WiFi Hot Spot Service Business for the Automotive and Oil Industries: A Competitive Analysis Or: "Refuel the car with petrol and information, and the car maintenance networks with information"*

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While you refuel for gas, why not refuel for information or upload vehicle data, using a cheap wireless technology as WiFi? This paper analyzes in extensive detail the user segmentation by vehicle usage, service offering, and full business models from WiFi hot spot services delivered to and from vehicles (private, professional, public) around gas stations. Are also analyzed the parties which play a role in such services: authorization, provisioning and delivery, with all the dependencies modelled by attributed digraphs. Account is made of WiFi base station technical capabilities and costs. Five year financial models (CAPEX, OPEX), and data pertain to two possible service suppliers: multi-service oil companies, and mobile service operators (or MVNOs). Model optimization on the return-on-investment (R.O.I.) is carried out for different deployment scenarios, geographical coverage assumptions, as well as tariff structures. Comparison is also being made with public GPRS and 3G data services, as precursors to HSPA/LTE, and the effect of WiFi roaming is analyzed. Regulatory implications, including those dealing with public safety, are addressed. Analysis shows that due to manpower costs and marketing costs, suitable R.O.I. will not be achieved unless externalities are accounted for and innovative tariff structures are introduced. Open issues and further research are outlined. Further work is currently carried out with automotive electronics sector, wireless systems providers, wireless terminals platform suppliers, and vehicle manufacturers. Future relevance of this work is also discussed for the emerging electrical reloading grids for electrical vehicles.

Keywords: *WiFi, Fuel Stations, Business Models, Oil Company, Mobile Operator, WiFi Services, Regulations, Professional Vehicles*

1 Background

1.1 Hotspot areas

For several reasons (e.g. range and coverage) WiFi technologies were, until recently, mainly used in private areas like offices (both large enterprise offices and SOHOs) and homes. Research and activities of leading technology firms and mobile network operators show that the interest into applying WiFi within public areas is growing. Especially the "hotspot areas" (e.g. airports, shopping centers, congress centers, etc.) are focus points. Among network operators operating large public wireless LANs now, or considering whether to do so in the near future, are European service providers Orange, British Telecom, Telia Sonera, Telenor, Deutsche Telekom, Mobilcom, Swisscom, as well as elsewhere Korea Telecom and AT&T; there are also many smaller resellers.

1.2 Vehicles

Another aspect that forms the background for this research is the fact that more people spend time in their vehicle(s). The number of vehicles (cars, buses and freight vehicles; no motorcycles) per 1000 people is increasing, in the Netherlands as well as in the other European countries, although this in-vehicle time is stable in USA. Related to that, the traffic intensity grew enormously. In The Netherlands the traveling distance per year for passenger cars grew in the period 1997 –

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2007 by 24, 6%. The largest growth was for delivery vans with an increase of 107, 5%. The traveling distance for buses and truck increased with respectively 5, 4% and 7, 6%.

1.3 Wireless access for vehicles while "on the move"

If we combine the two factors above, we can conclude, based on simple technology diffusion principles, that there will be an increasing demand for wireless services from and to vehicles while on the move.

Public voice services are already integrated into vehicles in a way satisfying safety regulations (e.g. integrated hands-free telephone sets), and with sometimes additional usage limitations protecting safety. The growth of mobile Internet as well as access to content on mobile terminals and smartphones (often with GPS) show that this penetration can only grow further. The combination of the number of vehicles per 1000 people and a high penetration of mobile phone users with enhanced services, leads to the plausible fact that more and more drivers and passengers will use mobile services from and to a vehicle on the move, at the same time as safety regulations impose an integration of the access devices into the vehicles This impacts the deployment in the vehicles of Bluetooth technology for communication between devices in the vehicle as well as between the vehicle and its environment.

1.4 Service requirements and provisioning

Many of the wireless services have a multimodal character with a variety of requirements on communication networks such as bandwidth, asymmetry and interactivity. Besides this, users expect a cost-efficient access to their information, entertainment, technical and communication services. WiFi (IEEE 802.11 standards) meet most of these requirements, by offering high data rates (11-100 Mbit/s), but at short range, and with in several countries a regulatory framework allowing value added services to be deployed locally. Another fundamental aspect is that the device cost levels for WiFi components are in line with the low costs of most automotive components, while many public network terminals are not (even at modem level). GPRS/EDGE and 3G/HSPA services meets most of these requirements as well, with good coverage, with nominal data rates up to 7 Mbit/s with wide coverage, but service provisioning by public operators only, and usually higher device costs. Bluetooth based Personal Area networks offer a third route, limited to a collection of devices at short range, but with no data connectivity or management.

1.5 Examples of uses of WiFi in vehicle environments

In November 2001 Mercedes-Benz demonstrated a c320 sedan that had been outfitted with an IEEE 802.11a LAN. Web and media content can be radioed from roadside access points via an interface card to the sedan's onboard computer[1].

In 2001, Ten Square Inc. started rolling out its point-of-sale network, called the OuterNet network, which allows drivers to do everything from downloading a coupon for a free cup of coffee from the receipt printer on the pump, to selecting MP3 and video files from the dispenser screen and downloading them wirelessly in the approximately 240 seconds that it takes the average gas tank to fill up[2].

Sensoria Corp. introduced its Telematics Environment at DEMOmobile 2001. The Sensoria Telematics Environment is claiming to be a standards-based platform for delivering next-generation telematics services over conventional cellular, Bluetooth and wireless LAN connections. It is claimed to bring new voice and data applications into the vehicle[3].

