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TaxiCom '95:
International Survey of Leading Innovational Taxi Communications and Operations Approaches

August 1995

FEDERAL TRANSIT ADMINISTRATION

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International Survey of Leading Innovational Taxi Communications and Operations Approaches

Final Report
August 1995

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PREFACE

TaxiCom '95 is an update and extension of *Taxi-Based Paratransit Technology/Operation Packages in Europe,* a technical survey prepared by EcoPlan in 1985 and distributed by the U.S. Department of Transportation/Federal Transit Administration's (FTA) Technical Assistance and Technology Sharing Program. The coverage of **this report is limited to European developments and accomplishments. However, it is intended to serve U.S. transit, paratransit, and taxi operators, planners and policy makers in understanding the state-of-art of taxi paratransit operations abroad.**

The objective of this report is to provide an authoritative overview of the European TaxiCom practices and accomplishments. **The definition of TaxiCom includes a wide range of computer, and communications technologies applied to or applicable not only to the taxi industry, but also to transit and especially paratransit operators. It encompasses computer dispatch, mobile data transmission, fleet management, accounting and management software, PABX telephone systems, "smart" taximeters, cellular/Global System for Mobile (GSM) communications, magnetic card readers, vehicle location systems** and a host of similar related technologies.

Our colleagues in the U.S. have been keenly aware of the need to update the general knowledge about the technological evolution and application of TaxiCom systems. **European taxi operators continue to lead the way in terms of technology, and perhaps even more significantly, in the array and quality of services offered to customers. U.S. communities, transit/paratransit operators, and taxi firms can continue to learn a great deal from the European applications of TaxiCom.**

TaxiCom-95 has been prepared by EcoPlan International of Paris, France, in collaboration with the Leber Group of Bilboa, Spain, and by Gardner Consulting Planners (GCP) of Carson, California, which provided management of the study. EcoPlan International is a well-know international research group that has been actively charting urban transportation technology and institutional developments for many years. EcoPlan was responsible for the preparation of the earlier 1985 study. The Leber Group has specialized in providing technical and engineering counsel to public and private transportation enterprises. Project research was carried out over a six month period in 1994 and 1995 by a team working under the direction of Eric Britton, Managing Director of EcoPlan International, with active collaboration by the Leber Group.

GCP has provided a wide range of technical services to the bus and rail transit/transportation, airport, aerospace technologies, and other ground transportation sectors. Throughout the study, GCP provided the EcoPlan/Leber team with the guidance, contractual support, and perspective that was important to make this study applicable and valuable to U.S. readers and potential technological or operations users. GCP's effort was led by Darcy E. Coles, Vice President and Bedros Enfiedjian, Project Manager. The combination of these teams was designed to bring about a integration of the European and U.S. perspectives.

The scope of this study has been limited to a number of Western European countries, and is not intended to provide detailed conclusions about the overall state of TaxiCom in the U.S. However, one of the suggestions gathered from this study is the confirmation that, **compared to the Western European experience, the U.S. has lagged in the development of TaxiCom. Fewer U.S. communities and transportation operations appear to be evaluating the possibilities for TaxiCom technology application in the same broad, systematic manner that is happening in Europe. This trend is unfortunate, considering the fact that the technology is available, the economics appear favorable, and the market needs clearly exist.**

Of course, differences exist between the European and U.S. contexts. Compared to Europe, and even Canada, needs **the metropolitan centers in the U.S. are much more dispersed, and the use of both transit and taxis is much less. Yet, this very fact would seem to create a greater need for marketing innovation in the U.S. transportation context. Additionally, the type of technologies and applications represented by TaxiCom, would seem to create a logical approach to appeal to the highly individualized of the U.S. transportation consumer.**

An additional incentive to advancing both the state of the art, and the state of TaxiCom application in the U.S. context is **the evolving nature of the U.S. transit industry. Once only a fixed-route operation, U.S. communities have evolved to include a wide range of personalized paratransit services, meeting intermediate needs between transit and taxi. Due to the expansion of shuttle bus and van services serving airports, universities, and business/shopping centers, ridership has increased enormously in the decade** since the initial EcoPlan report was prepared. **The requirements for compliance with the Americans for Disabilities Act (ADA) of 1991, have also greatly increased the need for U.S. communities to serve the specialized needs of the physically challenged customers.**

Many communities have chosen to expand paratransit as the most effective way to serve the needs of the physically challenged community. **Paratransit systems have struggled to incorporate the technologies required to serve this important clientele in a timely fashion. In addition, evolving metropolitan, suburban, and rural communities have developed new types of services to meet the specialized needs of their markets. A number of these services were described at the Forum on Regional Mobility at the 1994 American Public Transit Association (APTA) Annual Conference** by Emile A. Gardner, Partner of GCP. We suspect that many of these types of specialized transit services, as well as taxis, can benefit from the technologies inherent in TaxiCom.

The EcoPlan/Leber/ GCP Team see the **potential for integrating the results and lessons gained from this European study, into the overall Strategic Plan programs and policies of the Federal Transit Administration,** and other divisions within the U.S. Department of Transportation.

Specifically, **the consultant team recommends building upon the base established by this study.** A useful first step might be, to **develop a summary update of some earlier surveys** that have explored the opportunities for TaxiCom implementation over the past decade. This update could beneficially **include the latest information on current TaxiCom deployments,**

and the state-of-the-art of computerized paratransit and taxi dispatching in the U.S. and Canada. It can also **examine rather carefully, the overlaps in such related areas as Dial-a-Ride, Demand Responsive Transit (DRT), vehicle location technologies, and most recently, Intelligent Vehicle Highway Systems (IVHS), now Intelligent Technology Systems (ITS).**

TaxiCom advances may also be useful in other Federal Transit Administration applications, especially those being diligently **pursued in the Advanced Public Transportation Systems (APTS) program.** As part of the APTS, **FTA has undertaken studies on "Smart Commuting", "Smart Cards", "Travlink", "Genesis", Mobility Management, Automatic Vehicle Location and Smart Bus Evaluations** for various states and localities. In addition, **FTA has had a major study underway to develop requirements, and standard support, for advanced passenger transportation systems. While these efforts have not focused specifically on taxi-based technologies, TaxiCom '95 suggests pursuing the integration of TaxiCom technologies and application within the overall APTS framework.**

An evaluation of the feasibility of the potential uses of TaxiCom applications in the U.S. would be an important and crucial first step in identifying the specific potential for TaxiCom implementation of U.S. transit, paratransit, and taxi operators. A comprehensive study approach will require that the information and insight be interpreted and packaged in a manner that will be directly useful to this U.S. industry. This should also be useful to communities, which are on the lookout for innovations to increase mobility, and to eliminate transportation barriers that presently confront many of our communities and their residents. It is here that the challenge will be the greatest to overcome.

Peter Johnston of the European Commission, presented the challenges that need to be addressed by public policy makers on his continent, by these words:

> *"European cities and regions are the motors of economic and social change. They face challenges in congestion, mobility, environmental quality and employment renewal. The cities and the regions must take the initiative, within the context of national and European policies. The pioneers in the rethinking of mobility, work and city planning will set the agenda for those that follow."*

Gordon Linton, Federal Transit Administrator, in describing the U.S. challenge, articulated a similar sentiment:

> *"Over the next twenty years, we must improve public transportation, if we are to meet the travel needs of all Americans, particularly those residing and working in congested areas. Research on travel needs shows that we cannot meet these needs solely by building roads. In congested travel corridors, we must make transit a more effective alternative to driving a car. This means increased capital investment."*

From these two perspectives, it seems evident that transportation challenges, on both sides of the Atlantic, do in fact share common threads. If the concepts described in

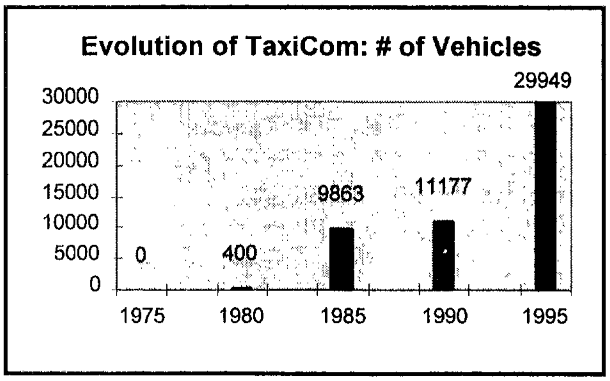
TaxiCom '95, are put to work in the U.S. environment, we would be a step closer in providing technology solutions for the mobility challenges that face us in the 21st century.

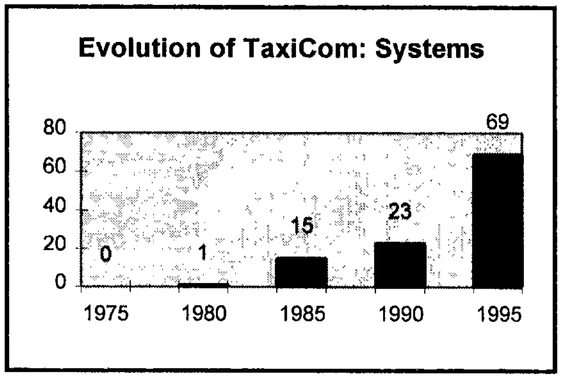
EXECUTIVE SUMMARY

This report maps the development of TaxiCom systems in Europe since their first appearance in 1978, and assesses applications and implications for operators, communities and transportation planners at local, regional and national levels. It has been prepared specially to inform communities, operators, suppliers, policy makers and other interested parties of the situation of this new industry, its state-of-the-art applications and its potential.

TaxiCom is a term coined by EcoPlan in 1985 to cover a wide and increasing range of computer, commuter and communication technologies, applied or applicable to the taxi industry. In a stricter, technical sense, **it encompasses computer dispatch, mobile data transmission, fleet management, accounting and management software, PABX telephone systems, "smart" taximeters, cellular/GSM communications, magnetic card readers, vehicle location systems** and a host of similar related technologies. **If the full potential of these technologies is harnessed,** TaxiCom, in its broader sense, **can be a vital means of reshaping the way in which taxis operate,** and the way in which taxis are viewed by both the community and public sector.

The origins of what can now be considered an industry dates to the mid-1970s in both North America and Europe. As the following two charts clearly indicate that, **after a rather slow start, development of TaxiCom type systems in Europe has been quite rapid since 1985, and has almost mirrored the speed of development of the two industries on which it depends most.**





As computer and communications capabilities have developed, the initial capital investments necessary to develop and operate a TaxiCom system, **have been reduced significantly, in parallel with an increase in performance, modularity and reliability.** As a result, **there has been a significant surge of both operators and suppliers in the last decade. However, this surge is relatively still in its infancy stage of development. As the charts suggests, the bulk of the potential market still lies ahead in the future.**

Since its origins in the late 1970s, qualitative changes have accompanied quantitative developments within the TaxiCom industry. **Once conceived as integral units, modern TaxiCom systems are increasingly marketed in modular form. Systems are now tailored to specific needs and budgets, resulting in smaller and more specialized suppliers, which are able to enter the market, and operators obtain better and more flexible products for far less cost.**

With the advent of PCs replacing mainframes, coupled with the current advances in communications, **TaxiCom related components can now be "broken down" into separate modules, allowing multiple configurations of hardware and software, thus making it increasingly accessible to smaller operators.** This has also affected the relative importance of software and hardware in performance and budgetary considerations. **Software is progressively taking the lead, as the cost-to-performance ratio of hardware improves over time.**

Structural changes with the industry have been substantial, especially since the mid-1980s. In the last decade, **mergers, acquisitions, bankruptcies and voluntary exit from the market, have largely transformed the supplier side of the industry.** Several of the larger original suppliers, have grown to become international "telecom" giants. However, **initially these major suppliers apparently did not regard the taxi industry as a market, with enough potential to merit specific resource allocation.** As a result, **product lines were not suited for the specifics of the taxi industry, and/or did not evolve in step with the aforementioned technological progress. The smaller original suppliers included operators which successfully had developed their own systems, and later attempted to market the acquired knowledge in the domain.** Most of these attempts were unsuccessful however, essentially due to errors in not only strategy, but also admittedly, due to a lack of sufficient economies of scale. They also had a somewhat naive view of the difficulties of international marketing in such a demanding environment.

Operators using TaxiCom were considered "pioneers" in their communities. Situated at the beginning of the sector's learning curve, not only did **operators not know exactly what they wanted from such a system, but even if they did, suppliers could only offer largely pre-packaged systems that were not well integrated. Although not perfectly adapted to their specific needs, the systems were sufficient enough to improve service and the market share.** It also covered the initial outlays of capital, thus somewhat making it justifiable. **This study could not identify any operator who has abandoned, or subsequently downgraded the TaxiCom component of their operation, once it was installed.**

More than a decade later, operators now know what to expect from those systems, and suppliers can provide it to them. In fact, most post-1985 systems have been developed through joint operator-supplier specifications. For the first time, local markets are now seeing competition among "on-line" operators. Paris can serve as an extreme example, for as late as 1992, not one operator was using TaxiCom. By mid 1995, there was at least three major operators, with an estimated 7,000 taxis, hooked up to competing TaxiCom systems. This situation is by no means unique to Paris. A similar phenomena can be seen increasingly in larger communities with multiple operators, **as TaxiCom "pioneers" make large gains in market share, competitors that are left behind scramble to go on-line as well.**

Throughout Europe, the implementation of these technologies has definitely accelerated. In the Scandinavian countries where European TaxiCom initially developed, **most large operators have already installed modern systems, and/or are looking to upgrade. Meanwhile, smaller operators are purchasing, or looking to purchase, modern multi-company TaxiCom systems (in which more than one operator can independently and discreetly function on a single TaxiCom network).** In the United Kingdom **the number of on-line vehicles has increased rapidly, mainly because competition has accelerated the rate in which operators are leaving manual dispatching, and are opting for computerized dispatch systems.** In countries such as France, Germany and Italy, which did not have operating TaxiCom systems running prior to 1990, new systems are being implemented at a rapid pace[1], as shown in **Table 1** .

Table 1: 1995 European Deployments of TaxiCom Systems by Country
[1990 figures are shown in ( ) for comparison]

Country	# of systems		# of vehicles		% Change (vehicles)
Austria	8	(1)	3,326	(130)	2,458.5
Denmark	2	(0)	460	(0)	--
Finland	1	(0)	350	(0)	--
France	5	(0)	4,870		--
Germany	7	(0)	4,355		--
Italy	21	(0)	3,421		--
Netherlands	1	(1)	580	(580)	0
Norway	7	(6)	2,613	(2,330)	12.15
Sweden	6	(6)	2,914	(2,914)	0
Switzerland	5	(1)	1,790	(400)	347.5
United Kingdom	6	(1)	5,270	(1,630)	223.31
Total	**69**	**(16)**	**29,949**	**(7,974)**	**275.58%**

The cost involved in acquiring a TaxiCom system, has also evolved considerably in the last ten years. These costs are somewhat difficult to estimate, since each operator has different needs concerning not only performance, but also computer and communications hardware and software. Fleet size has a direct influence on the cost of their internal allocation. For fleets of 500 taxis and up, costs tend to be more or less equally spread out. Fixed costs (i.e. the expenditures necessary to equip the control room and establish the communications hardware base), make up a large percentage of the capital outlay for small operators. A rough estimate of the investment necessary to

[1] France, Germany and Italy combined now represent in excess of 42% of on-line vehicles.

fully equip an operator with a fleet of 500 taxis, is approximately $300,000-$400,000 for the control room and communications base, and an additional $3,000-$4,000 per taxi in mobile equipment. Fixed costs can fluctuate dramatically in either direction, and depend on additional factors such as detailed system specifications, service area in km^2 (which implies additional base stations), fleet size, services offered and hardware already in use. Thus, the cost can be disproportionate for similar sized fleets. It should also be kept in mind, that operators can now share a TaxiCom system (multi-company options and including the control room and communication base), which can significantly reduce costs, and is an especially viable alternative for small operators operating in adjacent communities.

The following table illustrates the range of actual costs, where available, encountered by operators of different modern TaxiCom systems:

Table 2: Cooperating Operators

#	Operator	# of taxis	Supplier	System	Date Installed	Total Costs	1995 US Dollars
1	Taxi Bleus (Paris)	2000	Indelco/ Pragmatic	"Basic" w/GPS	Sep, 95	FF. 30M	157,200k
2	Computer Cab Co. (London)	2500	Computer Cab Co.	Self-developed	1989	N/A	
3	Glasgow T.O.A.R.S. Ltd.	480	GMSI	MDCS	Jul, 93	£500k	800k
4	Hansa Funk Taxi (Hamburg)	600	Indelco AG	"Simple"	1990-1991	DM 2.6M	3,900k
5	Linkoping Taxi Econ Union	89	Volvo/Ericsson	Taxi-80	1984	SKr 4M	30,600k
6	Taxi Asker og Baerum (Hovik)	300	Volvo/Ericsson	Taxi-80	1984	NKr 1.3M - 1984 NKr 4.5M - 1994	208k 720k
7	Taxi Gothenburg	615	Volvo/Ericsson	Taxi-80	1982	N/A	
8	Taxi G7 (Paris)	2000	Motorola	MDI	May, 92	FF. 50M	262,000k
9	Taxisentralen Drammen	94	Volvo/Ericsson	Taxi-80	1986	NKr 8M	1,280k
10	Taxi Zentrale Stuttgart	700	Innova/Unitax	Self-configured	1989	DM 250k - 1989 DM 80k - 1992 DM 80k - 1994	375k 120k 120k

The reduced costs and increased benefits of TaxiCom, coupled with the success of on-line taxi operators, has transformed initial aversion to this new technology, to a whole-hearted embrace from an industry which traditionally resisted change. More and more operators are coming on-line, and those operators already using TaxiCom, are upgrading and expanding their systems. **These technologies allow a modern system to be put in place, using existing hardware and software, thus allowing operators to further reduce costs and increase the life of past investments.**

Technology currently allows a modern system to be put in place, using much of existing hardware and software - thus allowing operators to reduce costs and increase the life of past investments. The gains in productivity and market share, the simplification of record-keeping and report generation, reduced stress and absenteeism, and the overall improvement in service, all have apparently been convincing to management, passengers, dispatchers, drivers and communities alike about the virtues of TaxiCom. The departure from traditional taxi management and operations seems irreversible, once operators engage themselves with a TaxiCom type of operations. As the movement accelerates and we approach the year 2000, it seems evident that TaxiCom is progressively becoming the norm, rather than the exception.

CHAPTER 1 - BACKGROUND AND INTRODUCTION

1.1 Scope and Objectives

In the early 1980s, EcoPlan began work on what eventually became a series of more than twenty major surveys and reports on issues of innovative transportation technologies, institutional developments, and more generally on the changing role of transportation in our society[2]. Among these was the report *Taxi-Based Paratransit Technology/Operations Packages in Europe* which was published in May 1985 under the aegis of the United States Department of Transportation's Technology Sharing Program. This report detailed the state-of-the-art of "TaxiCom", a word coined by EcoPlan at the time to blanket a certain range of innovative paratransit technology and operations packages for taxi operators which were just then beginning to come on line.

The geographic scope of this survey has been limited to Western Europe for several reasons, and above all, because it is in Europe that this new industry has taken hold the quickest. While there have been some developments and deployments along these lines in the United States and Canada, there can be no doubt that it is Europe that is the real hot bed of these developments.

The present report offers an update and extension of that original survey. In it we have attempted to document the present state-of-the-art of these systems and technologies, chart the evolution of what can now legitimately be referred to as the *TaxiCom Industry*, and detail the results and experiences of European operators, suppliers and communities who have been and are involved in the TaxiCom "experience".

At the time of the original report we conjectured that with the advent of these new technologies we would see an evolution of the role that taxis played in their respective communities. While this evolution has been slow, we have in fact witnessed increased synergy between taxis and public transportation, the business community and social services. This is due in large part to these technological innovations and the institutional reshuffling that they are inevitably associated with. In Scandinavia, where TaxiCom is an operator requirement for participation in social services, those operators who are on-line are able to take advantage of a demand that can constitute up to fifty percent (50%) of their business. In England operators who are on-line have been able to snatch over seventy percent (70%) of demand for the mobility handicapped (through the Taxicard scheme). In Paris, TaxiCom has brought forth a slew of new services to the private sector and has redefined the way in which taxis are viewed and used.

[2] This report can be usefully read against the background provided by the small number of reports that appear in the closing bibliography, which will help to set these basically technological issues in the broader context of institutions, practices and public policy.

The benefits of TaxiCom are varied and may or may not be obvious to our readers. TaxiCom is a computerized (or computer assisted) dispatching and a lot more. A quote from our 1985 report may shed some light on this:

> *The benefits of this technology are not restricted to dispatching, where the efficiency gains have been shown to be considerable. The central computer can also be employed to calculate demand, and both, to plan fleet requirements and allocate taxis within the city accordingly. This further increases TaxiCom's ability to provide superior service, since the vehicles can be positioned closer to the areas where they will be most needed. At the same time it ensures appropriately heavy usage of all those vehicles that have been slated for service within the period.*
>
> *Furthermore, there are a wide range of fleet management tasks that can be performed, with heretofore unachievable levels of detail and efficiency, as a result of applying the new computer resources to such tasks as planning, standing account management, route planning for package delivery and ridesharing. Of course there are other ways of using computers in taxi management to achieve these objectives, but the beauty of TaxiCom is that it provides a means for linking virtually all aspects of management to daily operational procedures, so that reporting can be greatly simplified and more accurate.*
>
> *It is our finding that the benefits of computerized fleet management...may just turn out to be the most important of the longer term advantages of such systems. To this end, the report recommends that when considering communities and companies, give close attention to this part of the TaxiCom equation when they are deciding about and planning their new system.*
>
> *A second message which we feel is worth stressing is that the places most likely to turn to TaxiCom (and to benefit most from it) are just those communities and taxi operations that have already taken some steps in this direction. Thus, TaxiCom gives them, as much as anything else, not a magic wand to transform their otherwise failing or moribund operations, but rather a structured program along which to channel yet further operational, technological and management improvements.*
>
> *Among the most enticing aspects of TaxiCom is the potential for yet further innovation and improvement which provide a way to "loop" daily operational results back into the management information system of the taxi company, in a way in which is at once easy to do, low in cost and highly effective. Because of this structure, the system and service can continuously be refined and improved on a continuing basis without needing major new investments and disruption, and which can be effected with little adjustment to the existing technology.*

Ten years later these observations still ring true. While TaxiCom has made considerable strides in regards to technology, the underlying rationale as to who should be using TaxiCom and why it has not changed much since its inception. Operators and communities should keep this in mind as they read the pages that follow.

1.2 The Broader Project and Policy Background

The main lead in investigating these systems in Europe has been taken by EcoPlan, under the general guidance of Gardner Consulting Planners, in association with the Leber Group, under not one but two on-going programs which would be useful to mention briefly by way of background to the detailed information that follows.

The first of these is the series *New Transportation and Technology*, which was first initiated in 1969 and which to date has seen preparation of more than forty major reports surveying new technology developments in the fields of transportation and related communications technology. These reports have looked into leading edge developments in terms of new transportation systems, motors, fuels, communications and locations systems and vehicle designs. The point is that the present survey of innovative dispatching and control technologies for taxis is clearly in the same broad range of these studies.

However, this is not the view the most current studies and professional concerns leading up to the present project. A thoroughly 'social technology' such as TaxiCom cannot, of course, be understood in a vacuum, and therefore needs to be looked at and understood in its broader human and institutional context. With this in view, we carried out this survey also as an extension of a second, on-going program entitled *ACCESS.*

EcoPlan established ACCESS in 1988 as an independent international collaborative and support program, aimed directly at the challenge of first defining and then implementing sustainable transportation systems. The program is built on more than two decades of cross-disciplinary research and advisory work with the problems of transportation, the economy, energy, environment, industry and quality of life, and more generally with the broader challenges of managing technology in society.

The following ten points highlight the main concerns of this program, and provide the broader context within which we will examine the very specific technologies and operational approaches surveyed in this report.

1. Transportation Systems of Cities Are In Trouble

In most places around the world, our transportation systems are no longer working effectively. This is causing major problems of environmental degradation, lost time in traffic, declining life quality, and unaffordably high levels of public investment. It is also imposing greater costs on local businesses and the community as a whole. This already bad situation is made worse by the fact that the traditional methods of dealing with the problems (such as infrastructure construction and other forms of traffic *facilitation*) are no longer able to cope with them.

2. Priority On Protecting The City

The city is the cradle of our civilisation, among our most precious historical, architectural, economic and cultural heritages. The goal of public policy in all areas, therefore, must be to enhance and protect our cities and those who live there -- so that they can continue in the 21st century to play the same dynamic and civilising role for our society that they have in the past.

3. Transportation Is But One Building Block Of A Healthy City

The transportation sector must be approached as a means, not an end or objective, of public policy. All decisions concerning transportation matters must be taken in the context of the overall requirements of the city, the region and the people who live and work there. Transportation is but one part of the whole urban/regional *system*.

4. Systemic Complexity

The common point that unites most cities is that their transportation problems have in most places reached such a degree of seriousness and complexity that it is no longer possible to "fix" the system by introducing individual or piecemeal measures. Despite what many people claim, there are no simple answers. Transportation matters in cities evolve out of situations where one thing touches and influences another, and then yet another in turn. Thus, a coherent, broad-based, multi-level program and systems approach becomes crucial. This would mean a major departure with past policies and practices.

5. Limits Of Understanding

Since virtually everyone who walks or drives considers himself an expert on these matters, there will never be any shortage of opinions and advice. Most of this counsel, however, suffers from at least two fundamental drawbacks. First, few people actually have sufficient knowledge concerning how these problems are being handled at the leading edge in other places. Second, such recommendations usually reflect specific "point" concerns and solutions, which do not take into account the complex systemic nature of the issues.

6. Deep Knowledge Of The Community

Those responsible for policy decisions must be willing to go back and develop a profound understanding of the key economic, social and ethical issues which lie at the base of a transportation system and the community. This requires not only knowledge, but also great patience and imagination. Any plan that rushes to specific technical recommendations without first considering these basic issues and their complex relationships is unlikely to attain its full potential.

7. Daily Life Focus

The only valid focus for transportation policy formulation in a democratic society is the citizen in his or her daily life. This is a distinction that has not always been respected in the past. Policy should not address itself to the requirements of car traffic, the infrastructure, or the glorious things you can accomplish with technology, instead it must be oriented to serve the ordinary requirements of a wide range of people as they go about the business of their daily lives.

8. Opportunity

Our towns and cities now have a unique opportunity to shape their transportation systems for the 21st century. This opportunity will not be repeated. The cost of continuing with the old transportation philosophy and arrangements will be very high. To profit from this opportunity, those responsible must look carefully and with imagination at the actual circumstances that prevail locally and address them with good knowledge of how similar problems are being approached in other leading cities.

9. A Very Different Future

Because of the structural changes that are rapidly transforming all of society, there can be no doubt that our towns and cities will be very different places in the 21st century from what they are today. Life styles, economic arrangements, land use, technology, work concepts, environmental pressures, time organization, communications, education, leisure patterns, etc., will all be vastly different from those we know today -- with far-reaching implications for the transportation system.

10. Beyond Transportation

The quality of the decisions made in the transportation sector and the processes behind them tell us much about how a city is doing in other areas as well. The problems transportation poses are far from the most difficult our cities face; most can be relatively easily solved, once the necessary degree of understanding and political support are there. The same cannot be said of these more threatening and intractable challenges as drugs, youth alienation, violence, endemic unemployment, and others. But, precisely because it is relatively straight-forward, the transportation sector can lead the way toward new and more effective public policy approaches which reach more deeply into the fabric of society, identify the problems in their true dimensions and, then, lay the groundwork for genuinely collaborative solutions that have a chance of success.

The seventh and final chapter of this report looks at the various technologies and systems approaches, and attempts to comment on their prospects from this broader perspective.

1.3 Methodology

In order to update and extend the findings of our 1985 report we re-contacted, where possible, all previously-featured operators, suppliers and interested groups as well as operators from all major European countries, North American and European suppliers and relevant groups from around the world.

To collect the information featured in this report we relied on on-site visits, interviews, telephone contacts, direct mailings, fax and telephone surveys, public and private database searches, sales and marketing materials and other publicly available information. Obviously not all information collected has been included in this report[3]. However, we have attempted to include enough information so that readers, no matter what their previous level of familiarity with these technologies, will understand TaxiCom, its implications, and what is needed to be done to get a system up and running with a minimum of difficulty and potentially expensive errors.

The information accumulation process was naturally influenced by the European TaxiCom "deployment". This process thus largely targeted the more substantial markets such as the Northern European, in general, and Scandinavian markets in particular. However we have also made a considerable attempt to include as many regions and countries as possible from varying socio-economic and geographic backgrounds so as to provide a broader picture of the diffusion of these technologies in Europe.

A three-stage information gathering process was implemented with cooperating operators. In the first stage, operators in those countries using, implementing or purchasing a TaxiCom system, were sent a *TaxiCom Profile Questionnaire* (**Appendix A**) and asked to return the filled-in form sheet and their remarks. The second stage included the preparation of a profile draft for each operator. The third stage included a series of telephone interviews and fax exchanges, the result of which was the final operator profile. Wherever possible site visits were included in stage three. Of the completed profiles, only those which presented a special diversity, i.e. operators of all sizes, with different systems, from different geographic or demographic areas, were included.

Suppliers are more numerous and heterogeneous in nature today than in 1985. We have contacted, where possible, the suppliers presented in our 1985 report, and all those who seem to be playing a role (or could potentially) in the European TaxiCom market. An attempt has been made to capture the full range of supplier types, including small to large sized, established and new, turnkey and segmentalized, hardware and software. All suppliers were asked to furnish sales, marketing and training materials and other relevant available information. Personal interviews were conducted extensively which identified interesting information. Much of this information, as can be assumed, was supplied off the record, and therefore cannot be reproduced in this study. Meetings with vendor representatives were also carried out whenever possible.

The information gathering process concerning vendors was in many cases more difficult than one would imagine. This illuminates the rapidly changing structure of the supply side of the TaxiCom market during the last decade and the ensuing lack of cohesion among some larger suppliers. Profiles were compiled for all suppliers who supplied sufficient information (and even for those that did not) but who were deemed too important or potentially important to omit.

The information gathered from other interested groups (city planners, various ministries, community leaders, public transportation representatives, journalists et al.) appears in various

[3] Among these: commercial confidentiality of information shared with us by suppliers, detailed marketing information which does not belong in this report, considerable masses of technical information which can be obtained from these sources in due course, and, finally, much institutional detail which is site specific and not necessary to the full understanding of these materials.

places in this report. These groups have a lot more to add to the TaxiCom equation than perhaps might generally be imagined. It is assumed that they will play an increasing role in the evolution of the industry, and the relationship TaxiCom will have with the communities in which it serves.

For several reasons, operators and suppliers are not always disposed to disclosing price/cost information. When available this information has been included, which is obviously sensitive to exchange rates, system specifics and other factors. Thus, prices and costs mentioned in this report may not be representative and should be considered as indicative. That said, the reader will find that the orders of magnitude are realistic, giving enough information for at least a preliminary decision to look into these systems more closely or not. From that point on, you will have to depend on your own knowledge of the business and ability to sort out fact from fiction.

1.5 Presentation of Report

This report contains seven main chapters and several appendices and is introduced by a brief Executive Summary[4].

The report is laid out in such a way as to help the reader quickly gain good working knowledge of TaxiCom in general and the specifics of European TaxiCom in particular.

The materials are presented in such a manner so that those looking to gain only an elementary understanding of the subject do not need to read the entire document. Chapter 2, "TaxiCom". Essentially will give the reader a basic 'nuts and bolts' understanding as to the "what, why, who and how" of TaxiCom. For some this information may suffice; however those looking to gain understanding of TaxiCom and its role within Europe will want to continue reading the full report.

Chapter 3, "European TaxiCom in 1995", provides a general overview of the status of TaxiCom in Europe and some of its particularities, culminating in a case study of San Sebastian, Spain.

Chapter 4, "Operator Experience: 1980-1995", is comprised of ten operator profiles interspersed with two "stories" and a section entitled "Results". The operators profiled, are of various sizes, configurations and systems. The "stories" section will give the reader a better understanding of the different factors involved in TaxiCom, such as the planning and implementation process, the history and development - from the operator's point of view. "Finding and Conclusions of Main Actors" section presents the feedback of management, drivers, dispatchers and passengers relative to their experience with TaxiCom.

4 We have included in these pages only those portions of the previous study necessary to ensure that the present report can be fully understood autonomously, in the knowledge that a number of our readers will be unfamiliar with the 1985 report. For those interested in obtaining the complete 1985 report please contact EcoPlan, 10 rue Joseph Bara, F-75006 Paris, France (fax: 331.4326.0746) or the Office of Mr. Norman Paulhus, Office of the Secretary, US Department of Transportation, Nassif Building, 407th Street SW, Washington, D.C. 20590.

In Chapter 5, "The Changing Supply Scene" the supply side of the TaxiCom equation is elaborated. Thirteen profiles are presented, each constructed with a different emphasis (some are general, others technical). The idea is to present a road-map of the various facets of TaxiCom and allow the reader to attain the degree of 'technicality' desired. For example the SMS supplier profile is rather technical in nature and details hardware, whereas the Ericsson supplier profile details software and programming.

Chapter 6, "Planning and Implementing TaxiCom", is intended as a guideline to help facilitate what can be a long and difficult process towards implementation.

Chapter 7, "The Taxi Sector in a Time of Change -- New Roles for the Public Sector", represents an attempt on the part of the authors to provide arguments in favor of a more active policy on the part of public sector institutions. Local, state and national governments can play a role in improving the performance of this sector in many ways, but this will require new approaches and attitudes on the part of both the public and private sector participants.

Appendices appearing in the back of the report include a **Appendix A - the TaxiCom Operator Profile Form**, **Appendix B - a brief bibliography**, and **Appendix C - a glossary of key terms**.

CHAPTER 2 - TaxiCom Essentials

2.1 What is TaxiCom?

The term TaxiCom was coined by EcoPlan in 1985 to encapsulate taxi management and technology packages, and the corresponding communications and commuter elements. In a rather strict sense, TaxiCom can be understood as computer dispatching technologies coupled with advanced communications technologies (i.e. data, digital, PABX, etc.).

All TaxiCom systems have a common structure composed of essential building blocks. These are:

1) A computer (older systems use a mainframe or host computer while modern systems tend to use parallel processors and Personal Computers (PCs)) and computer terminals. Most systems use a DOS/UNIX environment.

2) Software - for computer (or computer-assisted) dispatch, statistics and database management, report generation and accounting. Some software is sold in modular form and others are integral.

3) Communications hardware which may include any and all of an array of modems, base stations (emitters), multiplexers, PABX phone systems, control units, antennae, mobile data terminals, et al.

4) An increasing array of options including vehicle location systems such as Global Positioning Stations (GPS), credit/smart card readers, automatic "call boxes", "dispatcherless dispatch", multi-company options and more.

However to consider only the "technical" aspects of TaxiCom means overlooking the broader implications. TaxiCom is more than just a modern technology package, and to view it as such is to ignore its true potential. When viewed in its wider context, TaxiCom is an ensemble of technologies which:

- significantly changes the way in which taxi operators do business;
- modifies and improves the community's perception of taxis;
- helps transform the public sector's perception of taxis and their potential role in the community;

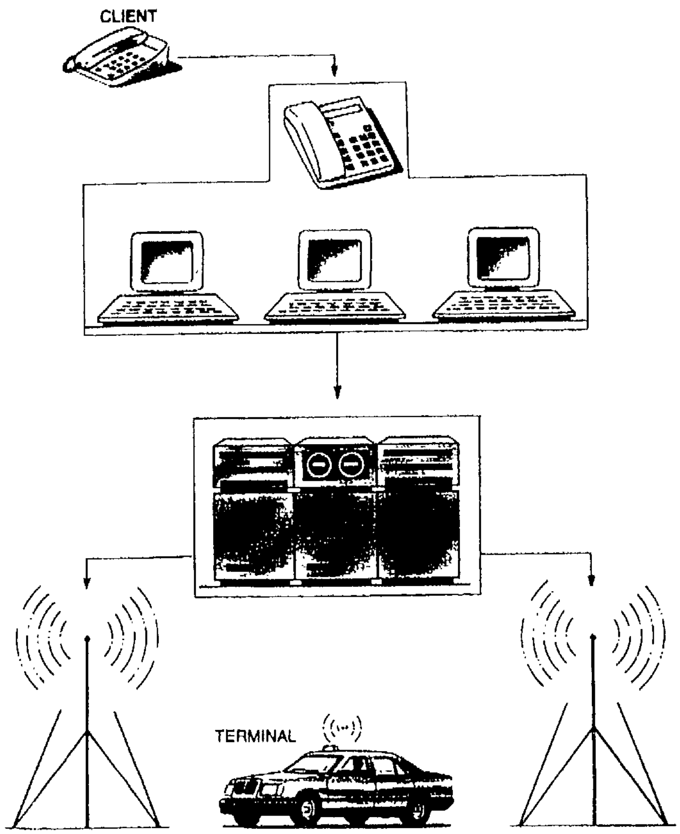
- extends the shape and scope of the taxi market;

- can change the way in which visitors view a given community;

With TaxiCom, taxi operations can become more profitable and better perceived. Customers find that the quality of services improves dramatically and conversely public transportation is able to use taxis as a viable support to its service. Finally, city planners can integrate the until-now ignored taxi equation into transportation problems/solutions. Viewed as such TaxiCom and its corresponding technological elements are a means to an auspicious end - that is, they fundamentally change the conception of taxis in the community.

2.2 How TaxiCom Works

TaxiCom systems have a commonality in that they are all designed to help people get taxis when they want them and with less effort, to help drivers find their customers quickly and easily, thus an increase in their earnings, and improve dispatcher productivity. They share many common attributes and modus operandi because all rely on such common elements as computer-aided dispatching and data communications.



D2-1

A 7-step process can be found in a similar configuration among most TaxiCom systems. While the process is not exactly the same among all systems, they are similar enough that the reader will have a general idea of how TaxiCom works.

- **Step 1:** Customer Calls Central Dispatch To Request Taxi Service

  A fully-featured system can handle three kinds of service requests: a) immediate pick-up requests; b) reservation service (delayed pick-up); and c) standing orders. The basic workings of these three types of service begin in the same manner. The customer telephones a Central dispatch and, in response to the dispatcher's prompts, gives the name, address and any other information specific to the order. Thus, for instance a customer desiring a station wagon, a driver that speaks a certain language, or a handicapped adapted vehicle, will make these known at this time as well.

  If the call is for immediate pick-up, the customer is informed within a few seconds (as little as 15) as to exactly how long the expected wait is, and often the color and/or make of the taxi.

  Some systems offer additional services such as personal client numbers to yet shorten the order-taking process.

- **Step 2:** Operator Enters Order Into Computer.

  This process is done directly with the help of the computer, which prompts the call-taker for information and assists the dispatching process concomitantly. It should be noted that this process can be successfully completed by a call taker after just a few hours of training, and does not necessitate the level of knowledge and experience associated with a traditional system. (See illustration D2-2, shown on the next page)

Illustration - D2-2

- **Step 2a:** Computer verifies address and searches for free vehicle in the customer's zone;

  Most TaxiCom systems have a database of all street, names and addresses in the operator's service area. These can be prompted with the first letters of the street thus reducing errors and misunderstandings between customer, call-taker and driver. The service area is usually divided into zones, and the system will first attempt to allocate a vehicle already in the customer's zone.

