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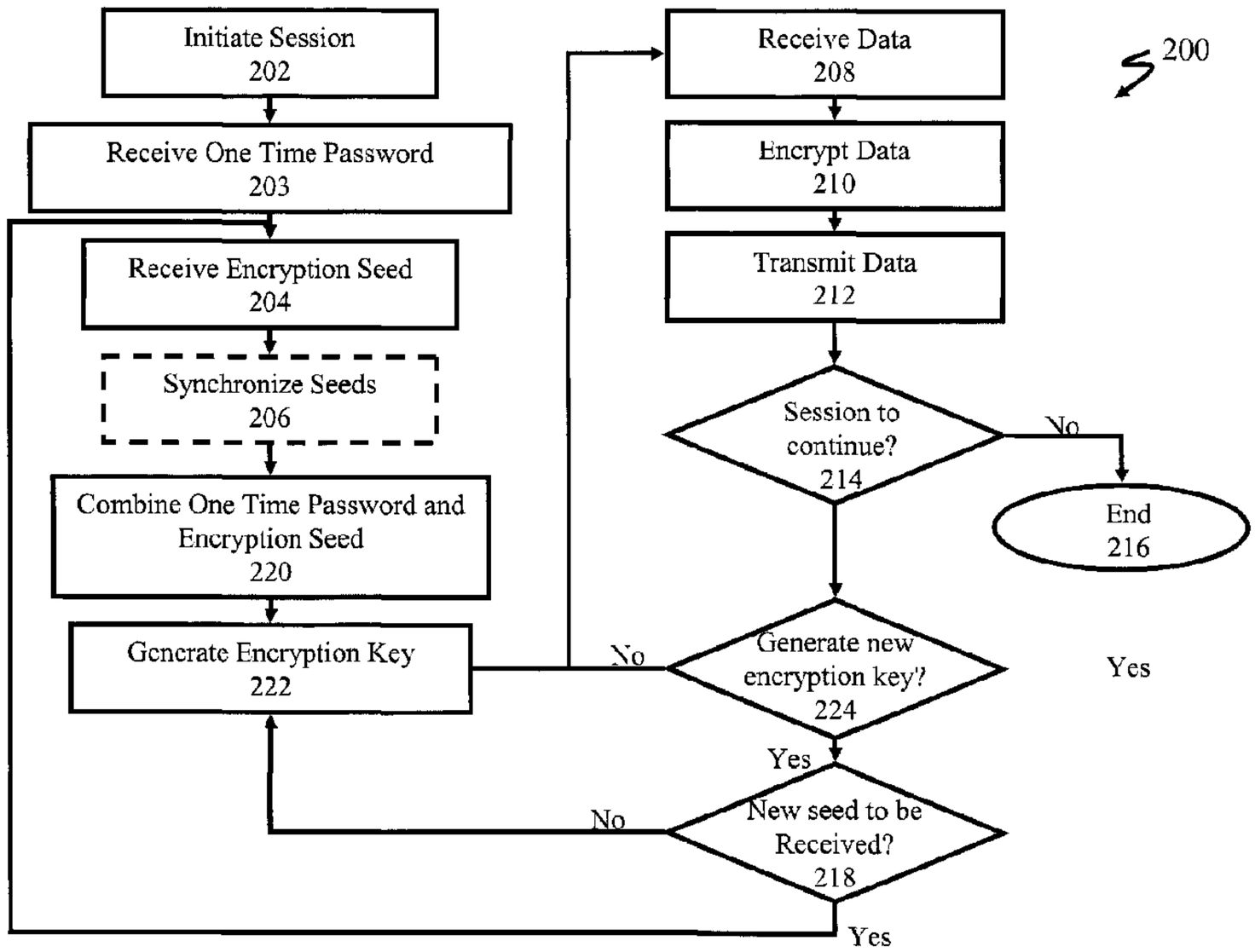
(54) **Titre : SYSTEME ET METHODE DE CHIFFREMENT DU TRAFIC SUR UN RESEAU**
(54) **Title: SYSTEM AND METHOD FOR ENCRYPTING TRAFFIC ON A NETWORK**



(57) **Abrégé/Abstract:**
According to embodiments of the present invention a system and method for encrypting traffic on a network is disclosed. Encrypted data is transmitted between a first network element and a second network element by: acquiring an encryption seed at the first network element, the encryption seed being substantially similar to a decryption seed at the second network element; generating at least one encryption key from the encryption seed; receiving data; encrypting the data using the encryption key to generate encrypted data; transmitting the encrypted data from the first network element to the second network element via a network; and updating the encryption seed at the first network element in response to an event trigger

ABSTRACT

According to embodiments of the present invention a system and method for encrypting traffic on a network is disclosed. Encrypted data is transmitted between a first network element and a second network element by: acquiring an encryption seed at the first network element, the encryption seed being substantially similar to a decryption seed at the second network element; generating at least one encryption key from the encryption seed; receiving data; encrypting the data using the encryption key to generate encrypted data; transmitting the encrypted data from the first network element to the second network element via a network; and updating the encryption seed at the first network element in response to an event trigger

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SYSTEM AND METHOD FOR ENCRYPTING TRAFFIC ON A NETWORK

FIELD OF THE INVENTION

This invention relates generally to communication networks and more specifically to a system and method for encrypting data on a network.

BACKGROUND OF THE INVENTION

Transmission of data through a communications network has become a commonplace activity in modern life and business. Indeed transmission of data through communications networks such as the public internet, or other packet-based communications networks, has become an activity that is a necessary part of most business structures, including transmission of data from PC's and laptops as well as transmission of data from business related network access devices such as customer service terminals and automated bank machines. Oftentimes the nature of the data being transmitted through the communications network from these devices can be of a sensitive nature, including business information, credit card or debit card numbers, including passwords, as well as personal financial information and the like.

In general, sensitive data will be encrypted prior to transmission through the communications network in a manner that is well known in the art: a pre-defined scheme is used to encrypt data at the originating device using an encryption key. The data is transmitted to a destination device where it is decrypted using a decryption key complementary to the encryption key. There are many methods for producing and exchanging the keys which are well known to those of skill in the art. One such encryption method is known as RSA, which is a public key encryption system widely used in electronic commercial protocols as disclosed in US Patent Serial No. 4405829 by Rivest et al.

Encryption of data is often used in combination with a "tunnel" through a communications network, such as a virtual private network (VPN) or a permanent virtual circuit (PVC). In particular a VPN "tunnel" provides secure transmission of data through

the communications network by encapsulating one protocol or data transfer session inside another. In a VPN, the message to be sent from the originating device to the destination device is encrypted at the originating device using an encryption scheme known by the destination device, for example an RSA encryption scheme. The encrypted message will include the data of interest, as well as data relevant to the transmission. Data relevant to the transmission can include header information, etc.

The encrypted message is then transmitted to the destination device, using methods well known to those of skill in the art. The destination device receives the message and subsequently decrypts it. After decryption, it appears to the destination device as if the decrypted message was sent directly to the destination device through the communications network, without encryption, using the original transmission data.

In one such scheme for establishing a VPN, an encryption key generator within a client at the originating location is provided with a seed. The encryption key generator uses the seed to generate a first encryption key. This is passed to an encrypting client, which uses the first encryption key to encrypt the data to be transmitted. A header is then attached to the encrypted data and the encrypted data is transmitted to the destination device, through the communication network, such as the public internet. The destination device has been pre-provisioned with a decryption key generator, as well as a seed complementary to the one provided to the encryption key generator; in general the encryption and decryption seeds are the same seed. The decryption key generator uses the seed to produce a first decryption key, complementary to the first encryption key, which is passed to a decrypting client at the destination, which in turn decrypts the encrypted data.

After a period of time, the first encryption key is passed to the input of the encryption key generator, in essence to be used as a new encryption seed, to produce a second encryption key. Again, after another period of time has elapsed, the second encryption key is passed to the input of the encryption key generator to produce a third encryption key. This process continues during the entire encryption session as a means to discourage unauthorized users from discovering the current encryption key and gaining access to the

data. A similar process occurs at the destination location to generate a complementary decryption key each time a new encryption key is generated. A synchronization step may occur at the beginning of this process or further be synchronized by a common clock or pre-synchronized clocks, to ensure that the current decryption key is always complementary to the current encryption key.

Generation of the seed for the encryption key generator and the decryption key generator is crucial to this process. In the RSA scheme referred to previously, a user is provided with a seed generating device which provides a seed to the user, which is entered into the encryption key generator to begin the cycle of key generation. Often, the user will also enter a permanent password which is combined with the seed provided by the seed generating device to create a combined seed which is used to begin the cycle of key generation. While the seed generating device is often enabled to produce a seed periodically, for example every 60 seconds, the user uses only one seed for the entire session. To ensure that the generated decryption keys are complementary to the encryption keys, the decryption key generator must be provisioned with a seed generator synchronized with the user's seed generator, as well as the user's permanent password.

A common problem associated with this scheme is that if a malicious user understands the algorithm for generating keys, and can learn the original seed for the session, including the user's permanent password, used to generate the keys, or a key fed back into the key generator, it is possible to intercept the encrypted data on the communication network and decrypt it, hence compromising the integrity of the encrypted data. Hence there is a risk that providing a single seed for a session may not be adequate to fully protect the sensitive data in question. In particular, certain business institutions such as banks and brokerages may be particularly sensitive to the possibility of information being cracked by a malicious user.

There remains a need therefore for an improved system and method for encrypting data on a network.

SUMMARY OF THE INVENTION

The invention addresses at least one of the above stated needs and mitigates at least one of the stated problems.

A first broad aspect of the present invention seeks to provide a method for transmitting encrypted data between a first network element and a second network element. The first step of the method comprises acquiring an encryption seed at the first network element, the encryption seed being substantially similar to a decryption seed at the second network element. The second step of the method comprises generating at least one encryption key from the encryption seed. The third step of the method comprises receiving data. The fourth step of the method comprises encrypting the data using the encryption key to generate encrypted data. The fifth step of the method comprises transmitting the encrypted data from the first network element to the second network element via a network. The sixth step of the method comprises updating the encryption seed at the first network element in response to an event trigger.

