Group 1
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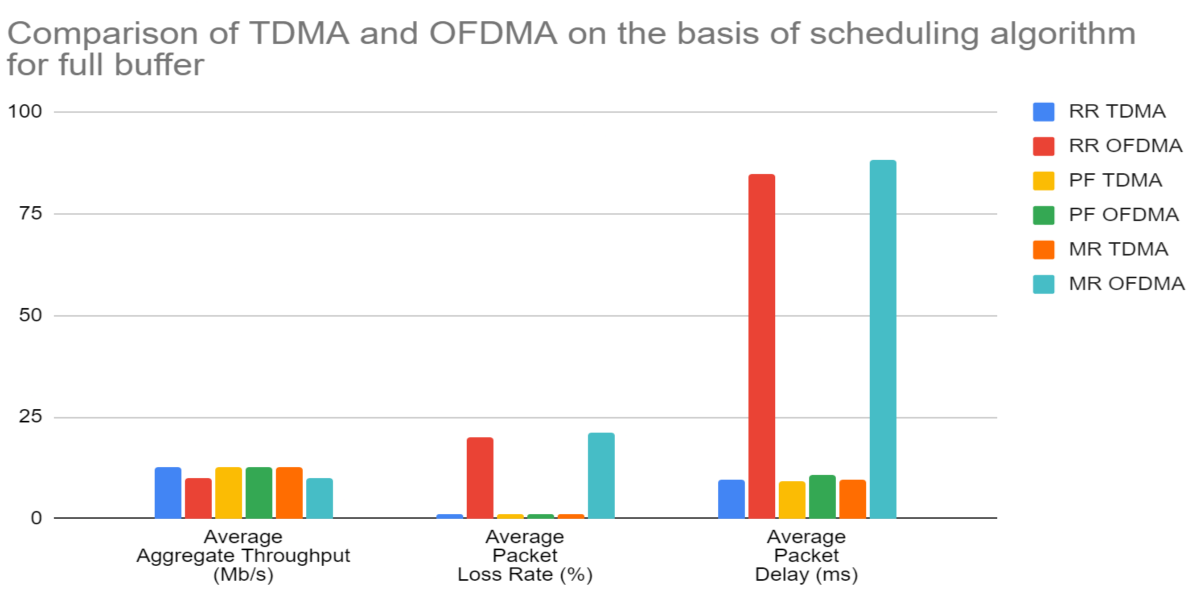
Task 1

Part A (Average of all UEs)

i. Full Buffer

	RR		PF		MR	
	TDMA	OFDMA	TDMA	OFDMA	TDMA	OFDMA
Average Aggregate Throughput (Mb/s)	**12.5812**	**10.1871**	**12.5843**	**12.579**	**12.5814**	**10.0493**
Average Packet Loss Rate (%)	**1.22774**	**20.0543**	**1.18948**	**1.31121**	**1.22774**	**21.1046**
Average Packet Delay (ms)	**9.71118**	**84.75733**	**9.16172**	**10.90087**	**9.71185**	**88.11133**



Throughput:

TDMA: The throughput in TDMA depends on how the time slots are allocated to users. In the RR algorithm, each user gets an equal share of the available time slots, resulting in a fair distribution of resources. However, if some users have higher data rate requirements than others, the overall throughput may be limited. PF and MR algorithms in TDMA can improve throughput by prioritizing users with better channel conditions and higher data rates, respectively.
OFDMA: OFDMA inherently supports higher throughput due to allocating multiple subcarriers to different users. The RR algorithm in OFDMA provides fairness in resource allocation, but it may not fully exploit the potential throughput of the system. PF scheduling in OFDMA dynamically allocates subcarriers based on channel conditions, enabling better users to receive more resources and improving overall throughput. MR scheduling maximises system throughput by allocating more subcarriers to users with better channel conditions and modulation capabilities.

Packet Delay:

