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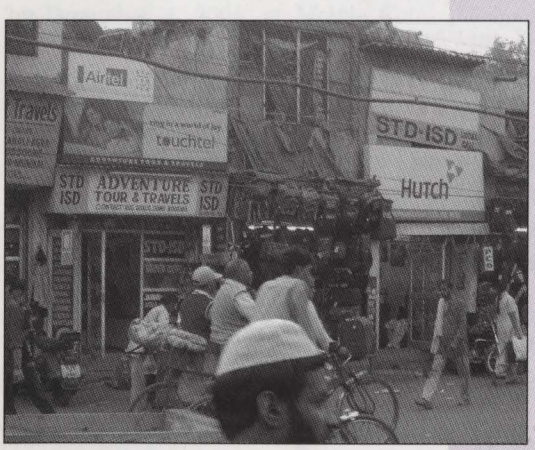

Public Call Offices compete for business near New Delhi's main railway station. Ashok Jhunjhunwala and David Koilpillai discuss India's Mobile Revolution on Page 11.

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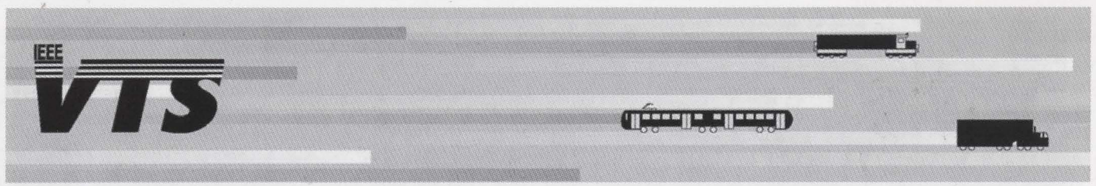

Foreword

James Irvine, Editor

All good things must come to an end...

Welcome to the final issue of Volume 52, and, indeed, the last ever VTS News. In the 53 years since its inception by the IRE Professional Group on Vehicular Communications, 'vehicular technology' has changed out of all recognition. In 1952, land mobile radio for the emergency services had been in operation for almost 25 years (the first being for the Detroit police force in 1928), but radios were valve based and only as portable as the vehicle itself. Other automotive electronics were almost unknown, and in many countries the prime mover for railways was steam power. In one area, however, we are going back to the future. Many cities had extensive electric light rail provision, which are only recently becoming popular again.

It is fitting, then, that the Society should adapt to the times. A number of IEEE Societies have considered the future of their newsletters, with some going down the route of an electronic-only version. As someone who loves the printed page, I'm very happy that the Board decided not to follow suit, but to commit the significant investment required to turn the newsletter into a magazine.

That financial investment would be wasted without the efforts of all who contribute to the newsletter, and in particular the senior editors who volunteer much of their time to report on their specialist areas. I would like to thank them for all their efforts, and also those who have agreed to join the enlarged team to work on the VT Magazine. Harvey, Javier and Charles will, I am sure, not mind me drawing particular attention to Bill Fleming, who has been reporting on developments in Automotive Electronics since 1974. This means that Bill has had a column in well over half the newsletters the Society has produced.

Bill's 122nd column will appear in the 1st issue of the VT Magazine, along with columns on mobile radio and land transportation, as well as features on the History of Vehicular Technology, Heterogeneous communications enabled by cellular operators, AM & FM's Digital Conversion, the State of the Art in Smart Antennas and abstracts from JRC2006. Bundled with the magazine will be the VTS Digital Archive.

All good things must come to an end...

...so that even better things may start!

Copy for the first issue of the VT Magazine should reach Dr. James Irvine by December 4, 2005. at Mobile Communications Group, EEE, Strathclyde University, George Street, Glasgow G1 1XW Scotland,
E mail: j.m.irvine @ieee.org.
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IPv6 based OverDRiVE Moving Networks for Vehicles

Michael Wolf, Tim Leinmüller, DaimlerChrysler AG, Telematics Research, Alexandru Petrescu, Christophe Janneteau, Hong-Yon Lach, Motorola Labs, Christoph Barz, Matthias Frank, Markus Pilz, University of Bonn, Miklós Aurél Rónai, Kristóf Fodor, Ralf Tönjes, Ericsson Research

The European IST project OverDRiVE tackles the issue of the growing demand of telecommunication and digital broadcasting industry for cost-efficient provision of mobile multimedia services. This article focuses on one subject of the project, namely the mobility support for moving networks such as found in future cars and trains. The basic solution relies on Mobile IPv6 enhancements that lead to the development of a Mobile Router concept. Additionally, advanced topics like route optimization, multicast support and combination with micro-mobility approaches are discussed. The key findings were demonstrated and validated by performing trials.

Introduction

The OverDRiVE project (http://www.ist-overdrive.org) aims at UMTS enhancements and co-ordination of existing radio networks to a hybrid network to ensure resource efficient provision of mobile multimedia services. This is achieved by an IPv6 based overlay architecture to enable interworking of cellular and broadcast networks and dynamic spectrum allocation (DSA) techniques on the physical layer to allow system co-existence in a common frequency range. The project objective is to enable and demonstrate the delivery of spectrum efficient multi- and unicast services to vehicles. The project takes an integrated approach that takes into account the network side, the radio access side, and the vehicular terminal. OverDRiVE issues are:

- Improving spectrum efficiency by system coexistence in one frequency band and DSA.
- Enabling mobile multicast by UMTS enhancements and multiradio multicast group management.
- Developing a Mobile Router (MR) supporting roaming into the Intra-Vehicular Area Network (IVAN).

The common approach achieves a significant improvement for delivering uni- and multicast services in terms of service quality, efficiency and cost.

This article focuses on the development of a Mobile Router (MR) by investigating the idea of mobile hosts and mobile networks in vehicular environments. The research takes into account scenarios starting from mobile networks in passenger cars and moving up to larger mobile networks in public transport vehicles (e.g. buses and trains) that comprise a dynamic number of nodes. In these scenarios, vehicles are seen as moving IPv6 networks which can use several access technologies to provide Internet connectivity. OverDRiVE denotes these networks as IVANs (Intra Vehicular Area Networks). The following discussion concentrates on mobility management and IVAN management. Mobility management includes special issues like nesting of mobile networks, mobility within large vehicles, and optimized use of the network in terms of routing. Moreover, IVAN management tasks are regarded with respect to the effect of mobility management on transport protocols, bandwidth scheduling and protection against congestion. These topics are taken from the field of authentication, authorization and accounting (AAA) and reflect the issues that have to be considered in heterogeneous wireless environments. This article also describes the validation of OverDRiVE concepts which was accomplished by field trials and two prototypical implementations.

The remaining part of the article is organized as follows: the first section describes the scenarios that were taken into consideration for the research work and a problem statement. The second section explains the findings with respect to the Mobile IPv6 based mobility management approach. Advanced topics like route optimization, combination with micro-mobility approaches and traffic management within a moving network are described in the third section. The validation and prototypical implementation is explained in the last section.

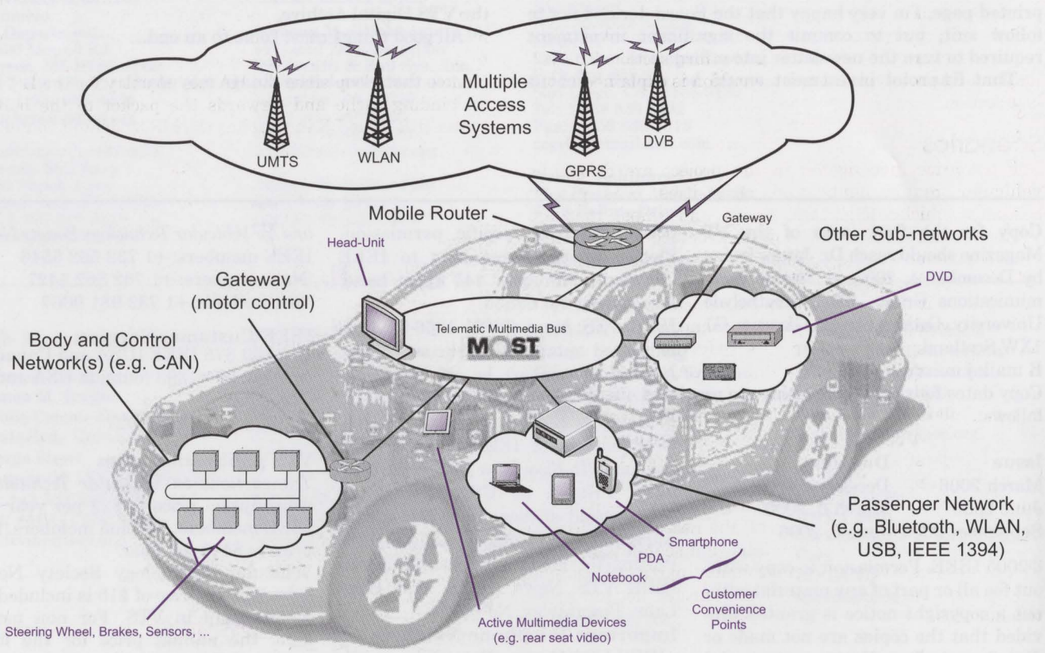

Figure 1 Vehicular Environment

Scenarios

The scenarios investigated in the project are driven by vehicular requirements and necessities. The project assumes vehicles (e.g. cars, trains and ships) that are equipped with an IPv6 based infrastructure with mobility unaware components (e.g. single-purpose sensors with IPv6 connectivity, displays, etc.). Besides, the users (e.g. car driver) bring their own devices into the vehicular environment. While the vehicle is on the move it connects to a variety of wireless access technologies to satisfy the user's/application's need for system performance (WLAN, GPRS, UMTS and DVB-T, which are envisioned to coexist in one frequency band supported by dynamic spectrum allocation).
While the moving network as a whole needs to accommodate mobility related actions (handover, roaming, etc.), the applications running on devices inside the moving network will not be involved in the mobility management — it is the Mobile Router (MR) that takes all the necessary actions to let the moving network stay online in a seamless manner. Figure 1 shows a vehicular environment particularized to a car and consisting of several interconnected networks and technologies.

Problem Statement

A moving network is a network segment that can move and change its point of attachment to the Internet. By definition, it is a leaf network and can only be accessed through specific gateways, called Mobile Routers (MRs). Mobile IPv6 (and Mobile IPv4) supports the mobility of the MR. However, the nodes in the subnetwork of the MR are no longer accessible when the MR (and thus the moving network) moves away from the home network as described below.

The main problem addressed by Mobile IPv6 is that in the current Internet design every IPv6 address corresponds to a fixed "location" in the routing fabric, the route information towards this location being maintained by all the intermediary routers. A mobile host (MH) or MR is permanently assigned a Home Address that is valid in the home domain, i.e. the official administrative domain to which this MH or MR belongs. Mobile IPv6 introduces a Home Agent (HA) that intercepts all packets addressed to the home address (using proxy Neighbour Discovery) and subsequently encapsulates them towards the MH's current Care-of-Address (CoA) – a unicast routable address associated with the MH on a foreign link. The CoA has a foreign subnet prefix. The association of the Home Address of a MH with a CoA for that MH is called a binding.

In a symmetric manner, the MH in a foreign domain will first encapsulate all its outgoing packets towards the HA which will decapsulate and resend them towards the original destination. These two encapsulation mechanisms are currently referred to as bidirectional tunnelling and together with binding cache management constitute the essence of the Mobile IPv6 protocol. Thus, Mobile IP provides ubiquitous accessibility at a permanent home address while being transparent to applications by maintaining existing connections even when the assigned address changes as a result of physical mobility.

Mobility of entire networks consisting of fixed nodes is not supported by the current Mobile IPv6 protocol. Experimental trials reported in [1] expose an inappropriate routing table management of Mobile IPv6. Basically, packets that are sent to a Local Fixed Node (LFN) while the MR is away from home enter a loop since the HA has no entry for the LFN in its binding cache and forwards the packet to the border router (BR). The BR in turn has the MR as default router for

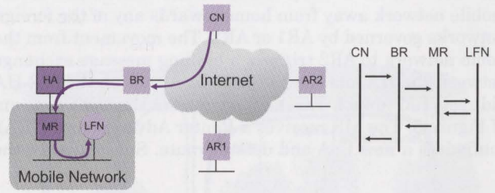

Figure 2 Routing to Local Fixed Node of Mobile Network at Home

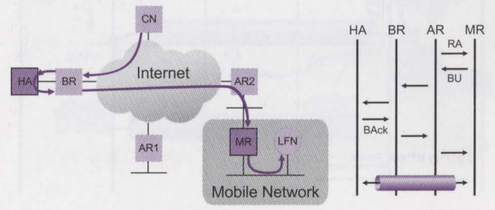

Figure 3 Tunnel Setup for Simple Moving Networks

the moving network. These packets are intercepted by the HA and so forth. Details can be found in [1].

Mobility Management

The approach of OverDRiVE for network mobility is vanilla Mobile IPv6 wherever possible in order to keep the impact on existing implementations small. Therefore, only changes to the MR and its HA are suggested. The approach employs a bidirectional tunnel between the MR and its HA. The basic idea is to include a 'R' –flag for the MR in the HA's binding cache, indicating the relocation of a complete moving network (and not only a host) moved. The HA forwards packets through the MR-HA tunnel for all nodes within the network of the MR. The HA acts on behalf of the link-local addresses of MR's interfaces (when the MR is in a foreign network). As in the mobile host's case, the MR uses binding updates (BU) and binding acknowledgements (BAck) with the HA to maintain the MR-HA bidirectional tunnel. For a more detailed description please refer to [2].

Figure 2 illustrates a generic initial setting for moving networks. The following entities are depicted: a large Internet cloud, a Correspondent Node CN, two Access Routers AR1 and AR2 as well as the home network composed of a Border Router BR, a Home Agent HA and the moving network comprising the Mobile Router and a Local Fixed Node LFN. For this scenario we assume that an application continuously runs between the CN and the LFN. Here, changing addresses induced by the mobility of the MR do not affect the communication. In our particular trials, a CN continuously moves towards the Home Address of LFN and the LFN displays that stream on a video screen, as the packet exchanges in the right diagram of Figure 2 suggests.

The packet stream and the encapsulation/decapsulation actions are illustrated in Figure 4, where bent arrows at the left of vertical bars represent decapsulations, and at the right encapsulations. In that figure, the detailed Neighbour Discovery messaging between BR and HA is excluded; a complete description can be found in [3]. In the other direction, when a LFN needs to send a packet to CN and the mobile network is not at home, it will first send the packet to its default route, the MR. The MR encapsulates it back to HA which decapsulates and forwards it to the original destination. Figure 3 (left) describes the movement of the mobile network away from home towards any of the foreign networks governed by AR1 or AR2. The movement from the home network to AR2 triggers a binding message exchange between the HA and the MR in order to set up the MR-HA bidirectional tunnel. This is illustrated in the right diagram of Figure 3. The MR receives a Router Advertisement (RA), configures a new CoA and default route. Subsequently, the MR sends a BU to the HA. Subsequently, the HA sets up its endpoint of the MR-HA tunnel and replies with a BAck. At this moment the MR-HA tunnel endpoint at the MR is set up, as well. Once that tunnel is established, the streaming between the CN and the LFN continues via the new CoA. The CN sends the next application packet towards the BR and the latter asks for the link-layer address corresponding to the IPv6 address of the MR. The HA replies on behalf of the MR. Afterwards, the HA encapsulates and forwards this packet through the MR-HA tunnel towards the current CoA. The MR decapsulates the received packet and forwards it to the LFN. Symmetry can be noticed by drawing an imaginary horizontal axis through the centre of Figure 4: packets from CN to LFN take exactly the same path backwards, without a state being maintained neither on CN nor on LFN, as a consequence of bidirectional tunnelling.

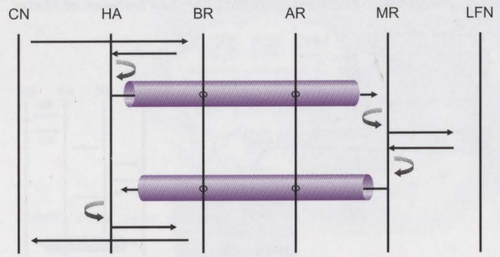

Figure 4 CN-LFN Exchanges, Simple Moving Networks

The simplicity of this approach is advantageous to supporting moving networks. The topology presented in Figure 2 can be easily augmented with a large number of moving networks, ARs and CNs. All packet exchanges involved are similar (if not the same) to the packet exchange in Figure 4.

Advanced Topics

While the mobility management solution described above provides a basic functionality, advanced features like route optimization, combination with micro-mobility solutions, multicast support and traffic management were investigated and described in the following subsections.

Route Optimization

Benefits of Route Optimization outside IVAN

Route Optimization (RO) is a process used for enabling packet delivery along the (topologically) shortest path between two communicating nodes. Basically, in Mobile IP scenarios this means to eliminate tunnelling over a HA and to establish a direct connection between two communicating nodes.

Route Optimization techniques offer solutions to a well-known challenging problem of the Mobile IP protocol family. Succinctly, the problem is induced by the artificial necessity to forward all packets between CN and MH through the MH's HA, even if HA is not in the (topologically) shortest IP path between MH and CN.

In the case of moving networks, the route optimization problem is much harder; due to the effects of nesting and the presence of several HA's.

We define the IP end-to-end distance between two communicating nodes as the number of IP hops through which the application-level packets flow. This is, of course, a generalization based on several simplifying assumptions:

- The path taken by the packet flow in one direction is the same as the path taken in the reverse direction.
- All intermediary point-to-point links have approximately the same costs and bandwidth, and are symmetric.
- Paths are stable during the entire application-level communication.

We used this simplifying definition of the IP path length when analyzing the benefits that can be obtained from using Route Optimization.

Intuitively, we have identified that the Route Optimization techniques are beneficial to the LFN-CN communication only if the IP end-to-end distance between CN and LFN is much shorter than the distance between LFN and HA and the distance between the CN and the HA. For more details on a detailed analysis and measurements confer to [4], section on "Validation of Mobile Router".

Protocol for Route Optimization inside IVAN

Route Optimization for Visiting Mobile Nodes inside the moving network is another facet of RO that has been addressed in OverDRiVE. To exemplify our approach, we consider the example scenario as depicted in Figure 5. The mobile network consists of two separate subnets, interconnected by the MR. A visiting mobile node connects to subnet 1 and wants to communicate with a local fixed node in subnet 2. Without route optimization, the entire traffic resulting from this communication is tunnelled twice through the external link.

When the mobile node joins the mobile network, the node detects its movement by the reception of a router advertisement that contains a previously unknown prefix. In addition to the IPv6 standard [5], the router advertisement in our solution has a supplementary option that also contains the prefix of the entire mobile network (from which the prefix on the respective link is only a subset) as well as the MR's IPv6 address on this link. This option is required because the visiting mobile node needs to know the entire prefix to be able to do route optimization for the entire mobile network, otherwise route optimization would only be possible for the respective subnet.

After the reception of the router advertisement, the visiting mobile node updates the bindings with its home agent first (as it usually does, according to [6]). But instead of trying to do route optimization directly with the local fixed nodes, the visiting mobile node sends a binding update message to the MR. The MR responds with a binding acknowledgment (BAck).

As soon as the registration is completed, packet transfers between the visiting mobile node and the local fixed nodes in the mobile network work as follows. When the visiting mobile node wants to send packets to local fixed nodes, it finds the MR's address in its binding cache, associated with the mobile network's prefix. This is why it decides to encapsulate the packets and to send them to the MR. The MR decapsulates the packets and forwards them to the destination nodes, which are the local fixed nodes.

The routing of packets in the reverse direction – from a local fixed node to a registered visiting mobile node – follows the same pattern. The local fixed node sends a packet to the visiting mobile node's home address which has to be routed via the MR. The MR detects the visiting mobile node's home address in the IPv6 header destination address field and using its binding cache MR determines the actual care-of address (CoA) of the visiting mobile node. The MR encapsulates the packet and forwards it to the visiting mobile node, which finally decapsulates the packet.

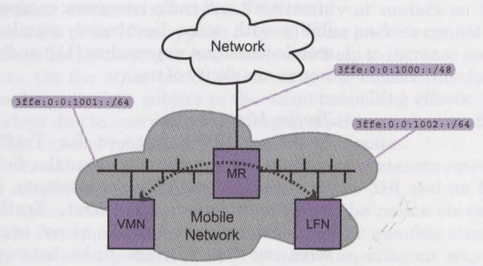

Figure 5 Internal Route Optimization via VMN-MR Tunnel

In both directions, tunnelling between the MR and the visiting mobile node is necessary to maintain topologically correct routing and addressing. Moreover, there might be intermediate routers between the MR and the visiting mobile node that would not be aware of the visiting mobile node's care-of address.

Combination with Micro-Mobility Solutions

In large vehicles, such as trains, ships, etc., there is a need for local mobility management of users residing in the vehicle. The OverDRiVE project examined ways of combining network mobility with micro-mobility (as an alternative to RO described above). For example, the BRAIN Candidate Mobility Management Protocol (BCMP) [7], which was earlier developed in the IST BRAIN and MIND projects, can be used to handle the local mobility of user devices. The BCMP infrastructure hides the movement of the users inside the vehicle and, by providing fast handover mechanisms, handles the mobility of the passengers seamlessly.

In Figure 6, the theoretical overview of the MRHA-BCMP combined solution can be seen. Inside the moving network infrastructure BRAIN access routers (BAR) are connected to the MR. To have BCMP mobility management inside the moving network the MR is co-located with a BCMP anchor point (ANP) and a user registry (UR). Either visiting mobile nodes (VMN) or local fixed node (LFN) can be connected to the moving network's infrastructure.

VMNs get their IP address from the BCMP User Registry (UR) when they connect to the moving network. All IP addresses assigned to visiting mobile nodes point to the ANP and belong to the address space of the MR's home agent. After the VMN received its new IP address it sends a binding update (BU) to its home agent updating its location information using the new IP address as a care-of-address. LFNs get their IP addresses through IPv6 auto-configuration or they are configured manually. All IP addresses assigned to local fixed nodes also belong to the address space of the MR's home agent, but in this case the address points to the local fixed node itself.

If a correspondent node (CN) wants to communicate with a mobile node residing in the moving network, it sends the packets to the mobile node's home address. The home agent of the mobile node (HAMN) intercepts the packets

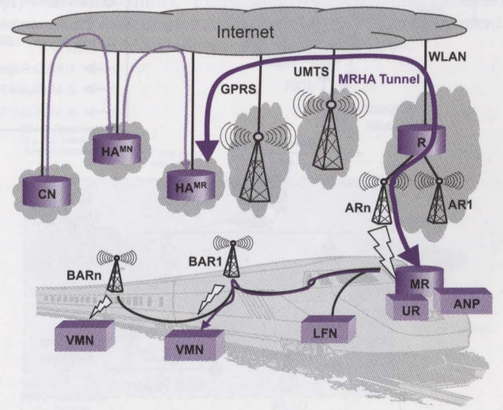

Figure 6 Theoretical overview of the MRHA – BCMP combined solution

and forwards them to the MR's home agent (HAMR), because the care-of-address of the mobile node points to this entity. The MR's home agent injects the packets into the MR-HA tunnel and on the other end of the tunnel the MR receives the packets.

Depending on the destination address and the MR's routing table, the MR sends the packets either directly to the local fixed nodes (LFN) or to the BCMP anchor point (ANP). In case the destination is a VMN, the ANP receives the packet and it tunnels the packet to that BAR, where the visiting mobile node is located. Finally the BAR sends the packet to the visiting mobile node.

Multicast

As described previously, the OverDRiVE base network mobility solution relies on a bidirectional tunnel between the MR and its Home Agent (HA). It provides the continuity of unicast sessions for nodes in a moving network by extending the MR's Home Agent to support redirection for the whole moving network prefix (MNP) in addition to the MR's home address.

Since multicast routing highly differs from unicast routing, this Home Agent forwarding mechanism based on the MNP does not serve the forwarding of multicast packets. The key reason is that multicast packets are sent to a multicast address that is unrelated to the prefixes of the networks where potential multicast receivers are located (e.g. the moving network prefix).

However, there are many use cases where the support of IP multicast for nodes inside moving networks is needed. Scenarios range from professional applications, such as remote-repair activities including mass software upgrade to embedded devices in a fleet of vehicles, to entertainment applications, for instance enabling passengers in a vehicle to participate in group communications, such as video conferencing.

Two approaches have been investigated in OverDRiVE. The first one suggests the use of the MR-HA bidirectional tunnel for the forwarding of multicast traffic too, in both directions, between the MR and its home link. By co-locating a multicast routing function on both the MR and its HA, multicast routing protocol messages can be exchanged over the MR-HA tunnel. This allows the creation of multicast branches from the Internet to receivers in the moving network, as well as from sources in the moving network to receivers in the Internet.

The second approach is an attractive alternative in situations where the first one is either not possible (e.g. due to MR or HA capabilities), or the network and radio overhead (i.e. sub-optimal routing, and encapsulating header) introduced by the MR-HA tunnel is not acceptable. It proposes to re-apply the Remote Subscription (RS) principle [8], inherited from mobile multicast hosts, to the case of a MR serving a moving network. As it moves, the MR uses Multicast Listener Discovery (MLD) [9] messages to re-subscribe to the ongoing multicast sessions through the local multicast router in the visited link. In case of the moving network, however, the MR must (1) be able to discover which multicast groups the nodes in the moving network are interested in, and (2) provide optimal multicast routing inside the moving network by avoiding flooding. The selected approach relies on the deployment of "MLD-based Multicast Forwarding (MLD-proxying)" [10] inside the moving network, in order to solve the two above mentioned issues. As illustrated in Figure 7, this allows group membership information to propagate router-by-router from the routers serving multicast receivers towards the MR. Each intermediate router learns group membership information from its downstream interfaces, aggregates this information and proxies it upstream. Similarly, it forwards multicast traffic, based upon that information, only to downstream interfaces in the direction of receivers. Such a configuration, combined with the use of Remote Subscription at MR, allows multicast support for moving networks, without the need to run a multicast routing protocol.

This approach also supports multicast sources located inside moving networks. Receivers in the same moving network will get the multicast packets thanks to the MLD-based forwarding mechanism. In order to reach receivers outside of the moving network, the MR intercepting the multicast packet from the local source should then forward this packet towards its home network, by taking advantage of the MR-HA tunnel.

The advantages of this approach include the capability to roam in any visited link in the Internet (irrespective of the multicast routing protocol locally deployed); optimal routing even in case of nested moving networks; optimization of network and radio resources; compatibility with some host-based seamless mobile multicast approaches [11]; and of course simplicity of use.

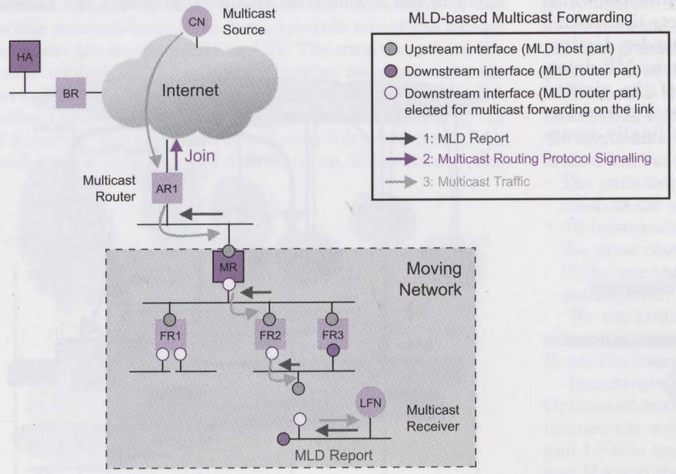

Figure 7 Multicast for Moving Networks with MLD-based Multicast Forwarding

Traffic Management

The OverDRiVE concept for Traffic Management originates from the field of AAA [12] and its application in mobile environments. First, Traffic Management mainly aims at not overstressing the wireless links between the MR and its AR. Additionally, it can be used as a basis for bandwidth reservation to ensure that important applications are granted a share of the bandwidth. In the scope of OverDRiVE moving networks, bandwidth reservation for an IVAN (i.e. between a MR and its HA) can involve multiple networks under the administration of different corporations. As the IVAN is mobile in terms of its point of attachment towards the Internet, handovers can imply frequent changes of network path characteristics.

While modifications to the MR and its HA are possible, it was a design premise to not apply any changes to the AR [13]. The MR-HA tunnel as an alternative allows for limiting the data rates sent to and from the MR. However, shaping the MR-HA tunnel calls for the knowledge of the capacity of the network path between the MR and its HA in both directions. Although the MR-HA tunnel is bidirectional, it is not necessarily symmetric in terms of capacity, e.g. most radio technologies provide asymmetric transport services to accomplish the requirements of web browsing, video streaming, etc.

An estimation of the capacity of this tunnel by a simple traffic monitoring approach to incoming and outgoing traffic at the MR or a capacity estimation based on the net-work hardware of MR's wireless links in combination with a propagation of results to the HA and nested MRs seems not sufficient. The OverDRiVE solution uses packet dispersion techniques [14][15] in order to estimate the capacity of the network paths between the MR and its HA. There are two fundamental techniques to estimate the path capacity: sender and receiver based packet pair techniques. Sender based technologies need neither measurements at nor status reports from the receiver. Instead, small echo packets are triggered. The arrival times of these echo packets are then measured at the sender. However, this approach does not disburden the receiver from resource intensive measurement tasks as both directions need to be monitored. Instead, an additional source of error is introduced, as not only the probing packets are subject to error due to cross traffic, but the echo packets as well. In addition, the ratio of echo packet sizes to probing packet sizes determines the maximum asymmetry of the network path that can be measured.

OverDRiVE's Traffic Management uses a receiver based packet pair technique to estimate the path capacity. The receiver does the measurements and sends status reports to the sender. The sender can perform traffic shaping based on these results. The probing packets are sent actively. However, data tunnelled between MR and HA can be used as a further source for capacity estimation. Furthermore, probing packets can either be sent on the same interface that is used to maintain the MR-HA tunnel or on the virtual MR-HA tunnel interface itself. Sending probing packets via the tunnel interface ensures on the one hand that the probing steam is not treated differently at routers on the network path. If encryption is used, these packets cannot be identified by their content, which may help to increase security. On the other hand, when using the tunnel interface, packet pairs are subject to the same tunnelling effects, i.e. delays due to encryption and fragmentation, as data traffic. This ensures meaningful measurement results.

Based on the results gathered from the measurements a scheduling mechanism is needed at the MR and its HA to share the tunnel capacity between the nodes on each side. An approach for implementing a fair queuing strategy has been published in [16] where an efficient way of realizing fair queuing by Deficit Round Robin (DRR) has been proposed.

