MEMORANDUM

TO: Mr. David G. Greenstein, Chairman and Members of IEEE 802.4L

FROM: Chandos A. Rypinski

RE: Plenary Meeting of CCIR IWP 8/13, March 10-18, Melbourne, Aust.
Future International Public Mobile Digital Radio Telephone Service

SUMMARY

Attended by about 45 delegates from 17 countries, the second meeting of this CCIR Working Party seeks to define a standard for high density radiotelphone technology enabling technical interworking of units with international roaming capability. Since the USA, Canada and UK have systems in place which still have a few years to go before saturation, there is no urgent need for a new system. The European countries, particularly France and Germany, not having a high capacity system, urgently need to do something which they prefer to be advanced relative to the US cellular system. The frequency band and technical standards for this next step are the subject of GSM (Groupe Spe'cial Mobile), a CEPT sponsored group, which should produce a decision before the end of March. There will then be one more different 900 MHz system used internationally. The IWP 8/13 hopes to prevent the same situation from occurring with a next generation system above 1000 MHz, but the possibilities are limited by the very nominal cooperation from the USA.

These problems put aside, this work is very important in bringing out the possibilities of frequency allocations for mobile services, the complexities of the tradeoffs in picking a suitable transmission technology, the inevitability of relative small cells at microwave frequencies, and the working definitions of ISDN compatibility linked to the network services to be rendered. While results from this group may seem most distant, some of the technical work that has been done is of great relevance to the IEEE 802.4L committee.

The USA has a positive position only with respect to a radio method of local distribution to replace the last 300 meters of the wireline network with a wide area cordless telephone. The plan is sponsored by Bellcore (D. C. Cox, P. Porter) and has been presented publicly on several occasions. One consequence is a landmark reference paper, submitted to IWP 8/13 at this meeting, on propagation in, around and through buildings at 900 MHz and higher frequencies.

The USA will not agree to "anything that even hints at frequency allocations" (even as broad as 1-3 GHz); and it is doing everything possible to keep the opportunity open for new candidate technology.

Most of the other countries wish to get on with the work, picking standards now, so that timely presentations leading to frequency assignments after WARC in 1988 and at the XVIIth Plenary in 1990.

Current technical contributions are quite relevant to parts of 802 as described below and as shown in the attachments.

PROPOSED SCENARIOS

After going through several submitted plans, each with different emphasis and detail, subcommittee selected the following scenarios as representative:

1. **Integrated mobile and personal system** where there is a small cell personal system overlaid on standard cell vehicular system either of which can be used for access for the personal units. Base stations and personal units are mostly outdoor.
2. **Separate personal system** where the new system is new small cell fixed network, and which can provide a second link, equivalent to a cordless telephone, to a normal mobile system. Base stations and personal units are either inside or outside. Street shaped cells and cells within busses and ferries are considered.

3. **Alternative radio local distribution** to ordinary telephone service subscribers. With neighborhood sized cells, base stations are outside and personal units are both inside and outside.
4. **PBX radio local distribution.** With one floor of an office building as a cell, both base stations and personal units are mostly inside.

GENERAL TECHNICAL CONCLUSIONS

A highly abridged summary of technical positions with substantial consensus taken from the submissions of the various administrations is presented as follows:

The 1st system above required a 0.5 watt portable, but the others required 50 milliwatts or less for cell sizes of 100-1000 meters in diameter (50-500 meters maximum range).

Propagation for short distances is "Rician" rather than Rayleigh. Rician fading is the sum of free space (6 dB/octave) and secondary paths, and Rayleigh is typically 10-12 dB/octave over cluttered non-optical paths.

All proposals assumed that 12 to 16 kilobits/second is enough capacity to provide voice quality equal to present compandored FM used in current cellular systems. Tests indicate that a particular type of speech coding combined with forward error correction provides better performance in a dispersive medium generally superior to compandored FM on a mean opinion scoring test.

