

InfoCom 2019



Fronthaul optical architectures for transporting high bit rates of mobile networks

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outline

- Objectives
- Work plan
- Challenges
- Scenarios
- Analysis and outcomes

5G STEP FWD - Objectives

- Optimized and cost efficient work for 5g operation - For Stadium and Urban area @ 3.5GHz and 26GHz spectrum
- CLASSIC 5G AND 5G STEP FWD COMPARISON

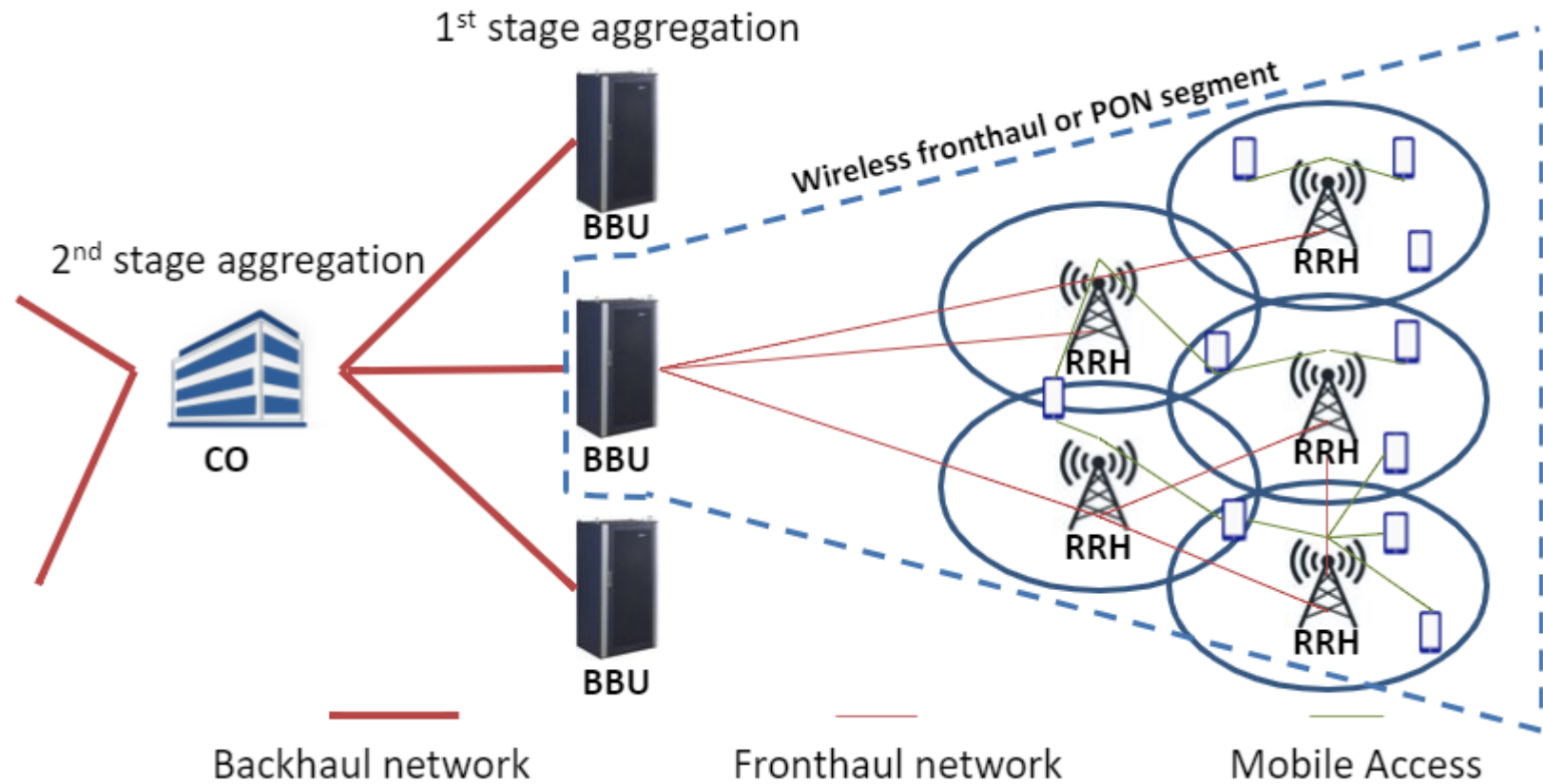
General Work Plan

1. Definition of current network cost and power consumption
2. Definition of realistic topology and user demands
 - ▶ *Topology information to be collected: Area coverage characteristics for both wireless and fixed network.*
3. Calculation of required resources and optimized resources
 - ▶ *Min/max/optimized number of BBUs/RRHs.*
4. Evaluation of the SDM-enabled fronthaul network cost and power consumption
 - ▶ *Then extract the overall system cost and power consumption, i.e. BBU/RRH.*

The Challenge

- High global demand for broadband connections
 - Households and Small & Medium Enterprises.
- Broadband: Fixed vs. Mobile
 - Fixed, e.g. FTTH requires time and cost to deploy.
 - Mobile, e.g. 5G requires high front/back-haul bandwidth.
- Fixed Wireless Access (FWA)
 - Combines fixed and mobile broadband solutions.
- Could 5G STEP FWD be a cost-efficient solution?
 - Viable and profitable from the service provider's perspective.
 - To find out, we compare with the classic 5G deployment.
 - 10-year cost-benefit analysis (CAPEX/OPEX, revenues, cash flow, EBITDA, NPV), including methodology, results and conclusions.

Centralized RAN



Network Architecture Components

Network part	5G Components	5G STEP FWD Components
Backhaul	Fiber	Fiber
Fronthaul	Macro Base Station	Multi-Core Fiber
Access	RRH	RRH

