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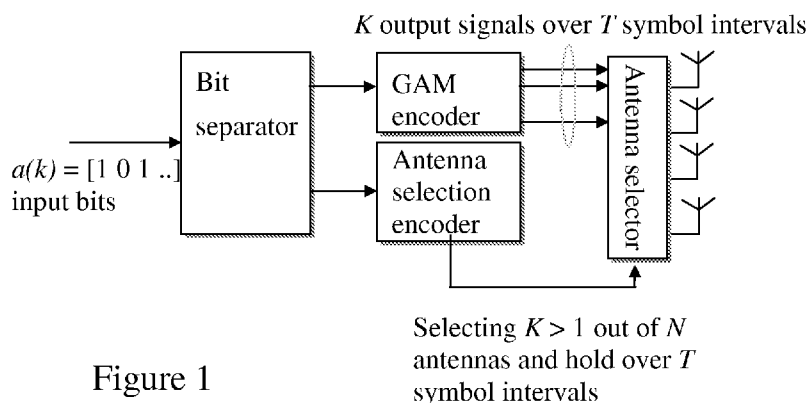
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(54) Title: METHOD FOR TRANSMISSION IN A WIRELESS COMMUNICATION SYSTEM



(57) Abstract: The present invention relates to a method for transmission in a wireless communication system and more particularly to a method in a transmitter which comprises a plurality of transmit antennas. An example embodiment according to the invention comprises encoding of signals for transmission and provides for transmission over a selected number of transmit antennas.

METHOD FOR TRANSMISSION IN A WIRELESS COMMUNICATION SYSTEM

Technical Field

The present invention relates to transmission in a wireless communication system and more particularly to a method in a transmitter which comprises a plurality of transmit antennas. Furthermore, a transmitter device relating to the method is disclosed.

Background

When a transmitter has multiple transmit antennas, a transmission scheme can be selected in a plethora of different ways depending on the aim of a transmission. The transmission schemes can heuristically be categorized into two groups, namely those providing diversity and those providing capacity. However, some transmission schemes provide both capacity and diversity.

To increase the reliability of a wireless link, transmit diversity schemes have been proposed in prior art. Most transmit diversity schemes are often designed to maintain a simple receiver structure, and these schemes commonly operate well with a single receive antenna. Transmit diversity has a low spectral efficiency, but it is possible to increase the spectral efficiency slightly if transmit diversity is used in conjunction with e.g. link adaptation.

To obtain transmit diversity, each information bit or symbol may be transmitted from more than one transmit antenna. In this way each bit or symbol will pass through at least two different fading channels, and by proper combining in the receiver, diversity is obtained. A straightforward approach is therefore to transmit the same symbol from all available transmit antennas. However, with this straightforward approach, transmitted symbols may destructively interfere in the receiver due to the fading in the channel, and performance gain is lost. Use of multiple receive antennas may circumvent this detrimental condition of destructive combining, but will increase the cost and complexity of the receiver.

Another solution to circumvent the above mentioned problem is to utilize an orthogonal Space Time Code (STC). The STC is a well known transmit diversity scheme, which through the design of the code allows for single antenna reception. STC from orthogonal designs also avoid signal cancellation at the receiver antennas by transmitting different symbols from different antennas at each transmission instant. Instead, multiple transmission instants are used to make sure that each symbol is transmitted from more than one antenna, thereby obtaining transmit diversity. Hence,

with STC the symbols are coded (distributed) over multiple antennas and multiple symbol intervals in time. It is not necessary to use time as a second dimension, which is the case in space time codes. In fact, this so called auxiliary dimension may be frequency which will give a Space-Frequency Code (SFC) and the encoder then uses multiple symbol intervals in the frequency domain. In the following description, the notation STC will be used for simplicity but it shall be understood that other auxiliary dimensions than time may be used.

STC from orthogonal designs with full rate (i.e. effectively one modulation symbol transmitted per channel use) exists only for two transmit antennas through the well known Alamouti code design. If the orthogonality of the STC must prevail when increasing the number of antennas the effective number of transmitted symbols per channel use must be reduced below one, hence full rate is no longer achieved. In a four antenna transmit diversity scheme, according to the 3GPP LTE Release 8 standard, the full rate Alamouti code is combined with antenna hopping in such a way that the output from a two antenna transmit diversity (SFC) encoder based on the Alamouti scheme is alternating in frequency direction between transmission from antenna 1 and 2, and antenna 3 and 4. This scheme is denoted Space Frequency Block Code plus Frequency Switched Transmit Diversity (SFBC+FSTD).

In contrast to transmit diversity, Spatial Multiplexing (SMUX) schemes are known to increase the spectral efficiency significantly by transmitting several layers of independent data streams simultaneously. Usually one stream per transmit antenna is transmitted, or equivalently one (different) modulation symbol is transmitted from each antenna. A drawback of SMUX schemes is the receiver complexity, such as for linear detection and for the requirement of at least as many receive antennas as there are streams. The reason is Inter Stream Interference (ISI) present in the SMUX schemes that must be handled by a Multiple Input Multiple Output (MIMO) receiver capable of reducing the ISI.

In some broadcast systems, such as the Multi-media Broadcast over Single Frequency Network (MBSFN) according to 3GPP standard, many user terminals receive a same transmitted signal and the user terminals may be equipped with different number of receive antennas; some of them even with a single receive antenna. So in these types of systems, spectral efficiency can not be increased by employing SMUX schemes since single antenna user terminals can not receive multiple layers.