In some embodiments of the first broad aspect, the event trigger comprises a first event trigger, and the method further comprises updating the encryption seed in response to a second event trigger. Further in these embodiments a period between the first and second event triggers is less than the period required to derive one of the encryption seed and the at least one encryption key from the encrypted data.

In some embodiments of the first broad aspect, the event trigger is the receipt of an updated encryption seed.

A second broad aspect of the present invention seeks to provide a method for transmitting encrypted data between a first network element and a second network element. The first step of the method comprises acquiring an encryption seed at the first network element, the encryption seed being substantially similar to a decryption seed at the second network element. The second step of the method comprises generating at least one encryption key from the encryption seed. The third step of the method comprises receiving data. The

fourth step of the method comprises encrypting the data using said encryption key to generate encrypted data. The fifth step of the method comprises transmitting the encrypted data from the first network element to the second network element via a network. The sixth step of the method comprises updating the encryption seed at the first network element in response to an event trigger. Further the acquiring an encryption seed at the first network element, and the updating the encryption seed at the first network element in response to an event trigger occurs during a single data session.

In some embodiments of the second broad aspect updating the encryption seed at the first network element in response to an event trigger comprises acquiring an updated encryption seed.

A third broad aspect of the present invention seeks to provide a system for encrypting data for transmission from a computing apparatus to a destination network element via a network. The system includes an encryption seed generation apparatus enabled to: generate an encryption seed, the encryption seed being substantially similar to a decryption seed at the destination network element; transmit the encryption seed to the computing apparatus; and generate an updated encryption seed and transmit the updated encryption seed to the computing apparatus. The system further includes a computing apparatus coupled to the network and the encryption seed generation apparatus, the computing apparatus enabled to: receive an encryption seed; generate at least one encryption key from the encryption seed; receive data; encrypt the data using the encryption key to generate encrypted data; transmit the encrypted data from the computing apparatus to the destination network element via a network; and update the encryption seed with the updated encryption seed in response to an event trigger. Further in this embodiment, a period between the receipt of the encryption seed and the updating the encryption seed is less than the period required to derive one of the encryption seed and the at least one encryption key from the encrypted data.

In some embodiments of the third broad aspect the event trigger is the receipt of an updated encryption seed.

In other embodiments of the third broad aspect the event trigger is the receipt of a defined quantity of the data.

In further embodiments of the third broad aspect the event trigger is the receipt of a signal from a synchronization entity, the entity coupled to the network and the computing apparatus.

In some embodiments of the third broad aspect the event trigger comprises a first event trigger, wherein the system further comprises updating the encryption seed in response to a second event trigger.

In other embodiments of the third broad aspect the event trigger is the receipt of an updated encryption seed.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are described with reference to the following figures, in which:

Figure 1a is a block diagram illustrating a system for encrypting data on a network according to one embodiment of the present invention;

Figure 1b is a block diagram illustrating a system for encrypting data on a network according to one embodiment of the present invention;

Figure 1c is block diagram illustrating components of a router deployed in the system for encrypting data on a network according to one embodiment of the present invention;

Figure 2 is a flow chart depicting the steps performed to encrypt data on a network according to one embodiment of the present invention;

Figure 3 is a flow chart depicting the steps performed to encrypt data on a network according to one embodiment of the present invention;

Figure 4 is a block diagram illustrating a system for encrypting data on a network according to one embodiment of the present invention;

Figure 5 is block diagram illustrating components of a router deployed in the system for encrypting data on a network according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Figure 1a depicts a system **100** for encrypting data on a network according to an embodiment of the present invention. The system **100** comprises at least one originating communications device **110** in communication with a router **120**, which is further in communication with a communications network **130**. The at least one originating communications device **110** may comprise a computing device equipped with a processor, a memory and an input/output interface (I/O). System **100** may include a plurality of N originating communications devices **110**, labelled **110a**, **110b**, $\mathbf{110_N}$ in **Figure 1a**. Communications device **110** may include personal computers and the like, as well as other network access devices such as customer service terminals, automated bank machines (ABMs) and the like.

In some embodiments, each communications device **110** is in wireline communication with router **120**, using cabling such as twisted pair or coaxial cables and the like; in further embodiments one or more communications device **110** are in wireless communication with router **120**. In embodiments where wireless communication is employed, both communication device **110** and router **120** communicate wirelessly using protocols such as Wi-Fi, WiMax and the like. Further, suitable encryption schemes may be employed to ensure secure transfer of data between the communications device **110** and the router **120**, the encryption schemes being independent of further encryption schemes described below.

Router **120** may comprise any commercially available router, such as one manufactured and distributed by Cisco Systems, Inc. of 170 West Tasman Dr., San Jose, CA 95134, USA, enabled to accept data from at least one communications device **110**, and to accept input from encryption seed generator **140**, including an encryption seed **145** generated by encryption seed generator **140**.

Details of router **120** in one embodiment of the present invention are depicted in Figure **1c**. Key generator **121** accepts encryption seed **145**. Key generator uses encryption seed **145** to generate encryption key **122**. Encryption key **122** passed to encryption device **123**, which further accepts data **124** from communications device **110**. The encryption device uses encryption key **122** to encrypt the data **124**, resulting in encrypted data **126**, which is then transmitted to communications network **130**. Key generator **121** is further enabled to pass encryption key **122** to the input of key generator **121**, which then uses the encryption key **122** as a new seed to generate a new encryption key **122**; this process typically occurs on a periodic basis.

In a further embodiment of the present invention key generator **121** is located in combination with encryption seed generator **140**. Within this embodiment router **120** is enabled to accept encryption key **122** periodically and further enabled to pass encryption key **122** back to encryption key generator **121**, to act as a new seed in the production of a new encryption key **122**. In yet further embodiments, encryption device **123** may be located at computing device **110**; within this embodiment router **120** is enabled to pass encryption key **122** to communication device **110**. Once the encryption key **122** is received by communications device **110**, encryption device **123** encrypts data **124** and passes the encrypted data **126** back to router **120** for transmission to communications network **130**. Various other combinations may occur to those with skill in the art and are within the scope of the present invention.

Router **120** and encryption seed generator **140** are protected by a secure barrier **125** which limits physical access to router **120** and encryption seed generator **140**. Secure barrier **125** may be a locked room, a locked box and the like, containing Router **120** and encryption seed generator **140**, and which allows only authorized users access to the elements inside secure barrier **125**. In one embodiment secure barrier **125** is also provided with a secure access system such as a key, or password enabled access, such as an electronic access system, or a combination of these. Other means of secure access may occur to those of skill in the art. Secure barrier **125** should also be constructed in a sufficiently rugged manner to deter a non-authorized user from breaking into it. As a non-

limiting example, secure barrier **125** may be constructed of high security, thick steel walls, similar to those materials used in constructing a vault, for example. The combination of a secure access system coupled with rugged construction prevents non-authorized users from gaining access to the router **120** and encryption seed generator **140**, and prevents non-authorized users from obtaining sufficient information to learn details of encryption seed **145**.

In some embodiments of the present invention, the router **120** is incorporated directly into one of a plurality of communications devices **110**. In these embodiments, the plurality of communications devices **110a**, **110b**, **110N** are in communication with the communication devices **110** incorporating the router **120** and through which all data from the remaining communications devices pass.

The encryption seed generator **140** may be a logical encryption seed generator, resident in router **120** or one of the communications devices **110**, or a hardware based encryption seed generator implemented within a separate computing apparatus enabled to generate a plurality of encryption seeds **145** and to communicate with router **120**. Encryption seed generator **140** may be further equipped with an internal clock, and enabled to generate a new encryption seed periodically, for example every 60 seconds. In a non-limiting example, encryption seed generator **140** may be a commercially available encryption seed generator, such as RSA SecureID® USB Token manufactured and distributed by RSA Security of 174 & 176 Middlesex Turnpike, Bedford, Massachusetts 01730.

In embodiments of the present invention encryption seed generator **140** generates an encryption seed **145** to initialize the production of encryption keys in an encryption key generator. The encryption seed generator **140** may use at least one encryption seed generation scheme. One such example of an encryption seed generation scheme is an RSA encryption seed generation scheme wherein a private numerical code is used to generate at least one encryption seed **145**. In such an encryption scheme, the encryption seed generator **140** is provided with a pre-equipped random number, as well as method for generating a new encryption seed **145** periodically, for example every 60 seconds,

according to the internal clock, or alternatively, synchronized with an external clock. In one encryption seed generation scheme, the time is combined with the code and an algorithm to create the encryption seed **145**. In an alternative embodiment the counter number from an event counter may be combined with the code and an algorithm to create the encryption seed **145**. Thus using the code, and least one other factor generated periodically, encryption seed generator **140** generates an encryption seed **145** according to a method described in US Patent Serial No. 4405829 by Rivest et al. Though the generation of encryption seed **145** is described with reference to an RSA scheme, alternative encryption schemes may be used including the ElGamal algorithm, DSA and elliptic curve cryptography, or other encryption schemes well known to those of skill in the art.

Communications network **130** may comprise any network which allows for transmission of data from an originating communications device to a destination communications device. Specific non-limiting examples include: the PSTN, including PBX and Centrex networks; and packet switched networks such as the internet, or an intranet such as a LAN or a WAN. The communications network **130** could be based on a variety of protocols including, but not limited to internet protocol (IP) or asynchronous transfer mode (ATM) protocol. In some embodiments, portions of communications network **130** may be enabled to transfer data using a first protocol, whereas further portions can transfer data using another additional protocol; in these embodiments the communications network **130** will include an apparatus to translate transmitted data between each protocol.

As depicted in Figure **1a**, communications network **130** is in further communication with a destination device **150** which can accept data transmitted from the communications network **130**. The destination device **150** may comprise a computing device equipped with a processor, a memory and an input/output interface (I/O). In some embodiments the destination device **150** may comprise a personal computers and the like, while in further embodiments the destination device is a network servers and the like. In a non-limiting example destination device **150** may be a server which accepts financial data, such as

financial transactions, from at least one originating data device **110**, such as an automated bank machine. In this example, destination device **150** may accept the financial data from the automated bank machine and further process the financial data, or alternatively act as a gateway to a larger system for processing financial data and transaction. Other examples of destination device **150** may occur to those of skill in the art.

