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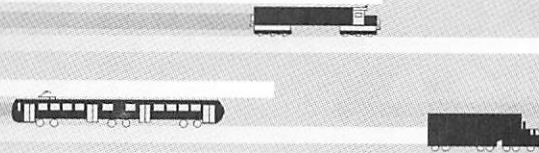
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Foreword

Harvey Glickenstein, Senior Editor

There has been much debate in the United States over the future of Amtrak. Its current president, David Gunn, admits that Amtrak has made management mistakes in the past and that past assurances that it could convert itself into a profit-making enterprise were unrealistic. Mr. Gunn expects to substantially reduce losses, but has already declared that Amtrak will never become profitable. He points to the passenger services in other countries that US politicians praise, none of which could survive without substantial subsidies from their governments.

While US politicians complain about their loss-making rail passenger service, politicians elsewhere look to the US private freight railroads for solutions to the heavy deficits that their nationalized railroads produce every year. It appears that the common factor overlooked by most of these observers is that an efficiently run freight operation (most of these non-US railroads are basically passenger railroads with limited freight service) can more easily make a profit than a passenger operation.

The US airline industry demonstrates the difficulties that passenger carriers have making a profit over the years. Like the loss-making European Railways, they also carry small amounts of freight. The multiple bankruptcies of Continental, Midway, US Airways, and United, the possible bankruptcy of the largest US airline, American, and the complete disappearance of such former powerhouses as Eastern, TWA, and Pan Am further testify to problems running a profitable passenger business.

Europe has made the decision to separate out the infrastructure from the operating company in order to create profitable passenger train operating companies. The theory is that the infrastructure would continue to be owned and maintained by the government, although in the United Kingdom there was the hope that the infrastructure com-

pany would also become self-sufficient. The result was an unmitigated disaster; the government was required to bail out the infrastructure company and has been completely unable to eliminate the subsidies being paid to the operating companies.

The January 2003 *Railway Gazette International* magazine reports that even the first country to propose the separation of passenger train operating company from infrastructure company, Sweden, is having second thoughts. The company operating the passenger service in Sweden, SJ AB, is expected to declare bankruptcy unless the government provides additional funding. The freight train operating company, Green Cargo AB, is also losing money, but has substantially reduced its losses.

Once Mr. Gunn solves the problems of Amtrak that are its own doing, he will still be left with the problem of operating on the tracks of other railroads—freight railroads in most of the United States and the MTA Rail Road in the Northeast. This problem would be faced by any privatized passenger railroad in the US. In addition, Amtrak's problems would increase if it lost control of the portions of the Northeast Corridor it presently controls.

Hopefully the politicians calling for the break-up and privatization of Amtrak will look to the problems in Europe, and also at the difficulty that Japan is having trying to make profitable entities out of the six passenger railroads into which Japanese National Railways was split. The US could have a passenger rail system as attractive as Western Europe or Japan, but only if adequate capital investment is provided and only if the government recognizes that the constitutional mandate for Congress to provide for post roads and support interstate commerce includes an obligation to subsidize the operating costs of an interstate passenger rail system.

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Overview and Recent Challenges of MIMO Systems

Tad Matsumoto, University of Oulu, Juha Ylitalo, Nokia Networks, and Markku Juntti, University of Oulu

The primary objective of this article is to provide an overview of techniques for multiple-input multiple-output (MIMO) wireless communication systems. Information theoretic background of the significant capacity enhancement supported by MIMO radio network configurations is first explained. Current activities towards the utilization of MIMO concepts in the third generation systems as well as recent challenges in signal processing for single carrier signaling-based MIMO communication systems are then introduced.

1. Introduction

It is natural to set the bit rate targets for post-third generation (3G) systems higher than 3G's maximum speed, with the aim of supporting *real-multimedia* communications. Given that the system bandwidth needed to realize broadband communication may not be fully available, the post-3G networks will have to have greater resistance to co-channel interference (CCI).

The recently raised interest towards multiple-input multiple-output (MIMO) systems has been largely triggered by the potential capacity increase promised by information theory. It has been well-known for a long time that using multiple receive antennae can improve communication link quality. Tremendous efforts are currently being made to exploit the spatial dimension of channels with the aim that the MIMO system concept can really be in place [1–3]. An enormous number of research papers have been published that introduce joint space/time (S/T) signal processing algorithms for MIMO communications. References [4] and [5] survey the historical background of the technology, and summarize current trends in S/T-equalizer algorithm development.

There are two main mechanisms on which receive antenna-based capacity increase can rely on. One applies smart antenna (or beam-forming) techniques wherein CCI from other radio-frequency radiators other than the transmitter of interest can be suppressed. The other mechanism has been based on widely spaced receive antennae providing diversity against fading. Based on the same ideas, it became soon evident that rather similar advantages can also be obtained via multiple transmit antennae.

A goal of this article is to provide an overview of techniques for MIMO wireless communication systems. In Section 2, information theoretic background of the significant capacity enhancement supported by MIMO radio network configurations is introduced. Section 3 describes current activities towards the utilization of MIMO concepts in the third generation systems. Section 4 introduces recent challenges in signal processing for single carrier signaling-based MIMO communication systems.

2. Wireless MIMO Channel Capacity

We first review briefly the basic capacity considerations from information theory, and then present their application to MIMO systems. It is assumed that multiple antennas are used both at transmit and receive sides. In this set-up, statistically uncorrelated antenna elements with large distance are usually considered, and that is the case also in this section. In practice, the spatial channels often have some correlation which reduces the potential performance and capacity gains from the ideal ones predicted herein. The spatial channel modeling is under intensive study, and various channel models have been proposed and are under development. We do not go in detail to this issue, suffice it to say that the channel depends on the environment, and all the results depend on the true channel model.

2.1 Capacity of Gaussian Channels

The information theoretic capacity [6], [7] refers to the maximum rate at which it is possible to communicate reliably, i.e., with decoding error probability approaching zero when the codeword length is approaching infinity. Finding the capacity of a memory-less channel reduces to selecting the input codewords (signals) so that the mutual information between channel input and output is maximized. In the additive white Gaussian noise (AWGN) channel, the achievable capacity in bits per channel use is

$$C = \log(1 + \gamma),$$

where γ is the signal-to-noise ratio (SNR) per symbol. The capacity is achieved by so called Gaussian codebook, i.e., by coding the information messages to random(-like) signals with Gaussian distribution.

2.2 Capacity of Fixed MIMO Channels

The capacity of MIMO channels subject to AWGN can be easily derived as an extension of the well-known capacity of parallel Gaussian channels. The capacity of K parallel, independent AWGN sub-channels is the sum of the capacities of each of the sub-channels, i.e.,

$$C = \sum_{k=1}^K \log(1 + \gamma_k),$$

where γ_k is the SNR per symbol on the k th sub-channel. A practical well-known example of the parallel channel concept is multicarrier or orthogonal frequency-division multiplexing (OFDM) communications, where each subcarrier is considered as an independent sub-channel. The capacity is again achieved by Gaussian signals. Since the noise power spectral density values on each sub-channel are in general different, maximum capacity is achieved by allocating different powers for different sub-channels. This needs to be done according to the celebrated wa-

ter-filling principle, where most power is allocated to those sub-channels on which the noise level is the lowest. The water-filling naturally requires that the transmitter has the channel state information available. In other words, the transmitter needs to know the channel gain and noise power spectral density on each sub-channel. The channel state information can be based either on feedback information or in time-division duplex systems to the channel estimation of the receiver.

The MIMO channel capacity is a special case of the parallel channel capacity [8], [9]. The output vector of a MIMO channel is the channel input vector multiplied from the left by the channel gain matrix \mathbf{H} . By applying the singular value decomposition to the channel matrix \mathbf{H} , equivalent independent parallel sub-channels can be formed. In that way, the MIMO channel capacity with channel state information at the transmitter becomes

$$C = \log \left[\det \left(\mathbf{I}_{N_r} + \frac{\gamma}{N_T} \mathbf{H} \mathbf{Q} \mathbf{H}^H \right) \right]$$

where \mathbf{I}_n is an n -by- n identity matrix, \mathbf{Q} is power allocation matrix, N_T and N_R denote the number of transmit and receive antennae, respectively. The capacity is achieved with Gaussian signaling and spatial water-filling. The latter means that the transmit power is directed towards the eigenvectors of $\mathbf{H}^H \mathbf{H}$ proportionally to the singular values of matrix \mathbf{H} or equivalently to the eigenvalues of $\mathbf{H}^H \mathbf{H}$; $()^H$ denotes complex conjugate transpose.

2.3 Capacity of Fading MIMO Channels

Fading in radio channels complicates the capacity analysis in many respects. If the coding and interleaving frame is long enough so that the fading can be modeled as an *ergodic* random process, the fading AWGN channel capacity is the expected value of the capacity in fixed AWGN channels averaged of the distribution of the channel gain, i.e.,

$$C = E_{\mathbf{H}} \left\{ \log \left[\det \left(\mathbf{I}_{N_r} + \frac{\gamma}{N_T} \mathbf{H} \mathbf{H}^H \right) \right] \right\}$$

The above expression is illustrated in Fig. 1 when the number of transmit and receive antennae is equal. The capacity can be observed to increase linearly with respect to the number of antenna elements. This phenomenal capacity increase is the great motivator for the interest towards MIMO techniques.

If the fading process is *non-ergodic* over the interleaving frame, the conventional Shannon capacity is usually zero. For such cases, the probability of outage needs to be considered. For more details on MIMO capacity in fading, see [1], and capacity in fading channels [9] and references therein.

2.4 Practical Considerations

The great capacity increased promised by MIMO channel configuration is based on several over-simplified assumptions. The channel is assumed to be perfectly known in both the transmitter and receiver. This is never reality even in the receiver, and even harder to obtain in the transmitter. Furthermore, the singular value decomposition is sensitive to errors in channel estimates. By carefully designed closed-loop link adaptation techniques [10], these problems can, however, sometimes be overcome, and the optimal transmission can be approximated up to adequate accuracy. There has also been major interest towards open loop MIMO and transmit diversity techniques, which do not assume

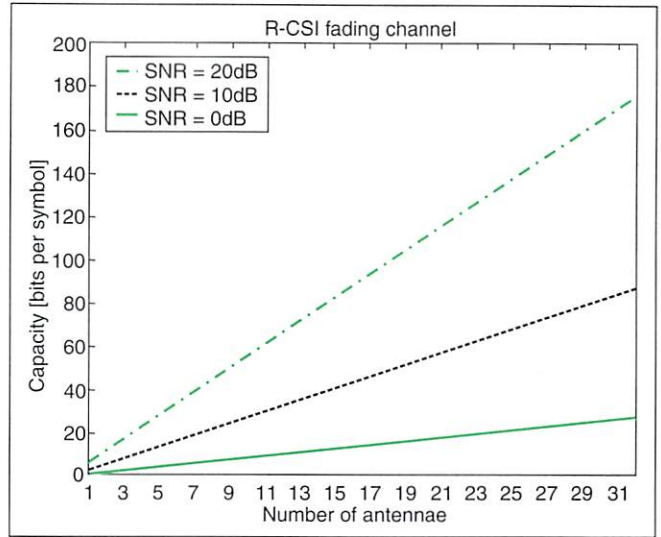


Figure 1 Capacity of fading MIMO channel vs. the number of antennae (N_T and N_R).

channel state information in the transmitter. In particular, space-time coding techniques [20] have been under intensive study recently. In the sequel, some of the most promising techniques are briefly reviewed.

3 MIMO Techniques in 3G Networks

In this section we discuss the MIMO prospects mainly for 3GPP specification of the W-CDMA system. Except CDMA2000, there has not been much progress in developing MIMO schemes for other cellular standards such as EDGE and TD-SCDMA. However, it has been acknowledged in different considerations for 4G that MIMO may have an essential role in future wireless communication systems when striving towards throughput rates of 100 Mbit/s and beyond. First, some standard features of W-CDMA are described since they provide a good starting point for future MIMO system specification. Then the current harmonization work between 3GPP and 3GPP2 for MIMO channel modeling is discussed. As an example, we address briefly one MIMO scheme that has drawn attention in recent years, namely the so-called BLAST (PARC) concept.

3.1 Current Status

3GPP specification for W-CDMA inherently supports the MIMO transmitter structure because it includes different transmit diversity modes. For example, in the open loop Tx diversity mode called STTD (Space-Time Transmit Diversity) two different data streams for each user are transmitted from two separate antennae. Figure 2 illustrates the transmitter structure and the STTD coding scheme, in which two consecutive symbols are transmitted from two transmit antennae using the same spreading code. The main benefits of the STTD coding are that only a single spreading code is needed, it preserves the orthogonality of the two data streams, and the decoding process is very simple in the terminal. The same transmitter structure allows in principle also the use of a de-multiplexer instead of the space-time encoder to produce two entirely different parallel data streams for doubling the data rate. Indeed, such code-reuse scheme originally known as BLAST (Bell Labs Layered Space-Time Architecture) has been proposed already in the early phases of 3GPP specification [2].

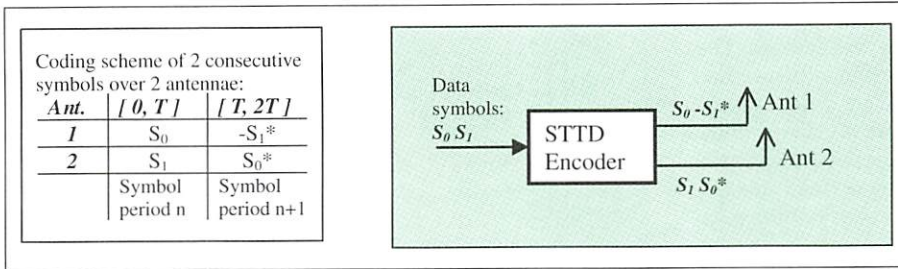


Figure 2 Principal block diagram of a transmitter employing open loop transmit diversity (STTD) in a W-CDMA system. Same symbol is transmitted from each antenna in consecutive symbol periods in a STTD coding manner enabling simple detection at the terminal.

Recently the 3GPP specification for Release 5 has further broaden the possibilities for MIMO type of transmission since it allows the deployment of a wide class of modulation and coding schemes (MCS). Thus the transmission data rate from the base station can be adjusted by adaptive MCS to the underlying radio channel status. The feedback of Channel Quality Indicator (CQI) from the terminal is an important feature of High-Speed Downlink Packet Access (HSDPA) in 3GPP. The HSDPA downlink channel can be shared by a number of users and it can take advantage of multiple transmit antennae. In the specification of HSDPA, the main goals have been to achieve higher data rates (up to 10 Mbit/s) in 5 MHz band and improve the spectral efficiency. Figure 3 shows the basic idea of HSDPA. When the radio channel to terminal 1 is in a good state the base station transmits data to it with the highest possible MCS for the particular channel condition. In the next moment, data is transmitted to terminal 2 with the proper MCS selection. It is obvious that system level issues like packet scheduling have a large impact to the overall network capacity. For example, the so-called round robin scheduler distributes capacity in a blind manner on a fair basis. On the other hand, the scheduler which serves on highest SIR basis allows significantly higher cell throughput but tends to give best service to those terminals that are close to the base station. Feedback of channel quality information can be further utilized in future MIMO systems for improved performance since transmission to partially known channel allows to employ water filling techniques. Similar techniques of link adaptation are also applied in the so-called High-Data Rate technique (HDR) for CDMA2000 evolution modes of 1xEV-DO and 1xEV-DV to achieve data rates of about 2-3 Mbits/s in 1.25 MHz band.

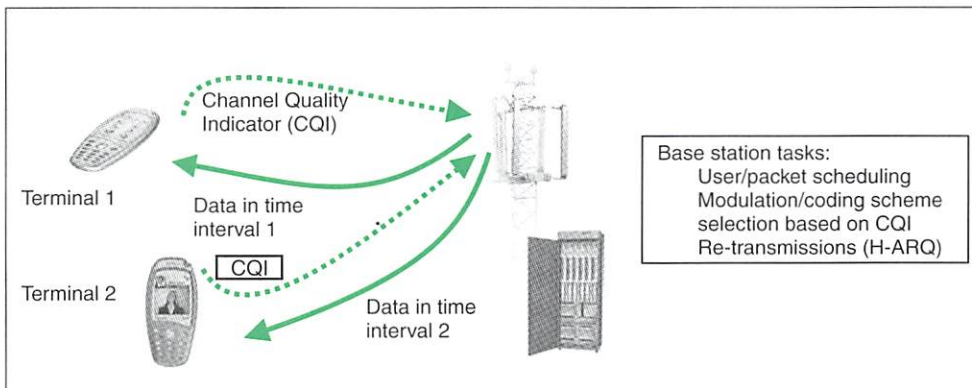


Figure 3 Principle of High-Speed Downlink Packet Access (HSDPA) employing channel state information from the terminals.

3.2 3GPP/W-CDMA Evolution Towards MIMO

The above mentioned characteristics of W-CDMA pave the road for a full adoption of the MIMO techniques as soon as multi-antenna terminals become feasible. MIMO was approved as a study item in 3GPP in 2001 but at the same time it was agreed that it will be specified in a later release than Rel. 5. Currently, as Rel. 5 is finalized, a combined ad-hoc group from 3GPP and 3GPP2 is defining the Spatial Channel Model (SCM) to be used as a common reference for evaluating different MIMO concepts [11]. The scope

of the 3GPP-3GPP2 SCM AHG is to develop and specify parameters and methods associated with spatial channel modeling that are common to the needs of the 3GPP and 3GPP2 organizations (harmonization). The scope includes development of specifications for both the link level and system level evaluations. Important spatio-temporal radio channel parameters such as power delay profiles, number of propagation paths and azimuth power spectrum in different user environments are defined. In addition, different antenna configurations and reference cases are described for common system evaluation methodology. It has been agreed that link level evaluations are used only for calibration purposes of the simulators and the actual comparisons between different concept proposals are based on system level results. The final report of the SCM group for approval is expected to be ready by the end of March, 2003. However, the final conclusions will be drawn only in September, 2003. Therefore, it is evident that the specification of the MIMO concept for 3GPP release 6 will actually start only in the second half of 2003.

One example of the MIMO concept is the well-known BLAST that employs code re-use in transmission from multiple antennae. In BLAST the same spreading code is used for the parallel data streams. The basic idea is that transmitting parallel data streams without transmit diversity high data rates can be achieved while multiple receive antennae provide adequate diversity to combat fading. Simulation results suggest that depending on the number of transmit and receive antennas BLAST can offer spectral efficiency as high as 20-40 bits/s/Hz [2]. In addition, measurements have demonstrated that it is possible to increase cellular capacity in outdoor urban environment by a factor of four with 4x4 MIMO arrangement [21]. This result was obtained in good SNR conditions (approximately 20 dB) and is in good agreement with theory. A recent measurement campaign shows that in suburban outdoor environment a very high spectral efficiency of up to 38 bits/s/Hz could be reached in favorable radio channel conditions using 5 transmit and 7 receive antennae [22]. In general, the number of receive antennae must be equal or higher than the number of transmit antennae. In practise, it is realistic to assume that a 3G base station could employ 4-8 anten-

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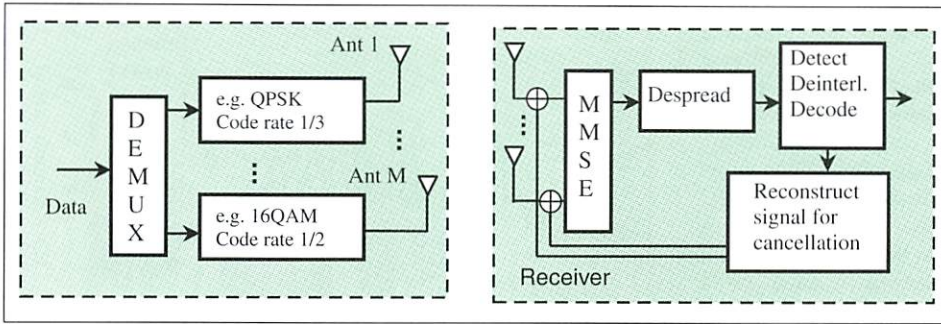


Figure 4 Principal block diagram of a PARC transmitter and receiver (multi-code option not illustrated). Different modulation and coding schemes (data rates) can be applied on antenna basis. An advanced receiver is required which applies on an iterative manner MMSE for antenna signal combining followed by interference cancellation of the detected signal.

nae and the terminal 2-4 antennae (in 3GPP 4x4 MIMO has been discussed). The drawback of exploiting parallel data streams is that the performance of the conventional Rake receiver is rather poor. Instead, advanced receiver structures are required due to the fact that the streams interfere with each other in practical radio channels with multi-path fading. Therefore, some degree of receive diversity must be allocated to interference suppression, which suggests that the number of receive antennae should be larger than the number of transmit antennae. An advanced version of BLAST is called PARC ("Per Antenna Rate Control"), which allows different data rates from different transmit antennae, see Fig. 4 [12]. This concept has also been discussed in 3GPP as a scheme which can take advantage of channel state information from the terminal. In PARC multi-code transmission can be used to further increase the data rate.

It remains to be seen in 3GPP specification whether the main focus will be in increased data rates (theoretically up to 20-40 Mbits/s) or in improved data coverage for medium data rates. Increased data coverage implies that the operation point of the W-CDMA is at low SNR range which favors for conventional diversity techniques. On the other hand, if high peak data rates with reduced coverage are desired, then the operation point is at relatively high SNR level and the use of MIMO techniques becomes feasible. Therefore, it is possible that some degree of reconfigurability between current W-CDMA diversity schemes and the MIMO approach is needed. This kind of flexibility allows effective combination of diversity and MIMO techniques to the radio resource management (RRM) algorithms, especially the packet scheduler. In any case, the MIMO concept which will be adopted to 3GPP Rel. 6 must be backward compatible to the diversity schemes of the earlier releases. In fact, the future MIMO terminals must co-exist with all the terminals from Rel.99 through Rel. 5.

4 Challenges Towards Single Carrier Signaling-Based MIMO Systems

It has long been believed that single carrier signaling is not suitable for broadband mobile communications. This is because the computational complexity of equalizers that can compensate for severe inter-symbol interference (ISI) caused by the multipath propagation scenario increases exponentially with the equalizer's coverage, which has been in many cases considered to be prohibitive.

The discovery of the Turbo codes has driven research on the creation of new signal detection

concepts that are, in general, referred to as the Turbo approach [13]. Recently, a computationally efficient Turbo equalizer, soft-canceller followed by a minimum mean square error (SC/MMSE) filter, has been proposed for equalization of channels suffering from severe ISI. The SC/MMSE Turbo equalizer [14], [15] has overturned the belief of the equalizer complexity: it can achieve almost equivalent performance to that of the optimal detector based on the maximum likelihood sequence estimation (MLSE) technique, even though its computational complexity is only at a cubic order of the equalizer's coverage. References [16] and [17] further reduce the complexity to a square order of the equalizer's coverage without sacrificing its performance. The surprising results shown in References [13-17] have motivated the idea that the SC/MMSE concept be applied to the signal detection of single carrier broadband MIMO systems.

The low complexity of the SC/MMSE MIMO Turbo equalizer has triggered research on single carrier broadband MIMO systems, where all users use the same time-slots and the same frequency-slots without relying on orthogonal signaling or spread spectrum techniques. Obviously, the single

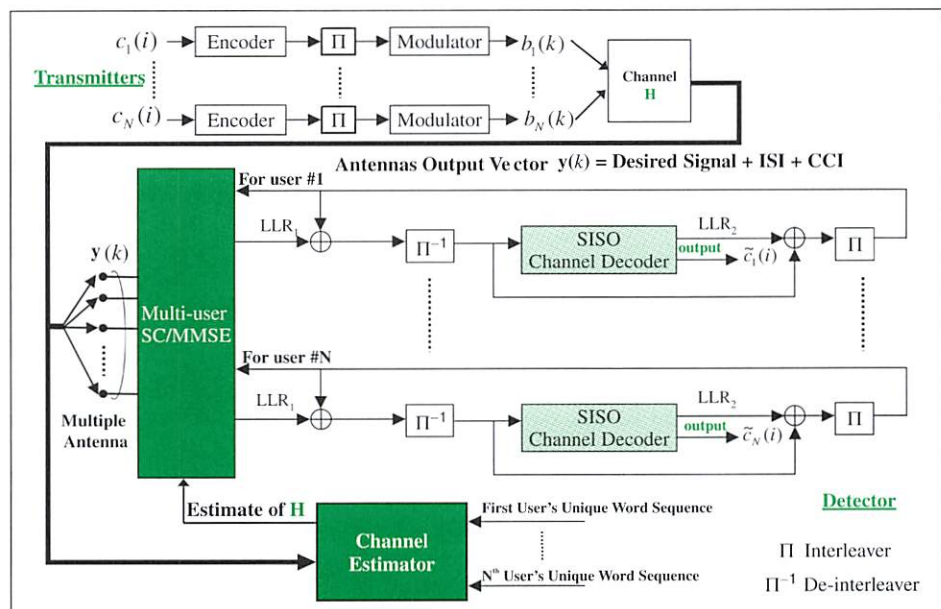


Figure 5 A Block diagram of single carrier MIMO system and SC/MMSE Turbo Equalizer.

carrier approach can fully exploit the path diversity improvement.

