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Fisher

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(54) **WIRELESS BIDIRECTIONAL COMMUNICATIONS BETWEEN A MOBILE DEVICE AND ASSOCIATED SECURE ELEMENT**

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(22) Filed: **Nov. 17, 2010**

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(60) Provisional application No. 60/766,171, filed on Dec. 31, 2005, provisional application No. 60/766,172, filed on Dec. 31, 2005.

(51) **Int. Cl.**
G06K 5/00 (2006.01)

(52) **U.S. Cl.**
USPC **455/466**; 455/41.1; 455/41.2; 455/556.1; 235/380; 340/5.4; 340/5.41; 705/41; 705/64

(58) **Field of Classification Search**
USPC 455/41.1, 41.2, 466, 552.1, 556.1; 235/380; 340/5.4, 5.41; 705/41, 64
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,228,155 B2 * 6/2007 Saunders 455/558
7,280,847 B2 * 10/2007 Goldthwaite et al. 455/558
7,327,999 B2 * 2/2008 Kang 455/406
7,554,570 B2 * 6/2009 Benco et al. 348/14.01
7,697,894 B2 * 4/2010 Zilliacus et al. 455/41.2
7,702,361 B2 * 4/2010 Lai et al. 455/553.1
7,729,986 B1 * 6/2010 Hoffman et al. 705/41
7,920,827 B2 * 4/2011 Huomo et al. 455/41.1
7,997,476 B2 * 8/2011 Gannon 235/379
8,019,365 B2 * 9/2011 Fisher 455/466
8,170,527 B2 * 5/2012 Granucci et al. 455/406
8,190,087 B2 * 5/2012 Fisher et al. 455/41.2
8,275,312 B2 * 9/2012 Fisher 455/41.2
8,290,443 B2 * 10/2012 Stirling-Gallacher et al. 455/67.13
8,332,272 B2 * 12/2012 Fisher 705/16
8,417,643 B2 * 4/2013 Mardikar 705/67
8,447,836 B2 * 5/2013 Mahalal et al. 709/219
2004/0127256 A1 * 7/2004 Goldthwaite et al. 455/558
2004/0235450 A1 * 11/2004 Rosenberg 455/406
2005/0222949 A1 * 10/2005 Inotay et al. 705/40
2006/0079284 A1 * 4/2006 Lu et al. 455/558
2006/0111053 A1 * 5/2006 Wu et al. 455/90.3
2006/0253389 A1 * 11/2006 Hagale et al. 705/39
2006/0287004 A1 * 12/2006 Fuqua 455/558
2007/0075133 A1 * 4/2007 Yeager 235/380
2007/0131759 A1 * 6/2007 Cox et al. 235/380

(Continued)

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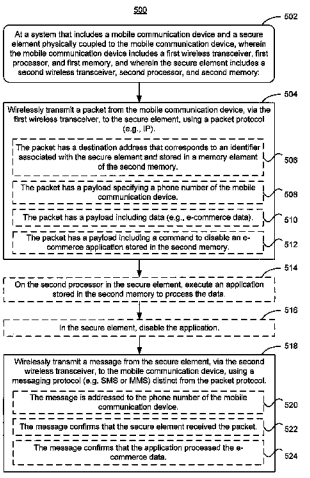
(57) **ABSTRACT**

In some embodiments, a system includes a mobile communication device and a secure element physically coupled to the mobile communication device. The mobile communication device includes a first wireless transceiver, first processor, and first memory. The secure element includes a second wireless transceiver, second processor, and second memory. The mobile communication device is configured to transmit data via the first wireless transceiver to the secure element in packets, using a packet protocol. The secure element is configured to transmit data via the second wireless transceiver to the mobile communication device in messages, using a messaging protocol distinct from the packet protocol.

23 Claims, 12 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0152035	A1*	7/2007	Adams et al.	235/380
2007/0162381	A1*	7/2007	Petralia et al.	705/38
2007/0220494	A1*	9/2007	Spooner	717/130
2007/0293155	A1*	12/2007	Liao et al.	455/41.2
2008/0048022	A1*	2/2008	Vawter	235/380
2008/0208742	A1*	8/2008	Arthur et al.	705/41
2009/0012879	A1*	1/2009	Choi	705/27
2009/0075592	A1*	3/2009	Nystrom et al.	455/41.1
2009/0112765	A1*	4/2009	Skowronek	705/44
2009/0182630	A1*	7/2009	Otto et al.	705/14
2009/0281947	A1*	11/2009	Erel	705/44
2010/0042546	A1*	2/2010	Humbel	705/64
2010/0088188	A1*	4/2010	Kumar et al.	705/17
2010/0280945	A1*	11/2010	Vago et al.	705/41
2011/0022484	A1*	1/2011	Smith et al.	705/17
2011/0047038	A1*	2/2011	Halevi	705/17
2011/0151900	A1*	6/2011	Yu et al.	455/466
2011/0165859	A1*	7/2011	Wengrovitz	455/411
2012/0029990	A1*	2/2012	Fisher	705/14.19
2012/0101943	A1*	4/2012	Park	705/41
2012/0143707	A1*	6/2012	Jain	705/18
2012/0196529	A1*	8/2012	Huomo et al.	455/41.1
2013/0006872	A1*	1/2013	Chandoor et al.	705/75

* cited by examiner

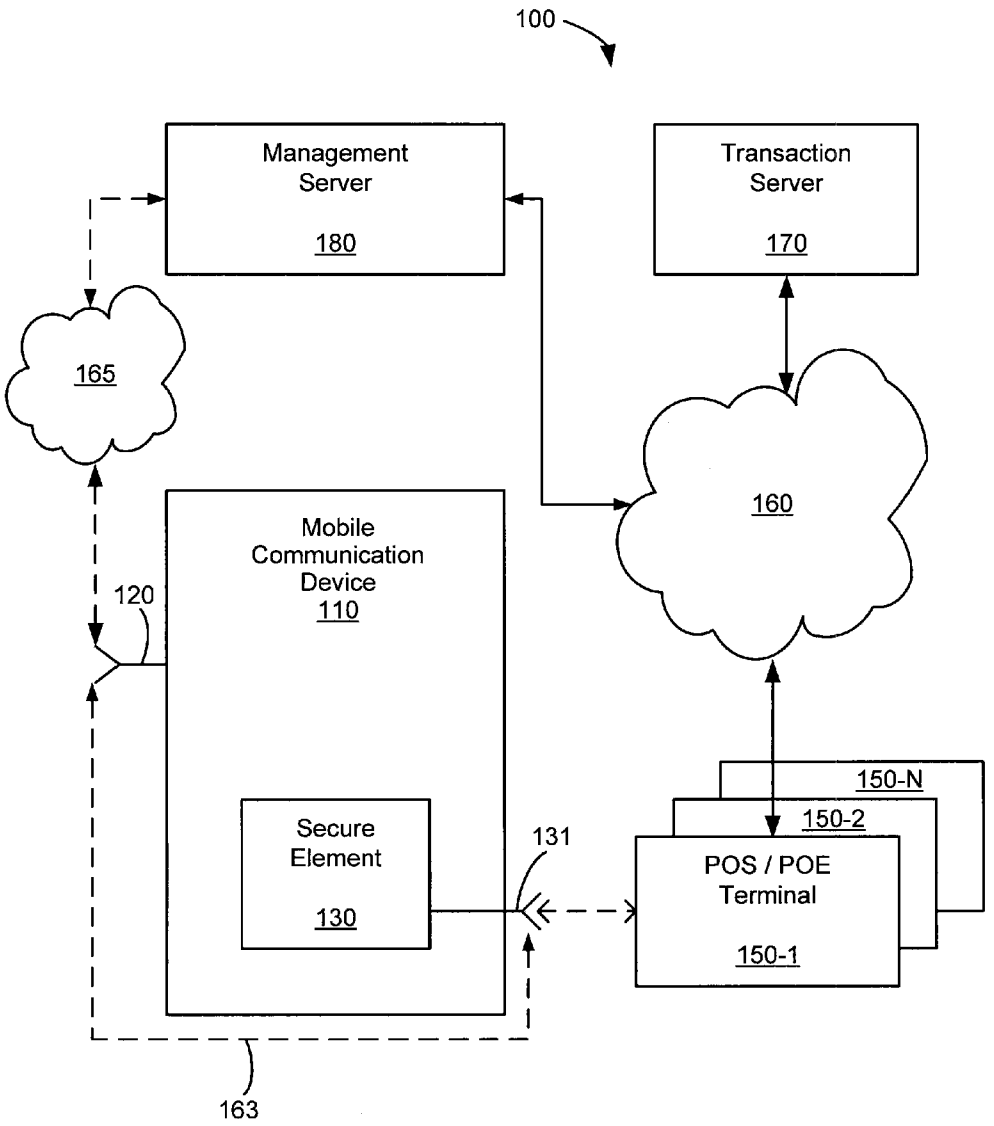

100
Management Server
180
Transaction Server
170
165
160
Mobile Communication Device
110
120
Secure Element
130
131
150-N
150-2
POS / POE Terminal
150-1
163

Figure 1

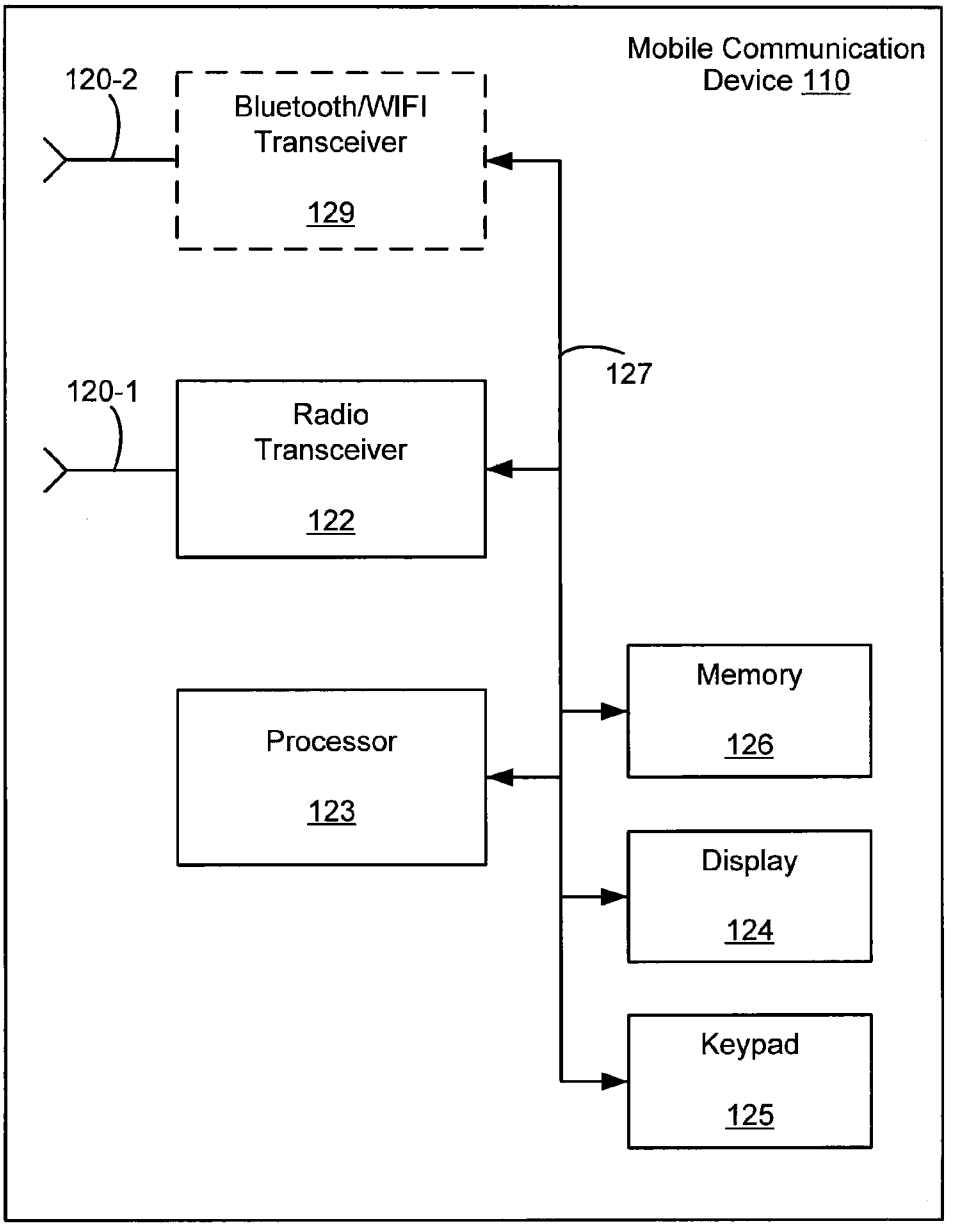

Mobile Communication Device 110
120-2
Bluetooth/WIFI Transceiver
129
127
120-1
Radio Transceiver
122
Memory
126
Processor
123
Display
124
Keypad
125

