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Broadband Wireless ISPs

Roaming between Wireless ISPs

A new breed of innovative Internet service providers (ISPs) is establishing broadband wireless services in public "hotspot" locations using an increasingly popular technology – wireless LAN, or WiFi. Primary target groups for these broadband wireless ISPs (WISPs) are travelling businessmen and knowledge workers, who need access to their corporate information resources and the Internet when they are on the road. To meet this need, each WISP will need to extend the footprint of its service through roaming agreements with other WISPs.

Lessons can be learned from existing roaming agreements for GSM telephony and dial-up Internet access. In particular, the technologies for roaming in the dial-up Internet world could form a starting point for roaming in the broadband wireless field as well. However, these technologies will need to be enhanced in order to preserve more of the experience of the home WISP for the user, and to provide the kind of seamless service that very demanding users and corporations will require. Business models for roaming and clearing in the dial-up space are founded on the need to keep transaction costs low for the ISPs involved. On the contrary, in the GSM world the roaming and clearing arrangements reflect the traditional independence and strength of the mobile operators and their need to control every aspect of the service. WISPs are likely to put more emphasis on roaming than other ISPs, but would nonetheless be inclined to want to keep transaction costs low.

GUNNAR ALMGREN

WISP Roaming

Roaming is an established feature of cellular/mobile telephony services and also, although to a lesser extent, of dial-up based Internet access. Roaming will be no less important for the high-speed wireless data services offered by Wireless ISPs (WISPs). The Wireless Ethernet Compatibility Alliance (WECA), an industry association that has been very successful in pushing WiFi (certified IEEE 802.11b) as the world standard for wireless LAN, recently started an activity aimed at developing a technical recommendation for inter-WISP roaming. The WECA activity underlines the importance of roaming to the wireless LAN industry in general.

A small but growing group of companies has recognised WISP roaming as a business opportunity and is targeting the WISP market with a variety of offerings related to roaming; most notably clearing and brokering/aggregation services that will lower the trans-

action costs for WISPs who want to achieve roaming with other WISPs. Ipass (www.ipass.com), GRIC communications (www.gric.com), Excilan (www.excilan.com) and t-net (www.weroam.com) all aspire to service the WISP market with different kinds of roaming offerings. GRIC and Ipass are established players on the dial-up Internet market and approach WISP roaming as a fairly straightforward extension of dial-up roaming; while others like Excilan and t-net can trace their backgrounds in GSM roaming. There are lessons to be learned from both the cellular world and the dial-up Internet world when designing roaming arrangements for WISPs. There are, however, features of the WISP user experience that are unique, and business models that call for extensions to existing roaming models.

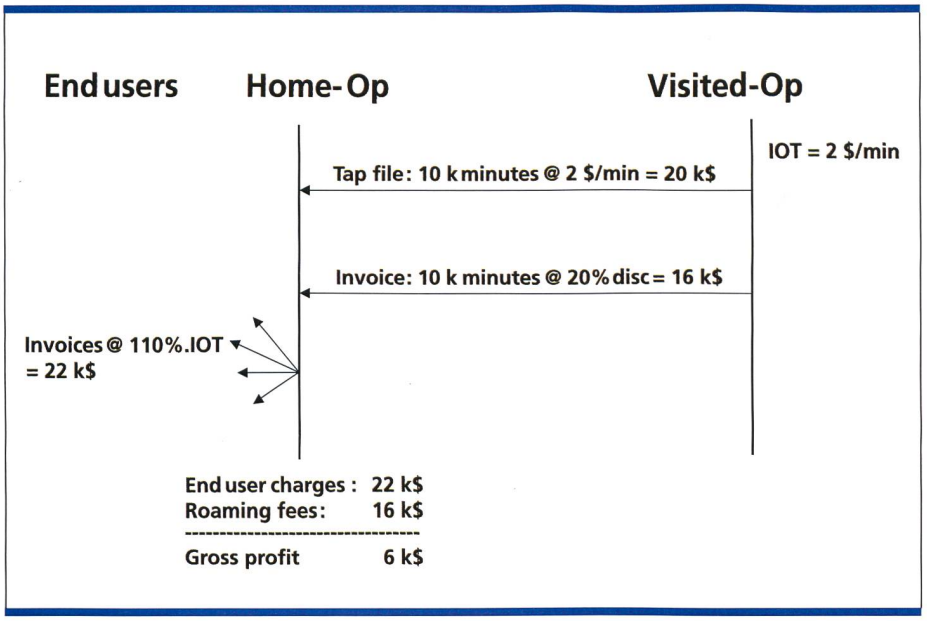

Fig. 1. GSM roaming information and invoicing flows.

Roaming in the GSM World

Background

Basic international roaming support is an integral part of the GSM standard. GSM operators also cooperated in the GSM Association to achieve agreement on the business and technology aspects of roaming not directly addressed by the standard. Consequently, GSM roaming has been an established feature for quite some time – to the advantage of operators as well as their users.

