

instances_generator

April 24, 2024

```
[ ]: import networkx as nx
import matplotlib.pyplot as plt
import random
```

```
[ ]: # create a graph with a random number of nodes and edges
```

```
G = nx.DiGraph()

for i in range(1,7):
    G.add_node(i)

G.add_edge(1,2)
G.add_edge(2,3)
G.add_edge(3,4)
G.add_edge(4,5)
G.add_edge(5,6)

print(G.nodes())
print(G.edges())
```

```
[1, 2, 3, 4, 5, 6]
[(1, 2), (2, 3), (3, 4), (4, 5), (5, 6)]
```

```
[ ]: for i, (u, v) in enumerate(G.edges()):
    G[u][v]['id'] = i + 1
    G[u][v]['g_e'] = []

# the dimension of the newtork is given in ns
SF_duration = 10**6 # 1 ms -> 10^6 ns
print(f"Super frame duration T: {SF_duration} ns.")

# 1->2 WiFi 24bit/4us 6MBit/s
G[1][2]['layer2'] = 'WiFi6Mb/s'
G[1][2]['throughput'] = 12 * 10**6 # 12Mbit/s -> 12*10^6 bit/s
G[1][2]['a_e'] = 24 # 24 bit
G[1][2]['tau_e'] = G[1][2]['a_e'] * 10**9 / G[1][2]['throughput']
G[1][2]['d_e'] = 4 * 10**3 # 4us -> 4*10^3 ns
```

```

# 2->3 Ethernet(Optical) 10Gb/s
G[2][3]['layer2'] = 'Ethernet10Gb'
G[2][3]['throughput'] = 4 * 10**9 # 10Gbit/s -> 10*10^9 bit/s
G[2][3]['a_e'] = 8 # 8 bit
G[2][3]['tau_e'] = G[2][3]['a_e'] * 10**9/ G[2][3]['throughput']
G[2][3]['d_e'] = 300 * 10**3 # 300us -> 300*10^3 ns
G[2][3]['note'] = 'hop distance 65Km'

# 3->4 Ethernet(Optical) 10Gb/s
G[3][4]['layer2'] = 'Ethernet10Gb'
G[3][4]['throughput'] = 4 * 10**9 # 10Gbit/s -> 10*10^9 bit/s
G[3][4]['a_e'] = 8 # 8 bit
G[3][4]['tau_e'] = G[2][3]['a_e'] * 10**9/ G[2][3]['throughput']
G[3][4]['d_e'] = 50 * 10**3 # 50us -> 50*10^3 ns
G[3][4]['note'] = 'hop distance 10Km'

# 4->5 Ethernet(Optical) 10Gb/s
G[4][5]['layer2'] = 'Ethernet10Gb'
G[4][5]['throughput'] = 4 * 10**9 # 10Gbit/s -> 10*10^9 bit/s
G[4][5]['a_e'] = 8 # 8 bit
G[4][5]['tau_e'] = G[2][3]['a_e'] * 10**9/ G[2][3]['throughput']
G[4][5]['d_e'] = 300 * 10**3 # 300us -> 300*10^3 ns
G[4][5]['note'] = 'hop distance 65Km'

# 5->6 WiFi 24bit/4us 6MBit/s
G[5][6]['layer2'] = 'WiFi6Mb/s'
G[5][6]['throughput'] = 12 * 10**6 # 12 Mbit/s -> 12*10^6 bit/s
G[5][6]['a_e'] = 24 # 24 bit
G[5][6]['tau_e'] = G[1][2]['a_e'] * 10**9/ G[1][2]['throughput']
G[5][6]['d_e'] = 4 * 10**3 # 4us -> 4*10^3 ns

for i, (u, v) in enumerate(G.edges()):
    G[u][v]['tau_e'] = int(G[u][v]['tau_e'])
    label = ""
    label += f"Interface e_{i+1} from hop_{u} to hop_{v}:\n"
    label += f"\tlayer2: {G[u][v]['layer2']}\n"
    label += f"\tthroughput: {G[u][v]['throughput']} bit/s.\n"
    label += f"\ta_e: {G[u][v]['a_e']} bits.\n"
    label += f"\ttau_e: {G[u][v]['tau_e']} ns.\n"
    label += f"\td_e: {G[u][v]['d_e']} ns.\n"
    label += f"\tnumber of time slots: {SF_duration / G[u][v]['tau_e']}\n"
    if 'note' in G[u][v]:
        label += f"\tnote: {G[u][v]['note']}"
    G[u][v]['label'] = f"e_{i+1}"

print(label)

