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5G RAN

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The big opportunity with 5G

Discover 5G market dynamics

Build your 5G technology strategy

Lawrence C. Miller

Arm Special Edition

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Arm Neoverse is their platform for developing microprocessors optimized for datacenters, communication networks, and edge computing. Some of the world's largest clouds and telecommunications operators have adopted Arm Neoverse solutions to improve performance while reducing energy consumption and total cost of ownership.

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Editorial Manager: Rev Mengle

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IN THIS CHAPTER

- Discovering 5G opportunities
- Looking at different use cases
- Recognizing 5G challenges
- Changing traditional network approaches

Chapter 1

5G: A Network like No Other

In this chapter, you learn about the 5G opportunity, new use cases, 5G challenges, and the limitations of traditional networks.

Understanding the 5G Opportunity

Make no mistake: 5G is here. Over 65,000 5G service offerings have been deployed worldwide by more than

168 carriers according to Ookla. Industry analysts expect the number of 5G handsets in use to surpass 1 billion in 2022.

Beyond mobile customers, 5G presents many other new opportunities as well. Lufthansa, Gestamp, and the Port of Antwerp are just a few examples of organizations already rolling out 5G trials to improve quality control, cut energy, and tighten supply chains.

Preventative, routine, and post-operative health care — with 5G at its core — represents a $76 billion opportunity according to Ericsson.

5G services will be offered through traditional carriers, public clouds, and private networks (managed by third parties or customers themselves). The applications and services enabled by 5G will have a ripple effect, paving the way for new applications, use cases, and revenue opportunities.

REMEMBER

To succeed, 5G will require a flexible, high-performance network built on new products, new standards, and cloud technologies. Spending on 5G infrastructure is expected to surpass $47 billion per year by 2027. This book is about the opportunities and challenges of building this invisible fabric to make everything work.

Exploring 5G Use Cases

There are three broad use cases for different 5G applications and services, as follows:

- **Enhanced Mobile Broadband (eMBB)** for consumer and enterprise connectivity. EMBB enables massive data bandwidth that can be used for augmented reality (AR), virtual reality (VR), better videoconferencing, and enhanced gaming — the kind of apps that used to require wired connections.
- **Massive Machine Type Communications (mMTC)** for the Internet of Things (IoT). The goal is to be able to connect up to 1 million devices within 1 square kilometer.
- **Ultra Reliable Low Latency Communications (uRLLC)** for Industrial IoT. uRLLC provides very high-speed communications with latency gaps as small as 1 millisecond. Many uRLLC applications such as industrial automation and smart grid monitoring will also require extreme reliability guarantees.

Addressing Performance, Power, and Cost Challenges

It's important to recognize that 5G isn't one network — it's three: low-band (600 MHz to 700 MHz), mid-band (2.5 GHz to 3.5 GHz), and high-band (3.5 GHz to 39 GHz). Low-band radio waves can travel long distances, but can only carry around 250 megabits per second (Mbps), not much better than 4G. Mid- and high-band waves achieve greater speeds and can carry more data, which is great for IoT, AR, and autonomous vehicles, among others. But mid- and high-band waves are short (measuring in millimeters) and even raindrops can interfere with these waves.

5G will also accommodate features such as beam steering and network slicing designed to improve quality of service and manage the different performance requirements of 5G's frequencies and applications.

REMEMBER

The higher the frequency, the higher the bandwidth and speed.

The challenge for carriers is learning how to build networks that can support some or all three networks at the same time. More and different types of equipment, such as picocells and femtocells, will be needed. Plus, the equipment must be built in a way so that businesses, and not just carriers, can set up private 5G networks.

Femtocells are small mobile base stations, primarily used to offload congested networks, extend coverage, and improve coverage inside buildings or campuses.

Meanwhile, the performance demands of customers will explode: Network traffic will grow exponentially and customers will demand faster speeds.

These new application and performance demands raise the potential for higher equipment costs and higher energy consumption. Some industry analysts have predicted that energy consumption could rise by 160 to 300 percent without improved technologies.

