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IEEE VEHICULAR TECHNOLOGY SOCIETY NEWS

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FEATURES

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Florida signs up the JetTrain (see Page 43). Also in this issue, read the abstracts from the upcoming ASME/IEEE Joint Rail Conference in Baltimore. (Photo Bombardier)

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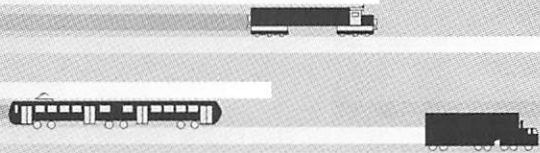
Foreword

James Irvine, Editor

Authors at VTC2004-Spring in Milan will have encountered a new phenomenon – an extra paper charge. This charge, which must be paid by an author for any additional papers after their first one, was introduced by the VTS Board last October. Since my other VTS hat is chair of the Conference Steering Committee, I thought it would be worth explaining some of the background to this charge.

As conference and travel fees have risen, and industrial travel budgets have reduced, the ratio of attendees to papers has fallen. At VTC'95 in Chicago, the ratio was about 3 to 1, but it fell to just below 1:1 after the dot com crash in 2001, and remained there through 2002. This is not to say that the only attendees at VTC are authors. In fact, many non-authors attend, but these are balanced by authors with 2 or more papers. Academics, in particular, were increasingly targeting conferences with multiple papers to keep costs down. The record, by the way, is 12.

This affect was not limited to VTC, and towards the end of 2002 the IEEE suggested that societies either charge a registration fee for each paper, or restrict authors to a single paper. The latter policy would mean rationing papers rather than selecting purely on merit, and therefore was discounted. However, over the previous years the registration fee had risen above inflation to fill the gap, and now stood at $575. Raising this further still would restrict members' ability to attend, so a decision was taken to try to keep the fee at this level, but require one registration fee per paper.

This policy put VTC back of a firm finanical footing, but did not prove popular. Authors of multiple papers did not see why they should pay for multiple meals when they could only eat one. In fact, the cost of food is a relatively small component in the overall cost of the conference, but the point is valid, and there are other one-off costs such as registration processing. For this reason, the Board decided to move to a publication charge for additional papers which reflects the true marginal cost of the extra paper.

There are two main costs for each paper: room and AV rental and publishing the paper itself. Adding a single paper to a conference only requires an existing room to be used longer, so has no marginal cost. However, the number of additional papers at VTC fills one and a half rooms over the three days, resulting in significant costs. Also, as the IEEE has reorganised its own financies, societies must bear the full costs of services they receive, and we pay both a charge per paper and per page to IEEE Conference Publishing for converting papers to IEEE Xplore™ standard, and publishing them on CD, paper and on the web. These costs add up, and for Milan, the publication charge is $275.

The publication charge makes the registration process slightly more complex, because the IEEE systems are adapted either for a full registration per paper or an unlimited number. However, so far for Milan it has worked well, allowing the member registration charge to remain at $575 and sharing the costs of the conference more fairly. If you want more details of the new policy, please feel free to contact either Conference Coordinator Glenda McClure or me (addresses on Page 2).

Software Defined Radio in Japan

Ryuji Kohno, Kenta Umebayashi, Kentaro Ikemoto and Kazuyuki Okuike, Yokohama National University

Across the range of wireless applications – cellular, wireless LANs, Personal Area Network, digital broadcastings, Intelligent Transport System (ITS), etc – there are a wide range of different incompatible systems. Software Defined Radio offers a solution to this dichotomy, because Software Defined Radio can provide multiple wireless communication systems within a single unit. This paper summaries the state of the art in Software Defined Radio in Japan.

1   Introduction

In the wireless communication field there are a variety of systems, e.g. cellular phone, Wireless Local Area Networks (WLAN) and satellite communication. Most people in Japan use a cell phone, and WLAN has become widely used in recent years. Analogue TV and radio has been used for long time. Digital terrestrial broadcasting started in Japan in 2003 with digital TV Integrated Services Digital Broadcasting for Terrestrial (ISDB-T), while Integrated Services Digital Broadcasting for Satellite ISDB-S has been available since 1996. Within the cell phone system itself, many systems and standards exist all over the world. Even in Japan, Personal Digital Cellular (PDC), Personal Handy phone System (PHS), Interim Standard-95 (IS-95) and International Mobile Telecommunications (IMT2000), e.g. CDMA2000 and WCDMA are used. If a user wants to access a number of such systems, they have to have multiple terminals corresponding to the number of required systems. Alternatively, Software Defined Radio (SDR) can adapt to multiple systems with a single terminal. Since most of the SDR is made up of programmable devices, e.g. DSP and FPGA, it can be reconfigured by changing its software. This is the key feature of SDR and it has been studied actively since 1995 [1-3]. In this paper, trends in SDR development in Japan are introduced.

Recently, SDR research has moved from the researcher's desk into practical implementations. Multiple SDR prototypes have been developed to research and study practical SDR. However, development of SDR techniques is still required. This paper looks not only at the basic research, but also to applied research for practical implementations.

This paper is organized as follows. In Section 2, basic concepts and the advantages of SDR are introduced. In Section 3, world research trends are described briefly. Section 4 covers the research in Japan. Finally, in Section 5 conclusions are drawn.

2   Software Defined Radio

There are several ways to explain the idea of SDR, but the obvious distinction between SDR and a conventional radio is that unlike conventional radios, SDR is designed to change its configuration. Reconfigurations are implemented in the system level and the module level. The advantage of this change is that SDR can adapt to several wireless communication systems with just one terminal. In addition, finding a single optimum algorithm for any situation is nearly impossible, because the optimization depends on not only the algorithms but also the situation, e.g. a channel and traffic, which are changing dynamically. However, since SDR can adapt with algorithm changes, it can give an optimal configuration. In this manner, SDR has the advantage of reconfigurability and adaptability over previous radios.

Figure 1 shows a simple SDR configuration. Three cases are illustrated. Case 1 corresponds to the conventional radio configured with digital devices in the Base Band (BB) area. The Radio Frequency (RF) and Intermediate Frequency (IF) subsystems are configured by fixed analog devises. Case 3 is the first concept of full SDR. Almost all areas are configured with digital devices, e.g. DSP (Digital Signal Processor) or FPGA (Field Programmable Gate Array). This means that the SDR can be completely reconfigured by changing its software. In case 2, the RF area is fixed, which gives it less flexibility than Case 3. However, it does not require the wideband Analog to Digital Converter (ADC)/ Digital to Analog Converter (DAC) and a higher speed programmable device of Case 3.

The application field of SDR is wide-ranging, e.g. military, surveillance of illegal users and many consumer systems. In military and surveillance applications, there are some cases where the specifications of the received signals are unknown to the receiver, so SDR concepts are required. In consumer wireless communications, SDR techniques are required in 4G to create a seamless network environment and adaptive communication. This can be realized by changing the communication schemes in a terminal. For example, SDR terminal could change not only between cellphone systems but also to other systems such as WLAN
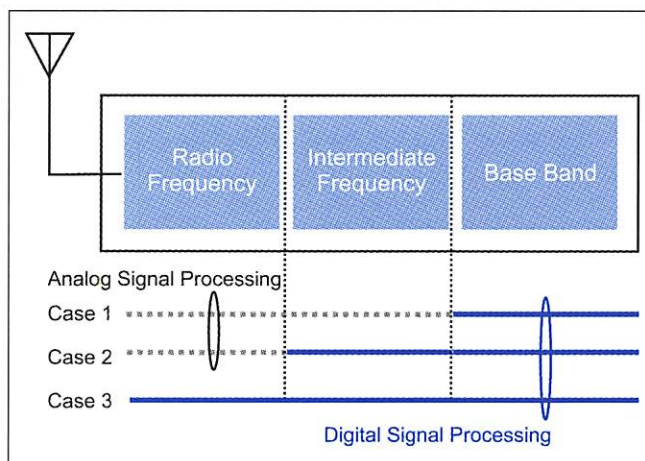

Figure 1 Configuration of SDR

to avoid interrupting communication. SDR could reconfigure the system to adapt to user needs or the channel environment, for example, between a high data rate communication channel to watch a movie, or a low rate channel for voice cellphone communications. SDR is likely to be applied in the near future in the consumer field.

3 Research Trends in the World

3.1 Overview

In the following sections, key topics relating to hardware, software and regulatory matters are described.

Looking first at hardware, the novel issue of superconductor techniques for SDR is introduced in [4,5]. In fact, this technique has been of interest for a long time, but the solutions introduced in this paper can be considered a breakthrough compared with the conventional results. The architecture of SDR is a key topic, and two approaches can be identified [6-8]. One of these approaches is based on the device, and another approach on the function of system designed with the devices. To realize the required programmability and performance, e.g. consumption and processing rate, discussion from both stances is necessary.

One of the remarkable topics in SDR is the Software Communications Architecture (SCA). In this paper, SCA is described as the topic of software and architecture [9-11].

SDR research has to consider regulation. Existing regulation assumes that the radio will change its system configuration after it is released. However, SDR does not conform to this and so can be illegal under conventional regulation. This paper compares views of the regulation among US, European and Japan [12-16]. To make SDR possible, regulation has to be consistent, but different attitudes currently prevail.

3.2 Hardware

3.2.1 Superconductor techniques

Work in [5] and [4] focuses on superconductor techniques to realize true digital RF for SDR. Previous work had considered a flexible architecture but without a digital RF (i.e. Figure 1, case 2), because a digital RF requires the super high performance ADC/DAC and digital processors. This new work shows that by using superconductor techniques, such high performance devices can be realized. The work assumes such techniques will be used in military applications, e.g. Joint Tactical Radio System (JTRS) and Military Satellite Communications (MILSATCOM), where cost is not such an issue. [4] introduces the cryo-packaging techniques which is key issue in the superconductor. Recent developments in the cryo-packaging techniques are remarkable in the reduction of the size, weight and power. In [4], a digital RF radio with a size for 19"–16" is introduced. [5] shows several examples using the superconductor techniques. Figure 2 shows the direct digital frequency conversion transceiver architecture, where the blue block is constructed by the cryogenic superconductor electronics. Based on this architecture, [5] attempts to design the SDR which covers from 2GHz to 55GHz. In addition, ADC/DAC operating with 15bit quantization and 20GHz sampling is shown.
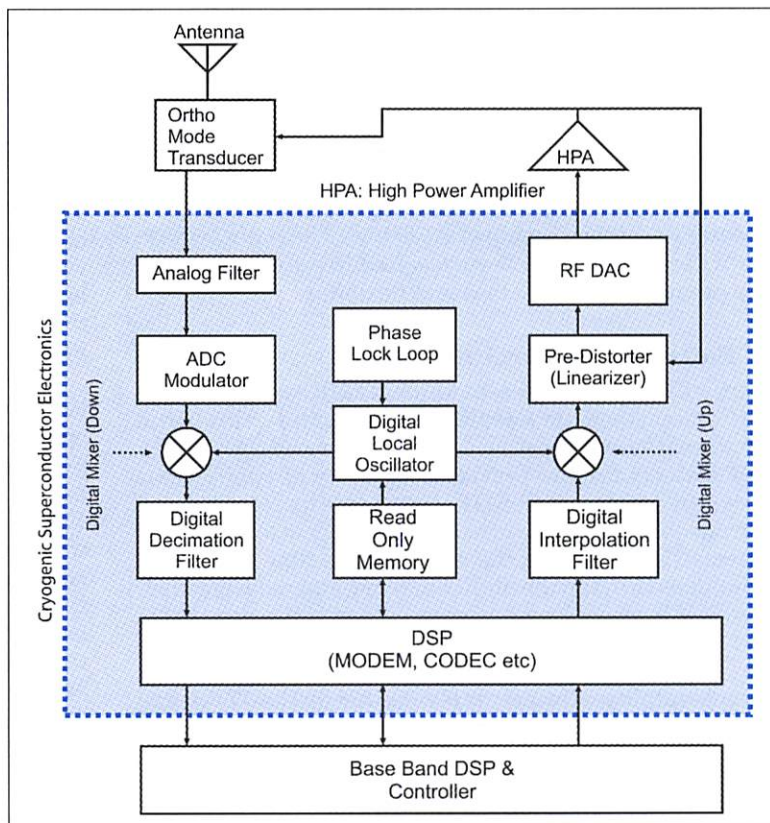
Figure 2 Direct Digital Frequency Conversion Transceiver Architecture

For consumer applications, [4] describes superconductor techniques that can be achieved in the base station of the cellphone system. Actually, if a transmitter configured with superconductor components can serve such a wide band, it could serve not only cellphones but also other applications in wireless communication concurrently.

3.2.2 Programmable devices and system architecture

The choice of the devices is the most important problem when the design of SDR is considered. For this problem, two approaches are considered. The first approach is to examine existing devices to improve them. The second is to start from the discussion of the SDR architecture to optimise devices considering necessary performance and cost.

Reference [6] presents the Silicon Hive's coarse-grained reconfigurable accelerator technology, which proposes to fill the gap between the non-programmable processors and conventional programmable processors. ASICs have low-cost and high performance, but are fixed. DSPs are programmable, but are high cost compared to ASIC. [6] has paid attention to this problem.

References [8] and [7] discuss Rake technique for multiple CDMA systems considering the kinds of the programmable devices. The Rake process consists of chip level processing and symbol level processing. If both are implemented in a single device, that device has to be suitable for the chip level processing, which is much faster than the symbol level processing. Hence, the processing speed of the device is excessive for the symbol level processing. In addition, programmable devices require more power than fixed devices. For this problem, [8] attempts to assign the suitable devices to each level of processing: the chip level process is on an FPGA and the symbol level processing on a programmable

devices, a DSP. In addition, [8] focuses on the modules implemented in SDR in the future. Existing radios cannot anticipate the future modules, so if unexpected modules are implemented in the previous radios, they cannot be operated correctly. Also multiple threads must be considered where the synchronization of each process has to be satisfied. To allow for future modules and multiple threads, [8] proposes an original architecture using a hardware accelerator and programmable switches and investigates a message command interface to retain flexibility.

3.3 Software and Architecture

There will be many different kinds of SDR systems. These SDR systems should ensure interoperability through a Software Communications Architecture (SCA) [9-11]. SDR systems need to provide portability of applications between different SDR implementations and upgradeability in terms of easy technology insertion. SDR systems should reduce the development time of the new techniques through the ability to reuse and redesign modules. SCA is an open, non-proprietary specification that is a set of rules that constrain the design of SDR. It is one of the elements of the SDR that will increase the interoperability of radios. It is required by the JTRS, and then validated by the JTEL (JTRS Technology Laboratory), for firms that want to be involved in large contracts for the government. Viewpoints are different in terms of its application. Waveform developers focus on the knowledge and skills required by the SCA related skills UML/Object Orientation, CORBA and XML and the observed waveforms environment in the SCA. Hardware engineers seek how to interface hardware with the emerging software requirements in the radio business. Managers think in terms of what direction to provide and where resources and infrastructure need to be allocated. To realize the SDR goal needs a standardization of the architecture. It should provide a foundation for the digital system and a level of abstraction from the implementation, describe system as the collection of elements, connections and topology, define interfaces among elements, and also allow elements to communicate.

3.4 Regulatory and Security Issues

There are different views on regulatory and security issues for SDR between Japan, US and Europe. In the US, the Federal Communications Commission (FCC) submitted "First Report and Order"[12] in September 2001. This report described the definition of SDR for the purpose of the new regulation and the new Class 3 Permissive Change for post-authorization radio software change. In Japan, the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) has been studying on necessary requirements for rule making of regulation and certification system for SDR and published reports [13-15]. In Europe in November 2001, Germany introduced a proposal to set-up a TCAM subgroup to study the regulatory aspects of SDR, and whether the R&TTE Directive can deal effectively with such products. There is a different attitude to regulation in that in the US, hardware manufacturers must take steps to prevent unauthorized software changes to a SDR. However, in Europe, hardware manufacturers don't have to take such steps, but must have responsibility for the intended uses of SDR. In Japan, the certification authority controls software download to prevent unauthorized software changes to a SDR.

4 Research Trends in Japan

4.1 Overview

The main SDR research topics in Japan are described in this paper.

Firstly, two regulatory issues and four security issues are explained. The regulatory issues: are ACU (Automatic Calibration Unit) and ACS (Automatic Certification System) which are particularly important for SDR, as existing radio law cannot be applied to SDR [16-20]. In the security issues, the secure download schemes and secure architectures in SDR are shown [17-27].

Secondly, digital signal processes for SDR are covered. A key feature of SDR is its multimode function, i.e., that it can operate with different air interfaces. There are two approaches to do this. The first is to have multiple units implementing each mode, but the size of the device would be huge. The alternative is to use a unit which can adapt, and this is the recent direction of the SDR research. New and intelligent algorithms are necessary, as are reviewed in this paper. Examples of the digital signal process studies are the modulation identification, the processing for multimode, adaptive or smart antenna techniques and adaptive modulation and coding techniques. Until now, modulation identification techniques have only been used in the only non-consumer field like a military or radio surveillance [28-32]. However, SDR allows use of such techniques in consumer applications, i.e. adaptive or multiple modulation schemes [33-35]. Also, since the digital signal processes for multimode functions will make the universal radio possible in future, multimode techniques are of great interest.

Studies are also underway on ADC and DAC. Given the SDR architecture, the position of ADC/DAC is very important, because it defines the flexibility and capability of SDR. In light of the requirements and development speed of ADC/DAC, actual ADC/DAC performance is below what is required. To address this, techniques such as parallel ADC with a filter bank have been proposed. ADC/DAC has a close connection with sampling rate [36]. In a multimode system, multiple sampling rates are necessary. Also, sampling jitter is a more sensitive problem in SDR, because data rate is assumed to change dynamically [37].

SDR architectures depend on the down convert technique chosen. Different digital down convert techniques and direct conversion techniques are described [38, 39].

Finally remote maintenance is considered [50,51]. This is a new concept for SDR, but it is possible this will become a key application in the future.

4.2 Regulatory & Security Issues in Japan

In order to realize SDR, several organizations have proposed systems to address regulatory & security issues. The targets of those studies are to verify the secure use of SDR.

4.2.1　Yokohama National University - Automatic Certification System

YNU (Yokohama National University) has proposed ACS (Automatic Certification System) to provide a simple method of authorizing SDR software [18-21]. ACS is a system which gives type approval automatically to software which affects such things as the output power, central frequency, frequency band, and modulation type in an SDR terminal. Figure 3 gives a block diagram of ACS. By mounting ACS in the terminal, it is possible to give approval to the software in a terminal, without applying to a governmental authority. ACS itself is software for reconfigurable hard-
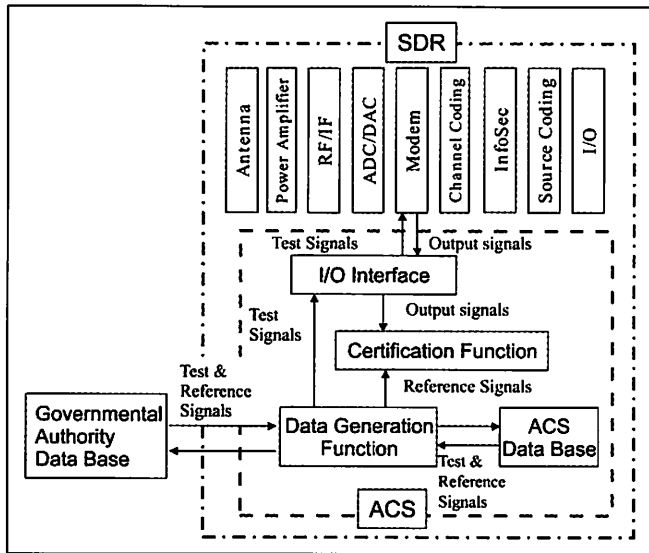
Figure 3 Configuration of ACS

ware, and therefore can be changed or updated. ACS consists of an I/O Interface, Data Generation Function, Database, and a Certification Function. The I/O Interface controls the test signals and output signals that are generated in the Data Generation Function for certification. It also sends the test signals to the reconfigurable hardware modules and receives the output signals from the reconfigurable hardware modules. After that, it sends the output signals to the Certification Function. The Data Generation Function generates the test signals and reference signals for certification from the ACS database or the governmental authority database. Generally an ACS database can be used, but a governmental authority database is used if the new software downloaded is not stored in the ACS database. The ACS database and the governmental authority database contain test signals for certification. The ACS database is included within the SDR systems (e.g., SDR terminal, SDR base station, and so on), therefore the ACS database is smaller than a database from a governmental authority. The database of such a government authority contains all I/O data. The Certification Function examines the changed modules using the output signals from the I/O Interface and test signals from the Data Generation Function.

ACS is one of three approaches to tackle this regulatory problem. The others are ACU [22-24], and C3PC which is proposed by Federal Communications Commission (FCC). Table 1 compares these approaches.

4.2.2 Yokohama National University - Secure Download System

YNU has proposed a secure framework in order to realize secure download in SDR [26, 27]. The framework assumes that software manufacturers are independent from hardware manufacturers.

The protocol of the proposed system is below.

1. A user (SDR terminal) sends his terminal ID and download request to the server.

2. The server searches the current mode of the terminal using the terminal ID. The server then generates a random number for the place-and-route operation as well as the configuration data (CD) which the terminal requested. The server then produces a differential CD using an Exclusive OR operation between the re-

	C3C (FCC Proposal)	ACU	ACS
Authorization Place	Appropriate governmental authorities	Appropriate governmental authorities	Appropriate governmental authorities + Terminal
Authorization method	Combination of HW and SW	Separate HW and SW	Combination of HW and SW
Authorization number (HW: M, SW: N)	MN	M+N	M
Prevent malicious or illegal software	e.g. label	e.g. label	Authorization
Role	Verification of integrity	Calibration	Authorization
Realization method	HW or SW	HW	SW
Power consumption	Only during approval	always	Only during approval
Update	Change SW/HW	Data base	Change SW

Table 1 Comparison of ACS and other schemes

quested CD and the current CD of the terminal. The user can now download the differential CD.

3. The user now performs an exclusive OR operation between the downloaded CD and its current terminal CD. The terminal of the user is now reconfigured.

4. The user sends a reconfigure complete notice to the server through a new downloaded communications system.

The random number is only used in the place-and-route operation. Sharing the random number between the server and the terminal is not required. The proposed system exploits the fact that the size of the downloaded CD is always the same. SDR terminals download the differential data generated by the exclusive OR operation performed between the requested CD and the current CD of the SDR terminal. This system is therefore seen to be similar to a private-key cryptosystem in that the current CD of the SDR is used as the key. This is renewed every time the SDR is reconfigured. Currently, the place-and-route operation necessary to configure the circuit on the FPGAs takes some time. It is therefore difficult for the server to perform this place-and-route in real time, so the proposed system caches some predesigned CDs temporarily on the server.

4.2.3 Tokyo Institute of Technology - Automatic Calibration Unit

TIT (Tokyo Institute of Technology) has proposed ACU (Automatic Calibration Unit) [22-24] to solve the compliance concern. The FCC proposed a new authorization policy on SDR [12]. SDR hardware must be licensed with initial set of software by the FCC, and applicants are responsible for preventing unauthorized software running. For now there is no manufacturer which can enable its equipment with such a mechanism, and even if manufactures come up with such a mechanism, it will be problematic to give an adequate, standardized evaluation of the degree of compliance provided. Moreover, all hardware and software combinations must be

tested to be authorised, which damages SDR's flexibility. To solve the compliance and stability concerns, TIT proposes an Automatic Calibration Unit (ACU) and promote a novel authorization procedure employing the ACU. The ACU is a hardware embedded module which controls Central Frequency, Output Power, Out of Band Emission, Occupied Bandwidth and the other necessary RF parameters within the regulation range. It operates during all stages of terminal lifecycle. At the initialization stage when a new software is loaded into memory, the ACU controls hardware calibration. Next, at the operation stage, it controls the terminal to secure the stable operation. At the final shutdown stage, the ACU controls the terminal to combat with any unexpected hardware malfunction. This allows the ACU to provide compliance and stability to SDR terminals. The novel authorization procedure called AMAP has 2 steps:

(a) new hardware + trial software

(b) new software + trial hardware

In step (a), a new hardware is tested using a trial software provided by the authorization body and licensed. In step (b), a new software is tested by a trial hardware provided by the authorization body and will be given license as well. Thus, hardware and software licensing procedures can be completely separated and SDR flexibility greatly improved.

4.2.4 Tokyo Institute of Technology - Global SDR Security Architecture

TIT has also proposed a radio security module that enables global roaming of an SDR terminal while complying with local radio regulation [23, 24]. Their security architecture enables separate software and hardware certification. This separation means that less certification is needed by the Telecommunication Certification Body. The architecture applies hybrid encryption to protect the software during download process. This enables the software maker to distribute its software freely without depending on the hardware maker. To realize this, a Radio Security Module (RSM) is proposed to be installed in every SDR terminal. The RSM takes care of the installation, storage, operation and termination of software in the terminal. Since different radio regulation exists in different countries, when a terminal roams, the RSM makes sure that only software that complies with local radio regulation is allowed to run. This is done by random GPS verification with the allowable GPS range of the running software by the RSM. A model of SDR terminal was implemented in a personal computer to investigate the software complexity of the RSM.

Figure 4 shows the proposed implementation of the RSM. The IF/baseband consists of FPGA and DSP chips. A microprocessor, RAM, ROM and flash-memory are built into a single chip, in a similar structure to a smartcard. The ROM stores a real-time OS with the RSM. User-inaccessible components are stored in flash memory. Only logical access to the flash memory through the RSM is allowed, so user-inaccessible components are tamper resistant. Logical access is protected by a password which is set by hardware maker during manufacturing process.