Delphi Automotive Systems demonstrated

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[1] "Mercedes-Benz shows new wireless technology at Comdex", November 2001, www.m-travel.com/11115.shtml

[2] "Pumps to deliver more than just gas", January 2001, www.nwfusion.com/news/2001/0129pumps.html

[3] "Sensoria Corp. introduces the first telematics solution to support advanced voice and data applications in vehicles", September 2001, Lexis Nexis

automotive applications for wireless data networks at the 2002 International Consumer Electronics Show in Las Vegas. On a specially equipped vehicle, Delphi showed how licensed video files, audio files and other data seamlessly could be transmitted to and from home, office and future service-provider sources[4].

There is a big push by the world's biggest automakers to roll out telematics systems: General Motors (initial product OnStar navigations system), Ford, Volvo, Toyota, BMW, Nissan and Renault.

1.6 Standardization and Government funded Research

Besides the above-mentioned commercial activities and initiatives, there is also development / specifications work done by standardization or governmental Organizations. The Dedicated Short Range Communications (DSRC) Standards Writing group of the American Society for Testing and Materials (ASTM) was sponsored by the Federal Highway Administration to test IEEE 802.11a products for telematics applications. This included vehicular public safety, electronic toll-taking, commercial vehicle operations, and information applications[5]. Since 1994, the European Union RTD activities have been carried out under the Framework Programmes (FP4 through FP7), e.g. in the DRIVE project. (acronym for Dynamic Radio for IP Services in Vehicular Environments), dealing with spectrum efficient high-quality wireless IP in a heterogeneous multi-radio environment, and with in-vehicle multimedia-services [6].There is also, under the European Road Transport Telematics Implementation Coordination Organization, the establishment of OSGi-based in-vehicle telematics aiming at ensuring interoperability[7].

1.7 Players

When discussing the business models for wireless services in the automotive area, an essential aspect is the identification of the players. Some of the technologies described above, such as public mobile voice service, have already been in use for some years, and distinct players have evolved.. The new mobile data services around WiFi will however allow new parties, such as the oil industry, to enter the market, but will also allow incumbents to broaden their outlet reach.

Who are the (potential) players?

- Government and municipalities (licenses, safety, taxes, regulations)
- Oil Companies (WiFi services being offered via "their" service stations")
- WiFi Service Providers (Third party that might start offering the communication service, but not the applications)
- Mobile Network Operators (might be threatened by WiFi or triggered to join (connection 3G/WiFi at access terminal level) or become WiFi Service Providers themselves)
- Service Station owners/operators (The WiFi equipment is going to be installed on "their premises")
- Content Providers (new services and content might be needed)
- Drivers/Users/Vehicle fleet owners (= the end users)
- Client enterprises (= the intermediary between the provider and the (professional) end-user, such as vehicle maintenance or certification companies)
- Vehicle manufacturers (vehicles will carry WiFi client equipment and will also be WiFi emitter platforms)
- After-market car equipment OEMs (might be producers of the in-car WiFi equipment and application specific equipment)
- Software producers and integrators (e.g. middleware and application specific software).

Regarding all these players one can furthermore ask:

- What role and place will they have in the value added and provisioning chains?

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[4] "Delphi shows how 802.11a and 802.11b will enhance mobile entertainment, information and commerce", January 2002, Lexis Nexis

[5] "Driving the Wireless Future", August 2001, www.atheros.com/news/telematics.html

[6] www.ist-drive.org

[7] http://dbs.cordis.lu/cordis-cgi/

- Who is authorizing whom?
- What are the dependencies?
- Who is paying whom?

For the uptake of Wireless WiFi services in the automotive field on commercial terms (as opposed to publicity or prototyping intentions), it is most likely that the car and automotive electronics industry will take no initiative in integrating the Wireless WiFi equipment in the vehicle., unless some players are investing in the required infrastructure and service creation, assuming however some equipment price levels. The infrastructure and service creation investors will, for their account, only do so if business models and profitability can be established. The users then will have to invest in after-market equipment (which already is the case for users that want to use the WiFi services in their current vehicles). This means an opportunity for producers of after-market electronic car equipment. When sound results can be presented and a number of solid parties are going to invest in WiFi services, then the car manufacturers are likely to join on a big scale in well identified service-uptake dependent areas (apart from demonstration or brand image retention reasons).The above remarks are not "judgmental" but based on deployment/adoption patterns for value-added wireless services in other areas.

2 Research focus: refueling stations as WiFi hot spots

2.1 Definition, argumentation and focus players

Many problem statements can be derived from the above-mentioned issues regarding wireless services and WiFi technologies. We focus here on the sub-area where, mobility, telematics, vehicles, commerce and the possibility for upstream as well as downstream wireless data services from the vehicles come together: the gas (petrol) stations. Furthermore we focus only on two classes of players, e.g. an incumbent Mobile service operator using his infrastructure, and an Oil company interacting with gas stations in different ways described below. This choice is due to the analysis that these players in turn are the only ones who can trigger the developments in the car industry itself as explained above. Car electronics manufacturers can install capabilities, but the usage will depend on others.

As mentioned WiFi have significantly higher data rate possibilities than cellular technologies, but on the other hand less coverage. This means that strategically located access areas have to be defined and created. For the automotive and telematics usage, locations on or near the roadside, including traffic signs, would be best suited, but such locations are completely government-owned and operated, and thus do not allow for free market dynamics.