User Experience

On entering a foreign country, the GSM handset detects the available networks. This usually happens automatically[1] with the telephone displaying the name of the new network. The automatic selection can be checked by the user and changed to any of the available and permitted networks. A permitted network is one with which the user's home operator has a roaming agreement. The user then will be able to use his phone pretty much like local subscribers to the visited network. Typically, the user experience is not totally transparent: some services such as SMS may be available exactly as they would in the home network, while others like voice mail and helpdesk hotlines may be available but require a different access method and identification. The level of service transparency very often varies depending on the roaming agreement between the home operator and the visited operator. The cost of calls made from the user's handset when roaming appear on the user's invoice. In most cases, the roaming user has to pay for the international portion of calls made to his or her handset as well.

Technology

When a roaming GSM customer turns on his handset, it presents its credentials to the visited operator's network. The visited operator then engages in an authentication exchange with the home operator to ascertain that this is in fact a user who is entitled to roam into the visited network. If this authentication and authorisation process is successful, the roaming user will be able to make calls via the visited network. Since the user is already authenticated, there is no need for any real-time interaction between the home and visited operator on a per-call basis. Billing is based on the Call Detail Record (CDR) generated in the visited network. This CDR is transferred to a clearing house, and then forwarded to the home operator where the customer is billed.

Pricing and Clearing Models

The financial aspects of GSM roaming are regulated in bilateral agreements between the operators involved[2]. A handful of companies referred to as clearing houses handle clearing and financial settlement in accordance with the applicable bilateral agreement. These clearing houses process CDR information from the visited operator but do not participate in the real-time authentication exchange with the home operator. Clearing houses charge the operators involved for the service provided. If the operators involved in a roaming exchange are tied to different clearing houses, the clearing houses will cooperate to achieve appropriate clearing and settlement.

In the GSM world, the technical standards and procedures for roaming are set by an industry organisation called the GSM Association. In particular, this Association has defined a Transferred Account Procedure (TAP). TAP is a set of formats and procedures for the exchange of billing information related to roaming. Specifically, TAP defines the formats of the CDRs and files that operators exchange with the clearing houses.

Each operator applies a tariff agreed in advance, which is called the inter-operator tariff or IOT. The IOT remains valid for a set period of time and is equal for all its roaming partners. The bilateral agreement between the home and the visited operator regulates the discount that the

[1] The SIM card can be pre-programmed to select or at least prioritise a particular network provider. If the SIM card has not been pre-programmed, the phone will select the network with the strongest signal the first time it is turned on in the foreign country. On a second visit, the phone will first try the network that was used for the previous visit, even if there is a stronger signal available from another network.

[2] However, there are companies such as Comphone who act as brokers and negotiate such agreements on behalf of operators.

home operator is entitled to relative to the IOT. This is somewhat parallel to a list price arrangement where all resellers see the same end user price list from a vendor, but have different discounts depending on the volume sold, etc.
The IOT is often roughly equal to the normal per minute price for local subscribers to the operator's network. The IOT is often the basis for charging the end user as well. The home operator is thus alleviated of the burden of keeping track of the actual IOTs of all its roaming partners. These money and information flows can be illustrated by a very simplified example. In this example, the visited operator has a published IOT of $2 per minute. The home and visited operators have a bilateral roaming agreement in which they grant each other a 20% discount on roaming charges (fig. 1).
For a particular month, the subscribers of the home operator have generated a total of 20 000 roaming minutes in the network provided by the visited operator. The TAP files sent to the home operator will tally these minutes as well as the applicable IOT of $2/minute. The home operator will use this information to charge its users. Since the home operator has a policy of applying a 10% mark-up on top of the IOT for all roaming partners, the customers are charged a total of $ 22 000. But since a 20% discount applies, the visited operator will invoice the home operator $ 16 000 rather than the $ 20 000 implied by the IOT. The home operator will thus make a gross profit from the roaming of its customers in that month[3].
With the advent of GPRS, there is a real-time, per session, interaction between the home and visited operator networks and thus the option to charge on CDRs generated in the home operator's networks. Interestingly enough, it appears that many operators will not use these CDRs for end-user charging, but rather will continue to rely on the TAP files. Why? Because otherwise they would need to keep a completely up-to-date rating matrix containing the actual network prices of their roaming partners in order to charge their own roaming users. With a large number of roaming partners, this matrix becomes complex and may require substantial resources to maintain.

[3] A real life example involving one or several clearing houses, long distance operators and complex end user discount schemes would be much more complex, of course.

Dial-up Roaming

Background

Subscribers of dial-up Internet services can generally use an international telephony call to access the service. This is expensive and the connection time and transmission quality are often worse than those experienced when calling a local ISP. Many users also find it cumbersome to reconfigure their software to use international dialling prefixes (despite the support that the predominant operating systems provide for managing this). Dial-up roaming is about solving these problems and helping users to access the Internet from a local ISP without the need for a subscription at that ISP or prior knowledge of access numbers.

