Annabel Z. Dodd

# THE ESSENTIAL GUIDE to TELECOMMUNICATIONS

SIXTH EDITION

A Completely Revised Bestseller: Extensively Updated Coverage of Wi-Fi, LTE Advanced, 5G, Broadband, Security Technologies, and the Competitive Landscape

# PRAISE FOR *THE ESSENTIAL GUIDE TO TELECOMMUNICATIONS, SIXTH EDITION*

*"Dodd's* The Essential Guide to Telecommunications *provides the history and context that make a fundamental underpinning of modern business more accessible to technologists and businesspeople alike. This new edition of her primer is an essential reference in the continuously evolving communications landscape."*

—Tom Hopcroft, President and CEO,
Mass Technology Leadership Council

*"Annabel Dodd's book is a clear guide and big-picture view of technologies and industries. It is an up-to-date guide for anyone who wants to be familiar with important innovations and key technologies. This is truly an industry bible for mobile, Internet, and networking services."*

—Hiawatha Bray, Technology Reporter,
*The Boston Globe*

*"Ms. Dodd's aptly titled* The Essential Guide to Telecommunications *has been my bible for all things telecom since my days as an AT&T transmission network engineer nearly twenty years ago. Exhaustively and meticulously researched, concisely written for lay folks and techs/engineers alike, this book aids me in my current role as an IT Support Technician II when discussing new technology with our telecommunications department. Thank you to Ms. Dodd for keeping us all current!"*

—Todd Garbarini, IT Support Technician II
Commvault Systems, Inc.

"The Essential Guide to Telecommunications *is probably one of the most useful and well-written books on our telecom bookshelf. Annabel Z. Dodd does a great job of capturing a snapshot of the current telecom industry. Even those with little or no technical training should be able to understand the text. This is the perfect book for salespeople who want to learn more about the products and services they are selling, or for those who just want to keep up to date on the latest in telecom technology."*

—William Van Hefner, President,
Vantek Communications, Inc.

*"Ms. Dodd continues to provide an excellent and thorough text on the telecommunications industry. As in her previous editions, she presents a good balance of technical and business-related information that is readily understandable by anyone with an interest in this key component of today's business environment. In her new edition, she has captured many of the recent changes in this dynamic field, which will affect every company in the years ahead. I strongly recommend her book to anyone who wants a better understanding of telecommunications."*

—Joe McGrath, VP, Sage Pharmaceuticals, Inc.

- Companies use VRUs as adjuncts to or in some cases substitutes for company operators. The voice response unit is programmed to answer and route:
  - All calls
  - Calls to particular telephone extensions or departments
  - After-hours calls
- Here is a classic example:

  *Thank you for calling ABC Company. If you know your party's extension, you may dial it now. For sales, press 1. For customer service, press 2.*

Poorly scripted, confusing, and overly long scripts tend to be a source of frustration for callers. Another source is the inability in some organizations to speak with a live operator. In some instances, pressing 0 does nothing except trigger the initial confusing menu to be replayed.

## Using Speech Recognition to Expand Self-Service

Many call centers add speech recognition to their integrated voice response platforms to make them more user-friendly and faster for callers to navigate. Toll-free directory services ask callers to speak the name of the company for which they require a toll-free number without operator assistance. Local telephone companies use speech recognition so that customers can easily obtain billing information without speaking with a billing representative. Making speech recognition and IVR user friendly is an important factor in ensuring callers' acceptance of the service.

## How Speech Recognition Works

Speech recognition works by first detecting and then capturing parts of spoken words (utterances). After removing background noise, it converts the captured utterances to a digital representation. Capturing the speech and digitally representing it is done by DSPs on high-speed specialized computer chips. The speech recognition software then breaks the sounds into small chunks and compares various properties of the chunks of sound to large amounts of previously captured data contained in a database.

Speech recognition systems can be either speaker dependent or speaker independent. *Speaker independent systems* such as those used by Amtrak, Apple, and the United States toll free directory are speaker independent. They recognize words spoken by large numbers of people. Originally, speaker independent systems recognized a limited number of words such as yes, no, and numeric digits. However, improved recognition and faster computer chips now enable speaker independent systems to recognize large vocabularies of words.