4.2.5 Sony CSL - Secure Download System

Sony CSL has proposed Secure Download System for SDR [40]. To promote the commercial implementation of software download for SDR terminals, a secure method of download is vital. They examine the need for software download for SDR, and propose a comprehensive system framework within which secure download can be carried out. The features of the proposed system include unique individual encryption for each terminal and secure exchangeability of
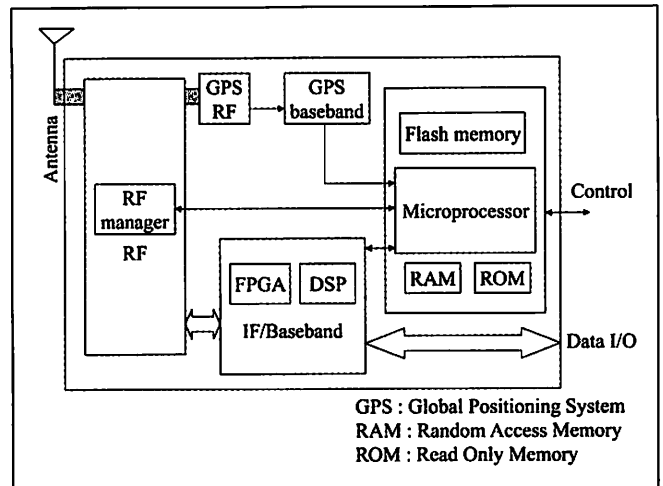
Figure 4 RSM implementation

any cryptographic components. The main goals of the security system are: (i) verification of the identity of the source of the software; (ii) control and verification of the integrity of the downloaded data; (iii) disabling of the ability to run unauthorized software on the software defined terminal; (iv) secrecy of the transmitted data. The proposed system is flexible and in harmony with current requirements regarding the SDR security issues.

4.2.6 NTT - Security Architecture

NTT has proposed a Security Architecture for SDR [25]. As SDRs can change their functions by replacing software, many security problems will arise which do not occur with fixed wireless terminals. The architecture was defined taking a distribution model of SDR terminal software into account. In the architecture, security layer 1, which concerns radio regulation, is mandatory for all use-cases. In order to preserve security, they propose security schemes which use digital signature technology for the distribution model. Three methods are quantitatively compared and discussed [25]. The proposed method can ensure the validity of SDR terminals by detecting tampered software and rejecting it before installation into the hardware.
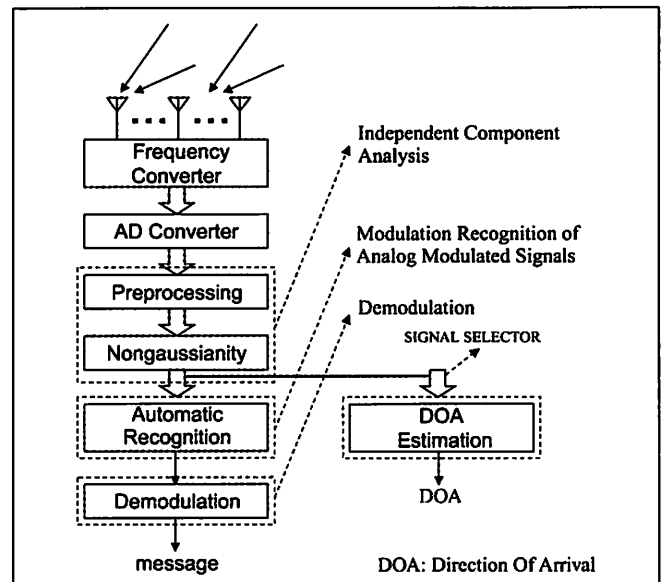
Figure 5 Radio surveillance system with the modulation identification algorithm

4.3 Digital Signal Processing

4.3.1 Modulation Identification

The study of the modulation identification techniques in SDR can be divided into three main approaches. The first approach is applied to the non-consumer field, i.e. radio surveillance [28-32] while the second is for the consumer field, i.e. adaptive modulation scheme [33-35]. A third approach does not assume specific applications [41-43]. Another trend for modulation identification techniques studies is that they are often combined with other techniques, such as synchronization, adaptive array antenna, equalization and noise power estimation. Table 2 gives a comparison of each of these studies.

| Scheme	Modulation	Application	Additional Function
[28], [29], [31]	FM, AM, DSB, SSB	Radio Surveillance	Array antenna
[33], [34], [35]	B, Q, 8-PSK, 16QAM	Adaptive modulation	Carrier Recovery
[41]	M-PSK	Non	Noise estimaton

Table 2 Comparison among the modulation identification studies for SDR

In the first approach which has been considered – modulation identification techniques in radio surveillance – an array antenna is used to estimate the direction of illegal radio signals using a Direction Of Arrival (DOA) estimation algorithm. After that, an Independent Component Analysis (ICA) algorithm is used to separate the independent source signals from the mixture of signals [28, 29]. The proposed system block is shown in Figure 5. In these papers, new work is reported on the blind source separation problem.

In [33], modulation identification and carrier recovery are considered by using a multimode PLL which is shown in Figure 6. This is suitable for consumer applications which have adaptive modulation schemes. This study focuses on phase lock detection which is similar to the modulation identification. The most important advantage of this proposal is that acquisition time is expected to be much shorter than the case where the carrier recovery and the modulation identification work separately. This is because with the

multimode PLL, carrier recovery and modulation identification are done at the same time. The basic behavior of the multimode PLL shown in Figure 6 is as follows.

1 Initially switch SW is open, so the conventional digital PLL illustrated in chain line does not operate.

2 At the receiver, the signal output from matched filter contains a fixed carrier offset, fixed initial phase offset and Additive White Gaussian Noise (AWGN), and the received signal is input to the Phase Lock Detectors (PLDs).

3 Each PLD detects the "Phase Lock" window by window, where the window corresponds to the observation period for "Phase Lock".

4 The modulation scheme is identified by the outputs of PLDs.

5 After the modulation scheme is identified, switch SW is closed and the Phase Error Detector (PED) and LooP Filter (LPF) are reconfigured corresponding to the identified modulation type, and the digital PLL operates to recover the carrier offset.

In [41], the blind noise power estimation for M-PSK is proposed by using high order moment parameters. Their proposed scheme is compared with other estimation methods using the other high order moment parameters and a most likelihood algorithm. The block diagram of modulation identification is shown in Figure 7. A brief explanation of the modulation identification algorithm in [41] is as follows.

The upper blocks estimate the SNR assuming their particular modulation. The results are $\hat{n}_{MOD}$, where MOD denotes the modulation type. For the noise estimation algorithm in [41], when the modulation type of the received signals is M_1-ary PSK and the SNR is estimated as M_2-ary PSK, if $M_1 < M_2$ the estimated SNR $\hat{n}_{M_2\text{-}ary}$ is less than true SNR. According to this characteristic, if the $\hat{n}_{MOD}$ is less than a threshold in a block, the block outputs 0, otherwise it outputs 1. The codeword is obtained from the outputs of each block, and by selecting the minimum distance between the obtained codeword and the reference code word, the modulation scheme can be identified.

In addition, these proposed schemes are applied for a blind beam forming algorithm of adaptive array antenna and blind modulation identification techniques.

In wireless communication, multi-path has to be considered. To solve this problem, equalizing and OFDM techniques are widely applied. Equalizing techniques can cancel the ISI from the multi-path channel, while OFDM can reduce the effect of ISI by lengthening the symbol period. However, few papers on modulation identification techniques consider multi-path channels. An exception is [41], which does so by combining modulation identification and blind equalization, but it cannot be said perfect blind receiver. In fact, the problem of synchronization has to be added to the previous ones of modulation identification and blind equalization.

4.3.2 Multimode Techniques for SDR

Multimode is considered to be one of the important characteristics of SDR. In addition to modulation identification, other issues include the pre-distortion for the amplifier and the synchronization technique of symbols. In SDR, signals with variable amplitude go through the amplifier in the RF unit, so the
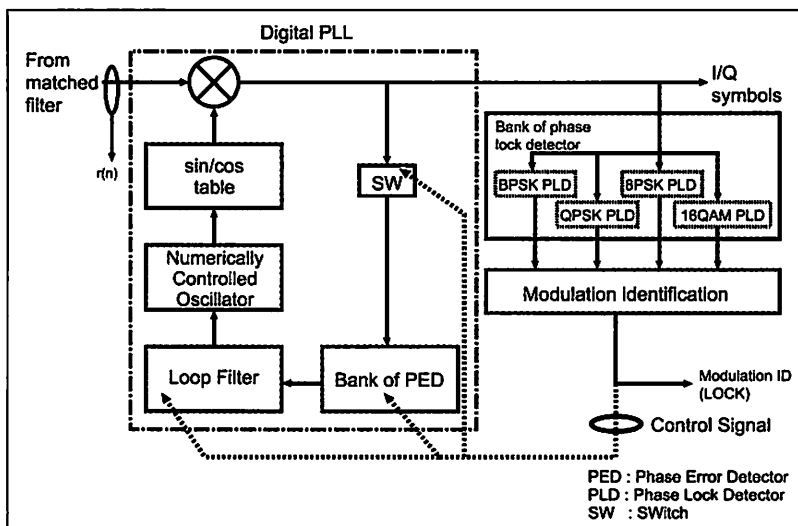

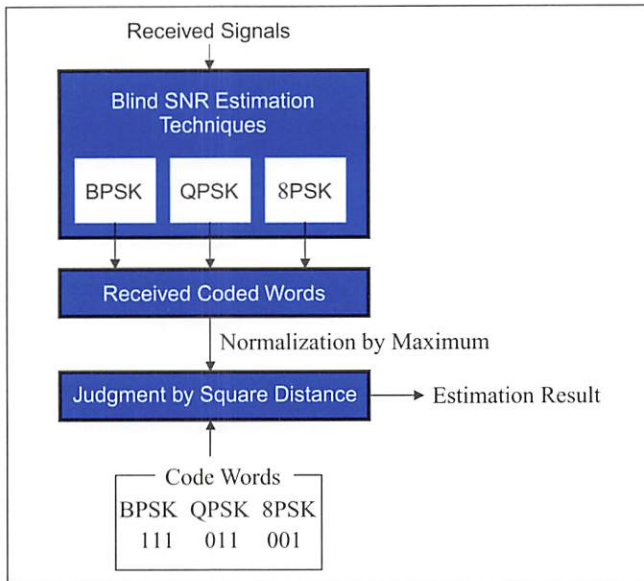**Figure 6** Block Diagram of Multimode PLL

Figure 7 Modulation Identification algorithm with blind SNR estimation algorithm

design of the amplifier is critical. To track the characteristic of amplifier, a pre-distortion function calibrates the input signal to the amplifier to satisfy the outputs of the amplifier. This problem is very similar to the peak power problem in OFDM. In OFDM, the peak power problem depends on the combination of input signal sequence, so a coding scheme can be used to solve the problem. However, SDR is multimode, so the problem changes. There are two approaches to resolve the problem: adaptive pre-distortion in RF [44] and a pre-distortion linearizer with Automatic Calibration Unit (ACU) in baseband [45]. The block diagram of pre-distortion linearizer is illustrated in Figure 8. The main difference of these approaches is where the pre-distortion is performed: RF or baseband. [44] has considered using digital signal processing distortion for amplitude and phase arbitrarily in RF, while [45] notes that RF distortion is analog, and so there are the problems of analog processing error as well as the difficulty of fine control. [45] uses a pre-distortion function which can compensate for the nonlinear distortion in baseband with digital signal processing, here, the out-of-band power spectral is suppressed about 10dB. However, in [45], the feedback circuit has to be added.

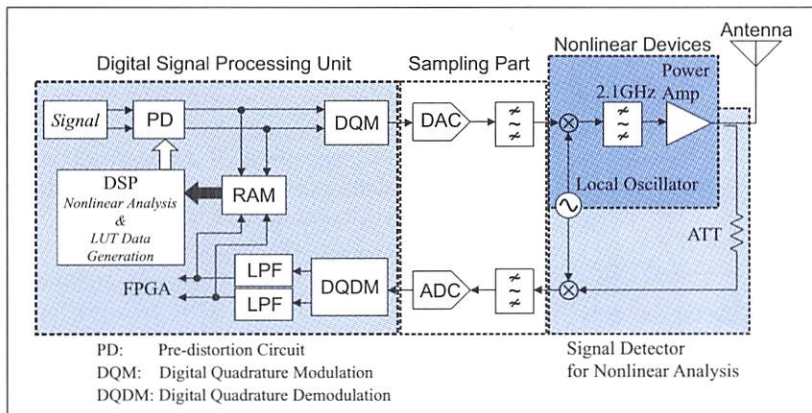In the SDR, variable symbol and data rates will occur. Clock and sampling rates for each could be implemented

in the SDR, but this results in a huge device. To resolve this problem, common rate sampling has been investigated [33]. By using one sampling rate, there is a case that the sampling rate is a non-integral multiple of symbol rate, so an adaptive symbol timing synchronization method has been considered. In adaptive symbol timing and flexible timing synchronization, maximum likelihood estimation is applied. This method estimates symbol synchronization points from patterns calculated by symbol rate and sampling clock by using memory where the patterns are stored. However, there are some worst cases which have very poor BER characteristics due to the relationship between sampling rate and data rate. Additionally, large memory size is also necessary. Therefore, [37] tries to reduce the number of patterns in order to decrease the memory size, while keeping the BER characteristic. However, the very poor BER characteristic problem has not been solved yet.

4.3.3 Adaptive Channel Coding Technique

Adaptive channel coding and decoding systems that can switch between different coding rates and error correcting capabilities in order to adapt to changing applications and environments, are effective for SDR [46]. This focuses on the adaptive radio which can change to match variations in the environment. Specifically, it considers adaptive coding techniques where the encoder is switched according to temporal changes in the environment, as in conventional adaptive coding schemes. The proposed adaptive coding scheme introduces reconstruction of the statistically and temporally changing environment with a finite state machine (FSM) to orient encoding switching. There are two benefits of the proposed scheme. Firstly, a FSM can orient the maximum likelihood trellis encoder estimation and switching thereby estimating the encoder transitions without using the supplementary information. Secondly, statistically steady and dynamic channels can be foreseen so as to switch the encoder and predict its transitions easily. This is the layered FSM.

So far, adaptive coding schemes require either additional information or that the decoder estimation is based solely on reliability. On the other hand, the aim of the study conducted by the authors is to minimize the DSE. Conventional systems use additional information in order to select the right decoder. As these techniques imply a certain redundancy, systems have been developed, that operate without such supplementary information.

This can for example be achieved by using reliability-based selection obtained with all Viterbi decoding results, the authors have published recently. However, with such a system it is hard to increase the distance between two encoders. The use of a trellis diagram is therefore proposed to estimate which encoder was used. By using a FSM for the encoder selection we further reduce the estimation error. The evaluation shows that one should avoid using supplementary information.

At the same time there are problems with the FSM. One problem is the gradual transition of the channel condition. It is not clear whether the proposed method of limiting the encoder transition by FSM is appropriate to support estimation of dynamic channels. The other problem is when there is no transition of channel condition. In the worst case, when the channel changes from the best state to the worst state suddenly, and moves between two states, this method of limiting the encoder
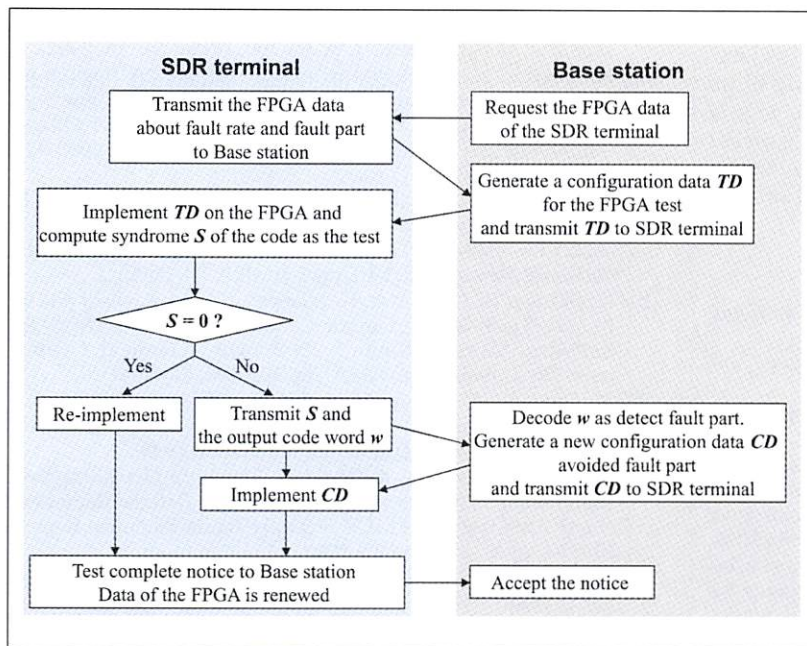

Figure 8 Pre-distotion Linearizer

Figure 9 Fault detecting algorithm flowchart

transition will deteriorate the BER and Frame Error Rate (FER) performance compared with the unrestricted encoder transition.

We propose a layered encoder transition countermeasure for these problems. The layered encoder transition scheme selects several encoder transitions of FSMs that can adapt to changes in the channel condition. The system can select the optimum encoder by switching several FSMs, each with different encoder transitions.

4.4 ADC & DAC
Power consumption of analogue-to-digital converters (ADCs) and base band circuits is a major problem in a battery-powered mobile terminal. Faster ADCs lead to increased power consumption, while increasing sophistication of the digital circuitry causes the same problem. To reduce the sampling rate of the ADC, quadrature sampling can be employed. This approach can reduce the rate, and hence power consumption, by using two ADCs for I and Q channels. Band pass sampling for limited-band IF signals has also been examined. As noted above, a contrasting approach – an architecture employing an extremely fast sampling ADC – has also been invented, employing super-conductive devices, and its feasibility proven. For this problem, there are new studies, i.e. parallel ADC with filter bank. ADC/DAC has a close connection with the sampling rate [36].

4.5 Down Converter Techniques
In addition to the ADC/DAC, the down converter is key to the SDR receiver architecture. These have been investigated with a view to making SDR more flexible. Until now the focus has been on down converter techniques, i.e. direct conversion or IF conversion [47-49]. However, recent research has considered a digital up and down converters with polyphase filters [38,39]. The decimator and the interpolator dominate power consumption, so work is targeted on these to reduce it. In addition, a digital down converter and digital up converter with high design flexibility can be built by using the coarse step frequency conversion of the 2-step digital down converter and digital up converter.

4.6 Fault detecting
When a conventional terminal has faults, a user must bring it to the manufacturer for hardware exchange. However, an SDR terminal may be remotely repaired due to the its reconfigurability. This is a significant advantage for both user and manufacturer. Therefore, [50] focuses on establishing reliability for SDR terminals assuming they are based on an FPGA. Fault diagnoses of FPGAs has been the subject of active study. The one proposed method is testing whether the FPGA performs a particular function correctly, but this is only suitable for testing unprogrammed FPGAs before shipment. Such diagnosis before the shipment is usually very comprehensive, since it is to improve manufacturing lines and find the cause of any detected faults. However, when an FPGA is tested periodically in the SDR terminal after shipment, it is only necessary to detect a faulty part, so much less computational effort is required.

Work reported in [50] proposes an efficient method for remote FPGA fault detection and location through the regularity of a test output pattern. The algorithm flowchart can be shown in Figure 9. The work employs error correcting codes (ECC) for this regularity. Using this system, computational cost can be reduced compared to a non-coded method. However, there is a trade-off between the reduction of the computational cost and the degradation in the probability of aliasing (the probability of not detecting a fault correctly). This is because the proposed method has some undetectable fault patterns. The ECC used is therefore selected for the particular FPGA involved.

5 Conclusion and future subjects
This paper has described the recent SDR research topics in Japan: regulatory & security issues, digital signal processing for multimode radio, ADC & DAC, down converter and some other topics. In the digital signal processes, modulation identification, digital down/up converter, pre-distortion methods to calibrate input signal of amplifier, and adaptive and flexible sampling methods were addressed.

It is not surprising that the these topics cannot cover all SDR research in Japan. Surveying these issues, future subjects are found easily.

To realize the usefulness and flexiblity of SDR, regulatory issues have to be addressed. Although the C3PC method is very simple, it has reduced flexibility. On the other hand, other methods such as ACU and ACS solve this flexibility problem but constrain architecture design. Other research topics, i.e. down convert techniques, ADC/DAC, also exert an influence on the SDR architecture. Therefore, future SDR research has to pay attention to the total design including all SDR topics.

In current wireless systems, there are various different communication schemes for cellular, wireless LAN, and Personal Area Network (PAN). One of the characteristics of future wireless communications is for it to be seamless. SDR can help achieve this because SDR is multimode ra-

dio. However, SDR techniques can go beyond this to create a new concept in communication system. In fact, [41] has proposed such a system with a blind receiver using blind modulation identification algorithms and some signal processing methods. When considering such new concept communication systems, the needs of the communication system and the problems of existing communication systems have to be considered.

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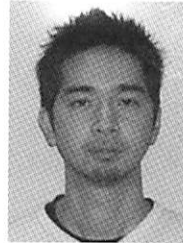
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Portable and Embedded Wireless Devices as Conduit for Telematics Applications

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As wireless devices and cellular networks continue to evolve, opportunities are created for enhancing the overall user experience with telematics related services. This paper discusses the pros and cons of portable phone systems and embedded phone systems as conduits for telematics applications. Methods to enhance embedded in-vehicle telematics systems to include operation with handheld wireless devices on both Wide Area Networks (WAN) and Wireless Local Area Networks (WLAN) will also be presented. Services will be discussed that allow vehicles and wireless devices to interact with each other and with remote servers. Implementation options will be explored along with an analysis of the key players in the telematics supply chain (i.e., OEMs, Suppliers, Carriers, Call Centers, Consumers) who ultimately benefit from each approach.

Introduction

Automotive telematics is the blending of wireless telecommunications, information technologies, and vehicle-based human-machine and machine-machine interfaces. Historically, automotive telematics functionality has consisted of safety and security applications such as air-bag deployment notification, remote engine diagnostics, roadside assistance, remote door lock/unlock and theft tracking. Other applications such as concierge services, hands-free cellular voice communications, navigation and traffic information have attempted to enrich the user's overall driving experience.

As the telematics market continues to grow, applications and services that seamlessly connect the automobile to the rest of the world will become increasingly important (Figure 1). Technological advancements and regulatory trends for in-vehicle cellular communications are helping to drive consumer interest in telematics products. Next to the workplace and home, consumers spend more time in their cars than anywhere else [1]. The challenge is to provide the right portfolio of applications and services that satisfy emerging regulatory trends, meet the needs of the consumer and fulfill the business models of the key players in the telematics supply chain.
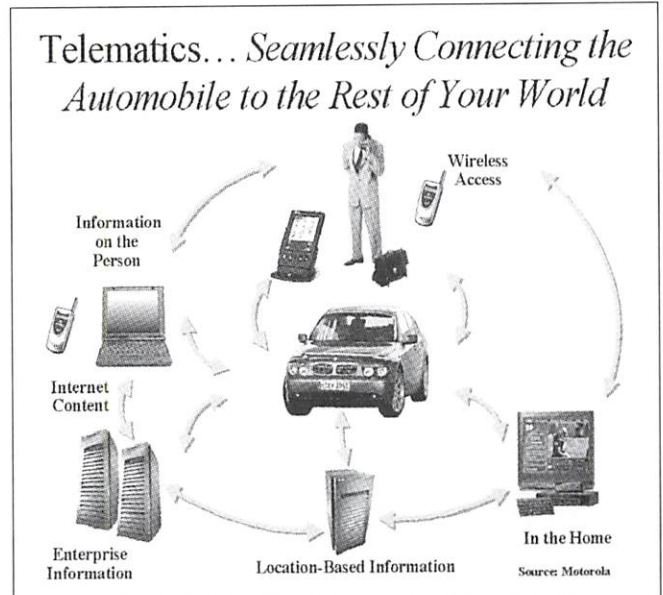
Figure 1 Seamless Telematics Connectivity

A recent Strategy Analytics survey (Figure 2) plotted key potential telematics applications and services in terms of value to the user versus potential frequency of use. This survey shows that Emergency Roadside Assistance (ERA), security, and cellular voice communications present the most significant opportunity for in-vehicle service providers because they are of highest value to users – across consumer segments [2]. Understanding these consumer interests and usage models is one key element in designing enhanced telematics systems.
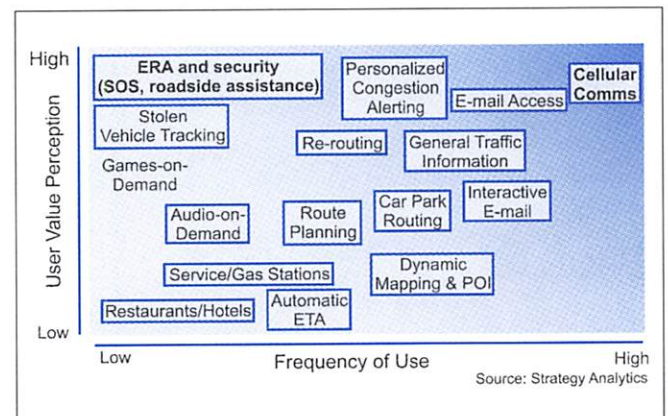
Figure 2 Strategy Analytics Consumer Survey

Wireless embedded phone systems, portable phone systems, and combined systems are the conduits for telematics applications and services. We will discuss in detail the advantages and disadvantages of these systems along with emerging technologies that will significantly influence the telematics industry. Overall, we believe there is no one single solution that satisfies the entire telematics market. Instead, a suite of products, services, and applications tailored for each automobile manufacturer and consumer segment will ultimately be the most beneficial solutions for the telematics market.

Traditional Telematics Architectures

Today's automotive telematics architectures are tailored for each automobile manufacturer. Figure 3 shows a combined embedded and portable phone system and the interaction with a service provider. In this design, an embedded transceiver is used to communicate wirelessly with the service center delivery gateway. This gateway provides both voice and data communications to the vehicle.
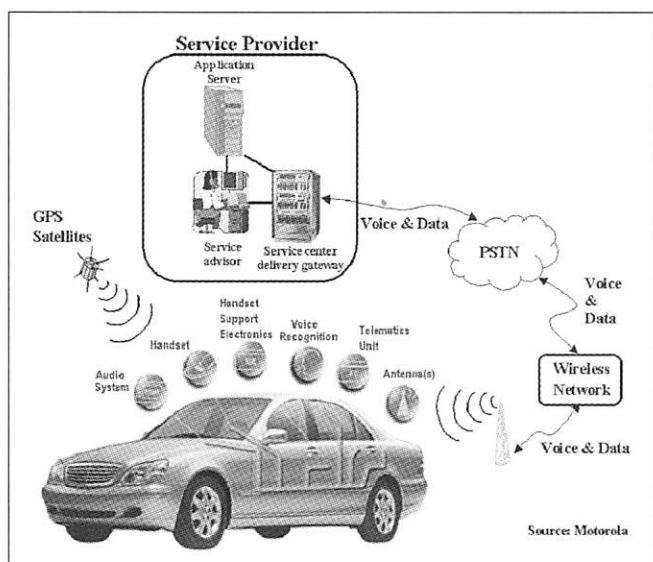
Figure 3 Telematics System

When the in-vehicle telematics system is activated, the Telematics Unit (TU) places a call to the service center where trained advisors respond with any number of services, from emergency assistance to providing concierge services. Advanced software allows the telematics unit to communicate with the on-board computer or engine control unit and provide enhanced services such as remote engine diagnostics, stolen vehicle tracking and automatic airbag notification.