Destination device **150** is coupled with a decryption seed generator **160**, adapted to generate at least one decryption seed **165**, complementary to at least one encryption seed **145**. The decryption seed **165** allows a device receiving data which has been encrypted using encryption keys generated from encryption seed **145** to be decrypted. In such a scheme, data is encrypted at an originating device, such as originating communications device **110**, or router **120**, using the encryption seed **145**, as a starting point for encryption key generation. The data is transmitted to the destination device **150** where the encrypted data may be decrypted using decryption keys generated from decryption seed **165**, in a manner known to those of skill in the art. Decryption seed generator **160** is further enabled to generate decryption key **165** periodically in a manner similar to the method used encryption seed generator **140** to generate encryption seed **145**. In some embodiments a secure barrier (not shown) similar to secure barrier **125** may be placed around encryption seed generator **160** and destination device **150** to prevent un-authorized users from gaining physical access to the system.

Decryption seed generator **160** is further synchronized with encryption seed generator **140** such that when encryption seed generator **140** generates encryption seed **145**, decryption seed generator **160** is enabled to generate a decryption seed **165** complementary to encryption seed **145**. Decryption seed generator **160** is enabled to generate a new decryption seed **165** periodically, for example every 60 seconds, in synchronization with encryption seed generator **140**. Encryption seed generator **140** and decryption seed generator **160** are synchronized with respect to time, each further equipped with an internal clock which have been synchronized to each other.

In alternative embodiments, encryption key generator **140** and decryption key generator **160** may exchange synchronization data to allow for said synchronization. The exchange of synchronization data may occur via communication network **130**, or alternatively could occur via a second communications network (not pictured), such as a wireless network, a backhaul network, or a secure network. In yet another embodiment synchronization data may be exchanged via a seed management entity which may be located at the router **120**, encryption key generator **140**, the originating communications device **110**, the destination device **150**, or at a separate network element in communication with communication network **130**.

Decryption seed generator **160** may generate a decryption seed **165** in a manner similar to the generation of encryption seed **145**. Continuing with the example of RSA encryption schemes, the decryption seed generator **160** is provided with the same code as the encryption seed generator **140**, and uses the same method for generating a new encryption seed periodically, for example every 60 seconds according to the synchronized internal clock. In one encryption seed generation scheme, the time is combined with the code and an encryption algorithm to create the decryption seed **165** which is similar to encryption seed **145**, the clock at the decryption seed generator **160** being synchronized with the clock at the encryption seed generator **140**.

Decryption seed generator **160** may be a logical decryption seed generator, resident in destination device **150** or a hardware based decryption seed generator implemented within a separate computing apparatus enabled to generate a plurality of decryption seeds **165** and to communicate with destination device **150.** Decryption seed generator **160** may be further equipped with an internal clock, and enabled to generate a new encryption key periodically, for example every 60 seconds. In a non-limiting example, decryption seed generator **150** may be a commercially available seed generator, such as RSA SecureID® USB Token manufactured and distributed by RSA Security of 174 & 176 Middlesex Turnpike, Bedford, Massachusetts 01730.

In an alternative embodiment, destination device **150** may be in communication with a plurality of originating communications devices, for example at different geographic locations, with each geographic grouping of originating communications devices coupled to communication network **130** using a separate router **120** local to each location, or local to each originating communications device **110**. In this embodiment each router may be equipped with a separate encryption seed generator **140** each of which may be assigned a different starting numerical code. Alternatively a single encryption seed generator **140** may be in communication with the various routers; the encryption seed generator **140** may be enabled to generate multiple encryption seeds from multiple starting numeric codes and to further securely transmit the relevant encryption seed to the relevant router. The generation of the encryption seeds may occur sequentially via a single encryption seed generator logic, or in parallel using a plurality of encryption seed generator logics. In this alternative the encryption seed generator **140** may be further equipped with an encryption seed management logic to ensure that the various encryption seeds are sent to the relevant routers. Further the secure transmission of the seeds may occur using a variety of techniques known to those of skill in the art.

In these embodiments, decryption seed generator **160** is enabled to generate a plurality of decryption seeds **165**, using a plurality of codes, such that destination device **150** may receive and decrypt data from a plurality of originating data devices. In this embodiment the decryption seed generator **160** may be enabled to generate multiple decryption seeds **165** from multiple starting numeric codes, the generation of decryption seeds **165** being synchronized with the encryption seeds **145** being generated at encryption seed generator **140**, and further complementing the encryption seeds **145** being generated at encryption seed generator **140**. The generation of the decryption seeds **165** may occur sequentially via a single decryption seed generator logic, or in parallel using a plurality of decryption seed generator logics. The decryption seed generator **160** may be further equipped with decryption seed management logic to ensure accurate communication of the various decryption seeds to the destination device **150**. In yet another alternative embodiment the decryption seed generator may reside as a logical decryption seed generator on destination device **150**.

Further in these embodiments destination device **150** may be enabled to accept a plurality of decryption seeds **165** from decryption seed generator **160**, and may be further enabled to generate a plurality of decryption keys from the decryption seeds **165** to decrypt encrypted data arriving from the various routers. The decryption keys may be generated sequentially by a single decryption key generator or in parallel by a plurality of decryption key generators. Destination device **150** may be further equipped with a decryption key management logic to ensure that the decryption keys are being generated to synchronize with the encryption keys generated at the various routers **120**, and to further ensure that the correct decryption key is being used to decrypt data arriving from a particular router. The decryption key management logic may be further enabled to manage the decryption seeds being input into the decryption key generator or generators

As depicted in Figure **1b**, in some embodiments system **100** may include an authentication server **170** in communication with communication network **130**. Authentication server **170** is enabled to authenticate and authorize a user for access to communication network **130**. Authentication server may be further enabled to authenticate and authorize a user for access to destination communications device **150**. In embodiments which include an authentication server **170**, decryption seed generator **160** may alternately be in communication with authentication server **170**, authentication server **170** being further enabled to deliver a decryption seed **165** to destination device **150** as a starting point for decryption key generation by a decryption key generator. Authentication Server **170** may comprise a commercially available AAA server such as a RADIUS server manufactured and distributed by Bridgewater Systems of 303 Terry Fox Drive, Suite 100 Ottawa, Ontario Canada K2K 3J1. In some embodiments a secure barrier (not shown) similar to secure barrier **125** may be placed around decryption seed generator **160** and authentication server **170** to prevent un-authorize users from gaining physical access to the system.

A method **200** for encrypting data on a network, according to an embodiment of the present invention, will now be described with reference to **Figure 2**. In order to assist in

the explanation of the method, it will be assumed that method **200** is operated using system **100** of **Figure 1a**. Furthermore, the following discussion of method **200** will lead to further understanding of system **100** and its various components. It should be understood that the steps in method **200** need not be performed in the sequence shown. Further, it is to be understood that system **100** and/or method **200** can be varied, and need not work as discussed herein in conjunction with each other, and that such variations are within the scope of the present invention.

By way of illustration only, method **200** will be described, when appropriate, using the non-limiting example of the method being executable within router **120**. It should be understood, however, that method **200** may be equally executable within at least one of originating communications devices **110a, 110b, 110N**. At step **202** a data transmission session is initiated between the router **120** and the destination device **150**. Such session initiation is well known to one of skill in the art and may involve a series of handshaking steps to establish communications.

At step **203** a one time password is received. The one time password is a fixed numerical code or password which is known to both router **120** and destination device **150**. The exchange of the one time password is implemented prior to the session initiation. The one time password may be specific to router **120**, or specific to each of originating computing devices **110a**, **110b**, ...**110**$_N$. Alternatively, each originating computing device may share the same one time password. The one time password may be already resident on router **120** and stored in memory, or may be received from at least one originating computing device **110**. In further embodiments the one time password may be omitted.

At step **204** an encryption seed **145** is received from encryption seed generator **140**. The encryption seed **145** enables an encryption key generator to initialize the production of encryption keys. In some embodiments, at step **206**, a check is made to ensure that the encryption seed received at step **204** is synchronized with the decryption seed **165** generated by decryption seed generator **160**, intended to initialize production of decryption keys, the decryption seed **165** received at destination device **150**. This may

comprise sending an encrypted test message to destination device **150**, via communication network **130**, the message encrypted by an encryption key generated from the encryption seed **145**, and receiving confirmation of successful decryption of said test message, also via communication network **130**, the decryption occurring using a decryption key generated from the complementary decryption seed **165**. Alternatively the encrypted test message and confirmation message may be transmitted on a second communication network (not depicted) if router **120** and destination device **150** are also coupled to the second communication network. If confirmation of successful decryption is not received, then resynchronization may need to occur, and a message may be sent to the administrator of the router **120**. Alternatively this step may be performed elsewhere in the method using data received from the originating communications device **110** as the test message. In yet another embodiment, this step may be omitted, with the various components assuming a synchronization scheme already to be in place. As a non-limiting example pre-synchronized internal clocks within the encryption seed generator **140** and the decryption seed generator **160** could be utilized.

At step **220** the encryption seed **145** and the one time password received at step **203** are combined into a combined encryption seed, which is used to generate an encryption key to encrypt data received from originating communications device **110**, prior to transmission to destination communications device **150**. It is understood that encryption key **204** will be used in conjunction with an encryption scheme resident on router **120**. In embodiments where a one time password is not used, this step may be omitted. In some embodiments the one time password may be used only to authenticate communications device **150**, or a user of system **100**, to router **120**. In these embodiments, step **220** may also be omitted.

At step **222** an encryption key is generated using the combined seed, generated at step **220**. Alternatively the encryption key may be generated using only the encryption seed **145** generated at step **204** and the one time password is used for initial authentication purposes only. The encryption key is generated using a suitable algorithm; it is understood that such algorithms typically incorporate functions in which it is difficult to

calculate the encryption seed input to the function given the encryption key output. Non-limiting examples of such algorithms include the RSA algorithm, the ElGamal algorithm, DSA and elliptic curve cryptography. However other algorithms for generating encryption keys will occur to those of skill in the art.