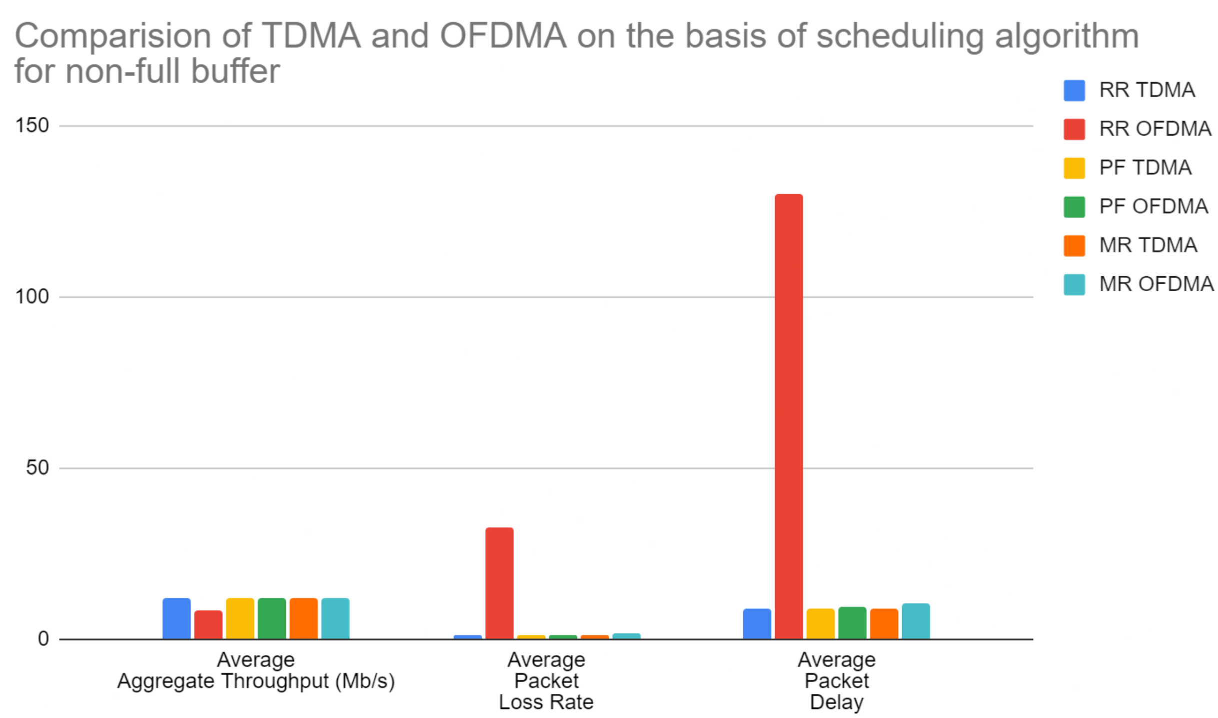
TDMA: In TDMA, packet delay depends on the assigned time slots and the transmission order. With the RR algorithm, users take turns transmitting, resulting in a predictable delay for each user. PF and MR algorithms in TDMA can prioritize users based on their channel conditions and data rate requirements, respectively, which may reduce the delay for users with better conditions.
OFDMA: Packet delay in OFDMA is affected by subcarrier allocation and transmission scheduling. The RR algorithm in OFDMA provides fairness in terms of resource allocation and can result in relatively consistent packet delay for users. PF scheduling dynamically allocates subcarriers based on channel conditions, which can reduce delay for users with better conditions. MR scheduling in OFDMA aims to maximize throughput and may prioritize users with better channel conditions, potentially reducing packet delay.

Packet Loss Rate:
TDMA: Packet loss rate in TDMA depends on the quality of the assigned time slots and transmission conditions. With the RR algorithm, each user gets a fair share of time slots, reducing the likelihood of packet loss due to resource contention. PF and MR algorithms in TDMA prioritize users based on their channel conditions and data rate requirements, respectively, which can help mitigate packet loss by allocating resources accordingly.
OFDMA: Packet loss rate in OFDMA is influenced by subcarrier allocation and transmission scheduling. The RR algorithm in OFDMA provides fair allocation of subcarriers, minimizing the chances of packet loss due to resource contention. PF scheduling in OFDMA adjusts subcarrier allocation based on channel conditions, which can help improve the overall system's performance and reduce packet loss. MR scheduling in OFDMA aims to maximize system throughput, and by allocating more subcarriers to users with better channel conditions, it can

potentially reduce packet loss.

Q.1
ii. Non-Full Buffer

	RR		PF		MR	
	TDMA	OFDMA	TDMA	OFDMA	TDMA	OFDMA
Average Aggregate Throughput (Mb/s)	**12.0834**	**8.22749**	**12.0834**	**12.075**	**12.0834**	**12.0591**
Average Packet Loss Rate	**1.15942**	**32.7645**	**1.15942**	**1.26087**	**1.15942**	**1.39493**
Average Packet Delay	**8.99188**	**130.26917**	**8.99332**	**9.46655**	**8.99188**	**10.25601**



Throughput:

TDMA: The throughput in TDMA depends on how the time slots are allocated to users. In the RR algorithm, each user gets an equal share of the available time slots, resulting in a fair distribution of resources. However, if some users have higher data rate requirements than others, the overall throughput may be limited. PF and MR algorithms in TDMA can improve throughput by prioritizing users with better channel conditions and higher data rates, respectively.
OFDMA: OFDMA inherently supports higher throughput due to allocating multiple subcarriers to different users. The RR algorithm in OFDMA provides fairness in resource allocation, but it may not fully exploit the potential throughput of the system. PF scheduling in OFDMA dynamically allocates subcarriers based on channel conditions, enabling better users to receive more resources and improving overall throughput. MR scheduling maximises system throughput by allocating more subcarriers to users with better channel conditions and modulation capabilities.