User Experience

Dial-up roaming refers to the capability of connecting to the Internet through a dial-up modem connection with a more or less local ISP without the need to have an account with that ISP. One of the biggest obstacles for roaming users is to find the access number of a local ISP that has some kind of roaming arrangement (direct or indirect) with his or her home ISP or corporation. Realising this, roaming brokers GRIC and Ipass have developed client software that includes a phone book and an integrated dialler for both cases. The actual roaming experience will vary somewhat, depending on whether the roaming agreement is a bilateral one or one provided through a roaming broker. There are also variations among roaming brokers. The following discussion will focus on the scenario with a roaming broker. The examples are modelled on Ipass, but should be generally applicable to other roaming brokers as well. It should be noted that the use of a special client is probably more a convenience than a strict necessity. It should be possible to use the services of a roaming aggregator with a built-in client such as MS-DUN, but the user would then have to use some other means of finding out the access number of a local ISP.
The first action of a roaming user would be to start up the client and start browsing for the access number of a local ISP. The user will need to enter the user ID/password for his/her home ISP. If the authentication is successful, the user will get access to the Internet but may experience some problems with value-added services that are available when access-

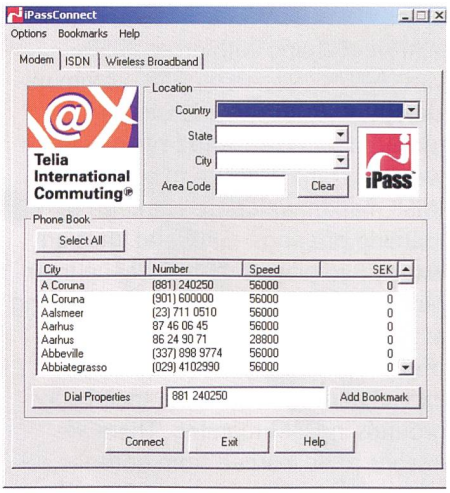

Fig. 2. Example of a roaming client.

ing the home ISP locally. A common example of this is outgoing mail transfer. Many ISPs apply strict anti-Spam policies to the effect that mail will not be forwarded from IP addresses that are not recognised by the mail server (forwarder). This leads to a situation where the user is unable to send mail unless he or she reconfigures the mail client to use the mail forwarder of the visited ISP (fig. 2).

Technology

The core technology used for dial-up roaming is (proxy) RADIUS. A local RADIUS server at the visited ISP receives the user ID or password from the user's laptop/PDA/PocketPC. The client software of the user appends some information, usually a domain suffix, to the user ID (here "Username") to provide information about the home ISP with a screen dump from the Ipass client software (fig. 3). In the example above, the Ipass client has been pre-configured with information about the home ISP, in this case Telia, and appends the domain suffix "telia.com" such that the user ID

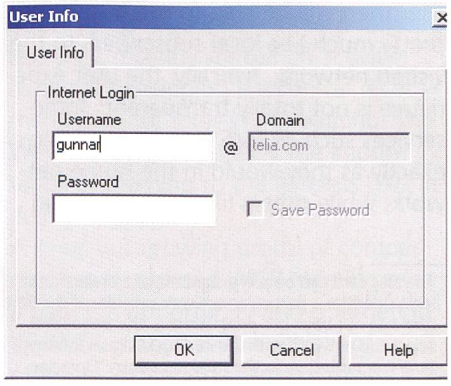

Fig. 3. Ipass client screen dump.

transferred to the visited ISP radius server will be "gunnar@telia.com" – a fully qualified Network Access Identifier (NAI). The visited ISP RADIUS server will recognise this as a connection attempt from a roaming user and will forward the request to the roaming aggregator's transaction centre. The transaction centre will inspect the NAI and extract the domain suffix, "telia.com" from the NAI. The transaction centre recognises "telia.com" as one of its roaming partners and forwards the authentication request to the home ISP. The software at the home ISP (Telia) checks the user ID or password and sends the authentication reply back to the transaction centre. From there the reply will be relayed back to the visited ISP, which will then, in the case of a positive reply, authorise the user to use the network (fig. 4). When the user terminates the connection, the visited ISP sends a disconnect indication to the transaction centre, which will forward this message to the home ISP. Accounting data will be generated at the transaction centre and optionally, at the home and visited ISPs.