Validation and Trials

OverDRiVE dedicated an important amount of efforts to trials and demonstrations of the protocols developed within the project. The foremost goal was to validate the findings by implementing the key aspects of the solution and performing tests in lab and real-life environments. At several places like in Paris, Bonn, Budapest and Turin testbeds consisting of at least a IPv6 backbone, GPRS, and WLAN access systems were established. Figure 8 depicts the demonstration setup at the HyWiN 2003 in Turin (http://www.ist-overdrive.org/HyWiN2003). To further visualize the benefits of the mobility management protocols, dedicated applications like video streaming, remote car control and software download to the car were realized. Details of all the testbeds, trials and applications can be found in [17]. Findings of the trials were also fed into the IETF NEMO group [18]

Summary

The OverDRiVE project successfully investigated and developed mechanisms to support network mobility based on Mobile IPv6 solutions. Such mobile networks may be found in future vehicles such as trains, cars, ships, etc. The work had significant impact on the scientific community by actively contributing to IETF NEMO working group and publications by all project partners on various conferences and workshops.

The demonstrations and trials provided valuable input to the project in order to validate the concepts and to identify further working areas.

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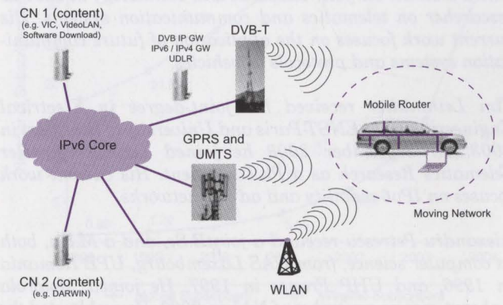

Figure 8 Field Trials Setup at the HyWiN 2003 in Turin

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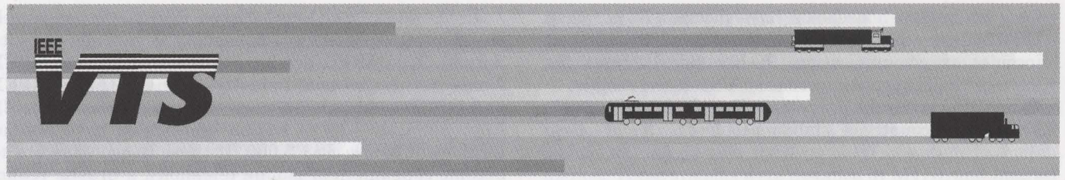


India's Mobile Revolution

Ashok Jhunjhunwala, David Koilpillai, IIT Madras

This article presents a comprehensive view of the mobile telecommunications in India—technology, business, regulatory, and services. The cellular industry in India is going though a period of explosive growth—adding approximately 1.5–2.5 million new subscribers each month. This article documents the key events of the last decade that have had an impact on this industry. One of the major aspects of this growth is the business model that makes mobile communications affordable to a mass market. The affordability of the Indian subscribers is explored in detail. The different technologies, spectrum issues and future growth aspects are described. The key elements that will catalyze the continued growth of this market are presented.

Introduction

India's mobile market is growing at a rate of 1.5 million to 2.5 million subscribers per month. Five years ago, it used to add barely 12,000 subscribers per month (Figure 1). The situation changed dramatically around late '99, and since then, the growth has continued to accelerate (Figure 1). The number of subscribers has increased nearly 10 fold since 2000, from 3.5 million to about 44 million mobile subscribers today. It has recently caught up with the number of fixed-line subscribers which was at 43.2 million in May 2004 (Figure 1). The mobile market will continue to grow and by 2009, The Centre for Monitoring Indian Economy (CMIE) and leading research groups expect it to cross 150 million subscribers which is comparable to the size of the US mobile market today.

This article examines the factors behind such an explosive growth in India. Section 2 presents the key issues that have driven this growth. It is primarily a combination of a conducive regulatory environment and a viable, attractive economic model. Section 3 summarises the technologies that have contributed to the cellular growth in India. It will specifically address the GSM – IS95 imbroglio, which had threatened to derail the whole process. Section 4 examines the factors that will make the market continue to grow: the key questions being, is this growth likely to saturate and what needs to be done to serve over one billion Indians. It will specifically look at the issues involved in serving the under-served and rural areas. Section 5 presents a summary of the demand for mobile data services. Section 6 discusses the spectrum issues and future technology options for the Indian market. Section 7 concludes the article.

Factors Behind Growth

Until the early 90's, telecommunication in India was a monopoly of the state owned operators, Bharat Sanchar Nigam Limited (BSNL) and Mahanagar Telephone Nigam Limited (MTNL). It is the National Telecom Policy 1994 (NTP-94), which paved the way for private players into the telecom sector. India was divided into 23 Telecom Circles or Service Areas for the provision of two types of telecommunication services – Cellular Mobile Telecom Service (CMTS) and Fixed Telecom Service (FTS)*. Licenses were offered in each of the circles, based on competitive bidding by operators. The first mobile service was launched in the city of Kolkatta in 1995. The mobile industry, hyped to be the sunrise industry of the 21st century, could manage to get only 1 million subscribers by 1998. The promise of large Indian market was nowhere to be seen. The private telecom operators were virtually crumbling financially.

The reasons are multi-fold but went back to 1994. Egged by their consultants and foreign partners, these operators had ignored the ground realities and over-hyped the potential of the Indian middle class and its purchasing power. Chasing this non-existent middle class money, operators bid for licenses at exorbitant rates in 1994. With the cost of mobile handsets at approximately US$ 500 and mobile tariffs at US 30¢ per minute, the projected growth in the number of subscribers and the return on investments (RoI) remained a mirage. Further, the infrastructure costs, including Capital Expenditure (CAPEX) and Operating Expenditure (OPEX) were very high, leaving the telecom industry on the verge of bankruptcy in 1998.

To better understand the source of the problem, i.e., the affordability of the Indian middle class, let us look at the current income distribution of households in India (Figure 2).

- Almost 50% of the Indian households have incomes of less than US$ 2,000 per year or less than US$ 200 per month. How much can they afford to spend on telecommunication services?

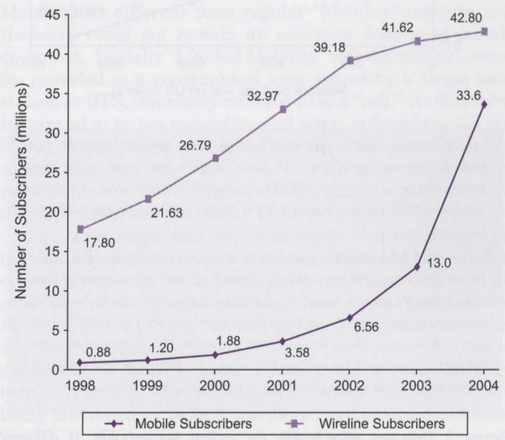


Figure 1 Telecom Subscribers in India [1,2,3]

1 The former was called Mobile Operation License while the latter was referred to as Basic Service License in popular press. The latter service was often referred to as BTS (Basic Telephone Service).

- Only 21 million households have incomes higher than US$ 500 per month. Even if they spend 3% of their incomes on communication, the Average Revenue per User (ARPU) cannot be more than US$ 15 per month.
- This ARPU is payable by potentially only 21 million subscribers in a country of 1 billion people.

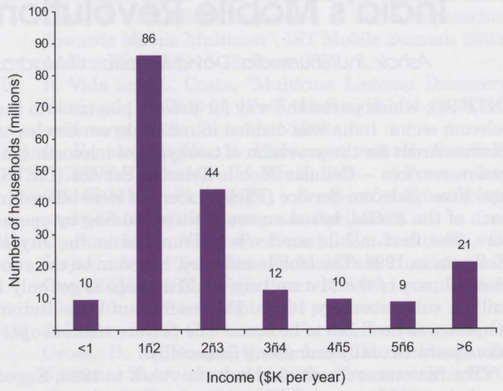
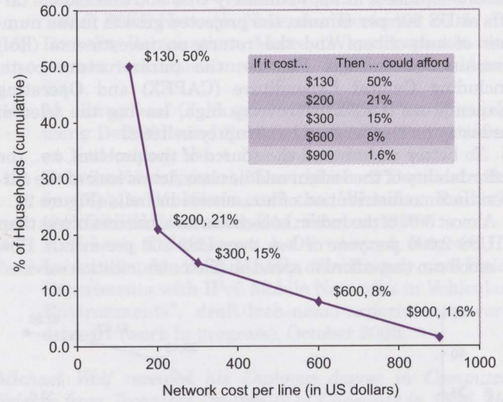


Figure 2 Income distribution among rural and urban households for 2002 (in millions) in India [4]



In mid-1990s, mobile operators had to spend around US$1000 per line as infrastructure cost. At such investment levels, operators needed to get a return of US$30 every month to break even. This was too steep for a country where the per capita income is a mere US$50 per month.

The chart illustrates the percentage of Indian households that could afford telephony and Internet connectivity, assuming 5 percent of their household income is spent on communications at various levels of investment per line. If the investment was around US$1000, hardly any Indian could afford the services. However, if the cost of network infrastructure could be reduced to about US$200 per line, telecom services could be easily affordable to close to 30 percent.

Figure 3 Telecom affordability for Indian households at different Network infrastructure costs [5]

In the west, spending between US$ 25-30 per month on telecom services for a household is considered quite normal. This ARPU determines the CAPEX and OPEX viable in their telecom industry. In India, these CAPEX and OPEX would give a narrow market (see Figure 3). Approximately 73% of Indian households have annual incomes of below US$ 3,000. If these households are to become consumers of mobile telephony, a drastic reduction in CAPEX and OPEX is required.

The ARPU and number of subscribers assumed by the operators when they bid for the licenses were extremely optimistic. It appeared that the mobile operators would not be able to survive and that mobile telephony had no future in India. Two critical steps salvaged the situation and helped to turn it around. One was in the domain of policy and regulation, which would re-examine the license fees paid during bidding. The second was in the domain of technology, where the network had to be built at a CAPEX and OPEX, hitherto unheard of.

The tide turned for the mobile industry with the introduction of the National Telecom Policy 1999 (NTP-99). The Government of India made a revolutionary gesture (see Box 1) attempted by no other country across the world. It waived the license fee obligation (committed to by the operators through open bidding in 1994) and migrated to a "revenue-share regime". The license fees paid by operators up to July 31, 1999 were considered as the entry fee. And since then, 15% (subsequently revised to lower levels) of the gross revenues of operators were to be passed on to the Government under the revenue-sharing model. NTP-99 also paved the way for an increase in the number of mobile operators in each telecom circle. With a maximum of 4 licenses allowed in each service area, there were 78 mobile licenses owned by 25 companies by December 2002.

In the post NTP-99 scenario, economies of scale achieved with the maturing of mobile technologies and standardisation helped rapidly bring down the cost of infrastructure. The CAPEX for GSM infrastructure in India is now as low as US$ 125 per subscriber* (including the cost of backbone and backhaul infrastructure). The cost of mobile handsets also dropped dramatically from the earlier levels of around US$ 500 to approximately US$ 50. Thanks to increased competition and a reduced cost structure, mobile tariffs dropped by over 90 percent in 4 years—an achievement unparalleled by any other sector or industry in India. The average airtime tariff in 2003 prevailed at around US 3¢ per minute as against the peak-ceiling tariff of US 30¢ per minute in 1998. In fact, in August '04, many of the operators cut their tariffs even further, which is now lower than US 2¢ per minute. While the current ARPU is US$ 12 per month, most operators are now bracing themselves to sustain even when the ARPU is likely to fall below US $8. Again in 2003, the Government of India introduced the "Calling Party Pays" (CPP) regime (wherein the recipient of a call does not incur any charges) and thus, played a key role in further increasing the affordability of mobile services.

All these factors resulted in a surge in the subscription of mobile services and mobile operators were able to venture into more cities and towns of the country. Currently, mobile services are available in almost 1400 cities and towns of India. The Indian mobile telephony sector has been growing at a Compounded Annual Growth Rate (CAGR) of 85 per cent.

2 In one of the largest GSM tenders in history, opened recently by India's incumbent operator, BSNL, the cost of infrastructure (excluding backhaul) is $ 75 per line.

NTP-94 paved the way for GSM-based mobile services by private operators. The operator licenses, which were awarded on open bids, were cumulatively worth US$ 15 Billion. The operators had over-estimated the potential of the Indian market. When the projected revenues never materialised, the financially-crippled operators defaulted on thir payments of the license fees. This led to several litigations against the government. Assessing the gravity of the situation, the Indian government came up with a revolutionary solution to rectify this situation. The "Fixed License Fee" regime, which was causing an unsustainable financial drain on the operators, was withdrawn and a "Revenue-Share" regime was introduced through NTP-99.

Migration to the revenue-share regime came into effect on August 01, 1999. This migration package was accepted immediately by the operators but cost the exchequer approximately US$ 3.33 Billion. Yet, in its bid to improve the state of telecom affairs in India, the Government went ahead with this proposal and paved the way for the subsequent booming of the telecom market. This move was unprecedented across industries in the country, and also in the world.

***Table 1** Revolutionary steps by the Government*

The GSM – IS95 Imbroglio

In 1994, when India decided to introduce mobile telephony services, it chose to use the globally popular GSM system. Thus the CMTS operators were allowed to use only GSM technology in India and appropriate spectrum was allotted for mobile operations accordingly.

When the mobile services were being introduced, it was believed that mobile telephony would be expensive and available only to the affluent. The initial tariff of US 30¢-40¢ per minute for even local calls was as much a reflection of this belief, as it was a reflection of the high CAPEX and OPEX prevailing then.

The government had simultaneously opened up the Basic or Fixed telephony services. The tariffs for this type of telephony were much lower, closer to US 2¢-3¢. It was this service, which served a larger section of people and was extended to under-served and rural areas. While obligating these fixed service operators to cover rural areas, the government did facilitate them to a large extent by allowing them to use any technologies that they chose.

As the local loop which provides connectivity from the local exchange to homes or offices amounted to a major portion [5] of the CAPEX and slowed the build-up of the network, Wireless-in-Local-Loop (WLL) was considered as an option to extend the connectivity to homes and offices. New technologies like corDECT WLL (www.midascomm.com) emerged primarily to serve this need. A dedicated spectrum was also allotted for corDECT.

At the same time, CDMA mobile technology (IS-95 standard) had emerged as a system capable of providing mobile services and was being deployed in the USA and South Korea. Being a latecomer as compared to GSM, the IS-95 systems faced tough competition. The cost of the infrastructure equipment and handsets for such CDMA systems were higher and the services (at that time) were not as competitive as those provided by GSM. The promoters of IS-95 (CDMA) technology were using the claim that it was more spectrally-efficient as compared to GSM in order to sell a higher-cost system, in market segments where regulations or spectrum allocation did not make GSM the automatic choice. An attempt was initially made in India to promote CDMA as an alternate mobile technology, but there were no takers.

At this time, fixed subscriber units were made for CDMA (IS-95) mobiles by essentially packaging the handset electronics in a fixed and larger box. With these changes, CDMA mobile technology sold itself as a WLL system in Indian market. These systems were installed by MTNL and Bharati Telenet limited to provide fixed services in 1996-97. The services did not prove to be successful, especially since care was not taken to design the CDMA subscriber units for fixed line service. For example, in a CDMA WLL phone, the CALL button needed to be pressed even after dialling all the digits, whereas most fixed line services do not require this to be done, i.e., the digits are transmitted even as they are dialed.

The next attempt was to sell CDMA WLL as a boon to rural areas, with a claim of a much larger reach (25-30 km). This was demonstrated with appropriate large gain fixed antennae connected to subscriber units. Several such systems were indeed deployed. However, problems occurred again, as the subscriber units placed at long distances consumed large quantities of power and were located in areas where power supply was either non-existent or highly unreliable. The solar power or battery-back up units used, not only pushed up the cost, but were also generally unreliable. Further, it is well-known that the CDMA effective cell-size shrinks when the system is loaded. Therefore, a telephone deployed 25 km from a base station works well initially when the load is low, would just stop functioning as usage in the cell increases.

Having failed to make any significant impact as a technology suited for fixed line services, the promoters of IS-95 technology changed tack in 1999. The private operators providing fixed basic services (FTS operators) had not yet made any noteworthy mark (especially because of high CAPEX) and were falling behind the mobile operators. Seizing this situation, the IS-95 promoters enlisted the support of some basic service operators and came up with a novel concept called "Limited Mobility." The definition of this was left deliberately vague and undefined. However, the key was that basic or fixed telephone service providers would now use IS-95, re-christened as a Limited Mobility WLL system, to provide mobile services. As expected, the mobile service operators protested as the providing mobile services were supposed to be their exclusive domain.

As a result, attempts were made to declare "Limited Mobility" as different from regular "Mobility" services and therefore could not remain an exclusive domain of mobile operators. Initially "Limited Mobility" was defined as a service provided in a geographical area served by a single base station or BTS, commonly referred to as a "cell." As this service proved to be too restrictive and since, subscribers did not like it, the definition of "limited" was broadened to mean one service area or a district. In essence, the difference between regular "mobile" and "limited mobile" services was now limited to the fact that the latter could not provide roaming.

At a later stage, this limit was again liberalised to mean that a subscriber could indeed roam, but would have a different telephone number as he/she goes to another city, with all calls forwarded from the original number to the new number. Each of these attempts was made amidst regulatory disputes and legal battles. The basic services operators tried to build public and political opinion by making claims that they were being prevented from serving rural areas, that they were being prevented by mobile operators from providing services

3 FDI in Telecom Operators was hitherto capped at 49%. Most CMTS operators wanted the limit to be enhanced so as to attract higher investment required in operations. FDI percentage was proposed to be hiked to 74% as a part of package.

4 MMS has been introduced recently (in 2004), and as of now, amounts to only a small percentage of total revenues.

for the common man at a lower cost and that the mobile operators were preventing "the forward march of technology." This battle went on for three years between 2000-2003 and involved the Department of Telecommunication (DoT), the Telecom Regulatory Authority of India (TRAI), the Telecom Dispute Settlement Authority (TDSAT), as well as the Supreme Court of India. Multiple court cases were filed and different agencies took contrary stands.

Most people and the media recognised that the CDMA/IS-95 lobby had not played the game by the rules and that it was taking unfair advantage. However, the silver lining in all of this was that cellular telephony was becoming competitive as the GSM and CDMA operators were attempting to best the tariffs of each other. Until then, the CMTS (GSM) providers were satisfied by providing services to a small section of people at higher tariffs. This competition helped customers and played a significant role in enlarging the customer base. Also, during this period, some basic services operators had built up considerable CDMA/IS-95 infrastructure, and it was becoming clear that it would not be politically feasible or fiscally prudent to demand the dismantling of this already built-up CDMA infrastructure in this resource-starved country.

Attempts were made to get the CMTS and basic services operators to come together for a compromise. But things did not move, as neither party was ready for it. Finally, towards the end of 2003, the TRAI took the bold step (in the face of accusations of being partisan) of recommending the conversion of both CMTS and FTS license into a Unified Service Provider license. This would allow all operators to provide full mobile services (as well as fixed services if they chose). The Department of Telecommunications quickly accepted the recommendation. The CMTS operators cried foul; but they were offered incentives in the form of a proposal to allow an increase in the percentage of Foreign Direct Investment (FDI) in telecom operations, and political pressure was brought upon them to accept this new recommendation and to withdraw all lawsuits from the court. In December 2003, the imbroglio ended and all parties agreed to compete in the market. The GSM operators have grown, leveraging the global volumes and scales of economy that resulted in a lower cost of infrastructure. At the same time, the CDMA operators fuelled their growth by leveraging attractive services. Currently, the number of subscribers for both the technologies is as given below: [1,6]

33 Million	GSM / GPRS / EDGE
9.3 Million	IS-95 / cdma2000 / 1xEV

Table 2 gives details of subscriber base and ARPU of various operators. While both GSM and cdma2000 subscribers are growing rapidly in India, statistics indicate that the GSM subscriber base is expanding faster. On the flip side, fixed line telephony has been the casualty in India with none of today's operators focusing to make a viable business case out of it.

Operator	Subscribers (millions)	ARPU ($ per month)
GSM Operators		
Bharati	6.76	10.11
BSNL	5.25	—
Hutch	5.15	11.88
Idea	3.72	9.66
BPL	1.88	8.82
Spice	1.20	8.16
Aircel[4]	1.02	8.16
CDMA Operators		
Reliance	> 6.8	15.6
Tata	< 2	12 – 14.4
HFCL	0.03	—
Shyam	0.03	—
BSNL	0.80	—
MTNL	0.13	—

Table 2 *Cellular operators' estimated ARPU in 2003-04 [Ref. 7]*

States	Teledensity Jan 2004
Chhattisgarh	1.58
Bihar	1.59
Assam	1.97
Jharkhand	1.97
West Bengal	2.53
Northeast –II	2.57
Uttar Pradesh east	2.74
Orissa	2.81
Jammu & Kashmir	2.9
Northeast-I	3.16
Madhya Pradesh	3.76

Table 3 *States with low teledensity*

Year	1999	2004
GSM subscribers	1.6 million	29 million
ARPU (US $)	$24.93	$8.30

Table 4 *Story of India Mobile (GSM): increasing numbers and decreasing ARPU [Ref. 7]*

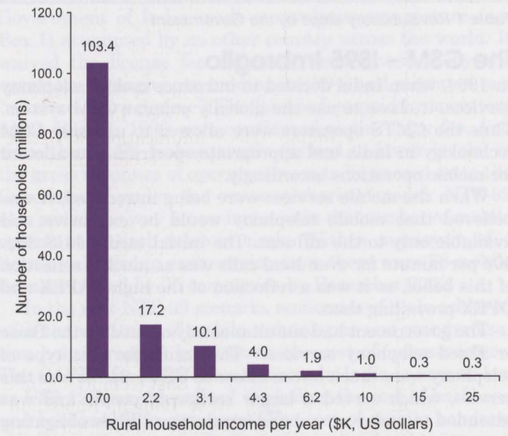


Figure 4 Income distribution of rural households in India [9]

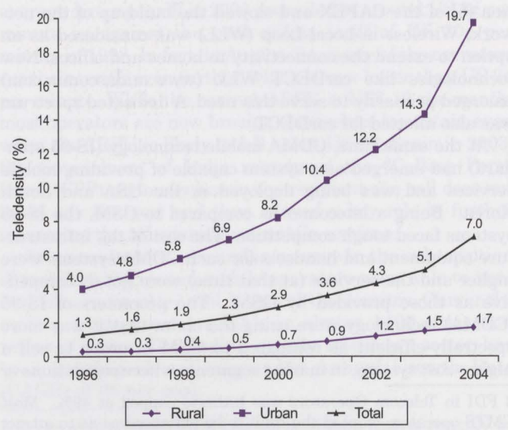


Figure 5 Urban vs. rural—widening gap in teledensity [9]

Growth: Urban vs. Rural

The telecom boom, which swept through the Indian telecom industry is predominantly urban in nature and has not addressed the needs or the opportunities in rural India. Also, the more developed and industrialised states have received the lion's share of the attention of the operators while the others have been relegated to lower priority. As a consequence, there is a huge discrepancy in the subscriber density of rural areas as compared to urban India.

According to the Indian Telecommunication Statistics, 2004 released by the Department of Telecommunications (DoT) of India, almost half of India, with as many as 13 out of the 27 circles have a much lower teledensity (the total number of telephones—wireline and wireless, per hundred population) than the pan-Indian average of 7.02 as on March 31, 2004 [8]. The telephone penetration per 100 inhabitants in these 13 circles ranged between 1.5 and 5. The teledensity growth in the less developed, predominantly agrarian states has been dismal.

Of the 27 circles in India, 11 circles, including Assam, Bihar, Jharkhand, Orissa, the North East (comprising of 6 states and union territories), West Bengal, Rajasthan, Madhya Pradesh, Jammu & Kashmir and Chhatisgarh account for a meager 6 percent of the total number of telephones (see Table 3).

In India, which is predominantly rural in nature, 741 million people (out of the total population of 1.027 billion), live in 638,365 villages scattered across the country. The rural GDP now stands at US$ 140 billion contributing to 24 percent of the national GDP. With 138.2 of the 191.9 million households living in rural areas, the GDP contribution is highly disproportionate. With an average of 5 people per household about 85 percent of households earning less than US$ 900 per annum, and with the per capita income at a modest US 50¢ per day, the majority of India remains poor to a large extent. 74% of rural households are in the low income bracket, earning less than US$ 700 per annum, 23.1% are in the middle income bracket earning between US$ 1,800 – 4,800 per year and a meager 2.9% are in the higher income bracket bringing home more than US$ 4,800 in a year.

Obviously, the ARPU supported is very low and the rural teledensity is languishing at less than 1.5 telephones per 100 inhabitants (see Figure 5). Further, the mobile coverage in rural India is limited to the periphery of towns and national highways. Interestingly, wherever coverage does exist, the number of mobiles has increased dramatically, often defying logic. But ARPU continues to be low, and operators have little incentive to increase the coverage. In fact, In India, the growth in number of subscribers and ARPU are inversely related, as is evident from Table 4.

Further, recent reports substantiate the fact that the growth in telecommunications is primarily driven by the urban consumers. There has been a dramatic increase in the teledensity of urban areas while the rural areas continue to languish, showing only marginal improvement in teledensity, as observable in Figure 5.

Fortunately, the state owned incumbent operator, BSNL, has more than 30,000 exchanges in the country, with about 25,000 being located in small towns and rural areas. Further, most of these exchanges are connected on a nationwide optical fiber backbone network. If mobile base stations are installed at each of these exchanges and a coverage radius of 10-15 km is ensured, most villages will be covered. While BSNL is continuously increasing its GSM coverage in this manner, the combination of low ARPU and high default in payments of mobile telephone bills have prevented large-scale expansion in rural areas.

How Far Will Mobile Go in India?

To address the serious issue of the high default rate on mobile telephony bills, which is as high as 20% for some

n-Logue Communications (www.n-logue.co.in), a Rural Service Provider in India, has been driving an effort to provide Internet kiosks in the villages of India. Capitalizing on the fibre already laid by BSNL to small towns, it uses the corDECT WLL system called to provide up to 200 Kbps dedicated connectivity. It helps a local entrepreneur to set up an Internet kiosk in the village and provide a variety of services. n-Logue is now experimenting with placing a GSM pico-base station on a mast next to the kiosk, backhauling the traffic through the IP connection provided by corDECT, and carrying out the soft-switching and interfacing with the telecom network at the town where fibre is located. It aims to get the kiosk operator to provide 50 to 100 GSM connections (second hand handsets are now available at a price as low as US $20) in a village; the kiosk operator would also service the customers, selling to the potential subscribers, registering them, carrying out billing and collections. The distance covered in the village would be about 2 Kms and no handover is contemplated (though the subscriber could go to the nearest town and roam). The idea is to make it work at an ARPU of US $2, with the local call charges close to US 0.5¢ (half a cent per minute) while not roaming.

Table 5 *Expanding Mobiles in Villages*

GSM	GPRS	CDMA
Portals Bollywood and local festival content Ringtone downloads Flash SMS Picture message	Browsing MMS picture download Wall paper download Polyphonic ringtone download Java enabled games Yahoo mail MSN m-banking Chat City entertainment Info Game replays Stock update	On-line bill viewing Java enabled games Ringtones Picture messages Movie clips Promotions Live news feeds Game updates Stock market updates
Yahoo Customized picture message		
Indiatimes Dating Polls		

Table 6 *Data services offered on Indian Mobiles [7]*

5 Some of the early GSM operators have been allotted 12.5 MHz + 12.5 MHz spectrum.
6 Recently acquired by Hutch at 223 Million Euros

operators, the operators have promoted pre-paid mobile subscriptions, where a subscriber buys a SIM card with advance payment to make calls. The pre-paid subscriptions (which grew at a rate of 27% in 2003-03 [7] have enabled fast expansion of mobiles in India. A subscriber can buy and use mobile telephony to the extent he/she can afford. But, the high overheads and handling charges have forced most operators to levy a minimum charge on pre-paid subscriptions also. Further, the call charges on pre-paid are often not as low as that in post-paid. This is stifling the growth in the pre-paid segment.

To better understand the limits of growth in mobile telephony in India, let us revisit to the household income data presented in Figure 4. Let us assume that a household will spend at most 3% of its income on mobile telephony. Thus an ARPU of US$ 7 per month is viable only for those households whose income is over US $3000 per year. There are only 53 million households whose income is this segment. Even assuming an average of two mobile telephones for those households with incomes above US$5000 per year, and one mobile for household with income between US$3000 and US$5000, the total mobile telephony will not exceed 82 million, and the total number of telephones (wireline and wireless) would barely reach 150 million.

To grow beyond that, the Indian telecom operators must serve the lower middle class in urban and rural India. Returning to Figure 4, approximately 44 million households have incomes between US$2000–3000. These households can be made consumers of mobile telephony, as long as operators can sustain their operations with an ARPU of US$ 5 per month. With the falling prices of infrastructure and with more innovative pre-paid schemes, these households could be added as subscribers in the next few years. The total number of telephones can thus reach 200 million!

However, as one moves beyond that, the difficulty increases. The bulk of urban and rural households have incomes between US$1000–2000 per year. The number here is large (86 million). Telephony spend by these households can not be more than US$3 per month. How does one cater to a market segment with such a low ARPU? Further, even at a tariff as low as US$0.02 per minute, the total talk time per month is only 150 minutes or 5 minutes a day. Would subscribers be satisfied with such limited talk time?

There are two possible solutions. The first is in the form of shared access. Back in 1987, operator assisted Public Call Offices (called as STD - PCOs in India) were introduced. An entrepreneur would set up such a booth on a street corner and provide telephone service the people living in that street. The booth was kept open for 16 hours a day, 365 days a week, and the PCO operator got 20% of the total call charges collected. It boomed into a big business with total number of such PCO being close to a million today, and earning close to 25% of total telecom income of the country till recently. An estimated 300 million people use these telephones regularly and no one need walk for more than 50 meters to access it. It is possible that such PCOs may offer even mobile telephony in future, with entrepreneurs going door to door to provide the service. The shared access could address these lower middle class households, but it would not provide personal telephony. The benefits of mobile, ability to be reached anywhere and ability to call from anywhere, would be denied to them.

