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Technology Application for Freight Data Collection

by

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ABSTRACT: This paper looks at the application of GPS, GIS, wireless communication networks and Personal Digital Assistant (PDA) technology to freight data collection. The Transport Research Centre (in Melbourne) is undertaking a Freight Activity and Commercial Travel Survey (FACTS) which aims to use this technology to collect metropolitan road based freight data in Melbourne. FACTS is currently at the prototype development stage and consists of a GPS based tool to automatically collect location and route choice information, and an electronic touch screen questionnaire to collect data on vehicle stops, the driver and the vehicle. This paper explains the prototype development.

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1. INTRODUCTION TO FREIGHT ACTIVITY AND COMMERCIAL TRAVEL SURVEY (FACTS)

Following the success of the Victorian Activity & Travel Survey (VATS) of household travel, the Transport Research Centre (TRC) at the Royal Melbourne Institute of Technology (RMIT) has embarked on a Freight Activity and Commercial Travel Survey (FACTS) to provide a much needed database of freight related information for the Melbourne metropolitan area. It is envisaged that FACTS will become a companion survey to VATS (the Victorian Activity and Travel Survey, which surveys person movement), which has been conducted by the TRC since December 1993. (Note that Melbourne is in the State of Victoria, in Australia)

FACTS will provide a dynamic picture of commercial and freight travel activities, which will ultimately benefit the community by allowing more informed discussion of freight transport issues.

The objective is to provide detailed, accurate and current data on freight travel and commercial activities in metropolitan Melbourne.

2. DATA TO BE COLLECTED

FACTS will be an ongoing or continuous survey collecting information on travel, activities, the vehicle and some basic information on the driver. The list of data to be collected is as follows:

Trip and location details:
- origin - destination
- trip distance, trip time, speed
- route
- major delays/congested areas
- location of stops
- time of day
- length of time at destination/origin

Vehicle details:
- vehicle type and size (engine size, GVM, vehicle with trailer dimensions, operator category, year of make, fuel type)
- number of axles
- initial load

Driver details:
- driver age and experience

Stop details:
- method of loading/unloading (eg whether using an on-street loading bay, parking on-street, double parking, parking on premises, or off-street loading bay)
- activities at destination/origin
- land use of destination (retail, office, industry, manufacturing, terminal, etc.)

- type of goods
- quantity of goods delivered (pallets, parcels)

3. HOW WILL THE DATA BE COLLECTED?

Continuous data collection means (in this case) a survey where data is collected every day for as long as the survey is in existence. Because it will be continuous, less vehicles are required to be surveyed each day, although it may take slightly longer to achieve an adequate sample size for some applications of the data. It is expected that 10 vehicles will be surveyed each day, equating to around 3,650 vehicles per year. It may be that each vehicle will be asked to participate in the survey for more than one day, say three days. The sample frame will be chosen from the registration database or equivalent.

3.1 Vehicle location data - GPS

The information on vehicle location will potentially be available in real time; using a Global Positioning System (GPS) receiver, with GPS differential to increase accuracy to ±5m. This (GPS) tracking data is linked to a Geographical Information System (GIS) to allow vehicles to be spatially viewed as they move around the road network.

***Challenges for GPS based network wide travel time information*.**

Challenges arise when you considered providing continuous real time congestion information by aggregating the speed and location data for each vehicle.

For the GPS/GIS system to maintain real time information (or even quasi real time information) on the congestion levels of specific links, the data is required to be updated constantly. For constant updates of say 5 minutes (which is not state of the art real time), a consistent stream of GPS fitted vehicles would be needed; at least at five minute intervals. Unless every vehicle is fitted with a GPS transponder this is not possible, especially when you consider that trucks only spend an average of 2 to 4 hours travelling per day; the remainder of the time is spent stationary[1]. Hence for information on real time travel times, fixed infrastructure such as loop detectors are currently more suitable and cheaper.

While the locational information is useful for data analysts because it provides route choice and origin-destination data, it is anticipated that real time data would also assist fleet managers with fleet efficiency. This could be provided over the internet with provision to ensure only companies own trucks are identifiable.

For modelling purposes GPS provides detailed and accurate origin-destination data, journey time, speed and route choice data.

[1] 1 Taylor SY (1997) *A basis for understanding freight and commercial vehicle travel*. Research Report ARR 300 (ARRB Transport Research, Vermont South, Victoria)

3.2 'Electronic' driver questionnaire - vehicle, driver and stop data

A system using a touch screen in the vehicle will be used to obtain information on the driver, the vehicle and the activities at each stop. A system will be developed which encourages the driver to respond to multiple choice type questions. Many of the problems of the pen and paper self completion questionnaire will be overcome and the need to transcribe the data from questionnaire to electronic form will be eliminated.

