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Inventor(s) Hite; Bradford T

Network Station Identification Based On Geodetic Datum

Abstract

A unique system for the implementation of a communications system whereby network communicators such as service providers and service users are accessed based on geodetic datum. Service providers broadcast geodetic based network identification information on a common control channel for reception by local proximity service users. The service user evaluates each received broadcast and determines if a secure paired network connection is required. The encoded data link is negotiated between user/provider for secure data transmission based on current geodetic network identification information. Geodetic information, being temporary in nature, can be propagated in position, time or both to provide dynamically updating network identification for any participant.

Inventors: **Hite; Bradford T (Valencia, CA)**

Applicant: **Hite; Bradford T** (Valencia, CA)

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Background/Summary

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

REFERENCES CITED

U.S. Patent Documents

[0003] U.S. Pat. No. 9,140,782 B2 September 2015 Alberth

Foreign Patent Documents

[0004] Not Applicable

OTHER PUBLICATIONS

[0005] Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0006] This invention relates to the field of providing a unique network identification or address for network communicators based on their geodetic datum parameters. Based on real time global navigation satellite system (GNSS) data, each communicator will have a unique set of geodetic datum parameters representing a precise location at an instant in time. These parameters are used to derive a communicator network identification having the properties of uniqueness, temporary persistence and one-time usage. Communicator identification can be used to uniquely encode/access a data link or channel to insure a secure paired communication path between network communicators. The invention is compatible with current methods of communications but in most cases will serve to simplify mobile network overhead management.

2. Description of the Related Art

[0007] Providing secure data communications between non stationary users presents a difficult situation due to the operational environment dynamics. Channels need to be dynamically allocated based on proximity and interaction requirements possibly forming multiple overlapping competing local networks. Additionally, secure data transmission adds in the need for cryptographic key content management outside of network channel management. These areas are being currently being investigated as part of an industry standard mobile network configuration. The present invention is a system and method to address these unmet needs.

[0008] Current industry acceptance of IEEE 802.11p and IEEE 1609 define a WAVE (Wireless Access in Vehicular Environments) network protocol stack specialized for vehicle communications. Further, SAE J2735 defines the specific messaging formats and structure for vehicle/vehicle (V2V) or vehicle/infrastructure (V2I) applications. These applications, as described in SAE J2945, are mainly centered on vehicle safety and interaction within traffic situations to provide a method to exchange information. The SAE J2735 protocol is built around a core message type called the “Basic Safety Message” openly broadcast by each vehicle. This message is broadcast by vehicles to provide situational data including location, heading, speed, etc to surrounding vehicles. Being an open broadcast with no security provisions, the messages are non-secure being susceptible to bad actor spoofing. Local V2V type continuous data transactions over an IEEE 801.11p network are provided by the Non-IP based the CALM-FAST protocol. Although Non-IP based, the protocol is based on MAC addressing whereby each network participant is identified by a unique static 48 bit MAC address. The present invention teaches a system whereby each network participant is identified by their unique real time geodetic (position/time) datum. Network identification derived from ever changing geodetic information has deterministic properties of being unique, usable for a temporary period and one time generation based the fact two communicators cannot occupy the same physical space at the same time. Geodetic datum can be propagated in position, time or both to provide dynamically updating network identification for any participant. Periodically changing or updating of each network participant's identification information based on the latest geodetic