Figure 2

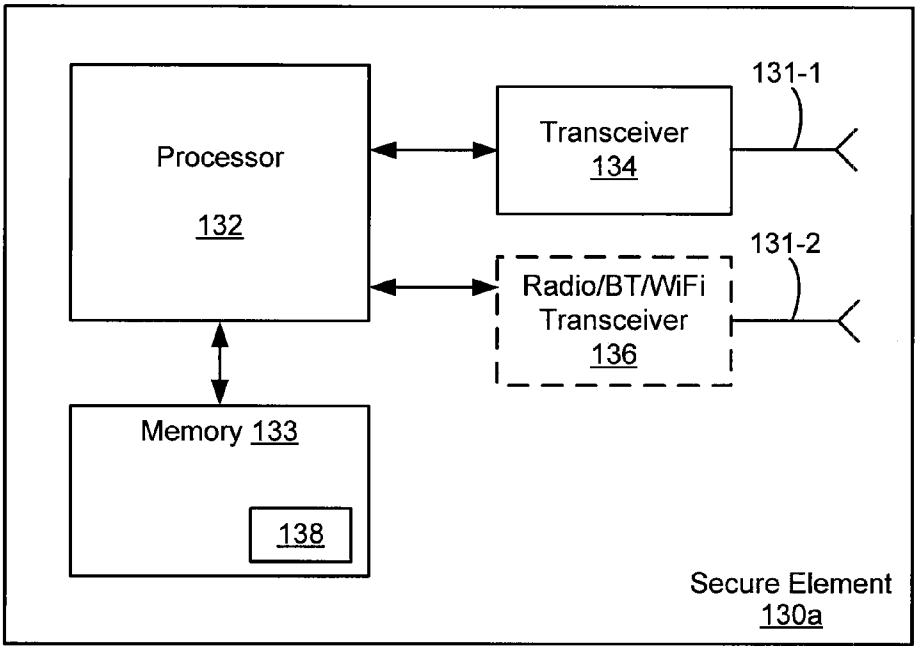


Figure 3A

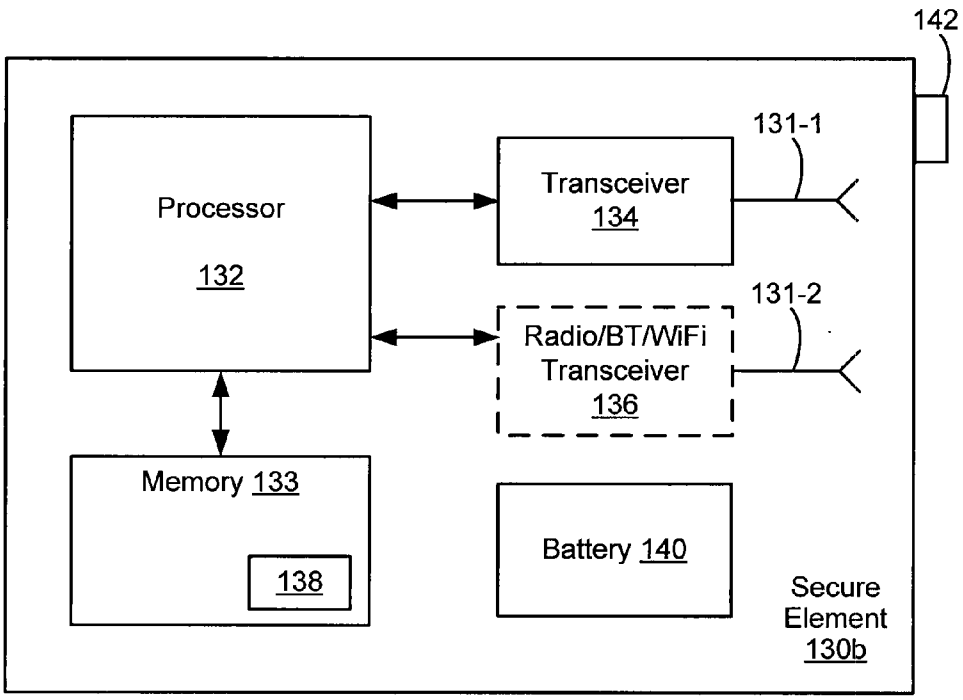


Figure 3B

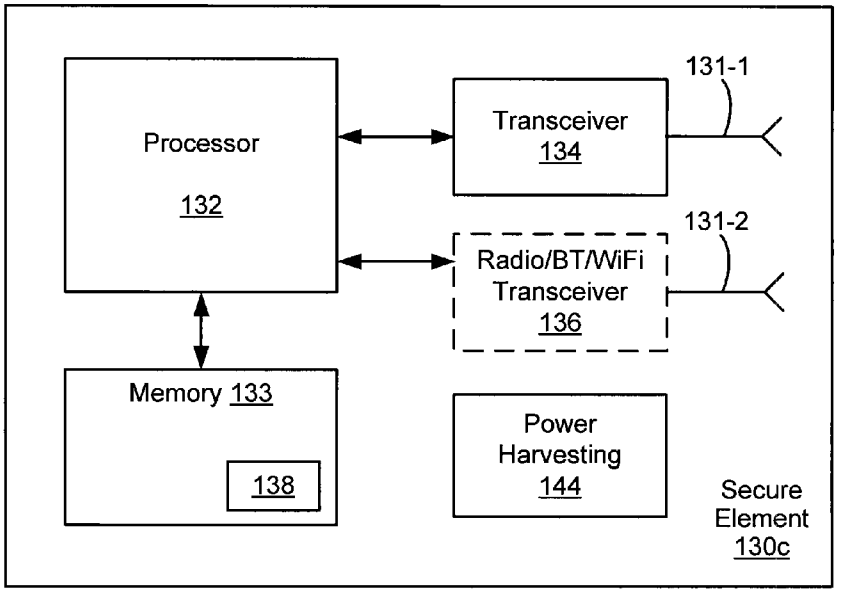


Figure 3C

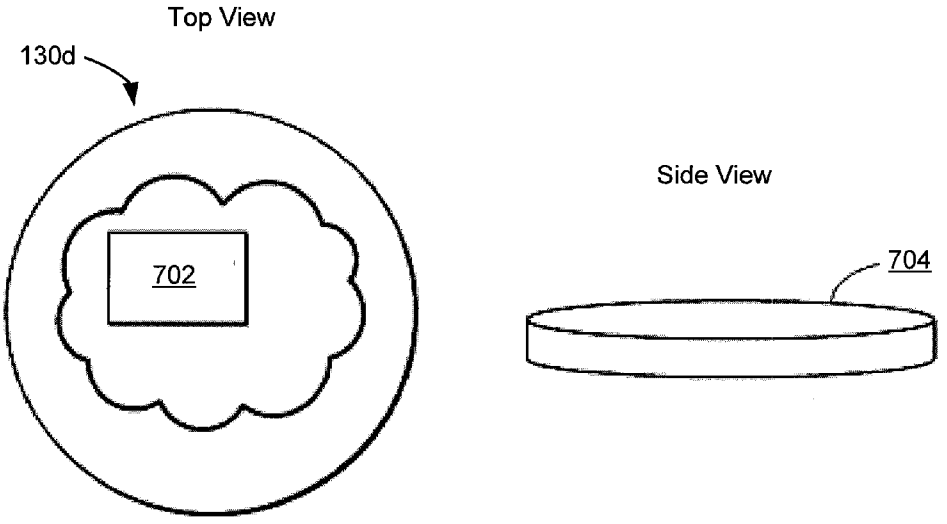


Figure 3D

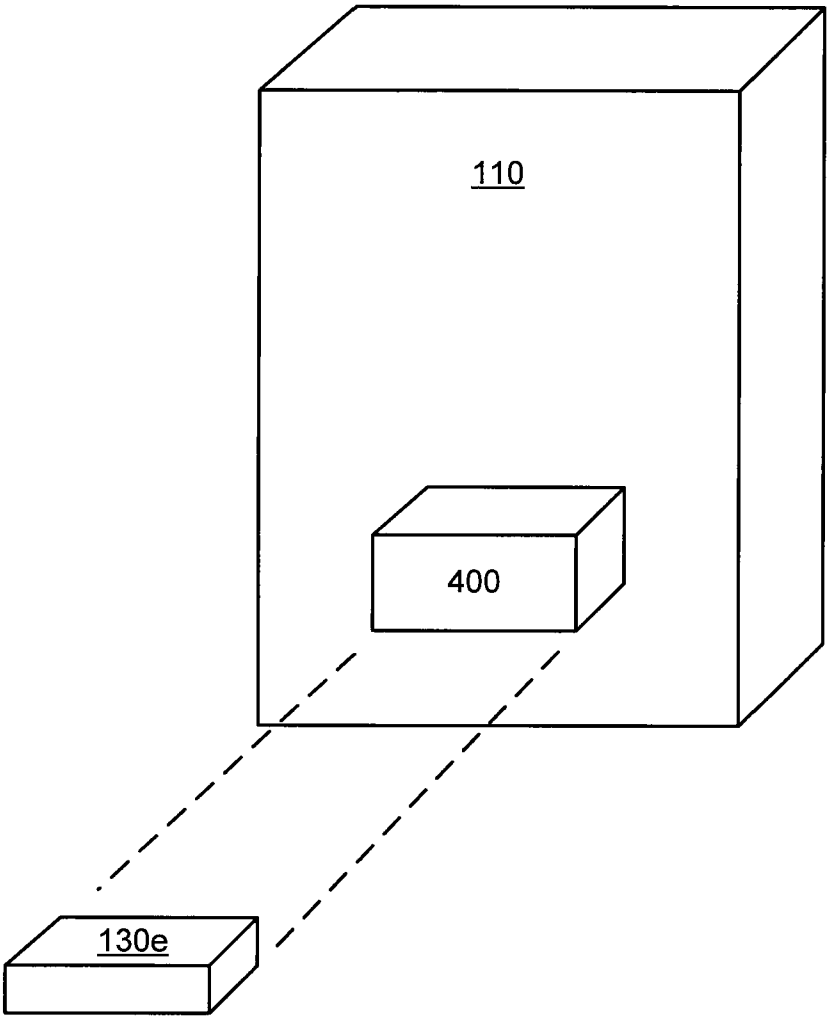


Figure 3E

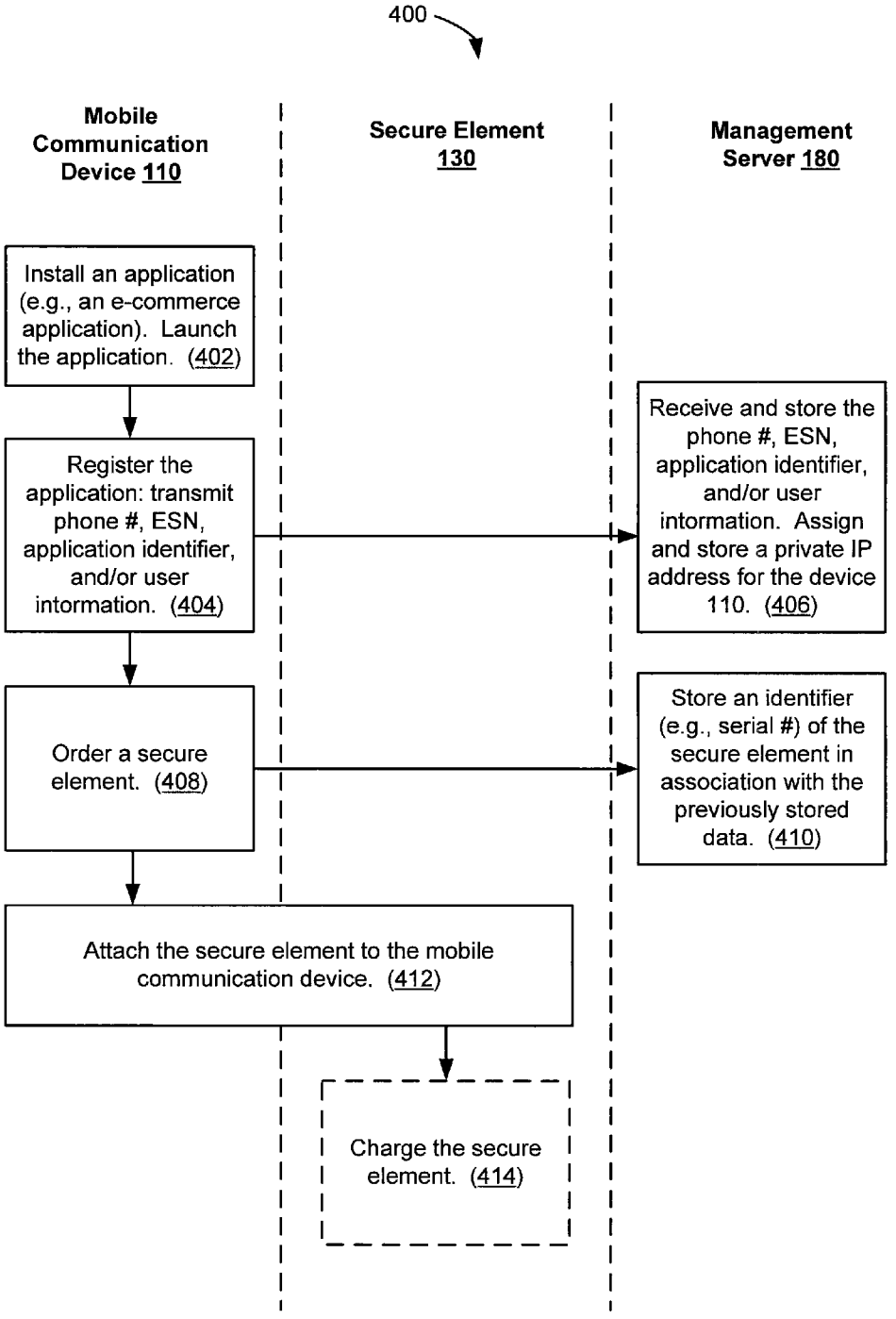

400
Mobile Communication Device 110
Secure Element 130
Management Server 180
Install an application (e.g., an e-commerce application). Launch the application. (402)
Register the application: transmit phone #, ESN, application identifier, and/or user intormation. (404)
Receive and store the phone #, ESN, application identifier, and/or user intormation. Assign and store a private IP address for the device 110. (406)
Order a secure element. (408)
Store an identifier (e.g., serial #) of the secure element in association with the previously stored data. (410)
Attach the secure element to the mobile communication device. (412)
Charge the secure element. (414)