4. STATE OF PROGRESS

The TRC has developed a prototype (hardware) system which will collect the above listed data. The system comprises GPS receiver and differential, Apple Newton Message Pad (2000) with touch screen, rechargeable battery and portable case so the system can be easily transported and is protected from damage. The cost of the system is around $4700.

The TRC is in the process of programming the software to run the touch screen questionnaire.

4.1 Challenges and issues

Some of the challenges are:

- The sample frame, if the registration database cannot be used due to privacy legislation. This will probably be addressed using business addresses in the yellow pages and industry listings.
- The correct installation of the equipment in the vehicles.
- Ensuring that the GPS receiver is activated at the beginning of the day (and determining the best way to detect that the vehicle has been stationary all day).
- Ensuring in the pilot that vehicles from a cross-section of sectors are trialed hence checking their ability to participate in the survey.
- Investigate the best way to collect data from firms which make a large number of trips per day (eg couriers). This may be more efficiently obtained from company records.

Challenges in obtaining driver cooperation

Generally truck drivers have a low level of formal education. They are also required to complete paperwork (eg invoices) for the goods they carry as well as some other mandatory company reporting. These factors correspond to driver reluctance to complete questionnaires for which they struggle to see direct benefits. Even when drivers are encouraged (or directed) to complete paperwork they soon become fatigued and impatient with details if the questions are long and or not clearly expressed.

Therefore it is essential to use good design and questionnaire technique which has been thoroughly tested, and also to use simple and clear survey instruments. Thirdly, thorough explanation of the survey purpose and advance publicity will greatly assist in gaining cooperation.

As much as possible FACTS will continue to involve assistance from the Victorian Road Transport Association and the Transport Workers Union (the employers and employees unions in the trucking industry respectively).

5. THE NEXT STEP

The pilot will begin in early 1998. Initially it is envisaged that the project will include rigid and articulated vehicles only. This is purely for reasons of simplicity; the incremental approach is more likely to produce identifiable successes and shortfalls. There may be other, better methods to obtain data on Light Commercial Vehicles (LCVs)?

SUPPLEMENTARY INFORMATION

A1. FACTS DATA USES

Below is a table identifying possible uses of the FACTS data:

Research area	Data	Users
Pavement wear	GVM, load, vehicle characteristics (suspension, engine make, etc), time of day of movement, origin and destination, route	VicRoads, NRTC, DoI, ARRB, Consultants
Environmental impacts: air quality, emissions, etc.	load, fuel type, vehicle size (engine size), origin and destination, time of day of movement, route.	EPA, RACV, DoI, ARRB, Consultants, LG
Economic impacts: value adding, cost to business	load, origin and destination, land use, operator category, route	Business Vic, DoI, BCA, operators, Consultants, Transurban
Planning: urban and transport	origin and destination, route, loading, land use, loading zone and type (eg off street).	DoI, Transurban, VicRoads, Consultants, Operators (strategic planning), LG
Modelling (generic)	origin and destination, land use, route, vehicle size, load, time of day of movement, fuel type, trip table, journey time.	DoI, DJA, ARRB, Transurban, BTCE?

A2. REAL TIME DATA TRANSFER: MOBILE TELEPHONE NETWORK OR THE RADIO FREQUENCY NETWORK?

There are two mediums which can be used to transfer data from a moving source to a static base station. They are the mobile telephone network and the radio frequency network (RFN). The mobile network is regulated by Austel while the RFN is owned by the Australian Communications Authority (ACA). The advantages of the mobile telephone network are that it is easy to gain access (e.g. through Optus or Telstra) and it doesn't require the development of additional infrastructure to use it. Provided you have a mobile phone with a modem you can use the mobile phone network to communicate text data.. A modem can be in the form of a PCMCIA card where the modem is in the card, or a modem can be built in to the phone with serial port connection.

Obtaining use of the radio frequency network entails either using a service provider or going on a waiting list until a spectrum becomes available. For dedicated use of a spectrum if you are developing your own data transfer system, it is best to obtain your own radio spectrum, otherwise you may be limited by the service provider's requirements. Spectrum frequency is obtained from the Australian Communications Authority (ACA) for an annual fee, plus signing up fee and renewal fee. For the first year this would cost about $1000 for very high frequency spectrum (VHF) and $500 pa thereafter. It should be noted that the cost depends upon the frequency of the spectrum specified by your equipment - whether very high frequency, ultra high frequency (UHF), etc.

