DYNAMIC POWER LEVELS IN NFC CARD COMMUNICATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application Serial No. 16/442,603, entitled "DYNAMIC POWER LEVELS IN NFC CARD COMMUNICATIONS" filed on June 17, 2019 (issued as U.S. Patent No. 10,516,447 on December 24, 2019). The contents of the aforementioned patent application are incorporated herein by reference in their entirety.

BACKGROUND

[0002] Near-field communication (NFC) is a set of communication protocols that enable two NFC-enabled components to establish communication by bringing them physically close to each other. One example of an NFC-enabled component may be a portable computing device, such as a smartphone. Another example of an NFC-enabled component may be a contactless card, which may be a credit-card sized article that contains embedded integrated circuits configured to communicate with a terminal device, such as the smartphone, via NFC.

[0003] Typically, for a smartphone and a contactless card to communicate with each other, the contactless card must be placed next to the smartphone in a precise manner to achieve NFC read-and-write capabilities. For complex transactions that require multiple reads and writes between the smartphone and the contactless card, the card may be required to be placed in a specific "sweet spot" near the smartphone for a predetermined amount of time.

[0004] Requiring a user, however, to precisely place a contactless card at a sweet spot for a specific duration of time is not only cumbersome, but also highly unreliable. Thus, there is a need to compensate for user imprecision and improve overall card usability.

SUMMARY

[0005] Various embodiments are directed to dynamically and temporarily adjusting power to an NFC reader of a computing device from a first power level to a second power level based on a feedback mechanism between a contactless card and the computing device. The contactless card may provide a message containing a checksum. The computing device may receive the message and calculate a checksum based on the received message. By comparing these two checksums, it may be determined whether the entire message has been correctly received. If not, the power to the NFC reader may be temporarily increased to allow better communication between the contactless card and the computing device.

[0005a] According to a first aspect of the present invention, there is provided a computing device, comprising:

a near-field communication (NFC) interface;

memory configured to store instructions; and

one or more processors coupled with the memory, the one or more processors operable to execute the instructions that, when executed, cause the one or more processors to:

receive data and a checksum value in one or more messages from a contactless card via the NFC interface;

determine a second checksum value based on the data;

determine whether the checksum value and the second checksum match; and

in response to the checksum value not matching the second checksum value, increase power for the NFC interface to receive the data and the checksum value again from the contactless card via the NFC interface.

[0005b] According to a second aspect of the present invention, there is provided a computer-implemented method, comprising:

receiving, via an NFC interface of a computing device, data and a checksum value in one or more messages in an NFC exchange from a contactless card;

generating, by the computing device, a second checksum value based on the data and a checksum algorithm;

determining, by the computing device, the second checksum value does not match the checksum value; and

increasing, by the computing device, power for the NFC interface; and

initiating, by the computing device, another NFC exchange to receive another instance of the data and the checksum value from the contactless card via the NFC interface.

[0005c] According to a third aspect of the present invention, there is provided a contactless card, comprising:

a near-field communication (NFC) interface;

memory configured to store instructions; and

one or more processors coupled with the memory, the one or more processors operable to execute the instructions that, when executed, cause the one or more processors to:

receive, via the NFC interface, a request for data from a computing device in an NFC exchange;

determine the data to communicate to the computing device based on the request;

generate a checksum value based on the data and a checksum algorithm; and

send, via the NFC interface, the data and the checksum value to the computing device in one or more messages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1A** illustrates an example data transmission system in accordance with one or more embodiments.

CLAIMS

1. A computing device, comprising:

a near-field communication (NFC) interface;

memory configured to store instructions; and

one or more processors coupled with the memory, the one or more processors operable to execute the instructions that, when executed, cause the one or more processors to:

receive data and a checksum value in one or more messages from a contactless card via the NFC interface;

determine a second checksum value based on the data;

determine whether the checksum value and the second checksum match; and

in response to the checksum value not matching the second checksum value, increase power for the NFC interface to receive the data and the checksum value again from the contactless card via the NFC interface.

2. The computing device of claim 1, wherein the instructions are further configured to cause the one or more processors to repeatedly increase the power and receive the data and the checksum value from the contactless card until the checksum value matches a calculated checksum or a timeout event occurs.