Figure 5 shows a block diagram of the SC/MMSE MIMO Turbo Equalizer for single carrier signaling. The SC/MMSE MIMO Turbo detector performs joint channel estimation, multiple stream signal detection, and decoding of channel codes, all in an iterative manner. The SC/MMSE MIMO Turbo detector forms soft replicas of CCI from other users' signals and ISI on the desired signal to be detected using *a priori* Log-Likelihood Ratios (LLRs) output by each user's Soft-Input Soft-Output (SISO) channel decoder. The soft CCI and ISI replicas are subtracted from the received signal vector, of which process is referred to as soft cancellation. MMSE filtering that follows the soft cancellation aims at suppressing the residual interference components remaining at the output of the soft canceller. *A posteriori* LLR value for each data stream is calculated from the MMSE filter output, and after de-interleaving, it is brought to each user's SISO decoder. The SISO decoders update the LLR values user-by-user, and then feed them back to the equalizer part, where soft estimates of CCI and ISI are formed using the updated LLR. The entire process is repeated. The more iterations, the better the performances.

Current advances in multi-dimensional channel sounding techniques [18] make it possible to evaluate performances of signal processing algorithms in realistic conditions. Channel impulse response (CIR) sequences from a transmitter to each of the multiple antenna elements can be recorded. Recorded real-time channel sounding measurement data can be used for realistic off-line simulations. Since the data represents a real propagation scenario, in-field performances can be accurately evaluated by running the measurement data through the signal processing algorithms of interest. This technique provides us with significantly more realistic performance estimates than model-based simulations [19].

Figures 6 (A) and (B) show for a 3-by-3 MIMO with the transmitter and receiver's antenna spacings being 1.0λ and 1.2λ , respectively, the time series of the bit errors after 4 iterations, indicated by grey bars. The measurement took place in Ilmenau, a typical sub-urban area in Germany. Through the measurement campaign, a series of the 3-by-3 MIMO channel's impulse response was recorded, and the set of data was used in off-line simulations to evaluate performance of the single carrier SC/MMSE MIMO Turbo Equalizer. The green curves in Fig. 6 (A) and (B) indicate the RMS spatial and delay spreads, respectively. It is found that the larger the spreads in the spatial and temporal domains, the better the BER performance.

5 Conclusions

In this article we have given an overview of MIMO wireless technologies that have been widely recognized as being able to achieve technological breakthrough towards future broadband mobile communications systems. The information theoretic background of the significant capacity enhancement supported by MIMO radio network configurations as well as current activities towards the utilization of MIMO concepts in the third generation systems were discussed. Recent challenges in signal processing for single carrier signaling-based MIMO communication systems was also introduced, where it has been shown that SC/MMSE MIMO Turbo Equalizers play a key role in simultaneously separating other users' signals and combining desired signal's multipath components.

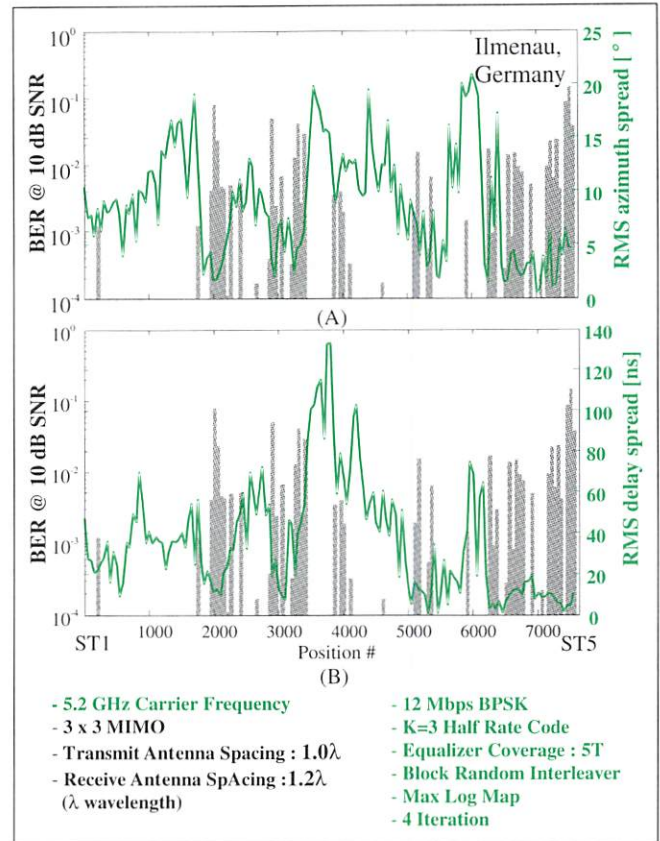


Figure 6 SC/MMSE BER Performances versus Delay and Spatial Spreads.

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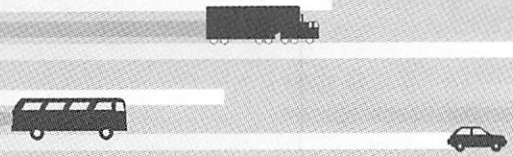
(PDC), and more latterly in the research on Code Division Multiple Access (CDMA) mobile communication systems. From 1992 to 1994, he served as a part-time lecturer at Keio University. In April 1994, he transferred to NTT America, before returning to NTT DoCoMo in March 1996, as a head of radio signal processing laboratory until August of 2001. For his work on the organization of VTC2000-Spring in Tokyo, he received an outstanding service award from the IEEE VTS. In May 2002, he moved to the Oulu University, Finland, where he is a professor at the Center for the Wireless Communications. He is a member of the VTS Board of Governors.



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The Mobile Wireless Ether – Finding its Way into the Automobile

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The application and usage of various wide-area (long range) to personal-area (short range) wireless technologies and associated services in automobiles has arrived. It is essential for implementers to understand the parameters and capabilities of these technologies, many of which utilize and depend upon remote data/information transport services across one or more physical and logical entities within an automobile. This dependence, coupled with unique and typically diverse operational characteristics and requirements of the various wireless technologies, presents significant integration challenges to the automotive OEM and systems/components providers. Investigating and providing insight into managing this complexity for currently and soon to be deployed wireless technologies is addressed in this paper.

Introduction

The mobile wireless ether is an enormous entity that continues to grow and mature on a continual basis. For the pur-

pose of this paper, we limit our scope of discussion to technologies either currently used in automobiles or those likely to be used in the not too distant future. We further limit the scope to focus on the data transport modalities of the particular technology; for instance, we do not address voice transmission/services when looking at Cellular/PCS technologies. Likewise, we do not address music program data/content when looking at Satellite Digital Audio Radio Services. It is assumed that the underlying technology is already present in the vehicle. This paper, then considers the impact of adding the data transport mechanism to the system. Specifically, the following technologies are discussed in this writing:

- ◆ Generation 1 Bluetooth
- ◆ Generation 2 Bluetooth
- ◆ IEEE 802.11b
- ◆ Satellite Digital Audio Radio Service (SDARS)
- ◆ Eureka 147 Digital Audio Broadcast (DAB)
- ◆ In Band On Channel (IBOC)
- ◆ CDMA Cellular/PCS (IS-95B)
- ◆ Wideband CDMA

In this paper these technologies are divided into three groups; Wireless Personal Area Networks (WPAN), Broadcast Distribution Systems (BDS), and Wireless Wide Area Networks (WWAN).

	1st Generation Bluetooth	2nd Generation Bluetooth	IEEE 802.11b
Classification	Low Power / Short Range WPAN	Low Power / Short Range WPAN	Medium-Power / Medium-Range WPAN
Deployment Status	Currently deployed	Under development – Estimate deployment in the 2005 timeframe.	Currently deployed
Specification	Release, Control, and Development under jurisdiction of the Bluetooth Special Interest Group (SIG).		Release, Control, and Development under jurisdiction of IEEE.
Scope Of Specification	Extensive. All software layers up to the application layers are completely specified. Qualification requirements and procedures are also comprehensively covered in the specification.		
Frequency Band	2440 – 2480 MHz	2400 – 2484 MHz	
Modulation	Gaussian Frequency Shift Keyed (GFSK)	$\pi/2$ -DBPSK, $\pi/2$ -DQPSK and 8-DPSK	DSSS-DPSK, FHSS-GFSK, IR_PPM
Specified maximum transmit power	(class 2 radio), +4dBm (2.5mW), EIRP.	1.25dBm (0.75mW), EIRP.	1000 mW max, 100 mW typical
Data Transport	Maximum gross half-duplex data rate of 723Kbps	Maximum gross half-duplex data rate of 2 Mbps	11 Mbps @ 30 meters
Protocol Stack (Data Mode)	Moderate complexity, approximately 50KB code space.	Moderate Complexity	Moderate, IEEE 802 specifications

Table 1: Wireless Personal Area Network (WPAN) Technology Comparison

	Satellite Digital Audio Radio Service (SDARS)	Eureka/147 Digital Audio Broadcasting (DAB)	In-Band On-Channel (IBOC)
Classification	Satellite Broadcast Service	Digital Broadcast Service	Digital Broadcast Service
Deployment Status	Commercial launch is complete.	Various pilot and commercial launches world-wide.	Primary service provider, iBiquity, has developed relationships with broadcasters, IC manufacturers, hardware suppliers, and data deliverers to support launch.
Specifications	Release, control, and development under the auspices of the service companies, Sirius and XM. Available to receiver manufacturers, such as Visteon, currently developing products. Scope of specifications is extensive, including everything from system architecture to user interface requirements.	Release, control, and development under the auspices of the Eureka Consortium. All specifications currently available through the European Telecommunication Standards Institute. Scope of specifications is extensive, including everything from system architecture to user interface requirements.	Release, control, and development under the auspices of iBiquity. Currently undergoing laboratory and field-testing through the National Radio Systems Committee (NRSC). Many specification details can be found from the Notice of Proposed Rulemaking (NPRM) to the FCC and from iBiquity requirements.
Delivery Mechanism	Hybrid satellite and terrestrial delivery system.	Implemented primarily as a terrestrial system.	Implemented primarily as a terrestrial system.
Frequency Band	Sirius (2320-2332.5 MHz) and XM (2332.5-2345 MHz).	VHF Band-III (170-240 MHz) and L-Band (1452-1492 MHz)	FM-Band (88 – 108 MHz) and AM-Band (520 – 1710 kHz)
Modulation	QPSK and COFDM	COFDM	COFDM
Data Transport Parameters	Gross data rate approximately 4 Mbps. Primary usage of data rate is delivery of audio content.	Per-ensemble data rate of approximately 1.7 Mbps.	Hybrid FM IBOC systems which marry existing analog to digital IBOC can achieve aggregate data rates of up to 96 kbps. All-digital FM IBOC systems can achieve aggregate data rates of up to 280 kbps.
Protocol Stack Parameters (Data Mode)	Initial data applications include content specific data (song title, artist name, etc.), channel information (names and categories), and multiplex information. Minimal code required to access and utilize currently available data sources	Various levels of data services including low-level Program Associated Data, higher level extended PAD (Program Associated Data), and full-blown data service support via MOT (Multimedia Object Transfer) and RDI (Radio Data Interface). Minimal code required to access and utilize low level data source	Various levels of data services including low-level Program Associated Data and higher rate data services. Data standards under development in conjunction with Impulse Radio.

Table 2: Broadcast Distribution Systems Technology Comparison

Service/Technology Parameters & Attributes

Wireless Personal Area Networks (WPAN)

Table 1 summarizes some general statistics of a representative group of WPAN technologies. WPANs are intended to have limited range to serve a particular user's needs. As such, they need flexibility to support a variety of physical devices that enter and exit the network on an ad hoc basis.

Broadcast Distribution Systems

In contrast to the WPAN systems, broadcast distribution systems provide a mechanism for delivering data to a very large number of vehicles in an efficient manner. The broadcast distribution systems that will be addressed in this work will include SDARS, DAB, and IBOC. Although there are two unique suppliers of SDARS, Sirius Satellite Radio and XM Satellite Radio, discussions here will group them together as a single delivery mechanism. Table 2 describes these technologies.

Wireless Wide Area Networks (WWAN)

WWANs are categorized as high power long-range communication media. This section discusses code division multiple access (CDMA) as a second and third generation technology (2G and 3G). CDMA was selected for discussion over other wireless technologies because wideband CDMA has emerged as the mainstream air interface solution for 3G networks.

CDMA overview

CDMA is a wireless WAN technology that provides secure communication between a mobile handset and a switching center that is connected to the Public Switched Telephone Network (PSTN). Spread spectrum techniques using pseudo-random number sequences are used to provide multiple access. This improves capacity and privacy over first generation analog systems.

Table 3 gives an overview of CDMA 2G and 3G systems. Note that CDMA 3G is divided into three sub-sections, as discussed below.

2nd Generation CDMA – cdmaOne™

The cdmaOne™ system is based on a spread spectrum multiple access technology. In this approach every active user shares the whole spectrum. This technique offers users spectral efficiency, excellent privacy, exceptional call quality and improved data rate. 3rd Generation CDMA The International Telecommunications Union (ITU), working with worldwide industry bodies, has implemented the International Mobile Telecommunications-2000 (IMT-2000) program to develop 3G systems. The following standards were developed as part of IMT-2000 program.

- ◆ CDMA2000 (1X, 1X EV and 3X)
- ◆ WCDMA (Universal Mobile Telecommunications System (UMTS))
- ◆ Time Division Synchronous CDMA (TD-SCDMA)

	CDMA 2G		CDMA 3G	
	cdmaOne™	CDMA2000	W-CDMA	TD-SCDMA
Classification	CDMA	Multi carrier	Direct Spread	TDD
Deployment Status	Currently Deployed	1X currently deployed	Currently deployed	Currently undergoing Field trials in China
Specification	IS-95B	CDMA2000	UMTS	TD-SCDMA
Channel Bandwidth	1.25 MHz	1.25,5,10,15,20 MHz	1.25, 5,10,20 MHz	1.6, 5, 20 MHz
Frequency Band	Cellular (Uplink: 824-849 MHz, Downlink: 869-894 MHz) PCS (Uplink:1930-1990 MHz, Downlink: 1850-1910 MHz).	450, 700, 800, 900, 1700, 1800, 1900, 2100 MHz	1920-1980, 2110-2170 MHz	1900-1920, 2010-2025 MHz
Modulation	QPSK	QPSK	QPSK	QPSK
Data Rate	64 Kbps	Up to 144 kbps for 1X Up to 2.4 Mbps for 1X-EV-DO	144 kbps Up to 2 Mbps	144 kbps Up to 2.048 Mbps

Table 3: Wireless Wide Area Networks Technology Comparison

- ✦ UWC-136 (Enhanced Data rate for Global Evolution (EDGE))
- ✦ Digital European Cordless Phone (DECT)

For brevity and clarity, this paper only includes discussion of three of these versions of 3G CDMA: CDMA2000, WCDMA, and TD-SCDMA. CDMA2000 is an ITU approved IMT-2000 (3G) standard. The name 1X implies that CDMA2000 can be implemented within the same spectrum as cdmaOne™ using a single (N=1) channel (1.25 MHz). The Third Generation Partnership Project (3GPP), formed by five telecommunication standard bodies from Japan, China, North America and Korea developed the CDMA2000 Specification.

WCDMA (Wideband Code Division Multiple Access) is one of the main technologies for the implementation of third generation cellular systems. This scheme has been developed as a joint effort between European Telecommunications Standards Institute (ETSI) and Association of Radio Industries and Business (ARIB) for Europe and Japan. Time Division Synchronous CDMA (TD-SCDMA) was proposed by China Wireless Telecommunication Standards Group (CWTS) and approved by the ITU in 1999. TD-SCDMA uses the Time Division Duplex (TDD) mode, which transmits uplink traffic as well as downlink traffic in a particular frame in different time slots.

Data-Enabled Vehicle Architecture

Regardless of which data service is implemented, the overall architecture of the data service vehicle subsystem will remain consistent at a high level. It is the partitioning of this subsystem that both enables and limits the flow of data to the ultimate user. The overall architecture can be seen in Figure 1.

It can be seen from this figure that the data must flow across many interfaces to get to the final destination.

The various subsystems involved are described below.

Wireless Ether

The wireless ether (or infrastructure) is the first interface across which the data must flow. It is the capacity of the infrastructure that sets the upper limit with respect to the amount of data that may be transferred to the ultimate user. The choice of modulation scheme, bandwidth efficiency, data refresh rate, broadcast vs. bi-directional, and multiple access techniques are communication parameters that define this upper limit.

Transceiver Subsystem

The transceiver subsystem encompasses everything from the wireless antenna, to the Radio Frequency (RF) receiver and transmitter sections, to the digital baseband decoding and coding sections that are used to extract the data from the infrastructure. Filter bandwidths, gain strategy, data encoding protocols, error correction, diversity, and channel coding all provide further limitations on the data transfer through the subsystem. An aggregate (or gross) data rate that is available from the infrastructure is further reduced to its usable (or net) rate after the action of the transceiver subsystem.

Data Decoder Subsystem

The data decoder subsystem takes the data stream from (or to) the transceiver subsystem and assembles the data in to a usable format that can be transferred to a storage medium for use by the data manager subsystem. The data decoder makes use of final redundancies in the data to insure an accurate transfer. It is after action by the data decoder subsystem that the application data is now in a format that is ready for use or distribution by the rest of the system and ultimately the final user.

Data Manager Subsystem

The data manager is the first subsystem that uses the actual content of the data to make decisions that benefit the ultimate user and most likely contains a storage media. One

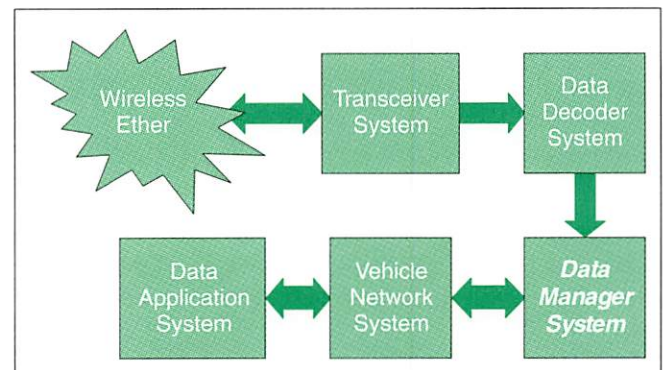


Figure 1 Data enabled vehicle architecture

type of decision-making process is the action of taking a constant stream of data from the data decoder subsystem, comparing it to its equivalent copy within the manager, and updating the data when appropriate. The data manager also handles the distribution of data to the vehicle network subsystem and prevents distribution when data errors or incompleteness exists.

Vehicular Network Subsystem

The vehicle network subsystem provides the connection from the data manager to the data application interface that presents the data to the ultimate user. Bandwidth and throughput are the greatest consideration in the network subsystem. The architecture of the network defines the ultimate scope of data services as it represents the ultimate bottleneck for data. A slow-speed serial interface style network will define the type of data that is available to the vehicle, while a high-speed network will allow the flexibility of multiple services.

Data Application Interface

The final subsystem in the vehicle data chain is that of the data application interface. This interface represents the hardware and software that the user interacts with to request and respond to the data. It can take the form of a display with an associated human-machine interface, implemented with a variety of technologies ranging from buttons to voice input. The complexity of the interface is dictated by the complexity and scope of the data to be presented. At this final point in the chain, it is expected that the results of the various transfers yield a data that is of the appropriate size and format for consumption. It is the external requirements such as styling and vehicle ergonomics that often have the greatest impact on the data application interface.

Managing Complexity

Addressing Cross-Domain Transport Issues

Defining Cross-Domain Transport

For the purpose of this paper, cross-domain transport is defined as the transfer of information and data content to between subsystems or devices using different technologies in those devices' domains. For instance, transporting data and information between a Bluetooth device and a MOST network-connected module via a gateway is a cross-domain transport. Similarly, transporting program information from a Satellite Radio receiver to a remote display device connected via CAN or any other vehicle network is also a cross-domain transport.

Cross-Domain Transport Metric

The cross-domain transport metric is an assessment representing overall inherent or incremental limitations and complexities associated with the particular cross-domain data transport case being examined. It is important to note that the rankings of the metrics in this paper are not absolute values; they are based on the authors' best judgment of the metric criteria given below. The metric criteria consist of the following parameters:

- ◆ Impact upon transport time, relative to the equivalent time required in the primary application device or domain.
- ◆ Incremental software complexity impact
- ◆ Incremental hardware complexity impact
- ◆ Key-Off current consumption impact

- ◆ Product or System qualification complexity impact including Software Validation, Design Verification, Regulatory Compliance, and Type Acceptance

Case Studies

Following the flow of the Data-Enabled Vehicle Architecture in Figure 1, we can examine some cases of data services and contrast their impact on the vehicle.

CASE #1 – 1st Generation Bluetooth

Wireless Ether

By definition, a WPAN needs only a limited range of operation. The limited transmit power specification guarantees this for Bluetooth. The interior of the vehicle, then, physically defines the range of the WPAN. For an RF medium such as Bluetooth, this has implications for antenna placement and system design to optimize radio link quality. The overall radio link is divided into separate sections to provide for audio and data communications. Of particular interest in vehicle applications is the section called a SCO link (Synchronous Connection-Oriented), over which audio data can be transferred to enable hands-free telephone conversations. Vehicle applications can also include data transfer for the purpose of PDA synchronization or other information downloads. This is accomplished over another section of the overall radio link called the ACL (Asynchronous Connectionless Link). It is the ACL feature of the infrastructure, then, that represents the addition of data to the overall system. Table 4 qualitatively summarizes the impact on the various subsystems of enabling the ACL data service within an existing Bluetooth system.

Transceiver Subsystem

A Bluetooth transceiver includes both an RF section and a baseband section, although current implementations may combine them into a single integrated circuit. The RF section performs the actual modulation and demodulation of the signal between the RF signal and the baseband information. The baseband section formats the SCO and ACL information into a single link according to commands given to it by a host microprocessor. The baseband section interfaces to the vehicle via digitized audio for the SCO link and via packets for ACL data. Since the ACL is a feature of the Bluetooth link itself, very little needs to be done to the transceiver subsystem to make use of the ACL.

Data Decoder Subsystem

For the SCO link (audio), the data decoder subsystem can be considered to be a Coder-Decoder (CODEC), or a similar arrangement that converts between an analog audio signal and a digital representation of the audio. ACL data may take the form of a command, packet data, or bulk file data. The ACL data is completely separate from the SCO data, and is mainly handled in software by the host microprocessor. Some sort of vehicle network would be involved as the interface from the data decoder to the rest of the vehicle.

Data Manager Subsystem

For the ACL data, the local microprocessor host that controls the Bluetooth hardware is typically also the entity that manages the distribution of data around the vehicle. Software must be developed to provide the proper interfaces and the integration, or qualification, of that software as it interacts at the vehicle level can involve significant effort. Also, a hardware path for the data may have to be added to the system. Again, the vehicle network is central to the process. Vehicular Network Subsystem It is clear from the discussion in other sections of this case study that vehicle network communica-

tion is a critical part of the ability to deliver data in usable form to the user. Further, the bandwidth requirement of the data itself dictates the type of vehicle network that must be present in the vehicle. A simple asynchronous network (operating at 9600 baud, for example) may be completely unable to deal with large data file transfers efficiently. Networks with greater bandwidth, such as Media Oriented Systems Transport (MOST), are specifically designed to accommodate audio and packet data for both the SCO and ACL connections of 1st Generation Bluetooth. Video data, which could be present in a 2nd Generation Bluetooth application, adds additional bandwidth requirements that may require special provision in vehicle design. Data Application Interface If the link in question is just a simple audio voice connection for a cellular phone call (Bluetooth SCO connection), the data application interface is really a speaker and microphone in the vehicle. The audio is simply driven to a speaker or a microphone input is delivered to the Data Decoder Subsystem. With ACL file transfers or with packet data, the application could be encapsulated within a personal computer, a PDA, or a more conventional module within a vehicle such as the audio head unit or a display on the instrument panel. The requirements of such applications are highly dependent on factors such as how the data may be presented to the user, how often it is presented, and whether the presentation is made in real-time. The impact of these requirements can be seen in Table 4.

