

**Title****Direct Currency Conversion****Technical Field**

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This invention concerns direct currency conversion, that is automatic currency conversion at point of payment for card transactions. In particular it concerns a method for operating equipment associated with a financial transaction. In other aspects it concerns the equipment itself, and a method of preparing a tree structure for use by the equipment.

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**Background Art**

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Credit cards, debit cards, charge cards and various other types of cards are used by consumers to make purchases or to obtain cash. These transactions generally take place at a merchant's premises using an electronic Point of Sale (POS) device, and during the transaction the device communicates with other parties to obtain authorization for the transaction, and to initiate the transfer of funds from the customer to the merchant. Similar transactions take place using computer equipment without the intermediary of a merchant.

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With increasing international travel, globalization of business and electronic commerce, cardholders sometimes wish to conduct transactions in a foreign country using their card. In this case the merchant would normally use a particular currency, which, in the case of a retailer, would generally be the local currency. The credit card would also have a currency, which would generally be the local currency of its issuing bank. Conventionally, for transactions where the two currencies are different, the currency of the transaction would be the currency of the merchant, and would appear as such, together with an exchange rate on the credit card statement. Dynamic currency conversion (DCC) allows a transaction of this kind to be conducted in the currency of the card, by detecting the card currency and applying a currency conversion at the time of the transaction, so that the cardholder sees the value of the transaction in the currency of the card, at that time.

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In a simple example of a purchase by a holidaymaker, a POS device would detect the card number and extract the Bank Identification Number (BIN). The machine would

associate the BIN with a currency, take this to be the currency of the card and conduct the sale/purchase in the card currency.

### **Disclosure of the Invention**

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In a first aspect the invention is a method for operating equipment associated with a financial transaction to determine the currencies available to be used for a card transaction using that equipment. The method includes the steps of:

- Presenting a card related to a customer's account.
- 10     Recording a card number from the card.
- Applying all or part of the card number to a tree structure, and automatically processing that number by the tree one bit at a time to arrive at an end-node of the tree coded with information related to the currency of the customer's card account.
- Determining the currency of the customer's card account.
- 15     Comparing the currency of the customer's card account with one or more currencies predetermined for the equipment.

     Where the comparison indicates different currencies, providing direct currency conversion services.

- 20     Traversing through a tree structure is highly efficient, since only data containing information relevant to the current enquiry is read. This is especially beneficial where the mapping is many to one, as it is in mapping BINs to currency codes.

- The equipment may be a Point of Sale (PoS) device, an automated teller machine  
25     (ATM) or equipment associated with telephone or Internet sales. In the case of telephone or Internet sales the card details may be remotely manually entered, rather than read automatically by the equipment from the card .

- The tree structure may be downloaded and stored at the equipment. In this case all the  
30     other steps can be performed at the equipment.

Other determinations may be made from the card number, using the invention. For instance detecting local cards, or trading area cards. This may be of use for instance in controlling qualification for tax free shopping etc.

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The equipment generally comprises a card reader, a computer processor and memory, a printer and a user interface. The tree structure may be stored in the memory in the form of a file. The tree may be a sparse binary tree. The end-nodes of the tree structure may be coded with country codes or currency codes.

- 5 The step of determining the currency may involve merely interpreting the codes at the end-node. Alternatively, this step may involve further processing such as using the end-code to look up a currency code in an ancillary table.

10 The comparing step may default to a predetermined currency in the event that a match is found, for instance the native currency of the country where the equipment is located. Alternatively, and when no match is found, all currencies of the card and device may be displayed for the customer's choice. The relevant exchange rates may also be displayed.

- 15 The processing and currency selection by the customer may precede the printing of a docket for the customer's approval. The docket may include the price in the currency selected and in the native currency of the equipment as well as the exchange rate, and all these numbers may be captured for use in preparing a statement for the customer's account.

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In another aspect the invention is equipment associated with a financial transaction comprising a card reader, computer processor and memory, a printer and a user interface, wherein a tree structure is stored as a file in the memory to process a number read by the card reader one bit at a time to arrive at an end-code of the tree coded with  
25 information related to a currency.

In a further aspect the invention is a method of preparing a tree structure for use in the method and saving it as a file, then downloading the file to the equipment associated with a financial transaction where it is stored for use in the method. The tree structure  
30 may be refined by removing duplicate nodes, mirror nodes and single sided nodes before being downloaded.

### **Brief Description of the Drawings**

- 35 An example of the invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of the functional environment of a Point of Sale device.

Fig. 2 is a binary sparse tree.