Most TDMA proposals are in the area of 250 kilobits/second for medium distance mobile transmission (7 kilometers, 120 km/hour) provided that some form of adaptive equalizer is used. It is generally accepted that the data rate limit is higher as the cell becomes smaller and the velocity of the personal station lower, and that the adaptive equalizer can be avoided in small cell or lower rate systems.

There is little technical change from the views reported at the 1986 Nordic Seminar on Digital Telephony which emphasized greater capacity at 900 MHz, except that there is increasing emphasis on smaller cells as the use of higher frequencies for next generation systems seems to be inevitable.

RELEVANCE TO 802.4L

The small cell of evolving microwave radio systems and the extents of an unbridged LAN are about the same geographic area.

Nearly all of the necessary technology and propagation has been or will be explored in the context of digital telephony with particular regard to cost, motion, environment and spectrum efficiency.

There is a great deal to be learned about how to go about securing FCC recognition of this service and the frequency space that it is to occupy as indicated below. The opinions shown below are derived in great part from the contacts which occured at this meeting.

OPERATING FREQUENCY (Opinion)

The recent 1700-1710 MHz Motorola application is not framed in a way that will produce either an allocation or a widely useful service after allocation. The position of the FCC is that there is no need for Radio Local Area Network services since there is no request for rulemaking in regard to such a service before it. At the start, it must be recognized that there are no virgin frequencies for allocation below 30 GHz, that the primary allocation plan for many frequencies below 2.5 GHz is for mobile services, and that many of the fixed point-to-point assignments now using them are on a secondary basis. A successful strategy must be based on co-use with an existing service. Accepting this premise, the technology used must depend on a multiplicity of low power (<50 milliwatts), short range (<500 feet) microwave radios.

That strategy is good because the same result will flow from attempting data rates in the 1 to 10 Mbs range. Assuming co-use and short range, it may no longer be necessary to seek the same spectrum efficiency that would be appropriate for longer range, exclusive use allocations. The design of diversity, modulation and forward error correcting codes may be affected by the type of outside interference to which the radio LAN could be exposed.

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In these circumstances, a bandwidth 100 to 200 MHz wide could be chosen moving the emphasis to low power, short range and simplicity of equipment. The operating frequency might be anywhere from 1.5 to 6 GHz.

Respectfully submitted,

Chandos A. Rypinski

ATTACHMENT A
TRANSCRIPTION OF DRAFT REPORT SECTION IWP 8/13 AT 17 MARCH 87
OBJECTIVES

Future Public Land Mobile Telecommunication Systems (FPLMTS) aim to achieve the following primary and secondary objectives (The numbers do no indicate an order of priority):

PRIMARY:

P1. To make available the voice and non-voice telecommunication service capabilities to users who are on the move or whose location may change (mobile users).

P2. To provide these services over a wide range of user densities and geographic areas.

P3. To make efficient and economical use ofthe radio spectrum consistent with providing service at an acceptable cost.

P4. To provide as far as practicable, a service of high quality and integrity, comparable to fixed network.

P5. To accomodate a variety of mobile terminals ranging from those which are small enough to be easily carried on the person (the personal pocket radio), to those which are based in a vehicle.

P6. To provide a framework for continuing extension of mobile network services, and access to services and facilities of the fixed network (PSTN ISDN) subject to the constraints of radio transmission, spectrum and system economics.

P7. To connect mobile users to other mobile users or fixed users, using the fixed network (PSTN ISDN) or other telecommunication networks as appropriate.

P8. To admit the use of the mobile system for the purpose of providing its services to fixed users: either permanently or temporarily.

P9. To admit the provision of service by more than one network in any area of coverage.

P10. To allow the mobile and fixed users to use the facilities irrespective of location (i.e. national and international roaming). The implication of this for the definition of one or more air interface standards is commented on in section 2.2.

P11. To provide the required user authentication and billing functions.

P12. To provide for unique user identification and ISDN/PSTN numbers in accordance with CCITT Rec. E212 and E213 respectively.