CASE #2 – In-Band On-Channel (IBOC)

Wireless Ether

The IBOC system described here represents one of the several broadcast distribution systems listed in Table 2. The infrastructure of an FM-IBOC system supports both the existing analog audio broadcast information and the additional digital data information, which is further subdivided into digital audio and digital data content. For this example, we chose a particular configuration in which approximately 20 kbps of the digital capacity of the infrastructure (for a single channel) has been allocated for an asynchronous data application. Here the infrastructure continuously delivers the information for consumption by the user. An example of this could be traffic data that is continuously updated at regular intervals.

Transceiver Subsystem

The transceiver subsystem encompasses the receive antenna, the tuner, analog to digital conversion, and channel and source decoding. It is in the channel decoding section of the transceiver subsystem where the gross data rate of approximately 20 kbps is reduced to a lower net data rate as a result of the redundancies and overhead incurred by error correction and channel coding techniques. The tradeoff here is between overhead and robustness, whereas certain data applications must optimize one or the other. The primary impact from a cross-domain transport perspective, as depicted in Table 5, is on the key-off current requirements if this data is expected to always be up to date, even while the vehicle is turned off.

Data Decoder Subsystem

The data decoder subsystem accepts the non-audio data stream from the transceiver subsystem and extracts the relevant data from the frame structure. If the data transferred is made up of large blocks that must be packetized and separately framed for transport, some of the data rate will be occupied by data within the frame that is dedicated to tracking the packets. This will result in an overall loss in total data capacity. Also, if the broadcasting scheme for this particular data application is such that the same data is trans-

mitted over and over again, regardless of whether it has changed, then there will be an additional load on the subsystem to constantly process the data even when new content is not available.

Data Manager Subsystem

The data manager is responsible for both the storage and delivery of the data application. Therefore, based on the data application, this could require a great deal of hardware and software, as can be seen in Table 5. Also, the need for concurrency from multiple sources, to multiple sinks, must also be addressed. In our traffic data example, a small amount of traffic data from a single channel for a particular geographical area could be managed with a moderate amount of RAM and might only be maintained for a short period of time. However, a more inclusive application taking data from multiple sources for multiple areas might require a large amount of high speed non-volatile memory, thus increasing cost and complexity. The cache and delivery action of this subsystem allows a majority of the incoming data to be made available to the user.

Vehicular Network Subsystem

From a baseline perspective, the vehicle must already support command, control, diagnostics, and data transport associated with the primary content. However, the additional resources required to support a unique data-service application are a function of both the network capability and the application requirements. For example, if our traffic data application were to be implemented with a vehicle architecture that supports a high-speed digital network such as MOST, then the incremental resources to support a relatively low-level application should be minimal. However, if the data application required much higher capacity, then complete network topologies might change. The greatest challenge here occurs when adding a data service to a low-level serial communication network. It is the validation of the service in the context of the entire system capacity that leads the resource effort.

Data Application Interface

The data application interface often requires a user interface in the form of a display and buttons. It is here where an impact is often felt in the hardware and software that is required. This is because the interface is often optimized, from a capabilities perspective, for the maximum non-data service. The addition of the service component results in additional requirements on the overall system.

CASE #3 – CDMA Cellular / PCS (IS-95B)

Wireless Ether

The wireless ether for CDMA systems consists of the wireless network, the carrier, and the service provider. The service provider can be viewed as a single point of contact to provide vehicle-specific, location-specific and generic services. Privacy and security are the main concerns over this section of the link. Considering the fact that there is a large geographic coverage for analog services as compared to digital services, the service provider should be capable of handling both modes of the transceiver subsystems. Also their infrastructure should be easy to upgrade to provide future 3G services. This section of the link carries data for different applications such as location data in case of emergency situations as well as to provide location-specific services, Internet content and vehicle diagnostics.

Transceiver Subsystem

This subsystem is the interface between the service provider and the vehicular network. A cellular phone and a navigation system could be viewed as different internal blocks of this

	Transceiver	Data Decoder	Data Manager	Vehicle Network	Data Application
Transport Time Impact	Low	Low	Low	Medium/High	Low
Software Complexity Impact	Medium	Medium	High	Medium	Medium
Hardware Complexity Impact	Low	Low	Medium	Medium	Medium
Key-off Current Impact	Low	Low	Low	Medium	Medium
Product Qualification Impact	Low	Low	High	Medium	Medium

Table 4: 1st Generation Bluetooth Cross Domain Transport Scores

	Transceiver	Data Decoder	Data Manager	Vehicle Network	Data Application
Transport Time Impact	Low	Low	Low	Low	Low
Software Complexity Impact	Low	Low	Medium-High	Medium	Medium-High
Hardware Complexity Impact	Low	Low	Medium-High	Medium	Medium-High
Key-off Current Impact	High (based on this traffic data example)	High (based on this traffic data example)	High (based on this traffic data example)	High (based on this traffic data example)	Low
Product Qualification Impact	Medium	Medium	Medium	Medium	Medium

Table 5: IBOC Cross Domain Transport Scores

	Transceiver	Data Decoder	Data Manager	Vehicle Network	Data Application
Transport Time Impact	Low	Low	Medium	Low	Low-Medium
Software Complexity Impact	Low	Low	Medium-High	Low-Medium	Medium
Hardware Complexity Impact	Low-Medium	Low	Medium	Low-Medium	Medium
Key-off Current Impact	Medium	Low	High	Medium	Low
Product Qualification Impact	Medium	Medium-High	High	Low-Medium	Medium

Table 6: CDMA Cellular / PCS (IS-95) Cross Domain Transport Scores

subsystem. The navigation system can provide location details of the particular automobile to the service provider, which can provide location-specific services. The cellular phone can be an IS-95B compliant phone operating in the PCS or cellular frequency bands with Advanced Mobile Phone System (AMPS) capabilities. Further, this subsystem can be connected to a host controller to provide vehicle diagnostics and automatic 'Mayday' notifications. A host micro-processor must act as the interface between the human-machine interface of the vehicle and the transceiver subsystem. Since this subsystem is required to handle voice, data, and combined voice and data, the primary impact is on product qualification to ensure proper integration of different blocks in all the three transmission modes mentioned above.

Data Decoder

This could be a CODEC resident on the transceiver subsystem. There are different bit rates available for IS-95 systems. A data decoder should be capable of handling various data applications of the transceiver subsystem. Following are some different data applications under consideration:

- ◆ Location-specific data along with the audio signal to be sent to the service provider
- ◆ Data only mode for web browsing
- ◆ Short Messaging Service (SMS) capabilities

Further, the CODEC also adds error detection and correction code to the signal to be sent on to the next block, which further reduces the effective throughput. It can be seen in Table 6 that the Product Qualification impact on the Data Decoder is ranked medium to high due to the additional testing and validation required for the data application. Data-Manager Subsystem As mentioned earlier, the data manager subsystem handles data storage and delivery. This subsystem can save audio files such as various ring tones, e-mails and MP3 files. Audio files containing ring and announcement tones can be custom defined and changed at any time during manu-

facturing or in the final application (over the air). Efficient operation of this subsystem requires proper memory mapping. Applications such as downloading MP3 files or storing phonebook data while the car is in 'ignition off' state, impact key-off current to a great extent. As depicted in Table 6, it is clear that the data manager is most affected, from a cross-domain impact perspective, by the addition of the data services. Vehicular Network Subsystem This subsystem enables communication between the data application interface and the transceiver subsystem. If the information being transferred is in the form of large data files, this places a requirement on the network to be able to handle data in bursts. The result is that the nature of the data traffic may affect the choice of vehicle network architecture.

Data Application Interface

Similar to the Bluetooth case, the audio support systems in the vehicle can provide access to the data application in the form of audio feedback to the user. A visual interface, however, is also required to handle data applications such as navigational information and web browsing and has an impact on the cross-domain transport metrics as can be seen in Table 6.

Conclusions

It seems clear from this work that the addition of data-applications to an already digital-radio-ready vehicle subsystems has very different effects on the various transport components. While some incremental resources are clearly affected by the nature of the data services, others are merely a function of the transport itself. In particular, the addition of ACL data in Bluetooth has very little impact on the lower, hardware-related technology domains because ACL is an integral part of the underlying technology. In contrast, adding data features in IBOC and CDMA has a much higher impact from the transceiver subsystem all the way to the data applications.

It can also be said that the challenges for vehicle designers in implementing these wireless technologies lie more at the system level than at the physical level. For example, in all three case studies, the transceiver transport time impact, the software complexity impact, and the hardware complexity impact metrics are either low or medium. That is to say, the technologies themselves are readily available as a functional block. In contrast, most of the medium and high scores are listed under the key-off current impact and product qualification impact metrics. Also, in all three case studies, the vehicle network subsystem was frequently described as being impacted at a medium or high level by the addition of these technologies in a vehicle. Such metrics deal more with vehicle-level concerns than with the specific technology itself. From this, it can be generically said that, although the strictly engineering aspects of these technologies cannot be taken for granted and are not trivial, there is a large body of work yet to be done at the vehicle level to effectively integrate the technologies that perhaps has not been addressed in many cases. The technologies are ready for the applications, but the applications may not be ready for the technologies.

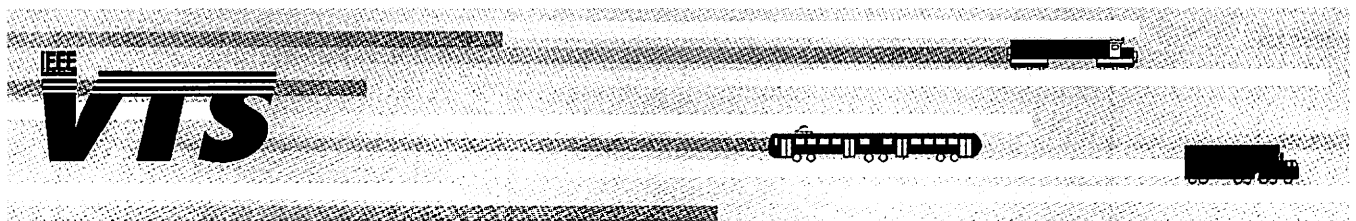
Glossary of Terms

2G – second generation technology
 3G – third generation technology
 ACL – Asynchronous Connectionless Link
 BDS – Broadcast Distribution Systems
 CDMA – Code Division Multiple Access
 CODEC – Coder-Decoder
 DAB – Digital Audio Broadcast
 IBOC – In Band On Channel
 IMT-2000 – International Mobile Telecommunications-2000
 ITU – International Telecommunications Union
 MOST – Media Oriented Systems Transport
 PCS – Personal Communication System
 RF – Radio Frequency
 SCO – Synchronous Connection-Oriented

SDARS – Satellite Digital Audio Radio Service
 TD-SCDMA – Time Division Synchronous CDMA
 UMTS – Universal Mobile Telecommunications System
 WCDMA – Wideband Code Division Multiple Access
 WPAN – Wireless Personal Area Networks
 WWAN – Wireless Wide Area Networks

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Mobile Landscape in South East Asia - Weathering the Storm

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Rocked badly by financial crisis in 1997 which saw the downfall of many industries across the region, coupled with the natural economic, political, social and cultural barriers, South East Asia economy is poised to be in deep water. Interestingly, this does not affect the mobile market in the region. Rather than falling, the mobile market is growing with leaps and bounds. What are the underlying forces behind this extraordinary phenomenon?

Background

Strategically placed between West and East Asia, sandwiched by three major oceans namely the Indian

Ocean, South China Sea, and the Pacific Ocean, South East Asia (SEA) is certainly a land of opportunity. Traditionally an important sea trading area due to its natural location, SEA has emerged in recent years as major economic trading house particularly in the area of manufacturing and agriculture industries. Consisting mainly of developing economies, SEA is made up of ten countries namely Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. All of these countries belong to a regional entity called the ASEAN (Association of South East Asia Nations), and because of its location in the Pacific Rim, is also members to the Asia Pacific

Economic Caucus (APEC) along with economic power house like United States of America (USA), Japan, and China. ASEAN is the third largest trading partner for the USA [1]. SEA is home to 518 million inhabitants, about 8.6% of the world's population. Indonesia alone is the world fourth most populous country, having 210 million people, accounting for 41 per cent of the ASEAN's population.

SEA has a diverse background in culture, languages, and religion in practice. Most SEA countries were colonized, except Thailand, by Western countries such as Britain (in Malaysia, Singapore, Brunei, and Myanmar), France (in Vietnam, Laos, and Cambodia), USA (in Philippines), and the Netherlands (in Indonesia). The colonialism has deep impact on the culture, languages, religion, and even development in each country. English and French for instance, are widely spoken until now in the colonized countries. Other languages used in SEA include Malay, Chinese, Indian, Javanese, Khmer, Burmese, Vietnamese, and Lao [2]. As for religion, Islam and Buddhism are the most predominant in the region. With different personality for each country, mass and widespread development of any kind would be difficult. For foreign suppliers like Nokia and Ericsson, they must not treat all the countries the same, but must do careful study to meet different individual needs. This may impose a challenge for foreign companies coming into SEA.

With a collective Gross Domestic Products (GDP) of USD 750 billion, the economies in SEA vary extremely from some of the world's wealthiest nations to least developed countries (LDC). Singapore had a Gross National Income (GNI) per capita of USD 25,090 and Brunei, the oil rich country had USD 24,910, while on the other end of the spectrum Cambodia and Laos had USD 1,450 and USD 1,550, respectively [3].

During 1997, South East Asia countries were hit badly by a financial crisis. This financial crisis contracted economies and caused exchange rates to tumble across all Asian countries. SEA was not spared. The 1997 financial crisis started in Thailand and spread to many other large ASEAN member nations, and has had a huge impact on the economies of the ASEAN countries. Telecommunication revenues hardly budged during the crisis after growing at annual double-digit rates throughout the early 1990s. However, telecommunication revenues finally revived in the year 2000 to reach USD13.3 billion in the region, up 10.6 percent over the previous year [4].



Figure 1 ASEAN countries

Country	Population (Million)	GNI per capita (\$US)	Phones per 1000 population	
			Fixed	Mobile
Brunei	0.34	24910	245	289
Cambodia	12.0	1450	2	10
Indonesia	210.4	2850	31	17
Laos	5.3	1550	8	2
Malaysia	23.3	8390	199	213
Myanmar	47.7	NA	6	NA
Philippines	75.6	4250	40	84
Singapore	4.0	25090	484	684
Thailand	60.7	6360	92	50
Vietnam	78.5	2010	32	10

Table 1 South East Asia Telecommunication Indicators at end of 2000 (Source: World Bank)

In the early nineties, South East Asia region had some of the fastest growing fixed telephone networks in the world with an average annual growth of 19.5%, which tripled the fixed subscribers to 19.5 million. However, the growth dropped sharply, averaging just 8% per year during the crisis. The network investment also saw a drop, as the operators have to pay significantly more in loans due to exchange rates and increase in the cost of foreign debt. In addition, major portion of investment is going towards to alternate network technologies such as wireless and IP networks, which are cheaper to build.

The Mobile Market

Before the crisis, cellular mobile subscribers grew on average by 63% a year compared to 43% a year following the financial crisis. The largest increase since 1995 was in the year 2000 with 75% growth. The number of mobile subscribers per 100 people rose from 0.09 in 1991 (when there were still four ASEAN countries without a mobile network) to 4.2 in 2000, almost 50 times since 1991. This trend is predicted to continue for the next few years [5].

Exponential growth would be an understatement when it comes to mobile growth in the Asia Pacific. There is nowhere in the world that has experienced a profound transformation in mobile like the Asia Pacific over the last decade. The region is the world's pocket of growth with the fastest growing mobile market in the world. Back in the early 1990's, there were fewer than one million mobile users within the region. At the beginning of year 2000, there were around 170 million. The ITU predicted that the Asia Pacific alone would account for half the world market by the year 2010 [6]. With two of the largest mobile companies in the world (measured by number of subscribers) in China Mobile and NTT DoCoMo, plus the sheer size of its market potential, it is logical to believe that Asia Pacific will be taking the lead from Western Europe as the leader and trend-setter for the mobile communications of the world in the near future. Being part of Asia Pacific, SEA nations are joining the wave.

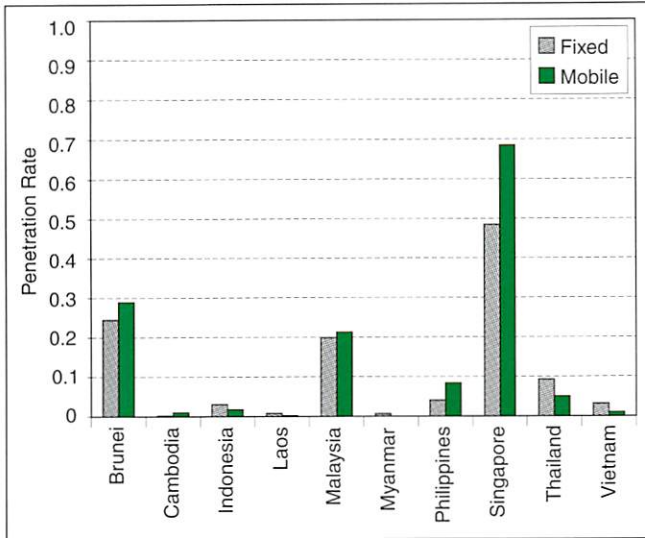


Figure 2 Penetration rates for fixed and mobile at the end of 2000

Mobile Indicators in South East Asia

The mobile subscriber has increased drastically to 12 million in the year 2000 compare to 3 million five years earlier. As shown in Table 1 and Figure 2, almost half of the ASEAN countries, namely Brunei, Cambodia, Malaysia, Philippines and Singapore, have more mobile than fixed telephone subscribers. Being the trend follower to the western countries and with the average penetration of only 16% of the region's population and an annual growth rate of 10%, it is estimated that potentially there will be a minimum of 100 million mobile subscribers by the end of 2010. As indicated in Appendix 1, there are currently 52 mobile providers in the region. The mobile system equipments in the region are imported from European countries, United States of America and Japan. Among the system, GSM is the most popular mobile system in the region with over 73% of subscribers. Nevertheless, there are varieties of other mobile systems implemented, more than any other regions. Myanmar is also getting into the act recently by introducing two systems, a CDMA and a GSM. Previously, Myanmar depended only on a Satellite communication. Nevertheless, the action of the Myanmar government indicates the importance of mobile and perhaps ICT in general for their future development.

Critical Role of Mobile in the economic development of SEA

Undeniably, telecommunication is one of the key elements in the development of any nation. In the LDC¹ nations of South East Asia, mobile is playing a crucial role in overall economic development by taking over that of the fixed line. Cambodia is a textbook example of wireless boosting telecommunication development. It was the first country in the world where mobile telephone subscribers overtook fixed ones back in 1993. Cambodia began the millennium with more than four out of five telephone subscribers using a wireless phone, the highest ratio in the world. Thanks to mobile, Cambodia's teledensity — telephone subscribers per 100 inhabitants — reached 1 in the year 2000, a significant achievement for an LDC. While mobile has contributed to the bulk of Cambodia's telecommunication progress over the last decade, wireless fixed lines have also helped and ac-

counted for 5% of all telephone subscribers at the beginning of 2001. The scenario of Cambodia is becoming common in LDC for the simple reason that mobile implementation is generally cheaper and easier to implement than fixed line. It does not require as large investment as fixed network as it does not need the digging and installing copper at the last mile. Last mile access is normally the most expensive investment for a fixed line operator, and also the hardest to implement and manage. In the case of handset, mobile operator does not have to invest and maintain the Customer Premise Equipment (CPE), unlike the fixed, and therefore can be seen as transferring the cost to the users [5].

Mobile: Supplementary or Substitute?

Mobiles are a substitute for voice communications in countries such as Cambodia, as depicted earlier, and the Philippines. In these two countries, mobile phones outnumbered fixed phones.

In the more advanced and wealthier countries like Brunei and Singapore and to a lesser extent in Malaysia, mobile is treated as a supplement to the conventional fixed phones [7]. In Singapore for instance, 51 percent of households had a mobile phone in 1998 even though 98 percent already had a fixed telephone [5]. Mobile phones are seen as more of a luxury than a necessity, to the extent that it is becoming more like a fashion or trend in the younger generations. This fact plus the convenience of a mobile phone and its features are the main reasons why mobile is preferred over fixed line. What is more is that, based on a survey by Mobile Computing (March 14, 2001), "more than half of mobile phone owners in the region prefer to use their handsets even when there is a fixed line nearby."

If the trend of mobile being the substitute and preferred over fixed line continues, coupled with reduced and more liberalized regulation, it will be highly likely that the number of mobile users will surpass the number of conventional fixed line users before the end of this decade. Already half of the nations in SEA have more mobile users than fixed. Taking into account the explosive growth of mobile against the slower and stagnant growth of fixed in all countries, the future would certainly be in mobile. This may be a good sign for SEA nations as presently, the fixed line business still very much monopolized and government-controlled whilst the mobile operators are very much new and more liberalized. The situation may force the governments to open up and liberalized the whole telecommunication market much quicker.

Threat of Globalisation and Open Policy

The threat of AFTA (ASEAN Free Trade Agreement) on competitive tariff and WTO (World Trade Organisation) on open and liberalized telecommunication market has sent shivers down to many SEA countries. As required by AFTA and WTO which will be in place before the decade ends, all SEA countries must open up for foreign competitors to come into the country to operate with competitive offerings. Therefore, in order for local providers to be competitive enough to compete and survive, necessary measures must be taken now to prepare for the onslaught. One of the main issue that need to be look at and reform is the regulation aspect, as many of the SEA countries, except Singapore, has fully open up. Regulation is essential from the fundamental perspective that it is intended to compensate for lack of real competition in an immature marketplace. In this respect, the communications market in SEA

¹Least Developed Country; a designation used by the United Nations, defined as a country with a per capita gross domestic product of \$100 (in 1968 United States dollars) or less; a share of manufacturing in total GDP of 10 per cent or less; an adult literacy rate of 20 per cent or less.

is at various stages of development – some are very advanced like Singapore, and to some extent Malaysia, while others are still very much state-run monopolies. The more open and liberalized regulation (or what is sometimes called deregulation) is needed to introduce better and healthier competition which leads to increasing penetration rates. A specific example would be the mushrooming of new telecommunications operators in recent years in the Asia Pacific region has been, to a large extent, triggered by important policy reforms [8]. Yet, there are still nations in SEA who is yet to open up its telecommunication policy like Myanmar and Laos, but most has already embracing, or at least seriously considering it. Fortunately in many other countries in SEA, mobile is less regulated than fixed line, which resulted in greater competition which finally drives the higher growth rate.

Another aspect that need to be looked at seriously is the tariff and pricing of mobile. It has great relation to the above need for more liberalized market as competition will actually push the price down. In countries like Myanmar and Vietnam whose price for mobile and telecommunication are high, the regulators may need to revise them to make it more competitive.

Prepaid is Getting Hotter

Prepaid has become a popular in recent years in SEA as a new alternative to subscribe to mobile phones, particularly for students, youngsters, and in general cost conscious users. The same phenomenon is also happening throughout the Asia Pacific. The prepaid users have increased tremendously from 33.6 million in 2000 to 108.2 million in 2001, more than triple which constituted 76.2% of new cellular connections for 2001. Philippines emerged as the leader with 93% of its mobile subscribers are prepaid, followed by Indonesia, Malaysia, and Thailand (see Figure 3) [9]. For mostly developing and emerging economies in SEA, prepaid gives a better alternative to postpaid due to its non-credit nature, better cost control, and affordable. No registration (as against postpaid) as well as widespread availability (through chain stores and resellers) makes it more appealing for the budget conscious and immigrants, as in the case in Malaysia. Unfortunately, due to the absence for proper customer profiling, the prepaid users are considered less loyal, (i.e., they tend to switch from one operator to another) which may drive higher churn rate as customer retention is becoming difficult.