*Speaker dependent* systems include Nuance's speech recognition software for consumers. Nuance also offers speech recognition software for specialized professions that use specific vocabularies. This includes radiologists who use speech recognition to dictate reports on results of medical imaging exams such as x-rays and MRIs. Speaker dependent software needs to be "trained" to recognize a particular person's commands. This is accomplished by having the purchaser of the speech recognition software read a few passages of text until the software recognizes the person's speech pattern.

*Natural language* speech recognition systems are those with the ability to recognize speech where users don't use specific, predefined commands such as "copy the phrase hello Mary", or "cut yours truly" as found in desk-top speech recognition applications. For example, natural language systems recognize "Turn on the Alarm" as well as "Set the alarm." Digital Assistant products such as Amazon's Alexa are capable of recognizing natural language commands. These systems are speaker independent systems.

High-speed computer processors perform the digitization and comparisons in milliseconds. They also take into account gender differences and regional accents. Speech recognition software contains different databases of expected responses based on the application. A corporate directory has a different speech database than one for airline scheduling or lost-luggage applications.

Until recently, Nuance had somewhat of a monopoly on speech recognition software. But, currently machine learning and computer chips with larger memories and faster transistors have led research universities and large companies including Microsoft and IBM to develop speech recognition, particularly for wearable devices such as Hoboken, NJ-based Essence Group's emergency alert devices that enable an incapacitated elderly person to call for help by voice commands without using his or her hands.

Speech recognition is integrated in:

- Home digital assistants
  - Amazon's Echo and Dot
  - Alphabet's Google Home
  - Microsoft's Cortana,
  - Apple's Siri
  - Baidu's Raven
  - Samsung's ViV
- Set-top boxes
  - Apple TV
  - Roku
  - Comcast X1

## Speech Recognition in Home Automation Devices

A digital assistant is essentially a computerized home assistant that supplies information in response to spoken questions and requests for information asked by users. Digital assistants are made possible by natural language speech recognition, high-speed computer networks, and machine learning. (See Chapter 1 for "Machine Learning.")

The large amounts of captured speech and information gathered on search engines and computers are key to the development of digital assistants. For example, Google has troves of data with commonly requested search requests. In addition, as digital assistants' databases of known utterances grow, the systems' speech recognition will continue to improve accuracy.

Digital assistants perform data look-ups using owners' Wi-Fi networks and broadband links. The look-ups are microsecond-speed data connections to the Digital Assistant's manufacturer's data centers, and their partners' computers. These computers send responses back to questions such as "Alexa, what is the weather today?" The following is a sampling of requests that digital assistants can respond to:

- What is the time?
- What is the time in China?
- Add eggs to my shopping list.
- What is the solution to this math problem?
- How many miles is Australia from New York?
- Play relaxing music.
- Play music by Mozart.
- Connect me to Spotify.
- Set the alarm for 6:30 AM

## Digital Assistant Software Integrated in Other Devices

Digital assistant software is integrated into smartphones, watches, and computers. An app on smartphones is required for these integrations. For example, Amazon's Alexa digital assistant software is integrated in cars, including Ford Motor Company and Tesla automobiles. There are also agreements to include Amazon's Alexa software in refrigerators, ovens ("Alexa, turn on the oven to 350 degrees, heat water for coffee"), thermostats, and lights. All of these integrations are ways that humans can interact with machines using speech as an input technology.

### Privacy with Digital Assistants

Privacy is residential customers' most common worry about home automation devices. According to the 2016 research by consulting firm Parks Associates, a U.S. Research and Analysis firm for Internet of Things (IoT), smart home, and connected entertainment technologies, half of consumers stated that privacy is their most pressing concern about home automated devices. Examples of IoT wireless products are drones, monitors, and lights, controlled by software.

The term privacy denotes the ability of people to control which people can see information about them. There have been fears that Amazon's digital assistants (Echo and Dot) store customers' speech. Amazon has stated that it only saves commands directed to its digital assistants, not other random speech spoken in the same room. It further has stated that each user is associated with a particular randomly selected code and that Amazon does not know which user is associated with any code associated with customers' speech.

### Possible Long-Term Impact of Digital Assistants

In addition to privacy, concerns about digital assistants revolve around depersonalization resulting from less need for communications between people. As people increasingly turn to computers to get information will they have less of a requirement to speak to each other?