P13. To be able to support integrated communication and signalling.

P14. To establish signalling interface standards in terms of the OSI model.

P15. To provide an open architecture which will permit the easy introduction of technology advancements.

SECONDARY:

Secondary objectives are those which some administrations or regions may not wish to include. They may conflict with primary objectives and should not override them.

S1. To provide for additional voice privacy and data security compared to that contained in P4.

S2. To provide service flexibility which permits the optional integration of services such as mobile telephone, dispatch, paging and data communication, or any combination thereof.

S3. To provide an indication of potentially high call charges to an initiating caller.

S4. To support the coexistence with, and interconnection with, mobile systems which use direct satellite links.

S5. To support terminal interfaces which allow the alternative use of terminal equipment in the fixed ISDN network.

ATTACHMENT B

CCIR
Interim Working Party IWP8/13
Melbourne, March 11-18, 1987

DOC No. CAN 1
20 February 1987
Original: English

Subject: Decides 2.2

CANADA

Classifications of Bands by Usage

1. Introduction

Frequency bands allocated for mobile services were outlined in Table 3, Section 3.6 of the Draft Report of the First Meeting of IWP8/13 (Document IWP8/13-27). As indicated in a note associated with the table, all of the allocations are shared with other services. The vast majority of the bands are shared with the fixed service. An attempt has been made to indicate the extent of usage of each band and this is shown on the attached table.

An indication of the extent of worldwide usage of each band has been derived from frequency notifications in the International Frequency List (March 1986) for each of the ITU Regions, with Region 2 further broken down to show Canadian notifications.

2. Discussion

There are a large number of frequency bands above 1 GHz allocated to the mobile service which are not currently used for that purpose, as lower bands have been used as a preference. However the frequency bands above 1 GHz allocated to mobile services are also allocated to other services, mainly fixed, and are used to a varying extent for that purpose throughout the three ITU Regions.

There is a need to identify a candidate band(s) that would be suitable for FPLMTS yet would have a lesser impact on existing and future usage by the other allocated services. In order to focus this task of identifying a candidate band(s), an upper limit of a suitable frequency range of FPLMTS should be selected in order to intensify the effort over a narrower range. It is our view that this upper limit should be 3 GHz based on propagation considerations and the likely evolution of the performance of radio design. Although the investigation of the feasibility of using higher bands should be continued, it would be more productive to focus most of the investigation towards frequency bands within a narrower range.

The identification of a candidate band(s) is also dependent on the extent and type of usage by existing and future potential services currently allocated to these frequency bands. The relevant CCIR Study Group 9 Recommendations for channeling arrangements for fixed systems have been included in the following table along with the IFRB notifications in the bands under study in order to depict the nature and extent of existing usage. The number of IFRB notifications may give a relative idea of the use of the band. Specific feedback from administrations is necessary to reflect total national usage in order to facilitate the ranking of the potential bands.

March 21, 1987

TABLE 1(a)