The telematics unit is the central component of the telematics system and is installed inside the vehicle. A typical system consists of a micro-controller, wireless cellular transceiver(s), Global Positioning System (GPS) receiver, vehicle bus interfaces, hands-free audio system, portable handset interface, crash sensory input and various discrete I/O.

The vehicle bus interfaces are automobile manufacturer specific and allow the in-vehicle telematics unit to communicate with other devices connected to these vehicle buses. Other devices routinely connected to the vehicle buses are head units, body electronic control modules, chassis electronics, and power train electronics. Discrete I/O and dedicated crash sensor inputs are routinely deployed for safety and security applications. Received phone audio is routed to the vehicle's sound system by a line level output. Optionally,

on some vehicles a backup speaker is installed to provide audio in the event the vehicle's sound system becomes disabled. One or more microphones provide uplink audio.

In the U.S., the embedded transceiver is typically an automotive hardened device used for communicating with Wide Area Cellular Networks (e.g., AMPS). Communication means can be bi-directional for both voice and data applications. The embedded transceiver can be used for personal calling, remote vehicle applications (e.g., unlocking doors, sounding horn, flashing lights), and communications with remote service providers such as OnStar™ and ATX™.

The GPS receiver provides location and time information to the vehicle for various applications such as vehicle location, vehicle tracking, time synchronization and future E911 Phase 2 positioning information. In some vehicles, dead reckoning sensors can be used in conjunction with the GPS receiver to provide positioning data when out of GPS coverage.

The portable interface is used to connect the user's portable phone to the vehicle for hands-free communications. This portable interface connection can be wired or wireless. With a wired connection, the vehicle is usually limited to one particular brand of handset. Once the system is active, the phone audio is routed through the vehicle's existing sound system, overriding the radio and initiating hands-free communication. With new Wireless Local Area Network (WLAN) technologies such as Bluetooth™ and 802.11, a new class of portable devices is emerging that allows multiple brands of handsets and devices to easily communicate with a vehicle equipped with a complementary WLAN transceiver. High-end systems also provide connections for battery charging, an external cellular antenna and a compensator. A compensator is a device that "compensates" for invehicle cable loss in both the uplink and downlink direction.

Todays Conduits for Telematics Applications & Services

The conduit for today's telematics applications and services is cellular (WAN) communications. Cellular provides broad geographic coverage needed for the four classes of applications and services shown in Table 1.

Table 1 Current Telematics Applications and Services

Air bag deployment notification
Emergency services
Stolen-vehicle tracking
Remote door lock/unlock
Remote diagnostics
Roadside assistance
Sound Horn
Flash Lights
Hands-free personal calling (Voice Recognition)
Convenience
Concierge (reservations, convenience)
Information
PIM (appointments, calendar, address book,
Email, news, sports, stocks, weather, traffic)
Tourist & recreational information
Navigation
Directions (voice delivered)
Traffic reports (voice, text-to-voice)

Source: Motorola

Safety and security applications require voice and data communications. Voice is used to communicate verbally with the service advisor (Figure 3). Data is used to transfer information about vehicle location, identification, and diagnostics. Some applications such as air bag deployment notification and concierge services send a small amount of data to the application server, followed by a transition to a voice call. Theft tracking requires a periodic transmission of a small amount of data from the vehicle to the application server. Distributed Navigation relies on a small data transmission from the vehicle with a modest amount of returned data. Hands-free personal calling only requires the voice telephony capability of the cellular phone.

With all of these existing applications and services, the amount of data transferred is small and can be easily handled by the use of voice-band modems operating over AMPS Cellular Systems.

Pros and Cons of Today's Portable and Embedded Phone Systems

In-vehicle telematics system configurations vary across automobile manufacturers. Typically, there are three main types of designs: Embedded Phone System; Portable Phone System; and a combined Embedded and Portable Phone System.

Embedded Phone System

An embedded phone system is a requirement for OEMs heavily focused on safety and security applications and who offer services such as automatic air bag notification, theft tracking and vehicle alarm notification. A portable phone and associated interfaces is not included in this system. The advantage of this design is reduced cost (as compared to a combined embedded and portable phone system) while providing an automotive hardened design that can be used for safety and security applications. Personal hands-free calling using the embedded transceiver is also possible with this design. This type of system addresses the ERA and security segments as well as the cellular communications segments shown in Figure 2. OnStar equipped vehicles such as Acura, Audi, Buick, Cadillac, Chevrolet, GMC, Hummer, Pontiac, Saab and Saturn typically fall into this category.

One disadvantage of this design is the inability for a user to attach a portable phone to the system for hands-free operation and phone number management. Typically, users also own portable phones. This results in two dialable numbers for the consumer, one phone number for the vehicle, and one phone number for the portable phone. This can make it confusing and difficult for users to manage the two phone numbers.

One work-around is for users to set up call forwarding on the portable device to forward calls to the embedded phone. However, this may leave the user with multiple voicemail boxes to manage. Cellular network upgrades to centrally manage multiple phone numbers via a single voice mailbox would be beneficial for users.

The costs of embedded systems have also limited the deployment of telematics into the mass market. Adding embedded telematics technologies into vehicles requires additional vehicle wiring, antennas, telematics unit, and integration costs. However, over the next few years the authors anticipate embedded telematics equipment costs to decline, as designs are further integrated and standardized.

Finally, embedded systems have also been historically harder to "upgrade" to newer cellular technologies over time. Embedded systems today are semi-custom designs highly integrated into the vehicles. To upgrade older cars to the latest technologies could require changes to the cellular antenna and telematics unit. In many cases, these upgrades would be cost prohibitive. Focusing on standardized vehicle wiring, connectors, mechanical packaging, multi-band antennas, and accessible locations to critical telematics components can enhance the upgradeability of future designs.

Portable Phone Systems

Today many people use portable phones in their vehicles. OEM portable phone systems focus on providing in-vehicle hands-free cellular communications. Recently, areas of the United States and other parts of the world have issued legislation which only allow portable cellular phones to be used with hands-free operation. OEMs can respond to these new legislative trends by providing wired or wireless hands-free solutions.

The advantage of portable-only phone systems is that they are low cost solutions for providing in-vehicle handsfree solutions. They also allow communications "mobility" where users can take the portable phone with them when they leave the vehicle. Newer in-vehicle technologies, such as Bluetooth, allow consumers to pick from a range of cellular products operating on numerous wireless carriers. It is these "universal" phone connections to the vehicle that consumers and OEMs prefer for maximum flexibility and upgradeability. For example, Chrysler recently announced a Bluetooth enabled in-vehicle communications system with factory installed availability in early 2003 [3].

The disadvantage with these portable phone systems is that they are a poor conduit for safety and security applications. Since no transceiver is embedded in the vehicle, services such as automatic air bag deployment notification would not work if the driver forgot his phone or failed to connect the phone into the vehicle.

Combined Embedded and Portable Phone Systems

Automotive telematics systems on some upscale vehicles contain both embedded and portable phone communications systems (e.g., Mercedes-Benz SClass). The advantage is phone number portability and the ability to offer a wider range of services and applications. Safety and security applications can use the embedded transceiver, whereas the portable phone system allows the user to integrate the portable phone into the vehicle for hands-free personal calling. These systems also provide the groundwork for advanced applications that allow the user to link vehicle operation to and from their portable phone. The disadvantages with these combined systems are higher costs and increased system complexity. In addition, on some systems the user is faced with two service bills, one for the embedded phone system, and one for the portable phone system.

Tiered Approach

As can be seen from Table 2, no single solution meets the needs of all of the telematics applications and services. Taking into account the pros and cons of these different systems, tiered solutions have been developed to address the different telematics market segments. For entry-level telematics systems emphasizing maximum communications portability, portable-based handsfree systems are an appropriate solution. Product groups emphasizing addi-

tional safety and security applications while providing handsfree personal calling can utilize an embedded telematics system. Finally, product groups emphasizing Safety & Security and communications portability can choose a combined telematics system.

Table 2 Pro and Con comparison of telematics capabilities for embedded, portable, and combined phone systems

Function	Embedded	Portable	Combined
SAFETY & SECURITY			
Air Bag deployment	+	–	+
Emergency Services (voice)			
Stolen Vehicle Tracking	+	–	+
Remote door lock/unlock	+	–	+
Remote diagnostics	+	–	+
Roadside assistance			
Sound Horn	+	–	+
Flash Lights	+	–	+
Handsfree Operation			
Automotive Grade	+	–	+
CONVENIENCE			
Communications Portability	+	+	+
Voice Recognition			
Concierge (voice access)			
Phone # management	+	+	+
Upgradeability	–	+	–
INFORMATION			
PIM			
Email, news, sports, stocks,			
Tourists & recreational info			
NAVIGATION			
Directions (voice delivered)			
Directions (data delivered)		–	
Traffic reports (voice, TTS)	+		+
COSTS			
Equipment	–	+	–

Key: "+" = Pro, "." = Con, " " = Neutral Source: Motorola

Emerging Technologies, Trends, and Regulatory Initiatives

The wireless industry is undergoing rapid changes that will strongly affect future embedded and portable phone systems. In particular, three areas are rapidly evolving that are important to the automotive telematics market: Wide Area Communications Systems, WLAN & PAN Communications Systems, and Regulatory Initiatives.

Wide Area Communication Systems

The embedded transceiver in the vehicle provides voice and data communications between the in-vehicle telematics systems and the wide area cellular infrastructure. Today in the United States this in-vehicle wireless link is AMPS based at 800 MHz in order to maximize geographic coverage. As these cellular networks migrate to new digital standards (Figure 4), AMPS capacity will be reduced over a period of time to make way for additional capacity on the digital channels. In addition, new digital standards will offer enhanced services, capacity, data rates and cost efficiencies. This will cause a fundamental shift from embedded transceivers utilizing only AMPS to multi-mode transceivers (e.g., CDMA with AMPS or GSM with AMPS). AMPS func-
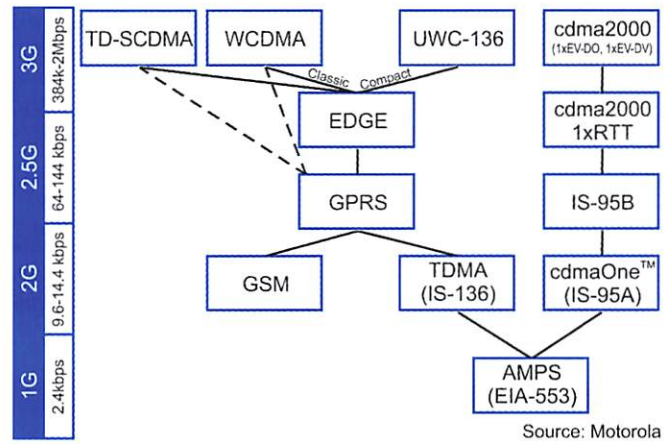
Figure 4 Wireless Standards Migration

tionality will be desired until digital coverage is comparable to today's analog coverage.

This shift to digital technology will allow for new highspeed packet data transports into the vehicle. Packet data is of particular interest since it reduces the connection time compared to analog-based modems and allows the vehicle to be "always connected." Higher data rates will enable new applications and services such as server-based navigation, additional diagnostic capabilities, entertainment, email, web browsing and vehicle configuration and control. Digital technology will also provide a more cost-effective means to transfer large amounts of data for telematics applications.

Carriers also prefer packet data to circuit switched data since packet data makes better use of network capacity, distributes the load more efficiently and is more cost effective. Digital transceivers also use advanced technologies that lower the overall standby power consumption. This allows the possibility for embedded in-vehicle transceivers that are "always on." The disadvantages with these dual mode transceivers are that they are typically more expensive and complex compared to analog-only transceivers.

WLAN & PAN Communication Systems

Over the last several years, industry initiatives have aimed at providing short-range wireless connectivity solutions for mobile devices. The goal was to wirelessly connect devices such as cellular phones, personal digital assistants (PDAs), laptop computers, printers and headsets to each other and to other access points. Emerging from these industry efforts have been two concepts: PAN and WLAN.

A wireless Personal Area Network (PAN) is a short-range communications scheme that utilizes technology that allows compatible devices to detect each other and communicate with each other without user intervention. Bluetooth is an example of a PAN technology. Originally designed as a replacement for connecting cables, Bluetooth enables devices such as PDAs, cellular phones, and laptops to communicate wirelessly over short distances. Bluetooth provides several classes of operation, the most common being Class 1 with a range of about 100 meters, and Class 3 with a range of 10 meters. Bluetooth devices operate in the 2.4 GHz ISM band, allowing license-free operation [4]. Bluetooth is also considered a WLAN for some applications.

A Wireless Local Area Network (WLAN) is another shortrange communication technology. WLAN devices are emerging as a substitute or extension of existing wired Local Area Networks (LAN). A recent trend in data

communications has been the shift from wired solutions such as 10BaseT and 100BaseT to wireless solutions such as 802.11b (also known as Wi-Fi). 802.11b provides up to 11 Mbps data rate to fixed devices with a range of up to 100 meters. 802.11b devices also operate in the 2.4 GHz ISM band. Another technology beginning to appear is 802.11a, which provides up to 54 Mbps within a typically 50-meter distance [5].

These wireless networks provide a new class of alternate conduits into the vehicle. With their higher data rates, they are likely to be utilized for transferring much higher volumes of data than is considered for today's telematics systems. These higher data rates create the opportunity for new applications and services.

Regulatory Initatives

Two trends in the United States will have a significant impact on the telematics marketplace in the next few years. These trends are legislation to limit the use of wireless phones in motor vehicles while driving and the US E911 regulations.

Hands-free Legislation

There is growing legislation in the United States and other parts of the world to limit the use of cellular phones while operating a motor vehicle. A NHTSA survey completed in January 2001 found that 54% of motor vehicle drivers in the United States usually have a cell phone in their vehicles or carry cell phones when they drive. Almost 80% of these drivers leave their cell phone turned on while driving, and 73% report having talked on the phones while driving [6].

This legislation will be a key driver in creating a wide range of in-vehicle "hands-free" telematics systems. OEMs recognizing these trends continue to invest in telematics and new technologies that address consumer safety.

US E911 Regulations

In 1996, the FCC adopted new E911 rules as an initiative to improve the reliability of wireless 911 services and enhance features generally available for wire-line calls such as location or call back number. The E911 initiative was broken into two phases. Phase 1 requires that a dialable number accompany each 911 call and that cell site location (which gives a rough indication of caller's location) be transmitted to the Public Safety Access Points (PSAP). Phase 2 adds increased accuracy requirements for caller location (called Automatic Location Identification or ALI) [7]. It is this E911 Phase 2 mandate that has the potential to significantly impact the telematics industry.

Over the next few years, the E911 Phase 2 legislation will be driving location-enabling technologies into portable phones. This will help enable new personcentric location based applications and services for cellular phones that can complement automotive-based telematics. Today's in-vehicle applications such as safety and security, navigation and concierge services could be extended to portable phones. Thus, when a person leaves his vehicle the same type of in-vehicle services provided by telematics services providers could be extended to portable devices. This concept helps to create a seamless user experience for users to enjoy telematics services both within and outside of the vehicle. The marketing challenge is how to best blend these in-vehicle telematics features with "telematics" like applications running on wireless portable devices.

Similarly, hands-free and E911-like regulation trends are likely to be seen in Europe and other countries in the next few years. Together these new legislative and regulatory initiatives will lead to in-vehicle telematics solutions and new telematics applications on cellular phones.

Enhanced In-Vehicle Telematics Conduits

With these new emerging technologies and trends, opportunities are created for enhancing the conduits into the vehicles. The existing telematics applications were built on a foundation of a cellular phone providing a voice call, with the inclusion of transferring a modest amount of data. As described previously, the data consisted mainly of vehicle location, identity, and status information.

Today's embedded telematics systems can be enhanced to include WLAN communications. Figure 5 shows an enhancement to today's in-vehicle telematics unit. In this implementation, a Wireless Local Area Network (WLAN), such as 802.11b, is added to the telematics unit. The WLAN circuitry can be either embedded or plugged into the telematics unit via a standard form factor such as a PC card. An antenna is then routed from the WLAN to a suitable location in the vehicle. A Bluetooth node can also be used to wirelessly connect a portable cellular device to the vehicle for hands-free communications.
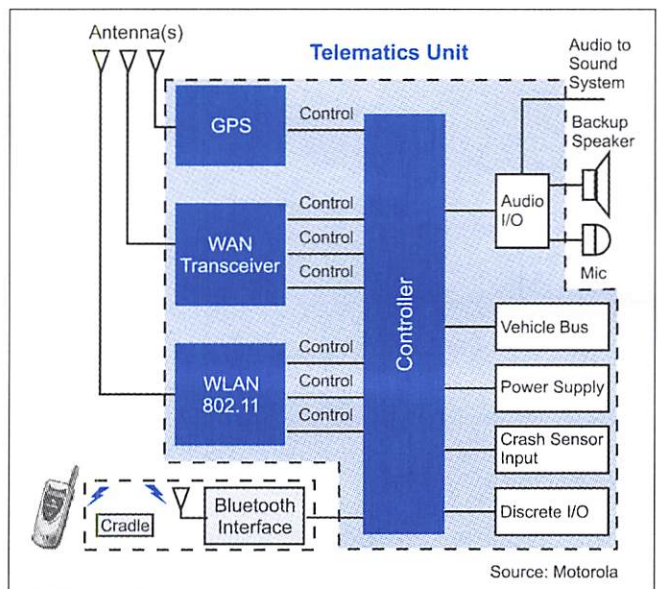
Figure 5 WLAN Telematics Enhancements

With the advent of higher data rates available through 2.5G and 3G cellular systems and WLAN connectivity to the vehicle, it is expected that advanced applications for telematics will be primarily concerned with transferring data to and from the vehicle. As shown in Figure 4, 2.5G systems will provide mobile data rates up to 64kbps, with 3G increasing the data rates up to 384kbps. General Packet Radio Service (GPRS) is a 2.5G system built on GSM cellular technology. These systems are delivering data today at a price of 0.6¢ to 2¢ per kbyte [8].

The types of telematics applications and services that can be offered are dependent on the in-vehicle components and the type of on-board communications technology (e.g., WAN or WLAN). The WAN communications link is used for applications and services that require extended geographic coverage. The WLAN link can be Bluetooth, 802.11a/b, or DSRC and provides a short range for applications and services that require high-speed connectivity. It is important to

note that for some applications to work properly the onboard WAN or WLAN must be "on" continuously to accept incoming commands or requests. This imposes a maximum average standby current drain requirement that is vehicle and manufacturer dependent.

Recently, Starbucks™ announced availability of 802.11b at some of their establishments for customers who choose to be online while enjoying their morning cup of coffee. The plan included expansion to include 70% of Starbucks' 4000 stores located in North America [9]. Airlines have started adding 802.11b coverage to their clubs and gate areas. Companies such as Boingo, Wayport, and others plan to provide areas of Wireless LAN coverage, referred to as "hot spots." For example, Boingo currently provides service in over 500 hot spot locations in airports, hotels and other public locations [10]. Hot spots provide wireless Internet access for users' devices, for example, allowing a laptop to connect back to a corporate mail server to access email when away from the office. Starbucks rate plans ranged from $0.07 to $0.30 per minute of connect time depending on the monthly rate plan [9]. Boingo provides access plans ranging from $2.50 to $7.95 per day with no limit on the amount of data that is transferred [10].

Similarly, it is envisioned that hot spots could provide Internet access for telematics units. Cahners In-Stat Group estimates that wireless Web access will soon be ubiquitous [12]. For example, while parked outside her favorite lunch establishment, a user's telematics unit could download the morning stock reports, complete with associated bulletins and reports. This information could then be viewed while the vehicle is stationary or read to the driver by a Text-to-Speech application.

Choosing a Transport

In choosing the transport that is best suited for a given transfer, one must first define 'best.' A number of factors must be considered. Here is an example listing:
1. Cost sensitivity of transfer
2. Real-time, or timeliness of the information
3. Size of the data to be transferred
4. Time to transfer the data
5. Vehicle speed at time of transfer
6. Geographic coverage requirements

For example, consider downloading the morning's email. Assuming for the moment the user has 10 emails, with the typical one page email with no attachments consisting of two kilobytes of data. This is about 20 kbytes of data. Transferring this over an AMPS channel using a Bell 212A voice-band modem operating at 1200 bps would take approximately 180 seconds not including messaging overhead. With overhead, this is likely four minutes or more. At a charge of $0.28 per minute, this costs the user approximately $1.12 [13]. Having the same messages delivered via GPRS at a cost of 0.6¢ per kbyte costs the user $0.12, a mere fraction of the cost of the same transfer using today's system.

Another example is the transfer of diagnostic information from the vehicle to the instrumentation in the service bay at the dealership. Here a WLAN connection is the logical choice, as the target for the transfer is located near the vehicle at the time that the data transfer is required. Onboard electronics modules could receive new software delivered through the WLAN with the Telematics unit acting as a gateway between the WLAN and the automobile buses.

A user's home network equipped with WLAN would permit "free access" to the user's home network and the

Table 3 Comparison of wireless transports for telematics services and applications

	WAN	WLAN
Safety & Security		
Air bag deployment notification	✓	
Emergency services	✓	
Stolen-vehicle tracking	✓	
Remote door/unlock	✓	✓
Remote diagnostics	✓	
Roadside assistance	✓	
Sound Horn	✓	✓
Flash Lights	✓	✓
Vehicle alarm notification	✓	
Vehicle location change alert	✓	
Vehicle start notification	✓	
Hands-free personal calling (Voice Recognition)	✓	✓
Vehicle "Black Box" data	✓	✓
Convenience		
Concierge (reservations, convenience)	✓	
Vehicle Start	✓	✓
Lock/unlock doors (proximity detection)		✓
Heater/defroster/air on/off	✓	✓
Personalization (radio, seat, mirrors)		✓
Electronic toll collection		✓
Electronic parking collection		✓
Electronic fuel payments		✓
Electronic food payments (e.g., drive thru)		✓
Electronic car wash payments		✓
Information (Upload & Download)		
PIM (appointments, calendar, address book)	✓	✓
Email, news, sports, stocks, weather, traffic	✓	✓
Tourist & recreational information	✓	✓
Vehicle upgrades (reflashing modules software)	✓	✓
Vehicle status (mileage, fuel remaining, emissions)	✓	✓
Navigation		
Directions (voice delivered)	✓	
Directions (maps, turn-by-turn) data download	✓	
Server based navigation	✓	
Traffic reports (voice, text-to-voice)	✓	
Dynamic Road Guidance (with real-time traffic info)	✓	
Location-based advertising	✓	✓
Vehicle-to-vehicle location sharing	✓	
Entertainment		
MP3 music downloads (pay-per-use)	✓	✓

Source: Motorola

Internet while the car is parked at home. One such example is to communicate with the user's in-home network while the car is parked in the garage. MP3 music and even video can be downloaded to the vehicle. Another example would be to download a video while parked at Blockbuster™. If Blockbuster provided WLAN connectivity, a video could be downloaded to the vehicle while the user is browsing inside.

Rental car return will be made much quicker and easier when the rental car is equipped with a telematics unit and WLAN connectivity. While the user parks the car, the rental agency check-in computer communicates with the on-board

telematics unit, retrieving the vehicle identification information, mileage, fuel usage, etc., and prints the receipt while the driver unloads his luggage from the vehicle.

Table 3 lists some of the anticipated Telematics applications and the authors' suggestions as to choice of transport for the particular application.

New Telematics Applications & Services

With these new enhanced telematics conduits, opportunities are created for new telematics applications and services. Research has shown that consumers are very interested in safety and security applications along with safe, hands-free cellular communications [2].

As one example, a new class of applications and services can be made available to automotive telematics users that extend the traditional in-vehicle telematics functionality to include out-of-vehicle operation with WAN and WLAN communications devices (e.g., cellular phones, PDAs, homes, kiosks, gas stations, car dealerships, etc.). The idea is to use the embedded invehicle telematics system and expand its functionality to allow remote operation and communications with complementary devices (e.g., cellular phones and PDAs).

Telematics Specific Portable Devices

Figure 6 shows an enhancement to the telematics system to include voice and data interactions with external wireless portable devices.
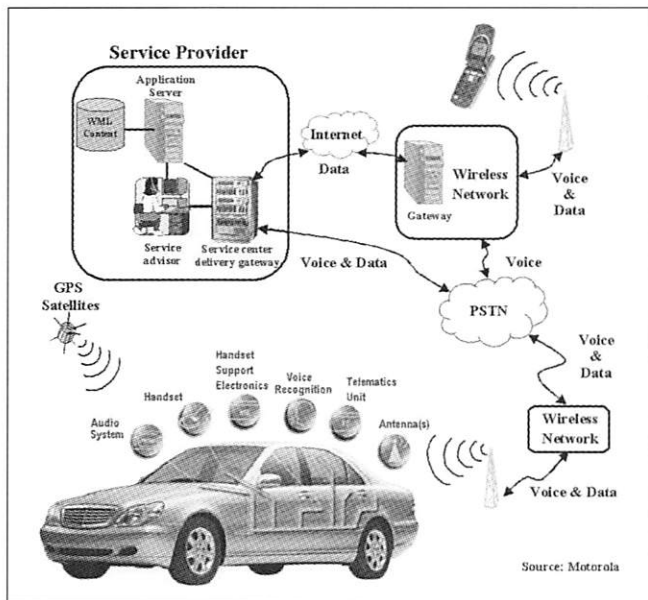

Figure 6 Enhanced Telematics Systems

In this implementation, a Wireless Application Protocol (WAP) interface is provided from the wireless portable device to the service provider over a wide area network. WAP is an application that runs on wireless portable products. It was developed to allow Internet access from portable products with limited resources like small displays, numeric-only keypads and low data bandwidth. WAP also supports various levels of security using Wireless Transport Layer Security (WTLS) protocols.