Spatial Modulation (SM) is a transmission scheme which aims at increasing spectral efficiency without introducing ISI (as in the mentioned SMUX scheme), and thereby allowing a low complexity receiver. In an SM scheme, a transmitter uses information bits at the transmitter side to select a modulation constellation symbol and to select an antenna from which the symbol shall
5 be transmitted. It is then the receiver's task to detect which modulation symbol that was transmitted and from which antenna.

An SM scheme denoted Generalized Space Shift Keying (GSSK) is known from prior art, where more than one antenna is selected per channel use, and each antenna transmits the same
10 waveform. Hence, no modulation symbols are used in this scheme. Therefore, the modulation constellation is trivial. No bits need be encoded for selecting the modulation constellation. Stated differently, in GSSK a constant predefined waveform is transmitted when the antenna is active. Therefore, the sole information conveying mechanism in this GSSK scheme is the antenna selection for active transmission.

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Summary

It is a problem in general to increase spectral efficiency in wireless communication systems, and this is especially the case in MBSFN networks. The present invention aims to provide a transmission scheme for a wireless communications system with high spectral efficiency for a
20 transmitter with a plurality of transmit antennas.

With a method and a transmitter according to an embodiment of the invention, the spectral efficiency may be improved compared to solutions according to prior art since the transmission scheme allows for selection of K out of N antennas for transmission and uses non-trivial
25 modulation constellations on the selected antennas.

Furthermore, a transmission scheme according to an aspect of the present invention allows for encoding of the modulated symbols to be transmitted from the K selected antennas and over T symbol intervals in an auxiliary dimension such as e.g. time or frequency, thereby avoiding signal
30 cancellation in the receiver.

Yet further, transmit diversity encoding is preferably used on the modulated symbols to be transmitted from the K selected antennas and over T symbol intervals providing diversity gain for both coded bits and uncoded bits, thereby ensuring diversity gain also at higher code rates.

Other advantages will be apparent from the following detailed description of embodiments of the present invention.

5 Brief description of the drawings

The appended drawings are intended to clarify and explain the present invention where:

- Figure 1 shows an embodiment of the present invention;
- Figure 2 shows an embodiment of the present invention where a Generalized Antenna Modulation (GAM) encoder comprises a modulator and a transmit diversity encoder;
- 10 - Figure 3 shows an embodiment of the present invention where a GAM encoder comprises a modulator and an Alamouti orthogonal block code encoder;
- Figure 4 shows an embodiment of the present invention where a GAM encoder comprises a spatial multiplexer;
- Figure 5 shows an example of an embodiment of the present invention where a transmitter
- 15 comprises a plurality of distributed antennas;
- Figure 6 shows simulations results for a transmission scheme according to the present invention; and
- Figure 7 shows additional simulation results for a transmission scheme according the present invention.

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Detailed description

With a Spatial Modulation (SM) scheme described above, one antenna out of N available transmit antennas is selected for transmission which means that

$$\left\lfloor \log_2 \left(\binom{N}{1} \right) \right\rfloor = \lfloor \log_2 N \rfloor \quad \text{bits}$$

25 can be encoded in the selection of antennas and with a modulation constellation with M signals points, then $\log_2 M$ bits can be encoded in the selection of modulation constellation symbol. In the expression above, $\lfloor x \rfloor$ denotes rounding the value x to the closest smaller integer because fractions of bits can not be transmitted in the antenna selection (it could therefore be practical if the number of transmit antennas is a power of two). Thus a total of

30

$$G_{SM} = \lfloor \log_2 N \rfloor + \log_2 M = \lfloor \log_2 NM \rfloor \quad \text{bits}$$

can be conveyed per channel use.

With the GSSK scheme mentioned earlier, K antennas are selected by the bits to be transmitted and the remaining $N - K$ antennas do not transmit anything. In this way, by selecting $K > 1$ out of N antennas there are more selection combinations available (unless all antennas $K = N$ are selected), and the number of information bits transmitted by antenna selection is thus increased compared to the case when $K = 1$. This can easily be seen by the following inequality,

$$\binom{N}{1} < \binom{N}{K} \text{ for } 1 < K < N,$$

where the binomial term $\binom{N}{K}$ gives the number of unique ways to select K out of N antennas.

Hence, selecting K out of N antennas always gives more combinations than selecting 1 out of N antennas and thus the former selection contains more information. Further, in GSSK, K out of N available transmit antennas are selected (where $K > 1$) which means that

$$G_{GSSK} = \left\lfloor \log_2 \left(\binom{N}{K} \right) \right\rfloor \text{ bits}$$

can be encoded in the selection of antennas, but in this GSSK scheme zero bits ($M = 1$) are used for the trivial (single point) modulation constellation symbol.

To address e.g. the mentioned problem of providing a spectral efficient transmission scheme, an Antenna Selection Modulation (ASM) method is provided comprising a Generalized Antenna Modulation (GAM) encoder and an antenna selection encoder. The GAM encoder takes at least one input bit and outputs K output signals over T symbol intervals, where $1 < K$, and the antenna selection encoder takes at least one input bit and selects and holds K out of N antennas for transmission of the K output signals for a period of T symbol transmission intervals, where N denotes the number of transmit antennas at the transmitter and where $1 < K < N$. The antenna selection encoder receives the bits for antenna selection and outputs the K indices of the antennas to be activated and used for the transmission of the output from the GAM encoder.