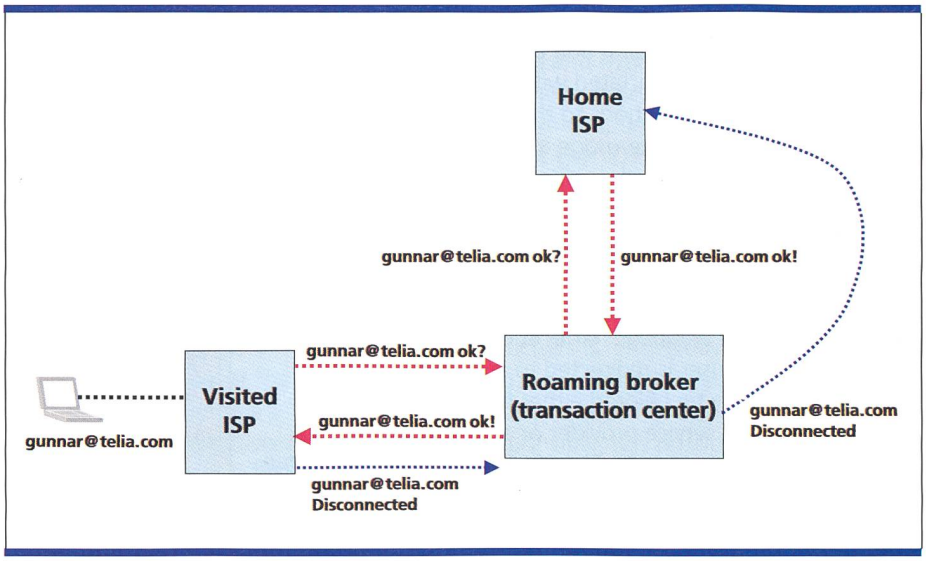

Fig. 4. Remote authentication exchange.

Pricing and Clearing Models

Contrary to the situation in the GSM telephony world, dial-up ISPs do not typically deal directly with each other through roaming agreements. Instead, each ISP has a direct relationship with the roaming broker but not with the other ISPs, who instead have similar relationships with that broker. This approach is referred to as bilateral. The roaming broker negotiates a wholesale rate with each of the ISPs within its footprint. The broker can then resell this capacity to ISPs and corporations that have roaming users. An ISP that wants to offer its users a roaming capability can thus sign an agreement with a roaming broker and does not need to have bilateral agreements with other ISPs. A typical ISP will thus have two relationships with the roaming broker:

- A seller relationship, where the ISP sells access capacity to the aggregator for the use of roaming users from other ISPs or corporations.
- A buyer relationship, where the ISP buys access minutes for the benefit of its own roaming users.

These two relationships may, of course, be regulated by a single agreement. For corporations that want to secure roaming access for their employees and who deal directly with the aggregator or one of its channel partners, only the second relationship is of relevance, since most corporations do not have a public dial-up infrastructure that they want to resell.

The roaming broker will pay the visited ISP for the minutes used and invoice the home ISP for the same usage. The margin for the broker comes from the difference between the selling and buying prices of the access capacity used. There is therefore no need for end-to-end clearing and settlement, as the relationship is between the ISP and the broker. However, the visited and home ISPs receive all usage data, as their client support must know exactly what their end users have done. The roaming brokers using the bilateral model are sometimes referred to as aggregators, since they aggregate the footprint of participating ISPs and then resell that footprint to ISPs and corporations. Excilan has proposed that a multilateral approach be used instead. Multilateral in this context means that WISPs sign agreements with other WISPs through a central entity, allowing each WISP to set its tariffs individually. The freedom of price setting and service delivery is the essential difference between bilateral and multilateral agreements or approaches.

Aggregating brokers have a stronger position with the local ISPs than the GSM clearing houses have with mobile operators. This is probably a reflection of two different historical situations. The ISP industry was, and to some extent still is, very fragmented. With a large number of actors, bilateral roaming is less efficient. Also, the limited size of most ISPs leaves them with limited negotiation leverage with aggregators. Mobile operators, on the other hand, have been fewer, better organised (through the GSM Association) and have more technical and financial resources and therefore are more powerful in their relationships with roaming brokers and clearing houses.

WISP Roaming

Background

The WISP industry is still in its infancy, but significant islands of public wireless LAN coverage have been established, primarily in the US and Scandinavia, but also in Australia and the Asia-Pacific region. At least two operators, Mobilestar (www.mobilestar.com) and SkyNetGobal (www.skynetglobal.com) have already established roaming between their respective networks. Existing roaming brokers GRIC and Ipass are working to adapt their clients to wireless LAN access and authentication methods; while Excilan (www.excilan.com) is working to form an international WISP association and common roaming service mark-ups. These are clear signs that roaming will be a priority for WISPs.

User Experience

WISPs will aspire to offer premium, high-profile branded services with a distinctive look and feel. An important objective will be to maintain the quality of the user experience even when roaming, such that the interaction with the service

is similar to what the users are accustomed to. Both GSM roaming and dial-up roaming are often associated with some disruptions or alterations to the service compared to service usage in the home network. It is highly desirable that WISP roaming does not suffer from these kinds of non-transparencies. Most wireless ISPs have deployed web-based log-in procedures. The user enters his credentials in a form on a webpage. After successful log-in, the user is redirected to a start page that may be tailored either to the location or the service provider or a combination of both[4] (fig. 5). The user can control the session by means of a web window, which at a minimum has a log-out button. The actual procedure, look and feel will vary between WISPs. In fact, there is much greater variation and less standardization in the log-in procedures for WISPs than for dial-up ISPs. The reason for this is partly technical and partly businessrelated. Since wireless Ethernet (802.11b) is not point-to-point, the usual PPP based log-in procedure cannot be applied without the use of special PPP-over-Ethernet (PPPOE) or similar clients – a choice from which most WISPs have shied away from.