A key advantage of using WAP is that it allows manufacturers, network operators, service centers and content providers to offer new services on many compatible prod-

ucts (e.g., cellular handsets and wireless PDAs). Other key advantages for automotive telematics are upgradeability and time to market. Since portable devices only need to support the WAP application, content and services can be easily upgraded over time on the hosting applications server. WAP can also be custom tailored to individual groups of users by specifying unique IP gateway addresses. This would allow an OEM or carrier to host unique applications and services.

Figure 7 shows a wireless mobile handset using WAP for accessing automotive telematics functionality. In this implementation, the service provider is hosting an application that allows the user to interface with the service provider for both voice and data communications.

The user can contact the service provider via a voice call by selecting the first menu option on the handset as shown in Figure 7. The number to be dialed is specified by the application server at the service provider. Thus, the user does not have to remember the number to contact the service provider. This methodology also allows the service provider to easily change the phone number.

This service can be used as a Customer Relationship Management (CRM) enhancement tool. The menu system could easily be expanded to include customer assistance call menus to other telematics players such as an OEM, wireless carrier, or other telematics service providers in the telematics supply chain. Other voice call menu possibilities could be made available for concierge services, roadside assistance, medical assistance and stolen vehicle reporting.

Figure 7 lists other data applications that can be provided to the user such as door unlock, sounding the horn, vehicle alarm notification, and web browsing. Other examples include the ability to lock the vehicles doors, flash the lights, turn on the heated seats, start the car (regulations permitting), configure user settings (e.g., seat position, radio channel settings, mirror position, etc.), transfer data, transfer vehicle information (e.g., mileage, location, error codes, fuel levels, tire pressure, etc.), traffic information and server based navigation.

The conduits or interfaces to the vehicles for these features can be over a WAN or WLAN. On vehicles equipped with both WAN and WLAN technologies, portable devices with complementary technology could be configured to choose how to interact with the vehicle in the most efficient manner. For example, if a person is trying to find her car in a parking lot the phone could first try to sound the horn on the Bluetooth link. If the car is out of range, then the phone could be configured to automatically switch to the cellular (WAN) link and sound the horn.

Figure 7 Telematics Specific Handset

Telematics Supply Chain Analysis

Traditionally, consumer demand for automotive telematics equipment and services has been based on in-vehicle applications. The basic idea is that drivers spend long hours in their vehicles so why not capitalize on this fact with a wide range of applications and services. Expanding the revenue opportunities to now include out-of-vehicle telematics operations with portable and WLAN communications devices is a logical migration for the telematics industry.

Figure 8 shows a Telematics Supply Chain as it relates to the inclusion of portable and embedded wireless communications devices and transports. One of the most important factors to the success of these applications and services is how the overall supply chain decides to work together to provide real consumer value. A telematics specific handset, as an example, could be a crossover-product that provides benefit to both the automotive and carrier markets. If, however, there are battles over customer ownership and/or business models, then this concept could falter. These telematics supply chain opportunities will now be discussed in detail.

	Content Providers	Service Providers	Wireless Carriers	Manufacturers	OEMs
Services					
Airtime	-	✓	✓	-	-
Billing	-	✓	✓	-	-
Activations	-	✓	✓	-	-
Concierge	-	✓	o	-	-
Content	✓	✓	✓	-	-
Applications	✓	✓	✓	o	-
Diagnostics	✓	o	o	-	✓
Customer assistance	✓	✓	✓	o	✓
Equipment (hardware)					
Handsets	-	-	✓	✓	✓
Embedded	-	-	o	✓	✓
Equipment (software)					
Client	o	o	o	✓	-
Server	✓	✓	o	✓	-
Wireless Transports					
WAN	✓	✓	✓	✓	✓
WLAN	✓	-	o	✓	o
Bluetooth™	-	-	✓	✓	✓

Key: ✓ : Strategic Investment / o : Opportunity / - : Minimal Investment

Source: Motorola

Figure 8 Telematics Supply Chain

Content Providers

Content providers are the natural owners of applications such as traffic reports, navigation, Points of Interest (POI), weather, news and stock quotes to name a few. Their revenue is derived from supplying content to service providers, wireless carriers and to the end users. Today, telematics content providers deliver information to the vehicle via the embedded in-vehicle communications node. Expanding the vehicle's communications devices to include WLAN connectivity is a growth opportunity for content providers. This additional conduit provides another means for transferring POI information, advertisements, locationbased information, m-commerce applications such as wireless gas payment, MP3 downloads, and toll booth applications. Delivery of telematics type content to portable wireless devices is another opportunity for content providers to expand their market to include wireless carriers.

Telematics Service Providers

To date, service providers have primarily focused on applications and services that use the vehicle's embedded WAN communications technology. These applications have primarily focused on convenience features, information, safety, and security. As an example, ATX Technologies, Inc. recently announced the "Dealer Connect" feature. This service provides drivers with a simple method to connect to their automobile dealership using the embedded WAN communications module for service or information pertaining to their telematics-enabled vehicle [14]. Other service providers have focused on reselling WAN airtime using the embedded in-vehicle communications system. Thus, service providers place a high value on the embedded communications system for both voice and data applications.

The authors believe that a logical step in the telematics evolution is to extend service and subscriptions to include telematics specific portable devices. This could be accomplished in one of two ways. First, to cover incremental costs associated with this service an additional nominal fee could be charged. Alternatively, service providers could simply add this capability as part of their standard product offering in an effort to increase sales and raise renewal rates. Increased operational efficiencies associated with the service (e.g., door unlock) may offset the increased costs.

As an example, OnStar has had more than 10 million interactions with subscribers in the United States and provinces of Canada. On a monthly basis, OnStar receives over 15,000 door unlock requests [15]. To handle these requests, trained operators are on call 24 hours a day, seven days a week. As telematics systems gain popularity, the number of user interactions and door unlock request will continue to rise. Reducing this "human" intervention and the overhead associated with delivering some telematics services is a key area for consideration.

Wireless Carriers

Wireless carriers can be involved in many different areas of the telematics market. Alliances with OEMs help drive the embedded in-vehicle communications technology (i.e., AMPS, GSM, or CDMA). Carriers recognize that some of their best customers frequently use cellular communications while operating a vehicle. Thus, controlling the in-vehicle embedded communications technology helps solidify wireless in-vehicle communications on their network.

Wireless carriers can also derive airtime revenue from portable phone systems operating in the vehicle. A Strategy Analytics survey found that "US cellular users who spend more than 90 minutes per day in the car/vehicle have an average revenue per user (ARPU) spending level of US $69 per month compared with an average monthly ARPU level of $45 across all US cellular users surveyed. Similarly, heavy commuters in the US have an average minutes of use (MOU) level of 97 minutes per week compared with a MOU of 60 minutes per week across all US cellular users surveyed" [16]. Thus, carriers want to attract and retain users who frequently use cellular service while operating a vehicle since these are high ARPU customers.

However, with portable phone systems the carrier does not have as much influence or control over which carrier's phone the user brings into the vehicle. Thus, the benefit to the carrier for portable-only phone system is not as high as controlling the embedded in-vehicle communications technology.

New applications and services on wireless WAN portable devices can also provide additional data revenue opportunities for the wireless carriers. As an example, in order for subscribers to take advantage of some telematics data applications they must subscribe to the Internet services at an additional fee. Today this fee ranges from $2.99 per month for basic access up to $12.49 per month for two megabytes of data [8]. At the end of 2001, OnStar was approaching two million subscribers [15]. As an example, if 25% of two mil-

lion subscribers signed up for this enhanced data service it could generate upwards of a million dollars per month in additional revenue for the carrier.

Opportunities are also possible for wireless carriers with telematics applications and services that use WLAN transports. However, the business cases and target applications for telematics users are still being developed. One of the best opportunities appears to be with those carriers who could extend beyond wireless networks and target residential Internet services. Consumers with WLAN internet access points in their homes could transfer high bandwidth data to their vehicles without incurring airtime charges on the WAN networks. A carrier who could provide both WAN and WLAN access point into the vehicle could then optimize the content delivery to the vehicle in the most efficient and timely manner.

Telematics Equipment Manufacturers

The revenue opportunity for manufacturers primarily lies in embedded and portable equipment sales and software sales. Manufacturers can benefit from both WAN and WLAN applications and services. Thus, telematics manufacturers are very interested in making the telematics industry as a whole successful in order to increase volumes. If sufficient volumes cannot be achieved, manufacturers will find it increasingly difficult to recover development costs.

Manufacturers can also become involved with applications or enabling applications to further increase equipment sales. Enabling telematics applications on portable devices creates the opportunity for expanding the size of the telematics product market. In the U.S., total light vehicle sales are expected to be roughly 15.9 - 16.5 million units in 2002 [17], whereas, U.S. & Canada cellular handset sales for 2002 are estimated at 74 million units [18]. Thus, extending telematics functionality into portable devices creates a much larger opportunity for additional equipment sales.

Automotive OEMs

OEMs will continue to look for ways to differentiate themselves in the market place. Telematics products can be seen as one approach for product differentiation. How the OEMs make money in telematics is still an ongoing debate. The authors believe that OEMs will continue to supply and generate revenue from the invehicle enablers for telematics. This includes the embedded communications modules, the hands-free cellular phone interface and telematics specific handset sales. Regulatory trends should drive consumer demand for superior in-vehicle hands-free systems. The OEMs will also continue to focus on key telematics services like safety and security.

The Business Case for Enhanced Telematics Applications & Services using Portable and Embedded Wireless Devices

The potential size of the telematics marketplace is generally agreed to be very large, both for devices and the associated services. Historically, safety and security type applications have dominated the product offerings. Now, as technology advances, it is becoming easier to offer applications and services that extend telematics functionality to seamlessly connect the automobile with the rest of the world. Here are four reasons why telematics players should consider adding enhanced portable and embedded wireless applications and services to their business plans:

1. Regulations Will Help Drive the Market

Safety, security, and cellular communications are at the center of consumer demand. As regulations continue to grow that limit in-vehicle cell phone use, drivers will be forced to give up holding their cellular phone in a vehicle and must find alternative solutions that allow hands-free communications. This will create the market opportunity for embedded and portable phone systems in the vehicles. OEMs, service providers and equipment manufacturers can capitalize on these trends with a range of products and services that fulfill consumer demand. Phone systems that allow hands-free operation will be essential for wireless carrier's business plans in order to retain revenue from in-vehicle phone usage.

2. Telematics Players Are Looking for Ways to Differentiate Themselves

Telematics equipment manufacturers, automotive OEMs, carriers, service providers, and content providers are looking for new applications and services to differentiate themselves from their competitors. Extending telematics functionality to include portable wireless devices and other communications nodes are key differentiators in the market place.

Handset manufacturers are looking at new ways to entice users into replacing their existing handsets as wireless subscriber penetration rates reach saturation. Offering handsets with telematics functionality is an opportunity for increasing handset sales.

OEMs can extend the in-vehicle communications technologies to allow increased functionality and consumer value with applications that improve the vehicle ownership experience. Enabling the vehicle for m-commerce, remote door lock/unlock, heater on/off, diagnostics, horn sounding and vehicle alarm notification are examples of applications that OEMs can use to differentiate themselves in the marketplace. Carriers, service providers and content providers can extend the telematics environment to portable devices and remote nodes as mechanisms to gain additional subscribers and reduce churn.

3. Operational Efficiencies

Service providers can achieve operational efficiencies with telematics applications and service on wireless portable devices. By leveraging the mobility and extensibility of telematics specific wireless devices, many lower-tier telematics services can be delivered without having to involve a human operator. As an example, applications and services that allow a user to remotely unlock their vehicle doors, without human interaction, in a safe and secure manner offer service providers the opportunity to increase operational efficiencies and reduce overall costs.

OEMs can also benefit from increased efficiencies with applications and services that utilize the in-vehicle communications equipment. WAN and WLAN technologies can be used to enhance the car dealership service experience with expedited documentation and information transfers (e.g., mileage, vehicle VIN, tire pressure, fluid levels, oil change indication, error codes).

Consumers using the in-vehicle WAN or WLAN can benefit from these same applications and services to electronically keep track of vehicle maintenance records, mileage, fluid levels, tire pressure, and overall vehicle health through their personal vehicle website.

4. Applications & Services Will Drive Consumer Demand

There is tremendous growth potential for new telematics applications and services. The embedded in-vehicle WAN communications technologies are migrating to digital while still including analog AMPS service to retain maximum geographic coverage. Packet data will be available on these new digital communications platforms to allow the convenience of being "always on." WLAN technology is becoming more widespread and migrating to cell phones and other products.

Recent consumer surveys suggest that telematics end customers will not be motivated to pay high enough prices to cover the costs of providing today's level of service [19]. For automotive telematics to be successful, new compelling applications and services are needed that will drive consumer demand. The authors believe the best short-term opportunity lies in applications and services that provide users with seamless mobility and tie together the core embedded safety and security product with cellular phone functionality at affordable prices. In a few years as technology progresses, there will be tremendous opportunities to extend telematics applications and services to WLAN systems and link the vehicle to other services such as fleet applications, mcommerce, automated toll booths and dealership service aids.

Conclusion

Wireless embedded phone systems, portable phone systems, and combined systems are the conduits for telematics applications and services. No single solution satisfies the entire telematics market. Instead, a suite of products, services, and applications tailored for each automobile manufacturer and consumer segment will ultimately be the most beneficial solutions for the telematics market.

For entry-level telematics systems emphasizing maximum communications portability, portable-based handsfree systems are an appropriate solution. Product groups emphasizing additional safety and security applications while providing handsfree personal calling can utilize an embedded telematics system. Product groups emphasizing Safety & Security and communications portability can chose a combined telematics system.

Opportunities exist for enhanced applications and services on both WAN and WLAN communications transports. Consumers will continue to desire cost competitive products that provide safety and security, as well as products that provide hands-free cellular phone use. Extending the telematics envelope to include outof- vehicle telematics operations with portable and WLAN communications devices will help drive consumer demand and create efficiencies in the telematics industry that will ultimately benefit the entire telematics supply chain.

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Definitions, Acronyms, Abbreviations

ALI: Automatic Location Identification
AMPS: Advanced Mobile Phone System
ARPU: Average Revenue per User
CDMA: Code Division Multiple Access
CRM: Customer Relationship Management
DSRC: Dedicated Short-Range Communications
ERA: Emergency Roadside Assistance
FCC: Federal Communications Commission
GPRS: General Packet Radio Service
GPS: Global Positioning System
GSM: Global System for Mobile communications
ISM: Industrial, Scientific, and Medical (Band)
IP: Internet Protocol
LAN: Local Area Network
MOU: Minutes of Use
OEM: Original Equipment Manufacturer
PAN: Personal Area Network
PC Card: Previously referred to as PCMCIA Card
PDA: Personal Digital Assistant
PIM: Personal Information Manager
POI: Point of Interest

PSAP: Public Safety Access Points
PSTN: Public Switched Telephone Network
SIM: Subscriber Identity Module
TTS: Text-To-Speech
TU: Telematics Unit
WAN: Wide Area Network – used in the paper mainly to refer to WAN utilizing cellular telephony
WAP: Wireless Access Protocol
WLAN: Wireless Local Area Network (e.g., Bluetooth™ or 802.11).
WTLS: Wireless Transport Layer Security

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Joint Rail Conference
Baltimore, MD April 6-8 2004

The 2004 ASME/IEEE Joint Rail Conference will be held at the Renaissance Harborplace Hotel in Baltimore, MD from 6th to 8th April 2004.

The Conference is sponsored by the ASME Rail Transportation Division and the Land Transportation Division of the IEEE Vehicular Technology Society. This year's theme is *Applying technology for system improvements*.

The conference hotel is located in Baltimore's famed Inner harbor area, and connected to the upscale Gallery shopping mall. Full details, along with on-line registration, can be found at http://www.asmeconferences.org/JRC04/ **The deadline for advance registration is 29 March.**

A technical tour is being planned for the afternoon of April 6. The tour site selection was not finalized when we went to press.

To whet your appetite for the conference, abstracts of the seventeen electronic and electrical papers which will be presented are reprinted here.

Determination of Traction Power Distribution System Impedances for Ac Railroad Electrification Systems

Tristan Kneschke, *LTK Engineering Services*, Phonigi Mbika, *LTK*

Electrical characteristics of the traction electrification system, together with the train power demand, headway, and operating scenarios, are the key factors in determining the overall system performance. For load flow and voltage profile studies along a railroad proposed to be electrified, the most important factor is the series impedance of power distribution and return systems. For harmonic distortion, electromagnetic interference, and lightning performance analyses, the shunt impedance needs to be taken into account together with the series impedance.

A mathematical procedure for calculation of traction power distribution system line impedances is developed using the Alternative Transient Program (ATP). The technique is applied to Direct Feed and Autotransformer Feed traction electrification systems and typical results for one-, two-, three-, and four-track railroads are presented. All self- and mutual impedance components are included in the calculations. The mathematical calculations in this paper are performed separately for the inductive impedance $Z = R + j$ XL and for the susceptance XC. Subsequently, the capacitance C is calculated from the susceptance.

Traction Power System Reliability Concepts

Sergo Sagareli, *Long Island Rail Road*

Reliability of a traction power system may be defined as its ability to continuously supply electrical power of adequate quality during sudden disturbances such as a short circuit or loss of system elements, while operating with a normal or scheduled maintenance and repair scheme configuration, without causing safety hazards, train delays or public nuisance. While for a utility power systems' reliability may be expressed in outage minutes per year (or any other time period), which is calculated as a ratio of customers' electrical energy deprivation to system's total power capacity, for a traction power systems' reliability evaluation, minutes of train delays caused by power interruption or relative values such as delay minutes per passenger-mile may be utilized. Considering the accelerated growth of traction power systems across the US in recent and coming years, creation of a reliability council similar to NERC to develop reliability standards within the railroad industry may be highly beneficial: it could pull together statistical data on reliability from different railroads, analyze them, and develop guidelines and recommendations for optimal solutions to provide adequate reliability with the lowest cost possible. IEEE Traction Power Substation Committee and AREMA Committee 33 on Electrical Energy Utilization could initiate and lay groundwork for the creation of such a council. While most of the contingency situations may be predicted and counteracted on the design stage, only the real-life experience is the ultimate test for reliability. That's why it is so important to keep and analyze records of any outages and contingencies encountered during traction

power system operations. Records for these purposes may be provided by Multi-Purpose Relays that become widely used in recently built substations. For existing systems, classification of voltage events may be based on the Institute of Electrical and Electronic Engineers (IEEE) Standard 1159-1995. For newly designed systems, comparison of different designs based on monetary value of electricity reliability is suggested.

Use of Intelligent Electronic Devices for Equipment Optimization in Traction Power Systems
Sergo Sagareli, *Long Island Rail Road*

Electrical traction systems have been successfully used for over 100 years, and during this time they went through dramatic changes, and still continue to develop. And, while for utility power systems the performance criteria are well established and pretty much standardized, traction power systems, being quite different, still need development of such criteria, standards and guidelines in order to reach optimal performance by means of improved design, construction and operation practices. The last 20 years were marked by accelerated changes due to rapid development of power electronics and information technologies; this is another reason why existing practices in traction power systems need to be re-evaluated.

Electrical equipment optimization in traction power systems is a multifaceted problem. For traditional utility power systems, electrical equipment optimization usually means reduction of energy losses under given operating conditions with minimal capital expenditures. Applied to traction power systems, this may be considered the first step in equipment optimization. According to Barnes, the potential energy savings due to loss reduction in transformers may be between 0.9 and 2.4 W/kVA of purchased transformer capacity. For the LIRR power system, this translates into approximately $86,700 annual savings. Transformer energy losses may be evaluated based on typical traction load diagrams as defined in NEMA RI-9 and IEEE C57.18.10-1998 standards or actual (if available). Until recently, actual load diagrams or energy losses could have been obtained only by conducting special field measurements or readings. Introduction of Intelligent Electronic Devices (IED's) such as Multifunction Relays (MFR or MPR) with memory capabilities opens the way to automated gathering of this information from substations through SCADA system routinely, so data is always available for traction power system performance evaluation, as well as for equipment optimal design or operation planning purposes. This data will make a good engineering tool for calculating actual savings of energy due to new design or improvement in operational practices.

Implementation of New Technologies in Traction Power Systems
Sergo Sagareli, *Long Island Rail Road*

Due to significant developments in power electronics since the 1980's, a row of new components are being used for both utility and traction power substations, leading to new concepts in their design and construction.

A significant reduction in the amount of protective and control devices (and associated wiring) has been achieved by introduction of multi-function relays (MFR), capable of replacing a whole group of relays used for equipment protection and automated control; for example, one MFR may perform functions of overcurrent and ground fault protection, over- and undervoltage protection, fault sensing and reclosing. Plus, it may be used for data recording purposes. Thus, one MFR (or, MPR - Multi-Purpose Relay) may replace about a dozen of traditional relays and devices, along with their wiring.

Thyristor Controlled Rectifiers (TCR's) are another significant innovation in traditional DC traction power substation design. Thyristor rectifiers are offering very important benefit of regulated DC voltage: at the substation's bus output, the voltage may be constant from 0 to a 100% load, which means improved train performance in terms of speed and reliability, as well as lower losses of energy in third rails, and possibility of raising third rail system voltage in the future, thus further lowering losses of energy in the system. LIRR installed one thyristor rectifier for experimental use in 2003.

Another important innovation that is being installed by the LIRR for experimental use is flywheel-based energy storage system. Power systems engineers have always been interested in electrical energy storage as a means of leveling a power systems' load by utilizing excess power and releasing it during peak consumption. Capturing and re-using kinetic energy from slowing-down trains by means of regeneration, rather than wasting it in mechanical brakes, is another important technical problem that may be successfully solved by energy storage systems. Other important benefits include improving reliability and quality of electrical energy due to quick responsiveness of these systems to supply interruptions, and voltage dips. LIRR is installing for experimental use trackside fly-wheel energy storage system developed and tested by the British uranium enrichment company Urenco. According to Tarrant, in March 2002 the company successfully tested the KESS - Kinetic Energy Storage System and demonstrated 11% to 18% energy savings in different conditions of operation, because of the lower losses due to higher voltage during the acceleration period.

CCS: A Railway Corridor Control System Utilizing Ultra Wideband Radio Technology
Paul Flaherty, *Goatlick Engineering Ltd.*

Ultra Wideband (UWB) radio is a unique technology which combines a megabit wireless local area network with a centimeter-resolution radiolocation (radar) capability over distances less than 100m. A linear chain of UWB nodes can be used to create a hop-by-hop data transmission network, which also forms a radar "corridor" along the chain. By co-locating such a chain of nodes along a railroad right-of-way, precise information on the location and velocity of trains could be distributed throughout the corridor. In addition, the radar corridor would detect the introduction of track obstacles such as rocks, people, and automobiles, as well as shifted loads and other high-wide train defects. Finally, the network of nodes would enable off-train communications with payload sensors, locomotive computers, and could also provide wireless connectivity for passenger service.

In this paper, we will examine issues which would arise in the deployment of UWB in the railway environment, including:

1. Robustness and graceful network failure; 2. Interaction with existing protocol stacks such as ATCS; 3. Powering a geographically distributed network; 4. Maintenance of the network.

Finally, we will look at a design example and usage scenarios for an urban railway corridor with a mixture of freight and passenger traffic. Distributing precise location and velocity information of trains and potential obstacles in

a robust fashion enables higher speeds and improved track capacity while maintaining proper safety margins.

Implementing Optical Speed Measurement (OSMES) for Communications Based Train Control

Edwin Mortlock, *Parsons Transporatation Group*, Geoffrey Hubbs, *New York City Transit*

As part of its ongoing modernization program, New York City Transit (NYCT) has initiated a program to install state-of-the-art communications-based train control (CBTC) technology, utilizing continuous, two-way digital RF communications between intelligent trains and a wayside network. The contract for re-signalling the Canarsie Line was awarded to a Joint Venture of Siemens Transportation Systems Inc, Union Switch & Signal, Inc. and RWKS Comstock. The new CBTC system is intended to provide enhanced safety, greater operational flexibility, increased throughput, improved reliability and availability, and reduced life cycle costs.

With CBTC, train location is known with a much higher resolution than with conventional track circuits. This allows trains to operate safely at much shorter headways and permits system operations to recover more rapidly in the event of a disturbance—all of which provides more regular and improved passenger service. CBTC therefore requires a much greater higher accuracy of speed measuring and distance measurement accuracy than conventional cab signal systems.

A combination of tachometers and Doppler radars was initially proposed for speed and position measurement, but it was determined that this would not provide the measurement accuracy needed for CBTC due to wheel slip and slide. Siemens proposed the use of an optical (laser based) speed and position measurement system (OSMES) that is independent of the train axles wheel-rail interface. Early versions of this device had been tested in France in 1998 and demonstrated to NYCT in 1999, but it was not ready for production and had not been used in revenue service.

An accelerated program to develop the OSMES into a production device had to be undertaken as well as solving many application obstacles, including severe clearance restrictions. The environmental conditions adjacent to the rail include high levels of vibration and shock, snow, sleet, dust, debris, and grease. NYCT also required a one year test running period of the device, with data logging, on a revenue train. This test is presently underway.

Implementing an unproven new subsystem during a resignalling contract on an operating transit system with tight project budget and schedule constraints presents many challenges of a technical, contractual, project management and institutional nature. The NYCT experience is demonstrating that these challenges can be met, but do require innovative approaches to implementing, integrating, design, integration and testing this new technology.

An Overview of Interface Management

Peter Harrison, *Booz Allen Hamilton*

An area that has traditionally been a source of unreliable operation for railroad and transit systems has been the interfaces between the various systems. These interfaces cover the whole of the range of areas and are often visible to the passengers. They can consist of mechanical issues like for the platform and vehicle interface, or electrical, as with the control of conducted interference currents at the vehicle power supply interface to achieve compatibility. Interfaces may also be a mixture of mechanical and electrical characteristics.