Each of the K outputs from the GAM is a modulated symbol belonging to a constellation size of $m_k, k = 1, \dots, K$ symbols per output, respectively. Since the number of input bits to the GAM is at least one, a non-trivial constellation is used (i.e. $m_i > 1$) for at least one of the K number of GAM outputs. That is, at least one of the selected antennas transmits a non-trivial modulation symbol. Examples of non-trivial symbol modulation constellation which can be used in the GAM encoder is: OOK, BPSK, M-PSK or M-QAM.

A general idea with the present invention is to use additional dimensions in the encoding of bits to be transmitted by antennas selected by antenna selection bits. The additional dimensions are visible in the output of the GAM encoder which outputs $K > 1$ encoded symbols over $T \geq 1$ symbol intervals.

An embodiment of an ASM transmitter according to the invention is shown in Figure 1. The transmitter comprises a plurality of N transmit antennas for transmitting signals in a wireless communication system. An input signal is received which comprises a plurality of bits for transmission ($a(k)$). The plurality of received bits can be blocks of encoded bits constituting code words for transmission, but can also be a stream of uncoded bits. The received bits are separated in a bit separator into r_e bits (or at least one bit) to be encoded and r_a bits (or at least one bit) for antenna selection. The resulting r_e bits from the bit separator equipment to be encoded are provided to a GAM encoder, where the r_e bits in this case are encoded generating K encoded output symbols over T symbol transmission intervals, i.e. T sets of K encoded symbols are obtained.

The r_a bits for antenna selection are provided to an antenna selection encoder, wherein each of the N transmit antennas has a unique antenna index. The antenna selection encoder selects K antenna indices associated with K transmit antennas to be activated out of the plurality of N transmit antennas. The antenna selection encoder holds the selection of K out of N associated antennas for transmission of the GAM over T symbol transmission intervals; the antenna selection encoder holds the selection synchronized with the ASM output signals over T symbol intervals. An example of an antenna selection encoder for $K = 2$ and $N = 4$ is given in Table 1 where the four antennas are assigned the indices 1, 2, 3 and 4, respectively. For example, for bits 00 corresponding indices are (1,2), for bits 01 corresponding indices (1,3) are, etc.

Antenna selection bits r_a	Indices of selected antennas
00	1,2
01	1,3
10	2,4
11	3,4

Table 1: Example of an antenna selection encoder where two antenna selection bits select $K = 2$ antennas in a system where $N = 4$ antennas are available.

Finally, the T sets of K encoded symbols are transmitted over T symbol intervals, respectively, and each of the K encoded symbols is transmitted on one of the K selected transmit antennas associated with the K antenna indices, respectively.

Another embodiment of a transmission scheme according to the present invention is shown in Figure 2. An ASM-TXD (Antenna Selection Modulation, transmit diversity) scheme is employed in this embodiment, hence the GAM encoder equipment comprises a symbol modulator and a transmit diversity (TXD) encoder in this example embodiment. An orthogonal STC might be used in the transmit diversity encoder, e.g. a two dimensional STC utilizing the space dimension and one additional auxiliary dimension such as time or frequency. A two dimensional design such as the orthogonal STC requires that the channel is invariant over T symbol intervals of the auxiliary dimension in order to keep the orthogonality. Therefore, the selection of K out of N antennas by the antenna selection encoder must hold the antenna selection constant for at least $T > 1$ symbol time intervals or, correspondingly, frequency bins.

An example of an ASM-TXD scheme for the case of $K = 2$ selected antennas, is the Alamouti encoder based Space-Time Block Code (STBC) or a Space Frequency Block Code (SFBC), where $T = 2$ symbol intervals are used in time or frequency dimension. An exemplary embodiment of an ASM-TXD encoder employing an Alamouti encoder is shown in Figure 3. The modulator takes $\log_2 M$ bits as input and produces as configured a modulated symbol taken from a symbol constellation with M different symbols. For instance, for BPSK $M = 2$ and for 16-QAM $M = 16$.

For the example, a block of $2 \log_2 M$ bits is modulated to produce a block of two modulated symbols s_k, s_{k+1} , respectively, each taken from a symbol constellation of M symbols. The two symbols s_k, s_{k+1} are thereafter Alamouti encoded over two antennas and over two symbol output intervals, hence, $K = 2$ and $T = 2$ in this particular example.

One well known implementation of the Alamouti orthogonal block code is given by,

$$\begin{pmatrix} s_k & -s_{k+1}^* \\ s_{k+1} & s_k^* \end{pmatrix} \begin{matrix} \text{Antenna 1} \\ \text{Antenna 2} \end{matrix},$$

Aux dim 1 Aux dim 2

where the rows are transmitted from different antennas and the columns are transmitted through the different auxiliary dimensions (as mentioned above, examples of auxiliary dimensions are time and frequency). The Alamouti encoder produces the output encoded symbols y_k, z_k

5 and y_{k+1}, z_{k+1} , respectively, for antenna 1 and 2 at symbol intervals in the auxiliary dimension k and $k+1$, respectively. These encoded symbols are thus transmitted over $T=2$ symbol intervals from the $K=2$ antennas selected by the antenna selection encoder. For example, assume that

there are $N=4$ antennas available, then there are $\binom{4}{2}=6$ unique combinations of selecting $K=2$

antennas. $\log_2 6 \approx 2.58$. Two antenna selection bits can identify 4 combinations of the four

10 antennas. An example of the antenna selection encoder is given in Table 1. A total of

$2\log_2 M + \left\lceil \log_2 \binom{N}{2} \right\rceil$ input bits are thus represented by the ASM-TXD transmission using $K=2$

antennas over $T=2$ symbol intervals, or effectively $\log_2 M + \frac{1}{2} \left\lceil \log_2 \binom{N}{2} \right\rceil$ bits per channel use

(i.e. per symbol interval). Compared to the SFBC+FSTD scheme according prior art, with

$\log_2 M$ bits per channel use there is a gain in spectral efficiency of $\frac{1}{2} \left\lceil \log_2 \binom{N}{2} \right\rceil$ bits per channel

15 use in this example. Other codes that might be used for transmit diversity encoding are e.g. Linear Dispersion Codes and Space Time Trellis Codes.