- **Step 2b:** Computer scans available taxis and chooses most suitable according to proximity and parameters defined by the customer. (See Illustration D2-3, shown on next page)

Illustration D2-3

- **Step 3:** Computer transmits order to selected vehicle via base (relay) stations located strategically to permit coverage of entire service area.

  All information can be transmitted through data communication with the corresponding modems, multiplexers, base stations and mobile data terminals (MDTs) without the use of voice or traditional radio transmission. (See Illustration D2-4, below) Voice is however retained as a backup to data transmissions.

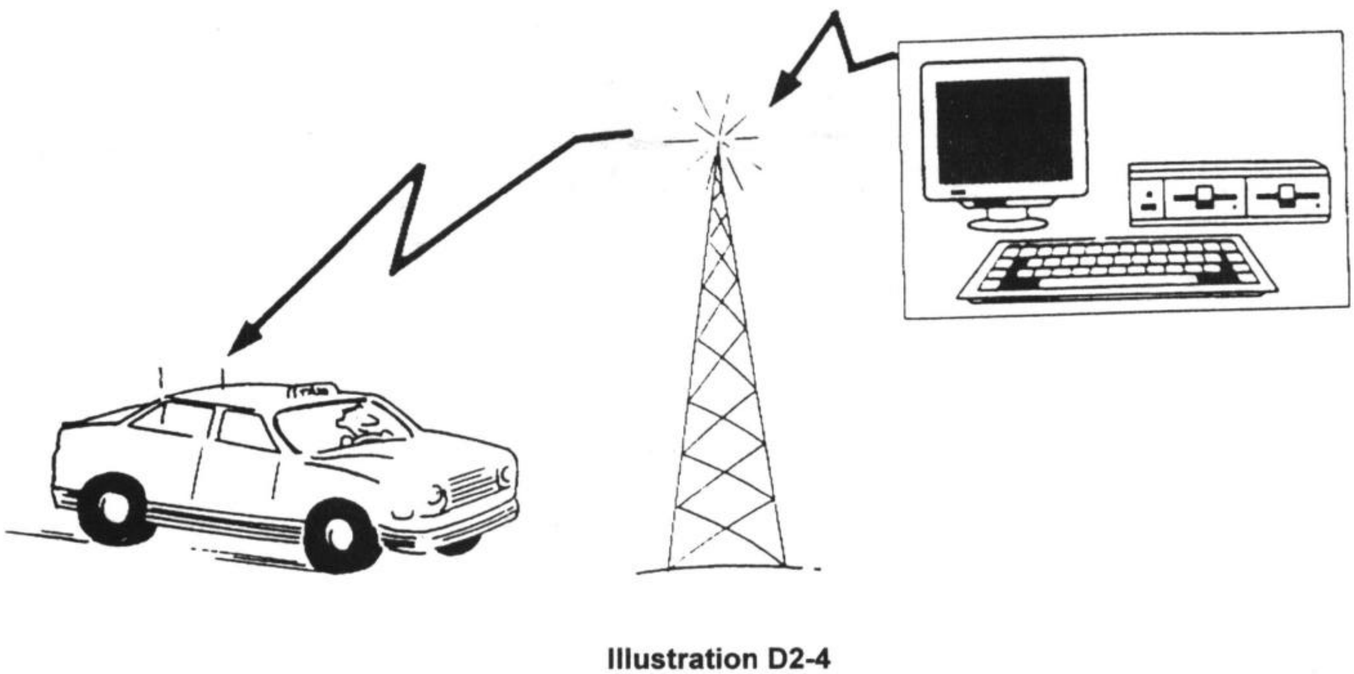


Illustration D2-4

- Step 4: Driver receives trip information and accepts/refuses order.

  The driver receives the necessary information on his MDT (no voice transmission necessary) and informs the Central if the trip is accepted or refused with the touch of one button. In this manner all information is clear to driver and dispatcher, since the noise and stress involved in traditional dispatching is eliminated.

- **Step 4a:**: the driver accepts the trip and proceeds to the pick-up point.

  The computer is informed of the driver's decision and the driver's status is changed to "not available". (See Illustration D2-5, below)

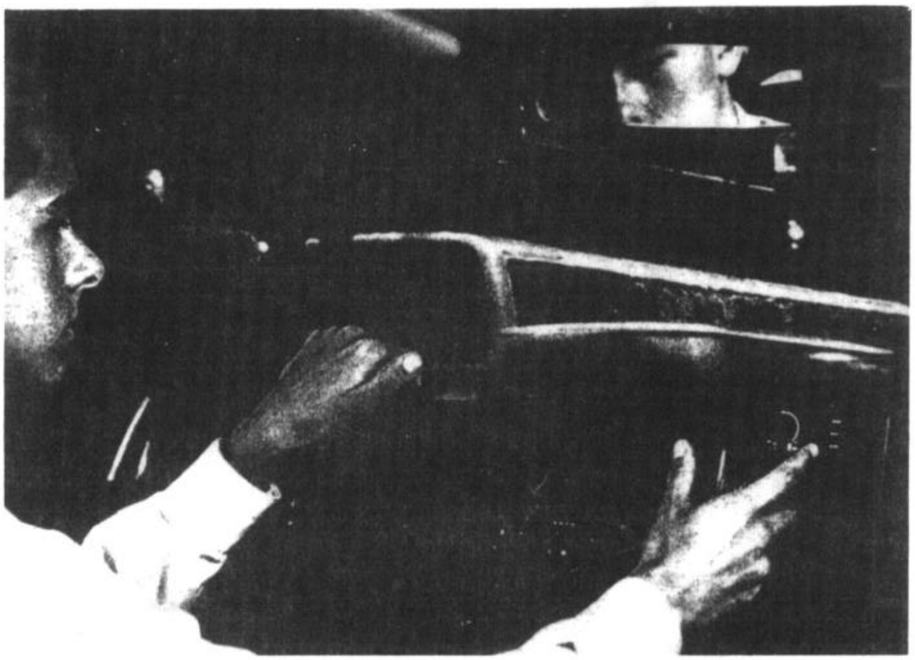


Illustration D2-5

- **Step 4b:** Driver refuses trip.

  The computer automatically contacts the next taxi that meets the customer's requirements, which the refusing driver keeps his queue number.

- **Step 5:** Dispatcher informs customer of order status (accepted or not) and expected time of pick-up.

  With TaxiCom, steps 1-5 can take from as little as 15 seconds to complete (one minute being the average) and with very little chance for error. The pick-up time is extremely accurate and often customers, unfamiliar with the performance of the system, discover that their driver has been waiting for them for some time. In order to reduce driver waiting times, some TaxiCom systems have included Automatic Call-out modules that automatically call clients to inform them of the taxi's arrival.

- **Step 6:** Driver picks up customer.

  Upon pick-up, the driver enters his location and the zone code of his destination into the MDT. (See Illustration D2-6, below) Some of the more advanced systems may indicate a suggested itinerary (with or without a corresponding graphics display).

Illustration D2-6

- **Step 7:** Driver reaches destination and informs Central of "free" or "soon free" status.

  Some TaxiCom systems have a "soon free" status and others have only a "free" status (to avoid driver abuse). Drivers indicate the zone in which they are located, or to which they are heading, and receive a queue number specific to the zone in question.

This is a simple illustration of the "TaxiCom process", but one which should give the reader a elementary understanding of how these systems generally work. It should be kept in mind however, that many systems also include automatic "call boxes" in which a taxi can be ordered - e.g. at airports and hotels with the touch of a single button, and with various additional services, options and capabilities.

2.3 Why TaxiCom?

The answers to this question depends, on who is asking - be it an operator, driver, passenger, dispatcher, local planning board, community leader, Ministry of Transportation or local banker. Answers to many of these questions can be found in Section 3.2 of this report which discusses the results of TaxiCom for the different groups involved. Other reasons which may be a little less obvious, will necessitate some thought and depend on a slew of parameters often particular to a given situation.

An attempt however will be made here to answer the question on a more general level. The survey suggests that simply put, TaxiCom makes sense for all concerned - operators, communities and city planners. This is especially the case if the operator and community concerned are suitable and ready to do their part.

Whatever the degree of sophistication, all TaxiCom systems have in common an effective use of computer and telecommunications technologies which improve the commercial aptitude of operators, and expand the real and potential role of taxicabs in both urban and lower density environments. Some of the more compelling arguments for TaxiCom are:

- It offers one of the rare examples of a paratransit innovation that can be entirely self-financing, and thus is not dependent on public subsidies;

- It offers a means of extending private taxi operations - which already account for fully ten to twenty (10-20%) of all public transportation patronage in most European cities, including a larger share of elderly and handicapped. It also provides a much fuller range of public services, at least some of which would appear to be otherwise unobtainable by conventional transit approaches;

- It is a possible means of turning around a marginally profitable and even loss-making taxi operation which would otherwise run the risk of going out of business altogether for want of new sources of revenue and productivity increases;

- It covers a fairly broad range of service and technology options, many of which are worth looking into by communities and city planners;

- It offers considerable potential for synergy with public transportation and social services on both operational and administrative levels;

- It facilitates accounting, payroll, management and the collection of data/statistics;

- It is compatible with Automatic Vehicle Location (AVL) and Monitoring (AVM), which can improve service, reduce traffic and facilitate city transportation planning;

- It is a means to improve the status of taxis within a community and improve the image of a city/community vis-à-vis tourists, visitors and the business community;

- It offers operators increased dispatcher productivity, better vehicle utilization, reduced fuel consumption, improved working conditions, improved communications (radio and data), improved safety and security, better overall service and increased profitability.

2.4 Who Should Be Using TaxiCom?

In preparing this report, it was thoughtful that this section be moved to the end of the report, i.e. after the reader has been familiarized with the many aspects of TaxiCom. Nevertheless, it was decided that it is imperative that the reader have this question clearly in mind while reading the rest of this report. This is for one main reason: **TaxiCom is not for everyone**.

The benefits of a TaxiCom system can be reaped on many levels and almost immediately in some cases. Any taxi operator can benefit from the accounting and report generation capabilities of TaxiCom from day one. However the same benefits can be obtained through simple computerization without using a full-blown TaxiCom system. In addition, a number of parameters and preconditions need to be met, not only by the operator, but also by the community, before a TaxiCom system can be successfully implemented.

An operator that relies essentially on a tourist trade that hails taxis in the streets will benefit only slightly, if at all from TaxiCom, and may find that the investment goes unpaid. Generally if a full-featured TaxiCom system can not pay for itself within a period of 2-5 years, then it should not be undertaken[5].

Typically, the operators and communities that benefit the most from TaxiCom are those in which a successful traditional taxi operation is already in place, and in which at least a third of all trips already emanate from dispatching. This is by no means an iron-clad rule, as we have seen an evolution within communities in their taxi-taking habits as they become aware and familiar with TaxiCom. A least a minimal propensity to call for taxis does need to exist initially.

The more successful TaxiCom experiences are found most often in high-density (urban or sub-urban) environments, but not exclusively. In many lower-density Scandinavian communities operators using TaxiCom systems have met with much success, due to increased client fidelity and an increased synergy with public transportation and social services. Furthermore, the reader should keep in mind that an urban setting is by no means a guarantee of TaxiCom success.

In a first instance, it is useful to think about why we are seeing systems of this sort operating in cities like Stockholm, Zurich, Gothenburg, Oslo, London, and more recently in places like Hamburg, Paris and Vienna. Meanwhile, there is as yet nothing along these lines on the streets of cities like Madrid, Athens, Naples, Prague, Detroit or Memphis (Tennessee). At first

[5] There are however exceptions to this as will be seen. In some instances it may be useful to invest additionally in order to achieve a certain number of objectives which go beyond the immediate accounting framework of the taxi operator. Thus, when the implementation extends to offer support services for buses, police or public service vehicles, or more general environmental or community objectives, another accounting framework will have to be applied.

glance this might seem to indicate yet another example of the classic north/south split of income, technology and social development in Europe. But there is considerably more to this story than that prognosis.

As a result of this latest round of interviews, site visits and evaluation, it can now be concluded that an operator, city or region needs to be 'fully ready' for such a system to be appropriate, and that this involves a number of considerations which includes:

- **Builds On Earlier Radio/Computer Experience**

  Up until now, every single TaxiCom operation that has come on-line has built on a preceding and generally successful radio taxi setup. Furthermore, virtually all have been established operations which have, at least in part, begun to computerize at least some of the functions involved in either dispatching or management. Thus, TaxiCom conversions have not, in any cases, been revolutionary, instead an evolutionary step up the ladder from previous successful voice radio operation. Furthermore, where there has been no previous experience with either radios or computers, we have yet to see a TaxiCom service emerge.[6] In other words, TaxiCom will not automatically transform a floundering operation into a flourishing one. A certain level of success is almost a prerequisite - most successful TaxiCom operators were previously successful traditional dispatch operators.

- **Institutional Coherence of Operators**

  In virtually all cases, these conversions have worked in places where the taxi sector enjoys at least a certain minimum level of what might be called 'institutional coherence'. Converting to TaxiCom requires an ability to convince at least a substantial minority of the drivers to use and somehow pay for the new system. In actual fact, this means either a large fleet, existing radio operator or 'taxi central', or some form of coherent cooperative organization which can bring together the

[6] Until quite recently in most places taxis have performed essentially as 'boxes on wheels'. All the brains to direct the vehicle have come from the driver. In many places this is still the case, but this has begun to change fast. There is thus a well known spectrum of stages whereby the taxi trade in a given place will begin to *increase the information content of the vehicles and overall system.* This transition goes in fairly clearly delineated stages more or less as follows: (Stage 1) Each taxi on completing trip deadheads back to assigned taxi stops or base station; (2) Selected stops equipped with special taxi radio facility ("bornes") which is manually accessed by first driver in queue; (3) Voice radio in taxis... Building on this base there are then various arrays of increased radio sophistication, computer assistance, etc., all eventually leading to full fledged TaxiCom deployments (which themselves of course also involve a range of telecom's sophistication). Other kinds of less 'systemic' information feedback devices or loops are also possible of course, including drivers use of normal car radios to tune in to stations with traffic information and mobile telephones, up to and eventually including much of the new equipment being developed at the leading edge, such as the ITS program in the United States and Road Telematics in Europe. One result of this transition is that the "information or intelligence content" of a taxi working in the old pattern as measured by the cost of on-board and other supporting electronics as a percent of total hardware cost borne by the owner/operator was close to zero, while today it is closer to ten percent (10%). It is reasonable to anticipate that this proportion will continue to advance as taxi operators become ever more efficient in their ever more challenging operating environments.

existing owner/operators. Without either direct ownership of some sort, or broad and effective cooperative support, it is unlikely that a new TaxiCom system will ever be successfully established.

- **New Markets for Services**

  It could be noted that in most places where these systems have sprung up, some of the leading local operators have already begun to look for, exploit or create new niche markets. These may include package delivery, special services via social service or other agencies for the transportation of elderly and handicapped people, contract school services, business package delivery, monthly direct billings, or various forms of cooperation with local bus and rail public services. There are of course other examples.

- **New Perceptions/Public Attitudes**

  With increasing public usage and accompanying changes in mental constructs about the ways of ordering taxis, new attitudes gradually begin to take hold on the part of the general public, especially with respect to what constitutes "taxi service" and to the potential role of taxis in the community more broadly. This signals the beginning of a break in the statement in many places which continues to perceive taxis as a marginal private activity (which is almost as annoying to the public sector as it is useful to their presumed few users).

- **Emerging Public Sector Role and Relationships**

  The taxi sector has begun to bring on line new services which has demonstrated a considerable change in both the entrepreneurial qualities of the sector and its position in the community. The taxi sector in these places has begun to develop not only a better defined public presence but also an increasingly coherent and continuing relationship with public agencies and local government. In such areas, representatives of the taxi sector manifest a new-found ability to speak with a single voice, both in its attempts to become a sound business in a radically different operating environment, and as a coherent partner for other public and private institutions within that place.

Additional parameters also play a role in the potential success of a TaxiCom system. Briefly some of these are:

- the present status of taxis in the community;
- the "human capital" level of taxi drivers i.e. communication skills, education, presentation, et al;
- the breakdown of clientele - consisting of the majority of clients from the business community, households, elderly and handicapped or are the majority tourists;

- geography - the more topographic and spread out the area covered by a single operator the more base stations (i.e. emitters or relay stations) necessary thus increasing initial and ensuing costs.

Such preconditions go a long way to laying the base for a successful TaxiCom conversion. If on the other hand today's taxi operations in a given city involve mainly street pickups, as they do in many southern European cities, or more or less desultory radio service as will be found in most parts of the United States, then it is unlikely to think that a system is going to leapfrog into full TaxiCom deployments. Both the sector and the city around it have to make progress on all, or at least most, of the above front first.

Whatever the case of a considering operator or community, the decision to go on-line should be heavily weighed, and all factors should be considered by all concerned. For some the decision to (or not to) implement TaxiCom may be a foregone conclusion. For others the right conclusion may be "not yet". Chapter 6 of this report supplies the reader with additional guidelines for the decision making process.

2.5 Developments

As TaxiCom progresses, many ancillary technologies (once considered as options) are progressively integrated into modern systems. Thus the rapid advance of computer and communications technologies have transformed recent technologies (such as "smart cards" and electronic card readers, wireless credit card authorization systems, smart taximeters, etc.) into standard components of state-of-the-art systems.

One of the most interesting and rapid developments of recent years is the increasing use of Automatic Vehicle Location (AVL) and Monitoring (AVM) systems. A significant amount of systems coming on-line during the 1990s are integrating some form of AVL, as are newly upgraded systems. Of AVL systems, the most popular is by far the Global Positioning System (GPS) due to its accuracy, flexibility, relative low cost, and ease of use and installation.

AVL and AVM systems which were initially used for military purposes, and are now increasingly being used for fleet management purposes (fire, ambulance, police, trucks, buses and of course taxis). The commonality of different systems is that they all measure the actual position of each vehicle in a given fleet. In order to give the reader an understanding of these technologies the following is a description of the various AVL/AVM systems commercially available at present:

- **Loran-C or Long Range Aid to Navigation**
  Loran-C is a land-based radio navigation system which uses low frequency waves to provide signal coverage. It determines location based on the reception of transmissions and associated timing. Radio transmissions are sent via a network of base stations and position is calculated by triangulation. The accuracy is 300 meters and may be inadequate for some urban applications. Due to problems with signal interference and reception, Loran-C is no longer widely used for real-time vehicle location.

- **Global Positioning Systems (GPS)**
  This technique is similar to that of Loran-C except that NAVISTAR satellites are used instead of towers. There is no charge for the satellite signals and accuracy is as little as 30-100 meters. A constellation of twenty four (24) satellites is employed; due to security consideration, the U.S. Department of Defense limits civilian use only one of the frequencies broadcasted. This is referred to as "Selective Availability" (SA). Some of the satellites used are US military satellites available for civilian use. Due to the fact that the US military employs SA of its satellites, which results in reduced accuracy, "differential GPS" (DGPS) may be necessary to correct for this inaccuracy.

- **Radio Determination Satellite System (RDSS)**
  A satellite sends a timed interrogation signal which is received, labeled and then retransmitted by the transceiver aboard the vehicle. This signal is then received by at least two satellites which then send the data to the Central for position calculation using pre-programmed algorithms. The accuracy of such a technology is on the order of yards. It is also possible to send and receive messages with the same system. Geostar is an example of such a system.

- **Mobile Satellite System (MSS)**
  This is primarily a satellite-based mobile phone communication system for digital data and/or voice, which can readily be linked to Loran-C or GPS to provide both a communication and location service.

- **"Dead" reckoning**
  Also known as deduced reckoning, this is the classic approach based on compass and odometer readings past a known location. Modern systems store an electronic road map and can display the path and current position on a display in either the vehicle, the Central or both. Tracking must be continuous and requires regular recalibration. [7]

Another recent development to watch for is that of taxi and public transportation synergy. As this technology continues to develop, we can expect to see an increased demand for smart taximeters which can handle multiple fares and passengers, ridesharing and various billing modalities such as group and deferred.

As we approach the end of this decade we anticipate that "TaxiCom 2000" will consist of expanded mobile data communications, GPS or DGPS vehicle location systems, full electronic card capabilities, smart taximeters and overall a significant increase in the information and technology content of taxis.

[7] For more information on these systems please see *Advanced Public Transportation Systems: the State of the Art, Update '94* and *Advanced Vehicle Monitoring and Communication Systems for Bus Transit* revised March, 1993 of the US Department of Transportation.

CHAPTER 3 - TaxiCom 1995: European Perspectives

3.1 Development of European TaxiCom 1978-1995

The European TaxiCom[8] industry can be dated to the mid - 1970s with Volvo Transportation Systems first experiments on the streets of Gothenburg. The appearance of true first-generation TaxiCom systems in the modern sense of the word, (systems that integrate computers and digital communications for the taxi industry), was around 1980. Some operators are still implementing them today, some are upgrading to second-generation systems, i.e. systems using variable data transmission/communications, while others are starting their TaxiCom experience directly with the second generation.

The first-generation of TaxiCom was detailed in our 1985 report for the United States Department of Transportation, *Taxi-Based Paratransit Technology/Operations Packages in Europe*[9]. At that time five distinct systems were operative in Europe - Taxi-80 (Volvo/Ericsson), Telco (Zurich Taxizentrale), Computer Cab, AP Radiotelefon (AP-Tax), and Taxi Telefoncentrale (TIC). These five systems then basically defined the European TaxiCom 'industry', together with two Canadian firms, Gandalf and Mobile Data International, who had decided to build on their early experience in North America and extend their operations to European cities.

The rapid evolution of the industry in the intervening ten years has resulted in a complete restructuring. None of the suppliers are playing a similar role to the one that played at the time of the initial report. Two of these were acquired by new players in the market. Some are no longer interested in a supply role per se and have applied their knowledge to their own operations or have adapted to change (and though still present, have lost their position as market leaders). Others have had to re-think their product lines and strategies to adapt to the advances made in the component of TaxiCom.

As TaxiCom integrates communications and computers, the technological revolutions, along with the pace of developments of the last decade, have had a significant effect on the state-of-the-art of the industry and on the state of the industry in general. Moreover, the rapid growth and diversification of communications suppliers, who became major players in TaxiCom, through mergers and above all acquisitions, have not only caused a major shuffle in the

[8] TaxiCom is a name, developed by EcoPlan in our 1985 US DOT report, which blankets a certain range of paratransit technology and operations packages including computer dispatch, data/digital transmission and communications, and a host of auxiliary/complementary services (accounting, GPS, AVL et al.).
[9] cf. *Taxi-Based Paratransit Technology/Operations Packages in Europe*, US DOT, UMTA, May 1985.

industry, but have resulted in situations in which products fall into gray areas between divisions and product lines[10].

The last decade has seen a significant *modularization* of TaxiCom, due to the fact that systems can be pieced together (by competent players) from suppliers of digital, radio or cellular communications, computer hardware, computer software, smart taximeters, mobile data terminals, or any combination of the above. This development has had a considerable impact from the vantage of the business as a whole, changing the attitudes and strategies of a number of the players in significant ways.

Advances made in the computer industry over the decade have greatly reduced the costs of hardware, reduced the necessary scale of profitable production, increased the importance of software and, thus, reduced Research and Development (RandD) costs. As most systems are now PC-compatible, they too are modular; PCs can be added easily and upgrades can be offered in modular form as software packages, thus implying little or no hardware outlays. This movement has resulted in the specialization of suppliers. Nonetheless, major suppliers are still the market leaders and make up the larger part of the European TaxiCom market.

At present, the major suppliers of turnkey TaxiCom operations in Europe are (in no particular order):

- Ericsson (no longer with Volvo - the pioneer having left the market!),
- Motorola (with the purchased MDI system),
- GMSI (once known as Gandalf and later purchased by Geotek),
- Indelco AG (Switzerland)
- Frogne (Denmark)
- Spectronics Micro Systems (UK)
- Auriga/Philips (a software/hardware partnership).

Other major suppliers of hardware, communications and/or software exist but do not supply entire system configurations (See Supplier Section 5.2).

3.2 The Particularities of European TaxiCom

3.2.1. Regional Geography of the Market

When referring to the 'European TaxiCom market' it should be noted that the general reference is to *Western* Europe, and more we are implicitly talking about *Northern Western* Europe. This is where the market first developed and where, until now, it continues to expand at the most rapid pace. This is however a situation which is now beginning to change.

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[10] A case in point is the MDI system which was one of the most popular systems in Europe. MDI was bought by Motorola and placed in its Mobile Data Division. The MDD then became known as the Wireless Data Group which was then sub-divided and MDI came under the auspices of Land Mobile Product Systems which has since stopped producing taxi specific products.

In Eastern Europe taxis were until recently marginal services. Though they were in some countries early converters to the private (or gray/black) sectors, they are progressively becoming privately-owned enterprises. However until now they are not as yet able or willing to make the necessary investments called for in a TaxiCom system. Attempts were made to solicit the input of a number of think-tanks and related ministries in Eastern Europe, but for the time being this relationship has only led to an information sharing process due to the complete absence of a TaxiCom market in this part of Europe.

The southern half of Europe has not been an early innovator in these services for a variety of reasons. While the combinations of factors differ considerably from place to place, in general they did not develop in the south because of lower incomes, lower fares, relatively poor or chaotic organization of the sector, lack of working links between taxi operators and local or other government (e.g. social service agencies which provide up to half of taxi income in parts of Scandinavia). Europe, however, is taking a different form and regional disparities in income and social organization have began to disappear. There are already beginning signs to set the pre-conditions that are needed to hasten the penetration of these technologies in the southern half of the region.

Further along these lines, it should be noted that a disparity, albeit smaller, exists in Northern Europe between the Scandinavian countries, which are often subsidized or otherwise incited to offer social services, and within other North Western European countries. For the sake of simplicity in this report, Northern Europe will be consider as one cohesive market barring any significant differences that will be remarked.

3.2.2 Barriers to Change

The technological changes in European TaxiCom have spread largely through the independent decisions of many operators. Each resisted or embraced changes as they perceived the importance of the possible benefits of TaxiCom, and their ability to raise the private capital necessary to purchase such a system. Consequently, technological changes within the industry have occurred at a cautious pace until now, and larger operators were usually the first to adopt these systems. This situation has changed with the reductions in the necessary capital outlays involved in the different TaxiCom systems and configurations, the ability to see first-hand their possibilities and benefits, and of course the success of operators already using TaxiCom.

One can notice that among the different operators covered by this report, most have experienced the same initial obstacles, have encountered the same initial resistance, have the same gripes, and more importantly have all enjoyed the same benefits. In all cases the resistance to change has been transformed into a warm embrace of the use of new technology. A case in point is the initial quasi-universal resistance among drivers and dispatchers upon implementation of a new system. Almost everywhere this resistance turned not only into an acceptance of the system, but into a potentially "dangerous" degree of dependence as the old manual communication skills were lost or forgotten.

It will be interesting to watch how the perceived benefits and drawbacks of these systems evolve. An example of an early benefit that has become less "beneficial" can be seen in some of the more rural areas. For example, the increased silence and tranquillity that came with the passage from vocal communications to data (so appreciated by many of the drivers), has recently given way to drivers complaining of isolation and loneliness on-the-job for lack of interaction with the Central and other drivers.

The learning curve necessary for an increase in productivity among drivers and dispatchers is relatively short, as is general the necessary preliminary training. General gains in productivity have also been accompanied by reduced absenteeism (attributed to improved working conditions), and has resulted in reduced personnel costs among all operators surveyed. Other benefits reported unanimously are the improved manageability of operations (invoices, trip records, and accounting are computerized for example), improved market share[11], driver demand for services (i.e. for those operating as a private service), improved customer service and less deadheading (see Section 4.3. for an in-depth look at the findings and conclusion of main actors).

Today with the increased availability of TaxiCom, many operators are now seeing the outcrop of competitors using TaxiCom. It seems that most companies who had implemented TaxiCom by 1985 report have either implemented a second-generation system, upgraded the original or are now looking to do so.

3.3 The Community and TaxiCom: San Sebastian, Spain

3.3.1 Suitability of San Sebastian as a TaxiCom Site

Back in 1984/85, the surveys were preoccupied with ensuring that there was an adequate understanding of the technology and operational aspects of these systems. The surveys then failed to give attention to the basic preconditions that need to be met *before* any given operator, city or region could begin to give serious consideration to such an implementation. However, as a result of the latest work under this program, which has required that we not only look at the latest technology developments, we also consider the basic implementation issues both in general and in the specific context of the San Sebastian region. A clearer picture of these essential prerequisites for a successful TaxiCom system has now begun to emerge.

Here briefly are some of the considerations in the San Sebastian region that raise cautious optimism about the eventual success of such an operation there:

- All operations are based on independent owner/drivers;
- Drivers are courteous, well informed and responsible;
- Taxi operators are clearly responsible and appreciated members of the local community;

[11] It should be noted that all operators experienced a growth in trip volume and market share the first few years of operation with a TaxiCom system but for those typically serving smaller communities growth tends to stagnate and market share to stabilize thereafter.

- A reasonably high degree of solidarity appears to exist among operators;
- Vehicles in general are clean and well maintained;
- Voice radio operation appears to work well;
- Central area is being increasingly encumbered by car traffic;
- City engineers and planners are working to find technical solutions of many different issues;
- Private car traffic is gradually being channeled and restrained in growing sections of the city;
- The increasing trend to lower densities in outlying areas is increasing deadheading distances;
- Fiscal pressures on the city are pressing for cost-savings in the provision of public transportation;
- Operators already developing new services;
- Basque cultural tradition of cooperatives should greatly facilitate this transition;
- City and regional government both appear willing to cooperate in finding new and better operating methods.

3.3.2 San Sebastian as a Demonstration Site

It can be noted that virtually all of the essential preconditions necessary for a successful TaxiCom deployment presently exist in the San Sebastian region. For these reasons, San Sebastian makes a prime site for implementing and demonstrating the first TaxiCom deployment in the Basque Region of Spain. By the same token it can also be noted that most of these pre-conditions do NOT exist in most other parts of Spain today.

Demonstration projects are needed. If other towns and cities in the country are eventually to make their own conversions in the next few years, there is every reason for regional and national government to be willing to provide a certain amount of support for a successful demonstration.

3.3.3 Finalizing the Deal

Implementing a new TaxiCom system can cost a fair amount of money. There is a considerable range of equipment and price configurations. It seems reasonable as a rough estimate of approximately six thousand dollars ($6,000) per vehicle, half of which involves hardware and software in the vehicles themselves, the remainder being in the Central and support system.

There are a number of ways that can be viewed regarding the financing of a new system. From the perspective of the individual owner/operator, their direct on-board costs can be expected to run somewhere around fifteen percent (15%) of the price of a new vehicle, the overall system costs roughly twice that amount. From a global perspective, if the regional goal is to convert some five hundred (500) vehicles, the overall price tag can be expected to be on the order of $3 million. Who is expected to pay for this and why is this question worth reflecting on? Obviously the answers to these questions will depend in good part on who will benefit as a result of these investments.

Without looking into the accounting specifics of the region for the moment, the pay-back time for these investments in most of the several dozen places where they have been put on-line over the last decade or so has been anywhere from two to six years, with three to four years being the average pay-back time. This would seem to represent a strong argument for self-financing, though it still leaves open many options in terms of different ways of carrying out the actual financing package. It also fails to address the issue of the various kinds of benefits which can accrue to a well planned new system beyond the taxi operators themselves. However, if TaxiCom is going to permit the trade to perform an expanded role within the region, it may be appropriate to examine the other potential beneficiaries of these new community services and functions.

Below is a listing of some of the areas in which a strong TaxiCom configuration could make a contribution to the region and its corresponding social agencies which are indicated in parenthesis:

- Potential for traffic reduction (city/traffic department, environmental agencies);
- Cost-effective replacement/addition for certain public transportation services (public transportation operators);
- Elderly and handicapped transportation (social service agencies);
- Package and document delivery (local business, courier services);
- Enhancement of access for tourists and visitors (local businesses, job creation);
- Communications interface with airports and train stations (local businesses, other);
- Job creation and job holding (both directly within the sector and more broadly over the region);
- Potential for energy savings (agencies responsible for energy, environment, economy);
- Statistics generation and traffic monitoring/feedback (public planning and private uses).

In order for the taxi sector to make a maximum contribution in these areas, more than just state-of-the-art telecommunications is required. In the specific case of San Sebastian, a prudent and well planned conversion to a TaxiCom operation is something that is well justified, for reasons that relate specifically to the taxi operators of the region and their customers. An excellent opportunity exists for the city and the region to take advantage of this occasion in order to achieve a number of important social and economic objectives which TaxiCom could facilitate. In order to accomplish these broader objectives, new partnerships may have to be established (or enhanced), laws and regulations will have to be modified, and a phased plan of improvement and integration will have to be launched. This is an extraordinary opportunity for local and regional government to step up and undertake the lead.

CHAPTER 4 - Operator Experience to 1995

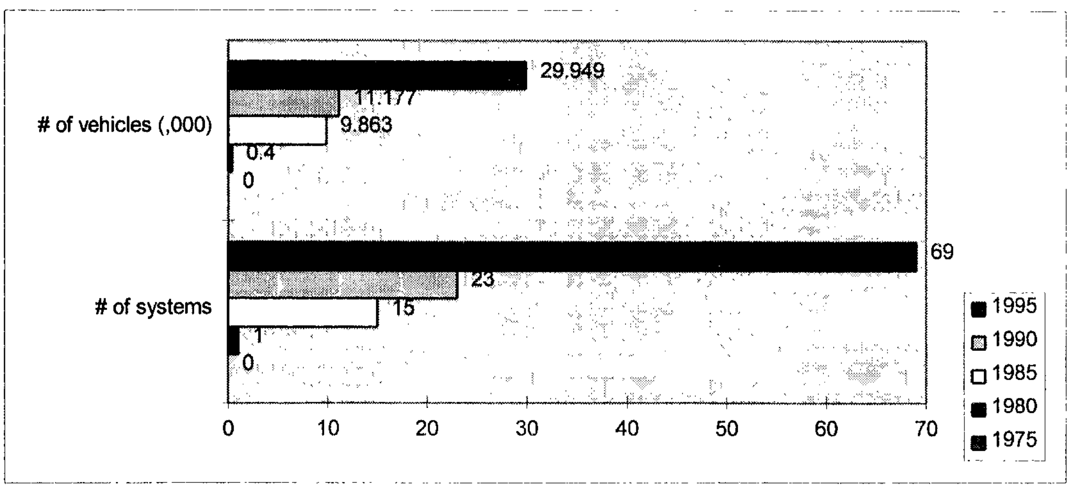
4.1 Overview

All operators covered in our original report were contacted for the purpose of this survey. In addition all operators using, implementing or purchasing a TaxiCom system were sent a "profile form" and asked for its return with their remarks. In this report we presented only those who included enough information to construct a complete profile, or those who responded partially but hold special interest for our readers.

Unlike the situation in 1985, virtually all of the operators that we re-contacted were aware of the existence of TaxiCom systems. In general those already using TaxiCom systems before 1985 are now looking to upgrade and/or purchase a new system, while the rest are either in the process of purchasing a system, implementing a system or in contact with different suppliers in order to verify the state-of-the-art and the accompanying costs. By 1995 most operators who were aware of TaxiCom had already taken a look at the new technology with the intent to purchase.

The operator situation within Europe has evolved considerably from 1980 to 1995. This evolution is at once qualitative, quantitative and to a certain extent geographic. The quality aspect is rather evident as TaxiCom embodies the recent advances in computer and communication technologies. The quantitative evolution has been rapid as can be seen in the following chart:

Chart 4.1-1: TaxiCom Evolution in Europe 1975-1995



In the Scandinavian countries where European TaxiCom initially developed, most large operators have already installed modern systems. Meanwhile, smaller operators are purchasing, or looking to purchase, modern multi-company TaxiCom systems in which more than one operator can independently and discreetly function on a single TaxiCom network.

In the United Kingdom, the number of vehicles on-line has increased rapidly as competition has accelerated the rate in which operators are leaving manual dispatch and opting for computerized dispatch systems. Countries such as France, Germany and Italy which did not have TaxiCom systems running before 1990 are adding new systems at a rapid pace.

As a result of this rapid development during 1990-1995, Western European countries largely overtook Northern European countries in both the number of systems and the number of vehicles on-line, as the following table shows:

Table 4.1-2: European Deployments by Region 1995
1990 figures in ( )

	# of systems		# of vehicles		Average vehicle/syst.	
Northern Europe:						
Denmark	2	(0)	460	(0)	230.00	
Finland	1	(0)	350	(0)	350.00	
Netherlands	1	(1)	580	(580)	580.00	
Norway	7	(6)	2613	(2330)	373.28	
Sweden	6	(6)	2914	(2914)	485.67	
Sub-total	**17**	**(13)**	**6917**	**(5844)**	**406.8**	**(343.76)**
Western Europe:						
Austria	8	(1)	3326	(130)	415.75	
Italy	21	(0)	3421		162.90	
France	5	(0)	4870		974.00	
Germany	7	(0)	4355		622.14	
Switzerland	5	(1)	1790	(400)	358.00	
United Kingdom	6	(1)	5270	(1630)	878.33	
Sub-total	**52**	**(3)**	**23032**	**(2130)**	**442.92**	**(710)**
Total	**69**	**(16)**	**29949**	**(7974)**	**434.04**	**(498.37)**

In Southern Europe, countries such as Spain, as well as several cities are presently considering "switching over" to TaxiCom but have not done so to date.

In Eastern Europe, a true interest in TaxiCom has yet to emerge, however as the taxi markets make the same transition as the rest of the economies, we can expect to see that similar systems can be expected in these countries before the turn of the century.

The following table lists those cooperating operators who have been included in this report, for reason of size, system used, particularities or general interest to the readers:

Table 4.1-3: Cooperating Operators

#	Operator/City	# of taxis	Supplier	System Type	Date Installed	Total Costs	Cost in U.S. Dollars
1	Taxi Gothenburg	615	Volvo/ Ericsson	Taxi-80	1982	N/A	
2	Taxis G7 (Paris)	2000	Motorola	MDI	May-92	FF 50M	262,000k
3	Computer Cab Co. (London)	2500	Computer Cab Co.	Self-developed	1989	N/A	
4	Taxi Zentrale Stuttgart	700	Multiple	Self-configured	1989	DM 250k - 1989 DM 80k - 1992 DM 80k - 1994	375k 120k 120k
5	Taxi Asker og Baerum (Hovik)	300	Volvo/ Ericsson	Taxi-80	1984	NKr 1.3M - 1984 NKr 4.5M - 1994	208k 720k
6	Taxisentralen Drammen	94	Volvo/ Ericsson	Taxi-80	1986	NKr 8M	1,280k
7	Linkoping Taxi Econ Union	89	Volvo/ Ericsson	Taxi-80	1984	SKr 4M	30,600k
8	Hansa Funk Taxi (Hamburg)	600	Indelco AG	"Simple"	1990-1991	DM 2.6M	3,900k
9	Glasgow T.O.A.R.S. Ltd.	480	GMSI	MDCS	Jul-93	£500k	800k
10	Taxi Bleus (Paris)	2000	Indelco/ Pragmatic	"Basic" w/GPS	Sep-95	FF 30M	157,200k

These operators have all received and responded to the *TaxiCom Profile Form Sheet* (a copy of which can be found in Appendix A). The results of these city/operator surveys are presented below. They have been presented in a specific order to give the reader an understanding of the development of TaxiCom, their different configurations, the parameters that come into play from the planning and implementation stages through utilization, upgrades and possible reconfigurations[12]

Gothenburg, birthplace of TaxiCom in Europe represents a special interest due to the evolution its system has undergone since its inception. From consideration to implementation of the process, the formulation of Taxis G7 began as an attempt to "do-it-themselves" and culminated in a joint development project with a major supplier. Both the Gothenburg and Taxis G7 profiles have annexes that tell their stories in added detail.