Railroad and transit systems are becoming more sophisticated, and similar technologies are being applied to different systems of a railroad or transit system. For example the technology required to control a vehicle propulsion system is very similar to that required by the modern regenerative substation. Modern integrated systems are also spreading across the traditional system boundaries: an integrated passenger information system for an LRT or Metro system would span vehicles, stations, train control and communication systems. A key factor to improving the reliability of a railroad or transit system is early and effective control of the system interfaces and having the appropriate organization(s) responsible for the interface. This paper explores the factors which need to be considered for appropriate management of the interfaces. It relates the management of the interfaces to the types of contract mechanisms that can be used for procurement of equipment and considers associated advantages and risks.

Advanced Light Rail Vehicle Communication Systems Design

John Swanson, *PB Transit & Rail Systems, Inc.*

The use of electronic subsystems to perform complex tasks has grown in the consumer goods and automotive sectors to such a degree that these capabilities have become commonplace, yet in the field of light rail vehicles, they have made relatively little impact. The technology exists today to provide greatly increased passenger safety, security and system operational efficiency by the judicious application of mature subsystem designs. Such systems include radio based, fully integrated vehicle management systems with GPS, silent alarm capability and passenger information control, external passenger door and coupler monitoring video cameras, forward facing video recording for accident investigations, interior video recording for reduction in vandalism, interior video cameras linked to Passenger to Operator Intercoms to provide the Operator with more information and the transfer of data to and from vehicles via wireless LAN. This paper will describe these the application of these subsystems to the new Phoenix light rail vehicle and project what the future may hold.

Linear Synchronous Motor Propulsion of Small Transit Vehicles

Richard D. Thornton, Tracy Clark, Brian Perreault, *MagneMotion Inc.*

The Linear Synchronous Motor (LSM) has been used for several high speed maglev applications but only recently have developers applied it to urban transit. MagneMotion has worked with the Federal Transit Administration (FTA) as part of their Urban Maglev project to develop an LSM propelled maglev system called M3. The top speed is only half that of the Transrapid maglev trains now operational in China, but by using small vehicles with short headway and rapid acceleration it is possible to achieve better performance at lower cost. The combination of LSM technology and small vehicles is also applicable to conventional transit vehicles.

LSM is the enabling technology that makes it economically and technically feasible to achieve high capacity with short vehicles. Vehicles operate with short headway but are organized in clusters with a longer headway between clusters so as to achieve high capacity without offline loading.

Very precise position sensing and guideway based propulsion and control make short headways safe and affordable.

This paper presents simulations of scenarios for LSM transit applications that are applicable to both maglev and conventional transit. The examples are based on operational speeds up to 135 mph, accelerations up to 0.2 g, vehicle headways down to 5 seconds, and capacities up to 12,000 passengers per hour per direction. Examples include: 1 mile high capacity shuttle, 4 km unidirectional loop with several stations, and 30 km high speed airport connector. Calculations show that an LSM propelled transit system has lower capital cost than conventional systems using vehicle-based electric propulsion with either rotary motors or Linear Induction Motors (LIM). Vehicles are simplified, the cost of energy and maintenance is reduced and, most important, users of the transit system experience major reductions in travel and wait time.

Hardware-Software Structure For On-Line Power Quality Assessment
Ahmed Abouelseoud, *Alexandria Electricity Distribution Co.*, Adelmonum Musa, Emtethal Negm, *Alexandria University*

The demand for high quality electricity supply is, at present, one of the key requirements to ensure sustainable economic growth in our increasingly digital-based society. Voltage dips, short interruptions, and voltage harmonics may cause the tripping or the malfunctioning of equipment. These voltage events are considered the most important power quality problem for many industrial customers due to the economic effects that they can have on industrial processes. The development of new methods for real time detection and evaluation of voltage events in the distribution systems is of the greatest importance, in order to prevent the impact of these disturbances on customer equipment and to evaluate the economics of power quality improvement alternatives. The main objective of the proposed work is to introduce a new concept of advanced power quality assessment. To achieve the goal, hardware – software structure is constructed for further processing to the distorted signals that reflects the quality of power supply. The introduced system is implemented using applications of a set number of powerful software algorithms and a digital signal processor based hardware data acquisition system. The suggested schema is mainly to construct a system for real time detection and identification of different types of power quality disturbances that produce a sudden change in the power quality levels. Moreover, a new mitigation technique through generating feedback correction signals for disturbance compensation is addressed.

Simulated as well as real test examples of the proposed approaches were addressed. The obtained results reveal that, the introduced system detects fast and accurately most of the power quality disturbance events and introduced qualification numbers estimating the performance of any supply system subjected to a set number of disturbance events.

Computation and Validation of Rail-To-Earth Potential for Diode-Grounded DC Traction System at Taipei Rapid Transit System
Bih-Yuan Ku, *National Taipei University of Technology*, Thomas Hsu, *Siemens*

In this paper we present Taipei Rapid Transit System (TRTS) experience with frequent surges of unusually high rail-to-earth potential of the diode-ground DC traction system. The high values of rail potential and the resulting stray current are contradictory to the moderate values in the traction system DC study report and in related literatures. We conducted a theoretical study and field measurements to derive a more accurate circuit model for computation of rail-to-earth potential of the diode-ground DC traction system. Initial improvement results by main-line separation are also presented to show the significant reduction of stray current values. Rapid Transit system was introduced in Taiwan as late as 1990's. At the designing stage the diode-ground configuration was chosen for the earth of DC traction system based on the benefits of moderate rail-to-earth potential and stray current values as well as east and fast ground fault detection. The conception was the diode connected to the negative busbar of the traction substation provides a unidirectional return for stray current and maintain low potential at the negative busbar of each substation, as reported in literatures and DC study conducted by a prestigious international engineering firm. After the first heavy-rail transit line started commercial operation in 1997, however, high rail potential surges over 100 volts were observed to appear several times every hour of operation. The unusually high rail-to-earth potential values are not only two to three times the computational values but also above safe standard. Hence we conducted a thorough investigation into the phenomenon and concluded that the circuit model in most literatures needs to be modified. Due to the forward bias conduction nature of diodes virtually only one diode with the lowest potential at the entire system would conduct, leaving other diodes with floating potential. Hence the accumulating potential differences along the negative return path result in occasional high rail potential values from time to time, unless over potential switches are installed. Since the results are dramatically inconsistent with previous literatures it is the authors' intent to present details for further examination in the forthcoming IEEE/ASME Joint Rail Conference.

Optimization of Diesel Engine – Synchronous Alternator Group
Gelu F. Girda, *GO Transit*, Abdemusa Moosajee, *Bombardier Transportation*

The paper describes the findings of an experiment that is a result of close collaboration among the following companies: - GO Transit Toronto - owner of the equipment and the driving force of the experiment; - Bombardier Transportation - responsible for maintenance/repair and modification of GO Transit equipment; - Toromont - responsible for overhauling the HEP Diesel engine and advisor on operating parameters; - Pro - Tech Power Sales and Schweitzer Engineering Laboratories - suppliers of the relay SEL-701 and the services concerning the use of the relay.

The paper discusses the experiment on a GO Transit Locomotive by using a microprocessor-based relay, SEL – 701, for on-line measurement, control and optimization of a HEP (Head End Power) group. The HEP has a Diesel engine, Caterpillar 12 V 3412 DITTA, 740 HP, and a double wound three-phase self excited synchronous alternator, Stamford - Newage, 625 kVA, 575 V. The HEP group is installed on the F59PH Locomotive (General Motors), which supplies the electrical hotel power to the train's coaches.

The relay SEL - 701 (Schweitzer Engineering Laboratories) measures the Diesel engine temperatures on 7 different points and the winding temperatures at 3 internal points, one per each phase. The SEL - 701 monitors alternator output currents and voltages and controls one (or both) train lines when the Diesel engine's hottest temperature equals the maximum admissible temperature.

Amongst others the paper highlights the benefits derived by use of on-line measurements of the Diesel engine before and after relocation of a pre-existent engine shutdown temperature probe. In addition, the paper discusses the decrease in the numbers of Diesel engine shut downs due to the previous mode of protection and the increase in available electrical power supplied to the train lines together with the comparison of the HEP group efficiency before and after modification.

Processing of multiple frequency test data of Traction Auto Transformer

Di Yu, K. L. Lo, *University of Strathclyde*

In modern railway system, equipment features of multiple frequencies and especially at high frequencies are playing a more important role. Practical experiments using a wide range of frequencies are now used to detect and analyze the features of key equipment. Tests have been done on a 15MVA traction auto-transformer in multiple frequencies starting from 100Hz up to 12kHz. This paper introduces the use of numerical data processing techniques that would (a) transform the raw data from time domain into frequency domain and (b) curve smoothing over the frequency domain data. Discrete Fourier Transform (DFT), and correspondingly Fast Fourier Transform (FFT) are used in the transformation. The following issues relating to the transform are also investigated, including: cell definition, truncating, obtaining integral cycles, determining and decomposing the dc offset, and modifying the shift angle error over the cycle. This technique of handling has the advantage of able to minimize errors that could be introduced in the calculation. Least square method is applied to the data batch to obtain the results. In addition, analysis on the final transformed result is carried out by a subtle curve smoothing process of polynomial interpolation. The combined procedures is a powerful numerical data processing for use in the raw test data and the results obtained are readily available for use in other system calculation.

A Practical Machine Vision Based Wheel Profiler

Kambiz Nayebi, Ali Yousefi, Behzad Nazari, *Beena Vision Systems, Inc.*

In this work, we present a practical machine vision based wheel profile measurement system. This system is the result of a five-year research and development project that has resulted in an effective system.

This wayside machine vision system measures the profile of moving train wheels. Wheel profile images are captured using structured light sources and CCD cameras with high-speed shutters. The captured images are then processed to reconstruct wheel profiles and measure relevant wheel parameters, including flange height and thickness, rim thickness and the tread hollow.

A final version of the system is tested at TTCI (Transportation Technology Center) test grounds. The system has shown a good performance for speeds of up to 100 km/h.

The system performance is shown to be very good and the accuracy of the system measurements are in the range of 95 to 100 percent. The system is also proven to be very reliable, durable and its measurements are very repeatable.

The advantage of this system is that it can practically be installed almost anywhere without any major changes to the rail structure. The system has shown a good performance for speeds of up to 100 km/h.

The advantage of this system is that it can practically be installed almost anywhere without any major changes to the rail structure. The system is also designed to support a large database where any wheel in the fleet can be tracked automatically for maintenance scheduling and preventative maintenance. Any condemnable wheel can also be detected and reported for immediate action in the nearest station. The system can be accessed through a LAN/WAN/WEB based network for system monitoring and data collection.

The Paper will include the details of the system configuration and performance. The machine vision aspect of the system, including lighting, imaging, calibration, processing, database, etc issues will be presented. The results of the official test will also be part of the paper.

Reverse Engineering Car Control Software – A Hands On Approach

Karl W. Berger, PE, *DCM, Inc. Transportation Consultants*, Balaji Krishnamurthy, *Booz Allen Hamilton*

Preparation of a mid-life overhaul specification for a light rail vehicle raised questions concerning actual algorithms used for propulsion and braking. Although the cars are less than 15 years old the original carbuilder has gone through at least two corporate mergers and is no longer able to provide support at economic rates. Preliminary tests of braking control showed that blending of friction brakes and control of brakes on the unpowered truck differed from that described in the operations and maintenance manual.

In order to determine the actual control methodology a series of tests were designed and conducted. This paper describes the tests and shows how the data was reduced to determine control parameters. It will also address issues of equipment obsolescence and safety concerns in modifying software.

PATH's Downtown Restoration Program

Frederick R. Childs, Radomir Bulayev, *PATH*

On September 11, 2001, the terrorist attacks that destroyed the World Trade Center (WTC) in lower Manhattan, New York City, also damaged the Port Authority Trans-Hudson Corp. (PATH) terminal serving the heart of the thriving downtown financial district. The aftermath of the attacks also forced the closure of PATH's key station at Exchange Place that served Jersey City, New Jersey's expanding "Gold Coast" business and residential developments. PATH's more than 265,000 average weekday commuters between New Jersey and New York were affected in some way by these tragic events, and PATH ridership fell sharply during the following months.

Among the PATH facilities that were damaged or destroyed at WTC, and in the two Hudson River tubes, and at Exchange Place Station were all of the electrical, power, signal, and communications systems. Recovery and restoration work began immediately, but was hampered by the extensive rescue, recovery, removal, and demolition work at the World Trade site. Broken water lines and fire fighting efforts flooded both river tubes, which were later sealed at Exchange Place to prevent additional potential damage to PATH's New Jersey facilities.

This paper describes PATH's recovery program to replace the electrical, power, signal, and communications facilities from Exchange Place to the WTC Terminal. A temporary WTC terminal has been built to restore direct service to lower Manhattan's financial, business, and residential center as of November 23, 2003. As part of this

program, new trackwork was installed to enhance operational flexibility and provide temporary interim service to Exchange Place Station, which reopened in June 2003. Capacity expansion provisions were included to allow for future 10-car train operations when a new rail car fleet is procured.

Facilities replaced include a new traction power and auxiliary services substation, new cables, ductbanks, new signals and train control system, wayside phones, emergency power removal switches, tunnel lighting, radio antenna, and fiber optics. An accelerated design and construction schedule was followed, using a broad combination of in-house, consulting, and contractor forces.

Hybrid technology for the rail industry
Frank Donnelly, Raymond Cousineau, *Railpower Technologies Corp.*

A new type of battery dominant hybrid technology has been developed for the rail industry. Traditionally, switcher locomotive service is characterised by highly variable power output utilisation. This variability in demand is exploited to allow the incorporation of a significantly smaller, fuel efficient, tier 2 certified, low maintenance engine and generator combination to supply energy to the traction motors and to the application engineered battery pack. In the last three years, a demonstrator vehicle, the Green Goat, has been designed, tested, constructed and put into field trials for 18 months in various locations and types of service, with impressive (performance and operational) results. The design, concept, field trials results, as well as applications of the technology to other types of service are discussed.

Automotive Electronics

Bill Fleming, Senior Editor

2004 BMW Built-In Diversity Radio Signal Reception

Four different FM-radio antennas are built in a nested arrangement in the rear window of 2004 BMW 5 Series vehicles. An electronic control unit identifies and amplifies the best signal being received among the four antennas [1]. Four more antennas, also built into the rear glass, deliver signals for AM radio, TV, central locking, etc. The antennas are supplied by Hirschmann Electronics of Germany.

2004 Lincoln's Have Concealed GPS Antennas

The 2004 Lincoln Aviator SUV, Navigator SUV, Town Car, and LS vehicles all have Andrew Corp. concealed Global Positioning System antennas that are integrated in factory-installed navigation systems [2]. The antennas utilize planar ceramic-substrate, conductive-patch technologies; and include low-noise amplifiers, which provide 26-dB signal gain. The antennas are concealed underneath dashboards in the vehicles.

DaimlerChrysler Driver Advocate

DaimlerChrysler is working together with Motorola and the M.I.T. Media Lab to address the problem of driver information overload. Engine diagnostic messages, traffic information, and incoming cell phone calls are electronically prioritized in order to determine which message should be forwarded, or suppressed [3].

Chrysler Town & Country minivans are serving as demonstration vehicles. In these vehicles, drivers are alerted that a message has been suppressed when a steering-wheel button illuminates. If there's a potential for the message to become safety-critical, the lighted button flashes. Once the

Driver Advocate system determines that nonsafety-related information is appropriate to deliver — meaning the driver is no longer distracted by traffic/driving workload — that information is then conveyed. Second-generation future systems will additionally take into account what is happening outside the vehicle by incorporating lane departure, collision warning, and other driver assistance/personalization algorithms into the Driver Advocate system.

Black Box Debate

In Florida, a driver was sentenced to 30 years in prison for double vehicular manslaughter based on evidence taken from the data recorder in his 2002 Pontiac Trans Am which showed that he was going more than 100 mph in a 30-mph zone. More recently, South Dakota authorities have used Event Data Recorder (EDR) information to make a case against Rep. William Janklow, accused of speeding in his late-model Cadillac, and killing a motorcyclist last August [4].

The U.S. safety agency, NHTSA, says EDRs built by General Motors since 1999 are capable of collecting 16 major categories of pre-crash information. NHTSA's Administrator, Jeffrey Runge, is in favor of wider use of EDRs. However, safety researchers and privacy advocates are debating the use of EDRs in privately owned vehicles. On one hand, EDR data gives researchers their most accurate information about what is actually happening in car crashes. On the other hand, there's a question of data ownership (e.g., if the driver owns the vehicle, doesn't he or she also own the EDR data?) And there is a potential backlash from motorists who don't want their vehicles to snitch on them. But Runge points out that EDR information would do as much to defend the innocent as to incriminate the guilty [4].

Fuel Economy Inflated For Hybrid Vehicles

For its 2004 Prius hybrid-electric vehicle, Toyota cites the official EPA-certified fuel economy number of 55 mpg for combined highway/city driving. But most Prius drivers get closer to 44 mpg in combined driving. A survey of 750 first-generation Prius owners on *yahoo.com* showed them obtaining an average of 44 mpg; and an early poll of thirty 2004 Prius owners showed most got between 45 and 49 mpg — these numbers are consistently below the official EPA-certified fuel economy of 55 mpg for combined driving [5].

In J.D. Power's 2003 APEAL Study, consumers were only marginally more satisfied with the fuel economy of their Prius or Honda Civic Hybrid than they were with the base-engine versions of the comparably sized car, creating what J.D. Power termed, "an unfulfillment of expectations." Reasons for the fuel economy discrepancy, when actual driving is compared to the official EPA certification cycle, include:

+ Heavy engine loads, such as running air conditioning, which disproportionately penalizes battery-powered vehicles more than internal-combustion vehicles, isn't considered in the EPA cycle
+ Cold weather, also disproportionately penalizing battery-powered vehicles, again isn't considered
+ To keep up with traffic, real-life people drive harder, accelerate quicker, and brake faster, than what occurs in the EPA driving cycle

Accidents and Speeding vs. Occupation

An insurance research company, Quality Planning Corp., reviewed over one million driver records across the United States. They determined the top five, along with the bottom five, occupations of drivers involved in accidents and speeding violations. Results [6] are shown in the Table below.

Accidents and Speeding — Frequency vs. Occupation

Rank	Frequency of Accident Involvement	Frequency of Speeding Violation Involvement
1 (most frequent)	student	student
2	medical doctor	enlisted military
3	attorney/lawyer	manual laborer
4	architect	politician
5	real estate agent	architect
36	homemaker	teacher/professor
37	politician	clerical/secretary
38	pilot	law enforcement
39	fireman	librarian
40 (least frequent)	farmer	homemaker

According to the research company, "these numbers blow holes in the conventional wisdom about which professions are accident-prone or dangerous drivers." They say that, "it appears that educated professionals are most likely to be involved in accidents [6]. Interestingly, for those unlucky enough to be involved in an accident, individuals from two professions which are most helpful after such an incident —

doctors and lawyers — are the most likely to be on the scene." The high frequency of involvement of students is attributed to their lack of experience and low aversion to risk.

The bottom five occupational involvements are thought to be a consequence that they spend less of their time driving. On the other hand, occupations such as truck drivers, bus drivers, and taxi drivers — who spent much of their working hours on the road — were, contrary to one's expectations, not in the top five of either safety-risk category. Additional information on this study is obtained by accessing the link: http://qualityplanning.com

Six 2004 Vehicles Offer Embedded Bluetooth

Bluetooth [7] is a short-range wireless rf technology that lets electronic devices communicate with each other. A Bluetooth system allows a driver to talk on his or her cell phone hands-free. Voice comes through the car speakers, and the radio will mute when it senses an incoming call. Drivers can keep their phones in their pockets, purses, or briefcases; the phone just has to be turned on and Bluetooth wirelessly interfaces calls with the vehicle's radio sound system.

Six 2004-model-year vehicles offer embedded Bluetooth systems [8] — these include new Bluetooth introductions in Acura, Lexus, Lincoln, and Toyota (in addition to introductions already made in 2003 Chrysler and BMW vehicles). A Bluetooth installation typically costs the car buyer $250-to-$400.

There is heavy betting on future developments insofar as, "only 2 percent of the 150 million cell phone users in the United States currently have Bluetooth-enabled phones [8]." To address this problem, dealers are separately selling Bluetooth-enabled cell phones (for an additional $100 to $300), to provide compatibility with Bluetooth system installations.

A bright future for Bluetooth systems is forecast. It's predicted that, "nearly 20 percent of all vehicles worldwide will contain embedded Bluetooth hardware by 2007. Bluetooth silicon costs are said to run approximately $6, making the technology extremely attractive to automakers [9]. The first wave of Bluetooth devices in the vehicle is centering around telephony, while more advanced applications will follow — examples include: remote vehicle diagnostics, vehicle-to-vehicle safety communications, and remote audio and/or video downloads. In fact, Bob Schumacher of Delphi states that, "If Bluetooth remains the standard in telecommunications, there's a real possibility of having Bluetooth in every car by the end of the decade" [10].

Although in-vehicle Bluetooth services potentially offer a huge market, interference from existing rf devices (GPS, navigation, satellite radio, etc.) can be detrimental to Bluetooth broadband signals and require attention. RF interfence defenses include [11]:

+ frequency hopping where transmitter and receiver tune/hop to any of 79 different channels at a rate of 1,600 times per second in a predetermined pattern
+ channel-quality-driven data-rate information transmission that achieves optimum data throughput, by allowing a receiving device to electronically negotiate with its transmitter to change transmitted packet types according to conditions experienced at the receiver

On the other hand, there's always another side of the story, and other experts say that [12]:

"Bluetooth is Dead. Bluetooth will be superceded by Wi-Fi Wireless-Fidelity rollouts (*this is because Wi-Fi links let users transmit and receive data for short distances at 200 times the speed of a dial-up modem*). As a physical layer/in-

terface for data, Bluetooth is thought to be, "too slow, overpromised, and underdelivered. In a few short years, many will look back on Bluetooth as a lesson on marketing gone awry."

As the Fox news TV channel might say in regard to the future of Bluetooth, "we inform, you decide."

Digital-Broadcast Radio Poised for 2005 Model Year

Kenwood, Philips Semiconductors, and Texas Instruments have all rolled out new CD-quality radio chips [13], [14] to take advantage of iBiquity Digital's HD Radio [15] broadcast format. HD Radio digital broadcasts add sidebands to existing AM and FM frequencies, enabling AM broadcasts to produce "FM-type" sound, and FM broadcasts to produce "CD-type" sound. However, to capture signals from the sidebands, HD Radio receivers must include specialized digital signal processors [13]. Through last fall, 180 stations were licensed for HD Radio operation, and 50 were already on the air [14].

The Philips' HD Radio signal processing chip executes 650 million instructions per second, raw number-crunching power needed to serve vehicles with separate rear-seat audio, to play MP3 files, etc. [13]. HD Radio is promising because:

♦ it requires only small investment on the part of broadcasters
♦ users don't need to pay subscription fees
♦ besides providing higher quality audio, an additional data signal is available to broadcasters for potential use as an advertising venue
♦ availability of a "rewind" function will allow listeners to scroll back 30 seconds or so to catch, for example, the title of a song
♦ On-board DSP-tuner signal processing separates received analog and digital signals, compares strengths of the two sets of signals, and employs a "blending" process to produce the strongest possible received signal. (*This is particularly important for vehicles driving through mountainous regions or between tall buildings, where signal strength can be weak*)
♦ today there are 800 million analog radios in use in the U.S. market, and all these receivers are potentially "ripe for replacement to digital"

The company, iBiquity, sole owner of the HD Radio technology [15], expects HD Radio sales to reach tens of thousands in 2004, hundreds of thousands in 2005, and millions in 2006. It's also forecast that, "in the next decade, HD Radio technology may be installed in every new car radio made in America." However, cost remains a barrier since HD Radio-equipped radios presently cost about $200 more than analog radios in use today [16].

Automotive suppliers, including Visteon and Delphi Delco, plan to unveil HD Radio receivers for OEM automakers in Model Year 2005 vehicles. The consensus of industry analysts is that HD Radio may will gather momentum more quickly than satellite radio systems such as XM Radio and/or Sirius Radio [17]. This will be the case, especially if HD Radio broadcasters succeed in matching satellite radio in sound quality, which will help retain the local listener base [16].

2004 Acura DVD Audio Surround Sound

New developments in HD Radio digital and satellite radio audio broadcasting have been cited. But there remains one more audio technology that looms on the horizon. "Vinyl records are history, as are 8-track and cassette tapes, and now

CDs may be obsoleted by DVD 5.1-channel digital surround audio technology [18]." This audio employs six distinct channels, compared to two on typical CD premium sound. With DVD-A ("A" stands for "Audio"), all 14-guitar parts on the Eagles' "Hotel California" recording can be heard — something not possible with 2-track CD formats.

The first consumer DVD-A system is the Panasonic ELS Surround sound system, currently offered in the 2004 Acura TL model vehicles. The DVD-A audio system is also slated for select 2005 General Motors vehicles, Lexus, Infiniti, and Audi models [18]. There are, however, some DVD-A audio system limitations:

♦ while CDs will play on the DVD-A system, it does nothing to improve the sound of regular CDs; furthermore, DVD-A discs won't play on standard CD players
♦ few recordings have yet been re-mastered to the new DVD-A format, and few new albums are being released in this new format
♦ the DVD-A system does not incorporate a MP3 player
♦ DVD-A won't make radio broadcasts sound any better — only DVD-A recordings will sound better

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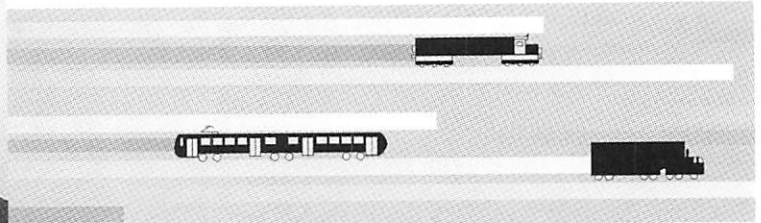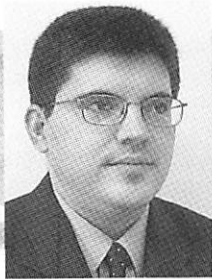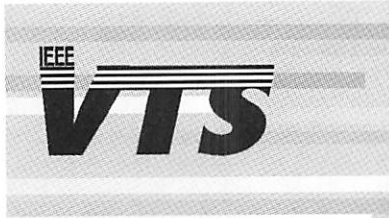
Mobile Radio

Javier Gozalvez, Senior Editor

WPAN and WLAN

Pulse~LINK has successfully demonstrated a Ultra Wideband (UWB) wireless transceiver prototype. The test showed a 125Mbit/s data rate transmission at 20 meters compliant with FCC power and spectrum regulations. Real-time, two-way, full motion video, sound and Internet browsing over a transmission range exceeding 50meters was also demonstrated. The demonstration was done in the presence of GPS, WiFi, cellular, two-way radio and Bluetooth equipment with no demonstrable degradation in performance to any of these equipment.