```

```

Super frame duration T: 1000000 ns.
Interface e_1 from hop_1 to hop_2:
    layer2: WiFi6Mb/s
    throughput: 12000000 bit/s.
    a_e: 24 bits.
    tau_e: 2000 ns.
    d_e: 4000 ns.
    number of time slots: 500.0

Interface e_2 from hop_2 to hop_3:
    layer2: Ethernet10Gb
    throughput: 4000000000 bit/s.
    a_e: 8 bits.
    tau_e: 2 ns.
    d_e: 300000 ns.
    number of time slots: 500000.0
    note: hop distance 65Km
Interface e_3 from hop_3 to hop_4:
    layer2: Ethernet10Gb
    throughput: 4000000000 bit/s.
    a_e: 8 bits.
    tau_e: 2 ns.
    d_e: 50000 ns.
    number of time slots: 500000.0
    note: hop distance 10Km
Interface e_4 from hop_4 to hop_5:
    layer2: Ethernet10Gb
    throughput: 4000000000 bit/s.
    a_e: 8 bits.
    tau_e: 2 ns.
    d_e: 300000 ns.
    number of time slots: 500000.0
    note: hop distance 65Km
Interface e_5 from hop_5 to hop_6:
    layer2: WiFi6Mb/s
    throughput: 12000000 bit/s.
    a_e: 24 bits.
    tau_e: 2000 ns.
    d_e: 4000 ns.
    number of time slots: 500.0

```

```

[ ]: # draw the graph, with the nodes colored by their degree

# first, calculate the degree of each node
degree = G.degree()

```

```

# write the name of the node on the graph
pos = nx.spring_layout(G)

# then, draw the graph, with the nodes colored by their degree
options = {
    'arrows' : True,
    'node_color': 'blue',
    'arrowstyle': '-|>',
    'arrowsize': 12,
    'with_labels': True,
    'font_weight': 'bold',
    'font_color': 'white',
    'font_size': 12,
    'node_size': 500,
}

nx.draw(G, pos, **options)

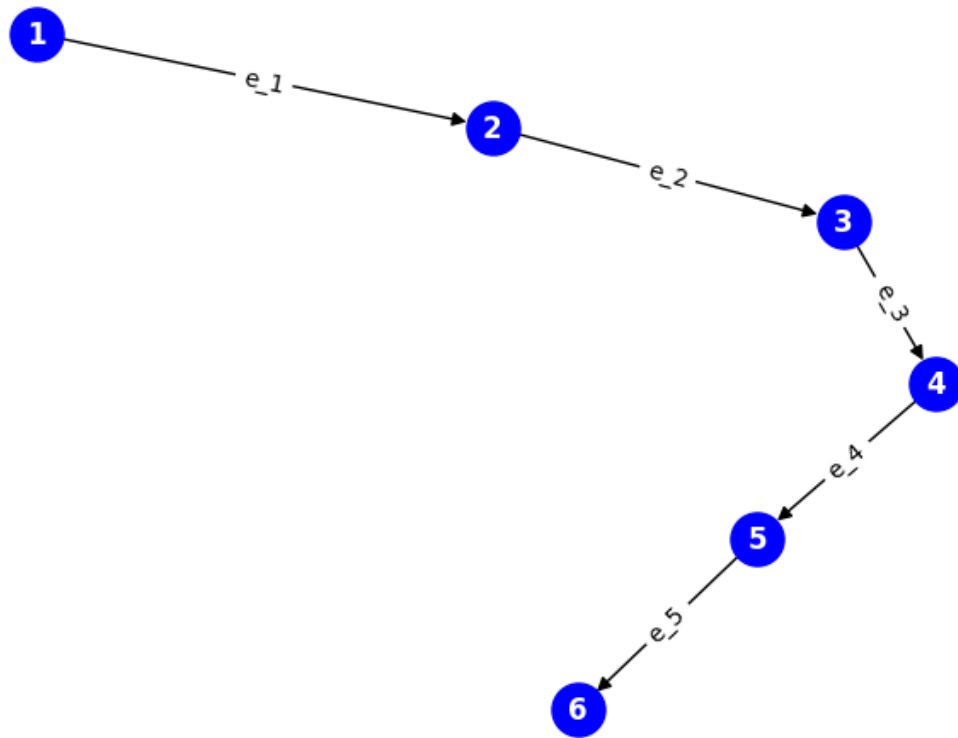
# draw the graph with labels
nx.draw_networkx_edge_labels(G, pos, edge_labels={(u, v): G[u][v]['label'] for u, v in G.edges()})