[12] These parameters will be discussed in Chapter 6, "Planning and Implementing TaxiCom"

London Computer Cab is an example of an operator which decided to self develop its own system. It may be interesting to make a comparison to Taxi Zentrale in Stuttgart, which is an example of a multiple-supplier self-configured system.

Taxi Asker og Baerum is an example of a system that has functioned well, but nonetheless necessitated a major upgrade within ten (10) years of installation. Similarly, Taxisentralen Drammen and Linkoping Taxi are both small operators that us first-generation technologies to their content, but feel that their present systems have reached their respective limits.

Hansa Funk Taxi is an example of a modern system that has shown significant cost improvements as a result of TaxiCom. Glasgow and Taxi Bleus are examples of modern systems making use of recent technologies, and as such are insightful in regards to actual cost, equipment and time considerations.

While reading the different operator profiles, it may be helpful to refer to the relevant supplier profile for a better understanding of the system discussed and the technologies involved.

4.2 Operator Profiles

4.2.1 Taxi Goteburg

4.2.1.1 Operator

City/Country:	**Gothenburg**/Sweden
Service area:	Size: __N/A__ km^2
Population:	700,000
Number of Taxis:	**615**
Average Radio calls/ day(total):	N/A
Operator type:	**Cooperative**

4.2.1.2 System Overview

A Volvo VTS/Ericsson Taxi-80 system was installed in 1982 which has been updated to include a route-planning system, a call-box system and an automated client ordering system.

4.2.1.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Volvo/Ericsson	Taxi-80	

Computers:	DEC	PDP 11/84	1 main unit, 1 backup
Communications:	Ericsson	C600 Verscom	Computerized mobile radio
Software:			
Comm.:			
Admin.:	NCR	Tower (UNIX)	Book-keeping, invoicing, follow-up tasks.
Other:	Ericsson	Planet	Route-planning system, uses a VAX 4,000-200 attached via Ethernet to host.
	Ericsson	BT80, BT2000	Automated call boxes
	Ericsson	TaxiVoice	Automated client ordering
On-Board Equipment:			
Terminal:	VTS/Ericsson	Taxi-80	No visual display, printer incorporated
Radio:	Ericsson	C600 Verscom	
Taximeter:	N/A		
Printer:	N/A	N/A	N/A

Special Features : Various community services, mainly transportation of elderly and handicapped, and ride-sharing (greatly improved after installation of Planet system). These services make up close to 50% of all trips.

Personnel:

DRIVERS:		CENTRAL:	
Total:	N/A	Dispatchers:	64 (down from 84)
Owner-drivers:	N/A	Management:	N/A
Employees:	N/A	Technical support:	**yes**
Renters:	N/A		

External Technical Support: None.

4.2.1.4 System History

Initial project discussion: N/A

Service start-up: 1982

Initial objectives: More effective dispatch. Better working environment for dispatchers. Increase volume and volume-handling capabilities. Fairer and more equal ride distribution. Faster and more efficient service for customers. Better interface and computerized invoice capabilities with/for public services.

Overall: Attained initial objectives. System works well..

4.2.1.5 Economic Summary

Total (estimated) system cost: N/A

Equipment cost:	Item	Cost
CENTRAL	Computer (main/host):	N/A
	Computer (terminals):	N/A
	Communications:	N/A
VEHICLE (unit cost)	On-board terminal (MDT):	N/A
	Radio:	N/A
	Taximeter:	N/A
	Printer:	N/A
Other costs:	Monthly rental/service charge (to drivers):	N/A

4.2.1.6 System Performance

Initial obstacles: N/A

Major plusses:

- Shorter response, order taking/processing, and call to pick-up times.
- More (estimated at 300%) calls per dispatcher.
- Personnel reduction (25% less dispatchers necessary)
- Less driving between order and pick-up - due to the division of Gothenburg into smaller zones.
- Since the implementation of the Planet system: less cruising, thus lower fuel consumption.
- Less deadheading.
- Higher degree of ride-sharing.

- Higher degree of ride coordination with community services (e.g. elderly and handicapped transportation).
- Overall better utilization of their taxis.
- Highly liked by drivers, dispatchers and customers.

Major minuses: The 1982 configuration of Taxi-80 is no longer adapted to today's communication and computer environment, is lacking in modularity, and no longer able to respond to Taxi Goteburg's demands.

4.2.1.7 Planned Next Steps

Near term: Although initially interested in an upgrade in 1990, Taxi Goteburg decided to wait for the appearance of a more suitable system on the market. Unable to find such a system, they have now begun a research and development process, mostly in-house with some external technical support, for a new specifically-designed system that should be completed in 1996. This system will be able to handle at least 600 units (including buses) and integrate dispatch, route-planning, follow-up and accounting software. The aim is to link all computers, software programs, taxis, buses, communications, taximeters, and possibly GPS into one integral unit. The system will be compatible with the January 1, 1996 Swedish taximeter regulations.

Long term: Implement above system with GPS capabilities.

ANNEX: A CASE STUDY IN THE EVOLUTION OF TAXICOM

Background

Much can be learned from the recent history of Taxi Goteburg and its relation to Taxi-80. One of the first operators in Europe to implement a TaxiCom system and obviously convinced of its benefits, Taxi Goteburg has since 1990 been looking to replace a system that it considers "performed well and flawlessly" but is no longer adapted to its needs. After a market survey indicated that there was no system that conformed to its specifications, Taxi Goteburg has undertaken a research and development process with a major supplier to ensure that it gets what it is looking for.

A few lessons can already be learned at this stage:

1. Rapid advances in computer and communications technology have left older (i.e. 5-10 years old) systems insufficient for operators needs.

2. The suppliers of the taxi industry have not been active in assuring that their products satisfy changing operator needs.

3. TaxiCom systems need to be modular so as to allow operators to adapt their systems to new software, services and technological advances.

4. Due to the specifics of each operator, the services offered and the community served, TaxiCom systems need to be developed with close operator-supplier cooperation.

The Need for Change

At the time of the deregulation of taxi services in Sweden (July, 1990), Taxi Goteburg performed a market survey of existing TaxiCom systems. None was found which was correctly adapted to their specific needs. Using a system that drivers, operators and customers alike found acceptable, but was no longer suited to operational needs, the management of Taxi Goteburg performed some slight hardware improvements and minor system upgrades. This added, most notably, Planet (a route-planning software program), TaxiVoice (automated customer ordering) and installed automated call-box (BT80 and BT200) terminals at major-client locations.

Considered highly cosmetic, these upgrades were initially put in place to keep the system operating acceptably until a new system could be found. Instead Taxi Goteburg's management decided to take matters into its own hands. They have initiated a planned 18 month research and development process to design a system that is tailored to their present needs, will be as accepted as the present system by those concerned, and will be able to adapt to any future needs painlessly. The stated aim is to develop a system that will integrate all central and mobile hardware and software into one highly-functional unit and be able to interface with the public services which are a major percentage of trip volume. The research and development process is largely in-house with some external technical assistance.

The Results

The results of the Taxi Goteburg and Taxi-80 relationship were first documented the our initial 1985 report. In fact, the streets of Gothenburg were the testing grounds for the first TaxiCom development projects in Europe which date to the 1970s (tests were performed in conjunction with Volvo VTS whose system was later to be purchased by Ericsson). The success of the passage to a TaxiCom system, and Taxi-80 system, can probably best be demonstrated by the fact that more than 10 years later, Taxi Goteburg is now ready to repeat its experience and still considers that Taxi-80 has performed "well and flawlessly". It seems that the first-generation TaxiCom products have now completed their life-cycle. A performance analysis is now in order, so as to take stock of past results and decide on the direction and specifications of future systems.

As described in the "System Performance- Major plusses" section above, the improvements in Taxi Goteburg's operations are similar to those described in the 1985 report* for all operators who have implemented TaxiCom systems. The present systems shortcomings all seem to

* See US DOT ***Taxi-Based Paratransit Technology/Operations Packages in Europe***, May 1985, Chap.5, pp.71-91.

originate from in the rapid communication and computer technological advances seen in the last decade, and the system's inability to keep pace with these advances.

Aside from the addition of the Planet route-planning system, TaxiVoice and the BT80/ BT2000 terminals, the system has maintained its initial 1982 configuration as briefly discussed below.

Advantages - Different Points Of View:

Management:
System allowed a better transmission of information to drivers, an economy of personnel, and a better interface and invoicing with public services.

Driver:
Overall are happy with system. However, feel increased isolation/loneliness.

Passenger:
Are happy with system and clarity of pricing.

Developments:

After initial increases in trip volume and cost reduction, these parameters seem to have stagnated with the present system and thus a need for a new system is felt.

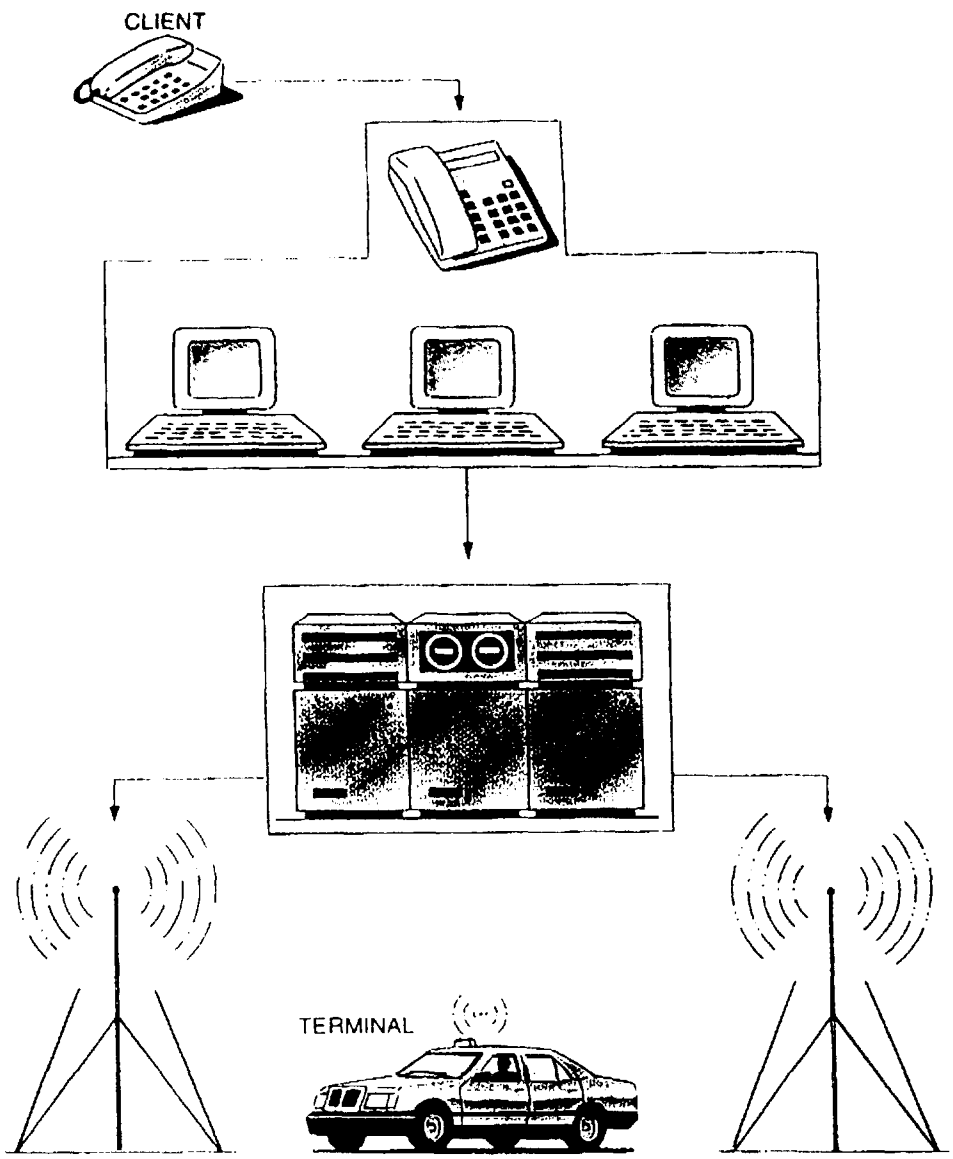


Illustration OP1-1

4.2.1.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

   Yes indeed. As a matter of fact we will do it all over again during 1995-1996. This time we would do it a bit different though in examining our own needs and making more thorough specifications before we make any investment decisions in a system this big.

4.2.2 Paris G7 Taxis

4.2.2.1 Operator Information

City/Country: **Paris,** France

Service area

Size: 12,000 km^2

Population: 10 million

Number of Taxis: 2,000

Average radio calls/day: 13,000

Operator type: Private service

4.2.2.2 System Overview

A Motorola system installed in 1992 which builds on earlier MDI/Motorola experience and equipment. The system was developed and adapted in association with G7, is considered to be successful and continues to be expanded and developed.

4.2.2.3. Present System Configuration

See complete process description below.

Configuration	Supplier	Model	Remarks
Global system:	Motorola	TaxiPak	STAR 7 is the name given to the personalized G7 system.
Computers:	Digital	DEC 5000-200	Unix based, RISC operated 30 VT 420 DECs
Communications:	Motorola	Standard VMEbus	ACC run on RS232 (Com port), link to host computer and com infrastructure via 8 base stations.
		MMP4008	80 MHz, 8 base stations, 8 modems

On-board equipment:

	MDI	MDT 7031	2-line LCD, reception is DSMA at 4800bps
Software:	Motorola	Informix	Database management system
		TaxiPak	Personalized to G7's needs

Special features: Personalized client features (see below), automatic or monthly payment possible.

Personnel:

Number of total employees: 120

DRIVERS:		CENTRAL:	
Total:	2,000	Dispatchers:	75 (was 90 pre-STAR 7)
Owner-drivers:	N/A	Management:	30
Employees:	0	Technical support:	15
Renters:	N/A		

External technical support: Mobile *Soft* consultants (see Key Contacts).

Remarks: France. "Auto

4.2.2.4 System History

Start-up: May-October 1992

Project initiation: August 8, 1989

Initial objectives: Provide high quality working conditions for drivers and improve quality of service to clients in order to gain market share in a declining, and highly competitive, Paris taxi industry.

Overall: Attained initial objectives. System works well. Acceptance of system is high among drivers, management and clients alike. System is considered to have performed "well and flawlessly" since its inception.

4.2.2.5 Economic Summary

Total (estimated) cost: FF 50M ($10M)
Unit cost: FF 30,000 ($6k)

Research/development:

Equipment cost:	**Item**	**Cost**
CENTRAL	Computer (main/host):	N/A
	Computer (terminals):	N/A
	Communications:	N/A
VEHICLE (unit cost)	On-board terminal (MDT):	N/A
	Radio:	N/A
	Taximeter:	N/A
	Printer:	N/A
	On-board equipment value:	FF 30,000 ($6k)
	Monthly rental/service charge	FF 1,200-1,500

Financing: Amount self-financed: 100%

4.2.2.6 System Performance

Initial obstacles: Driver skepticism and computer illiteracy. Technical 'bugs'. System failures. Driver trickery - system depends on driver 'good faith'.

Major plusses:

- Reduced client wait time ten-fold.
- Quieter ride.
- Improved driver working conditions.
- Impartial ride distribution.
- Eliminated client-stealing.
- Improved overall service.
- Improved driver safety.
- Allowed operator increased market share in a decreasing market.

Major minuses:

- Necessitated specific driver training.
- Complete driver satisfaction with new system was initially only 20%
- (see Initial Feedback section below).
- Manual fallback during system failure.

Overall: Attained initial objectives. System works well. After initial skepticism driver acceptance is high - today 2000 drivers on G7 waiting list.

4.2.2.7 Planned Next Steps

Near term: Implement 'Phase 2' of STAR 7: interface illuminated taxi sign with central computer to attain real driver availability. All units were equipped with credit (all major and Japan Credit) card payment in December, 1994.

Long term: Develop and implement 'Phase 3' (which remains confidential).

4.2.2.8 Commentary

1. "In the light of your experience with 'TaxiCom', what advice would you give to an operator wanting to develop a new system? What is the one thing, above all, that one should keep in mind?"

   Two points seem to be of utmost importance:

   a. *The system must be tailored, in terms of performance, to the most difficult situations: behavior during peak hours (foul weather, public transportation strikes, rush-hours, etc.). Essentially the extreme efficiency of a data dispatching system is only equaled by the extreme fragility of operations during system failures/breakdowns. The proper strategy is to maximize the security of the different system elements rather than envisioning a return to a lower grade of service (e.g. vocal dispatch).*

   b. *Much importance should be given to the evolution of the system. It should be able to improve with the addition of new functions and thus to accompany or even precede the development/growth of the business [operations]. The budget and the effort that need to be consecrated to finding the right system are not negligible.*

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   The most important evolution of the taxi industry will concern, the vehicles themselves with the advent of electric cars in city centers. As regards the systems, their will obviously be an improvement and miniaturization of the various on-board electronic equipment. Finally, especially for the smaller taxi companies, the transmission of information between the 'central' and the taxis will be able to be performed by means of public data transmission networks.

ANNEX: STAR 7 - HISTORY, DESCRIPTION AND DEVELOPMENT

Background

G7 is the descendant of a the oldest taxi company in Paris founded in 1902. It has a fleet of approximately 1900 taxis and treats 13,000 calls a day on the average. The STAR 7 system typically costs drivers French Francs (FF) 1200-1500 ($250-300) a month to rent, depending on the type of subscription, with on-board equipment valued at FF 30,000 ($6,000). The system has just completed its second year in operation.

The Need for Change

The need for a new integrated operations/communications system was discussed for the first time at Taxi G7 in 1984. At that time the Paris Taxi industry was suffering from a declining image and worst yet from a declining market. The state-of-the-art at the time was radio, and to a lesser degree, telephone kiosks which had seen very limited success. Radio/telephone was used by only forty-eight 48% of taxis and accounted for only ten percent (10%) of all rides. The radio's use was marked by intense driver competition, complaints about fairness , elevated driver stress, an uncomfortable and noisy environment for both client and driver, long and poorly estimated waiting periods (thus not conducive to developing client loyalty), and generally poorly adapted to Paris traffic conditions. Further aggravating the situation was the system's primitive technical interface and difficult manageability which resulted in inefficient ride distribution for both peak and non-peak demand.

Innovation or Adaptation? A Technical Challenge

The idea of a new system was first put forth in 1984. Two years of research was then financed under the "technology-work-employment" program by the French Ministry of Research. This research included a general feasibility study, a study of existing technological/technical conditions, the development of a prototype system and a study of psycho-sociological implications of such a system. The G7 group contributed some FF 40,000 (approximately $ 9,000) to the prototype development which was eventually buried. An unexpected result of the testing was that several taxi drivers quit G7 to work for their competitors.

In 1989 G7 decided that it was not feasible to go it alone and thus turned for help to Motorola's Mobile Data Division (today part of Motorola's Wireless Data Group and previously Mobile Data International, Inc.). On August 8, 1989 in Canada, the "STAR 7" project was launched. With the help of ten (10) North American and three (3) French engineers, and three years of research the STAR 7 (the specially adapted French version of the original MDI system) was not only born but running. STAR ("Systeme de Transmission et d'Affectation Rapide" or rapid affectation and transmission system) 7 is thus a strongly tailored adaptation of the hardware and software of the original MDI system (already operational in Northern Europe and England), specially geared to the Paris market and the first system of its kind in France. This system and its eventual improvements is considered by some to be the most advanced of its kind in use today*.

The investment necessary to develop the system was estimated at FF 50 million ($10,000,000) or FF 20,000 ($4,000) per vehicle. Moreover, the cost to the drivers was initially subsidized to be equal to that of the cost of the regular radio system. A typical on-board unit consisting of MDT, taximeter, and printer (as of January, 1994 a credit card payment device will be standard as well) now costs FF 1,200 ($250) a month to rent and is valued at FF 30,000 ($6,000).

* On the other hand, independent sources have indicated that the original equipment supplied by Motorola at the time of installation was not the top-of-the-line, state-of-the-art system. Be this as it may, the STAR system appears to have given full satisfaction to all involved

The Results

Process Description

Upon reception an operator (one of 75) registers the client's call on a console (one of 30 VT 420 DEC computers) which is then transferred to the central computer (a DEC 5000-200) using the TaxiPak software, written in C (program language). In order to maintain the transmission protocol, as well as the correction and protection codes Motorola put in place an "Advanced Communications Controller" (ACC) built around a VME standard bus which can be enlarged and adapted to the system as it evolves. The ACC interfaces with the host computer and functions in accord with the Motorola MMP 4008 radio protocol, which uses the DSMA technique to assure reception of all messages (new messages are put on a 'waiting list' until all earlier messages are processed). The central computer sends the allocated trip information to the ACC which transmits the numeric (RS232) signal to one of G7's eight modems. The trip request is then retransmitted in analog to one of the seven relay stations (beacons) spread throughout Paris. The relay stations dispose of a modem which reconstitutes the message in it's original form. The message is finally transmitted to the on-board taxi terminal (at 4600 bits/second). The driver then chooses a response from the MDT keyboard and the message follows the opposite trail. The system is thus informed of the trip's acceptance/refusal in real time.

The system is reliable, which is important when emission and reception is on a Hertzien network (on or around 80 MHz) subject to numerous perturbations. In fact STAR 7 is programmed to work on several frequencies at the same time, choosing the frequency instantaneously in function of transmission quality and the total charge on the considered channel.

For the drivers the real innovation is the manner in which trips are allocated. Paris and its outlying areas are divided into 208 numbered sectors (approximately 4 for each 'arrondissement'). Via the on-board MDT terminal the driver informs the central computer of his position, indicating the sector manually, and is given a queue number in the given sector. Once a trip request is made, TaxiPak chooses the vehicles closest to the client and attributes the trip directly to the driver with the lowest number. The requests are thus distributed with total impartiality and removes driver competition to be first on the spot. The confidentiality of the message has also eliminated 'ride-stealing'. This manner of distributing orders also allows G7 to assure a more complete coverage of all sectors.

Each on-board MDT terminal can handle up to twenty (20) 10-line messages. It can provide information on traffic circulation, streets and routes to avoid, the complete client address and the type of vehicle desired by the client.

Advantages- Different Points Of View

Management:

With STAR 7 (TaxiPak) G7 reports a definite gain in clientele and client loyalty. In a Paris taxi market that declined (fifteen percent) 15% from 1992 to 1993, G7 was able to increase its market share by two percent (2%). In general, the system allows management to understand better the details of supply and demand, the actual trips performed, a better estimation of wait time, better distribution of its taxis and overall a more efficient and client-friendly management. It also allows G7 to offer its clients special services and options not before available (monthly billing, a 'Club Affaires' (Business Club) package to large clients which can be personalized, et al.). It has even helped repair the tainted image of a much-maligned Parisian taxi service. As far as driver demand for application to G7 and it's system, there are presently 2000 drivers on the waiting list. This situation has allowed G7, who no longer needs to cater to the drivers whims, to be more selective about its drivers.

Driver:

With the present form of communication and trip distribution, the driver gains assurance of impartiality in the choice of driver, silence and comfort in the vehicle, reduced stress, no more need to race to be the first taxi on the spot, and reduced chance of driver error (the exact address is on screen). It should also be noted that the system contains an activated alert (which can be cached) allowing a distressed vehicle or driver to be located quickly, thus adding to driver/passenger safety. In addition, credit card payment will now be possible with end-of-day payment assured by G7, thus increasing driver safety (can reduce on-board cash) and eventually trip volume. Those drivers specially selected for participation in one of G7's special services also enjoy affluent clientele, higher trip volume, and a slightly higher fare level.

Passenger:

Orders are treated almost ten times faster with the present system than with normal radio communications. Wait time is reduced and estimated more accurately, and the client is informed of the color and make of the arriving taxi immediately. The non-verbal communication between the dispatcher and the taxi allows added discretion for the client. With STAR 7 the closest compatible taxi is always the one sent, thus reducing the initial rate to the client (who must pay for the 'en-route'). Passengers have a number of services available allowing different levels of trip priority (very important during periods of peak demand) and driver/taxi specifications.

Initial Feedback

A reasonable measure of the systems success is the fact that it managed to increase market share of its taxis in a declining market and driver demand. Upon initiation of the system in October, 1992 a survey was performed (*La Vie du Rail* no. 2398) which discovered that only twenty percent (20%) of drivers using the system were completely satisfied, and while 60% were still skeptical. By June of 1993 the proportions were reversed - eighty percent (80%) of drivers using the new system were completely satisfied (*La Vie du Rail*, no.2399). According to G7, satisfaction is now close to one-hundred percent (100%) because those drivers that remained opposed to the system have since left. Present driver application to G7 largely exceeds practicable supply (market share has to be enlarged prior to an increase in drivers).

Developments

With the aid of STAR 7, G7 has now begun to offer its clientele new services. Aside from the detailed computerized receipt system available to all clients, G7 offers monthly payment possibilities, a "Club Affaires" ('Business Club') package for large clients, "Service Plus" (priority during peak hours) and has recently developed an addition to STAR 7 called "Auto7"

Operational since September 1993, Auto 7 automates the entire process of ordering a taxi. Available to high volume clients (hotels, hospitals, large businesses) a taxi can be ordered with the touch of a button, and in less than one minute informs of the expected wait time, the model and color of the arriving taxi. Using a normal telephone line and installed for free or rented for FF 100 ($20) a month depending on client volume, Auto 7 is considered a means of further automating the order process and intended to increase client fidelity.

G7 is now planning to continue with phase 2 of development of the STAR 7 system. This phase will include an interface between the central computer and the taximeters in order to obtain the "real" availability of its drivers (thus eliminating the possibility that drivers still en route are reporting that they are available). This is part of the strategy which seeks to refine 'wait-time' estimations and includes factoring in more precisely the prevalent traffic conditions. An algorithm which takes into account the geographic zone, the hour of the day and traffic conditions is being developed to better estimate the length of each trip.

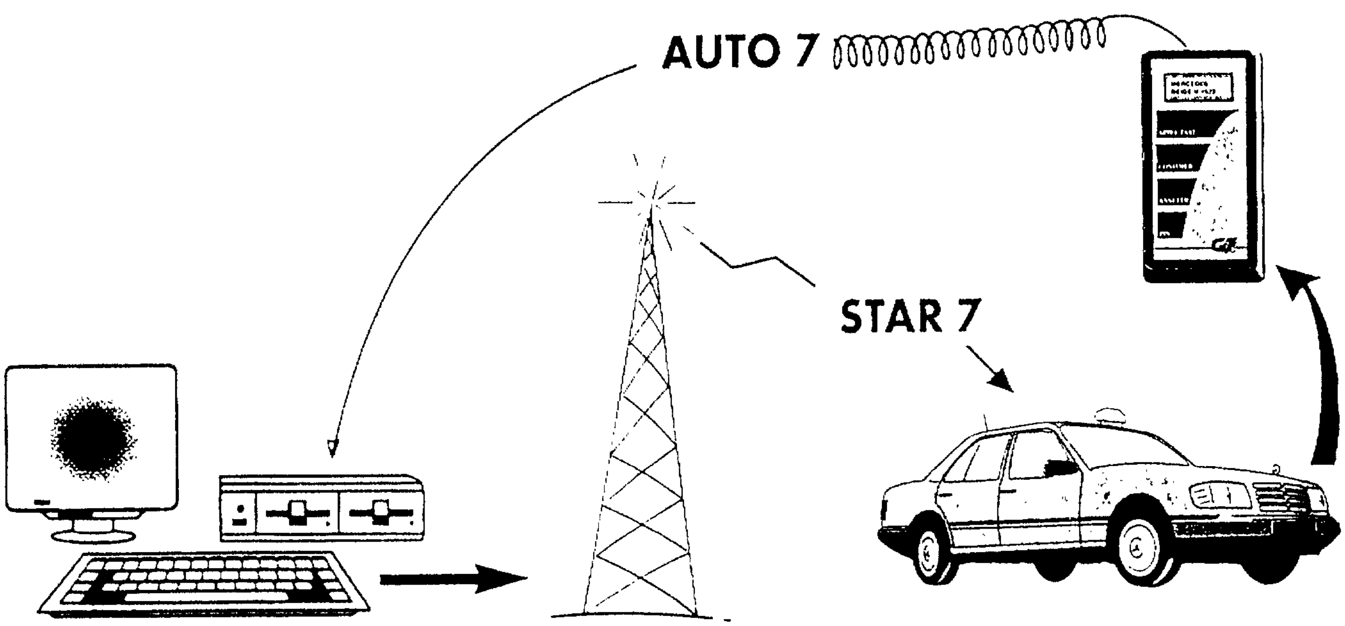


Illustration OP1-2

4.2.3 London Computer Cab

4.2.3.1 Operator Information

City/Country: **London**/Great Britain

Service area:
- Size: 1500 km^2
- Population: 7,000,000

Number of taxis: 2,500

Average radio calls/ day(total): N/A

Operator type: **Private service**

4.2.3.2 System Overview

Computer Cab was formed in 1974 under the name of London Wide Radio Taxis and changed its name to the present in 1980. In the early 1980s, management realized that TaxiCom and the rapid processing of orders, fast taxi allocation and sophisticated invoicing that came with it were "essential to satisfy the demands of its expanding fleet". However Computer Cab also realized that none of the then existing systems was suited to its specific needs and to the London environment in which they operated. "Computer Cab decided to embark on a phased development of a system specifically designed to meet the needs of its customers in the London metropolitan area."

The first phase, which was initiated in June, 1983 and completed later in the year, included computerized order-taking. Due to Computer Cab's system it was able to play a leading role in the London Taxicard scheme for the transportation of the mobility handicapped in the years to come.

The next phase in the development of Computer Cab's system, which begin in 1986, was the installation of data terminals in the taxis with built-in electronic card-read equipment. As Computer Cab was the only computerized supplier operating in London until 1990, it was able to achieve market share of over seventy percent (70%) of Taxicard supply.

Computer Cab had decided to take advantage of the experience it had amassed and attempted a limited commercialization of its own system. It seems that Computer Cab has had limited success in this endeavor, not unlike findings resulting from surveys from other operators attempting similar commercial applications.

Computer Cab is now in the process of developing a successor system which is to be proven in 1995.

4.2.3.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	CCDS	Red Admiral	Self-developed
Computers:	Honeywell Bull		
Software:			
Comm.			self-developed
Admin.			self-developed
On-board equipment:			
Terminal			self-developed
Radio			N/A
Taximeter			N/A
Printer			N/A

Special features : *(Specify capabilities: Elderly/Handicapped services, accounting features, ride-sharing, other special)* System is interfaced with the London Taxicard scheme for the transportation of the mobility handicapped.

4.2.3.4 System History

Initial project discussion: 06 /1983

Service start-up: end 1983

Initial objectives: Computerized dispatching, sophisticated invoicing.

4.2.3.5 Planned Next Steps

Near term: Implementation of new system during the course of 1995.

Long term: N/A

4.2.4 TaxiZentrale Stuttgart

4.2.4.1 Operator Information

City/Country: **Stuttgart**/Germany

Service area:
Size: 400 km^2
Population: 700,000

Number of taxis: 700

Average radio calls/ day(total): 4,500

Operator type: **Cooperative**

4.2.4.2 System Overview

A first-generation TaxiCom system, configured largely by the operator in obtaining the materials best- suited to its needs and budget considerations from multiple suppliers.

The system is thus an amalgam of digital, cellular, and radio communications and computer hardware/software integrated over the course of five years.

4.2.4.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Innova	Unitax	
Computers:	Indate	386	
Communications:	Motorola		Mobile phone
	Bosch	KF 163/168	Mobile phone
	Ascom	SE 540	Digital
	Teletron		Digital
Software:			
Comm.:	Innova	Unitax	
Admin.:			Self-developed
On-board equipment:			
Terminal:	Heedfeld	4000/5000	
Radio:	Ascom, Teletron		Digital
Taximeter:	Hale, Kienzle, Halda		
Printer:	Kienzle		Integrated Taximeter/printer
Other:	Motorola, Bosch		Mobile phone
Special features:	None at present		

Personnel:

DRIVERS:		CENTRAL:	
Total:	950	Dispatchers:	20
Owner-drivers:	635	Management:	Co-op
Renters:	N/A	Technical support:	N/A
Employees:	N/A		

External Technical Support: Innova provides technical support for control room.

4.2.4.4 System History

Initial project discussion: 1988

Service start-up: 1989

Major upgrades: 1992, 1994

Initial objectives: Increase quality and rapidity of service. Reduce personnel.

4.2.4.5 Economic Summary

Total (estimated) cost:
1989 ~ DM 250,000
1992- ~ DM 80 000
1994- ~ DM 80 000

Equipment cost:

	Item	**Cost**
CENTRAL	Computer (main/host):	DM 50,000
	Computer (terminals):	DM 20,000
	Communications:	
VEHICLE (per unit)	On-board terminal (MDT):	DM 1000/1500
	Radio:	DM 1500
	Taximeter:	DM 1000
	Printer:	N/A

Research and Development costs: ---

Financing: 100% self-financed

Other costs:
Monthly rental/service charge (to drivers): DM 250 + MWst (VAT)

4.2.4.6 System Performance

Initial obstacles: Attaining proficiency in handling system.
Acceptance of system among those involved initially low.

Major plusses: Allowed a reduction of personnel and costs.
Improved the quality and rapidity of service.

Major minuses: Use of system has reduced manual proficiency (i.e. in case of system malfunction) and induced a dependence on the computerized system.

4.2.4.7 Planned Next Steps

Near term: Implement an automated booking system.

Long term: Integrate a Global Positioning System.

4.2.4.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to yours or similar technology?"

   I would suggest similar technology, but I would suggest the use of more than one supplier. *The use of multiple suppliers reduces dependency on one supplier, instills price competition between suppliers, and improves supplier responsiveness to requests for additions to system once the system is installed.*

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   Towards the year 2000 the taxi industries expected to become completely dependent on the computer. The individuality will be lost and the traditional skills and knowledge of taxi drivers will disappear into the computer. It will no longer be necessary for a driver to be well oriented in the city in which he works as the computer will indicate the best route. With the demise of radio communications, the driver has become increasingly isolated from the 'central' and from other drivers. The advent of widespread global positioning systems within the industry is now warranted.

4.2.5 Taxi Asker og Baerum

4.2.5.1 Operator Information

City/Country: **Hovik**/Norway

Service area:
- Size: 300 km^2 (500 with outlying areas)
- Population: 140,000 (340,000 w.o.a.)

Number of taxis: **300**

Average radio calls/ day(total): **5,000**

Operator type: **Cooperative**

4.2.5.2 System Overview

This system consist of a standard Volvo VTS/Ericsson Taxi-80 system to which piece-meal additions have been made, including the self-development of software, the addition of new taximeters and the linkage to PCs.

4.2.5.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Volvo/Ericsson	Taxi-80	
Computers:	Digital Tandberg	PDP 11/44	PC MS DOS/UNIX network Terminals
Communications:	Ericsson	Verscom C604	
Software:			
Comm.:	Ericsson	Taxi-80	
Admin.:	Compact	Guide 90	Also known as Select 2000; 'Poly-booking' system
On-board equipment:			
Terminal:	ABB	Contec	LMT- Data with RAM card Taximeter Included in terminal
Printer:			Included in terminal
Radio:	Ericsson		Computerized mobile radio

Special features: A 'poly-booking' system (a ride-sharing system developed in conjunction with the other members of TAXUS Norway*) that integrates rides for

* TAXUS Norway is a group of six Norwegian taxi operators who cooperate on a variety of matters including research/development and group equipment purchases.

schools, businesses, and the elderly and handicapped. 'Auto-booking' equipment installed in hotels and large businesses.

Personnel:

DRIVERS		CENTRAL	
Total:	300	Dispatchers:	15
Owner-drivers:	240	Management:	6
Renters:	0	Technical support:	1
Employees:	300		

External Technical Support: None

4.2.5.4 System History

Initial project discussion: Jan, 1983

Service start-up: Mar-Jun, 1984

Initial objectives: Increase the quantity and quality of information transmitted between mobile units and the central unit. Assure equitable and equal ride distribution.

4.2.5.5 Economic Summary

Total (estimated) cost: NKr 1.3M (ca.$145k at 1983 rates) computer hardware in 1984
NKr 4.5M ($65k at 1994 rates) taximeters in 1994.

Equipment cost:

	Item	Cost
CENTRAL	Computer (main/host):	NKr 1.3M
	Computer (terminals):	Included above
	Communications:	N/A
VEHICLE (per unit)	On-board terminal (MDT):	N/A
	Radio:	N/A
	Taximeter:	NKr 15,000
	Printer:	N/A
	Total est. unit cost:	NKr 35,000

Research and Development costs: Supplier supported.

Financing: Amount self-financed: Initially 10% (without government aid)

Other costs: Monthly rental/service charge (to drivers): Full-time NKr 2800
Part-time NKr 1800

Return on investment: Approximately 5 years

4.2.5.6 System Performance

Initial obstacles: The transmission of information between the central and mobile units was not fast enough.

Major plusses: Reduced staff cost. Attained initial objective.

Major minuses: Manual procedures forgotten during data failures/breakdowns. System is outdated and the hardware is no longer suited to needs.

4.2.5.7 Planned Next Steps

Near term: Looking to purchase/develop new system in coming years with TAXUS Norway group.

Long term: Considering the integration of a satellite-positioning system (a GPS).

4.2.5.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

   YES!

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   Cheaper equipment, compatible units, well-known interfaces that are adjustable [modular]. Quicker information stream. Driver-operator interfaces that are easier to use.

4.2.6 Taxisentralen Drammen

4.2.6.1 Operator Information

City/Country: **Drammen**/Norway

Service area:
- Size: N/A
- Population: 75,000

Number of taxis: 94

Average radio calls/
day(total): N/A

Operator type: **Cooperative**

4.2.6.2 System Overview

A standard Volvo/Ericsson Taxi-80 system configuration.

4.2.6.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Volvo/Ericsson	Taxi-80	EDB system
Computers:	Digital (DEC)	PDP 11/73	
Communications:	Ericsson	C600 Verscom	
Software:			
Comm.	Ericsson	Taxi-80	Guide-90
On-board equipment:			
Terminal:	ABB	LMT	
Taximeter:	ABB	LMT	
Radio:	Ericsson	C600 Verscom	
Printer: N/A			

Special features: Elderly/Handicapped and ride-sharing services offered.

Personnel:

DRIVERS:		CENTRAL:	
Total:	94	Dispatchers:	N/A
Owner-drivers:	79	Management:	N/A
Renters:	N/A	Technical support:	N/A
Employees:	N/A		

External Technical Support: ABB installation/product support.

4.2.6.4 System History

Initial project discussion: N/A

Service start-up: 1986, 1993 (phase 2)

Initial objectives: N/A

4.2.6.5 Economic Summary

Total (estimated) cost: ≅ NKr 8M

Equipment cost:	**Item**	**Cost**
CENTRAL	Computer (main/host)	N/A
	Computer (terminals)	N/A
	Communications	N/A
VEHICLE	On-board terminal (MDT)	N/A
(per unit)	Radio	N/A
	Taximeter	N/A
	Printer	N/A

Remarks: Central equipment + MDTs purchased in 1986 at NKr 6M, Taximeters and printers upgraded in 1993 for NKr 1.4M.

Financing:

Amount self-financed: Initial 1986 purchase: 0%
1993 purchase: 100%

Other costs:

Monthly rental/service charge (to drivers): NKr 1200

4.2.6.6 System Performance

Initial obstacles: N/A
Major plusses: N/A
Major minuses: N/A

4.2.6.7 Planned Next Steps

Near term: Taxisentralen Drammen is planning to implement a new communications system in the next 2-3 years.