The second options would be to innovate with the infrastructure technology as well as delivery of service business model, so that even an ARPU of US $3 per month become sustainable. Also, to make it attractive, call charges, especially in local area, may have to go down to less than US 1¢ per minute. Some work towards such goals is being pursued in India (see Table 5). If successful, it will enable mobile telephony to reach these 86 million households. with multiple telephones in a home, the total number of telephones in India could approach 500 millions. India is waiting for more such innovations. As the saying goes, "Necessity is the mother of invention"!

Content Portals	Content Developers
Yahoo India Indiatimes MSN India	Mauj Octoplus Phoneytunes Indiagames Paradox studios

Table 7 *Content portals and content developers in India [7]*

35 Networks on 900 MHz
11 Networks on 1800 MHz

Table 8 *GSM networks in India*

Mobile Data Services

With voice call charges and ARPU falling well below the global levels, the operators have striven to enhance their revenue by introducing a variety of data services on mobile phones. Short Messaging Service (SMS) is extremely popular in India, with as many as 40 SMS sent by an average subscriber per month. The total number of SMS per month thus already has exceeded a billion and operators derive 8-10% of their ARPU from SMS or Multimedia Messaging Service (MMS)*. Further Value Added Services (VAS) riding on SMS and GPRS/3G-1X as well as Voice Based Services (VBS) contribute to another 5-7% of total ARPU. Most GSM operators now offer GPRS and operators like Hutch, Idea and Airtel have introduced EDGE. All CDMA operators in India offer cdma2000 1xEV services.

The services offered by different operators are listed in Table 6. The primary services used are ringtone download (66% of downloads), operator logo download (17%), wall paper download (11%) and games download (6%). Nearly 80% of these services are on SMS platform, though GPRS and cdma2000 1xEV data services are beginning to be introduced.

Note: Applications based on WAP have not been successful till date. The attributed reasons are the lengthy download times and confusion over tariffs.

Almost 1 million games are estimated to be downloaded each day, 30% of which are Java-based games. Roughly half the games are free games, whereas the other half are games for which there is a charge for download. However, not enough local content is yet available for download. The platform is complicated by the fact that the billing relation exists only between the telecom operator and the subscribers, and the telcos tend to keep most of the revenue. For example, for ringtone and operator logo download from a website, an operator gets to keep 60% of the revenue. Sometimes for most services hosted by an application service provider, operator keeps 60-70% of the revenue. Operator keeps 80% of the revenue for SMS based TV polls and 75% of revenue for downloading a movie clip. For games, the developers get at most 35% of the revenue with the operators and content portals keeping the rest. Table 7 provides some of the pay portals and content providers in India.

Besides the data-based value-added services, voice-based service (VBS) is also used widely. Live commentary for cricket matches, live astrological broadcast, and live news are most in demand.

The fact that content developers and the portals, which host the content do not get significant portion of the revenue, acts as a damper to the new and local content developers. The content available is thus not as local as would be desirable. M-banking services are being offered by operators, specifically on GPRS and cdma2000. However, as of now, most subscribers are not confident about the security of the transaction; sufficient communication from the operators in this regard has not taken place. Data services integrated with enterprise solutions is still missing. Basic information services like train and bus time tables, train and flight or cinema ticket reservation, advertisement campaigns based on location (location-based services) are still in the nascent stage.

Internet access is being now offered both on GPRS (and EDGE) as well as on cdma2000 1xEV. It is now being increasingly used by subscribers to connect their laptops to Internet while they are travelling or are in the cars. However, as only a small fraction of mobile subscribers use laptops, its usage is limited. Yet for those who have laptops and travel, it's a great boon, especially since many business executives and officials in India travel in chauffeur-driven cars. Remaining connected and being able to work when stuck in a traffic jam means a lot for this section of people. The bottleneck is the data rate. GPRS/cdma200-1xEV provides up to 100 Kbps Internet connection shared by all subscribers in a sector. While during non-busy hours, with only a few sharing the connection, it provides reasonable data-rates, while during busy hours, the data-rate per subscriber goes down sometimes to the levels of 1-2 Kbps. The problem is likely to get more exasperating as more and more users start sharing the Internet access bandwidth.

Spectrum Issues and Future Services

One of the limitations in increasing data usage on mobiles comes from the limitation of spectrum available to each operator. As many as four or more GSM operators (see Table 10) and another four or more CDMA operators can co-exist in a service area. Each of the operators are allocated a maximum of 10 MHz (downlink) + 10 MHz (uplink) spectrum. As the eight plus operators would thus require a total spectrum of 160 MHz, the frequency allocation in India has become a big bone of contention. Table 9 provides the frequency allocation done in 2002. The problem has been that India has allowed for too many operators, as a part of opening up and the 240 MHz allocated for mobile communication is partitioned amongst too many operators.

The National Frequency Allocation plan committee is

Service	Uplink (MHz)	Downlink (MHz)	Remarks
Cdma2000	824-844	869-889	Originally reserved for WLL, now used for cellular
GSM	890-902.5 902.5-915	935-947.5 947.5-960	6.2+6.2 MHz allocation per operator Case-by-case allocation up to 6.2+6.2 MHz, May not be contiguous (chunks of 0.6 MHz)
Railways	889-890	934-935	Also serves as guard band between cdma and GSM
Cellular	1710-1785	1805-1880	10+10 MHz allocation, fourth operator in region If 800 MHz spectrum fully utilized, 5+5 MHz allocation (case-by-case basis)
WLL/TDD (corDECT)	1880-1900		TDD systems
WLL/TDD	1900-1910		Reserved for future allocation
IMT-2000/FDD	1885-2025 1920-1980	2110-2200 2110-2170	For future allocation (subject to availability) Initial allocation
IMT-2000/TDD	2010-2025		For future allocation (subject to availability)

Table 9 *Cellular/WLL Frequency Allocation in India [10]*

	Voice	SMS	Internet
Bit rate (Kbps)	2 x 10	0.300	40
Price per minute	100 p	30 p	40 p
Amount per Kbps (US$)	.001	.02	.0002

Table 10 *Revenue earning by an operator for SMS, Voice and Internet for some spectrum usage.*

Technology	PDR-DL MHz/sector	PUDR-DL	ST-DL MHz	PDR-UL MHz/sector	PUDR-UL	ST-UL /MHz	Sensitivity BS/MS
	(in Kbps)						(in dBm)
GSM/EDGE [1-3]	2368	236.8	600	2368	236.8	325	-104/-108 †
CDMA2000 [1,3]	500	245.76	64	*	122.88	*	-107/-111 †
1X-EV/DO [3-5]	1920 (2480)	1920 (2480)	480 (*)	122.88 (1440)	122.88 (1440)	176	*
1X-EV/DV [5-7]	2480	2480	1000	1440	1440	480	*
WCDMA [8]	400	400	*	400	400	*	-106/-110 †
HSDPA [5,9]	2880	2000	500	400	400	*	*
WiMAX [10-11]	3750	*	2100 †	*	*	*	*
Flash-OFDM	2400 (3600)	2000	1200 (2400)	1200 (1800)	800	600 (1200)	*
WiBro [12]	2044	1000	*	678	*	*	*

PDR-Peak Data Rate, PUDR-Peak User Data Rate, ST-Sector Throughput (with 1/1 sector reuse), DL-Down Link, UL-Up Link, BS-Base Station, MS-Mobile Station
* Studies ongoing/data awaited
† For lowest user rate

Table 11 *Summary of Capabilities of Alternative Technologies*

meeting (in 2004) to find additional spectrum for mobile telephony, especially for 2.5G and 3G services. With sufficient spectrum being unavailable, the policy has become contentious and both the GSM as well CDMA lobbies continue to fight each other, with a goal to reserve additional spectrum for their respective technologies.

In such a spectrum-starved situation, it becomes difficult for an operator to promote Internet services by providing larger spectrum for it. The comparative revenue that an operator earns today while providing SMS, voice telephony and Internet based services is given in Table 10. It is obvious that Internet can not be the operator's priority.

The Internet on Wireless can thus become a reality in India, only if more spectrum efficient wireless communication is available. It is believed that even the 3G mobile communication is not good enough. Therefore India is making a serious effort to examine the pros and cons of various technologies that may contribute to the next generation broadband wireless services (3.5G and 4G). Center of Excellence in Wireless Technologies (CEWiT) (http://cewit.org.in/home.html), Chennai is examining these from the point of view of India's requirement and has recently published a draft requirement [12]. The data capabilities of various new wireless technologies have been summarized by CEWiT and are presented in Table 11. It is yet to be seen whether these or other new technologies could answer the needs of India in providing the required voice and data services for the fast growing market.

Conclusion

To conclude, India with over a billion people, is a large market for wireless and mobile technologies. But the potential can be harnessed only if the services are made affordable. CAPEX as well as OPEX for Telecom operators have fallen rapidly over the years, making India one of the fastest growing telecom markets. The trend is likely to continue over the next few years. However, to expand beyond 200 million telephone connections, further innovations are required in terms of technology, as well as in business models. It is evident that such innovations are possible and likely to happen in the next few years. However, a continued thrust is required towards this.

It can be readily seen that mobile telephony has enabled a large portion of the middle and lower sections of the urban population to get connected. In the future, it will enable them to participate more fully in the economy, and possibly, improve their social and economic status. But the rural India continues to lag behind in terms of the benefits of such technologies. Further, with the current state of the economy in the rural areas, what is required is not just telephony, but also Internet access. This can enable the rural people to a very significant extent – access to education, training, and healthcare. Thereby it can enable them to enhance their livelihood. The developments of wireless technologies have already enabled Internet provisioning in many rural areas of India. As technology evolves, it should be possible to provide broadband Internet connections to each village. The challenge is to make it happen in a cost-effective manner, such that it can scale to all the 630,000 villages of India.

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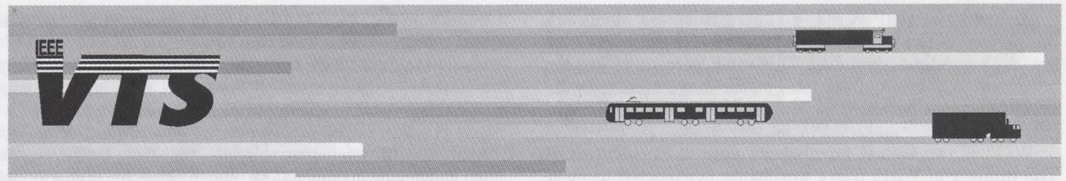

The New Wireless Frontier: Home and Vehicle Connectivity

Vladimir Rasin, Dave McNamara, Craig Simonds and Frank Perry, Ford Research & Advanced Engineering, Gary Streelman, Delphi Automotive Systems

Customers expect in their vehicles the same constant connectivity that they experience in their homes through high speed internet portals. New services based on these advances will be transparent and ubiquitous — completely integrated into our lives, just as electricity comes to the wall socket or water from the faucet. The Wi-Fi Radio implements this vision using Wireless Fidelity (Wi-Fi) based on the suite of IEEE 802.11 standards. Drivers have constant wireless connectivity and personalized digital content made available to them through the Wi-Fi Radio.

Ford and our partner Delphi developed the Wi-Fi Radio to overcome the inherent functional and packaging limitations of our vehicles, to quickly introduce new technology at affordable prices and to seamlessly integrate new services into the vehicle. We chose the radio as the integration site because the radio is accessible to every customer and affordable on every vehicle. In our vision, the radio serves as the access point for wireless connectivity.

The Wi-Fi radio with wireless, a flexible user interface and digital memory becomes a powerful, expandable and upgradeable computing & communications platform. The Wi-Fi radio design is flexible to quickly meet the customer's desire for new entertainment and eventually new wireless-based safety and security features. For example:

- *home connectivity to provide personalized content such as digitized music (downloadable MP3 files) and information*
- *eCommerce through connectivity with businesses*
- *and eventually new safety features enabled through Dedicate Short-range Communication (DSRC) such as vehicle-to-vehicle and infrastructure services – traffic, weather, construction and safety alerts such as highway closures, icy road warnings, etc.*

This paper describes why integration with the radio is a key strategy to enable the quick and rapid migration of technology, how the Wi-Fi revolution enables promising new services and the importance of "open software platforms" such as the Ford Vehicle Consumer Services Interface (VCSI). The VCSI is "middleware" or an Application Programming Interface (API) based on the Java programming language that enables the rapid introduction of new features.

The hardware/software design of the Wi-Fi Radio as developed by Ford and Delphi seamlessly integrates wireless and Ford's VCSI into an affordable and easy to use automotive radio. The vehicle and component integration challenges are presented:

- *hardware design integrates the 802.11 wireless chipset, digital memory and meets critical automotive requirements such as power utilization*
- *wireless reception using an automotive antenna design*
- *application of Ford's VCSI to demonstrate new services or features*
- *longer-range wireless and anytime availability presents new challenges, because the vehicle is constantly connected to external devices*

Through collaboration with Delphi, Lincoln has outfitted a 2004 Model Year Aviator sport utility vehicle (SUV) with Wi-Fi to showcase the future potential of wireless infotainment in the automobile. Ford has integrated the Wi-Fi Radio into a production Aviator vehicle to demonstrate the potential of integrating Wi-Fi and to characterize the available infrastructure. The Aviator represents the future of wireless technology in the automotive industry with the first application of Wi-Fi in a vehicle.

Introduction—The Wi-Fi Revolution

Wi-Fi is a high-speed digital technology primarily used today in homes, offices, and some businesses to provide an instant connection to the Internet without wires. The network standard uses radio waves to beam signals between Wi-Fi enabled devices such as a laptop or handheld computers. These devices at very high speeds (11-54 megabits per second) send and receive data indoors and outdoors, anywhere within a range of up to 300-ft.

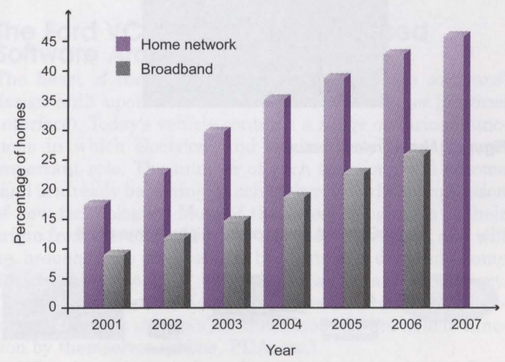

Figure 1 *Home network and broadband adoption trends*

According to NOP World of United Business Media [1], ten percent of the total public and one out of three PC owners have wireless capability. Thirty six percent of lap top owners (four percent of the total public) have accessed public hot-spots at hotels, businesses such as Starbucks, airports, etc.

Wi-Fi is the fastest growing wireless technology today. The number of Wi-Fi users worldwide is expected to more than triple, from 9.3 million in 2003 to 30 million in 2004, according to Gartner, Inc., a technology research firm in Stamford, Connecticut. ABI Research of New York projects that the number of global hot spots will increase from approximately 65 thousand in 2004 to more than 350 thousand in 2008. In 2002, there were about 4,200 hot spots in North America [2]. For 2008, ABI is forecasting over 150 thousand hotspots and 13,000 subscribers to those hotspots in North America.

The proliferation of wireless networking technologies into our daily lives means these technologies will soon enter the automotive environment as Wi-Fi hardware improves dramatically, i.e. hardware cost and power requirements. For example, Figure 1 describes the key trend of home wireless networks.

Today about twenty three percent or three percent of the total public have a wireless network at home being used primarily for internet access. The Wi-Fi radio is therefore the next step in the evolution from a device that only receives broadcasts to a wireless bi-directional transceiver for access to new services external to the vehicle. For example (Figure 2), these new wireless services available to the vehicle could include:

- download or transfer and store digital content such as music, audiobooks, calendar appointments, to-do lists, e-mail, contacts from a Wi-Fi enabled PDA, cell phone, laptop, and home PC.
- eCommerce - pay for a meal, a morning coffee, toll road and parking garage fees through a vehicle's radio.
- receive maintenance reminders from an auto dealership, schedule appointments, download navigation map updates or order vehicle accessories.
- and possibly in the future use the government sponsored road-side infrastructure to access real-time traffic, weather, construction and safety alerts such as highway closures, icy road warnings, etc.

The first new service developed for the Wi-Fi radio was home connectivity (see Figure 3). Home connectivity allows you to download music, audio, etc. directly from the internet access in your home or other locations and sends it directly to your vehicle radio where it is stored for your playback at any time. During the evening at your convenience, you can access the internet to obtain your digital content which is then wirelessly transferred to your vehicle's radio – ready for your drive the next day! Essentially, the radio becomes another device or computer on your home network. We expect the first new applications will be music and other audio information in the form of compressed digital files (MP3) transferred to the vehicle and have built our first Wi-Fi radio to implement these new features.

The future of Wi-Fi technology promises even more capability. For example, the auto industry, along with the United States Department of Transportation (USDOT) and the American Association of State Highway and Transportation Officials (AASHTO) are working together to determine the feasibility of a national roadside and vehicle Digital Short Range Communication (DSRC) infrastructure based on a variation of Wi-Fi technology.

DSRC is a general-purpose short range dedicated communications service that can support both public safety and private operations in roadside-to-vehicle and vehicle-to-vehicle communication environments. The proposed DSRC-enabled infrastructure would enable major new safety features that would also significantly change the way consumers receive news, weather, travel and other information in their vehicles.

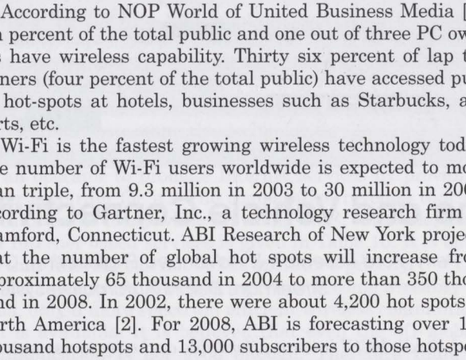

Figure 2 *New wireless features*

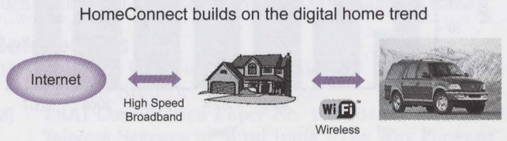

Figure 3 *Home Connectivity*

Wi-Fi Radio Design

The vehicle's radio has become the center of the vehicle's entertainment system (Figure 4).

It has evolved over the years from the early tube receivers to today's highly integrated multimedia infotainment systems. Today's radio receives information from the various one-way broadcast sources -AM, FM and more recently Satellite Radio. Our vision is that the radio becomes a highly capable computing & communications center to provide bi-directional wireless connectivity. The radio as the integration site for computing & communications leverages this prime interior real estate – the radio is accessible to every customer. Reliable and relevant digital content is made available to all our customers through a flexible, brand specific and upgradeable user interface.

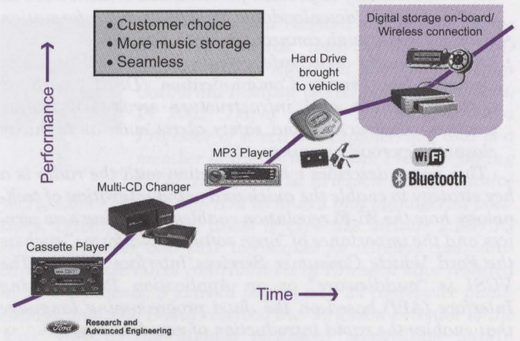

Figure 4 *The evolution of the radio*

The integration of Wi-Fi into today's radio impacts several areas of the radio design. The key elements of the design are:

Wireless integration – chipset and antenna
Memory storage for the digital content
User interface and software design

The complete integration of these key elements into the existing radio package of (2) DIN has the advantages of quality, weight and cost. We designed the radio so that the addition of Wi-Fi does not interfere with basic radio functions—media playback, AM/FM reception and the standard display and controls. The Wi-Fi chipset can be added as a plug in module for a quick upgrade of the chipset to the latest WiFi technology (802.X). The rapid evolution of Wi-Fi technology (Table 1) requires this flexibility.

The performance of the antenna is a key factor in the design. Ford and Delphi chose to take on the considerable challenge of developing an antenna integral to the vehicle to achieve the benefits of lower cost and ease of vehicle packaging.

Typically today's radios do not include digital storage media, therefore Delphi and Ford evaluated several digital media alternatives (Table 2) that included:

- flash or semiconductor memory, either built into the radio or as a flexible memory media as used in digital cameras
- a hard-drive adapted from the PC market, ruggedized for automotive applications

For the Wi-Fi application, either type of memory storage is appropriate, but it depends on how much music you would like to store on the radio. Our approach was to view the radio as temporary music storage and that the driver would keep their extensive music storage on their home PC, transferring music to the radio as needed. Therefore, the integrated memory requirements (and associated cost) were minimized.

The next consideration is the radio display. Most existing radios have a relatively small display designed to display limited information – radio station name for example. The advent of digital media (PP3 encoded CDs), satellite radio and now the Wi-Fi based services require a larger flexible display to present to the driver:

Song title
Artist
Album or program name
Genre or category for filing

The digital content, usually music, to be transferred to the vehicle will have additional information attached to each song. A larger display and associated controls need to be developed to allow the driver to navigate between "folders" containing the digital content. Folders are usually organized by the artist's name. The display used in the demonstration vehicle was three lines with 24 characters per line. Figure 5 is the photograph of the actual Wi-Fi radio as installed in the Aviator.

Lastly, the addition of wireless technology and Ford's VCSI required the micro-computer design to be up-graded (e.g. microprocessor capability and associated memory). The radio is fast becoming a very capable computing & communications platform versus a simple microprocessor designed solely to control the user interface and to switch various analog signals to the speakers. Selection of the appropriate micro-computer to anticipate the addition of new wireless based services is a key enabler to reducing development time.

	802.11b	802.11g	802.11a	802.11p
Primary Application	Wireless LAN	Wireless LAN	Wireless LAN	DSRC
Band	2.4 GHz	2.4 GHz	5.8 GHz	5.9 GHz
Max Data Rate	11 Mbps	54 Mbps	54 Mbps	27 Mbps
Range	100 m	100 m	45 m	1000 m

Table 1 *Wi-Fi Technology Standards*

Memory Type	Storage Capacity	Performance (Speed)	Durability
Semiconductor Flash	No limit	Best	Best
Compact flash	1.0 GB	Excellent	Good
MemoryStick Pro	1.0 GB	Excellent	Good
SD Card	1.0 GB	Excellent	Good
Hard Drive (HDD)	20-40 GB	Good	Temperature operation concerns

Table 2 *Digital memory storage alternatives*

Figure 5 *Aviator Wi-Fi Radio Display*

The Ford VCSI—New Service-Based Software Architecture

The heart of the Wi-Fi radio is the new "open software" design built upon Ford's VCSI (Vehicle Consumer Services Interface). Today's vehicle contains a range of various functions in which electrical and electronic systems play an important role. The number of such functions will become (and is already becoming) much larger with the introduction of new technologies. Most of these technologies have their origin from the consumer (non-automotive) market, and will be brought into the vehicle by customer demand. Some devices and modules will be installed at the factory. Customers will add others in the after-market. In most situations (though not always), these modules are able to function by themselves (phone, PDA, etc.).

When brought into the vehicle, the functionality of these devices could be extended, in which case they could become

part of potentially sophisticated use cases, providing the customer with a much richer selection of in-vehicle functions. These use cases are not always defined at the time of vehicle design. Also, these technologies evolve at a high rate, and it is difficult to know at design time, or even at manufacturing time, which particular technology or application the customer would like to use in his or her vehicle.

Every device represents one or more services, each of which may be a component of other more sophisticated sets of services available to the customer. The VCSI (Vehicle Consumer Services Interface) -in-vehicle software middleware designed by Ford Research & Advanced Engineering - provides the means to accommodate and control both factory and customer installed devices, ultimately providing an enhanced customer experience, and potentially creating new business models. Table 3 from www.webopedia describes in layman's terms that middleware is the important "software plumping" that connects two separate software products or applications.

The VCSI should enable Ford to synchronize the vehicle lifecycle with that of technologies existing outside of the automotive domain. The user will be able to bring new aftermarket devices into the vehicle, and use these devices as if they were part of the vehicle infrastructure, in cooperation with services provided by other devices. In this scenario, the vehicle is analogous to a personal computer, where Ford has control over the operating system and applications.

With Ford Motor Company's wide variety of vehicle models and platforms, we need to leverage the expertise of our suppliers to provide applications that bring rich services to our customers. The VCSI provides a software interface against which such in-vehicle applications will be written. The functionality available to applications depends on devices and modules presented in the vehicle and the services they provide, but an application written against

VCSI APIs will run in any vehicle equipped with the VCSI. This means that in principle, 'write once, run on all platforms' if implemented across the vehicle platforms would allow engineering resources to concentrate on 'What features should be in the vehicles' instead of 'How to implement them'.

Communication mobility requirements complicate a design of electrical architecture of an automotive platform. Mobile communications systems require a high degree of dynamism due to the variety of communications and applications protocols that might be required. In addition, an in-vehicle embedded platform has limited resources and any design must be capable of adding new required protocols, and removing those not currently needed. In order to meet the requirements of this sort of communications architecture, a service based component model is the optimal design.

A component can be defined as a self-contained software module that can be loaded into an existing infrastructure. A service component is one that has a well-defined single function set (coherent semantic meaning) that can be used by other software elements.

One advantage that Java software language has had in recent years is the ability to deliver code in a secure and reliable way to remote platforms. Part of this guarantee is based on a standardized byte code (Write Once Run Anywhere) and built-in security model. Even with this capability, certain infrastructure requirements (messaging, lifecycle, security, etc.) were not always available when code was downloaded unless that code came with its own infrastructure built in. Of course, this increases the code bulk and leads to duplication across multiple instances. Insuring that a service is composed of a minimal code set without any duplication requires the establishment of a standardized service framework. For the Java 2 Micro Edition (J2ME) Connected Device Configuration (CDC) platform, there are few choices for an open standards service framework. The framework chosen for the VCSI architecture was the Open Services Gateway Interface (OSGi) specification.

> Middleware is software that connects two otherwise separate applications. For example, there are a number of middleware products that link a database system to a Web server. This allows users to request data from the database using forms displayed on a Web browser, and it enables the Web server to return dynamic Web pages based on the user's requests and profile.
>
> The term middleware is used to describe separate products that serve as the glue between two applications. It is, therefore, distinct from import and export features that may be built into one of the applications. Middleware is sometimes called plumbing because it connects two sides of an application and passes data between them.
>
> http://www.webopedia.com/TERM/M/middleware.html

***Table 3** What is Middleware?*

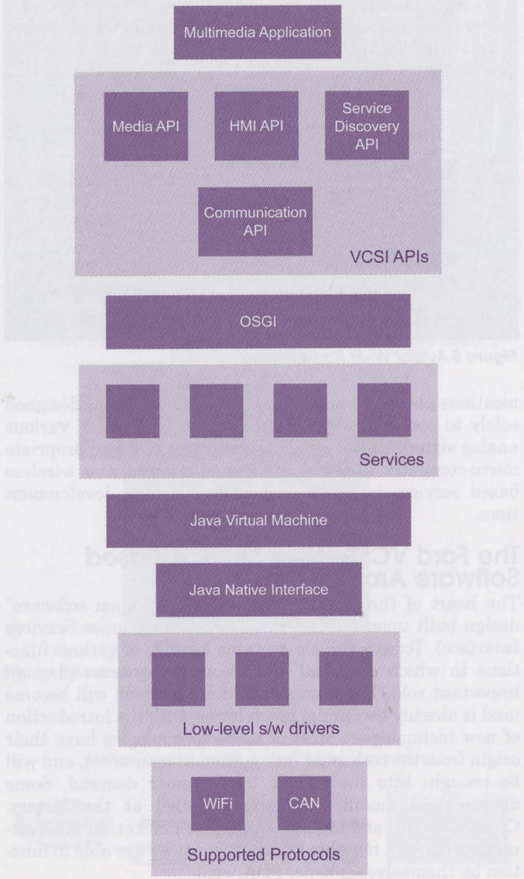

***Figure 6** Software Architecture Overview*

In the OSGi architecture, components are called service bundles. The OSGi service architectural paradigm defines two entities, an interface and an implementation. The interface is intended to be the means by which all users and developers refer to the public-facing aspect of the service. The implementation exists as a private entity providing a specific functional realization. This model uses the established object oriented best practices to hide/encapsulate the inner workings of the service. The advantage in this approach is that a wide variety of different functional implementations of a specific interface can be registered and used. For example, this allows for significantly different implementations of, say, a telephone service interface where there might be specific hardware implementations, or of one that is purely software (such as VOIP). The lifecycle of each service bundle has several operations: installation, start, stop, upgrade and remove. More details can be found in the OSGi documentation at OSGi www.osgi.org. Another important standard that influenced the VCSI's design is the Automotive Multimedia Interface Collaboration (AMIC). AMIC created a software specification that is similar to the VCSI in that it is also Java and OSGI-based. In fact, two VCSI APIs are adopted from the AMIC specification.

VCSI is a software infrastructure that defines an interface between applications and the underlying in-vehicle hardware and software environment. This interface has the potential to become standard across Ford vehicle platforms. VCSI includes a set of Application Programming Interfaces (APIs) (Human Machine Interface, Personalization, Security, etc.) that covers the wide range of multimedia, Telematics, and Infotronics applications. Core to the fundamental concept of the project is that every aspect of it from data to applications is highly dynamic. Figure 6 describes the VCSI framework and how this "middleware" works.

VCSI Application Programming Interfaces

Within the VCSI there are currently defined around twenty APIs that could be divided on core APIs (policy, security, resource management, etc.) and application level APIs (navigation, media, etc.). The choice of these APIs was based on the variety of use cases that were considered and against which the APIs were defined. New APIs can be added in the future as required to meet the growing demand for new features, such as a "streaming video" API. The VCSI infrastructure will provide a precise documented process for extending its own functionality as needed.

Communication API—responsible for interaction between the VCSI and the rest of the electrical infrastructure. In most cases it means communicating with something that resides outside of the automotive domain, for example server residing on the Internet, application on the desktop, accessible by short-range wireless communication, consumer device that is brought into the vehicle by customer, etc. It abstracts the media that is used for communication from the application. At the same time it provides a means for application developers to write and load their applications into the VCSI without compromising vehicle safety and security.

HMI (Human Machine Interface) API—responsible for interaction between the VCSI and user interface (UI) devices. It abstracts applications running in the VCSI from the knowledge of UI module and abstracts UI module from any knowledge about applications. HMI API flexibility facilitates easy upgrade of the vehicle functionality.

Personalization API—responsible for handling personalization information. It works with both user and system data. It abstracts an application from the data source (which could be an off-board server or a personal device such as phone or PDA). The Personalization API is agnostic to the media over which this data is delivered but defines the application level interface.