CANDIDATE BANDS VS INTERNATIONAL USAGE

Existing Frequency Bands Allocated for Mobile Services

CANDIDATE BANDS MOBILE ALLOCATION	CCIR STUDY GROUP 9 USAGE (FIXED)	ITU ALLOCATION TO OTHER SERVICES	FREQ. NOTIFICATIONS IFL of March 86 REGION 1	2	3
862 - 902 MHz primary all regions		862-890 - FIXED - BROADCASTING 890-902 - FIXED - BROADCASTING (Excl. R2) - Radiolocation	791	514	17
902 - 928 MHz primary regions 1 and 3; secondary region 2		FIXED BROADCASTING (Excl. R2) Amateur Radiolocation	644	377	19
928 - 942 MHz primary all regions		FIXED BROADCASTING (Excl. R2) Radiolocation	155	402	15
942 - 960 MHz primary regions 1 and 3; secondary region 2		FIXED BROADCASTING (Excl. R2)	173	999	15
1427 - 1525 MHz primary all regions	REP. 1057 REP. 379-4 REP. 380-1	1427-1429 SPACE OPERATION FIXED	274	1 919	20
1525 - 1535 MHz secondary all regions		SPACE OPERATION 1525-1530 - FIXED (Sec R2) Earth Exploration - Satellite 1530-1535 - MARITIME MOBILE - SATELLITE - Fixed	28	111	NIL
1660.5 - 1668.4 MHz secondary all regions		RADIO ASTRONOMY SPACE RESEARCH (passive) Fixed	1	NIL	NIL
1668.4 - 1690 MHz primary all regions		1668.4-1670 RADIO ASTRONOMY METEOROLOGICAL AIDS FIXED 1670-1690 METEOROLOGICAL-SAT	22	20	12
1710 - 2450 MHz primary regions 2 and 3 secondary - region 1	REC. 283-4 REP. 1057 REP. 390-1	FIXED 2290-2300 - SPACE RESEARCH 2300-2450 - Radiolocation (R1)/RADIOLOC	4 710	4.487	711
2450 - 2690 MHz primary all regions	REC. 283-4	FIXED 2450-2500 - Radiolocation (R1)/RADIOLOC 2500-2690 - BROADCASTING - SATELLITE 2500-2535 - FIXED - SATELLITE (Excl. R1) 2535-2655 - FIXED - SATELLITE (R2) 2655-2690 - FIXED - SATELLITE (Excl. R1) - Earth Exploration - Satellite Radio Astronomy Space Research	699	602	46
3400 - 3500 MHz secondary all regions		FIXED FIXED - SATELLITE RADIOLOCATION Amateur (R2)	379	1	16
3500 - 4200 MHz primary regions 2 and 3; secondary - region 1	REC. 382-4 REC. 635	FIXED FIXED - SATELLITE 3500-3700 - Radiolocation (Excl. R1)	6 935	7 301	4 412
4400 - 5000 MHZ primary all regions	REC. 382-4 REC. 635	FIXED 4500-4800 - FIXED - SATELLITE 4800-5000 - Radio Astron/RADIO ASTRON	1 024	2 559	59
5850 - 8500 MHz primary all regions	REC. 383-3 REC. 384-4 REC. 385-3 REC. 386-3 REC. 389-2	FIXED 5850-7075/7250-7750/7900-8400-FIXED-SAT 5850-5925 - Radiolocation (Excl. R1) - Amateur (R2) 7450-7550 - METEOROLOGICAL - SAT 8025-8400 - EARTH EXPLORATION - SAT (Sec. R1, Re) 8175-8215 - METEOROLOGICAL - SAT 8400-8500 - SPACE RESEARCH	14,574	19,131	7,440

ATTACHMENT C
ABRIDGED TRANSCRIPTION OF DRAFT REPORT
SECTION IWP 8/13 AT 17 MARCH 87

PROPAGATION CONSIDERATIONS

In order to define a system configuration of FPLMTS, propagation charateristics applicable to high mast and low mast antennas, indoor dat, etc., are required. Current estimates of important parameters for frequencies around 1 GHz are summarized in Table I as a reference for system design.

At the present time, the extent of propagation information as it relates to the urban environment is summarized in: Document US8/13-3 rev. 3; 27 January 87; "THE PORTABLE RADIO PROPAGATION ENVIRONMENT." These items should be brought to the attention of Study Group 5 (CCIR).

PROPAGATION CONSIDERATIONS AROUND 1 GHZ
Approximate values from available data as of 1986

	OUTDOORS		INDOORS
Mast height:	100 m (Large cell)	10 m (Small cell)	3 m
Delay Spread--microseconds			
Median:	3	0.15	0.15
Typical max.:	30	0.5	0.3
Propagation Path Loss			
Small Scale			
Statistics:	Rayleigh	Rician/Raylgh*	Rician/Raylgh*
Coherence distance:	wavelgth/4	wavelgth/4	wavelgth/4
Cross-polarization			
Coupling:		0-6 dB*	0-6 dB*
Correlation:		0*	0*
Large Scale			
Statistics:	Log-normal	Log-normal	Log-normal
Power law:	r^{-3} to r^{-5}	r^{-2} to r^{-6}	r^{-2} to r^{-6}
Std. deviation:	6-8 dB	10 dB	10 dB
Coherence distance:	30 m*	10 m*	3 m*

* Depending on specific environment.