In a yet another embodiment of a transmission scheme according to the present invention, an ASM-SMUX scheme is employed, which is shown in Figure 4. In the exemplary embodiment in

20 Figure 4, $K=3$ and $T=1$, and the GAM encoder comprises a bit selector and K symbol

modulators. An input bit stream to the GAM encoder is split into K parallel streams and each stream is modulated with an individual modulation constellation of size $m_k, k=1, \dots, K$ symbols

each. Hence, $T=1$ in this case since there is no encoding over auxiliary dimensions as in the previous ASM-TXD embodiments. The K output symbols are mapped to the K out of N transmit

25 antennas selected by the antenna selection encoder using K antenna indices associated with K transmit antennas. The total number of transmitted bits per channel use is therefore with ASM-

SMUX $\sum_{k=1}^K \log_2 m_k + \left\lfloor \log_2 \binom{N}{K} \right\rfloor$ bits, which is an increased number of transmitted bits compared to GSSK which can transmit $\left\lfloor \log_2 \binom{N}{K} \right\rfloor$ bits per channel use.

In yet another embodiment of the invention, a transmitter comprises a plurality of transmit
 5 antennas, wherein the plurality of transmit antennas are distributed antennas consisting each of a plurality of antenna elements. The antenna elements that transmit the same signal define an antenna port. The plurality of antenna elements of an antenna port may be geographically separated to obtain a wide coverage of a transmitted signal from each antenna port, such as for a 3GPP MBSFN. An example embodiment according to invention with a transmitter as described
 10 above is shown in Figure 5. In the example in Figure 5, a transmitter comprises three geographically separated transmitters, each with antenna elements 1 and 2, respectively, which transmits signals to a receiver. Antenna element 1 in transmitters 1-3 defines antenna port 1, and thus transmits the same signal. Similarly, antenna element 2 in transmitters 1-3 defines antenna port 2, and therefore transmits the same signal, which is different from what is transmitted on
 15 antenna port 1. From the receiver perspective, there are only two transmit antennas or, antenna ports, in this exemplified system since the receiver can not distinguish the signals from the individual antenna elements within each antenna port. Hence, in this example embodiment of the invention a plurality of transmit antennas correspond to a plurality of antenna ports.

20 Figure 6 and 7 shows simulation results for transmission schemes according to the present invention. In Figure 6, SFBC+FSTD, SM and ASM-TXD has been simulated in an OFDM system with $N = 4$ transmit antennas and 2 receive antennas. The fading channel was modelled according to the 3GPP Typical Urban (TU) channel model and a 3GPP Rel.8 Turbo encoder was used for the comparison. The results are given as the block error rate (BLER) as a function of the
 25 transmit signal power to receive noise power ratio (denoted SNR). The modulation scheme was 16-QAM, hence $M = 16$. It means that for SM, where one out of four antennas was selected, two antenna selection bits and four bits for selection of modulation symbols were used. In total, six bits per channel use (i.e. per symbol interval). In comparison, the SFBC+FSTD encode two symbols, each with $M = 16$, i.e. in total eight bits over two symbol intervals with auxiliary
 30 dimension frequency, so effectively four bits per channel use (i.e. per symbol interval). Finally, results for the present invention is shown with ASM-TXD, where two symbols are encoded (eight

bits) over two symbol intervals plus two bits to select $K = 2$ out of the $N = 4$ antennas. Effectively, information corresponding to five bits per channel use (i.e. symbol interval) is provided. The simulations show that the present invention with an ASM-TXD embodiment has the lowest BLER of the three compared schemes.

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In Figure 7 performance gains of ASM-TXD applied to an eight antenna Orthogonal Frequency Division Multiplex (OFDM) system for a MIMO setup in a 3GPP TU channel is shown. A 3GPP Rel.8 Turbo encoder was used for the comparison. The number of transmit antennas was eight and the number of receive antennas two or four. The results are given as the required receiver
 10 Signal to Noise Ratio (SNR) to reach 10 % BLER as a function of the number of transmitted information bits over a fixed resource of 168 OFDM subcarriers for two receive antennas (dashed lines) and four receive antennas (solid lines). Figure 7 shows the results of an ASM-TXD scheme using a 2x2 orthogonal STC (i.e. the Alamouti encoder) with frequency as auxiliary dimension, where ten bits are input to the bit separator, wherein two of the bits are used for antenna selection
 15 encoding and eight of the bits are used for Alamouti encoding two 16QAM symbols, respectively. The two bits for antenna selection are used to select antennas in pairs such as e.g. (1,2), (3,4), (5,6) or (7,8). The results for SFBC+FSTD with 16QAM and for SM, where three bits select one antenna out of eight, and four bits select a 16QAM modulation symbol are also shown in Figure 7, where the solid lines are results using four receive antennas and dashed lines are with two receive
 20 antennas. When the number of information bits in the four receive antenna scenario exceeds 500, which roughly corresponds to $500/168 \cong 3$ information bits per channel use, the ASM-TXD scheme shows the best performance among the compared schemes. The corresponding threshold for two receive antennas is $700/168 \cong 4.2$ information bits per channel use.