A3. VEHICLE LOCATION

Global positioning system (GPS) provides data on the position, timing, and therefore speed of a point, object or person fitted with a GPS receiver. The GPS receiver receives data from a subset of the 24 GPS satellites orbiting the earth. Providing there is an unimpeded view from the receiver to the sky the system operates in all weather conditions. The frequency of recording data at the receiver is called the update rate and if required can be set at less than one second.

GPS was developed by the US Department of Defence (DoD) and the satellites are still maintained by this organisation. The accuracy of GPS (without GPS differential) is often quoted as being ±50m and this depends on the number of satellites in view and the type of GPS receiver (Zito 1997, Leick 1995). The more satellites in view, the greater the accuracy although four satellites seems to give adequate accuracy. The largest error source is due to Selective Availability which is a deliberate error introduced by the DoD for civilian users. This error is introduced by a pseudo random code which degrades the signal accuracy, to prevent unauthorised people using the system for military purposes. However, it is intended that this error be phased out by 2007 (Gibbons 1996). It should be noted that even without selective availability, the accuracies will be ±10 to ±20m (Zito 1997).

The accuracy of positioning can be improved to ±5m using a GPS differential device which connects to the GPS receiver. The principle of the differential is that errors at a known point are applied to a roving or stationary GPS receiver. There are two forms of differential correction. They are block shift and pseudo range differential corrections (Zito et al 1997). The *pseudo range differential* correction is the method used to broadcast on Triple J and is intended for use in the FACTS project.

Block shift correction:
- Easiest and simplest.
- Compares the coordinates of a known point with the GPS receiver's point, and calculates the error coordinates delta x, y and z.

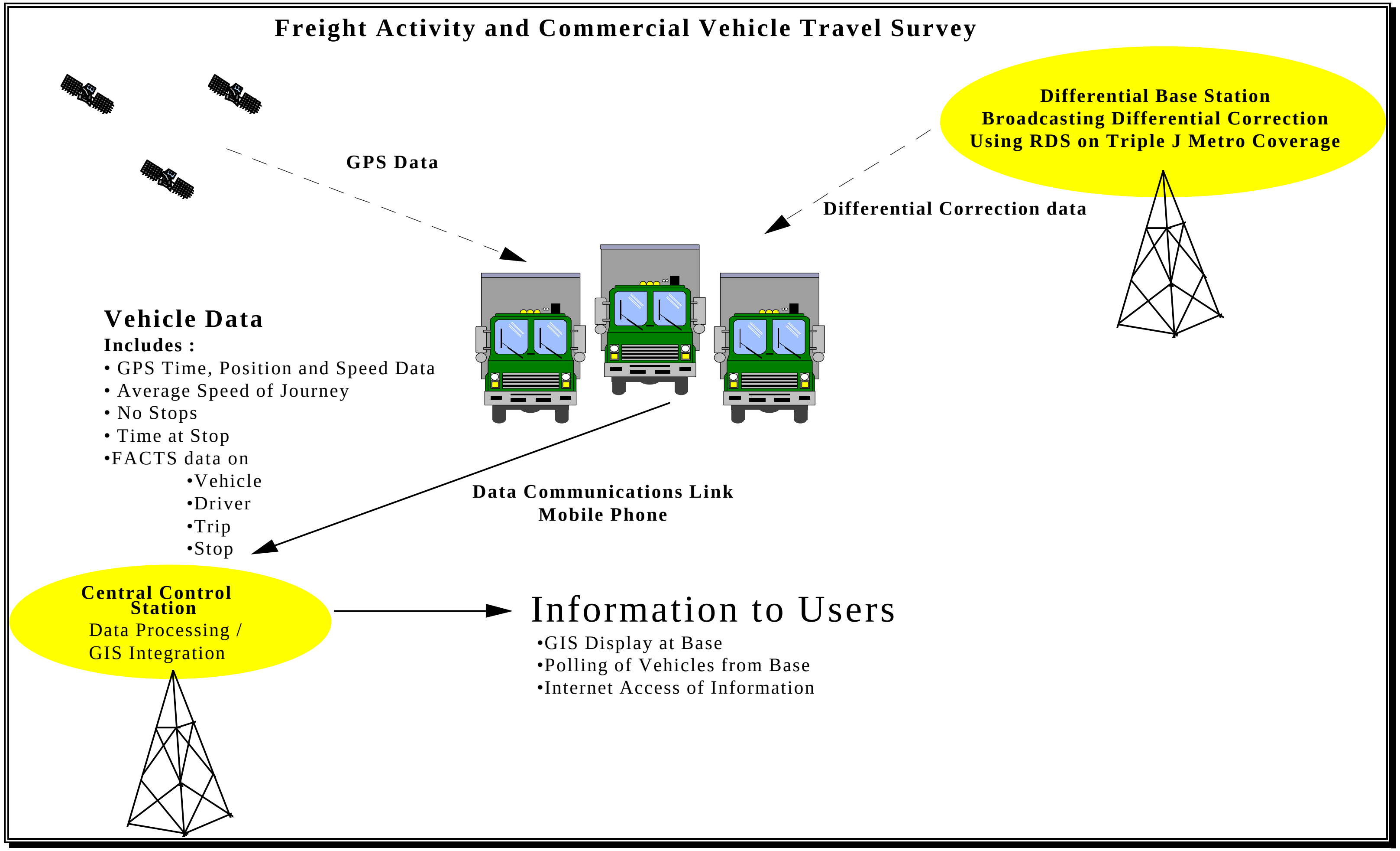
- For the correction to be valid the receiver must have the same constellation of satellites in view as when the error was calculated.
- Limited application.

