A COMPARISON OF ISMA AND DECT-DCS CHANNEL ACCESS POLICIES FOR INDOOR WIRELESS COMMUNICATIONS SYSTEMS

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ABSTRACT

This letter considers two channel allocation schemes for the *indoor* environment: a mobile-controlled scheme representative of DECT's Dynamic Channel Selection (DCS), and basestation-controlled inhibit sense multiple access (ISMA). It is shown that the mobile-controlled scheme is subject to inferior performance in packet based voice transmission due to a higher degree of front end clipping which is introduced.

INTRODUCTION

This letter assesses channel access mechanisms for indoor 3G mobile communications systems offering packet based services. One such service in which the channel access mechanism will have a significant impact is Voice over Internet Protocol (VoIP).

At present most indoor coverage is provided by illumination from external macrocellular base stations. However, as the number of subscribers continues to grow this approach may not meet the required capacity since active users of all buildings within the beam-width of the BS antenna must share the limited channels on the basestation. A solution to this problem is the deployment of low power indoor picocellular basestations, to provide local coverage.

Operators have begun installation of GSM indoor base stations, and the DECT cordless technology has been established in Europe for many years. It is widely expected that cellular and cordless systems will merge in future wireless communications systems and that indoor base stations will be required to support a wider range of services than their exterior counterparts. The channel access policies employed in such systems must be able to accommodate the requirements of the services which they support.

ACCESS POLICIES

The DECT system operates a DCS (Dynamic Channel Selection) scheme whereby mobiles monitor the channel-set and transmit on a channel that they perceive to be unoccupied (based on measurements of interference). The channel selection is based on a Least Interfered Channel (LIC) algorithm which is designed to avoid the simultaneous use of a particular channel by more than one mobile. The operation of the LIC algorithm is satisfactory in a circuit switched environment, however this letter indicates that performance may not be satisfactory when supporting packet voice transmission.

Inhibit Sense Multiple Access (ISMA) has shown promise in the indoor environment due to its ability to resolve the hidden terminal problem which occurs when mobile controlled schemes erroneously perceive that a channel is unoccupied. In contrast to mobile controlled schemes, the basestation informs each mobile which channels are vacant, hence reducing the potential of collision.

A number of studies [1-3] have shown ISMA to provide high throughput values. However, its ability to carry voice traffic has not been fully examined.

APPROACH

Simulations have been conducted to compare the performance of the DCS and the ISMA schemes for voice traffic. The interior of a building was simulated, comprising of a number of rooms separated by internal walls. The Motley Indoor Propagation Model [4-6] was used to determine the signal power of the various mobiles at the basestation. The mobiles were uniformly distributed around the building, changing position periodically. A collision occurs if two or more mobiles attempt to transmit on the same channel. In this event one or more packets may be lost; depending on whether one mobile was able to *capture* the channel.

To enable proper comparison between the two techniques, the GSM speech frame length (20 ms) and frame structure (8 X 577μs) was common to both techniques. Call traffic was generated via a poisson process (for equivalent circuit-switched traffic loads in erlangs). Throughout the duration of a call, voice activity is modelled by on-off periods of talkspurts and silences. During a talkspurt speech frames are produced with a constant arrival rate. Each speech frame is decomposed into speech packets and interleaved over a number of slots. The speech frame is interleaved over four slots as used in the GPRS system. In the evaluation of packet-speech systems two packet level metrics are commonly used; 95th percentile values for overall packet loss probability and packet loss probability at the beginning of talkspurts (packets lost from the first speech frame of a talkspurt constitute packet losses at the start of the talkspurt), shown in Figure 1. The metric values were extracted from the CDFs of various runs, averaged, and 95% confidence limits produced.

RESULTS

Figure 2 shows the average overall packet loss metric. It indicates similar performance of the two schemes, with ISMA providing superior performance below 20 erlangs, and DCS providing superior performance above this value.

When the packets are decomposed into separate groups: packets at start of talkspurts and packets elsewhere; a clearer picture of the relative performance of the two schemes emerges. The packets lost elsewhere dominate the overall packet loss metric due to their greater numbers relative to packets lost at the start of talkspurts. Figure 3 shows the relative performance of the two schemes considering packets lost elsewhere and is remarkably similar to those of Figure 2 for both schemes. Figure 4 shows the packet loss metric for packets lost at the start of a talkspurt, the ISMA scheme provides vastly superior performance compared to the DCS scheme.

Packets lost at the start of a talkspurt have a greater impact on perceived speech quality than those lost elsewhere. This is due to the inability to interpolate missing packets at the start of a talkspurt from preceding packets.

CONCLUSION

This letter has examined two channel allocation schemes: mobile controlled (DCS scheme), and basestation controlled (ISMA scheme). It has been shown that the ISMA system provides superior speech quality than the DCS scheme. Whilst collisions that occur in circuit-switched operation of the DCS scheme are tolerable, the number of collisions becomes unacceptably high for packet access techniques. The high number of collisions is the result of repeated access attempts at the start of talkspurts.