Short Messaging Services (SMS) Opens Up New Revenue Stream

The Philippines, dubbed the “texting” capital of Asia, has been the world leader in volume of short messaging services (SMS). In December 2001, Filipinos were sending more than 82 million text messages a day or around 8.5 per subscriber. The SMS craze in the Philippines was mainly due to the low price of SMS (2¢ US per outbound) as well as high voice call costs. Obviously, the more economic choice will be the SMS. The biggest growth in SMS volume is recorded in Malaysia, where the traffic more than quadrupled in 2001 over the previous year. This resulted from new inter-operator SMS agreements, investment in new messaging platforms and more marketing efforts by the carriers [10]. Thailand, which does not use a Roman alphabet, has a lower SMS market due to obvious difficulty in writing in Thai over

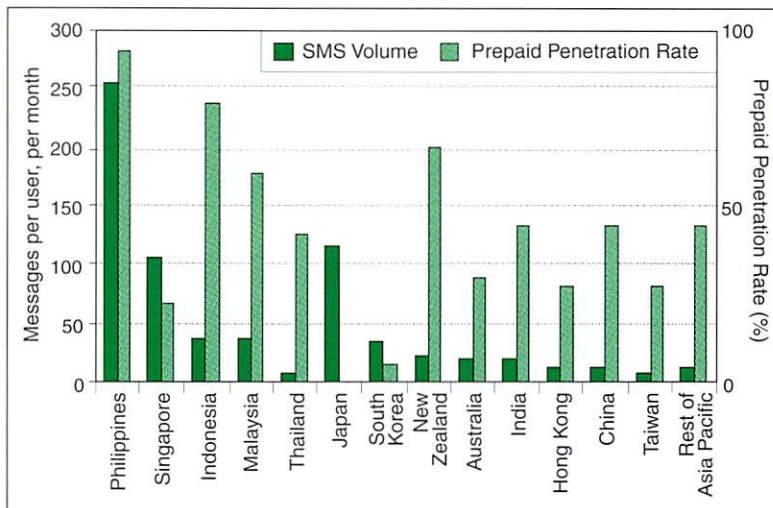


Figure 3 SMS Volume per user/month, and prepaid as a proportion of mobile users, for various countries.

(Source: Gartner Dataquest 2001)

the phone. Nonetheless, SMS gives a bright indication that mobile phone has an alternate revenue source to voice, which may lay the foundation for future new services like e-mail, WAP, GPRS, and 3G.

The Road to 3G and the Future

Mobile internet development in the region has been slow. One factor working in the region’s favour is that all the countries have adopted the digital GSM standard. Common standards should help simplify the migration to 2.5G and to third generation (3G) mobile networks. Although most countries have introduced wireless application protocol (WAP), and several have introduced or are launching higher speed GPRS networks, take-up has been lukewarm. This is due to consumer indifference. In some Indochina peninsula countries, there have been problems in adopting native languages to mobile phone text applications. So far, only Singapore and Malaysia have initiated 3G license bidding, and Malaysia has awarded the license to three telecommunication companies. In the other countries, recent GSM licensing and the launch of 2.5 generation systems is likely to delay the introduction of 3G.

Conclusion

SEA is a land of opportunities filled with great potential for Mobile to grow and foster. Its sheer market size alone is staggeringly huge that provide untapped market. With Mobile making waves throughout the continent, and with the current enthusiasm shown for mobile, the region certainly hold great promises waiting to be unleashed.

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Mohd Roslan Bin Mohd Rashidi graduated from Columbia University, New York in 1988 with a degree in Electrical Engineering. After a short stint in University of Malaya as a research assistant, he joined Telekom Malaysia in 1990 as a telecommunication engineer for switching and currently the Chief Technology Officer of TM Net, a wholly owned subsidiary of Telekom

Malaysia.

Appendix 1 Mobile Subscribers as of the end of 1999 in South East Asia (Source: US Dept. of Commerce)

Country	Operator	System	Launch	Subs (*)	Country	Operator	System	Launch	Subs (*)
Brunei	DST	GSM	1996	55,000	Myanmar	MPT	CDMA	2000	NA
		AMPS	1993	0			GSM	2000	NA
Cambodia	MobiTel (CamGSM)	GSM	1997	55,418	Philippines	Islacom	GSM	1994	180,000
	Cambodia Shinawatra	GSM1800	1998	10,000		Globe Telecom	GSM	1994	916,360
	CamTel	AMPS	1993	0		Piltel	CDMA	1998	20,986
	Tricelcam	TACS	1993	1,000			AMPS	1984	435,971
	Samart (Casacom)	NMT900	1992	19,000		Extelcom	AMPS	1991	145,000
		GSM	1992	4,151		Smart	TACS	1994	824,045
Indonesia	Telkomsel	GSM	1994	1,025,221	Singapore	SingTel	AMPS	1988	0
	Mobisel	AMPS	1986	12,801			GSM900/1800	1995	880,000
	Excelcomindo	GSM	1996	383,000		MobileOne	GSM	1997	428,000
	Komselindo	AMPS	1991	36,553		CDMA1900	1998	35,000	
	Metrocel	AMPS	1991	41,424	Thailand	AIS	GSM	1994	619,600
	Satelindo	GSM	1994	715,489			NMT900	1990	611,000
	Telekomindo/ Telesera	AMPS	1993	6,481		CAT	AMPS	1986	42,500
Laos	Lao Telecom	GSM	1994	9,400			CDMA	1998	7,500
		AMPS	1992	0		TAC	GSM1800	1991	474,400
Malaysia	DiGi Telecom	GSM	1994	9,400			AMPS	1994	640,300
						Digital Phone Company	GSM1800	1998	130,000
	Telekom Malaysia	GSM1800	1995	590,000	Vietnam	TOT	NMT470	1986	49,600
		AMPS	1993	122,000		Mobifone	GSM	1995	179,938
		DAMPS	1994	20,000		Vinaphone	GSM	1996	78,000
		GSM1800	1995	230,000		Saigon Call Link	AMPS	1992	6,000
	Maxis Comms (Binariang)	GSM	NMT450	1985	54,000				
			GSM	1995	800,000				
TRI Celcom	GSM								
Time (Sapura Digital)	GSM1800								

VTC2003-Fall in Florida – 6-9 October 2003

Over 2400 abstracts have been submitted to VTC2003-Fall, making it the most popular VTC held to date. Whether this is a sign of recovery in the mobile communications market, or the proximity of Disneyworld, is an open question, but it does ensure that attendees are promised a wide range of high quality technical presentations.

New for this conference is a range of symposia on subjects such as Next Generation Wireless Systems, Wireless Security, Ad hoc Networks, MIMO, etc. One of these symposia will be on Vehicle Power and Propulsion as part of the VTS VPPC's work to increase the number of vehicular papers at VTC.

Programme details will be finalised at towards the end of May when letters of acceptance will be sent to authors. Further information can be found on the web site at <http://www.vtc2003.org>

VTC offers an ideal opportunity to keep up to date with the latest developments in the field and meet friends old and new. The nearby attractions provide an excuse for bringing your family (or perhaps the other way round), and the Hyatt Orlando is conveniently located with good road connections to Orlando International Airport, which has a wide range of domestic and international flights. Make plans to be in Orlando for 6-9 October 2003.



An airboat tour of to see Central Florida's wildlife



Lake Oela in downtown Orlando



SeaWorld Orlando

PHOTOS COURTESY OF ORLANDO/ORANGE COUNTY CONVENTION & VISITORS BUREAU, INC.



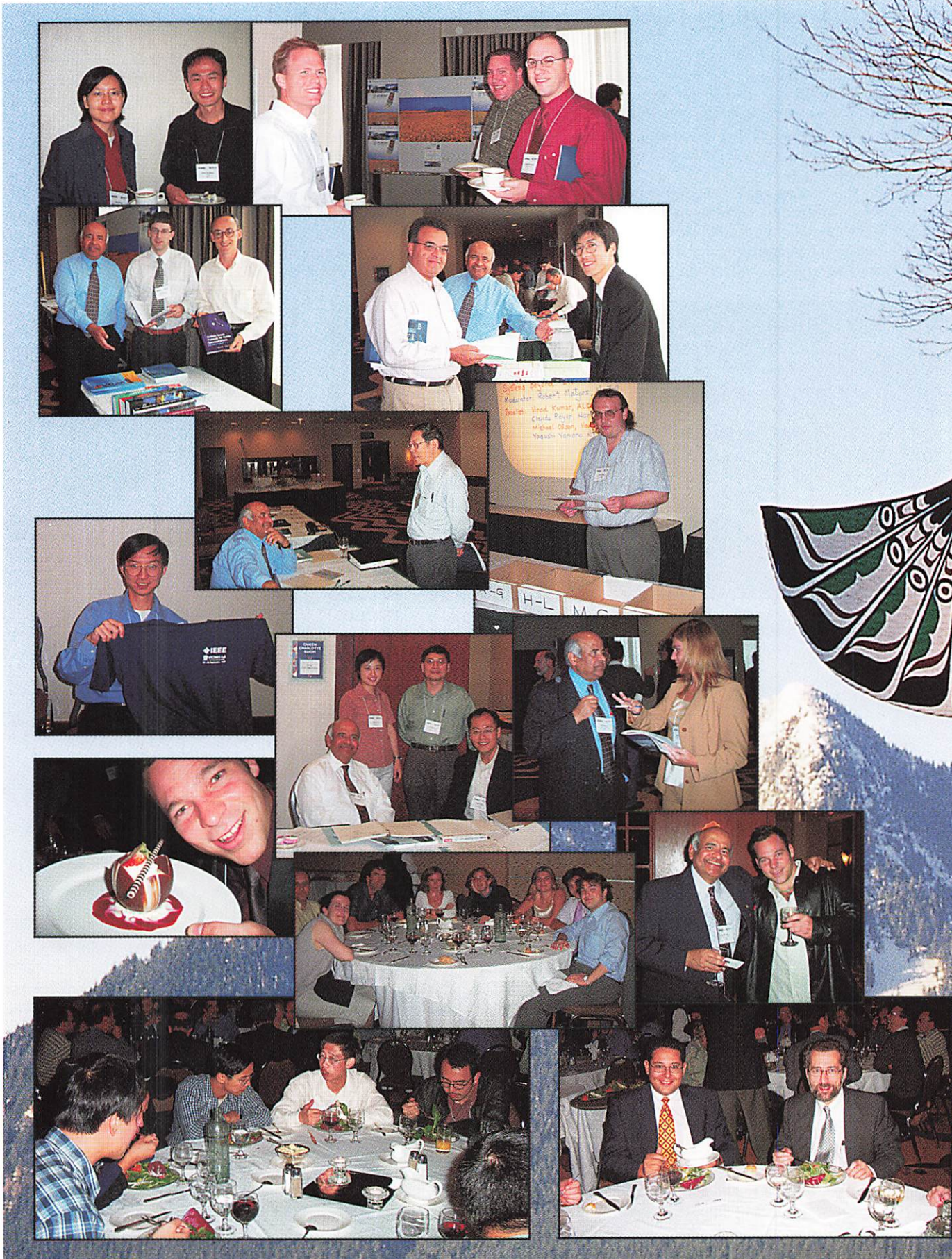
Report on VTC2002-Fall

The 24th to 28th of September last year saw 600 delegates from across the globe converge on Vancouver for VTC2002-Fall, the 56th Vehicular Technology Conference. The conference was run by Chairman Professor Vijay K Bhargava and his team of assistants from the University of Victoria, while the technical programme was the responsibility of Dr Annamalai Annamalai Jr from Virginia Polytechnic, who received the 2001 IEEE Leon K. Kirchmayer Prize Paper Award from IEEE President Joel Snyder at VTC2001-Spring in Rhodes. Dr Annamalai was previously a student of Professor Bhargava, so good liaison was assured! The conference secretariat was in the hands of Catherine Chang, who had to handle over 3000 email exchanges with delegates in the run up to the conference.

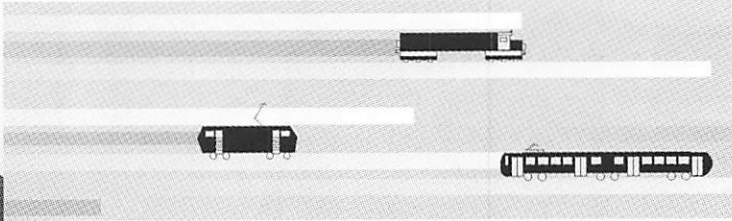
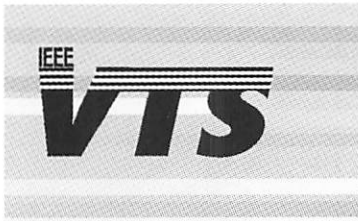
In addition to the technical sessions, two panel sessions were organized during the conference, on wireless initiatives and technologies for systems beyond IMT2000, and WLANs and WPANs (Wireless Personal Area Networks).

Unfortunately the banquet speaker could not attend. In compensation, Vijay arranged for an extra glass of wine, much to the delight of the delegates.

A key aspect of a professional conference is the opportunity which exists for renewing old acquaintances and anyone who has been to a conference Professor Bhargava has organised will know that this is a particular specialty. The student fee was slightly higher than usual, allowing everyone to attend all the functions; normally the student rate does not include meals or social functions. This allowed a great sense of community to develop, as can be seen from the photographs. Indeed, conference photographer Serkan Dost could constantly be seen snapping delegates for a slideshow during the banquet and for the web site. Some examples of his work are overleaf. Another ever present sight was that of Vijay circulating round the venue, greeting delegates, ensuring everything was running smoothly and that people were enjoying themselves. Great fun was indeed had by all!







Transportation Systems

Harvey Glickenstein, Senior Editor

Sound Transit and the Port of Seattle reached agreement on the light rail station to be built at Sea-Tac International Airport. When the first 14-mile section of the Central Link light rail system opens in 2009, it will terminate just north of the airport. Shuttle buses will be used to carry passengers to the airport. The agreement provides for extending the light rail system down the median of a new North Airport Expressway to reach the existing airport terminal.

Sound Transit was originally going to build to a proposed northern terminal that the Port of Seattle was planning. The Port has instead decided to expand the existing terminal and expand it both north and east. The Port of Seattle Commission has authorized \$10.6 million to develop a Comprehensive Development Plan for the north end of the airport, including the new expressway. The Sound Transit Board has authorized \$10 million to design the light rail extension.

The agreement calls for the two parties to work together to develop a conceptual design for the North Expressway, the light rail alignment, and the light rail station. Sound Transit is projecting a June 2005 date for beginning the preliminary engineering, environmental impact statement, and the final design.

The station is expected to be built between South 173rd and South 175th Streets on the west side of International Boulevard. It will be convenient to both the existing terminal and its associated parking garage.

The initial 14-mile portion of the light rail system received a boost when it was one of only two projects that received a "highly recommended" rating from the Federal Transit Administration. Phoenix was the only other line to receive this rating. The rating resulted in President Bush including \$75 million for the line in the current Department of Transportation budget.

Sound Transit has put a Tacoma Link light rail car on display in downtown Seattle in order to give residents a taste of what the new system will look like.

The Tacoma Link is planned to open in September. It will operate between the Tacoma Dome Station and downtown Tacoma. In conjunction with the Sounder commuter rail, which has a stop at the stadium, passengers will be able to take rail the entire distance between downtown Seattle and downtown Tacoma.

The Tacoma Link has five stations on its 1.6-mile length. It is planned to operate its 66-foot double-articulated cars on a ten-minute headway.

The Central Link light rail system south from Seattle to the airport will run even larger cars. They will also be configured to allow trains of up to four cars.

The Portland Streetcar has had a very successful year and a half of operation. In its first year it exceeded the ridership estimates of 1,200,000 riders by more than 10%.

The City of Portland contracts with TriMet, the operator of the Portland light rail system, to operate and maintain the system using 14 Operators, 2 Mechanics, and 3 Superintendents.

Portland's seven Czech-built streetcars come in four colors.

Portland Streetcar is planning a 0.6-mile extension of its line. The \$18.2-million extension would open in the middle of 2004. This cost includes the two additional streetcars delivered last year that increased their fleet size to seven and a new roadway called the Harrison Connector. There are additional proposals to extend the line even further in the future.

In addition to the seven modern streetcars that operate during the week, Portland Streetcar operates two vintage cars on Saturdays and Sundays.

New Jersey Transit has ordered its first bi-level cars. The 100 cars will be able to operate anywhere on the New Jersey transit commuter rail system, including through the tunnels under the Hudson River into New York City's Penn Station.

The order includes 15 cab cars and 85 coach cars. The cab cars can be used at the front of trains that are operated with the locomotive at the rear in a push-pull configuration. More than one half of the cars will have rest rooms.

At the request of the commuters, the seats will be configured in a 2-2 configuration rather than the more cramped 3-2 configuration that is common in commuter rail cars in the United States.

Bombardier Transportation Company of Canada will provide the cars starting in Autumn 2005 with final delivery of the \$250 million order by March 2007. New Jersey Transit also retains an option to purchase up to 176 additional cars.

The Chicago Transit Authority (CTA) has an ambitious plan to improve public transit in the Chicago area. The new Circle Line would build on the current rehabilitation projects for the Brown and Blue lines. It would feature three new stations on the CTA and new interconnections with Metra commuter rail stations.

Implementation of the Circle Line is planned for three phases.

First phase is the Paulina Connector Restoration. This track was built in 1895. It was taken out of revenue service in 1951 when the Dearborn Subway was built through downtown. In 1954 the Garfield Park "L" was torn down as part of the construction of the Congress Expressway. Douglas Park trains then used the connector until the Con-

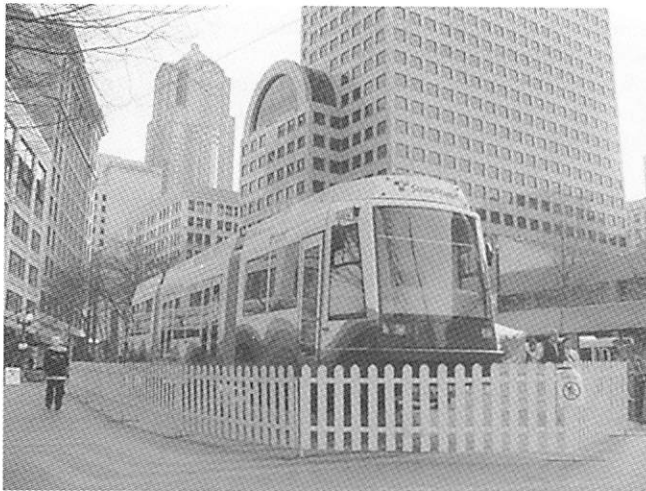


Figure Tacoma Link light rail car

gress Line opened in the median of the expressway in 1958. The ¾-mile long single-track line is now only used to allow Blue Line trains to reach the CTA Heavy Maintenance Shop in Skokie. The restoration will add a second track to the connector. A \$29.5 million addition to the current contract for rehabilitating the Blue Line has been approved for the Paulina Connector. When complete, the Douglas trains on the Blue Line will use the Connector to access the Loop via the Lake “L” instead of operating through the Dearborn subway. CTA then expects to increase the frequency of service on both the Forest Park Branch of the Blue Line and the Douglas Park Line to 54th and Cermak.

The next phase would be to build a 1.5-mile elevated connector from the Douglas Line south to the Orange Line at Ashland/Archer. This would improve access to Midway from the West Side.

The third phase would build a 3.3-mile connector north to the Red Line at North/Clybourn. This would provide a transfer to the Blue Line to O’Hare at Division and a new connection to the Metra North and Northwest commuter lines. A new station at North/Clybourn would provide a connection between the Red and Brown Lines as well as the Circle Line.

CTA is also starting a study of providing express service on both the Blue Line to O’Hare and the Orange Line to Midway. The study will be performed by a consultant under contract to the Chicago Department of Transportation and be partially subsidized by CTA. The study will include requirements to provide passing tracks on each line to allow express trains to pass local trains. A market analysis will also be provided to see if package delivery service would be viable on these lines.

Factory tests of the New York City Transit (NYCT) Canarsie Communications Based Train Control (CBTC) Project are scheduled for April through July 2003.

Phase II of the Canarsie Line project involves resignaling the entire Canarsie Line (22 track miles) and furnishing CBTC equipment for 212 new R143 cars. Siemens Transportation Systems Inc. (formerly MATRA Transport International) is responsible for the design and supply of the carborne and wayside CBTC subsystems including the data communications system, an Automatic Train Supervision subsystem, and overall project management and systems integration. Union Switch & Signal, Inc. is responsible for

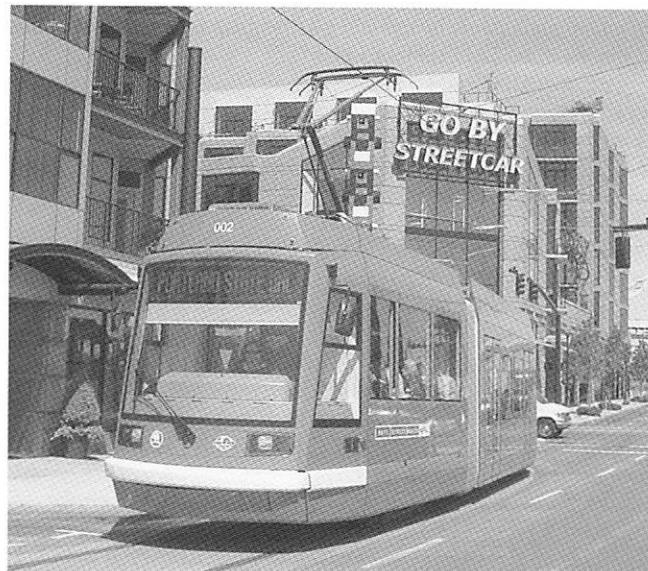


Figure One of Portland’s seven Czech-built streetcars

PHOTO COURTESY PORTLAND STREETCAR



Figure One of Portland’s two vintage streetcars

PHOTO COURTESY PORTLAND STREETCAR

the design and supply of the Auxiliary Wayside System (AWS) including six relay-based interlockings, track circuits, wayside home and approach signals, and automatic train stops. RWKS Comstock is responsible for equipment installation and associated equipment room construction.

The carborne CBTC equipment will be installed by NYCT forces on new R143 cars currently being procured from Kawasaki. These cars feature AC traction, full width cabs, and wide use of train networks. The CBTC interfaces to the cars has been carefully co-ordinated so that the cars will be “CBTC ready”. This means that space, power and all interface wiring for CBTC is provided, making equipment installation a relatively simple task. The first of these units, made of 4 car semi-permanently coupled cars, was delivered in May 2001 and the 30 day acceptance tests were completed Jan 2002. There are currently 13 eight-car R143 units accepted for operation on the Canarsie Line.

The CBTC Joint Venture has installed a set of “prototype” CBTC equipment on a 4-car unit to be used in testing the radio network and car interfaces, including simulation of ATO. Several months of testing took place on the Chauncey Middle Test Track (adjacent to East New York shop) which also includes some CBTC wayside equipment. The one-year

revenue testing of the optical positioning and speed sensing subsystem began in early February.

The installation of conventional wayside signal equipment is progressing. Construction of relay and CBTC rooms is 90% complete. The new interlocking at Rockaway Parkway was placed in service (pre-CBTC) in Nov 2002, on schedule, including a revised track layout to allow direct movements into all yard tracks from the mainline.

A key feature of the project is the attempt to create at least three viable bidders for future CBTC installations. The project started with a competition between different vendors of CBTC. Contracts were awarded to three vendors, a "Leader" and two "Followers." The Siemens-US&S-Comstock Joint Venture is the Leader. Alstom and Alcatel were awarded Follow contracts of \$13 to \$16 million each.

The Joint Venture will establish Interoperability Interface standards for future CBTC systems on NYCT under Phase III. The objective of Phase III is to successfully develop and validate Interoperability **Interface** Specifications so that multiple contractors are pre-qualified to bid on future NYCT CBTC equipment procurements (both way-

side and carborne). Phase III is also not, in any way, a consensus standard development effort; the system architecture, functional allocations, interfaces, and protocols are defined by the Leader. These demonstrations will take place in late 2003 to early 2004.

