US- 5G Talent Landscape Analysis
2018
AGENDA & Methodology

01 US- 5G Talent Landscape Analysis

Analysis Tracks

- US- Core 5G Talent Landscape: Talent hotspots, markets, universities & migration trend (Slide 3-4)
- 5G Certification and Upskilling initiatives (Slide 5)
- Key Universities with mature 5G research (Slide 6)
- 5G tech Stack, Job Corpus & talent distribution by core roles (Slide 7-9)
- Seattle Deep Dive: Core 5G Skill set distribution & Peer Employer profiles (Slide 10-18)

Adjacent Trainable Talent Analysis

- Adjacent Baseband Role: Definition, Skills, Workloads and Talent Size (Slide 20-21)
- US- Adjacent Baseband role Talent hotspots and Key employers in each location (Slide-22)
- Seattle Deep Dive: Talent size & micro hotspots (Slide 23)
- Talent Mobility to Seattle during last 1 year (Slide 24)
- Seattle Deep Dive: Key Employers & Job profiles (Slide 25-29)
- UE Vendors: List of Vendors across US hotspots and solutions/devices portfolio (Appendix)
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

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

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

20+ 5G related courses

Key Courses
- 5G New Radio Training Course and Certification
- 5G System Design
- 5G Device-to-Device Communication
- IoT in 5G

6+ Industry Partners

Key Courses
- 5G NR Training
- LTE, LTE-A, LTE-A Pro Migration to 5G
- 3GPP 5G Training
- 5G security Training
- 5G WiFi Offload Training

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

Key Courses
- 5G, Edge Compute and Intel Network Edge Virtualisation SDK course under Network Builders Program
- 5G New Radio Technical Course
- Cellular – V2X Course
- 5G Massive IoT
- 5G LTE Advanced courses

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

<table>
<thead>
<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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<tbody>
<tr>
<td><strong>Key Partners:</strong></td>
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<td><strong>Key Partners:</strong></td>
<td><strong>Key Partners:</strong></td>
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<tr>
<td>Qualcomm</td>
<td>AT&amp;T</td>
<td>KEYSIGHT</td>
<td>NOKIA</td>
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<td>AT&amp;T</td>
<td>HUAWEI</td>
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<td>Keysight</td>
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<tr>
<td>HUAWEI</td>
<td>Intel</td>
<td></td>
<td>ERICSSON</td>
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<tr>
<td><strong>Wireless Networking Communications Group</strong></td>
<td><strong>Berkeley Wireless Research Center</strong></td>
<td><strong>New York University Wireless</strong></td>
<td><strong>UCSD Center for Wireless Communications</strong></td>
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<tr>
<td>150+ Graduates</td>
<td>100+ Students</td>
<td>120+ 5G Related Publications</td>
<td>100+ Students</td>
</tr>
<tr>
<td>20+ Faculty Members</td>
<td>20+ Faculty Members</td>
<td>100+ Students</td>
<td>20+ Faculty Members</td>
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</table>

**UNIVERSITY OF TEXAS - AUSTIN**
- Extensive research into mmWave technologies.
- Developing hybrid beamforming transmission strategies to adaptively configure arrays at the transmitter and receiver.

**UNIVERSITY OF CALIFORNIA - BERKELEY**
Current research areas include:
- Software Defined Networking
- Networking functions virtualization
- Industrial Internet of Things (IIOT) and Augmented & Virtual Reality
- Low cost mmWave and RF technologies.

**NEW YORK UNIVERSITY**
Current research topics in 5G include:
- NYUSIM: 5G Channel Model Simulator
- mmWave 5G Channel Sounder
- Real-time Massive MIMO Channel Emulation

**UNIVERSITY OF CALIFORNIA – SAN DIEGO**
- Demonstrated the World's Fastest 28 GHz 5G Band, Bidirectional Phased-Array.
- Demonstrated World's First 5G, 100 to 200 Meter Communication Link up to 2 Gbps.

**Key Partners:**
- Professor Sanjay Shakkottai
- Ashley H. Priddy Centennial Professor in Engineering, WNCG Director
- Professor Ali M. Niknejad, Co-Director, BWRC
- David Lee/Ernst Weber
- Professor Theodore Rappaport, Director
- Professor Sujit Dey,
  Director Center for Wireless Communication

**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

5G Support Infrastructure and adjacent technologies

Network Management and Orchestration

Maintenance & Optimization

Service Exposure

OTT

Mobile Virtual Network Operator

OSS/BSS

Control Plane

Control Applications

Software Defined Mobile Network Control

Software Defined Mobile Network Connector

Data Plane

Virtual Network Function

Physical Network Function

Network

Radio Acess Network

Spectrum Efficiency | Cloud RAN | SON | MEC

Core Network

SDN | SD- WAN | NFV | Internet exchange Point

Transport Network

Millimetre wave

Hardware

Small Cell

Optical Technology

Massive MIMO

Smart Antenna

Code Division Multiple Access Points

Ultra Wide Band Network

Non Access Stratum

Radio Resource Control

Packet Data convergence Protocol

Radio Link Control

Medium Access Control

Long Term Evolution PHY

S1 Application Protocol

Stream Control Transmission Protocol

Internet Protocol

Ethernet

User Equipment

LTE Uu

5G (eNodeB)

S1 Mobility Management Entity

Mobility Management Entity

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 SW Developer

**5G Embedded/ ASIC 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

- **5G System Integration Architect**
  - Networking S/W Architect
  - Wireless Network Architecture & Design
  - 5G UDM Integration

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: 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 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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<table>
<thead>
<tr>
<th>Domain and Digital Skills</th>
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<tbody>
<tr>
<td>5G Software Development</td>
<td>~12,000</td>
</tr>
<tr>
<td>5G Baseband Engineering</td>
<td>~5,500</td>
</tr>
<tr>
<td>5G Embedded/ASIC Engineering</td>
<td>~1,500</td>
</tr>
<tr>
<td>Platform Orchestration/Network Architect</td>
<td>~3,000</td>
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<tr>
<td>Total Platform Orchestration/Network Architect Talent</td>
<td>~2,000</td>
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**Core 5G Talent Pool**

- Total Employed talent pool
- 5G Software Development
- Core 5G - Baseband Engineering
- 5G Embedded/ASIC Engineering
- Platform Implementation/Network Architect

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

**Total Employed talent pool**

Note: DRAUP’s Talent Simulation Module
Draup is an enterprise decision-making platform for global CXO leaders in sales and talent domains.

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