There are also business reasons for the web-based log-in procedure. Both the log-in and start pages offer the WISP an opportunity to brand the service as well as the location. In fact, allowing the location owner to have a presence on the user's screen can be an attractive option in or complement to revenue sharing arrangements between the WISP and the location owner. The webpages also offer advertising space where the WISP can promote its own offerings as well as 3rd party goods and services. It is highly desirable that the user experience, when roaming, does not deviate too much from the local user experience. To achieve this, there is a need to standardise the web-based interaction procedures, but there is also a need to standardise the means of transferring pertinent information about, for example, the start page. Recognising this need, WECA has initiated standardisation to address this area.

An even more serious issue relates to service differentiation and individualisation. Forward-looking WISPs want to differentiate their service offerings to fully exploit the market. It is important that the service characteristics are preserved even when roaming.

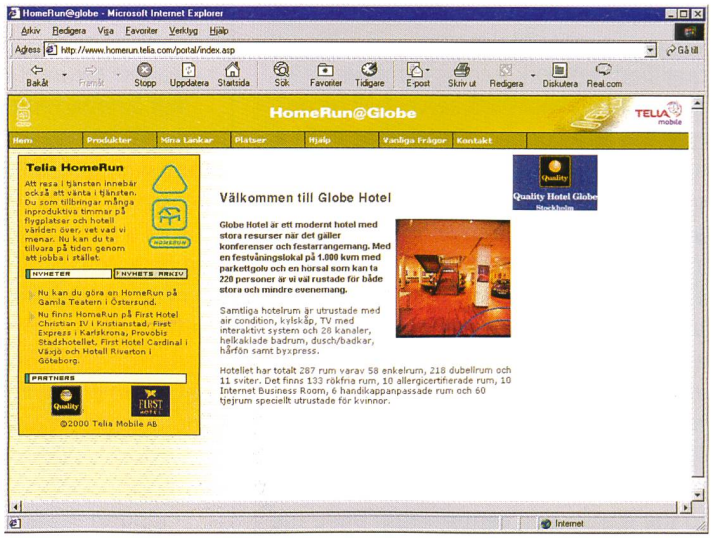

Fig. 5. Telia HomeRun tailored start page.

An example is a WISP that has designed a special service for a corporate customer. This service allows corporate users access to the corporate Intranet, but not the Internet at large. The service is engineered such that the user can only forward and receive packets through the company's firewall(s), thus making any Internet access subject to any corporate policies for security and acceptable use of the Internet. If these corporate users are provided with full Internet access when roaming, corporate policy cannot be enforced. Some WISPs may also offer security features such as token-based authentication. Such features in fact may be required by the security policies of corporate customers and should not be compromised when roaming.

Technology

Just as with dial-up roaming, proxy RADIUS is likely to be the predominant method for remote authentication for WISP roaming – at least in the short to medium term. By using RADIUS vendor-specific attributes (VSAs) in a pre-agreed (standardised) way, it is possible to transfer user profile information such as a start page from the home WISP. To provide user transparency in the more advanced examples above, it will be necessary to transfer and enforce more elaborate user profiles including quality-of-service and accessibility information. Since this is less likely in the short term, a possible workaround would be to specify that connection from certain users should be tunnelled to the home WISP where these features can be properly enforced. The situation is also complex when it comes to log-in methods. The current practice is to use different kinds of web-based log-in methods. Alternative approaches are also being discussed however, most notably 802.1X and PPPOE.

802.1X

802.1X is an IEEE standard for port-based access control. 802.1X provides a mechanism for authentication prior to the assignment of an IP address by defining a method for carrying authentication information directly in Ethernet frames. 802.1X needs to be supported both in the network driver, in the client device and in the 802.11 Access Point. Currently 802.1X is supported in Windows XP, but many other platforms still lack 802.1X support. The 802.11b access point terminates the 802.1X protocol and then uses RADIUS to contact the appropriate authentication server. It is unlikely that the AP will contact the broker or remote WISP directly, since roaming will be subject to policy that will be managed more centrally in the service provider network. The use of 802.1x will require the support of certain RADIUS attributes not necessary for web-based log-in, however.

PPPOE

PPP over Ethernet (PPPOE) is similar to 802.1X in that it provides an authentication mechanism prior to IP address assignment. PPPOE is widely used for authentication in DSL and other fixed broadband environments. PPPOE enjoys support from a wider set of client plat-

[4] In fact, some WISPs will probably choose to tailor part of the start page to the individual as well.

forms than 802.1X, but lacks some security features that could be important in a wireless environment.