Pseudo range differential correction:

- Same as the block shift in that it compares the coordinates of a known point with the GPS receiver's point. However, the method involves measuring the range error, where the range is the distance from the GPS satellite to GPS receiver. The difference between the measured range and known range (using the coordinates of the known point) is calculated as the pseudo range error, and is calculated for every satellite in view.
- Larger amounts of data are required to be broadcast from base station to GPS receiver placing a greater strain on the communications system.

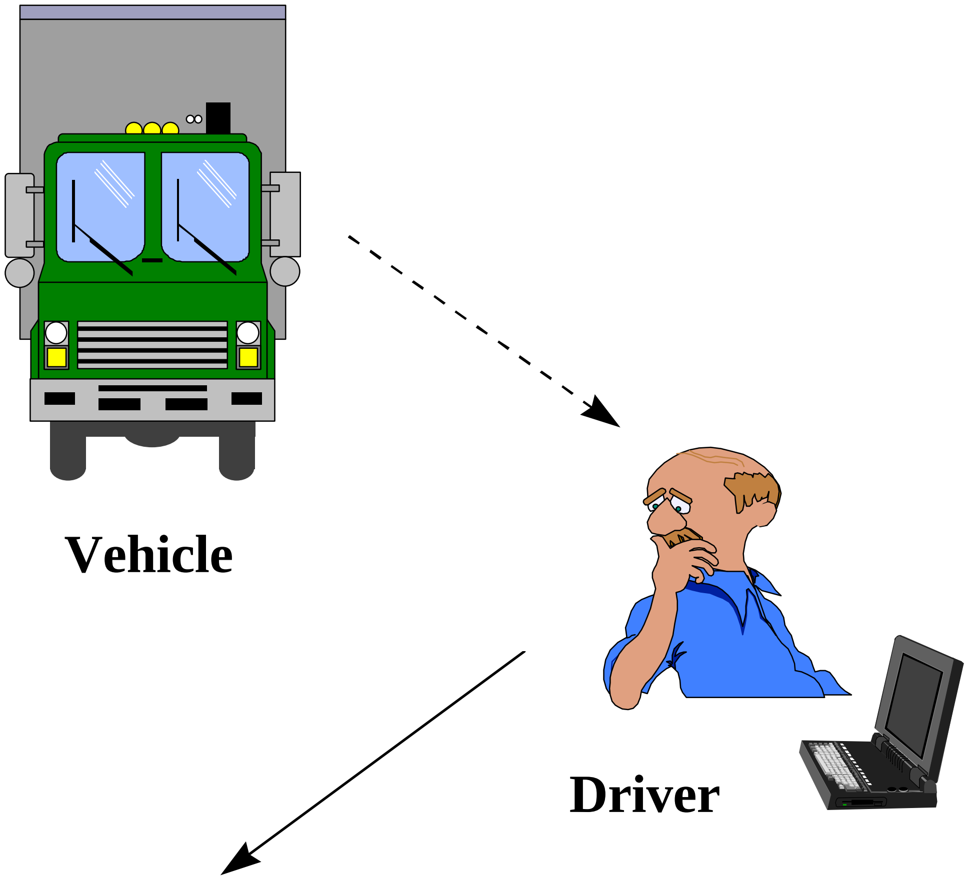
References

Leick A (1995) *GPS Satellite Surveying*. 2nd ed. (Wiley; New York)
Zito R, Taylor MAP and Blanks C (1997) *Differential GPS for efficient vehicle movement*. ITSA97 Conf. Proc. Brisbane (Intelligent Transport Systems Australia; ?)
Gibbons G (1996) A National GPS Policy, *GPS World*, May.