Figure 4A

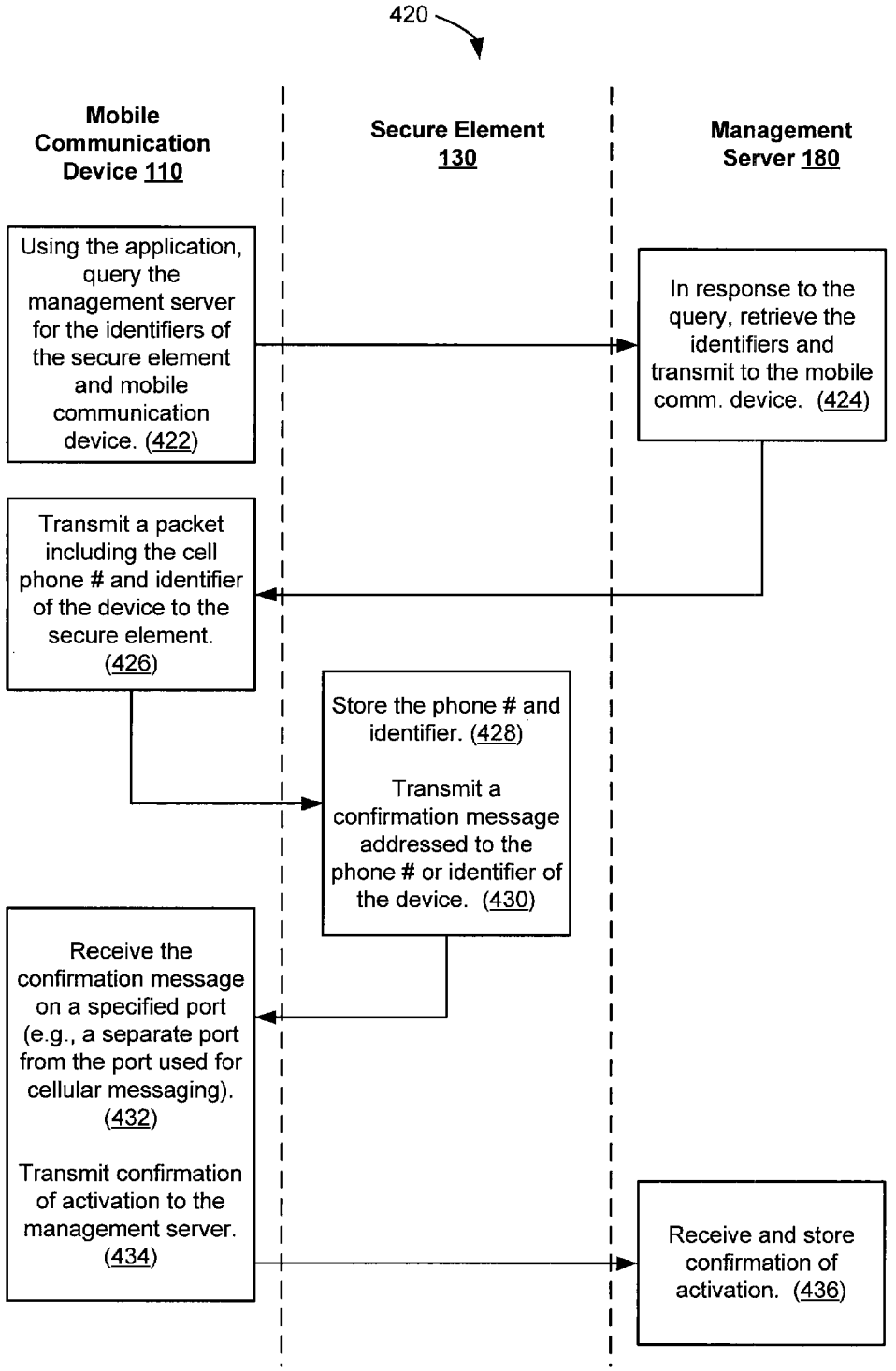

420
Mobile Communication Device 110
Secure Element 130
Management Server 180
Using the application, query the management server for the identifiers of the secure element and mobile communication device. (422)
In response to the query, retrieve the identifiers and transmit to the mobile comm. device. (424)
Transmit a packet including the cell phone # and identifier of the device to the secure element. (426)
Store the phone # and identifier. (428)
Transmit a confirmation message addressed to the phone # or identifier of the device. (430)
Receive the confirmation message on a specified port (e.g., a separate port from the port used for cellular messaging). (432)
Transmit confirmation of activation to the management server. (434)
Receive and store confirmation of activation. (436)

Figure 4B

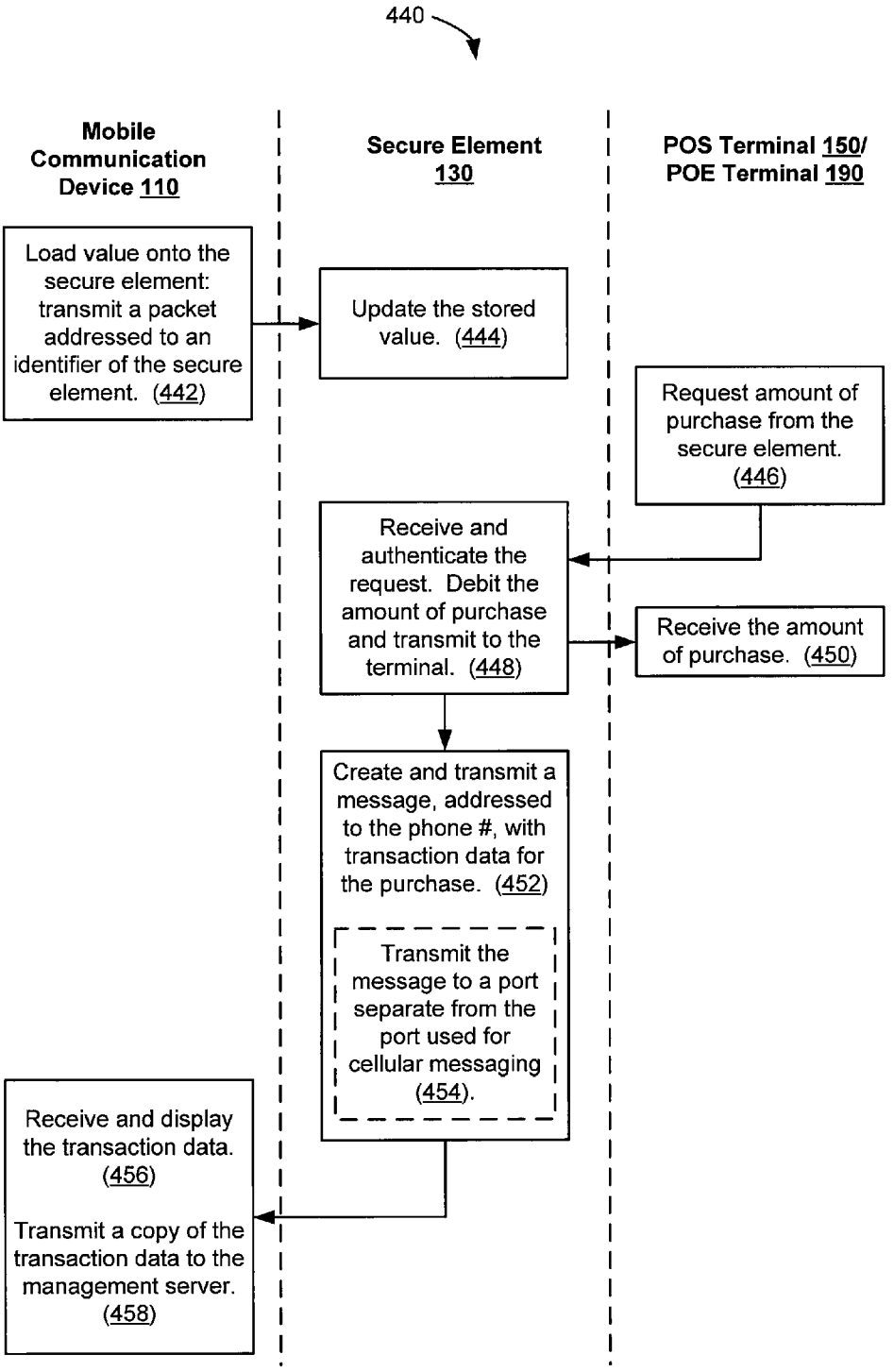

440
Mobile Communication Device 110
Secure Element 130
POS Terminal 150/ POE Terminal 190
Load value onto the secure element: transmit a packet addressed to an identifier of the secure element. (442)
Update the stored value. (444)
Request amount of purchase from the secure element. (446)
Receive and authenticate the request. Debit the amount of purchase and transmit to the terminal. (448)
Receive the amount of purchase. (450)
Create and transmit a message, addressed to the phone #, with transaction data for the purchase. (452)
Transmit the message to a port separate from the port used for cellular messaging (454).
Receive and display the transaction data. (456)
Transmit a copy of the transaction data to the management server. (458)

Figure 4C

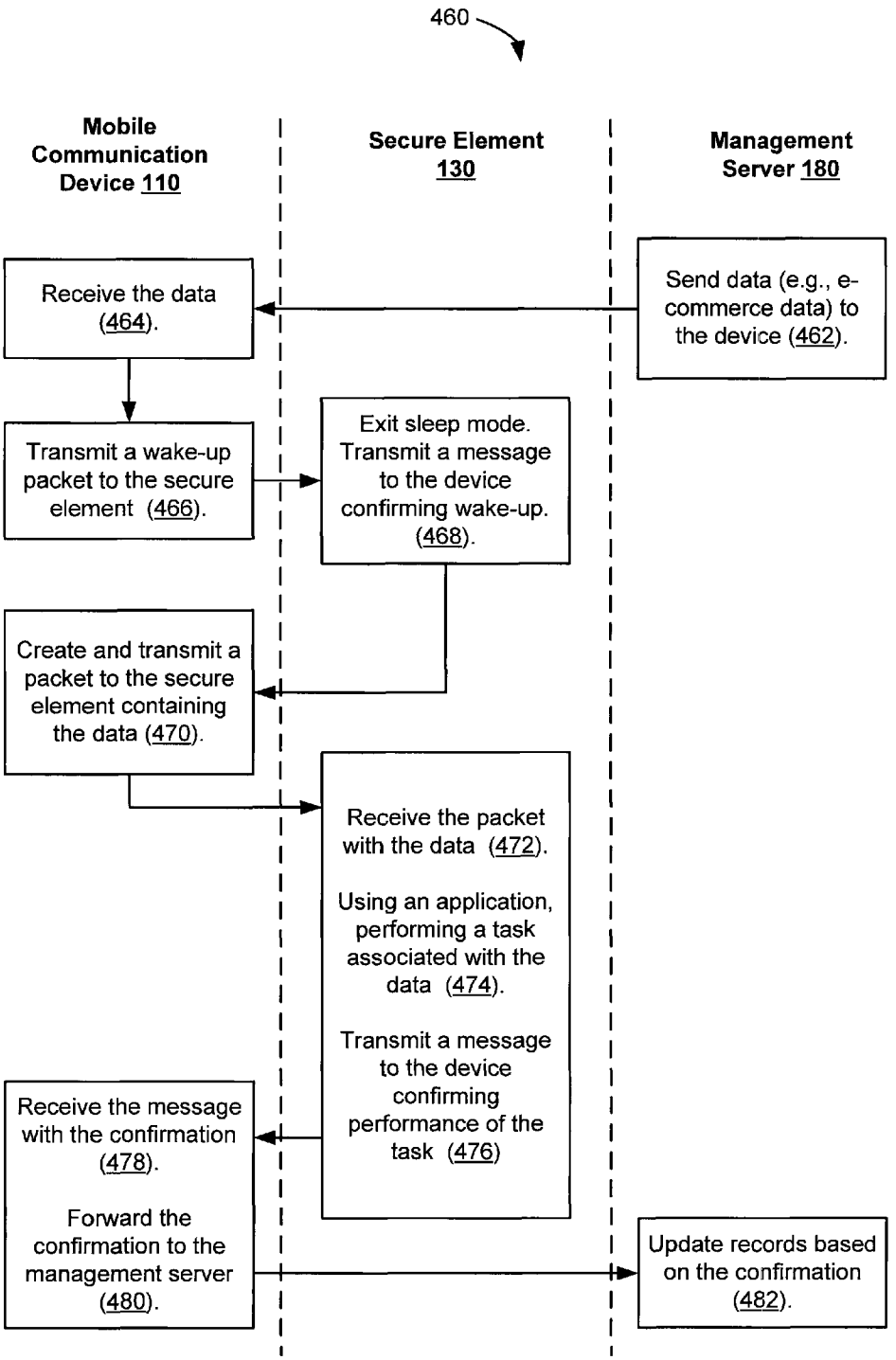

460
Mobile Communication Device 110
Secure Element 130
Management Server 180
Send data (e.g., e-commerce data) to the device (462).
Receive the data (464).
Transmit a wake-up packet to the secure element (466).
Exit sleep mode. Transmit a message to the device confirming wake-up. (468).
Create and transmit a packet to the secure element containing the data (470).
Receive the packet with the data (472).
Using an application, performing a task associated with the data (474).
Transmit a message to the device confirming performance of the task (476)
Receive the message with the confirmation (478).
Forward the confirmation to the management server (480).
Update records based on the confirmation (482).

