US- 5G Talent Landscape Analysis

2018
## AGENDA & Methodology

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US- Core 5G talent landscape: ~12,000 5G engineers; ~60% of the talent is concentrated at Six 5G catchment areas

Note: DRAUP’s proprietary talent module was used to analyse jobs by job roles and skill type across locations.
Overall US Talent Migration trends: Micro level analysis of talent movement patterns indicated emerging hotbeds around the 5G catchment locations.

- Las Vegas, Minneapolis, Waco etc.
- Top telecom giants such as T-Mobile, Verizon and AT&T, have announced setting up 5G network operations in these emerging hotbeds. Thus generating job requirement of 5G implementation and orchestration roles.

- San Francisco, New York and Austin, have set-up collaboration with Telecom employers which will attract TEMs & Network giants to set-up R&D centres.

- Las Vegas, Phoenix, Waco, Kansas City, Chicago are potential 5G market which are telecom companies such T-Mobile, Sprint, Verizon and AT&T are bringing 5G talent from nearby catchment areas.

Note: DRAUP's proprietary talent module was used to analyse jobs by job roles and skill type across locations.
**Upskilling & 5G Certifications:** TEM and Network providers are up-skilling existing talent pool through online learning platforms and internal training programmes.

**Technical Certifications and Training Programs in 5G Technology Domain**

- **6+ Industry Partners**
  - 5G-Courses.com
  - Coursera
  - Udemy

- **Key Courses**
  - Towards 5G – Research and Standardization
  - Internet of Things in 5G
  - 5G Engineering

- **20+ 5G related courses**
  - 5G New Radio Training Course and Certification
  - 5G System Design
  - 5G Device-to-Device Communication
  - IoT in 5G

- **20+ independent Organisations and Online Platforms offer 5G-related technical courses and programs to cater the 30,000+ 5G – trainable talent in US**

- **10+ 5G related courses**
  - 5G NR Training
  - LTE, LTE-A, LTE-A Pro Migration to 5G
  - 3GPP 5G Training
  - 5G security Training
  - 5G WiFi Offload Training

- **Key Courses**
  - 5G Mobile Communications – LTE & LTE-A
  - 5G, 4G – LTE Cellular Mobile Communications Wireless

- **20+ Industry Partners**
  - Cisco
  - Intel
  - Qualcomm

- **Company**
  - 5G, Edge Compute and Intel Network Edge Virtualisation SDK course under Network Builders Program

- **Independent Organisation**
  - 5G, 4G – LTE Cellular Mobile Communications Wireless

**Note:** DRAUP’s Talent Simulation Module analysed key emerging certifications and corporate earning programmes in 5G.
### US Top 5G Universities

which are undertaking large research programmes with corporates to accelerate 5G innovation

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<tr>
<th>UNIVERSITY OF TEXAS - AUSTIN</th>
<th>UNIVERSITY OF CALIFORNIA - BERKELEY</th>
<th>NEW YORK UNIVERSITY</th>
<th>UNIVERSITY OF CALIFORNIA – SAN DIEGO</th>
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<tr>
<td><strong>• Extensive research into mmWave technologies.</strong></td>
<td><strong>Current research areas include:</strong></td>
<td><strong>Current research topics in 5G include:</strong></td>
<td><strong>• Demonstrated the World’s Fastest 28 GHz 5G Band, Bidirectional Phased-Array.</strong></td>
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<td><strong>• Developing hybrid beamforming transmission strategies to adaptively configure arrays at the transmitter and receiver.</strong></td>
<td><strong>• Software Defined Networking</strong></td>
<td><strong>• NYUSIM: 5G Channel Model Simulator</strong></td>
<td><strong>• Demonstrated World’s First 5G, 100 to 200 Meter Communication Link up to 2 Gbps</strong></td>
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<tr>
<td><strong>Key Partners:</strong></td>
<td><strong>• Networking functions virtualization</strong></td>
<td><strong>• mmWave 5G Channel Sounder</strong></td>
<td><strong>Key Partners:</strong></td>
</tr>
<tr>
<td>Qualcomm</td>
<td><strong>• Industrial Internet of Things (IIOT) and Augmented &amp; Virtual Reality</strong></td>
<td><strong>• Real-time Massive MIMO Channel Emulation</strong></td>
<td><strong>Professor Sanjay Shakkottai</strong></td>
</tr>
<tr>
<td>AT&amp;T</td>
<td><strong>• Low cost mmWave and RF technologies.</strong></td>
<td><strong>Key Partners:</strong></td>
<td><strong>Ashley H. Priddy Centennial Professor in Engineering, WNCG Director</strong></td>
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<tr>
<td>Huawei</td>
<td><strong>Key Partners:</strong></td>
<td><strong>Professor Ali M. Niknejad, Co-Director BWRC</strong></td>
<td><strong>Professor Sujit Dey, Director Center for Wireless Communication</strong></td>
</tr>
<tr>
<td><strong>WIRELESS NETWORKING COMMUNICATIONS GROUP</strong></td>
<td>Qualcomm</td>
<td><strong>David Lee/Ernst Weber</strong></td>
<td><strong>Current research areas include:</strong></td>
</tr>
<tr>
<td><strong>150+ Graduates</strong></td>
<td>AT&amp;T</td>
<td><strong>Professor Theodore Rappaport, Director</strong></td>
<td><strong>• Demonstrated the World’s Fastest 28 GHz 5G Band, Bidirectional Phased-Array.</strong></td>
</tr>
<tr>
<td><strong>20+ Faculty Members</strong></td>
<td>Qualcomm</td>
<td></td>
<td><strong>• Demonstrated World’s First 5G, 100 to 200 Meter Communication Link up to 2 Gbps</strong></td>
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</table>