25 The method for transmitting signals from a transmitter, which comprises a plurality of transmit antennas and processing circuitry operating according to the method, is suitable for implementing based upon a computer program, having code means, which when run in a computer causes the computer to execute the steps of the method. The computer program is preferably included in a computer readable medium of a computer program product. The computer readable medium may
 30 consist of essentially any memory, such as a ROM (Read-Only Memory), a PROM (Programmable Read-Only Memory), an EPROM (Erasable PROM), a Flash memory, an EEPROM (Electrically Erasable PROM), or a hard disk drive.

Claims

1. Method for a transmitter of a wireless communication system, wherein said transmitter comprises a plurality of N transmit antennas for transmitting signals, said method
5 being characterised by:
- receiving a signal comprising a plurality of bits to be transmitted;
 - separating said plurality of bits for transmission into at least one bit to be encoded and at least one bit for antenna selection;
 - obtaining, from said at least one bit to be encoded, T sets of K encoded symbols, wherein
10 K , N and T are integers, and $1 < K < N$;
 - obtaining, from said at least one bit for antenna selection, K antenna indices associated with K transmit antennas out of said plurality of N transmit antennas; and
 - transmitting said T sets of K encoded symbols over T symbol intervals, respectively, wherein each of said K encoded symbols is transmitted on one of said K transmit antennas
15 associated with said K antenna indices, respectively.
2. Method according to claim 1, wherein said obtaining T sets of K encoded symbols comprises:
- modulating said at least one bit to be encoded into K modulated symbols.
20
3. Method according to claim 2, wherein said obtaining T sets of K encoded symbols comprises:
- transmit diversity encoding said K modulated symbols over said T symbol intervals.
- 25 4. Method according to claim 3, wherein said step of transmit diversity encoding is performed using a code from the group: Space Time Block Code (STBC), Space Frequency Block Code (SFBC), Linear Dispersion Codes and Space Time Trellis Codes.
5. Method according to claim 2, wherein said modulated symbols belongs to a
30 modulation symbol constellation in the group: OOK, BPSK, M-PSK and M-QAM.
6. Method according to claim 1, wherein $T = 1$.
7. Method according to claim 1, wherein $T > 1$.

8. Method according to claim 1, wherein said symbol intervals are in the time domain or in the frequency domain.

9. Method according to claim 1, wherein said plurality of transmit antennas are distributed antennas, and correspond to transmission antenna ports in a Multi-media Broadcast over Single Frequency Network (MBSFN) network.

10. Computer program, characterised in code means, which when run in a computer causes said computer to execute said method according to any of claims 1-9.

11. Computer program product comprising a computer readable medium and a computer program according to claim 10, wherein said computer program is included in the computer readable medium, and consist of one or more from the group: ROM (Read-Only Memory), PROM (Programmable ROM), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically EPROM) and hard disk drive.

12. Transmitter device of a wireless communication system, wherein said transmitter device comprises a plurality of N transmit antennas for transmitting signals, characterised by:

- circuitry for receiving a signal comprising a plurality of bits to be transmitted;
- circuitry for separating said plurality of bits for transmission into at least one bit to be encoded and at least one bit for antenna selection;
- circuitry for obtaining, from said at least one bit to be encoded, T sets of K encoded symbols, wherein K , N and T are integers, and $1 < K < N$;
- circuitry for obtaining, from said at least one bit for antenna selection, K antenna indices associated with K transmit antennas out of said plurality of N transmit antennas; and
- circuitry for transmitting said T sets of K encoded symbols over T symbol intervals, respectively, wherein each of said K encoded symbols is transmitted on one of said K transmit antennas associated with said K antenna indices, respectively.

13. Transmitter device of a wireless communication system according to claim 12, wherein said transmitter device comprises processing circuitry configured for the method in claims 2-9.

14. Communication system for connecting two or more transmit antennas via an antenna selection characterised by the antenna selection comprising processing circuitry for activating an integer number of the two or more antennas for transmission and electrical circuitry for feeding an integer number of sets of modulation signals to the activated integer number of the two or more antennas over a number of symbol bins corresponding to the number of sets of modulation symbols, and each activated antenna receiving dedicated modulation signals.

15. The communication system according to claim 14, wherein the dedicated modulation symbols are encoded over the activated integer number of the two or more antennas.

16. The communication system according to claim 15, wherein the dedicated modulation symbols are encoded over the integer number of symbol bins.

17. The communication system according to claim 16, wherein the symbol bins are time intervals.

18. The communication system according to claim 15, wherein the encoding over the activated integer number of the two or more antennas and the integer number of symbol bins comprises orthogonal or Alamouti encoding.