Component Variables

Fiber Length

Number of Macro Cells /
RRHs / small cells

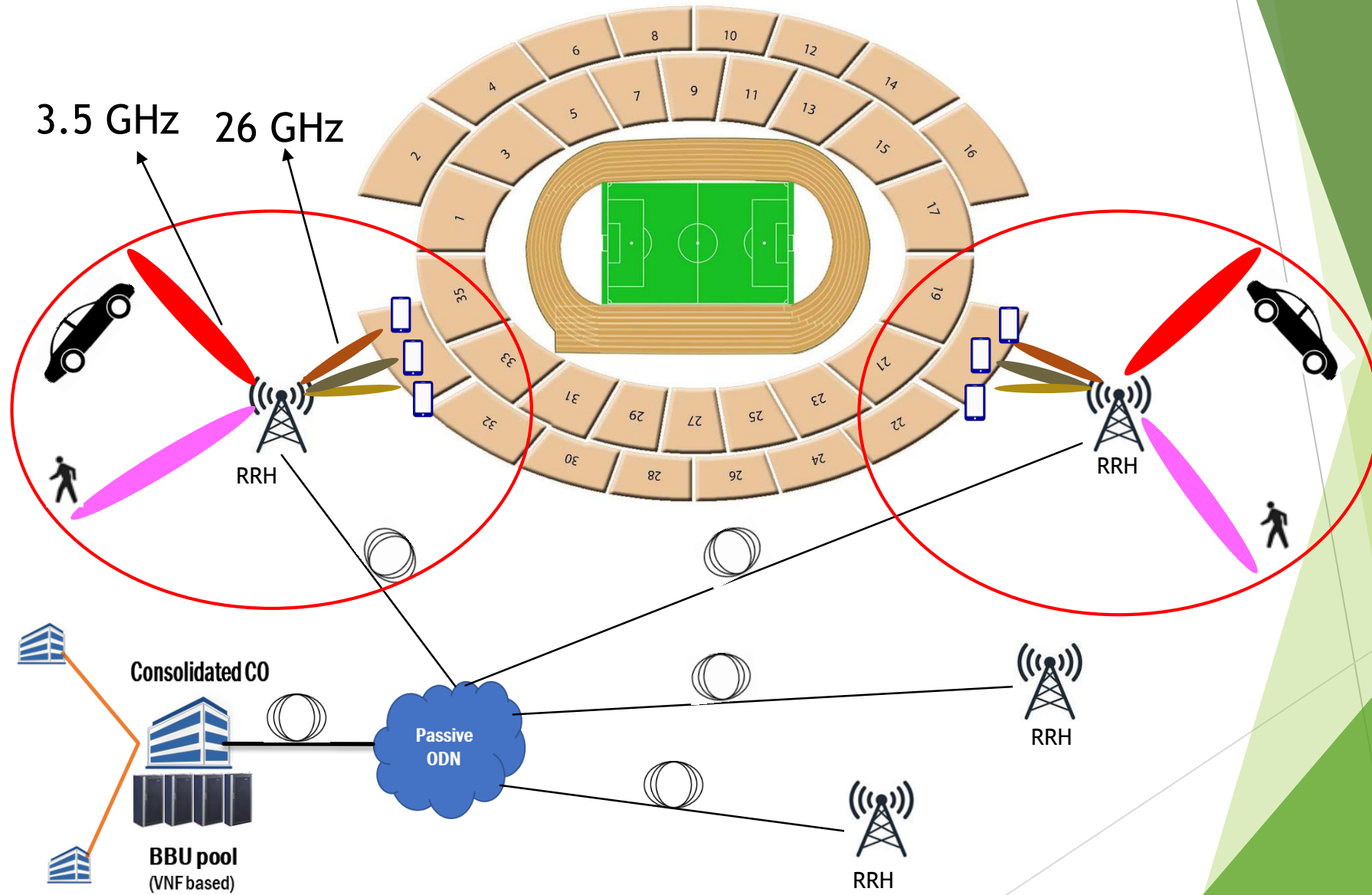
Additional Components

Antenna Arrays

MIMO

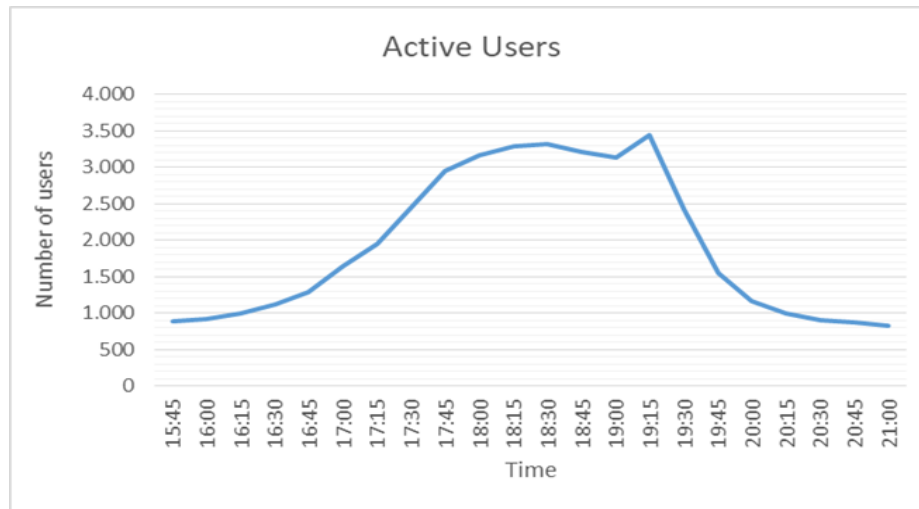
OBFN and eBFN

1) 5G STEP FWD : The Stadium



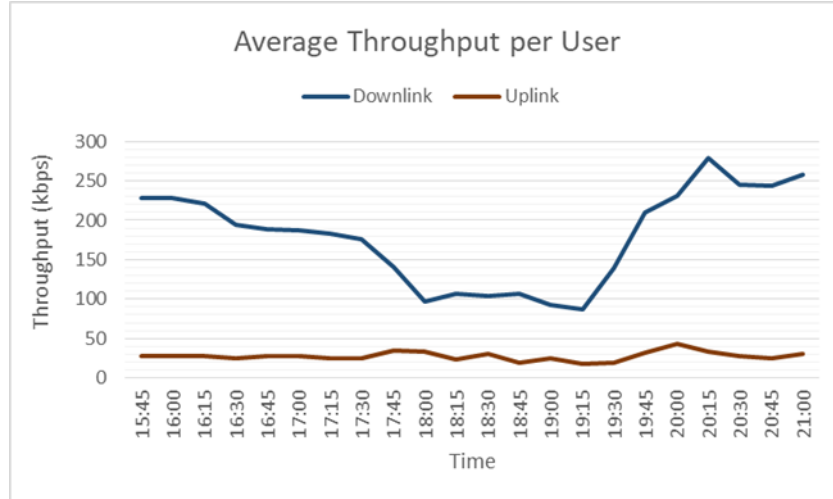
Real User Demands (PAOK Stadium)

- COSMOTE relevant department provided us with detailed data regarding:
 - The fixed & wireless access topology of the PAOK stadium (location of base stations & optical fibers).
 - The user demands during a game/concert/show (number of connected users, quantity of consumed UL/DL traffic).
 - Data during a match day (27/1/2019) over 15 min interval.



- Available capacity: 28,500
- Match attendants: 16,500
- Max. active users: 3,441

Real User Demands



- Avg. DL throughput/user: 180 kbps
- Avg. UL throughput/user: 28 kbps
- Current capacity: 540.925 Mbps
- **Future capacity: 108.185 Gbps**

- During the match, although the active users are tripled, the avg. DL throughput/user decreases!
- Available resources cannot adequately serve the clients' needs
- To meet the future capacity requirements, we scale up the current user demands.
 - DL/UL traffic volume will increase by 100 times.
 - Services: live streaming high definition videos and replay moments of the current game.