Figure 4D

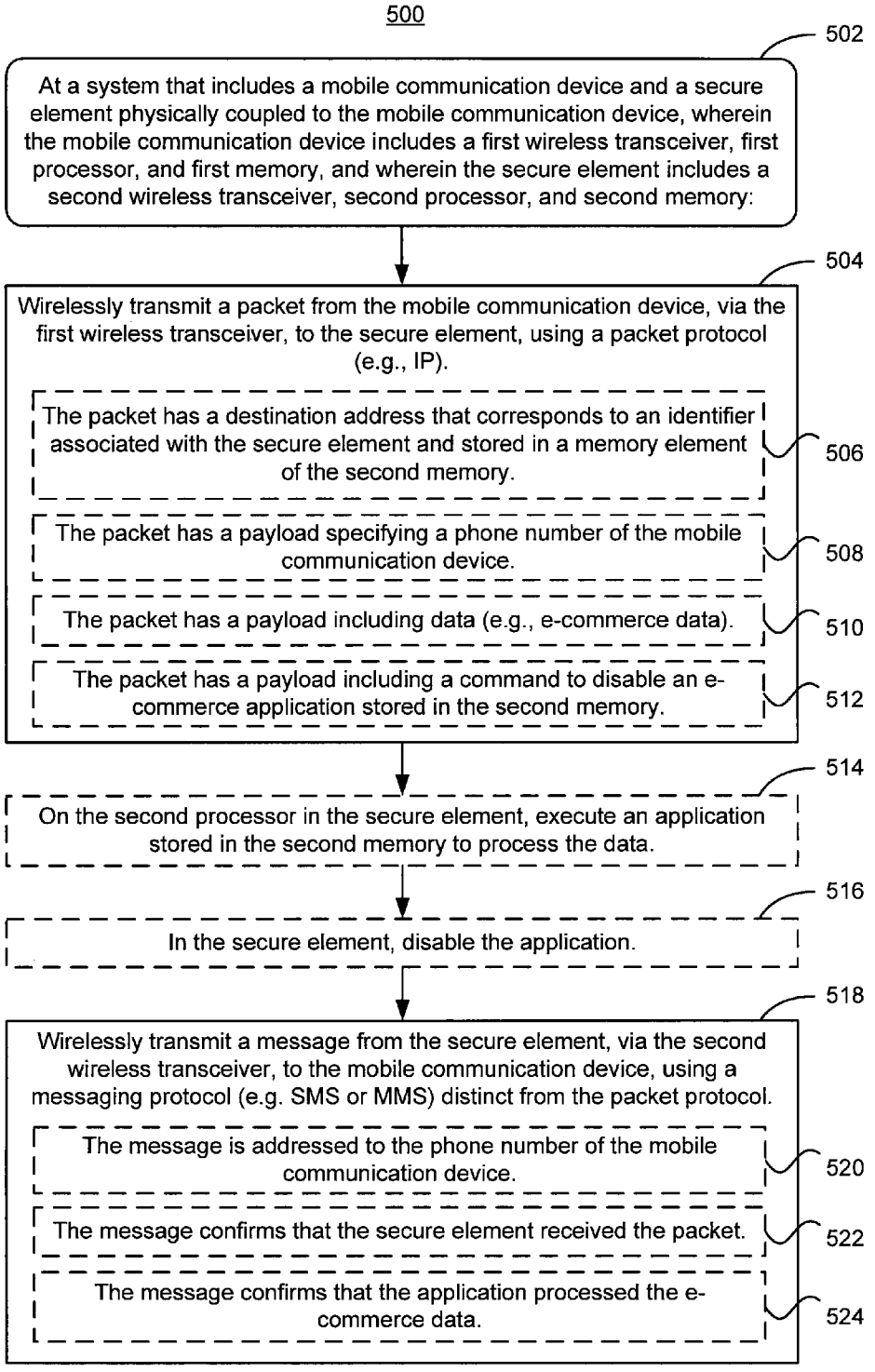

500
502
At a system that includes a mobile communication device and a secure element physically coupled to the mobile communication device, wherein the mobile communication device includes a first wireless transceiver, first processor, and first memory, and wherein the secure element includes a second wireless transceiver, second processor, and second memory:
504
Wirelessly transmit a packet from the mobile communication device, via the first wireless transceiver, to the secure element, using a packet protocol (e.g., IP).
The packet has a destination address that corresponds to an identifier associated with the secure element and stored in a memory element of the second memory.
506
The packet has a payload specifying a phone number of the mobile communication device.
508
The packet has a payload including data (e.g., e-commerce data).
510
The packet has a payload including a command to disable an e-commerce application stored in the second memory.
512
514
On the second processor in the secure element, execute an application stored in the second memory to process the data.
516
In the secure element, disable the application.
518
Wirelessly transmit a message from the secure element, via the second wireless transceiver, to the mobile communication device, using a messaging protocol (e.g. SMS or MMS) distinct from the packet protocol.
The message is addressed to the phone number of the mobile communication device.
520
The message confirms that the secure element received the packet.
522
The message confirms that the application processed the e-commerce data.
524

Figure 5

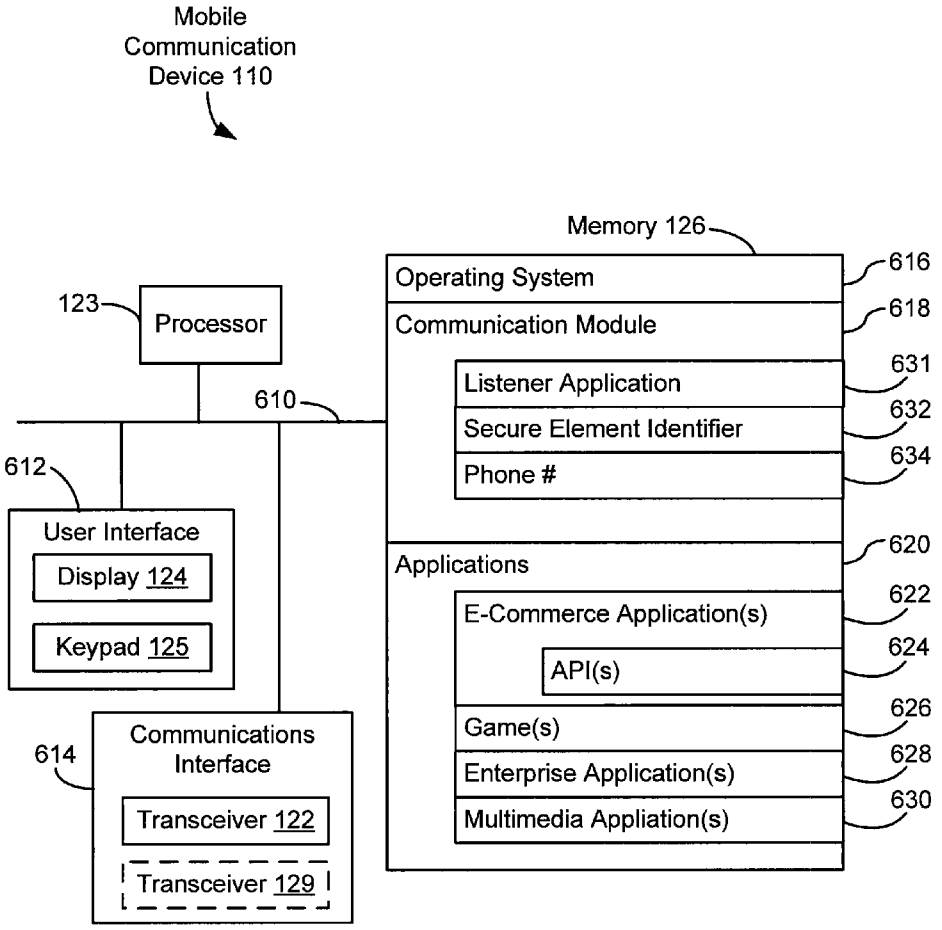

Mobile Communication Device 110
Memory 126
Operating System
616
Communication Module
618
Listener Application
631
Secure Element Identifier
632
Phone #
634
123
Processor
610
612
User Interface
Display 124
Keypad 125
Applications
620
E-Commerce Application(s)
622
API(s)
624
Game(s)
626
Enterprise Application(s)
628
Multimedia Appliation(s)
630
614
Communications Interface
Transceiver 122
Transceiver 129

Figure 6

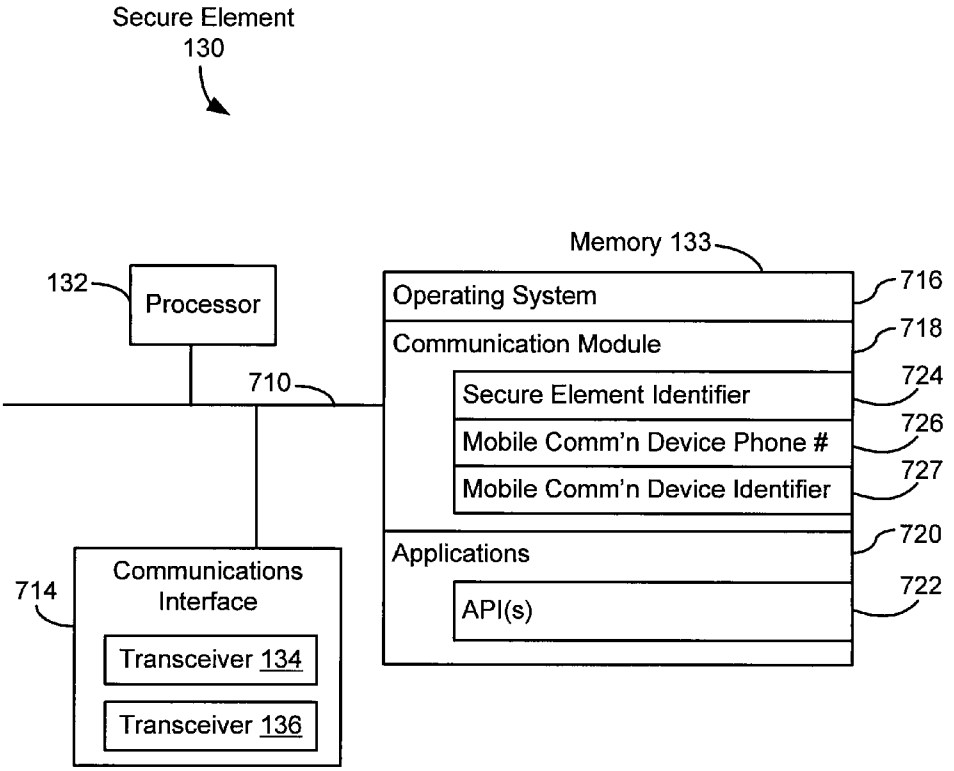

Secure Element
130
Memory 133
132
Processor
Operating System
716
Communication Module
718
710
Secure Element Identifier
724
Mobile Comm'n Device Phone #
726
Mobile Comm'n Device Identifier
727
Applications
720
714
Communications Interface
API(s)
722
Transceiver 134
Transceiver 136

Figure 7

WIRELESS BIDIRECTIONAL COMMUNICATIONS BETWEEN A MOBILE DEVICE AND ASSOCIATED SECURE ELEMENT

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 11/933,321, titled "Method and System for Adapting a Wireless Mobile Communication Device for Wireless Transactions," filed Oct. 31, 2007 now U.S. Pat. No. 8,275,312, which is a continuation-in-part of U.S. patent application Ser. No. 11/467,441, titled "Method and Apparatus for Completing a Transaction Using a Wireless Mobile Communication Channel and Another Communication Channel," filed Aug. 25, 2006 now abandoned, which claims priority to U.S. Provisional Patent Application No. 60/766,171 titled "Mobile Credit Card Account Installer" filed Dec. 31, 2005 and Application No. 60/766,172, titled "Mobile Ticket" filed Dec. 31, 2005. All of the above-referenced patent applications are incorporated by reference herein in their entirety.