Long term: N/A

4.2.6.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to yours or similar technology?"

   Yes we would encourage the use of a similar technology, we are very satisfied with our Taxi-80 system.

4.2.7 Linkoping Taxi Economic Union

4.2.7.1 Operator Information

City/Country: **Linkoping**/Sweden

Service area:
- Size: 30 km^2
- Population: 100,000

Number of Taxis: 89

Average radio calls/ day (total): 1,500

Operator type: Private service (owned by drivers)

4.2.7.2 System Overview

A first-generation Taxi-80 system configured on a base of multi-supplier in-taxi mobile equipment.

4.2.7.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Volvo/Ericsson	Taxi-80	
Computers:	Digital	PDP 11/73	
Communications:	Ericsson	Verscom 604	
Software:			
Comm.:	Ericsson	Taxi-80	
Admin.:			
On-board equipment:			
Terminal:			Various different types-unspecified
Printer:			Various different types-unspecified
Taximeter:			Various different types-unspecified
Radio:	N/A		

Special features: Ride-sharing, Elderly/Handicapped, package delivery and other specialized micro-services.

Personnel:

DRIVERS		CENTRAL	
Total:	90	Dispatchers:	10
Owner-drivers:	74	Management:	3
Renters:	N/A	Technical support:	N/A
Employees:	17		

External Technical Support: None.

4.2.7.4 System History

Initial project discussion: 1983

Service start-up: 1984

Initial objectives: Not specified.

4.2.7.5 Economic Summary

Total (estimated) cost: SKr 4 M (2M mobile equipment).

Equipment cost:

	Item		Cost
CENTRAL	Computer (main/host): Computer (terminals): Communications:		SKr 2M for all 1984 computer and comm equipment
VEHICLE (per unit)	On-board terminal (MDT): Radio: Taximeter:		SKr 2M for all mobile equipment purchased in 1984
	Printer:	N/A	
	Total per-unit(est.):		$10k*

Other costs:
Monthly rental/service charge (to drivers): N/A

4.2.7.6 System Performance

Initial obstacles: Original management no longer present thus unspecified.

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* In 1994 US$ as estimated by operator.

Major plusses: Good guidance/routing function.
Reliable (system failures rare).
System user-friendly and easy-to use.
Acceptance is high among all concerned, thus are wary of change.

Major minuses: System is reaching its limits - difficult to improve upon incrementally.
Difficult to integrate administrative systems and to manipulate statistics.
Considered inflexible and no longer adapted to the operators needs.

4.2.7.7 Planned Next Steps

Near term: Looking to switch to a PC-based system, possibly satellite-linked.
Cooperating with Norkoping Taxi to find a compatible system.

Long term: Would be interested in a Sweden-wide collaboration to move towards one compatible system.

4.2.8 Hamburg Hansa Funktaxi eG

4.2.8.1 Operator Information

City/Country: **Hamburg**/Germany

Service area:
Size: 31 km^2
Population: 1.7 Million

Number of Taxis: **600**

Average radio calls/ day(total): 7,000-8,000 (12-13 trips per car)

Operator type: **Cooperative**

4.2.8.2 System Overview

An Indelco AG "Simple" taxicom system*.

4.2.8.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Indelco AG	30/40	

* See Indelco AG operator profile.

Computers:	NCR	Tower 75	Host
	Wyse		PC (x 3)
Communications:	Telenorma	TB 40	
Software:			
Comm.:	Austrosoft	6.7	
Admin.:			Self-developed

On-board equipment:

Terminal:	Indelco	MDT 4030	
Radio:	*idem*		
Taximeter:	Kienzle, Hale, Halda		
Printer:	none		
Other:	Credit-card capabilities		Planned for 2nd trimester 1995

Special features: None.

Personnel:

DRIVERS:		CENTRAL:	
Total:	1,400	Dispatchers:	22 (in shifts of 4-5)
Owner-drivers:	480	Management:	3
Renters:	610	Technical support:	1
Employees:	---		

External Technical Support: Local workshop selected in conjunction with Indelco.

4.2.8.4 System History

Initial project discussion: 1980/81

Service start-up: 1990/ 1991

Initial objectives: Improve driver conditions (reduce noise, stress);
Improve customer service.

4.2.8.5 Economic Summary

Total (estimated) cost: DM 2.6M

Equipment cost:	**Item**	**Cost**
CENTRAL	Computer (main/host):	DM 170 000
	Computer terminals - 18:	DM 90 000
	Communications:	DM 220 000

VEHICLE (per unit)	On-board terminal (MDT):	DM 1700
	Radio:	DM 2200
	Taximeter:	N/A
	Printer:	N/A

Research and Development costs: None.

Financing: Amount self-financed: 100% of project.

Other costs:

Monthly rental/service charge (to drivers): DM 70 per month for a 72 month subscription.

[Other] Cooperative fee: DM 400 per month

Table 4.2.7-1
Cost improvements - Hamburg

	Without data radio	With data radio	Percentage Improvement
Cost per order	DM 1.50	DM 1.10	30%
Orders per dispatcher	40 per hr.	79 per hr.	98%
Number of dispatchers	35	22	-38%
Dispatchers reported sick	11,424 hrs./yr.	1,690 hrs./yr.	-325%
Control room Budget	DM 1.5 M	DM 1 M	-35%

4.2.8.6 System Performance

Initial obstacles: Driver/Operator resistance to new technology (dissipated after Indelco presentation of system).

Major plusses:

- Offered opportunity to revamp management;
- Decentralization of decision making;
- Financing was made available (loans could be raised);
- Improved working conditions in car and central (much more quiet);
- Reduced absenteeism - attributed to a more agreeable workplace, absentee rate dropped from 17 % in 1990 to less than 5% in 1991.

Major minuses: Loss of specific driver/dispatcher knowledge ("none of us would be able to work with radio dispatch") - circumvented by specific area division (per dispatcher); isolation of drivers (no contact with other drivers/ dispatch)

4.2.8.7 Planned Next Steps

Near term: Automatic call boxes; credit-car-reading and accounting system; automatic recall ('call-out') system.

Long term: Complete separation of data and radio waves.

4.2.8.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

   YES !!!!!!

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   "We don't think that the state-of-the-art can be much improved. Data volume seems too big to be managed by satellite."

4.2.9 Glasgow T.O.A.R.S. Ltd.

4.2.9.1 Operator Information

City/Country: **Glasgow**/Scotland

Service area:
- Size: N/A
- Population: 630,000

Number of Taxis: **480**

Average radio calls/ day(total): 3,500-4,000

Operator type: **Cooperative**

4.2.9.2 System Overview

Recently installed Gandalf MDCS system

4.2.9.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Gandalf/GMSI	MDCS	
Computers:	Intel		PC-based
Communications:	Gandalf		Personalized NCC
Software:			
Comm.:	N/A		
Admin.:	N/A		
On-board equipment:			
Terminal:	Gandalf	MDT 40(01 or 20)	
Radio:	N/A		
Taximeter:	N/A		
Printer:	N/A		

Special features: 70% (336) of fleet are wheelchair accessible vehicles.

Personnel:

DRIVERS:		CENTRAL:	
Total:	700	Supervisors:	6
Owner-drivers:	430	Management:	5
Renters:	---	Technical support:	--
Employees:	32		

4.2.9.4 System History

Initial project discussion: 1991

Service start-up: July, 1993

Initial objectives: A more efficient ride distribution throughout area served.

4.2.9.5 Economic Summary

Total (estimated) cost: £500,000 (ca. $312,500)

Equipment cost:	**Item**	**Cost**
CENTRAL	Computer (main/host):	N/A
	Computer (terminals):	N/A
	Communications:	N/A

VEHICLE (per unit)	On-board terminal (MDT):	£1000
	Radio:	£400
	Taximeter:	£350
	Printer:	N/A

Financing: Amount self-financed: £200,000 % of project: 40%

Other costs:
Monthly rental/service charge (to drivers): £178.60

4.2.9.6 System Performance

Initial obstacles: Frequent system seizures, screen freeze and slow-downs.

Major plusses: Has increased radio dispatches, cash (22%) and accounts (8%).

Major minuses: Only one voice channel.

4.2.9.7 Planned Next Steps

Near term: Purchase new radios.

Long term: N/A

4.2.9.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

   "Yes. The initial start-up is very hard work but worth it."

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   Perhaps we will see the implementation of Automatic Vehicle Location systems.

4.2.10 Paris Taxi Bleus

4.2.10.1 Operator Information

City/Country: **Paris**/France
Service area:
Size: 1,600 km^2

Population:	12 million
Number of Taxis:	**2,000**
Average radio calls/ day(total):	16,000
Operator type:	Private service

4.2.10.2 System Overview

An Indelco AG system (cf. Indelco profile) specially configured to the clients needs through a technical partnership with Pragmatic SA of Paris integrating GPS and an intricate mapping system.

4.2.10.3 Present System Configuration

Configuration	Supplier	Model	Remarks
Global system:	Indelco	/Pragmatic	
Computers:	Intel-based	Pentium 90	30 PCs
Communications:	Indelco	DBS 150	Base station
	Indelco	DDTI	LAN manager
Software:			
Comm.:	Pragmatic	P14X	Fleet management (taxi and bus)
Admin.:	Pragmatic	P14X	Admin. and accounting
On-board equipment:			
Terminal:	Indelco	MBGC	
Radio:			Integrated part of MDT
Taximeter:		Various	Kienzle e.g.
Printer: N/A			
Other:	Trimble	GPS	

Special features: System makes use of an intricate mapping system positioning taxis with a deviation of under 300 meters from actual position.

Personnel:

DRIVERS:		CENTRAL:	
Total:	2,000	Dispatchers:	60
Owner-drivers:	1,500	Management:	10
Renters:	500	Technical support:	3

Employees: ---

External Technical Support: 5 persons from Indelco and Pragmatic.

4.2.10.4 System History

Initial project discussion: June, 1992

Service start-up: September, 1995

Initial objectives:

- Develop a larger client base
- Be able to offer a better and more rapid service
- Reduce stress in central and in taxis
- Reduce noise and errors due to vocal dispatch
- Reduce deadheading
- Increase driver security

4.2.10.5 Economic Summary

Total (estimated) cost: 30M FF

Equipment cost:	Item		Cost
CENTRAL	Computer (main/host):		100,000 FF
	Computer (terminals):		200,000 FF
	Communications:		400,000 FF
VEHICLE (per unit)	On-board terminal (MDT):	ü	14,000 FF
	Radio:	þ	part of MDT
	Taximeter:		Various
	GPS		2,000 FF
	Printer:	1,000 FF	

Research and Development costs: None (externally developed).
Financing: Amount self-financed: 100% of project.
Other costs:

- Maintenance is approximately 10% of total cost.
- Monthly rental/service charge (to drivers): 1,400 FF
- Indelco guarantees new versions of software as they come on-line as part of a 10% annual software maintenance contract.

Return on investment: Conservatively estimated at 7 years if market share rests unchanged.

4.2.10.6 System Performance

Initial obstacles: Initial tests will begin with 10 taxis 3/95, 400 taxis 5/95 and complete operations, 2000 taxis, planned for 9/95.

Major plusses: System will use latest model MDT integrating GPS and new software.

Major minuses: Less channels per vehicle due to the use of GPS (which necessitates one dedicated channel).

4.2.10.7 Planned Next Steps

Near term: Magnetic card swipe with printer (end of 1995).

Long term: Implementation of a computerized routing system which will indicate the ideal and alternate routes to the driver. Partnerships, information and data base sharing with other taxi companies from other regions and countries in order to form a network and be able to offer more services and simple billing.

4.2.10.8 Commentary

1. "In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

   "Of course!"

2. "The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

   Communication compatibility with other peripherals and means locally and around the world like credit card links, traffic evaluation information, and CD ROM with city maps.

4.3 Findings and Conclusions of Main Actors

While not all of those involved in the survey have recorded the same responses, the results reported by the different parties affected by TaxiCom systems have either been broadly the same or have overlapped considerably. This report considers any comments received at least three times from operators, drivers or passengers as general comments. Otherwise any specific remarks will be found in the corresponding profile - which may be of general interest to our readers. The reactions that was received to TaxiCom in this report are broadly similar to those that were reported on in 1985, with a few exceptions which will be remarked upon later.

Obviously the rapidly spreading use of TaxiCom by operators is the best attestation to its value and success. At the time of compilation of this report, 10 new deployments we located that were underway in Europe. Also, approximately the same number of operators were looking to replace or upgrade their current TaxiCom system.

Overall a pattern has emerged along the following lines:

- When first implemented the TaxiCom system often encounters the initial resistance of a certain proportion of dispatchers and drivers alike.

- However, as actual hands-on experience accumulates, within a short time (usually weeks), sentiment generally turns to an embrace of the technology.

- The reduction in stress and noise that follows the change from voice to a data messaging and communications improves working conditions for all and notably reduces absenteeism among dispatchers.

- Operators find that manageability has greatly improved from the human and accounting perspectives. Those offering a private service in which drivers pay to hook up to their system have been able to change the shape and essence of their business, i.e. instead of courting drivers, they find themselves courted.

- Productivity gains are made by dispatchers, call-takers, and drivers. This has most often resulted in a reduction of personnel in the Central (which is, of course, positive or negative depending on whether you are management, an employment-concerned agency or the displaced worker) or an increase in volume per existing personnel.

With time, a strong dependence on the system is developed as the old manual dispatching practices are forgotten by drivers, dispatchers and management alike.

The following are the findings of the reported hands-on results of the European TaxiCom experience, for the period of 1979-1995 from four different perspectives. Management, Personnel, Drivers, Passengers, and some Lessons for the Future.

4.3.1 Management

Most operators report that TaxiCom has increased their market share, improved service to clients (passengers as well as drivers), reduced personnel costs, cut back on absenteeism, and solved many problems concerned with record-keeping and accounting. Indeed a general expression of increased "system manageability" has been reported, which extends to the accounting and record-keeping aspects as well as the human behavior with considerable improvements in efficiency reported on both levels.

Some of the more frequent remarks have been:

- Increases in market share and/or trip volume[13].
- The increased overhead resulting from the initial investment and operating expenses is compensated with increases in generated revenues, productivity and reduced personnel costs.
- Return on investment has been estimated at 2 1/2 - 5 years for large operators and from 3-7 years for operators serving smaller communities[14].
- Private service operators have reported substantial increases in driver demand for their services and thus allows operators increased selection of drivers and reduced driver turnover.
- Costly driver and dispatcher training programs are compensated by increases in productivity and efficiency.
- Accounting and record-keeping tasks are more easily and efficiently handled. Reports are easily generated and *a posterior* analyses can be undertaken with relative ease.
- Better real-time information is available on the number of taxis available.
- Additional services can be offered with TaxiCom such as group billing, personalized services and call boxes.
- Allows (and is often prerequisite to) participation of Scandinavian operators in social services, which may constitute up to half of all trip volume.
- Often allows a reduction of personnel or a lower personnel to trip volume
- Large operators can differentiate the posts (call-takers vs. dispatchers) or the service (business service driver vs. regular) to motivate employees.
- Improved service during peak hours.
- Better driver distribution throughout the service area.
- System reliability is high and total failures of more than a few minutes are rare once the system is fully operational).
- Most companies say they will never go back to traditional (vocal) dispatch.

4.3.2 Personnel

With TaxiCom, the Central becomes a much more tranquil and less stressful environment to work in. Dispatchers are no longer exposed to an environment in which they are bombarded with calls from drivers, and no longer have to yell and continuously repeat information to drivers. In addition, the tasks become easier as all street names are computerized and trip allocation is done by the computer.

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[13] Taxi G7 attributes its increased market share in a declining Paris market to TaxiCom. Today competitors, e.g. Taxi Bleu, are implementing similar systems specially in order to be able to compete with G7 and gain market share.

[14] This is a very tricky calculation, especially where the new and extended taxi operations begins to deliver "services" to the community which may or may not be compensated directly. Thus where operators carry new passengers at full price (e.g. elderly and handicapped), the payback period can be considerably shortened. If on the other hand, the new "output" is improved (but uncompensated) quality of service and working conditions, reduced traffic and pollution, this will not usually influence the payback period directly. This we believe is wrong - it should!

Other factors:

- Almost all operators have cited reduced absentee rates as a result of TaxiCom.
- Dispatchers and call-takers have improved their productivity and efficiency.
- Less skill is involved for both dispatchers and call-takers[15].
- On-the-job training allows almost anyone to fill the post of dispatcher which was once a knowledge-specific task.
- More calls can be processed per hour and per operator, thus reducing the number of unhandled calls that went to competitors.
- Reduced driver pressure on individual dispatchers.
- TaxiCom often allows the reduction of call-takers and dispatchers but often implies the addition of qualified (and thus better paid) technicians.
- Less favorably, fewer personnel know how to manually dispatch in case of system breakdown.

4.3.3 Drivers

The most cited topics from drivers were stress reduction, fairer trip distribution, reduced competition between drivers, increased revenue, and improvements in the quality of information provided. But all also cited with regret the fact that "traditional taxi skills" were being lost. Many drivers were skeptical of the systems initially and some even left their companies to join services using manual dispatch. The majority, however, have expressed content with TaxiCom and prefer this mode of dispatch to the old forms.

Some of the more oft-cited driver-related remarks:

- With data communications the taxi is quieter, the driver does not need to constantly concentrate on what is being said on the radio, the driver accepts/refuses trips discreetly, receives trips in his vicinity and thus finds the job considerably less stressful[16].
- Trips are distributed more evenly and fare stealing is almost completely eliminated.
- Dispatcher favoritism (real and imaginary) is eliminated and thus so is driver-dispatcher tensions.
- Errors are reduced and drivers do not find themselves at incorrect locations due to dispatcher errors.
- More information can be transmitted and the driver does not have to memorize or write anything down.
- Liberty is increased as drivers can choose the location/area in which they work.
- Work location can be chosen according to the number of drivers already logged in to a specific area, areas with high demand-to-driver ratios, or other criteria - thus increasing trips per hour worked.
- Issuing receipts is easier and faster.

[15]It is no longer necessary for a dispatcher to know by rote the map of the entire service area.

[16] Drivers in low-density regions (e.g. Nordic areas) who initially embraced the increased tranquillity of their taxi have increasingly complained of a feeling of loneliness and isolation due to a lack of communication with fellow drivers and the central.

- Better drivers (i.e. consistent, multilingual, friendly) can be appointed to special services (e.g. "Business Class") thus increasing revenue.
- With systems offering credit card or other non-cash payments the driver can accept more trips and can carry less cash thus improving revenue and safety.
- The cached emergency buttons and the different emergency features improve driver safety .
- With less stress and better earnings, drivers can be more accessible for passengers and, eventually, 'social services' (which can, in turn, lead to increased earnings).

4.3.4 Passengers

With the advent of TaxiCom, passengers have come to expect better service and have developed something that has heretofore been rare in the taxi industry - "client loyalty". The outcrop of services offered and the various payment schemes allow the passenger increased liberty, reduced waiting times and personalized service.

Typical remarks have been:

- Wait times are reduced considerably and estimated more precisely[17].
- Call times are reduced and repeat or permanent clients can often order a trip within seconds.
- Hotels, clubs and other large businesses can offer their clientele automatic call boxes which order taxis with the push of a single button.
- Clients can specify the type of taxi desired (specially equipped, specific language-speaking driver or minivan.).
- Trips are more tranquil with the absence of radio chatter.
- Receipts are computerized, more easily obtained and contain more information.
- Clients can have service tailored to their needs (e.g. taxis on certain days, at certain times).
- Elderly and handicapped passengers are better served.
- Recipients of certain social services (especially in Scandinavian countries) are constrained to use taxis with TaxiCom due to hook-up to public services, billing and invoicing.

4.3.5 Lessons for the Future

Although for the most part TaxiCom is advantageous to all concerned there are a certain number of points related to these systems that we advise the reader to keep in mind:

[17] Several operators have estimated the reduction in waiting times. The low end of the spectrum is 3 times less and the high end is 10 times less waiting time. At first this catches clients unaware as taxis are often on the scene more quickly than expected.

- The implementation of TaxiCom is not often painless; initial software bugs and hardware failures are not rare. Almost immediately however system failures become rarer and are of shorter duration when they do occur (a good backup system is indispensable!).

- In the case of system failure traditional voice dispatch can be used, however personnel has become less adept at manual dispatch as dependence on TaxiCom grows. A good TaxiCom system should thus assure that reverting to manual dispatch is as painless as possible for operators. Operators should ensure the 'manual' proficiency of their personnel.

- Market share has increased for all operators surveyed following implementation. Until now all companies surveyed have been the first or second operators to introduce these systems into their communities. Foreseeably, the proliferation of TaxiCom systems within a given community may influence such factors as market share growth[18], rate of return on investment and call volume. Some changes may be significant and others may be slightly modified, therefore, operators should avoid regarding past results as absolute givens. For example, in small communities an increase in trip volume is seen initially, but becomes stable, thereafter.

- The increase in the "modularity" of TaxiCom has also seen an increase in the number of suppliers. Operators who have constructed their systems from many different suppliers have often found that these firms are no longer around a few years later when hardware fails or an upgrade is desired. However with the reconfiguration of large suppliers through mergers and acquisitions, size is not necessarily equivalent with a consistent presence in the TaxiCom market either. Operators should attempt to discern a supplier's mid-term plans and assure the continuity of service in their contracts.

- Although operators are often tempted/advised to scrap their existing manual system in turning to TaxiCom, many of these systems can be installed using existing equipment and software, thus reducing initial costs and investment.

- Several companies can consolidate or share one computing system for cost savings. Significant savings can be attained through group purchasing bids or through 'multi-company options' offered by some suppliers.

Once TaxiCom is installed significant upgrades can usually be made with simple software additions necessitating little or no additional hardware and relatively minor costs.

[18] As communities learn of TaxiCom's advantages and potential one can expect to see changes in transport habits and thus an increase in overall market size. Potential thus exists for on-line operators to increase market share or maintain their piece of a "growing pie".

CHAPTER 5 - The Changing Supply Scene

5.1 Overview

Much has transpired on the supplier side of the industry since 1985. Not only have the firms present in the market changed significantly but the modalities of supply have been transformed as well.

The industry has undergone substantial structural and conceptual change. Structural change is due, in large part, to the various mergers, acquisitions, partnerships, bankruptcies and voluntary exits from the market of the various TaxiCom, telecom and computer suppliers which make up the essence of the industry. Together with a change in concept - from integral units to modular configurations (often laid over existing systems instead of replacing them), the industry has been transformed both quantitatively and qualitatively.

Of the larger original suppliers several have become part of international "telecom majors", who subsequently concluded that the taxi market did not have sufficient potential to merit specific technology and marketing programs. Others found themselves with TaxiCom products as a result of acquisitions or mergers. The result, in several cases, was product lines neither suited for the specific requirements of the taxi industry and the demands of operators, nor in step with the rapid progress the accompanying technologies were making.

The smaller original suppliers included several operators who had successfully developed their own in-house systems, and who subsequently attempted to market the acquired knowledge and products to other operators and cities. Most of these attempts were unsuccessful, due essentially to errors in strategy but also, admittedly, to a lack of sufficient economies of scale (and a somewhat naive view of the difficulties of international marketing in such a demanding environment). Other successful attempts were left in their infant stage, as they implied too large of a departure from the intended business.

Today, TaxiCom embodies computer dispatch, mobile data transmission, fleet management, data dispatch, trunked communications systems, "smart" taximeters, cellular communications, GSM, magnetic card readers, GPS, and AVL among others. All suppliers of these or related technologies are potential TaxiCom suppliers. TaxiCom can now be readily configured in modular form, by various for both hardware and software, particularly owing to the replacement of mainframes with PCs and advances in the various constituent technologies.

Systems are now tailored to specific needs and budgets, and more often than not configured with equipment emanating from multiple suppliers. It is not uncommon to find communications equipment, computer equipment, taximeters, printers, and credit card readers being added at different stages in the implementation of a TaxiCom system or its upgrade. The immediate

result is that smaller and more specialized suppliers are able now to enter the market and operators are no longer bound to one supplier for the life of their systems.
As hardware becomes less costly, high-performance software takes on increasing importance. More partnerships between suppliers of hardware and software have appeared. One Europe-wide supplier offers its hardware and develops software in conjunction with software firms located in the vicinity of the operator. Language problems are thus avoided, software is operator-specific, debugging becomes simpler and the quality and speed of post-installation maintenance and service is ensured.

The various existing or potential suppliers who have installed TaxiCom systems and/or major components in Europe and the leading suppliers in North America, Australia, New Zealand and Japan have been contacted. Those suppliers who have responded with enough information with which to construct a "Supplier Profile" (consisting of more than just marketing materials) have been included in this report. The reports have been constructed with the help of marketing and sales materials, manuals, interviews with technicians, on-site visits[19], formal and informal conversations, quarterly reports and other official publications, and database information.

[19] For cross-checking purposes the EcoPlan team vivited the following operators: Taxis G7 and Taxis Bleus in Paris, Gothenburg, Berlin, Vienna and the planned sites in San Sebastian.

The following table lists the main suppliers in the European TaxiCom market:

Table 5:1-1 - Leading European TaxiCom Suppliers

#	Supplier	Integral TaxiCom system	Communications system	Hardware	Software
1	Alcatel	no	yes	yes	no
2	Auriga	no	no	no	yes
3	Ericsson	yes	yes	yes	yes
4	GMSI Inc.	yes	yes	yes	yes
5	Indelco AG	yes	yes	yes	yes
6	Micro Dynamics Corp.	no	no	if needed	yes
7	Microtek	yes	yes	yes	yes
8	Motorola	yes	yes	yes	yes
9	Nokia	no	yes	no	no
10	Philips	no	yes	yes	no
11	SMS	yes	yes	yes	yes
12	Frogne A/S	no	no	yes	yes
13	Taxitronic	no	no	yes	yes

A profile has been prepared for each of these suppliers with a breakdown, where possible, of the different technologies offered, the possible configurations and costs and the principal contact for further information. The various profiles though similar in nature differ in content and should be careful, read. An attempt has been made to orient the profiles so as to present a global and in-depth coverage of the different aspects of TaxiCom. Thus each profile is an overview of the specific supplier but from a slightly different vantage point. Some examples of the specific aspects developed in individual profiles and things to look for are:

SMS: Different technical components involved and detailed explanation of their functions;

Indelco: Different available configurations of turnkey operations;

Auriga: Software breakdown and modular approach to TaxiCom;

Philips: Hardware in various configurations;

Gandalf: MDTs, various software and ancillary options;

Ericsson:	Indications for structuring and programming necessary databases and dispatching software modalities;
Motorola:	Market presence and auxiliary technologies;
Micro Dynamics:	Breakdown of software components and costs.

Essentially the profiles overlap in structure, but each accentuates a different facet. Thus readers, regardless of their level of familiarity with TaxiCom, have the opportunity to discover the many different possible configurations of these technologies, as well as the possibility to deepen their knowledge of a given aspect, if so desired. For example, some profiles are rather technical in nature while others are geared to a more general explanation of the software, architecture, options and services available.

5.2 Supplier Profiles

5.2.1 Spectronics Micro Systems

5.2.1.1 Overview

Division: Mobile Communication systems
Product type: Mobile voice and data

SMS is a provider of information technology and mobile communications systems which use voice and data transmission over radio. SMS appeared on the market at the same time as the first generation of taxicom products over a decade ago but only began supplying taxi specific products in 1990 . Services include system design, project management, radio propagation prediction and survey, installation, system testing, and support.

5.2.1.2 System Configuration

SMS designs computer aided dispatch and accounts systems specific to a taxi fleet. Hardware is manufactured and sourced by SMS and software can be taken from a portfolio of SMS products or developed in-house to meet client specifications. Pioneer, a recently developed computer dispatch software, runs on a Windows platform. SMS has also developed a GPS taxicom system, initially named Path-Finder, which will be commercially available by the end of 1994. It should be noted that SMS has not actively developed generalized products for the taxi industry. This is due to the perceived disparity of needs and configurations of the different taxi operators which results in ad hoc configurations using SMS software and hardware in modular form.

- **Mobile Data Terminals (MDTs):**
  Two different MDT models are offered.

SMS S650 MOBILE DATA TERMINAL

Illustration PR1-1

The S650 MDT: An 8-line x 40 character backlit LCD display with 12 keys (9 of which are alphanumeric), **(See Illustration PR1-1, above)** The twelve keys can be predefined for task selection. Supports a number of languages including English, Chinese, Thai, Kanji/Kata Kana, Arabic.

Ports: 4 serial ports RS 232C asynchronous (software selectable 75-9600 baud rate) and a serial magnetic swipe port. Three serial interfaces are provided at the rear of the unit to allow connection of auxiliary devices such as computers, keyboards, printers, bar-code readers and AVL systems.

Memory is 256k Bytes, non-volatile RAM. Net transmission speed is 500 characters per second and 8000 baud GMSK. The S650 incorporates a data transmission protocol unique to SMS and is designed to interface directly with several software packages and control systems.

S645 MOBILE DATA TERMINAL

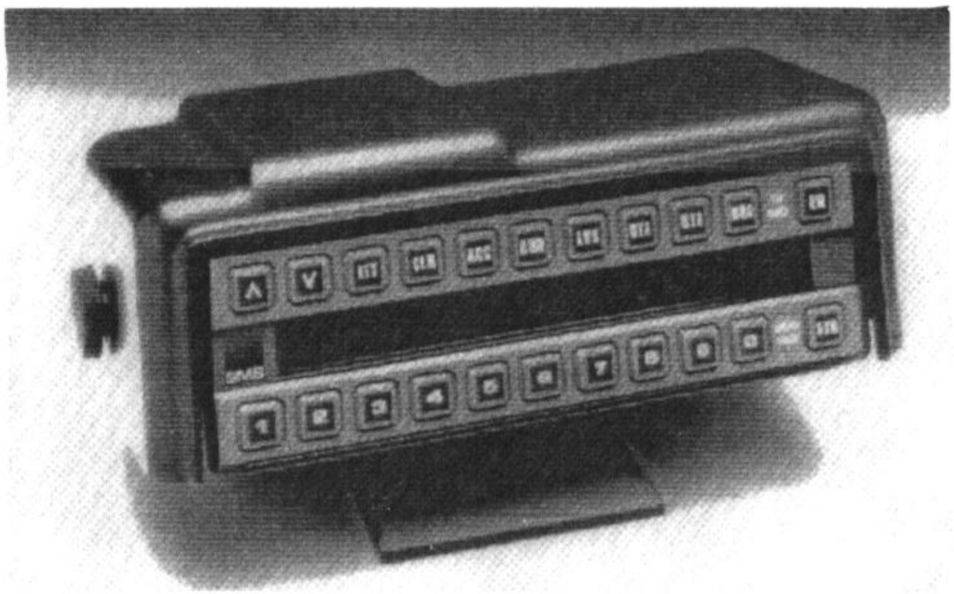


Illustration PR1-2

S645 MDT: This system is designed for use with conventional mobile radio and allows two-way data communication with a remote host over the radio link. On-line processing of data is possible with the help of the same serial interfaces as is found on the S651 model. **(See Illustration PR1-2, above)**

It also has a two-line x 40 character backlit LCD display with 22 backlit keys. These keys provide data entry, including short form alphanumerics, fixed function and status keys which can be programmed to operator specifications. The two lines of the display can be scrolled to view a full page of text. The terminal is multi-tasking (can receive messages while examining/entering others). The S645 incorporates the SPDX data transmission protocol.

Two variants are offered: standard 1200 baud FFSK or the 1920 Baud QPSK. The S645 controls voice use of the radio and mutes incoming data as standard.

Ports: Serial RS232C ASCII asynchronous with a software selectable 75-9600 baud rate. Net transmission speed is 100-160 characters per second (depending on baud rate).

S4033 DATA COMMUNICATIONS CONTROLLER

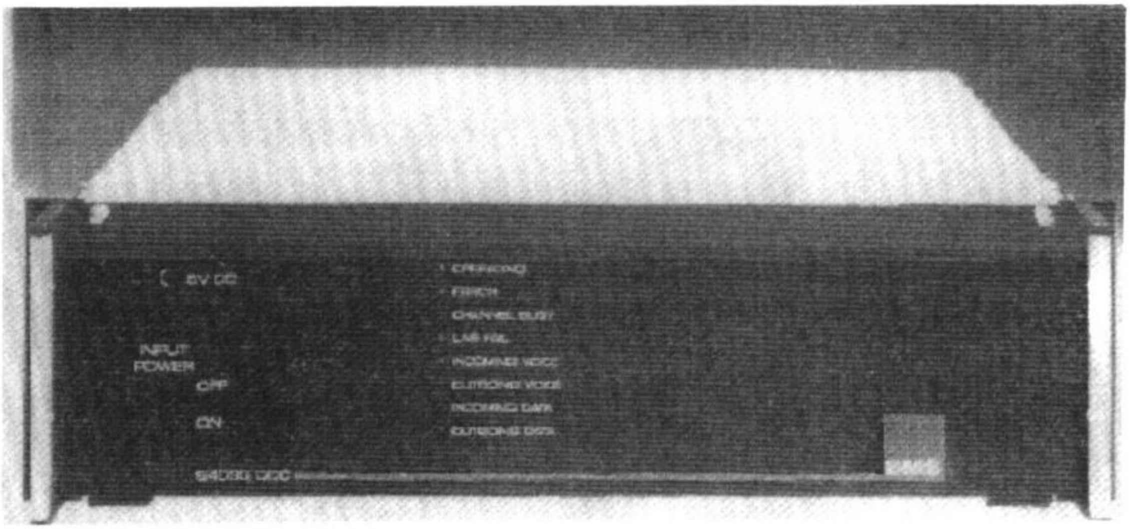


Illustration PR1-3

__Communication Control__

The **S4033 Data Communications Controller (DCC):** (See Illustration PR1-3, above)

As an advanced multi-function DCC, it supersedes the SMS S4012 DCC. The primary function of any DCC is to transmit and receive data messages over a radio link between a user's host computer and a fleet of mobile units (taxis). The DCC undertakes contention, addressing, multiple tries for messages under adverse conditions and error correction. Thus freeing the user's computer. Together with the S4070, the S4033 can act as the core of a taxicom system. The S4033 supports two variants of the SMS air protocol SPDX. The original SPDX uses standard FFSK tone signaling through the radio's audio channel at 1200 baud, and the SPDXII which has an increased on-air data rate and a recommended QPSK modulation.

The S4033 also undertakes the normal functions of arbitrating between voice and data use of the channel and controlling the data flow. This includes prioritization and message buffering, plus fully muting incoming data.

The S4033 can also be equipped so as to act as a remote data reconstitutor. The reconstitutor situated with the base station ensures that error free data tones are transmitted to the MDTs and also ensures that incoming messages are decoded and passed to the land line in an error free format for transmission back to the user's control site. Monitoring signals can be configured so as to monitor items such as transmitter output status, aerial conditions and receiver operation.

Communications protocol is SPDX or SPDXII hybrid forward error protection and handshake protocol with automatic retry. Buffer capacity is normally three outgoing messages. Effective net data rate is 100 characters per second (FFSK) or 160 per second (QPSK).

S4070 MULTIPLEXER/MULTI-SITE CONTROLLER

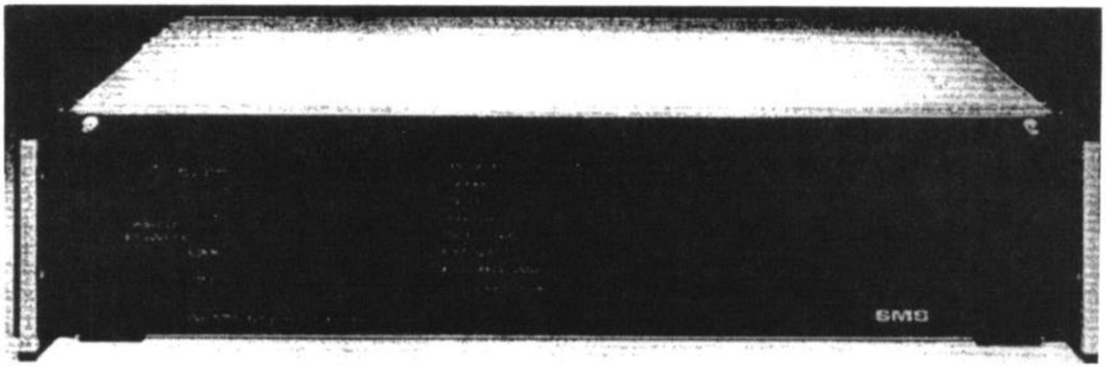


Illustration PR1-4

The **S4070** Multiplexer/Multi-site controller:

The S4070 is a multi-channel serial multiplexer/ multi-site controller for mobile data systems. It is essentially a statistical multiplexer (MUX). It is used to interconnect a user's Command and Control computer to its DCCs - one for each radio site. The S4070 can buffer outgoing or incoming messages in its message store, in order to ensure message reception during peak transmission periods. The multi-site control elements hold a continuously updated table of which base station site is being used currently to serve which taxi. The S4070 provides failure mode detection in its own right and supports failure mode detection and handling throughout the rest of the mobile data system. It has an internal processor and a power supply monitor. If a fault occurs on the operating MUX unit then the standby unit is switched into operation. In addition the MUX polls any SMS equipment to which it is directly connected (e.g. DCCs) and responds with warning messages if any error condition is detected.

The S4070 can also be connected to a suitable network management system, which can send polling messages to ascertain the status of remote communications equipment. Each MUX unit can typically support up to 15 separate radio base stations and 1000 mobile units (i.e. taxis).

Interfaces: Interface is serial RS232C asynchronous to DCC and to host, 1200 or 9600 baud (with hardware flow control) to DCC and 1200,4800 or 9600 baud to host computer.

S2050 VOICE SWITCH UNIT (VSU)

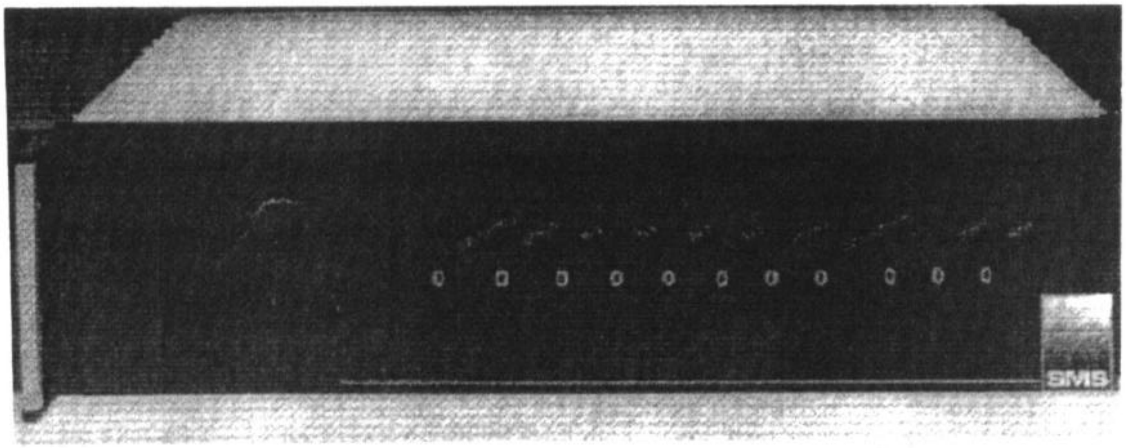


Illustration PR1-5

The **S2050** Voice Switch Unit:

The SMS radio data system allows voice and data to be used on the same channel. The S2050 VSU provides the capability to connect one or more operators to one or more voice/data channels. If only one operator position is required then the simple voice combiner FA3010 model can be used. Up to 32 ports can be fitted, in blocks of 8. Control of the S2050 is via RS232 directly from the S2100 Channel Concentrator Unit which makes all the decisions concerning the routing of voice between operators and channels.