That's difficult in any industry, but especially chilling in telecommunications. Average revenue per customer has remained somewhat flat. While 5G's new applications promise to dramatically raise the number of connections and revenue opportunities, building 5G networks involves risks.

As one seasoned exec recently said, "We need to make networks that are economically viable."

Addressing the challenges of 5G will certainly strain the capital budgets and creativity of carriers. They will have to learn how to provide more and better services while still

making money. Expect to see efforts around boosting the performance of low-band and extending the range of mid- and high-band.

A New Way of Thinking about Networks

The demand for higher performance combined with the economic and environmental challenges faced by carriers and infrastructure providers means one thing: Carriers need to rethink basic assumptions about equipment, services, and networks. Those large antennas on distant hills? They will still be there, but the internal technology will change and more processing will occur on clouds and data centers.

Chapter 2 discusses five key areas where companies are combining new technologies, ideas from the cloud, and earned wisdom from 30 years in wireless to rise to the challenge: processors, hardware, software, cloud hosting, and open standards. These factors are interrelated. Greater processing power paves the way for new equipment and virtualization while open standards will encourage new processors.

IN THIS CHAPTER

- Building a high-performance foundation for 5G
- Leveraging virtualization and containerization
- Deploying to the cloud

Chapter 2
Understanding the Keys to 5G

This chapter explores five key areas that will experience a sea change with 5G adoption and growth.

Processors

To handle the flood of traffic and higher performance requirements of 5G within tight economic and power budgets, the performance of CPUs and other chips inside 5G equipment will have to increase exponentially.

Radio Units (RUs), the first stop on the network for 5G devices and phones, will see the greatest change: RUs will contain server-grade chips that will leverage artificial intelligence (AI) to orchestrate traffic.

Centralized Units (CUs), which act like data centers for RUs, and *Distributed Units (DUs)* will also get a significant upgrade to handle larger and more complex workloads. So too will core networks, which connect these *radio access network (RAN)* assets to the central telco network. Likewise, new features like beamforming and network slicing will put further demands across the stack. In short, everything gets smarter for 5G.


TIP

Some chip designers are already reporting a threefold increase in performance per watt with new products. Chip designers will also combine graphics processing units (GPUs) into 5G chips to boost performance while keeping a lid on power and cost.

Hardware

Historically, carriers built networks on equipment from a few select vendors, which limited their ability to configure or customize their services.

5G hardware will change in three fundamental ways:

- **Equipment will be disaggregated.** Traditional equipment will be separated into different devices (that is, RU, DU, and CU) and optimized through virtualization and containerization to increase capacity.
- **Equipment will be produced by a larger group of new vendors.** These vendors will be able to take advantage of the new software and processors coming to market.
- **Hardware will be tailored to set up private 5G networks.** These will be managed by carriers, factory owners, and others.

In other words, a wider array of equipment from more vendors will be offered to a larger group of customers. This will speed innovation and drive down cost.


TIP

As discussed in Chapter 1, high-band 5G will be great for Industrial Internet of Things (IIoT) and campus environments where speed and data volumes will be extremely high. You can give those customers a *micro-cell* (that is, a radio tower) to use the still largely vacant radio spectrum to communicate with everything on the campus.

Software

Virtualization and container software will be extensively deployed to get greater utilization out of hardware. It will also lay the foundation for services like network slicing that allow uRLLC to coexist with other applications. Virtualized RAN (vRAN) systems could grow from 7 percent of systems today to 48 percent by 2025.

Operating systems, applications, and network optimization software will also be recompiled to run on the new foundation of disaggregated 5G silicon and hardware.

Much of the work to be done in software will be addressed by standards. The Third Generation Partnership Project (3GPP) Releases 15 through 17 specifications will outline a baseline capability that will need to be implemented into design.

Artificial intelligence (AI) and machine learning (ML) technologies can be used, for example, to extend the range of 5G millimeter wave (mmWave) transmissions by counteracting different environmental conditions and weak signals.