In order to accelerate the adoption of UWB technology in Wireless Personal Area Network (WPAN) applications, Texas Instruments has announced plans to offer royalty-free licenses under TI essential patents directed towards the IEEE 802.15.3a standard (www.ti.com/uwb), pending ratification of the MultiBand OFDM Alliance's (MBOA) proposal as the new IEEE 802.15.3a standard for WPANs. TI's technology is designed to comply with all existing FCC requirements. On the other hand, Motorola has recently announced its decision to purchase the assets of XtremeSpectrum demonstrating its support for the company's UWB technology. This technology is rival to that developed by Intel and TI in their efforts to become the final standard adopted by the IEEE 802.15.3a working group. XtremeSpectrum has also made a proposal to offer royalty-free licenses if its contributions to the IEEE 802.15.3a standard are adopted.

NEC has developed and demonstrated a software that allows for fast sign-on and handover between access points. The software, tested in an automobile test track in Tokyo, involved four IEEE802.11b access points placed at 500m intervals. The access points were connected to a router where the company's software is installed. The company successfully demonstrated handovers between the access points while traveling at a speed of 205mph and downloading a file to the PC in the car from a web server. The software has been developed for use in intelligent transport system applications.

Microsoft has announced its Wireless Provisioning Services (WPS) technology allowing users of Windows XP to connect to Wi-Fi hotspots with a seamless sign-up process and enabling a more secure wireless network access.

The Wi-Fi Alliance has launched a cell phone service that enables users to use a WAP browser to locate their nearest Wi-Fi hotspot access points. Membership in the Wi-Fi zone program is free of charge to WLAN providers whose locations use Wi-Fi certified equipment.

Sprint has launched a service, called PCS Wi-Fi Access, providing access to the Internet in more than 685 locations through a roaming agreement with Wayport. Sprint intends to add Wi-Fi service in Seattle, through 250 hotspots run by Cometa Networks. Other companies, such as Verizon Wireless, AT&T Wireless and SBC Communications have entered into similar agreements with Wayport. Sprint, together with Truckstop.net, is also planning to bring Wi-Fi access to 3000 US truck stops. Initial rollout consists of 25 locations and the initiative plans to bring 300 locations online per quarter.

BT has unveiled plans to install WiFi access to more than 200 of the company's payphones. The service, branded BT Openzone, initially targets areas nearby hotels or restaurants. BT expects the range of the service to be limited to a usable range of 60m. More information on the service, pricing and hotspots can be found in: www.bt.com/openzone

A new report from industry body The UMTS Forum provides an in-depth analysis of radio spectrum bands availability around the world for private and public WLANs. Titled "WLAN Spectrum Report - after WRC-03", the new report assesses the availability of frequency bands at 2.4 GHz and 5 GHz for the implementation of WLANs, and includes latest information following WRC-03 where global allocation of frequencies in the 5 GHz band for WLAN usage was decided. The report details designated frequency bands, their license exemption status and technical restrictions on the use of these frequencies for private and public WLAN usage in key European, American and Asian territories.

Insight Research Corporation has predicted that $163billion will be spent worldwide over the next five years on WiFi services and equipment. The company expects WLAN technology to grow faster in Europe than North America. It also predicts worldwide WiFi revenues will grow from $7billion in 2003 to over $44billion in 2008 at a compounded annual rate of 44%.

In a new report, Disruptive Analysis predicts there will be as many as 25million "multimode" wireless devices worldwide by the end of 2006 that will be able to hop between cellular and WLAN networks. It also expects a market for managed corporate mobility services in excess of $4billion. The firm says the market will be initially driven by laptops and industrial handhelds and early adopters are corporate mobile workforces, service/logistics personnel and military/public safety forces.

Global Wi-Fi has estimated the number of hotspot locations globally to surpass 45000 by the end of 2003. More than half of these hotspots are expected to reside in Asia.

Wireless Data

Qualcomm has announced the third major release of its Binary Runtime Environment for Wireless™ (BREW)

client software and BREW SDK™ (software development kit) tool. The new BREW 3.0 client software extends a mobile handset's multimedia functionality by adding support for removable storage media and a serial interface that allows users to easily connect their BREW-enabled handsets to other devices, such as keyboards or personal computers. In addition to multimedia enhancements, the BREW 3.0 client software also offers group management features, which will enable operators to segment consumers, including business users and corporations, to deliver tailored wireless applications portfolios. BREW 3.0 software also allows developers to take advantage of its secondary display access capabilities. Qualcomm also announced BREWChat, its push-to-chat solution which is planned for commercial availability in the first quarter of 2004. Built on Qualcomm's QChat™ technology, BREWChat enables person-to-person and person-to-group communication between subscribers at the push of a button. BREWChat carries the same features of its root technology, Qualcomm's QChat solution, but was specifically designed for CDMA2000 1X Release 0 networks. BREWChat offers superior call set-up performance and bandwidth savings to operators. BREWChat uses standard voice-over-Internet protocol (VoIP) technologies to enable quick push-to-chat functionality on 3G CDMA wireless devices and networks. The US manufacturer also announced that wireless subscribers have securely downloaded more than 50 million BREW-based applications since BREW-enabled products and services became commercially available less than two years ago.

NTT DoCoMo announced that Italy's Wind Telecomunicazioni has launched an i-mode service to the Italian market, which means that Italy becomes the 8th market for i-mode. Moreover, the operator has announced that total subscribers to 2G and 3G i-mode mobile internet service in Japan surpassed 40 million in October 2003, that is in about four and a half years since the service was launched on February 22, 1999.

Forums and Industry Alliances

The Open Base Station Architecture Initiative (OBSAI), an industry forum creating open specifications for base station architecture, has announced the availability of the OBSAI interface specification for the radio and baseband functions within the base station. The addition of the radio module interface specification means that OBSAI has now defined a complete set of interface specifications to cover the functions of all key base station modules: control; transport; baseband and radio. Full details of the OBSAI specifications can be found at www.obsai.org

The CPRI (Common Public Radio Interface) industry initiative has announced the open publication of the specification for the key internal interface in the radio base station. CPRI focuses on a 3G radio base station design that divides the radio base station into a radio and a control part, by specifying one new interface - the only and unique radio driven interconnect point within base stations. This will enable each part of the base station to better benefit from the technology evolution in its respective area. The CPRI specification is openly available for the benefit of the wireless industry. The parties' individual objectives are to introduce products compatible to the specification on the market during 2004. More information can be found at: www.cpri.info

The Open Mobile Alliance has released its MMS (Multimedia Messaging Service) version 1.2 enabler. The release is designed to provide a global industry standard for MMS application development by defining a minimum set of requirements and conformance to enable end-to-end interoperability of MMS applications, MMS-capable handsets and servers and content provisioning.

The OSGi Alliance has announced the formation of the Mobile Expert Group, a new working body designed to further promote the use of Java technology in the mobile space. The group is chartered with defining requirements and specifications for the next generation of Java technology-based platform software, targeting data-capable mobile devices. The Mobile Expert Group will work to define specifications that expand the current marketplace for downloadable games to encompass downloadable middleware and extended APIs-enabling end users to accomplish multiple tasks, simultaneously, using the same device. It will also work toward facilitating the growth of the Java developer community.

Wireless, PMR and Public Safety

Motorola, in partnership with NATO C3 Agency (Consultation, Command and Control Agency), have announced the successful trial of a satellite link between Motorola TETRA Dimetra IP infrastructure and a SATCOM (Satellite Communications) ground station. The trial is part of the Motorola initiative to push the boundaries of TETRA so that NATO and the international community can provide quickly deployable, secure, end-to-end communication into new environments. According to the company, this is the first time that a packet switched TETRA system has been successfully deployed over a satellite link. This link can be used in remote locations to provide TETRA network coverage, ensuring communications during incidents such as natural disasters, major incidents, peacekeeping efforts, and disaster relief. The trial linked a military SATCOM ground station situated on top of the Motorola Copenhagen facility, to a Motorola MBTS TETRA base station connected to the NATO ground station in The Hague. The connection was via a space segment provided by Supreme Headquarters Allied Powers, Europe and spanned 72,000 km at a data speed of 64 Kbits per second. The MBTS is only 60cm tall and weighs just 70kg, creating a base station that is transportable and quick to deploy. This allows emergency response services to transport and deploy TETRA base stations easily and quickly in order to save time in mission-critical situations. Secure calls are supported on encrypted handsets, with transmission channel, control channel and air interface transmissions robustly protected. Dimetra IP end-to-end encryption was also successfully trialled. Motorola has also announced that multi-slot packet data, supported by Motorola's TETRA Dimetra IP system, will be available in 2004.

APD Communications and Motorola have announced a fully integrated end-to-end Personal Location Solution. The Motorola MTH800 TETRA handportable, integrated with APD's location management software, 'Coordinator', provides the personal location solution that many organisations need, to locate on-foot patrols or out-of-vehicles field workers. At the heart of the new location solution is Motorola's Instant GPS engine, together with a patented RF antenna delivering outstanding sensitivity, allowing the unit to track GPS satellites

where traditional solutions fail. The Instant GPS solution is a single chip device resulting in ultra-low current consumption, meaning that the use of GPS does not impact on the battery life of the MTH800, a critical requirement for Public Safety users. The Instant GPS chip features an on-board processor and memory, providing a single interface to the host radio. This high level of integration means the GPS location process is completely independent of the host device.

Nokia introduced, at the annual TETRA World Congress, its TB3 TETRA base station, which, according to the company, brings extreme coverage enhancements. Its first deliveries are expected to take place during the second half of 2004. According to Matti Peltola, Senior Vice President of Nokia Networks: "up to 75 percent greater handheld coverage is a dramatic improvement indeed. For example, the height of the base station antenna mast would have to be almost doubled to achieve the same coverage improvement"

The Finish manufacturer also announced the launch of a TETRA system that operates on the 300 MHz frequency band. This achievement will make Nokia TETRA networks available for Russian customers, who can use the 300 MHz frequency band. The new TETRA 300 MHz system will be available for deliveries during the second half of 2004.

Motorola, Science Applications International Corporation (SAIC) and Siemens, have been selected to provide the secure two-way radio communications system that will be used by public safety agencies during the 2004 Olympic Games in Athens. The public safety communications system for the Athens Games will be based on TETRA standard and will employ Motorola's level three-encryption security. The consortium stated that deployment of the TETRA system has already commenced, with the network expected to be fully installed and operational by April of 2004. Motorola, in partnership with Danimex Communication, also supplied the first Compact TETRA network in Africa to the recent COJA (Comité D'Organisation des Jeux Africains) All African Games 2003. The system supplied comprised two single sites, with three voice channels per site, connecting 200 portable handsets and 20 mobile radios. Danimex used a Codan microwave link to connect the two sites, due to its reliability and ease of set-up. Compact TETRA systems can handle up to 8 sites, with 10,000 users and 128 channels.

The Finnish public safety network Virve, serving more than 35,000 users across Finland, has brought into operational use two high-security features, Authentication and Air Interface Encryption. The Authentication and Air Interface Encryption features in Nokia's digital TETRA system use dynamic encryption keys, to protect the network from unauthorized radio users and make eavesdropping impossible. In TETRA Authentication, the system checks that a radio terminal is authentic and not an illegal clone. TETRA Air Interface Encryption hides the contents of the calls and messages that are transmitted on the radio path. The signalling and coded speech sent on the radio path are ciphered using encryption keys and an encryption algorithm. TETRA Air Interface Encryption protects the network against eavesdropping, analysis of traffic patterns, and unauthorized use. Major user groups of the Virve network are the emergency, fire and rescue services, the police, the Frontier Guard, the Social and Health Services, the Customs Authority and the Finnish Defence Forces.

The international public safety mobile broadband standardization partnership, Project MESA, is expecting initial drafts of their system-oriented technical specifications by 2004. At a recent meeting, working group members reaffirmed MESA's development approach to consider MESA capabilities as a "system of systems" for communication between authorities and organizations, maximizing usage of existing communications technologies and infrastructures. Proposed MESA systems and capabilities will involve emergency communication scenarios where infrastructure exists and where it is nonexistent or exhausted. MESA specification development is taking a technology neutral approach and resulting implementations may involve private and/or commercial technology and systems, along with new technologies still under development. MESA specifications also envision the identification of standards that satisfy needed capabilities and functionalities which standards organizations, vendors and governmental agencies can utilize in their implementation and procurement scenarios.

ETSI Project TETRA has announced significant progress on the TETRA Voice plus Data (Release 1.2) standard with additional TETRA Enhanced Data Services (TEDS) specifications. TEDS provides high speed data services with backward compatibility with the existing TETRA V+D standard based equipment, fitting seamlessly into existing spectrum allocations. Areas of progress in TEDS are: user requirements specification; final decision on carrier types, access method (TDMA) and carrier bandwidths (25, 50, 100 and 150 kHz); key decision on selection of suite of modulation types and levels (4QAM, 16QAM, 64QAM plus D8PSK and DQPSK) to serve in an adaptive environment to combat propagation effects. Working Groups within ETSI Project TETRA will be adding new Voice Codecs into the standard to provide greater user applications for TETRA. These activities have already resulted in the Adaptive Multi-Rate (AMR) codec being standardised and a new NATO codec is also planned for standardisation. Under Release 2, the air interface will be adapted to allow TETRA to operate up to distances well in excess of 58 km for applications such as those required for Air to Ground communications.

3G News

NTT DoCoMo has announced that the number of subscribers to the 3G FOMA service nationwide passed the 1 million mark two years after launch of the service. DoCoMo has striven to improve handset quality, lengthen battery life and expand the area of network coverage. To cost-effectively expand coverage area, the company has developed micro-base stations for its FOMA service, and now provides network availability to 96% of the nation's population. Overall network accessibility will be further expanded to 99% of the population by the end of March 2004. DoCoMo will increase the number of FOMA base stations in existing service areas to upgrade service quality. Base stations will be expanded to 3,200 locations in the Kanto-Koshinetsu region and 10,700 nationwide by the end of December 2003. This includes expanding In-building Mobile Communication Systems to 358 locations in the Kanto-Koshinetsu region and about 800 nationwide, which will enable wider use of FOMA service in

high-rise buildings, underground shopping areas and train stations. The number of subway stations with FOMA access will increase from seven to 52 as a result. To facilitate highly advanced network services inside buildings and underground malls as well, DoCoMo plans to have a total of 1,600 indoor micro-base stations in place by the end of March 2004. The Japanese operator has also announced that the company will invest in manufacturers of 3G FOMA handsets to encourage early development of evermore sophisticated FOMA handsets in terms of native applications and functionality. DoCoMo particularly hopes to accelerate the evolution of state-of-the-art 3G technologies in the areas of handset application software running on advanced OS platforms (Linux and Symbian) and HSDPA (High-Speed Downlink Packet Access) technology. HSDPA will enable much faster data transmission via the W-CDMA network. DoCoMo will provide a total of about 37 billion yen over two years (fiscal 2004 and fiscal 2005) to Fujitsu Limited, Mitsubishi Electric Corporation, Motorola Japan Ltd., NEC Corporation, Panasonic Mobile Communications Co., Ltd., and Sharp Corporation. DoCoMo will continue to upgrade the service by introducing various technologies including HSDPA, which is expected to be launched within 2005. DoCoMo has also signed an agreement with Symbian to use the Symbian OS platform in the next generation of 3G phones. The agreement will give DoCoMo access to Symbian OS source code and the right to deliver extended versions of this code to Symbian OS licensees.

AT&T Wireless has began offering, what it claims is, the fastest national mobile wireless data service in North America by launching its EDGE (Enhanced Data rates for Global Evolution) network. According to the company, EDGE offers average data speeds between 100-130 kbps — nearly twice as fast as other national mobile wireless networks. EDGE service is now available nationally to customers located in areas served by the AT&T Wireless GSM/GPRS Next Generation network, covering approximately 215 million people, some 6,500 cities and towns and areas along more than 30,000 miles of major highways. The company is offering EDGE in Puerto Rico and Bermuda, and plans to deploy EDGE throughout its properties in the Caribbean in the near future. In addition, Rogers AT&T Wireless has added EDGE capability in the Greater Vancouver area and will deploy EDGE throughout its Canada-wide network beginning next year. The first market launch of EDGE occurred in Indianapolis by Cingular Wireless (June 2003), followed by additional launches throughout the world within Hong Kong, Thailand, Finland, Chile, and Canada.

Sony Ericsson and AT&T Wireless have announced the commercial availability in North America of the world's first EDGE PC Card. The GC82 is a dual band (850/1900 MHz) next-generation PC Card, incorporating high speed EDGE technology into mobile PC computing, providing AT&T Wireless customers with data speeds averaging 100-130kbps and bursts up to 200kbps.

Telefónica Móvil Chile has announced the launch of commercial EDGE services in the metropolitan Santiago area and in the coastal city of Valparaiso. The Telefónica Móvil Chile launch is the first commercial launch of EDGE services in Latin America and the first for the Telefónica Móviles group worldwide. Westel, an Hungarian mobile operator, launched commercial EDGE service

in the heaviest traffic areas of Budapest and is extending service to 130 sites in the capital city by the end of the year. TeliaSonera has announced it will launch an EDGE network upgrade this autumn in Finland and is investigating to extend the technology to other Nordic and Baltic markets. In total, the GSA association has reported that 50 network operators have publicly committed to deploy EDGE.

The world's first roaming of multimedia mobile data services over a live EDGE network was conducted in Asia Pacific. Advanced Info Systems (AIS), Thailand and CSL Ltd, Hong Kong showed how a CSL end user could already enjoy such services as live TV from Hong Kong while roaming on AIS's EDGE network in Thailand. DTAC of Thailand also presented high-speed mobile data services including streaming and downloading over their live EDGE network, further underlining the position of EDGE in the Asia Pacific region.

KDDI, Japan's second largest wireless service provider, has commercially deployed CDMA2000 1xEV-DO services and applications in metropolitan Tokyo, Nagoya and Osaka. The network, marketed under the name CDMA 1X WIN, is available to customers since November 2003. CDMA 1X WIN represents the first commercial CDMA2000 1xEV-DO deployment in Japan and KDDI will be the sixth operator worldwide to deploy a commercial CDMA2000 1xEV-DO network, joining operators in the United States, South Korea and Brazil. Using CDMA2000 1xEV-DO-enabled PC cards and handsets, subscribers can take advantage of a download service called EZ Channel, which allows users to quickly download large files from 15 channels that offer various applications, such as music, movies, fashion, sports, news and electronic novels. KDDI plans to expand nationwide coverage of its CDMA2000 1xEV-DO infrastructure by fall 2004. The company will also introduce EZ Flat, the first fixed packet communications service rate plan in the industry that will allow an unlimited usage for a fixed monthly charge of 4,200 yen. Verizon Wireless has commercially launched CDMA2000 1xEV-DO service and applications in metropolitan Washington, D.C. and San Diego. The 3G network is marketed under the name BroadbandAccess. Verizon Wireless is the first major operator in North America to introduce CDMA2000 1xEV-DO. BellSouth has commercially deployed CDMA2000 networks in Argentina and Peru. The company now offers CDMA2000 services in Argentina, Chile, Colombia, Ecuador, Guatemala, Nicaragua, Panama, Peru and Venezuela. CODETEL, a Verizon company and the largest operator in the Dominican Republic, has commercially launched CDMA2000 1X services and the first BREW-based products and services in the Dominican Republic.

Telefónica Móviles España has presented 'Oficin@ MoviStar UMTS', the first pre-commercial UMTS service to be publicly launched by a wireless operator in Spain, along with the company's plans for its 3G project for the next few months. The Spanish operator will distribute the first UMTS PCMCIA cards to its corporate customers, enabling them to access all UMTS 'Oficina MoviStar' data services from a laptop PC at speeds of up to 384 kbit/s. Telefónica Móviles España also plans to invest around Euro 1 billion in 3G infrastructure between 2003-2006. The company's target is to have coverage in the 52 provincial capitals of Spain by the end of 2003 and between 7,000 and 8,000 UMTS base stations in 2005.

Vodafone Spain has also announced the start of its pre-commercial customer trials of Spain's first 3G dual mobile data card - compatible with both GPRS and 3G. Customers will be able to download information from their network at speeds of up to 384 kbps. Vodafone Spain will begin to commercially offer customers its first 3G services in 2004 and anticipates complete coverage in Spain's 23 largest cities by October 2004.

Vodafone has also started in Germany a UMTS test for business customers to access the UMTS network via a UMTS data card. Vodafone provides UMTS coverage in more than one hundred towns all over Germany. At Vodafone, the commercial UMTS launch is scheduled for 2004.

O2 Ireland has announced that it has exceeded its regulatory requirements for the introduction of its 3G service and has commenced limited services among selected business and individual customers. O2's 3G network coverage extends to more than 35% of the population and covers major urban centres such as Dublin city and county and the cities of Cork, Limerick, Galway, Waterford and Kilkenny. In addition to voice services, initial applications will include high-speed internet access at speeds significantly faster than dial-up, ISDN or GPRS connections, as well as video messaging and other multimedia services.

TTPCom has achieved a 216 kbps download using its EDGE module. The download, which took place on Ericsson's EDGE infrastructure at their development site in Sweden, achieved maximum 4 slot, multi-slot class 9 throughput. TTPCom's EDGE team downloaded a 10 Mbyte file from the Internet to a PC, using the EDGE module. The download was repeated using a selection of files and runs, and the 216 kbps data rate was achieved consistently. The actual maximum application data rate for EDGE is lower than the theoretical maximum data rate (236.8 kbps) due to protocol overheads. The difference is consistent with the overheads associated with FTP download.

Alcatel and Philips have announced the success of a series of interoperability tests performed with Alcatel's EDGE-ready Evolium network solutions (radio access and core) and Philips Nexperia Cellular System Solution. The tests, carried out on a scale 1 reference terminal in November 2003, achieved a successful uninterrupted download of 30 Mbytes at 220 kbit/s. This is a best-in-class speed achieved in a live EDGE operational environment, and a major improvement on GPRS performance.

Qualcomm and Huawei Technologies have announced the successful demonstration of a CDMA2000 1xEV-DO 450MHz end-to-end solution, at ITU Telecom World 2003 in Geneva, by using a CDMA handset and trial system equipment provided by Huawei. The peak data rate of 2.4 Mbps for CDMA2000 1xEV-DO was achieved during this demonstration.

Qualcomm has unveiled the highly integrated radioOne Zero Intermediate Frequency (ZIF) RFR6250 device, a complete dual-band WCDMA (UMTS) and Global Positioning System (GPS) receive chip. Supporting WCDMA (UMTS) at 1900 MHz and 2100 MHz, as well as simultaneous assisted GPS capabilities, the RFR6250 combines three radio frequency (RF) chips into one, delivering, what the manufacturer claims is, one of the industry's most integrated and cost-effective RF solutions to support global roaming and location based services for WCDMA (UMTS) networks. Samples of the RFR6250 chipset are expected to ship to customers in the second quarter of 2004.

A new report from The UMTS Forum into the potential impact of real-world mobile multimedia applications on use of 3G mobile radio spectrum has concluded that at least twice as much data traffic will flow to customers on radio downlinks as will be carried "upstream" from users' mobile devices to 3G networks. Available free to UMTS Forum web site visitors, Report #33 - titled "3G Offered Traffic Characteristics" - examines the nature of traffic driven by internet, content and other services that is likely to flow across UMTS networks. Parameters assessed in the report that will have an impact on overall traffic flows include: file sizes for non-real time sessions; expected data rates over up- and down-links of the air interface; session frequency and duration; "busy hour" traffic characteristics; and mobile subscribers' adoption of individual 3G services. Concluding that data traffic on downlinks will exceed uplink traffic by a factor of 2.3, the report also observes that the possibility exists for mobile operators to control this asymmetry through their choice of pricing plans, traffic shaping and service definition.

The CDMA Development Group (CDG) has reported that the 3G CDMA2000 subscriber base has nearly doubled since December 2002, reaching 60 million at the end of August, and is growing at an average 3.5 million users per month. More than 30 percent of CDMA subscribers now use 3G services. There are 70 commercial networks and 20 more will be deployed within the next six months in Asia, Australia, Africa, Europe and the Americas. Whereas one year ago, the vast majority of CDMA2000 subscribers resided in Asia, today over 40 percent are in North and South America as well as Europe. CDG also announced at the CDMA Americas Congress that CDMA2000 is rapidly expanding in the Americas with 45 commercial networks and over 29 million subscribers. Nearly 30% of 102 million CDMA subscribers in the region have access to 3G services. According to the EMC Database, more than 77% of the wireless data subscribers in the region use CDMA2000. A number of carriers, including BellSouth in Chile, Movilnet in Venezuela, and Vesper in Brazil, use CDMA2000 to offer broadband Internet access. Five carriers in the region have already, or will, deploy CDMA2000 1xEV-DO.

Top Global and Lucent Technologies have announced an agreement to provide wireless service providers in the Asia-Pacific and EMEA (Europe, Middle East, and Africa) regions with a solution that integrates 3G mobile networks and Wi-Fi networks. This enables operators to leverage wide-area 3G CDMA2000 and UMTS/W-CDMA mobile networks to carry the data traffic generated by Wi-Fi hot spots. Top Global's hot spot solution, called 3G MobileBridgeTM, serves as a gateway that links the Wi-Fi and 3G networks, enabling business users and consumers to use their Wi-Fi-enabled devices in truly mobile environments such as trains, buses and other vehicles. Under the agreement, Top Global and Lucent will collaborate to ensure the compatibility of Top Global's 3G MobileBridgeTM solution with Lucent's 3G CDMA2000 and UMTS/W-CDMA mobile networking equipment.