Features: fully digital switching using Digital Signal Processing on two internal PCM highways, up to 32 four-wire ports with line barriers and RJ-45 jacks, built-in 2970 Hz keytone generator, fallback operation which reverts back to a default set of voice paths in the event of a control system failure. Each port has an opto-isolated DC keying input and can be used as either operator ports or radio channel ports.

The PCM data is passed up the input PCM highway and processed by a Digital signal processor (DSP) which sends the results down the output PCM highway. The DSP controls the routing, mixing and keytone generation as well as the DC keying and RS232 interface.

S2100 VOICE SWITCH UNIT (VSU)

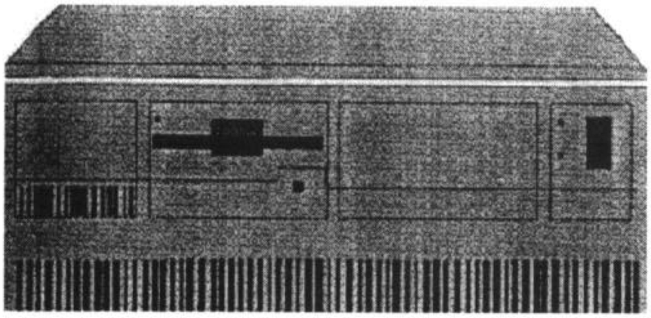


Illustration PR1-6

The **S2100 Channel Concentrator Unit (CCU):**

The S2100 is a channel concentrator for mobile data systems which is used to interconnect the user's command and control infrastructure to a number of Line to Concentrator Gateway (LCG) units - one for each base station. The S2100 buffers outgoing/incoming messages effectively handle peak communication periods. It is intended for use in a radio system based on a cellular frequency plan and allows the various transmitters to be operated independently.

The S2100 also functions as a multi-site controller for a wide area coverage private mobile radio (PMR) system based upon mobile data control. The multi-site functions are similar to those of the MUX. The S2100 can be connected to a suitable network management system. It features up to 16 serial ports, of which 12 are normally available for connection to LCGs, and therefore each can support up to 12 base stations.

Specifications: IBM PC minimum 486, 66MHz, 8 MB RAM, local Bus video card, 3Com Ethernet card (3C509), Digiboard intelligent serial controller (8 port for 5 LCGs, 16 port for 12 LCGs). Interface to LCG is serial RS232C Asynchronous, 4800 or 9600 baud with flow control.

5.2.1.3 TaxiCom installations

Table 5:2-1 TaxiCom Installations

Country	City	Customer	Date installed	Units	Base stations	Remarks/ Costs
New Zealand	Auckland	Auckland Co-op Taxi Society	June 1994	600	4	£500k
Scotland	Aberdeen	Mairs Taxis	Nov. 1993	140	-	£125k
Scotland	Dundee	89000 Taxis	Dec. 1993	80	-	£87k

5.2.1.4 Estimated Costs

The following costs estimates are extrapolated from past SMS installations and may not be indicative as costs may vary largely for similar sized operators according to the configuration of the system, hardware and software needs and other specifications. For this reason SMS does not give cost estimates except on a per project basis.

Table 5:2-2 Estimated Costs

# of TAXIS	Control room (central)	Mobile unit (per unit)	Total
50	Yes	50 x	£60k
500	Yes	500 x	£450k

5.2.1.5 Contact Information:

Mr. Ed Mitcham, Marketing
SMS Ltd.
Bar Hill Business Park
Saxon Way Bar Hill
Cambridge CB3 8SL
England
Telephone: 44 (954) 780888
Fax: 44 (954) 781612

5.2.2 Indelco

5.2.2.1 Overview

Division: Industrielle Elektronik, Data radio systems

Product type: Taxi data radio

Indelco is a Swiss electronics and service company, established in 1975, that supplies private and public sector integrated data radio systems. Offers situation and problem analysis, consultancy and system engineering, turn-key installation, training, and maintenance services. Has established technological partnerships with a number of European manufacturers of software and hardware.

These companies include Austrosoft GmbH (Vienna), CenCom AS (Oslo), Altimex AG (Altendorf), Nelm AG (Mendrisio), Kapsch (Vienna), Hansafunk Taxi (Hamburg) and Pragmatic SA (Paris).

The company's staff breakdown is as follows:

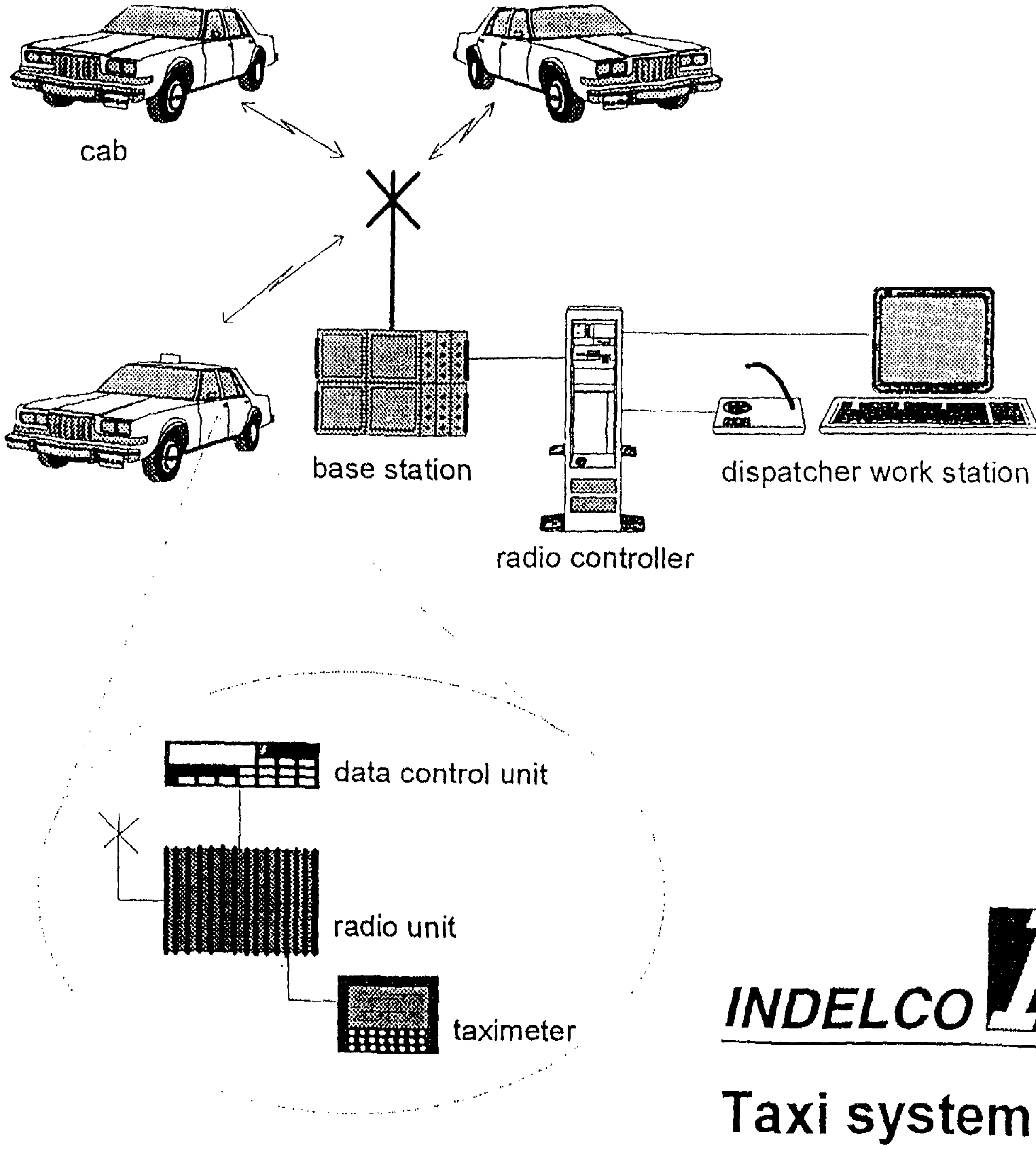
Administration:	10
Development:	12
Project management:	5
Production:	13

5.2.2.2 System Configuration

Although custom-tailored systems are implemented, Indelco typically supplies one of three configurations unofficially classed as 1)Simple Taxi System 2)Taxi System with card reader and printer and 3)Taxi System with GPS. A multi-modal region/country wide data radio transportation system also exists which can be configured as a multi-company option.

Listed on the following pages, with illustrations, are the architectural types used as a planning base for the respective configurations:

* **Simple taxi system**



INDELCO

Taxi system (simple)

Illustration PR2-1

- **Taxi system with card reader and printer**

INDELCO

Taxi system
with card reader and printer

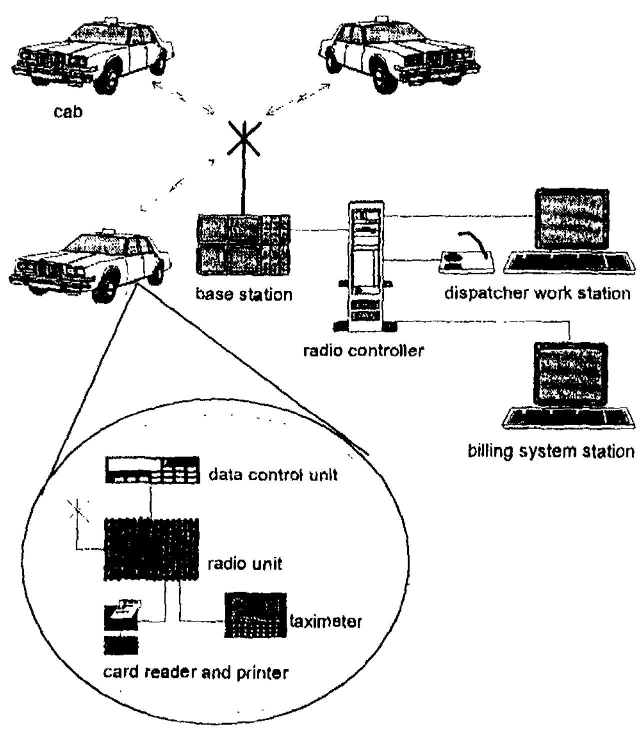


Illustration PR2-2

- **Taxi system with GPS**

INDELCO

Taxi system
with GPS (Global Positioning System)

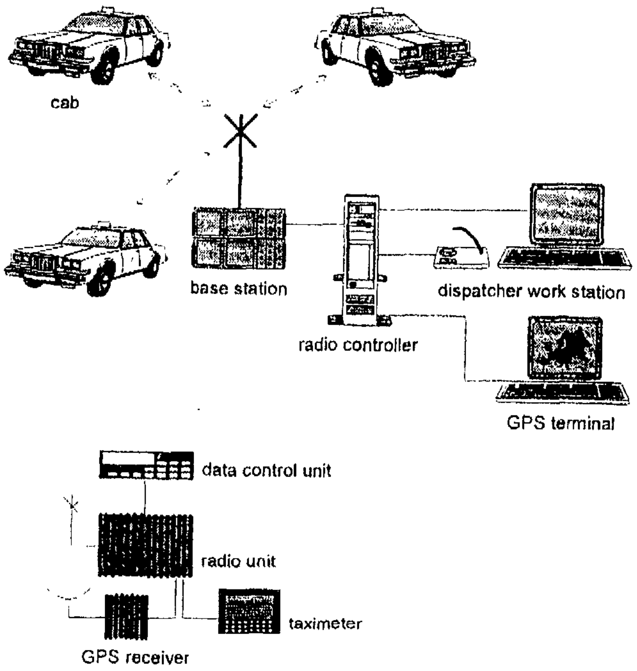


Illustration PR2-3

- **Multi-modal or multi-company option**

INDELCO

Country wide data radio transport system

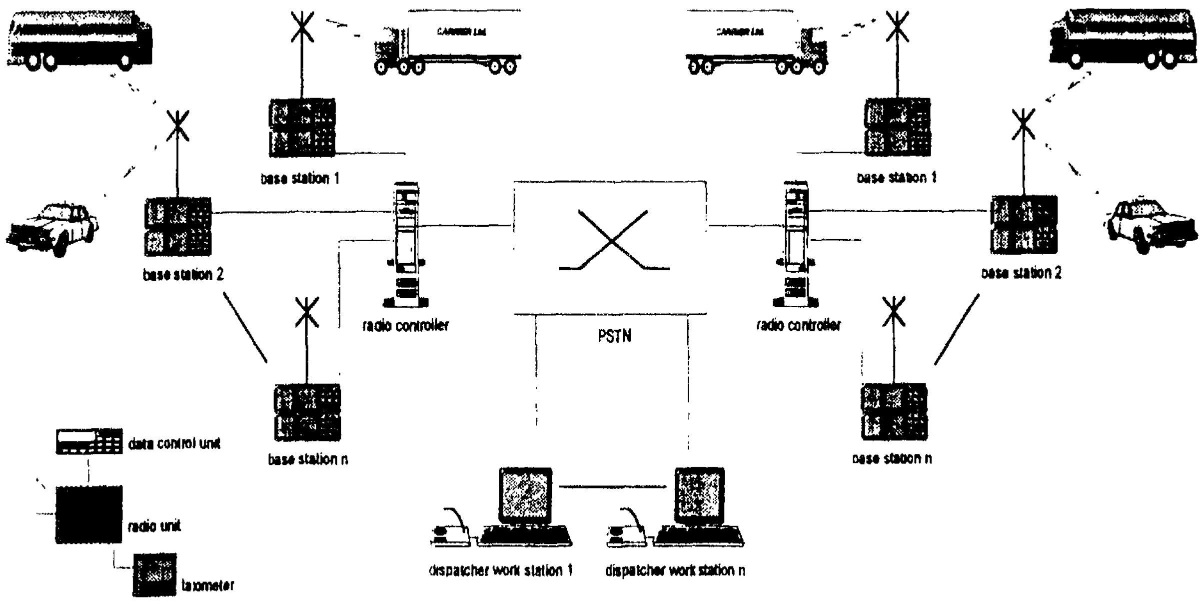


Illustration PR2-4

- **Mobile Data Terminals (MDTs):**

Indelco has used and developed four generations of MDT since 1980. The first generation MDT called DBG was used in conjunction with a Sonab radio unit. In 1984 a DGBA model was developed compatible with a Pfitzner of Ericsson radio unit. DBGB, 1988, was the first MDT unit configured directly to an Indelco radio unit and 1992 saw the development of DBGC.

In 1994 Indelco developed a hand-held radio unit compatible with its taxi systems.

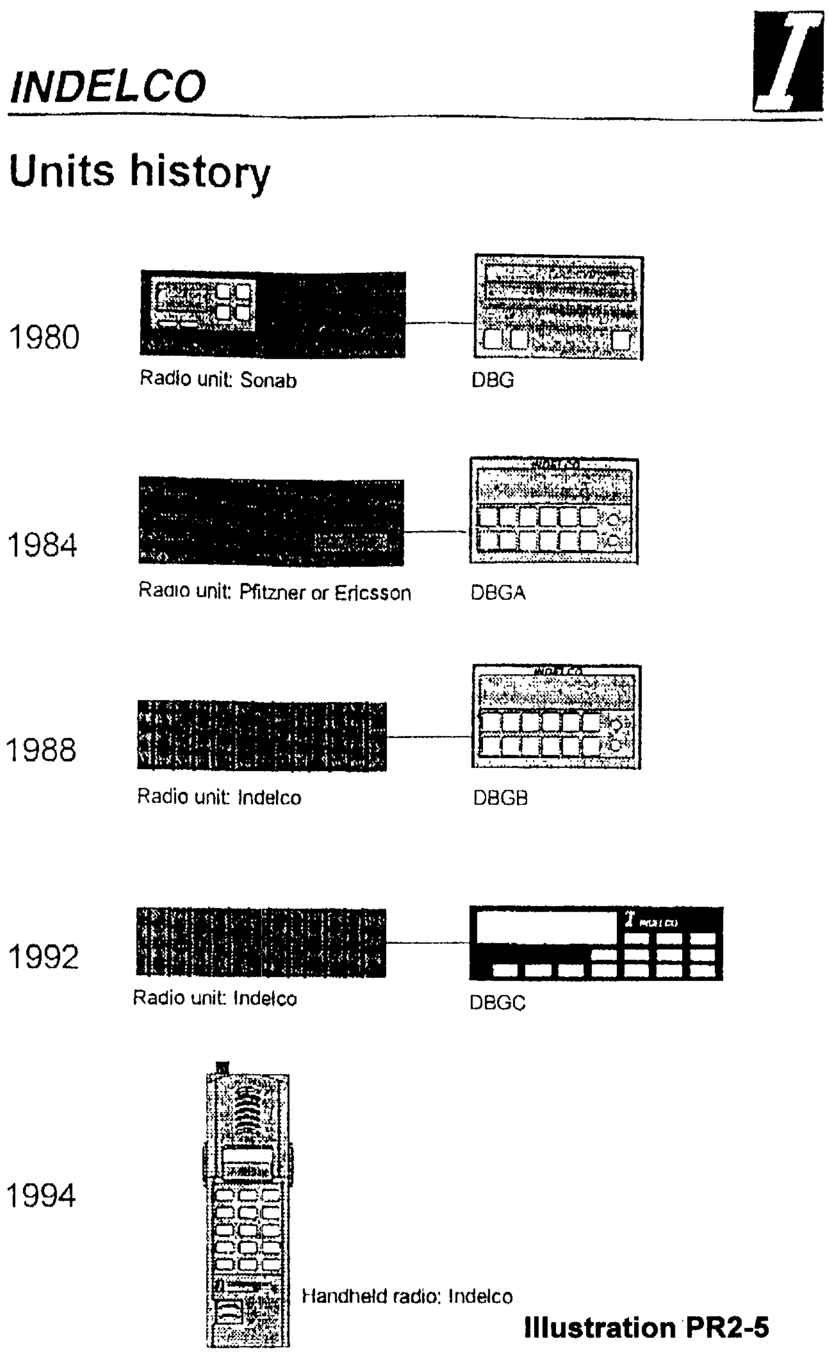


Illustration PR2-5

The DGBC that is currently present in most taxis appears as follows:

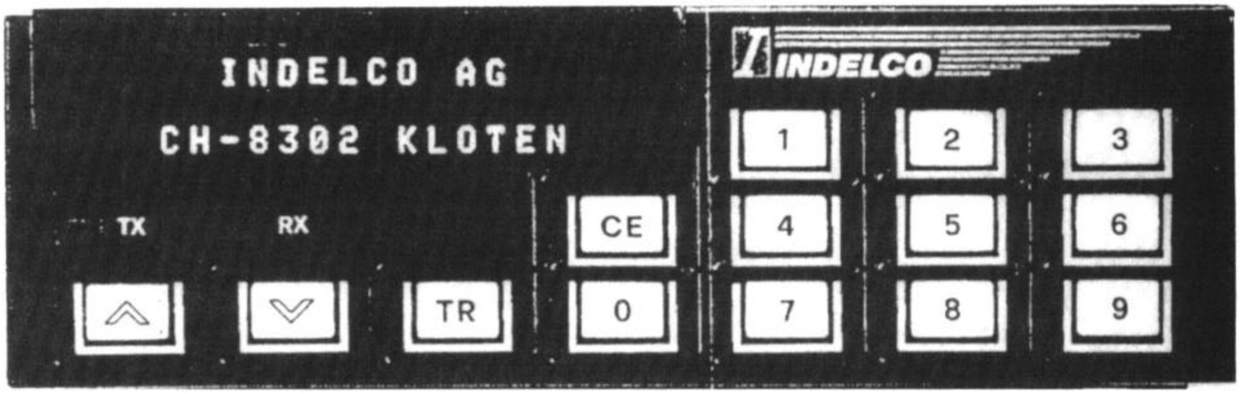


Illustration PR2-6

- **Communication Control**

Indelco has developed a communications system researched initially for public/regional transportation. The system is connected to an MDT called Combo which can send/receive 16 character messages and/or one of 10 pre-programmed messages. Combo operates with 60 semi-duplex channels in the 415-430 MHz frequency range usually necessitating a number of transceivers evenly spread over the service area. Radio interference is still possible but the risk is reduced due to the use of the higher frequencies. Each conversation/transmission is assigned its own channel. Indelco has developed its own transmission modem, the DPSK (most hardware suppliers use FFSK), which speeds up transmission and necessitates less message repetition when used with a Simplex protocol.

5.2.2.3 European TaxiCom Installations

Indelco has implemented taxicom systems in the following countries: Austria, Germany, Benelux, Scandinavia, Switzerland, and France as appears in the following table:

Table 5:2-3 Indelco European TaxiCom Installations

Country	Customer	Date installed	Units	Base stations
Switzerland	TaxiZentrale Zurich	1979	480	5
Austria	WIHUP (Vienna)	1987	1200	5
Germany	Minicar Kiel GmbH (Kiel)	1989	120	1
Austria	City Funk (Graz)	1989	150	3
Switzerland	Co-op of Lausanne Taxis	1991	270	3
Germany	Hansa Funk Taxi (Hamburg)	1991	650	7
Switzerland	TaxiZentrale Basel	1992	150	2
Switzerland	Taxiphone Centrale SA (Geneva)	1992	440	4
Austria	WIHUP (Linz)	1992	31	1
Austria	31300 (Vienna)	1993	850	4
Austria	Vot (Vienna)	1993	850	4
Switzerland	Taxi 2000 AG (Zurich)	1993	350	3
Germany	Taxifunkzentrale 230033 (Frankfurt)	1993	200	3
Austria	Landleruf (Gotzis)	1993	70	1
Austria	Funktaxi 66106 (Salzburg)	1994	25	1
France	Taxi Radio Lyon	1994	270	3
France	Allo Taxi/Taxi Bleus (Paris)	1994-5	2000	8
France	Allo Taxi Nicois (Nice)	1995	400	3

ANNEX: PUBLIC TRANSPORTATION PROJECTS

Indelco has been active in various projects around Europe involving the connection of taxi companies to public transportation systems. Indelco has also installed systems for several (purely) public sector projects:

Table 5:2-4: Indelco Public Transportation Projects

Country	City	Customer	Date installed	Units	Base Stations
Switzerland	Bern	SVB	1986	250	3
Netherlands	Different	COMBO	1992+	8000	250
Switzerland	Bern	RBS	1994	50	17
Switzerland	9 cities	PTT	1992+	N/A	9

5.2.2.4 Profitability: A Case Study

The following table shows the results of the installation of a 1991 taxicom system for the 600 taxis of Hansa Funk Taxi in Hamburg*:

Table 5:2-5 Cost Improvements - Hamburg

	Without Data Radio	With Data Radio	Percentage Improvement
Cost Per Order	DM 1.50	DM 1.10	30%
Orders Per Dispatcher	40 per hr.	79 per hr.	98%
Number Of Dispatchers	35	22	-38%
Dispatchers Reported Sick	11,424 hrs./yr.	1690 hrs./yr.	-325%
Control Room Budget	DM 1.5 M	DM 1 M	-35%

Indelco estimates a 3-4 year return on investment which is the average payback period based on past experience.

5.2.2.5 Estimated Costs

The following are rough cost estimates for an "average" fully configured system:

Table 5:2-6 Estimated Costs

# of TAXIS	Control room (central)	Mobile unit (per unit)	Total
50	500k FF (including software)	50 x 18,000 FF	1.4M FF
500	1.8M FF	500 x 14,000 FF	8.8M FF

Indelco includes a maximum 5 hour "breakdown guarantee" and tele-analysis of system problems. All software and hardware (MDTs) developed and installed by Indelco will be updated without charge as new similar software/hardware is developed.

5.2.2.6 Contact Information:

President: A. Chapuis
Sales/Marketing: P. Cavin or A. Baumann
Indelco AG
Hohstrasse 1

* The following data was supplied by Indelco. See also Hansa Funktaxi operator profile.

CH-8302 Kloten
Switzerland
Telephone: 41 (1) 814-1014
Fax: 41 (1) 814-1214

5.2.3 Alcatel

5.2.3.1 Overview

Division Mobile Communications

Product type: Private Mobile Radio, GSM, DCS

Although Alcatel does not supply taxi-specific products, the Alcatel 900/1800 Basic Network can be applied to fleet management suitable to small taxi operations. This system is an amalgam of the Global System for Mobile Communications (GSM) 900 series and the Digital Communications System (DCS) 1800 series. Alcatel typically supplies private mobile radio, GSM, digital and cellular communication products, which can be applied to fleet management and taxi operations but are not specifically marketed as such.

5.2.3.2 System Configuration

Alcatel 900/1800 is a GSM/DCS based system, fully compliant with the open interfaces as laid out in the GSM/DCS specifications for Europe. With the Alcatel 900/1800 Basic Network Architecture taxicom systems can be configured on the basis of the following flow chart (or a variation thereof):

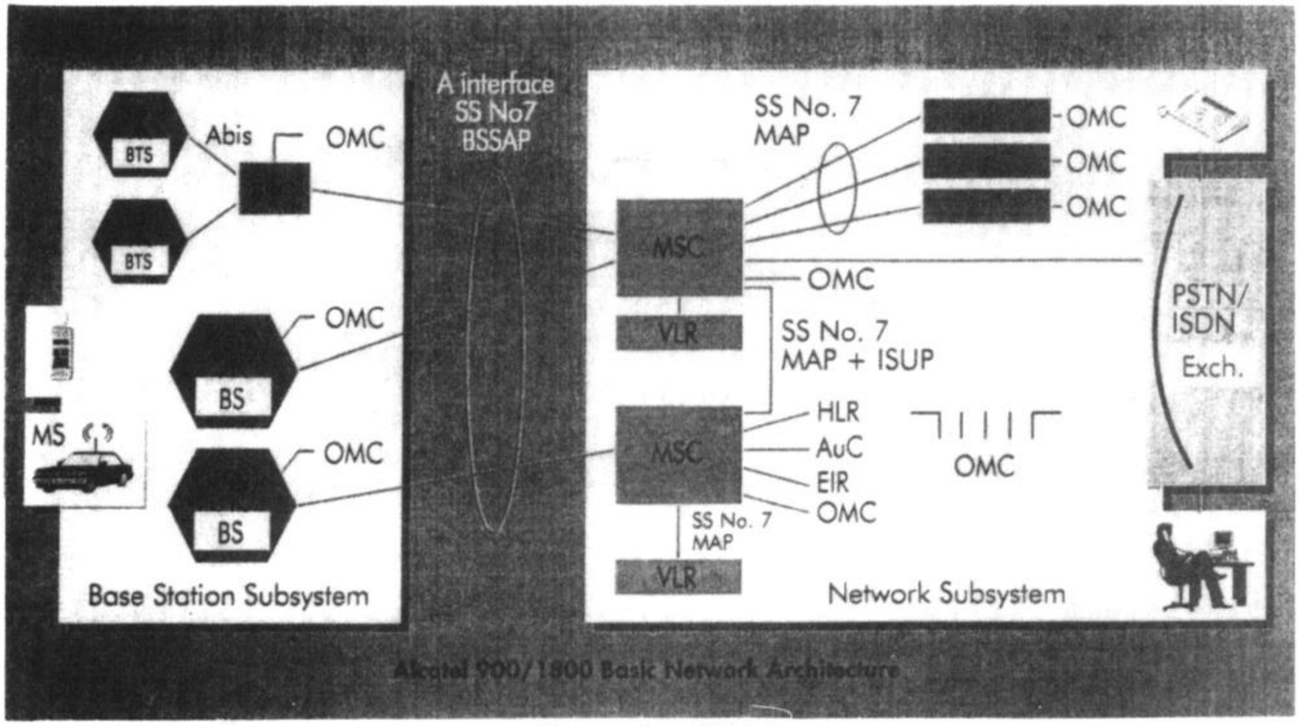


Illustration PR3-1

Abbreviations:

BTS	Base Transceiver Station	BSC	Base Station Controller
BS	Base Station	MS	Mobile Station
SSno.7	Operation and Maintenance Center	SUP	ISDN User Part
BSSAP	Base Station Subsystem Application Part		
MAP	Mobile Application Part	VLR	Visitor Location Register
MSC	Mobile Services Switching Center	HLR	Home Location Part
ISDN	Integrated Services Digital Network	AuC	Authentication Center
EIR	Equipment Identification Center	Exch.	Exchange
PSTN	Public Switched Telephone Network		

<u>Mobile Data Terminals (MDTs):</u>

The 900/1800 system is compatible with the Alcatel 9109 MB 3 GSM mobile phone. The main features are: high-definition LCD screen, external call-signaling (horn or vehicle headlights), maximum power of 8 watts, compact transceiver, Short Message Service Mobile (SMS) function (alphanumeric text reception), Hands-free function, emergency call function.

Alcatel 9109 MB 3
GMS Mobile Phone

In addition, Alcatel 9220 MX range of private mobile radios can be used as MDTs, due to features that render it suitable for data messaging. This series of products has wraparound menus for immediate user guidance with pre-programmed function keys. The screen is four-line by 16 character LCD and can display characters or pictograms. Upgrades are possible via connection to a PC and software downloading.

Alcatel 9200 MX

Illustration PR3-3

Communication Control

Variable and dependent on system configuration.

5.2.3.3 Contact Information

Mr. Bruno Fabre, Director of Marketing
Tel. 33 - 1 - 46521278
Alcatel Mobile Communications
32, avenue Kleber
92707 Colombes Cedex
France
Telephone: 33-1-46521010

5.2.4 Auriga

5.2.4.1 Overview

Division: Taxi management systems

Product type: SIRIUS (modular software)

Auriga Communications Ltd. specializes in the design and installation of modular management systems. It offers training, installation, radio and licensing assistance and a 24-hour emergency service system. In offering fully modular software, Auriga has established an alliance with Philips which provides communications hardware and credit (through Philips Finance Services Ltd.).

5.2.4.2 System Configuration

The SIRIUS Taxi Management System is a computer package offering a modular approach to taxi fleet management. The SIRIUS modules, though designed to work in conjunction with the core Control Room Management System, may be used alone or with any number of the other módules.

The following modules make up SIRIUS:

- **Control Room Management**

  Forms the core of the Vehicle Management System. Designed to replace all paperwork and speed up the allocation of jobs. All other modules are designed to work alongside this core module. The call taker enters all relevant trip information including special requirements, account details and area references. This is passed on to the dispatcher screen from which a driver is allocated. Both the call taker and the dispatcher can draw from a list of information such as pricing, booking rates, account details, and area references. Little computer or keyboard skills are required.

- **Accounts**

  Available in two versions - a simple administration and invoicing package or a full company accounts package. The former enables a view of pricing, a printed report and a manual invoice (if necessary) of customer billing and driver administration. The latter incorporates a full sales ledger, statement and invoice print-outs, the ability to access each individual account and generate personalized invoices and statements. Options also exist for calculating VAT and general financial information.

- **Auto-Booking**

  An option designed to allow regular customers to access SIRIUS direct without going through a call taker/dispatcher. A client is assessed a PIN code which they can enter via the keypad on any touch-tone phone. The computer instantly recognizes the client information and dispatches a driver. This system is applicable to dedicated phone lines for large clients (restaurants and hotels).

- **Vehicle Location**

  Gives operators a visual representation of the taxi fleet. Dispatchers can easily identify all vehicles within a given area. The geographical areas are viewed via a visual representation of the region on a computer screen. To differentiate between busy and free drivers different colors are used. This system also queues up the drivers in the order of availability in a given area so as to equally distribute the trips. Special vehicle types, such as wheelchair capable, minibuses and minivans, can also be designated on screen. The system also incorporates driver's start and finish times.

- **Selcall Messaging**

  Selcall is a special type of signaling which can be installed in many modern radios to allow drivers non vocal communications. For smaller operators the ANI feature of a radio can be used to stack drivers calling the office. It can be configured to recognize a signal from either the microphone button or another suitable switch. This signal, called Selcall, is interpreted by an Auriga decoder connected to the base station and the information is presented on a computer screen in the control room. By reducing the amount of voice traffic and ensuring driver identification this module offers a solution to operators suffering from the errors due to congested airwaves and radio abuse.

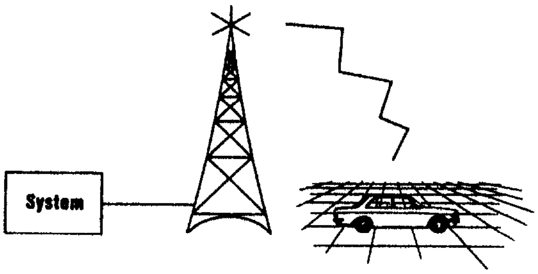
- **Data Messaging**

  Allows two-way data transmission via an MDT. The unit can be connected to most electronic taximeters to know whether the taxi is free or not. The driver indicates what area he is in or mobile to and is assigned a queue number for that area. The first driver in the queue is then matched to the first trip which is nearest the taxi. The driver is then given trip details and with one button can accept or refuse the trip. The MDT can store up to four trips for reference. The system records all movements for later references and analysis. For those taxis with several drivers different PIN codes can be used for each one ensuring work is correctly attributed to the driver. An emergency feature exists which activates an alarm in the control room and the drivers microphone goes live - all other cars are also alerted. A manual voice backup is retained but preset messages keep this to a minimum. The base can send messages to the entire fleet or per driver. All transmissions are confidential. Credit card swipe and AVL are compatible with this module.

(operator/dispatcher module>add-on accounts>add-on zoning>additional Modules)

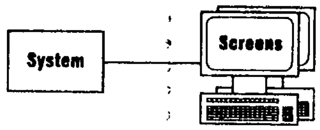
Additional modules

With constant development and evaluation of communications technology, additional modules are being developed to improve the efficiency of taxi fleet operations.



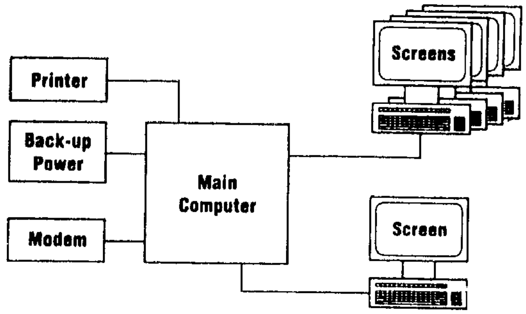
Add-on zoning module

Shows the location and status of all vehicles in area zones. Because vehicle allocation is decided by computer, the distribution of journeys is always fair – there is never any preference to any drivers.
The Module also offers an optional meter facility.



Add-on accounts and administration module

This supplies driver and customer invoices thus eliminating the repetition of paperwork. We can also supply further accounting functions if required.



Operator/despatcher module

Illustration PR4-1

- **Mobile Data Terminals (MDTs)**

  Auriga typically configures its systems with one of two Philips MDTs, model PRM80 or FM1000.

- **Communication control**
  See Philips profile.

- **Multi Company option**
  See Philips profile.

5.2.4.3 TaxiCom Installations

Table 5:2-7 European TaxiCom Installations

Country	City	Customer	Date Installed	Units	Base Stations	Remarks/Costs
UK	Liverpool	Davy Liver Ltd.	1992	250	2	Joint Philips project
UK	Derby	75 Taxis	1992	60	2	*idem*
UK	Leeds	Telecabs	1993	100	2	*idem*
UK	Carlisle	Radiocabs	1993	60	1	*idem*
UK	Edinburgh	City Cabs	1993	400	2	*idem*
UK	Harrogate	Blue Line	1993	60	2	*idem*

5.2.4.4 Contact Information:

Mr. Paul Bennett or Ms. Sara Justice
Richmond House
Hicks Road
Markyate
Herts AL3 8LQ
England
Telephone: 44 - 582 - 840074
Fax: 44 - 582 - 84242

5.2.5 Philips

5.2.5.1 Overview

Division: Telecom

Product type: Taxi Fleet Management, Private Mobile Radio, SOPHO telephone system

Philips has joined its Telecom hardware and finance services with the software of Auriga Communications Ltd. to offer what it calls an integrated vehicle fleet management and communications package. Philips/Auriga offer a three stage process of Analysis, Implementation and Support - each stage being sub-divided accordingly. While Auriga adds its modular SIRIUS software (see Auriga Profile) to the partnership, Philips typically provides radio communications hardware from its PRM80 or FM series and/or its SOPHO telephone system.

5.2.5.2 System Configuration

Auriga/Philips offer three basic configurations called 1.A Basic System, 2.A Mid-range System, and 3. A Large-fleet System.

1) A Basic System

Suitable for a fleet of approximately 20 taxis, the system comprises:

- minicomputer and local printer
- uninterruptable power supply (if necessary)
- modem
- one call taker
- one dispatcher
- SIRIUS software modules - customized

The radio system comprises either a local or remote-controlled base station (type PRF1060) with an M81 controller and desk microphone or optional headset. Taxi radios are the PRM1080 or PRM8020 units with a facility socket to allow future additions. The call taker enters trip details into the computer using the booking screen. This information is automatically presented on the dispatcher's screen, who, in turn contacts taxi cabs by voice to allocate the trip or invite bids.

2) A Mid-range System

Suitable for a fleet of 100 taxis, this system comprises:

- main mini computer and local printer
- standby mini computer (if required)
- uninterruptable power supply
- modem
- three or more call takers
- one dispatcher
- SIRIUS software modules - customized (Basic plus AVL)

This system provides all the aspects of the Basic system with the addition of AVL which allows drivers to log in and out of each zone in the coverage (see Auriga profile), as well as updating their status. Each dispatcher position has two screens, one of which displays details of the current trip while the other shows the zones and status of all taxis in each zone. The radio comprises two local or remote-controlled base stations (type

PRF1060) and an M82 controller. One base station is connected only to the controller, while the other is connected also to the computer system via a tone-signaling decoder. The first channel provides voice communication, the second is used only to decode identity and status information sent by the drivers.

Like the Basic system dispatch informs vehicles of trips by voice. When drivers accept a trip they press a button on their PRM80 radio to update their status. On completing a trip a driver relays the zone number he/she is in and the computer updates the status.

3) A Large-fleet System

Suitable for fleets of 200 or so taxis, this system comprises the same modules as the Mid-range system with the addition of Data Transfer. The Data Transfer module provides two-way data communications between the dispatcher and the vehicles (FFSK at 2400 baud). Each vehicle is fitted with an MDT.

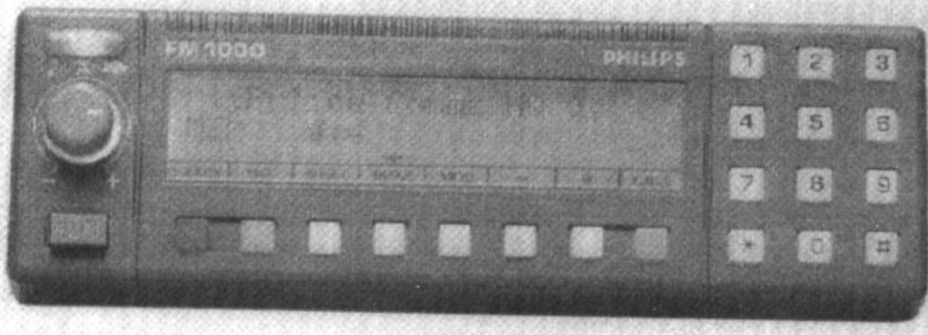
The radio system comprises two remote controlled (type PRF10) base stations. An M81 controller provides the voice capability on one channel, while the second base station is connected to the computer to provide the data communications channel.

Drivers may use their MDTs to look at how the current trip and vehicles are distributed. Each driver decides which area to work in, moves into the area and logs in his position. He is then allocated a queue position. Dispatchers allocate the jobs according to position and queue number in updating the appropriate taxi of trip details automatically. Manual voice capabilities are retained and drivers may press a 'request to speak' button.