PROPAGATION CONSIDERATIONS IN URBAN ENVIRONMENT
IN AND AROUND BUILDINGS IN GENERAL

Fundamental limitations on portable radio system parameters and on the application of radio link techniques result from the effects of radio propagation within and around houses and buildings. This is a very complex and difficult radio propagation environment because the shortest direct path between any pair of fixed and portable set locations is usually blocked by walls, ceilings or other objects. Often many attenuated propagation paths exist between any pair of locations. The different propagation pathes are produced by reflections from walls, ceilings and objects. Each path may have a different time delay and a different attenuation. The overall result is a complex and widely varying multipath transmission channel between fixed radio terminals (i.e. base stations) and portable sets. Because of the complexity and variability, analytical determination of many of the multipath propagation parameters is not feasible. It is usually necessary to resort to measurements and to empirically determine statistical distributions of many of the parameters for different locations of fixed radio terminals and portable sets.

The portable radio environment is qualitatively similar to the mobile (vehicular) environment. That is, propagation is dominated by the effects of shadowing and reflections from walls, objects and the ground. Therefore, some of the small scale multipath propagation characteristics are the same in both environments. However, in the portable environment, antenna heights will be lower, or antennas will be located within buildings, an distances between transmitters and receivers will shorter than in the mobile environment.

LARGE SCALE STATISTICS

Measurements have been made in the 800 to 900 MHz range between locations (base station and portable) entirely within large buildings. The results show scatter of measured values about adistance-dependent regression line. Distance dependences ranging from about r^{-2} to r^{-6} were observed for typical office and laboratory buildings with values of r^{-4} to r^{-5} appearing to be typical.

Similar studies have concluded that:

(a) High rise buildings are very effective in blocking signals.

(b) Propagation losses, along streets where transmitters are located, followfree space attenuation losses. On turning to leave these streets, the signal levels drop by typically 20 dB, while turning other corners will have much less effect.

(c) Across a floor, in some instances power laws approach 20 dB/decade (r^{-2}).

(d) High loss through floors, especially those built with "lost" steel framework. The value of this through floor isolation has been measured at 26 dB at 45 meters.

(e) Low loss through windows and so high levels of interference between some buildings is likely.

(f) Along a corridor the received signal can be greater than the free space level over the entire distance span (by up to 11 dB in the 15-40 meter range), suggesting channeling of the energy by the corridor.

(g) The received signal level can decrease abruptly by 25 dB or more at the transition from the corridor to an adjoining room (a distance of 7 meters or less).

Additional variation is probably due to additional attenuation resulting from reflection from and propagation through intervening houses and trees. The additional attenuation might be better represent by dB/distance, i.e. e^{-r} or 10^{-r}, variation rather than by a power-law variation r^n, since the number of attenuating objects (houses,trees, etc) increases more or less uniformly with distance, however this has not been experimentally demonstrated.

The lower antenna heights result in greatly reduced illumination of faraway reflecting surfaces because intervening attenuating objects (buildings, hills, etc) are more likely to exist. Also, shorter base-to-portable distances decrease the attenuation of more direct and shorter reflection paths and increase the relative attenuation to far away reflectors. These effects produce the significantly lower delay spread values observed in the portable radio environment as compared to the mobile radio environment.

LARGE SCALE VARIATION

After removal of the distance dependence from the signal strength data, the remaining variation is approximately normally (Gaussian) distributed in dB, with a mean of 0 dB and a standard deviation of roughly 10 dB.