Policy API—responsible for management of policies in the vehicle. Policy generally defines the rule for how and under what circumstances the vehicle should function. Policy API could be leveraged in any aspect of the vehicle functionality as deemed necessary. It is a conduit for the implementation of business rules, safety and security regulations, etc.

- Resource Management API—double responsibility:
- Management of access to in-vehicle resources, including arbitration. Resources, in this case, represent services available in the vehicle for use by applications or other services.
- Handling and storage of applications/service configurations. Each service could be accompanied with its own configuration that could be changed at any time.

Security API—responsible for in-vehicle security infrastructure, and included as a part of overall security architecture. Security API covers three fields of in-vehicle security: security per user, security per application, and security per device.

Service Discovery API—designed to facilitate dynamic interaction of various services and devices in the vehicle. This API assumes the dynamic nature of many services in the vehicle that necessitates a mechanism capable of dealing with such services without prior 'hardcoded' knowledge about the implementation details of the services.

Although VCSI APIs cover a wide range of various applications it is not necessary to include all VCSI software interfaces in any particular implementation. The choice of APIs will depend on the kind of in-vehicle application to be supported and the requirements for this application, such as security.

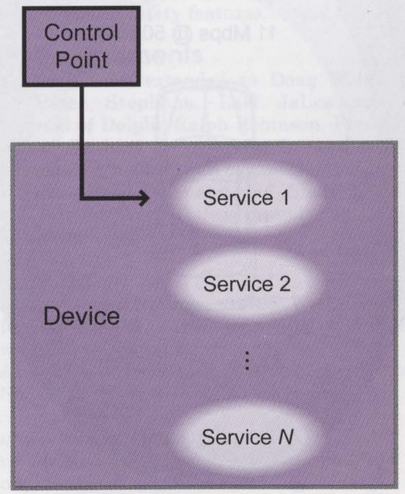

***Figure 7** UPnP Framework*

VCSI Application to the Wi-Fi Radio

The VCSI framework is the heart of Wi-Fi radio software design. The type of media over which this radio will communicate with the outside world is known but the applications and upper levels of protocols are not. It is close to impossible to predict at any given time what kind of application will be demanded by the customer. For example, a current application might involve a connection to a certain off-board server and the loading of content from this server into a Wi-Fi radio. This communication is done over an application level protocol, dictated by the server. To ensure the relevance of Wi-Fi radio in the future (at the time of production and after the vehicle is delivered) it should provide a way to incorporate other content providers and, therefore, another application protocols. In addition, current content provider uses Universal Plug And Play (UPnP) as a service discovery mechanism. There is no guarantee that the same mechanism will be required in the future.

All these considerations determine the subset of VCSI APIs used in this project. The choice of Media API is quite straightforward. Media API abstracts the application from any knowledge about the details of the underlying hardware and software that is used to deliver and present multimedia content to the customer. In particular, it allows for the easy replacement of drivers for a specific multimedia bus without affecting existing applications, and provides uniform access to the multimedia content.

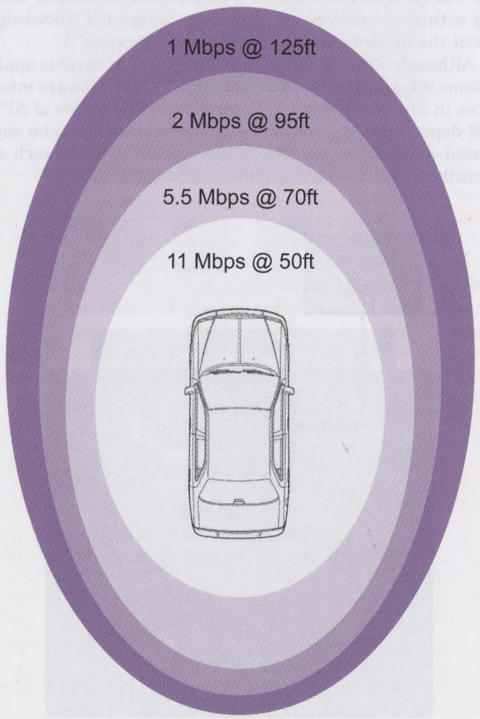

***Figure 8** Wi-Fi Coverage—Lincoln Aviator*

The user interface is obviously an important part of any in-vehicle infotainment system. The VCSI HMI API ensures that new user interfaces could be created for new applications and new content, subject only to physical limitations of user interface. New user interfaces will not require any changes in the software code in the radio and are based on Vehicle User interface Markup Language (VUML). VUML was created internally at Ford and is an extension of XML. The Wi-Fi radio contains a VUML engine that allows an easy HMI update by just loading new VUML data.

The VCSI Service Discovery API deals with services, and from the VCSI perspective every aspect of in-vehicle functionality is a service. Examples of such services include the door locking mechanism, voice recognition engine, or content available on the server over a wireless connection. The services may be provided by factory installed devices, by devices that will be brought into the vehicle by the customers, or through some other way. In the case of Wi-Fi radio, the service is provided by the server. Whatever the origin of the service, the Service Discovery API hides the specific details of service implementation.

The current implementation of Wi-Fi radio leverages Universal Plug And Play (UPnP) to interact with the off-board content provider and, therefore, the Service Discovery API is implemented using UPnP. The UPnP specification was developed to support automatic device and service discovery for various applications from a variety of device vendors. It provides a means for any device that supports UPnP to dynamically join any IP-based network, announce its presence to other participants on the network, including details of the service it provides (if any), and learn about the presence of other devices and services available on the network.

Bit Rate	Throughput (Mbps)	Transfer Time (sec)
1 Mbps	0.50	61.0
2 Mbps	1.00	30.5
5.5 Mbps	2.75	11.1
11 Mbps	5.50	5.5

***Table 4** Time required to transfer a 4Mb file at various bit rates*

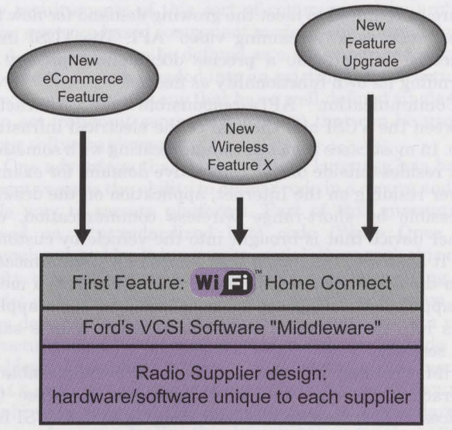

***Figure 9** VCSI flexibility*

UPnP leverages various Internet protocols and standards, such as HTTP, SOAP and XML. Such choice of protocols ensures that practically any device capable of supporting these protocols could become a part of the UPnP infrastructure regardless of its hardware and software implementation (such as what software development language was used to implement the service). There are three parts of UPnP architecture (Figure 7).

First, a UPnP device is any entity that implements protocols required by the UPnP specification. Every UPnP device contains zero or more services, where a service is a unit of functionality implemented by a device. Some of the services are defined/standardized by the UPnP Forum and some of them are totally proprietary. The UPnP Forum also standardizes the set of services that are supposed to be supported by a device of a certain type. The current Wi-Fi radio implementation leverages the content management service, defined by UPnP, but also contains some additional functionality (the decision of what kind of services to support in the VCSI based Wi-Fi radio is dictated by what services are available on the server side). Every service includes a set of methods or actions, each with optional input and output parameters similar to C programming language. The difference is that UPnP describes these methods in XML based language in a way that is independent from implementation.

The third part of the UPnP infrastructure is the control point. In terms of client/server architecture, the control point is the client and the device is the server. Control point can invoke the service methods available on the device, providing necessary inputs and receiving return values. It can also subscribe for notifications when the device state changes. In Wi-Fi radio implementation, the VCSI/radio is mostly a control point, and a server/desktop is a device. At the same time, in some cases the roles could be reversed, and VCSI could become a server when some information needs to be obtained from the radio.

Wi-Fi Vehicle— The Challenge of Vehicle Integration

The challenge of integrating the Wi-Fi radio into a production vehicle was undertaken by the Ford and Delphi team. A 2004 Model year Aviator was selected and the Wi-Fi Radio seamlessly designed into the vehicle for a production representative implementation. There were several challenges. The Aviator was produced with a (1.8) DIN radio with a different wiring arrangement than the (2) DIN Wi-Fi radio. Harness adapters were fabricated to address the wiring issues and a bracket had to be fabricated to mount the new radio. Fortunately, the Aviator Instrument Panel had enough space to fit the larger radio, although a new fascia had to be fabricated and painted to make the installation appear factory installed.

The fascia was created from the original piece of trim by removing unnecessary sections and adding a section of "ren" board. This addition completed the top portion of the radio opening and allowed us to create the curvature necessary to blend with the lines and curves of the production instrument panel and related trim. The piece was finished with silver-nickel paint that matched other center stack trim.

Another issue addressed was power conditioning and control. We developed a method for powering the radio independently to enable connectivity when the rest of the vehicle is powered down (key off). The last and most significant challenge was to package the Wi-Fi antenna with the radio in a way that provided adequate range and signal quality while keeping it out of sight. The antenna is packaged in the Instrument Panel to provide the needed range and signal quality. Figure 8 shows a typical reception pattern around the Aviator.

Conclusion

The Ford Research and Advanced Engineering team through collaboration with Delphi has developed and showcased the future of wireless infotainment. Ford has integrated the Wi-Fi Radio and streaming video into a production Aviator vehicle to demonstrate the potential of integrating Wi-Fi. The Aviator represents the future of wireless technology in the automotive industry with the first application of Wi-Fi integrated in the vehicle's radio.

The integration of Wi-Fi to today's radio impacted several areas of the radio design:

- Wireless integration – chipset and antenna
- Memory storage for the digital content
- User interface and software design

We have described in detail how the challenges of integrating these new technologies were addressed and the importance of an "open software" design.

The heart of the Wi-Fi radio design is the new "open software" design which is Ford's VCSI (Vehicle Consumer Services Interface). Today's vehicle contains a range of various functions in which electrical and electronic systems play an important role. Tomorrow, these new wireless features with their origin from the consumer (non-automotive) market, must be quickly and seamlessly built-in into the vehicle to meet growing customer demand. The VCSI is Ford's "middleware" that will allow us to quickly integrate these "consumer" features with quality (Figure 9). Eventually, new safety features enabled through new wireless technologies such as Dedicate Short-range Communication (DSRC) will enable vehicle-to-vehicle and road-side services. The VCSI is a key enabler to provide these exciting new entertainment and safety features.

Acknowledgements

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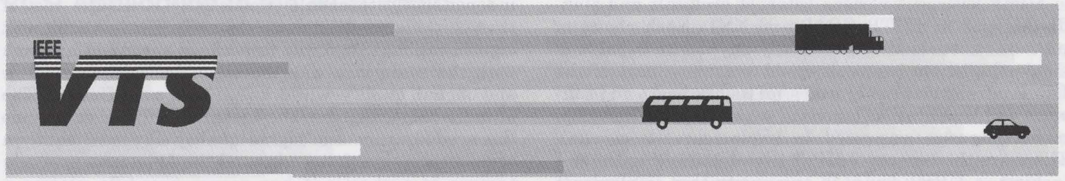

Plug and Play Personal Telematics

Axel Fuchs, Cogenia Partners, Chuck Spaur, Cellport Systems

This paper discusses the underlying connectivity architecture that enables the car maker to bridge the life-cycle between the automotive industry and the portable consumer electronics industry. Universal connectivity requires a physical link for communications, a link for audio, an external antenna connection, a power supply, and an adapter for secure device mounting. In order to link devices with disparate operating environments and physical link technologies, the connectivity framework includes a link independent communication abstraction, an application layer service advertisement and discovery protocol, mechanisms for service management, security, and software upgrades.

Introduction

Over the past two years a new trend in Telematics is emerging. Instead of adding functions to the car during the automotive design cycle, Plug&Play Personal Telematics consists of two parts, an in-vehicle Telematics Control Unit (TCU) that provides access to vehicle resources (e.g. HMI functions such as displays, audio, and buttons), and a portable consumer device that provides the compute power, the wireless connectivity, and the upgradeable memory for user applications. Powered by Moore's Law, portable consumer devices such as cellphones, digital cameras, and digital media players are doubling processing and storage capabilities every 18 month. In addition, the new market for converged devices is growing very fast. Converged devices combine wireless voice and data connectivity with the ability to run a variety of user applications, such as personal information management, media player (MP3, MPEG4, JPEG, etc), digital camera, et al. In Europe, Plug and Play Telematics is on track to outpace embedded Telematics in 2004, with more than 700,000 Plug & Play Telematics solutions shipped to vehicle line fit installs in 2003 and over 1.5 million expected to ship this year, making this segment the fastest growing in Telematics.

The Automotive Challenge

The key challenge of integrating consumer devices with the car is the disparity of life-cycles. Typically, a car is designed over a period of 4-6 years and is in use for another 10 years. In comparison, consumer electronics devices are designed in 6-12 months and are in use for 2-3 years. To make things worse, consumer devices are discontinued after one or two years on the market. Thus, the car companies face a difficult challenge in supporting consumer devices. Today, most of the portable device integration with vehicles provides a very limited enhancement for the consumer and centers on a better user interface for the voice service along with audio integration. But this degree of integration is already challenging as the following key aspects have to be considered:

Power—Throughout the history of portable devices, power management has been and still is a primary concern. Given the increased connectivity and compute power of converged devices, it makes a lot of sense to charge these devices while they are used or stowed away in a vehicle.

External Antenna—The ever-increasing connectivity with WiFi, Cellular, Bluetooth, GPS, etc. will work better with the car environment if there is an external antenna. In addition, many carmakers are worried about the impact of the multi-spectrum radiator on their mission critical wired car-networks.

Audio Integration—Most hands-free solutions today have to deal with arbitration of multiple audio sources that are competing for the single output to the driver. The driver may listen to a radio source, when a phone call comes in, which again might have to be interrupted for a turn instruction from the navigation system. In addition, media player capabilities require the transmission of high-quality stereo audio signals to the vehicle.

But future portable devices have much more to offer. A new generation of portable devices, called "converged devices", a term that captures the ever increasing number of functions that are bundled in a single device. Such devices aim to solve the need to carry a mobile phone and a pen-based handheld or a mobile phone and a pager. Converged devices also include an expanding list of applications, such as voice calling, multimedia messaging, e-mail, personal information management (PIM), digital image capture, playing digital encoded music files, playing single-player and connected games, etc. Driven by the need for connectivity, these devices all have some sort of enhanced networking capability, which includes a primary and a secondary communication link. The primary link is typically the main communications link of a cell-phone such as GSM or CDMA. The secondary link may be based on wired and wireless technologies such as RS232, USB, Bluetooth, or IEEE 802.11. If a car maker wants to integrate those increasingly popular digital appliances, additional challenges arise:

Connectivity to the Car Systems—A key motivation to connect portable devices in the car is human-machine-interface (HMI) integration. Legislation is driving "hands-free" functionality that goes beyond hands-free audio. Integration with the vehicle's speech recognition and text-to-speech capability as well as access to buttons, controls, and displays will be a key requirement. In addition, adding on vehicle environment specific capabilities such as GPS, odometer reading, diagnostics, etc will be required by applications running on phones. Already, Motorola has shown with its phone based navigation system ViaMoto, that this need is justified even today.

An important factor is the choice of the connectivity standard. Today, wired systems use mostly simple serial lines and the wireless integration is done via Bluetooth. Based on the roadmap presented above, USB should be considered as well. USB is a very stable and backward compatible standard in the PC industry. On the wireless connectivity side, is Bluetooth enough? Already, Bluetooth is not able to stream decoded stereo audio data (PCM stream), let alone streaming video to remote displays. Many industry analysts forecast that Ultrawideband (IEEE 802.15.3a) technology will eliminate Bluetooth in portable devices starting in 2006.

Supporting Distributed Applications—Today's portable device integration solutions can't leverage the low-cost/high volume benefit of the portable device for car integration. Resources are distributed between car and portable device and can't be used in each system. Looking at the consumer electronics industry today, we will find that multiple application environments are established. Qualcomm is very successful in rolling out their BREW environment, while PalmSource and Microsoft are fighting over the PDA market. Many devices and wireless carriers support SUN Microsystem's Java programming environment. The problem is that the automotive industry can not live with just supporting one mechanism. Therefore a standard "wire-level" messaging protocol (like the AMIC VSI specification, see [5]) and the ability to update the firmware of the communication interface to accommodate newer consumer devices should be defined.

Data Synchronization—Another key aspect of a converged device is its ability to share information with the home or office PC and other devices, see [6]. This includes the ability to download data to local storage (like music files), run applications and store user data that reaches beyond personal information manager capabilities. The portable device is able to serve as "personal storage" device. Today, people synchronize their address books with their PC PIM software. Why would it not also make this information available to the user interface in the car? In addition, personal settings like seat or mirror adjustments and the driving log could also be stored in the portable device.

Security and Quality Management—Bringing in consumer devices poses a significant security threat to the car makers. Examples of misusing the open Bluetooth standard by making phone calls on someone else's bill ("Blue-Jacking) have shown that this problem exists today without integration with the vehicle. In addition, mobile phone carriers can't monetize the secondary link of the portable device because external resources can't be controlled with software security. Without security mechanisms, any business model for portable device integration can't be protected. Finally, without resource protection, the functional integrity between validated portable devices and the automotive electronics can't be guaranteed and connected portable devices can expose the car to attacks.

Consumer Choice—Without an open application environment and adaptability to new communication interfaces such as Bluetooth, WiFi etc, and resources such as GPS, Flash Memory, etc., the consumer choice will be limited. Without universal software connectivity, consumers can't choose their portable devices independent from their cars.

The New Connectivity Approach

It is clear that automotive electronics can't follow the consumer electronics trend of ever increasing computing and storage performance, agility in connectivity, ability to store and share information at the cost of a consumer device. So the over-arching question is: what can car makers do to integrate these devices in cars?

Clearly, universal docking solutions address many of the challenges on the hardware side. But it does not provide the consumer with the upgrade choices that they would like to see on the automotive side. Therefore we propose to consider a solution that includes a third port, the accessory interface port. The idea here is that the consumer can add on consumer electronics accessories that enrich the overall features of the distributed electronic system. Figure 1 shows the layout of such a new Plug&Play Telematics concept, which includes a portable device port, an accessory port, and a vehicle interface port. Physically, the accessory port can utilize widely adopted consumer electronics standards, such as PCMCIA or Compact Flash. A wide variety of accessory solutions are available for the mobile device market that could be directly leveraged by the automotive community for non mission-critical applications. Finally, the vehicle interface port has to be adapted to the specific vehicle. The Plug&Play TCU manages the communications and the resources that are available either in the portable device, the attached accessory, or the vehicle electronics. The Plug&Play TCU also serves as secure gateway between the mission-critical car functions on the vehicle interface port and the consumer oriented add-on functions on either the portable port or the accessory port.

Wireless communications to the portable device, such as Bluetooth, WiFi or UWB, render a wired integration optional and allow the car maker to enable more portable devices to communicate with the car than could be provided cradles and wiring harnesses. But in this scenario, the

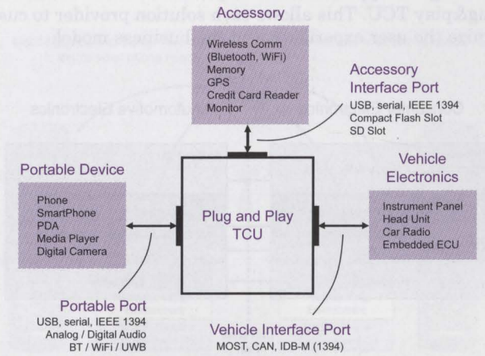

***Figure 1** Plug and Play Telematics*

need for a secure software oriented connectivity framework becomes even more important.

The AMI-C vehicle services interface specification is a step in the right direction, but it doesn't completely address the issues of integrating portable devices as it focuses mostly on the vehicle interface port.

The following requirements for a connectivity software can be stated:

1. *Communication link independence:* As portable devices may connect via various link technologies, the Plug&Play TCU software environment must provide applications with communication link independent communications interfaces. Current hands-free solutions based on the Bluetooth standard suffer from a serious limitation, because all Bluetooth profiles assume that the underlying link technology is only Bluetooth, but don't work over other wired or wireless link technologies, see [4].

2. *Service Discovery and management across multiple devices:* To leverage the increasing compute power and connectivity of portable devices, applications in the car must be able to discover and use remote resources. A further consideration is the volatile nature of resources. As portable devices may be connected or disconnected, the application needs to recognize the change of status and modify operations accordingly.

3. *Independence of S/W operating environment:* It is unrealistic to assume that all cars and portable devices will share the same application environment. Therefore, the connectivity framework needs to function within many environments such as BREW, Windows.Net, Java MidPi, or OSGi.

4. *Upgrade of functionality:* Upgrading functionality in cars is a difficult proposition. Yet, upgrading software in connected portable devices securely, has been solved with Qualcomm's BREW and Sun's Java J2ME Environment. Thus the task is now to extend this functionality to the Plug&Play TCU.

5. *Resource and link security:* Specific consideration has to be given to securing the link to the car and the resources that the car or the portable device may provide to each other.

6. *Customization:* It would be a great achievement if the entire industry would agree on a single standard for portable device integration. But the history of application level vehicle communication and wireless messaging protocols has shown that this is not achievable. Instead, we propose to only define certain minimum functionality as a messaging standard and allow for customization by customizing the application in the portable device and in the plug&play TCU. This allows each solution provider to customize the user experience and the business model.

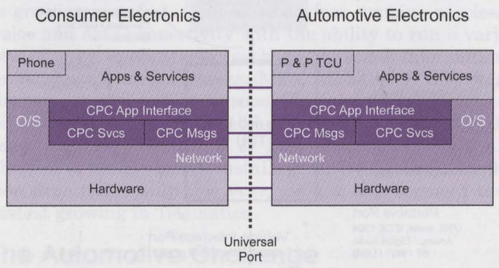

***Figure 2** CP-Connect Integration in Software Stack*

CP-Connect Software Framework

Cellport Systems has developed CP-Connect, a distributed software framework that addresses all the requirements for portable device integration that we have stated above. This software framework needs to live in the portable device and in the Plug&Play TCU. Figure 2 shows how the CP-Connect framework fits into the overall software stack. CP-Connect assumes that an operating system with networking capabilities exist for the target hardware. CP-Connect (CPC) then manages the interaction between

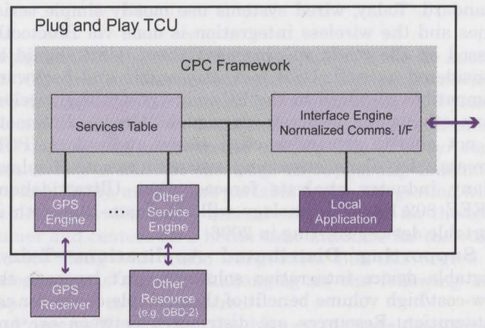

***Figure 3** CP-Connect Framework*

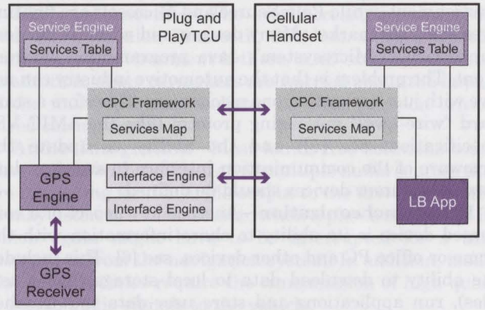

***Figure 4** CP-Connect Location based Service Example*

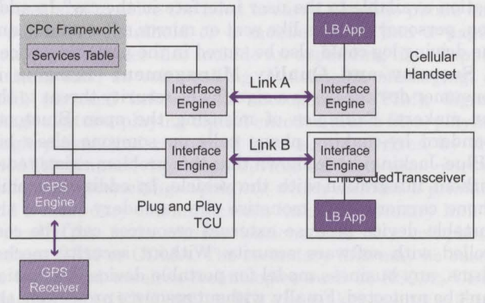

***Figure 5** CP-Connect with two Communication Resources*

devices with CPC Messages and CPC Services. Applications on each device interact with CP-Connect through the CPC Application Interface.

The CP-Connect Framework consists of three major components:

1. *Interface Engines* remove communication link technology dependence such that applications can utilize or provide services in the same manner, regardless of the connection technology

2. *Service Management* lets applications securely discover, share, and access distributed resources.

3. *Service Engines* make resources available to the *Service Management* and handle the specific application messaging with local and remote applications.

Even though standard message sets are desirable, this framework also allows applications to use proprietary messaging and service features. The messages are tied to the service engines and can be upgraded and changed as new devices and features become available. Thus, each vendor can choose which application messages and protocol scheme they want to advertise to the CP-Connect Framework. In addition, Service Engines can restrict access to resources and ask applications to provide the appropriate security credential(s).

Interface Engines can support a wide variety of communication links and allow remote applications to access local services. Conversely, Interface Engines also enable local applications to access remote services. In either case, the Interface Engine presents a communication pipe and functions as a proxy for the remote service or application. More capable Interface Engines may utilize descriptive parameters to select the appropriate communication channel. Typical parameters can be type of channel, communication cost, available bandwidth, and latency.

Figure 3 shows a Plug&Play TCU with the CP-Connect Framework, a GPS-Receiver (resource) and Interface Engine, and a Local Application that can utilize the resources.

In order to further demonstrate the flexibility of the approach, the following example in Figure 4 shows a location based service application that runs on a cellular handset, which does not have a GPS receiver to obtain a position periodically. In this case, the location based phone application (which could be turn-by-turn navigation) interfaces with the CP-Connect framework on the Cellular Handset. The CP-Connect Framework establishes a communication link to a remote CP-Connect framework that is hosted on a Plug&Play TCU. The remote framework has access to its GPS Engine and makes this resource available to the Cellular Handset through the Interface Engine. Thus, the Location Based Application on the Cellular Handset can use the remote GPS as soon it is connected to the Plug&Play TCU.

Please note that in this setup it doesn't matter what operating system each component is using as long as CP-Connect is ported to both environments. Because a remote application uses the vehicle's GPS information, the GPS engine may require the Location Based Application to authenticate itself and to provide the appropriate security certificate.

In Figure 5, we demonstrate how a GPS Engine can serve two applications that may be connected through two separate communication links. In this scenario, a location based application on a cellular handset and a location based application on an embedded transceiver are requesting information from the GPS resource. The CP-Connect Framework handles both communication links and can therefore arbitrate and grant resource access to a variety of applications.

Provisioning of Applications

In order to provide a secure environment and in order to upgrade functionality in a connected device, consumers cannot be allowed to install and configure applications on their own. Instead, a provisioning back-end is needed that can install, configure, upgrade, and retire applications securely. Figure 6 shows how this is done for portable phones. The user selects an application from a menu and asks the provisioning server to enable this application or service. The provisioning capability in the programming environment (e.g. BREW or Java J2ME) negotiates with the provisioning server, what capabilities and applications are needed. This could include the entire CP-Connect framework, certain Interface Engines, or certain Service Engines. Then, the Provisioning Server authenticates the device and delivers what the device needs and automatically installs it on the device. After the software is installed, the new application becomes available. In Figure 6, a customized hands-free application has been downloaded.

Further consideration is given the concept of extending the provisioning environment into the Plug&Play TCU. Thus, the vehicle services engines can also be updated and adjusted to new consumer devices.

Conclusion

This paper discusses a novel and very flexible approach to bridge the lifecycle disparity between consumer electronics devices and automotive electronics. Key considerations are an upgradeable Plug&Play Telematics Control Unit and a software framework that enables applications to share and access distributed resources.

Applications can utilize resources in the phone, the Plug&Play TCU, attached accessories, over the vehicle interface, or a from a remote platform. Interface Engines remove communication link technology dependence and allow applications to utilize or provide services in the same manner, regardless of the connection technology.

This approach will help the automotive industry to maintain quality control by only granting authorized applications and devices access to the vehicle resources. It will also allow the car makers, carriers, and portable device makers to monetize the secondary communication link of mobile phones. Car makers will be able to provide

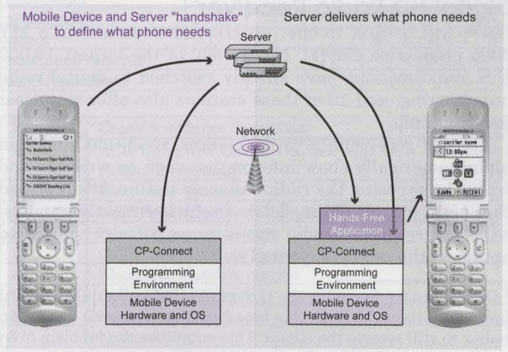

***Figure 6** Application Deployment to Mobile Device*

customized applications for vehicle integration that could be made available through the wireless carrier's infrastructure. Thus, new and exciting applications and features can be rolled out without the need for a standardization process. Further, third parties can create new mobile applications that are much better integrated with the vehicle infrastructure. Because all applications are managed from the provisioning backend, security and quality can be maintained at a high level.

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Definitions, Acronyms, Abbreviations

Application: A software process providing functionality beyond the basic capability of the operating system. Application is a generic term that includes Service Engines and Clients.

Client: An application utilizing resources via the CP-Connect Framework.

CP-Connect or CPC: Cellport's Connectivity Framework.

CPC Client Interface: CPC Framework interface utilized by applications to discover and access advertised services.

Interface Engine: CP-Connect process that enables access to remote services for local clients, and

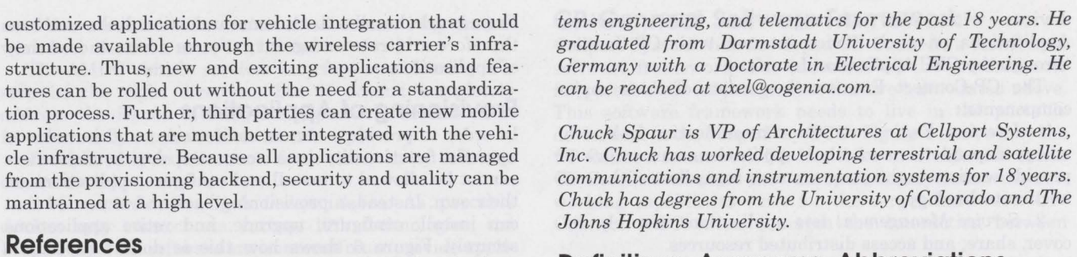
OS or O/S: Operating System

Remote Service: A service running on a platform distinct from that of the Client.

Service Engine: A software process that advertises one or more services.