- **Mobile radio units - the PRM80 series**
  Private mobile radio available in two models, the PRM8010 (9 channel fixed signaling, encode-decode option) and the PRM8020 (64 channels and variable signaling). Operator controls can be customized by software and switch labels. Features include: ANI (automatic number identity), group call, auto acknowledge, emergency alarm and operator-selectable scanning (PRM8020 only).

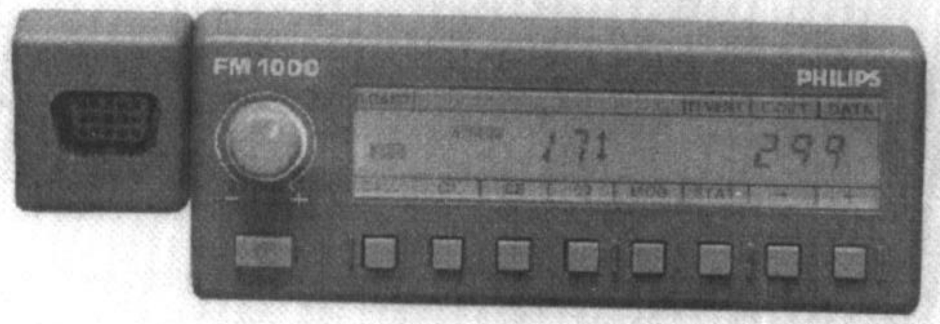
- **Mobile Data Terminals (MDTs) - the FM1000 series**
  The FM1000 series comprises three main product variants: FM1100, FM1200, and FM1300, each dedicated to a particular type of radio system. FM1100 provides speech and tone signaling for use on conventional private mobile radio systems. FM1200 provides speech data and FFSK signaling for MPT1327/1343 trunked systems and the FM1300 operates on the Philips TN100 private trunking system. (See Illustration PR5-1, on the next page)

Top-of-the-range PMR keypad control head with the capability of 48 alphanumeric characters.



Standard FM1100 control head with 100 channel capability. Six-digit liquid crystal display. Software coded function buttons.

Standard FM1200/1300 control head for trunked systems providing short form dialling and in-fleet calls. Software coded function buttons.



Basic FM1100 control head. Operates up to seven PMR channels or preprogrammed signalling functions. Individual LED indicators for every function button.

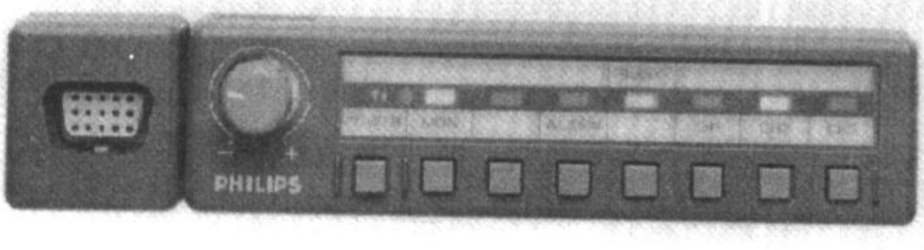


Illustration PR5-1

- **SOPHO Telephone System**

  Sopho handles calls digitally through the central control unit. Access to the digital network offers a number of valuable features including faster dialing, remote access to a voice mail system for auto booking and connection to a PC to transfer data. An optional software package displays real-time information on a computer screen about what is happening on exchange lines and extensions, such as incoming calls waiting or abandoned, and lines free or on hold. The system also provides historical reports on the performance of the telephone system and call takers.

5.2.5.3 TaxiCom Installations

Table 5:2-8 TaxiCom Installations

Country	City	Customer	Date Installed	Units	Base Stations	Remarks/ Costs
UK	Liverpool	Davy Liver Ltd.	1992	250	2	Joint Auriga project
UK	Derby	75 Taxis	1992	60	2	*idem*
UK	Leeds	Telecabs	1993	100	2	*idem*
UK	Liverpool	Delta Taxis	1993	390	3	Stand alone project
UK	Carlisle	Radiocabs	1993	60	1	Joint Auriga project
UK	Edinburgh	City Cabs	1993	400	2	*idem*
UK	Sheffield	Shefftax	1993	120	2	Stand alone project
UK	Harrogate	Blueline	1993	60	2	Joint Auriga project
UK	Liverpool	Circle Cabs	1994	100	1	Stand alone project

5.2.5.4 Additional Services

Philips Financial services (PFS)

PFS supplies credit to operators and a number of financial plans- Lease, Lease Purchase and Hire Purchase.

5.2.5.5 Estimated Costs

The following are cost estimates for an "average" fully configured system:

Table 5:2-9 Estimated Costs

# of TAXIS	Control room (central)	Mobile unit (per unit)	Total
50	10-20,000£	50 x N/A	N/A
500	40-80,000£	500 x N/A	N/A

5.2.5.6 Contact Information:

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Telephone: *44 - 223 - 61222 or 358985*
Fax: *44 - 223 - 322770 or 66867*

Ms R. Molloy, Marketing Research Executive
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Fax: *44 - 223 - 312243*

Philips Telecom- Private Mobile Radio
P.O Box 24
St. Andrews Road
Cambridge CB4 1DP
England

5.2.6 GMSI - Gandalf

5.2.6.1 Overview

Division: Gandalf Technologies Inc., Mobile Data Communications System (MDCS)

Product type: Advanced Mobile Data Products (AMDP)- Cabmate

GMSI (a Geotek company) provides data communications systems for mobile workforces. GMSI has provided the transportation industry for over one decade. Its computerized taxi dispatch and management system, Cabmate, is used in 25 locations in North America and serves approximately 10,000 mobile personnel. Customers may receive project management, installation, testing, training, and full support.

Gandalf Mobile Systems Inc. was one of the early pioneers in the TaxiCom field, initially operating mostly in North America. Since 1985 a large part of the company's activities has focused on the European market. Taken over in 1991/93 by Geotek Inc., the company is currently known as GMSI.

The Mobile Data Communication System (MDCS) is a real-time fleet management system for the ground transportation industry. It provides bi-directional messaging between an office/central computer system and a fleet of vehicles using data communications over a two-way radio. This system may be interfaced with a variety of hardware (taximeters, printers and AVL receivers) and software (dispatch, routing, scheduling, billing, accounting) products according to the operators specifications and existing equipment.

5.2.6.2 System Configuration

The MDCS computer is connected to the fleet operator's existing base radio system via a Base Signaling Unit. MDTs are installed in each vehicle by connecting them to the vehicle's existing mobile radio. The MDT allows the driver to communicate and receive information from the host system via the MDCS. The system removes most voice communication but retains voice as a backup. The interface is assured by a Network Communications Controller (NCC).

In general the office software products and the MDCS run on separate platforms. Communication between the two platforms are via the NCC and are typically assured through ASCII file transfer or a database interface.

A typical Gandalf MDCS system with Cabmate software is configured as follows:

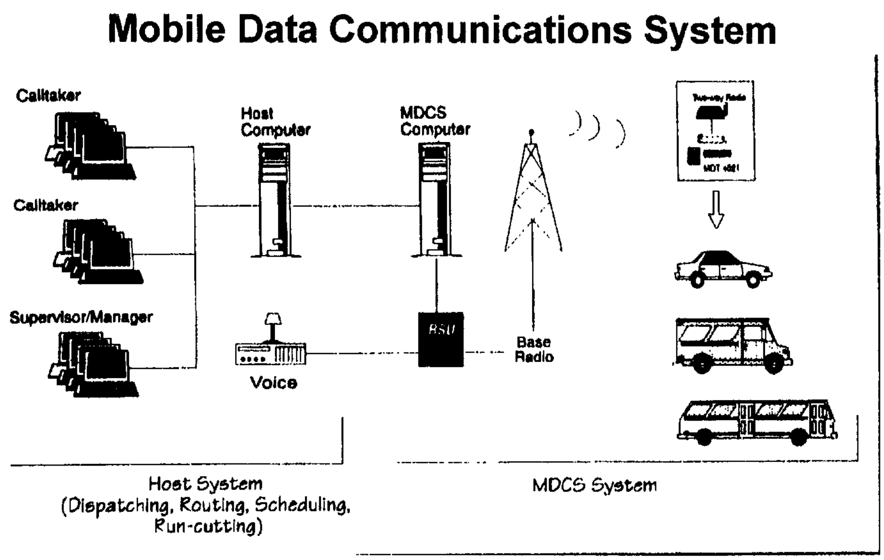

Illustration PR6-1

MDCS also automates the collection, validation, transfer, and storage of driver, passenger and trip information in real time. The following types of information are collected:

- content, time, and date of all messages to and form the driver
- vehicle odometer readings
- time and date of driver log on/off
- vehicle, passenger and trip identification
- time and date of passenger pickup/drop-off, site arrival and departure and no-shows
- amount collected and method of payment of fares

Mobile Data Terminals (MDTs):

Gandalf offers a number of MDTs with its systems. Some MDTs are obligatory with a specific configuration (e.g. with the Multi Company option) but are, in general, interchangeable and can even be mixed within a given configuration.

Two of these MDTs are:

- **MDT 4000 series**

  The MDT 4001 (for example) is an integrated one-piece model with a 4-line x 40 character LED display. The keyboard is typewriter style with the addition of a numeric keypad and 4 function keys. The user can generate messages with the built-in text editor which provides unlimited message creation capabilities, by selecting pre-programmed messages, or by completing pre-defined forms that are permanently stored in the unit's memory. The user can select message classification levels and a dedicated key for maximum priority emergency messaging. This unit can be fix-mounted or free-standing.

MDT 4001 Mobile Data Terminal

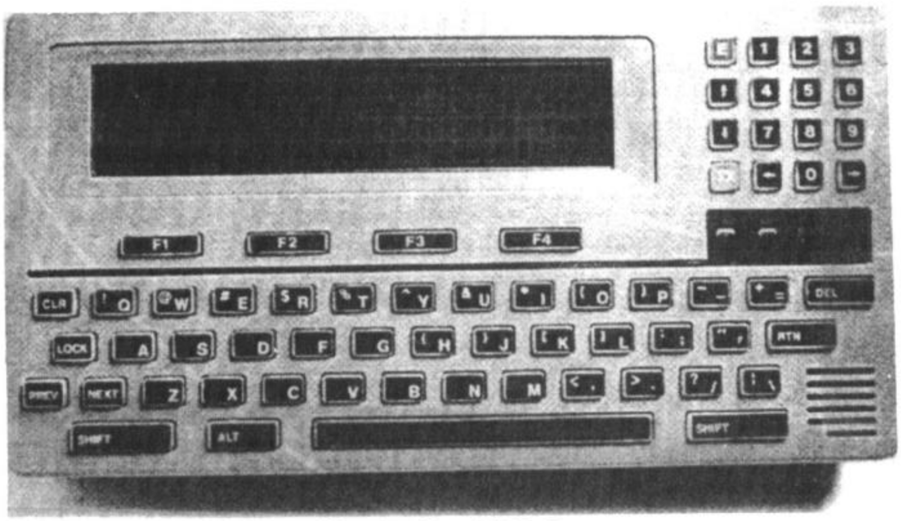

Illustration PR6-2

- **MDT 4020 series**

  The units of this series offer the same functionality as the 4000 series but are configured in three pieces - keypad, display, and controller unit. The keys are pre-defined to allow the user to make inquiries and provide responses to certain conditions with a minimum number of keystrokes. As the 4000 series the units of this series provide connections for auxiliary devices such as bar code readers, printers and magnetic strip readers.

MDT 4020 Series Mobile Data Terminal/Modem

Illustration PR6-3

- **Communication Control**

  All connections between the central unit and mobile units are managed by a Network Communications Controller (NCC). The mobile equipment communicates with the computer, via the NCC, over a wireless communication link. The NCC rearranges information from the primary computer, as well as the mobile equipment, to ensure efficiency and compatibility. The NCC can be personalized to fit the operators specifications and can be linked to satellite communications, cellular data, trunked radio, or a private radio network. The NCC manages message flow control, queuing, transmission and end-to-end acknowledgments.

- **Multi Company Option**

  Gandalf also offers a multiple company option for its Cabmate computerized dispatch system. This option allows up to five operators to share a central dispatch system and radio channels. Common information such as street addresses and zone databases are stored in the dispatch computer. The operators all share this information. On the other hand all confidential information such as fare, vehicle and customer account information is stored separately for each operator.

  In this configuration one company is designated as the primary operator, where the dispatch computer is located. There can be up to four secondary operators, which are usually remotely located from the primary one. The operators terminals in the primary company have a direct link to the dispatch computer. The operator terminals at the secondary companies connect to the dispatch computer through Gandalf Remote Multiplexers (RMUX) installed in each location. An RMUX is installed at the primary operator site in the Access Server to provide the connection between the dispatch computer and the secondary sites. The RMUX can receive information from a number of terminals and transmit it over a single telephone line to the primary location. Each operator is assigned a unique number and system usage reports are generated individually and identified by company name. Each company has its own operators (typically: system, fleet, and account managers, report, time call and callback operators, supervisor and call taker) who are responsible for the day-to-day operations of their company.

Multiple company system requirements: the dispatch computer must have a minimum of 8 megabytes RAM, a 380 megabyte disk, and an Ethernet network. Secondary operators can use only MDT 4021 in-vehicle terminals while the primary operator may use either MDT 3602 or 4021 in-vehicle terminals, or both.

A typical multiple operator configuration may look as follows:

Multiple Company Cabmate Option

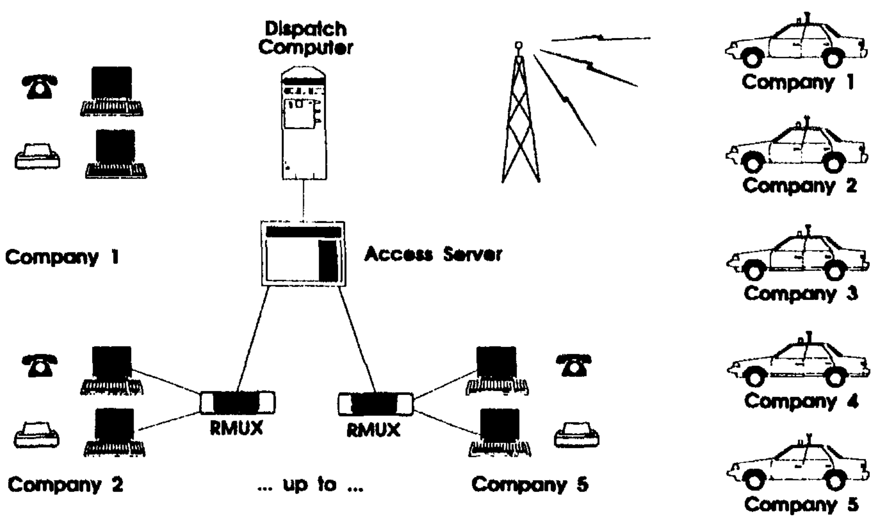

Illustration PR6-4

5.2.6.3 GMSI TaxiCom Installations

Table 5:2-10 TaxiCom Installations

Country	City	Customer	Date Installed	Units	Base Stations	Remarks
Scotland	Glasgow	TOARS	1994	480	N/A	
United States				6,360	N/A	Cabmate
Canada				2,705	N/A	Cabmate

5.2.6.4 Additional Services

- **Cabmate and GPS**
  Cabmate software can be integrated with a Global Positioning System (GPS). This option allows the central unit to monitor the location of all vehicles in the operators fleet. Vehicles can be automatically booked in, preventing drivers from booking into a zone that they are not actually in. In addition the location and heading of a distressed vehicle are immediately known.

- **Automated Order Entry**
  Allows account customers to request taxis without talking to a call taker. The entire process takes on average 20 seconds. AOE works with any dispatch system and reduces costs and errors.

- **Automatic Callout**
  This option automatically tells customers when their taxi has arrived. The driver presses the Call button on the MDT keypad and the dispatcher calls the customer. No callback operator intervention is required. The driver is automatically informed whether to wait for the customer or that the fare has been canceled.

- **Credit Card Authorization**
  This option allows drivers to automatically authorize credit card transactions in approximately 35 seconds. The CCA can authorize up to nine different cards (in the USA).

- **Fleet Management Business System**
  FMBS is a fully-integrated fleet management and business control system incorporating Cabmate software.

- **Computer Aided Voice dispatching**
  CAVD is a system that provides quasi-TaxiCom capabilities by supplementing a traditional radio dispatch system with computer assisted dispatching and additional management software.

- **Mobility Automated Data Collection**
  An independent module, MADC can automate ridership data collection through personal Smart Cards, electronic card readers and data exchange with the Central.

5.2.6.5 Contact Information

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GMSI Europe
Longbow House
14-20 Chiswell Street
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5.2.7. Nokia

5.2.7.1 Overview

Division: Telecommunications, Mobile phones

Product type: Various telecommunications, GSM

Nokia does not produce any taxi specific technology or equipment but does produce communications equipment that can be applied to taxi systems and to fleet management systems in general.

Nokia did produce until 1993 a Model 6050 GSM communications system specific to taxi operators but discontinued this product[20]. Nokia is presently discussing possible taxi specific applications of its technologies but has not as yet made any information public to this effect.

5.2.7.2 Contact Information:

Mr. Nalin, Nokia France, Marketing
Telephone: 33 (1) 49151619
Fax: 33 (1) 48912981

5.2.8 Microtek

5.2.8.1 Overview

Division: Industrielle Elektronik, Data radio systems

Product type: Integral TaxiCom system

Microtek is an Italian electronics and service firm, established in 1983, that supplies integral TaxiCom systems. Microtek offers both hardware and software as well as situation/problem analysis, system engineering, maintenance, training and turn-key installation (except radio installation).

5.2.8.2 System Configuration

Microtek has developed the RS200, a multi-processor modular computer which, when used with Microtek's MDTs, offers an integral TaxiCom system. The software and hardware of each specific system can be customized.

A companion-computer is always on-line as a back-up in case of hardware failure. Each computer has a built-in battery backup (1-hour autonomy) and hardware includes a meter for self-diagnosis of system.

[20] Nokia sources have indicated that the product line was discontinued due to the weak demand resulting from the increased availability of personal GSM units.

PC terminals are used as dispatching stations and each has a chip card reader for log in/out. Each user's privilege and access level can be supervisor-defined. Up to 24 dispatchers can work simultaneously on the system.

Software includes 20 cross-related archives and all orders and events can be converted to a DOS-PC (ASCII or DBF format) environment.

Die Bausteine der Gerateserie in der Zentrale

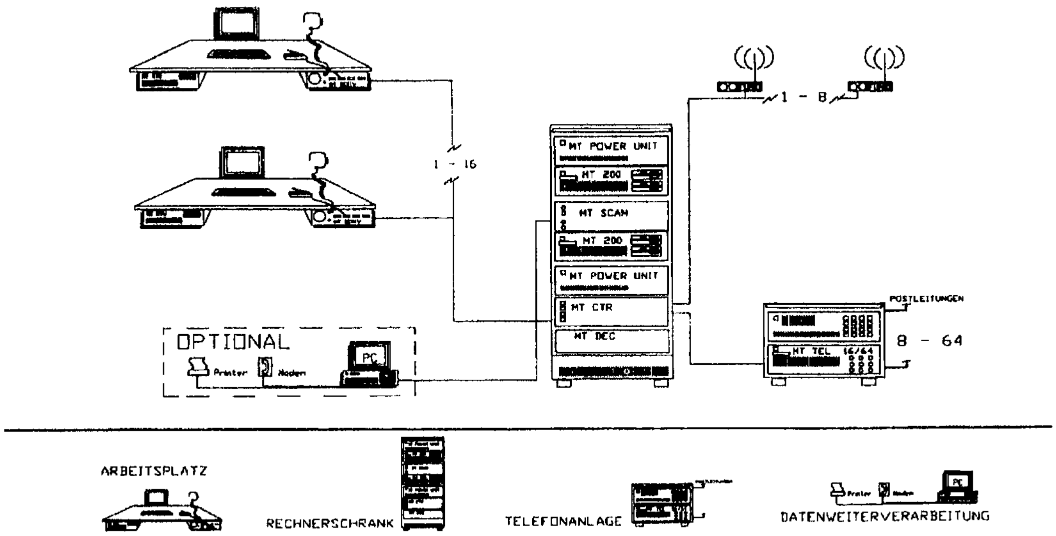

Illustration PR8-1

Microtek has also developed a "dispatcherless" dispatch which is fully automatic (see below). This system permits full operations without a human presence at the central. So far implemented in 12 small operators and mostly used nighttime when loads are low. A fully automatic dispatch, operating day and night, has been installed in Meran, Italy.

Mobile Data Terminals (MDTs):

- **MT8G**
  The MT8G is an MDT composed of two units the MT8GC and the MT8GD.

- **MT8GD**
  The MT8GD is the display unit of the MDT and consists of the following:
  - plastic housing
  - vacuum fluorescent "graphic" display
  - numeric keyboard and 7 function keys
  - chip card reader option
  - 16 bit microprocessor
  - MT8GC interface
  - optional alphanumeric keyboard interface

- **MT8GC**

  The MT8GC is the controlling unit of the MDT and consists of the following :
  - radio modem
  - radio control functions (loudness and channel)
  - RS232 interface for Taximeter
  - GPS interface
  - printer interface
  - chip/magnetic card reader interface
  - MT8GD interface
  - "Flash" Eprom memory up to 1 MB
  - 16 bit microprocessor

- **Capabilities**

  The MT 8 G has the following special capabilities:
  - interfaces with the RS200 for full "speechless" TaxiCom operations
  - most data available in real time
  - acoustic signals
  - automatic renewal of central data archives
  - dedicated functions for archive chip card management
  - fast data transfer through mobile retrieval of central data archives
  - alarm button
  - various message display

Mobiles Datenterminal Fur Funkgerate

Illustration PR8-2

- **MT AR**

The MT AR is an addition to the MT 8 G and the existing radio system and is intended to be used in conjunction with a fully automatic (i.e. dispatcherless) dispatching configuration. The MT AR consists of a keypad and a "technical details" control system which are encased in two separate units.

Control system unit:

- radio system interface
- 8 bit microprocessor
- Eprom function parameter
- radio modem

Keypad:

- 7 LED keys:
  * on/off
  * repeat
  * interruption
  * telephone number request
  * pick-up address change
  * reservation
  * confirmation
  * acoustic signals

MT AR Radio System

Illustration PR8-3

5.2.8.3 European TaxiCom Installations

Microtek has implemented TaxiCom systems in the following countries: Austria, Germany, and Italy as appears in the following table:

Table 5:2-11 Microtek European TaxiCom Installations

Country	City	Customer	Date Installed	Units
Germany	Osnabruck			25
Germany	Koln	Taxi Ruf	11/92	1200
Germany	Offenbach	Taxi Funk	6/93	90
Germany	Berlin	Taxi Funk	11/93	2200
Germany	Nurnberg	TaxiZentrale	10/92	520
Austria	Innsbruck	Funk TaxiZentrale	8/88	130
Italy	Vicenza	Cooperativa Taxi	12/92	40
Italy	Brescia	Radio Taxi	9/87	90
Italy	Como	Consorzio Taxisti	3/93	24
Italy	Milano	ARCO	9/90	700
Italy	Genova	Coop. Concessionaria Auto Publicche	8/90	500
Italy	San Remo	Consorzio Taxisti	11/90	30
Italy	La Spezia	Cotas La Spezia	9/90	45
Italy	Reggio Emilia	Consorzio Taxisti	5/93	25
Italy	Verona	Unione Radiotaxi	12/86	150
Italy	Firenze	Co.Ta.Fi./ So.Co.Ta.	4/88/7/91	240/350
Italy	Siena	Cotas Siena	9/89	32
Italy	Merano	Coop. Taxi	12/91	20
Italy	Bolzano	Coop. di Servicio Taxi	9/89	45
Italy	Udine	C.A.P.U.	9/90	50
Italy	Treviso	Co.Ta.Tre.	12/91	22
Italy	Venezia	Radio Taxi Mestre	12/87	70
Italy	Padova	Co.Ta.Pa.	4/89	150
Italy	Ferrara	Consorzio Taxisti	11/91	45
Italy	Bologna	Co.Ta.Bo/C.A.T./ S.A.C.A.	12/85/ 12/89/3/93	530/100/ 100
Italy	Imola	Radio Taxi	12/87	13
Italy	Bari	Co.Ta.Ba	11/92	50

5.2.8.4 Additional Services

Call-box systems options: MT ME and MT GU

- **MT ME**

This unit is an automatic call box for hotels and restaurants. Taxis can be ordered directly by the customer without making a call. The parameters of the call box are programmed with special (Eprom) software.

MT ME **MT GU**

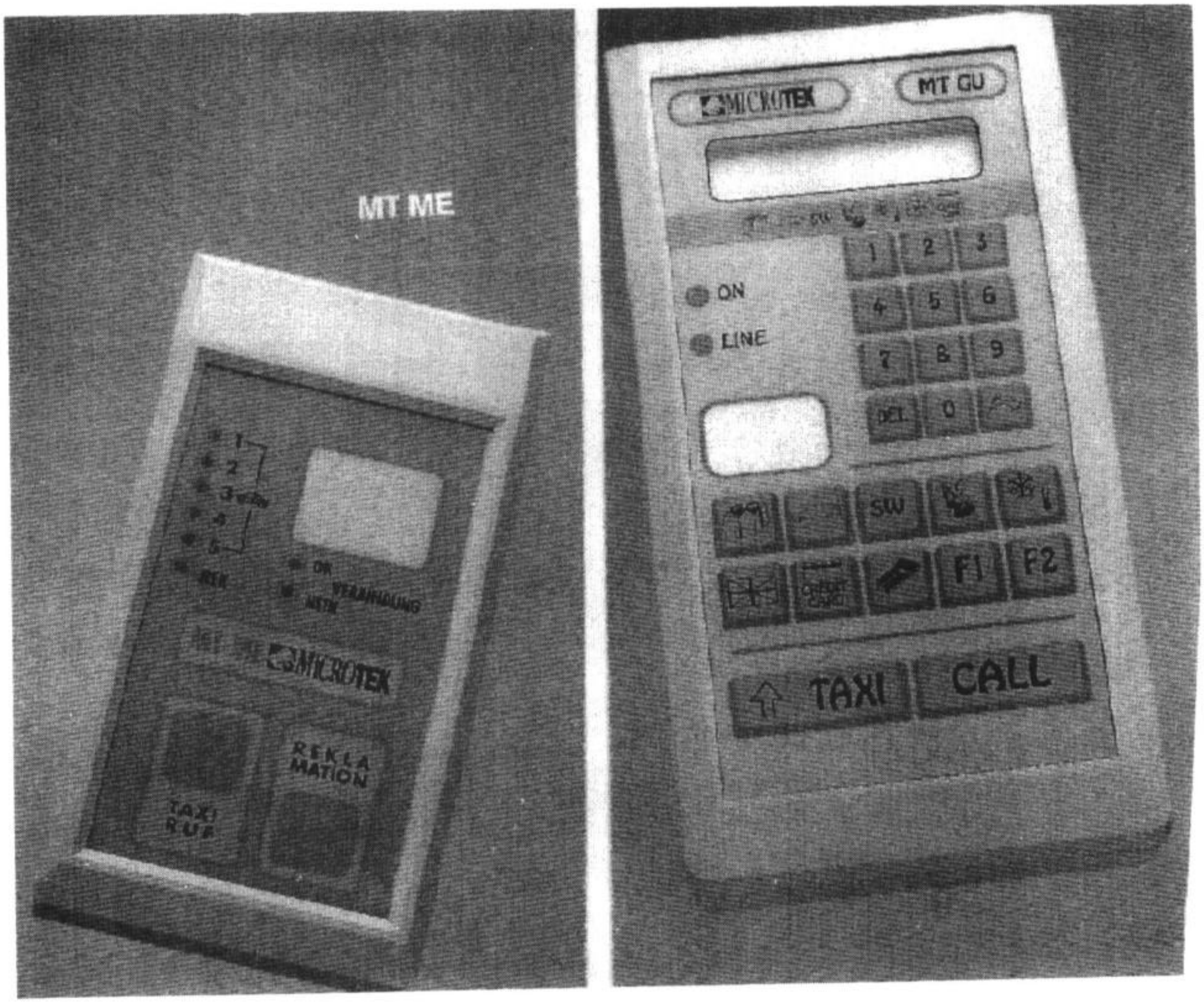

Illustration PR8-4

MT GU

Automatic call box for hotels and large businesses. This call box allows customers to order one or several taxis and to specify the taxi desired (station wagon, minivan and handicap equipped). The customer is informed of waiting time and additional information depending on the programmed parameters of the system. For example hotels can inform the client from the call box if there are any vacancies from their airport call box).

The MT GU has a numeric keypad and 10 function keys. 7 of the function keys are used to specify the desired taxi (according to size, parcels, animals, air conditioning, foreign language and credit card payment).

5.2.8.5. Estimated Costs

Please Give Rough Cost Estimates For An "Average" Fully Configured System.

Table 5:2-12 Estimated Costs

# of TAXIS	Control room (Central)	Mobile unit (per unit)	Total
	DM 100-350k	DM 2200-2400	
50	DM 100k	50 x DM 2300	DM 215k
500	DM 350k	500 x DM 2300	DM 1.5M

Six months of system software maintenance and optimization is included.

5.2.8.6 Contact Information:

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Fax: 49-471-964031

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Telephone: 39-432-573597
Fax.: 39-432-573398

5.2.9. Ericsson

5.2.9.1. Overview

Division: Emergency Control Systems AB
Product type: Integral TaxiCom systems - Taxi-80 and Taxi-800
Ericsson is Sweden's largest telecom supplier and electronics manufacturer. Once a joint venture with Volvo's VTS division, who was entirely responsible for the initial conception, global system design and development as well as the traffic routing and dispatching algorithms, Ericsson now markets its TaxiCom packages, Taxi-80 and Taxi-800, independently. Ericsson installed 20 Taxi-80 installations in Europe (chiefly in Scandinavian countries) from 1980 to 1990 and has since begun implementing primarily its second generation package Taxi-800.

5.2.9.2. System Configuration

Taxi-80

Taxi-80 is a complete TaxiCom package which is configured with a Digital CPU, the Volvo developed software, Ericsson radio base stations, and an Ericsson C600 Verscom computerized mobile radio unit which incorporates a transceiver, a logic unit and a printer. The system traditionally runs on DEC PDP computers, the model of which depends on the fleet size (11/24 for up to 150 taxis and 11/70 for up to 2000 taxis) and utilizes Tandberg and Visual 200 terminals (though any VT 100 compatible terminals will do).

The C600 Taxi-80 mobile unit, shown on next page:

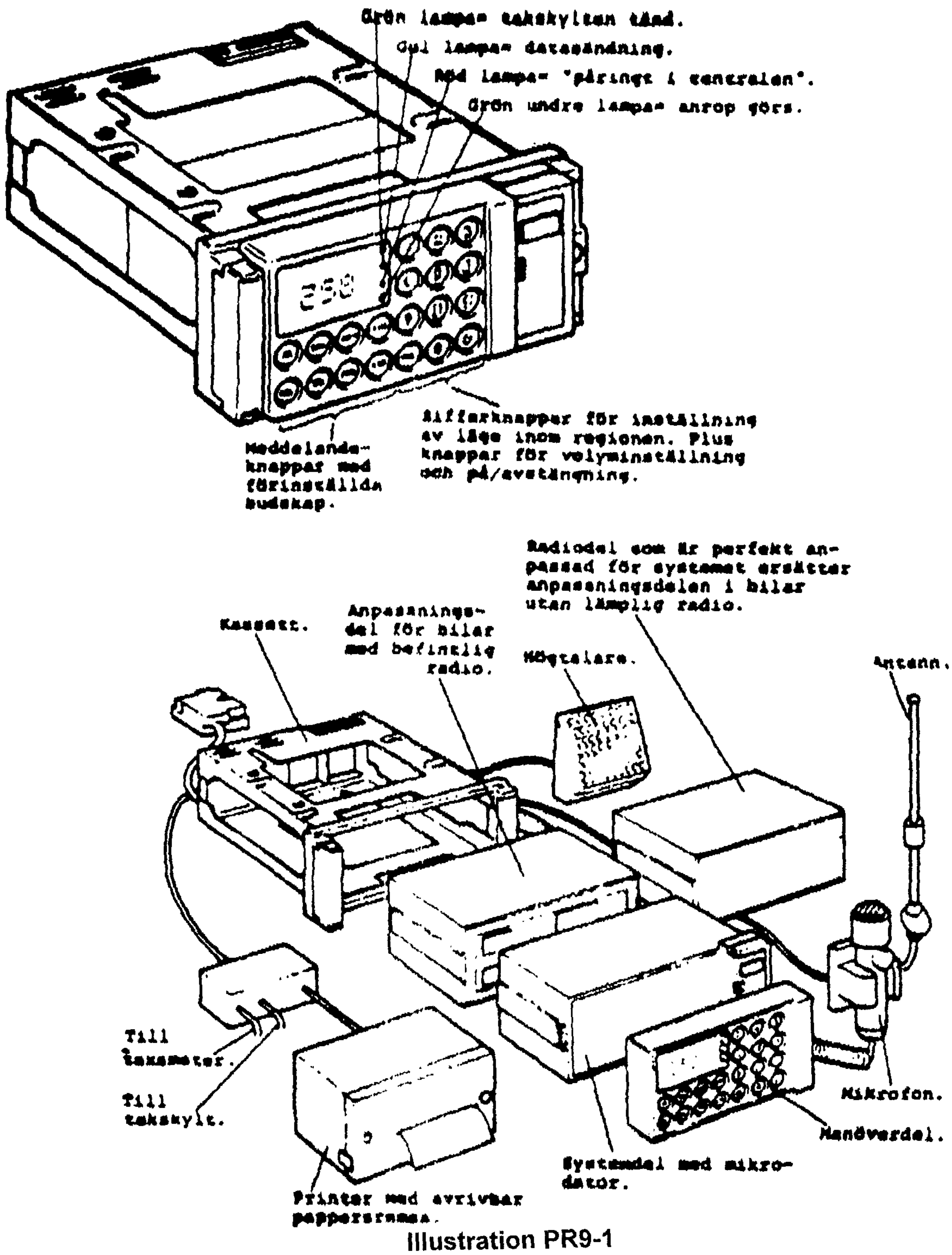


Illustration PR9-1

Taxi-800

With the deregulation of the Scandinavian taxi market and the increased dynamism of the taxi market in general during the 1980s, Ericsson began a specification phase for a new taxi application. This concept which is now known as Taxi-800 is an attempt at configuring a more efficient dispatch module which facilitates development and expansion of an operators taxi business.

Taxi-800 has been designed to run on any UNIX system or on VAX/VMS. It has been developed in Progress, a fourth generation language (4GL) environment and uses a relational database. Progress provides database features such as stored procedures and triggers, and provides tools to monitor database performance, restructuring and reorganization. It uses a data dictionary which facilitates data administration and together with Progress Results can generate end-user reports.

The capacity requirements of the system vary largely depending on such parameters as size of fleet, orders per hour, required history and report generation demands.

TAXI 800 SYSTEM ARCHITECTURE

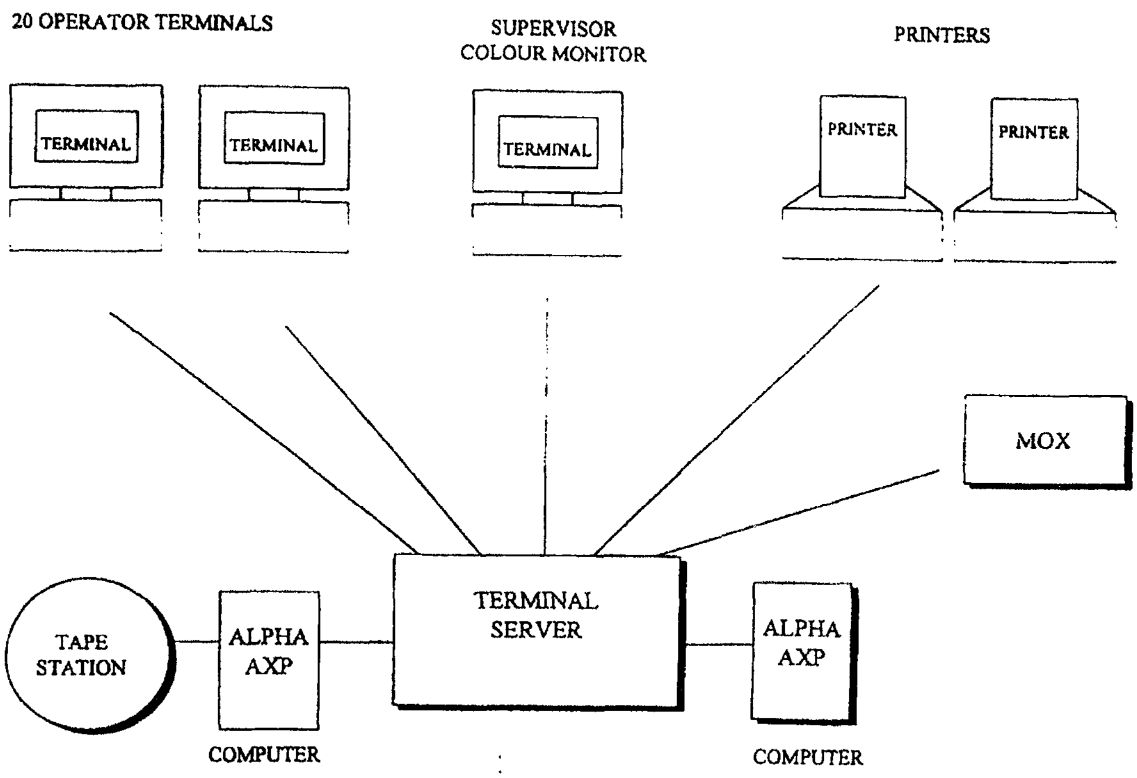


Illustration PR9-2

Background programs

Taxi-800 comprises various background programs. The following is a short list of the central ones:

- Communications programs
- Booking program
- Activation program (for advance orders)
- Alarm program (for late orders)
- Emergency/Speech request program
- Statistics sampling program
- Time out for YES/NO answers
- Supervision program (checks if programs are active)

Printers and Reports

Taxi-800 uses a flexible printing system which is defined by the system manager. A printer can be "upright" or "landscape" and the user is given a choice of printers when wanting to print a report. Almost all reports can be displayed on the screen terminals. Various reports can be generated with the system some of which are:

- Database tables
- Addresses
- Zones or zone groups
- Special, advance or repeating order reports
- History reports
- Statistics reports

Forms

The Taxi-800 system uses a large number of pre-defined forms and parameters to facilitate use of the system and minimize the time necessary for communications. Most system parameters and forms can be changed by the system manager. These forms and parameters are subdivided under the following subject headings:

- Orders/Booking
- Repeating orders
- Geography
- Vehicle
- Parameters
- Report ordering
- Survey/Logging

History and Statistics

The system saves all orders for a set number of days which can very depending on the capacity of the system. Those orders are then automatically deleted. Statistics are stored in 5-minute intervals and are then summarized into 30-minute intervals and eventually 1-day intervals. Statistics are subdivided by group:

- Status
- Order/booking
- Logging

Survey and Logging

The supervisor has several manners in which to monitor the status and the queues in the system. A special form is used to give the users an overview of operation status. This form has an overview screen and several detailed screens.