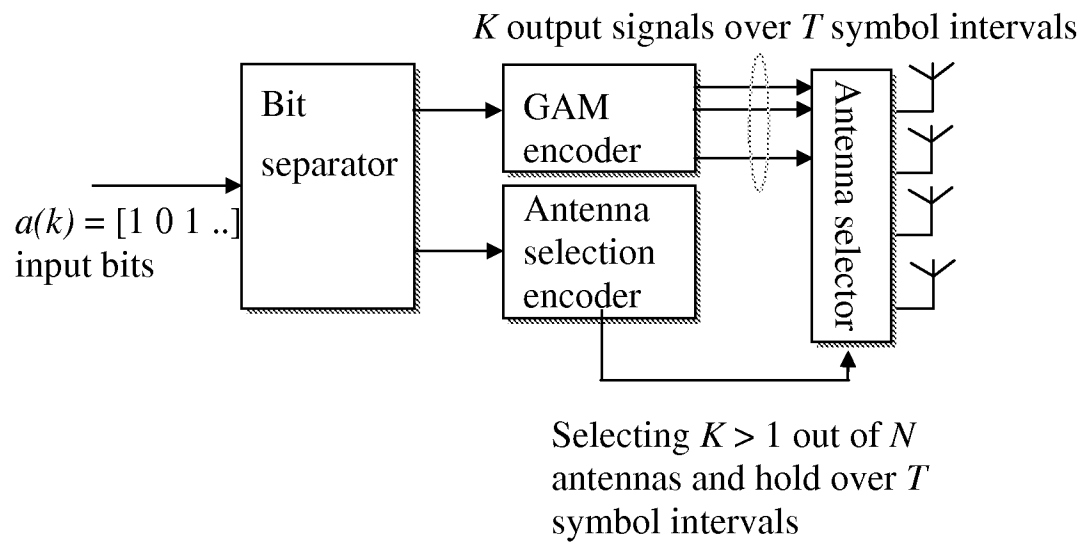


Figure 1

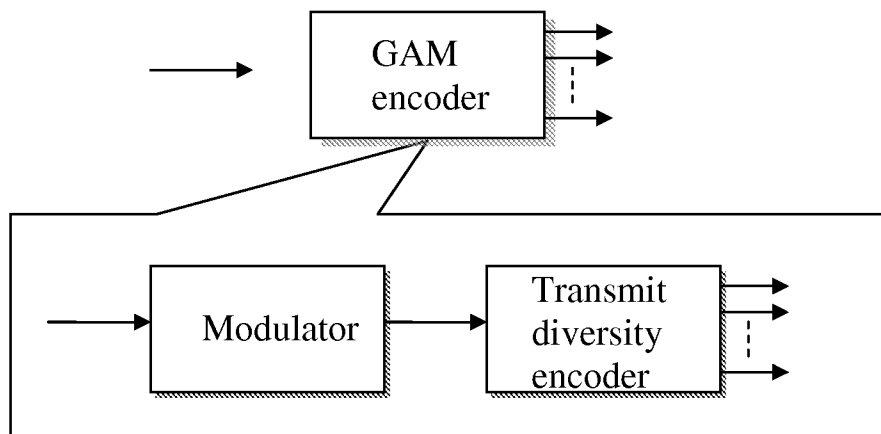


Figure 2

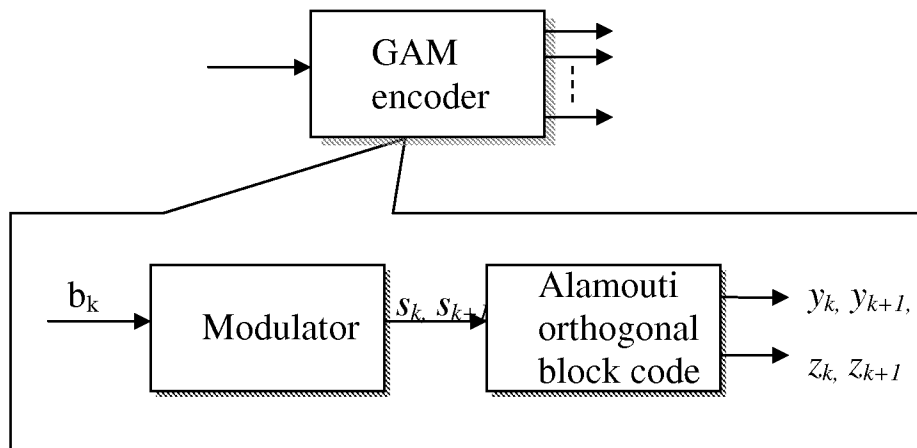


Figure 3

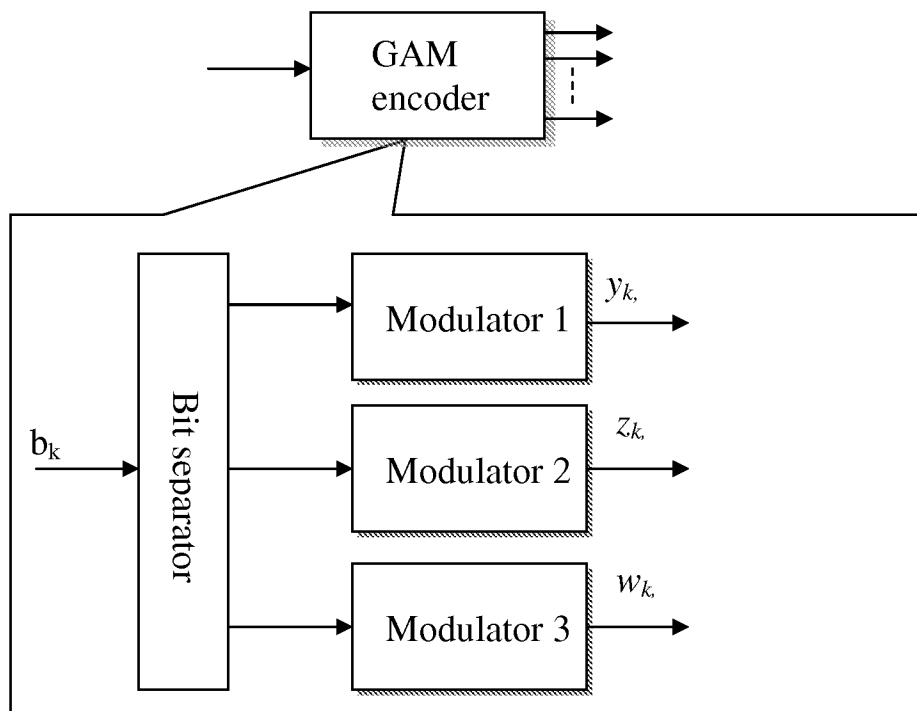


Figure 4

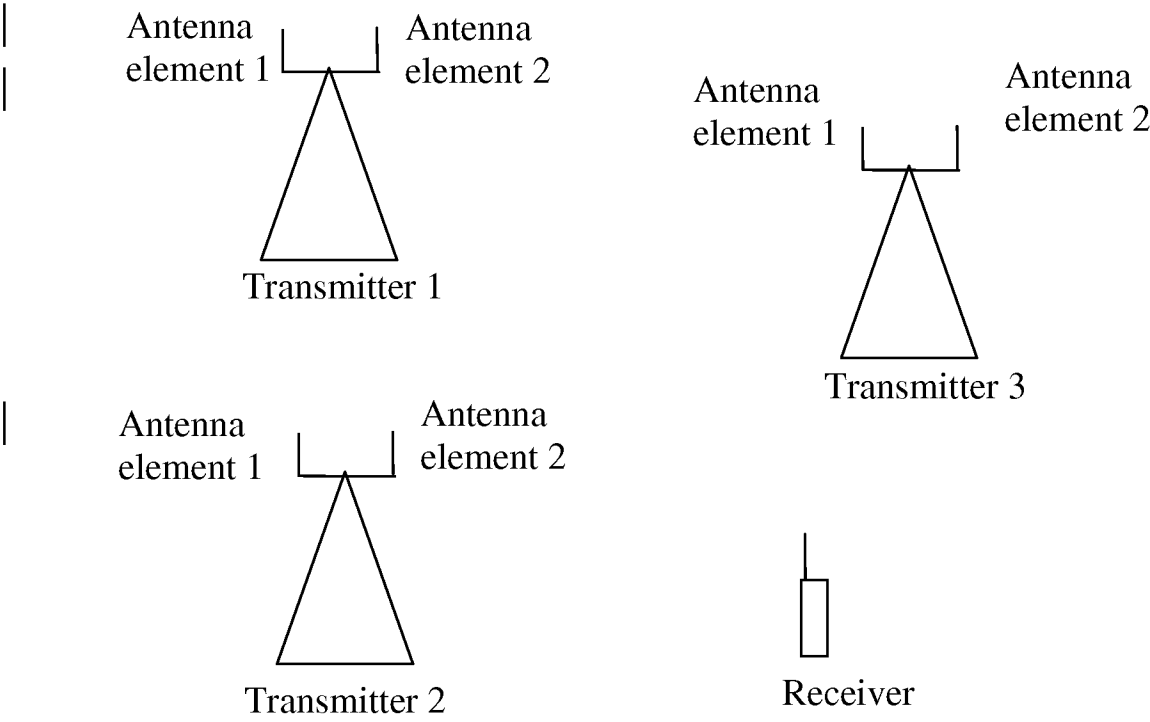


Figure 5

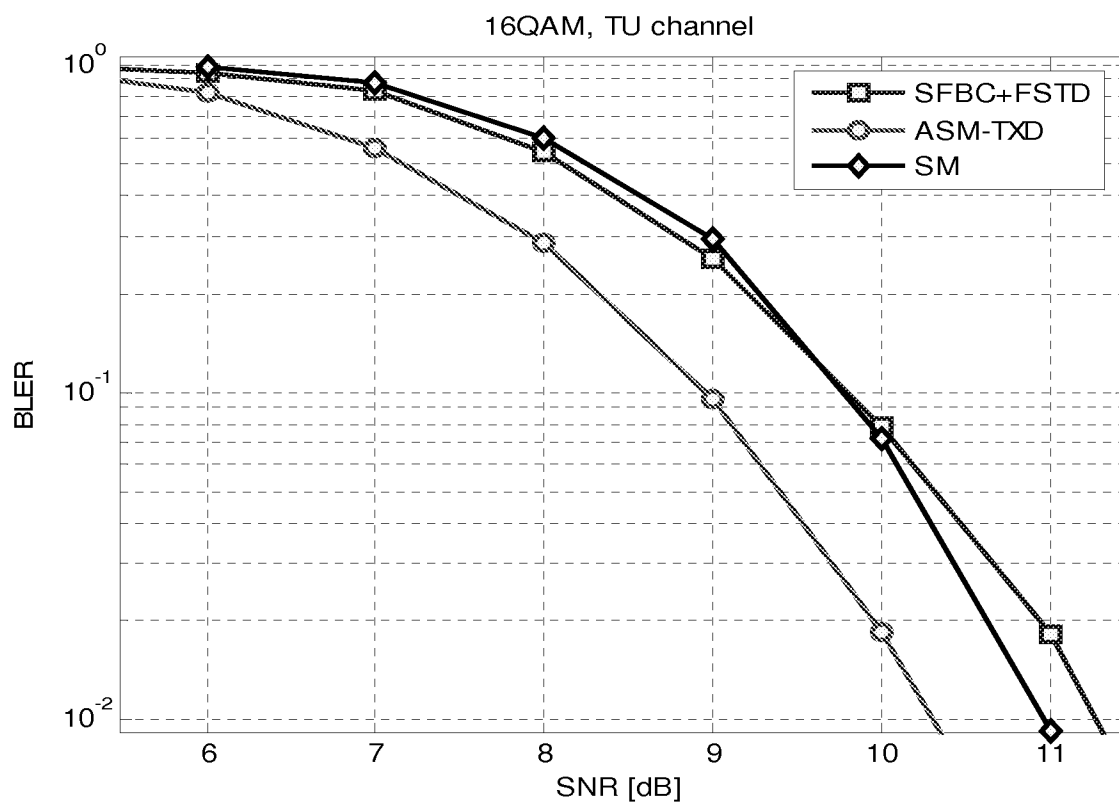


Figure 6

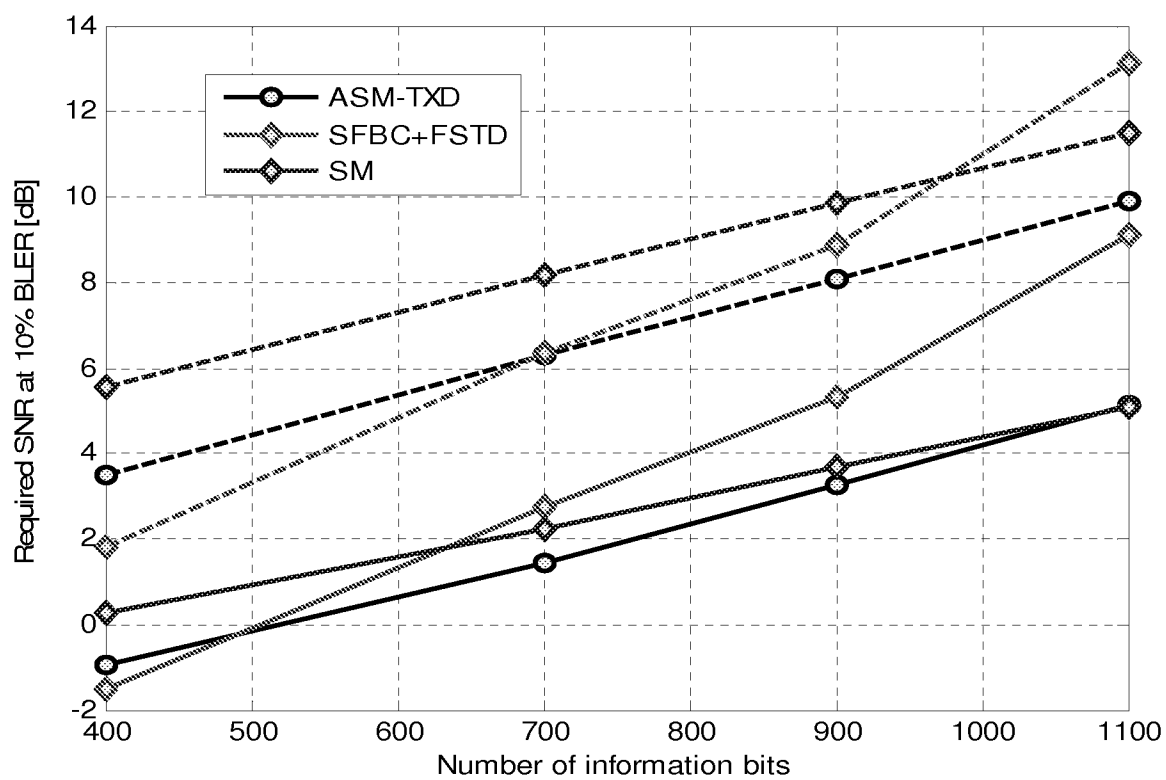


Figure 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/073515

A. CLASSIFICATION OF SUBJECT MATTER

H04B1/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04B1/-, H04Q7/-, H04L1/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CPRS,CNKI,WPI,EPDOC,PAJ: ANTENNA, TRANSMIT+, SEND+, SENT, SEPARAT+, DISPART+, DIVID+, CODE?, ENCODE?, BIT?, SELECT+, MODULAT+, SYMBOL?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1497988A(SAMSUNG ELECTRONICS CO LTD) 19 May 2004(19.05.2004) See the whole document	1-18