The Preliminary Interoperability Interface Specifications were delivered in March 2002. A substantial update to these specifications was delivered in December 2002. These are substantial documents (now over 600 pages) and are being thoroughly reviewed by NYCT and the Followers.

Interoperability for NYCT means cars equipped by one CBTC contractor can operate with wayside systems supplied by another contractor and vice versa. Interoperability is also required between coupled 4-car sets equipped by different contractors, and between adjacent wayside territories by different contractors. NYCT is not looking to achieve interchangeability of subsystems or subsystem components.

Initial CBTC testing in the field is expected to begin in October 2003. It is planned to operate the CBTC in a shadow mode on the east end of the line starting in April 2004. All of the cars will be equipped by August 2004 and the system is scheduled to be placed in revenue service on the entire Canarsie Line by December 2004.

The Chicago Transit Authority (CTA) will be providing for cell phones in its subways.

The contract approved at the March meeting of the Chicago Transit Board provides for the installation of a state-of-the-art wireless communications system in the CTA subway tunnels, underground stations, and underground passageways. The \$11.2 million contract provides for design, analysis, implementation, testing, and maintenance of a complete and operational wireless communications system.

The system, which will use new radio transmitters, radio receivers, and antennas, will utilize CTA's existing fiber optic cables. It is planned to be in service by Fall 2004.

CTA originally planned on soliciting bids from providers of cell phone services to build a system to provide these services within the underground portions of the CTA. Since no provider or group of providers was willing to build the system at their own expense, CTA withdrew their original Request for Proposal and readvertised a system that would be financed by the CTA's parent agency, the Regional Transportation Authority. CTA will now advertise for wireless service providers who would like to use the infrastructure being installed by the CTA.

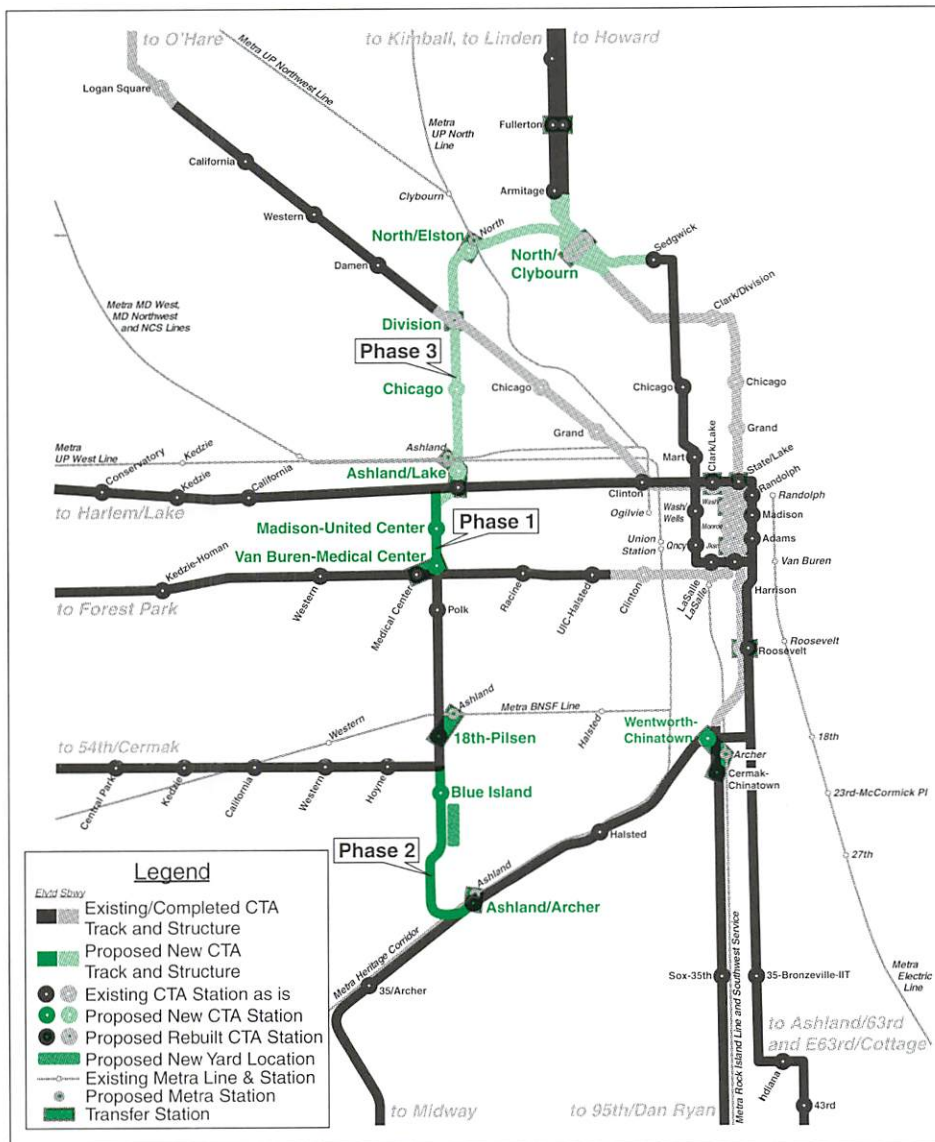
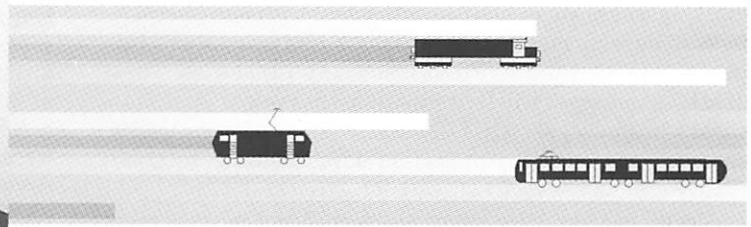


Figure Conceptual Track and Station Location and Construction Phasing for Proposed CTA 'Circle Line'



Mobile Radio

Javier Gozalvez, Senior Editor

Technology and Research News

Researchers from Lucent Technologies' Bell Labs revealed architectural and performance details of the world's first turbo decoder chip for 3G wireless data terminals that supports the evolving High Speed Downlink Packet Access (HSDPA) standard. The Bell Labs-designed chip, which will be licensed to manufacturers of wireless data terminals, is powerful enough to handle data rates up to 24 Mbps. The chip was described during a presentation at the International Solid State Circuits Conference (ISSCC). The chip is fast enough not only to support first-generation HSDPA systems, which will offer transmission speeds between 5 and 10 Mbps, but also future Multiple-Input/Multiple-Output (MIMO) HSDPA systems, which are expected to achieve peak data rates up to 20 Mbps. The chip achieves this speed in part thanks to a unique implementation of turbo codes. In addition, the chip also can be reconfigured for different packet sizes and data rates on the fly, making it compatible with the variable data rates arising from Adaptive Modulation and Coding (AMC) – a key capacity-enhancing feature of HSDPA. A Bell Labs research team in Sydney, Australia, designed the turbo decoder – the same team that last October announced the industry's first chip that incorporates Bell Labs Layered Space Time (BLAST) MIMO technology for mobile communications. The design team chose a highly parallel architecture for the turbo decoder chip and employed a new compression technique that enables it to operate at a low clock frequency and yet still achieve high data rates. By operating at low clock frequencies, the chip consumes very little power. Additional technical details about the chip can be found in the researchers' recently published paper, "A 24 Mbps Radix-4 LogMAP Turbo Decoder for 3GPP-HSDPA Mobile Wireless," which is available at <http://www.bell-labs.com/issccpaper/>

Ericsson, Nokia and Siemens are jointly defining specifications for an open standard to speed the adoption of direct-call push to talk service over GPRS. Push to talk is a cost-efficient, simple to use direct voice service for GPRS-based systems that has attracted the interest of leading operators. The technology uses the capabilities of the IP Multimedia Subsystem (IMS) as specified by 3GPP for enabling IP connections between mobile phones. IMS adds the ability to deliver integrated voice and data services over the IP-based packet switched network. Initial trials are expected to begin in the second half of 2003. The specifications created through this collaboration will be submitted to relevant industry bodies in order to create a standard that will avoid fragmentation and establish a unified push to talk over GPRS market with the same economies of scale that made GSM a global success.

Qualcomm announced that it will allow free use of its SOBER and Turing encryption algorithms for any purpose. In the past, Qualcomm provided the encryption software only to its licensed manufacturers or for non-commercial use. Turing and the SOBER family are high-speed, highly secure stream ciphers and are thought to be immune to any practical cryptanalytic attacks. Stream ciphers can be much more efficient for encryption than the more common block ciphers, such as the Advanced Encryption Standard. Stream ciphers can mean lower cost of hardware implementation or, at times, the choice to use a software implementation instead of building any specialized hardware. Qualcomm was recently granted a new patent, U.S. Patent 6,510,228, that covers the SOBER cipher and its descendants, including its new encryption algorithm Turing. The Turing cipher is significantly faster than the recently adopted Advanced Encryption Standard algorithm (Rijndael), and can offer advanced protection for CDMA networks, the Internet and electronic commerce. The SOBER family of encryption algorithms can be used for a variety of CDMA applications, as well as other uses, such as high-speed routers. Source code for the ciphers is available from Qualcomm Australia's Web site at www.qualcomm.com.au

As part of the EU-project IPv6 Wireless Internet Initiative (6WINIT), a consortium of Universities together with Ericsson conducted the world's first IPv6 over 3G UMTS/WCDMA network demonstration. The medical emergency system, called Guardian Angel, showed vital medical data, voice and video using IPv6 and seamlessly roaming over 2G and 3G systems as well as WLAN.

Qualcomm has announced that it will conduct the world's first GSM1x technology trial with China Unicom, the second largest wireless service provider in China. The trial will enable China Unicom's GSM subscribers to access the high-speed data services of China Unicom's CDMA2000 1X wireless network and accelerate the commercial availability of GSM/CDMA dual-mode handsets. The initial stage will demonstrate CDMA2000 1X data service with a GSM core network and provide an environment to perform testing of dual-mode GSM/CDMA2000 1X handsets. The following stage will have an expanded scope, including various roaming scenarios between CDMA and GSM networks. The GSM1x trial is scheduled to begin in the second quarter of 2003. GSM1x is a CDMA2000 1X solution for GSM operators in any band, and combines the benefits of CDMA2000 1X and GSM-MAP.

Siemens ICM has launched what it claims is the world's first dual-band radio module that operates in GSM/GPRS networks and supports Java 2 Micro Edition (J2ME). The new TC45 with Java technology is employed in telemetry and telematics sectors and is particularly suited for applications

in security systems, remote electricity, water or gas metering. Qualcomm announced an agreement with Sun Microsystems to develop and distribute Java 2 Platform, Micro Edition (J2ME Platform) virtual machine technologies. These J2ME technologies will be compatible with select Qualcomm CDMA Technologies (QCT) Mobile Station Modem (MSM) chipsets, the BREW Application Programming Interface (BREWapi) and system software for wireless devices.

Alcatel has launched a new and significant improvement to today's wireless service level monitoring: service level monitoring on the mobile phone. Alcatel's new technology, the Mobile Beacon Technology (patent pending), creates a lightweight mechanism to detect network coverage issues and interaction issues between applications, SIM cards and phones. Application providers can set flags, or beacons, in their mobile applications in order to detect events of interest for analysis, reporting & alerts. These beacons can warn against service malfunctions, guide towards service improvements, and measure the fit between the operator's target market and the subscribers who actually use the services. Until now, operators limited their service level monitoring to the network. Alcatel's Mobile Beacon Technology completes existing monitoring by turning users' cell phones into network monitors that warn against issues that are difficult to detect from the network, such as reduced cell coverage or spurious handovers.

Ericsson has been granted a patent for a mobile phone that will float in water. Ericsson has designed a plug-on pack that would attach to the back of a mobile phone and give it sufficient buoyancy that it will then float in water. Ericsson has also introduced MINI-LINK Traffic Node, a scalable microwave aggregation node for mobile networks. According to Ericsson, the new node provides a ten-fold increase in aggregated transport capacity, while enhancing network quality, flexibility and control, and reducing site space by up to 70%.

Nujira Ltd has announced a patent-pending power amplifier technology that can lead to significant reductions in basestation costs. The company claims that by optimising the efficiency of wireless transmitters, their technology reduces the power required by the power amplifier by over 60%.

Motorola, has launched the Motorola A760, the world's first handset combining a Linux Operating System and Java Technology, with full multimedia PDA functionality. The Motorola A760 combines the ideal features of a mobile phone with the capabilities of a PDA, digital camera, video player, MP3 player, speakerphone, advanced messaging, instant Internet access and Bluetooth wireless technology.

The NTT Group companies have developed, for the first time in the world, a video communication platform conforming to international standards. The platform enables real-time bi-directional video communication between personal computers connected to a broadband network environment and FOMA handsets. The companies are planning to conduct trial services of the technology.

Lucent Technologies has announced that the company has been granted its 30,000th U.S. patent. This milestone patent covers the mechanisms for guaranteeing Quality of Service (QoS) in Internet Protocol (IP) networks, which should help make packet-based networks as reliable as today's telephone networks. Specifically, this is achieved by establishing a virtual channel in which information flows uninterrupted between a sender and receiver.

Mobile Phones and Health Concerns

Hong Kong's Telecommunications Authority (TA) is planning to introduce a scheme that would provide relevant information to consumers on radio frequency radiation safety of mobile phones. The authority has decided to adopt the S.A.R. limits of ICNIRP and ANSI/IEEE as the safety standard on RF radiation exposure for hand-held mobile phones. According to a spokesperson of the Office of the Telecommunications Authority (OFTA), mobile phones type-approved in Hong Kong will comply with either of these limits from 1 April 2003. Consumers will be able to identify a phone's S.A.R. by checking the OFTA website or by looking the prescribed label affixed to the device.

The Health Council of the Netherlands has released a new report recommending the establishment of a "center of expertise" on health effects of electromagnetic fields and also made recommendations for proposed research studies. An executive summary of the report can be found in www.gr.nl

A study, from scientists in Lund University (Sweden), published in the Journal Environmental Health Perspectives (EHP), claims to have found, for the first time, that electromagnetic fields emitted by certain mobile phones damaged neurons in the brains of rats. According to the authors they "cannot exclude that after some decades of often daily use, a whole generation of users may suffer negative effects as early as middle age". Although the authors acknowledged the study sample was small, they also stated that the combined results are highly significant.

GSM Europe, the European Interest Group of the GSM Association, has announced the first implementation Review of the base station deployment 'good practice' recommendations, which aims to address community health and environmental concerns about network rollout and base station siting.

New guidelines, produced by central and local government with the mobile phone industry, have been published in the UK aiming to ensure local people are fully consulted about the siting of transmitters and receivers on public property. Figures released by the UK government have also shown that emissions from mobile phone masts throughout the country are well below international guidelines. The study examined mobile phone masts on 109 sites across the UK, looking at 82 school sites and 27 hospitals. The study showed that emission readings ranged from hundreds to millions of times below international guidelines.

US Mobile Market

The Federal Communications Commission (FCC) has reallocated spectrum that can be used to provide a variety of new wireless services, including advanced wireless services (AWS), commonly referred to as "Third Generation" or "3G." The Commission reallocated 30 megahertz of spectrum from the 2 GHz Mobile Satellite Service (2 GHz MSS) to fixed and mobile services. The Commission also sought comment on potential uses of an additional 15 megahertz of spectrum previously identified for new wireless services and on increased flexibility in the Unlicensed Personal Communications Service (UPCS) band. These actions will facilitate more efficient use of existing spectrum and enable an expanded array of innovative products and services for consumers. In a *Third Report and Order* ("Order"), the Commission allocated for fixed and mobile wireless services the 1990-2000 MHz, 2020-2025 MHz, and 2165-2180 MHz bands. The Commission concluded that 2 GHz MSS – which is currently authorized to operate in the 1990-2025 MHz and 2165-2200 MHz bands – can operate in less than the 70

megahertz of spectrum it had previously been allocated. The Commission's action retains 40 megahertz of spectrum for 2 GHz MSS in the 2000-2020 MHz and 2180-2200 MHz bands. The FCC sought further comment on use of the 1910-1920 MHz band. This band is currently available for UPCS asynchronous (generally data) applications, but at present is unused. This band – or a portion thereof – could be paired with the 1990-2000 MHz band to support the development of AWS, or could be used to support the relocation of other wireless licensees. The FCC concluded that the 1920-1930 MHz band should be retained for UPCS use and sought comment on whether it should provide for additional flexibility in that band, as well as any additional spectrum retained for UPCS use in the 1910-1920 MHz band. In the *Notice*, the Commission also sought additional comment on potential uses for spectrum in the 2155-2160/62 MHz band that is currently used by the Multipoint Distribution Service (MDS), and the 2160-2165 MHz band identified for emerging technology use. The Commission also sought comment on suitable relocation spectrum for MDS licensees currently operating in the 2150-2160/62 MHz band, and asked what portions of the 2155-2180 MHz band could be suitable for AWS use.

The FCC and the National Telecommunications and Information Administration (NTIA) have executed a new Memorandum of Understanding (MOU) on spectrum coordination. The MOU will apply to coordination of spectrum issues involving both federal and non-federal users. The new agreement establishes procedures relating to frequency coordination, as well as spectrum planning provisions contained in the Communications Act.

The FCC has opened a proceeding designed to facilitate the provision of fixed and mobile broadband access, educational and other advanced wireless services in the 2500-2690 MHz bands. By this action, the FCC seeks to promote competition, innovation and investment in wireless broadband services, and to promote educational services. Additionally, the FCC also seeks to foster the development of innovative service offerings to consumers as well as educational, medical and other institutions, simplify the licensing process and delete obsolete and unnecessary regulatory burdens. Currently, the 190 megahertz of spectrum in the 2500-2690 MHz bands is designated for the provision of Instructional Television Fixed Service (ITFS), Multipoint Distribution Service (MDS) and the Multichannel Multipoint Distribution Service (MMDS) (collectively, the Services). The Commission requests comment on operational, technical, and procedural rule changes. Specifically, the Commission invites comment on how to reconfigure the 2500-2690 MHz band. The Notice also proposes technical rules designed to increase licensee flexibility while eliminating unnecessary regulations and protecting incumbent operations in the 2500-2690 MHz bands, including rules governing mobile operations.

The FCC has issued a Notice of Inquiry asking for public comment on the possibility of incorporating receiver interference immunity performance specifications into its spectrum policy on a broader basis. Such specifications could be in the form of incentives, guidelines or regulatory requirements in particular frequency bands, services or across bands and services. Incorporation of receiver performance specifications could serve to promote more efficient utilization of the spectrum and create opportunities for new and additional use of radio communications by the American public.

The FCC has adopted a *Memorandum Opinion and Order* that largely reaffirmed the procedures adopted last year to

authorize the unlicensed operations of ultra-wideband ("UWB") devices. Minor changes were implemented to further facilitate the operation of imaging devices. These rule amendments respond to fourteen petitions for reconsideration that were filed in response to the First Report and Order that established the UWB standards. In general, the Commission did not make any significant changes to the existing UWB technical parameters, indicating that it is reluctant to do so until it has gained more experience with UWB devices. The FCC indicated that it also intends to investigate the potential impact of UWB devices on various radio services and would continue its review of the UWB standards to determine where additional changes warrant consideration. In response to the petitions, the Commission amended the rules to facilitate the operation of through-wall imaging systems by law enforcement, emergency rescue and firefighter personnel in emergency situations. The Commission also proposed additional new rules to address issues raised regarding the operation of low pulse repetition frequency (PRF) UWB systems, including vehicular radars, in the 3.1-10.6 GHz band; the operation of frequency hopping vehicular radars in the 22-29 GHz band as UWB devices; the establishment of new peak power limits for wideband Part 15 devices that do not operate as UWB devices; and the definition of a UWB device.

FCC Chairman Michael K. Powell has announced that the Commission will launch an Enhanced 911 (E911) Coordination Initiative, bringing together relevant stakeholders to share experiences and devise strategies for expediting E911 deployment. The Initiative will officially commence with a meeting held at the Commission on April 29, 2003. The meeting will address ongoing implementation issues such as Public Safety Answering Point (PSAP) funding, wireless carrier implementation and prioritization, issues relating to Local Exchange Carriers (LECs), and challenges faced by rural carriers.

The United States Supreme Court has upheld a decision voiding the decision by the FCC to cancel the licenses awarded to the bankrupt NextWave Communications. NextWave originally bid \$4.7 billion in 1996 for the wireless licenses but filed for bankruptcy in 1998 after only making an initial down payment of \$500 million. The FCC resold later the licenses but after accepting that they would probably be handed back to NextWave it refunded the deposits paid by the secondary winners.

AT&T Wireless and US Cellular Corporation have signed an agreement to swap wireless licenses and properties covering 15 states and more than 18 million people. AT&T Wireless will get US Cellular licenses covering 10 markets in Florida and Georgia. US Cellular will get wireless licenses in 13 states including Indianapolis, Oklahoma City, St. Louis, Springfield, Burlington and Portland.

AT&T Wireless has announced it will test market a walkie-talkie-like cell phone feature in Seattle during the fourth quarter. Verizon Wireless, ALLTEL and Sprint PCS are also developing push-to-talk services that would compete with Nextel's Direct Connect Service.

According to the latest figures from EMC, the US wireless market had grown to 141.4 million subscribers by the end of 2002, which means it has passed the 50% penetration rate. The figures also showed that growth slowed in 2002 to 12 million net additions compared to 17 million in 2001. CDMA continues to be the leading technology in the US market as it accounts for 43% of all users. Although, EMC expects CDMA to still be the dominant technology in the US in 2007 with a 44% market share, it also forecasts that GSM, which

currently accounts for 11% of the market (up from 6% in 1999), will account for 33% of all users in 2007.

Strategy Analytics has published a new report, "US Cellular Market Outlook 2003-2008: Verizon & T-Mobile Shine as Cingular Plays Catch Up", regarding the US cellular subscriber market. The study concludes that the US market will grow at a compound annual rate of 6% over the next five years resulting in penetration approaching 70%. The study also expects that wireless minutes sold will double to 1.6 trillion while operator service revenues will approach \$133 billion.

In another report on the US mobile market, Upoc has found that although American's use of wireless text messaging has jumped by more than 50% in the past year, only half of wireless customers even are aware that their phones can send and receive text messages. Market research firm Telephia has also conducted a study on the US mobile market and has concluded that one in four non-subscribers expects to sign up for mobile service in 2003, with the young adult and Hispanic populations likely to emerge as high-growth market segments.

According to the 2003 Telecommunications Market Review and Forecast, produced by the TIA, after two years of relatively flat growth in the data communications and internetworking equipment market in 2001 and 2002, enterprise spending in this area will jump 5.3% to \$72.5 billion in 2003. The study expects wireless communications spending to increase from \$123.4 billion to \$164.5 billion during 2003-2006, at a 9.6% compound annual rate.

3G News

LG Electronics has introduced the world's first Dual Band Dual Mode (DBDM) phone for both CDMA and WCDMA modes. The phone, LG-K8100, comes with a TFT-LCD screen and an embedded camera. The manufacturer has already provided the phone to KTICOM for a test run. LG Electronics also plans to develop a "one chip solution" phone that needs only one chip for DBDM function.

Sony Ericsson has launched its GC82 EDGE PC Card for Dual Band 850/1900 MHz GSM networks in North America. The company has also announced a strategic alliance with AT&T Wireless to support the carrier's roll-out of EDGE services in the US. Ericsson Mobile Platforms has announced it can now offer solutions for personal video telephony working end-to-end on a fully integrated dual-mode WCDMA/GSM platform. The Swedish manufacturer demonstrated standard compliant video telephony on the 64kb/s circuit switch bearer using state-of-the-art 15 video frames per second working end-to-end between two test phones as well as video streaming on the 384kb/s packet data bearer.