The overview screen has the following information:
- total number of taxis in operation
- number of taxis in speech queue
- number of advance orders within the next 45 minutes
- number of unassigned orders
- number of alerted orders
- current communication load

The detailed screens show:

- Vehicle screen: Number of taxis per status (free, booked, pause)

- Order screen: Mean "waiting time" for the customers the last 30 minutes

- Communication screen: Peak load

- Map: A semi-graphic dynamic map with information on the number of current free taxis and number of current orders presented at the appropriate positions on the map. The map can be shown with different scales (1:20,000 to 1:10,240,000) and scrolled both horizontal and vertical.

Taxi-800 contains 30 different "events" that can be logged, which can be switched on and off by the system manager. The logging can be switched on so that only specific taxis will be logged for certain events. Logging can be done on a printer, terminal, sequential file or in the database. All logged events are stored for a preset number of days (similar to the system statistics).

Vehicle Functions

All taxis are identified by their "taxi number" which can be allotted by "vehicle types". Each taxi is equipped with a mobile unit with an alpha numeric display and a numeric keypad with soft function keys.

The standard function keys are:

- ACCEPT
- NOT ACCEPT
- SOON FREE
- FREE
- PAUSE
- FIXED PRICE
- EMERGENCY
- ZONE

The drivers enter their current (or planned) zone code. This code is noted in the central database and can be displayed with several forms. These forms display all current information for the taxi and the date/time of the latest changes. The current queue position is transmitted to the taxi.

A **"Phase 2"** is planned in which the system will handle **GPS** information and forward it to the central automatically.

The user in the central may send **free text** to a taxi or group of taxis which are defined in the communication network (Mobitex). To facilitate the use of free text, Taxi-800 has a standard text library.

Taxi-800 also has a **Vehicle Activated Functions** (VAF) option. One allows the driver to get information on all advance orders nearby, when they can be carried out (estimated to the nearest hour). A second VAF allows the driver to send messages to other taxis with a special function. A specific zone code can be linked to a standard text at the central. For example the driver enters zone code 091. The message is sent to the central. The following text is sent to all taxis: "One customer is waiting at 091". A number of standard texts can be preprogrammed in the system and the zone codes 050-099 are normally used for these functions.

An **emergency button** can be placed in the taxi. When the driver pushes the button twice within a predetermined span of time, an alarm signal will be sent to the central showing all available information on the taxi (status, type of vehicle, zone code and time for last change of zone and pickup and delivery address).

Options

- **BT2000 order terminal**

  This "call box" option is the size of a normal telephone and is placed in hotels, airports and large businesses. The customer just pushes a button and the terminal automatically contacts the Taxi-800 system, which uses a template order to create a normal order. The customer will receive the booking number, the preliminary taxi number and estimated arrival time directly on the terminal screen.

The template orders for each terminal can have the same order definition as normal orders:

- service (special demands)
- pickup address
- delivery address
- other

Each order terminal can have four sub-identifiers which can be used to define pick-up point or type of service. Some examples of sub-identifiers are type of taxi (normal, station wagon, minibus), specific language-speaking driver and location (main entrance, side entrance, employees entrance).

Taxi Voice

The Taxi Voice system is located in an optional unit box. The customer calls a designated phone number and enters the customer code and PIN with a dial tone keyboard. The system uses an artificial voice when communicating with the customer. Taxi Voice then contacts the Taxi-800 system which has a template order for each customer ID. The template order is then copied to a normal order (normally the customers home or business address). The system can support up to 99,999 different customer numbers.

5.2.9.3. Ericsson TaxiCom Installations

Table 5:2-13 TaxiCom Installations (partial)

Country	Customer	Date Installed	Units	Remarks/Costs
Taxi-80				
Sweden	Taxi Goteburg (Gothenburg)	1982	615	N/A
Norway	Taxi Asker og Baerum (Hovik)	1984	300	NKr 1.3M
Sweden	Linkoping Taxi Econ Union	1984	77	SKr 4M
Norway	Taxi Trondheim	1983	189	N/A
Sweden	Taxi Stockholm	1983	1725	N/A
Sweden	Boras Taxi	1983	62	N/A
Norway	Taxisentralen Drammen	1986	94	NKr 8M
Taxi-800				
Finland	South West Finland Taxidata Oy	1993	350	N/A

5.2.9.4 Contact Information:

Mr. Mats Almqvist, Sales Manager
Telephone: *46-31- 89 79 35*
Fax: *46-31- 89 78 37*

Ericsson Emergency Control Systems AB
AO Person and Godstrafik
Box 2102, Radiovagen 2
421 02 V. Frolunda

Mr. Lars-Olof Karner, Marketing Manager
Telephone: *46-31- 89 79 70*
Fax: *46-31- 89 94 98*

5.2.10 Motorola

5.2.10.1 Overview

Division: PDS, LMPS, MIMS
Product type: Various

Motorola is not at the time of this publication supplying integral TaxiCom systems as it has done in the past. Motorola is however continuing to supply MDTs originally developed by MDI of Canada and vertical products applicable to the TaxiCom industry such as GPS and communications hardware.

5.2.10.2 System Configuration - Applicable Products

Motorola manufactures a host of products that can be applied towards a TaxiCom system. As a result of a corporate decision to concentrate on other lines of business, these products are now scattered among various divisions and system groups, so extensive information on these products is not easy to come by. The following is a brief description of some products that are currently available from Motorola and may be applied to a modern TaxiCom system.

- **MDT 420**

A compact MDT, shown below, for in-vehicle applications with three communication ports and high resolution graphics. The MDT includes a MC68302 microprocessor-based platform, software drivers and a multi-tasking PSOS operating system which allows customer-written applications. The MDT 420 has a numeric keyboard with three function keys and 8 control keys. Text messages and maps can be received with appropriate application software.

MDT 420 - Mobile Data Terminal

Illustration PR10-1

- **ASTRO**

Newly developed Motorola digital technology that enables voice and data t be transmitted on the same channel.

- Mobile Logic Unit (MLU)

MLU, shown below, is a product for GPS and AVL applications. The MLU is a microprocessor that combines most of the functions required in GPS applications: GPS receiver, radio interface circuitry, radio modem, sensor inputs and AVL application software. The MLU functions as a modem and a communications controller.

Mobile Logic Unit

Illustration PR10-2

- AVL/GPS systems

Motorola offers a number of AVL and GPS systems, shown below, for fleet management systems. In typical AVL applications each vehicle is equipped with a MLU, a MDT and a mobile radio. The MLU can provide continuous navigation and/or location and the host computer at the central can be programmed to process the data into a wide range of management reports.

Mobile Security System

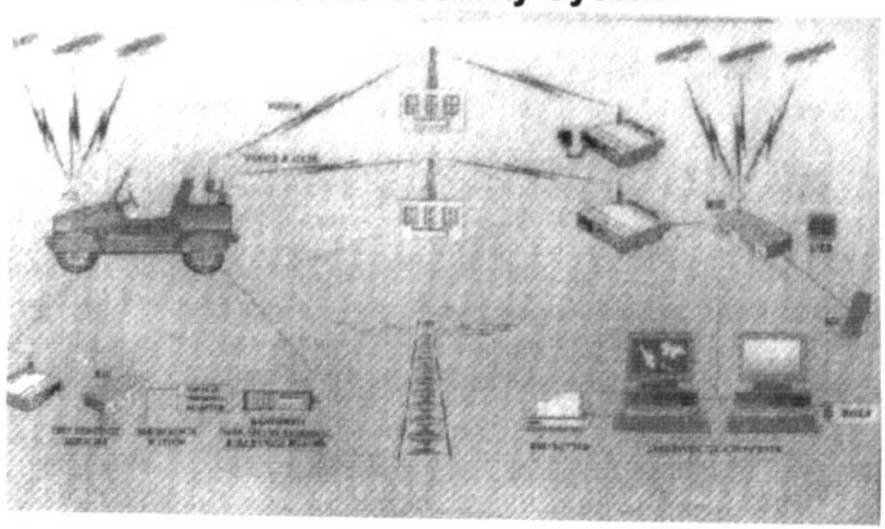


Illustration PR10-3

- **Conventional/Trunked Communications**

Motorola offers a large array of both trunked radio and conventional communications systems and systems that can support an amalgam of the two. Motorola is prominent in developing the Trans-European Trunked Radio (TETRA) system.

5.2.10.3 European TaxiCom Installations

Table 5:2-13 Some Motorola European TaxiCom Installations[21]

Country	City	Customer	Date Installed	Units
France	Paris	Taxi G7	1992	2000
UK	London	Dial-a-Cab		1400
UK	London	Radio Taxi London		1300

5.2.10.4 Annex: Motorola And TaxiCom

The evolution of TaxiCom within Motorola is an interesting story in and of itself. Motorola's initial entry into the market was made through the acquisition of MDI, the Canadian supplier of mobile data terminals, which it configured with software it developed called TaxiPak thus offering an integral TaxiCom system. The MDI unit was then integrated within the Mobile Data Division which later became the Wireless Data Group (WDG). By the mid-1980s Motorola and the MDI system had a major part of the market in Europe. However, the WDG was later subdivided and the ex-MDI products were put under the aegis of Land Mobile Product Systems (LMPS) at which point Motorola seemed to lose interest in the taxi market as it ceased to proactively offer turnkey operations and seemed content to upkeep the systems already in place. Motorola has since stopped producing taxi-specific products but now offers segments of applicable vertical systems (developed for fire, ambulance, police, public transportation and trunked communications) which can be found in LMPS (now Land Mobile and Private Sector), Private Data Systems and Messaging and Information Media Sector (MIMS) among others.

5.2.10.5 Contact Information:

Suzanne McDermott, Public Relations Systems
Victory House
3 Fleetwood Park
Barley Way
Fleet, Hampshire GU13 8US
Telephone: 44 (252) 801762
Fax: 44 (252) 801737

Richard Buchalter, Private Data Systems
Telephone: 44 (256) 330296
Fax: 44 (256) 58211

[21] Non-exhaustive list as Motorola did not furnish this data.

5.2.11 Micro Dynamics Corp.

5.2.11.1 Overview

Product type: Computer assisted dispatch systems

Micro Dynamics Corp. (MDC) is a small family-run American business specializing in the installation and implementation of software for its computer automated dispatch management operations systems (CADMOS). MDC offers two products called CADMOS-Pro+ and Dr. Dispatch. Clients are given the option of installing their own hardware, or MDC is willing to install IBM PC AT (or 100% compatibles) and Novell Netware compatible hardware itself. MDC's products are compatible with Gandalf (GMSI) MDTs, ANI monitoring systems, AVLs (LORAN or GPS) and Motorola paging and cellular systems.

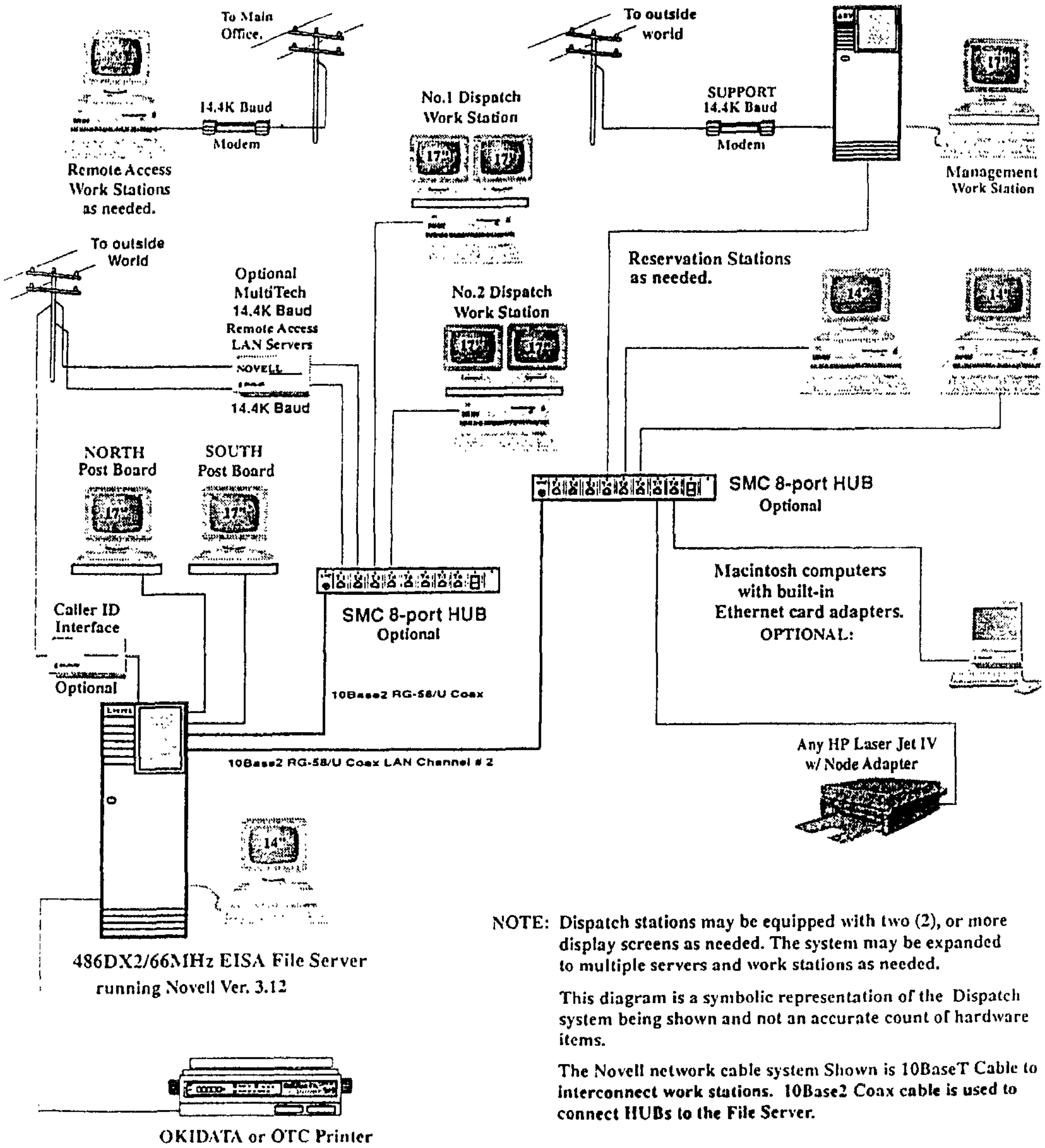
5.2.11.2 System Configuration

Hardware requirements

- Novell Netware v3.12 or greater
- Ethernet 16-32 bit topology
- Maynard 250 Mb-2.0 Gb Tape Back-up Systems
- Battery back-up protection
- Novell certified IBM compatibles only
- MS-DOS 5.0 to MS-DOS 6.22 systems
- 520 Mb- 2.2 Gb hard drive space for history and report generation

A typical dispatch hardware layout would resemble a variation on the diagram, **Dispatch Hardware System - 10 BaseT Layout Diagram**, on the next page:

Dispatch Hardware System
10 BaseT Layout Diagram



NOTE: Dispatch stations may be equipped with two (2), or more display screens as needed. The system may be expanded to multiple servers and work stations as needed.

This diagram is a symbolic representation of the Dispatch system being shown and not an accurate count of hardware items.

The Novell network cable system Shown is 10BaseT Cable to interconnect work stations. 10Base2 Coax cable is used to connect HUBs to the File Server.

Illustration PR11-1

Software Overview

CADMOS-pro+ and Dr. Dispatch operate in a multi-user mode that can track over 10,000 trips per day, 200,000+ clients and over one year of historical data. The systems allow simultaneous dispatching and provide primary and secondary dispatch boards showing trip requests, automatic call zoning, on-line help screens, a "slot" scheduling advisor, immediate, stand-by and prescheduled (timeset) trips. Over 40 management reports can be generated. The software is broken down as follows:

- **Trip Management**
  - User definable trip types with multiple rating codes
  - Cash, charge and combination payment trips
  - Fare, companion fare, co-payment and surcharge options

- **Client/Contract Management**
  - Tracks all vital client and trip information
  - User-defined alphanumeric account numbers
  - "Trip prescription" authorization tracking
  - Tracks contract billing information
  - Government programs support
  - Optional: electronic claims module

- **Driver/Vehicle Management**
  - Tracking of vital driver and vehicle information
  - User-defined alphanumeric driver/vehicle numbers
  - Tracks equipment usage statistics
  - Processing and billing of driver messages

- **Data Archiving**
  - Completed trips may be archived for future retrieval
  - Driver transactions may be archived
  - Archives may be optionally stored on floppy disks
  - Archiving may take place while system is in operation

- **Trip Request Management**
  - Automatic or manual vehicle assignment
  - Pickup and destination street management
  - Automatic street zoning
  - Mistaken/bad address tracking
  - Immediate or future trip tracking
  - Trip type, rating and purpose tracking
  - Tracks special requirement information
  - Charge account and credit card tracking
  - Optional: caller ID interface (where available)

- **Prescheduled Reservations**
  - Allows trip scheduling in advance
  - Built-in slot scheduling advisor
  - Graphical vehicle utilization viewer
  - Prints schedule listings
  - Multiple reservations permitted per client
  - Trip distance, travel time and wait time tracking

- **Dispatch Management**
  - Real-time demand-response dispatching
  - Prescheduled "batch" dispatching
  - Primary and secondary dispatch boards
  - Dispatcher can perform call-taking operations
  - Tracks driver log in/out with vehicle kilometrage
  - Allows entry of vehicle repair requests
  - Security protection with passwords
  - Tracks manual override of automatic assignments
  - Optional: multiple VGA dispatch instant graphical street mapping MDTs AVLs (Loran or GPS)

- **Management Reports**
  - Over forty reports are available under the following headings:
  - Trip Management reports (by trip type, purpose, account number, operator.)
  - Schedule Management reports (by date, vehicle, route.)
  - Miscellaneous reports (e.g. financial information)
  - System Information reports (by client, driver, vehicle, zone.)
  - Driver and Vehicle reports
  - Statistical/Demographic options (contract billing invoices, client service summaries, vehicle load.)

5.2.11.3 Estimated Costs

Software

CADMOS-pro+ 8 user software	$ 7,595.00
CADMOS-pro+ 24 user software	$12,495.00
Options:	
Instant Graphical Display module	$ 3,495.00
Caller ID Management software module	$ 995.00
Two-way Radio Interface module (allows integration of MDTs)	Price based upon application
Trip Rating module (with automatic fare calculation)	$ 695.00

Hardware

Everex 486DX/2, 66MHz EISA dedicated Tower File Server	$16,895.00
Dispatcher workstation (AST 486SX 33MHz 4MB RAM)	$ 3,450.00
Management and Reservation Workstation	$ 1,885.00
Novell Btrieve NLM continuous backup option	$ 1,285.00
Hardware, software and on-site training	$ 1,895.00

Total

Estimated total system costs with one year of support	$36,000.00

5.2.11.4 Contact Information:

Paul Buroker, Sr., President
Telephone: (812) 477-3090
Fax: (812) 477-3789

5.2.12 Frogne

5.2.12.1 Overview

Product type: Computer booking and dispatch systems, data communications, taximeters

Frogne is a Danish-owned company with headquarters in Copenhagen and a sales and service site in Sweden. The company has 15 years experience in computer booking systems and 7 years experience in data communications and the manufacturing of taximeters. Frogne has TaxiCom installations in Sweden, Denmark, Iceland and Germany.

5.2.12.2 System Configuration

Frogne uses essentially two configurations in its TaxiCom systems: a simple configuration and a system integrating GPS. A typical configuration of MDT, communications network (including base stations as necessary), central computer booking and dispatching is used. Software is custom-tailored to the clients needs. The planning and implementing process is estimated at 6 months.

The Central is configured with Hewlett Packard HP1000 and IBM-PC architecture and all taxi hardware is developed and manufactured by Frogne.

A typical configuration is shown on the following page:

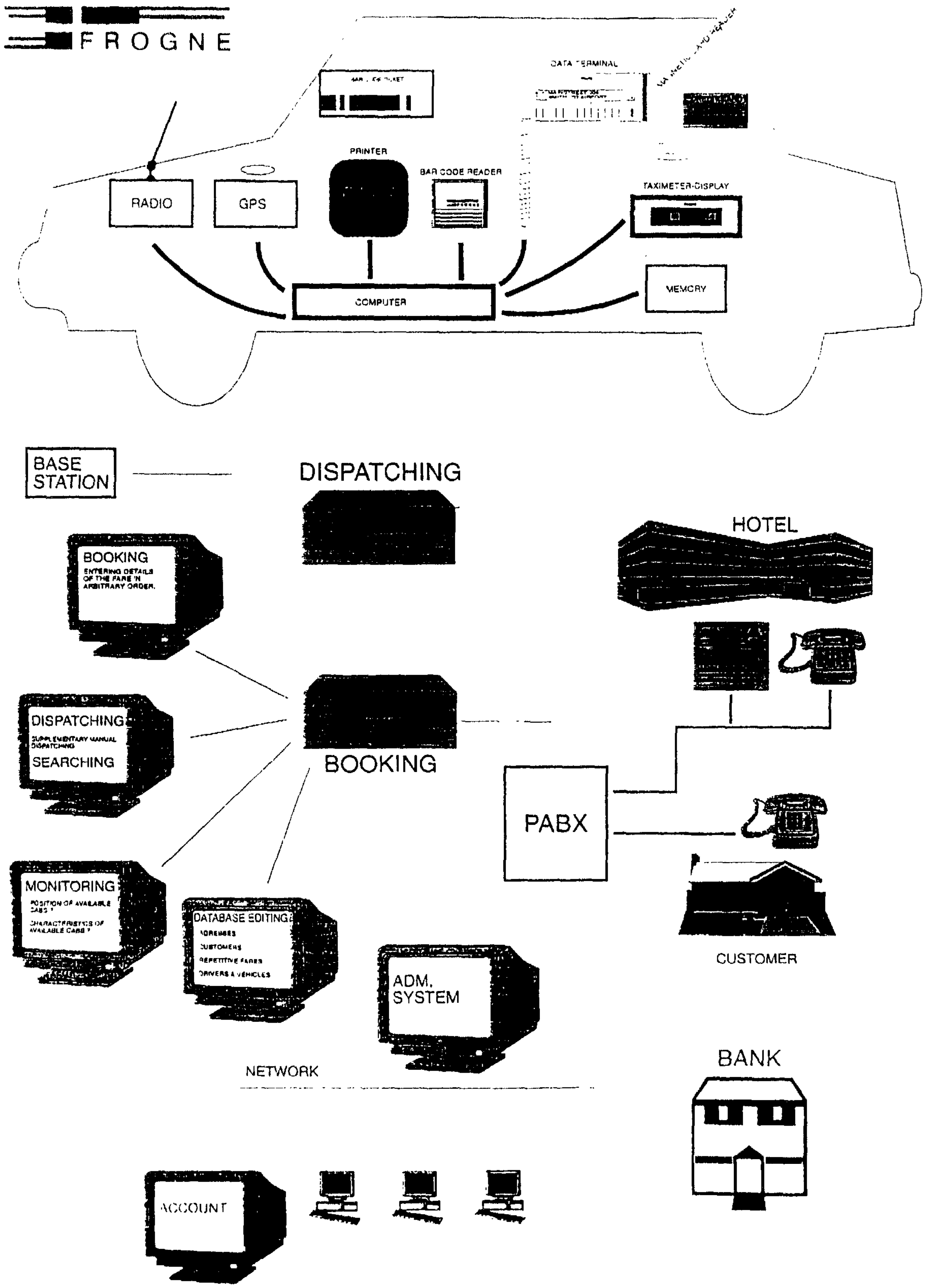


Illustration PR12-1

- **Mobile Data Terminals (MDTs):**

An interesting approach is the integrated taximeter-MDT unit (which fulfills the Swedish government's stringent taximeter standards) that Frogne typically installs in its TaxiCom systems.

Frogne MDT Unit

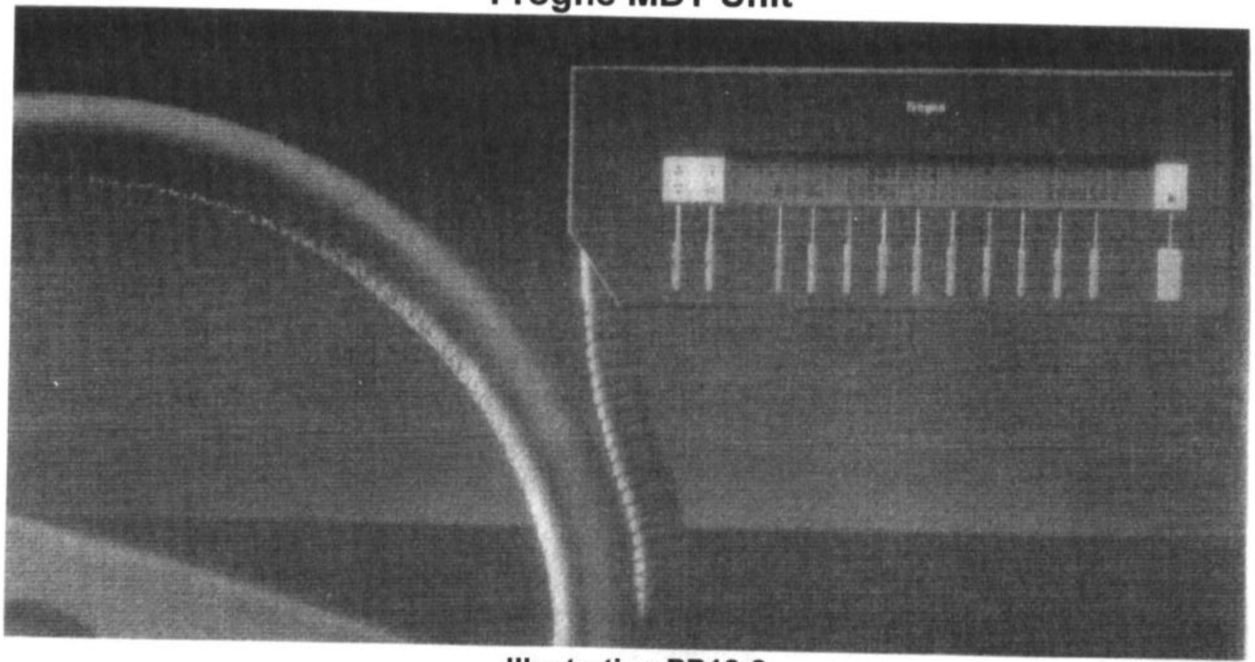


Illustration PR12-2

Communication Control

Communications control is assured via the typical TaxiCom array of base stations, multiplexers and modems. The transmission protocol was self-developed and designed to meet specific taxi communications demands. Transmission speed can attain 9600 Baud (dependent on local requirements).

Base station coverage depends on various parameters such as allowed transmitted power, antenna locations, and geography.

Memory Box

The Memory box is a sealed unit installed in the taxi which contains non-volatile memory. The memory box holds various information concerning completed fares and different tariffs. It contains different (up to 70) tariffs updatable via the Central, which is necessary in the Scandinavian, especially Swedish, markets. The memory box is compatible with multiple credit cards.

With the aid of the memory box shift reports can be generated.

Taxa-Nu

Taxa-Nu is an automatic call-box which is installed in hotels and other regular customers and allows customers to order a taxi with the touch of a button. Taxa-Nu can be used in three configurations: as an integral part of a TaxiCom system, as a stand-alone system or in defining a client as having priority over others.

Illustration PR12-3

5.2.12.3 TaxiCom Installations

Table 5:2-15 Frogne European TaxiCom Installations

Country	City	Customer	Date Installed	Units	Base Stations
Sweden	Stockholm	Taxi Kurir	n/a	630	8
Sweden	Stockholm	Taxi 020	n/a	470	3
Denmark	Copenhagen	Vest-Taxa	n/a	185	2

5.2.12.4 Additional Services

GPS

The cost of an integrated GPS with intelligent interface is approximately DKr 10k (approximately $1,750).

Credit Card Authorization

All systems are credit card compatible. In Frogne's Swedish systems, credit card transaction information is automatically transmitted from the taxi via the Central to the credit card company for authorization. The authorization usually takes 20 seconds. The system is also bar code compatible.

A taxi in a fully configured system will have approximately the following layout:

CAB Architecture

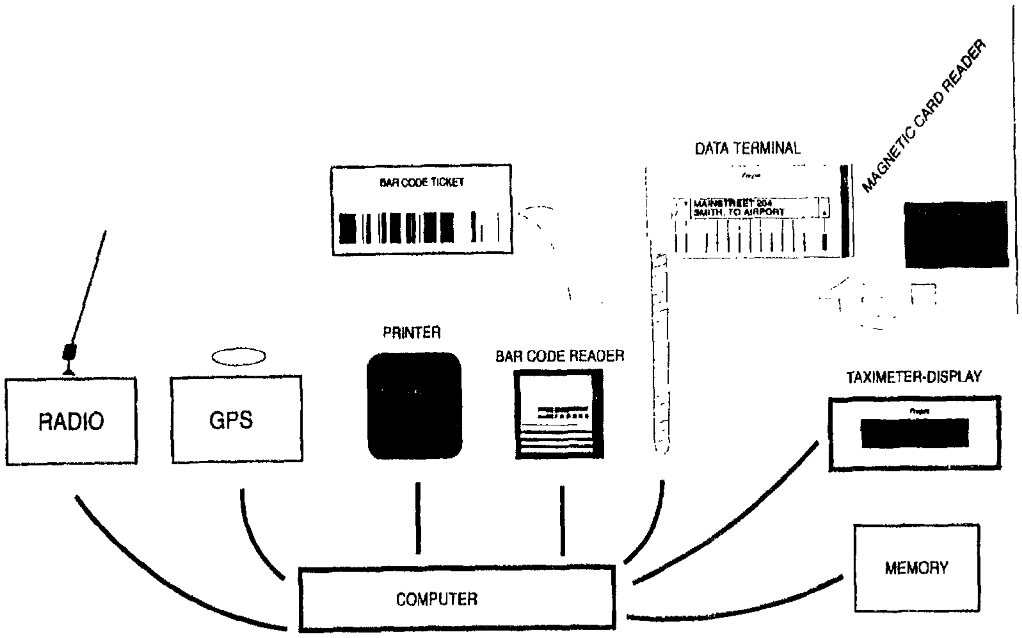


Illustration PR12-4

5.2.12.5 Estimated Costs

The following are rough cost estimates for an "average" fully configured system

Table 5:2-16 Estimated Costs

# of TAXIS	Control room (central)	Mobile unit (per unit)	Total
	DKr 10,000-20,000 ($1,750-3,500) per vehicle	DKr 35,000 ($6,000)	
50	$175,000	50 x $6,000	$475,000
500	$875,000	500 x $6,000	$3,875,000

5.2.12.6 Contact Information

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Denmark
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Fax: *45-4-3711282*

5.2.13 Taxitronic

5.2.13.1 Overview

Product type: "Smart" taximeters, MDTs, computer-assisted dispatch

Taxitronic Nederland B.V. is a Dutch electronics firm specializing in the manufacture of "smart" taximeters and increasingly in TaxiCom hardware.

Among the various products manufactured the following may be applied to a TaxiCom system:

- TX28-MT Taxitronic MultiTaximeter
- GDTN3V3+ Reading Station with memory cards (data base)
- TD-30 Taxitronic Data Terminal
- Taxitronic Alfa system (computer-aided dispatch)

General information is available directly from the company in various languages.

5.2.13.2 Contact Information:

Robin Van Lohuizen
Telephone: *31-55-413236*
Fax: *31-55-410745*

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Molenmalkershoek 52
7328 JK Apeldodan
The Netherlands

CHAPTER 6 - Planning and Implementing TaxiCom

6.1 Scope and Focus

> *"The first countries to enter the information society will reap the greatest rewards. They will set the agenda for all who must follow. By contrast, countries which temporize, or favor half-hearted solutions, could, in less than a decade, face disastrous declines in investment and a squeeze on jobs"*[22].

The Bangemann quote, when considered in a TaxiCom context, should send a powerful message to operators and their communities. Those who see TaxiCom as simply computerized dispatch or computerized fleet management have missed an important point and have overlooked its true potential. TaxiCom does encompass such technologies as computer dispatch, fleet management and varied report generation, and can be a way in which to favor a more efficient use of resources both human and material. However, if properly executed, TaxiCom can allow operators and communities to effectively adjust to technological advances, take advantage of each other's evolving needs and requirements and significantly modify the nature and depth of their relationship.

Communities and operators should keep in mind that with existing technology TaxiCom can be used to favor an increased synergy between public and private sector transportation. Such is already the case in Switzerland and several Scandinavian countries. Social, Elderly and Handicapped, school-children transportation and other services can easily be placed under the aegis of cooperating taxi operators or work in conjunction with them. With such TaxiCom capabilities as group and/or deferred billing, pre-programmed pickup/drop-off, and comprehensive report generation, this link becomes quite simple and profitable for all involved.

A TaxiCom system can be developed on the basis of a wide range of different operational and equipment configurations. Even within a given proprietary package of a given supplier there is not just one way to configure a system. Each supplier offers a wide variety of service and equipment options. With all these options and possible hybrids the final choice should correspond to an operator's needs, desires and financial capabilities. The increased modularity of such systems allows smaller operators to add on as capital becomes available and/or the extent of the benefits of TaxiCom become evident. Operators can mix and match, and today's hardware and software already in use is often compatible with modern TaxiCom systems, thus reducing the implied initial capital outlays. Unlike the situation in the past, suppliers are now increasingly willing and able to adapt their systems to the specific needs of the operator. However, more preparatory work is necessary on the part of operators, if they are to get exactly what they want and need.

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[22] Europe and The Global Information Society, Recommendations to the European Council (the "Bangemann Report"),p.5, May 1994.

Obviously costs and cost estimates represent a central element in the analysis of the feasibility and suitability of a TaxiCom system for a given operator/community. The costs involved have evolved considerably in the last ten years. These are somewhat problematic to estimate as each operator has different needs concerning not only performance, but also computer and communications hardware and software. Thus the following should be seen as indicative and based on operator experience to date.

Fixed costs (i.e. the expenditures necessary to equip the control room and establish the communications hardware base) make up a large percentage of the capital outlay for small operators. For fleets of 500 taxis and more costs tend to be equally spread out between fixed costs and total per taxi, i.e. unit costs. A rough estimate of the order of the investment necessary to fully equip an operator with a fleet of 50 taxis, is something in the order of $200,000 or so for the control room and communications base, and an additional $2,000-4,000 per taxi in mobile equipment.

The equivalent costs for a fleet of 500 taxis are roughly $300,000-$400,000 and a per unit cost of $2,000-$4,000. These figures can fluctuate dramatically in both directions depending upon such factors as detailed system specifications, service area in km^2 (which implies additional base stations), fleet size, services offered and hardware already in use.

Whatever the circumstances and budgetary considerations, a proper TaxiCom system should be compatible with the present and foreseeable needs of the operator and its community, and should allow for maximum flexibility for future additions and developments. Keep in mind that with TaxiCom new markets, services and benefits become available and the system chosen should enable these opportunities to be seized.

There are basically three ways to approach the challenge of planning and implementing a new TaxiCom system: 1) purchasing an existing system off-the-shelf, 2) developing a new system or 3) customizing components of an existing system.

The following is a guide (the questions that need to be asked and answered at each stage of the consideration to the implementation process) for those considering some, or all, of these technologies, whatever the desired approach may be.

6.2 Going It Alone?

Today, with the multiplicity of vendors specializing in the different aspects of TaxiCom, self-developing a system is not as difficult as it was at the time of the publication of our last report in 1985. Most of the equipment needed can be purchased off-the-shelf from the different vendors on the market.

Some operators may judge this as the best way to optimize their operations with their existing hardware, software, equipment and budget considerations. However going it alone is more time-consuming, difficult and costly than is generally imagined initially.

In order to gather the fruits of TaxiCom, all operators must go the path of the so-called "learning curve". This learning curve can be shortened considerably by virtue of an established supplier's experience, training, maintenance and service, i.e. by learning from other's mistakes. It has been observed that most operators who have initially gone it alone have operated with a sub-optimal system and/or have decided to convert to an established supplier's system, obviously at an additional cost.

Self-developing a system is time consuming and requires significant technical expertise and resources. Unless an operator/community has very unusual and specific needs and the resources necessary to develop a competent system, it is difficult to imagine the benefits of such an endeavor. Some elements of a system can be self-developed to meet specific needs unaddressed or unavailable in existing systems.

In the words of a supplier queried on this subject:

> *Self-developing order entry or call taking software is a feasible objective which can be done rather inexpensively. However, developing communications software which interfaces to a mobile data communications system is very complex...it has been found several taxi organizations who developed their own dispatching system wanted to add mobile data terminals. It has turned out to be less expensive and more efficient to replace their system with packaged software, rather than build a custom interface to their current software. In this respect, most computerized dispatch systems can be implemented in a two phase process. The first phase would involve a voice computerized system with MDTs added on at a later date.*

Against this background, it is our suggestion, whatever the plans and intended development path of an operator, that a major effort be made to contact all available TaxiCom suppliers and operators and listen to their suggestions and solutions before making any major decisions. Operators should above all understand how their operations will be modified by TaxiCom, determine what is a feasible/justifiable cost (total and per vehicle) and estimate increased earnings or volume/market share. This way, even if the decision to go it alone is made, the risk of making major mistakes is diminished and conversely the chances of success are increased.

6.3 Modularity and Technical Upgrades

The better TaxiCom development projects have given considerable attention to the principles of modular system design. We have distinguished three different approaches in this respect.

One approach is a system design geared towards **phased implementation and upgrading**. This approach allows operators to follow a "path" of increasing operational and equipment sophistication. Basic configurations are implemented from the outset and the system is then gradually added to and expanded in discrete increments, in order to arrive in due course to a full-featured systems package.

A second approach is that of **quasi-independent modularity**, i.e. system modules that can be used independently of other modules. A basic system configuration is necessary but ensuing modules can be added to the system according to the operator's needs and budget and without a corresponding or pre-determined order.

The third approach is that of **"dressing" a traditional dispatch system with TaxiCom capabilities**. Traditional radio communications can be transformed to enable data transmissions. This approach can reduce costs as existing communications hardware can be used. Operators should ascertain whether data transmission capabilities correspond to their needs, both present and future, as some systems allow only one-way transmission, transmission of pre-defined messages or minimal data capabilities in general. Certain makes and models of mobile radios are more easily adaptable and more efficient for mobile data systems. Operators should verify the compatibility of their system with the different systems offered on the next market ahead of time.

No matter what the approach is, operators must be aware of the increasing importance of software in system configurations and upgrades. Personalized software can now easily be developed. Some suppliers are working with operators and/or software houses to develop programs suited to the specific needs of the operator for which the system is being configured. The possible benefits of such an approach are obvious, but also depend in large part on the quality of the system specifications. For this to be properly executed (the first time), operators should give the latter careful attention and would be well served by substantial knowledge of TaxiCom capabilities.

As hardware becomes less costly, high performance software takes on increasing importance. An operator should look for a system that is suitable to its present needs and that can easily add software/modules as its needs evolve. Some suppliers now offer a "hardware base" and develop software with the operator and specialized software firms, while others offer software in modular form.

6.4 Main Planning and Implementation Steps

Time and resources are necessary to get even the simplest TaxiCom system up and running. However both parameters are shrinking as TaxiCom progresses and suppliers and operators gain experience. Today a full-fledged TaxiCom system can be planned and implemented in 12-18 months. In comparison with the first TaxiCom systems, which necessitated years of planning (6 years for the system in Gothenburg) and thus substantial research and development costs, the progress is evident.

Some operators may want to undertake the entire process themselves, while others may call in system/technical consultants at different stages of the process. Increasingly, operators in neighboring communities band together in order to specify similar systems, make group bids to purchase hardware, and recently to share a common TaxiCom system.