Therefore the more commercially oriented locations such as gas stations should be more amenable for a quick and comprehensive uptake on commercial terms. All the more so because, not only the vehicle users benefit from the new services, but there is also strategic and market potential for the gas station operator itself. It could for example, be very attractive or even critical for gas stations to start providing information needs and carrying out in-vehicle information collection. Also, in the future, hybrid or alternatively driven vehicles will enter the market; as a result the market for the traditional products a gas station provides (fossil fuels) will decline and alternative sources of revenues will be necessary. Besides the already existing alternative sources of income for gas stations, such as supermarket products, videos, car repair, rescue or rental services, the information access and collection services could be very attractive. Since the role of gas stations thereby gets broader and broader, it is more appropriate to call them "refueling stations" rather than gas stations.

Another strategic issue is about who will best operate such services, meaning either the present gas station owners/operators, public mobile operators, or other parties And for each of those, does the provisioning of WiFi hot spot based services around refueling stations offer potential and profit levels who match or exceed those of their other major operations ?

2.2 Research scope

Thus our research has been addressing the following questions with full business analyses and modeling:

- How is the gas service station market structured?
- What are the market drivers and what are the inhibitions?
- What and how are the parties involved and what roles are they going to play?
- What is the market potential for public automotive WiFi hot spot services?
- Where and how are the revenue streams going to be?
- What is the profit level of automotive WiFi hot spots, restricted to refueling stations, as assessed by quantitative/qualitative models and analysis?
- What are the open issues, such as role and influence of players not covered in this research?

Further details than those provided here can be found in (Oremus, 2002) and in other projects carried out in this area by the Rotterdam School of management.

2.3 Structure of gas service station market

Almost 50% of the service stations are owned by independent entrepreneurs; these dealers have contracts with oil Companies which supply them and usually allow them to operate under the oil company's brand name. Most of the times the Oil Company invests in the service station equipment. The dealer is obliged to exclusively sell the Oil Company's products (fuels and lubricants). By law, such a contract can in the Netherlands be valid for a maximum of five years. Apart from the branding/markings and the products, the dealer is himself responsible for exploitation of the service station. He is free to set a price and to optimize profit. He can also determine the product range for the shop. This model is called Dealer Owned / Dealer Operated (DoDo).

Around 20% of the service stations are owned by oil companies, but are being rented to dealers. These dealers are also independent entrepreneurs that pay a rent to the oil company. The Oil Company does all major investments in the service station. The dealer has the obligation to exclusively sell the Oil Company's products (fuels and lubricants). For the rest the situation is exactly the same as for the above described DoDo model: the dealer can determine the price and the shop assortment. This model is called Company Owned / Dealer Operated (CoDo).

The remaining 30% of the service stations are owned by oil companies and operated by a subsidiary. The Oil Company has complete control over the exploitation of these service stations. The price and complete product range is determined by the Oil Company. This model is called Company Owned / Company Operated (CoCo).

The above structure of the service station market is based on the situation in the Dutch market. The numbers are based on data from Shell.

2.4 Wireless LAN configuration at a refueling station

The attached Figure 1 visualizes the elements and their configuration.