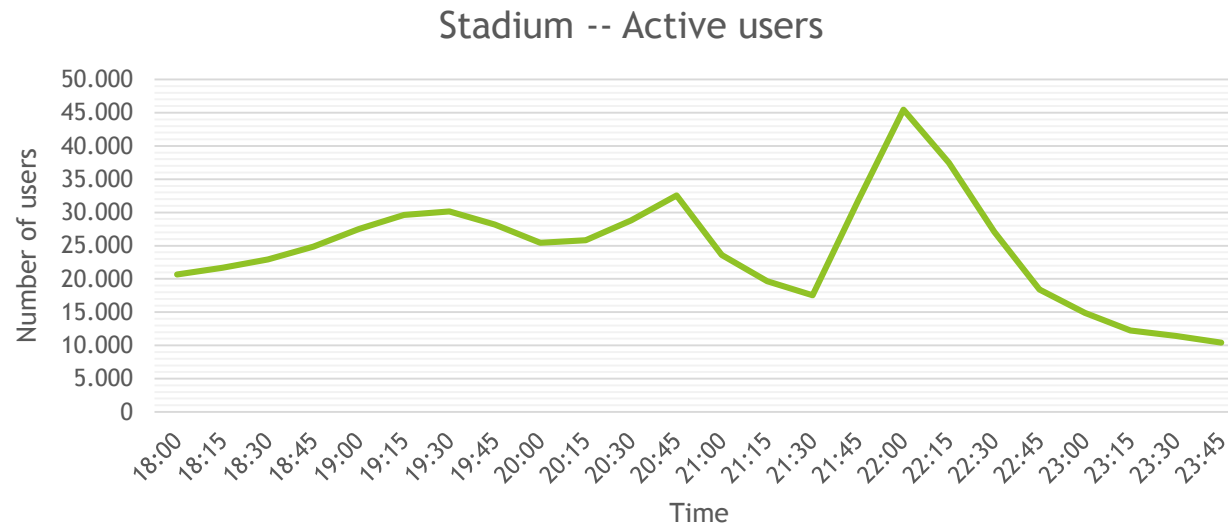
Assumptions & Throughput Analysis

	5G STEP FWD	Classic 5G
	<i>RRH</i>	<i>Macro Cell</i>
<i>Antenna arrays</i>	1	1
<i>Antenna array bandwidth</i>	200 MHz	1 GHz
<i>Ant. elements / ant. array</i>	4	16
<i>Beams / ant. array</i>	4	4
<i>OBFN</i>	4 x 4	4 x 16
<i>RF channel bandwidth / beam</i>	50 MHz	5 x 50 MHz
<i>Avg. throughput / beam</i>	342.7 Mbps	5 x 541.3 Mbps
<i>Aggregated throughput</i>	1,370.8 Mbps	5 x 2,165.2 Mbps

	5G STEP FWD	Classic 5G	
<i>RRHs</i>	79	79	10 Macro Base Stations
<i>DL users</i>	76	76	
<i>UL users</i>	48	48	

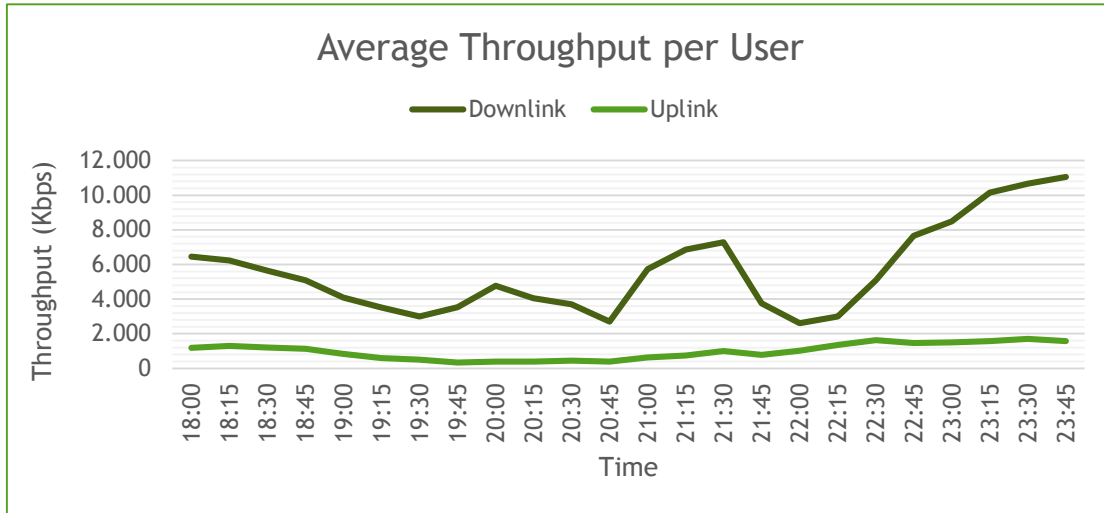
Real User Demands (Karaiskakis stadium)

- COSMOTE relevant department provided us with detailed data regarding:
 - The fixed & wireless access topology of the Karaiskakis stadium (location of base stations & optical fibers).
 - The user demands during a game/concert/show (number of connected users, quantity of consumed UL/DL traffic).
 - Data during a match day September 2019 over 15 min interval.



- Available capacity: 32,000
- Match attendants: 32,000
- Max. active users: 22,976

Real User Demands



- Avg. DL throughput/user: 930 kbps
- Avg. UL throughput/user: 230 kbps
- Current capacity: 18.1968 Gbps
- **Future capacity: 1,819.68 Gbps**