TECHNICAL FIELD

The disclosed embodiments relate generally to wireless communications for a mobile device, and more particularly, to wireless communications between a mobile device and an associated secure element using multiple communication protocols.

BACKGROUND

A secure element can be physically coupled to a mobile communication device to allow for transactions with remote terminals such as point-of-sale and point-of-entry terminals. Implementing wireless communications between the mobile communication device and the secure element, however, presents challenges. For example, it is desirable to address messages transmitted between the mobile communication device and the secure element in a manner that allows for easy receipt of the messages. Also, a method of communication between the mobile communication device and the secure element should allow for convenient activation of the secure element and remote deactivation of the secure element.

SUMMARY

Disclosed embodiments allow a mobile communication device to communicate wirelessly with a secure element that is physically coupled to the mobile communication device. Communications from the mobile communication device to the secure element use a different protocol than communications from the secure element to the mobile communication device.

In some embodiments, a system includes a mobile communication device and a secure element physically coupled to the mobile communication device. The mobile communication device includes a first wireless transceiver, first processor, and first memory. The secure element includes a second wireless transceiver, second processor, and second memory. The mobile communication device is configured to transmit data via the first wireless transceiver to the secure element in packets, using a packet protocol. The secure element is configured to transmit data via the second wireless transceiver to the mobile communication device in messages, using a messaging protocol distinct from the packet protocol.

In some embodiments, a method of communicating between a mobile communication device and a secure element physically coupled to the mobile communication device is performed. The mobile communication device includes a first wireless transceiver, first processor, and first memory, and the secure element includes a second wireless transceiver, second processor, and second memory. The method includes wirelessly transmitting a packet from the mobile communication device, via the first wireless transceiver, to the secure element, using a packet protocol. The method also includes wirelessly transmitting a message from the secure element, via the second wireless transceiver, to the mobile communication device, using a messaging protocol distinct from the packet protocol.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a communication system in accordance with some embodiments.

FIG. **2** is a block diagram illustrating selected elements of a mobile communication device in accordance with some embodiments.

FIGS. **3**A-**3**C are block diagrams illustrating a secure element to be physically coupled to a mobile communication device in accordance with some embodiments.

FIG. **3**D illustrates top and side views of a smart card that can be attached externally to a mobile communication device in accordance with some embodiments.

FIG. **3**E illustrates a mobile communication device with a slot for receiving a secure element in accordance with some embodiments.

FIG. **4**A is a flow diagram illustrating a method of installing a secure element in accordance with some embodiments.

FIG. **4**B is a flow diagram illustrating a method of activating a secure element in accordance with some embodiments.

FIG. **4**C is a flow diagram illustrating a method of using a secure element for a purchase in accordance with some embodiments.

FIG. **4**D is a flow diagram illustrating a method of transmitting e-commerce data to a secure element in accordance with some embodiments.

FIG. **5** is a flow diagram illustrating a method of communicating between a mobile communication device and a secure element in accordance with some embodiments.

FIG. **6** is a block diagram illustrating selected elements of a mobile communication device in accordance with some embodiments.

FIG. **7** is a block diagram illustrating a secure element to be physically coupled to a mobile communication device in accordance with some embodiments.

Like reference numerals refer to corresponding parts throughout the drawings.

DESCRIPTION OF EMBODIMENTS

Reference will now be made in detail to various embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present inventions. However, it will be apparent to one of ordinary skill in the art that the present inventions may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

FIG. **1** is a block diagram illustrating a communication system **100** in accordance with some embodiments. The com-

munication system **100** includes a hand-held, wireless mobile communication device **110** with an antenna **120** for wireless communication. While the antenna **120** is shown as extending from the mobile communication device **110** for visual clarity, the antenna **120** may be implemented internally within the mobile communication device **110**. Also, the mobile communication device **110** may include more than one antenna **120**. The mobile communication device **110** includes a user interface for entering data. For example, a display **124** (FIG. **2**) is a touch-screen display; alternatively or in addition, the mobile communication device **110** includes a keypad **125** (FIG. **2**) for entering data.

A secure element **130** is physically coupled to the mobile communication device **110**. In some embodiments, the secure element **130** is externally attached to the mobile communication device **110**. For example, the secure element **130** is adhesively affixed or mechanically secured to the housing of the mobile communication device **110**. Alternatively, the secure element **130** is housed within the mobile communication device **110**. The secure element **130** includes an antenna **131** for wireless communication. While the antenna **131** is shown as extending from the secure element **130** for visual clarity, the antenna **131** may be implemented internally within the secure element **130**. Also, the secure element **130** may include more than one antenna **131**. Communication occurs wirelessly between the secure element **130** and the mobile communication device **110** via respective antennas **120** and **131**, over a direct wireless channel **163** between the mobile communication device **110** and the secure element **130**. Thus, in some embodiments, the channel **163** does not pass through a network.

The secure element **130** also can communicate wirelessly with different point-of-sale (POS) or point-of-entry (POE) terminals **150-1** to **150-N** via the antenna **131**. In some embodiments, a POS terminal **150** receives a transaction request signal from the secure element **130** and transmits the transaction request signal to a transaction server **170** over a network **160**. Alternatively, a POE terminal **150** receives an entry request signal from the secure element **130** and transmits the entry request signal to the transaction server **170** over the network **160**. The network **160** is any suitable wired and/or wireless network and may include, for example, a local area network (LAN), wide area network (WAN), virtual private network (VPN), the Internet, a metropolitan area network (MAN), or any combination of these or similar networks. The transaction server **170** verifies the request and forwards a verification signal to the management server **180** via the network **160**. The management server **180** identifies the user corresponding to the verification signal and provides a response signal back to the mobile communication device **110**, which the mobile communication device **110** receives via the antenna **120**. The response signal thus is communicated back to the mobile communication device **110** using a communication channel that is different from the communication channel used to initiate the transaction. Alternatively, the response signal is communicated back to the mobile communication device **110** using communication channels from the management server **180** to the secure element **130** through the network **160** and POS terminal **150**, and then from the secure element **130** to the mobile communication device **110** via the antennas **131** and **120**.

In the example of an entry request signal received at a POE terminal **150**, the entry request is verified by the POE terminal **150** or the transaction server **170**, upon which the POE terminal **150** admits the user of the mobile communication device **110** to the corresponding venue or facility.

FIG. **2** is a block diagram illustrating selected elements of the mobile communication device **110** in accordance with some embodiments. A processor **123** is coupled to a wireless radio transceiver **122**, a display **124**, a keypad **125**, and a memory **126**. The radio transceiver **122** is connected to an antenna **120-1**, which is an example of an antenna **120** (FIG. **1**) and is adapted to send outgoing voice and data signals and receive incoming voice and data signals over a radio communication channel. The radio communication channel can be a digital radio communication channel (e.g., a cellular channel as provided by a cellular service provider), such as a CDMA or GSM channel. Such a radio communication channel has the capacity to communicate both voice and data messages using conventional techniques. In some embodiments, the processor **123** also is coupled to a second wireless transceiver **129** (e.g., a Bluetooth or WiFi transceiver), connected to a corresponding antenna **120-2** (which is another example of an antenna **120**, FIG. **1**), for communicating with an external device over an additional communication channel separate from the radio communication channel associated with the transceiver **122**.

The processor **123** has the capability to perform not only the radio communication services necessary to allow for phone and data communications (e.g., via the transceivers **122** and/or **129**), but also to execute various application programs (e.g., applications **620**, FIG. **6**) that are stored in the memory **126**. These application programs can receive inputs from the user via the display **124** and/or keypad **125**. In some embodiments, application programs stored in the memory **126** and run on the processor **123** are, for example, iPhone, Android, Windows Mobile, BREW, J2ME, or other mobile applications and can encompass a broad array of application types. Examples of these applications include e-commerce applications **622** (FIG. **6**), games **626** (FIG. **6**), enterprise applications **628** (FIG. **6**), and multimedia applications **630** (FIG. **6**). E-commerce applications can include ticketing applications; content, item and service purchase applications; and/or payment management applications. One example of an e-commerce application that runs on the processor **123** and is stored in the memory **126** is an event application that provides event information and ticketing (e.g., for movies, concerts, sports, airplanes, busses, trains, etc). In some implementations, the processor **123** recognizes secure communications (e.g., as received via the transceiver **122** and/or **129**) and transmits data from the secure communications to the secure element **130** for storage therein. The processor **123** also processes data received from the secure element **130**.

FIG. **3**A is a block diagram illustrating a secure element **130***a* in accordance with some embodiments. The secure element **130***a*, which is an example of the secure element **130** (FIG. **1**), includes a processor **132**, a memory **133**, and a wireless transceiver **134** with a corresponding antenna **131-1**. The memory **133** includes a memory element **138** (e.g., a register, or alternatively a group of memory cells in a memory array in the memory **133**) for storing an identifier (e.g., a serial number) associated with the secure element **130***a*. The memory element **138** is non-volatile and thus can store the identifier even in the absence of power. The transceiver **134** is adapted to communicate wirelessly with POS and POE terminals **150** (FIG. **1**). For example, the transceiver **134** is adapted to send transaction request signals to POS terminals **150**, to send entry request signals to POE terminals **150**, and to receive corresponding responses from the terminals **150**. In some embodiments, the transceiver **134** is a near-field communication (NFC) transceiver (e.g., operating in accordance with the ISO 18092 standard), which includes an NFC modem. In some implementations, the NFC modem has a set

of registers that can be read and written by the processor **132** and are also available for reading and writing by an external device (e.g., a POS or POE terminal **150**) over the wireless (e.g., RFID) communications channel between the transceiver **134** and the external device. This set of registers serves, for example, as a shared memory between the processor **132** within the secure element **130** and an RFID reader associated with a POS or POE terminal **150**. This communication between the secure element **130***a* and POS or POE terminal **150** is performed, for example, in accordance with the ISO 14443A/B standard and/or the ISO 18092 standard.

In some embodiments, the secure element **130***a* includes one or more additional transceivers **136** (e.g., radio, Bluetooth, and/or WiFi transceivers) and associated antennas **131-2**. The one or more additional transceivers **136** are adapted to communicate wirelessly with the mobile communication device **110** (e.g., via the transceiver **122** and/or **129** (FIG. **2**) in the mobile communication device **110**).

The memory **133** stores one or more applications, including one or more e-commerce applications (e.g., applications **720**, FIG. **7**), to be executed by the processor **132**. Associated with respective e-commerce applications are respective application programming interfaces (APIs) for interacting with corresponding applications run on the processor **123** in the mobile communication device **110** (FIG. **2**) and with POS or POE terminals **150** (FIG. **1**). Examples of such interactions are provided below with respect to FIGS. **4**A-**4**D.

In some embodiments, the mobile communication device **110** establishes a point-to-point connection with the secure element **130** via the wireless channel **163** (FIG. **1**) using Point-to-Point Protocol (PPP). Using PPP, the mobile communication device **110** tunnels packets (e.g., IP packets) to the secure element **130**. After transmission of the packets is complete and acknowledgements confirming the packets have been received from the secure element **130**, the PPP connection is disabled. Alternatively, Transmission Control Protocol/Internet Protocol (TCP/IP) is used to tunnel the packets from the mobile communication device **110** to the secure element **130**. In other embodiments, the mobile communication device **110** establishes a Virtual Private Network (VPN) or a General Packet Radio Service (GPRS) connection with the secure element **130**, which is used to tunnel the packets. In still other embodiments, the mobile communication device **110** uses WiFi, Bluetooth, ZigBee (i.e., the IEEE 802.15.4-2003 standard), or non-directed infrared to transmit the packets (e.g., via the transceiver **129**, FIG. **2**) to the secure element **130** and thus to communicate with the secure element **130**. In some embodiments, the secure element **130** also uses WiFi, Bluetooth, ZigBee, or non-directed infrared, respectively, to communicate with the mobile communication device **110**.

In some embodiments, the mobile communication device **110** transmits data to the secure element **130** over the direct wireless channel **163** (FIG. **1**) using a first communications protocol, while the secure element **130** transmits data to the mobile communication device **110** over the direct wireless channel **163** (FIG. **1**) using a second communications protocol distinct from the first protocol. For example, the device **110** transmits data to the secure element **130** using a packet protocol (e.g., Internet Protocol (IP)) in which an identifier of the secure element **130** (e.g., as stored in the memory element **138**, FIGS. **3**A-**3**C, and also in the memory **126**, FIG. **2**) is used as a local, private IP address for the secure element **130**. The processor **123** in the device **110** (FIG. **2**) creates packets with the identifier as a destination address and the data as the packet's payload, and delivers the packets to the transceiver **122** or **129**, which transmits the packets to the secure element **130**. The secure element **130** receives the packets via the transceiver **134** or **136**, which provides the packets to the processor **132** (FIGS. **3**A-**3**C). The processor **132** disassembles the packets and processes the data contained in the packets. In some embodiments, however, transmissions from the secure element **130** to the device **110** do not use the packet protocol. Instead, for example, the secure element **130** uses a messaging protocol. Examples of messaging protocols include Short Message Service (SMS) and Multimedia Messaging Service (MMS). The processor **132** (FIGS. **3**A-**3**C) in the secure element **130** creates messages addressed to the phone number associated with the device **110** and provides the messages to the transceiver **134** or **136**, which transmits the messages to the device **110**. In some implementations, the messages are SMS messages with 132 or fewer characters. The device **110** receives the messages at the transceiver **122** or **129** and provides the messages to the processor **123**, which extracts and processes the data contained in the messages. The device **110** typically includes multiple ports associated with the transceiver **122**. In some embodiments, the device **110** receives the messages from the secure element **130** via a port of the transceiver **122** that is separate from a port of the transceiver **122** used to receive messages (e.g., SMS or MMS messages) transmitted to the device **110** over a carrier network (e.g., a cellular network). The use of different protocols depending on the direction of communication between the device **110** and secure element **130** allows communications to be addressed using readily available information: the identifier of the secure element **130** and the phone number of the device **110**. In some embodiments, the mobile communication device uses Dual Transfer Mode (DTM) to transmit the packets at a frequency different from a frequency used for cellular communication.