Spectrum Licenses

Three mobile licenses have been awarded in Iraq to Asia Cell Telecommunications, Orascom Telecom and Atheer Telecom. The awards divide Iraq into three regions that

will be operated by one of the winners. The winners plan to build GSM networks. Algeria has awarded its third GSM license to Wataniya Telecom which already operates in Kuwait, Tunisia and Iraq. Currently, Algeria's mobile penetration rate is about 4.5%. Sudan has awarded its second GSM license to Bashair Telecom. Saudi Arabia is set to license at least one new cellular license. The Communications and Information Technology Commission is inviting comments from interested parties on the procedures to be used and the conditions to be applied in the licensing of cellular service providers. Iran is offering its second GSM license. The license, which will last 15 years and can be renewed in 5 years increments, will be offered in the GSM900 and GSM1800 bands.

TeliaSonera and Tele2 have agreed to buy Sweden's fourth UMTS license from Orange. The two companies already jointly own a 3G license. Orange is asking 6.9 million dollars for the license. Switzerland's Federal Communications Commission (ComCom) has decided to award one GSM license respectively in the 1800MHz frequency band to the companies In&Phone (2×5.8MHz) and Tele2 (2×8.6MHz). The licenses were awarded in a competition that excluded the three existing GSM operators. South Cyprus has awarded the country's second GSM license to the Lebanese Scancom group. The license is for 20 years. Georgia is set to auction a third GSM license in the country and also some additional radio spectrum for the incumbent operators. Bidders will not be allowed to participate in the auction if by winning they end up with more than 50% of the resources in the GSM 1800MHz frequency range. The UK telecom regulator Ofcom has made available new spectrum at 5.8GHz for wireless broadband services. The regulator expects download speeds up to 1Mbits/s. The service providers will have to share the spectrum with military radiocommunications applications by using dynamic frequency selection technology to minimize interference. Ofcom, together with the UK Radiocommunications Agency, have announced the beginning of a joint consultation on proposals to allow the trading of rights to use radio spectrum. At present, spectrum licenses cannot be traded or sold. The consultation document can be found at: http://www.ofcom.org.uk/consultations/current/spectrum_trading/condoc.pdf

Technology and Research News

Vanu and Mid-Tex Cellular have announced the successful trial deployment of what they claim is the world's first all-software GSM base station in a commercial 800MHz cellular network. The network's BTS and BSC are each a Vanu Software Radio application running on HP ProLiant servers. In addition, an ADC Digivance system and TELOS Sonata SE softswitch have been installed to complete the solution. Phased installation of the Vanu Software Radio-based network is scheduled to begin early in 2004, with the complete rollout of a 24-site system scheduled for completion by the end of 2004.

Ericsson and TeliaSonera have successfully demonstrated IPv6 services over a commercial GPRS network in an international roaming scenario. The demonstration shows that IPv6 services can be supported in a commercial mobile infrastructure, even when roaming, using automated IP tunneling. This can be seen as a stepping-stone toward native IPv6 networks and services including peer-to-peer applications. An IPv6-enabled laptop with a Sony Ericsson GPRS PCMCIA was used to set up a connection through a commercial GPRS network in Belgium to the home network at TeliaSonera in Sweden. The laptop client automatically set up an IPv6-in-IPv4 tunnel using Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) to TeliaSonera's IPv6 test mobile network, where IPv6 application servers are located and connectivity to the IPv6 Internet is provided.

Nokia has demonstrated what it claims is the world's first dual stack IPv4/IPv6 CDMA handset. This prototype handset addresses the increasing demand for advanced Internet-connected mobile devices in an environment in which existing Internet Protocol version 4 (IPv4) addresses are rapidly being depleted, and will soon be replaced by nearly infinite Internet Protocol version 6 (IPv6) addresses. Nokia is currently offering prototype IPv6 CDMA handsets to operators for testing purposes, and will be ready for commercial delivery of dual stack IPv4/IPv6 handsets during 2004. Besides the obvious increase in address space that it provides, IPv6 also provides additional security benefits to users. The introduction of dual stack IPv4/IPv6 devices is essential for the seamless transition of current IPv4 based networks and devices to the upcoming IPv6 environment.

ETSI project Smart Card Platform (EP SCP) has agreed to the introduction of a new smart card, which is half the size of the existing Subscriber Identity Module (SIM) card. Since backwards compatibility is a major issue, it was decided that this would be a determining factor for the work. In addition, it was agreed that the smaller card size must not affect the performance of the smart card, by limiting chip size. So the decision is that the contact area remains the same, and the result is that the third form factor will be a smaller version of the existing plug-in card, with much of the excess plastic cut away, but in such a way as not to impose restrictions on the chip size.

Digita, MTV, Nelonen, Nokia, Radiolinja, TeliaSonera Finland, YLE and the Finnish authorities have signed an agreement to start pilot testing a commercial broadcast service to mobile devices. The aim of the pilot is to gain experience about real end-user acceptance for mobile broadcasting services. To gain statistically meaningful results of the end-user acceptance, 500 end-users will be recruited for the pilot test to start next fall within Helsinki metropolitan area. Finland currently has three terrestrial networks (multiplexes) for digital television broadcasting. A fourth digital broadcast network would be reserved for mobile datacasting, i.e. for Internet protocol datacast (IPDC) services based on the emerging DVB-H (handheld) standard.

Motorola SPS is offering acceleration and pressure sensor integrated circuits (ICs) which are designed to enable sensor networks with the convenience and reduced installation expense of wireless technology, through their compatibility with the ZigBee protocol. These ICs are designed to help enable the deployment of wireless sensor networks in environments as diverse as a factory floor to a game console in the family living room. Wireless sensor networks should obtain real-time data on systems or devices without requiring physical contact, enabling remote monitoring and reduced labor costs. ZigBee is a wireless networking technology based on the newly defined IEEE 802.15.4 standard.

Nokia has unveiled what it claims is the world's first GSM push-to-talk handset, the Nokia 5140 phone. The GSM/GPRS/EDGE Nokia 5140 phone will be available in a GSM 900/1800/1900 MHz version primarily for the Europe/Asia market and in a GSM 850/1900/1800 MHz version primarily for the Americas market. Both versions are expected to be available during the 2nd quarter of 2004. Nokia has also launched two new products that enable GSM/GPRS operators to offer push-to-talk services. The Nokia Push to Talk Call Processor handles PoC (Push-to-talk over Cellular) traffic, while the Nokia Push to Talk Register handles PoC subscriber data. The two PoC products can be connected to existing multi-vendor GPRS networks. Commercial deliveries will start in the first quarter 2004. Siemens Mobile has announced that, by mid-2004, it will be the world's first provider to make its entire product range available for PoC, which is based on the open, cross-vendor specification. And this will be end-to-end: from mobiles to components for the mobile radio infrastructure. Extensive tests are already underway. Mobile operators in the USA, Europe and Asia will be conducting their own trials on Siemens' technology during the first half of next year.

Italy's TIM and RFI, the group responsible for the Italian railway network, have signed an agreement that will enable TIM to optimise the coverage of its GSM network in tunnels by installing dedicated masts. The cooperation agreement also provides for national roaming on RFI's GSM-R network. Orange has successfully completed the first phase of tests to deliver continuous network coverage throughout the UK's rail tunnels. The tests demonstrated full coverage can be provided in the tunnel using selected antennas close to the entrance even at high speeds. Andrew Corporation is supplying Ericsson with a comprehensive RF coverage solution for the Rio de Janeiro subway. The system integrates Andrew multioperator remote optical repeaters and boosters with RADIAX coaxial cable, connectors and accessories. In the Rio subway, there are three master units that provide RF connectivity and administer some thirteen optical remote units allowing to provide RF coverages in tunnels and stations.

MTN South Africa has developed a traffic monitoring service, called MTN Traffic Cam, for major highway interchanges. The system works through cameras placed on MTN radio masts giving motorists live feeds over MMS's. LogicaGMC has developed a traffic monitoring system that gathers the information by tracking the volume and movement of GSM mobile phones being used by drivers. Studies conducted have proven that the data produced by this system provides an accurate reflection of traffic movement.

Mobile Phones and Health Issues

A study conducted by the Dutch technological research institute TNO claims that 3G base stations could cause nausea and headaches in people close to them. The study also compared the impact of radiation from GSM base stations with 3G base stations. Moreover, the study found that cognitive functions such as memory and response times were boosted by the GSM and 3G base station emissions.

After clashes between Hutchison and residents over placement of the company's 3G masts, the Australian Communications Authority has released a fact sheet on the effects of radiation from 3G towers. According to the association's chairman, the emission levels produced by 3G transmitters ae considered to be low with an average radiated power of around 3watts. The fact sheet can be found at: http://ww.aca.gov.au

US Mobile Market

In a Report and Order, the Federal Communications Commission (FCC) has provided service rules for the 1710-1755 MHz and 2110-2155 MHz spectrum bands. As determined by the FCC in November 2002, these bands can be used to offer a variety of new and advanced wireless services, including voice, data, and broadband services – popularly referred to as 3G services – using high-speed fixed and mobile networks. The rules adopted include provisions for application procedures, licensing, technical operations, and competitive bidding. This spectrum will be licensed by geographic areas under the FCC's flexible, market-oriented Part 27 rules, and will be assigned by competitive bidding. The licenses for these bands will have an initial 15-year term with 10-year renewal terms. Licensees will be required to show that they have provided substantial service by the end of the license term; however, no interim construction requirements have been imposed. Licensees will be able to aggregate spectrum in these bands and will be able to partition and disaggregate their licenses. The licenses will be assigned via auction in the future. Fifteen percent bidding credits will apply for entities meeting the definition of small business used in the broadband PCS auctions, while 25 percent bidding credits will apply for very small businesses. The Order also establishes rules to protect co-channel and adjacent channel Government and non-Government operations from interference.

The FCC has also made available an additional 255 megahertz of spectrum in the 5.470-5.725 GHz band for unlicensed devices. The Commission made the spectrum available for use by unlicensed National Information Infrastructure (U-NII) devices, including Radio Local Area Networks (RLANs), operating under Part 15 of the FCC's rules. This increases the spectrum available for use by unlicensed devices in the 5 GHz region of the spectrum by nearly 80%. In addition, the Commission also adopted several allocation changes consistent with the results of the 2003 World Radio Conference and an agreement reached with the U.S. Department of Defense, the National Telecommunications and Information Administration (NTIA). To provide federal users with additional protection from harmful interference, the FCC is requiring that U-NII devices operating in the 5.250-5.350 GHz and the 5.470-5.725 GHz bands employ dynamic frequency selection (DFS), a listen-before-talk mechanism, and transmit power control.

The FCC has adopted service rules for the commercial use of spectrum in the 71-76 GHz, 81-86 GHz, and 92-95 GHz bands. These bands are well-suited for licensees to offer a broad range of innovative products and services, including high-speed, point-to-point wireless local area networks, and broadband Internet access. The action outlines a flexible and innovative regulatory framework for these bands. Traditional frequency coordination between users will not be required. Instead, each path will be registered in a database, and entitled to interference protection based on the date of registration. The FCC believes that this non-exclusive licensing approach will stimulate investment and spur research and development in new "wireless optics" technologies and services.

The FCC also believes that this approach will provide an effective means of achieving greater spectrum efficiency by allowing a maximum number of users – both non-Federal and Federal Government – to share these bands while evolving their systems to meet future needs and requirements. The 71-76 GHz and 81-86 GHz bands will be divided into four unpaired 1.25 gigahertz segments, for a total of eight segments, and the segments may be aggregated without limit. Pairing will be permitted in a standardized manner, e.g., 71-72.25 GHz may be paired only with 81-82.25 GHz, and so on. The co-primary portion of the 92-95 GHz band will be divided into two segments, 92.0-94.0 GHz and 94.1-95.0 GHz, which also may be aggregated by licensees. The FCC is also permitting unlicensed, indoor use of the 92.0-94.0 GHz and 94.1-95.0 GHz bands by non-Federal Government users, to be governed by Part 15 of the FCC's rules and based on existing regulations for the 57-64 GHz band. The FCC will not permit unlicensed use of the 71-76 GHz and 81-86 GHZ bands at this time. The FCC's Spectrum Policy Task Force has announced that it will soon launch a new research tool on its Internet site (www.fcc.gov/sptf) that will allow the public to track the progress of all Commission spectrum-related rulemaking proceedings and initiatives in one place.

The FCC has adopted a Notice of Inquiry and Notice of Proposed Rulemaking that sets forth and seeks comment on a possible new way to quantify and manage interference among different services. Termed "interference temperature", this model for addressing interference takes into account the actual cumulative radiofrequency (RF) energy from transmissions of spectrum-based devices, and would set a maximum cap on the aggregate of these transmissions. In contrast, the current approach for managing interference focuses on specifying and limiting the transmit powers of individual spectrum-based devices as the chief way to prevent interference. The "interference temperature" approach may facilitate more intensive use of the radio spectrum, creating the opportunities for new services and improving the predictability of any interference to existing services. The Notice of Inquiry seeks comment on a number of issues related to the need for, development, and implementation of an interference temperature model for managing interference.

The FCC has adopted an Order and Second Further Notice of Proposed Rulemaking revising the scope of its Enhanced 911 (E911) rules and clarifying which technologies and services will be required to transmit E911 location information to public safety answering points (PSAPs). The FCC concluded that the following services should be subject to its E911 requirements: certain telematics services and resold cellular and broadband PCS mobile wireless services, including mobile pre-paid calling cards. Mobile satellite services carriers that provide interconnected voice service are required to establish call centers for the purpose of answering 911 calls and forwarding such calls to an appropriate PSAP.

The FCC has adopted a Notice of Proposed Rulemaking and Order that sets forth proposals and seeks comment on the use and applications for cognitive "smart" radio systems. The Notice seeks comment on the ways in which the Commission can encourage and remove regulatory impediments to continued development and deployment of smart radio technologies, including, for example, facilitating the ability of licensed spectrum users to deploy them for their own use to increase spectrum efficiency, and to facilitate secondary markets, allowing licensees to lease their spectrum access to third parties using such technologies. The Notice also seeks comment on ways in which smart radios can facilitate opportunistic use of the spectrum by unlicensed devices, while protecting incumbents from harmful interference.

In its Semi-Annual Wireless Industry Survey, CTIA found that for the first 6 months of 2003, US wireless operators earned service revenues of $41.4billion, up 13% from the previous year. Total billable minutes of use was 380billion for the first half of 2003, up from 292billion the previous year. Data revenue increased by 70% from $411million to $700million. The number of wireless subscribers also went up by 10% from 134.6million in June 2002 to 148.1million in June 2003.

The USA's General Accounting Office (GAO) has reported that only 65% of emergency centers are ready for the deployment of location tracking of emergency phone calls (E-911). According to a database sponsored by the Department of Transportation (DOT), as of October 2003, nearly 65% of public safety answering points had E-911 phase I, which provides the approximate location of the caller, and only 18% had E-911 phase II, which provides a more precise location. The USA's House of Representatives has approved a bill that promises to speed technology upgrades at thousands of E-911 emergency call centers. The bill would also establish a federal office to ensure better coordination among federal, state and local public safety officials.

AT&T Wireless has signed an agreement to purchase US Cellular's TDMA operations in south Texas, a market covering a population of more than 1.3million people. The deal allows AT&T Wireless to complement its nationwide TDMA and GSM/GPRS networks and expand its presence in south central Texas. Cingular Wireless and Dobson Communications have signed an agreement to exchange Dobson's ownership in its Eastern Shore of Maryland cellular property for Cingular's ownership in its Northwest Michigan cellular property.

Industry Forecasts and Surveys

Technology market research firm ABI has said total UMTS base stations deployments for 2003 will reach just about 35000 units compared to the earlier estimates of about 32500 units. Just over a third of all contracts were awarded in the Asia-Pacific region, about one quarter in the Americas, slightly less than a quarter in Europe and 15% in the Middle East and Africa. The overall industry revenue is set to reach about $17billion in 2003. ABI also projects UMTS equipment revenue growth of nearly 40% from 2003 to 2004.

According to Gartner, worldwide mobile phone sales totaled 132.8milion units in the third quarter of 2003, which represents a 22% increase from the same period in 2002. Nokia's market share decreased. Second place corresponds to Motorola followed by Samsung, Siemens, LG and SonyEricsson. In mature markets, sales of color mobile terminales and camera phones increased while demand for low-cost terminals has also continued. The North American market was driven by replacement sales. The predictions from Strategy Analytics correspond to a 23% annual increase in mobile handsets sell-in in Q3 2003 up from an 11% increase in the same period of the previous year.

IDC is forecasting the number of worldwide camera phones shipments will increase from 19million in 2002 to 298million in 2007. According to the firm's survey results, 44% of respondents planning to purchase a camera phone in the next 6 months would be willing to pay more than $21 per month in addition of their standard service charge for the ability to send and receive images over their mobile phone. However, the firm states that increasing user satisfaction to stabilize retention rates is critical for the long-term success of the market.

Research conducted by IMS Research reveals that worldwide revenues generated by push to talk services will exceed $50billion in 2008. According to the firm, at present, the market activity is concentrated in the USA. However, Nokia has stated that all its GPRS/WCDMA handsets will feature PTT technology from 2005.

Research conducted by BearingPoint, in cooperation with Nokia Networks, claims that enterprises could obtain savings of as much as 25% in some cases by moving more or all of their voice traffic from fixed-to-mobile telephones.

A report from the Yankee Group claims that between 20% and 40% of voice traffic originates on mobile networks and wireless revenue will soon overtake the total fixed switched-access market. The firm also expects an increase in both penetration of data services and ARPU. On the other hand, a decrease in voice ARPU is expected. According to its estimates, the Yankee Group expects an increase in nearly 9% from 2002-2007 in the number of global subscribers, exceeding 1.75billion. Revenue is also expected to grow 9% with Asia-Pacific clearly registering the highest growth, nearly 15%, due to an expected 20% growth in China.

In a new study, the Wireless World Forum expects the mobile games market will grow from $450million this year to $1.93billion in 2006. The company even expects these estimates to be on the conservative side. At present, Japan and Korea represent 64% of the market. However, the firm expects China and US to dominate the industry in 2006. The Yankee Group expects US consumers will spend $500 million on wireless games in 2006, Europeans about $1billion and Asians more than $2billion. According to the firm, wireless games will represent about 20% of wireless entertainment services. Frost&Sullivan expects the European market for mobile gaming to grow from $800million in 2002 to $7billion in 2006. The firms expects that by 2006 mobile gaming will represent arounf 5% of total operator wireless data revenues. Around 50% of devices sold in 2003 are expected to be download-enabled.

A report from Alexander Resources claims that worldwide revenues for all forms of gambling on mobile phones can reach $16billion by 2008. The company has identified three segments as the drivers of the business: mobile casino style betting, mobile lotteries and mobile sports betting.

In the report 'Maximizing the Potential of Multimedia Messaging Service Applications', Strategy Analytics said MMS services have the potential to reach $22billion in revenue by 2008. The firm also advises operators to open up the market by allowing third-party content providers to deliver services to their base customers. The report also expects 380million MMS users by 2008.

According to predictions from Park Associates, UWB technology will be used in 150million devices by the end of 2008. The firm expects that the PC industry will be one of the first to embrace the technology.

3G Americas has reported that GSM is the fastest growing technology in the Americas with an overall annual growth in the region of 89% from September 2002 to September 2003, according to the EMC World Cellular Database. In Latin America alone, GSM grew by 146% over the same time period, with Brazil and Mexico representing a substantial portion of this growth. The growth in the US and Canada was higher than 66%. According to EMC, at the end of 3rd quarter 2003, there are nearly 1billion GSM customers worldwide: with more than 921 million subscribers on more than 685 GSM networks in more than 200 countries. In fact, Djibouti became the 200th country to adopt the GSM technology. Other newcomers include Timor Celeste, Honduras and Guyana.

Other News

ITU TELECOM WORLD 2003 took place from 12 to 18 October 2003 in Geneva. The event included 911 exhibitors representing 51 countries, with a strong presence from the Asia-Pacific region that was represented by more than 145 exhibitors. Two of the show's largest stands were those of Huawei Technologies and ZTE Corporation, both Chinese companies. According to Mr Yoshio Utsumi, Secretary-General of the International Telecommunication Union (ITU), "WORLD 2003 has been about getting down-to-business, restoring confidence and building growth". Among the major contract announcements were those from BT with "3" in Ireland to build and operate its 3G radio access network and Nortel Networks' supply agreement with Israel's Pelephone to expand its 3G Wireless Data Network. Announcements of partnership agreements included that of Microsoft creating mobile Web services standards with Vodafone, Boingo (TM) Wireless announcement of a deal with PicoPoint, an Amsterdam-based global Wi-Fi hot spot enabler, HP's announcement with Alcatel of advanced business services to the SMB market and Samsung Electronics' agreement with Orca Interactive. More information can be found at http://www.itu.int/home/index.html

CTIA Wireless I.T. & Entertainment took place in Las Vegas in October 2003. During the event, Verizon Wireless and Vodafone announced an agreement to develop exclusive games and content for their customers. TSI launched a Hosted Multimedia Messaging Service designed to give operators a means to launch and deliver MMS without the need to buy and operate a MMS center. CTIA and its members launched the initiative 'Wireless...The New Recyclable'. The aim of this action is to promote environmentally sound recycling of used wireless products and accessories. Aiirnet Wireless, a Wi-Fi Internet service provider, announced its AiirLink Hot-Spot-In-A-Box, a plug-and-play device allowing retailers to offer wireless access to its users with Wi-Fi enabled devices. LogicaCMG announced the commercial availability of the newest version of uOne, a next-generation IP-based voicemail and unified messaging solution. BVRP Software introduced its software Network Nomad. This software is designed to help users to connect to a wireless or wired network by finding all available networks when a laptop is on, either automatically defaulting to the preferred setup configuration or offering a list of possibilities for the user to select.

The French railway infrastructure manager RFF and the French railways operator SNCF have selected Nortel Networks to provision a France-wide GSM-R network under a 15-year agreement. The system will handle voice and data communications for operation of trains within 15000km of track as a replacement for the existing analog radio system. The system will provide features and telematics applications to enable railway operators to enhance emergency procedures, improve operational efficiency and safety and reduce the overall cost of operations. The first commercial lines are expected to be delivered by the end of 2005. China's Ministry of Railways and Huawei Technologies have signed a framework agreement on the GSM-R project cooperation of Datong-Qinhuangdao line in Beijing. The railway track covers over 600km. Orga Systems and Sentori have announced a contract for their combined "Over the Air" SIM Profile Management, GSM-R provisioning and Subscriber Management solution at Jernbaneverket, Norway's national railway authority. The authority began rolling out GSM-R over its rail network in August 2003.

The Bluetooth Special Interest Group (SIG) has announced the adoption of Bluetooth Specification Version 1.2. The updated version of the core specification ushers in a new era for the short-range wireless technology and includes new features resulting in a more reliable and robust user experience for consumers. In particular, the new features include: Adaptive Frequency Hopping (AFH), enhanced voice processing, faster connection setup and backward compatibility with version 1.1. AFH was explicitly designed to reduce interference between wireless technologies sharing the 2.4 GHz unlicensed radio spectrum.

Alcatel has announced that the assets of Mobicom, a European mobile satellite data communications systems and service provider of Alcatel Space for the trucking market, are being purchased by Qualcomm. As part of the transaction, Alcatel Mobicom's customer base will now be serviced and supported by Qualcomm Wireless Business Solutions Europe.

Sun and Siemens Mobile have launched the Java Masters 2004 award. Students worldwide are once again invited to develop innovative Java applications. Participants will be asked to create new functionalities for Siemens M55, MC60 and SX1 mobile phones. In addition, this year's Business (BIZ) Award, which is an integral part of the "Java Masters 2004" competition, will welcome entries from start-up companies as well. More information at: http://www.javamasters.org

Nokia has announced that its certified training in mobile software application development, initially launched in Asia, will be made available in North America and Europe as part of the program's ongoing global roll-out. This new comprehensive training approach for the global developer community offers focused modules to help developers learn new and existing technologies in the mobile application environment, as well as the basics of wireless development. More information at www.forum.nokia.com/training

Standards

Dennis Bodson, Senior Editor

IEEE Standard Offers Coexistence of WPAN with Other Wireless Devices

The IEEE Standards Association has released IEEE 802.15.2™, 2003 Edition. IEEE 802.15.2 aims to develop a recommended practice for an IEEE 802.15 Wireless Personal Area Network (WPAN) that coexists with other selected wireless devices operating in unlicensed frequency bands. The intended users of this recommended practice include IEEE 802 Wireless LAN developers as well as designers and consumers of wireless products being developed to operate in unlicensed frequency bands. To purchase this standard in PDF form, visit the IEEE Online Catalog & Store: http://shop.ieee.org/store/product.asp?prodno=SS95135

Sit Back, Relax and Enjoy The Wi-Fi

Intel Corporation has created a "Wi-Fi chair" in response to the increasing use of IEEE 802.11 (TM) (Wi-Fi) in the U.K. These new chairs, designed by a team from Central St Martins College, are constructed of recycled computer cables enclosed in clear resin to reflect the end of the cable era, according to an article in *EE Times*. With the number of Wi-Fi users in the U.K. expected to reach 1.5 million by 2005, Intel hopes to install these chairs in some of the over 4,100 Wi-Fi spots in the U.K., including such locations as train stations and hotels. For more information, please go to: http://www.commsdesign.com/printableArticle?doc_id=OE G20030813S0022

IEEE Standards Board Approves Amendment to 802.11

The Institute of Electrical and Electronics Engineers has approved an amendment to the IEEE 802.11™ wireless local area network (WLAN) standard that avoids interference between IEEE 802.11a™ WLAN products and other systems operating in the 5 GHz bands used by IEEE 802.11a systems. Systems that could be affected by IEEE 802.11a WLANs include radar and those for the Earth Ex-

ploration Satellite Service (EESS) and the Space Research Service (SRS).

The amendment, IEEE 802.11h™, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, Spectrum and Transmit Power Management Extensions in the 5 GHz Band in Europe," allows WLANs to meet regulations initially adopted by European countries and then made a global requirement of the ITU Radio Regulations at World Radiocommunication Conference 03.

"IEEE 802.11h should help open the 5 GHz spectrum to WLANs in the many countries that have been concerned about the interference issues posed by wireless networks in this frequency band," said Stuart J. Kerry, Chairman of the IEEE P802.11 Standards Committee. "This amendment is part of the IEEE 802.11 Working Group's commitment to create standards for all aspects of wireless LAN operation worldwide."