datum provides a secure method for network data communications.
[0009] Ad-hoc V2V communication systems have been proposed in the art most notably by Alberth in U.S. Pat. No. 9,140,782 titled “Inter-Vehicle Alert System with Nagable Video Look Ahead”. The system of Alberth utilizes millimeter wave radar sensors mounted front/rear to send video data between vehicles for collision avoidance. Communication between vehicles is simply based on “addressing information” whereby no further description is provided. This is different from the generalized geodetic based network identification data links proposed by the present invention whereby the system of Alberth is specialized to radar sensors and video type data.
BRIEF SUMMARY OF THE INVENTION
[0010] The present invention comprises a communications system whereby network communicators such as service providers and service users are accessed using network identification based on geodetic datum. Service providers can broadcast geodetic based network identification information on a common control channel for reception by local proximity service users. Each service user evaluates received broadcasts and determines if a secure paired network connection is required. The encoded data link is negotiated between user/provider for secure data transmission based on current geodetic network identification information. Geodetic information, being temporary in nature, can be propagated in position, time or both to provide dynamically updating network identification for any participant.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0011] FIG. **1** is a system block diagram for the preferred embodiment of the present invention.
[0012] FIG. **2** is a communication block diagram for the preferred embodiment of the present invention.
[0013] FIG. **3** is an example process diagram detailing the establishment of an encoded channel.
[0014] FIG. **4** is an example block diagram detailing the encoder hardware circuit.
[0015] FIG. **5** is an example block diagram detailing the decoder hardware circuit.
[0016] FIG. **6** is an example software flow chart detailing a service provider station control software processing steps.
[0017] FIG. **7** is an example software flow chart detailing the service user station control software processing steps.
TABLE-US-00001 REFERENCE NUMERALS IN THE DRAWINGS 100 Vehicle #1 102 Fixed Station Communicator Communicator 104 Vehicle #2 106 Vehicle #3 Communicator Communicator 108 Vehicle #1 Control 110 Vehicle #1 to Fixed Channel Broadcast Station Encoded Data Link 112 Vehicle #1 to 114 Vehicle #1 to Vehicle Vehicle #2 Encoded #3 Encoded Data Link Data Link 116 Vehicle #2 to 118 Vehicle #2 to Fixed Vehicle #3 Encoded Station Encoded Data Data Link Link 120 Fixed Station Control 122 Vehicle #2 Control Channel Broadcast Channel Broadcast 124 Vehicle #3 Control 126 Vehicle #3 to Fixed Channel Broadcast Station Encoded Data Link 128 GNSS Signal 200 Vehicle #1 202 Fixed Station Communicator Communicator 204 Remote Vehicle #3 206 Remote Vehicle #2 Communicator Communicator 208 Fixed Station GNSS 210 Remote Vehicle #2 Signal GNSS Signal 212 Remote Vehicle #3 214 Remote Vehicle #2 GNSS Signal Pos/Time/ID Control Channel Broadcast 216 Vehicle #1 to Fixed 218 Remote Vehicle #2 to Station Encoded Data Vehicle #1 Encoded Data Channel Channel 220 Remote Vehicle #3 to 222 Fixed Station to Vehicle #1 Encoded Vehicle #1 Data Link Data Channel Request Control Channel Transmission 224 Vehicle #1 226 Vehicle #1 to Remote Pos/Time/ID Vehicle #3 Data Link Control Channel Request Control Broadcast Channel Transmission 228 Remote Vehicle #3 230 Vehicle #1 to Remote Pos/Time/ID Vehicle #2 Data Link Control Channel Request Control Broadcast Channel Transmission 232 Vehicle #1 GNSS Signal 300 Service