At step **208**, data to be transmitted to destination device **150** is received from originating communications device **110**. At step **210** the data is encrypted using the encryption key generated by key generator **140**. The encryption is performed using, for example, an RSA encryption scheme; however other encryption schemes may be used. At step **212** the encrypted data is transmitted to destination device **150** via communication network **130**.

After transmission of the encrypted data, router **120** may determine if the session is to continue. In one embodiment router **120** may query communications device **110** to determine if more data is to be transmitted. If no more data is to be transmitted then the session is terminated at step **216**.

However, if more data is to be transmitted then, at step **224**, a determination is made as to whether or not a new encryption key is to be generated. In one embodiment a new encryption key is generated periodically, for example every 60 seconds. This embodiment may include a synchronization step, to ensure that the new encryption key is synchronized with a new decryption key at the destination device **150**. The synchronization may occur via a pre-synchronized process on both the router **120** and the destination device **150**, in which encryption key and complementary decryption keys are generated periodically, for example every 60 seconds. Alternatively a synchronization message may be exchanged between router **120** and destination device **150** either via communication network **130** or a second communication network (not shown). In yet another alternative destination device **150** may store the current decryption key as well as a number of previous keys, and may even generate and store a number of expected future decryption keys; if encrypted data received cannot be decrypted by the expected current decryption key, the destination device may test the success of decrypting the encrypted data using a number of previous and future keys to determine if resynchronization needs

to occur. The resynchronization can be automatic, with the decryption key that successfully decrypts the encrypted data becoming the current decryption key, or a handshaking step may occur between destination device **150** and router **120** in order to resynchronize the production of the encryption and decryption keys, and to re-authenticate the communication between the two devices. If no decryption key located at destination device **150** is successful at decrypting the data, either a resynchronization step may occur or, alternatively, a message may be sent to an administrator informing the administrator of the problem; indeed this may signal a breach in security or may indicate the need to repair equipment.

However, in further embodiments, criteria other than periodic production may be used to determine whether a new encryption key should be generated; for example a new encryption key may be generated once a certain amount of data has been encrypted with the current key. Note that in this embodiment the new encryption key may be further synchronized with the decryption key generated at the destination device **150**. This may be triggered by the decryption of a certain amount of data using the current decryption key, the amount of data which triggers the new decryption key generation being similar to the amount of data which triggers the new encryption key generation. Alternatively a trigger may be sent to destination device **150** from router **120** signalling the need to generate a new decryption key. In yet another alternative, a signal may be sent to a synchronization management entity which may then trigger the generation of a new decryption key at destination device **150**, by sending a signal to destination device **150**.

In yet another embodiment a synchronization management entity can trigger the production of synchronized encryption and decryption keys at both router **120** and destination device **150** by sending a trigger signal to both router **120** and destination device **150** when a new pair of keys is to be generated.

In yet another embodiment a new encryption key may be generated upon the initiation of any new transmission of data originating from communication device **110**. This may apply, for example, when communication device is a customer service terminal or an

automated banking machine; when a new customer uses the communication device and initiates a new data transmission session, a new encryption key may be generated. The synchronization of the new encryption key with the generation of a complementary decryption key at destination device **150** may be coordinated by signalling the destination device **150** that a new decryption key is to be generated, either through communication network **130**, through a second network, via a synchronization management entity, similar to that described above, or though including information about the data transmission in the unencrypted header of the data transmission. Alternatively, destination device **150** may store a number of past decryption keys, the expected current decryption key and a number of expected future decryption keys. Destination device **150** may attempt to decrypt the encrypted data with a number of the stored decryption keys, including the expected current decryption key and the next expected decryption key.

If a new encryption key is to be generated, it must be decided at step **218** if the new encryption key is to be generated using the original encryption seed **145**, or if the new encryption key should be generated using a new encryption seed **145,** to be received from encryption seed generator **140**. If the new encryption key is generated without receiving a new encryption seed **145**, the router returns to step **222**, and a new encryption key is generated using the current encryption key as the input to the encryption key generation algorithm; in other words the current encryption key acts as a seed to generate the new encryption key. Alternatively the current encryption key may be combined with the one time password to create a new combined encryption seed to act as a seed to generate the new encryption key.

However, if a new encryption seed **145** is to be received from encryption seed generator **140**, the router returns to step **204** to receive the new encryption seed **145**. In one embodiment, a new encryption seed **145** is generated periodically, for example every 60 seconds; in this embodiment the router, at step **218**, will expect to receive a new encryption seed **145** if the defined period has passed and the current encryption seed **145** is expired or is about to expire. Within this embodiment a synchronization step may occur to ensure that the complementary decryption seed **165** is received at destination

device **150**. The synchronization step may be similar to the synchronization steps previously described in relation to the synchronization of the encryption and decryption keys. Similarly, other criteria may be used to determine if a new encryption seed is to be received, such as the transmission of a certain amount of data, a trigger from an internal clock or external synchronization entity, or the start of a new data transmission. Synchronization steps for these embodiments are similar to those described above for similar approaches to encryption key/decryption key generation and synchronization.

In embodiments of the present invention, encryption seeds are used to initialize encryption key generation for transmission of data through a network, and the encryption seed used to initialize encryption key generation is changed in a manner that deters malicious and non-authorized users from gaining access to the data. Indeed regularly updating the encryption seed acts as a deterrent to malicious users as, within embodiments of the present invention, the life of an encryption seed is less than the time required to derive or calculate the encryption seed **145**, or one of the encryption keys, using electronic methods, using the encrypted data or other information, as a starting point.

Though depicted as following step **224** in Figure **2**, step **218** may occur at any point in method **200**, following either step **204**, **206**, **208**, **210**, **212**, **214**, **220**, or **222**. Indeed triggering of a receipt of a new encryption seed may occur somewhat independently of the order of the steps of method **200**, for example occurring at pre-set time intervals, such as every 60 seconds, or alternatively after a pre-set quantity of data has been transmitted, or after each transaction on computing device **110**, or a combination of these. Other triggers for receiving a new encryption seed may occur to those of skill in the art.

Further, step **218** may be triggered by a component of system **100** external to the apparatus on which method **200** is being executed, for example an external synchronization entity. Such an entity would be substantially similar to the entity described above with reference to the synchronization of encryption keys, and capable of transmitting a trigger to generate a new encryption key to the router **120** and further

capable of transmitting a trigger to generate a new decryption key to the destination device **150**. In one embodiment a trigger is sent to both apparatus; in other embodiments a single trigger is sent to a single apparatus, which then further sends a trigger to the second apparatus.

Continuing with the non-limiting example, if method **200** is being executed on router **120**, step **218** may be triggered at any point within method **200**, including during the execution of steps **204**, **206**, **208**, **210**, **212**, **214**, **220**, **222**, or **224** when encryption seed generator **140** generates a new encryption seed **145** and sends said encryption seed **145** to router **120**.

As a non-limiting example, Figure **3** depicts method **300** for encrypting data on a network, according to an alternative embodiment of the present invention. Method **300** is substantially similar to Method **200** depicted in Figure **2**, however the determination if a new encryption seed **145** is to be received from seed generator **140** occurs following the receipt of data, as described in step **208** of Method **200**. It should be understood that step **302** of Method **300** corresponds to step **202** of method **200**, step **304** corresponds to step **204** and so on.

Within method **300**, following encryption key generation step **322**, a determination is made if data has already been received at step **326**. This is the only additional step that occurs within method **300** that does not correspondingly occur in method **200**. If data has not been received, then router **120** receives the data at step **308**. If data has been received, a determination if a new seed is to be received occurs at step **318**. Similarly, step **318** is executed after receiving data in step **308**. The determination of whether or not a new seed is to be received may occur at this point in method **300,** either as an integral part of method **300** or, in an alternative embodiment, the insertion of step **318** at this point in method **300** may occur due to an external trigger, such as encryption seed generator **140** transmitting the encryption seed **145** at pre-determined time intervals. If a new encryption seed **145** is to be received, then router **120** returns to step **304** to receive a new encryption seed **145**. If a new encryption key **145** is not to be received, the received data is encrypted

at step **310**, and the encrypted data is transmitted at step **312**. At step **314**, a determination is made as to whether there is more data to transmit. If so, a determination is made as to whether a new encryption key is to be generated at step **324;** if not the session terminates at step **316**.

Alternatively, if there is no immediate need to transmit data, the session may not end and router **120** will wait until new data is to be received. In a non-limiting example, this may occur if originating data device **110** is a customer service terminal, where data transmission occurs intermittently, and where a business administering the customer service terminal wishes to reduce latency for a customer using the terminal. In this embodiment, the administrator may wish to initiate a single session which lasts, for example, during the operating hours of the business. In this embodiment the session would not terminate unless such termination is initiated by the administrator.

Returning to Figure **2**, the insertion of the step to determine if a new encryption seed **145** is to be received may similarly occur following the encryption step, depicted as step **210** in method **200**. It is understood that additional steps may then be required to determine if encrypted data is to be re-encrypted with a new encryption key generated from the new encryption seed **145** prior to transmission, or if the new encryption seed **145** is to be used only with additional data received. Further synchronization steps may also occur. Similarly the insertion of the step to determine if a new encryption seed **145** is to be received may similarly occur following the transmission step, depicted as step **212** in method **200**. It is understood that additional steps may be required to determine if data is to be retransmitted using a new encryption key generated from the new encryption seed **145** prior, or if the new encryption seed **145** is to be used only with additional data received.