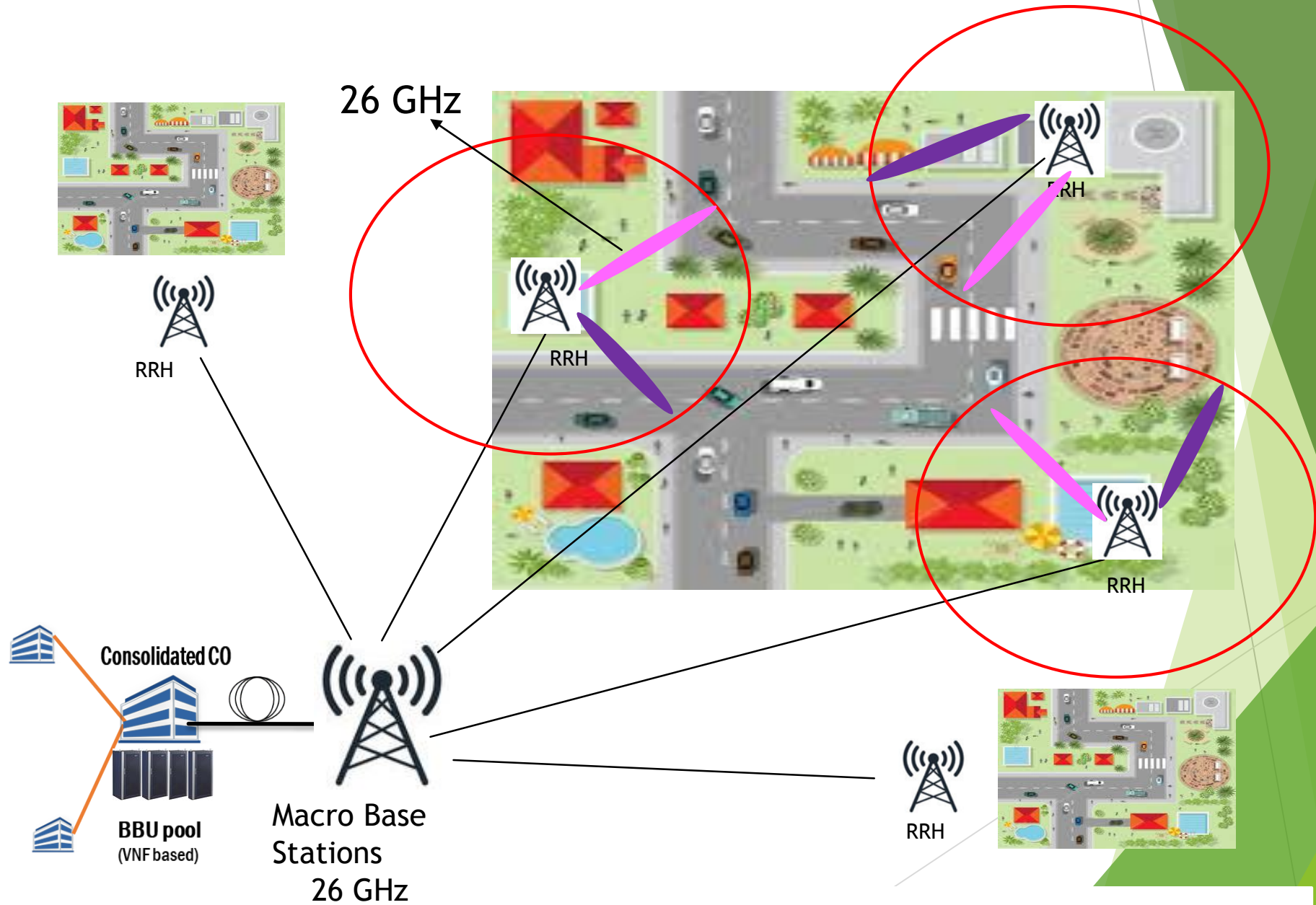
- During the match, although the active users are tripled, the avg. DL throughput/user decreases!
- Available resources cannot adequately serve the clients' needs
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 - DL/UL traffic volume will increase by 100 times.
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Assumptions & Throughput Analysis