Provider Out 302 Determine Current Going Event Pos/Time/Id Information 304 Public Cryptographic 306 Data Encryption Key 308 Broadcast Pos/Time/ID 310 Re-Transmit Delay On Control Channel Period Timer 312 Service User In Coming 314 Receive Pos/Time/ID Event Info Broadcast 316 Private Cryptographic 318 Data Decryption Key 320 Determine Data Link 322 Transmit Data Link Parameters Request On Control Channel 324 Service Provider In 326 Receive Data Link Coming Event Request Transmission 328 Establish Pos/Time 330 Queue Data Link Encoded Data Link Frame Based Data Blocks 332 Start Epoch Frame 334 Service User In Transmission Coming Event 336 Establish Pos/Time 338 Start Epoch Frame Encoded Data Link Reception 340 Synchronize Epoch 342 Start Data Block Frame Reception Reception 400 GNSS Receiver 402 Control Channel Modem 404 Control Channel 406 Control Channel Transmitter Receiver 408 Encoded Data Link 410 Processor Transmitter 412 Latitudinal Based 414 Pseudo Random PRN Seed Binary Sequence Generator 416 Longitudinal Based 418 Pseudo Random PRN Seed Binary Sequence Generator 420 Temporal Based 422 Pseudo Random PRN Seed Binary Sequence Generator 424 Self ID Based PRN 426 Pseudo Random Seed Binary Sequence Generator 428 PRBS Output 430 PRBS Data Stream Combiner Combiner 432 Control Software 434 Encoded Data Stream 500 GNSS Receiver 502 Control Channel Modem 504 Control Channel 506 Control Channel Transmitter Receiver 508 Processor 510 Latitudinal Based PRN Seed 512 PRBS Output 514 PRBS Remover Combiner 516 Pseudo Random 518 Longitudinal Based Binary Sequence PRN Seed Generator 520 Encoded Data Link 522 Pseudo Random Receive Binary Sequence Generator 524 Temporal Based 526 Pseudo Random PRN Seed Binary Sequence Generator 528 Self ID Based PRN 530 Pseudo Random Seed Binary Sequence Generator 532 Control Software 534 Encoded Data Stream 600 Initialize Program 602 Initialize Modem Variables Process Interface Process Step Step 604 Broadcast 606 Channel Request Pos/Time/ID Event Received Decision Decision Block Block 608 Re-synch Data Link 610 Get GNSS Information Event Decision Process Step Block 612 Broadcast 614 Determine Data Link Pos/Time/ID On Parameters Process Control Channel Step Process Step 616 Establish 618 Queue Link Frame Pos/Time/ID Based Data Blocks Encoded Data Link Process Step Process Step 620 Start Epoch Frame 622 Get GNSS Information Transmission Process Step Process Step 624 Insert Pos/Time/ID 626 Update Pos/Time/ID In Last Epoch Encoded Data Link Process Step Process Step 700 Initialize Program 702 Initialize Modem Variables Process Interface Process Step Step 704 Receive 706 Encoded Channel Pos/Time/ID Event Active Decision Block Decision Block 708 Re-synch Data Link 710 Encoded Channel Event Decision Required Decision Block Block 712 Transmit Channel 714 Establish Pos/Time/ID Request on Control Encoded Data Link Channel Process Process Step Step 716 Start Epoch Frame 718 Synch Epoch Frame Reception Process Reception Process Step Step 720 Start Data Block 722 Retrieve Latest Reception Process Pos/Time/ID In Last Step Epoch Process Step 724 Update 726 Evaluate Pos/Time/ID Pos/Time/ID Parameters Process Encoded Data Link Step Process Step

DETAILED DESCRIPTION OF THE INVENTION

[0018] The preferred embodiment system block diagram of the present invention is shown in FIG. **1** as three mobile vehicle communicator stations and a fixed position communicator station. In the context of this preferred embodiment the terms pos/time/ID and identification information are used interchangeably. Each communicator station is equipped to receive GNSS information **128**. Vehicle communicator station **100** accesses common control channel **108** to initially broadcast a data packet representing network identification information to include for example current position, time and self identification. The common control channel is available to all network communicators for open broadcasts or other type data transactions. Network identification information is analogous to an address uniquely identifying the communicator on the network. The self identification can further comprise a cryptographic key to allow encryption/decryption of network communications. FIG. **1** shows other local proximity communicator stations as vehicle **104**, vehicle **106** and fixed station **102** whereby each receive the vehicle **100** network identification information broadcast. Common control channel access points for each is of the local communicator are identified by vehicle **104** as node **122**, vehicle **106** as node **124** and fixed station **102** as node **120**. Based on the vehicle **100** broadcast, each local communicator will determine if an encoded data link is required. An encoded data link for example can be a uniquely paired communications path or channel between communicators only accessible by knowing the current network identification information. Determination of a required data link can be based on such parameters but not limited to: distance, direction, link integrity, interaction, coordination, data transfer, etc. Setup of an encoded data link is performed using the control channel whereby each local communicator (service user) sends control information including a channel request back to the network identification information broadcaster (service provider). Based on this transaction, encoded channels are initiated between the service user and provider as shown in FIG. **1**. Vehicle **100** communicates with vehicle **104** via encoded data link **112**, vehicle **106** via link **114** and fixed station **102** via link **110**. Similarly, vehicle **104** communicates with vehicle **106** via link **116** and fixed station **102** via link **118**. Finally, vehicle **106** communicates with fixed station **102** via link **126**.

