

**Centralized**

**Decentralized**

**Decentralized ETTM**  
**What does it really mean?**  
**An explanation of the differences.**

tralized accounting and validation, although manual. The patron prepays an amount of tolls and receives back a representation of that payment in the form of tokens (stored-value). Each time a facility is used, the balance of tokens is reduced by the toll amount.

Decentralized Electronic Toll and Traffic Management (ETTM) embodies the concept of stored value in a wireless computer device, called a smart transponder. The five enhancements decentralized ETTM provides as compared to the mass transit or token models are:

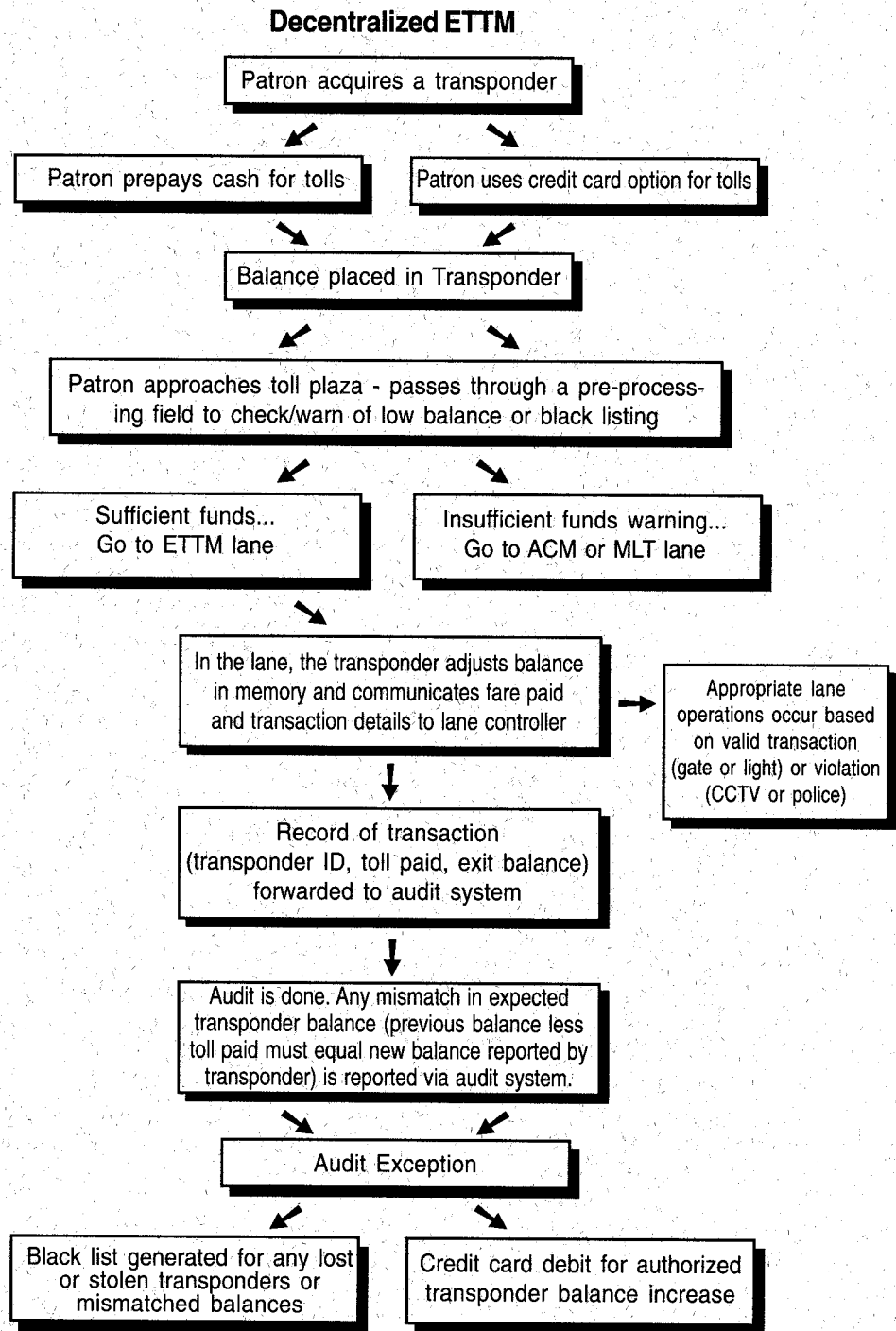
1. The use of two-way radio to communicate the transaction, thus eliminating the slow process of "swiping" a fare card through a reader or stopping to drop tokens in an automatic coin machine.
2. The ability for the patron to check a balance at the push of a button. The balance is displayed on an LCD view screen.
3. Pre-warning of insufficient funds just prior to reaching the toll plaza.
4. The communication of all pertinent data associated with the transaction to an audit system, such that the balance on each device becomes known to the agency at the time of the audit.
5. The ability of a single stored-value device to hold several discrete accounts, thus eliminating the requirement for multiple fare cards, token-types or even a clearinghouse.