Cloud Infrastructure

5G network elements, such as vRANs, will also be hosted in public and private clouds to reduce costs, similar to the way private data centers have gone to the cloud.

Dish recently announced a deal to build a cloudified, standards-based 5G network on AWS services. Although standalone equipment will remain a big part of 5G, substantial portions will become cloudified.

Open Standards

Like in PCs and data centers, open standards in 5G infrastructure will help eliminate technical problems that can slow adoption, expand the market to more participants, and reduce the risk of vendor lock-in.

Some estimate Open RAN hardware and software could account for half of the 5G footprint by 2030 and reduce the total cost of ownership (TCO) by 10 to 15 percent or more.

While lower cost is often cited as the main benefit of open standards, eliminating vendor lock-in and encouraging faster innovation become more important over time.

REMEMBER

Going "open" will take work. Wireless is both a high-performance computing problem and a real-time computing problem. Open RAN-based equipment will be adopted more quickly for some parts of the network. Virtualized and more traditional architectures will coexist in varying ways.

Several organizations and industry initiatives have been formed to take on the challenges of open 5G infrastructure, including:

- **O-RAN Alliance** is a worldwide community of mobile network operators, vendors, and researchers creating open specifications for software, hardware, and networks.
- **Open RAN Policy Coalition** promotes policies to advance open and interoperable RAN solutions.
- **TIP** is developing and testing standards for open and disaggregated technology solutions.
- **Project Cassini** is an Arm-based initiative setting hardware and software standards so edge devices can securely run cloud-native software stacks.
- **Facebook Connectivity** seeks to provide high-quality internet connectivity around the world by developing standards-based prototypes for building networks.

REMEMBER

To fulfill the promise of 5G, networks have to become more cloudified, which requires rethinking the underlying technology. This work is well underway across the industry.

Chapter 3
Ten Things to Remember

Here are ten key takeaways to keep in mind:

- **It's here and it's growing rapidly.** According to the *Ericsson Mobility Report Q4 2020 Update*, 5G subscriptions now total more than 220 million. 5G should pass the billion-phone mark by 2022.
- **The big benefit comes in apps and services.** 5G will be a huge economic opportunity for vendors, service providers, and their customers. 5G will fuel IoT.

- **It will be offered through carriers, clouds, and private networks.** The new service paradigm will impact everyone across the supply chain.
- **A new way of building infrastructure is needed.** We need to rethink processors, hardware, software, and network design.
- **Processors will need to deliver greater efficiency and performance.** Chips will undergo a revolution in design.
- **New vendors and new designs in hardware will proliferate.** More hardware and vendor options will speed adoption.
- **Virtualization and containerization will maximize value.** These technologies increase utilization, improve performance, and reduce costs.
- **More capacity will be deployed in the cloud.** Not all 5G equipment will be deployed in the field. A good portion will be in data centers.
- **Open standards will further accelerate innovation.** Open standards help promote interoperability and eliminate vendor lock-in.
- **Learn from early deployments.** 5G deployment challenges are being discovered and lessons learned are being established now. Stay connected to 5G industry forums, communities, and partners to gain valuable insights from their experiences.

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+ **Optimized CPU design delivers both performance per watt and performance per dollar**
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+ **Supports high data throughput with minimal power consumption**
+ **Fully leverages diverse Arm software ecosystem**

Discover the trends and innovations driving 5G

5G is a new kind of platform that combines leading-edge technology innovations in 5G new radio (NR) air interface and 5G NextGen core network designs. 5G radio access networks (RAN) can connect any device with improved performance, efficiency, and cost. This book explores the exciting new market opportunities for mobile network operators (MNOs), equipment vendors, software developers, and other service providers.

Inside…

- Address CPU performance needs
- Deploy disaggregated hardware
- Use virtualization and containers
- Host infrastructure in the cloud
- Leverage open standards

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Lawrence C. Miller has worked in information technology in various industries for more than 25 years. He is the co-author of *CISSP For Dummies* and has written more than 200 *For Dummies* books on numerous technology and security topics.

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