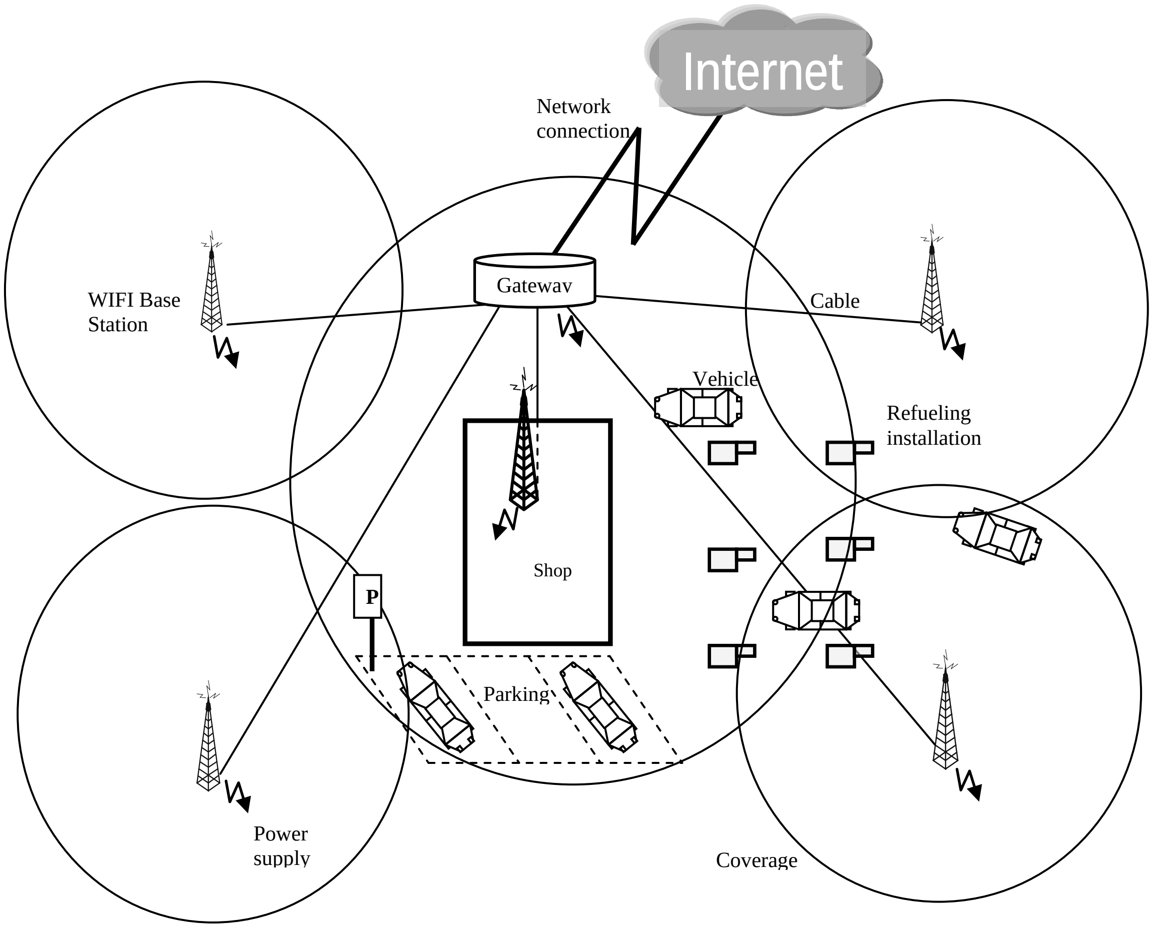

Fig. 1. Wireless LAN equipment at a service station

2.5 Value Chains and Externalities

The estimated returns, and positive externalities (noted: + factor) linked to the introduction of WiFi services at refueling stations are depicted in Figure 2.

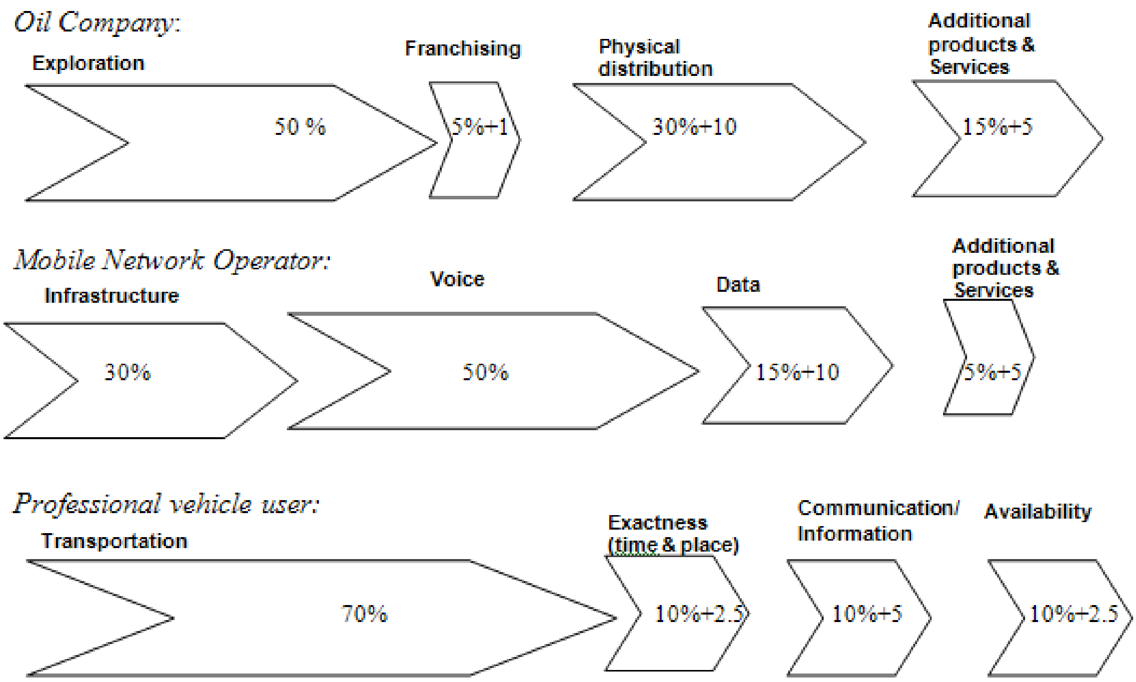

Fig. 2. The estimated returns and positive externalities

3 User, Service and Provider segmentation

To get a realistic representation of Wireless LAN services in refueling stations, segmentation has to be determined, especially of users and of services.

3.1 Vehicle/ user segmentation

The Tables 1 and 2 below give the segmentation of private vehicle types and of professional vehicles. The user groups related to this professional vehicle category are professional, public and specialty users.

Table 1. Different vehicle categories in absolute numbers for the Netherlands

Vehicle Category	Number[8]
Cars	6518634
Professional vehicles	970814
Motorcycles	460822
Total	7950270

Table 2. Distribution of the professional vehicle category in absolute numbers for the Netherlands

Vehicle Category	Number[9]
Delivery van	755977
Truck	143286
Special vehicle	39599
Taxi	20578
Bus	11374
Total	970814

3.2 Service segmentation

In order to come to a segmentation of the services a number of steps have to be taken. To define the needs, vehicle stopping points and the corresponding needs are analyzed.. Table 3 shows the relevant elements for private and professional users for a refueling station as a stopping point within WiFi coverage. Table 3 differentiates between wireless and non-wireless services requiring a physical action.

3.3 Usage segmentation

Furthermore, the Wireless LAN services are segmented according to usage categories usually linked to Vehicle segmentation: common usage (meaning for all categories of users), professional, private, business, and public and specialty usage.