Pricing and Clearing Models

The aggregating broker model established for dial-up Internet access has many features that should be attractive to WISPs:

- It offers a large, assembled footprint. The footprint that a specialised player such as the aggregating broker can assemble will likely exceed what any individual WISP will be able to obtain in the short term through bilateral agreements with other WISPs.
- Aggregating brokers offer this footprint in a one-stop-shop fashion, minimising the administrative and legal costs for roaming arrangements.

WISPs will have somewhat different requirements from dial-up ISPs, however, and some of these may cause concern in relation to established aggregating broker practice:

- The desire to make special deals with priority partners. It is therefore likely that WISPs will want special deals from those WISPs that they feed with large amounts of roaming traffic.
- The desire to regulate for the preservation of the user experience: Some WISPs may set high standards for the preservation of the user experience. Such WISPs will be willing to pay a higher price to roaming partners who preserve more of the original (local) user experience. In fact, WISPs may want to block their users from using other WISPs who do not preserve a defined minimum of user experience.
- Avoiding backdoor competition: WISPs who invest heavily in infrastructure in a particular region or country might be very sensitive to opening up their footprint to competitors targeting the same geographical user group. Mobile telephony operators competing in the same geographical area do not generally have roaming agreements with each other.

It is important for existing aggregating brokers to be sensitive to this type of requirement when entering the field of WISP roaming. Roaming will be a much higher priority for wireless than for dial-up ISPs. For dial-up ISPs, roaming is usually a marginal feature of their service offering, used by a small fraction of the customer base (typically 1–3%). While it may be a high-margin service, volumes are comparatively low. Contrary to the WISP situation, it is often possible to reach the home network via an international phone call. Therefore, roaming is seldom a high priority for dial-up ISPs. On the contrary, for wireless ISPs, roaming will be a key feature. Offering a large and attractive footprint will be essential to most WISPs and roaming is central to achieving this end. In the initial phase, when the user community is dominated by travelling businessmen and "road warriors", roaming may also account for a significant part of the revenue stream. Some WISPs estimate that 30% of their revenue will come from roaming. WISPs are therefore likely to make roaming a priority. They will be more inclined than dial-up ISPs to make special deals with priority roaming partners and customers, etc.

Alternatives to Inter-WISP Roaming

In the absence of roaming arrangements between WISPs, users will have to establish some kind of direct relationship (for example a subscription) with the visited operator. Signing up for a full subscription is usually cumbersome and will most often involve recurring fees that the casual visiting user is unwilling to impose on him or herself. However, many operators will offer lighter "user pays" plans using mechanisms such as credit card billing and over-the-counter access vouchers. Access vouchers are a form of anonymous, time-limited subscription with a user ID or password typically valid for 24 hours or multiples thereof. Access vouchers can take a form similar to prepaid telephony cards for the iobox WLAN service in Germany (www.iobox.de). Roaming using credit card or access vouchers is referred to as "plastic" roaming, since using the service involves using a plastic card (fig. 6).

In principle, it is possible to distribute user ID or password information from the operator using SMS or some other electronic means but the plastic 24-hour card format is most common today. Plastic roaming has substantial drawbacks, however. The typical business traveller wants a one-stop-shopping service with one invoice and a consistent experience, which can only be provided through a roaming arrangement.

Conclusions

Roaming will be just as important for WISPs as for GSM operators, and more important for WISPs than for ISPs. The basic RADIUS-based technology for inter-operator roaming exchanges should be leveraged for WISP roaming as well. However, it is important that the technology is extended to provide for greater transparency of user experience. The pricing and clearing models for WISPs are still open, but given the emphasis that WISPs will put on roaming, it is likely that they will want to have a significant influence both on the selling side (at what price and on what terms and conditions their basic service is sold) and the buying side (at what price and on what terms and conditions they can buy services for their own customer base). Voicestream's recent confirmation that the company intends to acquire the as-

Fig. 6. iobox WLAN access vouchers

sets of WISP Mobilestar means that for the first time a major GSM operator is about to enter the WISP arena. It is likely that such players will want a greater degree of control over pricing and the delivery of roaming services. Therefore, the public WLAN industry should focus on technology that allows a more substantial preservation of the user experience in roaming situations as well as pricing and clearing models that give WISPs the control and flexibility they want. [6]