In embodiments where the determination of whether a new encryption seed **145** is to be received is triggered by an entity external to the apparatus on which method **200** is occurring, this determination may occur during one of steps **204**, **206**, **208**, **210**, **212**, **214**, **220**, **222**, or **224**. As a non limiting example, encryption seed generator **140** may attempt

to send a new encryption seed **145** to router **120**, while one of steps **204**, **206**, **208**, **210**, **212**, **220**, **222** or **224** is occurring. In some embodiments the step may be allowed to complete; in other embodiments the step may be interrupted to receive the new encryption seed **145**. In the latter embodiment, should the step be interrupted during the encryption step **210**, or the transmission step **212**, additional steps may occur to determine if the data is to be re-encrypted and/or re-transmitted using a new encryption key generated from the new encryption seed **145**. If the external entity triggers the receipt of the new encryption seed **145** during the receiving data step **208**, method **200** may be modified to allow the receiving data step **208** and the receive new encryption seed step **204** to be performed in parallel. Alternatively, one step may be completed before the other step occurs. Alternatives may occur to those of skill in the art and are within the scope of the present invention.

In further embodiments the determination to generate a new encryption key step **224**, may occur at any point method **200**, similar to the determination to generate a new encryption seed step **218**. Indeed step 224 may follow, or occur during, steps **204**, **206**, **208**, **210**, **212**, **214**, **218**, **or 220**, and embodiments where either of these alternatives occur are substantially similar to those described with reference to step **218**.

Figure **4** depicts system **400**, an alternative embodiment for encrypting data on a network. System **400** is substantially similar to System **100** depicted in Figure **1**, with similar network elements having similar numbers; in Figure **4** router **120** from System **100** is labelled router A **120** for clarity. The primary difference between system **100** and system **400** is the addition of router B **420**, which couples destination device **150** and decryption seed generator **160** to communication network **130**. In this embodiment authentication of originating data device **110**, and subsequent decryption of data may occur at router B **420**. Alternatively router B **420** may act as a gateway to an authentication server **170**, similar to authentication server **170** depicted in Figure **1b**. In yet a further embodiment authentication and decryption may occur at destination device **150** with router **420** acting only as a gateway to destination device **150**. In further embodiments authentication server **170**, destination device **150** and router B **420** may each authenticate and/or decrypt in a

variety of combinations, each being within the scope of the present invention, with a network connection being secured between router A **120** and router B **420**.

In an alternative embodiment decryption seed generator **160** may be incorporated into router B **420**, destination device **150**, or authentication server **170**. In yet further embodiments router B **420** may be incorporated into authentication server **420** or destination device **150**.

Details of router B **420,** depicted in Figure 5, are substantially similar to Router A **120** depicted in Figure 1c. However, Router B **420** contains a decryption key generator **521** to produce a decryption key **522**, as well as a decryption device **523** that accepts encrypted data **126** and produces decrypted data **124**. The production of decryption keys **522** by decryption key generator **521** is substantially similar to the production of encryption keys **122** by encryption key generator **121**.

Router B **420** may also act as a gateway to a secure communication network (not depicted), which is considered a secure communication network by both the users of originating communication device **110** and the users of destination device **150**. Within this embodiment data is received at router B **420**, decrypted and forwarded on to destination device **150**, which is an element of the secure communication network. Indeed Router B **420** may decrypt data for a plurality of destination devices **150** connected to secure communications network **150**. In this manner, a single pair of routers, router A **120** and router B **420**, may act to securely encrypt and decrypt data transmissions between a plurality of originating communications devices **110** and a plurality of destination devices **150**.

Persons skilled in the art will appreciate that there are yet more alternative implementations and modifications possible for implementing the present invention, and that the above implementations and examples are only illustrations of one or more embodiments of the present invention. The scope of the invention, therefore, is only to be limited by the claims appended hereto.

We claim:

1. A method for transmitting encrypted data between a first network element and a second network element, the method comprising:

acquiring an encryption seed at said first network element, said encryption seed being substantially similar to a decryption seed at the second network element;

generating at least one encryption key from said encryption seed;

receiving data;

encrypting said data using said encryption key to generate encrypted data;

transmitting said encrypted data from said first network element to said second network element via a network;

receiving at said first network element a synchronization signal transmitted from a synchronization management entity to both said first network element and said second network element;

acquiring a synchronized encryption seed in response to the received synchronization signal;

updating said encryption seed at said first network element with the acquired synchronized encryption seed; and

generating a new encryption key for use in encrypting data based on the synchronized encryption seed, wherein a period between receiving said synchronization signal and receiving a second synchronization signal is less than the period required to derive one of said encryption seed and said at least one encryption key from said encrypted data; and

wherein the synchronization management entity is a separate entity from the first network element and the second network element.

2. The method of claim 1, wherein the synchronization signal is transmitted in response to an event trigger.

3. The method of claim 2, wherein said event trigger is at least one of:

receipt of a defined quantity of said data;

transmission of a defined quantity of said data;

expiration of a defined period of time; and

occurrence of an external event.

4. The method of claim 1, wherein a plurality of synchronization triggers are received and new encryption keys generated during a single data session.

5. The method of claim 1, further comprising:
receiving said synchronization signal at said second network element;
retrieving a synchronized decryption seed corresponding to the synchronized encryption seed in response to the received synchronization signal; and
generating a new decryption key corresponding to the new encryption key for us in decrypting encrypted data.

6. The method of claim 5 further comprising verifying synchronization of the new encryption key of the first network element and the new decryption key at the second network element.

7. The method of claim 6, wherein verifying synchronization comprises:
sending a test message encrypted using the new encryption key from the first network element to the second network element; and
decrypting the test message using the new decryption key.

8. A system for transmitting encrypted data comprising:
a synchronization management entity enabled to transmit a synchronization signal; and
a first network element enabled to:
acquire an encryption seed substantially similar to a decryption seed at a second network element;
generate at least one encryption key from said encryption seed;
receive data;
encrypt said data using said encryption key to generate encrypted data;
transmit said encrypted data from said first network element to said second network element via a network;

receive the synchronization signal transmitted from the synchronization management entity to both said first network element and said second network element;

acquire a synchronized encryption seed in response to the received synchronization signal;

update said encryption seed at said first network element with the acquired synchronized encryption seed; and

generate a new encryption key for use in encrypting data based on the synchronized encryption seed;

wherein a period between receiving said synchronization signal and receiving a second synchronization signal is less than the period required to derive one of said encryption seed and said at least one encryption key from said encrypted data; and

wherein the synchronization management entity is a separate entity from the first network element and the second network element.

9. The system of claim 8, wherein said synchronization signal is transmitted in response to an event trigger.

10. The system of claim 9, wherein said event trigger is at least one of:

receipt of a defined quantity of said data;

transmission of a defined quantity of said data;

expiration of a defined period of time; and

occurrence of an external event.

11. The system of claim 8, wherein a plurality of synchronization triggers are received and new encryption keys generated during a single data session.

12. The system of claim 8, further comprising:

said second network, which is enabled to:

receive said synchronization signal at said second network element;

retrieve a synchronized decryption seed corresponding to the synchronized encryption seed in response to the received synchronization signal; and

generate a new decryption key corresponding to the new encryption key for us in decrypting encrypted data.

13. The system of claim 12, wherein the second network element is further enabled to verify synchronization of the new encryption key of the first network element and the new decryption key at the second network element.

14. The system of claim 13, wherein verifying synchronization comprises:

sending a test message encrypted using the new encryption key from the first network element to the second network element; and

decrypting the test message using the new decryption key.

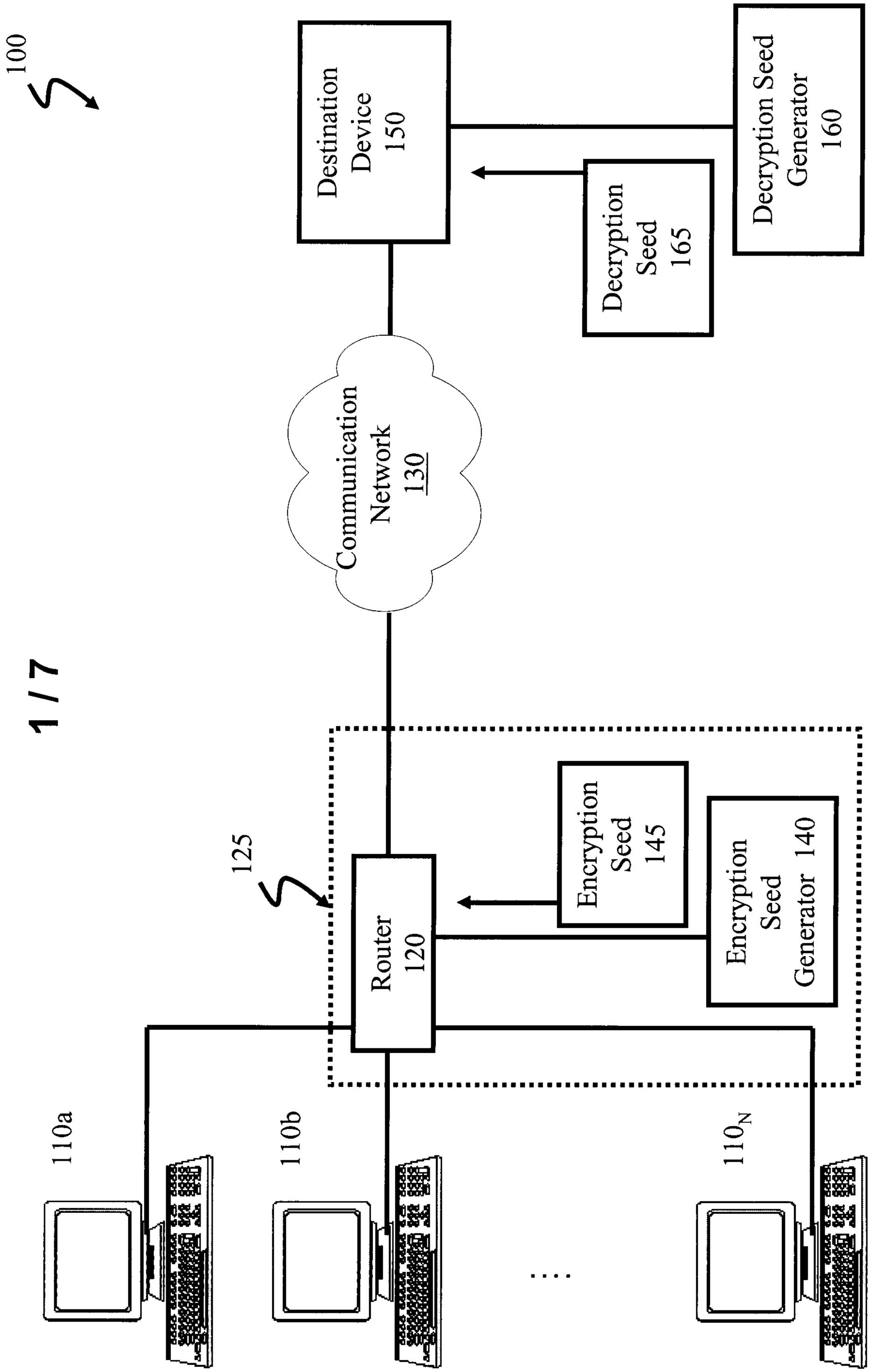

100
Destination Device 150
Decryption Seed Generator 160
Decryption Seed 165
Communication Network 130
125
Router 120
Encryption Seed 145
Encryption Seed Generator 140
110a
110b
110N