3.3.1 Private usage

The private users are in number the largest group. That implies market potential. Therefore it is useful to examine the characteristics of this user group:

- The size of the user group helps to reach critical mass (in number of users)
- The Wireless LAN services offered have to be cheap and the percentage of common service usage will be high
- Because of a high percentage of common service usage, it is hard for a WiFi service provider to distinguish his offer from competitors. A high churn rate could be the result.
- Private users are not likely to be willing to do after-market investments in Wireless LAN car equipment

[8] Source: Centraal Bureau voor de Statistiek (CBS), 2001

[9] Source: Centraal Bureau voor de Statistiek (CBS), 2001

Table 3. Service needs at refueling stations

Service cluster	Physical action	Wireless Service	User group
Get/Give Information	-	Get/Give statistics (e.g. on cargo)	Professional
	-	Notification (location)	Professional
Passenger Entertainment	Sound/Music	Sound/Music	Private
	Image/Video	Image/Video	Private
	Gaming	Gaming and -download	Private
	Reading	Reading	Private
Refuel	Get petrol	Location aid to nearest refueling	Both
Refreshment	Drink and Eat	-	Both
	Rest and Sleep	-	Both
Specific information	-	Services inquiry	Both
Maintenance	Replace/Fill up parts	-	Both
	-	Remote car diagnosis	Both
Infotainment	Sound/Music	Sound/Music	Both
	Image/Video	Image/Video	Both
	Gaming	Gaming and -download	Both
	Reading	Reading	Both
Get/Give Information	Route information (maps)	Route information	Both
	News (newspaper)	News	Both
	-	Traffic information	Both
Communication	Talk	Talk	Both
	Send/Receive e-mail	Send/Receive e-mail	Both
Payment	Pay at cashier	E-pay	Both

- Private users are probably not the early adopters
- Every user has to be triggered and contracted individually, which entails high marketing and administrative costs

3.3.2 Professional usage

The professional user group has other characteristics than mere numbers to make it an interesting one.

- Because of a direct relationship to daily business (Wireless LAN services can save time and money) the professional users are likely to be heavy users. This helps to reach critical mass (in service use).This likelihood is modeled and sensitivity analysis has been done in this research.
- The Wireless LAN services offered don’t have to be “cheap” and the percentage of specific service usage will be relatively high ; however the tariffs must be in line with competing platforms such as GPRS, 3G, low capacity WiFi, etc.
- Because of a relatively high percentage of specific service usage it is easier for a WiFi service provider to distinguish from competitors. A high level of customer loyalty is easier to achieve
- Professional users (i.e. their employers) are likely to be more willing to do after market investment in fleet Wireless LAN equipment
- A large group of new users can be triggered and contracted at once by contracting a single company as client
- Their is a spill over effect onto private usage

3.4 Provider segmentation and characteristics

As discussed above, we consider here only a Mobile operator service provider and an Oil company as focus providers. It should be noted however that the Mobile service provider considered here may not be a public wireless license owner but a value added

WiFi service provider accessing the public license owner's infrastructure or a mobile virtual operator (MVNO) running both public and WiFi services.

3.4.1 Mobile Operator Service Provider characteristics

- Site rental fee weighs heavy on OPEX
- Offering Wireless LAN services is (probably) core business at least at Division level of the mobile operator
- A Mobile operator service provider can contract several Oil Companies and thereby obtain a large market share in terms of refueling stations.
- For a value added service provider it could be difficult to gain market share (in terms of clients), because of a non-existent brand image
- The Mobile operator service provider probably doesn't have the positive externalities the oil Company has.

3.4.2 Oil Company Service provider characteristics

- No or low site rental fees, and availability of on-spot support staff
- Offering Wireless LAN services probably is not core business (yet?)
- The Oil Company can quickly obtain market share in terms of equipped refueling stations, but is probably limited only to its own. In order to overcome this limit, the Oil Company would have to cooperate with competitors, which is unlikely because of the fierce competition in the fuel and lubricant market
- The Oil Company can leverage its customer base and brand image to obtain market share
- The Oil Company is likely to experience positive externalities (e.g. service stations will sell more fuels and maintenance /mapping services, because of the Wireless LAN services)

4 Qualitative modeling

Although this article does not give enough space to elaborate, full qualitative modeling via attributed directed graphs has been made to encompass all players, all factors and identify business model bottlenecks, uncertainties or trigger conditions. They also serve as a base for project planning and budgeting. The directed graphs are furthermore colored to illustrate which parts thereof are used in the quantitative relations, and switching between subgraphs due to conditional elements. The graph coloring also serves to show billing/charging paths, both subscription based as well as prepaid.

The qualitative modeling also highlights:

- Complex models and a high cardinality (many mutual dependencies) in the interactions for any business model
- The role/ impact of government is unclear
- The difficulty in meeting different usage business models in a way such that cost reductions (reduction in number of nodes) can be designed
- Quite many different parties have "fitting" conditions to become WiFi Service Providers by leveraging their roles as stakeholders.

5 Quantitative business modeling

5.1 Introduction

Two quantitative calculation models, over a 5 year horizon, have been developped for the Dutch market (but were in other related projects extended to other geographical areas worldwide), one for an Oil company as refuelling station WiFi service provider, and the second for a Mobile operator as refuelling station WiFi service provider. These models cover all professional users, usages and include parametric service mix assumptions.

These models allow to perform cash flow forecasts, profit or R.O.I (return-on-investment) level forecasts, and above all to perform sensitivity analysis to identify which parameters play a role in determining the business outcomes, and how they influence each other. Thereby an insight into the structure and the working of the model and (part of) the market is provided.

The input variables include: usage (determined from stopping frequencies, WiFi service coverage, etc.), tariffs, service mix, service demand, CAPEX and OPEX. The

outputs include: cash flows, profit/loss estimations and market shares.
By stating goal functions and constraints, optimization is carried out, to identify multipliers and thus most critical constraints and parameters.