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Zusammenfassung

Roaming zwischen Wireless ISP

Eine neue Kategorie innovativer Internet Service Provider (ISP) schickt sich an, an öffentlichen Hotspots drahtlose Breitbanddienste einzurichten. Sie bedienen sich hierzu einer Technik, die immer mehr Anhänger gewinnt: Wireless LAN, auch WiFi genannt. Die Hauptzielgruppe dieser «Broadband Wireless ISPs» (WISPs) sind die Globetrotter unter den Geschäftsleuten und die so genannten «Knowledge Worker», die darauf angewiesen sind, sich jederzeit von unterwegs in die Firmendatenbank oder ins Internet einwählen zu können. Da ein WISP nicht beliebig viele Standorte bedienen kann, muss er, will er seine anspruchsvolle Kundschaft zufrieden stellen, den Versorgungsbereich seines Dienstes durch Roamingabkommen mit dem der anderen WISP verbinden. Anschauungsunterricht bieten hier die Roamingabkommen für die GSM-Telefonie und den Internetzugang über die Modemwahlverbindung. Vor allem die Techniken für das Roaming im Einwahl-Internet dürften sich als Anknüpfungspunkt für das Roaming im Bereich der drahtlosen Breitbandnetze eignen. Allerdings müssen diese Techniken ausgebaut werden, damit dem Nutzer die Erfahrung der heimischen WISP erhalten bleibt und auch die anspruchsvollsten Privat- und Geschäftskunden die nahtlosen Dienste bekommen, die sie sich wünschen.
Den Geschäftsmodellen für das Roaming und das Clearing im Einwahlverkehr liegt das Bestreben zugrunde, die Transaktionskosten der beteiligten ISP tief zu halten. Anders sieht es in der GSM-Welt aus, wo die Roaming- und Clearingabkommen die traditionelle Unabhängigkeit und Stärke der Mobilfunkbetreiber und ihren Willen, keinen Teil des Dienstes aus der Hand zu geben, zum Ausdruck bringen. Den WISP dürfte also mehr als anderen ISP am Roaming gelegen sein, doch werden auch sie Transaktionskosten sparen wollen.

Mehr als 500 GHz

Im letzten Jahr hatten sie es nicht mehr geschafft, die Wissenschaftler des Communications Research Laboratory (CRL), der Universität von Osaka und der Fujitsu-Labors: Die 500-GHz-Marke für den schnellsten HEMT (High Electron Mobility Transistor) der Welt verpassten sie nur knapp. Damals kam man «nur» auf eine Cutoff-Frequenz von 472 GHz. Jetzt aber übersprangen die Forscher die magische Marke und präsentierten einen HEMT mit einer Cutoff-Frequenz von 562 GHz: neuer Weltrekord. Mit diesem InP-HEMT könnte man elektronische Schaltungen für das Milli-Band (30–300 GHz) bauen und Datentransporte um die 160 Gbit/s möglich machen.

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Wächst und wächst und wächst ...

Der grösste Ingenieurverband der Welt, das Institute of Electrical and Electronics Engineers (IEEE), ist auch 2001 weiter gewachsen, trotz (oder eventuell sogar wegen) der wirtschaftlichen Flaute. 377 342 Mitglieder (+3%) wurden Ende 2001 verzeichnet. Zum Vergleich: Der auf Grund der Bevölkerungszahl entsprechende Dachverband EUREL der elektrotechnischen Vereine in Europa kommt auf knapp 300 000 Mitglieder. Während in den frühen 90er-Jahren die Zahl der IEEE-Mitglieder bei etwa 315 000 stagnierte, gab es seit 1999 kräftigen jährlichen Zuwachs.

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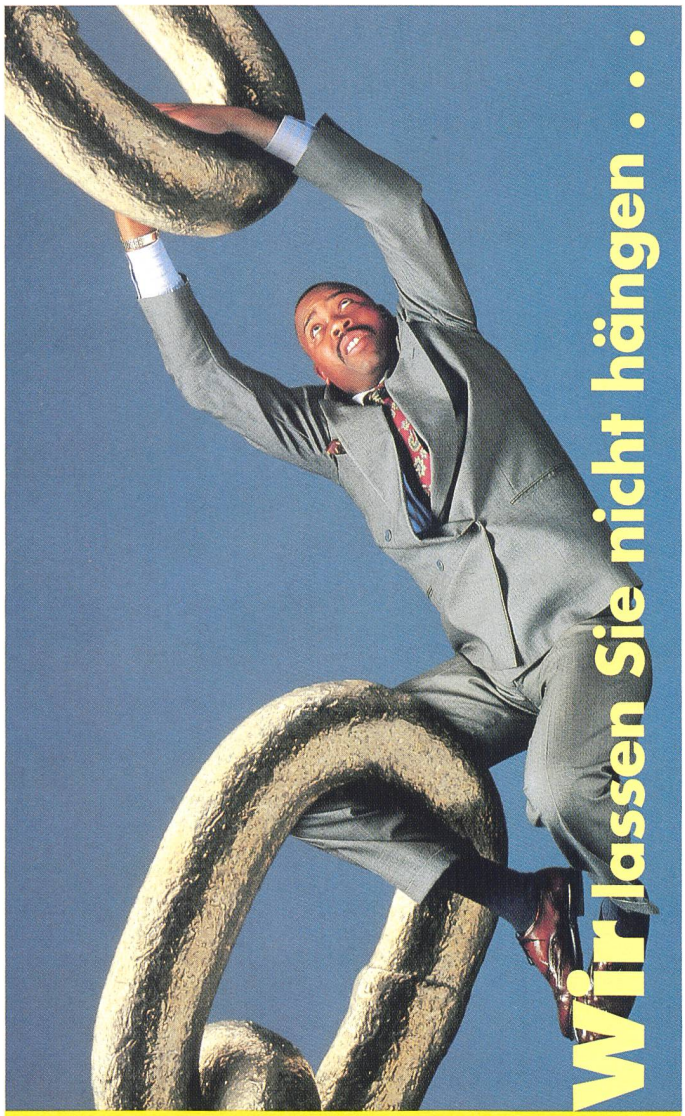

