

# **Device-to-Device Communication in 5G Cellular Networks: Challenges, Solutions, and Future Directions**

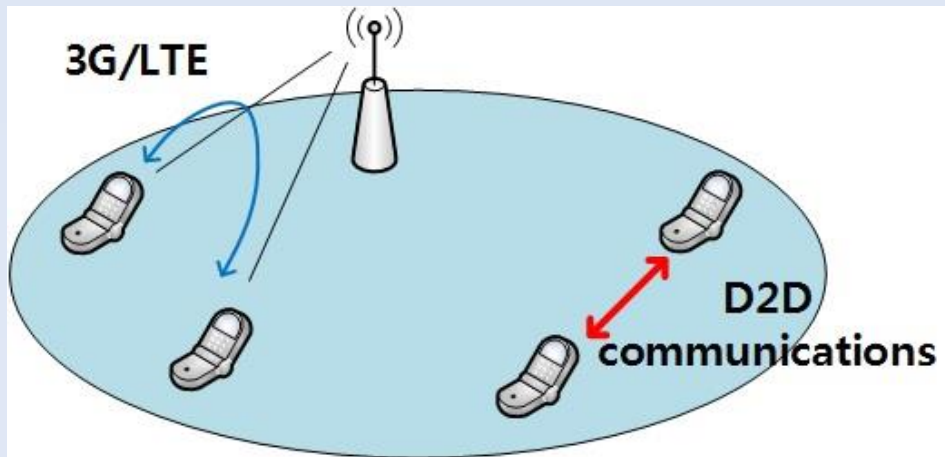
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# Introduction

- Increased number of hand-held devices
- Bandwidth hungry applications
- High data rate requirements

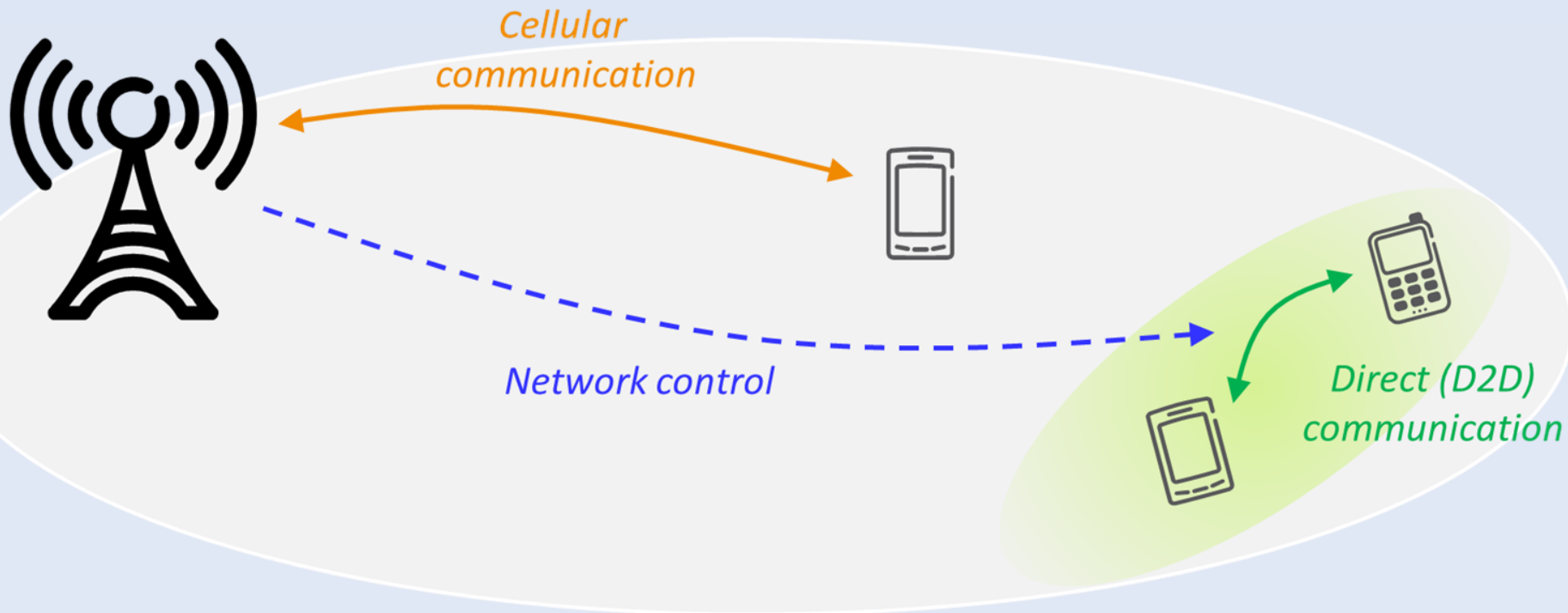
# D2D Communications

- Help with effective sharing of resources
- Take some load off the network of local areas
- Provide service when the BS is damaged