Source: Rocco Zito (1997)

Figure 1: Freight Activity and Commercial Travel Survey Framework



Data input by driver during the day and time-stamped:

Vehicle details:
- vehicle type, size, GVM,
- operator category, suspension type,
- fuel type, year of make

Driver details:
- driver age, experience, licence type

Stop details:
- unloading/loading method,
- activities at destination,
- land use of destination,
- type and quantity of goods

Figure 2: Data input by the driver

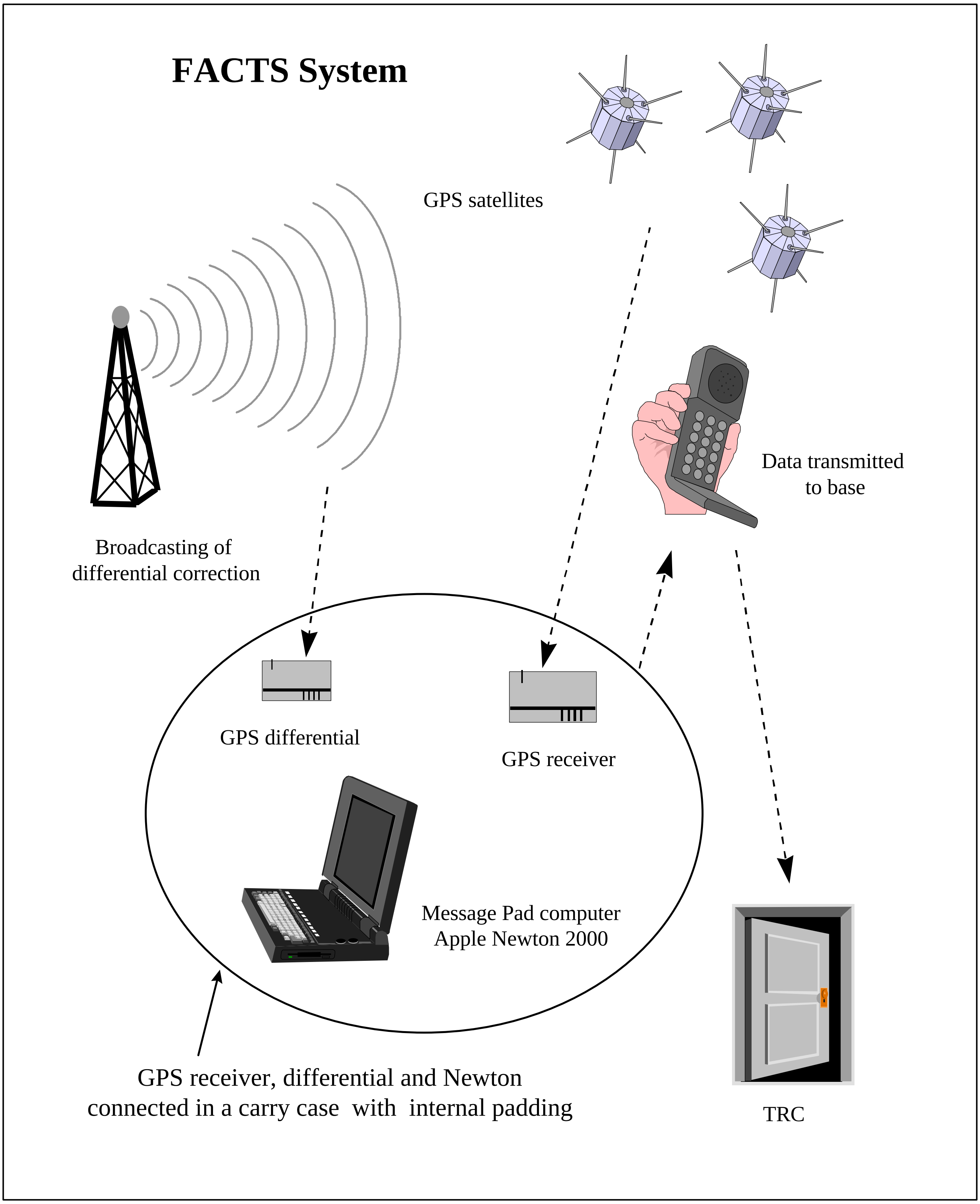


Figure 3: FACTS system