Device-To-Device (D2D) Communication in 5G Cellular Networks

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Cellular Network Evolution

The higher speeds, the more services

<table>
<thead>
<tr>
<th>Year</th>
<th>Generation</th>
<th>Speed</th>
</tr>
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<tbody>
<tr>
<td>1980s</td>
<td>1G (Voice band)</td>
<td>9.6Kbps</td>
</tr>
<tr>
<td>1991</td>
<td>2G/GSM</td>
<td>384 Kbps</td>
</tr>
<tr>
<td>2002</td>
<td>3G/UMTS</td>
<td>100Mbps</td>
</tr>
<tr>
<td>2009</td>
<td>4G/LTE</td>
<td>10Gbps</td>
</tr>
<tr>
<td>2020</td>
<td>5G</td>
<td></td>
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5G Key Enabling Technologies (1/2)

Device to Device Communication (D2D)

- Advanced Network
- mmWave System
- ACM & Multiple Access
- Advanced Small Cells
- Advanced MIMO
- Multi-RAT
## 5G Key Enabling Technologies (2/2)

<table>
<thead>
<tr>
<th></th>
<th>Peak Data Rate</th>
<th>Cell Edge Data Rate</th>
<th>Cell Spectral Efficiency</th>
<th>Mobility</th>
<th>Energy/Cost Efficient</th>
<th>Simultaneous Connection</th>
<th>Latency</th>
</tr>
</thead>
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Network Models

Multi-hop Comm. with Operator (MCO)  Multi-hop Comm. with Out Operator (MCOO)

Direct link  Relay link  Control link

Direct Comm. with Operator (DCO)  Direct Comm. with Out Operator (DCOO)
Research Perspective

- **Network Speed, Bandwidth**
  - MCO
  - DCO
  - (licensed Band)

- **Security threads**
  - Interference avoidance, Quality of Service (QoS)

- **Power Utilization**
  - MCOO
  - DCOO
  - (Unlicensed Band)

- **Future models?**
  - Cooperative comm.
User & Operator Perspective

Conventional comm. models

<table>
<thead>
<tr>
<th>MCOO</th>
<th>DCOO</th>
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</table>

Pricing & QoS models?

Future models?
D2D Comm. Framework Proposal

- Device to Device applications
- Communication Services Interface
  - Wireless Comm. Framework (e.g., Samsung Chord SDK, Bluetooth APIs...)
  - Wireless Routing Protocol (e.g., TMRP/OLSR/AODV)
- Telephony Manager
  - Security (Open Access/ Closed Access)
  - Power Management
  - QoS
- Telephony Protocols suite
- Linux Kernel

Device to Device applications

Wireless Comm. Framework (e.g., Samsung Chord SDK, Bluetooth APIs...)

Wireless Routing Protocol (e.g., TMRP/OLSR/AODV)

Telephony Protocols suite

Linux Kernel
Research Challenges & Trends

- Security
- Power Consumption
- Bandwidth Utilization
- Spectral Interference
- QoS
- D2D Communication
  - Pricing Models
  - Mobility Management
  - Wireless Multi-hop Routing
  - Cognitive Radio
  - QoS
  - Security
  - Power Consumption
  - Bandwidth Utilization
  - Spectral Interference
  - QoS
References

Thank you for your listening

Q&A