TCU: Telematics Control Unit

USB: Universal Serial Bus



Automotive Electronics

Bill Fleming, Senior Editor

BMW 7 Series to Offer Digital HD Radio Receiver

BMW will be first to offer an HD radio receiver in a MY 2006 production car [1]. Nearly 500 of the largest 13,000 U.S. radio stations have already switched to digital radio broadcasting, and 19 of these stations also offer simulcast programming.

Digital receivers provide clearer reception and can alphanumerically show information such as weather and traffic by pressing the radio's display button. It's reported that eight brands (30 models) of vehicles (mostly imports) will feature digital radio receivers as a factory-installed option in the next few years [1].

Fractal Antenna Supplier Has Big Plans

Advanced Automotive Antennas, Barcelona, Spain, forecasts sales of its fractal-based antennas to increase from 15,000 units in 2004 to more than half a million in 2007. Fractal antennas feature a self-repeating geometric design that enables much smaller packaging and the reception of multi-band broadcast signals. They debuted on 2004-model-year Fiat, Peugeot and Citroen models in Europe [2].

The antennas are one-sixth the size of traditional external monopole units; e.g., they are only 2.4 inches long vs. the industry monopole average of 15.7 inches. This allows fractal antennas to be integrated within existing components such as inside and outside rearview mirrors, spoilers and high-mounted rear brake lights, eliminating the need for separate external antennas. PSA and Fiat feature miniature AM/FM antennas, along with tri-function antennas that bundle AM/FM, GSM and GPS functions. These antennas will be available on several additional vehicles beginning in MY 2006. Advanced Automotive Antennas says the size and performance benefits of its technology should eventually help to make fractal technology an industry standard for antennas [2].

[1] Digital radio schemes in the U.S. maintain compatibility with their old analog broadcasting schemes, using an approach known as "In-Band On-Channel." With this broadcast method, both analog and digital signals are sent on the same channel, allowing older analog radios to still receive the signal. This simplifies the problem of frequency allocation, since existing radio broadcast channels can be used simultaneously for digital transmissions. For further details, see the article 'AM & FM's Digital Conversion: How HD Radio™ Will Spur Innovative Telematics Services for the Automotive Industry' in the first issue of the IEEE VT Magazine.

By 2010 Software will Account for 13% of Vehicle Cost

For engine control alone, the volume of software code count doubles every three years. It's gone from 250K lines in 2000, to 500K in 2003, and to 1M-lines in 2006. According to Siemens VDO's CEO, John Sanderson, "by 2010, software will account for 13% of vehicle cost [3]."

The V6 engine developed for the 2006 Chevrolet Impala illustrates the impact of software. GM used a software math model to create a "virtual" fuel-quality sensor (that detects alcohol in fuel), thereby eliminating need for a physical sensor [3].

Army Tests Wireless Sensors as Vehicle Inspectors

The U.S. Army is investigating whether sensors and IBM Corp. middleware can replace humans as inspectors of military ground vehicles. So far, it appears, the Army likes what it sees. The vehicles' embedded sensors send signals wirelessly from the field to IBM middleware in central locations, to remotely diagnose repairs and determine the need to replenish fuel and ammunition [4]. [Note, "middleware" is defined as, "a database management system that supports the application and development of data delivery processes"].

Troops today have to make in-person inspections of their vehicles, sometimes in combat areas. Embedded sensors in the vehicles will relay information via wireless networks to computers in trucks that transport and replenish parts from various locations. With this approach, the Army will be able to automate what is now a labor-intensive chore. The goal is to eliminate the monitoring of vehicles for failures and ordering parts using pencils and paper and clerks at a desk. Ultimately, the process would be fully automated and will join the Army's Common Logistics Operating Environment.

Last year, IBM announced its Sensors and Actuators Solutions initiative, a $250 million investment over five years. "We have 1,000 people across IBM working on these solutions and three IBM test centers in Tokyo, France and North Carolina," said Robert Mayberry, vice president of Sensors and Actuators Solutions. The above work done with TACOM extends the role of IBM's Business Consulting Services Group in helping the Pentagon develop a policy for the more than 43,000 defense suppliers who will be required to deploy RFID tags on new equipment supplied to the Army [4].

Bosch's Speeding Reminder/Warning

Robert Bosch GmbH has a device that may keep lead-foot drivers out of trouble with the law. Bosch has developed a road sign recognition system, which uses a CMOS camera placed below the rear-view mirror to survey the road ahead. An onboard image recognition system is programmed to identify speed-limit and other traffic signs. The reminder system is set up with a black-and-white video display of the road ahead, with the road sign highlighted in color. Once identified, the vehicle gives audible notification to the driver, e.g.: "Speed limit, 50."

The system notifies the driver each time speed limits change. The device could be handy in city traffic, where limits frequently change. It can also be programmed for a customer's preference. For instance, a visual notice can be given to the driver, rather than an audible one. The system can be programmed to notify the driver only if the vehicle is exceeding the speed limit by 5 mph or 10 mph (8 or 16 km/h). The Bosch system recognizes both round European speed-limit signs and rectangular U.S. signs. Bosch says their CMOS cameras possess high dynamic range, allowing them to work equally well at night or during the day [5].

Types of Crashes Addressed by Avoidance Technologies

In reference to a NHTSA Request for Information [6], CAMP (Crash Avoidance Metrics Partnership), which includes GM and Ford Motor, submitted a response [7]. In their response, to identify safety problems that vehicular crash avoidance systems will address, CAMP used NHTSA's NASS-GES data. [NASS-GES is the National Automotive Sampling System - General Estimates System, and it includes all U.S. police-reported crashes]. This database included records for the 6.3-million crashes that occurred in 2003.

CAMP next mapped (cross referenced) all crash avoidance systems that are currently in production or are under development for future deployment, to the types of crashes that each system would address. Their results — taken from p.7 of [7] — are shown in Table 1.

Also seen in Table 1; although crossing-path crashes are common, they aren't addressed by any of the crash avoidance systems which are listed there. Other future Initiatives, such as the Cooperative Intersection Collision Avoidance System, and the Vehicle-Vehicle Communication, are being developed; and will address the avoidance of crossing-path types of crashes [7].

LED Headlights Forecast for 2008 Introduction

Hella has developed a prototype LED headlight that includes a dynamic cornering feature with no mechanical components. The lamp's LEDs are switched on electronical-

GES Data		Crash Avoidance and Related Safety Systems								
Crash Type	freq.	A	B	C	D	E	F	G	H	I
rear-end	29%	X				X				
crossing path	25									
off road	23			X	X		X	X		
lane change	9		X	X			X	X		
animal	5					X	X	X		X
opposite direction	2									X
backing	2								X	
pedestrian	1					X	X	X		X
pedalcyclist	1					X	X	X		X
object	< 1					X	X	X	X	X
untripped rollover	< 1						X	X		
other/undefined	3									

System	Crash Avoidance Operation
A	ACC (Adaptive Cruise Control) and FCW (Forward Collision Warning)
B	Blind zone warning
C	Lane departure warning
D	Lane keeping assistant
E	Collision mitigation by braking
F	Electronic stability control
G	Roll stability control
H	Backing warning
I	Night vision

Table 1 *Types of Crashes Addressed by Avoidance Technologies [7]*

ly, and scatter light with the aid of specially designed plastic lenses (called 'Cartoval lenses'). A cornering light is housed in the headlight as a separate module in the lower part of the front bumper. Four Cartoval plastic lenses, arranged next to one another, are aligned in different directions; and different switch-on algorithms can be realized using electronic controls. The four elements can be individually switched on or dimmed depending upon speed and steering angle [8].

Hella's prototype uses standard LEDs which were developed for automotive applications in cooperation with Stanley Electric. Five plastic-lens modules in the upper part of the headlight produce the low beam, two additional modules positioned vertically on the outside of the headlight form the high beam, and two standard LEDs together with dimmed high-beam modules produce a daytime running light. LED headlights are expected to provide lighting brightness equal to Xenon headlights when they become available in the U.S., expected in 2008 (later in Europe, due to European regulatory barriers) [8].

LEDs draw 80-percent less electrical power than incandescent lamps, and turn on nearly 250-ms faster to provide earlier brake-light warning. However, LED lighting presently produces only about 30 lumens/watt, and this is just a third of that available from HID lighting. Additionally, LEDs are expensive, costing about twice that of premium HID headlights [9, 10].

Cadillac offers live TV system

General Motors has taken the first step toward bringing live TV programming to every full-sized SUV it sells in the United States. KVH Industries Inc. (Middletown, R.I.) said it will begin offering its TracVision automotive satellite TV system as a dealer-installed option on the 2005 Cadillac Escalade and SRX — the first offer of its kind [11]. The cost: about $3,000.

Cadillac expects to sell about 2,000 Escalades and SRXs equipped with the system in its first year. The system consists of a receiver and a roof-mounted antenna that can pick up channels from DIRECTV Group. Access to DIRECTV requires payment of a monthly fee, which in turn provides 125 channels of TV programming, including 36 channels of commercial-free music. "You get the full DIRECTV programming. You can watch ESPN, the Starz movie package or Bloomberg." It's thought that this has a more universal appeal than entertainment systems "for kids in the back seat of the minivan."

An on-vehicle antenna, capable of receiving both TV, internet, and Wi-Fi signals; is available from RaySat Inc. [12, 13]. The antenna is fairly large (approximately 1 x 1 x 0.1 m3), weighs 45 pounds, and is currently best suited for mounting atop an SUV-like vehicle. The antenna itself, a hybrid design, is inside a disk-shaped radome. The antenna is motorized to allow it to continuously steer in the azimuthal (horizontal) plane and also electronically (via phase-shift elements) steer in elevation angle towards the transmitting satellite. The antenna can download internet data at 2 Mbps, and upload data at 128 Kbps. Since it communicates via satellite, it can be used in remote areas where cellular and land-line connections aren't available. Presently, this antenna costs about $2000.

Technology Turns Cars into Mobile Warning Systems

BMW group is running three research cars in Munich to prove that the cars' telematics systems — known as, Extended Floating Car Data XFCD — can be used to turn the vehicles into mobile sensors that automatically and instantly report to a traffic control center. All the cars needed were a small software upgrade [14].

In another related program, DaimlerChrysler is pursuing FleetNet, which uses several computer-equipped Smart cars as test vehicles. A tiny two-way radio antenna for the network is mounted on top of a Smart's rear hatch. A data collection center gets information from the test cars that include:

- Location
- Direction of travel and speed
- Operation of the brakes (and whether the antilock system has been activated)
- Dynamic suspension controls
- Rain sensor and wiper activity
- Hazard lights usage
- Outside temperature
- Climate control settings
- Headlight and fog light use

It was stated, "Imagine you are driving at high speed and there has just been an accident round the next bend. No problem! You apply the brakes in time because your car has warned you before you could even see the accident."

According to the German auto club ADAC, about 5 million of the country's 45 million cars have satellite-navigation systems, a number that is growing by 19 percent a year; this could mean that by 2015, about 2.14 million cars would be able to transmit Extended Floating Car Data [14].

Automotive Electronics Awards

Automotive News listed the 11 winners in its "best of the best" 2005 PACE (Premier Automotive suppliers' Contributions to Excellence) awards [15]. Six of the 11 awards involved automotive electronics products, and they're listed here.

1 **Fractal Antennas** made by Advanced Automotive Antennas SL (Spain). "Broccoli florets" have a huge surface area for the volume of space they fill. Using fractals, antennas can be made 10 times smaller than existing ones, and eventually will be made to pick up multiple bandwidth signals for radio, telephone and GPS. They can be tucked inside rearview mirrors, spoilers and other places where they do not cause drag, are protected from damage, and don't obstruct visibility or mar styling. The first applications are by Fiat, Peugeot and Mazda.
2 **Racklift** made by Dura Automotive Systems Inc. (Rochester Hills, Mich.). Instead of making side window lifts out of heavy steel using arm-and-sector devices or cables that can fail or slip out of adjustment in cable-and-drum systems, Dura has introduced an all-plastic lift with dual rack-and-pinion gears. The lightweight lift saves 6 to 14 pounds per four-door vehicle. The lift motor that actuates the device travels along with the glass instead of being anchored within the door. No lubrication is needed on the proprietary plastic tracks and gears. The component only moves the glass up and down, without any back-and-forth jamming. Dust, contaminants and cold weather can't obstruct this lift, unlike lubrication-dependent systems. Dura will produce more than 700,000 units to replace traditional regulators on an unnamed North American vehicle this year.
3 **SmartBeam** made by Gentex Corp. (Zeeland, Mich.). Knowing when to switch from high-beam or low-beam headlight settings can be a headache for drivers. Gentex has created a camera-on-a-chip semiconductor device (which includes object recognition processing) that turns on high beams when needed and automatically shifts to low-beam intensity when it detects oncoming headlights or the taillights of vehicles ahead. The component is integrated into an automatic-dimming rearview mirror. The SmartBeam device is on the 2005 Jeep Grand Cherokee and on the Cadillac STS; GM calls it "Intellibeam."
4 **DEKA VII Electronic Gasoline Fuel Injector** made by Siemens VDO Automotive AG (Auburn Hills, Mich.). Precision fuel injectors are complex to assemble and vulnerable to the grit and dust of manufacturing. Siemens has created a modular injector design that reduces the number of assembly steps from 122 to 57 and seals off fragile components early in the assembly process. The injectors contain 30 percent fewer components, have no internal "O" rings, and reduce scrap by more than half. As many as 36 configurations may be built from the same injector design. The injectors were first used for the Renault F4RT engine, and since have been used by BMW, Mercedes-Benz, PSA and Volkswagen.
5 **Color Head-up Display** made by Siemens VDO Automotive AG (Babenhausen, Germany). The Siemens head-up display translates instrument panel information into an image that appears to float in space just ahead of the car. Using multiple mirrors, a color light-emitting diode array projects a clear image even under strong sunlight. The 128 ultrabright micro light-emitting diodes are printed on a silicon base that takes only a small space. A light sensor adjusts display brightness as outside light conditions change. The head-up display is programmable by vehicle manufacturers, allowing them to offer drivers the ability to customize some controls. BMW's 5 and 6 series have the innovation.
6 **Valeo/Iteris Lane Departure Warning System** made by Valeo SA's Switches Detection Systems (Creteil, France). Valeo has created a lane-departure warning system that consists of a camera, an image processor and software. The unit, which is small enough to fit in the palm of a hand, usually is mounted between the windshield and rearview mirror. The camera tracks even the most hard-to-see lane markings, day or night. When a vehicle begins to drift out of its lane, the unit makes a rumble-strip noise to alert the driver. The noise is not made if a safe lane change is under way, indicated by a turn signal. The system has been on the road in European commercial trucks since 2000 and will be used on future Infiniti vehicles in North America.

Automotive Electronics New Products

At the Geneva Switzerland International Motor Show, several manufacturers displayed new automotive electronics products [16], and they're likewise listed here.

1 **The Cadillac BLS concept car** provides a preview of what can be expected in spring 2006 when the production premium mid-class sedan hits the streets. The 1.9-L four-cylinder turbodiesel, from the Fiat-GM Powertrain joint venture, has common-rail direct-injection technology, and features a maintenance-free diesel particulate filter that will comply with Euro 4 emission standards.
2 **Citroën C6** technology includes active suspension elements with variable damping, an electric parking brake, lane departure warning, directional xenon headlamps, and a headup display (HUD). Engine choice is PSA Peugeot Citroën's 2.7-L, 150-kW (201-hp), V6 HDi (High-pressure Direct injection) turbodiesel with particulate filter, with a six-speed auto gearbox.
According to Citroën, the HUD makes a significant contribution to safety with its direct readout; 0.5 s are saved, based on the time normally taken by drivers to look away from the road and refocus on the screen in front of them. Vehicle speed is constantly projected, but the driver can select other information as required. The C6 is also fitted with a lane-departure-warning system, activated from 80 km/h (50 mph).
3 **Hyundai Grandeur**, a new vehicle, aims to move the brand upscale in the executive car segment. Safety features include active headrests, and front/rear side and curtain airbags, and ESP (Electronic Stability Program) as standard on all models. Windshield de-icing is optional. Inside the car is dual-zone climate control with an air-quality control system.
4 **Lexus IS** will be available with its first diesel engine. The engine has common-rail technology with piezoelectric injectors — claimed as a first in its displacement category. Safety available equipment features 10 airbags, including double knee bags. The vehicle also offers a radar-controlled pre-crash safety system, adaptive cruise control, and intelligent adaptive front lighting system. Steering utilizes a new electric speed-sensitive system. The satellite navigation system is said to have the world's fastest route calculation technology and incorporates Bluetooth hands-free capability for compatible mobile phones. Voice recognition also covers audio and climate functions.
5 **Mercedes-Benz SLK 320 concept** vehicle has a V6 triple turbodiesel engine. Two of the SLK's turbochargers are positioned on the outside of the cylinder banks, with the third between the V of the banks. At reduced engine speeds or on light loads, air flows through all three, but with the two smaller ones doing most of the work. When engine speed rises and the flow is continuous, the largest takes over supplying the greatest share of the charge pressure, and the smaller two are turned off via a bypass system.
The Mercedes B-Class also uses a newly developed electromechanical variable assistance steering system. The car's electronic stability program now includes steer control operating in tandem with the electromechanical power steering, providing "appropriate" servo assistance in critical handling situations to help the driver stabilize the car. Selective dampers are fitted, stiffening through turns at higher speeds.
The B-Class is "predestined," to eventually have fuel-cell motive power. Mercedes announced a new high-torque electric motor that will develop more than 100 kW, 35 kW more than the prior unit. Range is now up to almost 400 km (249 mi).
6 **Mitsubishi concept vehicle** showed an instrument panel that incorporated a GPS navigation system, monitors, and internet connection.
7 **Senso concept vehicle** was developed by Bayer Material Science, Rinspeed a Swiss automotive design house, plus engineering company Esoro. It can actually "sense" the driver by measuring his or her biometric data, according to Bayer. It can then exert a positive effect on the driver with the help of patterns, colors, music, and fragrances.
A biometric Polar watch measures the driver's pulse and a camera records driving behavior including speeds reached and lane changes made. An onboard computer evaluates the data and establishes, with the aid of special algorithms, the driver's state of mind. Then four Sharp LCD monitors emit stimulating (orange/ yellow), relaxing (blue/violet), or neutral (green) color patterns in the driver's line of vision. They are integrated into the

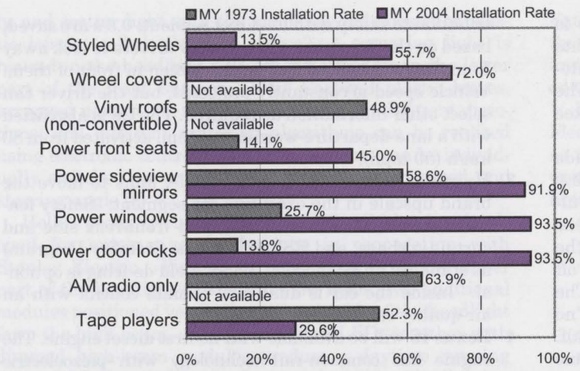


Figure 1: *Ward's Factory-Installed Equipment Data Shows Huge Swings Over 30 Years for Domestic Cars for the U.S. Market [18]*

interior panels, bathing the cockpit in dazzle-free ambient light. This is made possible by using smart electroluminescent surface treatment.

8 **Saab 9-3 SportWagon** incorporates frosted, steeply raked light cluster lenses and LED rear lighting technology. The 2.8-L V6 Turbo has an ESP-Plus stability system, with Hill Start Assist for manual gearboxes to prevent rollback.

9 **Skoda Yeti concept vehicle** includes a single windshield wiper which runs on parallel rails across the whole rectangular area of glass.

10 **Volkswagen Passat** offers diesel engines that range from 88 to 125 kW (118 to 168 hp), and the engines will be available with a particulate filter, and the most powerful getting a piezo high-pressure injection system. Brakes have a wipe function, the pads are applied lightly at specific intervals in wet-road conditions. An electronic park brake is standard (a claimed first in the Passat's class). Options include adaptive cruise control, draft-free Climatronic ventilation, and bi-xenon headlights with a cornering function.

More Information on the some of these new automotive electronics products can be found in Ref. [17] — descriptions for the following products are in [17]:

Electric power variable steering (Lexus)

Heated-wiper windshield de-icing (Cadillac DTS — supplied by Microheat "HotShot")

Automatic headlight dimming (Jeep Grand Cherokee, Cadillac STS — Gentex)

Real-time navigation (Honda — uses Alpine; and GM — uses Delphi)

Side–object radar detection and lane departure warning (Infiniti Q45 — Visteon)

Rear-seat entertainment (video, DVDs, WiFi — Delphi)

Keyless Go engine start (Mercedes-Benz, Mazda, Toyota)

Out With The Old

If you're the sentimental type, allow a few moments to reflect on all the features that have disappeared from the automotive parts-sourcing catalog during your lifetime. Examples include: distributor caps, carburetors, motorized seat belts, 8-track tape players, step-on high-beam headlamp switches, CB radios, vinyl roofs (though still alive and kicking in the aftermarket) and wheel covers [18]

More important, maybe, are today's "endangered components," those still in use but which could disappear within the next 10 to 20 years, destined for the great parts bin in the sky, namely: manually actuated parking brakes, mast antennas, dipsticks, manual locks, ignition/door keys, door handles, spare tires and cassette decks.

If your job is to design the handle used to adjust a sideview mirror, you should freshen your resume. Only 7.5% of '04 U.S. cars had manual-adjust exterior mirrors, according to Ward's data. Power mirrors are the norm. Similarly, once they've done away with the crank window, they have all that space, which before was taken up. Now that space can be utilized for something else.

Forty years ago Brose launched its first power window regulator for the European market. Today, it's estimated that more than 90% of new cars produced in Western Europe come equipped with power windows. In the U.S., 93.5% of new cars produced in the U.S. in 2004 came so equipped, according to Ward's data [18].

As for conventional whip antennas, designers and photographers hate them and would love to see them go away. But they do their job inexpensively, and purchasing departments won't quibble with that reality. Buyers already have it in for motorized retracting antennas, which have earned a reputation for warranty problems. With the arrival of satellite radio, however, vehicles are beginning to sprout more than one antenna, which probably drives designers completely mad.

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Mobile Radio

Javier Gozalvez, Senior Editor

Mobile TV

Orange has announced the launch of the UK's first TV-on-the-mobile service allowing customers to watch news, sport and entertainment programmes on their phone. Running over Orange's high-speed 3G network, the service has an initial line-up of 9 channels including ITN News, CNN, Cartoon Network and extreme sports. O2 and Arqiva (previously known as NTL Broadcast) have also teamed up with Nokia and leading terrestrial and satellite broadcasters to kick-off the UK's first trial of full multi-channel mobile TV. The trial will run for up to six months and the service is based on the new DVB-H transmission technology. In addition to aggregating the content and operating the trial service, Arqiva is providing the DVB-H transmitter network that will cover an area of 120 sq km centred on Oxford. However, O2 has said that it doesn't expect to launch its digital TV-to-mobile broadcast service commercially until 2008 because of a regulatory delay.

Abertis Telecom, Nokia and Telefónica Móviles Spain are starting a mobile TV pilot using Digital Video Broadcasting-Handheld (DVB-H) technology. The project, which is backed by major regional and local channels, is first of its kind to take place in Spain. The pilot will take place in Madrid and Barcelona between September 2005 and February 2006, coinciding with the closing ceremony of the GSM World Congress 2006 in Barcelona. An important objective is to test the quality of the signal and broadcast in- and outdoors, in order to determine the best technical parameters for the viability of DVB-H based services.

Digita, Elisa, MTV, Channel Four Finland, Nokia, TeliaSonera Finland and YLE jointly conducted a pilot in Finland between March and June 2005 with 500 users accessing mobile TV using the Nokia 7710 smartphone and DVB-H technology. The companies have now revealed the results of the pilot with 41% of pilot participants saying they would be willing to purchase mobile TV services and half thought that a fixed monthly fee of 10 euros was a reasonable price to pay. In general, mobile TV users spent approximately 20 minutes a day watching mobile TV, although more active users watched between 30 to 40 minutes per session. Participants also watched mobile TV at different times than traditional TV peak hours. Pilot members were charged a monthly fee of 4.90 euros although half of those that took part thought 10 euros per month was a reasonable price to pay. Users preferred a fixed pricing model although many were also interested in a pay per view model.

Hantro and Freescale Semiconductor have demonstrated a mobile solution capable of playing DVB-H broadcasted TV signals. The H.264 multimedia solution from Hantro is fully compliant with the standard and meets IP-IRD capability level A as specified for UMTS phones. Freescale's i.MX21 multimedia applications processor brings easy scalability to QVGA resolution and power management necessary for a low power, high quality real-time viewing experience.

NTT DoCoMo has announced the development of the 3G FOMA P901iTV, DoCoMo's first mobile handset to receive terrestrial digital broadcasting signals, in addition to conventional analog signals. The handset was developed in response to the planned launch of mobile digital broadcasting in April 2006. The handset's main display will be a 2.5-inch, wide-view LCD screen. An antenna-embedded earphone will enhance TV signal reception. Vodafone K.K., Sharp and NHK have also announced the development of a handset prototype capable of receiving digital broadcasts. The prototype is capable of receiving and playing H.264/AVC1 images and is compatible with data broadcasts based on BML2.

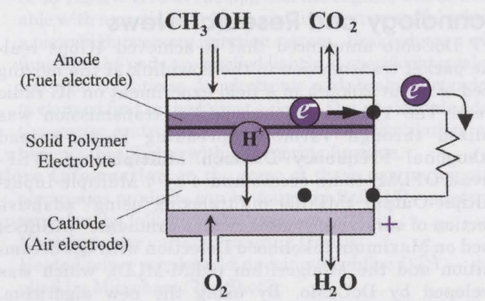
Technology and Research News

NTT DoCoMo announced that it achieved 1Gbps real-time packet transmission in the downlink at the moving speed of about 20km/h in a field experiment on 4G radio access. The 1Gbps real-time packet transmission was realized through Variable Spreading Factor-Spread Orthogonal Frequency Division Multiplexing (VSF-Spread OFDM) radio access and 4-by-4 Multiple-Input-Multiple-Output (MIMO) multiplexing using "adaptive selection of surviving symbol replica candidate" (ASESS) based on Maximum Likelihood Detection with QR decomposition and the M-algorithm (QRM-MLD), which was developed by DoCoMo. By using the new algorithm, DoCoMo was able to reduce the large computational complexity of the original MLD method while maintaining almost the same achievable throughput performance. Frequency spectrum efficiency, which is expressed as information bits per second per Hertz, is 10 bits per second per Hertz, about 20 times that of 3G radio networks' spectrum efficiency.

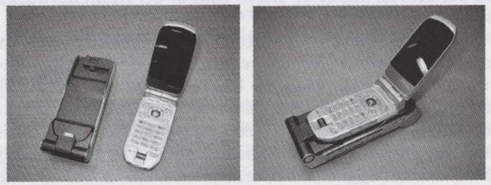
3Way Networks has launched a breakthrough in rapid-deployment secure communications with the launch of a hand-portable UMTS network capable of supporting up to 100 user devices. The equipment packs a complete 3GPP Release 5 compliant system with radio network, switching and packet elements into a tiny 30x56x80cm ruggedised case. Called DBX-m, the system offers a highly cost-effective solution for a range of applications including disabling third-party 3G networks, providing home calling facilities for armed service personnel, or ruggedised basestations with the bandwidth to support the spectrum of remote sensing applications from battlefield sensors to multi-media UAV communications. DBX-m can be used in conjunction with 3G terminals and NATO approved secure encryption devices,

and the new generation of secure UMTS terminals currently in development. The system can be used standalone or connected to a satellite uplink employing commercial internet protocol, circuit-based, or military satellite infrastructure. As standard, the system offers a 5W output, but can optionally be fitted with a power amplifier to achieve the desired range. DBX-m can be used for electronic warfare, to temporally disable third-party 3G terminals prior to enemy engagement for instance. This activity can be performed in a far subtler manner than a broad spectrum jammer.

3Way Networks Portable UMTS Network



Anode	$CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$
Cathode	$3/2O_2 + 6H^+ + 6e^- \rightarrow 3H_2O$
whole reaction	$CH_3OH + 3/2O_2 \rightarrow 2H_2O + CO_2$



Height x width x thickness	150 x 56 x 19mm
Size (volume)	160cc
Weight	190g
Fuel	Max. 18cc (more than 99 % methanol concentration)
Output	Max. 9Wh

NTT DoCOMo/Fujitsu Labs 2005 Prototype Micro Fuel Cell

NTT DoCoMo and Fujitsu Laboratories have announced they have developed a new and improved prototype methanol fuel cell for 3G FOMA handsets. The new prototype enables eight hours of continuous talk time, three times the capacity of the existing prototype, while weighing the same, 190g. The new device is expected to greatly extend usage time once it goes into commercial production. DoCoMo improved the capacity by increasing the methanol concentration from 30% to over 99% and developing a method of recycling the generated water. Medis Technologies has also entered into a cooperation agreement with a UK 3G operator for the testing and introduction to the market of the company's fuel cell Power Packs as a secondary power source for portable electronic devices. General Dynamics C4 Systems has also announced plans to offer military customers a liquid fuel cell powerpack developed by Medis Technologies as an accessory for its popular Sectéra Secure Wireless Phone for GSM. The stand-alone fuel cell powerpack will operate on a proprietary sodium boro-hydride formula and will be packaged in a modular housing about the size of a pack of cigarettes.

Airgo Networks has announced its third generation True MIMO chipset with support for data rates up to 240Mbps. Airgo's new chipset is 100% compatible with 802.11b, 11g and 11a Wi-Fi. Real-world tests showed that Airgo's third generation True MIMO provides actual TCP/IP throughput of over 120Mbps with uncompressed traffic, surpassing the performance of wired 100BaseT Ethernet. In addition, Airgo's True MIMO Gen3 chipset features a single chip with two complete radios fully integrated to achieve further aggressive board-level integration, which has resulted in a 15% reduction in the overall Bill of Material (BOM) cost and a 20% reduction in power consumption.

Researchers from Imperial College London, Durham University and the University of Sheffield claim that mobile phones could one day have the memory capacity of a desktop computer thanks to a microchip that mimics the functioning of the brain. The researchers said the chip design uses a complex interconnected network of nanowires, with computing functions and decisions performed at the nodes where they meet a similar approach to neurons and axons in the brain. Cornice has launched a 4GB hard drive that could be embedded inside mobile phones. Cornice's architecture lowers cost by using only one side of the disk and removing components not needed in small portable electronic devices.