5.2 General assumptions

For the two models, a number of general assumptions are made. These general assumptions are presented below:

- The calculation period is 5 years
- Linear growth of users is assumed over the calculation period
- The stopping frequency can be derived from the total number of kilometers driven and gas tank size for each vehicle type
- No churn is taken into account
- The market share in the Dutch market of the service provider to be modeled, is assumed to be stable over the calculation period
- The amortization is linear over 5 years and residual values are zero
- All installations are assumed to be finished in year 1
- All contracted service stations are assumed to be contracted and operational in year 1
- Roaming is assumed
- Roaming behavior of non-clients is similar to client's
- User / vehicle specific services are assumed to be available only at contracted service stations
- All professional vehicles refuel in the Netherlands
- The refueling WiFi service provider contracts only one Oil Company for gas

The first step in determining the potential of the market for refueling WiFi services is taken by calculating the number of clients that have a subscription with the Service Provider (whatever party this may be). In order to come to this figure the total number of vehicles and the category of professional vehicles are taken as a starting point. This means that the number of users is calculated in number of vehicles. The user / driver of a vehicle is assumed to belong to the same category as its vehicle and one subscription is assumed to be contracted per vehicle.
As described above, the market for gas service stations isn't homogenous. There are different types of service stations, related to ownership and operation. Since these different types of service stations are likely to have different cost structures this sensitivity is brought into the model by distinguishing explicitly the three possibilities.
For all services, a usage frequency, set-up time and access time are defined.
Regarding service demand, for professional users, a profile determines from each category base services and additional services for that category. The common service portfolio includes the plain voice access, the billing service and a number of services that the provider offers as a package without extra charges. For this package of standard services, the user is charged a flat rate fee. This means that for a fixed periodical fee the user has unlimited access to these services. On top of the standard services in the package, the provider offer additional services (often professional or value-added) with a usage specific fee (Table 4).

Table 4. Professional vehicle/user specific services

Wireless Service	**Standard / Additional**
Exchange cargo-administration	Additional
E-pay (e.g. paying invoice, etc.)	Additional
Get orders	Additional
Real-time check passenger list	Additional
Real-time update passenger list	Additional
Internet access	Standard
Get/Give statistics (e.g. on cargo)	Additional
Location information	Standard
Wirelessly update fleet software	Additional

Wirelessly check fleet status	Additional

5.3 Geographical service coverage

Assuming that the total market can be covered by the total number of service stations, we define a percentage covered by the provider, based on the total number of contracted service stations (e.g. 9 %). Since the Oil Company is assumed to have contracted more service stations than a Mobile operator provider, its geographical coverage is also higher.

The geographical coverage ratio will influence the revenue. The relation is defined as a 1/X formula, which means the revenue reduction is relatively higher when the provider has less service stations contracted. Since the Oil Company has a higher geographical coverage ratio than the Mobile operator Provider, its revenue reduction ratio is lower.

For one given refueling WiFi service provider to offer coverage to other stations than those he owns or licenses, a roaming fee is payable to competitors, which is charged to OPEX. Normally the Mobile operator is at an advantage here as this Provider can use his backbone to this effect.

5.4 CAPEX elements

Capital expenditure elements include both the total number of contracted service stations, spectrum license fee (if any), all WiFi radio infrastructure elements (base stations, cables, antennas) based on service station areas and RBS coverage. Importantly, CAPEX also includes related installation and configuration cost.

5.5 OPEX elements

Operational expenditure elements include: general staff costs, site rental costs based on site ownership structure, power costs, marketing costs linked mostly to the number of new subscribers, customer support costs for the standard package as well as additional services, reconfiguration / update / maintenance costs linked to site numbers and usage, roaming costs payable to competitors based on station ownership distribution and roaming frequency by users.

5.6 Tariffs

The service package fee is a variable, subject to optimization, while additional service fees are set forth below, and are either common to all user types or user category specific.

Table 5. Additional common service fee, and vehicle/user specific service fees

Additional common service	**Fee (Euros per month)**
Image/Video	10
Gaming and -download	10
E-pay (e.g. parking fee, etc.)	5
Theft prevention	10
Alarm notification	10
Occupation help	5
Avg. Additional common service fee	8
Assumed additional common services (per user)	33% = 2
Additional vehicle/user specific service (professional user)	**Fee (Euros per month)**
Exchange cargo-administration	20
E-pay (e.g. paying invoice, etc.)	20
Get orders	15
Real-time check passenger list	10
Real-time update passenger list	10
Get/Give statistics (e.g. on cargo)	20
Wirelessly update fleet software	25
Wirelessly check fleet status	15
Avg. Additional common service fee	17

Assumed additional common services (per user)	75% = 6

5.7 Provider CAPEX, revenues and OPEX
With common service package fees in line with mobile operator public fees for a usual (voice+SMS) package, the Oil company or Mobile operator refueling station WiFi service providers have distributions of CAPEX, revenues, and OPEX, as illustrated in a typical case in the attached Figures 3, 4, 5. They show that common service revenues and vehicle/user specific services are typically in balance.