Whatever the preferred approach, we see the process of planning and implementing a TaxiCom system is now proceeding in seven broad phases discussed below:

6.4.1 Initial Study Phase (In-House Project)

Phase objective: *Should TaxiCom be looked into further for eventual implementation in our company/community?*

Literature should be amassed by contacting all available suppliers and similar (in size, nature and demographics) operators and communities already using TaxiCom in order to reach a thorough understanding of what TaxiCom is and implies. Keeping in mind that though TaxiCom offers some immediate benefits, it might not make “sense” (economic or other) everywhere. For example taxi operations dependent exclusively on tourists and street hails may not find that TaxiCom justifies itself. At this stage only rough cost and earnings estimates should be ventured and a rough picture of what TaxiCom entails should begin to emerge.

6.4.2 Pre-feasibility Probe Phase

Phase objectives: *Determine if TaxiCom should be implemented in your company or community. Verify if institutional support exists.*

The following parameters should be defined:

- likely service area
- radio requirements and availability
- system objectives
- absence or presence of topographical difficulties
- service requirements (traditional, social, Elderly and Handicapped, and new)
- cooperation with public transportation systems (synergy, replacement, reinforcement)
- cooperation with local government
- preliminary costing
- possible forms of funding

This phase can take anywhere from 1-3 months and should culminate with a 30-50 page report with recommendations on all key points. A final debriefing session with all key groups and agencies is also suggested.

6.4.3 Feasibility Study Phase

Phase objective: *Define all actions/decisions that need to be made for remainder of planning cycle and guidelines for implementation phase.*

At this point the following additional parameters should be thoroughly analyzed and defined:

- detailed program budgeting
- complete financial plan

- operations plan outline
- compatibility of existing hardware/software
- specification of all necessary additional hardware/software
- identify compatible hardware/software suppliers
- ranking and justification of preferred supply sources
- implementation plan outline

This phase will range between 2-6 months, and should be undertaken by a small multi-disciplinary team with a local project manager and preferably a skilled technical consultant.

The first three phases can cost up to $45,000, depending on their scope and thoroughness and the extent to which they are performed in-house or use external consultants. It should be kept in mind that Phase 3 can partially be merged with the proposal process of turnkey suppliers.

The following phases will be mentioned by name only as they will depend on the parameters defined by each operator/community.

6.4.4 Full Operations Plan Phase

Phase objective: *Definitive guidelines for all necessary actions through implementation phase.*

A comprehensive plan of action should be constructed for the remaining phases. This will include, among others, the naming of a project leader, fully defining the budget parameters, and the establishment of a complete timetable.

6.4.5 Equipment Purchase and Installation Phase

Phase objective: *Final source specification, equipment purchase and installation, contract specification.*

All final hardware and software suppliers should be identified. All equipment purchased should be guaranteed. Installation should be done by the supplier(s). Service contracts and guarantees should be for a period of at least one year and ensuing service/replacement fees should be defined at time of purchase. The contract should stipulate a guarantee of service in case of supplier departure from market (be it for whatever reason).

6.4.6 Start-up

Phase objective: *Training, testing, debugging and trial operation.*

A phased testing to full operation process should be used and is usually done in increments of five to ten percent (5-10%), twenty to fifty (20-50%) and one-hundred percent (100%) of taxi fleet. Traditionally this has taken from 3 to 12 months. Training of operators, dispatchers and drivers usually requires 1 day to 2 weeks and can represent an additional cost if not included in initial contracts.

Debugging of the system (which can take up to one year but is usually a matter of weeks) and the trial operation process, should be included in supply contracts and performed in accordance with the supplier/s. Manual dispatching capabilities and an effective backup system must be planned, so that system failures will not have a paralyzing affect.

6.4.7 Operations and Monitoring

Phase objective: *Full operations.*

The first year of operation of a TaxiCom system is crucial. For this reason, one year of support is usually included in supply contracts. System bugs and problems usually surface within this first year time period. Thus make sure initial contracts spell out the nature of the support, the costs that are included and what materials are covered by the (often various) guarantees and by whom. Ensuring that your system meets your expectations and requirements is a lot easier and less costly to do at this stage than in ensuing years.

It can not be stressed enough the importance of including interfaces that will allow the TaxiCom system to evolve with the nature of the operations, the needs and the role it can play within the community. Many of the initial TaxiCom operators did not, or were not able to do such, and found themselves making major upgrades within five (5) years and purchasing a new system within ten (10) years, (as their business and role within their communities took on new and unexpected dimensions).

6.4.7.A System Extension, Upgrades and Reconfigurations

All TaxiCom systems implemented until now have been upgraded or extended within a few years of implementation as new opportunities and advantages become apparent. Some have been done in conjunction with the original supplier/s, but the majority are performed through new or alternative suppliers. For example, installing a credit card reader (or smart card reader) can be done with a specialized supplier and the appropriate credit facilities and does not require the expertise of previous suppliers. Hopefully this eventually will be taken into consideration while planning your system.

Most upgrades and extensions can be performed without disturbing the existing system setup. The system is supplemented without requiring a major overhaul in the present configuration. A typical example is the addition of credit card capabilities, which only implies the addition of the magnetic/smart card reader in each vehicle, and sometimes, minimal software modifications (and the necessary agreements with local credit establishments).

For hardware upgrades, compatibility with already installed equipment must be verified before purchasing as some protocols, computer environments and components are not compatible with others. Software however is easier to adapt, and often a well-specified older software can outperform the modern software offered by suppliers. Buying new hardware or software should not be rushed and not before obtaining various opinions (from different suppliers or technical consultants) concerning what can still be used effectively and what real benefits the new equipment offers. Some suppliers offer upgrades free of charge for certain components and software (which is another issue that should be discussed with suppliers prior to purchase).

Some system extensions require additional time and resources to implement. In order to install a GPS, for example, numerous hours of data programming and meticulous sectorization are often needed initially. In this case, unit price and ensuing costs may not be significant, but total cost may be affected by the one-time initial implementation cost.

Reconfigurations are a hybrid between the acquisition of a new system and the retooling of existing components. To date these have been rare, due to the rate in which hardware has become outdated. But as hardware becomes more flexible and more advanced, it becomes easier to envision the "recycling" of components for use in modern systems. Reconfiguring a new system around existing software has been more frequent, and reinforces the notion that if the initial specifications are done correctly, there is no need to redo the process. In both cases it is suggested that a reconfiguration be treated as an outright acquisition, and that phases 3-7 be repeated.

6.5 Planning Overview and Commentary

The European Taxi Confederation organized a conference in San Sebastian, Spain on February 9-11, 1995. The object of the conference was to address the common problems and potential solutions for taxi operations in a changing business environment, with particular attention to the harnessing of new data and communications technologies.

Among the different presentations was that of Mr. Philip Cavin from the Swiss firm of Indelco AG (see Section 5.2.2). The following are excerpts from the translation of his presentation given on the general aspects of TaxiCom and the different modern options of such a system. It provides the readers expect insight into the background and perspective on planning these systems -- irrespective of supplier, size of system or country.

"Before illustrating the different available options and configurations of TaxiCom we would like to speak to you about the feasibility of such a system. Three basic components need to be considered initially:

1. *The Dispatching and Control Center (the DACC or the Central), its necessary administration, personnel, hardware and software;*

2. *Communications (radios, base stations and antennae) equipment;*

3. *Mobile equipment.*

Prior to implementing a new system, an in-depth study should be undertaken, best conferred to a qualified transportation consultant, in which the following questions are answered:

1. *How can/will my personnel structure be modified? Can personnel be reduced according to the selected solution?*
2. *How many radio channels are needed? Are supplementary channels needed? (Note that 150-200 vehicles can operate on one channel and that each frequency needs to be confirmed for a duration of eight to ten (8-10) years).*
3. *Are clients content with prevailing service? Will the new system be adapted to an expanded clientele (school children transportation, elderly and handicapped services, etc.)?*
4. *How much will the entire project cost? How will it be financed (leasing, loan or other)? How much will the initial preparation cost?*
5. *How long will it take to get operations up and running?*
6. *Will profitability be affected? By how much, if personnel reductions are taken into account?*
7. *Should all mobile equipment be purchased outright by management and leased to drivers, or should drivers be asked to purchase their own equipment?*
8. *Will the location of the Dispatching and Control Center need to be moved, and if so, how much will the move cost?*

These are some of the reasons why you should not undertake such a project without first conducting a preliminary study of these problems and available solutions. So as to avoid possible unpleasant surprises, do not underestimate the importance of the feasibility and planning phases of the project.

Option A: Basic Computer Aided Dispatching (CAD)

There are several possible ways in which to computerize a DACC. The simplest (which may look like the cheapest in the short run, but which may prove the most expensive in the long run) is a "basic computerization" of the DACC. This implies the purchase of computer dispatch software (which requires data input of the street and address directory of the service area), the purchase of a PC, and possibly a central unit (i.e. along the lines of a minicomputer with extended memory).

Advantages

1- *Some possibilities to achieve personnel reductions;*
2- *Report generation and statistic gathering capabilities (for clients and drivers);*

3- *Allows operators to improve service, locate repeat customers and thus to increase client fidelity;*

Disadvantages

1- *Almost impossible to have an efficient security system;*
2- *Taxi arrival time can not be accurately estimated;*
3- *The return on investment is rather long as the only real savings are due to minimal reductions in operational costs.*

Costs

The following costs are estimated for a Central serving 300 vehicles, with 4 call-taking/dispatching stations and a 30-minute security/intervention unit:

Software: $80,000-200,000
Hardware: $40,000-100,000

Thus total cost of such a setup can be estimated at $120,000-300,000.

Option B: CAD with Partial Mobile Data Transmission

The second possible solution is a computerized Central with partial mobile computerization (i.e. one-way data transmission).

This implies the same procurement as Option A with the addition of a data display in the vehicles. Depending on what radio equipment is already installed, new radios may or may not be necessary (as some are not compatible with the technology).

The service area is then "sectorized", that is divided into main sectors/sub-sectors of activity each receiving a numeric or alphanumeric code. Drivers inform the Central of their position and then receive a queue position within the sector. The driver can then decide if he prefers to remain in the sector or reposition to one with a higher queue number. The trip is then allocated via traditional voice radio dispatch.

Advantages (relative to Option A)

1- *Dispatchers know whereabouts and availability of vehicles in real time and can better estimate arrival times;*
2- *Deadheading is reduced (which economizes fuel and vehicle wear);*
3- *Vehicles can be more evenly distributed within the service area;*
4- *Return on investment is estimated at 10 years.*

This solution can be configured as one-way transmission in the other direction, i.e. the Central questions the vehicles by radio as to there whereabouts and availability and transmits information about the trip to the data display directly. The advantages being that the driver *receiving the trip is privy to the information, does not need to write any information down or remember any, and the risk of error due to misunderstanding is eliminated.*

Costs

For a similar configuration as described previously, the cost of this system is estimated at:

Software:	*$100,000-300,000*
Hardware:	*$60,000-120,000*
Data display installation:	*$600-1,000 per vehicle*
Radio installation (if necessary):	*$1,000-1,600 per vehicle (taxes not included)*
Total estimated cost:	*$340,000-1,200,000*

There are cheaper configurations available for both of the first two solutions, but our research has indicated only those that are prevalent among operators.

Option C: Full Function TaxiCom System

We will now pass to a true full-feature TaxiCom system including a completely computerized DACC and mobile units, complete service area sectorization and automatic trip distribution. This solution requires a more powerful PC configuration or Tower that can handle extended software.

Various transmission protocols exist (the standard being 1382) and can be used as well as modems, data terminals and radios.

An effective alarm system is also an integral part of this configuration (the details of this alarm will not be exposed in this forum so as not to compromise driver security).

Advantages

1- *Significant reduction in personnel (20-40%);*
2- *Decreased deadheading (15-35%);*
3- *Immediate client response;*
4- *Increased taxi punctuality;*
5- *Credit or "smart" card capability (with on-line validation) can be easily added;*
6- *High-performance security system;*
7- *Return on investment is estimated at five (5) years;*

Costs

Software:	*$100,000-240,000*
Hardware:	*$80,000-120,000*
DACC data and radio equipment:	*$50,000-60,000*
Mobile radio and	

display: *$1,400-3,800 per vehicle*
Total estimated cost: *$650,000-1,560,000*

This last configuration is the most expensive, but also the one which can pay for itself most quickly. This is due to reduced personnel and deadheading costs, and the resulting increase in passenger/client volume. The increase in driver security may also attract additional drivers for operators renting their services, thus resulting in an additional source of revenue.

Keep in mind that the larger the system the better the chance that the average unit price will be lower.

Option D: Full Function System with GPS

A GPS vehicle location system can be installed and added to this system. Trip allocation is performed in real time, with the possibility of choosing the vehicle (not always the closest) that can arrive the quickest. Thus arrival times can be estimated with minimal deviation.

This configuration can be added to and improved with Differential GPS (DGPS) which increases accuracy to 20 meters of actual position (regular GPS accuracy 50-100 meters). There are also traffic control systems that operate independently of GPS which can locate vehicles with accuracy of up to 200 meters.

Costs

GPS:	*$400-700 per vehicle (once installed GPS use is free)*
DGPS:	*The unit cost is roughly the same as the GPS but needs 2 people and 3 to 10 months of preparation (depending on the specifics of the service area) with an additional cost of $40,000-80,000.*

Option E: Top-of-the-Line System ("TaxiCom 2000")

There are various auxiliary services and options that can be added on to a fully-featured TaxiCom system.

Among available options there are PABX phone lines, automatic "call-boxes" (from which taxis can be ordered with the touch of a button), automatic call-takers (with touch- tone), smart card and smart taximeter technologies.

With these and similar technologies a quasi-automatic Central can be attained.

Option F: Multiple Company/User TaxiCom Systems

We would also like to mention possible solutions for small operators, cities and towns. Three possible solutions exist.

The first solution is a 'multi-company' option which regroups several taxi operators under one central TaxiCom system. Each company can operate discreetly on the same system - thus reducing costs without reducing advantages.

The second possibility is a 'multi-user' option in which taxi, police, fire, ambulance and/or towing services within a community use one central system.

Increasingly we are seeing a third option: linked taxi and public transportation systems (which we see as a natural affiliation as taxis are of considerable public utility, even if they are privately-owned).

The systems and configurations we have described are those prevalent in the world today. In the future we may see the emergence of systems in which vehicle guidance and traffic systems are included, addresses appear directly on graphic displays (i.e. electronic city maps) and/or high-performance GPS systems (with absolute real-time accuracy).

Remember, before investing in a new system a serious study should be undertaken to analyze the needs of the operator, the community and the region, the various costs involved in the project and the possible modes of financing. Keep in mind that the more expensive systems are usually the ones that pay for themselves first and never, never purchase a system that you have not seen functioning in another location.

CHAPTER 7 - The Taxi Sector in a Time of Change: New Roles for the Public Policy

Taxis constitute an important element of the transportation systems of every advanced industrial nation, as well as most of the developing countries. Despite their importance as providers of transportation services, as generators of jobs, and as markets for industrial products, they have until now received little structured attention from policy makers in most places. And yet, their potential usefulness is far greater than has traditionally been recognized.

The taxi sector presents a number of timely specific challenges and timely opportunities for both private and public sectors. It also offers a full and vivid microcosm of many of the issues which concern transportation planners and policy maker, in their work more generally. Here are just three examples of many:

- If for instance the concern of the community is to find ways to make better use of road space to avoid unnecessary new construction, a well functioning modern taxi system can make a non-trivial contribution in this respect.
- If the problem is reduction of private car traffic in city centers, here too taxis can play a useful role.
- Likewise, if the challenge is that of ensuring cost effective transit services in lower density areas or in off-peak periods, creating more local jobs, achieving fair levels of mobility for the elderly and handicapped and introducing state of the art electronics to reinforce performance levels, then an appropriately throughout and far-reaching analysis of the taxi sector can provide many useful insights and eventual policy instruments.

7.1 Traditional Public Sector Attitudes Towards Taxis

Despite the fact that there have been taxis -- public hire vehicles -- plying the streets of our communities for hundreds of years, they have by and large not been the subject of much thoughtfulness or helpful input from planners or policy makers in most places.

This is not because they are unimportant, because the fact is that in many places, they rival the official public transportation system as an effective carrier of people and even goods. In the United States alone, for example, with some 6,300 operators and 170,000 vehicles on the road, they carry about the same number of people as all bus transit systems combined.[23]

[23] Gorman Gilbert in "IVHS in the Taxi Industry" presented at the IVHS Annual Meeting, Reston, Virginia, March 1991

Firmly rooted in the private sector, the taxi sector presents a number of anomalies from the vantage of the public policy maker. Most of these trace to our ignorance of what is actually going on within the sector. This ignorance stems from a number of factors and leads to a number of problems. It also leads to some significant opportunities which are getting lost in the process.

The reality is that the taxi transportation section is doing a considerable job of moving people, without the benefit of public subsidy or public management, but its development and social contribution is being impeded in most places by a structure of regulation and control which is antiquated, chaotic, excessive, and demonstrably counterproductive. To make a bad situation even worse, the quantity and quality of the information that is available on the sector is generally so poor that few can even see that there might be a problem at all.

The approach of most of those who are, or at least should be, concerned with developments in the sector appears to be to rely on what Professor Galbraith years ago kindly labeled as "conventional wisdom". The conventional wisdom as far as the vision of the taxi business on the part of most planners and policy makers can be summarized as follows:

1. Taxis are not really very important, either in transportation, economic social or political terms.
2. There are, if anything, already too many of them on the road.
3. They line up poorly, if at all, with the structures and priorities of our post-industrial societies; and, in any event...
4. The sector is best left to its own devices.

This point of view is not only widely held, but it is shared both by casual observers and also by most transportation experts and policy makers. It is also, one could argue, a point of view that is consistently and pervasively wrong.

In order to consider in more detail the opportunities that are opening up in this sector, a somewhat broader perspective needs to be undertaken and understood.

* * *

If taxis were trivial as providers of transportation services and as sources of jobs, as the conventional wisdom seems to imply, there would be little reason to take the time or the trouble to engage in a rethink of the sector. But consideration of the evidence points to some rather different conclusions.

For the European Economic Community (EEC) region as a whole, the totals are perhaps surprisingly impressive: the sector involves putting more than one million vehicles on the road, provides more than two million direct jobs, carries somewhere around ten billion passengers annually, including in emergency and other situations where no other form of transportation is available.[24] To finance this capacity, taxi operators are spending close to three billion dollars annually on equipment alone, while direct government subsidies are close to zero.

Judged on the basis of the facts, the underlying reality of the world taxi sector as it stands today in 1995 is that it is:

- Already massive in its dimensions;
- A significant provider of needed social services;
- An entrepreneurial structure which provides services without the need for public subsidies or operation;
- Far reaching in terms of its social and economic implications;
- Extremely different from country to country in terms of its size, structure, performance, requirements and prospects;
- Steadily changing in its structure, technology and mix of services offered;
- On the brink of the most important technological revolution in the sector since the introduction of the gasoline engine; and
- Poorly understood and substantially underestimated by transportation planners and policy makers alike.

If this is true, it would seem reasonable that, before writing off taxis as a possibly more useful transportation option, we give further attention to considering what could be done about them from a public policy perspective -- bearing in mind that there are still few unresolved transportation problems lingering about, that the public purse is not bottomless, and that job creation has gone from being an academic phrase to a social and political issue of considerable importance.

7.2 Perceptions, Contradictions, and Change

While that is the reality, the *perception* of what is going on is often quite different. Because of its highly fractionalized nature, the taxi sector has rarely been regarded by either its regulators, suppliers or customers as anything other than a small business -- and as a purely local concern. Worse, until recently in many countries across the region, the taxi business itself had, for a variety of reasons, been in a state of steady decline.

The widely shared perception of most of those involved -- with rare exceptions -- is that business is not very good. However, this survey reveals that in most places this has more to do with the perspective of those who hold this opinion than with actual fact. This tendency to pessimism reflects that:

[24] Source: Estimates from *EcoPlan World Taxi Survey*, Paris, 1994

(a) there actually have been a number of tough years in the past;

(b) on-going structural changes ensure that there are a certain number of losers out there (and in this business everybody can spot the losers); and

(c) the lag time that inevitably separates perception from reality, whatever the country or sector.

But things are now -- at long last -- changing on a number of fronts. In many places the quality of taxi management is on the upswing. The basic structure of the sector is evolving in a number of important ways, including in terms of ownership patterns and operating methods. New kinds of business are being created. New generations of radio control equipment and small computers are coming on line in ways which are stimulating sharp improvements in productivity and profitability -- and which in the longer run hold the promise of a major technological revolution.

Furthermore, after many years of general neglect, the taxi business has begun to be "legitimized" by the public sector. A recent wave of studies have demonstrated how taxis are, in country after country, providing cost- effective transportation for many parts of the society, including the elderly, handicapped, poor, non-drivers and people who either on a temporary or permanent basis find themselves without access to cars.

As a result of all these forces, the old cobweb of restrictive regulations and practices is slowly beginning to be reformed in countries across the region. The results show that the leading edge of the taxi trade is gradually developing new products, tightening up its management, and attaining levels of billings and profitability never known in the past. Thus, what is seen today across the region is not a sector in decline, as the conventional wisdom would suggest, but a business which is both changing and expanding.

7.3 The Public Policy Vacuum

A careful observation regarding the taxi industry in most countries shows a vacuum in policy. This situation exists at virtually all levels of transportation policy, but it is most marked at the national level.

Because of the highly decentralized nature of the taxi business, regulating and other controls have in most places long since been handed over to local government agencies. These in turn have tended to deal with the problems and priorities of the sector -- whether from the vantage on its clients, its impact of the local economy, its role as a supplier of jobs, or its relationship to the transportation system as a whole -- from an immediate local perspective and on an issue-by-issue basis.

As a result, there have been few concerted attempts at the national level, either in the United States or in Europe or the EEC region more generally, to come to grips with the problems -- and the opportunities -- before the sector as a whole. One result of this public policy void has been a basically unstructured, and in places even chaotic, environment for taxi operators and the public they service.

In this universe of poor information and fractionalized policies, irregular performance and continuing ad hoc improvisation on the part of just about everybody involved with the sector, is the norm. As a result, in most communities the sector is substantially under-performing. Less service is being offered, often at unnecessarily high prices. Too few jobs are being created. The business and working circumstances of those already in the sector are inadequate. Public monies are having to be poured into public transit modes which could possibly enhance private taxis operators.

A further result of these circumstances of "benign neglect" is that the taxi business has been obliged to lumber along with products that, by and large, have been defined to operate in quite different kinds of situations. Neither the concerned industrial suppliers nor government, have fully appreciated either the true dimensions of the market, the real needs of the operators behind the wheel, or the requirements of the traveling public.

Under these circumstances it would seem fair to ask why is it that policy makers in most places have failed to come to grips with the problems and the opportunities of the sector. The short answer to that would seem to be because:

(a) The underlying structure of the sector is changing, and in places quite rapidly;
(b) Administrative fractionalization has led to a situation wherein nobody is really responsible for its global development -- so initiatives at the national level are easy to duck, and finally because
(c) Virtually all aspects of the sector are in general poorly identified in terms of the available statistics.

For a variety of reasons the information we have on taxis and their actual performance is in most cases extremely poor. These limitations exist at virtually all levels of operation, oversight and control in nearly all countries. This situation has come about because of not one but a whole chain of circumstances:

> First, the general and pervasive reluctance of many individual drivers to make all of the facts available on their daily operations known to the their employers.
>
> Second, the operators who tend to be little interested in turning over all of their actual records to the various government agencies involved.
>
> Third, the fact that the numerous concerned governmental agencies. Each tend to develop and retain only portions of the database, more often than not, in a form which is not really usable or available to anybody else.
>
> Finally, precious little of this data makes its way beyond the immediate operating area to the national level -- while for reasons of language, sectoral organization, and lack of either professional interest or established channels, the amount of

international transmissions of such information is marginal and occasional at best.

The absence of adequate information and perspective on the sector has led to three closely related developments, each a problem in its own right:

- First, a virtual abandoning of the sector by national transportation agencies, on the grounds that this is essentially a local business and as such properly the concern of local government.
- Second, a basically unstructured and ad hoc environment for both operators and customers alike.
- Third, a substantial and visible under-servicing of the sector by industrial suppliers, as a result of long held preconceptions about the (limited) importance of the market.

7.4 The No-Policy Policy for Taxis

Few ministries or departments of transportation anywhere in the world today appear to feel particularly strongly about the lack of a national policy as far as the taxicab industry is concerned. To the contrary, one can detect a certain feeling of relief on the part of most that they have, in fact, managed to avoid getting themselves embroiled in this particular sector in the past.

Given the enormous subsidies costs and difficulties over the last several decades that have resulted from central governments' involvement with public transportation sector, and given the clear desire now of most governments to reduce their degree of involvement in these issues; it is almost anomalous to suggest that any government agency should now consider the formulation of a coherent national or even regional policy for the taxicab industry.

The fact is however that the present policy void actually has its own costs. Much of this is hidden, though, because the database is so poor and the issue has received so little structured attention, that informed commentary is difficult if not impossible. Here are what is perceived as being among the more serious problems encountered, as well as some of the opportunities lost as a result of this "no-policy policy":

- Inadequately dynamic development of the taxi sector itself (with the concomitant of lost service and lost jobs);

- Poor or non-existent coordination with other transit modes which, among other things, has led to unnecessary subsidies to loss-making public enterprises in situations where taxis may offer a cost advantage;

- Inadequate service of certain geographic areas, or transportation disadvantaged groups for whom taxis may be the most efficient mobility provider;

- The precarious economic structure of taxi operators, which all too often leads to poor working conditions and pay, unnecessary bankruptcies, irregular business practices and eventually even criminality, etc.

Against this background what is clearly now is needed: a) a new planning framework against which planners, policy-makers and others concerned can look at their national and immediate local situations, b) getting a fix on the relative performance and limitations in their region or community, and c) drawing on the results of leading edge experience in the taxi sector to develop checklists of ideas and initiatives that could help them strengthen the sector in their country, state or city -- as a provider of needed services, as a generator of jobs, and as a useful compliment to the other transportation services in their cities, towns, suburbs and rural areas.

Until such time that we improve our knowledge of what is actually going on, there can be little hope of coherent policies or broad-based breakthroughs in the sector. Furthermore, as long as the information on performance, benefits, and costs remains too inadequate to permit even a basic definition of the problems and opportunities that currently exist, policy makers will be able to continue to avoid the issue. This is the real "Catch 22" situation which currently exists in much of the EEC region and which we now needs to be addressed and remedied.

7.5 Taxi Industry Developments and Prospects in a Broader *Access* Context

Many new developments can be expected in the taxi sector in the years ahead, as attitudes toward 'transportation in cities' and transportation in general continue to evolve. This is an on-going process which is picking up considerable speed in more places within the EEC region. Many US cities have yet to begin to show signs of these new approaches and achievements, yet there exists a large number of examples in Europe which are leading the way.

Development within the taxi sector can be expected to be both quantitative (more trips, more vehicles, more drivers, higher revenues, better earnings) and qualitative (wider ranges of services offered, better working conditions, more 'social' services, less deadheading, different kinds and sizes of vehicles). Part of this will come about as society re-adjusts its collective sights in terms of how private cars are used, especially in cities but also in other places as well.

Another push for change in the sector will result from the growing understanding that the alternative to cars, with an average of 1.3 passengers, is not 'conventional' public or mass transportation. "Taxis" (dynamically redefined to include a growing range of service types), or, better, flexible 'demand responsive' services based on smaller vehicles (but not only conventional passenger cars) with increasingly sophisticated electronics and communications systems and <u>human drivers</u>, could well have an increasing role to play in this panoply of alternatives. Taxis thus will begin to be looked at as part of a greater whole -- the city or the area's revised and extended global access system.

This begins to be possible and make real sense increasingly as the information-communication component permits them to move into new and more useful roles within the community. One of these roles has to do with providing regular transportation for those within our communities who, for one reason or another, should not be driving.

Another has to do with what shifts in attitudes toward employment in the transportation sector -- bearing in mind that one of the major thrusts of public policy and private initiative over the last five decades has been to make MAJOR reductions in the human content (say jobs) of the transportation system, under the soothing rubric of 'labor saving innovations".

Among the 'new partners' of the 21st century taxi industry will be the social service agencies, who will increasingly provide customers via the sort of 'social taxi' or 'farndjenst' services that have first developed in Scandinavia, and which already account for somewhere on the order of fifty percent (50%) of many operator's business. The more sophisticated communications and administrative-billings systems that become possible with TaxiCom will be central pillars of this conversion.

A major next step that can be anticipated -- and this will be a literal quantum leap in most places -- will be to use taxis extensively for group riding or ridesharing. Thus, just about all of the hoped for objectives of DRT of the late sixties will in fact be attained in large part via their TaxiCom properties.

7.6 TaxiCom and the Transition to an Information Society

To understand better the longer term challenges and prospects of this called TaxiCom, it will be useful in closing to reflect on it if only briefly as but one part of a much larger phenomenon, the transition to an *information society*.

The electronics revolution, the information society (or whatever one cares to call) it is a concept that needs to be carefully interpreted from several very different perspectives. On the one hand it refers to a broad package of technologies and associated institutional and working arrangements. This is what most discussions on these matters tend to emphasize. But it has another role as well: that of an *enabler*, something which can help make society to think creatively about *virtually all aspects of the economy and society* in the broadest sense -- and in the process putting us directly before the larger issues of managing the transition to a knowledge society.

There can be no doubt that the vital key to this on-going revolution, is the combination of new telecommunications and information technologies -- never to be separated from their management, institutional and behavioral support systems. Taken together, these are the main constituents of the *Knowledge Revolution* that is now rapidly transforming the ways in which we live, work and play. A number of outstanding characteristics of this global revolution in process can be noted, which together point up the very real urgency of informed policy:

1. This is a transformation which is already in progress and making its impacts felt with steadily increasing force.
2. Its potential for transforming the nature of society is enormous.
3. These developments are still only in their very early stages, meaning that this is the time in which they can best be shaped and harnessed.
4. As with all of technology, this is not a wholly benevolent movement, and that while there is much hope for doing good, there are also substantial potential for negative impacts, both in general and on specific groups, and regions.
5. While many important decisions are being taken each day which shape the future of society, in most cases the level of information and insight (as yet available against which to take wise decisions) is in very short supply.

Mankind stands today on the brink of new order of technology that is already transforming the face of society and the economy. This presents a challenge once in a lifetime and opportunity for our leadership. Despite the fact that there is an enormous, dominant role for the private sector, and a whole plethora of other actors and institutions to play in this broad area, there is also a very important leadership responsibility from the vantage of society as a whole. This is a challenge which now needs to be met head on. There will be a unique, one-time opportunities for policy makers (at all levels of government) to take a leadership role in influencing this process of transformation for the better of all concerned.

For a variety of reasons, these challenges and opportunities cannot be left solely to the pressures and preferences of private interests and unrestrained market forces. There are important issues of community involvement which require thoughtful and effective public leadership. This is however a most delicate task, and should not be interpreted as a call for substituting public sector command-and-control decisions, technocratic intervention and/or infusion of taxpayer monies for the private sector. The role of the public sector will be to create an informed, responsible and convivial context for the dynamics of this transformation. If there were ever an occasion for sound information, wisdom and far-sighted leadership from the public sector, now is the time.

In many ways, this can be thought of as <u>a most useful testing ground for public policy</u> -- including at the local government and well as state, regional and national levels. Certainly if various levels of government as eventually "succeed" in improving its relationships and roles relevant with the transition that the transportation sector is now undergoing. They should be well positioned to handle the remainder of the new technology policy issues which are ongoing as part of the Knowledge Revolution, of which transportation is but one part.

In this respect, there are many roles that the public sector can play, virtually all of which contrast vividly with the transitional behavior of policy makers in the transportation sector. Among these are:

* as a *champion* of new ideas and concepts;
* a coordinator helping to bring together many groups and interests into projects and decision making;
* a communicator of information on good practices and successful projects elsewhere;
* sponsor of exemplary demonstrations of a kind that can lead to ready replication in many places.

This is a responsibility which contains many parts. In the first place, the public sector could undertake a special "shepherding" responsibility for ensuring that these powerful new technologies and tools are going to provide positive opportunities for poorer people, poorer areas, disadvantaged groups, and in general those people and areas having difficulty making the transition to the post-industrial information age society. The electronics revolution and the technologies behind it offer exceptional opportunities in this regard, which need to be aggressively factored into the public policy effort.

Peter Johnston of the European Commission wrote this of the challenge as he sees it in a recent paper[25]:

> *European cities and regions are the motors of economic and social change. They face challenges in congestion, mobility, environmental quality and employment renewal. The cities and the regions must take the initiative, within the context of national and European policies. The pioneers in the rethinking of mobility, work and city planning will set the agenda for those that follow.*

Those who care about US performance on these issues of technology, economy and society may usefully consider these words.

[25] "Telework And Transport In The Transition To An Information Society", written for an international meeting organised by the EcoPlan/Leber Group in Toledo Spain in July 1994

Appendix A: Operator Profile

The following profile questionnaire was sent to all cooperating operators:

1. OPERATOR

Company name: ______________________________

City/Country: ______________________________

Service area: Size: ________km^2 Population:________________

Number of Taxis: ________________ Average radio calls/day(total): ____________

Operator type: Cooperative ___ Taxi fleet owner ___ Private service___ Other________

2. SYSTEM OVERVIEW

(To be filled in by EcoPlan as per your information, supplier materials, articles, etc.)

3. PRESENT SYSTEM CONFIGURATION

Configuration	Supplier	Model	Remarks
Global system:	________	________	____________
Computers:	________	________	____________
Communications:	________	________	____________
Software:	________	________	____________
Comm.:	________	________	____________
Admin.:	________	________	____________
On-board equipment:			
Terminal	________	________	____________
Radio	________	________	____________
Taximeter	________	________	____________
Printer	________	________	____________
Other	________	________	____________

Special features: *(Specify capabilities: Elderly/Handicapped services, accounting features, ride-sharing, other special)* ____________________

____

____

Personnel:

DRIVERS:		CENTRAL:	
Total:	______	Dispatchers:	______
Owner-drivers:	______	Management:	______
Renters:	______	Technical support:	______
Employees:	______		

External Technical Support: (if applicable) ____________________

4. SYSTEM HISTORY

Initial project discussion: ______, 19___ **Service start-up:** ________

Initial objectives: ____________________

____

5. ECONOMIC SUMMARY

Total (estimated) cost: ____________

Equipment cost:	**Item**	**Cost**
CENTRAL	Computer (main/host):	________
	Computer (terminals):	________
	Communications:	________
VEHICLE	On-board terminal (MDT):	________
(per unit)	Radio:	________
	Taximeter:	________
	Printer:	________

Research and Development costs:______________________________________

Financing: Amount self-financed: ____________ % of project: ________%

Other costs:

Monthly rental/service charge (to drivers): ______________________________

[Other] __________________________: ______________________________

6. SYSTEM PERFORMANCE

Initial obstacles: ____

Major plusses: ____

Major minuses: ____

7. PLANNED NEXT STEPS (expansion, reconfiguration, replacement, etc.)

Near term: ____

Long term: ____

8. COMMENTARY

"In the light of your experience with 'TaxiCom', would you encourage other cities/operators to adapt to your or similar technology?"

"The state-of-the-art in the taxi industry of the 90's is much more advanced than that of the 80's. What do you see as the major developments we can expect to see in the taxi industry towards the end of this decade and into the year 2000?"

Appendix B: Bibliography

This bibliography is intended for those seeking additional information on technologies and issues mentioned in this report. It is in not extensive by design but should serve as a guide for further reading. For those seeking specific technical/ technological information, the suppliers themselves can be the source of a wealth of information (usually via Public Relations). For more general and/or practical information, contacting the operators and communities already using TaxiCom systems is highly recommended.

Access to Taxis, Transport for People with Mobility Handicaps, ECMT, OECD Publications Service, ISBN 92-821-1166-0, 1992.

Advanced Public Transportation Systems: The State of the Art, Update '92, US Department of Transportation, Federal Transit Admin., Office of Technical Assistance and Safety, DOT-VNTSC-FTA-92-3, April 1992.

Advanced Public Transportation Systems: The State of the Art, Update '94, US DOT, FTA, Office of Technical Assistance and Safety, DOT-T-94-09, April 1992

Advanced Vehicle Monitoring and Communication Systems for Bus Transit, Benefits and Economic Feasibility, US DOT, FTA, Office of Technical Assistance, DOT-T-94-03, September 1991, revised March 1993.

Assessment of Computer Dispatch Technology in the Paratransit Industry, US DOT, FTA, Office of Technical Assistance and Safety, DOT-T-92-23, March 1992.

EcoPlan, *Taxi-Based Paratransit Technology/Operations Packages in Europe*, US DOT, UMTA Technical Assistance Program, DOT-I-86-11, May 1985.

Appendix C: Glossary of Key Terms

ANI	Automatic number identification or identity
AOE	Automated order entry
ASCII	American standard code for information interchange
ATM	Asynchronous Transfer Mode
AuC	Authentication Center
AVL	Automatic vehicle location system (cf. GPS or Loran)
Baud	Unit of measure of data transfer speed equal to pulses or bits per second
BPS or bps	Bits per second
BS	Base Station
BSC	Base Station Controller
BSSAP	Base Station Subsystem Application Part
BTS	Base Transceiver Station
CAD	Computer-assisted dispatch
CCU	Channel concentrator unit
CPU	Central Processing Unit
CentralTaxi	Dispatching and Control Center (also Zentrale)
DACC	Dispatching and Control Center
DCC	Data communications controller
DCS	Digital Communications System
Deadheading	Any vehicle movement while taximeter is off (i.e. passengerless transit)
DRT	Demand-responsive transportation
DSP	Digital signal processor
EandH	Elderly and handicapped
EEC	European Economic Commuity
EIR	Equipment Identification Center
Exch.	Exchange
FFSK	Transmission protocol
GMSI	Gandalf Mobile Systems Inc.
GMSK	Transmission protocol
GPS	Global positioning system, based on satellite-intersect technology
GSM	Global System for Mobile Communications
HLR	Home Location Part
Host	Mainframe-computer
ISDN	Integrated Services Digital Network
LAN	Local are network
LCD	Liquid crystal display
LCG	Line to concentrator gateway units
Loran	Vehicle location and navigation system based on radio technology
LRG	Line to radio gateway
MAP	Mobile Application Part
MDCS	Mobile Data Communication System, proprietary name of GMSI software

MDT	Mobile data terminal
Modem	Modulator/DEModulator, used for the transmission of data on analogue lines
MS	Mobile Station
MSC	Mobile Services Switching Center
MWSt	German value added tax
MUX	Multiplexer
NCC	Network Communications Controller
PABX	Private automatic branch exchange
PC	Personal computer
PMR	Private mobile radio (system)
Polling	Method of receiving documents/files held by a distant microprocessor
PSTN	Public Switched Telephone Network
RAM	Random access memory
RISC	Reduced instruction set computer
RS	(cf. RS232)
SSno.7	Operation and Maintenance Center
SUP	ISDN User Part
Taxi-80	Proprietary name of Volvo TS and later of Ericsson EBS
TaxiCom	EcoPlan appellation for integrated computer, commuter and communications systems
TaxiPak	Proprietary name for Motorola software
UNIX	Computer operating system/environment
VAF	Vehicle Activated Functions
VLR	Visitor Location Register
VSU	Voice switch unit
VTS	Volvo Transportation Systems

CREDITS

This report documents the research conducted under contract number DTUM60 93-C-41001, Task Order Number One with the Federal Transit Administration's Office of Technical Assistance and Safety. The research staff and associates who participated in the research include:

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NOTICE

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Technology Sharing

A Program of the U.S. Department of Transportation