Kopin Corp. has announced that Scalar Corporation has integrated Kopin's CyberDisplay 180K color-filter microdisplay into Scalar's Teleglass, the world's smallest video eyewear for video-on-the-go applications. Connected

Scalar's Teleglass, the world's smallest video eyewear

to a mobile phone, portable DVD player or digital camera, Teleglass projects high-resolution video on eyeglasses, creating a virtual 28-inch TV screen as viewed from seven feet away. This system has a switcher for the people to use dominant eye to watch video. The eyewear projects images in either the left or right eye, enabling the wearer to privately watch movies or TV, read text or view pictures without obstructing the other eye. The device weights just five grams.

ITX E-Globaledge, NTT DoCoMo, Sharp and Waseda University have jointly developed IrSimple, a high-speed wireless communications protocol using infrared. IrDA (Infrared Data Association), an industry organization that develops and standardizes specifications for infrared communications, has decided to formally adopt the protocol as its standard. IrSimple achieves faster data transmission speeds (at least 4 to 10 times faster than at present) by improving the efficiency of the current infrared IrDA protocol. In addition, the IrSimple protocol also maintains backward compatibility with the existing IrDA protocols.

Qualcomm announced the first live, over-the-air demonstration of FLO (Forward Link Only) Technology delivered to a wireless handset. FLO Technology, a multicast innovation and key component of the MediaFLO System, is an air-interface technology designed to increase capacity and coverage and reduce cost for multimedia content delivery to mobile handsets. The demonstration featured over-the-air delivery and viewing of multiple channels of wireless multimedia content, both streaming video and multicast packet data on a form factor accurate (FFA) handset. Specific performance features of FLO Technology include: support for at least 20 streaming channels of QVGA quality video at 30 frames per second, 10 stereo audio channels (HE AAC+ parametric stereo) and more than 800 minutes of stored short-format video clips; low power consumption; and an average channel switching time of 1.5 seconds without buffering or progress bars. FLO Technology is independent of the cellular network but complements CDMA2000 1X, 1xEV-DO and WCDMA cellular network data and voice services.

Qualcomm has also announced the sampling of the RFR6500 and RFT6150 devices, a receive diversity solution for CDMA2000 1X and 1xEV-DO networks based on the company's radioOne architecture. Mobile receive diversity improves network performance on the forward link by reducing dropped calls and increasing network capacity, for an improved user experience. Receive diversity uses an additional antenna and associated receive chain to support improved signal reception, enabling higher data throughput and significant increases in network capacity for CDMA2000 1X and 1xEV-DO networks, especially in dense urban environments. The RFR6500 device also supports simultaneous hybrid dual-receive operation, which allows for 1X paging signal monitoring during a 1xEV-DO connection, while monitoring other frequency bands for hand-off.

Qualcomm launched the Fourth-Generation Vocoder (4GV), a core voice codec suite that offers CDMA2000 1X and 1xEV-DO operators the flexibility to make network adjustments that prioritize voice quality and network capacity. This vocoder was specifically designed to leverage 1xEV-DO Rev. A, increasing the overall quality of end-to-end services for delay-sensitive applications such as VoIP. Qualcomm's 4GV solution supports both circuit-switched and packet-switched voice networks in a combined core that increase capacity by up to 40%. Technology trials of 4GV are expected in the second half of 2005, with commercialization as early as 2006.

Magnolia Broadband has announced that they have successfully completed field trials of Magnolia's Mobile Transmit Diversity solution, DiversityPlus, with SK Telecom. As seen in this and prior tests conducted by SK Telecom, mobile transmit gains of 4 to 5 dB's have shown to significantly improve capacity, coverage and data throughput in commercial cdma2000 1xEVDO networks. DiversityPlus is a family of RF chipset products designed around Magnolia's unique algorithms for CDMA, UMTS and WiMax mobile terminals. Simulations have shown that Magnolia expects comparable performance gains in both UMTS and WiMax.

Telsis has unveiled what it claims is the world First 3G and GSM Data Card Texting Solution. Its SMS Data Card Identity System automatically replaces data card numbers with customers' phone numbers. The first of its kind in the world, the Telsis SMS Data Card Identity System is a small footprint, stand-alone solution that can be simply added to any mobile network.

In an initiative led by the Finnish Population Register (VRK), a department of the Finnish Ministry of the Interior, SmartTrust is helping mobile users in Finland to securely identify themselves and sign for goods and services across a range of public and private sector providers using just their mobile phone. Since 1999, VRK has been responsible for issuing State Citizen Certificates to Finns, a national ID card seen as an important means of electronic identification. Now, the security functionality contained within these cards has been incorporated into the SIM card by SmartTrust, turning the mobile phone into a personal trusted device able to remotely authenticate an individual and create a legally binding digital 'signature'.

Mobile Phones and Health Issues

A study conducted by The Institute of Cancer claims that using a mobile phone doesn't increase the risk of developing nervous system tumours that occur close to where mobile phones are held to a user's head. The study took place in the UK, Denmark, Finland, Norway and Sweden, countries characterised by an early introduction of mobile technology. The researchers collected information from 4231 people, 678 of whom had acoustic neuroma, a benign tumour that grows in the nerve that connects the ear and inner ear to the brain. Despite not having found substantial risk of acoustic neuroma in the first 10 years after starting mobile phone use, the researchers haven't rule out that longer-term use could increase risks. The researchers also found no difference between results when testing analog or digital phone use.

Location-based services

Siemens has claimed to be one of the first companies to bring a standardized solution for Assisted Global Positioning Systems (A-GPS) to the market: The so-called Secure User Plane Location (SUPL) standard is being developed by the Open Mobile Alliance (OMA) and is scheduled for release in June 2005. Siemens is already conducting interoperability tests with A-GPS chipset suppliers Global Locate and SiRF Technology and with device manufacturers Compal Communication and HP. Current A-GPS solutions are based on the so-called control plane architecture, which requires extensive modifi-

cations of the mobile network infrastructure in line with the 3GPP location services standards. In contrast, SUPL-based A-GPS systems employ a "user plane" architecture. In this design, a location server, which communicates directly with the mobile device via an IP link, is integrated into the mobile communication network. Core and radio networks remain unchanged.

Siemens is also providing the "Local Positioning Radar" (LPR) technology for the newly founded company Symeo GmbH. This wireless technology provides a means of accurately determining the position of persons and objects even in situations in which GPS or optical positioning systems are not usable. Transponders (TP) mounted at known positions, are used as reference marks for the positioning of a base station (BS). The BS sends out a signal that is received, processed and reflected by all TPs within range. The signal echoed from the TP carries the TP identity as an additional information. The round trip time-of-flight from BS to all TPs and back is computed in the BS to determine the exact distance between these components. Knowing at least 3 distances to 3 different TPs, the BS can determine its position absolutely.

According to a new report from Berg Insight, revenues from mobile location-based services (LBS) in the European Market will grow by 153% during 2005 to reach $330million. The firm estimates that for the next five years, the average annual growth rate is expected to be 83%. Juniper Research has estimated that the total available market for LBS will grow from under $1billion at the end of the current year to over $8.5billion by the end of 2010. According to the company, the largest geographic market will be Asia Pacific, with Europe and North America second and third respectively.

Heterogeneous wireless communications

Ericsson and BB Mobile have demonstrated what they claim is the first seamless handover of circuit-switched voice and IP Multimedia Subsystem (IMS) based video services between 3G mobile and WLAN. The live demonstration was carried out over Softbank BB's commercial WLAN network and BB Mobile's WCDMA 3G mobile network operating on the 1.7GHz radio frequency band. Handover capabilities for combinational services between WCDMA and WLAN networks are being considered for inclusion in 3GPP Release 8.

Nortel has achieved China's first seamless handoff of broadband voice and multimedia services between a live HSDPA network and a Wireless Mesh network. The successful demonstration was conducted at the new Customer Lab at Nortel's China R&D Center in Guangzhou. Nortel's Wireless Mesh Network solution helps provide a more cost-effective way to extend WLAN coverage for businesses and consumers, both indoors and outdoors.

Calypso Wireless has announced that they have successfully completed a demonstration with Ecutel with its dual mode C1250i Wi-Fi-GSM-GPRS VoIP cellular phone. The Calypso mobile phone, which utilizes the Microsoft VoIP SIP Client operating system, was able to successfully interconnect with Cisco Systems networking equipment using Ecutel telephony network systems.

Alcatel has announced that it is offering a powerful solution for Unlicensed Mobile Access (UMA), which provides access to GSM and GPRS mobile services over Bluetooth and Wi-Fi unlicensed spectrum technologies. By deploying UMA technology, service providers can enable their subscribers to roam and handover between cellular networks and public and private unlicensed wireless networks using dual-mode GSM/GPRS and UMA-enabled handsets or PDAs. Motorola has also announced trials of its UMA solution with seven major European operators, including TeliaSonera Denmark. The trials are designed to demonstrate smooth deployment for operators planning to introduce seamless mobility across cellular and broadband IP networks. In addition, Motorola is launching a Network Convergence Operator Clinic, giving both fixed and mobile European operators the chance to learn from Motorola's experience in delivering seamless mobility solutions. For more information about UMA technology: www.umatechnology.org

Motorola has announced that it is joining forces with Cisco Systems to deliver a seamless enterprise mobility solution that will include WLAN IP telephony and cellular phone technologies. The Motorola-Cisco solution will provide a single mobile communications device that bridges the physical and virtual-office environments to enable anytime, anywhere communications for mobile business professionals. The Motorola and Cisco solution will operate using 802.11 technology inside the enterprise and cellular telephony elsewhere, with a seamless hand-off of communications between networks. Motorola has also announced the launch of the FOMA M1000 WLAN-integrated WCDMA and GSM/GPRS dual-mode smartphone.

Qualcomm has announced that its Mobile Station Modem (MSM) chipsets will support Philips' WLAN module. This integrated solution will offer connectivity to WLAN networks as well as to existing cellular networks and will feature compatibility with 802.11b and 802.11g protocols on both CDMA2000 and WCDMA (UMTS) networks.

According to ABI Research, annual global sales of 'dual-mode' mobile phones able to connect to WiFi or cellular networks are likely to exceed 100million during the final year of this decade.

HSDPA News

Ericsson and 3 Scandinavia have performed successful demonstrations of enhanced uplink, also known as HSUPA, being standardized in 3GPP release 6. According to the Swedish firm, this is the first time that enhanced uplink, implemented in a live WCDMA system based on commercial products, is being demonstrated over the air. Demonstrated mobile broadband applications include e-mail uploads at 1.5 Mbps, VoIP and IP based high quality video conferencing. Initial terminals and PC-cards will be available on the market during the second half of 2006, with handsets coming early 2007. Ericsson has also announced HSDPA (High Speed Downlink Packet Access) supply contracts with Cellcom and Partner (Israel), and Maxis (Malaysia).

Vodafone Italy and Nokia have successfully made what they claim is the first data connection with HSDPA using fully commercial WCDMA 3G network equipment. The call obtained extremely good user data speeds of 1.5 Mbps. The end-to-end call utilized a commercial UTRAN provided by Nokia as well as HSDPA-capable end-user equipment.

BB Mobile and Nortel have completed what is believed to be Japan's first wireless data transmission of 14.4Mbps using HSDPA technology. Live field tests were conducted with mobile handsets on BB Mobile's wireless network built by Nortel. BB Mobile and Nortel conducted HSDPA testing after a trial license for W-CDMA at 1.7GHz spectrum was issued on May 30, 2005.

Lucent Technologies and eAccess have announced that the two companies have completed successful HSDPA data calls using the 1.7GHz-spectrum band that is being made available in Japan for the deployment of mobile service. Following these successful tests, the two companies plan to conduct a field trial in commercial and residential areas of Tokyo in the coming months. The trial will also incorporate Lucent's IP Multimedia Subsystem (IMS) solution. Lucent Technologies also announced it successfully completed the first field trial of HSDPA technology in China, conducting a series of data calls on a 3G trial network deployed by China Netcom in Shanghai. For the end-to-end trial network, Lucent provided its Flexent OneBTS BS, Flexent Radio Network Controller, as well as its W-CDMA packet core solution including its Flexent Serving SGSN, and Gateway GGSN. Lucent's Bell Labs-developed HSDPA solution is currently capable of supporting peak data speeds of up to 7.6Mbps, however the maximum speeds supported by the current generation of mobile devices is 1.8 Mbps.

Alcatel and Novatel Wireless announced that both companies have completed thorough interoperability tests between Alcatel Evolium radio access infrastructure and the Novatel Wireless' Merlin U740 Wireless PC Card Modem in order to enable mobile operators worldwide to undertake live HSDPA field introductions. These introductions will leverage the HSDPA interoperability tests already carried out by Alcatel and Qualcomm (Qualcomm's MSM6275 chipset was integrated by Novatel Wireless). Alcatel has also announced that tele.ring (Austria) has selected Alcatel to introduce HSDPA in Austria following previous lab tests. A field introduction program is now planned for Vienna beginning in the second half of 2005. tele.ring is envisaging a commercial launch of its HSDPA service in the first half of 2006. Siemens also announced that it has been selected by T-Mobile in Austria and Germany to upgrade its network with HSDPA. Beginning in spring 2006, the HSDPA solution will enable customers in Germany to initially download data to their mobile devices at speeds of up to 1.8Mbps. As demonstrated by a field test on the autobahn in the vicinity of Ulm, Germany, these high data rates are also possible when travelling at high rates of speed; the tests were conducted at 130 km/h.

Tektronix has announced the addition of the HSDPA software option to its NetTek Wireless RF Field tester, claiming to be the first manufacturer to provide HSDPA test and measurement capabilities in a handheld form factor. The capabilities added allow to accurately analyze NodeB transmitter performance and provide demodulation measurements including EVM.

3G News

ZTE has unveiled a full range of TD-SCDMA commercial equipment. Following successful MTNET tests, ZTE´s TD-SCDMA equipment has demonstrated diversified 3G multimedia services including voice phone, streaming media and data download. The portfolio comprises core networks and service servers and was shown at the last TD-SCDMA International Conference in Beijing. Alcatel and Datang Mobile have also announced that they have completed the industrialization phase of TD-SCDMA in China and are now ready to deliver TD-SCDMA products to the China 3G market. Through its partnership with Datang mobile, Alcatel is now ready to provide an end-to-end TD-SCDMA solution, including core, access, application platform and terminals.

IPWireless has announced UMTS RailLink, a new network solution that allows operators to offer high-speed broadband connectivity and WiFi access even in the world's fastest trains. UMTS RailLink, which is based on IPWireless's commercial UMTS TD-CDMA mobile broadband technology, was successfully proven to reach speeds up to 220km/h in a series of recent road and rail demonstrations. In the future, IPWireless expects that the solution will support speeds of more than 400km/h. The solution supports very low network latencies, which is critical for delivering real time applications, and handover, so the connection is never lost, even at high speeds. During the demonstration in Europe, uninterrupted megabit-plus access was provided to a train across multiple cell sites over 39 kilometers of track, including a bridge span. The UMTS RailLink solution can be deployed over the existing unpaired IMT-2000 1900MHz spectrum owned by GSM operators, as well as any of the other commercially available TD-CDMA spectrum bands. T-Mobile Czech Republic has announced the launch of a wireless broadband network based on UMTS TDD technology from IPWireless in Prague by year-end; nationwide coverage to be built during consequent months. T-Mobile aims to maximize the value of its acquired UMTS license by using UMTS TDD technology operating in its "unpaired" 1.9 GHz UMTS spectrum. It will be the world's fastest commercial UMTS network, capable of delivering peak sector speeds of up to 4.5 Mbps (average user experience runs to 512 Kbps). T-Mobile also plans to extend its wireless broadband footprint in first phase till summer 2006 to cover nearly half of the Czech population by leveraging the same UMTS TDD technology in the 872 MHz spectrum that it recently acquired. Nextel Communications also announced the deployment of a wireless broadband trial based on UMTS TD-CDMA technology from IPWireless. The field trial will begin during the third quarter in Washington, D.C.; Arlington, Va.; Alexandria, Va.; Reston, Va. and Bethesda, Md.

Verizon Wireless and Lucent Technologies have announced the completion of the wireless industry's first, live, over-the-air calls using CDMA2000 1xEV-DO Revision A technology. CDMA2000 1xEV-DO Revision A is an enhanced version of CDMA2000 1xEV-DO that increases the efficiency, data speeds and capacity of existing EV-DO networks. CDMA2000 1xEV-DO Revision A enables users to receive data (forward link) at speeds of theoretically up to 3.1Mbps and send data (reverse link) at speeds of theoretically up to 1.8Mbps. These increased reverse link data speeds reduce data latency and will enable operators such as Verizon Wireless to deliver VoIP and other multimedia services on CDMA2000 networks in the future. Verizon Wireless and Lucent demonstrated simultaneous video, voice and data services such as two-way video conferencing at speeds of up to 3.1Mbps on the forward link and 1.8 Mbps on the reverse link. Lucent's CDMA2000 1xEV-DO Revision A infrastructure will be commercially available in 2006.

Verizon Wireless has announced plans to embed its technology in notebook computers from Dell, HP and Lenovo. The operator offers its BroadbandAccess service, which is based on EV-DO, in 60 markets across the US. Download speeds average between 400kbps and 700kbps. Cingular Wireless has also announced plans with Dell to bring its 3G wireless broadband technology to Dell notebooks. Beginning in the first quarter of next year, Dell will offer notebook computers with integrated HSPDA

wireless broadband capability, offering customer choice in network providers.

Vodafone, Linksys and Cisco Systems have announced the launch of the 3G/UMTS Router, enabling teams of up to five people to use the wireless LAN capability already built in to most laptop computers to access high speed mobile data services provided by the Vodafone 3G network. The 3G/UMTS WLAN Router combines the Linksys WRT54G3G Wireless-G Router, which provides Wireless LAN coverage for users, and the Vodafone Mobile Connect 3G/GPRS data card.

Topex has introduced what it claims is the world's first module based UMTS gateway for the use of VoIP Providers and Alternative Operators. multiACCESS UMTS is a versatile equipment working with UMTS modules; it features multiple possibilities of interfaces: VoIP, PRI, BRI, E1, UMTS/GSM, FXO, FXS in the same time. As signaling protocols, it supports H323, SIP, ISDN, SS7, R2, R1.5 and therefore it also acts as a protocol converter.

Rohde & Schwarz has expanded its RF Conformance Test System R&S TS8950 by WCDMA test cases for the FDDV and FDDVI (Frequency Division Duplex) frequency bands. According to the company, the R&S TS8950 is the world's first certification system to cover not only four GSM frequency bands but also four frequency bands for UMTS. Mobile radio manufacturers can use this system to certify their mobile phones for UMTS850 and UMTS800 in accordance with the 3GPP TS 34.121 test specification.

The UMTS Forum has affirmed that worldwide subscriptions to 3G mobile networks have now passed the 50 million mark, with UMTS/WCDMA subscribers outnumbering those using other 3G technologies by a factor of two. Thanks to a sustained period of growth, UMTS/WCDMA customers now stand at approximately 33 million worldwide - an increase of more than 15% in the total base since the end of June this year. 3G/UMTS subscriber growth remains significantly higher than that of 2G/GSM networks in their first few years of operation. According to the UMTS Forum, subscriptions to the other fully commercialized 3G technology, CDMA 1x EV-DO, now exceed 17 million worldwide - mainly in South Korea and Japan. Japan remains the world leader in WCDMA network subscriptions. As of end August this year, there were more than 16.5 million Japanese WCDMA customers, representing just over 50% of the global 3G/UMTS user base. Italy ranks second to Japan in terms of subscriber numbers, with just over 6.75 million customers on its four 3G/UMTS networks. The UK, meanwhile, currently ranks as the world's third largest 3G/UMTS market with just over 4 million customers. According to the GSA, the number of 3G/WCDMA commercial networks is now 82 in 37 countries, an increase of 22 networks during 2005. The Vodafone Group has reported that the number of 3G devices has risen to 4.35milluin at August 2005, comprising 3.95million consumer devices and 400,000 Vodafone Mobile Connect 3G/GPRS data cards.

Spectrum Licenses

Malta has awarded two 3G licenses to the country's incumbent operators. The operators have 60 months to complete their network rollout and have complete national coverage. Netia Mobile has won a tender for an additional 3G frequency operating UMTS in Poland. The country's telecom operator also announced it rejected all bids in a tender for a GSM1800 frequency. Japan is accepting applications for new licenses in the 1.7GHz bandwidth (up to two operators) and the 2GHz (up to one operator). Following TeliaSonera's take-over of Orange in Denmark, Denmark will launch an auction for the returned 3G license. The authorities are maintaining the objectives of the 2001 auction. Ireland has announced it is offering a tender for a fourth 3G license which could also include spectrum in the GSM bands. The winning operator will be required to launch commercial services no lather than April 2007. The license involves minimum requirements of 33% and 53% demographic coverage by October 2009 and October 2011 respectively.

France is set to launch the auction process for WiMAX licenses. The French regulator will offer two licenses for each region, or 44 in total. The bidding process will supposedly finish by February 2006. The Finnish government has granted operator Digita a license for a mobile broadband network using Flarion's FLASH-OFDM technology that enables download speeds of up to 1.5Mbps. Digita will build the network in the 450MHz band. The first stage of the network is scheduled to be on line in September 2006.

The European Commission has presented a new strategy for an optimal use of radio spectrum in Europe. At the moment, radio spectrum usage is still fragmented among the 25 member states. On the other hand, the Commission proposes to develop common EU rules for a number of promising new mass-market applications including UWB, broadband wireless access technologies and RFIDs. The Commission proposes that between now and 2010 the exclusive usage rights for significant parts of the radio spectrum ought to be made tradable according to common EU rules. The Commission also foresees investigating further the opportunities to make available license-free radio frequencies to allow different users to share bands as already the case for WiFi radio access.

According to a report published by the Independent Audit of Spectrum Holdings (IASH), there is significant demand for additional radio spectrum in the UK to support commercial services over the next 20 years. The audit was established by the UK government in 2004. IASH said that around 2.5GHz of additional spectrum could be required by 2025, with the demand being more important in urban than rural areas.

Forums and Industry Alliances

The World Wide Web Consortium (W3C) has announced the launch of the Mobile Web Initiative (MWI) to make web access from a mobile device simpler and easier. MWI participants will initially focus on two areas: best practices and mobile device descriptions. In the first case, the working group will develop authoring guidelines and best practices to help content providers to develop web content that works on mobile devices. The second working group will address the development of improved device description solutions, i.e. a database of descriptions that can be used by content authors to adapt their content to a particular device.

The CDMA Development Group (CDG) has announced the formation of the CDMA Certification Forum (CCF, www.globalccf.org), a collaboration between CDMA operators and CDMA device vendors. The mission of the forum is to develop and implement a global standardized certification process to significantly reduce the time and cost of bringing CDMA devices to market. The CCF will establish and maintain a core global device certification process that helps ensure device quality and network compatibility around the world. CDG has also announced that it has signed a cooperation agreement with the TD-SCDMA Forum to develop joint market opportunities for CDMA2000 and TD-SCDMA technologies. Key joint initiatives for the CDG and TD-SCDMA Forum include developing interoperability and roaming capability between CDMA2000 and TD-SCDMA systems, developing a joint strategy for standards coordination, and promoting regulatory policies that enable rapid development of advanced wireless services.

The FLO Forum (www.floforum.org), an organization that will work to promote the development of products and services related to the delivery of advanced multimedia services to wireless devices around the world using FLO technology, has been created. The FLO technology was designed specifically for a terrestrial mobile multimedia environment, making its performance characteristics ideally suited for use in cellular handset operation. According to the forum's members, FLO technology-based multimedia multicasting will complement wireless operators' existing networks by delivering multimedia content to cellular handsets used on these networks.

The Taiwan-based BenQ Group has announced it will acquire Siemens' entire mobile phone business with more than 6,000 employees worldwide. The business will be headquartered in Munich. With this acquisition, BenQ will advance to become one of the world's leading mobile phones vendors.

PMR and Public Safety

The Association of Public-Safety Communications Officials (APCO) International has announced the next phase of an effort to develop information exchange reference standards for sharing information between computer aided dispatching systems from various vendors and with other systems such as alarm and mapping. A coalition of public and private organizations will collaborate to set the standards, which are an extension of the preliminary work conducted by APCO's Project 36. This new collaborative effort will expand to include other critical message formats and content.

Motorola has announced the introduction of multiple new products developed for public safety and government organizations. Motorola solutions introduced include: the first wireless data system to deliver 96 kbps of data in the current private radio frequency band; the first remote speaker microphone with Global Positioning Systems (GPS) personnel tracking capability; Motorola's first fully IP Dispatch Console designed to perform to Mission Critical customer specifications; and a complete end-to-end wireless broadband solution that provides real-time video monitoring and 'Intelligent' video surveillance. Motorola has also announced the availability of two new MPT-Trunked Professional Radios, the PTX700 Plus and the PTX760 Plus, that deliver quality audio in a compact and lightweight form factor that makes these radios the smallest radios from Motorola based on the MPT1327 signalling standard. Motorola's unique X-PAND voice compression and low-level expansion enables crisper, clearer and stronger audio quality by reducing noise usually heard during pauses in conversation.

ZTE showcased its GoTa (global open trunking architecture) technology at an exhibition organised by China Tietong. The GoTa system – the world's first digital trunking mobile communications system based on CDMA 2000 technology – underpins China Tietong's new telecommunication services. The GoTa system is unique to ZTE and offers services including trunked radio systems, packed data, positioning and instant messaging.

Sanswire Networks Sanswire One

Satellite and in-flight wireless solutions

The founding members of the Eurely and iNavSat consortia delivered their joint proposal for the Galileo Concession to the Galileo Joint Undertaking (GJU) that was accepted by the European Union. The submission of this joint proposal follows the decision "that the GJU could not select a preferred bidder as the two bids were too close to separate, considering their quality and complementary options". The Galileo has been proposed as Europe's own version of the GPS system.

The European aviation authorities have said that mobile phones would improve security on commercial flights (enabling sky marshals to communicate with security officials on the ground) without posing a safety risk to the passengers on-board. The findings were included in a report entitled 'Certification Considerations for Cellular Telephone Systems in Civil Transport Aircraft'. However, the report cautioned that although it is technically possible to operate mobile phones on planes, there are significant spectrum licensing and operational issues to be addressed.

Siemens has signed an exclusive contract with Airbus to jointly develop a solution for the use of in-flight communication via GSM. Siemens will provide the GSM technology, while Airbus will take charge of its integration in the existing electronics systems. The commercial launch of this new customer service is planned for 2006. The GSM solution is implemented via a Siemens nano-GSM/GPRS base station on the airplane attached behind the ceiling panel. The product is based on IP and is linked to the terrestrial GSM mobile network with the aid of satellite technology. An important prerequisite for implementing the solution is the integration of channel selector technology. This technology prevents the end devices from establishing contact with terrestrial networks and hence interfering with the avionics. It therefore ensures that radio communication from the airplane is conducted solely via satellite. The new solution will be modular in structure so that it can be expanded to accommodate more GSM capacity and other technologies such as WLAN. TAP Portugal and the UK-based bmi airlines are

preparing to trial in-flight mobile services on an airbus A320 in late 2006. Qualcomm and Connexion by Boeing have also announced that they are working together to test and demonstrate in-flight wireless communications aboard Connexion One, a specially equipped Boeing 737-400 aircraft. The companies have performed a series of test flights that successfully demonstrated the simultaneous use of CDMA and GSM mobile phone technology over an on-board network with infrastructure and integration support from UTStarcom. The data tests were conducted over CDMA2000 1X and CDMA2000 1xEV-DO and voice calls were made over CDMA2000 and GSM.

Sanswire Networks has announced that the Stratellite prototype, Sanswire One, has been completed, floated and tested. The new design increased the overall size of the airship to 188 feet in length and is believed to be the largest rigid frame airship in existence. Sanswire One was floated and tested within the airspace specified by the FAA and was tethered at all times. Airborne stress measurements and other data were gathered by the Sanswire Engineering team. A Stratellite is a high-altitude airship that when in place in the stratosphere (approximately 65,000 feet) will provide a stationary platform for transmitting various types of wireless communications services currently transmitted from cell towers and satellites.

WiMAX & Wireless LAN

Marconi has announced that it has been selected to support the largest public trial of WiMAX to date, providing WiMAX connectivity in Italy's Piedmont and Sicily regions. Marconi will deploy Airspan's AS.MAX family of WiMAX broadband wireless access products. According to the companies, the AS.MAX product family is IEEE 802.16-2004 compliant and due to its Software Defined Radio technology, it can be upgraded to be IEEE 802.16e compliant, to include Spatial Division Multiple Access advanced services. AT&T has also announced it will start this fall an intensive test of WiMAX technology, applications and its business case during a trial in Atlanta. The company has already been testing the technology in Middletown using pre-standard equipment. The Atlanta trial will use equipment designed to comply with the WiMAX standard. Adaptix is also planning to launch a trial of its OFDMA-TDD pre-WiMAX system with the help of the NY3G partnership. The trial will demonstrate the broadband fixed and mobile capabilities of the technology. Deutsche Telekom's T-Com has also launched a WiMAX field trial in Germany that will end in March 2006. Siemens is acting as systems integrator and maintenance supplier.

ZTE has announced it will provide to VeratNET the first ever commercial WiMAX network in Serbia. ZTE will provide VeratNet with a nationwide WiMAX network which is due for completion by June 2007, serving almost 10 million subscribers with wireless broadband. In January 2006, the first phase of the deployment will be completed offering wireless broadband access to business subscribers in Serbia´s capital, Belgrade. Siemens and Belarius government-owned telecommunications operator BEST have signed a memorandum of understanding for the delivery of the WiMAX solution. The broadband radio network is part of a new initiative in Belarus designed to provide large parts of the population with internet access. In addition, the Belarussian government wants to use the WiMAX network for an innovative telemetering solution with which all household consumption data for electricity, gas and water will be transmitted over the air to a central billing system. Siemens also announced that it has succeeded in completing the first live data transfer with SkyMAX, a new end-to-end WiMAX solution based on the IEEE 802.16-2004 standard, in its test lab in Milan, Italy. During the live link between a modem and a base station in the 3.5GHz frequency spectrum, data was transmitted at a top speed of up to 12Mbps in 3.5MHz bandwidth. The connection between the SkyMAX base stations and a number of modems was tested in a non-line-of-sight setup.