It is unclear how or why the U.S. toll industry originally came to believe that effective ETC or ETTM could be accomplished on a centralized validation basis. Virtually all of Europe and certainly the Pacific Rim, as well as some U.S. toll agencies have never viewed the centralized process as long-term viable. This is why most U.S. ETTM manufac-

urers have announced decentralized product development for Europe and the Pacific Rim and recently the United States. With the cost effective availability of sophisticated read-write radio chips, inexpensive processors, memory, displays, and audio

alarms, along with advanced encryption techniques, the cost and complexity of centrally validating fare transactions becomes obviously disadvantageous.

Here's how decentralized ETTM works:



Note in the flow chart that the account is maintained in the respective transponder, but an audit balance is known to the agency whenever that audit occurs. This could be real-time, hourly, daily or weekly; whenever the agency wishes to complete an audit. In the lane, valid and sufficient funds are determined by the transponder rather than by the plaza/host, as with a centralized system. This eliminates all the processing overhead in the lane and plaza - measured in the cost of lane and plaza hardware/software and in time to complete a transaction. The return data from the transponder to the lane includes the electronic serial number of the respective transponder, the fare paid, and the ending balance for accurate and reliable audit down to the individual transponder balance. By decentralizing the transaction validation process in the lane, existing lane controllers and plaza computers can be used without expensive upgrading or replacement. Preexisting systems just act as data carriers with only a new serial port required at the lane controller. And... accurate audit is archived down to the transponder balance more readily and timely than centralized systems update black or white lists.

ETTM audit is accomplished with decentralized processing by comparing the transponder reported balance to the balance the audit database expects after that specific transaction. If a transponder starts with \$20 (the audit system tracks all credits as well) and the first transaction reported back to the audit database is \$.50, the audit expects that the reported exiting balance will be \$19.50. If it isn't, the mismatch is reported as an exception.

Any mismatch of expected balance found in the audit will generate an exception. This indicates one of two occurrences:

1. Data link failure between lane and audit system
2. Credit card increase in transponder balance

If a Data Link between a lane and plaza or between a plaza and audit system goes down, accurate transactions still occur in the lane, and account balances in the respective transponders still debit properly. These communication link failures will be caught in the audit exception report at a subsequent transaction as a transaction balance less than the expected balance, thus indicating a system service requirement. With a centralized system, the account is not debited until a record of the transaction actually reaches the central accounting center. A breakdown in the communication link between lane and plaza or plaza and host means increased risk to revenue and added memory cost at lane or plaza level to buffer transaction records during data link failures.

A Credit Card increase in a transponder balance occurs only when the credit card option has been enabled in a transponder and then only when the transponder balance reaches a low balance threshold such as ten dollars. This automatic increase in

balance will be caught by the audit as a balance exception where the reported balance is greater than the expected balance. All exceptions are checked against the credit card authorization list and, if authorized, the credit card will automatically be charged \$40.00.

In the virtually impossible event that someone illegally increases the balance in a transponder, an exception would be generated by the audit system indicating a reported balance higher than the expected balance and the transponder would be black listed, thus the device disabled at the next transaction and a video image captured.

Transponder balance can be increased by cash in a designated toll lane (like selling tokens) or cash, check, or credit card option can be used at a Business Center kiosk. The credit card option, when set in the transponder, will automatically cause the balance to increase by \$40.00, for instance, in the transponder when the transponder balance reaches ten dollars. The increase of \$40.00 will be identified in the audit database as a mismatched balance and mapped automatically in the audit system to an authorized credit card list. That credit card would be automatically charged \$40.00. This eliminates the need for cash handling and is 100% automated.

***Radio communication without encryption is a terrible risk to revenue. And, simple tags are relatively easily duplicated. The AT/Comm transponder uses masked ROM, processor security keys, and radio encryption. It is virtually impossible to illegally increase a balance in an AT/Comm transponder and literally impossible to get away with it because of secondary audit.***