## 5 Best Modes of the Invention

Referring first to Fig. 1, a typical card transaction involves a customer presenting their card 1 to a merchant to purchase goods or services. The merchant swipes the card 1 through a card-reader 2 which is part of a POS device 3. The card reader 2 reads the  
10 card number 4 from the card 1, and the device 3 determines the currency of the customer's card account. The device is then able to present the cost to the customer in the currency of their account whether they are at home or abroad.

When the customer is at home, the device realizes that both merchant and customer  
15 prefer to use the same currency, and the transaction is considered not to be eligible for direct currency conversion.

When the customer is abroad the device is also able to provide the rate of exchange being applied, and the cost in the local currency. The customer may choose whether to  
20 accept the price in either currency, and to confirm the exchange rate that will apply to the transaction if they choose the currency of their account. In this way, the customer is able to have full details of the transaction before receiving a statement from the card issuer.

To enable this functionality the device 3 stores a binary sparse tree in a file. A tree is a series of distinct pathways, each made up of a number of links between nodes. Each node would normally have two outward links representing "1" and "0". So a pathway would be a binary number made up of "1"s and "0"s. The pathways are made to  
25 represent BINs in binary form and end in the currency appropriate to that BIN. It then follows that if a BIN is converted to binary form and mapped on to the tree, it will yield  
30 the currency of the card carrying the BIN.

Fig. 2 is a simplified example of such a tree and has been generated to decode the following four bit numbers 0001, 0010, 0011, 1001, 1010, 1011 and 1110.

It can be seen that binary numbers do not appear in the tree. Instead at each node there is a binary decision to be made. An incoming number, say 1010, is processed by the tree one bit at a time. Taking the left hand bit first, that is "1", this bit is used at the first node of the tree 21 to follow the path to node 22. (Had it been "0" it would have followed the path to node 23). At node 22 the next bit "0" is used to follow the tree to node 24. The next bit "1" is used to follow the tree to node 25. The final bit "0" follows the tree to the currency code "GBP" at end-node 25. Note that the tree does not contain any dead end nodes, that is numbers that are not supposed to be there will result in no currency being found.

Such a tree is generated from information provided by the card networks 6 (for instance Visa or MC), information received from issuing banks 7 and any other information useful in relating cards to currencies. Tree generation is a back-office operation that takes place at a dedicated service provider 8.

Once a basic tree has been generated it is processed a number of times to compress it before installing it on POS devices. These compression processes are explained below: First duplicate nodes are removed. If two nodes A and B are the same, then all other nodes pointing to B can be modified to point at A. Then node B can be deleted. Next mirror nodes are removed. All nodes have two pointers or two currency values. If the two values in the node are the same then any node pointing to the mirror can just take the mirror node value instead. Single sided nodes can be stored in half the space. If only one side of a node has a value, such as node 26, then that node can be stored in half the space. The compression process is repeated until no more changes can be effected. Compression is also done as part of the back-office operation.

The tree is prepared for a POS device to use by saving it as a file, and it is downloaded from the specialist service provider 8 to the device 3 over the Internet 9. Of course, the tree may be downloaded using PSTN or any other communications media. Note that the original tree contains memory pointers. If there are 16384 or less nodes the whole tree can be stored in less than 64 kbytes. This is important because then each pointer can be replaced by a 16 bit offset within the file. To ensure that reaching an end-node is correctly identified, all the end-nodes are moved to the start of the file. Then if an offset value is above a certain value it is known not to be an end-node.

To determine the currency of a card a selected part of the card number, for instance the BIN number, is traversed through the tree, taking the correct branch at each node depending on the bit values of the number. As in the example above, if the card number is ten (binary value 1010) the result arrived at is 'GBP'. Currency codes do not necessarily have to be at the end-nodes of the tree. Other information could be presented there, for instance country codes. In this case the result from the tree may require further mapping to establish the appropriate currency code. For example a country code for France could be mapped to the Euro. More complicated situations could also arise, for instance where a British bank issues a card for a US dollar account.

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The financial side of the transaction may be managed by the POS device, or by a server belonging to a bank or card issuer. The POS device or the server may collect particular data related to DCC transactions, and store it in a DCC statistical data packet for transmission to the DCC Operating Company. This company may be a bank or card issuer or another party. The packet may be analysed and a report produced.

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The data allows for the performance to be monitored. In the event of poor performance the DCC Operator can decide to carry out re-training or remove the service. On the other hand good performance can lead to activation of a reward under an incentive program.