The Canadian Wireless Telecommunications Association, in conjunction with national wireless service providers Bell Mobility, Fido, Rogers Wireless and TELUS Mobility, has announced the launch of inter-carrier Wi-Fi service along with plans to develop more than 500 new hotspot locations. This new hotspot network, the broadest inter-carrier undertaking of its kind in North America, allows for cross-Canada roaming between carrier-run hotspots under a common brand. When customers access Wi-Fi service in any location with the common hotspot identifier they will be presented with an identical, browser-based login area that ensures a simple, consistent and secure experience. If user support is required, clients will continue to access their own carrier's customer service.

The Sacramento City Council has approved a plan to provide WiFi coverage over the entire capital within two years. The council has selected a proposal by MobilePro over competing plans offered by SBC Communications and Motorola. The city will provide the firm with access to city buildings and light poles to install wireless transmitters and receivers. In exchange, the company will install and operate the system, offering some limited free access and sell service to both residential and business users.

According to In-Stat, WiMAX subscriber base in the Asia Pacific market will grow from more than 80000 in 2005 to more than 3.8million by 2009. The firm estimates that in 2009, Asia Pacific will account for 45% of the world's WiMAX total subscriber base. Strategy Analytics predicts that there will be 20million fixed WiMAX installations by 2009, which will be enough for the technology to be considered a success in the marketplace. However, the firm has still doubts regarding the viability of mobile WiMAX.

North America Mobile Market

The United States of America and the Government of Canada have concluded an amendment to the 1962 United States-Canada Agreement concerning coordination and use of radio frequencies above 30 megacycles per second, to add a new Arrangement that will be administered by the Federal Communications Commission (FCC) and Industry Canada covering use of the Frequency Bands 764-776 MHz (TV channels 63 & 64) and 794-806 MHz (TV channels 68 & 69). The new Arrangement will facilitate the deployment of public safety systems in these bands near the U.S.-Canada border, providing public safety licensees near the border with much needed additional spectrum as well as interference-free operations and interoperability. The original band plan for this spectrum adopted by the FCC in October 2003 included a mixture of license sizes and geographic areas in order to accommodate the needs of wireless providers of various sizes serving a range of different geographic areas. The new Order maintains such a mixture but increases the amount of spectrum licensed on a small geographic area basis (Cellular Market Areas, or CMAs) from 10 MHz to 20 MHz in order to provide greater opportunities for smaller rural or regional providers to obtain access to this spectrum at auction. The Order also provides for an additional 10 MHz of spectrum licensed by Economic Areas (EAs). The new band plan splits the original 30 MHz E block at 1740-1755 MHz and 2140-2155 MHz into one 10 MHz block (new block E) and one 20 MHz block (new block F).

The FCC has advanced its efforts to make spectrum available for an array of innovative wireless services and technologies offered over 3G mobile networks. A new Order modifies the band plan, and licensing and service rules – originally adopted in October 2003 – for the 90 MHz of Advanced Wireless Service (AWS) spectrum at 1710-1755 MHz and 2110-2155 MHz. The changes made in the Order adopted enhance flexibility for potential AWS licensees and provide additional opportunities for smaller and rural wireless carriers to access this spectrum.

In July 2004, the FCC adopted a Report and Order which reconfigured the 800MHz band to eliminate interference to public safety and other land mobile communication systems operating in the band. As specified in the Report and Order, the band reconfiguration process is being overseen by a Transition Administrator (TA) which has provided the FCC with a plan detailing when band reconfiguration will commence in each of the fifty-five 800 MHz National Public Safety Planning Advisory Committee (NPSPAC) regions. On March 11, 2005, the Bureau approved the TA's basic 800 MHz band reconfiguration schedule, i.e., the grouping of the NPSPAC regions into four waves (Waves 1-4) and starting the reconfiguration process in each wave on the dates recommended by the TA. With a recently published Public Notice, the FCC has announced that the 800MHz band reconfiguration process for non-NPSPAC channels will start June 27, 2005, in the NPSPAC regions assigned to Wave 1. A list of NPSPAC regions can be found at the FCC's website: www.fcc.gov

Canada's wireless service providers have introduced inter-carrier multimedia message services (MMS) to wireless phone customers across the country. This broadest initiative of its kind in North America, announced by the Canadian Wireless Telecommunications Association (CWTA), will enable customers with MMS-capable mobile phones, regardless of the customer's wireless service provider, to instantly send and receive messages with rich content to and from the MMS-capable phones. Until now, sharing of MMS messages was limited to customers using the same wireless provider. The overall solution for sharing multimedia messages across the Canadian carriers was made possible through the use of a comprehensive MMS interoperability platform by VeriSign, a provider of intelligent infrastructure services for the Internet and telecommunications networks. Cingular has also announced that its customers can exchange pictures and short video messages, including text and audio, with any Cingular, Sprint, T-Mobile, Verizon Wireless, Leap Wireless and US Cellular customer, who has an MMS-enabled device, as well as any email address. With Intercarrier Multimedia Messaging Service, Cingular customers have access to the broadest wireless MMS community, representing 80% of wireless subscribers in the U.S.

Verizon Wireless has announced it is acquiring 23 spectrum licenses from Leap Wireless International. The licenses, 19 of which are not currently under commercial operation, cover a population of 8million in Michigan, Wisconsin, Arkansas, Mississippi, Alabama and upstate New York. Of the markets, nine represent new entries for Verizon. Leap Wireless International also announced it is selling spectrum to Dobson Cellular Systems and American Cellular in Alaska and Minnesota. The deal in Anchorage involves 30MHz of spectrum while the Duluth agreement covers a 10MHz block. Verizon Wireless has also closed a deal to expand its presence in North Carolina by acquiring spectrum licenses covering 10 markets from bankrupt Urban Comm-North Carolina. The 1.9GHz licenses in North Carolina involve 10, 20 and 30MHz licenses covering a population of 3.9million people.

According to CTIA's semi-annual wireless industry survey, US wireless service penetration rate stands at 65% thanks to the addition of 25.2million new subscribers from June 2004 to June 2005. SMS traffic in June 2005 hit 7.2billion sent messages, up from 2.8billion sent during June 2004. Revenue related to the SMS messages came in at $1.28billion, up 154% year-over-year. Total revenue for the first six months of 2005 totalled $55.6billion. Six-month revenue related to wireless data services also increased to nearly $3.8billion in June 2005.

Industry Forecasts and Surveys

Dell'Oro Group has reported that the total mobility infrastructure market grew 13% in the second quarter of 2005 compared to the same period a year ago. For the first half of 2005, growth in the WCDMA market slowed to 13% over the same period in 2004. According to the firm, the market for GSM-based infrastructure grew 16% in the same time period. The worldwide market for CDMA-based infrastructure grew 5% year-over-year driven by CDMA 1X-EV-DO upgrades in North America. In-Stat has predicted that the market for macro-cellular base stations will increase from 1.8million in 2004 to 3.5million in 2009. The firm also said that, in some cases, in the last five years, base stations prices have dropped by a factor of 10. A report from Telecom Trends International estimates that the mobile wireless network revenue will grow from US$60.7billion in 2004 to US$100.1billion in 2011, with a compound annual growth rate of 7.4% over a seven year period. The mobile wireless market will experience a 9.3% growth rate in 2005. According to the report, Tier 1 vendors (Ericsson, Nokia and Siemens) garnered 49% of the revenue in 2004, and Tier 2 vendors (Motorola, Lucent, Nortel and Alcatel) obtained 33% of the revenue.

According to Gartner, wireless phone sales hit 190.5million units in the second quarter of 2005, with models from Nokia and Motorola accounting for nearly half of the handsets sold. Nokia has the largest market share, followed by Motorola, Samsung, LG and Sony Ericsson. Latin America reported the greatest amount of growth at 50% year-over-year. Strategy Analytics estimated that global mobile phone shipments grew 18% year-over-year to 188million units during the second quarter of 2005. According to the firm, emerging markets such as South America and Africa are driving demand for increasing number of devices. IDC said that Western European mobile phone market experienced a 20% year-on-year growth in the second quarter of 2005. The firm

also announced that the growth of WCDMA handsets year-on-year was 164%. Juniper Research has estimated that the total mobile subscriber market will reach 2.7billion by 2010 and that shipments of handsets will break the 1billion mark by 2009. 3G subscribers are predicted to grow from 30million in 2004 to over 300million by 2010. Strategy Analytics has released a new report in which it estimates that the worldwide cellular user base will increase from 1.7billion at the end of 2005 to 2.5billion by the end of 2010. Average revenues fall 7% to US$30 per user per month in 2005. The firm expects voice usage to increase from 5.6trillion minutes in 2005 to 12.6trillion in 2010. GSM-based systems will account for 76% of service revenues in 2010. The firm also forecasts that 3G subscribers will pass 50million at the end of 2005.

Juniper Research estimates that global mobile entertainment revenues can exceed US$59billion by 2009. The firm expects gambling and games to be the key drivers of mobile content, with their respective markets worth US$19.3billion and US$18.5billion respectively by 2009. The mobile entertainment market is expected to reach US$17.6billion in 2005 which represents a 71% increase compared to 2004. In a new report, Generator has estimated that Europeans will spend US$640million in 2010 downloading full-track songs. With expenditure on real music ringtones forecast to be an additional US$1.2billion, mobiles will account for US$1.8billion or 15% of total music sales by 2010 compared with just 3.4% in 2005. IDC expects the US wireless full-track music market to surge to US$1.2billion in revenue and over 50million customers by 2009.

In a new report, Portio Research forecasts that MMS will generate revenues of US$50billion by 2010. The firm also estimates SMS revenues to reach US$50billion by 2010 driven by almost 2.38trillion messages. Meanwhile, Telia announced that during June-August 6.1million MMS messages were sent through its Swedish mobile network, which represents a 56% increase compared to the same period during the past year.

The firm IDC has announced that US wireless carriers generated US$1.6billion in data service and application revenues in the fourth quarter of 2004 from a base of 178.2million subscribers. In the same time period, data represented 5.8% of the industry-wide ARPU. However, IDC expects this value to grow to better than 15% of total service revenues in the years ahead. The firm also estimated that total revenues from paid downloads by US wireless subscribers approached US$250million in the fourth quarter of 2004.

The Yankee Group announced that the MVNO market in the US will reach US$10.7billion in service revenue by 2010, with most of that revenue being dominated by large Tier 1 MVNOs. The firm estimates that by 2010 the MVNO market will be comprised of three subscriber tiers totalling 29million customers.

A survey commissioned by Motorola has confirmed strong consumer demand for Unlicensed Mobile Access (UMA)-enabled services across key European territories, with Italy, Spain and Sweden the most enthusiastic nations in terms of acceptance and potential take-up. The online survey, conducted by BrainJuicer, which targeted 1,000 consumers in each of six leading European markets – Germany, France, Italy, Spain, Sweden and the United Kingdom – concludes that a UMA-enabled service would be positively received. If mobile calls in the home were priced the same as fixed line calls then over 50% of respondents said they would be likely to sign up to a UMA service within 12 months. On the other hand. a report from Disruptive Analysis found that by 2009 there will be a market for 46.8million Wireless VoIP (VoWLAN) phones, of which 64% will be dual-mode cellular/VoWLAN devices. Despite the expectation on UMA technology, the study finds that just 5.5m households worldwide will use WLAN-based UMA services by the end of 2009, with 6.7million UMA VoWLAN phones being sold during that year. The firm believes that limitations to the business model will stall roll-out and uptake.

Other News

eBay has agreed to acquire Skype Technologies for approximately $2.6 billion in up-front cash and eBay stock, plus potential performance-based consideration. Skype also announced a landmark partnership with E-Plus, Germany's third largest mobile phone network. From October, Skype software will be bundled with E-Plus' flat-rate data subscription, allowing people to gain both a high bandwidth Internet connection and free, high-quality Skype calling over E-Plus' mobile network.

France Telecom has announced that its subsidiary Orange has executed an agreement to acquire 80% of the shares of Auna owner of 97.9% of Amena, Spain's third mobile operator.

Motorola has been selected by the GSM Association to serve for a second phase as the sole supplier of handsets for the Emerging Market Handset (EMH) program – a program that strives to advance the social and economic development of emerging markets through mobile communications. The GSMA estimates that despite 80% of the world's population having wireless access, only 25% are able to use it, with cost identified as the single biggest barrier to mobile communications usage in emerging markets. The partnership with Motorola will aim to extend the reach of mobile telephony and connect the unconnected in countries such as India, South Africa, Russia, Egypt, Philippines and Indonesia.

3G Americas has reported that as of August 2005, there are 1.5 billion GSM customers according to the latest subscriber data from Informa Telecoms & Media. Remarkably, it was just in Q1 2004 that the GSM technology reached the one billion customer milestone and with a robust and unrivaled growth, GSM already totaled 1.46 billion customers worldwide at the end of Q2 2005, passing the 1.5 billion milestone in August. As of June 2005, GSM again added more new customers annually than the total subscriber base any other mobile digital technology with 347.2 million new GSM customers. GSM customers account for 82% of all new digital wireless customers in the first half of this year.

The CDMA Development Group (CDG) has reported that the number of CDMA2000 (3G) subscribers grew by 17 million in Q2 2005 to reach 185.6 million worldwide. In the first six months of 2005, CDMA2000 added more than 39 million new users and 73 million since June 2004. In addition, the CDG announced that CDMA is growing at a rate of 27% annually and garnered 13.6 million new users in the last quarter and close to 58 million in the past year, bringing the worldwide CDMA subscriber base to more than 270million people. Close to 68% of all CDMA users now access CDMA2000 3G services.

Standards

Dennis Bodson, Senior Editor

China Slows Ambitious Plans for 3G Networks

China has over the past several months quietly scaled back plans for a multibillion-dollar upgrade of its wireless networks, dealing a possible blow to U.S. and European phone-equipment companies that hope to cash in on the construction.

China's powerful, state-controlled phone companies are now expected to deploy fewer – and smaller – 3G wireless networks across the country in the next few years, industry executives and analysts say. That means significantly less spending on big-ticket equipment from Western suppliers. Those companies built most of China's existing wireless infrastructure and were hoping for big upgrade contracts under some Chinese carriers' original, more ambitious plans.

Expectation of a "gold rush" from 3G network-building in China "is a little bit over," says Christoph Caselitz, head of mobile networks for Siemens AG's communications group in Munich. There is now "a more realistic view" about spending, he says. Big suppliers also are still waiting for the Chinese government to issue basic licenses to authorize phone carriers to offer 3G service, a waiting game that continues to frustrate some companies.

May Delay Issuing 3G Licenses

Western firms such as Germany's Siemens, as well as giants Telefon AB L.M. Ericsson, Sweden, Nokia Corp. of Finland, Motorola Inc., of Schaumburg, Ill., Lucent Technologies Inc., Murray Hill, N.J., France's Alcatel SA and Canada's Nortel Networks Corp., have been banking on growth from China to bolster their bottom lines, particularly as they face more-saturated phone markets in Europe and Japan. With 330 million subscribers, China is the world's biggest cellphone market. Only 26% of the population have a cellphone subscription.

Chinese authorities are proceeding more cautiously with their rollout of fancy 3G networks, mostly because of cost concerns, industry executives and Chinese authorities say. Third-generation phones offer greater Internet bandwidth and more sophisticated services, such as allowing people to watch TV and hold videoconferences on their phones.

China is mindful that many companies have run into debt building such networks in Europe and Japan, and that many customers are using expensive 3G phones mostly for old-style services, like placing calls. Those services don't help carriers rack up the hefty fees necessary to make 3G profitable. That is a concern for China as it ponders big 3G investments, says Guo Gan, a researcher at a think tank affiliated with China's Ministry of Information Industry, which regulates phone companies.

Some analysts now expect China's phone companies to fork out just $10 billion to $12 billion in the next two or three years to build 3G networks, down from estimates of three or four times that just a year ago. Still, given the need for new sources of revenue in the industry, "$10 billion over three years is not a bad deal," says Mr. Caselitz, of Siemens.

Simon Leung, president of Motorola's Asia-Pacific operations, remains cautious. He expects 3G networks to be confined initially to China's wealthier cities and coastal provinces, where consumers presumably would be able to pay for advanced services.

Still, government 3G licenses may not be awarded until as late as early 2006, and officials seem in no hurry to hand them out. Western executives – some of whom had expected licenses to be issued last year and are frustrated by the delays – say the government still is busy studying 3G deployments abroad and how to consolidate the country's own phone industry.

Mats H. Olsson, who runs Ericsson's greater China business, and many industry analysts believe China will award just three 3G licenses, as opposed to the four or five that originally had been anticipated. Ericsson now has the largest chunk of wireless-infrastructure business in China, controlling more than 35% of the market.

China may be holding back on issuing licenses for another reason: to buy time to develop its controversial, homegrown technical standard, TD-SCDMA, which stands for "time-division synchronous code-division multiple access." That standard favors domestic vendors, such as Huawei Technologies Co. and ZTE Corp., which have been tapped by regulators to develop products based on it. If China widely deploys TD-SCDMA, U.S. and European telecommunications vendors could lose out.

The technology is an alternative to the two other global 3G standards, which hail from Europe and the U.S. It is brand new and didn't perform well in some government-sponsored tests last year. Still, TD-SCDMA is improving, and "it's very likely that all three technologies...will be deployed in some fashion in China," says Robert Mao, president and chief executive of Nortel's greater China business.

Beijing is thought to be intent on promoting its own standard partly to try to lessen China's dependence on technology developed by companies such as Qualcomm Inc. of San Diego. China has been trying to develop its own standards in an array of sectors, with the aim of decreasing royalty fees Chinese companies pay to foreign companies and leveraging China's growing market heft.

That is why some Western companies are scrambling to hook up with Chinese partners who are developing TD-SCDMA. Nortel has a deal to develop the technology with phone maker China Putian Corp., while Ericsson last month cemented a venture with ZTE. Siemens has a deal with Huawei, and Alcatel, through its Alcatel Shanghai Bell unit, works with a unit of Datang Telecom Technology Co. Others, such as Motorola, have invested in ventures that are making TD-SCDMA chipsets.

TD-SCDMA also raises big questions for Qualcomm. The company insists that parts of the technology rely on its core "code division multiple access" technology, and Qualcomm would be owed royalties by companies that deploy TD-SCDMA equipment.

The Chinese government disagrees. TD-SCDMA "is a domestic patent," says Xin Yongfei, another official with the Ministry of Information Industry-affiliated think tank. Mr. Xin says the government is in negotiations with Qualcomm over the royalty issue, which he describes as "very difficult."

Qualcomm officials declined to comment on the talks, or on whether the company might offer reduced royalty rates to Chinese companies. They say, however, that at least 60 companies already have licensing agreements with Qualcomm that would cover TD-SCDMA if and when that technology hits the market. None of these companies, they say, is Chinese.

Call for Submissions from IEEE-SA Members and Volunteers

Write a piece about standards development for the IEEE-SA Member-Only Areas and gain recognition from your peers by submitting on a variety of standards development topics. If your paper or article is chosen, we'll give you a prominent byline, bio, and include your photograph. Your article will be published on the IEEE-SA website, in the members-only IEEE-SA Member Central and Corporate Community web areas. We'll also send a nice gift for your participation. Eventually, we would like to publish a journal of collected articles when we have enough articles. Your permission will be obtained first, of course, by signing a release form for one-time publication rights.

- Positive or challenging experiences you've had in standards development.
- Historical milestones in standards development.
- The future of standards development, IP, open source information.
- Standards development and the environment.
- Standards development in the fields of nanotechnology, biomedical engineering, robotics, and other fields.
- Humorous or anecdotal stories concerning standards and standards development.
- The impact of standards by technical leaders and business professionals.
- Why standards development is important to you, your industry, the future, the planet.

Your participation in this new project is vital to building value for our members. The IEEE-SA is a not-for-profit standards development organization, and we look to our members and volunteers for content and knowledge for our standards development community. To have your ideas and wriiten submissions considered for publication, attach your article in MS Word format to an email and send to: Colleen Crary, IEEE-SA Membership Program Manager, c.crary@ieee.org

IEEE Standards Board Approves VTS Standards Activities

The IEEE Standards Board approved the following VTS items at their June 9, 2005 meeting:

P1609.4 – Standard for Wireless Access in Vehicular Environments (WAVE) – Multi-Channel Operations was approved until 31 December 2007. A copy of the file can be found on our website at

http://standards.ieee.org/board/nes/projects/1609-4.pdf.

P1609.3 – Standard for Wireless Access in Vehicular Environments (WAVE) – Networking Services was approved until December 31, 2007. A copy of the file can be found on our website at

http://standards.ieee.org/board/nes/projects/1609-3.pdf.

P1609.1 – Standard for Wireless Access in Vehicular Environments (WAVE) – Resource Manager was approved until December 31, 2007. A copy of the file can be found on our website at

http://standards.ieee.org/board/nes/projects/1609-1.pdf.

IEEE Begins Standard to Define Communication Channel for Broadband-Over-Powerline Systems

With momentum building to adapt the installed base of electrical power lines for Internet and other broadband communications, the IEEE has begun work on a standard to define the nature of the communication channel to be used. This standard, being developed within the IEEE-SA Corporate Program, will be an essential step in helping manufacturers develop the devices to be used in commercializing this approach.

The standard, IEEE P1901™, "Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications", will make it easier for high-speed communication equipment to be used with AC power lines. A entity-based standard, participants developing P1901 include companies and other organizations from the power, utilities and broadband communities. It is targeted for completion in early 2007.

IEEE P1901 will apply to broadband-over-power-line (BPL) devices for first-mile/last-mile connection to broadband services, as well as those for the local area networks and other data distribution systems to function over copper power lines in a building. The standard will create a balanced and efficient BPL channel that has the bandwidth and quality of service needed by all users.

"The ability to transmit digital data over power lines from substations to homes and offices is attracting attention because it transforms wall outlets into Internet portals," says Jim Mollenkopf, co-chair of the IEEE BPL PHY/MAC Working Group. "This approach resolves the tough task of linking long-distance fiber optic cables to individual computers and should make the Internet even more universal than it now is. If BPL is to become widespread, there is a need for a robust standard that supports the use many types of BPL devices. Our intent is for IEEE P1901 to be that standard."

Jean-Philippe Faure, the other working group co-chair, says BPL communications involves an open media able to be shared by many devices. "The physical and medium access layers to be defined in the new standard will ensure that BPL devices operating on the same network will be able to coexist without conflict. It also will allow for interoperability among BPL devices from different vendors so end users can create viable systems according to their needs."

In access BPL systems, communication signals are imposed on electrical distribution feeders and travel over medium-voltage lines to the step-down transformer at a residence or business. A repeater/router extracts the signal and places it on the low-voltage wiring where it can be accessed through a modem plugged into any outlet. BPL also allows utilities to deploy devices that can make electric service more efficient and reliable by monitoring system problems and performance.

The member organizations of the BPL PHY/MAC Working Group developing the standard are drawn from the utility, Internet service provider, BPL equipment producer and other communities. For more information on this working group and the broader IEEE broadband-over-powerline effort, see http://grouper.ieee.org/groups/bpl/index.html.

IEEE StandardsWire™ Launched

A new e-newsletter, launched by the IEEE Standards Association, a major developer of international standards, provides broad access to the most current information about IEEE standards and related products. The free opt-in e-newsletter offers those in companies, trade organizations, government bodies and academia worldwide the ability to learn about recently approved new and revised standards and the initiation of new standards work. It further provides detailed information about newly available standards categorized by technical interest, and highlights best selling standards and related product influencing the marketplace today.

"IEEE standards are a driving force in today's global marketplace. They create markets, increase profitability and ensure safety. With this, end users need a definitive source for their standards information," said Judy Gorman, IEEE-SA Managing Director. "We're pleased to provide a tool that will help our customers stay abreast of new and revised standards and related products that impact their bottom lines."

In addition to the monthly e-newsletter, StandardsWire has a supporting website at http://standards.ieee.org/standardswire/. This site provides additional links to IEEE standards products and services, the IEEE-SA news room, IEEE Standards Board actions and archives of the newsletter. Those interested in subscribing to StandardsWire can go to: http://standards.ieee.org/standardswire/subscribe.html

IEEE Announces Conference on Global Business Standards Trends

In response to the changing dynamics of today's standards world, the Corporate Standards Program of the IEEE Standards Association will host a conference on global standards trends in Munich, Germany, on 26 and 27 September 2005. The conference, "Standards for Global Business: The European Conference on Collaborative Trends in Europe and Global Standardization," will explore standardization from the perspective of both standards development organizations (SDOs) and corporations.

"Standards for Global Business" will address such areas as the growing cooperation among international and other standards bodies and new models for standards development developed in response to the business and market needs of European and global industry.

The SDO section will include presentations and interactive panel discussions by such organizations as the International Organization for Standardization, the International Electrotechnical Commission, and the International Telecommunications Union. Insight on corporate-based standards development and corporate reaction to global standardization trends will be provided by leading companies involved in information technology, consumer electronics, communications and other fields. Companies scheduled to lead discussions include IBM, Intel, Siemens, and Sony.

In considering the range of standards development options open to corporations, case histories will demonstrate how the IEEE's individual and corporate consensus programs and the consortia-type structure within the IEEE Industry Standards and Technology Organization are being used to create a full range of standards and implementations. Conference participants from industry may also attend a meeting of the IEEE Standards Association Corporate Advisory Group, the governing body for the IEEE Corporate Standards Program, which will be held on 27 and 28 September, immediately following the conference. For information on "Standards for Global Business: The European Conference on Collaborative Trends in Europe and Global Standardization," see http://standards.ieee.org/corpforum/europeconf/index.html.

Mobile Industry Applauds Latest 3G Specifications

Mobile communication manufacturers and network operators are applauding the finalisation of the latest series of technical specifications for 3rd Generation systems. This series of specifications, developed by the 3rd Generation Partnership Project (3GPP), is known as Release 6 and enhances earlier releases of the specifications to bring customers the full "3G" experience.

Release 6 completes many features that will fulfil the goals laid down for 3G by the International Telecommunication Union (ITU), notably the ability to benefit from true multimedia communications anytime, anywhere.

The radio technologies specified by 3GPP – W-CDMA (Wideband Code Division Multiple Access) and TD-CDMA (Time Division Code Division Multiple Access) – have been developed as effective solutions to the ITU's 3G vision. However, the realisation of 3G requires much more than just a highly efficient radio interface. The core network (evolved from that of the hugely successful Global System for Mobile Communication (GSM), standardised by the European Telecommunications Standards Institute, ETSI) is another critical element, as are the numerous applications and features essential to communications systems, such as billing, security and the like. All of these elements have been specified by 3GPP and form part of each release.

A 3GPP release builds on previous releases by adding further functionality, but the need to maintain backwards compatibility with systems built to the specifications embodied in the earlier releases, as well as earlier technologies such as GSM, GPRS and EDGE, has to be preserved. Notable among the 3GPP Release 6 features as major contributors to the "true 3G experience" are high-speed radio uplink (EDCH or HSUPA) to complement the High-speed downlink packet access (HSDPA) defined in Release 5. Combined, these technologies will permit very high speed symmetrical data communications, supporting multimedia, Voice over IP etc. HSDPA has a theoretical data rate of up to 14.4 Mbit/s; for EDCH the theoretical rate is up to 5.76 Mbit/s.

The second phase of the IP Multimedia Subsystem (IMS), comprising all the core network elements for the provision of multimedia services. IMS has been designed to enable full IP-based communication, exploiting the benefits of IP for all types of traffic, and providing for seamless operation between different systems and also with the Internet). Using the Session Initiation Protocol (SIP) defined by the Internet Engineering Task Force, IMS enables mobile operators to offer their subscribers multimedia services based on and built upon Internet applications, services and protocols. This second phase of IMS ensures interworking with circuit-switched networks, non-IMS networks, and

with the similar (but different) core network defined by 3GPP2 for CDMA systems.

Interworking with Wireless Local Area Networks (WLANs). In order to give users the greatest flexibility of choice in how they communicate (enabling them, for example, to access telecommunications services through a WLAN), 3GPP has proposed six interworking scenarios, of which the first three have been defined in Release 6: Common billing & customer care; 3GPP system based Access Control and Charging; and access to 3GPP system packet-switched based services. Specifications to support the remaining scenarios (service continuity; seamless services; and access to 3GPP circuit-switched services) may follow in a later release.

Multimedia Broadcast Multicast Service (MBMS), offering more efficient distribution of popularly-demanded multimedia content, such as video sports or music clips, to multiple recipients.

Enablers for conversational services such as Push to talk over Cellular (PoC), in collaboration with the Open Mobile Alliance.

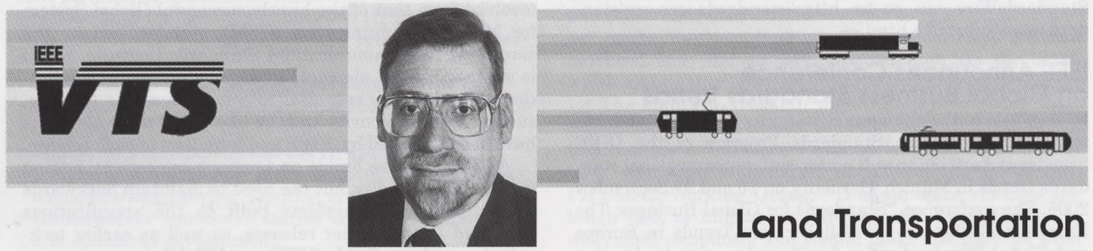
Karl Heinz Rosenbrock, Director-General of ETSI (one of the leading partner organisations in the 3GPP alliance) and Chairman of the 3GPP Project Co-ordination Group, said: "Release 6 marks a very significant milestone in the development of '3G'. Many of the features in this release have a direct impact on users, giving them precisely the mobile multimedia services that the industry has been promising for several years. As a result, we can foresee advanced 3G systems based on the 3GPP specifications really taking off in the next two to three years, and user numbers escalating to levels approaching those of current 2G deployments."

Release 6 also includes the Parlay X Web Services, defined in a multi-part Technical Specification (TS29.199) that has been prepared by 3GPP in close collaboration with the Parlay Group. The Parlay X Web Services are intended to stimulate the development of next generation network applications by developers in the IT community who are not necessarily experts in telephony or telecommunications. To assist developers test their applications designs, and as part of its Plugtests™ service, ETSI will be hosting an interoperability testing event dedicated to Parlay X on 14 to 18 March (see http://www.etsi.org/plugtests/OSAPARLAY.htm)

However, although a major achievement, Release 6 is not the end of the road because communications systems will continue to evolve and the 3GPP technologies need to remain competitive. Further enhancements are foreseen, and an initiative agreed at the 3GPP plenary meetings in Athens, Greece, in December 2004 will entail a study of evolutionary options, principally in the radio interface, due for completion by June 2006, followed by the consequent specification work to be finalised by June 2007.