FIGURE 1a

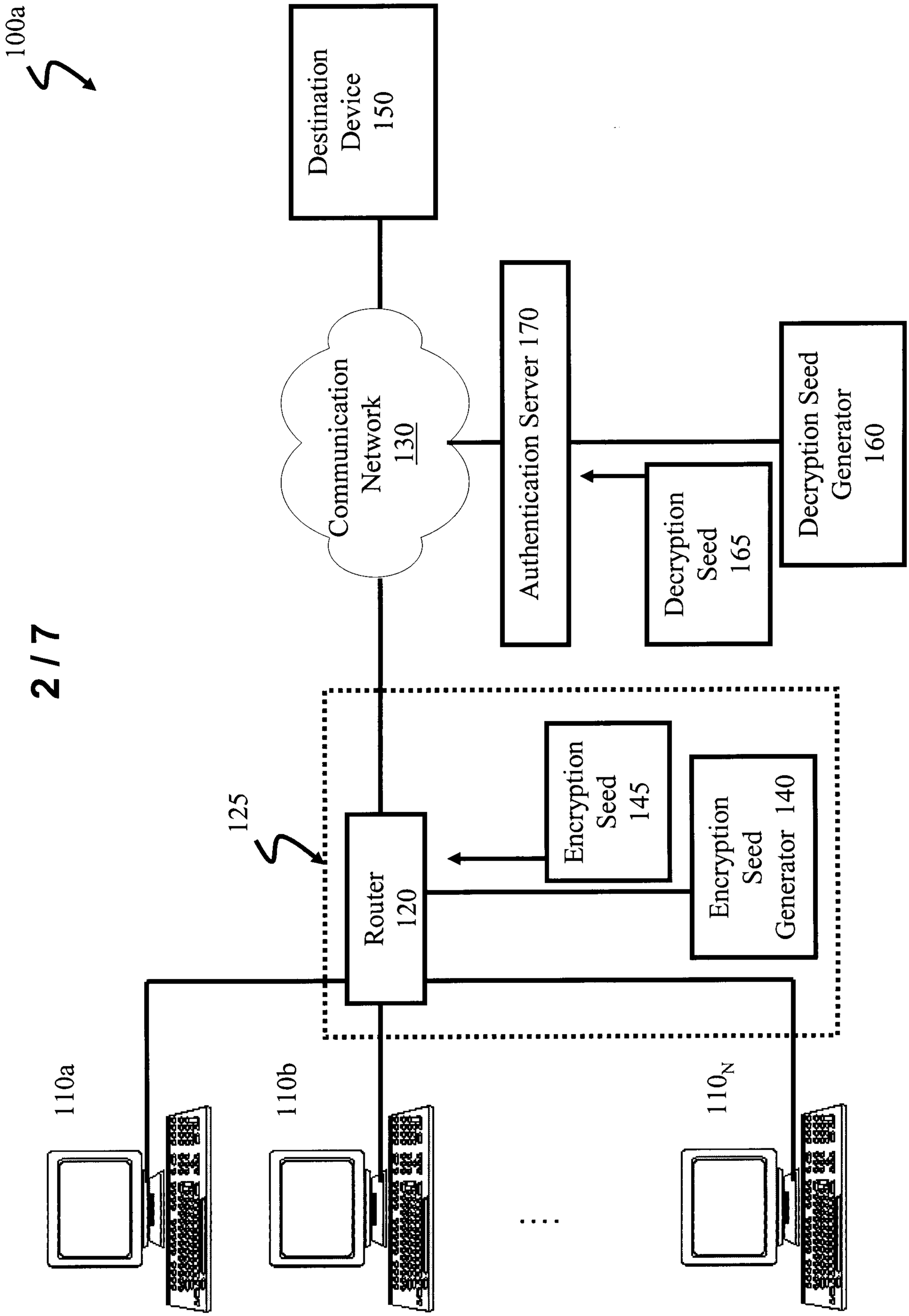

100a
Destination Device 150
Communication Network 130
Authentication Server 170
Decryption Seed 165
Decryption Seed Generator 160
2 / 7
125
Router 120
Encryption Seed 145
Encryption Seed Generator 140
110a
110b
110_N

FIGURE 1b

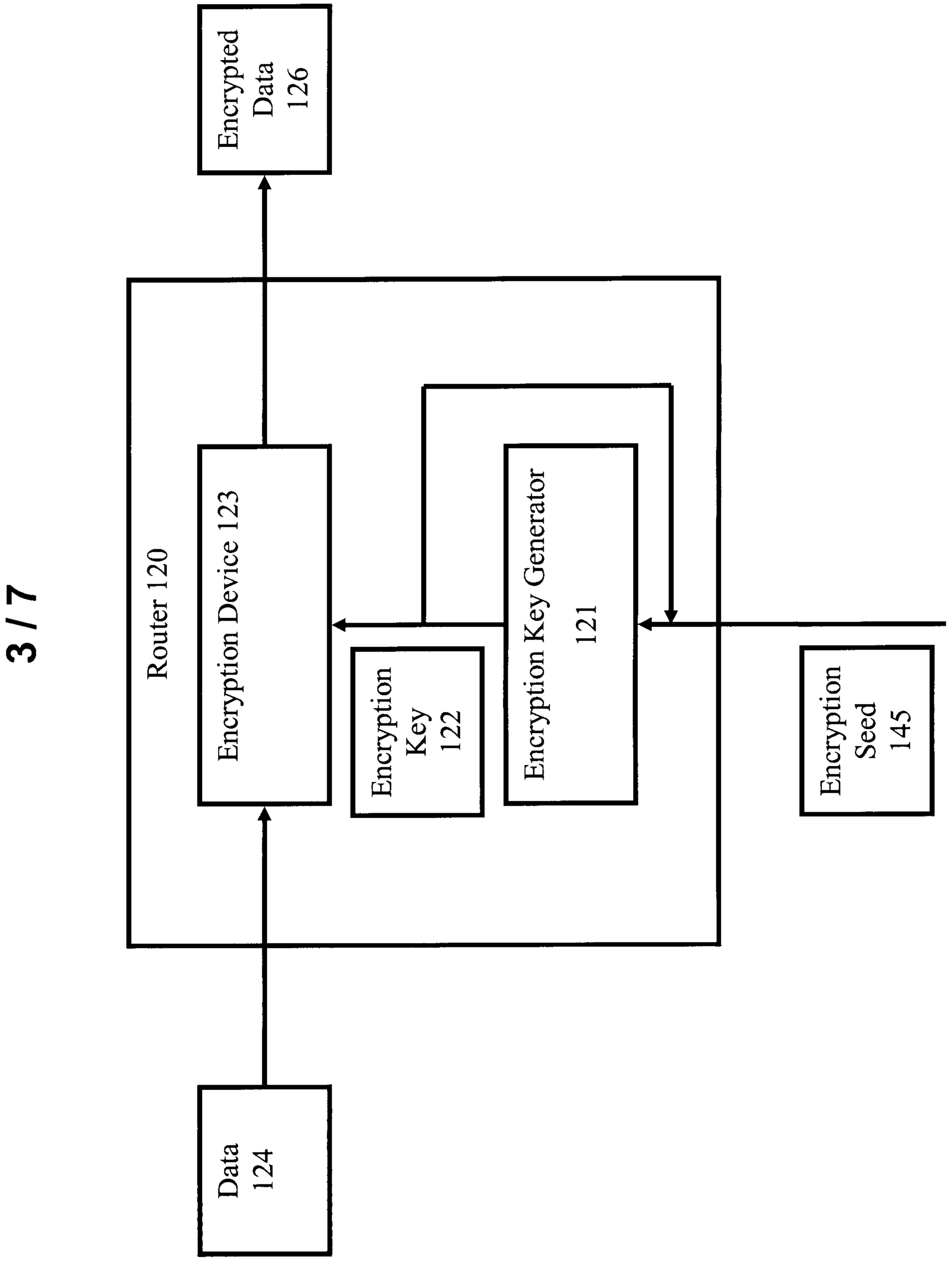

Encrypted Data 126
Router Computer 120
Encryption Device 123
Encryption Key 122
Encryption Key Generator 121
Encryption Seed 145
Data 124