DELAY SPREAD

Delay spread results from the recombination of several multipath signals with differing delays, at the receiver. If the delay spread is significant relative to the symbol period of the transmitted data then degradation of the demodulated signal will occur.

As cell size is reduce, delay spreads will be lower and so higher modulation rates are possible. This suggests that a variable rate system may be possible, making use of this useful increase in spectral efficiency.

As an example, a non-equalized channel transmitting binary modulation with raised cosine pulses and differential detection (i.e. DPSK) would have an irreducible bit error rate of 10^{-3} for a bit rate of about 300 kbs and a 0.25 microsecond delay spread.

The irreducible error rate is the error rate which occurs at high signal-to-noise rations for which the noise contribution to errors is negligible, and instead, errors are caused by intersymbol interference. The error rate depends somewhat on the shape of the power-delay profile; however, the effect of the profile shape is much less than the statistical uncertainty of the knowledge of the delay spread statistics that exists because of the limited number of the measurements that are available. Different types of digital modulation and different pulse shapings have different susceptibilities to delay spread. Further analysis, computer simulation and laboratory experiments are needed to assess the susceptibilities of the different modulations that are appropriate candidates for portable radio systems.

In other experiments, it was found that for urban mobile radio systems operating with low power and low base station antennas, multipath propagation is reduced. Maximum excess delays were found to be only 1.5 micorseconds as compared with the 10 microseconds reported for conventional systems. Impulse response averages showed that fewer multipath components are received as the distance from the transmitter to the receiver becomes shorter, although differences between characteristics on the block in which the transmitter is located, and the adjacent block are not great. No differences were found in the resultsfor lower (3.7 m) and higher (8.2 m) base station antennas. It is considered that this would be true, so long as base station antennas are kept well below the building tops.

SMALL SCALE STATISTICS

Signal envelopes measured in small areas that have walls blocking the direct path between transmitter and receiver are approximately Rayleigh distributed. The envelope distribution from the outtside area departs significantly from Rayleigh because of a strong direct path.

Across a floor, Rician rather than Rayleigh statistics apply, as a line-of-sight ray is often present. Except at the extreme ends of a corridor, only 2-4 dB of rapid signal variation is observed, suggesting the presence of a single dominant propagation path.

For high and low antennas, along the block on which the transmitter is located, and the one adjacent, envelope fading is Rician, corresponding to that which would occur under conditions where a specular signal is received with a power which is about 7 dB above that of received multipath signals. Where these conditions apply, it is beleived that will result in significantly better digital system performance, permitting widertransmission bandwidths than the Rayleigh fading conditions encountered on conventional mobile radio channels.

CROSS POLARIZATION COUPLING

The reflecting and scattering of radio signals in the multipath propagation environment also couples power from the transmitted polarization into the crossed polarization also arrives over paths with different time delays and different angles of arrival.

In the region of low signal levels, the cross polarization couplings are all greater than -6 dB and range up to slightly over 0 dB. Some of the scatter in data is due to measurement error and statistical uncertainty. Similar measurements in large building show even large values of cross polarization coupling. Measurements in Tokyo on sidewalks also yielded values in the -5 to -7 dB range.