ITU Radio Regulations call for WLANs and other devices to detect the presence of radars and EESS and SRS systems and then protect them from interference by selecting another operating channel or reducing transmit power. IEEE 802.11h creates a standard method to avoid interference so a manufacturer can create products that adhere to the ITU Radio Regulations and interoperate with similar products from other suppliers.

IEEE 802.11h amends the IEEE 802.11a PHY layer standard and the underlying IEEE 802.11 MAC layer standard to enhance network management and control extensions for spectrum and transmit power management in 5 GHz license exempt bands. It improves channel energy measurement and reporting, channel coverage in many regulatory domains, and dynamic channel selection and transmit power control mechanisms.

IEEE 802.11 standards form a family of specifications that define how WLAN equipment should be produced so equipment from different manufacturers can work together. The standards are developed by the IEEE 802.11 Working Group, which is sponsored by the IEEE 802 LAN/MAN Standards Committee of the IEEE Computer Society. For further information, visit: http://www.ieee802.org/

It's Time for a 4G (R)Evolution

With many worldwide mobile operators deploying third-generation (3G) mobile/wireless networks, it is an appropriate time to examine the breakthrough steps needed for what the editors of IEEE Communications Magazine call "the (r)evolutionary path" toward 3G+ and 4G Mobile Communication Systems. The authors of this month's guest editorial state that the vision of 3G+/4G wireless/mobile systems must incorporate broadband access, seamless global roaming, and Internet/data/voice everywhere, utilizing for each the most 'appropriate' always best connected technology. For more information, see http://www.comsoc.org/livepubs/pci/Public/2003/aug/index.html.

IEEE Standards Board Meeting, September 2003

The IEEE-SASB held its meeting series on 9-11 September 2003. An item of interest to all standards developers is a proposed change to the IEEE-SA Metric Policy :

IEEE Metric Policy

A motion was approved to make a change to Stage III of the IEEE-SASB Implementation Plan for IEEE Policy 9.19, which calls for measured and calculated values of quantities to be expressed in metric units in IEEE publications. The change is as follows:

"Proposed new standards and revised standards submitted for approval shall should use metric units exclusively in the normative portions of the standard. Inch pound data may be included, if necessary, in footnotes or annexes that are informative only."

More information may be obtained at http://standards.ieee.org/announcements/metric.html.

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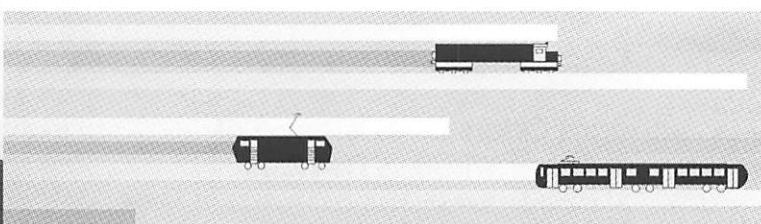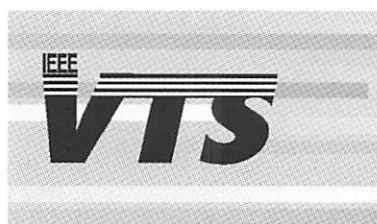
Transportation Systems

Harvey Glickenstein, Senior Editor

Working Group 2 of the IEEE Rail Transit Interface Standards Committee, the working group on Communications Based Train Control, had a meeting in Washington, DC on December 2, 2003. The final line-by-line review of IEEE Draft Standard P1474.1 (Revised), IEEE Standard for Communications-Based Train Control (CBTC) Performance and Functional Requirements, took place at this meeting. It is a revision to a previously approved standard. The major revision is to add driverless systems to Standard. Once approved, this standard will supersede the Amer- ican Society of Civil Engineers (ASCE) People Mover Standard in the area of train control, when the train control is accomplished by CBTC. ASCE members worked on the draft standard together with IEEE members and are expected to participate in the balloting group for the standard. The standard will be balloted early in 2004.

A companion standard, P1474.2, IEEE Standard for User Interface Requirements in Communications Based train Control (CBTC) Systems was approved late last year and should be available as an IEEE Standard early in 2004.

Hamburg has ordered its first dual-voltage trainsets for the S-Bahn. The trains will operate on 1.2 kV dc third rail on the existing S-Bahn network and 15 kV ac overhead on the extension from Neugraben to Stade.

The order consists of nine new three-unit trains and rebuilding of 33 existing Type 474 trains. All of the trains will be dual-voltage. The center unit of each three-car train will be equipped with a pantograph. The end units will be motored.

The 90 million order will be shared equally between Alstom and Bombardier with Alstom providing the mechanical equipment and Bombardier providing the electrical equipment. Delivery of the trains is scheduled for March 2006 through August 2007 in order to meet the planned opening of the extension in December 2007.

Florida has chosen the Fluor-Bombardier team to provide the first phase of their High Speed Rail Network, from Tampa to Orlando. The Florida High Speed Rail Authority decided to have the line between the Orlando Airport and Disney World run direct, bypassing the Convention Center. Disney had stated that they would eliminate their bus shuttle from the airport and utilize the train instead only if the more direct route that bypassed the Convention Center were chosen. The ridership projections from elimination of the bus shuttles were substantially higher than the ones that included the International Drive/Convention Center passengers.

The service will use Bombardier's JetTrain, a high-speed locomotive designed for 150 mph service that does not require electrification of the line.

Type 474 Unit for the type being rebuilt as dual voltage

Bombardier JetTrain

The Brussels Transport Authority (STIB) ordered 46 new trams for the city of Brussels. The contract with Bombardier is for 106 million for Flexity Outlook trams and 19 million for overhaul and corrective maintenance of the bogies and propulsion equipment for 15 years.

The trams are 100% low floor. Delivery is scheduled to take place starting in June 2005 and be complete in February 2007.

Testing of the new high-speed trains for the Spanish National Railways, RENFE, has begun at RENFE's workshop in Toledo. The new trains, being built by a consortium of Alstom and CAF, are designed for 155 mph operation.
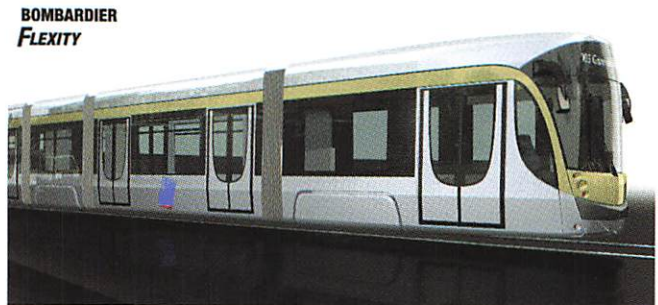
Bombarbier Flexity Outlook for Brussels

New high-speed trains for RENFE

Sound Transit Tacoma Link opening

The 20 trains in this order have a capacity of 237 passengers each. They are designed to provide a regional shuttle service on high-speed lines.

The first portion of the high-speed line between Madrid and Barcelona, consisting of almost 300 miles, opened in October of last year. Existing AVE high-speed equipment is now providing service on the high-speed portion of the line. Trainsets with gauge changing equipment that can run on the standard gauge of the high-speed line as well as the existing broad gauge line is providing through service between Madrid and Barcelona.

Until the ETCS Level 2 signaling being installed on the line is placed in service, speed limits on the high-speed line are being limited to 124 mph. Level 2 provides movement authorities by GSM-R radio and eliminates the need for wayside signals. Level 2 does retain fixed block signaling, however. After the Level 2 signaling is placed in service, speeds will be raised to 217 mph. Even with the lower speeds and the fact that only a portion of the high speed line has been completed, the trains between Madrid and Barcelona now make the trip in 4 hours and 30 minutes instead of the 7 hours it used to take for the trip.

Sound Transit opened its Tacoma Link in August of last year. The 1.6-mile long line brings streetcars back to Tacoma after a hiatus of 65 years. Five stations are provided from the Theater District to the Tacoma Dome Station. Union Station is located in the middle of the line.

The line is very popular. During the eight of the first 13 weekdays of service ridership exceeded the 2,000 forecast for the year 2010. The line runs seven days a week with 10-minute base headways stretching to 20 minutes on Sundays and holidays. Service is provided by three single-unit cars built by Skoda of the Czech Republic. Each car is 66 feet long and can accommodate 30 seated passengers and 26 standees. Bicycles are accommodated onboard the vehicles. Cars are double-ended.

Sound Transit broke ground for its 14-mile Central Link light rail line on November 8 of last year. The line will use the tunnel under downtown that was built for future light rail use. Currently the tunnel is used by trackless trolleys, rubber-tired buses that are electrically propelled inside the tunnel. They receive power from two overhead wires. As the buses approach the tunnel trolley poles are raised and contacts on the trolley poles contact the two wires. Once outside the tunnel the poles are dropped and the buses continue on diesel power.
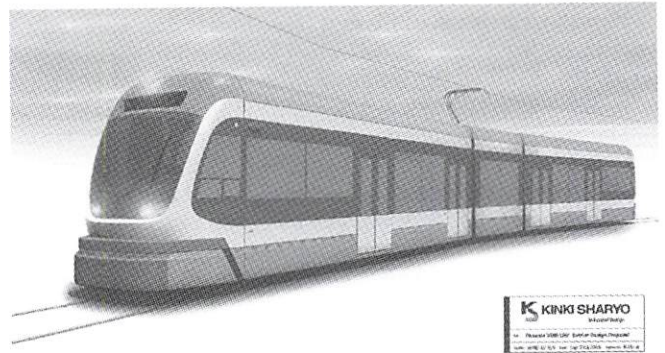
Trackless trolleys, also known as electric trolley buses used to be common in North America, but today they are limited to Boston; Philadelphia; Dayton, Ohio; San Francisco; Portland, Oregon; Seattle; and Vancouver, British Columbia.

Sound Transit opened bids for cars for the Central Link line last year as well. Low bidder for the cars was Kinki Sharyo of Japan. The bid was $131.8 million for 31 cars. Although the cars for Sound Transit will be articulated, like the cars for Phoenix, the Seattle cars will be 94 feet long. They will have 74 seats and be able to accommodate 200 passengers both seated and standing. Also, like the Phoenix cars, the Seattle cars will be low floor to meet the requirements of the Americans with Disabilities Act.

Sound Transit expects to begin service using two-car trains. As the number of riders increases, the intention is to increase the size of the trains up to a maximum of four cars each.

Delivery of the cars would begin in November 2006 and be completed by September 2008.

Valley Metro Rail of Phoenix will be awarding a contract to Kinki Sharyo of Japan for 36 light rail cars at $2.92 million each with an option for and additional 39 cars. The $115 million contract, which includes spare parts, will be the largest single contract ever awarded by Valley Metro Rail.

The cars are 90 feet long with two articulation joints to allow them to go around sharp corners. They have low floors to meet the requirements of the Americans with Disabilities Act. They can be linked into three-car trains that will span the length of a downtown city block, giving a capacity of 450 passengers in a train.

The first cars are scheduled for delivery in the summer of 2006. The 20-mile starter line is planned to be opened in stages starting in late 2006, with the final section being placed in revenue service in August 2007.

The Greek Railway company ERGOSE has awarded a contract for installation of the European Train Control System (ETCS) Level 1 on the new 68-mile line between Athens and Kiato near Corinth. Level 1, the lowest level of ETCS, retains track circuits for train detection and adds transponders known as Eurobalises for positive stop enforcement. The Eurobalises are similar to the transponders installed on Amtrak's

Northeast Corridor ACSES and New Jersey Transit's ASES for positive stop and civil speed enforcement.

The 105 million contract was awarded to a consortium of Siemens Transportation Systems, the Greek construction company AKTOR ATE, and the German track construction company H.F. Wiebe GmbH & Co.

When the line is completed the travel time between the two end points will be shortened from two hours to 40 minutes.

The 6.3-mile South Line Extension of the Sacramento light rail system to Meadowview Road opened in September of last year.

Swiss Federal Railways (SBB) is installing ETCS Level 2 signaling on its new line between Mattstetten and Rothrist. The line opened in December with conventional signaling. SBB has decided to limit speeds to 100 mph pending completion of ETCS Level 2. The only ETCS Level 2 signaling system currently in revenue operation is on the 22-mile SBB line between Olten and Lucerne. The Level 2 signaling has been in operation since April 2002. Train detection is by means of transponders called Eurobalises, rather than by track circuits. Speed on the Olten-Lucerne line is limited to 100 mph even with the Level 2 signaling.

ETCS Level 3 signaling is an enhancement to ETCS Level 2 that provides moving block operation. The web site for the European Train Control System, www.ertms.com, lists a number of Level 1 and Level 2 projects either in service or under construction. No projects are listed for Level 3. The Positive Train Control project being installed on 120 miles of railroad on the Union Pacific Railroad's Chicago to St. Louis line is expected to provide moving block operation this year, before any Level 3 moving block operation is placed in service in Europe.

The Altamont Commuter Express (ACE) between Stockton and San Jose, California has decided to extend the free Internet service for an additional three months. The service started in September 2003 and offered free WiFi interconnections. Although the service was originally supposed to be free for only three months, ACE has decided to increase the free trial period while enhancements are provided to the original service.

The Port Authority of New York and New Jersey (PANYNJ) placed their new AirTrain system serving JFK International Airport in service in December of last year. AirTrain at JFK is a light rail system that uses linear induction motors for propulsion. Power is provided to the vehicles from a 750 Vdc third rail. There are two inverters in each car, one for each motor. A solid reaction rail, which acts as the rotor in an induction motor, is located between the running rails. Bombardier, the supplier of the system, has provided similar Advanced Rapid Transit systems in Toronto; Detroit;

and Vancouver, British Columbia. While the other North American systems using this technology are designed to provide the usual type of transit service, the AirTrain system is designed to provide airport access. This means that the vehicles have wide doors to accommodate luggage and are otherwise designed with the airport passenger in mind.

There are three services provided by the AirTrain system. One 3-mile route operates between the airport and Jamaica, Queens, where passengers can transfer to the city subway


system or the Long Island Rail Road. A second 3.3-mile route operates between the airport and Howard Beach, Queens where passengers can transfer to a different subway line. Both these routes operate on the same track on a counter-clockwise loop at the airport.

The third route is a 1.8-mile on-airport loop that operates on a separate track. It circulates around the airport in the opposite direction to the routes to the other two routes.

From the airport loop the first stop is at Federal Circle for car rental. At this station, the Howard Beach Line diverges from the line to Jamaica. There is one intermediate stop on the Howard Beach Line serving employee and long term parking lots.

Fares are only collected at Howard Beach and Jamaica. The $5.00 fare is collected in each direction. Travel between stops within the airport or to and from the airport and the employee/long term parking and car rental stops is free.

The system, which will operate 24 hours a day, is fully automated. It is a moving block system similar to the Toronto, Detroit, and Vancouver systems.
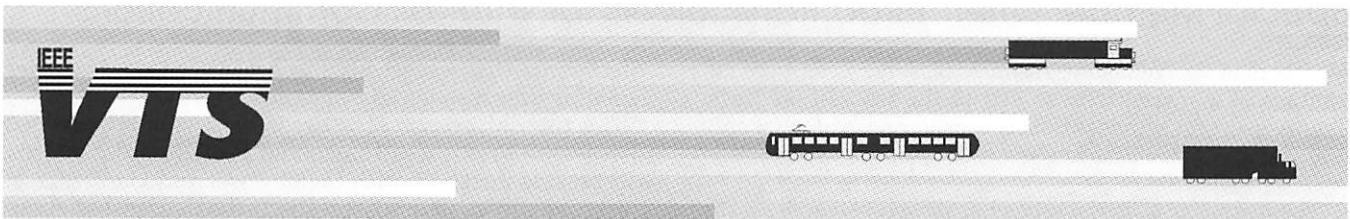
VTC2004-Spring: Towards a Global Wireless World

On behalf of the IEEE Vehicular Technology Society (VTS) and the 59th Conference Steering Committee, it is my honor to invite you to participate in the IEEE VTC2004-Spring conference, in Milan, 17-19 May 2004. The theme of the conference is "Towards a Global Wireless World."

The Vehicular Technology Conference, VTC 2004-Spring program, intends to capture the current state of the innovative and highly active mobility industry. Our aim is to present the changing face of wireless technologies and to give a glimpse in the future of this exciting field in Antennas and

The Duomo cathedral - one of the largest Gothic cathedrals in the world, with three museums inside. You can take an elevator up to walk outside on the roof, where you can see the graceful porticoes and ornate friezes of medieval Milan fade into the sharp lines and angles of the modern city.

Galleria Vittorio Emmanuele II - an immense covered area constructed in honour of the king who unified Italy. Full of restaurants and shops it is known locally as 'Milan's Living Room'

Propagation, Transmission Technology, Wireless Access, Mobile Networks, Mobile Applications and Services, Satellite Networks and Services, and Transportation. You will find a large number of highly qualified technical contributions to be presented along with panel sessions, tutorials, business applications and exhibits.

I would like to thank all of the people who have made contributions to the success of this conference. This includes the Conference Steering Committee, Technical Program Committee, VTS Board of Governors, reviewers, session chairs, tutorial and panel speakers, authors, and most important the delegates attending the conference. A very special thanks goes to the Technical Program Committee who reviewed hundreds of abstracts, accepted the papers, and organized them into appropriate tracks for the conference. Their dedication and commitment to this process has resulted in an outstanding technical program.

The conference venue is Milan, Italy. Fashion, finance, food and football – all synonymous with the sophisticated and stylish city of Milan. The world's design and fashion capital, Milan is also home to the Italian stock exchange and most of the country's important corporations are headquartered here. The city's sights include the magnificent Gothic cathedral, the world-class Brera Art Gallery, Leonardo's Last Supper and the Scala. Masterpieces can also be found in the small, hidden churches, and unusual shops.

We invite you to come and participate in VTC Spring-2004.

Dennis Bodson
General Chairman, VTC2004-Spring

Programme & Registration

The final programme, as well as online registration, can be found on the VTC2004-Spring web site, www.vtc2004spring.org

Tutorial Programme

A number of tutorials are planned from leading industrialists and academics. Subjects include WLAN/3G Interworking, High speed packet data support in IS-2000, Integrated Public Wireless Networks, Distributed-MIMO, Time Division Duplex (TDD), Software Defined Radio, Networks beyond 3G, Smart Antennas and High Altitude Platforms. Details in the last VTS News, or on the web.

Exhibits

If your company is interested in exhibiting or sponsoring at VTC2004-Spring, a number of opportunities are still available. For an opportunity to promote your message to 700 engineers and researchers, contact T E Strong (TEStrong@verizon.net)

Special Member Offer: Turbo Transceivers for Wireless Communications

Members of the Vehicular Technology Society can take advantage of a special offer to attend the tutorial on Turbo Transceivers for Wireless Communications in Milan for only $50. Simply book online at www.vtc2004spring.org, quoting code VTS5002

The discovery of Turbo codes has driven research on the creation of new signal detection concepts that can, in general, be referred to as the Turbo approach. This approach has made a drastic change in creating signal detection techniques and algorithms such as equalization of inter-symbol interference (ISI) experienced by broadband single carrier signaling over mobile radio channels.

This tutorial, presented by two internationally renowned instructors, Prof. Lajos Hanzo and Prof. Tad Matsumoto, will provide members with broad views and knowledge of Turbo codes by explaining how the Turbo concept-based signal transmission techniques are developed in various applications, and how it improves performances.

Note that it is not necessary to register for the conference if you are only attending the tutorial.

VTS NEWS

VTS Constitution

The Vehicular Technology Society at their Board of Governors meeting in Orlando, FL on October 8, 2003 approved several changes to the VTS Constitution. The revised Constitution will take effect in 2004.

The is a minor typographical change to Article V (Administration) Section 4, so the first sentence reads with the change "The Board of Governors shall elected from its membership the governing officers as specified in the Society Bylaws, which will include the election of the Society President.".

The substantive change is to Article VIII, on amendments to the constitution, the first three sections of which are amended as follows

Section 1. Amendments to this Constitution may be initiated by a petition submitted by at least 50100 voting members of the Society or by an affirmative vote of at least 10 members of the Board of Governors. Proposed amendments to the Constitution brought by petition do not require further approval by the Board of Governors.

Section 2. Approved or petitioned amendment proposals must be submitted to the IEEE Executive Committee for approval. If so approved, the BOG shall determine whether to attempt ratification by Method 1 or by Method 2:

Method 1: The proposed amendment will be published in the Society Transactions and/or Newsletter, or otherwise publicized by direct mailing to the membership with notice that it goes into effect unless 50100 or more Society members object in writing within 30 days. If such objections are received, ratification will be by Method 2.

Method 2: A copy of the proposed amendment shall be mailed with a ballot to all voting members of the Society at least 30 days before the date appointed for return of the ballots, and shall carry a statement of the time for their return to the IEEE office. Approval of the amendment by at least two-thirds of the members voting shall be necessary for its enactment.

Section 3. Amendment of the Society Bylaws may be initiated by a petition signed by at least 50100 members of the Society or by a Member of the Board of Governors of the Society.

The amendment has two affects. The first is to raise from 50 to 100 the number of petitioners required to propose a change to the constitution, or take it to a vote. The second change is to give the Board of Governors the option of calling a vote of all society members to approve a change in the constitution, without requiring members to object first.

IEEE VTC 2004 – Fall
Wireless Technologies for Global Security
SEPTEMBER 26–29, 2004 LOS ANGELES, CALIFORNIA

The IEEE Vehicular Technology Society and The Aerospace Corporation invite you to participate in the Vehicular Technology Conference 26-29 September 2004 (VTC 2004-Fall) in exciting Los Angeles, California, U.S.A. This will be the 60th Vehicular Technology Conference, and with over 40 countries represented, it is sure to be one of the best.

The VTC-2004 Fall international conference provides a forum for communications, sensor, and power experts to exchange ideas and to discuss their work on wireless technologies and systems that enhances global security. The conference will consist of approximately 1000 quality technical papers and posters along with a variety of distinguished panels, excellent tutorials, and numerous exhibits and demonstrations. A plenary session, luncheons, and dinner banquet will feature guest visionary speakers from industry, academia, and government.

Authors are invited to submit extended abstracts describing original research results, innovative applications, and experimental or demonstrative test results in the technology fields of wireless and mobile communications, digital signal processing, power efficient systems, and sensor technologies.

From the moment you arrive in Los Angeles, you will enjoy the beauty and glamour, the wonderful weather, and a variety of entertainment options in the area. Our committee will be working hard to ensure a world-class conference so that your visit will be memorable. Please mark your calendars for 26-29 September 2004.

www.vtc2004fall.org

Keynote Speakers and Distinguished Panel Chairs

Christine Anderson, Program Director, MILSATCOM Joint Program Office	**Irwin Jacobs**, Chairman of the Board and CEO, QualComm
William F. Ballhaus, Jr., President & CEO, The Aerospace Corp	**Paul MacCready**, Chairman/Founder, AeroVironment Inc.
Robert Berry, Chairman of the Board, Space Systems/Loral	**Richard John**, Director, Volpe National Transportation Systems Center
Ezio Biglieri, Professor, Politecnico di Torino	**Hugo Poza**, Vice President for Homeland Security, Raytheon
Vinton Cerf, Senior VP Technology Strategy, MCI	**Joe Straus**, Executive Vice President, The Aerospace Corp.
Neil Cox, Senior Consultant, SAIC	**David Zolet**, VP of Homeland Security, Northrop Grumman

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	
21-25 March 2004	WCNC2004	Atlanta, GA	http://www.wcnc.org/2004/	
23-24 March 2004	Workshop in Intelligent Transportation 2004	Hamburg, Germany	http://wit.tu-harburg.de/	
6-8 April 2004	ASME/IEEE Joint Rail Conference	Baltimore, MD	http://www.asmeconferences.org/jrc04/	
17-19 May 2004	VTC 2004-Spring	Milan, Italy	http://www.vtc2004spring.org/	
14–17 June 2004	IEEE Intelligent Vehicles Symp	Parma, Italy	http://www.ieeeiv.org/	
20-24 June 2004	ICC 2004	Paris, France	http://www.icc2004.org	
27-30 June 2004	IST2004	Lyon, France	http://www.mobilesummit2004.org	
30 August - 2 September 2004	IEEE Int. Symp on Spread Spectrum Techniques & Applications	Sydney, Australia	http://www.isssta2004.org/	
5-8 September 2004	PIMRC2004	Barcelona, Spain	http://www.pimrc2004.org	✓
20-22 September 2004	ISWCS'04	Mauritius	http://www.uon.ac.mu/events/iswcs04.htm	✓
26-29 September 2004	VTC 2004-Fall	Los Angeles, CA	http://www.vtc2004fall.org	✓
3-6 October 2004	ITSC04	Washington, DC	http://www.ewh.ieee.org/tc/its/conf.html	✓
18-20 October 2004	Convergence 2004	Detroit, MI	http://www.convergence2004.org	
29 May – 1 June 2005	VTC 2005-Spring	Stockholm, Sweden	http://www.vtc2005.org	
September 2005	VTC 2005-Fall	Dallas, TX	http://www.vtc2005fall.org	
Q2 2006	VTC-2006 Spring	Melbourne, Australia	mailto:fzheng@ieee.org	

Conferences marked '✓' have open calls for papers as of 31 December 2003. 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. We are particularly interested in adding listings for Automotive and Transportation conferences. Please send corrections and additions to Tom Rubinstein at t.rubinstein@ieee.org.

Chapter News & Meetings

Gasper Messina, Senior Editor

North Jersey

The North Jersey VTS chapter has held two meetings recently. At the first, on 23 October 2003, Thomas L. Marzetta of Lucent Technologies gave a paper on "New Developments in High Spectral Efficiency Multiple Antennas wireless (Systems)". The second, held on 20 November, was on "3 G Evolution", where Joseph A. Tarallo, also of Lucent Technologies, spoke to a substantial audience of 55, including 21 guests.

Vancouver

The Vancouver VTS chapter held a meeting on 22 September 2003, which heard a paper entitled: "The Future of Wireless Communications" by Javan Erfanian and David G. Michelson.

Call for Nominations: VTS BoG Elections

Nominations are sought for VTS members to serve on the VTS Board of Governors for the three year term from 1 January 2005 until 31 December 2007. Further details can be obtained from Past President J.R. Cruz at the address on Page 2, to whom nominations should be submitted by the end of March. This will allow the Nominations Committee to consider them prior to the April Board meeting, where a slate for this year's election will be agreed.