Packet Delay:

TDMA: In TDMA, packet delay depends on the assigned time slots and the transmission order. With the RR algorithm, users take turns transmitting, resulting in a predictable delay for each user. PF and MR algorithms in TDMA can prioritize users based on their channel conditions and data rate requirements, respectively, which may reduce the delay for users with better conditions.
OFDMA: Packet delay in OFDMA is affected by subcarrier allocation and transmission scheduling. The RR algorithm in OFDMA provides fairness in terms of resource allocation and can result in relatively consistent packet delay for users. PF scheduling dynamically allocates subcarriers based on channel conditions, which can reduce delay for users with better conditions. MR scheduling in OFDMA aims to maximize throughput and may prioritize users with better channel conditions, potentially reducing packet delay.

Packet Loss Rate:

TDMA: The packet loss rate in TDMA depends on the quality of the assigned time slots and transmission conditions. With the RR algorithm, each user gets a fair share of time slots, reducing the likelihood of packet loss due to resource contention. PF and MR algorithms in TDMA prioritize users based on their channel conditions and data rate requirements, respectively, which can help mitigate packet loss by allocating resources accordingly.
OFDMA: The packet loss rate in OFDMA is influenced by subcarrier allocation and transmission scheduling. The RR algorithm in OFDMA provides a fair allocation of subcarriers, minimizing the chances of packet loss due to resource contention. PF scheduling in OFDMA adjusts subcarrier allocation based on channel conditions, which can help improve the overall

system's performance and reduce packet loss. MR scheduling in OFDMA aims to maximize system throughput, and by allocating more subcarriers to users with better channel conditions, it can potentially reduce packet loss.

Q.2 same as 1

Part B (Individual UEs in Full Buffer)

Throughput (Mb/s), loss rate and delay (m/s):

NrMacScheduler = Tdma									
UE ID	RR			PF			MR		
	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay
1	2.0974	1.18948	9.56654	2.09747	1.18948	9.49089	2.09744	1.18948	9.56251
2	2.09737	1.18948	9.5359	2.09744	1.18948	9.51663	2.0974	1.18948	9.54396
3	2.09734	1.18948	9.55079	2.0974	1.18948	9.5397	2.09737	1.18948	9.5509
4	2.09731	1.18948	9.57202	2.09731	1.18948	9.80142	2.09734	1.18948	9.57213
5	2.09727	1.18948	9.59325	2.09727	1.18948	9.57657	2.09731	1.18948	9.59336
6	2.09455	1.41903	10.4486	2.09455	1.41903	10.4322	2.09455	1.41903	10.4482

NrMacScheduler = Ofdma									
UE ID	RR			PF			MR		
	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay
1	1.72164	18.96911	80.5259	2.09542	1.39816	11.1780	1.70067	19.88731	83.4383
2	1.72164	18.96911	80.7144	2.09672	1.29382	10.8630	1.69836	20.01252	84.2574
3	1.68595	20.59682	86.8259	2.09672	1.29382	10.8421	1.66258	21.68197	90.2432
4	1.68595	20.59682	86.8259	2.09672	1.29382	10.8421	1.66258	21.68197	90.2432

5	1.68595	20.59682	86.8259	2.09672	1.29382	10.8400	1.66258	21.68197	90.2432
6	1.68595	20.59682	86.8259	2.09672	1.29382	10.8400	1.66258	21.68197	90.2432

Q.3 same as 1.

Task 2

Part A (Average of all UEs in Full Buffer with TdmaPF)

	Numerology 0	Numerology 1	Numerology 2	Numerology 3
Average Aggregate Throughput (Mb/s)	12.5843	12.5871	12.5881	12.5896
Average Loss Rate	1.18948	1.16861	1.1547	1.14775
Average Delay	9.16083	8.95108	9.92987	8.808

Q.4

Throughput:

Numerology 0 has the largest subcarrier spacing and longer symbol durations. It provides better frequency selectivity and higher immunity to delay spread, making it suitable for low-mobility scenarios. It can achieve higher spectral efficiency and throughput.
Numerology 1 has smaller subcarrier spacing compared to numerology 0. It is commonly used for moderate mobility scenarios. It provides a good balance between frequency selectivity and Doppler spread tolerance, allowing for efficient transmission in various environments.
Numerology 2 has even smaller subcarrier spacing compared to numerology 1. It is suitable for higher-mobility scenarios, providing increased resilience to Doppler spread. However, the higher subcarrier density may result in increased interference and reduced overall system capacity.
Numerology 3 has the smallest subcarrier spacing among the considered numerologies. It is designed for extremely high-mobility scenarios, such as high-speed trains or vehicles. While it

offers robustness against severe Doppler spread, it has reduced spectral efficiency due to the increased overhead of shorter symbol durations.