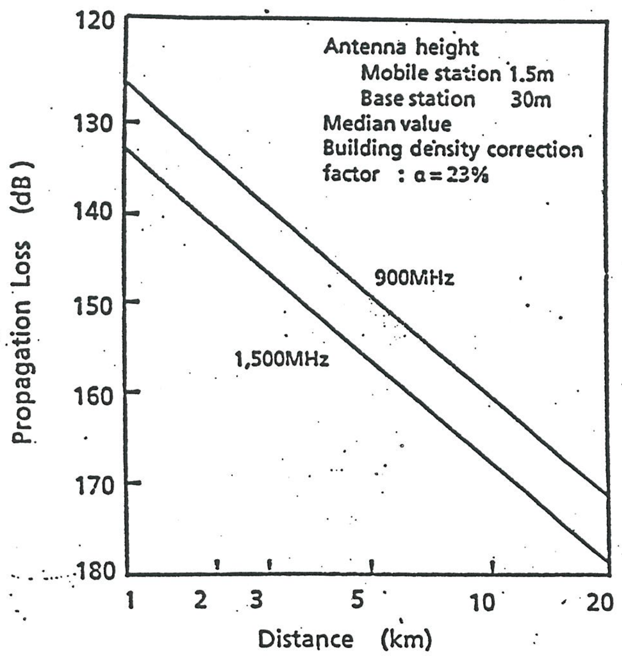
FREQUENCY DEPENDENCE

The frequency dependence of propagation is summarized in the following sections.

SPECIFIC EXPERIMENTAL RESULTS

(a) For mobile radio environments with 20 meter base station antenna heights, the median large scale attenuation in urban areas has been found to increase weakly with frequency between 100 MHz and 20 GHz. Some data indicates that the increase is about 4 dB between 100 MHz and 10 GHz.

(b) Other experiments showed a change of 6 dB between 900 MHz and 1.5 GHz for an antenna height of 30 m. This is illustrated in the Figure below.



Basic Propagation Loss Curve in Urban Areas

(c) Measurements at 940 MHz and 60 GHz at locations within buildings have been reported. They were not concurrent measurments and only qualitative comparisons can be made. Hoever, the signal levels were markedly lower at 60 GHz and coverage estimates for a 1 milliwatt transmitter were made. In a building with metal partition walls, estimated coverage at 940 MHz extended about two rooms from a base station location in a room (i.e. a distance of about 10 m). For a similar environment, estimated coverage at 60 GHz was only within the same room and the immediately adjacent hallway. In frame buildings with plasterboard walls, estimated 940 MHz coverage was about 30 meters. For similar buildings, 60 GHz coverage extended only to adjacent rooms.

TECHNIQUES TO IMPROVE SIGNAL RECEPTION

Several methods can be used to overcome the multipath problem such as:

(a) Adaptive channel equalization: Used to combat the frequency selectivity of a radio channel that exceeds coherence bandwidth.

(b) Space diversity: Two or more antennas are very effective in reducing the effects of Rayleigh fading. Two antennas separated by a few inches, i.e. a fraction of a wavelength at 900 MHz, would not likely be in a deep signal null simultaneously. This lack of correlation of signal levels for spatially separated antennas is the basis of space diversity used to mitigate small scale multipath signal variations.

(c) Frequency diversity: Use of wide-band radio channels offers a good protection while frequency hopping and spread spectrum direct sequence offer good frequency diversity and are effective against multipath. The latter technique can also be used to combine various multipaths to generate a stronger incoming signal. The impact on spectrum efficiency must be considered when using this technique.

(d) Polarization diversity: The improvement in link reliability obtainable from polarization diversity results from the fact that cross polarization coupling is near 0 dB over paths with no line-of-sight component. Other measurements show that signals received on orthagonal polarizations have low instantaneous correlations and may be used as inputs to any form of diversity combiner.

(e) Channel coding techniques (i.e. Reed-Solomon): These codes do not avoid multipath fades but correct the information bits that have been corrupted or lost during rapid fades. The more correction control one desires, the more overhead bits are needed with respect to information bits. Bit and packet interleaving can be considered another form of channel coding. The use of coding must be applied carefully, as it expands the necessary bandwidth.

The above techniques are designed to overcome the severe multipath environment experienced by present urban land mobile communication systems and characterized by Raleigh fading. Recent findings supported by measurements at 900 MHz indicate however that with a system concept in which base stations are located at street level and at every street corner, a Rician distribution with a strong direct propagation path is better suited to model the actual multipath environment than the more severe Rayleigh distribution.

Given that the path loss increases with frequency and the desire that FPLMTS should support low power portable communication units, it is reasonable to assume that there will be a trend towardssmaller cell diameters, leading to a Rician distribution of the radio signal envelope. With a strong direct ray, the problems associated with coherence bandwidth are eased.

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