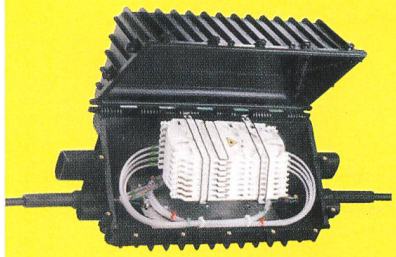

Fiber-Optik

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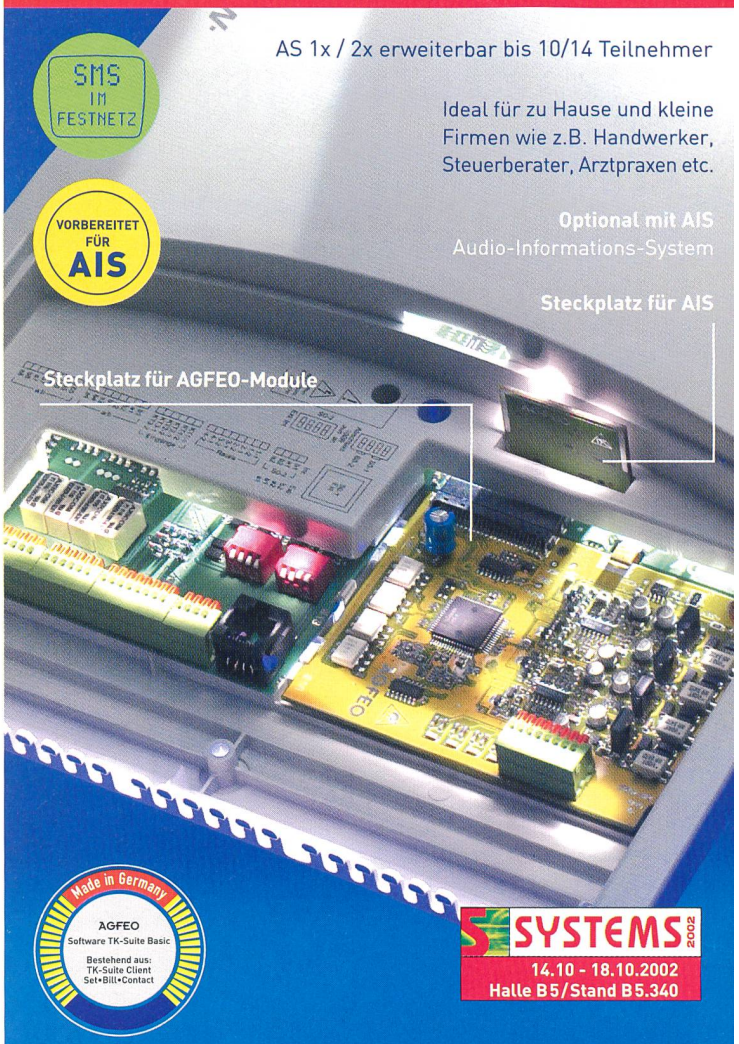
Komfortabel – Variabel

AS 1x / 2x modulare ISDN-TK-Anlagen



Optionales AIS Modul gestattet individuelle Musik und Ansagen in der Warteschleife. Außerdem können Weck- oder Alarmmeldungen über die Kontakt-/Sensoreingänge der TK-Anlage auf eine beliebige Rufnummer gesendet werden.

Die AGFEO AS 1x / 2x Basisanlagen verfügen über folgende Anschlüsse:

- 1 S0 extern
- 1 S0 extern/intern schaltbar
- 4 (8) analoge Anschlüsse, davon jeweils einer wählbar für TFE und MoH
- 1 USB-Schnittstelle mit ISDN Modemfunktion
- 1 Steckplatz für T-Modul 204 oder S0-Modul 220
- 1 Steckplatz für AIS-Modul

AGFEO AS 1x / 2x bieten durch ihre Modularität (Vollausbau 10 / 14 Teilnehmer) Investitionssicherheit und zeichnen sich durch ein gutes Preis-Leistungsverhältnis aus.

Noch Fragen?
Info-Line: +49 (0) 700 CALL AGFEO
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Fax: +49 (0) 521/447 09-98 555

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