Packet Delay:

Due to longer symbol durations and larger subcarrier spacing, **numerology 0** can offer lower packet delay in scenarios with lower mobility. The increased symbol durations provide more time for processing, reducing the potential for delays in the system.
Numerology 1 strikes a balance between frequency selectivity and Doppler spread tolerance, resulting in moderate packet delay. It is suitable for scenarios with moderate mobility where delays are generally manageable.
Numerology 2, with smaller subcarrier spacing, may experience slightly higher packet delay compared to numerology 1. The increased subcarrier density can lead to more frequent channel variations, potentially increasing processing and delay requirements.
Numerology 3, designed for high-mobility scenarios, may experience higher packet delay due to shorter symbol durations. The reduced symbol duration leaves less time for processing, potentially leading to increased delays.

Packet Loss Rate:

Numerology 0 with larger subcarrier spacing, provides better frequency selectivity and can mitigate packet loss due to interference. It can achieve lower packet loss rates compared to numerologies with smaller subcarrier spacing.
Numerology 1 can offer competitive packet loss rates in a variety of scenarios. It strikes a balance between frequency selectivity and Doppler spread tolerance, providing robustness against interference and maintaining acceptable packet loss rates.
Numerology 2 with smaller subcarrier spacing, may experience slightly higher packet loss rates compared to numerology 1. The increased subcarrier density can lead to more interference and potential degradation in packet loss performance.
Numerology 3 designed for high-mobility scenarios, may have higher packet loss rates due to shorter symbol durations. The reduced symbol duration reduces the resilience to channel variations, potentially increasing the chances of packet loss.

Part B (Individual UEs in Full Buffer with TdmaPF)
Numerology 0 is already done in the previous question.

NrMacScheduler = TdmaPF												
UE	Numerology 0			Numerology 1			Numerology 2			Numerology 3		
	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay	Throughput	Loss Rate	Delay
1	2.09747	1.18948	9.13347	2.09793	1.16861	8.96907	2.09816	1.14774	8.86893	2.09824	1.14774	8.80997
2	2.09747	1.18948	9.14112	2.0979	1.16861	8.9533	2.09815	1.14774	8.87921	2.09829	1.14774	8.80442
3	2.0974	1.18948	9.1533	2.09786	1.16861	8.92853	2.09814	1.14774	8.87941	2.09828	1.14774	8.80515
4	2.09737	1.18948	9.16616	2.09783	1.16861	8.94022	2.09812	1.14774	8.88488	2.09827	1.14774	8.8072
5	2.09734	1.18948	9.17902	2.0978	1.16861	8.95174	2.0981	1.14774	8.88996	2.09827	1.14774	9.90897
6	2.09731	1.18948	9.19188	2.09777	1.16861	8.96363	2.09743	1.18948	9.18183	2.09826	1.14774	8.81234

Q.5

Task 3

Average of all UEs in TdmaPF with Numerology=1

Average Aggregate Throughput (Mb/s):

Speed (meter/s)	RR	PF	MR
10	5.10333	5.27574	3.64785
50	2.42606	2.48821	2.69473

Avg Loss Rate :

Speed (meter/s)	RR	PF	MR
10	63.141	75.0053	73.6331

50	89.3063	93.4695	93.3919

Avg. Delay (ms):

Speed (meter/s)	RR	PF	MR
10	455.3617	478.953	500.103
50	526.2463	297.7067	218.6717

Q.6

Throughput:

The PF algorithm dynamically allocates resources based on channel conditions. It favors users with better channel quality, aiming to achieve a balance between fairness and maximizing system throughput. As users move in the random walk model, the PF algorithm can adaptively allocate resources to users with better channel conditions, thus potentially increasing throughput for those users.

Packet Loss:

The PF algorithm considers channel conditions when allocating resources. By prioritizing users with better channel quality, it can mitigate packet loss to some extent. Users with stronger signals and more favorable channel conditions are allocated more resources, reducing the probability of packet loss for those users. However, rapid changes in channel conditions due to mobility can still result in occasional packet loss events.

Packet Delay:

The PF algorithm aims to achieve fairness while maximizing system throughput. By considering channel conditions, it can allocate resources to users with better channels, potentially reducing packet delays for those users. However, in scenarios where users are moving rapidly and experiencing frequent handovers, the delay introduced by mobility-related factors may still have an impact.