3. The computing device of claim 1, wherein the one or more messages are NFC data exchange format (NDEF) messages.

4. The computing device of claim 1, wherein the data and the checksum value are received in the one or more messages based on an NFC read operation.

5. The computing device of claim 1, wherein the instructions are further configured to cause the one or more processors to:

determine an amount of the data not received based on the second checksum value; and

increase the power for the NFC interface an amount proportional to the amount of the data not received.

6. The computing device of claim 1, wherein the adjustment of the power includes the one or more processors to increase power for the NFC interface from a first power level to a

second power level such that a magnetic field emitted from the NFC interface is increased or strengthened.

7. The computing device of claim 6, wherein the instructions are further configured to cause the one or more processors to:

receive one or more subsequent messages from the contactless card at the second power level;

determine that data and checksum value in the one or more subsequent message is received correctly based on the checksum value and a calculated checksum value performed on the data; and

decrease the power to the NFC interface from the second power level to the first power level.

8. The computing device of claim 6, wherein the instructions are further configured to cause the one or more processors to automatically decrease the power to the NFC interface from the second power level to the first power level after a predetermined period of time.

9. The computing device of claim 1, wherein the increase in the power is: (i) a fraction of a maximum power providable to the NFC interface, wherein the fraction of the maximum power is inversely proportional to a percentage of the one or more messages that was correctly received or (ii) the maximum power providable to the NFC interface.

10. A computer-implemented method, comprising:

receiving, via an NFC interface of a computing device, data and a checksum value in one or more messages in an NFC exchange from a contactless card;

generating, by the computing device, a second checksum value based on the data and a checksum algorithm;

determining, by the computing device, the second checksum value does not match the checksum value; and

increasing, by the computing device, power for the NFC interface; and

initiating, by the computing device, another NFC exchange to receive another instance of the data and the checksum value from the contactless card via the NFC interface.

11. The computer-implemented method of claim 10, comprising repeatedly increasing the power and receiving instances the data and the checksum value from the contactless card until the checksum value matches a newly calculated checksum or a timeout event occurs.

12. The computer-implemented method of claim 10, wherein the one or more messages are NFC data exchange format (NDEF) messages.

13. The computer-implemented method of claim 10, wherein the data and the checksum value are received in the one or more messages based on an NFC read operation in the NFC exchange.

14. The computer-implemented method of claim 10, comprising:

determining, by the computing device, an amount of the data not received based on the second checksum; and

increasing, by the computing device, the power for the NFC interface an amount proportional to the amount of the data not received.

15. The computer-implemented method of claim 10, wherein the adjustment of the power includes the one or more processors to increase power for the NFC interface from a first power level to a second power level such that a magnetic field emitted from the NFC interface is increased or strengthened.

16. The computer-implemented method of claim 15, comprising:

receiving, by the computing device, one or more subsequent messages from the contactless card at the second power level;

determining, by the computing device, that data and checksum in the one or more subsequent messages is received correctly based on the checksum value and a calculated checksum value performed on the data; and

decreasing the power to the NFC interface from the second power level to the first power level.

17. The computer-implemented method of claim 16, comprising automatically decreasing the power to the NFC interface from the second power level to the first power level after a predetermined period of time.

18. The computer-implemented method of claim 10, wherein increasing in the power is: (i) a fraction of a maximum power providable to the NFC interface, wherein the fraction of the maximum power is inversely proportional to a percentage of the one or more messages that was correctly received or (ii) the maximum power providable to the NFC interface.

19. A contactless card, comprising:

a near-field communication (NFC) interface;

memory configured to store instructions; and

one or more processors coupled with the memory, the one or more processors operable to execute the instructions that, when executed, cause the one or more processors to:

receive, via the NFC interface, a request for data from a computing device in an NFC exchange;

determine the data to communicate to the computing device based on the request;

generate a checksum value based on the data and a checksum algorithm; and

send, via the NFC interface, the data and the checksum value to the computing device in one or more messages.

20. The contactless card of claim 19, wherein the instructions are further configured to cause the one or more processors to:

receive, via the NFC interface, a second request for the data from the computing device; and

resend, via the NFC interface, the data and the checksum value to the computing device.