```

```

[ ]: {(1, 2): Text(-0.18701923953228813, 0.6814228919730112, 'e_1'),
      (2, 3): Text(0.033081204932122556, 0.4308951693973776, 'e_2'),
      (3, 4): Text(0.15409890629987424, 0.08914947247212013, 'e_3'),
      (4, 5): Text(0.13075008280271153, -0.33427351133887184, 'e_4'),
      (5, 6): Text(0.03292033323241389, -0.7705723644451313, 'e_5')}

```



```

[ ]: paths = dict(nx.shortest_path(G))
def grouped(iterable):
    return [(iterable[i], iterable[i+1]) for i in range(len(iterable)-1)]

def random_path(debug=False):
    random_path = []
    start = random.choice(list(G.nodes()))
    dest = random.choice(list(paths[start]))
    while start == dest:
        start = random.choice(list(G.nodes()))
        dest = random.choice(list(paths[start]))
    random_path = paths[start][dest]
    random_path_e = []
    for u,v in grouped(random_path):
        if debug:
            print( f"Edge {u} -> {v}", G[u][v])
        random_path_e.append(G[u][v])
    return random_path_e

random_path(debug=True)

```

```
Edge 1 -> 2 {'id': 1, 'g_e': [], 'layer2': 'WiFi6Mb/s', 'throughput': 12000000,
'a_e': 24, 'tau_e': 2000, 'd_e': 4000, 'label': 'e_1'}
Edge 2 -> 3 {'id': 2, 'g_e': [], 'layer2': 'Ethernet10Gb', 'throughput':
40000000000, 'a_e': 8, 'tau_e': 2, 'd_e': 300000, 'note': 'hop distance 65Km',
'label': 'e_2'}
```

```
[ ]: [{ 'id': 1,
        'g_e': [],
        'layer2': 'WiFi6Mb/s',
        'throughput': 12000000,
        'a_e': 24,
        'tau_e': 2000,
        'd_e': 4000,
        'label': 'e_1'},
      { 'id': 2,
        'g_e': [],
        'layer2': 'Ethernet10Gb',
        'throughput': 40000000000,
        'a_e': 8,
        'tau_e': 2,
        'd_e': 300000,
        'note': 'hop distance 65Km',
        'label': 'e_2'}]
```

```
[ ]: from math import ceil

def generate_flow():
    _path = random_path()
    path = [e["id"] for e in _path]

    return {
        'id': 1,
        'period': 10**5,
        'path': path,
        'delay': 10**5, #1ms
        'jitter': 10**4, #0.1ms
        '#f' : 90 * 8 #90 bytes
    }

generate_flow()
```

```
[ ]: {'id': 1,
      'period': 100000,
      'path': [1, 2, 3, 4],
      'delay': 100000,
      'jitter': 10000,
      '#f': 720}
```

```
[ ]: requests = [generate_flow() for i in range(1, 200)]

requests
```

```
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```

```

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```

```

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 '#f': 720},
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```