Alcatel and DoCoMo Engineering, a 100% subsidiary of NTT DoCoMo, have signed a Frame Agreement on consulting services and cooperation for network design, operations and enhancement of 3G/UMTS indoor coverage. To provide this service, DoCoMo Engineering, thanks to its IMCS (In-building Mobile Communication System) service expertise, will collaborate with Alcatel, supporting system development such as network design and planning, network enhancement including QoS assessment, radio optimization, or new radio features introduction. IMCS is a system which has been developed by NTT DoCoMo for providing telecommunication services in the closed area. The service is made available by connecting radio base station located in underground or inside building with NTT DoCoMo's mobile and PHS network through leased circuit. Then the radio base station is linked to antenna located in several locations in closed area via coaxial cable, optical fiber etc.

Lucent Technologies has introduced Bell Labs-developed business-modeling tools that help enterprises quantify and characterize the benefits of secure, 3G data services for their businesses. Using the analysis programs, mobile operators can show enterprise decision-makers the economic benefits and process efficiencies that may be gained from equipping their field sales and service teams with wireless high-speed data access to corporate applications. The tools are part of Lucent's "Customer's Customer" program.

China's Datang Mobile, Philips Electronics and Samsung Electronics have announced the formation of a joint venture company, named T3G. The new company will design and license core TD-SCDMA chipsets and reference designs for mobile terminals and end-user equipment. T3G plans to produce core chipsets and reference designs for TD-SCDMA/GSM (GPRS) dual-mode mobile handsets that will be brought to market by Samsung and other handset manufacturers. However, Datang Mobile has said TD-SCDMA will not be available until 2004. Meanwhile, the Chinese government has said it plans to spend \$84.6 billion over the next five years to further new technologies being developed by companies in the country, with the leading technology being TD-SCDMA.

Hutchison has launched its 3G service, called 3, in the UK. The carrier officially opened its network for business with a live video phone call between the UK Trade and Industry Secretary and e-Commerce Minister. Consumers have been able to pre-order 3 service packages through the carrier's partner since February. Hutchison 3G's Italian affiliate is expected to launch its 3G network for full commercial services soon.

NTT DoCoMo has announced that the company will expand its FOMA 3G mobile phone service in the Kanto Koshinetsu region. As a result, FOMA service will cover approximately 97% of the region's populated areas, making nationwide coverage available to some 89% of the population. Plans call for FOMA service to cover approximately 91% of Japan's population by the end of March 2003 and some 97% by the end of March 2004. DoCoMo will also concentrate on boosting 3G access in buildings. DoCoMo is also increasing the number of FOMA base stations and it aims to have, by the end of March 2004, the same number of 3G base stations as PDC (800MHz) base stations, which currently stands at 2600.

Lucent Technologies and T-Mobile have launched a joint pilot project to evaluate secure high-speed data services using UMTS technology. The pilot, which will involve enterprises in the Nuremberg region, will demonstrate how business customers can benefit from secure, high-speed data mobile services and integrated end-to-end enterprise applications. Included in the pilot network is Lucent's UTRAN-comprised of the Flexent OneBTS base station and Flexent Radio Network Controller- as well as Lucent's core packet switching network offer, including the Super Distributed Home Location Register, a Bell Labs Research innovation that manages customer information for both voice and 3G data services. Meanwhile, T-Mobile Austria has said that the commercial launch of its UMTS offer will be in the third quarter of 2003.

Eurotel Praha has built an UMTS trial network in the center of Prague. The network is already being used for video calls, multiplayer multimedia games and Internet access with speeds of up to 360 kb/s. Eurotel's license for 3G services commits the carrier to begin coverage in Prague by January 2005.

América Móvil has chosen Nokia as the main infrastructure supplier for its new EDGE networks in Colombia and

Ecuador. The deployment of the two nationwide networks will start immediately. The deal will allow América Móvil to introduce GSM voice and GPRS/EDGE 3G data services to Colombia and Ecuador. The network will be EDGE capable from day one. Under the terms of the contract, Nokia will supply its high-capacity, end-to-end GSM/GPRS/EDGE solution for 800 MHz mobile service, including both core network, radio access and related services.

Grupo Iusacell, a wireless telecommunications operator in Mexico, has announced the commercial launch of the country's first CDMA2000 1X voice and high-speed data network. Iusacell subscribers in Mexico will be able to access the high-speed network with CDMA2000 1X-enabled devices or PDAs and laptop PCs equipped with CDMA2000 1X PC cards.

The CDMA Development Group has reported that the CDMA2000 subscriber base surpassed 30 million in January 2003. According to the organisation, 27 operators launched CDMA2000 networks in 2002, increasing the number of commercial systems to 37 on five continents. Three operators introduced CDMA2000 1xEV-DO. In 2003, 22 additional CDMA2000 networks are scheduled to be deployed. The market of CDMA2000 subscribers now accounts for more than 20% of total CDMA users. KDDI, the Japanese wireless operator, has announced that its 3G CDMA2000 1X network has surpassed five million subscribers. Services are accessible to 90% of the country's population.

The UMTS Forum has issued a new report, 'Strategic Considerations for IMS - the 3G Evolution', that addresses the technical and service issues facing mobile operators as they consider the business implications of upgrading their 3G networks to support IMS: the 'IP Multimedia Subsystem' that promises the integration of real-time and non-real-time IP-based multimedia communications. The UMTS Forum has also released a report that includes a market survey covering industry activities and views on TDD, provides a high level overview of UMTS TDD technology, including traffic capacity, and provides a comparison of UMTS TDD and WLAN technology from a deployment scenario perspective and a comparison of the overall system capabilities of the two technologies. The reports can be downloaded from www.umts-forum.org

UMTS to Mobilize the Data World, a report on the progress of UMTS has been published by 3G Americas. The report summarizes the steps in the evolution of UMTS (WCDMA), providing documentation of the milestones achieved and the expectations for 2003. The full report is available for free download at the 3G Americas website: www.3gamericas.org

InterDigital Communications has published the results of a 3G wireless economic and performance study. The study, conducted with Arthur D. Little, found significant capital, operating and total cost of ownership savings for operators that deploy Wideband TDD as part of a complete WCDMA wireless solution. The study also determined that WTDD deployed in a single 5MHz unpaired band provided higher capacity for data-intensive applications like video, internet access or multimedia messaging than FDD similarly deployed in two 5MHz paired bands of wireless spectrum. The study concluded that WTDD deployed for capacity enhancements can provide approximately 50% savings for operators in projected network capital and operating costs over a ten year period, and 25 to 35% savings in wide-area broadband data deployment scenarios.

Northstream has released a report providing an independent view on the choice between WCDMA and CDMA2000. According to the company, WCDMA will be the dominant 3G technology in the long term mainly because of the fact that

operators in the dominating GSM-network already have or will opt for WCDMA. GSM operators who face difficulties to find spectrum for a WCDMA deployment should rather use EDGE until spectrum for WCDMA becomes available. For TDMA operators, the company views both WCDMA and CDMA evolution paths as feasible. The full report can be downloaded from <http://www.northstream.se/download/wcdma-cdma2000.pdf>

Spectrum Licenses

The Chinese Government is expected to award 3G licenses for three different standards later this year. According to reports in the press, Chinese authorities will issue four 3G licenses covering spectrum for networks using WCDMA, cdma2000 and TD-SCDMA, with, in most cases, the license winners being free to choose the network standard for their licensed spectrum.

Portugal has cancelled the 3G license originally awarded to the Oniway 3G venture. The Portuguese Economy Ministry has said that the spectrum was to be split up and allocated to the three remaining 3G license holders, Portugal Telecom TMN, Vodafone Telcel and Optimus. Moldova has awarded a GSM license to the national landline operator Moldtelecom. The license is for 15 years and has a fee of \$1 million. The Moldovan government has announced plans to sell its majority in Moldtelecom later this year. The country has currently two GSM networks and a CDMA network. Belarus's GSM network Velcom has been granted capacity in the GSM1800 band. The UK's Radiocommunications Agency has scheduled the auction of 3.4GHz licenses in 15 regions for May. The licenses, one per region, would allow companies to offer fixed wireless broadband services to businesses and consumers.

Kenya is to offer a third GSM license to enhance competition with the incumbent operators Safaricom Kenya and KenCell Communications. The country has invited operators for a prequalification process. The final decision on the award of the nation-wide GSM900/1800 license is expected in July. Tritel, a joint-venture company of Malaysia's Celcom, has lost its GSM license in Tanzania after not paying the regulatory fees and not being able to meet its network expansion requirements. The company, which obtained the license in 1995, has been in operation since 1996.

Industry Forecasts and Surveys

According to Dataquest, worldwide mobile phone unit sales totaled 423.4 million units in 2002, a 6% increase from 2001. Samsung led all vendors with a 47.6% increase in sales to end-users. On the other hand and according to research from Dell'Oro Group, in 2002 mobility infrastructure revenues declined 16% to \$28.8 billion compared to 2001. This figure included GSM/GPRS/EDGE, TDMA, CDMA (all variants) and WCDMA. WCDMA, which more than doubled compared to 2001, comprised 6% of total mobility infrastructure revenue.

In-Stat/MDR expects that final 2002 Bluetooth chipset shipment figures will surpass 35 million, for a growth rate of about 250%. The company also expects Bluetooth chipsets to surge from 10.4 million to 510 million units from 2001 to 2006.

A report from Strategy Analytics has concluded that 18 million embedded-camera phones were sold worldwide in 2002, of which 13 million were sold in Japan. 36% of camera phone sales were through a Vodafone carrier in 2002. The firm expects that 37 million camera phones will be sold worldwide this year.

According to the findings of new research from the Learning and Skills Development Agency, almost half of the young adults surveyed expressed an interest in using a learning game on their mobile to improve their reading, spelling or maths. The greatest interest was expressed by girls aged 16 to 19 years old. A few also expressed an interest in using mobile phones for learning a foreign language. The research is part of a 3-year pan European project called m-learning to investigate the potential for mobile technologies as part of teaching and learning processes.

A survey conducted by Intuwave has found that the majority of UK corporate telecommunications managers are intent on delaying deployment of mobile data applications until 3G networks are fully established. Another study from TNS, carried out in 10 countries, has found that 42% of European mobile phone users are interested in 3G services. The majority of those users were also prepared to pay extra for 3G handsets and services.

Mobile Satellite Communications

The FCC has issued a Public Notice announcing that the auction of licenses to use the Direct Broadcast Satellite ("DBS") service allocation have been scheduled to commence on August 6, 2003 (Auction No. 52). This auction will include 4 licenses for unassigned channels at orbital locations of 175° W.L., 166° W.L., 157° W.L., and 61.5° W.L. These licenses would be subject to the Commission's DBS service rules. Specifically, DBS licensees must provide DBS service to Alaska and Hawaii where such service is technically feasible from the authorized location. The Commission has also decided to permit certain mobile satellite services (MSS) providers in three frequency bands to provide an ancillary terrestrial component (ATC) to their satellite systems. This new approach permits MSS licensees to integrate ancillary terrestrial components into their MSS networks. Specifically, it allows MSS operators to seek authority to integrate ATC into their networks for the purpose of enhancing their ability to offer high-quality, affordable mobile services on land, in the air and over oceans without using any additional spectrum resources beyond spectrum already allocated and authorized by the Commission for MSS in these bands. The decision covers three spectrum bands: 2GHz, Big LEO and L-band. The Commission also has adopted technical rules to mitigate the possibility of interference. In the 2 GHz band, the Commission adopted stringent out of band emissions limitations to protect against the possibility of interference to adjacent services including PCS. In the L-band, the Commission limited the number of base stations that could be deployed and a phase-in period of 18 months before the maximum number of stations could be deployed to protect against the possibility of interference to Inmarsat. In the Big LEO band, the Commission adopted a Notice of Proposed Rulemaking seeking comment on redistributing spectrum in the Big LEO band between two Big LEO licensees, Iridium and Globalstar.

Qualcomm has announced a technology breakthrough with the successful testing of high data rate technology over its satellite network, which will enable a peak data transmission rate at up to 200 times the existing rate that Qualcomm customers enjoy today. Qualcomm's OmniTRACS system is a satellite-based mobile communications and tracking system that provides real-time messaging and position reporting between fleets and their operations centers. Messages are sent via satellite through Qualcomm's Network Management Center (NMC) to dispatch centers throughout the United States.

ITU is partnering with Inmarsat Limited to help promote rural telecommunication and support emergency communications in least developed countries. Inmarsat, the London-based satellite consortium, will make a financial contribution towards the purchase of 15 Global Area Network (GAN) satellite terminals in beneficiary countries. ITU will select the beneficiary countries and will contribute an amount not less than the value of the donated Inmarsat GAN terminals. The project will assist least developed countries in stimulating development of their telecommunication infrastructures in order to enjoy the benefits of participation in the global information society.

Wireless LAN

Motorola, Avaya and Proxim have announced plans to add voice to enterprise Wi-Fi networks so that corporate employees could use one phone for voice calls on the WLAN as well as a cellular wide-area network. The three companies hope to begin customer trials of a dual-mode IP phone by year-end. The main challenges faced are: QoS with VoIP, battery life, security and interference.

Intel has announced a partnership with Singapore's Infocomm Development Authority to work on seamless Wi-Fi roaming throughout Asia. The two organisations will start work on April and hope to draw in several Asian operators. Some of the goals are uniform billing, account authentication and security.

Ericsson has signed a contract with IBN to deploy 5000 public Wi-Fi hot spots, which is considered to be Europe's largest public Wi-Fi network. Ericsson will equip the coin operated entertainment terminals from IBN with public Wi-Fi hot spot capabilities using DSL for backhaul of traffic, which enables rapid massive coverage with only minor infrastructure investments.

A report published by Analysys anticipates that revenue from public WLAN in US and Western Europe will grow from \$33.4 million in 2002 to \$5.5 billion by 2007. Hot spots are estimated to grow from 4800 in 2002 to 57000 by 2007. A study from IDC said that the European hot spot market has increased by 327% over the last year from 269 locations at the end of 2001 to around 1150 locations at the end of 2002. Dell'Oro Group has announced that the Wi-Fi market grew 3% last year, posting revenues of \$419 million in Q4 2002. The SOHO market continued to dominate most WLAN growth last year. According to Infonetics Research, worldwide WLAN hardware revenue totaled \$1.68 billion in 2002, hitting \$455.4 million in the fourth quarter. The company expects revenue to reach \$2.72 billion in 2006.

The UMTS Forum has released a report to provide some factual information relating to the current availability of frequency bands for the implementation of WLANs, including the license-exemption status and technical conditions applicable to WLAN devices. The report can be downloaded from www.umts-forum.org

Wireless Data

KDDI, Japan's second largest wireless operator, has announced the commercial launch of the operator's wireless applications service based on Qualcomm's Binary Runtime Environment for Wireless (BREW) platform. KDDI's BREW-enabled applications service now gives subscribers the ability to personalize their handsets over the air with a wide variety of services, ranging from game and entertainment applications to business, productivity and location based applications. KDDI has also launched its BREW download service. Applications will be offered on a subscription ba-

sis as well as per download for a fee. There will be a variety of price points and some applications will be offered free of charge. Qualcomm has also announced, together with Sony Music Entertainment (SME), that the two companies have successfully delivered SME music video content to CDMA2000 1xEV-DO trial users with BREW-enabled handsets. On the other hand, mmO2 is set to trial what it claims is the world's first 'music over mobile' service using GPRS networks. The company's service will allow customers to select, retrieve and store the latest chart hits via their GPRS-enabled phone onto a specially designed "digital music player" and start listening in around 12 seconds. The trials, starting in May in the UK and Germany, are expected to lead to the launch of a commercial service later this year. The download of a track can take around 90 seconds for a full track.

BellSouth has announced it is testing Navini Networks technology in Daytona using the 2.3GHz wireless communications services band. According to the operator, the trial includes multiple base stations, covers approximately 150 square miles and includes about 100 participants. The operator is testing the technology to determine whether it can be used to extend the company's DSL footprint in its nine-state coverage area.

NTT DoCoMo has announced it plans to unveil an always-on internet access service, dubbed "@FreeD", for use with compatible PHS terminals from April. The new service, which offers subscribers unlimited internet usage, will be available in two packages. The Japanese operator has also announced that it will expand its M-Stage Visual Net service to include PHS and landline phones that have teleconferencing capabilities. M-Stage Visual Net provides a communications platform that enables numerous people to participate simultaneously in mobile videoconferencing. This service was previously available only to FOMA users. Moreover, DoCoMo has said that sales of its i-shot handsets have topped the five million mark, less than one month after reaching the four million sales level. DoCoMo's i-shot service allows subscribers to transmit still images to virtually any device capable of receiving email.

The third in the series of 'm-Commerce Discovery Events', organized by ETSI to help companies apply mobile technology to their businesses, will be held at ETSI headquarters in Sophia Antipolis on 9 and 10 April as a joint event with The UMTS Forum. This event, that will bring together the telecommunications and banking communities, will examine the role of collaboration in enabling mobile commerce, concentrating particularly on the importance of trusted relationships in e-Transactions.

Forums and Industry Alliances

Orange, Telefonica Moviles, T-Mobile and Vodafone have announced that they have signed an agreement to form a new Mobile Payment Services Association aimed at delivering an open, commonly branded solution for payments via mobile phones, designed to work across all operator networks. The solution will work across country boundaries and will seek to complement existing industry solutions. The solution aims to become the industry standard for m-commerce payments. In addition to the four founding members, 3, debitel, KPN Mobile group, O2 and TMN have expressed interest in joining the Mobile Payment Services Association.

Ericsson has announced the creation of an interoperability test program for Instant Messaging and Presence Services (IMPS) solutions. IMPS extend traditional messaging and voice services by allowing users to view the availability of others before communicating. Sev-

eral key partners, including Ecrio, magic4, MessageVine, Motorola, Ruskun Software Technologies and Sony Ericsson have agreed to join the program. The testing and verification program includes interoperability development testing, network performance testing and verification of test suites. A multi-network test environment, including GSM, GPRS, CDMA2000 and UMTS/WCDMA will be available to testing partners.

Qualcomm and China Unicom have announced that they have established a joint venture - Unicom-BREW Wireless Technologies Ltd. - to foster the development of BREW-based CDMA wireless data applications and allow China's CDMA subscribers to experience outstanding leading-edge data services enabled by the BREW platform. Unicom-BREW's ownership is evenly split between the two companies. Unicom-BREW Wireless Technologies Ltd. will offer BREW training and technical support. The new company will also train local developers, establish a BREW developer lab, create a phone support center for developers, provide testing services for applications, as well as promote the BREW solution and conduct university outreach programs.

The SIMalliance has formed a new workgroup to support interoperability and standards enforcement between handset and SIM. The SIM Handset Interoperability Group will provide a vital point of contact between card manufacturers and mobile network operators and aims to improve SIM/handset communication to anticipate technology evolutions from both sides.

Samsung Electronics and Cambridge Positioning Systems (CPS) have announced a joint programme to drive development of E-OTD location technology for the 2G and 3G markets. Under the MoU, the two companies will work together on technology innovation for future integration into a range of Samsung products. The programme will provide Samsung access to the latest technology developments for GSM, including 50-metre accuracy for North America and other markets.

Wireless, PMR and Public Safety

The ITU hold a workshop, in February, on Telecommunications for Disaster Relief. The aim of the workshop was to identify telecommunications capabilities that will allow efficient support of disaster relief operations. The workshop included presentations from projects such as MESA, WIDER (WLAN in Disaster and Emergency Response) and TIPHON. It also included presentations from organisations such as Nato, ITU and Red Cross. All presentations are available from: www.itu.int/ITU-T/worksem/ets/program.html

The FCC's Office of Engineering and Technology (OET) sponsored several technology demonstrations of Ultra-wideband devices on February with applications for public safety, businesses and consumers. The event included demonstrations from XtremeSpectrum, Time Domain Corporation, Mala GeoScience, Geophysical Survey Systems, Sensors and Software and Multispectral Solutions. Multispectral Solutions's demos included a radar system, originally developed as a collision avoidance sensor for DARPA's Micro Air Vehicle program, that targets markets such as Homeland Defense, law enforcement, fire and emergency rescue and manufacturers' licensee applications. Time Domain demonstrated the capabilities of RadarVision, its ultra wideband radar device that enables users to detect the movement of people behind walls. This hand-held unit, which incorporates Time Domain's PulsON chipset technology, is lightweight and easy to operate, and provides a new

level of situational intelligence and awareness for law enforcement and public safety personnel.

Nokia is delivering a complete 800MHz TETRA network using IP technology to Tianjin Public Security. The network is the first of its kind in China and is expected to be operational during second half of 2003. This new TETRA network will cover the urban area in Tianjin providing advanced applications such as IP packet data for the related authorities in order to further enhance security communications. It will be interconnected to another TETRA network, which was provided by Nokia to Tianjin Water Conservancy Bureau. Nokia will deliver TETRA switching equipment, a number of base stations, dispatcher stations, and Nokia TETRA handsets. In addition to network equipment, Nokia will provide its Network Deployment Package, which covers implementation, commissioning and project management. The Finnish manufacturer also participated in the first ever in Bulgaria connection using a TETRA network. The TETRA system developed and implemented by Nokia for the Border Police National Service of Bulgaria is the first TETRA network on the Balkans. Nokia has also introduced a new solution for ultimate security in public safety communications – the Nokia DWSx Dispatcher Workstation. Nokia DWSx allows the use of end-to-end encrypted (e2ee) radio terminals in the full extent of the Nokia TETRA System. Using the air interface encryption (AIE) provides high level security against external threats. In addition to AIE some user groups may require ultimate secrecy provided by end-to-end encryption. It offers protection also against internal threats within the network at base station sites, transmission lines, and switching sites. Nokia DWSx can be delivered with a TETRA MoU recommended IDEA based encryption algorithm or, if necessary, adapted into a national encryption scheme. High-level security can be built by using generally known algorithms such as IDEA quickly and cost effectively. Using a secret national encryption algorithm may provide even higher security.

Motorola has been awarded a \$7.5 million contract to supply a TETRA digital radio network, TETRA handsets and Mobile Data Terminals for use by the Isle of Man Government. The system will be in place and working by December 2003 and the Government expects to have up to 16 different user groups on the system, including all the Emergency Services and other key Government users such as transport, forestry and utilities. In order to give the level of coverage required by the Emergency Services a total of 21 base station sites will be used. Motorola, together with the States of Jersey, has also announced that the world's first live TETRA system has now also become one of the first TETRA networks to be used operationally as a common communications system for five of its public safety agencies. Although the digital communications network has been used for inter-service exercises for some time, the Police, Fire, Ambulance, Honorary Police and Custom and Excise services have now all gone live on the network – meaning the five public safety agencies are now able to intercommunicate on a day to day basis. The Government of Québec has signed a \$35 million contract with Motorola for a new, state-of-the-art VHF ASTRO@25 Multicast communications system. The first of its kind in Canada, the system is part of Motorola's portfolio of integrated communications and information solutions to address mission-critical public safety and security requirements worldwide. The area-wide system is slated for installation at the end of 2003, with final system acceptance projected for year-end 2005. It will provide services to an estimated 10,000 mobile and portable two-way radios and will provide cover-

age over 125,000 square miles and serve a population of more than seven million people. All Québec government departments and public safety agencies, including Sûreté du Québec (Provincial Police), will have access to the system. Motorola also announced today it has been awarded a contract by Westmoreland County in Pennsylvania for a new, \$12.46 million ASTRO® 25 trunked communications system that will enable public-safety agencies countywide for the first time to communicate with each other over a shared communications system. Motorola will also provide Chesterfield County, Va., with an integrated public safety system that will enable the County's police, fire, and EMS agencies to share information and communicate more effectively.

3GSM World Congress

The 2003 3GSM World Congress took place in Cannes (France). Overall attendance reached a record 26000 from 154 countries (up from 24000 in 2002, from 140 countries), 576 vendors from 35 countries participated on the exhibition and over 86 new products were launched during the event.

During the event, Sun Microsystems and Nokia announced they have signed an agreement on digital content delivery for wireless applications and services. Sun Services will resell the Nokia Delivery Server as part of Sun's new Data Service Delivery Framework (DSDF) to service providers and operators. The collaboration between the two companies will offer service providers a viable end-to-end delivery mechanism for a wide variety of downloadable and browsing content, on a single platform. Nokia and IBM also announced that they intend to develop and implement joint solutions across a range of Nokia business terminals as well as Symbian-based devices. IBM also announced that it intends to develop and deploy its WebSphere Everyplace Access client for the Symbian operating system, which is becoming an increasingly significant enterprise class platform. Nokia also launched its IP Multimedia Core and Intelligent Content Delivery solutions as part of the Intelligent Edge, a new "service aware" capability to enhance existing packet core networks. Nokia Intelligent Edge also drives the introduction of new applications. IP multimedia service specified by 3GPP/3GPP2 enables direct IP connections between terminals.