In some embodiments, standard AT commands are used in the secure element **130** and the mobile communication device **110**. An API in the secure element **130** uses AT commands to create and transmit messages (e.g., SMS or MMS messages) to a specified port number associated with the radio transceiver **122** of the mobile communication device **110**. The messages are sent directly from the secure element **130** to the mobile communication device **110** via the channel **163**, (e.g., using a PPP connection or other connection). Alternatively, if the API in the secure element **130** determines that a carrier network (e.g., a cellular network) or wireless (e.g., WiFi) network is available, the API will detect this and format the messages for delivery over the network (e.g., using Http, https) to a Short Message Service Center (SMSC) (or other message service center) and then to the mobile communication device **110** and/or the management server **180**. For example, the API composes the SMS packets such that they are compliant with standard SMS protocol which includes a unique 5 digit shortcode approved by an authorized shortcode agency.

In some embodiments, the secure element **130**, while physically coupled to the mobile communication device **110**, is not electrically coupled to the device **110** and does not receive power from the device **110**. Instead, for example, the secure element **130***a* receives RF power from a remote terminal (e.g., a POS or POE terminal **150**) when in proximity to the remote terminal and uses this power to operate the processor **132**, memory **133**, and transceivers **134** and **136**. In the absence of another power source, the secure element **130***a* thus communicates with the mobile communication device **110** only when receiving power from a remote terminal. In some embodiments, a secure element **130***b* includes the components of the secure element **130***a* and also includes a battery **140**, as shown in FIG. **3**B. The battery **140** is charged induc-

tively (e.g., using a power mat), which allows the battery **140** to be encased within the housing or body of the secure element **130***b*. In some embodiments, the battery **140** is surrounded by or encased in RF shielding to prevent interference with antennae in the secure element **130**. The secure element **130***b* also may include one or more light-emitting diodes (LEDs) **142** to indicate a charge status of the battery **140**. In other embodiments, a secure element **130***c* includes the components of the secure element **130***a* and also includes power harvesting circuitry **144**, as shown in FIG. **3**C. The power harvesting circuitry **144** harvests power from ambient radio-frequency (RF) signals and uses the harvested power to power the other components of the secure element **130***b*. In some embodiments, a secure element **130** includes both a battery **140** and power harvesting circuitry **144**; the power harvesting circuitry **144** is used to recharge the battery. In FIGS. **3**B and **3**C, the power bussing between the battery **140** (FIG. **3**B) or power harvesting circuitry **144** (FIG. **3**C) and other components is not shown, for visual clarity.

In some embodiments, the components of the secure element **130***a* are implemented on a single integrated circuit (IC); this single integrated circuit is sometimes referred to as a smart chip. The smart chip and any other components (e.g., the battery **140**, FIG. **3**B, or power harvesting circuitry **144**, FIG. **3**C) of the secure element **130** are encased within a card, referred to as a smart card, that serves as a housing of the secure element **130**. In some embodiments, the smart card is adhesively affixed to the mobile communication device **110** and is referred to as a sticker.

FIG. **3**D illustrates top and side views of a smart card **130***d*, which is an example of a secure element **130** (FIG. **1**). The smart card **130***d* can be attached (e.g., affixed) externally to a mobile communication device **110**. In FIG. **3**D, the smart card **130***d* has a circular shape. The smart card **130***d* can have other suitable shapes (e.g., rectangular, triangular, and so on). The smart card **130***d* includes an embedded smart chip **702** that includes the components of the secure element **130***a* (FIG. **3**A). The smart chip **702** is capable of 2-way wireless communication with a remote terminal (e.g., a POS or POE terminal **150**) and with the mobile communication device **110** using the transceivers **134** or **136**.

In some embodiments, the transceivers **134** and/or **136** in the smart chip **702** are low-power RF transceivers. Their low power output makes them susceptible to RF interference from neighboring devices, such as the mobile communication device **110** to which the smart card **130***d* is attached. Thus, in some implementations, the smart card **130***d* includes an RF shield to insulate the smart chip **702** from external interference. In one implementation, a lining of the smart chip **702** is composed of an RF absorbent material. In general, each phone has different levels of interference, and a material, size and thickness of the RF lining can determine an effectiveness of the RF shield. Alternatively, instead of incorporating an RF shield within the smart card **130***d*, an RF shield can be placed between the smart card **130***d* and the mobile communication device **110**.

Given the abuse a mobile communication device **110** can take, smart cards **130***d* that are attached externally to a mobile communication device are designed to withstand some abuse. In some embodiments, the smart card **130***d* includes a ruggedized shell **704** that encases the smart chip **702**. In some implementations, the shell **704** is formed of a composite plastic or polymer. The shell **70** can be hard (and substantially inflexible) or soft (and pliable). In some implementations, the shell **704** includes a protective membrane for the smart chip **702** which prevents damage to internal circuitry of the smart chip **702**, a surface to adhere to an RF lining and/or the mobile communication device **110** with appropriate adhesive, and a surface that faces outward when the smart card **130***d* is attached to the mobile communication device **110**, on which to print branding and advertising. Types of adhesives that can be used to affix the smart card **130***d* to the mobile communication device **110** include, for example, paper glue, super glue, adhesive polymers, and the like. In one implementation, the shell **704** has a maximum width (or diameter) of 25 mm, and has a maximum thickness (or depth) of 5 mm.

In some embodiments, instead of being externally attached to the mobile communication device **110**, a secure element **130** is physically coupled to the mobile communication device **110** by being disposed internally within a body of the mobile communication device **110**. For example, as shown in FIG. **3**E in accordance with some embodiments, the mobile communication device **110** includes a slot **400** into which a secure element **130***e* is inserted. The secure element **130***e* is an example of a secure element **130***a*, **130***b*, or **130***c* (FIGS. **3**A-**3**C). Even though the secure element **130***e* is physically housed within the slot **400**, the secure element **130***e* and the mobile communication device **110** still communicate wirelessly with each other. Accordingly, in some implementations the slot **400** only provides for physical insertion and mechanical connection of the secure element **130***e* to the body of the mobile communication device **110**, and does not electrically couple the secure element **130***e* to the mobile communication device **110**.

Attention is now directed to methods of communication between various elements of the system **100** (FIG. **1**), including the mobile communication device **110** and the secure element **130**. FIGS. **4**A through **4**D illustrate examples of transactions involving the mobile communication device **110**, the secure element **130**, and other elements of the system **100**.

Various operations shown in FIGS. **4**A-**4**D, including operations **430** (FIG. **4**B), **452** (FIG. **4**C), **468** (FIG. **4**D), and **476** (FIG. **4**D), involving sending messages from the secure element **130** to the mobile communication device **110**. In some embodiments, these messages are addressed to the phone number and/or an identifier of the device **110** and also are directed to a specified port of the device **110** (e.g., a specified port of the transceiver **122**), which may be distinct from the port (e.g., of the transceiver **122**) that the device **110** uses to receive messages via a carrier network (e.g., from a cellular provider). In some embodiments, these messages are generated using standard modem AT commands. The transceiver **134** or **136** (FIGS. **3**A-**3**C) transmits the messages. In some embodiments, if an API running on the processor **132** of the secure element **130** detects that a carrier network or other wireless network is available, the API formats the messages to comply with a standard messaging protocol (e.g., standard SMS or MMS protocol) and the messages are delivered from the secure element **130** using the carrier network to the mobile communication device **110** and/or the management server **180** (e.g., using http, https, etc.). The messages may include a numeric shortcode (e.g., a 5-digit shortcode) approved by an authorized shortcode agency. Alternatively, the messages are transmitted directly from the secure element **130** to the mobile communication device **110** via the channel **163** (FIG. **1**) (e.g., using a PPP or other connection between the secure element **130** to the mobile communication device **110**).

In some embodiments, the messages include a character in the first position of the message to indicate that the message originated from the secure element **130**. The first character may be calculated as a function of an identifier (e.g., serial number) of the secure element **130** and of a second number, such as the date. For example, the digits of the date are added

together to provide an index value, and the digit of the identifier specified by the index value is used as the first character. In one example, if the date is Oct. 15, 2010, the index value is 1+5=6, and the 6th digit of the identifier is used as the first character.

Examples provided in the following description of FIGS. **4**A-**4**D describe embodiments in which packets transmitted from the mobile communication device **110** to the secure element **130** use a different protocol than the messages transmitted from the secure element **130** to the mobile communication device **110**. For example, the packets are IP packets (e.g., 128 byte IP packets), while the messages are SMS (e.g., **130** character SMS) or MMS messages. In other embodiments, however, the messages are packets formatted using the same protocol as the packets from the device **110**. For example, an API in the secure element **130** creates IP packets (e.g., 128 byte IP packets) as the messages and transmits them to the device **110** via the wireless channel **163**, using a connection (e.g., a PPP, VPN, or GPRS connection) established between the device **110** and the secure element **130**. The IP packets created by the API in the secure element **130** are addressed to an IP address associated with a transceiver in the device **110**. In still other embodiments, SMS or MMS packets are used in both directions for communications between the mobile communication device **110** and the secure element **130**. In such embodiments, the secure element **130** includes a "listener" application to listen for messages from the device **110**. Each message includes, for example, a shortcode approved by an authorized agency and an identifier in the first position of the message to indicate the origin of the message and distinguish the message from other messages.

In some embodiments, the secure element **130** selects a protocol to be used for a data transmission to the mobile communication device **110** based on the amount of data to be transmitted. For example, if the data can be transmitted using a predefined number of characters or less (e.g., **130** characters or less), the data are transmitted in an SMS message or similar message. If the data requires more than the predefined number of characters, the data is transmitted in a packet (e.g., a 128-byte IP packet).

FIG. **4**A is a flow diagram illustrating a method **400** of installing a secure element **130** in accordance with some embodiments. In the method **400**, an application (e.g., an application **620**, such as an e-commerce application **622**, FIG. **6**) is installed (**402**) on the mobile communication device **110** by storing the application in the memory **126** (FIG. **2**). The application is launched (**402**), thus initiating execution of the application by the processor **123** (FIG. **2**). The user of the application registers (**404**) the application: in response to an instruction to register the application, the application transmits to the management server **180** (FIG. **1**) the phone number and electronic serial number (ESN) of the mobile communication device **110**, along with an identifier of the application and/or user information. This information is transmitted, for example, in one or more packets addressed to the management server **180**, as created by the processor **123** and transmitted via the transceiver **122** or **129** (FIG. **2**). The management server **180** receives and stores (**406**) this information. In some embodiments, the management server **180** also assigns and stores a private IP address for the mobile communication device **110**, which serves as an identifier for the device **110**.

The user orders (**408**) a secure element **130**. The order is placed, for example, using the application. The management server **180** stores (**410**) an identifier of the secure element **130** to be provided to the user. For example, the management server **180** stores (**410**) a serial number of a smart chip **702** (FIG. **3**D) in a smart card **130***d* to be provided to the user. Alternatively, the user obtains the secure element **130** and enters a code printed on the secure element **130** into the application, which transmits the code to the management server **180**, where it is stored. The management server **180** uses the code to look up the identifier (e.g., the serial number) of the secure element **130**. The identifier (e.g., the serial number) of the secure element **130** will serve as an address (e.g., a private internet protocol (IP) address) of the secure element **130**; packets sent from the mobile communication device **110** to the secure element **130** will be addressed to this address. In some embodiments, the serial number of the secure element **130** is 128 bits and the private IP address of the secure element **130** is the serial number.

Upon receiving the secure element **130**, the user attaches (**412**) the secure element **130** to the mobile communication device **110**. For example, the user adhesively affixes a smart card **130***d* (FIG. **3**D) to the mobile communication device **110**. In another example, the user inserts a secure element **130***e* (FIG. **3**E) into a slot **400** in the mobile communication device **110**. If the secure element **130** includes a battery **140** (FIG. **3**B), the battery **140**, and thus the secure element **130**, is charged (**414**).

After the secure element **130** has been installed in accordance with the method **400**, the secure element **130** is activated. FIG. **4**B is a flow diagram illustrating a method **420** of activating a secure element **130** in accordance with some embodiments. In the method **420**, the user uses the application running on the processor **123** (FIG. **2**) to query (**422**) the management server **180** for the identifier of the secure element **130** and, in some embodiments, the mobile communication device **110**. In response, the management server **180** retrieves the stored identifier(s) and transmits (**424**) the identifier(s) to the mobile communication device **110**.