```

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 '#f': 720},
{'id': 1,
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```



```

    'path': [2, 3, 4, 5],
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    'jitter': 10000,
    '#f': 720},
{'id': 1,
 'period': 100000,
 'path': [3],
 'delay': 100000,
 'jitter': 10000,
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 'path': [3, 4, 5],
 'delay': 100000,
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```

```

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 '#f': 720},
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 '#f': 720},

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```

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 '#f': 720},
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}

```

```

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 'jitter': 10000,
 '#f': 720},
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 'path': [1, 2],
 'delay': 100000,

```

```

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    '#f': 720},
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{'id': 1,
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 '#f': 720},
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 '#f': 720},
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 'path': [5],
 'delay': 100000,
 'jitter': 10000,
 '#f': 720},
{'id': 1,
 'period': 100000,
 'path': [4, 5],

```

```

    'delay': 100000,
    'jitter': 10000,
    '#f': 720},
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 '#f': 720},
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 'path': [1, 2, 3],
 'delay': 100000,
 'jitter': 10000,
 '#f': 720},
{'id': 1,
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```

```

    'path': [3],
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    'jitter': 10000,
    '#f': 720},
{'id': 1,
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 'path': [3],
 'delay': 100000,
 'jitter': 10000,
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 '#f': 720},
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 '#f': 720},
{'id': 1,
 'period': 100000,
 'path': [2, 3],
 'delay': 100000,
 'jitter': 10000,
 '#f': 720},
{'id': 1,

```

```

    'period': 100000,
    'path': [5],
    'delay': 100000,
    'jitter': 10000,
    '#f': 720},
{'id': 1,
 'period': 100000,
 'path': [4],
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 'jitter': 10000,
 '#f': 720},
{'id': 1,
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 'jitter': 10000,
 '#f': 720},
{'id': 1,
 'period': 100000,
 'path': [4, 5],
 'delay': 100000,
 'jitter': 10000,
 '#f': 720}]

```

```

[ ]: from enum import Enum
import json
from os import mkdir
import pickle
from bitarray import bitarray

CHUNK_SIZE_PERCENTAGE = 0.1

class Complexity(Enum):
    LOW = 1
    LOWMEDIUM = 2
    MEDIUM = 3
    MEDIUMHIGH = 4
    HIGH = 5

    def get_delta_complexity(self):
        return {
            Complexity.LOW: 0.3,
            Complexity.LOWMEDIUM: 0.25,
            Complexity.MEDIUM: 0.2,
            Complexity.MEDIUMHIGH: 0.15,
            Complexity.HIGH: 0.5
        }[self]

```



```

def get_instance_name(self):
    return {
        Complexity.LOW: "low",
        Complexity.LOWMEDIUM: "lowmedium",
        Complexity.MEDIUM: "medium",
        Complexity.MEDIUMHIGH: "mediumhigh",
        Complexity.HIGH: "high"
    }[self]

for u, v in G.edges():
    G[u][v]['g_e'] = []

for complexity in Complexity:
    instance_name = complexity.get_instance_name()
    delta = complexity.get_delta_complexity()
    for i, (u, v) in enumerate(G.edges()):
        t_e = int(SF_duration / G[u][v]['tau_e'])
        T_e = bitarray('1' * t_e)

        #step = 1
        removes = 0
        to_remove = ceil(delta * t_e)
        step = ceil(to_remove * CHUNK_SIZE_PERCENTAGE)
        while removes < to_remove:

            # select a random time slot
            t = random.randint(1,t_e)
            while T_e[t-1] == False:
                t = random.randint(1,t_e)

            # remove the t
            for i in range(step):
                k = t + i
                if k >= t_e: k -= t_e
                T_e[k] = False
                removes += 1

            from bitarray.util import serialize
            with open(f"{instance_name}/
↳{instance_name}_directed_link_{G[u][v]['id']}.bin", 'wb') as file:
                # writebyte
                file.write(serialize(T_e))

            #wirte the json to a file
            for idx,f in enumerate(requests):
                with open(f"{instance_name}/{idx+1}.json", 'w') as file:
                    print(f"Writing {file.name}...")