[0019] The present invention preferred embodiment as shown in FIG. **2** provides more detail into the communication between four local proximity communicator stations. In this figure, each communicator station transmits or receives control or encoded data information using sensor equipment built into each vehicle or fixed position station. Example industry standard sensors found in the art capable of information transfer include but are not limited to: RF transceiver types such as Cellular, Dedicated short range communications (DSCR), Mobile wireless broadband (MWB), Satellite and other sensor types such as Millimeter wave radar, Infrared. Vehicle **200** acts as both a service user/provider; while remote vehicle **206** and vehicle **204** are service providers; and fixed station **202** is a service user. An example application could have vehicle **200** streaming sensor data from vehicles **206** and **204** while interacting with fixed station **202** for a billing service. In setting up the encoded data channels, vehicle **200** receives GNSS information **232** and then broadcasts pos/time/ID derived identification information **224** onto the control channel. Similarly, vehicle **206** also receives GNSS information **210** and broadcasts pos/time/ID derived identification information **214** onto the control channel while vehicle **204** receives GNSS information **212** and broadcasts pos/time/ID derived identification information **228** on the control channel. Vehicle **200** receives pos/time/ID derived identification information **214** and sends control information data link request **230** to vehicle **206** to initiate encoded data channel **218**. Vehicle **200** also receives pos/time/ID derived identification information **228** and sends control information data link request **226** to initiate encoded data channel **220**. Fixed station **202** receives pos/time/ID derived identification information **224** and sends control information data link request **222** to initiate encoded data channel **216**. Each of the encoded data channels **218**, **220** and **222** between service user and provider are unique being based on the pos/time/ID derived identification information sent by the service provider. The encoding of each encoded data channel **218**, **220** and **222** can be changed at anytime by transferring updated pos/time/ID derived identification information from service provider to user. This allows secure communications between communicators based on the encoding constantly changing thereby being difficult to intercept.

[0020] FIG. **3** shows an example of process steps used to establish the encoded data link between a service provider and service user. Service provider event **300** initiates the sequence to broadcast pos/time/ID derived identification information. The current pos/time/ID identification information is derived from GNSS information in step **302**. Encryption step **306** using public key **304** is an optional step to encrypt the identification information broadcast on the common control channel. Broadcast of pos/time/ID derived identification information on the common control channel is performed in step **308** whereby a period delay **310** is started to schedule a later broadcast event **300**. Service user event **312** is initiated upon reception of pos/time/ID derived identification information **314** from the common control channel. Decryption step **318** using private key **316** is an optional step to decrypt the identification information received on the common control channel.

Step **320** determines the data link parameters for the control information data link request transmitted on the common control channel **322**. Service provider event **324** is initiated upon reception of a control information data link request **326** on the common control channel. The data link parameters determined in step **320** is used to establish a pos/time/ID encoded data link **328**. Step **330** forms a queue of frame based data blocks to be transmitted on the encoded data link. Step **332** starts an epoch based frame transmission of data across the encoded data link. Service user event **334** is initiated upon transmission of the data link request to start encoded channel data reception. Step **336** uses the data link parameters determined in step **320** to establish a pos/time/ID encoded data link. Epoch data frame reception of the encoded data channel is started **338** and synchronized **340** prior to data block reception **342**. Termination of the encoded data channel can be initiated by the service provider based on the service being completed.