At the mobile communication device **110**, the processor **123** creates a packet (e.g., an IP packet), addressed to the identifier of the secure element **130**, that includes the phone number (e.g., cellular phone number) and, in some embodiments, the identifier of the mobile communication device **110**. The packet is transmitted (**426**) via the transceiver **122** or **129** (FIG. **2**). The secure element **130** receives the packet via the transceiver **134** or **136** (FIGS. **3**A-**3**C) and verifies that the packet is addressed to the secure element **130** by comparing the packet's address to the identifier stored in the memory element **138**. An API running on the processor **132** (FIGS. **3**A-**3**C) disassembles the packet and stores (**428**) the phone number and identifier of the mobile communication device **110** as provided by the packet in the memory **133**. For example, the phone number is stored in another memory element of the memory **133**, distinct from the memory element **138**.

The API running on the processor **132** creates a message (e.g., an SMS or MMS message) confirming that the secure element **130** received the packet transmitted in operation **426**. The message is transmitted (**430**) by the transceiver **134** or **136** (FIGS. **3**A-**3**C).

The mobile communication device **110** receives (**432**) the confirmation message at the specified port of the transceiver **122** (FIG. **2**). A "listener" application (e.g., **631**, FIG. **6**) on the device **110** listens on the specified port for the message and, upon receiving the message, unpacks it. If the mobile device does not receive the confirmation message, it retransmits the packet as described in operation **426**. After receiving the confirmation, the device **110** then composes a message compliant with the format used for delivery (e.g., via a public carrier network) to the management server **180** and transmits (**434**) the confirmation of activation of the secure element **130**

to the management server **180**, which receives (**436**) and stores the confirmation of activation of the secure element **130**.

Once the secure element **130** has been activated and its activation confirmed in accordance with the method **420**, the secure element **130** may be used for purchases at terminals such as a POS or POE terminal **150** (FIG. **1**). FIG. **4**C is a flow diagram illustrating a method **440** of using a secure element **130** for a purchase in accordance with some embodiments.

In the method **440**, the user instructs an application running on the processor **123** (FIG. **2**) of the mobile communication device **110** to load (**442**) value (e.g., money or credits) onto the secure element **130**. The application creates one or more packets (e.g., one or more IP packets), addressed to the identifier of the secure element, specifying the value to be loaded onto the secure element **130**; the packet(s) are transmitted via the transceiver **122** or **129**. The secure element **130** receives the packet(s) via the transceiver **134** or **136** (FIGS. **3**A-**3**C) and disassembles the packet. An application (or corresponding API) running on the processor **132** (FIGS. **3**A-**3**C) updates (**444**) the stored value of the secure element **130** by the amount specified in the packet. In some embodiments, the secure element **130** transmits a confirmation message (not shown) to the mobile communication device **110**. If the mobile communication device **110** does not receive the confirmation message from the secure element **130**, it retransmits the packet(s) as described in operation **442**.

To purchase an item or gain entry to a venue or facility, the user brings the mobile communication device **110** with its attached secure element **130** into proximity with a POS or POE terminal **150**. The terminal **150** requests (**446**) the amount of purchase (or entry) from the secure element **130**. The secure element **130** receives this request directly from the terminal **150** via the transceiver **134** (or alternatively, **136**). After authenticating the request, the secure element **130** debits its stored value by the requested amount and transmits (**448**) the requested amount to the terminal **150**, which receives (**450**) the amount.

An application (or corresponding API) running on the processor **132** (FIGS. **3**A-**3**C) of the secure element **130** creates (**452**) one or more messages (e.g., one or more SMS or MMS messages) with transaction data for the purchase (e.g., the amount, the date and time, identification of the terminal **150**, etc.). The one or more messages are transmitted (**452**) by the transceiver **134** or **136** (FIGS. **3**A-**3**C).

The listener application (e.g., listener application **631**, FIG. **6**) on the mobile communication device **110** listens on the specific port for messages. When it receives (**456**) the one or more messages at the specified port of the transceiver **122** (FIG. **2**), it unpacks the message, confirms the messages, and displays the transaction data contained in the message to the user. The device **110** transmits (**458**) a copy of the transaction data to the management server **180** (not shown in FIG. **4**C), which stores the transaction data. The device also sends a confirmation that it received the messages to the secure element **130**.

The method **440** of FIG. **4**C thus illustrates a purchase performed using the device **110** and secure element **130**. In some embodiments, data is provided to the secure element **130** for subsequent use or reference in a transaction such as the purchase of the method **440**. FIG. **4**D is a flow diagram illustrating a method **460** of providing data to a secure element **130** in accordance with some embodiments.

In the method **460**, the management server **180** sends (**462**) data to the mobile communication device **110**, which receives (**464**) the data. In some embodiments, the data is e-commerce data (e.g., a ticket, such as a ticket for a movie, concert, sporting event, airplane, bus, train, etc; a new value for a stored value card, credit card, or debit card; a coupon; or an advertisement). If the data includes a coupon, the coupon may include a merchant ID, promotion code, date of coupon delivery, time of coupon delivery, GPS coordinates associated with coupon delivery, etc. Other examples of the data include, but are not limited to, locations of smart posters; a code to unlock a door, computer, or vehicle; a code to start a vehicle, start a copy machine, withdraw funds from an ATM, or release medical records to a specific person or device; a list of authorized cell phone numbers, IMEI numbers, and/or serial numbers associated with secure elements for peer-to-peer funds transfer, or an instruction to disable the secure element **130** if the mobile device **110** has been reported as lost or stolen. The device **110** receives the data, for example, over a cellular network, via the transceiver **122**, or over an Internet connection, via the transceiver **129**. Instead of immediately forwarding the received data to the secure element **130**, the device **110** first transmits (**466**) a wake-up packet to the secure element **130**, in case the secure element **130** is in a sleep mode. The wake-up packet (e.g., an IP packet) is addressed to the identifier of the secure element **130** and is transmitted via the transceiver **122** or **129** (FIG. **2**) using the IP address of the transceiver **134** or **136** of the secure element **130**.

The secure element **130** receives the packet via the transceiver **134** or **136** (FIGS. **3**A-**3**C) and, in response, exits sleep mode. The processor **132** (FIGS. **3**A-**3**C) creates a message (e.g., an SMS or MMS message) confirming that the device has exited sleep mode and thus woken up. The message is transmitted (**468**) by the transceiver **134** or **136**.

The mobile communication device **110** receives the message at the specified port of the transceiver **122** (FIG. **2**). In response, the processor **123** (FIG. **2**) creates (**470**) one or more packets (e.g., one or more IP packets) containing the data received in the operation **464**. The one or more packets are addressed to the identifier of the secure element **130** and transmitted via the transceiver **122** or **129** (FIG. **2**) using the IP address of the transceiver **134** or **136** of the secure element **130**.

The secure element **130** receives (**472**) the packet(s) containing the data via the transceiver **134** or **136** (FIGS. **3**A-**3**C) and disassembles the packet(s) to access the data. Using an application (e.g., an e-commerce application) or corresponding API running on the processor **132** (FIGS. **3**A-**3**C), the secure element **130** performs (**474**) a task associated with the received data. For example, the data are stored in the memory **133**. If the data contain an instruction to disable the secure element **130**, the secure element **130** disables itself, thus preventing the secure element from being able to interact with a remote terminal (e.g., a POS or POE terminal **150**). If the data contain a ticket (e.g., for a movie, concert, sports, airplane, bus, train, etc.) or coupon, the secure element **130** stores the ticket or coupon in the memory **133** and subsequently redeems the ticket or coupon at a POS or POE terminal **150**, even if the mobile communication device **110** does not have network access and thus is offline. If the data contain instructions to increase or decrease the value of a stored value account, debit card, or credit card, the value as stored in the memory **133** is increased or decreased accordingly. If the data contain updates to information about a financial account (e.g. expiration date, billing address, etc), the information is updated in the memory **133**. If the data include one or more user-defined payment limits, an e-commerce application on the secure element **130** uses the payment limits to prevent transactions above the limits or to require entry of a PIN code to authorize transactions above the limits. If the data include a list of authorized cell phone numbers, IMEI numbers, and/

or serial numbers associated with secure elements that are authorized for peer-to-peer transactions (e.g., funds transfers), the secure element **130** stores the list in the memory **133** and subsequently uses the list to perform peer-to-peer transactions with other secure-element-equipped mobile communications devices that are placed in proximity to the device **110**. If the data include a access code (e.g., to provide access to a building, office, apartment, room, vehicle, safety deposit box, etc.), the secure element **130** stores the access code in the memory **133** and subsequently provides the access code to a POE terminal **150** to request access. If the data includes a code to operate an apparatus (e.g., a vehicle or electronic appliance such as a computer, copy machine, washing machine, ATM machine etc), the secure element **130** stores the code in the memory **133** and subsequently provides the code to a remote terminal associated with the apparatus to initiate use of the apparatus. If the data includes a code to provide access to computerized records (e.g., medical records), the secure element **130** stores the code in the memory **133** and subsequently provides the code to a computer to request access to the records.

The secure element creates and transmits (**476**) a message (e.g., an SMS or MMS message) to the mobile communication device **110** confirming that the task has been performed. The device **110** receives (**478**) the message at the specified port of the transceiver **122** (FIG. **2**) and forwards (**480**) the confirmation to the management server **180**, which updates (**482**) its records accordingly.

FIGS. **4**A-**4**D provide specific examples of how to use a mobile communication device **110** and associated secure element **130**. Attention is now directed to a more generalized method of communication between a mobile communication device **110** and a secure element **130** that is physically coupled to the device **110**. Specifically, FIG. **5** is a flow diagram illustrating a method **500** of communicating between a mobile communication device **110** and a secure element **130** in accordance with some embodiments.

The method **500** is performed at a system that includes a mobile communication device **110** and a secure element **130** physically coupled to the mobile communication device **110**. The mobile communication device **110** includes a first wireless transceiver (e.g., the transceiver **122**, FIG. **2**), first processor (e.g., the processor **123**, FIG. **2**), and first memory (e.g., the memory **126**, FIG. **2**). In some embodiments, the mobile communication device **110** includes a plurality of transceivers (e.g., the transceivers **122** and **129**, FIG. **2**). The secure element **130** includes a second wireless transceiver (e.g., the transceiver **134** or **136**, FIGS. **3**A-**3**C), second processor (e.g., the processor **132**, FIGS. **3**A-**3**C), and second memory (e.g., the memory **133**, FIGS. **3**A-**3**C). In some embodiments, the secure element **130** includes a plurality of transceivers (e.g., the transceivers **134** and **136**, FIGS. **3**A-**3**C).

In the method **500**, a packet (or a plurality of packets) is wirelessly transmitted (**504**) from the mobile communication device **110**, via the first wireless transceiver, to the secure element **130**, using a packet protocol (e.g., PPP, TCP/IP). In some embodiments, the packet has a destination address that corresponds (**506**) to an identifier associated with the secure element **130** (e.g., an IP address of the transceiver **134** or **136**) and stored in a memory element (e.g., the memory element **138**, FIGS. **3**A-**3**C) of the second memory. For example, the destination address is the identifier. In some examples, all or a portion of the identifier is used as a private IP address assigned to the secure element. In some examples, the secure element **130** includes a chip (e.g. a smart chip **702**, FIG. **3**D), configured for near-field communications, that includes the second wireless transceiver, second processor, and second memory. Because the chip is configured for near-field communications, it is referred to as an NFC chip. The identifier is the serial number of the NFC chip: for example, the serial number of the NFC chip is 128 bits; these 128 bits are used as a 128-bit IP address of the secure element **130**. This 128-bit IP address is used as the destination address in the header of TCP/IP packets sent to the secure element **130**.

Examples of packets transmitted in the operation **504** include the packets transmitted in the operations **426** (FIG. **4**B), **442** (FIG. **4**C), **466** (FIG. **4**D), and **470** (FIG. **4**D)

In some embodiments, the packet has a payload specifying (**508**) a phone number of the mobile communication device (e.g., as for the operation **426**, FIG. **4**B).

In some embodiments, the packet has a payload including (**512**) a command to disable an application (e.g., an application **720**, such as an e-commerce application) stored in the second memory (e.g., as described with respect to the operation **470**, FIG. **4**D). In response, the application is disabled (**516**) in the secure element **130** (e.g., in the operation **474**, FIG. **4**D).

The secure element **130** receives the packet via the second transceiver (e.g., transceiver **134**, FIGS. **3**A-**3**C), or alternatively via another transceiver distinct from the second transceiver (e.g., transceiver **136**, FIGS. **3**A-**3**C).

A message (or a plurality of messages) is wirelessly transmitted (**518**) from the secure element **130**, via the second wireless transceiver, to the mobile communication device **110**, using a standard messaging protocol (e.g. SMS or MMS) distinct from the packet protocol, or a variant of a standard messaging protocol. The message is transmitted, for example, using AT commands. In some embodiments, the message is addressed (**520**) to the phone number of the mobile communication device **110**. In some embodiments, the first character of the message will include a unique identifier (e.g., a specific letter) to identify that the message has been sent from the secure element **130**. The first character may be randomly generated according to a pre-determined algorithm to prevent spoofing.

Examples of messages transmitted in the operation **518** include the messages transmitted in the operations **430** (FIG. **4**B), **452** (FIG. **4**C), **468** (FIG. **4**D), and **476** (FIG. **4**D).