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The value fields collected to enable the service performance to be measured include, Total number of sale-type transactions ; Total number of potential DCC sale-type transactions ; Total number of actual DCC sale-type transactions ; Total value of all sale-type transactions ; Total value of potential DCC sale-type transactions ; Total value of actual DCC sale-type transactions ; Total number of refund-type transactions ; Total number of potential DCC refund-type transactions ; Total number of actual DCC refund-type transactions ; Total value of all refund-type transactions ; Total value of potential DCC refund-type transactions ; Total value of actual DCC refund-type transactions. All amounts are in base currency of the PoS device or server.

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After a successful transmission of a stats block to the rates download host all the stats counters and amount totals should be reset to 0.

Pre-auths and supplemental pre-auths should be ignored for stats purposes.

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A tip, if added to the value of an existing transaction, should update the total by just the tip amount, but not increment the transaction count. However if a tip is a completely separate transaction it should be treated as a normal sale. A void transaction should decrement the appropriate totals and decrement the appropriate counts. Potential DCC  
5 qualified transactions refers to transactions that qualify as DCC eligible and may or may not be accepted. Actual DCC qualified transactions refers to transactions that qualify as DCC eligible and were accepted and converted. Terminal non-DCC qualified transactions refer to transactions that did not qualify at all as DCC eligible. i.e. the card prefix was not recognised by the DCC currency recognition module.

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Although the invention has been described with reference to a particular example, it should be appreciated that many variations are possible. For instance, a simple modification of the file size to 256 kbytes using 16 bit indices allows the maximum number of nodes to be increased to 65536. It is also possible to avoid moving the end-  
15 nodes to the start of the file.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly  
20 described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

## Claims

1. A method for operating equipment associated with a financial transaction to  
5 determine the currencies available to be used for a card transaction using that  
equipment; the method includes the steps of:  
    presenting a card related to a customer's account;  
    recording a card number from the card;  
    applying all or part of the card number to a tree structure, and automatically  
10 processing that number by the tree one bit at a time to arrive at an end-node of the tree  
coded with information related to the currency of the customer's card account;  
    determining the currency of the customer's card account;  
    comparing the currency of the customer's card account with one or more  
currencies predetermined for the equipment;  
15 wherein, the comparison indicates different currencies, providing direct  
currency conversion services.
2. A method according to claim 1, wherein the equipment is one of:  
    a Point of Sale (PoS) device,  
20 an automated teller machine (ATM) or  
equipment associated with telephone or Internet sales.
3. A method according to claim 2, wherein, in the case of a PoS device or an  
ATM, the step of recording a card number from the card involves the equipment  
25 automatically reading the number.
4. A method according to claim 2, wherein, in the case of telephone or Internet  
sales, the step of recording a card number from the card involves remotely manually  
entering the number.  
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5. A method according to any preceding claim, wherein the tree structure is  
downloaded and stored at the equipment.
6. A method according to any preceding claim, wherein other determinations are  
35 made from the card number.

7. A method according to claim 6, wherein the other determination is detecting local cards.
8. A method according to claim 6, wherein the other determination is detecting trading area cards.
9. A method according to any preceding claim, wherein the equipment comprises a card reader, a computer processor and memory, a printer and a user interface.
10. A method according to claim 9, comprising the further step of storing the tree structure in the memory in the form of a file.
11. A method according to claim 10, wherein the tree is a sparse binary tree.
12. A method according to claim 10 or 11, wherein the end-nodes of the tree structure are coded with country codes or currency codes.
13. A method according to any preceding claim, wherein the step of determining the currency involves merely interpreting the codes at the end-node.
14. A method according to any one of claims 1 to 12, wherein the step of determining the currency involves using the end-code to look up a currency code in an ancillary table.
15. A method according to any preceding claim, wherein the step of comparing defaults to a predetermined currency in the event that a match is found.
16. A method according to any one of claims 1 to 14, wherein, when no match is found, all currencies of the card and device are displayed.
17. A method according to claim 16, wherein the relevant exchange rates are also displayed.
18. A method according to any preceding claim, further comprising the step of printing a docket.

19. A method according to claim 18, wherein the docket includes the price in the currency selected and in the native currency of the equipment as well as the exchange rate.

5 20. A method according to claim 19, wherein all the numbers displayed are captured for use in preparing a statement for the customer's account.

21. Equipment associated with a financial transaction comprising a card reader, computer processor and memory, a printer and a user interface, wherein a tree structure  
10 is stored as a file in the memory to process a number read by the card reader one bit at a time to arrive at an end-code of the tree coded with information related to a currency.

22. A method of preparing a tree structure for use in the method according to any one of claims 1 to 20, and saving the tree structure as a file, then downloading the file  
15 to the equipment associated with a financial transaction where it is stored for use in the method.

23. A method according to claim 22, wherein the tree structure is refined by removing duplicate nodes, mirror nodes and single sided nodes before being  
20 downloaded.