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Figure Captions:

Fig. 1 Packet Decomposition

Fig. 2 Overall Packet Loss

ISMA
DCS

Fig. 3 Packet Loss Middle/End Talkspurt

ISMA
DCS

Fig. 4 Packet Loss Start Talkspurt

ISMA
DCS

Figure 1

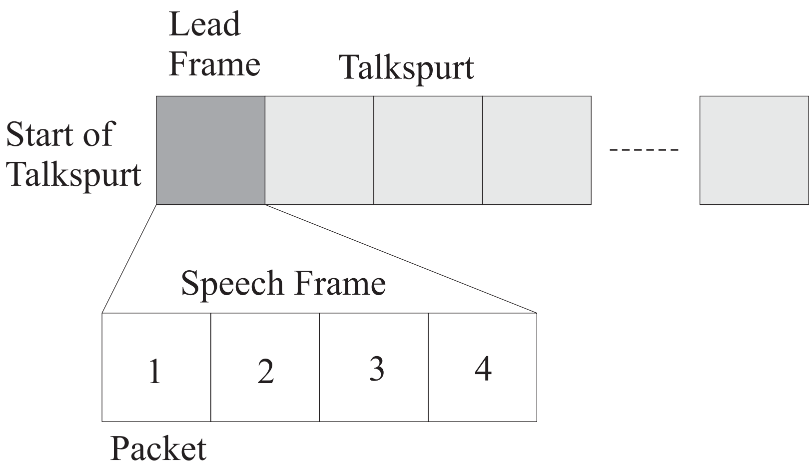

Figure 2

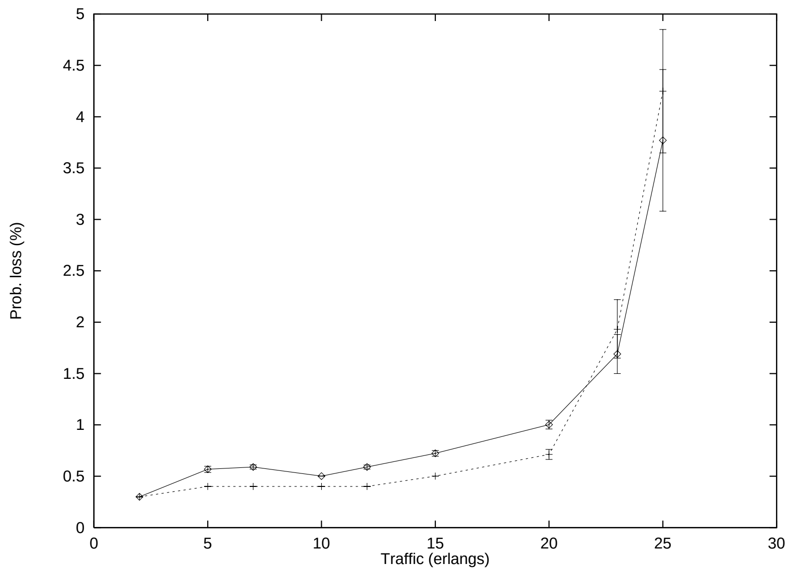

Figure 3

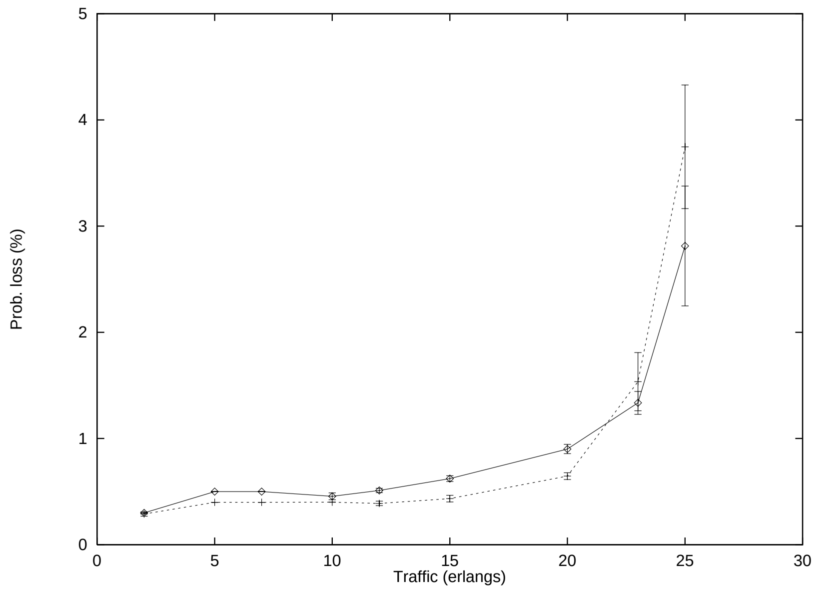

Figure 4