In some embodiments, the message confirms (**522**) that the secure element received the packet.

In some embodiments, the packet(s) have payload including (**510**) data (e.g., e-commerce data). Examples of data included in the payload include those data described with respect to operations **470** and **472** in the method **460** (FIG. **4**D). An application stored in the second memory is executed (**514**) on the second processor in the secure element **130** to process the data (e.g., as in the operation **474**, FIG. **4**D). The message confirms (**524**) that the application processed the data (e.g., as in the operation **476**, FIG. **4**D).

In some embodiments, prior to the operation **518**, the secure element **130** counts the number of characters to be used in the message. If the number of characters exceeds the number of characters allowed for the message using the messaging protocol, the secure element **130** does not transmit the message, but instead creates and transmits a packet with a payload larger than the number of characters allowed for the message using the messaging protocol. For example, an IP packet is created and transmitted. Alternatively, if the number of characters exceeds the number of characters allowed for the message using the messaging protocol, the secure element **130** creates and transmits a plurality of messages.

In some embodiments, the message provides transaction data (e.g., as in the operation **452**, FIG. **4**C). The transaction

data are associated with an e-commerce or other transaction. For example, the message provides a receipt from an e-commerce transaction; the receipt includes, for example, a transaction number, transaction amount, transaction date, transaction time, merchant ID, merchant name, product id, product name, location of transaction/merchant, and/or cashier D. In another example, the message provides an indication of redemption of an electronic coupon. Other examples of transaction data are described with respect to operations **470**-**478** in the method **460** (FIG. **4**D).

The mobile communication device **110** receives the message via the first transceiver (e.g., transceiver **122**, FIGS. **3**A-**3**C), or alternatively via another transceiver distinct from the first transceiver (e.g., transceiver **129**, FIGS. **3**A-**3**C). In some embodiments, the device **110** receives messages from a cellular service provider (e.g., forward by the cellular service provider but initially transmitted by another party) at a first port, and receives the message from the secure element **130** at a second port distinct from the first port.

In some embodiments, the secure element **130** receives power from a remote terminal (e.g., a POS or POE terminal **150**, FIG. **1**). For example, the secure element **130** receives power via RF signals transmitted by the remote terminal. The wireless transmission of the message in operation **518** is performed using the power received from the remote terminal when the secure element **130** is in proximity to the remote terminal. In other embodiments, the secure element **130** harvests power from ambient RF signals (e.g., using power harvesting circuitry **144**, FIG. **3**C). The wireless transmission of the message in operation **518** is performed using the harvested power. In still other embodiments, the secure element **130** includes a battery (e.g., a battery **140**, FIG. **3**B), and the wireless transmission of the message in operation **518** is performed using power from the battery. For example, the secure element **130** determines whether power is available from a nearby remote terminal. If power is not available from the nearby terminal, the message is wirelessly transmitted using power from the battery.

The method **500** thus allows for wireless bi-directional communication between a mobile communication device **110** and associated secure element **130** using a different protocol in each direction. While the method **500** includes a number of operations that appear to occur in a specific order, it should be apparent that the method **500** can include more or fewer operations, which can be executed serially or in parallel. An order of two or more operations may be changed and two or more operations may be combined into a single operation. For example, the order of the operations **504** and **518** may be reversed.

FIG. **6** is a block diagram illustrating a mobile communication device **110** (e.g., as shown in FIG. **2**) in accordance with some embodiments. The device **110** includes a processor **123**, one or more communications interfaces **614**, memory **126**, a user interface **612**, and one or more communication buses **610** for interconnecting these components. The communication buses **610** may include circuitry that interconnects and controls communications between system components. The user interface **612** includes the display **124** and keypad **125**. The communications interface **614** includes the transceiver **122** and, in some embodiments, the transceiver **129**. The memory **126** includes high-speed random access memory, such as DRAM, SRAM, DDR RAM and/or other random access solid state memory devices; and includes non-volatile memory, such as flash memory devices, a magnetic disk storage device, and/or other non-volatile solid state storage devices. The memory **126**, or alternately non-volatile memory device(s) within the memory **126**, includes a non-transitory computer-readable storage medium. While the memory **126** is shown as being separate from the processor **123**, all or a portion of the memory **126** may be embedded in the processor **123**. In some embodiments, the memory **126** stores the following programs; modules and data structures, or a subset thereof:

- an operating system **616** that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- a communication module **618** that is used for communicating with other devices (e.g., with the secure element **130** and the management server **180**, FIG. **1**) via the communications interface **614**; and
- applications **620**, including one or more e-commerce applications **622** (e.g., ticketing applications; content, item and service purchase applications; and/or payment management applications), games **626**, enterprise applications **628**, and/or multimedia applications **630**.

The communication module **618** includes a "listener" application **631** to listen on a specified port of a transceiver (e.g., the transceiver **122**, FIG. **2**) for messages from the secure element **130**. The communication module **618** also stores an identifier **632** of a secure element **130** that is physically coupled to the mobile communication device **110**, for use in transmitting packets to the secure element **130**, and the phone number **634** of the mobile communication device **110**, for use in receiving messages from the secure element **130**.

Associated with the e-commerce application(s) **622** are corresponding APIs for processing data received from other devices (e.g., the secure element **130** and the management server **180**, FIG. **1**) and data to be transmitted to the other devices. Similar APIs may be associated with the other applications **626**, **628**, and/or **630**.

In some embodiments, the non-transitory computer-readable storage medium of the memory **126** includes instructions for performing all or a portion of the operations shown in the "mobile device communication **110**" columns in FIGS. **4**A-**4**D (except for the attaching operation **412**, FIG. **4**A). Likewise, the memory **126** includes instructions for performing all or a portion of the operations **504**-**512** in the method **500** (FIG. **5**).

Each of the above identified elements in FIG. **6** may be stored in one or more of the previously mentioned memory devices in the memory **126**. Each of the above identified modules corresponds to a set of instructions for performing functions described above. The above identified modules or programs (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, the memory **126** may store a subset of the modules and data structures identified above. Furthermore, the memory **126** may store additional modules and data structures not described above.

FIG. **7** is a block diagram illustrating a secure element **130** (e.g., as shown in FIGS. **3**A-**3**E) in accordance with some embodiments. The secure element **130** includes a processor **132**, one or more communications interfaces **714**, memory **133**, and one or more communication buses **710** for interconnecting these components. The communication buses **710** may include circuitry that interconnects and controls communications between components. The communications interface **714** includes the transceiver **134** and, in some embodiments, the transceiver **136**. The memory **133** includes high-speed random access memory, such as DRAM, SRAM, DDR RAM and/or other random access solid state memory; and includes non-volatile memory, such as flash memory and/or

other non-volatile storage. The memory **133**, or alternately non-volatile memory within the memory **133**, includes a non-transitory computer-readable storage medium. While the memory **133** is shown as being separate from the processor **132**, all or a portion of the memory **133** may be embedded in the processor **132**. In some embodiments, the memory **133** stores the following programs, modules and data structures, or a subset thereof:

- an operating system **716** that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- a communication module **718** that is used for communicating with other devices (e.g., with the mobile communication device **110** and with POS and POE terminals **150**, FIG. **1**) via the communications interface **714**; and
- one or more applications **720** (e.g., e-commerce applications) and associated APIs **722**.

The communication module **718** stores an identifier **724** of the secure element **130** (e.g., an identifier of the transceiver **134** or **136**), for use in receiving packets from the mobile communication device **110** to which the secure element **130** is physically coupled, and also stores the phone number **726** and identifier **727** of the mobile communication device **110**, for use in transmitting messages to the mobile communication device **110**.

In some embodiments, the memory **133** includes instructions for performing all of the operations shown in the "secure element **130**" columns in FIGS. **4**A-**4**D (except for the attaching operation **412** and charging operation **414**, FIG. **4**A). Likewise, the memory **126** includes instructions for performing all or a portion of the operations **514**-**524** in the method **500** (FIG. **5**).

Each of the above identified elements in FIG. **7** may be stored in one or more of the previously mentioned components of the memory **133**. Each of the above identified modules corresponds to a set of instructions for performing functions described above. The above identified modules or programs (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, the memory **133** may store a subset of the modules and data structures identified above. Furthermore, the memory **133** may store additional modules and data structures not described above.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the inventions to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the inventions and their practical applications, to thereby enable others skilled in the art to best utilize the inventions and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A system, comprising a mobile communication device and a secure element physically coupled to the mobile communication device, wherein: the mobile communication device comprises a first wireless transceiver, a first processor, and a first memory; the secure element comprises a second wireless transceiver, a second processor, and a second memory; the mobile communication device is configured to address packets to a serial number of the secure element and transmit point of sale (POS) transaction data via the first wireless transceiver to the secure element in the packets using a TCP/IP packet protocol; and the secure element is configured to address messages to a phone number of the mobile communication device and transmit data via the second wireless transceiver to the mobile communication device in the messages using an SMS messaging protocol; and wherein the secure element is configured to use power received from a POS device to transmit the messages to the mobile communication device.

2. The system of claim **1**, wherein the secure element is adhesively attached to the mobile communication device.

3. The system of claim **1**, wherein the secure element is configured to detect the availability of a carrier network and to transmit the messages using the carrier network in response to detecting availability of the carrier network.

4. The system of claim **1**, wherein:

the second memory of the secure element comprises a memory element to store an identifier associated with the secure element; and

the packets comprise a destination address corresponding to the identifier.

5. The system of claim **4**, wherein:

the secure element comprises an NFC chip, the NFC chip comprising the second wireless transceiver, second processor, and second memory; and

the identifier comprises a serial number of the NFC chip.

6. The system of claim **1**, wherein:

the first memory of the mobile communication device stores an application that, when executed by the first processor, generates the packets and transmits the packets via the first transceiver; and

the second memory of the secure element stores an application that, when executed by the second processor, generates the messages and transmits the messages via the second transceiver.

7. The system of claim **6**, wherein:

the first memory is configured to store data to be transmitted to the secure element in the packets and data received from the secure element in the messages; and

the second memory is configured to store data to be transmitted to the mobile communication device in the messages and data received from the mobile communication device in the packets.

8. The system of claim **1**, wherein the mobile communication device further comprises:

a first port to receive, from a cellular service provider, messages compatible with the messaging protocol; and

a second port, distinct from the first port, to receive the messages from the secure element.

9. The system of claim **1**, wherein the mobile communication device further comprises:

a first port to receive, from a cellular service provider, messages compatible with the messaging protocol and to receive the messages from the secure element.

10. A method of communicating between a mobile communication device and a secure element physically coupled to the mobile communication device, wherein the mobile communication device comprises a first wireless transceiver, a first processor, and a first memory, and wherein the secure element comprises a second wireless transceiver, a second processor, and a second memory, the method comprising:

addressing packets to a serial number of the secure element; wirelessly transmitting the packets including point of sale (POS) transaction data from the mobile communication device, via the first wireless transceiver, to the secure element using a TCP/IP packet protocol; addressing messages to a phone number of the mobile communication device and wirelessly transmitting the

messages from the secure element, via the second wireless transceiver, to the mobile communication device using an SMS messaging protocol; and wherein the secure element is configured to use power received from a POS device to transmit the messages to the mobile communication device.

11. The method of claim **10**, wherein:

the packet comprises a payload comprising a phone number of the mobile communication device;

the message provides a confirmation that the secure element received the packet; and

wirelessly transmitting the message comprises addressing the message to the phone number.

12. The method of claim **11**, wherein a first character of the message is an identifier corresponding to the secure element.

13. The method of claim **10**, wherein:

the packet comprises a payload;

the method further comprises executing an application on the second processor of the secure element to process data in the payload; and

the message provides a confirmation that the application has processed the data.

14. The method of claim **10**, wherein:

the second memory of the secure element stores an e-commerce application; and

the packet comprises a payload comprising a command to disable the e-commerce application.

15. The method of claim **10**, wherein the message provides a receipt from an e-commerce transaction.

16. The method of claim **10**, wherein the message provides transaction data associated with an e-commerce transaction.

17. The method of claim **10**, wherein:

the packet comprises a payload comprising an electronic coupon; and

the message provides an indication of redemption of the electronic coupon.

18. The method of claim **10**, wherein the secure element is adhesively attached to the mobile communication device.

19. The method of claim **10**, further comprising storing an identifier associated with the secure element in a memory element of the second memory of the secure element, wherein the packet comprises a destination address corresponding to the identifier.

20. The method of claim **19**, wherein:

the secure element comprises an NFC chip, the NFC chip comprising the second wireless transceiver, second processor, and second memory; and

the identifier comprises a serial number of the NFC chip.

21. The method of claim **20**, wherein the identifier comprises a private IP address assigned to the secure element.

22. The method of claim **10**, further comprising storing an identifier associated with the second wireless transceiver of the secure element in a memory element of the second memory of the secure element, wherein the packet comprises a destination address corresponding to the identifier.

23. The method of claim **10**, further comprising:

at a first port of the mobile communication device, receiving messages compatible with the messaging protocol from a cellular service provider; and

at a second port of the mobile communication device, receiving the message transmitted from the secure element using the messaging protocol, wherein the second port is distinct from the first port.

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