In addition to privacy and depersonalization, there are worries about a possible decrease in children's ability to do math. This is because "asking Alexa" provides children solutions to even complex math problems. It's still early days in the availability of digital assistants to know for certain what its impact will be in the future. In the early days of calculators, many thought children would not learn basic math skills. Each new innovation brings concerns. The answers to these concerns are initially unknown.

## APPENDIX

**Table 2-2** *LAN Protocols, Devices, and Terms*

| Protocol, Service, or Device | Description |
|---|---|
| Backbone | The wiring running from floor to floor in single buildings and from building to building within a campus. A backbone connects switches in different wiring closets to one another. Backbones support high concentrations of traffic in carrier and enterprise networks. |

| Protocol, Service, or Device | Description |
|---|---|
| Blade server | Blade servers are computers packaged on individual boards—blades—that plug into slots in a chassis. A chassis is the metal frame on which components fit, similar to a custom cabinet with slots for specific items. In high density, chassis blades are arranged vertically. In low density, three- or four-blade servers, they are arranged horizontally. Chassis are placed on racks in data centers. Vertical arrangements conserve space and can share power supplies, fans, and cabling. In addition, blades can be easily added. |
| File server | A specialized computer with a large hard drive. File servers provide users with access to documents and applications in central locations in LANs. |
| Load balancing | The capability of equipment to balance traffic between networks and devices so that one network or device is not overloaded while others carry little or no traffic. |
| Local Area Network (LAN) | A group of devices such as computers, printers, and scanners that can communicate with one another within a limited geographic area, such as a floor, department, or small cluster of buildings. |
| Layer 2 switch (also called a switching hub) | A switch located in a wiring closet that allows multiple simultaneous transmissions within a single LAN. Layer 2 switches provide a dedicated connection during an entire transmission. |
| Layer 3 switch (also known as a routing switch) | A switch that routes traffic across the LAN backbone based on IP (network) addresses. They are more complex to manage than Layer 2 switches, but they can use alternate paths if one path is out of service. They are located in data centers and link wiring closets and buildings within a campus. |
| Layer 4 switch (also known as a content switch) | A switch located at hosting sites and corporate and government sites that host their own web pages. Layer 4 switches connect web traffic to the desired web pages by looking at the URL, the web address from which each packet was transferred to the site. |
| Router | Routers carry traffic between LANs, from enterprises to the Internet, and across the Internet. They are more complex than switches because they have routing tables with addresses and perform other functions. Routers select the best available path over which to send data. |

**Table 2-2** *(Continued)*

| Protocol, Service, or Device | Description |
|---|---|
| Server | A centrally located computer with common departmental or organizational files such as personnel records, e-mails, sales data, price lists, student information, and medical records. Servers are connected to Layer 2 or Layer 3 switches. Access to servers can be restricted to authorized users only. |
| Virtual Local Area Network (VLAN) | A virtual local area network is made up of devices, usually personal computers or VoIP devices, whose addresses are programmed as a group in Layer 2 switches. This segregates them from the rest of the corporate network so that all devices in the same VLAN can be given a higher priority or level of security. They are programmed as a separate LAN but are physically connected to the same switch as other devices. |
| Wide Area Network (WAN) | A group of data devices, usually LANs, that communicate with one another between multiple cities. |

**Table 2-3** *Protocols and VoIP Terms*

| Protocols and Terms for VoIP Service | Description |
|---|---|
| 802.1pq | 802.1pq is used to tag certain Virtual LAN traffic to indicate that it is part of a special group. It might tag voice packets to segregate them for special treatment and monitoring. It also contains bits that identify the packet's priority level. |
| CoS | Class of Service provides priority to particular types of traffic. Voice or video can be designated with a higher priority than voicemail. |
| DoS | Denial-of-Service attacks occur when hackers attempt to disrupt communications by bombarding endpoints or proxies with packets. |
| G.711 | G.711 is used to compress voice signals at 64,000 bits per second plus a 6- to 21-kilobit header for VoIP services. It produces good voice quality but uses more network capacity than other compression techniques. This technique requires 60 milliseconds to process and "look ahead" (check the route). |
| G.723.1 | G.723.1 is a compression protocol that uses small packets with 6.3Kbps compression. Small packets are more efficient than large ones, in terms of bandwidth use. With the header, total bandwidth is about 16Kbps. |