References

[1] Rebecca Buckman, Staff Reporter of The Wall Street Journal June 30, 2005
[2] EEE P1672 Working Group - Call for Volunteers
[3] IEEE-SA Press Release, June 30, 2005
[4] IEEE-SA Press Release, June 23, 2005
[5] ETSI Press Release, February 14, 2005



Land Transportation

Harvey Glickenstein, Senior Editor

The Guateng Province of South Africa has selected the Bombela consortium for a design-build-operate-maintain (DBOM) contract for the proposed 50-mile line between Johannesburg, Tshwane, and Johannesburg International Airport. The concession will include a bus feeder system as well as a 10-station rail line.

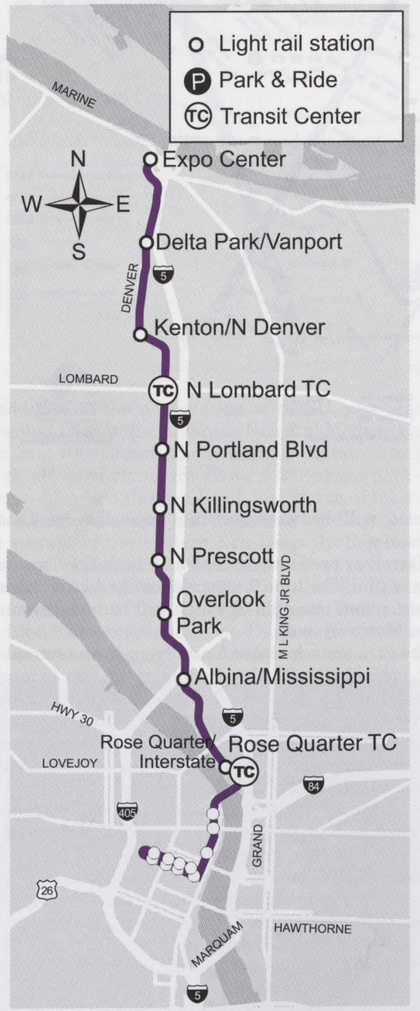
Bombardier will provide Electrostar vehicles and CITYFLO 250 train control technology for the project. The consortium, which will provide financing as well as DBOM services, includes Bombardier Transportation; Bouygues Travaux Publics, a French civil contractor; RATP Devéloppement, a French rail and bus operating company; Murray & Roberts, a South African civil contractor; two partnerships of South African companies—Loliwe Rail Contractors and Loliwe Rail Express. Negotiations with the consortium have begun, with financial close expected in 2006.

The vehicles will be manufactured in Derby, United Kingdom with final assembly in South Africa by UCW Partnership, a subsidiary of Murray & Roberts.

Opening of the line is scheduled for 2010, coincident with the 2010 Soccer World Cup that will be held in South Africa.

The French National Railways (SNCF) has ordered 28 double-deck trainsets for regional express services from Alstom. These were ordered under an option in a contract that was originally signed in November 2000.

Twenty-two of the trainsets will consist of three-car units to service the regions of Rhône Alpes, Lorraine, and Nord Pas de Calais. The other six trainsets will consist of four-car units to service the region of Picardy.



Portland's Interstate MAX light rail line

The cars are designated TER 2N NG for new-generation double-deck regional express train. They feature distributed power and have a top speed of 100 mph.

With a double-deck configuration, they have a capacity of 339 passengers in the three-car configuration and 450 passengers in the four-car configuration.

The 170 million euros cost of the cars is being financed by the regional authorities. Delivery of the trainsets is expected to start by the end of 2006.

Portland, Oregon's Interstate MAX light rail line celebrated its one-year anniversary on May 1, 2005. The line is a substantial success, having averaged 92% more ridership than the previous bus line in the route on weekdays, 97% more on Sundays, and 104% more on Saturdays. Portland's Interstate MAX light rail line

Not only has ridership increased on the route, but businesses, such as the new $15 million Fred Meyer's store, have located along the line.

The Los Angeles County Metropolitan Transportation Authority has received the first of 50 new light rail vehicles from Ansaldobreda.

The new cars use ac motors with IGBT inverters to convert the dc from the overhead catenary to ac. The cars also feature regenerative braking to put power back into the catenary when braking.

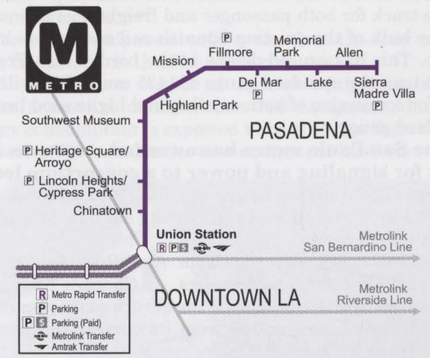
The 76-passenger cars are 90 feet long, making them as long as a railroad commuter car. They have four wheelchair locations for disabled passengers.

Global Positioning System (GPS) is used to provide automatic station announcements and to time stamp all events that are captured on the on-board event recorder. The announcement system has both interior and exterior speakers as well as variable message signs coordinated with the audio announcements.

Video recording is provided for security, including both interior and exterior views.

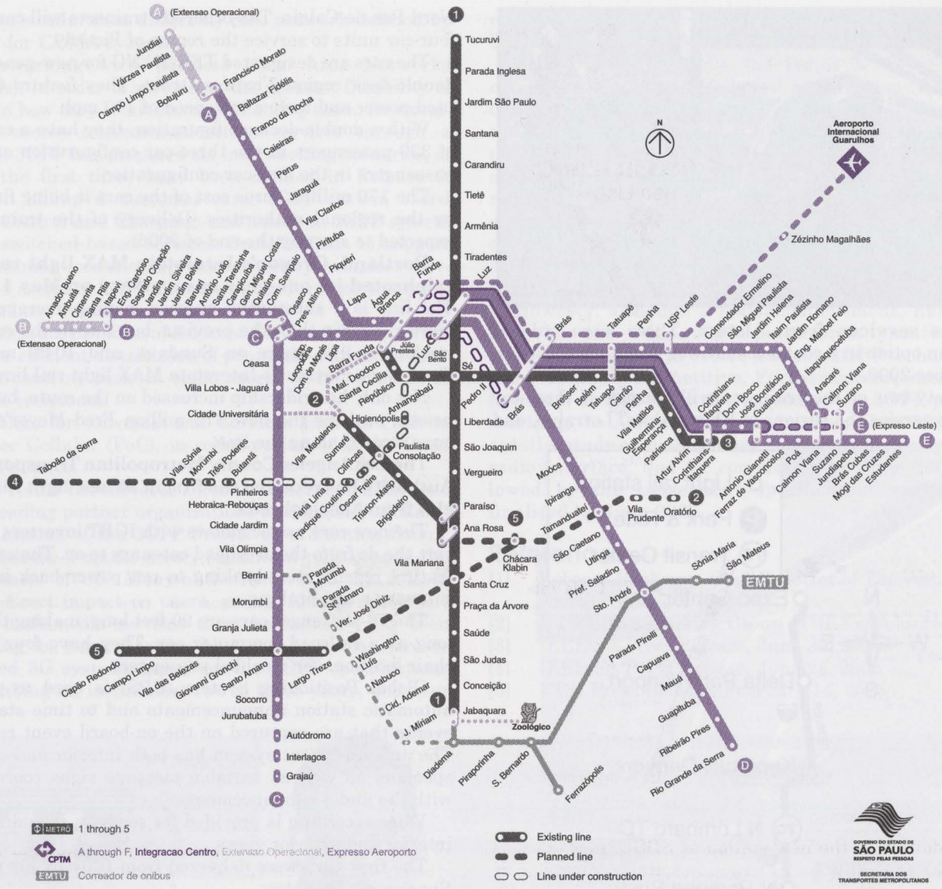
The first cars were delivered from Italy by air using a Russian air freighter.

The cars are scheduled to be deployed on the Metro Gold Line which runs between Pasadena and Los Angeles.



LA County MTA Gold Line

Spain has unveiled a 15-year strategic plan to upgrade transportation infrastructure called PEIT. Just under half of the total cost, over ¤118 billion, is devoted to main line and suburban rail improvements. One third of the total of ¤248 billion is devoted to creation of a high speed network of almost 5600 miles of standard



Sao Paulo Metro System

gauge track for both passenger and freight operations.

The bulk of the existing Spanish rail network is broad gauge. This has caused delays at the border with France, which uses the standard gauge of 1435 mm. PEIT will provide for conversion of both existing and high speed lines to standard gauge.

The Sao Paulo metro has awarded a systems contract for signaling and power to a consortium led by Alstom. The contract covers signaling and power supply for a 2.5-mile extension of the existing 4.3-mile long Metro Green Line (Line 2).

The extension will run from Ana Rosa to Chacara Klabin, Imigrantes, and Ipiranga. At Chacara Klabin the Green Line will connect with the future extension of the Metro Purple Line (Line 5) from its current terminus at Largo Traza to Chacara Klabin.

The extension of the Green Line is expected to open in two phases—the first 1.8 miles as far as Imigrantes in the first half of 2006, with the second phase to Ipiranga by the end of the year.

The Monterrey, Mexico Mass Transport Authority (Metrorrey) awarded a contract to a consortium that included Bombardier Transportation and Siemens for 14 high-floor light rail vehicles. The new vehicles will be used for the expansion of Line 2 of Metrorrey.

Metrorrey presently operates 70 high-floor trains on 14 miles of line. The Line 2 extension will add 5.4 miles to the system, about one mile of which will be underground. Sao Paulo Metro System

The cars are scheduled for delivery in the second half of 2007, coincident with the opening of the new extension.

San Diego's Mission Valley East Project opened for revenue service on July 10. The 5.9-mile Green Line connects the Blue and Orange Lines of the existing light rail system. Free rides were offered from Qualcomm Station on the Blue Line east to the end of the Orange Line at Santee Town Center on July 9 to introduce the connector to San Diegans. Because of the opening of the new line monthly ridership on the San Diego Trolley exceeded 3 million for the first time. The 9.5 percent increase in ridership compared to the previous July is expected to continue once the school year starts as the new line serves the San Diego State University (SDSU). The high price of gasoline is also expected to lead to still higher levels of ridership.

The new station at SDSU is in the middle of the only underground section of the system.

In addition to the new station at SDSU, new stations were built at Grantville, Alvarado Hospital Medical Center Station, and 70th Street. The Grantville Station is on a 40-foot high elevated structure above a 248-space park-and-ride lot on Alvarado Canyon Road, just North of Interstate 8. The other two stations are on ground level.

The success of the modern San Diego Trolley has now spurred a call for operation of vintage trolleys in San Diego similar to the vintage trolley operations in San Francisco, Sacramento, Seattle, Lowell, Tampa, and Dallas among other cities. The proposal for San Diego is for two vintage trolleys to operate through the downtown area on the same tracks as the existing trolley service, but only during off-peak hours and for special events. In Sacramento the vintage trolleys operate on the regular tracks but only for special events, while in other cities the trolleys operate on their own tracks at all times.

The French National Railway (SNCF) ordered 30 triple voltage electric freight locomotives from Alstom. These locomotives are part of an order for 300 electric locomotives that was given to Alstom in 1998. The original order was for dual-voltage locomotives. The modification was to deliver these 30 locomotives as triple voltage—1500 Vdc, 25 kVac, and 15 kVac.

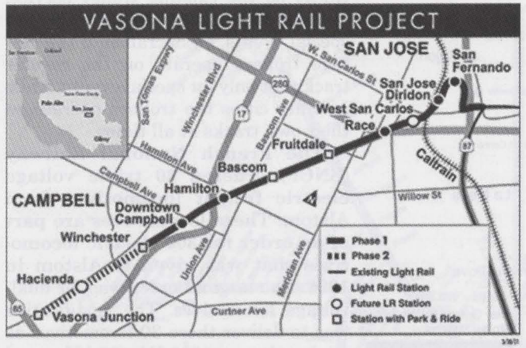
The new locomotives are BoBo, meaning that they have two powered trucks with two axles in each truck. Maximum speed of these freight locomotives is 87 mph. They will be used in freight service between France, Germany, Switzerland, and Luxemburg.

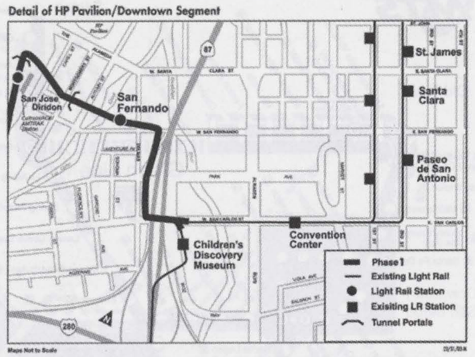
JR Central and JR West have received a pre-mass-production version of the new N700 Shinkansen trainset. The new trainset, when it enters revenue service in 2007, will provide for an increase in top speed on the Sanyo Shinkansen from 177 mph to 186 mph as compared to the 700 Shinkansen trainsets, although it will only be allowed to operate at 167 mph on the Tokaido Shinkansen.

Because it will be able to operate at 167 mph on 2500-meter radius curves instead of the top speed of 155 mph for existing 700 trainsets on such curves and because the acceleration of the new trainsets will be 1.61 mphps vs. 0.99 mphps on the Tokaido Shinkansen, the new equipment will reduce the travel time between Tokyo and Osaka.

The N700 equipment will be the first tilt-body equipment to operate on the Shinkansen routes.

The total power output of the new equipment is 30% higher than that of the Series 700 equipment, but the energy consumption is expected to be 10% less than that of the Series 700 because the new equipment has a new aero-





dynamically designed nose. The new equipment also provides regenerative braking, which is included in the anticipated 10% reduction in energy consumption.

Central Japan Railway (JR Central) has demonstrated a high temperature superconducting magnet using Bismuth instead of Niobium Titanium for use on the Yamanashi Maglev Test Line. The high temperature superconducting magnet works at a temperature of -235 degrees C as opposed to the Niobium Titanium magnet use previously that required a temperature of -269 degrees C.

The advantage of the higher temperature is that it can be obtained with refrigeration rather than requiring liquid helium or liquid nitrogen.

In other research in the area of superconductivity JR Central is developing a superconducting flywheel system. The goal is to demonstrate a 50 kWh superconducting flywheel that could be used not only in railway and maglev applications, but also to reduce load fluctuations in small/medium sized wind power generator systems and solar power generation systems.

The three-year project (FY2005-FY2007) is budgeted at 1.1 billion yen. The proposed flywheel would be about 2 meters in diameter, weigh about 20 tons, and rotate at 2000 rpm.

The superconductivity would be used to levitate the flywheel, eliminating physical bearings.

The Santa Clara Valley Transportation Authority (VTA) opened the portion of the Vasona Light Rail Line between San Fernando and Diridon Stations in August. Opening of this short extension allows access to the San Jose light rail system from the joint Amtrak, Caltrain, and Altamont Commuter Express (ACE) railroad station. Service on this extension operates on a 15-minute headway during peak hours and on a 30-minute headway off-peak and weekends.

The balance of the Vasona Line was scheduled to open in September. Local residents were disappointed that the opening of the portion of the Vasona Line between Diridon and Winchester Station in Campbell was rescheduled from August to September. Even the September 2005 date is earlier than the January 2006 date that was the originally targeted opening date.

The portion of the line beyond Diridon is on a corridor shared with the Union Pacific Railroad, a freight railroad regulated by the Federal Railroad Administration (FRA). VTA operates under regulation of the California Public Utilities Commission (CPUC) and will comply with the CPUC regulations on this corridor as VTA does in the rest of their system. VTA has petitioned the FRA for a waiver of certain operating rules that the FRA has imposed on the corridor which are different from the CPUC regulations. The delay in opening was to give more time for resolving the operating issues with the FRA.

The replacement for the Transportation Equity Act for the 21st Century (TEA-21) that had been extended many times over a 2-year period was signed by President Bush in August. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA: LU) includes money for many transit projects.

In the San Francisco area the Act includes a $5 million earmark for preliminary engineering to extend the Bay Area Rapid Transit (BART) from Warm Springs to San Jose. The BART extension is 16.3 miles long. Local funding for the extension will come from 30-year ?-cent sales tax that was authorized in 2000 and will start being collected in 2006. Construction of the BART extension is scheduled to begin in 2008, with revenue service to begin in 2015.

In the Los Angeles area SAFETEA: LU includes $400 million to progress the extension of the Metro Gold Line to East Los Angeles; $21 million for environmental and preliminary engineering for the Montclair extension of the Gold Line; $11 million toward the Exposition light rail line from downtown Los Angeles to Santa Monica; $167 million towards the Alameda Corridor East freight rail line from downtown Los Angeles to Barstow for traffic signal synchronization in the corridor, grade crossing elimination, and other improvements; $7 million towards a Bus Rapid Transit project, and other improvements.

Los Angeles County MTA receives its new light rail vehicles.

IEEE VTS NEWS

VTC Weddings

Those who attended VTC2001-Fall in Atlantic City will remember that the there were a large number of last minute cancellations due to September 11 the month before. One of the attendees was Michel Ivrlaã, from Munich, and since the session he had wanted to attend had been cancelled, he went to see another session where a paper was being presented by Lai Choi from Hong Kong. To cut a long story short, international co-operation ensued and they were married in Munich in January 2003. To celebrate they return to VTC each year, and attended VTC2005-Spring in Stockholm. They are pictured here at the banquet.

Another VTC inspired wedding occurred in August when your editor James Irvine married Laura Hyslop, Senior Program Coordinator in Conference and Custom Publishing at the IEEE. James and Laura met for the first time at VTC2003-Fall in Orlando, having been working with each other remotely for the previous six months on the proceedings of that conference. They married in Summit, NJ and are now living in Scotland.

VTS Board of Governors Election Results

This year's ballot for IEEE VTS Board of Governors election saw ten candidates run for the five positions which fell vacant this year. This year's successful candidates were:

Lajos Hanzo
James Irvine
Jae-Hong Lee
Thomas N. Rubinstein
Bob Shapiro

Thomas N. Rubinstein, currently webmaster and responsible for conference site selection, and James Irvine, newsletter editor, are existing members of the Board.

The new Board members have all had extensive experience in the society and in particular with VTC.

Lajos Hanzo will be well know to attendees at VTC, where he is both a regular tutorial presenter and a prolific writer of papers. A distinguished lecturer for the Society, Professor Hanzo is tutorial chair for VTC2006-Spring in Melbourne and VTC2007-Spring in Dublin.

Jae-Hong Lee also has a long-standing relationship with VTC, chairing VTC2003-Spring in Jeju, Korea, as well as being chair of the Korean chapter of VTS and instrumental in starting the Asia Pacific Wireless Communications Symposium.

Bob Shapiro, who is also a member of the Board of Governors of ComSoc, was general chair of the highly successful VTC2005-Fall in Dallas.

Mark Ehsani, chair of the Vehicle Power and Propulsion Committee, did not stand for re-election but remains on the Board in an appointed capacity as chairman of the VPPC.

The new members replace Mark Ehsani, Roger Madden and James Worsham.

VTS Executive Committee Elections

Elections were also undertaken at the Board of Governors meeting at VTC in Dallas for the Executive Committee for 2006. There were two nominations for the position of president: Dennis Bodson, the current incumbent, and J. R. Cruz, the senior Past President, who was president of the society in the period 2000-2001. After much debate and a close election, Dennis Bodson was elected to serve for 2006.

The other elections were less dramatic. James Irvine was elected unopposed to the position of Executive Vice President, replacing Sam McConoughey. The other Vice Presidents were re-elected to their current positions: Eric Schimmell as Vice President Mobile Radio, Harvey Glickenstein as Vice President Land Transportation and Joe Ziomek as Vice President Motor Vehicles.

IEEE VTS

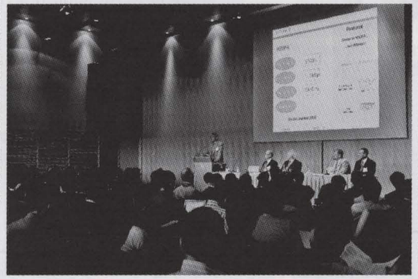
Photo Report on VTC2005-Spring, Stockholm

Alisdair McDiarmid, University of Strathclyde

Colin Arthur (conference webmaster, session manager, and AV firefighter extraordinairre) tests the equipment

The conference opened on Sunday with two tutorials. This is the introduction to OFDM/MC-CDMA by Prof Lajos Hanzo of Southampton University.

Monday morning is always a hectic time at VTCs. Here we see volunteer registration assistants, handing out name badges

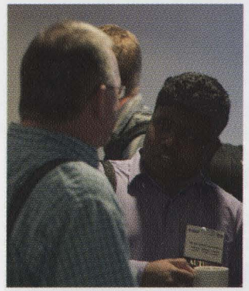


As is traditional, the conference was opened by the general chair, Dr Jan Uddenfeldt of Ericsson AB

Eight sessions were held in parallel, and most rooms were completely full. The quality of presentations was excellent.

The opening plenary was well-attended. Nearly 400 researchers and industrialists were squeezed into the banquet hall.

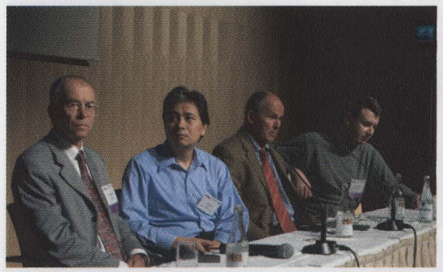
The coffee went quickly, and the queues were long. Fortunately, there was also a great selection of teas, infusions, and soft drinks.



Poster Discussion

As always, VTC was a great venue for collaborative work between attendees.

The panel chair was Jorge Pereira, Scientific Officer in the area of Mobile and Personal Communications at the European Commission.

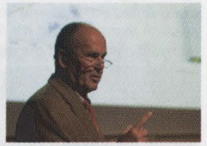


The first panel was held on Monday afternoon, and was titled "2020: Long-Term Perspectives in Mobile and Wireless". The panelists were (left to right) Ernst Bonek, Rene Cruz, Heinrich Meyr, and Ian Opperman. Masugi Inoue also took part.

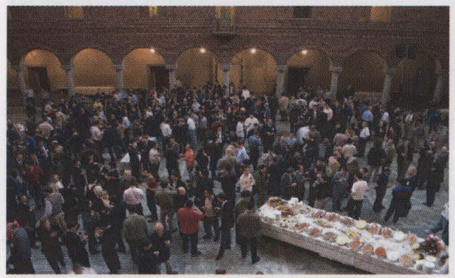
Professor Bonek focused on MIMO for high throughput demands.

Dr Ian Opperman introduced UWB and its applications in future networks.

Dr Matsugi Inoue proposed applications for next generation systems



Professor Meyr discussed developments in system-on-chip design

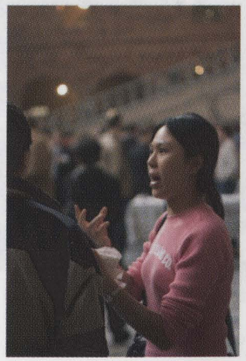


The conference reception and buffet was held on Monday night in the Stockholm City Hall

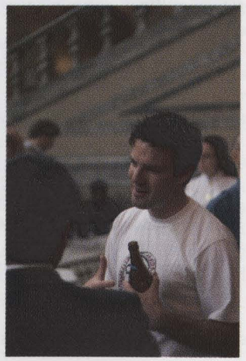
The reception was introduced by the Lord Mayor of Stockholm, who raised a toast to international collaboration.

Professor Cruz's presentation argued that wireless ad-hoc networks are an important enabler for reducing the cost of network access.

Our reception banquet was in the form of a Swedish buffet. The food was excellent, with many dishes to choose from.



As always, the conference functions are an excellent place to relax and chat about anything and everything.



The conference lunches were so full as to overflow into the main dining area.

The final keynote presentation of the conference was from Dr Augusto de Albuquerque of the European Commission. He presented his vision for ubiquitous personalised network access, using appropriate culinary metaphors for the luncheon venue.

The second panel was also well-received, and was a great success despite a few audiovisual difficulties.

Michael M. Wolf presents the OverDRiVE project on inter-vehicular networking.

Dr Uma S. Jha discusses the networking capabilities in the latest aircraft from Boeing.

Dr Mike Mattner discussed the status and future of the Galileo global navigation satellite system

Sandro Scalise presents the WirelessCabin project, enabling GSM networking on aircraft.

Paolo Conforto's presentation discusses technical details of the FIFTH project, which provides fast Internet access for high-speed trains

The banquet was held on Tuesday evening, and a presentation was made by Henrik Abramowicz of Sony-Ericsson AB

Richard Savage of Qualcomm closes the panel and opens for discussion.

The banquet audience was captivated by the keynote presentation.

As always, VTC was host to several exhibitors, including Orbit/FR and John Wiley Publishing.

Book Review

Internet Security: Cryptographic Principles, Algorithms and Protocols
Man Young Rhee
Published 2003 by Wiley
ISBN 0 470 85285 2
405 pages
Price $80 (US), £45.00/EUR67.50 (Europe)

Reviewed by Alisdair McDiarmid, University of Strathclyde, UK

The importance of Internet security is becoming increasingly visible, with horror stories of leaked industrial secrets, destructive break-ins, and stolen credit card details. This book aims to cover the entire field, from physical networking to firewalls. The author's focus is on describing specific cryptographic algorithms and protocols.

Two opening chapters give a brief overview of networking, including a short chapter on TCP/IP and some common application layer protocols. Following these are chapters on symmetric ciphers, asymmetric cryptosystems, and hash functions and message digests. The book concludes with an overview of public-key infrastructure, and chapters on network layer and transport layer security, email security, and internet firewalls.

In a book of this size, there is clearly not room to fully cover all of these areas. Most chapters give only technical descriptions of a selection of algorithms; the crypto section in particular suffers from a lack of general introductory material. There is no practical application advice given, which leaves this part of the book as a list of algorithms with worked examples. The purpose of a book on this subject should be to explain the algorithms, their application, and the reasoning behind their design. This section unfortunately seems to accomplish little towards these goals.

The best two chapters in the book are on network and transport level security (IPsec and SSL/TLS, respectively). However, these are very heavily based on the appropriate IETF RFC texts, and add very little to the freely-available material online.

While there is a large bibliography at the end of the book, there are no references at relevant points within the text. Coupled with the brevity of most sections, this makes it difficult for the interested reader to find specific information about a particular topic.

Unfortunately, the book also contains some errors. For example, a brute-force attack on DES is described as impractical; the record for breaking DES is just over 22 hours, and was set in 1999 – four years before the book was published! Other errors range from language mistakes, which merely make some sections difficult to understand, to fundamental technical misconceptions, which misinform the unknowing reader.

With the shortcomings discussed above, the book can really only be recommended as an introductory text for students and interested beginners to the area of Internet security. The book is unfortunately overly broad, low on detail, and offers little new to the fields it covers. There are many good introductory books on networking, and several on cryptography that this book will have to compete with.

Conferences of Interest

The following table shows VT-06 sponsored and co-sponsored conferences as well as related conferences not sponsored by the Society. While every attempt was made to ensure accuracy, you should contact the respective conference committee to confirm date and location.

DATE	CONFERENCE	LOCATION	WEB PAGE
22-24 February 2006	19th IZS	Zurich, Switzerland	http://www.izs2006.ethz.ch/
4-6 March 2006	IWAT '06	White Plains NY	http://research.ihost.com/iwat2006/
14-15 March 2006	3rd WIT	Hamburg, Germany	http://wit.tu-harburg.de/
4-6 April 2006	Joint Rail Conference	Atlanta, GA	http://www.asmeconferences.org/JRC06/
8-10 May 2006	VTC-2006 Spring	Melbourne, Australia	http://www.vtc2006spring.org
9-12 May 2006	13th ICT	Madeira PRT	http://ict2006.org
11-15 June 2006	ICC2006	Istanbul, Turkey	http://www.icc2006.org
9 July 2006	AP/URSI '06	Albuquerque, NM	http://www.eece.unm.edu/apursi2006/
6-8 September 2006	2nd VPPC	Windsor, United Kingdom	http://www.vppc2006.com
6-8 September 2006	ISWCS2006	Valencia , Spain	http:// www.iswcs.org/iswcs2006
25-28 September 2006	VTC2006-Fall	Montréal QC	http://www.vtc2006fall.org
23-25 April 2007	VTC2007-Spring	Dublin, Ireland	http://www.vtc2007spring.org
10-15 June 2007	AP/URSI '07	Honolulu HI	mailto:iskander@spectra.eng.hawaii.edu
24-28 June 2007	ICC2007	Glasgow, Scotland	http://www.icc007.org
1-3 October 2007	VTC2007-Fall	Baltimore MD	http://www.vtc2007fall.com

This list is based upon the conference calendar at our web site, which is updated more frequently than this list can be. To access it go to the following URL: http://www.vtsociety.org/, then click on "Conference List" in the left frame. Corrections and additions to this list are most welcome, and should be sent to Tom Rubinstein at t.rubinstein@ieee.org.

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IEEE Vehicular Technology Conference 2006 Fall
25 – 28 September 2006, Montréal, Canada

The 64th IEEE Vehicular Technology conference will be held from 25 to 28 September 2006 in the vibrant city of Montréal, Québec, Canada. The objective of the conference is to bring together researchers and practitioners in the field of vehicular technology. The conference will feature world-class plenary speakers, tutorials, and technical sessions. The city of Montréal is well known for its old world charm, French *joie de vivre* and a modern style all its own. The conference will take place during the world famous fall foliage season.

The technical program committee invites the submission of original, unpublished technical papers and tutorials in the areas of, but not limited to:

1. Radio Propagation
2. DSP for Multiple Antenna Systems
3. Radio Access Techniques
4. Radio Resource Management
5. Transceiver Technologies
6. Modeling and Simulation of Mobile Wireless Systems
7. Mobile Wireless Networks
8. Mobile Satellite Systems
9. Navigation and Positioning Technologies
10. Next Generation Services
11. Electro-Magnetic Compatibility Issues for Wireless and Mobile Networks
12. Circuits and Devices for Vehicular Systems
13. Transportation
14. Vehicular Industry Technology Track

Prospective authors are encouraged to submit a 5-page full paper (or a 2-page extended abstract including results) through the conference web site. All submissions will be reviewed by at least two referees.

Important Dates:

Papers and Tutorials Submission Deadline	February 13, 2006
Notification of Acceptance	May 1, 2006
Camera-Ready Papers Deadline	June 9, 2006

For more information and updates please visit

www.vtc2006fall.org