```

```

size = f["#f"]
E_f = f["path"]
P_f = f["period"]
DELAY_f = f["delay"]
JITTER_f = f["jitter"]

data = {
    "SF_duration" : SF_duration,
    "E" : [G[u][v]["id"] for (u, v) in G.edges()],
    "B_e" : [G[u][v]["throughput"] for i, (u, v) in enumerate(G.
↪edges())],
    "a_e" : [G[u][v]["a_e"] for i, (u, v) in enumerate(G.edges())],
    "tau_e" : [G[u][v]["tau_e"] for i, (u, v) in enumerate(G.
↪edges())],
    "g_e" : [G[u][v]["g_e"] for i, (u, v) in enumerate(G.edges())],
    "d_e" : [G[u][v]["d_e"] for i, (u, v) in enumerate(G.edges())],
    "F" : [1],
    "#f" : [size],
    "E_f": [E_f],
    "P_f": [P_f],
    "DELAY_f": [DELAY_f],
    "JITTER_f": [JITTER_f],
}
json.dump(data, file, indent=4)

```

```

Writing low/1.json...
Writing low/2.json...
Writing low/3.json...
Writing low/4.json...
Writing low/5.json...
Writing low/6.json...
Writing low/7.json...
Writing low/8.json...
Writing low/9.json...
Writing low/10.json...
Writing low/11.json...
Writing low/12.json...
Writing low/13.json...
Writing low/14.json...
Writing low/15.json...
Writing low/16.json...
Writing low/17.json...
Writing low/18.json...
Writing low/19.json...
Writing low/20.json...

```

Writing low/21.json...
Writing low/22.json...
Writing low/23.json...
Writing low/24.json...
Writing low/25.json...
Writing low/26.json...
Writing low/27.json...
Writing low/28.json...
Writing low/29.json...
Writing low/30.json...
Writing low/31.json...
Writing low/32.json...
Writing low/33.json...
Writing low/34.json...
Writing low/35.json...
Writing low/36.json...
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Writing low/65.json...
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Writing low/68.json...

Writing low/69.json...
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Writing low/72.json...
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Writing low/77.json...
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Writing low/111.json...
Writing low/112.json...
Writing low/113.json...
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Writing low/125.json...
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Writing low/165.json...
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Writing low/197.json...
Writing low/198.json...
Writing low/199.json...
Writing lowmedium/1.json...
Writing lowmedium/2.json...
Writing lowmedium/3.json...
Writing lowmedium/4.json...
Writing lowmedium/5.json...
Writing lowmedium/6.json...
Writing lowmedium/7.json...
Writing lowmedium/8.json...
Writing lowmedium/9.json...
Writing lowmedium/10.json...
Writing lowmedium/11.json...
Writing lowmedium/12.json...
Writing lowmedium/13.json...

Writing lowmedium/14.json...
Writing lowmedium/15.json...
Writing lowmedium/16.json...
Writing lowmedium/17.json...
Writing lowmedium/18.json...
Writing lowmedium/19.json...
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Writing lowmedium/38.json...
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Writing lowmedium/41.json...
Writing lowmedium/42.json...
Writing lowmedium/43.json...
Writing lowmedium/44.json...
Writing lowmedium/45.json...
Writing lowmedium/46.json...
Writing lowmedium/47.json...
Writing lowmedium/48.json...
Writing lowmedium/49.json...
Writing lowmedium/50.json...
Writing lowmedium/51.json...
Writing lowmedium/52.json...
Writing lowmedium/53.json...
Writing lowmedium/54.json...
Writing lowmedium/55.json...
Writing lowmedium/56.json...
Writing lowmedium/57.json...
Writing lowmedium/58.json...
Writing lowmedium/59.json...
Writing lowmedium/60.json...
Writing lowmedium/61.json...

Writing lowmedium/62.json...
Writing lowmedium/63.json...
Writing lowmedium/64.json...
Writing lowmedium/65.json...
Writing lowmedium/66.json...
Writing lowmedium/67.json...
Writing lowmedium/68.json...
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