A	CN1541465A(TOA CORP) 27 Oct. 2004(27.10.2004) See the whole document	1-18
A	CN101015137A(SAMSUNG ELECTRONICS CO LTD) 08 Aug. 2007(08.08.2007) See the whole document	14-18

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&”document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 02 Sep. 2009(02.09.2009)	Date of mailing of the international search report 17 Sep. 2009 (17.09.2009)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer REN Yang Telephone No. (86-10)62411485

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/073515

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. The independent claims 1, 10, 11, 12 claim a method for a transmitter of a wireless communication system, a computer program, a Computer program product and a corresponding transmitter, respectively;
2. The independent claim 14 claims a communication system for connecting two or more transmit antennas via an antenna selection;
There is one same technical feature, that is the antenna selection, in the independent claims 1, 10, 11, 12 and the independent 14, but the same technical feature is not considered as the same or corresponding special technical feature in the above two inventions, so the above two inventions do not form a single general inventive concept, and they do not meet the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on protest

- ☒ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/073515

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1815941A(MATSUSHITA ELECTRIC IND CO LTD) 09 Aug. 2006(09.08.2006) See the whole document	1-18
A	WO2007081181A2(LG ELECTRONICS INC) 19 Jul. 2007(19.07.2007) See the whole document	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2008/073515

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