[0021] An example channel encoder circuit based on position, time and ID network identification information for the preferred embodiment is presented in FIG. **4**. This example based on Code Division Multiple Access (CDMA) may be replaced with any channel multiplexing method including but not limited to: Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). Additionally, this encoder example is shown based on a horizontal datum coordinate system (Latitude/Longitude) but can be simply modified to include a vertical datum (altitude) component. GNSS receiver **400** provides the communicator's current geodetic datum information. An example GNSS receiver reporting geodetic datum information could utilize NEMA 183 messages. In these messages, strings representing latitude (ddmm.mmmm plus N/S indicator), longitude (dddmmm.mmmm plus E/W indicator) and time (hhmmss.ss) can all be converted to a 32-bit fixed point format. These three 32-bit numbers plus a 32-bit self ID field can be used as seed values (FIG. **4** **412**, **416**, **420**, **424** and FIG. **5** **510**, **518**, **524**, **528**) for the PRBS generators. Control channel modem **402** provides processor **410** access to the common control channel in conjunction with transmitter **404** and receiver **406**. Control software **432** executes on processor **410** to operationally control the encoder circuit. Latitudinal seed **412**, longitudinal seed **416**, temporal seed **420** and self ID seed **424** are calculated by control software **432** based on identification information received from the control channel. The seed values are loaded into PRBS generator circuits **414**, **418**, **422** and **426** to create multiple pseudo random bit streams. Logic element **428** combines the multiple PRBS into a single PRBS used to encode the data link. Finally, logic element **430** creates an encoded data stream **434** from a non-encoded data stream provided by control software **432**. The encoded data stream **434** is transmitted on the data link by transmitter **408**.

[0022] An example channel decoder circuit based on position, time and ID network identification information for the preferred embodiment is presented in FIG. **5**. This example based on Code Division Multiple Access (CDMA) may be replaced with any channel multiplexing method including but not limited to: Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). Additionally, this encoder example is shown based on a horizontal datum coordinate system (Latitude/Longitude) but can be simply modified to include a vertical datum (altitude) component. GNSS receiver **500** provides the communicator's current geodetic datum information. Control channel modem **502** provides processor **508** access to the common control channel in conjunction with transmitter **504** and receiver **506**. Control software **532** executes on processor **508** to operationally control the decoder circuit. Latitudinal seed **510**, longitudinal seed **518**, temporal seed **524** and self ID seed **528** are calculated by control software **532** based on identification information received from the control channel. The seed values are loaded into PRBS generator circuits **510**, **518**, **524** and **530** to create multiple pseudo random bit streams. Logic element **512** combines the multiple PRBS into a single PRBS used to decode the data link. Finally, logic element **514** removes the PRBS to create a decoded data stream as based on encoded data stream **534** provided by data link receiver **520**. The decoded data stream is sent to control software **532**.

[0023] FIG. **6** shows an example software flow chart for the service provider control software **432** of the preferred embodiment. Execution begins at the "Start" label first initializing program variables **600** and initializing the modem interface **602**. Decision block **604** determines if a pos/time/ID broadcast event has been scheduled. If so, the latest GNSS information is retrieved **610** and broadcast as pos/time/ID on the control channel **612**. If not, decision block **606** determines if a channel request has been received on the control channel from a service user. If so, the data link parameters are determined **614** and the pos/time/ID encoded data link is established **616** by seeding PRBS generators **414**, **418**, **422** and **426**. Data blocks are then queued into frames **618** and the epoch frame transmission is started **620**. If no channel request has been received, decision block **608** determines if an optional data link resynchronization event has been scheduled. If so, the current GNSS information is retrieved **622** and sent as updated pos/time/ID control information in a resynchronization epoch **624** to the service user. Finally, the pos/time/ID encoded data link is updated **626** by reseeding PRBS generators **414**, **418**, **422** and **426**.

[0024] FIG. **7** shows an example software flow chart for the service user control software **532** of the preferred embodiment. Execution begins at the "Start" label first initializing program variables **700** and initializing the modem interface **702**. Decision block **704** determines if a pos/time/ID broadcast event has been received. If so, the pos/time/ID parameters are evaluated to determine if an encoded data link is required. This determination can be based on such parameters but not limited to: distance, direction, interaction, coordination, data transfer, etc. If an encoded channel is required **710**, a channel request is transmitted on the control channel **712**. Next, decision block **706** follows and determines if an encoded data link has been activated. If so, the pos/time/ID encoded data link is established **714** by seeding PRBS generators **516**, **522**, **526** and **530**. Epoch data frame reception of the encoded data channel is started **716** and synchronized **718** prior to data block reception **720**. Termination of the encoded data channel can be initiated by the service provider based on the service being completed. Decision block **708** determines if an optional data link resynchronization event has been received. If so, updated pos/time/ID control information is retrieved from a resynchronization epoch **722**. Finally, the pos/time/ID encoded data link is updated **724** by reseeding PRBS generators **516**, **522**, **526** and **530**.