# Two Tier 5G Cellular Network

- Macrocell Tier- Conventional cellular network
- Device Tier – D2D Communications



# Device Tier Communication

- Device relaying with OC Link establishment
- Direct D2D with OC Link establishment
- Device relaying with DC Link establishment
- Direct D2D with DC Link establishment

# Technical issues

- Security
- Interference management



# Security

- Closed access
- Only relay data through devices on a trusted devices list
- Else we would use the Macrocell Tier

# Interference Management

- When the base station controls the link establishment, it can diminish the interference problems using centralized methods
- The Device tier need to be designed with appropriate interference management strategies and resource allocation schemes



# Pricing: Actual Scenario



- Operator controls all communications
- Easy to apply charges

# Pros and Cons

## Operator

- **Harder to manage**
- **Smaller infrastructure**
- **Serve more users**
- **Better service quality**

## Client

- **Battery consumption**
- **Bandwidth**
- **Device resources**
- **Plan discounts**
- **Provision of services**

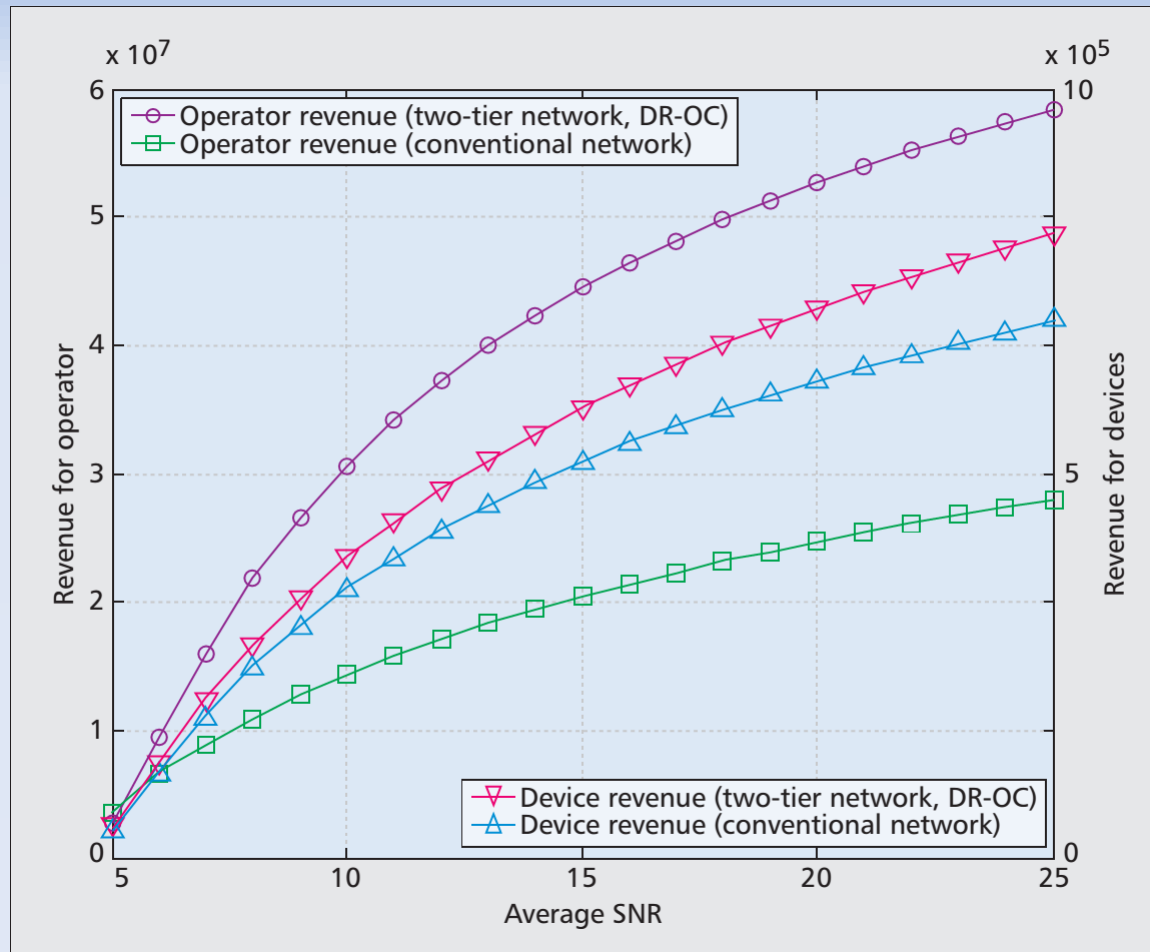


# Pricing for DC-OR

- Device relaying operator controlled
- All communications are controlled by mobile operator
- Operators should reward users with attractive incentives
- Revenue should be in function of services provided by the user
- Operators can implement any model