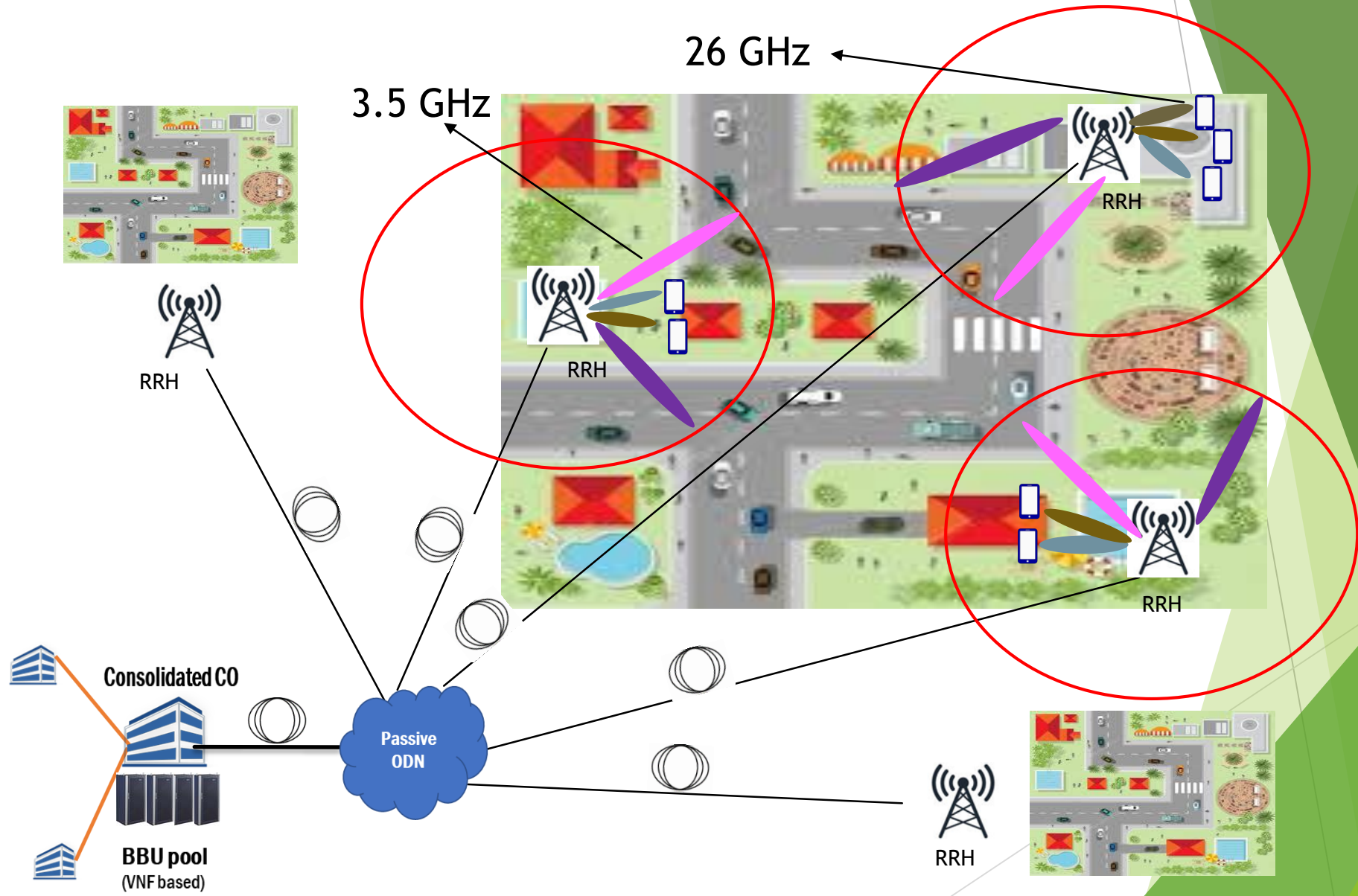
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	5G STEP FWD	Classic 5G	
<i>RRHs</i>	1360	1360	861 Macro Base Stations
<i>DL users</i>	14.74	14.74	
<i>UL users</i>	59.60	59.60	

2) Classic 5G: Urban City



2) 5G STEP FWD: Urban City



Thank you for your patience 😊