[0025] An alternative embodiment of the present invention comprises replacing the static IEEE 801.11 defined MAC address with a dynamic or changing value based on geodetic datum. A dynamic value replacing the static network identifier is especially useful for securing Non-IP routed network communications. In this manner, the network identification of a network communicator could be changed dynamically providing a method of secure communications. The dynamic network identification for a communicator would be derived from a combination of their geodetic position, time and self ID as described with reference to FIG. **4**. As described, the resultant 128 bit network identification would need to be reduced down to a unique 48 bit sized representation to be compatible with existing systems. This reduction in the numerical size could be achieved by a hashing function or some other method.

[0026] An exemplary application of the present invention would consist of a fixed position communication station acting as the service user to moving vehicular communication stations providing a service. Various examples of a fixed position communication station include but are not limited to: toll collection station, parking lot entry/exit station, restaurant/store drive thru station, etc. In this example, an automated fixed position toll station receives network identification information broadcast by vehicles moving past the station. The toll station will request an encoded channel with each passing vehicle to procure a toll payment. Since each vehicle's pos/time/ID used within the current network identification will be different, each encoded channel will be uniquely and securely paired. The network identification information also has the properties of being temporary and of one time usage. In comparison, a static MAC address is permanently assigned to a communicator and used for every interaction. This opens the possibility of a bad actor cloning the MAC address of another network communicator and impersonating them on the network. The problem is magnified within open air systems whereby MAC address transmissions are freely accessible to any user within receiving range of the signal. For purpose of this toll station example, a bad actor could receive and clone the MAC address of another user. This would allow the bad actor to freely interact to toll station inquires using a cloned MAC address and cheat the system.

Claims

1. A system comprising: a. a communication network coupled to at least two communication stations, the communication network routing data in response to the communication stations; b. a first communication station coupled to the communication network, the first communication station transmitting and receiving data in response to the communication network; c. a second communication station coupled to the communication network, the second communication station transmitting and receiving data in response to the communication network; d. wherein the first communication station is configured to receive GNSS information and derive first network identification information based on geodetic datum information; and e. wherein the second communication station is configured to receive GNSS information and derive second network identification information based on geodetic datum information.
2. The system of claim 1, wherein each communication station is configured to broadcast network identification information onto the communications network and receive broadcast network identification information from the communications network.
3. The system of claim 2, wherein each communication station is configured to establish an encoded data link based on network identification information.
4. The system of claim 2, wherein each communication station is configured to perform network communications using a RF transceiver sensor.
5. The system of claim 2, wherein each communication station is configured to perform network communications using an infrared sensor.
6. The system of claim 2, wherein each communication station is configured to perform network communications using a radar sensor.
7. A method comprising: a. routing data on a communication network in response to at least two communication stations; b. transmitting and receiving data by a first communication station in response to the communication network; c. transmitting and receiving data by a second communication station in response to the communication network; d. generating first communication station network identification information derived from geodetic data information in response to GNSS information; and e. generating second communication station network identification information derived from geodetic data information in response to GNSS information.
8. The method of claim 7, further comprising broadcasting network identification information by a communication station onto the communications network and receiving broadcast network identification information by a communication station from the communications network.
9. The method of claim 8, further comprising establishing an encoded data link by a communication station based on network identification information.
10. A system comprising: a. a fixed position communication station coupled to a communication network, the fixed position communication station transmitting and receiving data in response to the communication network; b. a mobile communication station coupled to a communication network, the mobile communication station transmitting and receiving data in response to the communication network; c. wherein the fixed position communication station is configured to receive geodetic datum derived network identification information from the mobile communication station, respond with network control information and establish an encoded data link with the mobile communication station; and d. wherein the mobile communication station is configured to receive network control information from the fixed position communication station and establish an

encoded data link with the fixed position communication station.
11. The system of claim 10, wherein the fixed position communication station comprises a toll collection station.
12. The system of claim 10, wherein the fixed position communication station comprises a parking lot entry/exit station.
13. The system of claim 10, wherein the fixed position communication station comprises a restaurant/store drive thru station.