FIGURE 1c

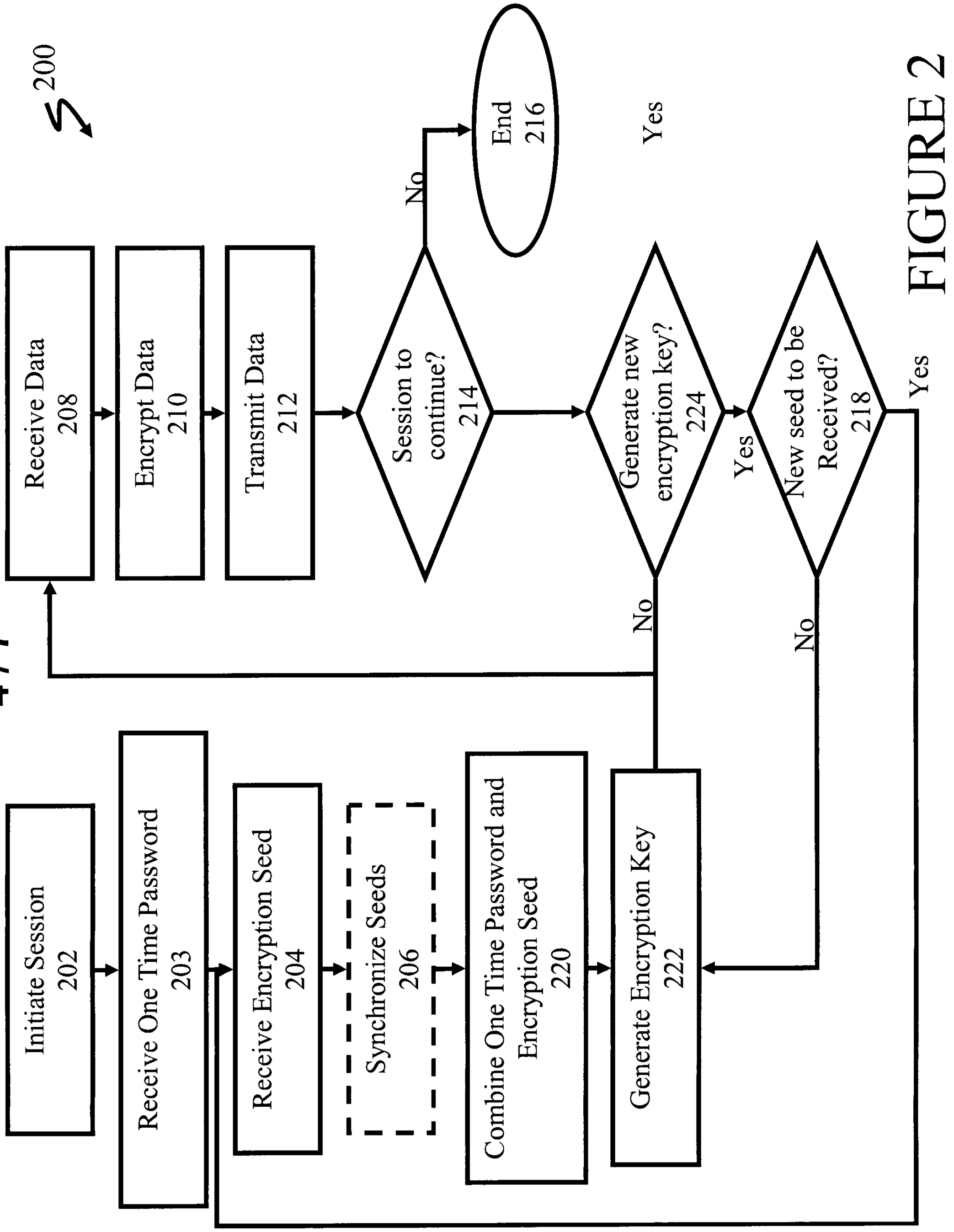

200
Initiate Session
202
Receive One Time Password
203
Receive Encryption Seed
204
Synchronize Seeds
206
Receive Data
208
Encrypt Data
210
Transmit Data
212
Session to continue?
214
End
216
Combine One Time Password and Encryption Seed
220
Generate Encryption Key
222
Generate new encryption key?
224
New seed to be Received?
218
Yes
No
Yes
No
Yes

FIGURE 2

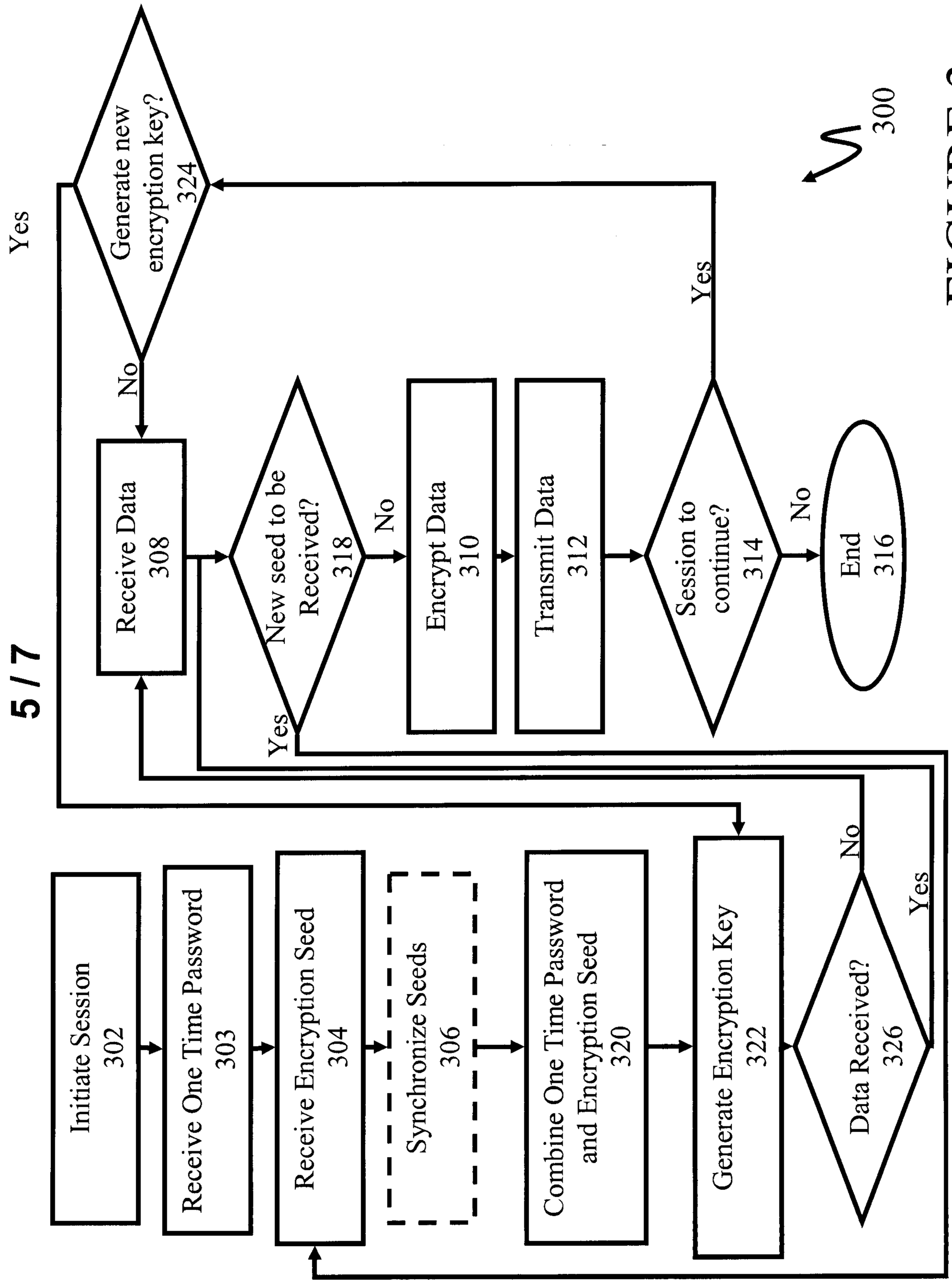

Initiate Session
302
Receive One Time Password
303
Receive Encryption Seed
304
Synchronize Seeds
306
Combine One Time Password and Encryption Seed
320
Generate Encryption Key
322
Data Received?
326
No
Yes
Receive Data
308
New seed to be Received?
318
No
Yes
Encrypt Data
310
Transmit Data
312
Session to continue?
314
No
End
316
Generate new encryption key?
324
Yes
No
Yes
300
5 / 7