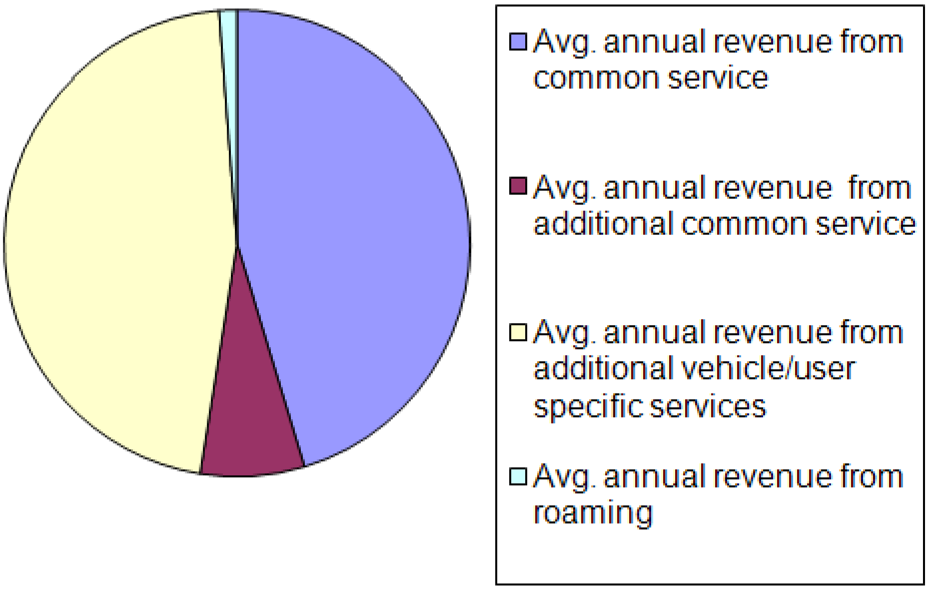

Fig. 3. Revenue Oil Company

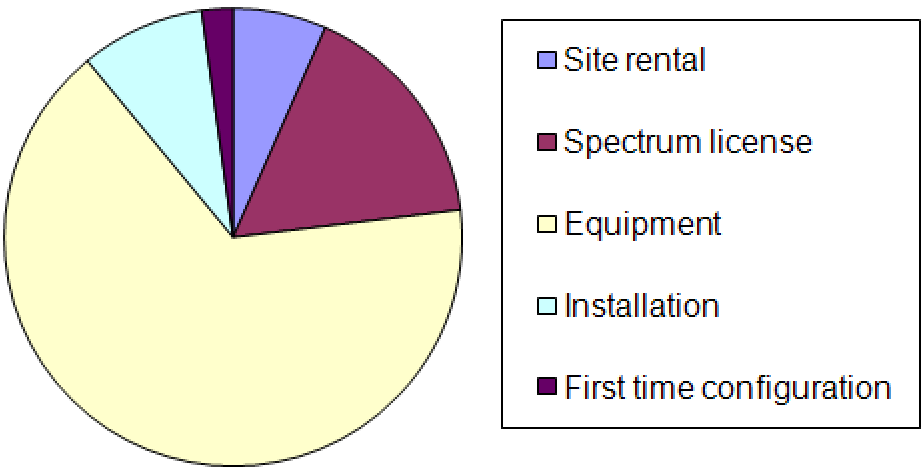

Fig. 4. CAPEX Distribution Mobile Operator

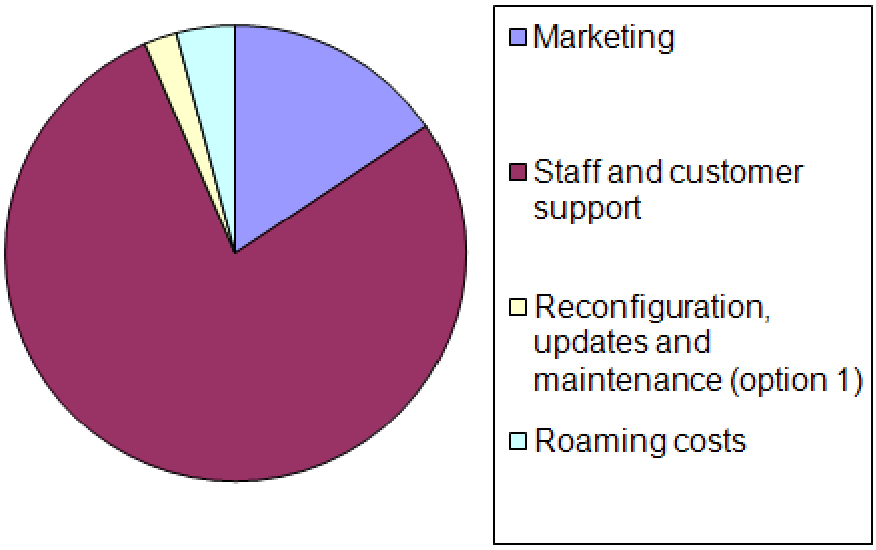

Fig. 5. OPEX Distribution Oil Company

5.8 Goal functions and variables for optimization

For basic sensitivity analysis, the goal function selected for the optimization, is the R.O.I ratio (return-on-investment) over 5 years, taken as the ratio of the net present value of the excess of operational revenues over operational expenses (OPEX), divided by the net present value of CAPEX

In order to find the maximum of the goal function, the variables that are to be iterated have to be defined, as well as the related constraints; they are typically the set jointly defined in the Table 6 below:

Table 6. Optimization variables

Optimization variables	Definition
Standard service fee	Periodical fee paid by the client to the provider for unlimited use of a portfolio of standard services ; aligned with public mobile tariffs, e.g. in 18 Euro/month range (early 2003)
Common service use frequency	Frequency with which a user demands a common service as compared to his specific service demand
Contracted Company owned service stations	Percentage total number of Company owned/ Company operated (CoCo) Service stations that have an agreement with this particular provider and have Wireless LAN infrastructure installed on their territory
Contracted Dealer owned service stations	Percentage of total number of Dealer owned/ Dealer operated (DoDo) and Company owned/ Dealer operated (CoDo) service stations that have an agreement with this particular provider and have Wireless LAN infrastructure installed on their territory

Running the optimization tool for both the Oil Company and the Mobile Operator Providers models, leads to different outcomes. The optimization gains are respectively, and dependent on initial values (with for all an initial standard service fee of 10 Euros/month), in the range 300% on the goal function for the Oil company, and 600 % for the Mobile operator, meaning that there is room for adaptation of the optimization variables. The computed outcomes, under the following alternative analysis scenarios :