Leading players from mobile industry, representing MMS handset, client and server manufacturers globally, performed live demonstrations of the interoperability of multimedia messaging solutions. The participating companies (Alcatel, Comverse, Ericsson, Logica CMG, Magic4, Matsushita (Panasonic), Microsoft, Mitsubishi, Motorola, Nokia, Openwave Systems Inc, Samsung, Sony Ericsson, Tecom and Telenity) performed a live demonstration of how multimedia messaging works seamlessly in a multivendor environment. All companies participating in this MMS Interoperability demonstration are members of the Open Mobile Alliance (OMA), and adhere to the open MMS specifications created by OMA, which is designed to be a center for mobile service standardization work.

During the event, Motorola's Global Telecom Solutions Sector (GTSS) announced it successfully completed simultaneous voice and data, or Multi-Radio Access Bearer (RAB) calls on Motorola A830 UMTS handsets during a drive test for a major global operator. Other key UMTS functionalities including soft handover, softer handover and power control were all successfully executed during the customer demonstration. All demonstrations were conducted in a live environment under drive test conditions and 3GPP Standard Release 99 version June 02 compliant. Numerous Adaptive Multi-Rate (AMR) voice calls and data calls at 64Kbps,

128Kps and 384Kps data rates were also completed during the drive tests. Motorola also demonstrated its UTRAN Pooled Resource feature. It allocates trunked capacity to the cell sector where it is most needed enabling the network to adapt to current capacity, coverage and quality demands while minimizing hardware requirements for the operator. In a subscriber "hot spot" scenario this feature can substantially reduce call blocking and help maintain quality of service. Motorola Semiconductor Products Sector also announced the industry's first live over the air call of its fully integrated wireless handset platform, i.300. Motorola's PCS and Siemens ICM have adopted the i.300 platform for its line of 3G mobile handsets. Apart from presenting new GSM and UMTS handsets and a Smartphone integrated hardware and software platform, Motorola introduced Motofolio, a web-based wireless content publishing and sourcing system providing rich content to operators and accompanying services to software developers.

Ericsson showcased WCDMA/UMTS system and terminal interoperability at the 3GSM World Congress by showing 3G voice and video telephony services in an Ericsson WCDMA network together with handsets from many of the leading handset vendors. Sony Ericsson unveiled the Z1010 dual mode UMTS/GSM-GPRS phone. The handset, optimised for video conferencing and video applications, features two inbuilt cameras, two displays and video support.

Qualcomm organised several demonstrations at 3GSM World Congress 2003, including applications based on Qualcomm's BREW client running on a GSM/GPRS handset and on a UMTS device, and Java technology applications running on the BREW client on a UMTS device. According to the manufacturer, these demonstrations validate BREW as an air-interface-independent solution. The first demonstrations, in Europe, of BREW-based applications on a GSM/GPRS handset were conducted using Maxon MX7830, which uses TTPCom's GSM/GPRS protocol stack. Further, Qualcomm opened a BREW Developer Lab in the UK in November 2002 to support the efforts of European application developers as they write applications for the BREW platform.

More information on the event can be found in <http://www.3gsmworldcongress.com/>

CeBIT

The CeBIT 2003 trade show took place in Hannover (Germany) in March. The event is considered as the world's largest IT and telecommunications fair.

During the event, Siemens ICM introduced the S55, the first Siemens mobile phone with i-mode compatible browser. Siemens Medical Solutions also introduced the Pen Tablet PC by Fujitsu Siemens Computers, a mobile electronic patient folder that is part of the SIENET Version 40 integrated radiology suite. The portable PC that weighs just over 3 lbs, is less than an inch thick, and has the size of a piece of paper (8½"), provides the physician with up-to-date patient information at any time, right at the patient's bedside. Using a wireless LAN infrastructure, the user has mobile access across the ward to the server containing the patient folders and all corresponding data and X-ray images. The system enables much more efficient data management and workflow. Siemens ICM also demonstrated wireless modules of different designs. The EU "Healthmate" project, in which Siemens mobile is participating along with international organizations, shows how wireless modules can be used to offer tele-care for people needing medical assistance, such as Alzheimer patients or those suffering from a heart disease.

Wireless modules are also integrated in the ALVA company's Mobile Phone Organizer which makes electronic communication easier for the visually impaired. Siemens engineers also presented a virtual mouse and a completely new type of 3D touchscreen display. Cell phone owners can use the virtual mouse to navigate through the phone's menu with simple hand movements. The touchscreen display also reacts to finger pointing. The virtual mouse has been installed in a cell phone with a camera in its back. This camera sends the images it records directly to the phone's large-format color display. When the user holds a normal pen about 30 centimeters in front of the camera, the system registers the tip of the pen as a mouse pointer. A red point then appears at the tip on the display. The 3D touchscreen display can make the keyboard on a cell phone superfluous. The display shows the image of a keyboard. When the user holds their finger over a point on the screen, the area beneath becomes bigger.

Samsung unveiled its latest advanced in-built camera phones, including the model SGH-P400 that includes a rotating screen that pivots 1800 degrees. Samsung also presented a GPRS wristwatch phone during the event. The phone includes Bluetooth and Speakerphone technologies.

Motorola announced the launch of c18, an innovative new CDMA 1X embedded data module. The new module is similar to a condensed cellular phone core, and can be integrated in any system or product that needs to transfer voice or data information. The c18 module delivers high-speed wireless data and voice communication in the CDMA 800/1900MHz and AMPS 800MHz range. It includes aGPS/AFLT capabilities and complies with the FCC E911 Phase II mandate. Motorola also announced the launch of g20, an innovative GSM/GPRS embedded module.

Alcatel and TNO Telecom announced they have launched a technical project with RTL Television for the development of innovative new 3G/UMTS mobile applications and services. At CeBIT, Alcatel and TNO Telecom showed live television broadcasting from RTL on mobile handsets, using Alcatel's 3G/UMTS technology and TNO's 3G Internet Video Gateway.

Lucent and T-Mobile demonstrated high-speed, secure data services for business customers. In a live presentation, the companies demonstrated how a business customer, using a laptop computer equipped with a 3GlobeTrotter UMTS wireless PC modem card — jointly developed by Lucent and Option — can access T-Mobile's mobile portals.

More information on the event can be found in <http://www.cebit.de>

Other News

Motorola has commemorated the 20-year anniversary of the world's first commercial portable cellular phone, unveiled by the company in 1983, with the MOBILE Exhibition, a visual history of the mobile phone. In 1983, the Motorola DynaTAC 8000X phone was the first portable cellular phone to receive FCC type acceptance. Additional information on the MOBILE Exhibit can be found at www.motorola.com/MotoInfo

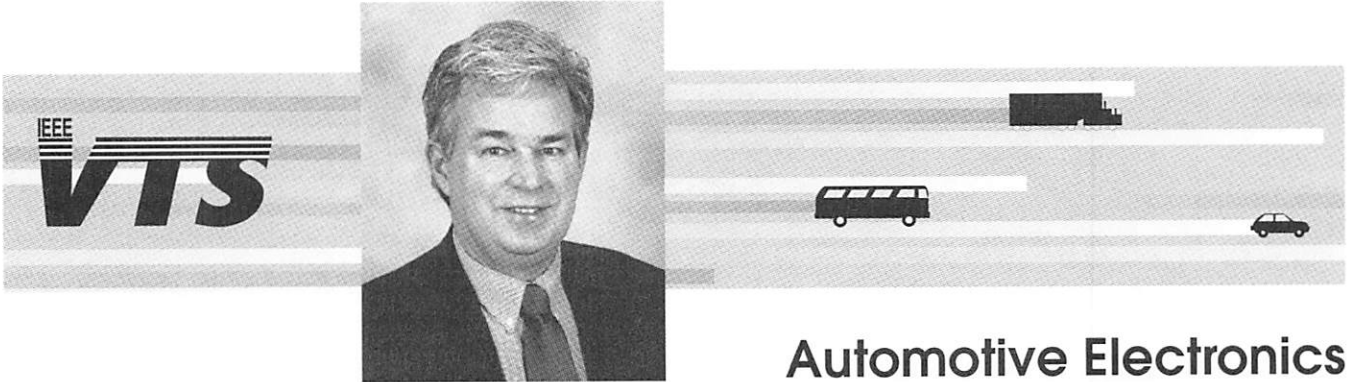
The second meeting of the preparatory committee for the World Summit on the Information Society concluded with two working documents for a draft declaration and action plan. The documents focus on ways to bridge the digital divide between developed and developing nations. One suggested benchmark is that 90% of the world's population is within wireless coverage by 2010 and 100% by 2015. More information can be found at <http://www.itu.int>

According to figures released by the GSM Association, it is estimated that at the end of 2002, there were 787 million

GSM subscribers across 190 countries. Since 1997, the number of GSM subscribers has increased by a 10 fold. During late 2003 or early 2004, it is predicted that global GSM subscribers will pass the 1 billion mark. According to the EMC World Cellular Database, GSM has become the fastest growing wireless technology in the Americas, registering a 37% year-over-year growth through September 2002. According to EMC, as of September 2002, there were 100.7 mil-

lion TDMA subscribers in the Americas, 83.7 million CDMA subscribers and 21 million GSM subscribers.

According to the Global Mobile Subscriber Database, the Asia-Pacific region added almost 104 million mobile subscribers in the 12 months to December, representing a 31.5% growth in subscribers year-on-year. China had the highest number of new subscriptions followed by Indonesia, India, Thailand and Japan.



Automotive Electronics

Bill Fleming, Senior Editor

Steerable Headlights

Steerable (or adaptive) headlights swivel with a vehicle's steering wheel and point in the direction the vehicle is turning so drivers literally can see around curves in the dark [1,2]. Some of us remember Tucker Motor's cars that included this feature 50 years ago (and a Citroen model that also had this feature 30 years ago). The headlights swivel (turn) as much as 90 degrees for sharp turns at intersections and tight corners. At low speeds, the steerable headlight side-directed beam pattern is limited to 30 m illumination. Beam patterns of steerable headlights adapt to vehicle speed. At moderately higher speeds, up to 50 km/h, the front headlights only swivel up to ± 15 degrees, depending on steering angle and vehicle speed. At speeds faster than 50 km/h, headlight beams remain fixed so as not to actuate during highway lane changes.

Three companies — Valeo, Hella, and Visteon — are currently supplying steerable headlight systems. Several vehicles (Porsche Cayenne, Mercedes E-Class, Lexus RX 330, Audi A8, Opel Vectra, and Opel Signum) now have, or soon (within the next model year) will introduce, steerable headlights [1,2]. There are two different steerable headlight designs: (a) mechanically swiveling designs, and (b) fixed bulb designs. In Europe, safety regulations already specifically authorize adaptive automobile lighting; whereas in the U.S., no NHTSA regulation yet exists regarding adaptive lighting. So now, in addition to the headlight glare issue (*previously reported in this column in the November 2002 issue*), NHTSA is soliciting public comments on adaptive headlights [1].

Backup, Parking Assist, Sensor Fusion

To assist motorists backing up their vehicle (a feature that is especially useful for hard-to-see-behind SUVs and minivans), Valeo has combined a rear-mounted camera along with four ultrasonic distance sensors. Valeo states that [3], "the video image itself is usually not enough to make a judgment about how far something is from the rear of a vehicle. The fusion of vision, plus ultrasonic distance measurements, provides the driver with much more accurate information on what's actually behind the vehicle."

Heated Washer Fluid — the Valeo OPTI-Wash System

A small quantity (60 ml) of washer fluid is kept heated to 65° C because "heated washer fluid more effectively helps wipers remove ice in the winter; and oil, wax, tar, and bugs in warmer seasons, from the windshield [3,4]." Since only a small amount of fluid is heated, the fluid is fully heated within 60 seconds of engine ignition. Although the heater at startup draws as much as 50 A, the heaters are turned off as soon as operating temperature is achieved. Valeo's OPTI-Wash System is expected to reach production in some MY 2005 vehicles.

BMW's R&D Programs

BMW's FIZ Center in Munich reviewed the following R&D programs currently under investigation at the automaker [5]:

- ◆ **Parking Assistant** uses side-looking radar sensors that scan the length of a parking space as the vehicle is driven by. If large enough, the driver is informed, the driver puts the car in reverse, and then activates the Parking Assistant. Next, after the driver touches the throttle, the system automatically steers the reversing vehicle into the parking space.
- ◆ **Alertness Assistant** uses an infrared camera to monitor the driver's eyelid movement. If eyelid movement becomes excessively frequent, drowsiness and/or sudden sleep are detected. (This system was motivated by research which showed that 24% of all fatal German autobahnen crashes were due to sudden sleep).
- ◆ **Active Accelerator Pedal** reacts to where the car is on the road. Using onboard vehicle navigation, the system knows the roadway characteristics (locations of traffic lights, speed limits, tight road bends, etc.). The system also reacts to inputs from radar to detect obstacles and slower-moving vehicles. As the vehicle enters a lower speed limit area, or begins to overtake a slower-moving car, an actuator in the accelerator pedal exerts a gentle counter-pressure warning signal.
- ◆ **Live Parking Information** is provided in densely populated cities like Cologne where one in seven cars at

Table 1 IEEE Spectrum's Top-10 Technology Cars

Vehicle	Outstanding Technical Features
<ul style="list-style-type: none"> • Volvo Safety Concept Car (featuring safety and security) 	<ul style="list-style-type: none"> ◆ see-through A-pillars for unobscured vision ◆ driver eye-positioning for best vision using automatic adjustment of seats/pedals/floor positions based on sensor measurements of driver's anthropometry (size) and detected eye position ◆ blind spot obstacle detection ◆ steerable headlights (<i>the lead item in this column</i>)
<ul style="list-style-type: none"> • 2003 Saab 9-3 (featuring telematics and safety) 	<ul style="list-style-type: none"> ◆ first to be equipped with wireless Bluetooth system ◆ includes access to Internet and satellite navigation ◆ rear-impact active head restraints
<ul style="list-style-type: none"> • 2004 Honda Civic GX (featuring powertrain) 	<ul style="list-style-type: none"> ◆ runs off compressed natural gas collected from a home fueling station that operates off of piped-in natural gas (this is the first engine optimized to run solely on natural gas)
<ul style="list-style-type: none"> • 2003 Honda FCX (featuring powertrain) 	<ul style="list-style-type: none"> ◆ first U.S. electric drive car powered solely by fuel cells (it meets zero-emissions standards by exhausting only water vapor) ◆ uses ultracapacitors to provide transient power inputs to electrical components (ultracapacitors offer longer life and faster discharge rates than batteries)
<ul style="list-style-type: none"> • 2003 Cadillac XLR (featuring chassis and body) 	<ul style="list-style-type: none"> ◆ electro-rheological fluid chassis damping (5 times faster than electromechanical dampers and 60% fewer parts) ◆ millimeter-wave radar adaptive cruise control ◆ keyless entry and keyless ignition (using smart card interrogation)
<ul style="list-style-type: none"> • 2003 Audi A8 (featuring telematics powertrain, body, and security) 	<ul style="list-style-type: none"> ◆ Multi-Media Central Control of all vehicle and telematics functions ◆ manual pushbutton operation of the automatic transmission gearbox ◆ fingerprint-sensing entry/security which recognizes the driver, and adjusts vehicle features to preset settings that correspond to the driver's fingerprint
<ul style="list-style-type: none"> • 2003 Mercedes-Benz SL500 (featuring chassis) 	<ul style="list-style-type: none"> ◆ first mass-production car to offer by-wire braking which seamlessly is integrated into its stability control and active suspension control systems
<ul style="list-style-type: none"> • 2003 Fiat Stilo (featuring powertrain) 	<ul style="list-style-type: none"> ◆ common-rail diesel engine features staged-intake-cycle (pre-, main-, and post-) high-pressure fuel injections that provide improved fuel economy, improved responsiveness, reduced noise, and low emissions
<ul style="list-style-type: none"> • 2003 Chevrolet Trailblazer (featuring powertrain) 	<ul style="list-style-type: none"> ◆ displacement-on-demand seamlessly shuts off fuel and exhaust valves for up to half the cylinders, providing a fuel savings of 8-to-25 percent
<ul style="list-style-type: none"> • 2003 Toyota Prius (featuring powertrain) 	<ul style="list-style-type: none"> ◆ hybrid gasoline engine/electric motor powertrain —the electric motor can either drive the car or re-generate electricity from braking — the gasoline engine can either drive the car or drive the motor generator — or both the engine and motor together can drive the car

any one time are said to be looking for a parking space. As part of BMW's ConnectedDrive research program, live parking information allows drivers to book a parking space while the vehicle is on the move. At the same time, information is also provided to the driver about public transport and a comparison of travel times.

IEEE Spectrum's Top-10 Technology Cars

The *IEEE Spectrum* recently selected what they considered to be the 10 most technically sophisticated MY 2003 cars [6]. Table 1 gives Spectrum's choices in the order they were listed.

Variable Translucence Roof

The new \$300,000 MY2003 DaimlerChrysler Maybach 62 features a variable translucence roof, which, under electrical control, can vary from clear outside vision to being nearly opaque by filtering out 76% of the sunlight [7]. A liquid-crystal membrane of conductive polymer plastic is sandwiched between an outer panel of thick safety glass and an inner glass panel. The roof also includes 30 silicon solar cells that generate electricity so the ventilation fan can cool the interior while the car is parked.

California Highway Patrol Motorist Distraction Study

Last year, a six-month study in California was completed by CHP (the California Highway Patrol). The study was fo-

cused on crashes caused by inattention — the following results were reported [8]:

- ◆ **Fatal Crashes:** 6 of 30 inattention fatal crashes (20%) were attributed to cell phone-related factors which were reported to be the most common inattention factor leading to a fatal crash
- ◆ **Injury Crashes:** 264 of 2,394 inattention injury crashes (11%) were attributed to cell phone-related factors (in close second and third places to cell phones were radio/CD factors, and then children)
- ◆ **Property-Damage-Only Crashes:** 341 of 3,253 inattention property-damage-only crashes (10%) were attributed to cell phone-related factors (in close second and third places to cell phones were radio/CD factors, followed by eating)

When all types of crashes were considered (regardless of whether inattention was a factor or not), CHP found that 611 of the 491,083 all-types-of-crashes (1%) were attributable to cell phone-related factors.

Ford F-150 Pickup Truck Powertrain Electronics

For MY2004, the best-selling Ford F-150 pickup truck 5.4-liter V8 engine will incorporate the following new powertrain electronics features [9]:

- ◆ Variable-cam engine valve timing where an electric solenoid, governed by the engine's computer, regulates oil

pressure that in turn rotates a cam, thereby producing the appropriate intake valve and exhaust valve timing.

- ◆ At low engine speeds, electric-motor-actuated motion-control intake runner valves are closed to produce more turbulent air flow for better air-fuel mixing, and at higher speeds the valves are opened up.
- ◆ Electronic-throttle by-wire control replaces the mechanical linkage between accelerator pedal and throttle, respectively, with an accelerator pedal-position sensor and a throttle electric motor actuator. This system has several safety features including redundant sensors, double return springs, redundant microprocessors, and self-diagnostic software — which insure that under any condition, the truck can always operate in its backup “limp mode.”

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Standards

Dennis Bodson, Senior Editor

Broadband Wireless Ad-Hoc Networks and Services

A Broadband Wireless Ad-Hoc Networks and Services Workshop was held in Sophia Antipolis, France on September 12th – 13th 2002. The aim of the workshop is to provide a forum for researchers, industrial partners and regulators to discuss advances in technologies applicable in broadband public safety wireless networks. System issues, networking and modelling aspects will be included in the workshop agenda. The broadband wireless public safety project MESA has a particular interest in this pre-standardization work and will follow the discussion on ad hoc wireless networks, adaptivity and mobility with the aim of including future research results in the global standardization process and thus bringing into life to an innovative future Mobile Broadband System.

Project MESA represents a revolutionary step beyond the scope of the currently available and ongoing cellular telephony evolution. The Project is the response to the growing demand for new a suite of standardized wireless technologies – covering bit rates well beyond 2 Mb/s – within public services such as public safety, law enforcement, emergency and medical services and the Civil Defence segments. Currently applied systems and implementations vary from country to country, within countries and between the various types of public services. Project MESA from the very beginning aims at producing market relevant technical specifications that reach out to a world market for a standardized wireless mobile broadband platform, for all kinds of such services.

This project represents a thrilling research challenge driven by the need to provide very high bit rate data communication and requires secure transmission within mobile wireless networks where fixed infrastructure may not exist or has been destroyed. The main focus of MESA research is to cover the areas of system adaptivity, wireless ad hoc protocols and reconfigurable radio interfaces.

ETSI and the League of Arab States Co-operate to Extend Telecommunications Standardization

The development of telecommunications in Europe and the Arab States has received a boost with the signing of a Memorandum of Understanding (MoU) between the European Telecommunications Standards Institute (ETSI) and the Arab Telecommunications Council of Ministers/League of Arab States (ACTM/LAS). The agreement comes after several months of discussions to establish common ground, and will help ensure co-operation in telecommunications standardization between Europe and the Arab world. For more information, see <http://www.etsi.org/pressroom/Previous/2002/LAS>.

New Version of TETRA General Network Design Approved

A new version of document ETSI EN 300 392-1 V1.2.0 (2002-09) establishes the background of the TETRA general network design for standardization purposes, defining addressing for TETRA supporting Voice plus Data (V+D). It

gives background information on the air interface, the interworking between TETRA systems and to other systems via gateways, the terminal equipment interface on the Mobile Station, the security aspects in TETRA networks, the management services offered to the operator, the performance objectives, and the supplementary services that come in addition to the basic and tele-services used as a basis for TETRA standardization. The document also defines and specifies the TETRA addressing and identities and their organization in groups corresponding to the different functions.

It gives information about:

- ◆ The circuit mode and packet mode reference points for the Mobile Station and switching and management infrastructure;
- ◆ A model of the air interface protocol stack, different functions of layers and sublayers;
- ◆ The functions provided by the circuit mode tele-services used for speech and basic services used for data transfer;
- ◆ The functions related to the management of the users' mobility across networks and inside a network including roaming and migration;
- ◆ The functions related to the transport of short data messages as a service specific to TETRA;
- ◆ the functions related to the support of packet data service in a way specific to TETRA;
- ◆ The supplementary services that mainly extend the capabilities of the circuit mode basic and tele-services;
- ◆ The various possibilities of individual circuit mode call scenarios, providing guidance on priority concepts for packet data and circuit mode services and on the service quality

The main technical changes of this version are that Clause 7.9 on interworking and roaming to other telecommunication networks has been added; the ISSI only (SSI part of the ITSI or GTSI) as the destination address refers to the current registered network of the Mobile Station instead of the home network. The other changes are alignment with the air interface part 2 clarifications and removal of the old packet data services.

Latest TETRA Supplementary Services Standards Published

During the last months a few new standards have been published from TETRA Working Group 3, which is in charge of the network aspects of TETRA and therefore of supplementary services, on supplementary services. All are within EN 300 392: Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D).

Part 10 covers Supplementary services stage 1, which describes the functional capabilities from the user's point of view. New standards include:

Sub-part 10: Priority Call (PC) – The supplementary service Priority Call enables a user to have preferential access to the network resources in the TETRA system. It allows the infrastructure to give priority network resource access to calls, which have been sent with priority status in times of congestion.

Sub-part 14: Late Entry (LE) – During a multipoint speech call, the infrastructure sends Late Entry indications related to this call to allow group members to join the ongoing call. This supplementary service may be used regardless of whether the members of the group are engaged in a call or not.

Sub-part 17: Include Call (IC) – The Include Call supplementary service enables the served user, while having a

call in progress, to make a new call and have the new party included in the original call.

Sub-part 18: Barring of Outgoing Calls (BOC) – The Barring of Outgoing Call supplementary service enables barring restriction for outgoing calls to be set. The barring can be set up and altered by the service provider. The authorized user may set and remove barring of the affected users.

