CHAPTER 1: Introduction

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Overview of Wireless Systems

- **Mobility**
  - **Outdoor**
    - Vehicle
    - Walk
    - Fixed
  - **Indoor**
    - Walk
    - Fixed/Desktop

- **Wide Area Network (WAN)**
  - Coverage

- **Personal Area Networks (PAN)**
  - Low Power Systems

- **Modern Cellular Systems (WAN)**
  - LTE
  - LTE Advanced
  - UMTS (3G)

- **Local Area Network (LAN)**
  - Hot Spots

- **Vehicular Networks**
  - (high mobility)

- **Sensor Networks**

- **Bluetooth**

- **WiFi**
  - 802.11a/b
  - 802.11n
  - 802.11 ac

- **UWB**

- **GSM, UMTS, HSPA, WiMAX**

- **Modern Cellular Systems (WAN)**
  - LTE
  - LTE Advanced

- **5G**
  - Bluetooth
  - Sensor Networks
  - 802.11p (VANET)
  - UMTS (3G)
  - HSPA, WiMAX
  - 802.11b/g/n/ac

- **10Gbps**
EVOLUTION OF CELLULAR SYSTEMS

1G
- AMPS
- TACS
- NMT
- 1980s
- Analog
- Different for each country
- 2.8 kbps – 56 kbps

2G
- 2.0G
- 2.5G
- 2.75G
- GSM
- cdmaOne
- 1990s
- Digital
- TDMA-based
- First data services
- 15 kbps - 400 kbps
- (Narrowband)

3G
- 3.0G
- 3.5G
- 3.9G
- UMTS
- HSPA
- CDMA-based
- (LTE: OFDMA-based)
- * Introduction of MIMO
- * Mobile Internet – Application Explosion
- * Range of Mbps
- (Broadband)

4G
- LTE-A
- LTE-B
- LTE-C
- 2010s
- All OFDMA-based
- Novel enabling technologies
- Range of Gbps
- (Mobile Broadband)
- xDSL like experience

5G
- 2020
- New Waveforms
- mm-Wave access & backhaul
- Ultra-dense small cells
- Range of tens of Gbps
- Fiber like experience

(Narrowband) (Broadband)

IFA’2018 ECE6610
EVOLUTION OF MOBILE TRAFFIC

Exabytes per month

3GPP Subscriptions (millions)

- HSPA
- LTE
EVOLUTION OF WIRELESS SYSTEMS

Global Mobile Data Traffic, 2015 to 2020

<table>
<thead>
<tr>
<th>Year</th>
<th>Exabytes per Month</th>
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<tbody>
<tr>
<td>2015</td>
<td>3.7</td>
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<tr>
<td>2016</td>
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<td>2017</td>
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<td>2018</td>
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<td>2019</td>
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<td>2020</td>
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</tbody>
</table>


1 Exabyte = 10^{18} Bytes

Pictures taken at St. Peter’s Square for papal inauguration ceremonies of Pope Benedict (2005) and Pope Francis (2013)
REQUIREDMENTS

Explosion of Users’ Demand for Mobile Data

Many New Services and Applications

Ubiquitous Wireless Broadband Access to a Very Large Cloud Platform