1. Scenario :Professional user focus vs. Total

users
2. Scenario :Desirable service fee in view of R.O.I. vs. Realistic service fee in view of public services competition
3. Scenario : Break even service fees
4. Scenario :Payback times
5. Scenario : Customer mix sensitivity

give the following qualitative trends:

- Higher R.O.I in general for the Oil Company
- High standard service fee in relation to upper bound constraint on the same
- Common service use frequency goes to the lower limit (as little common services and as much vehicle/user specific services as possible)
- Highest possible positive cash flow year 1 is 5% of total CAPEX
- Mobile Operator achieves higher cash flows
- Cash flow differences between the Oil Company and the Mobile Operator get smaller and smaller as tariffs increase
- Small percentage of service stations contracted. The Oil Company only contracts service stations that are owned by itself (no site rental costs).
- Differences mainly determined by different CAPEX levels
- In the long term the Mobile Operator achieves almost the same cash flow but with less service stations
- Large differences in R.O.I. between the Oil company and the Mobile Operator
- Solvability is a common problem in the first 3-4 year(s)

6 Regulatory aspects

WiFi is largely an unregulated access and unregulated business, while public wireless networks are subject to extensive regulation which may spill over to mobile data services. This study has therefore very interesting regulatory implications and issues attached to it:

- Should the right to access to public wireless broadband (of which WiFi is just an instance) apply equally to access via public operators and to networks with localized and moving presence (such as cars and vehicles)?
- If coverage conditions are being defined, how to unify their definitions when the broadband network includes peer-to-peer communication (such as vehicle-to-vehicle communication and file sharing)?
- What should spectrum allocation policies be for Public operators vs. e.g. Oil Companies or Maintenance shops?
- Can normally unregulated broadband access (such as WiFi Hot spot) remain so when it directly impacts public safety (here in the transport sector)?
- Should all proprietary content linked by broadband to a device (here: car, or smartphone) be considered on equal basis wrt. Bundled IPR?

Further regulatory analysis shows the following. Right to access to broadband should be equal for persons, machines, and persons via machines, in view of coexisting machine-to-machine and person-to-person services. Wireless broadband coverage cannot just be from licensed registered fixed sites (such as petrol stations), but must include a volume around all public access road network. Public wireless broadband data in vehicles when it affects directly or indirectly safety, must be subject to safety and signal quality regulations, extending those for voice in an automotive usage context. Spectrum should be allocated pre-emptively by regulator not just for person-to-person but also to machine-to-machine traffic. There is competition in the described automotive segment between the described parties, but regulators must include externalities as researched above in their basis for assessing the competitive positions.

7 Conclusions and open issues

7.1 Conclusions

The analysis of the business models around refueling station WiFi services for the dominant classes of vehicles, users and usage in the Netherlands, has been carried out from a context, to a qualitative, then to a quantitative level and with high modeling detail. This analysis has since been extended to other countries by the Rotterdam School of

management.
The complexity of the dependencies may be a hindrance when commercial principles apply. When initial values of the free variables are set at values comparable with current conditions for professional vehicles and tariffs in line with GPRS and 3G data services, return on investment is negative. Optimization moves towards a low percentage of contracted service stations because the cost structure of such WiFi services is still unsatisfactory. The reason for this is more in the high share of OPEX costs represented by staff expenses for different purposes, due to relatively high staffing levels which quality of service mandates for a distributed network of WiFi service delivery points. This holds true both for the Oil company as well as for a Mobile operator, even though refueling station WiFi services is a new business area for the first, and an incremental business area for the second The sensitivity analysis shows that the most critical other parameters are the subscription fee, the service mix and the percentage of contracted service stations This is also why, when shorter pay back is enforced, the Oil company achieves better profitability than the Mobile Operator as the Oil company has lower costs per service station
In conclusion, the refueling station WiFi services represent a very interesting business opportunity, but only if it is analyzed beyond the false or misleading "popularized" cost advantages of WiFi technology. The business opportunity lies in other elements of the business model.

7.2. Open issues

The first key open issue if the modeling of externalities (see Table 7) and how they modify the previous conclusions; the outcome is likely to be to the advantage of the Oil company However, a second open issue is the effect of the interoperability or integration between such refueling service station WiFi services with public GPRS/EDGE/3G services, not so much because of the usual coverage argument, but because of the impact on vehicles of simultaneous access to mobile connectivity for traffic management, etc., when the vehicles are not at hot spots.

Table 7. Some externalities

Externalities for Oil Company	Externalities for Mobile Operator
-Cross elasticity between fuel sales and information/service sales -Effects of business partnerships with vehicle maintenance and logistics sector -WiFi as a targeted usage marketing channel -Ability to build on campaigns about driver comfort and efficiency -Incremental revenues by fast enlarging scope of billing services offered by Oil Company -Relative advantage in getting WiFi spectrum licenses	-Cross elasticity between voice traffic at fixed refueling station sites (due to safety regulations) and mobile data/service traffic revenue from WiFi -Franchising revenues to refueling stations -Ability to build on safety campaigns -Incremental fees for handling third party content or service billing for new such parties -Relative disadvantage in getting WiFi spectrum licenses

7.3. Future issues: electrical battery reloading stations

The methodology above applies to a new business paradigm that is how to achieve mutual synergies from forthcoming electrical battery reloading stations (for cars) and communications networks. Already base stations have to have emergency and peak power storage, which applies as well to automotive needs; also, the oil companies will want to seize a share of the emerging electrical reloading grid to replace declining gas stations, or to combine the two.

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