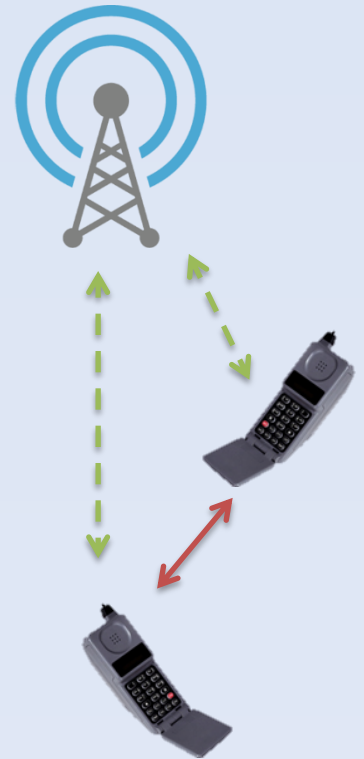


# Pricing for DC-OR



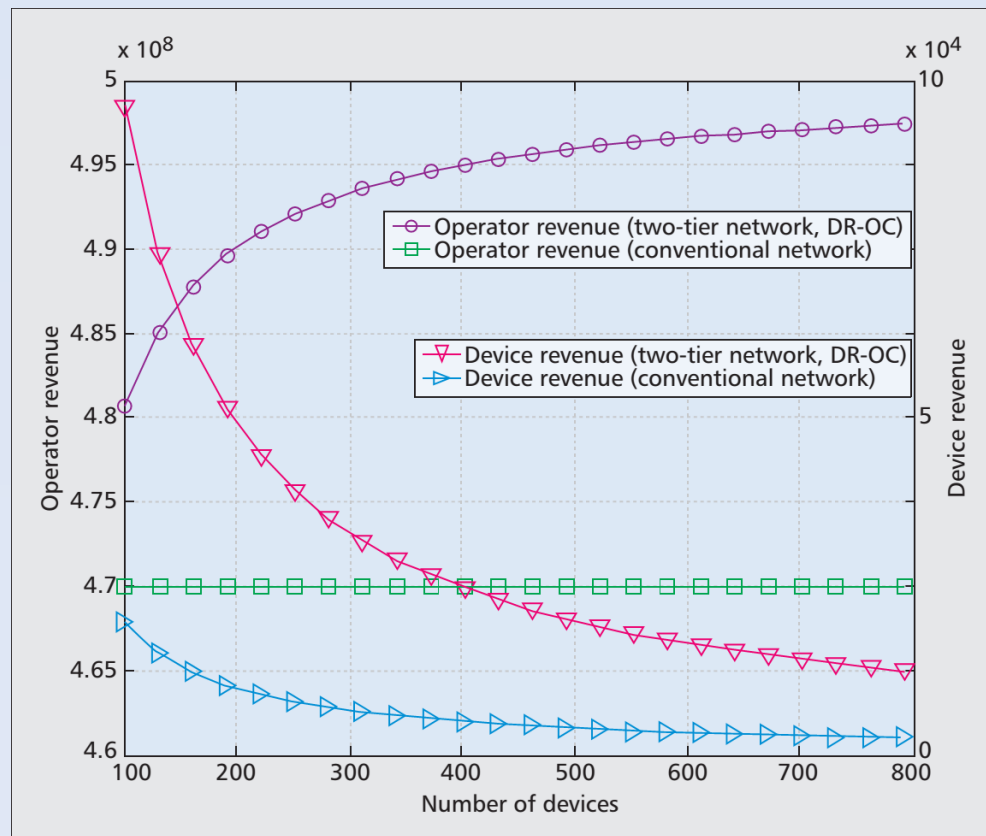
# Pricing for DC-OC

- D2D communication operator controlled
- Users can simply use free networks (e.g. WiFi or Bluetooth)
- Solution can be inspired in auction and game theory
- Useful in busy environments when network capacity is reached
- Users with higher bid will have access to the medium



# Pricing for DC-OC

- Operators revenue will increase with more devices



# Pricing for DR-DC and DC-DC

- Device controlled
- Operators don't participate in the communication
- Users can share information freely (e. g. WiFi or Bluetooth)
- Relay devices can ask money for the service
- Like in market – law of supply and demand



# Conclusion

- We envisioned a 5G network where devices can communicate with each other
- Two tiers: macrocell and device tier
- Different participation of operators and devices
- Technical difficulties: security, interference and resource allocation
- But, in the end, this kind of networks can bring good benefits for operators and users



# Questions

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