axis='x', rotation=45, labelsize=10)

# use of tight layout to compress while not overlapping texts.
```

```
plt.tight_layout()
plt.show()
```