Sub-part 19: Barring of Incoming Calls (BIC) – The Barring of Incoming Calls supplementary service, enables barring restrictions for incoming calls to be set. The barring can be set up and altered by the service provider. The authorized user may set and remove barrings of the affected users. The service provider may define certain numbers such as emergency numbers to remain outside of barring even though they are within the barred ranges of numbers.

Sub-part 14: The Late Entry supplementary service has been extended at two further stages. Stage 2 (Part 11 of the standard) defines the functional behaviour in terms of functional entities and information flows; describes the functional capabilities of the supplementary service introduced in the stage 1 description; and identifies the functional capabilities for the management of the service in the Switching and Management Infrastructure (SwMI), the Mobile Station (MS) and the Line Station (LS). Part 12: Supplementary services stage 3, defines gives a precise description of the Supplementary Service from the implementation point of view, it defines the protocols for the service, the encoding rules for the information flows and the processes for the functional entities and their behaviour.

ETSI and ITU-R Co-operate to Produce Standards More Quickly

The development of radiocommunications as a global initiative took a step forward this week when the European Telecommunications Standards Institute (ETSI) and the Radiocommunication Sector of the International Telecommunication Union (ITU-R) signed an Agreement to increase the exchange of information and strengthen co-operation between the two bodies.

This 'Agreement for the Mutual Co-operation and Exchange of Documentation' was signed on 17 June 2002 at the meeting of the ITU's Telecommunication Standardization Advisory Group (TSAG) in Geneva.

ETSI and the ITU-R share many common areas of activity. The ITU-R's responsibilities include studying and issuing recommendations on radiocommunications, while ETSI is responsible within Europe for standardization in the whole field of telecommunications, information technology and the related fields of broadcasting. However, standardization of telecommunications is becoming increasingly global; ETSI is active in many regions outside Europe, and its standards are being adopted around the world.

This collaboration will be undertaken in an environment that is characterized by a growing recognition of the economic value of frequency spectrum and the application of economic principles in the management of that resource, and an awareness of the rapid market-driven and user-oriented technological development in this area.

ETSI has previously been granted 'Sector Member' status within the ITU-R, and is therefore eligible to participate in relevant ITU-R meetings, to make technical contributions to ITU-R work and to assist the ITU-R in developing its Recommendations and Reports. Under the new Agreement, subject to its Technical Working Procedures, ETSI will now accept the participation of members of ITU-R Study Groups in the work of relevant ETSI Technical Bodies and their sub-

groups. This move will allow for a greater sharing of information and expertise in areas of common interest, thereby helping to produce better standards in radio-related areas more quickly.

The new Agreement also provides for the exchange of technical standards and recommendations between the two organizations, which will help reduce the duplication of effort and ensure the development of appropriate standards to meet global market needs.

The Agreement was signed by Mr Karl Heinz Rosenbrock, Director-General of ETSI, and Mr Robert Jones, Director of the ITU's Radiocommunication Bureau.

The IEEE-SA Launches New Standards Development Website

Standards developers at the Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA) now have their own web area, <http://standards.ieee.org/resources/development/index.html>. Launched by the IEEE-SA, a major developer of global standards, the site provides a focal point for the standards developer community.

The IEEE Standards Development Online site supports individuals and companies participating in the creation of standards at the IEEE. It consolidates the critical mass of standards development process and procedure information into one location on the IEEE-SA website. It also provides informative training modules and information for each step in the IEEE-SA standards development process. The site covers in detail how to initiate a standards project at the IEEE and how to write a standard. It covers the balloting or voting process of standards, as well as how standards get published and the various services the IEEE-SA offers to its standards development groups to help them get their standards out to market.

The launch of the IEEE Standards Development Online area represents the first major step in realizing the IEEE-SA's larger effort to automate its standards development process-giving 24/7 access to information and forms groups need in order to develop their standards in an effective and timely way. "IEEE Standards Development Online embraces our goal of meeting standards developer needs in today's fast-paced standards and business environments," says Judith Gorman, Managing Director of the IEEE-SA. "It provides the tools and information needed not only to embark on new work, but also provides a 'helping hand' every step of the standards development way. It is an excellent and competitive resource for IEEE standards developers."

Revised Event Data Recorder PAR Approved

The IEEE-SA Standards Board on December 11, 2002 approved the revised Project Authorization Request (PAR) for P1616, "Standard for Motor Vehicle Event Data Recorders (MVEDRs)." Many light-duty motor vehicles, and increasing numbers of heavy commercial vehicles, are equipped with some form of MVEDR. These systems, which are designed and produced by individual motor vehicle manufacturers and component suppliers, are diverse in function, and proprietary in nature. The continuing implementation of MVEDR systems provides an opportunity to voluntarily standardize data output and retrieval protocols to facilitate analysis and promote compatibility of MVEDR data. Adoption of the standard will therefore make MVEDR data more accessible and useful to end-users. The revised PAR reflects the consensus of the Working Group to alter the original Scope and Purpose to include all types of motor vehicles.

The original excluded motorcycles. The revised PAR also defines output data compatibility and export protocols.

Details of P1616 can be found at [http://www.automotive-suppliers.com/MVEDR\(P1616\)/P1616Standards.htm](http://www.automotive-suppliers.com/MVEDR(P1616)/P1616Standards.htm)

New VTS Standard for Battery Compartments in Rail Transit Vehicles

The IEEE-SA Standards Board at their December 2002 meeting approved a new standard, P1536, for the Vehicular Technology Society (VTS) in the Rail Transit area. P1536 is a standard for Rail Transit Vehicle Battery Physical Interface. It defines the maximum dimensional requirements of each battery tray for a specific number of cells and battery capacity or performance rating.

IEEE 1536 defines maximum battery tray size based on cell number and rated capacity and sets requirements for optimum battery compartment size and battery hardware. Sizes are consolidated in two capacity ranges for polymeric cells (80 to 120 and 120 to 240 ampere-hours) and in three capacity ranges for steel cells (80 to 120, 120 to 200, and 200 to 240 ampere-hours).

According to Stanley Kwa, IEEE P1536 Working Group Chair, "This standard eliminates the need to customize battery trays and enclosures in rail transit operations. It sets up a not-to-exceed footprint and overall dimensional envelope for the batteries used to keep internal low-voltage controls, lighting and other systems running when cars pass through gaps in third-rail DC power. Until now, rail car manufacturers tended to specify different battery sizes for different cars, which has made battery procurement and production much less efficient than it could be."

www.StandardsAmericas.net Opens Portal to Technical Standards

A new Web site, www.standardsamericas.net, launched by the Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA), a major developer of international standards, provides broad access throughout North, Central and South America to technical standards created by the IEEE and other standards development organizations (SDOs).

StandardsAmericas embraces all aspects of the standards world. It is a multidimensional resource for anyone who wants to learn about, obtain and formulate technical standards, especially in telecommunications, information technology, and power and energy. It also serves the needs of IEEE-SA volunteers who help create standards, as well as its members, customers and international partners by providing updates on IEEE and IEEE-SA activities.

The site provides information about standards under development and fills a communication void by linking specialists working on standards the world over. It also describes how companies are using IEEE standards.

Ben Johnson, President of the IEEE Standards Association, says the site was created to foster the use and creation of technical standards. "StandardsAmericas illustrates the interrelatedness of the standards world," he says. "It brings together all parties involved, from those who help formulate standards to the organizations that offer them to the companies that use them."

"The site also reinforces the many benefits standards offer, such as the return on investment companies realize when they help develop them. In addition, its StandardsShop™ area makes it easy to purchase technical standards, specifications and guides from the IEEE and other SDOs."

The site offers those in companies, trade organizations, government bodies and academia in North, Central and South America such options as:

- ◆ The ability to learn about and join new IEEE standards efforts.
- ◆ Links to Web sites carrying international and regional finance and economic news relevant to standards
- ◆ Links to IEEE "Standards Zones" to explore standards in specific technologies, such as wireless communications, microprocessors and power generation.
- ◆ Access to approved standards, either directly through the IEEE-SA or from third parties.
- ◆ Links to IEEE-SA's international standards partners, such as the International Electrotechnical Commission, International Organization for Standardization, and International Telecommunications Union.
- ◆ Profiles of volunteers in the Americas involved in standards development and how companies in the region are using IEEE-SA standards.
- ◆ Help in becoming an individual or a corporate member of the IEEE Standards Association.
- ◆ Details on the IEEE-SA and its standards process.

The site has many other aspects. For instance, it provides access to the IEEE Registration Authority, which assigns Ethernet addresses and local and metropolitan area network names, addresses and identifiers. It also allows visitors to link to the IEEE Industry Standards Technology Organization, which supports standards and technology development by industry consortia, alliances, forums and other groups.

IEEE Trans Tech Zone

A new zone has been added to the IEEE Standards Association web site that encompasses information about IEEE ITS, Vehicular and Transportation related standards activities and products. It enables a user to find the most current information about IEEE standards products and activities covering Intelligent Transportation Systems and Rail Transit/Vehicular Technology, including Working Group information, the status of IEEE standards and latest news. The "IEEE Trans Tech Zone" can be found at <http://standards.ieee.org/transtech/index.html>

ETSI Terms and Definitions Go Online

ETSI has recently launched web access to all the terms and definitions used in ETSI standards and reports. The PORTAL application, called TEDDI (TErms and Definitions Database Interactive), gives access to more than 45,000 combinations of terms, acronyms and abbreviations, and their related definitions and interpretations. They are shown exactly as they are stated in the now close to 10,000 deliverables (standards, specifications, guides and reports) published by ETSI

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- IEEE-SA Press Release, September 2002.



Robert Fenton

Former VTS President Dr Robert E. Fenton was one the 77 engineers and 9 foreign associates elected to the National Academy of Engineering (NAE) on February 14, 2003. Dr Fenton is a long-time VTS activist, and is Professor Emeritus in Electrical Engineering at the Ohio State University. His technical interests have been focussed principally on the communication and control aspects of automated highway systems, and he has published numerous papers on these subjects both in the VT Transactions and elsewhere.



Dr Fenton has served three terms on the VTS Board since 1971, the most recent of which ended only last year. Amongst his many VTS activities, he served as treasurer in the early 1980s, and was society president between 1985 and 1987. Elected an IEEE Fellow in 1986, Dr Fenton was previously honored with the Avant Garde Award in 1982, the Stuart F. Meyer Award in 1998, and the IEEE 3rd Millennium Medal in 2000.

Frank Lord

VTS News Senior Editor Frank Lord has been awarded a Divisional Professional Leadership Award by IEEE-USA. The award, given 'for sustained high quality contributions to the Vehicular Technology Society and as founder and first editor on IMPACT', recognises his long-standing work for the IEEE in professional development activities.



Dennis Bodson

Dennis Bodson was awarded the 2002 IEEE Standards Association (IEEE-SA) Distinguished Service Award in recognition of his contribution to the standards process and the objectives of the IEEE-SA. Mr. Bodson has been an active participant in the development of international, national, industry and federal standards for over 35 years. He has been a strong advocate and player in the development of IEEE standards and has made major contributions to the standards development process.

IRSE Technical Meeting

The Institution of Railway Signal Engineers (IRSE) North American Section (NAS) is pleased to announce a Technical Visit to the Northern Indiana Commuter Transportation District on 11 July 2003. This event is open not only to NAS

IEEE VTS Board of Governors' Meeting, 27 September 2002

The final IEEE VTS Board of Governors meeting of 2002 was held during VTC2002-Fall in Vancouver, with VTS President J. R. Cruz in the chair. Other Board of Governors members present were Charles Backof, Dennis Bodson, Robert French, Tad Matsumoto, Robert Mazzola, George McClure, Sam McConoughey, Tom Rubinstein, Eric Schimmel, Raymond Trott and Jim Worsham, while others present for all or part of the meeting included Vijay Bhargava, General Chair of VTC2002-Fall, Mark Ehsani, VPPC/Convergence Fellowship Chair, Mohsen Guizani, General Chair, VTC2003-Fall, Youngnam Han TPC Chair, VTC2003-Spring, James Irvine, VTS News Editor, Seong-Cheol Kim, Secretary, VTC2003-Spring, Jae Hong Lee, General Chair, VTC2003-Spring, Mel Lewis, Conference Coordinator, Roger Madden incoming elected BoG member, and VTS Secretary Y.-P. Eric Wang Secretary. The minutes of the previous meeting held on May 8, 2002 were approved without amendment, and there were no matters arising.

Secretary's Report: Eric Wang announced that he would leave the Secretary post after serving out the current term. He thanked the Board for its support during his term. President J. R. Cruz noted that the appointment of Secretary is at the discretion of the society president, and since his term also concluded at the end of the year, he would work with the president-elect to fill the position.

Treasurer's Report: Charles Backof summarized the current financial status of VTS. As of August 2002, the society's net worth was \$862K, down by \$32K from the previous year. However, unlike the previous year when the charge to cover the IEEE central deficit was taken by reducing the reserves, in the current year it was taking by an administration charge throughout the year, so the Society's accounts are relatively healthy.

There was a significant drop in the surplus recorded under meetings and conferences due to lower attendance after September 11. Board of Governors members were thanked for being cost conscious with their travelling, keeping committee expenses within budget. It was agreed by seven votes to four, with one abstention, to give VTS Board members and conference coordinators complimentary registration to VTCs to encourage Board members to participate in conference activities. Board meetings are usually held at each VTC, but many Board members do not stay for the rest of the conference, which provides an opportunity to meet with large numbers of VTS members.

President's Report: President J. R. Cruz announced the results of this year's Board of Governors election. Mark Ehsani, James Irvine, Tom Rubinstein, Roger Madden, and James Worsham were elected for a three-year term, starting from 2004.

President Cruz also reported that the main focus in last TAB meeting was current financial situation of the IEEE. Every society agrees to contribute funds to help alleviate the financial difficulties of the IEEE. In the mean time, a consulting firm is employed by the IEEE to find ways to improve organization and operation efficiency.

members, but to all IRSE members and prospective members as well, on a space available basis. Additional information can be found at <http://www.irse.org/page15NA.html> or by contacting Bill Scheerer (Section Chairman) at (816) 650-1653.

Eric Schimmel noted that the ballot turn-in rate for the Board of Governors election was poor. James Irvine suggested investigating whether ballots can be cast through the web because this process is easier for the members and the cost of returning a ballot can also be lowered. It was agreed that the web master would check with the IEEE headquarters to see whether on line voting is feasible.

Awards: Ray Trott reported on the year's awards. He will present the Outstanding Service Award in the Award Lucheon, with the two fellowship awards will be presented by Motorola and Mark Ehsani respectively.

Publications Committee: Greg Bottomley reported on the **Transactions**, introducing T. Wong, an Associate Editor, to the Board. He has added 6 new associate editors, bringing the total to around 30. He reported that the annual cost for the Transactions will be increased by \$3768 next year. The impact factor of our Transactions were ranked in the upper half in 2000 and 2001 among all Electrical and Electronics Engineering journals, according to Journal Citation Report. Charles Backof commented that the turn time from paper submission to publication is important for the success and impact factor of the Transactions. Greg Bottomley also requested the Board to recognize the services of Barbara Friedewald in her role as the Transactions system administrator, and this was agreed unanimously.

James Irvine reported on the **VTS News**. The IEEE has asked the newsletter editors to reduce the size and paper weight of newsletters to save postage cost, but considering the page count of our newsletter, this approach does not result in much saving, and reducing size and paper weight will however constrain the layout of the publication. The DECT Forum asked for permission to put the DECT article in our 3G series on their web site. This was agreed. Although back issues of the VTS News are archived, this is not available to members. It was agreed to check on getting the VTS News into Xplore. Eric Schimmel raised the issue of whether we can provide VTS News to some libraries, e.g. the ITS library, and he will provide a list of agencies to be considered for a free trial subscription.

VTS Digital Library: Tom Rubinstein reported on the VTS digital library. Costs have reduced, but are still in the order of \$100k, and the IEEE could not recommend alternative vendors. He therefore recommended that we put this project on hold. It was suggested that we revisit this issue next spring for including it as an initiative for the 2004 budget.

Conference Management Services: Bob Mazzola reported on conference management services comparison. Three proposals had been evaluated, ranging from \$25k to \$95k excluding expenses, which could be expensive. Based on his evaluation and feedback from long time conference organizers, he recommended that VTC's continue to be run with mostly volunteer help. Jim Worsham commented that the IEEE Conference Services provided good services for VTC'96 in Atlanta at a lower cost. J. R. Cruz commented that streamlining conference closing was the motivation of seeking conference management services, and expressed concern for the heavy workload on conference volunteers

and coordinators. Concern was also expressed about using US-based conference services for international conferences. Mel Lewis suggested that we give local committees discretion to hire local professional services to do certain works. After some debate, it was agreed to receive, rather than accept, the report.

Conference Reports: Conference General Chair Jae H. Lee submitted a status report for **VTC2003-Spring**. Expected income is \$40k based on 650 attendants (including 325 students), and they have received more than 1000 submissions; notification of acceptance will go out in December.

Conference General Chair Mohsen. Guizani submitted a status report for **VTC2003-Fall**. The web site is ready, and is now open to paper submissions. The TPC members are finalized, and two keynote speakers, Lucky and Hubert, have accepted an invitation.

Dr. Sumner Matsunaga of Aerospace Corporation presented a proposal for hosting **VTC2004-Fall** in Los Angeles on behalf of the VTS LA chapter and the Aerospace Corporation. The venue was proposed as the LAX Marriott, where there are multiple hotels within the walking distance, with a theme "Wireless Technologies for Homeland Security". A few Board members expressed concerns about the proposed theme as being U.S. centric. Eric Schimmel noted that in the international community the term PPDR (Public Protection and Disaster Relief) is more widely used to address public safety issues. Based on the suggestions from the Board, the organizing committee will work on a new conference theme and logo. It was also agreed that Aerospace Corporation's participation is to be noted in text references, but the Aerospace Corporation logo is not to be used on conference materials. It was agreed to accept the proposal on this basis.

President J. R. Cruz reported that **ISART-2003** and **IATED's WOC-2003** have requested technical co-sponsorship. This was agreed.

Tom Rubinstein reported that the proposal for hosting **VTC2006-Spring** in Melbourne had been modified to address most of the concerns raised in the last meeting. The proposal was agreed.

There was no progress report from the local committee of **VTC2004-Spring** in Genoa, but one will be obtained for the next meeting.

Eric Schimmel noted that there are grants available from federal agencies for promoting or subsidizing conferences. He suggested that VTS pursue these opportunities.

Jim Worsham submitted a report on past conferences. **VTC2001-Fall** (Atlantic City) is projecting a surplus is around \$35k, a very significant achievement in the circumstances. **VTC2002-Spring** (Birmingham) had 551 attendees, of whom half were students. They are also expecting a surplus. The on-going dispute with the conference organizing company of **VTC2001-Spring** (Rhodes), Dan Knassim, has still not been resolved.

Vehicle Power and Propulsion Committee: Mark Ehsani reported that there were 20 papers presented in 4 VPCC sessions during this conference. He expected the number of paper submissions would increase, as these VPCC sessions become better known. VPCC currently has 13 members from the US, Europe, and Japan. On the Convergence Fellowship, there were 4 nominations and the winner is Phillip Weicker.

Membership Development Committee: George McClure reported the status of VTS membership brochure. Producing 25,000 brochures would cost about \$8,800. A roll-up banner was also considered, but this would raise the cost over the \$10k threshold where IEEE approval is required. Therefore he recommended producing the brochures but deferring the banner production, and this was agreed.

Dennis Bodson reported that the **Standard Committee** had received an appeal on the P1616 policy and procedure manual. He has formed a panel with two members from VTS to look at this appeal.

Robert French reported that the **ITS Council** is in good financial condition, in spite of the IEEE financial difficulties. He also reported that there has been an increased interest in telematics technologies.

Elections: As reported in the last issue, elections were held at the close of the meeting, with the following result:

- President:* Charles Backof
- Executive Vice President:* Dennis Bodson
- Vice President - Motor Vehicles:* Robert Mazzola
- Vice President - Mobile Radio:* Eric Schimmel
- Vice President - Land Transportation:* Harvey Glickenstein
- Treasurer:* George McClure

Letters

Dear Sir,

I write to you in your capacity as Editor of the IEEE VTS News to enter an objection to the erroneous use of terminology in the otherwise good article, "Design of a Fuel Cell Hybrid Tramway (sic)" appearing in the February 2003 issue.

I would have been able to restrain myself from publicly objecting to the use of "tram", a primarily European synonym for "streetcar", in a publication which, while global, goes in the majority to North American readers. It is interesting that the authors are from North America, but understandably the Grenoble influence was heavy.

However, I cannot let pass the authors' use of "tramway" where clearly the correct term was and is "tram". Their article describes a vehicle. A "tram" is a vehicle. A "tramway" is the streetcar system upon which a tram runs.

Very truly yours,

David R. Phelps
Senior Project Manager - Rail Programs
American Public Transportation Association

Call for Papers

The VTC2004-Spring Conference, to be held in Genoa, Italy, from 10 to 14 May 2004, aims to capture and present the current state of the innovative and highly active mobility industry. We seek to present the changing face of wireless technologies and a glimpse in the future of this exciting field. We expect a large number of highly qualified technical papers and posters to be presented, along with tutorials, business application / panel sessions and exhibits. Authors are invited to submit extended abstracts describing original research results, innovative applications, and experimental or field trial results in the following: Antennas and Propagation, Transmission Technology, Wireless Access, Mobile Networks, Mobile Applications and Services, Satellite

Networks and Services, Transportation and Vehicular Power and Propulsion.

Paper authors should submit an extended abstract (up to 2 pages) and a short abstract (approx. 150 words) for review. Submissions must be made on the Conference web site at <http://www.vtc2004spring.com/> and include name, mailing address, telephone and fax numbers, the Technical Subject Area of the paper and the e-mail address of the primary author. Proposals for Tutorials and Panel sessions are also invited, and should consist of a 250 word summary, and a 100 word abstract.. Panel sessions should present leaders in a particular area discussing a topic of interest to the attendees.



All summaries should be submitted online by September 15, 2003.

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	CONFERENCE	LOCATION	WEB PAGE
11-15 May 2003	ICC2003	Anchorage, AK	http://www.icc2003.com
27-30 May 2003	World Wireless Congress	San Francisco, CA	http://wirelesscongress.com/
1-3 June 2003	MobiHoc 2003	Annapolis, MD	http://www.sigmobile.org/mobihoc/2003/
15-18 June 2003	SPAWC2003	Rome, Italy	http://www.spawc2003.it
15-18 June 2003	IST Summit	Aveiro, Portugal	http://www.mobilesummit2003.org/
23-27 June 2003	APS International Symposium/ URSI Radio Science Meeting	Columbus, OH	http://aps2003.eng.ohio-state.edu/
7-9 July 2003	Wireless 2003	Calgary, Alberta	http://www.cal.trlabs.ca/wireless/
14-16 July 2003	WOC 2003	Banff, Alberta	http://www.iasted.org/conferences/2003/banff/woc.htm
7-10 September 2003	PIMRC 2003	Beijing, China	http://www.pimrc2003.org
17-19 September 2003	MC-SS 2003	Oberpfaffenhofen, Germany	http://www.dlr.de/kn/kn-s/mcss2003
24-25 September 2003	8 th Int OFDM Workshop	Hamburg, Germany	http://ofdm.tu-harburg.de/ ✓
6-9 October 2003	VTC 2003-Fall	Lake Buena Vista, FL	http://www.vtc2003.org
19-22 October 2003	WPMC'03	Yokosuka, Japan	http://www1.ilcc.com/WPMC/ ✓
1-5 December 2003	Globecom 2003	San Francisco, CA	http://www.globecom2003.com
24-27 February 2004	European Wireless 2004	Barcelona, Spain	http://research.ac.upc.es/EW2004/ ✓
11-14 May 2004	VTC 2004-Spring	Genoa, Italy	http://www.vtc2004spring.com/ ✓
20-24 June 2004	ICC 2004	Paris, France	http://www.icc2004.org
26-29 September 2004	VTC 2004-Fall	Los Angeles, CA	mailto:Sumner.S.Matsunaga@aero.org
29 May - 1 June 2005	VTC 2005-Spring	Stockholm, Sweden	mailto:Jens.Zander@radio.kth.se
Q2 2006	VTC-2006 Spring	Melbourne, Australia	mailto:fzheng@ieee.org

Conferences marked '✓' have open calls for papers as of 15 May 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.