**Note:** The above information is based on data provided by the respective universities and Draup Proprietary Database.

**Note:** DRAUP Methodology
Core 5G Tech Stack: 5G Organizations are prioritizing diverse capabilities across infrastructure, platform and application segments

**Infrastructure**
- Small Cell
- Optical Technology
- Massive MIMO
- Smart Antenna
- Code Division Multiple Access Points
- Ultra Wide Band Network

**Network**
- Spectrum Efficiency
- Cloud RAN
- SON
- MEC
- SDN
- SD-WAN
- NFV
- Internet exchange Point
- Millimetre wave

**Platforms**
- Control Applications
  - Software Defined Mobile Network Control
  - Software Defined Mobile Network Connector
- Data Plane
  - Virtual Network Function
  - Physical Network Function

**Application**
- Control Plane
  - Software Defined Mobile Network Control
  - Software Defined Mobile Network Connector
- Data Plane
  - Virtual Network Function
  - Physical Network Function

**5G Support**
- Infrastructure and adjacent technologies

**5G Protocols**
- Radio Resource Control
- Packet Data convergence Protocol
- Radio Link Control
- Long Term Evolution PHY
- Medium Access Control
- S1 Application Protocol
- Stream Control Transmission Protocol
- Internet Protocol
- Ethernet

**Note:**
- SON – Self Organized Network
- MEC – Mobile Edge Computing
- SDN – Software Defined Networking
- NFV – Network Function Virtualization

**Note:** DRAUP Methodology
Core 5G Job Role Taxonomy: A deeper analysis of Job-Corpus resulted in **30+ Job roles** clustered across 7 **Job families**.

### Core Engineering Roles (Design, Development & Testing of 5G Platforms)

#### 5G Software Development (SW)
- 5G protocol stack S/W developer
- 5G S/W infrastructure engineer
- 5G mmW Design Engineer
- Wireless S/W Engineer
- RF/DSP S/W Design
- 5G-Baseband S/W Developer

#### Core 5G - Baseband Engineering (Embedded/SW)
- Baseband FPGA Engineer
- Baseband Test Engineer
- 5G Modem Design Engineer
- Baseband Infrastructure developer
- Baseband HW Engineer
- LTE/5G RF Engineer

#### 5G Embedded/ ASIC Engineering (Embedded/HW)
- 5G/LTE Embedded Firmware Engineer
- Firmware Engineer- 5G
- RF FEM/MEMS PHY Engineer
- 4G/5G Wireless System Engineer
- 5G Field Applications
- 5G Wireless RTL Engineer

### Implementation Roles

#### Platform Implementation/Network Architect
- 5G Standardization Engineer
- 5G Wireless System Integration
- 5G Cloud RAN System Specialist
- Network Planning Engineer
- LTE/WCDMA Packet core solution Architect

### Emerging Roles

#### 5G- IoT Engineering
- System Engineer, IoT, 5G
- Systems Engineer - 5G,NFV,IoT

#### 5G- ML Engineering
- System Engineer, IoT, 5G
- Systems Engineer - 5G,NFV,IoT

#### 5G- Security Engineering
- Solution Architect- 5G Security
- Cloud Security Architecture and E2E Solutions

### Note:
The DRAUP Methodology for analyzing job roles was used.

**SON** – Self Organized Network, **MEC** – Mobile Edge Computing, **SDN** – Software Defined Networking, **NFV** – Network Function Virtualization.

**Note:** DRAUP Methodology.
**US- Core 5G Skill Distribution Deep dive:** Precisely estimating the talent suited for 5G, involves several interviews and a deeper understanding of technical stacks across resumes and profiles.

Domain and Digital skills considered for analysis are filtered by the following criteria:

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<tr>
<th>Core 5G Talent Pool</th>
<th>Total Employed talent pool</th>
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<tr>
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<td>12,000</td>
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<tr>
<td>5G Software Development</td>
<td>~5,500</td>
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<tr>
<td>Core 5G- Baseband Engineering</td>
<td>~1,500</td>
</tr>
<tr>
<td>5G Embedded/ASIC Engineering</td>
<td>~3,000</td>
</tr>
<tr>
<td>Platform Implementation/Network Architect</td>
<td>~2,000</td>
</tr>
</tbody>
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- **Total 5G Software Development Talent**: ~5,500
- **Total 5G Baseband Engineering Talent**: ~1,500
- **Total 5G Embedded/ASIC Engineering Talent**: ~3,000
- **Total Platform Orchestration/Network Architect Talent**: ~2,000

**Adjacent talent pool in Seattle which can be upskilled to 5G engineers**: ~1,700