FIGURE 3

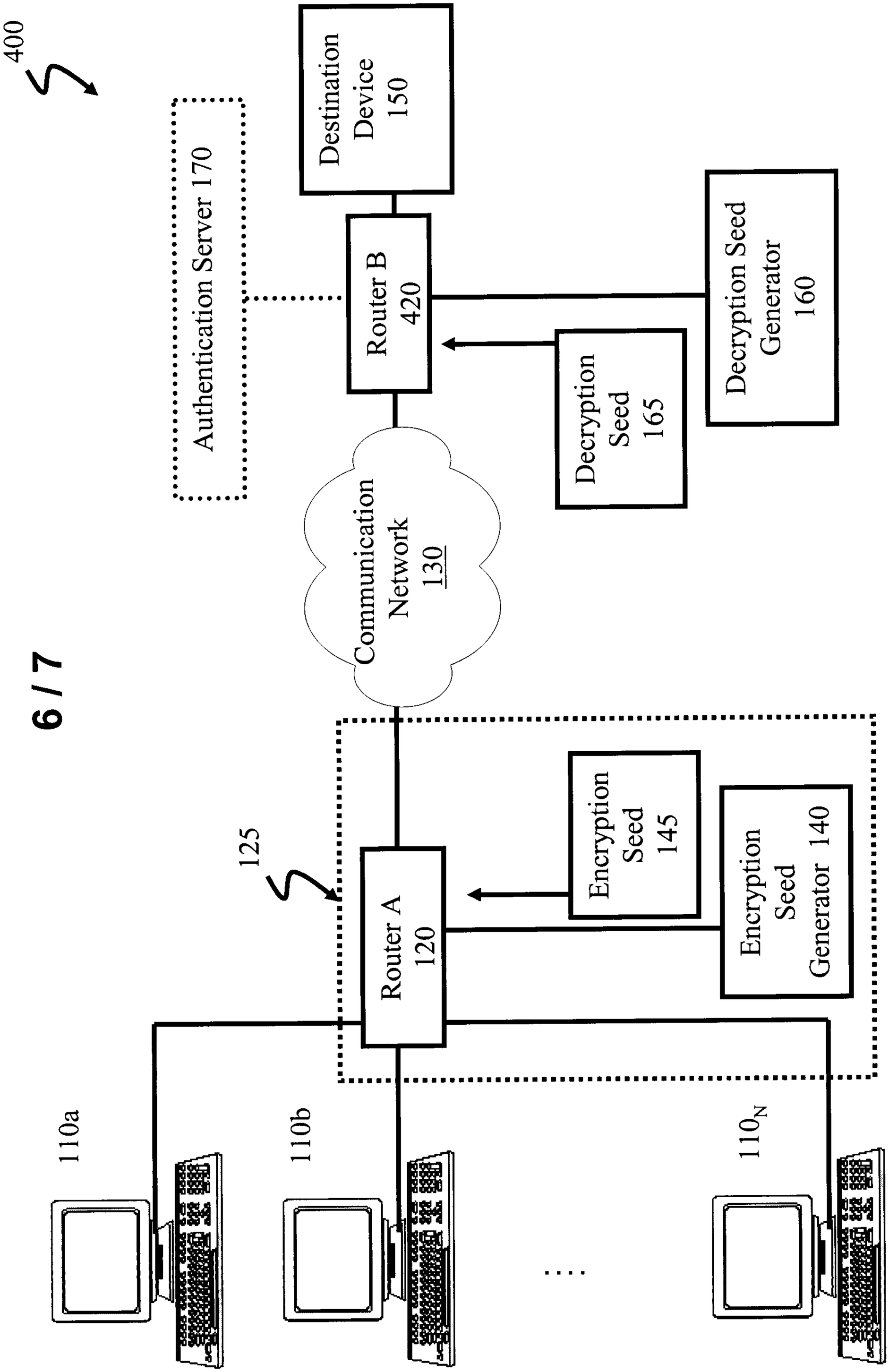

400
Authentication Server 170
Destination Device 150
Router B 420
Communication Network 130
Decryption Seed 165
Decryption Seed Generator 160
125
Router A 120
Encryption Seed 145
Encryption Seed Generator 140
110a
110b
110_N

FIGURE 4

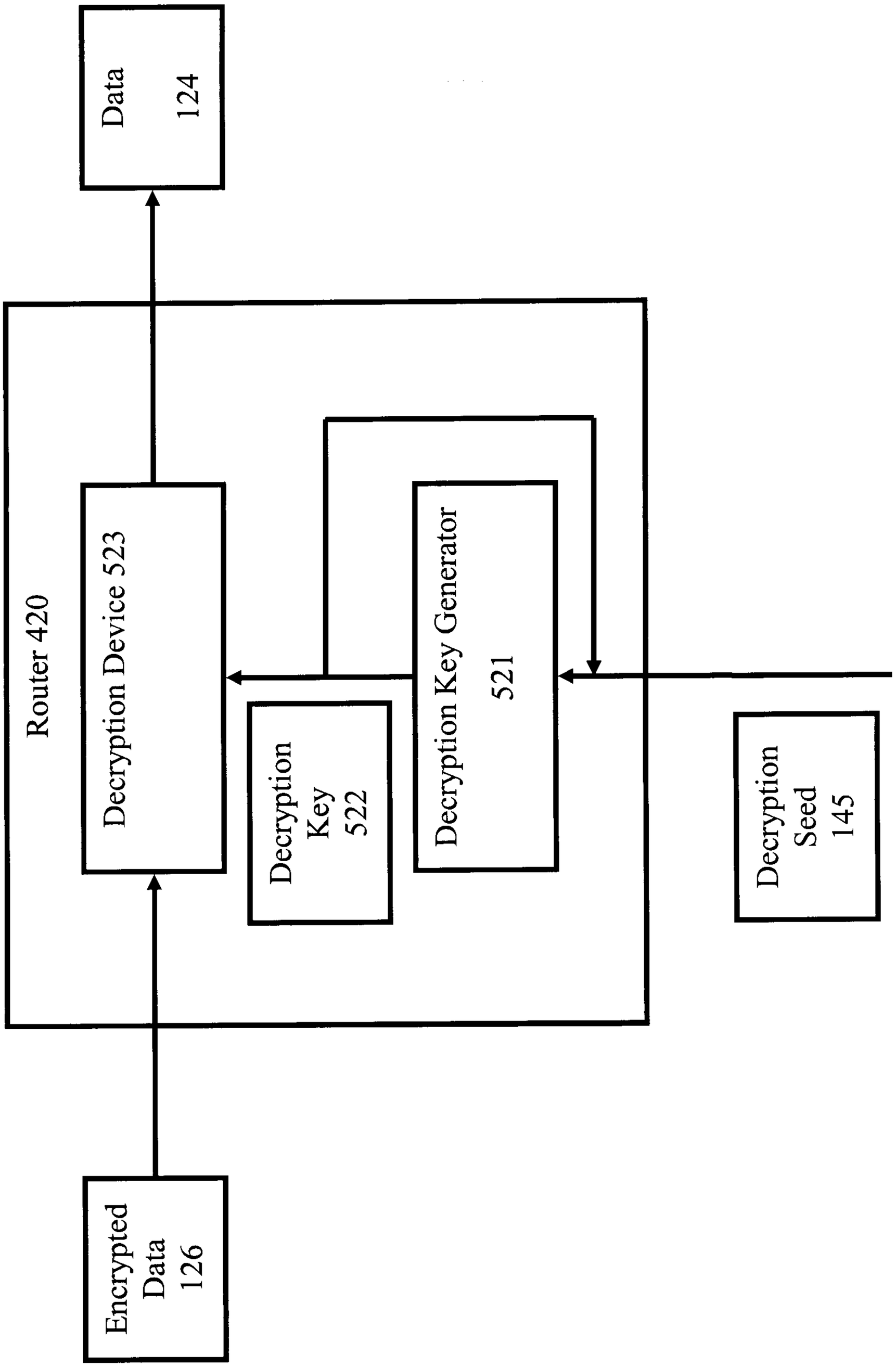
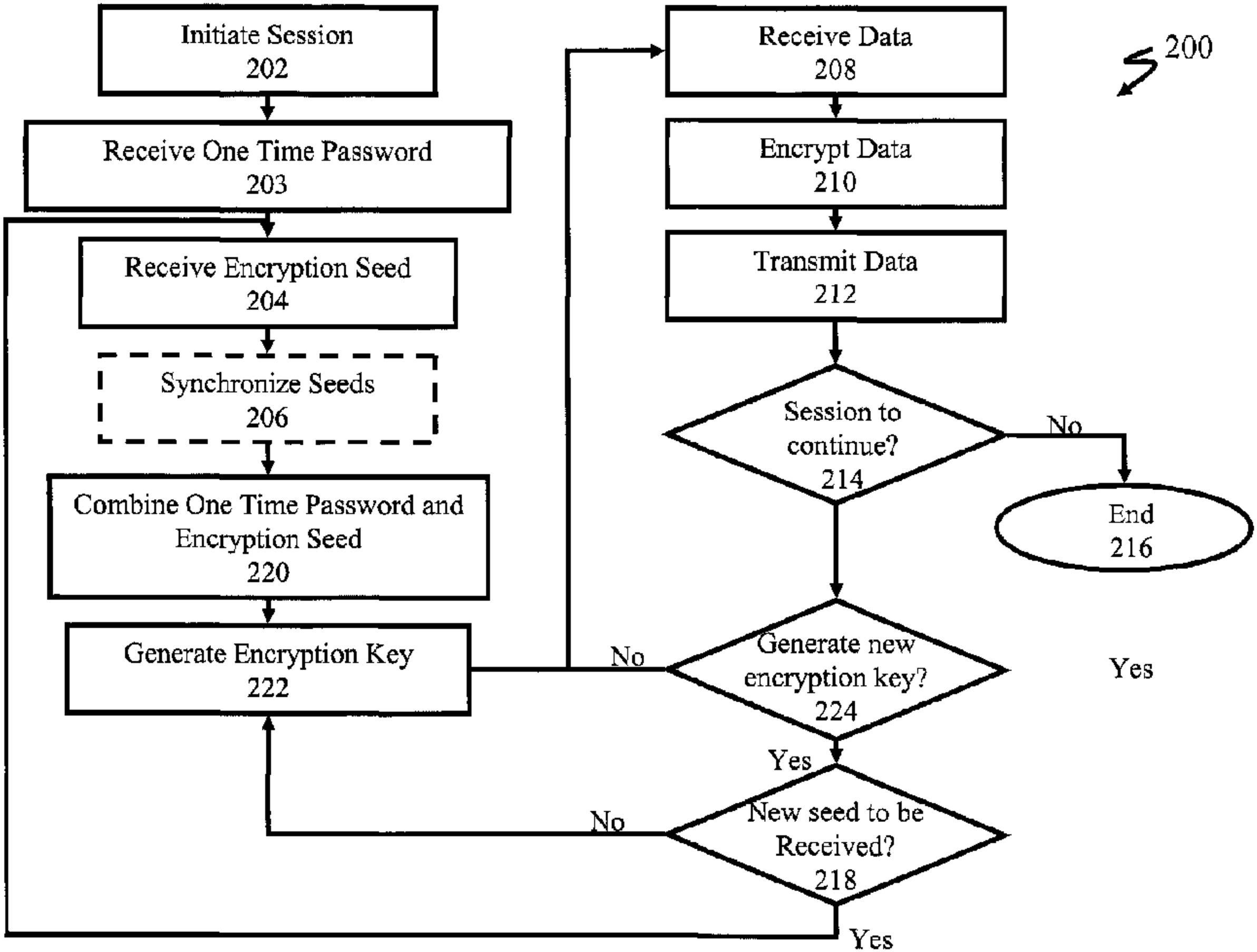

Data
124
Router 420
Decryption Device 523
Decryption Key Generator
521
Decryption
Key
522
Decryption
Seed
145
Encrypted
Data
126

FIGURE 5


Initiate Session
202
Receive One Time Password
203
Receive Encryption Seed
204
Synchronize Seeds
206
Combine One Time Password and Encryption Seed
220
Generate Encryption Key
222
Receive Data
208
Encrypt Data
210
Transmit Data
212
Session to continue?
214
No
End
216
Yes
Generate new encryption key?
224
No
Yes
New seed to be Received?
218
No
Yes
200